



## **eSure™**

MPPT Solar Converter Module

User Manual (UM1S482000E3), Revision J

Specification Number: 1S482000e3

Model Number: S48-2000e3

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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

## 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.
- f) For systems operating with 400 VDC power, do not work on an energized system without full arc flash and PPE protection.

## Voltages

### DC Input Voltages



**DANGER!** This system may operate from 400 VDC input voltage capable of producing fatal electrical shock. DC input power must be completely disconnected from the branch circuits wiring used to provide power to the system before any DC electrical connections are made. Follow local lockout/tagout procedures to ensure upstream branch circuit breakers remain de-energized during installation. DO NOT apply DC input power to the system until all electrical connections have been completed and checked.

### 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 solar 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.

## Personal Protective Equipment (PPE)



**DANGER!** ARC FLASH AND SHOCK HAZARD.

Appropriate PPE and tools required when working on this equipment. An appropriate flash protection boundary analysis should be done determine the “hazard/risk” category, and to select proper PPE.



This product is intended only for installation in a Restricted Access Location.

Only authorized and properly trained personnel should be allowed to install, inspect, operate, or maintain the equipment.

Do not work on LIVE parts. If required to work or operate live parts, obtain appropriate Energized Work Permits as required by the local authority, per NFPA 70E “Standard for Electrical Safety in the Workplace”.

## 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 contained on the Static Warning Page.

## 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.

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# INTRODUCTION

## Overview

The MPPT Solar Converter provides load power, battery float current, and battery recharge current during normal operating conditions. The solar converter is a constant power design. The solar converter is rated at its maximum output power. This means that, within the normal operating ambient temperature range and input voltage range, the maximum available output power is a constant 2000 W. Within these ranges, the solar converter operates in one of three modes, depending upon load demands. Transition between modes is completely automatic. If ambient temperature rises above or input voltage falls below acceptable values, the solar converter continues to operate but at derated output power levels.

- **Constant Voltage Mode:** For any initial output voltage setting from 42 VDC to 58 VDC, output voltage remains constant regardless of load. This is the normal operating condition, in which loads are being supplied and batteries are float charged. Solar converters operate in the Constant Voltage Mode unless load increases to the point where the product of load current and output voltage is approximately 2000 W.
- **Constant Power Mode:** As load increases above approximately 2000 W (non-adjustable), output current continues to increase, but output voltage decreases as required to maintain constant output power. Solar converters operate in the Constant Power Mode unless load continues to increase to the point where the current limit setting is reached.
- **Constant Current Mode:** If load increases to the current limit setting, output voltage decreases linearly to maintain output current at the current limit setting.

## Specifications

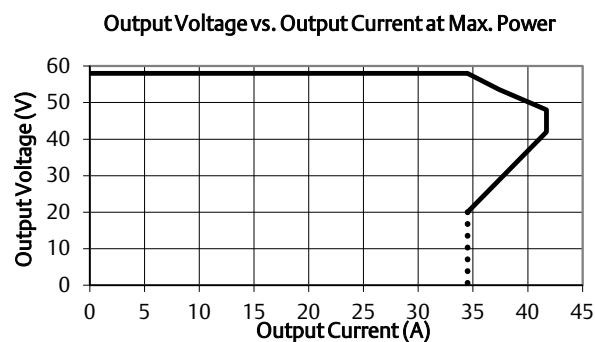
### DC Output Ratings



**NOTE!** A current limitation can be set by the User and the output voltage level is set through the controller.

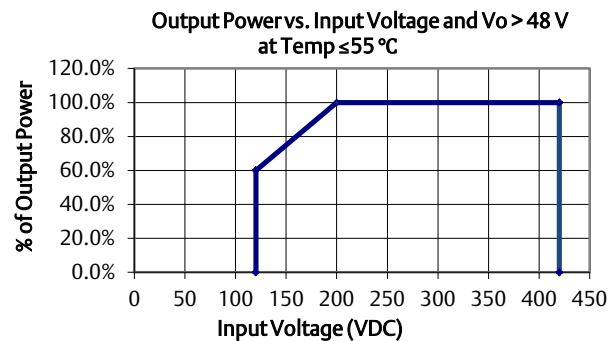
- **Voltage:** Nominal -48 VDC, positive ground. Output voltage is adjustable from -42 VDC to -58 VDC via the associated controller.
- **Output Power and Current:** 2000 W (41.7 A) @ 200 VDC to 420 VDC input and -48 VDC output.
- **Output Characteristics:** Refer to **Figure 1** for a graph of output voltage vs. output current.

**Figure 1:** Output Voltage vs. Output Current



- Power Derating Based on Input Voltage:** The solar converter power varies with changes in input voltage and output voltage. It uses an advanced power limitation method. The lower input threshold is 200 VDC. The solar converter can provide its maximum rated power (2000 W) as long as the input voltage is within the range of 200 VDC to 420 VDC. Below 200 VDC, and down to 120 VDC, the solar converter will continue to operate normally but will be in a power derating mode. The relationship between the output power and input voltage is illustrated in **Figure 2**.

**Figure 2:** Power Derating Based on Input Voltage



- Power Derating Based on Temperature:** With an input voltage in the range of 200 VDC to 250 VDC and an output voltage range between 50 VDC and 56 VDC, the solar converter delivers full power when operating at an ambient temperature of +65 °C (+149 °F) or below. Each solar converter continuously monitors the ambient temperature surrounding the power conversion circuit. If this temperature for any reason (such as a high ambient temperature) increases above approximately +65 °C (+149 °F), the solar converter will not shut down. Rather, the solar converter limits its maximum output power to maintain the temperature of the power conversion circuit within design parameters. Operation between +65 °C (+149 °C) and +80 °C (+176 °F) will result in output power being decreased. Full power capability is restored when the temperature decreases to below approximately +65 °C (+149 °F). Refer to **Figure 3** to view the relationship between the output power and the ambient temperature with the input voltage and output voltage within these ranges.

Other power rating values are as follow:

- At an ambient temperature of +65 °C (+149 °F), the power delivered by the solar converter is 2000 W.
- At an ambient temperature of +70 °C (+158 °F), the power delivered by the solar converter is 1500 W.

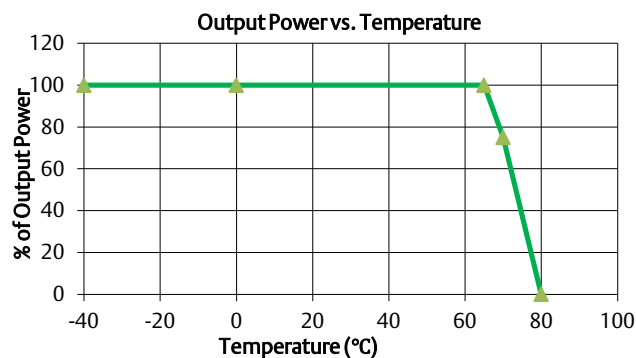
With an input voltage in the range of 250 VDC to 420 VDC and an output voltage range between 48 VDC and 50 VDC or between 56 VDC and 58 VDC, the solar converter delivers full power when operating at an ambient temperature of +55 °C (+131 °F) or below. Each solar converter continuously monitors the ambient temperature surrounding the power conversion circuit. If this temperature for any reason (such as a high ambient temperature) increases above approximately +55 °C (+131 °F), the solar converter will not shut down. Rather, the solar converter limits its maximum output power to maintain the temperature of the power conversion circuit within design parameters. Operation between +55 °C (+131 °C) and +80 °C (+176 °F) will result in output power being decreased. Full power capability is restored when the temperature decreases to below approximately +55 °C (+131 °F). Refer to **Figure 4** to view the relationship between the output power and the ambient temperature with the input voltage and output voltage within these ranges.



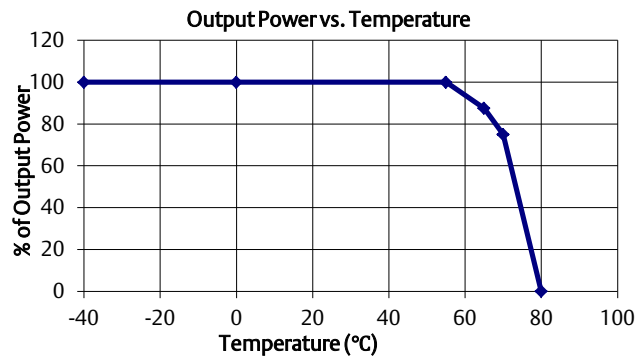
**WARNING!** Operation above +80 °C (+176 °F) is considered abnormal and should be used on a temporary<sup>1</sup> basis only.

- <sup>1</sup> Temporary Operation at Abnormal Temperature: Temporary operation is defined as a period of not more than eight consecutive hours per day, and a total of not more than 15 days in a year. (This refers to a total of 120 hours in any given year, but no more than 15 occurrences in that one-year period.)

**Figure 3:** Power Derating Based on Temperature  
(at 200 VDC <  $V_{in}$  < 250 VDC and 50 VDC <  $V_{out}$  < 56 VDC)



**Figure 4:** Power Derating Based on Temperature  
(at 250 VDC <  $V_{in}$  < 420 VDC and 48 VDC <  $V_{out}$  < 50 VDC or 56 VDC <  $V_{out}$  < 58 VDC)



- Regulation:

- a) Static: Steady state regulation is  $\pm 0.6\%$  as controlled within the solar converter for any and all combinations of load from no load to full load, input voltage, and input frequency at a constant ambient temperature. The associated system controller may provide increased regulation.
- b) Dynamic: For any step load change within the range of 10% to 90% of full load within 50 microseconds, per Telcordia GR-947-CORE, the maximum voltage transient will not exceed 5% of the initial steady state voltage within  $50 \pm 10$  microseconds. Recovery to within 1% of the initial steady state voltage does not exceed 1 milliseconds.

- Filtering:
  - a) Voice Band Noise: Complies with Telcordia GR-947-CORE.
    1. Output noise according to Telcordia GR-947-CORE is <38 dBrnC typical at normal input and 30% to 80% of rated load for more than one solar converter.
    2. Psophometric noise is  $\leq 2$  mV typical at 30% to 80% of rated load for more than one solar converter.
  - b) Wide Band Noise: Complies with Telcordia GR-947-CORE.
    1. Wideband noise emission is <250 mV peak to peak between 0 Hz to 100 MHz, and <50 mV rms in any 3 kHz band 10 KHz to 20 MHz.

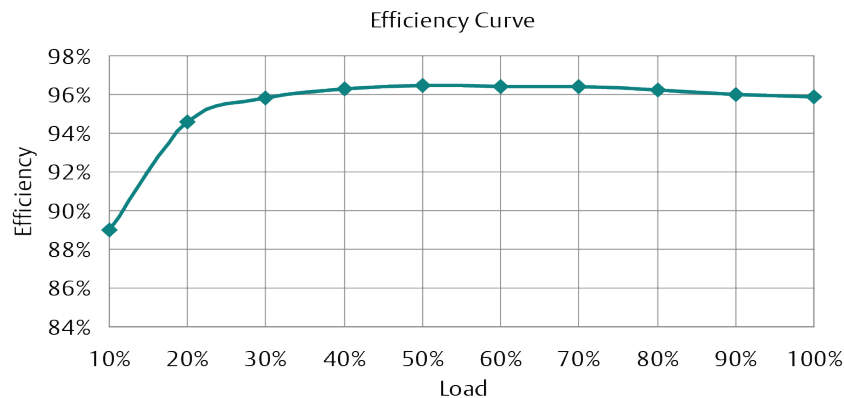
### **DC Input Ratings**

- Nominal Input Voltage: 140 VDC to 400 VDC.
  - Operating Range: 120 VDC to 420 VDC.
- Inrush Current: Peak does not exceed 1.5 times of the peak value of the maximum steady-state input current at 25 °C, and shall not trigger the unit's internal input fault protection device(s). Charging of input X and Y filter capacitors shall be ignored.
- Typical Input Data:
  - a) Refer to **Table 1**.
  - b) Maximum Input Current: 12 A.
  - c) Efficiency Curve: Refer to **Figure 5**.

**Table 1:** Typical Input Data

Nominal Input Voltage	Input Power (W)	Output Voltage (V)	Output Current (A)	Efficiency
260 VDC	2124.3	53.474	37.856	95.29%
	1952.4	53.490	34.844	95.46%
	1780.5	53.498	31.828	95.63%
	1663.9	53.510	29.771	95.74%
	1493.8	53.524	26.754	95.86%
	1271.8	53.550	22.792	95.97%
	1104.1	53.561	19.784	95.97%
	945.7	53.584	16.927	95.91%
	779.1	53.600	13.915	95.73%
	612.3	53.616	10.897	95.42%
	424.3	53.570	7.490	94.57%
	223.3	53.610	3.740	89.79%
133.8	53.640	1.875	75.17%	
300 VDC	2114.8	53.450	37.790	95.51%
	1943.3	53.460	34.780	95.68%
	1772.6	53.470	31.760	95.80%
	1566.7	53.490	28.125	96.02%
	1433.3	53.490	25.746	96.08%
	1265.3	53.510	22.740	96.17%
	1098.3	53.530	19.730	96.16%
	1045.1	53.530	18.780	96.19%
	826.6	53.550	14.820	96.01%
	625.9	53.570	11.174	95.64%
	426.2	53.580	7.530	94.66%
	224.5	53.630	3.724	88.96%
133.6	53.650	1.822	73.17%	
380 VDC	2094.4	53.450	37.560	95.85%
	1893.7	53.470	34.020	96.06%
	1671.4	53.480	30.075	96.23%
	1563.1	53.490	28.150	96.33%
	1386.1	53.500	24.980	96.42%
	1223.5	53.510	22.060	96.48%
	1110.0	53.520	20.010	96.48%
	1042.0	53.530	18.775	96.45%
	890.8	53.550	16.030	96.36%
	723.2	53.560	12.970	96.06%
	626.1	53.570	11.200	95.83%
	425.8	53.580	7.530	94.75%
224.8	53.630	3.750	89.46%	

**Figure 5: Efficiency Curve**



### **Environmental Ratings**

- Operating Ambient Temperature Range:
  - a) +55 °C (+131 °F) to +80 °C (+176 °F) with derating output.
  - b) -40 °C (-40 °F) to +55 °C (+131 °F) with full power performance.
- Temperature Coefficient: 0.02% per degrees Celsius.
- Storage Ambient Temperature Range: -40 °C (-40 °F) to +70 °C (+158 °F).
- Relative Humidity: This solar converter is capable of operating in an ambient relative humidity range of 0% to 95%, non-condensing.
- Altitude: 2000 m (6560 ft) at full power (power limited for heights above 2000 m).
- Surge Protection: Compliance with EN61000-4-5 (4 kV Line to Line, 4 kV Line to Earth). Capable of withstanding surges per ANSI/IEEE C 62.41 1999 Category B3 across the input terminals.



**NOTE!** This level of protection is a widely used standard for telecommunications power equipment. As with all such equipment, it is the end user's responsibility to provide an adequately sized Surge Suppression Device at the commercial power service entrance of the building that reduces all incoming surges to levels below the classes/categories stated for the equipment.

- Ventilation Requirements: The solar converters are fan cooled and utilize front to back forced ventilation. A solar converter must be mounted so ventilating openings are not blocked and temperature of the air entering the solar converter does not exceed the Operating Ambient Temperature Range stated above.
- Single Solar Converter Audible Noise: At 25 °C ≤50 dB(A) with fan in high speed. Measurement made at 0.6 m distance in front of solar converter and at same horizontal line of the middle of solar converter.
- High Voltage Category: II
- Power Distribution System: TN/TT/IT



**NOTE!** The solar converter module is recommended to be used in an environment with Pollution of Degree 2 or less. Pollution Degree 2 applies where there is only non-conductive pollution that might temporarily become conductive due to occasional condensation (such as the office environment).

- EMI/RFI Suppression:
  - a) Solar converters operating in an approved solar converter mounting shelf conform to the requirements of FCC rules Part 15, Class B for Radiated and Class A for Conducted emissions limits.
  - b) Solar converters operating in an approved solar converter mounting shelf conform to the requirements of European Norm, EN55022, Class B for Radiated and Class A for Conducted emissions limits.

### **Compliance Information**

- EMC: ETSI EN 300 386, FCC CFR 47 Part 15 class B, Telcordia GR-1089-CORE.
- EMI Load Range: 10% to 100%.
- Safety: IEC 60950, EN 60950, UL 60950.
- GR-3108 Class 2 Compliant

### **Standard Features**

- Type of Power Conversion Circuit: High frequency.
- Constant Voltage Mode: For any initial output voltage setting from 42 to 58 volts, output voltage remains constant regardless of load. This is the normal operating condition, in which loads are being supplied and batteries are float charged. Solar converters operate in the Constant Voltage Mode unless load increases to the point where the product of load current and output voltage is approximately 2000 W.
- Constant Power Mode: As load increases above approximately 2000 W (non-adjustable), output current continues to increase, but output voltage decreases as required to maintain constant output power. Solar converters operate in the Constant Power Mode unless load continues to increase to the point where the current limit setting is reached.
- Constant Current Mode: If load increases to the current limit setting, output voltage decreases linearly to maintain output current at the current limit setting.
- Input Protection:
  - a) Input Over/Under Voltage Protection: The solar converter will shut down at low or high voltage input; based on the following voltage levels:
    1. Low Voltage Disable Point: 115 V,  $\pm 5$  V; hysteresis is 10 VDC for restart.
    2. High Voltage Disable Point: 425 V,  $\pm 5$  V; hysteresis is 10 VDC for restart.
  - b) Between 120 V and 200 V the output power will be derated linearly based on the input voltage as follows:
    1. At input voltage of 120 V with output  $>48$  V, maximum output power is 1200 W.
    2. At input voltage of 154 V with output  $>48$  V, maximum output power is 1540 W.
    3. At input voltage of 176 V with output  $>48$  V, maximum output power is 1760 W.
    4. At input voltage of 200 V and output  $>48$  V, maximum output power is 2000 W.

- Output Protection:
  - a) Overload / Reverse Current: The solar converter has a 63 A fuse in the negative output DC bus. This fuse is not customer replaceable. The solar converter can be plugged into or pulled out of a shelf while operating, without damage or opening the fuse.
  - b) Current Limiting: The solar converter has a current limit function. The current limit point can be set between the range of 0 A to 41.7 A, adjustable via the controller. The current limit accuracy is  $\pm 1.5$  A when the output voltage ranges from 42 V to 58 V.
  - c) Advanced Current Limit Function: The solar converter has an advanced Current Limit Function. When a short circuit occurs at the solar converter output terminals, the solar converter will keep its output current at a constant value (value that is configurable via the controller). This function effectively protects the solar converter and the equipment connected to the solar converter. When the short circuit fault is cleared, the solar converter will automatically restore back to normal operation.
  - d) High Voltage Shutdown:
    1. Adjustable Control: If solar converter output voltage exceeds an adjustable preset value and the solar converter is delivering more than 10% of its rated current, the solar converter shuts down. (Adjustable from 56 VDC to 59 VDC via the controller. The restart hysteresis is  $0.5\text{ V} \pm 0.2\text{ V}$ .)

The solar converter then restarts and a HVSD restart timer starts (time value configurable via the controller, factory default is 5 minutes). If output voltage again exceeds the high voltage shutdown value before the HVSD restart timer expires, the solar converter shuts down and locks out. Manual restart is then required (by turning power to the solar converter off or by removing the solar converter, waiting until the LEDs on the solar converter extinguish, then turning power to the solar converter on or re-inserting the solar converter). If the solar converter does not experience a high voltage condition before the HVSD restart timer expires, the restart circuit is reset.

If two or more solar converters are paralleled, only the solar converter causing the high voltage condition shuts down.
    2. Backup: If solar converter output voltage exceeds  $59.5\text{ V} \pm 0.5\text{ V}$  (non-adjustable) and the solar converter is delivering more than 10% of its rated current, the solar converter shuts down. The solar converter then restarts and a HVSD restart timer starts (time value configurable via the controller, factory default is 5 minutes). If output voltage again exceeds the high voltage shutdown value before the HVSD restart timer expires, the solar converter shuts down and locks out. Manual restart is then required (by turning power to the solar converter off or by removing the solar converter, waiting until the LEDs on the solar converter extinguish, then turning power to the solar converter on or re-inserting the solar converter).
- Over-Temperature Protection: The solar converter provides over temperature protection by derating output power and recovers automatically.
- Active Load Sharing: The solar converter uses advanced digital active load sharing technology that maintains balancing to within 3% of rated current. The active load sharing is accomplished via a shared communication buss. The total system current is divided by the quantity of power modules installed in the system to determine the per module average load that each module should deliver. Each module



will adjust its output voltage in small increments so that the current delivered by the module is equal to the calculated average current per module.



**NOTE!** *Solar converters will not share load with rectifiers. Solar converters will go into current limit before rectifiers provide load current.*

- Hot Swappable: The solar converter is designed to be plug-and-play. The solar converter can be inserted or removed from a live DC power system with no damage. When the solar converter is plugged into the system, the system output voltage will not be affected.
- Cooling: Each solar converter module contains a fan for front-to-back force air-cooling.
  - a) Fan Fault Protection: The solar converter module shuts down and its alarm indicator (red) flashes if the fan fails. Fan failure is detected and reported to controller.
  - 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 solar converter module's internal temperature and output power. For example, a higher temperature or output power increases the fan speed. This feature can be disabled via the controller, allowing the fan to run at full speed regardless of temperature.
- Paralleling: Up to 30 solar converters can be connected in parallel in one system.
- Communication Failure: The solar converter's protection indicator (yellow) will flash should it experience a communication failure. The failure information will be reported to the controller and the controller will process the failure accordingly. During a communication failure, in order to protect the battery, the solar converter output voltage will automatically be adjusted as follows. When used with the ACU+ or NCU Controller, solar converter output voltage goes to the controller's output voltage setting (this setting is stored in the solar converter). The solar converter will revert to normal operation once normal communication is restored.
- Solar Converter Output Current Imbalance: When load sharing severe imbalance (output fuse open) and the output current drops to zero in average current >10% system, then the red fault indicator will illuminate.
- Monitoring Function: The solar converter has a built-in advanced DSP that monitors and controls the operation of the solar converter. The DSP also communicates with the controller in real time through the CAN bus. **Table 2** lists the different commands and information exchanged between the solar converter and the controller.

**Table 2:** Exchange of Information between Solar Converter and Controller

Commands / signals that can be received by the solar converter module from the controller.	Information gathered by the controller from the solar converter module.
<ul style="list-style-type: none"> <li>• Turn On/Off</li> <li>• Current Walk-in On/Off</li> <li>• HVSD (High Voltage Shutdown) Reset</li> <li>• Current Limit Adjustment</li> <li>• Voltage Regulation</li> </ul>	<ul style="list-style-type: none"> <li>• Input Voltage</li> <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</li> <li>• Protection Alarms, such as: Input Voltage Protection Inner DC Bus Voltage Protection High Temperature Protection</li> <li>• Thermal Derating</li> <li>• Imbalance Output Current</li> <li>• Address</li> <li>• Code</li> <li>• Date</li> <li>• Software Version</li> <li>• Hardware Version</li> </ul>

### **Mechanical Specifications**

- Dimensions:
  - a) Millimeters: 41.0 (Height) X 84.5 (Width) X 252.5 (Depth)
  - b) Inches: 1.6 (Height) X 3.3 (Width) X 9.9 (Depth)
- Weight: 1.13 kg (2.49 lbs)
- Indicators:
  - a) Power (Green LED)
  - b) Protection (Yellow LED)
  - c) Alarm (Red LED)

# OPERATION


## DC Input Protection Device Requirements/Recommendations

Refer to the system documentation supplied with the system the solar converter is installed in.

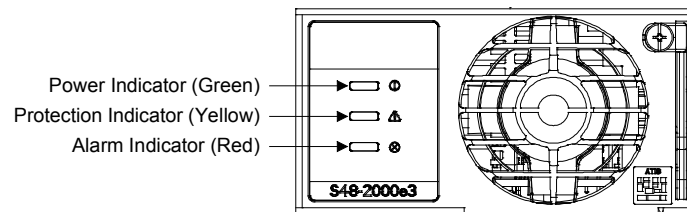
### Local Indicators

Location and Identification: Refer to **Figure 6**.

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

 **NOTE!** DC voltage must be present at the solar converter output terminals (from battery or an operating solar converter) or DC voltage at the input terminals.

**Figure 6:** Local Indicator Locations






## Solar Converter High Voltage Shutdown and Lockout Restart

### Procedure

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

**Table 3:** Solar Converter Module Indicators

Indicator		Normal State	Alarm State	Alarm Cause
	Power (Green)	On	Off	No input voltage. Internal input fuse open.
			Flashing	The solar converter is being identified by the controller.
	Protection (Yellow)	Off	On	DC input under/over voltage. PFC over voltage. Moderate load sharing imbalance. Solar converter not inserted into the slot completely. Solar converter over-temperature protection.
			Flashing	Loss of communication with the controller (the solar converter can provide power).
	Alarm (Red)	Off	On	Severe load sharing imbalance. Solar converter output disabled for any reason, including overvoltage shutdown and internal output fuse open. Solar converter addresses contradictory.
			Flashing	Fan not operating (solar converter shuts down).

## Installing Solar Converters

Solar converter modules can be inserted or removed with power applied (hot swappable).



**NOTE!** Each solar converter module locks into a module mounting shelf by means of a latch located on the bottom of the module. The latch and solar converter module handle are interactive. Pushing the handle up into the module's front panel causes the latch to extend to the locking position; pulling the handle down out from the module's front panel causes the latch to retract. See **Figure 7**.



**CAUTION!** This solar converter module contains double pole fusing; parts of the equipment that remain energized might represent a hazard during servicing after operation of the fuse.



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

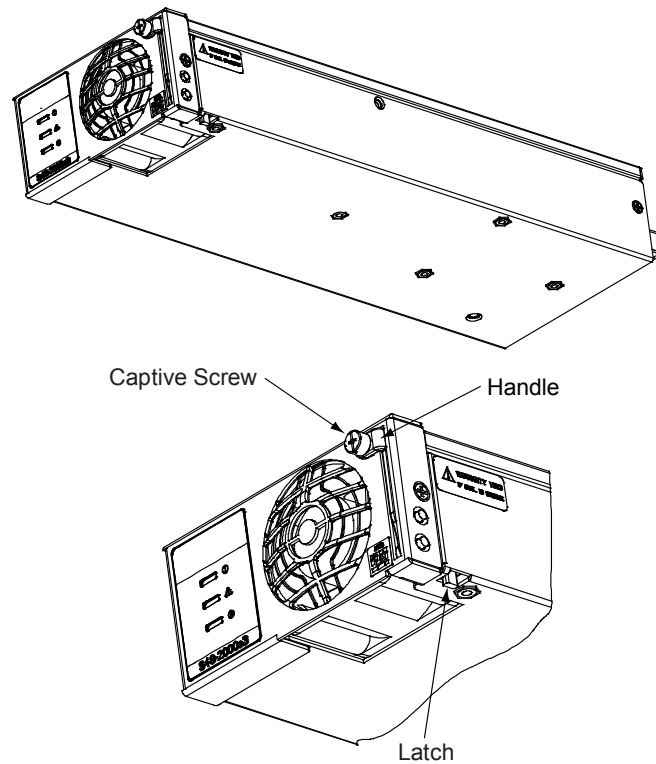
### Procedure



**DANGER!** Refer to **Figure 7** as this procedure is performed.

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

**Figure 7:** *Installing Solar Converter Module*



## TROUBLESHOOTING AND REPAIR

### Troubleshooting

#### **Solar Converter Current Sharing Imbalance**

When multiple solar converters are operating in parallel and the load is greater than 10%, if the current sharing imbalance among them is greater than 3%, check if the solar converter is properly seated in the shelf.




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

#### **Solar Converter Fault Symptoms and Troubleshooting**

The fault indicators that can be displayed by the solar converter are as follows. Refer to **Table 4** 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 4:** Solar Converter 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 solar converter.
	Protection Indicator (Yellow) On	DC input under/over voltage.	Correct the DC input voltage to within the acceptable range.
		PFC over voltage.	Replace the solar converter.
		Moderate load sharing imbalance.	Check if the solar converter is properly seated in the shelf. If this does not correct the fault, replace the solar converter.
		Solar converter not inserted into the slot completely.	Remove and properly insert the solar converter.
	Solar 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 solar converter inlet too close to a heat source: lower the ambient temperature or relocate the heat source.	
Protection Indicator (Yellow) Flashing	Loss of communication with controller (the solar converter can provide power).	Check the communication cables. Remove and properly insert the solar converter and controller.	
	Alarm Indicator (Red) On	Severe load sharing imbalance. Solar converter output disabled for any reason, including overvoltage shutdown and internal output fuse open.	Remove the solar converter from its shelf and then reinstall after 30 seconds. If solar converter fails to start or shuts down again; replace the solar converter.
		Solar converter addresses contradictory.	Replace the solar converter.
	Alarm Indicator (Red) Flashing	Fan not operating (solar converter shuts down).	Replace the fan.

## Replacement Procedures

### Solar Converter Module Replacement

Solar converter modules can be inserted or removed with power applied (hot swappable).



**NOTE!** Each solar converter module locks into a module mounting shelf by means of a latch located on the bottom of the module. The latch and solar converter module handle are interactive. Pushing the handle up into the module's front panel causes the latch to extend to the locking position; pulling the handle down out from the module's front panel causes the latch to retract. See **Figure 7**.



**DANGER!** Take care when removing a solar converter module that was in operation, as solar converter module surfaces could be very hot.



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

### Procedure



**NOTE!** Refer to **Figure 7** as this procedure is performed.

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 on the module's handle. Pull the handle down out from the module's front panel (this will also retract the latch mechanism). See **Figure 7**.
3. Grasp the handle and pull firmly to remove the module from the shelf.
4. Place the replacement solar converter module into the mounting position without sliding it in completely.
5. Loosen the captive screw on the module's handle. Pull the handle down out from the module's front panel (this will also retract the latch mechanism). See **Figure 7**.
6. Push the module completely into the shelf.
7. Push the handle up into the module's front panel. This will lock the module securely to the shelf. Tighten the captive screw on the handle.
8. Certain functions (i.e. solar converter addressing) may require adjustment when adding or replacing a solar converter module. Refer to the Power System documentation for instructions.
9. After the solar converter modules are physically installed in the mounting shelf(s), they are ready for operation immediately after power is supplied to them. Verify that the solar converters are operating normally.
10. Enable the external alarms, or notify appropriate personnel that this procedure is finished.
11. Ensure that there are no local or remote alarms active on the system.



## **Solar Converter Fan Replacement**

Each solar converter uses a fan (P/N: 32010474) for cooling. If fan replacement should become necessary, perform the following procedure.

Refer to **Figure 8** as this procedure is performed.



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

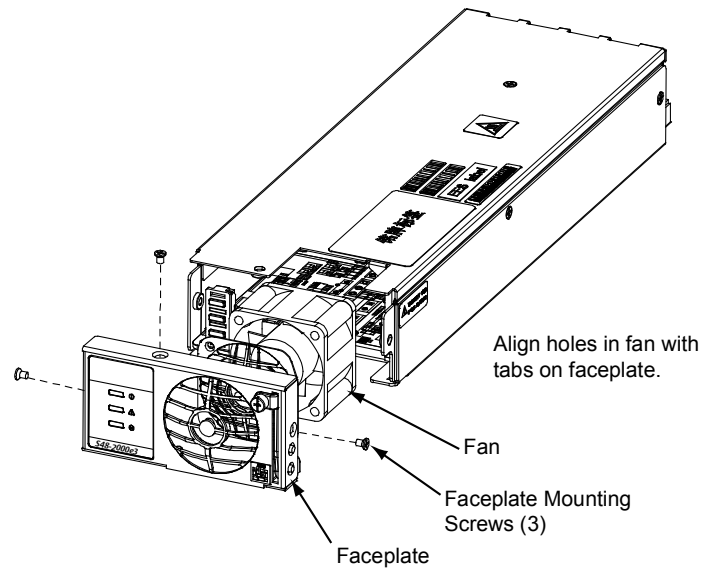


**NOTE!** When performing any step in this procedure that requires removal of existing hardware, retain all hardware for use in subsequent steps.

### **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 solar converter from the shelf. Refer to a previous procedure for step-by-step instructions.
3. Place the solar converter on a static-safe work surface. Connect an approved grounding strap to your wrist for the remainder of this procedure.
4. On this solar converter; remove the front panel by removing the three (3) screws securing the front panel to the chassis.
5. For proper orientation of the new fan, observe the location of the fan wires and the fan rotation and air flow arrows on the old fan.
6. Carefully remove the fan from the solar converter chassis and unplug the fan power cable from the printed circuit card.
7. Plug the power cable of the replacement fan into the connector on the printed circuit card. Carefully slide the replacement fan into the solar converter chassis (ensure the fan wires and fan rotation and air flow arrows match the orientation of the old fan).
8. Note that the fan has four holes in the front corners and that the faceplate has three tabs. Carefully slide the faceplate into position, aligning the fan holes with the faceplate tabs. Secure the faceplate to the solar converter chassis with the three (3) screws previously removed.
9. Replace the solar converter into the shelf. Refer to the previous procedure for step-by-step instructions.
10. When the fan starts, check to ensure that it is providing front-to-back airflow. If air direction is wrong, immediately remove the solar converter from the shelf. Repeat previous steps to check fan orientation, and correct as necessary. Reinstall the solar converter and again check for proper airflow.
11. Enable the external alarms, or notify appropriate personnel that this procedure is finished.
12. Ensure that there are no local or remote alarms active on the system.

**Figure 8:** Fan Replacement



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