WOODWARD

Product Manual 26760
(Revision -, 01/2023)
Original Instructions

OH6 Service Manual
HMC

Installation and Operation Manual

General Precautions

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.

Practice all plant and safety instructions and precautions.

Failure to follow instructions can cause personal injury and/or property damage.

Revisions

This publication may have been revised or updated since this copy was produced. The latest version of most publications is available on the Woodward website.

www.woodward.com/publications

If your publication is not there, please contact your customer service representative to get the latest copy.

Proper Use

Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.

Translated Publications

If the cover of this publication states "Translation of the Original Instructions" please note:

The original source of this publication may have been updated since this translation was made. The latest version of most publications is available on the Woodward website.

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Always compare with the original for technical specifications and for proper and safe installation and operation procedures.

If your publication is not on the Woodward website, please contact your customer service representative to get the latest copy.

Revisions— A bold, black line alongside the text identifies changes in this publication since the last revision.

Manual 26760

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Important Definitions

This is the safety alert symbol used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

- **DANGER** - Indicates a hazardous situation, which if not avoided, will result in death or serious injury.
- **WARNING** - Indicates a hazardous situation, which if not avoided, could result in death or serious injury.
- **CAUTION** - Indicates a hazardous situation, which if not avoided, could result in minor or moderate injury.
- **NOTICE** - Indicates a hazard that could result in property damage only (including damage to the control).
- **IMPORTANT** - Designates an operating tip or maintenance suggestion.

WARNING

Lockout/Tagout LOTO

Ensure that personnel are fully trained on LOTO procedures prior to attempting to replace or service equipment on a "live" running engine. All safety protective systems (overspeed, over temperature, overpressure, etc.) must be in proper operational condition prior to the start or operation of a running engine. Personnel should be equipped with appropriate personal protective equipment to minimize the potential for injury due to release of hot hydraulic fluids, exposure to hot surfaces and/or moving parts, or any moving parts that may be activated and are located in the area of control of the unit.

WARNING

Overspeed / Overtemperature / Overpressure

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

WARNING

Personal Protective Equipment

The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:

- **Eye Protection**
- **Hearing Protection**
- **Hard Hat**
- **Gloves**
- **Safety Boots**
- **Respirator**

Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.

WARNING

Start-up

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

WARNING

Automotive Applications

On- and Off-highway Mobile Applications: Unless Woodward's control functions as the supervisory control, customer should install a system totally independent of the prime mover control system that monitors for supervisory control of engine (and takes appropriate action if supervisory control is lost) to protect against loss of engine control with possible personal injury, loss of life, or property damage.

WARNING

IOLOCK

IOLOCK: driving I/O into a known state condition. When a control fails to have all the conditions for normal operation, watchdog logic drives it into an IOLOCK condition where all output circuits and signals will default to their de-energized state as described below. ***The system MUST be applied such that IOLOCK and power OFF states will result in a SAFE condition of the controlled device.***

- **Microprocessor failures will send the module into an IOLOCK state.**
- **Discrete outputs / relay drivers will be non-active and de-energized.**
- **Analog and actuator outputs will be non-active and de-energized with zero voltage or zero current.**

Network connections like CAN stay active during IOLOCK. This is up to the application to drive actuators controlled over network into a safe state.

The IOLOCK state is asserted under various conditions, including:

- **Watchdog detected failures**
- **Microprocessor failure**
- **PowerUp and PowerDown conditions**
- **System reset and hardware/software initialization**
- **PC tool initiated**

NOTE—Additional watchdog details and any exceptions to these failure states are specified in the related section of the product manual.

NOTICE

Battery Charging Device

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.

Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:

- **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).**
- **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.**
- **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.**

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

Follow these precautions when working with or near the control.

1. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
2. Touch your finger to a grounded surface to discharge any potential before touching the control, smart valve, or valve driver, or installing cabling connectors. Alternatively, ESD mitigation may be used as well: ESD smocks, ankle or wrist straps and discharging to a reference grounds surface like chassis or earth are examples of ESD mitigation.
    - ESD build up can be substantial in some environments: the unit has been designed for immunity deemed to be satisfactory for most environments. ESD levels are extremely variable and, in some situations, may exceed the level of robustness designed into the control. Follow all ESD precautions when handling the unit or any electronics.
        - I/O pins within connectors have had ESD testing to a significant level of immunity to ESD, however do not touch these pins if it can be avoided.
            - Discharge yourself after picking up the cable harness before installing it as a precaution.
        - The unit is capable of not being damaged or improper operation when installed to a level of ESD immunity for most installation as described in the EMC specifications. Mitigation is needed beyond these specification levels.

IMPORTANT

External wiring connections for reverse-acting controls are identical to those for direct-acting controls.

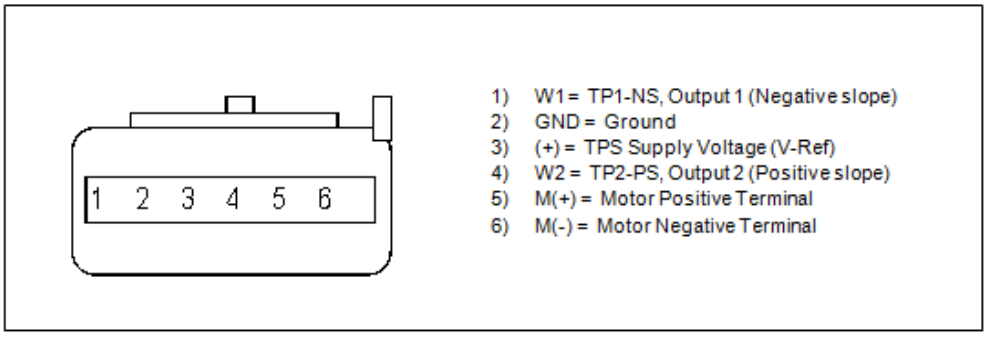
Chapter 1.
System Components / Subsystems

Throttle Component / Subsystem

The throttle controls the air flow into the engine. Throttle position is controlled by the ECM which sends a command current to the throttle..

The throttle is equipped with a redundant position sensor which sends two voltages back to the ECM indicating the current position of the throttle. The ECM uses the position feedback to adjust the throttle command, to detect any problems with the throttle operation and set faults to guarantee safe operation.

Electrical Pin Out



ECU		COMP
BM3	←--------→	1 - TPS1 Signal
CE4	←--------→	2 - Sensor Ground
CE3	←--------→	3 - Sensor Power (5VDC)
BL3	←--------→	4 - TPS2 Signal
CC2	←--------→	5 - Motor Power (24VDC)
CC3	←--------→	6 - Motor Ground

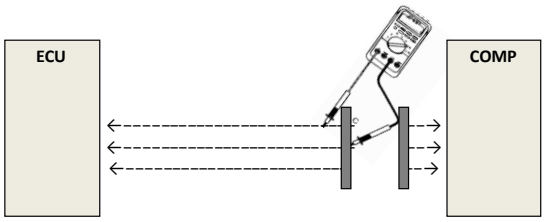
Service Instructions

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

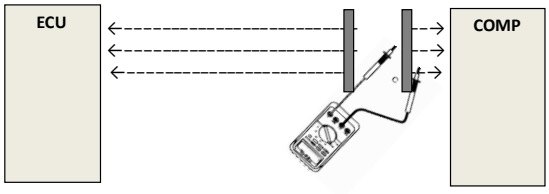
The following tasks should be performed during your visual check:

- Check the motor resistance (1.7 Ohms ± 10% @ 20 °C).
- Check physical wiring connections.
- Check plate for binding and spring return action both above and below null point.
- Check for proper null point positioning – approximately 80 above the closed stop position.

1. Check wire harness connections to ensure component is connected
    a. If the wire harness is unplugged or only partially seated
        i. Examine both sides of the connector pins for dirt or other contaminants. Gently remove contaminants and/or clean the contacts
        ii. Reconnect the Throttle connector
        iii. Clear the Trouble Code
        iv. Allow System to re-test the Component. If no Trouble Code is set, return vehicle to service
2. Check Wire Harness back to ECU (controller)
    a. Unplug the component
    b. Examine both sides of the connector pins for dirt or other contaminants. Gently remove contaminant and/or clean the contacts
    c. Using the method described in “Proper Use of Multimeter”, Check voltage readings across connector pins of the harness leading to the ECU according to Electrical Pin Out above.
        i. Pin 3 (Sensor Power) to Pin 2(Sensor Ground): 5+/-0.5VDC
        ii. Pin 1 (TPS1 Signal) to Pin 2 (Sensor Ground): 0+/-0.1VDC
        iii. Pin 4 (TPS2 Signal) to Pin 2 (Sensor Ground): 0+/-0.1VDC
        iv. Pin5 (Motor+) to Pin 6 (Motor-): 0+/-0.5VDC



3. Check the Throttle Body
    a. Using the method described in “Proper Use of Multimeter”, Check resistive readings across connector pins 5 (Motor+) and 6 (Motor-) of the harness leading to the Component according to Electrical Pin Out. Motor resistance: 1.7 Ohms ± 10% @ 20C. This will only work for the motor pins. The TPS sensors are non-contacting and so cannot be checked with a multimeter.



Electronic Throttle Body Cleaning Procedure

If checks or DTCs indicate that the throttle is sticking, the procedure below may be used to clean the throttle.

NOTICE

The electronic throttle body (ETB) and its associated parts are sensitive instruments; care should be exercised to avoid risk of damage to the ETB and its ancillary parts.

Avoid the entry of foreign matter into the manifold when the ETB is being removed and refitted.

Items required

- Clean work surface
- Good quality carburetor cleaner in spray form
- New gasket, if required
- Clean cloths (one for cleaning, the other to wipe dry) and a clean covering, either cloth or a plate, to place over the manifold
- Face masks, protective eye wear, and gloves

Procedure

NOTICE

No cleaning procedure should commence until engine diagnostics have been run and DTCs noted. If the codes are not on the list relevant to the procedure (see below), clear those codes first.

1. Be sure the vehicle has been switched off.
2. Locate and separate the ETB electrical connector.
3. Using the appropriate tools, carefully remove the ETB assembly.
4. When the ETB has been removed, cover the exposed manifold opening with a clean cloth or plate.
5. On a clean work surface remove the ETB contamination, using soft, clean cloth and, if necessary, a throttle body/injector cleaner.
    a. **DO NOT** apply the throttle body/injector cleaner in a confined space or near open flames. Read and comply with instructions for the cleaning solutions.
    b. **DO NOT** apply the throttle body/injector cleaner to the bearing and grease at the throttle shaft.
    c. **DO NOT** use petrol and/or alcohol.
    d. **DO NOT** use wire brushes, scourers, sand and emery paper or any other abrasive agents when removing the contamination.
6. Proper cleaning will result in a smooth aluminum surface of the bore and plate (flat face and edges).
7. Any pieces of contamination which do not readily dissolve should be re-sprayed with the cleaner and left for at least 5 minutes to dissolve. Again, removal of contamination should only be undertaken using soft cloths.
8. When satisfied that the ETB is free of contamination around the throttle plate and bore, indent the square boss on the housing sufficiently to leave a permanent mark. This can be used as a future indication that the ETB has been serviced.
9. When the ETB is clean; wipe the unit dry with a clean soft dry cloth.
10. Check the gasket and replace it if necessary.
11. Remove the cloth or plate from the manifold and, using the correct tools, refit the ETB.
12. Reconnect the ETB plug and socket. Recheck all other connections and fixings.
13. Ensure the vehicle is safe and can be operated without impairing safety to operator or vehicle.
14. Check that the vehicle is fully operational and that fault codes have been removed.

Diagnostic Trouble Codes (DTC)s Relevant to this Cleaning Procedure

DTC P0638 – Throttle Valve Stuck
DTC P0638 will be set if the throttle set point and position deviate by a calibrated amount (default 10%) for a duration that exceeds the calibrated delay time (default 1s). Also, the Throttle Spring Test Fault, TPS1 Adapt Low Min Fault, TPS1 Adapt Low Max Fault, TPS2 Adapt Low Min Fault, or TPS2 Adapt Low Max Fault could occur due to contamination or icing.

Codes observed other than those listed may indicate that the ETB is NOT contaminated.

Refer to the DTC section of this manual for any codes other than those listed. Other DTCs must be rectified and cleared before confirming a Throttle Valve Stuck fault.

Removal and Installation Instructions

After installation of the throttle allow the PCM/ECM to learn the settings of the throttle; turn on the key, wait 10 seconds, and then turn off the key and wait for communications with the diagnostics tool to cease.

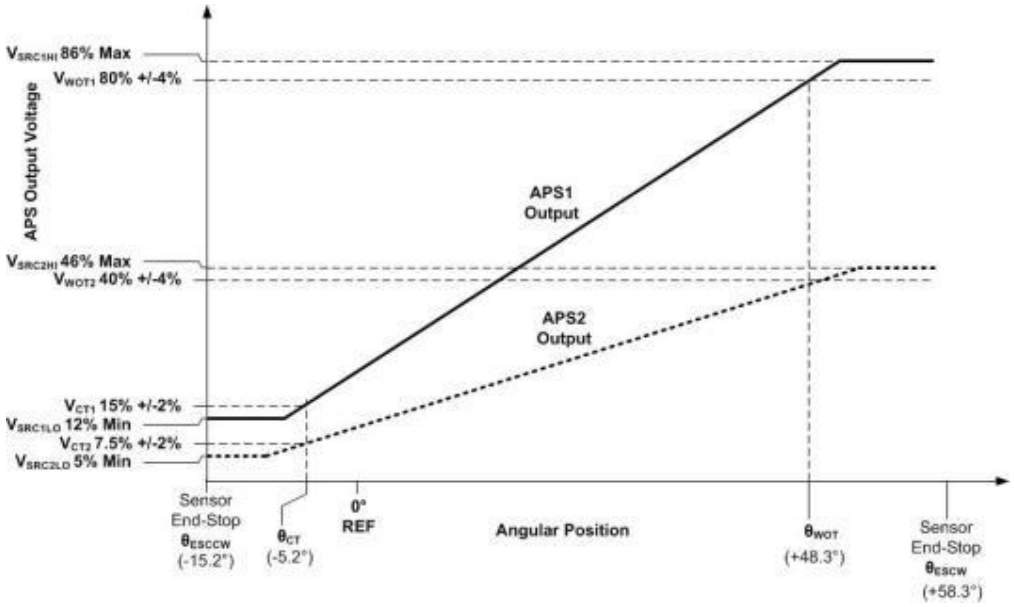
Pedal Component / Subsystem

The accelerator pedal assembly for the OH -6 system combines a ruggedized pedal mechanism with an environmentally hardened redundant position sensor. The sensor provides two voltages to the ECM OH which the ECM OH translates to pedal position. There is no mechanical linkage between the pedal and the engine.

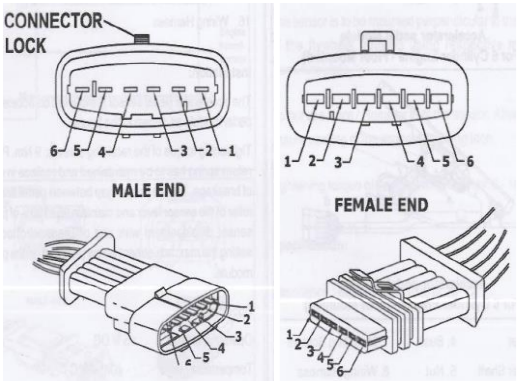
The redundant electronic position sensors permit detection of pedal or wiring harness faults in order to guarantee safe operation of the engine and vehicle.

Dual Linear Sensor

This configuration provides two analog voltages to the ECM OH which is proportional to pedal position. If the two voltages indicate grossly different pedal positions, the ECM OH will register a fault and employ suitable fault management logic to assure safe vehicle operation.



Note: The output range accounts for manufacturing tolerances and sensor/ pedal wear.



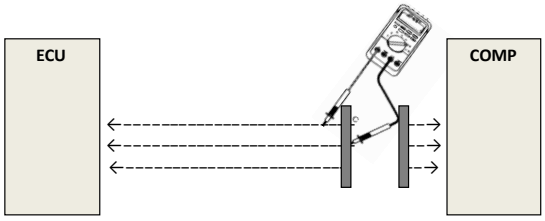
Electrical Pin Out

ECU		COMP
A-F3	←--------→	1 - APP1 Signal
A-H1	←--------→	2 - Power (5VDC)
A-H2	←--------→	3 - Ground
A-E4	←--------→	4 - APP2 Signal
A-H1	←--------→	5 - Power (5VDC)
A-H2	←--------→	6 - Ground

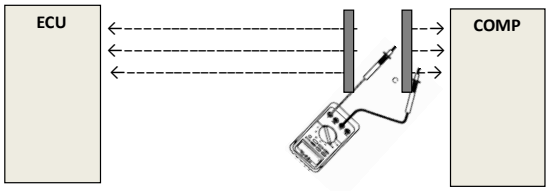
Service Instructions

1. Check wire harness connections to ensure component is connected
    a. If the wire harness is unplugged or only partially seated
        i. Examine both sides of the connector pins for dirt or other contaminants. Gently remove contaminants and/or clean the contacts
        ii. Reconnect the sensor
        iii. Clear the Trouble Code
        iv. Allow System to re-test the Component. If no Trouble Code is set, return vehicle to service
2. Check Wire Harness back to ECU (controller)
    a. Unplug the component

b. Examine both side of the connector pins for dirt or other contaminates. Gently remove contaminates and/or clean the contacts
c. Using the method described in “Proper Use of Multimeter”, Check voltage readings across connector pins of the harness leading to the ECU according to Electronic Pin Out above.
    i. Pin 1 (APP1) to Pin 3 (Ground) 0 +/-0.1VDC
    ii. Pin 4 (APP2) to Pin 6 (Ground) 0 +/-0.1VDC
    iii. Pin 2 (+5V) to Pin 3 (Ground) 5+/- 0.5VDC
    iv. Pin 5 (+5V) to Pin 6 (Ground) 5+/- 0.5VDC



3. Check the Sensor Resistance
    a. Using the method described in “Proper Use of Multimeter”, check resistive readings across connector pins of the harness leading to the Component according to Electronic Pin Out above.
        i. Pin 1 (APP1) to Pin 3 (ground) – per plot above for APS1
        ii. Pin 4 (APP2) to Pin 6 (ground) – per plot above for APS2



Removal and Installation Instructions

- Tightening torque: per vehicle OEM
- Operating temperature: -40 to 85 °C
- Supply voltage: +5V

Fuel Injection (FMV) Component / Subsystem

The Side Feed Gaseous (SFG) injector Fuel Metering Valve (FMV) is an assembly of fittings, injectors, and sensors that meters mass flow of natural gas fuel to engines. This product is designed to function in Compressed Natural Gas (CNG) vehicle fuel systems. For operation with CNG vehicles, the pressure regulator upstream of the SFG FMV maintains a constant delivery pressure to the FMV; typically, 7-10 bar absolute.

The SFG FMV operates in conjunction with an engine control module (ECM). The ECM monitors the required fuel delivery to the engine during operation and, by determining fuel density from the temperature and pressure values measured from the FMV sensor, delivers the appropriate pulse width to the SFG injectors. The SFG injectors provide a broad flow control range, allowing precise control of relatively low fuel mass to facilitate engine idle or relatively high flow rate to allow operation at rated engine power.

Table 1-1 shows various configurations of the fuel metering valve.

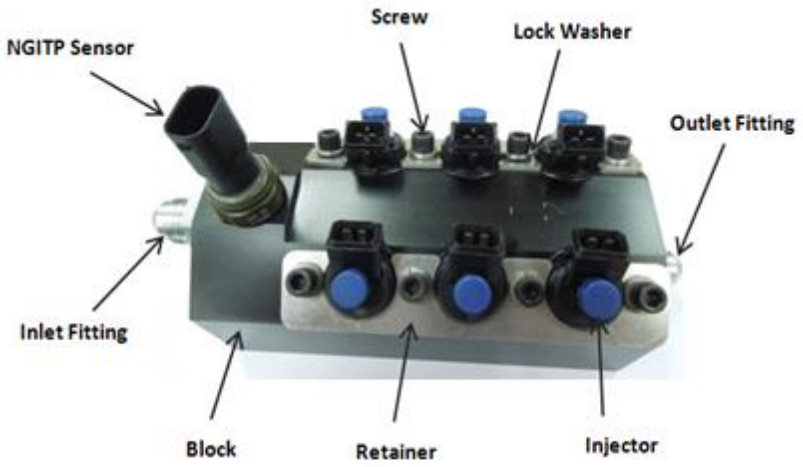


Table 1-1. Fuel Metering Valve Part Numbers

Description	Woodward PN	Notes
SFG Injector	1309-6188	SFG = Side Feed Gaseous injector
NGITP Sensor	1680-1067	NGITP = Natural Gas Injection Temperature and Pressure
3-inj. FMV	8235-094	3 injectors (2 – 1 "V" configuration)
4-inj FMV	8235-095	4 injectors (2 – 2 "V" configuration)
5-inj FMV	8235-096	5 injectors (3 – 2 "V" configuration)
6-inj FMV	8235-097	6 injectors (3 – 3 "V" configuration)
8-inj FMV	8235-098	8 injectors (4 – 4 "V" configuration)
10-inj FMV	8235-033	10 injectors (5 – 5 "V" configuration)

SFG Injector Operation

The SFG injector is a solenoid operated, fixed-lift valve. When sufficient voltage is applied across the terminals of the injector, electrical current flows through an internal coil wire winding that creates a magnetic force. The magnetic force pulls open the armature of the injector, which then allows fuel to flow through the throat. When electrical voltage is removed, the spring inside the injector pushes the armature to the closed position, and a rubber seal prevents the fuel from leaking past the injector.

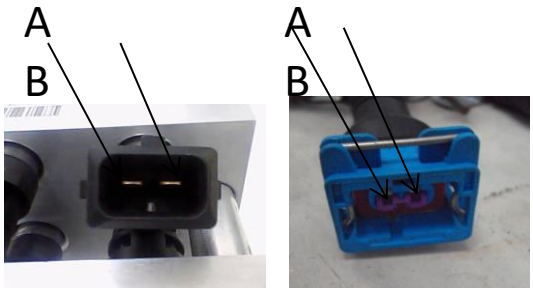
The injector is designed to use a peak-and-hold electrical controller (usually built into the Engine Control Module). A peak-and-hold controller applies a regulated voltage to the injector to provide sufficient electrical current to open the injector, then while the injector is flowing in the open position, the current is reduced to prevent overheating and damage to the coil.

NGITP Sensor Operation

The Natural Gas Injection Temperature and Pressure (NGITP) sensor has two measurement functions integrated into a single unit. The pressure sensor portion features an electronic circuit that converts pressure at the sensor port to an analog voltage output. The relationship between pressure and voltage is the characteristic curve of the pressure sensor and allows the engine control module algorithm to convert the signal to the correct pressure value.

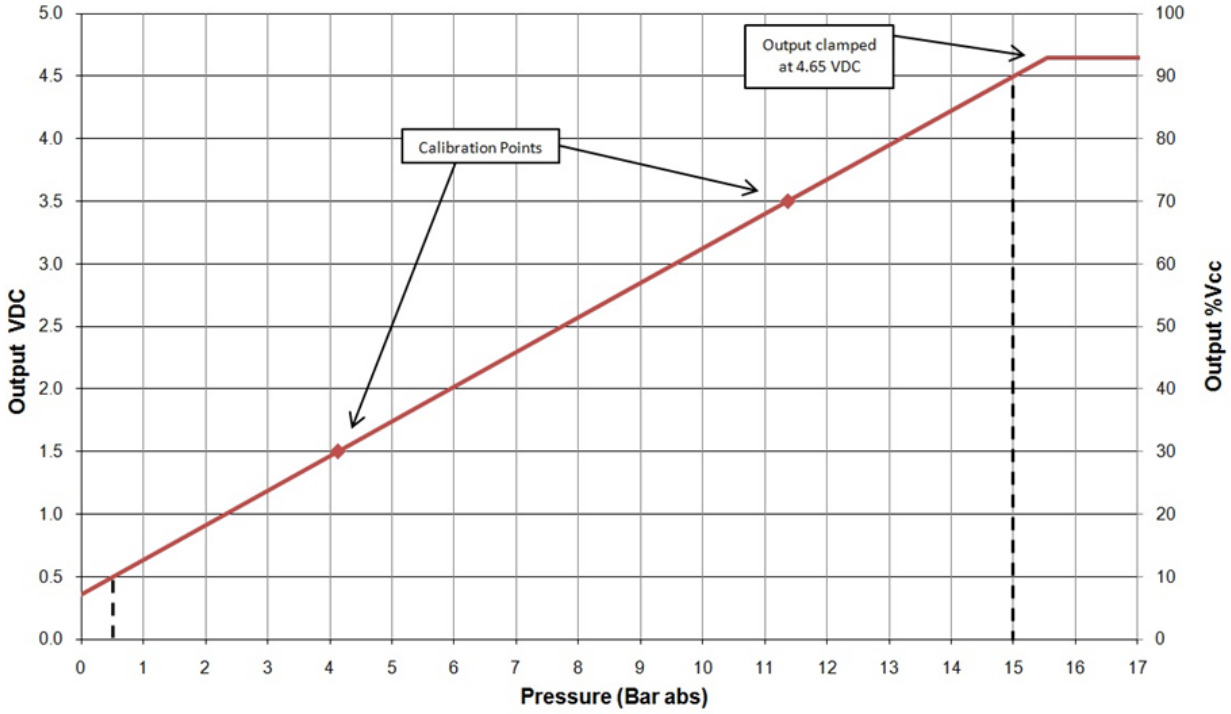
The temperature sensor integrated into the NGITP sensor is a Negative Temperature Coefficient (NTC) thermistor. The thermistor has a known characteristic resistance curve versus temperature. The engine control module reads the change in resistance via an internal voltage divider circuit, such that the final voltage signal is converted to a temperature value in the engine control algorithm.

SFG Connector



NGITP Connector

NGITP Pressure Transfer Function



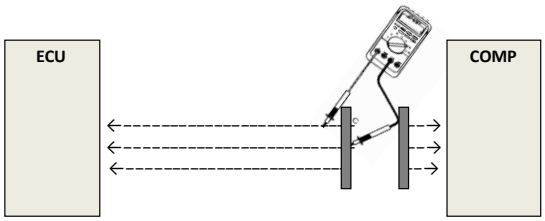
Electrical Pin Out

ECU		COMP
Injector 1		Injector 1
CH4	←--------→	1
BL1	←--------→	2
Injector 2		Injector 2
CH3	←--------→	1
BL1	←--------→	2
Injector 3		Injector 3
CH2	←--------→	1
BL1	←--------→	2
Injector 4		Injector 4
CH1	←--------→	1
BL1	←--------→	2
Injector 5		Injector 5
CG4	←--------→	1
BL1	←--------→	2
Injector 6		Injector 6
CG1	←--------→	1
BL1	←--------→	2
NGITP		NGITP
CE4	←--------→	1 - Ground
CB3	←--------→	2 - NGT Signal
CB2	←--------→	3 - NGP Signal
CE3	←--------→	4 - Power (5VDC)

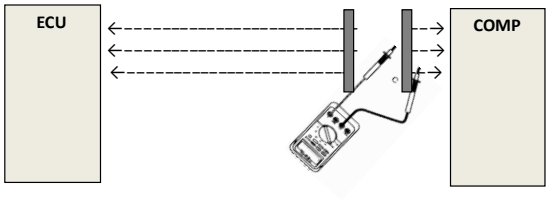
Service Instructions

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

1. Check wire harness connections to ensure component is connected
    a. If the wire harness is unplugged or only partially seated
        i. Examine both sides of the connector pins for dirt or other contaminants. Gently remove contaminants and/or clean the contacts
        ii. Reconnect the sensor
        iii. Clear the Trouble Code
        iv. Allow System to re-test the Component. If no Trouble Code is set, return vehicle to service
2) Check Wire Harness back to ECU (controller)
    a. Unplug the component
    b. Examine both side of the connector pins for dirt or other contaminates. Gently remove contaminates and/or clean the contacts
    c. Using the method described in “Proper Use of Multimeter”, Check voltage readings across connector pins of the harness leading to the ECU according to Electronic Pin Out above.
        i. NGITP - Pin 2 (NGT signal) to Pin 1 (Ground): 5+/-0.5VDC
        ii. NGITP Pin 3 (NGP signal) to Pin 1 (Ground): 0+/-0.1VDC
        iii. NGITP Pin 4 (5VDC) to Pin 1 (Ground): 5 +/-0.5VDC



3) Check the Temperature Sensor
    a. Using the method described in “Proper Use of Multimeter”, check resistive readings across connector pins of the harness leading to the Component according to Electronic Pin Out above.
        i. NGITP – Pin 2 (NGT signal) to Pin 1 (Ground): 9900 to 10100 Ω @ 25 °C.



4. Check resistances of all injectors: (4.2 ± 0.5) Ω @ 20 °C

Fuel Fittings

Anytime a fuel fitting is removed from the SFG FMV block, the fitting O-rings should be lightly lubricated with light oil or synthetic grease before reinstallation.

Injector Cleaning

Many CNG fueling distribution systems utilize compressors that transfer some quantity of compressor oil into the fuel stream. This oil, if not 100% removed before vehicle filling, will propagate through the fuel system and gradually foul the SFG injectors. The fouling can reduce the flow rate of the injector and eventually a vehicle fault code or loss of power will result. It is a simple matter of cleaning the injectors with an approved solution to restore the SFG injectors to like-new performance. The maintenance interval for cleaning will depend upon the level of fuel contamination from the filling station, as well as quality of the coalescing filter and maintenance routine.

The following solutions are NOT allowed as cleaning solutions for the SFG:

- Any solution containing methanol
- Any acidic solution

Use of cleaning solution that is NOT allowed with the SFG may result in product failure, including damage to the internal seals which may result in permanent fuel leakage through the injector.

The following solutions are recommended cleaning solutions for the SFG:

- N-Heptane
- Stoddard solvent

When using an approved cleaning solution, do not expose the injectors to prolonged soak periods in the solutions. The cleaning process should briefly flush the injectors with an approved solution for a few minutes, and then the injectors should be purged with clean natural gas to remove any residual liquids. Long term exposure to cleaning solutions, even those in the recommended category, may damage the seals in the SFG injector.

The cleaning solution may be admitted to the FMV through the inlet fitting. The solution should be forced through the injectors with pressure as the injectors are cycled. The engine control system should feature a diagnostic mode that actuates the injectors when prompted by a diagnostic tool. In some markets there are dedicated natural gas injector cleaning hardware kits available to make the process quick and effective.

Removal and Installation Instructions

If replacement of the SFG injectors is required, the following procedure should be followed:

1. Move the vehicle to safe location to perform maintenance.
2. Close the manual fuel shut-off valve(s) at the fuel tank.
3. Do not rely on the HPLO solenoid valve to act as the positive fuel shutoff for performing fuel system maintenance. Always close the manual shut-off valve(s) at the vehicle fuel tanks. Refer to SFG Fuel Metering Valve Product Manual 26636
4. Start the vehicle and allow the engine to idle and consume the fuel trapped in the fuel lines until the engine stalls. Turn the ignition switch to the off position.
5. Disconnect the negative cable from the battery.
6. Clean as much debris from the FMV as possible before removing from the vehicle. This will minimize the potential for contamination to enter the FMV during the injector replacement.
7. Unplug the connectors at the SFG injectors and NGITP sensor.
8. Using a backing wrench to support the fuel fittings in the FMV block, loosen the fuel line connections at the inlet and the outlet of the FMV.
9. Remove the fasteners that attach the FMV to the bracket.
10. Remove the FMV from the vehicle.
11. Clean any external surfaces of the FMV that could not be accessed in the vehicle.
12. Loosen the socket head screws that secure the injector retainers.
13. Remove the retainer from the FMV block.
14. While applying a back-and-fort rotation, gently pull the injectors from the FMV block – do not use pliers or extraction tools if the injector(s) are to be reused.
15. Remove the NGITP sensor from the block by gently loosening it with a wrench.
16. Thoroughly clean the FMV block and retainer plates with a mild solvent, n-Heptane, or injector cleaner – take care that all debris is removed from the internal passages of the FMV block.
17. When the FMV block is thoroughly dry, apply caps to the inlet and outlet fittings.
18. Apply a thin coat of clean motor oil, or petrolatum to the new injector O-rings.
19. While applying a back-and-forth rotation, gently insert the injectors into the glands of the FMV block, fully seating them so that the flange is flush with the top of the block.
20. Install the retainer plates onto each side of the FMV, ensuring that the stamped “H” is facing upwards, and reinstall the socket head screws and lock washers.
21. Tighten the socket head screws to 10.8 Nm.
22. Ensure that the NGITP sensor O-ring is clean, then apply a thin coat of clean motor oil or petrolatum to the O-ring.
23. Install the NGITP sensor into the FMV port and tighten to 7 Nm.
24. Install the FMV on the mounting bracket on the vehicle and tighten the fasteners to 20 Nm.
25. Connect the fuel hoses to the FMV finger-tight and using a backing wrench to support the fittings at the block, tighten the connections 1.5 hex flats for a tube connection, or 1.0 hex flats for a swivel-nut hose connection. 1 hex flat = 1/6th turn.
26. Connect the harness leads to the injectors and NGITP sensor.
27. Slowly open the tank shutoff valves.
28. Connect the negative cable to the battery terminal.
29. Turn the ignition switch to the on position but do not start the vehicle.
30. Check the FMV for external fuel leaks using a bubble solution – repair any leaks before starting vehicle.
31. Start vehicle and double check for leaks before departing the service station.

UEGO Sensor Component / Subsystem

UEGO stands for Universal Exhaust Gas Oxygen (also referred to as Wide Band Lambda sensors). UEGO sensors are designed to measure the portion of oxygen that is in an exhaust gas flow. This measurement is used to infer an air/fuel ratio at the time of combustion, ignition timing corrections, and the proportions of pollutants entering the catalytic converter.

LSU4.9
Wide Band Lambda Sensor
Mating Connector Pinout

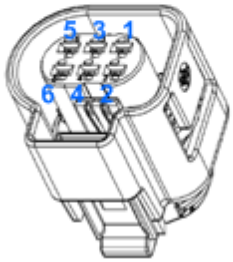


Table 1-2. UEGO Pinout

Description	Sensor Wire Color	Sensor Connector Pin	ECM-OH UEGO 1		ECM-OH UEGO2	
			Channel	Pin	Channel	Pin
Pumping Current	Red	1	UEGO1_IP	BE3	UEGO2_IP	BE1
Virtual Ground	Yellow	2	UEGO1_VM	BD4	UEGO2_VM	BF2
Heater-	White	3	UEGO1_Heater	CG3	UEGO2_Heater	CG2
Heater+ Vbatt	Grey	4	Vbatt	24V	Vbatt	24V
Trim Resistor	Green	5	UEGO1_IA	BE4	UEGO2_IA	BE2
Nernst Voltage	Black	6	UEGO1_UN	BD3	UEGO2_UN	BF1

Electrical Pin Out

ECU		COMP
BE1	←--------→	1 IP
BF2	←--------→	2 VM
CG2	←--------→	3 Heater
Battery	←--------→	4 Heater 24V
BE2	←--------→	5 IA
BF1	←--------→	6 UN

Service Instructions

The ECU performs active checks of the sensor depending upon the type of system. The OH6 OBD system performs the most advanced checks including:

- Heater open
- Heater short
- Heater temperature lower than expected
- Heater temperature higher than expected
- Heater temperature control failure
- Sensor internal faults
- Air calibration failure
- Air calibration at upper limit
- Air calibration at lower limit

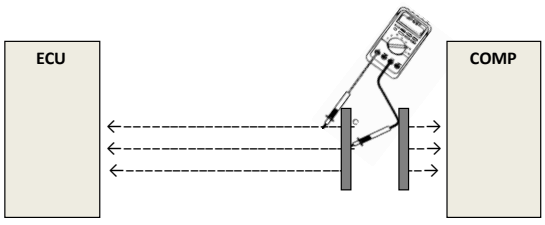
The above problems may be caused by wiring harness problems and not sensor problems. Therefore, it is important to check that the wiring harness between ECU and the connector of the sensor. There are no serviceable parts in the sensor. If any part of the sensor is damaged, the whole sensor must be replaced. If any of the wiring between the sensor and the connector is damaged, the sensor must be replaced. The wire insulation is designed for high temperature environments and heat shrink or electrical tape will fail since they are not designed for high temperatures. Under no circumstances should the sensor connector be replaced as its internal trim resistor is matched to the sensor.

If the heater in the sensor was damaged, the sensor will not reach the correct temperature for the sensor to function. If heater failure is suspected, check the resistance of the sensor by using an ohmmeter across pins 3 and 4. If the ohmmeter shows that the circuit is open, the heater is defective and the entire sensor must be replaced. At room temperature (20-25°C), the resistance should measure 3.2±0.8 Ohms. If the sensor is still warm from operation, the resistance will measure higher. Wait until the sensor has fully cooled and re-check the resistance to see if it is within specification.

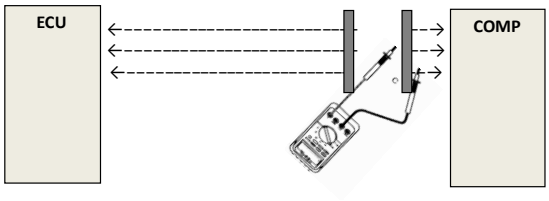
Visual/Physical Check

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

1. Check wire harness connections to ensure component is connected
    a. If the wire harness is unplugged or only partially seated
        i. Examine both sides of the connector pins for dirt or other contaminants. Gently remove contaminants and/or clean the contacts
        ii. Reconnect the sensor
        iii. Clear the Trouble Code
        iv. Allow System to re-test the Component. If no Trouble Code is set, return vehicle to service
2) Check Wire Harness back to ECU (controller)
    a. Unplug the component
    b. Examine both sides of the connector pins for dirt or other contaminates. Gently remove contaminates and/or clean the contacts
    c. Using the method described in “Proper Use of Multimeter,” check voltage readings across connector pins of the harness leading to the ECU according to Electrical Pin Out above.
        i. Pin 4 (Heater+) to Pin 3 (Heater -) VBatt (24V nominal)



3) Check the Sensor Heater Resistance
    a. Using the method described in “Proper Use of Multimeter”, Check resistive readings across connector pins of the harness leading to the Component according to Electrical Pin Out above.
        i. Pin 4 (Heater+) to Pin 3 (Heater): At room temperature (20-25°C), the resistance should measure 3.2±0.8 Ohms. If the sensor is still warm from operation, the resistance will measure higher.



Removal and Installation Instructions

1. Apply a high temperature anti-seize compound on the sensor threads before installing. The anti-seize compound must NOT contain silicone, which will damage the sensor element.
2. Tightening Torque: 40-60 Nm
3. Operating temperature: 350 to 850 °C exhaust temperature

Power Supplies Component / Subsystem

The power supplies consist of the 5V power supplies to the sensors and the 12V / 24V battery power supply to the actuators and ECU. If these voltages are too high or low it can affect the output from the sensors and cause damage to the sensors, actuators, and ECU.

Electrical Pin Out

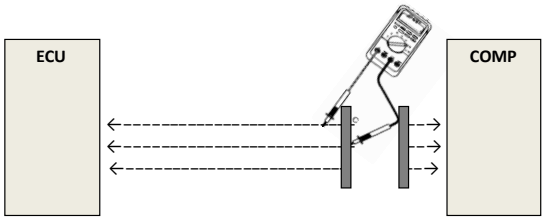
ECU		COMP
CE3	←--------→	XDRP_A - 5VDC
CE4	←--------→	XDRG_A - Grnd
AH1	←--------→	XDRP_B - 5VDC
AH2	←--------→	XDRG_B - Grnd
AH4	←--------→	Battery - 24VDC
AH3	←--------→	Key On - 24VDC
BL1	←--------→	DVRP1 - 24VDC
BM1	←--------→	DVRP2 - 24VDC

Service Instructions

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

1. Check wire harness connections to ensure component is connected
    a. If the wire harness is unplugged or only partially seated
        i. Examine both sides of the connector pins for dirt or other contaminants. Gently remove contaminants and/or clean the contacts
        ii. Reconnect the sensor
        iii. Clear the Trouble Code
        iv. Allow System to re-test the Component. If no Trouble Code is set, return vehicle to service

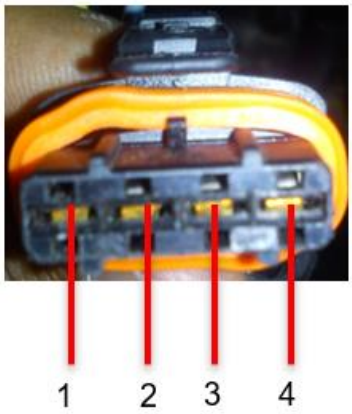
2. Measure the voltage at the ECU, see pin out for correct ECU pin to check
    a. Check all fuses – blown fuses should be replaced. If they blow again, examine circuit for shorts to ground, shorts to other circuits or damaged components which would cause excessive current draw. NEVER replace the fuse with one of a higher rating – this could lead to damage to components and ECM.
    b. Check all relays for proper operation. Test for welded contacts (always 'on') and failed operation (always 'off'). Replace as required.
    c. Examine both sides of the connector pins for dirt or other contaminates. Gently remove contaminates and/or clean the contacts
    d. Key on
    e. Measure the voltage between the following:
        i. XDRP_A and XDRG_A
            5VDC
        ii. XDRP_B and XDRG_B
            5VDC
        iii. Battery and Chassis Ground
            24VDC
        iv. Key On and Chassis Ground
            24VDC
        v. DRVP1 and Chassis Ground
            24VDC
        vi. DRVP2 and Chassis Ground
            24VDC
    f. Check for dead shorts between power pins and chassis ground. Resistance should never be less than 24V/fuse rating for that circuit.
    g. Measure resistance between XDRP1 (ECM pin CE3) and XDRG1 (ECM pin CE4). XDRP1 is a 5V voltage reference with a maximum current limit of 350 mA. Resistance should never be less than 15 ohms.
    h. Measure resistance between XDRP2 (ECM pin AH1) and XDRG2 (ECM pin AH2). XDRP2 is a 5V voltage reference with a maximum current limit of 100 mA. Resistance should never be less than 60 ohms.



Oil Temp / Pressure Sensor Component / Subsystem

The oil temperature and pressure sensors are used to measure the temperature and pressure of the engine oil. These are used to determine if the oil pressure or temperature are outside of the normal operating conditions and if any action needs to be taken to protect the engine.

The temperature sensor is a thermistor type device whose resistance varies inversely with temperature. The pressure sensor is an analog device output voltage directly related to pressure.

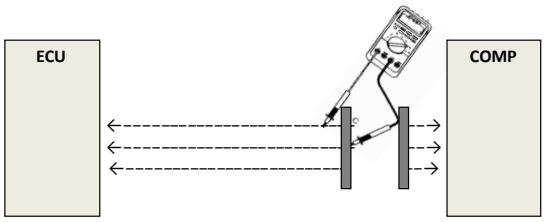


Electrical Pin Out

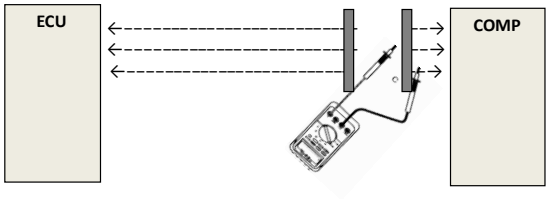
ECU		COMP
CE4	←--------→	1 XDRG1
BH1	←--------→	2 Oil Temperature
CE3	←--------→	3 +5V XDRP1
BJ1	←--------→	4 Oil Pressure

Service Instructions

1. Check wire harness connections to ensure component is connected
    a. If the wire harness is unplugged or only partially seated
        i. Examine both sides of the connector pins for dirt or other contaminants. Gently remove contaminants and/or clean the contacts
        ii. Reconnect the sensor
        iii. Clear the Trouble Code
        iv. Allow System to re-test the Component. If no Trouble Code is set, return vehicle to service
2. Check Wire Harness back to ECU (controller)
    a. Unplug the component
    b. Examine both sides of the connector pins for dirt or other contaminates. Gently remove contaminates and/or clean the contacts
    c. Using the method described in “Proper Use of Multimeter”, Check voltage readings across connector pins of the harness leading to the ECU according to Electronic Pin Out above.
        i. Pin 3 (XDRP1) to Pin 1 (XDRG1) 5+/-0.1VDC
        ii. Pin 4 (Oil Pressure) to Pin 1 (XDRG1) 5 +/-0.5VDC
        iii. Pin 2 (Oil Temperature) to Pin 1 (XDRG1) 5+/- 0.5VDC



3. Check the Sensor Resistance
    a. Using the method described in “Proper Use of Multimeter”, Check resistive readings across connector pins of the harness leading to the Component according to Electronic Pin Out above
        i. Pin 2 (Oil Temperature) to Pin 1 (XDRG1): 2.5kOhm +/-6% at 20ºC or per plot above for temperature

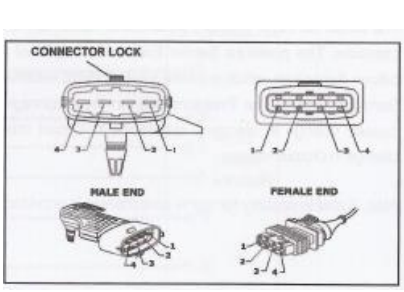


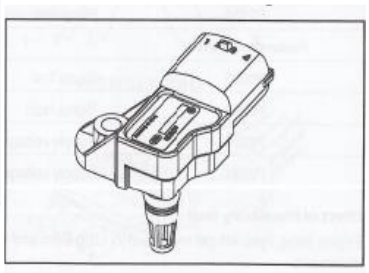
Removal and Installation Instructions

- Tightening Torque for screw: 3.3 Nm
- Specification:
    - Pressure Range: 50 to 1000 kpa
    - Temperature Range: -40 to 125 °C

Manifold Air Temperature / Pressure (TMAP) Sensor Component / Subsystem

The TMAP sensor measures the temperature and pressure of the air in the intake manifold. These values are used to calculate the density of the air which is then used to determine how much fuel to inject to achieve the desired air/fuel ratio. The sensors are also used to detect problems with the engine operation.
The TMAP sensor combines a Thermistor-type air temperture sensor with an analog air pressure sensor.



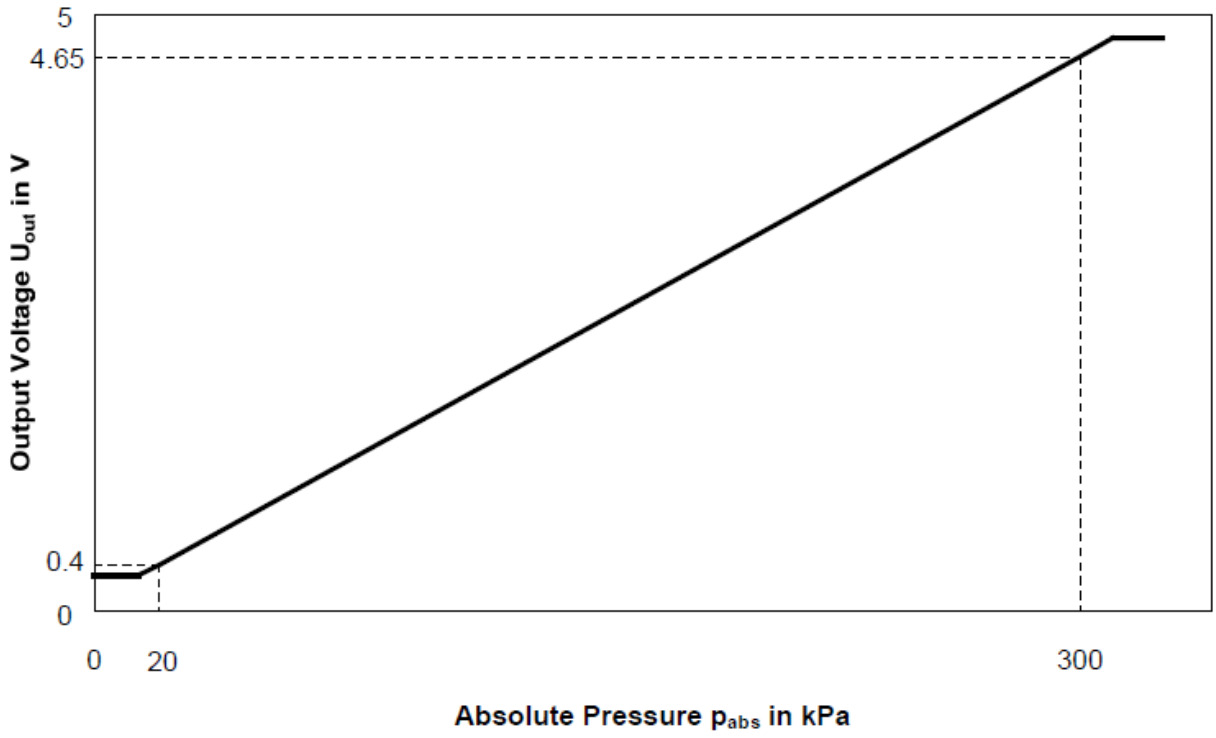


Electrical Pin Out

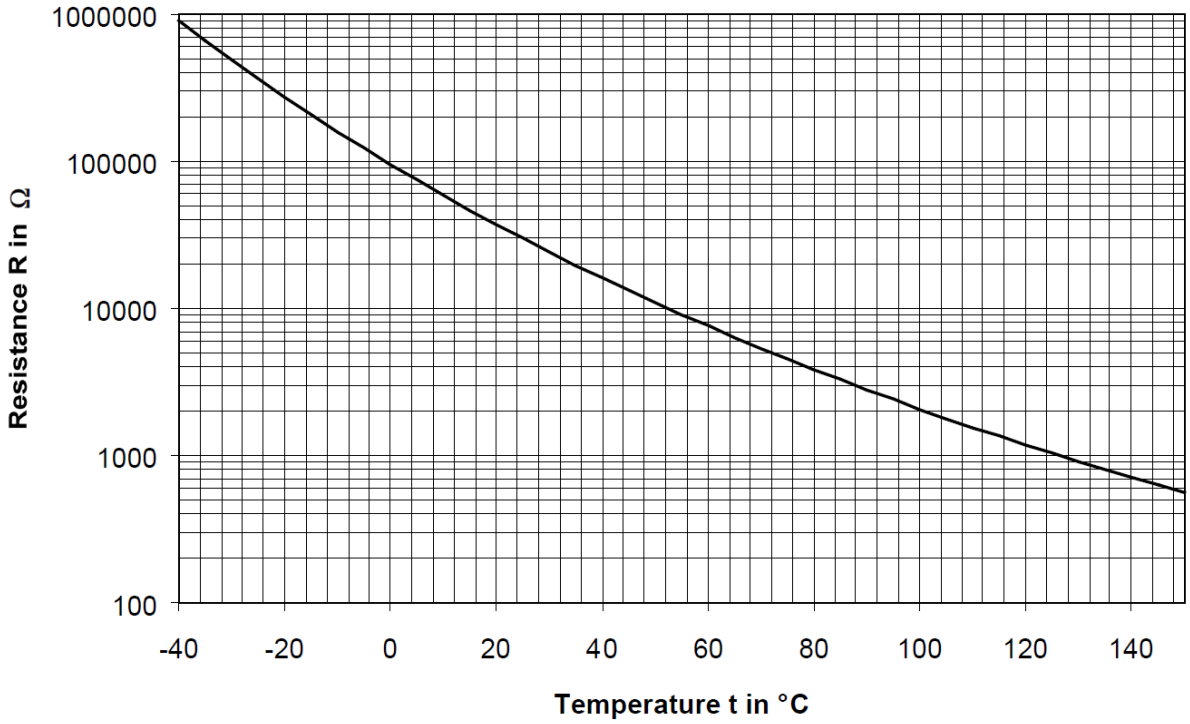
ECU		COMP
CE4	←——→	1 XDRG1
CD3	←——→	2 Air Temperature
CE3	←——→	3 +5V XDRP1
CA1	←——→	4 Air Pressure

Service Instructions

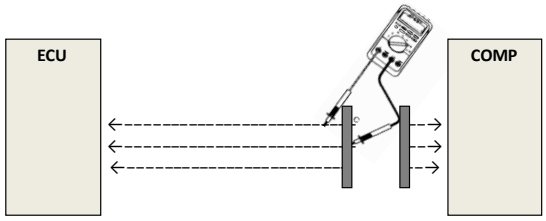
Pressure Sensor Characteristics: Voltage vs. Pressure



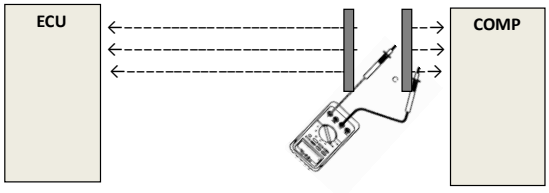
Temperature Sensor Characteristics: Resistance vs. Temperature:



1. Check wire harness connections to ensure component is connected
    a. If the wire harness is unplugged or only partially seated
        i. Examine both sides of the connector pins for dirt or other contaminants. Gently remove contaminants and/or clean the contacts
        ii. Reconnect the sensor
        iii. Clear the Trouble Code
        iv. Allow System to re-test the Component. If no Trouble Code is set, return vehicle to service
2. Check Wire Harness back to ECU (controller)
    a. Unplug the component
    b. Examine both sides of the connector pins for dirt or other contaminates. Gently remove contaminates and/or clean the contacts
    c. Using the method described in “Proper Use of Multimeter”, Check voltage readings across connector pins of the harness leading to the ECU according to Electronic Pin Out above.
        i. Pin 3 (XDRP1) to Pin 1 (XDRG1) 5+/-0.1VDC
        ii. Pin 4 (Air Pressure) to Pin 1 (XDRG1) 0 +/-0.5VDC
        iii. Pin 2 (Air Temperature) to Pin 1 (XDRG1) 5+/- 0.5VDC



3. Check the Sensor Resistance
    a. Using the method described in “Proper Use of Multimeter”, Check resistive readings across connector pins of the harness leading to the Component according to Electronic Pin Out above
        i. Pin 2 (Air Temperature) to Pin 1 (XDRG1): 30kOhm +/-6% at 25°C or per table above for temperature



Removal and Installation Instructions

- Tightening Torque : 3.3 Nm
- Specification:
    - Temperature Range : -40 to 130 °C

Actuator Outputs Component / Subsystem

The actuator outputs include dash lights/gauges, engine brake, alternator, starter, and lock off valve. These do not provide any information to the ECM, but the ECM is capable of detecting an open or short condition in the command wire that will trigger a fault.

These are simple on/off signals and there will be two wires to the actuator. One is battery power (with the key on) and the other is to the ECM.

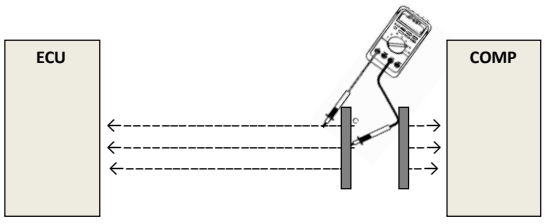
Electrical Pin Out

ECU		COMP
AA4	←--------→	Tachometer
AA3	←--------→	Overheat Lamp
AB4	←--------→	Fuel Gauge
AB1	←--------→	Low Fuel Lamp
AB3	←--------→	MIL
AB2	←--------→	RSG/Cruise/PTO Lamp
N/A	←--------→	Check Engine Lamp
N/A	←--------→	Engine Stopping Lamp
AG1	←--------→	Retarder Lamp
BK3	←--------→	Alternator
BK4	←--------→	Starter
CF3	←--------→	Lock off
CF1	←--------→	Engine Brake

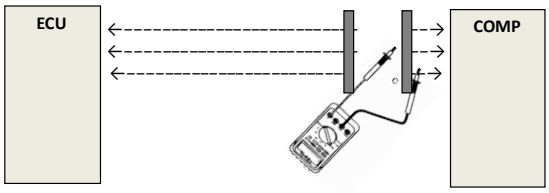
Service Instructions

1. Check wire harness connections to ensure component is connected
    a. If the wire harness is unplugged or only partially seated
        i. Examine both side of the connector pins for dirt or other contaminates. Gently remove contaminates and/or clean the contacts
        ii. Check the lamp for proper function, bulb may be burned out
        iii. Reconnect the sensor
        iv. Clear the Trouble Code
        v. Allow System to re-test the Component. If no Trouble Code is set, return vehicle to service

2. Check Wire Harness back to ECU (controller)
    a. Unplug the component
    b. Examine both side of the connector pins for dirt or other contaminates. Gently remove contaminates and/or clean the contacts
    c. Using the method described in “Proper Use of Multimeter”, check continuity between:
        i. The connector pin and the ECU connector pin
        ii. The connector pin and chassis ground
        iii. The connector pin and battery power



3. Check the sensor/actuator
    a. Using the method described in “Proper Use of Multimeter”, Check resistive readings across connector pins of the harness leading to the Component according to table.

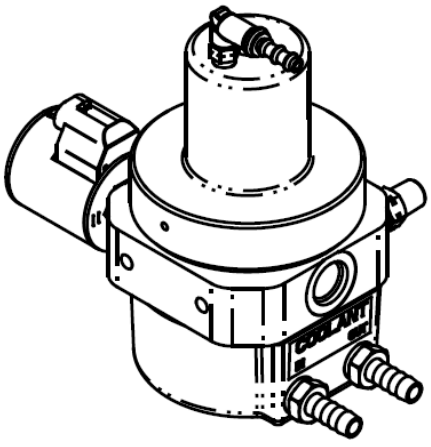


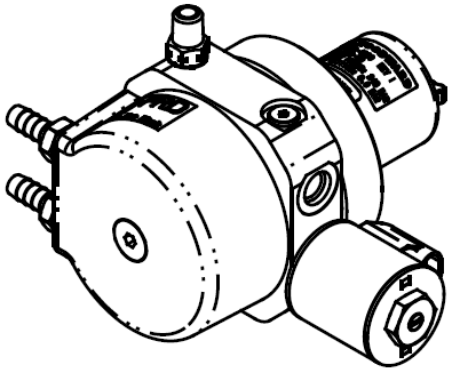
Fuel Pressure Regulator Component / Subsystem

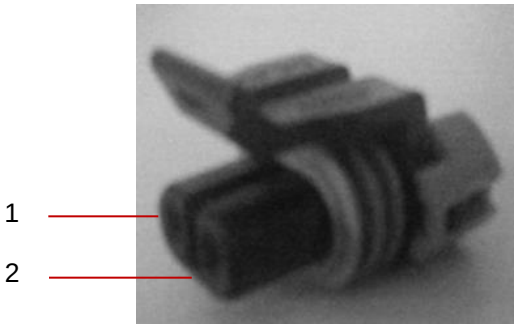
The compressed natural gas (CNG) pressure regulator with electric shut-off valve is a mechanical device that delivers fuel within a desired pressure window regardless of normal changes in inlet pressure and flow rate. This provides a reliable pressure source from which fuel delivery to the engine can be accurately controlled. It also integrates the ability to shut off the fuel supply to the downstream components, isolating them from the tank pressure when the vehicle is not in use or there is a fault action detected by the system requiring fuel shut-off.

CNG is stored in tanks on-board the vehicle at a tank pressure ranging from (17 to 248) bar gauge / (250 to 3600) psig. Given this tank pressure range and a flow demand of (0 to 76.0) kg/h / (0 to 167.6) lb/h, the regulator must maintain the outlet pressure within the 7 +/- 1.03 bar absolute. The pressure setting is non-adjustable, and is factory preset. If the pressure is not being controlled properly, the regulator should be replaced. If the plug that seals the top of the regulator is removed, the regulator will leak, and the regulator warranty will be voided.

The expansion of pressurized gas from the fuel tank as it passes through the pressure regulator causes extremely low fuel temperatures. Due to this effect, the regulator has the capability for the circulation of warm engine coolant. This prevents moisture within the gas from freezing inside the regulator, and it prevents material temperatures within the regulator from dropping below their rated temperature values. The high-pressure lock-off valve has been designed to open properly against the high forces induced by the CNG in the tank lines. The valve has a two-stage opening sequence: Stage 1 opens first when the differential pressure across the valve is high, allowing pressure to equalize across the main (Stage 2) valve. Stage 2 can then open once the pressure differential force reduces below the resulting magnetic opening force.







Electrical Pin Out

ECU		COMP
BL1	←--------→	1 DRVP1
CF3	←--------→	2 HPLO control

Service Instructions

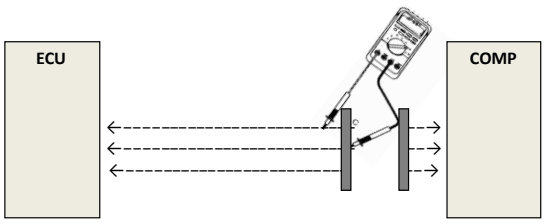
Visual/Physical Check
Check regulator, fuel lines, and coolant hoses for wear, damage, or leaks. Replace any damaged or leaking parts.

Check for proper coolant flow and check coolant passages for obstructions, flush as needed to clear.

Inspect fuel filter(s) and replace/clean as needed.

High Pressure Lockoff Solenoid

1. Check wire harness connections to ensure component is connected
    a. If the wire harness is unplugged or only partially seated
        i. Examine both sides of the connector pins for dirt or other contaminants. Gently remove contaminants and/or clean the contacts
        ii. Reconnect the sensor
        iii. Clear the Trouble Code
        iv. Allow System to re-test the Component. If no Trouble Code is set, return vehicle to service
2. Check Wire Harness back to ECU (controller)
    a. Unplug the component
    b. Examine both sides of the connector pins for dirt or other contaminates. Gently remove contaminates and/or clean the contacts
    c. Using the method described in “Proper Use of Multimeter”, Check voltage readings across connector pins of the harness leading to the ECU according to Electrical Pin Out above.
        i. Pin1 (DRVP1) to chassis ground: VBatt



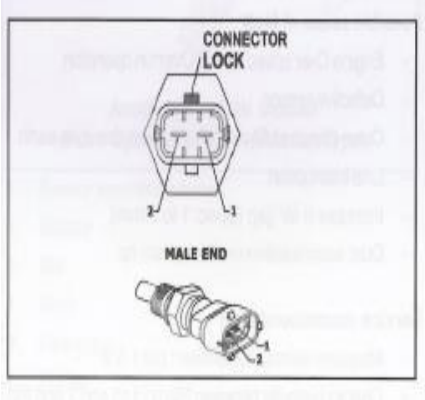
3. Check the actuator
    a. Using the method described in “Proper Use of Multimeter”, Check resistive readings across connector pins of the harness leading to the Component according to Electrical Pin Out above.
        i. Pin2 (HPLO control) to Pin1 (DRPV): 7.2 +/- 1 ohm at 25ºC. Resistance will be higher when solenoid is warm

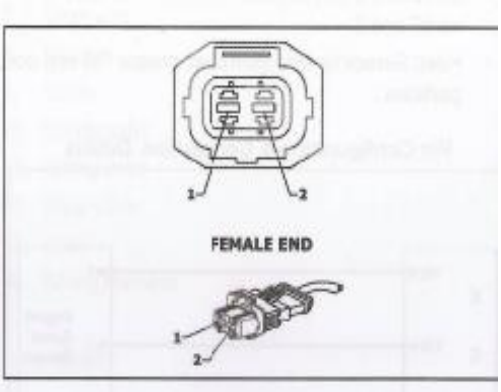
Removal and Installation Instructions

- Tightening Torque:
    - Inlet fuel fitting - 36.6 Nm
    - Outlet fuel fitting - 56.9 Nm
- Thread sealant (liquid or tape) is not required and is not recommended.

Engine Cooling System Component / Subsystem

The Engine Coolant Temperature (ECT) sensor measures the temperature of the engine coolant. ECT is used in calculating desired air-fuel ratio, spark advance, min governor setpoint. It is also used to determine when the engine is at normal operating temperature and to activate protection strategies in the event of overheating.





Electrical Pin Out

ECU		COMP
CE4	←--------→	1 XDRG1
CB4	←--------→	2 Sensor +

Service Instructions

Visual/Physical Check
Verify coolant fill level, add coolant as needed. Find and fix any coolant leaks.

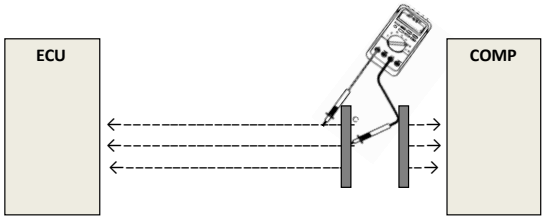
Verify proper operation of water pump and that coolant hoses are in good condition.

Thermostat
Remove thermostat and visually check if the thermostat is stuck open. Replace if needed.

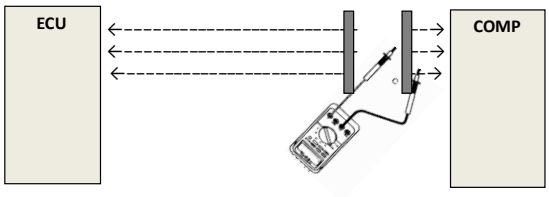
If thermostat is closed when cold place in a pot of water and heat until thermostat opens. Verify proper opening temperature and replace if not opening at correct temperature.

ECT Sensor

1. Check wire harness connections to ensure component is connected
    a. If the wire harness is unplugged or only partially seated
        i. Examine both side of the connector pins for dirt or other contaminates. Gently remove contaminates and/or clean the contacts
        ii. Reconnect the sensor
        iii. Clear the Trouble Code
        iv. Allow System to re-test the Component. If no Trouble Code is set, return vehicle to service
2. Check Wire Harness back to ECU (controller)
    a. Unplug the component
    b. Examine both side of the connector pins for dirt or other contaminates. Gently remove contaminates and/or clean the contacts
    c. *Using the method described in "Proper Use of Multimeter*", Check voltage readings across connector pins of the harness leading to the ECU according to table.



3. Check the sensor/actuator
    a. Using the method described in "Proper Use of Multimeter", Check resistive readings across connector pins of the harness leading to the Component according to table.



Removal and Installation Instructions

Sensor Tightening Torque : 20-24 Nm

Torque Request Component / Subsystem

These diagnostics detect a mismatch in the engine torque being requested from two different sources. If the brake pedal is pressed while another source (e.g., pedal) is requesting torque the other source will be ignored and the engine will go to idle.

Electrical Pin Out

ECU
None

COMP
None

Service Instructions

Visual/Physical Check
Check brake and accelerator pedal for any obstructions or interruptions in travel.

Check connectors and wiring for damaged or disconnection.

See Pedal and Switch Inputs subsections for more detailed information.

Barometer Pressure (Baro) Component / Subsystem

The Baro sensor measures the ambient barometric air pressure. This is then used in the fueling calculations and for diagnostics. Refer to engine OEM for additional technical information.

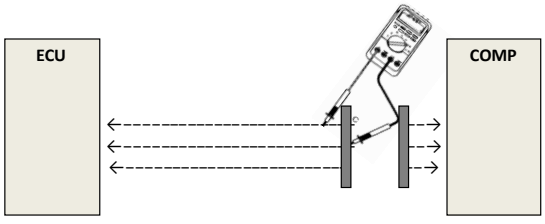
Electrical Pin Out

ECU		COMP
CE4	←--------→	1 - Ground
AN9	←--------→	2 - Signal
CE3	←--------→	3 - +5V Power

Service Instructions

Pressure Sensor Characteristics: Voltage vs. Pressure

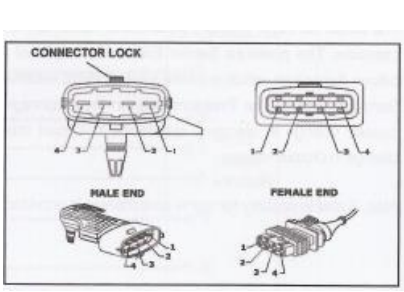
1. Check wire harness connections to ensure component is connected
    a. If the wire harness is unplugged or only partially seated
        i. Examine both sides of the connector pins for dirt or other contaminants. Gently remove contaminants and/or clean the contacts
        ii. Reconnect the sensor
        iii. Clear the Trouble Code
        iv. Allow System to re-test the Component. If no Trouble Code is set, return vehicle to service
2. Check Wire Harness back to ECU (controller)
    a. Unplug the component
    b. Examine both sides of the connector pins for dirt or other contaminates. Gently remove contaminates and/or clean the contacts
    c. Using the method described in “Proper Use of Multimeter”, Check voltage readings across connector pins of the harness leading to the ECU according to Electronic Pin Out above.
        i. Pin 3 (XDRP1) to Pin 1 (XDRG1) 5+/-0.1VDC
        ii. Pin 2 (Air Pressure) to Pin 1 (XDRG1) 0 +/-0.5VDC

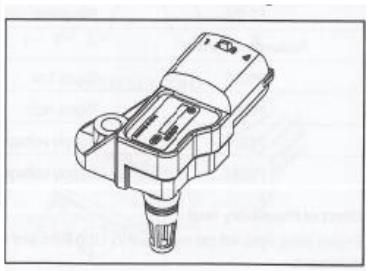


Boost Pressure Component / Subsystem

The pre-throttle pressure (PTP) sensor measures the air pressure in the intake before the throttle. The ECM uses this value for boost control and fueling calculations.

The PTP sensor provides an analog outlet voltage which increase with pre-throttle pressure.





Electrical Pin Out

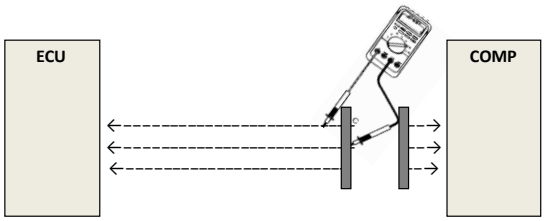
ECU		COMP
CE4	←--------→	1 - Ground
		2 - empty
AN9	←--------→	3 - +5V XDRP
CE3	←--------→	4 - PTP Signal

Service Instructions

Pressure Sensor Characteristics: Voltage vs. Pressure

Voltage(V)	Pressure(kPa)
0.001	1.172
0.500	32.500
4.500	284.000
4.600	290.327
4.700	296.614
5.000	315.476

1. Check wire harness connections to ensure component is connected
    a. If the wire harness is unplugged or only partially seated
        i. Examine both sides of the connector pins for dirt or other contaminants. Gently remove contaminants and/or clean the contacts
        ii. Reconnect the sensor
        iii. Clear the Trouble Code
        iv. Allow System to re-test the Component. If no Trouble Code is set, return vehicle to service
2. Check Wire Harness back to ECU (controller)
    a. Unplug the component
    b. Examine both sides of the connector pins for dirt or other contaminates. Gently remove contaminates and/or clean the contacts
    c. Using the method described in “Proper Use of Multimeter”, check voltage readings across connector pins of the harness leading to the ECU according to Electronic Pin Out above.
        i. Pin 3 (XDRP1) to Pin 1 (XDRG1) 5+/-0.1VDC
        ii. Pin 4 (Air Pressure) to Pin 1 (XDRG1) 0 +/-0.5VDC



3. Check the Sensor Resistance: There are no reliable sensor resistance values that can be used to diagnose a failed sensor.

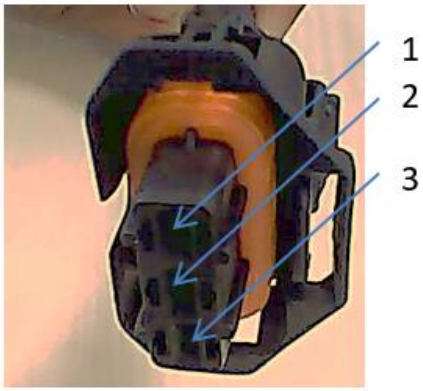
Removal and Installation Instructions

- Tightening Torque : 3.3 Nm
- Specification:
  - Temperature Range : -40 to 130 °C
  - Pressure Range: 32 to 315 kPa

Crank Sensor Component / Subsystem

The Variable Reluctance (VR) Crank Sensor has a permanent magnet inside which projects a magnetic field from the sensor tip. When ferrous material (e.g., target wheel) passes through and disrupts this magnetic field, a voltage (a sine wave) is generated.

This sensor is used to measure the engine crankshaft speed and position which are used by the ECU to determine the engine RPM and when to fire the spark plugs and injectors. It is also used for misfire diagnostics.

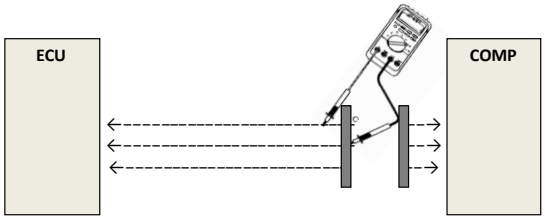


Electrical Pin Out

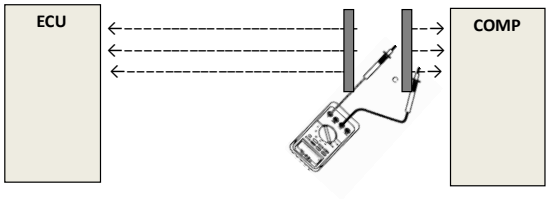
ECU		COMP
BF4	←--------→	1 VR+
BF3	←--------→	2 VR-
		3 Shield

Service Instructions

1. Check wire harness connections to ensure component is connected
    a. If the wire harness is unplugged or only partially seated
        i. Examine both sides of the connector pins for dirt or other contaminants. Gently remove contaminants and/or clean the contacts
        ii. Reconnect the sensor
        iii. Clear the Trouble Code
        iv. Allow System to re-test the Component. If no Trouble Code is set, return vehicle to service
2. Check Wire Harness back to ECU (controller)
    a. Unplug the component
    b. Examine both sides of the connector pins for dirt or other contaminates. Gently remove contaminates and/or clean the contacts
    c. Using the method described in “Proper Use of Multimeter,” check voltage readings across connector pins of the harness leading to the ECU according to Electronic Pin Out above.
        i. Pin 1 (VR+) to Pin 2 (VR-) 0 +/-0.1VDC



3. Check the Sensor Resistance
    a. Using the method described in “Proper Use of Multimeter”, Check resistive readings across connector pins of the harness leading to the Component according to Electronic Pin Out above
        i. Pin 1 (VR+) to Pin 2 (VR-) – Refer to Engine OEM for specification



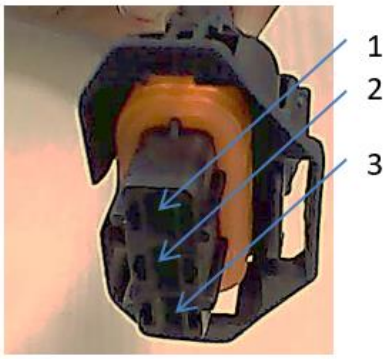
Removal and Installation Instructions

- Tightening Torque: 8 ± 2 Nm
- Air gap between sensor and trigger wheel is 0.3...1.8 mm

Cam Sensor Component / Subsystem

The Variable Reluctance (VR) Crank Sensor has a permanent magnet inside which projects a magnetic field from the sensor tip. When ferrous material (e.g., target wheel) passes through and disrupts this magnetic field, a voltage (a sine wave) is generated.

This sensor is used to measure the engine position which is used by the ECU to determine when to fire the spark plugs and injectors.

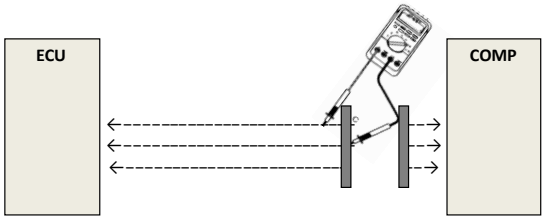


Electrical Pin Out

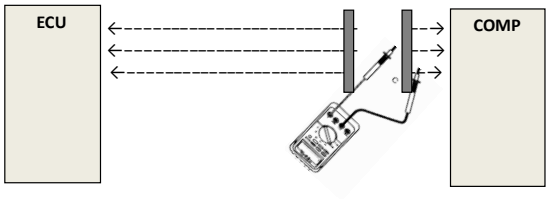
ECU		COMP
BH3	←--------→	1 VR+
BH4	←--------→	2 VR-
		3 Shield

Service Instructions

1. Check wire harness connections to ensure component is connected
    a. If the wire harness is unplugged or only partially seated
        i. Examine both sides of the connector pins for dirt or other contaminants. Gently remove contaminants and/or clean the contacts
        ii. Reconnect the sensor
        iii. Clear the Trouble Code
        iv. Allow System to re-test the Component. If no Trouble Code is set, return vehicle to service
2. Check Wire Harness back to ECU (controller)
    a. Unplug the component
    b. Examine both sides of the connector pins for dirt or other contaminates. Gently remove contaminates and/or clean the contacts
    c. Using the method described in “Proper Use of Multimeter”, Check voltage readings across connector pins of the harness leading to the ECU according to Electronic Pin Out above.
        i. Pin 1 (VR+) to Pin 2 (VR-) 0 +/-0.1VDC



3. Check the Sensor Resistance
    a. Using the method described in “Proper Use of Multimeter,” check resistive readings across connector pins of the harness leading to the Component according to Electronic Pin Out above
        i. Pin 1 (VR+) to Pin 2 (VR-) – Refer to Engine OEM for specification



Removal and Installation Instructions

- Tightening Torque: 8 ± 0.5 Nm
- Air gap between sensor and trigger wheel is 0.2...1.8 mm

Engine Speed Component / Subsystem

The OH6 system controls the engine idle speed and maximum speed. When this control is not able to be maintained within the acceptable limits, faults will be set, and action taken to protect the engine.

Electrical Pin Out

ECU
None

COMP
None

Service Instructions

Visual/Physical Check
Check throttle for any damage or obstructions, replace if needed.

Check Crank/CAM signal in scope, if any noise is observed, refer to crank or cam sensor sections.

Monitor the idle speed. If it is unstable or too high/low find and fix the cause.

Test vehicle and try to repeat overspeed condition. If able to repeat identify cause of overspeed condition and fix.

Vehicle Speed Component / Subsystem

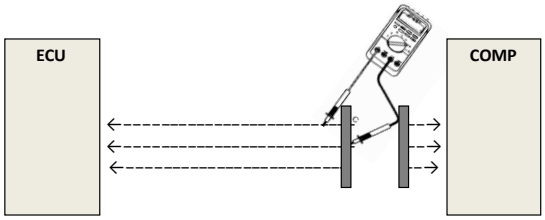
The vehicle speed sensor is used to measure the vehicle speed and to limit the maximum vehicle speed. It is a frequency sensor input. It is a frequency signal input

Electrical Pin Out

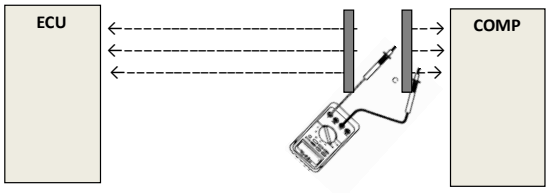
ECU		COMP
AD3	←--------→	1 - Signal

Service Instructions

1. Check wire harness connections to ensure component is connected
    a. If the wire harness is unplugged or only partially seated
        i. Examine both sides of the connector pins for dirt or other contaminants. Gently remove contaminants and/or clean the contacts
        ii. Reconnect the sensor
        iii. Clear the Trouble Code
        iv. Allow System to re-test the Component. If no Trouble Code is set, return vehicle to service
2. Check Wire Harness back to ECU (controller)
    a. Unplug the component
    b. Examine both side of the connector pins for dirt or other contaminates. Gently remove contaminates and/or clean the contacts
    c. Using the method described in “Proper Use of Multimeter”, check voltage readings across connector pins of the harness leading to the ECU according to Electronic Pin Out above.
        i. Pin 1 (APP1) to Pin 3 (Ground) 0 +/-0.1VDC
        ii. Pin 4 (APP2) to Pin 6 (Ground) 0 +/-0.1VDC
        iii. Pin 2 (+5V) to Pin 3 (Ground) 5+/- 0.5VDC
        iv. Pin 5 (+5V) to Pin 6 (Ground) 5+/- 0.5VDC



3. Check the Sensor Resistance
    a. Using the method described in “Proper Use of Multimeter”, check resistive readings across connector pins of the harness leading to the Component according to Electronic Pin Out above
        i. Pin 1 (APP1) to Pin 3 (ground) – per plot above for APS1
        ii. Pin 4 (APP2) to Pin 6 (ground) – per plot above for APS2



Engine Fan Component / Subsystem

The engine fan is used to pull air through the radiator to cool the engine coolant. . Depending on OEM's configuration, there are On/Off type Fan and close loop control Fan.

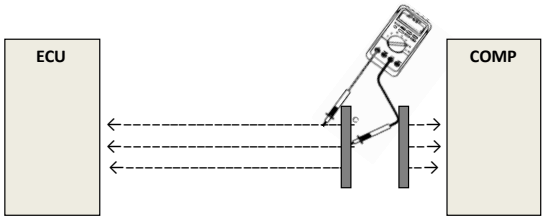
Electrical Pin Out

ECU		COMP
Fan 1		Fan 1
AA2	←--------→	1 - Command
Keyswitch	←--------→	2 - Power
Fan 2		Fan 2
N/A	←--------→	1 - Command
N/A	←--------→	2 - Power
Sensor		Sensor
N/A	←--------→	1 - Signal

Service Instructions

1. Check wire harness connections to ensure component is connected
    a. If the wire harness is unplugged or only partially seated
        i. Examine both side of the connector pins for dirt or other contaminates. Gently remove contaminates and/or clean the contacts
        ii. Check the actuator with override command
        iii. Reconnect the actuator
        iv. Clear the Trouble Code
        v. Allow System to re-test the Component. If no Trouble Code is set, return vehicle to service

2. Check Wire Harness back to ECU (controller)
    a. Unplug the component
    b. Examine both side of the connector pins for dirt or other contaminates. Gently remove contaminates and/or clean the contacts
    c. Using the method described in "Proper Use of Multimeter", check continuity between:
        i. The connector pin and the ECU connector pin
        ii. The connector pin and chassis ground for short
        iii. The connector pin and battery power for open



3. Check the sensor/actuator
    a. Check Fan Coil resistance according to OEM manual
    b. Check Speed sensor feedback reading with a scope.

Switch Inputs Component / Subsystem

The switch inputs include the clutch, brake, neutral, starter, cruise control, PTOPTO, parking brake, brake2, Retarder, Remote PTO, and Door Lock switches. These switches provide driver inpouts to the ECU so that it can command the correct outputs to the acuators to make the vehicle do what the driver is commanding.

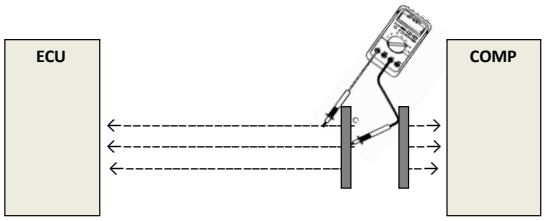
All the switches, except the starter switch, connect the ECU input pin lised below to the sensor ground pin, AH2. The starter switch connects the ECU pin shown below to 24V power from Keyswitch.

Electrical Pin Out

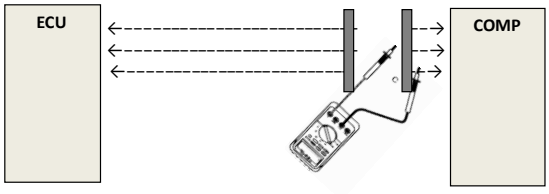
ECU		COMP
AF2	←--------→	Clutch
AE2	←--------→	Neutral
AN24	←--------→	Starter
BH2	←--------→	Cruise
AG2	←--------→	PTO/AC
N/A	←--------→	Parking Brake
AF4	←--------→	Brake
AG1	←--------→	Brake 2
AE1	←--------→	Door Lock
AF1	←--------→	Remote PTO
N/A	←--------→	Retarder
CD2	←--------→	Exhaust Brake

Service Instructions

1. Check wire harness connections to ensure component is connected
    a. If the wire harness is unplugged or only partially seated
        i. Examine both side of the connector pins for dirt or other contaminates. Gently remove contaminates and/or clean the contacts
        ii. Reconnect the sensor
        iii. Clear the Trouble Code
        iv. Allow System to re-test the Component. If no Trouble Code is set, return vehicle to service
2. Check Wire Harness back to ECU (controller)
    a. Unplug the component
    b. Examine both side of the connector pins for dirt or other contaminates. Gently remove contaminates and/or clean the contacts
    c. Using the method described in “Proper Use of Multimeter”, check voltage readings across connector pins of the harness leading to the ECU according to table.



3. Check the switch
    a. Using the method described in “Proper Use of Multimeter”, verify that the resistance changes to about 0 to open as the switch is activated.
    b. For Intermit switch, need to check whether switch tends to be stuck.



Exhaust Temperature Component / Subsystem

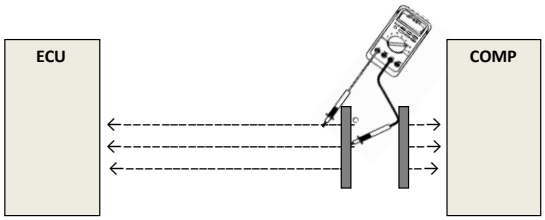
The exhaust temperature sensor provides the current exhaust temperature to the ECU. The ECU uses the exhaust temperature to verify proper operation of the oxidation catalyst, to maintain engine protection, and calculate EGR Cooler efficiency.

Electrical Pin Out

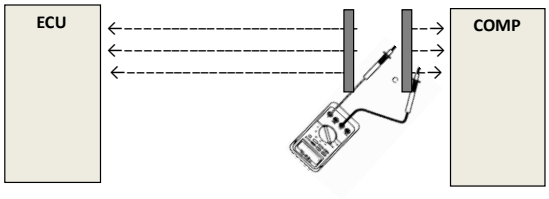
ECU		COMP
AG4	←--------→	1 - Signal
AH2	←--------→	2 - Ground

Service Instructions

1. For exhaust temperature high issue
    a. Check EGR failure or EGR close
    b. Check Air fuel Ratio
    c. Check Spark Timing (restart too much)
    d. Check misfire issue
    e. Check Intake Temperature (inner Cooler, EGR Cooler failure)
2. Check wire harness connections to ensure component is connected
    a. If the wire harness is unplugged or only partially seated
        i. Examine both sides of the connector pins for dirt or other contaminantsGently remove . contaminants and/or clean the contacts
        ii. Reconnect the sensor
        iii. Clear the Trouble Code
        iv. Allow System to re-test the Component. If no Trouble Code is set, return vehicle to service
3. Check Wire Harness back to ECU (controller)
    a. Unplug the component
    b. Examine both side of the connector pins for dirt or other contaminates. Gently remove contaminates and/or clean the contacts
    c. Using the method described in “Proper Use of Multimeter”, Check voltage readings across connector pins of the harness leading to the ECU according to Electronic Pin Out above.
        i. Pin 1 (APP1) to Pin 3 (Ground) 0 +/-0.1VDC
        ii. Pin 4 (APP2) to Pin 6 (Ground) 0 +/-0.1VDC
        iii. Pin 2 (+5V) to Pin 3 (Ground) 5+/- 0.5VDC
        iv. Pin 5 (+5V) to Pin 6 (Ground) 5+/- 0.5VDC



4. Check the Sensor Resistance
    a. Using the method described in “Proper Use of Multimeter”,check resistive readings across connector pins of the harness leading to the Component according to Electronic Pin Out above
        i. Pin 1 (APP1) to Pin 3 (ground) – per plot above for APS1
        ii. Pin 4 (APP2) to Pin 6 (ground) – per plot above for APS2



CAN Communication Component / Subsystem

The CAN comunications lines provide comumication between the multiple control modules on the vehicle. This allows each module to get information from the other modules.

A fault will be set when comunications are lost with a module or bad data is received. For these faults refer to the manual for the module that is causing the fault for service information.
A fault will also be set if all comunications with the CAN network ar lost.

Electrical Pin Out

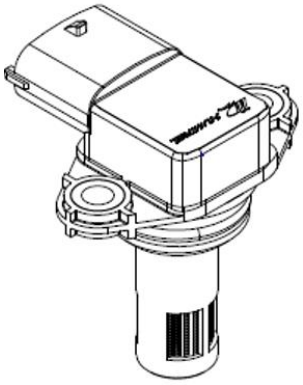
ECU		COMP
CAN 1		CAN 1
AD1	←-------→	1 - High
AD2	←-------→	2 - Low
CAN 2		CAN 2
AC1	←-------→	1 - High
AC2	←-------→	2 - Low
CAN 3		CAN 3
BC3	←-------→	1 - High
BC4	←-------→	2 - Low
CAN Shield		CAN Shield
AC3	←-------→	Shield wire

Service Instructions

- Check CAN resistance to make sure it is properly terminated.
- Check CAN connection if any CAN loss fault happens.
    - Based on source address, find which module has CAN communication issue.
    - Check CAN wiring for that module
    - Replace that module if needed, referring to OEM manual.

Humidity Sensor Component / Subsystem

The sensor measures relative humidity and temperature, which together with local pressure can be used to calculate specific humidity via psychrometric principles. The sensor is designed for on-engine, under hood mounting in automotive applications.



Electrical Pin Out

ECU		COMP
CE4	←--------→	1
CC4	←--------→	2
CE3	←--------→	3
CC1	←--------→	4

Service Instructions

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

- Check sensor for physical damage to the cover and connector. If damage found, replace sensor
- Check sensor wire harness connections to ensure all 4 pins are connected. If the wire harness is unplugged or only partially seated, check humidity reading and temperature reading in normal temperature. If not accurate, replace the sensor

Engine Control Module Component / Subsystem

The OH6 Engine Control Module (ECM-OH) is a 112-pin high performance controller that is capable of full engine management which includes control of injection, ignition and other engine and vehicle-level actuators based on various user and engine sensor inputs. The ECM contains no serviceable parts and is non-repairable.

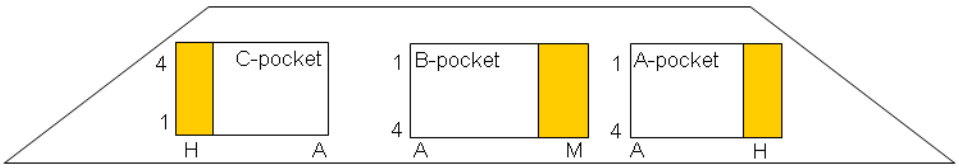


Table 1-3. Connector Pinout

A	Function	B	Function	C	Function
A1	LSO7	A1	SPK4	A1	AN05
A2	LS010	A2	SPK6	A2	AN06
A3	LSO8	A3	SPK1	A3	AN15
A4	TACH	A4	SPK3	A4	AN08
B1	LSO9	B1	SPK2	B1	AN09
B2	LSO11	B2	CAM_DG	B2	AN10
B3	LSO13	B3	CNK_DG	B3	AN11
B4	LSO12	B4	SPK5	B4	AN12
C1	CAN2H	C1	EGO2_RTN	C1	AN13
C2	CAN2L	C2	EGO1_RTN	C2	AN02
C3	CAN SHLD	C3	CAN3H	C3	AN01
C4	AN20	C4	CAN3L	C4	AN12
D1	CAN1H	D1	EGO2	D1	AN24
D2	CAN1L	D2	EGO1	D2	AN19
D3	DG3	D3	LSU1_UN	D3	AN14
D4	AN30	D4	LSU1_VM	D4	AN07
E1	AN29	E1	LSU2_IP	E1	AN33
E2	AN16/DG6	E2	LSU2_IA	E2	SW3
E3	AN22	E3	LSU1_IP	E3	XDRP1
E4	AN04	E4	LSU1_IA	E4	XDRG1
F1	AN18	F1	LSU2_UN	F1	LSO5
F2	AN25	F2	LSU2_VM	F2	LSO4
F3	AN03	F3	CNK_VR-	F3	LSO6
F4	AN17	F4	CNK_VR+	F4	LSO3
G1	SW2	G1	EK2-	G1	INJ6
G2	SW1	G2	EK2+	G2	LSO2
G3	DG8/BOOT	G3	EK1-	G3	LSO1
G4	AN21	G4	EK1+	G4	INJ5
H1	XDRP2	H1	AN27/DG5	H1	INJ4
H2	XDRG2	H2	AN26/DG4	H2	INJ3
H3	KEY	H3	CAM_VR-	H3	INJ2
H4	BATT	H4	CAM_VR+	H4	INJ1
		J1	AN32		
		J2	12VOUT		
		J3	AN31/DG7		
		J4	AN28		

Table 1-3. Connector Pinout (cont'd.)

A	Function	B	Function	C	Function
		K1	SPK8		
		K2	MPRD		
		K3	LSO14		
		K4	LSO15		
		L1	DRVP1		
		L2	H2+		
		L3	H1+		
		L4	PWRGND1		
		M1	DRVP2		
		M2	H2-		
		M3	H1-		
		M4	PWRGND2		

Electrical Pin Out

See Table 1-3.

Service Instructions

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

- Check ECM for physical damage to the housing, back cover, and connector
  - If damage found, replace ECM
- Check ECM wire harness connections to ensure all 3 harness plugs are connected
  - If the wire harness is unplugged or only partially seated
- Examine both sides of the connector pins for dirt or other contaminates
  - Gently remove contaminates and/or clean the contacts
- Examine the ECM for bent connector pins
  - Replace ECM if a bent pin is found
- Examine wire harness connector for a damaged terminal
  - Replace terminal if found
- Check the wiring harness for wear from rubbing on other components
  - Repair or replace harness if worn wire insulation is found
- Check system fuses
  - Replace any blown fuses
- Reconnect the ECM
- Clear the Trouble Code
- Start vehicle
- If no Trouble Code is set, return vehicle to service

Removal and Installation Instructions

ECM Replacement

If replacement of the ECM is required, the following procedure should be followed:

- Move the vehicle to safe location to perform maintenance.
- Disconnect battery negative cable
- Disconnect 3 harness connectors
- Remove 4 mounting bolts
- Remove ECM
- Replace with ECM with correct application software and calibration programmed
- Replace 4 mounting bolts and washers
- Tighten bolts
- Re-connect 3 harness connectors

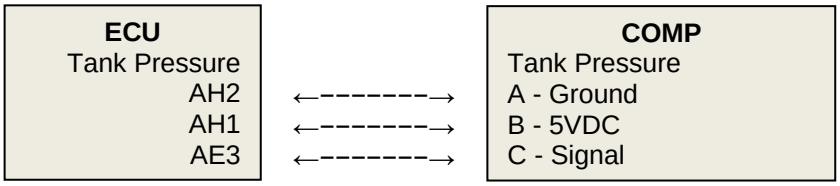
- Connect the negative cable to the battery terminal
- Start vehicle and check for trouble

Natural Gas Tank Component / Subsystem

The natural gas fuel tank is a high pressure vessel that contains the pressurized CNG. If any damage to the tank or fuel lines is detected the damaged component(s) need to be replaced immediately.

The natural gas tank pressure and temperature are monitored for fill level and to detect any potential leaks.

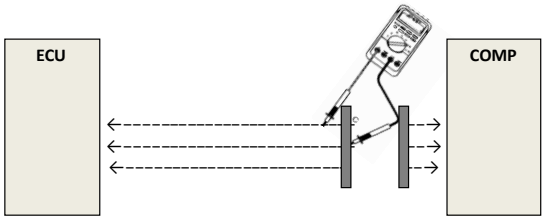
Electrical Pin Out



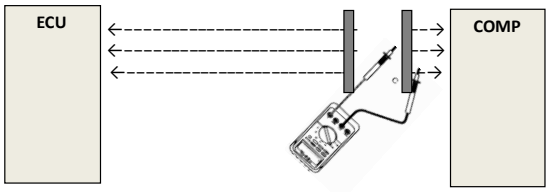
Service Instructions

Perform a visual inspection of the CNG tank and all fuel lines and fittings. If any damaged components are found replace them immediately before proceeding.
Check all fittings with a soap/water solution checking for leaks. Fix any problems found.

1. Check wire harness connections to ensure component is connected
    a. If the wire harness is unplugged or only partially seated
        i. Examine both side of the connector pins for dirt or other contaminates. Gently remove contaminates and/or clean the contacts
        ii. Reconnect the sensor
        iii. Clear the Trouble Code
        iv. Allow System to re-test the Component. If no Trouble Code is set, return vehicle to service
2. Check Wire Harness back to ECU (controller)
    a. Unplug the component
    b. Examine both side of the connector pins for dirt or other contaminates. Gently remove contaminates and/or clean the contacts
    c. Using the method described in “Proper Use of Multimeter”, Check voltage readings across connector pins of the harness leading to the ECU according to table.



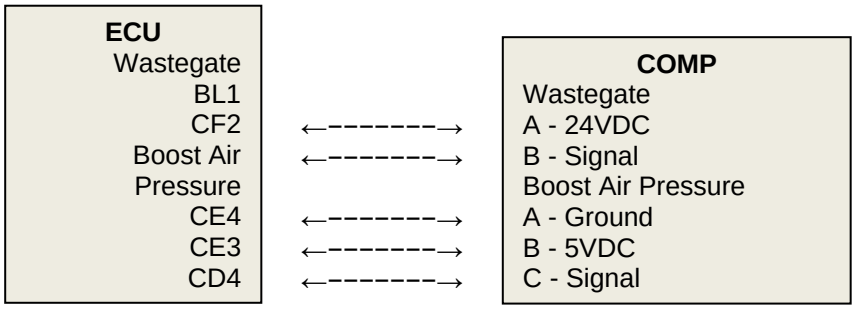
3. Check the sensor/actuator
    a. Using the method described in “Proper Use of Multimeter”, check resistive readings across connector pins of the harness leading to the Component according to table.



Boost Control Component / Subsystem

The boost control system monitors the boost pressure and operature the wastegate or blow off valve to control it. The boost air pressure regulator controls the pressure to the wastegate to control it function.

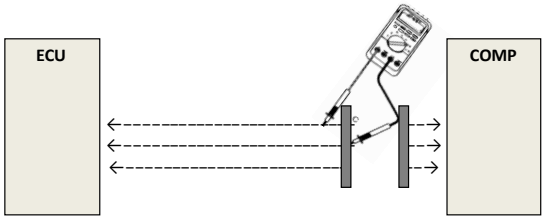
Electrical Pin Out



Service Instructions

Perform a visual inspection of the turbo, wastegate or blow off valve, air pressure regulator, sensors, hoses, and fittings. Fix any damaged components before proceeding.

1. Check all hose connection and leaking
2. Use WasteGate Diagnostics Mode to check wastegate's performance
    a. If wastegate doesn't respond, replace wastegate.
3. Start the engine to check Boost Air Pressure Reading see if regulator works fine.
4. Check wire harness connections to ensure component is connected
    a. If the wire harness is unplugged or only partially seated
        i. Examine both sides of the connector pins for dirt or other contaminates. Gently remove contaminates and/or clean the contacts
        ii. Reconnect the sensor
        iii. Clear the Trouble Code
        iv. Allow System to re-test the Component. If no Trouble Code is set, return vehicle to service
5. Check wire harness back to ECU (controller)
    a. Unplug the component
    b. Examine both sides of the connector pins for dirt or other contaminates. Gently remove contaminates and/or clean the contacts
    c. Using the method described in "Proper Use of Multimeter", check voltage readings across connector pins of the harness leading to the ECU according to table.



6. Check the sensor/actuator
    a. Check sensor reading with different regulator setting for accuracy.

Catalyst Component / Subsystem

The catalyst reduces the engine out emissions to meet the mandated emissions standards.

When a catalyst fails it typically is caused by too much heat that melts the ceramic substrate. This results in the substrate breaking up.

A catalyst's performance can also be degraded by poisoning and use to the point that it does not function well enough to pass emissions. This degradation may not cause any physical damage to the substrate. In either failure condition a fault will set to indicate the failure of the catalyst, unless the breakup of the substrate has blocked the exhaust to the point of restricting flow. This will cause a reduction in power.

Electrical Pin Out

None

Service Instructions

Remove the catalyst and perform a visual inspection. Check for damage to the ceramic substrate inside the catalyst. Look for any loose or broken off substrate. Using a flashlight verify that the honeycomb structure is intact and light can be see through the substrate.

If the fault has set indicating the catalyst is no longer functioning, check the related sensor for diagnostics (Temperature sensor, O2 sensor). If those sensors are in good conditions, replace the catalyst.

Before replacing the catalyst, check for and fix any causes of oil or coolant in the exhaust, misfire conditions, and rich or lean combustion. These conditions will damage the new catalyst and reduce its life.

Misfire Component / Subsystem

The misfire diagnostics detect misfire in a single cylinder or in multiple cylinders by detecting changes in the crankshaft speed after a firing event.

Electrical Pin Out

None

Service Instructions

Identify the cause of the misfire and correct the problem.
Possible causes of misfire include:

- Spark plugs
  - Check plug condition, replace if needed.
- Spark plug wires
- Ignition coils
  - Refer to ignition section to ensure ignition coils are in good condition.
- Uneven fueling
- Manifold Leaking
  - Check manifold reading to see if it is normal.
  - Check any leaking around intake manifold
- Air Fuel Ratio caused by injectors or UEGO sensor
  - For MPI engine, replace injector for misfire cylinder to see if problem is fixed.
  - Do a UEGO burn off to see if problem is fixed.
- Oil/Coolant in combustion cylinder

Knock Component / Subsystem

The knock sensor is used to detect if the engine is knocking and then the ECU can take action to stop the knock.

Electrical Pin Out

ECU		COMP
Knock1		Knock1
Knock+ BG4	←-------→	Pin 1 (no Polarity)
Knock- BG3	←-------→	Pin 2
Knock2		Knock 2
Knock+ BG2	←-------→	Pin 1 (no Polarity)
Knock- BG1	←-------→	Pin 2

Service Instructions

Identify the cause of the knock and correct the problem. Use fault info to identify whether it is knock sensor issue or engine knock issue. Identify which sensor has the issue or which cylinder has knock issue.

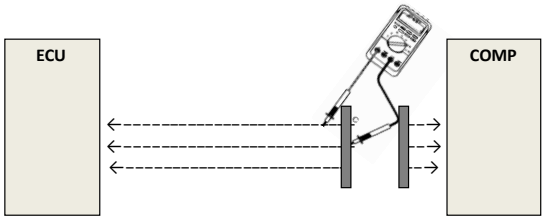
Possible causes of knock include:

- Poor fuel
- Spark plug heat range too high
- Timing too far advanced
- Hot spots in cylinder
- Check EGR control if EGR system is available
    - Lower EGR rate can cause engine knock for stoichiometric engine
- Check Spark and Spark wiring conditions if it is single cylinder knock.
- Check Intake Manifold Temperature Reading
    - Higher Intake Manifold Temperature (due to charge cooler or EGR cooler failure) can cause engine knock

Check knock sensors for damage and correct operation.

1. Check wire harness connections to ensure component is connected
    a. If the wire harness is unplugged or only partially seated
        i. Examine both side of the connector pins for dirt or other contaminates. Gently remove contaminates and/or clean the contacts
        ii. Reconnect the sensor
        iii. Clear the Trouble Code
        iv. Allow System to re-test the Component. If no Trouble Code is set, return vehicle to service
2. Check Wire Harness back to ECU (controller)
    a. Unplug the component
    b. Examine both side of the connector pins for dirt or other contaminates. Gently remove contaminates and/or clean the contacts

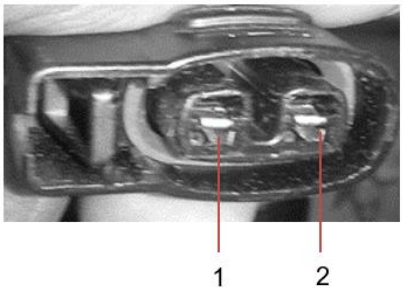
c. Using the method described in “Proper Use of Multimeter”, check voltage readings across connector pins of the harness leading to the ECU according to table.



3. Check the sensor/actuator
   a. Check sensor reading with key on and engine not running. Should have a voltage value between 0 V to 5 V (refer to OEM manual).
   b. Check Sensor Capacitance value according to OEM manual

Ignition Component / Subsystem

The ignition system provides the spark to ignite the fuel/air mixture in the cylinders. The timing and strength of the spark are determined by the ECU.



Electrical Pin Out

ECU		COMP
Coil 1		Coil 1
BA3	←--------→	1
Battery	←--------→	2
Coil 2		Coil 2
BB1	←--------→	1
Battery	←--------→	2
Coil 3		Coil 3
BA4	←--------→	1
Battery	←--------→	2
Coil 4		Coil 4
BA1	←--------→	1
Battery	←--------→	2
Coil 5		Coil 5
BB4	←--------→	1
Battery	←--------→	2
Coil 6		Coil 6
BA2	←--------→	1
Battery	←--------→	2

Service Instructions

Identify the cause of the ignition and correct the problem.

Possible steps of ignition check include:

- Check if any fault happens. Using the fault to point to the right ignition source.
- Check if Ignition wiring is loosen or disconnected
- Check if grounding is loosen or disconnected
- Check secondary lead or plug boot connection and conditions
- Check spark plugs (if gap is too large, should replace the plugs)
- If ignition problem only happens during high speed/load, check spark plugs and secondary lead/plug boot.
- Check fuse
- Check if ignition coil, spark plug are installed correctly
- Check Ignition Primary and Secondary resistance and capacitance.
- Replace Spark Plugs see if problem is gone.
- Run ignition diagnostics mode to see if ignition happens
    - If no ignition happens, replace ignition coil.
- Replace Ignition coil see if problem is gone.
- Replace the ECM-OH module see if problem is gone.

Removal and Installation Instructions

- Tightening torque: 40-60 Nm
- Operating temperature: -40 to 125 °C
- Supply voltage: +24 V

Chapter 2.
Diagnostic Modes

Introduction

The diagnostic modes provide the opportunity to isolate and test system components in order to troubleshoot any system issues. There are diagnostic modes for the ignition system, fuel injection system, throttle, wastegate control valve, exhaust brake, throttle clean, compression, and oxygen (UEGO sensor). There is also a special diagnostic mode for cleaning fuel injectors with fuel injector cleaner.

Spark & Injector Diagnostic Mode

The spark diagnostic mode allows an individual ignition coil or an individual injector to be enabled or disabled. The spark/injector diagnostic mode parameters are found in ToolKit on the “Diagnostic Modes – Spark, Injector” page. To enable the spark/injector diagnostic mode, the parameter Tune to 7 to Enable Spark Diagnostic Mode must be set to 7. To disable, set to 0. J1939 WWDM1 and UDS Routine control 0x205 can enable this Diagnostics Mode as well. This diagnostic mode will only function for the length Maximum Time (default 600 s). The diagnostic mode will also disable when the key is switched to the OFF position. The enabling and disabling of specific ignition coils is done through the Boolean checkboxes. THIS DIAGNOSTIC MODE REFERS TO CYLINDER ORDER AND NOT FIRING ORDER.

The Sample Speed Threshold sets an engine speed condition for the diagnostic. If the engine is operating below this speed, the throttle command will lock into place. This allows an engine speed decrease to be observed due to a reduction in the number of firing cylinders. The maximum time to keep an ignition coil disabled is 15 seconds.

If the diagnostic mode is entered above the Sample Speed Threshold, the throttle will operate normally. For this condition the ignition coil will be disabled for a maximum of 5 seconds. The user also has the option to disable closed loop fueling during the test. The engine will return to normal operating mode when the diagnostic mode is disabled or upon restart if the engine is shut down in the diagnostic mode.

Throttle Diagnostic Mode

The throttle diagnostic mode allows the user to test throttle function safely. Before this diagnostic mode can be used, the engine must be stopped and the key in the ON position. All relevant parameters are found on the “Diagnostic Modes – Throttle System” page in Toolkit (see below). To enable the throttle diagnostic mode, change the parameter Tune to 7 to Enable Throttle Diagnostic Mode from 0 to 7. To disable, set to 0. J1939 WWDM2 and UDS Routine control 0x201 can enable this Diagnostics Mode as well. This diagnostic mode enables the actuator driver and will only function for the length of time set in Maximum Time (default 600 s).

The diagnostic mode will also disable when the key is switched to the OFF position. Once enabled, the user can control the throttle directly with the foot pedal. Therefore, Foot Pedal Input will equal Throttle Demand and Throttle Position Sensor within ±5%. The engine will return to normal operating mode when the diagnostic mode is disabled or upon restart if the engine is shut down in the diagnostic mode.

Wastegate Control Diagnostic Mode

The wastegate control diagnostic mode allows the user to test the wastegate control valve functionality safely. Before this diagnostic mode can be used, the engine must be stopped and the key in the ON position. All relevant parameters are found on the “Diagnostic Modes – Wastegate Control Test” page in Toolkit. To enable the wastegate control diagnostic mode, change the parameter Tune to 7 to Enable Wastegate Diagnostic Mode from 0 to 7. To disable, set to 0. J1939 WWDM2 and UDS Routine control 0x202 can enable this Diagnostics Mode as well. This diagnostic mode enables the actuator driver and will only function for the length of time set in Maximum Time (default 600 s).

The wastegate control diagnostic mode allows the user to vary the wastegate control valve duty cycle between the limits Minimum Duty Cycle and Maximum Duty Cycle with the parameter Wastegate Test

Setpoint. The engine will return to normal operating mode when the diagnostic mode is disabled or upon restart if the engine is shut down in the diagnostic mode.

Exhaust Brake Diagnostic Mode

The exhaust brake diagnostic mode allows the user to test the exhaust brake functionality safely. Before this diagnostic mode can be used, the engine must be running and the key in the ON position. All relevant parameters are found on the “Diagnostic Modes – Exhaust Brake Test” page in Toolkit (see below). To enable the exhaust brake diagnostic mode, change the parameter Tune to 7 to Enable Exhaust Brake Diagnostic Mode from 0 to 7. To disable, set to 0. J1939 WWDM2 and UDS Routine control 0x204 can enable this Diagnostics Mode as well. This diagnostic mode only functions for the length of time set in Maximum Time (default 600 s).

The exhaust brake diagnostic mode allows the user to test the exhaust brake independent of the clutch or neutral switch status. The engine will return to normal operating mode when the diagnostic mode is disabled or upon restart if the engine is shut down in the diagnostic mode.

Injector Cleaning Diagnostic Mode

The injector cleaning diagnostic mode allows the user to clean the fuel injectors with fuel injector cleaning fluid by running the injectors. Before this diagnostic mode can be used, the engine must be stopped and the key in the ON position. All relevant parameters are found on the “Diagnostic Modes – Injector Cleaning” page in Toolkit. To enable the injector cleaning diagnostic mode, change the parameter Tune to 7 to Enable Injector Cleaning Diagnostic Mode from 0 to 7. To disable, set to 0. J1939 WWDM2 and UDS Routine control 0x203 can enable this Diagnostics Mode as well. This enables the mode for the next key cycle and is confirmed by the label Injector Clean Mode Request for Next Key Cycle indicating TRUE and Pattern Selected on Next Wake Up indicating 2. The key must be switched to the OFF position until the PCM-HD shuts down (about 20 seconds). Turn the key to the ON position and the system will be in injector clean mode.

The injectors will be pulsed at the frequency corresponding to 1000 rpm. The opening time of the injectors can be calibrated between 0 and 40 ms with the parameter Injector Clean Duration. The default value is 5 ms. This diagnostic mode enables the MPRD and will only function for the length of time set in Maximum Clean Time (default 30 s). The diagnostic mode will also disable when the key is switched to the OFF position and 20 seconds lapses. The system will return to normal operation on the next key cycle.

UEGO Test/Air Calibration Diagnostic Mode

The UEGO Test/Air Calibration diagnostic mode allows the user to test the UEGEO sensor and perform an air calibration. Before this diagnostic mode can be used, the engine must be stopped and the key in the ON position. All relevant parameters are found on the “Diagnostic Modes – UEGO Test/Air Calibration” page in ToolKit. To enable the UEGO Test diagnostic mode, change the parameter Tune to 7 to Enable UEGO Test Mode from 0 to 7. J1939 WWDM2 and UDS Routine control 0x207 can enable this Diagnostics Mode as well. This diagnostic mode enables the actuator driver and will only function for the length of time set in Maximum Time (default 600 s). The diagnostic mode will also disable when the key is switched to the OFF position. Once the diagnostic mode is enabled, the UEGO sensor heat activates and critical UEGO parameters can be monitored. If an air calibration is desired, select the Boolean Start UEGO1 Air Calibration. The UEGO sensor will heat up to the Target Temperature (default 780 °C) and stabilize within the ±Temperature Band (default 5 °C). The temperature must be stabilized before air calibration starts. The result of the air calibration will be displayed as IP Air Correction Factor. If the correction factor exceeds “Air Calibration Learn Limit” (default 0.15), UEGO2_AirCalLwrLimit (SFC 415) or UEGO2_AirCalUprLimit (416) will set.

Throttle Clean Diagnostic Mode

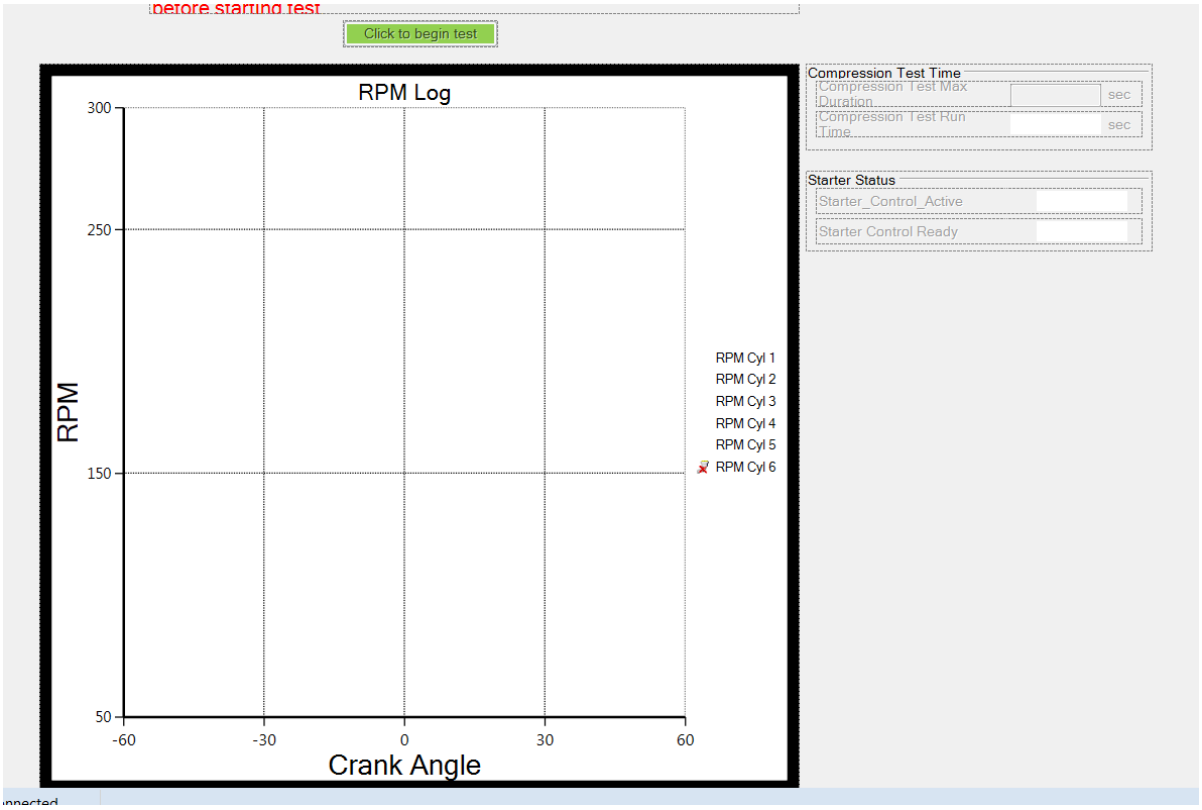
Throttle clean mode is for throttle patina clean. When throttle experiences control stability issue, it is most likely because throttle motor commutator builds up patina. Throttle clean procedure will help to clean up patina. The mode can be enabled through Toolkit, UDS Routine Control 0x20B, or J1939 WWDM2. To enable the Throttle Clean Test diagnostic mode, change the parameter Tune to 7 to Enable Throttle Test Mode.

When the mode is active, throttle will go through 10% to 90% stroking until a max timer expires (default is 30 seconds).

Compression Pressure Diagnostics Mode

Compression pressure Diagnostics are for abnormal compression pressure check. This mode is only supported through Toolkit (see Pages Diagnostic Modes – Abnormal Compression Pressure).

The diagnostics can be enabled from Toolkit. When the mode is enabled, engine will go to cranking mode, lock off is turned off and spark and injection are disabled. RPM vs crank angle plot will show up in Toolkit until the max time duration is reached or testing is disabled.



Chapter 3.
Toolless Diagnostics

MIL Flashing

The ECU will flash all stored fault codes when the foot pedal is cycled between idle and full pedal depression 3 times within 20 seconds with the key-on prior to engine starting. If the foot pedal circuit is faulted, then this method may not be available for obtaining fault codes.

The fault codes will be flashed in the following manner:

- An SFC number is made up of 3 digits, except for the starting and ending special SFC that is only 2 digits and is always the number twelve (12).
- The digit zero (0) is NEVER used.

A digit is made up of the entire short off times between a medium off pause. For instance, three flashes of the light on with a short pause between them equals the number 3. The digits are separated by a medium length off pause. Between two SFCs (3 digit sequences) there is a long pause. The order of the SFCs is based on fault history and is not in terms of fault importance.

For example, if SFC 231 and 711 are set in the Event Manager then the following sequence would be seen from the MIL flashing.
12 – Special SFC indicating start of fault list
231 – First fault code by numeric order
711 – Second fault code by numeric order
12 – Special SFC indicating end of fault list

Then repeat from top again forever or key is turned off or engine started.

SFC History and Adaptive Learn Fueling Clear

All stored fault codes except “PROTECTED” will be cleared after cycling the pedal 8 times and the adaptive learn table for Fuel will be cleared after cycling the foot pedal 12 times with the key-on prior to engine starting. When performing this action, after 3 foot pedal cycles, the MIL will begin to flash SFC information, and after the 8th foot pedal cycle will clear faults and turn off MIL flashing of SFCs (to indicate faults have been cleared. If the foot pedal circuit is faulted, then this method may not be available for obtaining fault codes.

Chapter 4.
Fault Codes

DTC: P0036: UEGO2 Htr Open or Short Grnd
SPN/FMI: 855/5
SFC: 135

Description	Enabling Conditions
UEGO heater circuit is either shorted or open.	MPRD On AND System Voltage < 'UEGO2_HtrDiagHighVoltLim' [30] AND System Voltage > 'UEGO2_HtrDiagLowVoltLim' [20] AND Sensor warmed for time >'UEGO2_SensorWarmDelayTimeThresh' [5] After clearing this Code, a total of 0 key cycles must occur before this fault can be set again

Malfunction Criteria
Heater Duty Cycle > 'UEGO2_HtrDiagHtrDCLowLim' [5] AND UEGO2_HeaterDiag <=2

Effect of Failure	Service Guidance – First Check
Fueling errors resulting in possible low power and misfire	• Check UEGO heater connector for corrosion or loose pin. • Check UEGO heater for an open circuit or short circuit to ground. • Check continuity between ECU pin and UEGO heater connector pin. • Check short circuit between ECU pin and XDRG.

Related Component/Subsystem: UEGO2

DTC: P0054: UEGO2 Heater Temperature Control
SPN/FMI: 855/7
SFC: 139

Description	Enabling Conditions
UEGO heater temperature not within control limits.	MPRD On AND System Voltage < 'UEGO2_HtrDiagHighVoltLim' [30] AND System Voltage > 'UEGO2_HtrDiagLowVoltLim' [20] AND Sensor warmed for time >'UEGO2_SensorWarmDelayTimeThresh' [5] AND Engine is Run or Hybrid ISG After clearing this Code, a total of 0 key cycles must occur before this fault can be set again

Malfunction Criteria
abs(UEGO2_Ri - Desired Temp)>'C_UEGO2_HeaterTempErrThresh' [20]

Effect of Failure	Service Guidance – First Check
Fueling errors resulting in possible low power and misfire	• Check UEGO heater connector for corrosion or loose pin. • Check continuity between ECU pin and UEGO heater connector pin.

Related Component/Subsystem: UEGO2

DTC: P0038: UEGO2 Heater Temperature HTE
SPN/FMI: 855/18
SFC: 137

Description	Enabling Conditions
UEGO heater temperature is higher than expected.	MPRD On AND System Voltage < 'UEGO2_HtrDiagHighVoltLim' [30] AND System Voltage > 'UEGO2_HtrDiagLowVoltLim' [20] AND Sensor warmed for time >'UEGO2_SensorWarmDelayTimeThresh' [5] AND Engine is either in Running or Hybrid ISG Mode AND Engine is either Hybrid ISG Mode or not in Fuel Cut After clearing this Code, a total of 0 key cycles must occur before this fault can be set again

Malfunction Criteria
UEGO2_Ri > 'UEGO2_HeaterTempUprLimit' [930] for time > 'UEGO2_HeatTempUprLimTimeThresh' [5]

Effect of Failure	Service Guidance – First Check
Fueling errors resulting in possible low power and misfire	• Check UEGO heater connector for corrosion or loose pin. • Check continuity between ECU pin and UEGO heater connector pin.

Related Component/Subsystem: UEGO2

DTC: P0054: UEGO2 Heater Temperature Control
SPN/FMI: 855/7
SFC: 139

Description	Enabling Conditions
UEGO heater temperature not within control limits.	MPRD On AND System Voltage < 'UEGO2_HtrDiagHighVoltLim' [30] AND System Voltage > 'UEGO2_HtrDiagLowVoltLim' [20] AND Sensor warmed for time >'UEGO2_SensorWarmDelayTimeThresh' [5] AND Engine is Run or Hybrid ISG After clearing this Code, a total of 0 key cycles must occur before this fault can be set again

Malfunction Criteria
abs(UEGO2_Ri - Desired Temp)>'C_UEGO2_HeaterTempErrThresh' [20]

Effect of Failure	Service Guidance – First Check
Fueling errors resulting in possible low power and misfire	• Check UEGO heater connector for corrosion or loose pin. • Check continuity between ECU pin and UEGO heater connector pin.

Related Component/Subsystem: UEGO2

DTC: P0183: NGT Voltage High
SPN/FMI: 3468/3
SFC: 141

Description	Enabling Conditions
Fuel Temperature Sensor voltage too high. Normally set if the fuel temperature sensor wire has been disconnected or the circuit has opened to the ECU.	Key on AND MRPD On After clearing this Code, a total of 0 key cycles must occur before this fault can be set again

Malfunction Criteria
NGT Voltage > 'FuelTempMax' [4.88] Volt

Effect of Failure	Service Guidance – First Check
• The ECU has been programmed such a way; it will take default value of 38 deg C in case of electrical faults. • Possible low power or poor running.	• Check fuel temperature sensor connector for corrosion or loose pin. • Check fuel temperature sensor for an open circuit or short to power. • Check continuity between ECU pin to sensor pin. • Check short circuit between ECU pin and XDRP.

Related Component/Subsystem: Fuel Injection (FMV)

DTC: P0182: NGT Voltage Low
SPN/FMI: 3468/4
SFC: 142

Description	Enabling Conditions
Fuel Temperature Sensor voltage too low Normally set if the fuel temperature sensor wire has shorted to ground or the sensor has failed.	Key on AND MRPD On After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
NGT Voltage < 'FuelTempMin' [0.05] Volt	
Effect of Failure	**Service Guidance – First Check**
• The ECU has been programmed in such a way; it will take default value of 38 °C in case of electrical faults. • Possible low power or poor running.	• Check fuel temperature sensor connector for corrosion or loose pin. • Check fuel temperature sensor for an open circuit or short to GND. • Check continuity between ECU pin to sensor pin. • Check short circuit between ECU pin and XDRG.

Related Component/Subsystem: Fuel Injection (FMV)

DTC: P1101: NGTdt - Least Severe Torque Derate
SPN/FMI: 3468/17
SFC: 143

Description	Enabling Conditions
Fuel Temperature decreasing rate too fast with least severe torque derate Normally set when the fuel temperature decreasing rate has been too fast.	Running After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
NGT / dt < 'FuelTempDerateZone' Table for > 'DerateLstSvr_SP' [1] sec Time	
Effect of Failure	**Service Guidance – First Check**
Possible low power or poor running by torque derating.	• Check the Coolant connections to the pressure regulator and heat exchanger. • Check the coolant level and circulation to the HP regulator and heat exchanger.

Related Component/Subsystem: Fuel Pressure Regulator

DTC: P1102: NGTdt - Moderately Severe Torque Derate
SPN/FMI: 3468/18
SFC: 144

Description	Enabling Conditions
Fuel temperature decreasing rate too fast with moderately severe torque derate Normally set when the fuel temperature decreasing rate has been too fast and keeping too long.	Running After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Least Severe Torque Derate for > 'DerateModSvr_SP' [1] sec	
Effect of Failure	**Service Guidance – First Check**
Possible low power or poor running by torque derating.	• Check the Coolant connections to the pressure regulator and heat exchanger. • Check the coolant level and circulation to the HP regulator and heat exchanger.

Related Component/Subsystem: Fuel Pressure Regulator

DTC: P1103: NGTdt - Most Severe Torque Derate
SPN/FMI: 3468/1
SFC: 145

Description	Enabling Conditions
Fuel temperature decreasing rate too fast with most severe torque derate. Normally set when the fuel temperature decreasing rate has been too fast and occurring as first time in this power cycle.	Running AND No occurrences of this fault this power cycle After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Medium Severe Torque Derate for > 'DerateMstSvr_SP' [1] sec	
Effect of Failure	**Service Guidance – First Check**
Possible low power or poor running by torque derating.	• Check the Coolant connections to the pressure regulator and heat exchanger. • Check the coolant level and circulation to the HP regulator and heat exchanger.

Related Component/Subsystem: Fuel Pressure Regulator

DTC: P0184: NGT Differs from Other Sensors
SPN/FMI: 3468/2
SFC: 146

Description	Enabling Conditions
Fuel temperature differs with other temperature sensors Normally set when the fuel temperature differs with average temperature by other temperature sensors at Key On.	KeyOffTimer> 'C_TempSenseDiffer_MinKeyOffTime' [28800] sec AND ECUP Delay Time > 'C_PowerTrigger_DlyTime' [1] sec AND KeyOffTimer Status is good AND 'TempSensDiffer_MaxAvgKeyOn' [30] DegC >=Average Temp >='TempSensDiffer_MinAvgKeyOn' [0] DegC After clearing this Code, a total of 1 key cycles must occur before this fault can be set again

Malfunction Criteria
abs(NGT- Average Temp) > 'NGT_AvgDeltaThresh' [6] DegC

Effect of Failure	Service Guidance – First Check
Possible low power or poor running.	• Check if fuel temperature sensor connector is disconnected or for an open circuit. • Check continuity between ECU pin to sensor pin. • Check Fuel Temperature Sensor for defective sensing.

Related Component/Subsystem: Fuel Injection (FMV)

DTC: P0168: NGT Higher Than Expected
SPN/FMI: 3468/20
SFC: 147

Description	Enabling Conditions
Fuel temperature too high. Fuel temperature has been remaining higher than expected at current engine running condition.	ECT > 50 deg C After clearing this Code, a total of 1 key cycles must occur before this fault can be set again

Malfunction Criteria
NGT >'FuelTemp_High' [120] degC Threshold

Effect of Failure	Service Guidance – First Check
• The ECU has been programmed such a way; it will take default value of 38 deg C in case of electrical faults. • Possible low power or poor running.	• Check the temperature of CNG before the pressure regulator. • Check the coolant level and circulation to the HP regulator and heat exchanger. • Check continuity between ECU pin to sensor pin. • Check Fuel Temperature Sensor for defective sensing.

Related Component/Subsystem: Fuel Pressure Regulator

DTC: P0181: NGT Lower Than Expected
SPN/FMI: 3468/21
SFC: 148

Description	Enabling Conditions
Fuel Temperature too low. Fuel temperature has been remaining lower than expected at current engine running condition.	ECT > 'FuelTempLow_MinECT' [50] deg C After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
NGT <'FuelTemp_LowTbl' degC Threshold	
Effect of Failure	**Service Guidance – First Check**
• The ECU has been programmed such a way; it will take default value of 38 deg C in case of electrical faults. • Possible low power or poor running.	• Check the Coolant connections to the pressure regulator and heat exchanger. • Check the coolant level and circulation to the HP regulator and heat exchanger. • Check continuity between ECU pin to sensor pin.

Related Component/Subsystem: Fuel Pressure Regulator

DTC: P0699: 2.5 Reference Voltage HTE
SPN/FMI: 1043/3
SFC: 151

Description	Enabling Conditions
Reference Voltage 2.5V higher than expected. This fault indicates ECU internal 2.5V reference voltage is higher than normal voltage range caused by internal chip failure.	Key = ON AND MRPD On After clearing this Code, a total of key cycles must occur before this fault can be set again
Malfunction Criteria	
VCAL Raw Voltage > 'VCALInputHiFltPos' [2.75] Volt	
Effect of Failure	**Service Guidance – First Check**
Possible shifting all sensor calibration.	Reset fault and run vehicle. If fault reoccurs replace ECU.

Related Component/Subsystem: Power Supplies

DTC: P0698: 2.5 Reference Voltage LTE
SPN/FMI: 1043/4
SFC: 152

Description	Enabling Conditions
Reference voltage 2.5V lower than expected This fault indicates ECU internal 2.5V reference voltage is lower than normal voltage range caused by internal chip failure.	Key = ON AND MRPD On After clearing this Code, a total of key cycles must occur before this fault can be set again
Malfunction Criteria	
VCAL Raw Voltage < 'VCALInputLoFltPos' [2.25] Volt	
Effect of Failure	**Service Guidance – First Check**
Possible shifting all sensor calibration.	Reset fault and run vehicle. If fault reoccurs replace ECU.

Related Component/Subsystem: Power Supplies

DTC: P0643: XDRP_A (+5V) Voltage HTE
SPN/FMI: 1079/3
SFC: 161

Description	Enabling Conditions
XDRPA 5V sensor power voltage higher than expected. This fault indicates ECU internal circuit failure or short circuit to system power line.	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
XDRP_1 Raw Voltage > 'XDRP1InputHiFltPos' [2.6] Volt (x 2 for engineering value)	
Effect of Failure	**Service Guidance – First Check**
Possible shifting XDRPA related sensor calibration.	• Check short circuit between ECU XDRPA and System Power voltage line. • Check ECU temperature.

Related Component/Subsystem: Power Supplies

DTC: P0642: XDRP_A (+5V) Voltage LTE
SPN/FMI: 1079/4
SFC: 162

Description	Enabling Conditions
XDRPA 5V sensor power voltage lower than expected. This fault indicates overload on XDRPA line.	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
XDRP_1 Raw Voltage < 'XDRP1InputLoFltPos' [2.4] Volt (x 2 for engineering value)	
Effect of Failure	**Service Guidance – First Check**
Possible shifting XDRPA related sensor calibration.	• Check shot circuit between XDRPA and XDRGA/XDRGB/Power GND.

Related Component/Subsystem: Power Supplies

DTC: P0653: XDRP_B (+5V) Voltage HTE
SPN/FMI: 1080/3
SFC: 163

Description	Enabling Conditions
XDRPB 5V sensor power voltage higher than expected. This fault indicates ECU internal circuit failure or short circuit to system power line.	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
XDRP_2 Raw Voltage > 'XDRP2InputHiFltPos' [2.55] Volt (x 2 for engineering value)	
Effect of Failure	**Service Guidance – First Check**
Possible shifting XDRPB related sensor calibration.	• Check short circuit between ECU XDRPB and System Power voltage line. • Check ECU temperature.

Related Component/Subsystem: Power Supplies

DTC: P0652: XDRP_B (+5V) Voltage LTE
SPN/FMI: 1080/4
SFC: 164

Description	Enabling Conditions
XDRPB 5V sensor power voltage lower than expected. This fault indicates overload on XDRPB line.	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
XDRP_2 Raw Voltage < 'XDRP2InputLoFltPos' [2.45] Volt (x 2 for engineering value)	
Effect of Failure	**Service Guidance – First Check**
Possible shifting XDRPB related sensor calibration.	• Check shot circuit between XDRPB and XDRGA/XDRGB/Power GND.

Related Component/Subsystem: Power Supplies

DTC: P2504: Battery Voltage Higher than Expected
SPN/FMI: 168/0
SFC: 165

Description	Enabling Conditions
Battery Voltage Higher than Expected. This fault indicates that the high system voltage supply or voltage regulator failure.	MPRD On After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
DRVP Raw Voltage > 'SysVoltInputHiFltPos' [3.91] Volt (x 8.322 for engineering value)	
Effect of Failure	**Service Guidance – First Check**
Possible ignition system failure.	• Check voltage regulator, alternator and charging system. • Check battery voltage during starting and with the engine running. • Check battery terminal wiring for loose connection and damaged wire.

Related Component/Subsystem: Power Supplies

DTC: P2503: Battery Voltage Lower than Expected
SPN/FMI: 168/1
SFC: 166

Description	Enabling Conditions
Battery Voltage Lower than Expected. This fault indicates that the low system voltage supply or battery charging system failure.	MPRD On AND RPM >= 'C_SysVoltLow_RPM_Thresh' [1000] After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
DRVP_Raw Voltage < 'SysVoltInputLoFltPos' [1.92] Volt (x 8.322 for engineering value)	
Effect of Failure	**Service Guidance – First Check**
Possible re-start failure.	• Check battery life for having enough charging and discharging capacity. • Check battery voltage during starting and with the engine running to verify charging system and alternator function. • Check battery terminal wiring for loose connection and damaged wire.

Related Component/Subsystem: Power Supplies

DTC: P2505: DRVP voltage is fluctuating abnormally
SPN/FMI: 444/2
SFC: 167

Description	Enabling Conditions
There is an interruption in the DRVP circuit probably caused by a missing or blown fuse or a bad wire.	Engine Running AND Abs(ECUP_V - previous ECUP_V) > 'DRVP_Abnormal_KeyThresh' [1.0] Volt for 'DRVP_Abnormal_KeyEnable' [0.25] sec After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
ABS(SysVolt - previous SysVolt) > 'DRVP_Abnormal_Thresh' [1.0] Volt OR ABS(ECUP_V - SysVolt) > 'DRVP_Abnormal_SysVoltKeyThresh' [50] Volt	
Effect of Failure	**Service Guidance – First Check**
DRVP voltage fluctuations possibly resulting in erratic behavior of the injectors and damage to the ECU	Check fuses for blown or missing fuse

Related Component/Subsystem: Power Supplies

DTC: P2508: Keyswitch Voltage Lower than expected
SPN/FMI: 158/4
SFC: 168

Description	Enabling Conditions
Key Switch Voltage Lower than Expected This fault indicates the low voltage on the Key Switch line.	Key = ON AND MPRD After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
ECUP < 'C_ECUP_LowVolt_Thd' [75] % * DRVP/100	
Effect of Failure	**Service Guidance – First Check**
Possible engine shutdown.	• Check Key Switch for bad electrical contact. • Check wire harness and connectors to find Key Switch wiring faults such as loose connection, corrosion of pins, damaged connector or wire.

Related Component/Subsystem: Power Supplies

DTC: P0132: PreCat O2 Voltage High
SPN/FMI: 3217/3
SFC: 171

Description	Enabling Conditions
PreCat O2 Voltage High	Key = ON AND MPRD After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
O2 Raw Voltage > 'O2Max' [2.17] Volt	
Effect of Failure	**Service Guidance – First Check**

Related Component/Subsystem: PreCatalyst HEGO Sensor

DTC: P0131: PreCat O2 Voltage Low
SPN/FMI: 3217/4
SFC: 172

Description	Enabling Conditions
PreCat O2 Voltage Low	Key = ON AND MPRD After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
O2 Raw Voltage < 'O2Min' [0.03] Volt	
Effect of Failure	**Service Guidance – First Check**

Related Component/Subsystem: PreCatalyst HEGO Sensor

DTC: P0135: PreCat O2 Heater Short Open Fault
SPN/FMI: 3217/5
SFC: 173

Description	Enabling Conditions
PreCat O2 Heater Short Open Fault	TimeSinceKeyOn > 'C_LSO_Diag_DelayTime' [5] AND MPRD On AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND IF PreO2Heater_FltCnfg2= Inhibit Fault Detection when DRVP is Low THEN EngineActuatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
'PreO2HtrFaultState' == 1 for 'C_PreO2Heater_ErrorTime' [2] second within 'C_PreO2Heater_MaxErrorTime' [5] second	
Effect of Failure	**Service Guidance – First Check**

Related Component/Subsystem: PreCatalyst HEGO Sensor

DTC: P2196: PreCat O2 Failed on Rich Side
SPN/FMI: 3217/15
SFC: 174

Description	Enabling Conditions
PreCat O2 Failed on Rich Side	O2 Close Loop Control After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
O2 Voltage >= 'O2_VSetpoint' Volt + 'O2ActiveRich' Volt for 'C_O2FailedRich_ErrorTime' [5] second within 'C_O2FailedRich_MaxErrorTime' [5] second	
Effect of Failure	**Service Guidance – First Check**

Related Component/Subsystem: PreCatalyst HEGO Sensor

DTC: P2195: PreCat O2 failed on Lean Side
SPN/FMI: 3217/17
SFC: 175

Description	Enabling Conditions
PreCat O2 failed on Lean Side	O2 Close Loop Control After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
O2 Voltage <= 'O2_VSetpoint' Volt - 'O2ActiveLean' Volt for 'C_O2FailedLean_ErrorTime' [5] second within 'C_O2FailedLean_MaxErrorTime' [5] second	
Effect of Failure	**Service Guidance – First Check**

Related Component/Subsystem: PreCatalyst HEGO Sensor

DTC: P0134: PreCat O2 insufficient activity
SPN/FMI: 3217/8
SFC: 176

Description	Enabling Conditions
PreCat O2 insufficient activity	O2 Close Loop Control After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
'O2_VSetpoint' - 'O2ActiveLean' < O2 Voltage < 'O2_VSetpoint' + 'O2ActiveRich' for 'C_O2NotActive_ErrorTime' [5] second within 'C_O2NotActive_MaxErrorTime' [5] second	
Effect of Failure	**Service Guidance – First Check**

Related Component/Subsystem: PreCatalyst HEGO Sensor

DTC: P0144: PostCat O2 Voltage High
SPN/FMI: 3227/3
SFC: 181

Description	Enabling Conditions
Post-catalyst O2 sensor voltage out of range high, sensor signal shorted to voltage source (5V or battery)	Key = ON AND MPRD After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
O2_PostCat Raw Voltage > 'O2_PostCatMax' [2.17] Volt	
Effect of Failure	**Service Guidance – First Check**
The ECU has been programmed such a way; O2 and Post O2 closed loop control will be disabled for electrical faults In case of failed lean and Rich faults, Engine will run at reduced power value and then will shut down after 25 sec	Check if O2 sensor installed after catalyst is shorted to +5Vdc or battery. Check continuity between ECU Post O2 signal pin to sensor pin B. Check continuity between ECU Post O2 signal pin to ECU ground pin for short to ground

Related Component/Subsystem: PostCatalyst HEGO Sensor

DTC: P0143: PostCat O2 Voltage Low
SPN/FMI: 3227/4
SFC: 182

Description	Enabling Conditions
Post-catalyst O2 sensor voltage out of range low, sensor signal shorted to ground	Key = ON AND MPRD After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
O2_PostCat Raw Voltage < 'O2_PostCatMin' [0.03] Volt	
Effect of Failure	**Service Guidance – First Check**
The ECU has been programmed such a way; O2 and Post O2 closed loop control will be disabled for electrical faults In case of failed lean and Rich faults, Engine will run at reduced power value and then will shut down after 25 sec	Check continuity between ECU Post O2 signal pin to sensor pin B. Check continuity between ECU Post O2 signal pin to ECU ground pin for short to ground

Related Component/Subsystem: PostCatalyst HEGO Sensor

DTC: P0146: Post O2 Inactive
SPN/FMI: 3227/8
SFC: 183

Description	Enabling Conditions
Post-catalyst O2 sensor control has sensed the O2 sensor is not responding as expected. If any Pre-O2 sensor faults are set, diagnose these first and after correcting these faults recheck if this fault sets. Possible causes for this fault are sensor disconnected, sensor heater failed, sensor element failed, heater relay, or SECM control of heater relay is disconnected or failed.	Engine is Running AND PostO2 CloseLoop After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
'PostO2InactiveMin' <= Post O2 Phi <= 'PostO2InactiveMax' AND Delta PostO2 Phi < 'O2_PostCat_ActiveThresh' for 'C_PostO2Inactive_ErrorTime' second within 'C_PostO2Inactive_MaxErrorTime' second	
Effect of Failure	**Service Guidance – First Check**
The ECU has been programmed such a way; O2 and Post O2 closed loop control will be disabled for electrical faults In case of failed lean and Rich faults, Engine will run at reduced power value and then will shut down after 25 sec	Check that Post-catalyst O2 sensor connections are OK. Check continuity between ECU Post O2 signal pin to sensor pin B. Check continuity between ECU Post O2 signal pin to ECU ground pin for short to ground

Related Component/Subsystem: PostCatalyst HEGO Sensor

DTC: P2271: PostCat O2 failed on rich Side
SPN/FMI: 3227/15
SFC: 185

Description	Enabling Conditions
The sensor indicates rich for an extended period of time. This could be caused by oxygen leak before or just after sensor, catalyst failure, sensor failure, or wiring/relay failure causing the sensor to not be properly heated. If any Pre-O2 sensor faults are set, diagnose these first and after correcting these faults recheck if this fault sets.	Engine is Running AND PostO2 CloseLoop After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
Post O2 Phi >= 'PostO2RichLimit' for 'C_PostO2FailedRich_ErrorTime' second within 'C_PostO2FailedRich_MaxErrorTime' second	
Effect of Failure	**Service Guidance – First Check**
The ECU has been programmed such a way; O2 and Post O2 closed loop control will be disabled for electrical faults In case of failed lean and Rich faults, Engine will run at reduced power value and then will shut down after 25 sec	Check continuity between ECU Post O2 signal pin to sensor pin B. Check continuity between ECU Post O2 signal pin to ECU ground pin for short to ground Look for leaks in exhaust, catalytic converter, HEGO sensors; repair leaks

Related Component/Subsystem: PostCatalyst HEGO Sensor

DTC: P2270: PostCat O2 failed on lean side
SPN/FMI: 3227/17
SFC: 186

Description	Enabling Conditions
The sensor indicates lean for an extended period of time. This could be caused by catalyst failure, sensor failure, or wiring/relay failure causing the sensor to not be properly heated. If any Pre-O2 sensor faults are set diagnose, these first and after correcting these faults recheck if this fault sets.	Engine is Running AND PostO2 CloseLoop After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
Post O2 Phi <= 'PostO2LeanLimit' for 'C_PostO2FailedLean_ErrorTime' second within 'C_PostO2FailedLean_MaxErrorTime' second	
Effect of Failure	**Service Guidance – First Check**
The ECU has been programmed such a way; O2 and Post O2 closed loop control will be disabled for electrical faults. In case of failed lean and Rich faults, Engine will run at reduced power value and then will shut down after 25 sec	Check continuity between ECU pin B-D1 to sensor pin B. Check for leaks in exhaust, catalytic converter, HEGO sensors; repair leaks. Check all sensor connections

Related Component/Subsystem: PostCatalyst HEGO Sensor

DTC: P0147: PostCat O2 Heater Short Open Fault
SPN/FMI: 3227/5
SFC: 187

Description	Enabling Conditions
Post Catalyst O2 Sensor Heater Fault, Heater has opened or shorted to ground or power or defective heater element	TimeSinceKeyOn > 'C_LSO_Diag_DelayTime' [5] AND MPRD On AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND IF PreO2Heater_FltCnfg2= Inhibit Fault Detection when DRVP is Low THEN EngineActuatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 0 key cycles must occur before this fault can be set again

Malfunction Criteria
'PostO2HtrFaultState' == 1 for 'C_PostO2Heater_ErrorTime' second within 'C_PostO2Heater_MaxErrorTime' second

Effect of Failure	Service Guidance – First Check
The ECU has been programmed such a way; O2 and Post O2 closed loop control will be disabled for electrical faults In case of failed lean and Rich faults, Engine will run at reduced power value and then will shut down after 25 sec	Check continuity between ECU pin to Sensor pin D. Check continuity between MPRD output to pin C. Verify O2 sensor heater circuit is operating by measuring heater resistance (2.1W ± 0.4W) O2 Pin B (HEATER GND) to Pin A (HEATER PWR)

Related Component/Subsystem: PostCatalyst HEGO Sensor

DTC: P0142: PostCat O2 Failed to Lean during FSO
SPN/FMI: 3227/2
SFC: 188

Description	Enabling Conditions
PostCat O2 Sensor failed to indicate lean condition during FSO (Fuel Shutoff)	TimeSinceRun> 'C_PostO2_Resp_StartupTime' [300] & 'C_Cat_CT_LowLimit' [70] <ECT< 'C_Cat_CT_HighLimit' [90] & 'C_Cat_IAT_LowLimit' [20] < IAT < 'C_Cat_IAT_HighLimit' [150] & 'C_Cat_CATT_LowLimit' [400]< Catalyst Bed Tempertature< 'C_Cat_CATT_HighLimit' [800] & 'C_PostO2_Resp_RPM_LowLimit' [1200] < RPM < 'C_PostO2_Resp_RPM_HighLimit' [2800] & Post O2 Rich Time > 'C_PostO2_Resp_PostO2RichTime' [0.1] AND FSO Transition After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
PostO2 Voltage < 'C_PostO2_FSO_LeanThreshold' [0.5] Volt in 'C_PostO2_FSO_Range_CheckTime' [2] Volt	
Effect of Failure	**Service Guidance – First Check**
Potential inaccurate fueling causing reduced power	Check and/or replace PostCat O2 Sensor

Related Component/Subsystem: PostCatalyst HEGO Sensor

DTC: P0145: PostCat O2 Response Time
SPN/FMI: 3227/10
SFC: 189

Description	Enabling Conditions
PostCat O2 sensor shows slow response time	TimeSinceRun> 'C_PostO2_Resp_StartupTime' [300] & 'C_Cat_CT_LowLimit' [70] <ECT< 'C_Cat_CT_HighLimit' [90] & 'C_Cat_IAT_LowLimit' [20] < IAT < 'C_Cat_IAT_HighLimit' [150] & 'C_Cat_CATT_LowLimit' [400]< Catalyst Bed Tempertature< 'C_Cat_CATT_HighLimit' [800] & 'C_PostO2_Resp_RPM_LowLimit' [1200] < RPM < 'C_PostO2_Resp_RPM_HighLimit' [2800] & Post O2 Rich Time > 'C_PostO2_Resp_PostO2RichTime' [0.1] AND FSO Transition After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
EWMA(The Response Time) (from PostO2 Voltage < 'C_PostO2_Resp_RichPoint' to PostO2 Voltage > 'C_PostO2_Resp_LeanPoint') >= 'C_PostO2_FSO_RespTime_Threshold' [0.2] second	
Effect of Failure	**Service Guidance – First Check**
Potential inaccurate fueling causing reduced power	Check and/or replace PostCat O2 Sensor

Related Component/Subsystem: PostCatalyst HEGO Sensor

DTC: P0522: Oil Pressure Voltage Low
SPN/FMI: 100/4
SFC: 191

Description	Enabling Conditions
Oil pressure sensor signal voltage too low. Sets when the signal wire has been disconnected or shorted to ground.	KeyOn After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
OilPressure Raw Voltage < 'OilPressureInputLoFltPos' [0.05]	
Effect of Failure	**Service Guidance – First Check**
No driver perceptible effect	Check sensor connector and wiring for an open circuit or short to GND. Check continuity between sensor signal and ECU pins C-E4 and A-H2 for short to ground. Check the sensor resistance against the specification.

Related Component/Subsystem: Oil Temp / Pressure Sensor

DTC: P0523: Oil Pressure Voltage High
SPN/FMI: 100/3
SFC: 192

Description	Enabling Conditions
Oil pressure sensor signal voltage too high. Sets when the signal wire has been shorted to battery power or 5V sensor power.	KeyOn After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
OilPressure Raw Voltage > 'OilPressureInputHiFltPos' [4.98]	
Effect of Failure	**Service Guidance – First Check**
No driver perceptible effect	Check sensor connector and wiring for a short to power. Check continuity between sensor signal pin and ECU pins C-E3 and A-H1 for short to power. Check the sensor resistance against the specification.

Related Component/Subsystem: Oil Temp / Pressure Sensor

DTC: P0197: Oil Temperature Voltage Low
SPN/FMI: 175/4
SFC: 193

Description	Enabling Conditions
Oil temperature sensor signal voltage too low. Sets when the signal wire has been shorted to ground.	EngineRunTime>=10 second AND KeyOn AND MRPD On After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
OilTemperature Raw Voltage < 'OilTemperatureMin' [0.05] Volt	
Effect of Failure	**Service Guidance – First Check**
No driver perceptible effect	Check sensor connector and wiring for a short to GND. Check continuity between sensor signal and ECU pins C-E4 and A-H2 for short to ground. Check the sensor resistance against the specification.

Related Component/Subsystem: Oil Temp / Pressure Sensor

DTC: P0195: Oil Temperature Voltage High
SPN/FMI: 175/3
SFC: 194

Description	Enabling Conditions
Oil temperature sensor signal voltage too high. Sets when the signal wire has been disconnected or shorted to battery power or 5V sensor power.	EngineRunTime>=10 second AND KeyOn AND MRPD On After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
OilTemperature Raw Voltage > 'OilTemperatureMax' [4.98] Volt	
Effect of Failure	**Service Guidance – First Check**
No driver perceptible effect	Check sensor connector and wiring for open circuit or short to power. Check continuity between sensor signal pin and ECU pins C-E3 and A-H1 for short to power. Check the sensor resistance against the specification.

Related Component/Subsystem: Oil Temp / Pressure Sensor

DTC: P0524: Oil Pressure Low
SPN/FMI: 100/1
SFC: 195

Description	Enabling Conditions
Low oil pressure while the engine is running.	RPM > 'EngSpeedLowOilPress' [500] AND Engine running for time > 'StartUpOilPressureDelay' [60] After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Oil Pressure is Low (LowOilPressSw == 1)	
Effect of Failure	**Service Guidance – First Check**
Vehicle will be running with torque limit resulting in low power.	Check engine oil level. Check for failed Oil Pressure switch, replace if necessary. Check harness between oil pressure signal wire and XDRG. Check continuity between the ECU and sensor pins.

Related Component/Subsystem: Oil Temp / Pressure Sensor

DTC: P0521: Oil Pressure Fault
SPN/FMI: 100/15
SFC: 196

Description	Enabling Conditions
Oil pressure detected when the engine is not running.	Engine in Stall for time > 'ShutdownOilPressureDelay' [1] AND 'DrivingCycleCompleted' = False After clearing this Code, a total of 1 key cycles must occur before this fault can be set again

Malfunction Criteria
Oil Pressure is High when engine is in Stall State (LowOilPressSw == 0)

Effect of Failure	Service Guidance – First Check
No driver perceptible effect	Check the sensor for damage or blockage. Check continuity between the ECU and sensor pins. Check sensor for proper operation. Check the sensor resistance against the specification.

Related Component/Subsystem: Oil Temp / Pressure Sensor

DTC: P1198: Oil Temperature High
SPN/FMI: 175/16
SFC: 222

Description	Enabling Conditions
Oil temperature is too high.	ECUP enabled After clearing this Code, a total of 0 key cycles must occur before this fault can be set again

Malfunction Criteria
Oil Temperature > 'OilTemperatureHighFaultThreshold' [115] DegC

Effect of Failure	Service Guidance – First Check
No driver perceptible effect	Check the actual engine oil temperature when the fault triggers. Check continuity between the ECU and sensor pins. Check the sensor resistance against the specification.

Related Component/Subsystem: Oil Temp / Pressure Sensor

DTC: P1199: Oil Temperature Severe
SPN/FMI: 175/1
SFC: 223

Description	Enabling Conditions
Oil temperature is extremely high.	ECUP enabled After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Oil Temperature > 'OilTemperatureSevereFaultThreshold' [125] DegC	
Effect of Failure	**Service Guidance – First Check**
No driver perceptible effect	Check the actual engine oil temperature when the fault triggers. Check continuity between the ECU and sensor pins. Check the sensor resistance against the specification.

Related Component/Subsystem: Oil Temp / Pressure Sensor

DTC: P0198: Oil Temperature IR High
SPN/FMI: 175/15
SFC: 197

Description	Enabling Conditions
Oil temperature sensor reading is above an expected range.	Engine is Running After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Oil Temperature > 'OilTemperature_High' [120] DegC	
Effect of Failure	**Service Guidance – First Check**
No driver perceptible effect	Check the engine oil connections to the engine. Check the engine oil level and circulation. Check continuity between the ECU and sensor pins. Check sensor for proper operation. Check the sensor resistance against the specification.

Related Component/Subsystem: Oil Temp / Pressure Sensor

DTC: P0196: Oil Temperature IR Low
SPN/FMI: 175/17
SFC: 198

Description	Enabling Conditions
Oil temperature sensor reading is below an expected range.	Engine Run Time > 'C_OilTemp_Low_RunTimeThresh' [300] sec After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Oil Temperature < 'OilTemperature_Low' [-10] DegC	
Effect of Failure	**Service Guidance – First Check**
No driver perceptible affect	Check the engine oil connections to the engine. Check the engine oil level and circulation. Check continuity between the ECU and sensor pins. Check sensor for proper operation. Check the sensor resistance against the specification.

Related Component/Subsystem: Oil Temp / Pressure Sensor

DTC: P1195: Oil Temperature Differs from Other Sensors
SPN/FMI: 175/2
SFC: 199

Description	Enabling Conditions
Oil temperature does not agree with other temperature sensors.	KeyOffTimer> 'C_TempSenseDiffer_MinKeyOffTime' [28800] sec AND ECUP Delay Time > 'C_PowerTrigger_DlyTime' [1] sec AND KeyOffTimer Status is good AND 'TempSensDiffer_MaxAvgKeyOn' [30] DegC >=Average Temp >='TempSensDiffer_MinAvgKeyOn' [0] DegC After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
abs(OilT- Average Temp) > 'OilT_AvgDeltaThresh' [6] DegC	
Effect of Failure	**Service Guidance – First Check**
No driver perceptible effect	Check oil temperature against actual ambient temperature when the engine is cold. Check continuity between the ECU and sensor pins. Check sensor for proper operation. Check the sensor resistance against the specification.

Related Component/Subsystem: Oil Temp / Pressure Sensor

DTC: P0123: APP1 Voltage High
SPN/FMI: 91/3
SFC: 211

Description	Enabling Conditions
Pedal Pot 1 volts too high. APP1 sensor voltage out of range high, normally set if the APP1 signal has shorted to power	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
APP1 Raw Voltage > 'APP1InputHiFltPos' [4.8] Volt	
Effect of Failure	**Service Guidance – First Check**
• The ECU has been programmed such a way; it will value from APP2 when APP1 sensor fails • When both the sensor fails, engine will be run little bit higher than idle RPM	• Check foot pedal connector • Check continuity between ECU pin to Accelerator pedal pin • Check short circuit between ECM PINs • Check the APP sensor, disconnect the Sensor connector and measure the resistance between Accelerator pedal pins

Related Component/Subsystem: Pedal

DTC: P0122: APP1 Voltage Low
SPN/FMI: 91/4
SFC: 212

Description	Enabling Conditions
Pedal Pot 1 volts too low. APP1 sensor voltage out of range low, normally set if the APP1 signal has shorted to ground, circuit has opened or sensor has failed	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
APP1 Raw Voltage < 'APP1InputLoFltPos' [0.3] Volt	
Effect of Failure	**Service Guidance – First Check**
• The ECU has been programmed such a way; it will value from APP2 when APP1 sensor fails • When both the sensor fails, engine will be run little bit higher than idle RPM	• Check foot pedal connector • Check continuity between ECU pin to Accelerator pedal pin • Check short circuit between ECM PINs • Check the APP sensor, disconnect the Sensor connector and measure the resistance between Accelerator pedal pins

Related Component/Subsystem: Pedal

DTC: P2163: APP1 Adapt High Max
SPN/FMI: 91/16
SFC: 213

Description	Enabling Conditions
Pedal Pot 1 volts at max travel is too high.	Key = ON
Learned full pedal end of APP1 sensor range higher than expected	After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
min (5 APP1 Raw Voltage) > 'APP1Adapt_Hi_Max' [4.75] Volt	
Effect of Failure	**Service Guidance – First Check**
• The ECU has been programmed such a way; it will value from APP2 when APP1 sensor fails • When both the sensor fails, engine will be run little bit higher than idle RPM	• Check APP connector and pins for Corrosion/Damaged pedal • Check continuity between ECU pin to Accelerator pedal pin

Related Component/Subsystem: Pedal

DTC: P2109: APP1 Adapt Low Min
SPN/FMI: 91/18
SFC: 214

Description	Enabling Conditions
Pedal Pot 1 volts at min travel is too low.	Key = ON
Learned idle end of APP1 sensor range lower than expected	After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
max(5 APP1 Raw Voltage) < 'APP1Adapt_Low_Min' [0.34] Volt	
Effect of Failure	**Service Guidance – First Check**
• The ECU has been programmed such a way; it will value from APP2 when APP1 sensor fails • When both the sensor fails, engine will be run little bit higher than idle RPM	• Check APP connector and pins for Corrosion/Damaged pedal • Check continuity between ECU pin to Accelerator pedal pin

Related Component/Subsystem: Pedal

DTC: P0223: APP2 Voltage High
SPN/FMI: 29/3
SFC: 215

Description	Enabling Conditions
Pedal Pot 2 volts too high	Key = ON
APP2 sensor voltage out of range high, normally set if the APP2 signal has shorted to power	After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
APP2 Raw Voltage > 'APP2InputHiFltPos' [4.8] Volt	
Effect of Failure	**Service Guidance – First Check**
• The ECU has been programmed such a way; it will value from APP1 when APP2 sensor fails • When both the sensor fails, engine will be run little bit higher than idle RPM	• Check foot pedal connector • Check continuity between ECU pin to Accelerator pedal pin • Check short circuit between ECM PINs • Check the APP sensor, disconnect the Sensor connector and measure the resistance between Accelerator pedal pins

Related Component/Subsystem: Pedal

DTC: P0222: APP2 Voltage Low
SPN/FMI: 29/4
SFC: 216

Description	Enabling Conditions
Pedal Pot 2 volts too low	Key = ON
APP2 sensor voltage out of range low, normally set if the APP2 signal has shorted to ground, circuit has opened or sensor has failed	After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
APP2 Raw Voltage < 'APP2InputLoFltPos' [0.3] Volt	
Effect of Failure	**Service Guidance – First Check**
• The ECU has been programmed such a way; it will value from APP1 when APP2 sensor fails • When both the sensor fails, engine will be run little bit higher than idle RPM	• Check foot pedal connector • Check continuity between ECU pin to Accelerator pedal pin • Check short circuit between ECM PINs • Check the APP sensor, disconnect the Sensor connector and measure the resistance between Accelerator pedal pins

Related Component/Subsystem: Pedal

DTC: P2164: APP2 Adapt High Max
SPN/FMI: 29/16
SFC: 217

Description	Enabling Conditions
Pedal Pot 2 volts at max travel is too high Learned full pedal end of APP2 sensor range higher than expected	Key = ON After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
min (5 APP2 Raw Voltage) > 'APP2Adapt_Hi_Max' [4.75] Volt	
Effect of Failure	**Service Guidance – First Check**
• The ECU has been programmed such a way; it will value from APP1 when APP2 sensor fails • When both the sensor fails, engine will be run little bit higher than idle RPM	• Check APP connector and pins for Corrosion/ Damaged pedal • Check continuity between ECU pin to Accelerator pedal pin

Related Component/Subsystem: Pedal

DTC: P2113: APP2 Adapt Low Min
SPN/FMI: 29/18
SFC: 218

Description	Enabling Conditions
Pedal Pot 2 volts at min travel is too low Learned idle end of APP2 sensor range lower than expected	Key = ON After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
max (5 APP2 Raw Voltage) < 'APP2Adapt_Low_Min' [0.34] Volt	
Effect of Failure	**Service Guidance – First Check**
• The ECU has been programmed such a way; it will value from APP1 when APP2 sensor fails • When both the sensor fails, Engine will be run little bit higher than idle RPM	• Check APP connector and pins for Corrosion/Damaged pedal • Check continuity between ECU pin to Accelerator pedal pin

Related Component/Subsystem: Pedal

DTC: P2136: APP IVS Conflict
SPN/FMI: 558/7
SFC: 219

Description	Enabling Conditions
Pedal Pots do not agree - mechanical or electrical fault	Key = ON and DynoMode Disabled
APP position sensors do not track well, intermittent connections to APP or defective pedal assembly	After clearing this Code, a total of 0 key cycles must occur before this fault can be set again

Malfunction Criteria
APP1 < 'APP1_IVS_ON' [0.5] Volt when IVS is OFF OR APP1 >'APP1_IVS_OFF' [0.83] Volt when IVS in ON

Effect of Failure	Service Guidance – First Check
When both of the APP and IVS status conflicts each other, Engine will be run little bit higher than idle RPM	• Check APP connector and pins for Corrosion • Check the signal voltages of ECM pin with pushing and releasing accelerator pedal • Check continuity between ECU pin to Accelerator pedal pin • Check the APP sensor, disconnect the Sensor Connector and measure the resistance between Accelerator pedal pins with pushing and releasing pedal

Related Component/Subsystem: Pedal

DTC: P2135: APP Sensors Conflict
SPN/FMI: 91/7
SFC: 221

Description	Enabling Conditions
Pedal Pots do not agree - mechanical or electrical fault	Key = ON
APP position sensors do not track well, intermittent connections to APP or defective pedal assembly	After clearing this Code, a total of 1 key cycles must occur before this fault can be set again

Malfunction Criteria
absolute value of (APP1 - APP2) > 'APP1_APP2_Max_Deviation' [30] %

Effect of Failure	Service Guidance – First Check
When both the sensor conflicts each other, Engine will be run little bit higher than idle RPM	• Check APP connector and pins for Corrosion • Check the signal voltages of ECM pins

Related Component/Subsystem: Pedal

DTC: P0098: MAT Voltage High
SPN/FMI: 105/3
SFC: 231

Description	Enabling Conditions
Manifold Air Temperature Sensor Voltage is High. Normally set if the MAT temperature sensor wire has been disconnected, the circuit has opened to the SECM, or a short to Vbatt or sensor power has occurred.	Key = ON AND MPRD After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
MAT Raw Voltage > 'MATMax' [4.95] Volt	
Effect of Failure	**Service Guidance – First Check**
The fueling will not be accurate, Possible low power or poor performance	Check continuity between ECU pin to sensor pin 2. Check continuity between XDRP1 output to pin 3. Check continuity between ECU ground and Sensor pin 1 Check the MAT sensor by disconnecting the TMAP connector and measuring the resistance of the sensor

Related Component/Subsystem: Manifold Air Temperature / Pressure

DTC: P0097: MAT Voltage Low
SPN/FMI: 105/4
SFC: 232

Description	Enabling Conditions
Manifold Air Temperature Sensor Voltage is Low. Normally set if the MAT temperature sensor wire has shorted to chassis ground or the sensor has failed.	Key = ON AND MPRD After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
MAT Raw Voltage < 'MATMin' [0.05] Volt	
Effect of Failure	**Service Guidance – First Check**
The fueling will not be accurate, Possible low power or poor performance	Check continuity between ECU pin to sensor pin 2. Check continuity between XDRP1 output to pin 3. Check continuity between ECU ground and Sensor pin 1 Check the MAT sensor by disconnecting the TMAP connector and measuring the resistance of the sensor

Related Component/Subsystem: Manifold Air Temperature / Pressure

DTC: P0127: MAT Higher than Expected
SPN/FMI: 105/0
SFC: 233

Description	Enabling Conditions
Manifold Air Temperature is too high	Engine In Run State AND MAP > 'MAP_Thresh_forMap' [135] Kpa After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
MAT >'MAT_HIGH' [100] DegC	
Effect of Failure	**Service Guidance – First Check**
The fueling will not be accurate, Possible low power or poor performance	Check continuity between ECU pin to sensor pin 2. Check continuity between XDRP1 output to pin 3. Check continuity between ECU ground and Sensor pin 1 Check the MAT sensor by disconnecting the TMAP connector and measuring the resistance of the sensor

Related Component/Subsystem: Manifold Air Temperature / Pressure

DTC: P0096: MAT Data Insufficient Activity
SPN/FMI: 105/10
SFC: 234

Description	Enabling Conditions
Manifold Air Temperature is not changing as expected	Time Since Run > 300sec AND Engine in Run State AND MAT Key up < 'MAT_COLD' [30] threshold AND RPM > 'MATPower_MinRPM' [1400] RPM TorquePcnt > 'MATPower_MinTorque' [50] % FOR 'MATPower_LatchTime' [50] seconds AND RPM > 'MATIdle_MinRPM' [600] RPM TorquePcnt < 'MATIdle_MaxTorque' [20] % ECT > 'MATIdle_MinECT' [75] DegC FOR 'MATIdle_Timer' [50] sec After clearing this Code, a total of 2 key cycles must occur before this fault can be set again
Malfunction Criteria	
(max MAT - eAmbTemp) < 'MAT_STUCK' [5] Deg threshold for 'C_MAT_IR_ErrorTime' [5] second within 'C_MAT_IR_MaxErrorTime' [5] second	
Effect of Failure	**Service Guidance – First Check**
The fueling will not be accurate, Possible low power or poor performance	Check continuity between ECU pin to sensor pin 2. Check continuity between XDRP1 output to pin 3. Check continuity between ECU ground and Sensor pin 1 Check the MAT sensor by disconnecting the TMAP connector and measuring the resistance of the sensor

Related Component/Subsystem: Manifold Air Temperature / Pressure

DTC: P026A: Charge Air Cooling Failure
SPN/FMI: 5285/7
SFC: 236

Description	Enabling Conditions
The intercooler is not functioning properly.	RPM > 'C_ChargeCooler_RPM_Thresh' [1000] rpm AND MAP > 'C_ChargeCooler_MAP_Thresh' [50] Kpa AND Compressore Outlet Temp > ECT AND Engine is in Diag Steady State After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
(COT-AftercoolerTemp)/(COT-CIT) < ChargeCoolingEffThresh Table based on MAF	
Effect of Failure	**Service Guidance – First Check**
Lower power as a result of higher intake air temperature.	Check intercooler for obstructions blocking the air flow over the intercooler.

Related Component/Subsystem: Manifold Air Temperature / Pressure

DTC: P0109: MAT Differs from Other Sensors
SPN/FMI: 105/2
SFC: 235

Description	Enabling Conditions
Manifold Air Temperature much different than other temperature sensors	KeyOffTimer> 'C_TempSenseDiffer_MinKeyOffTime' [28800] sec AND ECUP Delay Time > 'C_PowerTrigger_DlyTime' [1] sec AND KeyOffTimer Status is good AND 'TempSensDiffer_MaxAvgKeyOn' [30] DegC >=Average Temp >='TempSensDiffer_MinAvgKeyOn' [0] DegC After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
abs(MAT- Average Temp) > 'MAT_AvgDeltaThresh' [6] DegC	
Effect of Failure	**Service Guidance – First Check**
The fueling will not be accurate, Possible low power or poor performance	Check Sensor temperature against actual ambient temperature when engine is cold Check the sensor resistance against the specification.

Related Component/Subsystem: Manifold Air Temperature / Pressure

DTC: P1601: Tacho Short Open Fault
SPN/FMI: 1620/5
SFC: 241

Description	Enabling Conditions
Tach Driver Line Short or Open Fault This monitor is to detect a Tacho Short Open Fault. This monitor is to detect Tacho Device open or short Fault.	TimeSinceKeyOn > 5 AND MPRD On AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND IF Tach_FltCnfg2= Inhibit Fault Detection when DRVP is Low THEN VehicleIndicatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
'TachFaultState' == 1 for 'C_Tach_ErrorTime' [1] second within 'C_Tach_MaxErrorTime' [60] second	
Effect of Failure	**Service Guidance – First Check**
Vehicle will not indicate correct Engine Speed or Transmission Load.	• Check Tacho device connector to find loose pin, damaged pin or corrosion. • Check open or short circuit on Tacho Device. • Check power source connection for Tacho device. • Check continuity between ECU pin to Tacho device pin. • Check short circuit between ECU pin and Power line.

Related Component/Subsystem: Actuator Outputs

DTC: P0655: Over Heat Lamp Short Open fault
SPN/FMI: 5100/5
SFC: 242

Description	Enabling Conditions
Over Heat Lamp Driver Line Short or Open Fault This monitor is to detect Over Heat Lamp open or short Fault.	OverHeat_Lamp == 0 AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND IF Overheat_Lamp_FltCnfg2= Inhibit Fault Detection when DRVP is Low THEN VehicleIndicatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
Over Heat Lamp Fault ==1 for 'C_Overheat_Lamp_ErrorTime' [5] second within 'C_Overheat_Lamp_MaxErrorTime' [5] second	
Effect of Failure	**Service Guidance – First Check**
Vehicle will not indicate correct Over Heat condition by lamp indicator	• Check Lamp device connector to find loose pin, damaged pin or corrosion. • Check open or short circuit on Lamp device. • Check power source connection for Lamp Device. • Check continuity between ECU pin to Lamp Device. • Check short circuit between ECU pin and Power line.

Related Component/Subsystem: Actuator Outputs

DTC: P0078: Engine Brake Short Open Fault
SPN/FMI: 5081/5
SFC: 243

Description	Enabling Conditions
Engine Break Driver Line Short or Open Fault This monitor is to detect an Engine Brake Device open or short Fault.	TimeSinceKeyOn > 5 AND MPRD On AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND IF LockOff_FltCnfg2= Inhibit Fault Detection when DRVP is Low THEN EngineActuatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 1 key cycles must occur before this fault can be set again

Malfunction Criteria
'EngineBrakeFaultHrdwrState' == 1 for 'C_EngineBrake_ErrorTime' [1] second within 'C_EngineBrake_MaxErrorTime' [1] second

Effect of Failure	Service Guidance – First Check
Vehicle will not be able to close Exhaust Brake valve.	• Check Engine Brake device connector to find loose pin, damaged pin or corrosion. • Check open or short circuit on Brake device. • Check power source connection for Brake Device. • Check continuity between ECU pin to Brake Device. • Check short circuit between ECU pin and Power line.

Related Component/Subsystem: Actuator Outputs

DTC: P0480: Fan 1 Short Open Fault
SPN/FMI: 977/5
SFC: 244

Description	Enabling Conditions
Fan1Driver Line Short or Open Fault This monitor is to detect a Fan1 Device Short Open Fault.	TimeSinceKeyOn > 5 AND MPRD On AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND IF FCC1_FltCnfg2= Inhibit Fault Detection when DRVP is Low THEN EngineActuatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 1 key cycles must occur before this fault can be set again

Malfunction Criteria
'FCC1_State_Raw' == 1 for 'C_FCC1_ErrorTime' [2] second within 'C_FCC1_MaxErrorTime' [2] second 'FCC1_State_Raw_OpenShortGnd' == 1 or 'FCC1_State_Raw_Short' == 1 will set 'FCC1_State_Raw' == 1

Effect of Failure	Service Guidance – First Check
Vehicle will not be able to control Fan 1 clutch or speed.	• Check Fan Device connector to find loose pin, damaged pin or corrosion. • Check open or short circuit on Fan Device. • Check power source connection for Fan Device. • Check continuity between ECU pin to Fan Device pin. • Check short circuit between ECU pin and Power line.

Related Component/Subsystem: Engine Fan

DTC: P0481: Fan 2 Short Open fault
SPN/FMI: 1557/5
SFC: 245

Description	Enabling Conditions
Fan2 Driver Line Short or Open Fault This monitor is to detect an Fan2 Device open or short Fault.	TimeSinceKeyOn > 5 AND MPRD On AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND IF FCC2_FltCnfg2= Inhibit Fault Detection when DRVP is Low THEN EngineActuatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
'FCC2_State' == 1 for 'C_FCC2_ErrorTime' [2] second within 'C_FCC2_MaxErrorTime' [2] second	
Effect of Failure	**Service Guidance – First Check**
Vehicle will not be able to control Fan 2 clutch or speed.	• Check Fan Device connector to find loose pin, damaged pin or corrosion. • Check open or short circuit on Fan Device. • Check power source connection for Fan Device. • Check continuity between ECU pin to Fan Device pin. • Check short circuit between ECU pin and Power line.

Related Component/Subsystem: Engine Fan

DTC: P0620: Alternator Fault
SPN/FMI: 3353/5
SFC: 246

Description	Enabling Conditions
Alternator Inhibit Driver Line Short or Open Fault This monitor is to detect an Alternator Inhibit Device open or short Fault.	Alternator_Inhibit == 0 AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND IF Alternator_Inhibit_FltCnfg2= Inhibit Fault Detection when DRVP is Low THEN EngineActuatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 1 key cycles must occur before this fault can be set again

Malfunction Criteria
Alternator_Inhibit Fault ==1 for 'C_Alternator_Inhibit_ErrorTime' [10] second within 'C_Alternator_Inhibit_MaxErrorTime' [20] second

Effect of Failure	Service Guidance – First Check
Vehicle will not be able to inhibit Alternator working when vehicle want to have high torque and power.	• Check Alternator Control Device connector to find loose pin, damaged pin or corrosion. • Check open or short circuit on Alternator Control Device. • Check power source connection for alternator Control Device. • Check continuity between ECU pin to Alternator Control Device pin. • Check short circuit between ECU pin and Power line.

Related Component/Subsystem: Actuator Outputs

DTC: P1604: Fuel Gauge Short Open Fault
SPN/FMI: 96/5
SFC: 247

Description	Enabling Conditions
Fuel Gauge Driver Line Short or Open Fault This monitor is to detect a Fuel Gauge Device Short Open Fault.	TimeSinceKeyOn > 5 AND MPRD On AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND IF FuelGauge_FltCnfg2= Inhibit Fault Detection when DRVP is Low THEN VehicleIndicatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 1 key cycles must occur before this fault can be set again

Malfunction Criteria
'FuelGaugeStateRaw' == 1 for 'C_FuelGauge_ErrorTime' [10] second within 'C_FuelGauge_MaxErrorTime' [20] second

Effect of Failure	Service Guidance – First Check
Vehicle will not be able to indicate correct Fuel Level. Fuel gauge will indicate Maximum or Minimum level.	• Check Fuel Gauge Device connector to find loose pin, damaged pin or corrosion. • Check open or short circuit on Fuel Gauge Device. • Check power source connection for Fuel Gauge Device. • Check continuity between ECU pin to Fuel Gauge Device pin. • Check short circuit between ECU pin and Power line.

Related Component/Subsystem: Actuator Outputs

DTC: P0656: Low Fuel Lamp Short Open Fault
SPN/FMI: 96/4
SFC: 248

Description	Enabling Conditions
Low Fuel Lamp Driver Line Short or Open Fault This monitor is to detect Low Fuel Lamp open or short Fault.	Low_Fuel == 0 AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND IF LowFuelLamp_FltCnfg2= Inhibit Fault Detection when DRVP is Low THEN VehicleIndicatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 1 key cycles must occur before this fault can be set again

Malfunction Criteria
Low_Fuel Fault == 1 for 'C_LowFuelLamp_ErrorTime' [10] second within 'C_LowFuelLamp_MaxErrorTime' [20] second

Effect of Failure	Service Guidance – First Check
Vehicle will not indicate correct Low Fuel condition by lamp indicator.	• Check Lamp device connector to find loose pin, damaged pin or corrosion. • Check open or short circuit on Lamp device. • Check power source connection for Lamp Device. • Check continuity between ECU pin to Lamp Device. • Check short circuit between ECU pin and Power line.

Related Component/Subsystem: Actuator Outputs

DTC: P0615: Starter Control Short Open Fault
SPN/FMI: 430/5
SFC: 249

Description	Enabling Conditions
Starter Control Driver Line Short or Open Fault This monitor is to detect Starter Control open or short Fault. (LSO15 pin in ECM-OH).	TimeSinceKeyOn > 5 AND MPRD On AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND IF StarterControl_FltCnfg2= Inhibit Fault Detection when DRVP is Low THEN EngineActuatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 1 key cycles must occur before this fault can be set again

Malfunction Criteria
StartControl State ==1 for 'C_StarterControl_ErrorTime' [10] second within 'C_StarterControl_MaxErrorTime' [20] second

Effect of Failure	Service Guidance – First Check
• ECU will not be able to control Starter. • Possible vehicle cannot start engine. • Possible starter motor damage.	• Check Starter Control Device connector to find loose pin, damaged pin or corrosion. • Check open or short circuit on Starter Control Device. • Check power source connection for Starter Control Device. • Check continuity between ECU pin to Starter Control Device pin. • Check short circuit between ECU pin and Power line.

Related Component/Subsystem: Actuator Outputs

DTC: P0005: Lock Off Short Open Fault
SPN/FMI: 632/5
SFC: 251

Description	Enabling Conditions
Lock-Off Driver Line Short or Open Fault The fuel lock off device(s) has an open or short condition.	TimeSinceKeyOn > 5 AND MPRD On AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND IF LockOff_FltCnfg2= Inhibit Fault Detection when DRVP is Low THEN EngineActuatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 1 key cycles must occur before this fault can be set again

Malfunction Criteria
LockOffFaultState == 1 or if('LockOff_DualLockOffValves' = Yes then LockOffCurrent < 'LockOff_DualValveOpenThresh' amp AND HPLO_LockOff_DC > 5%) for 'C_LockOff_ErrorTime' second within 'C_LockOff_MaxErrorTime' second

Effect of Failure	Service Guidance – First Check
Possible shutdown engine.	• Check Lock-Off Device connector to find loose pin, damaged pin or corrosion. • Check open or short circuit on Fuel Shut-off Device. • Check power source connection for Fuel Shut-off Device. • Check continuity between ECU pin to Fuel Shut-off Device pin. • Check short circuit between ECU pin and Power line. • If the vehicle has dual lock off valves, then check the current to the valves. This can be read in Toolkit on the Diagnostics - Toolkit page, LockOffCurrent or with a current probe and a multimeter. • If the current is below 100 mA, then there is a problem with both valves or the wiring for both valves. • If it is above 100mA then the problem is only affecting one of the two valves. • The current check has to be done when the valve(s) are being commanded open, during the first 2 seconds after key on.

Related Component/Subsystem: Actuator Outputs

DTC: P0650: MIL Short Open Fault
SPN/FMI: 1213/5
SFC: 252

Description	Enabling Conditions
MIL Driver Line Short or Open Fault This monitor is to detect MIL open or short Fault. (LSO13 pin in ECM-OH).	MIL == 0 AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND IF MIL_FltCnfg2= Inhibit Fault Detection when DRVP is Low THEN VehicleIndicatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 1 key cycles must occur before this fault can be set again

Malfunction Criteria
'MILFaultHrdwrState' Fault == 1 for 'C_MIL_ErrorTime' [10] second within 'C_MIL_MaxErrorTime' [20] second

Effect of Failure	Service Guidance – First Check
Vehicle will not indicate MIL condition by lamp indicator.	• Check Lamp device connector to find loose pin, damaged pin or corrosion. • Check open or short circuit on Lamp device. • Check power source connection for Lamp Device. • Check continuity between ECU pin to Lamp Device. • Check short circuit between ECU pin and Power line.

Related Component/Subsystem: Actuator Outputs

DTC: P260D: RSG/Cruise/PTO Lamp Short Open Fault
SPN/FMI: 527/5
SFC: 253

Description	Enabling Conditions
RSG/Cruise/PTO Lamp Driver Line Short or Open Fault This monitor is to detect RSG/Cruise/PTO lamp open or short Fault.	Lamp is off AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND IF RSGCruisePTOLamp_FltCnfg2= Inhibit Fault Detection when DRVP is Low THEN VehicleIndicatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 1 key cycles must occur before this fault can be set again

Malfunction Criteria
RSTCruisePTOLamp Fault Status == 1 for 'C_RSGCruisePTOLamp_ErrorTime' [10] second within 'C_RSGCruisePTOLamp_MaxErrorTime' [20] second

Effect of Failure	Service Guidance – First Check
Vehicle will not indicate correct mode by lamp indicator for Road Speed Control, Cruise Control or PTO mode.	• Check Lamp device connector to find loose pin, damaged pin or corrosion. • Check open or short circuit on Lamp device. • Check power source connection for Lamp Device. • Check continuity between ECU pin to Lamp Device. • Check short circuit between ECU pin and Power line.

Related Component/Subsystem: Actuator Outputs

DTC: P1605: Check Engine Lamp Short Open Fault
SPN/FMI: 2648/5
SFC: 254

Description	Enabling Conditions
Check Engine Lamp Driver Line Short or Open Fault This monitor is to detect Check Engine Lamp open or short Fault.	CEL is off AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND IF CEL_FltCnfg2= Inhibit Fault Detection when DRVP is Low THEN VehicleIndicatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
CEL Lamp Fault Status == 1 for 'C_CEL_ErrorTime' second within 'C_CEL_MaxErrorTime' second	
Effect of Failure	**Service Guidance – First Check**
Vehicle will not indicate correct Check Engine condition by lamp indicator.	• Check Lamp device connector to find loose pin, damaged pin or corrosion. • Check open or short circuit on Lamp device. • Check power source connection for Lamp Device. • Check continuity between ECU pin to Lamp Device. • Check short circuit between ECU pin and Power line.

Related Component/Subsystem: Actuator Outputs

DTC: P1606: Engine Stopping Lamp Short Open Fault
SPN/FMI: 623/5
SFC: 255

Description	Enabling Conditions
Engine Stopping Lamp Driver Line Short or Open Fault This monitor is to detect Engine Stopping Lamp open or short Fault.	Lamp is off AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND IF PreO2Heater_FltCnfg2= Inhibit Fault Detection when DRVP is Low THEN EngineActuatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
EngineStopping Fault Status == 1 for 'C_EngineStopping_ErrorTime' [10] second within 'C_EngineStopping_MaxErrorTime' [20] second	
Effect of Failure	**Service Guidance – First Check**
Vehicle will not indicate correct Engine Stopping condition by lamp indicator.	• Check Lamp device connector to find loose pin, damaged pin or corrosion. • Check open or short circuit on Lamp device. • Check power source connection for Lamp Device. • Check continuity between ECU pin to Lamp Device. • Check short circuit between ECU pin and Power line.

Related Component/Subsystem: Actuator Outputs

DTC: P1607: Retarder Lamp Short Open Fault
SPN/FMI: 5081/6
SFC: 256

Description	Enabling Conditions
Retarder Driver Line Short or Open Fault This monitor is to detect Retarder Lamp open or short Fault.	Lamp is off AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND IF Retarder_TransLoad_FltCnfg2= Inhibit Fault Detection when DRVP is Low THEN VehicleIndicatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
Retarder_TransLoad Lamp Fault Status == 1 for 'C_Retarder_TransLoad_ErrorTime' [10] second within 'C_Retarder_TransLoad_MaxErrorTime' [20] second	
Effect of Failure	**Service Guidance – First Check**
Vehicle will not indicate correct Retarder condition by lamp indicator.	• Check Lamp device connector to find loose pin, damaged pin or corrosion. • Check open or short circuit on Lamp device. • Check power source connection for Lamp Device. • Check continuity between ECU pin to Lamp Device. • Check short circuit between ECU pin and Power line.

Related Component/Subsystem: Actuator Outputs

DTC: P0118: ECT Voltage High
SPN/FMI: 110/3
SFC: 261

Description	Enabling Conditions
Engine Coolant Temperature Sensor voltage too High. Normally set if coolant sensor wire has been disconnected or circuit has opened to the ECU or shorted to power.	Key = ON AND MPRD After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
ECT Raw Voltage > 'ECTMax' [4.95] Volt	
Effect of Failure	**Service Guidance – First Check**
• The ECU has been programmed such a way; it will take a default value of 88 degC that may lead to problem during cold starting. • Reduction in thermal efficiency may shows impact in drivability.	• Check coolant temperature sensor connector for corrosion or loose pin. • Check coolant temperature sensor for an open circuit or short to power. • Check continuity between ECU pin to sensor pin. • Check short circuit between ECU pin and XDRP.

Related Component/Subsystem: Engine Cooling System

DTC: P0117: ECT Voltage Low
SPN/FMI: 110/4
SFC: 262

Description	Enabling Conditions
Engine Coolant Temperature Sensor voltage too Low Normally set if the coolant sensor wire has shorted to chassis ground or the sensor has failed.	Key = ON AND MPRD After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
ECT Raw Voltage < 'ECTMin' [0.05] Volt	
Effect of Failure	**Service Guidance – First Check**
• The ECU has been programmed such a way; it will take a default value of 88 degC that may lead to problem during cold starting. • Reduction in fuel quantity may shows impact in drivability.	• Check coolant temperature sensor connector for corrosion or loose pin. • Check coolant temperature sensor for an open circuit or short to GND. • Check continuity between ECU pin to sensor pin. • Check short circuit between ECU pin and XDRG.

Related Component/Subsystem: Engine Cooling System

DTC: P0217: ECT Higher than Expected
SPN/FMI: 110/0
SFC: 263

Description	Enabling Conditions
Engine Coolant Temperature too High. The sensor has measured an excessive coolant temperature typically due to the engine overheating.	Engine In Run State After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
ECT > 'ECTSensorRangeHiThesh' [99] DegC	
Effect of Failure	**Service Guidance – First Check**
Possible low power or poor running by torque derating.	• Check faulty thermostat. • Check coolant level. • Check proper work on cooling fan. • Check coolant temperature sensor for defective sensing. • Check coolant temperature sensor for an open circuit or short to GND.

Related Component/Subsystem: Engine Cooling System

DTC: P0125: ECT Insufficient Activity
SPN/FMI: 110/10
SFC: 264

Description	Enabling Conditions
Engine Coolant Temperature lower than expected Normally set if Coolant Temperature sensor is not responding to changes in actual temperature.	Latch(ECT> 'ECT_Thermostat' [80] degC AND Time Since Run > 300 sec.) After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
ECT_Max - ECT_Min < 'ECT_Stuck' [1] during Enable debouncing time	
Effect of Failure	**Service Guidance – First Check:**
• Reduction in thermal efficiency may shows impact in drivability. • Possible emissions issues by disabling Phi Closed Loop.	• Check faulty thermostat. • Check coolant level. • Check proper work on cooling fan. • Check coolant temperature sensor for defective sensing. • Check coolant temperature sensor connector for corrosion or loose pin. • Check coolant temperature sensor for an open circuit or short to power.

Related Component/Subsystem: Engine Cooling System

DTC: P0119: ECT Differs from Other Sensors
SPN/FMI: 110/2
SFC: 265

Description	Enabling Conditions
Coolant Temperature differs with other temperature sensors Normally set when the coolant temperature differs with average temperature by other temperature sensors at Key On.	KeyOffTimer> 'C_TempSenseDiffer_MinKeyOffTime' [28800] sec AND ECUP Delay Time > 'C_PowerTrigger_DlyTime' [1] sec AND KeyOffTimer Status is good AND 'TempSensDiffer_MaxAvgKeyOn' [30] DegC >=Average Temp >='TempSensDiffer_MinAvgKeyOn' [0] DegC After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
abs(ECT- Average Temp) > 'ECT_AvgDeltaThresh' [6] DegC	
Effect of Failure	**Service Guidance – First Check:**
Reduction in thermal efficiency may shows impact in drivability.	• Check coolant temperature sensor for defective sensing. • Check coolant temperature sensor connector for corrosion or loose pin. • Check coolant temperature sensor for an open circuit or short to power/GND.

Related Component/Subsystem: Engine Cooling System

DTC: P050C: ECT Warmup Slower than Expected
SPN/FMI: 110/1
SFC: 266

Description	Enabling Conditions
Coolant Temperature does not warm up as expected at engine start-up Normally set when the coolant temperature does not increase from initial temperature as expected when vehicle run enough time with load for warming up.	Indicated Torque > 'ECT_TorqueThreshold' [40] % for 'ECT_TorqueTimerThres' [300] sec AND ECT Keyup < ('ECT_Thermostat' [80] degC-'ECT_WarmUp' [30]-10) AND Engine in Run State After clearing this Code, a total of 1 key cycles must occur before this fault can be set again

Malfunction Criteria
ECT < (ECT keyup + 'ECT_WarmUp' [15] DegC)

Effect of Failure	Service Guidance – First Check:
Reduction in thermal efficiency may shows impact in drivability.	• Check thermostat for sticking open. • Check coolant temperature sensor for defective sensing. • Check coolant temperature sensor connector for corrosion or loose pin. • Check coolant temperature sensor for an open circuit or short to power/GND.

Related Component/Subsystem: Engine Cooling System

DTC: P0128: ThermoStat Stuck Open
SPN/FMI: 1659/7
SFC: 267

Description	Enabling Conditions
Thermostat is not functioning correctly resulting in the engine warming up slower than normal.	eECT reaches 'Tstat_DiagTemp' [80] AND (RPM<1000) Time Ratio < 'Tstat_MaxIdleRatio' [50] AND (Road Speed < 'Tstat_MinSpeed') Time Ratio < 'Tstat_MinSpeedRatio' [50] AND (Road Speed > 'Tstat_MaxSpeed') Time Ratio < 'Tstat_MaxSpeedRatio' [50] AND (MAFPort <= 'Tstat_MinMAF') Time Ratio < 'Tstat_MinLoadRatio' AND Engine Run Time > 10 s AND MAT-MAT_keyup >= 'Tstat_MATDelta' After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	

IF (MAT Keyup >= 'Tstat_ColdTempBreakPt' [10] DegC)
ECT+'Tstat_TempAllowDelta' DegC < eECT
ELSE
ECT+'Tstat_TempAllowCold' DegC < eECT	

Effect of Failure	**Service Guidance – First Check:**
Engine warms up slower than expected.	Check for a thermostat that is not functioning correctly, either stuck open or opening too early.

Related Component/Subsystem: Engine Cooling System

DTC: P0A00: HEV Coolant Temperature Open Fault
SPN/FMI: 5890/5
SFC: 268

Description	Enabling Conditions
HEV controller has detected an open circuit on the HEV coolant temperature sensor	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
HEVCoolantTempFault == 4	
Effect of Failure	**Service Guidance – First Check:**
Refer to HEV controller manual	Refer to HEV controller manual

Related Component/Subsystem: HEV Coolant Temperature

DTC: P0A02: HEV Coolant Temperature Short Fault
SPN/FMI: 5890/6
SFC: 269

Description	Enabling Conditions
HEV controller has detected a short circuit on the HEV coolant temperature sensor	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
HEVCoolantTempFault == 8	
Effect of Failure	**Service Guidance – First Check:**
Refer to HEV controller manual	Refer to HEV controller manual

Related Component/Subsystem: HEV Coolant Temperature

DTC: P2299: APP Brake Mismatch
SPN/FMI: 512/7
SFC: 271

Description	Enabling Conditions
Accelerator Pedal position and Brake Pedal position mismatch. If brake switch position shows vehicle is on brake but accelerator pedal position doesn't, the mismatch fault will be set.	Road_speed_final > 'APP_Brake_OverrideMaxSpd' [-1] kmh, ClutchSw = 0, AND NeutralSw = 0 After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
BrakeSw = On AND TorqueAPP > 'APP_Brake_OverrideMaxTrq' [30] % for 'APPBrakeOverrideTime' [1] Second	
Effect of Failure	**Service Guidance – First Check:**
Possible low power or poor running by torque derating.	• Check if there is APP sensor fault code. • Check Brake Switch mechanical failure between brake pedal and switch. • Check Brake Switch connector for corrosion or loose pin. • Check Brake Switch for an open/short circuit or short to power/GND. • Check continuity between ECU pin to Brake Switch connector pin. • Check short circuit between ECU pin to XDRG.

Related Component/Subsystem: Torque Request

DTC: P0504: TSC1 and Brake Mismatch
SPN/FMI: 695/7
SFC: 272

Description	Enabling Conditions
TSC1 Speed/Torque demand and Brake Pedal position mismatch. If brake switch position shows vehicle is on brake but TSC1 demand doesn't, the mismatch fault will be set.	P_SPD_FinalClutchOrNeutralSwitch = 0 AND Road_speed_final > 'Brake_OverrideMaxSpd' [-1] kmh, After clearing this Code, a total of 0 key cycles must occur before this fault can be set again

Malfunction Criteria
(TSC1_Mode1BrakeMismatch for 'Mode1BrakeOverrideTime' [1] Second OR TSC1_Mode2BrakeMismatch for 'Mode2BrakeOverrideTime' [1] Second) AND BrakeSw = On AND TSC1_SpeedTorqueCTRL > 'Brake_OverrideMaxTrq' [30] % FOR 'TSC1_BrakeOverrideFltDly' [5] Second Time

Effect of Failure	Service Guidance – First Check:
Possible low power or poor running by torque derating.	• Check if there is TSC1 side devices fault such as speed demand source or torque demand source. • Check Brake Switch mechanical failure between brake pedal and switch. • Check Brake Switch connector for corrosion or loose pin. • Check Brake Switch for an open/short circuit or short to power/GND. • Check continuity between ECU pin to Brake Switch connector pin. • Check short circuit between ECU pin to XDRG.

Related Component/Subsystem: Torque Request

DTC: P1001: Mileage based service fault 1
SPN/FMI: 914/15
SFC: 281

Description	Enabling Conditions
Indicates that the interval for routine service has expired.	None After clearing this Code, a total of 0 key cycles must occur before this fault can be set again

Malfunction Criteria
DistanceTravelled_Current - Service_1_Distance >= 'Service_1_Thresh' km

Effect of Failure	Service Guidance – First Check:
Routine service needed	Check Service Manual for required routine service. Perform service then clear fault.

Related Component/Subsystem: Routine Maintenance

DTC: P1002: Mileage based service fault 2
SPN/FMI: 914/16
SFC: 282

Description	Enabling Conditions
Indicates that the interval for routine service has expired.	None After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
DistanceTravelled_Current - Service_2_Distance >= 'Service_2_Thresh' km	
Effect of Failure	**Service Guidance – First Check:**
Routine service needed	Check Service Manual for required routine service. Perform service then clear fault.

Related Component/Subsystem: Routine Maintenance

DTC: P1003: Mileage based service fault 3
SPN/FMI: 914/0
SFC: 283

Description	Enabling Conditions
Indicates that the interval for routine service has expired.	None After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
DistanceTravelled_Current - Service_3_Distance >= 'Service_3_Thresh' km	
Effect of Failure	**Service Guidance – First Check:**
Routine service needed	Check Service Manual for required routine service. Perform service then clear fault.

Related Component/Subsystem: Routine Maintenance

DTC: P0107: MAP Voltage Low
SPN/FMI: 106/4
SFC: 341

Description	Enabling Conditions
Manifold Absolute Pressure Sensor Voltage is Low Normally set if the TMAP pressure signal wire has been disconnected or shorted to ground	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
MAP Raw Voltage < 'MAPInputLoFltPos' [0.05] Volt	
Effect of Failure	**Service Guidance – First Check:**
The fueling will not be accurate, Possible low power or poor performance	Check continuity between ECU pin to sensor pin 4. Check continuity between XDRP1 output to pin 3. Check continuity between ECU ground and sensor pin 1

Related Component/Subsystem: Manifold Air Temperature / Pressure

DTC: P0108: MAP Voltage High
SPN/FMI: 106/3
SFC: 342

Description	Enabling Conditions
Manifold Absolute Pressure Sensor Voltage is High Normally set if the TMAP pressure signal wire has become shorted to power, shorted to the MAT signal, or the TMAP has failed	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
MAP Raw Voltage > 'MAPInputHiFltPos' [4.8] Volt	
Effect of Failure	**Service Guidance – First Check:**
The fueling will not be accurate, Possible low power or poor performance	Check continuity between ECU pin to sensor pin 4. Check continuity between XDRP1 output to pin 3. Check continuity between ECU ground and sensor pin 1

Related Component/Subsystem: Manifold Air Temperature / Pressure

DTC: P2073: MAP Data Drift High
SPN/FMI: 106/20
SFC: 343

Description	Enabling Conditions
Manifold Absolute Pressure sensor indicates higher pressure than expected	Commanded TPS < {C_MAP_IRH_TPS_Thd} AND PTP > Baro - 'C_MAP_IR_HI_PTP_Thd' [20] kPa AND Engine State = RUN After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
PTP-MAP < 'C_MAP_IR_HI_Thd' [40]kPa for 'C_MAP_IR_HI_ErrorTime' [2] Second within 'C_MAP_IR_HI_MaxErrorTime' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
The fueling will not be accurate, Possible low power or poor performance	Check continuity between ECU pin to sensor pin 4. Check continuity between XDRP1 output to pin 3. Check continuity between ECU ground and sensor pin 1

Related Component/Subsystem: Manifold Air Temperature / Pressure

DTC: P2074: MAP Data Drift Low
SPN/FMI: 106/21
SFC: 344

Description	Enabling Conditions
Manifold Absolute Pressure sensor indicates lower pressure than expected	Commanded TPS > 'MAP_IR_TPS_OP' [40] AND Engine State = RUN After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
MAP/BARO < 'MAP_IR_LO' [0.5] for 'C_MAP_IR_LO_ErrorTime' [3] Second within 'C_MAP_IR_LO_MaxErrorTime' [3] Second	
Effect of Failure	**Service Guidance – First Check:**
The fueling will not be accurate, Possible low power or poor performance	Check continuity between ECU pin to sensor pin 4. Check continuity between XDRP1 output to pin 3. Check continuity between ECU ground and sensor pin 1

Related Component/Subsystem: Manifold Air Temperature / Pressure

DTC: P0068: MAP Sticking
SPN/FMI: 106/2
SFC: 345

Description	Enabling Conditions
Manifold Absolute Pressure sensor not changing as expected	Commanded TPS < 'MAP_TPS_STUCK' [50] AND Engine State = RUN After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
BARO - MAP < 'MAP_STUCK' [50] Kpa for 'C_MAP_STICKING_ErrorTime' [2] Second within 'C_MAP_STICKING_MaxErrorTime' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
The fueling will not be accurate, Possible low power or poor performance	Check continuity between ECU pin to sensor pin 4. Check continuity between XDRP1 output to pin 3. Check continuity between ECU ground and sensor pin 1

Related Component/Subsystem: Manifold Air Temperature / Pressure

DTC: P0106: MAP Fault
SPN/FMI: 106/31
SFC: 346

Description	Enabling Conditions
Manifold Absolute Pressure sensor greater than physical range	Engine not in Stall State After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
MAP > 'MAPInputFltPos' [300] Kpa	
Effect of Failure	**Service Guidance – First Check:**
The fueling will not be accurate, Possible low power or poor performance	Check continuity between ECU pin to sensor pin 4. Check continuity between XDRP1 output to pin 3. Check continuity between ECU ground and sensor pin 1

Related Component/Subsystem: Manifold Air Temperature / Pressure

DTC: P2229: Barometer Voltage High
SPN/FMI: 108/3
SFC: 351

Description	Enabling Conditions
Barometer pressure sensor signal voltage too high. Sets when the signal wire has been shorted to battery power or 5V sensor power.	Key = ON AND MPRD After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
BaroSensor Raw Voltage > 'BaroSensorInputHiFltPos' [4.6] Volt	
Effect of Failure	**Service Guidance – First Check:**
Barometer pressure will default to set value, may cause errors in fueling that result in loss of power.	Check sensor connector and wiring for a short to power. Check continuity between sensor signal pin and ECU pins C-E3 and A-H1 for short to power. Check the sensor resistance against the specification.

Related Component/Subsystem: Barometer Pressure

DTC: P2228: Barometer Voltage Low
SPN/FMI: 108/4
SFC: 352

Description	Enabling Conditions
Barometer pressure sensor signal voltage too low. Sets when the signal wire has been disconnected or shorted to ground.	Key = ON AND MPRD After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
BaroSensor Raw Voltage < 'BaroSensorInputLoFltPos' [0.2] Volt	
Effect of Failure	**Service Guidance – First Check:**
Barometer pressure will default to set value, may cause errors in fueling that result in loss of power.	Check sensor connector and wiring for an open circuit or short to GND. Check continuity between sensor signal and ECU pins C-E4 and A-H2 for short to ground. Check the sensor resistance against the specification.

Related Component/Subsystem: Barometer Pressure

DTC: P0129: Baro Lower than Expected
SPN/FMI: 108/1
SFC: 353

Description	Enabling Conditions
Barometer pressure is below the expected range.	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Barometric pressure measured or estimated < 'Baro_Lower_Thresh' [57] Kpa	
Effect of Failure	**Service Guidance – First Check:**
May cause errors in fueling that result in loss of power.	Check for loose or corroded connectors and wires. Check the sensor resistance against the specification.

Related Component/Subsystem: Barometer Pressure

DTC: P2227: Baro Higher than Expected
SPN/FMI: 108/0
SFC: 354

Description	Enabling Conditions
Barometer pressure is above the expected range.	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Barometric pressure measured or estimated > 'Baro_High_Thresh' [104] Kpa	
Effect of Failure	**Service Guidance – First Check:**
May cause errors in fueling that result in loss of power.	Check for loose or corroded connectors and wires. Check the sensor resistance against the specification.

Related Component/Subsystem: Barometer Pressure

DTC: P0238: PTP Voltage High
SPN/FMI: 102/3
SFC: 371

Description	Enabling Conditions
Pre-throttle pressure sensor signal voltage too high Sets when the signal wire has been shorted to battery power or 5V sensor power.	Engine is Running After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
PTP Raw Voltage > 'PTPInputHiFltPos' [4.8] Volt	
Effect of Failure	**Service Guidance – First Check:**
Poor boost control, engine may overboost or underboost affecting drivability.	Check sensor connector and wiring for a short to power. Check continuity between sensor signal pin and ECU pins C-E3 and A-H1 for short to power. Check the sensor resistance against the specification.

Related Component/Subsystem: Boost Pressure

DTC: P0237: PTP Voltage Low
SPN/FMI: 102/4
SFC: 372

Description	Enabling Conditions
Pre-throttle pressure sensor signal voltage too low. Sets when the signal wire has been disconnected or shorted to ground.	Engine is Running After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
PTP Raw Voltage < 'PTPInputLoFltPos' [0.05] Volt	
Effect of Failure	**Service Guidance – First Check:**
Poor boost control, engine may overboost or underboost affecting drivability.	Check sensor connector and wiring for an open circuit or short to GND. Check continuity between sensor signal and ECU pins C-E4 and A-H2 for short to ground. Check the sensor resistance against the specification.

Related Component/Subsystem: Boost Pressure

DTC: P1235: PTP Data Drift High
SPN/FMI: 102/20
SFC: 373

Description	Enabling Conditions
Pre-throttle pressure is above the expected range.	Baro = 'C_PTP_IR_MinBaro' [70]kPa MAP >= 'C_PTP_IR_MinMAP' [30]kPa MAF >= 'C_PTP_IR_MinMAF'[20]g/s TPS Setpoint >= 'C_PTP_IR_MinTPS' [0]% FuelShutoff not active Engine in Diag Steady State if 'C_PTP_IR_SSEng_Diag_Allowed' [1] == YES After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
([PTP - Virtual PTP] / PTP) * 100 >= 'C_PTP_IRH_PercentError' [20]	
Effect of Failure	**Service Guidance – First Check:**
Poor boost control, engine may overboost or underboost affecting drivability.	Check for loose or corroded connectors and wires. Check the sensor resistance against the specification.

Related Component/Subsystem: Boost Pressure

DTC: P1236: PTP Data Drift Low
SPN/FMI: 102/21
SFC: 374

Description	Enabling Conditions
Pre-throttle pressure is below the expected range.	Baro = 'C_PTP_IR_MinBaro' [70]kPa MAP >= 'C_PTP_IR_MinMAP' [30]kPa MAF >= 'C_PTP_IR_MinMAF'[20]g/s TPS Setpoint >= 'C_PTP_IR_MinTPS' [0]% FuelShutoff not active Engine in Diag Steady State if 'C_PTP_IR_SSEng_Diag_Allowed' [1]== YES After clearing this Code, a total of 0 key cycles must occur before this fault can be set again

Malfunction Criteria
0 - ((PTP - Virtual PTP) / PTP) * 100 >= 'C_PTP_IRL_PercentError' [20]

Effect of Failure	Service Guidance – First Check:
Poor boost control, engine may overboost or underboost affecting drivability.	Check for loose or corroded connectors and wires. Check the sensor resistance against the specification.

Related Component/Subsystem: Boost Pressure

DTC: P023D: PTP/MAP Keyon Check
SPN/FMI: 102/31
SFC: 375

Description	Enabling Conditions
The pre-throttle pressure and manifold pressure disagree at key on, engine off when the pressures should be the same	Engine is transitioning to Running After clearing this Code, a total of 1 key cycles must occur before this fault can be set again

Malfunction Criteria
abs(Keyon MAP - Keyon PTP) > 'C_Keyon_PTP_MAP_Threshold' [5] kpa

Effect of Failure	Service Guidance – First Check:
Poor boost control, engine may overboost or underboost affecting drivability. May also affect fueling resulting in low power.	Check for loose or corroded connectors and wires on the MAP and PTP sensors. Check the sensor resistance against the specification on the MAP and PTP sensors.

Related Component/Subsystem: Boost Pressure

DTC: P018D: NGP Voltage High
SPN/FMI: 2980/3
SFC: 381

Description	Enabling Conditions
Fuel Pressure sensor volts too high Normally set if the NGP signal wire has become shorted to power, the NGP has failed or the ECM OH has failed.	Key = ON AND MPRD After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
NGP Raw Voltage > 'NGPInputHiFltPos' [4.95] Volt	
Effect of Failure	**Service Guidance – First Check:**
• The ECU has been programmed such a way; it will take default value of 700 kpa in case of electrical faults. • Possible low power or poor running.	• Check NGP sensor connector for corrosion or loose pin. • Check NGP sensor for an open circuit or short to power. • Check continuity between ECU pin to sensor pin. • Check short circuit between ECU pin and XDRP.

Related Component/Subsystem: Fuel Injection (FMV)

DTC: P018C: NGP Voltage Low
SPN/FMI: 2980/4
SFC: 382

Description	Enabling Conditions
Fuel Pressure sensor volts too low Normally set if the NGP pressure signal wire has been disconnected or shorted to ground or the circuit has opened to the ECM OH.	Key = ON AND MPRD After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
NGP Raw Voltage < 'NGPInputLoFltPos' [0.03] Volt	
Effect of Failure	**Service Guidance – First Check:**
• The ECU has been programmed such a way; it will take default value of 700 kpa in case of electrical faults • Possible low power or poor running	• Check NGP sensor connector for corrosion or loose pin. • Check NGP sensor for an open circuit or short to GND. • Check continuity between ECU pin to sensor pin. • Check short circuit between ECU pin and XDRG.

Related Component/Subsystem: Fuel Injection (FMV)

DTC: P0089: NGP Higher than Expected
SPN/FMI: 2980/16
SFC: 383

Description	Enabling Conditions
Fuel Pressure sensor volts too low Normally set if the NGP pressure signal wire has been disconnected or shorted to ground or the circuit has opened to the ECM OH.	Lock Off Enabled AND TimeSinceKeyOn > 'NGPKeyOnDly' [3] Second AND SFC >= 'C_NGP_IR_MinSFC' [2] Kg/hr AND Tank Pressure > 'NGP_Expected' + 'C_NGP_IR_NGTPDeltaThresh' [200] Kpa After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
NGP > 'NGP_Expected' + 'NGP_IR_Threshold' [140] Kpa	
Effect of Failure	**Service Guidance – First Check:**
• The ECU has been programmed such a way; it will take default value of 700 kpa in case of electrical faults • Possible low power or poor running	• Check pressure regulator setting has not been tampered. • Check continuity between ECU pin to sensor pin. • Check short circuit between ECU pin and XDRP.

Related Component/Subsystem: Fuel Pressure Regulator

DTC: P018B: NGP Lower than Expected
SPN/FMI: 2980/18
SFC: 384

Description	Enabling Conditions
Fuel Pressure too low Fuel pressure has been remaining lower than expected at current engine running condition.	Lock Off Enabled AND TimeSinceKeyOn > 'NGPKeyOnDly' [3] Second AND SFC < 'C_NGP_IR_MinSFC' [2] Kg/hr AND Tank Pressure > 'NGP_Expected' + 'C_NGP_IR_NGTPDeltaThresh' [200] Kpa After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
NGP < 'NGP_Expected' - 'NGP_IR_Threshold' [140] Kpa	
Effect of Failure	**Service Guidance – First Check:**
• The ECU has been programmed such a way; it will take default value of 700 kPa in case of electrical faults • Possible low power or poor running	• Check Fuel Tank pressure. • Check fuel filter for clogging. • Check proper connection between HP regulator bias port and intake manifold. • Check pressure regulator setting has not been tampered. • Check continuity between ECU pin to sensor pin. • Check short circuit between ECU pin and XDRG.

Related Component/Subsystem: Fuel Pressure Regulator

DTC: P0088: System Overpressure Fault
SPN/FMI: 2980/0
SFC: 385

Description	Enabling Conditions
Fuel system pressure abnormal high	Engine running
Fuel system pressure has exceeded 900kPa as default.	After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
NGP > 'System_OverPress_Thresh' [1500] Kpa threshold for 'C_System_Overpressure_ErrorTime' [0.04] Second within 'C_System_Overpressure_MaxErrorTime' [0.04] Second	
Effect of Failure	**Service Guidance – First Check:**
Possible shutdown engine	• Check pressure regulator setting has not been tampered • Check pressure regulator for defective regulation

Related Component/Subsystem: Fuel Pressure Regulator

DTC: P0094: NGP Leak
SPN/FMI: 1240/10
SFC: 386

Description	Enabling Conditions
NGP is leaking	Lockoff Disabled after Lockoff Enable > 'NGPKeyOnDly' [10] second
After engine shutdown this diagnosis monitors the NGP to determine if a possible leak is occurring in the fuel system. This fault indicates leakage either leaking tank pressure to fuel rail or leaking rail pressure to outside.	AND DriveCycle is NOT complete After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
(NGP_Max > 'NGP_Expected' + 'C_NGP_Lockup_Threshold' [150] Kpa OR NGP_Min < 'NGP_Expected' - 'C_NGP_Loss_Threshold' [100] Kpa) during 'C_NGP_Leak_CheckWindow' [3] second	
Effect of Failure	**Service Guidance – First Check:**
Possible low power or poor running or shutdown engine	• Check fuel line faults, loose pipe connection or damage on pipe fitting or fuel pipe or fuel device, between HP Regulator, Heat Exchanger and Fuel Metering Valve. • Check for gas leak from inlet to outlet when HP Lock-off valve is closed.

Related Component/Subsystem: Fuel Pressure Regulator

DTC: P0087: NGP Low
SPN/FMI: 2980/1
SFC: 387

Description	Enabling Conditions
Fuel system pressure abnormal low Fuel system pressure has been lower than 500kPa as default.	Engine is Running After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
NGP < 'C_NGP_Low_Threshold' [500] Kpa Threshold	
Effect of Failure	**Service Guidance – First Check:**
Possible shutdown engine	• Check Fuel Tank pressure. • Check fuel filter for clogging. • Check proper work on shut-off valve. • Check pressure regulator setting has not been tampered.

Related Component/Subsystem: Fuel Pressure Regulator

DTC: P1120: UEGO2 UN Fault
SPN/FMI: 3057/11
SFC: 411

Description	Enabling Conditions
UEGO sensor line short circuit. Open circuits not detected.	Engine in Running State AND ECUP On After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
(UEGO2_UNDiag == 1 *OR* UEGO2_UNDiag == 2 *OR* Sensor Not Warmed *AND* UA Volts < 0.2 V) for 'UEGO2_DiagDelayTimeThresh' [1.5] second	
Effect of Failure	**Service Guidance – First Check:**
Fueling errors resulting in possible low power and misfire	• Check UEGO sensor connector for corrosion or loose pin. • Check UEGO sensor for an open circuit or short circuit to ground. • Check continuity between ECU pin and UEGO sensor connector pin. • Check short circuit between ECU pin and XDRG.

Related Component/Subsystem: UEGO2

DTC: P1121: UEGO2 VM Fault
SPN/FMI: 3057/14
SFC: 412

Description	Enabling Conditions
UEGO virtual ground line short circuit. Open circuits not detected.	Engine in Running State AND ECUP On After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
UEGO2_VMDiag <=2	
Effect of Failure	**Service Guidance – First Check:**
Fueling errors resulting in possible low power and misfire	• Check UEGO virtual ground connector for corrosion or loose pin. • Check UEGO virtual ground for an open circuit or short circuit to ground. • Check continuity between ECU pin and UEGO virtual ground connector pin. • Check short circuit between ECU pin and XDRG.

Related Component/Subsystem: UEGO2

DTC: P1122: UEGO2 IA Fault
SPN/FMI: 3057/15
SFC: 413

Description	Enabling Conditions
UEGO trim sensor short circuit. Open circuits not detected.	Engine in Running State AND ECUP On After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
UEGO2_IADiag == 1 or UEGO2_IADiag == 2	
Effect of Failure	**Service Guidance – First Check:**
Fueling errors resulting in possible low power and misfire	• Check UEGO trim resistor connector for corrosion or loose pin. • Check UEGO trim resistor for an open circuit or short circuit to ground. • Check continuity between ECU pin and UEGO trim resistor connector pin. • Check short circuit between ECU pin and XDRG.

Related Component/Subsystem: UEGO2

DTC: P1124: UEGO2 Air Cal Sensor Failed Fault
SPN/FMI: 3057/2
SFC: 414

Description	Enabling Conditions
UEGO sensor air calibration has failed.	Keyon & Air Calibration has been run once in this key cycle. After clearing this Code, a total of key cycles must occur before this fault can be set again

Malfunction Criteria
UEGO2_BadAirCalCounter > 'UEGO2_BadAirCalCountThresh' [5] (UEGO2_BadAirCalCounter increments when UEGO2_AirCalMeasValid == 0 *or* UEGO2_AirCalLearnLwrLimit == 1 *or* UEGO2_AirCalLearnUprLimit == 1 after an air cal event completes, the counter decrements if the above conditions are false when air cal event completes) AND UEGO2_AirCalMeasValid == 0 (UEGO2_AirCalMeasValid == 0 if UEGO2_AirCalCorrRaw >= 1+ 'UEGO2_AirCalSensorFailedDelta' [0.2] + 'UEGO2_AirCalLearnLimitDelta' [0.15])

Effect of Failure	Service Guidance – First Check:
Fueling errors resulting in possible low power and misfire	• Check UEGO sensor connector for corrosion or loose pin. • Check continuity between ECU pin and UEGO sensor connector pin.

Related Component/Subsystem: UEGO2

DTC: P1125: UEGO2 Air Cal at Lower Limit
SPN/FMI: 3057/17
SFC: 415

Description	Enabling Conditions
UEGO sensor air calibration has reached the lower control limit.	KeyOn After clearing this Code, a total of 0 key cycles must occur before this fault can be set again

Malfunction Criteria
UEGO2_BadAirCalCounter > 'UEGO2_BadAirCalCountThresh' [5] AND UEGO2_AirCalLearnLwrLimit == 1 (UEGO2_AirCalLearnLwrLimit == 1 if UEGO2_AirCalCorrFactor <= 1 - 'UEGO2_AirCalLearnLimitDelta' [0.15])

Effect of Failure	Service Guidance – First Check:
Fueling errors resulting in possible low power and misfire	• Check UEGO sensor connector for corrosion or loose pin. • Check continuity between ECU pin and UEGO sensor connector pin.

Related Component/Subsystem: UEGO2

DTC: P2626: UEGO2 Air Cal at Upper Limit
SPN/FMI: 3057/16
SFC: 416

Description	Enabling Conditions
UEGO sensor air calibration has reached the upper control limit.	KeyOn After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
UEGO2_BadAirCalCounter > 'UEGO2_BadAirCalCountThresh' [5] AND UEGO2_AirCalLearnUprLimit == 1 (UEGO2_AirCalLearUprLimit == 1 if UEGO2_AirCalCorrFactor >= 1 + 'UEGO2_AirCalLearnLimitDelta' [0.15]	
Effect of Failure	**Service Guidance – First Check:**
Fueling errors resulting in possible low power and misfire	• Check UEGO sensor connector for corrosion or loose pin. • Check continuity between ECU pin and UEGO sensor connector pin.

Related Component/Subsystem: UEGO2

DTC: P1138: UEGO2 UA Voltage High
SPN/FMI: 3057/3
SFC: 417

Description	Enabling Conditions
Lambda output amplifier voltage too high. This can be set if the output is shorted to power, there is a failure of the UEGO, or there is a failure in the ECM-OH / CJ125 IC.	Engine is running AND Sensor is warm After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
UEGO2_UA_Volts > 'UEGO2_UAInputHiFltPos' [5.1] Volt	
Effect of Failure	**Service Guidance – First Check:**
Fueling errors resulting in possible low power and misfire	• Check UEGO sensor output connector for corrosion or loose pin. • Check UEGO sensor for a short circuit to power. • Check continuity between ECU pin and UEGO sensor connector pin. • Check short circuit between ECU pin and XDRP.

Related Component/Subsystem: UEGO2

DTC: P1137: UEGO2 UA Voltage Low
SPN/FMI: 3057/4
SFC: 418

Description	Enabling Conditions
Lambda output amplifier voltage too low. This can be set if the output is shorted to ground, the output is disconnected, or there is a failure of the UEGO, or there is a failure in the ECM-OH / CJ125 IC.	Engine in running AND Sensor Warm After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
UEGO2_UA_Volts < 'UEGO2_UAInputLoFltPos' [0.5] Volt	
Effect of Failure	**Service Guidance – First Check:**
Fueling errors resulting in possible low power and misfire	• Check UEGO sensor output connector for corrosion or loose pin. • Check UEGO sensor for a short circuit to ground. • Check continuity between ECU pin and UEGO sensor connector pin. • Check short circuit between ECU pin and XDRP.

Related Component/Subsystem: UEGO2

DTC: P1126: UEGO2 UR Voltage High
SPN/FMI: 855/3
SFC: 441

Description	Enabling Conditions
UEGO Sensor signal resistance output voltage too high.	Engine is running AND Sensor is warm After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
UEGO2_UR_Volts > 'UEGO2_URInputHiFltPos' [4.9] Volt	
Effect of Failure	**Service Guidance – First Check:**
Fueling errors resulting in possible low power and misfire	• Check UEGO sensor output connector for corrosion or loose pin. • Check UEGO sensor for a short circuit to power. • Check continuity between ECU pin and UEGO sensor connector pin. • Check short circuit between ECU pin and XDRP.

Related Component/Subsystem: UEGO2

DTC: P1127: UEGO2 UR Voltage Low
SPN/FMI: 855/4
SFC: 442

Description	Enabling Conditions
Nernst cell resistance output voltage too low.	Engine is running AND Sensor is warm After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
UEGO2_UR_Volts < 'UEGO2_URInputLoFltPos' [0.2] Volt	
Effect of Failure	**Service Guidance – First Check:**
Fueling errors resulting in possible low power and misfire	• Check UEGO sensor output connector for corrosion or loose pin. • Check UEGO sensor for a short circuit to ground. • Check continuity between ECU pin and UEGO sensor connector pin. • Check short circuit between ECU pin and XDRP.

Related Component/Subsystem: UEGO2

DTC: P1123: UEGO2 IP Fault
SPN/FMI: 3057/0
SFC: 443

Description	Enabling Conditions
UEGO pump current line short circuit. Open circuits not detected.	O2CtrlMode = Closed Loop > 'UEGO2_O2CtrlDelayTimeThresh' [5] THEN IP Activity Check Active for 'UEGO2_IPOpenCheckTime' [40] IP Acivity Check Active resets once CheckTime is reached After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
MAX of [abs(UEGO2_IP_MaxValue - 1) & abs(1 - UEGO2_IP_MinValue)] < 'UEGO2_IP_Stuck' [0.02]	
Effect of Failure	**Service Guidance – First Check:**
Fueling errors resulting in possible low power and misfire	• Check UEGO pump current connector for corrosion or loose pin. • Check UEGO pump current for an open circuit or short circuit to ground. • Check continuity between ECU pin and UEGO pump current connector pin. • Check short circuit between ECU pin and XDRG.

Related Component/Subsystem: UEGO2

DTC: P0340: CAM Sensor Loss Fault
SPN/FMI: 637/7
SFC: 421

Description	Enabling Conditions
CAM Loss Fault The purpose of this diagnostics algorithm is to check CAM Sensor Loss Fault. The fault can be caused by cam sensor failure, unconnected cam sensor, or shorted to ground.	RPM > 'C_Encoder_RPM_Threshold' [0] After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
CamErrorCnt >= 'C_CAM_ErrorCount_Thresh' [3] AND CamError == 2 (Loss)	
Effect of Failure	**Service Guidance – First Check:**
• If the fault happens during cranking, it will trigger Fall back mode to get engine start with Crank sensor only. • Possible engine shutdown when Crank sensor loss fault occurs.	• Check CAM sensor connector to find loose pin, damaged pin or corrosion. • Check open or short circuit on CAM sensor. • Check CAM sensor installation if sensor has been installed with proper Air Gap. • Check CAM encoder for mechanical damage. • Check continuity between ECU pin to CAM sensor pin. • Check short circuit between ECU pin and XDRG/XDRP.

Related Component/Subsystem: Cam Sensor

DTC: P0335: CRANK Sensor Loss Fault
SPN/FMI: 636/7
SFC: 422

Description	Enabling Conditions
Crank Loss Fault The purpose of this diagnostics is to detect Crank Sensor Loss Fault. The fault can be caused by crank sensor failure, unconnected crank sensor, or shorted to ground.	After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
CrankErrorCnt >= 'C_CNKLoss_ErrorCount_Thresh' [3] AND CrankError == 2 (Loss)	
Effect of Failure	**Service Guidance – First Check:**
• Possible engine starting issues. • Possible engine shutdown when CAM sensor loss fault occurs.	• Check Crank sensor connector to find loose pin, damaged pin or corrosion. • Check open or short circuit on Crank sensor. • Check Crank sensor installation if sensor has been installed with proper Air Gap. • Check Crank encoder for mechanical damage. • Check continuity between ECU pin to Crank sensor pin. • Check short circuit between ECU pin and XDRG/XDRP.

Related Component/Subsystem: Crank Sensor

DTC: P0315: CRANK Sensor Sync Fault
SPN/FMI: 636/2
SFC: 423

Description	Enabling Conditions
Crank Sync Fault The purpose of this diagnostics is to detect Crank Sensor Sync Fault. The fault can be caused by Crank sensor shifting or CAM sensor shifting.	After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
CrankErrorCnt >= 'C_CNKSync_ErrorCount_Thresh' [3] AND CrankError == 1 (Sync)	
Effect of Failure	**Service Guidance – First Check:**
• Possible engine starting issues. • Possible ignition timing shifts.	• Check Crank sensor installation if sensor sifts from correct position. • Check CAM sensor installation if sensor sifts from correct position. • Check CAM encoder installation if encoder sifts from correct position. • Check Crank encoder for mechanical damage. • Check CAM encoder for mechanical damage.

Related Component/Subsystem: Crank Sensor

DTC: P0016: CAM Sensor Phase Fault
SPN/FMI: 637/2
SFC: 424

Description	Enabling Conditions
CAM Phase Fault The purpose of this diagnostics is to detect CAM Sensor phase fault. The fault can be caused by aged timing belt, CAM sensor shifting, or CAM sensor/time belt installation.	RPM > 'C_Encoder_RPM_Threshold' [0] After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
CnkCamPhaseErrorCnt >= 'C_CAMPhase_ErrorCount_Thresh' [3] (By measuring 0 tooth phase, if phase is over threshold, ErrorCnt increases)	
Effect of Failure	Service Guidance – First Check:
Possible engine shutdown when Crank sensor loss fault occurs.	• Check CAM encoder installation if encoder sifts from correct position. • Check timing belt for mechanical damage. • Check CAM encoder for mechanical damage.

Related Component/Subsystem: Cam Sensor

DTC: P0339: CRANK Sensor Other Fault
SPN/FMI: 636/11
SFC: 425

Description	Enabling Conditions
Crank Fault Other The purpose of this diagnostics is to detect Crank Sensor Fault other than Loss and Sync. The fault can be caused by crank sensor noise.	After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
CrankErrorCnt >= 'C_CNK_ErrorCount_Thresh' [3] AND CrankError != 1 or 2	
Effect of Failure	**Service Guidance – First Check:**
Possible engine starting issues.	• Check Crank sensor connector to find loose pin, damaged pin or corrosion. • Check shielding for Crank sensor wiring. • Check Crank sensor installation if sensor has been installed with proper Air Gap. • Check Crank encoder for mechanical damage.

Related Component/Subsystem: Crank Sensor

DTC: P0344: CAM Sensor Other Fault
SPN/FMI: 637/11
SFC: 426

Description	Enabling Conditions
CAM Fault Other The purpose of this diagnostics is to detect CAM Sensor Fault other than loss. The typical ones are half cycle and synchronization faults. The fault can be caused by CAM sensor failure, CAM sensor noise, or CAM sensor installation.	RPM > 'C_Encoder_RPM_Threshold' [0] After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
CamErrorCnt >= 'C_CAM_ErrorCount_Thresh' [3] AND CamError != 2	
Effect of Failure	**Service Guidance – First Check:**
Possible engine shutdown when Crank sensor loss fault occurs.	• Check CAM sensor connector to find loose pin, damaged pin or corrosion. • Check shielding for CAM sensor wiring. • Check CAM sensor installation if sensor has been installed with proper Air Gap. • Check CAM encoder for mechanical damage.

Related Component/Subsystem: Cam Sensor

DTC: P0219: Engine Soft OverSpeed
SPN/FMI: 190/15
SFC: 427

Description	Enabling Conditions
Engine speed has exceeded first level (1 of 3) of overspeed protection	FuelShutOff not active After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Engine Speed > 'BaseRevLimit' [2550] RPM THEN Engine Speed > 'BaseRevLimit' [2550] - 'RevLimitHyst' [20] RPM AND Medium OverSpeed not Active	
Effect of Failure	**Service Guidance – First Check:**
None after engine speed returns to normal	Usually associated with additional ETC faults Check for ETC Sticking or other ETC faults Verify if the vehicle was motored down a steep grade

Related Component/Subsystem: Engine Speed

DTC: P1208: Engine Medium OverSpeed
SPN/FMI: 190/16
SFC: 428

Description	Enabling Conditions
Engine speed has exceeded second level (2 of 3) of overspeed protection	FuelShutOff not active After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Engine Speed > 'BaseRevLimit' [2550] RPM + 'MediumRevOffset' [70] RPM THEN Engine Speed > 'BaseRevLimit' [2550] RPM + 'MediumRevOffset' [70] RPM - 'RevLimitHyst' [20] RPM AND Hard OverSpeed not Active	
Effect of Failure	**Service Guidance – First Check:**
None after engine speed returns to normal	None, Disabled

Related Component/Subsystem: Engine Speed

DTC: P1209: Engine Hard Overspeed
SPN/FMI: 190/0
SFC: 429

Description	Enabling Conditions
Engine speed has exceeded third level (3 of 3) of overspeed protection	FuelShutOff not active After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Engine Speed > 'BaseRevLimit' [2550]+ 'HardRevOffset' [100] THEN Engine Speed > 'BaseRevLimit' [2550]+ 'HardRevOffset' [100] - 'RevLimitHyst' [20]	
Effect of Failure	**Service Guidance – First Check:**
None after Engine Speed returns to normal	Usually associated with additional ETC faults Check for ETC Sticking or other ETC faults Verify if the vehicle was motored down a steep grade

Related Component/Subsystem: Engine Speed

DTC: P0500: Vehicle Speed Insufficient Activity
SPN/FMI: 84/2
SFC: 431

Description	Enabling Conditions
Engine is under load but no road speed is sensed. Possible tampering with road speed sensor	RPM >= 'RPMMinThreshRSGFault' [1200] RPM threshold AND MAP >= 'MAPMinThreshRSGFault' [60] Kpa threshold for 'C_RSGFault_DelayTime' [5] Second After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Road Speed < 'RSGThreshRSGFault' [5] Kph threshold	
Effect of Failure	**Service Guidance – First Check:**
Vehicle speed features such as Road Speed Limiting or Cruise control will not function. Engine power may be limited	Check continuity between ECU pin to sensor pin A2. Check for 24V Vbat supply coming to sensor. Check RSG connector and wiring open or short to power or GND Check vehicle Speed sensor

Related Component/Subsystem: Vehicle Speed

DTC: P0527: Fan Speed Unexpected Noise
SPN/FMI: 1639/8
SFC: 433

Description	Enabling Conditions
Noise has been detected on the cooling fan speed signal	KeyOn AND FanSpeed>0 After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
Fan Speed Duty Cycle > 'C_FanSpd_DC_UpperThresh' [55] Threshold OR Fan Speed duty Cycle < 'C_FanSpd_DC_LowerThresh' [45] OR Fan Speed Frequency > 'C_FanSpd_Freq_UpperThresh' [5000] Hz Threshold	
Effect of Failure	**Service Guidance – First Check:**
No driver perceptible effect	Check continuity between Fan Speed sensor pins and ECU pins Check Fan Speed Sensor Continuity

Related Component/Subsystem: Engine Fan

DTC: P0483: Fan Speed Close Loop Control
SPN/FMI: 1639/7
SFC: 434

Description	Enabling Conditions
Cooling Fan speed is zero when Cooling Fan should be turning	Fan1_Output > 'FanNoSpeed_MinDC' [45] % AND EngineState = Run After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
FanSpeed < 'FanNoSpeed_MinSpeed' [300] RPM	
Effect of Failure	**Service Guidance – First Check:**
Engine may run hotter than normal or overheat	Check continuity between Fan Speed sensor pins and ECU pins Check Fan Speed Sensor Continuity Check continuity between Cooling Fan pins and ECU pins Check Cooling Fan Continuity

Related Component/Subsystem: Engine Fan

DTC: P0318: Rough Road Voltage High
SPN/FMI: 516098/3
SFC: 436

Description	Enabling Conditions
Rough road sensor voltage is high.	Key = ON AND MPRD After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
RoughRoad Raw Voltage > 'RoughRoadInputHiFltPos' [4.25] Volt	
Effect of Failure	**Service Guidance – First Check:**
There will be an increased chance of detecting false misfires.	• Check rough road sensor output connector for corrosion or loose pin. • Check rough road sensor for a short circuit to power. • Check continuity between ECU pin and rough road sensor connector pin. • Check short circuit between ECU pin and XDRP.

Related Component/Subsystem: Rough Road Sensor

DTC: P1318: Rough Road Voltage Low
SPN/FMI: 516098/4
SFC: 437

Description	Enabling Conditions
Rough road sensor voltage is low.	Key = ON AND MPRD After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
RoughRoad Raw Voltage < 'RoughRoadInputLoFltPos' [0.75] Volt	
Effect of Failure	**Service Guidance – First Check:**
There will be an increased chance of detecting false misfires.	• Check rough road sensor output connector for corrosion or loose pin. • Check rough road sensor for a short circuit to ground. • Check continuity between ECU pin and rough road sensor connector pin. • Check short circuit between ECU pin and XDRG.

Related Component/Subsystem: Rough Road Sensor

DTC: P1319: Rough Road In Range High
SPN/FMI: 516098/16
SFC: 438

Description	Enabling Conditions
Rough road sensor is stuck in range high.	Road Speed <0.1 kph After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
abs(Rough Road)> 'C_RoughRoad_IRH_Threshold' [0.3] g	
Effect of Failure	**Service Guidance – First Check:**
There will be an increased chance of detecting false misfires.	• Check rough road sensor output connector for corrosion or loose pin. • Check rough road sensor for a short circuit to power. • Check continuity between ECU pin and rough road sensor connector pin. • Check short circuit between ECU pin and XDRP.

Related Component/Subsystem: Rough Road Sensor

DTC: P1320: Rough Road Sensor Stuck
SPN/FMI: 516098/2
SFC: 439

Description	Enabling Conditions
Rough road sensor is stuck in range.	Road Speed > 'C_RoughRoad_Stuck_MinRoadSpeed' [40] kph After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
Rough Road Max- Rough Road Min < 'RoughRoad_STUCK' [0.3] g in 'C_RoughRoad_Stuck_CheckTime' [5] sec	
Effect of Failure	**Service Guidance – First Check:**
There will be an increased chance of detecting false misfires.	• Check rough road sensor output connector for corrosion or loose pin. • Check rough road sensor for a short circuit to other pins. • Check continuity between ECU pin and rough road sensor connector pin.

Related Component/Subsystem: Rough Road Sensor

DTC: P0171: Adaptive Learn Correction on Hi Limit
SPN/FMI: 1695/16
SFC: 471

Description	Enabling Conditions
Adaptive fuel control at high limit. Fuel system may not be able to reach intended air-fuel ratio. This can be due to any number of causes such as natural gas pressure (pressure, regulator, sensor), failing exhaust gas oxygen sensor, fuel injector problems (disconnected, stuck open or closed).	Fuel Adaptive is Enabled After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Fuel Adapt > = ('FuelFlowCompMaxValue' [1.2] - 0.01)	
Effect of Failure	**Service Guidance – First Check:**
• Engine may run leaner than desired. • Engine may misfire or stall if too lean.	• Check natural gas pressure • Check natural gas pressure sensor • Check exhaust gas oxygen sensor • Check fuel injectors for disconnection, plugging, or stuck closed

Related Component/Subsystem: Fuel Injection (FMV)

DTC: P0172: Adaptive Learn Correction on Low Limit
SPN/FMI: 1695/18
SFC: 472

Description	Enabling Conditions
Adaptive fuel control at low limit. Fuel system may not be able to reach intended air-fuel ratio. This can be due to any number of causes such as natural gas pressure (pressure, regulator, sensor), failing exhaust gas oxygen sensor, fuel injector problems (disconnected, stuck open or closed).	Fuel Adaptive is Enabled After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Fuel Adapt < = ('FuelFlowCompMinValue' [0.8]+ 0.01)	
Effect of Failure	**Service Guidance – First Check:**
• Engine may run leaner than desired. • Engine may misfire or stall if too lean.	• Check natural gas pressure • Check natural gas pressure sensor • Check exhaust gas oxygen sensor • Check fuel injectors for stuck open

Related Component/Subsystem: Fuel Injection (FMV)

DTC: P0148: Fuel Per Cylinder at Limit
SPN/FMI: 633/15
SFC: 473

Description	Enabling Conditions
Fuel quantity (per cylinder) at maximum limit. Fuel system may not be able to reach intended air-fuel ratio. This can be due to any number of causes such as natural gas pressure (pressure, regulator, sensor), failing exhaust gas oxygen sensor, fuel injector problems (disconnected, stuck open or closed).	Engine is Running After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
FPCLimitErr < 0	
Effect of Failure	**Service Guidance – First Check:**
• Engine may run leaner than desired. • Engine may misfire or stall if too lean.	• Check natural gas pressure • Check natural gas pressure sensor • Check exhaust gas oxygen sensor • Check fuel injectors for disconnection, plugging, stuck open or closed

Related Component/Subsystem: Fuel Injection (FMV)

DTC: P0832: Clutch Switch Stuck on Fault
SPN/FMI: 598/3
SFC: 451

Description	Enabling Conditions
Clutch switch indicates driveline disconnected while engine is under load	Road Speed >= 'ClutchStuck_RoadSpdLmt' [60] Kph AND APP >= 'ClutchStuck_APPLmt' [20] % After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
ClutchSw == 1	
Effect of Failure	**Service Guidance – First Check:**
No driver perceptible effect	Check continuity of wires between clutch switch and ECU Check for short from clutch switch signal wire to ECU XDRG pin Check for proper operation of clutch switch

Related Component/Subsystem: Switch Inputs

DTC: P0852: Neutral Switch Stuck on Fault
SPN/FMI: 604/2
SFC: 452

Description	Enabling Conditions
Neutral switch indicates driveline disconnected while engine is under load	Road Speed >= 'NeutralStuck_RoadSpdLmt' [60] Kph AND APP >='NeutralStuck_APPLmt' [20] % After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
NeutralSw == 1	
Effect of Failure	**Service Guidance – First Check:**
No driver perceptible effect	Check continuity of wires between neutral switch and ECU Check for short from neutral switch signal wire to ECU XDRG pin Check for proper operation of neutral switch

Related Component/Subsystem: Switch Inputs

DTC: P0571: Brake No Switch
SPN/FMI: 597/4
SFC: 453

Description	Enabling Conditions
Brake switch not changing through several drive cycles of the vehicle	Engine is Running After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
In 'MaxBrakeSW_TestCtr' [10] times Road Speed changes from 'MaxVSSBrakeSW_Test' [25] kph to 'MinVSSBrakeSW_Test' [2] kph, Brake state swtiches less than 10 - 'BrakeSWFailures_Allowed' [2]	
Effect of Failure	**Service Guidance – First Check:**
No driver perceptible effect	Check continuity of wires between brake switch and ECU Check for short from brake switch signal wire to ECU XDRG pin Check for proper operation of Brake switch

Related Component/Subsystem: Switch Inputs

DTC: P0830: Clutch No Switch
SPN/FMI: 598/4
SFC: 454

Description	Enabling Conditions
Clutch switch not changing through several drive cycles of the vehicle	Engine is Running After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
In 'MaxClutchSW_TestCtr' [10] times Road Speed changes from 'MinVSSClutchSW_Test' [2] kph to 'MaxVSSClutchSW_Test' [25] kph, Clutch state swtiches less than 10 - 'ClutchSWFailures_Allowed' [2]	
Effect of Failure	**Service Guidance – First Check:**
No driver perceptible effect	Check continuity of wires between clutch switch and ECU Check for short from clutch switch signal wire to ECU XDRG pin Check for proper operation of clutch switch

Related Component/Subsystem: Switch Inputs

DTC: P0900: Clutch Neutral Switch disconnected
SPN/FMI: 598/2
SFC: 455

Description	Enabling Conditions
Clutch/Neutral Switch indicates driveline disconnected while engine is under load	RPM >= 'RPMMinThreshRSGFault' [1200] rpm threshold AND MAP >= 'MAPMinThreshRSGFault' [80] Kpa threshold After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
'ClutchNeutralSw' == 1	
Effect of Failure	**Service Guidance – First Check:**
No driver perceptible effect	Check continuity of wires between clutch/neutral switch and ECU Check for short from clutch/neutral switch signal wire to ECU XDRG pin Check for proper operation of clutch/neutral switch

Related Component/Subsystem: Switch Inputs

DTC: P0512: Starter Switch Stuck On
SPN/FMI: 1675/2
SFC: 456

Description	Enabling Conditions
Starter Switch stuck in 'On' state since key-on	TimeSinceKeyOn > 'StarterStuck_TestTime' [30] seconds After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
'StarterCtrl_Switch' == 1	
Effect of Failure	**Service Guidance – First Check:**
Engine will not crank	Check continuity of wires between starter switch and ECU Check for short from starter switch signal wire to ECU XDRG pin Check for proper operation of starter switch

Related Component/Subsystem: Switch Inputs

DTC: P0564: Cruise Switch Stuck On
SPN/FMI: 596/2
SFC: 457

Description	Enabling Conditions
Cruise Enable Switch stuck in 'On' state since key-on	TimeSinceKeyOn > 'CruiseStuck_TestTime' [0.25] seconds After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
'CruiseEnableSwitch' == 1	
Effect of Failure	**Service Guidance – First Check:**
Cruise control not operable	Check continuity of wires between cruise enable switch and ECU Check for short from cruise enable switch signal wire to ECU XDRG pin Check for proper operation of cruise enable switch

Related Component/Subsystem: Switch Inputs

DTC: P251C: PTO Switch Stuck On
SPN/FMI: 980/2
SFC: 458

Description	Enabling Conditions
PTO Enable Switch stuck in 'On' state since key-on	TimeSinceKeyOn > 'PTOStuck_TestTime' [0.25] seconds After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
'PTO_AC_Switch' == 1	
Effect of Failure	**Service Guidance – First Check:**
PTO control not operable	Check continuity of wires between PTO enable switch and ECU Check for short from PTO enable switch signal wire to ECU XDRG pin Check for proper operation of PTO enable switch

Related Component/Subsystem: Switch Inputs

DTC: P081C: Parking Brake Swtich Stuck On
SPN/FMI: 70/2
SFC: 459

Description	Enabling Conditions
Parking Brake Switch input is on while road speed is above a threshold	RoadSpeed >= 'ParkBrakeStuck_RoadSpdLmt' [250] kmh After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
ParkingBrakeSwitch ==1	
Effect of Failure	**Service Guidance – First Check:**
No driver perceptible effect	Check continuity of wires between parking brake switch and ECU Check for short from parking brake switch signal wire to ECU XDRG pin Check for proper operation of parking brake switch

Related Component/Subsystem: Switch Inputs

DTC: P0546: Engine EGT-Voltage High
SPN/FMI: 173/3
SFC: 491

Description	Enabling Conditions
Exhaust Gas Temperature sensor voltage out of range high	MPRD AND Engine Run Time > 'C_EGTMax_MinEngineRunTime' [30] sec AND ECT > 'C_EGTMax_MinECT' [50] Deg After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
EGT Raw Voltage > 'EGTMax' [4.95] Volt	
Effect of Failure	**Service Guidance – First Check:**
No driver perceptible effect	Check if EGT sensor is shorted to +5Vdc or battery. Check continuity between ECU EGT signal pin to sensor pin. Check continuity between ECU EGT signal pin to ECU ground pin for short to ground Check the sensor resistance against the specification.

Related Component/Subsystem: Exhaust Temperature

DTC: P0545: Engine EGT-Voltage Low
SPN/FMI: 173/4
SFC: 492

Description	Enabling Conditions
Exhaust Gas Temperature sensor voltage out of range low	Key = ON AND MPRD After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
EGT Raw Voltage < 'EGTMin' [0.05] Volt	
Effect of Failure	**Service Guidance – First Check:**
No driver perceptible effect	Check continuity between ECU EGT signal pin to sensor pin. Check continuity between ECU EGT signal pin to ECU ground pin for short to ground Check the sensor resistance against the specification.

Related Component/Subsystem: Exhaust Temperature

DTC: P2428: Engine EGT-Temperature HTE
SPN/FMI: 173/0
SFC: 493

Description	Enabling Conditions
Exhaust Gas Temperature higher than expected	Engine Running After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
Exhaust temperature > 'EGTOverTempThresh' [800] DegC for 'C_EGTOverTemp_ErrorTime' [2] Second within 'C_EGTOverTemp_MaxErrorTime' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
No driver perceptible effect	Check if engine has had excessive load for extended period Check ignition timing Check the sensor resistance against the specification.

Related Component/Subsystem: Exhaust Temperature

DTC: P2081: EGT Differs from Other Sensors
SPN/FMI: 173/2
SFC: 497

Description	Enabling Conditions
Exhaust Gas Temperature much different from other temperature sensors	KeyOffTimer> 'C_TempSenseDiffer_MinKeyOffTime' [28800] sec AND ECUP Delay Time > 'C_PowerTrigger_DlyTime' [1] sec AND KeyOffTimer Status is good AND 'TempSensDiffer_MaxAvgKeyOn' [30] DegC >=Average Temp >='TempSensDiffer_MinAvgKeyOn' [0] DegC After clearing this Code, a total of key cycles must occur before this fault can be set again
Malfunction Criteria	
abs(EGT- Average Temp) > 'EGT_AvgDeltaThresh' [6] DegC	
Effect of Failure	**Service Guidance – First Check:**
No driver perceptible effect	Check Sensor temperature against actual ambient temperature when engine is cold Check the sensor resistance against the specification.

Related Component/Subsystem: Exhaust Temperature

DTC: P0403: EGR Valve H bridge Fault
SPN/FMI: 2791/6
SFC: 511

Description	Enabling Conditions
EGR Valve driver circuit faulted	Key = ON AND MPRD After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
'EGRVHBridgeFaultState' ==1	
Effect of Failure	**Service Guidance – First Check:**
EGR disabled	Check continuity of EGR valve driver wiring. Check for short to ground, short to VBAT, short to +5V Check for Corroded connections Check EGR Valve resistance

Related Component/Subsystem: EGR

DTC: P0487: EGR Valve Open Fault
SPN/FMI: 2791/5
SFC: 512

Description	Enabling Conditions
EGR Valve open circuit	'EGRV_DriverDutyCycle' > 'EGRV_OC_MIN' [80] AND Key = ON AND MPRD After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
'EGRV_DriveCurrent' < 'EGRV_I_MIN' [5] mA for 'C_EGRV_Open_ErrorTime' [1] Second within 'C_EGRV_Open_MaxErrorTime' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
EGR Disabled	Check continuity of EGR valve driver wiring. Check for short to ground, short to VBAT, short to +5V Check for Corroded connections Check EGR Valve resistance

Related Component/Subsystem: EGR

DTC: P2413: EGR Spring Test Fault
SPN/FMI: 2791/2
SFC: 513

Description	Enabling Conditions
EGR Spring test failed	Spring Test Completed After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
'EGRVSpringTestTime' > 'EGRV_SpringTestFailTimeThresh' [3] Second	
Effect of Failure	**Service Guidance – First Check:**
Excessive EGR flow	Check EGR valve for binding or excessive carbon buildup Check plunger for proper return to closed position

Related Component/Subsystem: EGR

DTC: P0400: EGR Valve Stuck
SPN/FMI: 2791/7
SFC: 514

Description	Enabling Conditions
EGR valve position error	SetPointMode == 0 AND No CutEGRVAction action No EGRV_StallStateShutdown No Duty CYcle Override Enabled AND Time Since Run > 'EGRV_Sticking_DelayTime' [15] Second After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
(Position Error > 'EGRV_StickingThresh' [5] AND NO EGR Control Error sign Change) OR EGRVIMin >= 'EGRV_PositionITerm' AND 'EGRV_IStickEnable' [1] == 1 OR EGRVIMax <= 'EGRV_PositionITerm' AND 'EGRV_IStickEnable' [1] == 1'	
Effect of Failure	**Service Guidance – First Check:**
Inaccurate EGR flow	Check EGR valve for binding or excessive carbon buildup

Related Component/Subsystem: EGR

DTC: P0402: EGR High Flow
SPN/FMI: 2659/16
SFC: 515

Description	Enabling Conditions
EGR flow rate higher than commanded	EGRReference < 'C_EGRHiFlow_MaxCmdFaultEnable' [15]% AND 'C_EGR_HiFlow_MinRPM' [600] < RPM < 'C_EGR_HiFlow_MaxRPM' [2000] AND 'C_EGR_HiFlow_MinLoad' [50] < MAP < 'C_EGR_HiFlow_MaxLoad' [200] AND EGR in Close Loop AND Engine is Steady State After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
(EGR PID Error < 'C_EGRHiFlow_ErrFaultLimit' [-3] % for 'C_EGRHiFlow_ErrorTime' [20] Second within 'C_EGRHiFlow_MaxErrorTime' [30] Second	
Effect of Failure	**Service Guidance – First Check:**
Excessive EGR flow	Check EGR valve for binding or excessive carbon buildup

Related Component/Subsystem: EGR

DTC: P0401: EGR Low Flow
SPN/FMI: 2659/18
SFC: 516

Description	Enabling Conditions
EGR flow rate lower than commanded	EGRReference > 'C_EGRLowFlow_MinCmdFaultEnable' [3] % AND 'C_EGR_LowFlow_MinRPM' [600] < RPM < 'C_EGR_LowFlow_MaxRPM' [2000] AND 'C_EGR_LowFlow_MinLoad' [50] < MAP < 'C_EGR_LowFlow_MaxLoad' [200] AND EGR in Close Loop AND Engine is Steady State After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
(EGR PID Error > 'C_EGRLowFlow_ErrFaultLimit' [3] % for 'C_EGRLowFlow_ErrorTime' [20] Second within 'C_EGRLowFlow_MaxErrorTime' [30] Second	
Effect of Failure	**Service Guidance – First Check:**
Not enough EGR flow	Check EGR valve for binding or excessive carbon buildup

Related Component/Subsystem: EGR

DTC: P2457: EGR Cooling Fault
SPN/FMI: 4752/11
SFC: 518

Description	Enabling Conditions
EGR temperature is not as expected	TimeSinceRun >'EGRCoolingFltRunThresh' [60] Second AND PTP < 'EGRCoolingFltMaxPTP' [200] Kpa AND RPM > 'EGRCoolingFaultMinRPM' [1000] RPM AND EGR Actual Pcnt > 'EGRCoolingFltMinEGR' [20] % AND Engine is at Steady State (Diag) for 'C_EGRCooling_SS_DelayTime' [20] sec After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
(EGT - EGRT)/(EGT-ECT) < {EGRCoolingEffThresh} based on EGR Flow for 'C_EGRCooling_ErrorTime' [20] Second within 'C_EGRCooling_MaxErrorTime' [30] Second	
Effect of Failure	**Service Guidance – First Check:**
Excessive carbon buildup and/or excessive heat	Check EGR cooling system for blockage, carbon buildup, dirt, and coolant flow

Related Component/Subsystem: EGR

DTC: P1400: EGR Flow not as expected
SPN/FMI: 2659/7
SFC: 517

Description	Enabling Conditions
EGR flow not as expected	EGRMon_Done = 1 AND EGR_Mon_FIR_Complete_Tests = 'C_EGR_Mon_FIR_TestNum' [2] After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
EGR_Mon_EWMA_DeltaPhi < 'C_EGR_Mon_OBD_Threshold' [0.02] with FIR	
Effect of Failure	**Service Guidance – First Check:**
Inaccurate EGR flow	Check EGR valve for binding or excessive carbon buildup

Related Component/Subsystem: EGR

DTC: P040D: EGR Temperature Range High
SPN/FMI: 412/3
SFC: 519

Description	Enabling Conditions
EGR temperature sensor signal voltage too high. Sets when the signal wire has been disconnected or shorted to battery power or 5V sensor power.	Key = ON AND MPRD After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
EGRT Raw Voltage > 'EGRTMax' [4.95] Volt	
Effect of Failure	**Service Guidance – First Check:**
No driver perceptible effect	Check sensor connector and wiring for open circuit or short to power. Check continuity between sensor signal pin and ECU pins C-E3 and A-H1 for short to power. Check the sensor resistance against the specification.

Related Component/Subsystem: EGR

DTC: P040C: EGR Temperature Range Low
SPN/FMI: 412/4
SFC: 521

Description	Enabling Conditions
EGR temperature sensor signal voltage too low. Sets when the signal wire has been shorted to ground.	Key = ON AND MPRD After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
EGRT Raw Voltage < 'EGRTMin' [0.05] Volt	
Effect of Failure	**Service Guidance – First Check:**
No driver perceptible affect	Check sensor connector and wiring for a short to GND. Check continuity between sensor signal and ECU pins C-E4 and A-H2 for short to ground. Check the sensor resistance against the specification.

Related Component/Subsystem: EGR

DTC: P040B: EGR Over temperature Fault
SPN/FMI: 412/0
SFC: 522

Description	Enabling Conditions
EGR Temperature is too high.	Key = ON After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
EGR Temperature > 'EGRTOverTempThresh' [700] DegC for 'C_EGRTOverTemp_ErrorTime' [5] Second within 'C_EGRTOverTemp_MaxErrorTime' [10] Second	
Effect of Failure	**Service Guidance – First Check:**
No driver perceptible effect	Check the actual EGR temperature when the fault triggers. Check continuity between the ECU and sensor pins. Check the sensor resistance against the specification. Check the EGR cooling system for proper function.

Related Component/Subsystem: EGR

DTC: P0406: EGR Diff Pressure Range High
SPN/FMI: 411/3
SFC: 523

Description	Enabling Conditions
EGR differential pressure sensor signal voltage too high. Sets when the signal wire has been disconnected or shorted to battery power or 5V sensor power.	Key = ON AND MPRD After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
EGRDP Raw Voltage > 'EGRDPInputHiFltPos' [4.8] Volt	
Effect of Failure	**Service Guidance – First Check:**
No driver perceptible effect	Check sensor connector and wiring for open circuit or short to power. Check continuity between sensor signal pin and ECU pins C-E3 and A-H1 for short to power. Check the sensor resistance against the specification.

Related Component/Subsystem: EGR

DTC: P0405: EGR Diff Pressure Range Low
SPN/FMI: 411/4
SFC: 524

Description	Enabling Conditions
EGR differential pressure sensor signal voltage too low. Sets when the signal wire has been shorted to ground.	Key = ON AND MPRD After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
EGRDP Raw Voltage < 'EGRDPInputLoFltPos' [0.05] Volt	
Effect of Failure	**Service Guidance – First Check:**
No driver perceptible effect	Check sensor connector and wiring for a short to GND. Check continuity between sensor signal and ECU pins C-E4 and A-H2 for short to ground. Check the sensor resistance against the specification.

Related Component/Subsystem: EGR

DTC: P040E: EGRT Differs from Other Sensors
SPN/FMI: 412/2
SFC: 525

Description	Enabling Conditions
EGR temperature does not agree with other temperature sensors.	KeyOffTimer> 'C_TempSenseDiffer_MinKeyOffTime' [28800] sec AND ECUP Delay Time > 'C_PowerTrigger_DlyTime' [1] sec AND KeyOffTimer Status is good AND 'TempSensDiffer_MaxAvgKeyOn' [30] DegC >=Average Temp >='TempSensDiffer_MinAvgKeyOn' [0] DegC After clearing this Code, a total of key cycles must occur before this fault can be set again
Malfunction Criteria	
abs(EGRT- Average Temp) > 'EGRT_AvgDeltaThresh' [6] DegC	
Effect of Failure	**Service Guidance – First Check:**
No driver perceptible effect	Check EGR temperature against actual ambient temperature when the engine is cold. Check continuity between the ECU and sensor pins. Check sensor for proper operation. Check the sensor resistance against the specification.

Related Component/Subsystem: EGR

DTC: P0409: EGR Valve Position Intermittent Fault
SPN/FMI: 27/10
SFC: 527

Description	Enabling Conditions
Indicates an intermittent open or short in the sensor or wiring.	Key = ON After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
EGRVPS1RangeHigh Fault in suspected AND not in Test Failing OR EGRVPS1RangeLow Fault in Suspected AND not in Test Failing OR EGRVPS2RangeHigh Fault in suspected AND not in Test Failing OR EGRVPS2RangeLow Fault in Suspected AND not in Test Failing OR EGRVPS_Sensors_Conflict Fault in Suspected AND not in Test Failing	
Effect of Failure	**Service Guidance – First Check:**
May cause the engine to stumble or hesitate due to rapid changes in EGR.	Check for loose, corroded, or worn wiring and connectors. Check continuity between wire harness sensor pins and ground/power while wiggling harness. Check the sensor resistance against the specification.

Related Component/Subsystem: EGR

DTC: P0408: EGR 1 Position Voltage High
SPN/FMI: 27/3
SFC: 531

Description	Enabling Conditions
EGR position sensor signal voltage too high. Sets when the signal wire has been shorted to battery power or 5V sensor power.	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
EGRVPS1_Raw Voltage > 'EGRVPS1_InputHiFltPos' [4.98] Voltage	
Effect of Failure	**Service Guidance – First Check:**
No driver perceptible effect	Check sensor connector and wiring for open circuit or short to power. Check continuity between sensor signal pin and ECU pins C-E3 and A-H1 for short to power. Check the sensor resistance against the specification.

Related Component/Subsystem: EGR

DTC: P0407: EGR 1 Position Voltage Low
SPN/FMI: 27/4
SFC: 532

Description	Enabling Conditions
EGR position sensor signal voltage too low. Sets when the signal wire has been shorted to ground.	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
EGRVPS1_Raw Voltage < 'EGRVPS1_InputLoFltPos' [0.05] Voltage	
Effect of Failure	**Service Guidance – First Check:**
No driver perceptible effect	Check sensor connector and wiring for a short to GND. Check continuity between sensor signal and ECU pins C-E4 and A-H2 for short to ground. Check the sensor resistance against the specification.

Related Component/Subsystem: EGR

DTC: P140A: EGR 1 Adapt Lo Min
SPN/FMI: 27/1
SFC: 533

Description	Enabling Conditions
The EGR valve signal is too low when valve is driven closed. Indicates the valve and/or the valve seat is worn and out of spec.	Key = ON After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
EGRVPS1Raw_Adapt_Low < 'EGRVPS1_AdaptLowMin' Volt limit	
Effect of Failure	**Service Guidance – First Check:**
No driver perceptible effect	Check for loose, corroded, or worn wiring and connectors. Check the sensor resistance against the specification at lower limit of valve travel. (valve forced closed)

Related Component/Subsystem: EGR

DTC: P140B: EGR 1 Adapt Lo Max
SPN/FMI: 27/0
SFC: 534

Description	Enabling Conditions
The EGR valve signal is too high when valve is driven closed. Indicates there may be something interfering with the valve preventing it from closing completely.	Key = ON After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
EGRVPS1Raw_Adapt_Low >'EGRVPS1_AdaptLowMax' Volt limit	
Effect of Failure	**Service Guidance – First Check:**
No driver perceptible effect	Check for loose, corroded, or worn wiring and connectors. Check the sensor resistance against the specification at lower limit of valve travel. (valve forced closed) Check for a foreign object blocking the valve or holding it open.

Related Component/Subsystem: EGR

DTC: P2128: TPS1 Voltage High
SPN/FMI: 51/3
SFC: 541

Description	Enabling Conditions
TPS1 Voltage Range High Faults This fault indicates TPS1 signal line has shorted to XDRP or power line.	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
TPS1_Raw Voltage > 'TPS1_InputHiFltPos' [4.98] Volt	
Effect of Failure	**Service Guidance – First Check:**
Possible low power and poor running caused by torque derating.	• Check throttle connector to find loose pin, damaged pin or corrosion. • Check open or short circuit on TPS1. • Check short circuit between ECU TPS1 and XDRP.

Related Component/Subsystem: Throttle

DTC: P2127: TPS1 Voltage Low
SPN/FMI: 51/4
SFC: 542

Description	Enabling Conditions
TPS1 Voltage Range Low Fault This fault indicates TPS1 signal line has shorted to XDRG or ground, or TPS1 signal line has opened.	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
TPS1_Raw Voltage < 'TPS1_InputLoFltPos' [0.05] Volt	
Effect of Failure	**Service Guidance – First Check:**
Possible low power and poor running caused by torque derating.	• Check throttle connector to find loose pin, damaged pin or corrosion. • Check open or short circuit on TPS1. • Check continuity between ECU pin to Throttle TPS1 pin. • Check short circuit between ECU TPS1 pin and XDRG.

Related Component/Subsystem: Throttle

DTC: P2167: TPS1 Higher than Expected
SPN/FMI: 51/0
SFC: 543

Description	Enabling Conditions
TPS1 Low Adapt Max Faults The purpose of this diagnostic is to make sure the TPS1 voltage is below a rational high threshold. This fault can be caused by TPS1 sensor drifting or throttle mechanism failure.	Key = OFF After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
TPS1_AfterRevpolarity >'TPS1_AdaptLowMax' [0.72] Volt limit	
Effect of Failure	**Service Guidance – First Check:**
Possible unstable idle speed due to TPS1 drifting.	• Check throttle connector to find loose pin, damaged pin or corrosion. • Check TPS1 voltage with minimum throttle position to find TPS1 drifting or mechanical failure.

Related Component/Subsystem: Throttle

DTC: P2116: TPS1 Lower than Expected
SPN/FMI: 51/1
SFC: 544

Description	Enabling Conditions
TPS1 Low Adapt Min Faults The purpose of this diagnostic is to make sure the TPS1 voltage is above a rational low threshold. This fault can be caused by TPS1 sensor drifting or throttle mechanism failure.	Key = OFF After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
TPS1_AfterRevpolarity < 'TPS1_AdaptLowMin' [0.37]Volt limit	
Effect of Failure	**Service Guidance – First Check:**
Possible increasing engine idle speed due to TPS1 drifting.	• Check throttle connector to find loose pin, damaged pin or corrosion. • Check TPS1 voltage with minimum throttle position to find TPS1 drifting or mechanical failure.

Related Component/Subsystem: Throttle

DTC: P2123: TPS2 Voltage High
SPN/FMI: 3673/3
SFC: 545

Description	Enabling Conditions
TPS2 Voltage Range High Faults This fault indicates TPS2 signal line has shorted to XDRP or power line.	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
TPS2_Raw Voltage > 'TPS2_InputHiFltPos' [4.98] Volt	
Effect of Failure	**Service Guidance – First Check:**
Possible low power and poor running caused by torque derating.	• Check throttle connector to find loose pin, damaged pin or corrosion. • Check open or short circuit on TPS2. • Check short circuit between ECU TPS2 and XDRP.

Related Component/Subsystem: Throttle

DTC: P2122: TPS2 Voltage low
SPN/FMI: 3673/4
SFC: 546

Description	Enabling Conditions
TPS2 Voltage Range Low Fault This fault indicates TPS2 signal line has shorted to XDRG or ground, or TPS2signal line has opened.	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
TPS2_Raw Voltage < 'TPS2_InputLoFltPos' [0.05] Volt	
Effect of Failure	**Service Guidance – First Check:**
Possible low power and poor running caused by torque derating.	• Check throttle connector to find loose pin, damaged pin or corrosion. • Check open or short circuit on TPS2. • Check continuity between ECU pin to Throttle TPS2 pin. • Check short circuit between ECU TPS2 pin and XDRG.

Related Component/Subsystem: Throttle

DTC: P2166: TPS2 Higher than Expected
SPN/FMI: 3673/0
SFC: 547

Description	Enabling Conditions
TPS2 Low Adapt Max Faults The purpose of this diagnostic is to make sure the TPS2 voltage is below a rational high threshold. This fault can be caused by TPS2 sensor drifting or throttle mechanism failure.	Key = OFF After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
TPS2_AfterRevpolarity >'TPS2_AdaptLowMax' [0.88] Volt limit	
Effect of Failure	**Service Guidance – First Check:**
Possible unstable idle speed due to TPS2 drifting.	• Check throttle connector to find loose pin, damaged pin or corrosion. • Check TPS2 voltage with minimum throttle position to find TPS2 drifting or mechanical failure.

Related Component/Subsystem: Throttle

DTC: P2115: TPS2 Lower than Expected
SPN/FMI: 3673/1
SFC: 548

Description	Enabling Conditions
TPS2 Low Adapt Min Faults The purpose of this diagnostic is to make sure the TPS2 voltage is above a rational low threshold. This fault can be caused by TPS2 sensor drifting or throttle mechanism failure.	Key = OFF After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
TPS2_AfterRevpolarity <'TPS2_AdaptLowMin' [0.31]Volt limit	
Effect of Failure	**Service Guidance – First Check:**
Possible increasing engine idle speed due to TPS2 drifting.	• Check throttle connector to find loose pin, damaged pin or corrosion. • Check TPS2 voltage with minimum throttle position to find TPS2 drifting or mechanical failure.

Related Component/Subsystem: Throttle

DTC: P2138: TPS Sensor Conflict
SPN/FMI: 51/7
SFC: 549

Description	Enabling Conditions
TPS Sensor Conflict Faults The purpose of this diagnostic is to detect a potential situation where the TPS1 and TPS2 position disagree the throttle position. The fault can be caused by a failed position sensor or fouling on the traces in the throttle.	The Following condition is not TRUE PosSensor1_AfterRevpolarity_V1 >RawSetpointLimitThresh AND PosSensor1_HighGain == 1 PosSensor2_AfterRevpolarity_V1 > RawSetpointLimitThresh AND PosSensor2_HighGain == 1 After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
Abs(TPS Position 1 - TPS Position 2) > Threshold ('TPS1_TPS2_Max_Deviation' [10])	
Effect of Failure	**Service Guidance – First Check:**
Possible low power and poor running caused by torque derating.	• Check throttle connector to find loose pin, damaged pin or corrosion. • Check TPS1 voltage change with traveling throttle position to confirm TPS1 tracking with throttle position. • Check TPS2 voltage change with traveling throttle position to confirm TPS2 tracking with throttle position.

Related Component/Subsystem: Throttle

DTC: P2124: TPS Intermittent
SPN/FMI: 51/2
SFC: 551

Description	Enabling Conditions
TPS Intermittent Faults The purpose of this diagnostic is to monitor all the suspected or failing TPS faults. The fault can be caused by TPS1 or TPS2 sensor drifting, throttle mechanical failure, short to ground/5V, or open TPS conditions.	Key = ON After clearing this Code, a total of 1 key cycles must occur before this fault can be set again

Malfunction Criteria
TPS1RangeHigh Fault in suspected AND not in Test Failing OR TPS1RangeLow Fault in Suspected AND not in Test Failing OR TPS2RangeHigh Fault in suspected AND not in Test Failing OR TPS2RangeLow Fault in Suspected AND not in Test Failing OR TPS_Sensors_Conflict Fault in Suspected AND not in Test Failing

Effect of Failure	Service Guidance – First Check:
Possible low power and poor running caused by torque derating.	• Check throttle connector to find loose pin, damaged pin or corrosion. • Check the possibility of intermittent short circuit between ECU TPS1/TPS2 and XDRP. • Check the possibility of intermittent short circuit between ECU TPS1/TPS2 and XDRG. • Check the possibility of intermittent open circuit between ECU TPS1/TPS2 and XDRG. • Check TPS1 or TPS2 mechanical failure.

Related Component/Subsystem: Throttle

DTC: P2101: Throttle Valve H bridge Fault
SPN/FMI: 3464/5
SFC: 552

Description	Enabling Conditions
Throttle Driver H-Bridge Faults The purpose of this diagnostic is to monitor the throttle H-Bridge driver chip condition. The H-Bridge chip senses overtemp condition due to high current outputs. The fault can be caused by throttle failures or overdriven throttles.	Key = ON AND MPRD After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
'HBridgeFaultState' == 1	
Effect of Failure	**Service Guidance – First Check:**
Possible low power and poor running caused by torque derating.	• Check TPS voltage tracking with throttle position to find mechanical failure. • Check too much friction or sticking on throttle valve to find mechanical failure.

Related Component/Subsystem: Throttle

DTC: P2100: Throttle Valve Open Fault
SPN/FMI: 3464/6
SFC: 553

Description	Enabling Conditions
Throttle Open Faults The purpose of this diagnostics is to monitor if the H-Bridge throttle circuit is open, which would result in the loss of throttle control. This fault can be caused by throttle failures or overdriven throttles	Throttle_DriverDutyCycle > 'Throttle_OC_MIN' [80] % AND Key = ON AND MPRD After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
'Throttle_DriveCurrent' < 'Throttle_I_MIN' [80] mA for 'C_Throttle_Open_ErrorTime' [1] Second time within 'C_Throttle_Open_MaxErrorTime' [2] Seconds period	
Effect of Failure	**Service Guidance – First Check:**
• Possible low power and poor running caused by torque derating. • Possible engine can be run at a little bit higher speed than idle speed by throttle null position.	• Check throttle connector to find loose pin, damaged pin or corrosion. • Check open circuit on Throttle Motor. • Check continuity between ECU pin to Throttle Motor pin.

Related Component/Subsystem: Throttle

DTC: P2119: Throttle Spring Test Fault
SPN/FMI: 3464/2
SFC: 554

Description	Enabling Conditions
Throttle Spring Test Faults The purpose of this diagnostics is to monitor if the internal spring in the throttle closes the throttle when no h-bridge current is present. This fault can be caused by mechanical throttle failures.	Spring Test Completed After clearing this Code, a total of 1 key cycles must occur before this fault can be set again

Malfunction Criteria
'SpringTestTime' > 'Throttle_SpringTestTimerThresh' [3] Second

Effect of Failure	Service Guidance – First Check:
Possible engine shutdown or overspeeding when occurring throttle motor driver shutdown.	• Check retention capability for null position without power to find mechanical failure.

Related Component/Subsystem: Throttle

DTC: P0638: Throttle Valve Stuck
SPN/FMI: 3464/7
SFC: 555

Description	Enabling Conditions
Throttle Sticking Faults The purpose of this diagnostics is to monitor if the throttle is sticking and not tracking the setpoint. The fault can be caused by mechanical throttle failures.	SetPointMode == 0 AND No CutThrottleAction action No Throttle_StallStateShutdown No Duty CYcle Override Enabled AND Time Since Run > 'Throttle_Sticking_DelayTime' [15] Second After clearing this Code, a total of 1 key cycles must occur before this fault can be set again

Malfunction Criteria
(Position Error > 'Throttle_StickingThresh' [10] AND NO Throttle Control Error sign Change) OR ThrottleIMin >= 'Throttle_PositionITerm' AND 'Throttle_IStickEnable' [1] == 1 OR ThrottleIMax <= 'Throttle_PositionITerm' AND 'Throttle_IStickEnable' [1] == 1 for 'C_Throttle_Sticking_ErrorTime' [10] Second within 'C_Throttle_Sticking_MaxErrorTime' [10] Second

Effect of Failure	Service Guidance – First Check:
• Possible low power and poor running caused by torque derating. • Possible high engine speed running or over speeding when disengaged clutch or transmission due to uncontrollable throttle position.	• Check too much friction or sticking on throttle valve to find mechanical failure. • Check reduction gear to find mechanical failure. • Check fouling material to the butterfly valve and shafts.

Related Component/Subsystem: Throttle

DTC: U0101: Transmission #1 Msg Timeout
SPN/FMI: 2003/9
SFC: 561

Description	Enabling Conditions
ETC1 CAN message is not being received	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
ETC1AgeCountTime > 'ETC1TimeoutThresh' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	If CAN tool is available, check if ETC1 CAN message is being sent. Troubleshoot module transmitting ETC1

Related Component/Subsystem: CAN Communication

DTC: U0402: Transmission #1 Data Invalid
SPN/FMI: 2003/19
SFC: 562

Description	Enabling Conditions
Invalid data in CAN message ETC1	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Output Shaft Speed > 8031.875	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	If CAN tool is available, check if ETC1 CAN message is being sent. Troubleshoot module transmitting ETC1

Related Component/Subsystem: CAN Communication

DTC: U1118: Tachograph Msg Timeout
SPN/FMI: 2238/9
SFC: 563

Description	Enabling Conditions
TCO1 CAN message is not being received	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
TCO1AgeCountTime > 'TCO1TimeoutThresh' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	If CAN tool is available, check if TCO1 CAN message is being sent. Troubleshoot module transmitting TCO1

Related Component/Subsystem: CAN Communication

DTC: U1418: Tachograph Data Invalid
SPN/FMI: 2238/19
SFC: 564

Description	Enabling Conditions
Invalid data in CAN message TCO1	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Tachograph Vehicle Speed > 250.996	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	If CAN tool is available, check if TCO1 CAN message is being sent. Troubleshoot module transmitting TCO1

Related Component/Subsystem: CAN Communication

DTC: U0129: Brakes - System Controller Msg Timeout
SPN/FMI: 2011/2
SFC: 565

Description	Enabling Conditions
EBC2 CAN message is not being received	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
EBC2AgeCountTime > 'EBC2TimeoutThresh' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	If CAN tool is available, check if EBC2 CAN message is being sent. Troubleshoot module transmitting EBC2

Related Component/Subsystem: CAN Communication

DTC: U0418: Brakes -System Controller Data Invalid
SPN/FMI: 2011/19
SFC: 566

Description	Enabling Conditions
Invalid data in CAN message EBC2	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
FrontAxleSpeed > 250.996	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	If CAN tool is available, check if EBC2 CAN message is being sent. Troubleshoot module transmitting EBC2

Related Component/Subsystem: CAN Communication

DTC: U1120: ETC2RxTimeoutFault
SPN/FMI: 2239/9
SFC: 567

Description	Enabling Conditions
ETC2 CAN message is not being received	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
ETC2AgeCountTime > 'ETC2TimeoutThresh' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	If CAN tool is available, check if ETC2 CAN message is being sent. Troubleshoot module transmitting ETC2

Related Component/Subsystem: CAN Communication

DTC: U1101: TSC1_1RxTimeoutFault
SPN/FMI: 520700/9
SFC: 568

Description	Enabling Conditions
TSC1 CAN message Source address 1 is not being received	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
TSC1_1AgeCountTime > 'TSC1_1TimeoutThresh' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	If CAN tool is available, check if TSC1_1 CAN message is being sent. Troubleshoot module transmitting TSC1_1

Related Component/Subsystem: CAN Communication

DTC: U1102: TSC1_2RxTimeoutFault
SPN/FMI: 520701/9
SFC: 569

Description	Enabling Conditions
TSC1 CAN message Source address 2 is not being received	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
TSC1_2AgeCountTime > 'TSC1_2TimeoutThresh' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	If CAN tool is available, check if TSC1_2 CAN message is being sent. Troubleshoot module transmitting TSC1_2

Related Component/Subsystem: CAN Communication

DTC: U1103: TSC1_3RxTimeoutFault
SPN/FMI: 520702/9
SFC: 571

Description	Enabling Conditions
TSC1 CAN message Source address 3 is not being received	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
TSC1_3AgeCountTime > 'TSC1_3TimeoutThresh' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	If CAN tool is available, check if TSC1_3 CAN message is being sent. Troubleshoot module transmitting TSC1_3

Related Component/Subsystem: CAN Communication

DTC: U1104: TSC1_4RxTimeoutFault
SPN/FMI: 520703/9
SFC: 572

Description	Enabling Conditions
TSC1 CAN message Source address 4 is not being received	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
TSC1_4AgeCountTime > 'TSC1_4TimeoutThresh' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	If CAN tool is available, check if TSC1_4 CAN message is being sent. Troubleshoot module transmitting TSC1_4

Related Component/Subsystem: CAN Communication

DTC: U1105: TSC1_5RxTimeoutFault
SPN/FMI: 520704/9
SFC: 573

Description	Enabling Conditions
TSC1 CAN message Source address 5 has not been received for a period of time	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
TSC1_5AgeCountTime > 'TSC1_5TimeoutThresh' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	If CAN tool is available, check if TSC1_5 CAN message is being sent. Troubleshoot module transmitting TSC1_5

Related Component/Subsystem: CAN Communication

DTC: U1106: TSC1_6RxTimeoutFault
SPN/FMI: 520705/9
SFC: 574

Description	Enabling Conditions
TSC1 CAN message Source address 6 has not been received for a period of time	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
TSC1_6AgeCountTime > 'TSC1_6TimeoutThresh' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	If CAN tool is available, check if TSC1_6 CAN message is being sent. Troubleshoot module transmitting TSC1_6

Related Component/Subsystem: CAN Communication

DTC: U1107: TSC1_7RxTimeoutFault
SPN/FMI: 520706/9
SFC: 575

Description	Enabling Conditions
TSC1 CAN message Source address 7 is not being received	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
TSC1_7AgeCountTime > 'TSC1_7TimeoutThresh' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	If CAN tool is available, check if TSC1_7 CAN message is being sent. Troubleshoot module transmitting TSC1_7

Related Component/Subsystem: CAN Communication

DTC: U1108: TSC1_8RxTimeoutFault
SPN/FMI: 520707/9
SFC: 576

Description	Enabling Conditions
TSC1 CAN message Source address 8 is not being received	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
TSC1_8AgeCountTime > 'TSC1_8TimeoutThresh' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	If CAN tool is available, check if TSC1_8 CAN message is being sent. Troubleshoot module transmitting TSC1_8

Related Component/Subsystem: CAN Communication

DTC: U0117: Woodward PTO
SPN/FMI: 2007/9
SFC: 577

Description	Enabling Conditions
WWCMD CAN message is not being received	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
WWCMDAgeCountTime > 'WWCMDTimeoutThresh' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	If CAN tool is available, check if WWCMD CAN message is being sent. Troubleshoot module transmitting WWCMD

Related Component/Subsystem: CAN Communication

DTC: U1110: Woodward Diagnostics Mode 2
SPN/FMI: 2551/9
SFC: 578

Description	Enabling Conditions
WWDM2 CAN message is not being received	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
WWDM2AgeCountTime > 'WWDM2TimeoutThresh' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	If CAN tool is available, check if WWDM2 CAN message is being sent. Troubleshoot module transmitting WWDM2

Related Component/Subsystem: CAN Communication

DTC: U1111: Woodward Diagnostics Mode 1
SPN/FMI: 2551/12
SFC: 579

Description	Enabling Conditions
WWDM1 CAN message is not being received	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
WWDM1AgeCountTime > 'WWDM1TimeoutThresh' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	If CAN tool is available, check if WWDM1 CAN message is being sent. Troubleshoot module transmitting WWDM1

Related Component/Subsystem: CAN Communication

DTC: U1112: CAN1 Line Circuit/Bus Error Passive
SPN/FMI: 639/11
SFC: 582

Description	Enabling Conditions
CAN Bus wiring problem	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
CANBusStatus' == 1	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	Check CAN bus for shorts or opens Check for frayed wires on CAN bus Check for corrosion in all CAN connections

Related Component/Subsystem: CAN Communication

DTC: U1129: Brakes - System Controller message Timeout
SPN/FMI: 2011/12
SFC: 585

Description	Enabling Conditions
EBC1 CAN message is not being received	Engine is Running After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
EBC1AgeCountTime > 'EBC1TimeoutThresh' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	If CAN tool is available, check if EBC1 CAN message is being sent. Troubleshoot module transmitting EBC1

Related Component/Subsystem: CAN Communication

DTC: U1114: CAN1 Tx_Rx Warning
SPN/FMI: 639/14
SFC: 586

Description	Enabling Conditions
CAN Bus noise or intermittent	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
'TxErrCount' > 0 OR 'RxErrCount' > 0	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	Check CAN bus for shorts or opens Check for frayed wires on CAN bus Check for corrosion in all CAN connections

Related Component/Subsystem: CAN Communication

DTC: U1115: High Resolution Wheel Speed Message
SPN/FMI: 2011/9
SFC: 587

Description	Enabling Conditions
HRW CAN message is not being received	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
HRWAgeCountTime > 'HRWTimeoutThresh' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	If CAN tool is available, check if HRW CAN message is being sent. Troubleshoot module transmitting HRW

Related Component/Subsystem: CAN Communication

DTC: U1117: Gas Flap Switch Message
SPN/FMI: 2551/14
SFC: 589

Description	Enabling Conditions
GFS CAN message is not being received	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
GFSAgeCountTime > 'GFSTimeoutThresh' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	If CAN tool is available, check if GFS CAN message is being sent. Troubleshoot module transmitting GFS

Related Component/Subsystem: CAN Communication

DTC: U0100: HEV Control Message
SPN/FMI: 520402/9
SFC: 591

Description	Enabling Conditions
HEV CAN message is not being received	Engine is Running After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
HEVAgeCountTime > 'HEVTimeoutThresh' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	If CAN tool is available, check if HEV CAN message is being sent. Troubleshoot module transmitting HEV

Related Component/Subsystem: CAN Communication

DTC: U1100: HEV Coolant Temperature Message
SPN/FMI: 520639/9
SFC: 592

Description	Enabling Conditions
HEV Coolant Temp CAN message is not being received	Engine is Running After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
HEVCoolantTempAgeCountTime > 'HEVCoolantTimeoutThresh' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	If CAN tool is available, check if HEV coolant temp CAN message is being sent. Troubleshoot module transmitting HEV coolant temp

Related Component/Subsystem: CAN Communication

DTC: U0113: Aftertreatment Gas Message SCR Outlet
SPN/FMI: 2082/9
SFC: 593

Description	Enabling Conditions
AT1OG1 CAN message is not being received	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
AT1OG1AgeCountTime > 'AT1OG1TimeoutThresh' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	If CAN tool is available, check if AT1OG1 CAN message is being sent. Troubleshoot module transmitting AT1OG1

Related Component/Subsystem: CAN Communication

DTC: U111A: HMC Customized Aux IO1
SPN/FMI: 2230/9
SFC: 594

Description	Enabling Conditions
EI1 CAN message is not being received	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
EI1AgeCountTime > 'EI1TimeoutThresh' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	If CAN tool is available, check if EI1 CAN message is being sent. Troubleshoot module transmitting EI1

Related Component/Subsystem: CAN Communication

DTC: U1119: HMC Customized Aux IO2
SPN/FMI: 2230/19
SFC: 595

Description	Enabling Conditions
EI2 CAN message is not being received	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
EI2AgeCountTime > 'EI2TimeoutThresh' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	If CAN tool is available, check if EI2 CAN message is being sent. Troubleshoot module transmitting EI2

Related Component/Subsystem: CAN Communication

DTC: U1121: Aftertreatment Gas Message SCR Inlet
SPN/FMI: 2083/9
SFC: 599

Description	Enabling Conditions
AT1IG1 CAN message is not being received	Key = ON After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
AT1IG1AgeCountTime > 'AT1IG1TimeoutThresh' [2] Second	
Effect of Failure	**Service Guidance – First Check:**
CAN message Information not available to ECU	If CAN tool is available, check if AT1IG1 CAN message is being sent. Troubleshoot module transmitting AT1IG1

Related Component/Subsystem: CAN Communication

DTC: P100C: RH Sensor Voltage High
SPN/FMI: 354/3
SFC: 611

Description	Enabling Conditions
Relative Humidity (RH) Sensor Voltage is High. Normally set if the RH signal wire has become shorted to power or failed.	Key = ON AND MPRD After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
RH Raw Voltage > 'RHMax' [4.9] Volt	
Effect of Failure	**Service Guidance – First Check:**
Potential misfire and long term water damage to throttle.	• Check RH sensor connector for corrosion or loose pin. • Check RH sensor for an open circuit or short to power. • Check continuity between ECU pin to sensor connector pin. • Check short circuit between ECU pin to XDRP.

Related Component/Subsystem: Humidity Sensor

DTC: P100D: RH Sensor Voltage Low
SPN/FMI: 354/4
SFC: 612

Description	Enabling Conditions
Relative Humidity (RH) Sensor Voltage is Low. Normally set if the RH pressure signal wire has been disconnected or shorted to ground or the circuit has opened to the ECM	Key = ON AND MPRD After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
RH Raw Voltage < 'RHMin' [0.1] Volt	
Effect of Failure	**Service Guidance – First Check:**
Potential misfire and long term water damage to throttle.	• Check RH sensor connector for corrosion or loose pin. • Check RH sensor for an open circuit or short to GND. • Check continuity between ECU pin to sensor connector pin. • Check short circuit between ECU pin to XDRG.

Related Component/Subsystem: Humidity Sensor

DTC: P1098: RHT Sensor Voltage High
SPN/FMI: 520192/5
SFC: 613

Description	Enabling Conditions
Relative Humidity Temperature (RHT) Sensor Voltage is High. Normally set if the RHT signal wire has become shorted to power or failed.	Key = ON AND MPRD After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
RHT Raw Voltage > 'RHTMax' [4.9] Volt	
Effect of Failure	**Service Guidance – First Check:**
Potential misfire and long term water damage to throttle.	• Check RHT sensor connector for corrosion or loose pin. • Check RHT sensor for an open circuit or short to power. • Check continuity between ECU pin to sensor connector pin. • Check short circuit between ECU pin to XDRP.

Related Component/Subsystem: Humidity Sensor

DTC: P1097: RHT Sensor Voltage Low
SPN/FMI: 520192/6
SFC: 614

Description	Enabling Conditions
Relative Humidity Temperature (RHT) Sensor Voltage is Low. Normally set if the RHT pressure signal wire has been disconnected or shorted to ground or the circuit has opened to the ECM	Key = ON AND MPRD After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
RHT Raw Voltage < 'RHTMin' [0.1] Volt	
Effect of Failure	**Service Guidance – First Check:**
Potential misfire and long term water damage to throttle.	• Check RHT sensor connector for corrosion or loose pin. • Check RHT sensor for an open circuit or short to GND. • Check continuity between ECU pin to sensor connector pin. • Check short circuit between ECU pin to XDRG.

Related Component/Subsystem: Humidity Sensor

DTC: P1099: RHT Insufficient Activity
SPN/FMI: 520192/14
SFC: 615

Description	Enabling Conditions
Relative Humidity Temperature (RHT) Sensor Voltage has stopped responding to changes in the actual temperature. Normally caused by a failed sensor.	Time Since Run > 'RHT_Activity_RunTimeThresh' [20] Second(once per cycle) AND KeyoffTime> 'C_RHTActivity_MinKeyOffTime' [28800] seconds AND ECT KeyOn < 'C_RHT_ECTKeyup_Thresh' [50] After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
RHT_MaxValue - RHT_MinValue < 'RHT_STUCK' [2] DegC in 'RHT_Acitivity_CheckTime' [300] Second when IndTorque > 'C_RHTActivity_TorqueThreshold' [20] %	
Effect of Failure	**Service Guidance – First Check:**
Potential misfire and long term water damage to throttle.	Check RHT sensor for damage Check RHT sensor internal resistance Verify resistance changes according to sensor spec when the temperature changes

Related Component/Subsystem: Humidity Sensor

DTC: P100E: Specific Humidity Higher than Expected
SPN/FMI: 354/0
SFC: 616

Description	Enabling Conditions
The Relative Humidity (RH) Sensor is reporting a humidity value high that is expected.	Engine running for delay time After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
Specific humidity over a calibrated amount (default = 35, range = 25 to 80 g H2O/kg dry air) AND Humidity sensor enabled	
Effect of Failure	**Service Guidance – First Check:**
Potential misfire and long term water damage to throttle.	Check RH sensor connector and wiring for corrosion, wear, or a loose pin. Check sensor resistance and compare to the spec.

Related Component/Subsystem: Humidity Sensor

DTC: P100F: RH Insufficient Activity
SPN/FMI: 354/10
SFC: 617

Description	Enabling Conditions
The Relative Humidity (RH) sensor has stopped responding to changes in ambient humidity.	RH > 'RHInactive_MinRH' [10] % AND TimeSinceRun >= 'RHInactive_RunTimeThresh' [10] sec AND RHEnabled = Enabled After clearing this Code, a total of 3 key cycles must occur before this fault can be set again
Malfunction Criteria	
ABS(RH-RH_Previous) < 'RHInactive_MinDelta' [1] % AND EngineWarmUpCycleFlag = 1	
Effect of Failure	**Service Guidance – First Check:**
Potential misfire and long term water damage to throttle.	Check RH sensor for damage Check RH sensor internal resistance Verify resistance matches sensor spec for actual relative humidity

Related Component/Subsystem: Humidity Sensor

DTC: P009A: RHT Differs from Other Sensors
SPN/FMI: 520192/2
SFC: 618

Description	Enabling Conditions
The Relative Humidity Temperature (RHT) sensor does not agree with other temperature sensors. Test is run after a long engine off time so that all temperature sensors should be at ambient temperature.	KeyOffTimer> 'C_TempSenseDiffer_MinKeyOffTime' [28800] sec AND ECUP Delay Time > 'C_PowerTrigger_DlyTime' [1] sec AND KeyOffTimer Status is good AND 'TempSensDiffer_MaxAvgKeyOn' [30] DegC >=Average Temp >='TempSensDiffer_MinAvgKeyOn' [0] DegC After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
abs(RHT- Average Temp) > 'RHT_AvgDeltaThresh' [6] DegC	
Effect of Failure	**Service Guidance – First Check:**
Potential misfire and long term water damage to throttle.	Check RHT temperature against actual ambient temperature when the engine is cold. Check continuity between the ECU and sensor pins. Check sensor for proper operation. Check the sensor resistance against the specification.

Related Component/Subsystem: Humidity Sensor

DTC: P0606: CPU Load Higher than Expected
SPN/FMI: 629/9
SFC: 621

Description	Enabling Conditions
CPU usage is higher than calibrated maximum threshold.	NONE After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
CPU load >'Max_CPULoad' [90] %	
Effect of Failure	**Service Guidance – First Check:**
Abnormal ECM operation resulting in erratic engine behavior.	Noise on speed, cam, and crank sensors.

Related Component/Subsystem: Engine Control Module

DTC: P0605: Flash Memory Fault
SPN/FMI: 629/31
SFC: 622

Description	Enabling Conditions
Flash Memory Fault cased the module to reset.	NONE After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
FlashFaultDetected ==1	
Effect of Failure	**Service Guidance – First Check:**
Abnormal ECM operation resulting in erratic engine behavior.	Reset fault and test drive trying to duplicate fault. Replace ECM if multiple failures.

Related Component/Subsystem: Engine Control Module

DTC: P0604: SRAM Memory Fault
SPN/FMI: 629/11
SFC: 623

Description	Enabling Conditions
RAM Fault cased the module to reset.	NONE After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
SRAMFaultDetected ==1	
Effect of Failure	**Service Guidance – First Check:**
Abnormal ECM operation resulting in erratic engine behavior.	Reset fault and test drive trying to duplicate fault. Replace ECM if multiple failures.

Related Component/Subsystem: Engine Control Module

DTC: P1620: Invalid Calibration Fault
SPN/FMI: 629/14
SFC: 624

Description	Enabling Conditions
Most recent calibration save attempt failed. Applied only to development modules.	NONE After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
RedundantCalibrationStatusPrevious ==4	
Effect of Failure	**Service Guidance – First Check:**
Abnormal ECM operation resulting in erratic engine behavior.	Check for normal shutdown sequence on development modules. Replace ECM.

Related Component/Subsystem: Engine Control Module

DTC: P118D: NGTP Voltage High
SPN/FMI: 159/3
SFC: 661

Description	Enabling Conditions
Natural Gas Tank Pressure Sensor Voltage is High Normally set if the NGTP signal wire has become shorted to power, the NGTP has failed or the ECM has failed.	Key = ON AND MPRD After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
NGTP Raw Voltage > 'NGTPInputHiFltPos' [4.8] Volt	
Effect of Failure	**Service Guidance – First Check:**
• The ECU has been programmed such a way; it will take default value of 50 bar in case of electrical faults. • Fuel gauge indicates just default value.	• Check NGTP sensor connector for corrosion or loose pin. • Check NGTP sensor for an open circuit or short to power. • Check continuity between ECU pin to sensor connector pin. • Check short circuit between ECU pin to XDRP.

Related Component/Subsystem: Natural Gas Tank

DTC: P118C: NGTP Voltage Low
SPN/FMI: 159/4
SFC: 662

Description	Enabling Conditions
Natural Gas Tank Pressure Sensor Voltage is Low. Normally set if the NGTP pressure signal wire has been disconnected or shorted to ground or the circuit has opened to the ECM	Key = ON AND MPRD After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
NGTP Raw Voltage < 'NGTPInputLoFltPos' [0.05] Volt	
Effect of Failure	**Service Guidance – First Check:**
• The ECU has been programmed such a way; it will take default value of 50 bar in case of electrical faults. • Fuel gauge indicates just default value.	• Check NGTP sensor connector for corrosion or loose pin. • Check NGTP sensor for an open circuit or short to GND. • Check continuity between ECU pin to sensor connector pin. • Check short circuit between ECU pin to XDRG.

Related Component/Subsystem: Natural Gas Tank

DTC: P118B: NGTP Lower than Expected
SPN/FMI: 159/1
SFC: 663

Description	Enabling Conditions
Natural Gas Tank Pressure Sensor indicates lower pressure than expected. Can be caused by a completely empty CNG tank.	Engine running After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
NGTP < 'NGTPLoThesh' Bar	
Effect of Failure	**Service Guidance – First Check:**
Possible low power or poor running	Check CNG tank pressure (fill level) Check NGTP sensor connector and wiring for corrosion, wear, or a loose pin.

Related Component/Subsystem: Natural Gas Tank

DTC: P118A: NGTP sensor inactive
SPN/FMI: 159/2
SFC: 665

Description	Enabling Conditions
The NGTP sensor has stopped responding to changes in tank pressure.	abs(NGTPStick_LastRunPress - NGTPRaw) >= 'NGTPStick_MinDeltaPress' [2] bar OR EngineHourMeter - NGTPStick_LastRunHrs >= 'NGTPStick_MaxNoDeltaHrs' [2] hours After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
abs(NGTPStick_LastRunPress - NGTPRaw) < 'NGTPStick_MinDeltaPress' [2] bar AND EngineHourMeter - NGTPStick_LastRunHrs < 'NGTPStick_MaxNoDeltaHrs' [2] hours	
Effect of Failure	**Service Guidance – First Check:**
Fuel level will be inaccurate	Check NGTP sensor for damage Check NGTP sensor internal resistance Verify resistance changes according to sensor spec when the tank pressure changes

Related Component/Subsystem: Natural Gas Tank

DTC: P1091: NG Tank Leak - Small
SPN/FMI: 1239/17
SFC: 664

Description	Enabling Conditions
A small leak has been detected in the CNG storage system	CNGTankFill = 0 After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
At Key on NGTP < NGTP_KeyOff - if(NGTTEnable = Enabled then 'CNGTankSmlLeak_Thresh' else CNGTankSmlLeak_NoNGTTThresh' [15]) bar	
Effect of Failure	**Service Guidance – First Check:**
Fuel leakage	Inspect fuel tank, hoses, and fitting for damage. Check all fittings and hoses for leaks with soap/water solution. Replace any damaged components.

Related Component/Subsystem: Natural Gas Tank

DTC: P1092: NG Tank Leak - Medium
SPN/FMI: 1239/18
SFC: 668

Description	Enabling Conditions
A medium leak has been detected in the CNG storage system	Engine running After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
CNGTankMedLeak_NGTPFilt + 'CNGTankMedLeak_Thresh' bar < CNGTankMedLeak_NGTPInit AND CNGTankMedLeak_Timer <= 'CNGTankMedLeakTime' [7] sec	
Effect of Failure	**Service Guidance – First Check:**
Fuel leakage	Inspect fuel tank, hoses, and fitting for damage. Check all fittings and hoses for leaks with soap/water solution. Replace any damaged components.

Related Component/Subsystem: Natural Gas Tank

DTC: P1093: NG Tank Leak - Large
SPN/FMI: 1239/1
SFC: 669

Description	Enabling Conditions
A large leak has been detected in the CNG storage system	Engine running After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
CNGTankLrgLeak_NGTPFilt + 'CNGTankLrgLeak_Thresh' bar < CNGTankLrgLeak_NGTPInit AND CNGTankLrgLeak_Timer <= 'CNGTankLrgLeakTime' [7] sec	
Effect of Failure	**Service Guidance – First Check:**
Fuel leakage	Inspect fuel tank, hoses, and fitting for damage. Check all fittings and hoses for leaks with soap/water solution. Replace any damaged components.

Related Component/Subsystem: Natural Gas Tank

DTC: P0243: Wastegate Cntrl Valve Open or Short
SPN/FMI: 1188/5
SFC: 691

Description	Enabling Conditions
Wastegate Control Valve open or shorted	TimeSinceKeyOn > 5 AND MPRD On AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND IF WGCV_FltCnfg2= Inhibit Fault Detection when DRVP is Low THEN EngineActuatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
'WGCVFaultState' == 1 for 'C_WGCV_ErrorTime' [2] Second within 'C_WGCV_MaxErrorTime' [10] Second	
Effect of Failure	Service Guidance – First Check:
• Inaccurate Boost control • Possible reduced engine power • Possible excessive boost pressure	Check continuity between ECU Wastegate Control signal pin to control valve pin B. Check if ECU Wastegate Control signal pin is shorted to ground or VBAT Check continuity of wastegate control valve

Related Component/Subsystem: Boost Control

DTC: P0234: Boost pressure Higher than Expected
SPN/FMI: 1692/16
SFC: 692

Description	Enabling Conditions
Boost pressure Higher than Expected	Engine in Running AND MAP > Baro + 'BoostRef_Val' [30] Kpa AND Boost_State = 6 (close loop) AND SSEngOpr_Diag = Steady After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
WGCVError < - 'BoostPressureHigh_Thresh' [20] kPa for 'C_Boost_HigherThanExpected_ErrorTime' [2] Second within 'C_Boost_HigherThanExpected_MaxErrorTime' [3] Second	
Effect of Failure	Service Guidance – First Check:
• Inaccurate boost control • Possible excessive boost pressure	Check for sticking wastegate or control valve

Related Component/Subsystem: Boost Control

DTC: P0299: Boost pressure Lower than Expected
SPN/FMI: 1692/18
SFC: 693

Description	Enabling Conditions
Boost pressure Lower than Expected	RPM > 'BoostPressDiag_RPMThresh' [1200] AND Altitude < 'C_Boost_IRL_AltThresh' [1600] m AND NoBoost action not set AND No 'FuelShutOff' AND Boost ref > 'BoostPress_LowThresh' [140] kPa AND Boost_State = 6 (close loop) AND SSEngOpr_Diag = Steady After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
WGCVError > 'BoostPressureLow_Thresh' [20] kPa for 'C_Boost_LowerThanExpected_ErrorTime' [7] Second within 'C_Boost_LowerThanExpected_MaxErrorTime' [10] Second	
Effect of Failure	**Service Guidance – First Check:**
• Inaccurate boost control • Possible reduced engine power	Check for sticking wastegate or control valve

Related Component/Subsystem: Boost Control

DTC: P2263: Overboost
SPN/FMI: 1692/0
SFC: 694

Description	Enabling Conditions
Excessive Boost Pressure has been detected	Engine in Running AND MAP > Baro + 'BoostRef_Val' [30] Kpa After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
WGCVError < -'OverBoostThresh' [34] Kpa for 'C_OverBoost_ErrorTime' [2] Second within 'C_OverBoost_MaxErrorTime' [3] Second	
Effect of Failure	**Service Guidance – First Check:**
Reduced engine power after fault detected	Check for sticking wastegate or control valve

Related Component/Subsystem: Boost Control

DTC: P1246: Boost Air Pressure Voltage High Fault
SPN/FMI: 1192/3
SFC: 731

Description	Enabling Conditions
Boost Air Pressure Voltage is out of range High	Engine not in Stall State After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
BoostAir_Press Raw Voltage > 'BoostAir_PressInputHiFltPos' [4.8]	
Effect of Failure	**Service Guidance – First Check:**
• Inaccurate or disabled Boost control • Possible Reduced power	Check continuity between ECU and sensor signal pin. Check if Boost Air Pressure signal is shorted to VBAT or +5 V Check continuity of Boost Air Pressure sensor ground to ECU ground

Related Component/Subsystem: Boost Control

DTC: P1245: Boost Air Pressure Voltage Low Fault
SPN/FMI: 1192/4
SFC: 732

Description	Enabling Conditions
Boost Air Pressure Voltage is out of range Low	Engine not in Stall State After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
BoostAir_Press Raw Voltage < 'BoostAir_PressInputLoFltPos' [0.05]	
Effect of Failure	**Service Guidance – First Check:**
• Inaccurate or disabled Boost control • Possible Reduced power	Check continuity between ECU and sensor signal pin. Check if Boost Air Pressure signal is shorted to ECU ground Check continuity of Boost Air Pressure sensor power to ECU XDRP pins

Related Component/Subsystem: Boost Control

DTC: P0224: Boost Air Regulator Set Point Fault
SPN/FMI: 1192/13
SFC: 733

Description	Enabling Conditions
Excessive Boost Control Error	WGCV_DC < 'BoostAirRegFaultMinDC' [5] AND TimeSinceRun >= 'BoostAirMonitor_RunMin' [120] Second After clearing this Code, a total of 0 key cycles must occur before this fault can be set again

Malfunction Criteria
BoostAir > ('BoostAirRegZeroPress' [240] Kpa + 'BoostAirRegZeroThresh' [10] Kpa) OR BoostAir < ('BoostAirRegZeroPress' [240] Kpa - 'BoostAirRegZeroThresh' [10] Kpa) for 'C_BoostAirRegSP_ErrorTime' [5] Second within 'C_BoostAirRegSP_MaxErrorTime' [5] Second

Effect of Failure	Service Guidance – First Check:
Possible reduced power	Check boost air regulator and actuator for smooth motion and full range of motion

Related Component/Subsystem: Boost Control

DTC: P1243: Wastegate Control Pressure Fault
SPN/FMI: 1192/7
SFC: 734

Description	Enabling Conditions
Excessive Boost Control Error	WGCV_DC > 'WGCVContrlPressFaultMaxDC' [95] AND TimeSinceRun >= 'BoostAirMonitor_RunMin' [120] Second After clearing this Code, a total of 0 key cycles must occur before this fault can be set again

Malfunction Criteria
BoostAir > ('WGCVContPress100' [0] Kpa + 'WGCVContlPressZeroThresh' [30] Kpa) OR BoostAir < ('WGCVContPress100' [0] Kpa - 'WGCVContlPressZeroThresh' [30] Kpa) for 'C_WGCV_ControlPress_ErrorTime' [5] Second within 'C_WGCV_ControlPress_MaxErrorTime' [5] Second

Effect of Failure	Service Guidance – First Check:
Possible reduced power	Check wastegate and actuator for smooth motion and full range of motion

Related Component/Subsystem: Boost Control

DTC: P0244: Boost Air Pressure Fault
SPN/FMI: 1192/16
SFC: 735

Description	Enabling Conditions
Excessive Boost Pressure	Engine not in Stall State After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
BoostAir > 'BoostAir_PressInputFltPos' [300]	
Effect of Failure	**Service Guidance – First Check:**
No driver perceptible effect	Check wastegate and actuator for smooth motion and full range of motion

Related Component/Subsystem: Boost Control

DTC: P0422: Three Way Catalyst Efficiency Low (Oxygen Storage)
SPN/FMI: 3050/7
SFC: 742

Description	Enabling Conditions
Catalyst Converter Efficiency Low Purpose of this diagnostic is to detect aged Three Way Catalyst converter. This fault can be caused by aged or damaged TWC that shows low oxygen storage capability.	TimeSinceRun> 'C_Cat_OSC_StartupTime' [300] & 'C_Cat_CT_LowLimit' <ECT< 'C_Cat_CT_HighLimit' & 'C_Cat_IAT_LowLimit' < IAT < 'C_Cat_IAT_HighLimit' & 'C_Cat_CATT_LowLimit'< Catalyst Bed Tempertature< 'C_Cat_CATT_HighLimit' & 'C_Cat_RPM_LowLimit' < RPM < 'C_Cat_RPM_HighLimit‘ & 'C_CAT_MinFuelCutTime' < Fuel Cut Time < 'C_CAT_MaxFuelCutTime' & Latched(Fuel Cut Transition) After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
EWMA(OSC/WPA) > 'C_Cat_OSC_OBD_Threshold' with FIR (2)	
Effect of Failure	**Service Guidance – First Check:**
Possible increase emission materials such as NOx, CO or HC.	• Check if the engine has misfire event. • Check the Phi at the upstream of catalyst that should be close to 1.0 and swings cyclic. • Check if the engine is burning oil or coolant. • Check the exhaust system for leaks upstream of the catalyst. • Check O2 Sensor connector for loose pin, damaged pin or corrosion. • Check O2 Sensor response rate for aged sensor.

Related Component/Subsystem: Catalyst

DTC: P0301: Cylinder 1 Misfire
SPN/FMI: 1323/31
SFC: 751

Description	Enabling Conditions
Cylinder 1 misfiring Misfire is monitored over 200 complete engine cycles. After each 200 cycle period the percent misfire is updated for each individual cylinder. Cylinder 1 misfire will be set with Cylinder 1 Misfire % > Overall Percent Misfire* 80%	Misfire_Fault Malfuction is TRUE AND all of the following DisableMisfireDetection fault action is inactive TimeSinceRun > 'Misfire_MinRuntime' System Voltage > 'Misfire_MinSysVolt' System Voltage < 'Misfire_MaxSysVolt' ECT > 'Misfire_MinECT' ECT < 'Misfire_MaxECT' Fuel_Amount > 'Misfire_MinFuelAmount' RoadSpeed > 'Misfire_MinRoadSpeed' RoadSpeed < 'Misfire_MaxRoadSpeed' 'Misfire_ClutchDelay' seconds have passed since a clutch switch transition After clearing this Code, a total of 1 key cycles must occur before this fault can be set again

Malfunction Criteria

Cylinder 1 Misfire Percent/TotalCylinderNum > 80% * Overall Misfire Percent
OR
(No single cylinder Misfire > 80% * Overall AND Cylinder 1 Misfire Percent > 20% * Overall Misfire Percent)

Effect of Failure	Service Guidance – First Check:
• Poor performance and fuel economy. • O2 sensor will read lean value in case of Coil/Spark failure. • Catalyst can get damaged.	• Check Ignition Coil 1 connector for corrosion or loose pin. • Check continuity between Main Power Relay output to Ignition coil 1 pin. • Check continuity between Ignition Coil 1 pin to ECU pin. • Check boots fault on Ignition Coil 1. • Check for spark output physically, if spark on the coil looks good. • Check spark plug gap • Check for any water accumulation in coil well, if so wipe it out.

Related Component/Subsystem: Misfire

DTC: P0302: Cylinder 2 Misfire
SPN/FMI: 1324/31
SFC: 752

Description	Enabling Conditions
Cylinder 2 misfiring Misfire is monitored over 200 complete engine cycles. After each 200 cycle period the percent misfire is updated for each individual cylinder. Cylinder 2 misfire will be set with Cylinder 2 Misfire % > Overall Percent Misfire* 80%	Misfire_Fault Malfuction is TRUE AND all of the following DisableMisfireDetection fault action is inactive TimeSinceRun > 'Misfire_MinRuntime' System Voltage > 'Misfire_MinSysVolt' System Voltage < 'Misfire_MaxSysVolt' ECT > 'Misfire_MinECT' ECT < 'Misfire_MaxECT' Fuel_Amount > 'Misfire_MinFuelAmount' RoadSpeed > 'Misfire_MinRoadSpeed' RoadSpeed < 'Misfire_MaxRoadSpeed' 'Misfire_ClutchDelay' seconds have passed since a clutch switch transition After clearing this Code, a total of 1 key cycles must occur before this fault can be set again

Malfunction Criteria

Cylinder 2 Misfire Percent/TotalCylinderNum > 80% * Overall Misfire Percent
OR
(No single cylinder Misfire > 80% * Overall AND Cylinder 2 Misfire Percent > 20% * Overall Misfire Percent)

Effect of Failure	Service Guidance – First Check:
• Poor performance and fuel economy. • O2 sensor will read lean value in case of Coil/Spark failure. • Catalyst can get damaged.	• Check Ignition Coil 2 connector for corrosion or loose pin. • Check continuity between Main Power Relay output to Ignition coil 2 pin. • Check continuity between Ignition Coil 2 pin to ECU pin. • Check boots fault on Ignition Coil 2. • Check for spark output physically, if spark on the coil looks good. • Check spark plug gap • Check for any water accumulation in coil well, if so wipe it out.

Related Component/Subsystem: Misfire

DTC: P0303: Cylinder 3 Misfire
SPN/FMI: 1325/31
SFC: 753

Description	Enabling Conditions
Cylinder 3 misfiring Misfire is monitored over 200 complete engine cycles. After each 200 cycle period the percent misfire is updated for each individual cylinder. Cylinder 3 misfire will be set with Cylinder 3 Misfire % > Overall Percent Misfire* 80%	Misfire_Fault Malfuction is TRUE AND all of the following DisableMisfireDetection fault action is inactive TimeSinceRun > 'Misfire_MinRuntime' System Voltage > 'Misfire_MinSysVolt' System Voltage < 'Misfire_MaxSysVolt' ECT > 'Misfire_MinECT' ECT < 'Misfire_MaxECT' Fuel_Amount > 'Misfire_MinFuelAmount' RoadSpeed > 'Misfire_MinRoadSpeed' RoadSpeed < 'Misfire_MaxRoadSpeed' 'Misfire_ClutchDelay' seconds have passed since a clutch switch transition After clearing this Code, a total of 1 key cycles must occur before this fault can be set again

Malfunction Criteria

Cylinder 3 Misfire Percent/TotalCylinderNum > 80% * Overall Misfire Percent
OR
(No single cylinder Misfire > 80% * Overall AND Cylinder 3 Misfire Percent > 20% * Overall Misfire Percent)

Effect of Failure	Service Guidance – First Check:
• Poor performance and fuel economy. • O2 sensor will read lean value in case of Coil/Spark failure. • Catalyst can get damaged.	• Check Ignition Coil 3 connector for corrosion or loose pin. • Check continuity between Main Power Relay output to Ignition coil 3 pin. • Check continuity between Ignition Coil 3 pin to ECU pin. • Check boots fault on Ignition Coil 3. • Check for spark output physically, if spark on the coil looks good. • Check spark plug gap • Check for any water accumulation in coil well, if so wipe it out.

Related Component/Subsystem: Misfire

DTC: P0304: Cylinder 4 Misfire
SPN/FMI: 1326/31
SFC: 754

Description	Enabling Conditions
Cylinder 4 misfiring Misfire is monitored over 200 complete engine cycles. After each 200 cycle period the percent misfire is updated for each individual cylinder. Cylinder 4 misfire will be set with Cylinder 4 Misfire % > Overall Percent Misfire* 80%	Misfire_Fault Malfuction is TRUE AND all of the following DisableMisfireDetection fault action is inactive TimeSinceRun > 'Misfire_MinRuntime' System Voltage > 'Misfire_MinSysVolt' System Voltage < 'Misfire_MaxSysVolt' ECT > 'Misfire_MinECT' ECT < 'Misfire_MaxECT' Fuel_Amount > 'Misfire_MinFuelAmount' RoadSpeed > 'Misfire_MinRoadSpeed' RoadSpeed < 'Misfire_MaxRoadSpeed' 'Misfire_ClutchDelay' seconds have passed since a clutch switch transition After clearing this Code, a total of 1 key cycles must occur before this fault can be set again

Malfunction Criteria

Cylinder 4 Misfire Percent/TotalCylinderNum > 80% * Overall Misfire Percent
OR
(No single cylinder Misfire > 80% * Overall AND Cylinder 4 Misfire Percent > 20% * Overall Misfire Percent)

Effect of Failure	Service Guidance – First Check:
• Poor performance and fuel economy. • O2 sensor will read lean value in case of Coil/Spark failure. • Catalyst can get damaged.	• Check Ignition Coil 4 connector for corrosion or loose pin. • Check continuity between Main Power Relay output to Ignition coil 4 pin. • Check continuity between Ignition Coil 4 pin to ECU pin. • Check boots fault on Ignition Coil 4. • Check for spark output physically if spark on the coil looks good. • Check spark plug gap • Check for any water accumulation in coil well, if so wipe it out.

Related Component/Subsystem: Misfire

DTC: P0305: Cylinder 5 Misfire
SPN/FMI: 1327/31
SFC: 755

Description	Enabling Conditions
Cylinder 5 misfiring Misfire is monitored over 200 complete engine cycles. After each 200 cycle period the percent misfire is updated for each individual cylinder. Cylinder 5 misfire will be set with Cylinder 5 Misfire % > Overall Percent Misfire* 80%	Misfire_Fault Malfuction is TRUE AND all of the following DisableMisfireDetection fault action is inactive TimeSinceRun > 'Misfire_MinRuntime' System Voltage > 'Misfire_MinSysVolt' System Voltage < 'Misfire_MaxSysVolt' ECT > 'Misfire_MinECT' ECT < 'Misfire_MaxECT' Fuel_Amount > 'Misfire_MinFuelAmount' RoadSpeed > 'Misfire_MinRoadSpeed' RoadSpeed < 'Misfire_MaxRoadSpeed' 'Misfire_ClutchDelay' seconds have passed since a clutch switch transition After clearing this Code, a total of 1 key cycles must occur before this fault can be set again

Malfunction Criteria

Cylinder 5 Misfire Percent/TotalCylinderNum > 80% * Overall Misfire Percent
OR
(No single cylinder Misfire > 80% * Overall AND Cylinder 5 Misfire Percent > 20% * Overall Misfire Percent)

Effect of Failure	Service Guidance – First Check:
• Poor performance and fuel economy. • O2 sensor will read lean value in case of Coil/Spark failure. • Catalyst can get damaged.	• Check Ignition Coil 5 connector for corrosion or loose pin. • Check continuity between Main Power Relay output to Ignition coil 5 pin. • Check continuity between Ignition Coil 5 pin to ECU pin. • Check boots fault on Ignition Coil 5. • Check for spark output physically, if spark on the coil looks good. • Check spark plug gap • Check for any water accumulation in coil well, if so wipe it out.

Related Component/Subsystem: Misfire

DTC: P0306: Cylinder 6 Misfire
SPN/FMI: 1328/31
SFC: 756

Description	Enabling Conditions
Cylinder 6 misfiring Misfire is monitored over 200 complete engine cycles. After each 200 cycle period the percent misfire is updated for each individual cylinder. Cylinder 6 misfire will be set with Cylinder 6 Misfire % > Overall Percent Misfire* 80%	Misfire_Fault Malfuction is TRUE AND all of the following DisableMisfireDetection fault action is inactive TimeSinceRun > 'Misfire_MinRuntime' System Voltage > 'Misfire_MinSysVolt' System Voltage < 'Misfire_MaxSysVolt' ECT > 'Misfire_MinECT' ECT < 'Misfire_MaxECT' Fuel_Amount > 'Misfire_MinFuelAmount' RoadSpeed > 'Misfire_MinRoadSpeed' RoadSpeed < 'Misfire_MaxRoadSpeed' 'Misfire_ClutchDelay' seconds have passed since a clutch switch transition After clearing this Code, a total of 1 key cycles must occur before this fault can be set again

Malfunction Criteria

Cylinder 6 Misfire Percent/TotalCylinderNum > 80% * Overall Misfire Percent
OR
(No single cylinder Misfire > 80% * Overall AND Cylinder 6 Misfire Percent > 20% * Overall Misfire Percent)

Effect of Failure	Service Guidance – First Check:
• Poor performance and fuel economy. • O2 sensor will read lean value in case of Coil/Spark failure. • Catalyst can get damaged.	• Check Ignition Coil 6 connector for corrosion or loose pin. • Check continuity between Main Power Relay output to Ignition coil 6 pin. • Check continuity between Ignition Coil 6 pin to ECU pin. • Check boots fault on Ignition Coil 6. • Check for spark output physically, if spark on the coil looks good. • Check spark plug gap • Check for any water accumulation in coil well, if so wipe it out.

Related Component/Subsystem: Misfire

DTC: P0300: Single/Multiple Cylinder Misfire
SPN/FMI: 1322/31
SFC: 759

Description	Enabling Conditions
Overall misfire fault, multiple cylinder misfire Overall Percent Misfire% is calculated by {(Cyl1 Misfire%)/6 + (Cyl2 Misfire%)/6 + (Cyl3 Misfire%)/6 + (Cyl4 Misfire%)/6 + (Cyl5 Misfire%)/6 + (Cyl6 Misfire%)/6} Overall Percent Misfire will be set with Overall Percent Misfire > Percent Misfire Threshold (Misfire Weighted Threshold)	No Rough Road AND NO Fuel Cut AND NO Encoder Faults AND all of the following DisableMisfireDetection fault action is inactive TimeSinceRun > 'Misfire_MinRuntime' System Voltage > 'Misfire_MinSysVolt' System Voltage < 'Misfire_MaxSysVolt' ECT > 'Misfire_MinECT' ECT < 'Misfire_MaxECT' Fuel_Amount > 'Misfire_MinFuelAmount' RoadSpeed > 'Misfire_MinRoadSpeed' RoadSpeed < 'Misfire_MaxRoadSpeed' 'Misfire_ClutchDelay' seconds have passed since a clutch switch transition Engine in Diag Steady State if 'C_Misfire_SSEng_Diag_Allowed' == YES After clearing this Code, a total of 1 key cycles must occur before this fault can be set again

Malfunction Criteria
Overall Misfire Percent > Weighted RPM/Load Threshold {Misfire_OBDII_SevirityTable} Based on Speed/Load

Effect of Failure	Service Guidance – First Check:
• Possible worse fuel economy. • Possible low power or poor running by torque derating. • Possible catalyst gets damaged. • Possible significant emissions issues.	• Check system voltage. • Check Main Power Relay output voltage should be same as system voltage. • Check continuity between Main Power Relay output to all cylinder Coil pin. • Check continuity between all cylinder coil pin to corresponding ECU pin. • Check for spark output physically, if spark on the coil looks good. • Check spark plug gap. • Check for any water accumulation in coil well, if so wipe it out.

Related Component/Subsystem: Misfire

DTC: P1300: Severe Cylinder Misfire
SPN/FMI: 1322/14
SFC: 761

Description	Enabling Conditions
Overall misfire active for prolonged periods with conditions Time Since Run, System Voltage, ECT, Fuel Amount and Road Speed.	Misfire_Fault Malfuction is TRUE AND all of the following DisableMisfireDetection fault action is inactive TimeSinceRun > 'Misfire_MinRuntime' System Voltage > 'Misfire_MinSysVolt' System Voltage < 'Misfire_MaxSysVolt' ECT > 'Misfire_MinECT' ECT < 'Misfire_MaxECT' Fuel_Amount > 'Misfire_MinFuelAmount' RoadSpeed > 'Misfire_MinRoadSpeed' RoadSpeed < 'Misfire_MaxRoadSpeed' 'Misfire_ClutchDelay' seconds have passed since a clutch switch transition Engine in Diag Steady State if 'C_Misfire_SSEng_Diag_Allowed' == YES After clearing this Code, a total of 1 key cycles must occur before this fault can be set again

Malfunction Criteria
Misfire_Fault exists

Effect of Failure	Service Guidance – First Check:
• Possible worse fuel economy. • Possible low power or poor running by torque derating. • Possible catalyst gets damaged. • Possible significant emissions issues.	• Check system voltage. • Check Main Power Relay output voltage should be same as system voltage. • Check continuity between Main Power Relay output to all cylinder Coil pin. • Check continuity between all cylinder coil pin to corresponding ECU pin. • Check for spark output physically, if spark on the coil looks good. • Check spark plug gap. • Check for any water accumulation in coil well, if so wipe it out.

Related Component/Subsystem: Misfire

DTC: P2336: High Engine Knock Level Cylinder 1
SPN/FMI: 1352/31
SFC: 771

Description	Enabling Conditions
Knock has been detected on cylinder 1	Key on After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
KnkMult1 > 'EngineKnockingFaultThreshold' [0.8]	
Effect of Failure	**Service Guidance – First Check:**
Audible knock may be heard	Correct all other faults first Check fuel quality Check spark plug heat range Check engine operating temperature Check O2 sensor reading Check engine oil level

Related Component/Subsystem: Knock

DTC: P2337: High Engine Knock Level Cylinder 2
SPN/FMI: 1353/31
SFC: 772

Description	Enabling Conditions
Knock has been detected on cylinder 2	Key on After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
KnkMult2 > 'EngineKnockingFaultThreshold' [0.8]	
Effect of Failure	**Service Guidance – First Check:**
Audible knock may be heard	Correct all other faults first Check fuel quality Check spark plug heat range Check engine operating temperature Check O2 sensor reading Check engine oil level

Related Component/Subsystem: Knock

DTC: P2338: High Engine Knock Level Cylinder 3
SPN/FMI: 1354/31
SFC: 773

Description	Enabling Conditions
Knock has been detected on cylinder 3	After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
KnkMult3 > 'EngineKnockingFaultThreshold' [0.8]	
Effect of Failure	**Service Guidance – First Check:**
Audible knock may be heard	Correct all other faults first Check fuel quality Check spark plug heat range Check engine operating temperature Check O2 sensor reading Check engine oil level

Related Component/Subsystem: Knock

DTC: P2339: High Engine Knock Level Cylinder 4
SPN/FMI: 1355/31
SFC: 774

Description	Enabling Conditions
Knock has been detected on cylinder 4	After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
KnkMult4 > 'EngineKnockingFaultThreshold' [0.8]	
Effect of Failure	**Service Guidance – First Check:**
Audible knock may be heard	Correct all other faults first Check fuel quality Check spark plug heat range Check engine operating temperature Check O2 sensor reading Check engine oil level

Related Component/Subsystem: Knock

DTC: P2340: High Engine Knock Level Cylinder 5
SPN/FMI: 1356/31
SFC: 775

Description	Enabling Conditions
Knock has been detected on cylinder 5	After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
KnkMult5 > 'EngineKnockingFaultThreshold' [0.8]	
Effect of Failure	**Service Guidance – First Check:**
Audible knock may be heard	Correct all other faults first Check fuel quality Check spark plug heat range Check engine operating temperature Check O2 sensor reading Check engine oil level

Related Component/Subsystem: Knock

DTC: P2341: High Engine Knock Level Cylinder 6
SPN/FMI: 1357/31
SFC: 776

Description	Enabling Conditions
Knock has been detected on cylinder 6	After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
KnkMult6 > 'EngineKnockingFaultThreshold' [0.8]	
Effect of Failure	**Service Guidance – First Check:**
Audible knock may be heard	Correct all other faults first Check fuel quality Check spark plug heat range Check engine operating temperature Check O2 sensor reading Check engine oil level

Related Component/Subsystem: Knock

DTC: P0327: Knock Sensor Open Circuit
SPN/FMI: 731/5
SFC: 781

Description	Enabling Conditions
Open circuit has been detected on Knock sensor	Load< 'KnockEnable_LoadThresh' [50] kpa OR RPM < 'KnockEnable_RPMThresh' [650] OR FSO OR Eng has run less than 'KnockEnable_EngRunningDly' [5] sec AND KnockDiagTime >='KnkSensorDiag_TimerThresh' [20]s +0.1 After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
ADC < 300	
Effect of Failure	**Service Guidance – First Check:**
• Audible knock may be heard • Knock detection disabled	Check continuity between ECU and knock sensor Check knock sensor

Related Component/Subsystem: Knock

DTC: P0328: Knock Sensor short Circuit
SPN/FMI: 731/6
SFC: 782

Description	Enabling Conditions
Short circuit has been detected on Knock sensor	Load< 'KnockEnable_LoadThresh' [50] kpa OR RPM < 'KnockEnable_RPMThresh' [650] OR FSO OR Eng has run less than 'KnockEnable_EngRunningDly' [5] sec AND KnockDiagTime >='KnkSensorDiag_TimerThresh' [20] s +0.1 After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
ADC > 950	
Effect of Failure	**Service Guidance – First Check:**
• Audible knock may be heard • Knock detection disabled	Check continuity between ECU and knock sensor check for short in knock sensor circuit Check knock sensor

Related Component/Subsystem: Knock

DTC: P0332: Knock Sensor 2 Open Circuit
SPN/FMI: 516098/5
SFC: 783

Description	Enabling Conditions
Open circuit has been detected on Knock sensor 2	Load< 'KnockEnable_LoadThresh' [50] kpa OR RPM < 'KnockEnable_RPMThresh' [650] OR FSO OR Eng has run less than 'KnockEnable_EngRunningDly' [5] sec AND KnockDiagTime >='KnkSensorDiag_TimerThresh' [20] s+0.1 After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
ADC < 300	
Effect of Failure	**Service Guidance – First Check:**
• Audible knock may be heard • Knock detection disabled	Check continuity between ECU and knock sensor 2 Check knock sensor 2

Related Component/Subsystem: Knock

DTC: P0333: Knock Sensor 2 short Circuit
SPN/FMI: 516098/6
SFC: 784

Description	Enabling Conditions
Short circuit has been detected on Knock sensor 2	Load< 'KnockEnable_LoadThresh' [50] kpa OR RPM < 'KnockEnable_RPMThresh' [650] OR FSO OR Eng has run less than 'KnockEnable_EngRunningDly' [5] sec AND KnockDiagTime >='KnkSensorDiag_TimerThresh' [20] s +0.1 After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
ADC > 950	
Effect of Failure	**Service Guidance – First Check:**
• Audible knock may be heard • Knock detection disabled	Check continuity between ECU and knock sensor 2 check for short in knock sensor 2 circuit Check knock sensor 2

Related Component/Subsystem: Knock

DTC: P2302: Spark 1 Open Secondary
SPN/FMI: 1268/14
SFC: 843

Description	Enabling Conditions
Ignition Coil 1 Open Secondary Fault The purpose of this diagnostic is to detect ignition coil 1 open secondary condition. The fault can be caused by an open secondary circuit or damaged spark plug 1.	Key = ON AND Engine is not stalled AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
SPK1 IO Fault Status is Fault AND MC33810 shows Open Secondary Fault	
Effect of Failure	**Service Guidance – First Check:**
• Occurring misfire. • Possible low power or poor running by torque derating. • Possible to cause damage to catalyst.	• Check the Boots of Ignition Coil for damaged secondary connection spring wire. • Check the spark plug for damaged electrode or plug gap. • Check the ignition ability for Coil 1 using Spark Gap Tester.

Related Component/Subsystem: Ignition

DTC: P2305: Spark 2 Open Secondary
SPN/FMI: 1269/14
SFC: 846

Description	Enabling Conditions
Ignition Coil 2 Open Secondary Fault The purpose of this diagnostic is to detect ignition coil 2 open secondary condition. The fault can be caused by an open secondary circuit or damaged spark plug 2.	Key = ON AND Engine is not stalled AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
SPK2 IO Fault Status is Fault AND MC33810 shows Open Secondary Fault	
Effect of Failure	**Service Guidance – First Check:**
• Occurring misfire. • Possible low power or poor running by torque derating. • Possible to cause damage to catalyst.	• Check the Boots of Ignition Coil for damaged secondary connection spring wire. • Check the spark plug for damaged electrode or plug gap. • Check the ignition ability for Coil 2 using Spark Gap Tester.

Related Component/Subsystem: Ignition

DTC: P2308: Spark 3 Open Secondary
SPN/FMI: 1270/14
SFC: 849

Description	Enabling Conditions
Ignition Coil 3 Open Secondary Fault The purpose of this diagnostic is to detect ignition coil 3 open secondary condition. The fault can be caused by an open secondary circuit or damaged spark plug 3.	Key = ON AND Engine is not stalled AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
SPK3 IO Fault Status is Fault AND MC33810 shows Open Secondary Fault	
Effect of Failure	**Service Guidance – First Check:**
• Occurring misfire. • Possible low power or poor running by torque derating. • Possible to cause damage to catalyst.	• Check the Boots of Ignition Coil for damaged secondary connection spring wire. • Check the spark plug for damaged electrode or plug gap. • Check the ignition ability for Coil 3 using Spark Gap Tester.

Related Component/Subsystem: Ignition

DTC: P2311: Spark 4 Open Secondary
SPN/FMI: 1271/14
SFC: 853

Description	Enabling Conditions
Ignition Coil 4 Open Secondary Fault The purpose of this diagnostic is to detect ignition coil 4 open secondary condition. The fault can be caused by an open secondary circuit or damaged spark plug 4.	Key = ON AND Engine is not stalled AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
SPK4 IO Fault Status is Fault AND MC33810 shows Open Secondary Fault	
Effect of Failure	**Service Guidance – First Check:**
• Occurring misfire. • Possible low power or poor running by torque derating. • Possible cause damage to catalyst.	• Check the Boots of Ignition Coil for damaged secondary connection spring wire. • Check the spark plug for damaged electrode or plug gap. • Check the ignition ability for Coil 4 using Spark Gap Tester.

Related Component/Subsystem: Ignition

DTC: P2314: Spark 5 Open Secondary
SPN/FMI: 1272/14
SFC: 856

Description	Enabling Conditions
Ignition Coil 5 Open Secondary Fault The purpose of this diagnostic is to detect ignition coil 5 open secondary condition. The fault can be caused by an open secondary circuit or damaged spark plug 5.	Key = ON AND Engine is not stalled AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
SPK5 IO Fault Status is Fault AND MC33810 shows Open Secondary Fault	
Effect of Failure	**Service Guidance – First Check:**
• Occurring misfire. • Possible low power or poor running by torque derating. • Possible cause damage to catalyst.	• Check the Boots of Ignition Coil for damaged secondary connection spring wire. • Check the spark plug for damaged electrode or plug gap. • Check the ignition ability for Coil 5 using Spark Gap Tester.

Related Component/Subsystem: Ignition

DTC: P2317: Spark 6 Open Secondary
SPN/FMI: 1273/14
SFC: 859

Description	Enabling Conditions
Ignition Coil 6 Open Secondary Fault The purpose of this diagnostic is to detect ignition coil 6 open secondary condition. The fault can be caused by an open secondary circuit or damaged spark plug 6.	Key = ON AND Engine is not stalled AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
SPK6 IO Fault Status is Fault AND MC33810 shows Open Secondary Fault	
Effect of Failure	**Service Guidance – First Check:**
• Occurring misfire. • Possible low power or poor running by torque derating. • Possible cause damage to catalyst.	• Check the Boots of Ignition Coil for damaged secondary connection spring wire. • Check the spark plug for damaged electrode or plug gap. • Check the ignition ability for Coil 6 using Spark Gap Tester.

Related Component/Subsystem: Ignition

DTC: P3300: Spark 1 Dwell Adapt at Max Limit
SPN/FMI: 1268/11
SFC: 861

Description	Enabling Conditions
Spark Cyl 1 Dwell Adaptive at Max Limit Fault The purpose of this diagnostic is to detect if the adaptive dwell controller reaches the limit for lengthening the dwell time for coil 1. The fault can be caused by increased circuit resistance between battery and primary coil on Cyl 1.	Key = ON AND Engine is not stalled AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND EngineActuatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Spark DwellAdaptCyl1 >= 'C_Spark_DwellAdaptMax' [0.35] ms - 0.00001	
Effect of Failure	**Service Guidance – First Check:**
• Possible low power or poor running by torque derating. • Possible decreasing ignition energy. • Possible misfire or backfire.	• Check the wiring resistance between Main Power Relay to Ignition Coil 1 connector pin that should be less than 1 ohm. • Check the wiring resistance between Ignition Coil 1 connector pin to ECU SPK1 pin that should be less than 1 ohm.

Related Component/Subsystem: Ignition

DTC: P0351: Spark 1 Dwell Adapt at Min Limit
SPN/FMI: 1268/31
SFC: 862

Description	Enabling Conditions
Spark Cyl 1 Dwell Adaptive at Min Limit Fault The purpose of this diagnostic is to detect if the adaptive dwell controller reaches the limit for shortening the dwell time for coil 1. The fault can be caused by defective ignition coil 1 such as layer short.	Key = ON AND Engine is not stalled AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND EngineActuatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Spark DwellAdaptCyl1 <= 'C_Spark_DwellAdaptMin' [-0.35] ms+ 0.00001	
Effect of Failure	**Service Guidance – First Check:**
• Possible low power or poor running by torque derating. • Possible decreasing ignition energy. • Possible misfire or backfire.	• Check the primary coil resistance or inductance to find defective coil. • Check the isolation properties between both pin of ignition coil connector with disconnecting connector.

Related Component/Subsystem: Ignition

DTC: P3303: Spark 2 Dwell Adapt at Max Limit
SPN/FMI: 1269/11
SFC: 863

Description	Enabling Conditions
Spark Cyl 2 Dwell Adaptive at Max Limit Fault The purpose of this diagnostic is to detect if the adaptive dwell controller reaches the limit for lengthening the dwell time for coil 2. The fault can be caused by increased circuit resistance between battery and primary coil on Cyl 2.	Key = ON AND Engine is not stalled AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND EngineActuatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Spark DwellAdaptCyl2>= 'C_Spark_DwellAdaptMax' [0.35] ms - 0.00001	
Effect of Failure	**Service Guidance – First Check:**
• Possible low power or poor running by torque derating. • Possible decreasing ignition energy. • Possible misfire or backfire.	• Check the wiring resistance between Main Power Relay to Ignition Coil 2 connector pin that should be less than 1 ohm. • Check the wiring resistance between Ignition Coil 1 connector pin to ECU SPK1 pin that should be less than 1 ohm.

Related Component/Subsystem: Ignition

DTC: P0352: Spark 2 Dwell Adapt at Min Limit
SPN/FMI: 1269/31
SFC: 864

Description	Enabling Conditions
Spark Cyl 2 Dwell Adaptive at Min Limit Fault The purpose of this diagnostic is to detect if the adaptive dwell controller reaches the limit for shortening the dwell time for coil 2. The fault can be caused by defective ignition coil 2 such as layer short.	Key = ON AND Engine is not stalled AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND EngineActuatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Spark DwellAdaptCyl2 <= 'C_Spark_DwellAdaptMin' [0.35] ms + 0.00001	
Effect of Failure	**Service Guidance – First Check:**
• Possible low power or poor running by torque derating. • Possible decreasing ignition energy. • Possible misfire or backfire.	• Check the primary coil resistance or inductance to find defective coil. • Check the isolation properties between both pin of ignition coil connector with disconnecting connector.

Related Component/Subsystem: Ignition

DTC: P3306: Spark 3 Dwell Adapt at Max Limit
SPN/FMI: 1270/11
SFC: 865

Description	Enabling Conditions
Spark Cyl 3 Dwell Adaptive at Max Limit Fault The purpose of this diagnostic is to detect if the adaptive dwell controller reaches the limit for lengthening the dwell time for coil 3. The fault can be caused by increased circuit resistance between battery and primary coil on Cyl 3.	Key = ON AND Engine is not stalled AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND EngineActuatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Spark DwellAdaptCyl3 >= 'C_Spark_DwellAdaptMax' [0.35] ms - 0.00001	
Effect of Failure	**Service Guidance – First Check:**
• Possible low power or poor running by torque derating. • Possible decreasing ignition energy. • Possible misfire or backfire.	• Check the wiring resistance between Main Power Relay to Ignition Coil 3 connector pin that should be less than 1 ohm. • Check the wiring resistance between Ignition Coil 1 connector pin to ECU SPK1 pin that should be less than 1 ohm.

Related Component/Subsystem: Ignition

DTC: P0353: Spark 3 Dwell Adapt at Min Limit
SPN/FMI: 1270/31
SFC: 866

Description	Enabling Conditions
Spark Cyl 3 Dwell Adaptive at Min Limit Fault The purpose of this diagnostic is to detect if the adaptive dwell controller reaches the limit for shortening the dwell time for coil 3. The fault can be caused by defective ignition coil 3 such as layer short.	Key = ON AND Engine is not stalled AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND EngineActuatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Spark DwellAdaptCyl3 <= 'C_Spark_DwellAdaptMin' [-0.35] ms+ 0.00001	
Effect of Failure	**Service Guidance – First Check:**
• Possible low power or poor running by torque derating. • Possible decreasing ignition energy. • Possible misfire or backfire.	• Check the primary coil resistance or inductance to find defective coil. • Check the isolation properties between both pin of ignition coil connector with disconnecting connector.

Related Component/Subsystem: Ignition

DTC: P3309: Spark 4 Dwell Adapt at Max Limit
SPN/FMI: 1271/11
SFC: 867

Description	Enabling Conditions
Spark Cyl 4 Dwell Adaptive at Max Limit Fault The purpose of this diagnostic is to detect if the adaptive dwell controller reaches the limit for lengthening the dwell time for coil 4. The fault can be caused by increased circuit resistance between battery and primary coil on coil 4.	Key = ON AND Engine is not stalled AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND EngineActuatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Spark DwellAdaptCyl4 >= 'C_Spark_DwellAdaptMax' [0.35] ms - 0.00001	
Effect of Failure	**Service Guidance – First Check:**
• Possible low power or poor running by torque derating. • Possible decreasing ignition energy. • Possible misfire or backfire.	• Check the wiring resistance between Main Power Relay to Ignition Coil 4 connector pin that should be less than 1 ohm. • Check the wiring resistance between Ignition Coil 1 connector pin to ECU SPK1 pin that should be less than 1 ohm.

Related Component/Subsystem: Ignition

DTC: P0354: Spark 4 Dwell Adapt at Min Limit
SPN/FMI: 1271/31
SFC: 868

Description	Enabling Conditions
Spark Cyl 4 Dwell Adaptive at Max Limit Fault The purpose of this diagnostic is to detect if the adaptive dwell controller reaches the limit for lengthening the dwell time for coil 4. The fault can be caused by defective ignition coil 4 such as layer short.	Key = ON AND Engine is not stalled AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND EngineActuatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Spark DwellAdaptCyl4 <= 'C_Spark_DwellAdaptMin' [-0.35] ms + 0.00001	
Effect of Failure	**Service Guidance – First Check:**
• Possible low power or poor running by torque derating. • Possible decreasing ignition energy. • Possible misfire or backfire.	• Check the primary coil resistance or inductance to find defective coil. • Check the isolation properties between both pin of ignition coil connector with disconnecting connector.

Related Component/Subsystem: Ignition

DTC: P3312: Spark 5 Dwell Adapt at Max Limit
SPN/FMI: 1272/11
SFC: 869

Description	Enabling Conditions
Spark Cyl 5 Dwell Adaptive at Min Limit Fault The purpose of this diagnostic is to detect if the adaptive dwell controller reaches the limit for shortening the dwell time for coil 5. The fault can be caused by increased circuit resistance between battery and primary coil on Cyl 5.	Key = ON AND Engine is not stalled AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND EngineActuatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Spark DwellAdaptCyl5 >= 'C_Spark_DwellAdaptMax' [0.35] ms - 0.00001	
Effect of Failure	**Service Guidance – First Check:**
• Possible low power or poor running by torque derating. • Possible decreasing ignition energy. • Possible misfire or backfire.	• Check the wiring resistance between Main Power Relay to Ignition Coil 5 connector pin that should be less than 1 ohm. • Check the wiring resistance between Ignition Coil 1 connector pin to ECU SPK1 pin that should be less than 1 ohm.

Related Component/Subsystem: Ignition

DTC: P0355: Spark 5 Dwell Adapt at Min Limit
SPN/FMI: 1272/31
SFC: 871

Description	Enabling Conditions
Spark Cyl 5 Dwell Adaptive at Max Limit Fault The purpose of this diagnostic is to detect if the adaptive dwell controller reaches the limit for lengthening the dwell time for coil 5. The fault can be caused by defective ignition coil 5 such as layer short.	Key = ON AND Engine is not stalled AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND EngineActuatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Spark DwellAdaptCyl5 <= 'C_Spark_DwellAdaptMin' [-0.35] ms + 0.00001	
Effect of Failure	**Service Guidance – First Check:**
• Possible low power or poor running by torque derating. • Possible decreasing ignition energy. • Possible misfire or backfire.	• Check the primary coil resistance or inductance to find defective coil. • Check the isolation properties between both pin of ignition coil connector with disconnecting connector.

Related Component/Subsystem: Ignition

DTC: P3315: Spark 6 Dwell Adapt at Max Limit
SPN/FMI: 1273/11
SFC: 872

Description	Enabling Conditions
Spark Cyl 6 Dwell Adaptive at Max Limit Fault The purpose of this diagnostic is to detect if the adaptive dwell controller reaches the limit for lengthening the dwell time for coil 6. The fault can be caused by increased circuit resistance between battery and primary coil on Cyl 6.	Key = ON AND Engine is not stalled AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND EngineActuatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Spark DwellAdaptCyl6 >= ['C_Spark_DwellAdaptMax' [0.35] ms - 0.00001]	
Effect of Failure	**Service Guidance – First Check:**
• Possible low power or poor running by torque derating. • Possible decreasing ignition energy. • Possible misfire or backfire.	• Check the wiring resistance between Main Power Relay to Ignition Coil 6 connector pin that should be less than 1 ohm. • Check the wiring resistance between Ignition Coil 1 connector pin to ECU SPK1 pin that should be less than 1 ohm.

Related Component/Subsystem: Ignition

DTC: P0356: Spark 6 Dwell Adapt at Min Limit
SPN/FMI: 1273/31
SFC: 873

Description	Enabling Conditions
Spark Cyl 6 Dwell Adaptive at Min Limit Fault The purpose of this diagnostic is to detect if the adaptive dwell controller reaches the limit for shortening the dwell time for coil 6. The fault can be caused by defective ignition coil 6 such as layer short.	Key = ON AND Engine is not stalled AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND EngineActuatorsEnable = 1 for > 0.7 seconds After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
Spark DwellAdaptCyl6 <= 'C_Spark_DwellAdaptMin' [-0.35] ms + 0.00001	
Effect of Failure	**Service Guidance – First Check:**
• Possible low power or poor running by torque derating. • Possible decreasing ignition energy. • Possible misfire or backfire.	• Check the primary coil resistance or inductance to find defective coil. • Check the isolation properties between both pin of ignition coil connector with disconnecting connector.

Related Component/Subsystem: Ignition

DTC: P1171: Pre-cat UEGO/HEGO Fueling CL Controller
SPN/FMI: 1696/7
SFC: 941

Description	Enabling Conditions
Fueling is not able to be maintained within the desired range	UEGO2 Warmed Up AND O2CtrlMode in Closed Loop for 'C_Phi_Control_CloseLoop_DelayTime' [5] sec AND Engine in Diag Steady State if 'C_Phi_Control_SSEng_Diag_Allowed' == YES After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
abs(UEGO2_Phi - FinalDesiredPhi) > 'C_Phi_Control_Error_Thresh' [0.15] for 'C_Phi_Control_ErrorTime' [6] Second within 'C_Phi_Control_MaxErrorTime' [8] Second	
Effect of Failure	**Service Guidance – First Check:**
Poor fueling control, may result in low power	Check fuel system for any blockage or restriction in flow. Check fuel injectors for proper operation. Clean injectors, see Fuel Injection (FMV) subsystem.

Related Component/Subsystem: Fuel Injection (FMV)

DTC: P0505: Idle Speed Governing CL Vontroller
SPN/FMI: 188/7
SFC: 943

Description	Enabling Conditions
Idle speed is not able to be maintained within the desired range	Engine is on Idle AND MinGovernor or APP is in Control and APP Filtered < 'C_Idle_APPPercentThresh' [4] % for 'C_Idle_Control_CloseLoop_DelayTime' [5] sec After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
abs(RPM - MinGovSetPoint) > 'C_Idle_RPMError_PercentThresh' [10] % * MinGovSetPoint/100	
Effect of Failure	**Service Guidance – First Check:**
Idle speed is too high or low	Check throttle for any blockage or stickiness in movement. Clean or replace as needed.

Related Component/Subsystem: Engine Speed

DTC: P0201: Injector 1 Shorted to Voltage / Injector 1 Open or Shorted to Ground
SPN/FMI: 651/6
SFC: 961

Description	Enabling Conditions
Fuel Injector 1 open circuit, broken injector 1 wire or defective injector	Key = ON AND Engine is not stalled AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND EngineActuatorsEnable = 1 for > 0.7 seconds AND IF InjDiag_CrankEnable = Disabled THEN EngineState = Run After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
INJ1ReactChan_FaultStatus_Timed' == 1	
Effect of Failure	**Service Guidance – First Check:**
The ECU has been programmed in such a way that it will compensate the fueling by opening other injectors for more time based on the O2 sensor in case of one injector fails. If more than one injector fails, engine may not start	Check INJ1 wiring for an open circuit Check Injector 1 Resistance Check continuity between ECU pin to injector 1 pin 1. Check continuity between MPRD output to injector 1 pin 2.

Related Component/Subsystem: Fuel Injection (FMV)

DTC: P0202: Injector 2 Shorted to Voltage/ Injector 2 Open or Shorted to Ground
SPN/FMI: 652/6
SFC: 962

Description	Enabling Conditions
Fuel Injector 2 open circuit, broken injector 2 wire or defective injector	Key = ON AND Engine is not stalled AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND EngineActuatorsEnable = 1 for > 0.7 seconds AND IF InjDiag_CrankEnable = Disabled THEN EngineState = Run After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
INJ2ReactChan_FaultStatus_Timed' == 1	
Effect of Failure	**Service Guidance – First Check:**
The ECU has been programmed in such a way that it will compensate the fueling by opening other injectors for more time based on the O2 sensor in case of one injector fails. If more than one injector fails, engine may not start	Check INJ2 wiring for an open circuit Check Injector 2 Resistance Check continuity between ECU pin to injector 2 pin 1. Check continuity between MPRD output to injector 2 pin 2.

Related Component/Subsystem: Fuel Injection (FMV)

DTC: P0203: Injector 3 Shorted to Voltage/ Injector 3 Open or Shorted to Ground
SPN/FMI: 653/6
SFC: 963

Description	Enabling Conditions
Fuel Injector 3 open circuit, broken injector 3 wire or defective injector	Key = ON AND Engine is not stalled AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND EngineActuatorsEnable = 1 for > 0.7 seconds AND IF InjDiag_CrankEnable = Disabled THEN EngineState = Run After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
INJ3ReactChan_FaultStatus_Timed' == 1	
Effect of Failure	**Service Guidance – First Check:**
The ECU has been programmed in such a way that it will compensate the fueling by opening other injectors for more time based on the O2 sensor in case of one injector fails. If more than one injector fails, engine may not start	Check INJ3 wiring for an open circuit Check Injector 3 Resistance Check continuity between ECU pin to injector 3 pin 1. Check continuity between MPRD output to injector 3 pin 2.

Related Component/Subsystem: Fuel Injection (FMV)

DTC: P0205: Injector 5 Shorted to Voltage/ Injector 5 Open or Shorted to Ground
SPN/FMI: 655/6
SFC: 965

Description	Enabling Conditions
Fuel Injector 5 open circuit, broken injector 5 wire or defective injector	Key = ON AND Engine is not stalled AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND EngineActuatorsEnable = 1 for > 0.7 seconds AND IF InjDiag_CrankEnable = Disabled THEN EngineState = Run After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
INJ5ReactChan_FaultStatus_Timed' == 1	
Effect of Failure	**Service Guidance – First Check:**
The ECU has been programmed in such a way that it will compensate the fueling by opening other injectors for more time based on the O2 sensor in case of one injector fails. If more than one injector fails, engine may not start	Check INJ5 wiring for an open circuit Check Injector 5 Resistance Check continuity between ECU pin to injector 5 pin 1. Check continuity between MPRD output to injector 5 pin 2.

Related Component/Subsystem: Fuel Injection (FMV)

DTC: P0206: Injector 6 Shorted to Voltage/ Injector 6 Open or Shorted to Ground
SPN/FMI: 656/6
SFC: 966

Description	Enabling Conditions
Fuel Injector 6 open circuit, broken injector 6 wire or defective injector	Key = ON AND Engine is not stalled AND DRVP > 'C_SysVolt_DiagEn_Thresh' [20] Volt AND EngineActuatorsEnable = 1 for > 0.7 seconds AND IF InjDiag_CrankEnable = Disabled THEN EngineState = Run After clearing this Code, a total of 0 key cycles must occur before this fault can be set again
Malfunction Criteria	
INJ6ReactChan_FaultStatus_Timed' == 1	
Effect of Failure	**Service Guidance – First Check:**
The ECU has been programmed in such a way that it will compensate the fueling by opening other injectors for more time based on the O2 sensor in case of one injector fails. If more than one injector fails, engine may not start	Check INJ6 wiring for an open circuit Check Injector 6 Resistance Check continuity between ECU pin to injector 6 pin 1. Check continuity between MPRD output to injector 6 pin 2.

Related Component/Subsystem: Fuel Injection (FMV)

DTC: P0170: Injector Duty Cycle Too High
SPN/FMI: 651/5
SFC: 967

Description	Enabling Conditions
Fuel injector on too much, clogged or sticking injector	Engine in Running After clearing this Code, a total of 1 key cycles must occur before this fault can be set again
Malfunction Criteria	
'TorqueInjDC_Derate' == 1 for 'C_InjectorDutyCycleTooHigh_ErrorTime' Second within 'C_InjectorDutyCycleTooHigh_MaxErrorTime' Second	
Effect of Failure	**Service Guidance – First Check:**
The ECU has been programmed in such a way that it will compensate the fueling by opening other injectors for more time based on the O2 sensor in case of one injector fails. If more than one injector fails, Engine may not start	Use injector clean feature and check individual injectors for operation Check all Injectors Resistance Check continuity between ECU pin to each injector pin 1. Check continuity between MPRD to each injector pin 2.

Related Component/Subsystem: Fuel Injection (FMV)

Chapter 5.
Performance Troubleshooting

BEFORE STARTING

1. Determine that the ECM and CEL light are operating. Verify operation by keying on and checking for CEL light to come on.

When the ignition key is turned on, the CEL will not illuminate and remain off until the engine is started. After the engine is started, the CEL lamp will turn on if one or more fault conditions are present. If a detected fault condition exists, the fault or faults will be stored in the memory of the engine control module (ECM). Once an active fault occurs the CEL will illuminate and remain ON. This signals the operator that a fault has been detected by the ECM.

2. Determine that there are no diagnostic codes stored. If there is a diagnostic code stored correct the cause of the fault before proceeding.

Intermittent Problems

An intermittent fault is the most difficult to troubleshoot since the CEL will come on at random, causing uncertainty in the cause and conditions present at the time of the fault. Also, the problem may or may not turn “ON” the CEL light or store a code.

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

CORRECTIVE ACTION
Most intermittent problems are caused by faulty electrical connections or wiring. Perform careful visual/physical check for:

- Poor mating of the connector halves or terminal not fully seated in the connector body (backed out).
- Improperly formed or damaged terminal. All connector terminals in problem circuit should be carefully reformed or replaced to insure proper contact tension.
- Corrosion on connector terminals and/or crimped wire.
- Loose connections or broken wires.
- Poor terminal to wire connection crimp.

If a visual/physical check does not find the cause of the problem, perform the following:

1. Drive the vehicle with a voltmeter or “Service” tool connected to a suspected circuit. Check if circuit is active and signal is reasonable.
2. Using the “Service” tool, monitor the input signal to the ECM to help detect intermittent conditions.
3. An abnormal voltage, or “Service” reading, when the problem occurs, indicates the problem may be in that circuit.
4. If the wiring and connectors check OK, and a diagnostic code was stored for a circuit having a sensor, check sensor.

An intermittent “Service Engine Soon” light with no stored diagnostic code may be caused by the following:

- CEL light wire to ECM or light driver equipment shorted to ground.
- ECM grounds (refer to ECM wiring diagrams

EST wires should be routed away from spark plug wires, coil in plug, and wires from ECM to ignition coil should have a good connection with low wiring resistance.

Surges and/or Stumbles

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

PRELIMINARY CHECKS
Perform the visual checks as described at start of “Diagnostics and Troubleshooting” chapter.

Be sure driver understands vehicle operation as explained in the operator manual.

Table 5-1. Surges and/or Stumbles Troubleshooting

Probable Cause	Corrective Action
Oxygen sensor malfunction	The fuel management should maintain a stoichiometric air-fuel ratio under all steady state operating conditions following engine warm-up. Failure of the Pre-catalyst O2 sensor should cause an O2 sensor fault that can be diagnosed with the CEL lamp or Service Tool.
Fuel system malfunction	**NOTE:** To determine if the condition is caused by a rich or lean system, the vehicle should be driven under similar conditions to where the problem occurs while monitoring the pre-catalyst O2 sensor output. Check fuel supply while condition exists. Check in-line fuel filter. Replace if dirty or plugged. Check fuel pressure. Check for contaminating the fuel injector. Perform injector cleaning process par instruction as required.
Air Intake System Malfunction	Check the waste gate control valve and linkage between actuator and waste gate. If there are intermittent work on waste gate control valve and sticky linkage on waste gate link, those can be caused of this condition. Check the TPS position using the Service Tool while exist condition with stable accelerator pedal position. If TPS position fluctuates while condition exists, checks throttle valve connector for loose connection and corrosion terminal. The TPS position should be stable when accelerator pedal keeps same position.
Ignition system malfunction	Check for proper ignition voltage output using spark tester. Check spark plugs. • Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. • Repair or replace as necessary. • Check condition of High tension lead, Coil in plug, and spark plug wires (where applicable). • Check ignition timing.
Component malfunction	Check vacuum lines for kinks or leaks.
Exhaust backpressure	Check condition of exhaust system. Check backpressure before catalyst. It should be less than 3.5 psig (24.13 kPa).

Related CEL Faults:
Pre-catalyst O2 sensor errors / O2 control errors /
Fuel Injector faults / Boost faults / EST faults / ETC faults

Engine Cranking but Will Not Start / Difficult to Start

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

PRELIMINARY CHECKS
Perform the visual checks as described at start of “Diagnostics and Troubleshooting” chapter.

Be sure driver is using correct method to start engine as explained in operator’s manual. Use “clear flood” mode during cranking by fully depressing the pedal and cranking the engine. If engine does not start, continue troubleshooting.

Table 5-2. Engine Cranking but Will Not Start / Difficult to Start Troubleshooting

Probable Cause	Corrective Action
Plugged fuel line	Remove obstruction from the fuel line. • Using caution, disconnect fuel line (some natural gas may escape). • Clear obstruction with compressed air. • Re-connect fuel line. • Leak test.
Clogged fuel filter	Repair/replace as required.
Faulty vapor connection between the pressure regulator, heat exchanger, FMV and the mixer	Check connection • Verify no holes in hose. • Clamps must be tight. • Look for kinked, pinched and/or collapsed hose.
Fuel lock-off malfunction	Repair/replace fuel lock-off.
Pressure regulator malfunction	Test regulator operation and pressure.
FMV malfunction	Perform injector cleaning process par instruction.
No crankshaft position sensor signal	Verify the crankshaft position signal is present during cranking.
No CAM encoder sensor signal	Verify the CAM encoder signal is present during cranking.
ECM / control system malfunction	Check Natural Gas Pressure Sensor using the Service Tool; Key off and stop the engine. Using caution, disconnect the fuel line at the FMV inlet port (some natural gas may escape). Check NGP reading that should be similar as ambient air pressure depending on altitude. If NGP reading is out of ambient pressure ± 10kPa, check supply voltage for NGP sensor that should be 5±0.1 V. If NGP sensor supply voltage is NG, check NGP sensor connector and wiring. If NGP sensor supply voltage is OK, replace NGP sensor. Check Coolant Temperature Sensor using the Service Tool; compare coolant temperature with ambient temperature on cold engine. If coolant temperature reading is 5° greater than or less than ambient air temperature on a cold engine, check resistance in coolant sensor circuit or sensor itself. Compare CTS resistance value to “Diagnostic Aids” chart at end of this section. Verify that there is no code for ETC spring check fault. Check for 0% APP during cranking. Cycle key ON and OFF and listen for throttle check (movement) on key OFF. Check for oil pressure switch faults. Check for sensor “sticking” faults. *Check TPS for stuck binding or a high TPS voltage with the throttle closed.*

Table 5-2. Engine Cranking but Will Not Start / Difficult to Start Troubleshooting (cont'd.)

Probable Cause	Corrective Action
Fuel system malfunction	Check fuel lock off: actuator should turn "ON" for 2 seconds when ignition is turned "ON". Check fuel pressure. Check for contaminated fuel. Check lock off fuses (visually inspect). Check the TPS position using the Service Tool during cranking to confirm proper throttle valve working. Check fuel injector duty cycle using the Service Tool during cranking. If duty cycle is 0%, check existing error code that will be caused for fuel shutdown condition. Check MAP using the Service Tool during cranking. If MAP signal is less than 17kPa. Check the MAP sensor for defect.
Ignition system malfunction	Check for proper ignition voltage output with spark tester. Check spark plugs. Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary. Check for: • Moisture on coil on plug* • Bare or shorted wires • Loose ignition coil ground • Pickup coil resistance and connections

(*) where present

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

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

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

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

Drive vehicle: verify problem exists.

Remove air filter and check for dirt or other means of plugging. Replace if needed.

Table 5-3. Lack of Power, Slow to Respond Troubleshooting

Probable Cause	Corrective Action
Fuel system malfunction	Check for restricted fuel filter. Check fuel supply. Check for contaminated fuel. Check for clogged fuel filter and repair or replace as required. Check for plugged fuel line and remove any obstruction from the fuel line: • Using caution, disconnect the fuel line (some natural gas may escape). • Clear obstruction with compressed air. • Re-connect fuel line. Check for faulty vapor connection between pressure regulator and mixer: • Verify that there are no holes in hose. • Observe that clamps are tight. • Look for kinked, pinched and/or collapsed hose. Monitor pre-catalyst O2 with Service Tool. Check for proper pressure regulator operation. Check for proper air/fuel mixer operation. Check the NGT reading during high load condition using the Service Tool. If NGT is lower than 0 °C. Check the coolant flow to the Heat Exchanger.
Ignition system malfunction	Check spark advance for excessive retarded ignition timing. Use Service Tool. Check secondary voltage using an oscilloscope or a spark tester to check for a weak coil. Check spark plug condition. Check poor spark plug primary and secondary wire condition.
Air intake system malfunction	Check for clogged air filter and clean or replace as required. Check MAT temperature using the Service Tool during high load condition. If MAT is higher than normal, check Air Inter Cooler efficiency. Checks boost pressure response for boost reference using the Service Tool. If observing slow response, check the waste gate control valve, waste gate actuator and linkage. Check the TPS position using the Service Tool during WOT condition. If TPS is lower than WOT position, check throttle valve sticking.
Component malfunction	Check ECM grounds for cleanliness and secure connection. See ECM wiring diagrams. Check exhaust system for possible restriction. Inspect exhaust system for damaged or collapsed pipes. • Inspect muffler for heat distress or possible internal failure. • Check for possible plugged catalytic converter by comparing exhaust system backpressure on each side at engine. Check backpressure by removing Pre-catalyst O2 sensor and measuring backpressure with a gauge.
Improper Adaptive Learn Accumulated	If there was some repair for component malfunction, try to clear adaptive learn table. The adaptive learn table can be cleared after cycling the foot pedal 12 times with the key-on prior to engine starting.
Engine mechanical	See Engine Manufacturer's Service Manual. Check engine valve timing and compression Check engine for correct or worn camshaft.

Related CEL Faults:
EST faults / ETC faults / ETC spring check / TPS faults / APP faults /Encoder error / Delayed Shutdown faults

Detonation / Spark Knock

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

PRELIMINARY CHECKS
Perform the visual checks as described at start of “Diagnostics and Troubleshooting” chapter.

Table 5-4. Detonation / Spark Knock Troubleshooting

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

Related CEL Faults:
EST faults
Encoder error
High coolant temperature faults

Backfire

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

PRELIMINARY CHECKS

Perform the visual checks as described at start of “Diagnostics and Troubleshooting” chapter.

Simulate condition by reviewing operation procedure practiced by vehicle operator.

Table 5-5. Backfire Troubleshooting

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

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

Rough, Unstable, Incorrect Idle, or Stalling

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

PRELIMINARY CHECKS
Perform the visual checks as described at start of “Diagnostics and Troubleshooting” chapter.

Check for vacuum leaks.

Check that ECM grounds are clean and tight. See ECM wiring diagram.

Table 5-6. Rough, Unstable, Incorrect Idle, or Stalling Troubleshooting

Probable Cause	Corrective Action
Clogged fuel filter	Repair/replace as required
Plugged fuel line	Remove obstruction from the fuel line. • Using caution, disconnect the fuel line (some natural gas may escape). • Clear obstruction with compressed air. • Re-connect fuel line.
Fuel lock-off malfunction	Repair/replace fuel lock-off
Faulty vapor connection between the pressure regulator, heat exchanger, FMV and the mixer	Check connection. • Verify no holes in hose. • Clamps must be tight. • Look for kinked, pinched and/or collapsed hose.
Vacuum leak	Check for vacuum leaks. • Between mixer and throttle body • Between throttle body and intake manifold • Between intake manifold and cylinder head

Related CEL Faults:
EST faults
ETC Sticking fault
Pre-catalyst adapts error
Injector Open/Short faults

Cuts Out, Misses

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

PRELIMINARY CHECKS
Perform the visual checks as described at start of “Diagnostics and Troubleshooting” chapter.

Table 5-7. Cuts Out, Misses Troubleshooting

Probable Cause	Corrective Action
Fuel system malfunction	Check fuel system specifically for plugged fuel filter, low pressure. Check for contaminated fuel. Check lock off intermittent connection. Check the NGT reading during high load condition using the Service Tool. If NGT is lower than 0 °C. Check the coolant flow to the Heat Exchanger.
Ignition system malfunction	Check for spark on the suspected cylinder(s) using a shop oscilloscope or spark tester or equivalent. If no spark, check for intermittent operation or miss. If there is a spark, remove spark plug(s) in these cylinders and check for cracks, wear, improper gap, burned electrodes, heavy deposits. Check spark plug wires by connecting ohmmeter to ends of each wire in question. If meter reads over 30,000 ohms, replace wire(s). Visually inspect coil on plug, and wires for moisture, dust, cracks, burns, etc. Spray plug wires with fine water mist to check for shorts. Check engine ground wire for looseness or corrosion.
Component malfunction	Check for electromagnetic interference (EMI). A missing condition can be caused by EMI on the reference circuit. EMI can usually be detected by monitoring engine rpm with Service Tool. A sudden increase in rpm with little change in actual engine rpm indicates EMI is present. If problem exists, check routing of secondary wires and check coil in plug ground circuit. Check intake and exhaust manifolds for casting flash or gasket leaks.
Engine mechanical	Perform compression check on questionable cylinders. If compression is low, repair as necessary. Check base engine. Remove rocker covers and check for bent pushrods, worn rocker arms, broken valve springs, worn camshaft lobes, and valve timing. Repair as necessary.

Related CEL Faults:
EST faults
ETC Sticking fault

High Idle Speed

Engine idles above the range of 750-1000 rpm.

PRELIMINARY CHECKS

Perform the visual checks as described at start of “Diagnostics and Troubleshooting” chapter.

Table 5-8. High Idle Speed Troubleshooting

Probable Cause	Corrective Action
Incorrect idle speed control	Check all hoses and gaskets for cracking, kinks, or leaks. Verify that there are no vacuum leaks.
Throttle sticking	Replace throttle. *See Fault Code 555/P-Code P0638: Throttle_Sticking*
Foot pedal sticking or incorrect pedal signal	Check pedal return spring travel for binding. Check APP function with Service Tool. Verify smooth change of APP reading with pedal movement.
Engine mechanical	Check for vacuum hose leak. Check for PCV malfunction. Check for defective intake gasket.

Related CEL Faults:

ETC Sticking fault
Idle adapt out of range
MAP Sticking fault
MAP high value
Fuel Regulator
O2 Sensor

Ignition System Faults

Misfires

Common ignition system ailments include misfire, hard stating, or a no start. Spark plugs can still be fouled by oil or fuel deposits as well as pre-ignition and detonation.

If the crankshaft position sensor fails, loss of the basic timing signal will prevent the system from generation a spark and engine will not start or run. A failed driver circuit within the ECM will also prevent proper ignition system operation if the override pin is in a high state.

It is important to remember that ignition misfire can also be caused by other factors such as worn or fouled spark plugs, loose or damaged coil connection or terminals dirty fuel injectors, low fuel pressure, intake vacuum leaks, loss of compression in the cylinder, or even contaminated fuel. These other possibilities should all be ruled out before a coil or ECM are replaced.

Ignition System Checks

The ignition coil can be tested with an ohmmeter. Measure primary and secondary resistance and compare to specifications. The EST input specification calls out for a nominal input impedance of 10K ohm connected in parallel with a 10 nF capacitor. If this resistance is out of specifications, the coil is bad and needs to be replaced.

Also, pay close attention to the tube that wraps around the spark plug. Cracks can allow voltage to jump to ground causing a misfire. The spark plug terminal should also fit tightly.

If a coil tests bad and is replaced, cleaning the connector and wiring harness terminals of the coil can often avoid future problems. Corrosion at either place can cause intermittent operation and loss of continuity, which may contribute to component failure.

Chapter 6.
Product Support and Service Options

Product Support Options

If you are experiencing problems with the installation, or unsatisfactory performance of a Woodward product, the following options are available:

1. Consult the troubleshooting guide in the manual.
2. Contact the **OE Manufacturer or Packager** of your system.
3. Contact the **Woodward Business Partner** serving your area.
4. Contact Woodward technical assistance via email (EngineHelpDesk@Woodward.com) with detailed information on the product, application, and symptoms. Your email will be forwarded to an appropriate expert on the product and application to respond by telephone or return email.
5. If the issue cannot be resolved, you can select a further course of action to pursue based on the available services listed in this chapter.

OEM or Packager Support: Many Woodward controls and control devices are installed into the equipment system and programmed by an Original Equipment Manufacturer (OEM) or Equipment Packager at their factory. In some cases, the programming is password-protected by the OEM or packager, and they are the best source for product service and support. Warranty service for Woodward products shipped with an equipment system should also be handled through the OEM or Packager. Please review your equipment system documentation for details.

Woodward Business Partner Support: Woodward works with and supports a global network of independent business partners whose mission is to serve the users of Woodward controls, as described here:

- A **Full-Service Distributor** has the primary responsibility for sales, service, system integration solutions, technical desk support, and aftermarket marketing of standard Woodward products within a specific geographic area and market segment.
- An **Authorized Independent Service Facility (AISF)** provides authorized service that includes repairs, repair parts, and warranty service on Woodward's behalf. Service (not new unit sales) is an AISF's primary mission.
- A **Recognized Engine Retrofitter (RER)** is an independent company that does retrofits and upgrades on reciprocating gas engines and dual-fuel conversions, and can provide the full line of Woodward systems and components for the retrofits and overhauls, emission compliance upgrades, long term service contracts, emergency repairs, etc.

A current list of Woodward Business Partners is available at www.woodward.com/local-partner.

Product Service Options

Depending on the type of product, the following options for servicing Woodward products may be available through your local Full-Service Distributor or the OEM or Packager of the equipment system.

- Replacement/Exchange (24-hour service)
- Flat Rate Repair
- Flat Rate Remanufacture

Replacement/Exchange: Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime.

This option allows you to call your Full-Service Distributor in the event of an unexpected outage, or in advance of a scheduled outage, to request a replacement control unit. If the unit is available at the time of the call, it can usually be shipped out within 24 hours. You replace your field control unit with the like-new replacement and return the field unit to the Full-Service Distributor.

Flat Rate Repair: Flat Rate Repair is available for many of the standard mechanical products and some of the electronic products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be.

Flat Rate Remanufacture: Flat Rate Remanufacture is very similar to the Flat Rate Repair option, with the exception that the unit will be returned to you in “like-new” condition. This option is applicable to mechanical products only.

Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned for repair, please contact your Full-Service Distributor in advance to obtain Return Authorization and shipping instructions.

When shipping the item(s), attach a tag with the following information:
- return number
- name and location where the control is installed
- name and phone number of contact person
- complete Woodward part number(s) and serial number(s)
- description of the problem
- instructions describing the desired type of repair

Packing a Control

Use the following materials when returning a complete control:
- protective caps on any connectors
- antistatic protective bags on all electronic modules
- packing materials that will not damage the surface of the unit
- at least 100 mm (4 inches) of tightly packed, industry-approved packing material
- a packing carton with double walls
- a strong tape around the outside of the carton for increased strength

NOTICE

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

Replacement Parts

When ordering replacement parts for controls, include the following information:
- the part number(s) (XXXX-XXXX) that is on the enclosure nameplate
- the unit serial number, which is also on the nameplate

Engineering Services

Woodward's Full-Service Distributors offer various Engineering Services for our products. For these services, you can contact the Distributor by telephone or by email.

- Technical Support
- Product Training
- Field Service

Technical Support is available from your equipment system supplier, your local Full-Service Distributor, or from many of Woodward's worldwide locations, depending upon the product and application. This service can assist you with technical questions or problem solving during the normal business hours of the Woodward location you contact.

Product Training is available as standard classes at many Distributor locations. Customized classes are also available, which can be tailored to your needs and held at one of our Distributor locations or at your site. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability.

Field Service engineering on-site support is available, depending on the product and location, from one of our Full-Service Distributors. The field engineers are experienced both on Woodward products as well as on much of the non-Woodward equipment with which our products interface.

For information on these services, please contact one of the Full-Service Distributors listed at www.woodward.com/local-partner.

Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory at www.woodward.com/support, where you may also find the most current product support and contact information.

You can also contact the Woodward Customer Service Department at one of the following Woodward facilities to obtain the address and phone number of the nearest facility at which you can obtain information and service.

Products Used in Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 8818 5515
Germany:	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (32) 422-5551
Poland	+48 (12) 295 13 00
United States	+1 (970) 482-5811

Products Used in Engine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 8818 5515
Germany	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+ 82 (32) 422-5551
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

Products Used in Industrial Turbomachinery Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 8818 5515
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+ 82 (32) 422-5551
The Netherlands	+31 (23) 5661111
Poland	+48 (12) 295 13 00
United States	+1 (970) 482-5811

Technical Assistance

If you need to contact technical assistance, you will need to provide the following information. Please write it down here before contacting the Engine OEM, the Packager, a Woodward Business Partner, or the Woodward factory:

General

Your Name _____

Site Location _____

Phone Number _____

Fax Number _____

Prime Mover Information

Manufacturer _____

Engine Model Number _____

Number of Cylinders _____

Type of Fuel (gas, gaseous, diesel, dual-fuel, etc.) _____

Power Output Rating _____

Application (power generation, marine, etc.) _____

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number _____

Control/Governor #2

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number _____

Control/Governor #3

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number _____

Symptoms

Description _____

_____

If you have an electronic or programmable control, please have the adjustment setting positions or the menu settings written down and with you at the time of the call.

Appendix A.
Using a Multimeter

DMM Digital Multimeter

A Digital Multimeter (DMM) is a device that may measure voltage, current, and resistance to diagnose electrical problems. To prevent electric shock, only trained individuals should operate a DMM. Refer to the OEM. The switch enables the functionality for measuring voltage, resistance, and current

Resistance Tests

To conduct a resistance test, turn on the multimeter. Set the multimeter to OHM setting. Take the probes and keep them from touching each other or anything else. The display screen should read infinity. This is displaying an open circuit condition. This indicates that there is infinite resistance. As a result of this open circuit condition there is a break in the circuit. This also can mean that the material being tested is an insulator or an incomplete circuit. Insulators do not conduct electrical current at a measurable degree by the meter, examples of this would be air or plastic. An open circuit will not register resistance because the path is broken, or the conductor is not connected. Now take the probe leads and touch them together. This will indicate a short circuit.

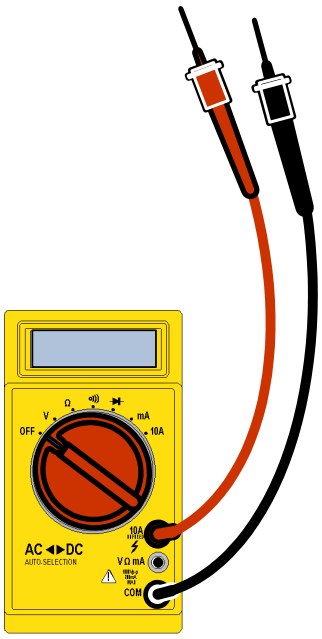


Figure A-1. Digital Multimeter

OHM Meter

An OHM meter measures the resistance in a circuit or component. Digital multimeters come with Ohm meter settings. The unit of measure for resistance is OHM or Ω. Resistance tests allow the tester to determine if the circuit is open, short, or if there is a resistance level. When measuring resistance three steps can be outlined:

1. Switch to OHMs or Ω
2. Disconnect the power to the circuit
3. Measure in parallel

Follow the diagram below. If the reading is not open or short as stated it will read out a measurement on the screen. This measurement may be compared to the specification for the component to see if the component passes or fails inspection.

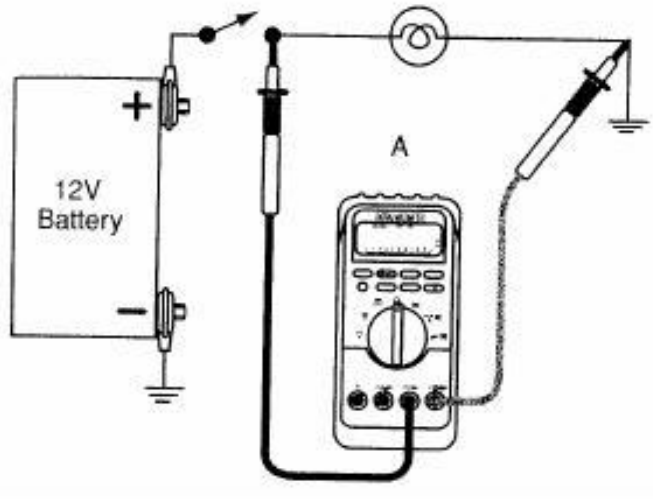


Figure A-2. Measuring Resistance with Power Disconnected

Using a Voltage Meter

Voltage tests the integrity of the ground circuit, or the active load on the circuit. There is the added value that voltage tests can verify if the element or component is working within specification. Measuring voltage is different from resistance in that power must be on. When measuring voltage, the switch should go to V with a line above it. Once the voltage is selected it must be drawn in parallel, like in figure below (A) or (B). When using voltage meter, probes should be put in proper direction otherwise it will result in negative voltage. Make sure red lead is connected to power and the black lead is connected to COM or common ground terminal. Compare the voltage read out on the screen to its corresponding specification.

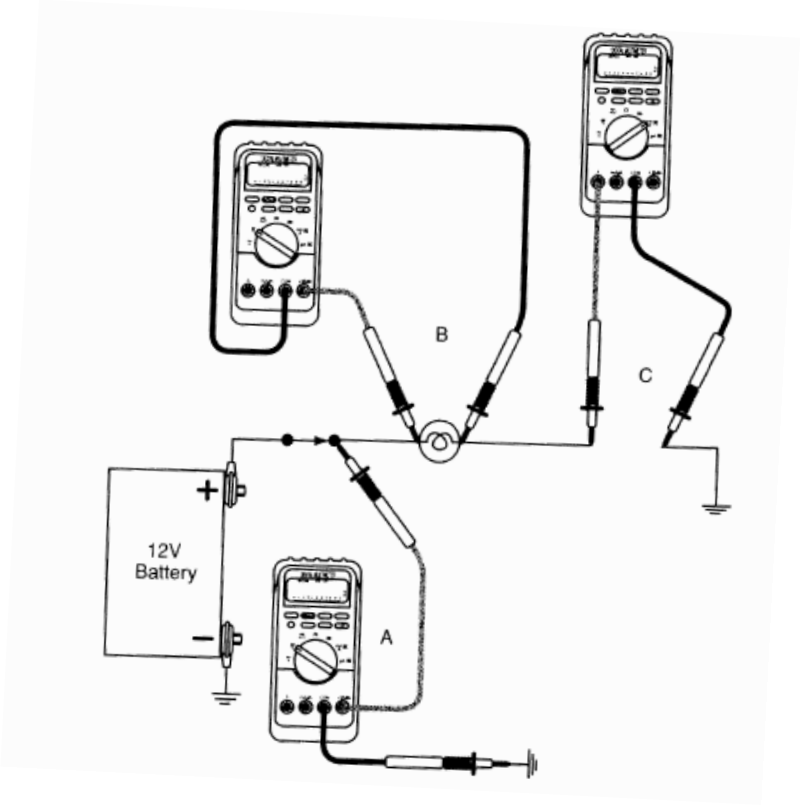


Figure A-3. Testing for Voltage with DMM (A), Testing Voltage Drop (B), Measuring Current (C)

Revision History

New Manual—

We appreciate your comments about the content of our publications.

Send comments to: industrial.support@woodward.com

Please reference publication 26760.

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Woodward has company-owned plants, subsidiaries, and branches, as well as authorized distributors and other authorized service and sales facilities throughout the world.

Complete address / phone / fax / email information for all locations is available on our website.