NetSure™ Solar Converter Shelf, 8.6 kW

Installation and User Manual

Specification Number (Global and North America Region): 744900180006, 744900180007
Specification Number (EMEA Region): BMK2257103-002, BMK2257103-004
Model Number: NetSure™ 8.6 kW Solar Add-On Shelf, NetSure™ 8.6 kW Solar Expansion Shelf

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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/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 v. To reduce the chance of accident, read the safety precautions very carefully before operation. The "Caution, Notice, Warning, Danger" in this manual do not represent all the safety points to be observed and are only used as supplement to various operation safety points. Therefore, the installation and operation personnel must be strictly trained and master the correct operations and all the safety points before actual operation. When operating Vertiv products, the local guidelines, the general safety points and special safety instructions specified in this manual must be strictly observed.

General Safety

WARNING! 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. When handling batteries, use gloves.

e) Use certified and well-maintained insulated tools. Use double insulated tools appropriately rated for the work to be performed.

f) Exercise extreme caution not to inadvertently contact or have any tool inadvertently contact an input, output, or battery terminal or exposed wire connected to an input, output, 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.

g) After handling of the enclosure or any such component, such as batteries, cables, busbars, etc., always wash hands immediately after.

h) This product is intended only for installation in restricted access locations.

i) This equipment in not suitable for use in locations where children are present.

Voltages

DC Input Voltages

DANGER! A properly configured solar array can have an open circuit voltage of 400 VDC. The solar array should be disconnected while installing and should only be connected once all electrical connections have been completed and checked.

Hazardous Voltage

DANGER! HAZARD OF ELECTRICAL SHOCK. The voltage from the solar array exceeds 60 VDC.

DANGER! HAZARD OF ELECTRICAL SHOCK. More than one disconnect is required to de-energize the system before servicing.

DANGER! HAZARD OF ELECTRICAL SHOCK.
Safety rules in the industry must be observed when installing the power system. The authorized personnel should be allowed to operate high voltage and DC power. In operation, conductive objects such as watch, bracelet, bangle, ring, etc. are not allowed to be worn. When water is found near or under the shelf, turn off all incoming and outgoing power immediately. In moist environment, precautions must be taken to keep moisture out of the power system. "Prohibit" warning label must be attached to the switches and buttons which are not permitted to be operated on during installation.

DANGER! HAZARD OF ELECTRICAL SHOCK.
High voltage operation may cause fire and electric shock. The connection and wiring of DC cables must be in compliance with the local rules and regulations.

DC Output Voltages

DANGER! This system produces DC power output less than 60 VDC. Although the DC voltage is not hazardously high, the solar converters can deliver large amounts of current.

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 to determine the “hazard/risk” category, and to select proper PPE.

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, such as NFPA 70E “Standard for Electrical Safety in the Workplace” or by other national buildings codes and local regulations.

Tools

WARNING! HAZARD OF ELECTRICAL SHOCK.
In high voltage operation, special insulated tools must be used.

Thunderstorm

DANGER! HAZARD OF ELECTRICAL SHOCK.
Do not work by a cell site, a roof top, or by a solar array when a thunderstorm is in the vicinity. Equipment, including the solar array, must have an earthed connection to the ground ring to reduce the harm to people and the equipment as a function of a lightning strike.

Short-Circuit

WARNING! During operation, never short the positive and negative poles of the DC distribution unit of the system or the non-earthing pole and the earth. The power system is always on DC power equipment; short circuit may result in equipment burning and endanger human safety.

Maintenance and Replacement Procedures

ALERT! When performing any step in the procedures that requires removal or installation of hardware, use caution to ensure no hardware is dropped and left inside the unit; otherwise, service interruption or equipment damage may occur.

NOTE! *When performing any step in the procedures that requires removal of existing hardware, retain all hardware for use in subsequent steps, unless otherwise directed.*

Basic Guidelines

WARNING! Contact the site operations manager or other responsible local personnel before commencing work. Inform all personnel near the equipment that work is in progress.

Reduce the risk of accidents and increase the operation reliability by keeping the power, cabinet, shelter, hut or room clean and clear of any unauthorized material.

While work is in progress, the equipment must also be protected against damages and unauthorized intervention. Busbars, live enclosures, etc., shall be protected during work using protective sheeting.

Do not leave equipment with unprotected parts under power unattended.

Inform the site operations manager or other responsible local personnel when the work is complete.

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 provided below.

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

The Vertiv™ NetSure™ Solar Converter provides additional (supplemental) solar power for -48 VDC telecom loads, with a peak power delivery of 8640 W.

The Solar Add-On Shelf includes intelligent control and metering using the Vertiv™ NetSure™ Control Unit (NCU).

The Solar Expansion Shelf can be integrated either with the Solar Add-On Shelf or other Vertiv NetSure systems with the NCU. CAN bus with an extension cable and a software upgrade may be required.

NOTE! *The CAN bus extension cable should be of high twist type (1 turn per 1 cm or 2.5 turns per inch).*

Minimum software revisions include:

- NCU rls 1, 1.2.60
- NCU rls 2, 2.2.60
- NCU rls 3, 3.2.40
- NCU rls 5, 5.2.50
- NCU rls 6, 6.2.60
- NCU rls 7, 7.2.60

The Solar Converter Shelf is 19 inches wide and includes brackets to support flush or recess mounting (5 inch off-set) in either a 19-inch or 23-inch rack. This shelf also supports wall mounting.

Features

4.320 kW Maximum Power Point Tracking (MPPT) Solar Converter Module:

- 4320 W output in a high density pluggable power module.
- Supporting a high current solar array (up to 24 A) with a wide voltage input (70 VDC to 400 VDC), enable support a wide range of solar technology such as HJT, large panels and cells (M12), TOPCon with resilience for small arrays and sites with complex site and shadow lines.
- High efficiency converter, with a peak over 97% and MPPT algorithm with an accuracy greater than 99.9%.
- Providing solar (renewables) energy to reduce your operating cost and supporting sustainability targets.

NCU (Solar Add-On only):

- NCU provides control of the solar converter module (S48-4300E4) output and provides alarms and logs.
- Remote secure communications via HTTPS, SNMP v2/v3, and local communications via RS-485, such as Modbus RTU-485 and EEM.
- Provides cumulative energy reporting.
- Input side lightning protection function (optional).
- Fault protection and fault alarm functions.

Configuration

Item	Solar Add-On Shelf	Solar Expansion Shelf
MPPT Solar Module	Model: S48-4300E4 2 X 4.3kW	
Controller	Model: M831A x 1	NA
Output Distribution	125A x 2 MCB, UL 1077 Rated	
Input Lightning Protection (optional)	Internal DC SPD (DIN mounted with remote indication) x 2 External IP65 Type 1+Type 2 / Class I+Class II SPD Box	

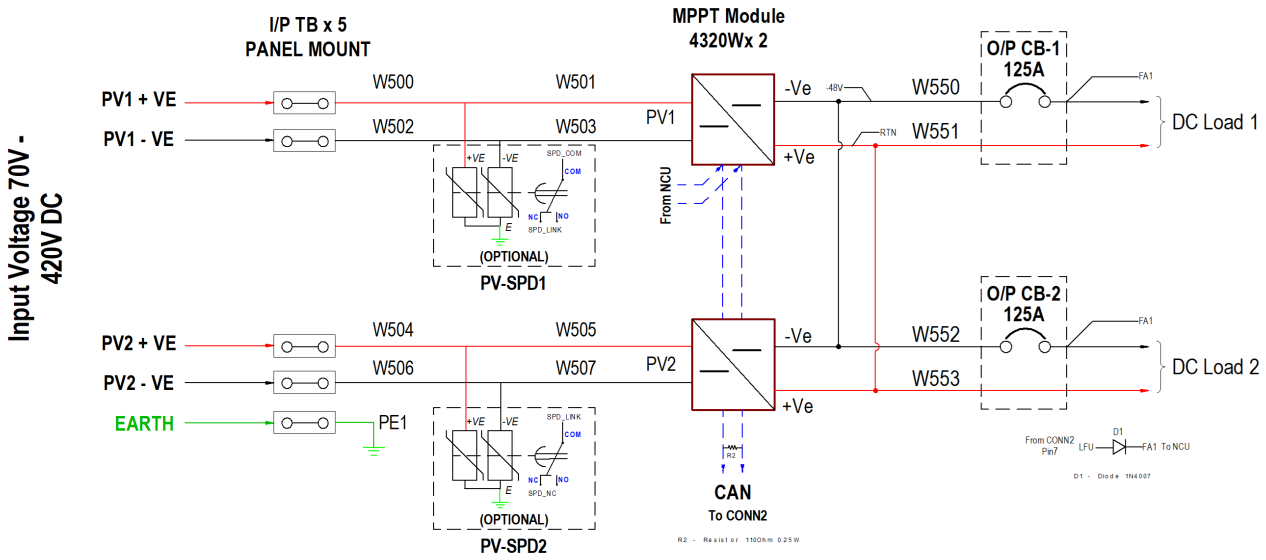
1.1 Technical Specification

Family:	NetSure™
System Parent No.:	Global and North America Region: 744900180006 (Solar Add-On Shelf), 744900180007 (Solar Expansion Shelf) EMEA Region: BMK2257103-002 (Solar Add-On Shelf with SPD), BMK2257103-004 (Solar Expansion Shelf with SPD)
Model/Spec. No:	NetSure™ 8.6 kW Solar Add-On Shelf, NetSure™ 8.6 kW Solar Expansion Shelf
System DC Input Ratings:	70 VDC to 400 VDC
	Maximum Current: 24 A per solar converter module
System DC Output Ratings:	-20 VDC to -58.5 VDC
	163 A (81.5 A @ 53 VDC per solar converter module)
Maximum DC Output Power:	8.640 kW
Framework Type:	For mounting in a 19-inch/ 23-inch-wide rack. Wall mounting
Mounting Width:	482.6 mm (19 inches)/ 584.2 mm (23 inches)
Mounting Depth:	425 mm (16.73 inches)
Mounting Height:	44.45 mm, 1U (1.75 inches)
Access:	Front for cabling
Control:	NCU with Solar Add-On Shelf via CAN bus
Environment:	Operating Ambient: -40 °C to +55 °C (-40 °F to +131 °F) at full power, derate output from +55 °C to +80 °C (+131 °F to +176 °F)
	Storage Ambient: -40 °C to +80 °C (-40 °F to +176 °F)
	Relative Humidity: 0% to 95%, non-condensing
Optional Internal Surge Protection:	Compliance with IEC 61643-31/ UL 1449, Class II/ Type 2.

2 Operation Theory

The basic operating theory of solar power system is shown in Figure 2.1.

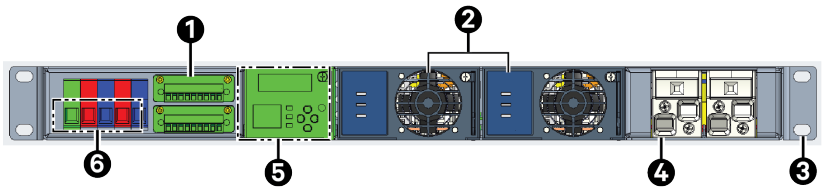
Figure 2.1 General Electrical Diagram



2.1 Mechanical Structure and Configuration

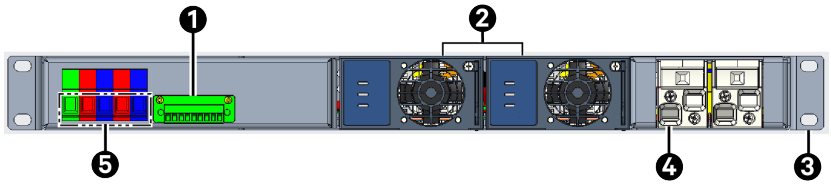
Solar power system is an indoor rack/panel/wall mount system. Only the front side is accessible to the operator when mounted on a rack/panel. It has a front cable entry. Earthing provisions are present on both the front and rear sides. For servicing, when fully connected, the top cover can be removed.

Figure 2.2 Front View: Solar Add-On Shelf



Item	Description
1	Signal Connectors CONN1 and CONN2 for Alarms, DI Solar Off, Temperature Probe and CAN bus Termination
2	Two (2) Vertiv™ eSure™ S48-4300E4 4.32 kW MPPT Solar Converter
3	Mounting Brackets (several options are available-see Figure 2.6 to Figure 2.18 for different configurations)
4	Two (2) UL 1077 MCB 125A
5	NCU
6	Solar Input and Earthing Terminal Block

Figure 2.3 Front View: Solar Expansion Shelf with 19-inch Mounting Brackets



Item	Description
1	Signal Connector CONN3 for Alarms and CAN bus Termination
2	Two (2) Vertiv™ eSure™ S48-4300E4 4.32 kW MPPT Solar Converter
3	19-inch Mounting Brackets
4	Two (2) UL 1077 MCB 125A
5	Solar Input and Earthing Terminal Block

Figure 2.4 Isometric View: Solar Expansion Shelf with 19-inch Mounting Brackets

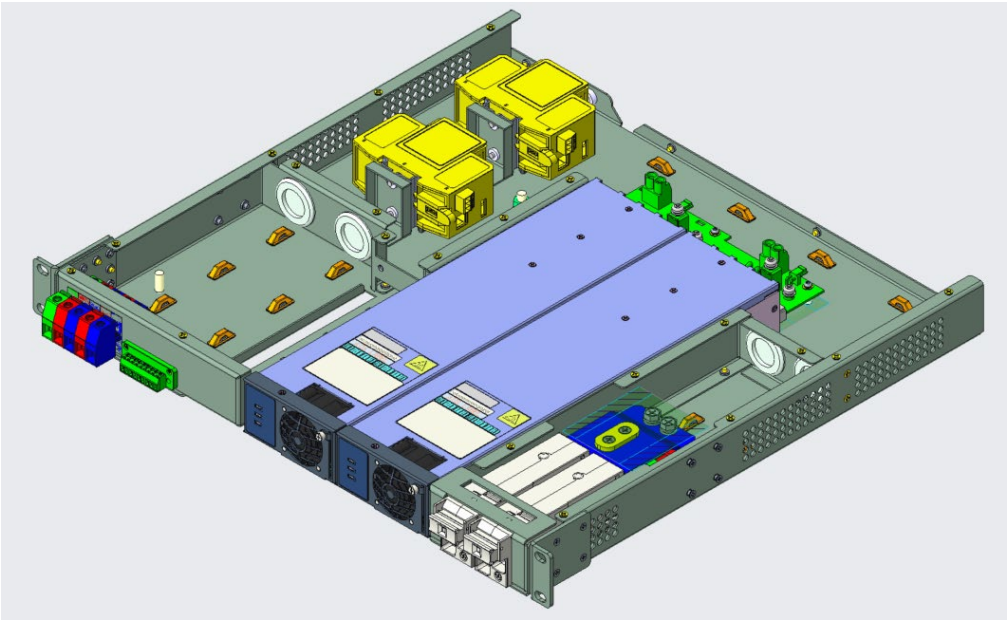
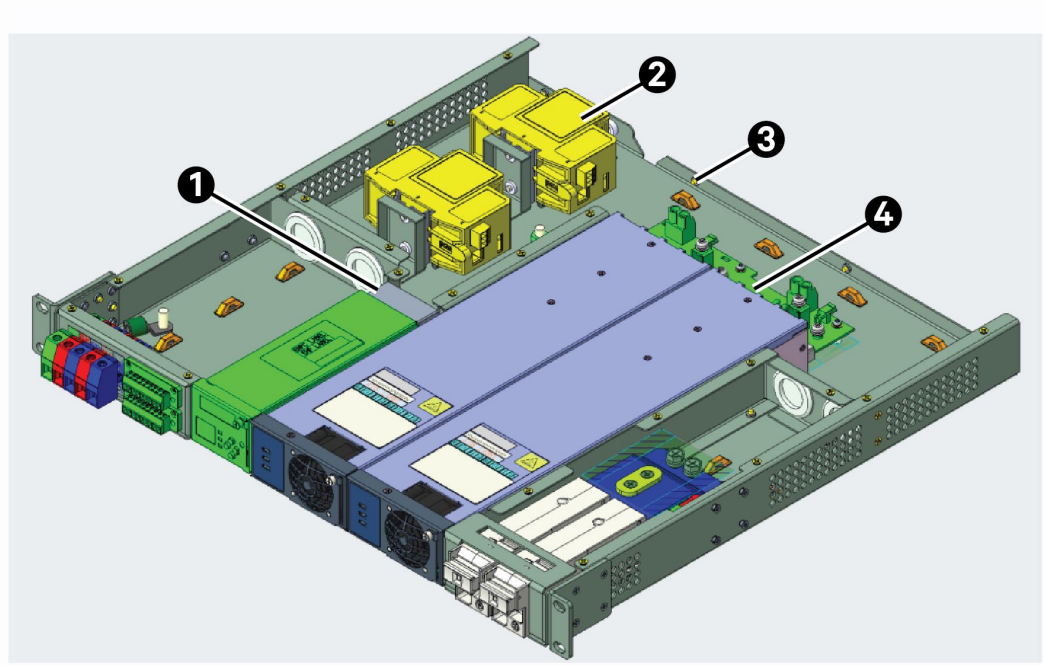


Figure 2.5 Front Isometric View: Solar Add-On Shelf with Top Service Cover Removed



Item	Description
1	NCU Backplane Connector
2	Two (2) PV SPD-Type 2 /Class II (optional)
3	Rear Side Earthing Termination Using M6 Barrel
4	S48 Backplane

Figure 2.6 Top View: Solar Add-On Shelf with 19-inch Mounting Brackets

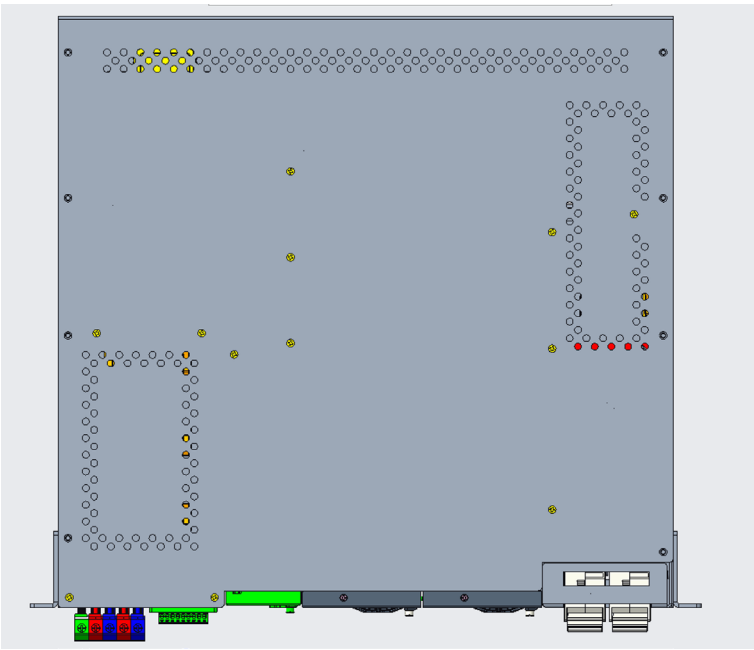


Figure 2.7 Top View Rack Mount: Solar Add-On Shelf with 19-inch Mounting Brackets with 5-inch Recess

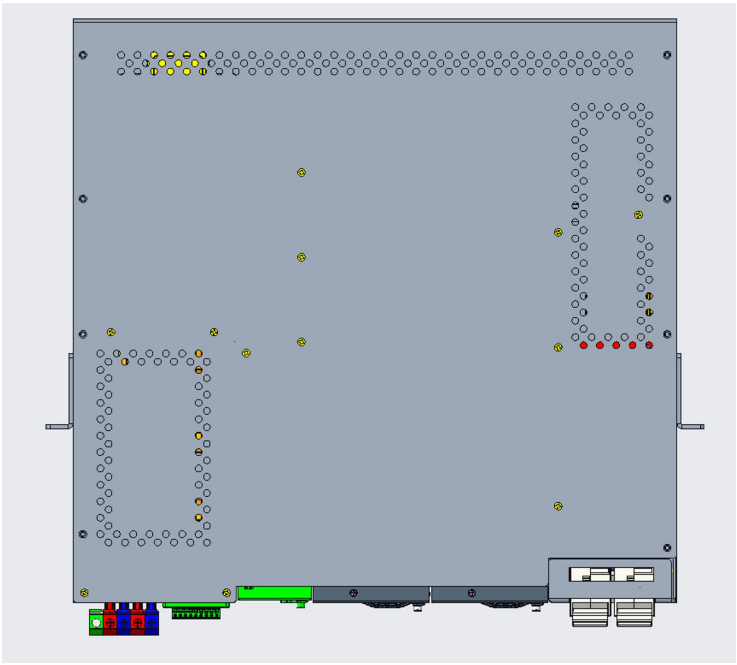


Figure 2.8 Isometric View Rack Mount: Solar Add-On Shelf with 19-inch Mounting Brackets with 5-inch Recess

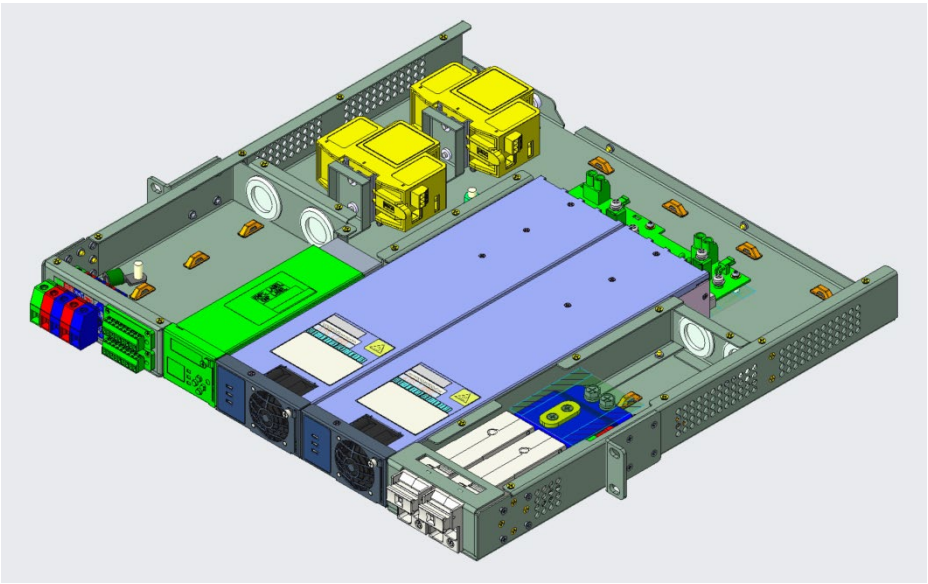
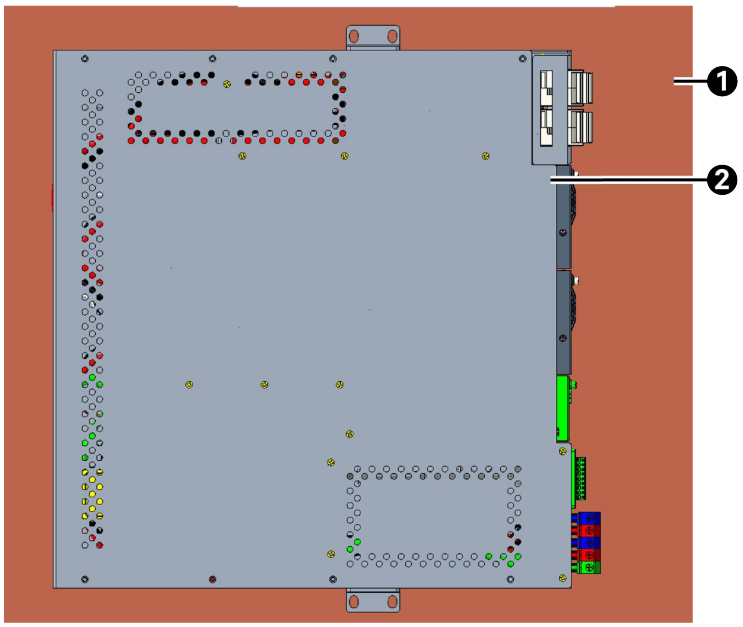


Figure 2.9 Side View Wall Mount: Solar Add-On Shelf with 19-inch Mounting Brackets



Item	Description
1	Wall
2	Solar Converter Shelf

Figure 2.10 Front View Wall Mount: Solar Add-On Shelf with 19-inch Mounting Brackets

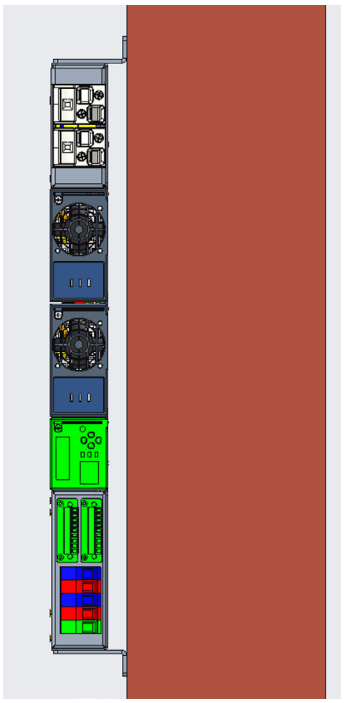
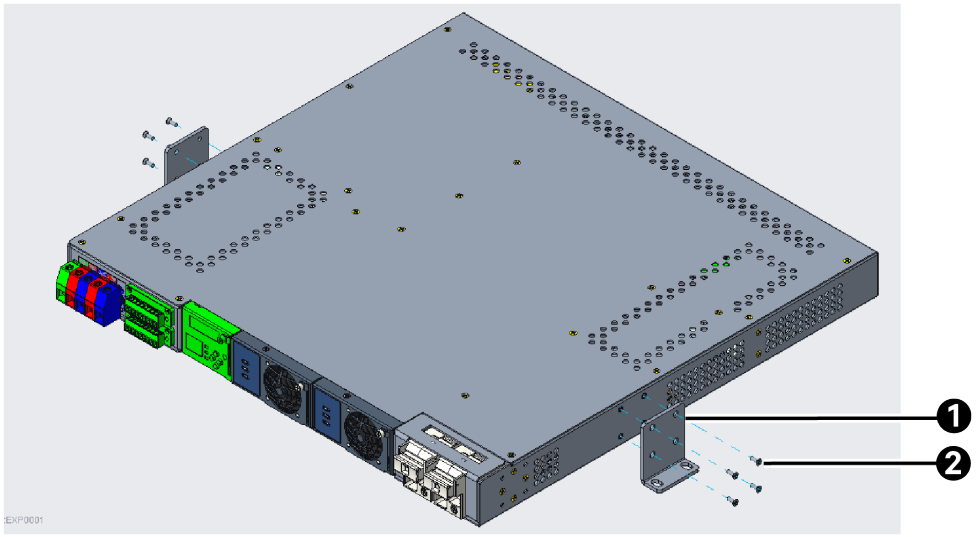


Figure 2.11 Exploded View Wall Mount: Solar Add-On Shelf with 19-inch Mounting Brackets



Item	Description
1	Two (2) 19-inch Brackets
2	Eight (8) M3 x 8 mm CSK Screws (provided with shelf)
Note: Four (4) M6 x 20 mm screws are required for mounting the shelf on the wall. These screws are not provided with the shelf.	

Figure 2.12 Front View: Solar Add-On Shelf with 23-inch Mounting Brackets

Figure 2.13 Top View: Solar Add-On Shelf with 23-inch Mounting Brackets

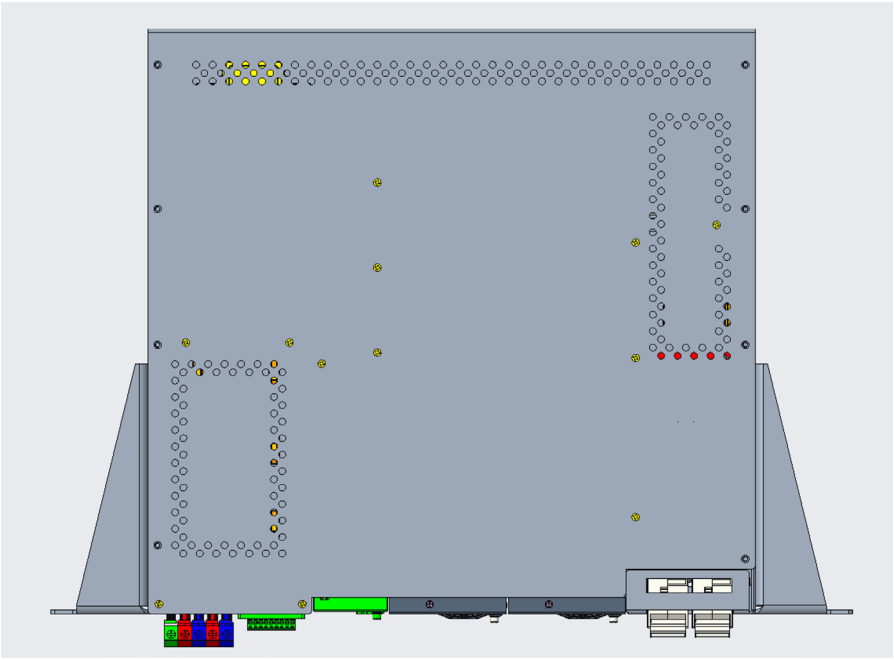


Figure 2.14 Isometric View: Solar Add-On Shelf with 23-inch Mounting Brackets

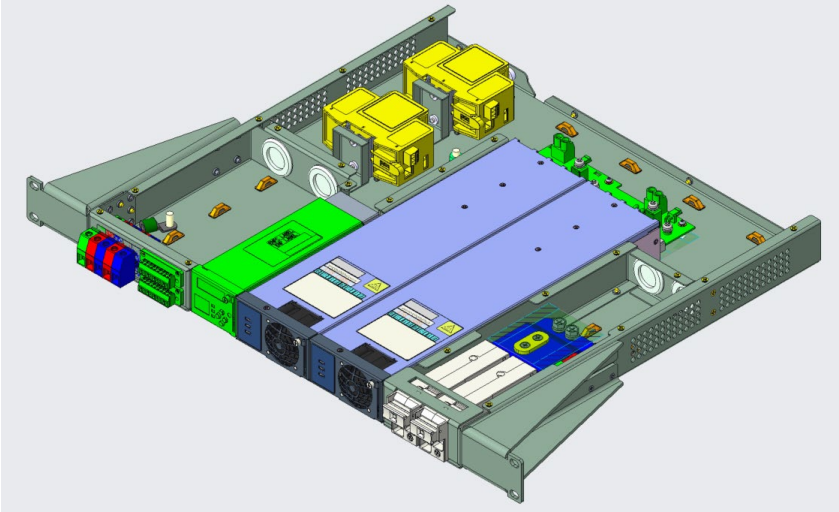
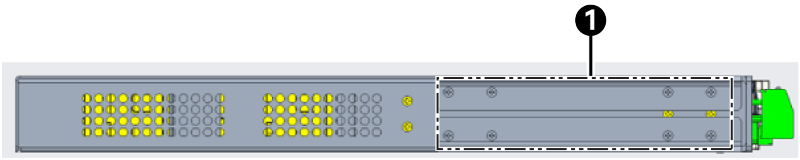


Figure 2.15 Side View: Solar Add-On Shelf with 23-inch Mounting Brackets



Item	Description
1	Use eight (8) M3 x 8 mm CSK screws to mount the bracket on one side of the shelf.

Figure 2.16 Top View Rack Mount: Solar Add-On Shelf with 23-inch Mounting Brackets with 5-inch Recess

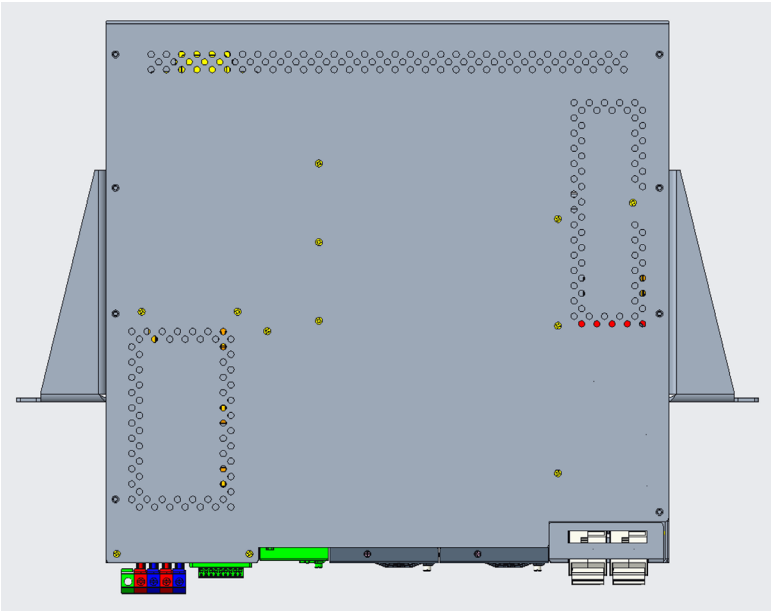


Figure 2.17 Isometric View Rack Mount: Solar Add-On Shelf with 23-inch Mounting Brackets with 5-inch Recess

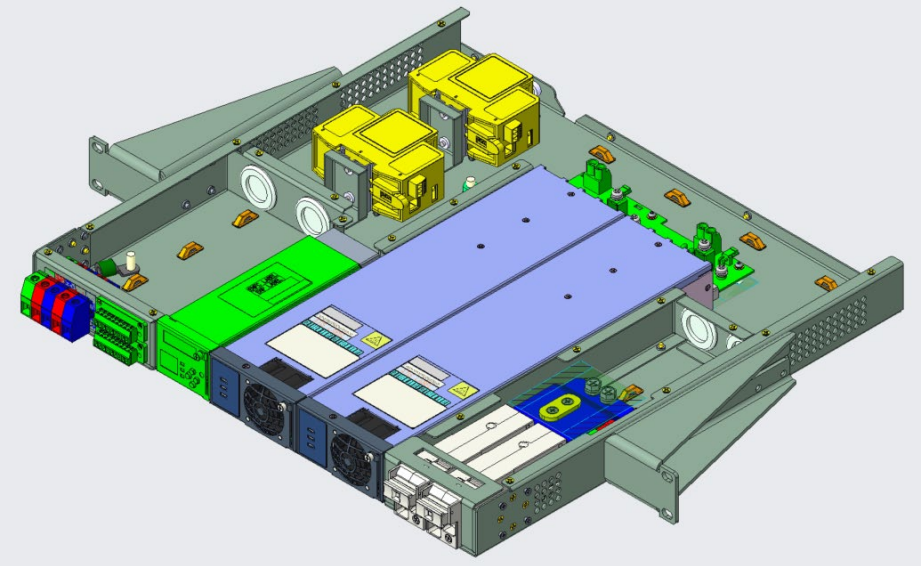
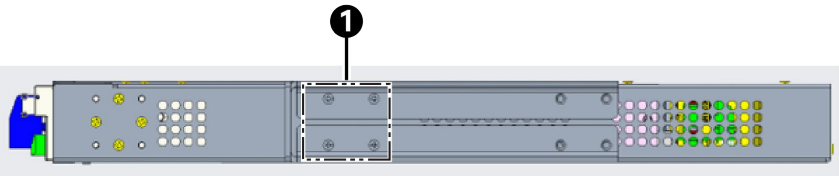


Figure 2.18 Side View: Solar Add-On Shelf with 23-inch Mounting Brackets with 5-inch Recess



Item	Description
1	Use four (4) M3 x 8 mm CSK screws to mount the bracket on one side of the shelf.

3 Installation Acceptance Checklist

Provided below is an Installation Acceptance Checklist. This checklist helps ensure proper installation and initial operation of the system. As the procedures presented in this document are completed, check the appropriate box in this list. If the procedure is not required for your installation site, also check the box in this list to indicate that the procedure was read. When installation is done, ensure that each block in this list has been checked.

NOTE! *The system should not powered up until the end of this checklist.*

Installing the System

- ❑ Visual Inspection
- ❑ System Secured to Cabinet Rack or Wall (as required)

Making Electrical Connections (Solar Add-On Shelf or Solar Expansion Shelf)

- ❑ Earthing Connections Made
- ❑ External Alarm, Reference, Monitoring, and Control Connections (including CAN bus) Made
- ❑ DC Output Connections Made
- ❑ DC Input Connections Made

NOTE! *The CAN bus extension cable should be of high twist type (1 turn per 1 cm or 2.5 turns per inch).*

Installing the Modules

- ❑ Install the Solar Converter Modules

Initially Starting the System

- ❑ System Started, Configured, and Checked

4 Installing the System

4.1 General Requirements

- This product is intended only for installation on or above a non-combustible dry surface.
- This product must be located in a controlled environment with access limited to authorized personnel only.
- The installer should be familiar with the installation requirements and techniques to be used in mounting the system's cabinet to rack/wall.
- The installer must be familiar with the host system and have an approved plan on where to add the solar power (physical location) and where on the DC bus.
- Cabinet ventilating openings must not be blocked and temperature of air entering solar converters must not exceed their rated operating ambient temperature range.
- Recommended minimum space clearance for the front of the shelf from the rack door is 120 mm (5 inches).

4.2 Unpacking the System

When the equipment arrives, make sure that all the boxes included in the shipping specification are delivered and that they have their correct numbers. Report any missing items to the carrier and your local Vertiv representative immediately.

While the system is still on the truck, inspect the equipment and shipping container(s) for any signs of damage or mishandling. As the equipment is moved off the truck and unpacked, visually examine the system for transit damage. Do not attempt to install the system if damage is apparent.

If any damage is noted, file a damage claim with the shipping agency within 24 hours and contact Vertiv to inform them of the damage claim and the condition of the equipment.

Do not unpack the equipment until the installation is to begin, thus avoiding the loss of loose details such as sets of parts delivered with the units. Keep equipment in a secure, protected warehouse, with a temperature limit of –40 °C to +80 °C (-40 °F to +176 °F) until the installation.

Record the serial number after unpacking the equipment.

4.3 Mounting the Shelf

After unpacking the equipment, follow the below steps for the installation:

1. Rack/Panel Mounting: The shelf has two options for rack/panel mounting – 19-inch and 23-inch. Mounting brackets are provided with the shelf. Attach the mounting brackets on the shelf with the provided M3 x 8 mm CSK screws, as required. Refer to "Mechanical Structure and Configuration" on page 3 for mounting configurations. Secure the shelf on the rack with four (4) screws, such as M6 x 20 mm (mounting screws are not included).
2. Wall Mounting: The shelf also supports wall mounting using the 19-inch brackets supplied for rack/panel mounting. Attach the mounting brackets on the shelf with the provided eight (8) M3 x 8 mm CSK screws as shown in Figure 2.11. Mount the shelf on the wall with four (4) screws, such as M6 x 20 mm (mounting screws are not included).
3. For EMEA DC power cabinet, order and install the mounting kit (P/N BMY1100004-8S).

4.4 Installing Optional Surge Protection Device (SPD) Kit

NOTE! *This option may not be available in some markets.*

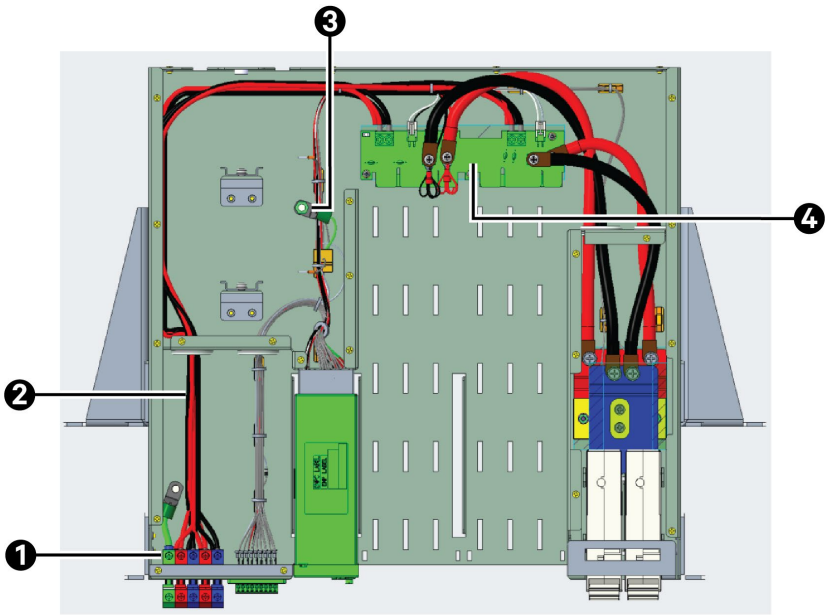
NOTE! *For global and EMEA region systems, the SPD kit is installed in the factory. This option is not available in the North America region.*

The system is provided with a DIN rail to mount the optional SPD. For optional SPD part numbers, refer to the “Part Lists” on page 40. This SPD part includes two (2) SPDs, a cable harness, and cable ties. Perform the following procedure to install the optional SPD.

Procedure

1. Remove the top cover.
2. Remove the cables from the input terminal block and the S48 backplane by using a screwdriver. Remove the M6 earthing nut and save it for later reuse. Remove all the cables and discard them. See Figure 4.1.

Figure 4.1 Removing the Cables

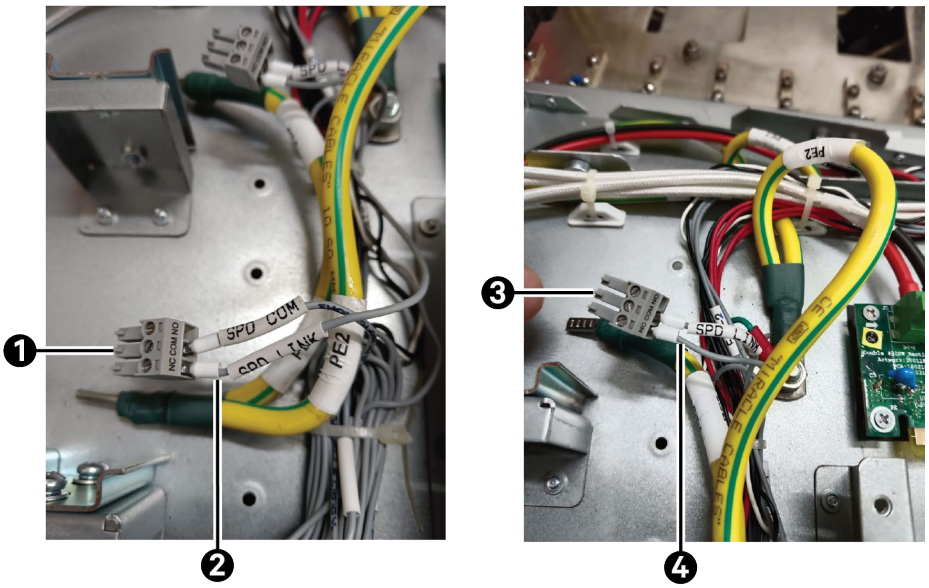


Item	Description
1	Input Terminal Block
2	Cables to be Discarded
3	M6 Earthing Nut
4	S48 Backplane

NOTE! *The signal cables of both SPDs are provided in a 2-way connector, and they are routed near the SPDs.*

3. Remove the signal cables from the 2-way connector and connect these cables to the signal connectors provided with the SPDs.

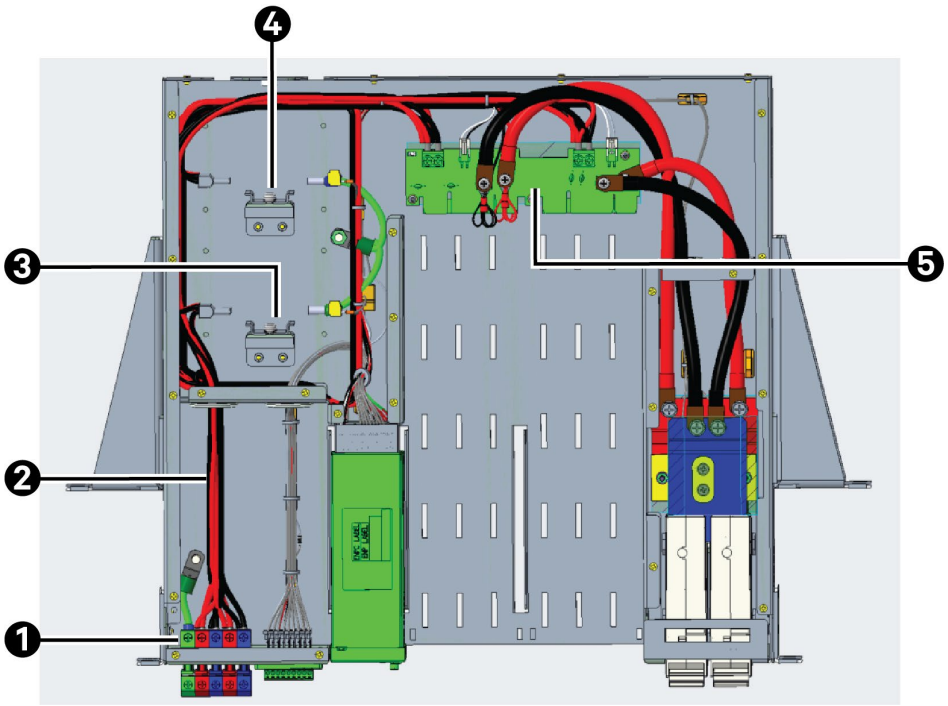
Figure 4.2 Connecting Connectors to Signal Cables



Item	Description
1	Signal Connector for SPD 1
2	Signal Cables for SPD 1
3	Signal Connector for SPD 2
4	Signal Cables for SPD 2

4. Route the new SPD cable harness from the input terminal block to the SPD locations and then from the SPD locations to the S48 backplane. See Figure 4.3.

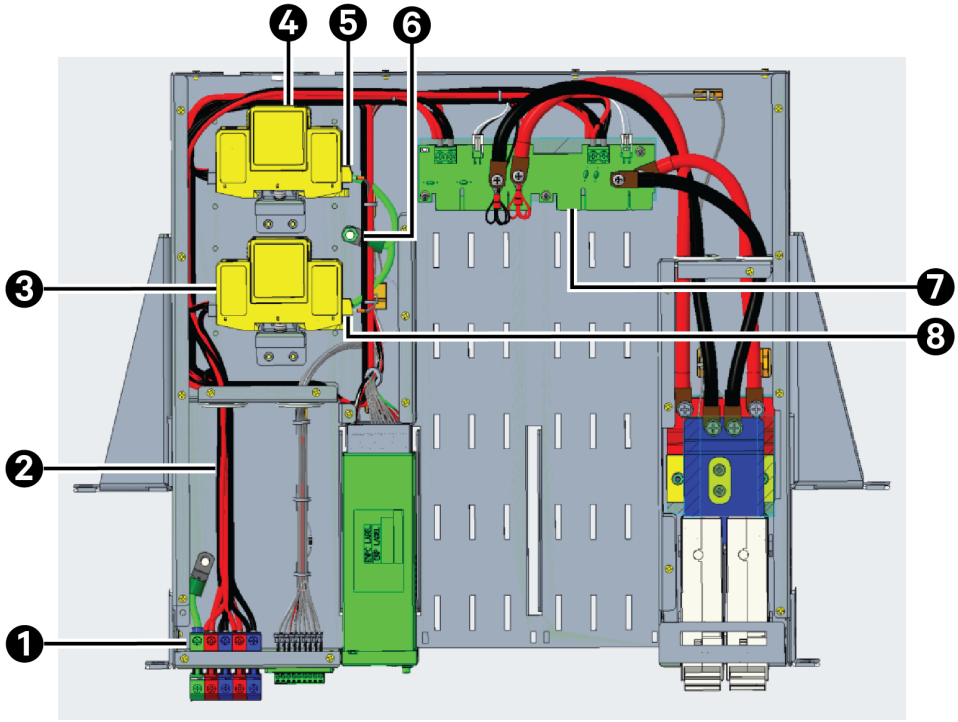
Figure 4.3 Routing of the New SPD Cable Harness



Item	Description
1	Input Terminal Block
2	New SPD Cable Harness
3	SPD 1 Location
4	SPD 2 Location
5	S48 Backplane

5. Connect the cables to the input terminal block, SPDs (SPD 1 and SPD 2) and S48 backplane by using a screwdriver. Connect the earthing cable and tighten the M6 earthing nut. Connect signal connectors to the SPDs. See Figure 2.1 for the electrical wiring connections.

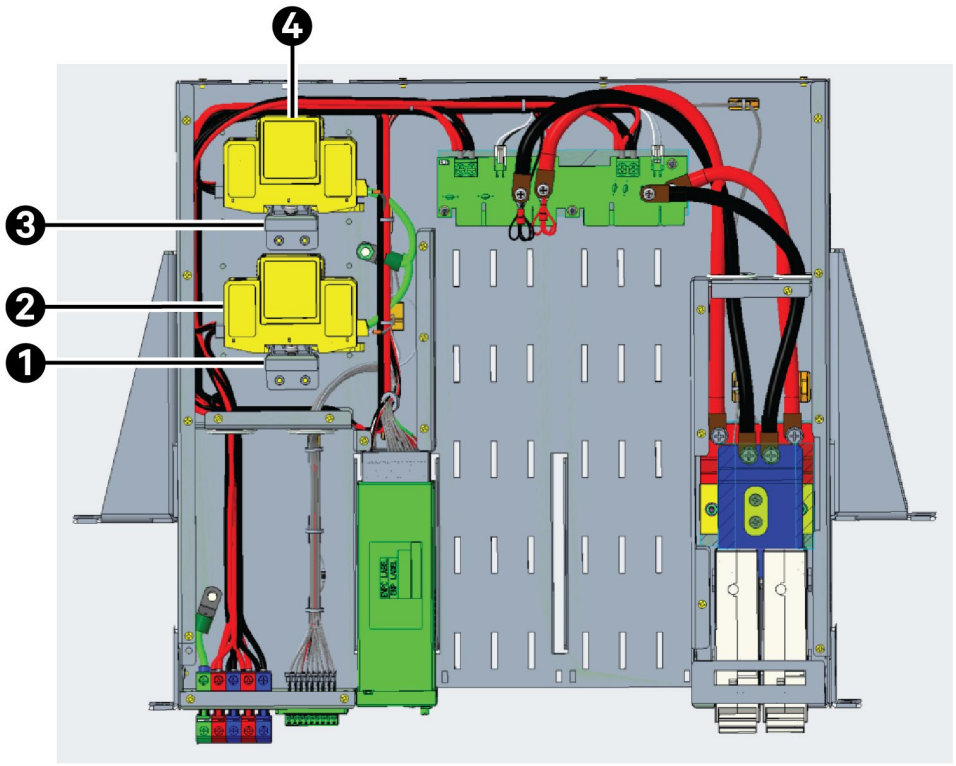
Figure 4.4 Connecting the Cables



Item	Description
1	Input Terminal Block
2	Cables
3	SPD 1
4	SPD 2
5	Signal Connector for SPD 2
6	M6 Earthing Nut
7	S48 Backplane
8	Signal Connector for SPD 1

6. Slide the SPD 1 downward until it locks on the DIN rail. Ensure that the SPD 1 is fixed on the DIN rail. Follow the same procedure to install SPD 2.

Figure 4.5 Installing the SPDs



Item	Description
1	DIN Rail to Mount SPD 1
2	SPD 1
3	DIN Rail to Mount SPD 2
4	SPD 2

7. Install the top cover.

5 Making Electrical Connections

5.1 Important Safety Instructions

DANGER! Adhere to the “Important Safety Instructions” starting on page vi before proceeding.

NOTE! *All the input and output to the system are to be turned OFF before making any further connections.*

5.2 Wiring Considerations

All wiring and branch circuit protection must follow the current edition of applicable local standards/codes. As a reference, the cable sizes listed in Table 5.1 should be considered, given ampacity and managing voltage drop.

Table 5.1 Cable Details

Input and Output Cable Details		Tool Required
Input Earth	8 AWG (10 mm^2)- Yellow Green Lug Type – Ring with M6 Screw of 15 mm Thread Length and Plain and Spring Washer or Pin Type	For Ring - Philips Screwdriver For Pin - Slotted Screwdriver
Signal Cable	22 AWG-16 AWG (0.34 mm^2 -1.5 mm^2), Lug Type - Pin	Slotted Screwdriver
DC Output	4 AWG (25 mm^2) /2 AWG (35 mm^2)*, Lug Type – Pin * 2 AWG (35 mm^2) can only be used with bare wire or ferrule without plastic sleeve.	Philips Screwdriver
Solar DC Input +ve and -ve (The wire-cable is rated for outdoor solar application)	12 AWG (4 mm^2) Cable up to 15 m (49 feet) 10 AWG (6 mm^2) Cable up to 25 m (82 feet) 8 AWG (10 mm^2) Cable up to 35 m (115 feet) Lug Type - Pin	Slotted Screwdriver
Note: Warranty will be void if inappropriate cable size is used.		

5.3 Earthing Connection

Procedure

1. Front termination - preferred for rack/panel mounting: Connect the earthing cable to the earth terminal block present at the front.

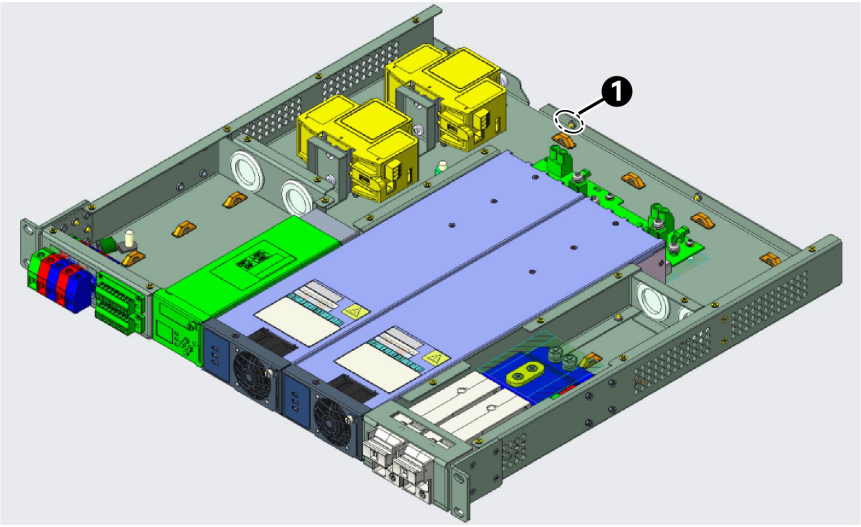
Figure 5.1 Earthing Connection on the Front Side

Item	Description
1	Input Terminal Block for Earth

2. Rear termination - preferred for wall mounting: Earthing cable with M6 barrel can also be connected on the rear side of the shelf, as per customer convenience.

NOTE! *It is recommended to use only the front grounding terminal.*

Figure 5.2 Earthing Connection on the Rear Side



Item	Description
1	Rear Side Earthing Termination Using M6 Barrel

NOTE! *The lowest resistance path will be through the terminal block, and the resistance variance of other earthing locations will be minimal.*

5.4 External Alarm, Reference, Monitoring, and Control Connections

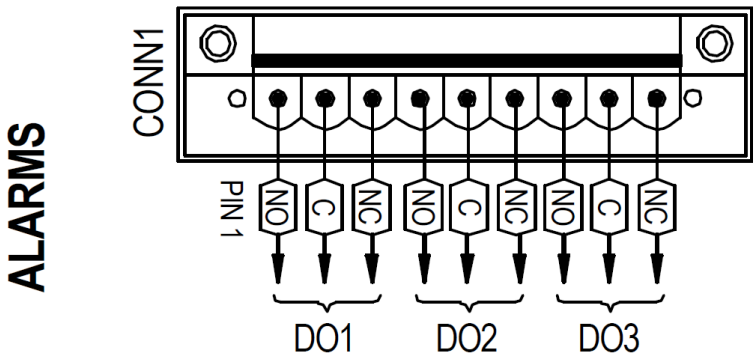
5.4.1 Solar Add-On Shelf Signal Connections

NOTE! *See "Solar Expansion Shelf Signal Connections" on page 28 for Solar Expansion Shelf signal connections.*

Alarms

Three (3) dry contacts are configured as alarms: Critical, Major and Minor. With the NCU, the user can change the alarms. For more details, refer to the NCU User Manual (UM1M831ANA).

Figure 5.3 Alarms Configurations — CONN1



Communication and DI connections

CAN connectors are used to connect the Solar Expansion Shelf.

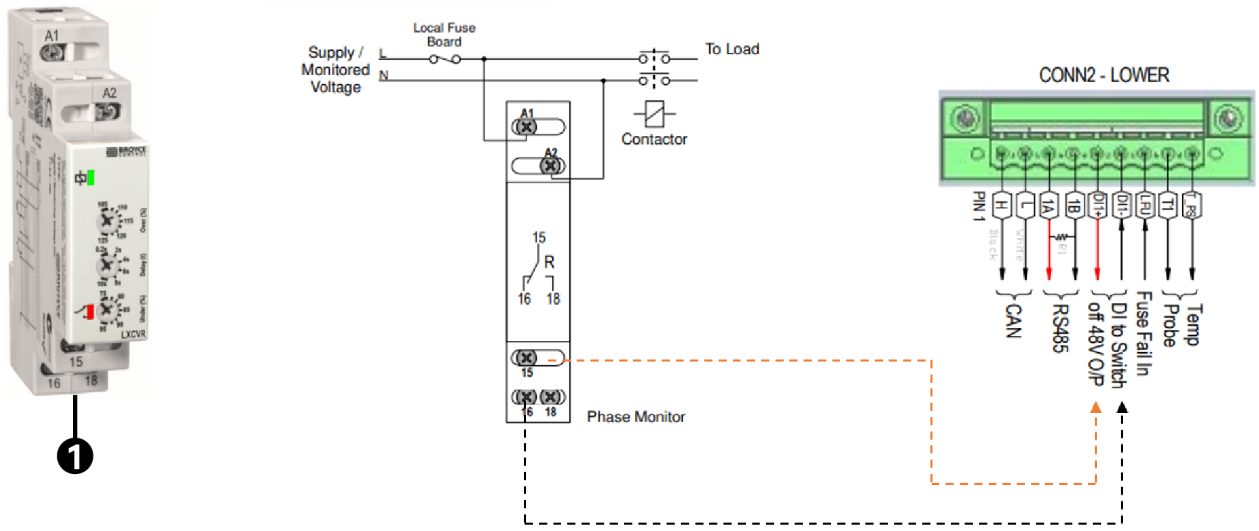
NOTE! *The CAN bus extension cable should be of high twist type (1 turn per 1 cm or 2.5 turns per inch).*

RS-485 and external +48V DI connections are provided on connector CONN2. RS-485 connection can be extended to get remote data from controller. Upon customer request agreement, a customer solution can be provided using the RS-485 as a data path for M2M communications, such as EEM.

External DI/ Solar Off DI, when enabled, is configured to stop the output power from the Solar Add-On Shelf. This is a +48V DI, which can be received from another controller or from an external AC Off Relay (optional).

To prevent the Power YoYo, an AC sense relay is to be provided as shown in Figure 5.4. The AC supply/monitored voltage need to be connected to this AC sense relay at terminals A1 and A2. When the AC supply/monitored voltage drops below 160 VAC, the output switch of this AC sense relay will trigger, and contact between terminals 15 and 16 of this AC sense relay will get open. The NCU will detect it through pins 5 and 6 (DI to Switch and Off 48V O/P) of the CONN2-LOWER connector as shown in Figure 5.4. After sensing, the NCU will switch off the MPPT module output. Once the AC supply voltage increases again to more than 170 VAC (10 VAC hysteresis), the AC sense relay terminals 15 and 16 will get connected again. After sensing, the NCU will switch on the MPPT module output.

Figure 5.4 AC Off Relay Connection



Item	Description
1	AC Sense Relay

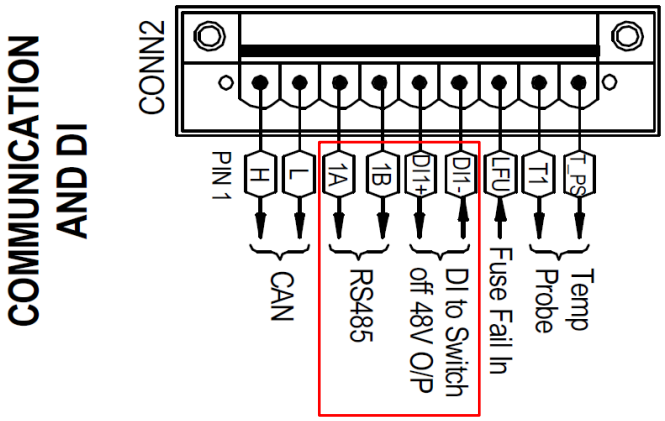
The technician is advised to use the External DI/Solar Off DI function to prevent the Power YoYo. A Power YoYo occurs when the available solar power is less than the load, and there is no other power source available to support, such as utility power via a rectifier or battery. This will result in the repeated startup and shutdown of the load, and it may also harm the operational life of the battery. To assist in understanding, a few such cases are mentioned below.

- In the evening, utility power drops and the battery drains.
- The system shuts down and the system is effectively off (cold).
- In the morning, when the sun rises, the load sees power and begins to restart, but does not recognize there is insufficient power.
- Once the load recognizes there is insufficient power, it shuts down.
- The process continuously repeats itself, until utility power is restored.

These low power cycles can harm a battery, and it is advised to disable solar power, when the utility is lost or when the battery capacity has dropped and is continuing to be drained.

In the event, the customer has a battery installed for which the maximum current limit is lower than the maximum power output of the solar, they should use a Solar DI Off strategy. Whether by external relay, external alarm, or the Solar Off function by the NCU, so as the solar array does not over-current the battery.

Figure 5.5 Communication and DI connections — CONN2



Fuse Fail Alarm means when the output MCB of Solar Add-On or Solar Expansion Shelf trips, the user will get this fuse fail alarm. To get the fuse fail alarm, the output of the solar shelf must be connected to the actual user load and not on any DC system.

Temperature Sensor Connections

One (1) temperature sensor from the NCU is provided to support the option of battery temperature compensation (this is applicable to lead acid batteries that may be in extreme conditions, and in the rare case where solar power is greater than the load). If the sensor is ordered, mount the sensor on the battery in the middle at the hottest location (usually the top) of the shelf.

Do not mount the sensor where it will be impacted by other components, such as cooling fans or air conditioners.

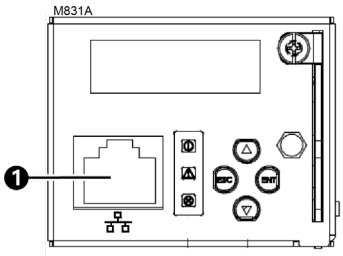
NCU Ethernet Connection

The NCU provides an Ethernet RJ-45 port with a default address of 192.168.1.2 that may be used to be integrated into the carrier's network. If a permanent Ethernet connection is to be left in-place, use a shielded cable at both ends.

The Ethernet is also available as a local craft user interface, this means that the user can connect their laptop to the NCU to enable a user-friendly web GUI to monitor and manage the solution. For more details, refer to the NCU User Manual (UM1M831ANA).

NOTE! *You can access the Web pages of the power system locally by using a "crossover" or "straight" cable connected directly between your PC and the NCU.*

Figure 5.6 NCU Ethernet Port



Item	Description
1	10/100M Ethernet Port (RJ-45)

5.5 DC Output Connections

Solar Add-On Shelf Output Connections

Refer to the below procedure for the DC output connections of the Solar Add-On Shelf.

Procedure

1. The -48 VDC output cables from the shelf are to be taken through the UL 1077 125A MCB highlighted in Figure 5.7.

Figure 5.7 DC Output Connections

Item	Description
1	-48 VDC Output Cables to be Connected to UL 1077 125A MCB

NOTE! *The customer is responsible for creating a connecting pair of output cables to terminate on the DC distribution bus of the host system/load.*

2. Before connecting the output cables to a host system, verify and record the output voltage of the host system using a DC voltmeter. This voltage should be between 47 VDC and 58 VDC. Connect the DC output cables from the shelf with the host breaker in the open position.

3. Make sure to connect the DC output cables to the designated busbar circuit breaker linked to the host system. Ensure proper polarity when connecting the cables.

NOTE! *For systems to comply with UL 62638, the host circuit breaker must be rated for UL 489.*

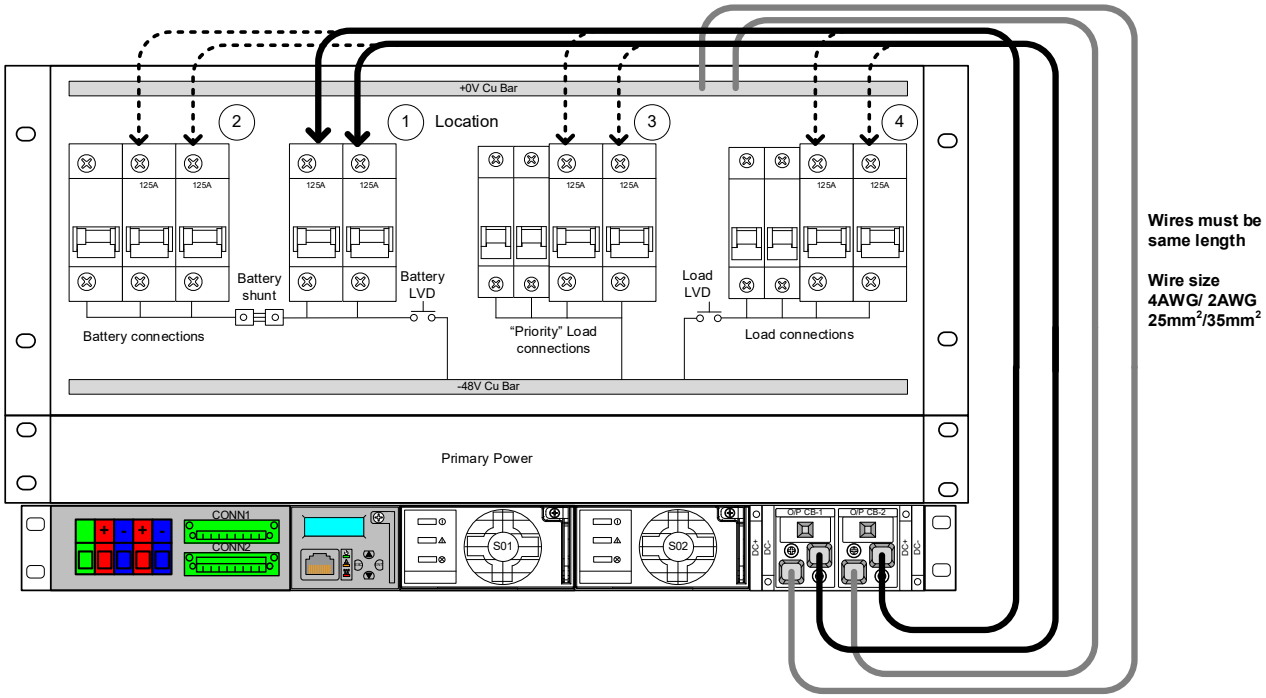
NOTE! *Circuit breakers are required to protect the wire, but in support of servicing, they isolate the host power from the solar converter shelf.*

The installing technician must consider and calculate the anticipated maximum voltage drop using tools/methods as approved by the carrier. This information is required for the final setup.

As a reference AS/NZS 3008 calculations are available at https://www.jcalc.net/voltage-drop-calculator-as3008, and SouthWire also makes available a free tool. As a default value, use a maximum of 81.5 A at 54 VDC.

Solar Add-On Shelf Interconnections

Figure 5.8 Solar Add-On Shelf Interconnections



WARNING! Adhere to the "Important Safety Instructions" mentioned on page vi.

The Vertiv™ NetSure™ Solar Converter Shelf is used as a supplemental power system to a host NetSure power system. As a supplemental power system, the key function is to reduce the loads dependency off the grid or support the load if the grid is absent, thus reducing the discharge of the battery.

Installation personnel is responsible to assess the existing host system, understand the expectations and implement in accordance with expectation. Before the installation, the installer should have answers to the following points.

- Understanding the primary power system including configuration, available space and thermal conditions.
- Existing voltage on the bus(es), batteries and any algorithm that may adjust the voltage, such as temperature compensation and equalize.
- Voltage and any current limits or restrictions in place, such as those associated with the battery, load, contactor limits, and shunts.
- Available location and placement of any power connections from the supplemental power shelf, relative to load, batteries, shunts and contactors.

WARNING! Vertiv recommends the connection from the NetSure Solar Converter Shelf into the primary power system include a breaker or disconnect at the primary power system. This enables the cables to be disconnected safely at either end.

Solar Off: The signal connector X2 position 5, 6 is listed as "Switch OFF -48VDC output", but also known as "Solar Off". When this feature is enabled, this solar converter shelf will stop the delivery of power. Sample user cases are below, where the technician is advised to use this function.

Power YoYo: A Power YoYo is defined when the only power available from solar is inconsistent and/or available solar power is less than the load at startup and in normal operation, resulting in the repeated startup and shutdown of the load. This condition is typically seen when AC power is off, and the battery is disconnected/discharged. The solar array, by itself, may not provide the power to sustain the load, especially:

- In the morning, the solar energy starts from zero power and slowly provides more power.
- In the evening, a transition as power drops as the sunsets.
- During the day, the passing of large shadows or dark clouds will result in a large drop of power being delivered.

To prevent the repeated startup and shutdown of the load, the Solar Off function should be activated when the grid is off and/or when the battery is no longer available to support the load, either as a function of a discharge battery or an open LVD.

Location 1 Connections:

Independent DC Power Port: The typical best location is on the battery bus on the power side of any battery shunt. If there is a battery LVD, if it is preferred, the connection is between the shunt and battery LVD, so the solar converter can charge the battery.

The advantage of this location is that the battery functions as an alternate load (or dump load) for the solar array.

CAUTION! In the event the solar array output is greater than the battery's stated maximum recharge limit, the technician should use the Solar Off feature when the load is disconnected.

Example: A single common 200Ahr AGM lead standby battery can support a maximum of 50 A charge, but a full 4.3 kW solar converter can generate a peak current of 82 A and thus exceed the original manufacturer's limit of the battery. In the event the load is disconnected, such as when a load LVD is open as the battery is discharging or a battery alarm is generated by an open breaker, then use the Solar Off function. The alternative is to reduce the size of the solar array. For example, create a solar array that cannot generate current more than 50 A.

Location 2 Connections:

Solar Battery: Similar to location 1 as stated above, with the additional consideration that the solar energy going into the battery will not be counted.

CAUTION! If the battery shunt is important or critical in monitoring the battery, this location should not be used.

Example: In a hybrid application where the battery state of charge (SOC) is calculated and used as a function of the current through the shunt, then this connection should not be done. In a time base hybrid control model, or DG control is a function of voltage or a smart battery reported SOC, this restriction may not apply. However, It must be acknowledged that such a connection will not account for the battery charging performed by solar.

Location 3 Connections:

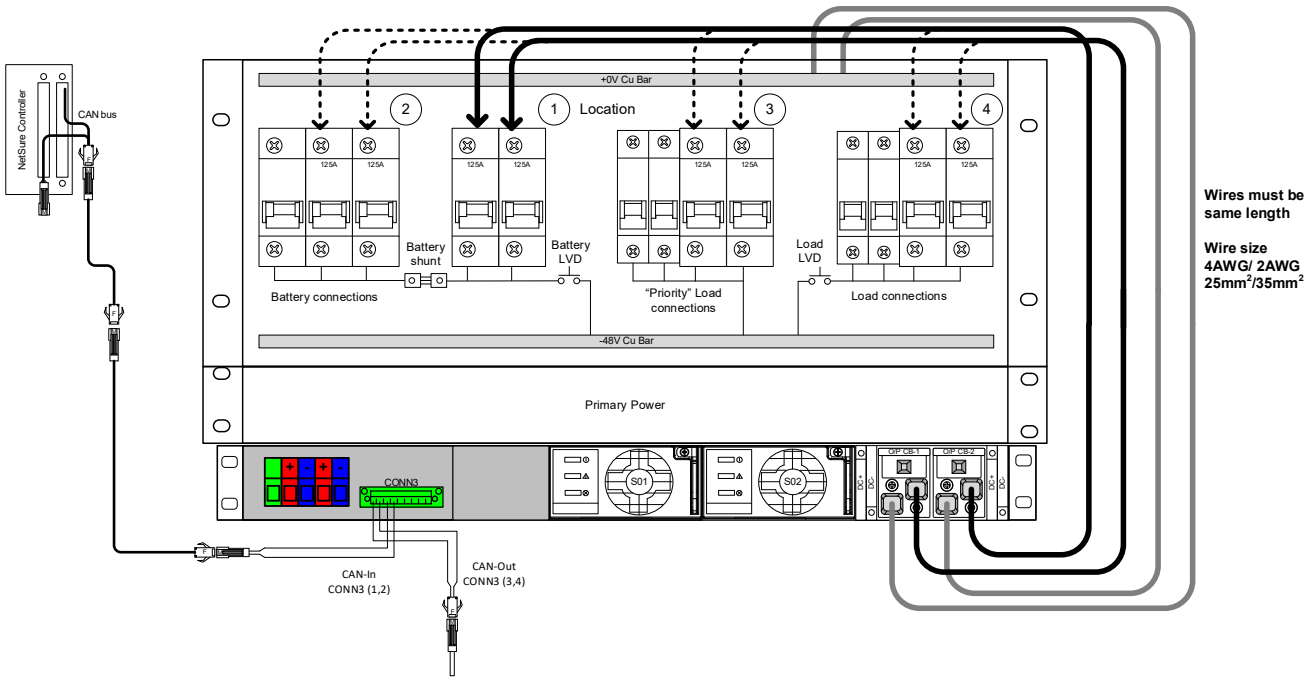
Priority Load: Similar to location 1, with the additional consideration that the solar shelf cannot charge the battery when the battery LVD is open.

Location 4 Connections:

Load: Similar to location 3, with the additional consideration that solar is isolated to one load branch when the load LVD is open.

Solar Expansion Shelf Interconnections

Figure 5.9 Solar Expansion Shelf Interconnections



NOTE! *CAN bus connection points differ by system.*

WARNING! Adhere to the "Important Safety Instructions" mentioned on page vi.

NOTE! *2 AWG (35 mm²) wires can only be used with bare wire or ferrule without plastic sleeve.*

The Vertiv™ NetSure™ Solar Converter Shelf is used as a supplemental power system to a host NetSure power system. As a supplemental power system, the key function is to reduce the loads dependency off the grid or support the load if the grid is absent, thus reducing the discharge of the battery.

Installation personnel is responsible to assess the existing host system, understand the expectations and implement in accordance with expectation. Before the installation, the installer should have answers to the following points.

- Understanding the primary power system including configuration, available space and thermal conditions.
- Existing voltage on the bus(es), batteries and any algorithm that may adjust the voltage, such as temperature compensation and equalize.
- Voltage and any current limits or restrictions in place, such as those associated with the battery, load, contactor limits, and shunts.
- Available location and placement of any power connections from the supplemental power shelf, relative to load, batteries, shunts and contactors.
- For the Solar Expansion Shelf connected to the NCU, locate and define where the host CAN bus connection is available and how the CAN bus cable and termination will be extended.
- For the Solar Expansion Shelf connected using an existing NCU, the host system may also require an NCU software update to recognize the solar converter module (S48-4300E4).

WARNING! The DC power output connection from the solar converter shelf into the primary power must include a breaker at the primary power system (for markets requiring UL NRTL compliance, the terminating breaker shall have a UL 489 rating).

If the load is offline or the solar power will exceed the demand of the load, the solar converter shelf can recharge the battery. So, it is important that the standalone setting of the solar converter shelf should consider the battery.

As an additional precaution, the Solar Off function is also available.

Example: A traditional 200Ahr AGM lead standby battery can support a maximum of 50 A charge, but a full 4.3 kW solar converter shelf can generate a peak current of 82 A, and thus exceed the original manufacturers limit of the battery.

Location 1 Connections:

The typical best location is on common bus.

Location 2 Connections:

The second best location is on the battery bus between any battery shunt and LVD.

Location 3 Connections:

If connecting to a load breaker, the customer is advised to implement the Solar Off function to prevent the YoYo.

Location 4 Connections:

Placing a power energy source BEHIND a battery shunt will result in abnormal readings for battery current and function-calculation that relies on this data.

5.6 DC Solar Input Connections

Unpowered cables from the solar array are to be connected to the shelf's input terminals, observing and correctly matching the polarity.

We advise, prior to entry into a shelter, cabinet, or similar, the solar array cables pass through a protection box, such as Vertiv's IP65 SPD box (Vertiv's IP65 box may not be available in all markets). When installed, this box provides surge protection to an external ground ring, a circuit breaker, and a method to disconnect the solar array from the solar converter shelf.

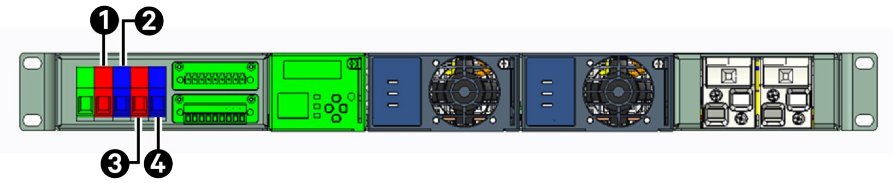
Refer to the below procedure for the DC solar input connections.

Procedure

1. Verify and record the solar array input voltage. This voltage should be between 70 VDC to 400 VDC, when light is on the array.
2. With the solar array breaker open, connect the cables from the solar array to the designated terminal blocks provided in the system. Terminate the +ve and -ve cables from the solar array on the +ve and –ve terminal blocks (ensure correct polarity). See Figure 5.10.

WARNING! High voltage precautions should be followed.

Figure 5.10 DC Input Connection



Item	Description
1	Input Terminal Block for PV1+ (Solar Array 1 Positive)
2	Input Terminal Block for PV1- (Solar Array 1 Negative)
3	Input Terminal Block for PV2+ (Solar Array 2 Positive)
4	Input Terminal Block for PV2- (Solar Array 2 Negative)

MC4 Red-Black solar input cables from Vertiv may be available as an option. These cables are available in three (3) sizes (length and gauge) to ensure voltage drop (losses) will be less than 1%. See Table 5.2.

Table 5.2 Input Cable Sizes

Cable Size	Distance from Source
12 AWG (4 mm^2)	15 m (49 feet) ± 0.1 m (0.32 feet)
10 AWG (6 mm^2)	25 m (82 feet) ± 0.1 m (0.32 feet)
8 AWG (10 mm^2)	35 m (115 feet) ± 0.1 m (0.32 feet)

5.7 Solar Expansion Shelf Signal Connections

Solar Expansion Shelf does not have a controller present in it. It can be integrated with the Solar Add-On Shelf, other Solar Expansion Shelf, or any other Vertiv NetSure system which has a controller that recognizes the solar converter module (S48-4300E4), (software update to the host system may be required).

NOTE! *The installer may require support from Vertiv's regional support to locate the host CAN bus port.*

Figure 5.11 Solar Expansion Shelf

Item	Description
1	Earthing Connection
2	Connector CONN3

Procedure

1. Connect the input earth cable to the shelf at designated location of the Solar Expansion Shelf.
2. Connect the CAN bus input to the Solar Expansion Shelf CONN3 Pin 1 and Pin 2 and connect the CAN bus output from the Solar Expansion Shelf CONN3 Pin 3 and Pin 4.

NOTE! *Make sure to terminate the CAN bus connection with 110 Ohm 1/4W Resistor.*

NOTE! *CAN is an abbreviated term to represents Vertiv's CAN bus that is dedicated datalink to manage and monitor Vertiv's rectifiers, converter and solar converters. No other CAN bus devices can be connected.*

3. Connect Fuse Fail DI input to CONN3 Pin 7 and Fuse Fail DI output to CONN3 Pin 6. Refer to Figure 5.13 for the connections details of CAN bus and fuse fail DI interconnection.
4. You may extend the SPD alarm to the Vertiv make DC power supply system, if it has the appropriate provision for it or the customer can use it for monitoring purpose.
5. Connect the load output from the Solar Expansion Shelf.

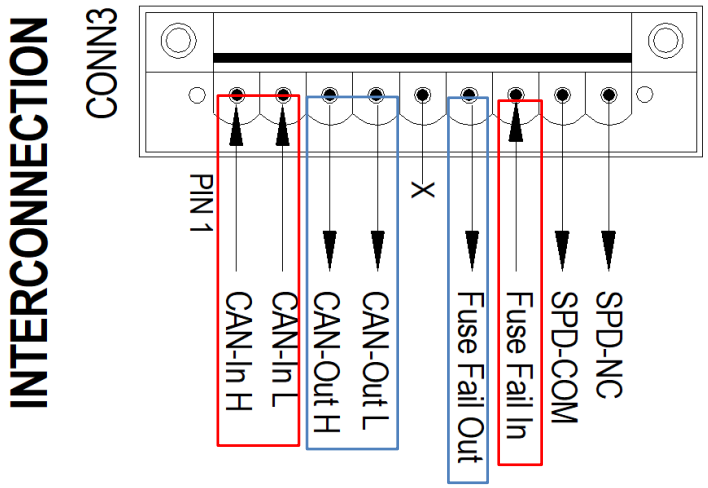
NOTE! *Make sure output breaker is Open before making connection.*

6. Connect the solar DC input to the Solar Expansion Shelf at the designated terminal blocks.

WARNING! While making connections, ensure proper polarity and the input breaker is kept open.

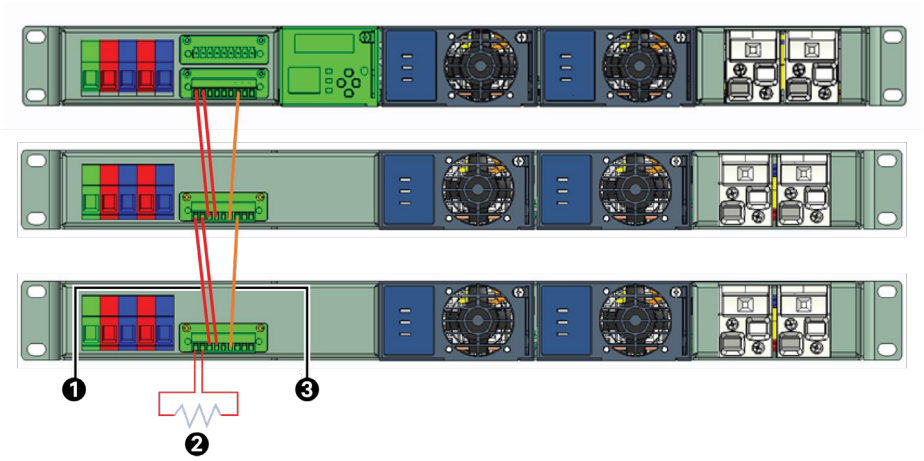
The Solar Expansion Shelf connector CONN3 has interface for CAN interconnection between Solar Add-On Shelf, other Solar Expansion Shelf or other Vertiv NetSure system. The load fuse fail signal from the Solar Expansion Shelf can be extended to any of these units (if they have a provision for it) for monitoring by the controller. It also can monitor fuse fail input sensing from other Solar Expansion Shelf. SPD fail in the Solar Expansion Shelf can be extended by the customer for monitoring purpose.

Figure 5.12 Interconnections of Solar Expansion Shelf Connector CONN3



Note: Red highlighted connections are input to the Solar Expansion Shelf.
Blue highlighted connections are output from the Solar Expansion Shelf.

Figure 5.13 Daisy Chain of CAN Bus and Fuse Fail with Solar Add-On Shelf



Item	Description
1	CAN bus Interconnection
2	Termination Resistor for CAN 110 Ohm 1/4W
3	Fuse Fail Interconnection

6 Installing the Solar Converter Module

Refer to the Solar Converter User Manual (UM1S484300E4) to install the solar converter module.

7 Initially Starting, Configuring, and Checking System Operation

WARNING! The unit is to be installed by authorized personnel only. Vertiv Energy assumes no responsibility if the unit is installed by untrained personnel. It is the customer's responsibility to ensure that technicians are adequately trained for installation.

7.1 Initial Startup Preparation

CAUTION! Interconnection to a host system as outlined in the procedure may lead to a service interruption and/or the extension of alarms in the host system. Notify any appropriate personnel before starting these procedures. Also, notify personnel when these procedures are completed.

- Ensure that all blocks, except the last one, in the “Installation Acceptance Checklist” on page 11 have been checked.
- Ensure that the solar converter module and the controller are fully seated, latched, and the latch handle screws secured.

7.2 Powering up

WARNING! Installation and powering up the solar system is to be done by authorized personnel only. As first step, it is necessary to check for any loose connections in transit.

NOTE! *For the Solar Add-On Shelf, follow the complete procedure. For the Solar Expansion Shelf, after step 3 directly follow the step from 7.*

NOTE! *If connecting the Solar Expansion Shelf to an existing NetSure Controller, the original controller may need to be updated.*

1. Once all ground (earth), data, and power connections are made, the unit is ready for power up. Before powering up, as a precaution, it is necessary to check for any shorting with the help of testing equipment. The load MCB is to be switched OFF before powering up the shelf.
2. Take a reference measurement of the input host voltage. Technician must also determine maximum voltage drop.
3. Once above two conditions are confirmed, switch on the solar input to the shelf.
4. Once the solar array is connected, the controller should recognize the solar converter module (S48-4300E4).
5. Refer to the NCU User Manual (UM1M831ANA) and login to the webpage. In accordance to company policies, update the language, password, date and time, and site name, if necessary. Identify any alarms and address.
6. After initial login and set up (for the Solar Add-On Shelf, the user can modify the NCU configuration as per the site requirements), observe the status of the indicators located on the controller and solar modules. If the system is operating normally, only the green LED will be illuminated. Any active alarms should be identified and resolved. Refer the NCU User Manual (UM1M831ANA) for the status and alarm indicators of the controller. Refer to the Solar Converter User Manual (UM1S484300E4) for the status and alarm indicators of the solar converter module.
7. Set the shelf output voltage approximately 0.3 VDC to 0.5 VDC higher than the host system voltage. The technician must consider the host system's voltage, whether temperature compensation is enabled, and the voltage drop.
8. In accordance with site design, enable Solar Off.
9. Switch on the load MCB in the solar shelf. Confirm that the solar panel is "lit" up and that the current is being delivered to the host system/load.

8 Using the Web Interface

Refer to the NCU User Manual (UM1M831ANA) for additional information.

8.1 Login

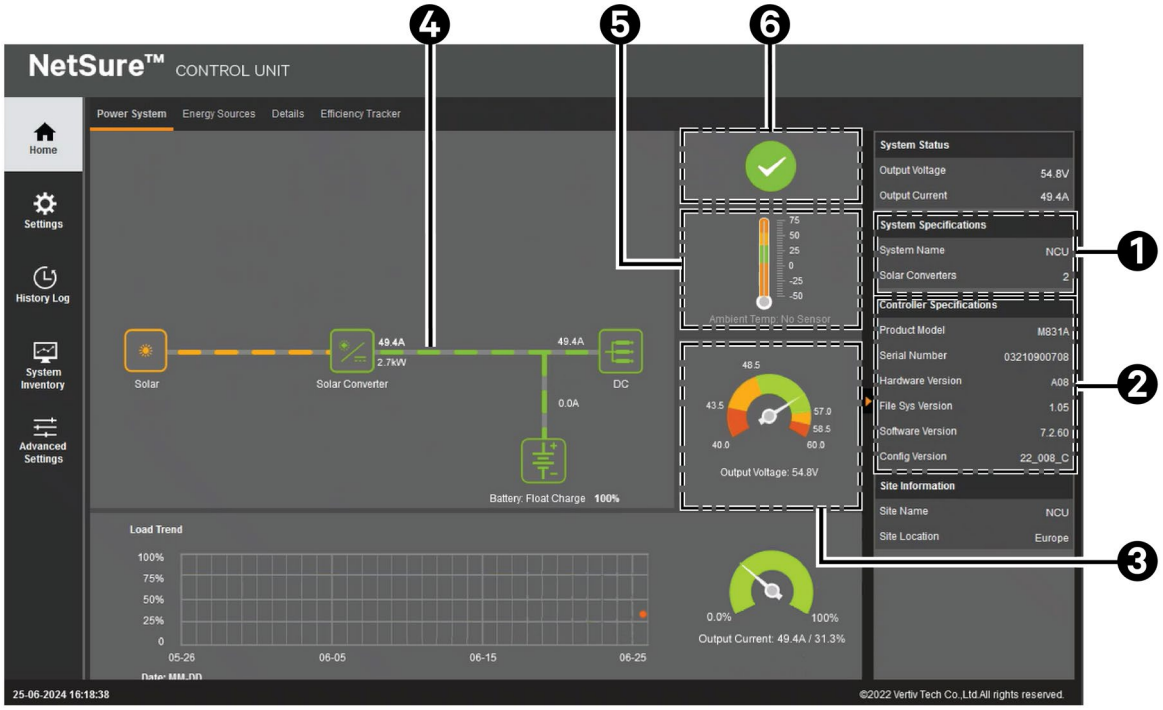
To login to the web interface of NCU, enter the default username and password as mentioned below:

- Default User Name: Admin
- Default Password: 12345678

User can change the password. Support special characters, include: ~ `!@/$#%^&*()\-+={}[]:;"'<>,.?

In the Web Interface, after entering a valid User Name and Password and clicking LOGIN, the "Homepage" window opens. See Figure 8.1.

Figure 8.1 Homepage



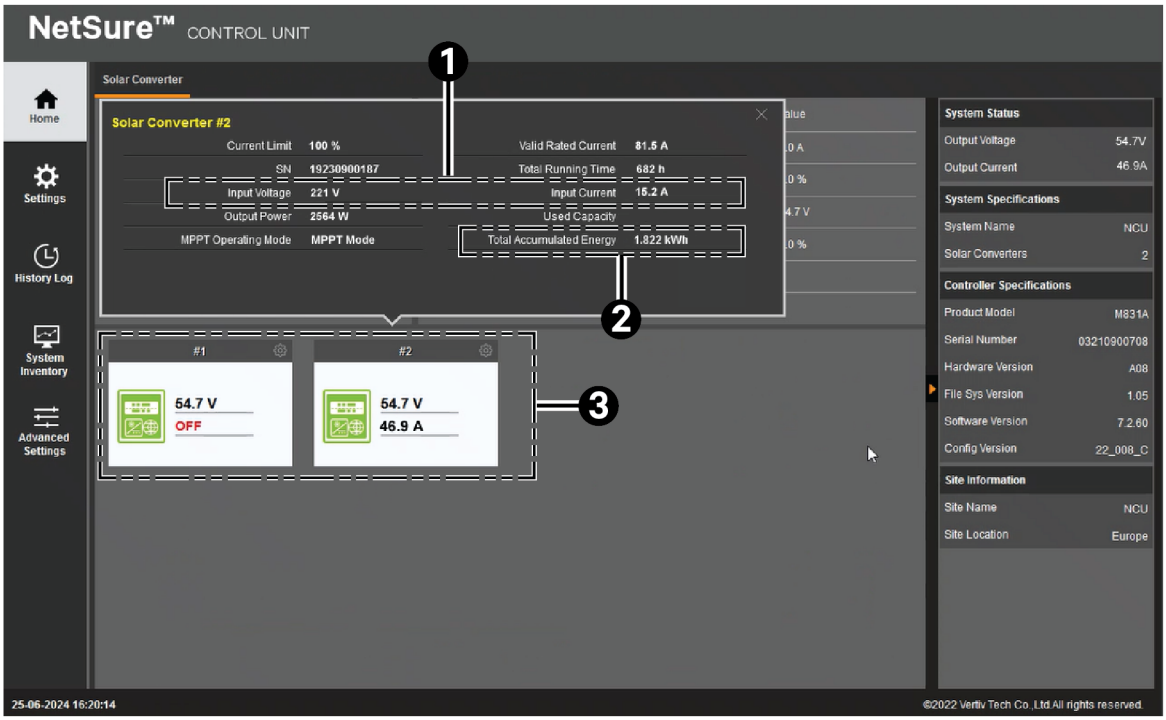
Item	Description
1	Number of S48-4300E4 solar converters recognized. Example: 2
2	Software and configuration version information. Example: 7.2.60 and 22_008_C
3	The voltage at which the solar converters are delivering power. Example: 54.8 VDC
4	The current and power being provided. Example: 49.4 A and 2.7 kW.
5	Ambient temperature.
6	If there are any alarms active.

NOTE! *There is no battery shunt measurement in this system, so the battery icon should be ignored.*

8.2 Solar Converters

To view each solar converter, click on the solar converter icon from the homepage screen. See Figure 8.2.

Figure 8.2 Solar Converters



Item	Description
1	Solar array input voltage and current. Example: 221 V and 15.2 A.
2	Energy Provided in Lifetime. Example: 1.822 kWh
3	Output voltage and current. Example: 54.7 V and 46.9 A

8.3 Solar Tab

In "Settings" under "Solar Tab", there are several controls to be considered that deal with the unique properties of solar being an intermittent power energy source and provides low power. The solar converter will not generate power at night. The low power provided by the solar array during the early morning and late evening is insufficient to maintain an active load without a battery.

The condition that occurs due to low power is known as "YoYo". Where the load frequently starts and shutdowns that will accelerate battery aging and may harm some components, such as LVD starter coils. This occurs when the battery is at or nearly exhausted and the solar power being delivered is less than the actual needs of the load. A case to describe this condition is mentioned below:

- When there is a power outage (utility and/or generator), it results in the system's battery discharging during the night and the site shutting down because of no AC power, no solar power, and fully discharged batteries.
- In the morning, as the sun rises and AC power is still off, the solar converters begin to provide power and may even partially recharge the batteries. An LVD may close, the load will eventually recognize power is now available, and begin to startup.
- If the power required to start the load is greater than the early morning power available, the system will soon shutdown.

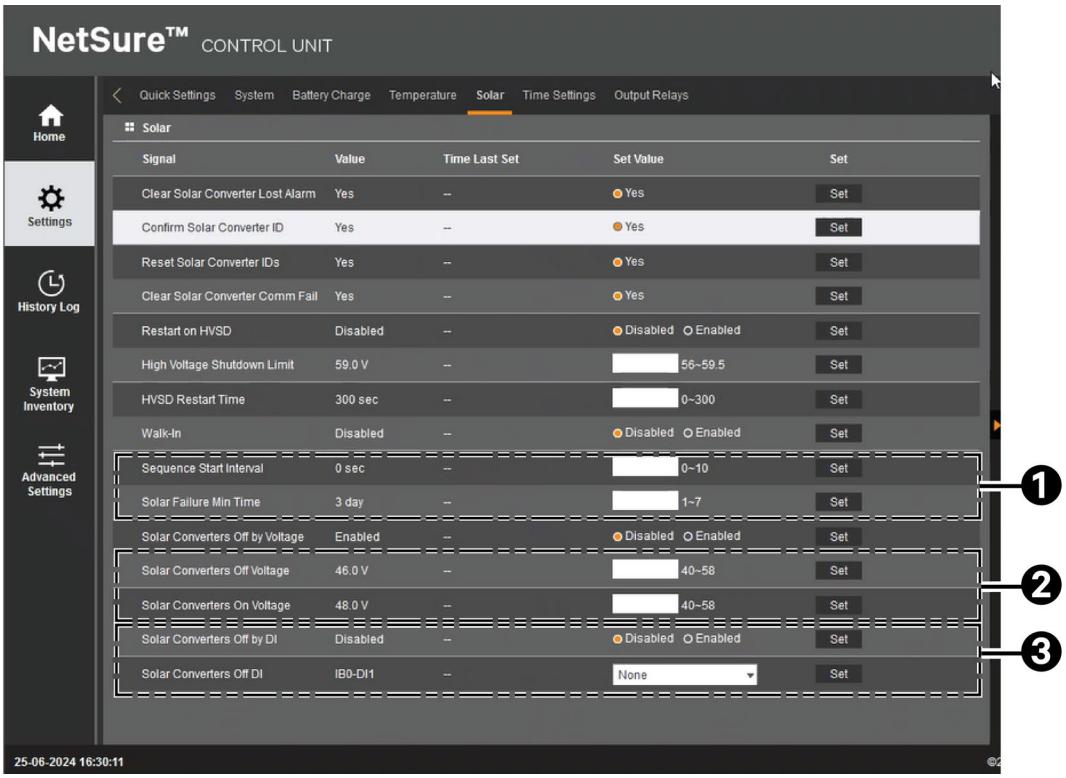
- This process of turning off and on will continue to repeat itself until sufficient power is available to support the load. In case of generator and solar is disabled, the load will not turn on and off continuously.

To prevent this, there are several strategies available:

- Using an external controller or relay to turn off or disconnect solar.
- Set the system controller to turn off solar when it senses a low voltage.

The Solar Add-On solution is supplemental power to support the load and should be used to replace the battery recharge of the host system.

Figure 8.3 Solar Settings



Item	Description
1	A night without solar is normal and no reason to be alarm, but one or more days is an indicator a fault needs to be addressed. The default setting is three days without any solar power, will generate an alarm. The user can change the default setting to one day to get an alarm.
2	To eliminate the probability of a 'YoYo' on recovery, turn off the solar converter when it detects the bus voltage is low. This setting may also be used to intentionally delay the solar converter 'reconnect' to the battery, in that case, the host system will continue to recharge the battery.
3	To eliminate the probability of a 'YoYo' on recovery, turn off the solar converter using an external relay or controller into the controller's DI.

8.4 Voltage and Temperature Sensor

The delivery of solar power from this solar supplemental solution is based on the principle of voltage dominance. The load and battery will take power first from the power source with the highest potential. In the event, the supplemental source is insufficient, the load and battery will also take power from the second source.

Therefore, the voltage from the solar converter should be a little higher (0.3 VDC to 0.5 VDC) than the rectifier.

Example 1:

1. If the lithium battery's recommended float voltage is -54.0 VDC and the solar array peak power is greater than the typical load, set the
    - Solar float converter to -54.0 VDC
    - Host system's rectifier voltage to -53.5 VDC.

At night, during the early morning and late afternoon, when the solar power available exceeds the load demand, the voltage to the load and battery will be -53.5 VDC. As the sun rises and delivers more power than the load requires, the voltage will rise to -54.0 VDC.

Example 2:

2. If the lead battery's recommended float voltage is -54.0 VDC and the solar array peak power is less than the typical load, set the
    - Host system's rectifier voltage to -54.0 VDC, with temperature compensation as per the battery manual.
    - Solar float converter to -54.5 VDC, with temperature compensation as per the battery manual.
    - Note that the host system's temperature compensation may have different data entry - variables and may look different than the NetSure Solar Converter Shelf; but the requirement is to allow the solar converter to replicate the same changes to voltage as the host system.

Host system rectifier voltage to -53.5 VDC.

Although the solar converter has the higher voltage, it does not have sufficient power to fulfill the load and battery requirements, so the voltage available for the load and battery is the same as that provided by the host system.

An optional temperature sensor is available with the NetSure Solar Converter, and it may be used to provide ambient temperature readings, which will help to adjust the voltage in support of battery temperature compensation.

Figure 8.4 Solar Converter Voltage Settings

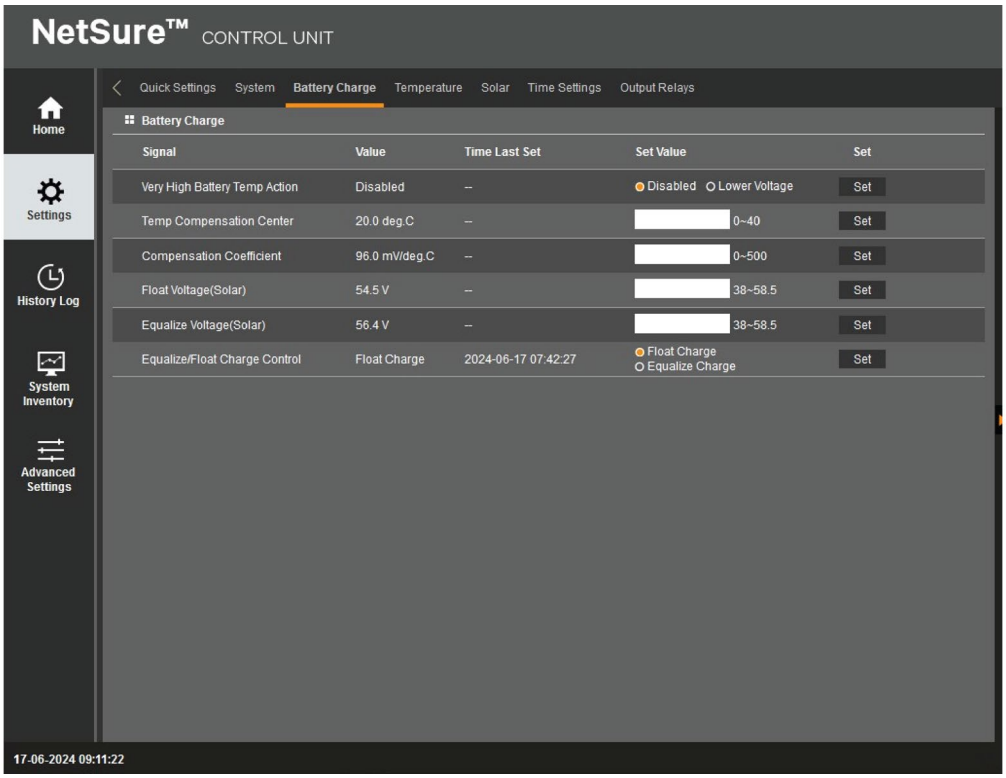
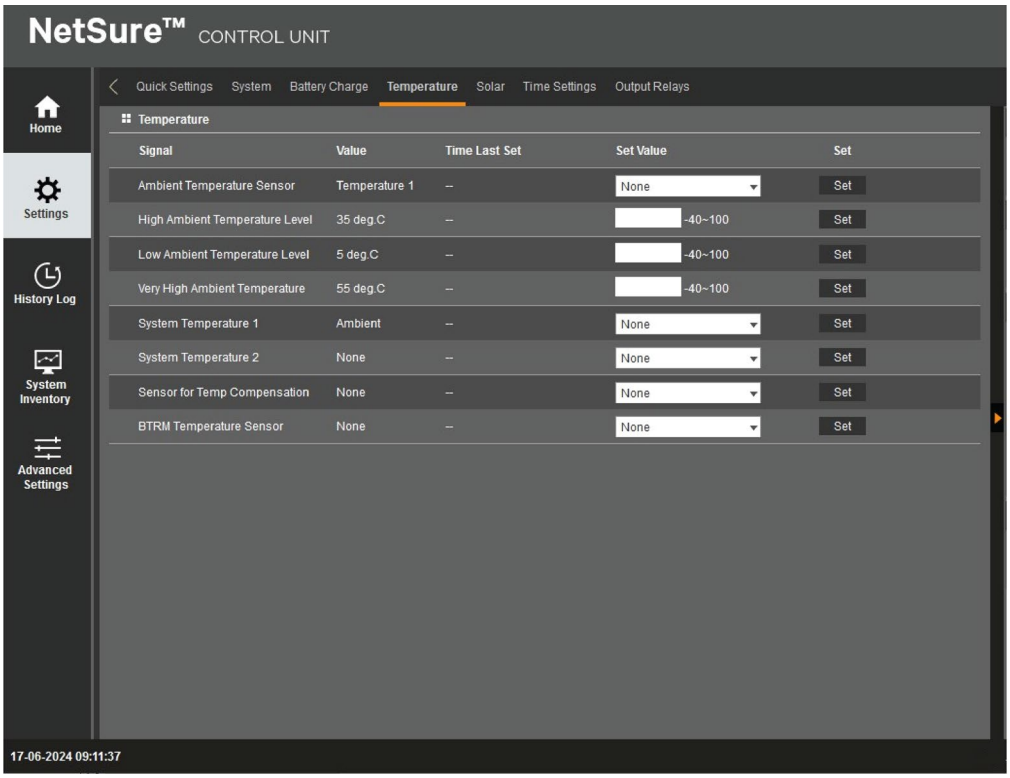


Figure 8.5 Assigning Temperature Sensor to its role



9 Technical Parameters of Solar Converter Module

Refer to the Solar Converter User Manual (UM1S484300E4) for the information of the technical parameters of solar converter module.

10 Maintenance

This chapter describes the routine maintenance, alarm and fault handling, and preventive maintenance.

NOTE! *The maintenance of solar shelf must be conducted in compliance with relevant safety rules. Only the trained personnel with adequate knowledge about the solar, solar array, and the solar converter shelf shall work on the internal parts of the system.*

10.1 Routine Maintenance

ALERT! Lack of maintenance is likely to cause system malfunction and reduced life of system components and will void warranty.

There is no general “recipe” for maintenance intervals, as they are affected by the climate (temperature, humidity), site’s local conditions (such as dust, sand, smoke, fumes, pollution, and salt), and application (such as on-grid, off-grid, depth of discharge, rate of recharge, and load). We recommend scheduling a maintenance check once a quarter.

In cooler and very clean environments, the frequency of maintenance can be as low as twice a year. However, at elevated ambient temperatures and with high pollutant content in the air, the maintenance frequency dramatically increases and can be as often as twice a month (site specific environmental conditions).

In the event of sand/dust storms or heavy rains, immediate maintenance can be required for solar panels mounted near the ground. Quick action is necessary to address potential issues such as debris accumulation on the array and potential splash back from heavy rainfall.

Conduct a routine maintenance during the mid-day. The routine maintenance items are listed in Table 10.1.

Table 10.1 Routine Maintenance Items

Maintenance Item	Frequency	Inspection Method/Tools	Actions
All switchgear is operational.	Once a quarter	Visual and mechanical inspection	Verify all wiring is secure, and all switches, breakers, fuses and accessible SPDs are operational.
Solar power is being delivered.	Once a quarter	Measure with Clamp Meter	During mid-day, when the sun is on the solar array, read the current being delivered by each solar converter as reported (NCU).
Indicator of each module is normal.	Once a quarter	Visual inspection	Log into NCU, verify all converters are visible and address any alarms
The solar array is clean and undamaged, including panels, cables, frames, protections, and grounding.	Once a quarter or if the solar array is constantly heavily covered in debris, sand, dirt or water spotting, increase the frequency of cleaning.	Visual inspection	Clean the solar array, and if any damage is detected, schedule a repair.

10.2 Handling Alarms and Fault

Handling of the Fault of Solar Module

Refer to the Solar Converter User Manual (UM1S484300E4) for the information on handling of the fault of solar module.

Handling Alarms of Monitoring Unit

Maintain a log of reading that includes date, weather, time, voltage, current and accumulated energy. This will assist in determining systematic operation.

Refer to the NCU User Manual (UM1M831ANA) for the handling alarms of monitoring unit. The handling methods of normal alarms about solar power shelf are given in Table 10.2.

Table 10.2 Handling Methods of Normal Alarms

No.	Name of Alarm	Handling Method
1	DC Over Volt Alarm	1. Check the DC output voltage and the DC Over Voltage Limits of the monitoring unit. If the DC Over Voltage Limits are inappropriate, change them. 2. Locate the solar converter module that is causing the over voltage alarm. Ensure that the batteries (if connected) can operate normally. Switch off the input to the shelf. Then connect the inputs and switch on the modules one by one. The module that generated the high voltage alarm is the faulty one. Replace this module.
2	DC Under Volt Alarm	1. Check the DC output voltage and the DC Under Voltage alarm setting value of the monitoring unit. If the DC Under Voltage Limits are inappropriate, change them. 2. Check if the DC input is within the range of operation of the solar module. If not, disconnect certain loads to prolong the operation of the solar power supply system. 3. Check if the solar converter modules are exiting operations (no output current). If yes, replace the unit. 4. Check the load total current. If the load total current in floating charge exceeds the total output current, then it needs to remove part load, or increase the solar modules, to make the total current of the solar module exceed 120% of the total load current, and there should be at least one redundancy backup of solar unit.
3	The Load Branch Disconnected	Check if the branch MCB is open (check the position of the MCB handle). If yes, locate and remove the fault. If not, the alarm loop is faulty; contact Vertiv.
4	Module Fault	The red LED in the module panel is lightened. Cut off the input of this module and restart it after some time. If it still alarms, replace the module.
5	Solar Module Protect	Check if the solar input voltage is outside the range of 70 V to 400 V (between the under-voltage point and the over-voltage point). If the solar module is often in an over/under-voltage state, contact the maintenance personnel to improve it.
6	Module Fan Fault	Check whether the solar module fan is still working. If the fan stands still, check whether the fan is blocked or not. If yes, clean it. However, if the fan still does not move, replace it.
7	Module Comm Failure	Check if the communication connection between the module and the monitoring module is normal. If it is normal, then restart the module. If the alarm continues, then replace the module.

No.	Name of Alarm	Handling Method
8	High Battery Temperature Alarm	Check if this is caused by an internal battery fault. If yes, replace the faulty battery. Check if the temperature in the battery room is too high. If yes, reduce the temperature in the battery room.
9	DC SPD Fault	Check the DC SPD status. If the DC SPD is damaged, replace it.

11 Troubleshooting and Repair

11.1 Controller and Solar Converter Module

For troubleshooting, repair, and replacement instructions on these units, refer to the following documents.

- NCU User Manual (UM1M831ANA)
- Solar Converter User Manual (UM1S484300E4)

User Replaceable Components

User replaceable part numbers are as follows.

Item	Model Number
Solar Module	S48-4300E4
Controller	M831A (must have a software configuration file matching that of the original being replaced)

11.2 Controller Configuration

If any controller configuration settings were changed, refer to the NCU User Manual (UM1M831ANA) and save a copy of the configuration file. This file can be used to restore the controller settings, if required, at a later date.

11.3 Replacement Procedures

DANGER! Adhere to the “Important Safety Instructions” presented at the front of this document.

11.3.1 Replacing the SPD

Replacement procedure for the SPD 1 is shown below. Follow the same procedure for replacement of the SPD 2.

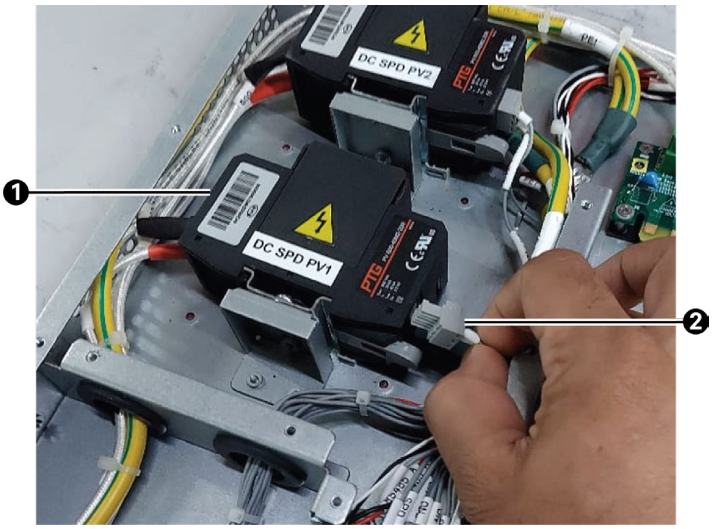
DANGER! Adhere to the “Important Safety Instructions” presented at the front of this document.

DANGER! Disconnect the DC input and output power from the shelf before performing this procedure.

Procedure

1. Remove the top cover of the unit.
2. Remove the signal cable connector from the SPD. See Figure 11.1.

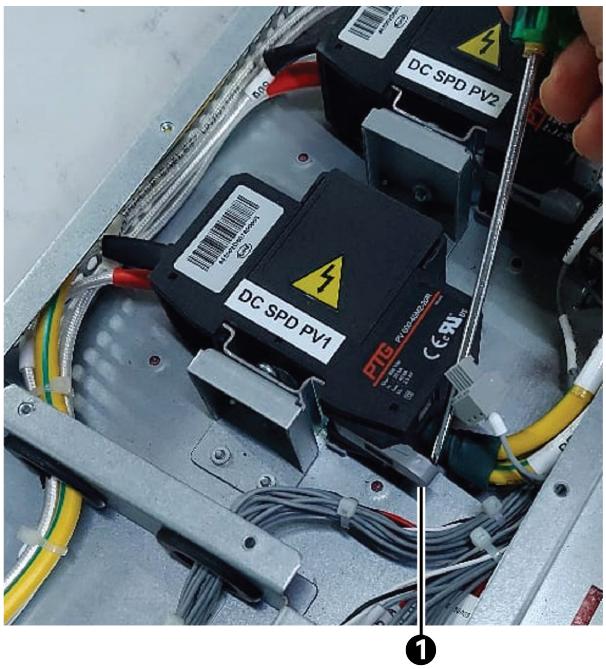
Figure 11.1 Removing the Signal Cable Connector



Item	Description
1	SPD
2	Signal Cable Connector

3. Push the latch downward by using a screwdriver to unlock the SPD from the DIN rail. See Figure 11.2.

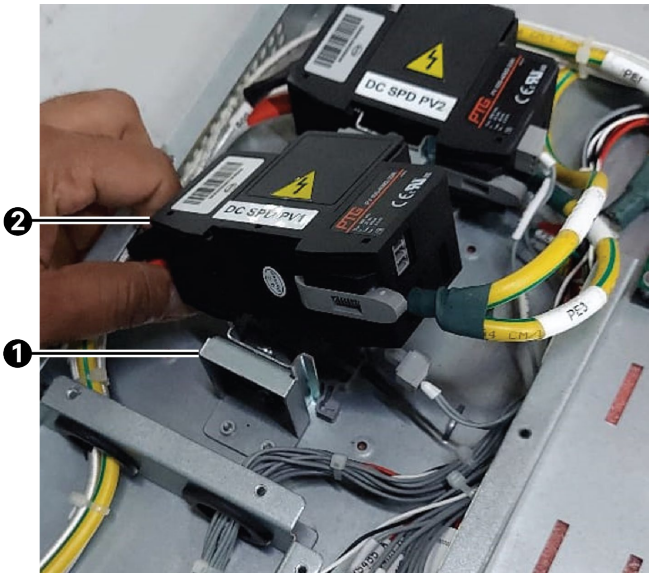
Figure 11.2 Unlocking the SPD



Item	Description
1	Latch

4. Slide the SPD upwards and remove it from the DIN rail. Figure 11.3

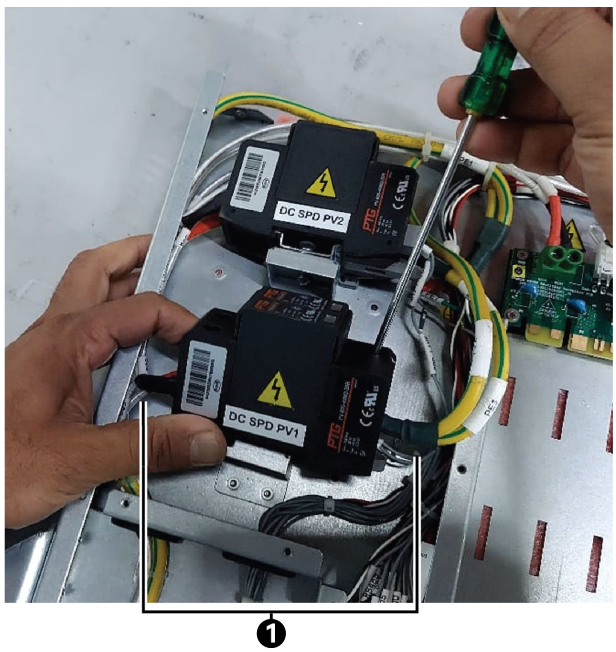
Figure 11.3 Removing the SPD



Item	Description
1	DIN Rail
2	SPD

5. Remove the cables connected to the SPD by using a screwdriver. Note the location of these cables on the SPD. See Figure 11.4.

Figure 11.4 Removing the Cables



Item	Description
1	Cables

6. Connect the cables that were removed in above step on the new SPD at the same locations.
7. Slide the SPD downward until it locks on the DIN rail. Ensure that the SPD is fixed on the DIN rail.
8. Connect the signal cable connector to the new SPD at the same location.
9. Verify there are no SPD related alarms being generated by the system.
10. Install the top cover.

12 Part Lists

Refer to Table 12.1 for global region part numbers. Refer to Table 12.2 for EMEA region part numbers. Refer to Table 12.3 for North America region part numbers.

Table 12.1 Part Numbers for Global Region (including options and spare parts)

Part Number	Description
1S484300E4	Vertiv™ eSure™ 4.3 kW Solar Converter
744900180006	Vertiv™ NetSure™ 8.6 kW Solar Converter Add-On Shelf
744900180007	Vertiv™ NetSure™ 8.6 kW Solar Converter Expansion Shelf
883500086000	Vertiv™ NetSure™ 8.6 kW Solar Converter Add-On Shelf with SPD
883500086001	Vertiv™ NetSure™ 8.6 kW Solar Converter Expansion Shelf with SPD
1M831AA	M831 Mini-NCU Controller
273645000056	Shelf CAN bus Terminator
280401252110	125A UL-1077 Output Breaker
323500000017	Temperature Sensor, 10 m
323500000018	MC4 Solar Input Cables, Red-Black, 5 m / 12 AWG (3.31 mm^2)
323500000013	MC4 Solar Input Cables, Red-Black, 15 m /12 AWG (3.31 mm^2)
323500000014	MC4 Solar Input Cables, Red-Black, 25 m / 10 AWG (5.26 mm^2)
323500000015	MC4 Solar Input Cables, Red-Black, 35 m / 8 AWG (8.36 mm^2)
323500000012	Output Cables, Black, 5 m / 4 AWG *1 Pair
283033100000	AC Relay for Solar Off
9084142	IP65 Solar Protection Box, w CB and SPD for 1 S48
237760000000	Class II SPD
237760000001	Class I+II SPD (field upgrade)
280400325212	Solar Input Circuit Breaker for 9084142 / BMG908423-2

Refer to Table 12.2 for EMEA region part numbers.

Table 12.2 Part Numbers for EMEA Region (including options and spare parts)

Part Number	Description
1S484300E4	Vertiv™ eSure™ 4.3 kW Solar Converter
BMK2257103-002	Vertiv™ NetSure™ 8.6 kW Solar Converter Add-On Shelf with SPD
BMK2257103-004	Vertiv™ NetSure™ 8.6 kW Solar Converter Expansion Shelf with SPD
BMP903110/1	M831 Mini-NCU Controller
NFS854114-125	125A UL-1077 Output Breaker
KET10306/3	Temperature Sensor, 10 m
BMY201457-4	MC4 Red-Black 4 mm^2 Power Cables, 5 m
BMY201457-5	MC4 Red-Black 4 mm^2 Power Cables, 10 m
BMY201457/2	MC4 Red-Black 6 mm^2 Power Cables, 20 m
RAV501230-1	AC Voltage Monitoring Relay
BMG908423-2	IP65 Solar Protection Box, w CB and SPD for 1 S48
NGC60122/2	Class II SPD
NGC60122/1	Class I+II SPD (field upgrade)
BMY2257103-1S	NCU to Expansion Shelf CAN bus Kit, 3 m
BMY2257103-3S	CAN bus Extension Shelf Kit, 7 cm
BMY2257103-4S	CAN bus Terminator Kit
BMY1100004-8S	DC Cabinet Mounting Kit

Refer to Table 12.3 for North America region part numbers.

Table 12.3 Part Numbers for North America Region (including options and spare parts)

Part Number	Description
1S484300E4	Vertiv™ eSure™ 4.3 kW Solar Converter
744900180006	Vertiv™ NetSure™ 8.6 kW Solar Converter Add-On Shelf
744900180007	Vertiv™ NetSure™ 8.6 kW Solar Converter Expansion Shelf
1M831AA	M831 Mini-NCU Controller
280401252110	125A UL-1077 Output Breaker
556155	10' Temperature Sensor
552992	33' Temperature Sensor
283033100000	AC Relay for Solar Off
562868	CAN bus Cable

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