



# DC/DC Converter Module

## User Manual

Specification Number: 1C24481500

Model Number: C24/48-1500

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## Technical Support Site

If you encounter any installation or operational issues with your product, check the pertinent section of this manual to see if the issue can be resolved by following outlined procedures.

Visit <https://www.vertiv.com/en-us/support/> for additional assistance.

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## Admonishments Used in this Document



**DANGER!** Warns of a hazard the reader **will** be exposed to that will **likely** result in death or serious injury if not avoided. (ANSI, OSHA)



**WARNING!** Warns of a potential hazard the reader **may** be exposed to that **could** result in death or serious injury if not avoided. This admonition is not used for situations that pose a risk only to equipment, software, data, or service. (ANSI)



**CAUTION!** Warns of a potential hazard the reader **may** be exposed to that **could** result in minor or moderate injury if not avoided. (ANSI, OSHA) This admonition is not used for situations that pose a risk only to equipment, data, or service, even if such use appears to be permitted in some of the applicable standards. (OSHA)



**ALERT!** Alerts the reader to an action that **must be avoided** in order to protect equipment, software, data, or service. (ISO)



**ALERT!** Alerts the reader to an action that **must be performed** in order to prevent equipment damage, software corruption, data loss, or service interruption. (ISO)



**FIRE SAFETY!** Informs the reader of fire safety information, reminders, precautions, or policies, or of the locations of fire-fighting and fire-safety equipment. (ISO)



**SAFETY!** Informs the reader of general safety information, reminders, precautions, or policies not related to a particular source of hazard or to fire safety. (ISO, ANSI, OSHA)

# Important Safety Instructions

## Safety Admonishments Definitions

Definitions of the safety admonishments used in this document are listed under “Admonishments Used in this Document” on page iv.

### General Safety



**DANGER!** YOU MUST FOLLOW APPROVED SAFETY PROCEDURES.

Performing the following procedures may expose you to hazards. These procedures should be performed by qualified technicians familiar with the hazards associated with this type of equipment. These hazards may include shock, energy, and/or burns. To avoid these hazards:

- a) The tasks should be performed in the order indicated.
- b) Remove watches, rings, and other metal objects.
- c) Prior to contacting any uninsulated surface or termination, use a voltmeter to verify that no voltage or the expected voltage is present. Check for voltage with both AC and DC voltmeters prior to making contact.
- d) Wear eye protection.
- e) Use certified and well maintained insulated tools. Use double insulated tools appropriately rated for the work to be performed.

### Voltages

#### DC Input Voltages



**DANGER!** This system operates from DC input voltage. Although the DC voltage is not hazardously high, the input power can deliver large amounts of current.

#### DC Output and Battery Voltages



**DANGER!** This system produces DC power and may have a battery source connected to it. Although the DC voltage is not hazardously high, the converters and/or battery can deliver large amounts of current. Exercise extreme caution not to inadvertently contact or have any tool inadvertently contact an output terminal or battery terminal or exposed wire connected to an output terminal or battery terminal. NEVER allow a metal object, such as a tool, to contact more than one termination or battery terminal at a time, or to simultaneously contact a termination or battery terminal and a grounded object. Even a momentary short circuit can cause sparking, explosion, and injury.

### Hazardous Voltage



**DANGER!** HAZARD OF ELECTRICAL SHOCK.

More than one disconnect may be required to de-energize the system before servicing.

### Handling Equipment Containing Static Sensitive Components



**ALERT!** Installation or removal of equipment containing static sensitive components requires careful handling. Before handling any equipment containing static sensitive components, read and follow the instructions under “Static Warning” on page vi.

## Static Warning



This equipment contains static sensitive components. The warnings listed below must be observed to prevent damage to these components. Disregarding any of these warnings may result in personal injury or damage to the equipment.

1. Strictly adhere to the procedures provided in this document.
2. Before touching any equipment containing static sensitive components, discharge all static electricity from yourself by wearing a wrist strap grounded through a one megohm resistor. Some wrist straps have a built-in one megohm resistor; no external resistor is necessary. Read and follow wrist strap manufacturer's instructions outlining use of a specific wrist strap.
3. Do not touch traces or components on equipment containing static sensitive components. Handle equipment containing static sensitive components only by the edges that do not have connector pads.
4. After removing equipment containing static sensitive components, place the equipment only on static dissipative surfaces such as conductive foam or ESD bag. Do not use ordinary Styrofoam or ordinary plastic.
5. Store and ship equipment containing static sensitive components only in static shielding containers.
6. If necessary to repair equipment containing static sensitive components, wear an appropriately grounded wrist strap, work on a conductive surface, use a grounded soldering iron, and use grounded test equipment.

# 1 Introduction

## 1.1 Overview

The Vertiv™ C24/48-1500 is a compact DC/DC converter module which offers efficient power conversion. It operates from a nominal +24 VDC source to provide nominal -48 VDC load power.

## 1.2 Specifications

### 1.2.1 DC Output Ratings

- Voltage: Nominal -48 volts DC, positive ground. Output voltage is adjustable from 48.0 to 55.5 volts DC via the associated controller.
- Nameplate Rating:
  - a) 48 - 52 Vdc, 31.25 - 28.9 A, 1500W max. @ 50°C.
  - b) 48 - 52 Vdc, 25 - 23 A, 1200W max. @ 65°C.
- Regulation:
  - a) Static: Steady state output voltage remains within  $\pm 1\%$  of the pre-adjusted voltage for any load current from no load to full load and over the specified input voltage range.
  - b) Dynamic: For any load step change within the range of 20% to 100% of full rated current, the maximum voltage transient will not exceed 5% of the initial steady state voltage.
- Filtering: With at least 10% of rated full load on the output (-20°C to +65°C).
  - a) Voice band noise is less than 32 dBrnC (for more than one converter module) or 40 dBrnC (for a single converter module) when measured with a noise meter using 600 ohm bridged input and C-message weighting.
  - b) Wide band noise does not exceed 250 millivolts peak to peak over the frequency range of 0 Hz to 100 MHz.
  - c) Wide band noise does not exceed 50 millivolts rms over the frequency range of 0 Hz to 100 MHz (as measured with an HP3400A true rms voltmeter).
  - d) Noise below -20°C is slightly higher.

### 1.2.2 DC Input Ratings

- Voltage: Nominal 24 volts DC.
- Nameplate Rating: 20.5 - 30 VDC, 87 - 59 A.
- Inrush Current: The peak value of the inrush current does not exceed 2 times the maximum steady-state RMS input current at 25°C and does not trigger the unit's internal input fault protection device.
- Filtering: Noise reflected back to the central office battery is within the parameters set forth in Telcordia Technical Reference TR-TSY-000009, paragraph 5.0, using test measurements in Telcordia Technical Reference PUB 43802, pages 5 and 6.
- Typical Input Data: When equipped with one DC-DC converter module.
  - a) The output voltage of the DC-DC converter module is initially adjusted to 48 volts at 50% load and 24 volts DC input.
  - b) Maximum Current: Input current is 83.32 amperes at full load (31.25 amperes) and 21 volts DC input.

**Table 1.1 Typical Input Data**

Input Voltage	Percent of Full Load	Input Current (Amps)	Efficiency (%)	Typical Heat Dissipation (BTU/Hr)
21 VDC	0	0.56	--	40.13
	25	19.56	91.2	123.34
	50	39.16	91.2	246.93
	75	59.76	89.6	445.33
	100	83.32	85.7	853.74
24 VDC	0	0.52	--	42.58
	25	17.28	90.4	135.85
	50	34.40	90.8	270.43
	75	52.52	89.3	460.19
	100	72.84	85.8	847.02
28 VDC	0	0.48	--	45.86
	25	15.04	89.0	158.06
	50	29.64	90.4	271.85
	75	45.28	88.7	488.84
	100	62.24	86.1	826.54

### 1.2.3 Environmental Ratings

- Specification Compliant Temperature Range: -20°C to +65°C (-4°F to +149°F).
- Reduced Load Temperature Range: +50°C to +80°C (+122°F to +176°F).
- Deviation to Noise Specs. Temperature Range: -40°C to -20°C (-40°F to -4°F).
- Storage Ambient Temperature Range: -40°C to +85°C (-40°F to +185°F).
- Humidity: This converter module is capable of operating in an ambient relative humidity range of 0 to 95%, non-condensing.
- Altitude: The maximum operating ambient temperature should be derated by 10°C at an elevation of 10,000 feet. For elevations between sea level and 10,000 feet, derate the maximum operating ambient temperature linearly.
- Ventilation Requirements: The converter module is fan cooled and utilizes front to back forced ventilation.
- Audible Noise: With four converter modules installed and operating, the audible noise at any point 5 feet from any vertical surface of the Module Mounting Shelf does not exceed 68 dBA when measured with a sound level meter conforming to ANSI S1.4.
- EMI/RFI Suppression: Converter modules operating in an approved Module Mounting Shelf conform to the requirements of FCC rules Part 15, Subpart B, Class B for Radiated and Conducted emissions limits.

### 1.2.4 Compliance Information

- Safety Compliance: This unit meets the requirements of UL 1950, Standard for Information Technology Equipment, and is UL Recognized as a power supply for use in Telephone, Electronic Data Processing or Information Processing Equipment. This unit meets the requirements of CSA 22.2, No. 950 and is tested and Certified by UL ("c UR") as a Component Type Power Supply.
- The converter module is RoHS 5/6 compliant.
- NEBS Compliance (when used in a compliant system): Compliance verified by a Nationally Recognized Testing Laboratory (NRTL) per GR-1089-CORE and GR-63-CORE. Contact Vertiv for NEBS compliance reports.

### 1.2.5 Standard Features

- Type of Power Conversion Circuit: High Frequency.



- Input Protection:
  - a) Fusing: A 100-ampere non-user replaceable fuse is located in the positive input lead of each DC-DC converter module.
  - b) Low Input Voltage Inhibit: Operation of each DC-DC converter module will inhibit if the input voltage drops to within the range of 19.25 to 20.5 volts. While operation is inhibited, each DC-DC converter modules will draw no more than 15mA. Operation will automatically resume after the input voltage returns to within normal operating limits.

- Output Protection:

- a) Overvoltage Protection: If output voltage exceeds an adjustable preset value (set via controller) and the converter module is delivering more than 10% of its rated current, the converter module shuts down.

After approximately 3 seconds, the converter module automatically restarts. If output voltage again exceeds the high voltage shutdown value within 5 minutes, the converter module shuts down and locks out. Manual restart is then required. If the converter module does not experience a high voltage condition within the 5-minute time-period, the restart circuit is reset.

If two or more converter modules are installed in a shelf, or if the shelf is paralleled with other Module Mounting Shelves, only the converter module causing the high voltage condition shuts down.

Adjustable from 49.0 to 60.0 volts DC via the controller.



**NOTE!** When the converter module is not used with a controller, the default high voltage shutdown point is 59.5Vdc  $\pm$ 0.5Vdc.

- b) Overcurrent Protection: When the output current of a DC-DC converter module increases to a preset overcurrent value between 102.5% and 115% of rated full load, the output voltage of the module will automatically decrease to limit current to this value. The output will recover to within specified limits when the overload condition is removed. Adjustable from 13.5A to 31.3A via the controller.



**NOTE!** When the converter module is not used with a controller, the default overcurrent point is 102.5% to 115% of rated full load.

- c) Power Limit: Output power is limited to 1500W.
  - d) Over Temperature Protection: The operation of a DC-DC converter module will automatically shut down if the internal temperature of the module exceeds a predetermined value. Operation will automatically resume after the over-temperature condition is corrected.
- Series Paralleling Output FET: A series paralleling output FET is provided in each DC-DC converter module. This allows the Modules to be paralleled for redundancy.
  - Hot Swappable: The converter module is designed to be plug-and-play. The converter module can be inserted or removed from a live DC power system with no damage. When the converter module is plugged into the system, the sub-system output voltage will not be affected.
  - Cooling: Each converter module contains two fans for forced convection cooling.
    - a) Fan Fault Protection: The converter module shuts down and locks out and its fault indicator (red) flashes if either fan fails. Fan failure is detected and reported to controller. The fans are field replaceable.
    - b) Fan Control: Fan speed is continuously variable. When input voltage is within normal range, the built-in processor adjusts fan speed according to the converter module's output power. For example, a higher output power increases the fan speed. Fan speed control can be disabled by the controller.

- Communication Failure: The protection indicator (yellow) will flash should communication between the converter module and associated system controller fail. The failure information will be reported to the associated system controller and the controller will process the failure accordingly. During a communication failure, the converter module output voltage will automatically adjust to 48.00Vdc. The converter module will revert to normal operation once normal communication is restored.
- Monitoring Function: The converter module has a built-in advanced DSP (Digital Signal Processor) that monitors and controls the operation of the converter module. The DSP also communicates with the associated system controller in real time through the CAN bus. The following table lists the different commands and information exchanged between the converter module and the controller.
- External Alarm Circuits: Provided via the associated controller. Refer to the separate Power System documentation for a description of available external alarms.

**Table 1.2 Monitoring Function**

Commands / signals that can be received by the Converter Module from the Controller.	Information gathered by the Controller from the Converter Module.
<ul style="list-style-type: none"> <li>• Turn On/Off</li> <li>• Voltage Walk-in On/Off</li> <li>• HVSD Reset</li> <li>• Current Limit Adjustment</li> <li>• Voltage Adjustment</li> <li>• Fan Speed Control Enable/Disable</li> <li>• HVSD Threshold</li> </ul>	<ul style="list-style-type: none"> <li>• Output Voltage</li> <li>• Output Current</li> <li>• Current Limit Setting</li> <li>• Temperature</li> <li>• Over Voltage Setting</li> <li>• On/Off Status</li> <li>• Fault Alarms, such as: HVSD, Fan Fail, EEPROM Failure</li> <li>• Protection Alarms, such as: Input Voltage Protection, High Temperature Protection</li> <li>• Thermal Derating</li> <li>• Address</li> <li>• Code</li> <li>• Date</li> <li>• Software Version</li> <li>• Hardware Version</li> </ul>

### 1.2.6 Mechanical Specifications

- Weight: 5.5 lbs.
- Dimensions (H x W x D): 1.63" (41.4mm) x 4.88" (124mm) x 14.96" (380mm).
- Local Controls: None.
- Local Status and Alarm Indicators:
  - a) Power (Green)
  - b) Protection (Yellow)
  - c) Alarm (Red)

## 2 Operation

### 2.1 Local Indicators

Location and Identification: Refer to Figure 2.1.

Description: There are three (3) indicators located on the converter module's front panel. The functions of these indicators are as shown in Table 2.1.



**NOTE!** DC voltage must be present at the converter module input terminals, (from battery or an operating Rectifier) for local indicators to illuminate.

### 2.2 Converter High Voltage Shutdown and Lockout Restart

Remove the converter, wait 30 seconds or more (until the LEDs on the converter extinguish), then re-insert the converter.

The converter may also be restarted from the controller. Refer to the controller's documentation.

Figure 2.1 Local Indicator Locations

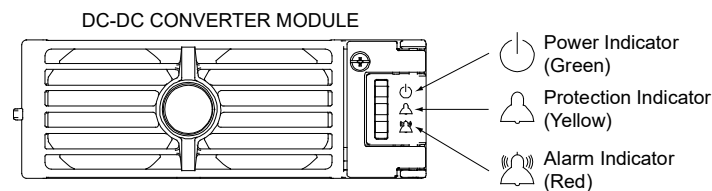


Table 2.1 DC-DC Converter Module Indicators

Indicator	Normal State	Alarm State	Alarm Cause
	Power (Green)	On	No input voltage. Internal input fuse open.
		Flashing	The converter is being identified by the controller.
	Protection (Yellow)	Off	DC input under/over voltage. Moderate load sharing imbalance. Converter not inserted into the slot completely. Converter over-temperature protection. Converter in ECO Standby Mode when ECO Mode is active in controller.
		Flashing	Loss of communication with the controller (the converter can provide power).
	Alarm (Red)	Off	Severe load sharing imbalance. Converter output disabled for any reason, including overvoltage shutdown.
		Flashing	One or both fans not operating (converter shuts down).

### 2.3 Installing Converter Modules

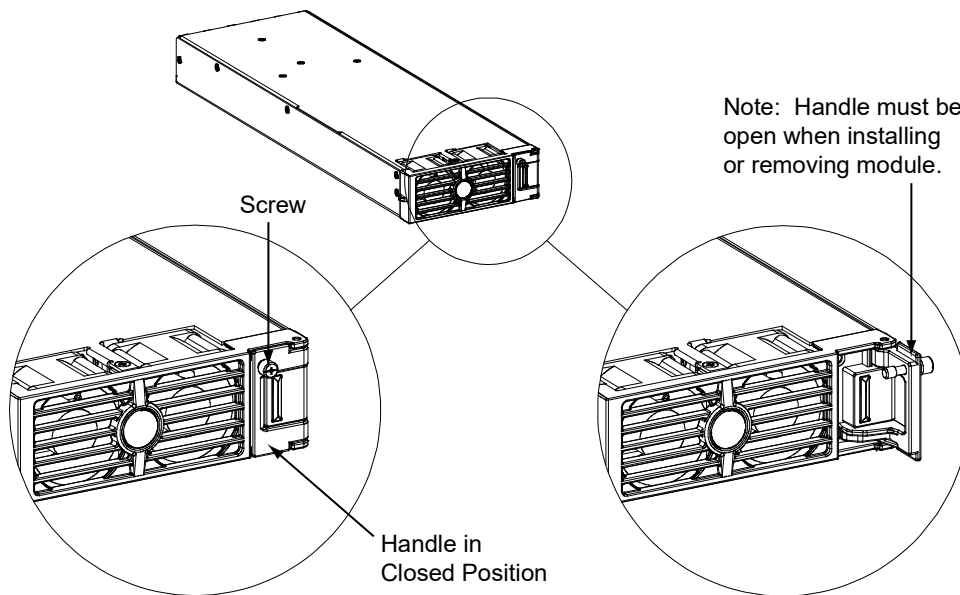
The converter module is hot swappable. It can be installed with the system operating.



**WARNING!** To prevent damage to the latching mechanism, ensure the handle is in the open position when installing or removing a converter module. NEVER hold the handle in the closed position when installing a converter module into a shelf.

**Procedure**

1. Place the module into an unoccupied mounting slot without sliding it in completely.
2. Loosen the captive screw on the module handle. Pull the handle to pivot it out of the module front panel (this will also retract the latch mechanism located at the right side of the module). Refer to Figure 2.2 for latch mechanism illustration.
3. Push the converter module completely into the shelf.
4. Push the handle into the front panel of the module. Tighten the captive screw on the handle. This will lock the module securely to the shelf.
5. Repeat the above steps for each converter module being installed in the system.
6. After the converter modules are physically installed in the mounting shelf(s), they are ready for operation immediately after power is supplied to them.
7. Certain functions (i.e. converter current limit, converter addressing) may require adjustment when adding or replacing a converter module. Refer to the Power System documentation for instructions.

**Figure 2.2 Converter Module Handle/Latch Mechanism**

## 3 Troubleshooting and Repair

### 3.1 Troubleshooting

#### 3.1.1 Converter Module Current Sharing Imbalanced

When multiple converter modules are operating in parallel and the current sharing imbalance among them is greater than 5%, check if the converter module is properly seated in the shelf.




If the current sharing imbalance still persists following the verification suggested above, replace the converter module exhibiting the current imbalance.

### 3.1.2 Converter Module Fault Symptoms and Troubleshooting

The fault indicators that can be displayed by the converter module are as follows. Refer to Table 3.1 for a list of possible causes and corrective actions.

- Power Indicator (Green) OFF
- Protection Indicator (Yellow) ON
- Protection Indicator (Yellow) Flashing
- Alarm Indicator (Red) ON
- Alarm Indicator (Red) Flashing

**Table 3.1 Converter Module Troubleshooting**

Symptom		Possible Cause(s)	Suggested Action(s)
	Power Indicator (Green) Off	No input voltage.	Make sure there is input voltage.
		Internal input fuse open.	Replace the converter.
	Protection Indicator (Yellow) On	DC input under/over voltage.	Correct the DC input voltage to within the acceptable range.
		Moderate load sharing imbalance.	Check if the converter is properly seated in the module mounting assembly. If this does not correct the fault, replace the converter.
		Converter not inserted into the slot completely.	Remove and properly insert the converter.
		Converter over-temperature protection.	Fan rotor blocked: remove any object that may be blocking the fan. Ventilation blocked (inlet or outlet): remove any object that may be blocking the inlet or outlet. Ambient temperature too high or rectifier inlet too close to a heat source: lower the ambient temperature or relocate the heat source.
	Protection Indicator (Yellow) Flashing	Converter in ECO Standby Mode when ECO Mode is active in controller.	--
	Alarm Indicator (Red) On	Severe load sharing imbalance. Converter output disabled for any reason, including overvoltage shutdown.	Remove the converter, wait 30 seconds or more (until the LEDs on the converter extinguish), then re-insert the converter. If converter fails to start, shuts down again, or load sharing imbalance persists; replace the converter.
	Alarm Indicator (Red) Flashing	One or both fans not operating (converter shuts down).	Replace the fan(s).

## 3.2 Replacement Procedures

### 3.2.1 Converter Module Replacement

The converter module is hot swappable. It can be removed and installed with the system operating.



**WARNING!** To prevent damage to the latching mechanism, ensure the handle is in the open position when installing or removing a converter module. NEVER hold the handle in the closed position when installing a converter module into a shelf.

#### **Procedure**

1. Performing this procedure may activate external alarms. Do one of the following. If possible, disable these alarms. If these alarms cannot be easily disabled, notify the appropriate personnel to disregard any alarms associated with this system while this procedure is performed.
2. Loosen the captive screw that is located on the module handle. (Turn the fastener several turns counterclockwise to loosen.) Pull the handle to pivot it out of the module front panel (this will also retract the latch mechanism located at the right side of the module). Refer to Figure 2.2 for latch mechanism illustration.
3. Grasp the handle and pull firmly to remove the module from the shelf.
4. Place the replacement converter module into the mounting position without sliding it in completely.
5. Loosen the captive screw on the module handle. Pull the handle to pivot it out of the module front panel (this will also retract the latch mechanism located at the right side of the module). Refer to Figure 2.2 for latch mechanism illustration.
6. Push the converter module completely into the shelf.
7. Push the handle into the front panel of the module. Tighten the captive screw on the handle. This will lock the module securely to the shelf.
8. Certain functions (i.e. converter current limit, converter addressing) may require adjustment when adding or replacing a converter module. Refer to the Power System documentation for instructions.
9. Enable the external alarms, or notify appropriate personnel that this procedure is finished.
10. Ensure that there are no local or remote alarms active on the system.

### 3.2.2 Converter Module Fan Replacement

Each converter module uses two fans for cooling. If fan replacement should become necessary, perform the following procedure. It is recommended that both fans in the converter module be replaced at the same time.

Refer to Figure 3.1 as this procedure is performed.



**CAUTION!** In a system with NO redundant converter module, battery must have sufficient reserve to power the load(s) while the converter module is removed for fan replacement.



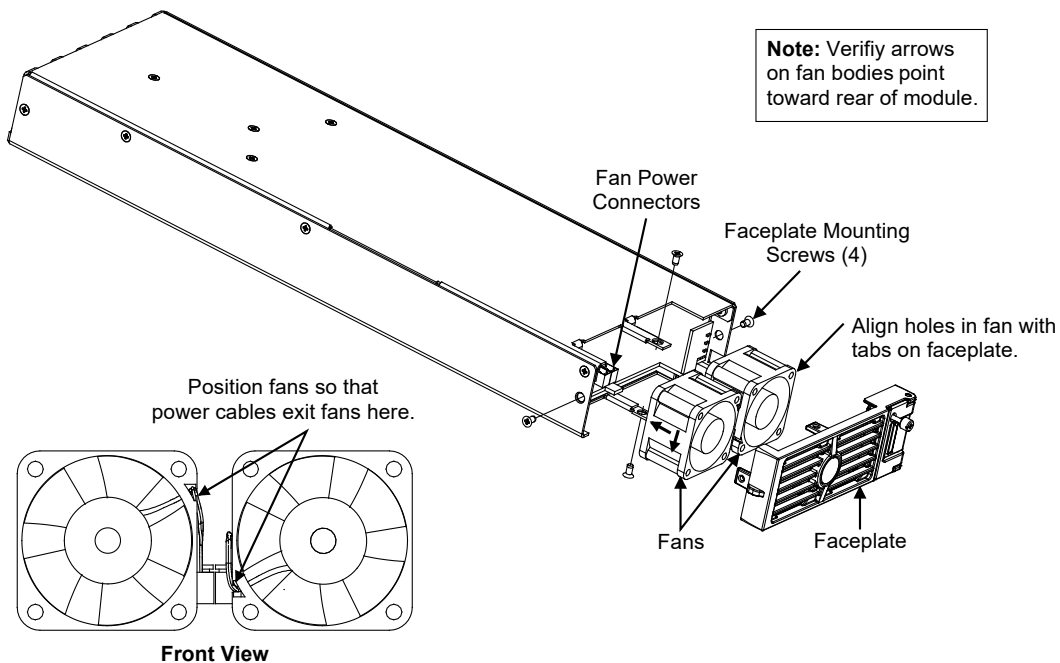
**NOTE!** When performing any step in this procedure that requires removal of existing hardware, retain all hardware for use in subsequent steps.

#### **Procedure**

1. Performing this procedure may activate external alarms. Do one of the following. If possible, disable these alarms. If these alarms cannot be easily disabled, notify the appropriate personnel to disregard any alarms associated with this system while this procedure is performed.
2. Remove the converter module from the shelf. Refer to the previous procedure for step-by-step instructions.

3. Place the converter module on a static-safe work surface. Connect an approved grounding strap to your wrist for the remainder of this procedure.
4. Remove the four (4) faceplate mounting screws shown in Figure 3.1 from the converter module. Remove the faceplate.
5. For proper orientation of the new fan(s), observe the location of the fan wires and the air flow arrows on the old fan(s).
6. Carefully pull the fan(s) out from the converter module, until the fan power cable(s) can be accessed.
7. Unplug the fan power cable(s) from connector(s) on the PC board, and remove the fan(s).
8. Plug the power cable(s) of the replacement fan(s) into the connector(s) on the PC board.
9. Place the new fan(s) in the space vacated by the old fan(s) (ensure the fan wires and air flow arrows match the orientation of the old fan), and plug it into the converter module.
10. Replace the faceplate on the converter module. Note that each fan has four holes in the front corners and that the faceplate has four tabs per fan. When replacing the faceplate, align the fan holes with the faceplate tabs. Ensure that no fan wiring is pinched. Secure faceplate with the four (4) previously removed screws.
11. Replace the converter module into the shelf. Refer to the previous procedure for step-by-step instructions.
12. When the fans start, check to ensure that each is providing front-to-back airflow. If air direction is wrong, immediately remove the converter module from the shelf. Repeat previous steps to check fan orientation, and correct as necessary. Reinstall the converter module and again check for proper airflow.
13. Enable the external alarms, or notify appropriate personnel that this procedure is finished.
14. Ensure that there are no local or remote alarms active on the system.

**Figure 3.1 Converter Module Fan Replacement**



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