

# 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 Single and Dual Bosch -044 Fuel Pump Installation Instructions.

Thank you for your purchase of the VaporWorx fuel module speed control system. This "Smart" system has been designed to work with the Bosch -044 fuel pumps. Beware that there are many counterfeit Bosch pumps. It is recommended to purchase a true Bosch pump from an authorized distributor. Counterfeit pumps may cause pump or controller malfunction.

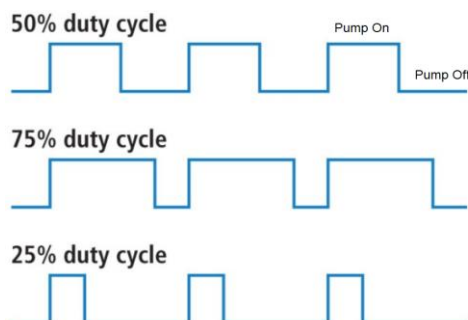
This VaporWorx controller kit is specifically tuned for the Bosch -044 fuel pump. Please consult VaporWorx if the controller is to be used on a pump different that originally specified.

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.

Unlike many other controllers, including some OE types, the VaporWorx PWM systems can operate at 100% duty cycle. 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/cruise fuel is not enough, so a bypass must be used. This bypass is included in the kit.

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 negative trigger. A 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 3bar MAP sensors. For other sensors, please contact VaporWorx.

**Unless otherwise specified the PressureWorx kits are tuned for GM 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. The GM 3bar "Brick" sensors will work as well.**

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.

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 pump 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 and/or have available appropriate personal protective equipment and safe automotive lifting, support, fire extinguishers, and working methods.

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

Some or all relay wiring may already be completed.

- 1) Disconnect the battery from the vehicle.
- 2) Note in Diagram 1 the suggested fuel system layout. Inlet and outlet filters are not shown but must be used per the pump and fuel injector manufacturers requirements. The mechanical regulator is used as a safety device in case of controller malfunction or pressure spikes. This mimics what the OEM's do with a mechanical safety valve in the integrated fuel module design. The mechanical regulator should be set 10-15psi higher than the maximum expected fuel pressure. Do not connect the manifold/boost referenced vacuum hose to the mechanical fuel pressure regulator.

For single pump applications simply eliminate the second pump, "T" connection, and wiring from the installation.

- 3) The VaporWorx bypass fitting has an open and restricted end. The open end must go toward the fuel pump and the restricted end toward the return line from the tank.

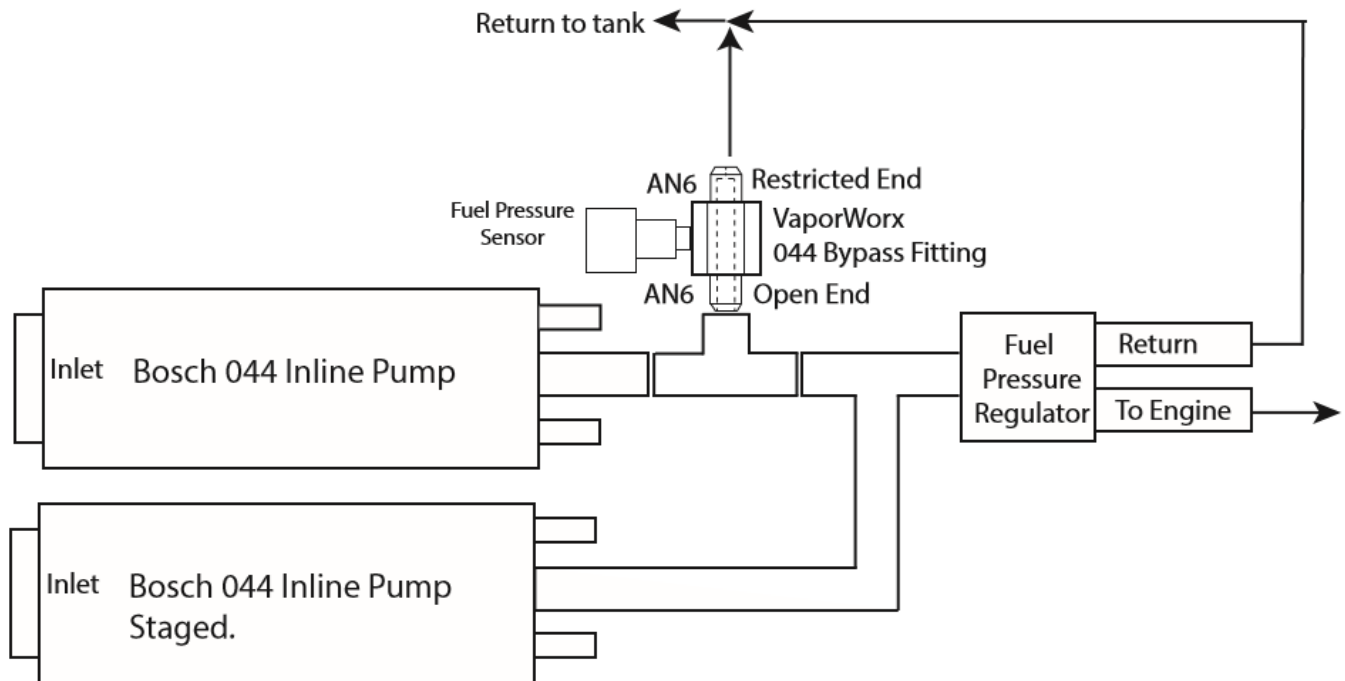


Diagram 1: Fuel line layout using the VaporWorx Bypass Fitting and solenoid valve. For single pump applications do not install the second pump, "T", or wiring.

- 4) Install the fuel pressure sensor into the VaporWorx -044 Bypass Fitting as noted in Diagram 1. The sensor must be mounted near the fuel pump outlet area. If the sensor is mounted in the engine fuel rail rapid pressure fluctuations may occur due to injector pulsations. Use a small amount of Teflon paste to seal **just the threads** of the sensor. The

bypass fitting and fuel pressure sensor may be downstream of the fuel filter if the filter is near the outlet of the pump. Due to the wide variety of injectors, rails, pressures, etc. the minimum distance from the engine fuel rail is unknown.

**Note:** For Steps 6-29, if combining wiring for the fuel pressure sensor and pump power into a common braided loom is desired, do not cut or crimp any terminals until all wiring has been routed to the controller area first.

- 5) 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. Fuel pressure sensor wiring, and any other wiring, may be combined into a common loom to/from the VaporWorx controller.
- 6) Plug the three-cavity fuel pressure sensor plug into the fuel pressure sensor and route the wires to the controller area.
- 7) Find a suitable flat surface to mount the VaporWorx pulse width modulation controller (black box) near the vehicle battery. **It is imperative that the controller 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 controller near sources of heat such as exhaust systems. The cooler the electronics are during operation, the longer their expected life will be. Screws are provided for mounting. Confirm that installed screws do not damage or penetrate body panels, fuel tanks, wiring looms, etc.
- 8) 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, heat, etc.
- 9) The VaporWorx controller GT150 six-pin connector provides fuel pressure sensor, MAP signals, and fuel pump enable/turn on circuit connections. Using the terminals and seals provided as seen in Photo 1A, crimp the terminals to the wires like that shown in Photo 2. Solder the terminals to the wires if needed. There will be 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. **\*\*SEE NOTE BELOW\*\***
  - E. Orange/Black 20ga from MAP - (Must be connected for dual/triple applications.)
  - F. Light Green 20ga from MAP + (Must be connected for dual/triple applications.)
  - G.

NOTE: Single pump applications do not require MAP sensor connections, but can be connected if MAP referenced fuel pressure is desired.

MAP sensor wiring must be connected for dual and triple pump applications. The VaporWorx controller uses MAP signal voltage to trigger the second and third pumps on. The standard controller is set to be used with a GM 3bar sensor and will trigger at approximately atmospheric pressure/1bar. If a different sensor is used improper operation will result.

**For ECM Controlled relay type applications (Pontiac G8, etc.):** Connect Pin D Blue wire to the OE Fuel Pump + wire like that in Diagram 2. The grey color in the diagram matches that of most modern GM vehicles without a fuel system control module. The goal here is to attach the blue wire to the fuel pump + wire in the chassis wiring harness.

**For Gen5 Camaro, CTS-V, GM Fuel System Control Module Vehicles:** Use the 20ga Green/White wire in the FSCM harness plug 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. A green wire is supplied in the kit to connect from the FSCM green/grey to Pin D. See Diagram 3.

- 10) Insert the wires into the Delphi GT150 female connector body as shown in Photo 3. The pinout schedule is listed in Step 10 for the connector body. A capital "A" and "F" can be found on the connector body. Just align to the colors from the VaporWorx GT150 connector.

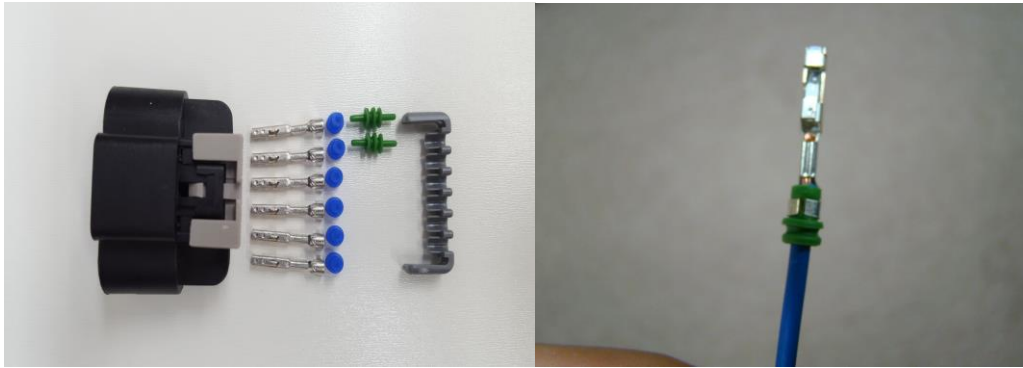


Photo 1: The GT150 connector body, terminals, seals, plugs, and terminal positional assurance clip. Photo 2: The terminal is crimped to the wire and seal. The part number for the Delphi terminal is 12191818. The seal is 15366022. Parts are available from VaporWorx.

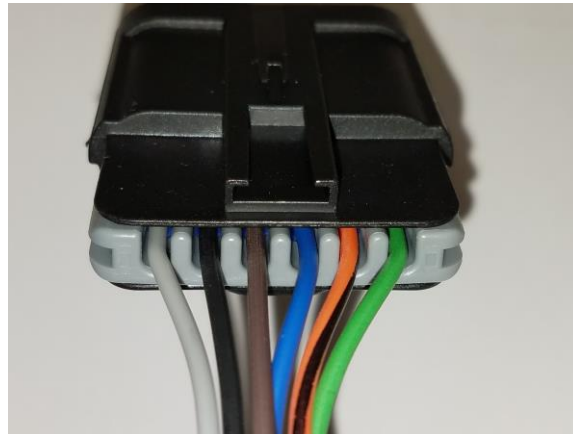


Photo 3: Delphi GT150 female connector. Note that the colors must align to each other on both plugs.

- 11) 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.
- 12) Once the correct wiring has been confirmed, install the grey terminal position assurance clip as shown in Photo 3.
- 13) Connect the blue wire to the ECM fuel system enable circuit. The VaporWorx controller requires a 12v positive signal to operate. If a negative signal is used the system will not function. For vehicles with no FSCM, connect blue wire/Pin D on the VaporWorx controller to the Fuel Pump + wire. This is usually a grey 14ga wire for GM vehicles. A blue-to-grey wire is included in the kit. For FSCM vehicles, connect the blue wire/Pin D to the green/grey 20ga wire in the GM FSCM harness plug. The FSCM harness plug will need to be disconnected and the ECM programmed so that the FSCM is not recognized. See Diagrams 2-3.

For systems such as FAST ECM's that have a negative/pull to ground circuit for the fuel pump enable function, VaporWorx has an option for this feature. Please contact VaporWorx.

- 14) See Diagrams 2-3 for Steps 17-23

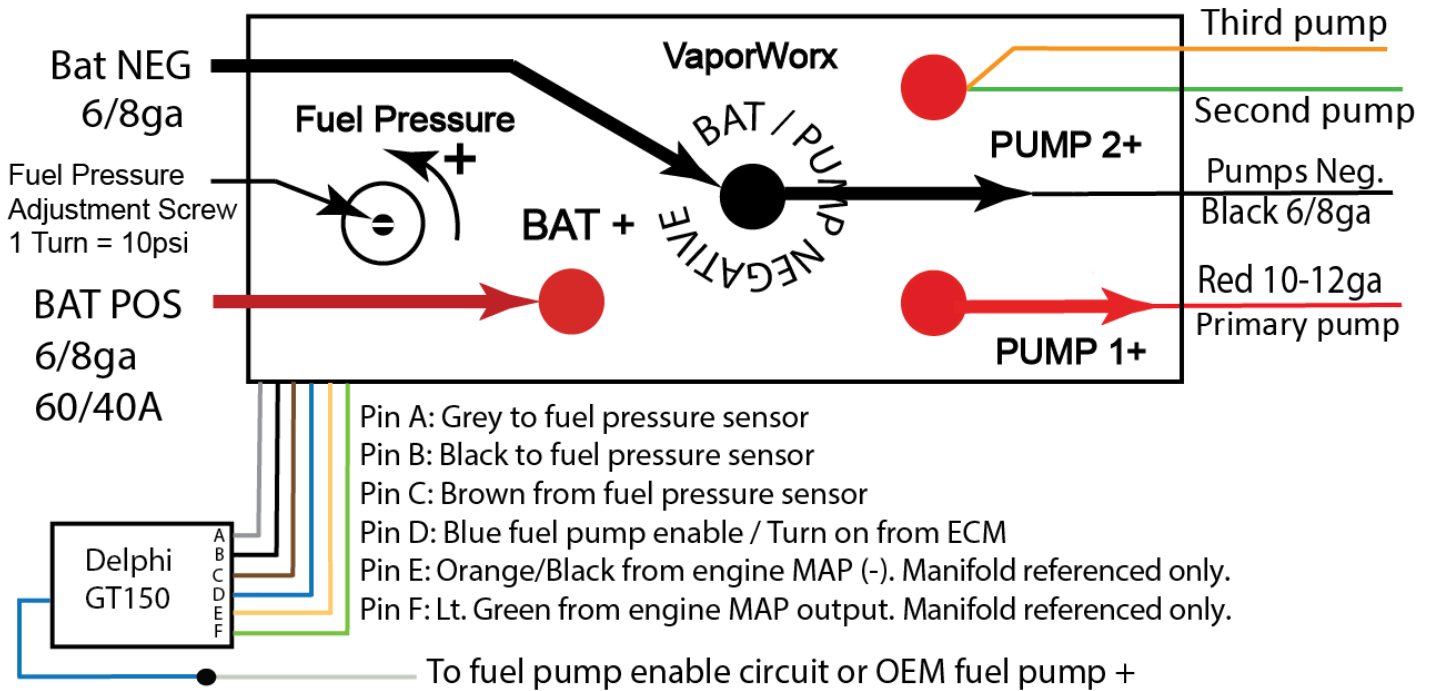


Diagram 2. For vehicles **without** factory installed Fuel System Control Modules. Battery connections come from the left, the output to the fuel pump to the right for illustration purposes only. Do not use chassis grounds for BAT/PUMP NEGATIVE connection.

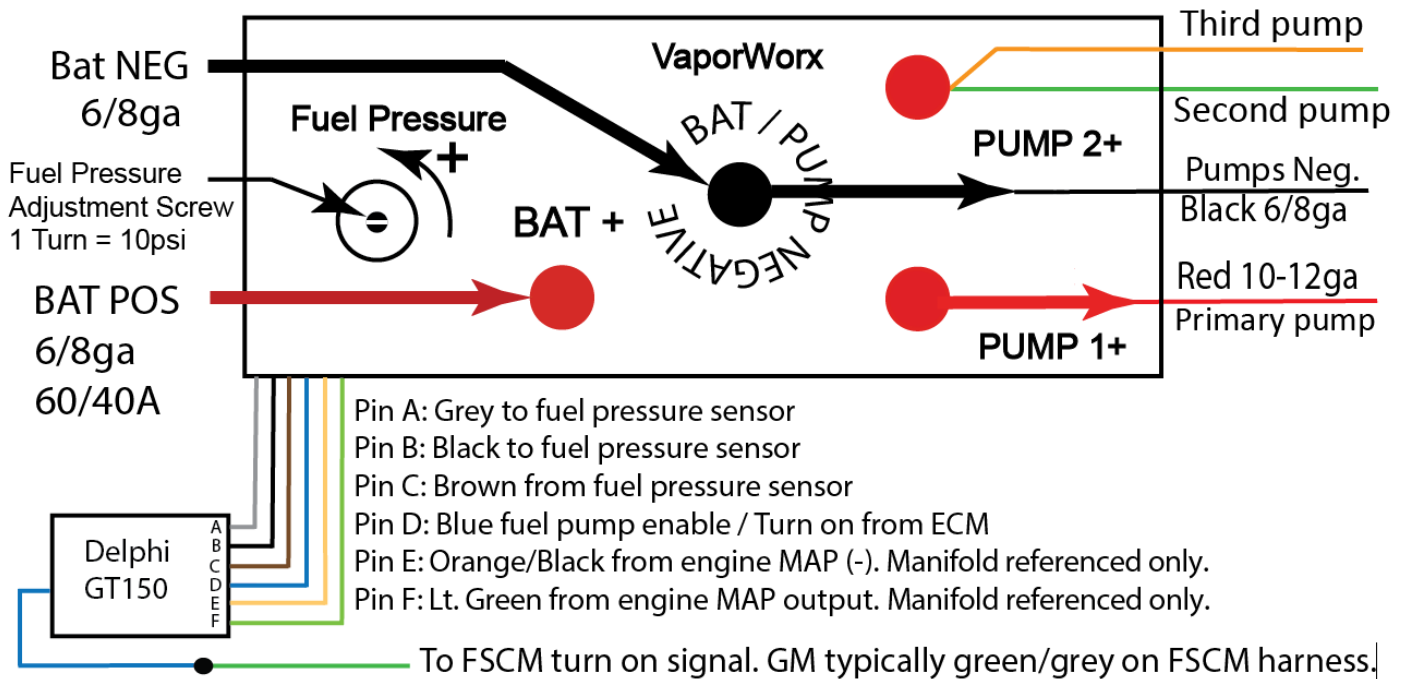


Diagram 3: For vehicles **with** an installed Fuel System Control Module (Gen5 Camaro, Gen2 CTS-V, etc.) use the green/grey wire in the FSCM plug to turn on/off the VaporWorx controller. Do not use the fuel pump + wire on the OEM harness plug. Do not use chassis grounds for BAT/PUMP NEGATIVE connection.

- 15) 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.
- 16) Unbundle the main power harness in the VaporWorx kit. Mount the red BAT + fuse holder, if applicable, in a secure location so that one end can be connected directly to the battery positive terminal.
- 17) The labeling the VaporWorx controller shows the input (BAT +) and output (PUMP 1+ and Pump 2+) posts. Attach one end of the fuse holder to the battery positive terminal (ring terminal installed.) Route the other end of the fuse

holder to the VaporWorx controller BAT + post. Trim the wire length to remove excess but leave enough length so there is no wire strain. Ring terminals are provided in the kit and will require heat shrink insulation tubing to be installed over the crimp. Tighten the brass nut to 10inlbs. *Do not over-tighten the brass nuts 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.

- 18) Route the 6/8ga black wire from the VaporWorx controller negative post (ring terminal installed) to the battery negative terminal. As before, remove excessive length. Ring terminals are provided in the kit, and use heat shrink tubing to insulate the terminal. Install, but do not tighten the brass nut on the VaporWorx controller. The fuel pump negative terminal will be installed later.
- 19) Note which pump has the straighter, least restrictive fuel path to the fuel rail. Consider this pump to be the primary pump and will connect to red wire/Pump 1+ on the VaporWorx controller. The green/orange second and third pumps will connect to Pump 2+. **For single pump applications do not connect the fuel pump wiring to the Pump 2+ terminal, only use Pump 1+ for single pump applications.**
- 20) Using the 6/8ga black wire harness, attach the 12ga split wires to the fuel pump negative terminals. Ring terminals are provided. Remove excessive wire length but leave enough length so that the wiring is not under strain. Securely crimp and heat shrink the terminal crimps. Use electrical tape to bundle your wiring together to make it easier to install the braided sleeve later on.
- 21) Begin routing the wiring from the 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 when passing through sheet metal and/or sharp edges.

See Wiring Layout Diagram for the following steps.

- 22) Route the pump+ red/green/orange wires to the controller. Trim excess length from the wires but leave sufficient length so that the wiring is not under strain.
- 23) Similar to the pumps, crimp the supplied ring terminals to the wires and heat shrink the terminal crimp area. For triple pump applications the wires may be combined into a single ring terminal.
- 24) Attach the red fuel pump wire terminal to the PUMP 1+ post on the VaporWorx controller. This is the wire to use for single pump applications. Tighten the #8-32 brass nut to 10inlbs.
- 25) (Dual and Triple Pumps Only) Attach the green and orange wires (triple pump) to the Pump 2+ post on the VaporWorx controller. Tighten the #8-32 brass nut to 10inlbs.
- 26) Using the #8 x 6/8ga ring terminals provided, cut and strip the 6/8ga fuel pump black wire to the correct length to attach to the BAT/PUMP NEGATIVE post on the VaporWorx controller. Trim excess length from the wires but leave sufficient length so that the wiring is not under strain. Solder the ring terminal to the wire if needed. Use heat shrink tubing to insulate the terminal. Combined with the ring terminal from BAT-, tighten the brass nut to 10inlbs.
- 27) Combining all of the wires from the pumps and sensors together, install the supplied wire braid over the wiring from the controller to the fuel pumps (if appropriate). Taping the ends of the wires will help facilitate installation through the braid. The ends of the braid should be cut with a soldering iron to help keep them from fraying. Slide the braid up as far as practical. Trim the braid and secure on both ends with heat shrink tubing.
- 28) Re-check and secure all connections and verify that all wiring is routed away from sources of potential damage and is not pinched.
- 29) Tighten the terminal stud nuts on the VaporWorx controller to 10-inlbs.
- 30) Insert the 60A/40A fuse into the fuse holder.
- 31) Reattach the vehicle battery.
- 32) *Once the fuel pump module is installed into the tank and all other assembly procedures completed, add fuel to the tank.*

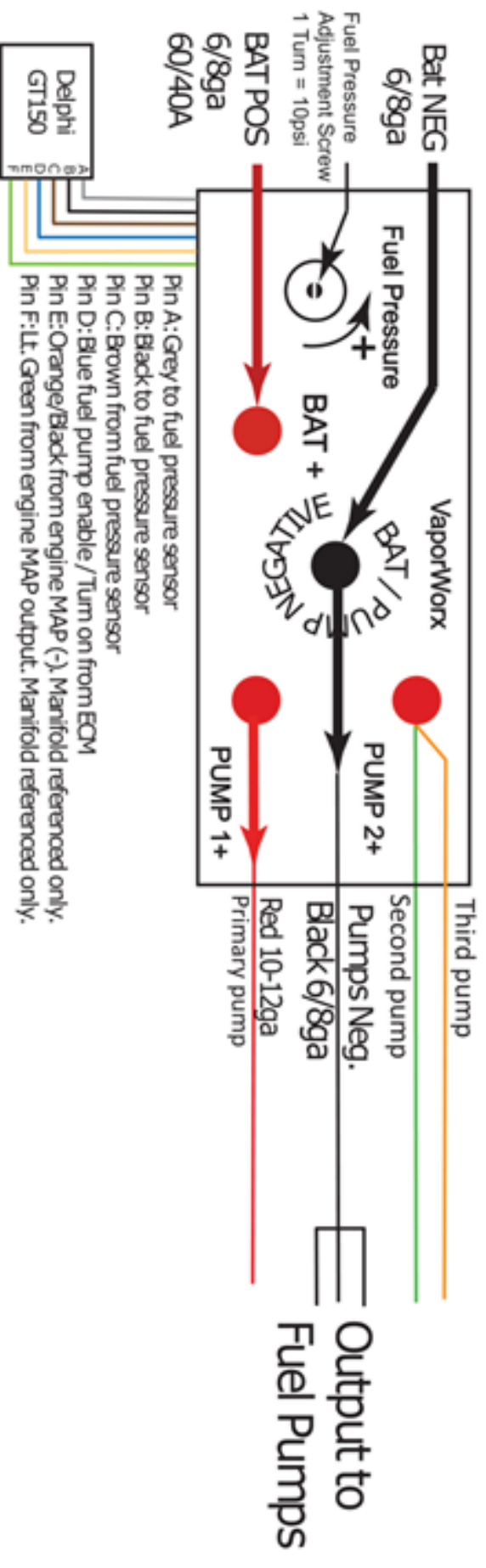


## Preparation Required Prior to Engine Startup

- 33) The controller comes pre-set to for approximately 50psi fuel pressure @ 100kpa/1bar (engine off.) At-idle fuel pressure will depend on engine and camshaft size, but typical at-idle fuel pressures are 40-42psi. **A fuel pressure gauge must be used to verify actual pressure.**
- 34) Turn on the ignition switch. The pumps will likely go to full speed as they try to prime. After 1-2 seconds the pumps should turn off. Repeat the cycle until the pumps prime and pressure can be observed on the fuel pressure gauge.
- 35) Turn off the ignition key and inspect the fuel system and engine fuel rails for leaks and correct as needed. It is normal that the fuel pressure may spike after fuel system shutdown. Fuel pressure should return to normal after engine start-up.
- 36) Start the engine. Use the blue adjustment tool included in the hardware kit to adjust the fuel pressure. The tool can be cut shorter for easier access.
- 37) Shut down the engine as soon as practical and check the fuel system for leaks. Correct as needed.



# VaporWorx Bosch -044 Dual Pump Layout Diagram



# Troubleshooting

- 1) Fuel pump runs at full speed when the engine is on:
  - a. Adjust the fuel pressure.
  - 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 runs at full speed at key-off.
  - a. Confirm that there is no 12+ to the blue trigger wire on the GT150 connector.
  - b. Controller may be damaged. Please contact VaporWorx.
- 3) Fuel pump does not run:
  - a. Check the input fuse and the holder for overheating or blown conditions.
  - b. Check fuel pressure sensor wiring connections Like that in 1b above.
  - 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 lower brass nuts that are under the battery and fuel module ring terminals. These may loosen over time. Retighten them 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 215°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.
  - k. The fuel pump may be damaged. The VaporWorx controller has a sensitive short circuit protection function, so if the pump is damaged, this may cause the controller to shut down.
- 4) 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. Move the fuel pressure sensor to as close to the fuel pumps as practical. In some case where a very short primary fuel line is used, a longer line from a "T" may be needed. The extra length acts a damper for the injector pulses.
- 5) 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. Check that the connections from the VaporWorx controller to the fuel module 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 module is internally damage (broken plastics), the fuel pump(s) have been damaged, or there is a large leak.

## Fuel Pump Output Testing

One question that often arises is how to monitor pump output. This is good to know in order to determine if the pump is adequate for the power produced. To test this, connect one voltmeter to the inputs of the VaporWorx controller (BAT+ and BAT-) and the other to the output (PUMP+ and BAT-). These connections must be made on the controller terminals. In a safe and legal way, have an assistant watch the meters as the car is driven at wide open throttle/maximum fuel demand. Once the output of the controller is 0.2volts less than the input, the controller is effectively sending maximum power to the pump(s). After this point is reached fuel pressure will begin to fall due to a pump over-capacity condition.