



# HPL Lithium-Ion Energy Storage System

**Operation Guide**

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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

<b>1 Important Safety Instructions</b> .....	<b>1</b>
<b>2 Overview</b> .....	<b>3</b>
2.1 Part Number Breakdown .....	3
2.2 Module Numbering Scheme .....	4
<b>3 Description</b> .....	<b>7</b>
3.1 Door Sensor .....	7
3.2 Power Chassis Assembly .....	7
3.3 Local Interface .....	10
3.3.1 Liquid Crystal Display .....	10
3.3.2 Enable and Stop Buttons .....	11
<b>4 Installation</b> .....	<b>13</b>
4.1 Remove the Vertiv HPL from the Shipping Pallet .....	13
4.2 Grounding .....	20
4.3 Control Wiring .....	21
<b>5 Operation</b> .....	<b>25</b>
5.1 Startup .....	25
5.1.1 Force Online .....	26
5.2 Shutdown .....	26
5.3 LEDs .....	26
5.3.1 DC Bus Connection/Disconnection Logic .....	27
5.3.2 Automatic Power-Off .....	27
5.4 Cooling Time After Discharge .....	29
5.5 Battery Runtime .....	29
<b>Appendices</b> .....	<b>31</b>
Appendix A: Technical Specifications .....	31
Appendix B: Warnings and Faults .....	33
Appendix C: Control Terminal Block (CTB) .....	37
Appendix D: Retrofits .....	39
Appendix E: Storage After Shipment .....	41
Appendix F: Technical Support and Contacts .....	43

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# 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 the instructions with this symbol may result in a serious accident, causing death or a severe injury.



**WARNING!** Failure to comply with the instructions with this symbol may result in a serious accident, causing severe injury or death.



**CAUTION:** Failure to comply with the instructions with this symbol may result in minor or moderate injury.

**NOTE:** Provides information considered important but not hazard-related. The information relates to property damage.











**IMPORTANT!** Indicates valuable tips for optimal installation and operation of the product.

## CRITICAL FIRE SAFETY COMPLIANCE NOTE TO CUSTOMERS AND ENGINEERS

This product was tested by Fire & Risk Alliance, LLC regarding UL 9540A: Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems, as described in the “Vertiv™ HPL 3P26A22S3PB Installation” test report. 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:** Vertiv™ HPL with 7 series battery modules (part number beginning in 3P27-), which is only available in certain regions, is not covered by the product's UL 9540A test report.

Table 1.1 Safety Symbols

	<b>DANGER</b> Indicates a hazardous condition that will result in serious injury or death if not avoided.
	<b>WARNING</b> Indicates a hazardous condition that could result in serious injury or death if not avoided.
	<b>CAUTION</b> Indicates a hazardous condition that could result in minor or moderate injury if not avoided.
	<b>NOTICE</b> Indicates a hazardous condition that will result in property damage if not avoided.
	<b>ENERGY STORAGE DEVICE</b> Avoid burns or electric shock: <ul style="list-style-type: none"> <li>• Service by properly trained and qualified personnel only.</li> <li>• Disconnect charger and verify no voltage present before maintenance.</li> <li>• Turn Off the battery system and lock-out/tag-out before maintenance.</li> </ul>
	<b>ELECTRIC SHOCK HAZARD</b> Do not remove cover or disassemble.
	<b>SHIELD EYES</b> Wear safety goggles at all times during installation, maintenance or removal. Observe personal protective equipment (PPE) rules at all times.
	<b>ELECTROLYTE HAZARD</b> Avoid contact with skin, eyes or clothing. If contact happens, immediately flush with water and seek medical attention immediately.
	<b>DO NOT DISPOSE IN TRASH</b> Transport legally and follow the manufacturer's instructions for disposal. Please recycle your lithium-ion battery - do not discard.
	<b>GROUND</b> This symbol indicates a ground point. Ground wires must be connected to a point with this symbol.

## 2 Overview

The HPL Lithium-Ion Energy Storage System is a high-power DC battery system for use with Vertiv Uninterruptible Power Supply (UPS) units, including the Liebert® EXL, Liebert® EXL S1, Liebert® NXL, Liebert® EXM 480V, Liebert® NX Vertiv™ Liebert® Trinergy Cube, Vertiv™ Liebert® EXM2 and Liebert® Series 600 and 610 products. This guide provides information necessary to operate the Vertiv HPL correctly.

This guide covers all Vertiv HPL part numbers that have been installed by Vertiv service personnel.

For technical specifications, see [Appendices](#) on page 31.



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



**WARNING! High Voltage - Electric Shock Hazard. The Vertiv HPL contains high-voltage electric shock sources. Do NOT open any cover of the Vertiv HPL enclosure, other than the front door.**

### 2.1 Part Number Breakdown

The Vertiv HPL's part number can be found on the main label inside the door. The part number takes the form of **3P2** [X][A22S3P][Y]0[Z][NN], where the letter description would be as per **Table 2.1** below :

**Table 2.1 Part Number Breakdown**

Letter	Description
[X]	Number of battery modules in series; either 4, 5, 6 or 7. The shorthand "HPL-X" (e.g. HPL-5) may be used in this manual to refer to an HPL with the given number of series battery modules.
[Y]	Internal product revision identifier; either A, B, or C. In this manual, this letter is referred to as the "product revision". Revision B added fire-mitigating features. Revision C adds 4, 5 and 7 battery module variants, improved PCA design and improved DC cable landing area.
[Z]	Region of manufacture.
[NN]	Internal customer-specific feature code.

**NOTE: Some sections of the Operation Guidel may only apply to certain part numbers.**

## 2.2 Module Numbering Scheme

The following image shows the module numbering scheme and location of the Cabinet Terminal Block (CTB).

Figure 2.1 Module Numbering Overview (HPL-4, -5, -6)

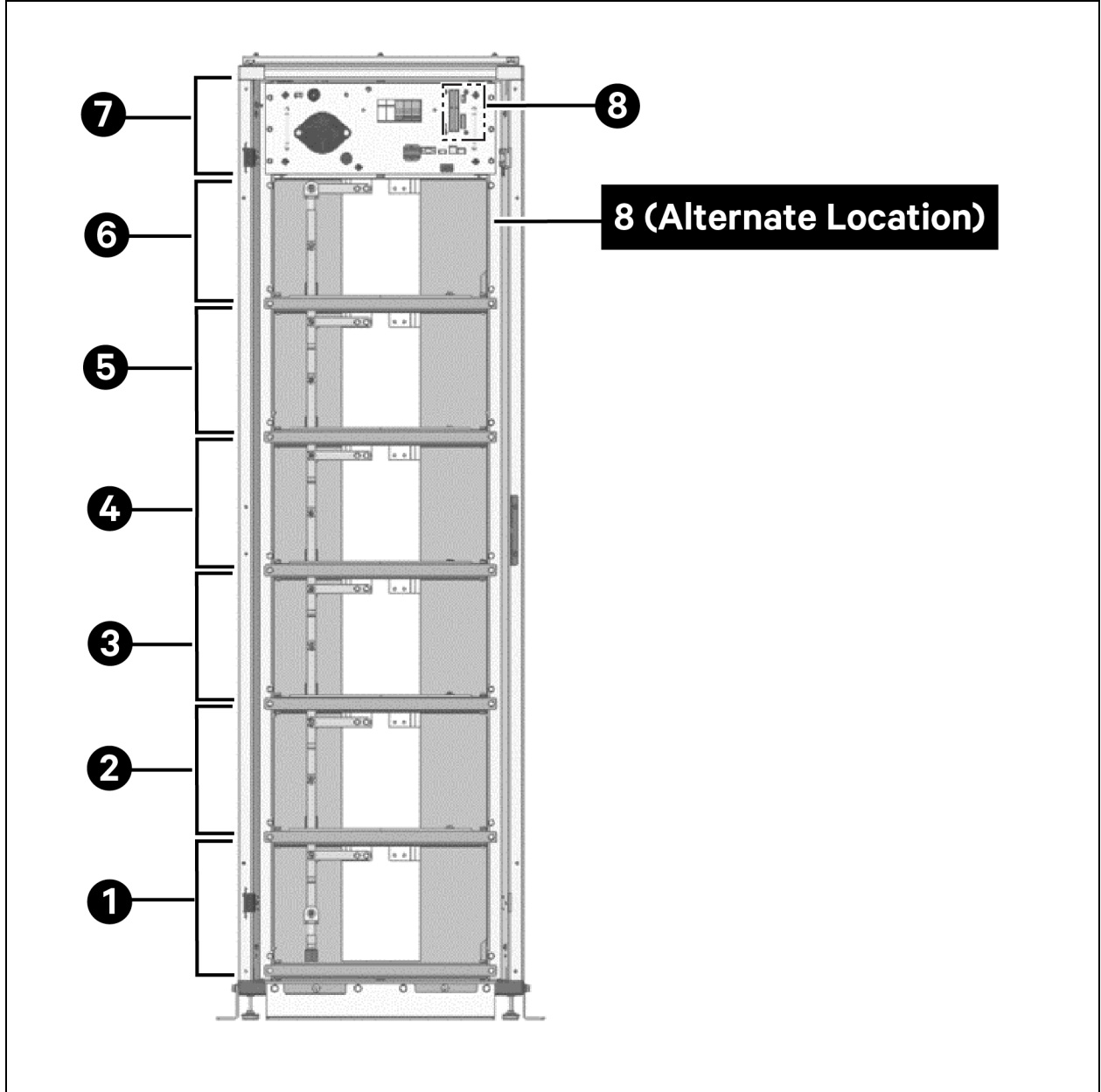


Table 2.2 Module Numbering Overview (HPL-4, -5, -6)

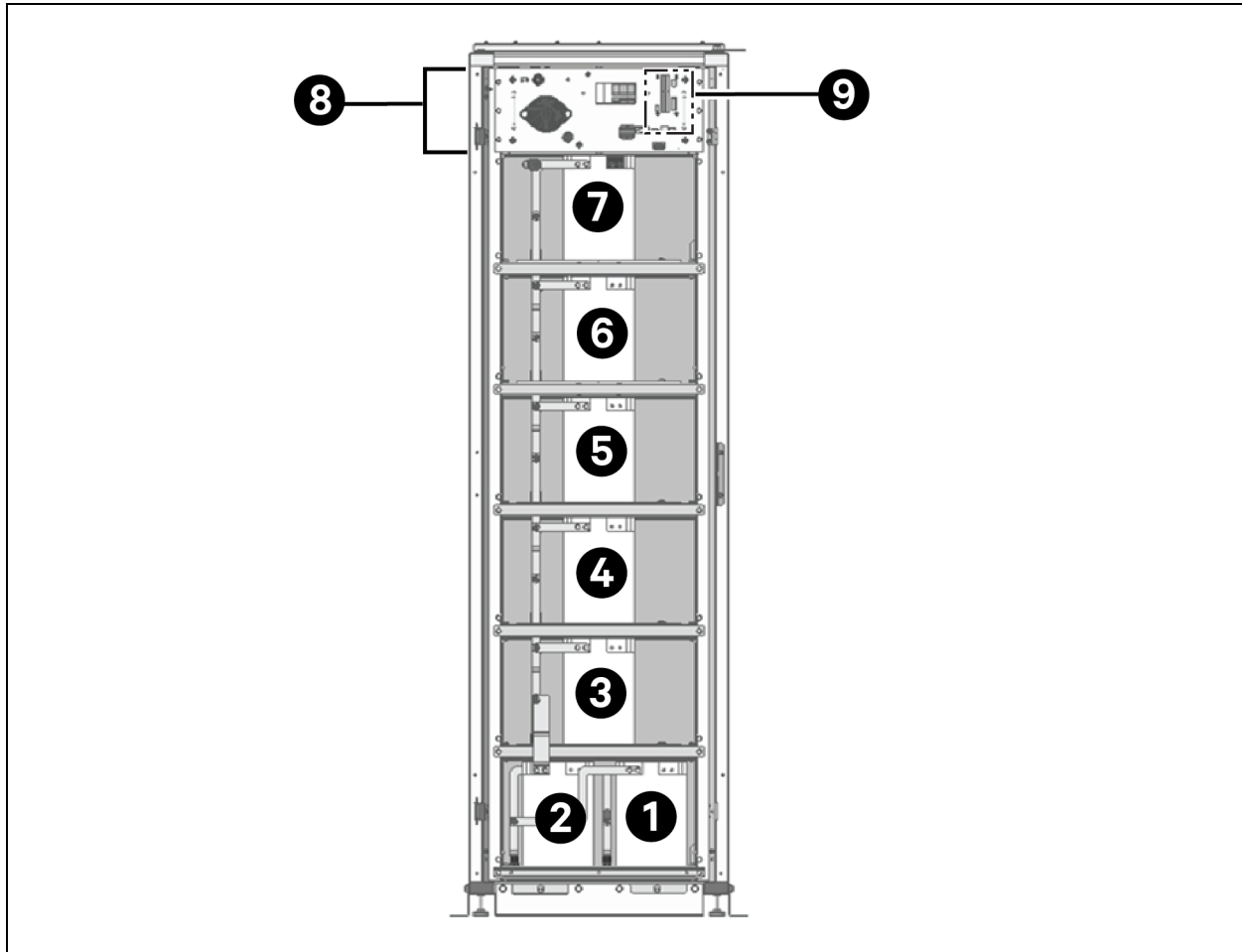
Item	Description	Item	Description
1	Module 1	5	Module 5. For HPL-4, this shelf is empty.
2	Module 2	6	Module 6. For HPL-4 or HPL-5, this shelf is empty.
3	Module 3	7	Power Chassis Assembly (PCA)



**Table 2.2 Module Numbering Overview (HPL-4, -5, -6) (continued)**

Item	Description	Item	Description
4	Module 4	8	Control Terminal Block. For product revision B, this is located in the top shelf bay.

**Figure 2.2 Module Numbering Overview (HPL-7)**



**Table 2.3 Module Numbering Overview (HPL-7)**

Item	Description	Item	Description
1	Module 1	6	Module 6
2	Module 2	7	Module 7
3	Module 3	8	Power Chassis Assembly (PCA)
4	Module 4	9	Control Terminal Block
5	Module 5		

Refer to Vertiv Submittal Drawings for signal wiring requirements and interconnection assignments, based on UPS type. The following table lists which drawings to refer to for each UPS.

**Table 2.4 UPS-Specific Submittal Drawings**

UPS Type	Submittal Drawings
Vertiv™ Liebert® EXM 480V	HPL-19-S002 HPL-19-S004 HPL-19-S005
Vertiv™ Liebert® Series 600 and 610 With Module Battery Disconnect	HPL-19-S005 HPL-19-S011 HPL-19-S012
Vertiv™ Liebert® Series 600 and 610 No Module Battery Disconnect	HPL-19-S005 HPL-19-S009 HPL-19-S010
Vertiv™ Liebert® EXL Vertiv™ Liebert® EXL S1 (with UPSBIBR) Vertiv™ Liebert® NXL Vertiv™ Liebert® NX 225-600	HPL-19-S013
Vertiv™ Liebert® EXL S1 (no UPSBIBR)	HPL-19-S014*
Vertiv™ Liebert® Trinerigy Cube	HPL-19-S007
Vertiv™ Liebert® EXM2	HPL-19-S015

**NOTE:** Using HPL without UPSBIBR requires UPS firmware that may not be available in all regions.

**Table 2.5 Other Submittal Drawings**

Applicable Equipment	Submittal Drawings
Cabinet with Conduit Box, Product Revision B	HPL-05-S003 (HPL-6)
Cabinet without Conduit Box, Product Revision B	HPL-05-S004 (HPL-6)
Cabinet with Conduit Box, Product Revision C	HPL-05-S007 (HPL-4)
	HPL-05-S005 (HPL-5)
	HPL-05-S011 (HPL-6)
	HPL-05-S009 (HPL-7)
Cabinet without Conduit Box, Product Revision C	HPL-05-S008 (HPL-4)
	HPL-05-S006 (HPL-5)
	HPL-05-S012 (HPL-6)
	HPL-05-S010 (HPL-7)
Technical Information	HPL-03-S004 (HPL-4)
	HPL-03-S003 (HPL-5)
	HPL-03-S002 (HPL-6)
	HPL-03-S005 (HPL-7)
Seismic Anchoring	HPL-17-S001
Product Handling	HPL-24-S001

## 3 Description

### 3.1 Door Sensor

Inside the enclosure at the upper right is a door sensor to indicate when the door is open or closed. If the door is open, a warning is indicated on the display. The door should remain closed during normal operation of the product.

### 3.2 Power Chassis Assembly

The power chassis assembly (PCA) is a 4U enclosed section that controls the connection of the battery enclosure to the DC bus. The PCA monitors each battery module's voltage and temperature to ensure operation within the manufacturer's specified limits throughout the life of the product.

**IMPORTANT!** Operation of the HPL Lithium-Ion Energy Storage System outside its recommended environmental or power limits may void the warranty.

Figure 3.1 Power Chassis Assembly (Product Revision B)

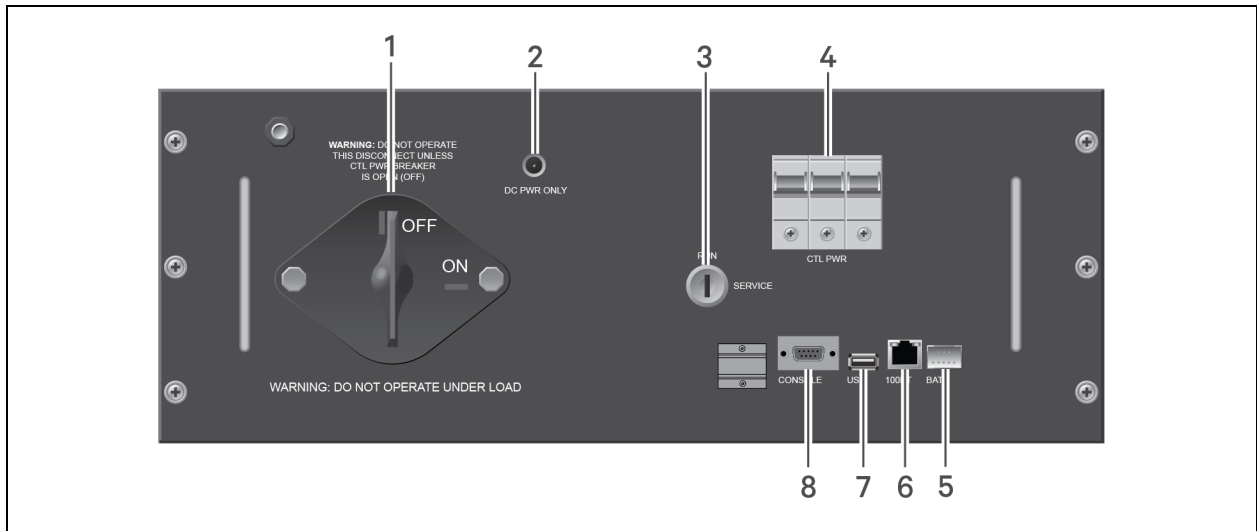


Table 3.1 Power Chassis Assembly Descriptions (Product Revision B)

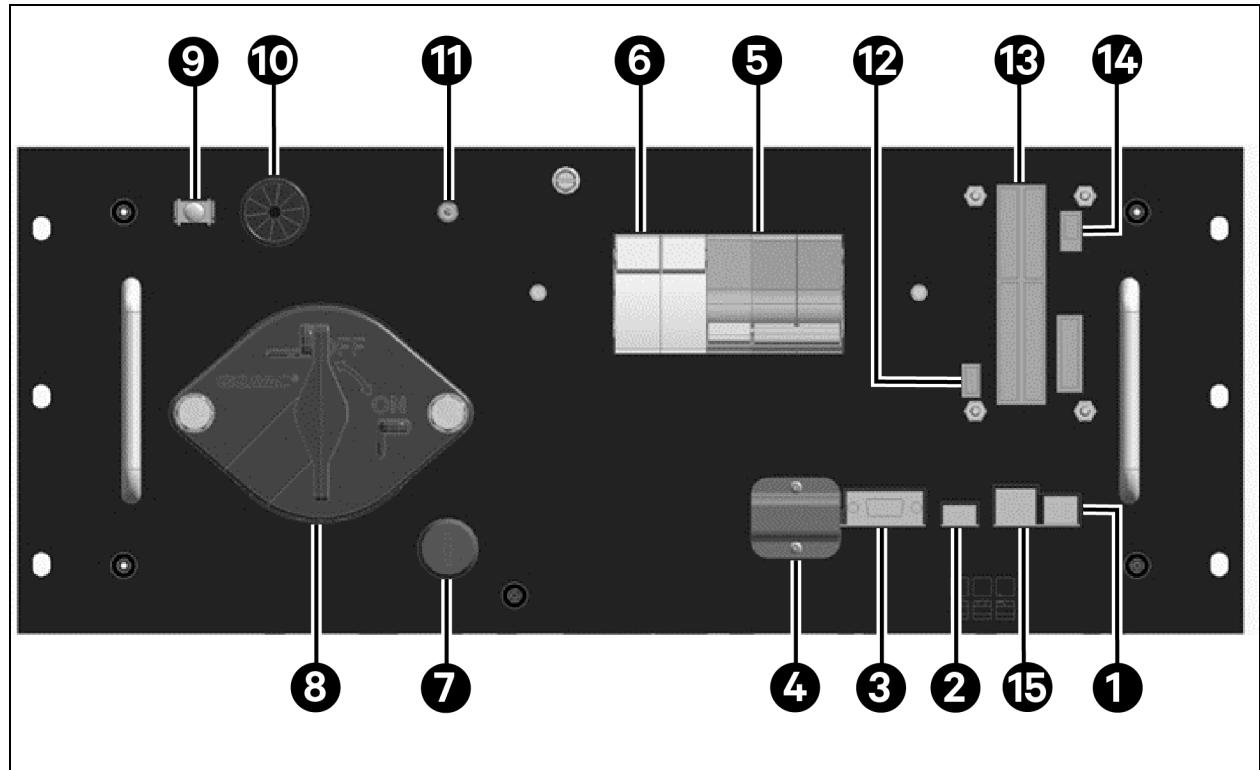
Item	Name	Description
1	S1 maintenance disconnect with lock-out, tag-out feature	Used to isolate the battery rack from the DC bus. <b>Warning:</b> Do not operate when the CTL PWR BREAKER is closed, except as specifically directed when logged in to the service console.
2 <sup>1</sup>	Service power input jack (24VDC 3A)	For use by Vertiv service personnel only. Provides control power for servicing the unit when battery power is unavailable.
3	RUN/SERVICE key switch	For use by Vertiv service personnel under guidance from tech support only.
4	Control power breaker (CTL PWR) and shunt trip	Interrupts control power from the battery.
5	Battery (BATT) interface	Communications connection to battery modules.
6	100BT interface	Ethernet interface for Modbus/TCP.

**Table 3.1 Power Chassis Assembly Descriptions (Product Revision B) (continued)**

Item	Name	Description
7	USB interface	Connection for retrieving data logs and commissioning information.
8	CONSOLE interface	RS-232 interface for Vertiv™ service personnel use only.

<sup>1</sup> Units manufactured in 2021 or prior may have an IEC C14 socket which accepts 120VAC 50/60Hz.

**Figure 3.2 Power Chassis Assembly (Product Revision C)**



**Table 3.2 Power Chassis Assembly Descriptions (Product Revision C)**

Item	Description
1	Battery signal wiring connector
2	USB port for log file download
3	DB9 female for RS-232 serial
4	SD card port with cover. Only for use by Vertiv Service personnel.
5	Circuit breaker & shunt trip for control power
6	F7-F8 fuses for internal control power supplies
7	Service/run mode switch
8	S1 switch (maintenance disconnect)
9	Ground terminal
10	Wire connections to door-mounted HMI
11	24VDC input power (factory & service use only)

**Table 3.2 Power Chassis Assembly Descriptions (Product Revision C) (continued)**

Item	Description
12	HPL-UPS or HPL-HPL CAN termination switch
13	Control terminal block (CTB), detail in appendix
14	Door position switch input
15	100Mbps network port

**NOTICE**

Risk of improper equipment operation. Can cause serious damage to the Vertiv™ HPL. The S1 maintenance disconnect is a static isolation and lockout device only and should not be operated while the Vertiv HPL is online. Doing so will damage the equipment. To open the disconnect you must follow the procedure below.

**To open the S1 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's turn red.
3. After 45 seconds, the CTL PWR BREAKER opens, indicating it is safe to open the *S1*.

**To close the S1 maintenance disconnect:**

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

### 3.3 Local Interface

A liquid crystal display and push buttons on the front door of the HPL Lithium-Ion Energy Storage System provide information on the status of the energy storage system.

Figure 3.3 Local Interface

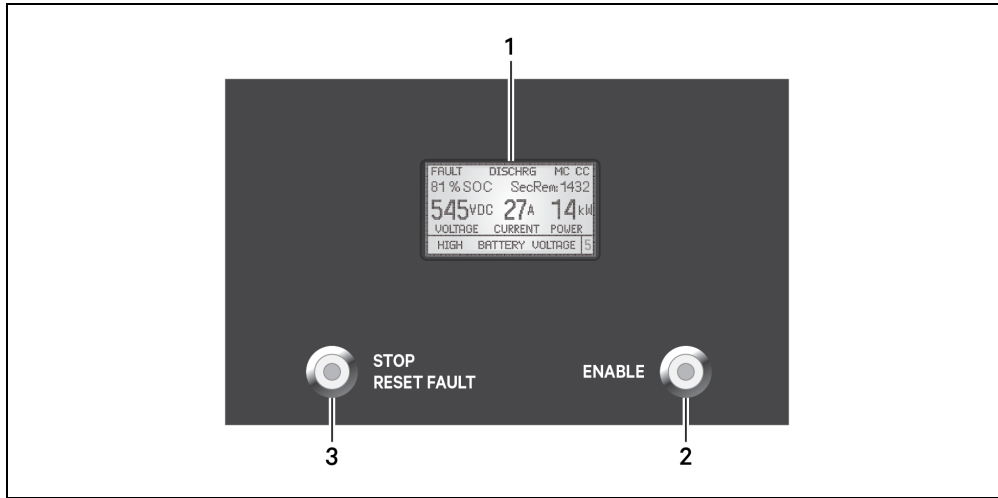


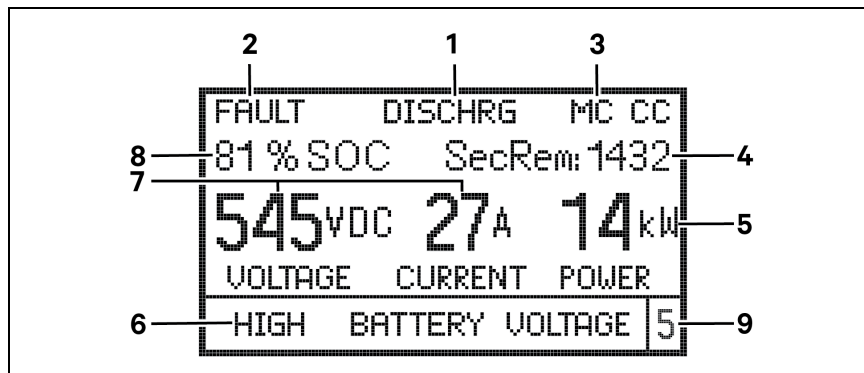
Table 3.3 Local Interface Descriptions

Item	Description
1	LCD
2	ENABLE button
3	STOP RESET button

Along with the Modbus/TCP interface, the local interface is the primary means of interacting with the Vertiv™ HPL.

#### 3.3.1 Liquid Crystal Display

Figure 3.4 LCD Layout



**Table 3.4 LCD Layout Descriptions**

Item	Name	Description
1	Rack Status (CHARGE/DISCHRG/FLOAT/FAULT)	<i>CHARGE</i> or <i>DISCHRG</i> indicate that current is flowing in either the charging or discharging direction. <i>FLOAT</i> indicates that the battery string voltage is very close to the UPS charging voltage and very little or no current is flowing, typically because the batteries are fully charged. <i>FAULT</i> indicates that a fault condition exists.  <b>NOTE: If the current during charging or discharging is very small, the BMS software considers this a "deadband" and will display FLOAT.</b>
2	Rack Mode	Displays the mode of the rack - <i>ONLINE</i> , <i>SHUTDOWN</i> , <i>FAULT</i> or <i>WAITING</i> .
3	Switchgear Status	Displays the status of the switchgear that connects or disconnects the batteries from the DC bus. There are separate symbols for Main Contactor (MC), which indicates that the batteries are available to the UPS for discharge, and Charging Contactor (CC), which indicates battery charging is enabled. The charging contactor occasionally opens and closes during normal operation in order to maintain an optimal state of charge.  <b>NOTE: In firmware version 1.0.4 and earlier, the direction of current flow (charge, discharge, or float) was displayed here instead.</b>
4	Seconds Remaining	Displays the number of seconds remaining until the battery is exhausted. When not discharging, this is an estimate based on the last observed discharge.
5	kW	Displays the actual power charge/discharge in kilowatts. This reading is always positive.
6	Fault/Warning Display	Rotates between displaying faults and warnings.
7	Voltage and Current	Displays actual battery voltage and actual current charge/discharge. This reading is always positive.
8	State of Charge (SOC)	Displays the percentage charge of the battery.
9	Rack Number	Displays the number of the rack in the system.

For warning and fault descriptions, see [Warnings and Faults](#) on page 33 .

### 3.3.2 Enable and Stop Buttons

The *ENABLE* button is at the right of the local interface. Pressing this button two times enables the HPL Lithium-Ion Energy Storage System to join the DC bus when conditions are right. Until that time, the rack will be in *WAITING* mode, as evidenced by the flashing LED (color dependent on the rack status) around the *ENABLE* button.

The *STOP RESET* button is at left of the local interface. Pressing this button two times disconnects the rack from the DC bus when it is online or, if a fault exists, resets the fault indication.

**NOTE: If a fault still exists after pressing the button, pressing *RESET* a second time resets the fault indication if the condition has cleared.**

For more information on the *ENABLE* and *STOP* buttons, see [LEDs](#) on page 26 .

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## 4 Installation

This section provides information to help you physically install the Vertiv™ HPL Lithium-Ion Energy Storage System at the customer site. Installation must be performed by installers familiar with rigging heavy equipment and connecting high-power electrical devices and control wiring.



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



**WARNING! HIGH VOLTAGE – ELECTRIC SHOCK HAZARD.** Battery modules and wires may be exposed, increasing the probability of electric shock. The energy Vertiv™ HPL contains high-voltage electric shock sources. Do NOT open any cover of the battery module or power chassis assembly.

### Notice

(To installers) Local building safety codes (e.g. those adopting the latest revision of NFPA 855) may require specific signage that indicates lithium-ion energy storage systems are installed in an area.

**Table 4.1 Recommended Minimum Clearances After Installation**

Item	Description
Above the Vertiv HPL	18 inches (457mm) to any obstruction
Front of Vertiv HPL	24 inches (610mm) to any obstruction
Between the Vertiv HPL and a combustible fire wall	6 inches (152mm)
Between two Vertiv HPLs (or Vertiv HPL and UPS) back-to-back	None
Between two Vertiv HPLs (or Vertiv HPL and UPS) side-by-side	None

\*Local building safety codes (e.g. those adopting the latest revision of NFPA 855) may require additional clearance to walls, ceilings or other equipment.

### 4.1 Remove the Vertiv HPL from the Shipping Pallet

The Vertiv HPL may be removed from its shipping pallet with either a forklift or with a lifting mechanism using slings attached to bolts on top of the cabinet.



**WARNING!** Failure to follow the safety procedures or using equipment insufficiently rated for the weight of the Vertiv HPL may result in injury or death.

**IMPORTANT!** Failure to follow these handling instructions may lead to damage to the Vertiv HPL. Such damage will not be covered by the warranty.

**To use a forklift to take the Vertiv™ HPL off its shipping pallet:**

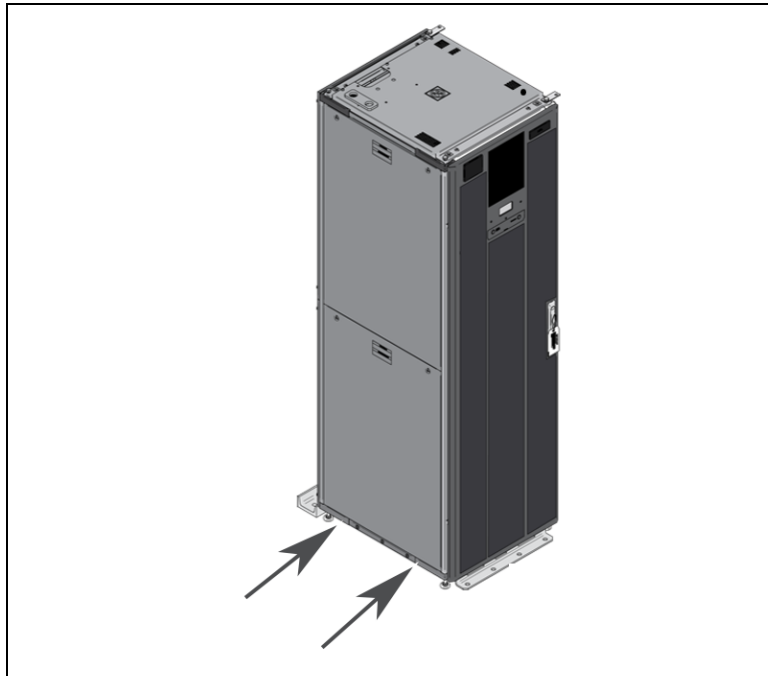
**Forklift Requirements**

- Maximum overall width of forks - 18 in. (457mm)
  - Maximum thickness of forks - 2 in. (51mm)
  - Lifting capacity - 1400 lb. (635kg) or equal to or greater than the weight of the Vertiv HPL.
1. Unpack the rack and remove the bolts holding the bolt-down brackets to the base of the Vertiv HPL and the shipping pallet.
  2. Remove the brackets on the sides of the Vertiv HPL.
  3. Crank the leveling feet up to their highest safe position and remove the brackets.

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

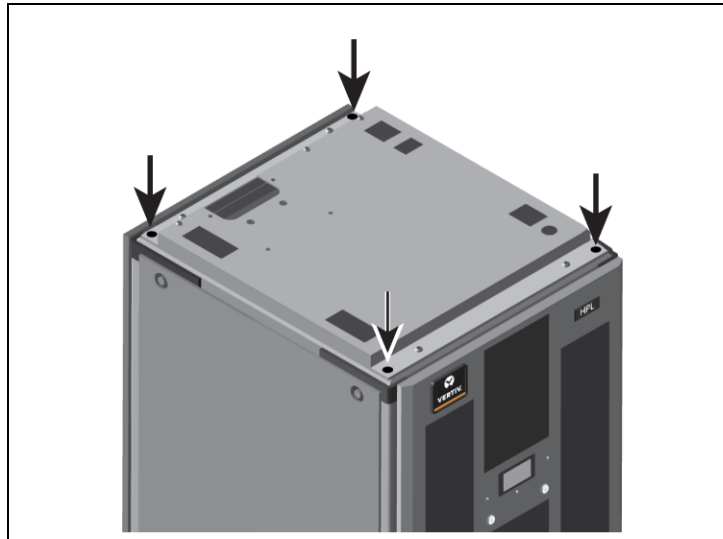
4. Position the forklift on the side of the Vertiv HPL and move the forks so they are just inside the casters.
5. Move the forks under the Vertiv HPL from the side until they are fully inserted.
6. Lift the cabinet straight up until it clears the shipping pallet.
7. Slide the shipping pallet from under the unit and lower the Vertiv™ HPL 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 storage system is in place and level, crank down the leveling feet to take pressure off the casters.

**Figure 4.1 Lift the Vertiv HPL with a Forklift**



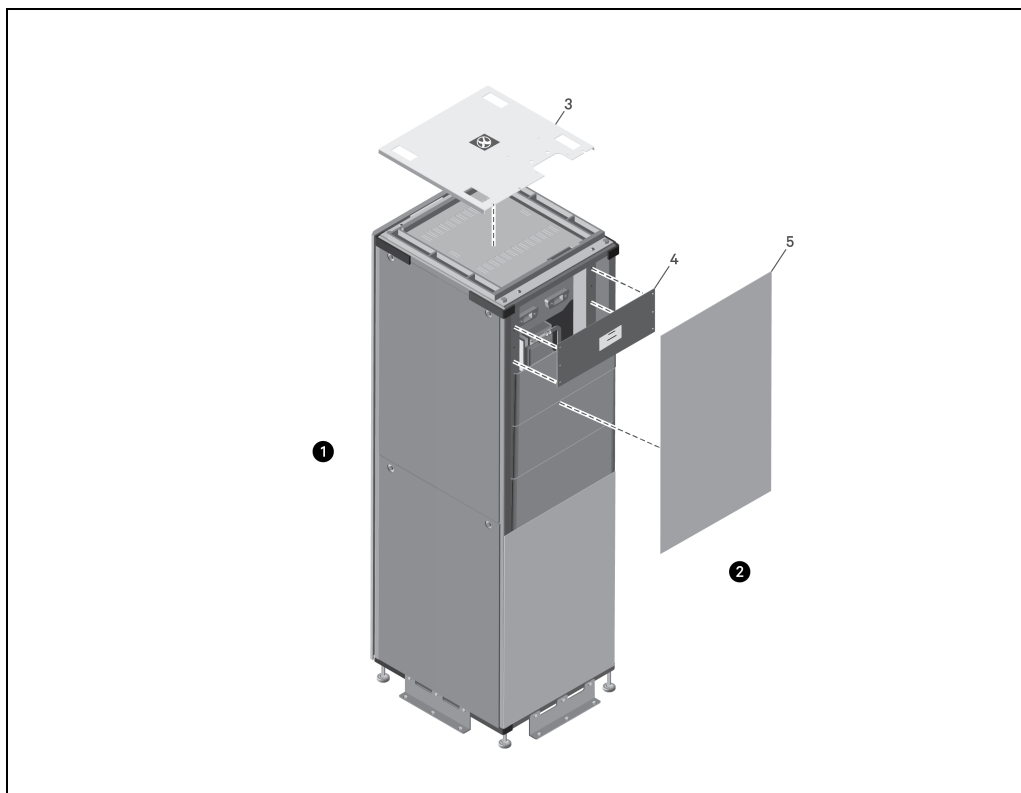
**To use slings to take the Vertiv™ HPL off its shipping pallet:****Eyebolt Requirements:**

- M10 x 1.5
  - Rated for a minimum of 600 lb. (272kg) vertical lifting capacity each; supplier and P/N: McMaster-Carr, P/N: 4843T14
1. Install four eyebolts, meeting the specifications above, one in each corner of the top of the Vertiv HPL.
  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 Vertiv HPL until it clears the shipping pallet.
  5. Slide the pallet from under the unit and lower the Vertiv HPL 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 the storage system 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 4.2 Hoisting the Energy Storage System****To install the HPL Lithium-Ion Energy Storage System:**

1. Remove the hardware on the top panel using a T-30 star bit or wrench.
2. Remove the top panel.
3. Loosen the upper rear panel hardware (4 locations) with a T-30 star bit or wrench.
4. On the top of the rear access panel, loosen the panel hardware with a T-30 star bit or wrench.
5. Slide the rear access panel up and off.
6. Remove the rear interior insulation barrier.

**Figure 4.3 Removing the Top and Rear Access Panel (Product Revision B)**



**Table 4.2 Removing the Top and Rear Access Panel Description (Product Revision B)**

Item	Description	Tool needed
1	Front of rack	10mm socket and wrench
2	Rear of rack	T-30 star drive bit
3	Top panel	T-30 star drive bit
4	Rear interior insulation barrier	10mm socket and wrench
5	Rear access panel	T-30 star drive bit

Figure 4.4 Removing the Top and Rear Access Panel (Product Revision C)

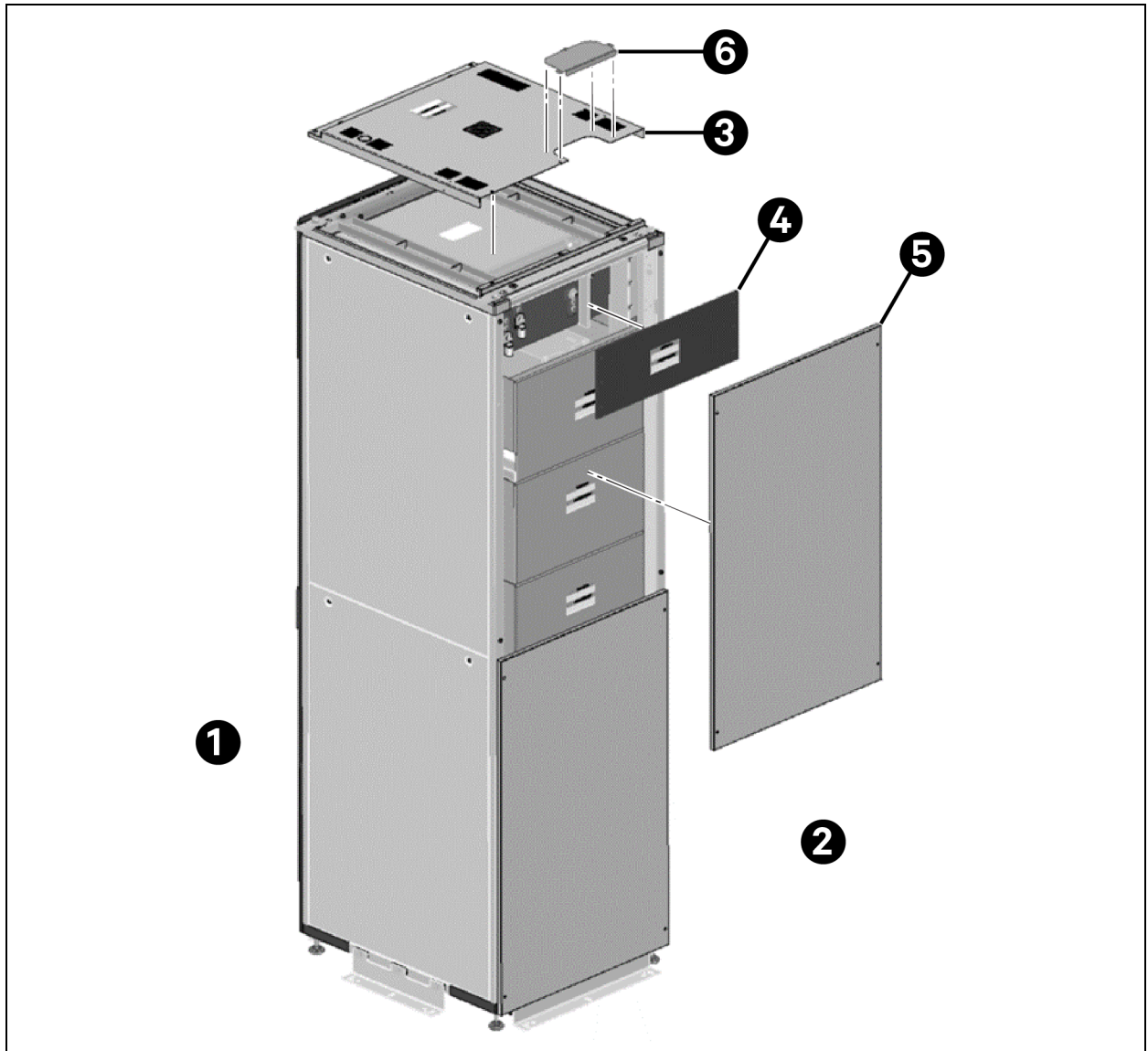


Table 4.3 Removing the Top and Rear Access Panel Description (Product Revision C)

Item	Description	Tool needed
1	Front of rack	10mm socket and wrench
2	Rear of rack	T-30 star drive bit
3	Top panel	T-30 star drive bit
4	Rear interior insulation barrier	10mm socket and wrench
5	Rear access panel	T-30 star drive bit
6	Conduit entry cover plate (can be punched or discarded)	T-30 star drive bit

7. Connect the Vertiv™ HPL to a DC bus. Refer to the outline submittal drawing for the torque required for the DC cable connections. Use an appropriate-sized cable to safely ensure less than 2VDC drop at 500A from the cable to the UPS.

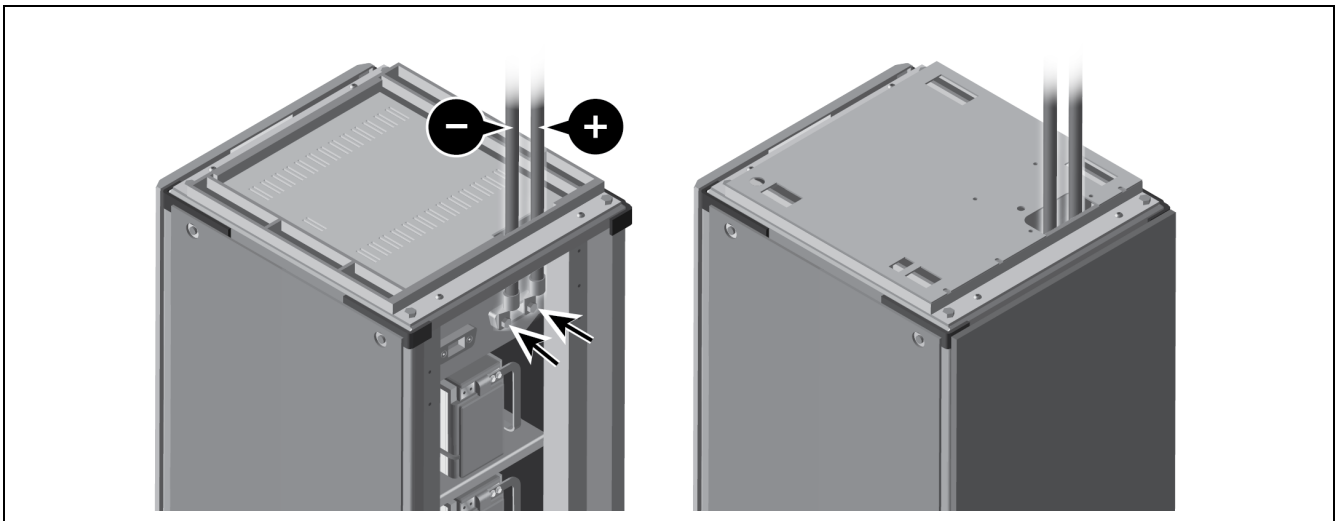
8. Reattach the rear insulation barrier, then reattach the rear access and top panel. Pass the cables through the U-shaped cutouts on the top panel.

Note that if the conduit box will be installed, the cables from the conduit box to the HPL's terminals are provided with the conduit box kit.

Each HPL's DC bus cables should travel between the HPL and a common junction cabinet (usually part of the UPS enclosure). The HPL's conduit box or backplane are not intended to land cables from multiple HPL cabinets.

**NOTE: There is a pre-punched hole in the top cover panel for low-voltage control wiring to enter the enclosure. If needed, a conduit fitting can be added or the hole can be punched larger in the field after removing the top panel.**

**Figure 4.5 Reattaching the Roof and Rear Access Panel**



**NOTE: Connect the DC bus and reattach the rear access and top panel before placing and bolting the rack in its final position.**

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

9. Bolt the storage system to the floor by using appropriate flooring bolts to secure the front and rear brackets at the base of the Vertiv HPL floor.

For seismic-rated units, the front and rear mounting brackets included in the seismic kit will require a total of eight 3/8 in. (M10) concrete anchors (Hilti Kwik Bolt-TZ or similar) to secure the mounting brackets to the floor. For detailed instructions, refer to the installation guide (P/N 571042P1) in the seismic anchor kit.

Side brackets are not required for standard or seismic-rated units.

Figure 4.6 Bolting the Energy Storage System to the Floor



Table 4.4 Bolting the Energy Storage System to the Floor Description

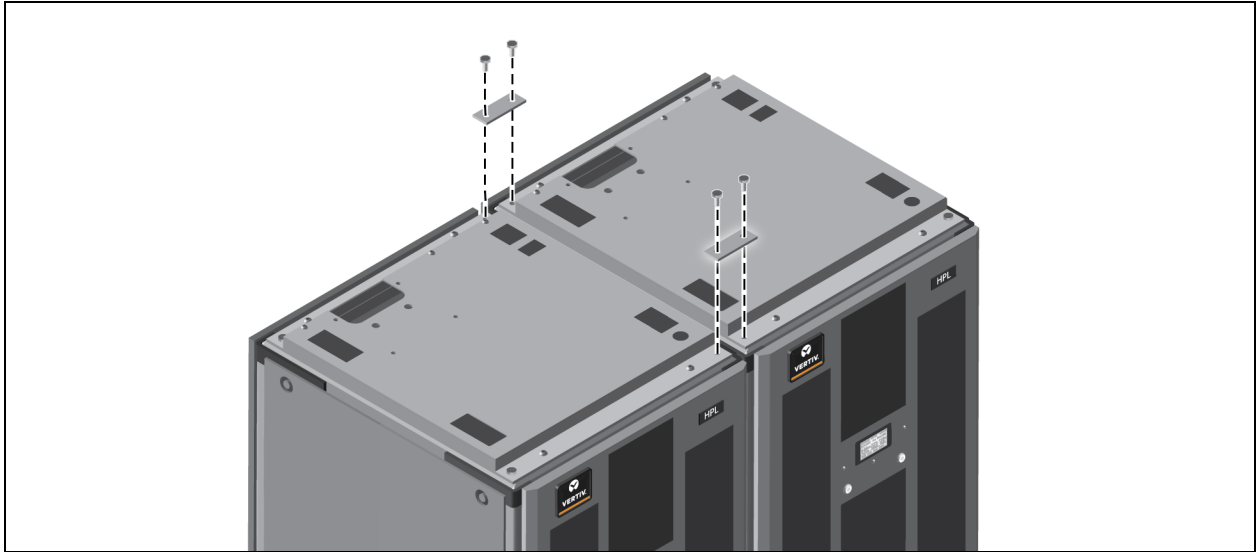
Item	Description
1	Vertiv™ HPL with standard brackets.
2	Vertiv HPL with seismic brackets (front and rear).

**NOTE:** Depending on whether the conduit box is used, it may be necessary to run the DC- and DC+ cable (typo) pairs in the same conduit. Consult Submittal Drawings for cable entry details.

**NOTE:** For side-by-side installation, do NOT remove the side panels. Use the brackets from the supplied accessory bag to bolt the racks together.

**NOTE:** The torque specification for standard mounting brackets is 9Nm/80 in-lb. The torque specification for seismic mounting brackets is 27Nm/240 in-lb.

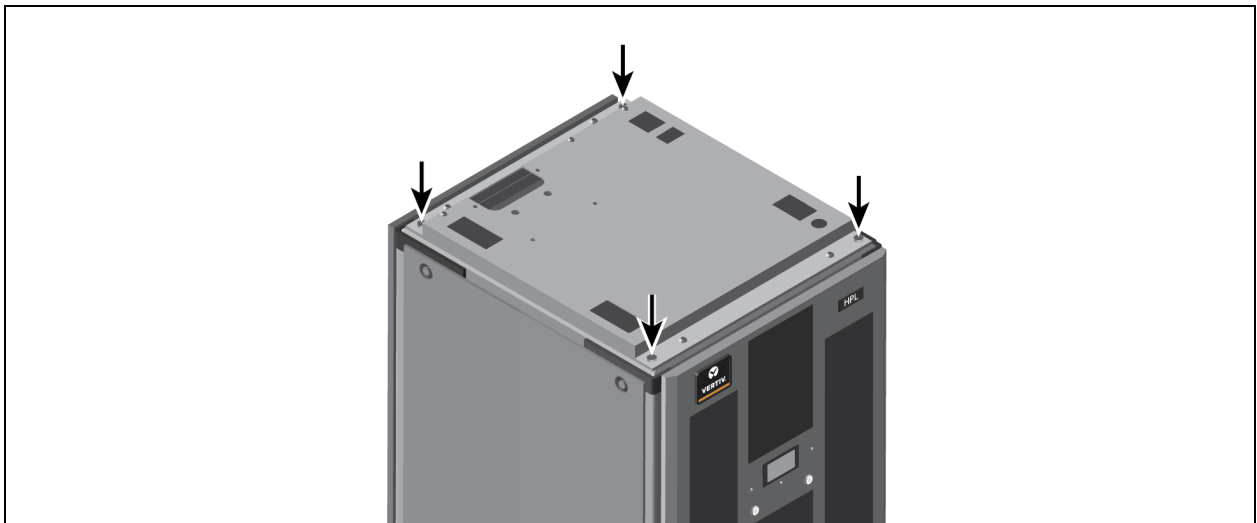
**Figure 4.7** Installing Baying Brackets for Side-by-Side Installation



## 4.2 Grounding

Each rack must be grounded using one of the M10-1.5 threaded holes at the top of the frame. Sizing of the equipment grounding conductor is based on applicable building codes. The following figure shows the location of the grounding points. If the bolted connection is used for electrical bonding between equipment, a factory-supplied star washer must be installed in contact with the cabinet and the bolt should be torqued to 20Nm / 177 in-lbs.

**Figure 4.8** Grounding Points



rog



## 4.3 Control Wiring

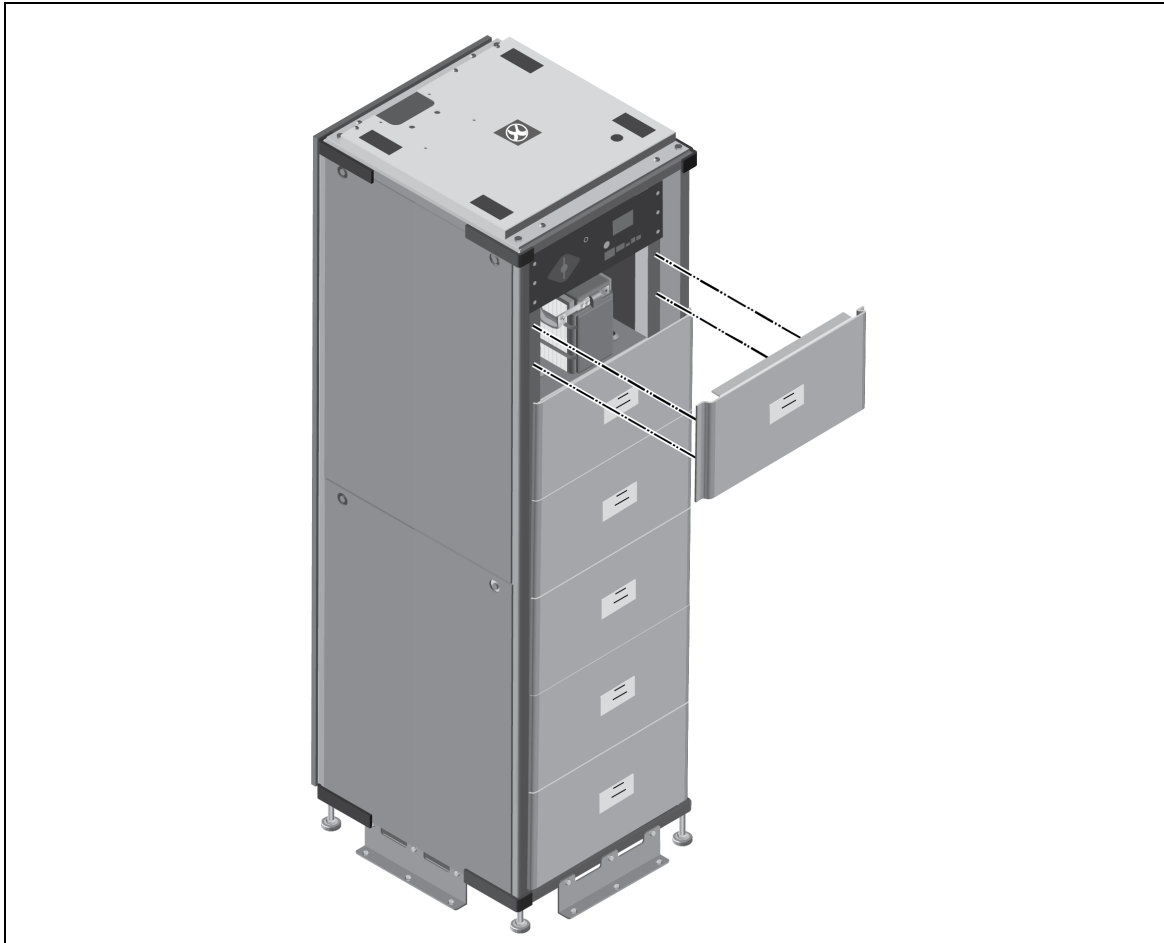


**WARNING! Personal Protective Equipment (PPE) is required for Step 4.**

To run low-voltage control wiring into the Vertiv™ HPL:

Remove the front/top shelf covers. Keep the covers and reinstall them before starting the UPS.

**Figure 4.9 Removing the Top Shelf Cover**



1. Run the control wiring through the conduit entry hole and drop it straight down into the vertical cavity of the rack. The control wiring will need to be dropped into the louver that opens into the upper shelf.
2. Grab the wire from the back, pull it out and connect it to the Cabinet Terminal Block (CTB).

Figure 4.10 Running the Control Wiring (Product Revision B)

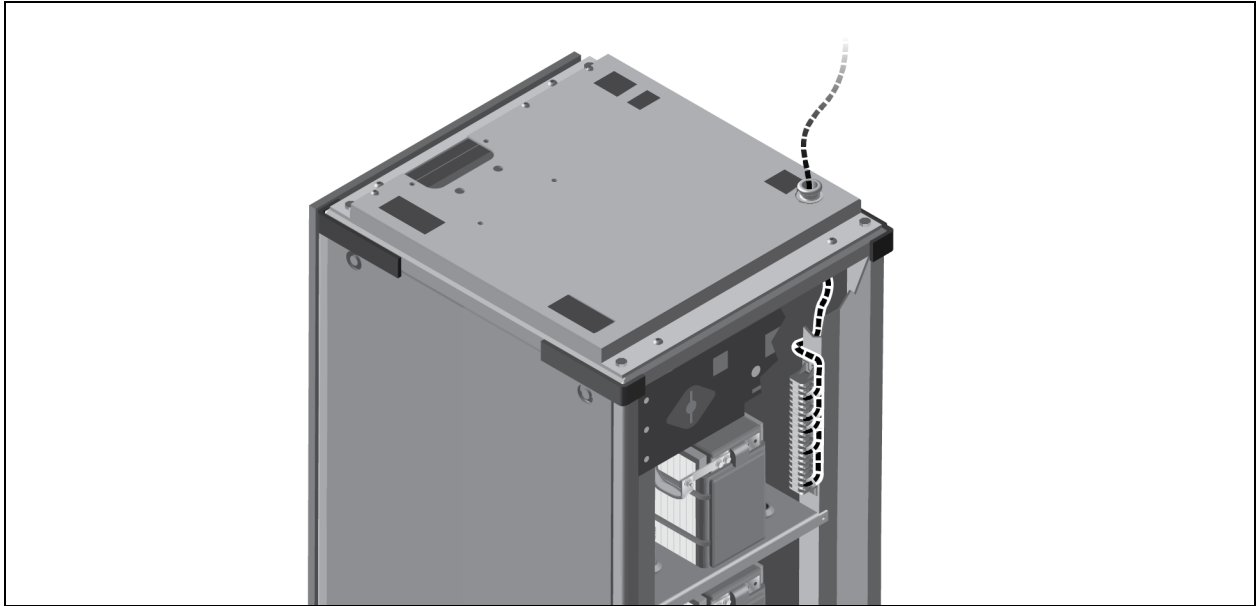
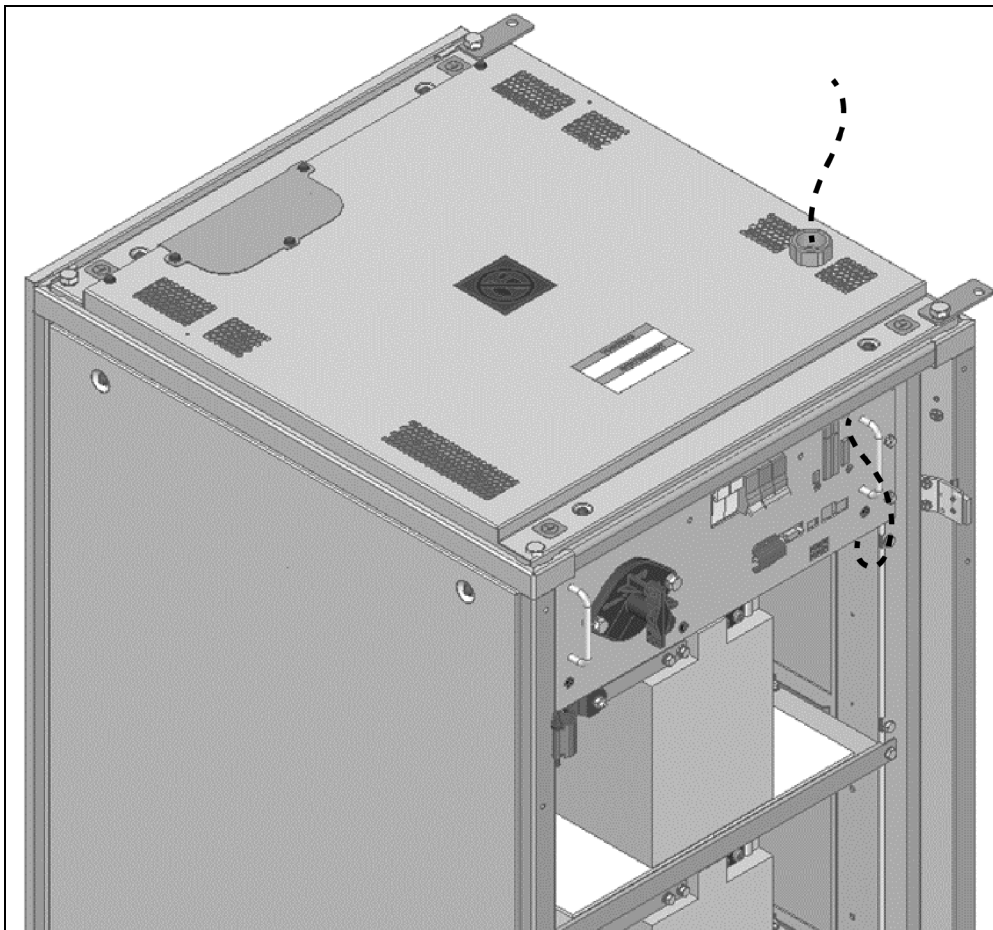


Figure 4.11 Running the Control Wiring (Product Revision C)



3. Connect the control wiring on the Cabinet Terminal Block (CTB) as shown in [Running the Control Wiring \(Product Revision B\)](#) on the previous page. Consult your Submittal Drawings for details about the required control wiring.
4. If applicable, connect the network cable. Because they share data across their inter-cabinet control wiring, a single network connection to a Vertiv™ HPL can be used to monitor a set of multiple battery cabinets.

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## 5 Operation

The following section will help you startup and operate your HPL Lithium-Ion Energy Storage System.

### 5.1 Startup

For the Vertiv HPL to operate properly, the maintenance disconnect and key status settings must be configured correctly.



**WARNING!** If the UPS is powered off, the Vertiv HPL's display should show "UPS Not Ready". If this message does not appear with the UPS off, the UPS may not have the correct settings programmed, there may be a problem with the control wiring, or there may be a problem with the battery interface board (BIB; North America region only).

#### NOTICE

Risk of improper equipment operation. Can cause serious damage to the Vertiv™ HPL. The S1 maintenance disconnect is a static isolation and lockout device only and should not be operated while the Vertiv HPL is online. Doing so will damage the equipment.

**NOTE:** On initial startup, the **STOP** button illuminates solid red, indicating no faults and disconnected from the DC bus.

#### To start the system:

Ensure the UPS and charger are both On.

Perform the following, in order:

1. Turn the *maintenance disconnect (S1)* On (Closed).
2. Turn the *CTL PWR circuit breaker* On (Closed).
3. Put the Key status in the *RUN* position on all racks.
4. Ensure all doors to enclosures are closed on all racks.
5. Working from Rack 1, press the *Enable* button twice. If the DC bus is not present or is too high or too low, the green or blue LED on the *Enable* button will flash slowly to indicate the rack is waiting to join the DC bus.

**NOTE:** Racks join the bus automatically in sequence. This process may take several minutes.

6. Observe that all rack LEDs indicate ONLINE (solid green or blue).

**NOTE:** To disconnect a rack, press and release the **Stop** button. Confirm by pressing and releasing the **Stop** button a second time.



**WARNING!** Do not remove power from the rack without following the power-Off sequence.

## 5.1.1 Force Online

The Vertiv™ HPL will normally protect the batteries from high current by disallowing connection to a DC bus that is not pre-charged by the UPS. 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 Vertiv HPL may assert a warning related to the voltage difference (see **High Delta Voltage** in [Warnings and Faults](#) on page 33 ), but the user can safely force the Vertiv HPL to join the bus by holding the ENABLE button for 5 seconds. The software will ignore this command if the voltage difference is too high for a safe connection.

## 5.2 Shutdown

### To power Off the HPL Lithium-Ion Energy Storage System:

If the HPL is enabled (connected to the DC bus), press the STOP button two times to disable it, then press and hold the **STOP** button for 8 seconds. The CTL PWR circuit breaker trips after approximately 45 seconds, which indicates the rack is powered down. If service is to be conducted during the shutdown (including opening of the S1 switch), observe the display for 10 seconds before holding the STOP button. This allows time to see any new fault or warning messages that are a result of the HPL opening its switchgear and disconnecting from the UPS. After the CTL PWR circuit breaker trips, opening the S1 switch and the F7-F8 fuse holder (if present) is recommended if service is going to be performed in or around the battery cabinet.

**NOTE: While the rack is powering Off, the display shows *POWEROFF REQUEST*.**

**NOTE: When the UPS is powered Off, the display shows *UPS NOT READY*.**

## 5.3 LEDs

Each push button on the local interface has corresponding LED indicators to provide feedback on the status of the Vertiv HPL Lithium-Ion Energy Storage System. [LED Descriptions](#) below describes the rack LEDs.

**NOTE: Both LEDs being solid red indicates the BMS software is not running. When the BMS software is not running, the rack is disconnected from the DC bus.**

**Table 5.1 LED Descriptions**

LED	Description
<b>Stop Button</b>	
Off	Indicates the Enable LED is in use. May also indicate the whole system is powered <i>Off</i> .
Solid Red	The rack is disabled and disconnected.
Flashing Red	Fault detected and the rack is disconnected from the DC bus. See the local display for the cause of the fault.
<b>Enable Button</b>	
Off	Indicates the Stop LED is in use. May also indicate the whole system is powered <i>Off</i> .
Solid Red	The BMS software is not running. Contact Vertiv Technical Support.
Solid Yellow	The DC bus is connected. A warning exists, but the system is operational.
Solid Blue	The DC bus is connected, but the battery is not fully charged.
Solid Green	The DC bus is connected, and the battery is fully charged.
Flashing White	Service mode is activated. This is for Vertiv service personnel only.
Flashing	The rack is waiting to connect to the DC bus. Flashing any color indicating status.

### 5.3.1 DC Bus Connection/Disconnection Logic

The Vertiv™ HPL has several means to ensure that it is not exposed to overcurrent conditions, especially when joining the DC bus. Reasons for overcurrent include high voltage difference between the battery rack and the DC bus and/or mismatch in state of charge (SOC) between batteries on the DC bus and those attempting to connect.

In single-rack systems, the BMS software generally joins the DC bus when enabled without waiting unless:

- The UPS is not ready.
- The DC bus voltage is too far above the recommended charging voltage range.
- The DC bus voltage is very low.

For multi-rack systems (in addition to the reasons shown previously):

- The system waits until all non-faulted racks in the system are enabled.
- Thereafter, the rack with the lowest state of charge (SOC) joins the DC bus first. Other racks wait until the DC bus (with the low SOC rack) voltage falls within a window of a few volts, which minimizes inrush currents and reduces stress on the batteries. Depending on the charge rate of the UPS charger and the SOC of the batteries, this may take minutes or up to an hour.
- In extreme cases the UPS charger voltage might need to be lowered to minimize inrush current for extremely low SOC battery racks.

### 5.3.2 Automatic Power-Off

To prevent over-discharge of the batteries, the Vertiv HPL will automatically shut down its controls when its total battery voltage becomes extremely low (approximately 64V per series battery module). This can occur if the batteries are fully discharged and then not recharged for a long period of time, such as after a natural disaster. It is recommended to leave the control power off until the batteries are able to be recharged again.



**WARNING! When the batteries are fully discharged after UPS input power is lost, and they cannot be recharged for more than 1 week, turn the HPL's CTL PWR circuit breaker off. If present on the PCA, open the F7-F8 fuse holder as well. This turns off the HPL's internal electronics, which helps avoid over-discharging the batteries. Severely over-discharged batteries cannot be used and must be replaced.**

After the Vertiv HPL shuts down in this manner, since its battery voltage is very low, it is necessary to follow a manual process to bring the batteries back to their normal operating voltage. For a parallel set of multiple battery cabinets, it is recommended to conduct these steps for each battery cabinet individually, one after the other.

1. Close the F7-F8 fuse holder (if present) and the *CTL PWR* circuit breaker.
2. Wait for the software to complete its startup process (approximately 1 minute).
3. Verify that the battery voltage indicated on the Vertiv HPL's display is at least as per below listed HPL variants :
  - HPL-4: 240V
  - HPL-5: 300V
  - HPL-6: 360V
  - HPL-7: 420V

If the voltage is below the value mentioned against each variant listed above, contact Vertiv technical support (see [Technical Support and Contacts](#) on page 43 ) and do not proceed further. It is normal for the display to show a warning regarding low battery voltage.

4. Verify that the UPS DC bus or charger output is energized.

5. Turn the key on the power chassis assembly from "RUN" to "SERVICE".
6. Press the *STOP / RESET* button two times.
7. Press the *ENABLE* button two times.
8. The contactors should operate to allow charging current into the batteries. If this does not occur, contact Vertiv technical support.
9. When the battery voltage indicated on the Vertiv HPL's display is in the following range, turn the key on the power chassis assembly from "SERVICE" to "RUN".
  - HPL-4: 280 - 290V
  - HPL-5: 350 - 360V
  - HPL-6: 425 - 435V
  - HPL-7: 495 - 505V
10. Press the *STOP / RESET* button two times.
11. Repeat [Step 1.](#) - [Step 10.](#) for each Vertiv HPL in a parallel set, if applicable.

Completed



## 5.4 Cooling Time After Discharge

The following points are important:

- It is normal for the batteries in the Vertiv™ HPL to become warm while discharging.
- The batteries can be recharged immediately after a discharge, even if they are warm. The temperature does not significantly increase during charging.
- The software 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 99°F (37°C), the batteries may reach their upper temperature limit before the normal end-of-discharge (EOD) voltage is reached, and runtime could be shorter than expected.
- If the battery temperature is warm and runtime will be shorter than expected, this is indicated by the present maximum battery cell temperature showing on the display. The temperature does not appear on the display if the batteries are in the normal range for standby (see [Technical Specifications](#) on page 31)
- If the batteries are discharged until their EOD voltage is reached, it may take up to 5 hours (8 hours for HPL-7) until their temperature decreases enough to provide the full expected runtime again, even after they are recharged fully.

## 5.5 Battery Runtime

The Vertiv™ HPL should always be operated in the normal temperature range for standby shown in the [Technical Specifications](#) on page 31.

The runtime that is available from the Vertiv HPL batteries is affected by factors such as age, cycle count, load during discharge, and temperature at the start of discharge. In general, higher age, higher cycle count, higher load and lower temperature will result in lower runtime.

Battery runtime tables are published separately, but it is important to note that the published runtimes are benchmarked at a certain facility ambient temperature (e.g., 25°C or 30°C) and a certain load, expressed in kWb (kW supplied by the battery). With a larger load on the batteries or lower temperature - during commissioning activities, for example, when some loads in the facility are not operating - runtime may be lower than the published tables.

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# Appendices

## Appendix A: Technical Specifications

**Table 6.1** Technical Specifications

Parameter	Value	Notes
Dimensions	600mm x 725mm x 2022mm (23.6in. x 28.5in. x 79.6in.)	Without optional conduit box. Packaging materials not included.
Weight	HPL-4: 494kg (1090 lbs) HPL-5: 540kg (1190 lbs) HPL-6: 585kg (1290 lbs) HPL-7: 630kg (1390 lbs)	
Cell Type	Lithium-Ion NMC Pouch Cell	26Ah per cell.
Module Type	22S3P	Series/Parallel internally fused.
Module Qty.	4, 5, 6, or 7	Connected in series.
Energy	HPL-4: 25.3 kWh HPL-5: 31.7 kWh HPL-6: 38.0 kWh HPL-7: 44.7 kWh	
Max Rack Voltage	HPL-4: 363V HPL-5: 454V HPL-6: 545V HPL-7: 634V	Auto disconnect when charging above this value.
Min Rack Voltage	HPL-4: 263V HPL-5: 329V HPL-6: 395V HPL-7: 468V	Auto disconnect when discharging below this value.
Max Current (Discharge)	510A for 15 Seconds	
Cutoff Current (Discharge)	525A	Instantaneous
Maximum Discharge Power	HPL-4: 138kW HPL-5: 173kW HPL-6: 207kW HPL-7: 242kW	As measured at output of rack.
Maximum Charge Current	30A	
Maintenance disconnect	1	With LOTO support.
Charge Inhibit Circuit	Included	Prevents overcharge and ensures no ripple at top of charge to maximize battery life.

**Table 6.1 Technical Specifications (continued)**

Parameter	Value	Notes
Switchgear	800VDC Contactors	
DC Connections	Lugs to Terminals	Located on the rear and top of the rack.
Network Interfaces	100BaseT Ethernet	Modbus I/P, Secure Shell (SSH).
Service Interfaces	RS-232, USB	For use by Vertiv service personnel.
Signaling	Isolated discretes	Contact closure inputs for UPS status. Outputs for Rack status.
Front Panel	Backlit LCD	Display system status and fault information.
High Voltage and Current Accuracy	±0.5%	Current and High Voltage readings.
Cell Voltage Monitoring Accuracy	±0.0015V per cell	Each cell group monitored to prevent overcharging and undercharging.
Storage Temperature Range	0°C to 40°C (32°F to 104°F)	Avoid storage above 30°C (86°F) to ensure battery life.
Operating Ambient Temperature	22°C to 30°C (70°F to 86°F)	Rated runtimes assume that a discharge begins in this temperature range.
Cooling	Convective	No fans.
Control Power	Internal	Internally derived control power. No need for AC power.
Service Power	24VDC	Service power port for temporary troubleshooting if required.
Float Voltage Setting	HPL-4: 360-363V HPL-5: 451-454V HPL-6: 542-545V HPL-7: 631-634V	Site dependent.
Recommended Low Voltage Cutoff	HPL-4: 273V HPL-5: 342V HPL-6: 410V HPL-7: 478V	Recommended UPS disconnect voltage.
Maximum Cell Temperature	70°C (158°F)	Monitored continuously by the battery management system. System disconnects at 62°C (144°F). Warning is displayed when temperature is less than 10°C (50°F).
Minimum Cell Temperature	20°C (68°F)	
Recovery time from Max T	5 Hours	Derated run times to avoid overtemperature until recovery complete.
Balancing Circuitry	Resistive	Cell groups are balanced as required for optimal performance.
Compliance	UL 1973, UL 1642, ISTA 3B, UNDOT 38.3, FCC 47 CFR 15B - Class B, CE mark. UL 9540A test for HPL-6 with report.	

## Appendix B: Warnings and Faults

Table 7.1 Warning and Fault Descriptions

Display message	Warning	Fault	Fault/grace period	Comment
Busbar Over Temp		X	85°C (185°F)	Battery module busbar reached over-temperature threshold. A fastener may be loose at the battery terminals.
BMS Low Memory	X		100MB	Software error.
Battery Voltage Fault		X		Sensor failure in battery module.
Check Contactor		X		Software detects stuck contactor (current flowing despite contactor coil being de-energized).
Charge Over Current	150A	X	250A or 15 sec.	Overcurrent during charge.
Cell Under Voltage	2.7V	X	2.0V or 15 sec.	One or more cells below minimum voltage.
Cell Over Voltage	4.17V	X	4.20V or 5 sec.	One or more cells above maximum voltage.
Cell Under Temp		X	10°C (50°F) (15°C (59°F) in firmware version 1.0.4 and earlier)	One or more cells below minimum temperature.
Cell Over Temp		X	62°C (144° F)	One or more cells above maximum temperature.
CANO Sync Lost	X	X		Warning, Fault after 90 seconds (battery module CANbus).
Peer Comms	X			Software is expecting communication from other HPL over CAN, but not receiving it.
CAN1 Not Running		X		Software error.
Configure Error		X		Software Version mismatch or other configuration error.
Calibration Req'd	X			Unit will not operate until calibration procedure has been completed.
Charge Voltage Low	X			UPS charger voltage too low for all battery cells to reach top of charge.
Current Fault	X	X		Sensor failure in power chassis assembly.
Confirmation Required	X			Confirm button press by pressing again.
DC Bus Voltage Fault		X		Sensor failure in power chassis assembly.
Door Open	X			<b>NOTE: : In firmware version 1.0.4 and earlier, the DOOR OPEN warning becomes a fault after 60 seconds.</b>
Disconnect Requested	X			Peer enclosure disconnect discrete has been asserted.
Disconnect Open	X			Service disconnect is Open.
Discharge Over Current	510A	X	525A or 15 sec.	Overcurrent during discharge.

**Table 7.1 Warning and Fault Descriptions (continued)**

Display message	Warning	Fault	Fault/grace period	Comment
End of Discharge	X		30 sec.	Indicated when approaching disconnection.
High SOC	X		99.9%	SOC above Target.
High Delta Voltage	X		-10V	DC bus voltage/battery voltage difference too large for batteries to safely join bus. See <a href="#">Force Online</a> on page 26 for more information.
High DC Bus Voltage	HPL-4: 365V HPL-5: 456 HPL-6: 547V HPL-7: 635V	X	10 min.	DC bus is overvoltage.
IOD Not Running		X		Software error.
IOB Frame Error	X			Communication error. Faults after 5 seconds.
IOB Reg PS Failure		X		Internal IO board has a regulated power supply failure.
Low Battery	X		HPL-4: 273V HPL-5: 342V HPL-6: 410V HPL-7: 478V	Battery approaching exhaustion.
Loopback Fault	X	30 sec.		Broken signal connection between power chassis assembly and battery modules. Check signal wire harness for loose connections.
Module Comms Error	X	X	90 sec.	Battery module communications problem.
Module Fault		X		Module Balancing Board has indicated a FAULT.
MBB Board Over Temp		X	75°C (167°F)	Battery balancing circuit board over-temperature.
MBB Volt/Temp Delta	X	60 sec.		Any cell temperature difference of +/- 20°F from the rack average cell temperature, or any battery module group voltage difference more than 1.7V from the rack average.
Overload Possible	X			Unable to support expected load. Place more racks online or reduce load.
Over Voltage	HPL-4: 365V HPL-5: 456V HPL-6: 547V HPL-7: 635V	X	HPL-4: 368V HPL-5: 460V HPL-6: 552V HPL-7: 642V	Battery rack voltage too high.
High/Low Temperature	60°C (139° F)	X	62°C (144° F)	Battery cell temperature is too cold or too hot; software is preventing the

**Table 7.1 Warning and Fault Descriptions (continued)**

Display message	Warning	Fault	Fault/grace period	Comment
				batteries from connecting to the UPS for this reason.
CANO Not Running		X		Software error.
Polarity Fault		X		A reversed polarity has been detected on the DC bus.
POS BATT Fuse Blown		X		Main DC bus fuse blown.
Pwr Supp Redund Loss	X			Redundant control power supply has failed.
Reset Fault Required		X		User must press STOP to clear a transient FAULT indication.
Replace Main Contactor		X	100	Too many high current disconnects. Replace main contactor.
SD Card I/O Error	X			Error communicating with SD card.
Service Mode				Service Key in SERVICE position.
Temperature Fault		X		Sensor failure in battery module.
UPS Comm Error	X			Communications error with UPS over CANbus.
Under Voltage	HPL-4: 273V HPL-5: 342V HPL-6: 410V HPL-7: 478V	X	HPL-4: 273V HPL-5: 342V HPL-6: 410V HPL-7: 478V or 15 sec.	Battery rack voltage too low.
WD Fault (1.0.8 firmware and earlier) Watchdog Override (1.1.0 firmware and later)		X	5 sec.	Hardware safety fault monitor (circuit board inside PCA) detects unsafe condition such as overcurrent.

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## Appendix C: Control Terminal Block (CTB)

**Table 8.1 Control Terminal Block Definitions**

CTB #	Description	Type	Description
CTB-1	DISCONNECT_NO	Contact Closure – NO	Form C relay; when energized, requests fast, coordinated disconnect from DC bus across multiple racks.
CTB-2	DISCONNECT_COM	Contact Closure – COM	
CTB-3	DISCONNECT_NC	Contact Closure – NC	
CTB-4	BAT_THIS_RACK_NO	Contact Closure – NO	Form C relay; when energized, indicates this rack is connected to the DC bus.
CTB-5	BAT_THIS_RACK_COM	Contact Closure – COM	
CTB-6	BAT_THIS_RACK_NC	Contact Closure – NC	
CTB-7	BAT_DISCONNECT_IMMINEENT_NO	Contact Closure – NO	Form C relay; when energized, indicates the batteries will soon reach exhaustion and will be disconnected from the DC bus. For firmware version 1.0.6 or later, the amount of time between the relay being energized and disconnection can be programmed during installation of the Vertiv™ HPL
CTB-8	BAT_DISCONNECT_IMMINEENT_COM	Contact Closure – COM	
CTB-9	BAT_DISCONNECT_IMMINEENT_NC	Contact Closure – NC	
CTB-10	CGND	Power Supply Reference	Isolated ground reference for CTB-17 and CTB-18.
CTB-11	BAT_MINOR_ALARM_NO	Contact Closure – NO	Form C relay; when NOT energized, indicates a minor alarm or maintenance warning for this rack.
CTB-12	BAT_MINOR_ALARM_COM	Contact Closure – COM	
CTB-13	BAT_MINOR_ALARM_NC	Contact Closure – NC	
CTB-14	BAT_FAULT_NO	Contact Closure – NO	Form C relay; when NOT energized, indicates a major alarm (fault) for this rack.
CTB-15	BAT_FAULT_COM	Contact Closure – COM	
CTB-16	BAT_FAULT_NC	Contact Closure – NC	
CTB-17	UPS_READY_LOW	Dry Contact Input (N.O.)	UPS is ready when tied to CTB-10.
CTB-18	DISCONNECT_REQUEST_LOW	Dry Contact Input (N.O.)	Coordinated disconnect has been requested when externally shorted to CTB-10.
CTB-19	CAN1_HI	CAN	CAN_HI signal for inter-rack communications.
CTB-20	CAN1_LO	CAN	CAN_LO signal for inter-rack communications.
CBT-21	BMX_AUX_INPUT_1	Dry contact input (N.O.)	Input active when shorted to CBT-22 or CBT-23
CBT-22	GND	Reference	Return for BMX_AUX_INPUT_2 and BMX_AUX_INPUT_2 inputs
CBT-23	GND	Reference	Return for BMX_AUX_INPUT_2 and BMX_AUX_INPUT_2 inputs
CBT-24	Reserved	N/A	-
CBT-25	CGND	Power Supply Reference	Isolated ground eference for CTB-17 and CTB-18
CBT-26	BMX_AUX_INPUT_2	Dry contact input (N.O.)	Input active when shorted to CBT-22 or CBT-23
CBT-27	BMX_AUX_INPUT_2	Dry contact input (N.O.)	Input active when shorted to CBT-22 or CBT-23
CBT-28	Chassis Ground	N/A	Internally connected to chassis/frame ground.

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## Appendix D: Retrofits

### D.1 Replacing UPS-Attached Battery Cabinets



**WARNING!** The Vertiv™ HPL should not be bolted to the sides of the UPS.

**NOTE:** When using the Vertiv HPL 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). On some combinations of UPS and attached battery cabinet, the outer side panel of the battery cabinet can simply be retained and fastened to the UPS to cover the opening. If the panel of the battery cabinet does not fit, a new side panel needs to be ordered for the UPS. Consult your Vertiv representative about whether a new side panel needs to be ordered.

Perform the following steps to remove the attached battery cabinets:

1. Electrically disconnect the batteries inside the battery cabinets (inter-tier connections) and from the UPS.
2. Remove the panel and set it aside, if the side panel of old battery cabinet is to be used to cover the open side of the UPS, .
3. Detach the old battery cabinet from the UPS and remove it from the room to open the side of the UPS.
4. Fasten the side panel (whether new or reused) to the side of the UPS.

### D.2 DC Ground Fault Detection

While installing new battery cabinets and/or DC cables, local building code 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. If you are required to install DC Ground Fault Detection, consult your Vertiv sales representative or Vertiv technical support (see [Technical Support and Contacts](#) on page 43 ) to determine the correct option for your specific UPS.

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## Appendix E: Storage After Shipment

After shipment from the factory, it is recommended for the Vertiv™ HPL to be stored in a non-condensing environment at a temperature in the range of 0 - 25°C (32 - 77°F) to minimize capacity loss in the batteries.

It is normal for lithium-ion batteries to self-discharge slowly. For this reason, if the batteries are to be stored for a long period after shipment from the factory, each battery module 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 Vertiv HPL. If a battery is found to have an OCV less than 77.2V, contact Vertiv™ technical support (see [Technical Support and Contacts](#) on page 43 ) about recharging the battery module.

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

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## Appendix F: Technical Support and Contacts

### F.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

1-800-543-2778

Liebert®Channel Products

1-800-222-5877

Liebert® AC and DC Power Products

1-800-543-2378

### F.2 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 / vertivc.service@vertiv.com

### **F.3 Technical Support/Service in Europe, Middle East & Africa Region**

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

### **F.4 Locations**

#### **United States**

Vertiv Headquarters  
1050 Dearborn Drive  
Columbus, OH, 43085, USA

#### **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



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