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Blue Bird Vision
Liquid Propane Autogas Fuel System
(4th Generation, 6.8L V10)

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-BA	Formatting and Revisions	06/2019
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SERVICE AND DIAGNOSTIC MANUAL
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Upodated 10/2019

FOREWARD

This manual is intended to provide technicians with the procedures required to maintain and service the unique components for the ROUSH CleanTech Liquid Propane Autogas (LPA) system. Service procedures for other vehicle components may be referenced to, which can be found in one of the Blue Bird Service Manuals. For base engine or transmission information, refer to the Ford F-650 (H561) workshop manual. For access to the Ford manual, please subscribe to www.motorcraft.com.

COMMONLY USED ACRONYMS

Acronym or Abbreviation	Description
BS	Bleed Solenoid
CAN	Controller Area Network
DTC	Diagnostic Trouble Code
DTE	Distance To Empty
ECU	Engine Control Unit
EFPR	Electronic Fuel Pump Relay
EGR	Exhaust Gas Recirculation
EPA	Environmental Protection Agency
EVAP	Evaporative
FPCM	Fuel Pump Control Module
FCS	Flow Control Solenoid
FPTS	Fuel Pressure and Temperature Sensor
FRP	Fuel Rail Pressure
FRPCM	Fuel Rail Pressure Control Module
GWM	Gateway Module
IPTS	Integrated Pressure Temperature Sensor
KOEO	Key On Engine Off
KOER	Key On Engine Running
LPA	Liquid Petroleum Autogas
MIL	Malfunction Indicator Lamp
MY	Model Year
NFPA	National Fire Protection Association
NFPA 58	Liquid Petrolum Gas Code from the NFPA
Nm	Newton Meter
OASIS	On-Line Service Information System
OBD	On-Board Diagnostic
OEM	Original Equipment Manufacturer
OPD	Overfill Protection Device
OTIS	One Touch Integrated Starting
PCM	Powertrain Control Module
PERC	Propane Education and Research Council
PID	Parameter Identification
PRV	Pressure Relief Valve
VECI	Vehicle Emission Control Information
WC	Water Capacity

UPDATES

Updates to the ROUSH CleanTech Gen 4 Liquid Propane Autogas Service Manual for the Blue Bird Vision include:

- Up-to-date procedures and information on the Gen 4 ROUSH CleanTech Liquid Propane Autogas system.
- Updated format to simplify finding and reviewing procedures and information.
- Consolidation of Warnings and Alerts to a single reference page for easy access.
- Quick reference section at the end of the publication with images and descriptions for most of the components of the ROUSH CleanTech Liquid Propane Autogas system.

ALERT MESSAGES

The following alert messages appear from time to time in the appropriate places in this manual. Ensure that all personnel in the immediate area are aware of these reminders. Although propane is nontoxic, nonpoisonous, has the lowest flammability range of any alternative fuel, and dissipates quickly when released into the atmosphere, extreme care must be taken when working with the fuel and fuel system.

IMPORTANT SAFETY INFORMATION

DANGER

Propane Safety

Leaked or vented propane will expand quickly when no longer pressurizing in the fuel system. Liquid propane expands at a ratio of 1:270 going from a liquid to vapor. Propane vapor is heavier than air and seeks the lowest point. When the ratio of propane to air is between 2.2% and 9.6%, propane will burn in the presence of an ignition source at 940°F (504°C) or hotter. Keep at least 35ft away from heat, sparks, flames, static electricity, lighted smoking materials, or other sources of ignition. Failure to heed this danger may result in severe personal injury or death.

DANGER

Fuel Lines

Fuel lines remain pressurized after engine shutdown. Keep away from heat, sparks, flames, static electricity, or other sources of ignition. Do NOT enter storage areas or confined space unless they are adequately ventilated. Failure to heed this danger may result in severe personal injury or death.

DANGER

Propane Vapor

Propane vapor is cold. The temperature of propane in its liquid state is -44°F (-42°C). When liquid propane is released from a pressurized vessel, it rapidly evaporates, creating a refrigeration effect that can cause frostbite. Wear non-porous, cold- safe gloves, eye protection, and ear protection during venting and repair operations. Keep moisture away from the **valves.** Failure to heed this warning can result in personal injury.

DANGER

NFPA 58 Guidelines

Always follow all NFPA 58 guidelines. When working on the propane fuel system or refueling a vehicle, you must be in a well- ventilated area at least 25 ft from any ignition source and 35 ft from any activity that throws sparks. Failure to heed this danger may result in severe personal injury or death.

DANGER

Battery

Disconnect the battery ground at the battery to ensure that the vehicle electrical system has no current. Failure to heed this danger could result in severe personal injury or death.

IMPORTANT WARNINGS

WARNING

Training

Technicians working with, or around, fuel systems should be properly trained to utilize extreme care and caution at all times. Failure to exercise extreme caution and care may lead to serious accidents which can result in property damage, personal injury, and/or death.

WARNING

Service and System Modification

Roush CleanTech nor Blue Bird approve of any additions to or modifications of this fuel system. This fuel system is designed and installed to meet federal standards and engine manufacturer's guidelines. The maintenance provider or modifier assumes all responsibility for the vehicle engine and fuel system if the fuel system is changed or modified. Some states require a special license to perform maintenance or work on propane powered vehicles. Check with local authorities or your state LP Gas Association for details. All fuel system components must be a minimum of 18 inches from any exhaust system component unless properly shielded. All service, maintenance and repairs performed on LP Gas systems must be done by an authorized LP Gas service technician.

WARNING

Tank Filling

For passenger safety, Blue Bird recommends all occupants disembark to a safety zone before fuel filling procedures take place.

WARNING

Working on Tank Components

Before removing any components from the fuel tank, it is very important to verify there is not any pressure remaining inside. The technician that is removing a tank component should always be the one to verify it is empty. This should be done right before starting the repair. Failure to do so could result in severe personal injury or death and/or damage to property. Refer to Tank Depressurization Verification Procedure before removing or working on any tank components.

WARNING

Tank Maintenance

Never cut or weld on or near the LPG fuel tank. Repairs to the fuel tank should only be made by a certified LPG tank repair facility. Failure to observe this warning could result in serious bodily injury, death and/or serious property damage.

INTRODUCTION

LPA System Overview

This manual is a supplement to the regular Ford Workshop Manual, covering the unique components of the ROUSH CleanTech Liquid Propane Autogas (LPA) fuel system. Unlike the traditional propane-powered vehicle that supplies propane to the engine in a vapor form, the LPA system delivers, meters, and injects liquid propane into the engine.

Similar to a modern gasoline engine, the LPA system stores liquid propane in the Fuel Tank. Dual in-tank electric Fuel Pumps circulate the propane through fuel rails which supply fuel to the Fuel Injectors. The injectors meter and inject liquid propane into each of the original inlet ports on the Ford engine. Fuel that is not used by the injectors will return to the Fuel Tank through a flow control solenoid.

The ROUSH CleanTech LPA system is fully integrated using Ford's one touch integrated start (OTIS) system. When the ignition key is turned to START and released to the ON position, the LPA system runs a purge process, then the starter engages and the vehicle starts with no further action required from the operator.

Fueling a propane-powered vehicle is noticeably different than on a conventional fueled vehicle. A propane fuel system is completely sealed and the major difference is the fill nozzle. There are two (2) types of fill nozzles and valves used for propane: a screw-on type and a quick-connect type (also known as "euro style"). When fueling with the screw-on type, turn connector clockwise to tighten, ensuring a good seal at the fill valve. With the quick-connect type, fully engage the nozzle to the valve, ensuring a good seal at the fill valve. The tank is equipped with an Overflow Protection Device (OPD), which only allows to tank to be filled to 80% of the overall tank volume, leaving room for the fuel to expand. At the 80% fill level, the dash fuel gauge will read full. The filling times should be comparable to that of gasoline or diesel but things such as ambient temperature and filling station pressure settings can affect these filling times.

Liquid propane autogas is also called liquid (or liquefied) petroleum gas (LPG, sometimes just LP gas). A vapor at normal room temperature and atmospheric pressure, a moderate increase in pressure produces its liquid state at ambient temperatures. It vaporizes readily when released. Because the liquid contains so much more energy than the same volume of vapor, liquid propane autogas is stored and shipped under pressure.

ROUSH CleanTech Customer Success

Technical issues involving starting, operating or re-fueling a propane power bus should be reported to your local qualified service provider. In the event further technical assistance is needed, you should first contact your authorized Blue Bird Dealer regarding any technical issues with your Blue Bird product.

In emergency situations or if immediate technical assistance is needed and the above mentioned technical assistance is unavailable you can call Call ROUSH CleanTech Customer Success Team at (800) 59-ROUSH (597-6874), Opt. 2 with any questions regarding the ROUSH CleanTech Liquid Propane Autogas system.

Maintenance

Ford vehicles equipped with the ROUSH CleanTech Propane fuel system should follow all engine, transmission, and body maintenance outlined in the Ford owner's manual. Alternate maintenance schedules or fluids are not recommended. For the propane fuel system, there is a Fill Filter and In-Line Supply Filter that both need to be replaced every 50,000 miles and during the replacement of a Fuel Pump. Refer to the replacement procedures in this manual.

Propane

Propane exists as a gas in its natural state, and like diesel fuel, gasoline, or natural gas, is a member of the hydrocarbon family. Propane is a by-product of refined petroleum and natural gas. When stored under pressure, the propane turns into a liquid. Propane is colorless, odorless, and non-toxic. Ethyl mercaptan is added to propane during the manufacturing process to give it a distinct, recognizable odor.

Propane is commonly referred to as LPG or LP gas. Like most liquids, liquid propane expands as its temperature increases. This is why propane tanks are only filled to 80% of its water capacity. Even with an 80% fill capacity, due to liquid propane's expansion ratio of 1:270 (liquid propane to a gas by volume) and its high BTU rating, a large volume of energy can be stored in a relatively small tank under relative low pressure.

Propane also has a very narrow range of flammability with a 2.2% threshold on the low side and a 9.6% threshold on the high side. This means that if the propane-to-oxygen mixture is lower than 2.2% or higher than 9.6%, the mixture is noncombustible.

Propane is heavier than air; therefore, a leak in a propane fuel system can result in a gas accumulation in low places, such as sewers, drains, or service pits. This can create a fire and health hazard as the propane will displace oxygen, potentially resulting in suffocation. For this reason, additional safety precautions should be observed when working on or around propane-powered equipment or storage tanks.

Propane is stored in the vehicle Fuel Tank under pressure as a liquid. The pressure in the tank is determined by the temperature of the fuel, ranging from 0 psi at minus 44°F, to 375 psi at 161°F. The tank has a Pressure Relief Valve (PRV) which vents the tank at pressures over 312 psi, depending on the application.

ROUSH CleanTech LPA vehicles require HD-5 propane, rated for automotive use. Use of HD-10 or other substandard propane may result in excess contamination of the system and premature failure of the Fuel Pump, injectors and in-tank filter.

Propane, like other fuels, must be handled safely with knowledge of its characteristics. Training in propane characteristics and handling is available through the Propane Education and Research Council (PERC), 1140 Connecticut Avenue, Washington, DC 20036. Their web address is www.propanecouncil.org.

SAFETY INFORMATION

The National Fire Protection Association (NFPA) publishes the NFPA 58, which is the industry benchmark standard for he safe storage, handling, transportation, and use of liquefied petroleum gas (LP-Gas or LPG). The NFPA58 is revised as necessary and updated regularly and has been adopted as law in virtually every political subdivision in the United States. Check with your local authorities for regulations applicable to liquid propane.

Installation, Garaging, and Training

Chapters 11 and 12 of NFPA 58 applies to engine fuel systems using LP-Gas in internal combustion engines, including containers, container appurtenances, carburetion equipment, piping, hose and fittings and their installation. Additionally, this chapter applies to garaging of vehicles and to the training of personnel.

Paragraph 11.2 specifies that each person engaged in “installing, repairing, filling, or otherwise servicing an LP-Gas engine fuel system shall be trained.” Contact the Propane Education and Research Council (PERC) to learn more about their CETP E-Learning computer-based training program.

Purging and Venting (Tanks and Lines)

Venting of LP-Gas to the atmosphere is covered by paragraphs 7.3.1, General, and 7.3.2, Purging of NFPA 58, 2017 edition. Refer to NFPA 58, Local Codes and Proper Training for specific information relating to safe venting of LPG.

General Propane Tank Filling

The most important aspect of filling a propane tank is safety. Understanding the properties, characteristics, and safe handling practices of the fuel is required before conducting any propane tank filling efforts.

A propane-powered vehicle is equipped with a propane tank built and certified to the regulations of the American Society of Mechanical Engineers (ASME). These tanks have a data plate with pertinent information including the ASME stamp (see Figure 1). This plate must be securely attached and legible or the tank should be taken out of service and replaced.

There are no requirements for recertifying ASME tanks, however, an inspection is required, and maintenance is recommended if there are signs of corrosion. Propane tanks are filled to 80% water capacity to allow for the liquid fuel to expand and contract, depending on ambient temperatures. All tanks built for use on motor vehicles are equipped with an overfilling prevention device (OPD). The National Fire Protection Association (NFPA) requires motor vehicle propane tanks be equipped with an Overfill Prevention Device to automatically prevent filling the tank beyond the maximum recommended capacity of 80%. This automatic stop fill system prevents overfilling of the fuel tanks. This requirement has been in effect since January 1, 1984.

Fill Stations

Propane is readily available anywhere in the United States. To locate the nearest station, check with www.afdc.energy.gov/afdc/locator/stations.

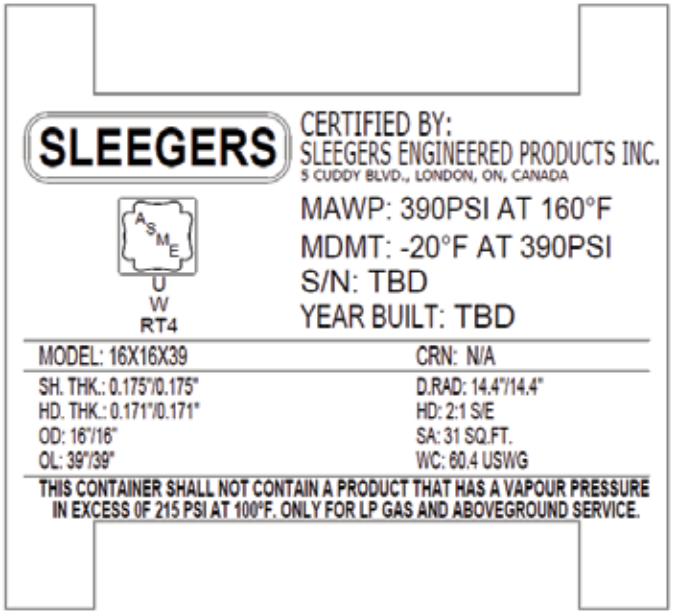

Figure 1. Fuel Tank Data Plate

ROUSH CleanTech recommends facilities designed for automotive refueling. Other locations may have low-output pumps, resulting in slow or no fill, or low-quality fuel which can result in premature component failure.

Note: Some fuel station pumps may have sufficient pressure to allow a small fuel flow into the tank even with the valves closed. The operator should stop the fill as soon the fuel flow drops noticeably.

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The vehicle is equipped with an 80% Overfill Prevention Device,

therefore it is not required that the liquid level gauge or Bleeder Valve be opened during regular refueling. Follow the instructions of your fuel station provider when refueling the vehicle. It is required that the nozzle output pressure be at least 25 psi higher than vehicle tank pressure for the vehicle to fill.

The fuel fill system includes the following components:

- Fuel Fill Valve, Cap and mounting bracket.
  - The valve is located behind a locked fuel door. There is also a switch mounted to the fill valve bracket, which is activated by contacting the door. **If the door is not closed and locked to activate the switch (when equipped), the Multiplex will not send the signal to the PCM to being the start sequence.**
- Fuel Fill hoses
  - The Fuel Fill hoses run between the Tank Fill Valve and the Fuel Fill Valve.
- Fuel Fill Filter and mounting clamp
  - The fill filter is mounted to the bus body in-line between the remote fill valve and the tank fill valve.
- Fuel tank mounted fill valve containing a mechanical Overfill Prevention Device (OPD).
  - The Tank Fill Valve and OPD are located at the top of the tank, near the center of the tank, and can be accessed through the service door in the floor of the bus.

Propane Tank Refueling Procedure

During a fill event, the system functions as follows:

1. Customer connects fuel filler nozzle to fill valve and activates the fill station pump.
2. Fuel pressure in the fill line causes the remote fill valve, tank fill valve and tank shutoff valve to open. In order for the valves to open, pressure in the fill line must be at least 20 psi higher than tank pressure (50 psi is recommended), otherwise no fill is possible.
3. Once the fuel reaches the 80% fill level the overfill prevention device closes the shut-off valve, not allowing additional fuel to flow into the tank.

NOTE: Some fuel station pumps may have sufficient pressure to allow a small fuel flow into the tank even with the valves closed. The operator should stop the fill as soon the fuel flow drops noticeably.

Vehicle Filling Procedure

This filling procedure is included for reference only. All personnel conducting fills should receive safety training on proper fill procedures and should **always wear propane-safe gloves while fueling a propane tank.**

Note: Vehicle myst be level, both front-to-rear and side-to-side, when fueling. Failure to fuel on a level plane may lead to over or under fills of the vehicle.

1. Entering the propane fueling station.
   a. Park the vehicle in close proximity to the motor fuel dispensing station.
2. Turn off the vehicle and remove the vehicle ignition key.
3. Exit the vehicle and ask all passengers to step outside the vehicle.
   a. Some stations may ask all passengers to stand outside the area where the fill process is taking place.
   b. Some stations could be self-service and the driver would perform the filling process; however in this case the driver has to be trained and certified to obtain an authorized filling station dispenser access card.
4. The attendant may need to inspect the propane tank for corrosion, dents and verify the data plate displays the ASME stamp and other pertinent information is correct. An attendant can refuse to fill your propane tank if it does not pass this inspection. Regular inspection and maintenance of your tank will prevent refusal to fill the tank.
5. Unlock and open the fuel door.
6. Verify the dispenser meter is set to zero.
   a. If the dispenser is an electronic dispenser it will set to zero automatically once the transaction has been initiated.
7. Connect the fuel nozzle to the vehicle fueling receptacle.
   a. The propane fueling nozzle must be fully engaged.
      i. Wear protective gloves while fueling a propane tank.
      ii. Remove the protective cap from the vehicle fueling receptacle.
      iii. Mate the nozzle coupling to the fueling receptacle.
      iv. If using the threaded fill valve and nozzle, turn the nozzle coupling in a clockwise direction; two or three turns until secure. A soft rubber washer or O-ring seals the connection so over tightening is not required. If using the quick-connect style fill valve and nozzle, push the nozzle firmly against the valve to fully engage the nozzle and the seal.
      v. Most nozzles for motor vehicle fueling are much like a gasoline type nozzle. The nozzles are also minimum bleed type for safety and to meet hydrocarbon release requirements in certain jurisdictions.
8. Turn on the propane dispenser/pump and begin the filling process.
   a. Open the nozzle to begin filling.
   b. Do not fill the tank based on a mechanical float gauge reading or the fuel level gauge on the dashboard.
   c. Pay attention and never walk away from the filling process.
   d. When the tank is full the overfill prevention device automatically stops the filling process at the 80% liquid level capacity of the tank.
9. Release or close the fueling nozzle.
   a. Turn off the fuel dispenser/pump.
   b. If using the threaded fill valve and nozzle, carefully and slowly unscrew the fueling nozzle (counterclockwise). If using the quickconnect nozzle, pull the nozzle away from the valve to disengage.
      i. A minimum bleed nozzle on the station's nozzle should have released any pressure left in the space between the nozzle and the receptacle when closed and should not bleed any pressure when unscrewing the connection.

Note: Some nozzles will have more pressure trapped between the nozzle and the receptacle, so it is necessary to slowly unscrew the connection to allow pressure to bleed off before removing the nozzle completely.

10. Replace the nozzle and fuel transfer hose of the dispenser.
11. Verify there are no leaks at the tank filling receptacle and replace the protective cap.
12. The fueling process is complete

OPD Inspection Procedure

Some companies or local or state governing bodies may require an annual Overfill Prevention Device (OPD) inspection on propane vehicles. This procedure tests that the OPD is stopping fuel fill at the correct 80% level.

Note: Test must be performed by a technician that has been trained to fill or service propane cylinders and can only be performed on vehicles with less than 50% fuel level, as indicated on the cluster.

1. Locate the vehicle propane tank data plate and reference the tank volume, often listed as W.C. (water capacity).
2. Calculate 5% of the W.C.
3. Park the vehicle at a fill station or near a refueling truck on level ground. Place a level on the frame rail or tank to ensure it is level.
4. Connect the fill nozzle to the vehicle fill valve.
5. Open the vehicle Bleeder Valve. You should have clear vapor emitting from the valve.
6. Begin filling per the refueling station manufacturer's procedure.
7. Once liquid (seen as a white mist) is visible at the Bleeder Valve, note the number of gallons filled. Fueling should stop before the calculated 5% volume is reached. If additional 5% is reached, stop fueling as vehicle is over filling and contact ROUSH CleanTech Customer Success (800) 59-ROUSH (597-6874), Opt. 2.
8. Turn off the fuel pump and close the Bleeder Valve.
9. Disconnect the nozzle and replace the fill cap.

Example: A functioning OPD on a tank with a 100 gallon WC will stop before five (5) gallons (100 WC x .05 = 5) have been added after the white mist is visible.

Note: OPD might stop before white mist is visible at the Bleeder Valve. This is normal as long as fuel gauge at the instrument cluster reads Full. The tank may have stopped filling before consistent liquid was visible at the bleeder valve. This indicates normal operation.

ROUSH CleanTech Fuel System Start Sequence

The ROUSH CleanTech LPA system is fully integrated using Ford's One Touch Integrated Start (OTIS) system. When the ignition key is turned to Start and released to the On position, and if the Blue Bird Multiplex start logic is satisfied, the LPA system will begin a purge process. Once the correct pressure and temperature is detected at the fuel rail, the starter engages and the vehicle starts with no further action required from the operator.

The full ROUSH CleanTech Fuel System start sequence is as follows:

1. CAN Bus Initialization
2. Bleed Diagnostic Pressure Read
3. Open Tank Solenoid
4. Open Supply Solenoid
5. Flush the Fuel Rails
6. Pressure Build
7. Crank

SERVICE PREPARATION
Fuel System Overview Images

Figure 3. Fuel Rail and Lines Installed on 6.8L Engine

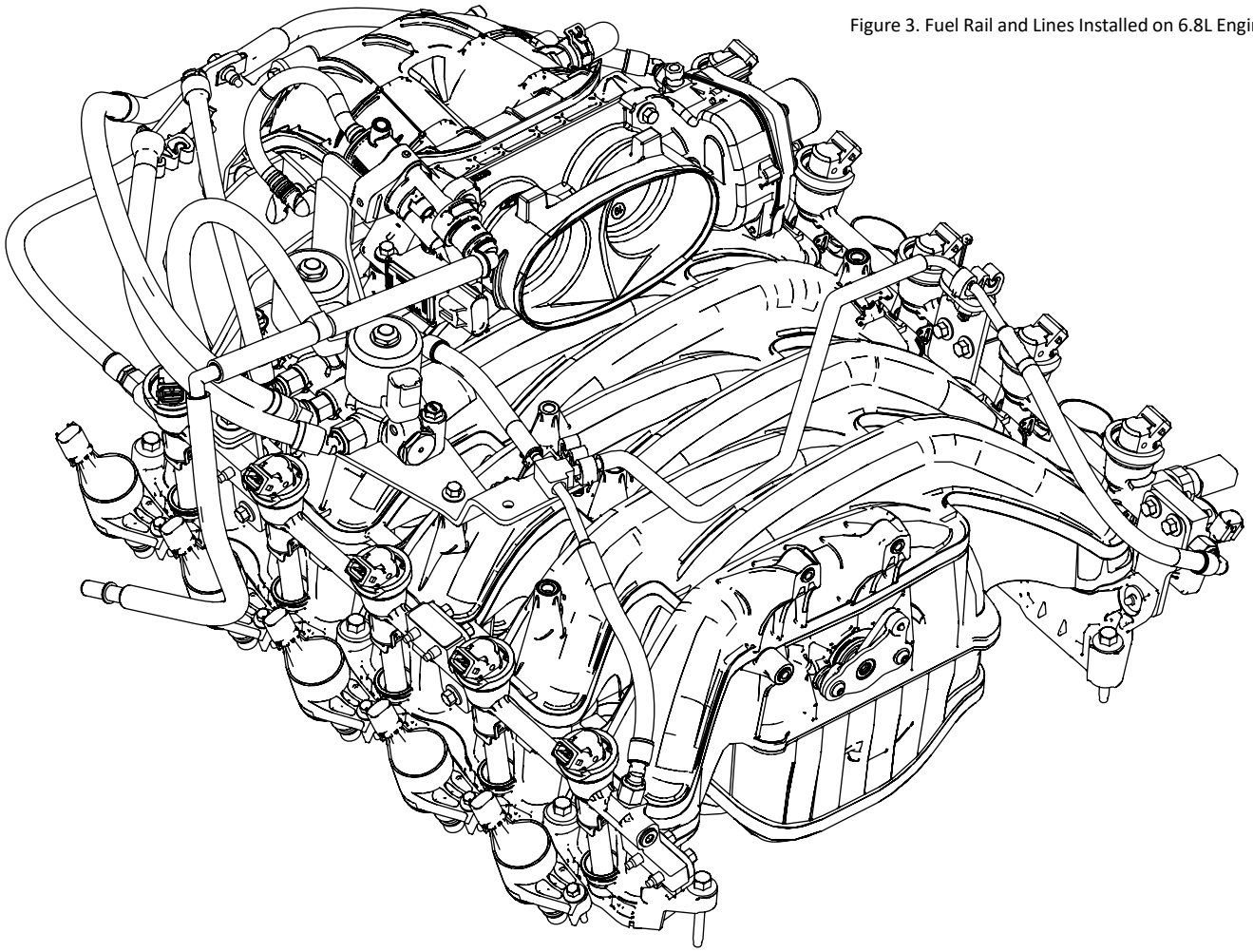


Figure 4. Fuel Rail and Lines

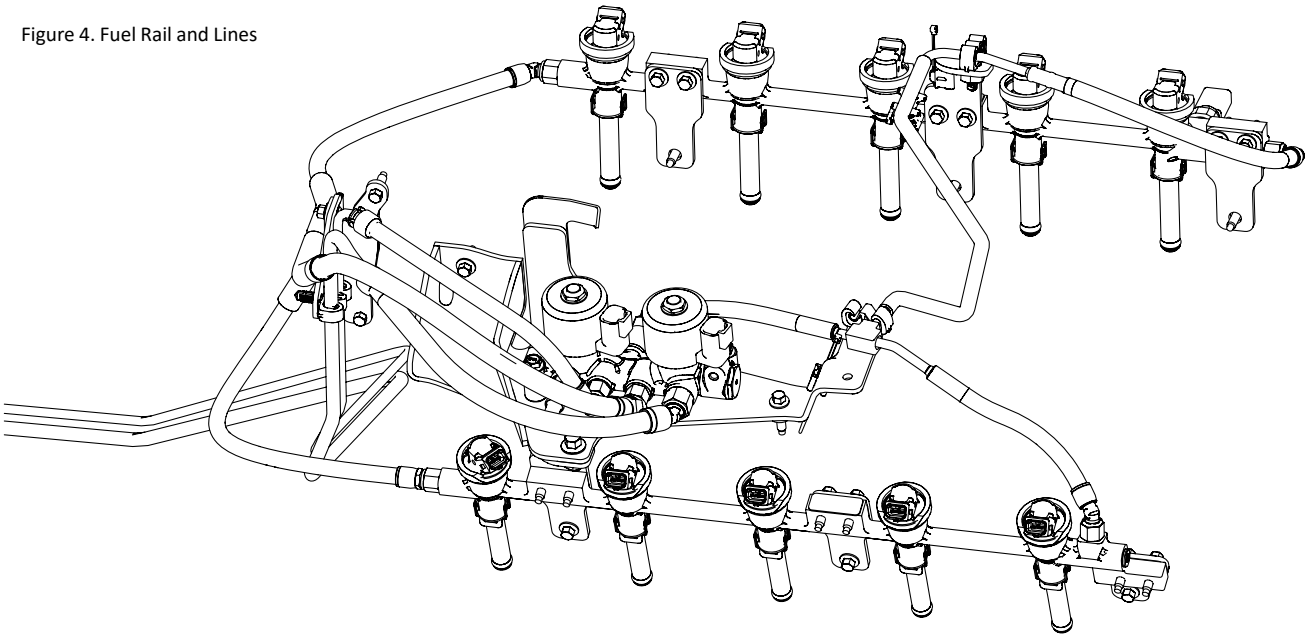
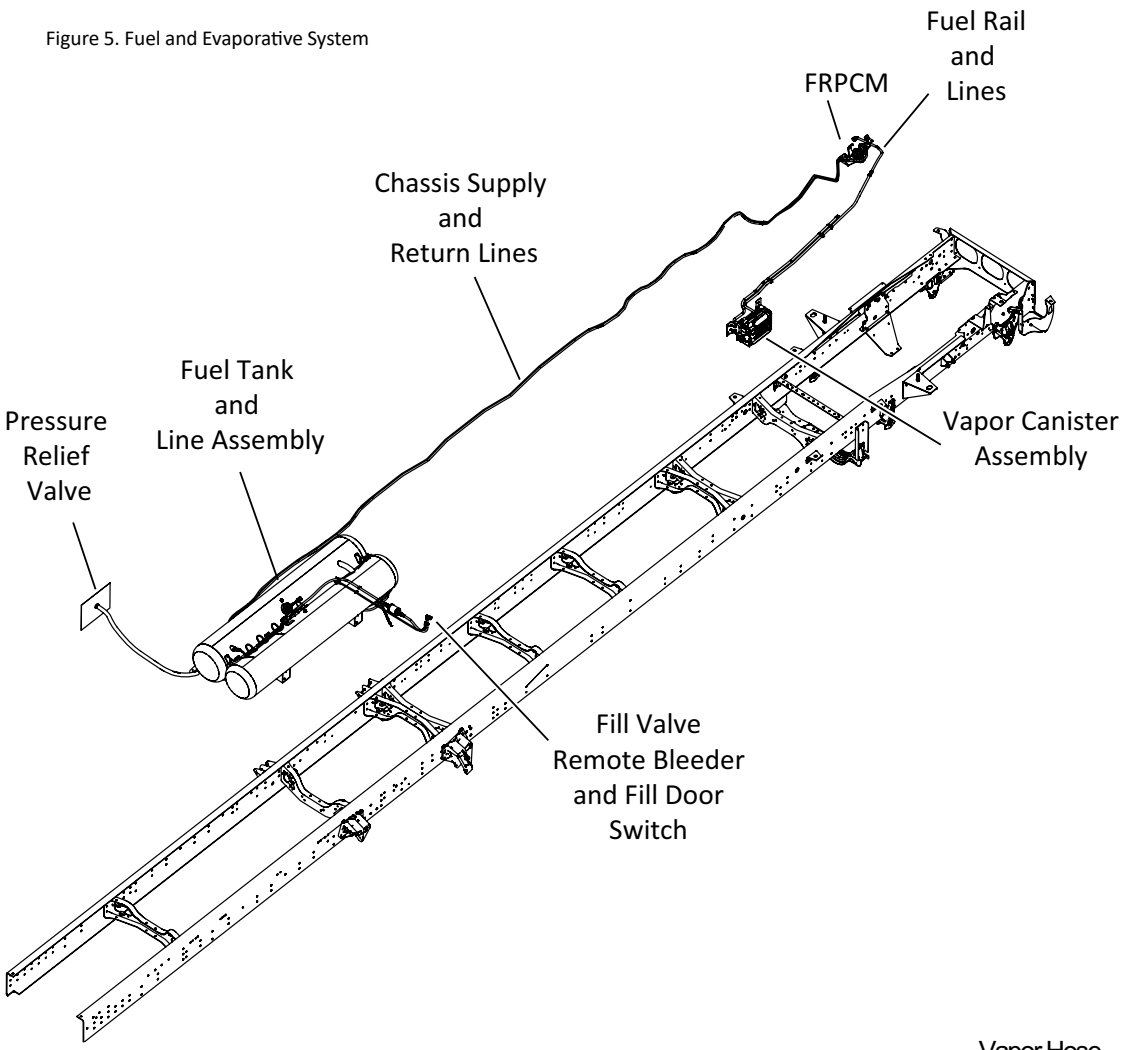


Figure 5. Fuel and Evaporative System



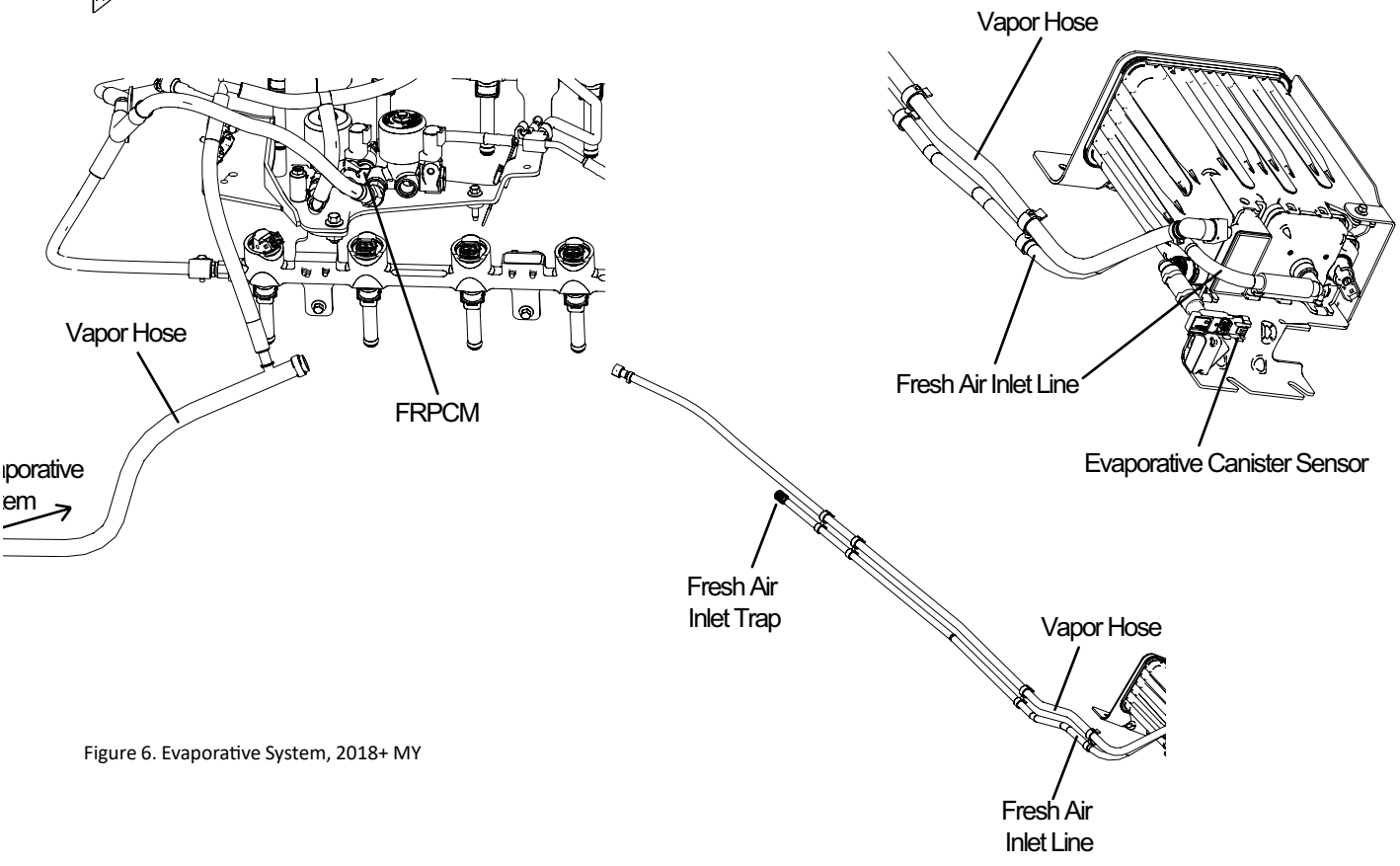


Figure 6. Evaporative System, 2018+ MY

Figure 7. Fuel Tank and Line Assembly Installed

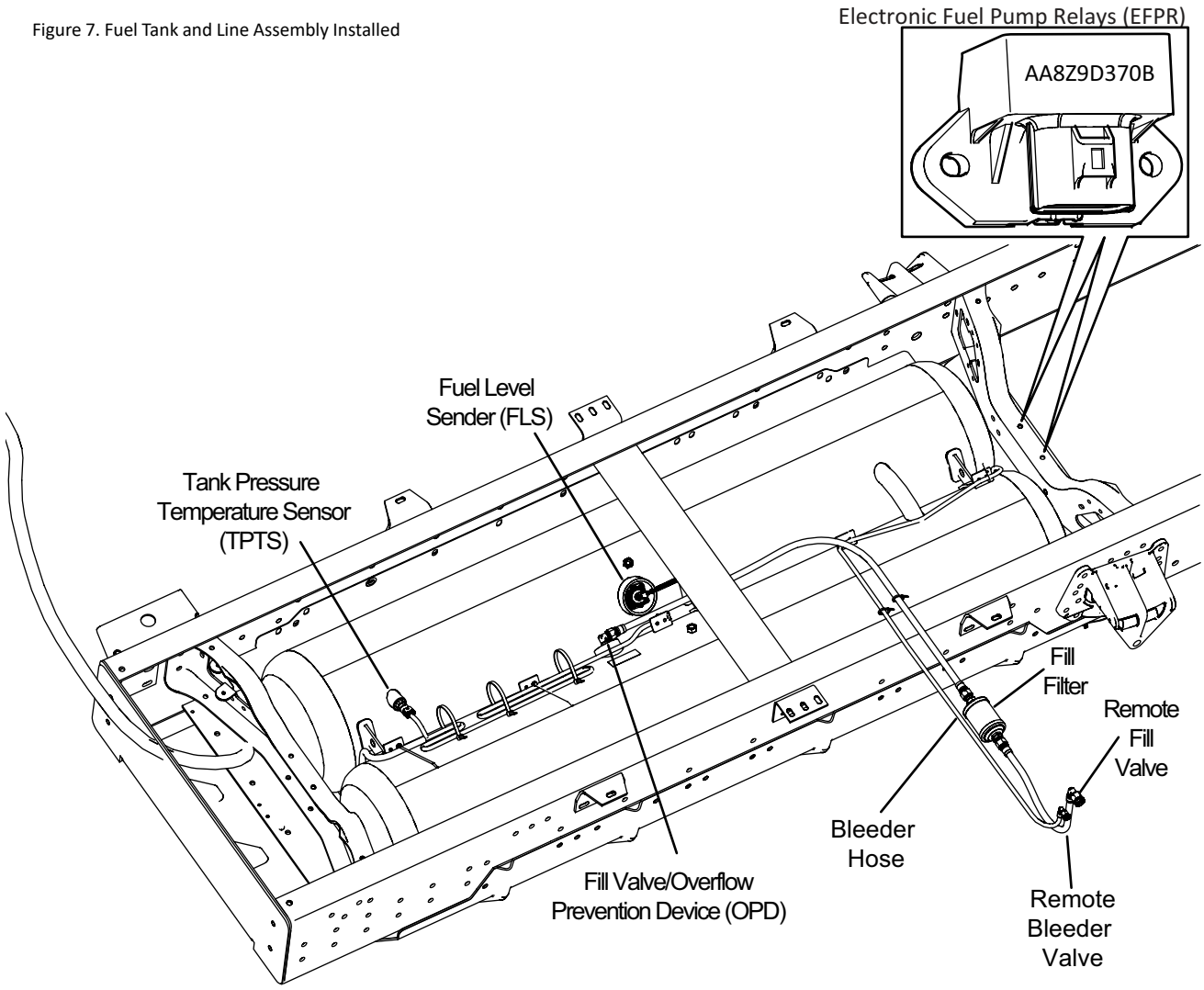
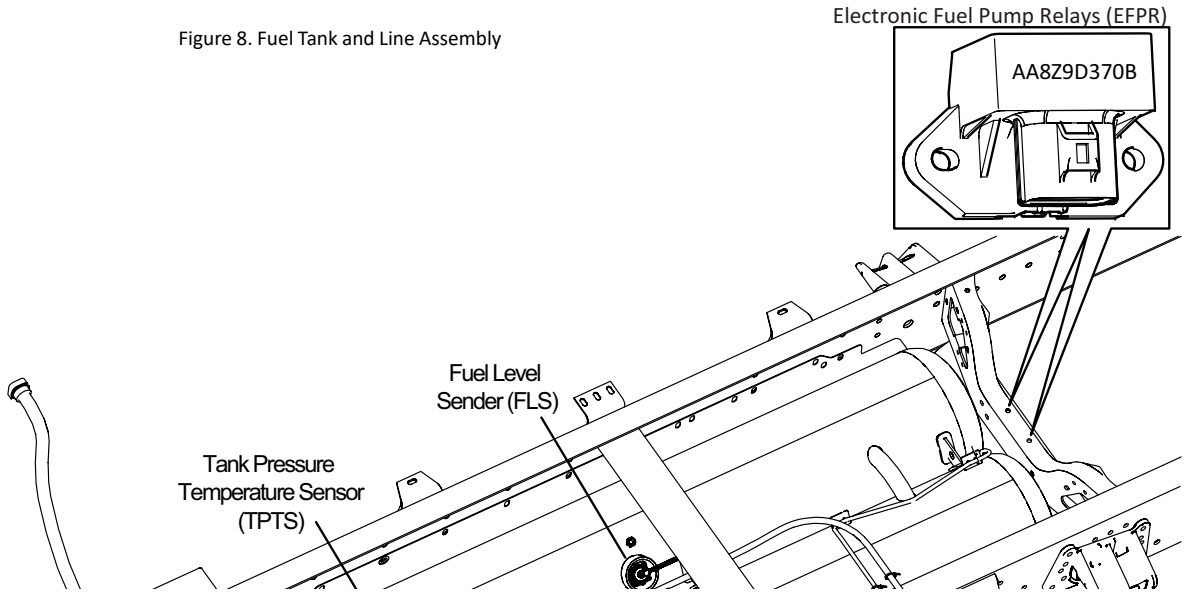


Figure 8. Fuel Tank and Line Assembly



Manual Fuel Shutoff

Description

This procedure ensures that no propane leaves the fuel tank during service activities.

Closing the Manual Fuel Shutoff

1. Locate the Supply Valve Assembly on the tank.
2. Turn the Manual Fuel Shutoff Valve on the Supply Valve Assembly clockwise by hand until it stops to close it. Do not tighten with a tool.

Opening the Manual Fuel Shutoff

1. After fuel system service is completed, locate the Manual Fuel Shutoff Valve on the tank and turn it counter-clockwise until it stops. Once the valve has fully opened, turn the knob 1/4 turn clockwise so that the so the valve is not sitting on the stop. This will assist in closing the valve in the future.

Note: After all fuel service procedures are completed, follow the Fuel System Priming Procedure.

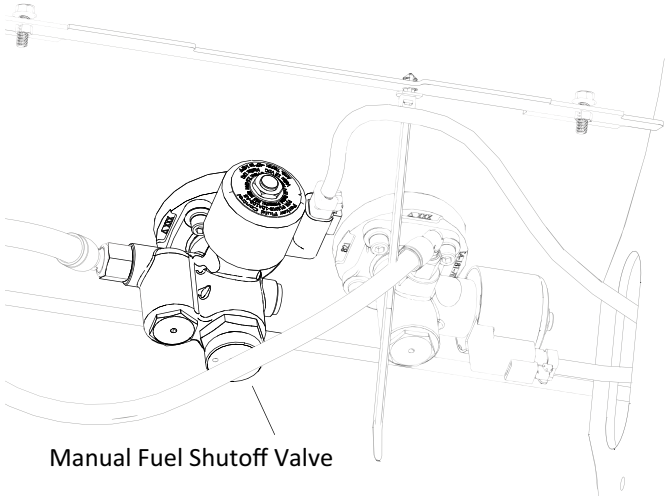


Figure 9. Manual Shutoff

Fuel Line Purging/Depressurization

Clearing the propane out of the fuel lines (purging) is required before working on many fuel system components. Following the suggested techniques for purging the fuel lines will reduce the amount of vapor released harmlessly into the atmosphere and will produce the least risk to life and property.

1. Move the vehicle to a well-ventilated area at least 35ft. away from any potential ignition source.
2. Close the Manual Fuel Shutoff Valve on the tank supply valve.
3. Disconnect the Fuel Pump electrical connectors at the fuel tank access cover.

Note: Operating the Fuel Pumps without fuel may lead to premature failure of Fuel Pumps.

4. Start the engine and let it run until it stalls. This purges the supply and return fuel lines of some liquid propane.

Note: This step may set fault codes to due to pump being unplugged and inability to build fuel rail pressure. These codes should be cleared before returning vehicle to service.

5. Turn off the ignition and disconnect the negative battery terminal.
6. Slowly loosen the fuel line connection at the outlet of the Supply Line Filter.

⚠ CAUTION

Note: Watch for liquid propane dripping from the line connection.

7. Slowly open the line at the Return Valve on tank to allow the remaining fuel to bleed off.
8. Inspect O-ring on return line at the Return Valve. Replace if damaged.

Note: Use an O-ring installation tool to limit potential damage to O-ring during installation.

9. Tighten fuel line fitting at the filter to 28 Nm (21 ft-lb) and the fuel line at the Return Valve to 31 Nm (23 ft-lb).
10. Reconnect the negative battery terminal.
11. Clear any fault codes set by this procedure.

⚠ CAUTION

Note: There may still be a small amount of propane in the lines after running this procedure. Open the lines slowly and cautiously to bleed off any remaining propane.

Fuel Tank Draining Procedure

⚠ DANGER

Note: Keep at least 35ft away from heat, sparks, flames, static electricity, lighted smoking materials, or other sources of ignition when draining a tank or performing any service on components. Failure to heed this danger may result in severe personal injury or death.

Overview

A propane fuel tank must be empty of propane before most tank components can be serviced or be transported by a carrier. There are three ways to evacuate fuel from the tank: transferring the fuel to another vessel, burning off the fuel through a flare tower, or venting the fuel to atmosphere.

Due to the volume of fuel likely to be retained in the fuel tank, releasing the vapor to the atmosphere is a slow procedure without special equipment as it must be done through the Bleeder Valve. This is mandated by NFPA 58 regulations. If using a transfer/ evacuation system or flare tower, follow the manufacturer's instructions. If not already equipped, it is suggested that a local, certified propane handling company be engaged to purge the fuel tank and recapture the fuel as the need requires.

Using In-Tank Pumps

Use of the in-tank pumps to drain the tank is an acceptable method assuming at least one of the two pumps and the supply valve are functioning normally. Temperature can affect transfer rates. Information on the ROUSH CleanTech transfer kit and procedures can be viewed at https://www.roushcleantech.com/service-manuals/.

Note: This method will not completely drain the tank and a final process of venting the tank will still be required. In some areas, it is not allowed or may not be safe to vent the fuel to the atmosphere. In this case, the fuel must be burned off.

1. Move the vehicle to an outdoor, well-ventilated area at least 35 feet from any external ignition sources.
2. Place the tank in which the fuel is to be captured close to the tank to be drained.
3. Purge the fuel lines by using the Fuel Line Purging/ Depressurization Procedure.
4. Disconnect supply line from forward side of inline filter at front of fuel tank.
5. Connect the fuel transfer hose to the receiving tank Fill Valve.
6. Connect the transfer hose to the forward side of filter that line was removed from in Step 4.
7. Disconnect the Fuel Pump wire harness at the tank access cover and connect a switch to the Fuel Pump wire connectors.
8. Open the automatic supply valve on the tank to be drained, this requires 12V power to the supply solenoid.
9. Turn the switch on the jumper harness to the ON position.

⚠ CAUTION

Note: Monitor the fuel transfer process and immediately turn off the fuel pumps when the transfer is complete. Failure to turn the pumps off immediately can lead to pump damage that may not be covered under warranty.

10. Slowly open the manual supply valve on the tank to be drained. You should hear the pumps in the fuel tank running and fuel will begin to transfer to the capture fuel tank.
11. There are three ways to monitor the fuel transfer process:
    1. Listening to the tone of the fuel pumps.
    When the tank is near Empty there will be a tonal change in the fuel pumps. When the tone changes, turn the switch to OFF immediately to avoid damage to the pumps.
    2. Measuring amperage.
    Install a non-contact amp clamp over one of the fuel pump wires, taking note of the initial reading of the clamp when the transfer begins. When the amp clamp drops approximately two (2) amps, immediately turn the switch to OFF to avoid damage to the pumps. Note that a large increase in amperage is a sign that the pumps are not working properly and the transfer should be stopped immediately.
    3. Monitoring the Twinsight.
    Monitor the transfer using the fuel level sender twinsight. When the twinsight reads near Empty, turn the switch to OFF immediately to avoid damage to the pumps.
12. Manually close the supply valve on the vehicle tank.
13. Loosen the fuel transfer hose and bleed off the fuel pressure.

⚠ CAUTION

Note: Fuel will be under pressure in the transfer line; use caution when disconnecting the fittings, slowly loosen the fittings, and use gloves and protective eye wear.

14. The remaining fuel in the tank will now need to be evacuated through the bleed valve.

Note: The tank can be evacuated using a flare stand, if the service center is equipped with a stand and has received the proper training. If using a flare stand to burn off the remaining fuel in the tank, this would require approximately a 50ft clearance from the vehicle, other vehicles, a building, or any combustible materials. Follow the manufacturer's instructions for your flare stand.

⚠ CAUTION

Note: Some states and municipalities may have regulations preventing the release of LPA into the atmosphere. Check with your local fire marshal or your local LPA supplier prior to venting or burning off a tank.

15. When the tank is no longer venting or burning off propane, perform the Verifying Tank Depressurization Procedure.

Note: If you have any questions or concerns or you feel unqualified to perform the process of venting the tank, contact your local fuel system provider or ROUSH CleanTech (800) 59-ROUSH (597-6874).

Verifying Tank Depressurization

This procedure will test for pressure in the tank even if there is a component failure.

⚠ WARNING

Note: Before removing any components from the fuel tank, it is very important to verify there is not any pressure remaining inside. The technician that is removing a tank component should always be the one to verify it is empty. This should be done right before starting the repair. Failure to do so could result in severe personal injury or death and/or damage to property.

1. The tank should be depressurized using your preferred NFPA 58 approved method. Refer to the Fuel Tank Draining Procedure.
2. Purge the fuel lines using the Fuel Line Purging/Depressurization Procedure.
3. Once the tank is empty. Open the Bleeder Valve. Ensure that no fuel is escaping. Repeat 2 times, closing and opening the Bleeder Valve to ensure the valve is not stuck
4. Check the sending unit external twin-site and ensure the needle is on E.
5. Repeat steps 2-4.
6. Key the vehicle to the On position. Using a capable OBDII scan tool, monitor fuel rail pressure (FRP).
7. Open the manual shut off valve.
8. Key the vehicle to the start position. Then after five seconds key it to Off.
9. Key the vehicle to On and measure fuel rail pressure.
10. If pressure is below 15 psi, components can be removed from the tank, following the replacement procedures in this ROUSH CleanTech service manual.

Note: For components threaded into the tank, slowly loosen them. For components fastened to the tank with a flange, slowly loosen each bolt until the component can move freely, then the component can be removed from the tank.

11. If pressure is above 15 psi, repeat steps 2-8. If after the second attempt pressure is still above 15psi, contact ROUSH CleanTech at (800) 59-ROUSH (597-6874) for further instruction.

⚠ CAUTION

Note: After depressurizing, there will still be propane vapors in the tank. Keep tank away from any sources of ignition and only use hand tools inside the tank. A depressurized tank can re-pressurize itself if re-sealed.

Fuel Tank Purging Procedure

⚠ DANGER

Always follow all NFPA 58 guidelines (paragraphs 7.3.1 and 7.3.2) when working on the propane fuel system or refueling a vehicle, you must be in a well- ventilated area at least 35 ft from any ignition source (add list to warning at start of manual) and 35 ft from any activity that throws sparks or risk severe personal injury or death.

Description

The following procedure is required to purge the air from the fuel tank after servicing tank components.

1. Ensure that all loosened lines and fittings are torqued to their proper specifications.
2. Fill the tank with approximately 3/10 gallon of propane with station pumps off.

Note: When filling an empty tank, start filling at a slow rate to build up pressure inside the tank. An initial fast fill may trip the OPD, creating a slow or no fill condition.

4. Open the bleeder valve until propane stops venting.
5. Fill tank to approximately 1/3 full, then close bleeder valve.
6. Key vehicle to start and slowly open manual fuel shutoff valve to pressurize the fuel lines.
7. Leak check fuel lines using an electronic leak detector or leak detection solution.
8. Open bleeder valve and continue fueling using the OPD Inspection Procedure. Instructions for this test can be found on page 5 of this publication.
9. Perform a final leak inspection at all fuel fill and fuel line connections that were serviced in this procedure to ensure no leaks are present using an electronic leak detector or leak detection solution.

Fuel System Priming Procedure

Description

After performing any fuel system service work where the fuel lines were depressurized, the fuel system must be leak checked and primed. This will prevent the Excess Flow Valve from checking as fuel quickly fills the empty fuel lines.

1. Make sure the battery is connected.
2. Check to make sure there is fuel in the tank, manual fuel shutoff valve is closed, and the fuel pumps are connected.
3. Turn the key to the START position. When you hear the fuel pumps activate, slowly open the manual fuel shutoff valve.
4. If vehicle cranks but does not start, close the manual fuel shutoff valve and repeat the process.

FUEL SYSTEM SERVICE COMPONENTS AND PROCEDURES

The ROUSH CleanTech LPA system utilizes a dual cylindrical manifold tank assembly to store the liquid propane. The two cylinders are permanently connected by mounting brackets and crossover tubes that create a single volume of fuel and are considered a single fuel tank assembly. The fuel tank is designed and certified to meet all applicable safety standards required for installation on a motor vehicle. The tank design includes structural mounting brackets, which are used for mounting the tank assembly between the frame rails. The tank assembly is secured to the chassis using specially coated and grade level fasteners.

In addition, the tank is fitted with a Pressure Relief Valve (PRV) that will open if tank pressure exceeds 312 psi, protecting the integrity of the tank.

The following components are mounted to the outside of the fuel tank:

- Liquid Level Gauge/Bleeder Valve,
- Return Circuit Assembly,
- Supply Circuit Assembly,
- Pressure Relief Valve (PRV),
- Pressure Relief Valve,
- Overfill Prevention Device (OPD),
- Fuel Pressure and Temperature Sensor (FPTS),
- Fuel Level Sender.

The LPA fuel tank is fitted with a service port flange for accessing the internals of the tank. The following components are located inside the fuel tank:

- Dual electric Fuel Pumps with an inlet filter,
- Jet pump,
- Wiring harness.

The tank components and their functions will be provided individually in this manual.

Fuel Tank Removal and Replacement

CAUTION

Note: If the tank internal or external components of the tank do not need to be serviced and the tank will be removed with propane inside, verify that the Manual Shutoff Valve and Tank Bleeder Valve are securely closed.

Removal

1. Purge the fuel lines using the Fuel Line Purging/Depressurization Procedure.
2. If the tank is being replaced or will be opened for service, drain the fuel tank using the Fuel Tank Draining Procedure.

WARNING

Note: Be sure that the tank has been completely drained before removing the OPD from the tank. Refer to Verifying Tank Depressurization Procedure. Failure to do so could result in severe personal injury or death and/or damage to property.

3. Carefully disconnect the chassis flex lines from the tank mounted hard lines using the appropriate disconnect tools.
4. Disconnect the supply and return line from the tank valves and unclip from retention points.
5. Remove the fill hose from the OPD.
6. Remove rear bumper, rear tow hooks and tow hook cross member, and detach the alarm harness from the frame. Refer to Blue Bird service manual for more information on removing these components.
7. Disconnect all tank electrical connections.
8. Remove tank end guard and rear tank cross member.
   - Remove six (6) fasteners attaching the rear tank cross member to the frame.
   - Remove four (4) fasteners attaching the rear tank cross member to the tank end guard.
   - Remove three (3) fasteners attaching the tank end guard to the tank support cross member.
9. Obtain a "table-style" hoist capable of safely lifting 1,000 lb (373 kg). Attach the hoist to the fuel tank using lifting straps. Support the tank while removing the tank mounting fasteners.
10. Remove the fasteners attaching the tank to the frame rails. Depending on the tank length, there will be four (4) or six (6) mounting points.

Note: Inspect and retain undamaged steel washers, rubber isolators, and crush limiters. Discard if damaged.

11. Remove four (4) tank support cross members, leaving the forward most cross member attached.
12. With the help of an assistant, slide tank along channel and away from the bus.

Fuel Tank Removal and Replacement (cont.)

Replacement

1. Using the hoist, carefully maneuver the fuel tank into position. Ensure the steel washers, rubber isolators, and crush limiters are installed in the order shown.

⚠ CAUTION

Note: Take care not to pinch fuel lines or wire harnesses.

2. Connect all wiring connections.
3. Install tank mounting fasteners. Torque to 105 Nm (77 ft-lb).
4. Connect the fuel supply line to the supply valve. Torque to 31 Nm (23 ft-lb).
5. Connect the return line to the return valve. Torque to 31 Nm (23 ft-lb).
6. If the tank was emptied, perform Fuel Tank Purging Procedure.
7. Leak check tank valves and line connections using an electronic leak detector or leak detection solution.
8. Perform Fuel System Priming Procedure.
9. Reinstall Tank Cover Plate.

Tank Cover Plate

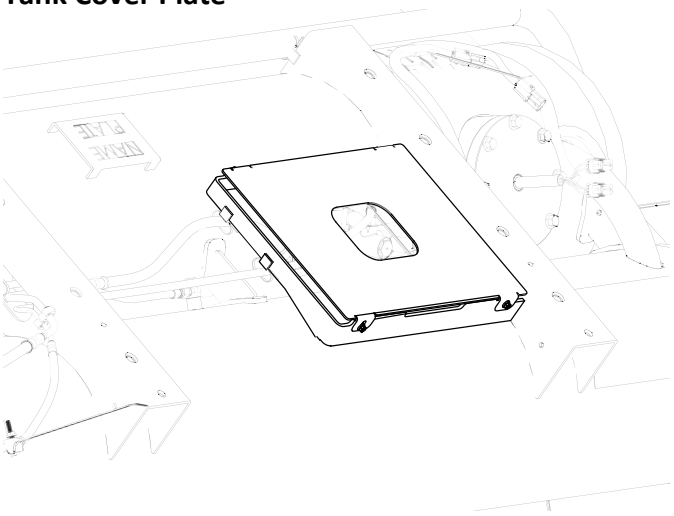


Figure 10. Tank Cover Plate

Description

The tank cover plate protects the tank valves. It has a small circular opening to allow access to the manual shutoff valve without having to be removed.

Removal

1. Remove the four (4) fasteners and weld nuts securing the tank cover plate to the tank.

Replacement

1. Prior to inserting the fasteners, cover the threads in marine-grade antisieze.
2. Align tank cover plate and thread the four (4) fasteners and weld nuts half-way in.
3. Torque all four (4) fasteners to 10 Nm (88.5 in-lb).

Fill Filter

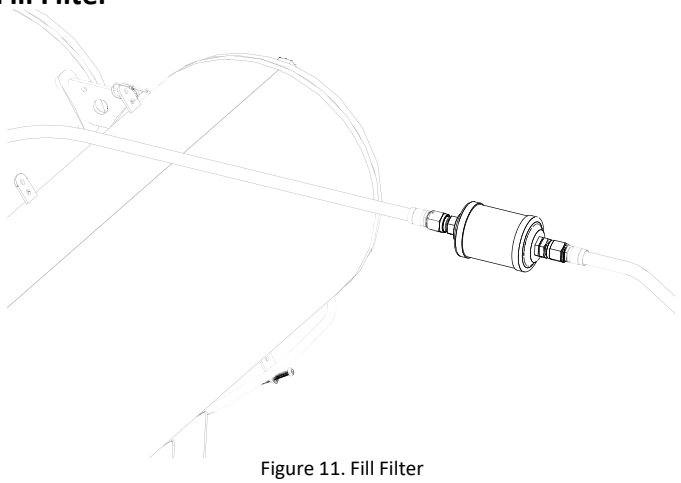


Figure 11. Fill Filter

Description

The Fill Filter is located on the by the remote fill valve, mounted to the bus body in-line between the remote fill valve and the tank fill valve and protected by a cover with . It has a 5-micron filter element to capture particulates. It is non-bypassing and will slow refueling if it becomes clogged. This filter should be replaced every 50,000 miles. Depending on body and bumper clearance, you may have to remove the two (2) bracket mounting bolts and lower the bracket.

Removal

1. Slowly loosen the fitting(s) at the filter to drain the fill lines.

⚠ WARNING

Note: This line will be pressurized with liquid propane. Follow all safety precautions described in this manual.

2. Disconnect the fuel fill line from the fuel filter inlet and outlet.
3. Remove the clamp retaining the fuel filter to the body.
4. Remove and discard the filter.

Note: OPD on tank is back checked to prevent fuel from leaving tank when removing filter.

Replacement

1. Connect the fuel fill lines to the filter inlet and outlet and torque to 57 Nm (42 ft-lb). Note filter orientation. There will be an arrow on the filter indicating the direction of flow.
2. Secure the fuel filter using the originally installed clamp.
3. If you removed the filter bracket, replace the bracket and install the two (2) mounting bolts. Torque to 10 Nm (7.4 ft-lb).
4. Connect the Fill Valve to a fuel dispensing source to charge the line.
5. Check all fittings for leaks using an electronic leak detector or leak detection solution.

Tank Fill Valve/Overfill Prevention Device (OPD)

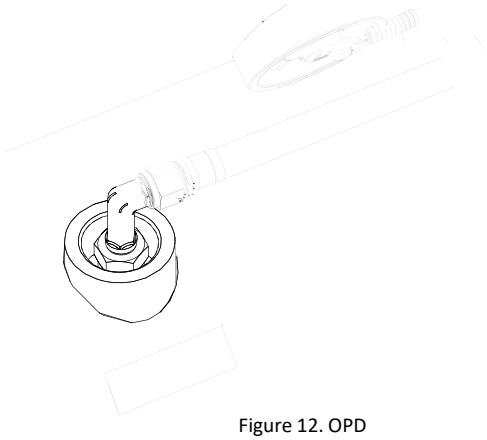


Figure 12. OPD

Description

Located at the top of the fuel tank, and accessed through the service door on the floor on the bus, the Fill Valve/OPD is opened mechanically by the refueling pump pressure during the fill process. It incorporates a back-flow check valve and an OPD that stops the fill at 80%. The back-flow check valve closes when vehicle tank pressure is greater than pressure outside of the tank to prevent fuel from escaping.

The Fill Valve/OPD should be clocked into the 12 o'clock position, with the marking “Top” on the Fill Valve needs to face vertically upwards to work properly when installed.

Removal

1. Park the vehicle outside in a well-ventilated area.
2. Remove panel for Fill Filter and loosen line at outlet side of the filter to depressurize line.

⚠ WARNING

Note: This line will be pressurized with liquid propane. Follow all safety precautions described in this manual.

3. Drain the fuel tank using the Fuel Tank Draining Procedure.

⚠ WARNING

Note: Be sure that the tank has been completely drained before removing the OPD from the tank. Refer to Verifying Tank Depressurization Procedure. Failure to do so could result in severe personal injury or death and/or damage to property.

4. Remove the tank fill line and 90 degree fitting.
5. Remove the Fill Valve/OPD.

Tank Fill Valve/OPD (cont.)

Replacement

Note: New Fill Valves/OPDs come with sealant already applied to the threads. If reusing an Fill Valve/OPD, clean the threads and apply Everseal PLS2 to the threads.

1. Re-connect Fill Filter and torque to 57 Nm (42 ft-lb).
2. Take note of the "Top" mark on the face of the Fill Valve/OPD.
3. Install the OPD and torque to 91 Nm (67 ft-lb).
4. Set a torque wrench to 130 Nm (96 ft-lb) and slowly rotate the Fill Valve/OPD clockwise until the "Top" mark is at the 12 o'clock position. Ensure the wrench does not exceed the torque. Do not turn the valve counter-clockwise if torque is exceeded.

⚠ CAUTION

Note: Do not exceed 130 Nm (96 ft-lb) as it could damage the part. If you achieve 130 Nm (96 ft-lb), remove and discard the Fill Valve/OPD. A new part will be required.

5. Connect the fuel fill line to the Fill Valve/OPD and torque to 45 Nm (33 ft-lb).
6. Perform the Fuel Tank Purging Procedure.
7. Reconnect the battery.
8. Fill tank and leak check all components that have been serviced in this procedure using an electronic leak detector or an approved leak detection solution.
9. Replace Fill Filter cover.

Tank Bleeder Valve/Liquid Level Gauge

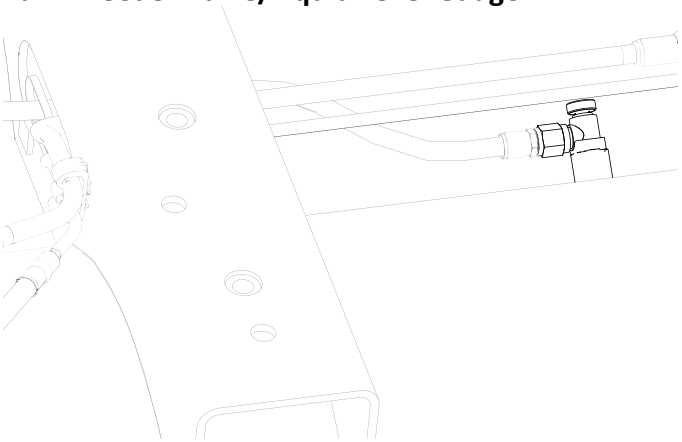


Figure 13. Bleeder

Description

The Tank Bleeder Valve is located on the bottom side of the tank and is connected to a steel tube that goes up to the 80% mark on the tank. The Bleeder Valve serves 3 functions.

- -4 AN fitting where a pressure gauge can be connected to read tank pressure,
- A liquid level gauge used in the OPD Inspection Procedure,
- A means of slowly bleeding the tank.

Note: Do not operate Bleeder Valve without propane safe gloves.

Removal

1. Purge the fuel lines using the Fuel Line Purging/Depressurization Procedure.
2. Drain the fuel tank using the Fuel Tank Draining Procedure.

⚠ WARNING

Note: Be sure that the tank has been completely drained before removing the Bleeder Valve from the tank. Refer to Verifying Tank Depressurization Procedure. Failure to do so could result in severe personal injury or death and/or damage to property.

3. Remove the bleeder line from the Tank Bleeder Valve.
4. Remove the Bleeder Valve from the tank.

Replacement

1. Apply pipe thread sealant (PLS-2 or Everseal 183) ONLY to the threads going into the tank.
2. Install the new Bleeder Valve assembly into the tank. Torque to 20 +/- 4.0 Nm (15 ft-lb) minimum, plus orientation, reverse torque not permissible.
3. Reinstall the bleeder line to the valve and torque to 18.5 +/- 3.0 Nm (13.5 ft-lb).
4. Purge the fuel rank using the Fuel Tank Purging Procedure.
5. Reconnect the battery.
6. Fill tank and leak check the fitting using an electronic leak detector or an approved leak detection solution.
7. Perform the Fuel System Priming Procedure..

Fuel Tank Pressure Relief Valve (PRV)

Figure 14. Pressure Relief Valve

Description

The PRV is a safety device that will vent propane vapor out of the tank if the tank exceeds the maximum rated pressure. This would occur if the tank was subjected to extreme temperatures (propane tank pressure changes with temperature) or the tank is overfilled. The PRV is set to vent at 312 psi (approximately 145°F). The PRV activating would be noticed by a loud popping sound followed by a cloud of propane vapor. The valve will reseal once pressure is lowered.

Note: If the PRV activates, it must be replaced as the calibration of the spring may be compromised.

Removal

1. Purge the fuel lines using the Fuel Line Purging/Depressurization Procedure.
2. Drain the fuel tank using the Fuel Tank Draining Procedure.

⚠ WARNING

Note: Be sure that the tank has been completely drained before removing the Pressure Relief Valve from the tank. Refer to Verifying Tank Depressurization Procedure. Failure to do so could result in severe personal injury or death and/or damage to property.

3. Remove the frame cross-member and shield behind the tank.
4. Disconnect the fuel pressure relief hose from the pipe away fitting on the tank.
5. Remove pipe away fitting from the Pressure Relief Valve.
6. Remove Pressure Relief Valve from tank.

Replacement

1. Install the new Pressure Relief Valve (thread sealant pre-applied) into the threaded coupling, torque to 120 Nm (89ft-lb) minimum plus 180-degrees rotation.
2. Clean the threads of the pipe away fitting.
3. Apply thread sealant (PLS-2 or Everseal 183) to the threads of the pipe away fitting.
4. Assemble the pipe away fitting to the Pressure Relief Valve and torque to 95Nm (70 ft-lb).
5. Purge the fuel tank using the Fuel Tank Purging Procedure.
6. Reconnect the fuel tank Pressure Relief Valve hose and clamp.
7. Install the frame cross-member and tank shield.
8. Reconnect the battery.
9. Perform the Fuel System Priming Procedure..

Tank Supply Valve Assembly

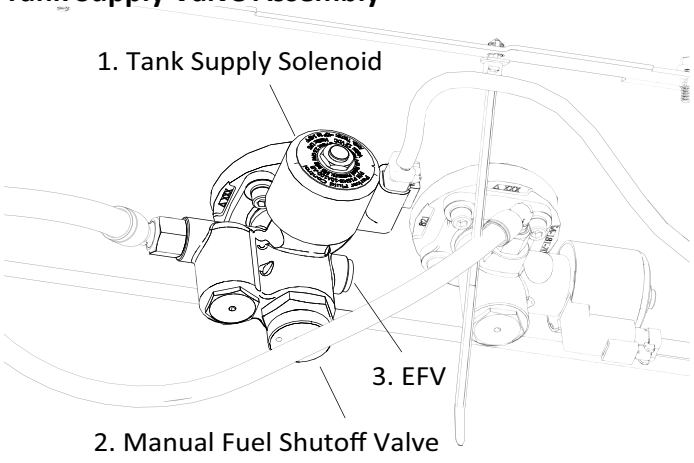


Figure 15. Supply Valve Assembly

Description

The Tank Supply Valve assembly is mounted to the tank, behind the Tank Cover Plate, and connects to the Fuel Pumps and supply line. It has three main components:

1. Tank Supply Solenoid

The Tank Supply Solenoid is an electrically operated automatic shutoff valve. It is located downstream from the Excess Flow Valve and Manual Fuel Shutoff Valve. The Tank Supply Solenoid is normally in a closed position (de-energized), preventing the flow of fuel to the engine. When the ignition key is turned ON to start the vehicle, power is supplied to the solenoid opening the valve and allowing fuel to flow from the tank to the engine. The Tank Supply Solenoid will close when the ignition is shut off or if the engine stalls (with ignition on).

2. Manual Fuel Shutoff Valve

The Manual Fuel Shutoff Valve is used to mechanically seal the outlet of the tank during shipping, service, or in case of a vehicle failure. It is located between the Excess Flow Valve and Tank Supply Solenoid valve. It is manually operated by turning the knurled knob mounted on the front of the Supply Circuit Assembly. Turning the knob clockwise closes the valve and turning the knob counterclockwise opens the valve. It should always be open when the vehicle is operating.

3. Excess Flow Valve (EFV)

The Excess Flow Valve is located in the Tank Supply Valve in the supply fuel path, ahead of the Tank Supply Solenoid and Manual Shutoff Valve. The valve is intended to shut off fuel flow from the tank in the event of a rapid increase of fuel flow exceeding 2.5 gallons per minute. Increased fuel flow could be caused by a severed line or an inadvertent disconnect without shutting the Manual Shutoff Valve. If the Excess Flow Valve trips (may happen after servicing the system), it can be reset by closing the Manual Shutoff Valve and then slowly opening it. The Excess Flow Valve does not completely stop flow and will not actuate with smaller leaks (less than 2.5 gallons per minute), so it should not be relied on for servicing purposes. If the Excess Flow Valve activates (such as immediately following service where the system may not be primed with fuel), turn OFF the key and wait 15-30 seconds, then retry.

Tank Supply Valve Assembly (cont.)

Removal

1. Purge the fuel lines using the Fuel Line Purging/Depressurization Procedure.
2. Drain the fuel tank using the Fuel Tank Draining Procedure.

WARNING

Note: Be sure that the tank has been completely drained before removing the Pressure Relief Valve from the tank. Refer to Verifying Tank Depressurization Procedure. Failure to do so could result in severe personal injury or death and/or damage to property.

3. Remove the supply line at the valve. Inspect O-ring and replace if damaged.
4. Disconnect the Tank Supply Solenoid electrical connection.
5. Slowly loosen the four (4) bolts evenly securing the valve to the tank until you can move the valve.
6. Remove the four (4) bolts securing the valve to the tank.
7. Pull the Supply Circuit Assembly away from the tank.

Note: Use caution that the supply line doesn't retract back into the tank.

8. Disconnect the internal Fuel Pump supply line by depressing the colored tabs on either side of the quick connect fitting and pulling it off the stem.
9. Remove and discard the O-ring from the bottom of the supply valve.

Note: When replacing the Tank Supply Valve Assembly, the tank seat O-ring must be replaced.

Replacement

1. Inspect the O-ring sealing surface and remove any debris.
2. Apply silicone O-ring lubricant (Parker Super Lube or equivalent) to the O-ring and install to the Supply Solenoid.
3. Lubricate the tip of the brass stem quick connect with a small amount of clean motor oil.
4. Connect the internal fuel pump supply line, push on until a “click” is heard, then tug to ensure it is secured.
5. Slide the Supply Valve Assembly to the tank seat.
6. While holding the Supply Valve Assembly, install the four (4) bolts and hand tighten.

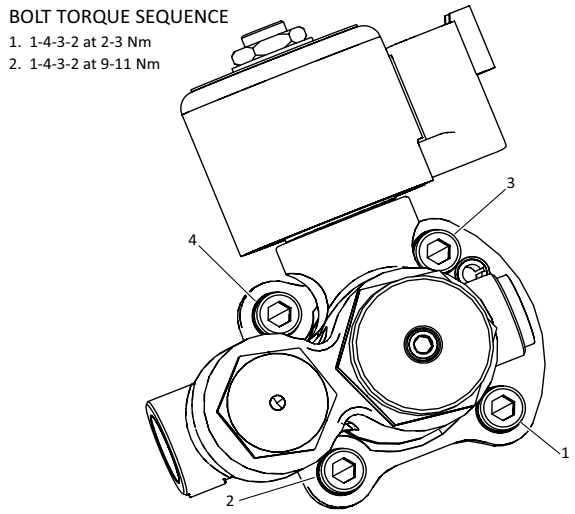


Figure 16. Tank Supply Solenoid

Tank Supply Valve Assembly (cont.)

7. Torque the bolts to an initial torque: Crossing pattern 2.5 Nm (22 in-lb). Refer to Figure 16 for the correct torquing pattern.
8. Torque the bolts to a final torque: Crossing pattern 10 Nm (7.4 ft-lb). Refer to Figure 16 for the correct torquing pattern.
9. Inspect the fuel line O-ring and install to the tank supply valve, torque to 31 Nm (23 ft-lb).
10. Connect the wiring harness to the solenoid coil.
11. Purge the fuel tank using the Fuel Tank Purging Procedure.
12. Reconnect the battery.
13. Check the tank supply valve and tank lines for leaks using an electronic leak detector or leak detection solution.
14. Perform the Fuel System Priming Procedure..

Return Valve Assembly

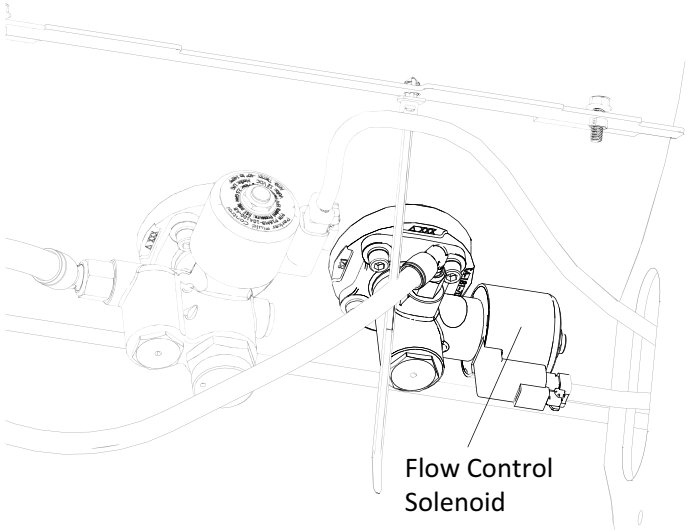


Figure 17. Return Valve Assembly

Description

The fuel Return Valve Assembly is mounted to the tank, behind the Tank Cover Plate, and incorporates a check valve that prevents fuel from flowing from the tank into the return line. The fuel Return Valve Assembly also contains the Flow Control Solenoid (FCS) which includes a small orifice to regulate fuel pressure in normal conditions as well as a bypass circuit to allow maximum fuel flow prior to engine starting or during extremely hot conditions.

Removal

1. Purge the fuel lines using the Fuel Line Purging/Depressurization Procedure.
2. Drain the fuel tank using the Fuel Tank Draining Procedure.

WARNING

Note: Be sure that the tank has been completely drained before removing the Pressure Relief Valve from the tank. Refer to Verifying Tank Depressurization Procedure. Failure to do so could result in severe personal injury or death and/or damage to property.

3. Remove the fuel return line from the Return Valve Assembly. Inspect the O-ring and replace if damaged.
4. Slowly loosen the four (4) bolts evenly securing the valve to the tank until you can move the valve.
5. Remove the four (4) bolts securing the valve to the tank.
6. Pull the Return Valve Assembly away from the tank.

Note: Use caution that the return line doesn't retract back into the tank.

7. Remove the return hose from the Return Valve Assembly quick connect fitting.

Replacement

1. Inspect the O-ring sealing surface and remove any debris.
2. Apply silicone O-ring lubricant (Parker Super Lube or equivalent) to the O-ring and install to the Return Valve Assembly.
3. Lubricate the tip of the brass stem quick connect with a small amount of clean motor oil.
4. Connect the internal return line, push on until a “click” is heard, then tug to insure it is secured. Take care not to let the hose fall back into the tank.
5. Slide the Return Valve Assembly to the tank seat.
6. While holding the Return Valve Assembly, install the four (4) bolts and hand tighten.
7. Torque the bolts to an initial torque: Crossing pattern 2.5 Nm (22 in-lb).
8. Torque the bolts to a final torque: Crossing pattern 10 Nm (7.4 ft-lb).
9. Inspect the fuel line O-ring and install onto the return valve, torque to 31 Nm (23 ft-lb).
10. Connect the wiring harness to the return solenoid coil.
11. Purge the fuel tank using the Fuel Tank Purging Procedure.
12. Check the return valve and tank lines for leaks using an electronic leak detector or leak detection solution.
14. Perform the Fuel System Priming Procedure..

Solenoid Coils

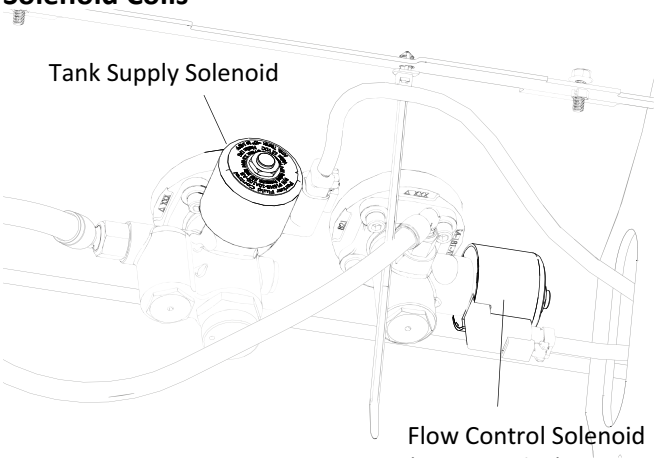


Figure 18. Supply Valve and Solenoid

Description

The same solenoid coil is used on the Supply Valve and Return Valve (see above), and FRPCM (not pictured). It is a 12V coil that when energized, opens a valve. The coils can be replaced independently of the valve assembly without depressurizing the fuel system.

Removal

1. Disconnect vehicle battery and remove 2-pin connection from solenoid to be serviced.
2. Note the coil orientation.
3. Remove the nut, wave washer, and data tag holding the coil onto the solenoid post.
4. Slide coil off the post.

Replacement

1. Verify that post is clean.
2. Slide new coil onto the post.
3. Position the coil in its original orientation. For the FRPCM, align the two (2) coil connectors with a straight edge.
4. Slide the data tag, wave washer, and nut onto the top of the coil on the solenoid post and torque to 5.4-5.5 Nm (47.5-48.5 in-lb).
5. Reconnect electrical connector to solenoid coil.
6. Reconnect vehicle battery.
7. Start vehicle and perform KOEO/KOER self- test to ensure vehicle is repaired and solenoid faults do not persist.
8. Check the base of the solenoid post for leaks using an electronic leak detector or leak detection solution.

Tank Service Cover

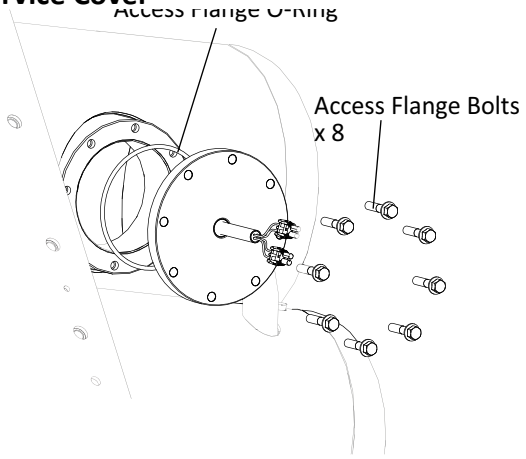


Figure 19. Tank Access Cover

Description

The Access Flange serves as a wire pass-through for the Fuel Pumps and allows access into the tank.

Removal

1. Drain the fuel tank using the Fuel Tank Draining Procedure.

⚠ WARNING

Note: Be sure that the tank has been completely drained before removing the Pressure Relief Valve from the tank. Refer to Verifying Tank Depressurization Procedure. Failure to do so could result in severe personal injury or death and/or damage to property.

2. Ensure the negative battery cable is disconnected.
3. Disconnect the external Fuel Pump connectors.
4. Slowly remove the Tank Service Cover from tank, loosening bolts in a star-pattern a small amount each time until the cover is loose. This will ensure no pressure is present.

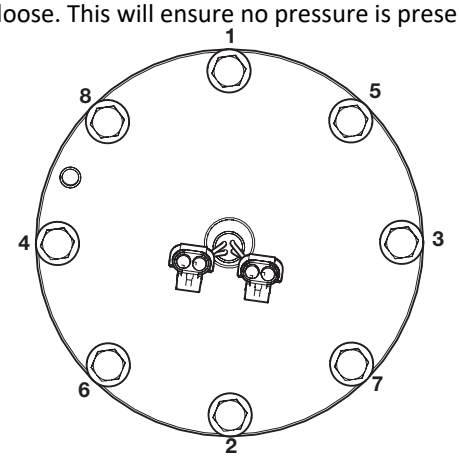


Figure 20. Tank Access Cover Bolt Removal/Torquing Pattern

5. Remove bolts and carefully remove the Access Cover, taking care not to damage the connected wiring.
6. Reach into the fuel tank and disconnect the Fuel Pump electrical connectors.
7. Discard the Access Cover O-ring.

Tank Service Cover (cont.)

Replacement

1. Inspect the Access Cover mounting surface on the tank and remove any debris.
2. Apply silicone O-ring lubricant (Parker Super Lube or equivalent) to the new O-ring and install into the groove in the tank Access Cover.
3. Move the Access Cover near the port and connect the internal Fuel Pump connectors.
4. Install the Access Cover on the tank and hand-tighten the eight (8) bolts.

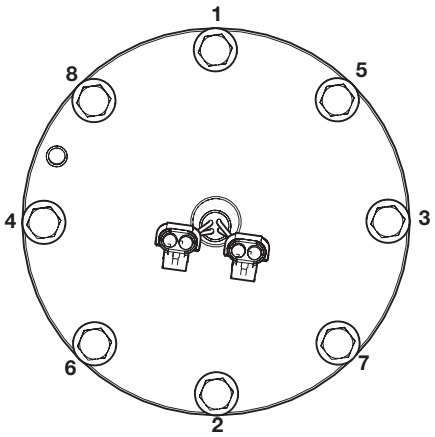


Figure 20 Tank Access Cover Bolt Removal/Torquing Pattern

5. Torque in a cross pattern to an initial torque of 3 Nm (26.5 in-lb). Refer to Figure 20 for the correct torquing pattern.
6. Torque in a cross pattern to a final torque of 40.6 Nm (30 ft-lb). Refer to Figure 20 for the correct torquing pattern.
7. Connect the external Fuel Pump connectors.
8. Purge the fuel tank using the Fuel Tank Purging Procedure.
9. Leak check Access Cover and all valves and fittings for leaks using an electronic leak detector or leak detection solution.
10. Perform the Fuel System Priming Procedure..

Fuel Pumps

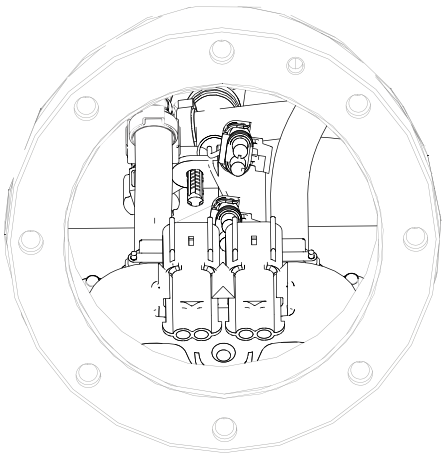


Figure 21 - In-tank Fuel Pump Assembly

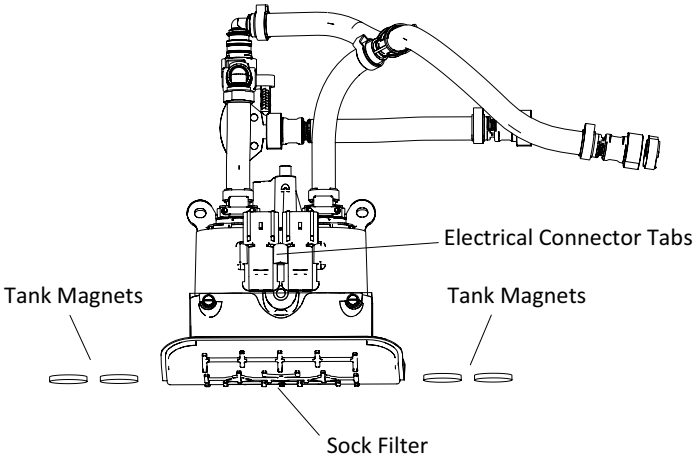


Figure 22. Fuel Pump Components

Description

The LPA fuel system utilizes two (2) 12-volt in-tank Fuel Pumps. The Fuel Pump assembly is mounted to brackets located in the bottom of the fuel tank and includes a sock filter on the bottom of the assembly. The pumps are serviceable through the service port opening on the bottom of the fuel tank.

The in-tank pumps receive a 12-volt supply when the ignition key is switched on and runs a purge cycle for up to 30 seconds. Each pump is controlled by an Electronic Fuel Pump Relay (EFPR), which are controlled by the PCM. The pump is provided with a constant ground signal. During operation the pump voltage will vary from 7 – 13.5V. The Fuel Pumps are serviced as an assembly.

There is one filter inside the tank and one outside the tank. The filter inside the tank is located on the bottom of the Fuel Pumps at the pump inlet ports. This filter is part of the Fuel Pump assembly and is non-serviceable on it's own. The filter on the outside of the tank is the in-line fuel filter and is located at the front end of the tank, in-line with the fuel supply line. It is recommended that this filter be replaced every 50,000 miles or whenever a Fuel Pump is serviced.

The sock filter should last the lifetime of the fuel pump assembly and will not require replacing .

Note: The Fuel Pumps are serviced as an assembly.

Removal

1. Replace the Supply Line Filter using the Supply Line Filter Removal Procedure.
2. Drain the fuel tank using the Fuel Tank Draining Procedure.

⚠ WARNING

Note: Be sure that the tank has been completely drained before removing the Pressure Relief Valve from the tank. Refer to Verifying Tank Depressurization Procedure. Failure to do so could result in severe personal injury or death and/or damage to property.

3. Ensure the negative battery cable is disconnected.
4. Remove the tank Access Flange using the Tank Access Flange Replacement Procedure.

Note: Use caution when working inside the fuel tank. There could be a flammable mixture of propane and air inside the tank when it's open. Do not use electric tool inside or near an open tank.

5. Release the two (2) Fuel Pump hose quick connects from the jet pump assembly.

⚠ CAUTION

Note: Use caution to prevent breaking the jet pump assembly.

6. Remove the center 8 mm bolt.
7. Remove the two (2) 10 mm nuts from the top corners of the pump assembly.
8. Pull the full pump assembly forward off the studs, then lift slightly upward, and remove it from the tank bottom first.
9. Wearing protective gloves, remove the magnets from the bottom of the tank and discard.

Note: Sliding the magnets to a seam inside the tank will ease the removal of the magnets.

Replacement

1. Install the four (4) magnets at the four corners of the fuel pump assembly
2. Place the new pump assembly on the two (2) fuel pump mounting studs and connect the quick connect hoses to the jet assembly.
3. Connect the two (2) fuel pump hose quick connects to the jet pump assembly.
4. Install the center 8 mm bolt and torque to 5.8 Nm (4.3 ft-lb).
5. Install the two (2) nuts on the pump bracket studs and torque to 8.5 Nm (6.3 ft-lb).
6. Connect the fuel pump electrical connectors.
7. Install the tank Access Flange using the Tank Access Flange Replacement Procedure.

Note: For MY 2019 or older Gen 4 vehicles, if no check valve sticker is present on the access cover, attach the sticker from Fuel Pump kit to the outside of the Access Flange. For MY 2019 or newer, no sticker is required.

8. Purge the fuel tank using the Fuel Tank Purging Procedure.

Note: During the Fuel Tank Purging Procedure, after filling with 15 gallons of fuel, stop fueling, close the Bleeder Valve, and start the vehicle. Check for adequate fuel rail pressure (25+ over tank), to ensure everything is connected in the tank. Then turn off vehicle and resume Fuel Tank Purging Procedure.

9. Check the Access Flange for leaks using an electronic leak detector or leak detection solution.

Fuel Level Sender (FLS) Assembly

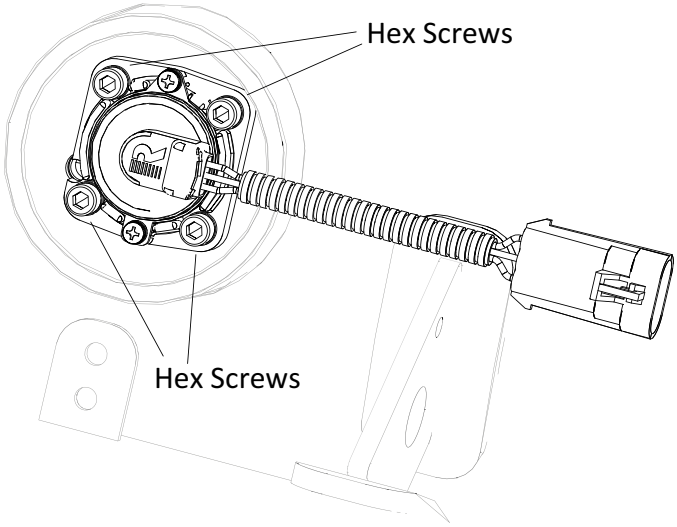


Figure 23. Fuel Level Sender (in tank)

Description

The Fuel Level Sender is located at the top of the tank and is serviced through the service opening in the floor of the bus. The tank is fitted with a fuel level sender that consists of an in-tank float arm coupled to an externally mounted variable voltage sensor. This sender provides a fuel level signal to the instrument panel, which utilizes an "anti-slosh" signal conditioner to provide a constant gauge reading.

Note: The fuel level indicator on the sender will vary from the actual fuel level. Always use the fuel gauge on the cluster to more accurately determine the amount of remaining fuel.

Removal

1. Purge the fuel lines using the Fuel Line Purging/Depressurization Procedure.
2. Drain the fuel tank using the Fuel Tank Draining Procedure

⚠ WARNING

Do not attempt to build your own flare tower. Failure to exercise extreme caution and care may lead to serious accidents which can result in property damage, personal injury, and/or death. Some states and municipalities may have regulations preventing the release of LPA into the atmosphere. Check with your local fire marshal or your local LPA supplier prior to venting or burning off a tank.

3. Disconnect the sender electrical connection.
4. Slowly loosen the four (4) hex screws securing the sender in a cross pattern until the part can move.
5. Remove the four (4) hex screws.
6. Remove the sender from the fuel tank.

Replacement

1. Inspect sender boss on the fuel tank and remove any debris.
2. Apply silicone lubricant to the sender O-ring.
3. Install the sender in the fuel tank with the four (4) hex screws. Hand-tighten the screws.
4. Torque the four (4) screws in a cross pattern to an initial torque of 2.5 Nm (22 in-lb).
5. Torque the four (4) screws in a cross pattern to a final torque of 10 Nm (7.4 ft-lb).
6. Connect the wiring to the sender.
7. Leak check the sending unit using an electronic leak detector or leak detection solution.
8. Purge the tank using the Fuel System Priming Procedure..

Fuel Level Sender (FLS) Twinsight

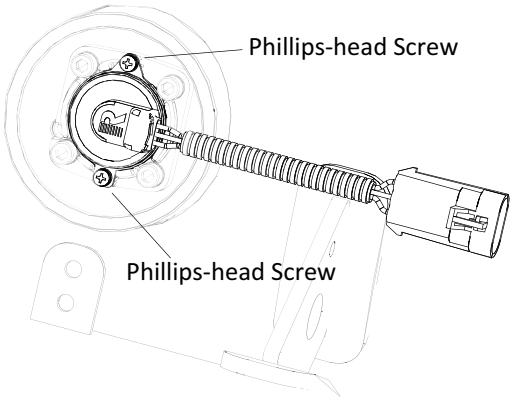


Figure 24. Twinsight

Description

The Fuel Level Sender Twinsight is located at the top of the tank, and is serviced through the service opening in the floor of the bus. The Twinsight is a Hall-effect sensor magnetically connected to the Fuel Level Sender body by two Phillips-head screws. It can be replaced independently of the Fuel Level Sender.

Removal

1. Disconnect the FLS electrical connection.
2. Remove the two (2) Phillips-head screws from the Twinsight.

Note: Do not loosen or remove the four (4) hex screws as this will remove the Fuel Level Sender Assembly. If you need to remove the entire Fuel Level Sender Assembly, follow the Fuel Level Sender Removal Procedure.

3. Remove the twinsight from the FLS body.

Replacement

1. Using a piece of magnetic metal, such as a socket or extension, (but not a magnet), move the sender needle to 1/2 by moving it along the back side of the Twinsight.

Note: Failure to move sender needle to 1/2 will lead to incorrect operation and readings from the Twinsight, which may lead to fuel transfer issues in dual tank applications.

2. Place the Twinsight on the FLS body, making sure that the indexing tabs (one square, one round) are installed correctly. The Twinsight will sit flush against FLS sending unit face with no gap if installed correctly.
3. Install the two (2) Phillips-head screws.
4. Connect the FLS electrical connection.

Tank Pressure Temperature Sensor (TPTS)

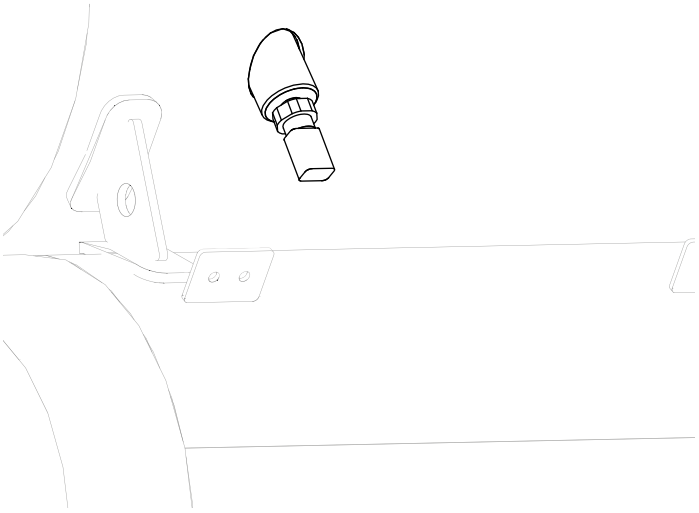


Figure 25. Tank Pressure Temperature Sensor (TPTS)

Description

The Tank Pressure Temperature Sensor (TPTS) is mounted on the tank assembly and it is a shared 5V reference sensor that measures both temperature and pressure in the fuel tank. The output from this sensor can be read using the ROUSH Diagnostic Tool (RDT).

Removal

1. Drain the fuel tank using the Fuel Tank Draining Procedure.

⚠ WARNING

Note: Be sure that the tank has been completely drained before removing the Pressure Relief Valve from the tank. Refer to Verifying Tank Depressurization Procedure. Failure to do so could result in severe personal injury or death and/or damage to property.

2. Disconnect the TPTS electrical connection.
3. Slowly remove the TPTS.

Replacement

1. Lubricate the TPTS O-ring using silicone lubricant.

Note: Do not get lubricant on the sensor element.

2. Install the TPTS in the tank and torque to 7 Nm (5.2 ft-lb).
3. Purge the tank using the Fuel Tank Purging Procedure.
4. Leak check the TPTS using an electronic leak detector or leak detection solution.
5. Perform the Fuel System Priming Procedure..

Supply Line Filter

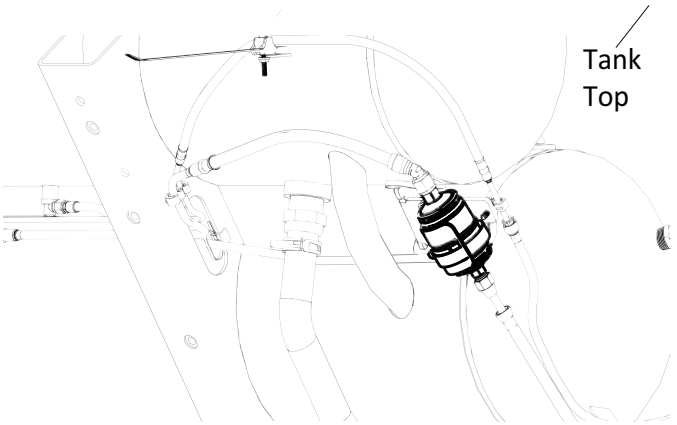


Figure 26. Supply Line Filter

Description

The Supply Line Filter is located on bottom of the tank mounted on the cross member. It has a very fine filter element, and filters fuel between the fuel tank and the Fuel Rails. This filter must be replaced every 50,000 miles. A restricted Supply Line Filter could cause driveability concerns

Removal

1. Purge the Supply Line using the Fuel Line Purging/ Depressurization Procedure.

Note: You can omit the step where you loosen the fitting at the Return Valve as only the supply line needs to be depressurized.

2. Using two (2) wrenches and a socket, slowly loosen the fittings on the Supply Line Filter.
3. Loosen the Supply Line Filter mounting clamp.
4. Remove the Supply Line Filter from the bracket.

Replacement

1. Install the new Supply Line Filter in the bracket.
2. Install the two (2) fuel lines to the filter and hand-tighten.
3. Counter-brace the filter and torque the inlet line (line between the filter and tank) to 57 Nm (42 ft-lb).
4. Counter-brace the filter and torque the outlet line (line between the filter and FRPCM) to 28 Nm (21 ft-lb).
5. Tighten the mounting clamp.
6. Leak check the filter and lines using an electronic leak detector or leak detection solution.
7. Perform the Fuel System Priming Procedure..

Fuel Rails

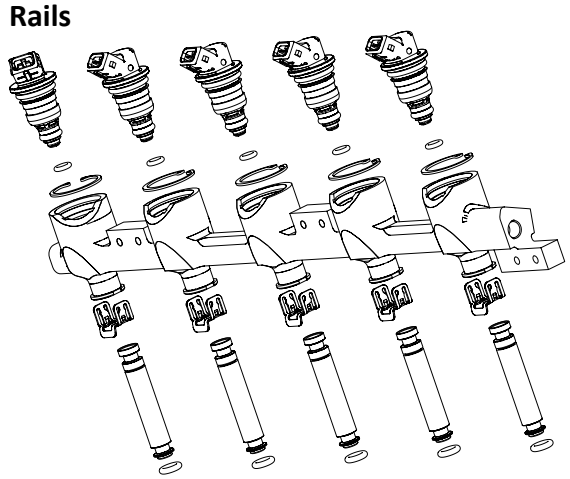


Figure 27. LH Fuel Rail

Description

The ROUSH CleanTech fuel rail mounts to the intake manifold and uses ten (10) individual injectors to inject liquid propane.

⚠ CAUTION

When removing or replacing any fuel delivery components which include: Fuel Rails, Injectors, or Supply Lines, thoroughly clean the work area with solvents and compressed air to remove any debris or contaminants. Always insure your hands are clean when handling fuel injection components to prevent contaminating the fuel delivery systems.

Removal

1. Purge the fuel lines using the Fuel Line Purging/Depressurization Procedure.
2. Disconnect the IPTS electrical connection (left fuel rail only).
3. Disconnect all five (5) fuel injector connections.
4. Disconnect the fuel rail supply and fuel rail return lines from the ends of the fuel rail. Inspect O-rings and replace if damaged.
5. Remove the two (2) bolts connecting the fuel rail to the intake manifold.
6. Lift upward to remove the fuel rail from the intake manifold.

Note: Lift upward to limit potential damage to the fuel rails.

Replacement

1. Lubricate the injector spacer tube O-rings with clean engine oil or silicone O-ring lubricant.
2. Insert the fuel rail into the intake manifold, pushing down firmly to seat the O-rings. Make sure that fuel rails go down straight to ensure properly seated.
3. Install the two (2) bolts connecting the fuel rail to the intake manifold, torque to 10 Nm (7.4 ft-lb).
4. Connect the fuel rail supply line and fuel rail return line to the fuel rail.
5. Torque return and supply line fittings to 21 Nm (15.5 ft-lb).
6. Connect IPTS electrical connector (left fuel rail only).
7. Connect the fuel injector electrical connectors.
8. Leak check all spacer tubes and fuel lines connections on the fuel rail assembly using an electronic leak detector or leak detection solution.
9. Perform the Fuel System Priming Procedure..

Fuel Injectors

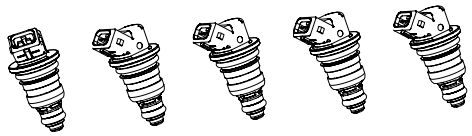


Figure 28. Injector

Description

The Fuel Injectors are mounted in the fuel rail and inject liquid propane into the intake manifold.

CAUTION

When removing or replacing any fuel delivery components which include: Fuel Rails, Injectors, or Supply Lines, thoroughly clean the work area with solvents and compressed air to remove any debris or contaminants. Always insure your hands are clean when handling fuel injection components to prevent contaminating the fuel delivery systems.

Removal

1. Purge the fuel lines using the Fuel Line Purging/Depressurization Procedure.
2. Disconnect the fuel injector electrical connector.
3. Using snap-ring pliers, remove the C-clip retaining the injector.
4. Pull up firmly on the injector.
5. Using needle nose pliers, remove fuel injector. (in fuel rail assembly)

Replacement

1. Lubricate the new fuel injector O-rings with clean engine oil or silicone lubricant.
2. Install the injector into the fuel rail, pressing down firmly to fully seat the injector.
3. Install the retaining C-clip.

Note: Insure that the C-clip is fully seated.

4. Install the injector electrical connector.
5. Leak check the injector using an electronic leak detector or leak detection solution.
6. Perform the Fuel System Priming Procedure..

Integrated Pressure Temperature Sensor (IPTS)

Figure 29. Integrated Pressure Temperature Sensor (IPTS)

Description

The IPTS is a shared 5V reference sensor mounted at the front of the driver-side fuel rail. It measures pressure and temperature of fuel in the rail. The fuel rail pressure and temperature reading is important for the start sequence, injector pulse width, as well as other functions.

CAUTION

When removing or replacing any fuel delivery components which include: Fuel Rails, Injectors, or Supply Lines, thoroughly clean the work area with solvents and compressed air to remove any debris or contaminants. Always insure your hands are clean when handling fuel injection components to prevent contaminating the fuel delivery systems.

Removal

1. Purge the fuel rail using the Fuel Line Purging/Depressurization Procedure.
2. Disconnect the IPTS electrical connector.
3. Remove the IPTS.

Replacement

1. Install the IPTS and torque to 7 Nm (5.2 ft-lb).
2. Connect the IPTS electrical connector.
3. Leak check the IPTS with an electronic leak detector or leak detection solution.
4. Perform the Fuel System Priming Procedure..

Fuel Rail Pressure Control Module (FRPCM)

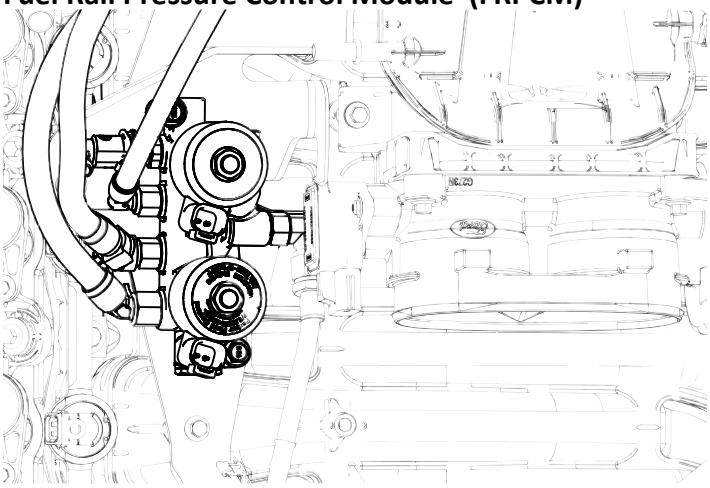


Figure 30. Fuel Rail Pressure Control Module (FPCM)

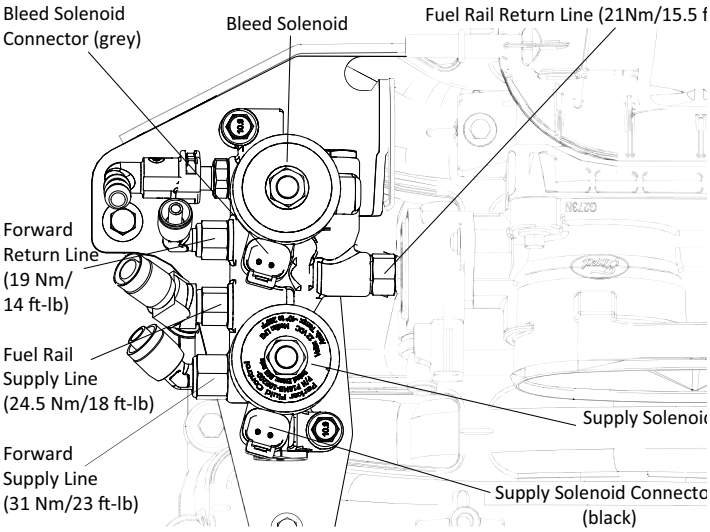


Figure 31. Fuel Rail Pressure Control Module (FPCM)

Description

The FRPCM is mounted on a bracket on the top of the intake manifold and consists of two (2) normally closed solenoids and a return check valve. The FRPCM is controlled directly by the Gateway Module which is governed by the PCM. Included in the FRPCM are:

1. **Supply Solenoid**
   Open (energized) when the engine is running, the Supply Solenoid allows fuel to flow from the chassis fuel lines to the fuel rail. The Supply Solenoid is closed when the engine is turned off, preventing fuel from flowing from the chassis fuel lines to the engine fuel rail. **There is a second Supply Solenoid located at the fuel tank which prevents fuel from flowing into the chassis fuel lines when the engine is turned off.**
2. **Return Check Valve**
   Open when rail pressure is increased, the Return Check Valve allows fuel to return from the Fuel Rails to the chassis fuel lines. The Return Check Valve closes when the engine is turned off, isolating the Fuel Return Line and fuel tank, and preventing fuel from backfilling the engine fuel rail.
3. **Bleed Solenoid**
   Closed when the engine is running, the Bleed Solenoid seals the Fuel Rail from the vehicle EVAP system. When ambient temperature is above 40°F and after the engine is turned off for approximately one and a half hours, the Bleed Solenoid energizes for a calibrated length of time, allowing all the fuel pressure to bleed from the fuel rail through a metered orifice and into the carbon canister. When the process is complete, the Bleed Solenoid closes, preventing fuel from entering the EVAP system.

Fuel Rail Pressure Control Module (FRPCM) (cont.)

Removal

1. Depressurize the fuel system using the Fuel Line Purging/ Depressurization Procedure.
2. Disconnect the electrical connector for each FRPCM solenoid.

Note: Take note of the connector locations.

3. Remove the fuel lines from the FRPCM.
4. Inspect fuel line O-rings and replace if damaged.
5. Remove the vapor line by squeezing the release tabs on either side of the connector.
6. Remove the two (2) fasteners securing the FRPCM to the bracket.

Replacement

1. Install the FRPCM to the bracket and torque fasteners to 10 Nm (7.4 ft-lb).
2. Install fuel lines starting with the line closest to the bleed port, working forward with the following torque specifications:
   - Forward return line: 19 Nm (14 ft-lb)
   - Fuel rail supply line: 24.5 Nm (18 ft-lb)
   - Forward supply line: 31 Nm (23 ft-lb)
   - Fuel rail return line: 21 Nm (15.5 ft-lb)
3. Connect the wiring harness wiring connectors.
   - Black connector to the Supply Solenoid
   - Grey connector to the Bleed Solenoid
4. Connect the vapor line.
5. Connect the batteries.
6. Leak check all FRPCM connection using an electronic leak detector or leak detection solution.
7. Perform the Fuel System Priming Procedure..

FRPCM Bleed Port

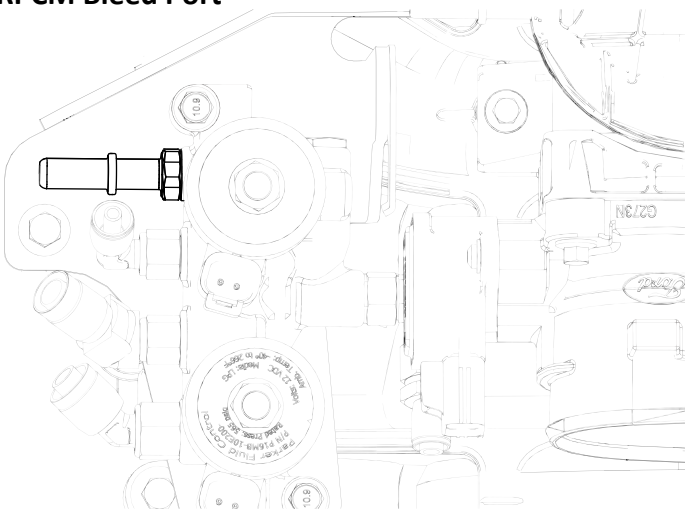


Figure 32. FRPCM Bleed Port

Description

The FRPCM Bleed Port meters the flow rate of the bleed-down process. The Bleed Solenoid will open 75 minutes after shutdown to depressurize the fuel rails.

Removal

1. Remove the vapor line connecting to the FRPCM bleed port by squeezing the release tabs on either side of the connector.
2. Remove the FRPCM bleed port.

Replacement

1. Install the FRPCM bleed port and torque to 19 Nm (14 ft-lb).
2. Install the vapor line to the FRPCM bleed port.

Gateway Module (GWM)

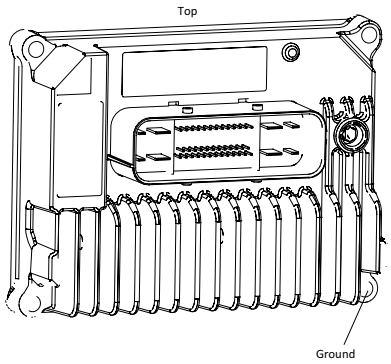


Figure 33. Gateway Module

Description

The Gateway Module (GWM) is an electronic control module that provides additional input/output features required for the LPA fuel system via the vehicle's controller area network (CAN) bus. The module is installed on the left front inner fender panel.

Removal

1. Disconnect the negative ground cables from the vehicle batteries.
2. Note the Gateway Module (GWM) orientation on bracket.
3. Disconnect the Gateway Module (GWM) electrical connector by pressing down the front tab, then pulling up on the connector lock and moving it to the other side of the connector. Carefully move the connector side-to-side when removing. Note connector orientation.
4. Remove the four (4) fasteners securing the Gateway Module (GWM) to the bracket and remove the Gateway Module (GWM).

Replacement

1. Place the Gateway Module (GWM) on the bracket as shown, checking for orientation.
2. Install the four (4) mounting fasteners and torque to 10 Nm (7.4 ft-lb).
3. Carefully install the Gateway Module electrical connector and lock the connector lock. Push until the connector is fully seated, then carefully close the lever by pulling the lever to the left until it clicks.
4. Reconnect the batteries.

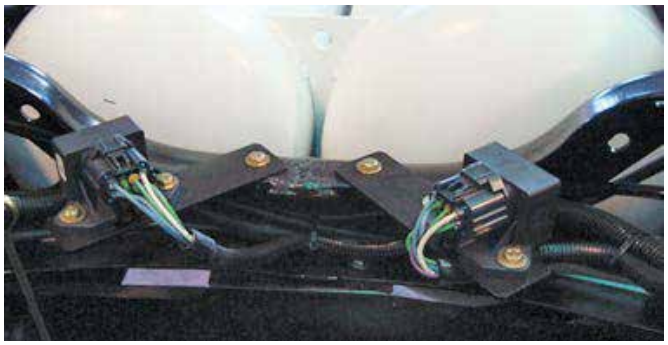
QUICK REFERENCE

Tank Bleeder Valve/Fixed Liquid Level Gauge

The Bleeder Valve/fixed liquid level gauge serves two functions:
1. Offers a means to evacuate the tank for tank internal component service procedures.
2. Allows annual verification of the function on the Overfill Prevention Device (OPD).

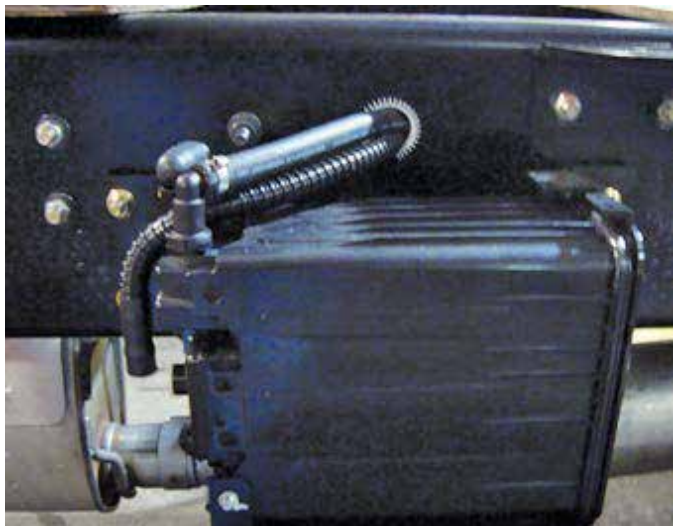
Note: The tank Bleeder Valve is to remain open during vehicle operation.

Torque Settings: 20 +/- 4.0 Nm (6.5 ft-lb) minimum, plus orientation, reverse torque not permissible.



Electronic Fuel Pump Relay (EFPR)

The relay controls the Fuel Pump voltage, which controls the Fuel Pump duty cycle. Each Fuel Pump is controlled by a separate EFPR. The EFPRs are mounted to a bracket on the frame cross member in front of the Fuel Tank.



Evaporative Canister Assembly

The Evaporative Canister is utilized to vent the remaining fuel vapor in the fuel rail during engine shut-off to prevent the fuel injectors developing a leak. The Evaporative Canister System is monitored by the PCM to ensure that the fuel rails vent into the canister.

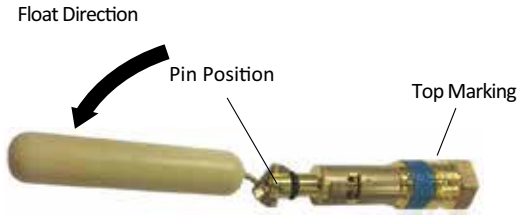
Excess Flow Valve (EFV)

The Excess Flow Valve is located in the supply fuel path, ahead of the Tank Solenoid and Manual Shutoff Valve. The valve is intended to shut off fuel flow from the tank in the event of a rapid pressure drop outside the fuel tank. A rapid pressure drop could be caused by a severed line or an inadvertent disconnect without shutting the Manual Shutoff Valve. If the Excess Flow Valve trips (may happen after servicing the system), it can be reset by closing the manual shutoff valve and then slowly opening it. The Excess Flow Valve does not completely stop flow and will not actuate with smaller leaks, so it should not be relied on for servicing purposes. If the Excess Flow Valve activates (such as immediately following service where the system may not be primed with fuel), turn off the key and wait 15-30 seconds then retry.

Fuel Level Sender (FLS)

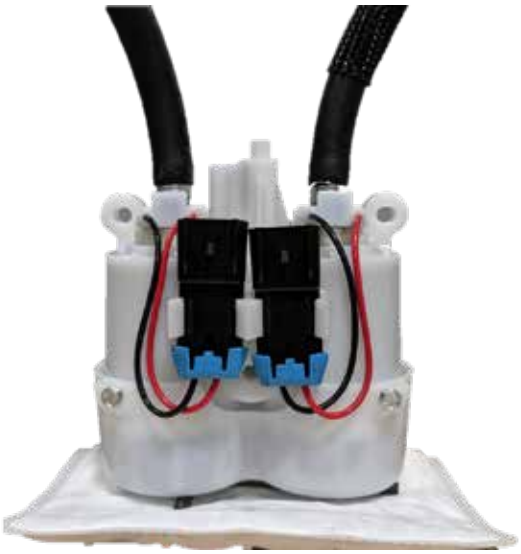
The tank is fitted with a Fuel Level Sender that consists of an in-tank float arm coupled to an externally mounted variable voltage sensor. This sender provides a fuel level signal to the instrument panel, which utilizes an "anti-slosh" signal conditioner to provide an accurate gauge reading. The Fuel Level Sender is serviceable from the top of the tank through a service opening in the floor of the bus and includes a visual indicator which can be referenced during service.

Note: The fuel level indicator on the sender will vary slightly from actual fuel level. Always check fuel level at the cluster.



Fuel Fill Valve/Overfill Prevention Device (OPD)

Located where fuel enters into the Fuel Tank, the fill valve is opened mechanically by the refueling pump pressure during the fill process. It also incorporates a back flow check valve and an overfilling prevention device. The back flow check valve closes when vehicle tank pressure is greater than pressure outside of the tank to prevent fuel from escaping.



Fuel Pumps

The ROUSH CleanTech fuel system uses two (2) Fuel Pumps that pump in parallel to push liquid propane up to the engine, and maintain liquid in the fuel rail. They come together in a Y at the supply valve. The Fuel Pumps are serviced as an assembly.

Torque Settings:

(2) Housing to Tank Bolt (top corners):	5.8 Nm (4.3 ft-lb)
(1) Housing to Tank Bolt (center)	8.5 Nm +/- .5 (6.3 ft-lb)

Fuel Rail Pressure Control Module (FRPCM)

The FRPCM is a unit consisting of two (2) normally closed solenoids and a return check valve. The FRPCM is controlled directly by the Gateway Module which is governed by the PCM. Included in the FRPCM are: one the the two Supply Solenoids (other is found on the tank), Return Check Valve, and the Bleed Solenoid.

Supply Solenoid:

Open (energized) when the engine is running and closed (off) when the engine is turned off, the Supply Solenoid allows fuel to flow from the chassis fuel lines to the fuel rail.

Return Check Valve:

Open (energized) when the engine is running and closed (off) when the engine is turned off, the Return Check Valve allows fuel to return from the fuel rails to the chassis fuel lines.

Bleed Solenoid:

Closed when the engine is running, the Bleed Solenoid seals the fuel rail from vehicle EVAP system.

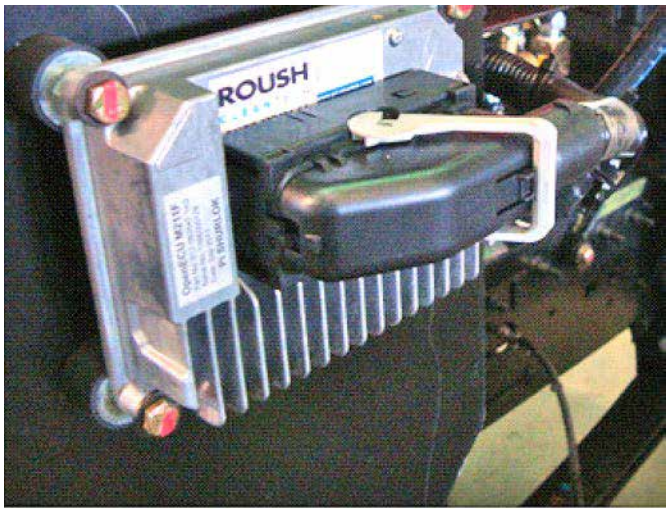
Torque Settings:

a. Forward return line: 19 Nm (14 ft-lb)
b. Fuel rail supply line: 24.5 Nm (18 ft-lb)
c. Forward supply line: 31 Nm (23 ft-lb)
d. Fuel rail return line: 21 Nm (15.5 ft-lb)

Fuel Lines

The fuel lines utilized in the LPA fuel system are made of a steel-reinforced PTFE with stainless steel hard line sections to provide long term protection and service. The 3/8" supply and 1/4" return lines contain ORB style fittings or compression style fittings. The use of line wrenches is recommended for removal and installation.

Note: When replacing hoses and lines, use Roush CleanTech replacement parts made from the same material and size. Always route and secure hoses as originally installed. All hoses and lines must be compliant and labeled per NFPA 58 requirements.



Gateway Module (GWM)

The Gateway Module controls the following functions within the LPA system:

- Fuel rail pressure control module solenoids
- Fuel Tank Supply Solenoid

The Gateway Module supplies the following information to the Ford engine controller:

- Fuel rail temperature and pressure
- Fuel tank temperature and pressure
- Second Fuel Pump relay module fault status
- Fuel level

Note: Signals supplied to the Ford engine controller will be diagnosed by the engine controller and reported as engine P-Codes. Lack of communication between the Gateway Module and the engine controller will also be reported by the engine controller which will reported as U-codes.

Integrated Pressure Temperature Sensor (IPTS)

The IPTS is a 5V reference sensor mounted at the front of the left fuel rail. It measures pressure and temperature of fuel in the rail. The fuel rail pressure and temperature reading is important for the start sequence, injector pulse width, as well as other functions.

Torque Settings: 7Nm +/- 1 (5.1 ft-lb)

Manual Shutoff

The Manual Shutoff Valve is used to seal the outlet of the tank during shipping, service or in case of a vehicle failure. It is located between the Excess Flow Valve and Tank Solenoid Valve. It is manually operated by turning the knurled knob mounted on the front of the Supply Circuit Assembly. Turning the knob clockwise closes the valve and turning the knob counterclockwise opens the valve. It should always be open when the vehicle is operating.

Tank Pressure Temperature Sensor

There is a Tank Pressure Temperature Sensor or (TPTS) mounted on the Fuel Tank assembly that reads both Fuel Tank pressure and Fuel Tank temperature and supplies these values to the Ford PCM via the Gateway module. This sensor is utilized to help target an expected fuel rail pressure to the engine to ensure the propane in the fuel rails remains in a liquid form at all times during operation.

Torque Settings: 7Nm +/- 1 (5.1 ft-lb)

Tank Return Valve Assembly

The Return Valve Assembly on the tank incorporates a check valve, which prevents fuel from flowing from the tank into the return line. The fuel Return Valve Assembly also contains the Flow Control Solenoid (FCS) which includes a small orifice to restrict return flow in normal conditions as well as a bypass circuit to allow maximum fuel flow prior to engine starting or during extremely hot conditions.

Tank Supply Valve Assembly

The Tank Supply Valve consists of an Excess Flow Valve, Tank Solenoid (automatic shut off valve) and a Manual Shutoff Valve. The Tank Supply Solenoid is ground-controlled by the Gateway Module (GWM). When given a ground, it is energized and opens the valve.

TORQUE CHART

Fuel Tank and Vehicle Components		
Component	**Quantity**	**Torque (Nm)**
Remote Fill Valve	1	Hand Tight + 1/4 to 1/2 turn
Remote Pressure Relief Outlet	1	Hand Tight + 1/4 turn
Remote Bleeder Valve		Hand Tight + 1/4 to 1/2 turn
Fuel Fill Line	1	At Filter: 57 +/- 4 At Valve: 45 +/- 4
Fill Filter Clamp Bolt	1	23.0 +/- 1.4
Bleeder Hose	1	18.5 +/- 3.0
Fuel Tank Assembly	1	-----
Fuel Tank Line Bolts – M6	2	11 +/- 1
Pressure Relief Outlet	1	95 +/- 5
Fuel Level Sender Screws – 1/4"	4	See Procedure
Bleeder Nozzle	1	20 +/- 4 MIN plus Orientation
Tank Access Cover Bolts – 3/8"	8	See Procedure
Fuel Filler – Tank OPD	1	91 + Orientation, not to exceed 130Nm
Fuel Return Circuit Screws – 1/4"	4	See Procedure
Fuel Supply Circuit Screws – 1/4"	4	See Procedure
Fuel Pump Housing to Tank Bolt – M5	1	5.8 +/- 0.3
Fuel Pump Wiring Bolts - M4	3	2.7 +/- 0.4
Fuel Pump Housing to Tank – M6 nuts	2	8.5 +/- 0.5
Pressure Relief Valve	1	213.5 Min.
Supply Circuit Cover – M5 Thumb Screw	4	Hand Tight
Fuel Rail and Line Assembly		
Component	**Quantity**	**Torque (Nm)**
Fuel Rail & Supply Line Bolts – M6	22	11 +/- 1
O-Ring Plug	1	8.9 +/- 0.9
Fitting – 1/4" and 3/8" Threaded	4	19 +/- 1
Fuel Pressure and Temperature Sensor	1	7 +/- 1
Evaporative System and Forward Fuel Components		
Component	**Quantity**	**Torque (Nm)**
Vapor Canister Bracket Bolts – Self Threading	3	2.75 +/- 0.25
Vapor Canister Bracket Bolts – M6	2	6.0 +/- 0.3
Vapor Canister to Frame Fasteners – M10	4	65.0 +/- 13.3
Gateway Module Bolt – 1/4"	4	11.5 +/- 0.5
FRPCM Bracket Assembly Bolts M6 Bolts M8 Bolt Bleeder Port	 2 1 1	 10 +/- 2 25 +/- 5 19 +/- 1

SYSTEM MAINTENANCE

LPA Fuel System

This section covers the items in the LPA fuel ystem, which requires regularly scheduled maintenance. For maintenance of the base engine or transmission refer to the 2017 Ford F650 service manual at www.motorcraft.com or consult the local Ford Medium Duty Truck Service Center.

Fuel Tank

The fuel tank equipped has been certified to ASME Tank and Pressure vessel requirements and the installation complies with all NFPA Pamphlet 58 Standards in affect at the time of certification. State and or local regulatory agencies may require a periodic inspection of the LPG tank. At a minimum of every 12 months the LPG tank should be inspected by a trained technician for the following items:

- Check for impact damage, dents, cuts or severe gouging or any tank deformation.
- Check for cracks in the welded seams or mounting brackets.
- Check to insure the service valves or shut off valves are functioning and manually closes the valve.
- Check to insure the pressure relief valve vent is clear of any obstructions and is properly orientated.
- Check all electrical connections to insure they are properly seated and have not become corroded.
- Check all mounting fasteners and brackets to insure the tank is properly fitted to the chassis.
- Check for cracks or excessive rust on the paint of the tank. Surface rust is commonly found, but does not affect the integrity of the tank.
- Leak check all external fittings and connection.

If during the tank inspection any or all the above have been observed you should have the tank repaired by a certified LPG Tank Repair Facility or replace the tank.

⚠ WARNING

Never cut or weld on or near the LPG fuel tank. Repairs to the fuel tank should only be made by a certified LPG tank repair facility. Failure to observe this warning could result in serious bodily injury, death and/or serious property damage.

FAQs

Q) How long should it take for my vehicle to start once I have cycled the key to on?

A) Typically the time will vary between seven (7) and fifteen (15) seconds, depending on the temperature of the fuel. Under severe operating circumstances (hot day, hot engine), the delay could be up to forty-three (43) seconds. Do not hold ignition in start position or engage starter multiple times.

Q) How long will it take to fill my ROUSH CleanTech System fuel tank?

A) Normal refueling rates are typically between five (5) and eight (8) gallons per minute but may vary depending on the ambient temperature conditions and pump capacity of the refueling equipment being used.

Q) Why does my refueling take longer when it's hot out?

A) On a hot day, refueling may take longer than usual because the heat will raise the pressure inside the fuel tank, which must be overcome by the refueling equipment.

Q) Is any special liquid propane autogas fuel required?

A) Yes, motor vehicles require the use of HD-5 automotive grade liquid propane autogas. Other grades of propane (including HD-10 or "commercial-grade") may contain higher levels of contaminants and could cause premature failure of fuel pumps and injectors, or clogging of system components. If you are unsure about the quality of your propane, check with your retailer or distributor.

Q) Where are liquid propane autogas filling stations located?

A) There are over 3,000 liquid propane autogas retail outlets available around the country to fill your vehicle. Liquid propane autogas filling locations can be found at these websites: www.afdc.energy.gov/afdc/locator/stations
www.roushcleantech.com

Q) Can I perform my own service or repair on the Roush CleanTech System?

A) Not recommended. Most states require a licensed technician to work on liquid propane autogas systems. We recommend that you go to a Blue Bird/Roush CleanTech Authorized Service Center for any service or repair to your vehicle. To locate a ROUSH CleanTech Authorized Service Center near you, visit us at www.roushcleantech.com or call us between the hours of 8 AM and 5 PM Eastern Time, Monday through Friday, at 800.59.ROUSH (800.597.6874).

Q) Can I add additional liquid propane autogas tanks?

A) No. Adding tanks to the vehicle would potentially violate emissions compliance of the vehicle and could result in drivability and emissions issues.

Q) Are there any unique maintenance requirements for the ROUSH Propane System?

A) Yes. There is a fuel filter in the fuel fill line and supply line to prevent contamination during refueling and operation. These filters are replaced at 50,000 mile intervals. No other ROUSH CleanTech System parts require periodic service. Some states require periodic certification

of the tank or filling systems, see your local gas association or state regulating agency for additional information.
NOTE: To maintain your warranty coverage, you must follow the normal maintenance schedule for your Blue Bird vehicle.

Q) Who do I contact for LPA warranty-related issues?
A) Take your vehicle to a Blue Bird/Roush CleanTech Authorized Service Center or, if not readily available, to any Ford dealer that is authorized to repair ROUSH CleanTech propane vehicles.

For further information about ROUSH CleanTech Systems or to locate a ROUSH CleanTech Authorized Service Center near you, visit us at www.roushcleantech.com or call us between the hours of 8 AM and 5 PM Eastern Time, Monday through Friday, (800) 59-ROUSH (597-6874), Opt. 2.

Q) Can I use any fuel additives?
A) No. It will void your warranty and harm the operation of the ROUSH CleanTech System installed on your vehicle.

Special Conditions

Refueling

DANGER

Before refueling, extinguish all open flames and smoking materials. Ensure that no electrical sparks are present. Failure to heed this danger may result in serious personal and property damage.

Stop refueling if there is any difficulty with the refueling process or the dispensing equipment. Notify the station operator at once. Failure to heed this danger may result in serious personal injury and property damage.

The filler cap screws on and off the filler valve. The filler nozzle either screws on or quick connects to the fill valve. Before attaching the filler nozzle, inspect the valve O-ring. If the O-ring is missing or damaged, replace it before attaching the filler nozzle.

Allow a station attendant to refuel your vehicle if you are not trained in proper liquid propane autogas refueling procedures and safety
precautions. Ensure that the vehicle rests on level ground and that the engine is not running.

NOTE: Failure to refuel on a level surface may result in an incomplete or overfill condition.

Troubleshooting

Troubleshooting – Refueling

My vehicle does not fill at all:
In order for the system to fill, the fuel supply pressure from the pump must be at least 50 psi higher than tank pressure (required to open the check valve in the fill system). Check the following:

- If the vehicle fuel tank is significantly warmer than the station storage tank, the station fuel pump may not be able to provide sufficient pressure (either due to insufficient pump capacity or a low bypass pressure setting). This can be a particular problem if the station fuel tank is underground and the vehicle is fueling on a hot day.
- If the fuel tank is over 3/4 full (indicated), or if the fuel tank is over 1/2 full and the vehicle is not level, it may be possible that the OPD is in the closed position due to fuel level at the location of the OPD. If vehicle is not level, turn the vehicle around and try to refill with vehicle pointed in the opposite direction. If vehicle is level, or if this does not change behavior, drive vehicle until indication is under 1/2 tank and attempt to fill again. If behavior repeats, take vehicle to qualified service center for diagnosis and repair.
- If fuel tank is under 1/2 full (indicated), and there is sufficient fuel pressure from the fuel pump (minimum 50 psi over tank), the OPD may be stuck closed. Diagnosis and repair by qualified service center is likely required.

My vehicle fills slowly (less than three (3) gallons/minute):
If the vehicle is filling slowly, it indicates that the OPD is functioning properly but something in the system is preventing normal flow.

- Confirm that fueling station has fueling equipment rated for Autogas applications (5-7.5 hp pump set at a minimum differential pressure of 125 psi). Lower capacity pumps may be acceptable for cylinder fills but can result in slow fills in automotive applications.
- If tank temperature is very high, the density of propane in the tank is relatively low which can result in higher than normal restriction and slow fill. This is most likely at temperatures above 100ºF ambient, especially if station has underground storage tanks. This does not indicate any problem with the vehicle. We suggest trying to fill in the morning (when vehicle and station are at similar temperatures), or trying another filling station.
- Fuel filter may be clogged. The inline fuel filter should be changed every 50,000 miles. If it has not been changed on schedule, have it changed by qualified technician. The technician should measure pressure drop to determine whether it has clogged prematurely (this is possible if the fuel has unusually high levels of contaminants).
- If filter has less than 50,000 miles, take vehicle to qualified service center for fuel fill system diagnosis/repair.

My vehicle does not fill completely (shuts off early):
During the fill event, it is possible for the tank ressure to increase causing the check valves to close. See “My vehicle does not fill at all”.

- Make sure vehicle is level (either due to the fill station

pavement, or to loading of the vehicle), the shutoff may occur early.
- The OPD system is required to be inspected annually to verify proper function, and may be inspected more frequently based on local or fleet-specific requirements. Check the OPD inspection label (located on driver's door pillar) to determine whether OPD has been recently inspected.
- Verify fuel tank is level. If tank is tilted away from the fill valve, some overfilling could result. Within reason, this should not result in any issues, but if fill area is severely non-level, it should be corrected.
- If consistent overfill is suspected, have the full OPD inspection procedure performed to verify correct operation.
- Fuel tanks which are overfilled may vent ropane unexpectedly, due to normal ambient temperature changes. Use caution if overfilled tank is suspected.

Troubleshooting – Starting

If the engine does not start within a few seconds of cranking, one touch integrated starting (OTIS) will disengage the starter. Check the fuel gauge before attempting to start again. If there is adequate liquid propane autogas fuel and the engine fails to start after several attempts, obtain the assistance of a qualified liquid propane autogas service technician to diagnose the problem. We recommend that you take your vehicle to a Blue Bird/ROUSH CleanTech Authorized Service Center to have such diagnosis performed. To locate a ROUSH CleanTech Authorized Service Center near you, visit us at www.roushcleantech.com or call us between the hours of 8 AM and 5 PM Eastern Time, Monday through Friday, at (800) 59-ROUSH (597-6874), Opt. 2.

The starter does not engage even after 40 seconds:
- Most common cause of no-start/no-crank is either that the PCM did not recognize the request for crank, or that the key did not remain in the "on" position after being turned to start. Turn key to off and repeat start sequence, making sure to firmly turn the key to the start position, and then allowing the key to return to "on" without overshooting back to "off" or "accy".
- Ensure transmission is in Neutral with parking brake engaged.
- Confirm vehicle battery is sufficiently charged and no other issues present.
- Refer to to Blue Bird multiplex vehicle starting diagnostics.
- If fuel pumps can be heard (roughly 1-2 seconds after turning the key to start), but starter does not engage, it likely indicates an issue with the vehicle unrelated to the propane system. If fuel pumps are not heard, there may be an issue where the propane system is not recognizing the start attempt. In either case, vehicle likely will need to be serviced.

The starter engages but engine does not start or starts and will not keep running:
- Confirm adequate fuel in the tank. On level road, tank indication at or above indicated "E" should be sufficient for starting; vehicles parked on grades (either front/rear or side/side) may experience lack of starting at indication of 1/8 tank.

- Ensure battery is properly charged, and turn off all electrical accessories. Propane fuel injectors operate at higher pressures than gasoline and can fail to open in low battery conditions (such as experienced in crank), especially in hot conditions. Turn off headlights, radio, A/C, etc. If issue is repeatedly seen, take vehicle to qualified service center for investigation/repair of charging system or propane system.
- The ROUSH CleanTech starting system attempts to achieve liquid conditions in the fuel rail prior to engaging the starter. However, if the system does not achieve known liquid conditions in under forty-three (43) seconds, it will attempt to start the engine (to avoid excessively long delays in extreme conditions). If the engine cranks but does not start, and there are no other indications of faults, key the engine off and attempt to start again. If vehicle continues not to start, or frequently requires multiple attempts, vehicle should be taken to qualified dealer for service.

The vehicle does start and run, but delay seems excessive:
- Due to the unique properties of liquid propane, vaporization in the rail is not always easy to predict and therefore long delays may be encountered unexpectedly. The following conditions are likely to result in longer delays:
- Vehicle fully warm, engine off for 5-90 minutes. This is a long enough condition for heat to build in the rail, but not so long for engine to cool down. Engine compartment fully warm, with tank relatively cool (below 60°F). In this condition, the rail needs to cool significantly prior to start. Generally starting in this condition is not a problem, but the delay may seem unusually long.
- Engine compartment fully warm, tank very warm (above 110°F). In this condition, rail pressure is extremely high and the fuel is not much cooler than the rail.
- If you do believe that the crank delay times are consistently excessive, take the vehicle to qualified service center for inspection and repair if necessary.

MAINTENANCE AND SPECIFICATIONS

ROUSH CleanTech System Use and Maintenance

Use, maintenance, service and repair of the ROUSH CleanTech System must be in accordance with regulations put forth by the NFPA in their pamphlets #54 and #58, by the American Society of Mechanical Engineers (ASME), the Department of Transportation (DOT), the American National Standards Institute (ANSI) and all applicable federal, state, provincial and local authorities. Among those responsible for compliance are the maintenance provider, refueler and end-user personnel.

Service Recommendations

It is strongly recommended that all service needs for the engine and fuel system of the ROUSH CleanTech System installed on your vehicle be referred to a qualified liquid propane autogas service technician. Working with pressurized liquid propane autogas that fuels an internal combustion engine requires special training. Technical issues involving starting, operating or re-fueling a propane power bus should be reported to your local qualified service provider. In the event further technical assistance is needed, you should first contact your authorized Blue Bird Dealer regarding any technical issues with your Blue Bird product.

In emergency situations or if immediate technical assistance is needed and the above mentioned technical assistance is unavailable you can call ROUSH CleanTech Customer Service at (800) 59-ROUSH (597-6874), Opt. 2 with any questions regarding ROUSH CleanTech Liquid Propane Autogas Systems.

⚠ WARNING

The installation, service or repair of the ROUSH CleanTech System by a person who is not licensed or registered to perform installation, service or repair to liquid propane autogas systems may result in personal injury, harm, or loss or damage to property. Contact a person licensed or registered to fit install, service or repair a liquid propane autogas system. A person licensed to install, service or repair a liquid propane autogas system may not be liable for damages caused by the modification of a liquid propane autogas system by an unlicensed person except as otherwise provided by applicable law. Failure to heed this warning may void your ROUSH CleanTech System warranty. We recommend that you go to a Blue Bird/ROUSH CleanTech Authorized Service Center for installation or repair of the ROUSH CleanTech System.

Each ROUSH CleanTech System has been specially developed and designed by ROUSH CleanTech for its intended vehicle application. Therefore, the ROUSH CleanTech System must not be installed on vehicles other than the intended vehicle application designated by ROUSH CleanTech. Additionally, the ROUSH CleanTech System must not be modified or altered (either before installation or at any time after installation, or as part of any service, maintenance or repair, etc., to the vehicle or the ROUSH CleanTech System), except as specifically directed by ROUSH CleanTech as part of a safety recall, technical service bulletin or other formal written direction by ROUSH CleanTech. Modification or alteration of the ROUSH CleanTech System without ROUSH's prior written authorization may void the ROUSH CleanTech Limited Warranty.

Refill Capacity

The Blue Bird bus is designed with a dual cylindrical manifold tank assembly, which will hold approximately 93, 67, or 45 gallons of usable capacity, depending on application.

Note: There is typically 8-10% of the usable tank capacity remaining once "Low Fuel" lamp light illuminates below this level. It is possible to experience drivability issues related to fuel pressure when operating on grades, hard accelerating and cornering.

Note: The density of the liquid propane changes significantly with temperature. On a hot day, it is not unusual for vehicle to apparently fill less than usual, and for the fuel gauge to read less than full after the tank cools off. This is normal and does not indicate a problem with the fill system.

Jump Starting

⚠ DANGER

Before attempting electrical connections for jump starting, check for battery and liquid propane autogas fumes. If there is any indication of a propane leak (rotten egg smell, ice buildup or visible vapor around fittings, audible hiss, etc.), follow the leak reporting procedure. Do not attempt to start the vehicle — sparks from the electrical connections may ignite the vapors. Failure to heed this danger may result in serious personal injury, including death and property damage.

Follow the jump starting procedures in the Driver's Manual.
NOTE: It may take up to forty-three (43) seconds for the engine to crank after initiating the start sequence.

Manual Shutoff Valve

Should the need arise (leaking or electrical failure, etc.) to stop the flow of liquid propane autogas manually, there is a manual shutoff valve on the liquid supply line of the ROUSH CleanTech System. The supply valve is located on the bottom of the ROUSH CleanTech System fuel tank; specific location of the valve is labeled on the tank. An access cover may be removed to allow access to the manual shutoff valve. Turn the knob clockwise, until it stops, to stop the flow of liquid propane autogas.

NOTE: Open this valve slowly when the system is restored to normal. Releasing liquid propane autogas quickly into an empty line may set off a special check valve restricting proper fuel flow. If difficulty occurs, close the valve completely and then open it slowly.
NOTE: This valve must always be fully open during vehicle operation. Service needs for the liquid propane autogas fuel system should be referred to a qualified liquid propane autogas service technician for inspection and correction. We recommend that you see a Blue Bird/ROUSH CleanTech Authorized Service Center to address any service needs you may have.

Storing the Vehicle

If the vehicle is to be stored for more than sixty (60) days, close the manual shutoff valve of the ROUSH CleanTech System and consult the Driver's Manual for information about protecting the

base vehicle.

NOTE: Remember to open this valve slowly before returning the vehicle to operation.

Repainting (Vehicle or Tank)

The fuel tank should not be repainted. Touchups, if required, should be performed according to National Fire Protection Association (NFPA) NFPA58. Repainting the tank for purposes other than touching up or repair may result in voiding the tank warranty.

⚠ DANGER

Note: Remove the ROUSH CleanTech System fuel tank before attempting to paint the vehicle. The high temperatures used in the painting process can set off the pressure relief valve, discharging liquid propane autogas into the hot chamber causing asphyxiation that could result in personal injury, including death.

Tank removal should be performed by a qualified liquid propane autogas service technician. We recommend that you see a Blue Bird/ROUSH CleanTech Authorized Service Center to have this procedure performed.

Technical issues involving starting, operating or re-fueling a propane power bus should be reported to your local qualified service provider. In the event further technical assistance is needed, you should first contact your authorized Blue Bird Dealer regarding any technical issues with your Blue Bird product.

In emergency situations or if immediate technical assistance is needed and the above mentioned technical assistance is unavailable you can call ROUSH CleanTech Customer Success at (800) 59-ROUSH (597-6874), Opt. 2 with any questions regarding ROUSH CleanTech Liquid Propane Autogas Systems.

ROUSH Diagnostic Tool

The Roush Diagnostic Tool (RDT) is a free desktop application available from ROUSH CleanTech for PCM and Gateway Module (GWM) calibration, performing advanced driveability diagnostics, relaying information directly to the ROUSH CleanTech hotline, DTC reading and clearing, and KOEO/KOER functions on Gen 3 and Gen 4 vehicles.

Required Equipment

Performing electronic diagnostics on a ROUSH CleanTech vehicle using the ROUSH Diagnostic Tool (RDT) requires the use of a capable J2534 Pass-Thru OBD-II device, which is required to communicate between the vehicle and the technicians laptop.

A list of laptop system requirements can be found at http://rdt.roush.com/RoushRdt/.

Downloading and Installing the ROUSH Diagnostic Tool

A laptop with a working USB port and a constant and uninterrupted wifi signal are required to run RDT. RDT is licensed per machine, so the software can only be used on the machine that it has been downloaded to.

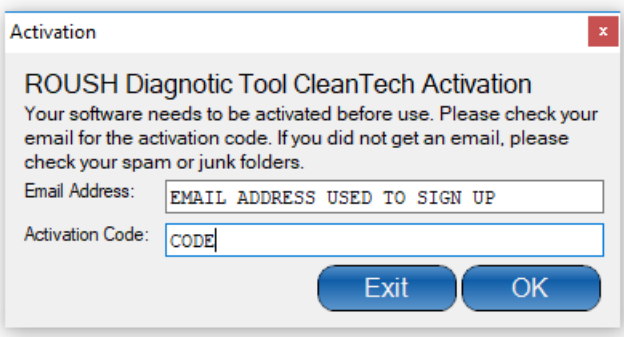
Prior to installing RDT, install all drivers required for the chosen J2534 Pass-Thru device. Consult the installation instructions for the chosen Pass-Thru device to ensure drivers are properly downloaded.

To Download:

1. Access the ROUSH Diagnostic Tool page on the ROUSH CleanTech website to start the download process. The Google Chrome browser works best for downloading RDT.
2. Complete all of the required fields and click "Submit".
3. Click on "ROUSH CleanTech Client" to download RDT for ROUSH CleanTech. The Roush Performance Client will not work with a ROUSH CleanTech Vehicle.

To Install:

1. Locate the file that was downloaded and then run the file.
2. Run the downloaded file to begin installation of the software. Review and agree to the licensing terms and begin the install, which may take several minutes.
3. Locate Roush Diagnostic Tool icon on the desktop and open the program. Read and Accept the warning.
4. Enter email address that was registered and software activation code from above.
5. After installtion, close and re-open RDT before first use.

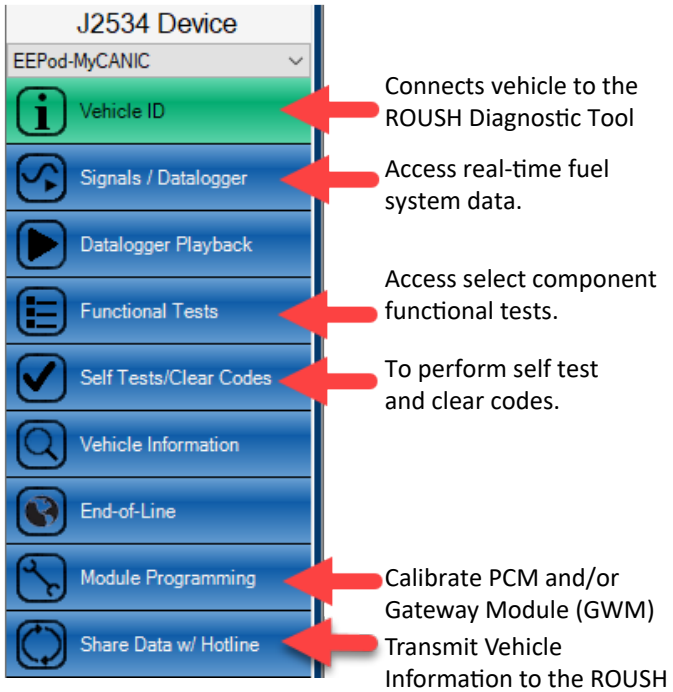


Utilizing the ROUSH Diagnostic Tool

A reliable internet connection is required at all times when working with with RDT.

Accessing Functions in RDT

1. Connect J2534 Pass-Thru OBD-II device into the OBD port of the vehicle. This port can be found in the steering column. If changing Pass-thur devices, RDT will have to be closed and re-opened each time a new device is to be used.
2. Locate the RDT icon on the desktop and open the program. If multiple Pass-Thru devices have been used, select the chosen device via the drop down menu. Follow any messages from RDT to finish the device selection process.
3. Select Vehicle ID and verify that the VIN and vehicle type are correct. This is required prior to using any functions within RDT.
4. Select the function that is required.
   - To access data on various vehicle functions through the use of RDT PIDs, click on Signals/Datalogger.
   - To access Output State Controls, the Fuel Pump Perfomance test, Fuel Transfer test, or Misfire test, select Functional Tests.
   - To Self Tests, KOEO and KOER tests, or remove DTC codes, select SelfTests/ClearCodes.
   - To calibrate the PCM or Gateway Module (GWM), select Module Programming (see https://www.roushcleantech.com/rdt/ for more information on PCM and Gateway Module (GWM) voucher codes)



For diagnostic procedures that utilize RDT, look for the RDT logo throughout this diagnostic manual.

RDT Technical Assistance and ROUSH CleanTech Customer Success

For assistance with the ROUSH Diagnostic Tool, please contact RDT-Support@roush.com.

For any other questions please contact ROUSH CleanTech Customer Success Team at (800) 59-ROUSH (597-6874), Opt. 2.

RDT PID List for Gen 4 Vehicles (list)

*** Denotes Most Commonly Used**

Name	PCM Parameter
Fuel Tank Pressure (PsiA)*	**Rpr_pt_prs**
Fuel Rail Pressure (PsiA)*	**rpr_fr_prs**
Fuel Rail Target Pressure (PsiA)*	**rpr_fr_prs_tgt**
Fuel Pump Duty Cycle*	**rf_dc**
Fuel Rail Pressure (PsiA)	rf_ap_actual
Fuel Tank Pressure (volts)	rpr_pt_prs_volts
Fuel Tank Temperature (F)	rpr_pt_temp
Fuel Tank Temperature (volts)	rpr_pt_temp_volts
Fuel Rail Pressure (volts)	mux_rpr_rail_pres
Fuel Rail Temperature (F)	rpr_fr_temp
Fuel Rail Temperature (F)	ful_railtemp
Fuel Rail Temperature (volts)	mux_rpr_rail_temp
Propane State (unitless)	rpr_state
Adaptive Vapor Offset (PsiA)	rpr_vpr_prs_offset_flt_m
Adaptive Vapor Maturity Index	rpr_adap_vpr_offset_refuel_m_index
Fuel Rail Saturation Pressure Adapted (PsiA)	rpr_fr_adap_prs_sat_fnl
Fuel Rail Saturation Pressure (PsiA)	rpr_fr_prs_sat
Supply Solenoid 1 Command (Flag)	rpr_ss1_cmd
Supply Solenoid 2 Command (Flag)	rpr_ss2_cmd
Bleed Solenoid Command (Flag)	rpr_bs_cmd
Flow Control Solenoid Command (Flag)	rpr_fcs_cmd
Fuel rail target Pressure (PsiA)	rpr_fr_prs_tgt
Fuel Rail Bleed Status (Gateway Module/SRM)	mux_rpr_bleed_status
Slave Tank Pressure (PsiA)	mux_rpr_slv_tank_prs
Slave Tank Transfer in Progress (Flag)	mux_rpr_reful_inprg
Supply Solenoid 1 Status (Bit map)	mux_rpr_ss1_status
Supply Solenoid 2 Status (Bit map)	mux_rpr_ss2_status
Supply Solenoid 3 Status (Bit map)	mux_rpr_ss3_status
Flow Control Solenoid Status (Bit map)	mux_rpr_fcs_status
Bleed Solenoid Status (Bit map)	mux_rpr_bs_status
Gateway Module (GWM) CALID	mux_rpr_srm_ver
Gateway Module (GWM) PRV setting (Psi)	mux_rpr_prv_max_prs
Fuel Rail Pressure After Bleed (PsiA)	mux_rpr_bleed_prs
Fuel Rail Temperature After Bleed (F)	mux_rpr_bleed_temp
Master Tank Fuel level (Counts)	MUX_FUELLVL_ACTV_SIDE
Slave Tank Fuel level (Counts)	MUX_FUELLVL_PSSV_SIDE
Supply Solenoid 1 fault bit (Flag)	MUX_RPR_SS1_FAULT
Supply Solenoid 2 fault bit (Flag)	MUX_RPR_SS2_FAULT
Supply Solenoid 3 fault bit (Flag)	MUX_RPR_SS3_FAULT
Bleed Solenoid fault bit (Flag)	MUX_RPR_BS_FAULT
Flow Control Solenoid fault bit (Flag)	MUX_RPR_FCS_FAULT

RDT PID Screen for Gen 4 Vehicles

Highlighting Denotes Most Commonly Used

RPR_PT_PRS	RPR_PT_PRS_VOLTS	RPR_PT_TEMP	RPR_PT_TEMP_VOLTS	RPR_FR_PRS
RF_AP_ACTUAL	MUX_RPR_RAIL_PRES	RPR_FR_TEMP	FUL_RAILTEMP	MUX_RPR_RAIL_TEMP
RPR_STATE	RPR_FR_PRS_SAT	RPR_SS1_CMD	RPR_SS2_CMD	RPR_BS_CMD
RPR_FCS_CMD	RPR_FR_PRS_TGT	MUX_RPR_BLEED_STATUS	MUX_RPR_SLV_TANK_PRS	MUX_RPR_REFUL_INPRG
MUX_RPR_SS1_STATUS	MUX_RPR_SS2_STATUS	MUX_RPR_SS3_STATUS	MUX_RPR_FCS_STATUS	MUX_RPR_BS_STATUS
MUX_RPR_SRM_VER	MUX_RPR_PRV_MAX_PRS	MUX_RPR_BLEED_PRS	MUX_RPR_BLEED_TEMP	ACT
ECT	KAMRF[0]	KAMRF[1]	LAMBSE[0]	LAMBSE[1]
FADPT_COL[0][0]	FADPT_COL[0][1]	FADPT_COL[0][2]	FADPT_COL[0][3]	FADPT_COL[0][4]
FADPT_COL[1][0]	FADPT_COL[1][1]	FADPT_COL[1][2]	FADPT_COL[1][3]	FADPT_COL[1][4]
MUX_FUELLVL_ACTV_SIDE	MUX_FUELLVL_PSSV_SIDE	MUX_RPR_SS1_FAULT	MUX_RPR_SS2_FAULT	MUX_RPR_SS3_FAULT
MUX_RPR_BS_FAULT	MUX_RPR_FCS_FAULT	ENGINE_SPEED	LOAD	RF_DC
ESL_CTL_TG	FP_INPUT_VLT	RF_ADAPT[1][1]	RF_ADAPT[1][2]	RF_ADAPT[2][1]
RF_ADAPT[2][2]	AAT1_ENG	IAT11_ENG	IAT12_ENG	MCT
MAP	IMRCM2_VOLTS	IMRCM_VOLTS	IAT11_VOLTS	IAT12_VOLTS
MAP_VOLTS	TPP_FMEM	INJDC_AIRLMT	RF_DP_ACTUAL	RF_DPREF
ETC_FMM_MODE__A	MAP_STATUS	BP	CHT_ENG	INALT_VBATTERY
FLI_ENG1	RPR_FP_V_FLOWRATE	LAM_30MS[0]	LAM_30MS[1]	VBAT
MIS_RATE200	MIS_RATE1000	RPR_FP_DP_INJ_CLIP_FLG	RPR_FP_DP_INJ_MAX	INFAMB_KAM
RPR_SMR_TMR	RPR_FR_TEMP_TGT	SOAK_TIME	FLI_ENG	MUX_RPR_SLV_PUMP_FAULT

DIAGNOSTIC TROUBLE CODES

All diagnostic trouble codes (DTCs) known to be affected by the liquid propane autogas (LPA) system are covered in this manual. For all other DTCs, refer to the Ford Powertrain Control/Emissions Diagnosis Service Manual at www.motorcraft.com.

Code	Description
P0005	Fuel Shutoff Valve “A” Control Circuit/Open
P0090	Fuel Pressure Regulator Circuit/Open
P009B	Fuel Pressure Relief Control Circuit/Open
P009E	Fuel Pressure Relief Control Performance/Stuck Off
P009F	Fuel Pressure Relief Control Stuck On
P0148	Fuel Delivery Error
P0171	System Too Lean (Bank 1)
P0172	System Too Rich (Bank 1)
P0174	System Too Lean (Bank 2)
P0175	System Too Rich (Bank 2)
P0181	Fuel Temperature Sensor “A” Circuit Range/ Performance
P0182	Fuel Temperature Sensor “A” Circuit Low
P0183	Fuel Temperature Sensor “A” Circuit High
P0190	Fuel Rail Pressure Sensor Circuit (Bank 1)
P0192	Fuel Rail Pressure Sensor Circuit Low (Bank 1)
P0193	Fuel Rail Pressure Sensor Circuit High (Bank 1)
P01A0	Alternate Fuel Tank “A” Pressure Sensor Circuit Low
P01A1	Alternate Fuel Tank “A” Pressure Sensor Circuit High
P01A2	Alternative Fuel Tank “A” Pressure Sensor Circuit Intermittent/Erratic
P01AC	Alternate Fuel Tank Temperature Sensor Circuit Low
P01AD	Alternate Fuel Tank Temperature Sensor High
P01AE	Alternate Fuel Tank Temperature Sensor Circuit Intermittent/Erratic
P025A	Fuel Pump Module “A” Control Circuit/Open
P025B	Fuel Pump Module “A” Control Circuit Range/ Performance
P027B	Fuel Pump Module “B” Control Circuit Range/ Performance
P03xx	Misfire
P0442	EVAP System Leak Detected (small leak)
P0443	EVAP System Purge Control Valve “A” Circuit
P0446	EVAP System Vent Control Circuit
P0451	EVAP System Pressure Sensor/Switch Range/ Performance
P0452	EVAP System Pressure Sensor/Switch Low
P0453	EVAP System Pressure Sensor/Switch High
P0454	EVAP System Pressure Sensor/Switch Intermittent
P0455	EVAP System Leak Detected (large leak)
P0461	Fuel Level Sender “A” Circuit Range/Performance

Code	Description
P0462	Fuel Level Sender “A” Circuit Low
P0463	Fuel Level Sender “A” Circuit High
P0627	Fuel Pump “A” Control Circuit Open
P064A	Fuel Pump Control Module “A”
P116E	Fuel Pressure Relief Valve Actuated
P1453	Fuel Tank Pressure Relief Valve Malfunction
P1456	Fuel Tank Temperature Sensor Circuit Malfunction
P2195	Heated Exhaust Gas Oxygen Sensor Stuck
P2197	Heated Exhaust Gas Oxygen Sensor Stuck
P25B0	Fuel Level Sensor “A” Stuck
P2632	Fuel Pump “B” Control Circuit/Open
P2665	Fuel Shutoff Valve “B” Control Circuit/Open
P26B3	Fuel Shutoff Valve “A” Control Circuit Performance/ Stuck Off
P26B5	Fuel Shutoff Valve “B” Control Circuit Performance/ Stuck Off
P26EA	Fuel Pump Control Module “B”
U0108	Lost Communication with Alternative Fuel Control Module
U0109	Lost Communication with Fuel Pump Control Module “A”
U016C	Lost Communication with Fuel Pump Control Module “B”

P0005 — Fuel Shutoff Valve "A" Control Circuit Open	
Description	TS circuit fault. The Gateway Module (GWM) monitors tank solenoid circuit for open and short circuit faults.
Possible Causes	• Short to voltage • Water in the harness connector • Open power circuit • Open GND circuit • Low battery voltage • Corrosion • Incorrect connections • Damaged TS coil • Blown fuse
Symptom	Vehicle does not start. The pumps run but no pressure builds in the fuel rail.
Diagnostic Aid	Check the FRPCM and Gateway Module electrical connectors for damage, corrosion and water intrusion.
Action	Refer to the Tank Solenoid Electrical Check procedure in Diagnostic Tests and Procedures.

P0090 — Fuel Pressure Regulator Circuit Open	
Description	FCS circuit fault. Gateway Module (GWM) monitors FCS circuit for open and short circuit faults.
Possible Causes	• Short to voltage • Water in the harness connector • Open power circuit • GND circuit • Low battery voltage • Corrosion • Incorrect connections • Damaged FCS coil • Blown fuse
Symptom	Fuel pressure in the rail does not change when commanded. Extended fuel rail flush time.
Diagnostic Aid	Check the FRPCM and Gateway Module electrical connector for damage, corrosion and water intrusion.
Action	Refer to the Flow Control Solenoid procedure in Fuel Rail Pressure Control Module Electrical Check.

P009B — Fuel Pressure Relief Control Circuit Open	
Description	Bleed solenoid circuit fault. The Gateway Module (GWM) monitors Bleed Solenoid circuit for open and short circuit faults.
Possible Causes	• Short to voltage • Water in the harness connector • Open power circuit • Open GND circuit • Low battery voltage • Corrosion • Incorrect connections • Damaged BS coil
Symptom	Fuel rail bleed system does not operate correctly. There is a potential for fuel odor or hard start.
Diagnostic Aid	Check the FRPCM and Gateway Module (GWM) electrical for damage, corrosion and water intrusion.
Action	Refer to the Fuel Rail Pressure Control Module Electrical Check procedure in Diagnostic Tests and Procedures.

P009E/P26B3 — Fuel Pressure Relief Control Performance Stuck Off/Fuel Shutoff Valve "A" Control Circuit Performance Stuck Off	
Description	Fuel rail failed to bleed. The PCM measures fuel rail pressure on key-up to determine if fuel rail has been properly bled.
Possible Causes	• BS did not open • FRPCM check valve leaked (P26B3) • FRPCM Supply Solenoid leaked (P26B3) • Bleed port (bleed rate restrictor in outlet to VMV) clogged • EVAP line kinked • Blown fuse
Symptom	Fuel pressure present in the fuel rail after bleed event should have occurred; this may result in hard starts.
Diagnostic Aid	Check that FRPCM bleeds fuel from rail. Leaks to FRPCM can also trigger a fault.
Action	Refer to the Fuel System Fails to Bleed procedure in Diagnostic Tests and Procedures.

P009F — Fuel Pressure Relief Control Circuit Stuck On	
Description	Bleed solenoid stuck open. While the engine is running, the PCM seals the EVAP system and checks for a rise in pressure. If pressure in the EVAP system exceeds the threshold, a fault is set.
Possible Causes	• Short to the GND (ground) • Armature stuck in post • Solenoid seal compromised
Symptom	There is a potential fuel odor.
Diagnostic Aid	—
Action	Refer to the Fuel Rail Pressure Control Module Electrical Check procedure in Diagnostic Tests and Procedures.

P0148 — Fuel Delivery Error	
Description	To maintain target fuel rail pressure increase, the fuel pump voltage has been increased to a maximum adaptive limit and the fuel trims have gone lean.
Possible Causes	• Severely restricted fuel filter • Severely restricted fuel supply line • Damaged or worn fuel pump • Fuel pump wiring or fuse faults • Excess flow valve tripped • Tank Supply Solenoid or FRPCM Supply Solenoid closed • Tank manual shutoff valve not completely open
Symptom	Vehicle hesitation or stall condition.
Diagnostic Aid	This is a non-MIL setting DTC to aid the technician in diagnosing a possible fuel system fault. Do not diagnose if no symptoms or other fault codes are present.
Action	If other fault codes are present, diagnose those first. If symptoms are present, refer to diagnostic flow chart for that vehicle symptom.

P0171, P0174 — System Too Lean (Bank 1 and Bank 2 respectively)	
Description	Refer to the Ford Powertrain Control/Emissions Diagnosis Service Manual for more descriptive information.
Possible Causes	• The LPA system was operated in the vapor region • Refer to the Ford Powertrain Control/Emissions Diagnosis Service Manual for a list of other causes.
Symptom	—
Diagnostic Aid	Verify that no LPA system faults are present and then follow the Ford Powertrain Control/Emissions Diagnosis Service Manual procedure.
Action	Refer to the Engine Stumble, Stall, Rough Idle AND Fuel Pressure Drop procedure in Diagnostic Tests and Procedures.

P0172, P0175 — System Too Rich (Bank 1 and Bank 2 respectively)	
Description	Refer to the Ford Powertrain Control/Emissions Diagnosis Service Manual for more descriptive information.
Possible Causes	• The LPA system was operated in the vapor region • Refer to the Ford Powertrain Control/Emissions Diagnosis Service Manual for a list of other causes.
Symptom	—
Diagnostic Aid	Verify that no LPA system faults are present and then follow the Ford Powertrain Control/Emissions Diagnosis Service Manual procedure.
Action	Refer to the Engine Stumble, Stall, Rough Idle AND Fuel Pressure Drop procedure in Diagnostic Tests and Procedures.

P0181 — Fuel Temperature Sensor “A” Circuit Range/Performance	
Description	The Gateway Module (GWM) reads the IPTS and passes the voltage reading over the CAN bus to the PCM. The PCM monitors the voltage as if the sensor were plugged into the vehicle.
Possible Causes	• CAN bus fault between the Gateway Module (GWM) and PCM • Wiring fault between IPTS and Gateway Module (GWM) • Short in harness • Short in harness • Open circuit • Open or short to voltage in harness • Incorrect harness connection • Damaged IPTS • IPTS failure • Gateway Module (GWM) failure
Symptom	—
Diagnostic Aid	Verify the fuel rail temperature PID value to determine open or short.
Action	Refer to the Injection Pressure Temperature Sensor Electrical Check procedure in Diagnostic Tests and Procedures.

P0182 — Fuel Temperature Sensor “A” Circuit Low	
Description	The Gateway Module (GWM) reads the IPTS and passes the voltage reading over the CAN to the PCM monitors the voltage as if the sensor were plugged into the vehicle.
Possible Causes	• CAN bus fault between the Gateway Module (GWM) and PCM • Wiring fault between IPTS and Gateway Module (GWM) • Short in harness • VREF open or short • Low ambient temperature operation • Incorrect harness connection • Damaged IPTS (or FTS) • IPTS failure • Gateway Module (GWM) failure
Symptom	—
Diagnostic Aid	Verify the fuel rail temperature PID value to determine open or short.
Action	Refer to the Injection Pressure Temperature Sensor Electrical Check procedure in Diagnostic Tests and Procedures.

P0183 — Fuel Temperature Sensor "A" Circuit High	
Description	The Gateway Module (GWM) reads the IPTS and passes the voltage reading over the CAN bus to the PCM. The PCM monitors the voltage as if the sensor were plugged into the vehicle.
Possible Causes	• CAN bus fault between the Gateway Module (GWM) and PCM • Wiring fault between IPTS and Gateway Module (GWM) • Open circuit • Open or short to voltage in harness • Incorrect harness connection • Damaged IPTS (FTS) • IPTS failure • Gateway Module (GWM) failure
Symptom	—
Diagnostic Aid	Verify the fuel rail temperature PID value to determine open or short.
Action	Refer to the Injection Pressure Temperature Sensor Electrical Check procedure in Diagnostic Tests and Procedures.

P019F— Fuel Vapor Pressure Excessive - Low	
Description	Tank pressure is lower than expected for current temperature.
Possible Causes	• Non HD-5 fuel in tank • Faulty tank pressure temperature sensors (TPTS)
Symptom	Check engine light.
Diagnostic Aid	Resolve any sensor faults prior to diagnosing this code.
Action	Refer to the Tank Pressure Temperature Sensor Electrical Check procedure in the Diagnostic Tests and Procedures.

P0190 — Fuel Rail Pressure Sensor Circuit	
Description	The Gateway Module (GWM) reads the IPTS and passes the voltage reading over the CAN bus to the PCM. The PCM monitors the voltage as if the sensor were plugged into the vehicle.
Possible Causes	• CAN bus fault between the Gateway Module (GWM) and PCM • Wiring fault between IPTS and Gateway Module (GWM) • VREF open in harness • VREF open in sensor • Vacuum leaks • IPTS failure • Gateway Module (GWM) failure
Symptom	—
Diagnostic Aid	VREF should be between 4.5-5.5 volts.
Action	Refer to the Injection Pressure Temperature Sensor Electrical Check procedure in Diagnostic Tests and Procedures.

P0192 — Fuel Rail Pressure Sensor Circuit Low	
Description	The Gateway Module (GWM) reads the IPTS and passes the voltage reading over the CAN bus to the PCM. The PCM monitors the voltage as if the sensor were plugged into the vehicle.
Possible Causes	• CAN bus fault between the Gateway Module (GWM) and PCM • Wiring fault between IPTS and Gateway Module (GWM) • IPTS FRP signal short to SIG RTN or PWR GND • Damaged IPTS (or FRP) • IPTS failure • Gateway Module (GWM) failure
Symptom	—
Diagnostic Aid	A FRP PID value during ignition ON, engine OFF, or ignition ON, engine running is less than 0.3 volt. This indicates a concern is present.
Action	Refer to the Injection Pressure Temperature Sensor Electrical Check procedure in Diagnostic Tests and Procedures.

P0193 — Fuel Rail Pressure Sensor Circuit High	
Description	The Gateway Module (GWM) reads the IPTS and passes the voltage reading over the CAN bus to the PCM. The PCM monitors the voltage as if the sensor were plugged into the vehicle.
Possible Causes	• CAN bus fault between the Gateway Module (GWM) and PCM • Wiring fault between IPTS and Gateway Module (GWM) • IPTS FRP signal short to VREF or VPWR • IPTS (or FRP) open signal • Damaged IPTS (or FRP) • IPTS failure • Gateway Module (GWM) failure
Symptom	—
Diagnostic Aid	Verify the FRP PID value to determine open or short.
Action	Refer to the Injection Pressure Temperature Sensor Electrical Check procedure in Diagnostic Tests and Procedures.

P01A0 — Alternate Fuel Tank “A” Pressure Sensor Circuit Low	
Description	The Gateway Module (GWM) reads the TPTS and passes the voltage reading over the CAN bus to the PCM. The PCM monitors the voltage as if the sensor were plugged into the vehicle.
Possible Causes	• CAN bus fault between the Gateway Module (GWM) and PCM • Wiring fault between TPTS and Gateway Module (GWM) • VREF open in harness • VREF open in sensor • Vacuum leaks • TPTS failure • Gateway Module (GWM) failure
Symptom	—
Diagnostic Aid	VREF should be between 4.5-5.5 volts.
Action	Refer to the Tank Pressure Temperature Sensor Electrical Check procedure in the Diagnostic Tests and Procedures.

P01A1 — Alternate Fuel Tank “A” Pressure Sensor Circuit High	
Description	The Gateway Module (GWM) reads the TPTS and passes the voltage reading over the CAN bus to the PCM. The PCM monitors the voltage as if the sensor were plugged into the vehicle.
Possible Causes	• CAN bus fault between the Gateway Module (GWM) and PCM • Wiring fault between TPTS and Gateway Module (GWM) • TPTS Fuel Pressure signal short to SIG RTN or PWR GND • TPTS (or Fuel Pressure) open signal • Damaged TPTS • TPTS failure • Gateway Module (GWM) failure
Symptom	—
Diagnostic Aid	Verify the Propane Tank Fuel Pressure PID value to determine open or short.
Action	Refer to the Tank Pressure Temperature Sensor Electrical Check procedure in the Diagnostic Tests and Procedures.

P01A2 — Alternative Fuel Tank "A" Pressure Sensor Circuit Intermittent/Erratic	
Description	The Gateway Module (GWM) reads the TPTS and passes the voltage reading over the CAN bus to the PCM. The PCM monitors the voltage as if the sensor were plugged into the vehicle.
Possible Causes	• CAN bus fault between the Gateway Module (GWM) and PCM • Intermittent wiring fault between TPTS and Gateway Module (GWM) • TPTS Fuel Pressure intermittent signal short to SIG RTN or PWR GND • TPTS (or Fuel Pressure) intermittent open signal • VREF intermittent open in harness • VREF intermittent open in sensor • Vacuum leaks • Damaged TPTS • TPTS failure • Gateway Module (GWM) failure
Symptom	—
Diagnostic Aid	Verify the Propane Tank Fuel Pressure PID value to determine open or short.
Action	Refer to the Tank Pressure Temperature Sensor Electrical Check procedure in the Diagnostic Tests and Procedures.

P01AC — Alternate Fuel Tank Temperature Sensor Circuit Low	
Description	The Gateway Module (GWM) reads the TPTS and passes the voltage reading over the CAN bus to the PCM. The PCM monitors the voltage as if the sensor were plugged into the vehicle.
Possible Causes	• CAN bus fault between the Gateway Module (GWM) and PCM • Wiring fault between TPTS and Gateway Module (GWM) • Short in harness • VREF open or short • Low ambient temperature operation • Incorrect harness connection • Damaged TPTS • TPTS failure • Gateway Module (GWM) failure
Symptom	—
Diagnostic Aid	Verify the Propane Tank Fuel Pressure PID value to determine open or short.
Action	Refer to the Tank Pressure Temperature Sensor Electrical Check procedure in the Diagnostic Tests and Procedures.

P01AD — Alternate Fuel Tank Temperature Sensor Circuit High	
Description	The Gateway Module (GWM) reads the TPTS and passes the voltage reading over the CAN bus to the PCM. The PCM monitors the voltage as if the sensor were plugged into the vehicle.
Possible Causes	• CAN bus fault between the Gateway Module (GWM) and PCM • Wiring fault between TPTS and Gateway Module (GWM) • Open circuit • Open or short to voltage in harness • Incorrect harness connection • Damaged TPTS • TPTS failure • Gateway Module (GWM) failure
Symptom	—
Diagnostic Aid	Verify the Fuel Temperature PID value to determine open or short.
Action	Refer to the Tank Pressure Temperature Sensor Electrical Check procedure in the Diagnostic Tests and Procedures.

P01AE — Alternative Fuel Tank Temperature Sensor Circuit Intermittent/Erratic	
Description	The Gateway Module (GWM) reads the TPTS and passes the voltage reading over the CAN bus to the PCM. The PCM monitors the voltage as if the sensor were plugged into the vehicle.
Possible Causes	• CAN bus fault between the Gateway Module (GWM) and PCM • Intermittent wiring fault between TPTS and Gateway Module (GWM) • TPTS Fuel Pressure intermittent signal short to SIG RTN or PWR GND • TPTS (or Fuel Pressure) intermittent open signal • VREF intermittent open in harness • VREF intermittent open in sensor • Vacuum leaks • Damaged TPTS • TPTS failure • Gateway Module (GWM) failure
Symptom	—
Diagnostic Aid	Verify the Propane Tank Fuel Pressure PID value to determine open or short.
Action	Refer to the Tank Pressure Temperature Sensor Electrical Check procedure in the Diagnostic Tests and Procedures.

P025A — Fuel Pump Module “A” Control Circuit/Open	
Description	The Fuel Pump Control Module (FPCM) A receives control commands from the PCM on a Fuel Pump Command (FPC) pin. The FPCM A passes diagnostic information on the CAN bus to the PCM. If the FPCM A does not receive a control command from the PCM on the FPC, it sends a corresponding signal to the PCM on the CAN bus and the fault is set.
Possible Causes	Refer to the Ford Powertrain Control/Emissions Diagnosis Service Manual for a list of other causes.
Symptom	Poor starts, rough idle, hesitation/surge.
Diagnostic Aid	—
Action	Refer to the Fuel Pump Control Module Electrical Continuity Test procedure in Diagnostic Tests and Procedures.

P025B — Fuel Pump Module “A” Control Circuit Range/Performance	
Description	The Fuel Pump Control Module (FPCM) A receives control commands from the PCM on a Fuel Pump Command (FPC) pin. The FPCM A passes diagnostic information on the CAN bus to the PCM. If the FPCM A receives an invalid control command from the PCM on the FPC, it sends a corresponding signal to the PCM on the CAN bus and the fault is set.
Possible Causes	Refer to the Ford Powertrain Control/Emissions Diagnosis Service Manual for a list of other causes.
Symptom	—
Diagnostic Aid	
Action	Refer to the Fuel Pump Control Module Electrical Continuity Test procedure in Diagnostic Tests and Procedures.

P027B — Fuel Pump Module “B” Control Circuit Range/Performance	
Description	The Gateway Module (GWM) receives the output of the second fuel pump monitor line and repeats the output over the CAN bus to the PCM. The PCM monitors the commanded output versus the monitor’s feedback. If the monitor is out-of-range, a fault is set.
Possible Causes	Refer to the Ford Powertrain Control/Emissions Diagnosis Service Manual for a list of other causes.
Symptom	—
Diagnostic Aid	
Action	Refer to the Fuel Pump Control Module Electrical Continuity Test procedure in Diagnostic Tests and Procedures.

P03xx — Misfire	
Description	Refer to the Ford Powertrain Control/Emissions Diagnosis Service Manual for more descriptive information.
Possible Causes	• The LPA system was operated in the vapor region • Refer to the Ford Powertrain Control/Emissions Diagnosis Service Manual for a list of other causes.
Symptom	—
Diagnostic Aid	Verify that no LPA system faults are present and then follow the Ford Powertrain Control/Emissions Diagnosis Service Manual.
Action	Refer to the Engine Stumble, Stall, Rough Idle AND Fuel Pressure Drop procedure in Diagnostic Tests and Procedures.

P0442 - EVAP System Leak Detected (small leak)	
Description	The Ford PCM has detected a leak in the Evaporative Emissions System (EVAP).
Possible Causes	• Defective vapor management valve • Damaged EVAP canister • Leak in the EVAP system • Defective fuel tank pressure transducer
Symptom	Check engine light.
Diagnostic Aid	The fuel tank pressure transducer has been moved to a bracket near the EVAP canister. The system monitors the lines that go from the FRPCM bleed port to EVAP canister and purge valve. This system is used to de-pressurize the fuel rails after shutdown. The propane tank is sealed and is not part of this system.
Action	Test the EVAP system for leaks or damage.

P0443 - EVAP System Purge Control Valve “A” Circuit	
Description	This DTC sets when the signal moves outside the minimum or maximum limit for the commanded state.
Possible Causes	• VPWR circuit open • EVAPCP circuit open • EVAPCP circuit short to ground • EVAPCP circuit short to voltage • Damaged EVAP purge valve • Damaged PCM
Symptom	Check engine light.
Diagnostic Aid	Purge control valve is located near the rear of the intake manifold. To verify normal function, monitor the EVMV PID or EVAPCP PID and the signal voltage (PCM control side). With the valve closed, the EVMV indicates 0 mA (0% duty cycle for EVAPCP) and voltage approximately equal to battery voltage. When the valve is commanded fully open, EVMV indicates 1,000 mA (100% duty cycle for EVAPCP) and a voltage drop of 3 volts minimum is normal.
Action	Refer to the Ford Powertrain Control/Emissions Diagnosis Service Manual for P0443 diagnostics.

P0446 - EVAP System Vent Control Circuit	
Description	This DTC sets when the signal moves outside the minimum or maximum limit for the commanded state.
Possible Causes	• VPWR circuit open • KAPWR circuit open • CANV circuit open • CANV circuit short to ground • CANV circuit short to voltage • CANV circuit short to KAPWR • Damaged EVAP canister vent valve • Damaged PCM
Symptom	Check engine light.
Diagnostic Aid	Vent control circuit is in the EVAP canister. To verify normal function, monitor the EVAP canister vent valve signal PID EVAPCV and the signal voltage (PCM control side). With the valve open, EVAPCV indicates 0% duty cycle and a voltage approximately equal to battery voltage. When the valve is commanded fully closed, EVAPCV indicates 100% duty cycle, and a minimum voltage drop of 4 volts is normal.
Action	Refer to the Ford Powertrain Control/Emissions Diagnosis Service Manual for P0446 diagnostics.

P0451 - EVAP System Pressure Sensor/Switch Range/Performance	
Description	This DTC sets when a fuel tank pressure (FTP) sensor range (offset) concern is detected. The FTP sensor output is offset by greater than 1.7 inches of water or less than -1.7 inches of water.
Possible Causes	• FTP circuit intermittent open • FTP circuit intermittent short • FTP sensor intermittent open • FTP sensor intermittent short • Contaminated FTP sensor • Damaged FTP sensor • Damaged PCM
Symptom	Check engine light.
Diagnostic Aid	The FTP sensor is located on a bracket near the EVAP canister. With the FTP sensor at atmospheric pressure, the FTP PID normally indicates 0 inches of water. Remove the quick connect hose at the canister that goes to the FTP sensor, wait one minute to allow the pressure to equalize with the ambient air pressure before accessing the PID.
Action	Refer to Blue Bird wiring diagram for more information.

P0452 - EVAP System Pressure Sensor/Switch Low	
Description	This DTC sets when the fuel tank pressure (FTP) sensor signal average drops below a minimum allowable calibrated parameter.
Possible Causes	• Contamination internal to the FTP sensor connector • FTP circuit open • VREF circuit open • FTP circuit short to ground • FTP circuit short to SIGRTN • Damaged FTP sensor
Symptom	Check engine light.
Diagnostic Aid	The FTP sensor is located on a bracket near the EVAP canister. An FTP voltage PID reading less than 0.22 volt in ignition ON, engine OFF or ignition ON, engine running indicates a concern is present.
Action	Refer to Blue Bird wiring diagram for more information.

P0453 - EVAP System Pressure Sensor/Switch High	
Description	This DTC sets when the fuel tank pressure (FTP) sensor signal average jumps above a maximum allowable calibrated parameter.
Possible Causes	• Contamination internal to the FTP sensor connector • FTP circuit open • VREF circuit open • FTP circuit short to ground • FTP circuit short to SIGRTN • Damaged FTP sensor
Symptom	Check engine light.
Diagnostic Aid	The FTP sensor is located on a bracket near the EVAP canister. An FTP voltage PID reading more than 4.85 volt in ignition ON, engine OFF or ignition ON, engine running indicates a concern is present.
Action	Refer to Blue Bird wiring diagram for more information.

P0454 - EVAP System Pressure Sensor/Switch Intermittent	
Description	This DTC sets when the fuel EVAP system pressure changes greater than 14 inches of water in 0.1 seconds.
Possible Causes	• Contamination internal to the FTP sensor connector • FTP circuit open • VREF circuit open • FTP circuit short to ground • FTP circuit short to SIGRTN • Damaged FTP sensor
Symptom	Check engine light.
Diagnostic Aid	The FTP sensor is located on a bracket near the EVAP canister. Monitor the FTP PID and note if it changes +/- 15 inches of water multiple times in 1 minute.
Action	Refer to Blue Bird wiring diagram for more information.

P0455 - EVAP System Leak Detected (large leak)	
Description	The PCM monitors the complete evaporative emission (EVAP) control system for no purge flow, the presence of a large fuel vapor leak, or multiple small fuel vapor leaks. This DTC sets when no purge flow, which is attributed to fuel vapor blockages or restrictions, a large fuel vapor leak, or multiple fuel vapor leaks are detected by the EVAP running loss monitor test with the engine running, but not at idle.
Possible Causes	• Disconnected or cracked fuel EVAP canister tube, EVAP canister purge outlet tube, or EVAP return tube • EVAP purge valve stuck closed • Slow responding EVAP purge valve • Blockages or restrictions in the fuel vapor hoses or tubes • Loose fuel vapor hose or tube connections to the EVAP system components • EVAP canister vent valve stuck open • Damaged fuel tank pressure (FTP) sensor • Damaged EVAP canister
Symptom	Check engine light.
Diagnostic Aid	The fuel tank pressure transducer has been moved to a bracket near the EVAP canister. The system monitors the lines that go from the FRPCM bleed port to EVAP canister and purge valve. This system is used to de-pressurize the fuel rails after shutdown. The propane tank is sealed and is not part of this system.
Action	Check for audible vacuum noise in the engine compartment or near the EVAP canister with engine running.

P0461 — Fuel Level Sender “A” Circuit Range/Performance	
Description	Refer to the Ford Powertrain Control/Emissions Diagnosis Service Manual for more descriptive information.
Possible Causes	Refer to the Ford Powertrain Control/Emissions Diagnosis Service Manual. Causes are the same except that communication is between the sender and the Gateway Module (GWM) and not the IPC.
Symptom	—
Diagnostic Aid	The Gateway Module (GWM) reads fuel level sender input and broadcasts it to the IPC and PCM.
Action	Refer to the Fuel Level Indication System Check procedure in Diagnostic Tests and Procedures.

P0462 — Fuel Level Sender “A” Circuit Low	
Description	This DTC sets when the Fuel Level Gauge signal is electrically less than the minimum allowable sender value.
Possible Causes	• Fuel level sender wiring shorted to ground • Damaged Fuel Level Sender • Gateway Module (Gateway Module (GWM))
Symptom	P0462 — Fuel gauge may read empty all the time or P2067 — Fuel gauge will only show primary tank
Diagnostic Aid	Gateway Module (GWM) reads fuel level sender and broadcasts to the PCM and Instrument Cluster.
Action	Refer to the following tests located later in this manual. • Gateway Module (GWM) Electrical Check • Fuel Level Indication System Check

P0463 — Fuel Level Sender "A" Circuit High	
Description	This DTC sets when the Fuel Level Gauge signal is electrically less than the minimum allowable sender value.
Possible Causes	• Fuel level sender wiring is disconnected or shorted to above 5 volts • Damaged Fuel Level Sender • Gateway Module (GWM)
Symptom	P0463 — Fuel gauge may read full all the time P2068 — Fuel gauge will only show primary tank
Diagnostic Aid	Gateway Module (GWM) reads fuel level sender and broadcasts to the PCM and Instrument Cluster.
Action	Refer to the following tests located later in this manual. • Gateway Module (GWM) Electrical Check • Fuel Level Indication System Check

P0627 — Fuel Pump "A" Control Circuit Open	
Description	The Fuel Pump Control Module (FPCM) A diagnoses faults of fuel pump A. The FPCM A passes diagnostic information on the CAN bus to the PCM. If the PCM receives a FPCM A signal indicating a fuel pump problem, the fault is set.
Possible Causes	• Wiring fault between FPCM A and fuel pump A • Open circuit • FPCM A fault • CAN fault • Faulty fuel pump
Symptom	—
Diagnostic Aid	
Action	Refer to the Fuel Pump Control Module Electrical Continuity Test procedure in Diagnostic Tests and Procedures.

P064A — Fuel Pump Control Module "A"	
Description	The Fuel Pump Control Module (FRPCM) A has its own internal diagnostics. The FPCM A passes diagnostic information on the CAN bus to the PCM. If the PCM receives a FPCM A signal indicating an internal problem, the fault is set.
Possible Causes	• FPCM A fault • CAN fault
Symptom	—
Diagnostic Aid	
Action	Refer to the Fuel Pump Control Module Electrical Continuity Test procedure in Diagnostic Tests and Procedures.

P116E — Fuel Pressure Relief Valve Actuated	
Description	Maximum injection pressure reached. The PCM monitors fuel rail pressure and battery voltage. Based on these measurements, the PCM adjusts fuel pump speed to stay below the maximum operating pressure of the injectors.
Possible Causes	• Operating the vehicle in high ambient conditions • Vehicle operated in a low voltage condition
Symptom	Vehicle hesitation, stall, rough idle, misfire or no start.
Diagnostic Aid	The P116E code is meant as an indication that the fuel system was operated at the limits of the system. The customer may have experienced drive issues although the system is performing as expected.
Action	Refer to the Maximum Pressure Check procedure in Diagnostic Tests and Procedures.

P1453 — Fuel Tank Pressure Relief Valve Malfunction	
Description	The Gateway Module (GWM) reads the TPTS and passes the voltage reading over the CAN bus to the PCM. If the pressure value of the propane fuel tank approaches the Pressure Relief Valve "pop-off" pressure, a fault is set.
Possible Causes	• High ambient temperature operation • Propane tank fill is contaminated with nitrogen or other constituents • Vehicle is parked over heat source • Tank Pressure Temperature Sensor shorted or reading higher than expected values • Overfill prevention device allowed tank to overfill
Symptom	The driver is alerted with a coolant gauge High setting until the fault condition clears.
Diagnostic Aid	Use mechanical pressure gauge to check tank pressure and an inferred temp gun to check tank temperature. Can also cause a P1285 to set due to failsafe cooling being on, diagnose P1453 first.
Action	Check for other diagnostic fault codes such as Tank Pressure or Temperature P01A1 or P01AD and correct them first. Refer to the Maximum Pressure Check procedure in Diagnostic Tests and Procedures.

P1456 — Fuel Tank Temperature Sensor Circuit Malfunction	
Description	Propane tank sensor when it is inconsistent with the Intake Air Temperature (IAT11_ENG), Rail Temperature (RF_RAILTEMP), and Tank Temperature (RPR_PT_TEMP) rationality check after six hour cold soak.
Possible Causes	Wiring concerns Defective tank pressure temperature sensor
Symptom	Check engine light possible. Possible engine performance issues.
Diagnostic Aid	—
Action	Refer to the Tank Pressure Temperature Sensor Electrical Check procedure in the Diagnostic Tests and Procedures.

P2195, P2197 — Heated Exhaust Gas Oxygen Sensor Stuck	
Description	Refer to the Ford Powertrain Control/Emissions Diagnosis Service Manual for more descriptive information.
Possible Causes	• The LPA system was operated in the vapor region • Refer to the Ford Powertrain Control/Emissions Diagnosis Service Manual for a list of other causes.
Symptom	—
Diagnostic Aid	Verify that no LPA system faults are present and then follow the Ford Powertrain Control/Emissions Diagnosis Service Manual procedure.
Action	Refer to the Engine Stumble, Stall, Rough Idle AND Fuel Pressure Drop procedure in Diagnostic Tests and Procedures.

P25B0 — Fuel Level Sensor "A" Stuck	
Description	The Gateway Module (GWM) reads Fuel Level Sender (FLS) input and broadcasts it to the IPC and PCM. If the vehicle is driven a considerable distance and the FLS value doesn't change, the fault is set.
Possible Causes	• Wire fault between FLS and Gateway Module (GWM) • Defective fuel level sender or sender Twinsight • Gateway Module (GWM) fault
Symptom	The driver is unaware of a low fuel condition.
Diagnostic Aid	
Action	Refer to the Fuel Level Indication System Check procedure in Diagnostic Tests and Procedures.

P2632 — Fuel Pump "B" Control Circuit/Open	
Description	The Fuel Pump Control Module (FPCM) B diagnoses faults of fuel pump B. The FPCM passes the information to the Gateway Module (GWM) on a dedicated circuit. The Gateway Module (GWM) then sends the diagnostic information to the PCM over the CAN network.
Possible Causes	• Wiring fault between FPCM A and fuel pump A • Open circuit • FPCM A fault • CAN fault • Faulty fuel pump
Symptom	—
Diagnostic Aid	—
Action	Refer to the Fuel Pump Control Module Electrical Continuity Test procedure in Diagnostic Tests and Procedures.

P26B5 — Fuel Shutoff Valve "B" Control Circuit Performance/Stuck Off	
Description	The Gateway Module (GWM) monitors fuel rail pressure before and after the start sequence is initiated. If the fuel rail pressure rise is below a threshold, the fault is set.
Possible Causes	• Excess flow valve activated • Fuel pumps weak or inoperable • Manual shutoff valve not fully open • Tank Supply Solenoid not opening • FRPCM Supply Solenoid not opening • Restricted supply line filter • Kinked or restricted fuel lines • IPTS or TPTS signal inaccurate • Blown fuse
Symptom	The vehicle will crank no start or start and run poorly. Start sequence will be extended and fuel pumps and Supply Solenoids will be commanded on and off multiple times, attempting to build rail pressure.
Diagnostic Aid	Check Measuring Fuel Rail and Fuel Tank Pressure procedure.
Action	Refer to the Engine Cranks, No Start procedure in Diagnostic Tests and Procedures.

P2665 — Supply Solenoid Circuit Fault	
Description	FRPCM Supply Solenoid circuit fault. Gateway Module (GWM) monitors Supply Solenoid circuit for open and short circuit faults
Possible Causes	• Short to voltage • Water in the harness connector • Open power circuit • Open GND circuit • Low battery voltage • Corrosion • Incorrect connections • Damaged SS coil • Blown fuse
Symptom	Vehicle does not start. The pumps run but no pressure builds in the fuel rail.
Diagnostic Aid	Check the FRPCM and Gateway Module (GWM) electrical connectors for damage, corrosion and water intrusion.
Action	Refer to the Fuel Rail Pressure Control Module Electrical Check procedure in Diagnostic Tests and Procedures.

P26EA — Fuel Pump Control Module "B"	
Description	The Fuel Pump Control Module (FPCM) B diagnoses faults of fuel pump B. The FPCM passes the information to the Gateway Module (GWM) on a dedicated circuit. The Gateway Module (GWM) then sends the diagnostic information to the PCM over the CAN network.
Possible Causes	• FPCM B fault • CAN fault • Open fuel pump monitor 2 circuit (FPM2)
Symptom	—
Diagnostic Aid	—
Action	Refer to the Fuel Pump Control Module Electrical Continuity Test procedure in Diagnostic Tests and Procedures.

U0108 — Lost Communication with Alternative Fuel Control Module	
Description	Lost communication with Gateway Module (GWM). The PCM monitors CAN bus communication for missing messages from the Gateway Module (GWM). If the messages are continuously missing, a fault is set.
Possible Causes	• Wiring between the Gateway Module (GWM) and PCM • Gateway Module (GWM) lacks power • Blown fuse • Gateway Module (GWM) loses power or ground
Symptom	Rough idle.
Diagnostic Aid	Check the FRPCM and Gateway Module (GWM) electrical connectors for damage, corrosion and water intrusion. Check for power at the Gateway Module (GWM).
Action	Refer to the Gateway Module (GWM) Electrical Check procedure in Diagnostic Tests and Procedures.

U0109, U016C — Lost Communication with Fuel Pump Control Module A/B	
Description	The Gateway Module (GWM) repeats the signal from the second EFPR to the PCM over the CAN bus. The PCM monitors this communication. If there is a lack of communication for a long enough period of time, a fault is set.
Possible Causes	• Wire fault between the EFPR and Gateway Module (GWM) • Wire fault between Gateway Module (GWM) and PCM • No power to the EFPR • Gateway Module (GWM) fault • CAN bus fault • Faulty EFPR • Blown fuse • Refer to the Ford Powertrain Control/Emissions Diagnosis Service Manual for a list of other causes.
Symptom	Crank, no start, rough idle or lack of power.
Diagnostic Aid	—
Action	Refer to the Fuel Pump Control Module Electrical Continuity Test procedure and also the Gateway Module (GWM) Electrical Check procedure in Diagnostic Tests and Procedures.

DIAGNOSTICS AND PINPOINT TESTS

General Information

Under normal operating conditions, fuel pumps will operate at variable speeds. Fuel pump duty cycle will vary to maintain liquid in the fuel rails under different temperatures and operating conditions.

The fuel pressure controls are designed to keep the rails at a certain pressure over tank pressure, therefore, it is important to measure tank pressure prior to collecting fuel rail pressure data.
For example, if the fuel tank is at 150 psi (1034 kPa) and pressure in the rail is measured at 200 psi (1379 kPa), the rail is running at 50 psi (345 kPa) over tank.

Fuel rail pressure should maintain a minimum of 30 psi over tank under normal operating conditions, and will increase based on fuel system demand.

On a tank at ambient temperature conditions, the following pressures can be expected:

Temperature (°F)	Pressure (psi)		
	Min.	Nominal	Max.
0	15	25	35
5	19	29	39
10	23	33	43
15	28	38	48
20	33	43	53
25	38	48	58
30	43	53	63
35	49	59	69
40	55	65	75
45	62	72	82
50	69	79	89
55	77	87	97
60	84	94	104
65	93	103	113
70	102	112	122
75	111	121	131
80	121	131	141
85	131	141	151
90	142	152	162
95	153	163	173
100	165	175	185
105	178	188	198
110	191	201	211
115	205	215	225
120	219	229	239

Note: On vehicles that have been operated for extended periods of time, the tank (fuel) can be much warmer and so higher pressures are to be expected.

Measuring and Recording Fuel Tank Pressure, Fuel Rail Pressure, Fuel Rail Target Pressure, and Duty Cycle

Measuring Fuel Tank Pressure

Fuel tank pressure can be measured two ways:

Method 1:

1. Install a 0–500 psi (0–3447 kPa) fuel pressure gauge on the bleeder valve at the tank or to the remote bleeder valve location.
2. Open the valve to monitor the fuel tank pressure.
3. Record the value.
4. Close the valve.

Method 2:

1. Follow Steps 1-3 from "**Accessing Functions in RDT**" from Page 3.
2. After the vehicle information has been shown and verified, select the Signals/Datalogger tab.
3. Select the **Rpr_pt_prs** PID from the screen and click on Start.
4. Record the value.

Measuring Fuel Rail Pressure

Fuel rail pressure can be measured two ways:

Method 1:

1. Follow Steps 1-3 from "**Accessing Functions in RDT**" from Page 3.
2. After the vehicle information has been shown and verified, select the Signals/Datalogger tab.
3. Select the **rpr_fr_prs** PID from the screen and click on Start.
4. Record the value.

Method 2:

1. Refer to the Fuel Line Purging/Depressurization Procedure in the appropriate service manual and empty the fuel rails and fuel lines.
2. Disconnect the fuel supply line at the rear of the RH fuel rail.
3. Install the ROUSH service port adapter between the fuel line and the fuel rail.
4. Attach 0–500 psi (0–3447 kPa) fuel pressure gauge to the service port on the adapter.
5. Record the value.

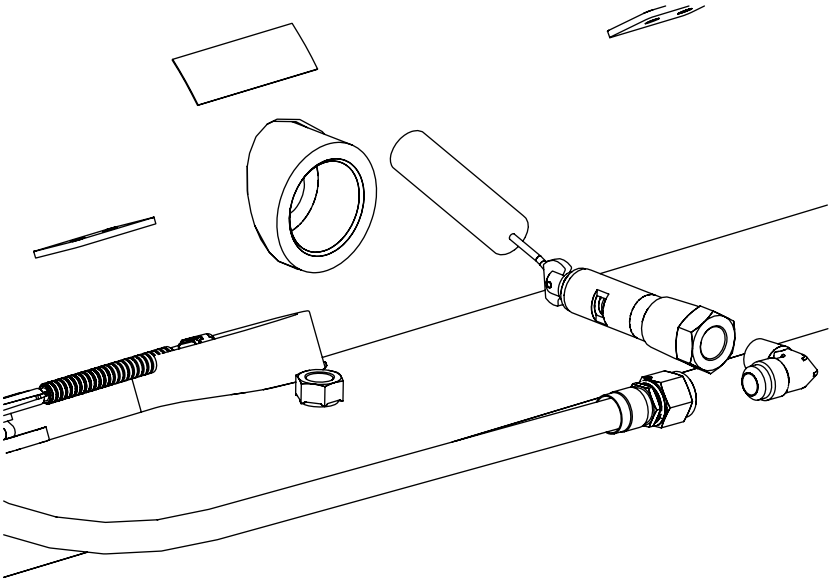
Measuring Fuel Rail Target Pressure

1. Follow Steps 1-3 from "**Accessing Functions in RDT**" from Page 3.
2. After the vehicle information has been shown and verified, select the Signals/Datalogger tab.
3. Select the **rpr_fr_prs_tgt** PID from the screen and click on Start.
4. Record the value.

Measuring Duty Cycle

1. Follow Steps 1-3 from "**Accessing Functions in RDT**" from Page 3.
2. After the vehicle information has been shown and verified, select the Signals/Datalogger tab.
3. Select the **rf_dc** PID from the screen and click on Start.
4. Record the value.

Pinpoint Test A: No Fill



Step	Procedure	Action
1	**Verify that the vehicle is not full of fuel.** a. Does the fuel cluster show less than 3/4? b. Does the Sending Unit/Twinsight show less than 3/4 tank?	**Yes** — Go to step 2. **No** — Re-attempt when fuel is less than 3/4.
2	**Check for sufficient fill station pressure.** a. Connect pressure gauge service tool to the vehicle fuel tank bleeder valve and record pressure. b. Locate output pressure gauge on stations. c. Connect and attempt to fill vehicle. d. Ensure turning on station pump before opening nozzle. If not, station EFV may be tripped. Is fill station pump pressure at least 25 psi (172 kPa) greater than tank pressure?	**Yes** — Go to Step 3. **No** — Go to Step 8.
3	**Check if fill valve O-ring is damaged or missing (threaded ACME fill valve only).** Is the O-ring damaged or missing?	**Yes** — Replace damaged or missing O-ring. **No** — Go to step 4.
4	**Open the remote bleeder valve. The remote bleeder valve is located on the tank, near the Pressure Relief Valve.** Is there a sustained liquid (opaque white mist) for more than ten (10) seconds? **Warning: When liquid propane is released from a pressurized vessel, it rapidly evaporates, creating a refrigeration effect that can cause frostbite. Wear non-porous, cold-safe gloves, eye protection, and ear protection during venting and repair operations. Keep moisture away from the valves. Failure to heed this warning can result in personal injury.**	**Yes** — Refer to Fuel Level Sender Electrical test. **No** — Go to step 5.
5	**Inspect vehicle to check for kinked or damaged fill lines** Are fill lines kinked installed incorrectly?	**Yes** — Replaced kinked fill lines. **No** — Go to Step 6.
6	**Inspect fill filter to ensure correct orientation** Is fill filter installed incorrectly?	**Yes** — Install fill filter with correct orientation. **No** — Go to step 7.
7	**Inspect OPD for correct orientation. Correct installation of the OPD will find the "Top" mark at the 12 o'clock position.** Is the OPD installed incorrectly?	**Yes** — Refer to OPD Installation Procedure and install new OPD. **No** — Call ROUSH CleanTech Customer Success at (800) 59-ROUSH (597-6874), Opt. 2.

8	**Check fuel station differential pressure (the pressure before and after the fuel station pump). The fuel station differential pressure should be below 125 psi.** Is the differential pressure greater than 125 psi?	**Yes** — Contact propane provider to adjust fuel station pump pressure. **No** — Go to step 9.
9	**Check fuel tank temperature and compare against the chart for tank temperature using an infrared temperature gun.** Does the temperature and pressure differ from the chart above?	**Yes** — Call ROUSH CleanTech Customer Success (800) 59-ROUSH (597-6874), Opt. 2. . **No** — Allow vehicle to cool and then retest. If still no, contact ROUSH CleanTech Customer Success (800) 59-ROUSH (597-6874), Opt. 2.

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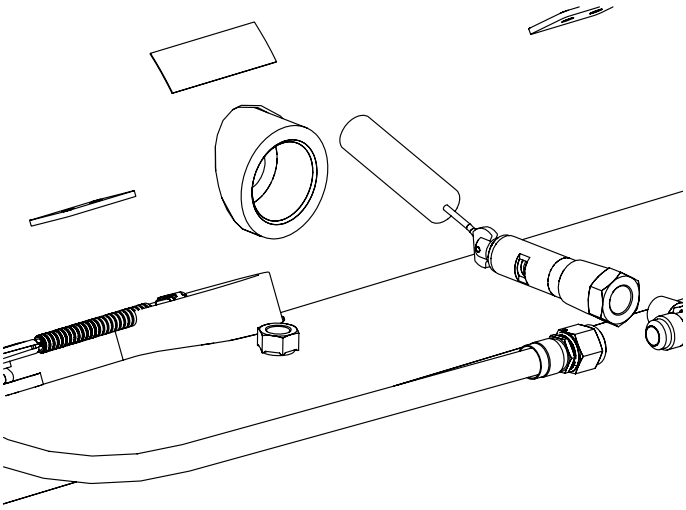
Pinpoint Test B: Slow Fill



Step	Procedure	Action
1	**Determine flow rate at which the vehicle fuel system fills.** a. Time the fill station pump for 10 seconds and record the number of gallons dispensed. b. Multiply the gallons dispensed by six to determine the flow rate in gallons per minute. c. Is the fill station pump flow rate at least 6 gal (23 L) per minute?	**Yes** — System fill rate is OK; diagnostic is complete. **No** — Fill station is not providing enough pressure to fill vehicle tank. Go to Step 2.
2	**Measure and compare vehicle fuel tank and fill station pressures.** a. Connect a pressure gauge service tool to the fuel tank bleeder valve and record fuel tank pressure. b. Locate output pressure gauge on stations. c. With the dispensing pump on and dispensing nozzle open, measure and record fill station pump pressure. d. Is fill station pump pressure at least 50 psi (345 kPa) greater than fuel tank pressure?	**Yes** — Go to next step. **No** — Fill station is not providing enough pressure to fill vehicle tank. Go to (path pressure not OK).
3	**Check fuel fill valve; it may not be opening completely.** a. Loosen the fuel fill line connection at the fill valve or at the inlet to the fuel filter to relieve any pressure in the fill line. b. Attempt to push open the piston in the fill valve to determine if it is opening completely. Piston should travel 1/4 inch. c. Is the fill valve piston opening completely?	**Yes** — Go to next step. **No** — Replace fill valve and retest. If persists, move to next step.
4	**Inspect vehicle to check for kinked fill lines.** Are fill lines kinked?	**Yes** — Replaced kinked fill lines. **No** — Go to next step.
5	**Replace the filter in the fuel fill line.** Does the vehicle fuel tank fill at greater than six gal (23 L) per minute?	**Yes** — Diagnostic is complete. **No** — Go to next step.
6	**Replace the overfill protection device (OPD) valve in the vehicle fuel tank.** **Note: Perform fuel tank purging procedure prior to testing. See Service Manual for vehicle for more information on the Fuel Tank Purging procedure.** Does the vehicle fuel tank fill at greater than six gal (23 L) per minute?	**Yes** — Diagnostic is complete. **No** — Call ROUSH CleanTech Customer Success at (800) 59-ROUSH (597-6874), Opt. 2.

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7	**Check fuel station differential pressure (the pressure before and after the fuel station pump). The fuel station differential pressure should be below 125 psi.** Is the differential pressure greater than 125 psi?	**Yes** — Contact propane provider to adjust fuel station pump pressure. **No** — Go to next step.
8	**Check fuel tank temperature and compare against the chart for tank temperature. Check fuel tank temperature using an infrared temperature gun.** Does the temperature and pressure differ from the chart on page 23?	**Yes** — Call ROUSH CleanTech Customer Success at (800) 59-ROUSH (597-6874), Opt. 2. **No** — Allow vehicle to cool and then retest. If still no, call ROUSH CleanTech Customer Success at (800) 59-ROUSH (597-6874), Opt. 2.

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Pinpoint Test C: OPD Test

Note: Test must be performed when the vehicle has less than 50% fuel level, as indicated on the cluster.

Step	Procedure
1	Locate the vehicle propane tank data plate and reference the tank volume, often listed as W.C. (water capacity).
	Calculate 5% of the W.C. This is the number of gallons the tank can be filled once liquid is visible at the Bleeder Valve.
2	Park the vehicle at a fill station or near a refueling truck on level ground. Place a level on the frame rail or tank to ensure it is level.
3	Connect the fill nozzle to the vehicle Fill Valve.
4	Open the vehicle Bleeder Valve. You should have clear vapor emitting from the valve.
5	Begin filling per the refueling station manufacturer's procedure.
6	Once liquid (seen as a white mist) is visible at the Bleeder Valve, note the number of gallons filled. Fueling should stop before the calculated 5% volume is reached. If additional 5% is reached, stop fueling as vehicle is over filling and contact ROUSH CleanTech Customer Success (800) 59-ROUSH (597-6874), Opt. 2.
7	Turn off the fuel pump and close the Bleeder Valve.
8	Disconnect the nozzle and replace the fill cap.

Note: If PRV is leaking or has been activated, replace PRV.

Example: A functioning OPD on a tank with a 100 gallon WC will stop before five (5) gallons (100 WC x .05 = 5) have been added after the mist is visible.

Note: OPD might stop before white mist is visible at the Bleeder Valve. This is normal as long as fuel gauge at the instrument cluster reads Full. The tank may have stopped filling before consistent liquid was visible at the bleeder valve. This indicates normal operation.

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Pinpoint Test D: Engine Does Not Crank

Note: If the bus is dropping out of Start in Progress, contact a Blue Bird Dealer or Service Center.

Step	Procedure	Action
1	**Perform a visual inspection to verify the following are working correctly or are in the correct position:** a. Verify that the vandal lock is not in the lock position. b. Verify that the bus is in nuetral. c. Verify that the fuel door is closed.	**Yes** — If everything is in working order, go to Step 2. **No** — Remedy these items and try to crank engine.
2	**Is the battery voltage above 12 volts?**	**Yes** — Refer to Blue Bird Multiplex Diagnostics or contact a local Blue Bird Dealer or Service Center. **No** — Determine the cause of the low battery situation.

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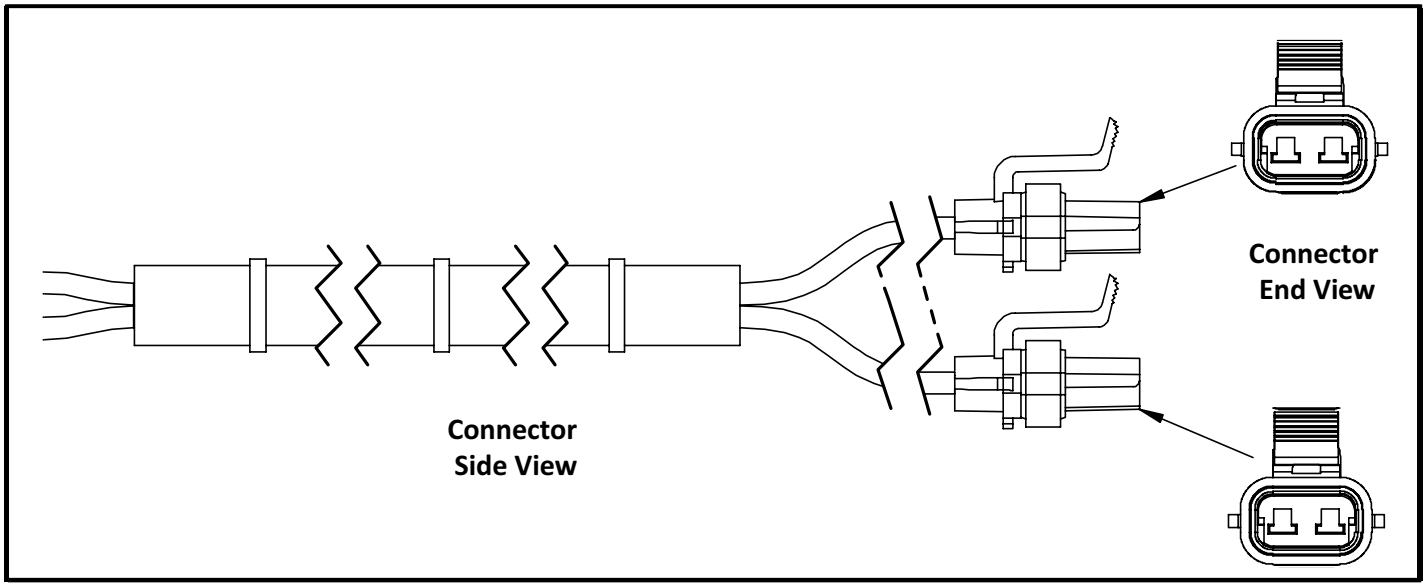
Pinpoint Test E: Engine Cranks, No Start

For harness and connector layout diagrams and system electrical schematics, refer to Wiring Diagrams and Electrical Schematics.

Note: If vehicle will restart when cold, but won't restart after stall when hot, go to Pinpoint Test F



Step	Procedure	Action
1	**Perform a visual inspection to verify the following are in working order:** a. Is there is at least 1/8 tank of fuel or more? (add fuel if necessary). b. Is the tank supply manual shutoff valve fully open? c. Is battery voltage above 12.5 volts? d. Are fuel lines free of kinks or damage? e. Inspect all fuses in both the Ford and ROUSH fuse boxes.	**Yes** — If everything is in working order, go to Step 2. **No** — Correct the fault and retry.
2	**Record any Diagnostic Trouble Codes (DTCs).** Are any codes present?	**Yes** — If ROUSH circuit faults are set, refer to the Diagnostic Trouble Code list earlier in this manual. If non-fuel system related faults are set, refer to Ford Powertrain Control/ Emissions Diagnostics Service Manual and correct those condition(s) and retest. If symptom persists, go to step 3. **No** — Go to Step 3.
3	**a. During start sequence, use the ROUSH Diagnostic Tool (RDT) to measure and record:** • **Fuel Tank Pressure (Rpr_pt_prs)** • **Fuel Rail Pressure (rpr_fr_prs)** • **Rail Target Pressure (rpr_fr_prs_tgt)** • **Fuel Pump Duty Cycle (rf_dc)** Refer to Measuring and Recording Duty Cycle, Fuel Rail Pressure, Fuel Rail Target Pressure, and Duty Cycle to read these values. **Note: If using a generic scan tool, you won't be able to collect Fuel Rail Target Pressure.** **If using Ford IDS, Fuel Pump Duty Cycle needs to be multipled by 2.**	**If Fuel Rail Pressure is equal or less than Tank Pressure** — Go to step 6. **If Fuel Rail Pressure is 0-55 psi over Tank Pressure** — Go to step 4. **If Fuel Rail pressure is 55psi over Tank Pressure or greater** — Refer to the Ford Powertrain Control/Emissions Diagnosis Service Manual.

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Pinpoint Test E: Engine Cranks, No Start (cont.)

3.	**b. Test rationality between Integrated Injection Pressure Temperature Sensor (IPTS) and Tank Pressure Temperature Sensor (TPTS).** If you have the ROUSH Diagnostic Tool (RDT) or Ford IDS, use the Manual Solenoid Activation Procedure, open tank supply solenoid and FRPCM supply solenoid. Using RDT, read Fuel Tank Pressure (**Rpr_pt_prs**) and Fuel Rail Pressure (**rpr_fr_prs**). Are pressures within 8psi of each other?	**Yes** — Go to Step 4. **No** — Go to Injection Pressure Temperature Sensor Electrical Check.
4	**a. Test Tank Supply Solenoid.** During Start Sequence or with tank supply solenoid manually activated, disconnect tank supply solenoid electrical connector and load test connectors with a Circuit Load Tester or Headlight Test Bulb across Pin-A and Pin-B, frame harness side. Does it pass a load test or light a headlight test bulb?	**Yes** — Go to Step 4b. **No** — Find and repair wiring fault.
	b. Perform Excess Flow Valve (EFV) Test Is Excess Flow Valve (EFV) functioning properly?	**Yes** — Go to Step 5. **No** — Replace the Supply Valve.
5	**Test FRPCM Supply Solenoid.** During Start Sequence or with FRPCM supply solenoid manually activated, disconnect FRPCM supply solenoid electrical connector, load test connectors with a Circuit Load Tester or Headlight Test Bulb across Pin-A and Pin-B, frame harness side. Does it pass a load test or light a headlight test bulb?	**Yes** — Go to Step 6. **No** — Find and repair wiring fault.
6	**Test Fuel Pump Connectors** a. During start sequence, measure and record voltage across Pin-A and Pin-B of both Fuel Pump Electrical Connectors, harness side. Note, this may set DTCs. Is voltage greater than 5V?	**Yes** — Move to the 6b. **No** — Go to the Fuel Pump Control Module Electrical Continuity Test.
	b. During start sequence, load test same connectors with a Circuit Load Tester or Headlight Test Bulb (or similiar). Does it pass a load test or light a headlight test bulb (or similiar)?	**Yes** — Move to the 6c. **No** — Go to the Fuel Pump Control Module Electrical Continuity Test.
	c. With engine off, measure and record resistance across Pin-A and Pin-B of both Fuel Pump Connectors, tank pass-through side. Is the resistance value OL or greater than 5ohms?	**Yes** — Replace Fuel Pump Assembly and retest. **No** — Refer to Ford Powertrain Control/Emissions Diagnostics Service Manual.
	d. Please record if possible: During starting sequence, Measure and record amp draw on the fuel pump connectors. Amp draw should be between 2 and 10amps at idle. Amperage should be similar between the two pumps.	

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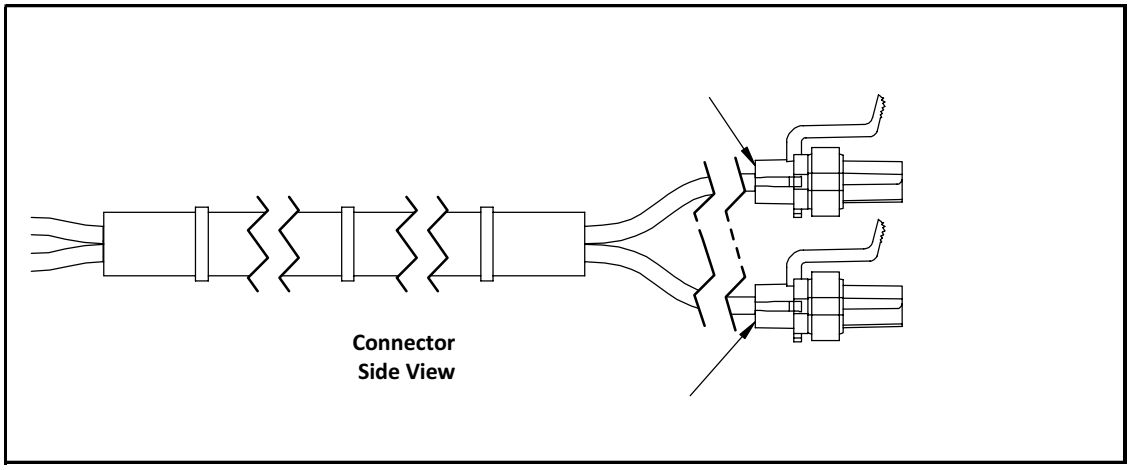
Pinpoint Test F: Engine Stumble, Stall, Rough Idle AND Fuel Pressure Drop

For harness and connector layout diagrams and system electrical schematics, refer to Wiring Diagrams and Electrical Schematics.



Step	Procedure	Action
1	**Perform a visual inspection to verify the following are in working order:** a. Is there is at least 1/8 tank of fuel or more? (add fuel if necessary). b. Is the tank supply manual shutoff valve fully open? c. Is battery voltage above 12.5 volts? d. Are fuel lines free of kinks or damage? e. Inspect all fuses in both the Ford and ROUSH fuse boxes. f. If vehicle has more than 50,000 miles, has Supply Line Filter been replaced within the last 50,000 miles? If not, change Supply Line Filter and retest.	**Yes** — If everything is in working order, go to Step 2. **No** — Correct the fault and retry.
2	**Record any Diagnostic Trouble Codes (DTCs).** Are any codes present?	**Yes** — If ROUSH circuit faults are set, refer to the Diagnostic Trouble Code list earlier in this manual. If non-fuel system related faults are set, refer to Ford Powertrain Control/ Emissions Diagnostics Service Manual and correct those condition(s) and retest. If symptom persists, go to step 3. **No** — Go to Step 3.
3	**Start vehicle. Let vehicle idle for at least one (1) minute.**	
4	**During start sequence, use the ROUSH Diagnostic Tool (RDT) to measure and record:** • **Fuel Tank Pressure (Rpr_pt_prs)** • **Fuel Rail Pressure (rpr_fr_prs)** • **Rail Target Pressure (rpr_fr_prs_tgt)** • **Fuel Pump Duty Cycle (rf_dc)** Refer to Measuring and Recording Duty Cycle, Fuel Rail Pressure, Fuel Rail Target Pressure, and Duty Cycle to read these values. **Note: If using a generic scan tool, you won't be able to collect Fuel Rail Target Pressure.** **If using Ford IDS, Fuel Pump Duty Cycle needs to be multipled by 2.**	**If Fuel Rail Pressure is equal or less than Tank Pressure** — Go to step 9. **If Fuel Rail Pressure is 1-55 psi over Tank Pressure** — Go to step 5. **If Fuel Rail pressure is 55psi over Tank Pressure or greater** — go to step 11.

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Pinpoint Test F: Engine Stumble, Stall, Rough Idle AND Fuel Pressure Drop

5	**Test Fuel Pump Connectors** a. With engine running, measure and record voltage across Pin-A and Pin-B of both Fuel Pump Electrical Connectors, harness side. Note, this may set DTCs. Is voltage greater than 5V?	**Yes** — Move to the next step. **No** — Go to the Fuel Pump Control Module Electrical Continuity Test.
	b. With engine running, load test same connectors with a Circuit Load Tester or 1156 Headlight Test Bulb (or similiar). Does it pass a load test or light a 1156 headlight test bulb (or similiar)?	**Yes** — Move to the next step. **No** — Go to the Fuel Pump Control Module Electrical Continuity Test.
	c. With engine running, measure and record amp draw on the fuel pump connectors. Amp draw should be between 2 and 10amps at idle. Amperage should be similar between the two pumps. Is amp draw within specification?	**Yes** — Move to the next step. **No** — Replace Fuel Pump Assembly.
	d. Turn off engine. Measure and record resistance across Pin-A and Pin-B of both Fuel Pump Connectors, tank pass-through side. Is the resistance value OL or greater than 5ohms?	**Yes** — Replace Fuel Pump Assembly and retest. **No** — Move to the next step. If you do not have Roush Diagnostic Tool (RDT), go to step 5.
6	**Test rationality between Integrated Injection Pressure Temperature Sensor (IPTS) and Tank Pressure Temperature Sensor (TPTS).** If you have the ROUSH Diagnostic Tool (RDT) or Ford IDS, use the Manual Solenoid Activation Procedure, open tank supply solenoid and FRPCM supply solenoid. Using RDT, read Fuel Tank Pressure (**Rpr_pt_prs**) and Fuel Rail Pressure (**rpr_fr_prs**). Are pressures within 8psi of each other?	**Yes** — Go to next step **No** —Go to Injection Pressure Temperature Sensor Electrical Check.
7	**Test Tank Supply Solenoid.** During Start Sequence or with tank supply solenoid manually activated, disconnect tank supply solenoid electrical connector and load test connectors with a Circuit Load Tester or 1156 Headlight Test Bulb across Pin-A and Pin-B, frame harness side. Does it pass a load test or light a 1156 headlight test bulb?	**Yes** — Go to next step. **No** — Find and repair wiring fault
8	**Test FRPCM Supply Solenoid.** During Start Sequence or with FRPCM supply solenoid manually activated, disconnect FRPCM supply solenoid electrical connector, load test connectors with a Circuit Load Tester or 1156 Headlight Test Bulb across Pin-A and Pin-B, frame harness side. Does it pass a load test or light a 1156 headlight test bulb?	**Yes** — Go to next step. **No** — Find and repair wiring fault
9	**Test Fuel Pump Duty Cycle** At idle is fuel pump duty cycle at 100% (1.0) **AND** fuel rail pressure less than 55psi over tank pressure?	**Yes** — Replace Fuel Pump Assembly. **No** — Move to the next step.
10	**Perform** Excess Flow Valve (EFV) Test Is Excess Flow Valve (EFV) functioning properly?	**Yes** — Refer to Ford Powertrain Control/Emissions Diagnostics Service Manual, correct those condition(s), and retest. **No** — Replace Supply Valve.
11	**Return Line Restriction Test** Are P0148 or P116E codes set AND Fuel Rail Pressure is greater than 80psi over tank AND problem occurs after heavy duty cycle operation?	**Yes —** Replace Return Valve Assembly. **No** — Refer to Ford Powertrain Control/Emissions Diagnostics Service Manual. Back to DTC List

Pinpoint Test G: Excess Flow Valve Check

The Excess Flow Valve (EFV) is designed to restrict fuel exiting the tank if the pump is energized while the fuel lines are not connected to the fuel tank. Under normal circumstances, the EFV should not trip. The EFV will reset itself after the fuel pumps have been off for about one minute.

It is common to trip the EFV after the fuel lines have been serviced and contain no pressure. If the EFV trips, turn the vehicle off, wait one minute, and restart. This may take more than one attempt. If the fuel lines have not been serviced recently and the problem persists, there may be a leak in the supply side fuel line. If the problem is only present after the vehicle has been sitting for a length of time, but not present during a short soak, or there is a propane odor when the vehicle is running, refer to the Fuel Line Leak Detection procedure in the service manual for the vehicle in question.

To manually reset the EFV, with the vehicle off, close the manual shutoff valve and wait one minute. Then key the vehicle to start and slowly open the manual shutoff valve. When the EFV resets there will be an audible click.

Step	Procedure	Action
1	**Inspect EFV for checking.** If both fuel pumps are operating properly and fuel rails have a 0psi increase over tank, the EFV may be checking. When the EFV resets there will be an audible click. **Note: Vehicle may cycle pumps multiple times during start up flush sequence.** Is EFV continuously checking during normal operation?	**Yes** — Replace the Supply Valve. **No** — No action needed.

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Pinpoint Test H: Maximum Pressure Check

The LPA system operates over a wide range of pressures depending on ambient temperature, driving mode, etc. When the vehicle is subjected to a severe drive cycle in high ambient temperatures, the fuel rail pressure can rise to the limit of the injectors capabilities. This limit is a function of injector voltage and fuel rail pressure. The PCM protects for this condition by reducing the fuel pump speed when the condition is sensed, however, there still may be drive concerns. When the PCM starts reducing fuel pump duty cycle, a P116E code is set. While this condition can occur in a normally functioning vehicle, it can also be exacerbated by several factors. If the fuel tank was not properly bled during the first fill, trapped air in the vapor space can increase tank pressure. In this condition there is often only a faint smell of propane when the Bleeder Valve is opened. The tank should be vented until there is a strong propane odor coming from the Bleeder Valve. The tank pressure should be confirmed against the expected pressure.

Allow the fuel tank to cool to ambient temperature before performing the following procedure.

Step	Procedure	Action
1	**Measure tank pressure and tank surface temperature.** Is tank pressure more than 15 psi (103 kPa) over expected tank pressure? Refer to pressure temp chart below.	**Yes** — Vent the tank until pressure is within the expected range. **No** — Vehicle is working properly; inform and explain operating characteristics to customer.

Temperature (°F)	Pressure (psi)		
	Min.	Nominal	Max.
0	15	25	35
5	19	29	39
10	23	33	43
15	28	38	48
20	33	43	53
25	38	48	58
30	43	53	63
35	49	59	69
40	55	65	75
45	62	72	82
50	69	79	89
55	77	87	97
60	84	94	104
65	93	103	113
70	102	112	122
75	111	121	131
80	121	131	141
85	131	141	151
90	142	152	162
95	153	163	173
100	165	175	185
105	178	188	198
110	191	201	211
115	205	215	225
120	219	229	239

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Pinpoint Test I: Fuel System Fails to Bleed

Step	Procedure	Action
1	**Check for diagnostic trouble codes (DTC).** a. Are both DTC 26B3 and P009E present?	**Yes** — Go to Step 8. **No** — Go to Step 2.
2	**Check for oil contamination at vapor port/EVAP line.** a. Disconnect EVAP line from vapor port. b. Is oil present in EVAP line or vapor port?	**Yes** — Replace vapor port and perform Step 3. **No** — Go to Step 3.
3	**Determine if fault condition repeats.** a. START the engine and allow it to run for a few minutes. b. Turn OFF the engine and wait one minute. c. Measure and record the fuel rail pressure, fuel rail temperature and fuel tank pressure with the Key ON Engine OFF (KOEO). d. Energize the Bleed Solenoid. Refer to the Manual Solenoid Activation Procedure. Verify wiring integrity and voltage to solenoid. e. With the engine OFF, monitor fuel rail pressure for 15 minutes. f. Does fuel rail pressure drop more than 20 psi (138 kPa)?	**Yes** — Potential intermittent fault. Return vehicle to customer and see if problem persists. **No** — Go to Step 4.
4	**Verify vapor port function.** a. Disconnect the EVAP line from the FRPCM port. b. Energize the Bleed Solenoid. Refer to the Manual Solenoid Activation Procedure. Verify wiring integrity and voltage to solenoid. c. Is there propane flowing from the port?	**Yes** — Go to Step 7. **No** — Go to Step 5.
5	**Verify Bleed Solenoid function.** a. Remove the vapor port. b. Energize the Bleed Solenoid. Refer to the Manual Solenoid Activation Procedure. Verify wiring integrity and voltage to solenoid. c. Is there propane flowing from the port?	**Yes** — Replace vapor port and repeat Step 3. **No** — Go to Step 6.
6	**Verify that wiring is in good condition and functioning.** a. Perform wiring checks of the FRPCM harness. b. Is the wiring OK?	**Yes** — Bleed solenoid stuck closed. Replace the FRPCM. **No** — Repair wiring and repeat Step 3.
7	**Check for a kinked EVAP line.** a. Inspect the EVAP line between the FRPCM and EVAP canister. b. Are there kinks in the line?	**Yes** — Replace the kinked EVAP line and then repeat Step 3. **No** — Go to Step 8.
8	**Check for leaks to the FRPCM.** a. START the engine and allow it to run for a few minutes. b. Turn OFF the engine. c. Measure and record fuel rail pressure. d. Activate Bleed Solenoid to bleed pressure from fuel rail until fuel pressure drops more than 50 psi (345 kPa). Refer to the Manual Solenoid Activation Procedure. e. De-energize Bleed Solenoid. f. Disconnect the FRPCM and wait 120 minutes. g. Measure fuel rail pressure and fuel tank pressure. h. Does fuel rail pressure rise more than 10 psi (69 kPa)?	**Yes** — FRPCM is leaking at either Supply Solenoid or return check valve. Replace FRPCM. **No** — Potential intermittent fault. Return vehicle to customer and see if problem persists.

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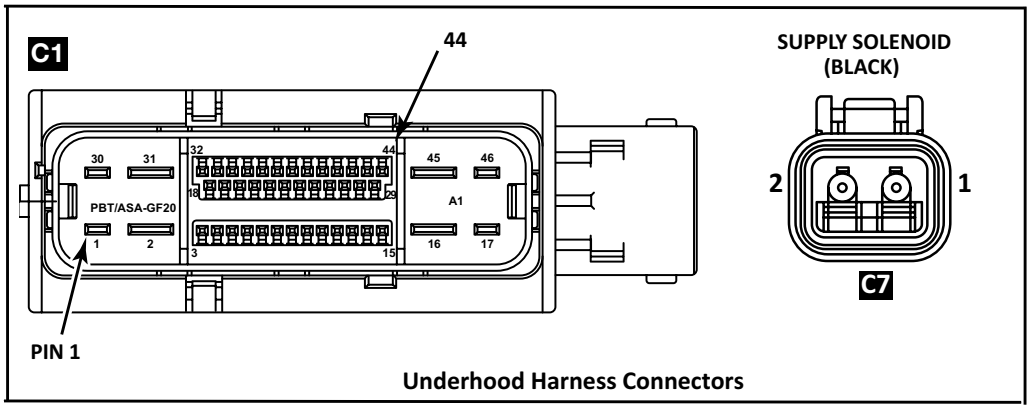
Pinpoint Test J: Tank Solenoid Electrical Check

For harness and connector layout diagrams and system electrical schematics, refer to Wiring Diagrams and Electrical Schematics.



Underhood Harness Connectors

Step	Procedure	Action
1	**Unplug the solenoid harness connector C7 from the tank solenoid. Using a multimeter, measure resistance of the solenoid.** Is the measured resistance within 6-11 ohms?	**Yes** — Go to Step 3. **No** — Replace the tank solenoid.
2	**Using a multimeter, measure voltage at the tank solenoid as follows:** a. With the ignition key ON, check for voltage present at pin-1, connector C7 (tank harness). Use the body as the reference ground. b. Is battery (B+) voltage present?	**Yes** — Supply circuit OK. Proceed to Step 5. **No** — Go to Step 4.
3	**Check fuse (E20, 10A) in auxiliary fuse box.** Is fuse blown?	**Yes** — Replace fuse and locate the short. **No** — Fuse OK; go to Step 5.
4	**Check supply circuit continuity from solenoid harness to fuse box. Refer to the Blue Bird Service Manual for wiring diagrams and schematics.** b. Is there good continuity in the circuit?	**Yes** — Go to Step 5. **No** — Repair supply circuit wiring.
5	**Check ground circuit continuity from tank harness to Gateway Module (GWM) connector. Check supply circuit continuity from solenoid harness to fuse box. Refer to the Blue Bird Service Manual for wiring diagrams and schematics.** b. Is there good continuity in the circuit?	**Yes** — Refer to the Gateway Module (GWM) Electrical Check procedure. **No** — Repair ground circuit wiring.

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Pinpoint Test K: Return Valve Procedure

For harness and connector layout diagrams and system electrical schematics, refer to Wiring Diagrams and Electrical Schematics.

Step	Procedure	Action
1	**Unplug the solenoid harness connector C4 from the return solenoid. Using a multimeter, measure the resistance of the solenoid.** Is the measured resistance within 6-11 ohms?	**Yes** — Go to Step 3. **No** — Replace the return solenoid.
2	**Using a multimeter, measure the voltage at the tank solenoid as follows:** a. With the ignition key ON, check for voltage present at pin-1, connector C4 (tank harness). Use the body as the reference ground. b. Is battery (B+) voltage present?	**Yes** — Supply circuit OK. Proceed to step 5. **No** — Go to step 4.
3	**Check fuse (F1-F2, 10A) in auxiliary fuse box.** Is fuse blown?	**Yes** — Replace the fuse. **No** — Fuse OK. Go to Step 5.
4	**Check supply circuit continuity from the solenoid harness to the fuse box.** a. Check continuity between: • Pin 1, connector C4 and Pin 12, connector C1 (tank harness). • Pin 12, connector C6 and Pin 12, connector C1 (rear frame harness). • Pin 12, connector C2 and Cavity F2, fuse box (underhood harness). b. Is there good continuity in the circuit?	**Yes** — Go to Step 5. **No** — Repair supply circuit wiring.
5	**Check ground circuit continuity from the tank harness to the Gateway Module (GWM) connector.** a. Check continuity between: • Pin 2, connector C4 and Pin 11, connector C1 (tank harness). • Pin 11, connector C6 and Pin 11, connector C1 (rear frame harness). • Pin 11, connector C2 and Pin 30, connector C1 (underhood harness). b. Is there good continuity in the circuit?	**Yes** — Refer to the Gateway Module (GWM) Electrical Check procedure. **No** — Repair ground circuit wiring.

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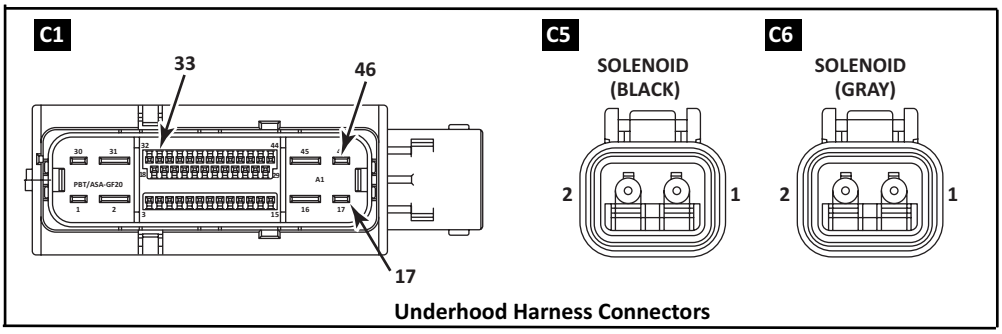
Pinpoint Test L: Fuel Rail Pressure Control Module Electrical Check

For harness and connector layout diagrams and system electrical schematics, refer to Wiring Diagrams and Electrical Schematics.



Underhood Harness Connectors

For the Supply Solenoid

Step	Procedure	Action
1	**Unplug the Supply Solenoid connector, C5. Using a multimeter, check the resistance of the solenoid.** Is the measured resistance within 6-11 ohms?	**Yes** — Go to Step 2. **No** — Replace Supply Solenoid.
2	**Using a multimeter, measure the voltage at the FRPCM Supply Solenoid as follows:** a. With the ignition key ON, check for voltage present at pin-1, connector C5 to fuse 2.	**Yes** — Supply circuit OK. Go to next step. **No** — Go to next step.
3	**Check ground circuit continuity from the underhood harness to the Gateway Module (GWM) connector.** a. Check continuity between: • Pin 2, connector C5 and Pin 32, connector C1.	**Yes** — Refer to the Gateway Module (GWM) Electrical Check procedure. **No** — Repair ground circuit wiring.

For the Bleed Solenoid

Step	Procedure	Action
1	**Unplug the Bleed Solenoid connector, C6. Using a multimeter, check the resistance of the solenoid.** Is the measured resistance within 6-11 ohms?	**Yes —** Go to next step. **No** — Replace Bleed Solenoid
2	**Using a multimeter, measure the voltage at the FRPCM Bleed Solenoid as follows:** a. With the ignition key ON, check for voltage present at pin-1, connector C6 to fuse 2.	**Yes** — Supply circuit OK. Go to next step. **No** — Go to next step.
3	**Check ground circuit continuity from the underhood harness to the Gateway Module (GWM) connector.** a. Check continuity between: • Pin2, connector C6 and Pin 33, connector C1	**Yes** — Refer to the Gateway Module (GWM) Electrical Check procedure. **No** — Repair ground circuit wiring.

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Pinpoint Test M: Injection Pressure Temperature Sensor Electrical Check

For harness and connector layout diagrams and system electrical schematics, refer to Wiring Diagrams and Electrical Schematics.

Step	Procedure	Action
1	**Unplug the connector C3 (underhood harness) to the IPTS. Check resistance of the injection pressure temperature sensor (IPTS).** a. With vehicle at ambient room temperature (20–30°C, 68–86°F) and using a multimeter, measure resistance across the IPTS terminals (between pin-1 and pin-3). b. Is the resistance value between 8K–12K ohms?	**Yes** — Go to Step 2 **No** — Replace the IPTS.
2	**Check circuit continuity between the IPTS and the Gateway Module (GWM).** a. Using a multimeter, check continuity in the underhood harness between: • Pin-1, connector C3 and pin-40, connector C1 • Pin-2, connector C3 and pin-20, connector C1 • Pin-3, connector C3 and pin-18, connector C1 • Pin-4, connector C3 and pin-25, connector C1 b. Is there good continuity in the circuits?	**Yes** — Refer to the Gateway Module (GWM) Electrical Check procedure. **No** — Repair circuit wiring.

Vout	PSIA
0.5	-0.0
0.6	12.7
0.7	25.5
0.8	38.2
0.9	51.0
1	63.7
1.1	76.5
1.2	89.2
1.3	102.0
1.4	114.7
1.5	127.5
1.6	140.2
1.7	153.0
1.8	165.7
1.9	178.5
2	191.2
2.1	204.0
2.2	216.7
2.3	229.5
2.4	242.2

Rmin	Rmax	degC	degF
301,183	331,179	-40	-40
162,304	175,994	-30	-22
90,938	97,349	-20	-4
52,781	55,836	-10	14
31,290	32,738	0	32
19,346	20,036	10	50
12,315	12,633	20	68
9,900	10,100	25	77
7,977	8,182	30	86
5,282	5,462	40	104
3,585	3,737	50	122
2,474	2,598	60	140
1,744	1,844	70	158
1,250	1,330	80	176
909.6	974.0	90	194
671.3	723.1	100	212
504.0	545.9	110	230
382.6	416.6	120	248
294.6	322.3	130	266
258.6	283.9	135	275

Vout	PSIA
2.5	255.0
2.6	267.7
2.7	280.5
2.8	293.2
2.9	306.0
3	318.7
3.1	331.5
3.2	344.2
3.3	357.0
3.4	369.7

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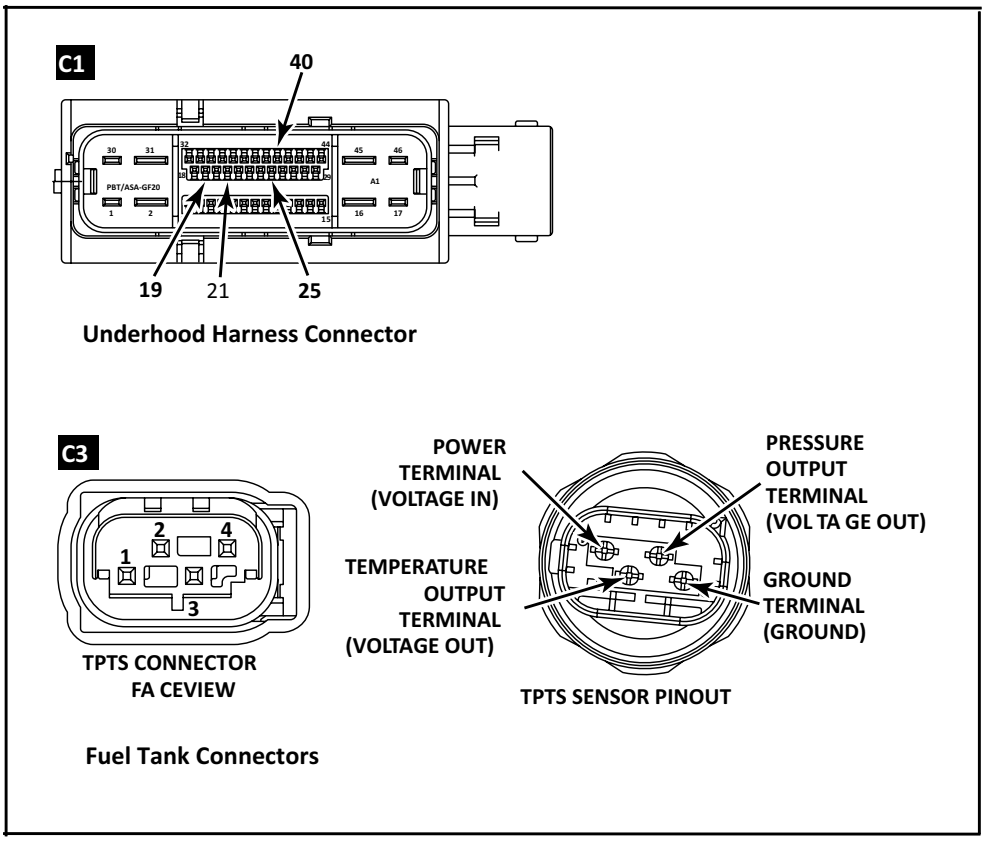
Pinpoint Test N: Tank Pressure Temperature Sensor Electrical Check

For harness and connector layout diagrams and system electrical schematics, refer to Wiring Diagrams and Electrical Schematics.



Step	Procedure	Action
1	**Unplug connector C3 (fuel tank harness) to the TPTS. Check resistance of the fuel pressure temperature sensor (TPTS).** a. With vehicle at ambient room temperature (20–30°C, 68–86°F) and using a multimeter, measure resistance across the FPTS terminals (between pin-1 and pin-3). b. Is the resistance value between 8K–12K ohms?	**Yes** — Go to Step 2. **No** — Replace the TPTS.
2	**Check circuit continuity between the TPTS and the Gateway Module (GWM).** a. Using a multimeter, check continuity in the underhood harness between: • Pin-1, connector C3 and pin-40, connector C1 • Pin-2, connector C3 and pin-21, connector C1 • Pin-3, connector C3 and pin-19, connector C1 • Pin-4, connector C3 and pin-25, connector C1 b. Is there good continuity in the circuits?	**Yes** — Refer to the Gateway Module (GWM) Electrical Check procedure. **No** — Repair circuit wiring.

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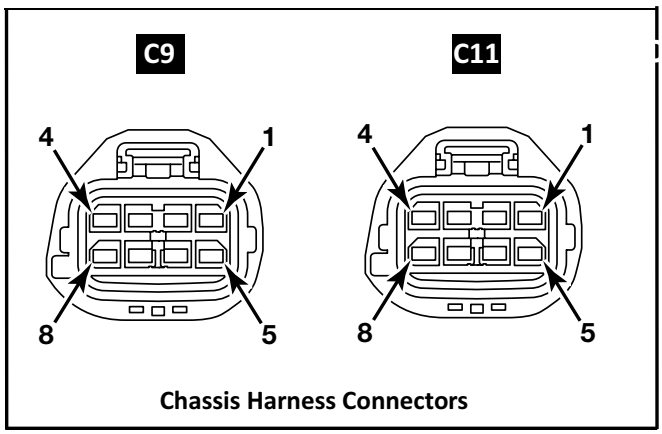
Pinpoint Test O: Fuel Pump Control Module Electrical Continuity Test

For harness and connector layout diagrams and system electrical schematics, refer to Wiring Diagrams and Electrical Schematics.



Chassis Harness Connectors

Step	Procedure	Action
For FPCM functional testing and diagnostic trouble codes, refer to the Ford Powertrain Control/Emissions Diagnosis Service Manual at www.motorcraft.com.		
1	**Check FPCM circuit continuity to Blue Bird fuse box. Refer to the Blue Bird Service Manual for circuit information.** a. Using a multimeter, check VPWR (V+) circuit to fuse box. b. Is there good continuity in the circuit?	**Yes** — Go to Step 2. **No** — Repair circuit wiring.
2	**Check fuse for FPCM at Blue Bird fuse box. Refer to the Blue Bird Service Manual for fuse box and circuit information.** a. Check the fuse at the fuse box. b. Is the fuse blown?	**Yes** — Go to Step 3. **No** — Repair circuit wiring.
3	**Check for continuity in the circuits.** a. Check for continuity in the circuits. b. Is there good continuity in the circuits?	**Yes** — Refer to the Ford Powertrain Control/Emissions Diagnosis Service Manual for functional testing of the FPCM. **No** — Repair circuit wiring.

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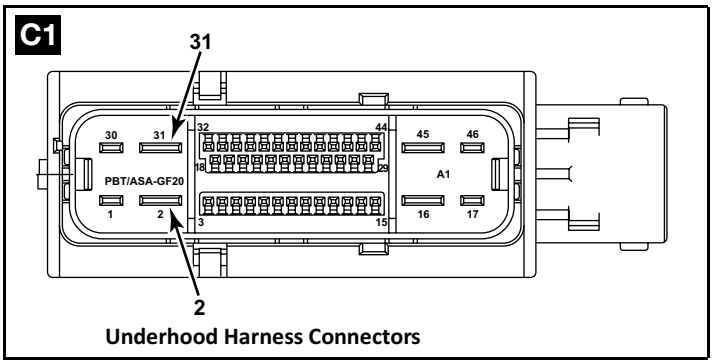
Pinpoint Test P: Gateway Module (GWM) Electrical Test

For harness and connector layout diagrams and system electrical schematics, refer to Wiring Diagrams and Electrical Schematics.



Underhood Harness Connectors

Step	Procedure	Action
1	**Disconnect the Gateway Module (GWM) connector C1. Refer to the Blue Bird Service Manual for circuit information.**	
2	**Check for battery voltage (B+) to the Gateway Module (GWM).** a. a. Using a multimeter, check for B+ voltage at cavity 2 of the SRM connector. Use the body as a reference ground. b. Is there voltage (B+)?	**Yes** — Go to Step 5. **No** — Go to Step 3.
3	**Check for continuity in the circuits.** a. Check circuit continuity between cavity 2 of the Gateway Module connector and the Blue Bird fuse box. Refer to the Blue Bird Service Manual for fuse box and circuit information. b. Is there good continuity in the circuit?	**Yes** — Go to Step 4. **No** — Repair circuit wiring.
4	**Check Gateway Module fuse at fuse box.** a. Check condition of Gateway Module power fuse in the Blue Bird fuse box. Refer to the Blue Bird Service Manual for circuit information. b. Is fuse blown?	**Yes** — Replace fuse. **No** — Go to Step 5.
5	**Check the Gateway Module ground circuit for continuity.** a. Using a multimeter, check ground at cavity 31 of the Gateway Module connector. Use the body as a reference ground b. Is there good continuity?	**Yes** — Go to Step 6. **No** — Repair circuit wiring.
6	**Check CAN wiring for Gateway Module circuit continuity. Refer to the Blue Bird Service Manual for circuit information.** a. Check Gateway Module for continuity. b. Is there good continuity in the circuits?	**Yes** — Call ROUSH CleanTech Customer Success at (800) 59-ROUSH (597-6874), Opt. 2. **No** — Repair circuit wiring.

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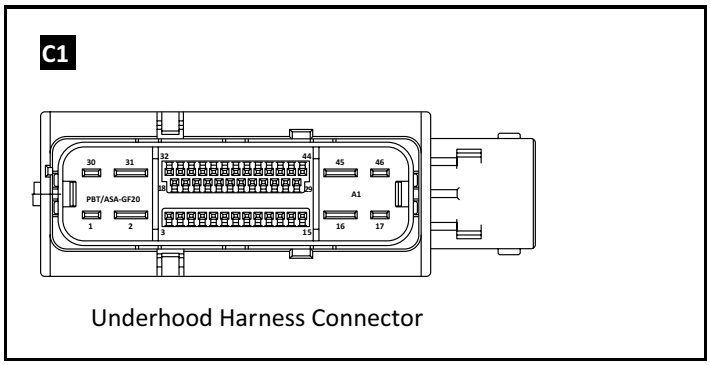
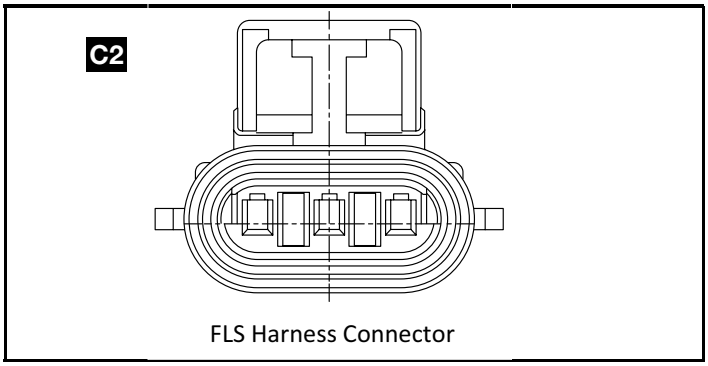
Pinpoint Test Q: Fuel Level Sender Electrical Check

For harness and connector layout diagrams and system electrical schematics, refer to Wiring Diagrams and Electrical Schematics.



Underhood Harness Connector



FLS Harness Connector

Note: The fuel level indication system is calibrated to the voltage output from the fuel level sender. The needle position on the sending unit Twinsight is a raw reading of the sender arm position and is not an accurate representation of the fuel level in the tank. The fuel level gauge on the cluster should display the correct fuel level. All continuity (OHMS) readings should be less than 0.5 OHMS.

Step	Procedure	Action
1.	**Perform a visual inspection to verify the following are in working order:** a. Inspect all fuses in both the Ford and ROUSH fuse boxes. b. Perform wiring checks of the Underhood harness and FLS connector. c. Verify that the twinsight is installed correctly and properly seated.	**Yes** — If everything is in working order, go to Step 2. **No** — Repair any issues and move go to Step 2.
2	**Check for DTCs** If any Gateway Module, IPTS, TPTS DTCs present go to Pin Point test and resolve those faults prior to diagnosing the Fuel Level Sender fault	**Yes** — Go to Gateway Module (GWM) Electrical Check or the Tank Pressure Temperature Sensor Electrical Test. **No** — Go to Step 2.
3	**Perform Wiggle test on FLS harness connector while monitoring Fuel Level Indicator parameter in RDT for a change in value. (ADD PID)** Does the fuel level value change erratically?	**Yes** — Repair connector or wiring and retest. **No** — Go to Step 3.
4	**Check reference on Fuel Level Sender** Turn key to on position. Check for 5-volt reference present across pin-A and pin-C harness side of the FLS connector. Is 5v power present?	**Yes** — Go to Step 4. **No** — Go to Step 3.
5	**Check 5v vref circuit and ground circuit of Fuel Level Sender for continuity.** a. Check for continuity from FLS pin-A frame side harness to pin-25 of Gateway Module (GWM) connector: Continuity present - **Yes**, go to Step 3b. b. Check for continuity from FLS pin-C frame harness at FLS and pin-40 of Gateway Module (GWM) connector. c. Is there good continuity in each circuit?	**Yes** — Go to Step 5. **No** — Locate and repair open circuit or replace harness.
6	**Perform output voltage check.** a. With harness fully connected and KOEO, place the universal probes into pin-B and pin-C of sending unit connector and monitor for voltage. b. Is voltage present?	**Yes** — Go to Step 6. **No** — Replace electronic portion of sending unit.

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7	**Perform sending unit range voltage test.** a. Remove sending dial dial. **Do not remove the four hex screws.** Using a non-magnetic socket or other steel/iron object, move sender from full to empty. Make sure the voltage smoothly changes between 0.1 volts min. to 4.98 volts max. b. Was there any concern with voltage range output test?	**Yes** — Replace electronic portion of sending unit clear faults and test. **No** — Refer to the Tank Draining and Sending Unit Replacement procedures within the appropriate Service Manual to replace the in-tank sending unit.

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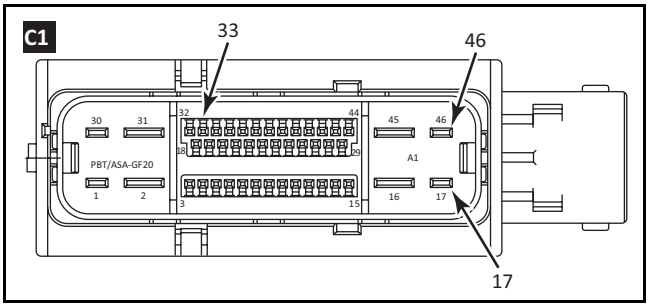
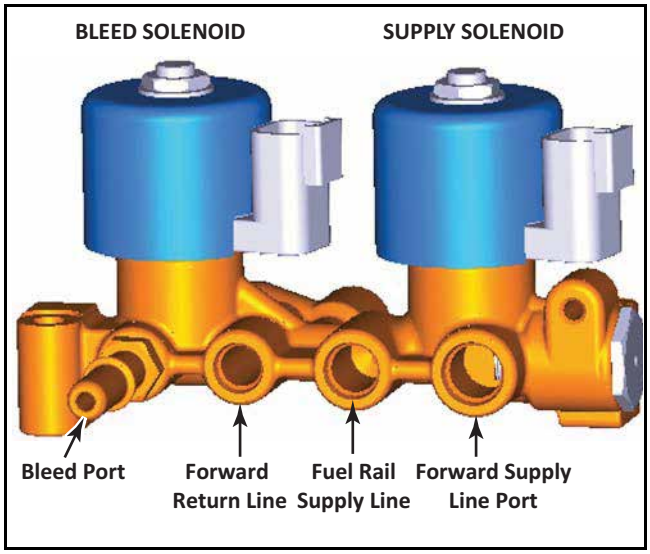
Pinpoint Test R: Manual and RDT Solenoid Activation Procedure

For harness and connector layout diagrams and system electrical schematics, refer to Wiring Diagrams and Electrical Schematics.



Connector End View



FRPCM Solenoid Locations

Manual Activation		
Step	**Procedure**	**Action**
1	Turn ignition to OFF. Disconnect the Gateway Module (GWM) wire harness connector at the Gateway Module (GWM).	
2	Energize the individual solenoids by providing a ground to the following pins in the Gateway Module (GWM) connector: **Note: Use caution not to damage Gateway Module (GWM) connector terminals. Always connect lead to the connector then to ground.** • Pin 33 – Bleed Solenoid • Pin 32 – Supply Solenoid • Pin 30 – Flow Control Solenoid **Note: The Tank Supply Solenoid cannot be actuated from the Gateway Module (GWM). 12v power and ground must be applied to the solenoid connector.**	

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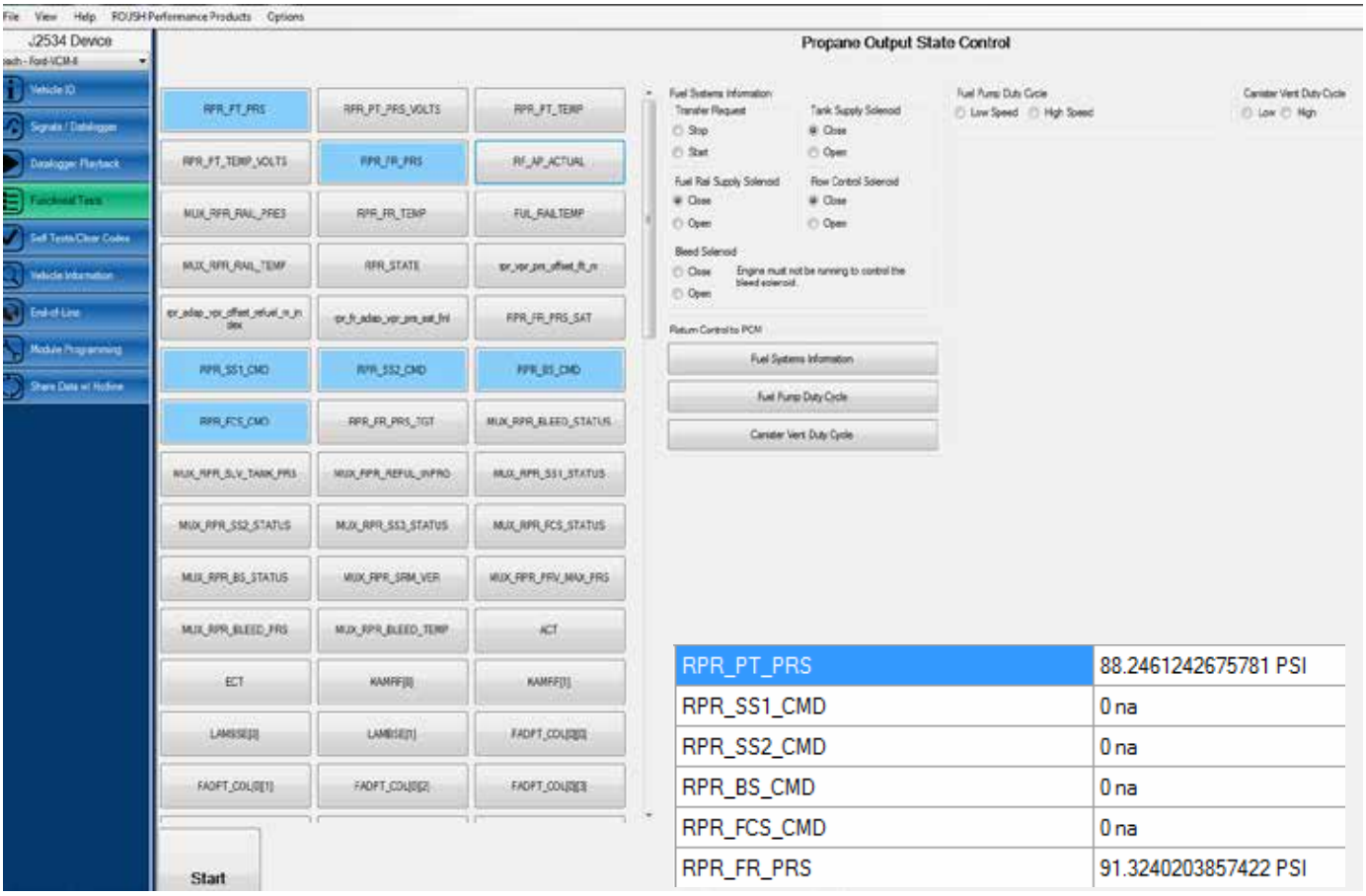
Pinpoint Test R: Manual Solenoid Activation Procedure (cont.)

Using the Roush Diagnostic Tool (RDT)



Step	Procedure	
1	Refer to the Utilizing the Roush Diagnostic Tool section of the Diagnostic Manual to open RDT and access the vehicle.	
2	Select Functional Tests from the left side menu.	
3	Select the PIDs required to gain solenoid control (see above)	
4	To open or close selected solenoids, click on the radio button for the chosen solenoid. *The Bleed Solenoid cannot be activated if the vehicle is running.	
5	When solenoid activation and test have been completed, return the solenoids to their pre-output test state. With the engine off this would have all of the solenoids close. After returning the solenoids back to their regular output state, disconnect the J2534 scan tool and wait a minimum of one (1) minute before starting vehicle. This will allow the vehicle PCM to take control of the start-up process.	

Pinpoint Test S: P1070 DTC Pinpoint Test

Step	Procedure	Action
1	**Test rationality between Integrated Injection Pressure Temperature Sensor (IPTS) and Tank Pressure Temperature Sensor (TPTS).** If you have the ROUSH Diagnostic Tool (RDT) or Ford IDS, use the Manual Solenoid Activation Procedure, open tank supply solenoid and FRPCM supply solenoid. Using RDT, read Fuel Tank Pressure (**Rpr_pt_prs**) and Fuel Rail Pressure (**rpr_fr_prs**). Are pressures within 8psi of each other?	**Yes** — Move to Step 2. **No** — Continue to Step 2.
2	Open bleeder valve for 60 minutes	Once complete, move to Step 3.
3	Close bleeder valve and wait 60 minutes while tank pressure stabilizes	Once complete, move to Step 4.
4	Using RDT, check tank and rail pressure	
5	Re-test rationality between Integrated Injection Pressure Temperature Sensor (IPTS) and Tank Pressure Temperature Sensor (TPTS). If you have the ROUSH Diagnostic Tool (RDT) or Ford IDS, use the Manual Solenoid Activation Procedure,, open tank supply solenoid and FRPCM supply solenoid. Using RDT, read Fuel Tank Pressure **Rpr_pt_prs**) and Fuel Rail Pressure (**rpr_fr_prs**). Are pressures within 8psi of each other?	**Yes** — Diagnostics complete. If problem persists, contact ROUSH CleanTech Customer Success at (800) 59-ROUSH (597-6874), Opt. 2. **No** — The vehicle has a volatile fuel mixture. Contact the fuel provider to resolve.