



AEROMOTIVE

Part # 66164

ReturnX Return-Type Pulse Width Modulation Controller INSTALLATION INSTRUCTIONS

This product is not legal for sale or use on emission-controlled vehicles except when used as a direct replacement part matching OEM specification.

WARNING!



Always be aware of flammable situations. Drilling and grinding can be potential ignition sources. Extinguish all open flames, prohibit smoking and eliminate all sources of ignition in the area of the vehicle and workspace before proceeding with the installation. Ensure you are working in a well ventilated area with an approved fire extinguisher nearby.

WARNING!



Installation of this product requires modification to a fuel tank/ the fuel system, failure to satisfy all safety considerations will result in fire, explosion, injury and/or loss of life to yourself and/or others. All fuel system components **MUST** be located as far from heat sources as possible, like exhaust, engine block, etc.

WARNING!



Mechanical and hydraulic lifting devices can tip over or lower accidentally due to incorrect maneuvering or technical errors. A falling object can cause injury and/or loss of life to yourself and/or others. When working under the vehicle, always use stands, and ensure that the ground or floor is stable and level. Never crawl under a vehicle which is only supported by a jack.

WARNING!



The fuel system is under pressure. Do not open the fuel system until the pressure has been relieved. Refer to the appropriate vehicle service manual for the procedure and precautions for relieving the fuel system pressure.

CAUTION!



When installing this product always wear safety glasses and other appropriate safety apparel. A drilling operation will cause flying metal chips. Flying metal chips can cause eye injury.

CAUTION:



Installation of this product requires detailed knowledge of automotive systems and repair procedures. We recommend that this installation be carried out by a qualified automotive technician. Careless installation of this product can result in damage to the product, injury or loss of life to yourself and/or others.

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, controller damage, and throttle runaway conditions will result if the TPS input is used.

Triggering On/Off

Similar to a relay, the VaporWorx needs a triggering 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. 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 on page 7.

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 $\frac{1}{4}$ 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/>

Fuel pressure regulators in a variety of types, styles, and fitment are available from Aeromotive. Please visit the Aeromotive website at www.aeromotive.com for more details.

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:

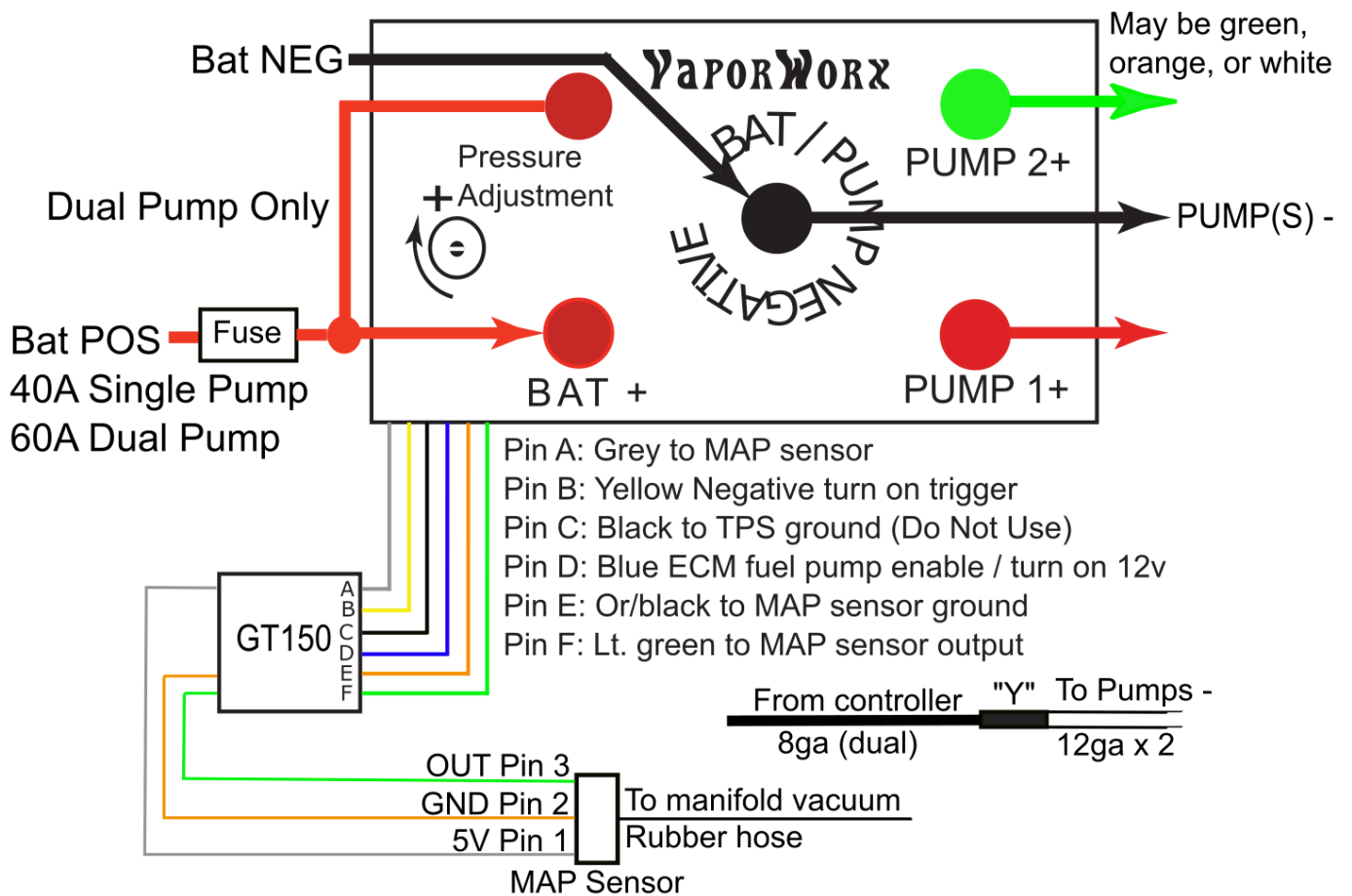


Diagram 1. Basic wiring layout for the VaporWorx controller. The wiring may enter/exit the controller area as needed provided there is no chance of shorting between connections.



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 20ga. To VaporWorx MAP (5v) sensor.
- B: Yellow 20ga from the ECM negative trigger fuel pump enable circuit***
- C: Not used.
- D: Blue 20ga from the ECM 12v+ fuel pump enable circuit***
- E: Orange/Black 20ga to the VaporWorx MAP (-) sensor
- F: Light Green 20ga to the VaporWorx MAP (output) sensor

NOTE *:** Use either the 12v+ or negative trigger source. Do not use both. Most all ECM fuel pump enable are 12v+ signals. Some Edelbrock and FAST systems use a negative trigger source. Be sure to confirm what trigger type the ECM source provides.

Grey 5v: This wire is used to provide a 5v source for the remote MAP sensor. It is routed to Pin 1 on the MAP sensor plug.

Yellow: Negative trigger on. When this wire is attached to ground 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 12v+ trigger for the fuel pump, do not connect this wire. However, this wire can be touched to ground and the controller will turn on, hence making pressure setting and controller tuning easier.

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 VaporWorx MAP sensor, Pin 2/ center cavity on the MAP sensor plug.

Light Green. This wire attaches to the MAP sensor (output) signal, Pin 3 on the MAP sensor plug. It provides the voltage signal so the ReturnX controller can change the speed of the pump(s).

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.

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 one 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, and mount the supplied MAP sensor to the block using the supplied M6 screw.
- 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 MAP sensor and trigger signal. There is 30' of wire, so take time to lay out the wire and group as needed.
- 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 to seal the ends of the braid. This will keep the braid from moving and the ends from fraying. See the braid and heat shrink on the VaporWorx controller as an example.
- 10) Connect the ECM trigger + signal wire to Pin D/blue wire on the GT150 signals connector. The VaporWorx controller blue wire requires a 12v positive signal to turn the controller on. If a negative turn on signal is provided by your ECM, please contact VaporWorx. 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 through Pin D 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. If a crimping tool is needed an inexpensive too offered by Ballenger Motorsports works well. P/N TOOL-01000
- 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.
- For single pump controllers, 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.
- For dual pump controllers, attach a voltmeter to the **Pump 2+** 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.
- Turn the ignition key to IGN only. The pump(s) should turn on momentarily by the ECM prime command. Once the prime cycle is complete, repeat if needed to build fuel line pressure by monitoring the pressure gauge.
- Check for leaks and repair as needed.
- The VaporWorx controller should be pre-set from with sufficient output power to get the car started. If needed, increase the pump speed by turning the "Pressure Adjustment" screw one turn. This does not increase fuel pressure, just the pump speed.
- Start the car and allow to idle. Set the fuel pressure with the mechanical regulator per the requirements of the engine.
- 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, turn the controller adjustment screw to reduce the fuel pressure to approximately 50psi.

- 2) Slowly increase fuel pressure 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 and should be similar to that in the above table.
- 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. 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. For negative trigger options try connecting the yellow Pin D wire to ground.
 - 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 $\frac{1}{2}$ - 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.

Contact US

RGa NUMBER REQUIRED FOR ALL RETURNS TO AEROMOTIVE.

To obtain an RGA number, please call (913) 647-7300 and ask for the Returns and Repairs department.

- **Shipping & Returns**
Aeromotive Inc.
10955 Mill Creek Road
Lenexa, KS 66219

General Inquiries and Tech Line: (913) 647-7300

General Email: info@aeromotiveinc.com

Tech Email: tech@aeromotiveinc.com

The Aeromotive Tech Lines are open Monday through Friday from 9:30AM to 5:00PM Central Standard Time.



WARNING: This product can expose you to chemicals, including chromium, which is known to the State of California to cause cancer or birth defects or other reproductive harm. For more information, visit: www.p65Warnings.ca.gov

AEROMOTIVE, INC. LIMITED WARRANTY

This Aeromotive Product, with proof of purchase dated on or after January 1, 2003, is warranted to be free from defects in materials and workmanship for a period of one year from the original date of purchase. No warranty claim will be valid without authentic, dated proof of purchase.

This warranty is to the original retail purchaser and none other and is available directly from Aeromotive and not through any point of distribution or purchase.

If a defect is suspected, the retail purchaser must contact Aeromotive directly to discuss the problem, possible solutions and obtain a Return Goods Authorization (RGA), if deemed necessary by the company. Please call 913-647-7300 and dial option 3 for the technical service dept. All returns must be shipped freight pre-paid to the company and with valid RGA before they will be processed.

Aeromotive will examine any product returned with the proper authorization to determine if the failure resulted from a defect or from abuse, improper installation, misapplication or alteration. Aeromotive will then, at it's sole discretion, return, repair or replace the product.

If any Aeromotive product is determined defective, buyer's exclusive remedy is limited in value to the sale price of the good. In no event shall Aeromotive be liable for incidental or consequential damages.

Aeromotive expressly retains the right to make changes and improvements in any product it manufactures and sells at any time. These changes and improvements may be made without notice at any time and without any obligation to change the catalogs or printed materials.

Aeromotive expressly retains the right to discontinue at any time and without notice any Aeromotive product that it manufactures or sells.

This warranty is limited and expressly limits any implied warranty to one year from the date of the original retail purchase on all Aeromotive products.

No person, party or corporate entity other than Aeromotive shall have the right to: determine whether or not this Limited Warranty is applicable to any Aeromotive product, authorize any action whatsoever under the terms and conditions of this Limited Warranty, assume any obligation or liability of any nature whatsoever on behalf of Aeromotive under the terms and conditions of this Limited Warranty.

This Limited Warranty covers only the product itself and not the cost of installation or removal.

This Limited Warranty is in lieu of and expressly excludes any and all other warranties, expressed or implied. This Limited Warranty gives you specific legal rights, and you may also have other rights which vary from state to state.