



Warning! This product can expose you to chemicals such as styrene which is known to the State of California to cause cancer. For more information, visit www.P65Warnings.ca.gov

California Proposition 65 Warning Label

VaporWorx

We Give You Gas

WARNING

Working with fuel is dangerous. If fuel is handled improperly it can lead to fires and death. It is imperative above anything else that all appropriate safety measures be used to control the fuel and any ignition sources, including static electricity, heat, sparks, and any other sources. Proper high-pressure fuel lines and connections must be used in accordance to the manufacturer's specifications and routed away from any potential sources of heat, ignition, and protected from mechanical damage. If you are unsure about your work or safety, stop work immediately and consult with a qualified automotive technician and/or safety official.

VaporWorx PressureWorx Dual and Triple Fuel Pump Installation Instructions.

Thank you for your purchase of the VaporWorx fuel module speed control system. These "Smart" systems are designed to work with many aftermarket PWM compatible fuel pumps in single, dual, and triple arrangements. The following pumps have been validated for use with the VaporWorx PressureWorx Pulse Width Modulation control system:

Dual GM LS3, ZL1, and CTS-V fuel modules.

Walbro F90000267 450lph E85 compatible pump(s).**

AEM CTS-V 320lph E85 compatible pump(s).

Aeromotive Stealth 340 pump(s).**

Deatschwerks CTS-V DW300 pump(s).

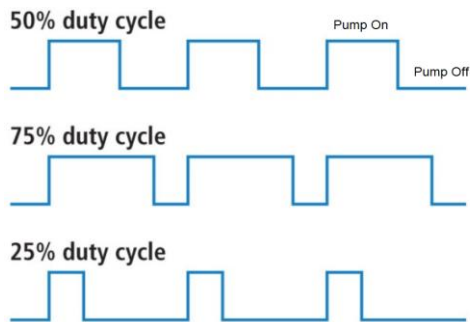
Bosch -044**

Please consult with VaporWorx on the maximum horsepower capability of each arrangement. Many variables can affect the amount of fuel delivered to the engine. Typical horsepower ratings can be found below and include wiring power loss and safety factors. Fuel line pressure loss is not included.

What is PWM?

In simplest terms, what PWM does is turn the power on and off very quickly to the fuel pumps. If the power is on for 10ms, then off for 10ms, the duty cycle is 50%. As the fuel line pressure decreases due to engine demand, the VaporWorx PWM control adjusts the duty cycle by increasing the speed of the pump. The opposite happens when the fuel demand falls. This allows a large pumping system to run reliably with significantly reduced heat generation. It effectively makes a very large pumping system seem much smaller during cruise/low fuel demand conditions.

The graph below shows what a typical set of duty cycles look like:



With the above pumps and a few modifications, a true PWM controlled returnless system is possible. For PWM to work properly some fuel must be pumped during operation. Idle fuel is not enough, so a bypass must be used. Usually an in-tank bypass/controlled leak is the best and cleanest solution. For the Fore Innovations dual and triple arrangements, a modification should be made and is outlined in another instruction sheet.

The VaporWorx standard system uses a 12v+ signal from the ECM for turn-on. However, some aftermarket EFI systems such as those made by FAST, provide a 12v- signal. In these cases, a different controller is available from VaporWorx for these systems. A simple relay can also be used to change the input polarity.

The PressureWorx system will provide a 1:1 rate of fuel pressure change with manifold pressure. Wiring connections to the engine MAP sensor are required. VaporWorx kits are specific to each MAP sensor, so ordering must be done accordingly (1bar, 2bar, 2.5bar, or 3bar.) The standard VaporWorx controller is tuned for GM LSA 3bar MAP sensors. For other sensors, please contact VaporWorx.

Unless otherwise specified the PressureWorx kits are tuned for 3-bar MAP sensors. Typical 3-bar sensors such as GM P/N 12592525 used on the LSA and ZR1 crate engines are a good choice.

This kit must operate in manifold/boost referenced fuel pressure mode to operate properly.

**** Pumps used in applications that are not used in an OEM fuel module with jet pumps must have some bypass fuel move through the pumps during engine operation. This amount is more than what the engine uses. Hence, a bypass fitting must be used. The hole should be approximately 1/8" long with a diameter as follows:**

1) AEM Stealth 340: 0.025" 2) Walbro F90000267: 0.041" 3) Walbro F90000285: 0.051" 4) Bosch -044: 0.041"

The AEM Phantom module has a provision on the bottom of the hat to drill a hole (only one needed) in a threaded pipe plug. VaporWorx has bypass fittings available for the other pumps

These instructions are a general guideline. For example, your application may have a different fuel level sensor wiring callout, or be a modern OE plastic tank vs. the photos shown. So, some of the instructions may not be needed for your application.

The VaporWorx PWM controller supplied in your kit has also been tuned for the pumps specified. The controller may not work properly if used with a different pump(s). Please contact VaporWorx for compatibility questions.

VaporWorx was founded on Customer Satisfaction and Service. We strive to treat people and our products the way we would want others to treat us and the products we purchase. That is why our electronics products are tested thoroughly before they are packaged and shipped. VaporWorx stands behind our products for one full year after purchase with a well-stocked repair facility and quick turnaround times. VaporWorx does not want to be the reason you cannot enjoy your car. The Terms of Warranty and Service are as follows:

Limited Warranty

VaporWorx warrants its products to be free from defects in material and workmanship under normal use and if properly installed for a period of one year from date of purchase. If found to be defective as mentioned above, it will be replaced or repaired if returned along with proof of date of purchase. This shall constitute the sole remedy of the purchaser and the sole liability of VaporWorx to the extent permitted by law, the foregoing is exclusive and in lieu of all other warranties or representations whether expressed or implied, including any implied warranty of merchantability or fitness. In no event shall VaporWorx be liable for special or consequential damages. This warranty is only valid on products purchased from VaporWorx or their Authorized Dealers.

Service

In case of malfunction, your VaporWorx component will be repaired free of charges according to the terms of the warranty. When returning VaporWorx components for warranty service, Proof of Purchase must be supplied for warranty verification. After the warranty period has expired, repair service is charged based on a minimum and maximum charge rate. (Contact VaporWorx for current rates).

VaporWorx
carlc@vaporworx.com
(805)390-6423

The following steps will help to ensure good fuel module operation and long life. Careful attention to wire routing, protection, strain relief, connectors, crimps, etc. will lead to a longer lasting and more reliable installation. Be sure to use appropriate personal protective equipment and safe automotive lifting, support, and working methods. A fire extinguisher must be kept available, ready, and functional at all times.

Please read these instructions before beginning installation. There are some steps that may affect later wiring decisions.

MAP Wiring Attachment is mandatory for this kit to function.

Refer to the wiring diagram on Page 7 for wiring layout.

- 1) Disconnect the battery. Find a suitable place to mount the VaporWorx pulse width modulation controller (black box) near the vehicle battery. **It is imperative that the box be mounted as close, and the wiring connected directly to, the battery as practical.** If not wired directly to the battery an excessive amount of electrical noise may be generated, causing radio noise. Grounding to the chassis can cause signal interference, causing controller malfunction. Do not mount the controllers near sources of heat such as exhaust systems, radiators, etc. The cooler the electronics are during operation, the longer their expected life will be. Screws are provided for mounting.
- 2) Install the fuel pressure sensor into a 1/8"-NPT female fitting that is tapped into the fuel line either in the outlet fitting as seen in Photo 1C, or immediately after the fuel module outlet. **The sensor must be mounted near the fuel module outlet.** If the sensor is mounted in the engine fuel rail rapid pressure fluctuations may occur. Use a small amount of Teflon paste to seal **just the threads** of the sensor. For Fore Innovations installations mounting sensor as shown in Photo 1C has worked well.
- 3) If desired the supplied braided loom can be installed over the fuel pressure sensor wiring. If so, slip a 1" piece of heat shrink tubing on the wiring first, then install the loom. The heat shrink will secure the ends of the loom to the wiring. The blue ECM fuel-enable wiring may also be integrated into this harness if desired.
- 4) Plug the three-cavity fuel pressure sensor plug into the fuel pressure sensor.
- 5) Route and secure the fuel pressure sensor wiring harness toward the VaporWorx controller. Be sure to leave sufficient wire length so that there is no strain on the wiring near the connectors. Secure the harness to the vehicle away from where it may become damaged from road hazards, chaffed or cut on sharp edges, etc.
- 6) The VaporWorx controller GT150 six-pin connector provides both fuel pressure sensor and fuel pump enable circuit connections. Using the terminals and seals provided as seen in Photo 1A-B, crimp the terminals to the wires like that shown in Photo 2. Solder the terminals to the wires if needed. There will be a total of four-six wires to crimp:
 - A. Grey 20ga from the fuel pressure sensor
 - B. Black 20ga from the fuel pressure sensor
 - C. Brown 20ga from the fuel pressure sensor
 - D. Blue 20ga from ECM fuel pump + enable circuit.
 - E. Orange/Black 20ga from MAP -
 - F. Light Green 20ga from MAP +

NOTE: **For Pontiac G8** applications, connect Pin D Blue wire to OE Fuel Pump + Grey wire.

For Gen5 Camaro applications use the Green/White wire in the fuel system control module and disconnect the FSCM plug from the OE controller. ECM tuning will be needed to disable the FSCM. Other GM models with an FSCM will be similar but may have a different wire color. The wire needed is what tells the FSCM to turn on.

- 7) Insert the wires into the Delphi GT150 female connector body as shown in Photo 1A. The pinout schedule is listed in Step 6 for the connector body. A capital "A" and "F" can be found on the connector body. Just align to the colors from the VaporWorx controller GT150 connector.

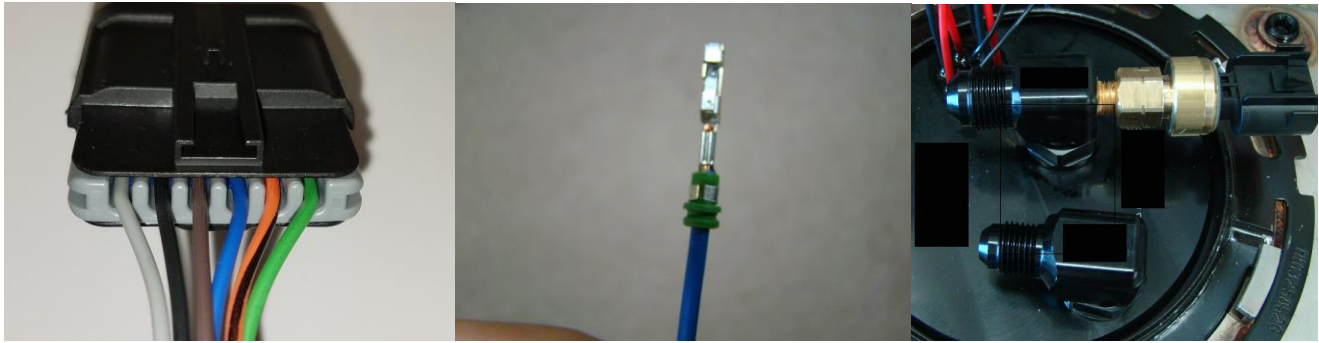


Photo 1A-B: The GT150 connector body, terminals, seals, and grey terminal positional assurance clip. The terminal is crimped to the wire and seal. The part number for the Delphi terminal is 12191818. The seal is 15366022. Photo C. Note that the sensor was installed by drilling/tapping a hole into the outlet fitting. Side installation may be possible as well and allow for more clearance. Installation into downstream "Y" connector is also acceptable as long as the "Y" is in the rear of the car.

- 8) Re-verify that the wires have been properly placed in the connector and that the colors align. If the wiring is incorrect then the terminals will need to be removed and placed in the proper cavity. This can be done by removing the purple cap on the inside of the connector body face using a small screwdriver to pry up on the sides. The terminal can then be released by very gently prying back on the locking tab that secures the terminal to the body. Once corrected re-install the purple connector body cap. NOTE: The cap acts as a terminal locking device. Once the cap is fully seated removal and installation of the terminals is very difficult. The cap has a pre-terminal installation position where it is located in the body but not fully seated. Seat the cap once terminal installation is completed.
- 9) Once the correct wiring has been confirmed, install the grey terminal position assurance clip as shown in Photo 1A.
- 10) Connect the blue wire to the ECM fuel system enable circuit. A blue wire with a grey end for G8 applications and a green end for Gen5/FSCM applications is included. The VaporWorx controller requires a 12v positive signal to operate. If a negative signal is used the system will not function. See Page 1 for information.
- 11) See Diagram 1 for Steps 12-18

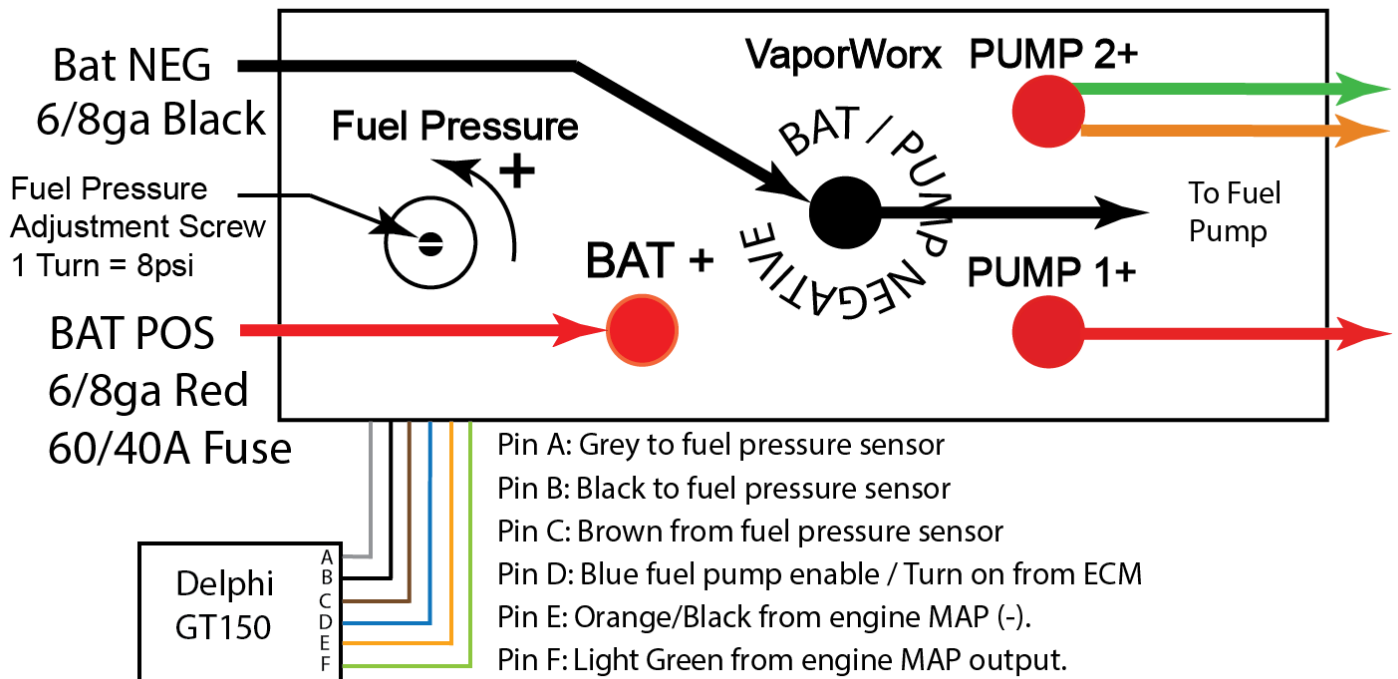


Diagram 1. Battery connections come from the left, the output to the fuel pump to the right for illustration purposes only. Negative wiring may be combined into a single ring terminal if desired. A 40A fuse is used for dual pumps, 60A/6ga for triple pumps. Dual kits have only a single wire routing to Pump 2+.

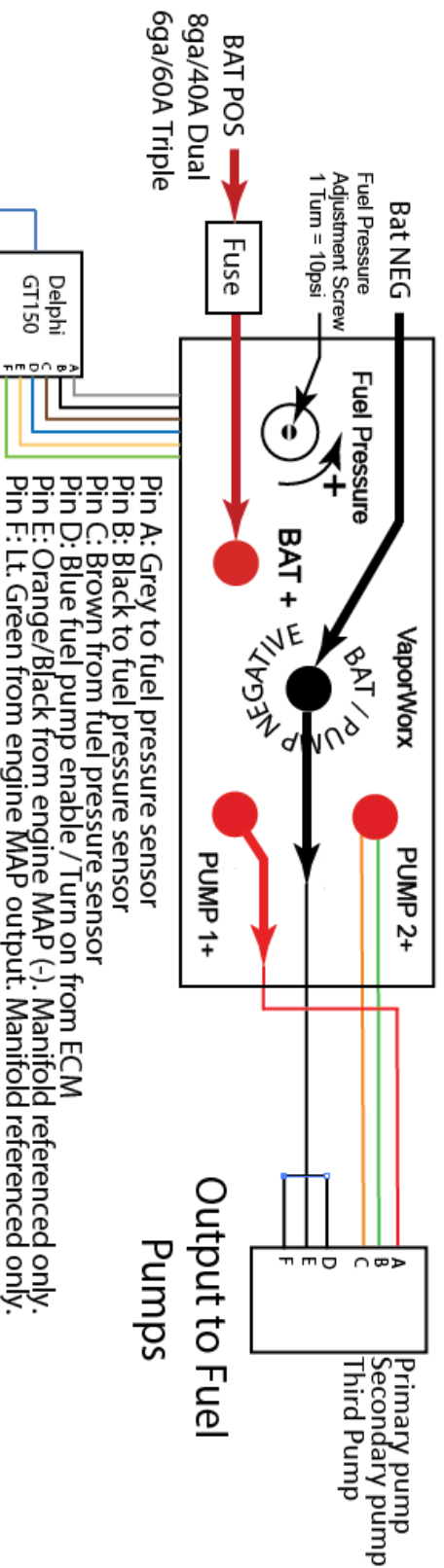
- 12) Plan the routing of your power input and output harnesses. Woven braid should be installed before terminals are crimped on the ends of the wires. The ends of the braid can be sealed from fraying with a soldering iron and to the wire bundle using heat shrink tubing.
- 13) Unbundle the main power harness. Mount the fuse holder, if applicable, in a secure location so that one end can be connected directly to the battery positive terminal.
- 14) The label on the top of the VaporWorx controller shows the input (BAT +) and output (PUMP +) terminals. Attach one end of the fuse holder to the battery positive terminal. Route the other end of the fuse holder to the VaporWorx controller BAT + terminal. Ring terminals are provided in the kit and may require heat shrink insulation tubing to be installed. Tighten the nut to 10-inlbs. *Do not over-tighten the brass nut on the VaporWorx controller.* Though there may be excessive wire length, keep the wire lengths as short as practical. Do not bundle or coil excess wiring.
- 15) Route the 6-8ga black wire from the battery negative terminal to the VaporWorx controller negative input. Ring terminals are provided in the kit, and use heat shrink tubing to insulate if needed. Do not tighten the brass nut on the VaporWorx controller at this time.
- 16) Begin routing the wiring from the fuel pumps to the VaporWorx controller. The VaporWorx controller is usually mounted in the trunk with a trunk mounted battery, so route the wiring harness using appropriate rubber grommets and protective sleeve.
- 17) Using the provided male six-pin Delphi GT280 connector, attach the connector to the wiring from the fuel pump. Align the Pump +/red to the red, green, and orange wires on the VaporWorx harness.
- 18) Attach the 10ga red wire from the primary fuel pump to the PUMP 1+ on the VaporWorx controller. A pre-installed six-pin sealed connector is included to make servicing easier (see Wiring Diagram.) 10ga ring terminals are also provided if needed. Tighten the terminal nut to 10-inlbs.
- 19) Attach the 10ga green and orange to the Pump 2+ terminal on the VaporWorx controller. Both wires will fit into the provided #8 x 8ga ring terminal. Crimp securely and solder if needed. Install heat shrink tubing to insulate the crimp section. Tighten the terminal nut to 10-inlbs.
- 20) Route the 6-8ga black wire to the negative terminal on the VaporWorx controller. Crimp securely the #6-8 ring terminal and solder if needed. Tighten the terminal nut to 10-inlbs.
- 21) For Pontiac G8 owners using aftermarket fuel module hats, extra lengths of brown and violet wire are included in the kit to allow extending the OE harness to the new fuel hangar/hat. Brown is the reference voltage, violet the sensor output.
- 22) Re-check and secure all connections and verify that all wiring is routed away from sources of potential damage and is not pinched.
- 23) Verify the installed torque for the terminal stud nuts on the VaporWorx controller have been installed to 10-inlbs.
- 24) Insert the 40A (dual pumps) or 60A (three pumps) fuse into the fuse holder.

Preparation Required Prior to Engine Startup

- 25) The controller is set to turn on the second and third pumps at approximately atmospheric pressure.
- 26) The controller comes pre-set to approximately 42psi at-idle fuel pressure. **A fuel pressure gauge must be used to verify actual pressure.**
- 27) Fill the fuel tank to 3/4-full minimum. Check for any leaks. If a fuel filter is installed just prior to the fuel rail connection and the hoses have been cleaned, the flushing sequence in Steps 33-36 can be skipped. However, please read Step 34 about priming time.
- 28) Disconnect the fuel line from the engine fuel rail. Route or extend this line to a fuel-rated and approved container. Secure the line to the container so that it will remain in place when fuel is pumped through the line. High-pressure fuel flow will cause a flexible line to whip if not secured.

- 29) Turn on the ignition switch. Fuel should begin to flow in several seconds. If the ECM controls the fuel turn-on circuit (blue wire) then it may take several cycles to flush the system. Most ECM's have a safety feature that turns off the fuel pump after 1-2 seconds if it does not sense that the engine is running.
- 30) In some cases, after several cycles the ECM may not turn the fuel circuit on until it senses engine rotation. In this happens, if needed, using a jumper wire 12v+ can be applied to the VaporWorx controller blue wire for a few seconds. The pump should begin to run. The fuel pressure sensor wiring must remain in place and not be disconnected.
- 31) Reconnect the fuel line to the engine fuel rail and attach a fuel pressure gauge to the engine fuel rail.
- 32) Turn on the ignition switch but do not start the engine. The fuel pressure gauge should rise and settle near its pre-set value. Turn off the ignition key and inspect the fuel system and engine fuel rails for leaks. It is normal that the fuel pressure will spike after fuel system shutdown. Fuel pressure should return to normal after engine start-up. The two-second priming rule is still in effect
- 33) If no leaks are found, start the engine. Fuel pressure may increase 2-3psi higher than what was observed during engine-off due to system voltage increases. Again, check for leaks.
- 34) Use the blue adjustment tool included in the hardware kit to adjust the fuel pressure. Typical fuel pressure settings are 36-42psi at idle. The tool can be cut shorter for easier access.
- 35) Shut down the engine as soon as practical and check the fuel system for leaks. Repair any leaks before continuing.
- 36) Restart the engine. Quickly depress and release the throttle pedal. The fuel pressure should change the same amount as the manifold pressure. In other words, the fuel pressure should increase as heavy throttle is applied, and decrease on lighter throttle.

VaporWorx Dual and Triple Fuel Pump Wiring Diagram



Fuel pump enable signal.

G8: To 14ga grey wire at fuel pump connector.

Gen5 Camaro: Green/Grey at fuel system control module plug.

CTS-V: Green/Grey at fuel system control module plug.

Other FSCM vehicles: FSCM power turn on signal from the ECM.

Other non FSCM vehicles: ECM fuel pump enable (+) or fuel pump relay output (Pump +)

VaporWorx validated pumps for dual or triple use:

- Walbro 450lph F90000267
- Aeromotive Stealth 340
- AEM 320lph 50-1200
- Deatschwerks DW300

Note: Manifold referenced/variable fuel pressure

only. Fuel system control module must be disabled.

ECM recalibration may be required.

Troubleshooting

- 1) Fuel pump runs at full speed when the engine is on:
 - a. Adjust the fuel pressure via the small screw on the side of the box.
 - b. Check fuel pressure sensor wiring connections. On the fuel pressure sensor plug Pin 1 = Brown, Pin 2 = Black, Pin 3 = Grey. Confirm that these wires align with the same wires on the controller GT150 plug. It is possible to crimp across the insulation of the wire and not obtain a good circuit pathway, hence, causing a controller malfunction.
 - c. Confirm that the input and output main power wires from the battery and to the fuel module are correct/not reversed.
 - d. Confirm the controller is connected directly to battery power. No chassis grounds.
- 2) Fuel pump does not run:
 - a. Check the input fuse.
 - b. Check fuel pressure sensor wiring connections. On the fuel pressure sensor plug Pin 1 = Brown, Pin 2 = Black, Pin 3 = Grey. Confirm that these wires align with the same color wires on the controller GT150 plug. It is possible to crimp across the insulation of the wire and not obtain a good circuit pathway, hence causing a controller malfunction.
 - c. Confirm that a minimum of 10v is available to the VaporWorx controller and blue wire Pin D. 12v + can be applied directly to the GT150 Pin D blue wire for testing only.
 - d. Check that the brass nuts for the battery and fuel module power wiring terminals are properly tightened and free of contamination and corrosion.
 - e. Check the brass nuts that are under the battery and fuel module ring terminals. These may loosen over time. Retighten them to 10-inlbs and test the system.
 - f. Excessive fuel pressure due to engine shutoff. After ignition shutoff the injectors shut but the pump still spins, causing a pressure spike. This is normal, but until the pressure drops below the set pressure, the controller will not send power to the fuel module.
 - g. Check the temperature of the VaporWorx controller black aluminum lid. If the lid is over 205°F the controller will shut down.
 - h. Confirm that the battery and butt-joint connections are good. Use a volt-ohm meter to check connections.
 - i. Confirm that the input and output main power wires from the battery and to the fuel module are correct/not reversed.
 - j. Confirm the controller is connected directly to battery power. No chassis grounds.
- 3) The fuel pressure rapidly fluctuates, especially at idle:
 - a. The fuel pressure sensor is too close to the fuel rail or insufficient fuel is being bypassed. The VaporWorx system can react fast enough to chase individual injector pulses at idle, hence causing rapid fuel pressure gauge readings. Once engine speeds increase this tendency reduces. Move the fuel pressure to as close to the fuel module as practical. In some case where a very short primary fuel line is used, a longer line from a "T" may be needed to install the fuel pressure sensor into. This extra head length acts a damping system for the injector pulses.
 - b. Insufficient bypass fuel through the pump at low engine demand. Extra bypass fuel may be needed. Please consult with VaporWorx.
- 4) Fuel pump does not have adequate pressure:
 - a. Turn the fuel pressure adjustment screw inside the hole on the side of the controller. A small eyeglass screwdriver can be used, as well as the tool supplied in the kit.
 - b. Remove the power wiring from the brass terminals on the top of the controller. Confirm that the lower brass nuts are tight.
 - c. Using a heavy gauge jumper wire, connect the BAT+ to the PUMP+ on the VaporWorx controller. If the fuse is good the pump should run. If the pump is running but little or no fuel pressure exists, then either the fuel module is internally damage (broken plastics), the fuel pump(s) have been damaged, or there is a large leak. The most common cause of fuel pump damage is running the pumps dry. Fuel is the life blood for pumps.
 - d. Check that the connections from the VaporWorx controller to the fuel module are good.



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Modifying the Fore Innovations transfer pump bypass hole for use with VaporWorx PWM systems.

In order for PWM to work with any closed-loop control system, a small amount of fuel is needed to pass through the pump(s) during operation to allow for smooth control. In the factory OE fuel modules this high pressure fuel is used to drive the transfer suction pumps that moves fuel from remote sections of the tank that will not gravity feed to the main module, and to help keep the module full. In the case of the TI 450lph pumps, this small amount of fuel needs to be increased due to the increased size of the pump.

- 1) Note on your Fore Innovations Fuel Pump Module the fuel pump bridge support, mid-span platform, and bulkhead hat as shown in Photo 1. The mid-span platform will need to be removed in Steps 3-6 below.
- 2) Exercise care to not place excessive loads/strain on the fuel pump outlets. They are plastic and can break.
- 3) Remove the two screws that hold the pump bridge to the mid-span platform as shown in Photo 1. Slide the bridge toward the large end of the pumps like that in Photo 2.
- 4) On triple fuel pump modules one pump will need to be removed to gain access to the hole that needs to be drilled. Remove the pump that is not shown in the photos.
- 5) On the top of the hat there is a single screw that secures the mid-span support. Remove the screw shown in Photo 3. Support the mid-span platform by hand so it does not fall off. The mid-span platform has o-rings and dowel pins between it and the hat mounting surface.
- 6) Remove the mid-span platform being careful to keep the o-rings and dowel pins in position. The result should be like that in Photo 4.
- 7) Note the small hole shown in Photo 5. Using the drill bits provided, increase the size of the hole. For TI450 pumps, use the 0.041" bit, for TI450, the 0.051: bit. Be careful, take your time, and use a drill cutting lubricant to make the cut. Once the drill breaks through to the manifold passage, be sure to clear the hole of chips by moving the drill bit in and out of the hole, spinning the drill bit, etc. The hole must be clear of chips and burrs.
- 8) Check the position of the o-rings and dowel pins in the mid-span platform. Be sure all are in place and clean like that in Photo 6. Reinstall the platform.
- 9) Re-assemble the fuel module in the reverse order.

Hat →

Mid-span platform →

Pump bridge →

Screws →

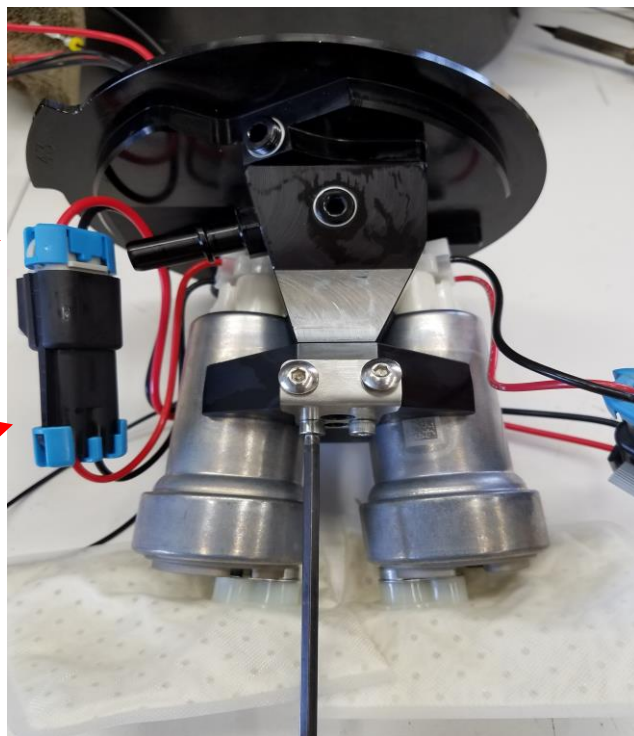


Photo 1. Note the hat, mid-span platform, and fuel pump bridge. Triple fuel pump systems will require the removal of one pump.



Photo 2. Slide the fuel pump bridge toward the large end of the pumps.

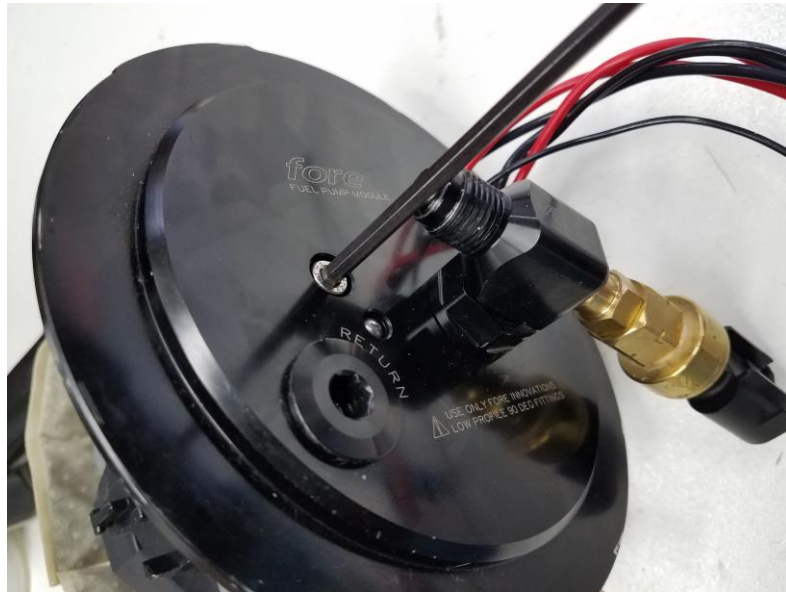


Photo 3. Remove the single screw from the top of the module hat. Support the mid-span platform by hand so it does not fall off.

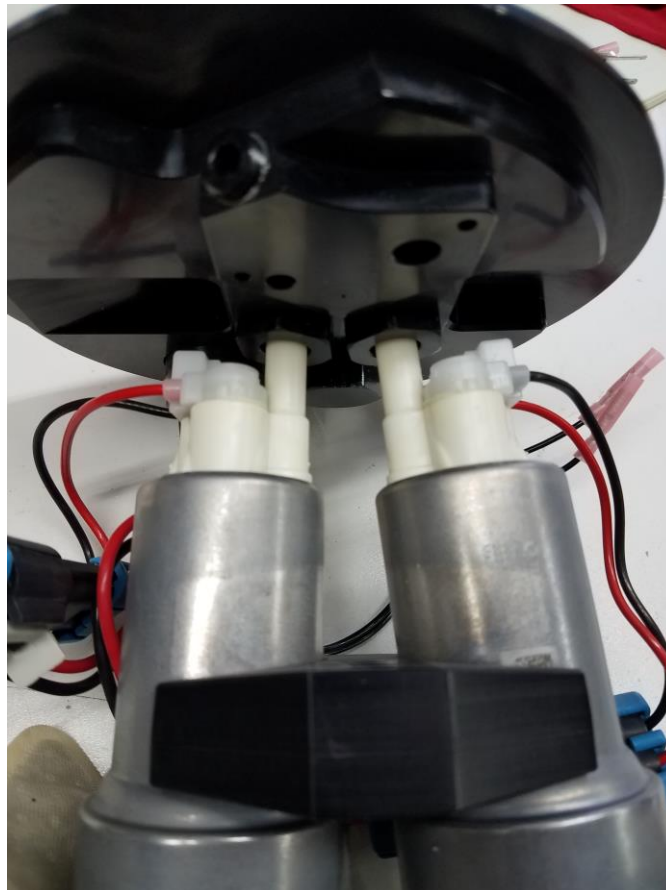


Photo 4. The disassembled module should look like this.

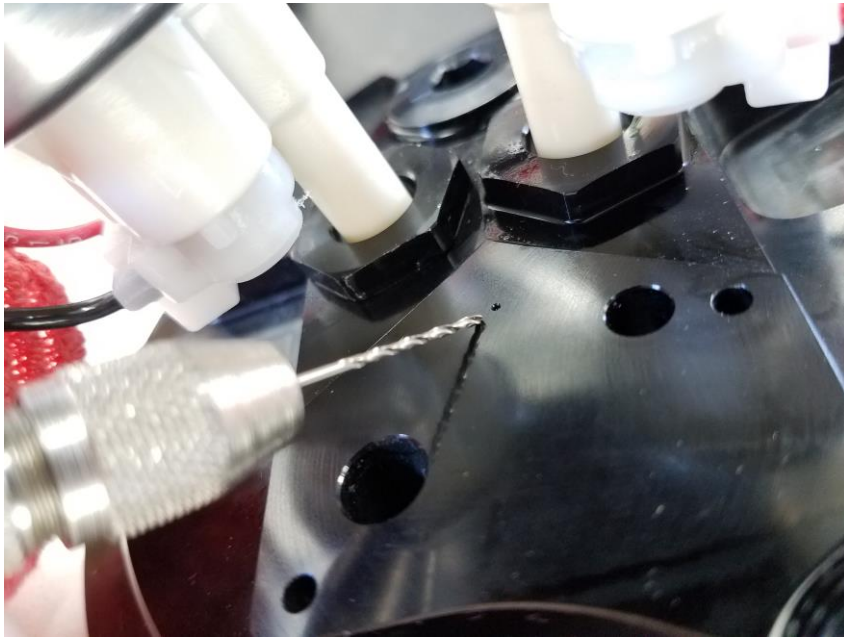


Photo 5. Using the drill bits provided, drill out the hole as shown. For TI450 pumps, use the 0.041" bit. For TI525 pumps, use the 0.051" bit. Only increase the size of this hole, do not drill past the manifold passage and into the hat. A pin vise works well to hold the drill bit. BE SURE TO USE THE BIT TO CLEAR THE HOLE OF BURRS AND CHIPS.



Photo 6. Confirm that all of the o-rings and dowel pins are in place and seated correctly. Some versions may appear a bit different, but the premise is the same.