EnergyCore Lithium 7

Installation and Operation 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/en-us/support/ for additional assistance.

TABLE OF CONTENTS

1 Important Safety Instructions

Read and follow these instructions

All the safety instructions in this manual are intended to ensure safety and prevent property damage. Before installing this product, be sure to read all safety instructions in this document for proper installation.

Failure to comply with safety instructions may result in a serious accident, causing death, or a severe injury.

WARNING! Risk of electric shock. May cause personal injury or death. Verify that all incoming line voltage (power) circuits are de-energized and locked out before installing cables or making connections in the unit. Equipment inspection and startup should be performed only by properly trained and qualified personnel wearing appropriate safety headgear, gloves, and shoes. Lethal voltages are present during startup procedures. Electrical safety precautions must be followed throughout inspection and startup. Only properly trained and qualified service personnel wearing appropriate safety headgear, gloves, shoes, and glasses should perform maintenance on the Vertiv™ EnergyCore Lithium 7. All voltage sources to the unit must be disconnected before inspecting or cleaning within the cabinet.

1.1 Critical Fire Safety Compliance

This product is tested in accordance with the UL 9540A: Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems. Vertiv can make this test report available upon request for the purpose of assisting Vertiv's customers, their engineers, and other stakeholders in satisfying their obligations to comply with all applicable fire safety, building, and electrical regulations, as well as any other laws or guidelines governing installation or use of this product.

NOTE: This critical fire safety compliance is for customers and engineers.

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2 Overview

The Vertiv™ EnergyCore Lithium 7 is a high-power standby battery cabinet designed for use with an uninterruptible power supply (UPS), see Technical Specification on page 63 for details of Technical specification of UPS.

WARNING! Failure to follow safety procedures during use of this product may result in death, serious injury or property damage.

WARNING! High voltage electric shock hazard. The Vertiv EnergyCore Lithium 7 contains high voltage electric shock sources. Do not open any cover of the Vertiv EnergyCore Lithium 7 enclosure other than the front door.

2.1 Model Nomenclature

The 15-digit part number is on the main label inside the door of Vertiv EnergyCore Lithium 7. The part number defines the configuration of the battery cabinet. Various battery modules are available in different series configurations, with increased number of battery modules allow higher voltage and additional energy storage.

Figure 2.1 Part Number

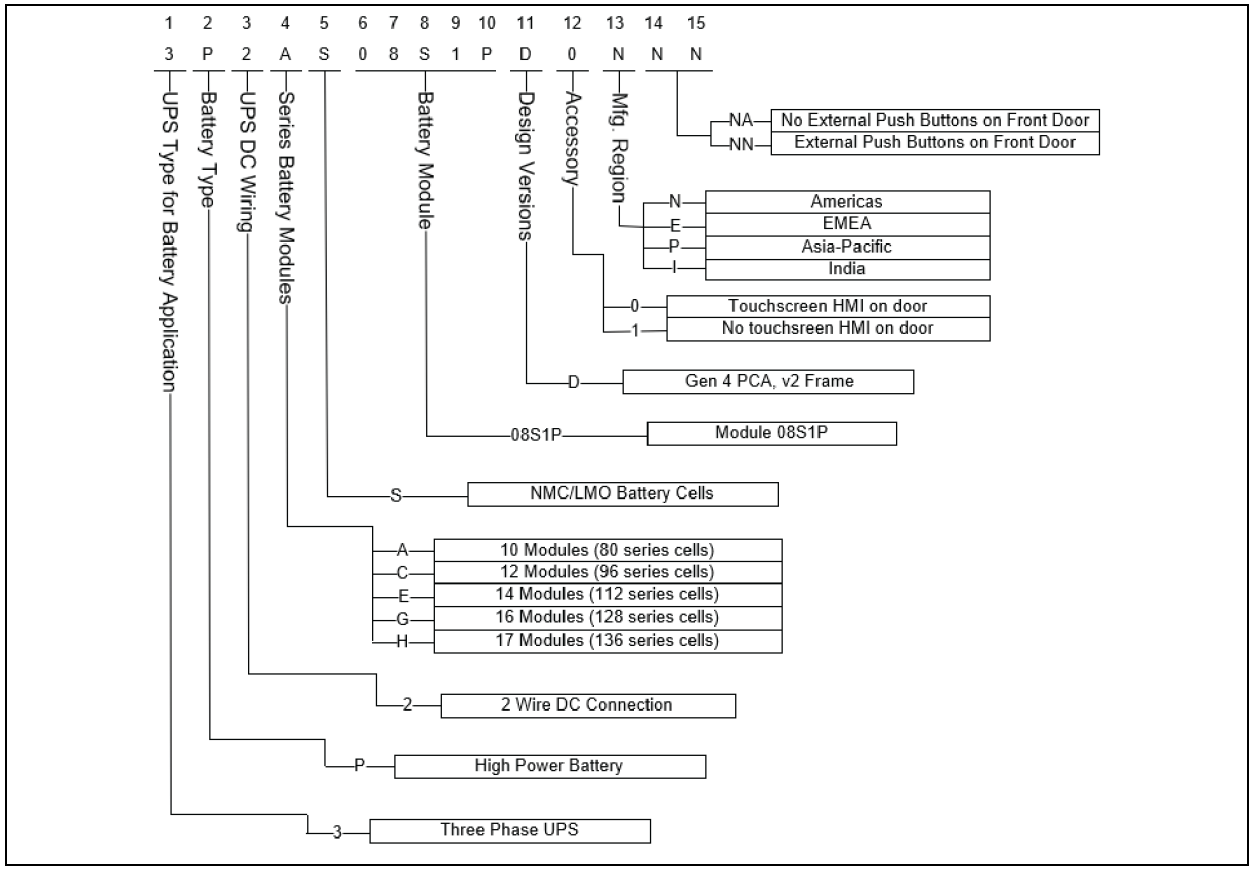


Table 2.1 Model Description

Digital	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Model	3	P	2	A	S	0	8	S	1	P	D	0	N	NA	NN

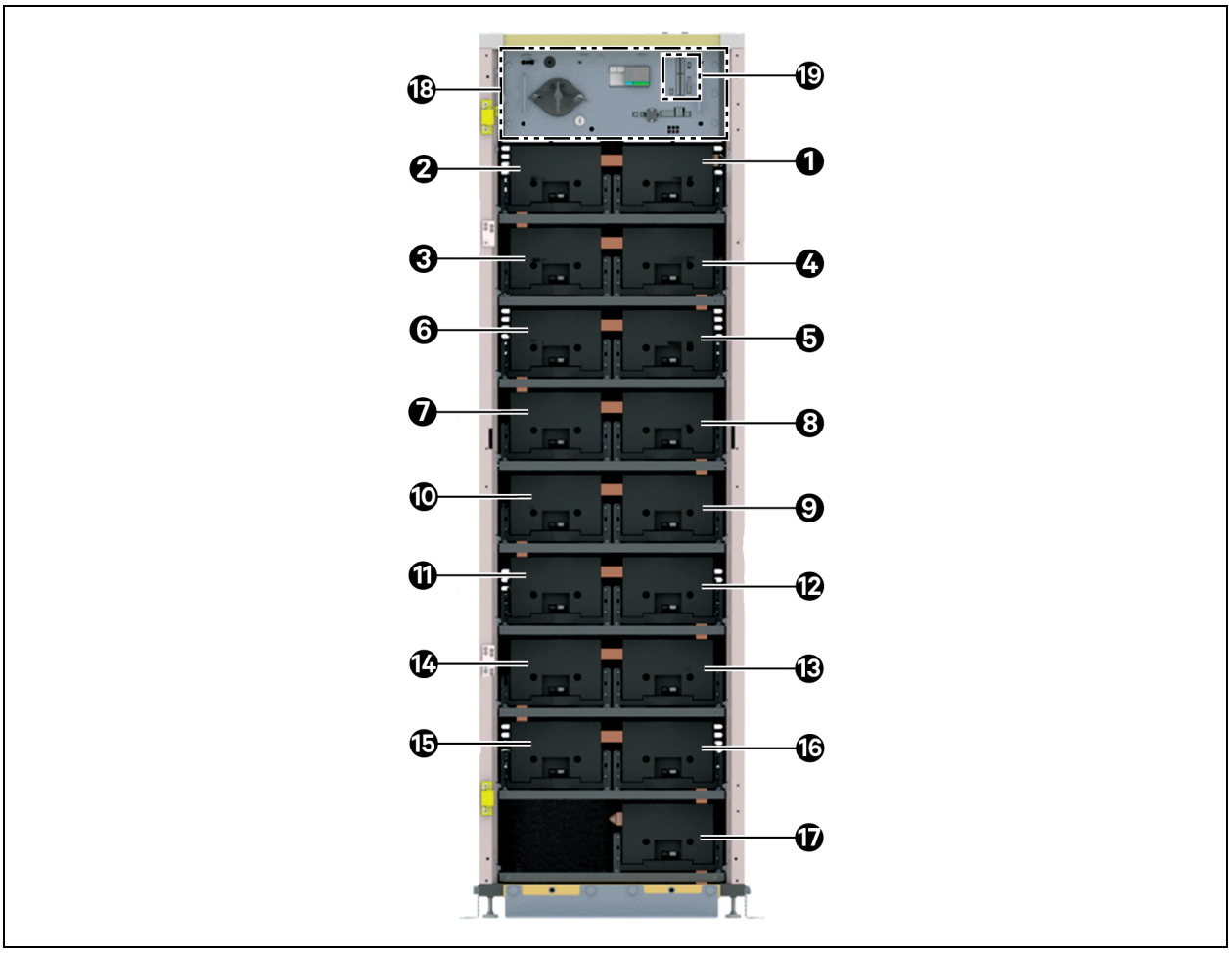
Table 2.2 Model Number Digit Description

Digit	Feature	Value	Description
1	UPS type for battery application	3	Three phase UPS
2	Battery type	P	High power battery
3	UPS DC wiring	2	2 wire DC connection
4	Series battery modules	A	10 modules (80 series cell)
		C	12 modules (96 series cell)
		E	14 modules (112 series cell)
		G	16 modules (128 series cell)
		H	17 modules (136 series cell)
5	Battery chemistry	S	NMC/LMO Battery Cells
6, 7, 8, 9, 10	Battery module	08S1P	Module 08S1P
11	Design version	D	Gen 4 power chassis assembly (PCA), v2 frame
12	Accessory	0	Touchscreen human machine interface (HMI) on door
		1	No touchscreen HMI on door
13	Manufacturing region	N	Americas
		E	EMEA
		P	Asia-Pacific
		I	India
14, 15	Other	NA	No external push buttons on front door
		NN	External push buttons on front door

2.2 Battery Module Numbering Scheme

The Figure 2.2 below shows the battery module numbering scheme in the cabinet and the location of the control terminal block (CTB). The battery modules are arranged on shelves, two battery modules per shelf, except for the 17 module configuration where there's only one battery on the bottom shelf. Each battery module has a monitoring and balancing board (MBB) attached internally which balances the battery cells and reports voltages and temperatures to the PCA, which serves as both the cabinet level and system level battery management system (BMS).

Figure 2.2 Battery Module Numbering Overview



Item	Description
1	Module 1—Type B module.
2	Module 2—Type B module.
3	Module 3—Type A module.
4	Module 4—Type A module.
5	Module 5—Type B module.
6	Module 6—Type B module.

Item	Description
7	Module 7—Type A module.
8	Module 8—Type A module.
9	Module 9—Type B module.
10	Module 10—Type B module.
11	Module 11—Type A module (if installed).
12	Module 12—Type A module (if installed).
13	Module 13—Type B module (if installed).
14	Module 14—Type B module (if installed).
15	Module 15—Type A module (if installed).
16	Module 16—Type A module (if installed).
17	Module 17—Type B module (if installed).
18	Power chassis assembly (PCA)
19	Control terminal block (CTB), see Control and Monitoring Points on page 71 for details.

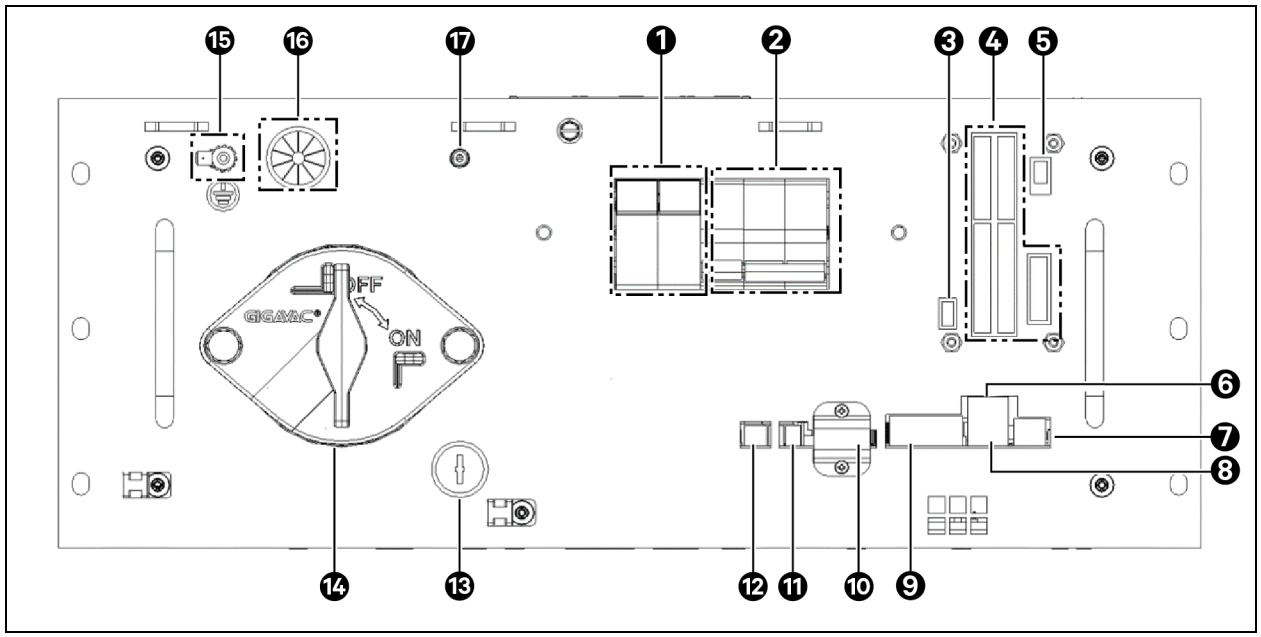
3 Description

3.1 Power Chassis Assembly

The PCA is a 4U-sized enclosed section that controls the connection of the batteries to the DC bus. It monitors voltage and temperature of battery to ensure operation within the specified limits throughout the life of the product.

IMPORTANT! Operation of the Vertiv™ EnergyCore Lithium 7 outside its recommended environmental conditions or power limits may void the warranty.

Figure 3.1 Power Chassis Assembly



Item	Description
1	F7-F8 fuses for internal control power supplies.
2	Circuit breaker and shunt trip for control power.
3	Termination switch (CAN TERM) for the external CAN communication line.
4	Control terminal block (CTB), see Control Terminal Block on page 71 for more details.
5	Door position switch input, not used.
6	100BT Ethernet port.
7	BAT 1 port carries RS485 for Modbus RTU server. See Control and Monitoring Points on page 71 for detailed connector information.
8	USB 2.0 port for log file download.
9	RS232 serial port for service use only. DB9 female.
10	Firmware SD card slot with cover plate (for service use only).
11	Power output port for optional HMI.

Item	Description
12	BAT 2 port for PCA to battery module communication.
13	Service/Run mode switch.
14	S1 switch (maintenance disconnect). **NOTE: This switch isolates the battery string from the DC bus. It must be in the off position when the battery string is being physically serviced, including installation, replacement, and measurement.**
15	Ground terminal.
16	Wire connections to door mounted buttons.
17	24 VDC input power socket (factory and service use only).

CAUTION: Risk of improper equipment operation. The S1 maintenance disconnect switch is a static isolation and lockout device. Do not operate the S1 maintenance disconnect switch while the cabinet is online (when an internal contactor is closed) or when the batteries are being charged or discharged.

3.1.1 S1 Switch Open and Close Procedure

NOTE: Opening and closing would occur when a cabinet is not online (connected to the bus).

To open the S1 switch (maintenance disconnect):

1. Verify that the RUN/SERVICE key switch is in the RUN position.
2. Press the Shutdown button on the HMI. Alternatively, if external push buttons are available, press and hold the STOP button for 5 seconds to 10 seconds or until the STOP and ENABLE LED turn red.
3. After 45 seconds, the CTL PWR BREAKER opens, indicating it is safe to open the S1 switch.

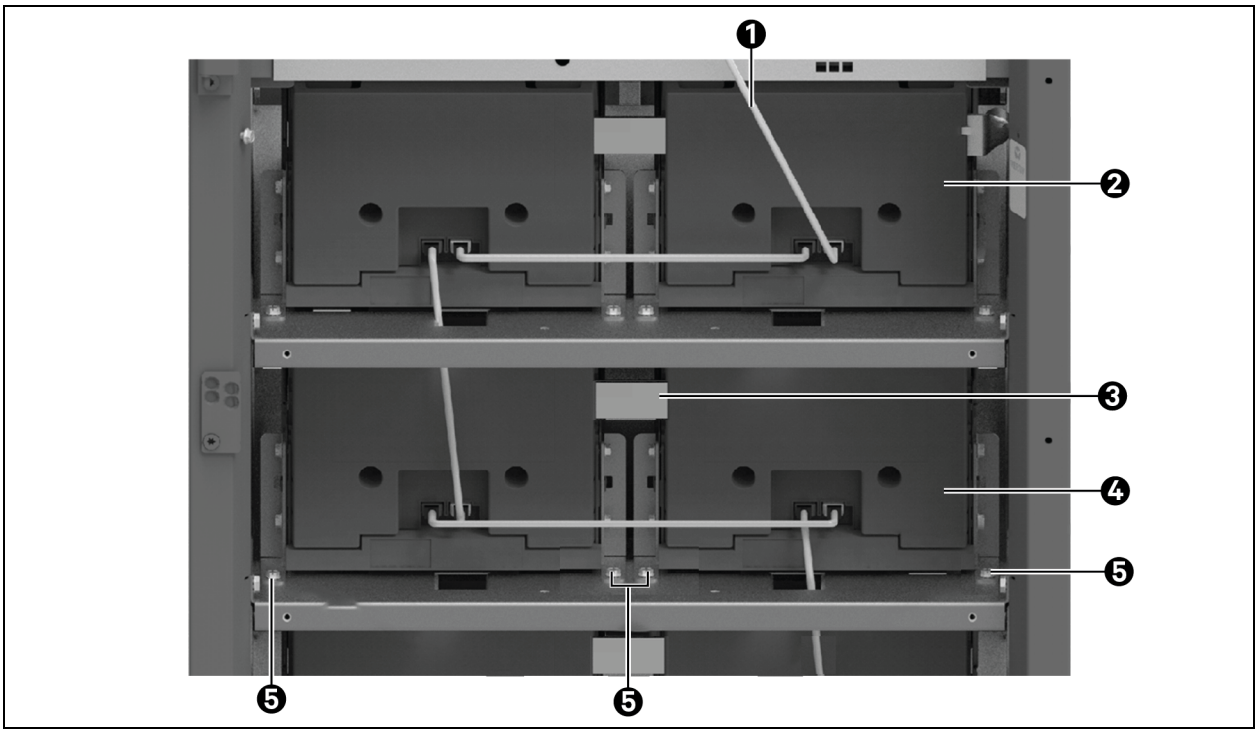
To close the S1 switch (maintenance disconnect):

1. Verify the CTL PWR BREAKER is open.
2. Verify the RUN/SERVICE key switch is in the RUN position.
3. Turn the S1 switch to ON position.
4. Close the CTL PWR BREAKER.

3.2 Battery Shelf

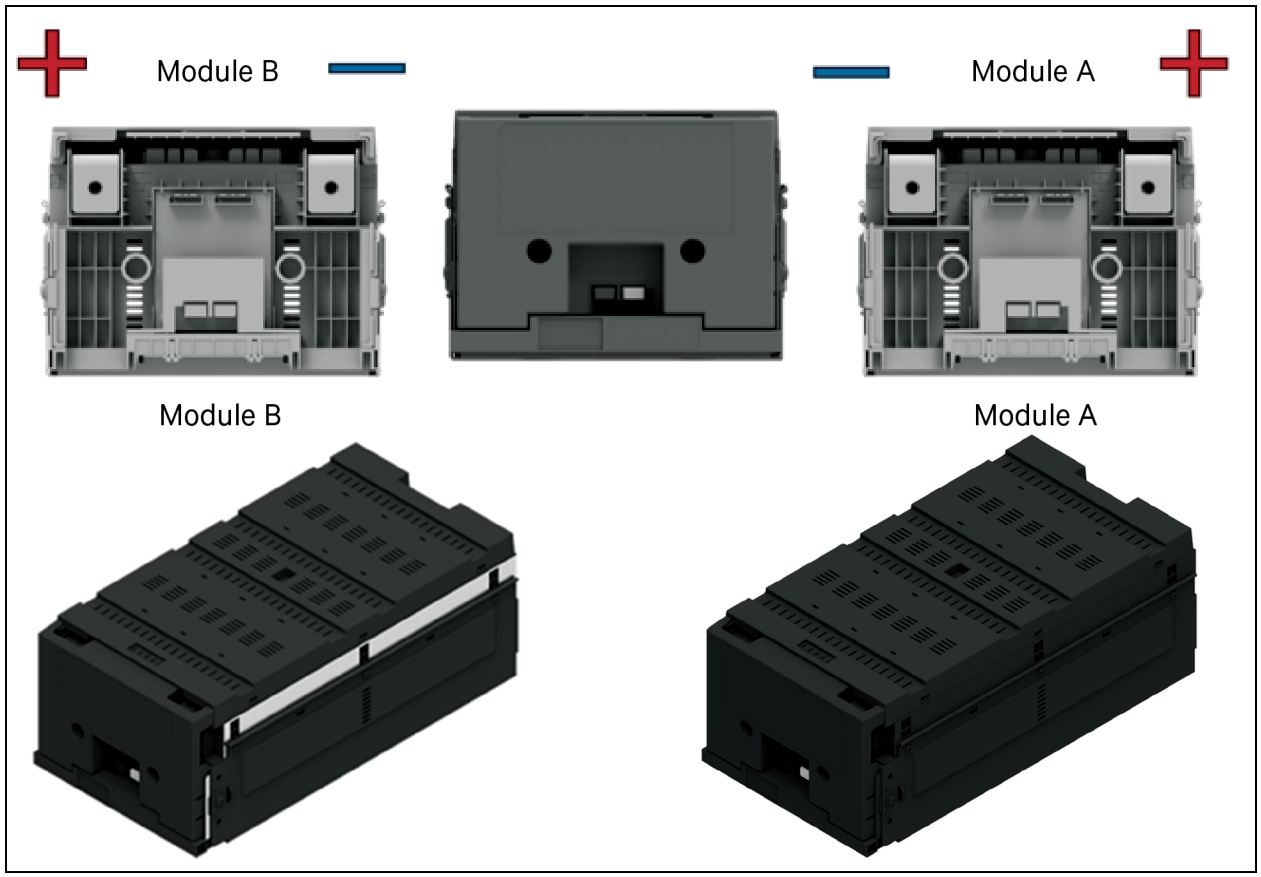
Each battery shelf contains two battery modules wired in series to the module above or below, as well as to the module on the side. Communication cabling is also connected between modules, in series. Communication cables transfer data between the battery monitoring and balancing boards (MBB) and the cabinet level BMS. See Figure 3.2 below for battery module wiring connections. The topmost shelf, which contains modules 1 and 2, will have type B batteries, and subsequent shelves will alternate between type B and type A. The module 17 configurations will have the 17th module on the right of the cabinet.

Figure 3.2 Battery Shelf Front



Item	Description
1	Communication cable
2	Type B module
3	Module to module busbar
4	Type A module
5	Shelf mounting hardware

Figure 3.3 Battery Modules



NOTE: The light gray stripe on the side of the type B module distinguishes type B from type A modules.

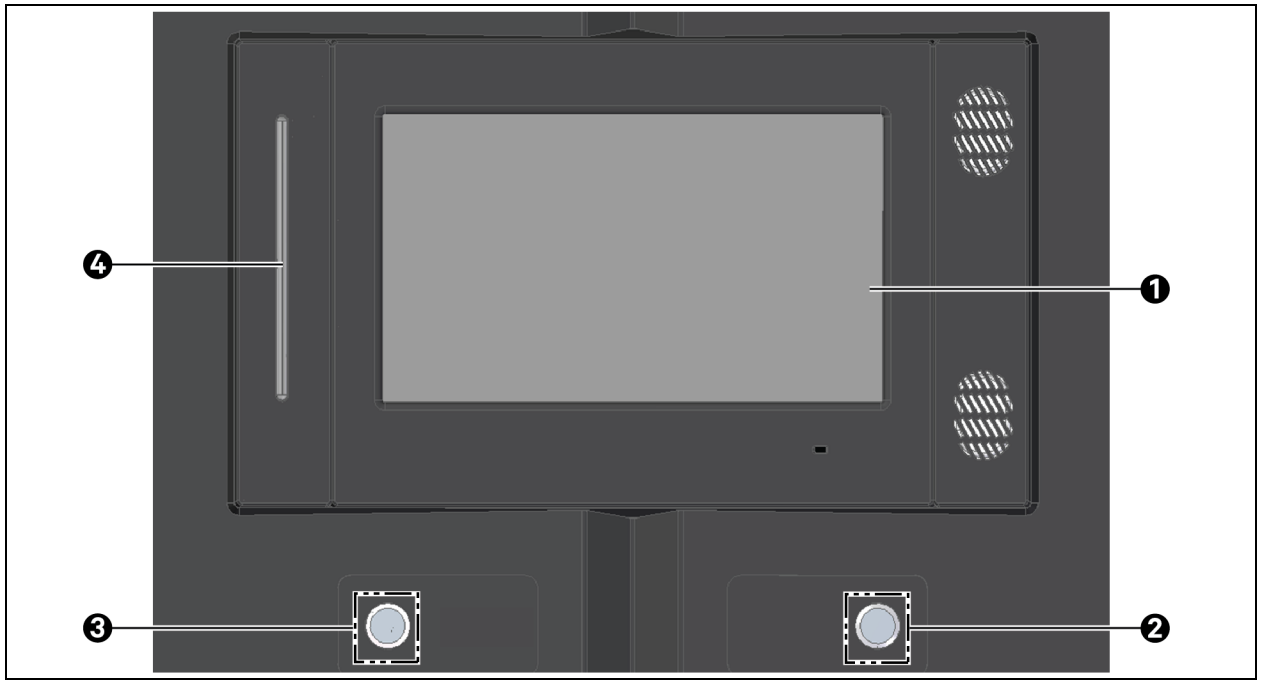
3.3 Local Interface

The local interface is the primary means of interacting with the Vertiv™ EnergyCore Lithium 7, see **Figure 3.4** below. The product offers the touchscreen HMI mounted on the cabinet door. The touchscreen HMI shows the status of all connected battery cabinets. The user can use the buttons on the HMI to bring the cabinet online (batteries connected to DC bus), disable the cabinet, and reset warnings or faults whose trigger condition has been cleared. The HMI light-bar also indicates the status of the battery cabinet.

A standard installation of the Vertiv EnergyCore Lithium 7 will have the touchscreen HMI on one battery cabinet while other parallel battery cabinets do not have the touchscreen HMI installed. More information on the HMI can be seen in Introduction of Global Human Machine Interface Touchscreen on page 13.

If the battery cabinet is ordered with external push buttons, the user may choose to bring the cabinet online (batteries connected to DC bus), disable the cabinet, and reset warnings or faults using the buttons. The illuminated buttons also indicate the status of the battery cabinet.

Figure 3.4 HMI Interface



Item	Description
1	Touchscreen HMI (optional)
2	ENABLE button (if present)
3	STOP/RESET button (if present)
4	LED status bar

3.3.1 ENABLE and STOP/RESET Buttons

NOTE: This section is only applicable if the battery cabinet has external push buttons. To bring the cabinet online (batteries connected to DC bus), disable the cabinet, and reset warnings or faults whose trigger condition has been cleared, the user can use push buttons on the HMI. See the following section.

The ENABLE button is at the right of the local interface. Press the button twice to enable the cabinet to connect its batteries to the DC bus when conditions are right. The system will be in waiting mode when the conditions for closing the contactors are not met. This is indicated by the flashing LEDs. The STOP/RESET button is at left hand side of the HMI interface. Press the button twice to open the internal contactors to disconnect the batteries from the DC bus. If a fault or warning is indicated but the trigger condition for it has been cleared, push STOP/RESET button once to reset the fault or warning indication. For more information of LED logic, see Table 3.1 below.

Table 3.1 ENABLE and STOP/RESET Button LED Logic

LED	Description
STOP/RESET button	
Off	ENABLE button LED is being used.
Red	This cabinet is disabled and disconnected.
Flashing	A fault status is active.
ENABLE button	
Off	STOP button LED is being used.
Red	The BMS firmware is not running, typically because the initial configuration has not been done yet. Contact Vertiv technical support.
Yellow	A warning status is active. Check the touchscreen HMI for detailed status.
Blue	The battery cabinet is online (connected), but batteries are not fully charged. No warnings are active.
Green	The battery cabinet is online (connected) and batteries are fully charged. No warnings are active.
Purple	Uncommon. Multi-cabinet coordinated disconnect request is active.
White	Uncommon. Service mode is active.
Flashing	The BMS firmware is waiting before closing switchgear. See Startup on page 49 for more information.

4 Introduction of Global Human Machine Interface Touchscreen

The global human machine interface (GHMI) is an integrated touchscreen control panel that allows for monitoring and management of a single or multiple Vertiv™ EnergyCore Lithium 7 cabinets. The GHMI collects a profusion of information about the health of the modules and presents it in a standardized format.

Dynamic display speeds operator response to managing system data and monitoring battery voltages and temperatures.

The interface of touchscreen control panel shows data either graphically or in text. The status scroll bar at the top of the touchscreen display summarizes system conditions. The scroll bar changes color to indicate status and includes an icon matched to the status. The status gauge shows details like system state of charge, system voltage, and time remaining during a discharge, if applicable.

The GHMI mimic provides comprehensive system information for the operator needs:

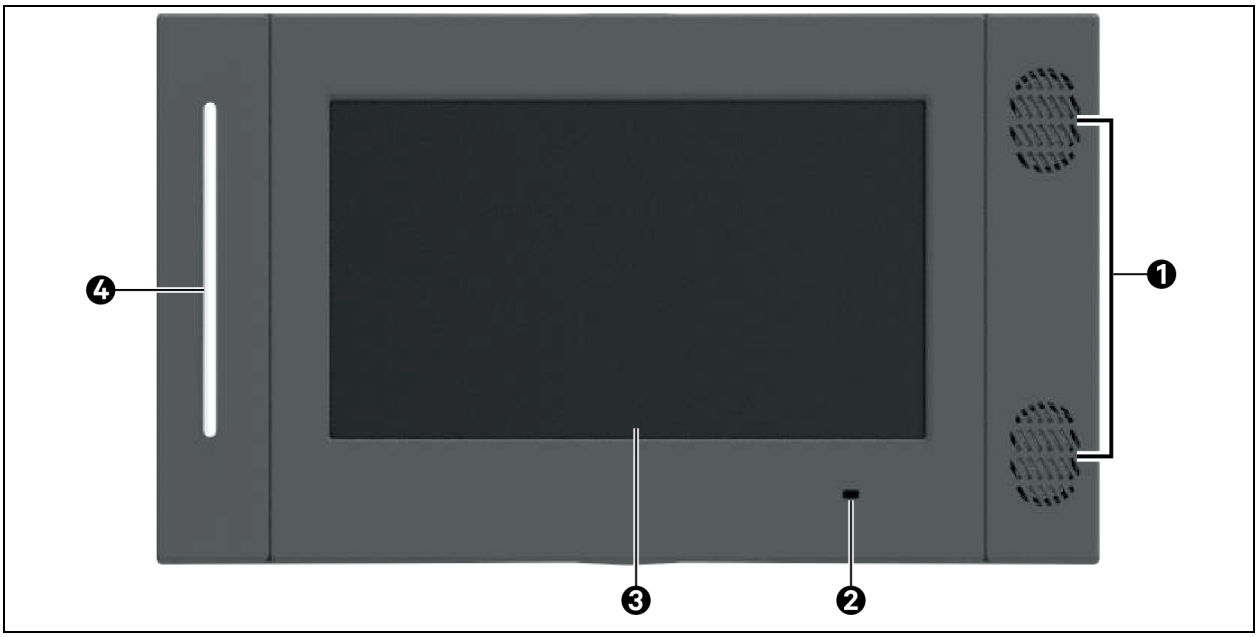
- State of battery cabinet
- Alarm summary
- Battery cabinet contactor status open/close
- Battery cabinet charge/discharge
- State of charge of the system

To check a specific battery cabinet, click on the mimic display. Information appears, allowing the operator to respond.

NOTE: Visual alarms notify personnel for faults and warnings that need to be fixed immediately.

Password protects the battery cabinet from unauthorized modification at Observer and Administrator access levels. Personnel without a password can view the status of the battery cabinets but cannot modify functions or configuration of the interface. Personnel with no passwords are operators.

Figure 4.1 Touchscreen Control Panel

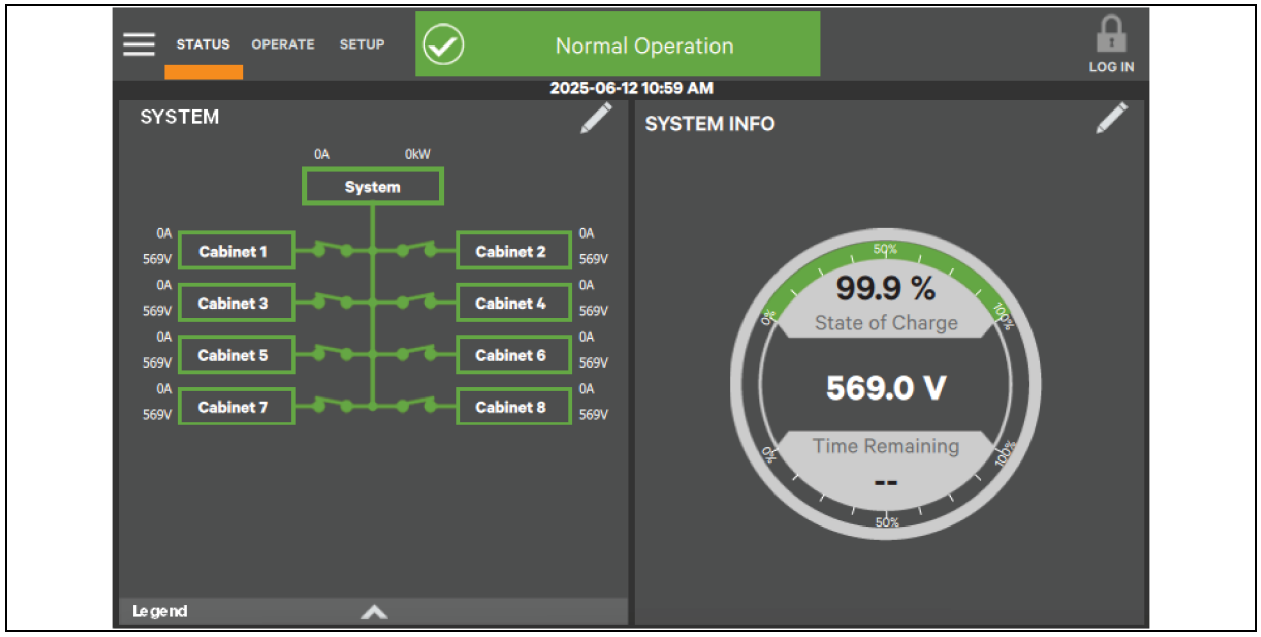


Item	Description
1	Speaker (not used)
2	GHMI LED status indicator (Green when On, No Color when Off)
3	Touchscreen HMI (optional)
4	LED status bar

4.1 Navigating Through the Touchscreen Control Panel

The touchscreen control panel is active when the control power breaker is closed and control power is available. The default view shows two panes such as SYSTEM and SYSTEM INFO. For more information of the default page, see Touchscreen Control Panel Components on page 16.

Figure 4.2 Vertiv™ EnergyCore Lithium 7 GHMI Default Screen



The touchscreen LCD on the front of the battery cabinet shows:

- System information of the UPS, battery cabinets, and battery modules.
- Battery cabinet status: normal operation, warnings, and faults.
- Battery runtime remaining, SOC, and total cabinet voltage during discharge.
- Active events.
- System level icon statuses: W, B, !, and ?. See Table 4.1 on page 25 for more information on system level icons.

4.1.1 Login Information

The touchscreen control panel has three access levels:

- Observer
- Operator
- Administrator

Each access has different levels of authority. Administrator is a default access level for the touchscreen control panel. When a PIN is set for the Administrator, the control panel opens at the operator level. To set or change a PIN, see Context Menu—SETUP on page 23.

Figure 4.3 below and Figure 4.4 below shows the GHMI display based on the three possible access levels.

Figure 4.3 Opening Screen Observer

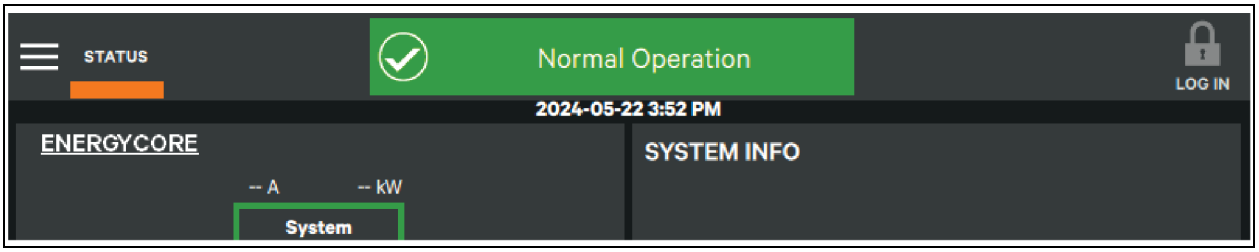
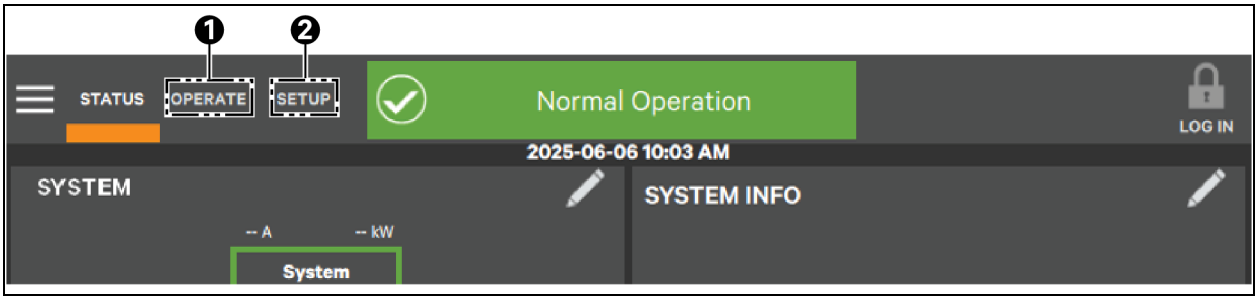


Figure 4.4 Opening Screen Operator/Administrator

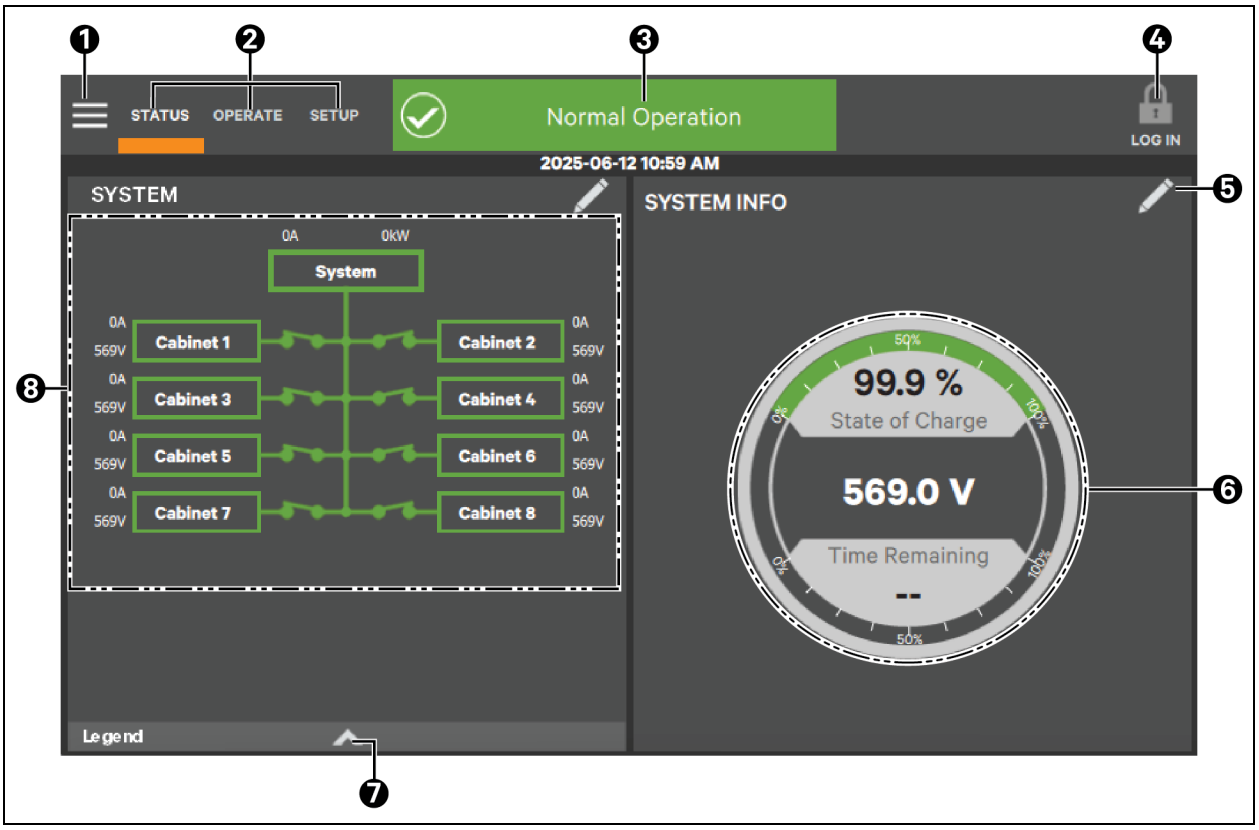


Item	Description
1	Operate tab (only displayed in Administrator mode)
2	Setup tab (only displayed in Administrator mode)

4.1.2 Touchscreen Control Panel Components

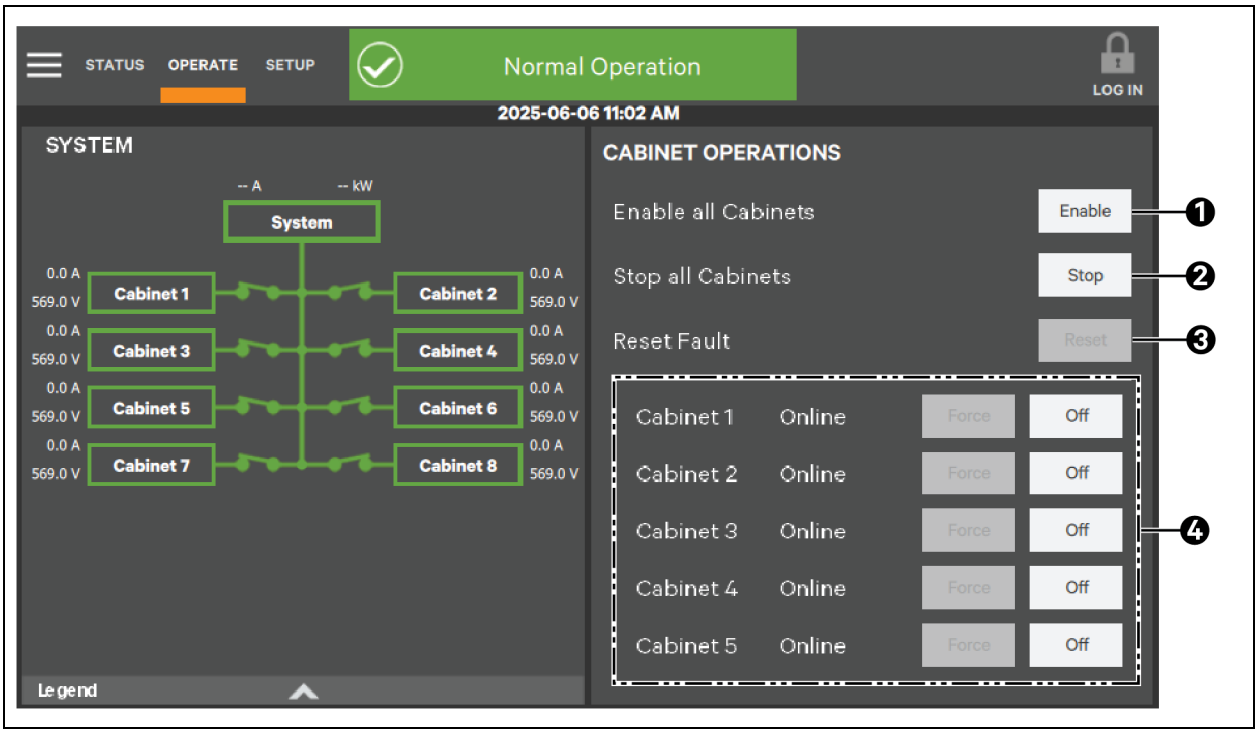
The touchscreen control panel opens to the STATUS screen upon login for all access levels. The status screen shows the system level data including the UPS, number of battery cabinets in parallel, system voltage, system state of charge (SOC), and more. The STATUS screen shows the animated mimic and system status readings at each login level.

Figure 4.5 Interface Overview STATUS Screen



Item	Description
1	Context menu icon
2	Function menu icons (varies by access level)
3	Alarm/status banner
4	Log In/Out icon
5	Press and hold the pencil icon for customization of the display
6	System status gauge
7	Legend drawer
8	Animated mimic display

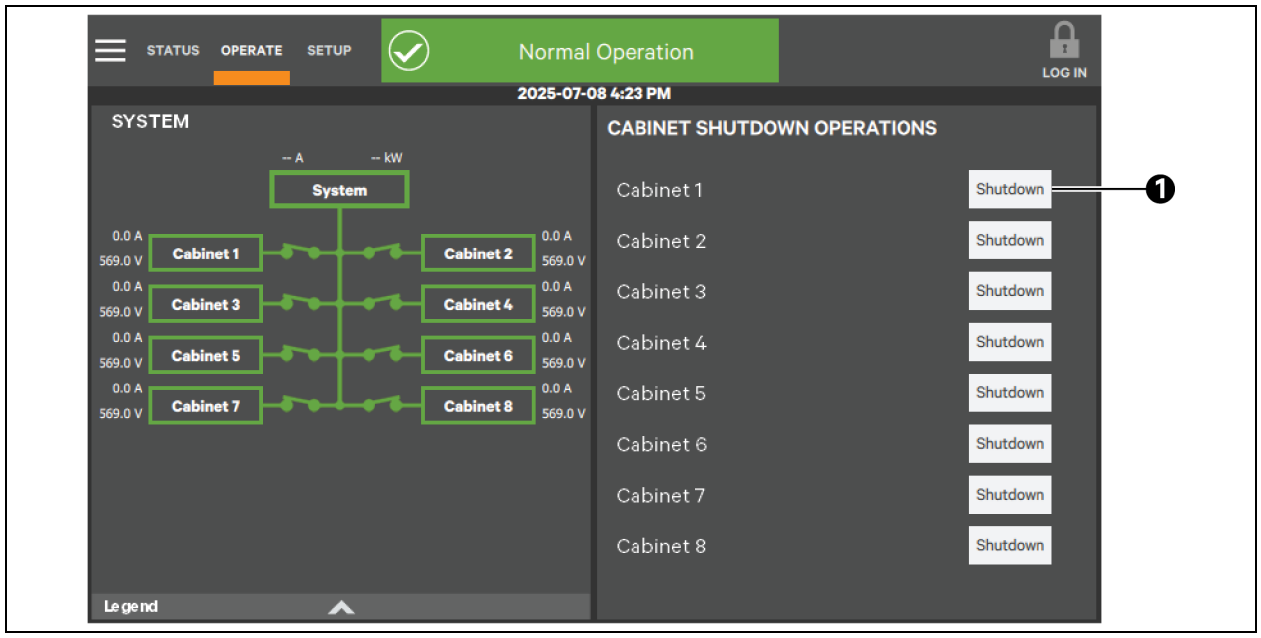
Figure 4.6 Interface Overview OPERATE Screen



Item	Description
1	Enable all cabinets in the system to the DC bus when conditions are right.
2	Disconnect all cabinets in the system from the DC bus.
3	Reset any active faults on battery cabinets within the system whose trigger conditions have been cleared.
4	Individual cabinet control. Buttons allow users to enable and remove individual cabinets from the DC bus. Force connection possible by pressing the 'Force' button. See Force Connection on page 52 for more information about force connection.

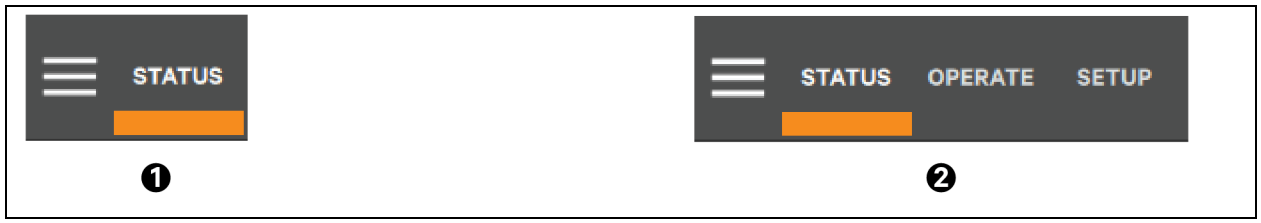
NOTE: The user will be prompted with a confirmation page after pressing any of the buttons above.

Figure 4.7 Interface Overview OPERATE Screen—Battery Cabinet Shutdown



Item	Description
1	Battery cabinet shutdown. Gracefully power down individual battery cabinets. Once pressing the button, the cabinet will take approximately 45 seconds to power down.

Figure 4.8 Control Display by Access Level (PIN Required)



Item	Description
1	Observer level
2	Operator/Administrative level

Different information and control options are accessible on each function menu. If PINs are required, the user's access level determines which function menu icons are displayed. For example, logging in as Administrator will show the STATUS, OPERATE, and SETUP function menus.

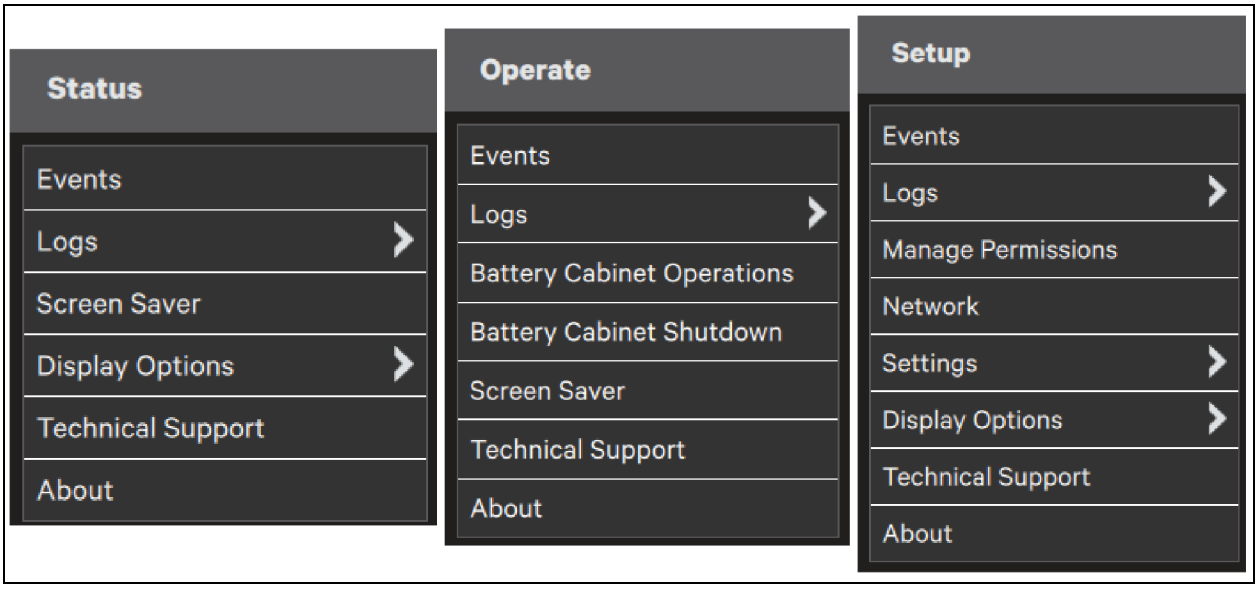
- STATUS: Shows the condition of the battery cabinet components and data affecting operation and performance. It is visible to all access levels.
- OPERATE: Allows user control of battery cabinet operations. It is visible to Administrator and Service levels.
- SETUP: Manages permissions through PINs. It is visible to Administrator and Service levels.

4.1.3 Context Menus

Click the Menu icon at the top left corner of the interface, a Context menu appears, showing information of the battery cabinet and allowing modifications of various settings.

The user's access level and the active Function Menu determine the functions that can be performed through the Context Menus (Status and Setup). For more information, see Figure 4.9 below.

Figure 4.9 Context Menus



Context Menu—STATUS

Click the STATUS and click the *Menu* icon, a status context menu appears that allows the user to access several actions or additional information. See **Figure 4.9** on the previous page. Click a STATUS context menu to show data, or expand the menu with more options. For more information, see **Figure 4.10** below.

Figure 4.10 Status Context Menu

Item	Description
1	Status context menu

The Context Menu for the STATUS icon shows below items:

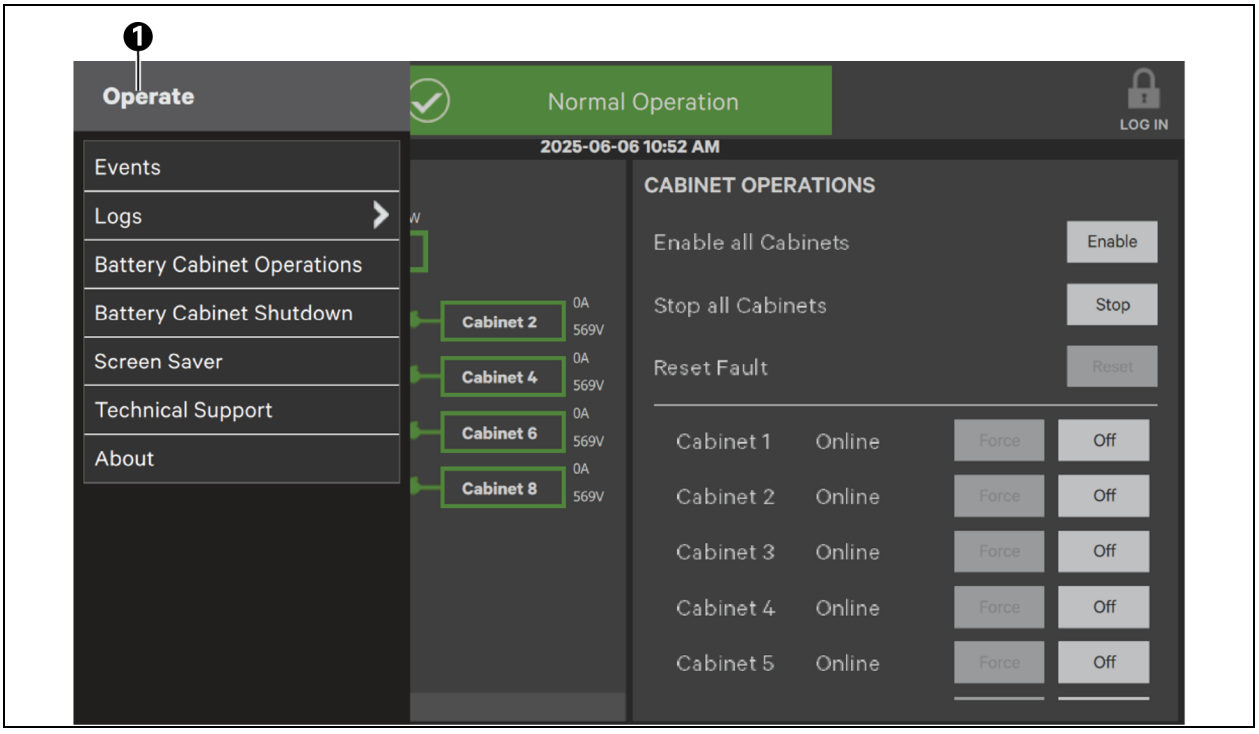
- **Events:** Date and time of occurrence, type of event, component affected and description. Events can be sorted by type, component, and description. The touchscreen allows filtering events by severity (Status, Alarm, or Fault) or by component (UPS or battery cabinet where the event occurred).
- **Logs:**
  - **Audit Log:** Audit Log shows date and time that users with battery cabinet Service or Admin access logged into and out of the system. In addition to date and time logging, the audit log shows user, event type, and ID data.
- **Screen Saver:** Display Sleep Mode notification (immediate entry into screen saver), screen goes dark and user is logged off. Click the screen reactivates the interface.
- **Display Options:**
  - **Display Properties:** Language, GHMI theme, display brightness, and audible alarm enabler.
  - **Date and Time:** Display of time zone, date, local time, and coordinated universal time (UTC time). It allows synchronizing time to network time.
  - **Formats:** Drop-down lists for date and time format and measurement system (metric or imperial).

- **Custom Labels:** Rename settings, serial ports, and network interfaces to ease troubleshooting and refine data. The default name of COM3 may be adequate but renaming it with the connected device may ease determining the cause of an alarm.
- **Technical Support:** Manufacturer provides support through e-mail address or telephone number.
- **About:** Information about the battery cabinet model, model number, and serial number.

Context Menu—OPERATE

Click the OPERATE and click the *Menu* icon, a status context menu appears that allows the user to access several actions or additional information. See **Figure 4.9** on page 19. Click the OPERATE context menu to show data, or expand the menu with more options. For more information, see **Figure 4.11** below.

Figure 4.11 Operate Context Menu



Item	Description
1	Operate context menu

The Context Menu for the OPERATE icon shows below items:

- **Events:** Date and time of occurrence, type of event, component affected and description. Events can be sorted by type, component, and description. The touchscreen allows filtering events by severity (Status, Alarm, or Fault) or by component (UPS or battery cabinet where the event occurred).
- **Logs:**
  - **Audit Log:** Audit Log shows the date and time that users with battery cabinet Service or Admin access logged into and out of the system. In addition to date and time logging, the audit log shows user, event type, and ID data.

- **Battery Cabinet Operations:** Allows the user to control the state of each individual battery cabinet or the entire system which includes enabling all/individual cabinets to the DC bus, disabling all/individual cabinets to the DC bus, resetting cabinet faults, and force connecting individual cabinets to the DC bus. Cabinet operation buttons include:
  - **Enable all Cabinets:** Button press closes the C1 contactor on all cabinets (cabinets connect to DC bus) within the system. Note: the cabinet's contactor will not close if a fault is present or UPS Ready Signal is de-asserted.
  - **Stop all Cabinets:** Button press opens the C1 contactor on all cabinets (cabinets disconnect from the DC bus) within the system.
  - **Reset Fault:** Button press resets any active fault within the system.

NOTE: The fault will clear once the cabinet is within normal operating limits.

  - **Cabinet 1 Force:** Button press forces the cabinet to the DC bus. The firmware will ignore this command if the voltage difference is too high for a safe connection. See Force Connection on page 52 for more information.
    - Force connect button is present for all individual cabinets within the system.
  - **Cabinet 1 Enable:** Button press closes the C1 contactor for the individual cabinet (cabinet connects to DC bus).

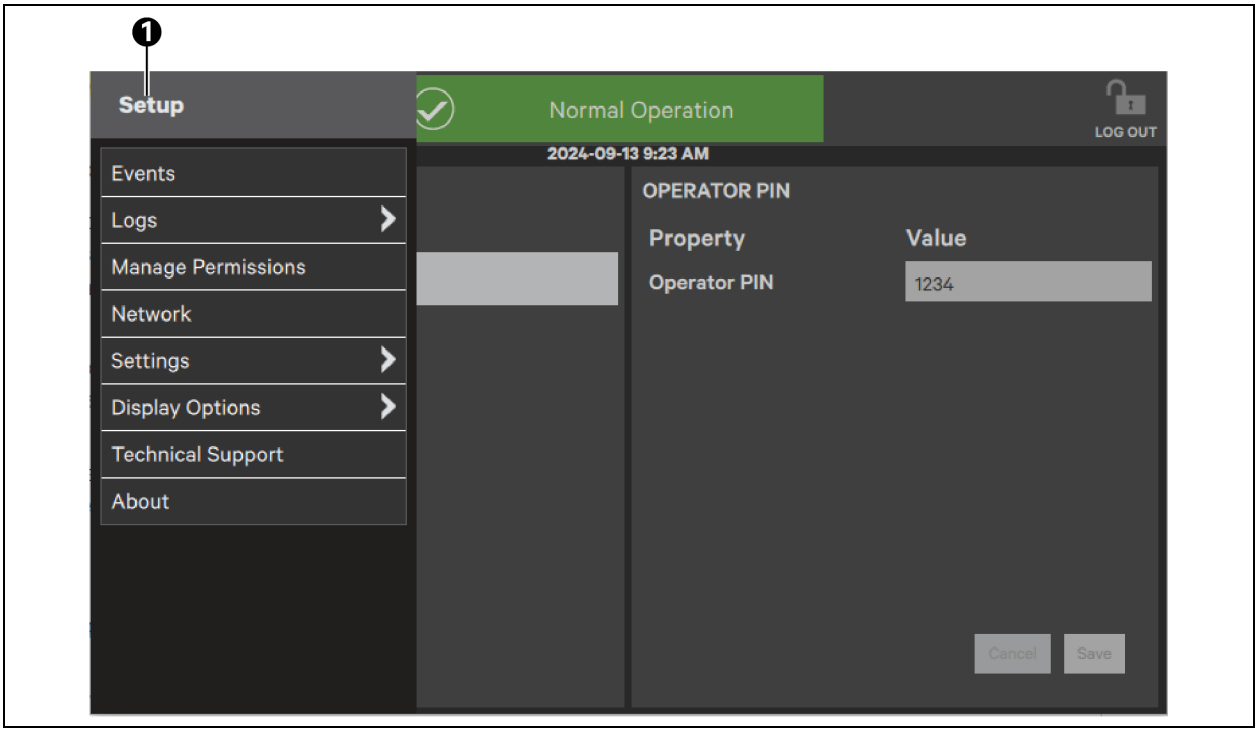
NOTE: The cabinet will not close its contactor if a fault is present or the UPS Ready Signal is de-asserted.

    - Enable button is present for all individual cabinets within the system.
  - **Cabinet 1 Stop:** Button press opens the C1 contactor for the individual cabinet (cabinet disconnects from the DC bus).
- **Battery Cabinet Shutdown:** Allows the user to shutdown (power off) each individual battery cabinet.
- **Screen Saver:** Display Sleep Mode notification (immediate entry into screen saver), screen goes dark, and user is logged off. Clicking on the screen reactivates the interface.
- **Technical Support:** Manufacturer provides support through e-mail address or telephone number.
- **About:** Information about the battery cabinet model, model number, and serial number.

Context Menu—SETUP

Click the SETUP and click the *Menu* icon, a setup context menu appears that allows the user to access several actions or additional information. See Figure 4.9 on page 19. Click a SETUP context menu to show data, or expand the menu with more options. For more information, see Figure 4.12 below.

Figure 4.12 Setup Context Menu



Item	Description
1	Setup context menu

The Context menu for the SETUP icon shows these items:

- Events: Date and time of occurrence, type of event, component affected and description. Events can be sorted by type, component, description. The touchscreen also allows filtering events by severity (Status, Alarm, or Fault), or by component (UPS or battery cabinet where the event occurred).
- Logs:
  - Audit Log: Audit Log shows date and time that users with battery cabinet Service or Admin access logged into and out of the system. In addition to date and time logging, the audit log shows user, event type and ID data.
- Manage Permissions: Change or require PIN for users of Administrators or Operators.
- Network: Modify communication settings.
- Settings:
  - Unit: modify or view unit name.
- Display Options:
  - Customize Layout: Change panel content and layout.

- **Display Properties:** Language, GHMI theme, backlight off timer, alarm window timeout, screen saver timer, auto-logout timer, display brightness, status indicator brightness, audible alarm enabler, lock screen enabler, and calibrate touch screen.
- **Date and Time:** Drop-down lists of time zone, date, local time, and UTC time allows synchronizing time to network time.
- **Formats:** Drop-down lists for date and time format and measurement system (metric or imperial).
- **Custom Labels:** Rename settings, serial ports and network interfaces to ease troubleshooting and refine data. The default name of COM3 may be adequate but renaming it with the connected device may ease determining the cause of an alarm.

- **Technical Support:** Manufacturer provides support through e-mail address or telephone number.
- **About:** Information about the battery cabinet model, model number, and serial number.

4.1.4 System Pane—Mimic Display Components

The animated mimic display, the default view for the control, shows each configured major component of the battery system, as shown in **Figure 4.14** on page 27. The mimic display is the same for all access levels. The DC bus path is shown by animated lines. Moving dashes show the active charge/discharge of the battery cabinets. Click a component to (except contactors) display details about the status of the component. See Touchscreen Control Panel Components on page 16 for more information on component status. The contactor is shown as open or closed.

System level icons follow the requirements below (icons consist of UPS, battery cabinets, and battery modules):

- Each icon features with an outline with a color indicating its status.
- The icon outline can either blink at one (1) Hz or not blink.
- In some cases, an information character like **!** or **?** is placed on or near the icon. For more information see Information Characters below.

Information Characters

- **B:** Cell balancing is present. Balancing can occur in any cabinet state. See cabinet states in **Table 4.1** on the facing page.
- **W:** The cabinet is in the waiting state. The system will be in WAITING mode, if the conditions are not suitable for the internal contactors to close. See Startup on page 49 for several reasons a cabinet may remain in the waiting state.
- **!:** A fault or warning is present.
- **?:** Unknown. Contact Vertiv Service for more information.

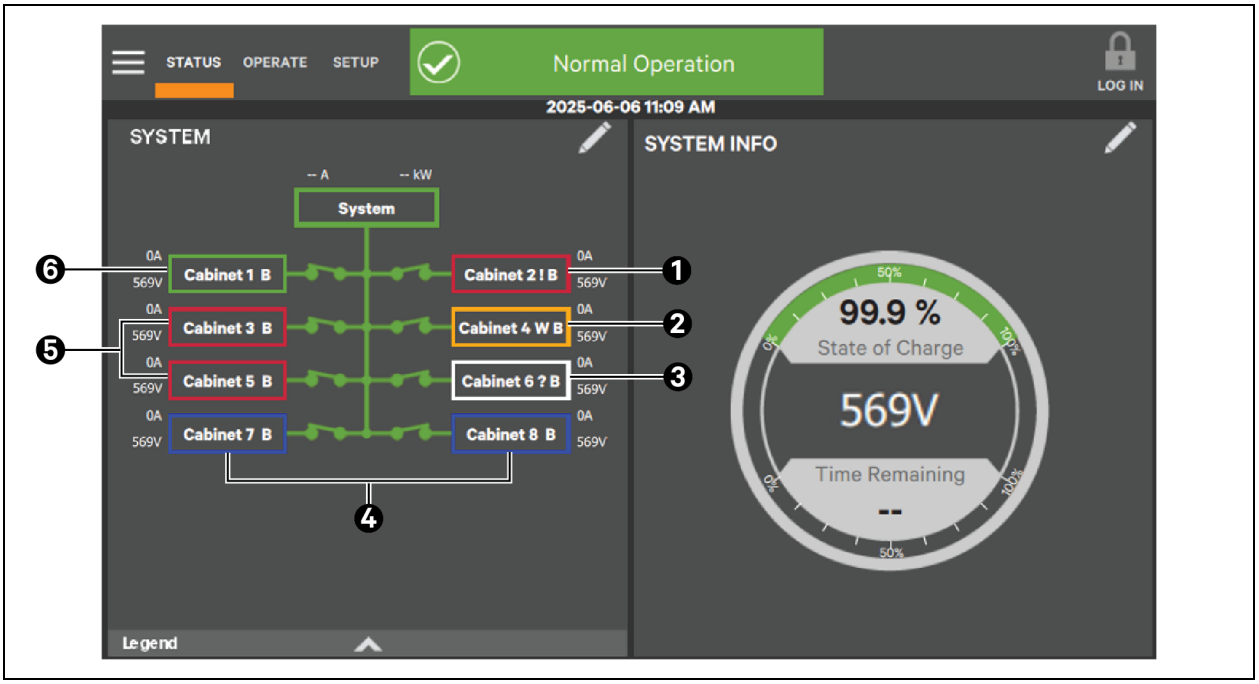
Table 4.1 below further explains the requirements.

Table 4.1 HMI Battery Cabinet Icon Behaviors in System View

Icon Behavior												
Icon Color	Red	Red	Yellow	White	White	Red			Red	Green	Blue	Yellow	Gray
Blink icon at 1 Hz?	No	No	Yes	No	No	No			No	No	No	No	No
Information character	(none)	?	W	(none)	!	Any			!	(none)	(none)	!	?
Conditions													
Cabinet State	STARTUP	UNK	WAITING	SERVICE		SHUTDOWN			FAULT	ONLINE			Any
Cabinet Warning Present?	Any	Any	Any	Any	Any	TRUE	Any	FALSE	Any	FALSE	FALSE	TRUE	Any
Cabinet Fault Present?	Any	Any	Any	FALSE	TRUE	Any	TRUE	FALSE	Any	Any	Any	Any	Any
Cabinet Fully Charged?	Any	Any	Any	Any		Any			Any	TRUE	FALSE	Any	Any
RECEIVED DATA FROM THIS CABINET IN LAST 5 SECONDS?	Yes												No

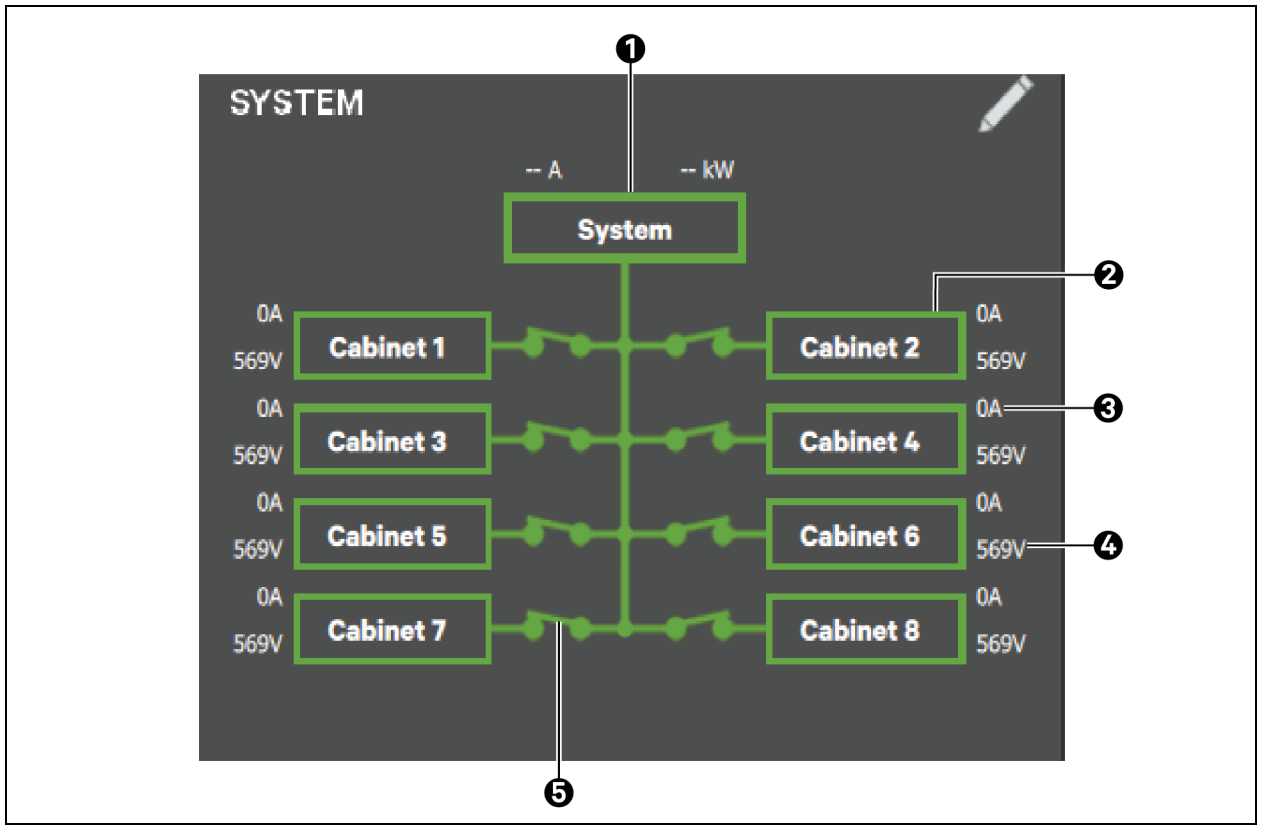
See **Figure 4.13** below for a visual display of a variety of system level icons.

Figure 4.13 Vertiv™ EnergyCore Lithium 7 System Level Icon Display Screen



Item	Description
1	Cabinet State: Fault. Cell balancing present.
2	Cabinet State: Waiting. Cell balancing present.
3	Cabinet State: Service. Cell balancing present and data has not been received from this cabinet in the last 5 seconds.
4	Cabinet State: Online. Cell balancing present and cabinet is not fully charged.
5	Cabinet State: Shutdown. Cell balancing present.
6	Cabinet State: Online. Cell balancing present and cabinet is fully charged.

Figure 4.14 Animated System Display



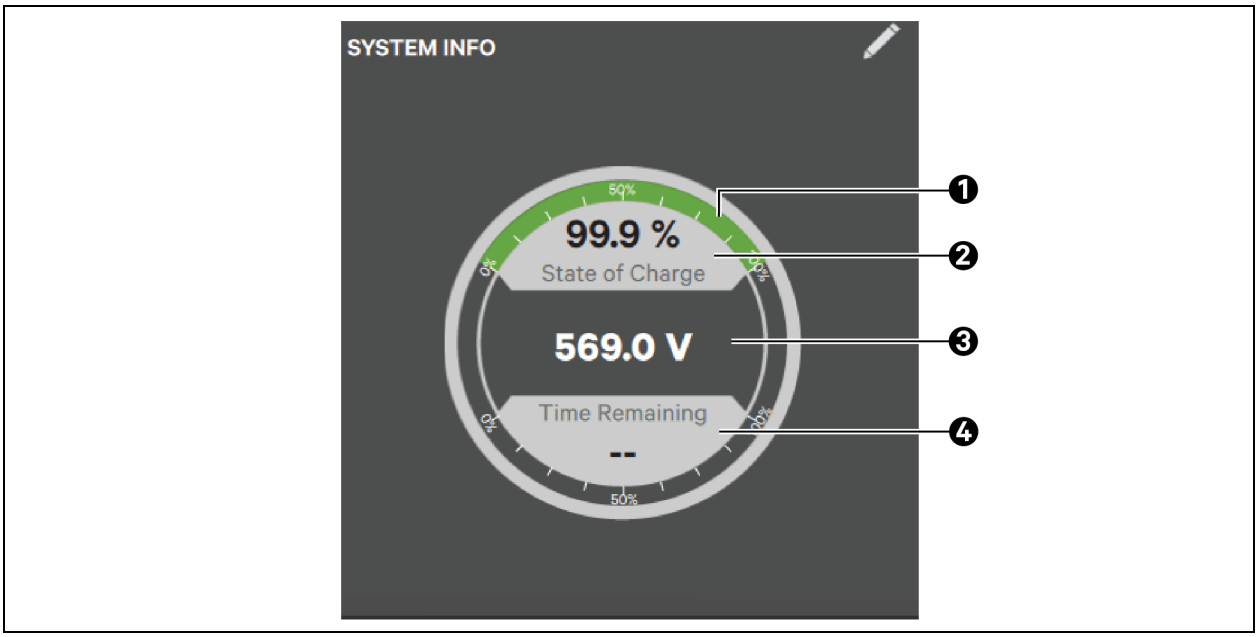
Item	Description
1	System icon
2	Battery cabinet icon
3	Battery cabinet current (non-zero value displayed during charge/discharge)
4	Battery cabinet voltage
5	Contactor

The system information display shows the average state of charge and battery voltage of the entire system. The remaining runtime will appear during a discharge. The system information gauge is shown in Figure 4.15 below. The color coding of the system gauge is as follows:

- State of charge is greater than or equal to 30%, system gauge shows green color.
- State of charge is less than 30% and greater than or equal to 10% system gauge shows yellow color.
- State of charge is less than 10% system gauge shows red color.

Remaining runtime replaces state of charge percentage during a discharge. Once time remaining is less than 30 seconds, a dash (-) will display.

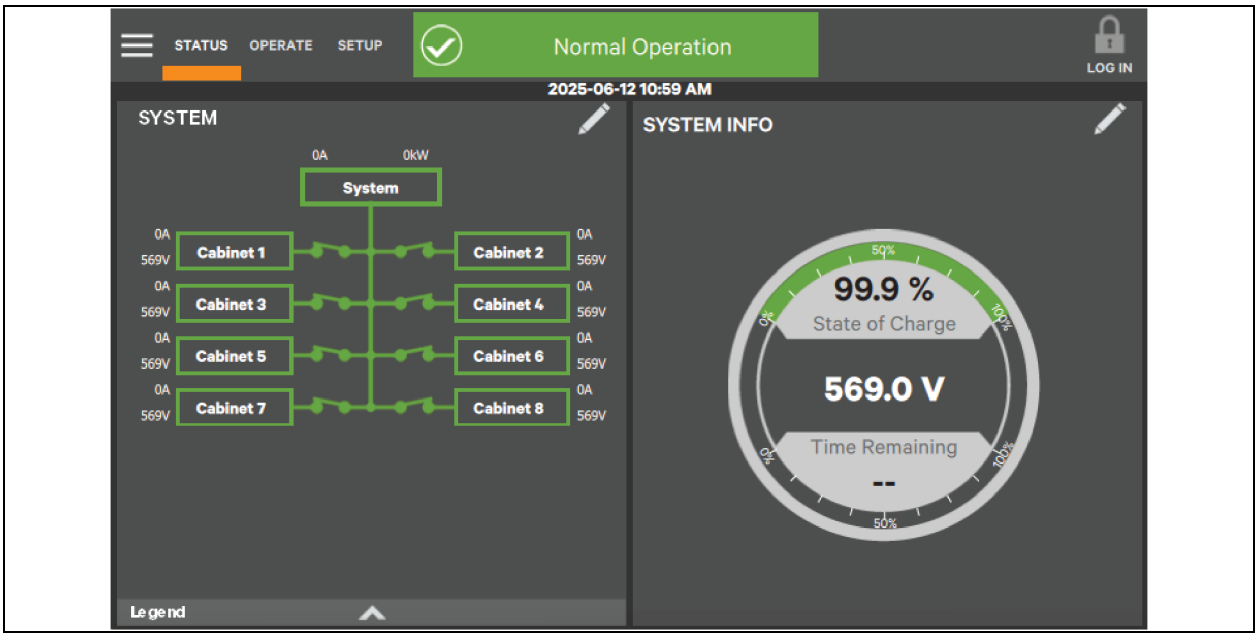
Figure 4.15 System Information Display



Item	Description
1	System gauge color coded visual SOC display
2	Average state of charge of entire system
3	Average rack voltage of entire system
4	System level runtime remaining appears during discharge **NOTE: If the load is greater than 35 kW, the runtime remaining appears immediately. If the load is less than 7 kW, runtime remaining appears after 2 seconds.**

Figure 4.16 below shows the default system view of the GHMI which includes the animated mimic display and the system information gauge.

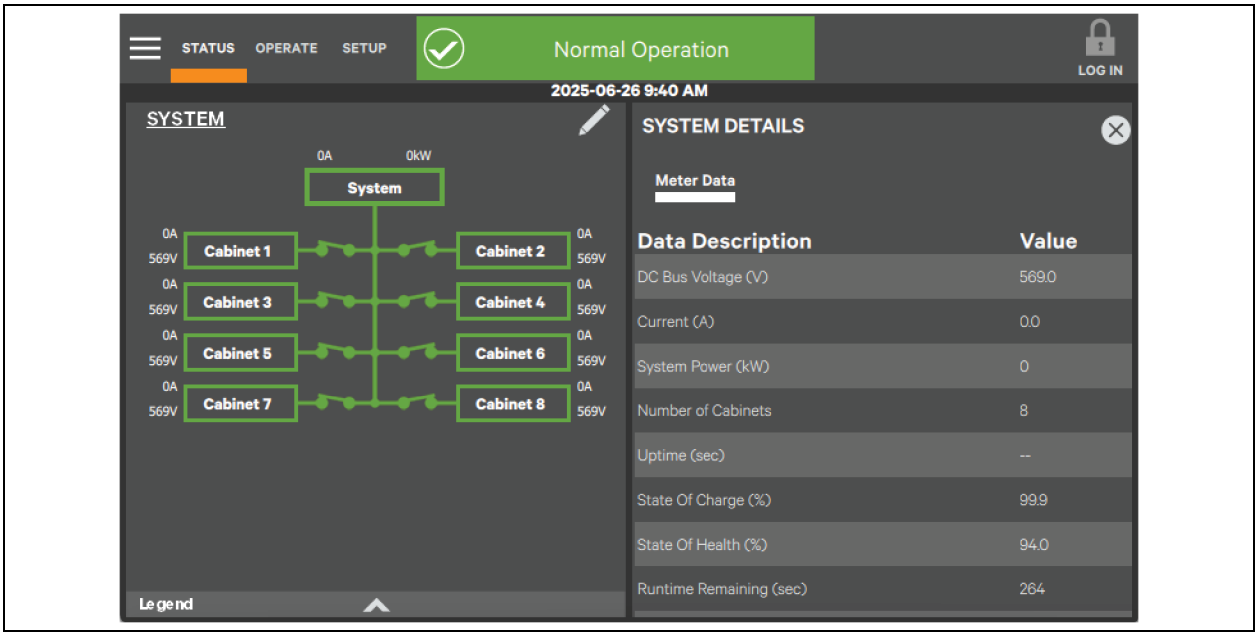
Figure 4.16 Default System View



4.1.5 System Overview

Click on the *System* icon from the default system page, the information of the UPS appears on screen, as shown in Figure 4.17 below.

Figure 4.17 System Overview

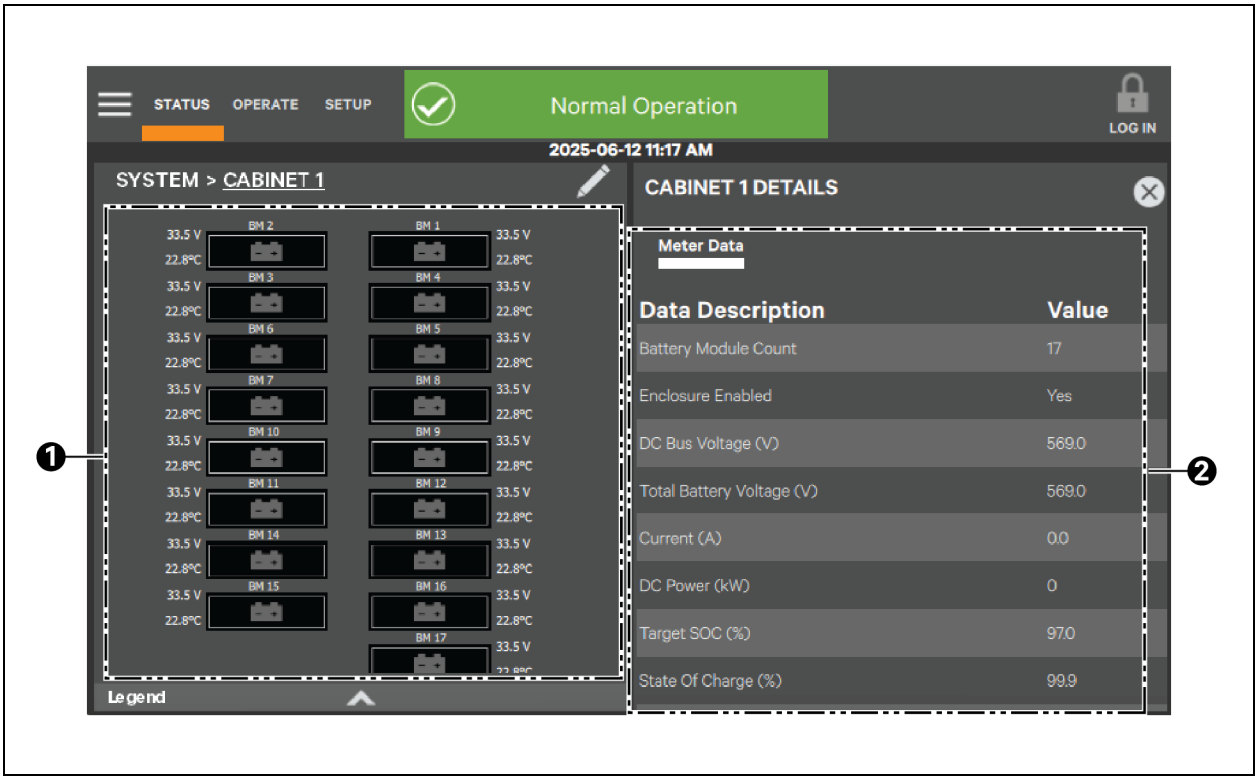


4.1.6 Battery Cabinet Overview

Click on the *cabinet* icon from the default system page, information of the selected cabinet appears on the screen, as shown in Figure 4.18 below. Cabinet 1 is selected.

Click a *battery module* icon, information about the specific battery module displays. See Battery Module Overview on the facing page for more information on battery module status.

Figure 4.18 Battery Cabinet Overview

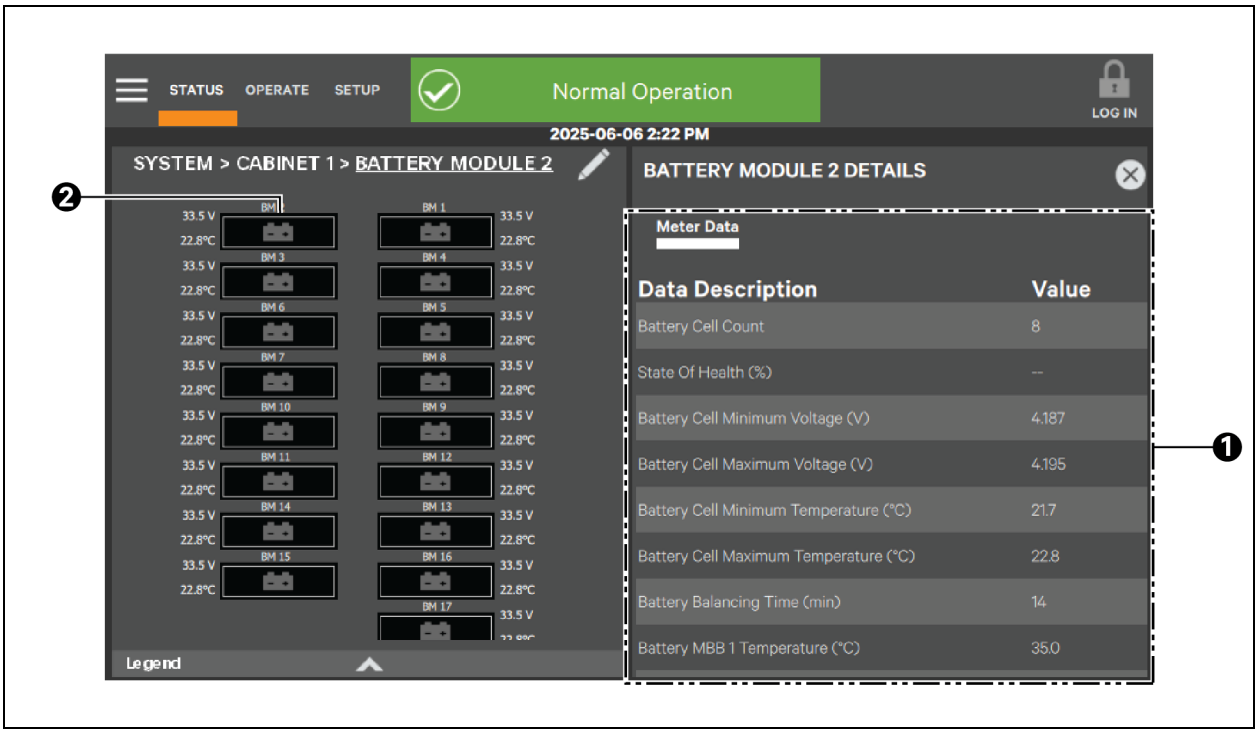


Item	Description
1	Battery module overview
2	Cabinet system overview

4.1.7 Battery Module Overview

Click on the *battery module* icon from the battery cabinet overview page, information of the selected module appears on screen, as shown in Figure 4.19 below. Battery module 2 is selected.

Figure 4.19 Battery Module Overview

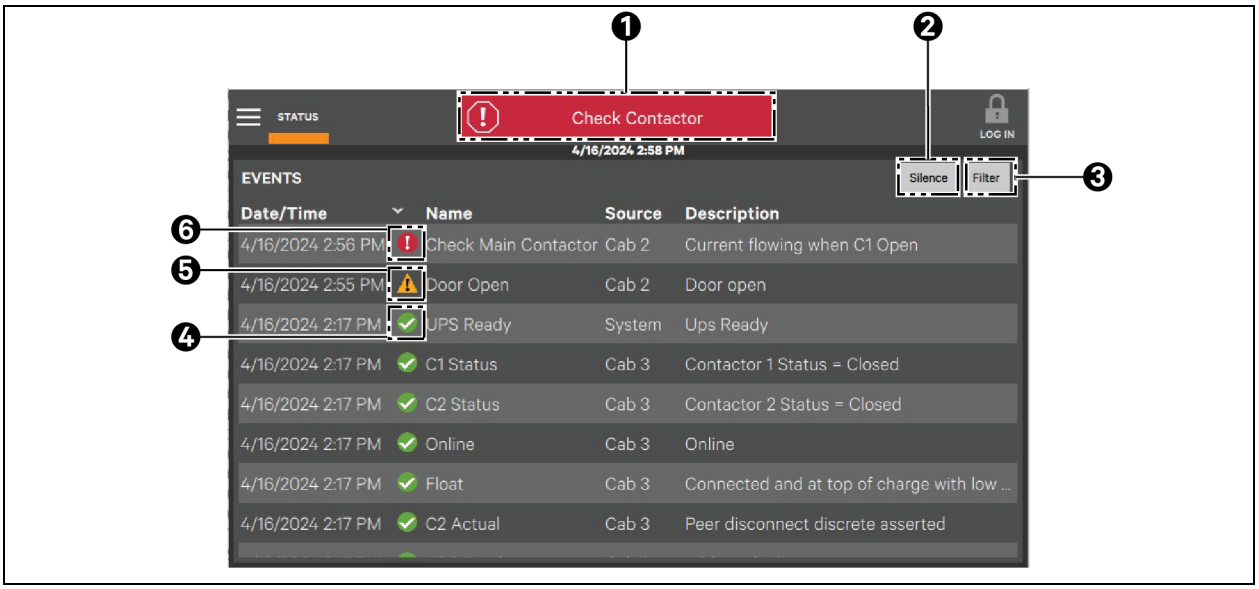


Item	Description
1	Battery module 2 overview
2	Battery module 2 selected

4.1.8 Events Overview

Click on the EVENTS option from the menu selection icon and a log of events will display. This log includes battery cabinet events such as any fault, warning and normal operation. For more information on warnings/faults, see Warnings and Faults on page 67. Click the Filter button to filter the log of events. Click the Silence button if any fault alarm is present. See Figure 4.20 below.

Figure 4.20 Events Overview



Items	Description
1	Alarm/status banner (fault displayed)
2	Silence alarm, if alarm is present
3	Filter event log
4	Normal operation
5	Warning present
6	Fault present

5 Installation

This section provides information to install the Vertiv™ EnergyCore Lithium 7 at the customer site. Installation must be performed by installers familiar with rigging heavy equipment and connecting high power electrical devices and control wiring.

WARNING! Risk of electric shock. Can cause injury or death. Equipment installation, inspection and startup should be performed only by properly trained personnel wearing appropriate, OSHA-approved PPE. Lethal voltages are present during startup procedures. Electrical safety precautions must be followed throughout inspection and startup.

WARNING! High voltage electric shock hazard. Battery modules and wires may be exposed, increasing the probability of electric shock. The Vertiv EnergyCore Lithium 7 contains high voltage electric shock sources. Do not open any cover of the battery module or power chassis assembly.

CAUTION: Failure to follow safety procedures during unpacking and installation may result in severe injury.

NOTICE

If a metal panel needs to be drilled or punched, remove the panel first to avoid debris falling into the battery cabinet. Local building safety codes may require specific signage that indicates lithium-ion energy storage systems are installed in an area. Edge guard or similar edge protector may be necessary to install in free drop installations to protect cabling.

NOTE: If all the batteries are connected in series, the left side of the backplane of the battery cabinet (when facing from the back of the cabinet) will have the full battery voltage.

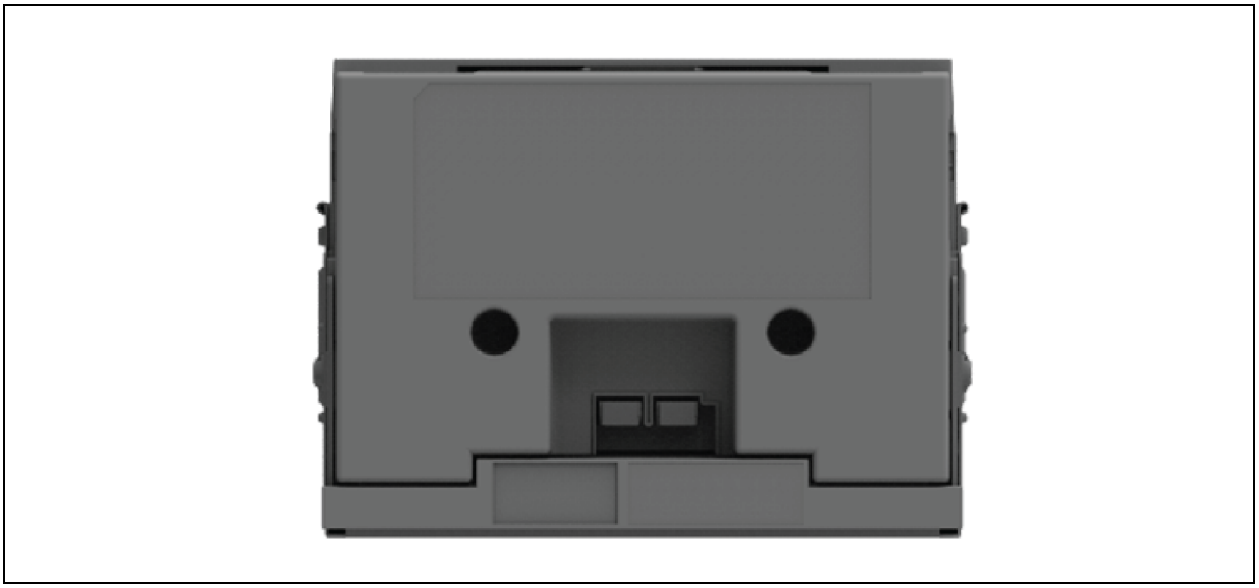
NOTE: Do not connect cables to the UPS charger until confirming that there is no voltage present on the left side busbars.

5.1 Arc Flash and Shock Hazard Safety

Each battery module has a protective cover installed to prevent accidental short circuits during installation.

NOTE: Do not remove the protective covers or connect the battery modules in series before the installation is completed.

Figure 5.1 Protective Cover



5.2 Location

The cabinet is intended to be installed in an area with the following characteristics:

- No corrosive or explosive gases in atmosphere, including hydrogen sulfide or sulfur dioxide.
- Indoors with controlled temperature and humidity.
- Not adjacent to a heat source, such as hot air duct or radiant heater.
- Not continuously exposed to direct, unfiltered sunlight.
- Not accessible to the public (controlled access area only).

Table 5.1 Required Minimum Clearances after Installation

Area	Description
Above the cabinet	18 in. (457 mm) to any obstruction. This is for technician working space.
Front of cabinet	36 in. (914 mm) to any obstruction. This allows the door to open and provides technician working space.
Between the cabinet and a combustible fire wall	1 in. (25 mm)
Between two cabinets (or to other equipment frame) back-to-back	Standard mounting: None Seismic rated mounting: 4 in. (102 mm)
Between two cabinets (or to other equipment frame) side-to-side	None
NOTE: Local building safety laws may require additional clearance to walls, ceilings, or other equipment.	

5.3 Unpacking and Placement of the Cabinet

The cabinet may be removed from its shipping pallet with either a forklift or a lifting mechanism using slings attached to bolts on top of the cabinet. The packaging containing busbars and hardware is inside of the Vertiv™ EnergyCore Lithium 7 cabinet. Take care to locate this, remove it from the cabinet, and do not discard.

WARNING! Failure to follow the safety procedure or using equipment insufficiently rated for the weight of the Vertiv EnergyCore Lithium 7 may result in injury or death.

CAUTION: Risk of shock loading during relocation. Can cause unit damage. Exercise caution while moving the unit to avoid equipment damage. Handle the unit so that it is not subjected to shock loading, such as being dropped or severely jarred.

CAUTION: Failure to follow these handling instructions may lead to damage to the Vertiv EnergyCore Lithium 7. Such damage will not be covered by the warranty.

CAUTION: Lithium batteries must be handled by trained professionals and handled with care to avoid collision and falling. Lifting equipment used to handle lithium batteries must have sufficient lifting capacity.

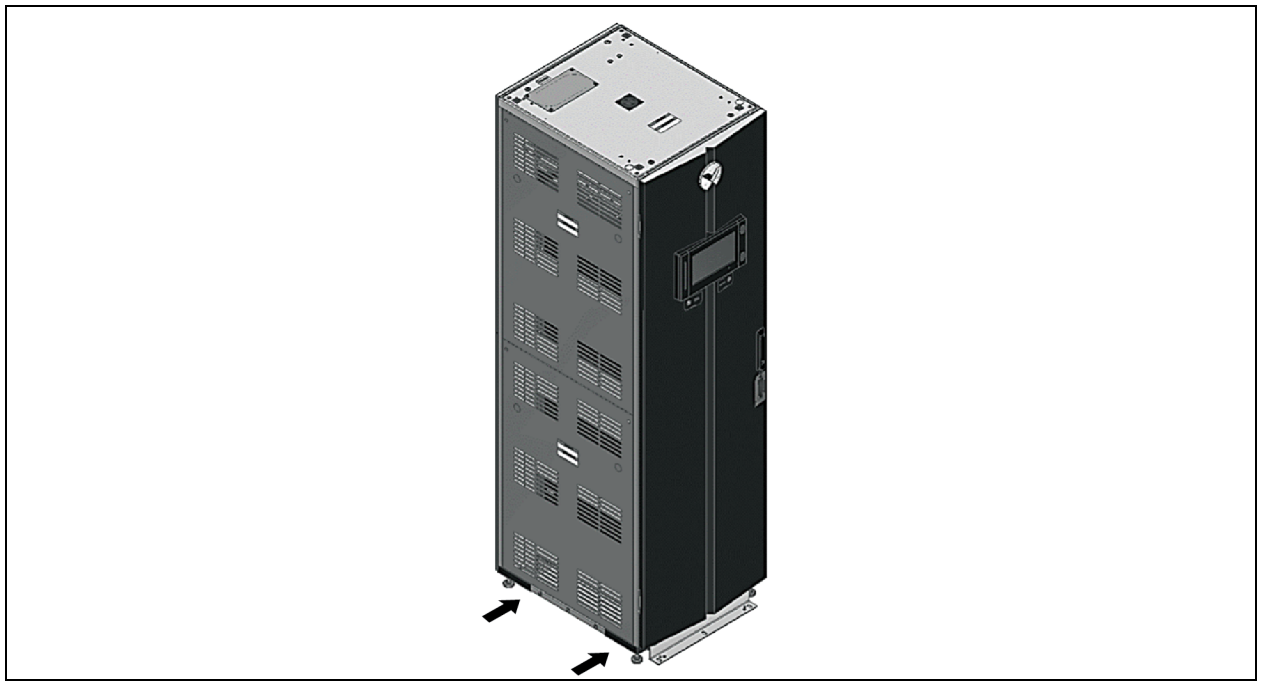
To use a forklift to the Vertiv EnergyCore Lithium 7 from its shipping pallet, follow this procedure:

1. The maximum overall width of the forks is 18 in. (457 mm) and the maximum thickness of the forks is 2 in. (51 mm). The minimum lifting capacity of forklift should be 635 kg (1400 lb.).
2. Unpack the rack and remove the bolts holding down brackets to the base of the cabinet and the shipping pallet.
3. Remove the brackets on the sides of the cabinet.
4. Crank the leveling feet up to their highest safe position and remove the brackets.

NOTE: If the cabinets are to be installed back to back, the conduit box must be used for the power cables. If the cabinets are to be installed side by side, using the conduit box is optional. If the conduit box is not in use, power cables must be installed from the rear of the cabinet before the cabinet is placed in its final position. There is minimal space for cable slack inside the cabinet.

5. Position the forklift on the side of the Vertiv EnergyCore Lithium 7 and move the forks so they are just inside the casters. See Figure 5.2 on the next page.
6. Move the forks under the cabinet from the side until they are fully inserted.
7. Lift the cabinet straight up until it clears the shipping pallet.
8. Slide the shipping pallet from under the unit and lower the Vertiv EnergyCore Lithium 7 onto a level surface.
9. Use the casters to move the unit into place. Do not use the lifting mechanism to transport the unit.
10. When the unit is in place and level, crank down the leveling feet to take pressure off the casters.

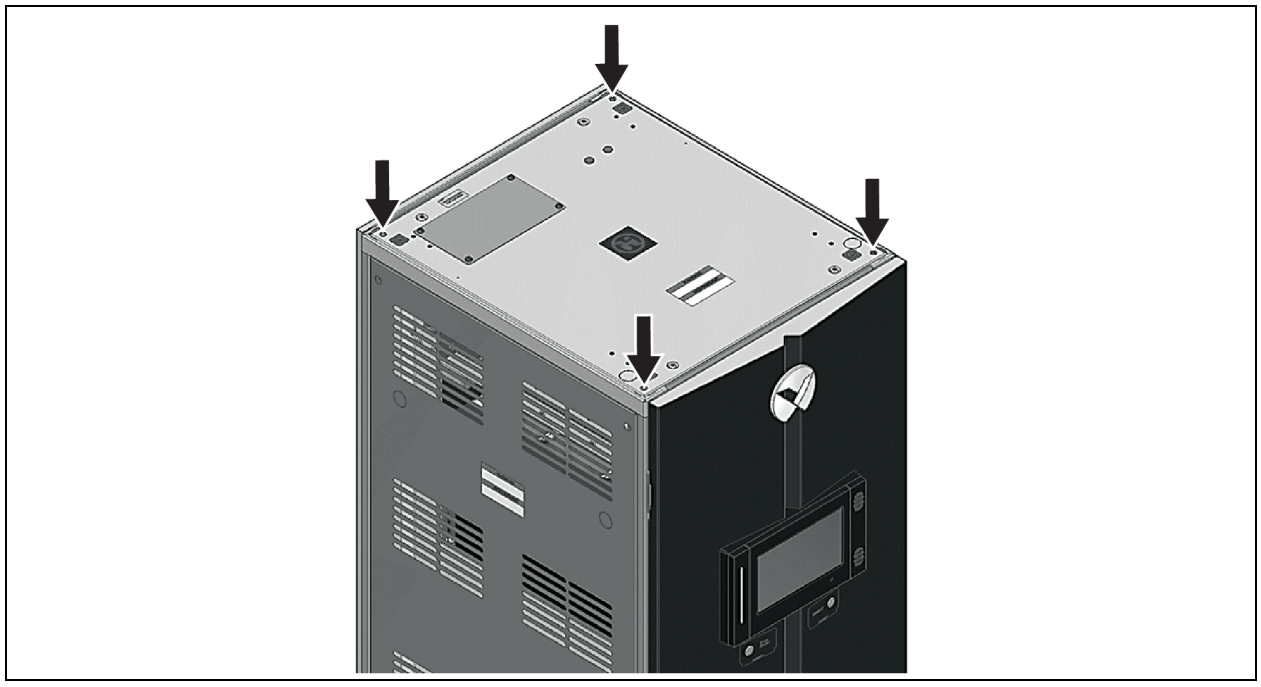
Figure 5.2 Lift the Battery Cabinet with a Forklift



To use slings to take the Vertiv™ EnergyCore Lithium 7 off its shipping pallet, follow this procedure:

1. Use an M10 x 1.5 eyebolt to lift the cabinet. Verify that each eyebolts has a minimum vertical lifting capacity of 600 lb. (272 kg). For further details on the eyebolts, refer to the supplier and part number McMaster-Carr 4843T14.
2. Install four eyebolts, meeting the specifications above, one in each corner of the top of the battery cabinet.
3. Connect the slings securely to the eyebolts.
4. Position the lifting mechanism so that the slings are less than 30 degrees from vertical.
5. Raise the battery cabinet until it clears the shipping pallet.
6. Slide the pallet from under the unit and lower the cabinet onto a level surface.
7. Use the casters to roll the unit into place. Do not use the lifting mechanism to transport the unit.
8. When unit is in place and level, crank down the leveling feet to take pressure off the casters.
9. Remove the four eyebolts and retain them for future use.

Figure 5.3 Hoisting the Vertiv™ EnergyCore Lithium 7 with Slings



When the battery shelves are connected in series, there is a shock and arc flash hazard at the positive and negative terminals of the cabinets.

NOTE: Do not use eyebolt lifting when battery busbars are installed between modules.

NOTE: Before removing the top or rear panel, verify that the battery module busbars are not connected. Failure of this will result in full battery bus potential across the battery cabinet busbars.

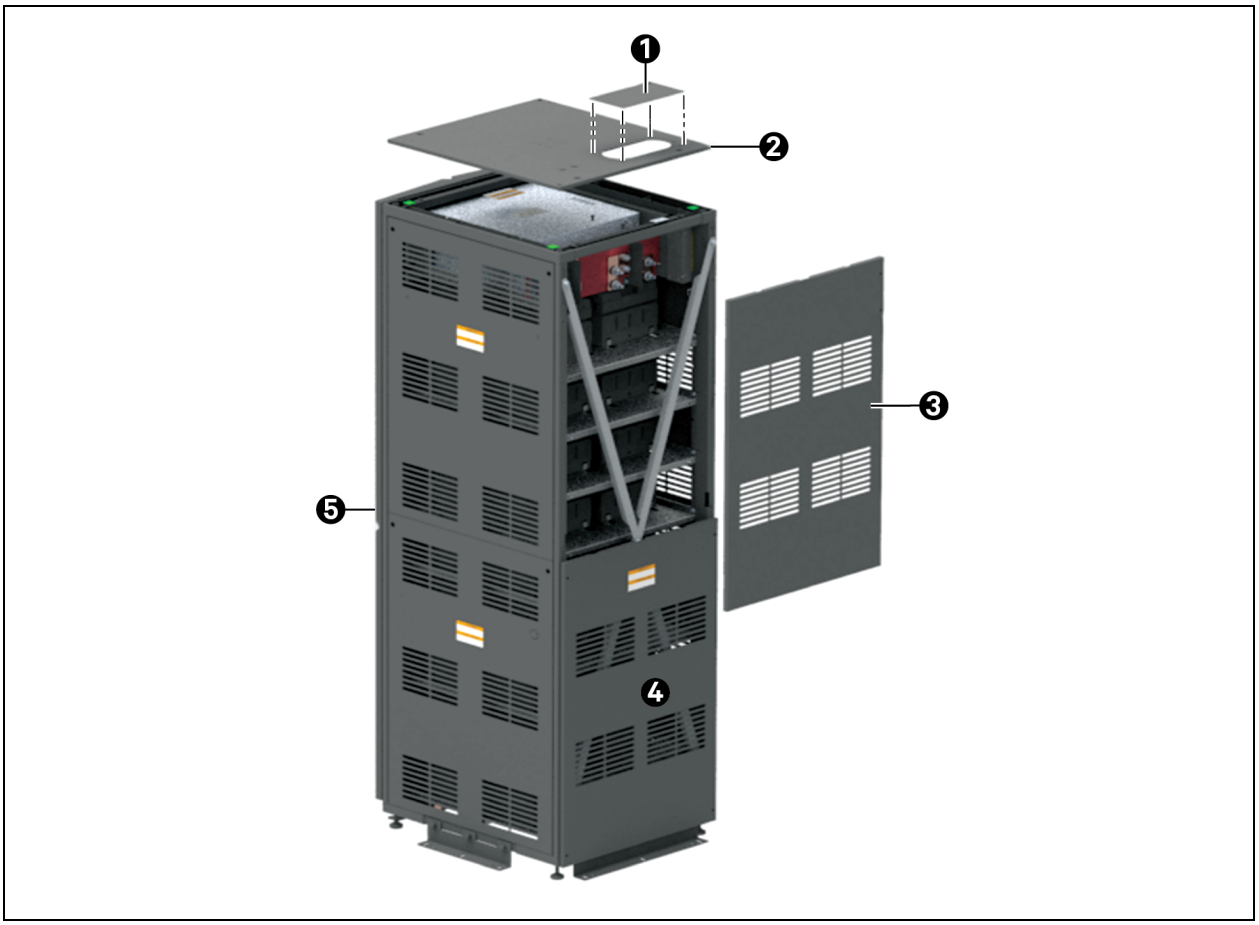
5.4 Installation of Vertiv™ EnergyCore Lithium 7

NOTE: The control wire conduit hardware must be installed before power cables are installed.

1. Remove the hardware on the top panel using a T-30 star bit or wrench, then remove the top panel. Depending on the cable installation method, this may allow easier access for installing power cables in the rear, if applicable.
2. Loosen all four upper rear panel screws about three turns using a T-30 star bit or wrench. See Figure 5.4 below for location of the screws.
3. Slide the upper rear panel up and remove the panel outward.

NOTE: A clearance of 1 inch is required between the cabinet and the wall. No clearance is required between adjacent cabinets.

Figure 5.4 Removing the Top and Upper Rear Panel



Item	Description	Tool Needed
1	Power cable entry cover plate (can be punched or discarded)	T-30 star drive bit
2	Top panel	T-30 star drive bit
3	Upper rear panel	T-30 star drive bit

Item	Description	Tool Needed
4	Rear of unit	T-30 star drive bit
5	Front of unit	10 mm socket and wrench

Before connecting power cables between the battery cabinet and the DC bus, the installing contractor must measure the voltage across the battery cabinet DC cables. See Figure 5.5 below for more information. Verify no voltage is present between the positive and negative battery busbars. If no voltage is present, proceed with the installation.

If voltage is present, do not proceed with the installation and follow these steps:

1. For maximum safety, reattach the top/rear covers. Voltage across the battery cabinet DC cables suggest the battery modules are connected in series.
2. Open the battery cabinet door. Confirm the battery modules are connected in series.
3. Remove the module covers and the module connecting busbar from the topmost battery module to the battery module busbar connection.

NOTE: Do not remove the power cable from the first and last battery module.

4. Reconnect the busbar covers.
5. Close the battery cabinet door.
6. Remove the top/rear covers of the battery cabinet.
7. Verify no voltage is present between the positive and negative battery busbars.
8. Proceed with power cable installation. Once installed reconnect the previously removed busbar and hardware.

Figure 5.5 Battery Cabinet DC Cables—Voltage Check

Item	Description
1	DC bus
2	Battery cabinet busbars (required that no voltage is present across DC cables to proceed with installation)

The cable landing busbars are silver plated. It is common for oxidation to occur. If the cable landing busbars are severely oxidized, as shown in Figure 5.6 below, clean the busbar with fine grit (240 grit to 400 grit) sandpaper or a light or medium duty scouring pad until the color of the busbar is gray or gray yellow. The Vertiv startup/commissioning team will inspect the installation and notify the installer if the busbars require further cleaning due to oxidation.

Figure 5.6 Cable Landing Busbars

Item	Description
1	Busbar requires cleaning before attaching cables
2	Busbar does not require cleaning

9. Connect power cables between the battery cabinet and the DC bus (UPS, charger, or junction cabinet). Apply a torque of 240 in-lb. (27 Nm) to the cable landing points on the Vertiv™ EnergyCore Lithium 7. Power cable requirements are as follows:

NOTE: Only one connection to the cabinet level ground is required, either on the top of the cabinet or on the rear side of the top panel. Do not connect the both points.

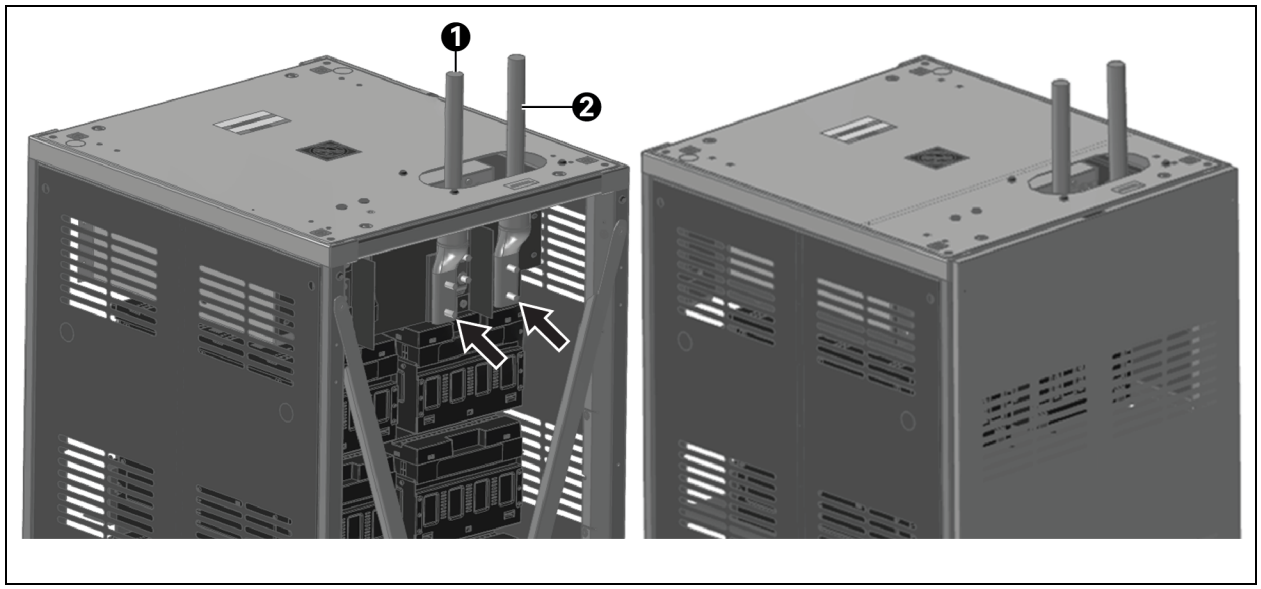
- If multiple battery cabinets are connected in parallel, each cabinet must have its power cables travelling to a single, common landing point, usually a busbar in the UPS enclosure. The power terminals and conduit box are not designed to land cables from multiple battery cabinets.
- Vertiv recommends sizing cables based on the 500 A overcurrent protection device inside the battery cabinet.
- Voltage drop through the cable at 500 A must not exceed 2 V. This may require larger cable for longer distance.
- It is recommended for cable runs to have a similar number of positive and negative cables placed in the same conduit or cable tray.

10. Reinstall the top panel using the original screws. The top panel has a cover plate in the area where the power cables pass into the cabinet. The cover plate can be punched as needed or discarded.

NOTE: The optional conduit box will be installed, the power cables from the conduit box to the power terminals are provided with the conduit box kit.

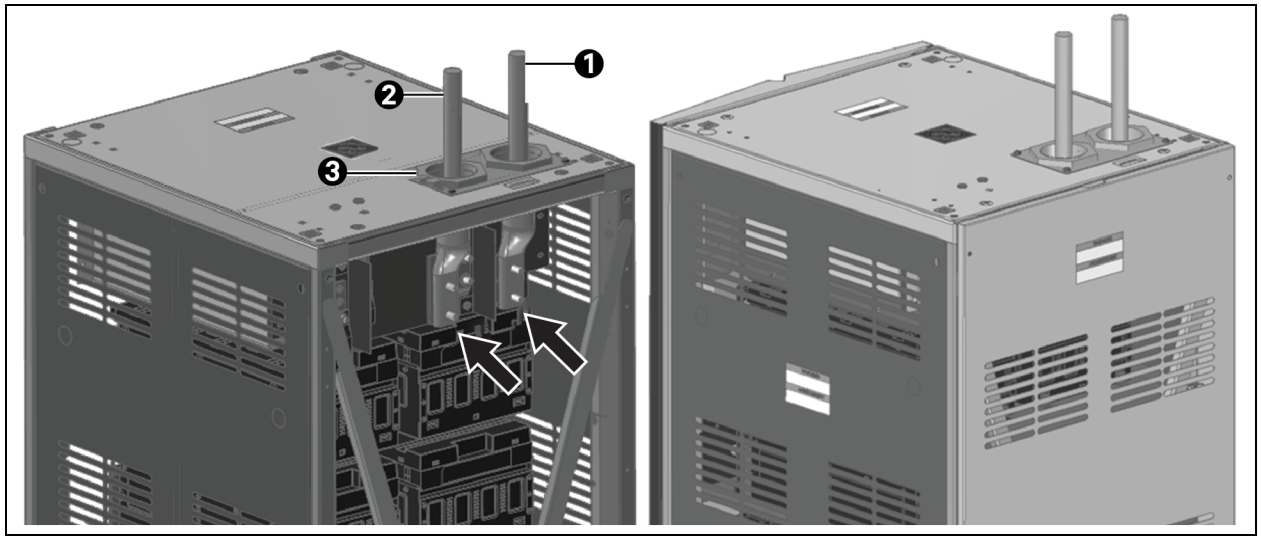
11. Reinstall the upper rear panel using the original screws.

Figure 5.7 Reattaching the Top Panel and Upper Rear Panel—Cover Plate Discarded



Item	Description
1	Positive terminal
2	Negative terminal

Figure 5.8 Reattaching the Top Panel and Upper Rear Panel—Cover Plate Punched for Conduit



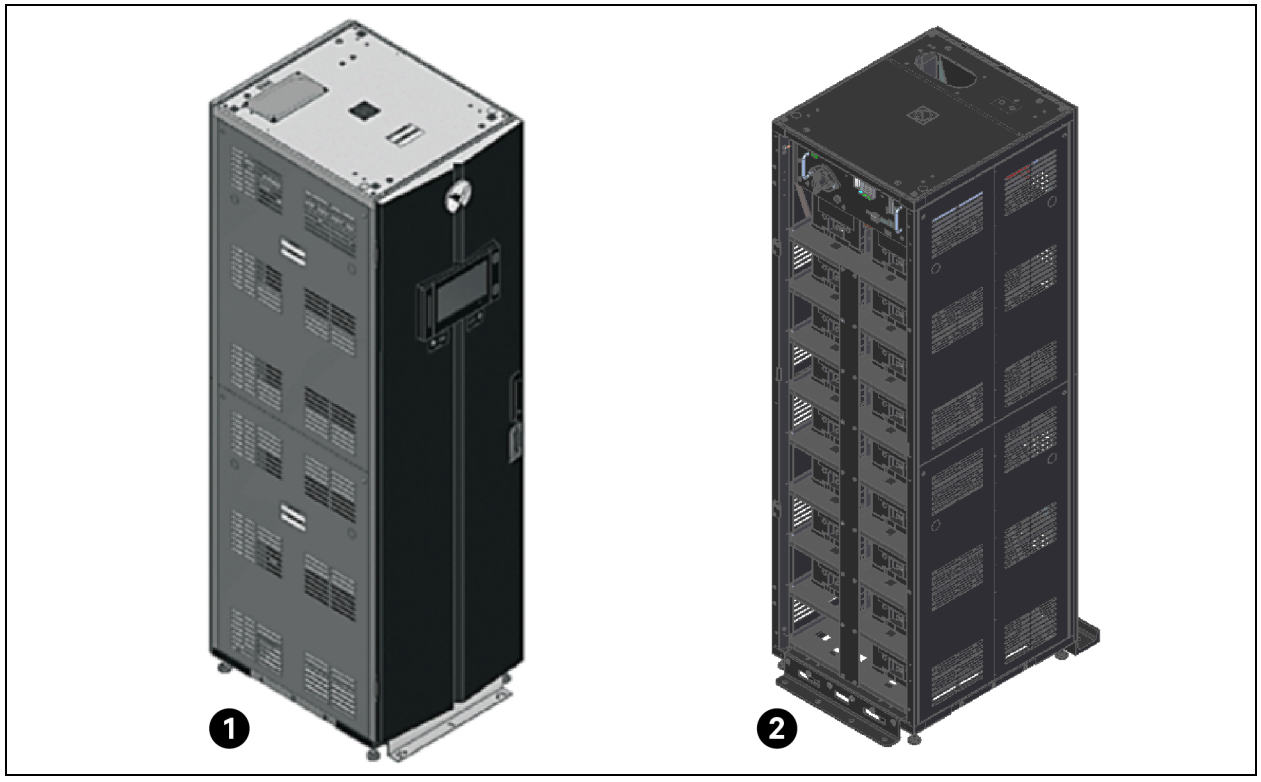
Item	Description
1	Positive terminal
2	Negative terminal
3	Cover plate for conduit

NOTE: For raised floor applications, a solid top floor stand or pedestal should be installed under the cabinet to avoid forcing air into the cabinet.

12. Bolt each cabinet to the floor by using appropriate flooring bolts to secure the front and rear brackets at the base of the unit. For seismic rated units, the front and rear mounting brackets included in the seismic mounting kit will require a total of eight 3/8 in. (or M10) concrete anchors to secure the mounting brackets to the floor. It is recommended to use Hilti Kwik Bolt-TZ or similar for the anchor. For detailed instructions, refer to the Installation Guide Reference 10059360 in the seismic mounting kit. The side of the cabinet frame does not need a bracket attaching it to the floor.

NOTE: The torque specification for standard floor mounting brackets is 80 in-lb. (9 Nm). The torque specification for seismic rated mounting brackets is shown on the instruction sheet in the seismic mounting kit.

Figure 5.9 Bolting the Cabinet to the Floor

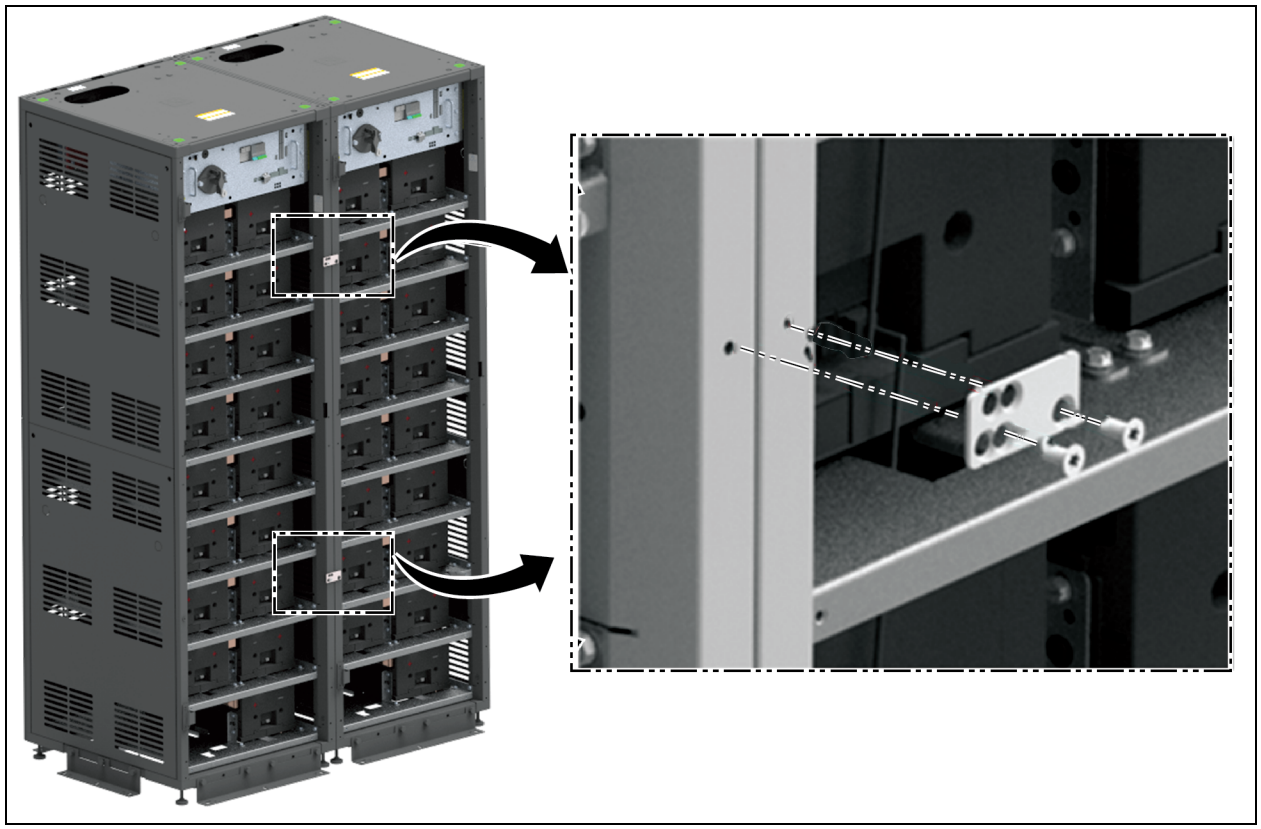


Item	Description
1	Vertiv™ EnergyCore Lithium 7 with standard mounting brackets.
2	Vertiv™ EnergyCore Lithium 7 with seismic bracing and brackets.

NOTE: When conduit is used, DC+ and DC- must be run together in the same conduit. See Submittal Drawings on page 59 for cable entry details.

For multiple battery cabinets installed side by side, do not remove the side panels. Use the provided brackets to bolt the cabinet frames together at the front, see Figure 5.10 below.

Figure 5.10 Bolting Cabinet Frames Together for Side by Side Installation



5.5 Grounding

The frame of each battery cabinet is connected to the building ground. One of the four M10-1.5 threaded holes at the top of the frame is available as a ground cable landing point, or a separate ground cable landing point is available on the underside of the top panel. It is recommended that the external ground connections, one of the four M10-1.5 threaded holes, be used for waterfall drops from cable trough. The ground cable landing point within the cabinet is recommended for cables routed through a single conduit. Only one ground connection is required per cabinet. Torque for the M10 fasteners in these locations is 240 in-lb. (27 Nm). See Figure 5.11 on the next page and Figure 5.12 on the next page for ground cable landing points respectively. It is recommended to use a ground cable with cross-section of at least 3/0 AWG/90 mm^2 (copper) or 250 kcmil 120 mm^2 (aluminum). Local building laws may require a larger cable, depending on the cable type, installation method being used, and overcurrent protective device ratings in the circuit.

NOTE: Do not daisy chain ground cables across multiple battery cabinets. Each battery cabinet must have its own ground cable connected to the building ground.

NOTE: Only one landing point to the cabinet level ground is needed, either on top of cabinet or on rear side of top panel. Connections are not needed at both points.

Figure 5.11 Ground Cable Landing Points—Top of Cabinet

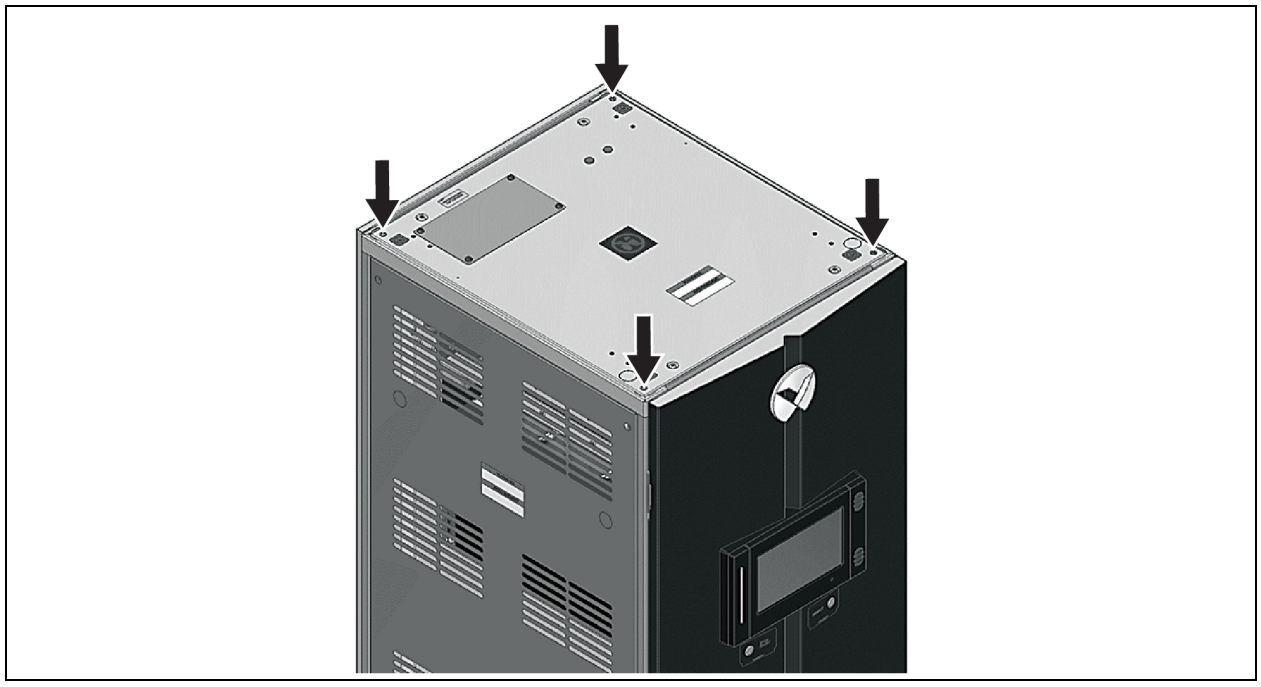
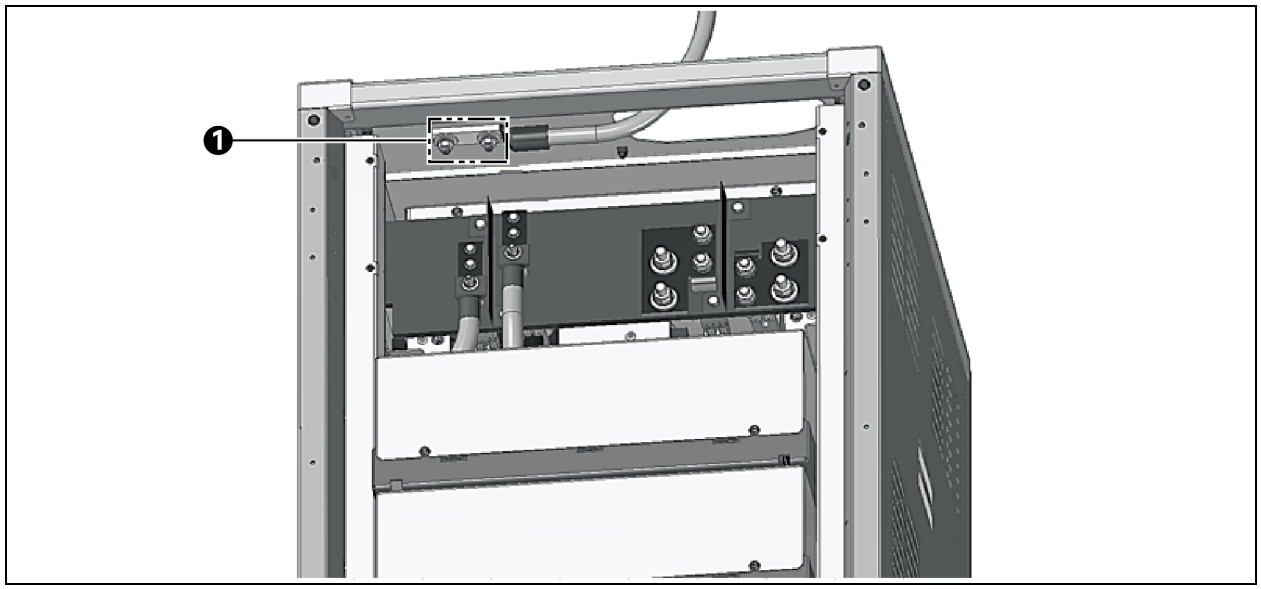


Figure 5.12 Ground Cable Landing Point—Rear Side of Top Panel



Item	Description
1	Ground cable landing point

NOTE: Ensure ground wiring is tightened enough to avoid interference with PCA blind mate connection points.

5.6 Control Wiring

This section describes how to run low voltage control wiring into the Vertiv™ EnergyCore Lithium 7. There are pre-punched holes in the side and top panel for low voltage control wiring to enter the cabinet. If needed, a conduit fitting can be added or the holes can be punched larger in the field after removing the top or side panel. Either the side panel pre-punched holes or the top panel conduit knock outs may be used for control wiring.

NOTE: It is required that edge guard, or an equivalent product, is used to protect the wiring from the metal edge of the pre-punched hole on the side of the cabinet that the wire passes through.

NOTE: The control wire conduit hardware can be mounted inside the cabinet without having to remove the PCA.

NOTE: Hardware for the conduit must be installed before power cables are installed.

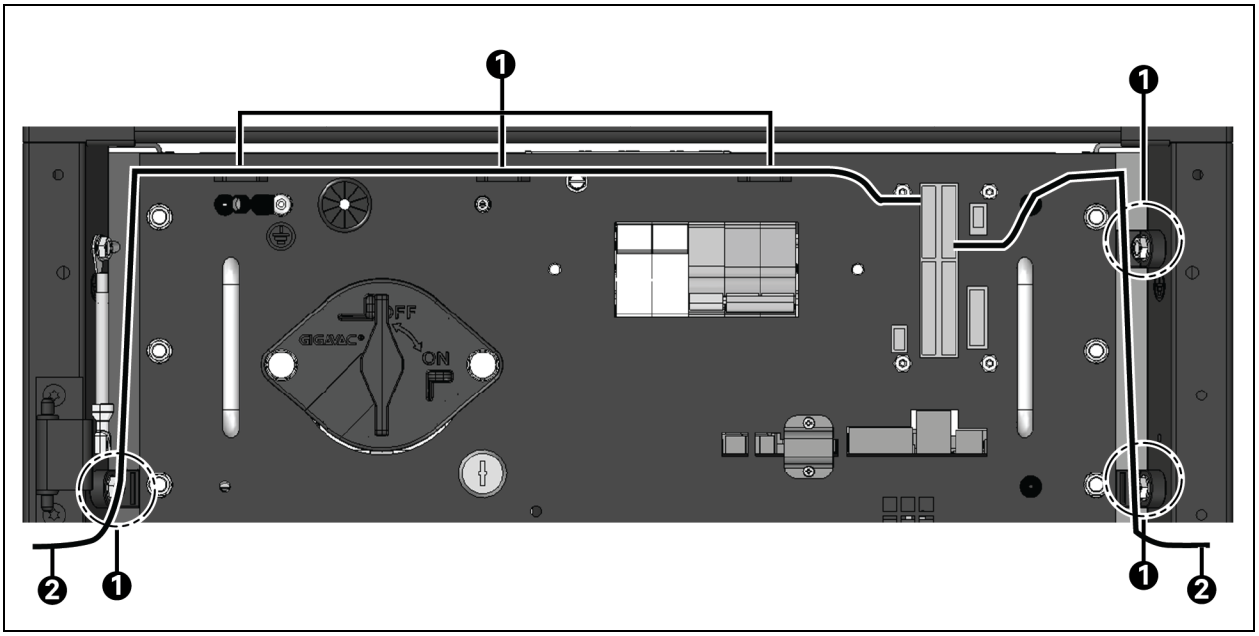
Follow the procedure below to route and connect low-voltage control wiring to the Vertiv EnergyCore Lithium 7 battery cabinet:

1. Run the control wiring through the side panel pre-punched entry holes in the frame. The wiring should enter through the left side panel pre-punched entry hole and exit through the right side panel pre-punched entry hole. The tie mounts must be used to securely fasten the control wiring.

   -Or-

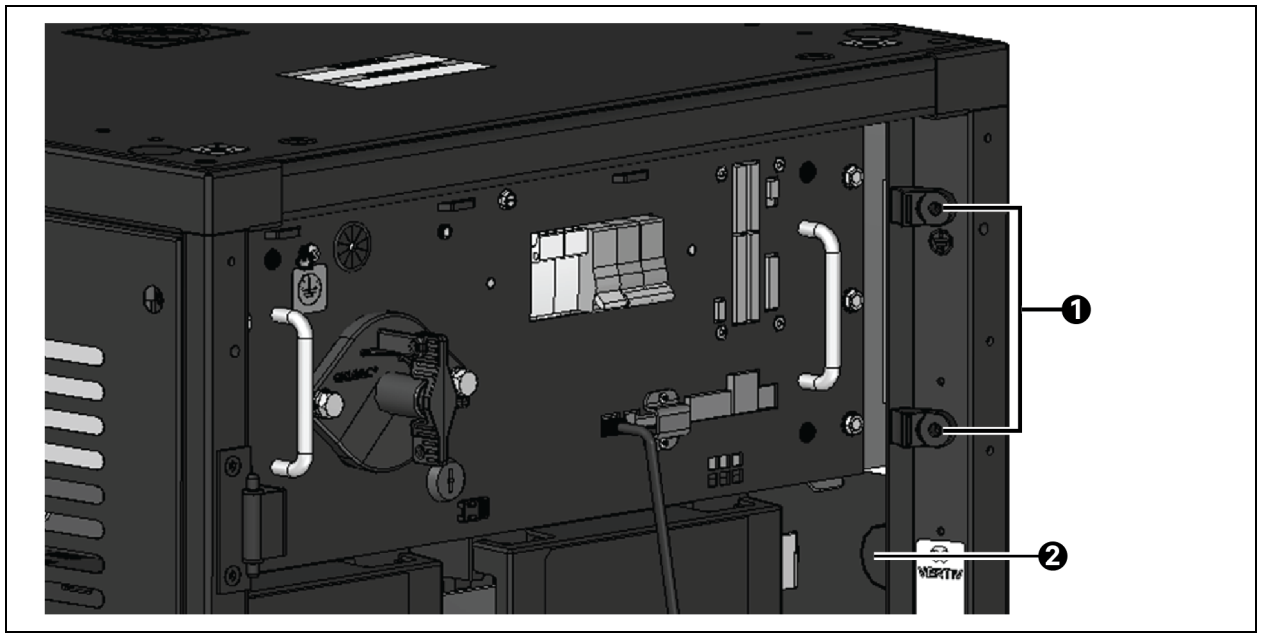
2. Run the control wiring through the specified top panel conduit entry hole shown in Figure 5.15 on page 47. The wiring should enter and exit the same knockout.

Figure 5.13 Routing the Control Wiring—Option 1 (Front View)



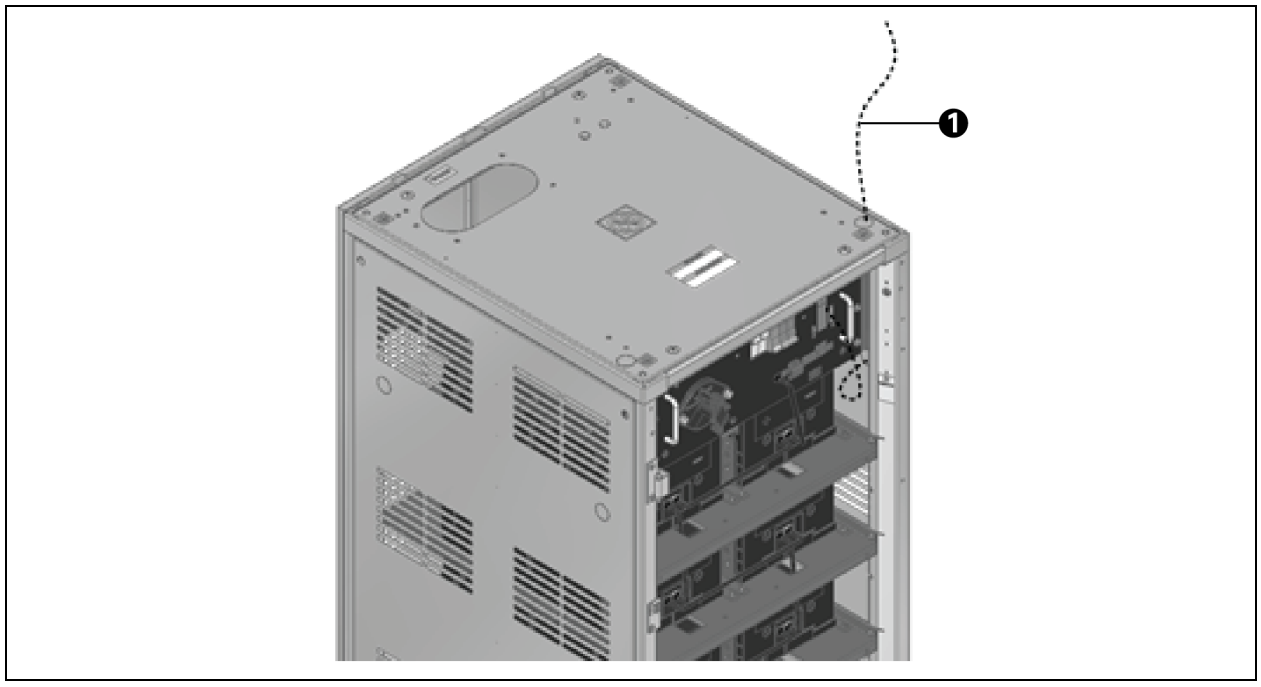
Item	Description
1	Control wire tie mounts. Only used for side panel wiring.
2	Control wire designated path.

Figure 5.14 Routing the Control Wiring—Option 1 (Side View)



Item	Description
1	Control wire tie mounts. Only used for side panel wiring.
2	Side panel pre-punched control wire entry hole.

Figure 5.15 Routing the Control Wiring—Option 2



Item	Description
1	Only used the specified conduit hole when running control wiring through the top panel conduit entry.

NOTE: Do not use any other conduit hole when using the top panel control wiring option.

3. Connect the control wiring to its desired location. See Submittal Drawings on page 59 for details about the required control wiring.
4. The battery cabinet can be monitored remotely via Modbus TCP or SNMP by connecting a network cable to the 100BT port on the PCA. Monitoring via Modbus RTU is also possible using the BAT1 port on the PCA. Because they share data across their inter-cabinet control wiring, a single connection to a Vertiv™ EnergyCore Lithium 7 can be used to monitor the status of multiple cabinets. See Control and Monitoring Points on page 71 for more details.

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6 Operation

6.1 Startup

To connect the Vertiv™ EnergyCore Lithium 7 batteries to the UPS or other DC source, after commissioning steps are completed follow the below steps:

1. Ensure the CTL PWR circuit breaker is off, turn the S1 switch to the ON position (closed).
2. Close the F7-F8 fuse holder on the PCA.
3. Close (handle up) the CTL PWR circuit breaker on the PCA.
4. Turn the SERVICE/RUN switch to the RUN position, if not already there.
5. Close the cabinet door.
6. Follow the above steps on all connected battery cabinets and wait for all to boot successfully.
    a. A Vertiv EnergyCore Lithium 7 takes approximately 2.5 minutes to boot after it is configured. Successful boot is indicated by the GHMI light bar being solid red. If push buttons are present, the STOP/RESET button being illuminated red and the ENABLE button being OFF also indicates successful boot.
7. Verify that no active faults are present on all parallel units using the GHMI. Alternatively, if external push buttons are present, verify that all parallel units have the STOP/RESET button illuminated solid red. A flashing red light indicates a problem that must be resolved. For more details, see Global Human Machine Interface Alarm Banner on page 60.
8. Pre-charge the UPS or DC source so its voltage is higher than the battery string voltage, if required.
    a. Some specific UPS models do not require the source to be pre-charged. Battery cabinet firmware allows a connection in these cases without pre-charging.
9. Press the ENABLE button next to the Enable all Cabinets option on the HMI. Alternatively, if external push buttons are present, the user may also press the ENABLE button twice on each cabinet.
    a. It is recommended to connect the battery cabinets with the lowest voltage first.
10. The system firmware operates internal switchgear to connect the battery strings to the UPS or DC source. When multiple battery cabinets are in parallel, they may automatically connect to the UPS at different times, allowing batteries with lower state of charge (SOC) to connect first.
11. A cabinet may remain in WAITING mode (indicated by a flashing ENABLE light, if push buttons are present). This may occur for several reasons:
    a. The cabinet is waiting for other connected cabinets to be enabled.
        - It is possible to force the cabinet online without waiting for others to be enabled by pressing the Force button on the HMI. Alternatively, if external push buttons are present, the user may also Force the cabinet online by hold the ENABLE button for 5 seconds. Force connection should be avoided unless it is done for troubleshooting purposes because it can result in a large difference in SOC across different battery cabinets.
    b. The SOC of the battery cabinet may be lower than the other cabinets. In this case, disconnect all battery cabinets and go through connection process by enabling the battery cabinet with the lowest SOC first, followed by the cabinet with the second lowest SOC, etc. Higher SOC battery cabinets will connect automatically as the lower SOC cabinets voltage increases.
    c. The UPS or DC source voltage is too low.
    d. The UPS or DC source voltage is too high.

e. The cabinet is not receiving an indication through the control wiring that the UPS or DC source is ready to have the batteries connected. This is called the UPS_READY signal. Typically checking and correcting the UPS settings, control wiring, or settings in the cabinet will resolve it.

f. In some extreme cases such as accidental over-discharge (causing low battery voltage), the charger voltage may need to be lowered to reduce inrush current. See Automatic Shutdown on the facing page for the recovery process.

12. When a battery cabinet has its batteries connected to the UPS, the battery cabinet icon on the HMI illuminates blue or green. Alternatively, if external push buttons are present, the ENABLE button illuminates solid blue or green.

6.2 Disconnecting and Shutdown

WARNING! The battery cabinet contains high voltage batteries. Switchgear in the system disconnects batteries from the UPS or DC source. Use PPE and safety procedures to work with high voltage batteries.

To ensure safe disconnection and shutdown of the battery cabinet, follow the procedure below:

1. After a Vertiv cabinet is connected to the UPS or DC source, they can disconnect by pressing the Stop button on the HMI. Alternatively, if external push buttons are present, the user may also press the STOP/RESET button twice. This will cause the STOP/RESET button light to turn red and ENABLE light to turn off.
2. To turn off control power:

NOTE: Do not manually open the control power breaker. Manually opening the control power breaker may result in future intermittent operation and corrupt the SD card. The BMS will operate the control breaker shunt trip and manually open the breaker.

a. Disconnect the batteries as described in step 1.

b. If push buttons are present, take note whether the STOP/RESET button begins blinking red after being disconnected. This can indicate a switchgear fault (failure to open internal switchgear). The fault status and reason can also be checked on the touchscreen HMI.

c. Press the Shutdown button on the HMI. Alternatively, if external push buttons are present, hold the STOP/RESET button for 5 seconds. Once the ENABLE button turns solid red, the BMS firmware begins to gracefully shutdown.

d. The battery cabinet will go through a shutdown process, avoiding loss of log data. This takes approximately 45 seconds.

e. The CTL PWR circuit breaker trips automatically when the shutdown is complete.

NOTE: Do not open the CTL PWR circuit manually.

f. If the UPS or DC source will not be available for charging for at least 1 week, open the F7-F8 fuse holder on the PCA. This extends the storage life of the batteries, avoiding the possibility of over-discharge.

3. If maintenance is to be performed in the battery shelf area, turn the S1 switch to the Off position after control power is off.

NOTE: Severely over discharged batteries cannot be used and must be replaced.

NOTE: Do not open the control power breaker to power down the unit manually. Doing so could corrupt the cabinet's firmware leading to abnormal behavior.

6.3 Automatic Shutdown

6.3.1 Shutdown Logic

To prevent over discharge of the batteries, the unit automatically shuts down its controls under these conditions:

1. Unit is left disconnected from the charger for more than three days.
2. Control power is on but the firmware configuration process has not been completed after 30 minutes or the BMS firmware is otherwise not running due to a problem (uncommon).
3. The total battery voltage is below the under voltage instantaneous fault threshold for 15 minutes.

If batteries must be left off of the charger or UPS for longer than a week, protect them by leaving the control power breaker (CTL PWR) off and open the F7-F8 fuse holder on the PCA until the batteries are able to be recharged again.

6.3.2 Recovery Method

When Vertiv™ EnergyCore Lithium 7 shuts down due to low battery voltage, follow this manual process to bring the batteries back to their normal operating voltage.

For a parallel set of multiple battery cabinets, perform this procedure for each battery cabinet:

1. Close the F7-F8 fuse holder.
2. Close the CTL PWR circuit breaker.
3. Allow the boot process to complete.
4. Before proceeding, verify that no over discharged battery cells are in this battery cabinet. All cells must be above 3 V. The touchscreen HMI can be used to see cell voltage readings.

NOTE: If the touchscreen HMI does not display the cell voltages for this cabinet or if there are over-discharged cells present contact Vertiv. See Technical Support and Contacts on page 57.

CAUTION: Low battery voltage warning indicates that the batteries are at a low SOC. This warning does not indicate the presence of severely over discharged cells.

5. Set the external power source or DC current limit to 20 A. Lower if using a smaller charger.
6. Set the external power source or DC voltage to the following levels:
    a. 10 series battery modules: 268 V
    b. 12 series battery modules: 322 V
    c. 14 series battery modules: 375 V
    d. 16 series battery modules: 429 V
    e. 17 series battery modules: 456 V
7. Turn the SERVICE/RUN switch on the PCA to the SERVICE position. If push buttons are present, the ENABLE button on the cabinet door illuminates solid white.
8. Press the Stop or Off button on the HMI. If applicable, the user may press the STOP/RESET button twice.
9. Press the Enable button on the HMI. If applicable, the user may press the ENABLE button twice.
10. The internal switchgear operates to allow charging current into the batteries. If this does not occur, contact Vertiv technical support.

CAUTION: If the battery is over temperature, over current, or over voltage, battery cabinet firmware will not permit battery charging.

11. When charging current has fallen below 6 A, turn the switch on the PCA from SERVICE to RUN position. The internal switchgear is opened, stopping the charging process. The batteries have now recovered to their normal voltage range.
12. Leave this cabinet disabled while repeating the steps from step 1 to step 10 for each cabinet which needs recovery.

6.4 Force Connection

The Vertiv™ EnergyCore Lithium 7 will normally protect the batteries from high current by disallowing connection to a DC bus that is not pre-charged by the UPS (expect for specific UPS models such as Vertiv™ EXM2 and Vertiv™ APM2).

In cases where the DC bus is already energized but there is a significant difference between the battery string voltage and the DC bus voltage, the battery cabinet may assert a warning related to the voltage difference. See High Delta Voltage on page 68. Unit can be safely forced to connect its batteries by pressing the Force button on the HMI. Alternatively, if external push buttons are present, hold the ENABLE button for 5 seconds. The firmware will ignore this command if the voltage difference is too high for a safe connection. If connection is refused by the firmware, let this battery cabinet charge alone until its voltage is closer to the other battery cabinets. This is sometimes required if a new battery cabinet is added to a set of cabinets that are already fully charged.

6.5 Discharge Runtime and Cooling Time

It is normal for the batteries in the cabinet to become warm while discharging.

The batteries can be recharged immediately after a discharge, even if they are warm. Due to the low recommended current limit, the temperature does not typically increase significantly when charging.

The firmware will disconnect the batteries from the DC bus and indicate a fault condition when their upper temperature limit is reached. If a discharge is started when the batteries are above their normal operating temperature range, see Technical Specification on page 63 for technical details of UPS, the batteries may reach their upper temperature limit before the normal end of discharge voltage is reached. Discharge runtime may be shorter than expected.

If the batteries are discharged until exhaustion, it may take up to 5 hours until the temperature decreases enough to provide the full expected runtime again, even after they are fully recharged.

For standby operation, the unit should be operated in the normal temperature range, see Technical Specification on page 63.

The discharge runtime available from the batteries is affected by factors such as age, cycle count, load during discharge, and temperature. In general, higher age, higher cycle count, higher load, and deviation from the specified temperature range results in lower runtime.

6.6 Initial Charging and Cell Balancing

If unbalance in the state of charge (SOC) is present across series battery cells it results in lower discharge runtime for the entire battery system. The Vertiv™ EnergyCore Lithium 7 is designed with an individual cell balancing circuit for each cell which ensures the cell is held in a very small SOC window. The balancing circuits begin operating automatically when the batteries are first charged after installation is completed.

Although some UPS or DC sources can charge the battery string quickly to near 100% SOC, the cell balancing circuits typically require more time to minimize SOC unbalance across all cells. During the commissioning process of Vertiv EnergyCore Lithium 7, it is required for cells within a battery cabinet to be balanced with 80 mV of one another (high cell voltage from the low cell voltage). If after 120 hours of cell balancing on the initial charging process there remains an imbalance of over 80 mV it is likely a battery cell has a capacitance issue, and needs replaced. Replace the battery module with the cells furthest from the cabinet's average cell voltage, reset the 5-day normal operation, and allow the cabinet to balance.

This initial charging and balancing is required for a first time discharge and commissioning test. After this initial charging and balancing process, cells will maintain a small delta voltage and the prolonged balancing will not be needed.

For optimal performance and to ensure runtime autonomy is met, use the GHMI display to check each of the following:

1. Charge current is zero.
2. Minimum cell voltage of the entire system is 4.17 V*.
3. Total rack voltage is greater than or equal to the following.
    a. 10 module: 334.3 V
    b. 12 module: 401 V
    c. 14 module: 468 V
    d. 16 module: 534.8 V
    e. 17 module: 568.2 V
4. Minimum and maximum battery temperatures are between 18 °C to 28 °C (64.4 °F to 82.4 °F). See Technical Specification on page 63 for more information.

NOTE: Slightly lower runtime is expected if the above requirements are not met. Requirements are not fulfilled in the event of a transient condition.

NOTE: *Contact Vertiv Service to verify cell voltages.

NOTE: For the most optimal performance of a system, The Vertiv™ EnergyCore balancing circuit will target a 4 mV delta within a cabinet. While the system may be balancing, as the long as the above four requirements are fulfilled, the run time will be met.

NOTE: If step load testing is included in commissioning test, it may be required to lower charge voltage to 4.12 V per cell (VPC). A Slightly lower runtime is expected when charger voltage is lowered. Contact Vertiv Service to update charge voltage.

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7 Routine Maintenance Disposal at End of Life

7.1 Routine Maintenance

The Vertiv™ EnergyCore Lithium 7 BMS firmware monitors the health of the batteries, making this information available through both remote monitoring interfaces and a local touchscreen HMI. It is not required to perform manual health checks on the batteries (such as discharge tests or impedance measurement).

The below routine maintenance checks are recommended with an interval of 3 to 12 months:

1. Verify ambient temperature and humidity are within the limits of Technical Specification on page 63.
2. Verify each battery cabinets status is normal:
    a. Online (batteries connected)
    b. No warnings or faults
    c. Cell voltages are balanced to within 30 mV of each other (only if recent discharge has not occurred)
3. Verify the battery cabinet is in good condition:
    a. No discoloration near busbars and cables indicating high temperature
    b. No damaged insulation
    c. No rust
4. Verify that the state of health (SOH) for each battery cabinet indicated on the touchscreen HMI is above 80%. End of life for the batteries is 80%. Below this SOH, replacement is recommended.

7.2 Disposal at End of Life

WARNING! The battery modules in the Vertiv EnergyCore Lithium 7 should never be put in a normal trash bin or in a fire. The batteries can be dangerous if not disposed of properly.

Local laws typically require specific methods of disposal or recycling for lithium batteries. Most of the material in the product can be recycled, including the battery modules. If you need guidance on this topic, contact Vertiv sales representative or Vertiv technical support.

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Appendices

Appendix A: Technical Support and Contacts

A.1 Technical Support/Service in the United States

Vertiv Group Corporation

24x7 dispatch of technicians for all products.

1-800-543-2378

Liebert® Thermal Management Products

1-800-543-2378

Liebert® Channel Products

1-800-222-5877

Liebert® AC and DC Power Products

1-800-543-2378

A.2 Locations

Vertiv Americas Headquarters

505 N. Cleveland Avenue

Westerville, OH 43082

Vertiv EMEA Headquarters

Victor-von-Bruns Strasse 21,

8212 Neuhausen am Rheinfall, Switzerland

Vertiv Asia Headquarters

Singapore Location

151 Lorong Chuan, Lobby D #05-04

New Tech Park, Singapore 556741

India Location

Vertiv Energy Private Limited,

Plot No. C 20, Road No. 19

Wagle Industrial Estate, MIDC,

Thane (West), Maharashtra 400604, India

China Location

Vertiv Technology Co., Limited

Floors 1–4 and 6–10,

Building B2, Nanshan I Park

No. 1001 Xueyuan Road, Nanshan District

Shenzhen, Guangdong 518055, China

A.3 Technical Support/Service in the Asia/Pacific Region

Australia:

+61 1300 367 686 / au.service@vertiv.com

New Zealand:

+64 0800 100 877 / au.service@vertiv.com

Malaysia:

+60 1800 221 388 / my.service@vertiv.com

Singapore:

+65 1800 467 2326 / sg.service@vertiv.com

Philippines:

+63 2 8620 3655 / ph.service@vertiv.com

Thailand:

+66 2 278 6650 / callcenter.th@vertiv.com

Vietnam:

vn.service@vertiv.com

India:

+91 18002096070

China:

+86 4008876510 / vertiv.service@vertiv.com

A.4 Technical Support/Service in Europe, Middle East and Africa Region

https://www.vertiv.com/en-emea/contacts/

Appendix B: Submittal Drawings

Refer to Vertiv submittal drawings for signal wiring requirements and interconnection assignments, which depend on UPS type. The Table B.1 below indicates which drawings apply for each UPS. Access the submittals through technical knowledge online (TKO).

NOTE: Some UPS models are not available in all regions.

Table B.1 UPS Specific Submittal Drawings

UPS Type	Submittal Drawing	Note
Vertiv™ Liebert® APM2, Vertiv™ PowerUPS 9000, and Vertiv™ EXM2 with battery CAN communication ability	VEC-19-S015	Maximum of 4 battery cabinets per every Vertiv APM2 UPS. Maximum of 12 battery cabinets per every Vertiv PowerUPS 9000 and Vertiv EXM2.
Vertiv™ EXL S1 (UL version) Vertiv™ Trinergy™ Cube (UL version) Vertiv™ NXL	VEC-19-S017	Distributed BIB kits, 1 BIB board per cabinet. Maximum of 8 cabinets.
	VEC-19-S018	Single BIB kit located in cabinet #1. Maximum of 12 cabinets.
Vertiv™ EXL S1 (CE version)	VEC-19-S014	Maximum of 12 cabinets.
Vertiv™ Trinergy™ Cube Centralized System (CE version)	VEC-19-S019	Maximum of 12 cabinets.
Vertiv Trinergy Cube Distributed System (CE version)	VEC-19-S022	Maximum of 12 cabinets.
Vertiv™ Trinergy™ Distributed System	VEC-19-S024	Modbus + Dry Contacts. Maximum of 12 cabinets.
	VEC-19-S025	Dry Contacts. Maximum of 12 cabinets.
Vertiv™ Trinergy™	VEC-19-S021	Distributed BIB kits, 1 BIB board per cabinet. Maximum of 8 cabinets.
	VEC-19-S023	Single BIB kit located in cabinet #1. Maximum of 12 cabinets.

Table B.2 Other Submittal Drawings

Description	Submittal Drawing
Technical Information	VEC-03-S006 (10 module only) VEC-03-S007 (12 module only) VEC-03-S008 (14 module only) VEC-03-S009 (16 module only) VEC-03-S010 (17 module only)
Outline Drawing	VEC-05-S002
Seismic Anchoring	VEC-17-S001
Product Handling	VEC-24-S001

Appendix C: Global Human Machine Interface Alarm Banner

Table C.1 below, Table C.2 on the facing page, and Table C.3 on page 62 shows the BMS, AUX1, and AUX2 status alarm banner with descriptions.

Table C.1 BMS Status Alarm Banners

Fault/Warning Banner Displayed on GHMI	Description
BMS Misc. Safety Fault	CAN processor within the BMS is not running.
CAN1 Error	Peer processor within the BMS is not running.
Cell Over Temperature	Cell over temperature fault. One or more cells is over temperature.
Cell Over-Voltage	One or more cells is over voltage.
Cell Under-Temperature	One or more cells is under temperature.
Cell Under-Voltage	One or more cells is under voltage.
Check Contactor	Current flowing when C1 Open.
High SOC	Battery SOC above target.
IOD Not Running	IOD processor within the BMS is not running.
Low SOC	Battery SOC below target SOC. Disconnect in 15 seconds.
Misc. BMS Safety Fault	CIB Override Active. Fault occurred on the IOB board which opened the contactor, C1.
Misc. IOB Safety Fault	IOB preventing C1 closure. Caused by active fault.
Module Comms Error	One or module not talking to BMS.
None	Balancing active.
None	Contactor 1 Status 1 = Closed.
None	Contactor 2 Status 1 = Closed.
None	Online.
Over-Current (Charging)	Rack Over Current (such as over charge) Fault.
Over-Current (Discharge)	Rack under Current (such as over discharge) Fault.
Over Voltage	Rack Over Voltage Fault.
Peer Comms Error	CAN status is nonzero. Cabinet to cabinet communication interrupted.
Summary Warning	Warning Status - System still available.
Summary Fault	Rack in FAULT mode.
Under Voltage	Rack Under Voltage Fault.

Table C.2 Aux 1 Status Alarm Banners

Fault/Warning Banner Displayed on GHMI	Description
Batt. Module Temperature Delta	MBB voltage or temperature too far from mean.
Busbar Over Temp	Busbar on module is overtemperature.
Configuration Fault	Configuration error detect.
Conformation Required	Press ENABLE again or STOP again. Only if external push buttons are present on the battery cabinet door.
Disconnect Open	Disconnect is opened.
Fuse Blown	Internal fuses within the PCA (fuse 5 and/or 6) have blown.
High DC Bus Voltage	DC bus voltage out of bounds.
High Delta Voltage	The bus voltage and the battery voltage are too far apart for the battery cabinet to safely connect.
IOB Frame Error	Invalid data frame.
Low Memory	BMS board memory below 150 MB.
MBB Board Over Temp	An MBB board is overtemperature.
None	Mains fail.
None	Release the STOP/RESET button (if applicable).
None	Release the ENABLE button (if applicable).
UPS Not Ready	UPS Ready signal is not active.
Overload Possible	Expected/actual load > online capacity.
Over Voltage	Battery over voltage.
Peer Comms Error	One or more peer cabinets are not communicating.
Power Supply Redundancy Loss	Power supply redundancy loss.
Replace contactor	Contactor needs replaced. May result from exceeded current limit during discharge.
Reset Fault Required	Latching fault requires acknowledgment. Fault will not reset if cabinet conditions have not cleared the fault thresholds.
Warm battery	Battery temperature is 29 °C (84 °F) or greater.

Table C.3 Aux 2 Status Alarm Banners

Fault/Warning Banner Displayed on GHMI	Description
Batt. Module Temperature Delta	Temperature fault.
Calibration Required	Calibration required. Vertiv CE to run commissioning to recalibrate the system.
Charge Voltage Low	Charge voltage too low.
Check contactor	Potential C1/C2 or DIODE failed.
Disconnect Requested	Cabinet peer disconnect signal asserted.
IOB Reg PS Failure	The IOB board has a regulated power supply issue. Check IOB connections.
Misc. BMS Safety Fault	CIB Override Active. Fault occurred on the IOB board which opened the contactor, C1.
Module Comms Error	CAN0 disrupted but not yet faulted.
Polarity Fault	Reversed polarity on DC bus detected.
UPS Comm Error	UPS on CAN1 not talking.

Appendix D: Technical Specification

D.1 Technical Specification of Battery Cabinet

Table D.1 Technical Specification of Battery Cabinet

Parameter	Value	Notes
Battery Module Configuration	8S1P	
Cell Type	Li-ion, NMC/LMO hybrid	
Control Power Source	Internal	
Cooling	Convective (no fans)	
Compliance and Test Reports	CSA mark (UL 1973 3rd edition) CE mark (IEC 62619:2022) ISO 13849-I:2023 Cat. B PL (b) IST A 3B UNDOT 38.3 FCC 47 CFR 15B UL 9540 A 4th edition report	CSA mark, CE mark, CB report may not be applicable to every region of manufacture.
Dimensions	600 mm width 750 mm depth 2000 mm height	Packaging materials not included. If optional conduit box is added, total height is 2268 mm.
HVAC Load Cycling	10 modules: 0.28 kWh (965 BTU) 12 modules: 0.34 kWh (1143 BTU) 14 modules: 0.39 kWh (1323 BTU) 16 modules: 0.42 kWh (1426 BTU) 17 modules: 0.44 kWh (1515 BTU)	Heat generated by max. power discharge and recharge, then dissipated during cool down. Approximately efficiency is 95.5%.
HVAC Load Standby	30 W	
High Voltage and Current Measurement Accuracy	0.5%	
Ingress Protection Rating	IP20	
HMI Service Interfaces	RS-232 serial, USB 2.0	
Log File Storage	Internal, always on	
Maximum Cell Temperature	69 °C (156 °F)	
Maximum Parallel Cabinet Count	12	
Maximum Current (Discharging)	440 A continuous	BMS firmware protection above 600 A.

Table D.1 Technical Specification of Battery Cabinet (continued)

Parameter	Value	Notes
Maximum Power (Discharging)	10 modules: 108 kW 12 modules: 129.6 kW 14 modules: 151.2 kW 16 modules: 172.8 kW 17 modules: 183.6 kW	Up to 20% short time overload is possible without exceeding current limit, but runtime is reduced.
Maximum Continuous Charging Current	64 A	
Nominal Capacity	67 Ah	
Nominal Energy	10 modules: 20.4 kWh 12 modules: 24.5 kWh 14 modules: 28.5 kWh 16 modules: 32.6 kWh 17 modules: 34.6 kWh	Maximum rated energy for a single battery cabinet. For max rated energy of an entire system, multiple max energy for a single battery cabinet by cabinet quantity. See Submittal Drawings on page 59 for maximum amount of cabinets per UPS.
Operating Altitude Maximum	3000 m	
Operating Humidity Range	5 to 95% relative humidity	Must be non condensing.
Operating Temperature Range	23 ± 5 °C (73.4 ± 41 °F)	Environment and discharge rate can affect runtime. Reduced discharge runtime may occur when temperature is outside 18 °C to 28 °C (64 °F to 82 °F).
Recommended Charger Voltage	10 modules: 335.2 V 12 modules: 402.24 V 14 modules: 469.28 V 16 modules: 536.32 V 17 modules: 569.84 V	
Recommended End of Discharge Voltage	10 modules: 256 V 12 modules: 307.2 V 14 modules: 358.2 V 16 modules: 409.6 V 17 modules: 435.2 V	Up to 100% load. For overload, higher EOD voltage setting is required to avoid overcurrent alarm at end of discharge.
Recommended Charging Current Limit	22.3 A	
Remote Monitoring Interfaces	100BT Ethernet supports Modbus TCP or SNMP. RS485 supports Modbus RTU.	
Series battery module Quantity	10 module: 10 12 module: 12 14 module: 14 16 module: 16 17 module: 17	

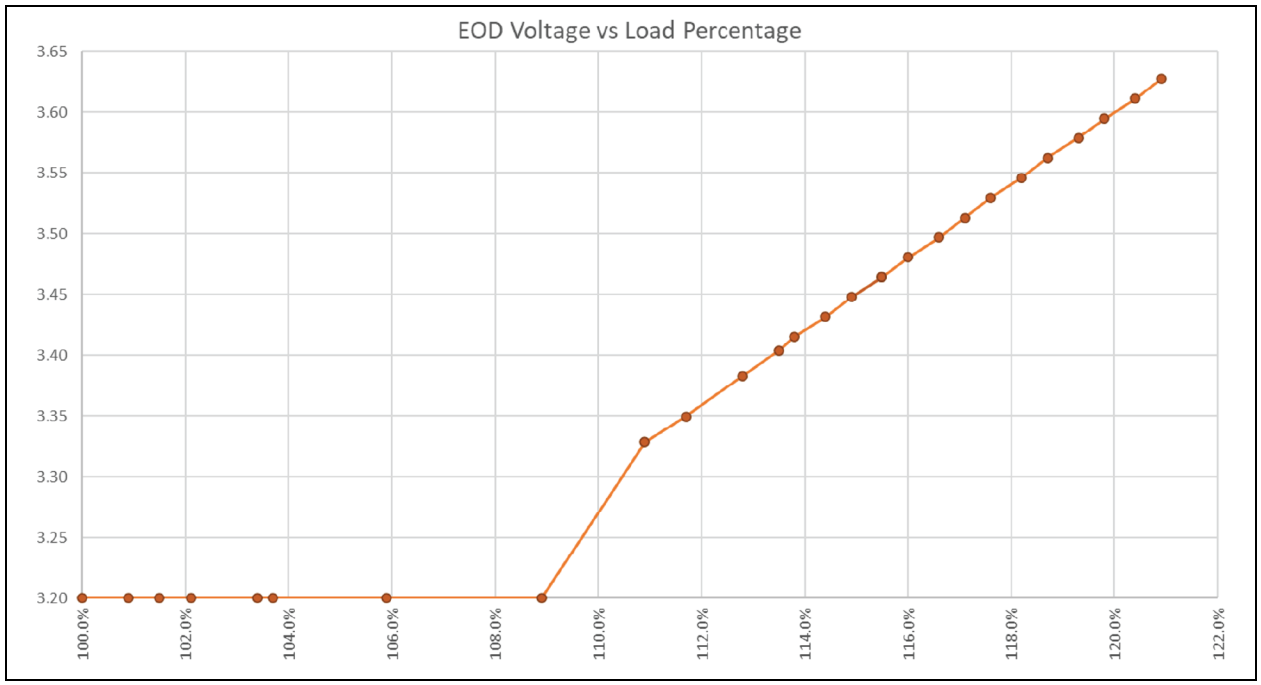
Table D.1 Technical Specification of Battery Cabinet (continued)

Parameter	Value	Notes
Storage Altitude Maximum	3000 m	
Storage Humidity Range	0 to 80% relative humidity	Must be non condensing
Storage Temperature Range	Maximum 6 months: 5 °C to 28 °C (41 °F to 82 °F) Maximum 1 month: -20 °C to 40 °C (-4 °F to 104 °F) Maximum 3 months: -20 °C to 40 °C (-4 °F to 104 °F) Mean daily maximum temperature within 30 °C (86 °F).	See Storage after Shipment on page 75 for details.
Short Circuit Current at DC Bus Terminals	10 modules: 9990 A, 1.7 ms 12 modules: 10160 A, 1.7 ms 14 modules: 10280 A, 1.7 ms 16 modules: 10370 A, 1.7 ms 17 modules: 10400 A, 1.7 ms	Single cabinet
Switchgear	Contactors, internal	
Usable Capacity at 25% Load	97.5%	Approximate; beginning of life at 25 °C (77 °F).
Usable Capacity at 50% Load	94.8%	
Usable Capacity at 75% Load	92.3%	
Usable Capacity at 100% Load	78%	
UPS Communication Interfaces	CANbus	
UPS or DC Source Architecture	2 poles (positive, negative)	
Weight	10 modules: 350kg (788 lbs) 12 modules: 397kg (874 lbs) 14 modules: 436kg (960 lbs) 16 modules: 475kg (1045 lbs) 17 modules: 495kg (1088 lbs)	Optional conduit box adds 31 kg (68 lbs). Packaging adds 30 kg (66 lbs).

Appendix E: End of Discharge Voltage Settings

The Figure E.1 below shows the adjustment of end of discharge (EOD) voltage as the percent load increases. For exact values refer to Vertiv battery sizing tables.

Figure E.1 Graph of EOD vs Maximum Load



Appendix F: Warnings and Faults

Warnings and faults can be one of three types:

1. Warning

   A warning status is indicated informing a problem after the grace period ends. The firmware will not disconnect the batteries from the DC bus. When the cause is resolved, the warning is cleared.

2. Fault

   After the grace period ends, a fault status is indicated and the firmware opens internal switchgear to disconnect the batteries from the DC bus. Reset the fault status by pressing the Reset button on the HMI. If applicable, the user can also press STOP/RESET button once.

3. Expiring Warning

   A warning appears immediately. The warning clears itself when the cause is resolved. After the grace period ends, a fault status is indicated and the firmware opens internal switchgear to disconnect the batteries from the DC bus. Reset the fault status by pressing the Reset button on the HMI. If applicable, the user can also press STOP/RESET button once.

Table F.1 Description of Warning and Fault

Description	Type	Grace Period	Threshold	Comment
Battery Module Temperature Delta	Fault	5 seconds	15 °C (59 °F)	At least 1 battery module has a large temperature difference between its internal temperature sensors. Caused by a faulty battery module or MBB.
Battery Module Over-Voltage	Fault	5 seconds	33.6 V	At least 1 MBB is reporting that its battery module total voltage is too high.
Calibration Required	Warning	None		Voltage and current sensor calibration needs to be done (calibrate command line program). This may appear after replacement of a circuit board in the PCA.
CAN0 Error	Fault	10 seconds		CANbus application for internal communication between processors on BMS board inside PCA has stopped. This may be caused by a faulty BMS board or poor system grounding.
CAN1 Error	Fault	10 seconds		CANbus application for external communication (BMS to BMS, BMS to UPS, or BMS to HMI) has stopped. This may be caused by faulty control wiring.
Cell Over-Voltage	Fault	1 seconds	4.27 V	A battery cell was charged too high. The UPS charger settings may be incorrect. May also occur if there is an extreme state of charge imbalance between parallel battery cabinets during initial charging.
Cell Under-Voltage	Expiring Warning	15 seconds	2.7 V	During discharging, a battery cell voltage was too low. UPS may not have correct settings. May also occur if batteries are discharged before cell balancing is finished, see Initial Charging and Cell Balancing on page 53. It is possible to recharge the batteries if they have been discharged below these levels, see Recovery Method on page 51.
	Fault	None	2.525 V	

Table F.1 Description of Warning and Fault (continued)

Description	Type	Grace Period	Threshold	Comment
Cell Over-Temperature	Fault	None	69 °C (156 °F)	At least 1 battery module is too hot.
Cell Under-Temperature	Fault	None	5 °C (41 °F)	At least 1 battery module is too cold. May also be caused by a damaged temperature sensor in the battery module.
Check Contactor	Fault	5 seconds		Current sensed when not expected, internal contactor may be stuck.
Charger Voltage Low	Warning	1 hour		Batteries are not being fully charged. Check UPS settings. Rarely may trigger due to small (< 15A) discharge for > 15 minutes.
Configuration Fault	Fault	None		Incorrect value for RACK_ID set during firmware configuration process or firmware configuration has not occurred yet.
Confirmation Required	Warning	None		Warning only applicable if external push buttons are present on the battery cabinet door. Waiting for STOP/RESET or ENABLE button to be pressed again.
Disconnect Open	Warning	None		S1 switch is open. May also be caused by faulty wiring inside PCA.
Disconnect Requested	Fault	None		Coordinated multi-cabinet disconnection has been requested by another cabinet.
End of Discharge	Fault	None		Occurs at end of battery discharge. Indicates batteries have been exhausted.
Fuse Blown	Fault	5 seconds	Battery voltage <60 V	May indicate either a cleared internal fuse (main power fuse) or faulty wiring inside the PCA. Note that this will also appear if the system is powered without the battery shelves having been connected in series.
High DC Bus Voltage	Fault	1 hour	10 mod: 339.3 V 12 mod: 407.2 V 14 mod: 475.1 V 16 mod: 542.9 V 17 mod: 576.9 V	Charger voltage is too high.
High Delta Voltage	Warning	None	8 V when other batteries are connected to DC bus, or 25 V when other batteries are not connected to bus.	Difference between DC bus voltage and battery voltage is too large to allow safe connection, so cabinet will stay in WAITING mode. In some cases it is possible to bypass this protection, see Force Connection on page 52.
High SOC	Warning	None	100%	Battery state of charge is too high. May be caused by incorrect UPS/charger settings.
IOB-MBB Voltage Fault	Fault	10 seconds	10 V	Difference between cell voltage sum and measured battery voltage is too large. May be caused by faulty MBB. This fault may be caused by one module being installed in reverse polarity. If this fault is received it is important that module orientations are verified.

Table F.1 Description of Warning and Fault (continued)

Description	Type	Grace Period	Threshold	Comment
IOB Frame Error	Expiring Warning	5 seconds		Internal communication error between subsystems in the PCA. Occasional short disruptions are normal. May be caused by faulty circuit board inside the PCA, faulty control wiring or poor system grounding.
IOB Reg PS Failure	Fault	5 seconds		Internal IO board has a regulated power supply failure (faulty circuit board).
IOD Not Running	Fault	10 seconds		Firmware which drives internal communication has stopped. May be accompanied by the IOB Frame Error fault and may be caused by faulty circuit board inside the PCA, faulty control wiring or poor system grounding.
Low Memory	Warning	None	200 MB	This warning appears when the short-term log file storage memory is low due to malfunctioning firmware.
Low SOC	Warning	None	1%	Battery state of charge is very low. Warning is cleared when SOC rises above 3.5%.
MBB Board Over Temp	Fault	None	75 °C (167 °F)	MBB reporting its own temperature is too high, possible MBB failure. Check MBB temperature for each battery module on touchscreen HMI.
Module Comms Error	Expiring Warning[VY1]	5 seconds		Long communication dropout between PCA and MBBs. May be caused by failed communication cable inside the cabinet. Occasional short disruptions are normal.
Misc. BMS Safety Fault	Fault	5 seconds		Safety subsystem on BMS board senses a problem, typically accompanied by other faults or warnings unless BMS board is faulty. After safety-related fault conditions have been cleared, this persists for 15 seconds and will clear if cell voltages are under the over voltage limit.
Misc. IOB Safety Fault	Fault	5 seconds		Safety subsystem on IO board has a problem, typically accompanied by other faults or warnings unless IO board is faulty.
Overcurrent (Charging)	Expiring Warning	60 seconds	64 A	Current too high during charging. Can be caused by incorrect UPS settings or, rarely, connecting two or more battery cabinets which have a large voltage difference. Instant fault above 250 A.
Overcurrent (Discharge)	Expiring Warning	13 seconds	444 A	Current too high, discharging. Instant fault at 600 A.
Overcurrent (Hardware Backup)	Expiring Warning	5 seconds	277 A charging 650 A discharging	Backup overcurrent sensor trip.
Overload Possible	Warning	None	Total power available < 102% of total expected load	Number of online cabinets is not enough to support expected load. Note that in most installations, expected load is determined by the BMS based on the most recent battery discharge.
Over Voltage	Expiring Warning	15 seconds	10 mod: 339.4 V 12 mod: 407.2 V 14 mod: 475.1 V 16 mod: 543 V 17 mod: 576.9 V	Battery string voltage too high. Instant fault if it reaches 101% of the listed values. May be caused by incorrect charger/UPS settings.

Table F.1 Description of Warning and Fault (continued)

Description	Type	Grace Period	Threshold	Comment
Peer Comms Error	Warning	30 seconds		Firmware is expecting CANbus communication from another cabinet but not receiving it.
Polarity Fault	Fault	None	DC bus < -30 V	Reverse polarity is detected on the DC bus connections.
Power Supply Redundancy Loss	Warning	1 second		One of the two control power sources inside the PCA, which derives power from the batteries, is not active. May be caused by faulty power supply or faulty wiring inside PCA.
Replace Contactor	Warning	None	100	BMS firmware estimates the health of the internal contactors by recording the number of disconnections under high load. This warning indicates that the contactors are at end of life and PCA replacement is recommended. This should only be expected if battery discharges above maximum rated conditions occur frequently over the life of the product.
Reset Fault Required	Fault	None		Press the Reset Fault button on the HMI. If applicable, push the STOP/RESET button after the cause of a problem is cleared. See ENABLE and STOP/RESET Buttons on page 12.
SD Card I/O Error	Warning	None		Firmware has lost its connection to the SD card mass storage. Log files are not being stored. May be caused by faulty firmware installation on the SD card.
Under Voltage	Expiring Warning	15 seconds	10 mod: 232 V 12 mod: 278.4 V 14 mod: 324.8 V 16 mod: 371.2 V 17 mod: 394.4 V	Battery string voltage is too low. See Recovery Method on page 51. Instant fault if voltage reaches 98.5% of the threshold value.
UPS Comm Error	Warning	30 seconds		Long communication dropout with the UPS. Only used when digital communication is enabled between BMS and UPS. May be caused by faulty control wiring.
Warm Battery	Warning	None	29 °C (84 °F)	Battery temperature is slightly high. Typically caused by prior charging and discharging or high ambient temperature. Runtime during discharge will be shorter than normal even if batteries are fully charged.

Appendix G: Control and Monitoring Points

Control Terminal Block

Control terminal block (CTB) is provided to each Vertiv™ EnergyCore Lithium 7 cabinet which is where low voltage control wiring typically lands. For ease of installation when multiple wires must land on the same terminal number, positions 1 through 21 each have two landing points which are connected internally.

Figure G.1 CTB Position

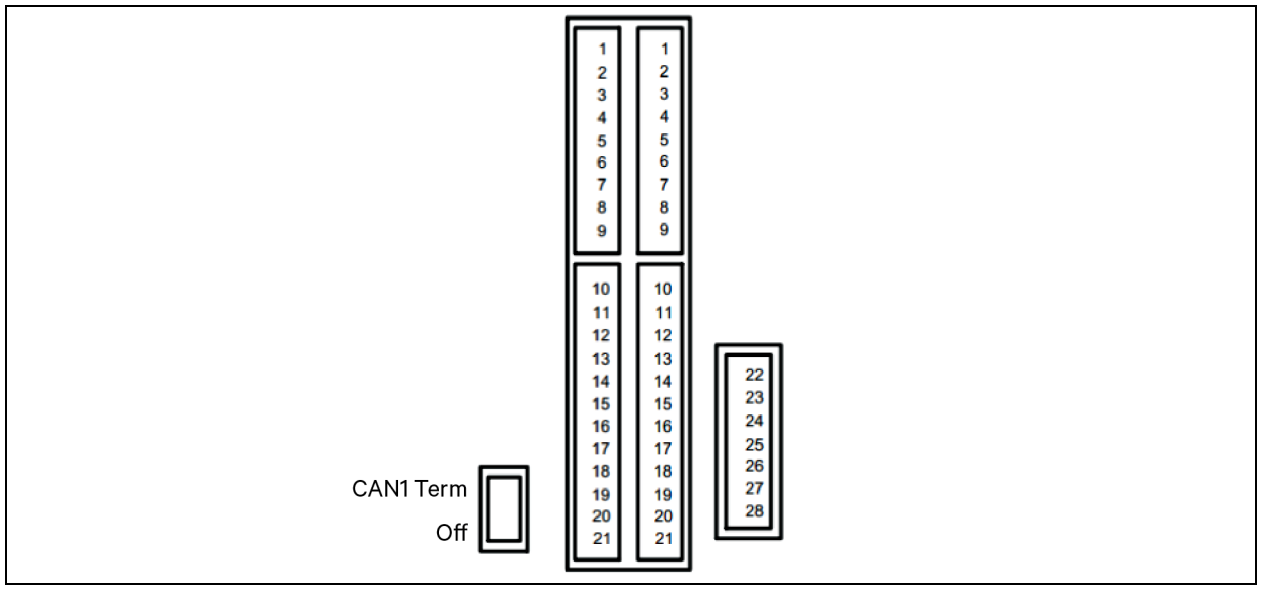


Table G.1 CTB Position

CTB Number	Name	Type	Description
CTB-1	DISCONNECT_NO	Form C relay - NO	This is energized by the BMS to request fast, coordinated disconnection across multiple cabinets.
CTB-2	DISCONNECT_COM	Form C relay - COM	
CTB-3	DISCONNECT_NC	Form C relay - NC	
CTB-4	BAT_THIS_RACK_NO	Form C relay - NO	When energized, indicates this cabinet's batteries are connected to UPS or DC source.
CTB-5	BAT_THIS_RACK_COM	Form C relay - COM	
CTB-6	BAT_THIS_RACK_NC	Form C relay - NC	
CTB-7	BAT_DISCONNECT_IMMINENT_NO	Form C relay - NO	When energized, indicates the batteries will soon be exhausted and will disconnect.
CTB-8	BAT_DISCONNECT_IMMINENT_COM	Form C relay - COM	
CTB-9	BAT_DISCONNECT_IMMINENT_NC	Form C relay - NC	
CTB-10	CGND	Power supply reference	Isolated ground for CTB-17 through CTB-20.

Table G.1 CTB Position (continued)

CTB Number	Name	Type	Description
CTB-11	BAT_MINOR_ALARM_NO	Form C relay - NO	When NOT energized, indicates an alarm status for this cabinet. If this cabinet is assigned as BMS_ID 1 during firmware configuration, this relay will indicate a warning if any cabinet in the set has an active warning.
CTB-12	BAT_MINOR_ALARM_COM	Form C relay - COM	
CTB-13	BAT_MINOR_ALARM_NC	Form C relay - NC	
CTB-14	BAT_FAULT_NO	Form C relay - NO	When NOT energized, indicates a fault status for this cabinet. If this cabinet is assigned as BMS_ID 1 during firmware configuration, this relay will indicate a fault if any cabinet in the set has an active fault.
CTB-15	BAT_FAULT_COM	Form C relay - COM	
CTB-16	BAT_FAULT_NC	Form C relay - NC	
CTB-17	UPS_READY_LOW	N.O. dry contact input	External short to CTB-10 indicates UPS ready for battery online.
CTB-18	DISCONNECT_REQUEST_LOW	N.O. dry contact input	External short to CTB-10 indicates request for coordinated multi-cabinet disconnection.
CTB-19	CAN1_HI	CAN	CANbus signal for HMI and peer to peer communication.
CTB-20	CAN1_LO		
CTB-21	BMS_AUX_INPUT_1	N.O. dry contact input	Input active when shorted to CTB-22 OR CTB-23.
CTB-22	GND	Power supply reference	Return for BMS_AUX_INPUT_x.
CTB-23	GND	Power supply reference	Return for BMS_AUX_INPUT_x.
CTB-24	Reserved	N/A	
CTB-25	CGND	Power supply reference	Isolated ground for CTB-17 and CTB-18.
CTB-26	BMS_AUX_INPUT_2	N.O. dry contact input	Input active when shorted to CTB-22 or CTB-23.
CTB-27	BMS_AUX_INPUT_2	N.O. dry contact input	Input active when shorted to CTB-22 or CTB-23.
CTB-28	Chassis Ground	N/A	Internally connected to chassis/frame ground.

Remote Monitoring Ports

Modbus RTU

The Vertiv EnergyCore Lithium 7 can act as a Modbus RTU server through an RS-485 serial port which is accessible on the BAT 1 connector on the PCA. Modbus RTU must be activated during the initial setup and firmware configuration process. The data format is published in a separate document.

NOTE: The RS-485 signal is not isolated at the cabinet. If the signal wiring must travel to a distant device with a different ground potential, it is recommended to add an isolated RS-485 repeater near the cabinet to avoid excess noise or damage to one of the devices.

The mating connector for the BAT 1 port is Molex 513531000 or Wurth Elektronik 624010213322.

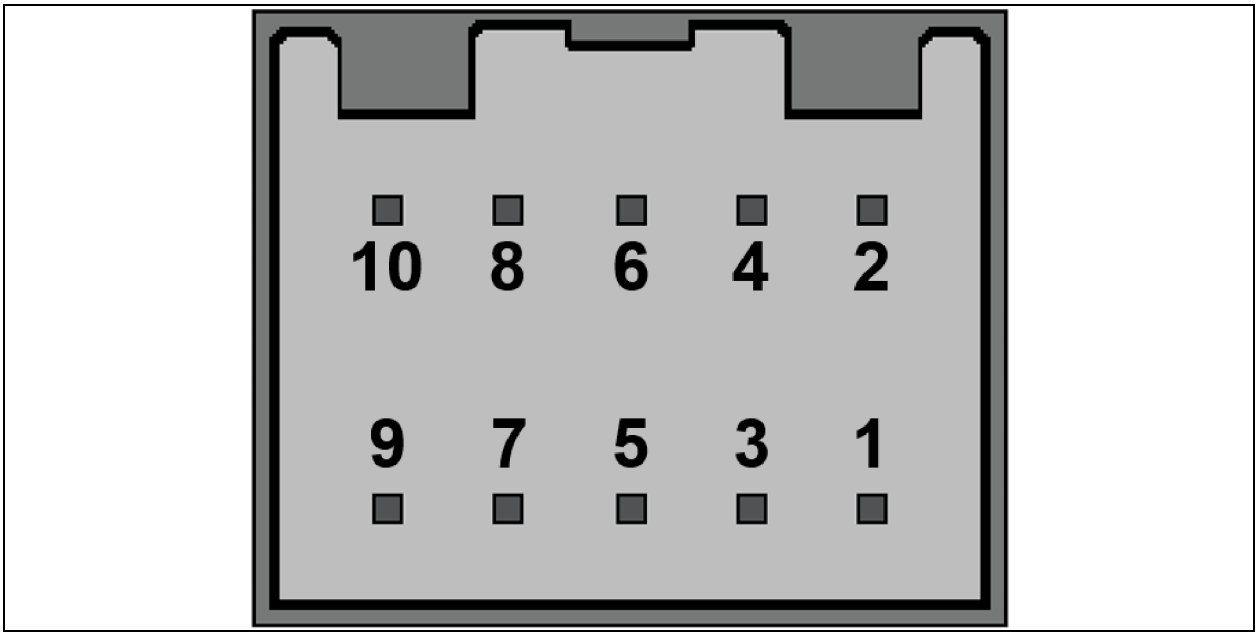
Communication cable to be installed by others.

Table G.2 Battery Terminal Position

BAT 1 Terminal Number	Function
7	RS-485 negative
8	RS-485 positive
9	GND

BAT 1 port terminal positions viewed from the front of the Vertiv™ EnergyCore Lithium 7 are illustrated in Figure G.2 below.

Figure G.2 BAT 1 Port Terminal



NOTE: Mating receptacle is MOLEX 51353-1000. This component, if needed, is furnished by others.

Modbus TCP and SNMP

The Vertiv™ EnergyCore Lithium 7 can be configured as a Modbus TCP or SNMP server during the initial setup and firmware configuration process. These protocols use the 100BT Ethernet port at the front of the PCA. The data format is published in a separate document.

Appendix H: Retrofits

H.1 Replacing UPS Attached Battery Cabinets

When using the Vertiv™ EnergyCore Lithium 7 to replace older battery cabinets that are attached to the side of the UPS, a panel needs to be installed onto the UPS to cover the open side (previously shared with the battery cabinet). In some cases of an UPS with attached battery cabinet, the outer side panel of the battery cabinet is secured and fastened to the UPS to cover the opening. If the panel of the battery cabinet does not fit properly (on an UPS), a new side panel needs to be ordered for the UPS. Contact a Vertiv representative about whether a new side panel needs to be ordered.

Perform the following steps to remove the attached battery cabinets:

1. Disconnect the electrical connections of the batteries inside the battery cabinets (module-to-module connections) and from the UPS.
2. Remove old battery cabinet side panel and secure it if it will be reused.
3. Disconnect the old battery cabinet from the UPS and remove it from the room.
4. Attach the side panel (whether new or reused) to the side of the UPS.

H.2 DC Ground Fault Detection

When installing new battery cabinets or DC cables, local building laws may require a DC ground fault detection device to be installed on the DC circuit. In particular, the US National Electric Code (NFPA 70) added this requirement for energy storage systems using ungrounded DC conductors in 2014. A ground fault detection device is typically installed in the UPS and is available with most of the Vertiv UPS models. To install DC ground fault detection, contact a Vertiv representative or Vertiv technical support, see Technical Support and Contacts on page 57 to determine the correct option for specific UPS.

Appendix I: Storage after Shipment

It is recommended for the Vertiv™ EnergyCore Lithium 7 to be stored in a climate controlled area to minimize capacity loss after shipment from the factory. However, a short period of storage outside this range will not significantly affect the capacity of the batteries. See Technical Specification on page 63 for allowable storage temperature and humidity.

It is normal for lithium-ion batteries to self discharge slowly. Severe over discharge (below 0% state of charge) will damage the batteries. For this reason, if the batteries are to be stored for a long period after shipment from the factory, each battery shelf should have its open circuit voltage (OCV) measured 9 months after the reference date, and then every 6 months thereafter. The reference date is written on a tag that ships with each cabinet. If a battery shelf is found to have an OCV less than 28.7 V, contact Vertiv. See Technical Support and Contacts on page 57. To obtain assistance for recharging the batteries so they can continue to be stored without becoming over discharged.

If a spare battery module is kept onsite, the annual OCV measurement described above should be conducted. The battery module should be kept in the original box or crate in which it shipped to avoid accidental damage.

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