



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.

Thank you for your purchase of the VaporWorx ReturnX fuel pump(s) speed control system. These systems are designed to work with traditional pressure regulation systems that use a return line.

A 12v+ or BAT- signal can be used to turn on the controller. The supplied stand-alone MAP sensor must be used. The fuel pressure can be either constant/static or manifold referenced.

The purpose of the VaporWorx Pulse Width Modulated system is to allow the fuel module pump(s) to adjust their speed based on the MAP sensor feedback. As MAP voltage increases the ReturnX controller speeds up the pump(s). This allows a large pumping system to run reliably with significantly reduced heat generation. It effectively makes a very large pump(s) seem much smaller during cruise/low fuel demand conditions where reduced fuel volume is advantageous.

The ReturnX controller is tuned for the supplied MAP sensor. If a replacement sensor is needed only replace with the same type and model/part number. Spare MAP sensors are available from VaporWorx.

The second pump in the ReturnX system is always running. This means that there are no pressure switches, relays, etc. to trigger. Testing has shown that at 42psi two 450LPH pumps under ReturnX control use 1/3 less power than a single 450LPH pump running at full speed. Having both pumps running in parallel means a smooth ramp up in pump power.

The output power of the controller will typically not fall below 7v if set according to the instructions. This allows the pumps to remain spinning even at low fuel demand / high MAP settings.

Stand Alone MAP Sensor Operation Only

The VaporWorx stand-alone MAP sensor controller cannot be used with a TPS input. Controller malfunction will result if the TPS input is used. If TPS control is desired the controller can be sent back to VaporWorx for modifications to work with a TPS input. Wiring is provided for the TPS for this option.

Fuel Pressure Suggestions

For dual pump systems, such as the Walbro 450 and 525/535LPH, it is highly recommended for EFI supercharged applications that the fuel pressure be done in manifold referenced mode with an at-idle fuel pressure in the low 40psi range. Excessive fuel heating will lead to lower pump life and a greater chance of cavitation/vapor lock at the inlet to the pump.

For naturally aspirated EFI applications with large dual pumps like the Walbro 450/525LPH, set the at-idle fuel pressure to as low as practical but keeping at or above 42psi as shown in the table below.

Fuel Tank Liquid Levels

Aftermarket fuel pumping systems have only recently taken a leap forward. ALM Performance, Fueled By AI, and KPM have made great improvements vs. what has been essentially unchanged in aftermarket electric fuel pump hanger design. Simply put, it's been a pump-on-a-stick that is put into a tank with limited or no effective means to control the fuel around the pump.

However, what comes with all of these systems is increased heat generation and the potential for pump inlet cavitation/vapor lock. Besides helping to keep the fuel cool by using control systems to slow down the pump(s), another simple measure to help pump life is to keep the tank at least ¼ full. Letting the fuel level fall very low in modern cars with stainless steel or thermally insulated plastic tanks can lead to pumps running dry and hot. Poor fuel control, like pump-on-a-stick designs, can also lead to pump failure due to running them, even momentarily, dry. Help them stay cool and lubricated by keeping lots of fuel in the tank.

Fuel Pressure Regulator and Return Line Installation

The ReturnX controller will work in either a full return or deadhead arrangement. For details, see the Resources section of the VaporWorx website, <https://www.vaporworx.com/resources/fds/1-fuel-delivery-101/>

VaporWorx has tested a variety of bypass fuel pressure regulators and have found good performance and volume capability with the inexpensive Holley 12-886 (EFI) and 12-887/12-803BP (carburetor) regulators. Other regulators will typically work well, so if a regulator is already in place or a different model desired, there should be little issue.

Another popular regulator is the C5 Corvette fuel filter regulator. The ReturnX controller works very well with this regulator when a single pump is used. Dual pumps, especially the larger TI 450/525lph versions, have too much volume for this regulator. The OEM GM or the Wix version are the only suggested types. VaporWorx has tested many versions of this part and only the GM OEM and the Wix parts work as intended with the ReturnX controller. Beware of grey market and counterfeit parts as it is very common for sellers to buy inexpensive, poorly performing regulators.

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).

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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. Appropriate safety equipment, lifting procedures, jacking, vehicle support/jackstands, PPE, and all other proper and safe work methods must be utilized at all times. An appropriate ABC rated fire extinguisher must be at the ready at all times. If you are unsure of your work stop immediately and consult with a qualified automotive specialist.

- 1) Find a suitable **flat metal surface** to mount the VaporWorx pulse width modulation controller (black box) near the vehicle battery. The metal surface helps to act as a heat sink. It is imperative that the box be mounted as close and connected **directly to the battery** as practical. If not connected directly to the battery controller malfunction will result. 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. #8 x 3/4" screws are provided for mounting. Be sure to confirm that the #8 x 3/4" screws are not too long and cause unwanted damage.

See Diagram 1 and Photo 1 below for the following steps:

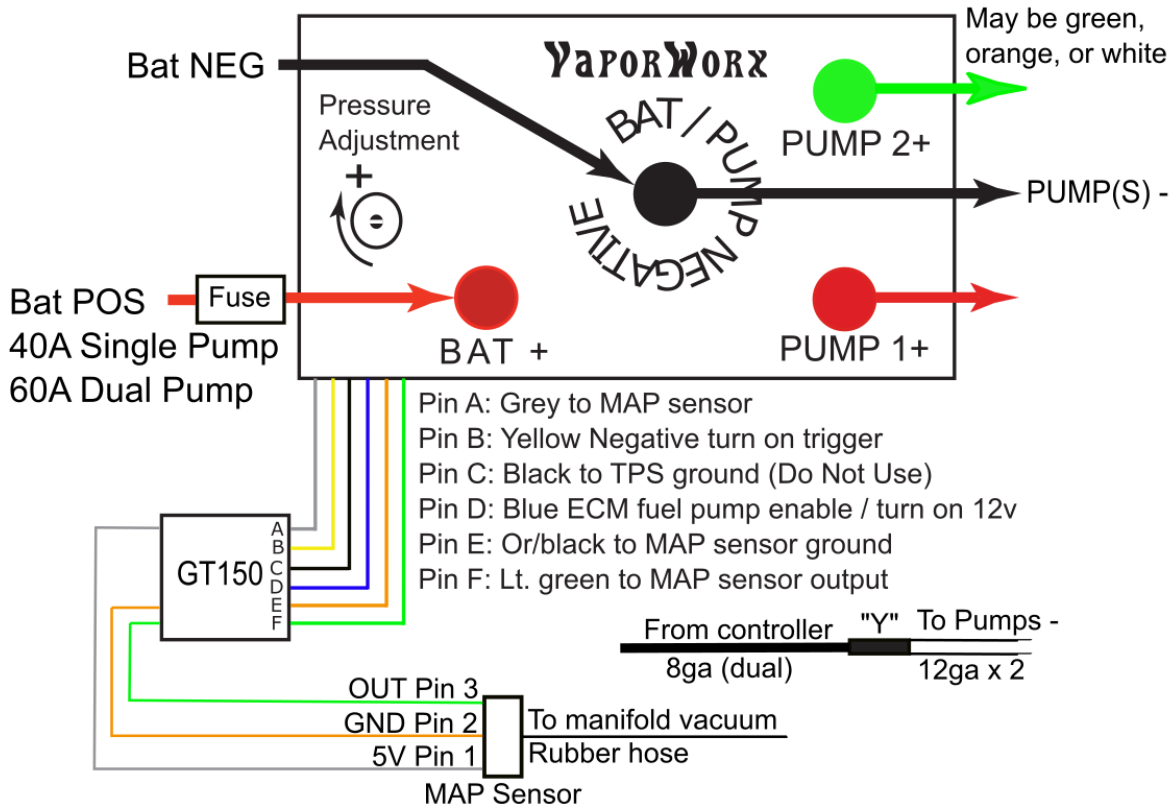


Diagram 1. Basic wiring layout for the VaporWorx controller. The wiring may enter/exit the controller area as needed provided there is no chance of shorting between connections.



Photo 1 . Basic connection points for GM MAP sensors. Pin 1 = 5v Grey. Pin 2 = GND Or/Black. Pin 3 = Output Lt. Green

2) The ReturnX GT150 six-pin connector provides signals interfacing for the remote sensors and turn-on signals. The female plug is already installed. The pinout schedule follows:

- A: Grey 5v. Only used if a VaporWorx supplied remote sensor is supplied
- B: Yellow 20ga from the ECM battery negative fuel pump enable signal
- C: Black 20ga from TPS (-) sensor **DO NOT USE**
- D: Blue 20ga from the ECM 12v+ fuel pump enable circuit
- E: Orange/Black 20ga from the MAP (-) sensor
- F: Light Green 20ga from either the MAP (output) sensor..

NOTE: If using a VaporWorx stand-alone MAP sensor the TPS option is not available together with the stand-alone MAP sensor option. In order to use the TPS option the controller will need to be sent back to VaporWorx for modifications.

Grey 5v: This wire is used to provide a 5v source for both controller testing during assembly and to provide a power source when a remote MAP sensor is used / Pin 1 on the MAP sensor plug.

Yellow: Negative trigger on. When this wire is attached to ground the controller will turn on. Most all ECM's use a 12v+ signal except for FAST and Megasquirt. However, using this feature will make getting the initial tune easier and make for future tuning/diagnosis simple. If used to trigger the controller on during normal driving it must be connected to the ECM controlled fuel pump enable circuit, the same signal that will turn on a fuel pump relay.

Black: DO NOT USE. This wire, if it was used, must route to the TPS (-) wire.

Blue: Positive trigger on. When this wire is attached to 12v+ the controller will turn on. It must be connected to the ECM controlled fuel pump enable circuit, the same signal that will turn on a fuel pump relay. If the ECM is a negative trigger for the fuel pump, do not connect this wire. However, this wire can be touched to 12v+ and the controller will turn on, hence making pressure setting and controller tuning easier.

Orange/Black: This wire must route to the MAP sensor, Pin 2/ center cavity on the MAP sensor plug.

Light Green. This wire attaches to the MAP sensor (output) signal, Pin 3. It provides the needed voltage signal for the ReturnX controller in order to change the speed of the pump(s). The engine MAP sensor must match the tune in the VaporWorx controller or full pump speed may not be reached.

All wire routing must avoid heat sources such as exhaust manifolds or pipes, be kept away from rotating components, and be protected with grommets or other means to prevent cuts/damage to the wiring.

DO NOT USE A RELAY TO PROVIDE BAT+ POWER TO THE VAPORWORX CONTROLLER. BAT+ MUST BE CONNECTED DIRECTLY TO THE BATTERY AS SHOWN IN DIAGRAM 1.

- 3) The labels on the top of the VaporWorx controller lid shows the input and output sides of the controller. Using the supplied fused link, connect the short end directly to the battery positive and the other to the controller BAT+ input terminal. Ring terminals are provided in the kit. Use the provided heat shrink to seal the ring terminal crimps. **Do not over-tighten the brass terminal nuts on the controller / 10 in-lbs maximum torque.**
- 4) A 4' black wire is provided to route from the controller BAT/PUMP- terminal to the battery negative terminal. The controller side ring terminal is already installed on the wire. Similar to the positive side, crimp and heat shrink the battery negative side terminal. *Do not tighten the nut on the negative terminal on the controller since the fuel pump negative will also be attached.*
- 5) Find a suitable location to mount the VaporWorx MAP sensor mounting block and sensor. Install the brass barb using thread sealant on just the threads. Mount the block using the supplied screws
- 6) Attach the rubber hose to the MAP sensor block brass barb. Route the other end to an engine manifold vacuum source. The supplied hose and barb may be replaced with other hose/fittings provided they are vacuum and pressure/boost rated for underhood temperatures.

- 7) Unwrap the signals harness slowly and group together the wires that need to be routed to the sensor and trigger signal. There is 30' of wire, so take time to lay out the wire and group as needed. Leave the unused trigger signal, coiled separately for now. It will be used later. The unused TPS wire can also be trimmed/coiled taking care to insulate the end of the wire.
- 8) Route the signals wiring toward their respective sources. It is highly recommended that the wiring be installed into a protective sheath(s), such as split-loom or woven braid as provided. Secure the wiring away from sources of heat, sharp edges, and any other potential damage points. Use grommets where needed when passing through sheetmetal. It is permissible to combine any of the signals wiring with the fuel pump wiring.
- 9) Install the protective braid over the signals wiring. Cutting the braid with a soldering iron will help prevent fraying. Slide heat shrink over the ends of the installed braid. Once all wire terminations are complete, heat can be applied to the heat shrink. This will keep the braid from moving and the ends from fraying.
- 10) Connect the ECM trigger wire to the appropriate terminal on the GT150 connector. The VaporWorx controller blue wire requires a 12v positive signal to turn the controller on. If a negative signal is needed, use the yellow wire. For many aftermarket engine harnesses and power centers a 10-14ga high power wire for the fuel pump is often supplied. This wire can also be used to turn on the ReturnX controller but it must be confirmed if the switched power is positive or negative.
- 11) Note in Diagram 1 and Photo 1 the position of the MAP sensor wiring. After cutting the wiring to length, strip the wire, install the seal, and crimp the terminal to the wire and seal. Install the wiring into the correct plug cavity as noted in Photo 1.
- 12) **Loosely** attach the long red 10ga red wire on to the PUMP 1+ terminal on the VaporWorx controller. The controller side terminals are already installed on the wire. Route the other end to the fuel pump connection area. Single pump controllers may only have "PUMP+" noted on the lid.
- 13) Connect the long red 10ga wire from Step 11 to the first fuel pump positive connection. Terminate as needed. There is usually no difference between which is the first or second pump.
- 14) For dual pump controllers, similar to Steps 11-12, route the 10ga green, orange, or white wire from the PUMP 2+ terminal to the second fuel pump positive connection and terminate as needed.
- 15) Similar to Steps 11-12, for **single pump controllers**, route the long 10ga black pump wire from the BAT/PUMP- terminal to the fuel pump negative connection point and terminate as needed.
- 16) Similar to Steps 11-12, for **dual pump controllers**, route the long 8ga black pump wire from the BAT/PUMP- terminal to the fuel pump area. Attach the 12ga wires from the "Y" to the two pump negative connections. Slide a piece of heat shrink on to the 8ga wire. Strip and crimp securely the 8ga butt connector on the "Y" to the 8ga black wire. Seal the butt connection with heat shrink.
- 17) Remove the loosely installed PUMP+ and PUMP – wiring on the VaporWorx controller. Slide the supplied braid over the wires and push toward the pump(s). Cut the braid and install heat shrink tubing to prevent fraying.
- 18) Re-attach the controller side wiring. Tighten the nuts to 10 in-lbs. *Do not over-tighten the brass terminal nuts on the controller / 10 in-lbs maximum torque.*
- 19) Secure the wiring with zip ties, cushion clamps, or other means to hold the wiring in place.

Preparation Required Prior to Engine Startup

- It is highly recommended on dual pump systems to use manifold referenced fuel pressure for supercharged applications. This brings the at-idle pump power requirements down significantly.
- For naturally aspirated applications with large dual pumps like the Walbro 450/525LPH, set the at-idle fuel pressure to as low as practical but keeping at or above 42psi as shown in the table below.

- Put sufficient fuel into the tank so that the pump(s) are well covered.
- Attach a voltmeter to the Pump 1+ and the BAT/PUMP- terminals. Set the range, if needed, to read up to at least 15v. The ReturnX controller is pre-set to a high output voltage. This is done in order to make sure there will be sufficient power available to drive the pumps at initial turn on.
- Attach a fuel pressure gauge to the fuel rail or similar pressurized location.
- Confirm that all connections, hoses, etc. are tight and secure.
- Insert the fuse into the VaporWorx fuse holder. A small spark is normal.

NOTE: The VaporWorx controller can be manually turned on using the unused trigger wire (blue or yellow.) Using this feature as follows will make tuning easier. Once tuning is complete the unused trigger wire may be trimmed and set aside/coiled and used for future diagnostics. The end of the wire must be insulated so that it will not come into contact with any source that could turn the fuel system on or possibly damage the controller.

- Touch the yellow wire to a clean ground source such as the VaporWorx controller BAT-/NEGATIVE terminal. The pump(s) should turn on. If the blue wire is the unused trigger wire, touch it to a 12v+ source such as the VaporWorx controller BAT+ terminal. Once pressure builds, detach the manual trigger wire and check for leaks and repair as needed.
- Turn the ignition key to IGN only. The pump(s) will turn on momentarily by the ECM prime command. Once the prime cycle is complete, reconnect the unused trigger wire to manually turn on the pump(s). Using the supplied tool, adjust the output voltage on the controller as follows:
 - a) Adjust to approximately 10.5 - 11 volts. This is done with the “Fuel Pressure Adjustment” screw inside the small hole on the controller lid. Turning with the adjustment arrow will increase the output voltage. The adjustment is sensitive. The controller should be set close to this value as received.

NOTE: For C5 Corvette Fuel Filter Regulator applications, no mechanical pressure adjustment is possible. Set the at-idle controller output voltage like that shown in the table below.

- Set the fuel pressure with the mechanical regulator per the requirements of the engine.
- Disconnect the unused trigger wire. It is suggested that this wire now be trimmed to a length that will make it easy to use in the future. Insulate the end of the wire so it will not accidentally touch a source that will turn on the pumps unexpectedly. Stow the unused trigger wire using zip ties or other means.
- Start the car and allow to idle. Set the output voltage on the controller as follows:

	Fuel Pressure Settings			
	Carburetors	42psi	50psi	60psi
Single Walbro 450/525LPH pump:	8 – 8.5v	8.5 – 9.0v	9.0 – 9.5v	9.5 – 10.0v
Dual Walbro 450/525LPH pumps:	7.5 – 8.0v	8.0 – 8.5v	8.75 – 9.0v	9.0 – 9.5v
Single Aeromotive Stealth 340:	8.5 – 9.0v	8.75 – 9.0v	9.25 – 9.5v	9.5 – 10.0v
Dual Aeromotive Stealth 340:	8.0 – 8.5v	8.25 – 8.75v	9.0 – 9.25v	9.25 - 9.75v

Use the above as a guideline for other pumps. For example, if a 400lph pump is being used, try setting to it similar to the 450lph pump with perhaps a 1/2v output increase at the respective pressure.

Corvette C5 fuel filter regulators: 9.0 – 9.5v

Alternative Corvette C5 fuel filter regulator setting:

- 1) With the car at idle, reduce the fuel pressure to approximately 50psi.

- 2) Slowly increase fuel pressure using the small provided screwdriver to turn the “Fuel Pressure Adjustment” screw located on the top lid of the controller. The fuel pressure should increase in a smooth manner.
 - 3) Once the fuel pressure stops increasing, the regulator has hit its pressure setting. Adjust the fuel pressure so it is right at the point where the pressure stops increasing.
 - 4) Noting the voltage reading at the controller output, turn the “Fuel Pressure Adjustment” screw to add $\frac{3}{4}$ - 1v to the controller output. Setting is complete.
- Reset the fuel pressure with the mechanical regulator per the requirements of the engine.
 - Test drive the car while monitoring the fuel pressure. For constant/static pressure systems it is common for there to be a 4-6psi pressure reduction from idle to full fuel pump power. If the pressure drop seems as if the pump(s) are not keeping up as fuel demand increases, increase the at-idle output voltage by $\frac{1}{2}$ volt and retest. Typical fuel pump output is increased by 15% for every 1volt, so be thoughtful on not overpowering the pumps.

Troubleshooting

- 1) Fuel pump runs at full speed when the engine is on:
 - a. Adjust the fuel pump speed via the small screw on the top of the controller.
 - b. Check the signal wiring connections. If the sensor negatives are mixed or a feedback wire is mistakenly hooked to a 5v source, it may force the controller into a full-speed mode.
 - 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. A 40A fuse has shown to be adequate for single modules with no voltage increasing devices (Boost-A-Pump). 60A for dual pump applications.
 - b.
 - c. Confirm that a minimum of 10v is available to the VaporWorx blue wire Pin D. 12v + can be applied directly to the GT150 Pin D blue wire for testing only.
 - d. Test by grounding the yellow negative trigger wire. If the controller turns on, confirm that the blue wire is getting 12v+ at initial key-on/engine-off.
 - e. Check that the brass nuts for the battery and fuel module power wiring terminals are properly tightened and free of contamination and corrosion.
 - f. Check the bottom brass nuts that are under the battery and fuel pump ring terminals. The shoulder washers that act as an insulator may relax over time. Retighten to 10 in-lbs maximum and test.
 - g. Check the temperature of the VaporWorx controller black aluminum lid. If the lid is over 225°F the controller will shut down.
 - h. Confirm that the battery and any 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. Increase the at-idle fuel pressure by $\frac{1}{2}$ - 1v.
 - b. If using the MAP sensor for feedback, the manifold vacuum may be unsteady if a very large camshaft is used.

- 4) Fuel pump does not have adequate pressure:
 - a. Increase the at-idle fuel pressure by $\frac{1}{2}$ - 1v.
 - b. Remove the power wiring from the brass terminals on the top of the controller. Confirm that the lower brass nuts are tight.
 - c. Check that the connections from the VaporWorx controller to the fuel pumps are good.
- d. 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 pump(s) have been damaged, or there is a massive leak. The most common cause of fuel pump damage is running the pumps hot and/or dry. Fuel is the life blood for pumps. If the pump does not run then there is a problem with the electrical wiring at the module connection.