



AEROMOTIVE
Part # 66172
VaporWorx Triple/FourX Fuel Pump Speed Control
System
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!



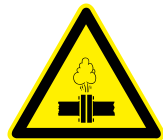
Installation of this product requires modification to a fuel tank/ the fuel system, failure to satisfy all safety considerations will result in fire, explosion, injury and/or loss of life to yourself and/or others. All fuel system components **MUST** be located as far from heat sources as possible, like 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 Triple or FourX fuel pump speed control system. This system is designed to work with triple brushed fuel pump hangers and Radium Engineering 20-0990-02 and 20-0990-03 surge tanks using traditional mechanical pressure regulation systems using a return line and manifold referenced fuel pressure.

The purpose of the VaporWorx fuel module control system is to allow the fuel pump(s) to adjust their speed based on the Manifold Absolute Pressure. As MAP sensor 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.

The triple pump control system will have a single primary pump (**on the Pump 2+ output**) and two secondary pumps (**on the Pump 1+ output**).

The Radium lift pump and 1st/primary engine pump in the surge tank must always run together on the **Pump 2+ output**. The lift pump, with zero pressure, will outflow the pressure pump, hence helping to keep the surge tank full. However, it is good practice to keep a minimum $\frac{1}{4}$ liquid height in the tank when possible.

The output of the controller will typically not fall below 7v (averaging of the PWM signaling) 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 can use either a 12v+ or ground wire as a turn on signal. An ECM provided signal is best since it will provide priming and safety features. An existing fuel pump power wire that is controlled by the ECM via a relay is also acceptable.

Fuel Pressure Suggestions

For 2/3/4 pump systems it is 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 pumps like the Walbro 450/525LPH, set the at-idle fuel pressure to as low as practical but keeping at or above 42psi.

Fuel Tank Liquid Levels

Aftermarket fuel pumping systems have only recently taken a leap forward. Integrated fuel modules, in-tank and external surge tanks, and other means have made great improvements vs. what has been essentially unchanged in aftermarket electric fuel pump delivery. 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 slosh 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 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 Aeromotive website.

VaporWorx has tested a variety of pressure regulators with good results. It is suggested that a high-volume regulator with sufficient pressure range be selected for your engine application. Aeromotive has a wide variety of pressure regulators, fuel filters and fuel lines. Please call Aeromotive Tech [913-808-2376](tel:913-808-2376) for assistance.

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.

Be sure to clean all fuel lines thoroughly before pumping fuel to the engine. A common error is to believe the filter will catch all contamination upon startup. But, what about the fuel line between the filter and the engine? If contaminated the hose will send all manner contamination to land in the injector or direct injection pump inlets.

Handy Bits To Have

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

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. 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 wire from the vehicle battery terminal.
- 2) Find a suitable **flat surface** to mount the VaporWorx Pulse Width Modulation controller (big black box) near the vehicle battery. It is imperative that the PWM controller be mounted as close and connected **directly to the battery** as practical. Do not mount the controller near sources of heat such as exhaust systems, radiators, etc. The cooler the electronics are during operation, the longer their expected life will be. ¼-20 screws are provided for mounting.

See Diagram 1 below for the following steps:

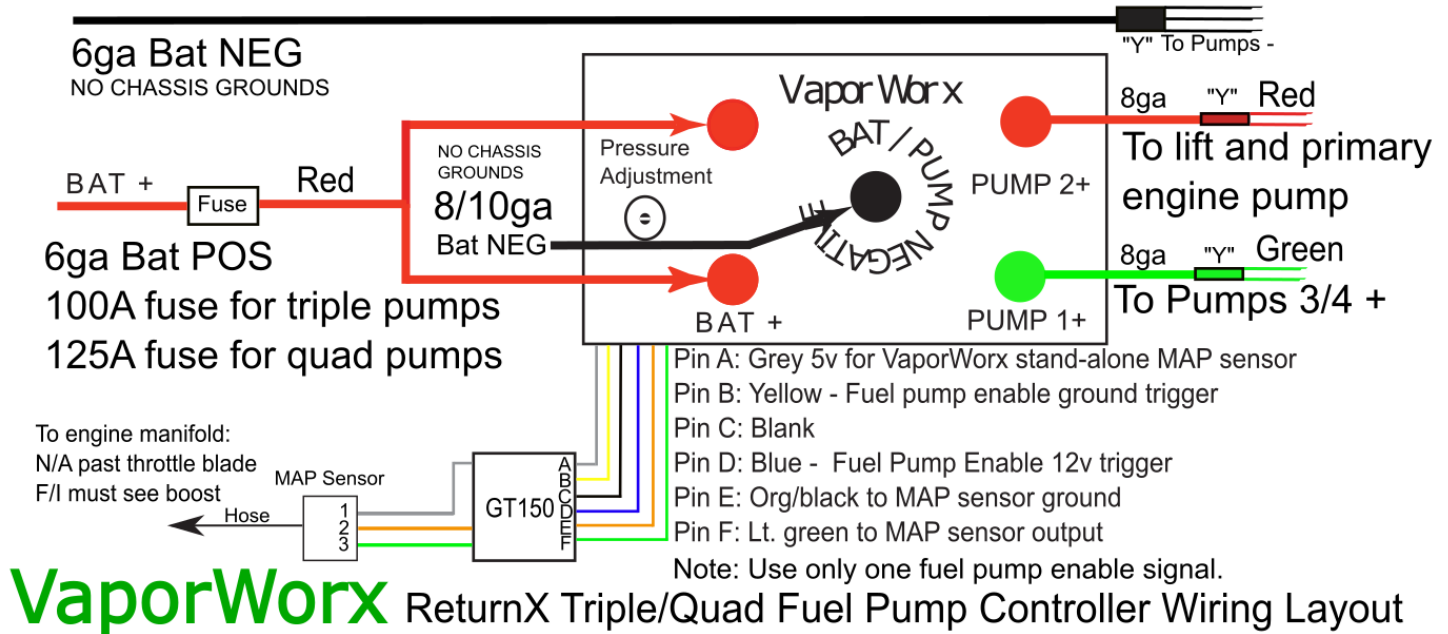


Diagram 1. Basic wiring layout for the VaporWorx Triple and FourX controller. The wiring may enter/exit the controller area as needed provided there is no chance of shorting between connections.

- 3) The ReturnX GT150 six-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: Yellow 20 to ECM negative/pull to ground fuel pump enable signal.
- C: Blank
- 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/signal feedback) sensor

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) Ring terminals are provided for many of the connections. Be sure to use heat shrink to cover the crimps. This provides not only electrical insulation but also corrosion protection. Confirm that the heat shrink clears the connection that it is attached to and not sandwiched between the components. Trim the heat shrink if needed.
- 5) Find a suitable place to mount the Mega fuse holder. Note the length of the red 6ga wire and plan the routing accordingly so the controller + fuse holder + distance to the battery is sufficient.

- 6) **Make sure the fuse is not installed in the fuse holder.** The labels on the top of the VaporWorx controller lid shows the input and output sides of the controller. Using the supplied 6ga red wire with the Y-connector and ring terminals, connect the ring terminals to the two input terminals as shown in Diagram 1. Tighten the brass controller nuts to 10in-lbs. **Do not over-tighten the brass terminal nuts on the controller / 10 in-lbs maximum torque. If the brass studs on the controller are broken it may not be possible to repair them.**
- 7) Using the remaining 6ga red wire and ring terminals, connect the other end of the Mega fuse to the battery positive terminal. Secure the nuts on the Mega fuse holder.
- 8) An 8/10ga x 4' black wire is provided to route from the **BAT/PUMP NEGATIVE** terminal on the controller to the battery negative lug. **NO CHASSIS GROUNDS.** The controller-side ring terminal is already installed. Tighten the **BAT/PUMP NEGATIVE brass nut to 10in-lbs.** Like the positive side, crimp and heat shrink the battery negative side terminal.

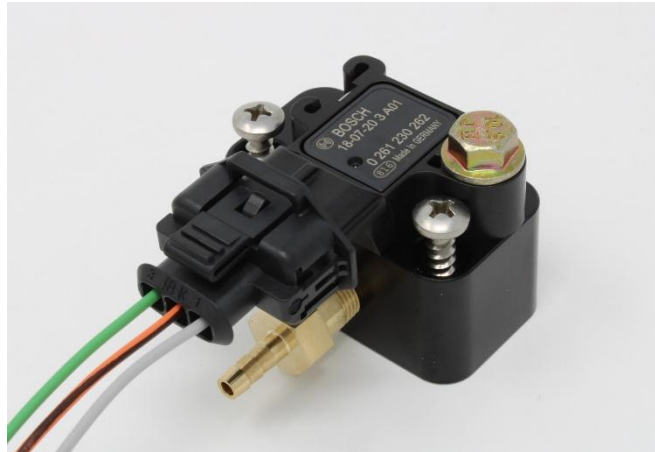


Photo 1. Basic connection points for VaporWorx supplied MAP sensor. Pin 1 = 5v Grey. Pin 2 = GND Or/Black. Pin 3 = Output Lt. Green

- 9) 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. Other vacuum and pressure rated hoses may be used. The barb thread is 1/8"-NPT.
- 10) Mount the block using the supplied screws, and mount the supplied MAP sensor to the block using the supplied M6 screw.
- 11) 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.
- 12) Unwrap the 20ga signals harness 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 provided. Use grommets where needed when passing through sheetmetal or other sharp objects.

TIP: Blue painters tape is handy to bind wire ends together while pushing them through the wire braid.

TIP: 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.



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

- 13) Plug the six-pin signals connector into the mating connector on the VaporWorx controller. Route the MAP sensor and fuel pump enable wiring to their respective sources and connect as noted in Diagram 1 and Photo 1. Terminals and seals are provided for the MAP sensor plug.
- 14) Connect the Pin D 20ga blue wire in the VaporWorx signals harness to the vehicle 12v+ ECM fuel pump enable circuit OR the Pin B 20ga yellow wire to the ground ECM fuel pump enable circuit. Only use one signal type. Many aftermarket engine harnesses and power centers have a 10-14ga high power wire for a fuel pump that is controlled by the ECM. This wire can be used to turn on the ReturnX controller by attachment to the respective trigger wire.
- 15) Unwrap the long 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. The controller side of the wiring has ring terminals installed. Noting the colors in Diagram 1, attach each to their respective Pump 1+ and Pump 2+ locations on the VaporWorx controller. Loosely attach these wires to the controller for now.
- 16) Using the supplied Y wiring connectors, cut each wire to length and attach to the pump terminals using user-supplied hardware. For the Radium Engineering four pump module, make sure that the red Y-connector goes to the lift and primary engine pump. The green Y-connector goes to pumps 2 and 3. Use heat shrink to seal crimp connections, if any.
- 17) Route the green Pump 1+ and red Pump 2+ wiring to the fuel pump area. Cut and strip the wiring to length and crimp to the same color wire butt connector. Use heat shrink to seal the butt connector. The **Pump 2+** VaporWorx controller terminal wiring should be red in color and match up to the red "Y" attached to the Radium lift and primary engine pump. For triple pump applications there will be no Y-connector for the red wire, so just connect this to the primary pump. Usually any of the pumps may be the primary but this should be confirmed by the pump module/hanger manufacturer.
- 18) 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 user-supplied terminals. Use heat shrink as needed to seal the crimp. Attach the pigtails to the pump negative terminals on the fuel pump hat. For triple pump applications the extra black wire can be taped and sealed off so as not to short to other components.
- 19) Route the 6ga black insulated wire to the battery negative terminal. NO CHASSIS GROUNDS. 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.
- 20) Remove the Pump 1+ and Pump 2+ wires from the VaporWorx controller. Slide the woven wire braid on over the wires as far as possible to the pumps. Cut to length using a soldering iron and slip on and heat set two pieces of the large heat shrink to seal the ends of the braid. Re-install the wiring to the controller and tighten the brass nuts to 10in-lbs.
- 21) Finalize 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.
- 22) Secure all wiring with zip ties, cushion clamps, or other means to hold the wiring in place.

- 23) Check that all wiring connections are tight and secure.
- 24) Install the circuit protection fuse. A small spark is normal.

Preparation Required Prior to Engine Startup

- 25) Attach the negative battery cable.
- 26) Put sufficient fuel into the tank so that the pump(s) are well covered.
- 27) Attach a voltmeter to the PWM controller Pump 2+ 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.
- 28) 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.
- 29) Confirm that all connections, hoses, etc. are tight and secure.
- 30) Insert the fuse into the fuse holder. A small spark is normal.
- 31) Put sufficient fuel in the tank to allow the liquid to submerge the pumps / 4-5" in height.
- 32) 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.
- 33) 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 ½-turn in the direction of the arrow. This adjustment does not significantly change the fuel pressure, just the pump speed. The fuel pressure regulator is what sets fuel pressure.
- 34) Start the car and allow to idle. Set the fuel pressure with the mechanical regulator per the requirements of the engine.
- 35) Set the output voltage on the controller as follows with the engine at idle:

Fuel Pressure Settings

	Carburetors	42psi	50psi	60psi	70psi
450/525LPH pumps:	8.5v	9v	9.0v	9.5v – 10v	10.5v

- 36) If needed, reset the fuel pressure with the mechanical regulator per the requirements of the engine.
- 37) 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. If it seems that the fuel pressure is lagging behind then increase the at-idle voltage at the Pump 2+ terminal by 1/2v and retest.

Troubleshooting

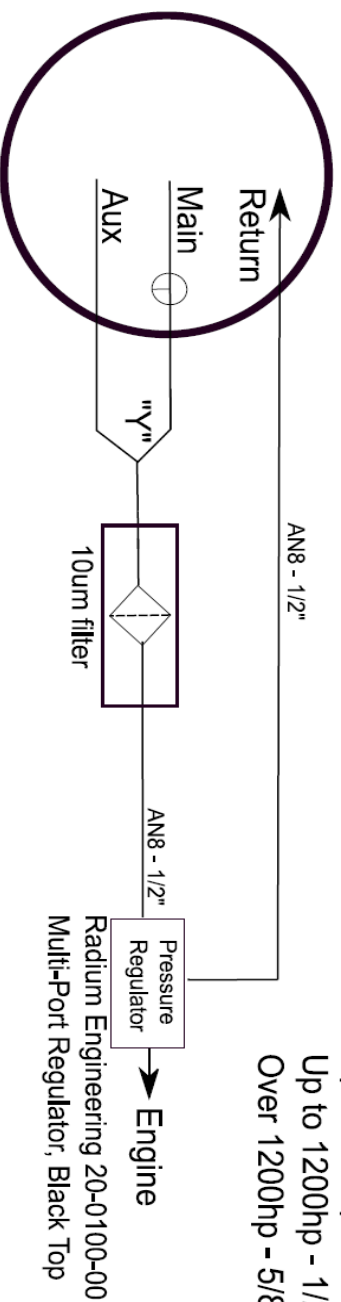
- 1) Fuel pump runs at full speed when the engine is on:
 - a. Adjust the fuel pump speed via the small screw on the top of the controller.
 - b. Check the signal wiring connections. Just line up the colors across the GT150 connector.
 - c. Confirm that the input and output main power wires from the 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 for positive trigger fuel pump enable systems. 12v + can be applied directly to the GT150 Pin D blue wire for testing only. Grounding of the yellow wire Pin B is also acceptable for testing.
 - 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) Fuel system does not have adequate pressure:
 - a. Increase the at-idle Pump 2+ voltage 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. If the Pump 2+ voltage is very high but insufficient pressure or volume is present then the pump attached to Pump 2+ may be faulty.
- 4) 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.

YAPORWORK

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"



For Radium Four Pump System

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.