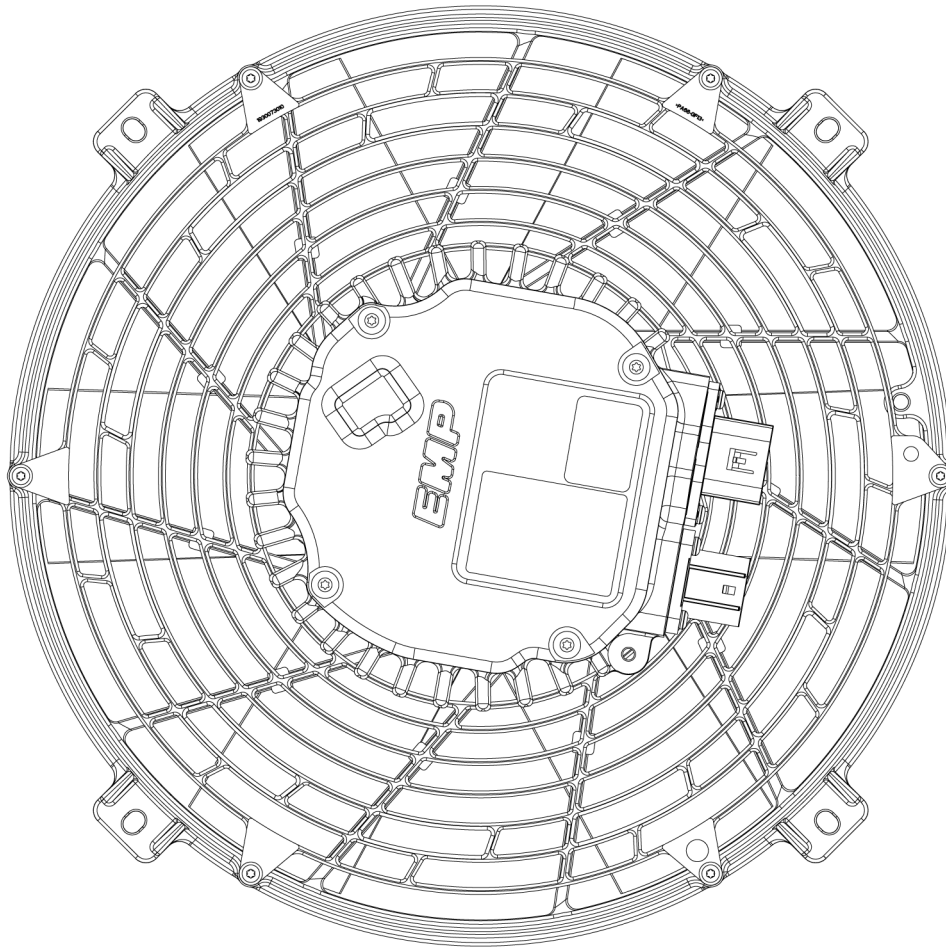




Service and Installation Manual

High Voltage 15 Inch Axial Fan Assembly



Rev	Rev By	Date	Description of Change	Approved By
A	ME	10/17/22	New Release	ECN7700

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Product Overview

NOTE: The FIC15-HV is still in development. The information contained in this document is preliminary and subject to change.

The EMP High Voltage 15" Fan Assembly is an advanced thermal management product designed for high voltage fan applications requiring high performance, efficiency, and robustness. Benefits include lower energy consumption, reduced noise, fan motor and controller diagnostics, and improved temperature control.

EMP FIC15-HV fans have a high voltage connection for motor power and a low voltage connection for communications and control board power. The motor operates between 450–850 volts, removing the need to convert motor power to low voltage, simplifying vehicle architecture.

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Introduction

Purpose

The purpose of this service manual is to present information and procedures required to install, properly service, and maintain the fan.

Service Technician Responsibilities

Ensure that all safety messages and information messages are read and understood before installation, maintenance, or repairs are performed. It is important to use caution when service work is performed. Knowledge of impacted systems and their operation are important before the removal or disassembly of any component. Knowledge of hazards present and risk of injury to the service technician while working on these systems is critical to personal safety.

Liability Disclaimer

EMP cannot anticipate every possible circumstance that might involve a potential hazard. The safety messages in this document, in related manuals, and on the product are therefore not all inclusive. If a tool, procedure, work method, or operating technique that is not specifically recommended by EMP is used, you must satisfy yourself that it is safe for you and for others. You should ensure that the product will not be damaged or be made unsafe by the operation, maintenance, or repair procedures that you choose.

Additional Information



Access <https://www.emp-corp.com/support/> for service software, service bulletins, service manuals, service drawings, and other documents related to your installed EMP systems and components. First time users may create a free customer login at <https://www.emp-corp.com/account/register/>.

Technical Help

Contact EMP Technical Service for technical help at +1 (906) 789-7497 or service@emp-corp.com.

About This Document

Warnings, Cautions and Notes

Two headings are used in this document to stress your safety and safe operation of the system. They are styled with a graphic bullet and bold, uppercase text:  **WARNING** and  **CAUTION**. Warnings highlight risks to personnel — hazards, unsafe conditions and practices that can result in personal injury or death. Cautions indicate conditions or practices that can cause damage to components, systems, or other equipment.

A third heading, styled as **NOTE**, calls attention to additional information about components and procedures discussed in the document.

Definition of Terms

CAN SAE J1939 controller area network.

DLA Data link adapter.

DVM Digital voltmeter.

ECU Engine control unit.

Electrically safe work condition A condition where the equipment has been de-energized, locked or tagged to prevent energizing the equipment, and tested using properly rated equipment and PPE to verify the absence of voltage.

ESD Electrostatic discharge.


HV High voltage.


HVIL High voltage interlock loop, a safety feature used to detect issues in the high voltage system.


MSD Manual service disconnect, device designed to disconnect the high voltage supply.


PLC Programmable Logic Controller.


Product Safety Warnings

 **WARNING:** EMP cannot anticipate every possible circumstance that might involve a potential hazard. The safety messages in this document, in related manuals, and on the product are therefore not all inclusive. If a tool, procedure, work method, or operating technique that is not specifically recommended by EMP is used, you must satisfy yourself that it is safe for you and for others. You should ensure that the product will not be damaged or be made unsafe by the operation, maintenance, or repair procedures that you choose.


 **WARNING:** Ensure that all safety messages and information messages are read and understood before installation, maintenance, or repairs are performed. It is important to use caution when service work is performed. Knowledge of impacted systems and their operation are important before the removal or disassembly of any component. Knowledge of hazards present and risk of injury to the service technician while working on these systems is critical to personal safety


 **WARNING:** Ensure that the equipment cannot move before doing any work or diagnostic procedures on the EMP component, system, or vehicle.

 **WARNING:** When working on or near electrical components, ensure that they have been disconnected from their energy source, cannot be accidentally re-energized, and verify the system is in a zero energy state.


 **WARNING:** Use extreme caution when working on systems under pressure (i.e. coolant, hydraulic fluids, air, fire suppression, etc.).

 **WARNING:** Ensure the work area is ventilated and well lit.

 **WARNING:** Ensure charged fire extinguishers are in the work area.


 **WARNING:** Ensure all safety guards, shields, and covers are reinstalled when tasks are completed.


 **WARNING:** Ensure all tools, parts and service equipment are removed from the work area.


 **WARNING:** Ensure that all system power and ground connection points are torqued to EMP and/or OEM specifications to prevent system damage. Failure to follow specified torque requirements can result in loose connections which can damage electronic components and will void EMP warranty.


High Voltage Safety


When properly integrated, EMP high voltage components are designed with safety features that protect personnel during operation and maintenance. All personnel involved in the integration and service of this equipment shall read and understand this manual and all instructions provided in the OEM documentation.


 **WARNING:** Always verify that an electrical circuit is in an electrically safe work condition before touching any electrical conductor during service. Always follow established procedures to de-energize equipment. Always test for absence of voltage.


 **WARNING:** It is mandatory to carefully read these instructions and the OEM system manual before installing or servicing EMP components.


 **WARNING:** The information contained in this manual is intended to supplement, rather than replace standard shop practices and safety procedures. Always make safety the number one priority during any maintenance task.

 **WARNING:** Make vehicle or system "Safe for Maintenance" in accordance with the safety portions of the OEM service manual and your company's safety policies prior to performing any maintenance action.

 **WARNING:** Always allow the vehicle/system OEM recommended time for high voltage system and components to discharge electricity before proceeding with service.

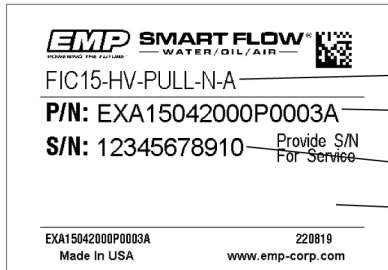
 **WARNING:** Risk of electric shock. Only trained, qualified personnel shall access high voltage components in accordance with site specific safety procedures. Failure to observe safety precautions may result in personal injury and/or death.

 **WARNING:** All tools, test equipment and personal protective equipment must be rated for the voltage and other electrical conditions on the system. Refer to system and/or vehicle documentation.

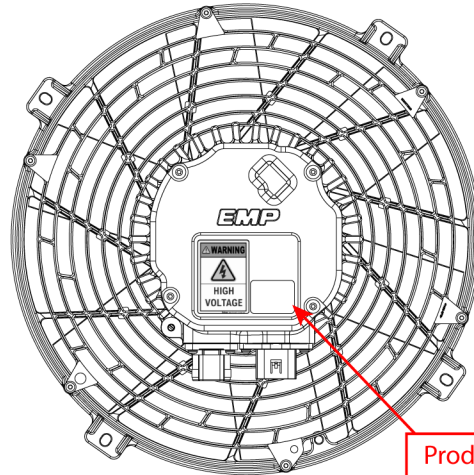
 **WARNING:** Risk of electric shock and arc flash. Any disassembly of motor and/or controller housing has the potential to expose high voltage. Do not disassemble the housings. The motor and controller do not contain any user serviceable parts.

Identification

Each component is labeled with a model code, part number, and serial number. The model code reflects hardware configuration options of the component (see the next page). The part number is based on the combined hardware and software configuration of the component. Each serial number is unique. Provide the component serial number with all enquiries to EMP technical service, it is used to trace the component hardware configuration, software calibration, date of manufacture, and other manufacturing data.

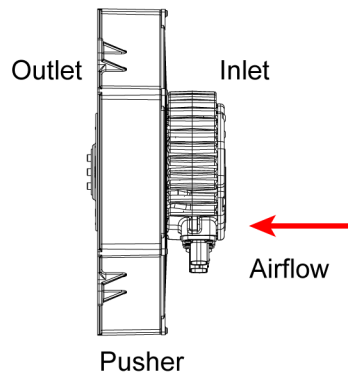
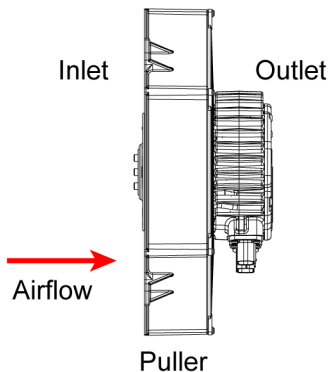


Model Code
Part Number
Serial Number
Programmed Control
Parameters



Product Label
Location

Flow Direction Definitions



EMP Fan Model Decoder

Example: FIC15-HV-PUSH-G-A

F	I	C	15	-	HV	-	PUSH	-	G	-	A	[OEM]	[Cert]	[Suffix]
1	2	3	4		5		6		7		8	9	10	11

1	Component F = Fan	5	Voltage HV = High voltage	9	OEM Omit if n/a
2	Controller I = Integrated Controller Omit if motor only	6	Normal Airflow Direction PUSH PULL (See manual for definition)	10	Certifications Omit if n/a E = E-Mark C = CSA U = UL
3	Communication C = CAN	7	Finger Guard N = No guard G = Installed guard	11	Suffix Denotes model variation
4	Size Diameter in inches	8	I/O options A = Address Input		

FIC15-HV-PUSH-G-A = Fan with integrated controller, CAN communication, 15" diameter, high voltage, push with finger guard, and address selection.

NOTE: Not every option combination is available.

Technical Information

Specifications

Component Construction	Cast Aluminum
Component weight.....	19 lbs
Minimum speed	500 rpm
Maximum speed	5400 rpm
Operating temperature minimum	-40 °C
Operating temperature maximum	95 °C

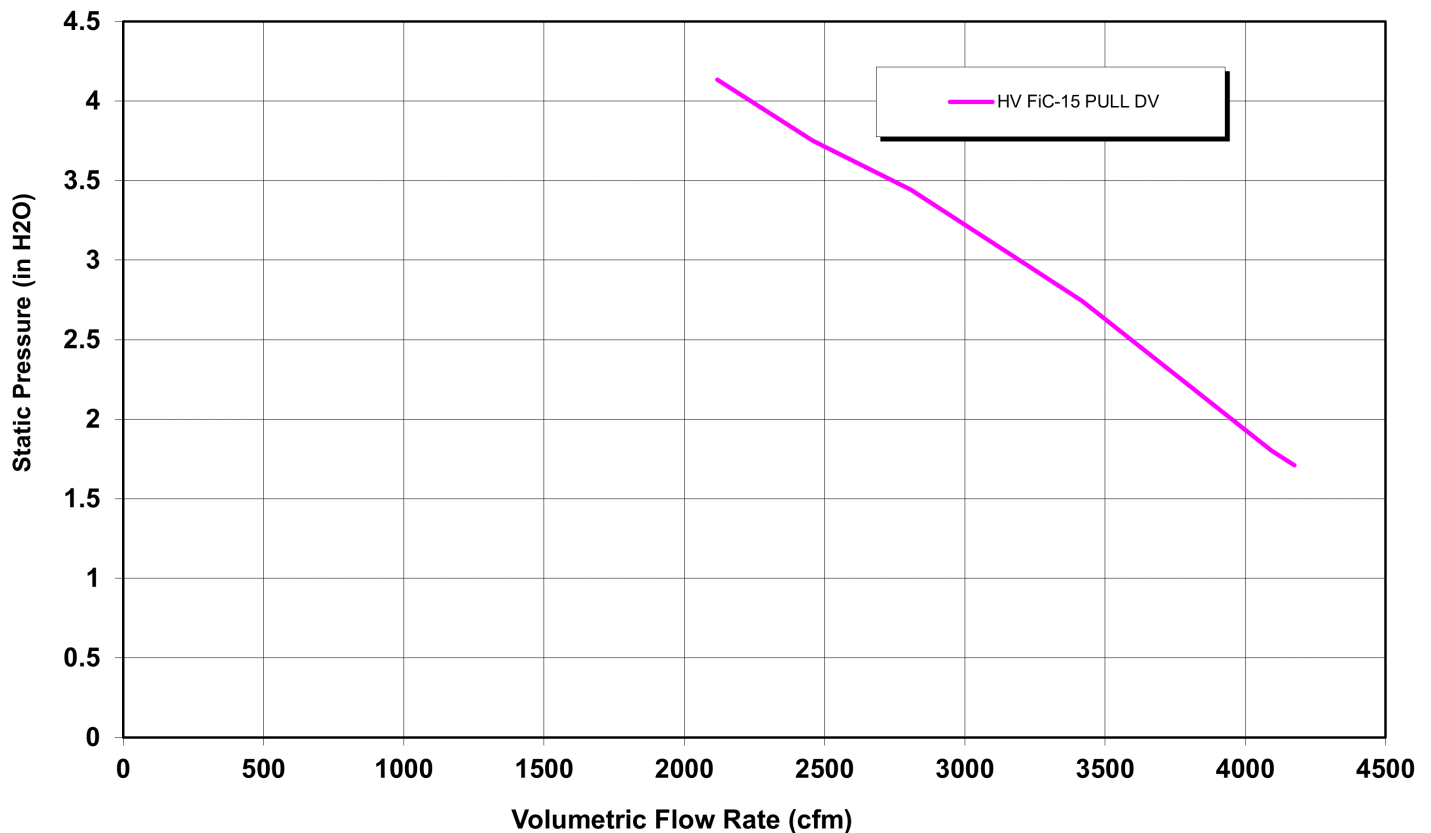
Internal Protections

Over temperature protection
 High voltage over current protection
 High voltage over voltage protection
 High voltage transient voltage protection
 Low voltage over voltage protection
 Low voltage transient voltage protection
 Short circuit protection
 ESD protection

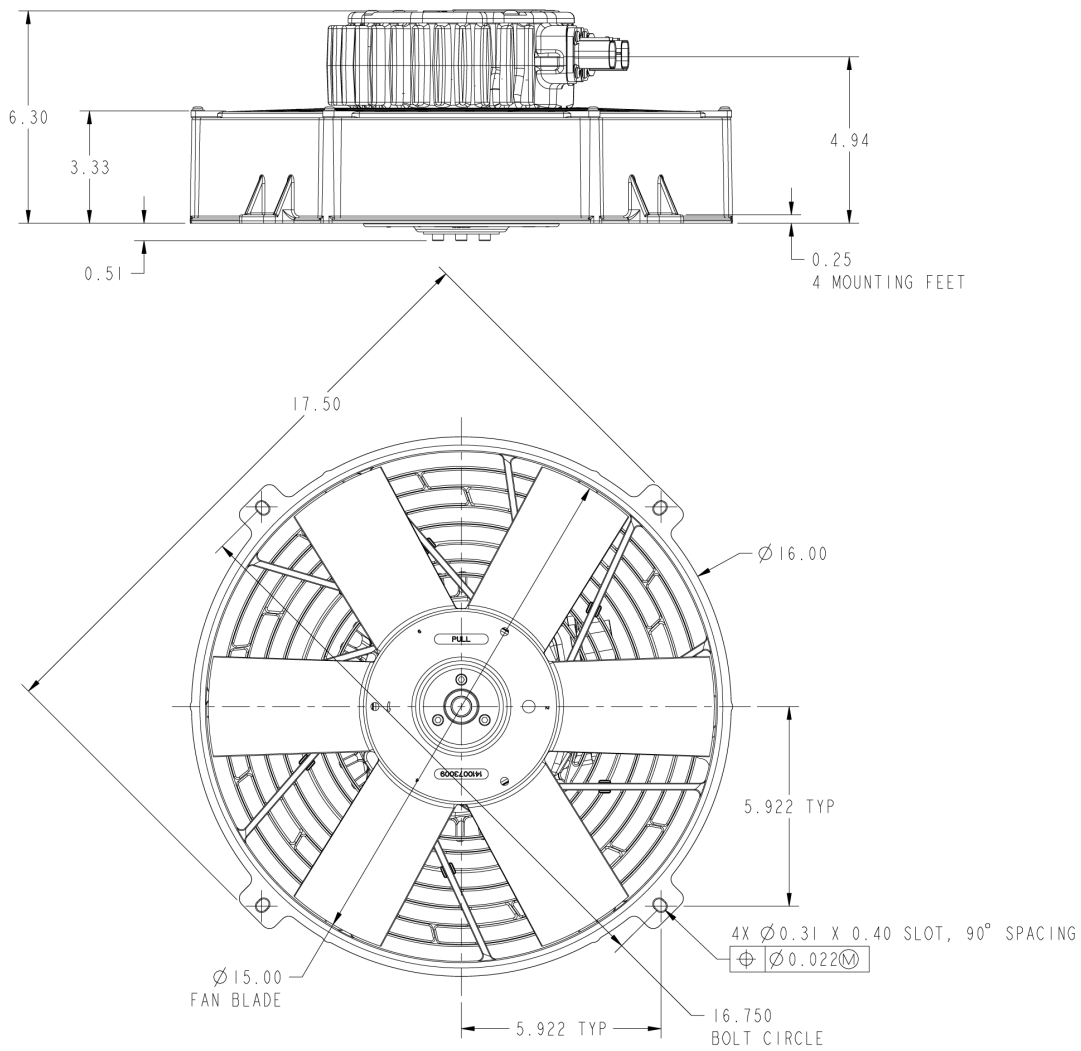
Sample Performance Chart

TRR-2022-007

Static Pressure -vs- Volumetric Flow Rate



Mounting and Dimensions



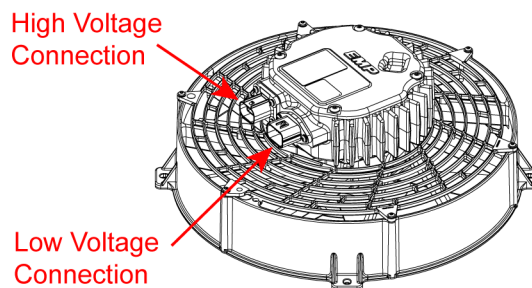
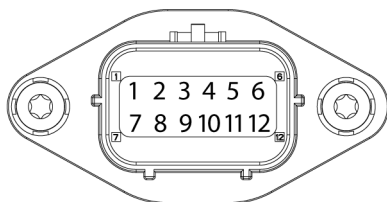
Electrical Connections

The high voltage FIC15 has 2 connections on the controller housing, one carrying high voltage power and HVIL, and one carrying low voltage power, CAN, ignition enable, address inputs and HVIL.

Low Voltage Connection

TE Connectivity 5ATM Thru Wall.

Pin	Description
1	LV supply
2	HVIL supply
3	Address input 1
4	Ignition enable
5	CAN high
6	Address input 2
7	Address input 3
8	HVIL return
9	Unused
10	CAN shield
11	CAN low
12	LV return



Mating Connector

TE Connectivity 5ATM connector assembly 12P, F, part number 1897462-2.

Additional Connector Components

Description	TE Part Number
Plug	0413-204-2005
Terminal, F, MCON 1.2CB, 0.5–0.75 mm ² , (20/18 AWG), Ag	1670144-3
Terminal, F, MCON 1.2CB, 0.25–0.35 mm ² , (24/22 AWG), Ag	1534594-3

Low Voltage Power Specification

The low voltage connection provides constant power to the component controller.

Component Low Voltage Supply Parameters

Parameter	Min	Nom	Max	Units
V _{in} – Operating	9	-	34	V
Operating current	-	-	0.5	A
Ignition off current	-	-	300	μA

Ignition Enable Specification

The ignition enable pin is used in power management of the controller. When this input goes high, the module will “wake up.” This input is designed for a switched power supply and will not be damaged by vehicle transients. Ignition enable must be separate from controller power so that power remains on when ignition is switched off to enable shutdown processes.

Component Ignition Enable Parameters

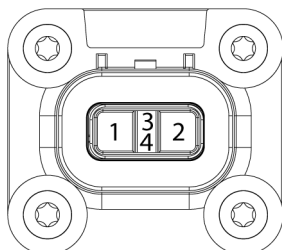
Parameter	Min	Nom	Max	Units
V _{in}	9	-	34	V
Ignition Current (28 V)		4		mA
V _{in} – Low (sleep)	-50	0	3.6	V

High Voltage Connection

TE Connectivity HVA 280 Header Assembly, Key A.

CAUTION: The HV280 connector must be capped or attached to the mating harness at all times to prevent contamination from entering the housing.

Pin	Description
1	High voltage positive
2	High voltage negative
3	HVIL supply
4	HVIL return



Mating Connector

TE Connectivity plug subassembly 4-2103015-1 (Key A). Additional parts required for complete mating connector, depends on wiring and HVIL configuration.

The sealing of the HV280 connector is dependent on the vehicle side wire harness. The vehicle side wire harness must be watertight.

High Voltage Power Specification

High voltage inrush current is not controlled by the EMP component and must be controlled by a system precharge. The internal bulk capacitance is 30.68 μ F.

The internal passive discharge circuit requires 60 seconds to limit internal voltage to below 60 volts when external high voltage power is removed.

WARNING: Due to internal capacitances, system and component voltage will remain above 60 volts after removal of power. Always allow the OEM specified period for system and components to discharge electricity before disconnecting any element of a high voltage circuit.

When driven above 600 rpm by external forces (such as RAM air), the fan can generate voltage exceeding 60 volts. Ensure fan is not spinning and at least 60 seconds has elapsed for passive discharge prior to performing service.

Component High Voltage Supply Parameters

Parameter	Min	Nom	Max	Units
V_{in} – Operating	450	-	850	V
Operating current		-	6	A

Equipotential Bonding

The high voltage system must be designed with isolation fault detection. A fault in the component may expose the component case to high voltage. The system must detect this condition and interrupt the high voltage supply.

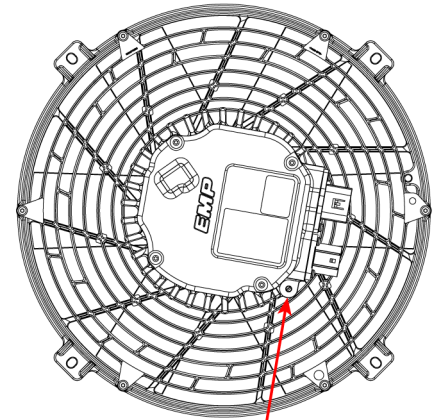
M6-1 threaded hole located on the controller case for equipotential bonding.

⚠ WARNING: Improper installation or degradation of the equipotential bonding connection may prevent the detection of isolation faults.

Fasteners must be compatible with 356-T6 aluminum, to prevent contact corrosion.

Fastener must stay properly secured during service life of component.

Ensure that the contact surface is clean and free of contamination when installing the bonding connection, the bonding harness must make a low resistance connection with the component housing.



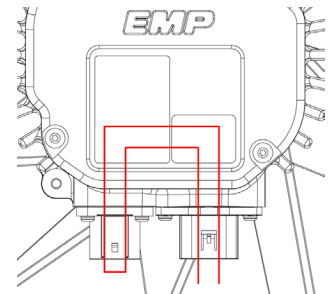
Equipotential Bonding

High Voltage Interlock Loop (HVIL)

The high voltage system must be designed to interrupt the high voltage supply when any connector on the high voltage component is not fully engaged. EMP components support several different interlock configurations.

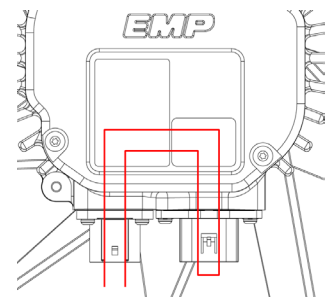
HVIL Vehicle Connection on Low Voltage Harnessing

HVIL supply shunted to HVIL return in customer side high voltage connector. When either connector is removed from the component, the HVIL will be disrupted.



HVIL Vehicle Connection on High Voltage Harnessing

HVIL supply shunted to HVIL return in customer side low voltage connector. When either connector is removed from the component, the HVIL will be disrupted.



Operation

On/Off Single Speed Control

Components configured for on/off single speed control start and run at a pre-configured default speed when low voltage power, high voltage power and ignition enable are provided. The components communicate on CAN, sending status and diagnostic messages. EMP also provides a “Power Hold” option which can keep the controller running for a specified amount of time after the ignition enable has been removed. This allows for post-shutdown cooling.

NOTE: For assistance with component calibrations and settings, please contact EMP Technical Service at service@emp-corp.com and provide a serial number for the part in question.

CAN Control

EMP high voltage components support the EMP Defined Messages and SAE J1939 Standard Messages defined in EMP document 9980001068, *Component Controller CAN Communication*.

EMP recommends using EMP Defined Messages in applications that do not require SAE J1939 Standard Messages. Components using EMP defined messages are SAE J1939 compliant, the message structures are proprietary (documented in 9980001068).

EMP Defined Message structures are documented in section 3 of 9980001068. The Motor command message is documented in section 3.1. The default output message, Motor status message 2, is documented in section 3.4. Motor status message 1, documented in section 3.2, is intended for support of legacy applications.

Section 4.1 of 9980001068 lists the supported SAE J1939 PGN pairs. SAE J1939 Standard Message structures are documented in the SAE [J1939 Digital Annex](#).

The controller expects to receive a command message at a 1 second rate. If this command is not received within the calibrated timeout (default of 5 seconds) the controller will run at the calibrated default speed. The controller can be commanded to a specific RPM or a percent of maximum RPM.

Each controller also supplies a status message at a 1 second rate. The status message supplies information such as operation status, command status, service status, current RPM, and power. Exact message content depends on the calibrated message choice.

NOTE: For assistance with component calibrations and settings, please contact EMP Technical Service at service@emp-corp.com and provide a serial number for the part in question.

CAN Baud Rate

At every startup (ignition enable on) the controller automatically detects the CAN baud rate before transmitting any data on the CAN bus. Automatic Baud rate detection is enabled by default, but a fixed baud rate can be requested if required. 250K, 500K, and 1M baud rates are supported.

Measurement Tolerances

In the CAN status messages, when measured motor speed and measured motor power are reported, these are calculated values. The resulting measurements are affected by circuit board component tolerances and therefore are not to be used for diagnostics and may not be suitable for control system inputs.

This controller has the following tolerances on these measurements:

Speed: ± 2%

Power: ± 8%

Selectable CAN Addresses

EMP high voltage 15" fans support a flexible addressing scheme. 16 addresses are assigned in the component calibration and selected from by reading the state of the address input pins on the low voltage connection. Address input 1 and address input 2 can sense open, short to power and short to ground. Address input 3 can sense open and short to ground.

NOTE: Open positions on the connector must be plugged to maintain seal integrity.

Address Input 1	Address Input 2	Address Input 3	CAN Address
Open	Open	Open	0x82
Open	Ground	Open	0x83
Ground	Open	Open	0x84
Open	Open	Ground	0x85
Ground	Ground	Open	0x86
Open	Ground	Ground	0x87
Ground	Open	Ground	0x88
Ground	Ground	Ground	0x89
Open	Power	Open	0x8A
Power	Open	Open	0x8B
Ground	Power	Open	0x8C
Power	Ground	Open	0x8D
Open	Power	Ground	0x8E
Power	Open	Ground	0x8F
Ground	Power	Ground	0x90
Power	Ground	Ground	0x91

NOTE: Address input 1 and address input 2 do not support sensing short of both pins to power. Address input 3 does not support sensing short to power.

NOTE: EMP default addresses shown in table. For assistance with component calibrations and settings, please contact EMP Technical Service at service@emp-corp.com and provide a serial number for the part in question.

As an example, to configure a component to use CAN address 0x86 in the EMP default calibration table, splice address input 1 (pin 3) and address input 2 (pin 6), to the LV return (pin 12) in the mating connection. Pin 7 would not have a wire connection but must be plugged to maintain seal integrity.

Installation

⚠ CAUTION: To avoid potential damage to the wiring and/or hoses, route all wires and hoses away from any sharp edges, moving objects, and heat sources.

⚠ CAUTION: All wires should be secured every 12–18 inches. All zip ties must be placed over wire loom/convoluted tubing and not over bare wires.

Locations/Orientations


NOTE: Ensure component connectors are not strained by wire routing.


- For optimum performance, the fan should be mounted to a shroud (typically fabricated aluminum or steel or molded plastic). The shroud provides the fan mount and helps guide the air through the desired location (heat exchanger or other). When mounting the fan in this fashion, no isolation is required.
- The recommended fastener size for fan mounting is a ¼" or a M6 fastener with a flange head or a washer. The recommended torque value is 85–105 in-lbs (9.6–11.9 N m). Because of the variety of fasteners, threaded inserts and shroud materials available, this joint should be validated for each unique application.
- For optimal airflow performance, the fan should be mounted a minimum of 2 inches (50.8 mm) away from a heat exchanger. This helps ensure even distribution of the air over the face of the heat exchanger.
- The recommended cutout diameter for mounting the fan is 15.375 inches (391 mm).
- The fan must be mounted with the wire seals facing down $\pm 45^\circ$ as shown in the picture above.
- For best performance keep airflow obstructions at least 3" from the inlet and outlet of the fan.
- Operating temperature limits must be considered during installation.
- Rubber isolators are not required for fan installation. The fan can be mounted directly to brackets, plastic shrouding or sheet metal shrouding.
- Ensure objects near the air flow path of the fan are secure and cannot be pulled into the fan during operation.
- When the fan is located in the stream of ram air (on-highway vehicles) and the ram air is sufficient to cause rotation of the fan, the ram air direction must match the airflow direction of the fan.



NOTE: These applications should be reviewed by EMP to ensure the desired product life is achieved.

Wiring

 **CAUTION:** To avoid potential damage to the wiring and/or hoses, route all wires and hoses away from any sharp edges, moving objects, and heat sources.

 **CAUTION:** All wires should be secured every 12–18 inches. All zip ties must be placed over wire loom/convoluted tubing and not over bare wires.

- Wiring or electrical harness must not rub on a sharp edge.
- The fan has a conductive outer casing. Protect against isolation faults.
- The HVIL circuit to the component should only be continuous when the high voltage and low voltage connectors are both mated with the system/vehicle side connectors.
- The voltage drop between the battery and the fan should not exceed 5% of the rated battery voltage. This should be verified at the fan maximum current draw.
- Wiring or electrical harness must not rub or make contact with a hot surface. There should be a 5" minimum clearance from any hot surface.
- Wiring or electrical harness should be supported every 12–18 inches.
- To avoid possible fire, shock, or arc flash, do not pinch any wiring or electrical harnesses.
- Incorporate drip loops into wiring designs. The fan connectors are environmentally sealed. However, good wire management can help ensure a good seal over the life of the product.
- Ensure fan connections are not strained by wire routing.

Service Parts Replacement

⚠ WARNING: To avoid serious personal injury, possible death, or damage to the vehicle, disconnect the power supply, main negative battery cable, and/or switch off the battery disconnect switch before installation or servicing. When working on or near the electric components, ensure battery power is off or lock out vehicle ignition, so the system cannot activate unexpectedly.

⚠ WARNING: Always verify that an electrical circuit is in an electrically safe work condition before touching any electrical conductor during service. Always follow established procedures to de-energize equipment. Always test for absence of voltage.

⚠ WARNING: Always allow the vehicle/system OEM recommended time for high voltage system and components to discharge electricity before proceeding with service.

⚠ WARNING: To avoid burn injuries, allow time for parts to cool to a safe working temperature before removing or installing any components.

⚠ CAUTION: To avoid potential damage to the wiring and/or hoses, route all wires and hoses away from any sharp edges, moving objects, and heat sources.

⚠ CAUTION: All wires should be secured every 12–18 inches. All zip ties must be placed over wire loom/convoluted tubing and not over bare wires.

NOTE: Refer to service drawings for proper torques. Obtain drawings at <https://www.emp-corp.com/support/documents/> by searching for the part number.

The fan blade is the only serviceable item on the fan assembly.

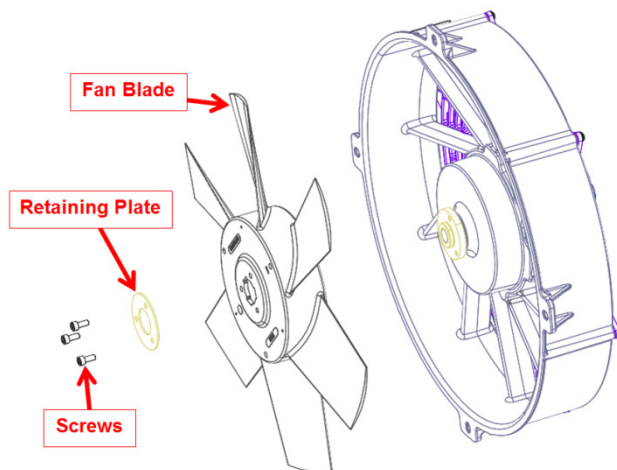
Fan Blade

Puller Blade Replacement Blade Kit 1370073063

Part Number	Description	Quantity
1410073009	Rotor, Puller Fan	1
1400005009	Plate, Retaining	1
5009009003	Scr-Cap, Soc Hd, M5-0.8 x 12	3

Pusher Blade Replacement Blade Kit 1370073064

Part Number	Description	Quantity
1410073006	Rotor, Pusher Fan	1
1400005009	Plate, Retaining	1
5009009003	Scr-Cap, Soc Hd, M5-0.8 x 12	3



1. Remove the three M5 x 12mm fan blade mounting bolts.
2. Place the replacement fan blade onto the hub.
3. Install the new retainer plate.
4. Line up the three holes in the retainer plate and fan blade with the threaded holes in the hub.
5. Install the three new M5 x 12mm mounting bolts and hand-tighten all three prior to applying the final torque.
6. Torque each of the three fan mounting bolts to specification per the service drawing.
7. With the power still disconnected from the fan, rotate the blade by hand to ensure it turns freely.

Final Item Checklist

- Is the fan supplied with the appropriate voltage?
- Is the fan securely mounted?
- Are all wires and/or hoses routed away from sharp edges, moving objects, and heat sources?
- Is the fan integrated with the high voltage safety systems?
- Is the ignition enable on a switched source and not tied to low voltage power?

Routine Maintenance

Frequency	Action
Every three months or more often if conditions are harsh	Visually inspect exterior of fan for evidence of damage. Check wires for wear or frayed insulation. Ensure all electrical connections are tight.
Annually	Ensure all wires and pin connections are intact. Inspect support structure for any damage or loose hardware.

Troubleshooting

Symptom	Probable Cause
Fan will not run	<ul style="list-style-type: none">• Incorrect supply voltage.• Blown fuse.• Electrical connection issue.• Problem with ignition switch.
Fan not running at commanded speed	<ul style="list-style-type: none">• Check for obstructions in the airflow path.• The controller will provide a status reason why the motor is not at commanded speed.

Product Warranty Registration Form

A standalone PDF of this registration form suitable for electronic submission is available in the [Product Documentation section of the EMP website](#). Search for document number 9960039049.

Customer Information

Customer/Business Name

Customer Contact Name

Customer Contact E-mail

Customer Contact Phone

Address

City

State/Province

Country

Postal Code

Product Information

Product Type Complete one form per product type. For complete thermal system assemblies you do not need to register each assembled fan, controller, and pump.

Electric Water Pump

Individual Fan

Controller

EMP Alternator

Oil Pump

Other

Electric Fan Cooling System

Number of Fans

Model Purchased

Part Number

Serial Number

Installation Date

Model, Serial Number, and Part Number are located on the EMP product label.

Vehicle Information

Vehicle Fleet ID

Vehicle Make

Vehicle Model

Vehicle Model Year

Vehicle Identification Number (VIN)

Vehicle Miles/Hours at Installation

If New System, Alternator Serial Number

Notes

Contact EMP

Mail/Fax/E-mail completed registration forms to:

EMP Advanced Development, LLC

2701 North 30th Street

Escanaba, MI 49829

USA

Fax: +1 (906) 789-7825

E-mail: warranty@emp-corp.com