



NetSure™ 7100

Hybrid DC Power System

Installation and User Manual

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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.

For the latest technical documentation scan this QR code or visit:



<https://www.vertiv.com/en-emea/products-catalog/critical-power/dc-power-systems/netsure-7100-hybrid/>

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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 vi.

### 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.



**NOTE!** Always verify that your voltmeter is in good condition by testing it towards a recognized supply.

- 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) This equipment is not suitable for use in locations where children are likely to be present.
- g) This product is intended only for installation in a Restricted Access Location.
- h) Only authorized and properly trained personnel should be allowed to install, inspect, operate, or maintain the equipment.
- i) 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 or by other national building codes and local regulations.

## Voltages

### Hazardous Voltage



**DANGER!** HAZARD OF ELECTRICAL SHOCK.

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

### DC Voltage (Solar)



**DANGER!** System supplied by high DC-voltage (70 VDC to 420 VDC). Exercise extreme caution not to inadvertently contact or have any tool inadvertently contact an input terminal or exposed wire connected to the terminal.

### DC Voltage (Independent DC Input)



**DANGER!** Correct polarity must be observed when connecting external supply to DC input. A DC input of low voltage can present a risk of high short circuit current. Installing/servicing should be performed or supervised only by properly trained and qualified personnel knowledgeable about low voltage DC precautions.

## AC Input Voltages



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

## DC Output



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



**DANGER!** Follow local lockout/tagout procedures to ensure DC branch circuit protection devices remain de-energized during installation at loads, as required.

## Battery



**WARNING!** Correct polarity must be observed when connecting battery leads.



**WARNING!** Special safety precautions are required for procedures involving handling, installing, and servicing batteries. Observe all battery safety precautions in this manual and in the battery instruction manual. These precautions should be followed implicitly at all times.



**WARNING!** A battery can present a risk of electrical shock and high short circuit current. Servicing of batteries should be performed or supervised only by properly trained and qualified personnel knowledgeable about batteries and the required precautions.

## 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.



## 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.

## Maintenance and Replacement Procedures



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



## 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 megaohm resistor. Some wrist straps have a built-in one megaohm 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 conductive or anti-static material such as conductive foam, conductive plastic, or aluminum foil. 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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# 1 General Information and Installation Acceptance Checklist

## 1.1 Customer Documentation Package

This document (10097821-01-UM) provides Installation and User Instructions for the NetSure™ 7100 Hybrid DC Power System.

The complete Customer Documentation Package consists of...

- Safety Rules: 11RG6161TN
- NetSure™ Power System Installation and User Instructions: 10097821-01-UM
- NCU (NetSure™ Control Unit) User Instructions: 11RF7981YC
- Table of Set Values, NetSure™ Power System with NCU: 11ER4379NP
- R48-4300E3 Rectifier User Instructions: 1R484300E3UM
- S48-4300E4 Solar Converter User Instructions: 1S484300E4-User Manual
- Installation Test Instructions: DOC-00003-T1
- Circuit Diagram: BMK22301-01-CD

## 1.2 System Description

The NetSure™ 7100 Hybrid DC Power System is complete integrated and flexible hybrid power system with rectifiers and solar converters, providing intelligent control, metering, monitoring and distribution. A fundamental principle of a hybrid solution is that all energy sources are always connected and available to recharge the battery, as such there is no battery disconnect and the controller is always on. With the exception of the NCU, discharging of the battery is effectively halted by opening all load disconnects.

Hybrid solutions are often deployed where managing energy is important including:

- On-Grid, where solar can be used to reduce the cost of operation.
- Bad Grid, where solar can be used to maintain the load and battery when power is out during the day
- Off-Grid, cycling batteries with generators, often refer to as CDC (Charge Discharge Charge).
- Off-Grid, CDC with Solar, where solar is used to minimize the demand on the generator.
- Off-Grid, Solar only where the load and battery are maintained using the energy from the sun.

The power system consists of the following components:

### 1.2.1 19" Multi-Function Subrack

The system includes a 19" multi-function subrack as follows:

- **Multifunction Unit:** The multifunction unit (MFU) houses the battery and the load distribution portion of the power system as well as the control and monitoring though controller NCU. Optional parts such as IB2, IB4, EIB and SPD boards.
- **Extended Distribution Unit:** The Extended Distribution Unit is an available option that can house additional distribution breakers.
- **Module Mounting Shelves:** The system can include up to three (3) shelves. See Table 1.1.
  - The rectifier/solar converter module mounting shelf which houses up to five (5) rectifiers/solar converters per shelf, in any combination (**Based on a type of AC/DC connection**).

## 1.2.2 23” Multi-Function Subrack

The system includes a 23” multi-function subrack as follows:

- **Multifunction Unit:** The multifunction unit (MFU) houses the battery and the load distribution portion of the power system as well as the control and monitoring through controller NCU. Optional parts such as IB2, IB4, EIB and SPD boards.
- **Extended Distribution Unit:** The Extended Distribution Unit is an available option that can house additional distribution breakers.
- **Module Mounting Shelves:** The system can include up to two (2) shelves. See Table 1.2.
  - The rectifier/solar converter module mounting shelf which houses up to six (6) rectifiers/solar converters per shelf, in any combination (Based on a type of AC/DC connection).

## 1.2.3 Battery Distribution

It supports for 1 to 6 Protective Battery Branch Circuits. For monitoring and support of control, a 500 A shunt is included.

## 1.2.4 Load Distribution

The DC load distribution provides control and protection of branch circuits with optional surge protection, circuit breakers and the opportunity to provide up to three (3) level load disconnects.

The use of three (3) load disconnects, allows ability to extend operation of critical services, while managing best cost in energy storage (battery).

## 1.2.5 Rectifier

The system provides for NetSure™ 7100 -48 VDC rectifier modules, including, but not limited to the R48-4300E3, enabling support to the load and battery, either from the grid and-or an AC generator. Refer to the Rectifier User Instructions, such as 1R484300E3UM.

## 1.2.6 Solar Converter

The system supports solar converter modules, which provide energy to the load and battery. Refer to the Solar Converter Instructions (1S484300E4-User Manual) for more information.

## 1.2.7 Independent DC Port

An independent DC Port, includes shunt for monitoring and management, can be configured into the system. This port is used to connect well behaved DC power-energy devices, such as Wind Turbines, DC Generators and Fuel Cells.

Maximum current is 160 A.

## 1.2.8 -58 VDC

Acknowledging the introduction of lithium batteries and batteries with embedded converters, the power system supports -58 VDC.

## 1.2.9 500 A

The primary bus support the load and battery is maximum 500 A. As it is possible to place-generate more than 500 A given the configuration options, the load and battery needs to be configured by responsible personnel to maintain the maximum current.

The total current shall not exceed the rating of the system of 500 A. Please refer to Table 4.4. for max current for a specific branch at specific ambient temperature. Maximum six (6) rectifiers R48-4300E3 and six (6) solar converters S48-4300E4 are supported.

## 1.2.10 NCU Controller

The system contains one NetSure™ Control Unit (NCU) system controller. The controller provides power-energy system control (including load disconnect), rectifier-converter control-communications, metering-monitoring functions, local/remote alarm functions with data-logging; plus, advanced battery and energy management. Temperature sensors may also be designated to monitor ambient temperature and/or battery temperature. For lead batteries, the controller with the temperature sensor supports battery charge temperature compensation. For ease of use, the controller front end includes a color LCD display with a keypad for local access.

An expanded view (a large screen) can also be achieved using the Ethernet Port to use the web-interface connection with a local or remote laptop. This Ethernet (TCP/IP) port may also be used for remote management, using standard interfaces such as SNMP and provide for NTP. Refer to the NCU Control Unit Instructions (11RF7981YC) for more information.

## 1.2.11 CAN-Bus extension

CAN-Bus extension is available to connect to other Vertiv devices. Refer to Figure 4.5 for location of the CAN-Bus.

## 1.2.12 RS232, RS485 and Fuel Sensor Connector

An optional kit can be provided that extends NCU functionality-communications, such as RS232 for communications, RS485 (Modbus) for connecting with smart devices such as lithium and two fuel sensor ports to help monitor and manage fuel.

## 1.2.13 IB2, IB4, EIB and SPD Board

All boards (IB2, IB4, EIB and SPD) are available in the subrack. They are for additional monitoring and control of customer equipment. Refer to the Circuit Diagram (BMK22301-01-CD) for more information.

## 1.2.14 Load Disconnect, including the Optional Three-Stage Priority

Solution can be configured with one to three load disconnects, with the first disconnect being available having either a 200 A or 400 A rating. All other disconnects are 200 A.

200 A disconnects can come with a shunt.

To prolong the service of critical loads during a long power outage, the DC distribution can be divided into three (3) branches. One (1) is for normal load and two (2) are for priority loads. In this way, load disconnection can be made in three (3) steps, extending service without having to increase investment in batteries.

## 1.3 Installation Acceptance Checklist

Provided below is an Installation Acceptance Checklist. This checklist helps ensure proper installation and initial operation of the system. As the installation procedures presented in this document are completed, check the appropriate box on 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!** Do not power the cabinet until completing the check list.



**NOTE!** Some of these procedures may have been performed at the factory for you.

### **Physically Installing the System**

- NetSure™ Standalone Cabinet Mounted (if provided)
- Standalone Subrack Mounted in Customer Cabinet (if provided)
- Standalone Subrack Mounted on Battery Stand (if provided)

### **Setting Switch Options**

- Switch Settings on Optional IB2 Interface Board Verified
- Switch Settings on Optional EIB Interface Board

### **Making Electrical Connections**

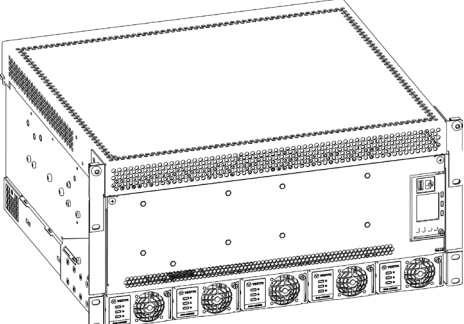
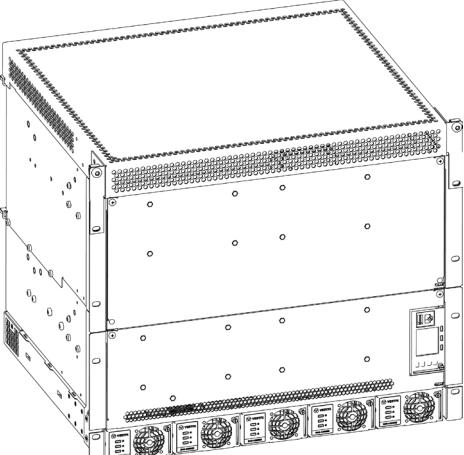
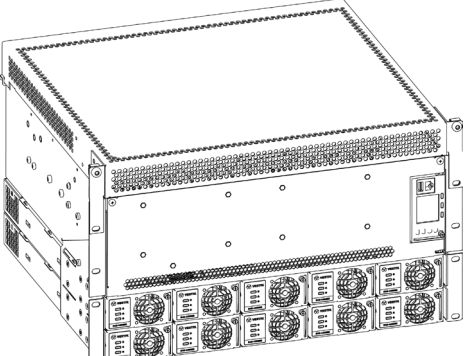
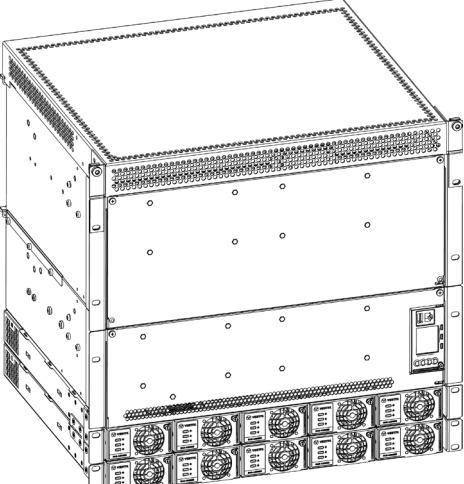
- Earthing Connections Made
- Solar DC Input Connections Made
- AC Connections Made
- DC Load Distribution Connections Made
- Independent DC Port Connections Made
- Battery Connections Made
- External Alarm, Reference, Monitoring, and Control Connections Made
- Ethernet Connection Made (if required)

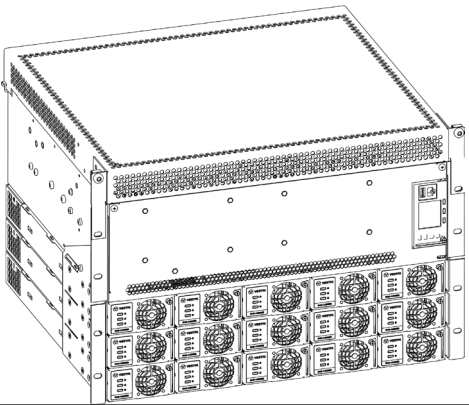
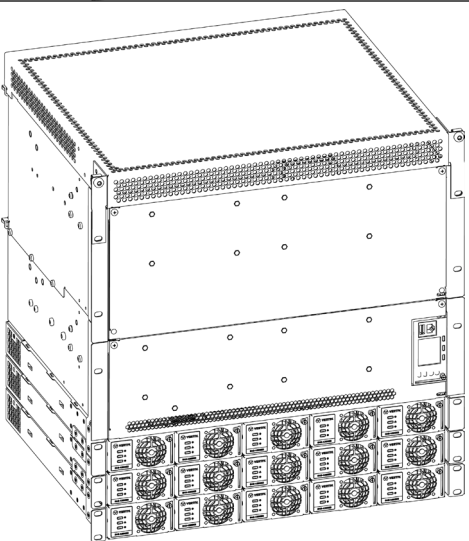
### **Installing the Module and Initially Starting the System**

- Rectifier Modules Installed
- Solar Converter Modules Installed
- System Started, Configured and Checked

### 1.3.1 19" Subracks

Table 1.1 NetSure 7100 power system 19" Subrack

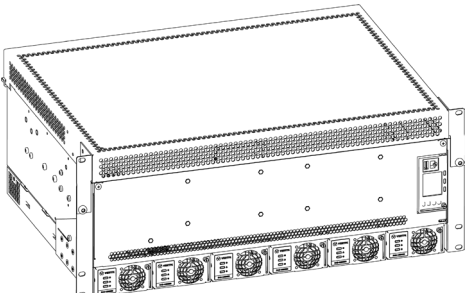
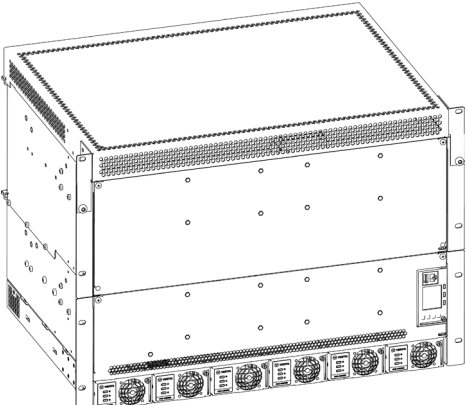
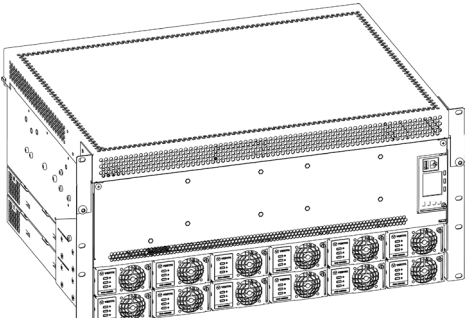
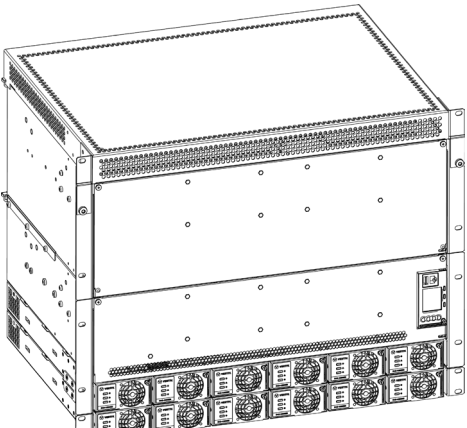
Picture of Subrack	Variants of Subrack System
	<p>7100 Subrack System with one rectifier/solar converter shelf, no XDU and top cover (5U)</p>
	<p>7100 Subrack System with one rectifier/solar converter shelf, optional XDU and top cover (9U)</p>
	<p>7100 Subrack System with two rectifier/solar converter shelves, no XDU and top cover (6U)</p>
	<p>7100 Subrack System with two rectifier/solar converter shelves, optional XDU and top cover (10U)</p>

Picture of Subrack	Variants of Subrack System
	<p>7100 Subrack System with three rectifier/solar converter shelves, no XDU and top cover (7U)</p>
	<p>7100 Subrack System with three rectifier/solar converter shelves , optional XDU and top cover (11U)</p>



### 1.3.1 23” Subracks

**Table 1.2** NetSure™ 7100 power system - 23” Subrack

Picture of Subrack	Variants of Subrack System
	<p>7100 Subrack System with one rectifier/solar converter shelf, no XDU and top cover (5U)</p>
	<p>7100 Subrack System with one rectifier/solar converter shelf, optional XDU and top cover (9U)</p>
	<p>7100 Subrack System with two rectifier/solar converter shelves, no XDU and top cover (6U)</p>
	<p>7100 Subrack System with two rectifier/solar converter shelves, optional XDU and top cover (10U)</p>

## 2 Physically Installing the Power System

### 2.1 General Requirements

- This product is intended only for installation in a restricted access location on or above a non-combustible surface.
- This product must be located in a controlled environment with access to crafts persons only.
- This product is intended for installation in network telecommunication facilities (CO, vault, hut, or other environmentally controlled electronic equipment enclosure).
- This product is intended for connection to the common bonding network in a network telecommunication facility (CO, vault, hut, or other environmentally controlled electronic equipment enclosure).
- The installer should be familiar with the installation requirements and techniques to be used in securing the battery rack to the floor.
- The NetSure™ 7100 subracks can be mounted into a 19" or 23" wide and minimum 600 mm deep enclosure or cabinet.
- The NetSure™ 7100 subracks requires a bottom support in all mounting variants (cabinet, enclosure or battery rack). Do not install without the bottom support!
- A cabinet, enclosure or subrack ventilating openings must not be blocked and temperature of air entering rectifiers must not exceed their rated operating ambient temperature range.
- Clearance requirements are:
  - Recommended minimum aisle space clearance for the front of each bay is 600 mm.
  - No clearance is required for the rear of each cabinet.
  - Recommended minimum free space above each cabinet is 300 mm.



**NOTE!** Use of large – diameter wire may require greater clearance..

### 2.2 Cabinets

The following cabinets and racks can be delivered from Vertiv.

**Table 2.1 Available Cabinet and Battery Rack Options for NetSure™ 7100 Subrack**

Properties	Comment	Depth (mm)	With (mm)	Height (mm)	Available Space for Batteries	Product Number
NetSure™ Standalone Cabinet *	With or without door	600	600	1847 (39U)	--	BMY1100025/1
		600	600	2024 (43U)	--	BMY1100025/2
Battery Rack	For mounting standalone subrack	600	600	780	2x 8U	BMY1100040/628
		600	600	1106	3x 8U	BMY1100040/638
		600	600	1462	4x 8U	BMY1100040/648

**NOTE!** If cabinets marked with an asterisk (\*) are ordered with the subrack system, the system will be factory-mounted in the cabinet.

## 2.3 Mounting a NetSure™ Standalone Cabinet (if provided)

If the subrack was shipped in a NetSure™ standalone cabinet, the cabinet can be anchored to the floor by screws through its bottom frame. As an alternative, the cabinet can be fixed to the wall with suitable screws through the holes at the back of its top cover. The materials (not included) should be chosen to fit the floor/wall material.

If adjustable feet are required, a kit is available (P/N BMY220045/1) that includes four (4) adjustable feet with plastic isolation. In this case the cabinet can be anchored to the wall only.

### 2.3.1 Installing Optional Foot Kit (if required)



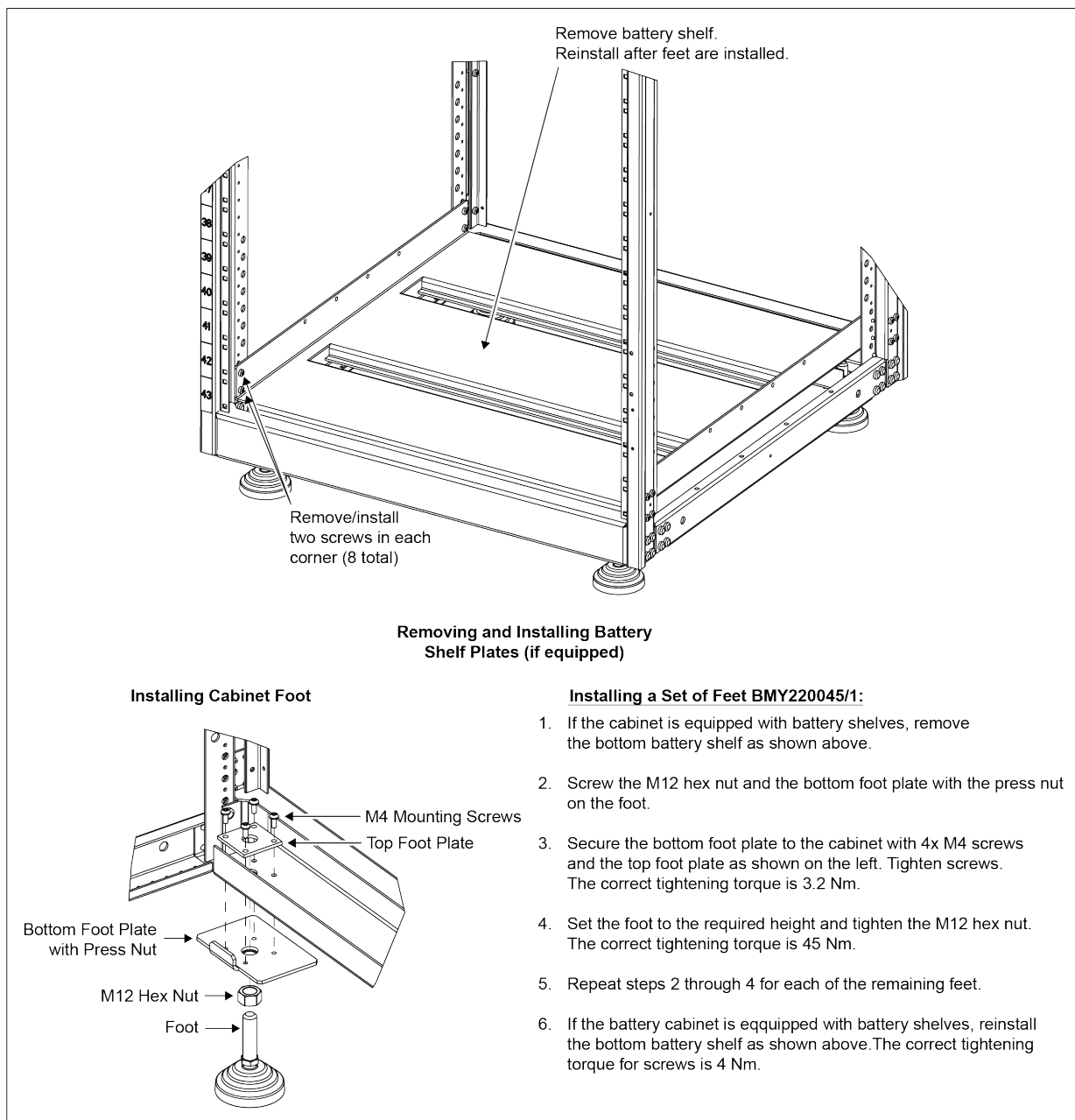
**NOTE!** If adjustable feet are not required, skip this procedure.

A kit is available (P/N BMY220045/1) that includes four adjustable feet with plastic isolation. If the optional feet are provided, refer to Figure 2.1 for a procedure.



**NOTE!** If the optional feet are installed, the cabinet cannot be anchored to the floor, and wall anchoring is required.

Figure 2.1 Installing Optional Feet



### 2.3.2 Anchoring to the Floor

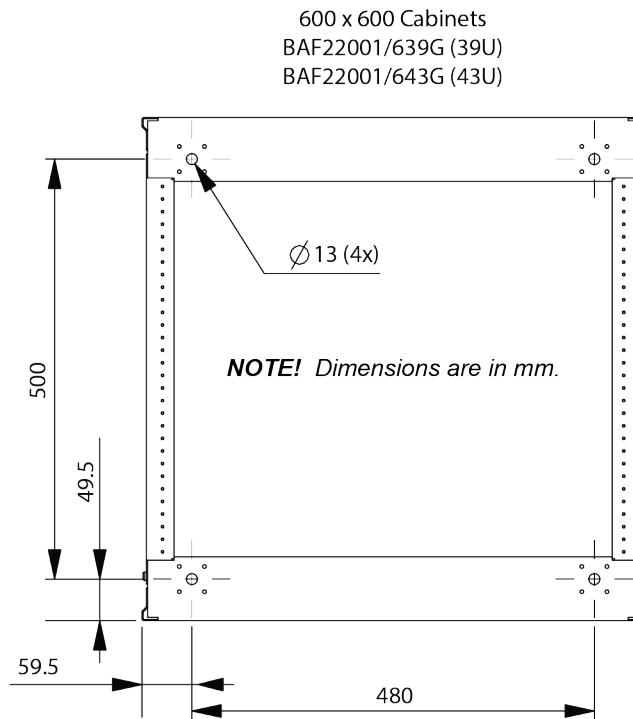


**NOTE!** A set of parts, BMY107125/1, furnished with each cabinet, provides cabinet anchoring material for floor and wall.

#### Procedure

1. Drill holes in the floor and insert suitable plugs in the holes. Refer to Figure 2.2 for floor mounting whole dimensions.
2. Place the cabinet into position.
3. Level the cabinet by placing metal plates or washers under the cabinet frame.
4. Fix the cabinet with four (4) screws through its frame. See Figure 2.3.

Figure 2.2 Floor Mounting Dimensions



### 2.3.3 Anchoring to the Wall

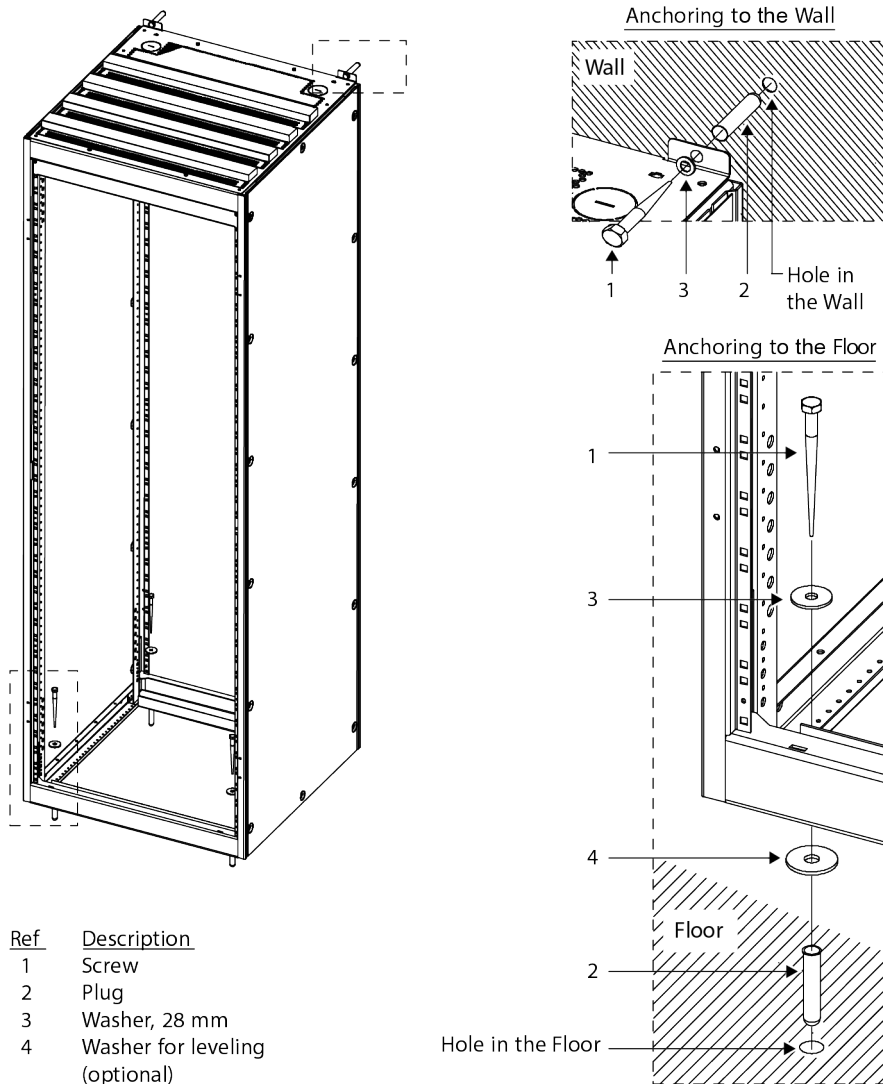


**NOTE!** A set of parts, BMY107125/1, furnished with each cabinet, provides cabinet anchoring material for floor and wall.

#### Procedure

1. Place the cabinet in its position.
2. Level the cabinet by placing metal plates or washers under the cabinet frame or by fitting and adjusting feet in the holes of the cabinet frame.
3. Drill two (2) holes in the wall and insert suitable plugs in the holes. Fix the cabinet to the wall with two (2) screws. See Figure 2.3.

Figure 2.3 Anchoring the Cabinet (Top cabled cabinet shown. Bottom cabled cabinet similar.)



## 2.4 Mounting a Standalone Subrack in a Customer-Provided Cabinet

Each subrack should be fixed to the cabinet by means of screws through the holes in the angle brackets of the subrack.

The following conditions apply:

1. The rectifiers/solar converters are fan cooled and utilize front to back forced ventilation. For proper airflow, the unit must be mounted so space in front and all ventilation openings are not blocked. Free space in front of the units must be  $\geq 30$  mm in condition of fully perforated ventilated door/cover to keep unobstructed airflow.
2. For cooling, a clear way of 100 mm must be maintained at the rear for the cooling of the rectifiers/solar converters. This chimney section shall not be obstructed with any horizontal plates. No mechanical parts or cables are allowed within the 100 mm free space. Refer to Figure 2.4.
3. The mains, solar array, distribution, and battery cables enter into the top of the subrack. There must be room for working with these cables above the subrack.
4. Depending on the cabinet and mounting practice, some high-energy parts of the subracks might be accessible. These parts must be covered according to EN62368-1.
5. Mounting brackets should be mounted to the correct position from factory. Information needs to be provided. For example, 00 mm offset or 75 mm offset. Refer to Figure 2.5.
6. The NetSure™ 7100 subracks requires a bottom support. Do not install without the bottom support!

Figure 2.4 Subrack Space Requirements

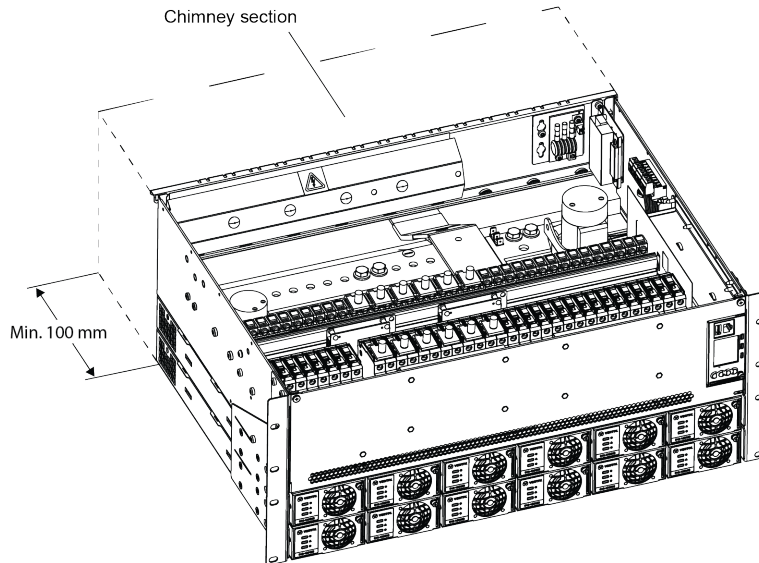
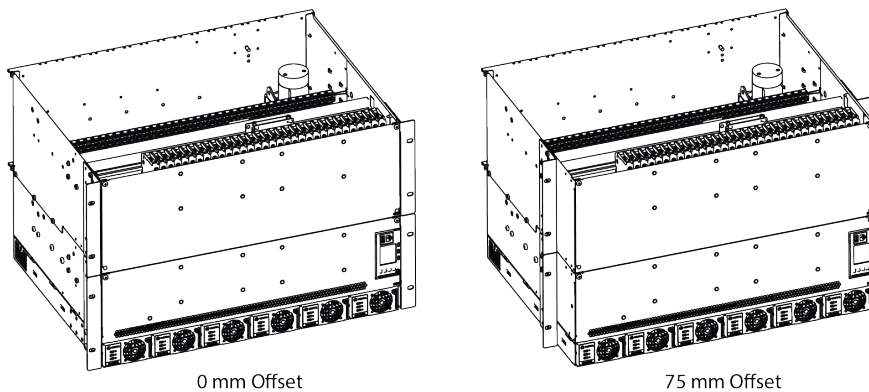


Figure 2.5 Positions of Mounting Brackets



## 2.5 Mounting a Standalone Subrack on a Battery Rack



**DANGER!** The battery rack must be securely anchored to the floor before mounting system components on top of the battery rack.

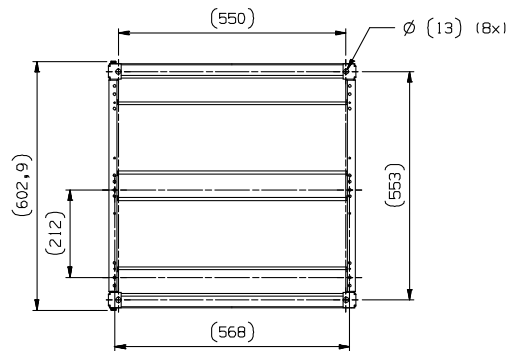
The standalone subrack system can be mounted on an Vertiv battery rack.

### 2.5.1 Installing the Battery Rack

The battery rack must be assembled on site. Refer to the documentation supplied with the battery rack. After assembling the battery rack, place the battery rack into position. Refer to the General Requirements section at the beginning of this chapter.

The battery rack must be secured to the floor. Secure the battery rack to the floor per site requirements. An optional “Tip Protection Kit” is available (P/N BMY107125/1) that contains plugs, washers, and screws for securing the battery rack to the floor.

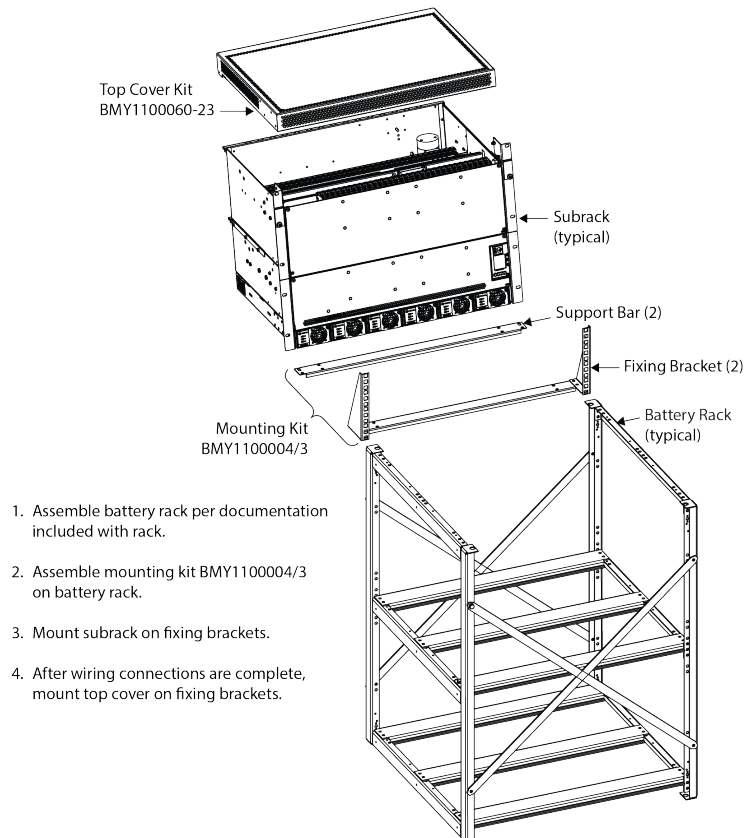
Figure 2.6 Footprint of Battery Rack BAF60122



### 2.5.2 Installing the Subrack on the Battery Rack

Refer to the procedure in Figure 2.7 to install the standalone power system subrack on the battery rack.

Figure 2.7 Mounting the Standalone Subrack on a Battery Rack



## 2.6 Installing Batteries in a Battery Rack

### **Procedure**

1. Put the battery blocks in position starting on the first (bottom) shelf.
2. Install the interconnectors between each block with the torque shown in the battery documents.



**NOTE!** For safety reasons, leave out one of the inter-cell connectors until the appropriate stage in the commissioning of the power supply plant.

3. Battery connections to the subrack will be made in a later procedure.

## 2.7 Installing Load Distribution or Battery Disconnect Circuit Breakers

Load distribution and battery disconnect circuit breakers have been factory installed for you. If space is available and you wish to install additional circuit breakers, refer to the “Adding a Load Distribution or Battery Disconnect Circuit Breaker” on page 35.

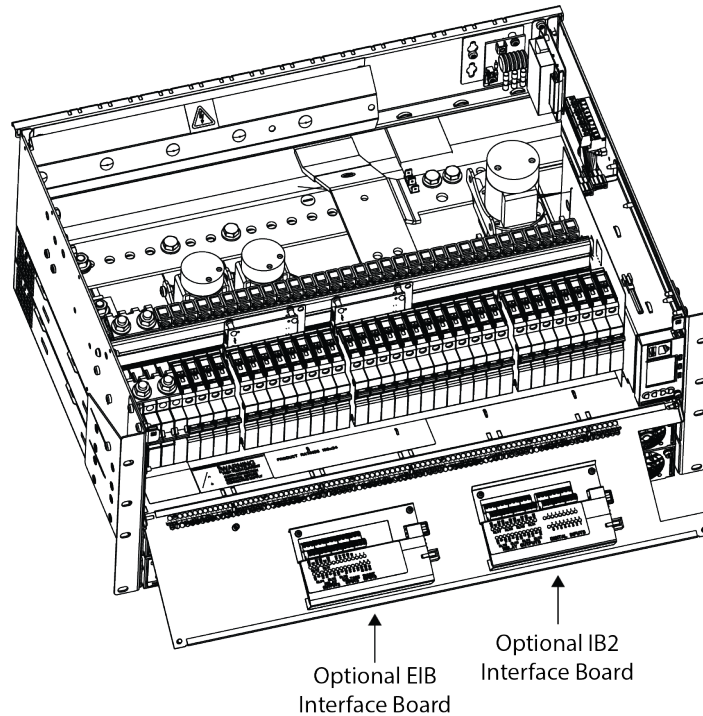


## 3 Setting Switch Options

### 3.1 Circuit Board Locations

Refer to Figure 3.1 for location of the boards containing option switches.

Figure 3.1 Boards Location with Option Switches



### 3.2 Switch Settings on IB2 Interface Board

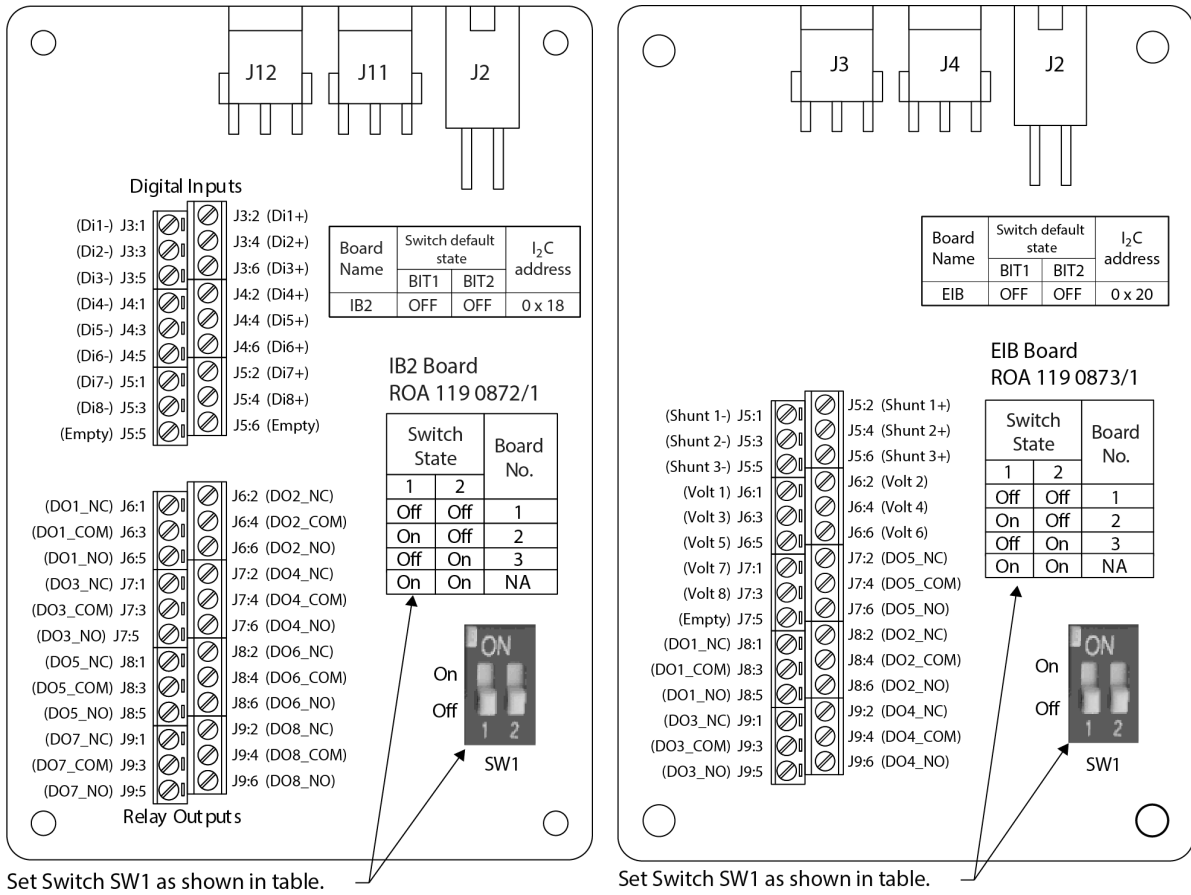
Dip Switch SW1 on the IB2 board is used to set the communications address for this board.

Perform the following procedure to verify the factory settings. This procedure can also be used to make adjustments on a replacement circuit board. Refer to Figure 3.2 for switch location.

#### **Procedure**

1. Ensure SW1 is set as shown in the table in Figure 3.2.

Figure 3.2 IB2 Board and EIB Board Switch Location and Settings



### 3.3 Switch Settings on EIB Interface Board

Dip Switch SW1 on the EIB board is used to set the communications address for this board.

Perform the following procedure to verify the factory settings. This procedure can also be used to make adjustments on a replacement circuit board. Refer to Figure 3.2 for SW1 location.

**Procedure**

1. Ensure SW1 is set as shown in the table in Figure 3.2.

## 4 Making Electrical Connections

### 4.1 Important Safety Instructions



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

### 4.2 Wiring Considerations

All wiring and branch circuit protection should follow the local national electrical building installation standards.

### 4.3 Cable Routing Guidelines

#### 4.3.1 Subrack in NetSure™ Cabinet

**Top Cabling:** The cables enter the top of the cabinet. There are three (3) flexible cables inlets for DC cables and signal cables, and two (2) knockouts for AC cables. Refer to Figure 4.1.

If the AC cable knockout is used, a suitable strain relief bushing should be installed in the knockout prior to installing cables.

In order to avoid the risk of objects falling into the cabinet, close all the flexible inlets and tighten their screws after the installation. For large cables, it is necessary to cut the foam (to cable width) for exact adjustment. Refer to Figure 4.1.

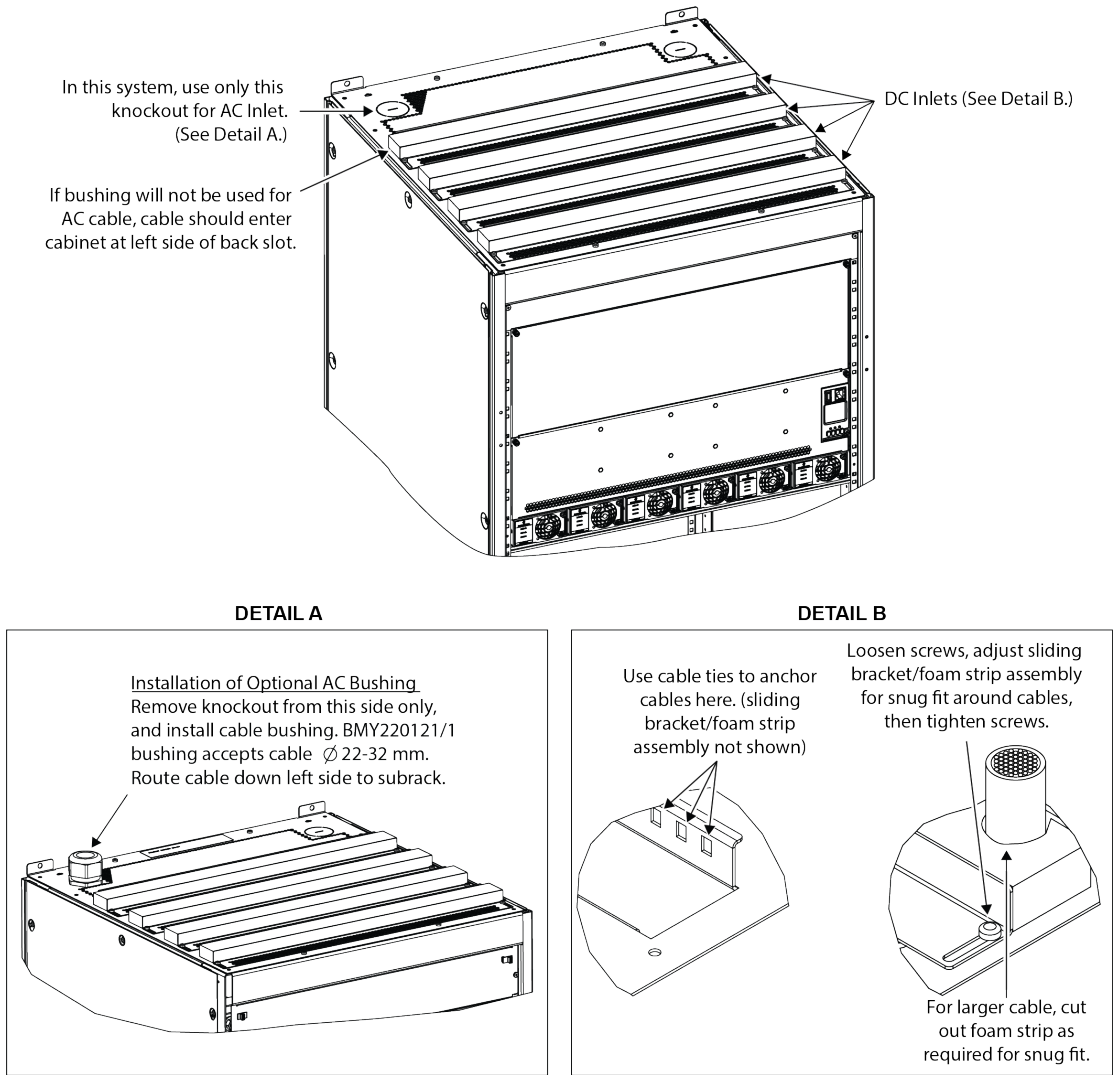
#### 4.3.2 Standalone Subrack

If the top cover is used, it must be removed to make electrical connections.

**Load, Battery, independent DC Port Wiring and Signaling Wiring:** The cables are routed from the rear if top cover is used. The top cover includes a flexible foam strip that will form around the wiring to seal the opening when the top cover is installed after wiring is completed.

**Individual AC Mains and DC solar input Wiring:** The cables are routed from the rear if top cover is used. The top cover includes a flexible foam strip that will form around the wiring to seal the opening when the top cover is installed after wiring is completed. For more information about Individual AC Mains and DC solar input connection refer to the Circuit Diagram (BMK22301-01-CD).

Figure 4.1 NetSure™ Cabinet Cable Inlets



## 4.4 Earthing Connections

The subracks have internal earthing. The rectifier/solar converter shelves, the mains PE, the mechanical structure of the cabinet and the system 0 V bars are interconnected to the subracks. Refer to Figure 4.2 for earthing connections.

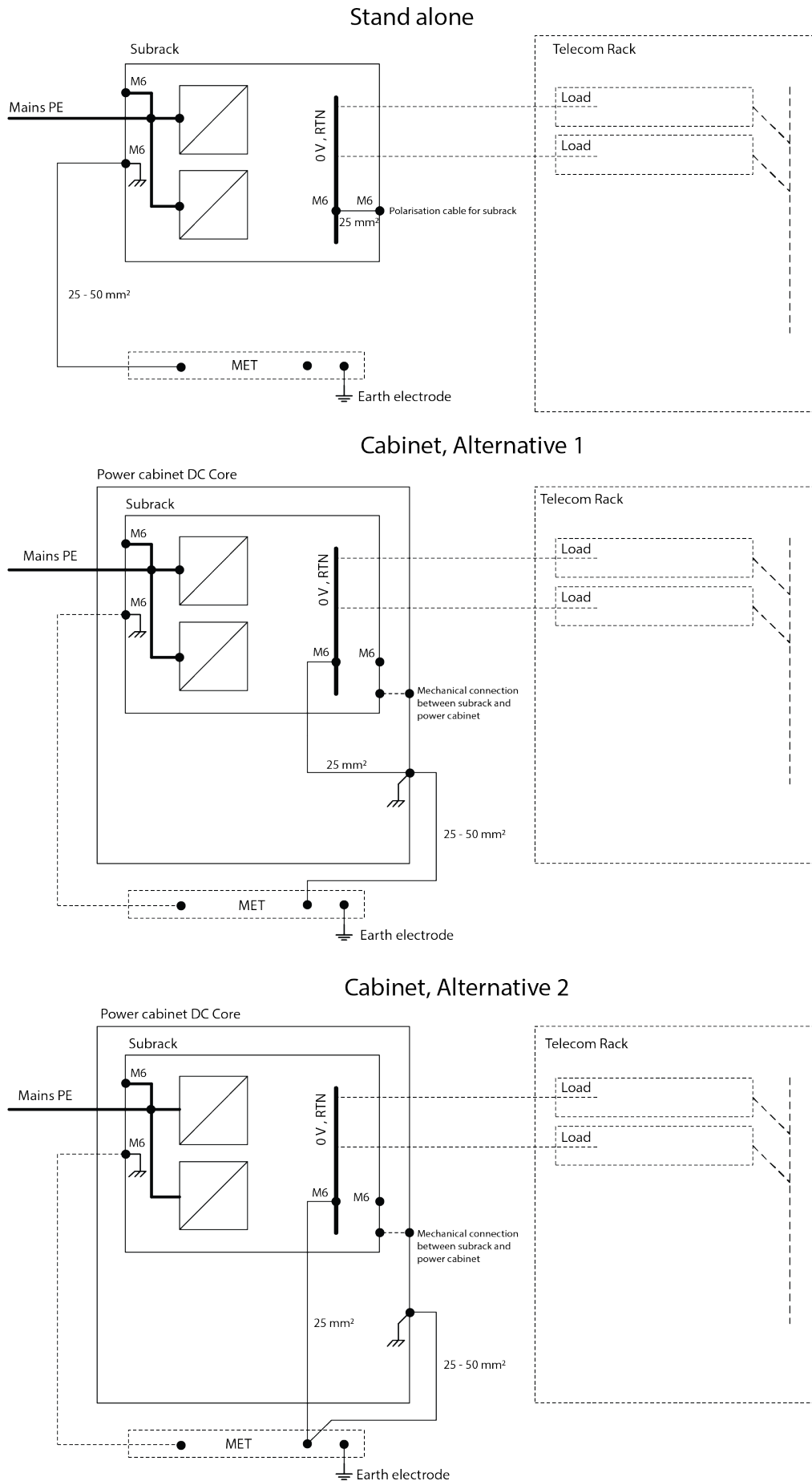
**NOTE!** This equipment is designed to permit the connection of the earthed conductor of the DC supply circuit (system earth) to the earthing conductor (protective earth) at the equipment.

### Procedure

1. Check that there is an insulated 25 mm<sup>2</sup> cable between the 0 V (+) terminal of the main subrack positive bar and the earth terminal of the cabinet. This link is essential if a DC short-circuit occurs between live pole (negative) of the system and the cabinet mechanical structure as it will protect the mains PE conductors from overload.
2. Connect an insulated cable minimum 25 mm<sup>2</sup> between the subrack or cabinet chassis and the earth collector bar (MET).

**NOTE!** This equipment shall be connected directly to the DC earth collector bar (Main Earth Terminal), or to the point to which the DC supply system earth electrode is connected. There must be no switching or disconnection devices in this circuit. Equipment (DC) located in the same immediate area (such as adjacent cabinets) must be earthed to the same earthing point.

Figure 4.2 Earthing Principle for the NetSure™ 7100 Hybrid System



### 4.4.1 DC Solar and AC Mains Connections



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



**DANGER!** This system can operate from DC Input capable of harm. Exercise caution not to inadvertently contact or have any tool inadvertently contact an input.



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

### 4.4.2 DC Solar Input

DC Solar input is often connected to the DC input terminal unit in an outdoor enclosure, as such, please refer to the outdoor enclosure instruction manual. Otherwise, the DC solar input is connected directly to the Input termination strip placed in a subrack. For DC solar input the PE connection is not required in input termination strip. Refer to Table 4.1 and Table 4.2. For IEC Compliance, a DC 2P Solar Breaker 400 VDC and PV SPD with PE connection should be placed in line between the array and solar converter. Vertiv provides such a PV protection box, but the location of the protection resides with local authority.

### 4.4.3 AC Input

AC input is connected to the AC terminal block. Refer to Table 4.1 for connections when an AC circuit breaker IS NOT provided.

AC input is connected to the AC terminal block.

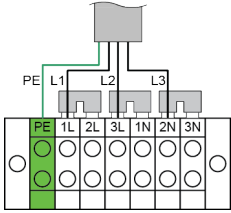
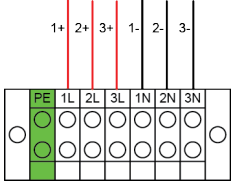
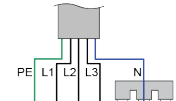
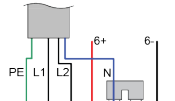
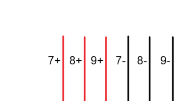
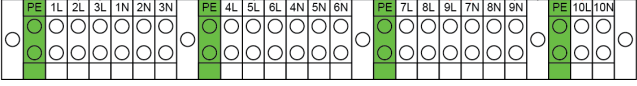
### 4.4.4 AC Terminal Connection

Refer to Table 4.1 for AC terminal connections.

**Table 4.1 AC Terminal Connection**

Shelf Type	Scheme
<p>Individual AC Mains and DC Solar Input connection in Hybrid system</p> <p>One rectifier shelf 19"</p> <p>(3P and 2P bridges are enclosed in package)</p>	<p>NET104027-705 Terminal 10 mm<sup>2</sup></p>
<p>Individual AC Mains and DC Solar Input connection in Hybrid system</p> <p>One rectifier shelf 23"</p> <p>(3P bridge is enclosed in package)</p>	<p>NET104027-706 Terminal 10 mm<sup>2</sup></p>
<p>Individual AC Mains and DC Solar Input connection in Hybrid system</p> <p>Two rectifier shelves 19"</p> <p>(3P bridge is enclosed in package)</p>	<p>NET104027-710 Terminal 10 mm<sup>2</sup></p>
<p>Individual AC Mains and DC Solar Input connection in Hybrid system</p> <p>Two rectifier shelves 23"</p> <p>(3P bridge is enclosed in package)</p>	<p>NET104027-712 Terminal 10 mm<sup>2</sup></p>
<p>Individual AC Mains and DC Solar Input connection in Hybrid system</p> <p>Three rectifier shelves 19"</p> <p>(3P bridge is enclosed in package)</p>	<p>AC Input Mains Y cable connection 5G6, 3W+N+PE 230/400 VAC, 27 A/ph, 45-65 Hz Rec: upstream protection 63 A</p> <p>AC Input Mains Y cable connection 5G8, 3W+N+PE 230/400 VAC, 27 A/ph, 45-65 Hz Rec: upstream protection 63 A</p> <p>AC Input Mains Y cable connection 5G6, 3W+N+PE 230/400 VAC, 27 A/ph, 45-65 Hz Rec: upstream protection 63 A</p> <p>AC Input Mains Y cable connection 5G6, 3W+N+PE 230/400 VAC, 27 A/ph, 45-65 Hz Rec: upstream protection 63 A</p> <p>Photovoltaic Input 3x Solar panel array 24 A, 200-420 VDC</p> <p>NET104027-715 Terminal 10 mm<sup>2</sup></p>

**Table 4.2 AC Mains Connections Options for Customer**

Connection	Scheme
<p>3-phase AC feeding each rectifier shelf -                      Δ configuration                      (2P bridge is enclosed in package)</p>	<p>Optional</p> <p>AC Input Mains Δ                      cable connection 4G10, 3W+PE                      230/400 VAC, 47 A/ph, 45-65 Hz                      Rec. upstream protection 63 A</p> 
<p>Individual DC Solar Input connection in 19" Hybrid system</p>	<p>Optional</p> <p>Photovoltaic Input                      3x Solar panel array                      24 A, 200-420 VDC</p> 
<p><b>3W+N+PE, 2W+N+PE, 5x 2W</b>                      AC feeding each rectifier and DC solar feeding</p>	<div style="display: flex; justify-content: space-between;"> <div style="width: 30%;"> <p>AC Input Mains Y                              cable connection 5G6, 3W+N+PE                              230/400 VAC, 27 A/ph, 45-65 Hz                              Rec. upstream protection 63 A</p>  </div> <div style="width: 30%;"> <p>AC Input Mains                              cable connection 5G6, 2W+N+PE                              230 VAC, 27 A/ph, 45-65 Hz                              Rec. upstream protection 63 A</p>  </div> <div style="width: 30%;"> <p>Photovoltaic Input                              5x Solar panel array                              24 A, 200-420 VDC</p>  </div> </div>  <p style="text-align: right;">Example: one 19" solar shelf only</p>



## 4.5 Load Connections

### 4.5.1 Wires Guidelines

Wires used for field connection shall have a minimum temperature rating of 90 °C. Consideration should also be taken to increase the area when exceeding 55 °C ambient. For the wire size recommendation see Table 4.3. The actual wire size is the responsibility of the installation team. Wires should be selected according to local regulations concerning voltage drop, operational temperature and type of installation (open, covered, number of layers, parallel connection, etc.). What wire dimension to choose depends on the circuit breaker size, the tolerated cable voltage drop and the distance between the power system and the load.

**Table 4.3 Wire Size Recommendation**

Wire Size at Specific Ambient Temperature			
CB Rating	Ambient up to 45°C	Ambient up to 55°C	Ambient up to 65°C
32 A	6AWG (16 mm <sup>2</sup> )	6AWG (16 mm <sup>2</sup> )	6AWG (16 mm <sup>2</sup> )
63 A	6AWG (16 mm <sup>2</sup> )	6AWG (16 mm <sup>2</sup> )	6AWG (16 mm <sup>2</sup> )
80 A	6AWG (16 mm <sup>2</sup> )	4AWG (25 mm <sup>2</sup> )	4AWG (25 mm <sup>2</sup> )
100 A	4AWG (25 mm <sup>2</sup> )	2AWG (35 mm <sup>2</sup> )	2AWG (35 mm <sup>2</sup> )
125 A	2AWG (35 mm <sup>2</sup> )	1AWG (50 mm <sup>2</sup> )	1AWG (50 mm <sup>2</sup> )
150 A	1AWG (50 mm <sup>2</sup> )	1AWG (50 mm <sup>2</sup> )	2/0AWG (70 mm <sup>2</sup> )
200 A	2/0AWG (70 mm <sup>2</sup> )	2x 1AWG (50 mm <sup>2</sup> )	2x 2/0AWG (70 mm <sup>2</sup> )
300 A	2x 2/0AWG (70 mm <sup>2</sup> )	2x 2/0AWG (70 mm <sup>2</sup> )	2x 3/0AWG (95 mm <sup>2</sup> )

### 4.5.2 Load Configuration (LVD1/LVD2/LVD3)

Please refer to Table 4.4 for load configuration.



**NOTE!** The total current shall not exceed the rating of the system.

**Table 4.4 Load Configuration**

System Capacity (kW)	Ambient (°C)	Max (Load+Battery) Output rating (A)	Battery Charge (A)	LVD1 – 400 (A)	LVD1 – 200 (A)	LVD2 – 200 (A)	LVD3 – 200 (A)
21	55	500 A @42 VDC	400	360	180	180	180
16,8	65	400 A @42 VDC	300	300	150	150	150

Loads are connected to the load distribution circuit breakers and neutral bar, as detailed in this section. Refer to figures Figure 4.3 and Figure 4.4.

Distribution cables should be selected according to local regulations concerning voltage drop, operational temperature and type of installation (open, covered, number of layers, parallel connection, etc.). What cable dimension to choose depends on the circuit breaker size, the tolerated cable voltage drop and the distance between the power system and the load.

Route load distribution wiring into the top of the subrack from the rear.



**ALERT!** Observe proper polarity when making load connections.

**Procedure**

1. Connect the positive (0 V) load return wire to the neutral bar.
2. Connect the negative (-48 V) load wire to the top terminal of a load circuit breaker.

**Figure 4.3 NetSure 7100 MFU with 3 LVD (-48 VDC Connections)**

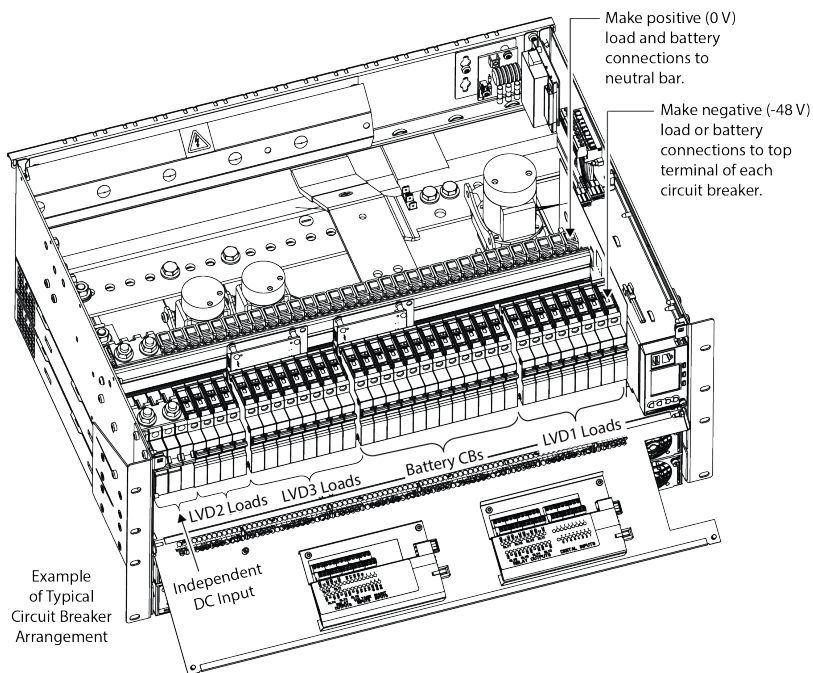
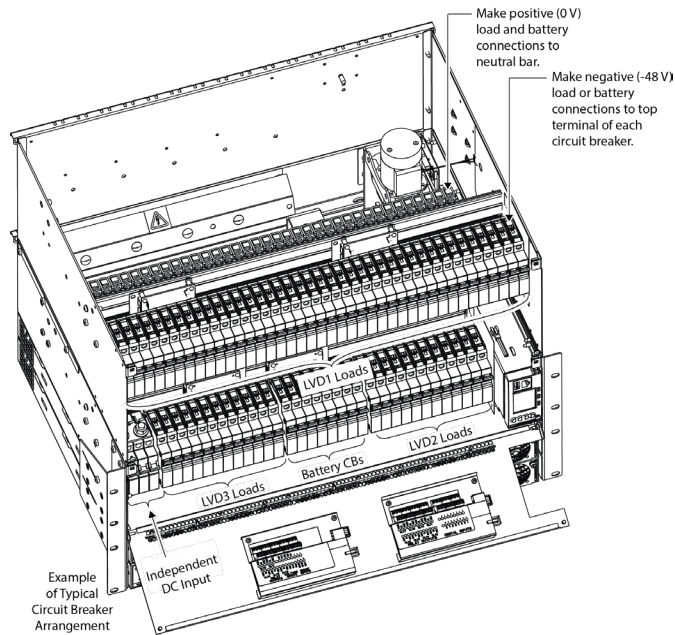


Figure 4.4 NetSure 7100 MFU and XDU with 3 LVD (-48 VDC Connections)



## 4.6 Independent DC Power Port Connections

**Important:** The Independent DC Power Port is for well-behaved and clean DC Power Devices. The system monitors and reports on the ports output but does not regulate or limit a DC Power Device. It is the responsibility of the integrator to ensure the DC device is properly managed and setup to provide safe and controlled power for the application.

The maximum current supported is 160 A at any operating voltage. A DC Input Breaker is provided for protection into the system, and the integrator is responsible the wiring and breaker is suitable for safe and reliable operation.



**ALERT!** Ensure power from Independent DC Power Source is OFF.

### Procedure

1. Independent DC Breaker is OFF.
2. Connect Wires.

## 4.7 Battery Connections

### 4.7.1 Important Safety Instructions



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



**ALERT!** Observe proper polarity when making battery connections.

Batteries are connected to the battery circuit breaker(s) and neutral bar, as detailed in this section.

Battery cables should be selected according to local regulations concerning voltage drop, operational temperature and type of installation (open, covered, number of layers, parallel connection, etc.). What cable dimension to choose depends on the circuit breaker size, the tolerated cable voltage drop and the distance between the power system and the battery.

### Procedure

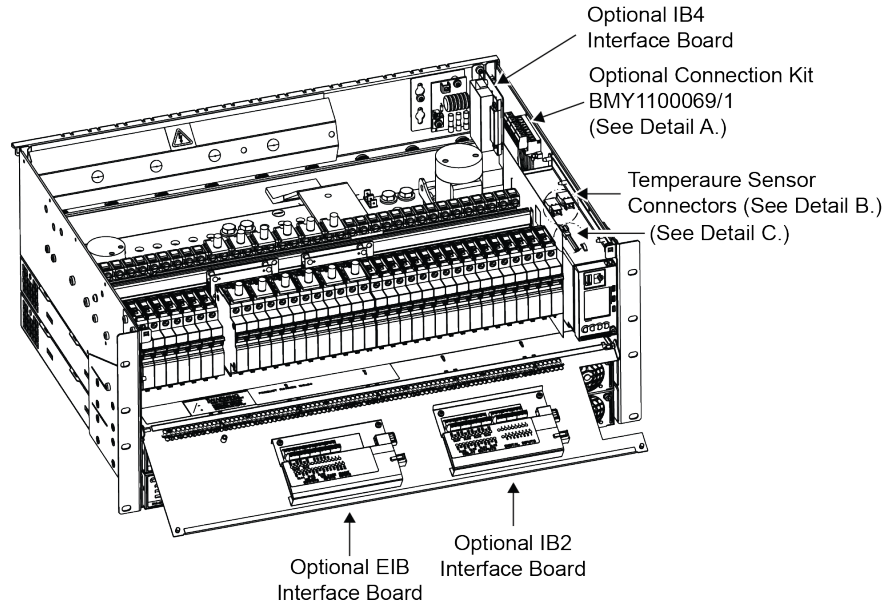
1. Connect the positive (0 V) battery wire to the neutral bar.
2. Connect the negative (-48 V) battery wire to a battery circuit breaker.

## 4.8 External Alarm, Reference, Monitoring and Control Connections

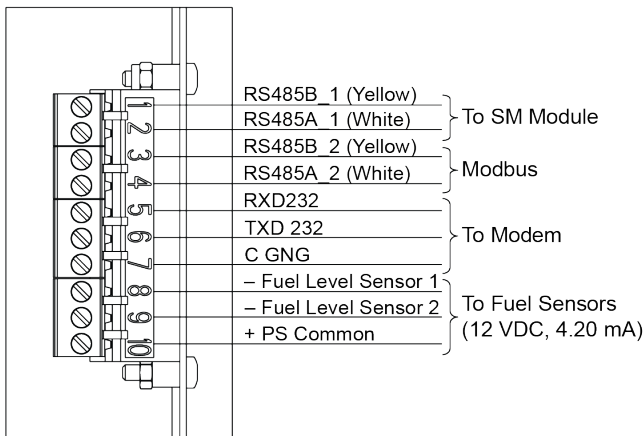
### 4.8.1 Connection Locations

Refer to Figure 4.5 for circuit board, temperature sensor connector and connection kit locations. Refer to Figure 4.6 for NCU connection location.

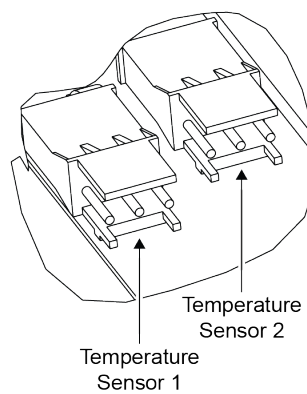
Figure 4.5 Signal Connection Locations



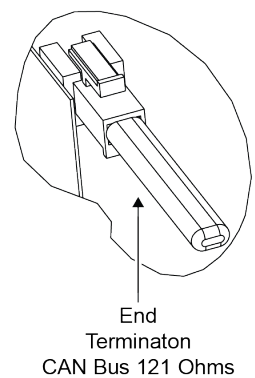
DETAIL A



DETAIL B



DETAIL C



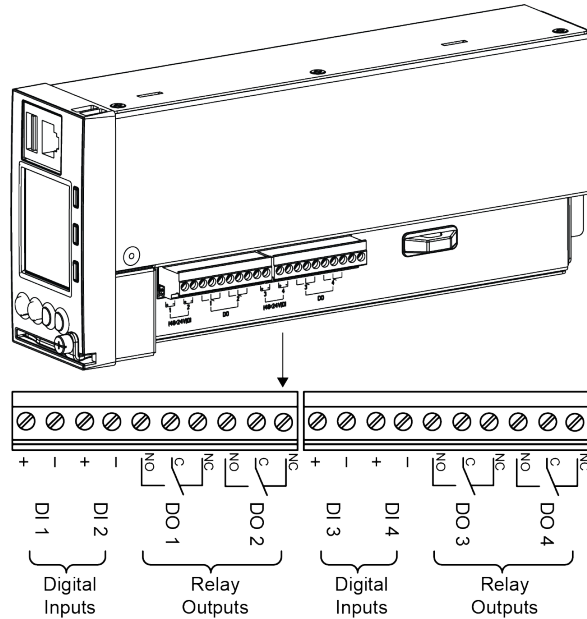
### 4.8.2 Connections Directly to the NCU Control Unit

The NCU provides connection points for digital inputs and programmable relay outputs.

#### Procedure

1. Pull out the NCU.
2. Run the signaling cables from the NCU into the subrack and out of the cabinet through the rear. The cables must be long enough for connection to the connector board when it is outside the subrack.
3. Refer to Figure 4.6 for terminal identification while making the following connections.

Figure 4.6 Connection of Signaling Cables to the NCU



4. **Digital Inputs and Relay Outputs:** Digital input and relay output leads are connected to screw-type terminal blocks. Recommended torque for these connections is 0.19 N-m (1.7 in-lbs.).

- a) **Digital Inputs:** Connect up to four (4) digital inputs to the NCU. Note that you must supply both paths for the digital input (either a positive or a negative signal and the opposite polarity return path). Observe proper polarity.

The digital inputs can be programmed to provide an alarm when the signal is applied (HIGH) or removed (LOW). Refer to the NCU Instructions (11RF7981YC) for programming information.

- b) **Programmable Relay Outputs:** The NCU provides four (4) programmable alarm relays with Form-C contacts. **Contacts have a maximum rating of 60 W: 2 A @30 VDC or 1 A @60 VDC.** Each relay is user configurable for alarm conditions. Refer to the NCU User Instructions (11RF7981YC) for programming information.



**NOTE!** If the subrack system is equipped with three (3) LVD contactors, relay 4 (DO4) on the NCU controls the LVD 3 contactor and is not available for customer use.

5. Arrange the signaling cables so they do not get stuck when the controller is inserted into the subrack.
6. Push in the controller completely into the subrack.

### 4.8.3 Connections to the Optional Connection Kit, BMY1100069/1

If furnished, the optional connection kit (BMY1100069/1) provides the following connection points. Recommended torque for these connections is 0.22 N-m (2.0 in.-lbs.). Refer to Figure 4.5 for connector location and terminal identification. Refer to the Circuit Diagram (BMK22301-01-CD) for additional information.

#### **RS485 Bus**

Terminals 1 and 2 provide connection points for Modbus, as well as NetSure™ SM modules, such as AC meter and Li-Ion batteries.

#### **RS232 Bus**

Terminals 3 and 4 provide connection points for a modem.

#### **Fuel Level Sensors**

Terminals 6, 7 and 8 provide connection points for Fuel Level Sensors.

#### 4.8.4 Connection of 1-2 Fuel Level Sensors

A fuel level sensor with a 5 m cable is available: KET10401/1. The sensor will support tanks as deep as 2.5 m. To extend the length of the fuel level sensor, order the fuel sensor kit and the extension cable TFK421212/002 which length is chosen by customer. The fuel sensor kit contains the junction box and the fuel level sensor.

Fuel level sensor is connected to the terminals 6, 7 and 8 of the optional connection kit (BMY1100069/1). Refer to Figure 4.5 for the connector location. For more information, see the circuit diagram (BMK22301-01-CD).

Refer to the NCU User Instructions (11RF7981YC) for programming information.

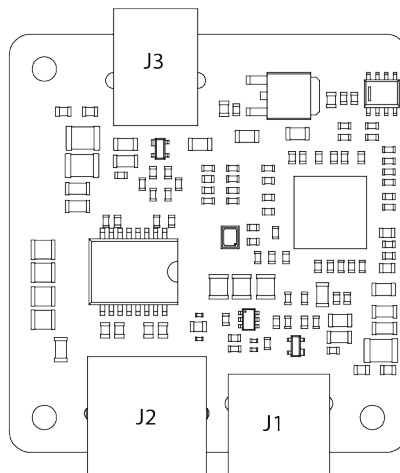
#### 4.8.5 Optional IB4 Board Connections

The IB4 board is a USB to LAN converter of NCU. It is installed inside the power system cabinet and outside of the NCU. It connects to the controller via USB cables. There are three connectors J1, J2, J3.

Description of the connectors:

- J1 – USB A connector (for customer)
- J2 – ETHERNET connector (for customer)
- J3 – USB B connector (from NCU)

Figure 4.7 IB4 Board Connections



#### 4.8.6 Optional IB2 Interface Board Connections

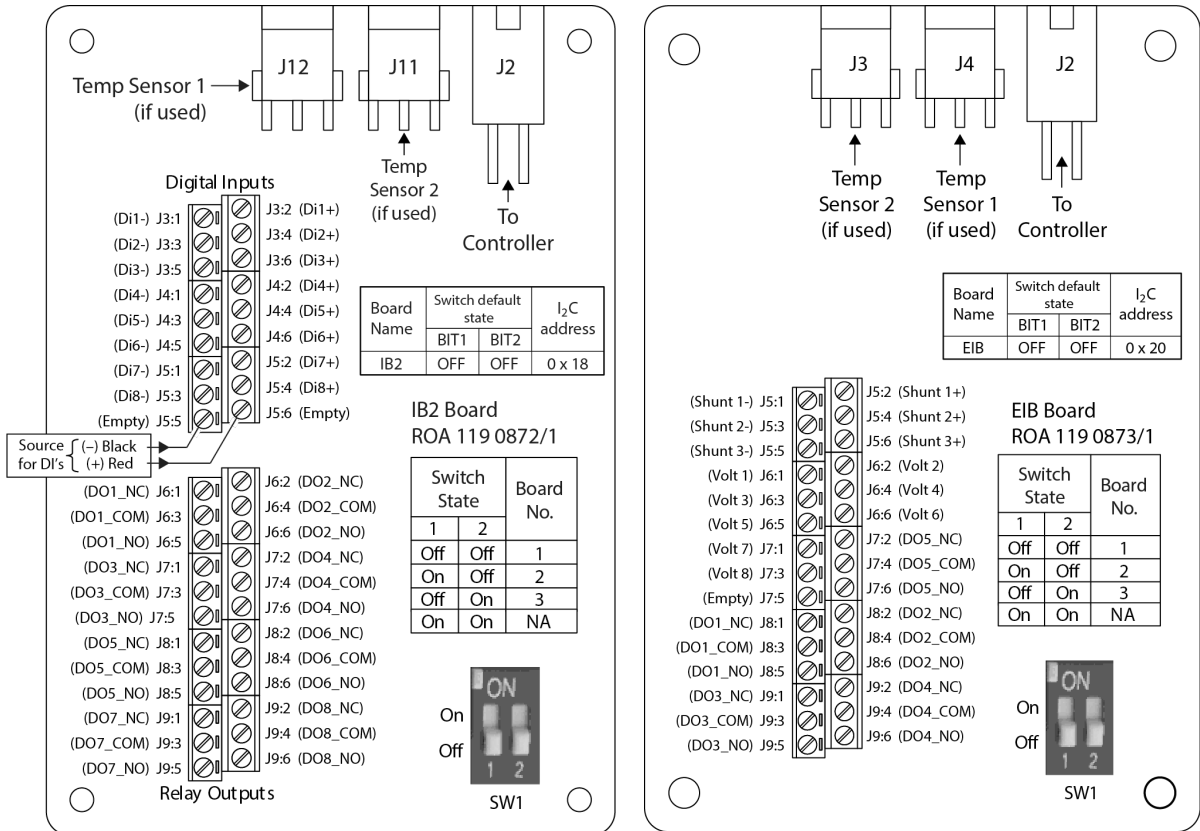
The optional IB2 board provides connection points for digital inputs, programmable relay outputs and temperature sensors. Refer to Figure 4.8. Route signaling wiring into the top of the subrack from the rear. The cables must be long enough for connection to the IB2 board when the subrack front door is open.

##### Procedure

**Digital Inputs and Relay Outputs:** Digital input and relay output leads are connected to screw-type terminal blocks located on the IB2 board. Recommended torque for these connections is 0.249 Nm (2.2 in-lbs.).

- a) **Digital Inputs:** Connect up to eight (8) digital inputs to the IB2 board. Note that you must supply both paths for the digital input (either a positive or a negative signal and the opposite polarity return path). Observe proper polarity. The digital inputs can be programmed to provide an alarm when the signal is applied (HIGH) or removed (LOW). Refer to the NCU User Instructions (11RF7981YC) for programming information.
- b) **Programmable Relay Outputs:** The IB2 board provides eight programmable alarm relays with Form-C contacts. Each relay is user configurable for alarm conditions. **Contacts have a maximum rating of 60 W: 2 A @30 VDC or 1 A @60 VDC.**

Figure 4.8 IB2 Board and EIB Board Connections



### 4.8.7 Optional EIB Interface Board Connections

The optional EIB board provides additional connection points for voltage and current inputs, programmable relay outputs, and temperature sensors. Refer to Figure 4.8. Route signaling wiring into the top of the subrack from the rear. The cables must be long enough for connection to the EIB board when the subrack door is open.

**Procedure**

**Voltage Inputs, Current Inputs, and Programmable Relay Outputs:** Voltage input, current input, and relay output leads are connected to screw-type terminal blocks located on the EIB board. Recommended torque for these connections is 0.22 N-m (2.0 in.-lbs.).

- a) **Current Inputs:** Connect up to three (3) shunt inputs to the EIB board. Observe proper polarity. Refer to Table 4.5 to determine what shunt input to connect to on the EIB board. Refer to the NCU User Instructions (11RF7981YC) and program the shunt input parameters.

**Table 4.5 NCU RJ-45 Ethernet Port Pin Configuration**

Number of Battery Shunts	Number of Load Shunts	Connect to EIB Shunt Inputs as Follows
1	0	Shunt 1 – Battery 1 Shunt 2 – none Shunt 3 – none
2	0	Shunt 1 – Battery 1 Shunt 2 – Battery 2 Shunt 3 – none
3	0	Shunt 1 – Battery 1 Shunt 2 – Battery 2 Shunt 3 – Battery 3
0	1	Shunt 1 – none Shunt 2 – none Shunt 3 – Load 1
0	2	Shunt 1 – none Shunt 2 – Load 2 Shunt 3 – Load 1
0	3	Shunt 1 – Load 3 Shunt 2 – Load 2 Shunt 3 – Load 1
1	1	Shunt 1 – Battery 1 Shunt 2 – none Shunt 3 – Load 1
2	1	Shunt 1 – Battery 1 Shunt 2 – Battery 2 Shunt 3 – Load 1
1	2	Shunt 1 – Battery 1 Shunt 2 – Load 2 Shunt 3 – Load 1

- b) **Voltage Inputs for Battery Block and Battery Midpoint Monitoring:** The NCU Controller can monitor battery blocks (12 V blocks) or midpoint battery voltage of battery strings connected to the EIB assembly. The EIB assembly provides a total of eight (8) DC voltage inputs for these connections. An alarm is issued when either battery block voltage or battery midpoint voltage is abnormal.

Refer to Figure 4.8 for connection details. Refer to the NCU User Instructions (11RF7981YC) and program the following parameters found in the EIB menu.

- Battery Block Monitoring

**Voltage Type:** Set to “48 (Block 4)”. This selects the EIB to monitor up to four (4) 48 V battery strings with four (4) 12 V blocks per string.

**BlockVDiff(12V):** This menu item appears if “48 (Block 4)” is selected above. Set to the alarm threshold for battery block monitoring per site requirements. The Controller issues an alarm when any block voltage of any battery string has an abnormal value. The alarm is issued when the difference between any block voltage and a reference voltage is greater than the value of the block voltage difference setting.

**Block In-Use:** Set to the number of 12 V battery blocks being used.

- Midpoint Monitoring

**Voltage Type:** Set to “Midpoint”. This selects the EIB to monitor the midpoint voltage of up to eight (8) battery strings.

**BlockVDiff(Mid):** This menu item appears if “Midpoint” is selected above. Set to the alarm threshold for battery midpoint monitoring per site requirements. The NCU Controller issues an alarm when any battery midpoint voltage of any battery string has an abnormal value. The alarm is issued when the difference between any battery midpoint voltage and a reference voltage is greater than the value of the block voltage difference setting.

**Block In-Use:** Set to number of 12 V battery blocks being used.



- c) **Programmable Relay Outputs:** The EIB board provides five programmable alarm relays with Form-C contacts. Contacts have a maximum rating of 60 W: 2 A @30 VDC or 1 A @60 VDC.

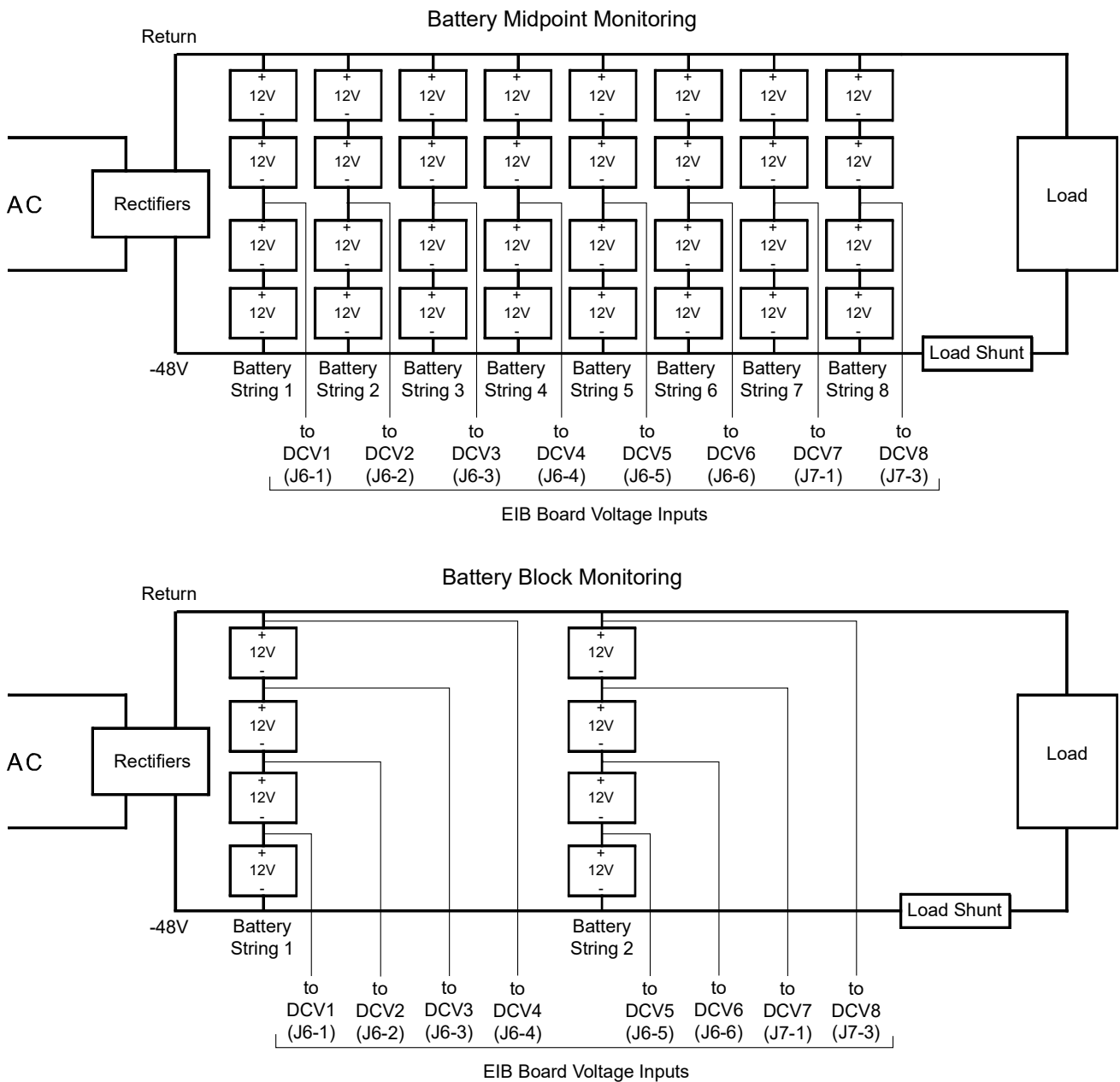


**NOTE!** The relays energize during an alarm condition, closing the contacts between the C and NO terminals, and opening the contacts between the C and NC terminals.

The default NCU Controller configuration programs these relays as follows. Refer to the NCU User Instructions (11RF7981YC) for programming information. Refer to the Table of Set Values (11ER4379NP) for your system's specific configuration.

- d) **Temperature Sensors:** Temperature sensors can be connected to the optional EIB board. Refer to "Temperature Sensors Connections" in a following section.

Figure 4.9 Sample Battery Block or Battery Midpoint Monitoring Connections



## 4.8.8 Temperature Sensors Connections

Two temperature sensors are available in standard configurations when batteries are installed in the same environment: KET10306/1 has a 3 m long cable, and KET10306/2 has a 10 m long cable.

An additional 10 m sensor is available for OSP solutions, where the battery is located in another cabinet, box, et cetera. – KET10306/3, which can be routed through cable inlets and grommets.

Temperature sensors are normally connected to two (2) connectors located at the right-hand side of the subrack interior. Refer to Figure 4.5 for connector location.

There is a possibility for a custom design use up to six (6) temperature sensors. Two (2) temperature sensors can also be connected to the subrack connectors and two (2) temperature sensors can also be connected to the IB2 board J12/J11 and/or optional EIB board J3/J4.

- Up to two (2) temperature sensors can be connected to the subrack connectors.
- Up to two (2) temperature sensors can be connected to the optional IB2 board.
- Up to two (2) temperature sensors can be connected to the optional EIB board.

A temperature sensor set as a battery sensor can also be designated to be used for the battery charge temperature compensation feature, or the battery charge temperature compensation feature can be programmed to use the average or highest value of all battery temperature sensors. The battery charge temperature compensation feature allows the controller to automatically increase or decrease the output voltage of the system to maintain battery float current as battery temperature decreases or increases, respectively. Battery life can be extended when an optimum charge voltage to the battery with respect to temperature is maintained. A temperature sensor set as a battery sensor can also be used for controlling against battery thermal runaway (BTRM feature). Refer to the NCU User Instructions (11RF7981YC) for programming information. Temperature compensation is typically used for lead acid batteries. Actual set-points are defined by the battery manufacturer.

## 4.9 Ethernet Connection to the NCU (if required)



**NOTE!** If the Web Interface is not being used with this system, skip this procedure.

The NCU Controller provides a Web Interface via an Ethernet connection to a TCP/IP network. An RJ-45 10BaseT jack is provided on the front of the NCU for connection into a customer's network running TCP/IP. This jack has a standard Ethernet pin configuration scheme, twisted pair. Refer to Figure 4.10 for location and Table 4.5 for pin outs. Use shielded Ethernet cable (grounded at both ends). Note that the NCU RJ-45 jack is connected to chassis ground. Refer to the NCU User Instructions (11RF7981YC) for operational details.



**NOTE!** A second Ethernet connection jack is provided on the optional IB4 board. Refer to Figure 4.5 for IB4 board location. Refer to the NCU Controller User Instructions (11RF7981YC) for further information.



**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 controller.



**WARNING!** The intra-building port(s) of the equipment or subassembly is suitable for connection to intra-building or unexposed wiring or cabling only. The intra-building port(s) of the equipment or subassembly MUST NOT be metalically connected to the interfaces that connect to the OSP or its wiring. These interfaces are designed for use as intra-building interfaces only (Type 2 or Type 4 ports as described in GR-1089-CORE, Issue 4) and require isolation from the exposed OSP cabling. The addition of Primary Protectors is not sufficient protection in order to connect these interfaces metalically to OSP wiring.

The intra-building port (RJ-45) of the equipment or subassembly must use shielded intra-building cabling (wiring) that is grounded at both ends.

Figure 4.10 NCU Ethernet Port

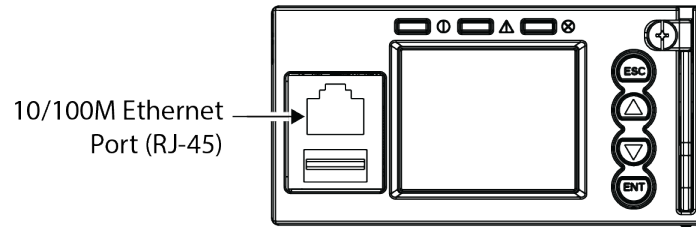


Table 4.6 NCU RJ-45 Ethernet Port Pin Configuration

Port Pin Number	Name	Definition
1	Tx+	Send Signal +
2	Tx-	Send Signal -
3	Rx+	Receive Signal +
4	--	no connection
5	--	no connection
6	Rx-	Receive Signal -
7	--	no connection
8	--	no connection

## 5 Initially Starting and Checking the System

For the start-up of a system, see the document Installation Test Instructions (DOC-00003-TI).

## 6 Operating Procedures

### 6.1 Controllers and Rectifiers

For operation instructions on these units, refer to the following documents:

- NCU Controller User Instructions (11RF7981YC)
- R48-4300E3 Rectifier User Instructions (1R484300E3UM)
- S48-4300E4 Solar Converter User Instructions (1S484300E4-User Manual)

### 6.2 Independent DC Power Port

Refer to the operation manuals provided with the DC Power Devices and the integrator's operating instructions.

### 6.3 Local Controls and Indicators

Refer to the NCU and Rectifier/Converter User Instructions for descriptions of the local controls and indicators located on these units.

### 6.4 Batteries


Refer to the operation manuals provided with the Batteries and the integrator's operating instructions.

## 7 Maintenance

### 7.1 System Maintenance Procedures

It is recommended that the maintenance procedures listed in Table 7.1 be performed every 6 months to ensure continual system operation.

**Table 7.1 Maintenance Procedures**

Procedure	Referenced In	Completed (✓)
Check ventilation openings for obstructions such as dust, papers, manuals, etc.	--	
Inspect and tighten all installer's connections	Making Electrical Connections section of this document.	
 <b>NOTE!</b> This table may be reproduced as necessary to record and document system performance.		

### 7.2 Adding a Rectifier/Converter Module to the System

To increase system current capacity, a rectifier module can easily be added to a subrack that contains an empty rectifier module mounting position.

For rectifier module installation instructions, refer to the Rectifier Instructions (1R484300E3UM).

For converter module installation instructions, refer to the Solar Converter Instructions (1S484300E4-User Manual). Refer also to the following.

It is recommended that the current limit point and battery wire-breaker wire sizing be checked whenever a rectifier/converter module is added to or removed from the power system. Refer to the NCU User Instructions (11RF7981YC) for a procedure.

The rectifier/converter module being added is assigned by the NCU the lowest available identification number. If desired, you can change the identification number. Refer to the NCU User Instructions (11RF7981YC) for a procedure.

### 7.3 Adding a Load Distribution or Battery Disconnect Circuit Breaker

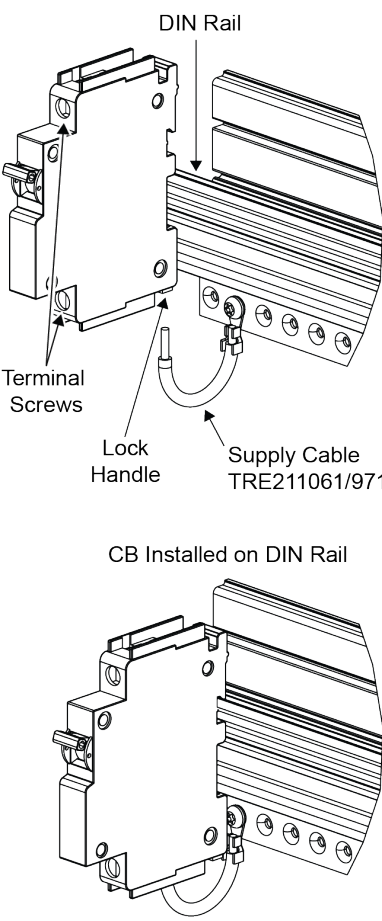
A load distribution or battery disconnect circuit breaker can easily be added to a subrack that contains an empty circuit breaker mounting position.

Refer to the label located beneath the circuit breakers on the subrack floor to see if additional space is available for battery or the required LVD. Refer to Figure 7.1 for the LVD Labels and Battery Label. Refer to Figure 7.2 for a procedure.

**Figure 7.1 LVD Labels and Battery Label**

LVD1 >      LVD2 >  
LVD3 >      BAT >

Figure 7.2 Adding a Load Distribution or Battery Disconnect Circuit Breaker




**DANGER!** If the power system is in service, hazardous voltage and energy are present inside the subrack. External wiring (especially from battery) may be energized from an external source. DO NOT allow bare wire ends to contact any grounded or energized object during this procedure. Use only insulated tools. Read "Important Safety Instructions" near the beginning of this document before performing this procedure.

**ALERT!** Observe correct polarity (+ to + and - to -) when making battery or load connections

1. On the new circuit breaker, TURN OFF the circuit breaker, loosen the terminal screws, and pull down on the lock at the back.
2. Connect cable TRE211061/971 to the feeding bar, using thread-forming screw 84/SBF226040/0080.
3. Connect cable TRE211061/971 to the bottom terminal of the circuit breaker. Tighten the terminal screw.
4. Referring to the label on the floor of the subrack for correct mounting location, mount the circuit breaker on the DIN rail.
5. Lock the circuit breaker to the DIN rail by pushing the lock up. (See NOTE.)
6. For battery circuit breakers only:
  - If optional reverse polarity alarm board IS NOT present: Locate an unused battery circuit breaker alarm wire. Remove the shrink tubing from the alarm wire termination. Insert the wire into the top terminal cavity of the battery circuit breaker. The terminal screw will be tightened later.
  - If optional reverse polarity alarm board IS present: Locate an unused battery circuit breaker reverse polarity alarm wire. Remove the shrink tubing from the alarm wire termination. Insert the wire into the top terminal cavity of the battery circuit breaker. The terminal screw will be tightened later.
7. For load circuit breakers only, locate an unused load circuit breaker alarm wire. Remove the shrink tubing from the alarm wire termination. Insert the wire into the top terminal cavity of the battery circuit breaker. The terminal screw will be tightened later.
8. Insert a negative (-48 V) battery and/or load cable into the top terminal cavity of the newly-installed circuit breaker. Tighten the terminal.
9. Connect the positive (0 V) battery and/or load cable to the subrack neutral bar. Tighten the terminal.
10. Turn on the circuit breaker.

**NOTE!** A tool with an offset shank is available as an optional item from Vertiv. This tool simplifies operating the circuit breaker lock. To order, specify product number LSY10822.



## 8 Troubleshooting and Repair

### 8.1 Controllers and Rectifiers

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

- NCU (NetSure™ Control Unit) User Instructions (11RF7981YC)
- R48-4300E3 Rectifier User Instructions (1R484300E3UM)
- S48-4300E4 Solar Converter User Instructions (1S484300E4-User Manual)

### 8.2 NCU Controller Configuration

If any NCU Controller configuration settings were changed, refer to the NCU User Instructions (11RF7981YC) and save a copy of the configuration file. This file can be used to restore the NCU Controller settings, if required, at a later date.

### 8.3 System Troubleshooting Information

This system is designed for ease in troubleshooting and repair. The various indicators as described in the section entitled Operating Procedures and, in the Controller and Rectifier User Instructions are designed to isolate failure to a specific element. Once the faulty element has been identified, refer to the “Replacement Information” and “Replacement Procedures” in this chapter.

#### 8.3.1 Troubleshooting Alarm Conditions on the NCU Controller

The NCU Controller displays alarm conditions as listed in the Available Alarms section of the NCU User Instructions (11RF7981YC). Programmable external alarm relays are also available. Refer to the “Table of Set Values” supplied with your power system documentation for your alarm relay configurations.

The NCU’s Active Alarm and Alarm History submenus allow the User to view alarm details. Refer to the NCU User Instructions (11RF7981YC) to access these menus.

#### 8.3.2 Checking the NCU Current Limit Point after Adding or Removing a Rectifier/Converter

If a rectifier/converter is added to the power system, the system current limit point will automatically increase by the percentage each existing rectifier was set to provide prior to the addition.

If a rectifier/converter is removed from the system (and the “Rect. Comm Fail”/ “Conv Comm Fail” alarm is reset), the current limit point will remain unchanged unless the capacity of the remaining rectifiers is not sufficient to maintain the present current limit point. If that happens, the current limit point will automatically increase to the maximum (121% of the remaining rectifiers).

It is recommended that the current limit point be checked whenever a rectifier is added to or removed from the power system. Refer to the NCU User Instructions (11RF7981YC) for a procedure.

#### 8.3.3 Clearing a Rectifier/Converter Communications Fail Alarm after Removing a Rectifier/Converter

If a rectifier/converter module is removed from the system, a rectifier/solar converter communications failure alarm is generated. If the rectifier/converter module will not be replaced, the alarm should be cleared. Refer to the NCU User Instructions (11RF7981YC) for a procedure for clearing alarms.

#### 8.3.4 Clearing a Rectifier/Converter Lost Alarm

If the NCU Controller resets while rectifier/converter communications fail alarm is active, the rectifier/converter communications fail alarm is replaced with a rectifier/converter lost alarm. Refer to the NCU User Instructions (11RF7981YC) for a procedure for clearing alarms.



**NOTE!** In a hybrid system, when power to the rectifier and solar converter is turned off, to conserve energy, the NCU will recognize the devices are no longer communicating and may generate an Observational Alarm.

## 8.4 Replacement Information

### 8.4.1 Replacement Assemblies

When a trouble symptom is localized to a faulty rectifier module, controller, or system circuit board; that particular device or circuit board should be replaced in its entirety. Other than a rectifier module fan replacement, no attempt should be made to troubleshoot or repair individual components on any rectifier module, controller, or circuit board.

## 8.5 Replacement Procedures



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

### 8.5.1 Replacing a Rectifier Module

Refer to the Rectifier User Instructions (1R484300E3UM) for a rectifier module replacement procedure.

The rectifier module being replaced is assigned by the NCU the lowest available identification number. If desired, you can change the identification number. Refer to the NCU User Instructions (11RF7981YC) for a procedure.

### 8.5.2 Replacing a Solar Converter Module

Refer to the Solar Converter User Instructions (1S484300E4-User Manual) for a converter module replacement procedure.

The converter module being replaced is assigned by the NCU the lowest available identification number. If desired, you can change the identification number. Refer to the NCU User Instructions (11RF7981YC) for a procedure.

### 8.5.3 Replacing the NCU Controller

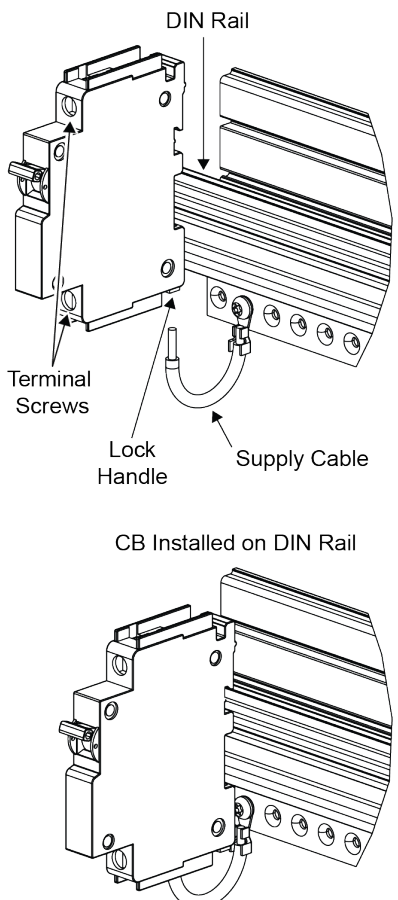
Refer to the NCU User Instructions (11RF7981YC) for a controller replacement procedure.

### 8.5.4 Replacing Load Distribution or Battery Disconnect Circuit Breakers

Refer to Figure 8.1 for a procedure.




Figure 8.1 Replacing a Load Distribution or Battery Disconnect Circuit Breaker



**DANGER!** If the power system is in service, hazardous voltage and energy are present inside the subrack. External wiring (especially from battery) may be energized from an external source. DO NOT allow bare wire ends to contact any grounded or energized object during this procedure. Use only insulated tools. Read "Important Safety Instructions" near the beginning of this document before performing this procedure.

1. TURN OFF the circuit breaker being replaced.
2. Loosen the circuit breaker terminal screws.
3. Remove wiring from top terminal of circuit breaker. Use extreme caution not to allow wire ends to contact any energized or grounded object.
4. Remove the supply wire from the bottom terminal of the circuit breaker. Use extreme caution not to allow wire end to contact any energized or grounded object.
5. Pull down on the lock at the back of the circuit breaker to unlock it from the DIN rail. (See NOTE.)
6. Remove the circuit breaker.
7. On the new circuit breaker, loosen the terminal screws, turn off the circuit breaker, and pull down on the lock at the back.
8. Mount the new circuit breaker on the DIN rail.
9. Lock the circuit breaker to the DIN rail by pushing the lock up.
10. Connect the supply wire to bottom terminal of circuit breaker.
11. Insert the wire(s) into the top terminal cavity of the circuit breaker. (For a load distribution circuit breaker only, ensure that the alarm wire is also inserted.)
12. Tighten both circuit breaker terminal screws.
13. Turn on the circuit breaker.

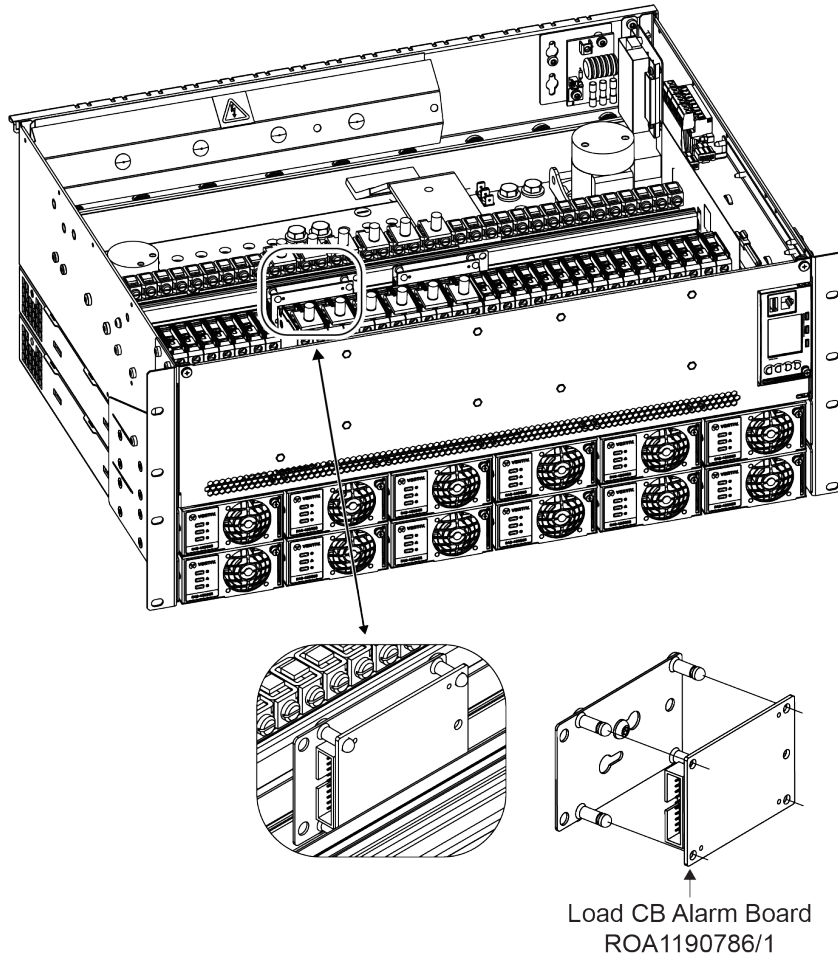
**NOTE!** A tool with an offset shank is available as an optional item from Vertiv. This tool simplifies operating the circuit breaker lock. To order, specify product number LSY10822.



## 8.5.5 Replacing the Load Circuit Breaker Alarm Board

The load circuit breaker alarm board is mounted on a plate on the support frame for the circuit breakers. The mounting plate has a keyhole and is fixed to the support frame with one screw that is not tightened. Slide the mounting plate with the board right or left and lift out the assembly. Disconnect wire harnesses from the board. Replace the board on the mounting plate. Reconnect the harnesses and slide the assembly back in position.

Figure 8.2 Replacing the Load CB Alarm Board



## 8.5.6 Replacing the Optional DC SPD Board

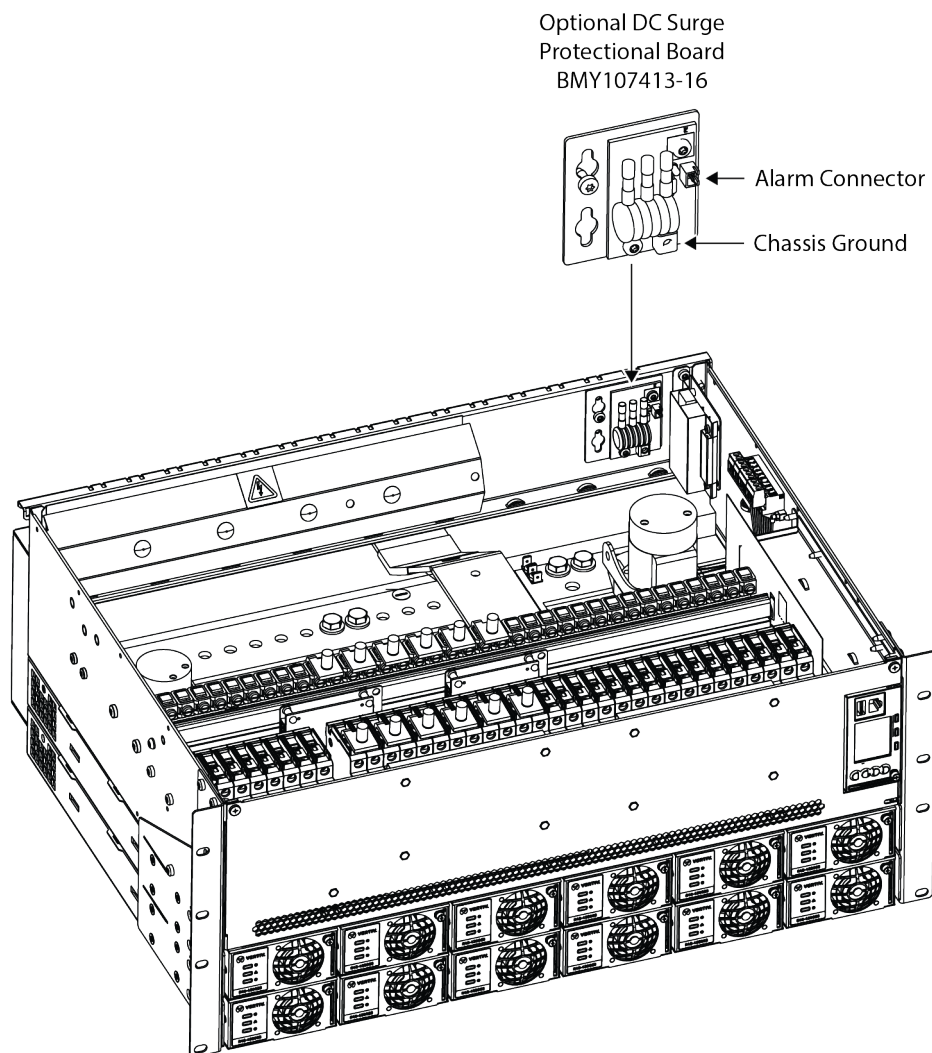
The DC SPD board is mounted on a plate in the rightmost upper back position of the power system. To replace the board, refer to Figure 8.3 and perform the following procedure.

### **Procedure**

1. Remove input power from the power system by opening all external protective or disconnect devices.
2. Turn OFF all battery disconnect circuit breakers in the power system.
3. If batteries are connected, battery voltage will still be present on the top terminals of the battery disconnect circuit breakers. Place a non-conductive sheet on top of the DC distribution/cables.
4. The mounting plate has a keyhole and is fixed to the cabinet with one screw. Loosen the screw, and lift up and remove the board and bracket.
5. Disconnect all cables from the DC SPC board.
6. Remove the board from the mounting plate.
7. Install the new board on the mounting plate.

8. Connect all cables to the new board.
9. Mount the board and plate in the power system, and secure with the one screw.
10. Remove the non-conductive sheet that was placed on top of the DC distribution/cables.
11. Turn ON all battery disconnect circuit breakers in the power system.
12. Restore input power to the power system by closing all external protective or disconnect devices.
13. Check to ensure there are no alarms.

**Figure 8.3 Replacing the Optional DC Surge Protection Board**



## 8.5.7 Circuit Board Replacement Procedures



**DANGER!** Circuit boards used in this power system contain static-sensitive devices. Read the Static Warning at the front of this document before performing any of the following procedures.

### General

The following circuit board replacement procedures can be performed with the system operating.

Refer to Figure 3.1 for circuit board locations.



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



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

## 8.5.1 IB2 Board and Optional EIB Board Replacement

### 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 future alarms associated with this system while the procedure is being performed.



**DANGER!** Performing the next steps exposes service personnel to battery potential. Exercise extreme caution not to inadvertently contact or have any tool inadvertently contact any energized electrical termination.

2. Open the front door of the subrack.



**ALERT!** Damage to the circuit board may result if the next step is not followed.

3. Connect an approved grounding strap to your wrist. Attach the other end to a suitable ground.
4. Carefully label the wires connected to the customer connection terminal blocks on the circuit board. These wires must be connected to the same terminals on the replacement circuit board. Refer to Figure 8.4.
5. Carefully label the connectors plugged into the circuit board. These connectors must be plugged into the same connectors on the replacement circuit board. Refer to Figure 8.4.



**DANGER!** In the next step, external wiring may be energized from an external source. DO NOT allow bare wire ends to contact any grounded or energized object.

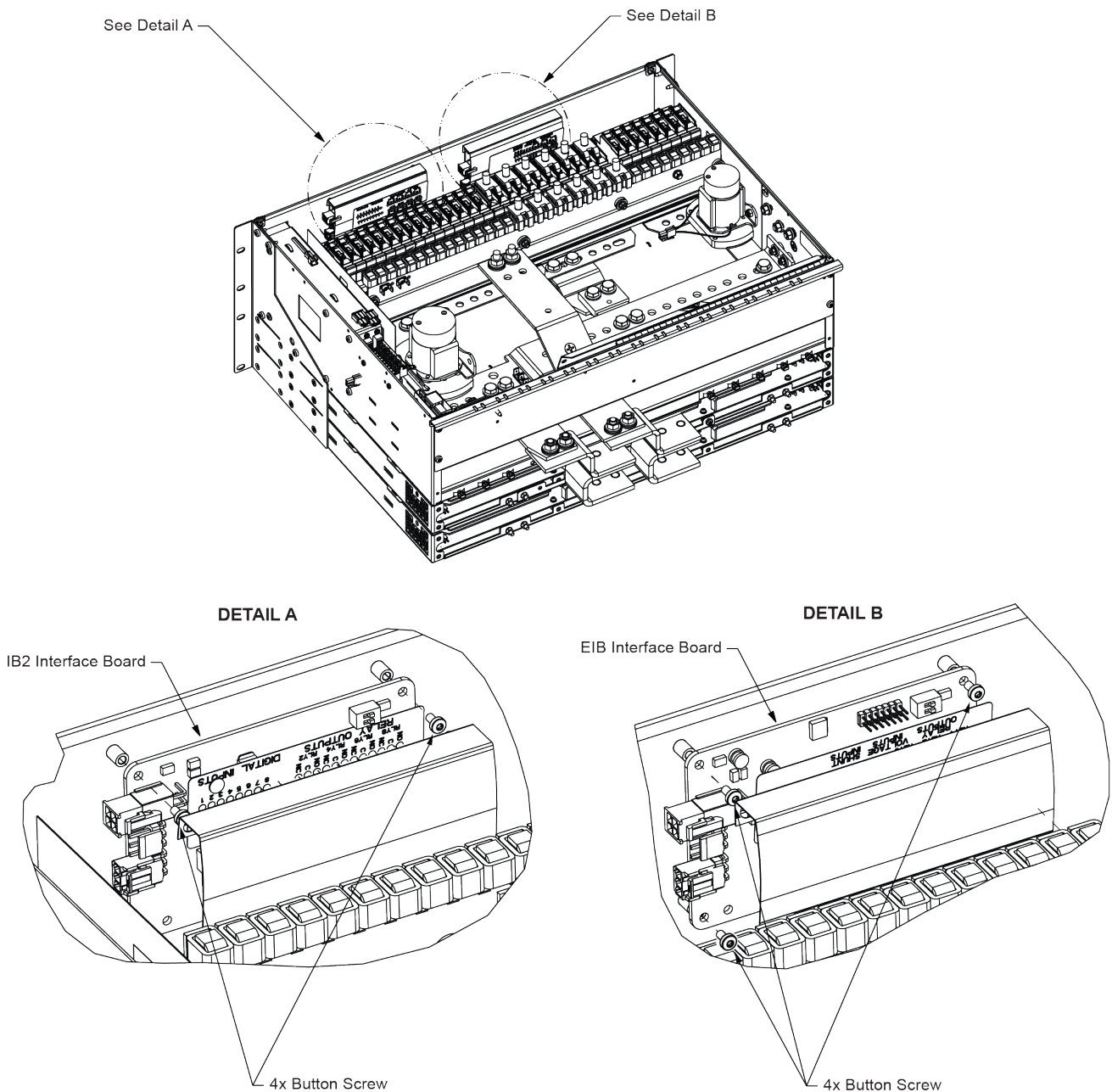
6. Remove the external wiring from the customer connection terminal blocks. DO NOT allow the bare wire end to contact any grounded or energized object. Isolate the wire end with electrical tape. Repeat for each wire to be removed.
7. Unplug all connectors plugged into the circuit board.
8. Remove the circuit board by removing the screws that secure it to the door.
9. In this step, ensure you do not intermix the old and replacement circuit boards. Set the switch on the replacement circuit board to the same setting as the old circuit board. Switch settings are documented in the section of this document entitled Setting Switch Options.
10. Secure the replacement circuit board to the front door, using the previously removed screws.
11. Plug all connectors removed from the old circuit board into the same position on the replacement circuit board.



**DANGER!** In the next step, external wiring may be energized from an external source. DO NOT allow bare wire ends to contact any grounded or energized object.

12. Reconnect the external wiring to the correct terminals on the customer connection terminal block. First remove the electrical tape that was applied to the bare wire end in a previous step. DO NOT allow the bare wire end to contact any grounded or energized object. After securing the wire, gently tug on the wire to ensure that it cannot be pulled out of the terminal block. Repeat for each wire to be reconnected.
13. Remove the grounding wrist strap.
14. Close the front door of the subrack.
15. Enable the external alarms, or notify appropriate personnel that this procedure is finished.
16. Ensure that there are no local or remote alarms active on the system.

**Figure 8.4 IB2 Interface Board and EIB Interface Board Replacement**



## 8.5.2 Replacing the IB4 Board (Optional)

### Procedure

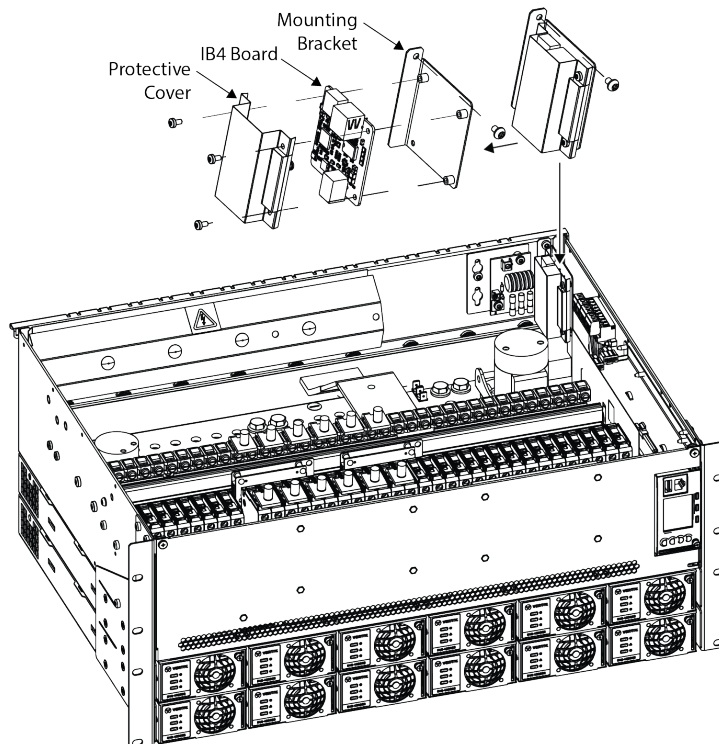
1. Performing this procedure may activate external alarms. Do one of the following. If possible, disable these alarms. If these alarms cannot be easily disabled, notify the appropriate personnel to disregard any future alarms associated with this system while the procedure is being performed.



**ALERT!** Damage to the circuit board may result if the next step is not followed.

2. Connect an approved grounding strap to your wrist. Attach the other end to a suitable ground.
3. Open the subrack front cover.
4. Remove the screw and release the mounting plate fixed to the rear plate.
5. Unplug all connectors plugged into the IB4 circuit board.
6. Remove the three (3) screws that secure the protective cover and circuit board to the mounting bracket.
7. Secure the replacement circuit board and the protective cover to the mounting bracket by installing the three (3) screws.
8. Plug all connectors removed from the old IB4 circuit board into the same position on the replacement circuit board.
9. Place back the mounting bracket with the new circuit board. Reinstall the screw removed in step 3.
10. Re-install the subrack front cover plate.
11. Remove the grounding wrist strap.
12. Enable the external alarms, or notify appropriate personnel that this procedure is finished.
13. Ensure that there are no local or remote alarms active on the system.

**Figure 8.5 Replacing the Optional IB4 Board**



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