VERTIV.

EnergyCore Lithium 5

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!

The following precautions are intended to ensure your 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 these 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 5. All voltage sources to the unit must be disconnected before inspecting or cleaning within the cabinet.

1.1 Critical Fire Safety Compliance

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

This product was tested in accordance with 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.

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2 Overview

The Vertiv™ EnergyCore Lithium 5 is a high power standby battery cabinet designed for use with uninterruptible power supply (UPS). See Technical Specification on page 41.

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 EnergyCore Lithium 5 contains high voltage electric shock sources. Do not open any cover of the EnergyCore Lithium 5 enclosure other than the front door.

2.1 Model Nomenclature

The 15-digit part number is on the main label inside the door of EnergyCore Lithium 5. 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 allows for higher voltage and additional energy storage.

Figure 2.1 Part Number

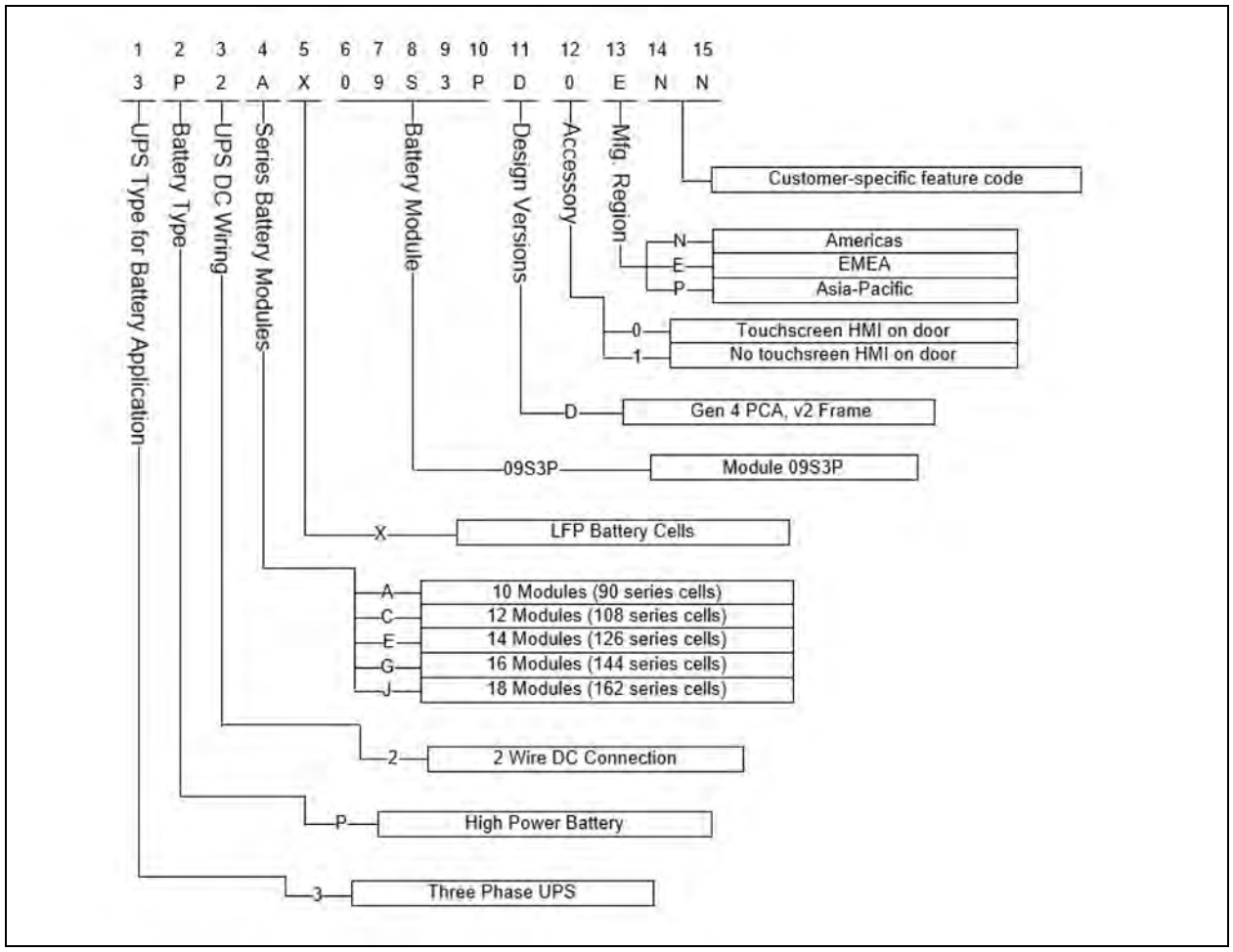


Table 2.1 Model Description

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
3	P	2	A	X	0	9	S	3	P	D	0	E	N	N

Table 2.2 Model Number Digit Description

Digit	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 (90 series cell)

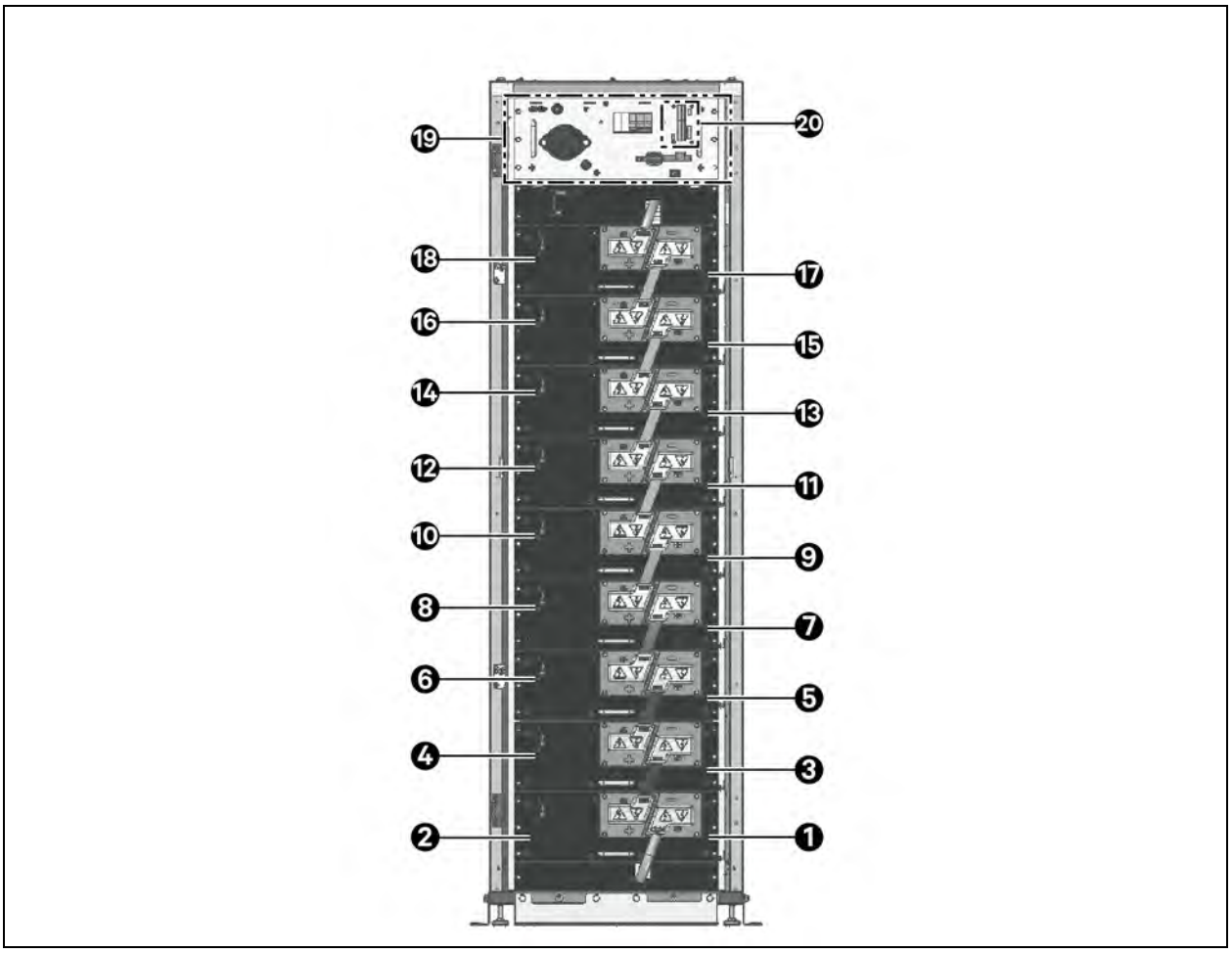
Table 2.2 Model Number Digit Description (continued)

Digit	Description
	• C -12 modules (108 series cell) • E - 14 modules (126 series cell) • G - 16 modules (144 series cell) • J - 18 modules (162 series cell)
5	X- LFP battery cell
6, 7, 8, 9, 10	Battery module • 09S3P-Module 09S3P
11	Design version • D - Gen 4 PCA, v2 frame
12	Accessory • 0 - Touchscreen HMI on door • 1 - No touchscreen HMI on door
13	Manufacturing region • N - Americas • E - EMEA • P - Asia-Pacific
14, 15	Customer specific feature code

2.2 Battery Module Numbering Scheme

See Figure 2.2 on the next page for the battery module numbering scheme in the cabinet and the location of the control terminal block (CTB). The battery modules are arranged on sliding shelves, with two battery modules connected in series together (internally) on each shelf. Each shelf has a positive and a negative power terminal. Each battery module has a monitoring and balancing board (MBB) attached to it internally which balances the battery cells and reports voltages and temperatures to the power chassis assembly (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. Always bottom-right. This is the most negative battery module in the cabinet.
2	Module 2. Always bottom-left. This is the second most negative battery module in the cabinet.
3	Module 3
4	Module 4
5	Module 5
6	Module 6
7	Module 7
8	Module 8
9	Module 9
10	Module 10
11	Module 11 (if installed)

Item	Description
12	Module 12 (if installed)
13	Module 13 (if installed)
14	Module 14 (if installed)
15	Module 15 (if installed)
16	Module 16 (if installed)
17	Module 17 (if installed)
18	Module 18 (if installed)
19	Power Chassis Assembly (PCA)
20	Control Terminal Block (CTB). See Control and Monitoring Points on page 49 for details.

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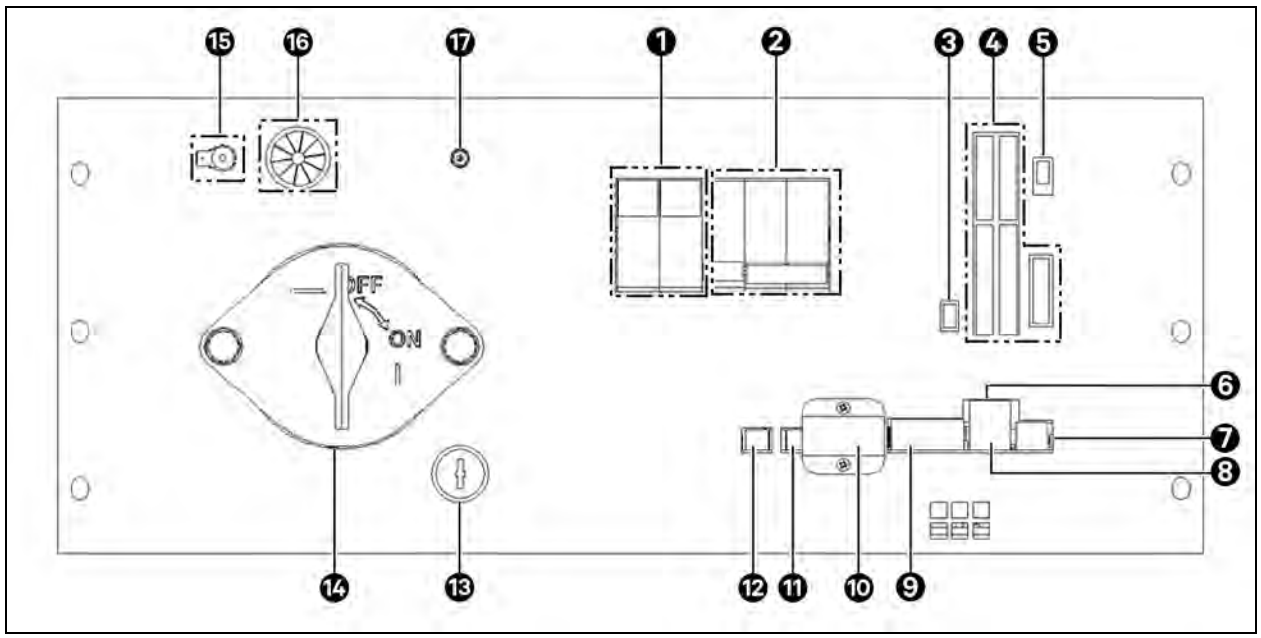
3 Description

3.1 Power Chassis Assembly (PCA)

The PCA is a 4U-sized enclosed section that controls the connection of the batteries to the DC bus. The PCA monitors each battery's voltage and temperature to ensure operation within the specified limits throughout the life of the product. See Figure 3.1 below for PCA.

IMPORTANT! Operation of the Vertiv™ EnergyCore Lithium 5 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. Refer **Vertiv™ EnergyCore Lithium 5 Service Manual SL-71289** for more information.
4	Control terminal block (CTB), see Control Terminal Block (CTB) on page 49 for more details.
5	Door position switch input, not used.
6	100BT Ethernet port
7	BAT 1 port carries RS-485 for Modbus RTU server. See Control and Monitoring Points on page 49 for detailed connector information.
8	USB 2.0 port for log file download.
9	RS-232 serial port for service use only. DB9 female.

Item	Description
10	Firmware SD card slot with cover plate (for service use only)
11	Power output port for optional HMI
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.

To open the S1 switch follow the procedure below:

To open the S1 switch (maintenance disconnect):

1. Verify that the RUN/SERVICE key switch is in the RUN position.
2. Press and hold the STOP button for 5 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.

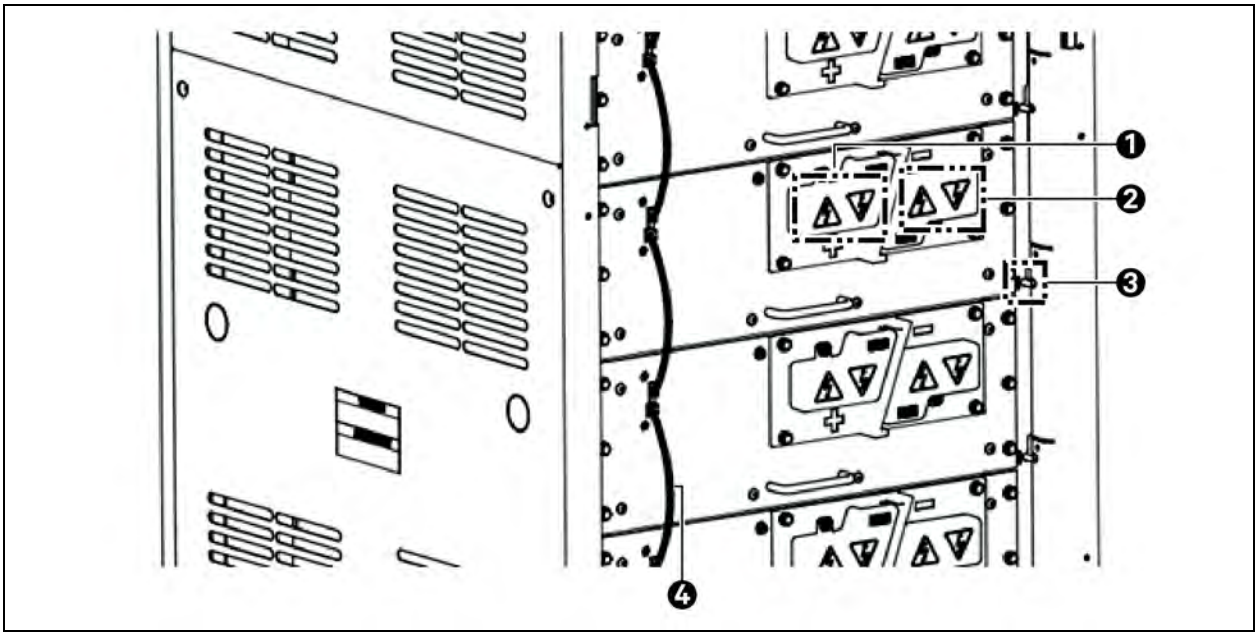
To close the S1 switch (maintenance disconnect):

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

3.2 Battery Shelf

Two battery modules are wired in series, a protective metal case, power terminals (positive shelf and negative shelf), and communication connectors in each battery shelf. Communication cables transfer data between the battery monitoring and balancing boards (MBB) and the cabinet level BMS. See Figure 3.2 on the facing page.

Figure 3.2 Battery Shelf Front



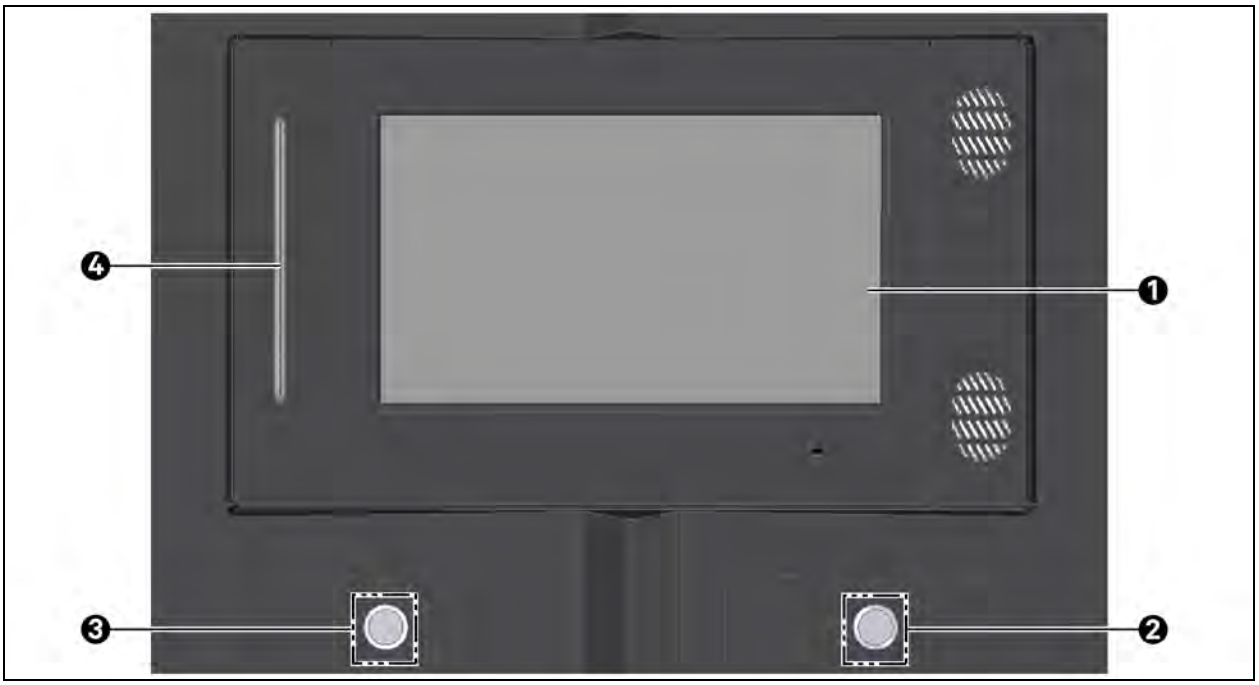
Item	Description
1	Battery shelf positive terminal. There is a protective cover during operation and shipment.
2	Battery shelf negative terminal. There is a protective cover during operation and shipment.
3	Safety lever. Push to release it. Limits extraction of battery module.
4	Communication cable.

3.3 Local Interface

The local interface is the primary means of interacting with the Vertiv™ EnergyCore Lithium 5, see Figure 3.3 on the next page. Two illuminated buttons are always present. The user can use the 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 illuminated buttons also indicate the status of the battery cabinet.

Additionally, the product offers the touchscreen HMI mounted on the cabinet door. The touchscreen HMI shows the status of all connected battery cabinets. A standard installation of the EnergyCore Lithium 5 will have the touchscreen HMI on one battery cabinet while other parallel battery cabinets do not have the touchscreen HMI installed.

Figure 3.3 Local Interface

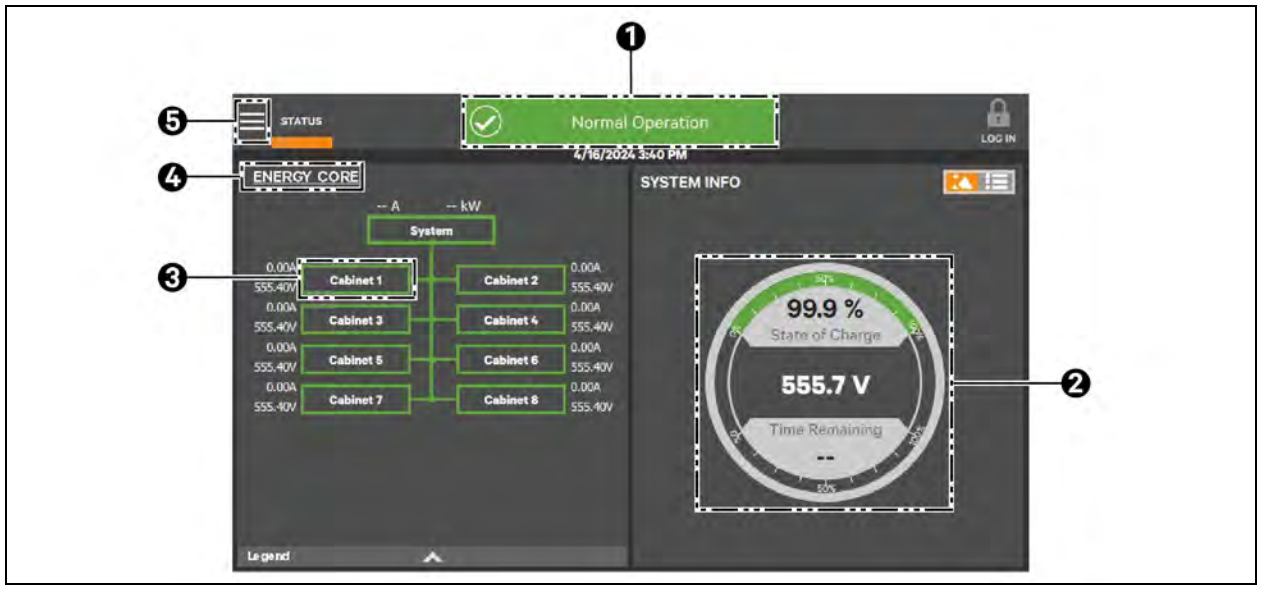


Item	Description
1	Touchscreen HMI (optional)
2	ENABLE button
3	STOP/RESET button
4	LED status bar

3.3.1 Touchscreen HMI

Vertiv™ EnergyCore Lithium 5 HMI display gives the information of all the connected battery cabinets. It gives the information of system overview, alarm/status banner, system information and menu selection option. See Figure 3.4 on the facing page.

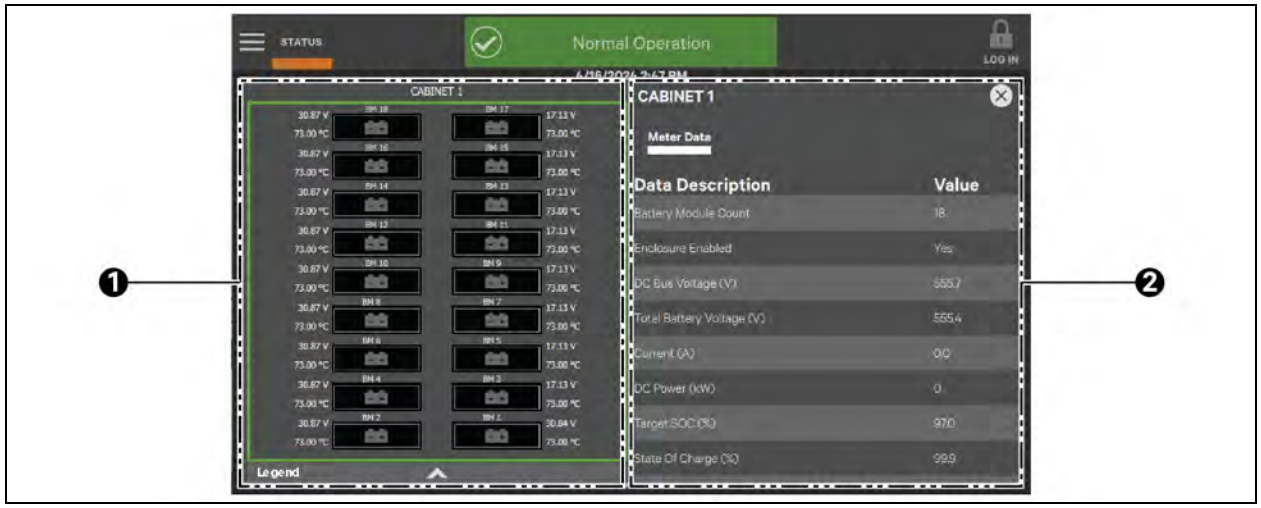
Figure 3.4 System Overview



Items	Description
1	Alarm/status banner
2	System overview
3	Cabinet icons
4	System information gauge
5	Pop-out menu selection

Click any cabinet icon from the EnergyCore system overview screen. The cabinet overview page will be displayed. It shows the overview of all the battery modules available in the selected cabinet on left hand side of the screen and the overview of the selected cabinet system on the right hand side of the screen. See Figure 3.5 below.

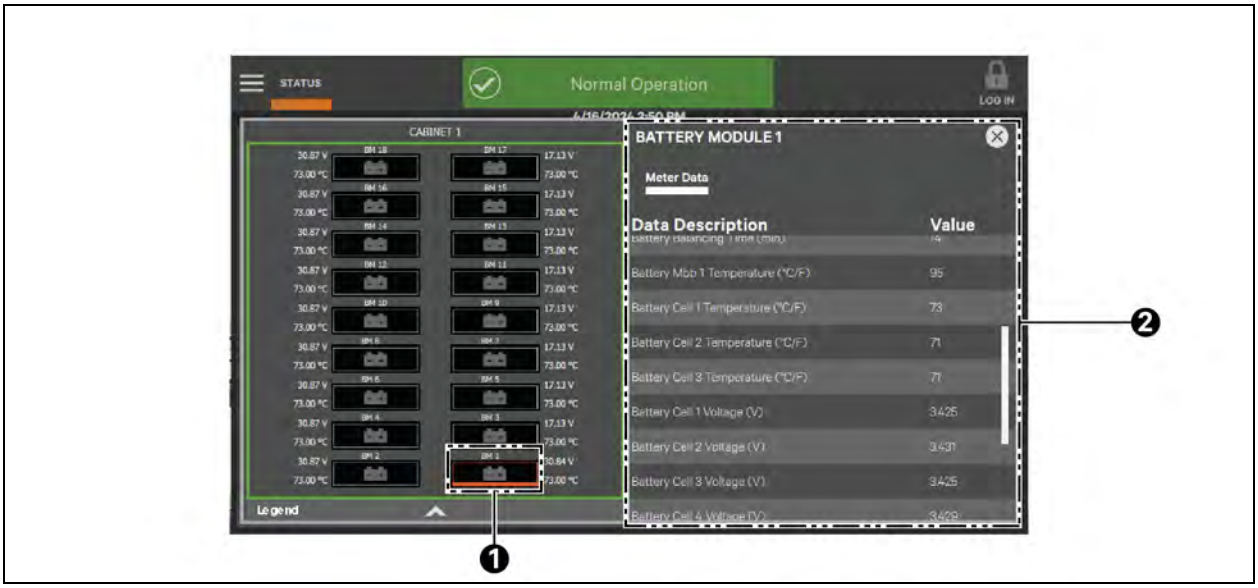
Figure 3.5 Cabinet Overview



Items	Description
1	Battery module overview
2	Cabinet system overview

To view specific details on any battery module in the cabinet, click the battery module icon on the left hand side of screen. The battery module overview page displays module data such as cell voltages and cell temperatures. See Figure 3.6 below.

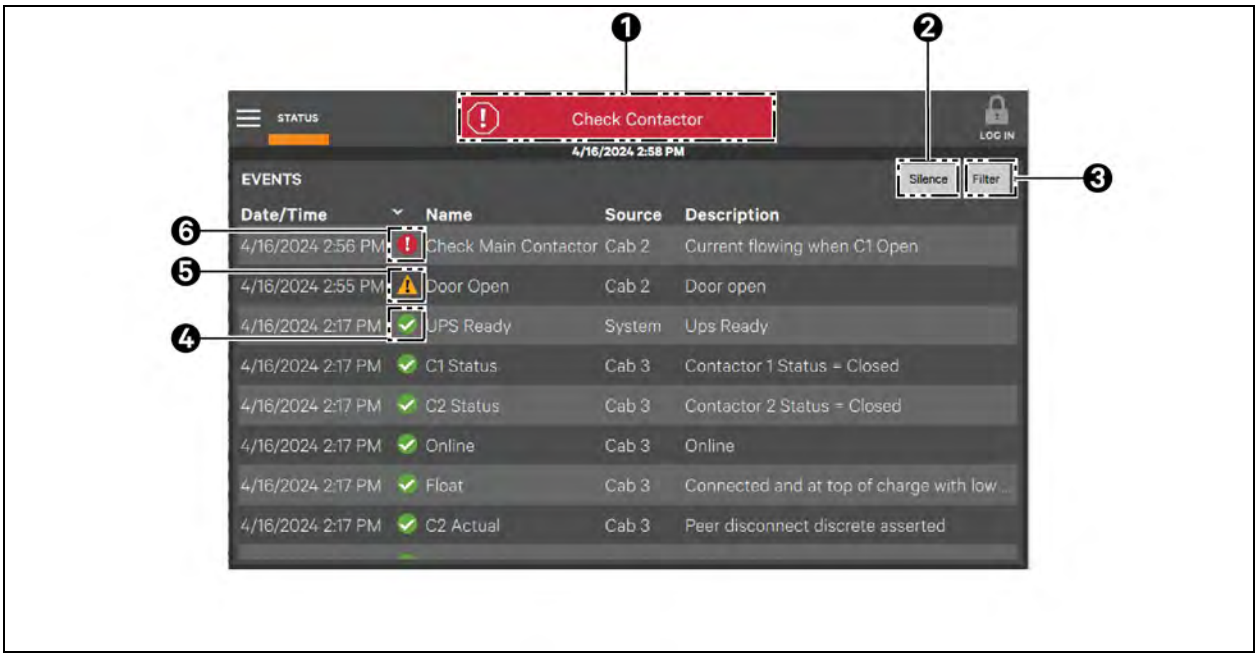
Figure 3.6 Battery Overview



Items	Description
1	Battery module 1 selected battery module 1 overview
2	Battery module 1 selected battery module 1 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 45. Click the Filter button to filter the log of events. Click the Silence button if any fault alarm is present. See Figure 3.7 on the facing page.

Figure 3.7 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

3.3.2 ENABLE and STOP/RESET Buttons

The ENABLE button is at the right hand side of the local interface. Press the button two times to enable the cabinet to join the DC bus (connect its batteries to the DC bus) when conditions are right. The system will be in WAITING mode, if the conditions are not suitable for the internal contactors to close, indicated by the flashing LED (with color dependent on the systems status) around the ENABLE button. The STOP/RESET button is at left hand side of the local interface. Press the button two times to open the internal contactors to disconnect the batteries from the DC bus (if not already disconnected). If a fault or warning is indicated but the trigger condition for it has been cleared, pushing the STOP/RESET button one time resets the fault or warning indication.

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 co-ordinated disconnect request is active.
White	Uncommon. Service mode is active.
Flashing	The BMS firmware is waiting before closing switchgear. See Startup on page 31 for more information.

4 Installation

This section provides information to install the Vertiv™ EnergyCore Lithium 5 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 start-up 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 energy EnergyCore Lithium 5 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.

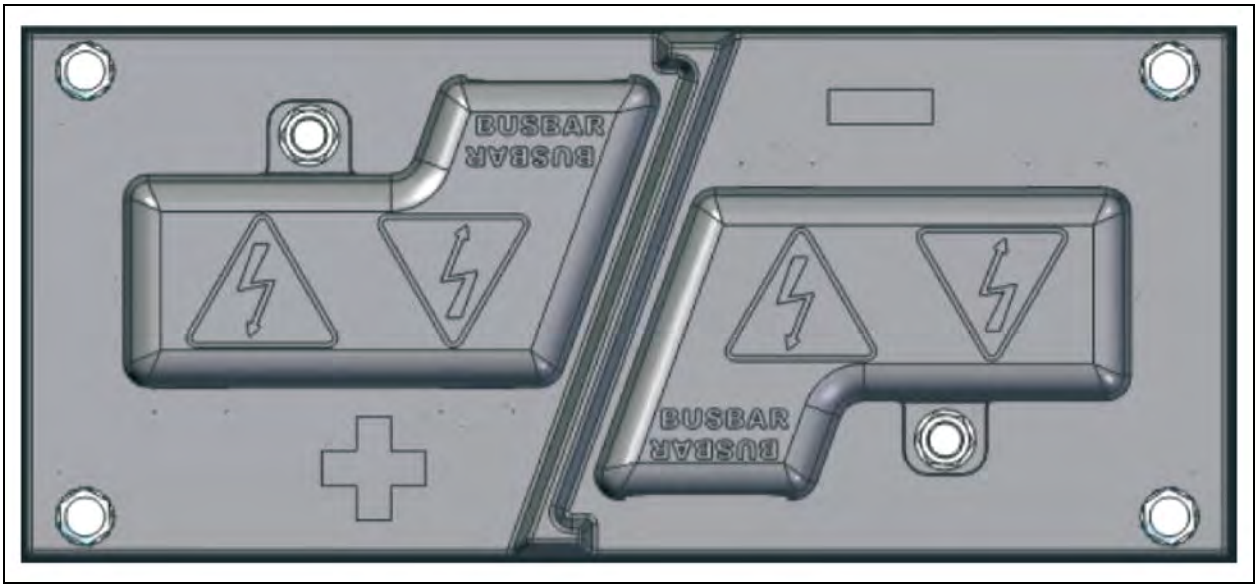
NOTICE

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.

4.1 Arc Flash and Shock Hazard Safety

Protective covers are installed on each battery shelf at the factory to prevent accidental short circuits during installation. Do not remove the protective covers or connect the battery shelves in series before the installation is completed.

Figure 4.1 Protective Cover



4.2 Location

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

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

Table 4.1 Required Minimum Clearances after Installation

Area	Description
Above the cabinet.	18 inches (457 mm) to any obstruction. This is for technician working space.
Front of cabinet.	36 inches (914 mm) to any obstruction. This allows the door to open and technician working space.
Between the cabinet and a combustible fire wall.	1 inch (25 mm)
Between two cabinets (or to other equipment frame) back to back.	**Standard mounting:** None **Seismic rated mounting:** 4 inches (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.	

4.3 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.

WARNING! Failure to follow the safety procedure or using equipment insufficiently rated for the weight of the Vertiv™ EnergyCore Lithium 5 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 instruction may lead to damage to the EnergyCore Lithium 5. Such damage will not be covered by the warranty.

IMPORTANT! 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 take the EnergyCore Lithium 5 off its shipping pallet, follow this procedure:

Forklift Requirements

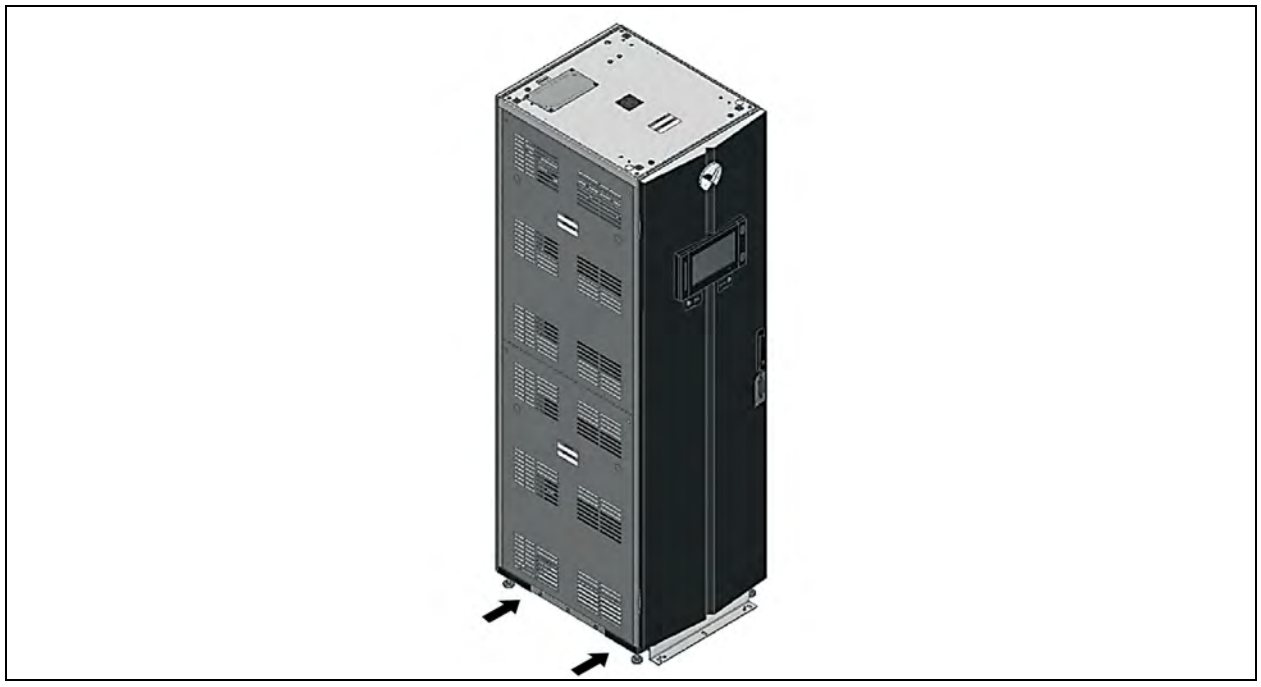
- Maximum overall width of forks - 18 in. (457 mm)
- Maximum thickness of forks - 2 in. (51 mm)
- Lifting capacity - 1400 lb. (635 kg) or equal to or greater than the weight of the EnergyCore Lithium 5.

1. Unpack the rack and remove the bolts holding down brackets to the base of the cabinet and the shipping pallet.
2. Remove the brackets on the sides of the cabinet.
3. 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.

4. Position the forklift on the side of the EnergyCore Lithium 5 and move the forks so they are just inside the casters. See Figure 4.2 on the next page.
5. Move the forks under the cabinet from the side until they are fully inserted.
6. Lift the cabinet straight up until it clears the shipping pallet.
7. Slide the shipping pallet from under the unit and lower the EnergyCore Lithium 5 onto a level surface.
8. Use the casters to roll the unit into place. Do not use the lifting mechanism to transport the unit.
9. When the unit is in place and level, crank down the leveling feet to take pressure off the casters.

Figure 4.2 Lift the Battery Cabinet with a Forklift



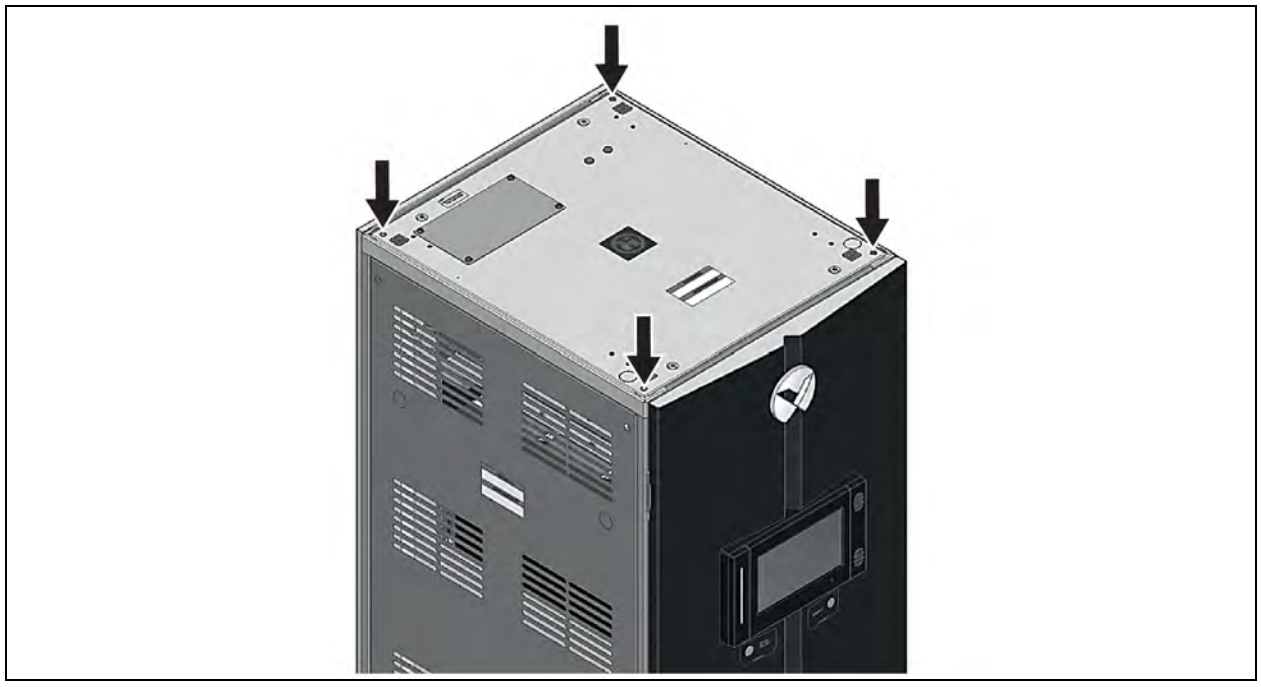
To use slings to take the Vertiv™ EnergyCore Lithium 5 off its shipping pallet, follow this procedure:

Eyebolt Requirements:

- M10 x 1.5
- Rated for a minimum of 600 lb. (272 kg) vertical lifting capacity each, reference supplier and part number McMaster-Carr 4843T14.

1. Install four eyebolts, meeting the specifications above, one in each corner of the top of the battery cabinet.
2. Connect the slings securely to the eyebolts.
3. Position the lifting mechanism so that the slings are less than 30° from vertical.
4. Raise the battery cabinet until it clears the shipping pallet.
5. Slide the pallet from under the unit and lower the cabinet onto a level surface.
6. Use the casters to roll the unit into place. Do not use the lifting mechanism to transport the unit.
7. When unit is in place and level, crank down the leveling feet to take pressure off the casters.
8. Remove the four eyebolts and retain them for future use.

Figure 4.3 Hoisting the Vertiv™ EnergyCore Lithium 5 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.

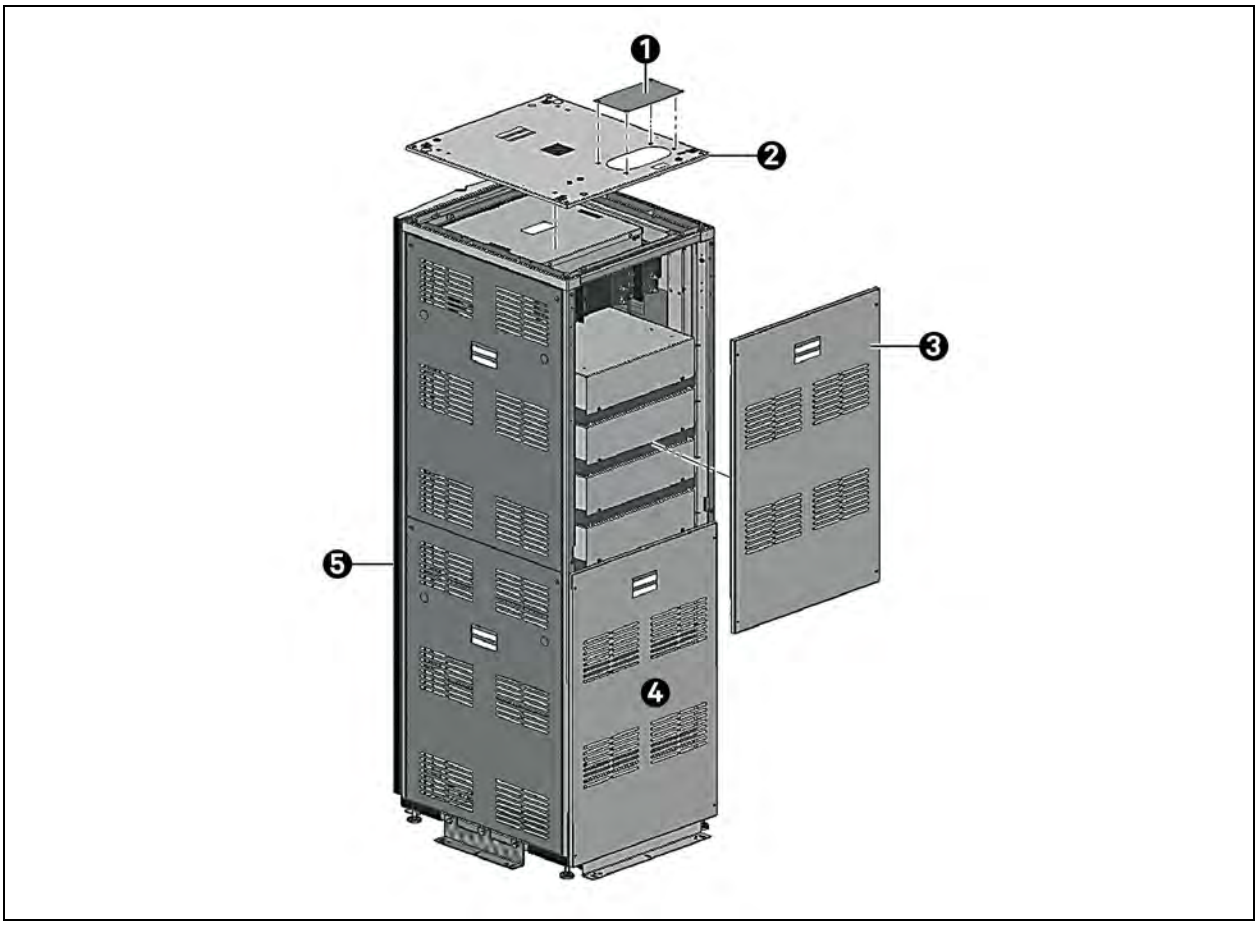
NOTE: Do not use eyebolt lifting when battery busbars are installed between shelves.

NOTE: Before removing the top or rear panel, verify that the battery shelf front busbars are not connected, refer EnergyCore Lithium 5 Service Manual SL-71289.

To install the EnergyCore Lithium 5:

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.
2. Loosen (approximately 3 turns) the upper rear panel screws (4 locations) with a T-30 star bit or wrench.
3. Slide the upper rear panel up and off.

Figure 4.4 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
4	Rear of unit	T-30 star drive bit
5	Front of unit	10 mm socket and wrench

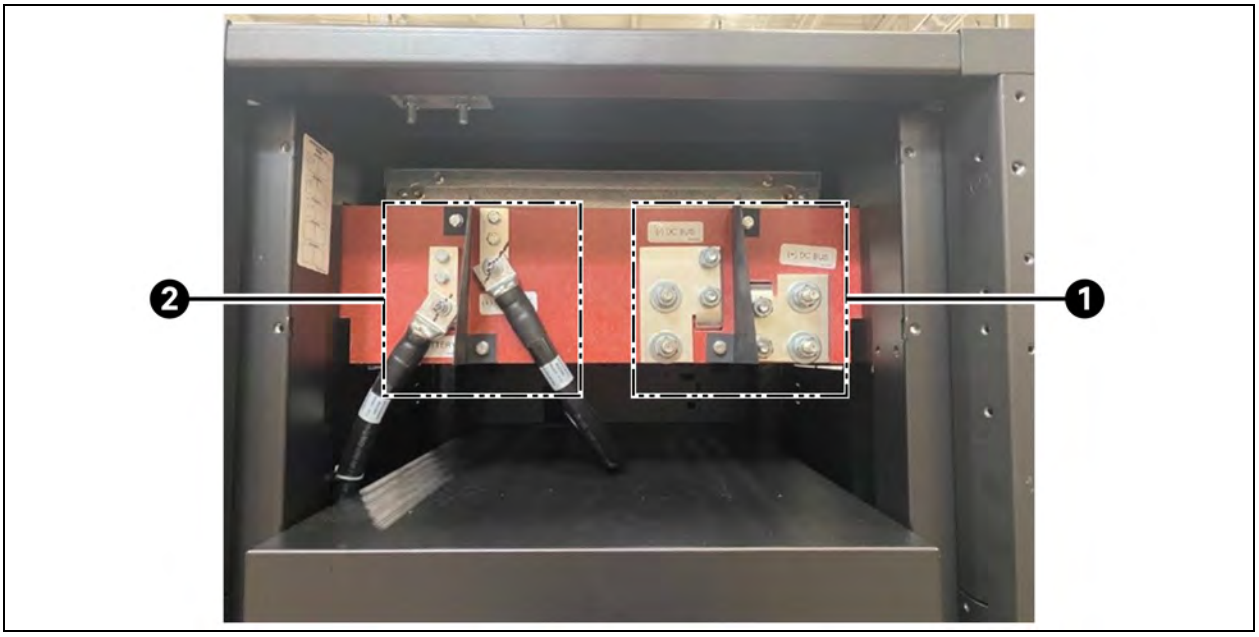
Before connecting power cables between the battery cabinet and the DC bus, the installing contractor must measure the voltage across the battery cabinet DC cables. Verify no voltage is present between the positive and negative battery busbars. If no voltage is present, proceed with the installation. If voltage is present, do not proceed with the installation and follow the steps below:

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 busbar covers and the shelf connecting busbar on the top most battery shelf to battery shelf busbar connection. Set the busbar aside for reinstallation later.

NOTE: Do not remove the power cable cover on the bottom and top shelf.

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 the installation.

Figure 4.5 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, see Figure 4.6 below, clean the busbar with fine grit (240 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 4.6 Cable Landing Busbars

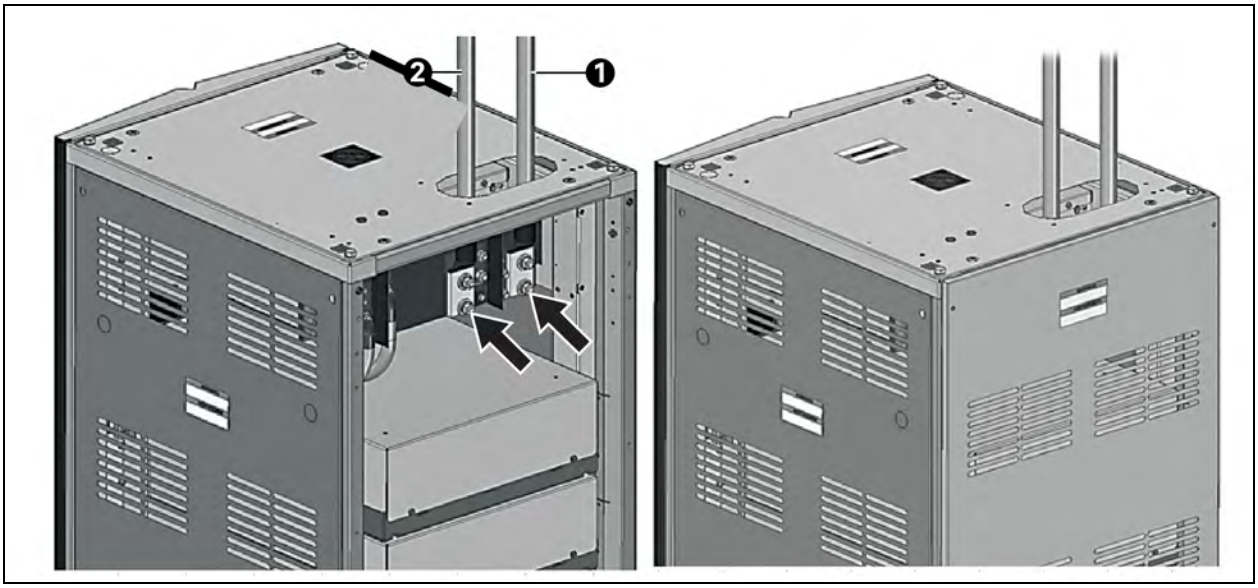
Item	Description
1	Busbar does not require cleaning
2	Busbar requires cleaning before attaching cables

9. Connect power cables between the battery cabinet and the DC bus (UPS, charger, or junction cabinet). Apply a torque of 27 Nm (240 in-lbs) to the cable landing points on the Vertiv™ EnergyCore Lithium 5. Power cable requirements are as follows:
    - 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.

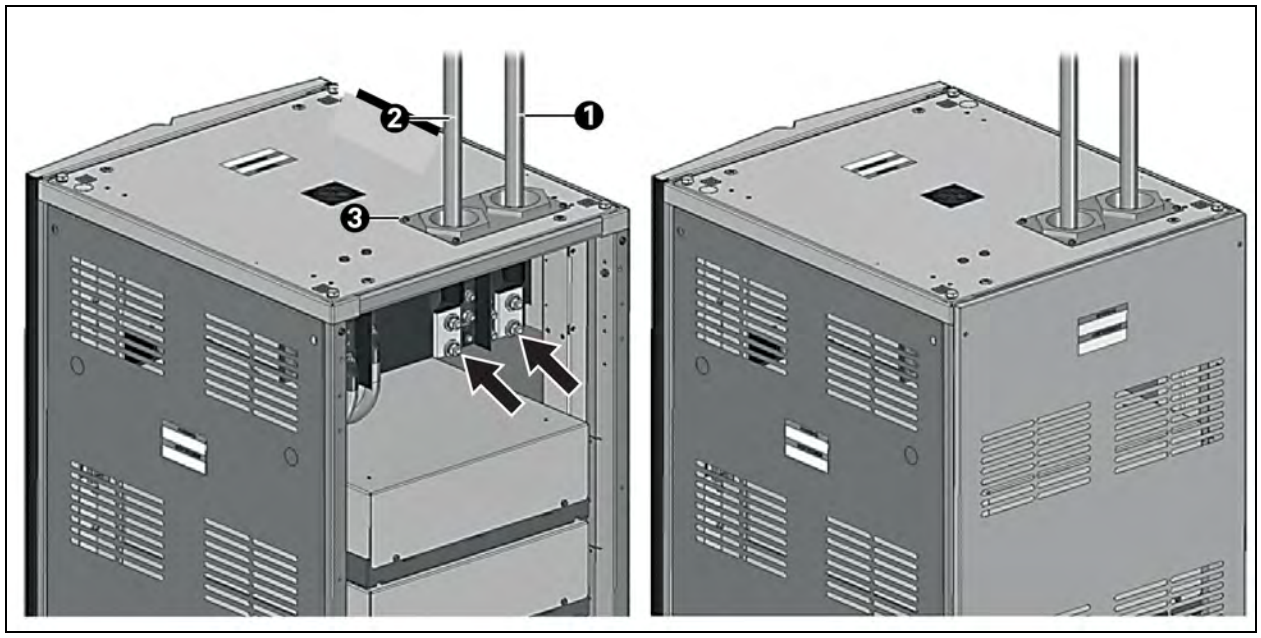
11. Reinstall the upper rear panel using the original screws.

Figure 4.7 Reattaching the Top Panel and Upper Rear Panel – Cover Plate Discarded



Item	Description
1	Positive terminal
2	Negative terminal

Figure 4.8 Reattaching the Top Panel and Upper Rear Panel – Cover Plate Punched for Conduit



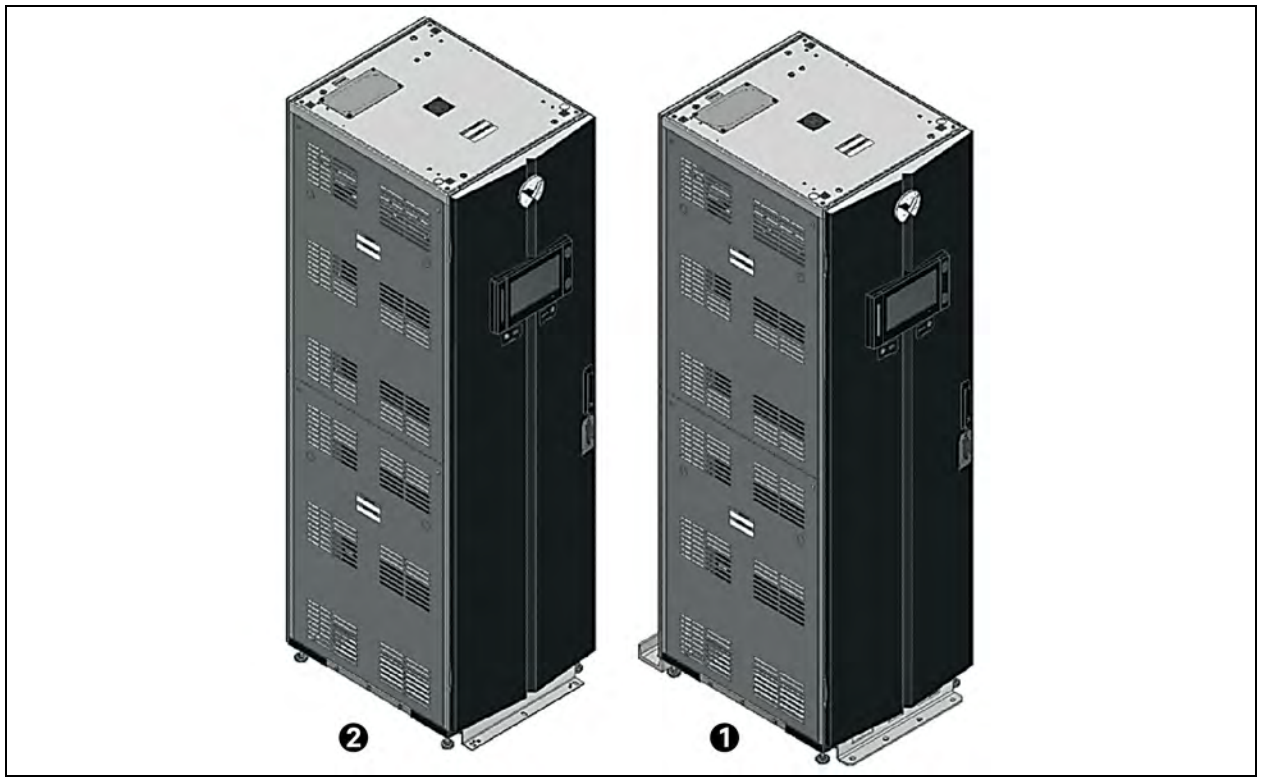
Item	Description
1	Positive terminal
2	Negative terminal
3	Cover plate for conduit

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

Figure 4.9 Bolting the Cabinet to the Floor

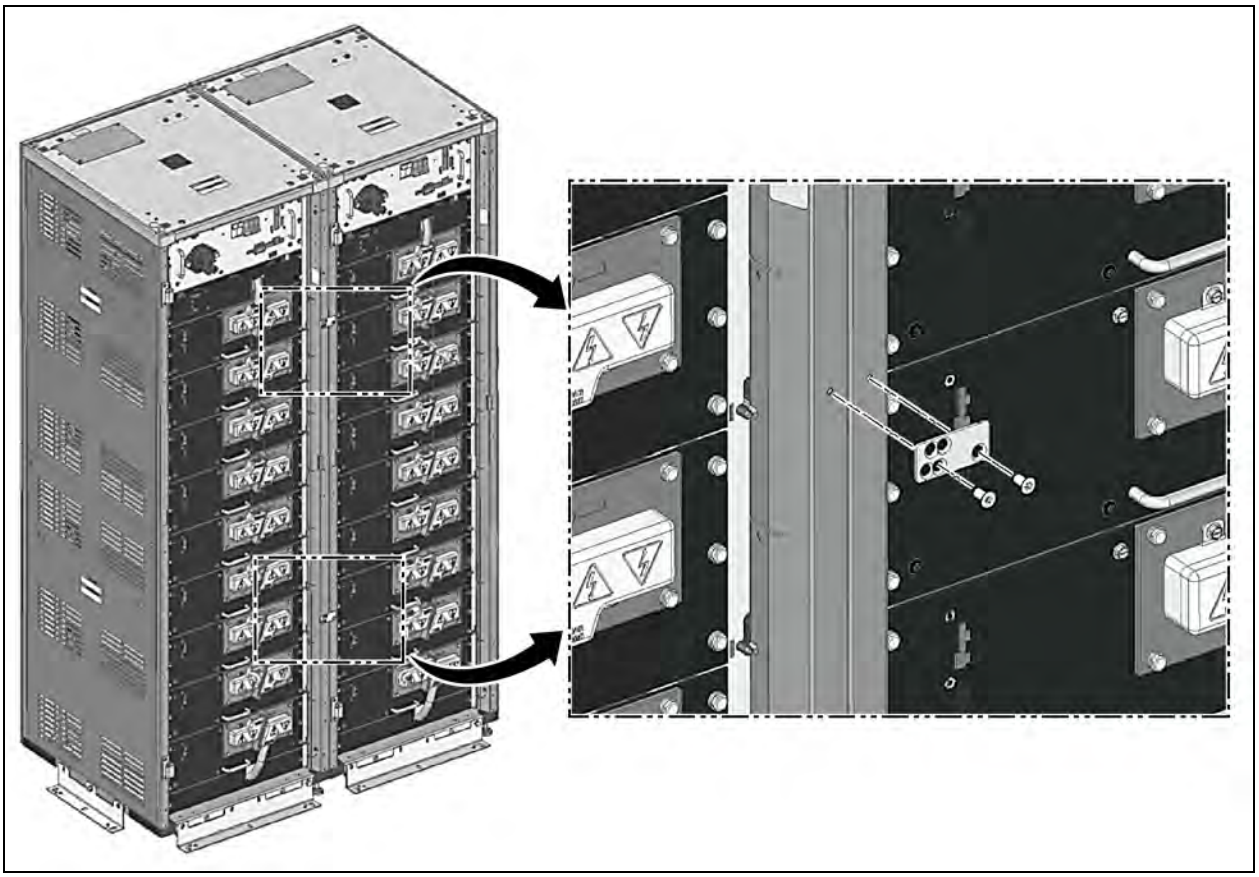


Item	Description
1	Vertiv™ EnergyCore Lithium 5 with optional seismic rated brackets (shipped separately) on front and rear.
2	EnergyCore Lithium 5 with standard mounting brackets, front and rear (shipped with each unit).

NOTE: When conduit is used, DC+ and DC- must be run together in the same conduit. Refer Submittal Drawings on page 39 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 4.10 on the facing page.

Figure 4.10 Bolting Cabinet Frames together for Side by Side Installation



4.4 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. Torque for the M10 fasteners in these locations is 27 Nm (240 in-lbs). See Figure 4.11 on the next page and Figure 4.12 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.

Figure 4.11 Ground Cable Landing Points – Top of Cabinet

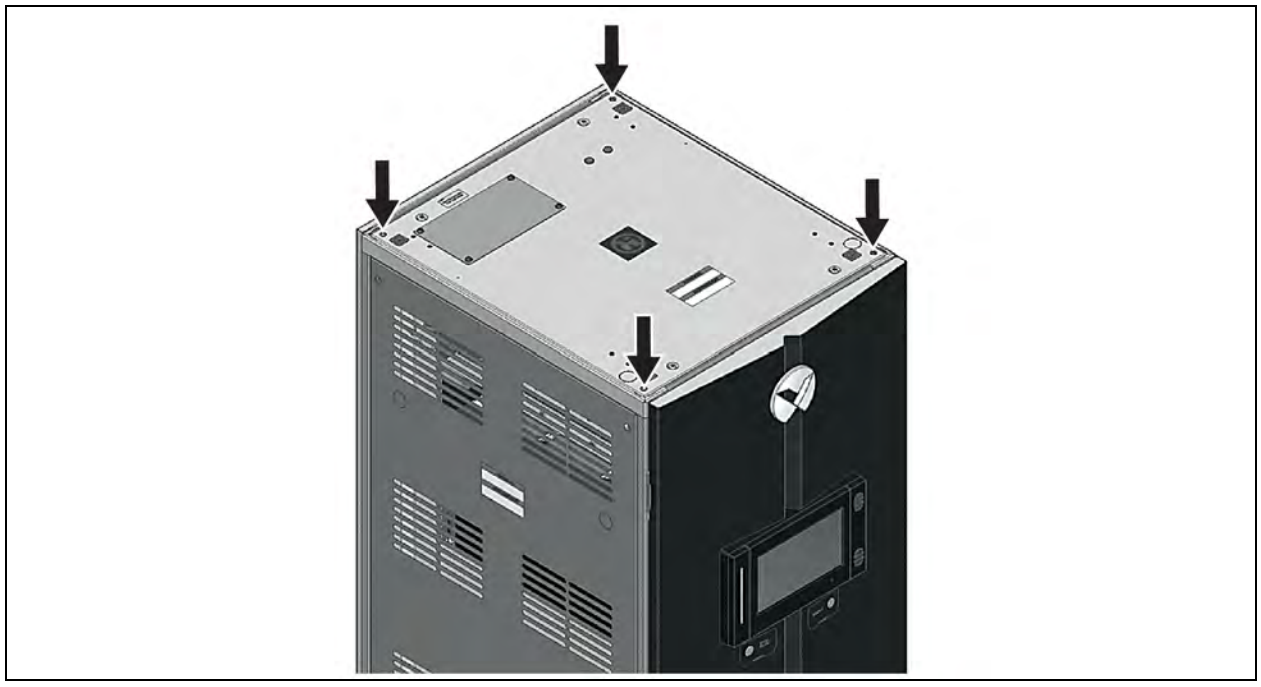
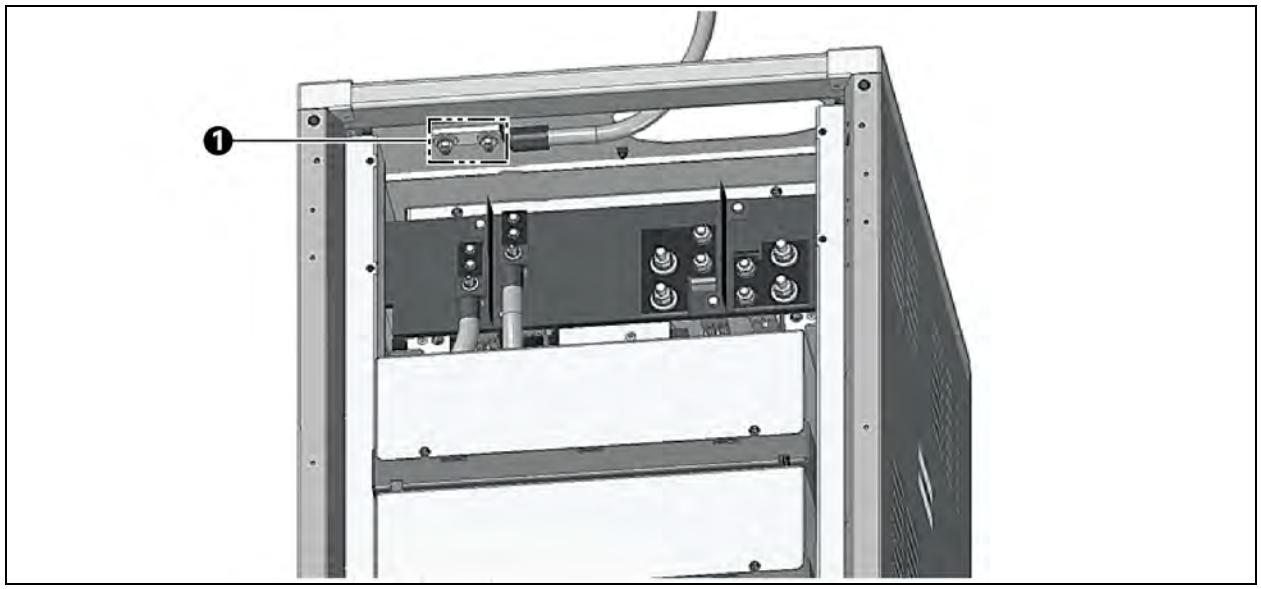


Figure 4.12 Ground Cable Landing Point – Rear Side of Top Panel



Item	Description
1	Ground cable landing point

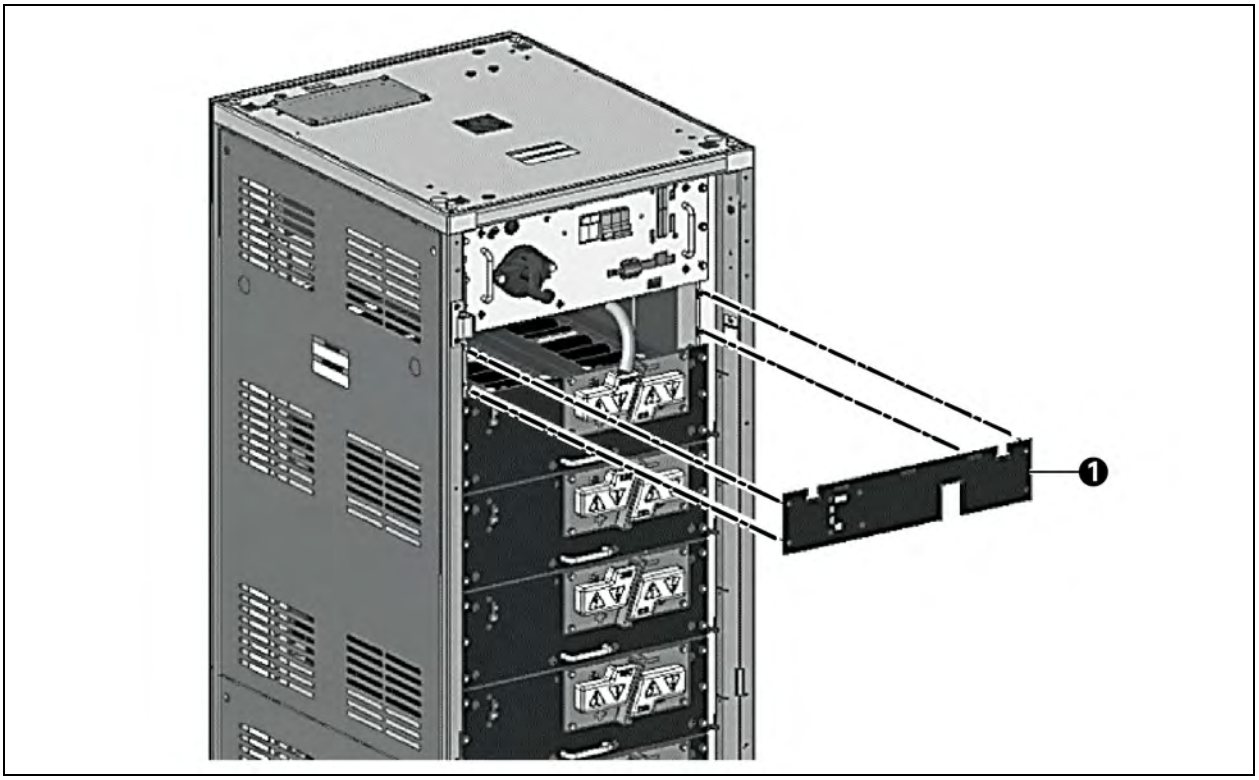
4.5 Control Wiring

This section describes how to run low voltage control wiring into the Vertiv™ EnergyCore Lithium 5. There are pre-punched holes in the 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 panel. A pre-punched hole is also placed on each side of the cabinet for low voltage control wiring entry.

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.

1. Remove the cover panel above the top battery shelf.

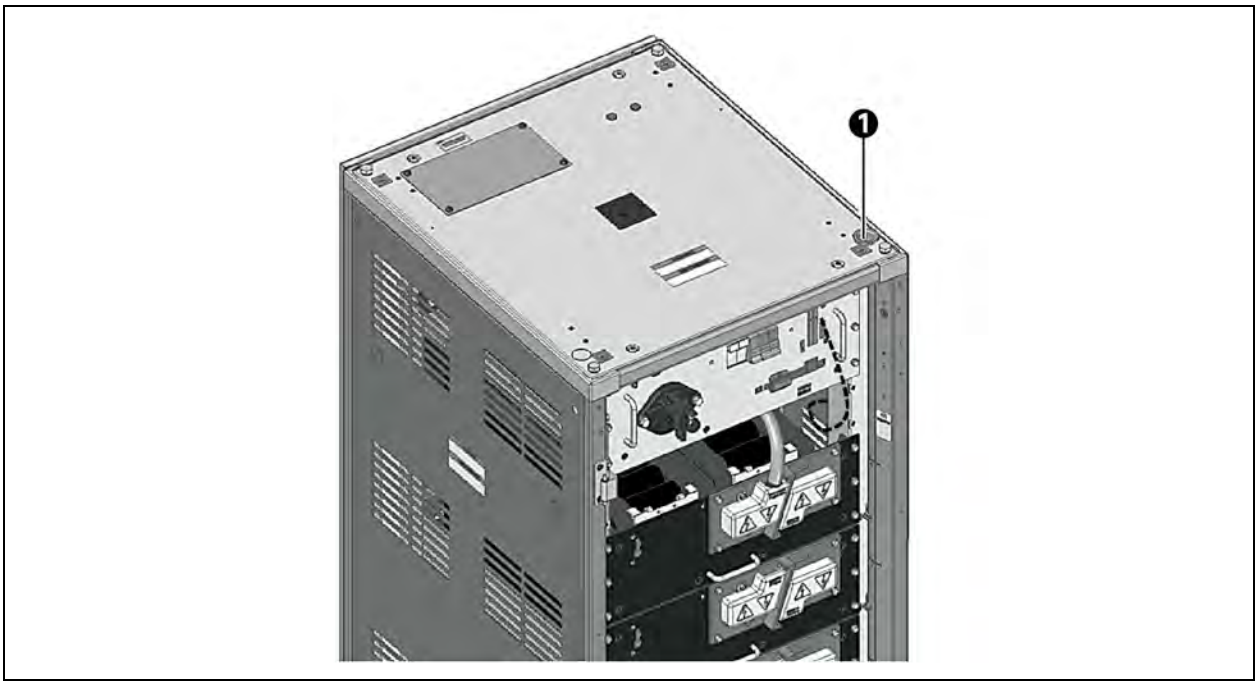
Figure 4.13 Removing the Cover Panel above the Top Battery Shelf



Item	Description
1	Cover panel

2. Run the control wiring through one of the conduit entry holes in the frame. The wiring should enter the cavity behind the cover panel that was removed.

Figure 4.14 Routing the Control Wiring



Item	Description
1	Routing the control wiring

3. Connect the control wiring to its desired location. Refer Submittal Drawings on page 39 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 5 can be used to monitor the status of multiple cabinets. See Control and Monitoring Points on page 49 for more details.

5 Operation

5.1 Startup

To connect the Vertiv™ EnergyCore Lithium 5 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 EnergyCore Lithium 5 takes approximately 60 seconds to boot after it is configured. Successful boot is indicated by the STOP/RESET button being Off and the ENABLE button being illuminated red.
7. 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 Warnings and Faults on page 45.
8. Pre-charge the UPS or DC source so its voltage is higher than the battery string voltage.
    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 two times on each cabinet.
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). 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 and holding the ENABLE button for 5 seconds. This 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. Charge lower SOC cabinets before connecting its batteries. When the other battery cabinets have charged to within 8 V, this cabinet connects its batteries automatically to minimize inrush current.
    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 next page for the recovery process.
12. When an battery cabinet has its batteries connected to the UPS, the ENABLE button illuminates solid blue or green.

5.2 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.

1. After a Vertiv™ cabinet is connected to the UPS or DC source, or if it is waiting to connect, see Startup on the previous page, disconnect it by pressing the STOP/RESET button two times. The ENABLE button light turns off and the STOP/RESET button light will turn red. See ENABLE and STOP/RESET Buttons on page 15 for more detailed information about the behavior of the button lights. Turn off control power and turn the S1 switch to the Off position before performing any maintenance on the battery modules, battery shelves, battery shelf busbars, or the battery cables.
2. To turn off control power:
    a. Disconnect the batteries as described in step 1.
    b. Take note whether the STOP/RESET button begins blinking red after the disconnection, which may indicate a switchgear fault (failure to open internal switchgear). The fault status and reason can also be checked on the touchscreen HMI.
    c. Hold the STOP/RESET button for 5 seconds.
    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 trips when the shutdown is complete.
    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.

5.3 Automatic Shutdown

5.3.1 Shutdown Logic

To prevent over discharge of the batteries, the unit automatically shuts down its controls if:

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.

5.3.2 Recovery Method

When Vertiv™ EnergyCore Lithium 5 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 must be above 2.55 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 37.

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 UPS or DC current limit to 20A. Lower if using a smaller charger.
6. Set the UPS or DC voltage to the following levels:
   a. 10 series battery modules: 280 V
   b. 12 series battery modules: 330 V
   c. 14 series battery modules: 390 V
   d. 16 series battery modules: 445 V
   e. 18 series battery modules: 500 V
7. Turn the SERVICE/RUN switch on the PCA to the SERVICE position. The ENABLE button on the cabinet door illuminates solid white.
8. Press the STOP/RESET button two times.
9. Press the ENABLE button two times.
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 6A, 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 steps 1 to 10 for each cabinet which needs recovery.

5.4 Force Connection

The Vertiv™ EnergyCore Lithium 5 will normally protect the batteries from high current by disallowing connection to a DC bus that is not pre-charged by the UPS (except for specific UPS models such as Vertiv™ Liebert® EXM, Vertiv™ Liebert® EXM2, Vertiv™ Liebert® 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 46. Unit can be safely forced to connect its batteries by holding 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.

5.5 UPS Cold Start

UPS cold start is possible for certain UPS models (sometimes called black start or start from battery) using the batteries (e.g. Vertiv™ Liebert® EXM2).

The Vertiv™ EnergyCore Lithium 5 firmware configuration must be completed first.

The below are the steps to cold start UPS:

1. Turn Off the UPS control power.
2. Turn the S1 switch to Off position on the battery cabinet.
3. Turn On the control power, allow firmware boot process to complete.
4. Wait until ENABLE button light is off and the STOP/RESET button light is solid red.
    a. ENABLE and STOP/RESET Buttons on page 15 for details about lights and system status.
5. Press the ENABLE button two times. The operating mode changes and the ENABLE button light begins blinking to indicate WAITING mode.
6. Press and hold the ENABLE button for 5 seconds.
7. The BMS connects the battery string to the UPS.

5.6 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 41). 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 41.
- The discharge runtime that is 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 will result in lower runtime.

5.7 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 5 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. The time required depends on the storage time of the batteries prior to commissioning, typically 1 to 3 days of balancing can be expected when storage time is less than 1 year. Slightly lower runtime is expected until the cell balancing process is complete. The touchscreen HMI can be used to check if cell balancing is active.

6 Routine Maintenance Disposal at End of Life

6.1 Routine Maintenance

The Vertiv™ EnergyCore Lithium 5 BMS firmware monitors the health of the batteries, making this information available to the user 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 41.
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 70%. End of life for the batteries is 70%. Below this SOH, replacement is recommended.

6.2 Disposal at End of Life

WARNING! The battery modules in the EnergyCore Lithium 5 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

United States

Vertiv Headquarters

505 N Cleveland Ave

Westerville, OH 43082

Europe

Via Leonardo Da Vinci 8 Zona Industriale Tognana

35028 Piove Di Sacco (PD) Italy

Asia

7/F, Dah Sing Financial Centre

3108 Gloucester Road, Wanchai

Hong Kong

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 below table indicates which drawings apply for each UPS.

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

Table B.1 UPS Specific Submittal Drawings

UPS Type	Submittal Drawing	Note
Vertiv™ Liebert® EXM 480 V	VEC-19-S002	
Vertiv™ Liebert® APM2 with battery CAN communication ability	VEC-19-S015	
Series 600 and 610 with module battery disconnect (MBD)	VEC-19-S011	
Series 600 and 610 without MBD	VEC-19-S009	
Vertiv™ Liebert® EXL S1 (UL version) Vertiv™ Liebert® Trinergy™ Cube (UL version) Vertiv™ Liebert® NXL	VEC-19-S017	Distributed BIB kits, 1 board per cabinet up to 8 max.
	VEC-19-S018	Single BIB kit located in cabinet #1
Vertiv™ Liebert® EXL S1 (CE version)	VEC-19-S014	
Vertiv™ Liebert® Trinergy™ Cube Centralized System (CE version)	VEC-19-S019	
Vertiv™ Liebert® Trinergy™ Cube Distributed System (CE version)	VEC-19-S022	
Vertiv™ Liebert® Trinergy™ with Modbus TCP communication	VEC-19-S021	

Table B.2 Other Submittal Drawings

Description	Submittal Drawing
Technical Information	VEC-03-S001 (10 module only) VEC-03-S002 (12 module only) VEC-03-S003 (14 module only) VEC-03-S004 (16 module only) VEC-03-S005 (18 module only)
Outline Drawing	VEC-05-S001
Seismic Anchoring	VEC-17-S001
Product Handling	VEC-24-S001

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Appendix C: Technical Specification

Parameter	Value	Notes
Battery Module Configuration	9S3P	
Cell Type	Li-ion, LFP cathode type	
Control Power Source	Internal	
Cooling	Convective (no fans)	
Compliance and Test Reports	CSA mark (UL 1973 3rd edition) CE mark (IEC 62619:2022) ISO 13849-1:2023 Cat b, PL a ISTA 3B UNDOT 38.3 FCC 47 CFR 15B UL 9540A 4th edition reports	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 module: 1.5 kWh (5120 BTU) 12 module: 1.9 kWh (6480 BTU) 14 module: 2.2 kWh (7510 BTU) 16 module: 2.5 kWh (8530 BTU) 18 module: 2.8 kWh (9550 BTU)	Heat generated by max. power discharge and recharge, then dissipated during cooldown. Round-trip efficiency is 95.5%.
HVAC Load – Standby	30 W	
High Voltage and Current Measurement Accuracy	0.5%	
Ingress Protection Rating	IP20	
Local Service Interfaces	RS-232 serial, USB 2.0	
Log File Storage	Internal, always on	
Maximum Parallel Cabinet Count	12	
Maximum Current (Discharging)	500 A continuous	BMS firmware protection above 600 A.
Maximum Power (Discharging)	10 module: 146 kWb 12 module: 175 kWb 14 module: 204 kWb 16 module: 234 kWb 18 module: 263 kWb	Up to 10% short time overload is possible without exceeding current limit, but runtime is reduced.

Parameter	Value	Notes
Maximum Continuous Charging Current	25A	BMS firmware protection at or above 59A. Cell over-temperature fault (see Warnings and Faults on page 45) will result if product is operated continuously with 26 A to 58 A charging current.
Maximum Cell Temperature	60 °C	
Nominal Energy	10 module: 17.3 kWh 12 module: 20.7 kWh 14 module: 24.2 kWh 16 module: 27.6 kWh 18 module: 31.1 kWh	
Nominal Capacity	60 Ah	
Operating Temperature Range	10 °C to 30 °C	Environment and discharge rate can affect runtime. Reduced discharge runtime may occur when temperature is outside 22 °C to 28 °C.
Operating Altitude Maximum	3000 m	
Operating Humidity Range	5 to 95% relative humidity	Must be non-condensing
Recommended Charger Voltage	10 module: 310 V 12 module: 372 V 14 module: 434 V 16 module: 495 V 18 module: 557 V	
Recommended End of Discharge Voltage	10 module: 250 V 12 module: 300 V 14 module: 350 V 16 module: 401 V 18 module: 451 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	20A	
Remote Monitoring Interfaces	100BT Ethernet supports Modbus TCP or SNMP. RS-485 supports Modbus RTU.	
Series Battery Module Quantity	10 module: 10 12 module: 12 14 module: 14 16 module: 16 18 module: 18	
Storage Temperature Range	Long period: -20 °C to 30 °C Less than 2 weeks: -20 °C to 45 °C Less than 1 week: -30 °C to 60 °C	See Storage after Shipment on page 55.

Parameter	Value	Notes
Storage Altitude Maximum	15000 m	
Storage Humidity Range	0 – 95% relative humidity	Must be non-condensing
Short Circuit Current at DC Bus Terminals	10 modules: 7360 A, 1.9 ms 12 modules: 8200 A, 1.6 ms 14 modules: 8800 A, 1.5 ms 16 modules: 9410 A, 1.3 ms 18 modules: 9950 A, 1.2 ms	Single cabinet
Switchgear	Contactors, internal	
Usable Capacity at 25% Load	96%	Approximate, beginning of life at 25 °C.
Usable Capacity at 50% Load	94%	
Usable Capacity at 75% Load	91%	
Usable Capacity at 100% Load	89%	
UPS or DC Source Architecture	2 poles (positive, negative)	
UPS Communication Interfaces	CANbus	
Weight	10 module: 400 kg (883 lbs) 12 module: 448 kg (987 lbs) 14 module: 495 kg (1092 lbs) 16 module: 543 kg (1196 lbs) 18 module: 590 kg (1301 lbs)	Optional conduit box adds 31 kg (68 lbs). Packaging adds 30 kg (66 lbs).

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Appendix D: 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 STOP/RESET button two times.

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 the internal switchgear to disconnect the batteries from the DC bus. Reset the fault status by pressing the STOP/RESET button two times.

Description	Type	Grace Period	Threshold	Comment
Batt. Module Temperature Delta	Fault	5 seconds	27 °F (15 °C)	At least 1 battery module has a large temperature difference between its internal temperature sensors. Caused by a faulty battery module or MBB.
Batt. Module Over-Voltage	Fault	5 seconds	33 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	5 seconds	3.6 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 34.
	Fault	None	2.55 V	It is possible to recharge the batteries if they have been discharged below these levels, see Recovery Method on page 32.
Cell Over-Temperature	Fault	None	135 °F (57 °C)	At least 1 battery module is too hot.
Cell Under-Temperature	Fault	None	50 °F (10 °C)	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.

Description	Type	Grace Period	Threshold	Comment
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		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: 316 V 12 mod: 379 V 14 mod: 442 V 16 mod: 505 V 18 mod: 569 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 33.
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.
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%.

Description	Type	Grace Period	Threshold	Comment
MBB Board Over Temp	Fault	None	167 °F (75 °C)	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	4 seconds	59 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	15 seconds	600 A	Current too high, discharging. Instant fault at 640 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: 316 V 12 mod: 379 V 14 mod: 442 V 16 mod: 505 V 18 mod: 569 V	Battery string voltage too high. Instant fault if it reaches 101% of the listed values. May be caused by incorrect charger/UPS settings.
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		Push the STOP/RESET button after the cause of a problem is cleared. See ENABLE and STOP/RESET Buttons on page 15.
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.

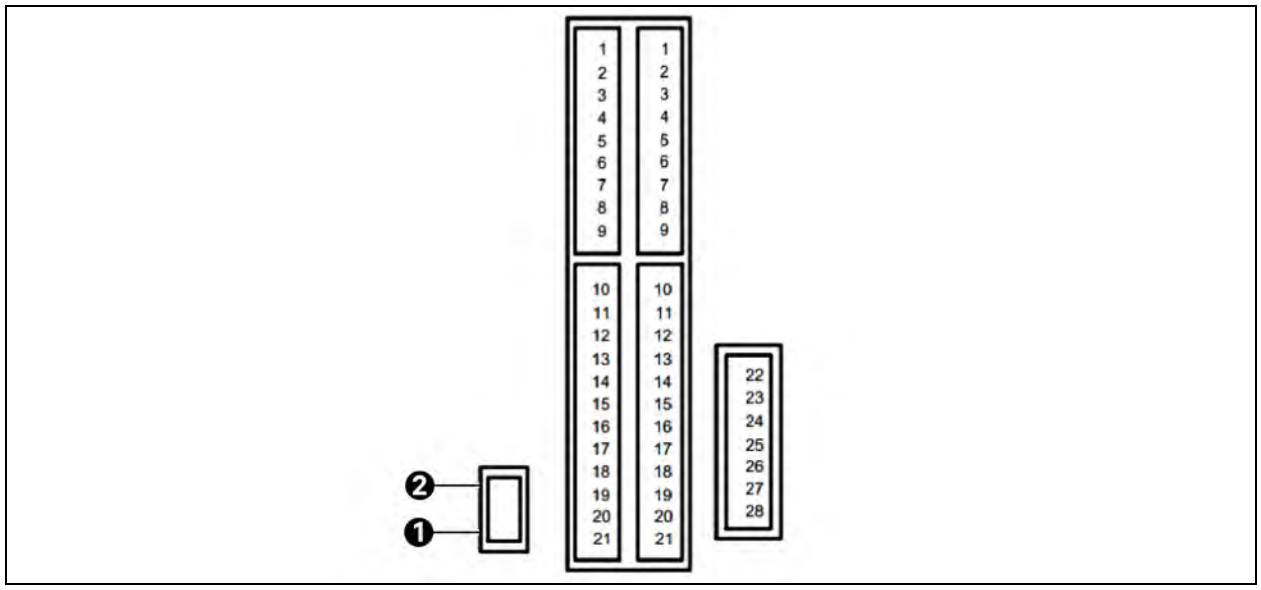
Description	Type	Grace Period	Threshold	Comment
Under Voltage	Expiring Warning	15 seconds	10 mod: 245 V 12 mod: 294 V 14 mod: 343 V 16 mod: 392 V 18 mod: 441 V	Battery string voltage is too low. See Recovery Method on page 32. Instant fault if voltage reaches 98.5% of the threshold value.
UPS Comm Error	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	100 °F (38 °C)	At least 1 battery module has large temperature difference between its internal temperature sensors; may be caused by a faulty battery module or MBB.

Appendix E: Control and Monitoring Points

Control Terminal Block (CTB)

CTB is provided to each Vertiv™ EnergyCore Lithium 5 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 E.1 CTB Position



Item	Description
1	OFF
2	CAN1 Term

Table E.1 CTB Position

CTB #	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	

Table E.1 CTB Position (continued)

CTB #	Name	Type	Description
CTB-10	CGND	Power supply reference	Isolated ground for CTB-17 through CTB-20.
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 5 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.

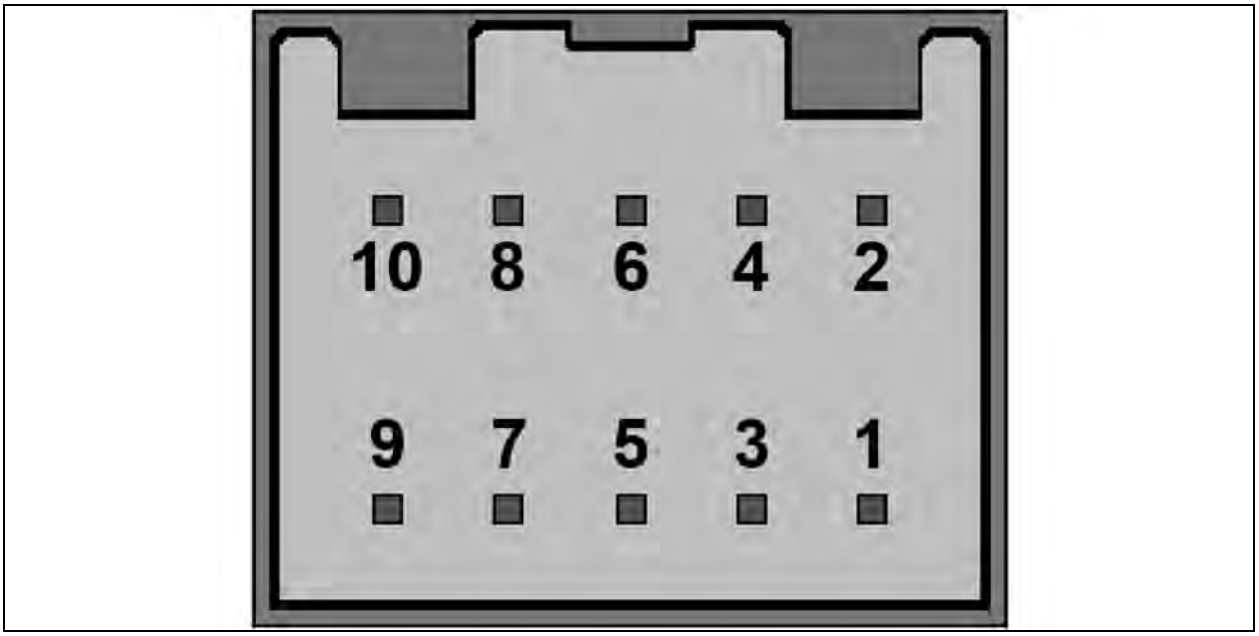
The mating connector for the BAT 1 port is Molex 513531000 or Wurth Elektronik 624010213322.

Table E.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 5:

Figure E.2 BAT 1 Port Terminal



Modbus TCP and SNMP

The Vertiv™ EnergyCore Lithium 5 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.

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Appendix F: Retrofits

Replacing UPS attached battery cabinets

When using the Vertiv™ EnergyCore Lithium 5 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 UPS and 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, a new side panel needs to be ordered for the UPS. Contact 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 (shelf-to-shelf connections) and from the UPS.
2. If the old battery cabinet side panel will be reused, remove it and secure it.
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.

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 Vertiv representative or Vertiv technical support, see Technical Support and Contacts on page 37 to determine the correct option for specific UPS.

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Appendix G: Storage after Shipment

It is recommended for the Vertiv™ EnergyCore Lithium 5 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 41 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 1 year after the reference date, and then annually 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 59 V, contact Vertiv. See Technical Support and Contacts on page 37. 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, except the minimum battery terminal voltage is half of the shelf voltage (28.9 V). The battery module should be kept in the original box or crate in which it shipped to avoid accidental damage.

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