



# Liebert® APM2

## User Manual

10 kVA to 60 kVA, 208 V, 4-Wire, 60 Hz

20 kVA to 120 kVA, 480 V, 4-Wire/3-Wire, 60 Hz

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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.

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# 1 Important Safety Instructions

## Save These Instructions

This manual contains important instructions that must be followed during installation of the Vertiv™ Liebert® APM2.

Read this manual thoroughly, pay attention to the safety instructions in mechanical and electrical installation chapters. Retain this manual for use by installing personnel.

A properly trained and qualified electrical personnel should install the equipment.

The Liebert® APM2 cannot be put into operation until it is commissioned by the manufacturer or authorized engineer. Otherwise, human safety may be endangered and damage to the uninterruptible power supply (UPS) will not be covered by the warranty.

The Liebert® APM2 is designed for commercial and industrial uses and cannot be used as life support equipment.



**WARNING! Risk of moving heavy equipment and electric shock. Can cause equipment damage, injury and death. Pay attention when handling UPS cabinets to avoid equipment damage or injury to personnel. The weight of Liebert® APM2 ranges from 374 kg to 1048 kg (824.7 lbs to 2310.8 lbs). Determine unit weight and locate center of gravity symbols before handling the UPS. Test lift and balance the cabinet before transporting it. Never tilt equipment more than 15 degrees from vertical. In case of fire involving electrical equipment, use only carbon dioxide fire extinguishers or those approved for use in fighting electrical fires. Extreme caution is required when performing maintenance. Be constantly aware that the UPS system contains high DC as well as AC voltages. Check for voltage with both AC and DC voltmeters prior to making contact.**



**AVERTISSEMENT! Risque lors du déplacement de l'équipement lourd et de décharge électrique pouvant entraîner des dommages matériels, des blessures et même la mort. Faites attention lorsque vous manipulez des armoires UPS pour éviter d'endommager l'équipement ou de blesser le personnel. L'armoire pèse de Liebert® APM2 374 kg to 1048 kg (824.7 lbs to 2310.8 lbs). Repérez les symboles de centre de gravité avant déplacer l'armoire ASC. Faites des essais de levage et d'équilibre avant de transporter l'armoire. N'inclinez jamais l'équipement à plus de 15 degrés à la verticale. En cas d'incendie associé à du matériel électrique, n'utilisez que des extincteurs à dioxyde de carbone ou homologués pour la lutte contre les incendies d'origine électrique. Les opérations d'entretien requièrent une extrême prudence. Soyez toujours conscient du fait que le système ASC contient des tensions c.c. et c.a. élevées. Vérifiez les tensions avec des voltmètres c.a. et c.c. avant d'établir tout contact.**



**WARNING! Risk of electric shock. Can cause equipment damage, injury, and death. As with other types of high-power equipment, dangerous voltages are present within the UPS and battery enclosure even after input power has been disconnected. The risk of contact with these voltages is minimized as the live component parts are housed behind a metal panel. Further internal safety screens make the equipment protected to IP20 standards. Never remove panels or covers or open doors that will expose internal components to contact. Read and obey all warnings, cautions and safety and operating instructions to avoid serious injury or death from electric shock. All equipment maintenance and servicing procedures involve internal access and should be carried out only by trained personnel.**



**AVERTISSEMENT!** Risque d'électrocution. Peut causer des dommages à l'équipement, des blessures et la mort. Comme pour d'autres types d'équipements haute puissance, des tensions dangereuses sont présentes à l'intérieur de l'onduleur et du boîtier de la batterie, même après que l'alimentation d'entrée a été déconnectée. Le risque de contact avec ces tensions est minimisé car les composants sous tension sont logés derrière un panneau métallique. D'autres écrans de sécurité internes permettent de protéger l'équipement selon les normes IP20. Ne retirez jamais les panneaux ou les couvercles ou n'ouvrez jamais les portes qui exposeraient les composants internes au contact. Lisez et respectez tous les avertissements, mises en garde et instructions de sécurité et d'utilisation pour éviter des blessures graves ou la mort par choc électrique. Toutes les procédures d'entretien et d'entretien de l'équipement impliquent un accès interne et ne doivent être effectuées que par du personnel qualifié.

## 1.1 Ground Leakage Current



**WARNING!** Risk of electric shock from high leakage current. Can cause injury, property damage, and death. Earth connection is essential before connecting the input supply. Earth leakage current exceeds 3.5 mA and is less than 1000 mA. Transient and steady state earth leakage currents, which may occur when starting the equipment, should be considered when selecting instantaneous residual current circuit breakers (RCCB) or residual current detector (RCD). RCCBs must be selected sensitive to DC unidirectional pulses (Class A) and insensitive to transient current pulses. Note also that the earth leakage currents of the load will be carried by this RCCB or RCD. This equipment must be earthed in accordance with the local electrical code of practice.



**WARNING!** Risk of electric shock. Can cause injury, property damage, and death. Under typical operation and with all UPS doors closed, only normal safety precautions are necessary. The area around the UPS system should be kept free of water, excess moisture, and debris. Special safety precautions are required for procedures involving handling, installation, and maintenance of the UPS system. Observe all safety precautions in this manual before handling or installing the UPS system as well as during all maintenance procedures. This equipment contains several circuits that are energized with high voltage. Only test equipment designed for troubleshooting should be used. This is particularly true for oscilloscopes. Always check with AC and DC voltmeters to ensure safety before making contact or using tools. Even when the power is turned Off, dangerously high electric charges may exist within the UPS. All power and control wiring should be installed by a qualified electrician. All power and control wiring must comply with the NEC and applicable local codes. ONLY qualified service personnel should perform maintenance on the UPS system. When performing maintenance with any part of the equipment under power, service personnel and test equipment should be standing on rubber mats. The service personnel should wear insulating shoes for isolation from direct contact with the floor (earth ground). Never work alone, even if all power is disconnected from the equipment. A second person should be standing by to assist and summon help in case of an accident.



**AVERISSEMENT! Risque d'électrocution. Peut causer des blessures, des dommages matériels et la mort. En fonctionnement typique et avec toutes les portes de l'onduleur fermées, seules les précautions de sécurité normales sont nécessaires. La zone autour du système UPS doit être exempte d'eau, d'humidité excessive et de débris. Des précautions de sécurité spéciales sont requises pour les procédures impliquant la manipulation, l'installation et la maintenance du système UPS. Respectez toutes les précautions de sécurité de ce manuel avant de manipuler ou d'installer le système UPS ainsi que pendant toutes les procédures de maintenance. Cet équipement contient plusieurs circuits qui sont alimentés à haute tension. Seul un équipement de test conçu pour le dépannage doit être utilisé. C'est particulièrement vrai pour les oscilloscopes. Vérifiez toujours avec des voltmètres AC et DC pour assurer la sécurité avant d'entrer en contact ou d'utiliser des outils. Même lorsque l'alimentation est coupée, des charges électriques dangereusement élevées peuvent exister à l'intérieur de l'onduleur. Tout le câblage d'alimentation et de contrôle doit être installé par un électricien qualifié. Tout le câblage d'alimentation et de commande doit être conforme au NEC et aux codes locaux applicables. SEUL un personnel de service qualifié doit effectuer la maintenance du système UPS. Lors de l'entretien avec n'importe quelle partie de l'équipement sous tension, le personnel de service et l'équipement de test doivent être debout sur des tapis en caoutchouc. Le personnel de service doit porter des chaussures isolantes pour l'isolation du contact direct avec le sol (terre au sol). Ne travaillez jamais seul, même si toute l'alimentation est déconnectée de l'équipement. Une deuxième personne doit être prête à aider et à appeler à l'aide en cas d'accident.**

## NOTICE

Risk of improper ground connection. Can cause equipment damage. Ground connection is essential before connecting the input supply. This equipment must be grounded in accordance with local electrical codes. Maximum load must not exceed that shown on the UPS rating label. Risk of improper electromagnetic shielding. Can cause radio communication interference. This unit complies with the limits for a Class A digital device, pursuant to Part 15 Subpart J of the FCC rules. These limits provide reasonable protection against harmful interference in a commercial environment. This unit generates, uses and radiates radio frequency energy and, if not installed and used in accordance with this instruction manual.



**WARNING! Failure to follow adequate grounding procedures can result in electric shock hazard to personnel, or the risk of fire, should a ground fault occur. All operations described in this section must be performed by properly trained and qualified electricians or technical personnel. If any difficulties are encountered, contact Vertiv. This device complies with part 15 of the FCC Rules. Operation is subject to the following conditions: This device may not cause harmful interference, and this device must accept any interference received, including interference that may cause undesired operation.**



**AVERISSEMENT! Le non respect des procédures de mise à la terre peut entraîner des risques d'électrocution du personnel, ou des risques d'incendie en cas de défectuosité de la mise à la terre. Toutes les opérations décrites dans cette section ne doivent être effectuées que par des électriciens ou des techniciens professionnels dûment formés et qualifiés. En cas de difficultés, communiquez avec Vertiv. Pour obtenir les renseignements de contact, consultez la dernière page de ce manuel.**



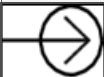








## NOTICE

Risk of improper ground connection. Can cause equipment damage. Ground connection is essential before connecting the input supply. This equipment must be grounded in accordance with local electrical codes. Maximum load must not exceed that shown on the UPS rating label.

**NOTICE**

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

**1.2 Symbols**

	Risk of electrical shock
	Indicates caution followed by important instructions
	AC Input
	AC Output
	Requests the user to consult the manual
	Indicates the unit contains a valve regulated lead acid battery
	Recycle
	DC Voltage
	AC Voltage
	Equipment grounding conductor
	Bonded to ground



## 2 Overview

This chapter describes the features, design concept, parallel system, operation mode, battery management and battery protection of the Vertiv™ Liebert® APM2 UPS.

### 2.1 Introduction

The Liebert® APM2 UPS can be configured as either a fixed capacity or scalable, transformer free, online uninterruptible power system with 208 V, 400 V, and 480 V capability. The Liebert® APM2 operates with 60 Hz.

When configured for scalability, the capacity of UPS can be set according to **Table 2.1** below. Contact Vertiv Services about adding capacity.

The Liebert® APM2 provides continuous, high quality AC power to business-critical equipment, such as telecommunications and data processing equipment. The Liebert® APM2 supplies power free of the disturbances and variations in voltage and frequency common to utility power, which is subject to brownouts, blackouts, surges, and sags.

The Liebert® APM2 utilizes the latest in high frequency, double conversion pulse width modulation technology and fully digital controls to enhance its reliability and increase the ease of use.

The Liebert® APM2 requires internal or external batteries to support the load when utility power is not present.

**Table 2.1 The Liebert® APM2 Model and Power Scale**

Product	Power Scalability
The Liebert® APM2 60 K 208 V 4-wire 60 Hz	10, 15, 20, 25, 30, 40, 50, 60
The Liebert® APM2 120 K 400 V/415 V 4-wire 60 Hz	20, 30, 40, 50, 60, 80, 90, 100, 120
The Liebert® APM2 120 K 480 V 4-wire/3-wire 60 Hz	20, 30, 40, 50, 60, 80, 90, 100, 120

### 2.2 Features

The UPS is connected between a critical load, such as a computer, and mains power to provide high quality power for the loads.

The UPS has the following advantages:

- Improves the input power quality.
- The UPS protects its output against the input power change through the intelligent controller.
- Protect the equipment in the scenario of mains direct power source failure.
- If the input power fails, the UPS will work in battery mode, and the power supply to the loads will not be interrupted.

### 2.3 Control and Display Panel

Information about using the UPS control panel is explained in **Vertiv™ Liebert® Touchscreen Control Panel User Manual SL-26200**, available at Vertiv's Web site [www.vertiv.com](http://www.vertiv.com).

## 2.4 Operation Modes

The UPS has the following operation modes:

- Normal mode
- Battery mode
- Automatic restart mode
- Bypass mode
- Maintenance mode
- Economy (ECO) mode
- Frequency converter mode
- Power conditioner mode
- Generator mode
- Dynamic online mode

### 2.4.1 Normal Mode

As shown in **Figure 2.2** on the facing page, the main input AC voltage is converted to DC voltage by the UPS rectifier and converted to conditioned AC voltage by the inverter to supply uninterrupted AC power to the loads. At the same time, the charger will use the DC voltage from the rectifier to charge the battery. For inverter overload protection, the Vertiv™ Liebert® APM2 UPS utilizes a dynamic counter that monitors each power module load level, every 40 milliseconds.

**Table 2.2 Inverter Overload Protection**

Load	Duration Inverter will Support Rated Load	Counter
≤ 105%	Continuous	0
105% to 110%	60 Minutes	1
110% to 125%	10 Minutes	6
125% to 150%	Minimum 60 seconds	6 to 60 Linear increase by load
150% to 200%	Minimum 200 milliseconds	23000

If any power module reaches the maximum overload counter value of 91500, the alarm overload timeout will be issued and the system load will transfer to Bypass.

Using 110% to 125% overloads as an example, the maximum possible time is  $91500/6 \times 40\text{ms} = 610$  seconds.

For 125% to 150%, the maximum possible time is  $91500/60 \times 40\text{ms} = 61$  seconds.

These counter increments can be visualized with **Figure 2.1** on the facing page:

Figure 2.1 Inverter Overload Protection

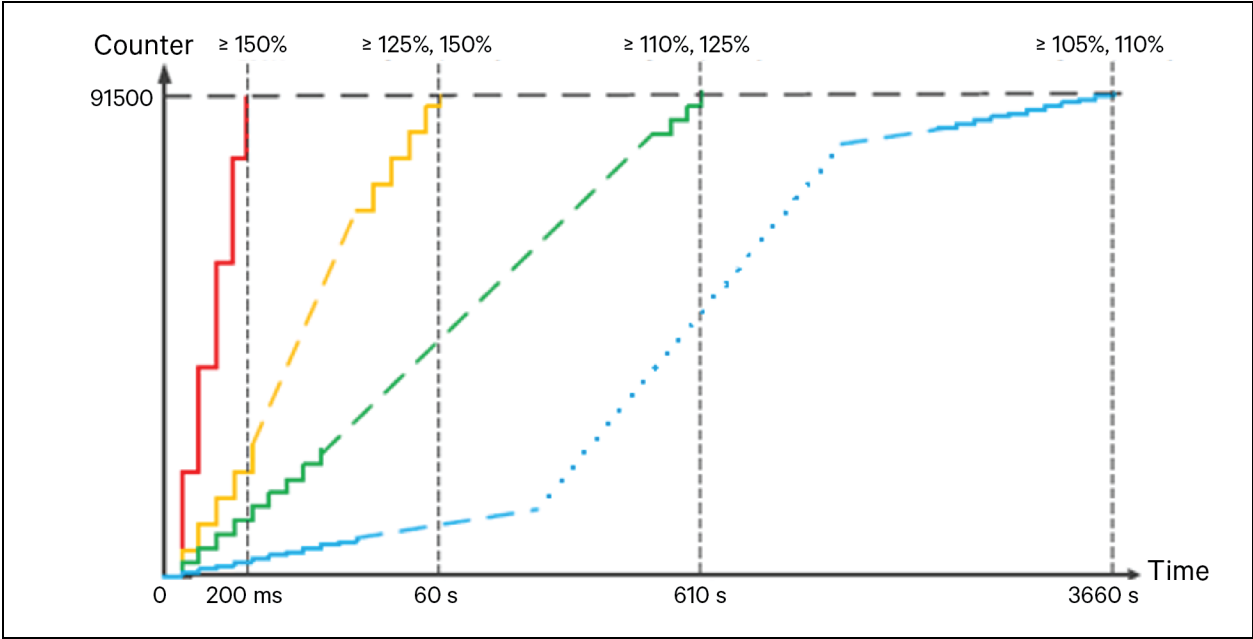
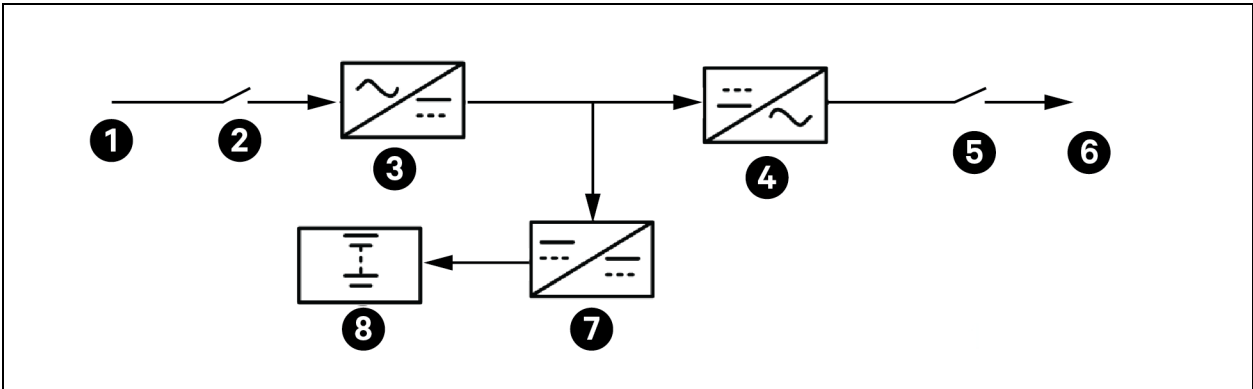


Figure 2.2 Schematic Diagram of Normal Mode

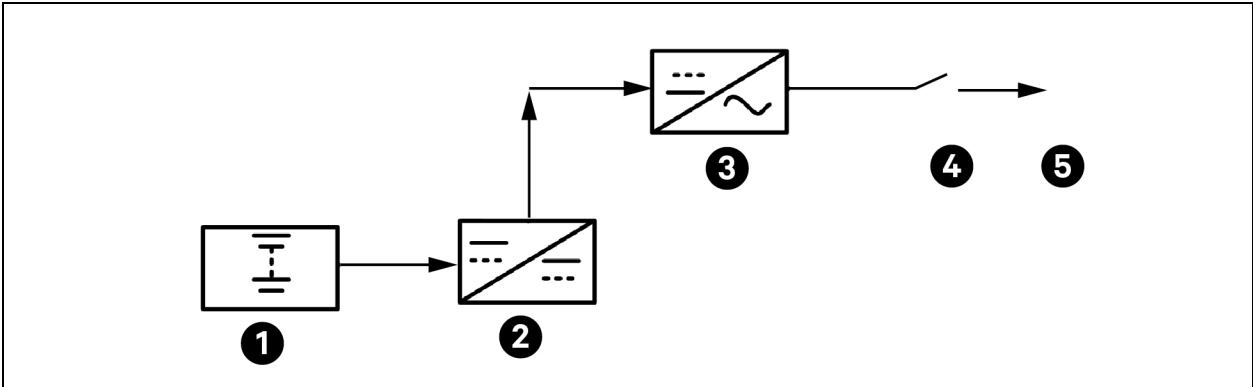


Item	Description	Item	Description
1	Main input	5	Maintenance isolation breaker (MIB)
2	Rectifier input breaker (RIB)	6	UPS output
3	Rectifier	7	Battery charger
4	Inverter	8	Battery

2.4.2 Battery Mode

As shown in **Figure 2.3** below, the operation mode in which the battery provides backup power supply to the loads through the battery charger/discharger and inverter is called battery mode. Upon mains failure, the system will automatically transfer to the battery mode with no load power interruption. When the mains is recovered, the system will automatically transfer back to the normal mode without any manual intervention, and the power to the load will not be interrupted.

Figure 2.3 Schematic Diagram of Battery Mode



Item	Description	Item	Description
1	Battery	4	MIB
2	Battery charger/discharger	5	UPS output
3	Inverter		

**NOTE:** Battery cold start function is available for switching the UPS On from Battery (charged) mode directly during mains failure. Battery power supply is independently used to improve the availability of the UPS.

2.4.3 Automatic Restart Mode

The battery may exhaust after an extended AC utility failure. The inverter shuts down when the battery reaches the end of discharge (EOD) voltage. The UPS may be programmed to Auto Recovery after EOD after a delay time if the AC utility recovers. This mode and any delay time may be programmed by the commissioning engineer.

**NOTE:** The default setting is for the battery circuit breaker (BCB) to trip when the UPS meets EOD. This setting will need to be changed by the commissioning engineer for Auto Restart mode to function.

Automatic restart helps to delay the shutdown process and the UPS will charge the battery to protect against the power Off risk of the load device caused by mains power failure.

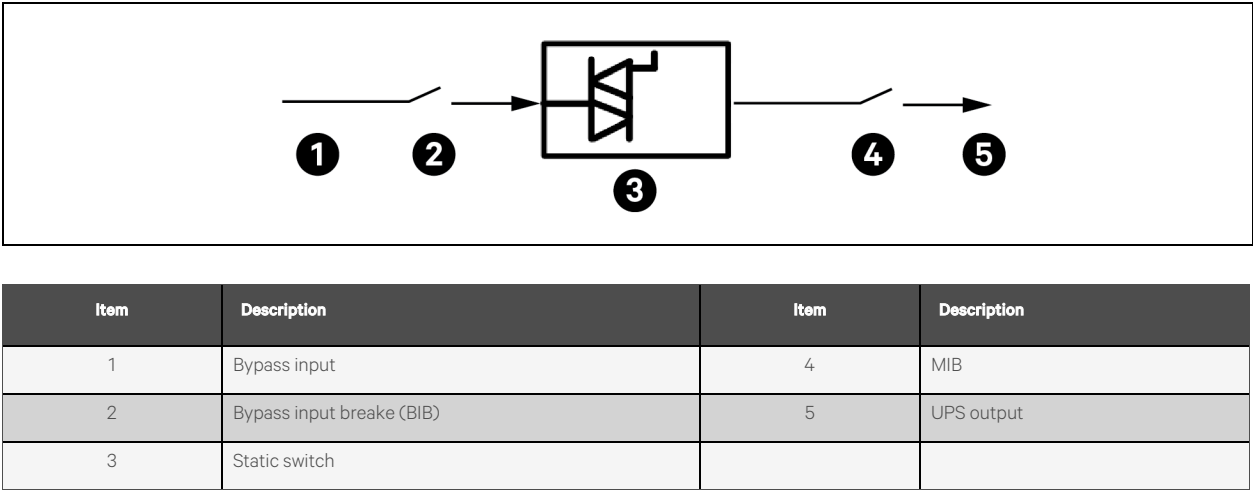
**NOTE:** The user can manually start the UPS through RESET FAULT function, if the automatic restart function has not set.

2.4.4 Bypass Mode

When the UPS is in bypass mode as shown in **Figure 2.4** below, and the inverter fails or the inverter gets overloaded or the inverter is shutdown manually, the static switch will transfer the load from the inverter to bypass without interrupting the power to the load.

**NOTE:** While transferring the load from the inverter to the bypass, if both are not synchronized, power supply to the load has transitory interruption, with a time of less than 20 millisecond.

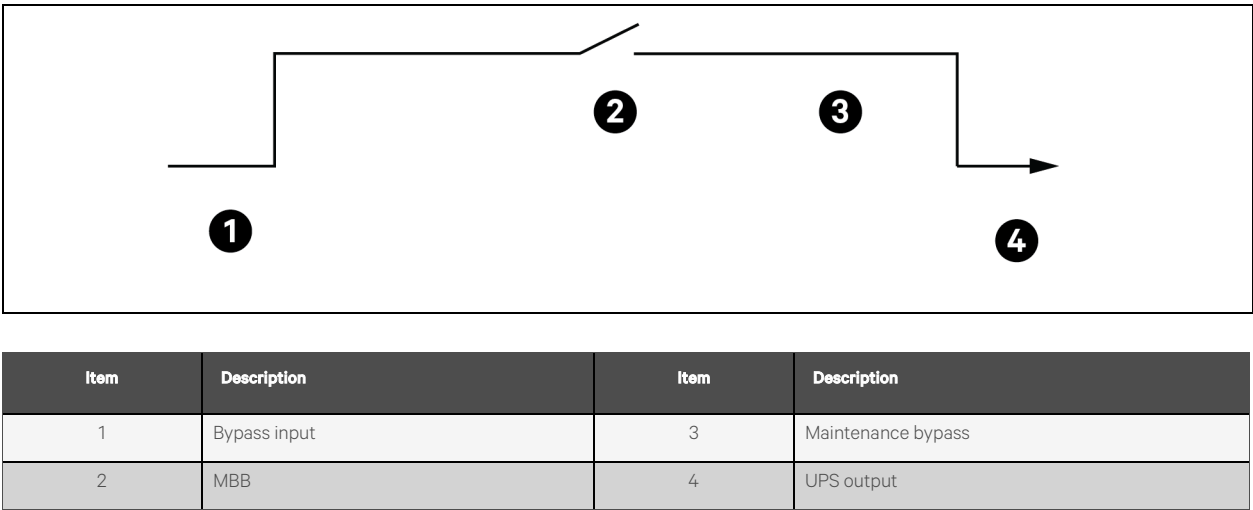
Figure 2.4 Schematic Diagram of Bypass Mode



2.4.5 Maintenance Mode

As shown in **Figure 2.5** below, if the UPS maintenance or service is required, follow the static bypass transfer instructions to use the maintenance bypass breaker (MBB) to transfer the load to maintenance bypass, with no interruption in power to the load.

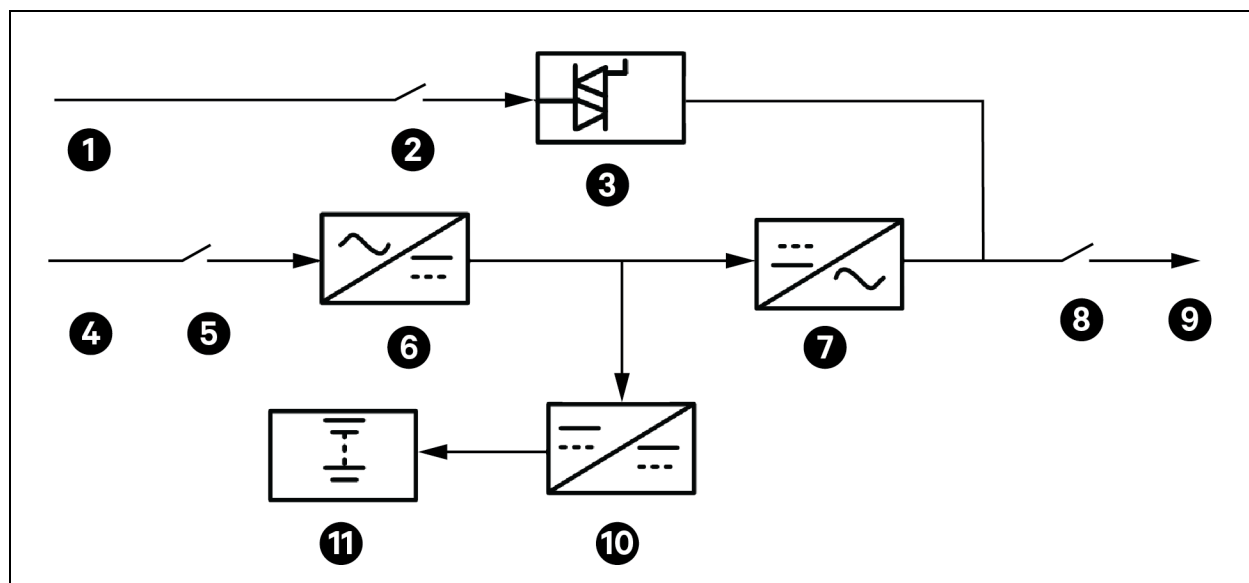
Figure 2.5 Schematic Diagram of Maintenance Mode



## 2.4.6 Economy Mode

As shown in **Figure 2.6** below, if ECO mode is selected, all power switches and the battery switches are closed except the maintenance bypass switch, and the system puts the load on the bypass mode, for energy saving. When the bypass supply is within the range of normal frequency and normal voltage (adjustable), the load is powered by the bypass, with the inverter on standby. When the voltage and/or frequency of the bypass supply are beyond the pre-defined and adjustable limits, the system will transfer to the inverter output and the transfer time for switching from bypass to inverter is less than 2 milliseconds (uninterrupted) and less than 5 millisecond (interrupted). In this mode, the system can normally charge the battery.

**Figure 2.6 Schematic Diagram of ECO Mode**



Item	Description	Item	Description
1	Bypass input	7	Inverter
2	BIB	8	MIB
3	Static switch	9	UPS output
4	Mains input	10	Battery charger
5	RIB	11	Battery
6	Rectifier		

**NOTE: If ECO mode is required, set the parameters through the touchscreen.**

The operation method of ECO mode is the same as that of [Single UPS Operation](#) on page 67. In normal mode, the load is powered by the bypass, the touchscreen displays Bypass mode.

**NOTE: In ECO mode, the load is not protected against mains distortion.**

## 2.4.7 Frequency Converter Mode

The UPS can be programmed into frequency converter mode for either 50 Hz or 60 Hz stable output frequency. The input frequency may vary from 40 Hz to 70 Hz. In this mode, open the MBB and disable the static bypass operation, and the battery becomes optional depending on any requirement to operate in battery mode. The frequency converter mode is set by the service engineer through the setting software.

## 2.4.8 Power Conditioner Mode

In this mode the Vertiv™ Liebert® APM2 only performs to condition and filter the incoming AC power for a clean regulated AC output. For this mode, a DC battery source is not installed and the Liebert® APM2 is incapable of operating on Battery Mode. When the Liebert® APM2 is set to Power Conditioner Mode, the battery alarm is disabled in this mode. This mode can only be enabled at the factory or by Vertiv Services.

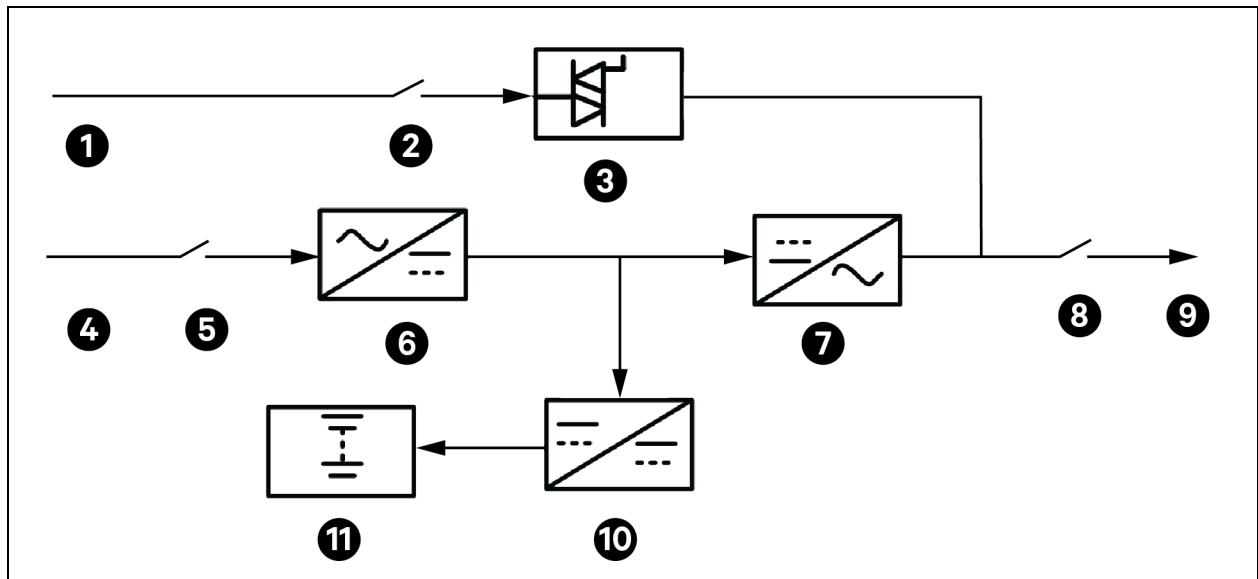
## 2.4.9 Generator Mode

The Liebert® APM2 UPS can be set up for operation in Generator Mode by a Vertiv Services engineer. The setup requires connecting Input Dry Contact Pin 14. The battery charger is disabled in Generator Mode.

## 2.4.10 Dynamic Online Mode

As shown in **Figure 2.7** below, when the UPS is in dynamic online mode, except the MBB, all other power breakers and battery breakers are turned On. The load power is preferentially supplied by bypass to save energy. When the load power supply is provided by bypass, the inverter is in the mode of quality compensation for the bypass voltage. When the bypass voltage exceeds the normal range, the system will switch to the inverter output. In this mode, the battery can still be charged through the charger normally.

**Figure 2.7 Dynamic Online Mode**



Item	Description	Item	Description
1	Bypass input	7	Inverter
2	BIB	8	MIB
3	Static switch	9	UPS output
4	Mains input	10	Battery charger
5	RIB	11	Battery
6	Rectifier		

## 2.5 Battery Management System

The battery management system (BMS) functions are set by the Vertiv service engineer through the setting software.

### 2.5.1 Normal Function

- **Constant current boost charge:** Adopt the constant current (within battery charging limit) to charge the battery. The function is for fast recovery of battery capacity. The charge current can be set.
- **Constant voltage boost charge:** Adopt the constant voltage to charge battery. The function is for fast recovery of battery capacity. For valve regulated lead-acid (VRLA) batteries, the maximum boost charge voltage must not exceed 2.4 V/cell.
- **Float charge:** The charging method is for keeping battery in full capacity. The function can balance the capacity loss due to battery self-discharge and is used for battery capacity recovery. For VRLA batteries, the float charge voltage must be between 2.2 V/cell and 2.3 V/cell.
- **Automatic transfer to float charge:** When the charge current is less than Threshold of Equalize Charge to Float Charge or 0.5 A, the charger will automatically transfer from boost charge to float charge. When boost charge time exceeds the limit of Equalize Charge Protect Time Limit, the charger will transfer to float charge to protect the battery.
- **Float charge temperature compensation (optional):** This function must be used with the battery temperature detection device. The Vertiv battery temperature sensor is a standard option for the selection.
- **EOD protection:** When the battery voltage drops to the EOD voltage, the battery converter shuts down automatically and the battery is inhibited to avoid further battery discharge. The EOD voltage is settable from 1.60 V/cell to 1.90 V/cell (VRLA).
- **Battery low pre-warning time:** The battery low pre warning time is adjustable between 3 minutes and 60 minutes. The default setting is 5 minutes.
- **Maximum battery discharge time:** When the battery has small current discharge for a long time, the battery is over discharged and even has unrecoverable damage, thus setting a battery discharge time to protect the battery is essential. The limit of time setting must be configured by service engineer through the Vertiv setting software.
- **Maximum boost charge protection time:** To protect against the battery overcharge damage caused by long time boost charge, a protect time setting is essential. The limit of time setting shall be configured by service engineer through the Vertiv setting software.



## 2.5.2 Advanced Functions

Item	Manual Battery Test	Automatic Battery Test	Remote Battery Test	Calibrated Battery Test
Load	0% <Load <100%	20% <Load <100%	20% <Load <100%	20% <Load <100%
Required Battery Voltage	≥ 97% of float charge voltage	≥ 97% of float charge voltage	≥ 97% of float charge voltage	≥ 97% of float charge voltage
Charger Status*	Float charge (5 hours)	Float charge (5 hours)	Float charge (5 hours)	Float charge (5 hours)
Setting	N/A	Automatic battery test must be enabled and scheduled	N/A	N/A
Trigger	From GHMI	Automatic	Through the input dry contractor	From GHMI
Action	Discharging until battery capacity is 80%	Discharging until battery capacity is 80%	Discharging until battery capacity is 80%	Discharging until battery is close to EOD state
Info	N/A	N/A	Only when the utility power is normal and there is no active alarm, UPS can allow the remote battery test function	N/A
*Float charge status required for at least 5 hours with VRLA, high discharge VRLA, wet, Ni-Cd batteries.				

**NOTE:** The battery will continuously discharge to the battery under voltage shutdown threshold, then the battery transfer to the charging state. When the capacity self-test is finished, the system will update the battery curve table.

**NOTE:** The user can manually stop the capacity self-test operation using the touchscreen.

## 2.5.3 Battery Temperature Compensation

The UPS system has battery charge temperature compensation function. When the ambient temperature is increased, the DC bus voltage (which charges the battery) will be reduced correspondingly to provide optimal charging voltage for the battery, thus increasing the battery service lifetime.

## 2.6 Battery Protection



**WARNING!** The user must select an appropriate MCCB to protect against short circuit and overload for the battery. It is recommended to use the Vertiv battery to provide a better solution.

The following battery protection functions are set by the service engineer through the Vertiv setting software.

### 2.6.1 Battery Low Pre-warning

The battery low pre-warning occurs before the EOD. After this pre-warning, the battery should have the capacity of 3 minutes discharging with full load. The time can be configured from 3 minutes to 60 minutes.

## 2.6.2 End of Discharge Protection

When the battery voltage drops to the EOD voltage, the battery shut down automatically. For VRLA batteries, the EOD voltage is adjustable from 1.60 V/cell to 1.90 V/cell (VRLA).

## 2.6.3 Battery Circuit Breaker Alarm

The external battery connects to the UPS through the BCB. The BCB is manually closed and tripped by the UPS control circuit.

# 2.7 Parallel System and Load Bus Synchronization System

## 2.7.1 Parallel System

For higher capacity or higher reliability, the outputs of multiple UPS units can be programmed to parallel directly. The built-in parallel controller in each UPS module ensures automatic load sharing. A parallel system can include up to four UPS units. For the operation principle diagram of the parallel redundancy mode, see **Figure 8.1** on page 90.

1. The hardware and software of parallel system are same as those of the single module. The parallel system configuration is achieved through settings in configuration software.
2. Parallel cables are connected in a ring, providing both system reliability and redundancy.
3. The total load of the parallel system is identified from the touchscreen of each UPS module.

## 2.7.2 Parallel System Requirements

A group of parallel units operate as if it is one large UPS with higher reliability. To ensure that all units are equally utilized and to comply with relevant wiring rules, make sure that the following requirements are met.

1. All UPS units must be in the same model and connect to the same bypass source.
2. The bypass and rectifier input sources must be connected to the same neutral line input terminal.
3. Any RCD, if installed, must be of an appropriate setting and located upstream of the common neutral line input terminal. Alternatively, the device must monitor the protective earth current of the system.

## 2.7.3 Load Bus Synchronization System

A dual bus system consists of two independent UPS systems, each containing one or more parallel UPS units. Unlike parallel operation, load bus synchronization (LBS) operation does not share the load between the UPS systems but will seamlessly switch the loads between them. The dual bus system has high reliability and is applicable to the load with multiple inputs. For single input load, a static transfer switch (STS) can be installed to power the load. For the operation principle diagram of the LBS mode, see **Figure 8.5** on page 97 and **Figure 8.6** on page 98.

## 3 Mechanical Installation

This chapter provides brief instructions for mechanical installation of the Vertiv™ Liebert® APM2 UPS, including environmental requirements, mechanical requirements, and mechanical considerations that must be considered while planning the positioning and the cabling of the UPS equipment.

### 3.1 Precautions

This section is a guide to general procedures and practices that should be observed by the installation engineer, so that they can troubleshoot and handle the specific situation of the site. The detailed installation steps are not provided in this section due to the unique characteristics of each installation site.

**NOTE: Professional installation required. Do not disassemble the package without permission or authorization from Vertiv. The UPS should be installed by an authorized engineer in accordance with the information provided in this chapter.**

**NOTE: The UPS can be connected to IT, TN, and TT AC distribution systems (IEC60364-3), and must be a 3-phase, 5-wire (A, B, C, N, PE) system.**



**WARNING! Risk of electric shock. Damage to the property, serious injury, or death are possible. When connecting batteries, the battery terminal voltage can reach above 400 VDC. Pay attention when installing the batteries.**

The following safety precautions must be followed while working on the batteries.

- Always wear protective equipment including eye wear and rubber gloves.
- Remove all the metal tools and jewelry, including finger rings, wristwatch, and so on.
- Use tools with an insulated handle.
- If the battery has electrolyte leakage or the battery is damaged, it must be replaced. Place the battery into the container that can withstand sulfuric acid and dispose of it according to the local regulations.
- If you come in contact with the battery's electrolyte, wash and flush the area with water immediately. If it comes in contact with your eyes, flush them with water and get medical aid immediately.

### 3.2 Transportation

The recommended mode of transportation is railroad transportation and shipping. If standard ground transportation is necessary, recommended transit should be in a fully enclosed container rated for the full weight of the UPS and protects the UPS from inclement weather types.



**WARNING! Risk of moving heavy unit and tipping over while moving. Can cause equipment damage, personnel injury, or death. See Table 12.2 on page 116 for the weight of the cabinet. Make sure that the equipment that will be used to move the UPS cabinet has sufficient lifting capacity. The UPS cabinet presents a tipping hazard. Do not tilt the cabinet more than 15 degrees from vertical while transportation.**

















It is recommended to use mechanical equipment like a forklift to load and unload and transport the cabinet to the installation site.

### 3.3 Tools









**WARNING!** Risk of electric shock and hazardous voltage. Can cause personal injury or death. The Installation tools under live operation must be insulated. The tools listed in **Table 3.1** below are the required for installation and connection and that the list below is provided for reference only.

**Table 3.1 Tools Required for Installation and Connection**

Name	Drawing	Name	Drawing
Electric hand drill		Adjustable wrench	
Slotted screwdriver		Cross head screwdriver	
Stepladder		Forklift	
Drill		Wire cutting plier	
Claw hammer		Diagonal cutting plier	
Insulating shoes		Antistatic gloves	
Electrician knife		Cable tie	
Insulating tape		Insulating gloves	

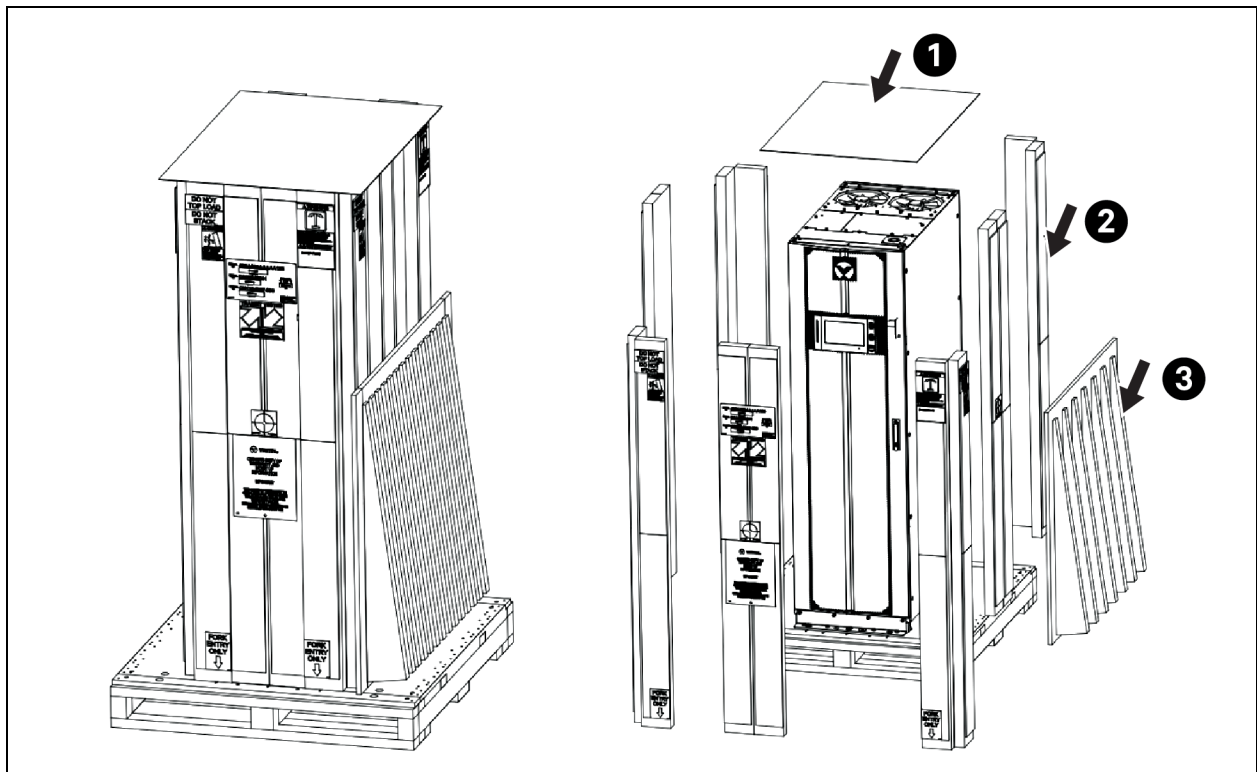
**Table 3.1 Tools Required for Installation and Connection**

Name	Drawing	Name	Drawing
Crimping plier		Heat shrinkable tube	
Insulated torque wrench		Torque screwdriver	
Multimeter		Clip-on ammeter	

### 3.4 Unpacking

Before unpacking the UPS and battery, inspect for any visual damage or signs of mishandling. Under the guidance of authorized Vertiv personnel, follow the below steps to unpack the UPS and battery packages.

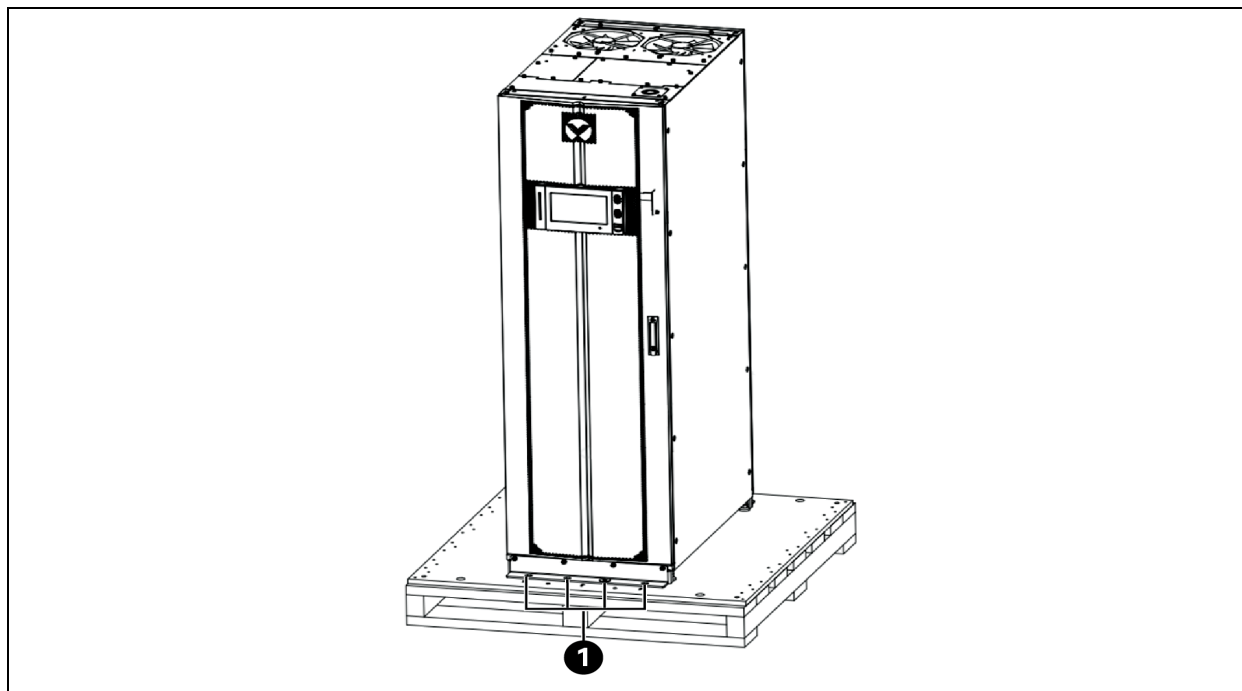
1. Remove the packaging as shown in **Figure 3.1** below.

**Figure 3.1 Removing the Packaging**

Item	Description	Item	Description
1	Top cover	3	Unloading ramp
2	Honeycomb board		

2. Remove the fixing bolts, shown in **Figure 3.2** below.
3. Vertiv™ Liebert® APM2 may be rolled on its casters for short distances only. For longer distances, move the UPS with a forklift or similar equipment to ease the relocation and to reduce vibration.

**Figure 3.2 Removing Fixing Bolts**



Item	Description
1	Fixing bolts

4. Move the cabinet to the installation location using the forklift. See [Transportation](#) on page 15 for more information regarding transporting the UPS.
5. Secure the UPS to the ground, as shown in **Figure 9.1** on page 104.
6. After the Liebert® APM2 UPS is installed, reinstall the bottom fixing bolts.

### 3.5 Pre-installation Inspection

Before installing the UPS, carry out the following inspections:

1. Ensure that the environment of UPS equipment room complies with the environmental requirements specified in the [Environmental Characteristics](#) on page 115, especially the ambient temperature, ventilation conditions, and dust situations.

2. Visually inspect the UPS and battery for any sign of transportation damage or mishandling. Do not attempt to install the system, if damage is apparent. Report it to the carrier or Vertiv representative immediately. Unpack the UPS and battery under the guidance of authorized service engineer.
3. Check the UPS label on the back of the door and confirm the contents match the UPS model, capacity and main parameters that were ordered.

## 3.6 Environmental Requirement

### 3.6.1 UPS Location Selection

Before installing the Vertiv™ Liebert® APM2 UPS, verify that the environment of the room where the UPS is to be installed complies with the environmental requirements specified in relevant international standard and specifications and the operating ranges given in **Table 12.1** on page 115. Pay attention to the ambient temperature and the air exchange system. Install the UPS in a cool, dry, clean air indoor environment with adequate ventilation and on concrete or other non-flammable, flat surfaces. The ambient environment should be free of conductive powder. Conductive powder include metallic powder, sulfide, sulfur dioxide, graphite, carbon fiber, and conductive fiber. The ambient environment should be from acid mist and other conductive media and strongly ionized substances.

The Liebert® APM2 UPS is cooled by internal fans. Cooling air enters the UPS through the perforated panels at the front of the cabinet and is exhausted out through the perforated panels at the back of the cabinet. To permit proper air flow and prevent overheating, do not block, or cover the perforated panels or blow air down onto the unit. The UPS requires at least 20 in. (500 mm) ventilation clearance at the rear side of the unit to avoid blocking the UPS heat dissipation, thus reducing the UPS internal temperature and improving the UPS life.

For the top fan airflow UPS, there are no perforated panels on the sides or back of the UPS. Leave a minimum of 24 in. (670 mm) between the top of the UPS frame and the ceiling to permit adequate air circulation above the unit. Vertiv does not recommend using air conditioning or other systems that blow across the top of the unit.

If necessary, install indoor extractor fans to aid cooling air flow to avoid increase in the room temperature.

**NOTE: When installing the UPS, use M12 expansion bolts to fix the base of the cabinet on the floor to prevent the cabinet from falling due to uneven ground.**

**NOTE: When the battery cabinet is installed near the UPS, the maximum allowable ambient temperature is dependent on the battery rather than the UPS.**

**NOTE: If the UPS is working in ECO mode, the power consumption will be less than that in Normal mode. Proper air conditioning system shall be selected according to the normal operating mode.**

### 3.6.2 Battery Location Selection

Batteries generate some hydrogen and oxygen at the end of a charge, so the fresh air volume of the battery installation environment must meet the EN50272-2001 requirements.

The ambient temperature is the main factor that affects the battery capacity and life. The normal operating temperature of the battery is 68 °F (20 °C). If the ambient temperature is higher than 68 °F (20 °C), the battery life will be reduced. If it is lower than 68 °F (20 °C), the battery capacity will be reduced. In normal situation, the allowable ambient temperature for the battery is 59 °F (15 °C) to 77 °F (25 °C). The ambient temperature of the battery must be maintained constant, and the battery must be kept away from heat source and air outlet.

Battery can be installed inside the specialized battery cabinet that must be close to the UPS. If the battery is placed on the raised floor, a bracket must be installed under the floor, just as for the UPS. If the battery adopts rack mounting or is mounted far from the UPS with other installation mode, the BCB must be installed near the battery, and the cabling distance must be minimized.

### 3.6.3 Storage

If the UPS will not be installed immediately, it must be stored with the original packaging indoors in a clean, dry, and cool location which should be protected from excessive humidity and heat sources. See [Environmental Characteristics](#) on page 115 for more information. The battery needs to be stored in a dry and cool place with good ventilation. The most suitable storage temperature ranges from 68 °F (20 °C) to 77 °F (25 °C).



**WARNING! During battery storage, periodically charge the battery according to the battery manufacturer instructions. In the charging process, temporarily connect the UPS to the mains and activate the battery by recharging the battery.**

## 3.7 Mechanical Requirement

### 3.7.1 Composition

The 60 kVA 208 V, 120 kVA 480 V UPS is a 23.62 in. (600 mm) wide cabinet with breaker option (top cable access).

### 3.7.2 Moving the Cabinet



**WARNING! The lifting equipment for moving the UPS cabinet must have enough lift capacity.**



**WARNING! The center of gravity of the UPS cabinet is high, avoid falling over during the cabinet movement.**



**WARNING! Vertical hanging of cabinet is prohibited.**

The UPS cabinet presents a tipping hazard. Do not tilt the cabinet more than 15 degrees from vertical while transportation.

Ensure that the UPS weight is within the designated surface weight loading of any lifting equipment. See [Mechanical Characteristics](#) on page 116 for weight of the UPS.

Vertiv™ Liebert® APM2 rolled on its casters for short distances only. For longer distances, move the UPS with a forklift or similar equipment to ease the relocation and to reduce vibration.

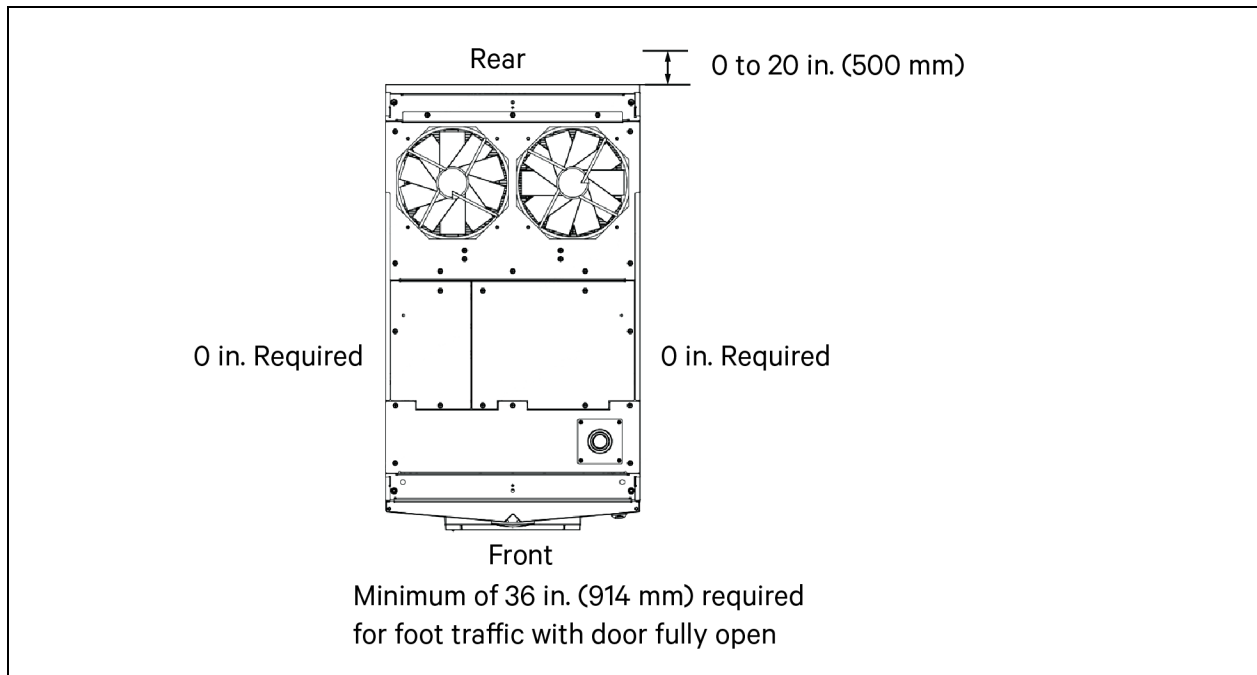
### 3.7.3 Clearance

Provide at least minimum clearance, as recommended by the NEC to the Liebert® APM2 UPS, 36 in. (914 mm) in front, to permit routine and tightening power terminals within the UPS and free passage for personnel with the door fully opened and at least 20 in. (500 mm) in the rear for the back airflow UPS, to permit adequate circulation of air coming out of the UPS.

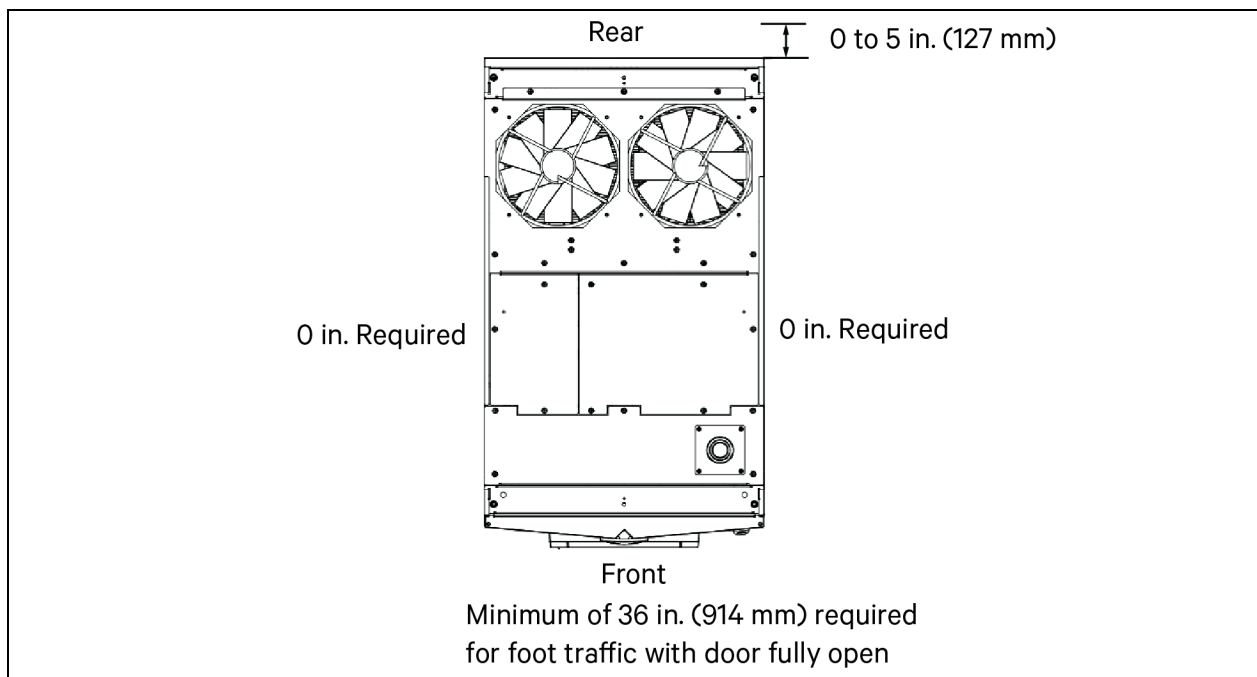


For the top fan airflow UPS, there are no perforated panels on the sides or back of the UPS, the UPS can be placed against the wall directly if there is no seismic anchoring. If the floor anchoring system used, up to 5 in. (127 mm) may be required in the rear of the UPS. Leave a minimum of 24 in. (670 mm) between the top of the UPS frame and the ceiling to permit adequate air circulation above the unit. Vertiv do not recommend using air conditioning or other systems that blow air onto the top of the unit

**Figure 3.3 Clearances for Airflow (Rear)**



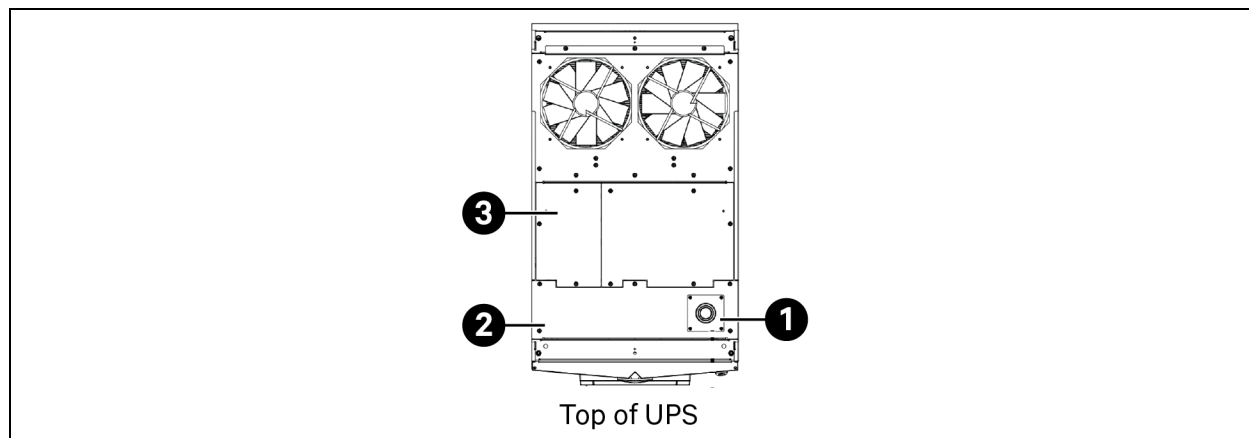
**Figure 3.4 Clearances for Airflow (Top Fan)**



**NOTE:** For the top fan airflow, rear clearance depend on anchoring method.

## 3.8 Installation

Figure 3.5 Cable Entry Locations



Item	Description
1	Signal wire knockout holes
2	AC power cable entry plate (remove plate from UPS before drilling or punching)
3	DC power cable entry plate (remove plate from UPS before drilling or punching)

Cables must enter the Vertiv™ Liebert® APM2 from the top.

Some plates have factory punched holes and others are designed to allow the personnel to punch holes for fitting and securing the conduit (remove plate from UPS before drilling or punching). Once the conduit holes are punched, these plates should be reattached to the UPS. The conduit size and wiring method must be in accordance with all local, regional, and national codes and regulations, including NEC ANSI/NFPA 70.

**NOTE:** When installing the UPS, the customer must provide a disconnect with over current protection at the output of the UPS.

## 3.9 Cabinets Installation

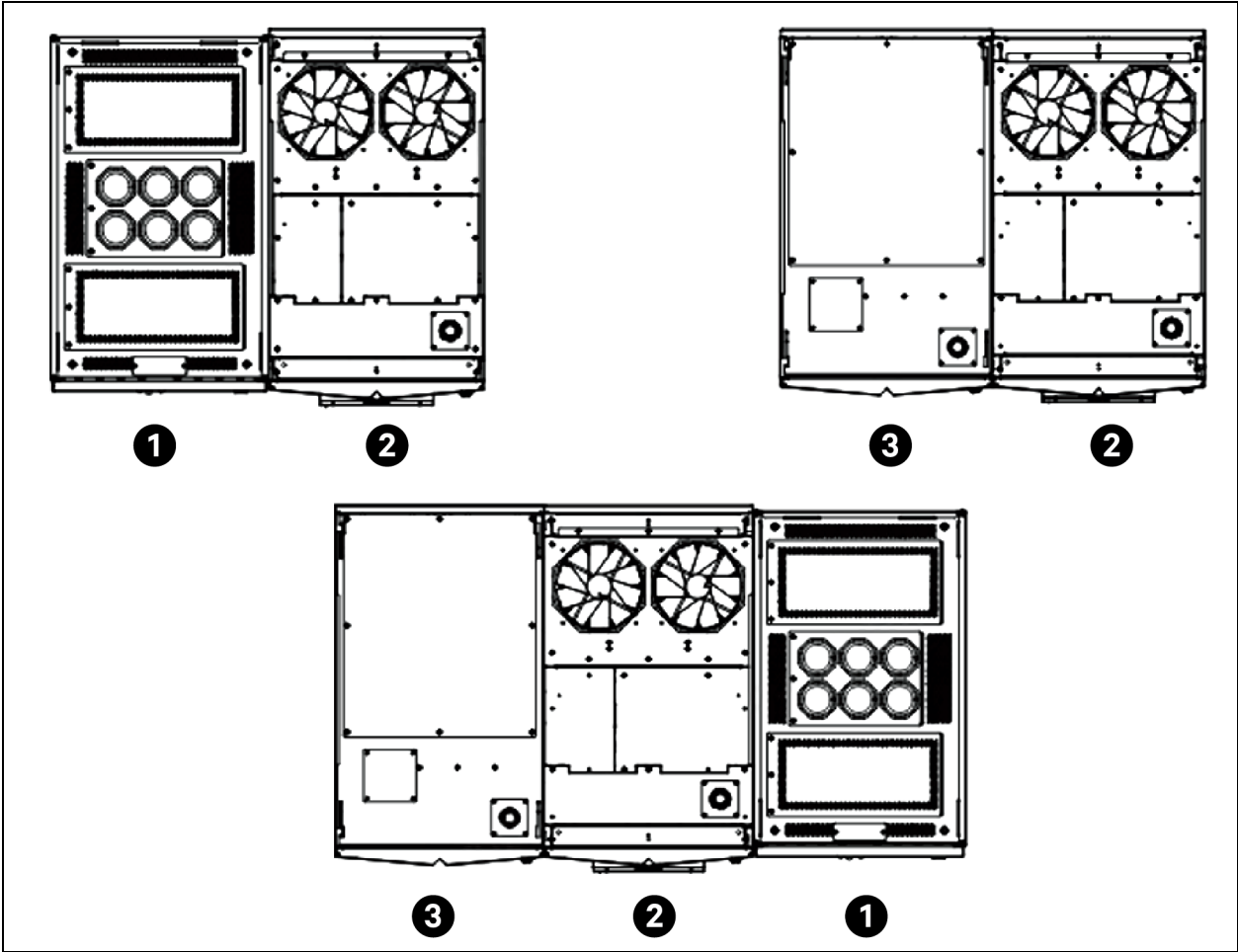
The Vertiv™ Liebert® APM2 10 kVA to 60 kVA 208V or 20 kVA to 120 kVA 480 V frame consists of a single cabinet housing the UPS components, including optional internal batteries VRLA and Lithium-ion.

Optional external battery cabinets (EBCs) are available for each Liebert® APM2 model to provide extended run time including modular battery cabinet or traditional VRLA battery. The battery cabinets are designed to be bolted to the left side of the UPS, as shown in **Figure 3.6** on the facing page or standalone. Refer to **Vertiv™ Liebert® APM2 External Battery Cabinet Installer/User Guide**, for details available on [vertiv.com](https://www.vertiv.com). Battery cabinet wiring is specified for optimal performance of the system.

Liebert® APM2 UPS supports Lithium-ion EBC from Vertiv's own Vertiv™ EnergyCore Lithium Battery System.

**System Composition:** A UPS system can comprise a number of optional equipment cabinets, depending on the system design requirements such as UPS cabinet, EBC. All cabinets used will be the same height and will be designed to be positioned side by side to form an aesthetically appealing equipment suite.

**Figure 3.6 Cabinet Arrangement for Vertiv™ Liebert® APM2 60 kVA 208 V and 120 kVA 480 V UPS**



Item	Description
1	Maintenance bypass cabinet
2	UPS
3	EBC

**NOTE:** All units viewed from above layouts shown are typical. Not all auxiliary cabinets are shown. Configurations may be different depending on ordered ancillary cabinets.

## 3.10 Installed Components

### 3.10.1 Power Module

#### Procedures for replacing power module:

1. If UPS is supporting load on inverter or in ECO mode, verify that the UPS has enough capacity with remaining power modules to support the load while the intended power module is being replaced. If there are not enough remaining power modules to support the load then follow the procedures in [Transfer from Normal Mode to Bypass Mode](#) on page 74 before continuing. Otherwise, if there are enough remaining power modules to support the load then continue to next steps with the UPS supporting load on inverter or in ECO mode.
2. Move the ready switch of power module to the left. This puts the power module into an unready state.
3. Remove the fixing screws on both sides after 2 minutes.
4. Quickly and firmly pull the power module out 3 in. to 6 in. (77 mm to 153 mm) to disconnect it from its back-plane connection. Then carefully remove the power module from the frame.

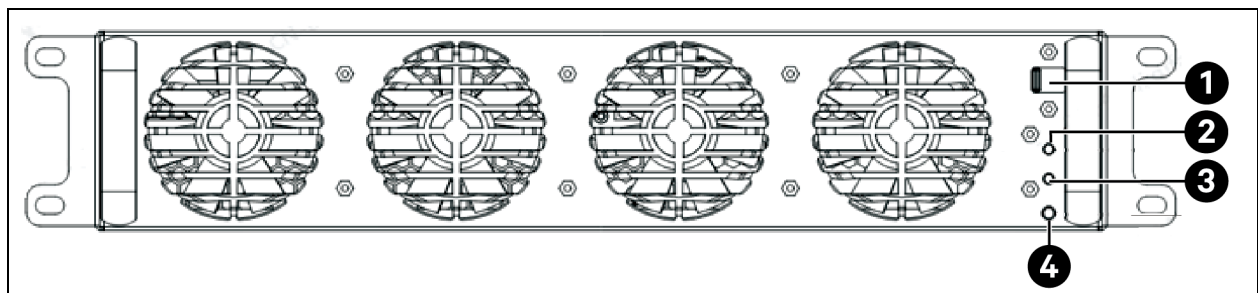
**NOTE: Power module is 35 Kg (77.2 lbs).**

5. Carefully insert the new power module into the UPS frame. At the final 3 in. to 6 in. (77 mm to 153 mm) before the power module is fully inserted, quickly and firmly push the module into its back-plane connection. Fasten the fixing screws on both sides of the power module.
6. Move the ready switch of power module to the right. This puts the power module into a ready state.
7. If the UPS is currently supporting load on inverter or in ECO mode, the power module will perform a power walk-in process before sharing load with other power-modules. Otherwise, if the UPS is offline or in a bypass state power on the UPS following the procedures in [UPS Start-up Procedures](#) on page 68 for single UPS operation or [Operation Procedures for Parallel System](#) on page 93 for parallel UPS operation.

**NOTE: Quickly and firmly remove or insert power module on the equipment in regard to back-plane connection, slow operation prohibited.**

**NOTE: There must be an interval of 5 seconds between repeated remove or Insert of the power module on the device.**

**Figure 3.7 Vertiv™ Liebert® Power Module Installation Indicators and Controls for Vertiv™ Liebert® APM2 60 kVA 208 V and 120 kVA UPS**



Item	Description	Item	Description
1	Ready switch	3	Run LED
2	Fault LED	4	Battery cold start switch

**NOTE: See Figure 4.7 on page 45 to Figure 4.10 on page 48 for more information.**

The Run LED illuminates green when the Liebert® Power Module Assembly is operating normally.

The Fault LED illuminates red when the Liebert® Power Module Assembly has a problem.

**Table 3.2 LED Indicators**

LED Status	Indication
<b>Run LED (Green)</b>	
Flashing Green	The inverter is starting, but has no output yet.
Constant Green	The inverter has started to supply power.
Off	The inverter has started to supply power. The inverter has not started up.
<b>Fault LED (Red)</b>	
Constant Red	Auxiliary power failure (15 V or 24 V), rectifier over temperature, rectifier failure (including battery SCR short circuit), battery converter failure, soft start failure, main circuit back feed, abnormal input current, inverter failure, output short circuit, bypass SCR short circuit fault, inverter relay short circuit fault, abnormal bus voltage, module not ready, module ID out of range and duplicated module ID.
Flashing Red	Charger failure, abnormal main circuit voltage, abnormal main circuit frequency, main circuit under voltage, main circuit reverse phase, battery unavailable, reverse battery, input zero-loss, current sharing failure, module overload, inverter relay disconnection fault, bypass SCR disconnection fault and input fuse blown.
Off	No above failures or alarms.

## 3.10.2 Bypass Module

### Procedures for replacing bypass module:

1. If UPS is supporting load on bypass mode, verify that the UPS has enough capacity to support the load while the bypass module is being replaced and follow the steps in [Transfer from Normal Mode to Bypass Mode](#) on page 74. Alternatively, transfer the UPS to Maintenance Bypass Mode following the procedures in [Transfer from Normal Mode to Maintenance Mode](#) on page 75 for single UPS operation or [Maintenance Bypass Procedures](#) on page 94 for parallel UPS operation before continuing. Otherwise, if the UPS is supporting load on inverter or in Maintenance Bypass Mode continue to the next steps.
2. Move the ready switch of bypass module to the left. This puts the bypass module into an unready state.
3. Remove the fixing screws on both sides after 2 minutes.
4. Quickly and firmly pull the bypass module out 3 in. to 6 in. (77 mm to 153 mm) to remove it from its back-plane connection then carefully remove the bypass module from the frame.

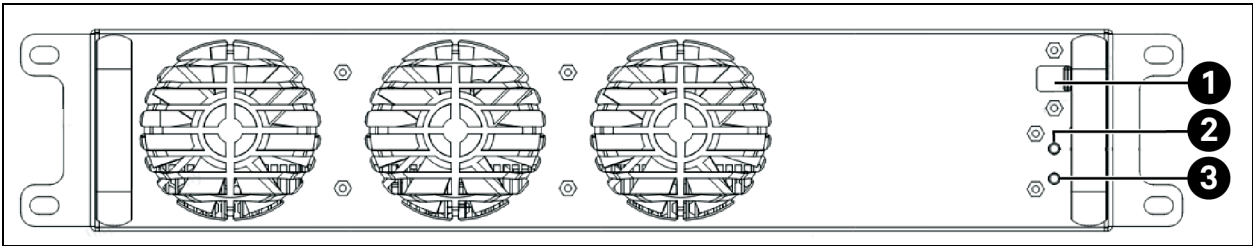
**NOTE: Bypass module is 35 Kg (77.2 lbs).**

5. Carefully insert the new bypass module into the UPS frame. At the final 3 in. to 6 in. (77 mm to 153 mm) before the bypass module is fully inserted, quickly and firmly push the bypass module into its back-plane connection. Fasten the fixing screws on both sides of the bypass module.
6. Move the ready switch of bypass module to the right. This puts the bypass module into a ready state.
7. The UPS can be transferred back to bypass from Normal Mode following the procedures in [Transfer from Normal Mode to Bypass Mode](#) on page 74. Alternatively, if the UPS is in maintenance bypass mode follow steps 1 to 5 of the procedure in [Transfer from Maintenance Mode to Normal Mode](#) on page 76.

**NOTE: Quickly remove or Insert Power module on the equipment in regard to back-plane connection, slow operation prohibited.**

**NOTE:** There must be an interval of 5 seconds between repeated remove or Insert of the power module on the device.

**Figure 3.8** Vertiv™ Liebert® Bypass Module Installation Indicators and Controls for Vertiv™ Liebert® APM2 60 kVA 208 V and 120 kVA UPS



Item	Description
1	DIP switches
2	Fault LED
3	Run LED

**NOTE:** See **Figure 4.7** on page 45 to **Figure 4.10** on page 48 for more information.

The Run LED illuminates green when the Liebert® Power Module Assembly is operating normally.

The Fault LED illuminates red when the Liebert® Power Module Assembly has a problem.

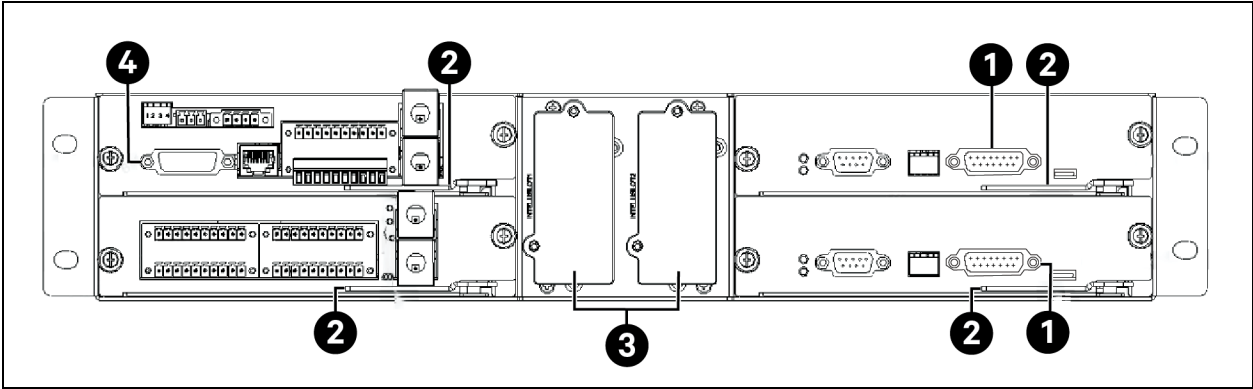
**Table 3.3** LED Indicators

LED Status	Indication
Run LED (Green)	
Flashing Green	The inverter is starting, but has no output yet.
Constant Green	The inverter has started to supply power.
Off	The inverter has not started up.
Fault LED (Red)	
Constant Red	Auxiliary power failure (15 V or 24 V), rectifier over temperature, rectifier failure (including battery SCR short circuit), battery converter failure, soft start failure, main circuit back feed, abnormal input current, inverter failure, output short circuit, bypass SCR short circuit fault, inverter relay short circuit fault, abnormal bus voltage, module not ready, module ID out of range, and duplicated module ID.
Flashing Red	Charger failure, abnormal main circuit voltage, abnormal main circuit frequency, main circuit undervoltage, main circuit reverse phase, battery unavailable, reverse battery, input zero-loss, current sharing failure, module overload, inverter relay disconnection fault, bypass SCR disconnection fault, and input fuse blown.
Off	No above failures or alarms.

### 3.10.3 Control Module

The Control module has two Vertiv™ Liebert® IntelliSlot™ interface card bays and connections for optional ancillary cabinets and for other options. See **Figure 4.7** on page 45 through **Figure 4.10** on page 48 for more information. Control Modules should only be replaced by authorized Vertiv service personnel.

**Figure 3.9 Control Module Assembly Connections**



Item	Description
1	DB15 (pinout is non industry conformal, paralleling cables must be Vertiv supplied)
2	Ready switch
3	Liebert®IntelliSlot™ Bays 1,2
4	DB9

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## 4 Electrical Installation

This chapter describes the electrical installation of the Vertiv™ Liebert® APM2 UPS.

After completing the mechanical installation of the UPS, it is necessary to connect the power cable and signal cable of the UPS. All signal cables must run separate from power cables in metal conduits or metal ducts that are electrically bonded to the metalwork of the cabinets to which they are connected. All signal cabling must be shielded.

The UL9540 ESS system requires an upstream input circuit breaker (feeder breaker), which is customer supplied responsibility for field installation, with a means of accessible manual disconnect. The customer must ensure that all lockout tagout (LOTO) devices are rated according to specification of manufacturer kilo ampere interrupting capacity (kAIC) as required by NFPA 70E and CSA Z462 per table 12. Before beginning any electrical installation or maintenance of ESS system, ensure proper LOTO procedure is followed for all upstream feeder breakers, and downstream output breakers directly connected to the UPS, and any DC breakers for the battery circuit to properly isolate power. The proper LOTO procedure will be determined by manufacturer for all applicable equipment. The size and type of LOTO device will be dependent on manufacture and size of disconnect device used. Refer to the manufacturer-supplied user information for all applicable equipment.

If the integrated MBB option is selected with the UPS, all LOTO devices must be applied to external upstream feeder breakers, external downstream output breakers, and external DC breakers. Applying LOTO to the integrated MBB is not sufficient to isolate power to the UPS when accessing the power cabling terminals.

Arc Flash Ratings should be determined as part of customer site arc flash coordination study. Ground fault detection is required per NFPA 70E and CSA Z462. For compliance with UL9540 ESS system requirements for the LOTO procedure of the DC source Vertiv™ EnergyCore Lithium 5 battery cabinet, refer to the **Vertiv™ EnergyCore Lithium 5 User Manual SL-71251**.

The Vertiv™ Vertiv™ Liebert® APM2 UPS is UL9540 only when used with the Vertiv™ EnergyCore Lithium 5 battery cabinets as a DC source. Any other DC sources with Vertiv™ Liebert® APM2 UPS will not be in compliance with UL9540 requirement. For UL9540 ESS system configuration, see [ESS System Configurations](#) on page 123.



**WARNING! Risk of electric shock. Can cause equipment, personnel injury, or death. Before connecting input power to the Liebert® APM2 ensure that you are aware of the location and operation of the overcurrent protection devices that connect the UPS input/bypass supply to the power distribution panel. De-energize and LOTO all incoming high and low voltage power circuits before installing cables or making any electrical connections.**



**AVERTISSEMENT! Risque de décharge électrique pouvant entraîner des dommages matériels, des blessures et même la mort. Avant de procéder au branchement de l'alimentation d'entrée du système APM2 de Liebert®, veuillez à prendre connaissance de l'emplacement et du fonctionnement des dispositifs de protection de surintensité qui raccordent l'alimentation d'entrée ou de dérivation du système ASC au panneau de distribution électrique. Coupez l'alimentation et appliquez le verrouillage ou l'étiquetage à tous les circuits d'alimentation haute tension et basse tension avant d'installer les câbles ou d'effectuer tout autre branchement électrique.**

## 4.1 Power Cable Wiring

### 4.1.1 System Configuration

The main factors affecting the choice and size of cable are voltage, current (overcurrent), room temperature and conditions of installation of the cable. Refer to ANSI/NFPA 70.

The power cables of the system must be sized with respect to the following description:

#### UPS input cables

The UPS input cables must be sized for the maximum input current, including the maximum battery charge current, see [Maximum Steady State AC and DC Currents](#) below, with respect to the UPS power ratings and the input AC voltages.

#### UPS bypass and output cables

The UPS bypass and output cables must be sized for the nominal output or bypass current, see **Table 4.1** below, with respect to the UPS power ratings and the output AC voltages.

#### Battery cables

Each UPS connects to its battery through the two cables connecting to the positive pole and negative pole. The cable size of the battery cable differs with the UPS power ratings, provided that it meets the battery discharge current requirement when the battery discharges to near EOD voltage, as shown in **Table 4.1** below.

### 4.1.2 Maximum Steady State AC and DC Currents

The power cables must be selected in accordance with current and voltage values as given in **Table 4.1** below as well as local wiring regulations and environmental conditions (temperature and physical media).

**NOTE: The cables used must be in accordance with NEC ANSI/NFPA 70. Cable sizes should be suitable for operation at a maximum temperature of 104 °F (40 °C).**

**Table 4.1 Maximum Steady State AC and DC Currents for Vertiv™ Liebert® APM2 60 kVA 208 V 4-Wire System**

UPS Power (kVA)	Rated Current (A)			Bus Stud Bolt/Nut Specification	
	Maximum Input Current <sup>1</sup>	Output/Bypass Current <sup>2</sup>	Battery Discharge <sup>3</sup> Current (+, -, N) at Rated Battery Voltage	Input, Battery, Output, Bypass/PE Cable	Recommended Torque lb-in. (Nm)
10	56	29	58	M8	205 (23)
15	71	44	87	M8	205 (23)
20	87	58	115	M8	205 (23)
25	100	71	146	M8	205 (23)
30	116	86	170	M8	205 (23)
40	145	114	227	M8	205 (23)
45	161	128	254	M8	205 (23)

**Table 4.1 Maximum Steady State AC and DC Currents for Vertiv™ Liebert® APM2 60 kVA 208 V 4-Wire System**

UPS Power (kVA)	Rated Current (A)			Bus Stud Bolt/Nut Specification	
	Maximum Input Current <sup>1</sup>	Output/Bypass Current <sup>2</sup>	Battery Discharge <sup>3</sup> Current (+, -, N) at Rated Battery Voltage	Input, Battery, Output, Bypass/PE Cable	Recommended Torque lb-in. (Nm)
50	175	144	285	M8	205 (23)
60	208	172	339	M8	205 (23)

<sup>1</sup>Maximum input current is calculated according to the low voltage input of 176 V (L-N) and 100% load percentage.

<sup>2</sup>Maximum output/bypass current is calculated according to the rated voltage and 100% load percentage.

<sup>3</sup>The battery discharge current is calculated according to the battery cell number of 40, EOD voltage of 1.63 V and 100% load percentage.

**Table 4.2 Maximum Steady State AC and DC Currents for Liebert® APM2 120 kVA 400 V 4-Wire System**

UPS Power (kVA)	Rated Current (A)			Bus Stud Bolt/Nut Specification	
	Maximum Input Current <sup>1</sup>	Output/Bypass Current <sup>2</sup>	Battery Discharge <sup>3</sup> Current (+, -, N) at Rated Battery Voltage	Input, Battery, Output, Bypass/PE Cable	Recommended Torque (Nm)
20	59	31	59	M8	205 (23)
30	75	46	85	M8	205 (23)
40	90	62	114	M8	205 (23)
50	106	77	141	M8	205 (23)
60	122	93	169	M8	205 (23)
80	156	122	225	M8	205 (23)
90	170	138	251	M8	205 (23)
100	187	154	277	M8	205 (23)
120	219	184	335	M8	205 (23)

<sup>1</sup>Maximum input current is calculated according to the low voltage input of 176 V (L-N) and 100% load percentage.

<sup>2</sup>Maximum output/bypass current is calculated according to the rated voltage and 100% load percentage.

<sup>3</sup>The battery discharge current is calculated according to the battery cell number of 40, EOD voltage of 1.63 V and 100% load percentage.

**Table 4.3 Maximum Steady State AC and DC Currents for Vertiv™ Liebert® APM2 120 kVA 480 V 4-Wire/3-Wire System**

UPS Power (kVA)	Rated Current (A)			Bus Stud Bolt/Nut Specification	
	Maximum Input Current <sup>1</sup>	Output/Bypass Current <sup>2</sup>	Battery Discharge <sup>3</sup> Current (+, -, N) at Rated Battery Voltage	Input, Battery, Output, Bypass/PE Cable	Recommended Torque (Nm)
20	47	26	59	M8	205 (23)
30	59	38	85	M8	205 (23)
40	72	50	114	M8	205 (23)
50	85	63	141	M8	205 (23)

**Table 4.3 Maximum Steady State AC and DC Currents for Vertiv™ Liebert® APM2 120 kVA 480 V 4-Wire/3-Wire System**

UPS Power (kVA)	Rated Current (A)			Bus Stud Bolt/Nut Specification	
	Maximum Input Current <sup>1</sup>	Output/Bypass Current <sup>2</sup>	Battery Discharge <sup>3</sup> Current (+, -, N) at Rated Battery Voltage	Input, Battery, Output, Bypass/PE Cable	Recommended Torque (Nm)
60	97	75	169	M8	205 (23)
80	121	100	225	M8	205 (23)
90	134	112	251	M8	205 (23)
100	146	125	277	M8	205 (23)
120	173	150	340	M8	205 (23)
<sup>1</sup> Maximum input current is calculated according to the low voltage input of 176 V (L-N) and 100% load percentage. <sup>2</sup> Maximum output/bypass current is calculated according to the rated voltage and 100% load percentage. <sup>3</sup> The battery discharge current is calculated according to the battery cell number of 40, EOD voltage of 1.63 V and 100% load percentage.					

### 4.1.3 Recommended Cross-sectional Area of UPS Cable

The recommended cross-sectional area (CSA) of the UPS cable is given in **Table 4.4** below.

**Table 4.4 Recommended CSA for Vertiv™ Liebert® APM2 60 kVA 208 V 4-Wire System**

Model	Input		Output		Bypass		Earth Cable		Battery	
	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)
10	2	8	2	12	2	12	1	4	2	10
15	2	6	2	8	2	8	1	4	2	6
20	2	4	2	6	2	6	1	4	2	4
25	2	3	2	6	2	6	1	4	2	3
30	2	3	2	4	2	4	1	4	2	2
40	2	1	2	3	2	3	1	4	2	1/0
45	2	1/0	2	2	2	2	1	4	2	2/0
50	2	2/0	2	1	2	1	1	4	2	3/0
60	2	3/0	2	1/0	2	1/0	1	4	2	4/0
NOTE: These values are at Ambient Temperature: 77 °F (25 °C).										

**Table 4.5 Recommended CSA for Liebert® APM2 120 kVA 400 V 4-Wire System**

Model	Input		Output		Bypass		Earth Cable		Battery	
	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)
20	2	6	2	10	2	10	1	4	2	8
30	2	4	2	8	2	8	1	4	2	6
40	2	4	2	6	2	6	1	4	2	4
50	2	3	2	4	2	4	1	4	2	3
60	2	2	2	4	2	4	1	4	2	2
80	2	1/0	2	2	2	2	1	4	2	1/0
90	2	1/0	2	1	2	1	1	4	2	2/0
100	2	2/0	2	1/0	2	1/0	1	4	2	2/0
120	2	3/0	2	2/0	2	2/0	1	4	2	4/0
NOTE: These values are at Ambient Temperature: 77 °F (25 °C).										

**Table 4.6 Recommended CSA for 120 kVA 480 V 4-Wire/3-Wire System**

Model	Input		Output		Bypass		Earth Cable		Battery	
	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)
20	2	8	2	12	2	12	1	4	2	8
30	2	8	2	10	2	10	1	4	2	6
40	2	6	2	6	2	6	1	4	2	4
50	2	4	2	6	2	6	1	4	2	3
60	2	3	2	6	2	6	1	4	2	2
80	2	2	2	3	2	3	1	4	2	1/0
90	2	1	2	2	2	2	1	4	2	2/0
100	2	1	2	2	2	2	1	4	2	2/0
120	2	1/0	2	1	2	1	1	4	2	4/0

**NOTE:** These values are at Ambient Temperature: 77 °F (25 °C).

**NOTE:** A 3-wire system does not need a neutral line. Use a minimum number AWG, 90 degrees copper wire.

The input neutral line of 4-wire system can be selected according to input cable, the output neutral line of 4-wire system can be selected with output-input cable.

#### 4.1.4 Recommended Breaker of UPS OPD

**NOTE:** The breakers used must be in accordance with NEC ANSI/NFPA 70. A disconnect breaker must be provided which will be used as over current Protection device for AC input, DC input and AC output.

- RIB
- BIB
- MBB
- MIB
- BCB

All recommended breakers in the **Table 4.7** below are based off of using 100% rated breakers.

**Table 4.7 Recommended OPD for Vertiv™ Liebert® APM2 60 kVA 208 V 4-Wire System**

Model (kVA)	RIB (A)	MIB (A)	BIB and MBB (A)	BCB (A)
10	70	35	35	60
15	90	60	60	90
20	110	80	80	125
25	125	90	90	150
30	150	110	110	175
40	200	150	150	250
45	200	175	175	300

**Table 4.7 Recommended OPD for Vertiv™ Liebert® APM2 60 kVA 208 V 4-Wire System**

Model (kVA)	RIB (A)	MIB (A)	BIB and MBB (A)	BCB (A)
50	225	200	200	300
60	300	225	225	400
NOTE: These values are at Ambient Temperature: 77 °F (25 °C).				

**Table 4.8 Recommended OPD for Liebert® APM2 120 kVA 400 V 4-Wire System**

Model (kVA)	RIB (A)	MIB (A)	BIB and MBB (A)	BCB (A)
20	80	40	40	60
30	100	60	60	90
40	125	80	80	125
50	150	100	100	150
60	175	125	125	175
80	200	175	175	225
90	225	175	175	300
100	250	200	200	300
120	300	250	250	400
NOTE: These values are at Ambient Temperature: 77 °F (25 °C).				

**Table 4.9 Recommended OPD for Liebert® APM2 120 kVA 480 V 4-Wire/3-Wire System**

Model (kVA)	RIB (A)	MIB (A)	BIB and MBB (A)	BCB (A)
20	60	40	40	60
30	80	50	50	90
40	90	70	70	125
50	110	80	80	150
60	125	100	100	175
80	175	125	125	225
90	175	150	150	300
100	200	175	175	300
120	225	200	200	400
NOTE: These values are at Ambient Temperature: 77 °F (25 °C).				

### 4.1.5 General Information

The following points are for general guidance only. If there are relevant local regulations, then follow the local regulations.

1. The protective earth cables must be selected in accordance with the AC power failure level, cable length, and protection type. The shortest connection route must be used for the grounding wire connection.
2. The parallel connection of small cables can be used to make easier installation for cables which are carrying large current.
3. The battery cable size must be selected in accordance with the current value given in [Maximum Steady State AC and DC Currents](#) on page 30 and a maximum allowed voltage drop is 4 VDC.
4. Avoid creating the coils to reduce the generation of electromagnetic interference (EMI).
5. Ensure that leave sufficient wiring space before wiring.

### 4.1.6 Power Cable Connection Terminal

The rectifier input, bypass input, output, and battery power cables are connected to the respective terminals as specified in the [Power Cable Connection Steps](#) on page 38.

### 4.1.7 Protective Ground

The protective earth cable is securely connected to the PE input terminal through the fixing bolt. See [Power Cable Connection Steps](#) on page 38. All the cabinets and cable conduits must be grounded according to the local regulations. The grounding wires must be securely fastened to prevent the loosening of the grounding wire tightening screws when the grounding wires are pulled.



**WARNING! Failure to ground as recommended may cause EMI, electric shock, or fire risk.**

### 4.1.8 External Protective Devices

For safety concerns, it is necessary to install the external circuit breakers or other protective devices for the input and battery of the UPS system. This section provides generic practical information for the qualified installation engineers due to the different specific installations. The qualified installation engineers must know the local regulatory wiring standards on the equipment to be installed. Rectifier and bypass input supply of the UPS:

1. Input overcurrent and short circuit protection. Install suitable protective devices in the distribution line of the incoming mains supply, considering the power cable current carrying capacity, system overload capacity and the short circuit capability of the upstream power distribution. See **Table 12.5** on page 117 and **Table 12.6** on page 118. The protective devices should provide functions such as the over current protection, short circuit protection, isolation protection, and tripping upon backfeed.
2. Split bypass configuration. If the UPS uses split bypass configuration, a separate protective device should be installed respectively on the rectifier input and bypass input in the distribution lines.

**NOTE:** The rectifier input and bypass input must use the same neutral line.

**NOTE:** For IT grid system, 4-pole protective components must be installed for the UPS external input power distribution.

3. Ground fault protection.



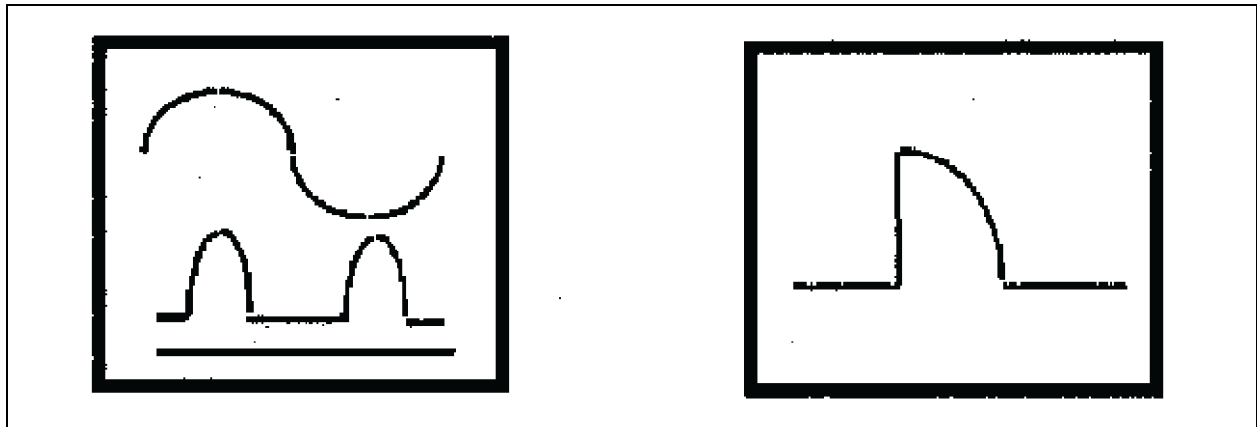
If the upstream input power supply has an RCD, the transient state and steady state ground leakage current upon the start-up of the UPS must be considered.

The RCCB must meet the following requirements:

- Must be sensitive to the DC unidirectional pulse (class A) of the whole distribution network.
- Must be insensitive to transient state current pulse.
- Must have an average sensitivity, adjustable between 0.3 A to 3 A.

The RCCB symbols are shown in **Figure 4.1** below.

**Figure 4.1 RCCB Symbols**



The UPS consist of an internal electromagnetic compatibility (EMC) filter. Therefore the leakage current of the protective earth cable current is less than 3000 mA. It is recommended to verify the RCD sensitivity of the upstream input distribution and the downstream distribution (to the load).

## External battery

The battery breaker has been installed for protecting the external battery. The battery breaker will provide overcurrent protection, short circuit protection and automatic tripping functions for the external battery.

This battery breaker is important for the battery maintenance and is generally installed in the battery.

The UPS output distribution must be configured with a protective device. The protective device must be different from the input distribution protection switch and able to provide overload protection. See **Table 12.5** on page 117 and **Table 12.6** on page 118.

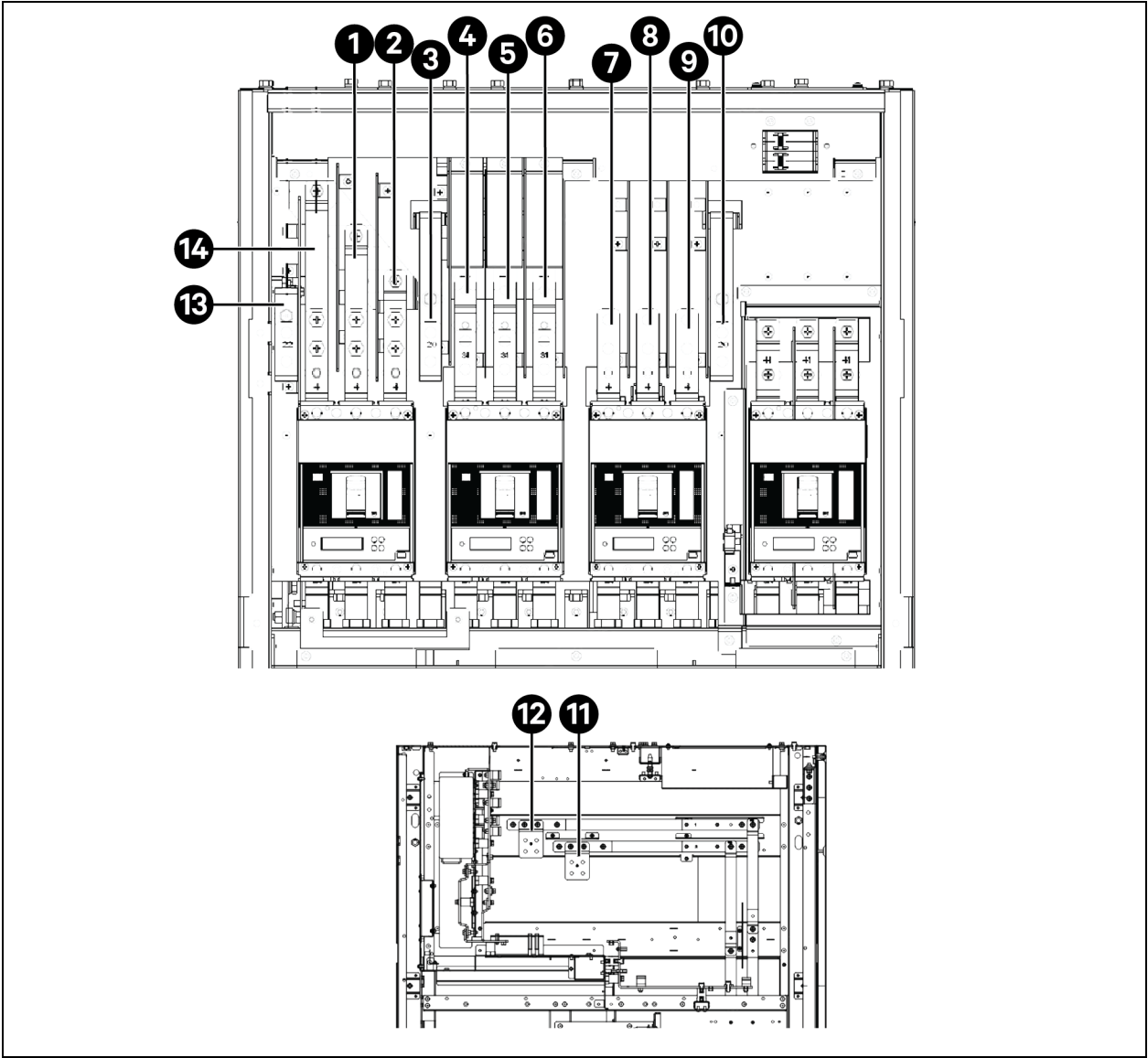
**NOTE: An IT grid system, 4-pole protective components must be installed for the UPS external input power distribution.**

### 4.1.9 Power Cable Connection Steps

#### Connection terminal

Figure 4.2 below shows the connection terminals of the UPS power cable.

Figure 4.2 Power Cable Connection Terminals 120 kVA



Item	Description	Item	Description
1	mB	8	oB
2	mC	9	oC
3	mN	10	oN

Item	Description	Item	Description
4	bA	11	Bat-
5	bB	12	Bat+
6	bC	13	mN-
7	oA	14	mA

**NOTE:** The power cables should be routed through tunnels or cable conduits to prevent cable damage due to mechanical stress. After that reduce the EMI to the surrounding environment.

**NOTE:** It is necessary to tie and fix the cables when routing the cables inside the cabinets to prevent cable damage because of mechanical stress.

### Cabling procedure



**CAUTION:** The operations described in this section must be performed by authorized electricians or qualified technical personnel. If you have any difficulties, contact your local Vertiv representative or Vertiv Services.



**Prudence:** Toutes les opérations décrites dans cette section ne doivent être effectuées que par des électriciens ou des techniciens professionnels dûment formés et qualifiés . En cas de difficultés, communiquez avec Vertiv. Pour obtenir les renseignements de contact, consultez la dernière page de ce manuel.

**NOTE:** Hydraulic pressure pliers, combinative tools and piston ring pliers should be used to connect AC wiring.

Once the equipment has been positioned and secured for operation, and the battery and ground lugs have been connected, connect the power cables as described below. Study the reference drawing in Installation Drawings.

1. Verify that all incoming high and low voltage power circuits are de-energized and locked out or tagged out before installing cables or making any electrical connections.
2. Remove the front I/O panel to gain easier access to the connections busbars.
3. Connect the facility ground and ancillary ground bus cables to the copper ground busbar. All cabinets in the UPS system must be connected to the user's ground connection.

**NOTE:** The grounding arrangement must comply with the National Electrical Code and all applicable local codes.

4. Identify and make power connections with incoming cables as per [step 1 in Common input connection](#) on the next page.

The Vertiv™ Liebert® APM2 series UPS supports top cable access. To route and connect the power cables, use the following procedure.

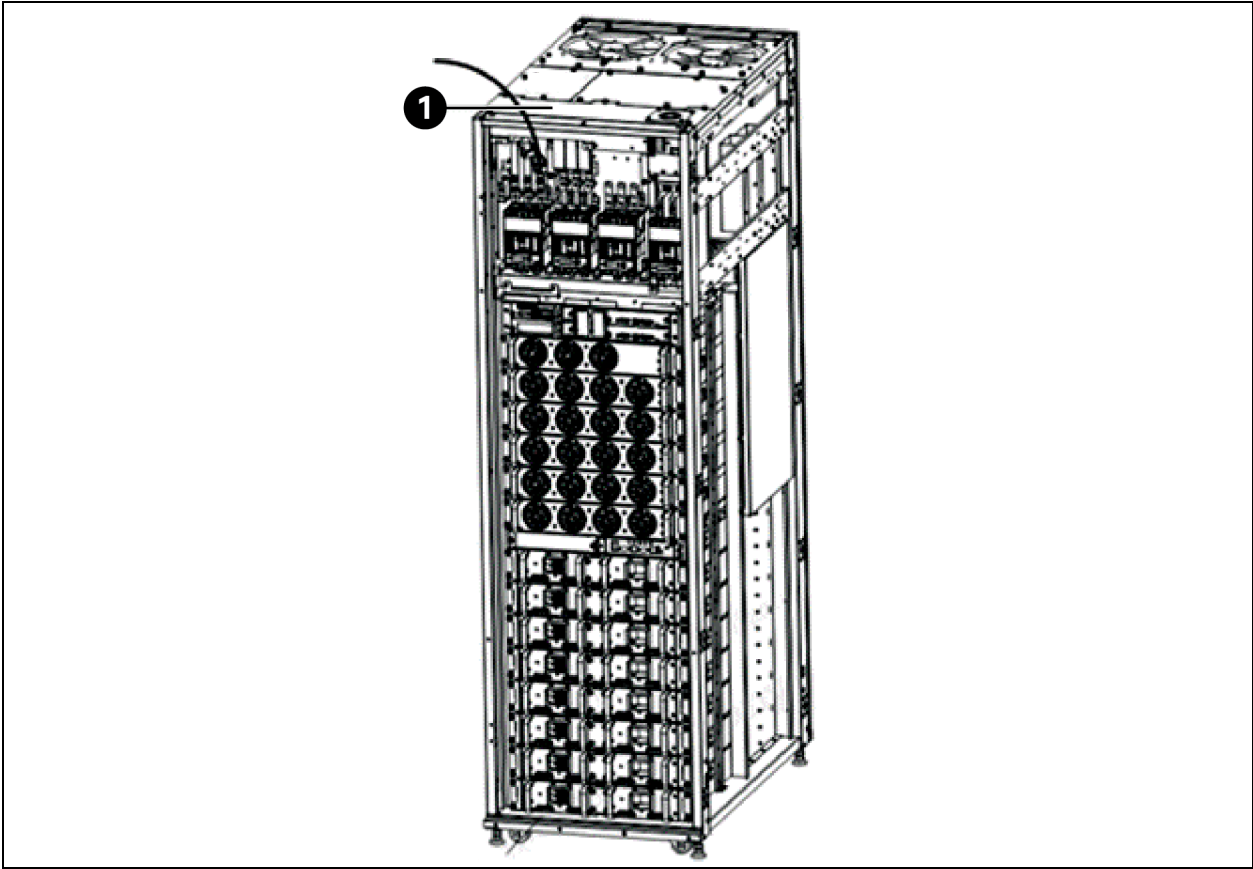


**WARNING!** Risk of electric shock. Can cause equipment damage, personnel injury or death. Verify that all external and internal power switches of the UPS are turned off and locked out or tagged out before installing the cables or making any electrical connections. Also, measure the voltages between the UPS terminals and the voltages between the terminals and the earth.

For 60 kVA 208 V and 120 kVA 480 V UPS power cable:

- 1. Remove the top cover.
- 2. Lead the power cables into the cabinet.
- 3. Connect them to corresponding terminals as shown in **Figure 4.3** below.

Figure 4.3 Power Cables Wiring Route 60 kVA 208 V and 120 kVA 480 V



Item	Description
1	Power cable through top cabinet entry plate



**WARNING!** Risk of electric shock or fire. Can cause equipment damage, personnel injury, or death. The earth grounding cable and neutral line connection must comply with the national electrical code and all the applicable local code.

Common input connection

- 1. For common bypass and main inputs, connect the AC input supply cables to the UPS input terminals (BYP-A, BYP-B, BYP- C) and tighten the connections to 240 lb-in. (27 Nm) (M10 bolt).
- 2. Ensure correct phase rotation. For more information, see **Figure 4.2** on page 38 and **Figure 4.3** above.

**NOTE:** For common bypass and main inputs, the AC input cables must be connected to the bypass terminal (BYP-A, BYP-B, BYP-C) but not the main input terminal (REC-A, REC-B, REC-C).

### Split bypass connections

If a split bypass configuration is used, connect the AC input supply cables to the rectifier input terminals (REC-A, REC-B, REC-C) and the AC bypass supply cables to the bypass input terminals (BYP-A, BYP-B, BYP-C) and tighten the connections according to [Power Cable Connection Steps](#) on page 38.

**NOTE:** For split bypass operation, ensure that the busbars between bypass and rectifier inputs are removed.

### Output system connections ensure correct phase rotation

1. Connect the system output cables between the UPS output busbars (OUT-A, OUT-B, OUT-C terminals) and the critical load.
2. With tighten the connections according to [Power Cable Connection Steps](#) on page 38.



**WARNING!** Risk of electrical shock and arc flash. Can cause property damage, injury and death. If the load equipment will not be ready to accept power when the commissioning engineer arrives, ensure that the system output cables are safely isolated.



**AVERISSEMENT!** Risque de décharge électrique pouvant causer des blessures graves, voire mortelles. Si les équipements branchés ne sont pas prêts à être alimentés à l'arrivée de l'ingénieur de mise en service, assurez-vous que les bornes des câbles de sortie du système soient isolées de façon sécuritaire.

**NOTE:** Observe the battery cable polarity. Be sure that the battery connections, if any, are made with the correct polarity.

Refit all protective covers removed for cable installation.

### External battery cabinet cable connection

1. Ensure correct polarity of the connections from the battery cabinet to the battery input terminals (BAT+, BAT-) in the UPS cabinet. That is, (BAT+) to (+) and (BAT-) to (-).
2. Do not reconnect these links and do not close the battery breaker before authorized to do so by the service engineer.
3. Refit all protective covers removed for cable installation.

**NOTE:** After connection, make sure to seal the cable entry hole on the cabinet.

## 4.2 Signal Cable Wiring

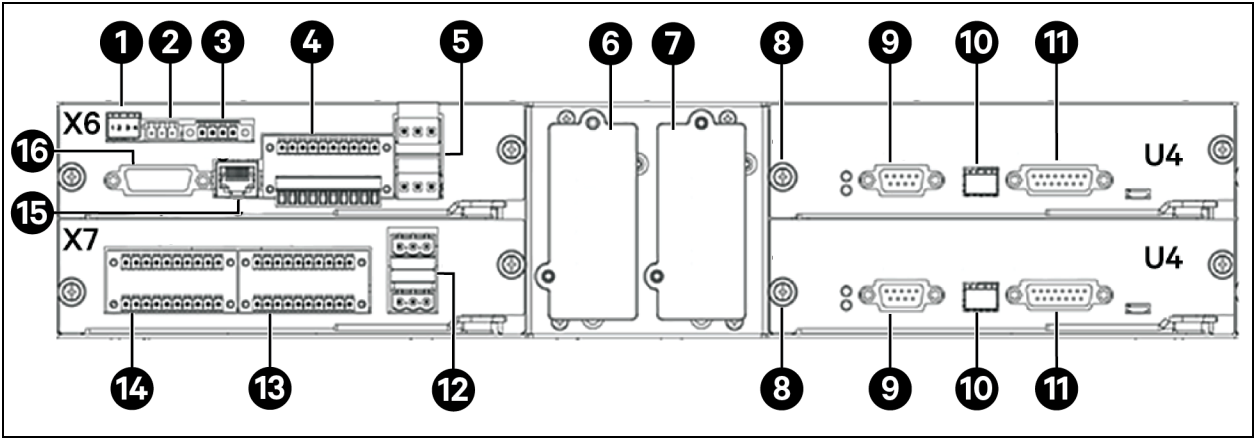
### 4.2.1 Overview

Based on the site’s specific requirements, the Vertiv™ Liebert® APM2 UPS can require:

- Auxiliary connection.
- Communicate with a computer.
- Provide alarm signal to the external devices.
- A way to provide an alarm signal to external devices for the REPO.
- To provide bypass back feed circuit breaker signal and parallel communication.

These functions are performed through the communication box in the Liebert® APM2 UPS cabinet. The communication box provides the ports as shown in **Figure 4.4** below.

**Figure 4.4 Overview of Communication Ports**



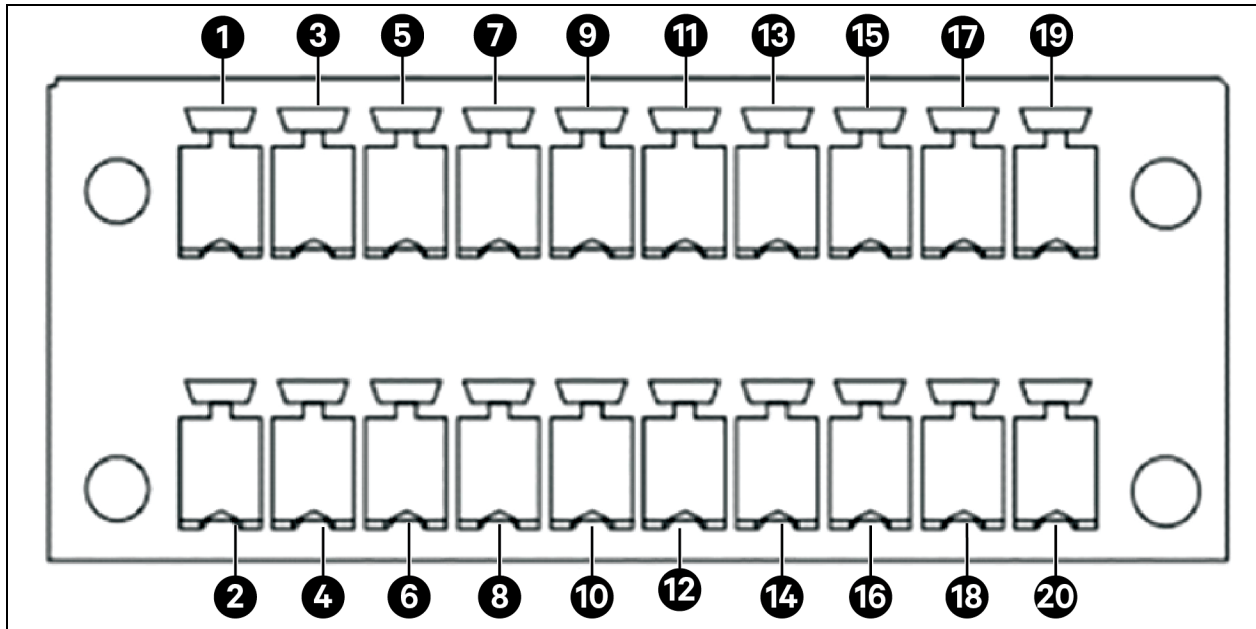
Item	Description	Item	Description
1	X6 SW1	9	U4 LBS sync signal port
2	X6 RS-485	10	U4 SW
3	X6 REPO port	11	U4 parallel communication port
4	X6 J3: BCB and I/O dry contact ports	12	X7 J3: Other programmable output dry contact port
5	X6 J22: Backfeeding port	13	X7 J2: I/O dry contact ports
6	Vertiv™ Liebert®Intellislot™ 1	14	X7 J1: BCB and I/O dry contact ports
7	Vertiv™ Liebert®Intellislot™ 2	15	X6 HMI port
8	Screw (quantity = 8)	16	X6 BATT: Battery temperature or BMS

**NOTE:** The screws should be tightened after each board is inserted, as shown in **Figure 4.4** above, to maintain proper grounding.

### 4.2.2 Dry Contact Port X6 J3

The schematic diagram of dry contact port J3 is shown in **Figure 4.5** below and the ports are described in **Table 4.10** below. The input dry contacts of this series provide 24 V/10 mA signals, and the output dry contacts are relay contacts that can accept 24 V/500 mA signals. The BCB drive signal can provide 12 V/10 mA signal.

**Figure 4.5** Dry Contact Port J3



**Table 4.10** Description of Dry Contact Port J3

Pin	Name	Meanings	Pin	Name	Meanings
1	Dry in	Input dry contact can be defined, the default setting is battery system failure.	2	BCB_Drive1	BCB1 drive signal
3	GND		4	Dry in	Input dry contact can be defined, the default setting is BCB1 status.
5	Dry in	Input dry contact can be defined, the default setting is charger off.	6	GND	
7	GND		8	Dry in	Input dry contact can be defined, the default setting is BCB1 online.
9	NO	Output dry contact can be defined, the default setting is UPS alarm.	10	GND	
11	Com1		12	Dry in	Input dry contact can be defined, the default setting is battery ground fault.
13	NC	Output dry contact can be defined, the default setting is UPS fault.	14	GND	
15	NO		16	PE	Shielding to PE
17	Com1		18	CAN+	CAN bus (reserved), set the matching resistor to PIN2 of SW1.
19	NC		20	CAN-	

**NOTE:** The BCB drive signal and external battery temperature signal must be carried through shielded cables, and both sides of the shielding coat must be securely connected to the enclosure.

The list of definable input dry contact functions are provided in **Table 4.11** on the next page.

Table 4.11 Input Dry Contact Functions

Number	Function Description	Number	Function Description
1	Breaker status - Selectable RIB, BIB, MIB, MOB, MBB, or LBB	9	Battery room overtemperature
2	Inverter inhibit	10	BCB tripping trip request
3	BCB online	11	Charger off
4	BCB status	12	Start battery manual test
5	Remote fault clear	13	Stop battery manual test
6	Battery system abnormal	14	Generator mode
7	Battery system fault	15	ECO mode paused
8	Battery low voltage	16	Battery ground fault

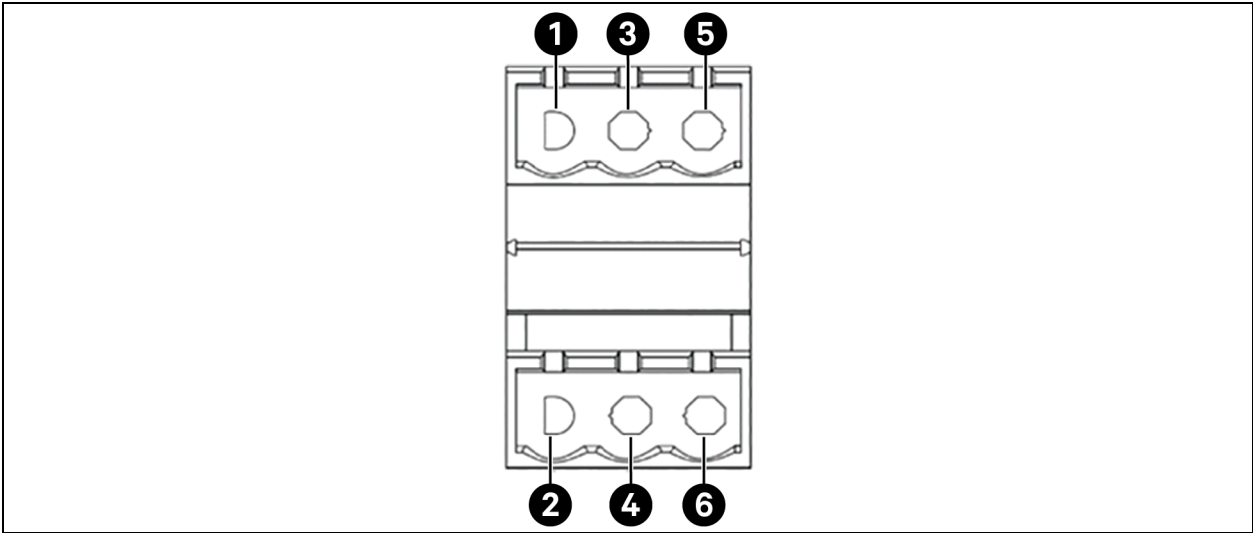
The list of definable output dry contact functions is described in Table 4.12 below.

Table 4.12 Output Dry Contact Functions

Number	Function Description	Number	Function Description
1	UPS alarm	7	Input voltage abnormal
2	UPS fault	8	Battery low voltage
3	On inverter	9	BCB trip command
4	On battery	10	ATS transfer enable
5	On bypass	11	Input back-feed detected
6	On maintenance bypass	12	Bypass back-feed detected

The schematic diagram of dry contact port J22 is shown in Figure 4.6 below and described in Table 4.13 on the facing page. The dry contact voltage is 24 VDC/250 VAC, and the current is 5 A.

Figure 4.6 Dry Contact Port J22



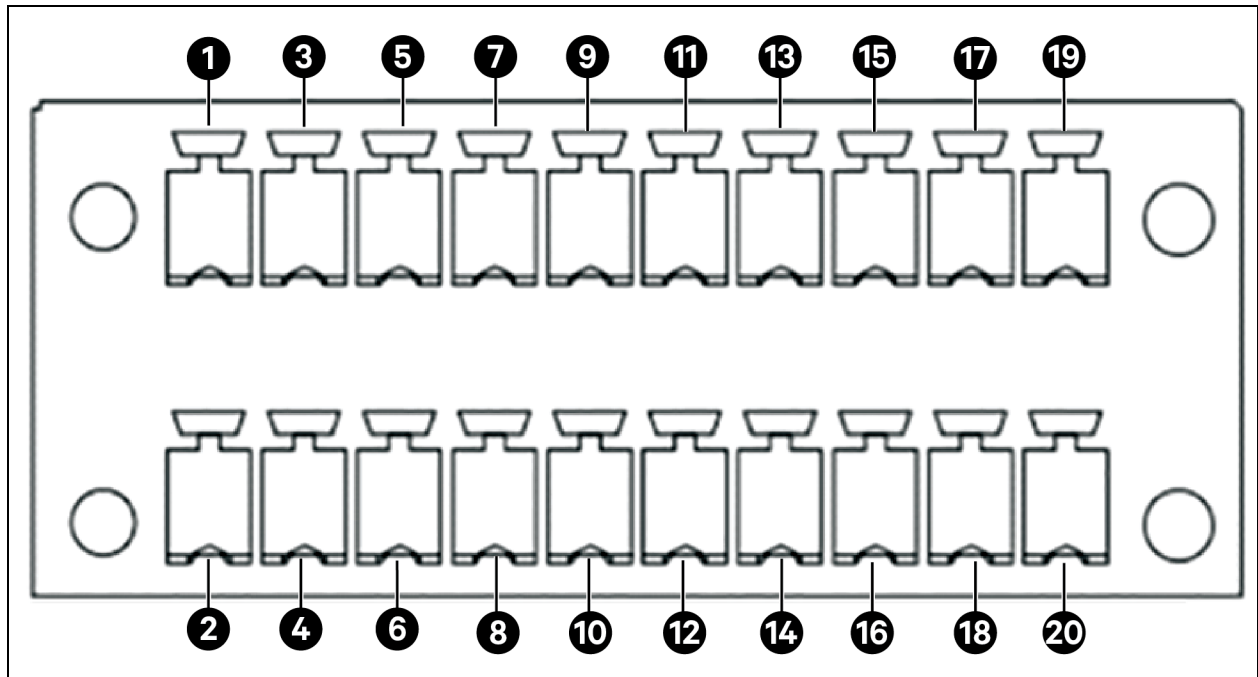


**Table 4.13 Description of Dry Contact Port J22**

Port	Pin	Name	Meanings
Bypass backfeed shunt trip	J22-1	BFP_O	Normally open. Closed when bypass has backfeed.
	J22-3	BFP_S	Bypass backfeed protection relay common. 24 VDC shunt trip drive.
	J22-5	BFP_C	Normally closed. Open when bypass has backfeed.
Bypass drive power	J22-2	N/A	Pin not used
	J22-4	24 V	Pin not used
	J22-6	24 V GND	24 V power ground

### 4.2.3 Output Dry Contact X7 J1 (Option)

The schematic diagram of output dry contact port J1 is shown in **Figure 4.7** below and described in **Table 4.14** below. The dry contact voltage is 24 VDC/250 VAC and the current is 5 A.

**Figure 4.7 Dry Contact Port J1****Table 4.14 Description of Dry Contact Port J1**

Pin	Name	Meanings	Pin	Name	Meanings
1	GND	BCB2 drive signal	2	GND	BCB3 drive signal
3	BCB_Drive2		4	BCB_Drive3	
5	Dry in	Input dry contact can be defined, the default setting is BCB2 status feedback	6	Dry in	Input dry contact can be defined, the default setting is BCB3 status feedback
7	GND		8	GND	

**Table 4.14 Description of Dry Contact Port J1**

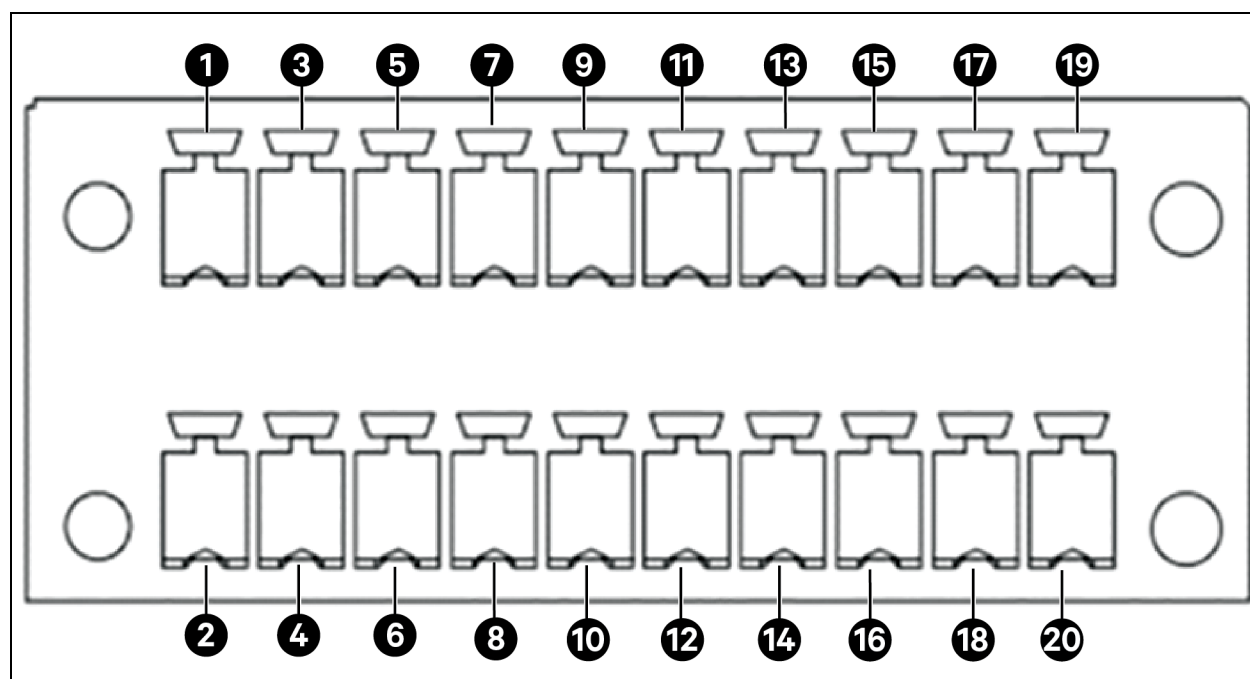
Pin	Name	Meanings	Pin	Name	Meanings
9	Dry in	The input dry contact can be defined, and the default setting is BCB2 enable signal	10	Dry in	The input dry contact can be defined, and the default setting is BCB3 enable signal
11	GND		12	GND	
13	Dry in	The input dry contact can be defined, and the default setting is to turn off the inverter	14	Dry in	The input dry contact can be defined, and the default setting is the state of the external output switch MOB/QE
15	GND		16	GND	
17	Dry in	The input dry contact can be defined, and the default setting is the maintenance switch MBB/QBP state	18	Dry in	The input dry contact can be defined, and the default setting is the state of the system total output switch MIB/QOP
19	GND		20	GND	

**NOTE:** The programmable dry contacts must be set in Paramset.

When using parallel system, if you want to use the dry contact function of the external maintenance isolation circuit breaker, the auxiliary contact signal must be connected to the respective dry contacts on all single racks in the parallel system at the same time.

#### 4.2.4 Output Dry Contact X7 J2 (Option)

The schematic diagram of output dry contact port J2 is shown in **Figure 4.8** below and described in **Figure 4.8** below. The input dry contacts of this series provide 24 V/10 mA signals, and the output dry contacts are relay contacts that can accept 24 V/500 mA signals. The BCB drive signal can provide 12 V/10 mA signal.

**Figure 4.8 Dry Contact Port J2**

**Table 4.15 Description of Dry Contact Port J2**

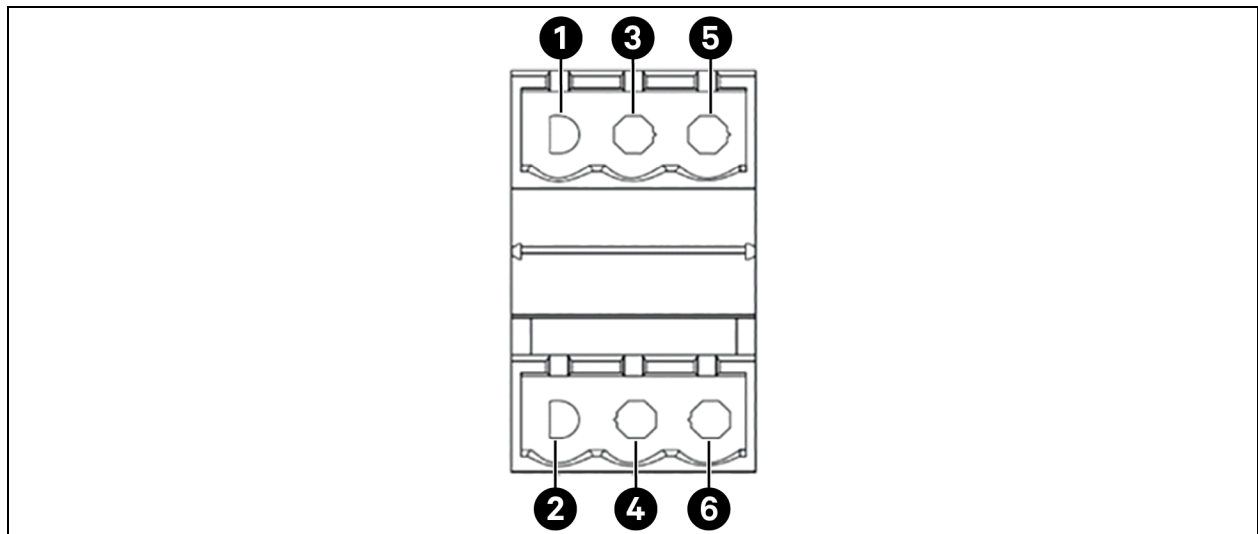
Pin	Name	Meanings	Pin	Name	Meanings
1	Dry in	The input dry contact can be defined, and the default setting is the load test switch LLBB state.	2	GND	BCB4 drive signal
3	GND		4	BCB_Drive4	
5	Dry in	The input dry contact can be defined, and the default setting is the state of the main input switch RIB/Q1.	6	Dry in	The input dry contact can be defined, and the default setting is BCB3 status feedback.
7	GND		8	GND	
9	NO	The output dry contact can be defined, and the default setting is bypass power supply.	10	Dry in	The input dry contact can be defined, and the default setting is BCB3 enable signal.
11	COM		12	GND	
13	NC		14	Dry in	The input dry contact can be defined, and the default setting is the state of the bypass input switch BIB/Q2.
15	NO	Normally open. Closed when RIB change the ON/OFF state.	16	GND	
17	COM	Relay common. Connected with 24 V driver power.	18	NA	NA
19	NC	Normally closed	20	GND	

**NOTE:** The programmable dry contacts must be set in Paramset.

If you want to use the dry contact function of the external maintenance isolation circuit breaker, when using a parallel system, the auxiliary contact signal must be connected to the respective dry contacts on all single racks in the parallel system at the same time.

### 4.2.5 Output Dry Contact X7 J3 (Option)

The schematic diagram of output dry contact interface J3 is shown in **Figure 4.9** below and described in **Table 4.16** on the next page. The input dry contacts of this series provide 24 V/10 mA signals, and the output dry contacts are relay contacts that can accept 24 V/500 mA signals. BCB drive signal can provide 12 V/10 mA signal.

**Figure 4.9 Dry Contact Port J3**

**Table 4.16 Description of Dry Contact Port J3**

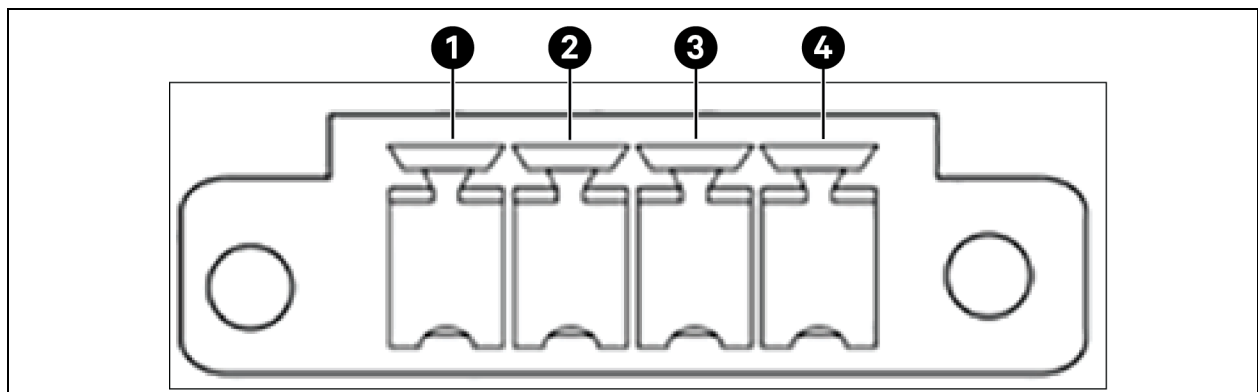
Port	Pin	Name	Default Signal
BCB shunt trip/ undervoltage relay	J3-1	NO	Normally open. Closes for shunt trip to open breaker.
	J3-3	COM	Common contact. 24 VDC BCB drive.
	J3-5	NC	Normally closed. Opens for UVR to open breaker.
MBB and MIB interlock signal	J3-2	NO	Normally open. Closes when UPS is on inverter.
	J3-4	COM	Common contact
	J3-6	NC	Normally closed. Opens when UPS is on inverter.
<b>NOTE: X7 J3 pins are programmable contacts.</b>			

## 4.2.6 Remote Emergency Off Port

The UPS has an emergency power off (EPO) function that operates by either an EPO button under a protective cover on the touchscreen of the UPS. To EPO the UPS remotely, the remote emergency power off (REPO) port must be wired according to the operation of the user supplied REPO switch as either normally open or normally closed. If the communication wire is 328.1 ft. (100 m) or less, use a shielded wire with both ends of the shielded wire properly grounded. If the length exceeds 328.1 ft. (100 m), the shielded wire must go through a metal conduit.

**NOTE: For Vertiv™ Liebert® APM2 with internal batteries the GHMI will remain online for 5 minutes unless the internal battery breakers are manually opened.**

The schematic diagram of REPO port is shown in **Figure 4.10** below and described in **Table 4.17** below.

**Figure 4.10 REPO Port****Table 4.17 Description of REPO Port**

Pin	Name	Meanings	Pin	Name	Meanings
1	EPO-NC	EPO activated when opened to Pin 2	3	+ 12 V	EPO activated when shorted to Pin 4
2	+ 12 V	EPO activated when opened to Pin 1	4	EPO-NO	EPO activated when shorted to Pin 3

The EPO is triggered when the pins 3 and 4 are shorted or the pins 2 and 1 are opened.

If an external EPO function is required, pins 1 and 2 or 3 and 4 are reserved for this function. The external EPO facility is also connected to the normally open or normally closed REPO switch between these two terminals using shielded cable. If this function is not required, pins 3 and 4 must be opened and pins 1 and the 2 must be closed.

**NOTE: The EPO action of the UPS shuts down the rectifier, the inverter and the static bypass, but it does not internally disconnect the mains input power supply. To disconnect all power to the UPS, open the external power switch, bypass input switch, output switch and BCB after the EPO is activated.**

## 4.2.7 Parallel and Load Bus Synchronization Communication Ports

See **Figure 4.4** on page 42 for the positions of the parallel and LBS communication port.

## 4.2.8 Vertiv™ Liebert® IntelliSlot™ Port

The Vertiv™ Liebert® APM2 UPS consist of two Liebert® IntelliSlot™ ports which allows field installation of the optional communication cards, including Vertiv™ Liebert® IS-UNITY-DP card, Vertiv™ Liebert® IS-Relay card. **Table 4.18** below describes the models and installation positions of the optional cards. For the detailed installation of the optional cards, refer to the respective contents in the Liebert® APM2 Option Configurations.

**Table 4.18 Models and Installation Positions of Optional Cards**

Optional Card	Model	Installation Position
Liebert® IS-UNITY-DP card	Liebert® IS-UNITY-DP	Liebert® IntelliSlot™ ports 1 to 2
Liebert® IS-RELAY card	Liebert® IS-RELAY	Liebert® IntelliSlot™ ports 1 to 2

**NOTE: The Liebert® IS-UNITY-DP or Liebert® IS-RELAY card can be inserted in either Liebert® IntelliSlot™ port 1 or 2, or both. When using, it is necessary to set the protocol to Velocity.**

## 4.2.9 Signal Cable Connection Steps

**NOTE: The power cables and signal cables should be routed respectively. The shielding coat of signal cable must be reliably earthed.**

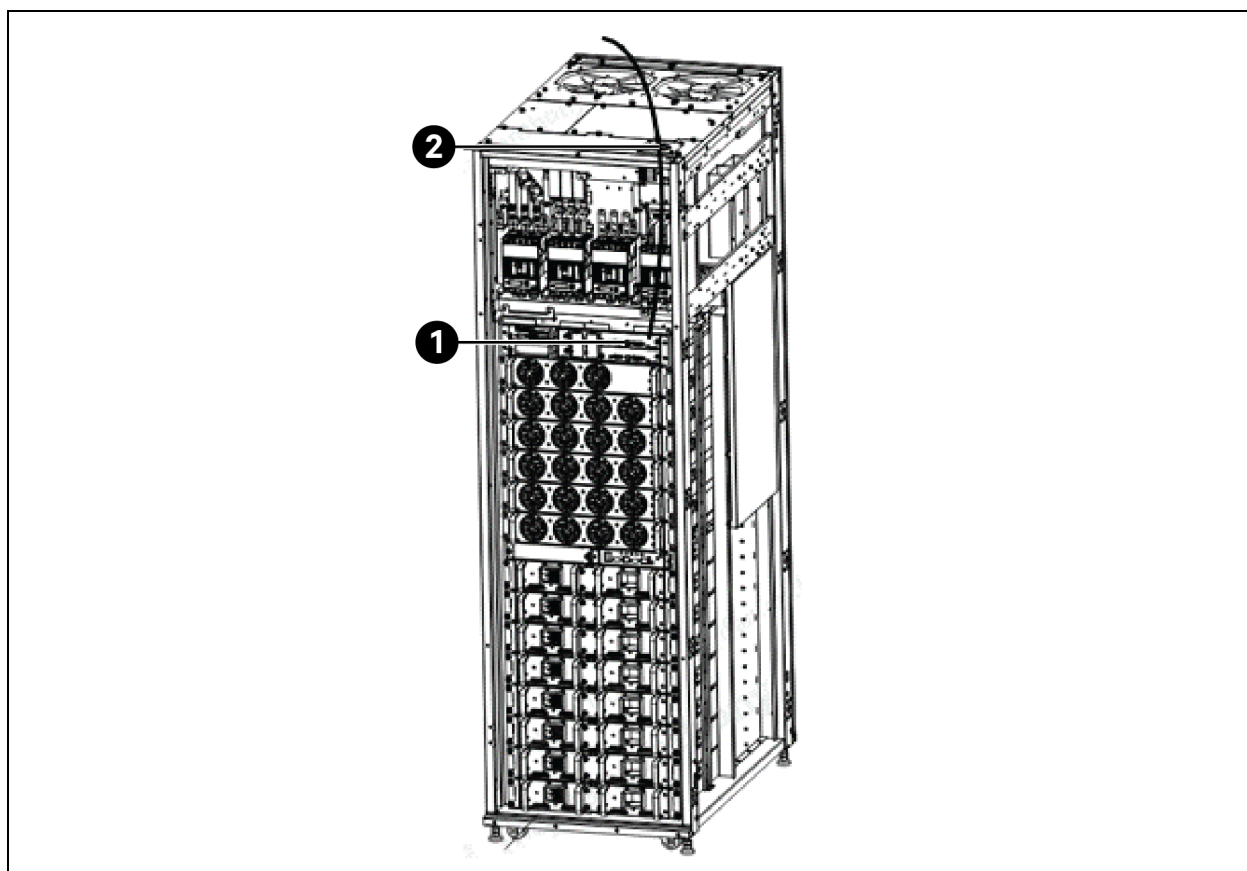
See **Figure 4.11** on the next page for cable routing of Liebert® APM2 60 kVA 208 V and 120 kVA 480 V UPS communication port for connecting signal cables to respective ports.



**WARNING! Risk of electric shock. Can cause equipment damage, personnel injury or death. Verify that all external and internal power switches of the UPS are turned off and locked out or tagged out before installing the cables or making any electrical connections. Also, measure the voltages between the UPS terminals and the voltages between the terminals and the earth.**

To route and connect the power cables, follow this procedure.

1. Remove the top cover.
2. Put the cables into the cabinet through cabinet hole. See **Figure 4.11** on the next page for top cable access.
3. Connect the signal cables to the respective terminals.

**Figure 4.11 Signal Cables Wiring Route of Vertiv™ Liebert® APM2 60 kVA 208 V and 120 kVA 480 V UPS**

Item	Description
1	Connect them to corresponding terminals.
2	Lead the signal cables into the cabinet through this cabling entry plate.

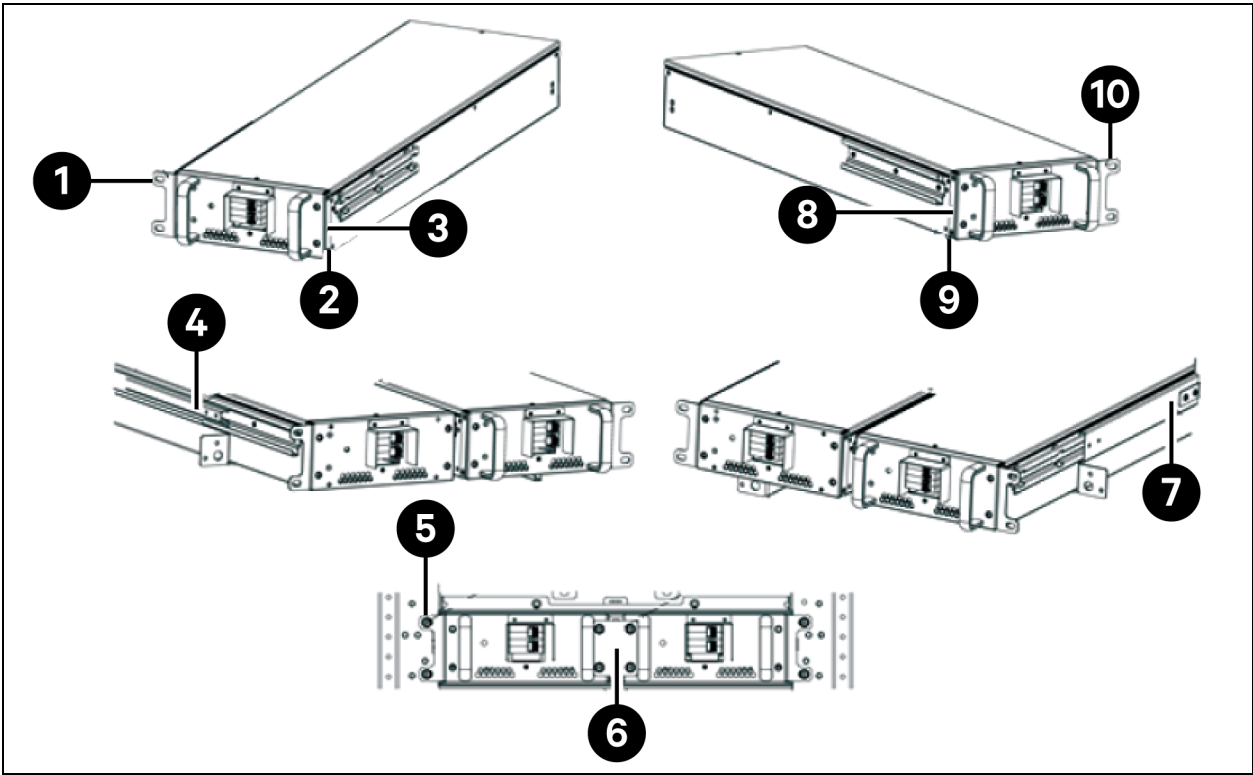
### 4.3 Built-in Lead-acid Battery Module Installation

The installation steps of the built-in lead-acid battery module are as follows:

1. Take out the battery module and the accessory bag, which contains the required screws, baffles and connecting pieces.
2. Two lead-acid battery modules can be installed in each battery shelf. First install the mounting ears and brackets on the left and right sides of the battery module. If the module is installed on the left side of the rack, install the mounting ears on the left side and the brackets on the right side. If the module is installed on the right side of the rack, install the mounting ear on the right side and the bracket on the left side. Use two M4 screws to fix the mounting ear and the bracket respectively.
3. Push the modules into the cabinet along the guide grooves on the left and right sides of the cabinet (starting from the bottom layer of the cabinet, and assemble them upwards in sequence).
4. Take out the connection piece from the accessory bag, fix the connection piece to the module with four M6 screws, and fix the mounting ears of the two modules to the cabinet respectively with four M6 screws.

See **Figure 4.12** below for the positions of the built-in lead-acid battery module installation.

**Figure 4.12 Installation Diagram of Build-in Lead-acid Battery**



Item	Description	Item	Description
1	Mounting ears	6	Connecting piece
2	M4 x 8 screw	7	Rack rail slot
3	Bracket	8	Bracket
4	Rack rail slot	9	M4 x 8 screw
5	M6 x 12 screw	10	Mounting ears

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## 5 Operator Control and Display Panel

### 5.1 Introduction

The integrated display of touchscreen control panel of the Vertiv™ Liebert® APM2 simplifies monitoring and managing single or multiple Liebert® UPS modules. The control collects a profusion of information about the health of the modules and presents it in a standardized format. This simple, dynamic display speeds operator response to changing power input and demand. Most of the settings will depend on the UPS type and features. Other settings will be made during the UPS setup by Vertiv tech service personnel. The touchscreen control panel display Liebert® APM2 shows data either graphically or as text. The status scroll bar at the top of the touchscreen shows the system conditions. The bar changes color to indicate status and includes an icon matched to the status. The Status Gauge displays details power demand from the connected load, input power quality, output and bypass on each phase and battery capacity.

### 5.2 Navigating through the Liebert® APM2 Touchscreen

The Liebert® APM2 touchscreen control panel is active when the UPS has input power. The touchscreen on the front of the UPS provides these functions:

- Login Capability. See [Login to the Vertiv™ Liebert® APM2 Touchscreen Control Panel](#) on page 55 for more information.
- Silencing alarms. See [Silence an Alarm](#) on page 58 for more information.
- Turning the UPS On. See [Inverter On](#) on page 58 for more information.
- Turning the UPS Off. See [Inverter Off](#) on page 58 for more information.
- Resetting faults. See [Reset Fault](#) on page 59 for more information.
- Enabling Energy Saving Mode. See [Energy Saving Mode Activation](#) on page 60 for more information.
- To check the status of the UPS and its external batteries, including all measured parameters, events and alarms, see [Viewing UPS Status](#) on page 61.

The display of Liebert® APM2 touchscreen control panel displays the one line graphic screen and unit status. The appearance can be changed to multiple panes that show other data. Customizing the appearance is detailed in customizing the display.

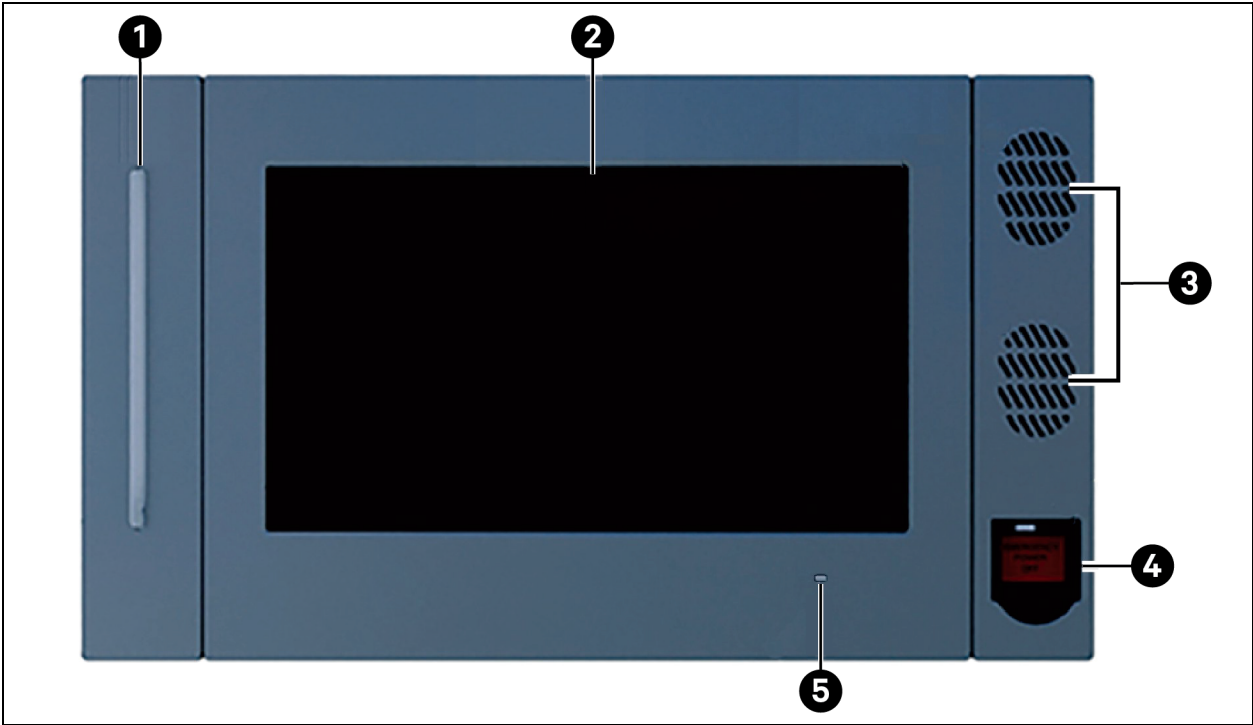


**CAUTION: Risk of unauthorized changes to operational settings. Can cause equipment damage. The default PIN numbers should be changed immediately to prevent unauthorized personnel from changing UPS operation or even shutting down the UPS. The PINs for Operator and Administrator may be changed by logging in with either Administrator or Service level access.**

5.2.1 Vertiv™ Liebert® APM2 Touchscreen Control Panel Components

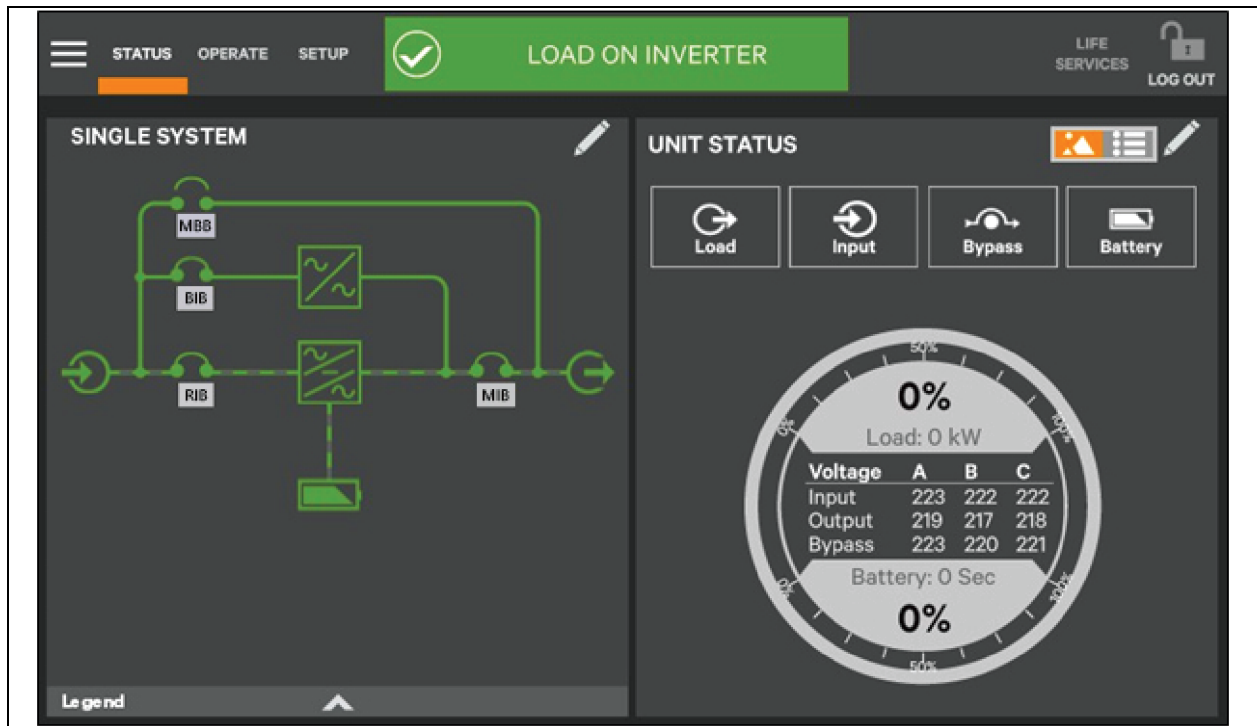
The main areas of the Liebert® APM2 touchscreen control panel are shown in **Figure 5.1** below and **Figure 5.2** on the facing page. The display arrangement and the information displayed can be changed. At login for all access levels, the Liebert® APM2 touchscreen control panel opens to the Status screen in graphic display. The status screen will show the graphic screen and system status readings at each login level. The appearance will differ only in the function menus displayed.

Figure 5.1 Liebert® APM2 Touchscreen Control Panel Components



Item	Description
1	UPS status LED
2	Touchscreen
3	Speakers (not used)
4	EPO switch
5	UPS status LED

Figure 5.2 Interface Overview — Status Screen Graphic Display



Information and control are different under each Function menu. The Function menus displayed are specific to the access level.

- **Status:** Condition of the UPS components and data affecting operation and performance. Visible to all access levels.
- **Operate:** UPS operation controls, such as inverter on, inverter off, energy saving status. Visible to Operator, Administrator and Service
- **Setup:** Manage permissions through PINs. Visible to Administrator and Service
- **Service:** Input wiring and breaker configuration, protocol used and battery charging method. Visible to Service

## 5.3 Operation

### 5.3.1 Login to the Vertiv™ Liebert® APM2 Touchscreen Control Panel

The Liebert® APM2 touchscreen control panel provides security by limiting the authority to change how the UPS operates. The four access levels offer different authority:

- **Observer:** Viewing permission only; can choose graphic or text display. No PIN is required.
- **Operator:** Permission to start the UPS, shut the system down, reset faults, and enable or disable ECO mode operation. PIN is required.
- **Administrator:** All functions of Operator plus permission to change PINs for operator and administrator level. PIN is required.
- **Service:** All functions of administrator plus permission to alter system configuration, choose serial communication protocol, enable equalize battery charging and change Service PIN. PIN is required.

Vertiv tech services provide PINs when setting up the UPS. These default PINs may be changed by those with administrator or service access.

**NOTE: The default Operator PIN is 2345.**



**CAUTION: Risk of unauthorized changes to operational settings. Can cause equipment damage. The default PIN numbers should be changed immediately to prevent unauthorized personnel from changing UPS operation or even shutting down the UPS. The PINs for Operator and Administrator may be changed by logging in with either Administrator or Service level access.**

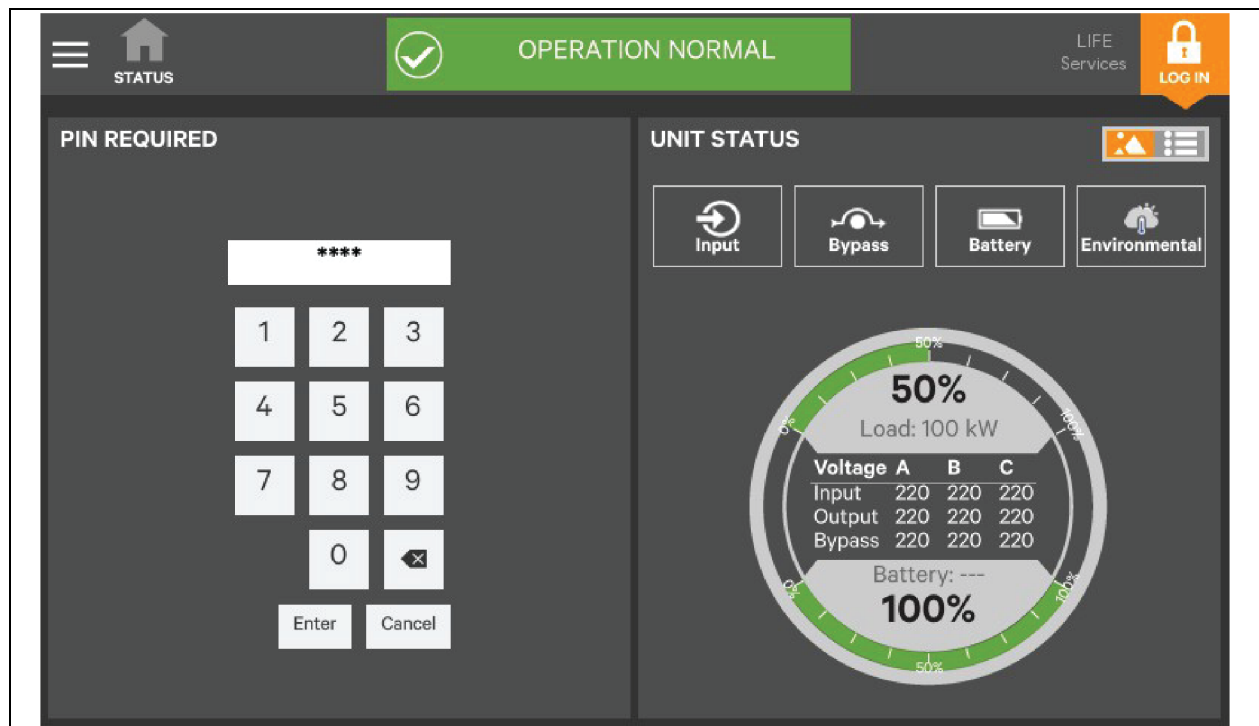
The Vertiv™ Liebert® APM2 touchscreen control panel is On when the UPS has control power. It is inactive and appears dark, depending on its settings. Touch the touchscreen to turn it On.

**To log in to the Liebert® APM2 touchscreen control panel:**

1. Touch the log in icon at the top right of the screen. The lock and background will change color and open the Pin Required screen, which has a keypad.
2. Enter a PIN as shown in **Figure 5.3** below.
3. Touch Enter.

**NOTE: If you enter an incorrect PIN, you are prompted that the number is invalid.**

**Figure 5.3 Log In Screen**



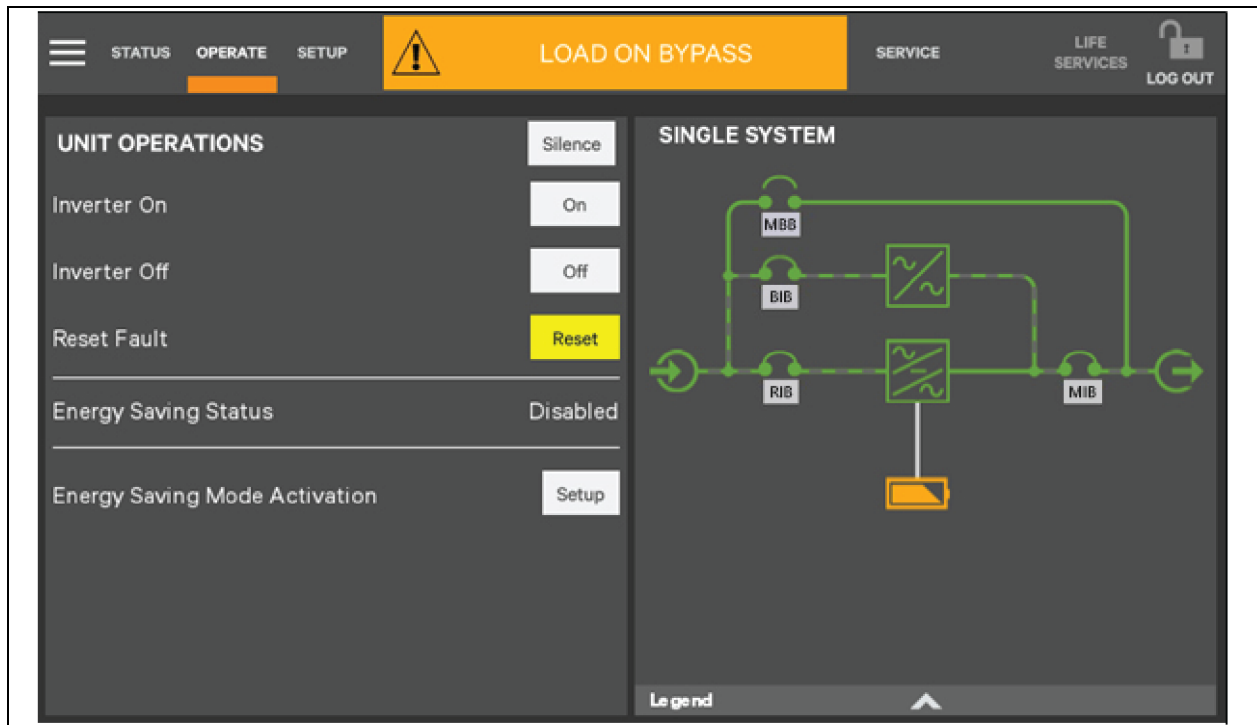
### 5.3.2 Operator Controls

The Operator log in enables control of UPS functions.

- Silence (Alarm)
- Inverter On
- Inverter Off
- Reset Fault
- Energy Saving Mode Activation
- Battery Operations

Each command is available under the Operate menu. The Operate menu may be used by logging in with Operator, Administrator, and Service access.

**Figure 5.4 Operate Menu**



**CAUTION:** Risk of improper operation. Can cause load drop resulting in equipment damage. The Inverter On, Inverter Off, Reset Fault, and Energy Saving Mode Activation commands will be available whenever the UPS is operating. Before executing any command, verify that the UPS status is suitable for the command to be performed.

All Operator commands are available from the Operate menu. The menu is available when the UPS has input power. The UPS need not be supplying power to the load for the menu to be available. The graphic screen is not linked to data in this view touching a component will not cause it to display data.

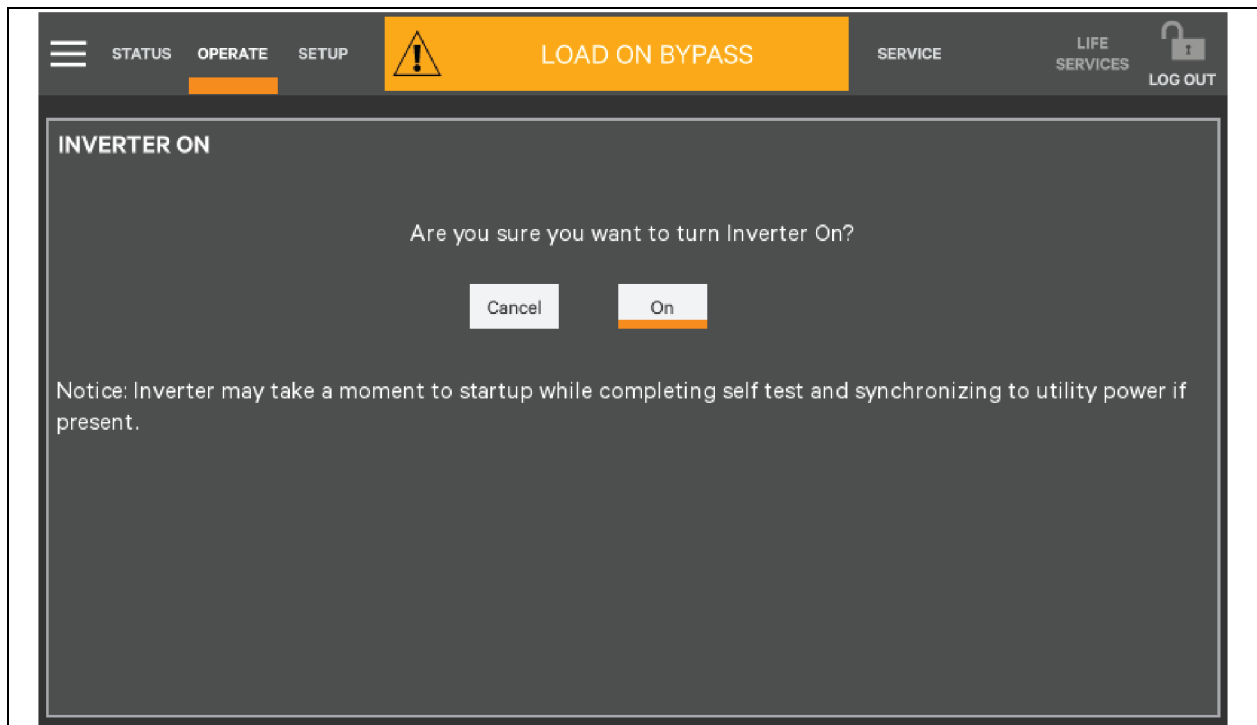
## Silence an Alarm

To silence an alarm, touch the Silence button at the top of the panel. The time the alarm will remain silenced varies, depending on the UPS type, type of alarm, and configuration.

## Inverter On

The Inverter on menu item is available when the UPS has input power and the inverter is off. Before executing the command, verify that the UPS is prepared for the inverter to start. When the operator access is shown, commands are the same for all access levels. The Vertiv™ Liebert® APM2 touchscreen control panel displays a message asking for confirmation. Touch On to confirm shown in **Figure 5.5** below. The control displays a progress window while the inverter starts.

**Figure 5.5 Inverter On Screen**



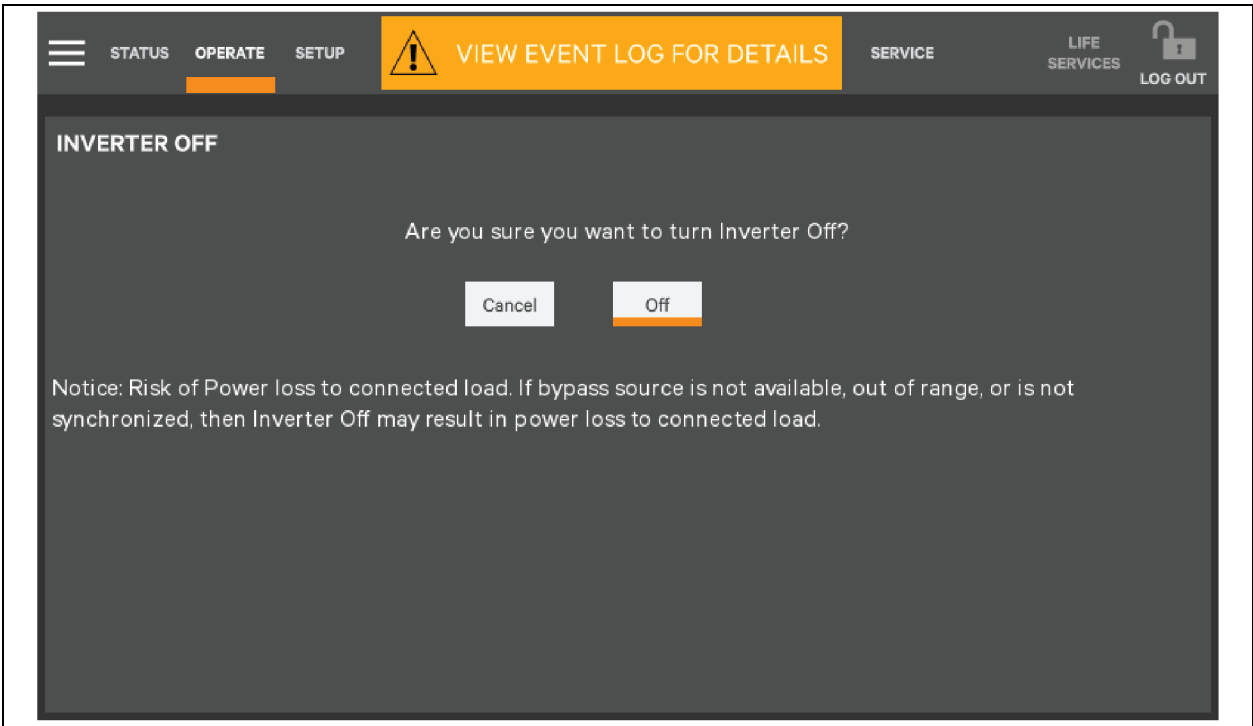
## Inverter Off

The Inverter Off menu item is available whenever the UPS has input power and the inverter is off. Before executing the command, verify that the UPS and connected load are prepared for the inverter to be shutdown. Touch Off to turn off the inverter. For more information see **Figure 5.6** on the facing page.



**CAUTION: Risk of improper operation. Can cause load drop resulting in equipment damage. The Inverter Off will shut off power to the connected load unless bypass power is available. Before executing this command, verify that the connected load is either shut off or that input power to the load will be supplied by another source, such as bypass.**

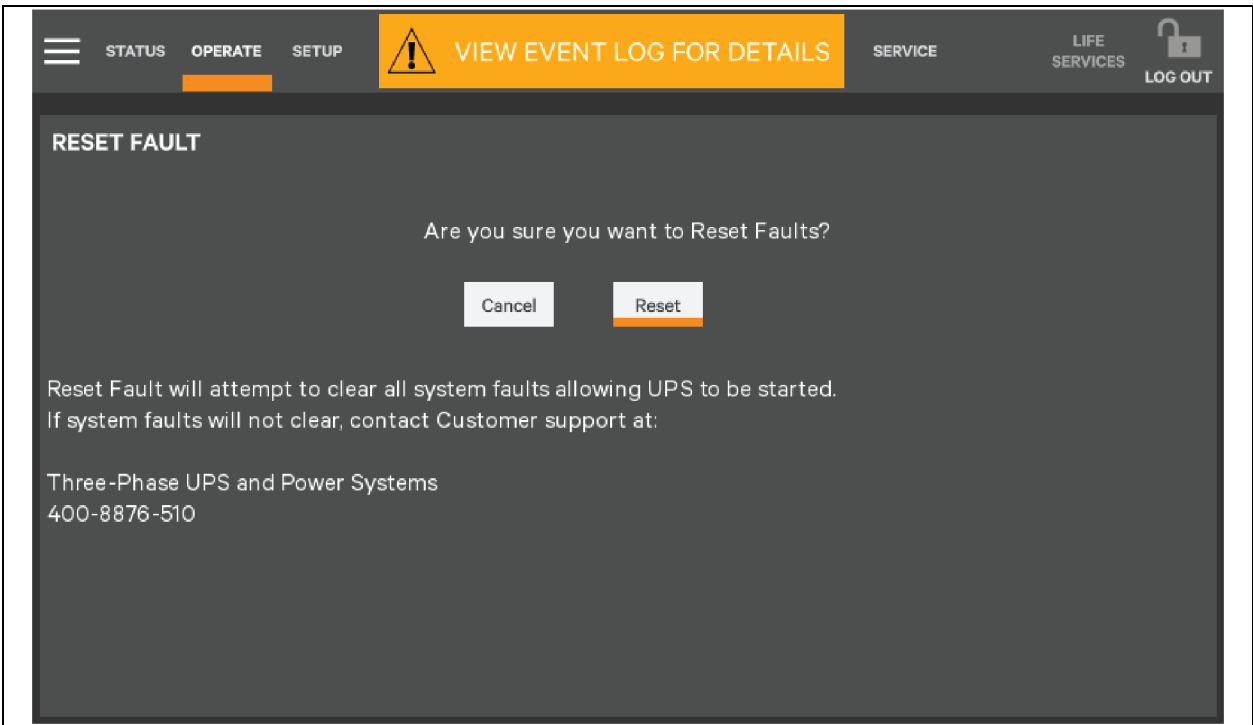
Figure 5.6 Inverter Off Screen



Reset Fault

Reset faults by touching the Reset button.

Figure 5.7 Reset Fault Screen



## Energy Saving Mode Activation

**NOTE:** Read this manual carefully before activating Energy Saving Mode. An Operator can enable or disable Energy Saving Mode. The available modes vary according to the UPS type and system configuration. The types available must be set up by either Administrator or Service personnel.

Energy Saving Mode may be activated or deactivated through the Operate menu screen. Two modes are available as ECO mode and Intelligent Parallel Mode.

ECO mode permits the UPS to reduce power consumption by powering the load through bypass power when utility supplied power is within acceptable ranges. The inverter will remain in a state that will permit it to resume supplying power if the utility power goes outside acceptable ranges.

Intelligent paralleling puts one or more power modules in a sleep mode until required to increase efficiency. To balance life of each power module, the working group will alternate automatically with sleeping cycle.

### To activate or deactivate Energy Saving Mode:

1. Touch the Setup button for Energy Saving Mode Activation.
2. Choose Enable or Disable from the drop-down option of Energy Saving Mode Activation. For more information as shown in **Figure 5.9** on the facing page.
3. Touch the Save button. The Save button is inactive until the activation state is changed.

**Figure 5.8 Activating Energy Saving Mode**

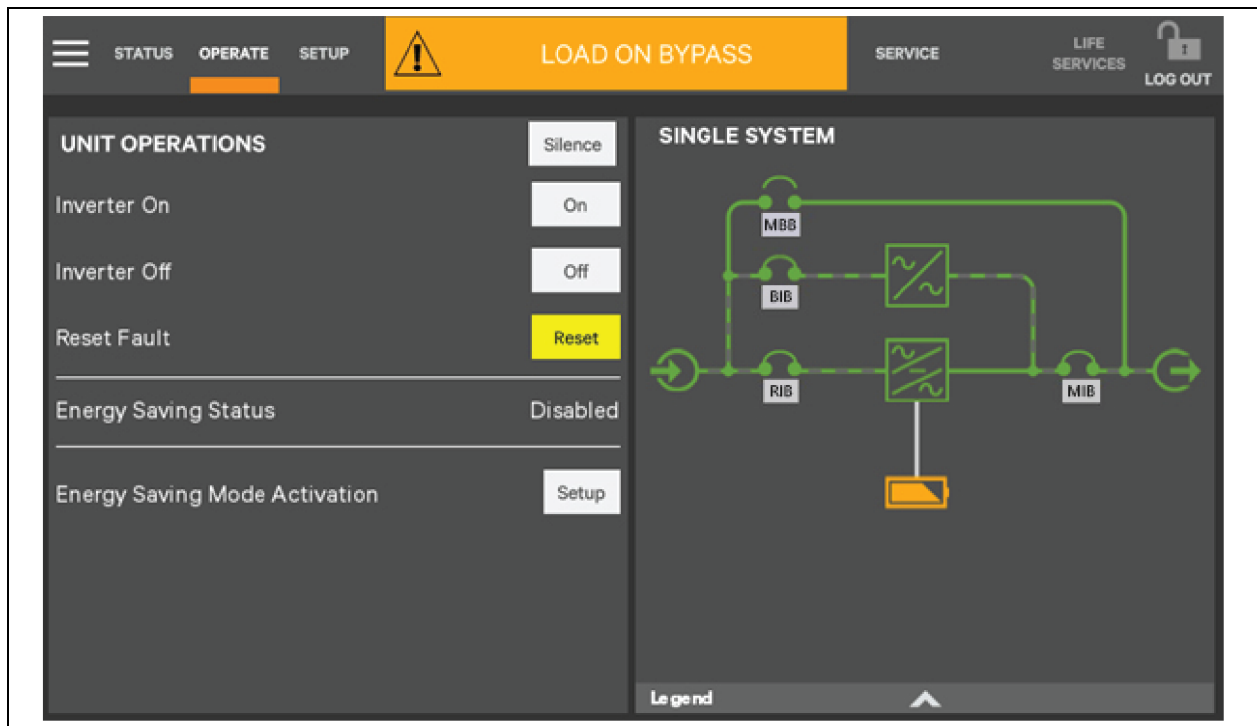
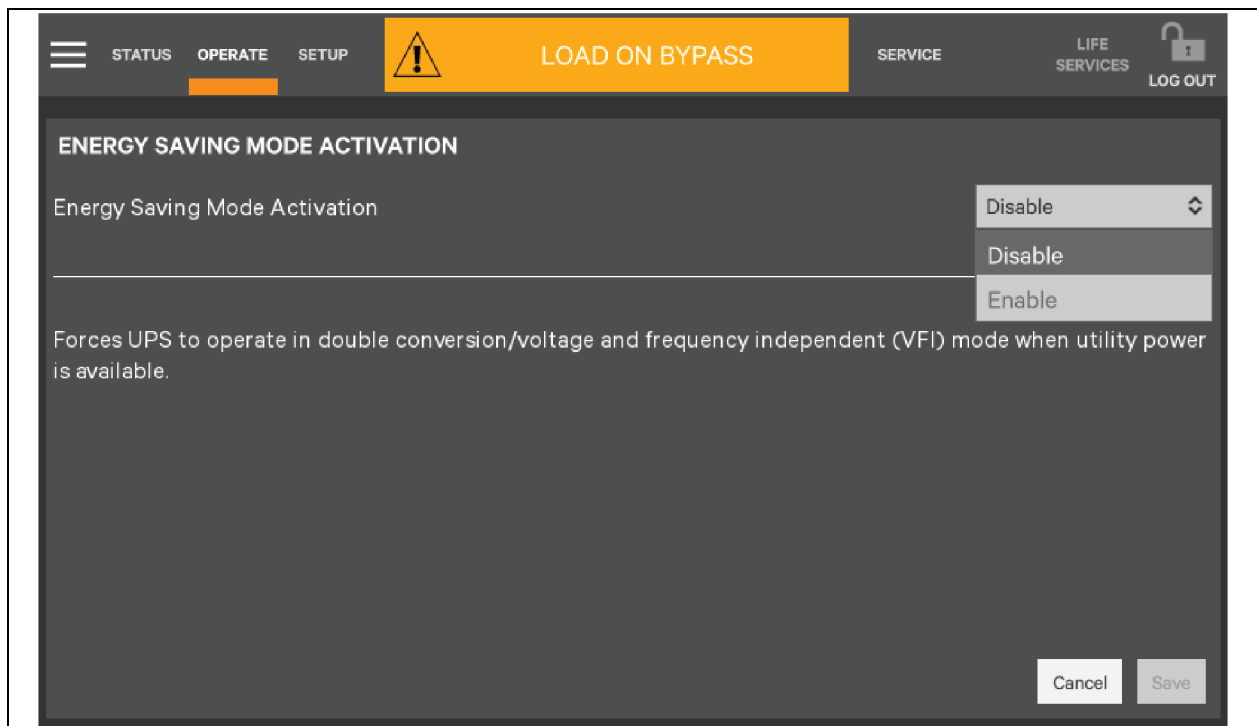




Figure 5.9 Energy Saving Mode Activation



## 5.4 Viewing UPS Status

The Vertiv™ Liebert® APM2 Touchscreen displays the UPS status in two ways: graphic views and text views. Each view shows the same readings.

### 5.4.1 Status Bar Component

The status bar indicates UPS status by:

- Changing color. Color indicators are green for normal, yellow for warning, and red for alarm.
- Showing an icon inside the bar, as shown in **Figure 5.10** below.

Figure 5.10 Status Bar Messages



Up to three messages may scroll through the status bar to the right of the status icon. Each message will have a duration of 4 seconds, except they change immediately if the system status changes.

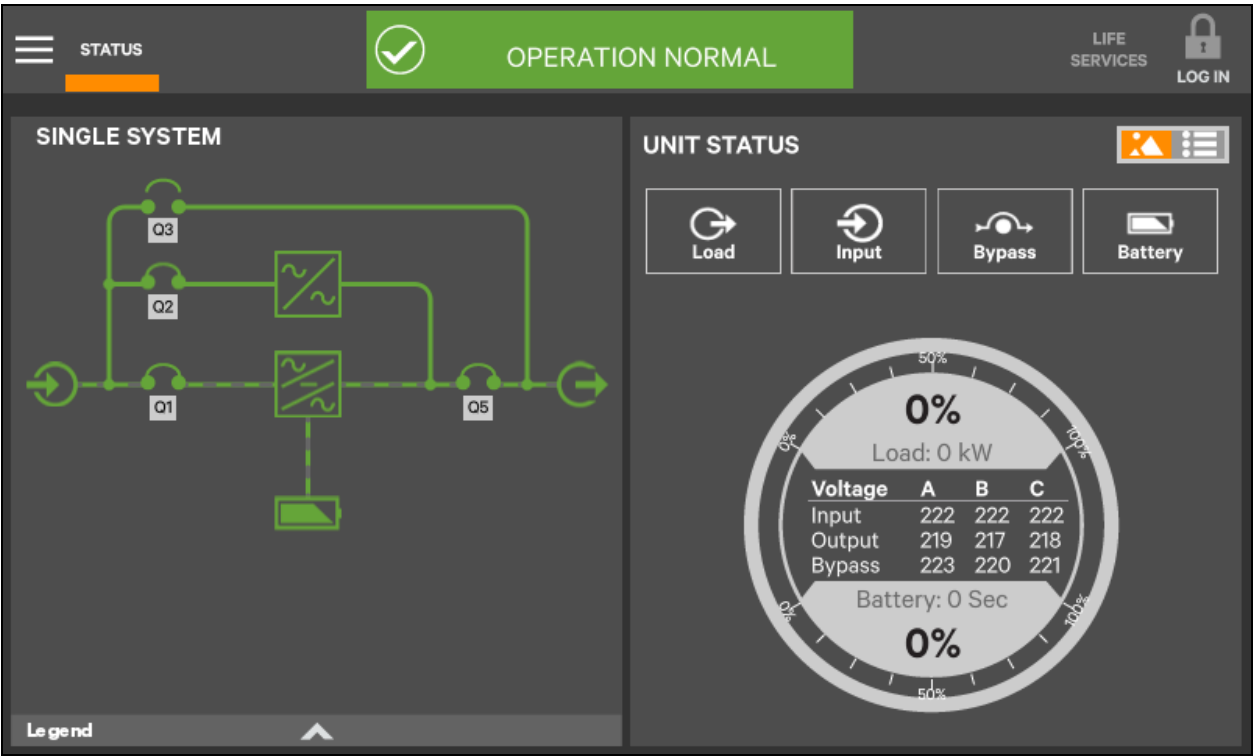
Alarms and certain events will trigger audible alarms and the LED on the bezel, the light bar and the status header will change color (audible alarms do not sound unless enabled). The scrolling information bar at the top of the interface summarizes information about the UPS status. The Status Gauge on the Unit Status pane gives additional details about the UPS status.

5.4.2 Viewing UPS Data with the Status Gauge

The Status Gauge offers a quick summary of the UPS status. The information shown depends on the type of UPS and its configuration and upon the choices made in the gauge setup. The data can be chosen by someone with Administrator or Service access.

The additional data will not replace the information shown in the center of the Status Gauge. Touching the center of the Status Gauge multiple times on will cycle through the data.

Figure 5.11 Default Status Gauge View



5.4.3 Viewing UPS Data with the Status Panel

More detailed information about the UPS status is readily available through the Status panel. Touching a component in the graphic screen display brings up data about the component on another pane. Touching a parameter icon on the Unit Status pane shows details about that parameter.

The same data can be viewed by switching to the text view. The length of the lists and order of the details may require scrolling to find the desired data.

**NOTE:** A parameter must be visible on the graphic view of the Unit Status screen for details to be viewed, even in the text view.

Figure 5.12 Unit Status — Input Details

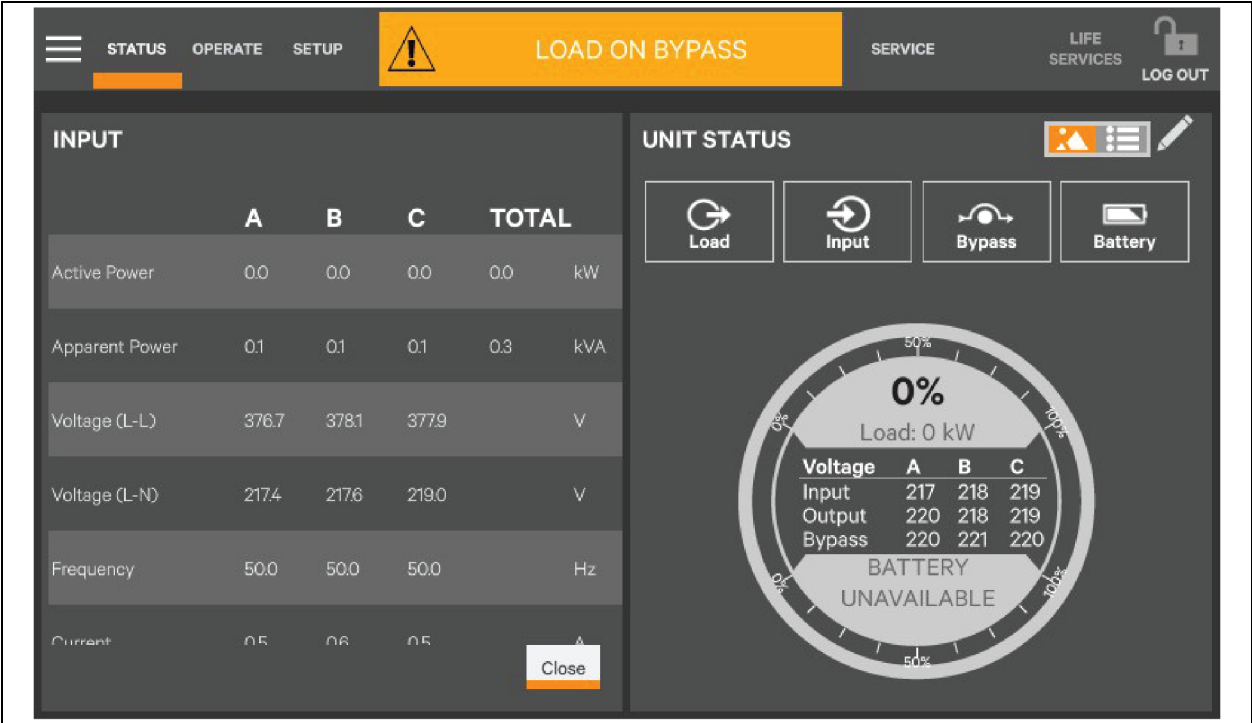


Figure 5.13 Unit Status — Bypass System

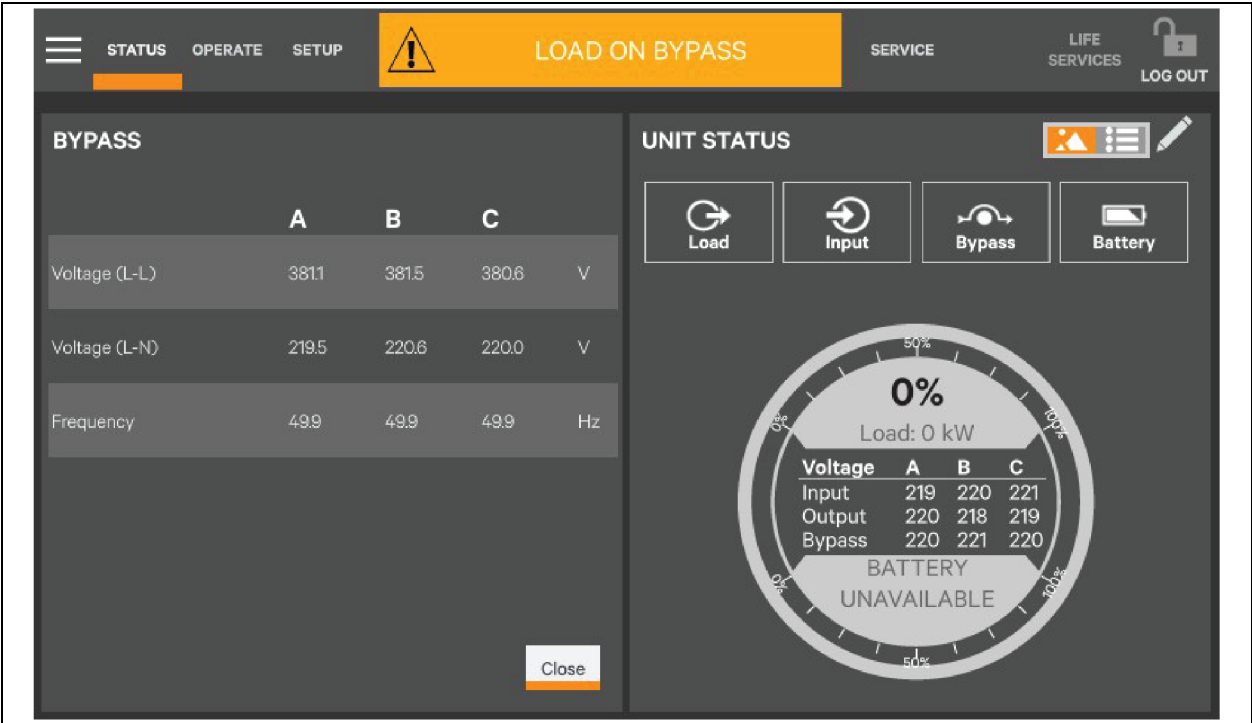


Figure 5.14 Unit Status — Battery Details

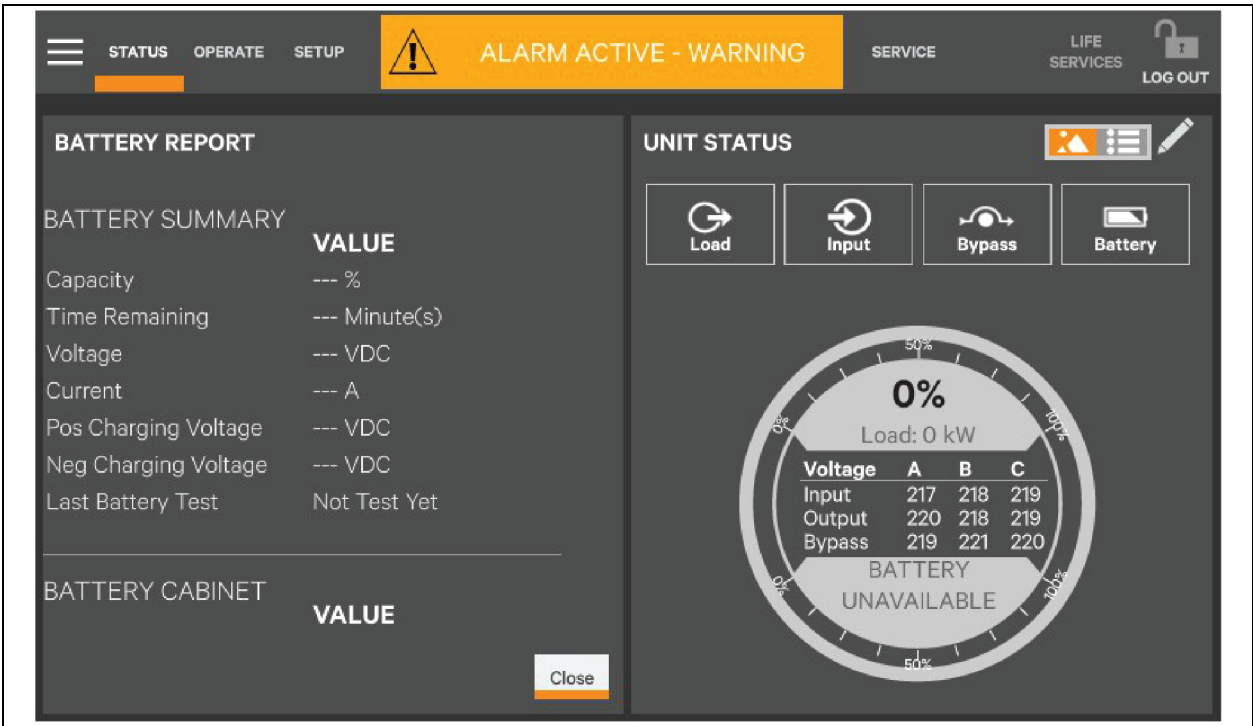
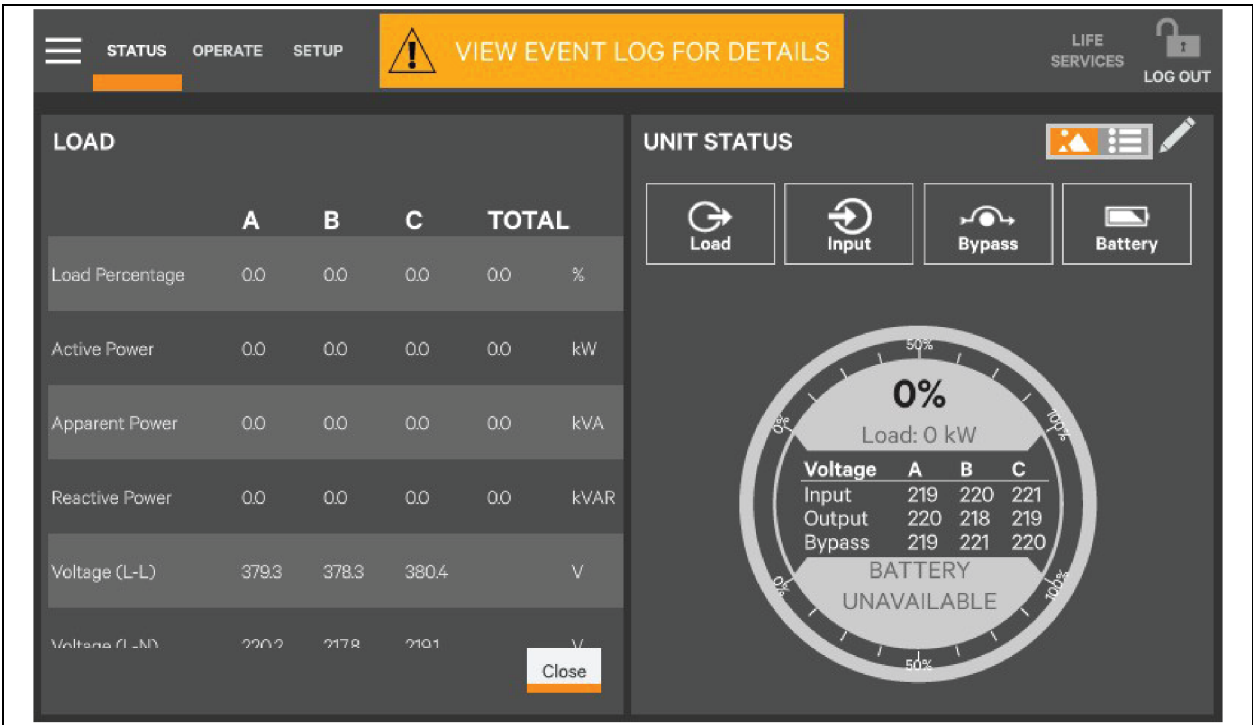


Figure 5.15 Unit Status — Load Details



### 5.4.4 Logs Alarms and Events

The Context Menu, when opened from the Status pane, permits viewing logs of alarms and events that have occurred on the UPS. Both logs include the date and time of occurrence, type, an ID, component affected, and a description of the alarm or event. The information is available to all users, including observers, those without a log in passcode.

#### To view the alarms or events:

1. Navigate to the Status pane, if required.
2. Touch the Context Menu icon.
3. Touch the log to view, alarms, or events, as shown in **Figure 5.16** below.
4. Touch the logs to see the UPS event log screen.
5. Touch Alarms to open a list of alarms.

**Figure 5.16 View Alarms or Events**

EVENTS						Reset Fault	Silence	Filter
Date/Time	Type	ID	Com.	Description	Wave			
23/2/2 PM2:56	✓	39F1	BYP	Module Comms. Normal				
23/2/2 PM2:57	⚠	3081	HMI	Load on Bypass				
23/2/2 PM2:56	✓	3011	HMI	Silence Active				
23/2/2 PM2:56	✓	39F1	MCM	Module Comms. Normal				
23/2/2 PM2:56	⚠	2021	PM1	No Battery				
23/2/2 PM2:56	✓	39F1	PM1	Module Comms. Normal				
23/2/2 PM2:56	⚠	2021	PM2	No Battery				
23/2/2 PM2:56	✓	39F1	PM2	Module Comms. Normal				

Figure 5.17 Event Logs

STATUS

OPERATE

SETUP

!

VIEW EVENT LOG FOR DETAILS

LIFE SERVICES

LOG OUT

EVENT LOG

ExportFilter

Date/Time	Type	ID	Status	Com.	Description	Wave
23/2/2 PM2:57	Warning	3081	Set	HMI	Load on Bypass	
23/2/2 PM2:57	Critical	30B1	Clr	HMI	Load Off	
23/2/2 PM2:57	Critical	30B1	Set	HMI	Load Off	
23/2/2 PM2:57	Critical	39A1	Clr	HMI	Power Hardware Mismatch	
23/2/2 PM2:57	Info	10B1	Clr	PM2	Inverter in Setting	
23/2/2 PM2:57	Info	10B1	Clr	PM1	Inverter in Setting	
23/2/2 PM2:57	Info	1881	Clr	BYP	Bypass in Setting	

## 6 Single UPS Operation

This chapter briefly describes the operating precautions and routine operations for the Vertiv™ Liebert® APM2 UPS single module. For the operating precautions and routine operating methods of UPS parallel system, see [Parallel System and Load Bus Synchronization System](#) on page 89.

### 6.1 Precautions

**NOTE:** The user can perform the next operation only after the authorized engineer completes the first power on and test of the UPS.



**WARNING!** Risk of electric shock and hazardous voltage of mains system and battery. The improper operation can cause equipment damage, personnel injury or death. The AC input and output terminals of the UPS have dangerous voltage. If the cabinet is equipped with an EMC filter, the filter may have dangerous voltage.

There are no operator serviceable parts located behind the covers that require a specific tool for removal. Only a qualified service engineer can remove the covers.

1. See [Operator Control and Display Panel](#) on page 53, for the detail operation procedure of the control keys and touchscreen.
2. The audible alarm sounds at various points during operation. The alarm can be canceled at any time by pressing the Silence On/Off key.
3. When the UPS uses a traditional lead acid battery, the system provides boost charge optional function. If a lead acid battery is used and there is an extended mains failure. The main input has a long time abnormal before the main restore. After the input be normal, battery's charging voltage will be higher than the normal charging voltage.

### 6.2 Power Breaker

The power breakers are inside the Liebert® APM2 UPS cabinet, that can be accessed by opening the front door of the UPS as shown in [Figure 6.1](#) on the next page and [Figure 6.2](#) on page 69, which includes the below breakers:

- RIB which connects the UPS to the main circuit power.
- BIB which connects UPS to the bypass.
- MBB (with error proof operation buckle) which supplies power to the load when UPS is being maintained.

**NOTE:** If the UPS system consists of more than two parallel UPS modules, do not use the internal maintenance bypass switch.

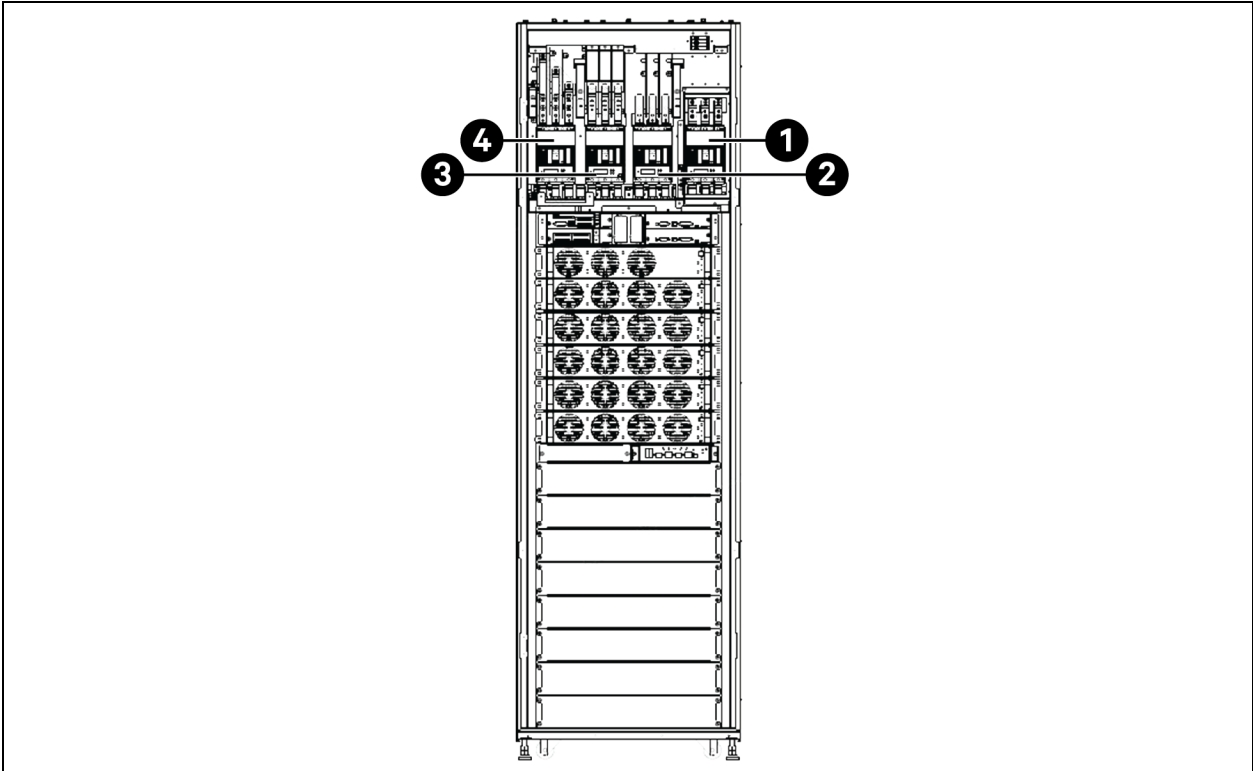
- MIB which connects UPS output to the load.

**NOTE:** RIB, BIB, MBB and MIB are available for the four switches model.

**NOTE:** When you are using MBB or the UPS without breaker, install all other breakers (including external MBB) for the UPS maintenance and dust removal.

**NOTE:** The input/output (I/O) neutral line inside the UPS is interoperable. If the external neutral line is not disconnected during maintenance, pay attention to safety.

Figure 6.1 UPS Power Switch Four Switches for Vertiv™ Liebert® APM2 60 kVA 208 V and 120 kVA 480 V UPS





Item	Description	Item	Description
1	MBB	3	BIB
2	MIB	4	RIB

6.3 UPS Start-up Procedures

The Liebert® APM2 UPS must be completely installed and commissioned before start-up by an authorized engineer. The external power supply switch must be closed. After these conditions are met, the UPS can be started.

6.3.1 Start-up Procedures in Normal Mode

- 

**WARNING!** These procedures result in mains voltage being applied to the UPS output terminals.
- 

**WARNING!** If any load equipment is connected to the UPS output terminals, check with the user that it is safe to apply power. If the load is not ready to receive power, disconnect the downstream load switch, and place a warning label on the connection point of the load.

To start the UPS from a fully powered down condition, follow the procedure below:

- 1. Open the front door of the UPS.

**NOTE:** Ensure that the internal MBB is disconnected, while the input cables, and copper bars are reliably connected.



2. Close the external input switch.
3. Ensure that the UPS input voltage, frequency, and phase are normal.



**WARNING! In parallel UPS configuration, all operations related to disconnecting or connecting of the maintenance bypass switch must be executed within three seconds to avoid overload situations and damage to the maintenance bypass switch.**

4. In the following order, close these switches output switch MIB, BIB, RIB, and all external output isolating breaker (if any) of the UPS.

The system is powered on, and the start-up screen opens.

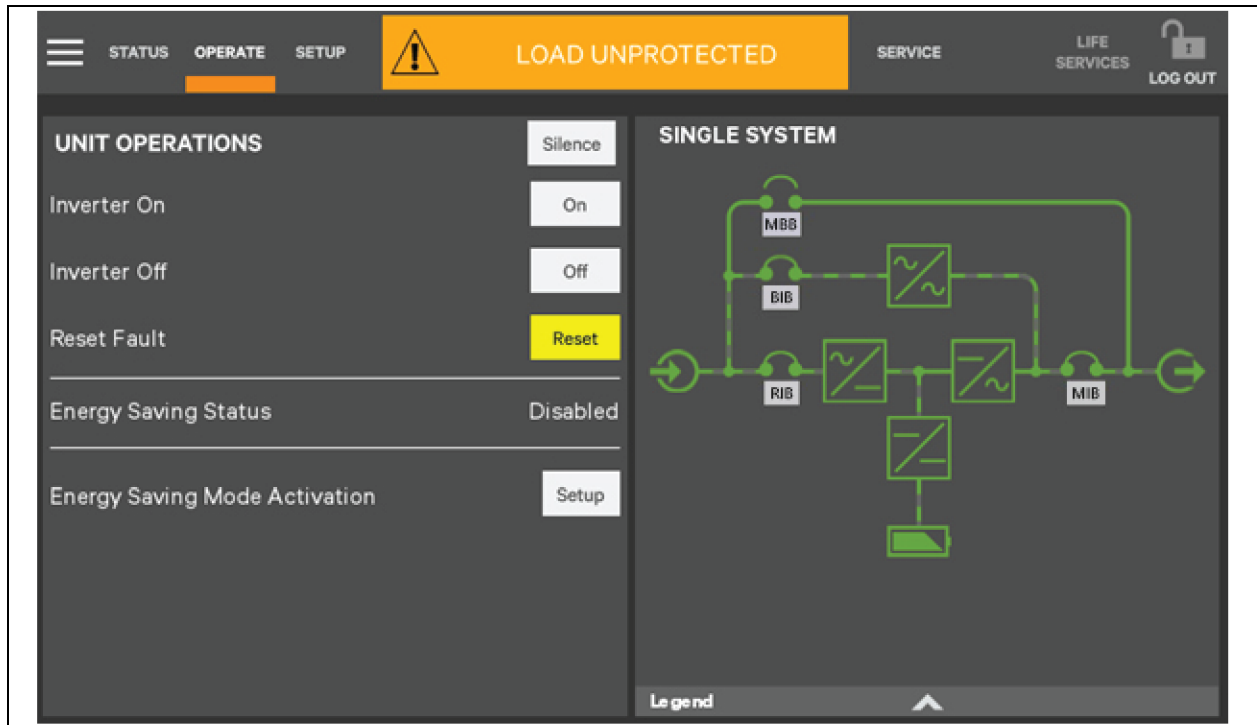
Wait 25 seconds and touch Log In icon to enter the system by typing correct password.

**Figure 6.2 Enter Password Screen**



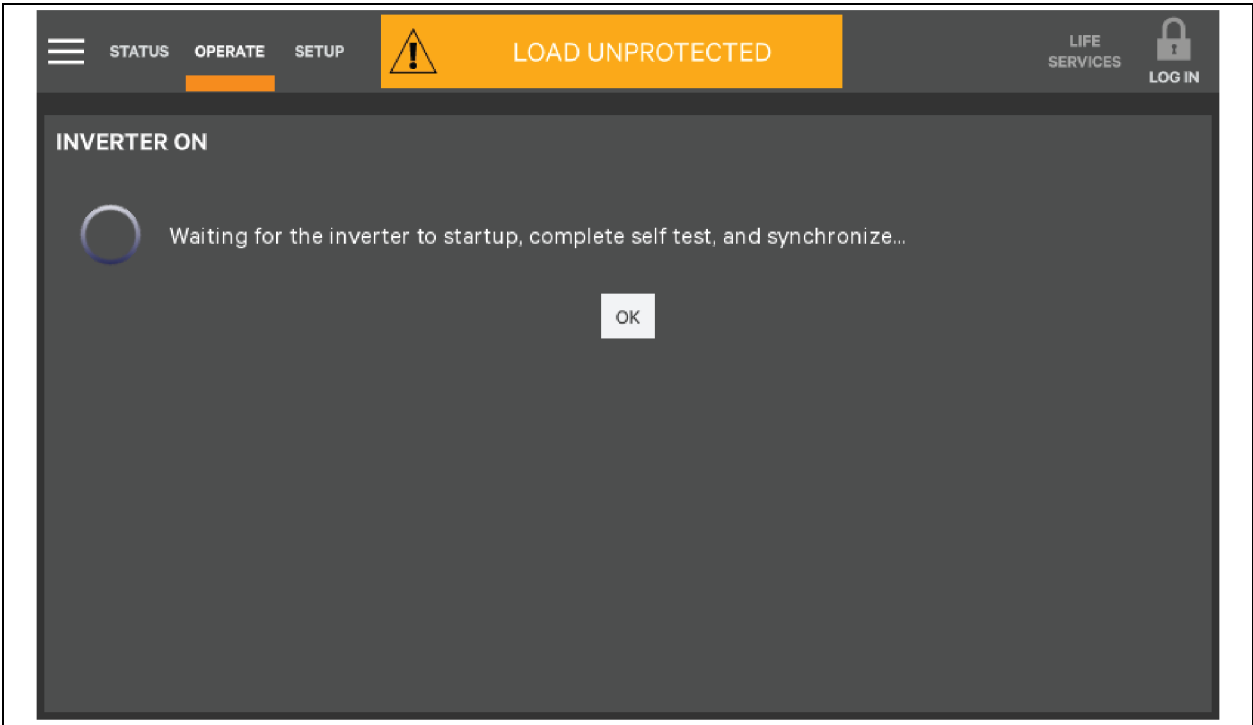
- When the rectifier start process is finished, close the BCB. The system runs in Bypass mode. Check the power flow in **Figure 6.3** below. Touch the On key. See [Navigating through the Liebert® APM2 Touchscreen](#) on page 53 for information regarding Operator Controls.

**Figure 6.3** Clicking Inverter On Key



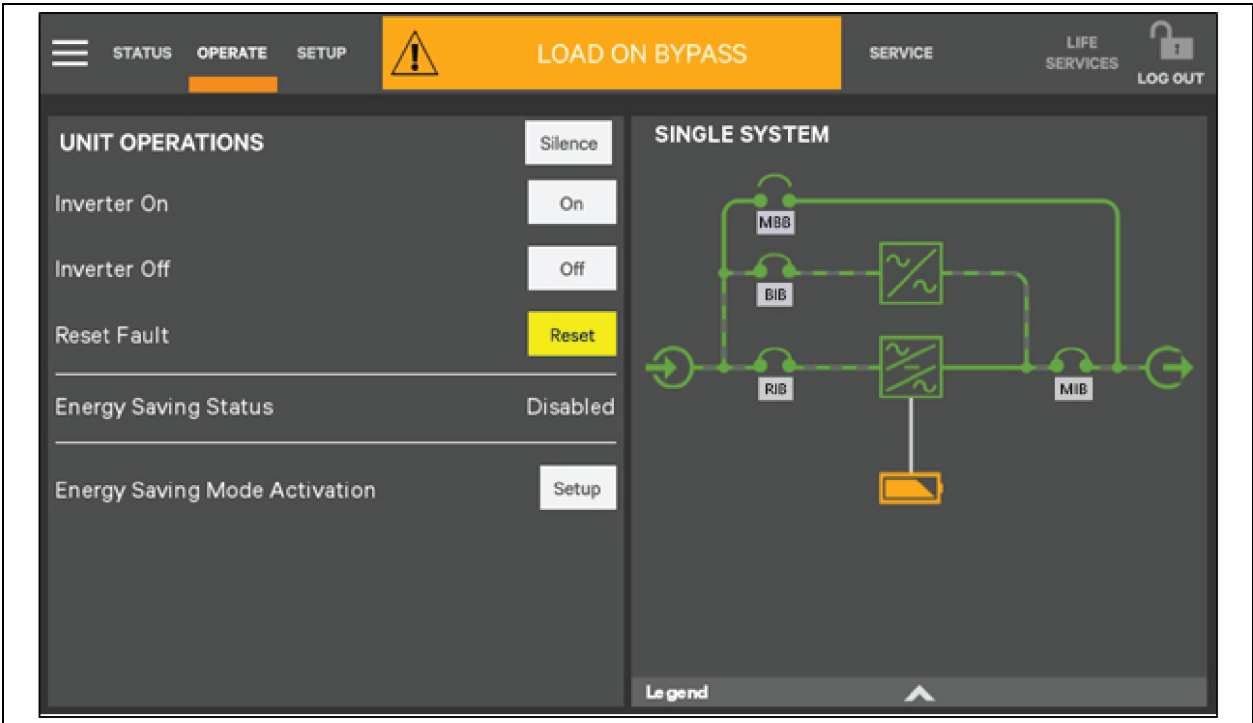
- 6. The inverter starts a self-test and synchronizes.

Figure 6.4 Inverter Self-Test and Synchronize



- 7. Start-up is finished.

Figure 6.5 Start-up Finished



### 6.3.2 Start-up Procedures in Economy Mode

1. Open the front door of the UPS.

**NOTE:** Ensure that the internal maintenance bypass switch breaker MBB Q3 is disconnected, and that the input cables and copper bars are reliably connected.



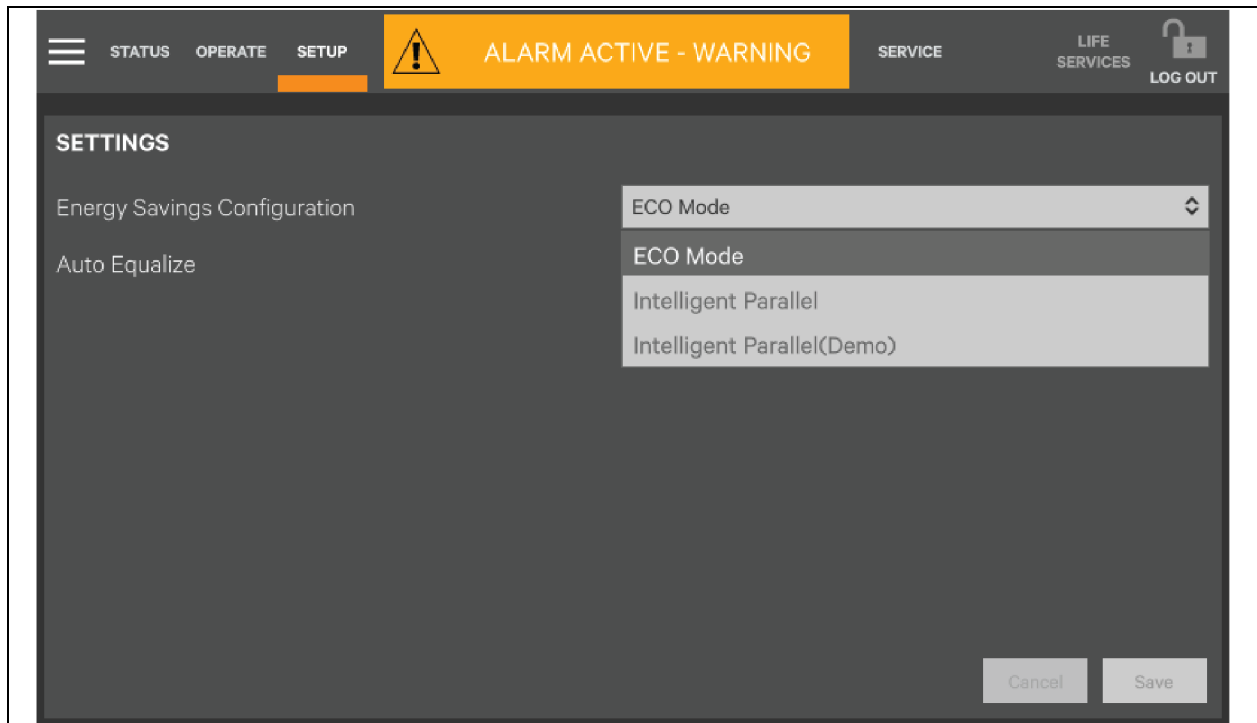
**WARNING!** In parallel UPS configuration, all operations related to disconnection or connection of the maintenance bypass switch shall be executed within 3 seconds to avoid overload situations and damage to the maintenance bypass switch.

2. Close the output breaker MIB, BIB, RIB, and all external output isolating breakers (if any) of the UPS in turn.

The system is powered on, and the start-up screen activates.

3. If ECO mode is necessary, contact a Vertiv service engineer to activate it through the software setting. If you wish to activate it by yourself, you can enable it through the Energy Saving Mode Activation on the touchscreen. For details, see [Operator Controls](#) on page 57.
4. Touch Setup next to the Energy Saving Mode Activation.
5. Select ECO mode from the drop-down.
6. Touch Save.

**Figure 6.6 Setting ECO Mode**



7. When the rectifier is started, start the system according to Start-up Procedures in Normal Mode (UPS Start-up Procedures).

After the inverter runs normally, if the bypass voltage is within the range of ECO power supply, then the system works in ECO mode; otherwise the system will transfer to inverter. The system will automatically work in ECO mode after the bypass voltage is within the range of ECO power supply and lasts for five minutes.

6.3.3 Start-up Procedures in Battery Mode (Battery Cold Start)

NOTE: Press and hold the battery cold start button for 1 second to perform the these procedures.

NOTE: Do not press the battery cold start button before switching on the BCB.

- 1. Verify that the battery has been connected, close the battery loop switch, and the battery voltage is transferred to the input terminal of the battery.
- 2. Wait for 30 seconds after the battery path switch is closed.
- 3. Press the battery cold start button of any module. See **Figure 6.7** below for position of cold start button.
- 4. When the rectifier starts, start the system according to [step 4](#) to [step 6](#) in [Start-up Procedures in Normal Mode](#) on page 68.


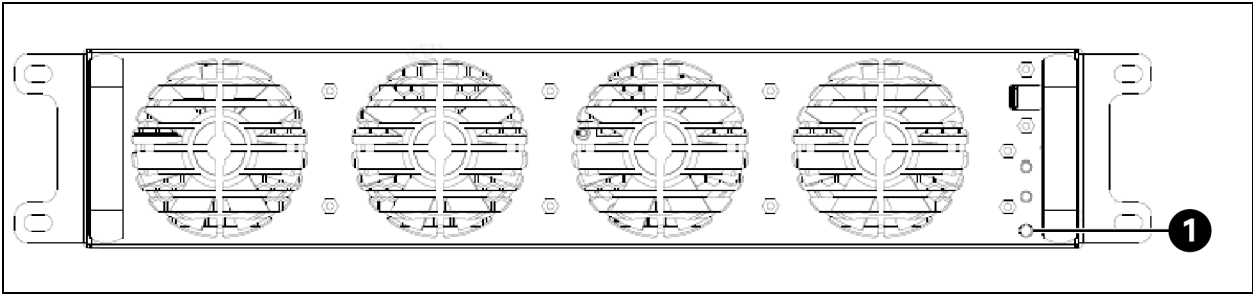
 **WARNING!** Start the UPS strictly following the above procedure. Failure to do so can cause the device to malfunction.

Figure 6.7 Battery Cold Start Button for Vertiv™ Liebert® APM2 60 kVA 208 V and 120 kVA 480 V UPS Power Module



Item	Description
1	Battery cold start button

6.4 Procedures for Transfer Between Operation Modes

6.4.1 Transfer from Normal Mode to Battery Mode

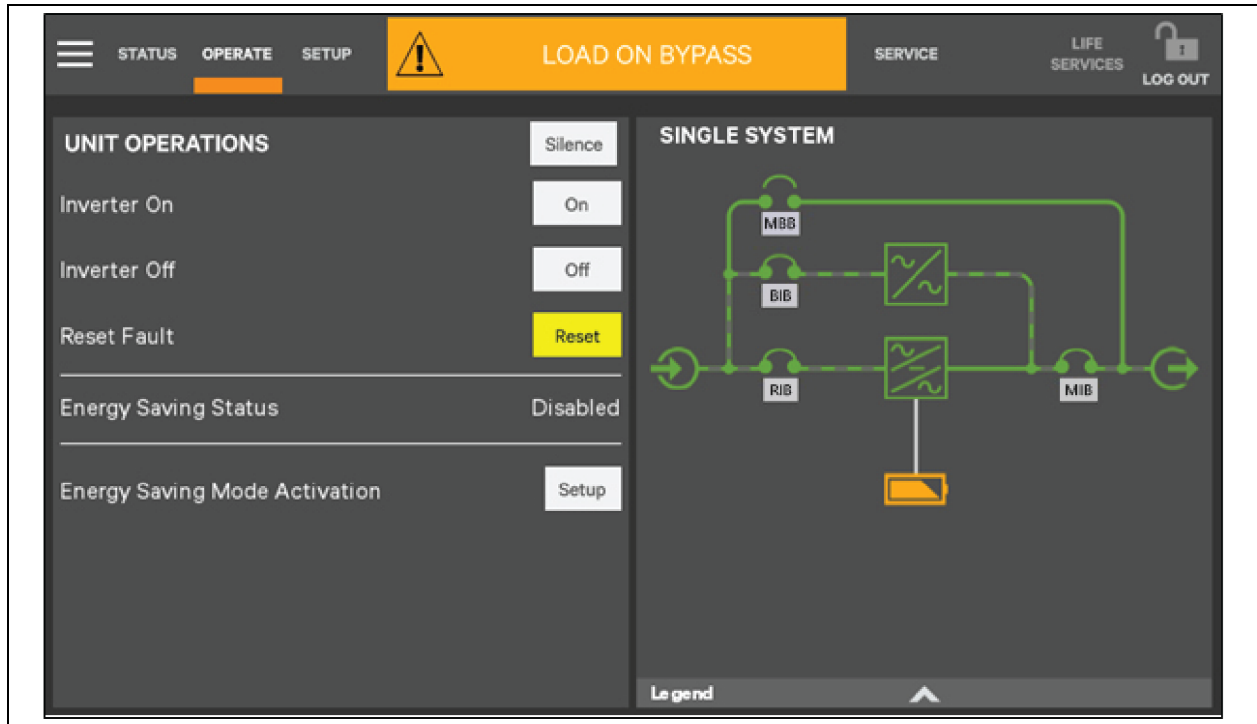
Open the external power switch to isolate the mains power and initiate the UPS on battery mode. To transfer the UPS back to normal mode, close the external power switch to reconnect the mains power to the UPS. The rectifier restarts automatically in about 10 seconds and the UPS works in normal mode.

## 6.4.2 Transfer from Normal Mode to Bypass Mode

Procedure to transfer the load from the normal mode to the bypass mode.

1. Activate the system and log in to the system.
2. Touch the Operate tab.
3. Touch the Off button next to the Inverter Off. See **Figure 6.8** below for more details, and the UPS will transfer to bypass mode.

**Figure 6.8 Transfer UPS to Bypass Mode**



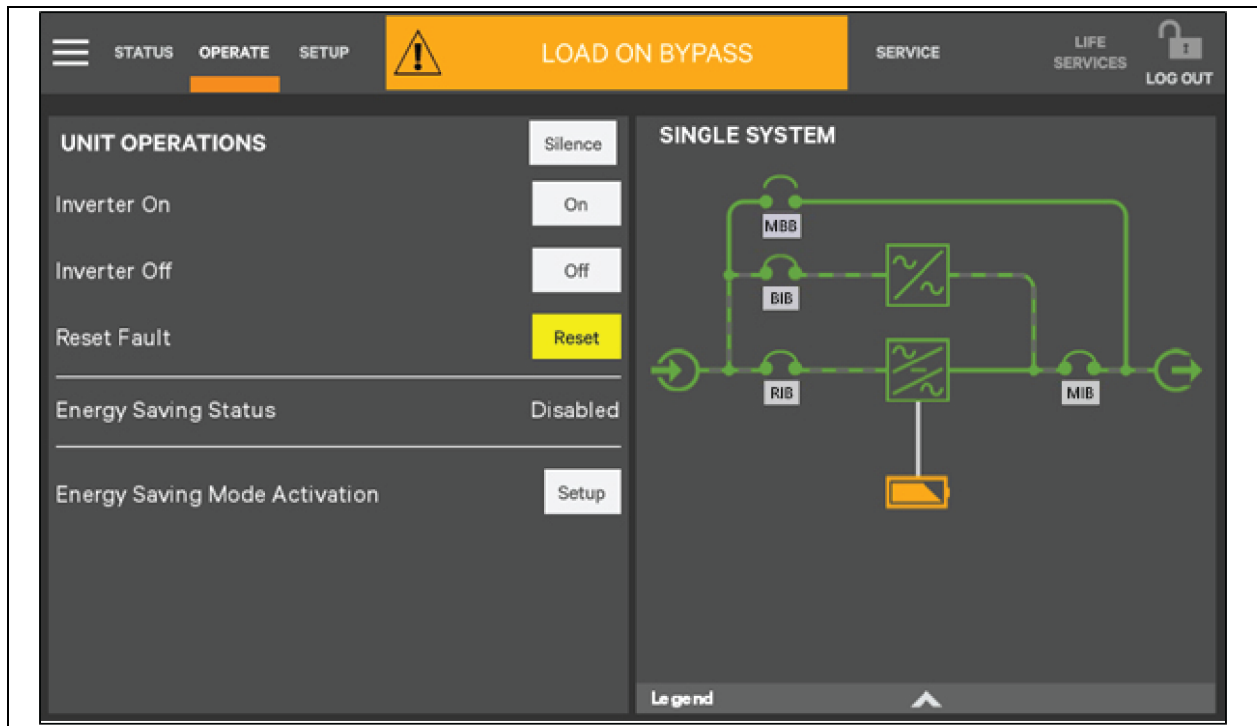
**NOTE:** In bypass mode, the load is directly supplied by the mains power instead of the pure AC power from the inverter.

## 6.4.3 Transfer from Bypass Mode to Normal Mode

Follow the procedure below to transfer the load from the bypass mode to the normal mode.

1. Activate the system and login to the system.
2. Verify that the Vertiv™ Liebert® APM2 UPS is in bypass mode.
3. Touch the Operate tab.
4. Touch the On button next to the Inverter On. See **Figure 6.9** on the facing page for more information. Then the UPS will transfer to normal mode from the bypass mode.

Figure 6.9 Transfer UPS to Normal Mode



#### 6.4.4 Transfer from Normal Mode to Maintenance Mode

The following procedures will transfer the UPS from inverter output mode to the maintenance bypass mode.



**CAUTION: Power supply interruption danger of the load. Before performing this operation, read the information on the touchscreen to make sure that the bypass supply is normal and that the inverter is synchronous with the bypass supply so as not to risk a short interruption in power to the load.**

1. Loosen the thumb screw on the interlock on the MBB.
2. Slide the interlock up and tighten the thumb screw to secure the interlock in place.
3. Close the MBB.
4. The maintenance bypass parallels with the UPS static bypass.
5. The touchscreen displays MBB Closed.
6. Open the following breakers:
  - a. All BCB if present.

**NOTE: All BCB's must be opened first to prevent the UPS from operating on battery power.**

- b. RIB, BIB, and MIB. This will electrically isolate the UPS module from AC power Input. All the internal power supplies and the GHMI touchscreen will shutdown.

**NOTE: Under maintenance mode, the load is directly fed by the mains power instead of the pure AC power from the inverter.**



**CAUTION:** When the UPS is in maintenance mode, the load is directly fed by the mains power instead of the pure AC power from the inverter and is not protected against abnormal mains supply. The system is now in maintenance bypass mode to allow the UPS module to be safely serviced by Vertiv Service.

**NOTE:** If the maintenance is required, wait 10 minutes for the internal DC bus capacitance to complete its discharging.



**WARNING!** The UPS maintenance must be done by qualified person only. The parts of UPS circuits also have hazardous voltage, though the RIB, bypass input switch and battery switch are disconnected.



**WARNING!** When the external input switch is not disconnected for models without RIB, BIB, and MIB, there is a hazardous voltage inside the UPS. For switch version frame, we can maintenance and remove dust when the MBB is activating. For no switch version frame, we can maintenance and remove dust when the external MBB is activating.

### 6.4.5 Transfer from Maintenance Mode to Normal Mode

Follow the procedure below to transfer the maintenance bypass mode of the UPS to normal mode:

1. Ensure that the safety interlock is still secured in the up position.
2. Close the RIB, BIB, and MIB and any BCB.
3. The UPS will begin its startup procedure and operate in internal bypass mode. Verify that the UPS is operating in internal bypass mode before proceeding.



**CAUTION:** Risk of improper operation. Can cause damage to the connected load. Failure to have the UPS operating on internal bypass and performing the next step will result in loss of all output power to the connected equipment.

4. Open the MBB.
5. Loosen the thumb screw on the interlock and slide it down and secure it in place by tightening the thumb screw.
6. Start the system according to [step 4](#) to [step 7](#) as specified in [Start-up Procedures in Normal Mode](#) on page 68. The UPS runs in Normal mode.

**IMPORTANT!** Start the bypass first, then disconnect the maintenance bypass switch. Failure to do so may cause output load power failure.

The load has transferred to UPS normal mode.

## 6.5 Battery Test Procedures

The battery test function is disabled by default. If you need this function, contact Vertiv's customer service.

The battery self-test includes a periodic self-test and a manual maintenance self-test.

- When the load factor is 0% to 20%, the system only supports the manual maintenance self-test.
- When the load factor is 20% to 100%, the system supports the periodic self-test and the manual maintenance self-test.



The battery discharges 20% of total battery energy.

The periodic self-test tests the battery activity. This test is regular and can be configured through the Vertiv setting software. During the periodic self-test, the system generates audible/visual alarm and corresponding records if the battery maintenance requirement is met. The periodic self-test does not update the battery curve table.

The mode of the manual maintenance self-test is similar to that of the periodic self-test although there are several differences.

- The maintenance self-test mode is started manually, and this operation is valid only one time, that is the system will not automatically start up the self-test once you exit.

When the load factor is 20% to 100%, during the maintenance self-test, the system generates an audible/visual alarm and corresponding records if the battery maintenance requirement is met. The maintenance self-test does not update the battery curve table.

**NOTE: The periodic self-test should satisfy the conditions of battery float charge at least 5 hours, while the generator is not connected. The manual maintenance self-test just satisfies the condition of battery fully charged.**

#### How to do a test:

1. **Manual maintenance self-test:** Through the touchscreen.
2. **Periodic self-test:** A self-test period can be configured through the Vertiv setting software. The periodic range of the battery self-test is 30 to 360 days. The default is 60 days.

#### Self-test start-up conditions:

1. System load rate is within 0% to 100% (manual maintenance) or 20% to 100% (periodic self-test), stable output.
2. UPS input is not connected with generator and the battery float charge is at least 5 hours, battery is in fully charged.
3. Current system is in float charge state.

#### Self-test exit conditions:

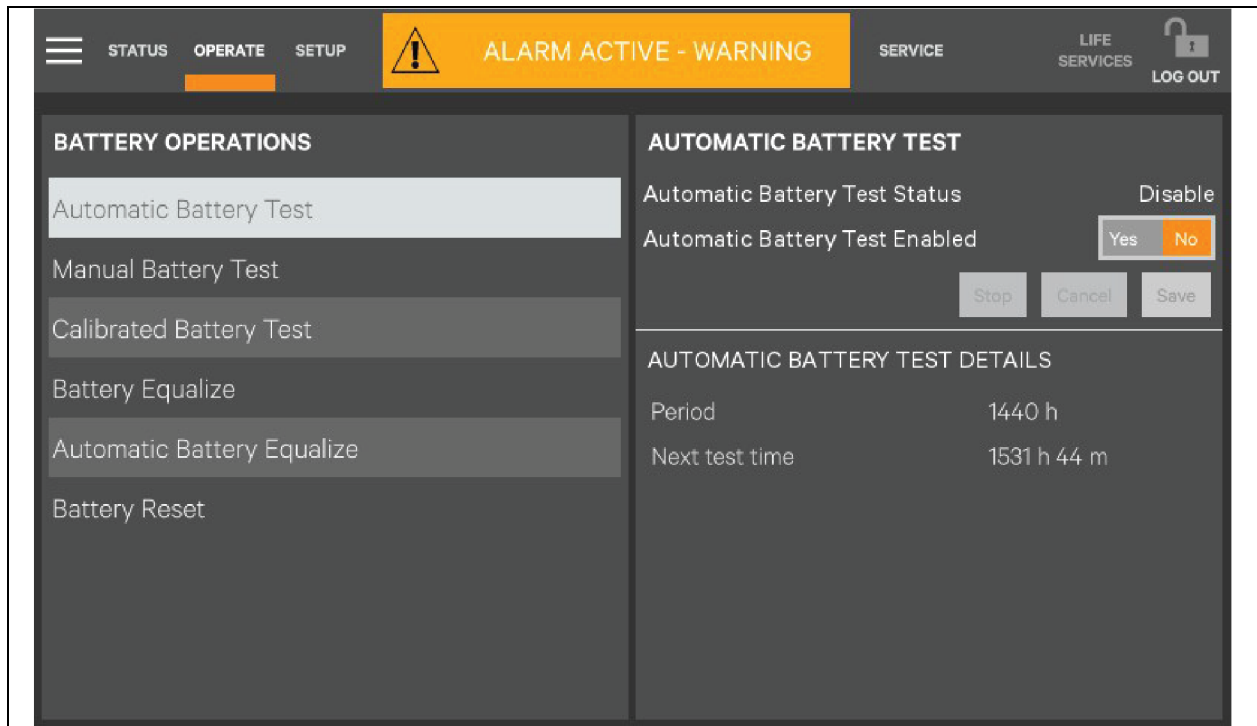
1. Confirm that the system is not in self-test state for at least 10 seconds and that the battery mode or rectifier is closed. The system shifts to battery supply state.
2. During the self-test, the system shifts to float charge state if the load fluctuates.
3. During the self-test, if the load fluctuates, the UPS module overload, or the battery may not no. The system stop the self-test and switch to the charging state.
4. The maintenance test can be manually stopped through the touchscreen.
5. During the manual maintenance self-test, when the load rate ranges from 0% to 20%, the system shifts to float charge state after the battery discharges for 5 minutes.

**NOTE: If the self-test is successful, the system fully clears the self-test interval counter. If the self-test fails, then exits the system. If the self-test conditions are satisfied again, enters self-test once more.**

#### Procedures for battery self-test:

1. Enter the level of Operate.
2. Touch the Operate icon.
3. Touch the menu icon on the upper left corner.
4. Touch the Battery Operations to display the interface. For more information see **Figure 6.10** on the next page.

Figure 6.10 Battery Management Interface



5. Touch Automatic Battery Test, Manual Battery Test, Calibrated Battery Test, or Battery Equalize, to access corresponding settings and operation.

## 6.6 UPS Shutdown Procedures

### 6.6.1 Procedures to Completely Power Down the UPS

Follow the below procedure to completely shutdown the UPS and load power off. All power switches, isolating switches, and breakers are disconnected, and then UPS no longer supplies power to load.



**CAUTION:** The following procedures will cut off the load power, making the load completely power off.

1. Touch the Inverter Off key to stop the operation of the inverter, then press the EPO button to stop the operation of the rectifier, static switch and battery. See [Operator Controls](#) on page 57.
2. Disconnect the external battery switch.
3. Disconnect the RIB, BIB, output switch breaker MIB. Now, all the internal power supply is off, and the touchscreen does not display any more.



**WARNING!** Place a notice at the AC input distribution (generally far away from the UPS) to communicate that the UPS is under maintenance.



**WARNING! Hazardous battery voltage. The battery terminals still have hazardous voltage after the UPS is completely shutdown.**

**IMPORTANT! Wait 30 minutes for the internal DC bus capacitance discharging. Then the UPS is completely shuts down.**

## 6.6.2 Procedures for Completely Powering Down UPS while Maintaining Power to Load

The procedures in [Transfer from Normal Mode to Maintenance Mode](#) on page 75 are suitable to completely power down the UPS and keep power supply to the load.

## 6.7 Emergency Power Off Procedures

The EPO is designed to switch off the UPS in emergency conditions (such as fire, flood, and so on). To carry out EPO, press the EPO button, then the system will turn off the rectifier and inverter, and stop powering the load immediately (including the inverter and bypass). The battery then stops charging or discharging.

After EPO, if the input mains is present, the UPS control circuit remains active; however, the output will be turned off. To remove all power from the UPS, first disconnect the external power switch of the UPS.

## 6.8 UPS Reset Procedures after Emergency Power Off

After shutting down the UPS through EPO or the UPS fault condition, clear the fault according to the alarm message appearing on touchscreen. Then carry out the following reset procedures to make UPS resume normal operation.

**After confirming the fault has been cleared and no REPO signal is received, the user can carry out the following procedures:**

1. Touch the Reset Fault button. See [Operator Controls](#) on page 57. The system exits the EPO/abnormal Off state and the alarm indicator flashes red.
2. After the rectifier start up is finished, normally start the UPS according to [Transfer from Bypass Mode to Normal Mode](#) on page 74.

**NOTE: The rectifier will start automatically when the over temperature fault disappears five minutes after the disappearance of over temperature signal.**

3. After the EPO button is pressed, if the mains input is switched off, the UPS will shutdown completely. When the mains input restored, the UPS will enable the bypass. Restore the power at the output terminal of the UPS.



**WARNING! If the MBB is closed and UPS has input power, UPS has outputs.**

## 6.9 Automatic Restart

The UPS uses the battery system to supply power to the load equipment in the event of mains failure until the batteries are discharged. When the UPS reaches its EOD threshold, it shuts down.

**The UPS automatically restart and enables output power only when the following conditions are met:**

1. Auto recovery after EOD enabling is enabled.
2. After the auto recovery after EOD delay time expires, the UPS restarts bypass, then inverter. After EOD, the default delay time is 10 minutes. During the automatic recovery delay, the UPS charges its batteries to provide a safety margin for equipment shutdown if input power fails again.

**NOTE: During the automatic restart process, manual start-up is disabled. Automatic restart must be set by Vertiv's authorized service engineer through Vertiv setting software.**

## 7 Battery

This chapter provides information about the battery, the battery types, charging/discharging, battery cold start, safety, installation and maintenance information, battery protection function, and the connection of BCB cabinet (optional), battery temperature sensor (option), and battery ground fault detector.

### 7.1 Introduction

The UPS battery string consists of several batteries in series connection and provides rated DC input voltage for the UPS inverter. The required battery backup time (time for battery to supply load upon mains failure) is subject to the ampere hour value of the battery. Sometimes, it is necessary to connect several battery strings in parallel.

To facilitate the UPS installation, the battery is generally installed on the specially designed battery rack or in the battery room.

During the maintenance or repair, the battery must be disconnected from the UPS. This operation is carried out with the BCB of proper capacity. This circuit breaker must be located as close as possible to the battery connecting terminal. The wiring distance of the power and signal cables connected to the UPS must be minimized.

When several strings of battery are connected in parallel to increase the battery backup time, disconnecting device shall be equipped, so that the maintenance operation on a certain battery string will not affect the normal operation of other battery strings.

### 7.2 Safety



**WARNING! Work carefully with the batteries connected to the UPS when all the blocks are connected, the battery string voltage can be up to 540 VDC. This is potentially dangerous. Follow the precautions for high voltage operation. Only qualified personnel can install and maintain the battery.**

To ensure safety, the external batteries are to be installed inside a lockable cabinet or in a purpose designed, dedicated battery room, so that they are only accessible to qualified service personnel.

Make sure that the battery switch has been disconnected before battery maintenance.

The UL9540 ESS system requires an upstream input circuit breaker (feeder breaker), which is customer supplied responsibility for field installation, with a means of accessible manual disconnect. The customer must ensure that all LOTO devices are rated according to specification of manufacturer kAIC as required by NFPA 70E and CSA Z462 per table 12. Before beginning any electrical installation or maintenance of ESS system, ensure proper LOTO procedure is followed for all upstream feeder breakers, and downstream output breakers directly connected to the UPS, and any DC breakers for the battery circuit to properly isolate power. The proper LOTO procedure will be determined by manufacturer for all applicable equipment. The size and type of LOTO device will be dependent on manufacture and size of disconnect device used. Refer to the manufacturer-supplied user information for all applicable equipment.

If the integrated MBB option is selected with the UPS, all LOTO devices must be applied to external upstream feeder breakers, external downstream output breakers, and external DC breakers. Applying LOTO to the integrated MBB is not sufficient to isolate power to the UPS when accessing the power cabling terminals.

Arc Flash Ratings should be determined as part of customer site arc flash coordination study. Ground fault detection is required per NFPA 70E and CSA Z462. For compliance with UL9540 ESS system requirements for the LOTO procedure of the DC source Vertiv™ EnergyCore Lithium 5 battery cabinet, refer to the **Vertiv™ EnergyCore Lithium 5 User Manual SL-71251**.

## 7.2.1 Safety Precautions

Observe the following safety precautions when working on the batteries:

1. The battery must be firmly and reliably connected. After the connection is completed, the screw connections between all the terminals and the batteries shall be calibrated. The requirements on torque specified in the specifications or user manual provided by the battery manufacturer shall be satisfied. The connections between all the wiring terminals and the batteries shall be inspected and tightened at least once a year. Otherwise it may cause fire.
2. The battery appearance must be inspected before accepting and using the battery. If there exists any package damage, dirty battery terminal, terminal erosion, rust, or enclosure crack, deformation or liquid leakage, replace it with a new battery. Otherwise, battery capacity reduction, electric leakage or fire may be occur.
3. The battery is very heavy. Use a proper method to move and lift the battery, so as to prevent any harm or injury to personnel or damage to the battery terminal. Severe damage to the battery may cause fire.
4. The battery connecting terminal must not be subject to any force, such as the pulling force or twisting force of the cable, otherwise, the internal connection of the battery may be damaged. Severe damage to the battery may cause fire.
5. The battery shall be installed and stored in a clean, cool and dry environment. Do not install the battery in a sealed battery chamber or a sealed room. The battery room ventilation shall at least meet the requirement of EN50272-2001. Otherwise, battery bulging, fire, or human injury may occur.
6. The battery shall be installed far away from the heating products (such as the transformer). The battery must not be used or stored near a fire source and must not be burnt or put into fire. Batteries can leak, bulge, explode, or cause fire if near heating products, stored near a fire source, or placed in fire.
7. Do not directly connect any conductor between the positive and negative terminals of the battery. Remove jewelry, watches, and other metal items from your person or near the battery before operating the battery. Ensure that tools required to install, maintain, use, or test the battery (such as wrench) are covered with insulating material. Otherwise, battery leakage, bulging, fire or explosion may occur. Injury or death may occur.
8. Do not disassemble, modify or demolish the battery. Disassembly, modifications to the battery, or demolishing the batter may cause the battery to short circuit or leak fluid. Human injury is possible
9. Clean the battery enclosure with a wet cloth. To avoid static or arcing, do not use a dry cloth or duster to clean the battery. Do not use organic solvent (such as thinner, gasoline, or volatile oil) to clean the battery. Improper cleaning can crack the battery enclosure. A possibility of fire exists with improper cleaning.
10. The battery has diluted sulfuric acid. In normal use, the diluted sulfuric acid will be absorbed by the baffle and polar plate of the battery. However, if the battery is damaged, the acid may leak from the battery. Therefore, personal protective equipment (such as protective glasses, rubber gloves, and apron) must be used when operating the battery. Diluted sulfuric acid can injure eyes and cause blindness and can cause skin burns.
11. The battery may have short circuit its electrolyte can be dried up, or have positive pole erosion failure at the end of its life. Inspect the battery for defects. If bulging, leaking fluid, or other defects are found, replace the battery.
12. Before connecting or disconnecting the battery connection cables, isolate the charging power.
13. Check if the battery has been unexpectedly earthed. If this is the case, remove the earth connection. Contact with any part of the earthed battery may result in an electric shock.

## 7.3 UPS Battery

The UPS adopts valve regulated battery. Valve regulated means the sealed type or maintenance free.

The valve regulated battery is not completely sealed, when it is overcharged, there is gas leaked. The volume of the gas escape is less than with a water injection battery. However, during the installation design of the battery, temperature rise should be considered, and enough room must be reserved to ensure good ventilation.

The valve regulated battery is not maintenance free. The valve regulated battery must be kept clean and inspected regularly to check for corrosion and to ensure that the connection is reliable.

It is recommended to connect no more than four strings of batteries in parallel. Batteries of different types, names or newness must not be used together. Otherwise, the battery inconsistency will cause frequent over discharge or under charge of certain battery. At last, the battery will have premature failure, and the entire string of battery will have insufficient backup time.

Batteries must be stored in a fully charged state. Batteries will lose some capacity because of self discharge during transportation or storage. Charge the battery before use. During the storage, ensure that the ambient temperature must not exceed the range of 5 °F to 113 °F (-15 °C to +45 °C), and the optimal temperature is 68 °F to 77 °F (20 °C to 25 °C). To compensate for the self discharge of the battery during the storage, the battery must be charged every 3 months during the storage. The specific time may differ for different batteries. For details, refer to the requirements of the battery manufacturer.

It is very important to fully charge the battery testing the battery backup time onsite. The test may take several days. Therefore, it should be conducted after the battery is float charged uninterrupted for at least 1 week.

When the battery is running for several weeks or subject to 2 to 3 charge and discharge cycles, the battery performance will increase.

To avoid the battery over charge or under charge, set the battery management parameters according to the equalizing/float charge voltage and temperature compensation factor specified in the manuals provided by the battery manufacturer. Charge the battery immediately after discharge.

## 7.4 Precautions for Installation Design

**NOTE: Use and maintenance of the battery are described in the relevant battery manual provided by the battery manufacturer. The safety precautions described in this section include the important precautions that must be considered during the installation design. The design results may be changed according to the local situations.**

## 7.5 Battery Installation Environment and Number of Batteries

### 7.5.1 Installation Environment

#### Fresh air volume (EN50272-2001)

The operating environment of the battery must be ventilated. During the operation of the battery, the following requirement for the fresh air ventilation must be satisfied:

$$Q=0.05 \times n \times I_{gas} \times Crt \times 10^{-3} [m^3/h]$$

Where:

Q - The fresh air ventilation volume per hour, the unit is m<sup>3</sup>/h

n-Number of cells

I<sub>gas</sub> - The gas evolving current density under battery float charging or boost charge conditions, the unit is mA/Ah.

I<sub>gas</sub>=1, under the float charging condition of 2.27 V/cell.

I<sub>gas</sub>=8, under the boost charge condition of 2.35 V/cell.

$C_{RT}$ – 20 hr battery rated capacity.

## Temperature

**Table 7.1 Ambient Temperature Range**

Type	Temperature Value	Remark
Recommended optimal temperature	68 °F to 77 °F (20 °C to 25 °C)	The ambient temperature for the battery operation must not be too high or too low. If the average operating temperature of the battery rises from 77 °F to 95 °F (25 °C to 35 °C), the service life of the battery will be reduced by 50%. If the operating temperature of the battery is over 104 °F (40 °C), the service life of the battery will be reduced exponentially each day.
Short time allowable temperature	5 °F to 113 °F (-15 °C to 45 °C)	

The higher the temperature is, the shorter the battery service life will be. At low temperature, the charge/discharge performance of the battery will be reduced.

The battery must be installed in a cool and dry environment with a humidity of less than 90% and be protected from the heat source and direct sun rays.

The ambient temperature, ventilation, space, float/boost charge voltage, and ripple current affect the battery temperature. Uneven temperature among the battery strings will cause uneven voltage distribution and thus result in problem. Therefore, it is important to maintain balanced temperature in the battery string, and the temperature difference between batteries of different layers should be kept within 37.4 °F (3 °C). Valve regulated battery is very sensitive to the temperature, therefore the valve regulated battery should be used in 59 °F to 77 °F (15 °C to 25 °C). If the battery cabinet is installed near the UPS, the maximum design ambient temperature should be determined according to the battery rather than the UPS. That is, if valve regulated battery is used, the indoor ambient temperature must be 59 °F to 77 °F (15 °C to 25 °C) rather than the operating temperature range of the main equipment. Under the precondition that the average temperature will not exceed 77 °F (25 °C), it is allowed to have short time temperature deviation.

### 7.5.2 Number of Batteries

The number of batteries, EOD voltage, and float charging voltage shown in **Table 7.2** below.

**Table 7.2 Number of Batteries**

Parameter	Vertiv™ Liebert® APM2 60 kVA 208 V	Liebert® APM2 120 kVA 400 V	Liebert® APM2 120 kVA 480 V
Number of cells (standard)	96 to 144 jars, 96 to 144 jars without derating	92 to 264 jars, 192 to 264 jars without derating	92 to 264 jars, 192 to 264 jars without derating
EOD voltage	1.60 VDC/Cell to 1.90 VDC/Cell, 1.67 V/Cell recommended.		
Float charging voltage	2.2 VDC/Cell to 2.3 VDC/Cell, 2.27 V/Cell recommended.		

## 7.6 Battery Protection

**IMPORTANT! Users must choose appropriate switching devices to protect the battery from short circuit and overload. It is recommended to use the Vertiv BCB to provide better battery protection.**

The battery is connected to the UPS through the BCB. The BCB is manually closed and has the electronic tripping device controlled by the UPS control circuit. If the battery adopts rack mounting (or is far away from the UPS cabinet), the BCB must be installed as close to the battery as possible, and the wiring distance of the power and signal cables connected to the UPS must be minimized.

The BCB has the following features:



- Isolation.
- Short circuit protection.
- In case the inverter locked by battery under voltage, the switch automatically disconnects, avoid the damage of battery over discharge.
- If equipped with a REPO button, can use the EPO button to remotely disconnect the BCB.

To obtain the required backup time, the batteries may be connected in parallel. In this case, each battery string must be connected to a separate BCB.

**NOTE: Only trained personnel must operate and maintain the BCB.**

## 7.7 Battery Installation and Connection



**WARNING! Only a qualified engineer should install and connect the batteries. The battery has hazardous high voltage and requires reliable insulated tools for safety protection.**

1. Before installation, check the battery appearance to ensure that there is no damage, inspect and count the accessories, and carefully read this manual and the user manual or installation instruction provided by the battery manufacturer.
2. Make sure that there is at least a 0.4 in. (10 mm) gap between the batteries in the vertical direction, for the free circulation of the ambient air of the batteries.
3. Clearance should be maintained between the battery top and the upper layer to facilitate for the monitoring and maintenance of the battery.
4. The batteries should be installed from the bottom to top to avoid a too high gravity center. The batteries should be installed properly and protected from vibrations or shock.

## 7.8 Internal Battery

Vertiv™ Liebert® APM2 UPS supports the following internal modular VRLA batteries. Each Liebert® APM2 UPS supports up to sixteen integrated VRLA battery modules. Each individual battery module contains BCB, eight 9AH VRLA batteries connected in series, and communications to central UPS BMS. The 208 V system uses two battery modules in series, and the 400 V and 480 V systems use four battery modules in series. Detailed information can be found in Liebert® APM2 internal VRLA battery module, refer **Vertiv™ Liebert® APM2 Modular EBC User Manual SL-71373**.

UPS Model	Minimum Battery Jars/UPS Number Derating	Battery Jars in One String (Series)	Battery Bus Voltage	Internal Battery Capacity/Ah	Battery Quantity
Liebert® APM2 60 kVA 208 V	16	2	218	72	2≤n≤16
Liebert® APM2 120 kVA 400 V	32	4	435	36	4≤n≤16
Liebert® APM2 120 kVA 480 V	32	4	435	36	4≤n≤16

Liebert® APM2 UPS also supports the following internal modular Lithium-ion batteries. Each Liebert® APM2 UPS supports up to eight integrated UPS Lithium-ion battery modules. The 208 V system uses one battery module in series, and the 400 V and 480 V systems use two battery modules in series. Refer **Vertiv™ Liebert® APM2 Lithium Battery Module\_SL-71173** for more information of Liebert® APM2 internal VRLA Lithium-ion battery module.

UPS Model	Minimum Lithium-ion Modules/UPS Number Derating	Lithium-ion Modules in One String (Series)	Battery Bus Voltage	Internal Battery Capacity/Ah	Battery Quantity
Liebert® APM2 60 kVA 208 V	1	1	237.6	14	1≤n≤8
Liebert® APM2 120 kVA 400 V	2	2	475.2	14	2≤n≤8
Liebert® APM2 120 kVA 480 V	2	2	475.2	14	2≤n≤8

### 7.8.1 Lithium-ion Battery Cabinet

Vertiv™ Liebert® APM2 series UPS supports the Vertiv™ EnergyCore Lithium battery. The EnergyCore Lithium is a high power standby battery cabinet designed for use with a UPS. The EnergyCore Lithium is configured based on the requirement of customer. Various battery modules are available in different series configurations, with increasing number of battery modules allows for higher voltage and additional energy storage. For detail information, refer to the **Vertiv™ EnergyCore Lithium 5 Service Manual\_SL-71289** available at [Vertiv.com](https://www.vertiv.com).

## 7.9 External Modular VRLA Battery Cabinet (Option 1)

If users wish to choose a battery system with a long backup time, they can choose modular external battery cabinet (EBC), which can carry more battery modules. For lead-acid batteries, up to 32 modules can be placed. For more details, refer **Vertiv™ Liebert® APM2 Modular EBC User Manual SL-71373**.

## 7.10 External Matching VRLA Battery Cabinet (Option 2)

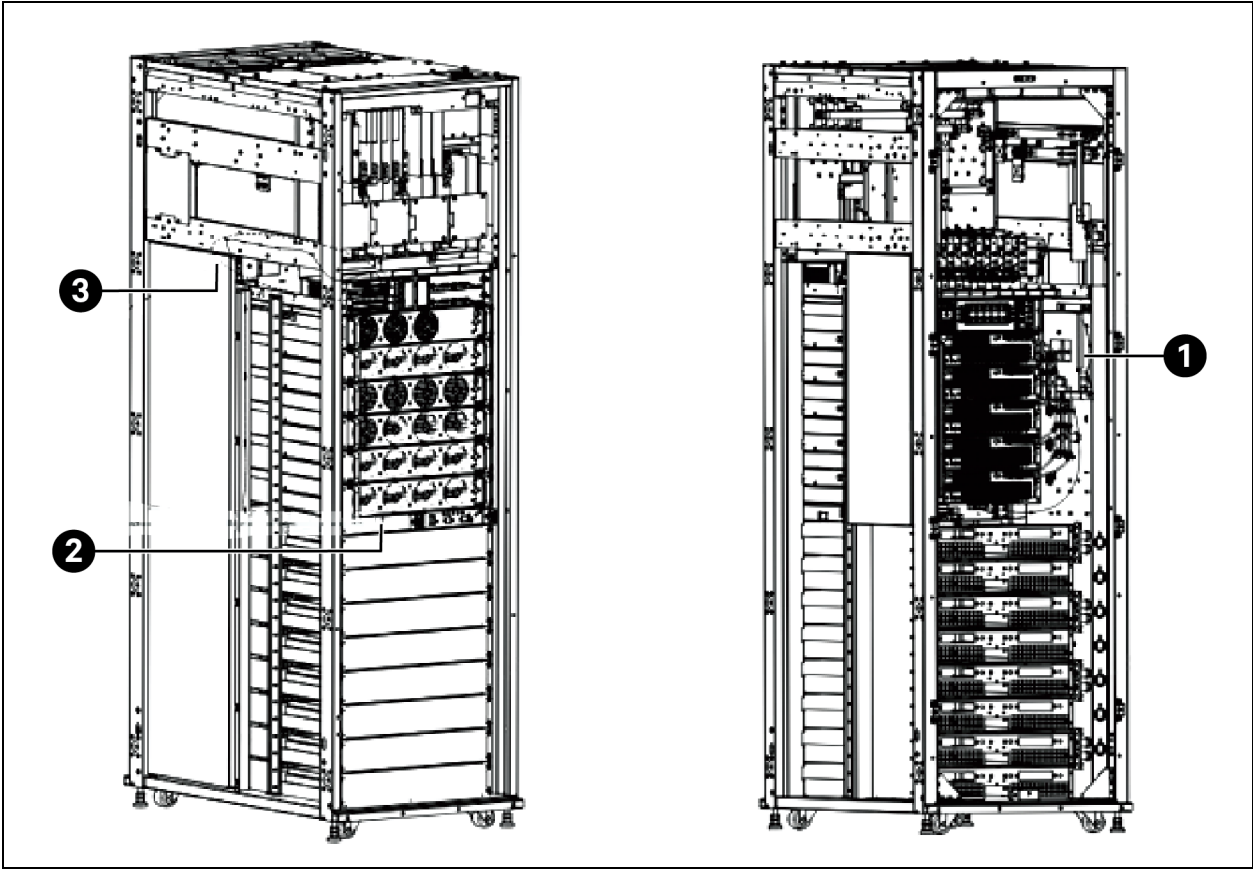
Vertiv™ Liebert® APM2 10 kVA to 120 kVA is compatible with optimized matching VRLA cabinet which can be attached to UPS for line-in-match solution including internal power cabinet. Refer **Vertiv™ Liebert® APM2 UL EBC User Manual SL-71958** for detail information.

## 7.11 Battery Ground Fault Detector (Option)

Vertiv provides an optional battery ground fault detector. It includes a mutual inductor and PCB, those will be installed assembled in UPS before out of Vertiv factory.

**NOTE: If a battery ground fault detector is installed, the positive, negative and neutral battery cables from the battery into the BCB cabinet must be routed through the hole of the mutual inductor of the battery ground fault detector, while other cables must bypass the mutual inductor for connection.**

Figure 7.1 Battery Ground Fault Detector for Vertiv™ Liebert® APM2 60 kVA 208 V and 120 kVA 480 V UPS



Item	Description
1	Ground fault detection board
2	CT
3	This part inside frame

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## 8 Parallel System and Load Bus Synchronization System

This chapter provides details on the installation of the parallel system and LBS system.

### 8.1 General

The parallel system is comprised of up to four UPS modules of the same power rating and connected in parallel without the need for a centralized mains static bypass. Instead the bypass static switches of each UPS share the load when the system transfers to the mains bypass supply.

In a parallel system, each module is internally identical to the single module configuration. A parallel system requires inter-module control signals to manage the load sharing, synchronizing, and bypass switching. The control signals are connected through parallel cables, which are multicore ribbon cables connected between the units of the system to form a closed loop.

### 8.2 System Installation Procedures

The basic installation procedure of a parallel system is the same as that of a single module system. The installation of a parallel UPS should follow the installation procedure for a single UPS module with the additional requirements detailed in this section.

#### 8.2.1 Preliminary Checks

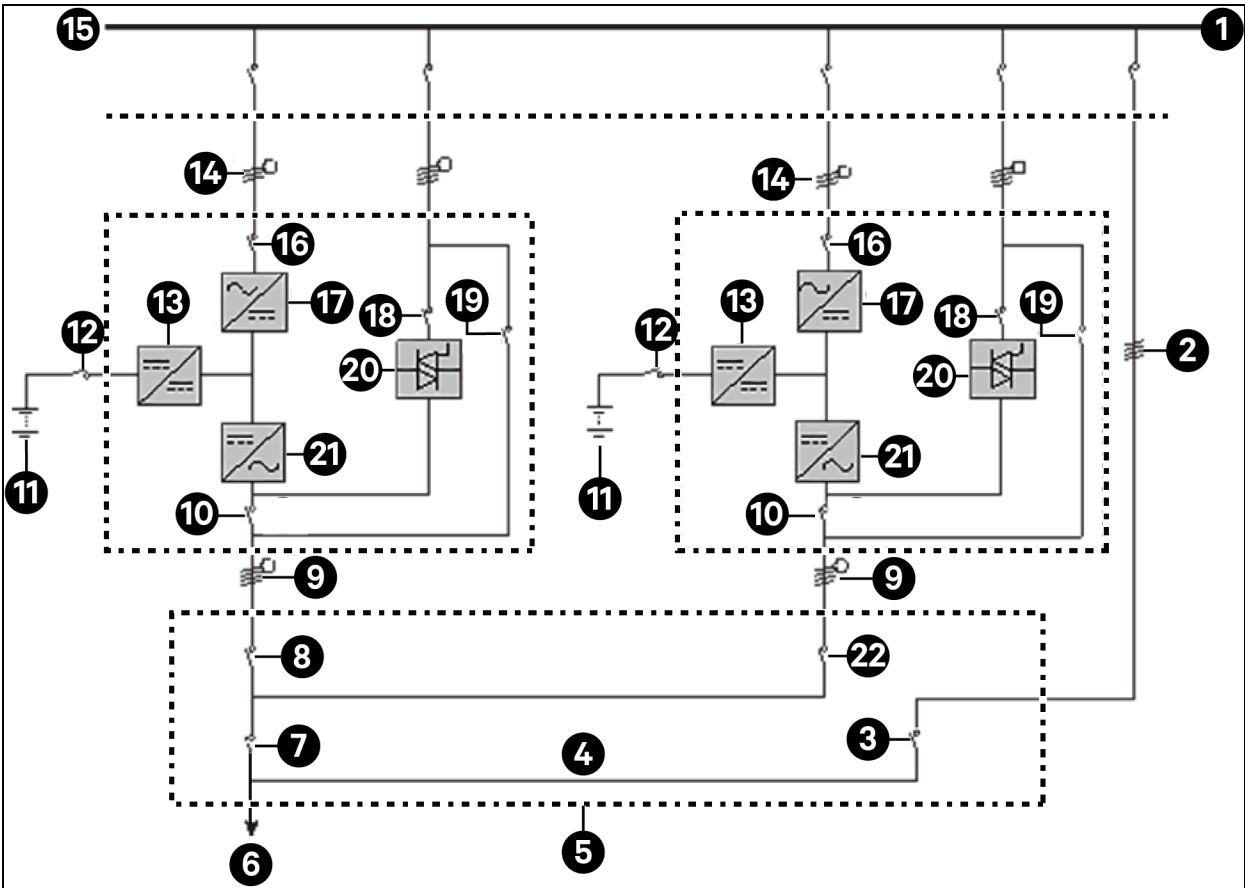
Ensure that the selections of the parallel cables are correct, and that the modules are of the same rating, model, and use the same software and hardware release.

**IMPORTANT! Vertiv service personnel must configure each module separately using Vertiv setting software to achieve coordinated operation of the modules in the parallel system.**

#### 8.2.2 Cabinet Installation

Place the UPS modules side by side and interconnect as shown in **Figure 8.1** on the next page. The output distribution mode (MOB1, MOB2 must be configured) shown in **Figure 8.1** on the next page is recommended to facilitate maintenance and system testing.

Figure 8.1 Schematic of Typical Parallel System with Common Input, Separate Batteries, and Output



Item	Description	Item	Description
1	External bypass switch	12	BCB
2	External maintenance bypass	13	Charger
3	MBB	14	Mains input L1, L2, L3, N
4	BCB	15	Input power supply
5	MBB	16	RIB
6	To load	17	Rectified
7	QOP	18	BIB
8	QE1	19	MBB
9	L1, L2, L3, N	20	Static switch
10	Q5	21	Inverter
11	Battery 1		

NOTE: RIB, BIB, MIB, and MBB are optional.

### 8.2.3 External Protective Device



**WARNING!** High earth leakage current. Earth connection is essential before connecting the input supply (including both the mains supply and battery). The equipment must be earthed in accordance with the local electrical regulations.

### 8.2.4 Power Cable

The power cable of dual bus power system is similar to that of single system. See the [Power Cable Wiring](#) on page 30.

The bypass and rectifier input supplies must use the same neutral line input terminal. If the input has a current leakage protective device, the device should be installed with upstream of the neutral line input terminal.

### 8.2.5 Parallel Cable

The cables must be interconnected in a ring-shaped connection between the UPS modules, as shown in **Figure 8.2** below. The ring connection ensures the reliability of the control of the parallel system.

**NOTE:** Shielded and double insulated parallel cables are available in lengths of 16.5 ft., 32.1 ft., and 49.3 ft. (5 m, 10 m, and 15 m).

The parallel cable of one single UPS is connected from the PARA1 port of the communication box to the PARA2 port of the immediate next single machine communication box and is in sequence. The front panel of the communication module provides parallel ports, as shown in **Figure 8.2** below. Make sure to check all the reliable cable connections before starting up the UPS system.

**Figure 8.2 Parallel Signal Cables Connection (Parallel System)**

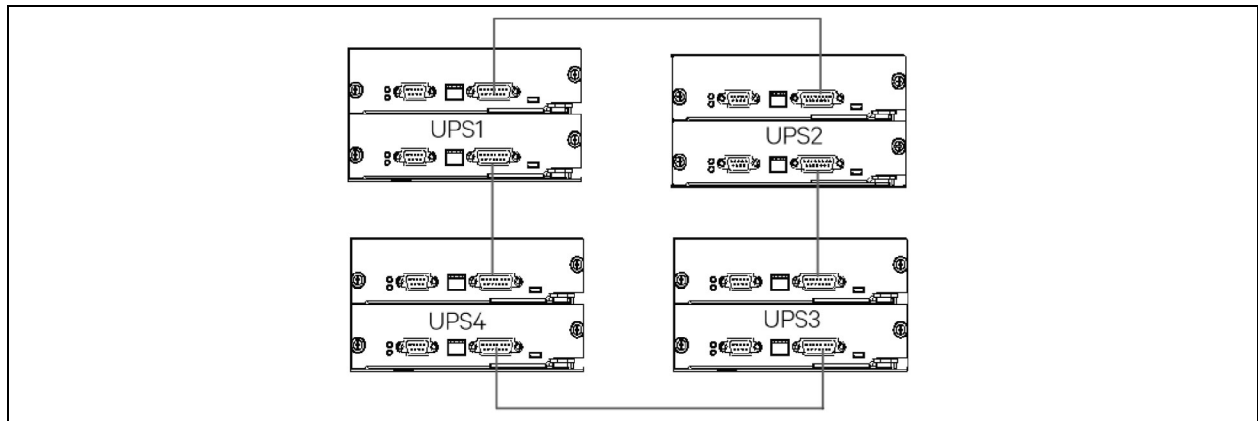
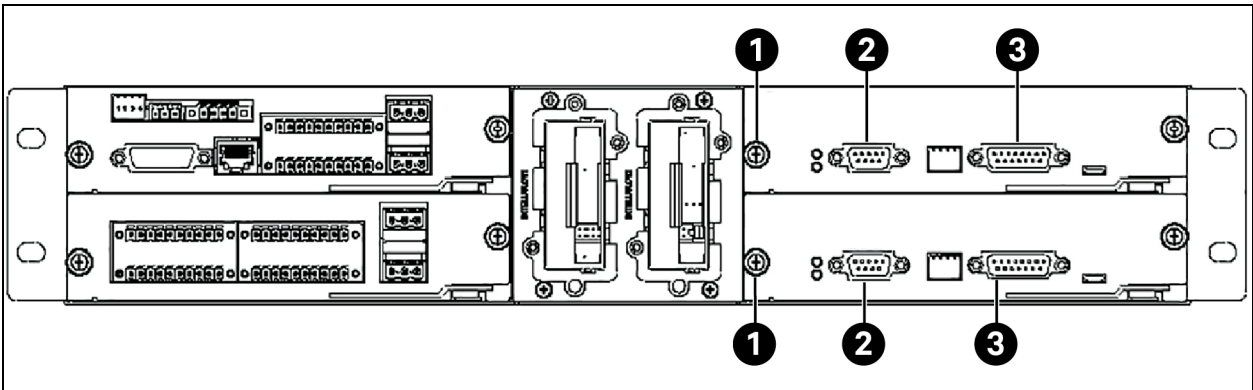


Figure 8.3 Parallel Port on the System Control Module



Item	Description
1	U4
2	LBS
3	Parallel

8.2.6 Remote Emergency Power Off

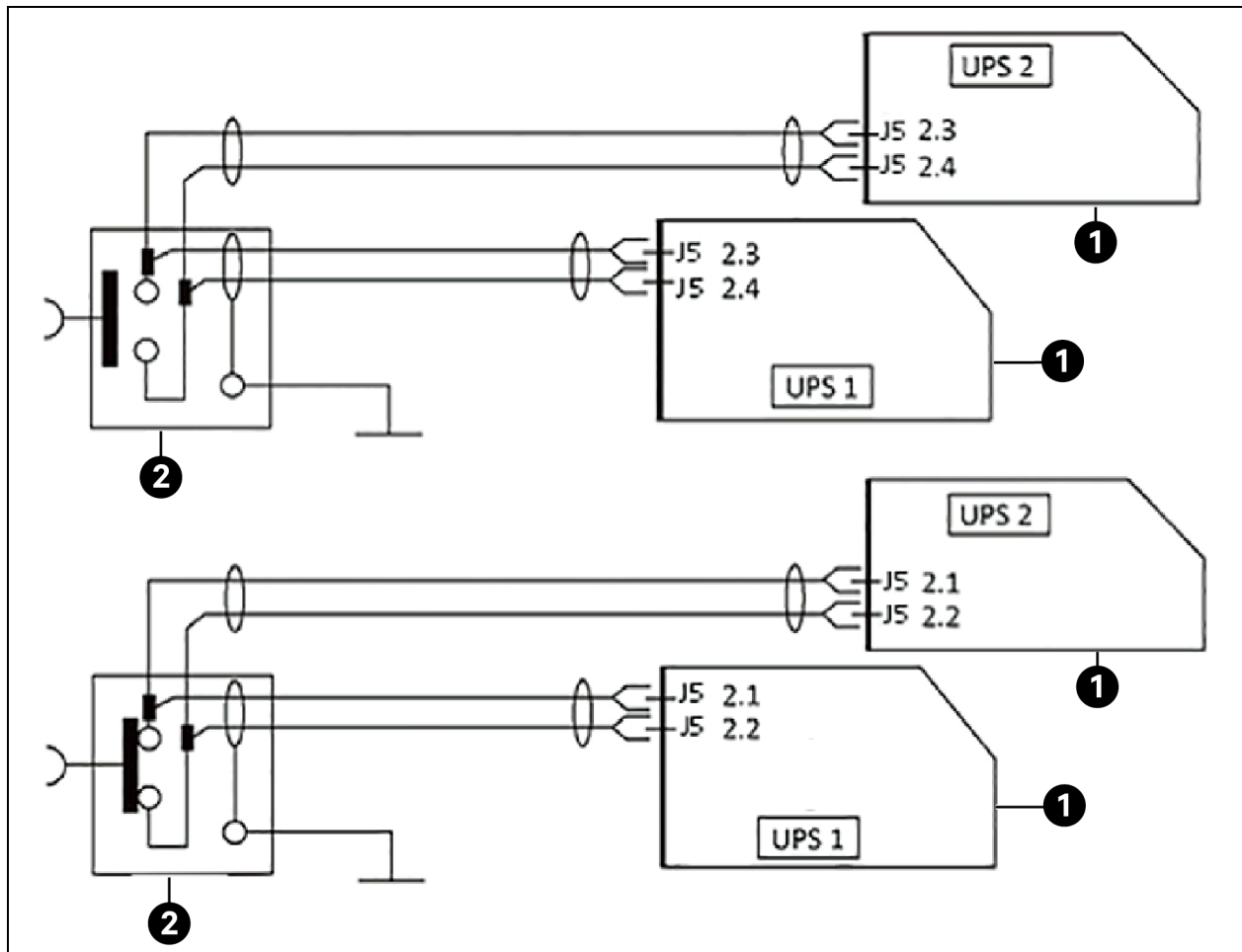
In addition to the remote emergency power off (REPO) switch provided on the operator control and display panel of each UPS module for controlling the REPO of each module respectively, the parallel system also provides remote REPO function for controlling all UPS modules to shutdown simultaneously from a remote terminal, as shown in **Figure 8.4** on the facing page.

**NOTE:** The REPO switch must provide dry contact signal, which is normally open or normally closed. The open circuit voltage provided is 12 VDC, <20 mA.

**NOTE:** The external REPO device is consists of another control system which can disconnect UPS mains supply or bypass input. Pins 1 and 2 of the normally closed REPO port on the integrated control module is linked in factory.



Figure 8.4 REPO Circuit Diagram



Item	Description
1	Integrated control module
2	REPO

**NOTE:** In Figure 8.4 above, the upper one is normally open type, and the lower one is normally closed type.

## 8.3 Operation Procedures for Parallel System

Only one step is required at a time, and the subsequent step may only be completed when this operation step of each UPS module has been completed.

### 8.3.1 Start-up Procedures in Normal Mode

These procedures are applicable to start the UPS under total power down state, which means the UPS or the maintenance bypass switch has not supplied the load before. Make sure UPS has been completely installed and commissioned by the engineer, and external power supply switch has been turned off.



**WARNING!** These procedures result in mains voltage being applied to the UPS output terminals. If any load equipment is connected to the UPS output terminals, check that it is safe to apply power. If the load is not ready to receive power, disconnect the downstream load switch, and place a warning label on the connection point of the load.



**WARNING!** In parallel UPS configuration, all operations related to disconnection or connection of the maintenance bypass switch must be performed within three seconds to avoid overload situations and damage to the maintenance bypass switch.

#### Procedure to turn on the UPS from a fully powered down condition:

1. Confirm that the total external maintenance bypass switches are disconnected.
2. Open the front door of each UPS in turn.
3. Ensure that the internal maintenance bypass switch Q3 is disconnected.
4. Check all the input cables, parallel cables and copper bars are connected properly.
5. Close the total bypass input switches.
6. Close the output switch Q5, BIB Q2, RIB Q1, and all external output isolating breakers (if any) of each UPS in turn.

When the above steps are complete, the system is powered on, and the start-up screen pops up.

Wait 25 seconds and confirm that the touchscreen shows that the rectifier power supply and the bypass power supply are normal.

If not, check whether the Q1 and Q2 breakers are closed. Then the rectifier starts up, about 30 seconds after the rectifier enters normal operation, the bypass static switch is closed.

When the rectifier start process is finished and the rectifier indicator turns solid green, close the external BCB.

For each UPS, manually turn on the inverter. The inverter starts up, the whole UPS system will power the load.

### 8.3.2 Maintenance Bypass Procedures



**WARNING!** If the UPS system is composed of more than 2 parallel UPS modules, and the load capacity exceeds the single module capacity, do not use the internal maintenance bypass switch.

Maintenance Bypass will transfer the load from UPS power supply protection state to direct connection with AC input bypass state.



**CAUTION:** Power supply interruption danger. Before performing this procedure, check the LED information first and make sure the bypass is normal and that the inverter is synchronized. Otherwise, load power may be interrupted for a while.

1. Manually turn off the inverter of each UPS. The power flow diagram shows **Inverter Off** and the buzzer alarms. The load transfers to the static bypass, and the inverter shuts down. All UPS units are then transferred to Bypass Mode.

**NOTE:** Pressing the Silence Off button silences the alarm; however, the alarm message on the touchscreen does not disappear until the alarm status is cleared.

2. Close the UPS all the external maintenance bypass breakers but, do not close the internal maintenance bypass switch Q3 of each UPS. While you are closing these switches, all the external maintenance bypass should be parallel connected with static bypass of each of the UPS's. The touchscreen of each UPS should display Main Switch Closed.
3. Disconnect the output switch Q5 of each UPS in turn, and the maintenance bypass can supply power to the load.



**CAUTION:** Load is not secured on the maintenance bypass anymore unless there is power generator running instead of normal grid utility.

4. Pressing the EPO button of each UPS stops the operation of rectifier, inverter, static switch, and battery, but this action will not affect the maintenance bypass power the load normally.

**NOTE:** In maintenance mode, the load is directly fed by the mains power instead of the pure AC power from the inverter.

5. Disconnect the rectifier input switch Q1 and bypass input switch Q2 of each UPS in turn. After all the internal power supply is disconnected and the touchscreen does not display will also be turned off.

**NOTE:** Wait for 10 minutes before maintenance for the internal DC bus capacitance to get discharged.



**WARNING!** The parts of UPS circuits also have hazardous voltage, though the rectifier input switch, bypass input switch and battery switch are disconnected. Therefore, the UPS maintenance is applicable to qualified personnel only.

### 8.3.3 Procedures for Isolating One UPS Module from Parallel System

**IMPORTANT!** The isolation procedures should be carried out only by Vertiv certified service personnel.

**NOTE:** After isolating one UPS module, when the parallel system is not overload, then proceed with steps below.

To isolate the UPS module from the parallel system for any major repairing activity, follow the steps below.

1. Turn off the rectifier, inverter, static switch, and battery with the EPO button on the GHMI.

**NOTE:** Turning off the rectifier, inverter, static switch, and battery will not affect all the other UPS in parallel system and the load will remain powered normally.

2. Disconnect the external power mains switch, rectifier input switch Q1, external power bypass switch, bypass input switch Q2, output switch Q5, BCB, and single module external output switch.



**WARNING!** Place a notice at the AC input distribution (far away from the UPS) to alert that UPS maintenance is being performed.

**NOTE:** Wait 10 minutes for the internal DC bus capacitance to discharge. Then the UPS is completely shutdown.

### 8.3.4 Procedures for Inserting One isolated UPS Module in Parallel System

**IMPORTANT!** These procedures must only be carried out by service personnel of Vertiv or under their guidance.

The following procedures are used to reintegrate a UPS module that has been previously isolated from the parallel system:

1. Confirm that the I/O cable, battery cable, and parallel cable of the single module are correctly connected.
2. Confirm that the maintenance bypass switch Q3 or the single module external maintenance switch is disconnected.
3. Close the output switch Q5, external output switch, external power bypass switch, bypass input switch Q2, rectifier input switch Q1, and external power mains switch of each UPS in turn.
4. When the single module starts, close the BCB and then manually turn on the inverter.

Wait for few seconds after starting the inverter the UPS system, it connects with existing systems for parallel operation automatically.

### 8.3.5 Procedures for Completely Powering Down UPS

Complete UPS shutdown and load power off should follow the below procedure. All power switches, isolating switches, and breakers are disconnected, and then UPS no longer supplies power to the load.



**CAUTION:** In the powering down procedure of the UPS, the load power will be cut off.

1. Press the EPO button of each UPS to stop the operation of rectifier, inverter, static switch, and battery.
2. Disconnect the RIB Q1 and BIB Q2 of each UPS that will close the internal power supply and the touchscreen display will stop functioning.
3. Disconnect the output breaker Q5 of each UPS.



**CAUTION:** Place a notice at the AC input distribution (generally far away from the UPS) to alert that the UPS maintenance is being performed.



**CAUTION:** Wait 10 minutes while the internal DC bus capacitance discharging. Then the UPS is completely shutdown.



**WARNING!** Hazardous battery voltage. The battery terminals will have hazardous voltage even after the UPS complete shutdown.

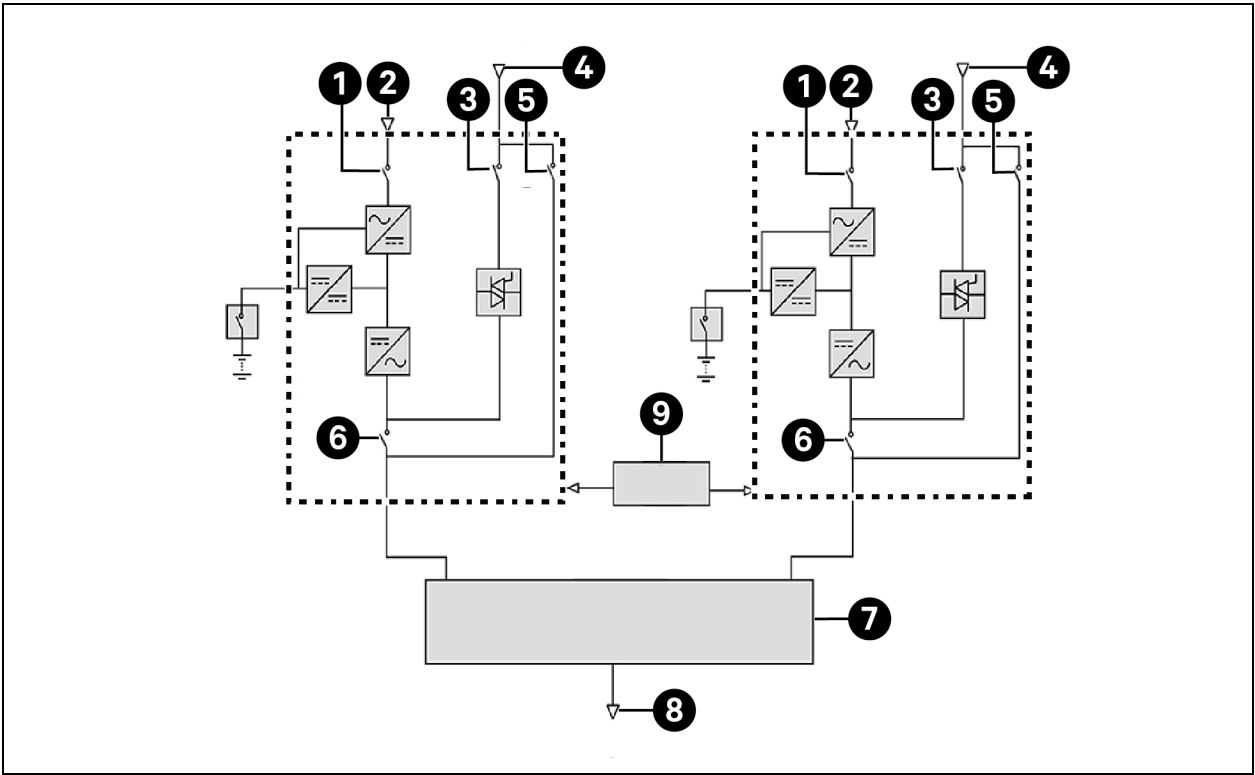
## 8.4 Load Bus Synchronization System

### 8.4.1 Cabinet Installation

An LBS system consists of two independent UPS systems, each containing one or more parallel UPS modules, as shown in **Figure 8.5** below and **Figure 8.6** on the next page. The LBS system is high reliability and applicable to the load with multiple inputs. For single input load, a STS can be installed to feed power to the load.

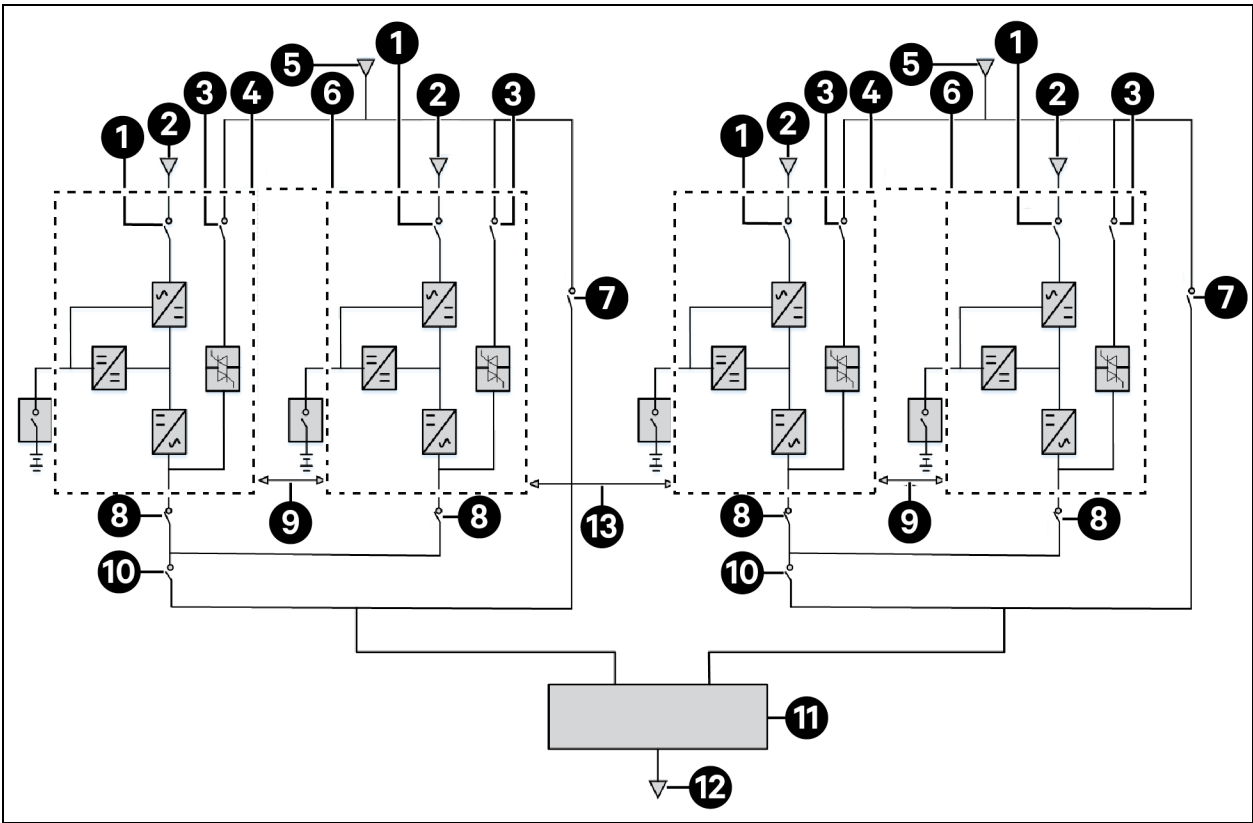
The system uses the LBS cables to keep the output of two independent UPS systems in synchronization. One set of UPS system (single/parallel) is designated as the primary, the other set of UPS system (single/parallel) is designated as the secondary for the operation in LBS mode.

**Figure 8.5 LBS System (UPS Module)**



Item	Description	Item	Description
1	Q1	6	Q5
2	Rectifier	7	STS
3	Q2	8	To load
4	Bypass	9	LBS
5	Q3		

Figure 8.6 LBS System (Parallel System)



Item	Description	Item	Description
1	Q1	8	MOB
2	Rectifier	9	Parallel cable
3	Q2	10	MIB
4	UPS1	11	STS
5	Bypass	12	To load
6	UPS4	13	LBS
7	MBB		

NOTE: RIB, BIB, MIB, and MBB are optional.

NOTE: In a dual bus system, the two UPS systems must have the same voltage and frequency, and the load should not exceed the power rating of a UPS module system.

8.4.2 External Protective Device

See [External Protective Devices](#) on page 36.

8.4.3 Power Cable

The power cable of dual bus power system is similar to that of single system. See the [Power Cable Wiring](#) on page 30.

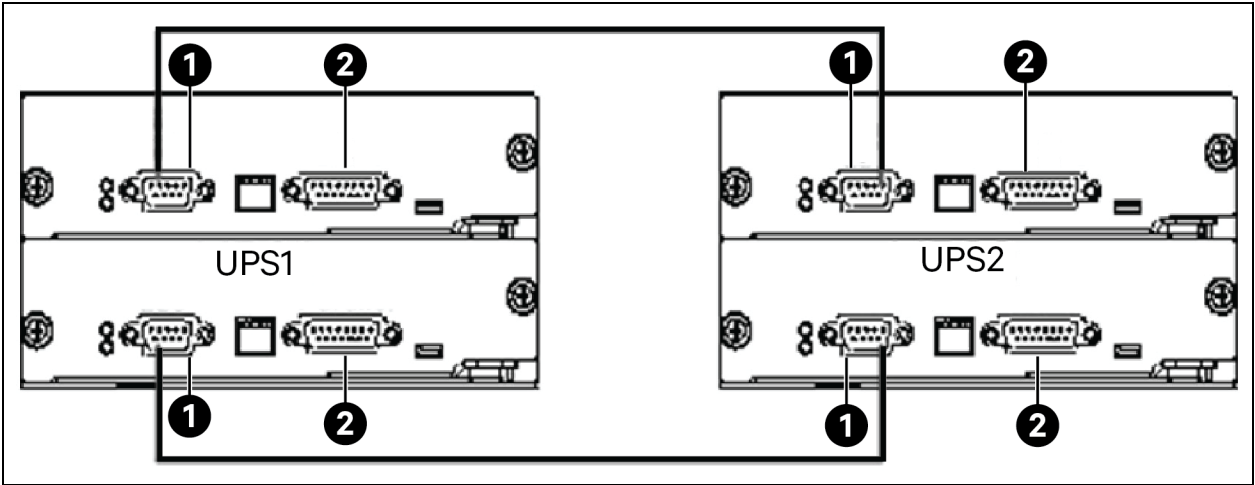
The bypass and rectifier input supplies must use the same neutral line input terminal. If the input has a current leakage protective device, the device should be installed with upstream of the neutral line input terminal.

8.4.4 Load Bus Synchronization Cable

For 120 kVA dual bus system, connect the optional LBS cables and 32.1 ft., 49.3 ft., and 65.7 ft. (10 m, 15 m, and 20 m) between the LBS ports or PARA2 and LBS port of the two UPS systems.

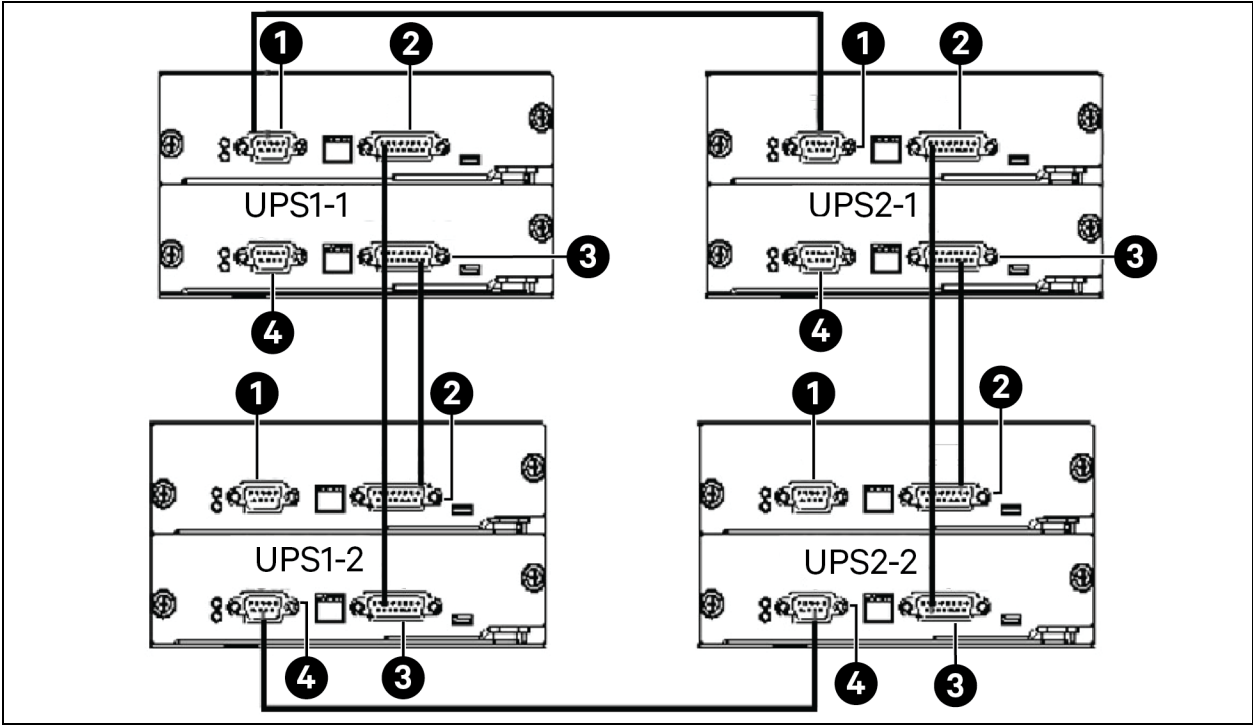
**NOTE:** You must use the shortest LBS cable suitable for the application and must not coil excess. Meanwhile, separate the LBS cable from the power cables to prevent electrical interferences.

Figure 8.7 LBS Cable Connection of Typical Synchronous Double Busbar System (Single Unit)



Item	Description
1	LBS
2	Parallel

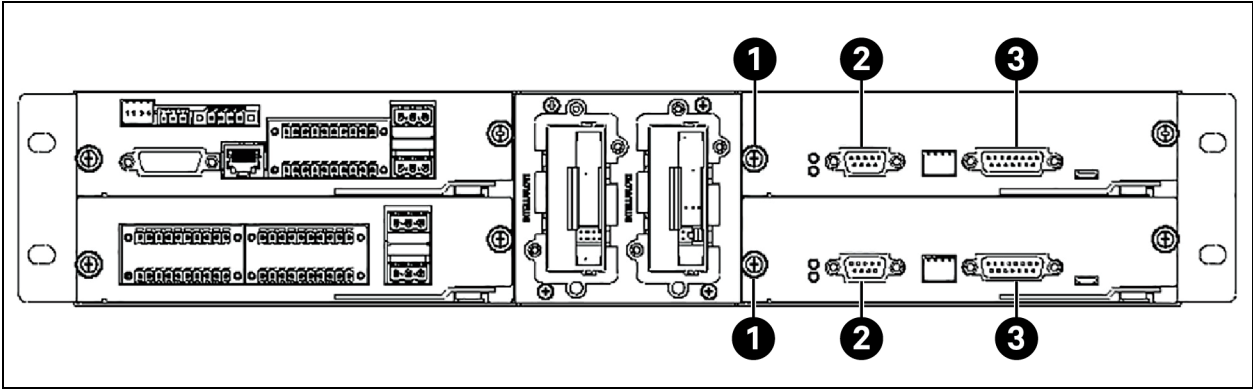
Figure 8.8 LBS Cable Connection of Typical Double Busbar System (Single and Parallel)



Item	Description
1	LBS 1
2	Parallel 1
3	Parallel 2
4	LBS 2



Figure 8.9 LBS Port



Item	Description
1	U4
2	LBS
3	Parallel

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## 9 Vertiv™ Liebert® APM2 Option Configurations

This chapter provides the information about available options for Liebert® APM2 UPS.

### 9.1 Options List

**Table 9.1 Options List**

Number	Option Name	Remark
1	Battery temperature sensor kit	N/A
2	Battery ground fault kit	N/A
3	Seismic anchor kit	N/A
4	Vertiv™ Liebert® IS-UNITY-DP card	Vertiv™ Liebert® Intellislot™ ports 1 to 2
5	Vertiv™ Liebert® IS-UNITY-LIFE card	Liebert® Intellislot™ ports 1 to 2
6	SIC card	Liebert® Intellislot™ ports 1 to 2
7	UF-RS-485 card	Liebert® Intellislot™ ports 1
8	Vertiv™ Liebert® IS-RELAY card	Liebert® Intellislot™ ports 1 to 2
9	External remote LBS box	N/A
10	BCB cabinet	N/A
11	Parallel cable	Available in 16.5 ft., 32.1 ft., and 49.3 ft. (5 m, 10 m, and 15 m)
12	LBS cable	Available in 32.1 ft., 49.3 ft., and 65.7 ft. (10 m, 15 m, and 20 m)
13	Common source copper bar	N/A

**NOTE:** The RS-232 of Liebert® Intellislot™ 2 shares communication resources with the RS-485 of the HMI RJ-45 interface. To avoid conflicts, when using the HMI interface to communicate with BMS, the Liebert® IntelliSlot™ interface 2 can only connect to the Liebert® IS-Relay card.

### 9.2 Options Introduction

#### 9.2.1 Battery Ground Fault Kit

Liebert® APM2 UPS has an optional battery ground fault detector kit, it helps to detect and remove battery ground fault to ensure reliable system operation.

When a battery ground fault is detected, the indicator alarms On the UPS display panel.

The battery ground fault detector kit includes a mutual inductor and a PCB, to be installed in the BCB box. For the installation and connection of the battery ground fault detector, see [Battery Ground Fault Detector \(Option\)](#) on page 86.

#### 9.2.2 Seismic Anchor Kit

Liebert® APM2 UPS has an optional seismic anchor kits. It helps to avoid and reduce the damage to UPS caused by earthquake or vibration in the earthquake prone areas.

See **Table 9.2** on the next page for dimensions of the seismic anchor kit.

Table 9.2 Dimensions and Content of the Seismic Anchor Kit

Item	Width In. (mm)	Length In. (mm)	Quantity
Seismic anchor	2.4 (60)	23.1(585)	-
23.7 in. (600 mm) width cabinet	Two seismic anchors	M8 × 25 tapping screws	8
		M12 expansion bolts	6
47.3 in. (1200 mm) width cabinet	Four seismic anchors	M8 × 25 tapping screws	16
		M12 expansion bolts	12

Fix the UPS onto the concrete floor.



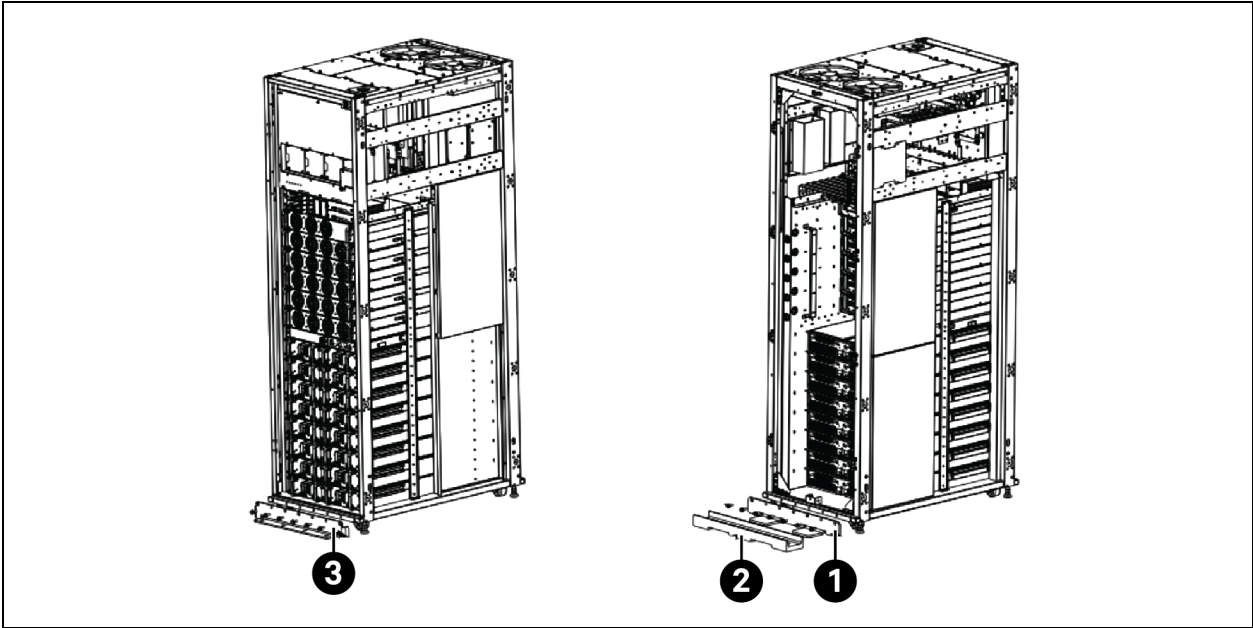
**WARNING!** Execute the installation according to the instructions. Failure to do so can cause personnel injury or damage to the UPS and seismic anchor kits.

Keep the seismic anchor kit, as shown in **Table 9.2** above, and one cross head screwdriver, a torque spanner, and an adjustable spanner handy before starting the installation.

Installing the Seismic anchor:

- 1. Use M8 × 25 tapping screws (four) to install seismic anchor on the rear bottom side of the UPS cabinet, and use M12 expansion bolts (three) to install seismic anchor on the ground, as shown in **Figure 9.1** below.

Figure 9.1 Seismic Anchor Dimensions for Vertiv™ Liebert® APM2 60 kVA 208 V and 120 kVA 480 V UPS



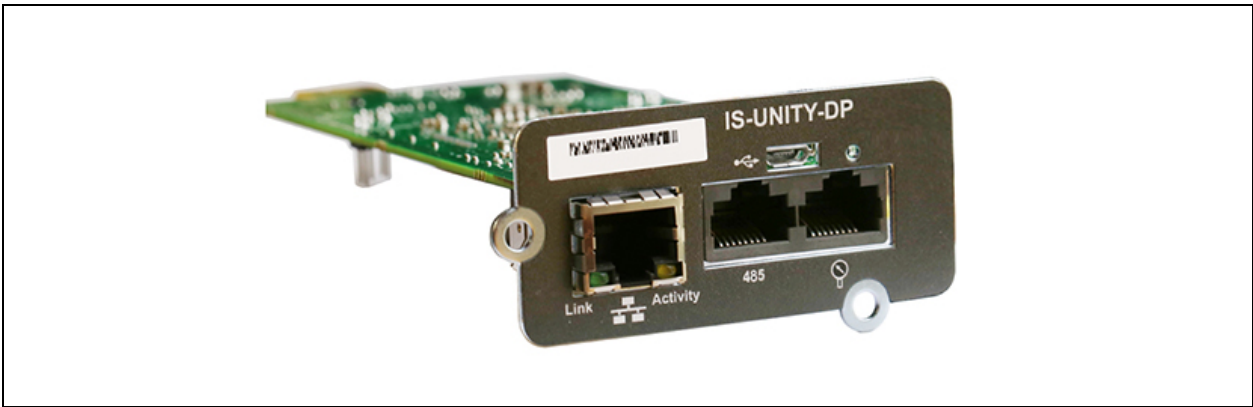
Item	Description	Quantity
1	Channel rear OSHPD Vertiv™ Liebert® APM2	1
2	Bracket back base	1
3	Bracket front base Liebert® APM2 208 FR1	1

9.2.3 Vertiv™ Liebert® IS-UNITY-DP Card

IMPORTANT! It is recommended to use the shielded cables to enhance the EMC.

The appearance of the Liebert® IS-UNITY-DP card is shown in Figure 9.2 below.

Figure 9.2 Liebert® IS-UNITY-DP Card



For further description and installation of the Liebert® IS-UNITY-DP card, refer to **Vertiv™ Liebert® IntelliSlot™ Unity Card User Manual\_SL-52645** Web, simple network management system (SNMP), Modbus, BACnet, and YDN23.

NOTE: Preserve the screws and port cover for future use.

Insert the UNITY card (along two sides of the Vertiv™ Liebert® IntelliSlot™ port) into the indicated position recommended in **Table 1.1** on page 1, and then tighten the screws.

## 9.2.4 Vertiv™ Liebert® IS-UNITY-LIFE Card

**IMPORTANT!** We recommend using the shielded cables to enhance the EMC.

The Liebert® IS-UNITY-LIFE card is shown in **Figure 9.3** below.

**Figure 9.3** Liebert® IS-UNITY-LIFE Card



For further description and installation of the Vertiv™ Liebert® IS-UNITY-DP card, refer to **Vertiv™ Liebert® IntelliSlot™ Unity Card User Manual\_SL-52645** Web, SNMP, Modbus, BACnet, and YDN23.

## 9.2.5 Vertiv™ Liebert® IS-Relay Card

Vertiv™ Liebert® APM2 UPS has an optional Liebert® IS-Relay card to use the dry contact signal to monitor the UPS functionalities. The functions of the Liebert® IS-Relay card are listed in **Table 9.3** on the facing page. See **Figure 9.4** below for more information of IS-Relay card.

**Figure 9.4** Liebert® IS-Relay Card



**Table 9.3 Function of UPS Vertiv™ Liebert® IS-Relay card**

Pin	Function	Operation
1	Common-Low Battery	N/A
2	Low Battery	Closed if low battery point occurs
3	Low Battery	Closed if battery is OK
4	Common-UPS Fault	N/A
5	UPS Fault	Closed if UPS fault occurs
6	UPS Fault	Closed if no UPS failure
7	Common-On Battery	N/A
8	On Battery	Closed if On battery power (utility failure)
9	On Battery	Closed if not On battery power (utility OK)
10	Signal Ground	Future release
11	Signal Ground	Future release
12	UPS Any-Mode Shutdown	Future release
13	Summary Alarm	Closed if no alarm conditions are present
14	Summary Alarm	Closed if summary alarm occurs
15	Common-Summary Alarm	N/A
16	On UPS	Closed if On UPS (inverter) power
17	On Bypass	Closed if On Bypass
18	Common-On Bypass	

For more information of the Liebert® IS-Relay card, refer to the **Vertiv™ Liebert® IntelliSlot™ IS-Relay Card User Manual\_SL-52645** in accessory.

The installation method of the Liebert® IS-Relay card is the same as that of the SIC card described in SIC card. See [Signal Cable Connection Steps](#) on page 49 for the cabling and routing of the signal cables.

## 9.2.6 Parallel Cable

Connect a module parallel cable from its PARA1 port to the PARA2 port of another module. Similarly connect other parallel cables.

Shielded and double insulated parallel cables available in lengths 16.5 ft., 32.1 ft., and 49.3 ft. (5 m, 10 m, and 15 m) must be interconnected in a ring configuration between the UPS modules, as shown in **Figure 8.2** on page 91.

The ring connection ensures the reliability of the control of the parallel system. Ensure to verify the cable connection before starting up the UPS system.

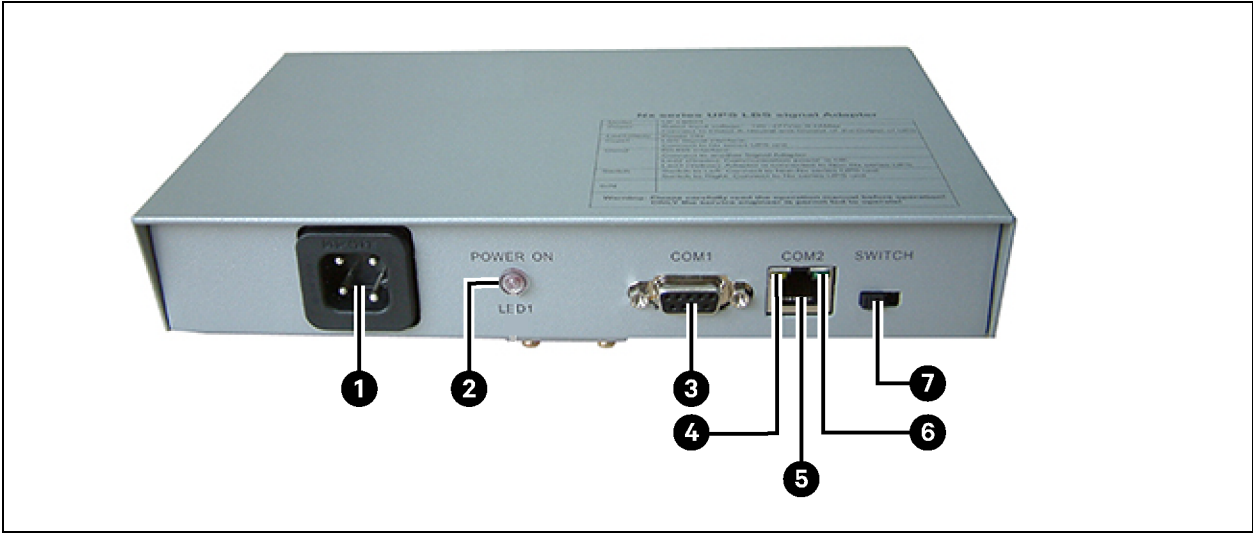
## 9.2.7 Load Bus Synchronization Cable

Shielded and double-insulated parallel control cables (LBS 1 and LBS 2) available in lengths of 32.1 ft., 49.3 ft., and 65.7 ft. (10 m, 15 m, and 20 m). The LBS cable must be interconnected in a branch configuration between LBS 1 and LBS 2 of any UPS modules, as shown in **Figure 8.7** on page 99, **Figure 8.8** on page 100, and **Figure 8.9** on page 101.

### 9.2.8 Load Bus Synchronization Extender

The LBS extender, as shown in **Figure 9.5** below is designed to extend the LBS function up to 4922 ft. (150 m) between the two UPS units or systems of a dual bus system, and it also enables an Vertiv™ Liebert® APM2 UPS to synchronize with other UPS models.

**Figure 9.5** LBS Adapter



Item	Description	Item	Description
1	Power Port	5	COM2
2	LED1	6	Green LED
3	COM1	7	Switch
4	Yellow LED		

For details about how to install and connect cables, refer to **Vertiv™ Dual Bus UPS LBSTM Expander/Adapter Installation Manual\_SL-71058**.



## 10 Communication

This chapter provides information about the compatible communication protocols.

Vertiv™ Liebert® APM2 Supports:

- SNMP Protocol communication.
- Modbus protocol communication.
- Dry contact communication.
- Velocity protocol communication.

### 10.1 Simple Network Management System Protocol Communication

Vertiv's IS-Unity-DP support SNMP protocol that helps to monitor the UPS through network.

IRM series sensor can also be connected to Vertiv™ Liebert® IS-Unity-DP card to provide environmental monitoring function. When the intelligent equipment generates an alarm, the Liebert® IS-Unity-DP card can notify the user by recording the log, sending trap information, and trigger mails.

The Liebert® IS-Unity-DP card provide three approaches for you to monitor your intelligent equipment and equipment room environment:

- Using web browser. Through the Web server function provided by UNITY card.
- Using network management system through the SNMP function provided by the Liebert® IS-Unity-DP card.

The Liebert® IS-Unity-DP card shall be installed at the Vertiv™ Liebert® IntelliSlot™ port. See **Figure 4.4** on page 42 for more information of position of various communication card. And the installation and configuration can refer to **Vertiv™ Liebert® IntelliSlot™ Unity™ Card Installer/User Guide\_SL-52645** through the link <https://www.vertiv.com/4a2068/globalassets/shared/Liebert-IntelliSlot-Unity-Card-UM-EN-NA-SL-52645.pdf>

### 10.2 Modbus Protocol Communication

The Modbus (RTU) protocol communication is supported by the Liebert® IS-Unity-DP card.

### 10.3 Dry Contact Communication

The UPS provides the following two dry contact communications:

- Vertiv™ Liebert® IS-Relay card (Optional)
- Dry contact port of central control module

#### 10.3.1 Communication through Liebert® IS-Relay Card

The UPS provides an IS-Relay card user to use dry contact signals to monitor the UPS. For the installation and use of the IS-Relay card, refer to **Vertiv™ Liebert® IntelliSlot™ IS-Relay Card User Manual**.

### 10.3.2 Communication through Dry Contact Port of Central Control Module

For field specific needs, the UPS may need auxiliary connection to have functions like acquiring external equipment status information, providing alarm signals to external devices, and REPO. These functions are realized through the following interfaces on the bypass control module:

- Input dry contact port status information.
- Output dry contact ports of alarm signal.
- EPO input port.

For the functions and detailed information of these ports, see [Signal Cable Wiring](#) on page 42.

# 11 Service and Maintenance

The UPS system (including the battery) requires periodic service and maintenance to ensure long service life. This chapter provides information about the service life, regular inspection, maintenance, and replacement of the key UPS components.

The UL9540 ESS system requires an upstream input circuit breaker (feeder breaker), which is customer supplied responsibility for field installation, with a means of accessible manual disconnect. The customer must ensure that all LOTO devices are rated according to specification of manufacturer KAIC as required by NFPA 70E and CSA Z462 per table 12. Before beginning any electrical installation or maintenance of ESS system, ensure proper LOTO procedure is followed for all upstream feeder breakers, and downstream output breakers directly connected to the UPS, and any DC breakers for the battery circuit to properly isolate power. The proper LOTO procedure will be determined by manufacturer for all applicable equipment. The size and type of LOTO device will be dependent on manufacture and size of disconnect device used. Refer to the manufacturer-supplied user information for all applicable equipment.

If the integrated MBB option is selected with the UPS, all LOTO devices must be applied to external upstream feeder breakers, external downstream output breakers, and external DC breakers. Applying LOTO to the integrated MBB is not sufficient to isolate power to the UPS when accessing the power cabling terminals.

Arc Flash Ratings should be determined as part of customer site arc flash coordination study. Ground fault detection is required per NFPA 70E and CSA Z462. For compliance with UL9540 ESS system requirements for the LOTO procedure of the DC source Vertiv™ EnergyCore Lithium 5 battery cabinet, refer to the **Vertiv™ EnergyCore Lithium 5 User Manual SL-71251**.

**NOTE: Effective maintenance of the UPS system can reduce the risk of UPS failure and will increase the UPS service life.**

## 11.1 Safety for Service and Maintenance



**WARNING! Service and maintenance must be performed by trained personnel only. Replacement of the device must be done by trained personnel only. Failure to follow this information can cause the device to malfunction.**



**WARNING! The neutral line has hazardous voltage. When servicing the UPS, use caution to prevent accidental injury or death. Use personal protective equipment.**



**WARNING! For the UPS without switch or single switch, switch off the connect device before maintenance, and check whether the UPS is powered off.**



**CAUTION: The components that can only be accessed by opening the protective cover with tools cannot be operated by the user. Only qualified service personnel are authorized to remove such covers.**

## 11.2 Service Procedures of Power Module and Bypass Power Module



**WARNING! Service and maintenance must be performed by trained personnel only. Replacement of the device must be done by trained personnel only. Failure to follow this information can cause the device to malfunction.**

1. Remove the power modules and bypass power module from top to bottom to prevent cabinet toppling due to high gravity center.
2. Do not disassemble the power module, bypass power module, and central control module. They have high voltage inside.
3. Unplug the power and bypass power modules and wait 5 minutes.
4. Service the power modules and bypass power modules.
5. Wait 5 minutes after servicing.
6. Put the modules back into the cabinet.
7. Do not take out different types of modules out of the cabinet at the same time.

## 11.3 Key Components and Service Life of UPS

When in use, some components of UPS system will have shorter service life compared to the UPS due to abrasion. For the safety of the UPS supply system, it is necessary to have regular inspection and replacement of these components. This section introduces the key components of UPS and the reference years of service life. For systems under different conditions (environment or load rate) assessment and advice by service engineers on whether to replace the device are required with reference to the information provided in this section.

### 11.3.1 Life Parameters and the Proposed Replacement Time of Key Components

Key components in **Table 11.1** below are used in the UPS system. To prevent system failures due to some device failure by wear, it execute the regular inspection and replacement during its estimated life.

**Table 11.1 Life Parameters and the Proposed Replacement Time of Key Components**

Key Components	Estimated Life	Proposed Replacement Time	Proposed Inspection Period
Fan	Not less than 7 years	5 years to 6 years	1 year
Air filter	1 year to 3 years	1 year to 2 years	2 months
VRLA battery (5-year life)	5 years	3 years to 4 years	6 months
VRLA battery (10-year life)	10 years	6 years to 8 years	6 months

### 11.3.2 Replacement of Air Filter

**NOTE: The air filters need regular inspection and replacement, which depends on the environmental conditions of the UPS. Under normal environmental conditions, the air filters should be cleaned or replaced once every two months and need more frequent cleaning and replacement in dusty or other unclean environments.**

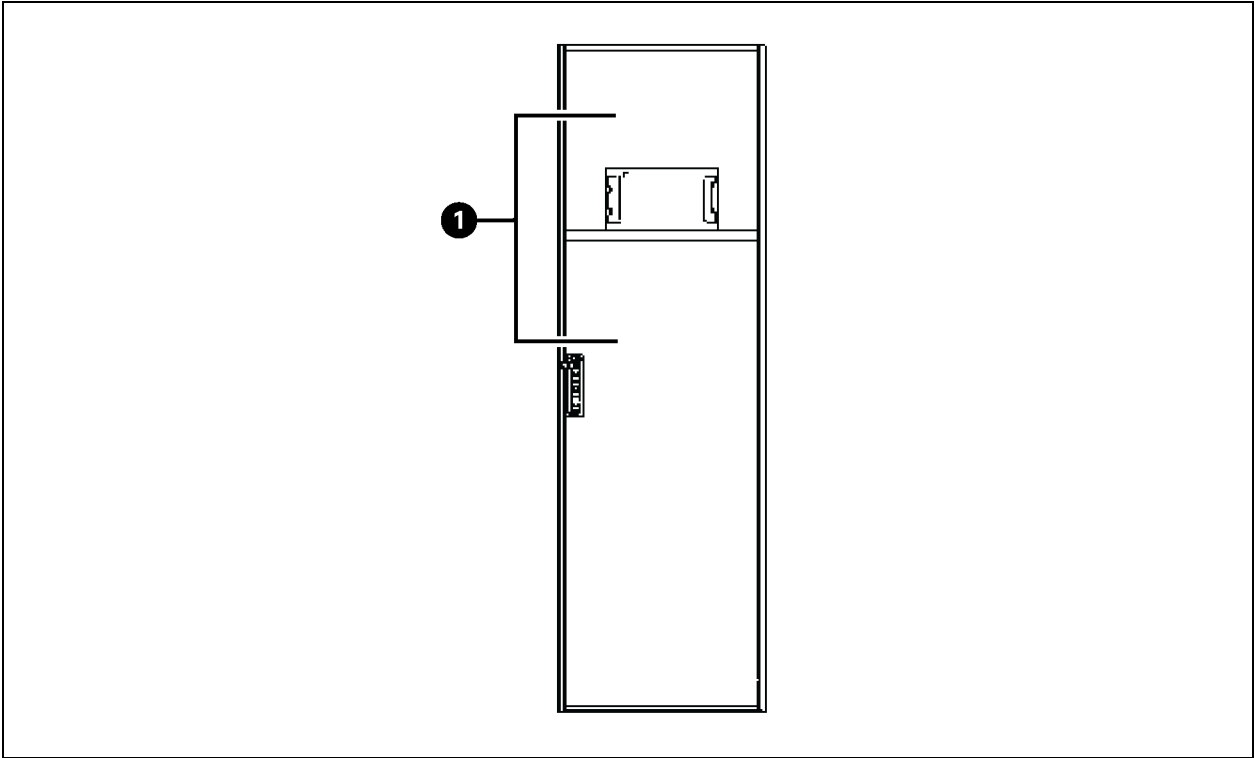
The UPS has air filters mounted on the rear side of the front door of the cabinet. The filters can be replaced while the UPS is operational.

The air filters are fixed by bars on both the sides. See **Figure 11.1** on page 114 for location of filter.

**To replace the air filters:**

1. Open the front door of the UPS.
2. Loosen the screws to remove one of the fixing bar while leave the other bar as it is.
3. Replace the clean air filter.
4. Reinstall the fixing bar and tighten all the fixing screws.

Figure 11.1 Replacing Air Filter



Item	Description
1	Air filter

11.4 Maintenance of UPS and Options

UPS and the options need common maintenance:

- 1. Keep good maintenance record. Keeping good maintenance record facilitates failure treatment.
- 2. Keep the surrounding clean, prevent dust and moisture entering the UPS.
- 3. Maintain appropriate ambient temperature of 68 °F to 77 °F (20 °C to 25 °C) for battery.

**NOTE:** Very low temperatures reduce the battery capacity. If it is too high the battery life will reduce.

- 4. Check wiring regularly for any damage.
- 5. Check and tighten screws. Tighten all the screws periodically, at least once a year.
- 6. Check regularly for any abnormality in the upstream or downstream switch to ensure that the input or output can be cut when the current is too large.
- 7. Regularly check the status of the LED light on the built in lightning protection board of the UPS. If the indicator light is abnormally off, replace the lightning protection board. See Power switch for the position of the lightning protection board.

Maintenance staff should be familiar with the typical ambient conditions where UPS is working in order to rapidly position which ambient conditions are unusual; the setting of UPS touchscreen should be known as well.

For information of the UPS battery maintenance, refer to Battery Maintenance.

## 12 Specifications

This chapter includes all the required UPS specifications.

### 12.1 Conformance and Standards

The Vertiv™ Liebert® APM2 has been designed to conform to the following standards:

- Safety UL 1778, 5th Edition, CSA 22.2 107.3-14.
- FCC PART 15-RADIO FREQUENCY DEVICES, Subpart B, CLASS A.
- Transportation ISTA 3B
- ISO 9001

The Liebert® APM2 has UL and ceUL approval.

The Liebert® APM2 UPS is ENERGY STAR certified satisfying ENERGY STAR Program Requirements Product Specification for UPS - Eligibility Criteria, Version 2.0.

### 12.2 Environmental Characteristics

**Table 12.1 Environmental Characteristics**

Item	Normative Reference	Rated Power (kVA)	
		Liebert® APM2 60 kVA 208 V	Liebert®APM2 120 kVA 480 V
Noise within 3.3 ft. (1 m) (in the front)	dB (A)	≤ 65	≤ 70
Altitude	m	≤ 1500; derate power by 1% per 328.1 ft. (100 m) between 4921.3 ft. (1500 m) and 9842.6 ft. (3000 m)	
Relative humidity	%RH	0 to 95%, non-condensing	
Operating temperature	°C	0 to 50. 0 to 40, at full load 41 to 45, 90% load; 46 to 50, 80% load	
Storage and transportation temperature for UPS	°C	<b>Storage:</b> -13 °F to 131 °F (-25 °C to +55 °C) <b>Transportation:</b> -40 °F to 158 °F (-40 °C to +70 °C)	
Over voltage level	Level 3	480 V at 100% load (+10%) 208 V and 220 V at 100% load (+20%)	
Pollution level	Level 2	/	
Grid system	TN, TT, IT	TN, TT, and IT	

## 12.3 Mechanical Characteristics

Table 12.2 Mechanical Characteristics

Item		Unit	Rated Power (kVA)	
			Vertiv™ Liebert® APM2 60 kVA 208 V	Liebert® APM2 120 kVA 480 V
Power module Dimensions (W × D × H)	power	kVA	15 kVA 208 V	30 kVA 480V
	Packing excluded	in. (mm)	17.4 x 20.4 x 3.5 (440 x 518 x 87)	17.4 x 20.4 x 3.5 (440 x 518 x 87)
	Packing included	in. (mm)	19.7 x 27.6 x 5.2 (500 x 700 x 130)	19.7 x 27.6 x 5.2 (500 x 700 x 130)
Net weight		kg (lbs)	26.4 (58.3)	26.4 (58.3)
Gross weight		kg (lbs)	30 (66.2)	30 (66.2)
System Dimensions (W × D × H)	Packing excluded	in. (mm)	23.7 x 40.56 x 78.8 (600 x 1030 x 2000)	23.7 x 40.56 x 78.8 (600 x 1030 x 2000)
	Packing included	in. (mm)	31.5 x 51.2 x 86.7 (800 x 1300 x 2200)	31.5 x 51.2 x 86.7 (800 x 1300 x 2200)
	Net weight (not include power module)	kg (lbs)	328 (723.2)	328 (723.2)
	Gross weight (not include power module)	kg (lbs)	500 (1102.4)	500 (1102.4)
Color		RAL7021 black orange pattern		
Protection degree, IEC (60529)		IP20 (front door open or closed)		

## 12.4 Electrical Characteristics (Input Rectifier)

Table 12.3 Rectifier AC Input (Mains)

Item	Unit	Rated Power (kVA)	
		Liebert® APM2 60 kVA 208 V	Liebert® APM2 120 kVA 480 V
Rated AC input voltage	VAC	208/220 4-wire (3-phase + N +PE)	480 4-wire (3-phase + N +PE) 480 3-wire (3-phase +PE)
Input voltage range	VAC	102 to 144 (full load) 72 to 102 (with derating)	408to 528 (full load) 288 to 408 (with derating)
Frequency	Hz	50/60 (range: 40 to 70)	
Power factor	kW/kVA, full load (half load)	0.99	
Input current	A, rated	208	174
Total current harmonic distortion	%	3	



## 12.5 Electrical Characteristics (Battery Bus)

Table 12.4 Battery

Item	Unit	Rated Power (kVA)	
		Vertiv™ Liebert® APM2 60 kVA 208 V	Liebert® APM2 120 kVA 480 V
Max. charging current	A	140	
Quantity of lead-acid cells (nominal)	Block	16 to 24 jars for lead acid battery (208V). 18-24 jars without derating	30 to 50 (12 VDC). (40 to 50 full load, 40 derated to 95%, 36 derated to 90%, 34 derated to 85%, 32 derated to 80%, 30 derated to 75%)
Float voltage	V/cell (VRLA)	2.27 (selectable from 2.20 V/cell to 2.30 V/cell) Constant current and constant voltage charge mode	
Temperature compensation	mV/°C/cell	-3.0 (selectable from 0 to -5.0 around 77 °F (25 °C) or 86 °F (30 °C), or inhibit)	
Ripple current	% C10	≤ 5	
Boost voltage	V/cell (VRLA)	2.35 (selectable from 2.30 to 2.40 Constant current and constant voltage charge mode)	
Boost control	/	Float-boost current trigger 0.050C10 (selectable from 0.001 to 0.070) Boost-float current trigger 0.010C10 (selectable from 0.001 to 0.025) 8hr safety time timeout (selectable from 8 hr to 100 hr) Boost mode inhibit also selectable	
EOD voltage	V/cell (VRLA)	<b>EOD Lower Voltage:</b> 1.60-1.67Vpc, 1.63Vpc default for lead acid battery <b>EOD Upper Voltage:</b> 1.67-1.85Vpc, 1.75Vpc default for lead acid battery	

## 12.6 Electrical Characteristics (Inverter Output)

Table 12.5 Inverter Output (to Critical Load)

Item	Unit	Rated Power (kVA)	
		Liebert® APM2 60 kVA 208 V	Liebert® APM2 120 kVA 480 V
Rated AC voltage	VAC	208/220 4-wire (3-phase + N + PE)	480 4-wire (3-phase + N + PE) 480 3-wire (3-phase + PE)
Frequency	Hz	50/60	
Power factor		0.99	
Overload	%	<105%, long time; <110%, ≤1 Hr; <125%, ≤10 minutes <150, ≤1 minutes >150, ≤200 milliseconds	
Max. short circuit current of inverter	A	200% rated output current , 200 milliseconds	
Non-linear load capability	kVA	24	

**Table 12.5 Inverter Output (to Critical Load)**

Item	Unit	Rated Power (kVA)	
		Liebert® APM2 60 kVA 208 V	Liebert® APM2 120 kVA 480 V
Steady state voltage stability	%	±1	
Transient voltage response	%	±5	
Total voltage harmonic distortion	%	< 1 (linear load), < 3 (non-linear load)	< 1 (linear load), < 3 (non-linear load)
Synchronization window	Hz	Upper Limit: 0.5 , 1 , 2 , 3 , (+10%); Default: +10%. Lower Limit: -0.5 , -1 , -2 , -3 , (-10%); Default: -10%	
Slew rate (maximum change rate of synchronization frequency)	Hz/s	0.6; setting range: 0.1 to 3	

## 12.7 Electrical Characteristics (Bypass Input)

**Table 12.6 Bypass Input**

Item	Unit	Rated Power (kVA)	
		Vertiv™ Liebert® APM2 60 kVA 208 V	Liebert® APM2 120 kVA 480 V
Rated AC voltage <sup>1</sup>	VAC	208/220 4-wire (3-phase + N + PE)	480 4-wire (3-phase + N + PE) 480 3-wire (3-phase + PE)
Rated current	A	211	179
Frequency <sup>2</sup>	Hz	50/60	
Bypass voltage tolerance	%VAC	Upper limit selections: +10%, +15%, +20%; default +15%. Lower limit selections: -10%, -15%, -20%, -30%, -40%; default -20%.	Upper limit selections: +10%. Lower limit selections: -10%, -15%; Default: -10%.
Bypass frequency tolerance	%	±10	
Bypass SCR I2T	A2S	97000	97000
Bypass kAIC fuse <sup>3</sup> I2T	A2S	135000	135000
<sup>1</sup> Factory set to 380 V to 400 V or 415 V can be selected by service engineer at site.			
<sup>2</sup> Factory set to 50 Hz to 60 Hz can be selected by service engineer at site.			
<sup>3</sup> The short time withstand current of the bypass thyristor is from one of the manufacturers.			

## 12.8 Efficiency and Loss

**Table 12.7 Efficiency, Loss, and Air Exchange for Vertiv™ Liebert® APM2 60 kVA 208 V 4-Wire System**

AC/AC Efficiency	Data								
Rated power, kVA	10 kVA to 60 kVA								
Dual conversion mode efficiency, %	95%±0.2%								
ECO mode efficiency	98.4%±0.1%								
Rated power	10	15	20	25	30	40	45	50	60
Rated normal mode (full load) loss	0.6	1.0	1.1	1.4	2.0	2.5	3.1	3.0	4.1
Rated normal mode (no load) loss	0.14	0.14	0.23	0.23	0.23	0.32	0.32	0.40	0.40
ECO mode (full load) loss	0.20	0.24	0.34	0.40	0.48	0.67	0.75	0.99	1.18
Maximum forced air cooling (Back Air Flow) CFM (m <sup>3</sup> /hr)	480 (816)	480 (816)	960 (1632)	960 (1632)	960 (1632)	1440 (2448)	1440 (2448)	1920 (3264)	1920 (3264)
Maximum forced air cooling (Top Fan) CFM (m <sup>3</sup> /hr)	1235 (2100)	1235 (2100)	1235 (2100)	1235 (2100)	2470 (4200)	2470 (4200)	2470 (4200)	2470 (4200)	2470 (4200)
Heat Dissipation, BTU/Hr (kWH)	2001 (0.6)	3616 (1.1)	3857 (1.1)	5175 (1.5)	7116 (2.1)	9005 (2.6)	11238 (3.3)	10889 (3.2)	14984 (4.4)

**Table 12.8 Efficiency, Loss, and Air Exchange for Liebert® APM2 120 kVA 480 V 3-Wire System**

AC/AC Efficiency	Data								
Rated power, kVA	20 kVA to 120 kVA								
Dual conversion mode efficiency, %	96.5%±0.2% maximum								
ECO mode efficiency	99%±0.1%								
Rated power	20	30	40	50	60	80	90	100	120
Rated normal mode (full load) loss	0.8	1.1	2.1	1.9	2.0	2.9	3.2	3.5	5.1
Rated normal mode (no load) loss	0.78	0.78	0.97	0.96	0.97	1.09	1.09	1.27	1.27
ECO mode (full load) loss	0.20	0.26	0.35	0.41	0.49	0.67	0.72	0.97	1.14
Maximum forced air cooling (Back Air Flow) CFM (m <sup>3</sup> /hr)	480 (816)	480 (816)	960 (1632)	960 (1632)	960 (1632)	1440 (2448)	1440 (2448)	1920 (3264)	1920 (3264)
Maximum forced air cooling (Top Fan) CFM (m <sup>3</sup> /hr)	1235 (2100)	1235 (2100)	1235 (2100)	1235 (2100)	2470 (4200)	2470 (4200)	2470 (4200)	2470 (4200)	2470 (4200)
Heat Dissipation, BTU/Hr (kWH)	2910 (0.9)	3888 (1.1)	7516 (2.2)	6647 (1.9)	7096 (2.1)	10193 (3.0)	11336 (3.3)	12448 (3.7)	18129 (5.3)

**Table 12.9 Efficiency, Loss, and Air Exchange for Liebert® APM2 120 kVA 480V 4-Wire System**

AC/AC Efficiency	Data								
Rated power, kVA	20 kVA to 120 kVA								
Dual conversion mode efficiency, %	97%±0.2% maximum								
ECO mode efficiency	99%±0.1%								
Rated power	20	30	40	50	60	80	90	100	120
Rated normal mode (full load) loss	0.7	1.0	1.3	1.6	2.1	2.6	3.1	3.2	4.0
Rated normal mode (no load) loss	0.73	0.73	0.89	0.89	0.89	1.05	1.04	1.20	1.20
ECO mode (full load) loss	0.19	0.24	0.33	0.40	0.46	0.62	0.70	0.92	1.08
Maximum forced air cooling (Back Air Flow) CFM (m <sup>3</sup> /hr)	480 (816)	480 (816)	960 (1632)	960 (1632)	960 (1632)	1440 (2448)	1440 (2448)	1920 (3264)	1920 (3264)
Maximum forced air cooling (Top Fan) CFM (m <sup>3</sup> /hr)	1235 (2100)	1235 (2100)	1235 (2100)	1235 (2100)	2470 (4200)	2470 (4200)	2470 (4200)	2470 (4200)	2470 (4200)
Heat Dissipation, BTU/Hr (kWH)	2321 (0.7)	3580 (1.0)	4482 (1.3)	5676 (1.7)	7535 (2.2)	9140 (2.7)	11072 (3.2)	11389 (3.3)	14235 (4.2)

# 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

## Appendix B: Glossary

Term	Definition
BCB	Battery circuit breaker
CSA	Cross sectional area
EMC	Electromagnetic compatibility
EMI	Electromagnetic interference
EOD	End of discharge
LBS	Load bus synchronizer
RCCB	Residual current circuit breaker
RCD	Residual current detector
STS	Static transfer switch
UPS	Uninterruptible power system
VRLA	Valve regulated lead-acid

## Appendix C: ESS System Configurations

Table A.1 Vertiv™ APM2 FR 1 Series UL9540 ESS System Configurations

UPS Power Scalability (Voltage/Ratings kVA/kW)		ESS Model	Model Configuration	Minimum Cabinets	Maximum Cabinets
480/400/415 VAC	20, 30, 40, 50, 60, 80, 90, 100, 120	Vertiv™ EnergyCore Lithium 5 series	16 and 18 Module	1	4
208 VAC	10, 15, 20, 25, 30, 40, 45, 50, 60	EnergyCore Lithium 5 series	10 Module	1	4

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