

State of California
AIR RESOURCES BOARD

EXECUTIVE ORDER D-213-8
Relating to Exemptions Under Section 27156
of the Vehicle Code

VORTECH ENGINEERING, INC.
A-TRIM V-1 GEARCHARGER SYSTEM

Pursuant to the authority vested in the Air Resources Board by Section 27156 of the Vehicle Code; and

Pursuant to the authority vested in the undersigned by Sections 39515 and 39516 of the Health and Safety Code and Executive Order G-45-5;

IT IS ORDERED AND RESOLVED: That the installation of the A-trim V-1 Gearcharger supercharging system with a 2.5 inch inducer diameter, manufactured by Vortech Engineering, Inc. of 5351 Bonsai Avenue, Moorpark, California 93021, has been found not to reduce the effectiveness of the applicable vehicle pollution control system and, therefore, is exempt from the prohibitions of Section 27156 of the Vehicle Code for the vehicles listed with corresponding modifications to OEM engine systems in Exhibit A which is attached hereto and incorporated herein.

This Executive Order is valid provided that installation instructions for this kit will not recommend tuning the vehicle to specifications different from those submitted by Vortech Engineering, Inc.

Changes made to the design or operating conditions of the supercharging system, as exempt by the Air Resources Board, which adversely affect the performance of a vehicle's pollution control system shall invalidate this Executive Order.

Marketing of this supercharging system using any identification other than that shown in this Executive Order or marketing of this supercharging system for an application other than those listed in this Executive Order shall be prohibited unless prior approval is obtained from the Air Resources Board. Exemption of the supercharging system shall not be construed as exemption to sell, offer for sale, or advertise any component of the kit as an individual device.

This Executive Order does not constitute any opinion as to the effect the use of this supercharging system may have on any warranty either expressed or implied by the vehicle manufacturer.

This Executive Order is granted based on results from emissions tests conducted in accordance with Cold-Start CVS-75 Federal Test Procedure. However, the ARB finds that reasonable grounds exist to believe that use of the A-trim V-1 Gearcharger supercharger system may adversely affect emissions of motor vehicles when operating under conditions outside the parameters of the previously prescribed test procedures. Accordingly, the ARB reserves the right to conduct additional emission tests, in the future, as such tests are developed, that will more adequately measure emissions

from all cycle phases. If such test results demonstrate that the A-trim V-1 Gearcharger supercharging system adversely affect emissions during off-cycle conditions (defined as those conditions which are beyond the parameters of the Cold-Start CVS-75 Federal Test Procedure), this Executive Order shall be effectively rescinded as of the date the test results are validated. Further, if such test results or other evidence provides the ARB with reason to suspect that the A-trim V-1 Gearcharger supercharging system will affect the durability of the emission control system, Vortech Engineering, Inc. shall be required to submit durability data to show that the durability of the vehicle emission control system is not, in fact, affected and/or that the add-on or modified part demonstrates adequate durability.

In addition to the foregoing, the ARB reserves the right in the future to review this Executive Order and the exemption provided herein to assure that the exempted add-on or modified part continues to meet the standards and procedures of Title 13, California Code of Regulations, Section 2222, et seq.

THIS EXECUTIVE ORDER DOES NOT CONSTITUTE A CERTIFICATION, ACCREDITATION, APPROVAL, OR ANY OTHER TYPE OF ENDORSEMENT BY THE AIR RESOURCES BOARD OF CLAIMS OF THE APPLICANT CONCERNING ANTI-POLLUTION BENEFITS OR ANY ALLEGED BENEFITS OF THE VORTECH ENGINEERING, INC.'S A-TRIM V-1 GEARCHARGER SUPERCHARGING SYSTEM.

No claim of any kind, such as "Approved by the Air Resources Board" may be made with respect to the action taken herein in any advertising or other oral or written communication.

Section 17500 of the Business and Professions Code makes untrue or misleading advertising unlawful, and Section 17534 makes violation punishable as a misdemeanor.

Section 43644 of the Health and Safety Code provides as follows:

"43644, (a) No person shall install, sell, offer for sale, or advertise, or, except in an application to the state board for certification of a device, represent, any device as a motor vehicle pollution control device for use on any used motor vehicle unless that device has been certified by the state board. No person shall sell, offer for sale, advertise, or represent any motor vehicle pollution control device as a certified device which, in fact, is not a certified device. Any violation of this subdivision is a misdemeanor."

Any apparent violation of the conditions of this Executive Order may result in its rescission or submission to the Attorney General of California for such action as he deems advisable.

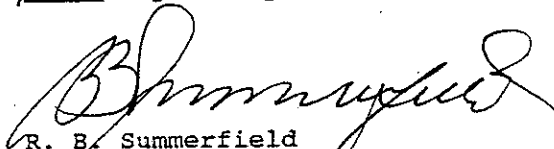
VORTECH ENGINEERING, INC.
A-TRIM V-1 GEARCHARGER SYSTEM

EXECUTIVE ORDER D-213-8
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The Bureau of Automotive Repair will be notified by copy of this order.

Executive Orders No. D-213-4, dated February 20, 1992, and No. D-213-7, dated April 8, 1993, are superseded and of no further force and effect.

Executed at El Monte, California, this 16th day of September, 1993.



R. B. Summerfield
Assistant Division Chief
Mobile Source Division

State of California
AIR RESOURCES BOARD

EVALUATION OF VORTECH ENGINEERING, INC.'S A-TRIM V-1 GEARCHARGER SYSTEM
FOR EXEMPTION FROM THE PROHIBITIONS OF VEHICLE
CODE SECTION 27156 IN ACCORDANCE WITH SECTION 2222, TITLE 13, OF THE
CALIFORNIA CODE OF REGULATIONS

by

Mobile Source Division
9528 Telstar Avenue
El Monte, CA 91731-2990

(This report has been reviewed by the staff of the California Air Resources Board and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Air Resources Board, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.)

EXHIBIT A

CHRYSLER CORPORATION

<u>Vortech</u> <u>Part Number</u>	<u>Model</u> <u>Year</u>	<u>Vehicle</u> <u>Make and Model</u>	<u>Engine</u> <u>Size(liter)</u>	<u>Pulley Diameter(inches)</u> <u>Crankshaft</u>	<u>Input</u>
4CB218-060	1991-93	Dodge Dakota	5.2	7.25	3.125
4CB218-068	1991-93	Dodge Dakota Polished	5.2	7.25	3.125

Exempted Modifications

1. Relocate ignition coil.
2. Replace coolant recovery reservoir.
3. Relocate crankcase vent outlet to air filter cover.
4. Install Gearcharger unit with associated pulleys, new accessory belt, brackets, oil feed and drain, modified intake air ducting incorporating a new air filter cover, and discharge plenum and ducting.
5. Install Fuel Management Unit (FMU) on fuel return line and connect to intake manifold air pressure source.
6. Install auxiliary fuel pump.

FORD MOTOR COMPANY

<u>Vortech</u> <u>Part Number</u>	<u>Model</u> <u>Year</u>	<u>Vehicle</u> <u>Make and Model</u>	<u>Engine</u> <u>Size(liter)</u>	<u>Pulley Diameter(inches)</u> <u>Crankshaft</u>	<u>Input</u>
4FA218-010	1986-93	Ford Mustang Standard Output	5.0	6.00	3.33
4FA218-018	1986-93	Ford Mustang Standard Output - Polished	5.0	6.00	3.33

Exempted Modifications

1. Relocate fuel evaporation canister.
2. Relocate Mass Airflow sensor to new air filter cover.
3. Relocate crankcase vent outlet to air filter cover.
4. Relocate alternator and air injection pump with supplied brackets.
5. Shorten hose between air injection pump and air control valve.
6. Install Gearcharger unit with associated pulleys, brackets, oil feed and drain, and modified intake air ducting incorporating a new air filter cover.
7. Install Fuel Management Unit (FMU) on fuel return line and connect to intake manifold air pressure source.

Vortech Part Number	Model Year	Vehicle Make and Model	Engine Size(liter)	Pulley Diameter(inches)	
				Crankshaft	Input
4FB218-040	1987-93	Ford Truck and Van	7.5	7.00	2.875
4FB218-048	1987-93	Ford Truck and Van Polished	7.5	7.00	2.875

Exempted Modifications

1. Modify air bypass tube.
2. Install Gearcharger unit with associated pulleys, brackets, oil feed and drain, and modified intake air ducting.
3. Install Fuel Management Unit (FMU) on fuel return line and connect to intake manifold air pressure source.
4. Install Ignition Retard Module.
5. Install supplemental fuel pump.
6. Replace thermostat housing

GENERAL MOTORS

Vortech Part Number	Model Year	Vehicle Make and Model	Engine Size(liter)	Pulley Diameter(inches)	
				Crankshaft	Input
4GA218-010	1990-93	Chevrolet and GMC Truck	4.3	7.50	3.33
4GA218-028	1990-93	Chevrolet and GMC Truck Polished	4.3	7.50	3.33
4GB218-050	1990-93	Chevrolet and GMC Truck and Van	5.0 5.7	7.50	3.125
4GB218-058	1990-93	Chevrolet and GMC Truck and Van - Polished	5.0 5.7	7.50	3.125
4GC218-090	1990-93	Chevrolet and GMC Truck and Van	7.5	7.50	2.875
4GC218-098	1990-93	Chevrolet and GMC Truck Van - Polished	7.5	7.50	2.875

Exempted Modifications

1. Drill two holes in base of TBI unit.
2. Install Gearcharger unit with associated pulleys, new accessory belt, brackets, oil feed and drain, modified intake air ducting incorporating a new air filter cover, and discharge plenum and ducting.
3. Install Supplemental Fuel Injection Computer (SFIC) and related hardware including an auxiliary fuel pump, throttle spacer block, fuel pressure regulator, supplemental fuel injectors and associated fuel lines.

Vortech Part Number	Model Year	Vehicle Make and Model	Engine Size(liter)	Pulley Diameter(inches) Crankshaft	Input
4GF218-060	1988-92	Chevrolet Camaro and Pontiac Firebird	5.0 5.7	7.50	3.48
4GF218-068	1988-92	Chevrolet Camaro and Pontiac Firebird - Polished	5.0 5.7	7.50	3.48

Exempted Modifications

1. Relocate fuel evaporation canister.
2. Install new windshield washer reservoir.
3. Install Gearcharger unit with associated pulleys, brackets, oil feed and drain, and modified intake air ducting incorporating a new air filter cover and discharge plenum.
4. Install Fuel Management Unit (FMU) on fuel return line and connect to intake manifold air pressure source.
5. Install Ignition Retard Module.
6. Install auxiliary fuel pump.

Vortech Part Number	Model Year	Vehicle Make and Model	Engine Size(liter)	Pulley Diameter(inches) Crankshaft	Input
4FA218-020	1986-93	Ford Mustang High Output	5.0	6.50	3.125
4FA218-028	1986-93	Ford Mustang High Output - Polished	5.0	6.50	3.125

Exempted Modifications

1. Relocate fuel evaporation canister.
2. Relocate Mass Airflow sensor to new air filter cover.
3. Relocate crankcase vent outlet to air filter cover.
4. Relocate alternator and air injection pump with supplied brackets.
5. Shorten hose between air injection pump and air control valve.
6. Install Gearcharger unit with associated pulleys, brackets, oil feed and drain, and modified intake air ducting incorporating a new air filter cover.
7. Install Fuel Management Unit (FMU) on fuel return line and connect to intake manifold air pressure source.
8. Install Ignition Retard Module.
9. Replace in-tank fuel pump.

Vortech Part Number	Model Year	Vehicle Make and Model	Engine Size(liter)	Pulley Diameter(inches) Crankshaft	Input
4FC218-030	1987-93	Ford Truck and Van	5.8	6.50	2.875
4FC218-038	1987-93	Ford Truck and Van Polished	5.8	6.50	2.875
4FC218-040	1993	Ford Lightning Truck	5.8	6.50	2.875
4FC218-048	1993	Ford Lightning Truck Polished	5.8	6.50	2.875
4FE218-070	1987-93	Ford Truck and Van	5.0	6.50	2.875
4FE218-078	1987-93	Ford Truck and Van Polished	5.0	6.50	2.875

Exempted Modifications

1. Install Gearcharger unit with associated pulleys, brackets, oil feed and drain, and modified intake air ducting incorporating a new air filter cover and discharge plenum.
2. Install Fuel Management Unit (FMU) on fuel return line and connect to intake manifold air pressure source.
3. Install Ignition Retard Module.
4. Install supplemental fuel pump.

State of California
AIR RESOURCES BOARD

EVALUATION OF VORTECH ENGINEERING, INC.'S A-TRIM V-1 GEARCHARGER SYSTEM
FOR EXEMPTION FROM THE PROHIBITIONS OF VEHICLE
CODE SECTION 27156 IN ACCORDANCE WITH SECTION 2222, TITLE 13, OF THE
CALIFORNIA CODE OF REGULATIONS

September 1993

SUMMARY

Vortech Engineering, Inc., of 5351 Bonsai Avenue, Moorpark, California, 93021, has applied for an exemption from the prohibitions in Section 27156 of the California Vehicle Code (VC) for the A-trim V-1 Gearcharger system. The A-trim V-1 Gearcharger system is designed for installation on motor vehicles listed with corresponding modifications in Appendix A.

Based on the results from comparative intake manifold air pressure tests performed at an independent laboratory, the staff concludes that Vortech Engineering, Inc.'s A-trim V-1 Gearcharger system will not adversely affect exhaust emission from vehicles for which an exemption is requested when tested in accordance with the CVS-75 Federal Test Procedure (FTP).

The staff recommends that Vortech Engineering, Inc. be granted an exemption as requested and that Executive Order D-213-8 be issued.

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EVALUATION OF VORTECH ENGINEERING, INC.'S A-TRIM V-1 GEARCHARGER SYSTEM
FOR EXEMPTION FROM THE PROHIBITIONS OF VEHICLE
CODE SECTION 27156 IN ACCORDANCE WITH SECTION 2222, TITLE 13, OF THE
CALIFORNIA CODE OF REGULATIONS

I. INTRODUCTION

Vortech Engineering, Inc. of 5351 Bonsai Avenue, Moorpark, California, 93021 has applied for an exemption from the prohibitions in Section 27156 of the California Vehicle Code for the A-trim V-1 Gearcharger system. The A-trim V-1 Gearcharger system is designed for installation on motor vehicles listed in Appendix A.

Vortech Engineering, Inc. has submitted data from comparative intake manifold air pressure tests conducted on a 1992 Ford Mustang equipped with a 5.0 liter electronic fuel injection (EFI) engine and a 1990 Chevrolet light-duty truck equipped with a 5.7 liter throttle-body fuel injected engine at Milton Roy Company, Orange, California.

II. CONCLUSIONS

Based on the results from comparative intake manifold air pressure tests performed at Milton Roy Company on a 1992 Ford Mustang equipped with a 5.0 liter EFI engine and a 1990 Chevrolet light-duty truck equipped with a 5.7 liter throttle-body fuel-injected engine, the staff concludes that Vortech Engineering, Inc.'s A-trim V-1 Gearcharger system will not adversely affect exhaust emissions from vehicles for which an exemption is requested when tested in accordance with CVS-75 Federal Test Procedure (FTP).

III. RECOMMENDATION

The staff recommends that Vortech Engineering, Inc. be granted an exemption for their A-trim V-1 Gearcharger system for installation on motor vehicles listed in Appendix A. The staff also recommends that Executive Order D-213-8 be issued.

IV. DEVICE DESCRIPTION

A supercharger is a mechanical device which increases the air pressure and volumetric fuel rate delivered to the engine's combustion chambers. The purpose of supercharging is to increase the engine's volumetric efficiency and maximum power output as compared to the identical normally aspirated engine. In operation, a supercharger acts as an air compressor. It receives filtered air, compresses it to a pressure determined by the compressor design and engine speed and delivers the compressed air to the intake tract. Fuel is supplied before or after the air compression process depending on the design of the supercharger and/or the method of fuel delivery.

The Vortech Engineering's A-trim V-1 Gearcharger system is a vehicle specific supercharging system designed for installation on motor vehicles listed in Appendix A. It incorporates spark, air and fuel delivery system modifications in conjunction with the original equipment manufacturer (OEM) computer controlled fuel delivery and, according to the manufacturer, without any modification to OEM emission control systems. The Vortech proprietary supercharger is marketed by the trade name "GearchargerTM", model "V-1", "A-trim" configuration indicating the version of the impeller wheel and compressor housing with an inducer diameter of 2.5 inches; it is a centrifugal air compressor mounted and powered similarly to an automotive air conditioning compressor. The air compression operation is achieved by rotating the impeller wheel within the compressor housing. Rotational energy is transferred from the engine's crankshaft to compressor input shaft by a belt and pulley system. The rotational speed of the compressor input shaft is increased with respect to the crankshaft by the vehicle specific ratio of the crankshaft pulley diameter divided by the input shaft pulley diameter (for vehicle specific ratios, see

Appendix A). The air compressor's geardrive increases the impeller wheel's rotational speed by 3.45 times the rotational speed of the compressor's input shaft. According to the manufacturer, the impeller rotational speed should never exceed 58,000 rpm while best performance is at speeds not exceeding 46,000 rpm. Therefore, if the crankshaft vs. input shaft pulley diameter ratio is increased by changing the pulley(s), then the volume of compressed air delivered to the intake manifold will be increased.

According to the manufacturer, air is supplied from the OEM or equivalent air filtration system with no modifications of any OEM emission related sensors or emission control devices. The air compressor discharges the pressurized air into the system's replacement ducting connecting to the OEM throttle body.

The installation of the A-trim V-1 Gearcharger system includes various fuel system modifications depending on vehicular application and indicated maximum boost level. All systems, except General Motors' trucks equipped with 4.3, 5.0, 5.7 and 7.5 liter engines, incorporate Vortech's Fuel Management Unit (FMU). Installed at the outlet of the stock regulator on the fuel rail return line to the fuel tank, it acts as a secondary fuel pressure regulator. In operation, it increases the fuel rail pressure in proportion to the intake manifold air pressure level. Increased fuel rail pressure ensures increased fuel delivery which is necessary during periods of positive intake manifold pressure to prevent lean air/fuel mixtures. The FMU monitors the intake manifold air pressure directly with a hose plumbed from the intake manifold or other similar source. According to the manufacturer, intake manifold air pressures exceeding 1.5 pounds per square inch above atmospheric pressure (psig) activate the FMU. It increases the fuel rail pressure by 12 times the intake manifold air pressure on most applications except for the General

Motors' F-Body passenger cars application where it is increased by 10 times the intake manifold pressure.

On General Motors' trucks equipped with 4.3, 5.0, 5.7 and 7.5 liter engines, Vortech utilizes their Supplementary Fuel Injector Computer (SFIC) to provide additional fuel required for the engine to operate safely at positive manifold pressures. It is designed to control two electronic fuel injectors which are housed in a replacement plate mounted under the throttle body assembly. The SFIC is initially activated by a pressure transducer at 1.5 psig and progressively pulses the additional injectors as intake manifold air pressure and engine speed are further increased. The supplemental injectors are supplied fuel at 30 psig at idle, by a regulator included in the Vortech system. A supplemental fuel pump incorporated in series with the OEM fuel pump ensures adequate fuel volume to prevent lean air/fuel ratios. At the outlet of the Vortech regulator, fuel is routed to the OEM throttle body where the pressure is regulated by the OEM throttle body internal regulator to OEM pressure and excess fuel returned to the fuel tank.

With the exception of the standard output Mustang system, all systems require an additional fuel pump. The supplemental or auxiliary fuel pump's purpose is to provide sufficient fuel volume at required pressures to assure proper air/fuel ratio during all periods of Gearcharger operation.

The Ignition Retard Module, previously exempted by Executive Order No. D-213-6, dated July 10, 1992, as the Vortech/MSD Boost Timing Master Unit, is utilized by the Ford Motor Company Mustang Hi-Output version, the Ford Motor Company 5.0, 5.8 and 7.5 liter truck and the General Motors' F-Body 5.0 and 5.7 liter systems. This Module, upon measuring greater than 2 psig intake manifold air pressure, retards the ignition timing by $\frac{3}{4}$ of one degree for each additional 1 psig increase in intake manifold air pressure. The purpose

of this module is to prevent pre-ignition or detonation of the air/fuel mixture which can cause engine damage.

With each system, Vortech supplies a new air filter cover and a fitting. Location varies by application and the crankcase breather hose outlet may be relocated. In OEM configuration, the crankcase breather hose is plumbed into the air intake system between the air filtration assembly and the intake manifold - usually on or near the throttle body. Since the A-trim V-1 Gearcharger system pressurizes the intake tract downstream of the air compressor, the necessary vacuum no longer exists at OEM location. Therefore, according to the manufacturer, the crankcase breather outlet is relocated upstream of the air compressor where the vacuum conditions exist to ensure the breather continues to perform its original function.

Vortech supplies all necessary brackets, hoses, ducting, hardware, installation instructions and a guide to maintain the supercharger equipped vehicle.

V . A-TRIM V-1 GEARCHARGER SYSTEM EVALUATION AND DISCUSSION

Vortech Engineering, Inc., in lieu of actual emissions testing, performed a modal analysis of the intake manifold air pressure during a Hot-Start 505 FTP. The purpose of this test was to compare the airflow when the A-trim V-1 Gearcharger supercharging system is operating, to the airflow when the system's drive belt is removed. Vortech Engineering, Inc. claims removal of the drive belt disables the supercharger, resulting in an intake tract airflow characteristics equivalent to the OEM. A 1992 Ford Mustang equipped with an 5.0 liter EFI engine and a 1990 Chevrolet light duty truck equipped with a 5.7 liter throttle body fuel injected engine was used for the evaluation of the A-trim V-1 Gearcharger system. The dynamometer inertia weight and loading used were 4000-lbs and 8.2-hp and 6000-lbs and 16.1-hp respectively.

Comparative intake manifold air pressure tests conducted by Milton Roy Company for Vortech Engineering, Inc. consisted of one Hot-Start 505 LA4 drive cycle with the drive belt removed from the air compressor unit (baseline configuration), followed by one Hot-Start 505 LA4 drive cycle in the modified (with the A-trim V-1 Gearcharger operational) configuration. The tests were conducted with drive pulley ratios that, at maximum engine speed, produced intake manifold air pressure levels greater than the systems to be exempted.

Staff evaluated the graphs produced during the test procedure and found that the intake manifold air pressure did not significantly change. Vortech Engineering claims if intake manifold air pressure is unchanged during the FTP and since all their fuel and ignition modification are activated by positive intake manifold air pressure, then the A-trim V-1 Gearcharger system does not alter the performance of the OEM system. Therefore, if the A-trim V-1 Gearcharger system does not alter the performance of the OEM system, then it cannot adversely affect exhaust emissions. The Air Resources Board (ARB) did not perform tests to confirm the test results submitted by the applicant.

The ARB did not perform any durability testing at this time and reserves the right, in the future, to request further documentation of this device's effect on vehicle emission control system durability. Therefore, the installation of Vortech Engineering, Inc.'s A-trim V-1 Gearcharger supercharging system should not have an adverse effect on exhaust emissions on the requested vehicular applications.

Vortech Engineering, Inc. submitted all the required information and fulfilled the requirements for exemption.

Appendix

Appendix A

APPENDIX A

CHRYSLER CORPORATION

Vortech Part Number	Model Year	Vehicle Make and Model	Engine Size(liter)	Pulley Diameter(inches) Crankshaft Input	
4CB218-060	1991-93	Dodge Dakota	5.2	7.25	3.125
4CB218-068	1991-93	Dodge Dakota Polished	5.2	7.25	3.125

Exempted Modifications

1. Relocate ignition coil.
2. Replace coolant recovery reservoir.
3. Relocate crankcase vent outlet to air filter cover.
4. Install Gearcharger unit with associated pulleys, new accessory belt, brackets, oil feed and drain, modified intake air ducting incorporating a new air filter cover, and discharge plenum and ducting.
5. Install Fuel Management Unit (FMU) on fuel return line and connect to intake manifold air pressure source.
6. Install auxiliary fuel pump.

FORD MOTOR COMPANY

Vortech Part Number	Model Year	Vehicle Make and Model	Engine Size(liter)	Pulley Diameter(inches) Crankshaft Input	
4FA218-010	1986-93	Ford Mustang Standard Output	5.0	6.00	3.33
4FA218-018	1986-93	Ford Mustang Standard Output - Polished	5.0	6.00	3.33

Exempted Modifications

1. Relocate fuel evaporation canister.
2. Relocate Mass Airflow sensor to new air filter cover.
3. Relocate crankcase vent outlet to air filter cover.
4. Relocate alternator and air injection pump with supplied brackets.
5. Shorten hose between air injection pump and air control valve.
6. Install Gearcharger unit with associated pulleys, brackets, oil feed and drain, and modified intake air ducting incorporating a new air filter cover.
7. Install Fuel Management Unit (FMU) on fuel return line and connect to intake manifold air pressure source.

Vortech Part Number	Model Year	Vehicle Make and Model	Engine Size(liter)	Pulley Diameter(inches) Crankshaft	Input
4FA218-020	1986-93	Ford Mustang High Output	5.0	6.50	3.125
4FA218-028	1986-93	Ford Mustang High Output - Polished	5.0	6.50	3.125

Exempted Modifications

1. Relocate fuel evaporation canister.
2. Relocate Mass Airflow sensor to new air filter cover.
3. Relocate crankcase vent outlet to air filter cover.
4. Relocate alternator and air injection pump with supplied brackets.
5. Shorten hose between air injection pump and air control valve.
6. Install Gearcharger unit with associated pulleys, brackets, oil feed and drain, and modified intake air ducting incorporating a new air filter cover.
7. Install Fuel Management Unit (FMU) on fuel return line and connect to intake manifold air pressure source.
8. Install Ignition Retard Module.
9. Replace in-tank fuel pump.

Vortech Part Number	Model Year	Vehicle Make and Model	Engine Size(liter)	Pulley Diameter(inches) Crankshaft	Input
4FC218-030	1987-93	Ford Truck and Van	5.8	6.50	2.875
4FC218-038	1987-93	Ford Truck and Van Polished	5.8	6.50	2.875
4FC218-040	1993	Ford Lightning Truck	5.8	6.50	2.875
4FC218-048	1993	Ford Lightning Truck Polished	5.8	6.50	2.875
4FE218-070	1987-93	Ford Truck and Van	5.0	6.50	2.875
4FE218-078	1987-93	Ford Truck and Van Polished	5.0	6.50	2.875

Exempted Modifications

1. Install Gearcharger unit with associated pulleys, brackets, oil feed and drain, and modified intake air ducting incorporating a new air filter cover and discharge plenum.
2. Install Fuel Management Unit (FMU) on fuel return line and connect to intake manifold air pressure source.
3. Install Ignition Retard Module.
4. Install supplemental fuel pump.

Vortech Part Number	Model Year	Vehicle Make and Model	Engine Size(liter)	Pulley Diameter(inches)	
				Crankshaft	Input
4FB218-040	1987-93	Ford Truck and Van	7.5	7.00	2.875
4FB218-048	1987-93	Ford Truck and Van Polished	7.5	7.00	2.875

Exempted Modifications

1. Modify air bypass tube.
2. Install Gearcharger unit with associated pulleys, brackets, oil feed and drain, and modified intake air ducting.
3. Install Fuel Management Unit (FMU) on fuel return line and connect to intake manifold air pressure source.
4. Install Ignition Retard Module.
5. Install supplemental fuel pump.
6. Replace thermostat housing

GENERAL MOTORS

Vortech Part Number	Model Year	Vehicle Make and Model	Engine Size(liter)	Pulley Diameter(inches)	
				Crankshaft	Input
4GA218-010	1990-93	Chevrolet and GMC Truck	4.3	7.50	3.33
4GA218-028	1990-93	Chevrolet and GMC Truck Polished	4.3	7.50	3.33
4GB218-050	1990-93	Chevrolet and GMC Truck and Van	5.0 5.7	7.50	3.125
4GB218-058	1990-93	Chevrolet and GMC Truck and Van - Polished	5.0 5.7	7.50	3.125
4GC218-090	1990-93	Chevrolet and GMC Truck and Van	7.5	7.50	2.875
4GC218-098	1990-93	Chevrolet and GMC Truck Van - Polished	7.5	7.50	2.875

Exempted Modifications

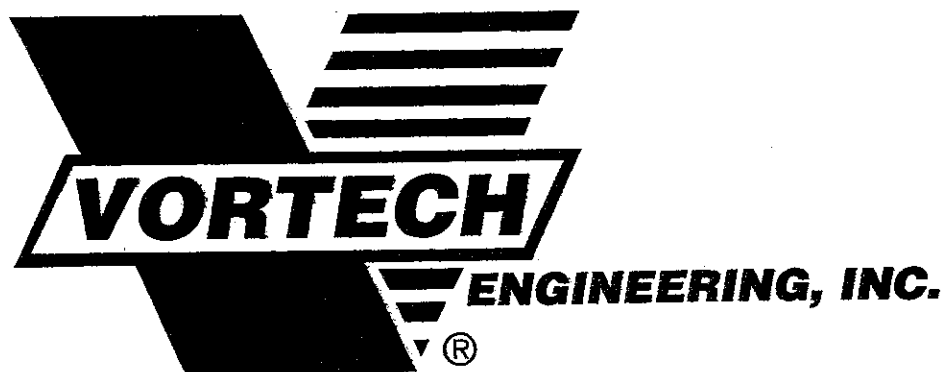
1. Drill two holes in base of TBI unit.
2. Install Gearcharger unit with associated pulleys, new accessory belt, brackets, oil feed and drain, modified intake air ducting incorporating a new air filter cover, and discharge plenum and ducting.
3. Install Supplemental Fuel Injection Computer (SFIC) and related hardware including an auxiliary fuel pump, throttle spacer block, fuel pressure regulator, supplemental fuel injectors and associated fuel lines.

Portech Part Number	Model Year	Vehicle Make and Model	Engine Size(liter)	Pulley Diameter(inches) Crankshaft	Input
4GF218-060	1988-92	Chevrolet Camaro and Pontiac Firebird	5.0 5.7	7.50	3.48
4GF218-068	1988-92	Chevrolet Camaro and Pontiac Firebird - Polished	5.0 5.7	7.50	3.48

Exempted Modifications

1. Relocate fuel evaporation canister.
2. Install new windshield washer reservoir.
3. Install Gearcharger unit with associated pulleys, brackets, oil feed and drain, and modified intake air ducting incorporating a new air filter cover and discharge plenum.
4. Install Fuel Management Unit (FMU) on fuel return line and connect to intake manifold air pressure source.
5. Install Ignition Retard Module.
6. Install auxiliary fuel pump.

Appendix B



Creative Thought... Functional Solutions!

***Please read this FIRST, before installing
your Gearcharger™ unit or system.***

***This document contains important
warranty and service information.***

***Failure to read this fully before beginning
installation, may result in a dramatic
reduction of the optional service period
available for your Gearcharger™ unit.***

Contents:

- **V-1 Gearcharger Limited Warranty**
- **Care & Feeding Guide for Gearcharger**
- **Gearcharger EXTENDED SERVICE
PROGRAM & REGISTRATION FORM**

VORTECH® care and feeding guide for GEARCHARGER™ units or systems.

The following information and recommendations are designed to promote years of untroubled service from your Gearcharger. Each Gearcharger unit is built to exacting tolerances using the best materials available. Every unit is subjected to an intensive quality audit procedure from the time we first receive raw castings to the time the precision machined components become a completed Gearcharger. All Gearcharger systems are likewise developed with the greatest attention to detail in the industry. Air fuel ratios, ignition timing requirements and all aspects required to build fully integrated systems are tested rigorously. Once developed fully, no expense is spared in the final production version. A Vortech system typically costs a bit more, but ensures you a product which is refined to the point that a successful installation can be performed easily by an average enthusiast. When applied to a stock engine in sound working order, the installation of a complete Vortech Gearcharger system results in the Highest Street Legal Performance at a Minimum of Engine Wear. If the proper care is given the unit and it is operated within the range specified (see SECTION 4 - GEARCHARGER DESIGN GOALS & OPERATIONAL LIMITS), the unit is designed to last the life of most vehicles.

For extra heavy duty racing purposes, the Vortech V-1 Gearcharger also delivers! We have included some very important engineering, safety and performance information for you to consider before pushing the envelope beyond the limits encompassed in the standard Gearcharger system design (see SECTION 4 - GEARCHARGER DESIGN GOALS & OPERATIONAL LIMITS). **So please read and note the following.** Whether your expectation is to make mole hills out of the Rocky Mountains with your truck and trailer, or to test your car's performance at the track, the information contained in this care guide will prove valuable.

SECTION 1 - BASIC OPERATION

- 1) Never operate at full throttle condition when the engine is cold. When starting the engine each day, always allow plenty of time for the oil to reach full operating temperature before running above 2,500 rpm.
 - A) Full operating temperature is generally achieved only after the water temperature has been at the normal indicated operating range for two or three minutes. This is because the orifice on the oil inlet to the Gearcharger is only .036" diameter and can be plugged by particulates which can by-pass the filter when the oil is cold, thus eliminating oiling to the Gearcharger. This in turn will cause a Gearcharger failure and a potentially expensive repair.
 - B) A heavy duty and racing use **Auxiliary Oil Filter** system is available from Vortech. Call your Authorized Vortech Distributor or Vortech for additional details and pricing.
- 2) Always utilize the highest octane SUPER UNLEADED fuel available in your area.

Vortech recommends you use a National Brand wherever possible.

 - A) After filling up with fuel from a source other than one you utilize regularly, always perform an audible test for possible detonation. Roll up the windows, turn off the radio and the air conditioning and/or heater fan and accelerate at full throttle to redline.
 - I) In automatic equipped vehicles, use second gear.
 - II) In manual transmission vehicles, use third gear.
 - B) If any increased detonation is audible, you may have a fuel problem. Cease utilizing heavy throttle and drive with greater care until the fuel is gone. If a significant amount of detonation is still evident at lighter throttle loads, it is necessary to inspect for other causes, such as:
 - I) Faulty fuel pump(s). (Remember, many vehicles are now equipped with more than one pump).
 - II) Dirty injector(s), clogged fuel filter or pinched fuel line.
 - III) Faulty spark plug(s) or spark plug wires with too much resistance. Consult your factory repair manual. Most wires should not exceed approximately 10 ohms of resistance.
 - IV) Improper initial timing, not set to factory specification.
 - V) Faulty coil.
 - VI) Cooling system not functioning properly. Check for a faulty thermostat, faulty or improper calibration of the thermostatic fan switch, the water pump slipping or a plugged radiator.
 - VII) An overly dirty air cleaner can also contribute to this problem.

SECTION 4 - GEARCHARGER OPERATIONAL LIMITS

1) Impeller Speed.

A) The Gearcharger impeller speed is limited in two ways.

- I) Physically, by the size of the selected drive pulleys employed.
- II) Theoretically, by the fact that as the impeller speed nears or exceeds 50,000 rpm the impeller (compressor) efficiency begins to be reduced. This results in a dramatic increase in discharge air temperature and reduced proportionate gains in horsepower. This also puts the engine under a significant degree of additional thermal stress and taxes the support systems of fuel management, ignition and cooling to a point where engine damage may actually become likely.

B) **Maximum impeller speed must never exceed 58,000 rpm.**

Safety beyond this point is compromised. Impellers can become unstable and there is even a potential for them to come apart. This, if it occurs, will in turn cause massive destruction. The Gearcharger itself will not be able to be rebuilt and there exists a high probability that substantial damage may occur to the vehicle.

I) Calculating impeller speed.

- a) Divide the Crankshaft Pulley diameter (CP) by the Gearcharger Drive Pulley (DP) times 3.45 (the amount of step up internal within the Gearcharger unit) times the engine's redline rpm:

$$CP \div DP \times 3.45 \times \text{engine rpm @ redline} = \text{rpm impeller speed}$$

- b) As example, a Hi-Output Vortech Gearcharger for 86 to 92 Mustang 5.0 applications uses a 6.5" crank pulley, a 3.25" Gearcharger drive pulley and has a rev limit of 6,000 rpm. This would calculate as:

$$6.5" \div 3.125" \times 3.45 \times 6,000 = 43,056 \text{ rpm impeller speed}$$

- B) The success of any custom or racing application of the V-1 Gearcharger will be greater when the impeller speed is kept at or below 46,000 rpm. Development of new impellers is ongoing at Vortech and the V-1 is expected to be joined by several additional versions in the future. Please don't hesitate to call Vortech @ (805) 529-9330 if any information regarding the care and feeding of your Gearcharger remains unclear.

GEARCHARGER™ EXTENDED SERVICE PROGRAM

REGISTRATION FORM

(must be completed in full & returned within 30 days)

Name: _____
Address: _____
City: _____ State: _____ Zip: _____
Daytime phone: (____) _____
Evening phone: (____) _____

Purchase date: _____
Purchased From: _____
Distributor's Invoice #: _____
Gearcharger Serial #: _____

VEHICLE INFORMATION

Make: _____ Model: _____ Year: _____

Engine: _____ cubic inch

Engine Parts Currently:

Modified or Replaced

- | | | |
|--------------------------------|--------------------------|--------------------------|
| 1. Exhaust system (after cats) | ☐ | ☐ |
| 2. Headers | ☐ | ☐ |
| 3. CD Ignition | ☐ | ☐ |
| 4. Larger Mass Air | ☐ | ☐ |
| 5. Throttle body | ☐ | ☐ |
| 6. Intake Manifold | ☐ | ☐ |
| 7. Cylinder heads | ☐ | ☐ |
| 8. Camshaft | ☐ | ☐ |
| 9. Larger Injectors | ☐ | ☐ |
| 10. Adjustable fuel regulator | ☐ | ☐ |

Planned for Future:

Modification or Replacement

- | | | |
|--------------------------------|--------------------------|--------------------------|
| 1. Exhaust system (after cats) | ☐ | ☐ |
| 2. Headers | ☐ | ☐ |
| 3. CD Ignition | ☐ | ☐ |
| 4. Larger Mass Air | ☐ | ☐ |
| 5. Throttle body | ☐ | ☐ |
| 6. Intake Manifold | ☐ | ☐ |
| 7. Cylinder heads | ☐ | ☐ |
| 8. Camshaft | ☐ | ☐ |
| 9. Larger Injectors | ☐ | ☐ |
| 10. Adjustable fuel regulator | ☐ | ☐ |

Transmission type:

Automatic or Manual

☐ ☐

Is it? Stock or Modified

☐ ☐

Other areas of Modification:

Aerodynamic Package ☐
Suspension ☐
Wheels & Tires ☐

Publications you read:

Autoweek ☐
Car & Driver ☐
Car Craft ☐
Coast to Coast (RV) ☐
Fabulous Mustangs ☐
Field & Stream ☐
Forbes ☐
Four Wheel & Off Road ☐
Four Wheeler ☐
Hot Rod ☐
Motor Trend ☐
Muscle Mustangs ☐
National Dragster ☐
Off Road ☐
Playboy ☐
Popular Mechanics ☐
Popular Hot Rodding ☐
Road & Track ☐
Sport Truck ☐
Sports Illustrated ☐
Super Chevy ☐
Super Ford ☐
Time ☐
Trailblazer (RV) ☐
Truckin' ☐
Turbo & Hi-Tech Perf. ☐

What MOST Influenced You in Selecting a Vortech Gearcharger System?

Advertisement ☐
Authorized Vortech Dealer ☐
Extended Service Program ☐
Racing Success ☐
Recommended by Friend ☐
Other (please specify) ☐

Clubs or Associations to Which You Belong:

IMSA ☐
NHRA ☐
NRA ☐
SCCA ☐
SCORE ☐
Other (please specify) ☐

Household Income:

\$15,000 to \$24,000 ☐
\$25,000 to \$34,000 ☐
\$35,000 to \$44,000 ☐
\$45,000 to \$59,000 ☐
\$60,000 to \$79,000 ☐
\$80,000 and up ☐

Your Age:

18 to 24 ☐
25 to 34 ☐
35 to 39 ☐
40 to 44 ☐
45 to 49 ☐
50 and up ☐

I have read and understand the terms and qualifications for Vortech's Extended Service Program. I have not altered my Gearcharger™ drive mechanism in any way and will not during the entire Extended Service period. I have read and answered all questions on this form. I have enclosed a copy of the original invoice from an Authorized Vortech Distributor reflecting a purchase date after July-1-92. I have also enclosed my check for \$25⁰⁰ enrolling my Gearcharger™ (serial number indicated above) in the Vortech Extended Service Program for an additional 30 months beyond the standard limited warranty period of 6 months.

signed: _____

date: _____ / _____ / _____

Mail completed registrations to: Vortech Engineering, Inc.
5351 Bonsai Ave., Dept. ESP
Moorpark, Ca. 93021

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Questions? Call us at (805) 529-9330 8:30 to 5 pm Pacific time M thru F.