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 FourX Fuel Pump Speed Control System.

Thank you for your purchase of the VaporWorx ReturnX FourX fuel pump speed control system. This system is designed to work with the Radium Engineering 20-0990-02 and 20-0990-03 surge tanks using traditional mechanical pressure regulation systems that use a return line and manifold referenced fuel pressure.

The purpose of the VaporWorx fuel module control system is to allow the fuel module pump(s) to adjust their speed based on the Manifold Absolute Pressure. As MAP voltage increases, the ReturnX controller speeds up the pumps. 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 where reduced fuel volume is needed.

A VaporWorx Smart Relay Controller is used to turn the 2nd and 3rd pumps on based on the supplied MAP sensor voltage. The turn-on points are adjustable by a simple voltage measurement and potentiometer setting. In most cases, having the second pump turn on at 3psi boost, and the third at 8psi boost, is a good starting point. The relay controller default setting.

The Radium lift pump and 1st/primary engine pump in the surge tank will always run together.

The output 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.

Triggering On/Off

Similar to a relay, the VaporWorx PWM controller needs a trigger signal to turn on/off. The ECM fuel pump enable circuit should be used for this purpose to keep the priming and safety features functional. The VaporWorx controller, unless otherwise specified, requires a 12v+ ECM trigger signal to be applied to the small blue wire on the GT150 signals connector. If a pull to ground signal is provided by the ECM (FAST, etc.) for fuel pump enable, VaporWorx can convert your controller to accept this signal.

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 for most applications (check your engine requirements). 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 module 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 cars with stainless steel or plastic tanks that provide little heat rejection can lead to pumps running dry and hot. 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 return regulators, all with good results. It is suggested that a high-volume regulator with sufficient pressure range be selected, such as the Radium Engineering 20-0100-00 and 20-0100-01.

Horsepower guidelines for line size going to the engine:

Under 750hp: AN6
Under 1200hp: AN8
Under 2000hp: AN10

There is no drawback to using a larger line size except for cost and difficulty of installation/available space. Teflon/PTFE hoses are highly suggested due to their superior chemical compatibility with all automotive fuels (gasoline, E85, methanol, etc.)

Return line sizes can typically be one AN size smaller than the feed line.

Handy Bits To Have

A Schrader valve, aka Fuel System Diagnostics Port, is often not included in most aftermarket fuel rail or feeders for mechanical pump/DPI systems. However, it's really hard to measure fuel pressure with a good 'ol mechanical gauge unless there is a Schrader valve. You will thank yourself later for taking the time to have one easily accessible.

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. 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) Disconnect the negative battery wire from the battery.

2) Find a suitable **flat surface** to mount the VaporWorx Pulse Width Modulation controller (big black box) and the relay controller box near the vehicle battery. It is imperative that the PWM controller be mounted as close and connected **directly to the battery** as practical. The relay controller will need to be nearby the PWM controller as well, so use the connecting wire harness as a maximum length guide. 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 ¾" screws are provided for mounting.

See Diagram 1 below for the following steps:

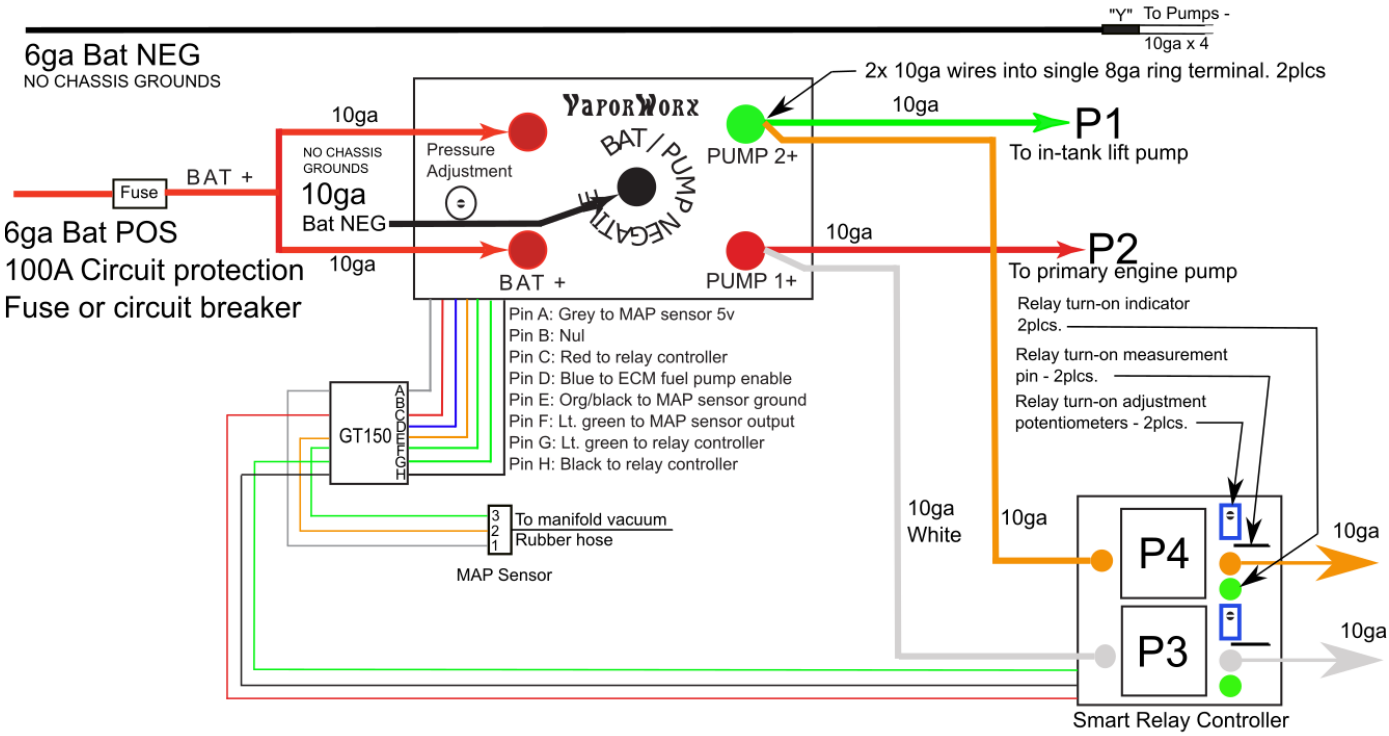


Diagram 1. Basic wiring layout for the VaporWorx FourX controller. The wiring may enter/exit the controller area as needed provided there is no chance of shorting between connections.

3) The ReturnX GT150 eight-pin connector provides signals interfacing for the remote sensors and turn-on signals. The pinout schedule follows:

A: Grey 20ga to the MAP (5v) sensor.
B: Nul
C: Red 20ga to the Smart Relay Controller
D: Blue 20ga to the ECM 12v+ fuel pump enable circuit
E: Orange/Black 20ga to the MAP (-) sensor
F: Light Green 20ga to the MAP (output) sensor
G: Light Green 20ga to the Smart Relay Controller
H: Black 20ga to the Smart Relay Controller

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.

4) The labels on the top of the VaporWorx controller lid shows the input and output sides of the controller. Using a user-supplied 100A rated fuse holder or circuit breaker, connect one end of the red 6ga wire directly to the battery positive and the other to the controller BAT+ input terminals. ***Make sure the fuse is removed or the circuit breaker is off.*** 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. If this, and the other brass studs on the controller are broken, it may not be possible to repair them.***

5) In the hardware kit a 10ga x 4' black wire is provided to route from the **BAT/PUMP NEGATIVE** terminal on the controller to battery negative. NO CHASSIS GROUNDS. The controller-side ring terminal is already installed. Like the positive side, crimp and heat shrink the battery negative side terminal. Tighten the **BAT/PUMP NEGATIVE to 10in-lbs.**

6) A stand-alone MAP sensor and mounting bracket are provided like that shown in Photo 1. The rubber hose runs from the brass barb fitting to the pressurized side of the intake manifold/supercharger. The hose needs to be attached in a similar place that would be used to attach a boost gauge. If placed before the supercharger/turbocharger compressor the fuel pumps will not reach full speed and a lean condition may result. Use the screws provided to secure the mount and attach the sensor as shown.

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

7) Unwrap the 20ga signals harness slowly and group together the wires that need to be routed to the MAP sensor and the ECM fuel pump enable trigger signal. These wires can be combined with any other wires used in the VaporWorx controller kit. It is highly recommended that the wiring be installed into a protective sheath, such as split-loom or the woven braid as provided. Use grommets where needed when passing through sheetmetal or other sharp objects.

NOTE: Using a soldering iron to cut/seal the woven braid will prevent the ends from fraying. Once cut and cooled, the ends of the braid can be rolled between fingers to help break up the halo of melted material, hence making installation over the wiring easier. Applying heat shrink the ends of the installed braid will keep the braid from further fraying and make for a clean and professional installation. See Photo 2 below.

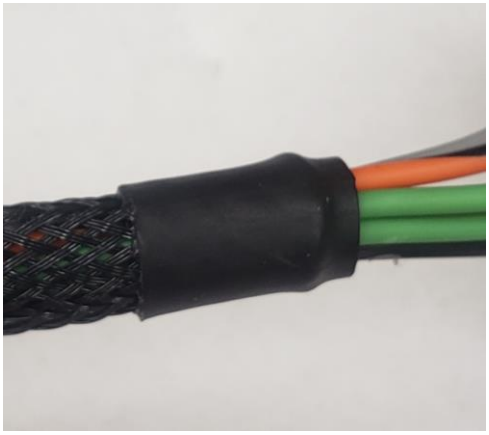


Photo 2. Note how the heat shrink covers the end of the braid to reduce fraying.

8) Plug the MAP senor wiring into the MAP sensor. Route the wires back to the VaporWorx controller. Do not yet terminate the wiring at the controller.

9) Route the ECM fuel pump enable wire back to the VaporWorx controller. Do not yet terminate the wire at the controller.

10) Connect the blue wire to the ECM fuel pump enable circuit. The VaporWorx controller blue wire requires a 12v positive signal to turn the controller on. If a negative signal is provided by the ECM, please contact VaporWorx. Many aftermarket engine harnesses and power centers have a 10-14ga high power wire for a fuel pump. This wire can also be used to turn on the ReturnX controller by attachment to the blue trigger wire.

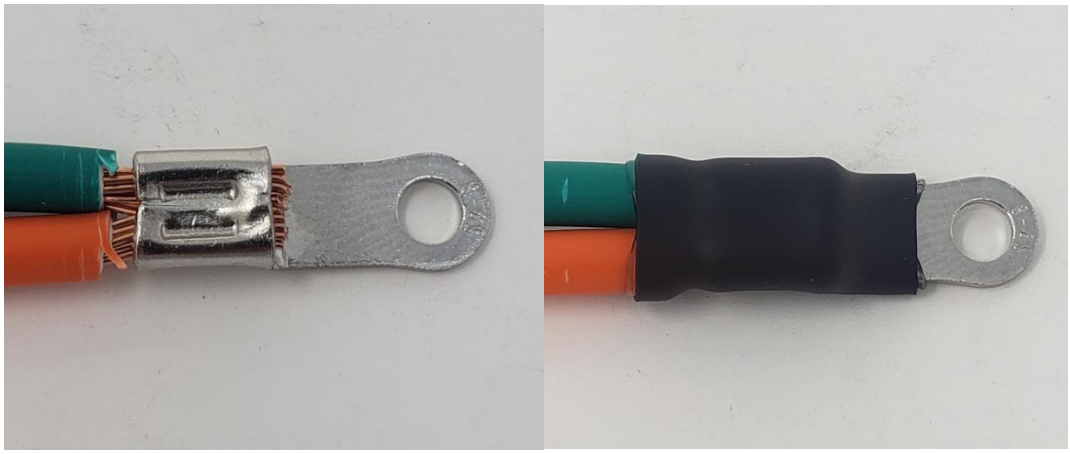
11) Unwrap the wiring harness that has the six-pin female GT280 plug with five wires attached. Plug this into the Smart Relay Controller and route the wiring toward the PWM controller. Do not yet terminate the wiring.

    Handy Tip: The terminal used usually determines gender, not the plug body.

12) Unwrap the wiring harness that has the two-pin female GT280 female plug with the white and orange 10ga wiring. Plug the two-pin connector into the mating connector on the Smart Relay Controller. Route the wiring toward the fuel pumps leaving sufficient length on both ends to make terminal connections, proper routing, securing, etc.

13) Unwrap the long 10ga red and green wires. Route these wires toward the fuel pumps leaving sufficient length on both ends to make terminal connections, proper routing, securing, etc.

14) The white 10ga wire from the Smart Relay controller will be combined with the 10ga red wire into a single 8ga ring terminal at the PWM controller Pump 1+ terminal stud. The green and orange 10ga wires will be combined into a single 8ga ring terminal at the PWM controller Pump2+ terminal stud. Use protective braid over the white and orange wires, and slip two pieces x ½" long of heat shrink over braid. Confirm the proper lengths of all wires, then cut each one to length. Strip approximately ½" of insulation from the end of each wire and install into the ring terminal. Securely crimp the terminal. See Photos 3-4.



Photos 3-4. 2x 10ga wires tie into the single 8ga ring terminal. Use heat shrink to cover the crimp. 10ga white and red similar.

15) Attach the red/white 10ga to the PWM controller Pump 1+ stud, and the 10ga green/orange to the Pump 2+ stud. Tighten the nuts to 10 in-lbs. The PWM controller wiring layout should look like that in Photo 5.

16) Unwrap the long 6ga black insulated wire. One end has 4x wire pigtails for the fuel pump grounds. Trim the pigtails to length and install the Radium required ring terminals. Use heat shrink as needed to seal the crimp. Attach the pigtails to the pump negative terminals on the Radium Engineering fuel pump hat.

Photo 5. Wiring connections at the PWM Controller.

17) Route the 6ga black insulated wire to the battery negative terminal. Ring terminals are provided but your application may require a specific size that is not included. Securely fasten the ring terminal to the battery positive terminal.

18) Route the 10ga red, white, orange, and green wires to the Radium Engineering fuel pump hat. Try to keep them tidy and bundled nicely. Use tape to help keep the bundle together.

19) Route the four 10ga wires as follows to the fuel pump hat:

    a) Green 10ga: Lift pump+ (P1 in Diagram 1)
    b) Red 10ga: Primary engine feed pump+ (P2)
    c) White 10ga: Second engine feed pump+ (P3)
    d) Orange 10ga: Third engine feed pump+ (P4 – if used)

20) Leaving a bit of extra length to accommodate minor routing changes, cut each wire to the appropriate length to reach the intended terminal. Do not strip end of wires.

21) Using blue painters tape, tape the ends of the wires to the main bundle. This will make installing the woven wire braid easier.

22) Slide the woven wire braid on to the four-wire harness. Cut to length using a soldering iron and slip on two pieces of the large heat shrink. Remove the blue tape. Do not set the heat shrink.

23) Like the pump negative terminals, install the ring terminals and attach according to the schedule in Step 19.

24) Finalize the four-wire harness routing, adjust the woven wire braid accordingly, and set the heat shrink over the ends of the braid. Confirm that any unprotected wire will not contact its surroundings. If contact occurs, use split loom tubing, a split rubber hose, etc. to protect the wire from rubbing.

25) Going back to the 20ga signal wires, route all of them toward the eight-pin connector on the PWM controller. Route the wiring along its final path to the controller so that the wires can be cut to the appropriate length. It is suggested to leave a bit of extra length to allow for minor routing changes.

26) Install the woven wire braid and heat shrink tubing as needed onto all signal wiring. Do not set the heat shrink.

27) Strip approximately 3/16” of insulation from each wire. Slide the blue wire seal onto the insulation until the end of the seal is at the end of the insulation. Crimp the terminal to the wire first, then crimp the terminal to the seal. The crimp should look like that in Photo 6.

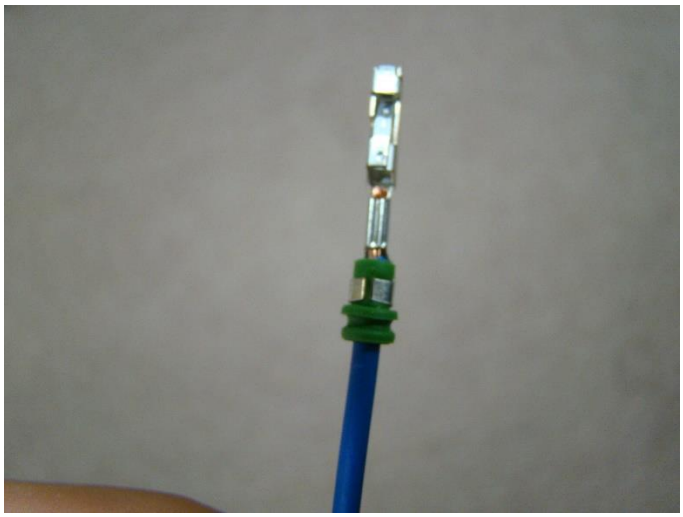


Photo 6. GT150 terminal and seal installed.

28) Using the PWM controller eight-pin connector body as a guide, install each wire into the mating connector. Just line up the colors. The two light green wires connect to the same point inside the controller, so if they are mixed it will cause no problems. However, the placement as shown in Diagram 1 should make for best routing to the MAP sensor and Smart Relay Controller. If needed, remove the purple cap on the end of the connector and release the terminal by lightly prying up on the internal release tab.

29) Finalize woven wire braid placement and set the heat shrink.

30) Secure all wiring with zip ties, cushion clamps, or other means to hold the wiring in place.

31) Check that all wiring connections are tight and secure.

32) Place any woven wire braid and heat shrink as needed to help protect the wiring.

Preparation Required Prior to Engine Startup

33) Re-attach the negative battery cable.

34) It is recommended that Steps 34-35 be skipped until after the engine has been started and running normally/not under heavy power. Just get the car running/idling normally first, then test with the provided settings. If changes are needed then follow Steps 34-35.

35) As noted in Diagram 1, P3 and P4 will be connected to the PWM controller once the relay activates for each circuit. The green LED lamp will illuminate when the relay activates.

36) The turn-on point for each relay can be tuned to activate at the desired manifold pressure. The supplied settings should turn on P3 at approximately 3psi boost, P4 at 8psi boost. P3 must turn on before P4. The following can be performed to change the turn on levels:

- Attach a voltmeter positive lead to the exposed pin next to the potentiometer for the relay to be tuned. Using a test lead with alligator clips to attach to the pin is helpful. Attach the voltmeter negative lead to the BAT/PUMP NEGATIVE stud on the VaporWorx controller. See Photo 7.

- Energize the fuel pump enable wire. This can be done via HP Tuners/EFI Live or other software to force the fuel pump on. The car can also be started with the engine running.

- Measure the voltage at the exposed pin. Using the supplied miniature screwdriver, adjust the potentiometers according to Chart 1 below:

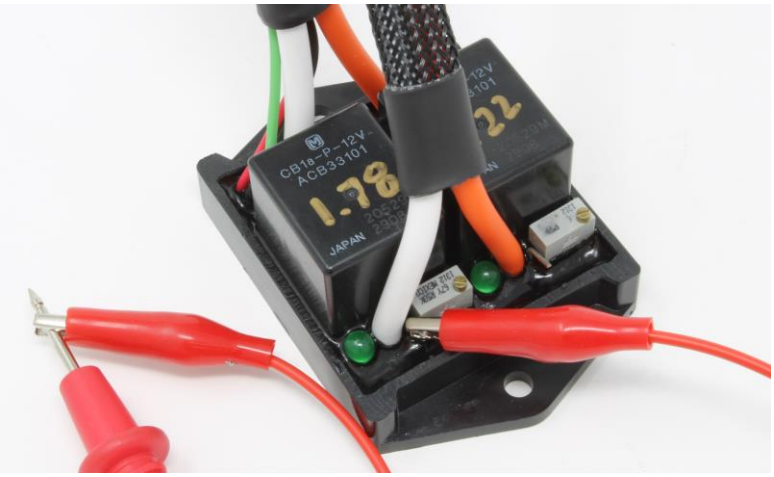


Photo 7. The voltmeter positive lead is attached to the P3 adjustment pin. Adjustments are made via the small brass screw on the adjacent potentiometer. The LED next to the P3 relay will illuminate when the relay is activated. P4 and its relay will act the same way. Be sure to set P3 to come on before P4. P3 must come on first.

Kpa ABS	InHg/psi	Voltage at pin
60	12	1.06
70	9	1.18
80	6	1.30
90	3	1.42
100	0	1.55
110	1.5	1.67
120	2.9	1.79
130	4.4	1.91
140	5.8	2.03
150	7.3	2.15
160	8.7	2.27
170	10.2	2.39
180	11.6	2.51
190	13.1	2.63
200	14.5	2.75
210	16.0	2.87
220	17.4	2.99
230	18.9	3.12
240	20.3	3.24
250	21.8	3.36
260	23.2	3.48
270	24.7	3.60

Chart 1. The relay turn-on point is set by changing the potentiometer setting. Turn the potentiometer until the measured voltage is at the "Voltage at pin" in the chart that corresponds with the manifold pressure turn-on point desired. The 1.78v/2.22v settings as supplied should work well for most applications. The relay will turn off at approximately 4psi below the set point.

37) Put sufficient fuel into the tank so that the pump(s) are well covered.

38) Attach a voltmeter to the PWM controller Pump 1+ and the BAT/PUMP- terminals. Set the voltmeter range, if needed, to read up to at least 15v. The ReturnX controller is pre-set to a high output voltage. This is done to make sure there will be sufficient power available to drive the pumps at initial turn on.

39) Attach a fuel pressure gauge to the fuel rail or similar pressurized location. It is recommended to have a fuel pressure diagnostics port / Schrader valve be easily accessible.

40) Confirm that all connections, hoses, etc. are tight and secure.

41) Insert the fuse into the fuse holder or turn on the circuit breaker. A small spark is normal.

42) Turn the ignition key to IGN only. The pump(s) should turn on momentarily by the ECM prime command. Once the price cycle is complete, repeat if needed to build fuel line pressure by monitoring the pressure gauge.

43) The VaporWorx controller should be pre-set with sufficient output power to get the car started. If needed, increase the pump speed by turning the “Pressure Adjustment” screw one turn in the direction of the arrow.

44) Start the car and allow to idle. Set the fuel pressure with the mechanical regulator per the requirements of the engine.

45) Set the output voltage on the controller as follows:

			Fuel Pressure Settings		
	Carburetors	42psi	50psi	60psi	70psi
450/525LPH pumps:	7.5 – 8.0v	8.0 – 8.5v	8.75 – 9.0v	9.0 – 9.5v	10.5v

46) Reset the fuel pressure with the mechanical regulator per the requirements of the engine.

47) Test drive the car while monitoring the fuel pressure. Pressure should increase on a 1:1 basis, fuel pressure vs. manifold pressure. If the manifold pressure goes up by 5psi, so should the fuel pressure.

Troubleshooting

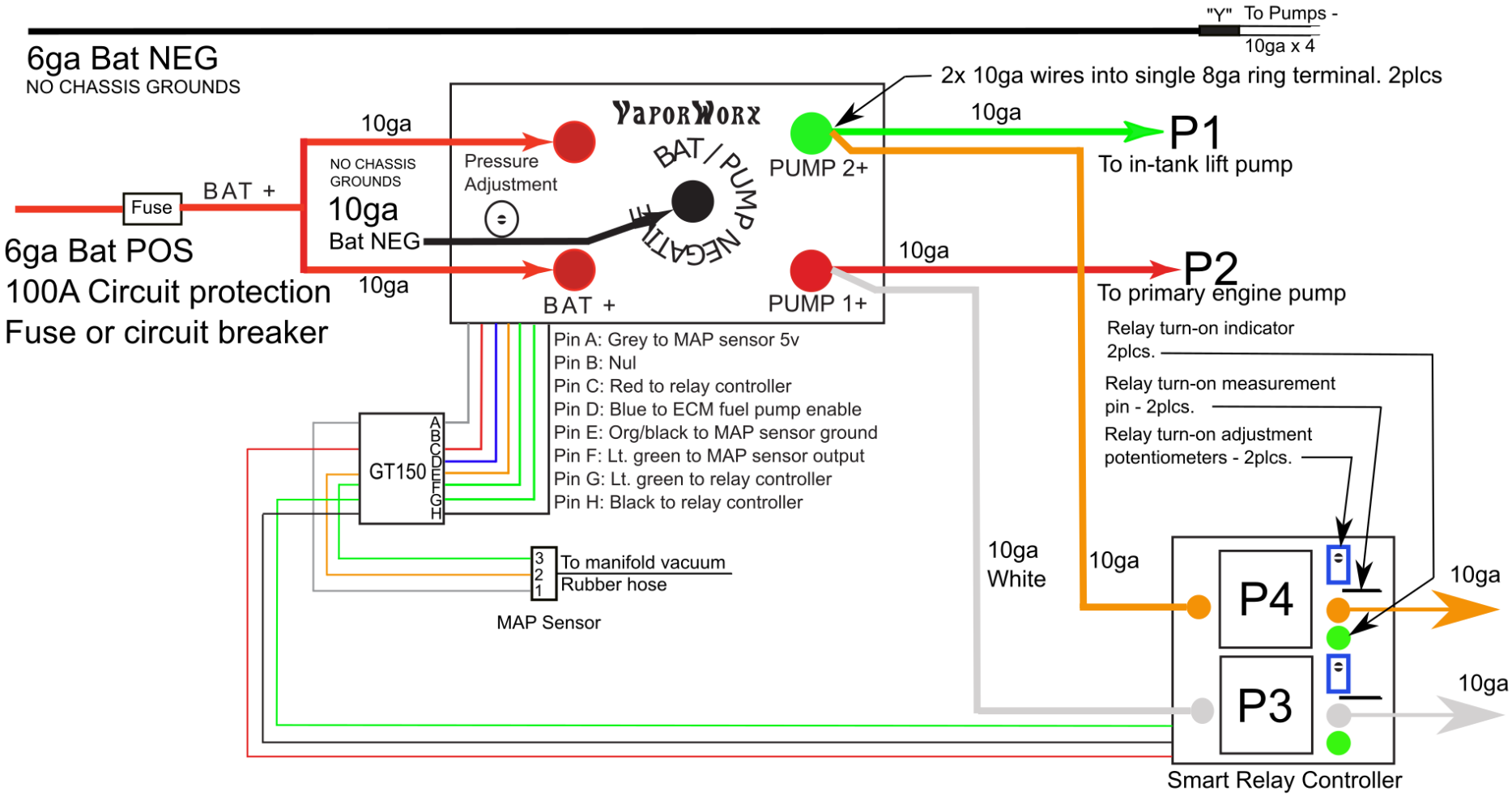
1) Fuel pump runs at full speed when the engine is on:
   a. Adjust the fuel pump speed via the small screw on the top of the controller.
   b. Check the signal wiring connections. If the sensor negatives are mixed or a feedback wire is mistakenly hooked to a 5v source, it may force the controller into 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.
   b. 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.
   c. Check that the brass nuts for the battery and fuel module power wiring terminals are properly tightened and free of contamination and corrosion.
   d. 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.
   e. Check the temperature of the VaporWorx controller black aluminum lid. If the lid is over 225*F the controller will shut down.
   f. Confirm that the battery and any butt-joint connections are good. Use a volt-ohm meter to check connections.
   g. Confirm that the input and output main power wires from the battery and to the fuel module are correct/not reversed.
   h. 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 ½ - 1v.
   b. If using the MAP sensor for feedback, the manifold vacuum may be unsteady if a very large camshaft is used.

4) Fuel system does not have adequate pressure:
   a. Increase the at-idle Pump 1+ voltage by ½ - 1v. 1v changes pump performance by roughly 15%.
   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 1+ on the VaporWorx controller. If the fuse is good the P1 and P2 pumps should run. If the pump is running but little or no fuel pressure exists, then fuel pump(s) damage may have occurred. 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 may be a problem with the electrical wiring at the module connection or the pump is locked up.

5) Fuel pumps run all the time, even at key-off:
   a. Check that the blue trigger wire is off.
   b. If the pumps are running full speed at key off, controller damage may have occurred. Please contact VaporWorx.



P3 must turn on before P4.

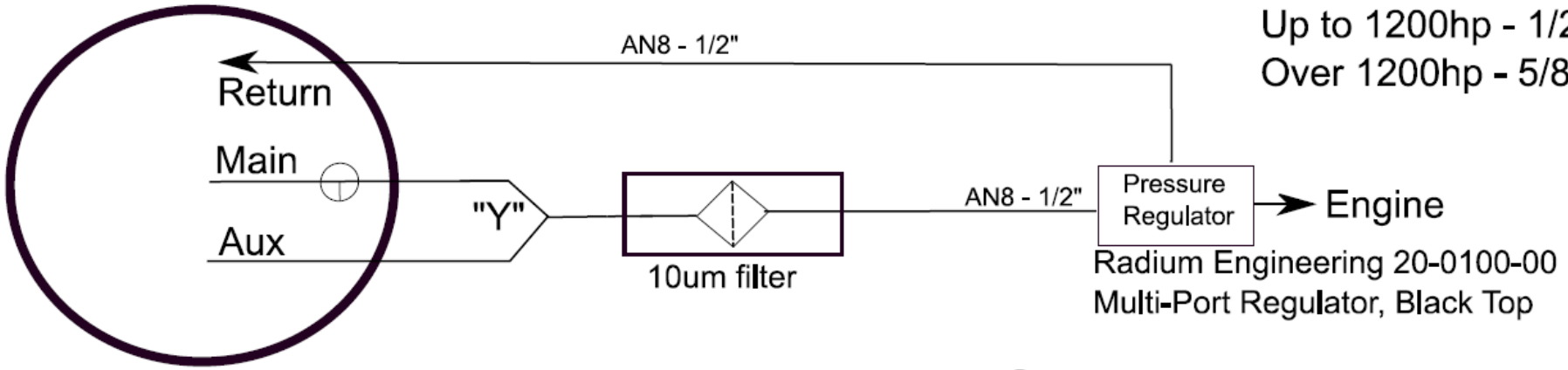
Turn potentiometer CW to increase the turn on point

VaporWorx FourX Return-Type Fuel System Controller

VaporWorx

Typical plumbing layout for single or multi-pump hydraulic fuel systems utilizing mechanical pressure regulators.

Line size to engine:
Up to 750hp - 3/8"
Up to 1200hp - 1/2"
Over 1200hp - 5/8"



Radium Engineering 20-0100-00
Multi-Port Regulator, Black Top

For Radium Four Pump System