



Liebert® APM2

User Manual

60 kVA to 150 kVA, 208V, 4-Wire, 60 Hz

60 kVA to 600 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

1.1 Save These Instructions

This manual contains important instructions that should be followed during installation and maintenance of the uninterruptible power supply (UPS) and batteries of the Vertiv™ Liebert® APM2 UPS.

Read this manual thoroughly, paying special attention to the sections that apply to your installation, before working with the UPS. Retain this manual for use by installing personnel.


A properly trained and qualified electrical contractor should oversee the installation of 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 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. Exercise extreme care when handling UPS cabinets to avoid equipment damage or injury to personnel. The weight range of Liebert® APM2 from 391 kg to 1047 kg (862 lbs to 2308 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 preuve d'une extrême prudence lors de la manutention des armoires ASC afin d'éviter de les endommager ou de blesser le personnel. L'armoire Liebert® APM2 pèse de 391 kg to 1047 kg (862 lbs to 2308 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 follow all warnings, cautions, and safety and operating instructions to avoid serious injury or death from electric shock. No risk exists to any personnel when operating the equipment in the normal manner, following the recommended operating procedures. All equipment maintenance and servicing procedures involve internal access and should be carried out only by trained personnel.



AVERTISSEMENT!

Risque de décharge électrique pouvant entraîner des dommages matériels, des blessures et même la mort. À l'instar des autres types d'équipement haute puissance, des tensions dangereuses sont présentes à l'intérieur de l'armoire ASC et du châssis de batteries même après le débranchement de l'alimentation d'entrée. Le risque de contact avec ces tensions est diminué, car les parties de composants sous tension sont abritées derrière un panneau métallique. D'autres écrans de sécurité internes protègent l'équipement en conformité avec les normes IP20. Ne retirez jamais les panneaux ou les couvercles et n'ouvrez pas les portes donnant accès aux composants internes avec lesquels vous pouvez entrer en contact. Veuillez lire et suivre l'ensemble des avertissements, des mises en garde et des instructions de sécurité et de fonctionnement afin d'éviter des blessures graves, voire la mort, pouvant être causées par une décharge électrique. Il n'y a aucun risque pour le personnel lorsque l'équipement est utilisé normalement, en suivant les procédures de fonctionnement recommandées.

1.2 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 puddles 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 an accident should occur.



AVERTISSEMENT! Risque de décharge électrique pouvant causer des blessures, des dommages matériels et même la mort. Les précautions de sécurité habituelles suffisent lorsque le système ASC est en mode de fonctionnement normal et que toutes les portes sont fermées. La zone entourant le système ASC doit être exempte de flaques d'eau, d'humidité excessive et de débris. Des précautions de sécurité spéciales sont requises pour les procédures associées à la manutention, à l'installation et à l'entretien du système ASC. Observez toutes les précautions de sécurité décrites dans le présent manuel avant de manipuler ou d'installer le système ASC, ainsi que pendant toutes les procédures d'entretien. Cet équipement comporte plusieurs circuits à haute tension. Seuls des équipements d'essai conçus pour le dépannage doivent être utilisés. Cette mise en garde couvre notamment les oscilloscopes. Utilisez toujours des voltmètres c.a. et c.c. pour vérifier les tensions avant d'établir un contact ou d'utiliser des outils. Des tensions dangereusement élevées peuvent demeurer dans le système ASC même une fois l'alimentation coupée. Tous les câbles d'alimentation et de contrôle doivent être installés par un électricien qualifié. Tous les câbles d'alimentation et de contrôle doivent être conformes au Code national de l'électricité des États Unis (NEC) et celui du Canada, ainsi qu'aux codes locaux en vigueur. L'entretien du système ASC ne doit être confié qu'à des professionnels qualifiés. Les responsables de l'entretien et l'équipement d'essai doivent reposer sur des tapis de caoutchouc lors de toute intervention sur une pièce d'équipement sous tension. Les responsables de l'entretien doivent porter des chaussures isolantes pour prévenir tout contact direct avec le plancher. Ne travaillez jamais seul, même si toute l'alimentation d'entrée est coupée de l'équipement. Une seconde personne devrait toujours être présente pour porter assistance ou chercher de 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, may cause harmful interference to radio communications. This unit is not designed for use in a residential area. Operation of this unit in a residential area may cause harmful interference that the user is solely responsible for correcting.



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. See the back page of this manual for contact information. This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.



AVERTISSEMENT! 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.

1.3 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 (VRLA) battery
	Recycle
	DC Voltage
	AC Voltage
	Equipment grounding conductor
	Bonded to ground

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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 can operate at 50 Hz or 60 Hz and has optional frequency conversion mode.

When configured for scalability, the capacity of UPS can be set according to **Table 2.1** below. Scalable capacity option is necessary to order through factory configuration to apply proper capacity rating labels. Scalable capacity hardware and/or firmware upgrades must be applied through Vertiv Services. 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 external batteries to support the load when utility power is not present.

Table 2.1 Liebert® APM2 Model and Power Scale

Product	Power Scalability	Remark
Liebert® APM2 150 K 208 V/220 V 4-wire	60, 75, 80, 90, 100, 120, 140, 150	External battery can be configured.
Liebert® APM2 300 K 380 V/400 V/415 V 4-wire/3-wire	60, 120, 150, 180, 200, 225, 240, 250, 300	External battery can be configured.
Liebert® APM2 300 K 480 V 4-wire/3-wire	60, 120, 150, 180, 200, 225, 240, 250, 300	External battery can be configured.
Liebert® APM2 600 K 380 V/400 V/415 V 4-wire/3-wire	60, 120, 180, 240, 300, 360, 400, 420, 480, 500, 540, 600	External battery can be configured.
Liebert® APM2 600 K 480 V 4-wire/3-wire	60, 120, 180, 240, 300, 360, 400, 420, 480, 500, 540, 600	External battery can be configured.

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 Operator Control and Display Panel

Information about using the UPS control panel is detailed in **Vertiv™ Liebert® Touchscreen Control Panel User Manual SL-26200**, available at Vertiv's Web site 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
- 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 Liebert® APM2 UPS utilizes a dynamic counter that monitors each power module load level, every 40 milliseconds.

Table 2.2 Load and Time Duration of Inverter

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 $91500/6 \times 40 \text{ milliseconds} = 610 \text{ seconds}$.

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

These counter increments is shown in **Figure 2.1** below.

Figure 2.1 Overload

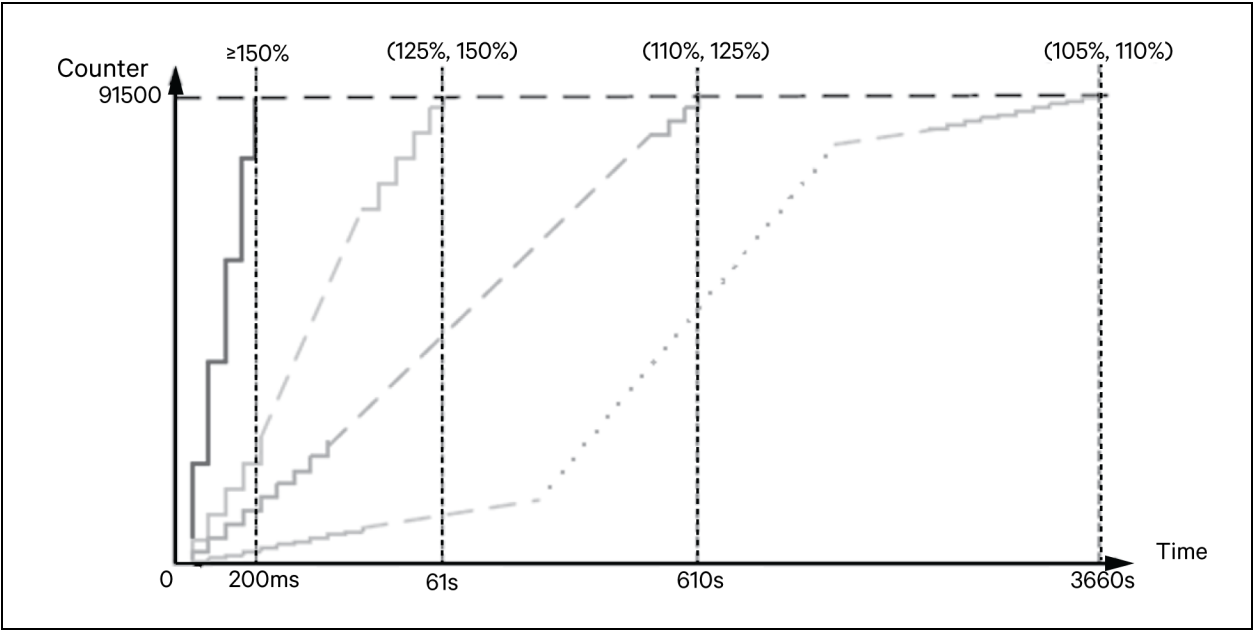
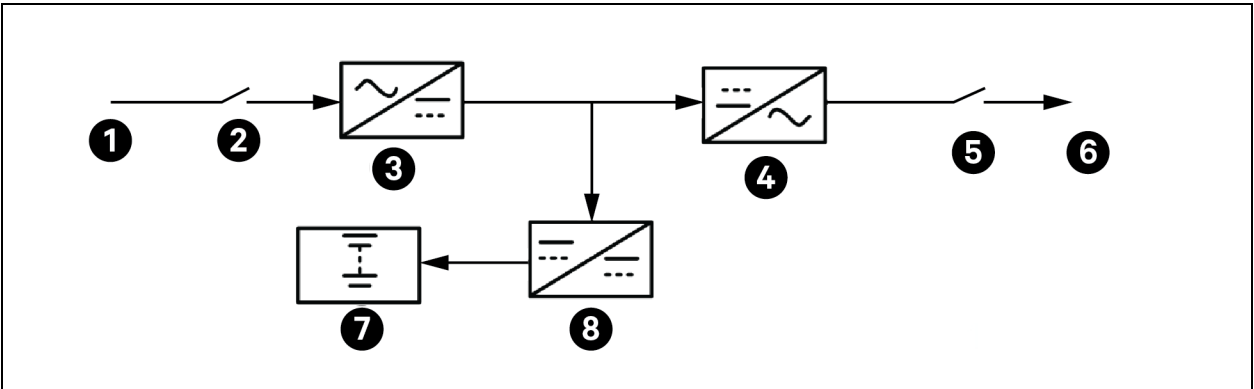


Figure 2.2 Schematic Diagram of Normal Mode

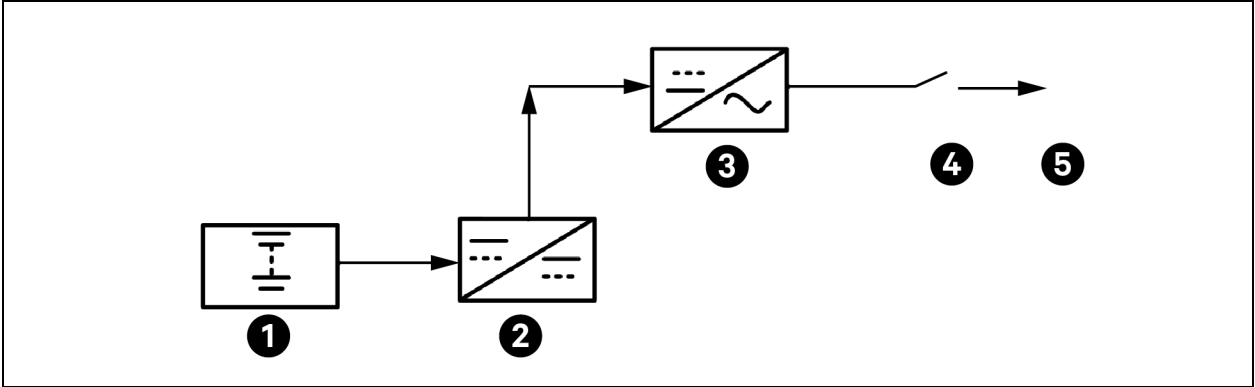


Item	Description	Item	Description
1	Main input	5	Maintenance isolation breaker (MIB)
2	Rectifier input breaker (RIB)	6	UPS output
3	Rectifier	7	Battery
4	Inverter	8	Battery charger

2.4.2 Battery Mode

As shown in **Figure 2.3** on the next page, 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 main failure, the system will automatically transfer to the battery mode with no load power interruption. When the mains are 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 used independently to improve the availability of the UPS.

2.4.3 Automatic Restart Mode

The battery may become exhausted following 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: EOD without battery circuit breaker (BCB) trip functions must be set by a Vertiv authorized service engineer.

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.

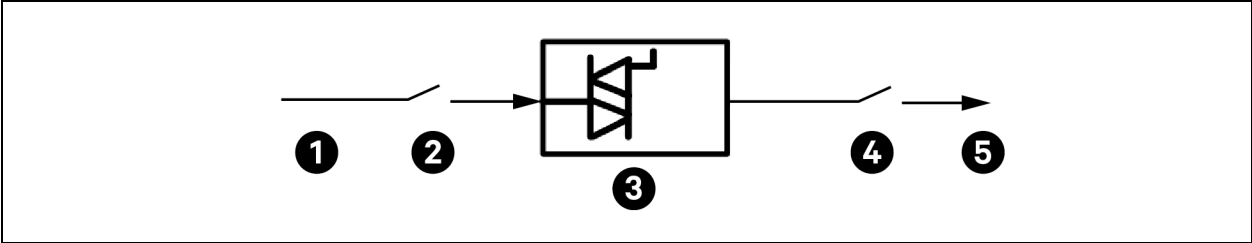
NOTE: The user can manually start the UPS through RESET FAULT function, if the automatic restart function has not set.

2.4.4 Bypass Mode

When the UPS is in bypass mode as shown in Figure 24 on the facing page 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 of 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 miliseconds.

Figure 2.4 Schematic Diagram of Bypass Mode

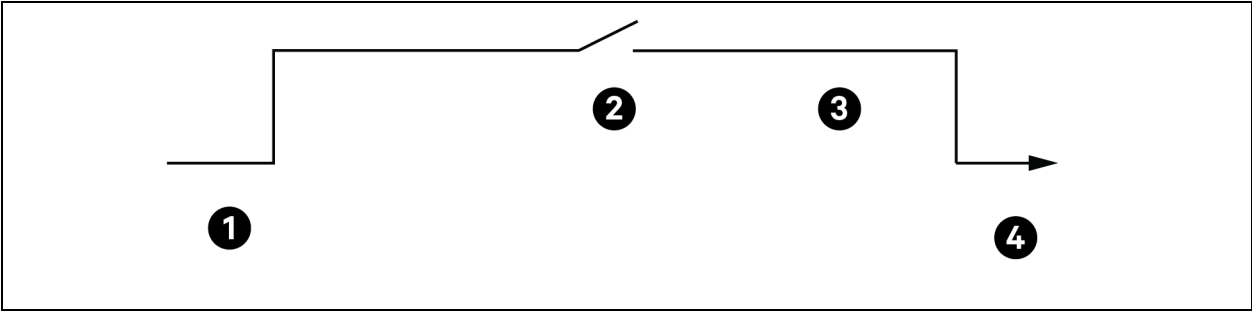


Item	Description	Item	Description
1	Bypass input	4	MIB
2	Bypass Input breaker (BIB)	5	UPS output
3	Static switch		

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

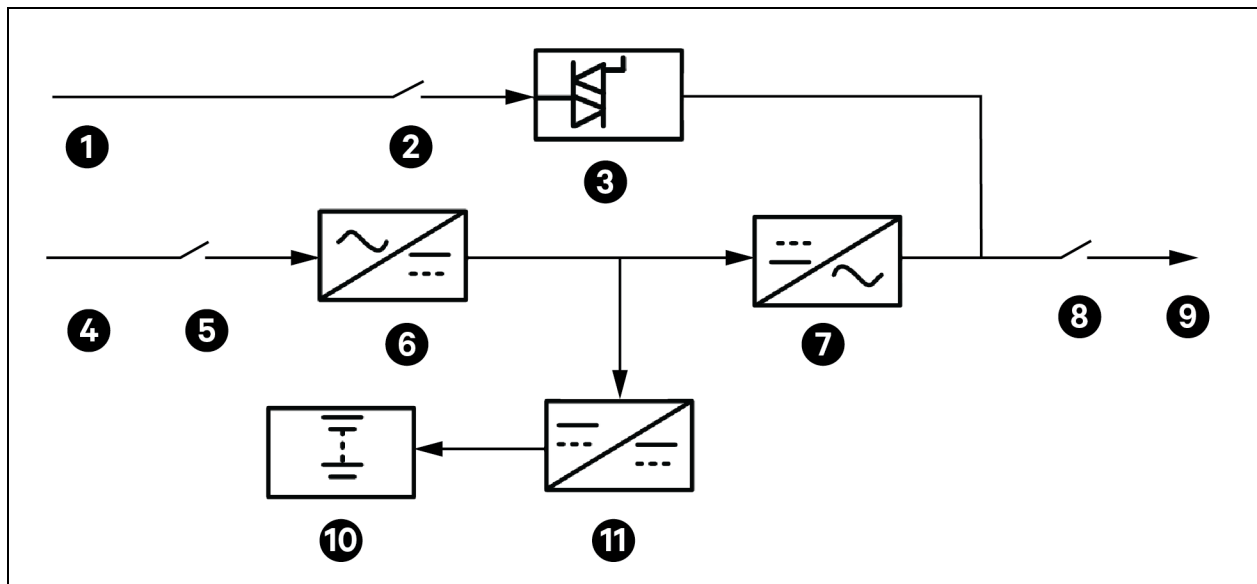


Item	Description	Item	Description
1	Bypass input	3	MIB
2	MBB	4	UPS output

2.4.6 Economy Mode

As shown in **Figure 2.6** on the next page, 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 miliseconds (uninterrupted) and less than 5 miliseconds (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
5	RIB	11	Battery charger
6	Rectifier		

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

The operation method of ECO mode is the same as the description in [Single UPS Operation](#) on page 79. 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.

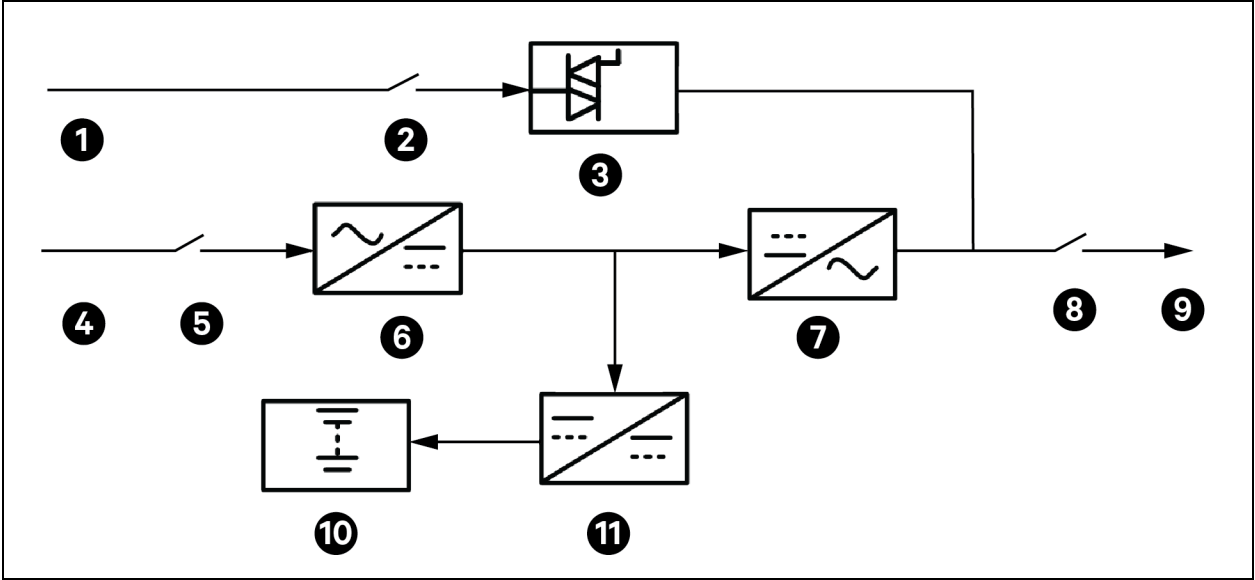
2.4.9 Generator Mode

The Vertiv™ 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	Main input	10	Battery
5	RIB	11	Battery charger
6	Rectifier		

2.5 Battery Management System

The battery management 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 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

Item	Manual Battery Test	Automatic Battery Test	Remote Battery Test	Calibrated Battery Test
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 prolonging 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 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 principal diagram of the parallel redundancy mode, see **Figure 8.1** on page 106.

1. The hardware and software of parallel system are completely the 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 through additional redundancy.. 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 principal diagram of the LBS mode, see **Figure 8.5** on page 113 and **Figure 8.6** on page 114.

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 when 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 handle the specific situation of the site. The detailed installation steps are not provided in this section due to unique characteristic of each installation site.

NOTE: Professional installation required. Do not disassemble the package without permission of 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, TT, and HRG AC distribution systems (IEC60364-3), and must be a 3-phase, 5-wire or 4-wire (only for 480 V) systems.



WARNING! Risk of electric shock. Damage to the property, serious injury, or death are possible. When connecting batteries, the battery terminal voltage will reach 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.
- 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. The UPS cabinet is heavy. See Table 12.2 on page 132 weight of the cabinet. Make sure, that any 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 an 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. Insulated tools must be used for installation.

The tools listed in the **Table 3.1** below are required for installation and connection. The list below is provided for reference only.

Table 3.1 Tools Required for Installation and Connection















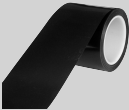







Name	Drawing	Name	Drawing
Electric hand drill		Adjustable wrench	
Slotted screwdriver		Cross head screwdriver	
Stepladder		Forklift	
Drill		Wire cutting plier	
Claw hammer		Diagonal cutting plier	
Insulating shoes		Antistatic gloves	
Electrician knife		Cable tie	
Insulating tape		Insulating gloves	

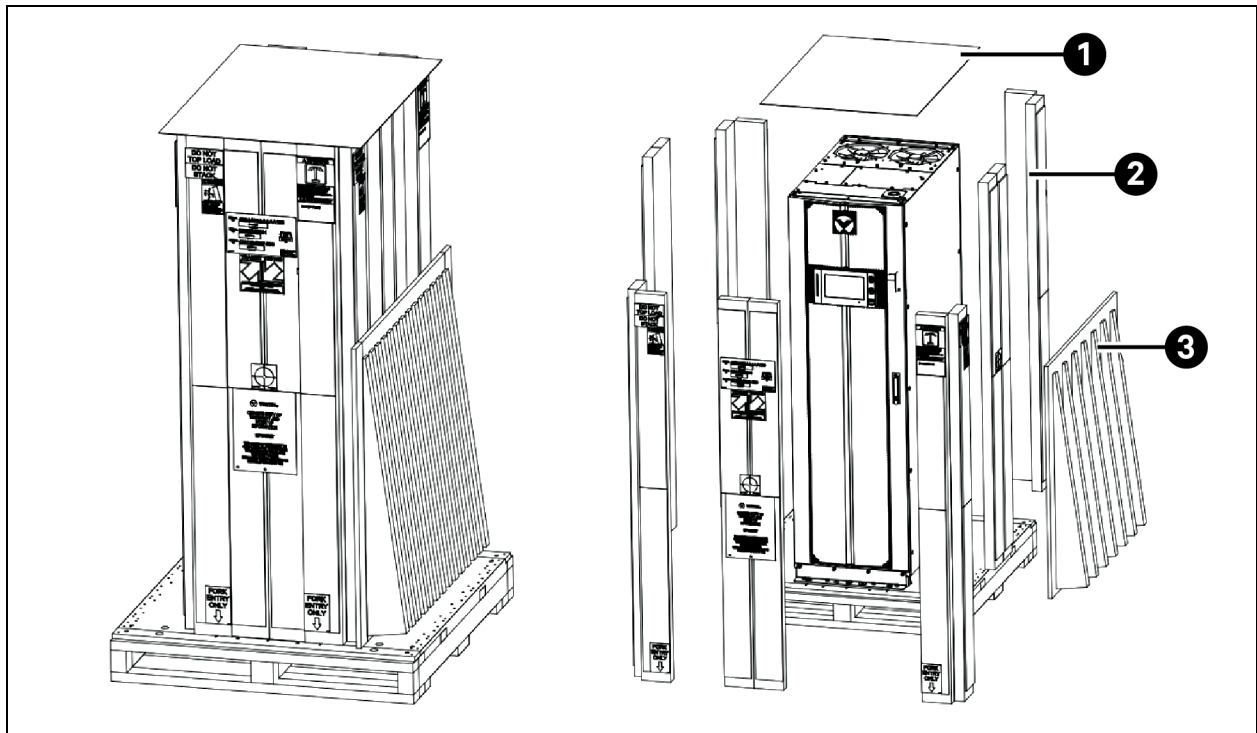
Table 3.1 Tools Required for Installation and Connection

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.

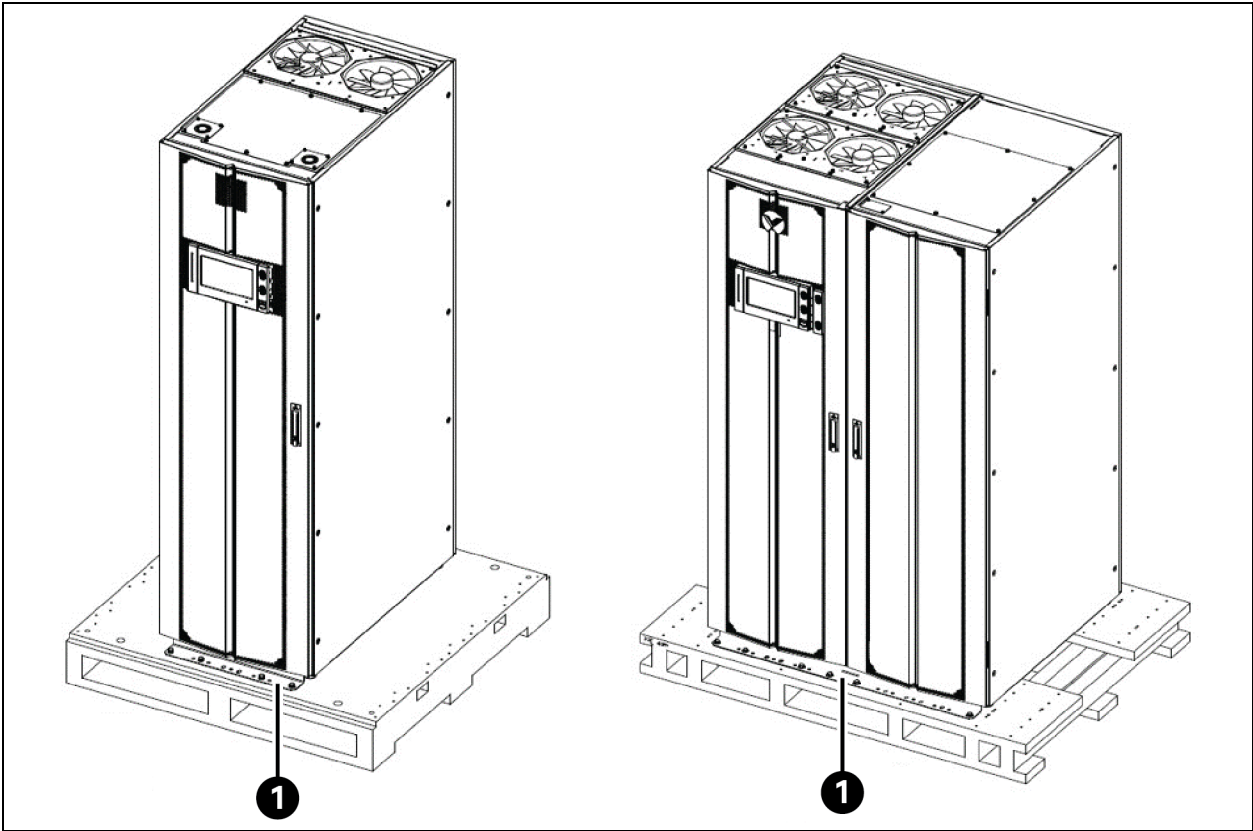
1. Remove the packaging as shown in **Figure 3.1** below.

Figure 3.1 Removing the packaging

Item	Description
1	Top cover
2	Honeycomb board
3	Unloading ramp

- 2. Remove the shipping brackets, as 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 Shipping Brackets



Item	Description
1	Shipping brackets

- 4. Move the cabinet to the installation location using the forklift. See [Transportation](#) on page 17 for more information regarding transporting the UPS.
- 5. Secure it to the ground as shown in **Figure 9.1** on page 118.
- 6. After the Liebert® APM2 UPS is installed, reinstall the 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 131, 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, carry out the following inspections: 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 131. Pay special 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 nonflammable, flat surfaces. The ambient environment should be free of conductive powder. Conductive powders include metallic powder, sulfide, sulfur dioxide, graphite, carbon fiber, and conductive fiber. The ambient environment should be free 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 ventilation openings (perforated panels) or blow air down onto the unit. For front to rear airflow (no top fan), 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 **Table 12.1** on page 131 for more details. The battery needs to be stored in a dry and cool place with good ventilation. The most suitable storage temperature ranges from 68 °F to 77 °F (20 °C to 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

300 kVA 480 V UPS is a 23.6 in. (600 mm) wide cabinet with breaker option (top cable access).

For 600 kVA 480 V UPS, the UPS with I/O cabinet is 47 in. (1200 mm) width, which provides bypass back feed protective contactor and support the top cable access.

3.7.2 Moving the Cabinet



WARNING! Risk of improper moving. Can cause serious injury or death. Building and equipment damage may also result. Use only lifting equipment that is rated for the unit weight by an OSHA-certified rating organization. The center of gravity varies depending on the unit size and selected options. The slings must be equally spaced on either side of the center of gravity indicator. Shipping weights and unit weights are specified in the Application and Planning Guide. Use the center of gravity indicators on the unit to determine the position of the slings.

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 **Table 12.2** on page 132 for weight of the UPS.

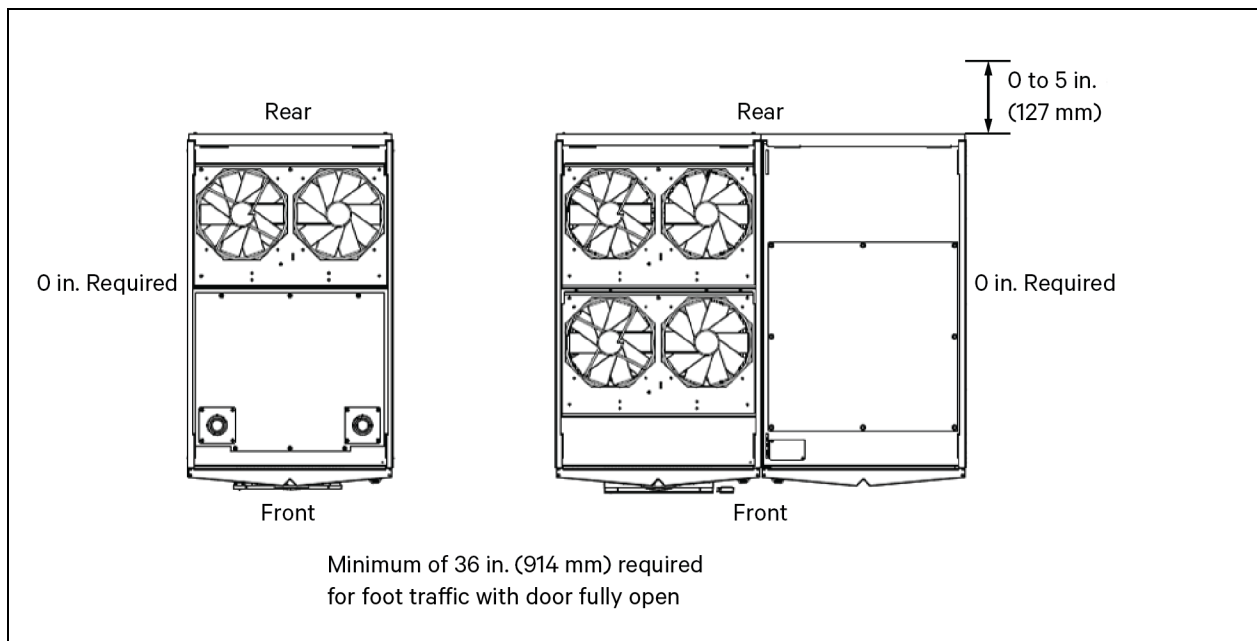
The Vertiv™ Liebert® APM2 UPS cabinet can be moved by forklift or other similar lifting equipment. For short distances, the UPS can be moved by provided casters.

3.7.3 Clearance

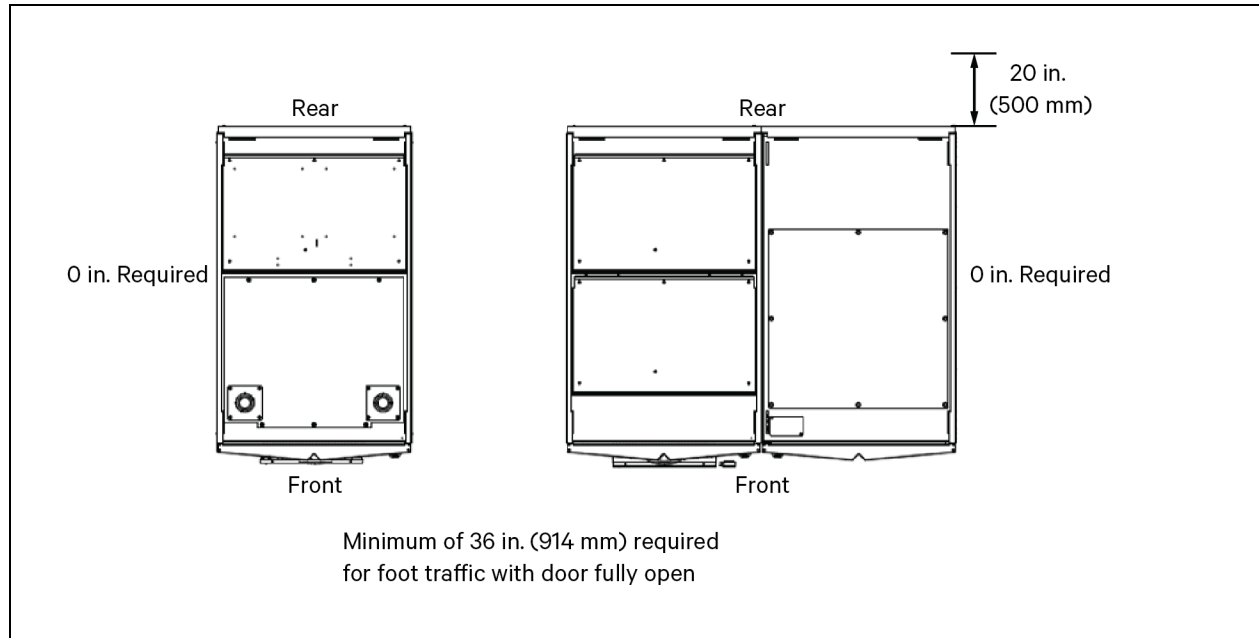
Provide at least minimum clearance required by the Liebert® APM2 UPS, including 36 in. (914 mm) in front, to permit routine tightening power terminals within the UPS and free passage for personnel with the door fully opened and at least 19.68 in. (500 mm) in the rear for the front to rear airflow UPS, 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 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. (610 mm) between the top of the UPS frame and the ceiling to permit adequate air circulation above the unit. Vertiv recommends against using air conditioning or other systems that blow air across the top of the unit.

Figure 3.3 Clearances



NOTE: For the top fan air flow, can be placed against wall with no seismic brackets. If seismic brackets required, then 5 in. (127mm) recommended for installation.



3.7.4 Cable Access

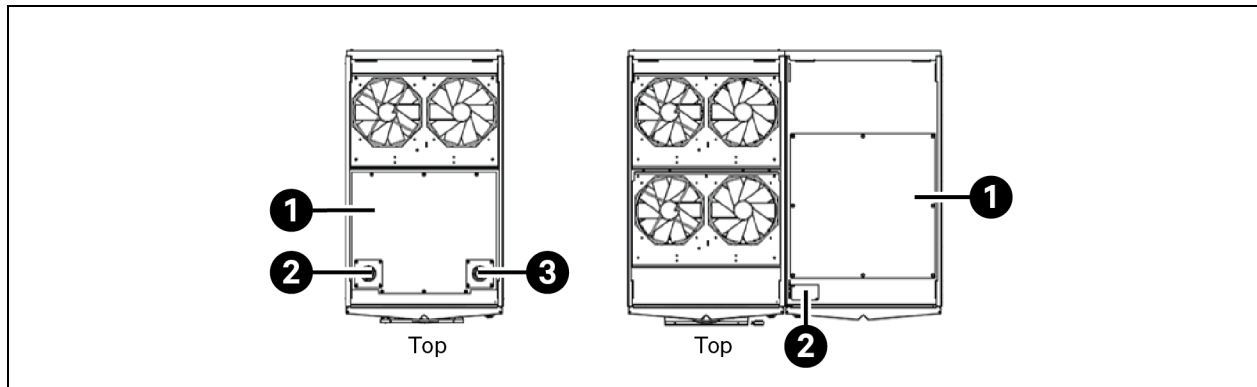
Cables must enter the Vertiv™ Liebert® APM2 from the top.

Some plates have factory punched holes and others are designed to allow the personnel to punch holes for fitting and securing the conduit. 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.

3.8 Installation

Figure 3.4 Cable Entry Locations



Item	Description
1	Power cable knockout hole cover
2	Signal wire knockout holes
3	Signal wire knockout holes

3.9 Cabinets Installation

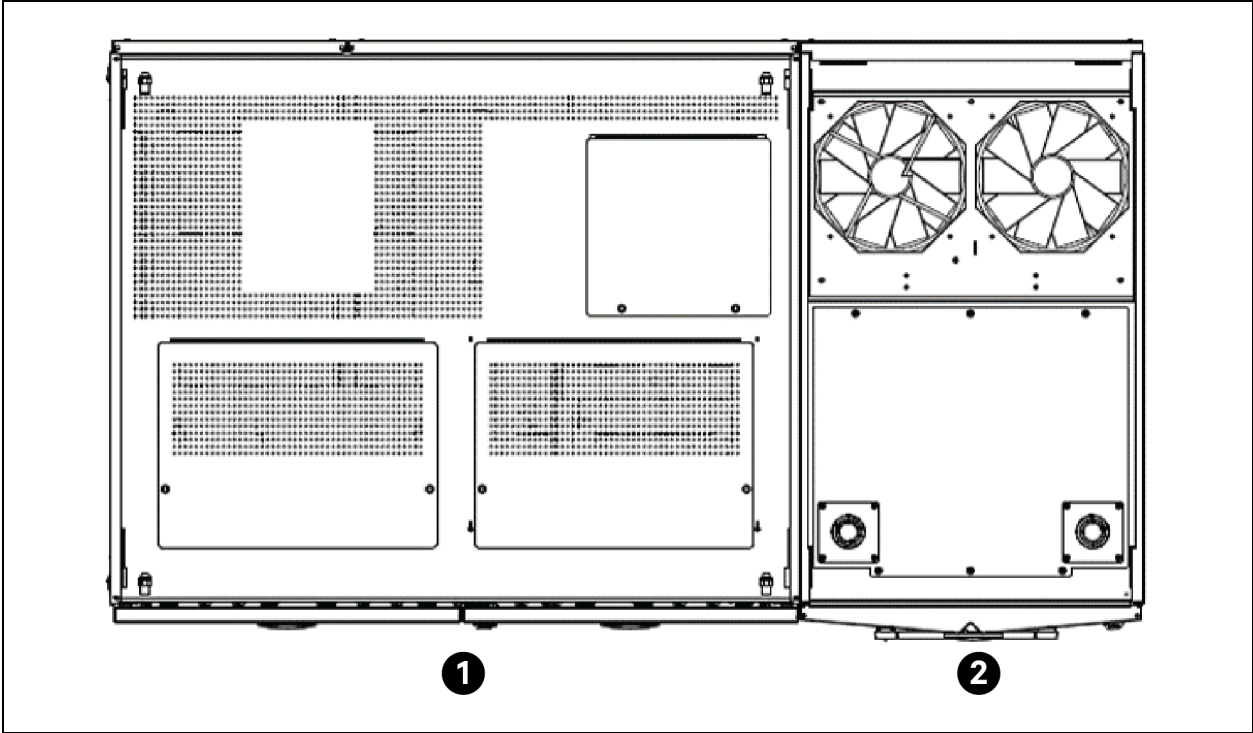
The Vertiv™ Liebert® APM2 frame consists of a single cabinet housing the UPS components. It does not accommodate internal batteries. The UPS requires external battery cabinets (EBC) for extended run time.

Battery Cabinets: Optional EBC are available for each Liebert® APM2 model to provide extended run time. The battery cabinets are designed to be bolted to the left side of the UPS for 150 kVA 208 V and 300 kVA 480 V frame or Right side for 600 kVA frame, as shown in **Figure 4.4** on page 49 or standalone. **Vertiv™ Liebert® APM2 External Battery Cabinet Installer/User Guide_SL-71958**, for details, available on 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 several optional equipment cabinets, depending on the system design requirements e.g., 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.

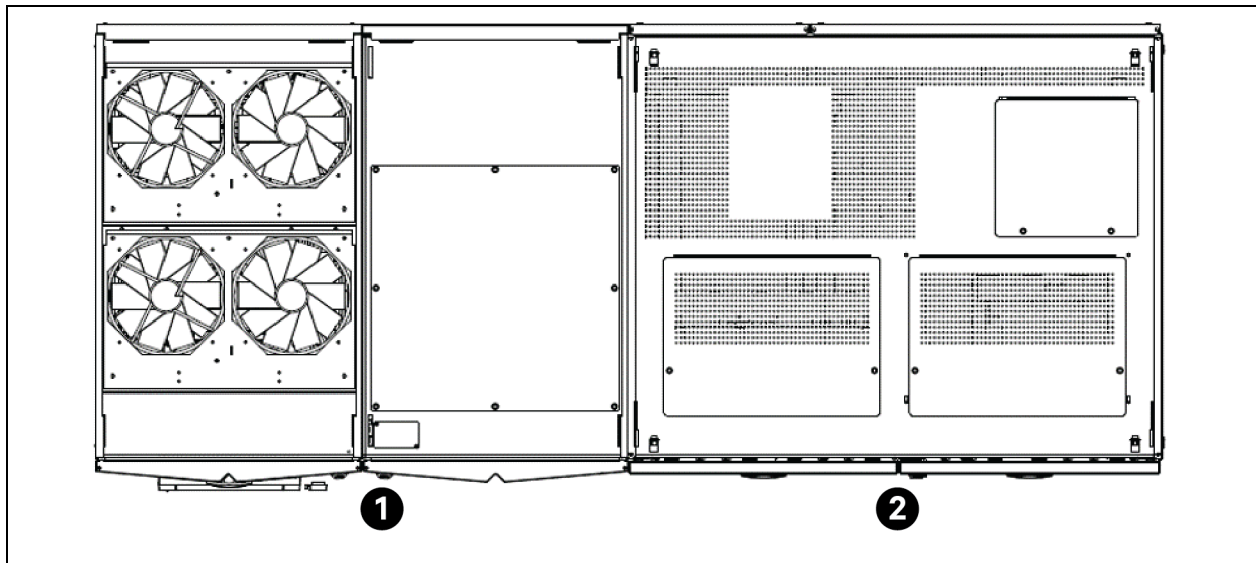
Figure 3.5 Cabinet Arrangement for Vertiv™ Liebert® APM2 150 kVA 208 V and 300 kVA 480 V UPS



Item	Description
1	EBC
2	UPS

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

Figure 3.6 Cabinet Arrangement for Vertiv™ Liebert® APM2 600 kVA 480 V UPS



Item	Description
1	UPS
2	EBC

NOTE: Layouts shown are typical. Not all ancillary cabinets are shown. Configurations may be different depending on ordered ancillary cabinets.

3.10 Installed Components

3.10.1 Power Module

To replacing power module, follow the below procedure:

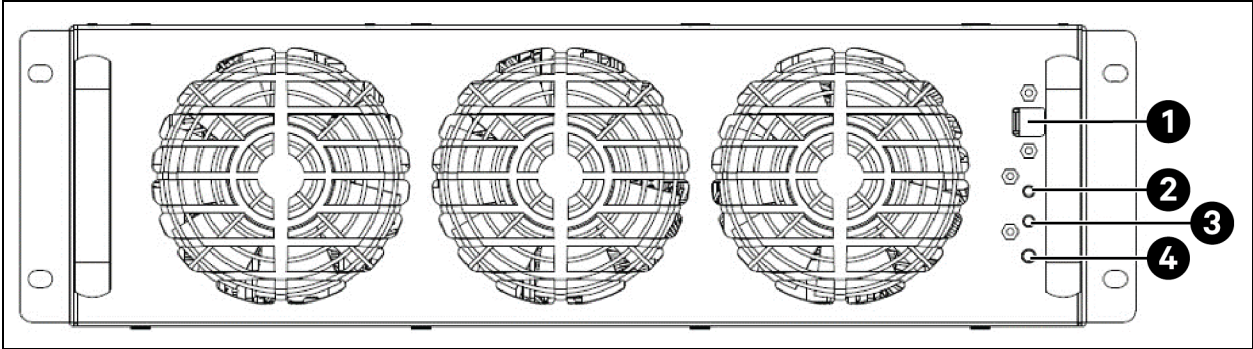
1. If UPS is supporting load on inverter or in ECO mode, verify that the UPS has enough capacity with remaining power modules to support the load while the intended power module is being replaced. If there are not enough remaining power modules to support the load then follow the procedures in [Transfer from Normal Mode to Bypass Mode](#) on page 89 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 two minutes.
4. Quickly and firmly pull the power module out 3 to 6 inches to disconnect it from its back-plane connection. Then carefully remove the power module from the frame.

NOTE: the weight of power module is 35 Kg.

5. Carefully insert the new power module into the UPS frame. When the power module is 3 to 6 inches from being 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 [Startup Procedures in Normal Mode](#) on page 84 for single UPS operation or [Operation Procedures for Parallel System](#) on page 110 for parallel UPS operation.

Figure 3.7 Liebert® Power Module Installation Indicators and Controls for Liebert® APM2 150 kVA 208 V and 300 kVA to 600 kVA 480 V UPS



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

NOTE: See [Figure 4.10](#) on page 57 through [Figure 4.14](#) on page 62 for details.

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
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 started to supply power. 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 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

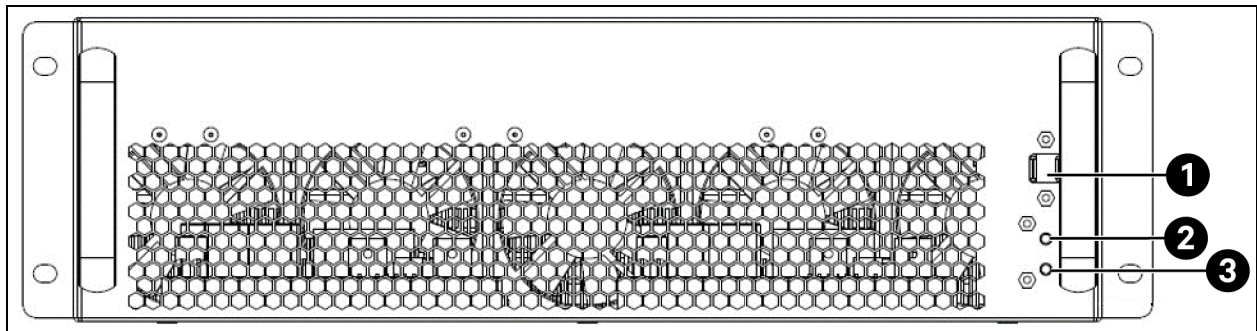
To replacing bypass module, follow the below procedure:

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 89. Alternatively, transfer the UPS to Maintenance Bypass Mode following the procedures in [Transfer from Normal Mode to Maintenance Mode](#) on page 90 for single UPS operation or [Maintenance Bypass Procedures](#) on page 110 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 two minutes.
4. Quickly and firmly pull the bypass module out 3 to 6 inches to remove it from its back plane connection. Then carefully remove the bypass module from the frame.

NOTE: The weight of bypass module is 35 Kg.

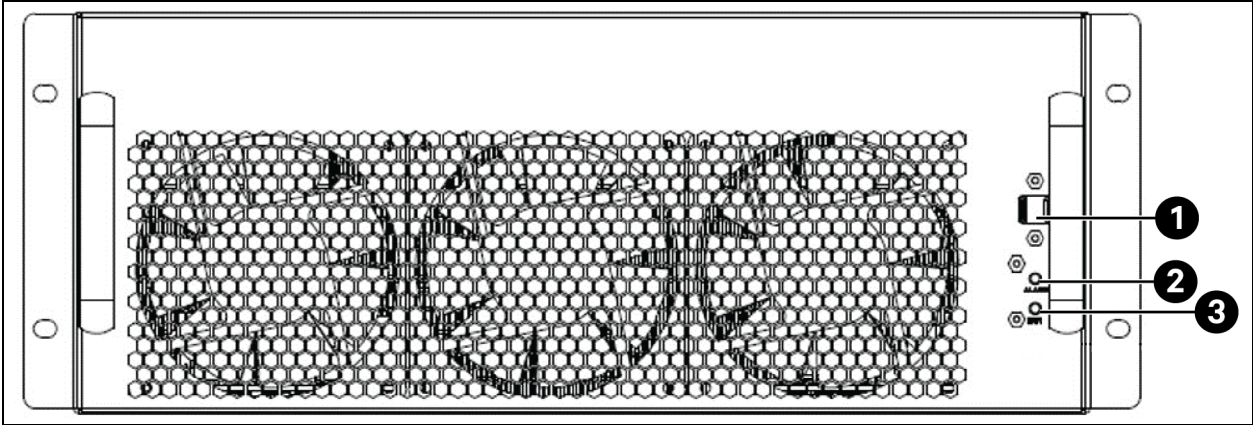
5. Carefully insert the new bypass module into the UPS frame. When the power module is 3 to 6 inches from being fully inserted, quickly and firmly push the module into its back-plane connection. Fasten the fixing screws on both sides of the power module.
6. Move the ready switch of bypass module to the 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 89. 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 92.

Figure 3.8 Bypass Module Installation Indicators and Controls for Vertiv™ Liebert® APM2 150 kVA 208 V and 300 kVA 480 V UPS



Item	Description
1	DIP switches
2	Fault LED
3	Run LED

Figure 3.9 Bypass Module Installation Indicators and Controls for Vertiv™ Liebert® APM2 600 KVA 480V UPS



Item	Description
1	Ready switch
2	Fault LED
3	Run LED

NOTE: See Figure 4.10 on page 57 through Figure 4.14 on page 62 for details.

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.

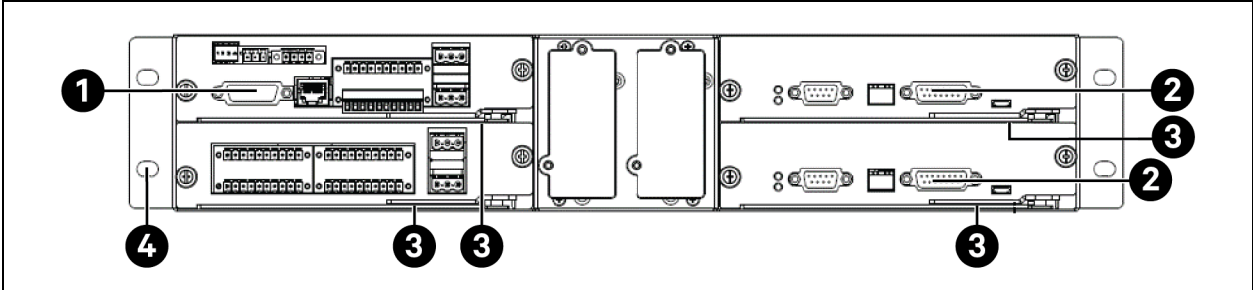
Table 3.3 LED Indicators

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 Installation

The Control module has three Vertiv™ Liebert® IntelliSlot™ interface card bays and connections for optional ancillary cabinets and for other options. See **Figure 4.10** on page 57 through **Figure 4.14** on page 62 for details.

Figure 3.10 Static Bypass Assembly Connections



Item	Description
1	DB9
2	DB15
3	Ready switch
4	Liebert® IntelliSlot™ Bays 1, 2, 3

NOTE: See **Table 4.19** on page 53 through **Figure 4.14** on page 62 for details.

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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™ 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 Liebert® APM2 UPS will not be in compliance with UL9540 requirement. For UL9540 ESS system configuration, see [ESS System Configurations](#) on page 142.



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. Deenergize and lockout or tagout 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 (also considering 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 150 kVA 208 V 4-Wire System

UPS Power (kVA)	Rated Current (A)				Bus Stud Bolt/Nut Specification	
	Maximum Input Current ¹	Output/Bypass Current ²	Bypass Current ² at Full Load	Battery Discharge ³ Current (+, -, N) at Rated Battery Voltage	Input, Battery, Output, Bypass/PE Cable	Recommended Torque lb-in. (Nm)
60	207	175	175	235	M10	5.1 (45)
75	254	221	221	285	M10	5.1 (45)
80	290	230	230	310	M10	5.1 (45)
90	322	265	265	350	M10	5.1 (45)
100	356	290	293	385	M10	5.1 (45)
120	418	351	355	465	M10	5.1 (45)
140	480	403	408	536	M10	5.1 (45)
150	510	435	438	583	M10	5.1 (45)

¹ Maximum input current is calculated according to the low voltage input of 120 V (L-N) and 100% load percentage.

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

³ The battery discharge current is calculated according to the battery cell number of 24, EOD voltage of 1.63 V and 100% load percentage.

Table 4.2 Maximum Steady State AC and DC Currents for Liebert® APM2 300 kVA 400 V 4-Wire System

UPS Power (kVA)	Rated Current (A)				Bus Stud Bolt/Nut Specification	
	Input Current ¹	Output Current ² at Full Load	Bypass Current ² at Full Load	Battery Discharge ³ Current (+, -, N) at Rated Battery Voltage	Input, Battery, Output, Bypass/PE Cable	Recommended Torque lb-in. (Nm)
60	118	98	100	140	M10	5.1 (45)
120	228	188	190	275	M10	5.1 (45)
150	283	232	232	340	M10	5.1 (45)
180	345	280	280	405	M10	5.1 (45)
200	389	310	310	450	M10	5.1 (45)
225	430	350	351	505	M10	5.1 (45)
240	457	375	376	540	M10	5.1 (45)
250	470	385	385	560	M10	5.1 (45)
300	552	469	467	650	M10	5.1 (45)

¹ Maximum input current is calculated according to the rated voltage input of 220 V (L-N) and 100% load percentage.

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

³ 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 300 kVA 480 V 4-Wire/3-Wire System

UPS Power (kVA)	Rated Current (A)				Bus Stud Bolt/Nut Specification	
	Input Current ¹	Output Current ² at Full Load	Bypass Current ² at Full Load	Battery Discharge ³ Current (+, -, N) at Rated Battery Voltage	Input, Battery, Output, Bypass/PE Cable	Recommended Torque lb-in. (Nm)
60	94	80	80	140	M10	5.1 (45)
120	184	150	150	270	M10	5.1 (45)
150	228	187	190	338	M10	5.1 (45)
180	274	226	230	405	M10	5.1 (45)
200	301	250	248	450	M10	5.1 (45)
225	339	282	278	508	M10	5.1 (45)
240	363	300	300	540	M10	5.1 (45)
250	375	312	312	565	M10	5.1 (45)
300	444	376	373	672	M10	5.1 (45)

¹ Maximum input current is calculated according to the rated voltage input of 277 V (L-N) and 100% load percentage.

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

³ 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 4.4 Maximum Steady State AC and DC Currents for Liebert® APM2 600 kVA 400 V 4-Wire System

UPS Power (kVA)	Rated Current (A)				Bus Stud Bolt/Nut Specification	
	Input Current ¹	Output Current ² at Full Load	Bypass Current ² at Full Load	Battery Discharge ³ Current (+, -, N) at Rated Battery Voltage	Input, Battery, Output, Bypass/PE Cable	Recommended Torque lb-in. (Nm)
60	119	96	96	140	M10	5.1 (45)
120	233	194	191	270	M10	5.1 (45)
180	349	278	279	400	M10	5.1 (45)
240	450	370	372	528	M10	5.1 (45)
300	567	463	467	660	M10	5.1 (45)
360	684	558	559	793	M10	5.1 (45)
400	750	619	622	880	M10	5.1 (45)
420	784	647	654	930	M10	5.1 (45)
480	920	742	750	1060	M10	5.1 (45)
500	957	776	788	1110	M10	5.1 (45)
540	1049	846	843	1200	M10	5.1 (45)
600	1134	937	939	1345	M10	5.1 (45)

¹ Maximum input current is calculated according to the rated voltage input of 220 V (L-N) and 100% load percentage.

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

³ 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 4.5 Maximum Steady State AC and DC Currents for Vertiv™ Liebert® APM2 600 kVA 480 V 4-Wire/3-Wire System

UPS Power (kVA)	Rated Current (A)				Bus Stud Bolt/Nut Specification	
	Input Current ¹	Output Current ² at Full Load	Bypass Current ² at Full Load	Battery Discharge ³ Current (+, -, N) at Rated Battery Voltage	Input, Battery, Output, Bypass/PE Cable	Recommended Torque lb-in. (Nm)
60	106	79	82	140	M10	5.1 (45)
120	194	156	155	270	M10	5.1 (45)
180	279	231	227	392	M10	5.1 (45)
240	367	296	302	528	M10	5.1 (45)
300	465	370	377	659	M10	5.1 (45)
360	551	444	451	792	M10	5.1 (45)
400	609	494	503	880	M10	5.1 (45)
420	635	528	527	930	M10	5.1 (45)
480	719	596	601	1058	M10	5.1 (45)
500	758	621	627	1109	M10	5.1 (45)

Table 4.5 Maximum Steady State AC and DC Currents for Vertiv™ Liebert® APM2 600 kVA 480 V 4-Wire/3-Wire System

UPS Power (kVA)	Rated Current (A)				Bus Stud Bolt/Nut Specification	
	Input Current ¹	Output Current ² at Full Load	Bypass Current ² at Full Load	Battery Discharge ³ Current (+, -, N) at Rated Battery Voltage	Input, Battery, Output, Bypass/PE Cable	Recommended Torque lb-in. (Nm)
540	812	672	680	1200	M10	5.1 (45)
600	910	742	753	1345	M10	5.1 (45)

¹ Maximum input current is calculated according to the low voltage input of 277 V (L-N) and 100% load percentage.

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

³ 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 4.6** below.

Table 4.6 Recommended CSA for Vertiv™ Liebert® APM2 150 kVA 208 V 4-Wire System

Model (kVA)	Input		Output		Bypass		Earth Cable		Battery	
	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)
60	2	1/0	2	1/0	2	2	1	2	2	2
75	2	2/0	2	2/0	2	1/0	1	2	2	1/0
80	2	3/0	2	3/0	2	1/0	1	2	2	2/0
90	2	3/0	2	3/0	2	2/0	1	1/0	2	2/0
100	2	4/0	2	4/0	2	3/0	1	1/0	2	3/0
120	2	250	2	300	2	4/0	1	2/0	2	250
140	2	350	2	350	2	250	1	2/0	2	300
150	2	400	2	400	2	300	1	2/0	2	350

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

Table 4.7 Recommended CSA for Liebert® APM2 300 kVA 400 V 4-Wire System

Model (kVA)	Input		Output		Bypass		Earth Cable		Battery	
	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)
60	2	1	2	1	2	1	1	2	2	2
120	2	1/0	2	1/0	2	1	1	2	2	1/0
150	2	2/0	2	2/0	2	1/0	1	2	2	2/0
180	2	4/0	2	4/0	2	2/0	1	1/0	2	3/0

Table 4.7 Recommended CSA for Liebert® APM2 300 kVA 400 V 4-Wire System

Model (kVA)	Input		Output		Bypass		Earth Cable		Battery	
	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)
200	2	250	2	250	2	3/0	1	1/0	2	4/0
225	2	300	2	300	2	4/0	1	2/0	2	250
240	2	300	2	300	2	4/0	1	2/0	2	300
250	2	350	2	350	2	250	1	2/0	2	300
300	2	400	2	500	2	350	1	2/0	2	400
NOTE: These values are at Ambient Temperature: 77 °F (25 °C).										

Table 4.8 Recommended CSA for Vertiv™ Liebert® APM2 300 kVA 480 V 4-Wire/3-Wire System

Model (kVA)	Input		Output		Bypass		Earth Cable		Battery	
	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)
60	2	1	2	1	2	1	1	2	2	1
120	2	1/0	2	1/0	2	1	1	2	2	1/0
150	2	1/0	2	1/0	2	1	1	2	2	2/0
180	2	2/0	2	2/0	2	1/0	1	2	2	3/0
200	2	3/0	2	3/0	2	2/0	1	1/0	2	4/0
225	2	4/0	2	4/0	2	2/0	1	1/0	2	250
240	2	4/0	2	4/0	2	3/0	1	1/0	2	300
250	2	4/0	2	250	2	3/0	1	1/0	2	300
300	2	300	2	350	2	250	1	2/0	2	500
NOTE: These values are at Ambient Temperature: 77 °F (25 °C).										

Table 4.9 Recommended CSA for Liebert® APM2 600 kVA 400 V 4-Wire System

Model (kVA)	Input		Output		Bypass		Earth Cable		Battery	
	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)
60	5	1	4	1	5	1	1	2	6	1
120	5	1	4	1	5	1	1	2	6	1
180	5	1	4	1	5	1	1	1/0	6	1
240	5	1/0	4	1/0	5	1	1	2/0	6	1
300	5	2/0	4	3/0	5	1/0	1	2/0	6	1/0
360	5	4/0	4	4/0	5	2/0	1	3/0	6	2/0

Table 4.9 Recommended CSA for Liebert® APM2 600 kVA 400 V 4-Wire System

Model (kVA)	Input		Output		Bypass		Earth Cable		Battery	
	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)
400	5	4/0	4	250	5	3/0	1	3/0	6	3/0
420	5	250	4	250	5	4/0	1	3/0	6	3/0
480	5	300	4	300	5	4/0	1	3/0	6	4/0
500	5	350	4	350	5	250	1	3/0	6	4/0
540	5	400	4	400	5	250	1	3/0	6	250
600	5	500	4	500	5	350	1	3/0	6	300

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

Table 4.10 Recommended CSA for Vertiv™ Liebert® APM2 600 kVA 480 V 4-Wire/3-Wire System

Model (kVA)	Input		Output		Bypass		Earth Cable		Battery	
	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)	Quantity	Size (AWG)
60	5	1	4	1	5	1	1	2	6	1
120	5	1	4	1	5	1	1	2	6	1
180	5	1	4	1	5	1	1	2	6	1
240	5	1	4	1	5	1	1	1/0	6	1
300	5	1/0	4	1/0	5	1	1	2/0	6	1/0
360	5	2/0	4	3/0	5	1	1	2/0	6	2/0
400	5	3/0	4	3/0	5	1/0	1	3/0	6	3/0
420	5	3/0	4	4/0	5	1/0	1	3/0	6	3/0
480	5	4/0	4	4/0	5	2/0	1	3/0	6	4/0
500	5	250	4	250	5	2/0	1	3/0	6	4/0
540	5	250	4	250	5	3/0	1	3/0	6	250
600	5	300	4	300	5	4/0	1	3/0	6	300

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

NOTE: A 3-wire system does not require neutral line. Use minimum number AWG or Kcmil, 194 °F (90 °C) 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 Cross-sectional Area of UPS Knockout

The recommended CSA of the UPS Knockout is given below.

Table 4.11 Recommended CSA Knockout for Vertiv™ Liebert® APM2 150 kVA 208 V 4-Wire System

Model (kVA)	Input		Output		Bypass		Battery	
	Size in. (mm)	Quantity	Size in. (mm)	Quantity	Size in. (mm)	Quantity	Size in. (mm)	Quantity
60	2 (53)	4	2.5 (63)	2	2 (53)	2	2 (53)	2
75	2 (53)	4	2.5 (63)	2	2.5 (63)	2	2 (53)	2
80	2 (53)	4	2.5 (63)	2	2.5 (63)	2	2 (53)	2
90	2 (53)	4	2.5 (63)	2	2.5 (63)	2	2 (53)	2
100	2 (53)	4	3 (78)	2	2.5 (63)	2	2.5 (63)	2
120	2.5 (63)	4	3.6 (93)	2	3 (78)	2	2.5 (63)	2
140	2.5 (63)	4	3.6 (93)	2	3 (78)	2	3 (78)	2
150	3 (78)	4	3.6 (93)	2	3 (78)	2	3 (78)	2

Table 4.12 Recommended CSA Knockout for Liebert® APM2 300 kVA 480 V 4-Wire/3-Wire System

Model (kVA)	Input		Output		Bypass		Battery	
	Size in. (mm)	Quantity	Size in. (mm)	Quantity	Size in. (mm)	Quantity	Size in. (mm)	Quantity
60	2 (53)	4	2.5 (63)	2	2 (53)	2	2 (53)	2
120	2 (53)	4	2.5 (63)	2	2 (53)	2	2 (53)	2
150	2 (53)	4	2.5 (63)	2	2 (53)	2	2 (53)	2
180	2 (53)	4	2.5 (63)	2	2.5 (63)	2	2.5 (63)	2
200	2 (53)	4	3 (78)	2	2.5 (63)	2	2.5 (63)	2
225	2.5 (63)	4	3 (78)	2	2.5 (63)	2	3 (78)	2
240	2.5 (63)	4	3 (78)	2	2.5 (63)	2	3 (78)	2
250	2.5 (63)	4	3.6 (93)	2	2.5 (63)	2	3 (78)	2
300	3 (78)	4	3.6 (93)	2	3 (78)	2	3 (78)	2

Table 4.13 Recommended CSA Knockout for Vertiv™ Liebert® APM2 600 kVA 400 V 4-Wire System

Model (kVA)	Input		Output		Bypass		Battery	
	Size in. (mm)	Quantity	Size in. (mm)	Quantity	Size in. (mm)	Quantity	Size in. (mm)	Quantity
60	2.5 (63)	4	2.5 (63)	4	2.5 (63)	3	2.5 (63)	2
120	2.5 (63)	4	2.5 (63)	4	2.5 (63)	3	2.5 (63)	3
180	3 (78)	4	2.5 (63)	4	2.5 (63)	3	2.5 (63)	3

Table 4.13 Recommended CSA Knockout for Vertiv™ Liebert® APM2 600 kVA 400 V 4-Wire System

Model (kVA)	Input		Output		Bypass		Battery	
	Size in. (mm)	Quantity	Size in. (mm)	Quantity	Size in. (mm)	Quantity	Size in. (mm)	Quantity
240	3 (78)	4	2.5 (63)	4	2.5 (63)	3	3 (78)	3
300	3 (78)	4	3 (78)	4	3 (78)	3	3 (78)	3
360	3 (78)	4	3 (78)	4	3 (78)	3	3 (78)	3
400	3.6 (93)	4	3.6 (93)	4	3 (78)	3	3.6 (93)	3
420	3.6 (93)	4	3.6 (93)	4	3 (78)	3	3.6 (93)	3
480	3.6 (93)	4	3.6 (93)	4	3 (78)	3	3.6 (93)	3
500	105 x 4	4	3.6 (93)	4	3.6 (93)	3	3.6 (93)	3
540	4.1 (105)	4	3.6 (93)	4	3.6 (93)	3	4.1 (105)	3
600	4.6 (118)	4	4.1 (105)	4	4.1 (105)	3	4.1 (105)	3

Table 4.14 Recommended CSA Knockout for Liebert® APM2 600 kVA 480 V 4-Wire/3-Wire System

Model (kVA)	Input		Output		Bypass		Battery	
	Size in. (mm)	Quantity	Size in. (mm)	Quantity	Size in. (mm)	Quantity	Size in. (mm)	Quantity
60	2.5 (63)	4	2.5 (63)	4	2.5 (63)	3	2.5 (63)	3
120	2.5 (63)	4	2.5 (63)	4	2.5 (63)	3	2.5 (63)	3
180	2.5 (63)	4	2.5 (63)	4	2.5 (63)	3	2.5 (63)	3
240	2.5 (63)	4	2.5 (63)	4	2.5 (63)	3	3 (78)	3
300	3 (78)	4	3 (78)	4	2.5 (63)	3	3 (78)	3
360	3 (78)	4	3 (78)	4	3 (78)	3	3 (78)	3
400	3 (78)	4	3 (78)	4	3 (78)	3	3.6 (93)	3
420	3 (78)	4	3 (78)	4	3 (78)	3	3.6 (93)	3
480	3 (78)	4	3 (78)	4	3 (78)	3	3.6 (93)	3
500	3.6 (93)	4	3.6 (93)	4	3 (78)	3	3.6 (93)	3
540	3.6 (93)	4	3.6 (93)	4	3 (78)	3	4.1 (105)	3
600	3.6 (93)	4	3.6 (93)	4	3 (78)	3	4.1 (105)	3

4.1.5 Recommended Breaker of UPS OPD

NOTE: The branch circuit over current protection breakers used must be in accordance with NEC ANSI/NFPA 70 and the Canadian Electrical Code, Part I, C22.1. A disconnect breaker must be provided which will be used as overcurrent Protection device for AC input, DC input and AC output.

- RIB
- BIB
- MBB
- MIB
- BCB

All recommended breakers are all 100% rated breaker.

Table 4.15 Recommended OPD for Vertiv™ Liebert® APM2 150 kVA 208 V 4-Wire System

Model (kVA)	RIB	MIB	BIB and MBB	BCB
60	300	225	225	300
75	350	300	300	400
80	400	300	300	400
90	450	350	350	450
100	450	400	400	500
120	550	450	450	600
140	600	550	500	700
150	650	550	550	750

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

Table 4.16 Recommended OPD for Liebert® APM2 300 kVA 400 V 4-Wire System

Model (kVA)	RIB	MIB	BIB and MBB	BCB
60	160	125	125	200
120	300	250	250	350
150	400	300	300	450
180	450	350	350	550
200	500	400	400	600
225	550	450	450	650
240	630	500	500	700
250	600	500	500	700
300	700	600	600	850

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

Table 4.17 Recommended OPD for Vertiv™ Liebert® APM2 600 kVA 400 V 4-Wire System

Model (kVA)	RIB	MIB	BIB and MBB	BCB
60	150	125	125	150
120	300	250	250	300
180	450	350	350	400
240	600	500	500	550
300	750	600	600	700
360	900	700	700	800
400	1000	800	800	900
420	1000	850	850	950
480	1200	950	950	1100
500	1200	1000	1000	1200
540	1400	1100	1100	1200
600	1500	1200	1200	1400
NOTE: These values are at Ambient Temperature: 77 °F (25 °C).				

Table 4.18 Recommended OPD for Liebert® APM2 600 kVA 480 V 4-Wire/3-Wire System

Model (kVA)	RIB	MIB	BIB and MBB	BCB
60	150	125	125	150
120	250	200	200	300
180	350	300	300	400
240	500	400	400	550
300	600	500	500	700
360	700	600	600	800
400	800	650	650	900
420	800	700	700	950
480	900	800	800	1100
500	1000	800	800	1200
540	1200	900	900	1200
600	1200	1000	1000	1400
NOTE: These values are at Ambient Temperature: 77 °F (25 °C).				

4.1.6 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 the previous page and a maximum allowed voltage drop is 4 VDC.
4. Avoid creating the coils to reduce the generation of electromagnetic interference (EMI).
5. Make sure to leave sufficient wiring space before wiring.

4.1.7 Power Cable Connecting 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 46.

4.1.8 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 46 for more details. 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 required may cause EMI, electric shock, or fire risk.

4.1.9 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 should be knowledgeable about 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 134 and **Table 12.6** on page 135. The protective devices should provide functions such as the overcurrent protection, short circuit protection, isolation protection and tripping upon backfeed.

The Vertiv™ Liebert® APM2 300 kVA to 600 kVA 480 V UPS Frame has a built in back feed contactor for backfeed protection. See **Figure 6.3** on page 83.

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.

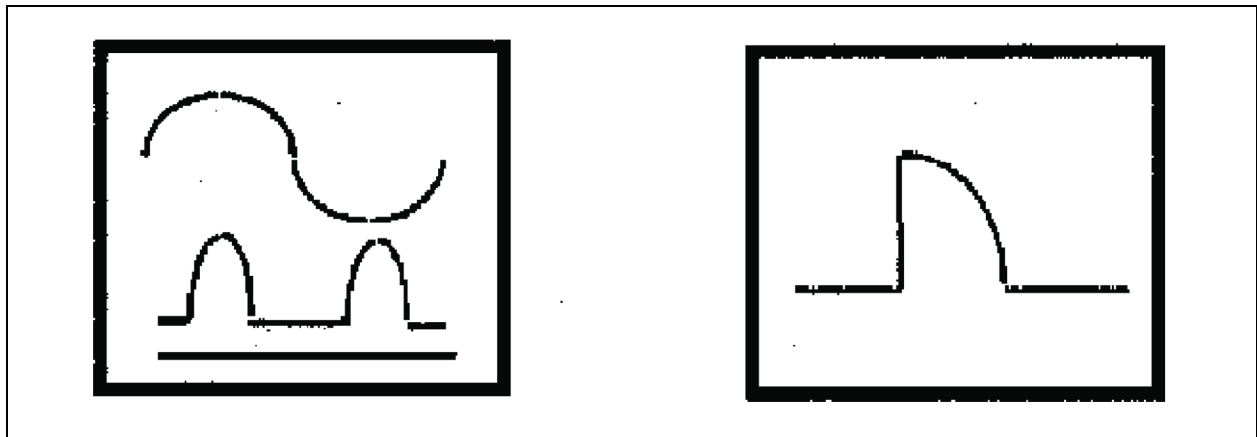
3. **Ground fault protection:** If the upstream input power supply has an RCD, the transient state and steady state ground leakage current upon the startup of the UPS must be considered.

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 protective earth cable's leakage 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 134 and **Table 12.6** on page 135 for more details.

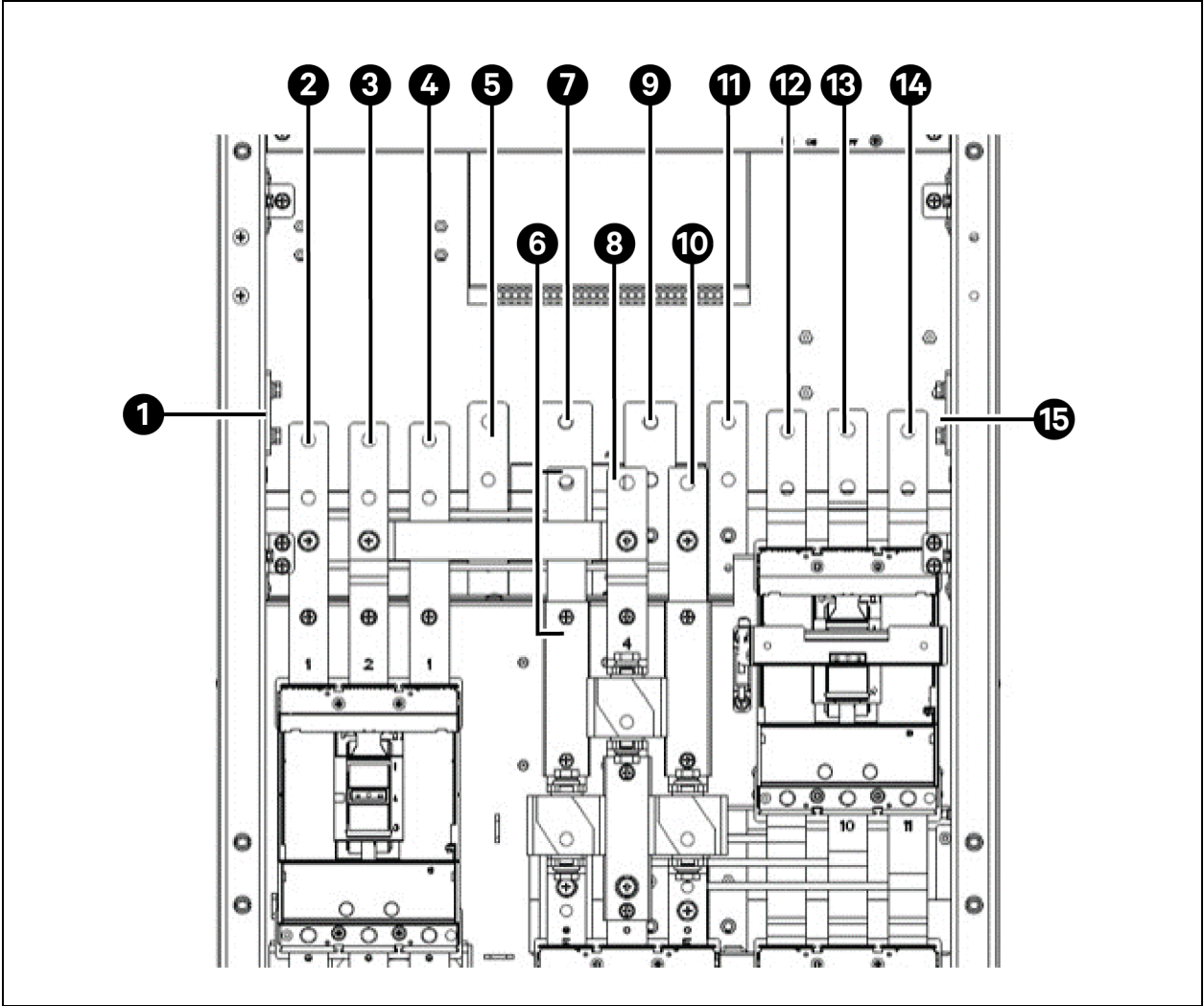
NOTE: An IT grid system, 4-pole protective components must be installed for the UPS external input power distribution.

4.1.10 Power Cable Connection Steps

Connection terminal

See Figure 4.2 below for the connection terminals of the 150 kVA 208 V and 300 kVA 480 V UPS power cable.

Figure 4.2 Power Cable Connection Terminals for Vertiv™ Liebert® APM2 150 kVA 208 V and 300 kVA 480 V UPS

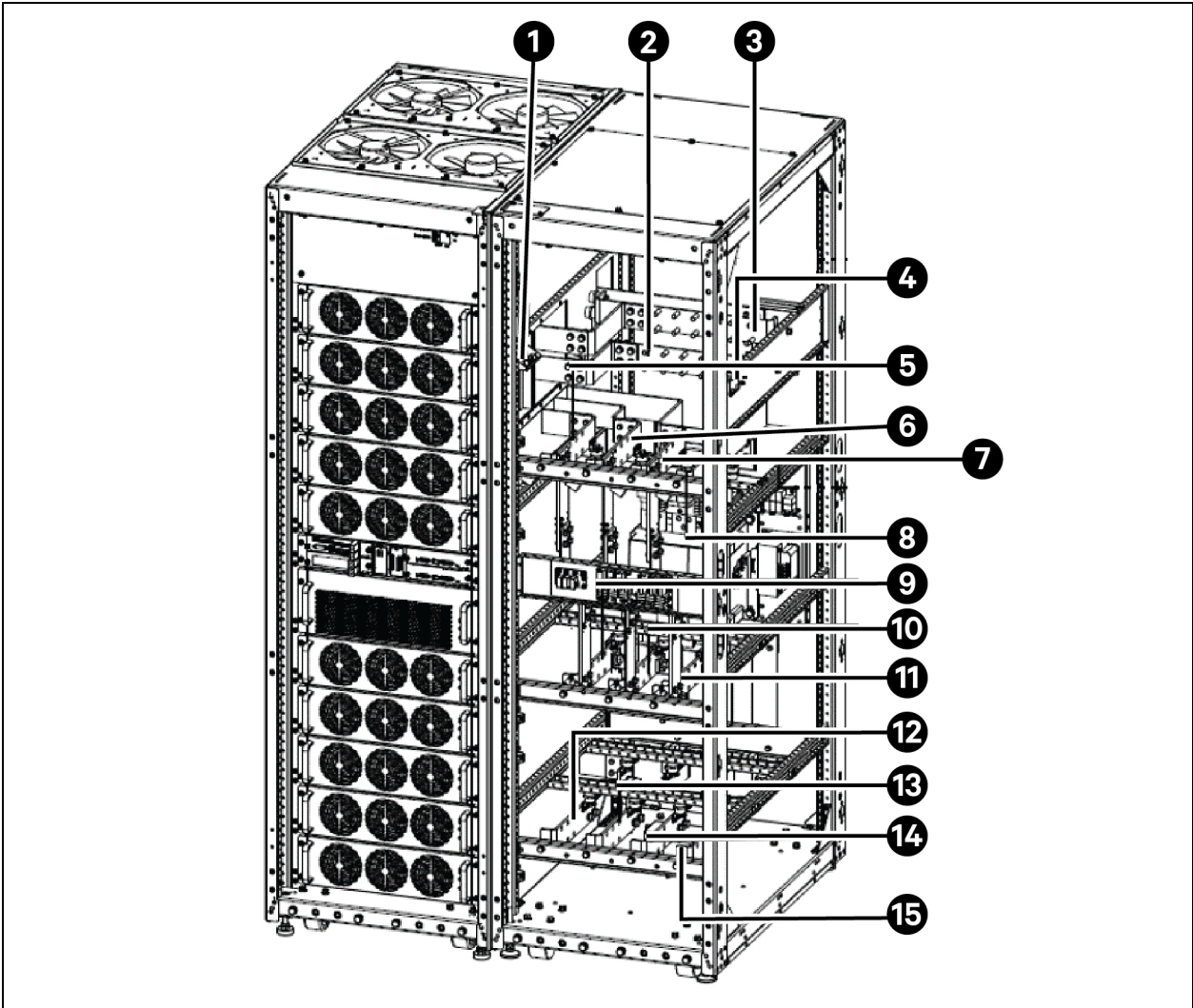


Item	Description	Item	Description
1	PE	9	BAT +
2	mA	10	bC
3	mB	11	oN
4	mC	12	oA
5	mN	13	oB

Item	Description	Item	Description
6	bA	14	oC
7	BAT -	15	PE
8	bB		

See **Figure 4.3** below for cable routing and connection of the Vertiv™ Liebert® APM2 600 kVA 480 V UPS.

Figure 4.3 Power Cable Connection Terminals of Liebert® APM2 600 kVA 480 V UPS



Item	Description	Item	Description
1	PE	9	bA
2	BAT +	10	bB
3	BAT -	11	bC
4	PE	12	oN

Item	Description	Item	Description
5	mA	13	oA
6	mB	14	oB
7	mC	15	oC
8	mN		

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 from 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. See [Power Cable Wiring](#) on page 34 for more details, connect the power cables as described below.

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 of 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 according to [step 1](#).

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

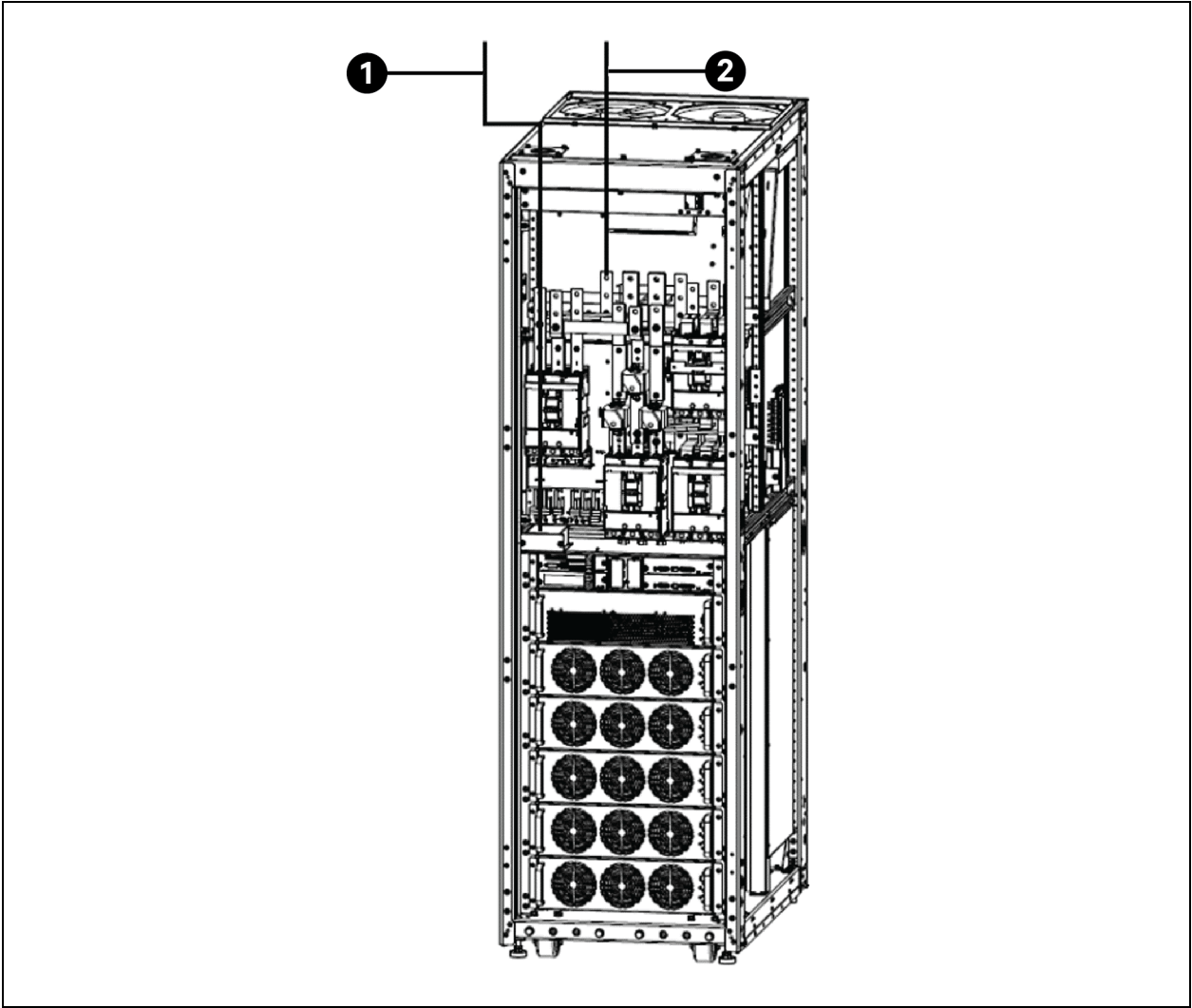


WARNING! Risk of electric shock. Can cause equipment damage, personnel injury, or death. Verify that all external and internal power switches of the UPS are turned off and locked out or tagged out before installing the cables or making any electrical connections. Also, measure the voltages between the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

For Vertiv™ Liebert® APM2 150 kVA 208 V and 300 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, See **Figure 4.4** below.

Figure 4.4 Power Cables Wiring Route 150 kVA 208V and 300 kVA 480V

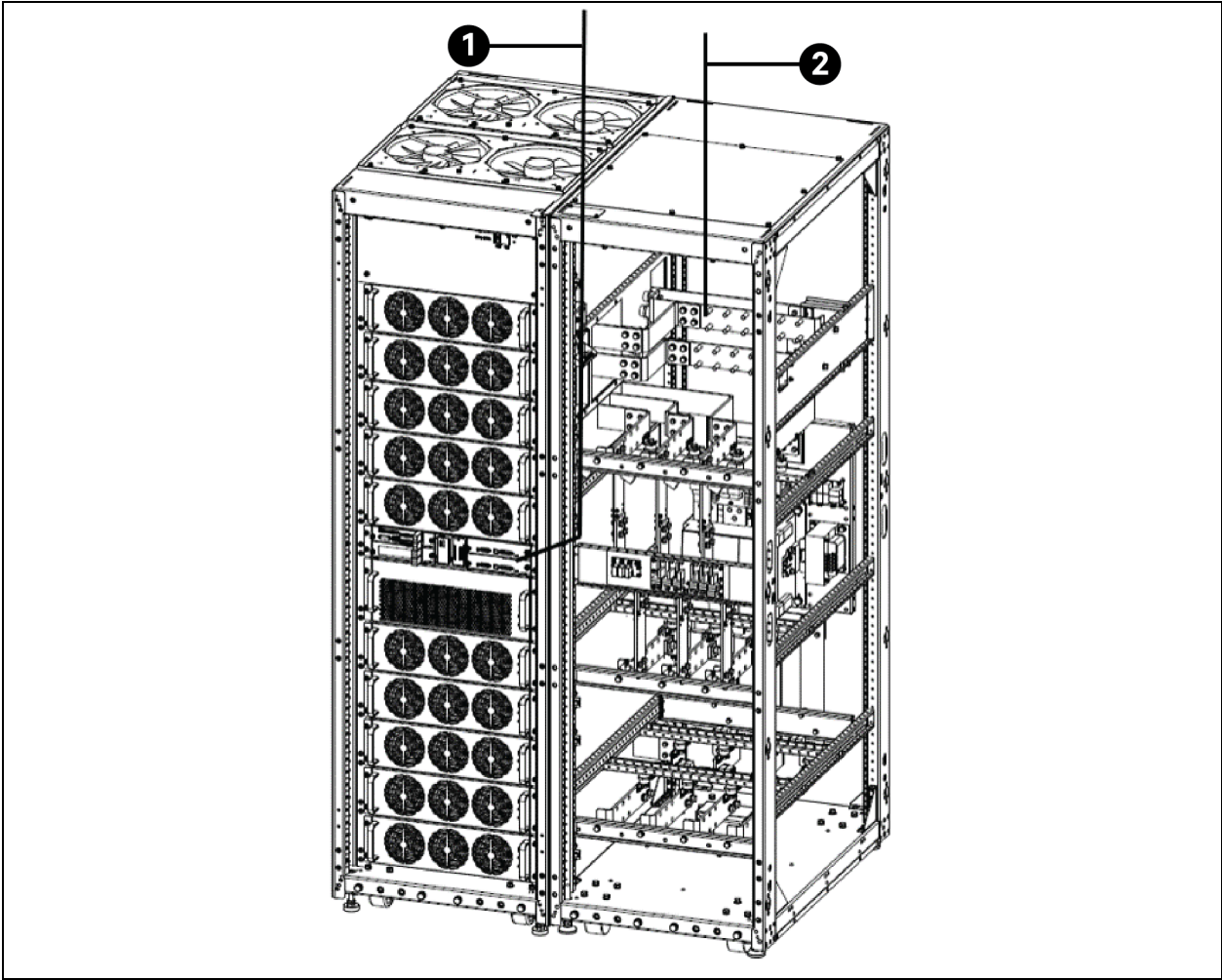


Item	Description
1	Power cable through top cabinet entry plate
2	Signal cable through the top cabinet hole

For Vertiv™ Liebert® APM2 600 kVA 480 V UPS power cable:

- 1. Remove the top cover cable entry plate. Drill or punch cable entry holes after removing as required. Do not drill or punch holes while cable entry plate is installed on top of unit.
- 2. Put the power cables into the cabinet through cabinet hole. See **Figure 4.5** below for top cable access.
- 3. Connect the power cables to the respective terminals.

Figure 4.5 Power Cables Wiring Route Liebert® APM2 600 kVA 480 V



Item	Description
1	Signal cable through the top cabinet cable entry plate
2	Power cable through the top cabinet cable entry plate

- 4. Open the front door of the UPS and remove the protective cover to gain access to the power cable connection terminals. See **Figure 4.2** on page 46 and **Figure 4.3** on page 47. Connect the protective earth cable to the PE input terminal in the cabinet.



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. See **Figure 4.2** on page 46 and **Figure 4.3** on page 47 for additional details.

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 46.

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. Tighten the connections according to [Power Cable Connection Steps](#) on page 46.



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.



AVERTISSEMENT! 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.

Connecting batteries

1. Ensure correct polarity of the connections from the battery cabinet to the battery input terminals (BAT+, BAT-) in the UPS cabinet.
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

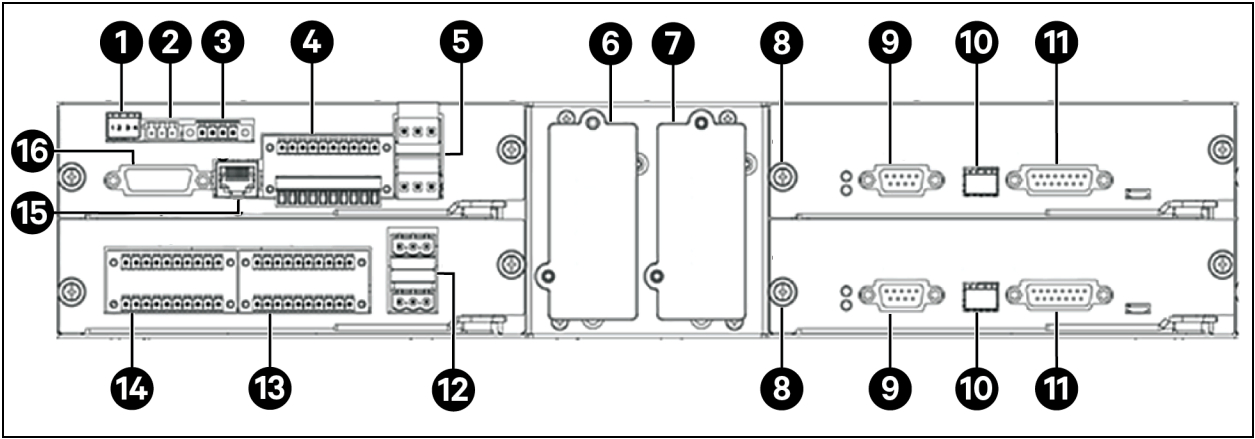
4.2.1 Overview

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 remote emergency power off (REPO).
- To provide bypass back feed circuit breaker.

These functions are performed through the communication box in the Liebert® APM2 UPS cabinet. The communication box provides the ports as shown in **Figure 4.6** below.

Figure 4.6 Overview of Communication Ports



Item	Description	Item	Description
1	X6 SW1	9	U4 LBS: 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	Liebert® IntelliSlot™ 2	15	X6 BATT: Battery temperature or BMS communication port
8	Screw (quantity = 8)	16	X6 HMI port

NOTE: The screws should be tightened after each board is inserted, as shown in **Figure 4.6** above, to maintain proper grounding.

4.2.2 Dry Contact Port X6 J3

The schematic diagram of dry contact port J3 is shown in **Table 4.19** below and the ports are described in **Table 4.19** 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 4.7 Dry Contact Port J3

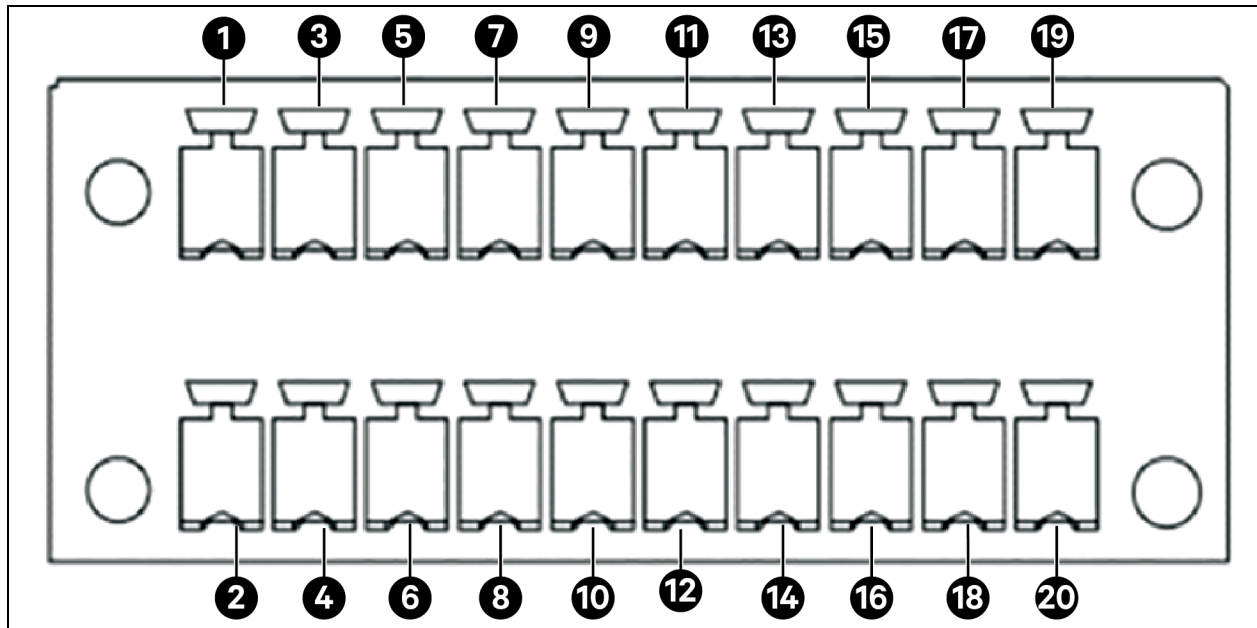


Table 4.19 Description of Dry Contact Port J3

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 enabled.
5	Dry in	Input dry contact can be defined, the default setting is charger off.	6	PE	
7	GND		8	Dry in	Input dry contact can be defined, the default setting is BCB1 enabled.
9	NO	Output dry contact can be defined, the default setting is UPS alarm.	10	Dry in	
11	Com1		12	Dry in	Input dry contact can be defined, the default setting is battery grounding signal.
13	NC		14	Dry in	
15	NO	Output dry contact can be defined, the default setting is UPS fault.	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 provided in **Table 4.20** below.

Table 4.20 Input Dry Contact Functions

Number	Function Description	Number	Function Description
1	External switch status (optional mains input/bypass input/external output/external maintenance bypass/load switch)	9	Battery room over temperature
2	Turn off the inverter	10	BCB tripping required
3	BCB enabled (8-group settable)	11	Charger off
4	BCB feedback status (8-group settable)	12	Start battery manual test
5	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 grounding fault (8-group settable)

The list of definable output dry contact functions is described in **Table 4.21** below.

Table 4.21 Output Dry Contact Functions

Number	Function Description	Number	Function Description
1	UPS alarm	5	On bypass
2	UPS fault	6	On maintenance bypass
3	On inverter	7	Input voltage abnormal
4	On battery	8	Battery low voltage

The schematic diagram of dry contact port J22 is shown in **Figure 4.8** on the facing page and described in **Table 4.22** on the facing page. The dry contact voltage is 24 VDC / 250 VAC, and the current is 5 A.

Figure 4.8 Dry Contact Port J22

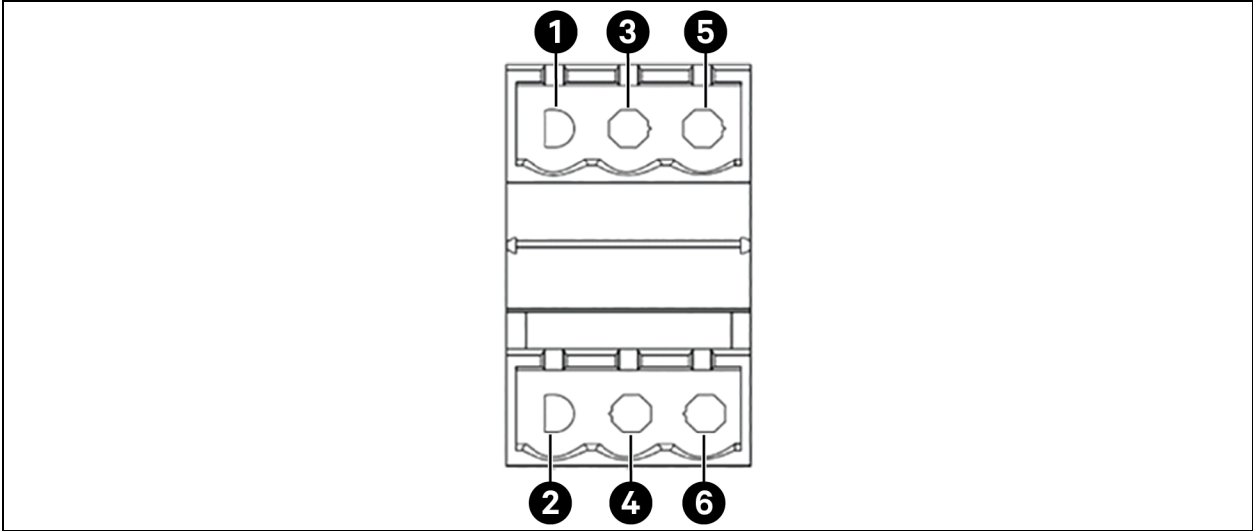


Table 4.22 Description of Dry Contact Port J22

Port	Item	Name	Meanings
Bypass Backfeed	1	BFP_O	Normally open. Closed when bypass has backfeed.
	3	BFP_S	Bypass backfeed protection relay common. Connected with 24 V driver power.
	5	BFP_C	Normally closed. Open when bypass has backfeed.
Bypass Drive Power	2	N/A	N/A.
	4	24 V	Pin not used
	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 4.9** on the next page and described in **Table 4.23** 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. The BCB drive signal can provide 12 V / 10 mA signal.

Figure 4.9 Dry Contact Port J1

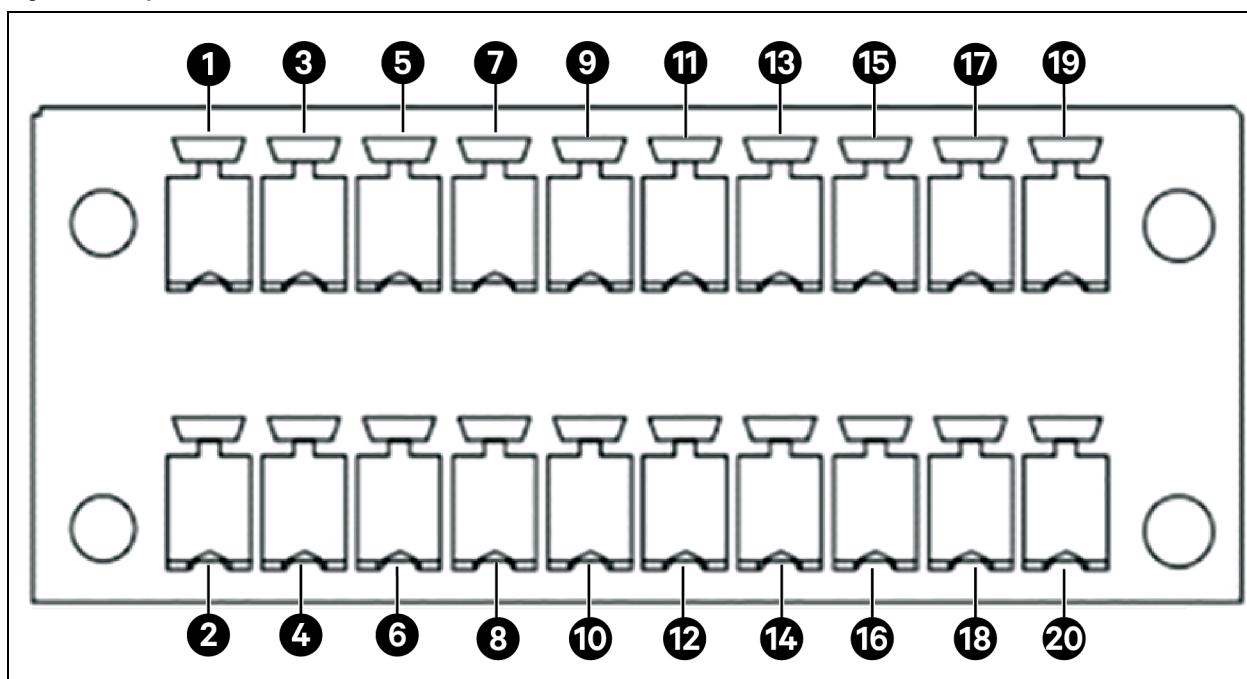


Table 4.23 Description of Dry Contact Port J1

Pin	Name	Meanings	Pin	Name	Meanings
1	BCB_Drive2	BCB2 trip signal	2	BCB_Drive3	BCB3 drive signal.
3	GND		4	GND	
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	
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 4.10** below and described in **Table 4.24** 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 4.10 Dry Contact Port J2

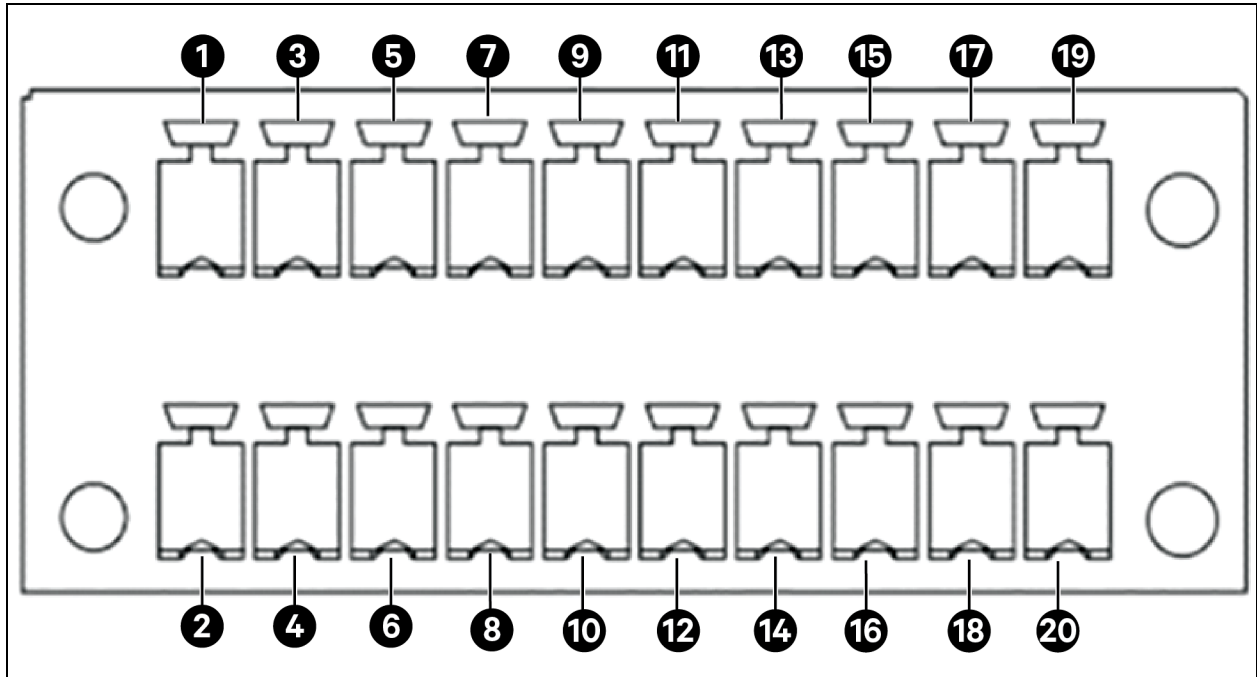


Table 4.24 Description of Dry Contact Port J2

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	BCB_Drive4	BCB4 drive signal
3	GND		4	GND	
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 4.11** below and described in **Table 4.25** below. The dry contact voltage is 24 VDC / 250 VAC, and the current is 5 A.

Figure 4.11 Dry Contact Port J3

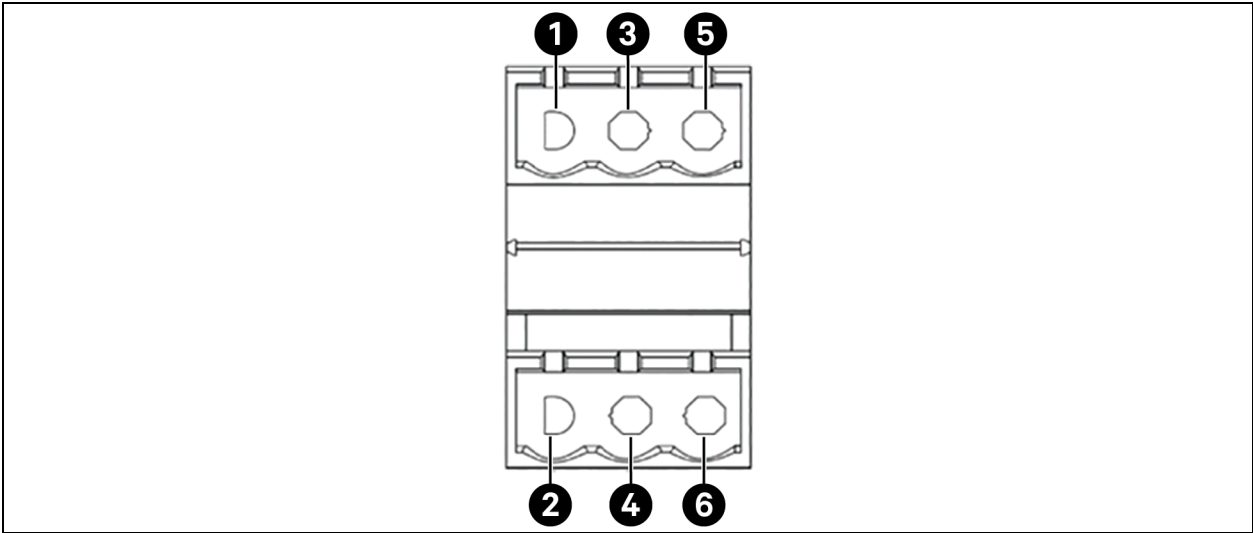


Table 4.25 Description of Dry Contact Port J3

Port	Item	Name	Default Signal
BCB backfeed	1	NO	Normally open. Closed when BCB change the ON/OFF state.
	3	COM	Common contact. Connected with 24 V driver power.
	5	NC	Normally closed
MBB and MIB interlock signal	2	NO	Normally open. Closed when MBB and MIB interlock signal change the ON/OFF state.
	4	COM	Common contact
	6	NC	Normally closed
NOTE: X7 J3 pins are programmable contacts. J3_2,4,6 can connect two wires of MBB and MIB interlock signal only.			

4.2.6 Remote Emergency Power Off Port

The UPS consist of an REPO function that operates by either a REPO button under the protective cover on the touchscreen of the UPS or a remote contact provided by the user. The REPO button has a protective cover. To REPO the UPS remotely, the REPO port must wired accordingly to the operation of the user supplied REPO switch as either normally open or normally closed.

Within 328.1 ft. (100 m) of the communication line, use a shielded wire, and both ends of the shielded wire are grounded. If the length exceeds 328.1 ft. (100 m), the shielded wire must go through a metal pipe.

The schematic diagram of REPO port is shown in **Figure 4.12** below and described in **Table 4.26** below.

Figure 4.12 REPO Port

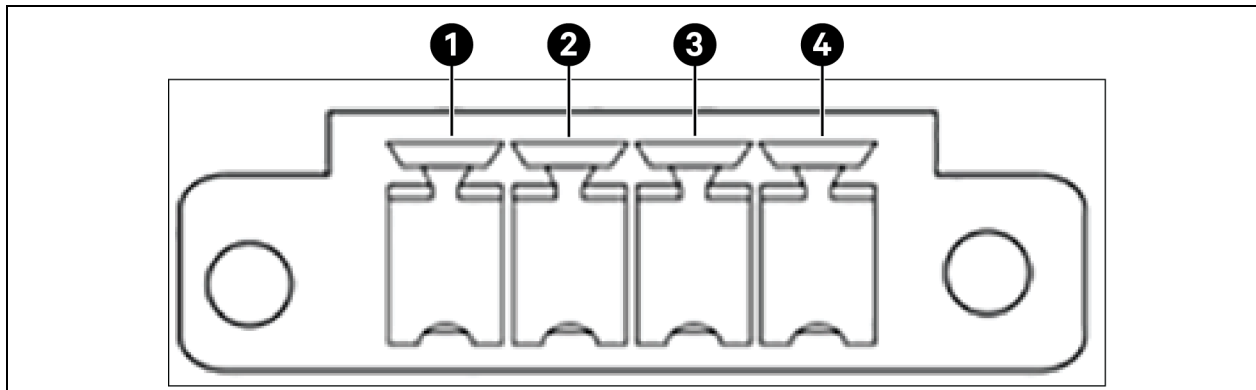


Table 4.26 Description of REPO Port

Item	Name	Meanings	Item	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 remote EPO 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 4.6 on page 52 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, SIC card, and RS-485 card. **Table 4.27** on the next page describes the models and installation positions of the optional cards. For the detailed installation of the optional cards, see the respective contents in the [Vertiv™ Liebert® APM2 Option Configurations](#) on page 117.

Table 4.27 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
SIC card	UF-SNMP810	Liebert® IntelliSlot™ ports 1 to 2
Liebert® IS-Relay card	Liebert® IS-RELAY	Liebert® IntelliSlot™ ports 1 to 2

Table 4.27 Models and Installation Positions of Optional Cards

Optional Card	Model	Installation Position
Vertiv™ Liebert® IS-UNITY-LIFE card	Liebert® IS-UNITY-LIFE	Vertiv™ Liebert® IntelliSlot™ ports 1 to 2
UF-RS-485 card	UF-RS-485	Liebert® IntelliSlot™ port 1

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.

Figure 4.13 on the facing page shows the cable routing of Vertiv™ Liebert® APM2 150 kVA 208 V and 300 kVA 480 V UPS. and see **Figure 4.14** on page 62 for Liebert® APM2 600 KVA 480 V UPS communication port for connecting signal cables to respective ports.

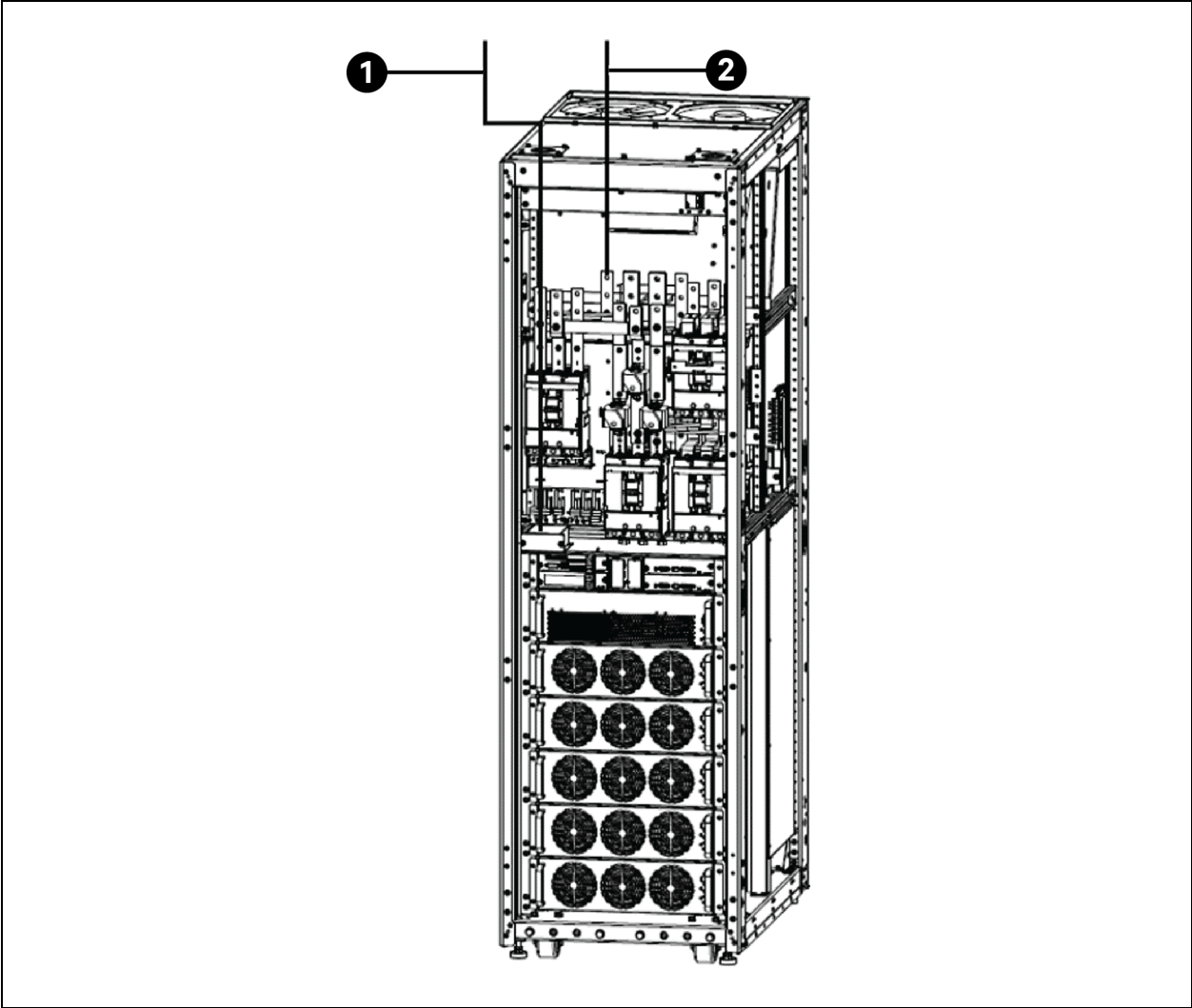
To route and connect the power cables, follow this procedure.

1. Remove the top cover.
2. Put the cables into the cabinet through cabinet hole. See **Figure 4.13** on the facing page for top cable access.
3. Connect the signal cables to the respective terminals.



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.

Figure 4.13 Signal Cables Wiring Route of Vertiv™ Liebert® APM2 150 kVA 208 V and 300 kVA 480 V UPS

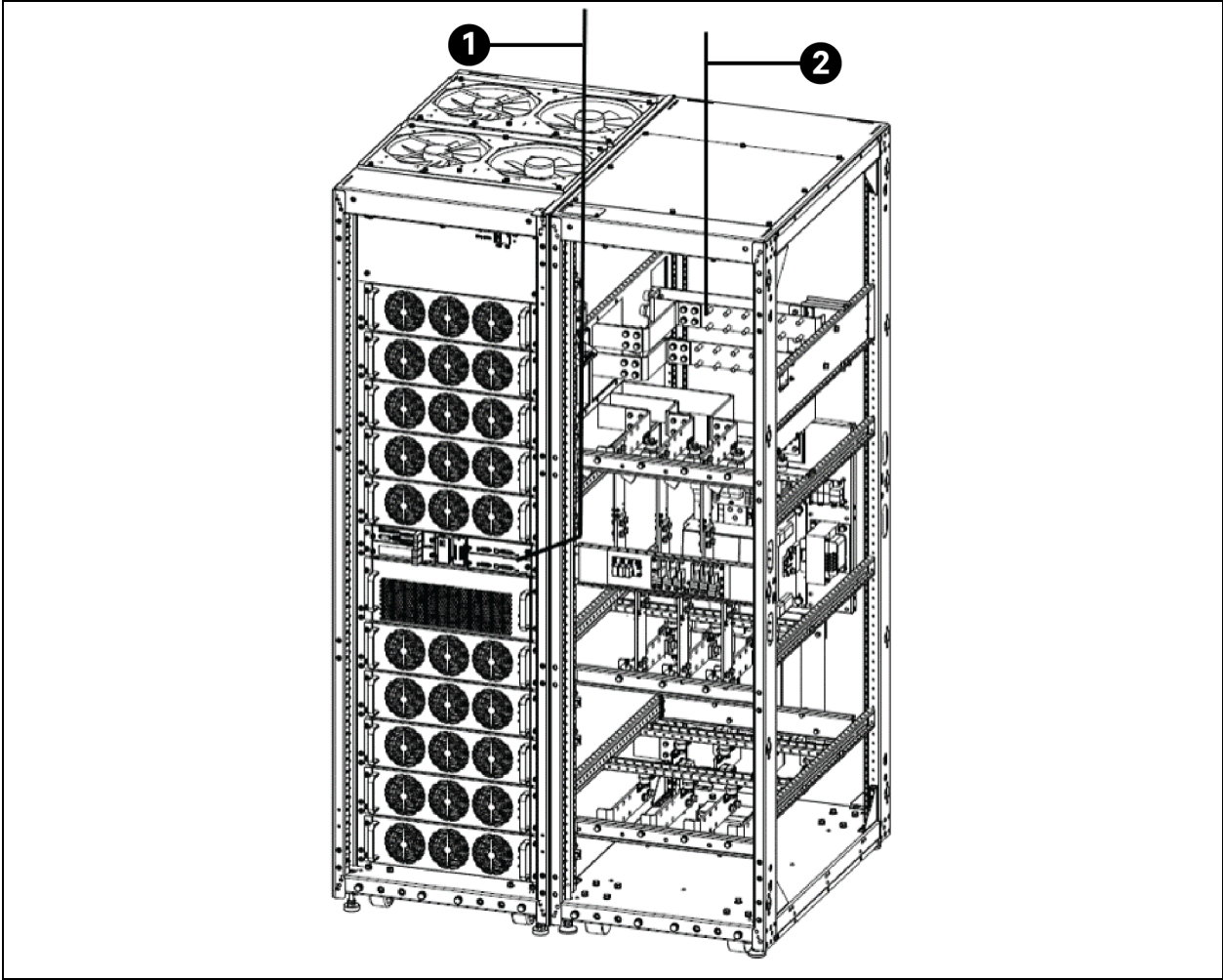


Item	Description
1	Connect them to corresponding terminals
2	Lead the signal cables into the cabinet through this cabling entry plate

For Liebert® APM2 600 kVA 480 V UPS:

1. Remove the top cable entry plate.
2. Put the cables into the cabinet through cabinet hole. See **Figure 4.14** on the next page for top cable access.
3. Connect the signal cables to the respective terminals.

Figure 4.14 Signal Cables Wiring Route of Vertiv™ Liebert® APM2 600 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.

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 [Log in to the Vertiv™ Liebert® APM2 Touchscreen Control Panel](#) on page 65 for more information.
- Silencing alarms. See [Silence an alarm](#) on page 68 for more information.
- Turning the UPS On. See [Inverter On](#) on page 68 for more information.
- Turning the UPS Off. See [Inverter Off](#) on page 68 for more information.
- Resetting faults. See [Reset Fault](#) on page 69 for more information.
- Enabling energy saving mode. See [Energy Saving Mode Activation](#) on page 70 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 71 and [Vertiv™ Liebert® APM2 Touchscreen Control Panel Components](#) on the next page.

The Liebert® APM2 touchscreen control panel's display default view is two panes: 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.

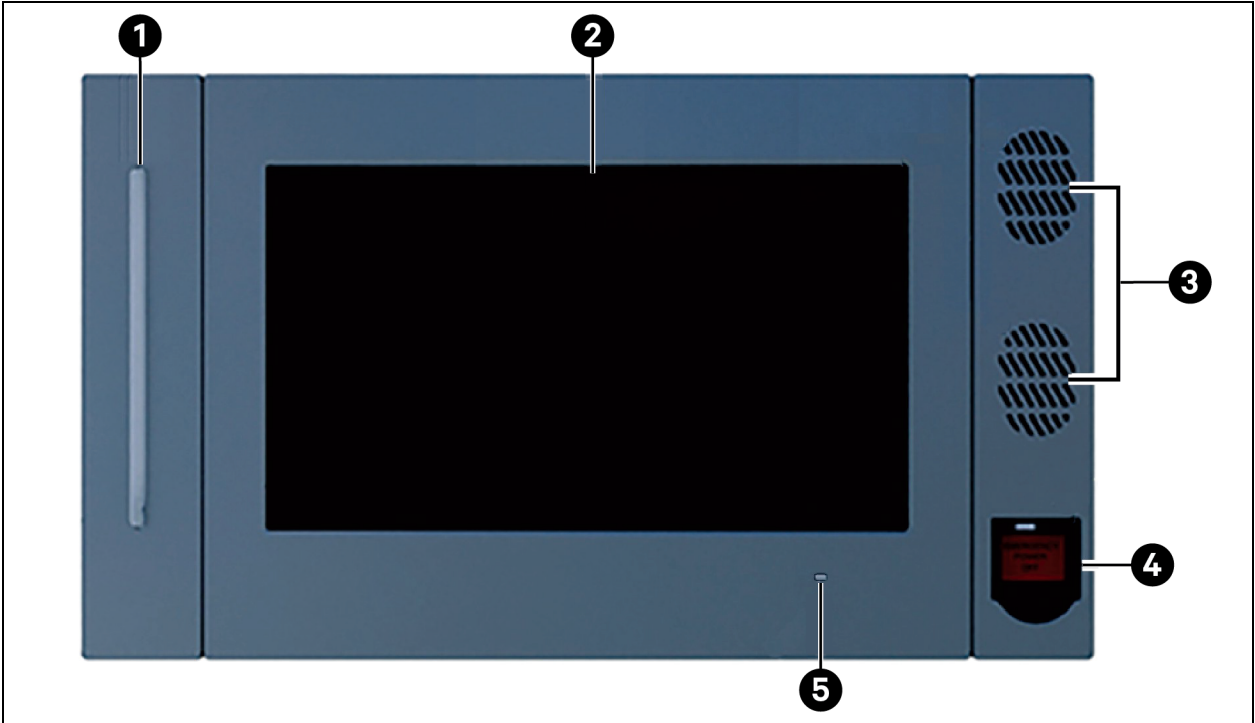


CAUTION: Risk of unauthorized changes to operational settings. Can cause equipment damage. The default PIN numbers should be changed immediately to prevent unauthorized personnel from changing UPS operation or even shutting down the UPS. The PINs for Operator and Administrator may be changed by logging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

5.2.1 Vertiv™ Liebert® APM2 Touchscreen Control Panel Components

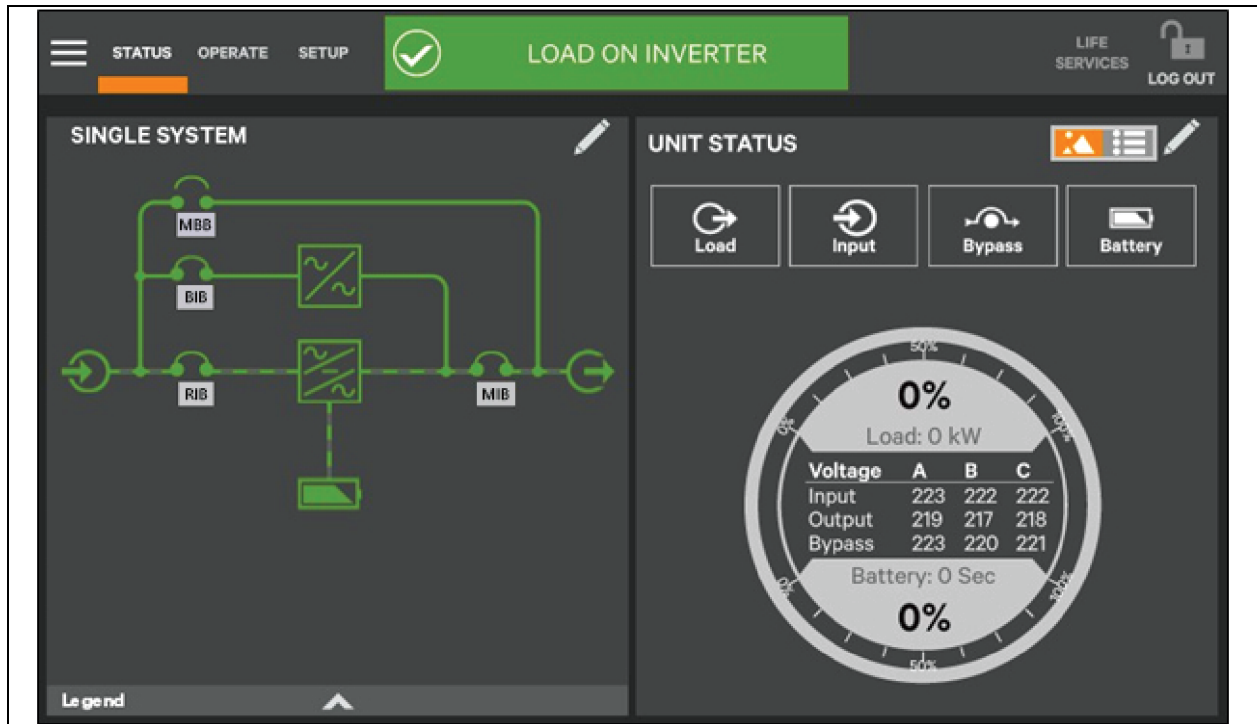
The main areas of the Liebert® APM2 touchscreen control panel are shown in **Figure 5.1** below and **Figure 5.2** on the facing page. The display arrangement and the information displayed can be changed. At login for all access levels, the Liebert® APM2 touchscreen control panel opens to the STATUS 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. See **Figure 5.3** on page 66 for more details.

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. Visible to Service.

5.3 Operation

5.3.1 Log in 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™ Liebert® 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 1234.



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.

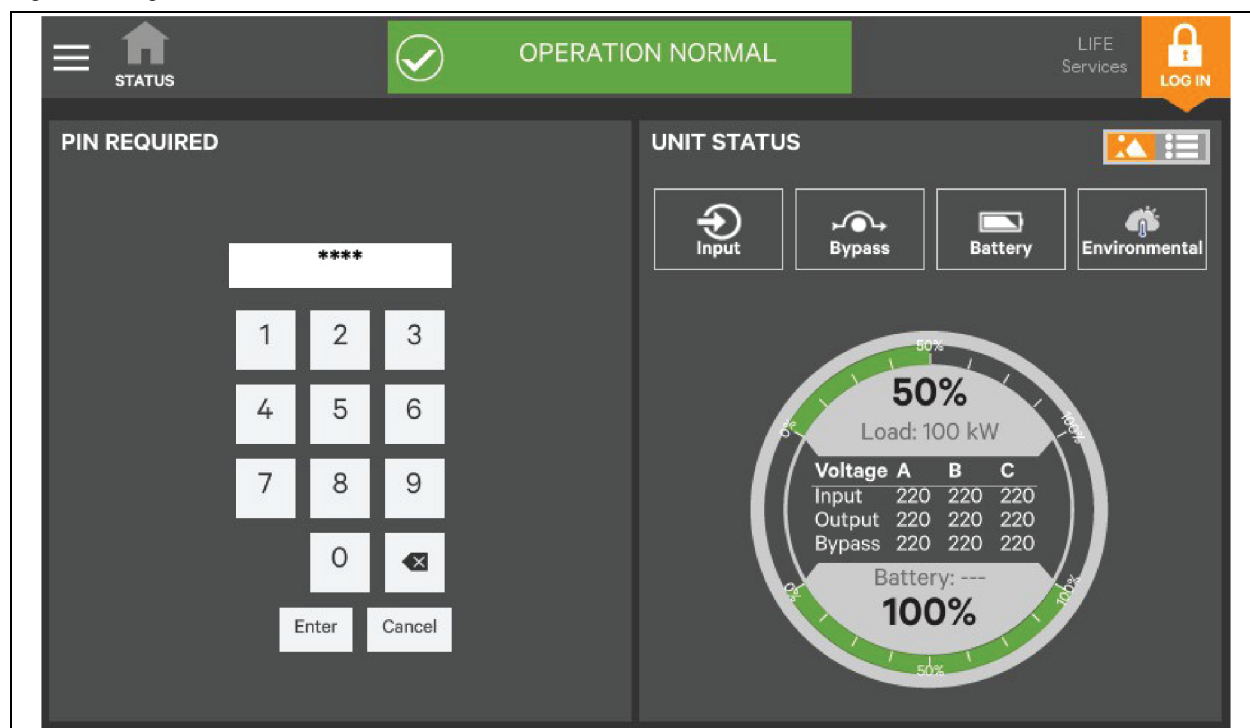
The Vertiv™ Liebert® APM2 touchscreen control panel is on when the UPS has control power. It is inactive and appears dark, depending on its settings. Touch the touchscreen to turn it on.

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 at the screen below.
3. Press Enter.

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

Figure 5.3 Log In Screen



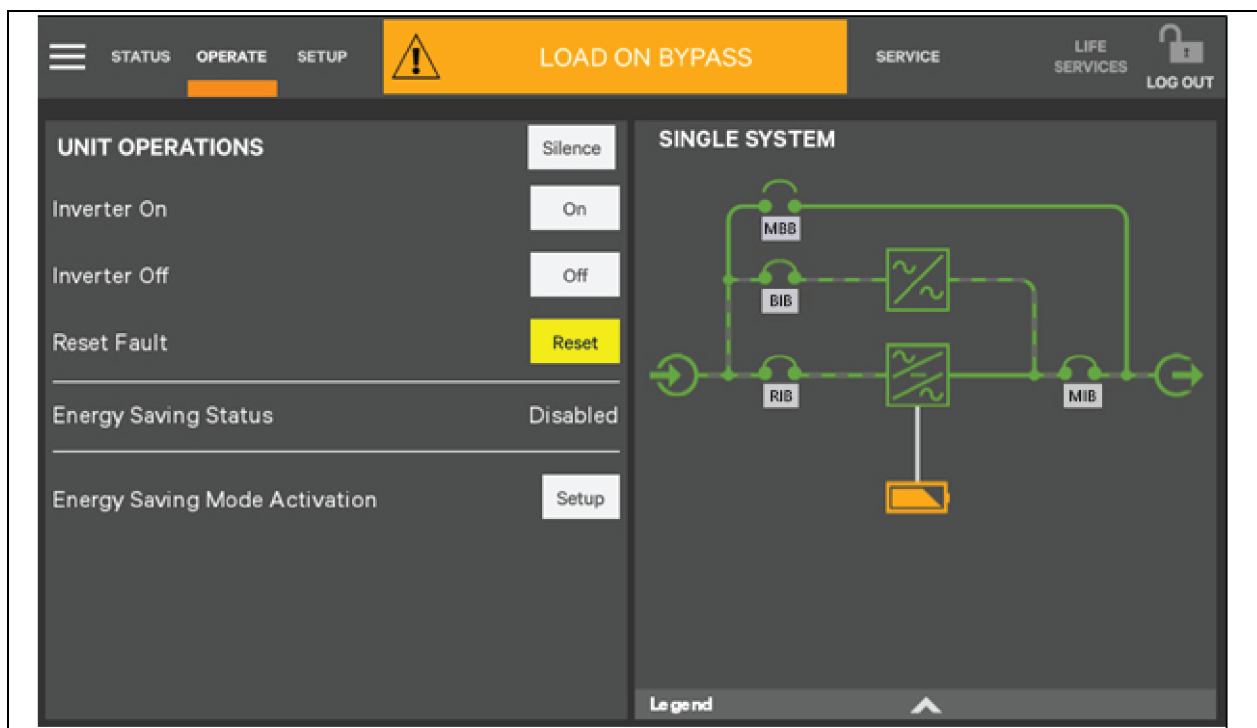
5.3.2 Operator Controls

The Operator login 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.

Operate menu commands

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.

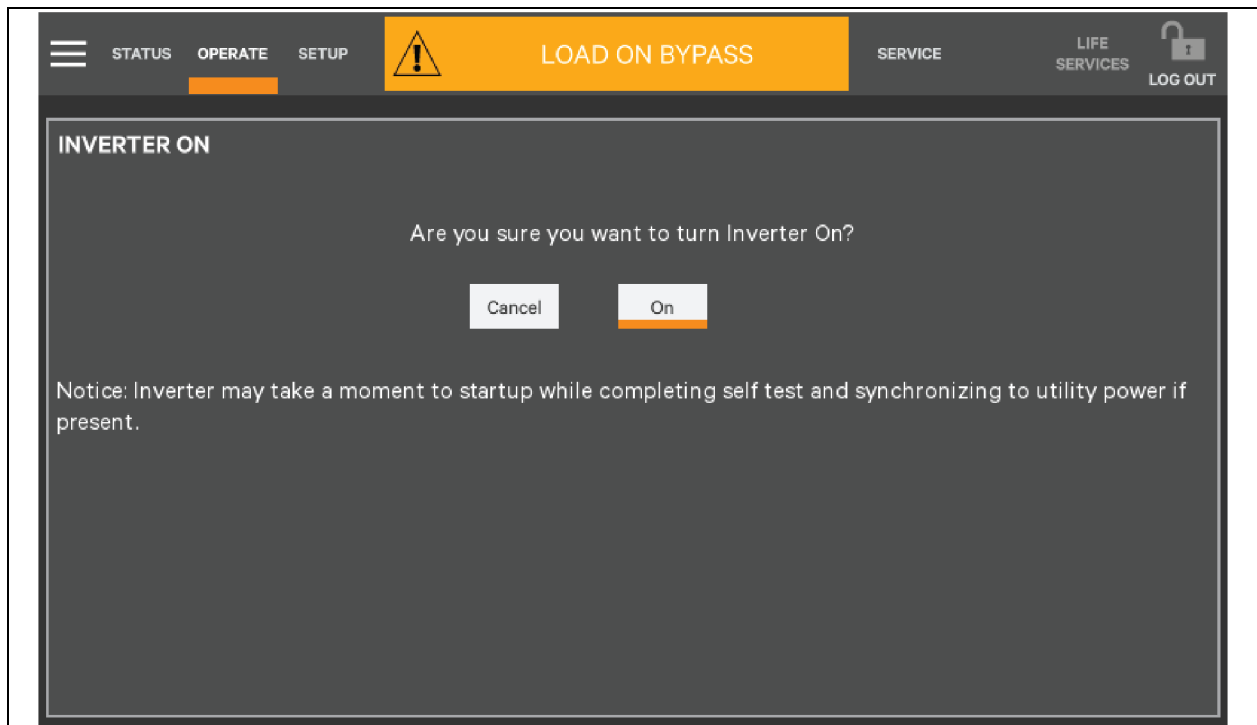
Silence an alarm

To silence an alarm, touch the Silence radio 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 as shown in **Figure 5.5** below. The control displays a progress window while the inverter starts.

Figure 5.5 Inverter On Screen



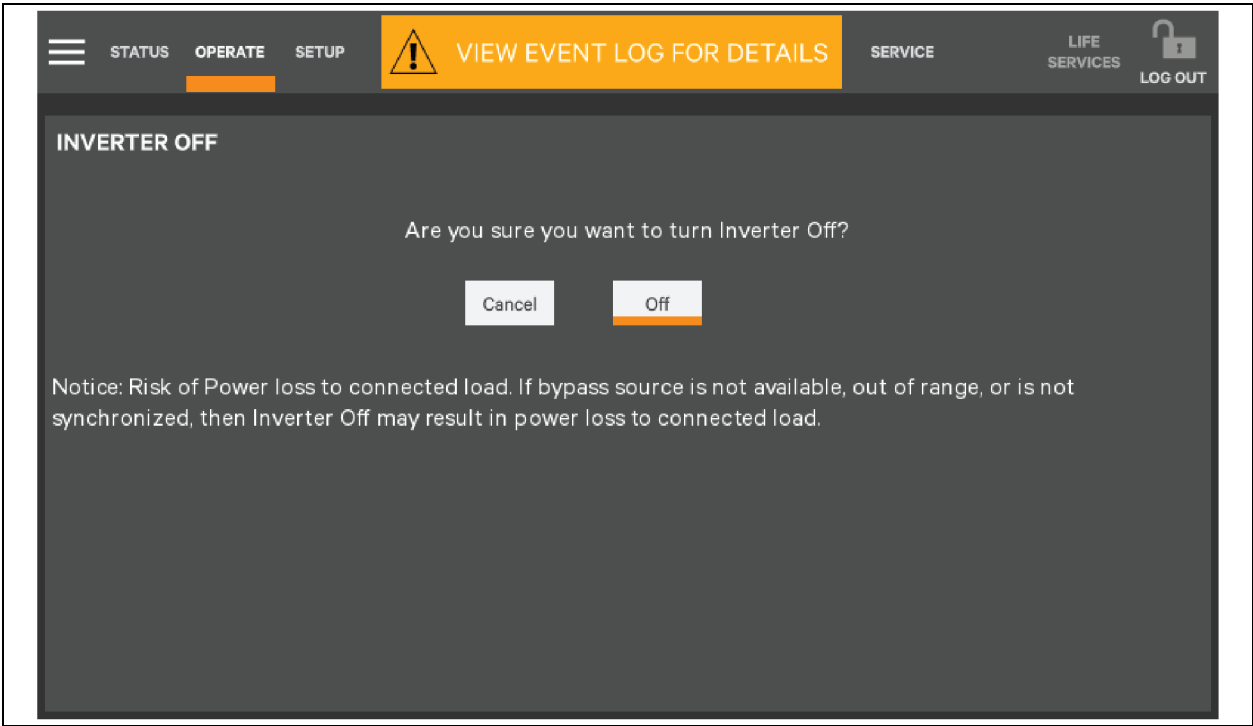
Inverter Off

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 the inverter off.



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.

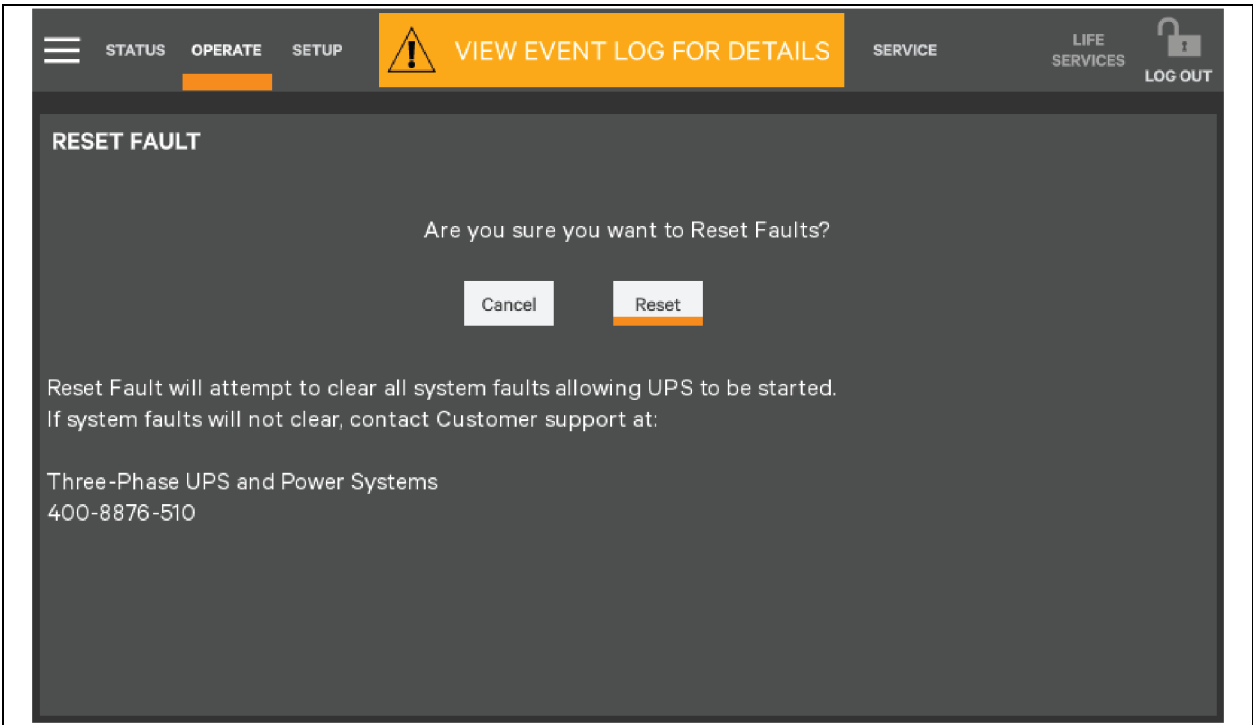
Figure 5.6 Inverter Off Screen



Reset Fault

Faults may be reset with the Reset radio 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 radio button for Energy Saving Mode Activation, as shown in **Figure 5.8** below.
2. Enable or disable Energy Saving Mode, 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

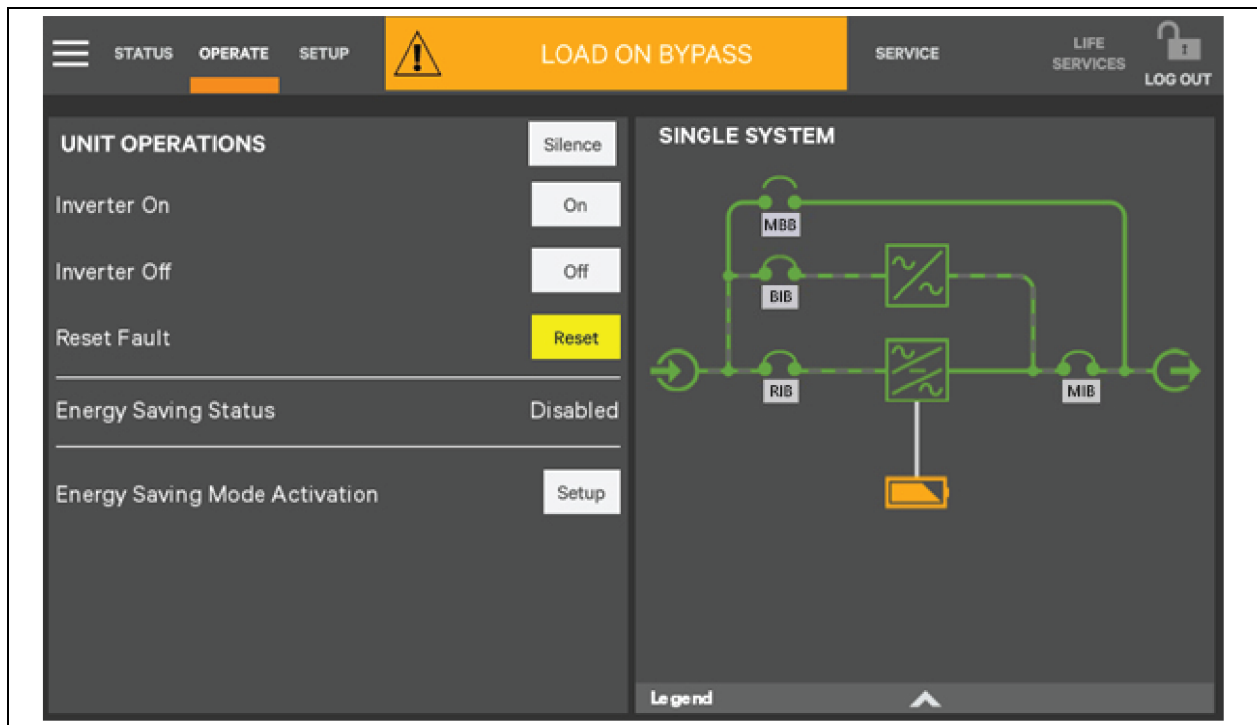
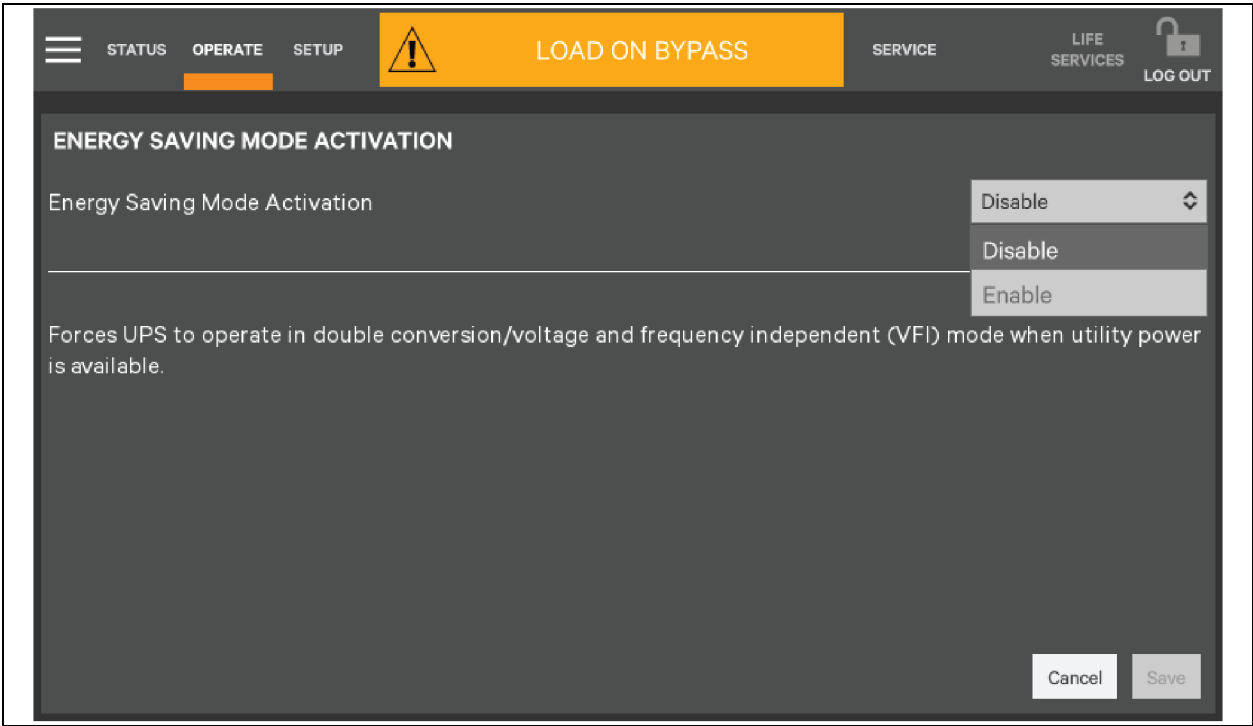


Figure 5.9 Energy Saving Mode Activation



5.4 Viewing UPS Status

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

5.5 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.
- **Figure 5.10** below shows an icon inside the bar.

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.

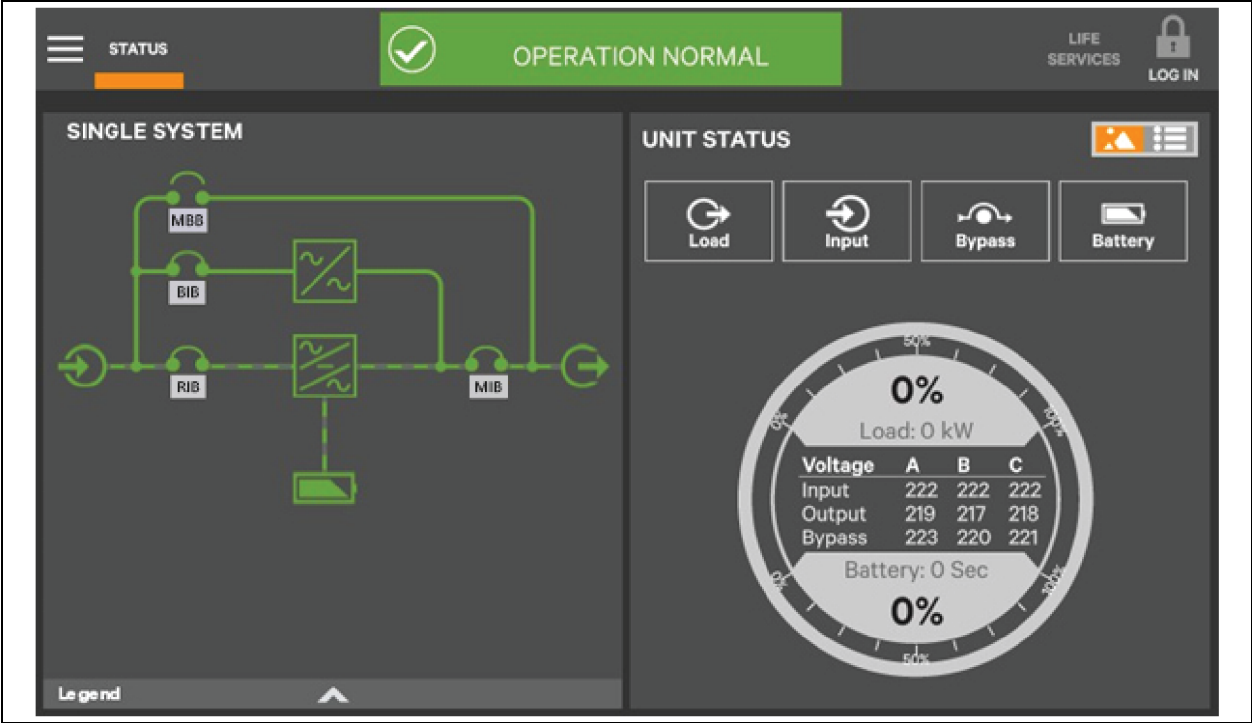
Alarms and certain events will trigger audible alarms and the LED on the bezel, the light bar and the status header will change color (audible alarms do not sound unless enabled). The scrolling information bar at the top of the interface summarizes information about the UPS status. The Status Gauge on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

5.5.1 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



5.5.2 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

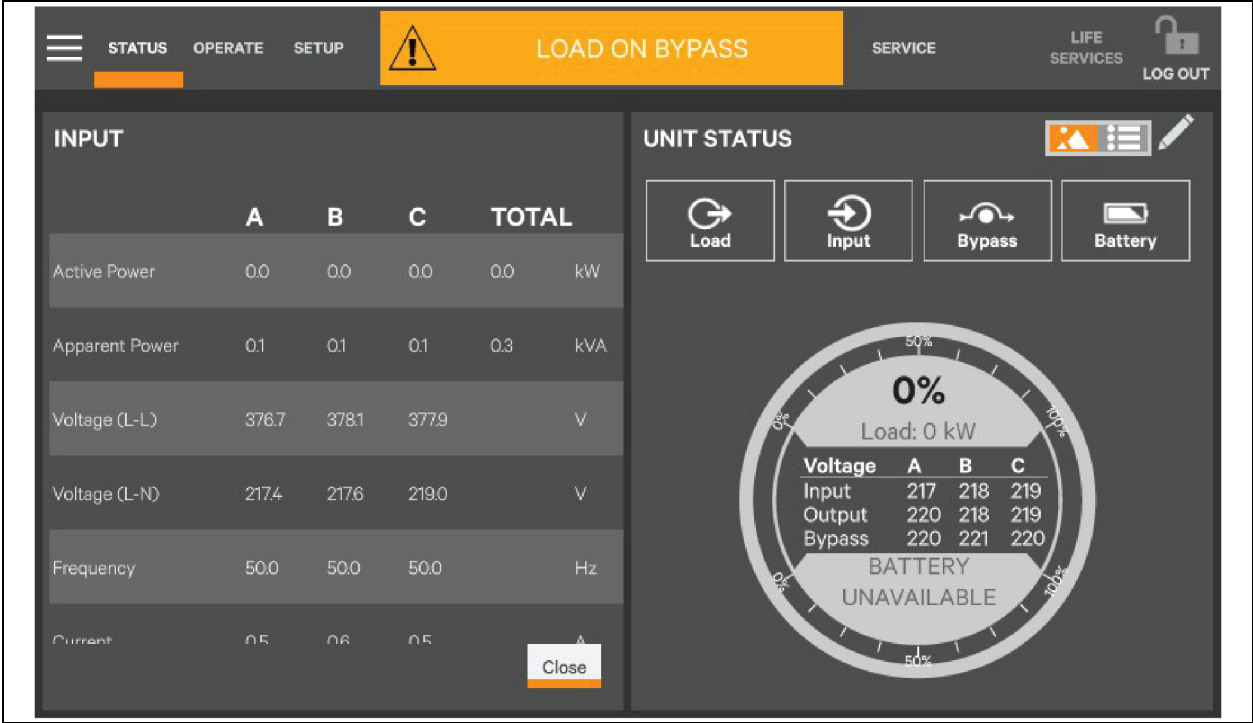


Figure 5.13 Input Details — Bypass Details

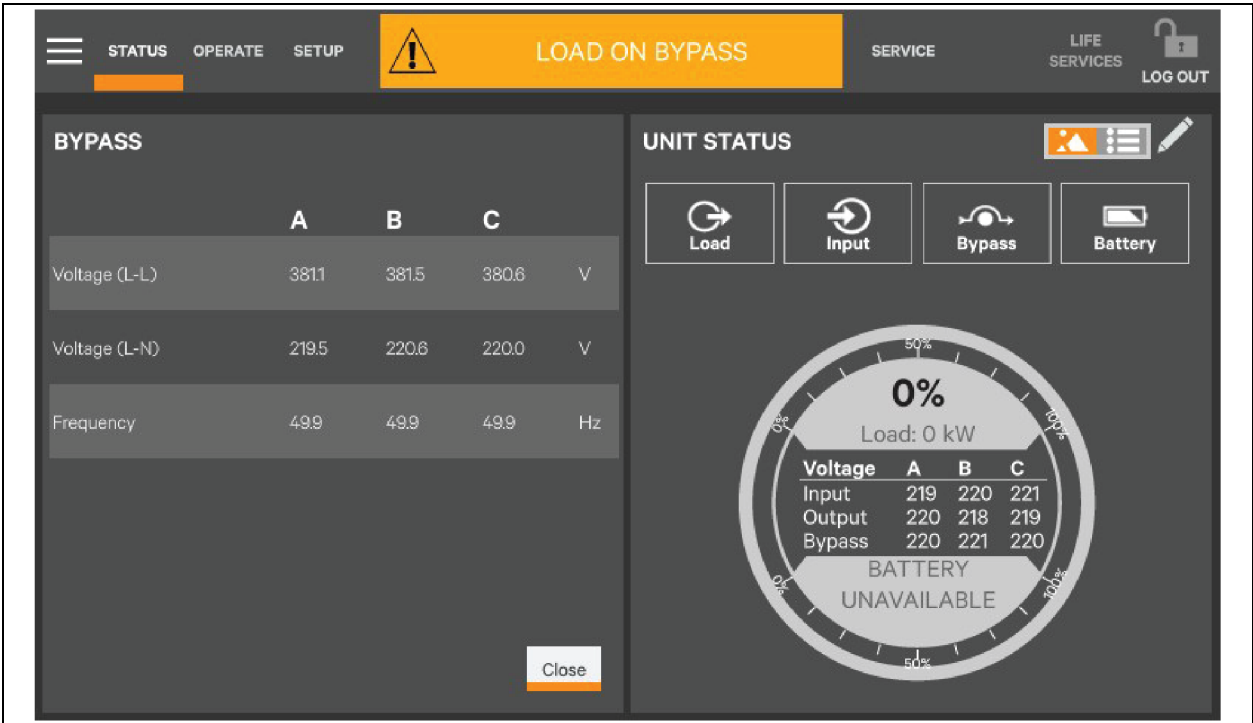


Figure 5.14 Unit Status — Battery Details

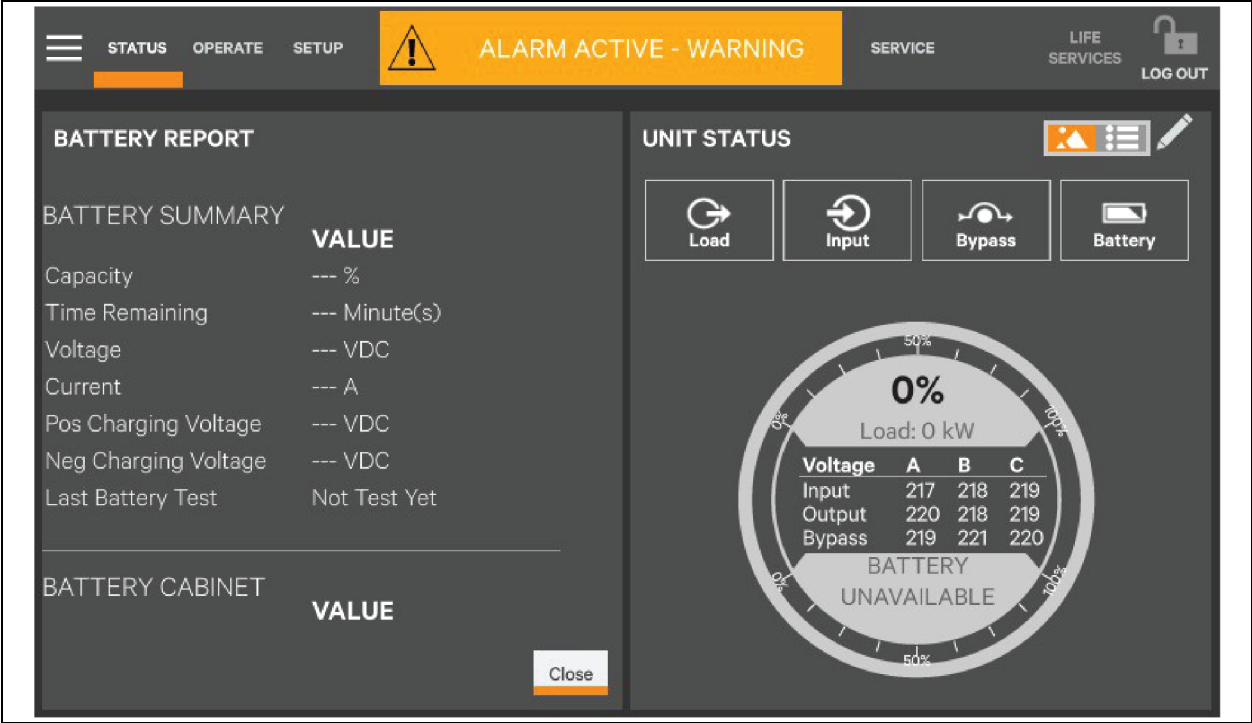
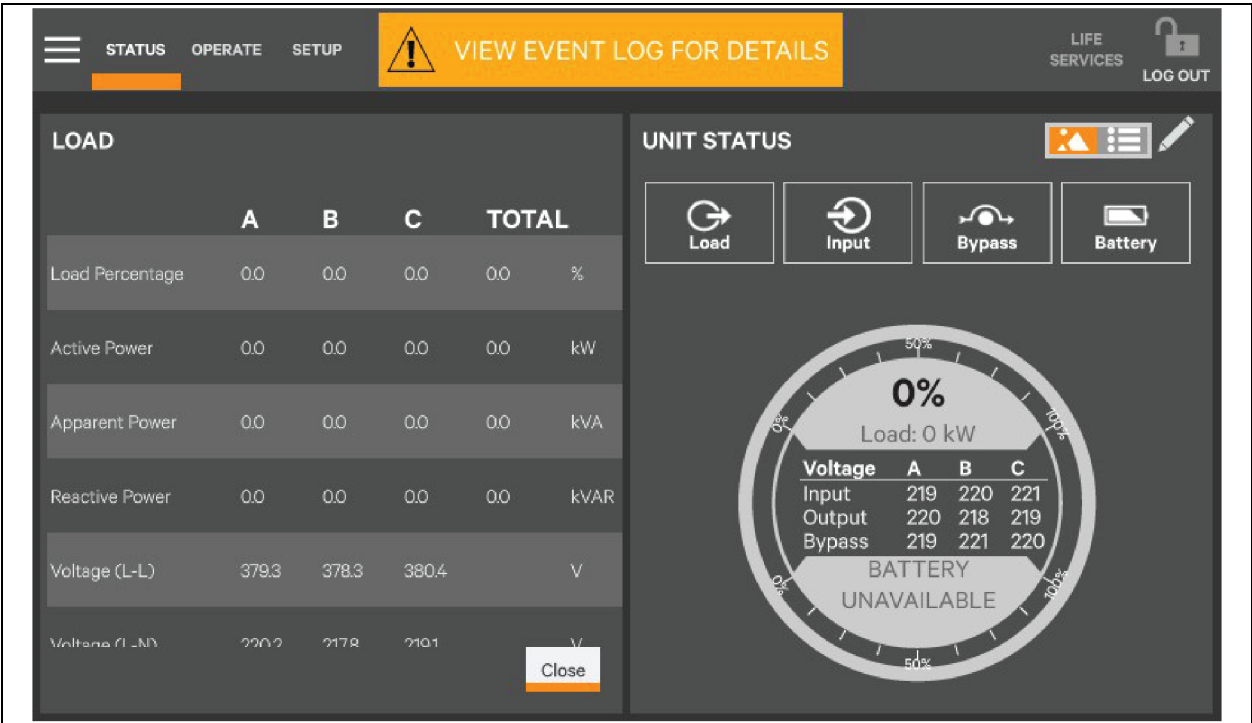


Figure 5.15 Bypass Details — Load Details



5.5.3 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. See **Figure 5.16** below.
- 4. Touch the logs to see the UPS event log screen. See **Figure 5.17** on the facing page.
- 5. Touch the Alarms to open a list of alarms.

Figure 5.16 View Alarms or Events

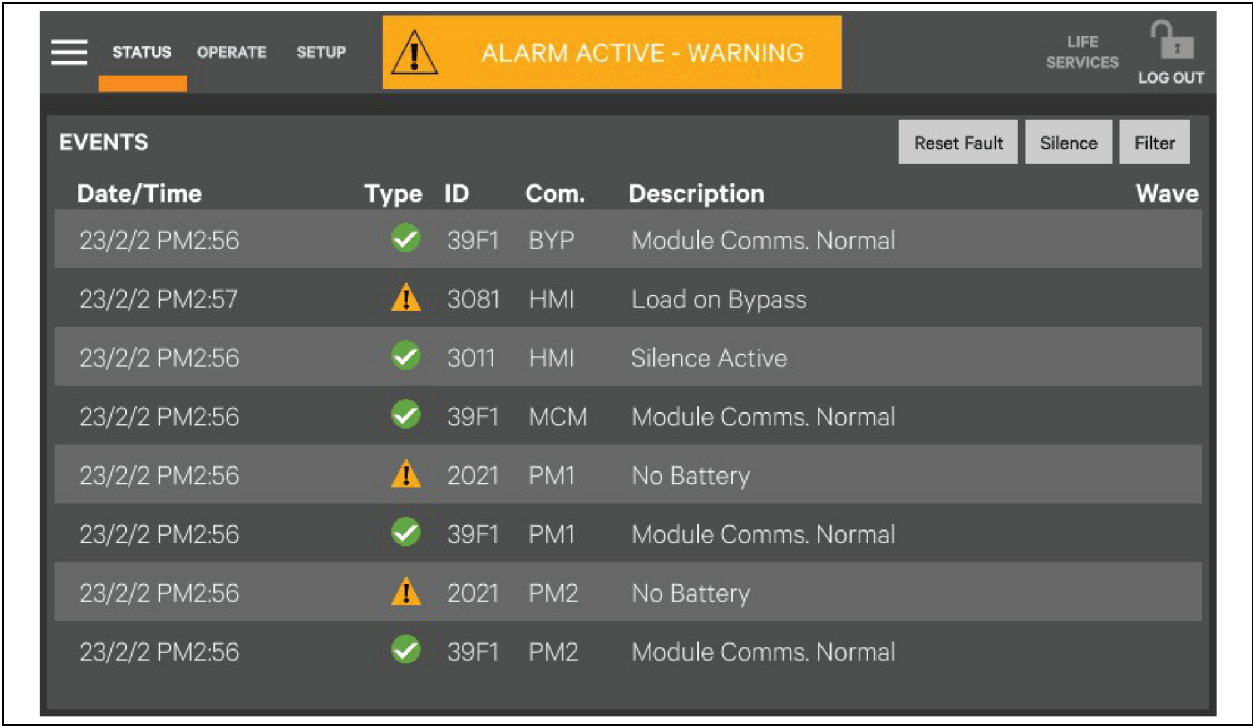


Figure 5.17 Event Logs

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	

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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 105 for more details.

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. 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 service able parts located behind the covers. Only a qualified service engineer can remove the covers.

1. See [Operator Control and Display Panel](#) on page 63, or 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. This is normal and the charging voltage of the battery returns to normal value after a few hours charging.

6.2 Integrated Maintenance Bypass Breakers (Option) 150 kVA 208 V and 300 kVA 480 V Frame

The integrated MBB (Option) is located 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 page 81 and [Figure 6.3](#) on page 83, 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 safety interlock) 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 breakers 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.

6.3 Maintenance Bypass Breaker Interlock Operation

6.3.1 Transfer UPS from Normal Mode to Maintenance Bypass Mode

1. Transfer the Vertiv™ Liebert® APM2 UPS to internal bypass by following the procedures in the UPS user manual.
2. Loosen the thumb screw on the interlock on the MBB.
3. Slide the interlock up closing the MBB and tighten the thumb screw to secure the interlock in place.
4. Open the RIB, Bypass BIB and MIB to electrically isolate the UPS module from AC power Input. The system is now in maintenance bypass mode to allow the UPS module to be safely serviced by Vertiv Service.

6.3.2 Transfer UPS from Maintenance Bypass Mode to Normal Mode

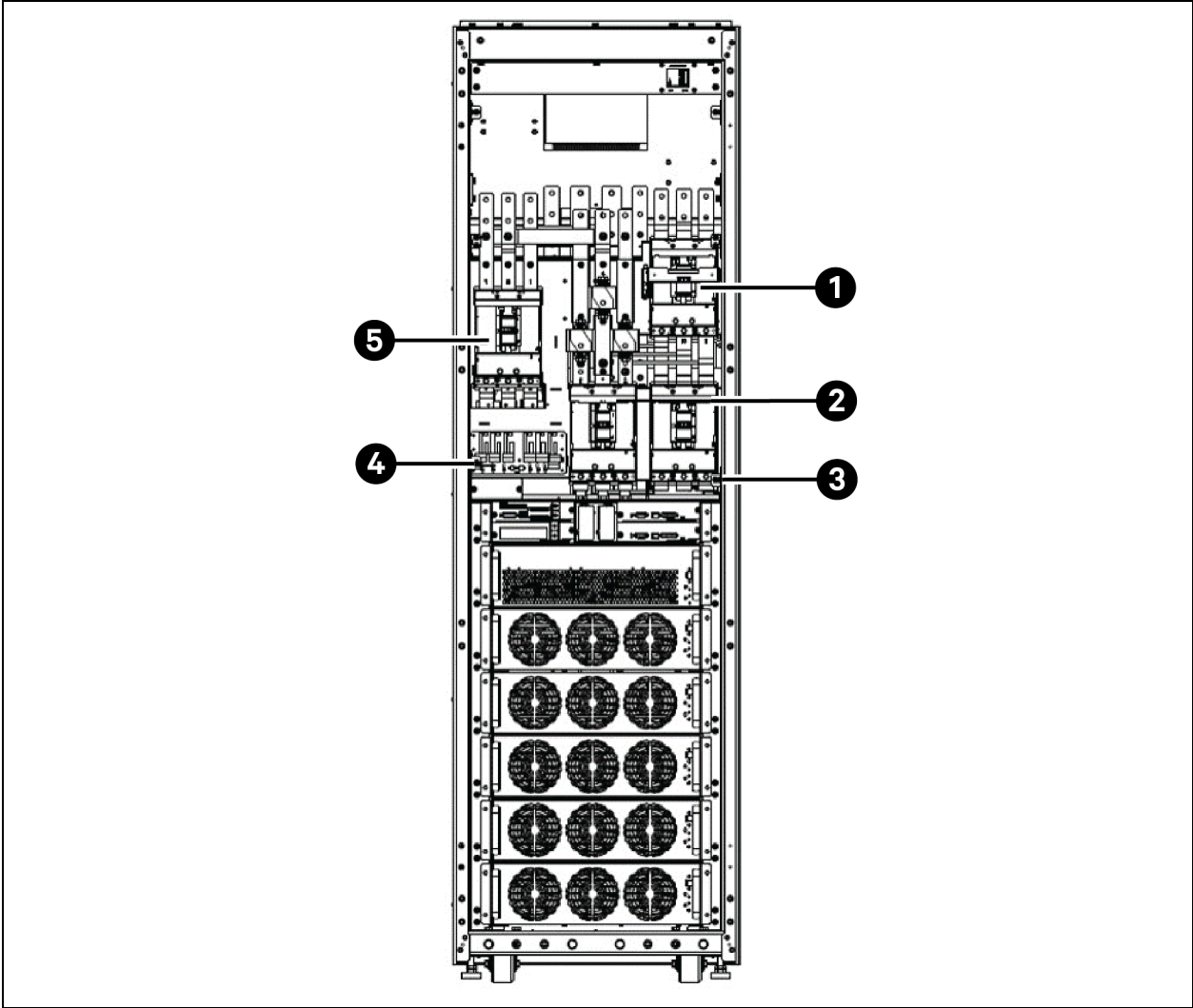
1. Ensure that the mechanical interlock is still secured in the unlocked position.
2. Close the RIB, BIB, and MIB.
3. The UPS will begin its startup procedure and operate in internal bypass mode. Verify that the UPS is operating in internal bypass mode before proceeding.

NOTE: 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 mechanical interlock and slide it down and secure it in place by tightening the thumb screw.
6. Transfer the UPS from internal bypass to inverter power following the procedures in the UPS user manual.

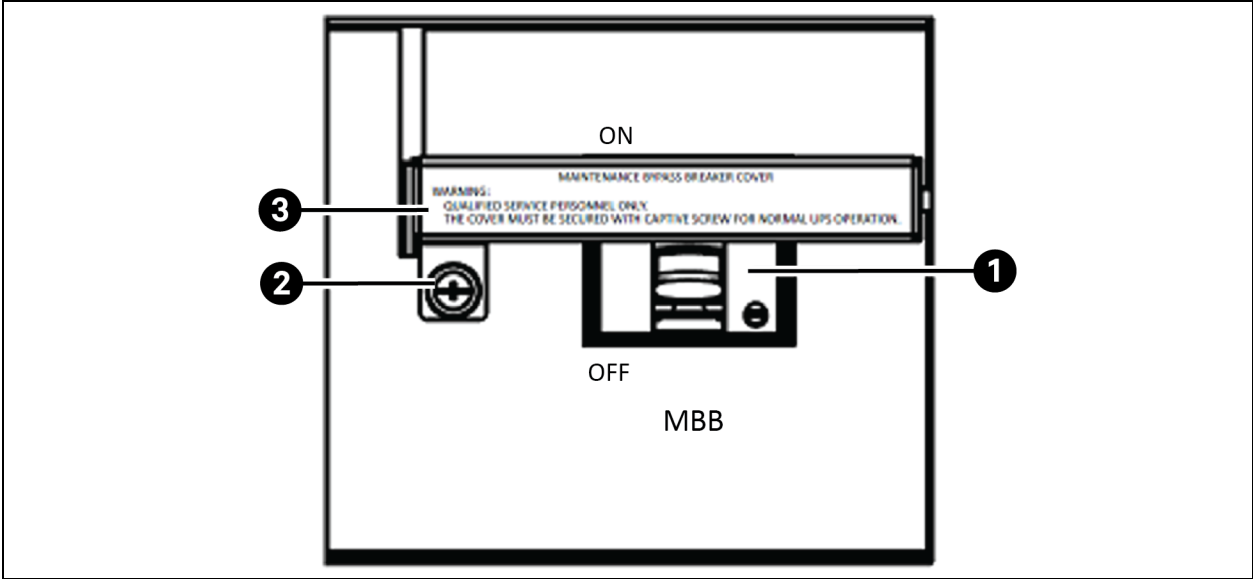
The UPS is now in normal operation, and the connected equipment is supplied with protected power.

Figure 6.1 UPS Integrated MBB for Vertiv™ Liebert® APM2 150 kVA 208V and 300 kVA 480V UPS



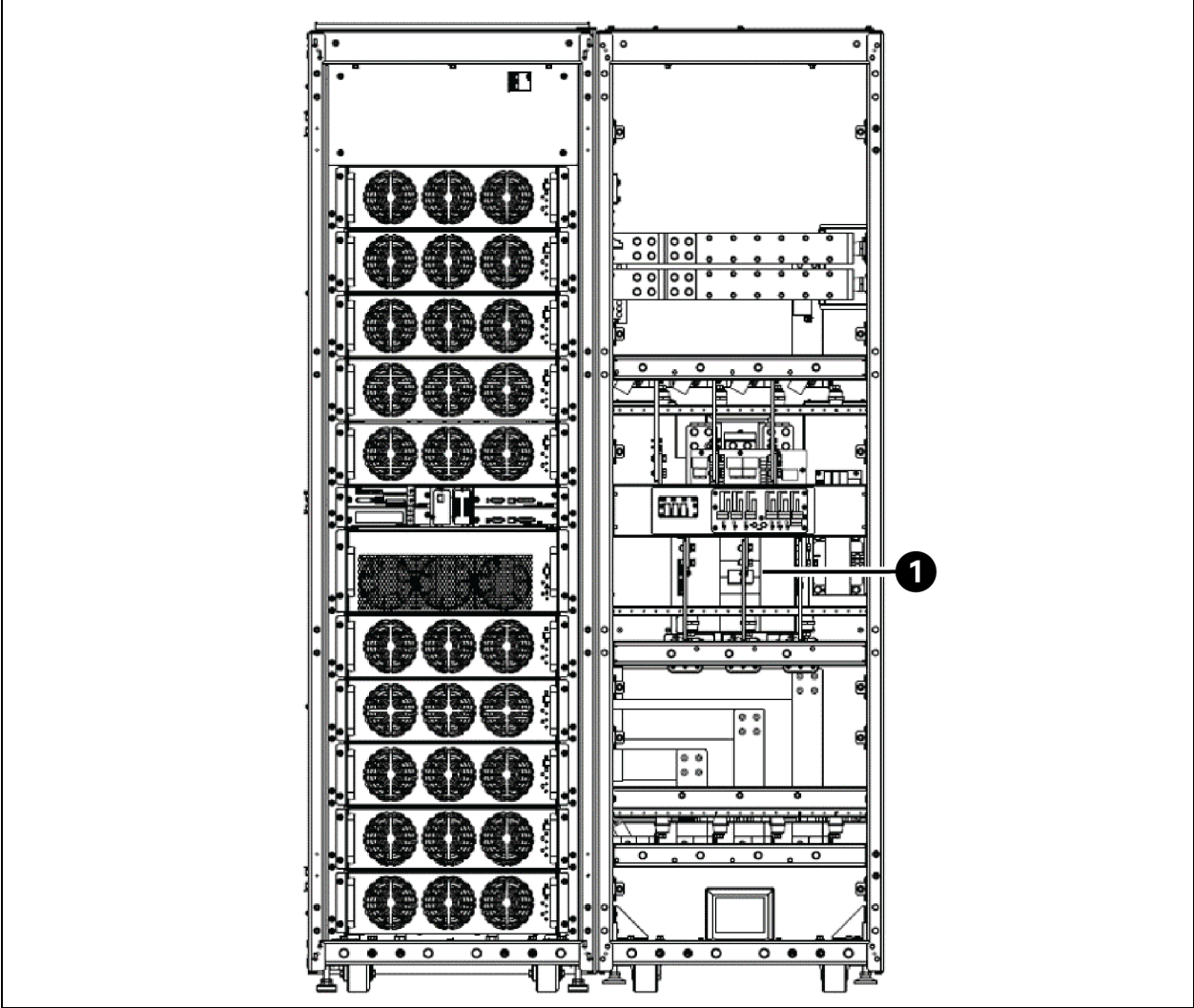
Item	Description	Item	Description
1	MIB with safety interlock	4	Position of lightning protection board
2	MBB	5	BIB
3	RIB		

Figure 6.2 MBB Safety Interlock for Vertiv™ Liebert® APM2 150 kVA 208V and 300 kVA 480V UPS.



Item	Description
1	MBB
2	Interlock thumbscrew
3	Interlock

Figure 6.3 UPS Power Back Feed Contactor for Vertiv™ Liebert® APM2 600 kVA 480 V UPS



Item	Description
1	Position of contactor

6.4 UPS Startup Procedures

The Vertiv™ Liebert® APM2 UPS must be completely installed and commissioned before startup by an authorized engineer. The external power supply breaker must be closed. After these conditions are met, the UPS can be started.

6.4.1 Startup 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 breaker, and place a warning label on the connection point of the load.

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

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 breaker.
3. Ensure that the UPS input voltage, frequency, and phase are normal.



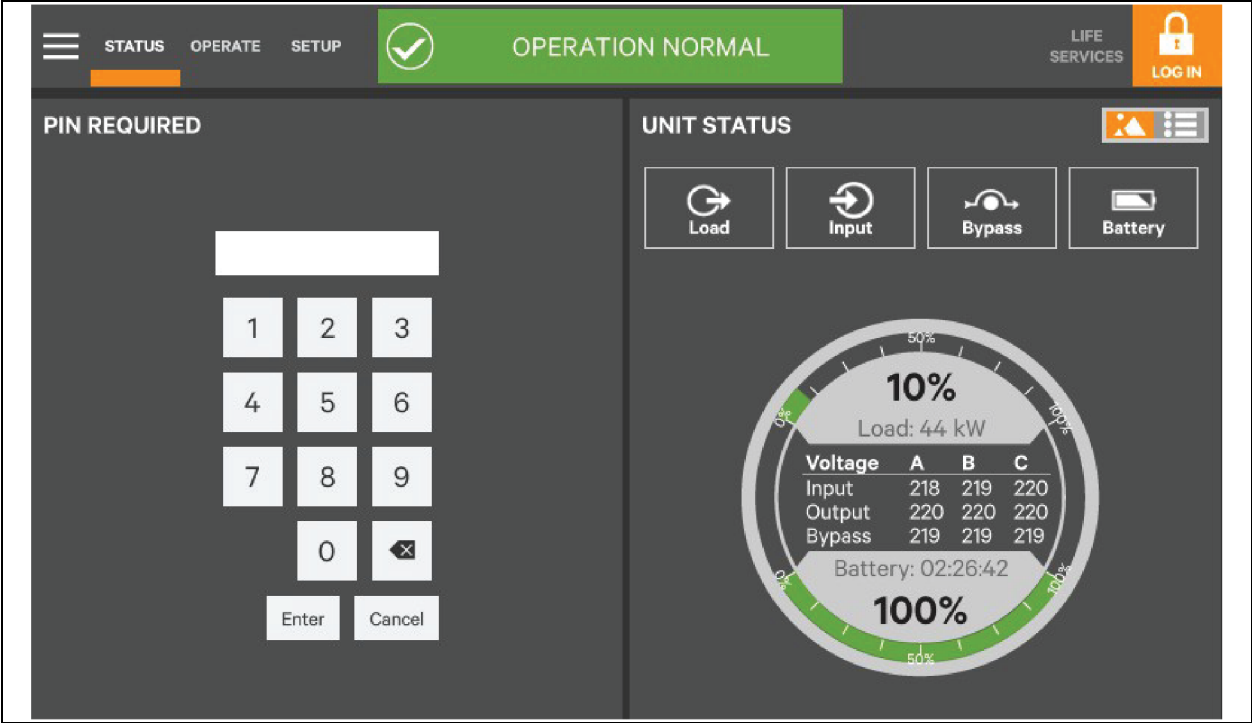
WARNING! In parallel UPS configuration, all operations related to disconnecting or connecting of the maintenance bypass switch must be executed within three seconds to avoid overload situations and damage to the MBB.

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

Now, the system is powered on, and the startup screen pops up.

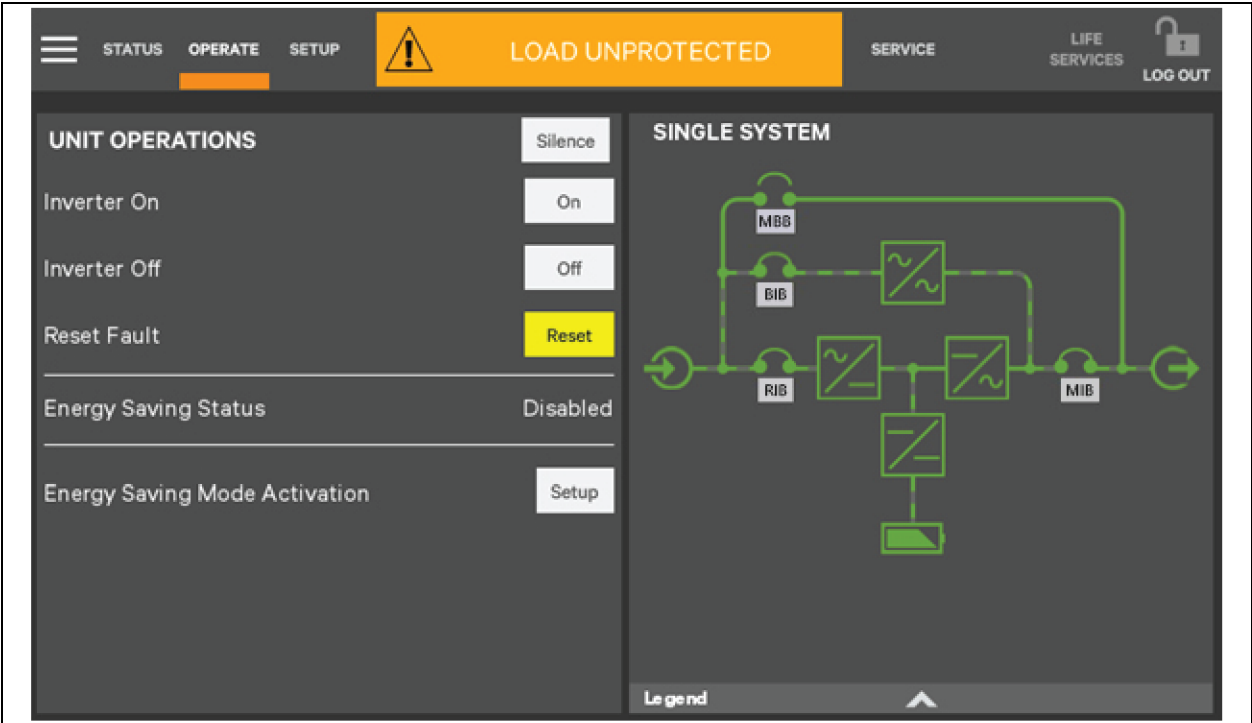
Wait 25 seconds and touch the Log In icon to enter the system by typing correct password.

Figure 6.4 Inputting Password



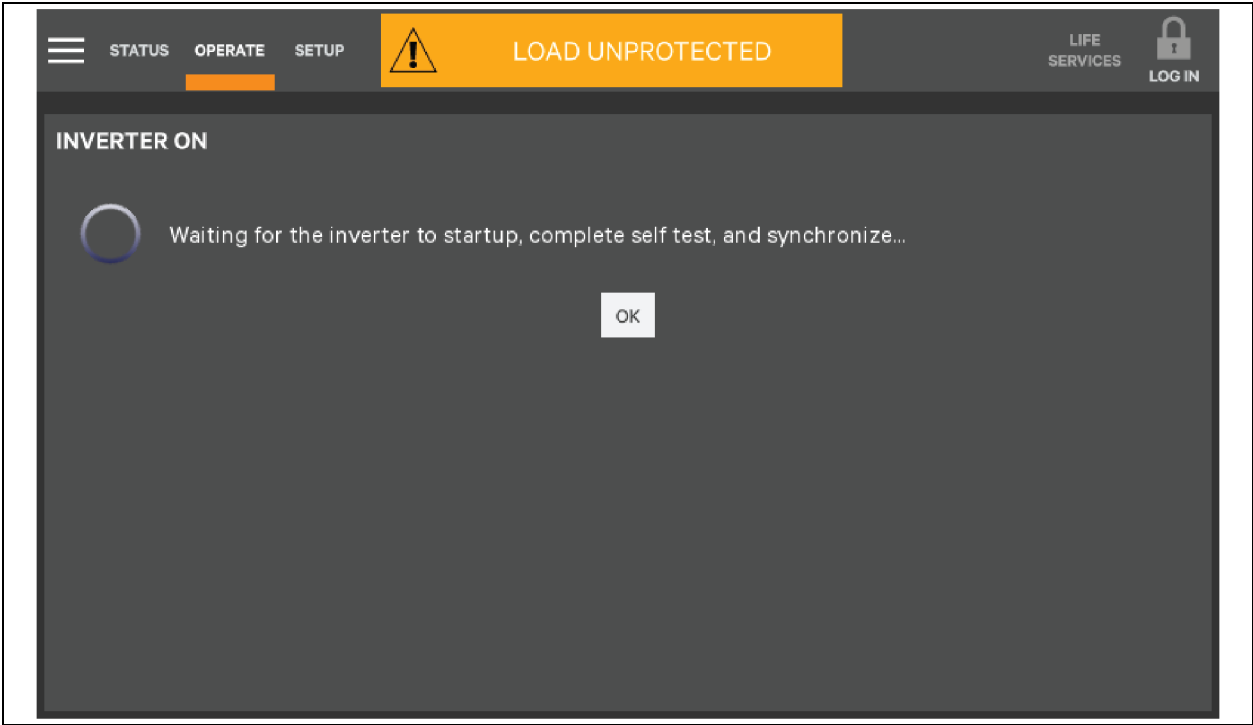
5. When the rectifier start process is finished, close the BCB. The system in Bypass mode. See Power flow shown in **Figure 6.5** below. Touch the On key. See [Operator Controls](#) on page 67 shown in [Navigating through the Liebert® APM2 Touchscreen](#) on page 63 for more details.

Figure 6.5 Clicking Inverter On Key



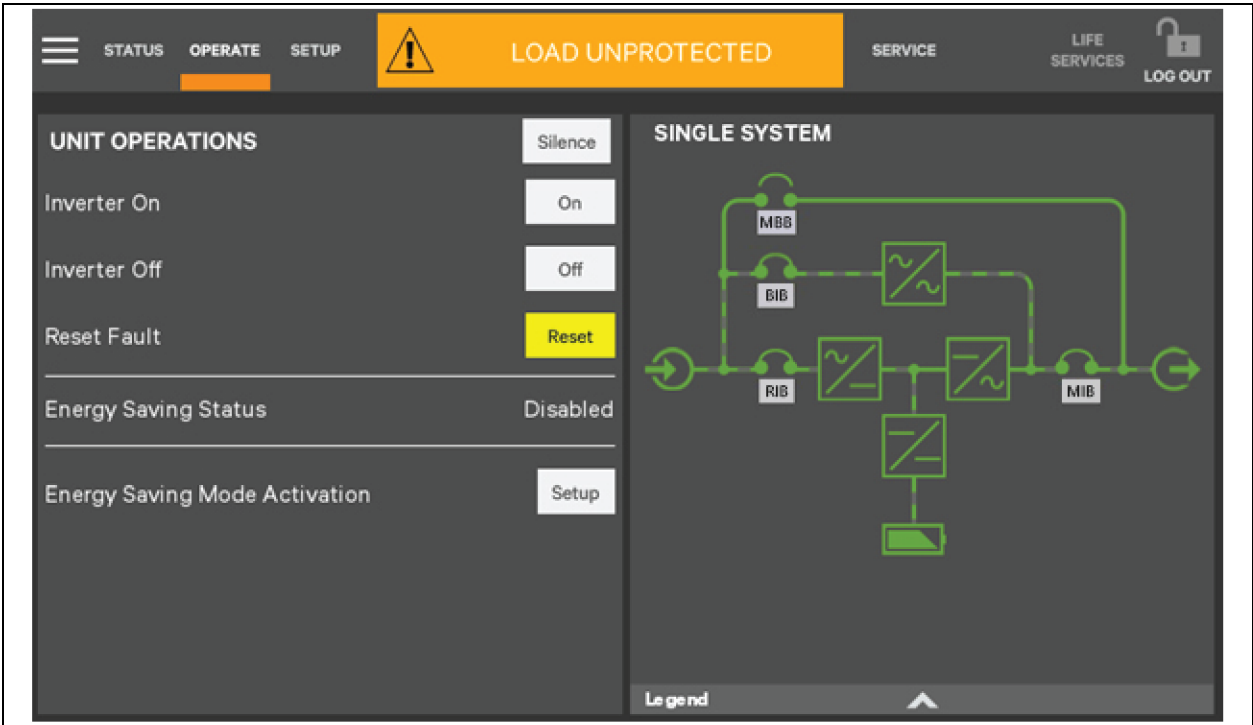
6. The inverter starts a self-test and synchronizes.

Figure 6.6 Inverter Self-Test and Sync



7. Startup is finished.

Figure 6.7 Start Up Finished



Startup procedures in ECO mode

1. Open the front door of the UPS.

NOTE: Ensure that the internal MBB MBBQ3 is disconnected, and that the input cables and copper bars are reliably connected.



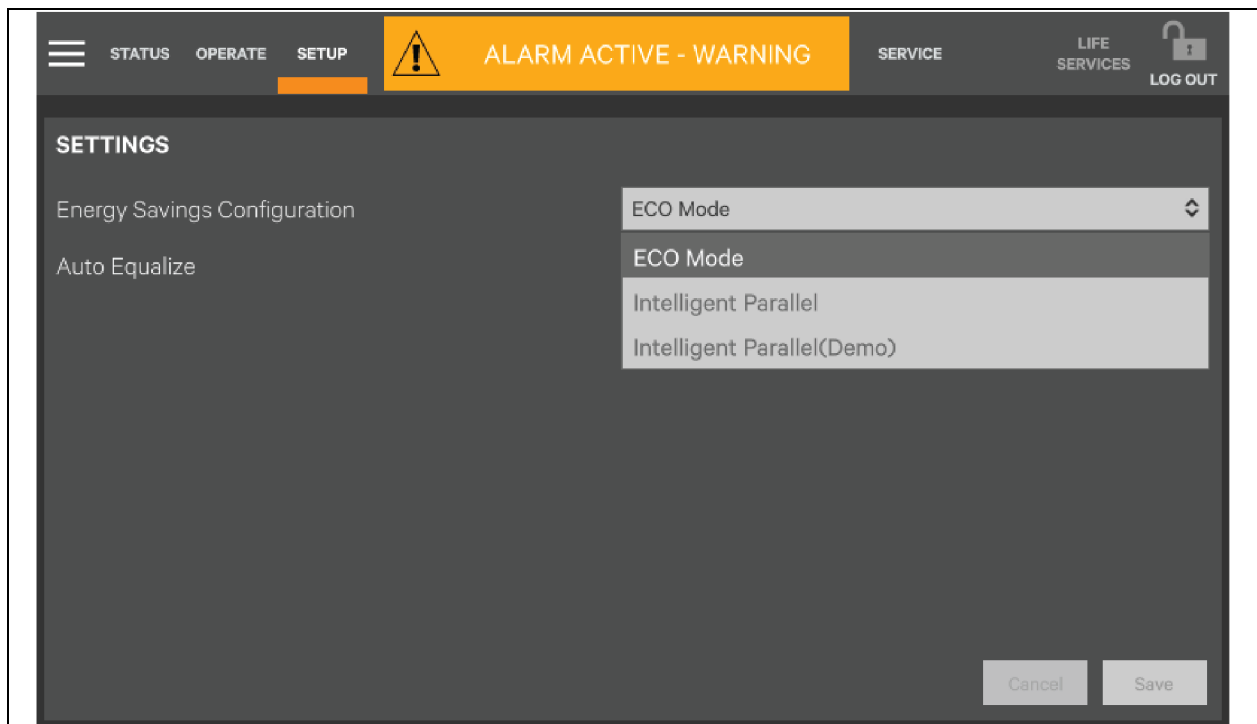
WARNING! In parallel UPS configuration, all operations related to disconnection or connection of the maintenance bypass switch must be executed within 3 seconds to avoid overload situations and damage to the maintenance bypass switch.

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

Now the system is powered on, and the startup 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 67.
4. Touch Setup next to the Energy Saving Mode Activation.
5. In the drop-down menu, touch ECO Mode.
6. Touch Save.

Figure 6.8 Setting ECO Mode



7. When the rectifier is started, start the system according to Startup Procedures in Normal Mode. See [UPS Startup Procedures](#) on page 84 for more details.

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.

6.4.2 Startup Procedures in Battery Mode (Battery Cold Start)

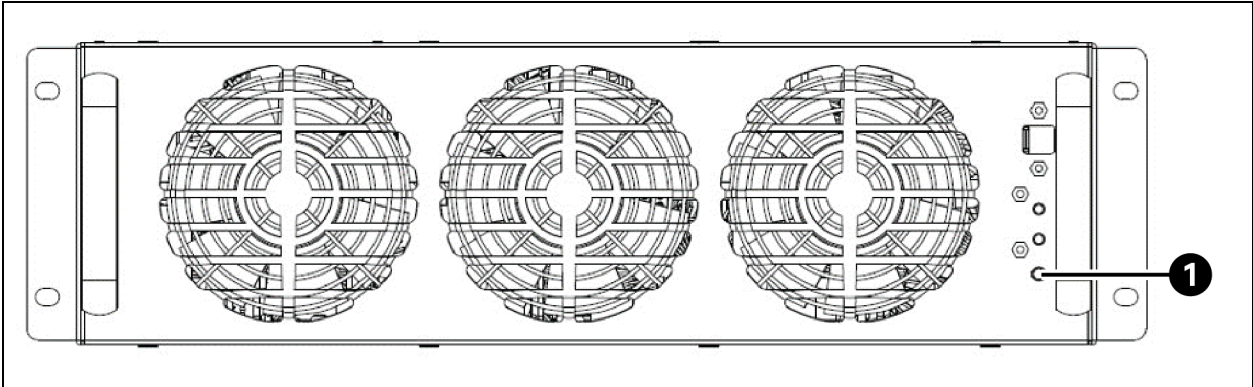
NOTE: Press and hold the battery cold start button for 1 second to perform these procedures.

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, as shown in **Figure 6.9** below for its position of any module.
- 4. When the rectifier starts, start the system according to [step 4](#) to [step 6](#) in Section [Startup Procedures in Normal Mode](#) on page 84.

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

Figure 6.9 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

6.5 Procedures for Transfer between Operation Modes

6.5.1 Transfer from Normal Mode to Battery Mode

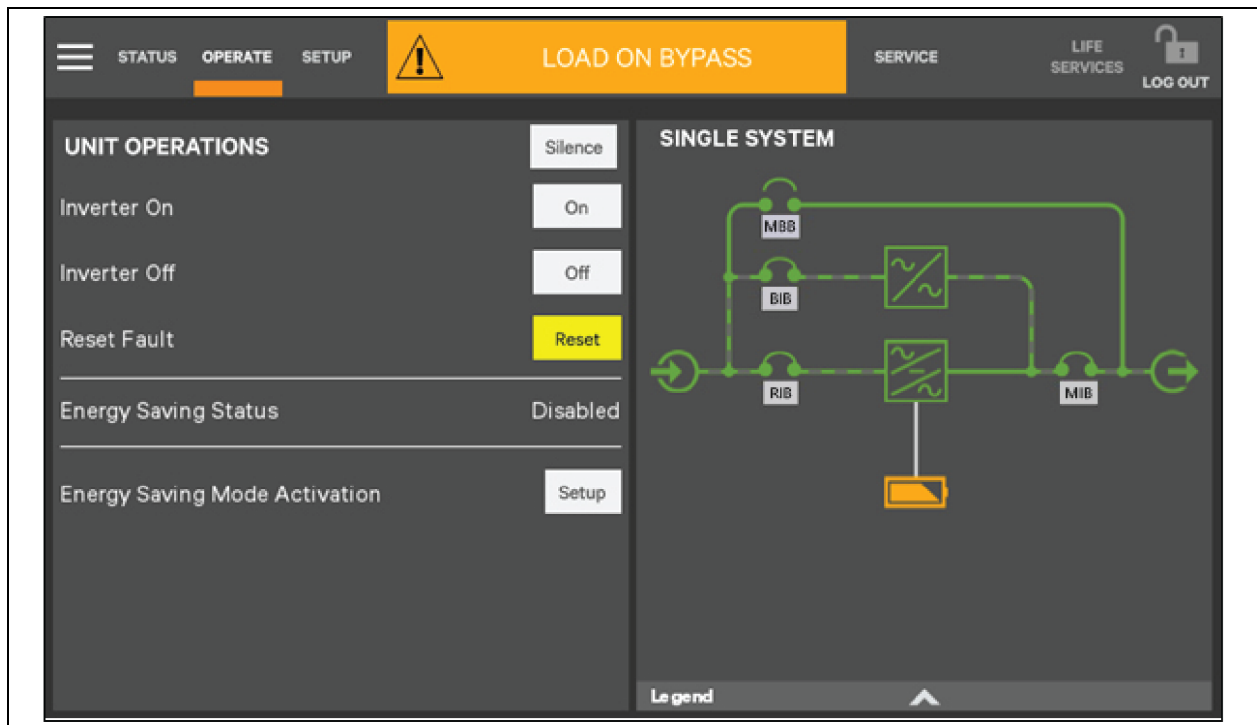
Open the external power switch to isolate the mains power and initiate the UPS on battery mode. To transfer the UPS back to normal mode, close the external power switch to reconnect the mains power to the UPS. The rectifier restarts automatically in about 10 seconds and the UPS works in normal mode.

6.5.2 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 6.10** below, and the UPS will transfer to bypass mode.

Figure 6.10 Transfer UPS to Bypass Mode



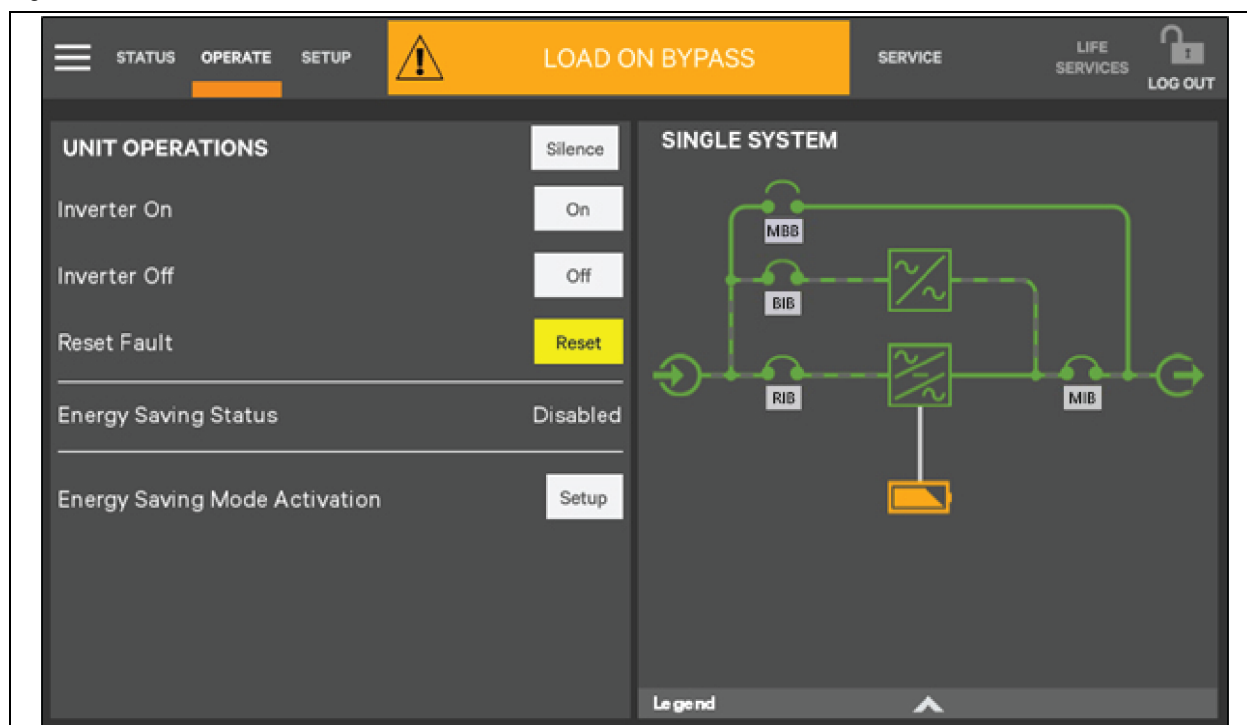
NOTE: In bypass mode, the load is directly supplied by the mains power instead of the pure AC power from the inverter.

6.5.3 Transfer from Bypass Mode to Normal Mode

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

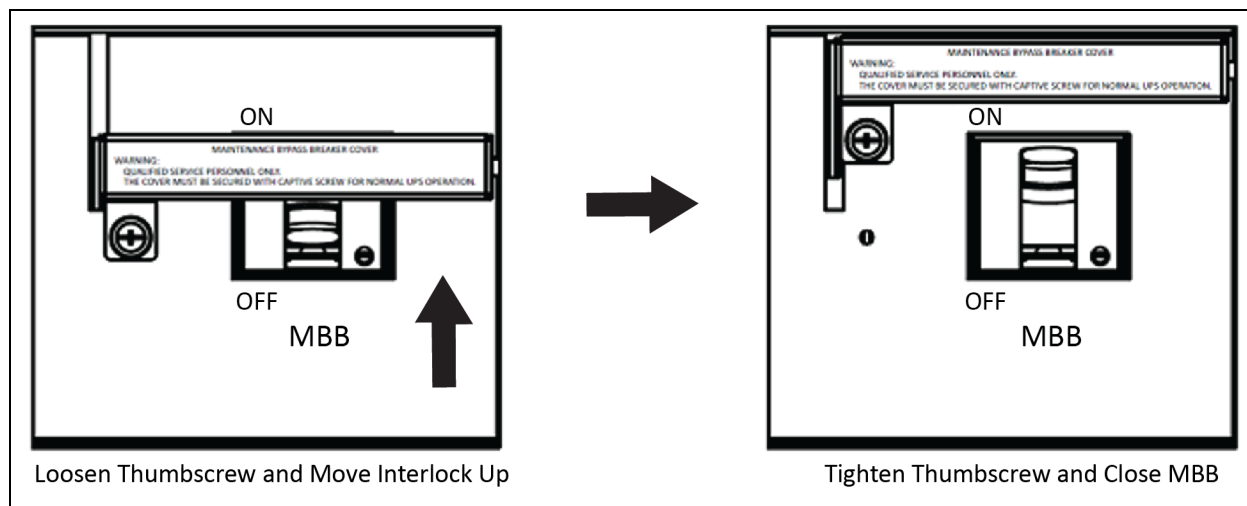
1. Activate the system and login to the system.
2. Verify that the Vertiv™ Liebert® APM2 UPS is in bypass mode.
3. Touch the Operate tab.
4. Touch the On button next to the Inverter On. The UPS will transfer to normal mode from the bypass mode. See **Figure 6.11** on the next page.

Figure 6.11 Transfer UPS to Normal Mode



6.5.4 Transfer from Normal Mode to Maintenance Mode

Figure 6.12 MBB Interlock Up



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. Shut down the inverter following instruction on [Transfer from Normal Mode to Bypass Mode](#) on page 89.

NOTE: The alarm can be silenced but the alarm message displayed until the alarm condition is rectified.

2. Loosen the thumb screw on the interlock on the MBB.
3. Slide the interlock up and tighten the thumb.
4. Close the MBB.
5. The maintenance bypass parallels with the UPS static bypass.
6. The touchscreen displays MBB Closed.
7. 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.

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.



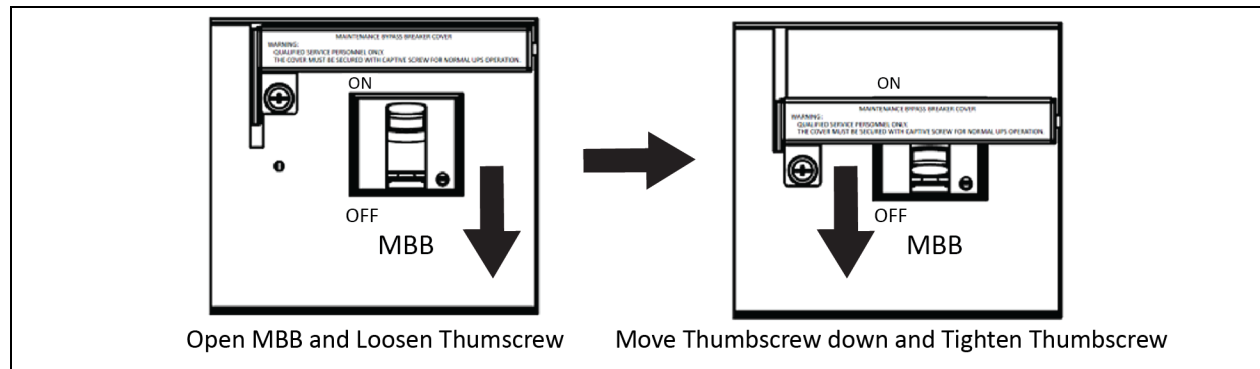
WARNING! The UPS maintenance must be done by qualified person only. The parts of UPS circuits also have hazardous voltage, though the RIB, bypass input switch and battery switch are disconnected.



WARNING! When the external input switch is not disconnected for models without RIB, BIB, and MIB, there is a hazardous voltage inside the UPS. To perform maintenance and dust removal, switches including external maintenance bypass switches, must be installed when using MBB or the UPS without breaker only.

6.5.5 Transfer from Maintenance Mode to Normal Mode

Figure 6.13 MBB Interlock Down



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 steps 4 to 7 as specified in [Startup Procedures in Normal Mode](#) on page 84. The UPS runs in Normal mode.

The load has transferred to UPS normal mode.

6.6 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 via the Vertiv setting software. During the periodic self-test, the system generates audible/visual alarm and corresponding records. The periodical 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, which 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 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. **Periodical 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 startup conditions

1. System load rate is within 0 to 100% (manual maintenance) or 20% to 100% (periodical self-test), stable output.

2. Battery in fully charged state, the battery float charge is at least 5 hours, and the generator is not connected.
3. Current system is in float charge state.

Self-test exit conditions

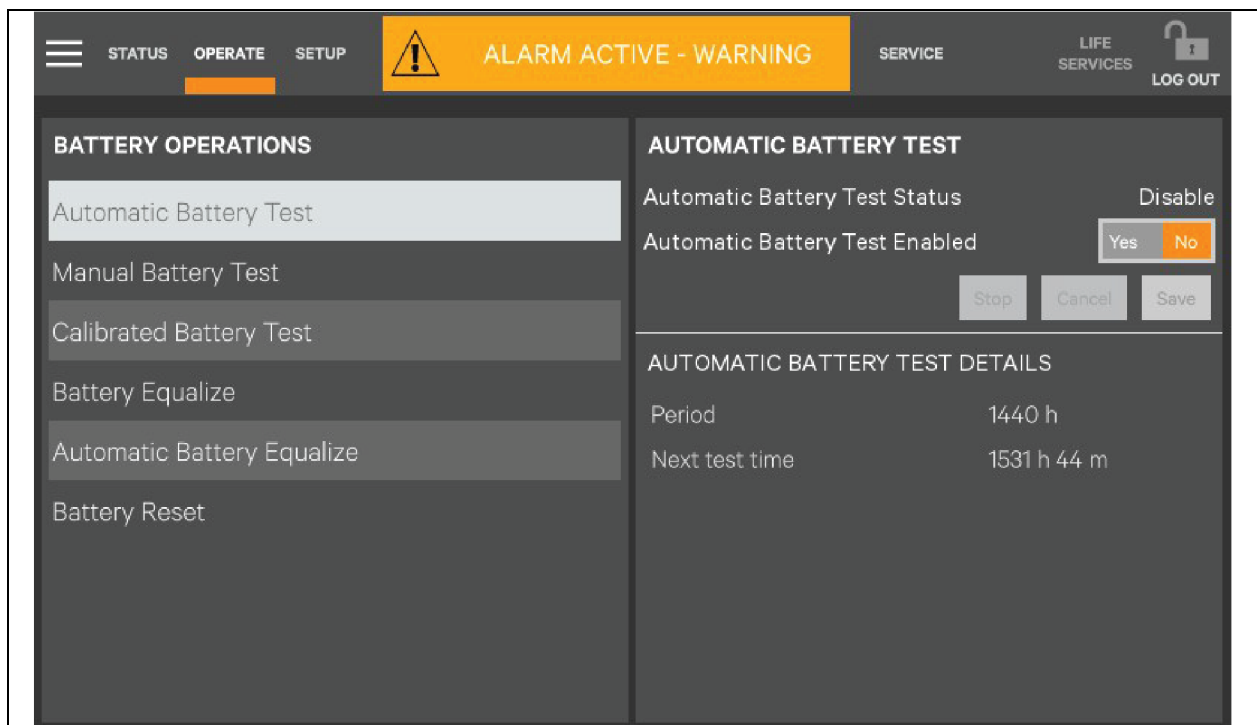
1. Confirm that the system is not in self-test state for at least 10 seconds and that the battery mode or rectifier is closed. The system shifts to battery supply state.
2. During the self-test, the system shifts to float charge state if the load fluctuates.
3. During the self-test, if the battery voltage is lower than the calculated pre-alarm voltage or if the battery discharge exceeds the protection time, the system shifts to float charge state.
4. The maintenance test can be manually stopped via 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: When the self-test is successful, the system fully clears the self-test interval counter. When the self-test fails, exits the system. When self-test conditions are satisfied again, the self-test begins again.

Procedures for battery self-test

1. Enter the level of Operate.
2. Touch the Operate icon.
3. Touch the menu icon from the upper left corner.
4. Touch the Battery Operations to display the interface shown in **Figure 6.14** on the next page.

Figure 6.14 Battery Management Interface



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

6.7 UPS Shutdown Procedures

6.7.1 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.

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 67,
2. Disconnect the external battery switch.
3. Disconnect the RIB, BIB, and output MIB. Now, all the internal power supply is off, and the Touchscreen does not display any more.



WARNING! Place 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.

6.7.2 Procedures for Completely Powering Down UPS while Maintaining Power to Load

The procedures in [Transfer from Normal Mode to Bypass Mode](#) on page 89 are suitable to completely power down the UPS and keep power supply to the load.

6.8 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 are 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.

6.9 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 remote EPO signal is received, the user can carry out the following procedures:

1. Touch the Reset Fault button. See [Operator Controls](#) on page 67 for more details, the system will exit 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 89.

NOTE: The rectifier will start automatically when the overtemperature fault disappears five minutes after the disappearance of overtemperature 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.

6.10 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 a and enables output power only when the following conditions are met:

1. If Auto Recovery after EOD Enabling is enabled.
2. After the Auto Recovery after EOD Delay Time expires, the UPS restarts bypass, then inverter. The default EOD 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 startup is disabled. Automatic restart must be set by Vertiv's authorized service engineer through Vertiv setting software.

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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 ECB 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 breaker 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 occurred.
3. The battery is very heavy. Use a proper method to move and lift the battery, so as to prevent any damage to human being. 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 even 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. Dis-assembly, 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 generally adopts valve regulated battery. Valve regulated means the sealed type or maintenance free.

The valve regulated battery is not completely sealed, when it is over charged, there is gas escape. 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 that the connection is reliable.

It is recommended to connect no more than four strings of batteries in parallel. Batteries of different types, brands, or age 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 requirement 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:

$$Q=0.05 \times n \times I_{gas} \times C_{rt} \times 10^{-3} \text{ (m}^3\text{/h)}$$

Where:

Q - The fresh air ventilation volume per hour, the unit is m³/h

n-Number of cells

I_{gas} - The gas evolving current density under battery float charging or boost charge conditions, the unit is mA/Ah

I_{gas}=1, under the float charging condition of 2.27 V/cell

I_{gas}=8, under the boost charge condition of 2.35 V/cell

C_{RT}- 20 hours 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 cool and dry environment with the humidity 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 will 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 under the 208 V and 480 V voltage system are consistent, as shown in **Table 7.2** below.

Table 7.2 Number of Batteries

Parameter	Vertiv™ Liebert® APM2 150 kVA 208 V	Liebert® APM2 300 kVA 400 V	Liebert® 600 kVA 480 V
Number of cells (standard)	96 to 144 jars 120 to 144 jars without derating	180 to 300 jars 240 to 300 jars without derating	180 to 300 jars 240 to 300 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 remote EPO 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 properly installed and protected from vibration or shock.

7.8 External Battery (Optional)

7.8.1 Valve Regulated Lead-Acid Battery Cabinet

The Vertiv™ Liebert® APM2 UPS supports below non-module VRLA battery cabinet, Each Liebert® APM2 Battery Cabinet contains one series string of different cells of VRLA batteries in a matching cabinet. Multiple battery cabinets are combined into systems by attaching the cabinets with internal wiring sized for the UPS rating. Each battery cabinet has a built-in circuit breaker. The Liebert® APM2 will support additional strings of the same battery up to four strings per UPS. The detail information can refer to **Vertiv™ APM2 Modular EBC User Manual SL-71373**.

UPS	Minimum Battery Jars/UPS No Derating	Battery Jars in One String	EBC Bus Voltage	EBC Capacity/Ah	EBC Type [In. (mm)]	EBC Quantity
Liebert® APM2 150 kVA 208 V UPS	20	24	288	83/71/43/38	23.7 (600)	2≤n≤4
		24	288	123/119/94	34.7 (880)	2≤n≤4
Liebert® APM2 300 kVA 480 V UPS	40	40	480	123/119/94/83	47.3 (1200)	2≤n≤4
Liebert® APM2 600 KVA 480 V UPS	40	40	480	123/119/94/83	47.3 (1200)	3≤n≤4

7.8.2 Lithium-ion Battery Cabinet

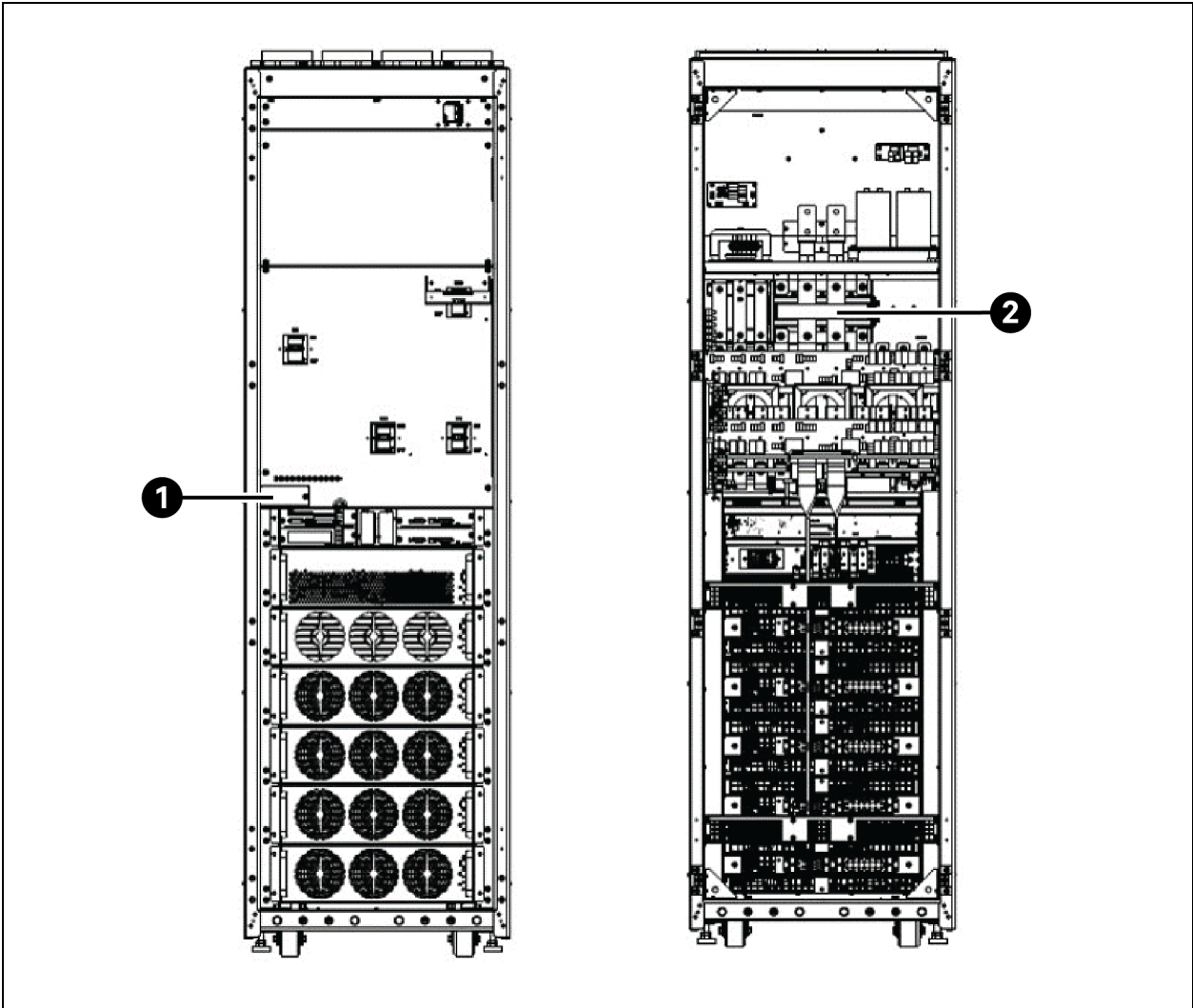
Liebert® APM2 series UPS supports Vertiv™ EnergyCore Lithium battery, the EnergyCore Lithium is a high power standby battery cabinet designed for use with UPS. EnergyCore Lithium can be defined by the requirement. Various battery modules are available in different series configurations, with increased number of battery modules allows for higher voltage and additional energy storage. The detail information, refer to **Vertiv™ EnergyCore Lithium 5 service manual SL-71289**.

7.9 Battery Ground Fault Detector (Optional 2)

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.

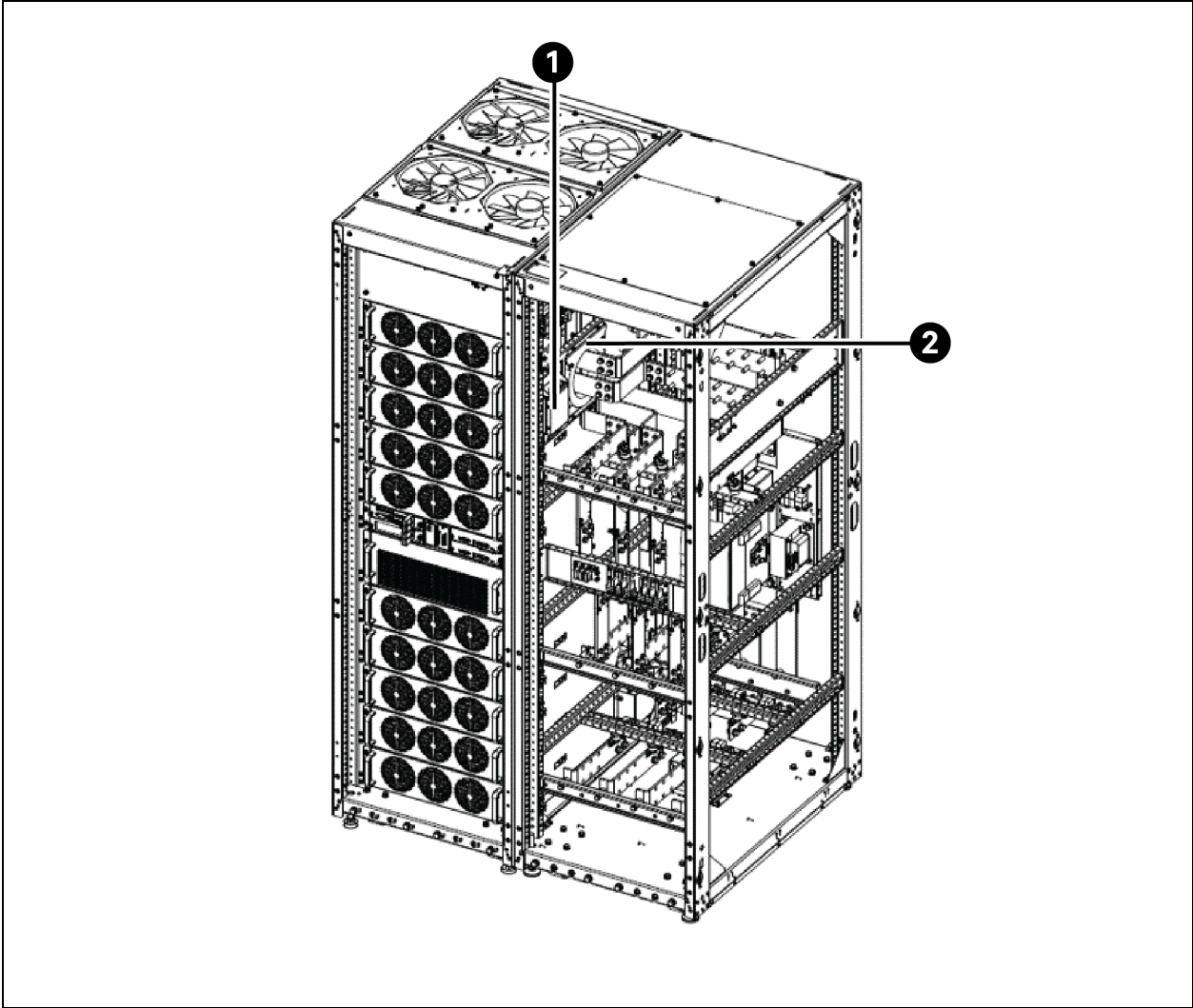
NOTE: If a battery ground fault detector is installed, the positive, negative and neutral battery cables from the battery into the BCB cabinet must be routed through the hole of the mutual inductor of the battery ground fault detector, while other cables must bypass the mutual inductor for connection.

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

Figure 7.2 Battery Ground Fault Detector for Vertiv™ Liebert® APM2 600 kVA 480 V UPS



Item	Description
1	Ground fault detection board
2	CT

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 comprises 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

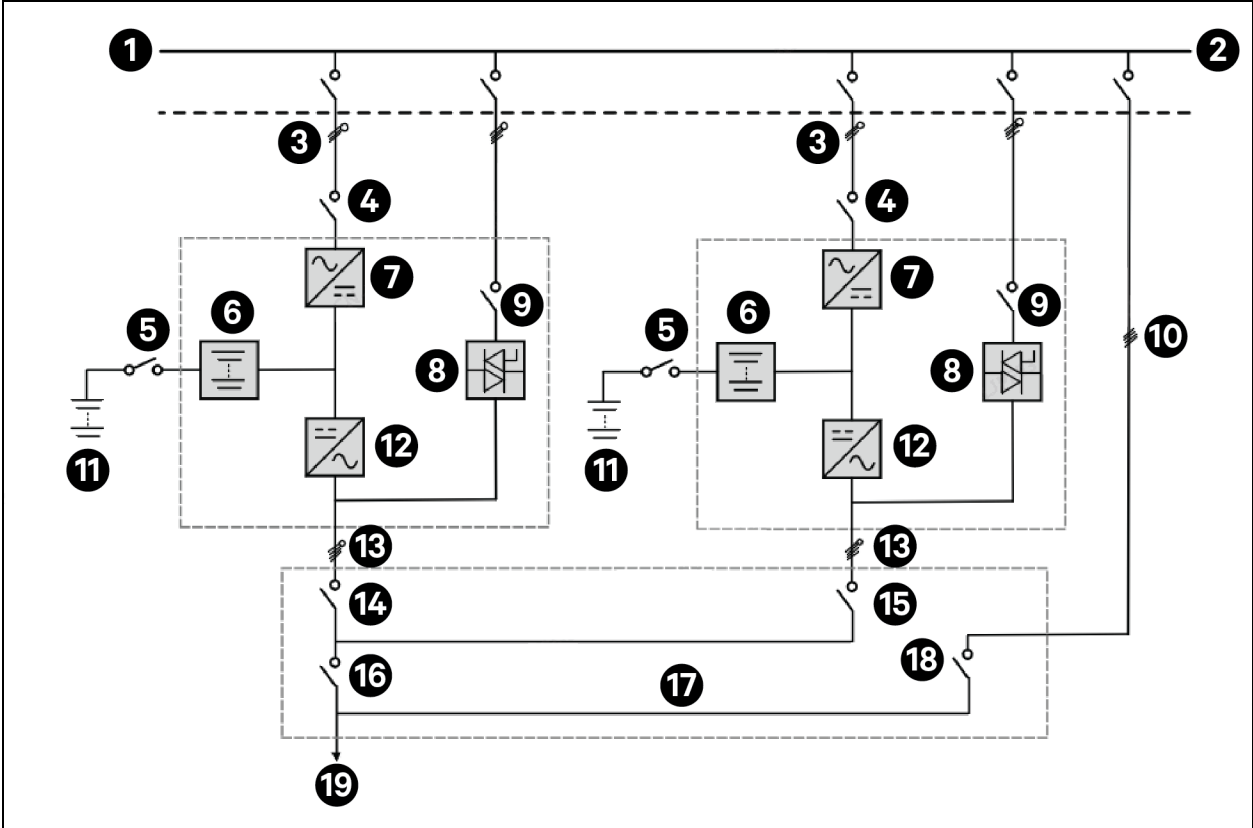
Ensure that the selections of the parallel cables are correct, and that the modules are of the same rating, model, and use the same software and hardware release.

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** below. The output distribution mode (MOB1 and MOB2 must be configured) shown in **Figure 8.1** below 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	Input power supply	11	Battery 1
2	External bypass switch	12	Inverter
3	Mains input L1, L2, L3, N	13	L1, L2, L3, N
4	RIB	14	MOB1
5	BCB	15	MOB2
6	Charger	16	MIB
7	Rectified	17	Output distribution
8	Static switch	18	MBB
9	BIB	19	To load
10	External maintenance bypass		

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 single system. See [Power Cable Wiring](#) on page 34 for more information.

The bypass and rectifier should be connected with same neutral line input terminal. The current leakage protective device must be installed on the 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** on the next page. 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., 32.9 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 are shown in **Figure 8.3** on the next page. Make sure to check all the reliable cable connections before starting up the UPS system.

Figure 8.2 Parallel Signal Cables Connection (Parallel System)

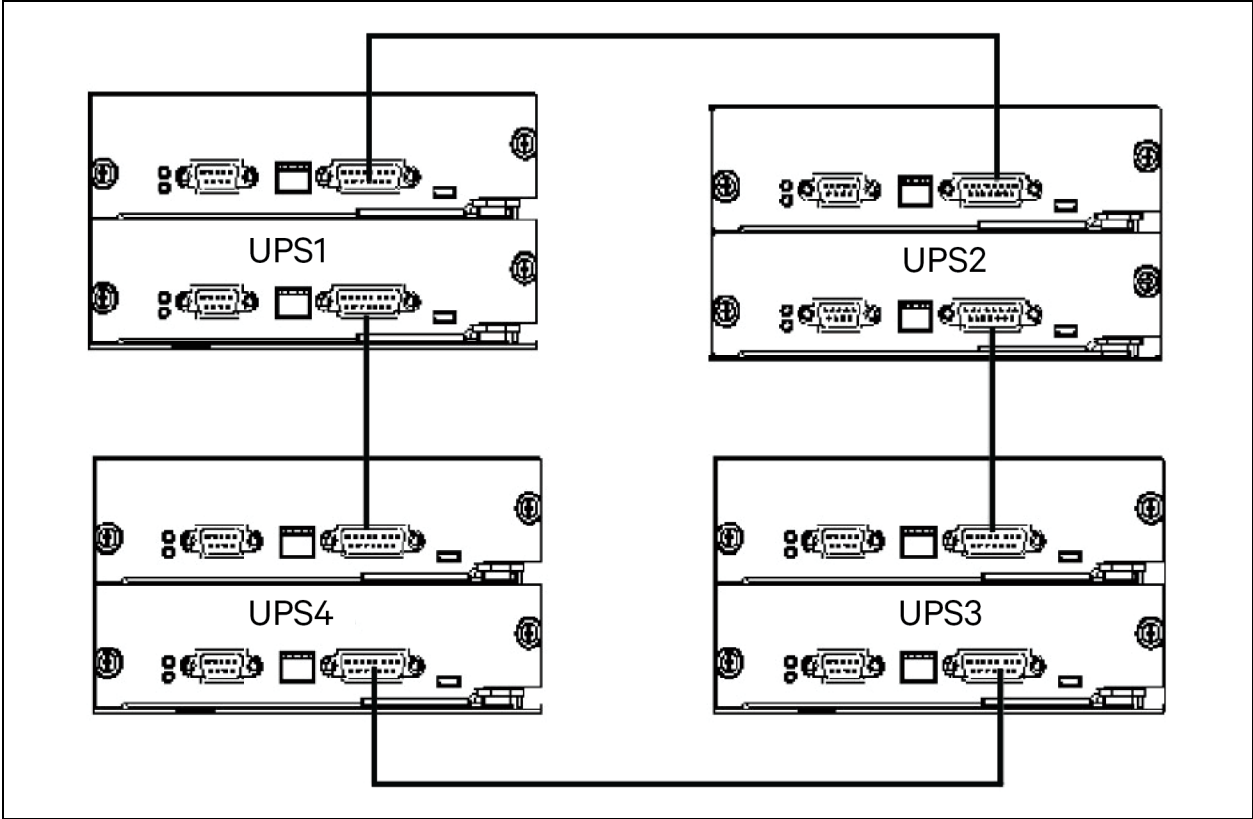
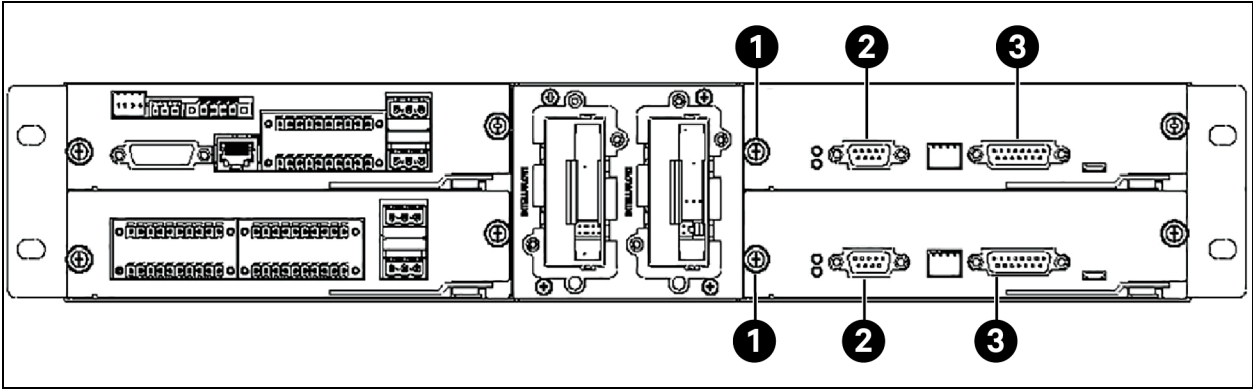


Figure 8.3 Parallel Port on the System Control Module



Item	Description
1	U4
2	LBS
3	Parallel

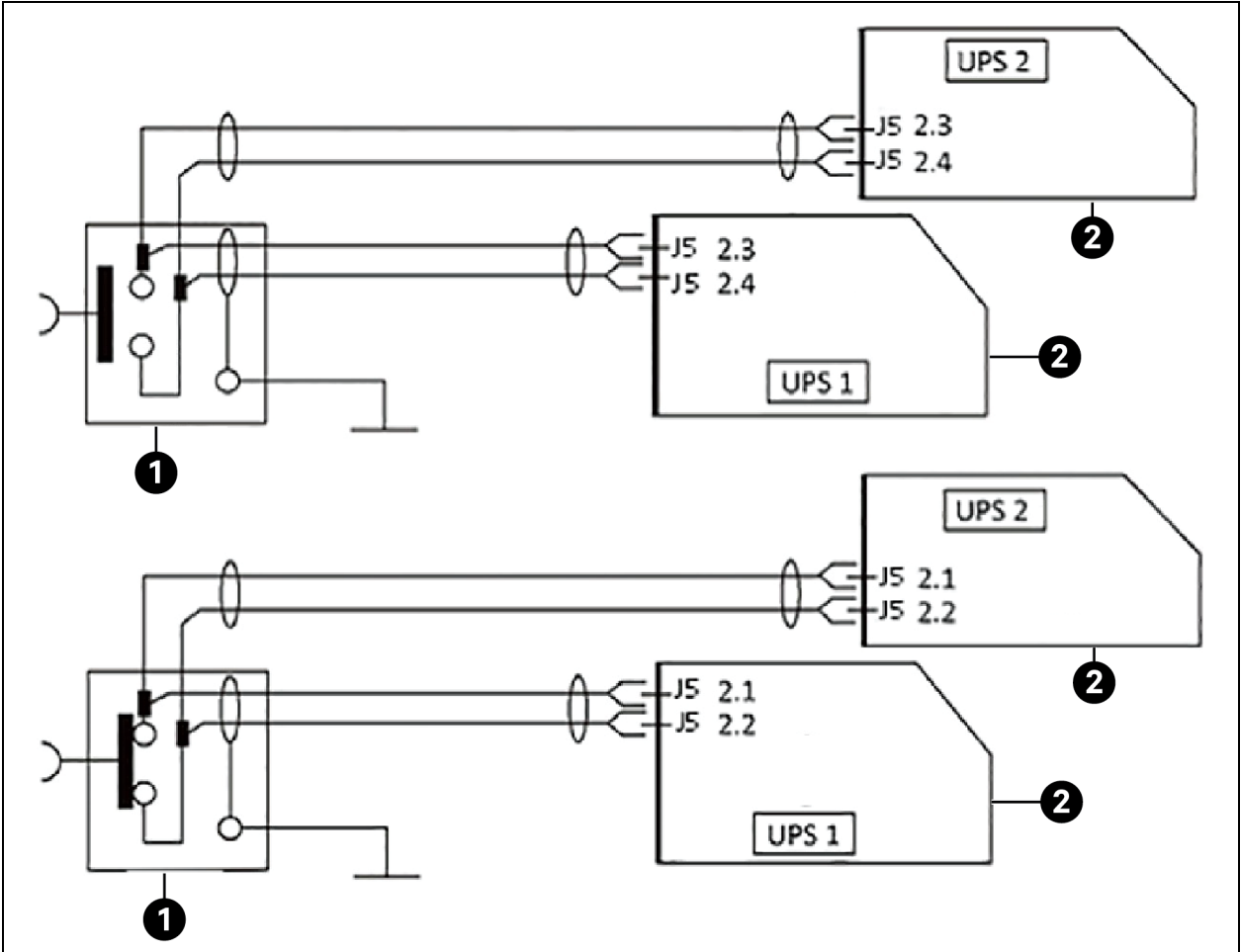
8.2.6 Remote Emergency Power Off

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

NOTE: The remote EPO switch must provide dry contact signal, which is normally open or normally closed. The open circuit voltage provided is 12 VDC, less than 20 mA.

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

Figure 8.4 EPO Circuit Diagram



Item	Description
1	EPO
2	Integrated control module

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 Startup 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 MBB are disconnected.
2. Open the front door of each UPS in turn.
3. Ensure that the internal maintenance bypass switch MBB is disconnected.
4. Check all the input cables, parallel cables and copper bars are connected properly.
5. Close the total BIB.
6. Close the MIB, BIB, RIB, 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 startup 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 RIB and BIB 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, it may result in the 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 MBB but, do not close the internal MBB of each UPS. While you are closing these breakers, all the external maintenance bypass should be parallel connected with static bypass of each of the UPSs. The touchscreen of each UPS should display Main breaker Closed.
3. Disconnect the output breaker MIB 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 RIB and BIB 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, RIB, external power bypass breaker, BIB, MIB, BCB, and single module external output breaker.



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 MBB or the single module external maintenance breaker is disconnected.
3. Close the output breaker MIB, external output breaker, external power bypass breaker, BIB, RIB, and external power mains breaker 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 and BIB of each UPS that will close the internal power supply and the touchscreen display will stop functioning.
3. Disconnect the output breaker MIB 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.

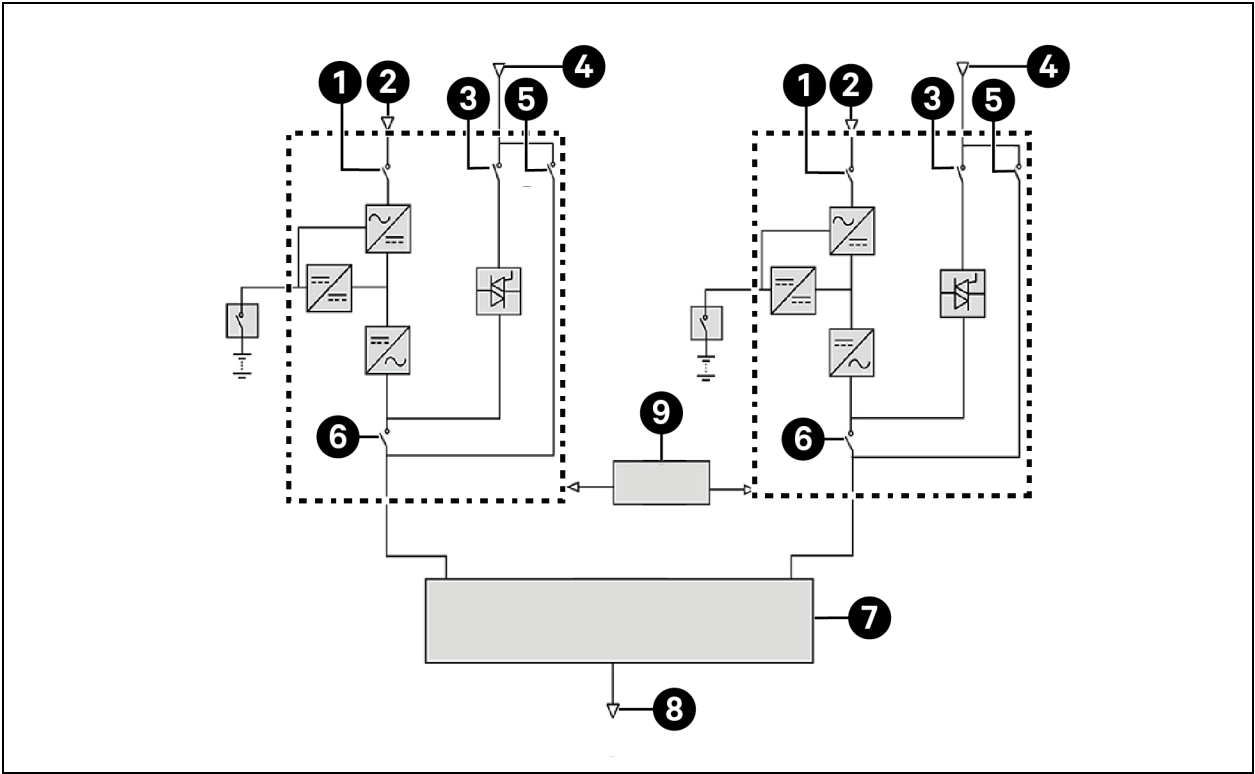
8.4 Load Bus Synchronization System

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.

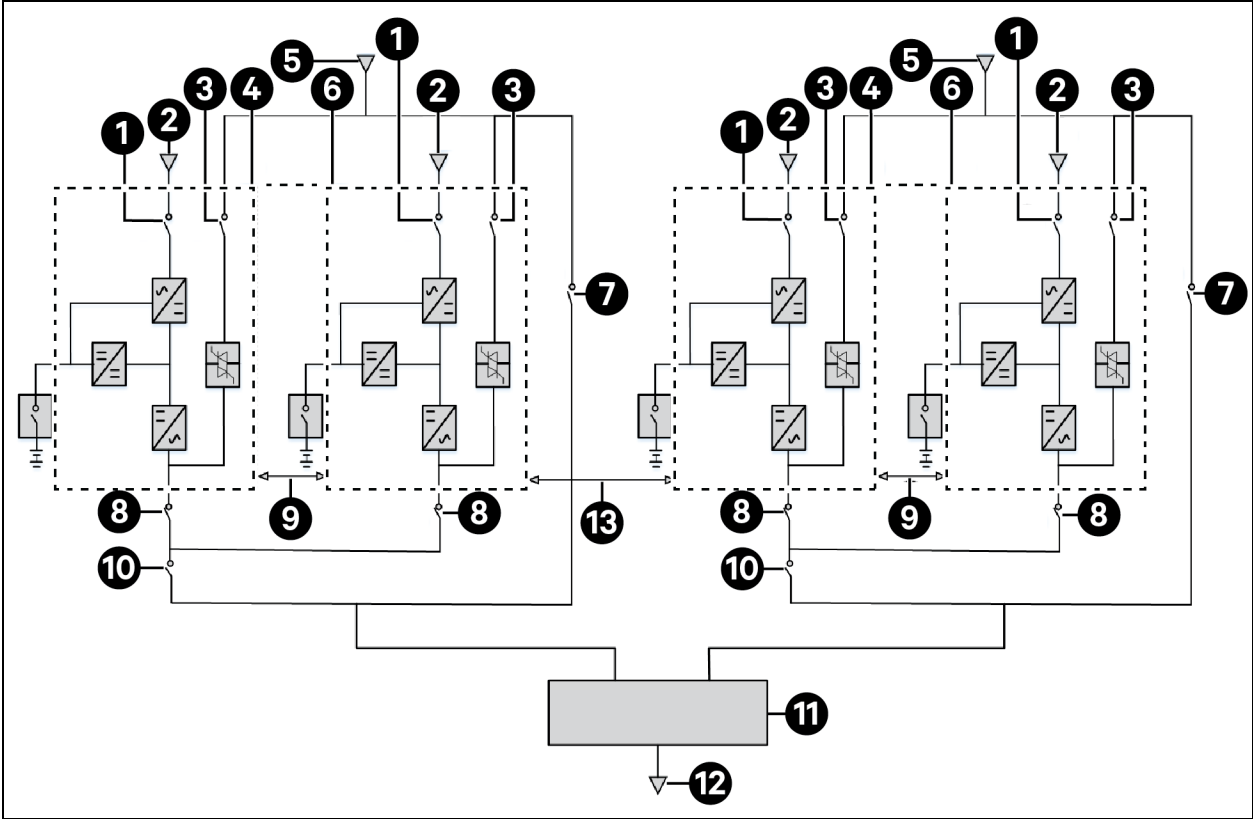
The system uses the LBS cables to keep the output of two independent UPS systems in synchronization. One set of UPS system (single/parallel) is designated as the master, the other set of UPS system (single/parallel) is designated as the slave for the operation in LBS mode.

Figure 8.5 LBS System (UPS Module)



Item	Description	Item	Description
1	RIB	6	MIB
2	Rectifier	7	STS
3	BIB	8	To load
4	Bypass	9	LBS
5	MBB		

Figure 8.6 LBS System (Parallel System)



Item	Description	Item	Description
1	RIB	8	MOB
2	Rectifier	9	Parallel cable
3	BIB	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 44.

8.4.3 Power Cable

The power cable of dual bus power system is similar to single system. See [Power Cable Wiring](#) on page 34 for more information.

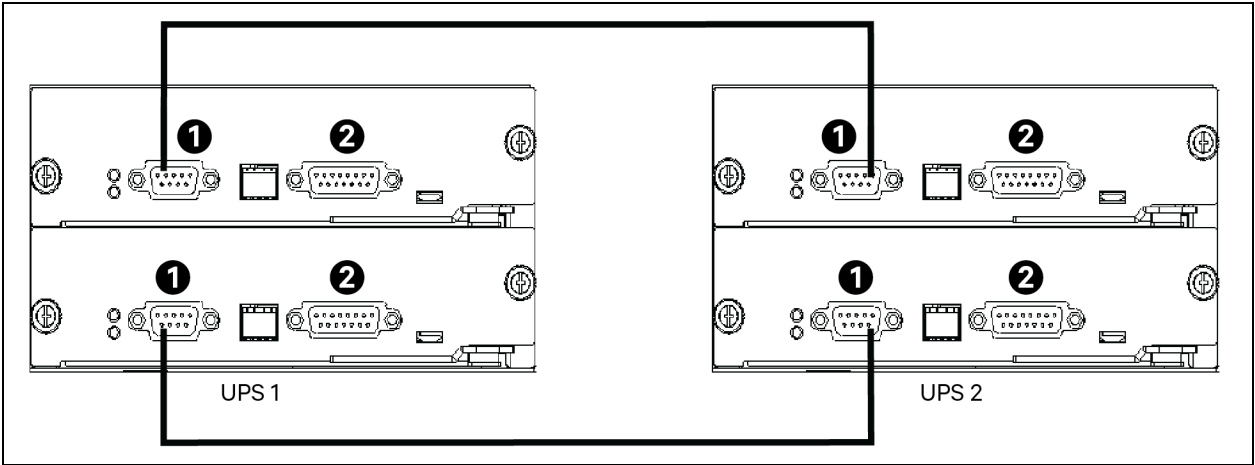
The bypass and rectifier should be connected with same neutral line input terminal. The current leakage protective device must be installed on the upstream of the neutral line input terminal.

8.4.4 Load Bus Synchronization Cable

Connect the optional LBS cables 32.8 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, for Vertiv™ Liebert® APM2 series dual bus system, shown in **Figure 8.7** below and **Figure 8.8** on the next page. The LBS port is shown in **Figure 8.9** on the next page.

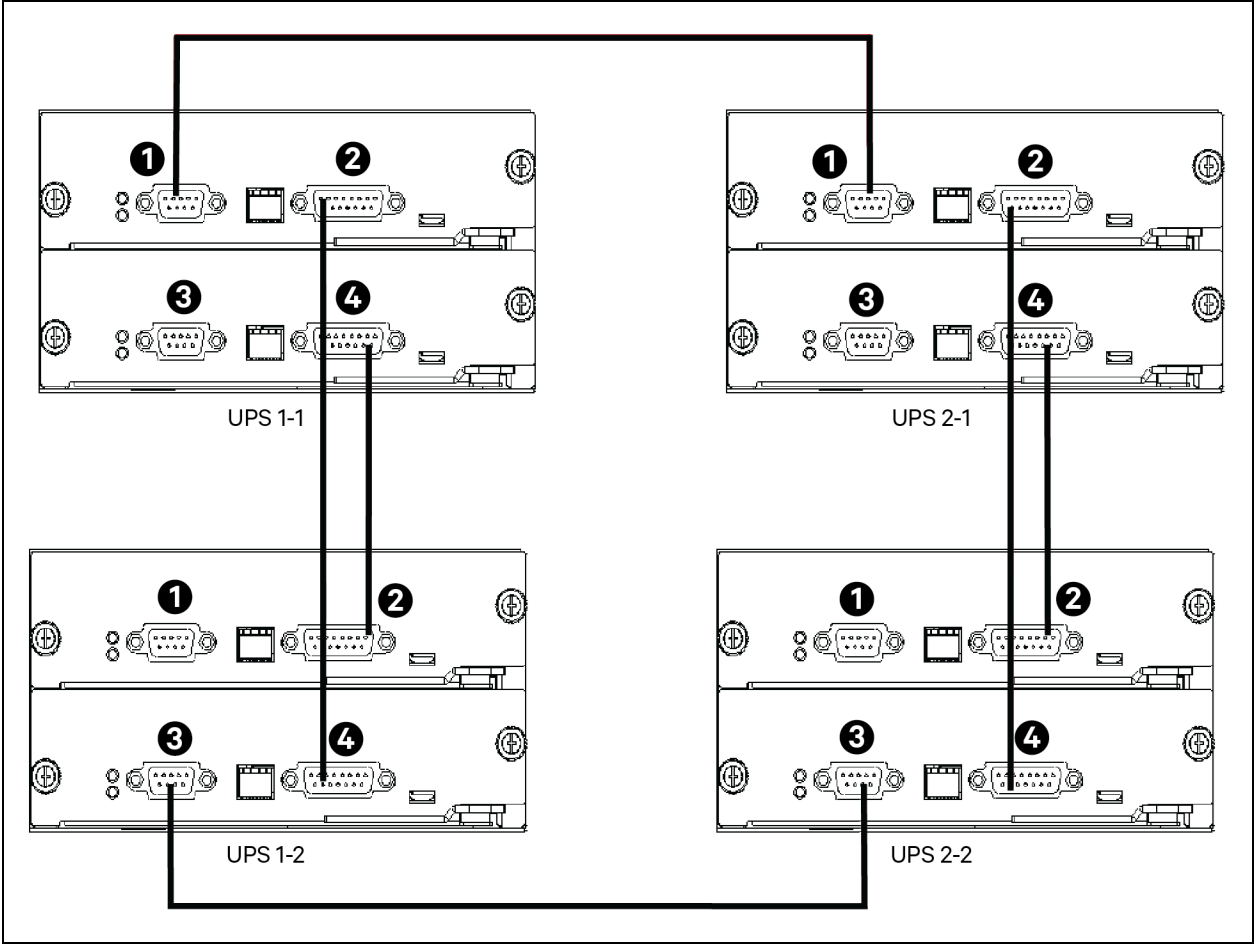
NOTE: You must use the shortest LBS cable suitable for the application and must not coil excess. Meanwhile, separate the LBS cable from the power cables to prevent electrical interferences.

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



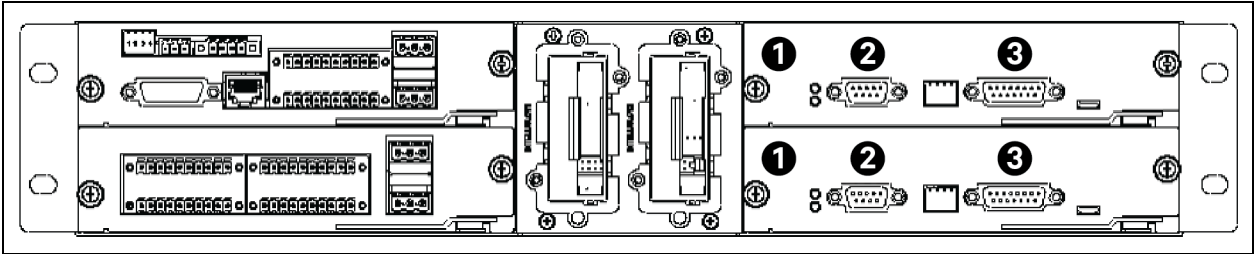
Item	Description
1	LBS
2	Parallel

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



Item	Description	Item	Description
1	LBS1	3	Parallel 2
2	Parallel 1	4	LBS2

Figure 8.9 LBS Port



Item	Description
1	U4
2	LBS
3	Parallel

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 ground fault kit	N/A
2	Seismic anchor kit	N/A
3	Vertiv™ Liebert® IS-UNITY-DP card	Vertiv™ Liebert® Intellislot™ ports 1 to 2
4	Vertiv™ Liebert® IS-UNITY-LIFE card	Liebert® Intellislot™ ports 1 to 2
5	Vertiv™ Vertiv™ Liebert® IS-RELAY card	Liebert® Intellislot™ ports 1 to 2
6	LBS extender	N/A
7	Parallel cable	Available in 16.5 ft., 32.9 ft., and 49.3 ft. (5 m, 10 m, and 15 m)
8	LBS cable	Available in 32.8 ft., 49.3 ft., and 65.7 ft. (10 m, 15 m, and 20 m)

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 \(Optional 2\)](#) on page 103.

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.

Table 9.2 below shows the dimensions of the seismic anchor kit.

Table 9.2 Dimensions and Content of the Seismic Anchor Kit

Item	Width	Length	Quantity
Seismic anchor	2.4 in. (60 mm)	23.1 in. (585 mm)	N/A
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.



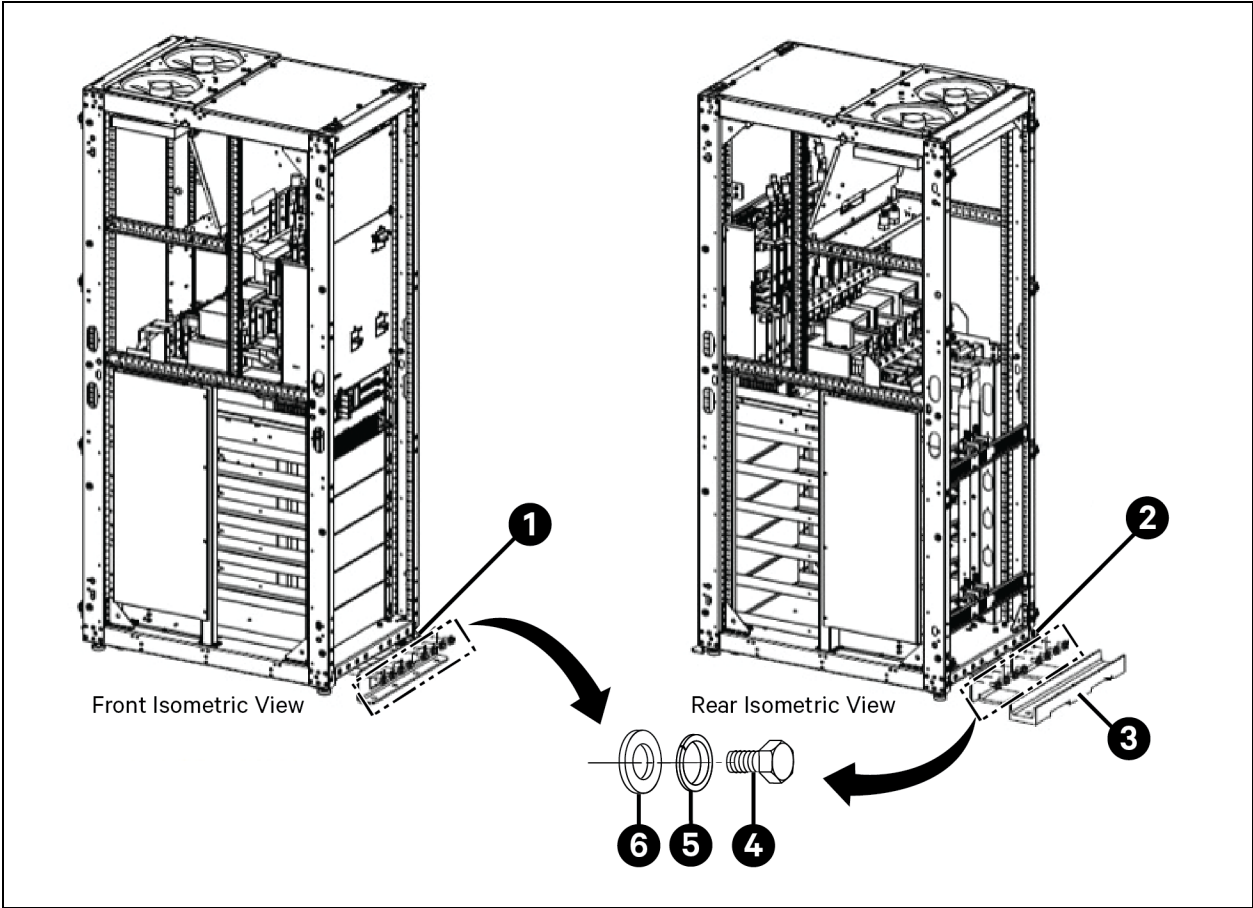
WARNING! Execute the installation according to the instructions. Failure to do so can cause personnel injury or damage to the UPS and seismic anchor kits.

Keep the Seismic Anchor Kit. See **Table 9.2** on the previous page for kit details, 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 (quantity = 4) to install seismic anchor on the rear bottom side of the UPS cabinet, and use M12 expansion bolts (quantity = 3) to install seismic anchor on the ground, as shown in **Figure 9.1** below.

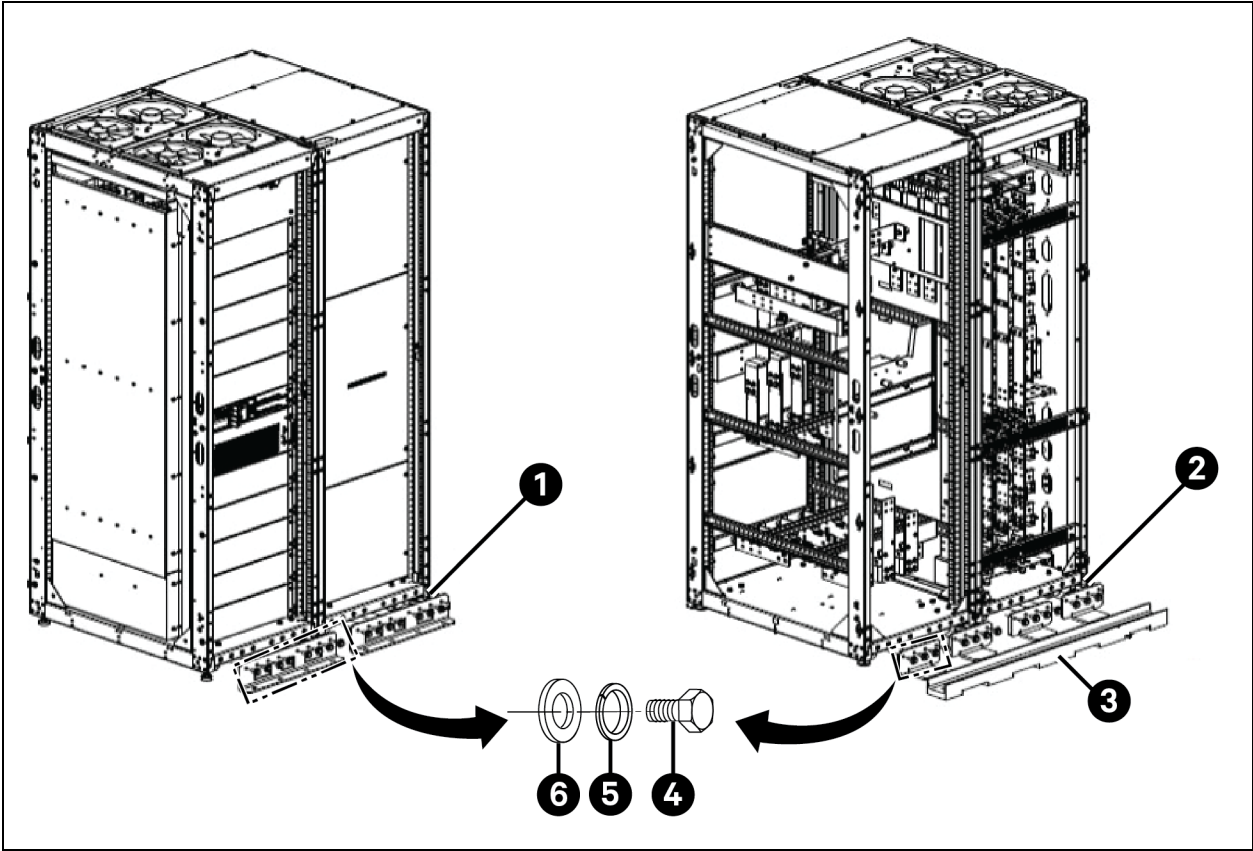
Figure 9.1 Seismic Anchor Dimensions for Vertiv™ Liebert® APM2 60 kVA 208 V and 120 kVA 480 V UPS



Item	Description	Quantity
1	Bracket front cabinet base	1
2	Bracket back base	2
3	Channel rear	1

Item	Description	Quantity
4	Screw cap HH M10 1.5 x 30 mm ZP	16
5	Washer split LKG M10 ZP	16
6	Washer flat LGPAT M10 ZP	16

Figure 9.2 Seismic Anchor Dimensions for Vertiv™ Liebert® APM2 600 kVA 480 V UPS



Item	Description	Quantity
1	Bracket front cabinet base	2
2	Bracket back base	4
3	Channel rear	1
4	Screw cap HH M10 1.5 x 30 mm ZP	32
5	Washer split LKG M10 ZP	32
6	Washer flat LGPAT M10 ZP	32

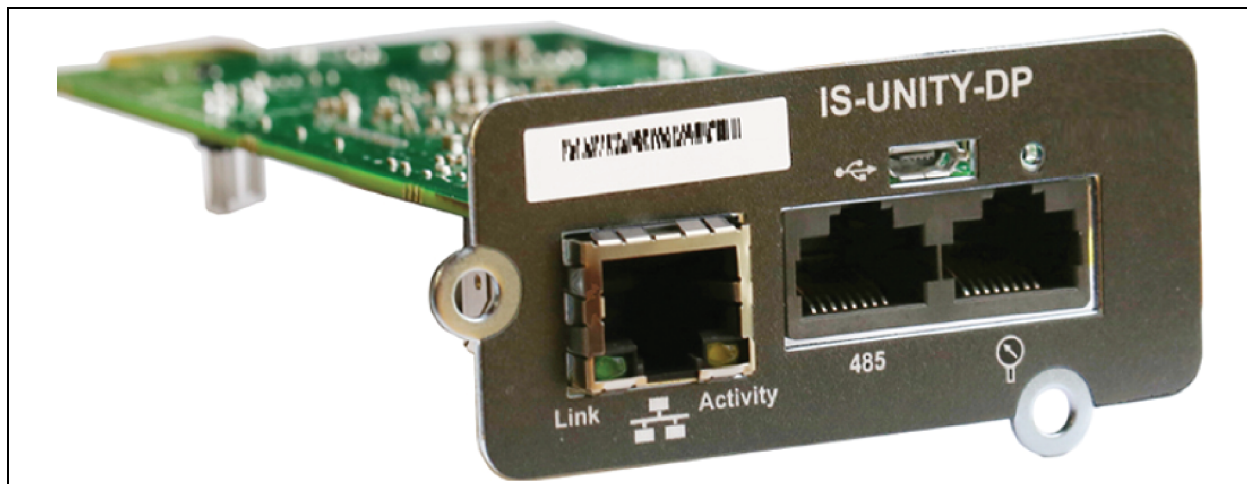
2. Use M8 × 25 tapping screws (quantity = 4) to install seismic anchor on the front bottom side of the UPS cabinet, and use M12 expansion bolts (quantity = 3) to install seismic anchor on the ground, as shown in **Figure 9.2** above.

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 9.3** below.

Figure 9.3 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 Web, SNMP, Modbus, BACnet, and YDN23 SL-52645**.

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

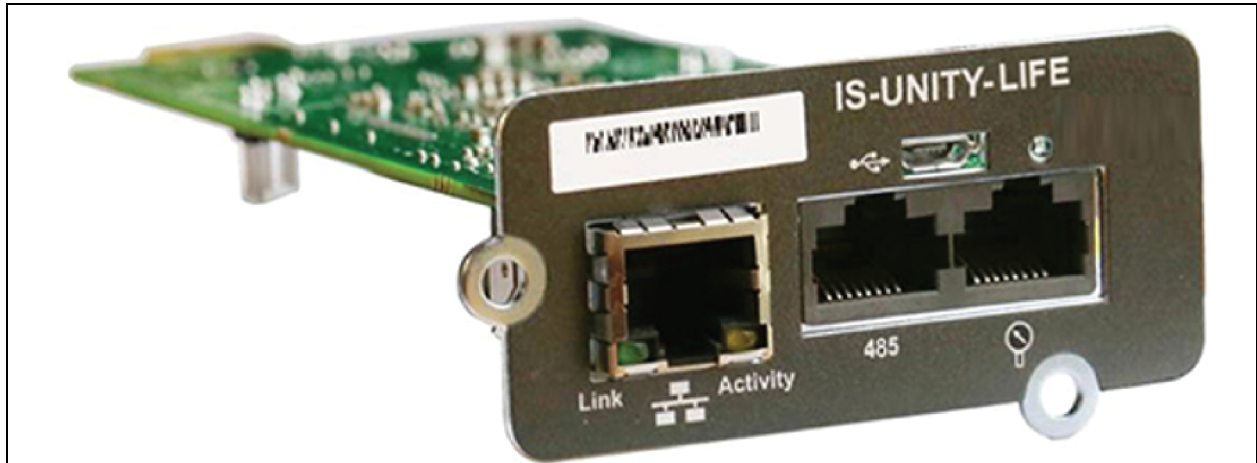
Insert the UNITY card (along two sides of the Vertiv™ Liebert® IntelliSlot™ port) into the indicated position recommended in **Table 4.27** on page 60, and then tighten the screws.

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 9.4** below.

Figure 9.4 Liebert® IS-UNITY-LIFE Card



For further description and installation of the Liebert® IS-UNITY-LIFE 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** below. See **Figure 9.5** below for more information of Liebert® IS-Relay card.

Figure 9.5 Vertiv™ Liebert® IS-Relay Card



Table 9.3 Function of UPS 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

Table 9.3 Function of UPS Liebert® IS-Relay card

Pin	Function	Operation
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	N/A

For more information of the Vertiv™ Liebert® IS-Relay card, refer to the **Vertiv™ Liebert® IntelliSlot™ IS-Relay Card User Manual_SL-26100** in accessory.

The installation method of the Liebert® IS-Relay card is the same as that of the SIC card described in **Vertiv™ Liebert® IntelliSlot™ RDU-SIC G2 Card User Manual_SL-31323**. See [Signal Cable Connection Steps](#) on page 60 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 of 16.5 ft., 32.9 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 108.

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.

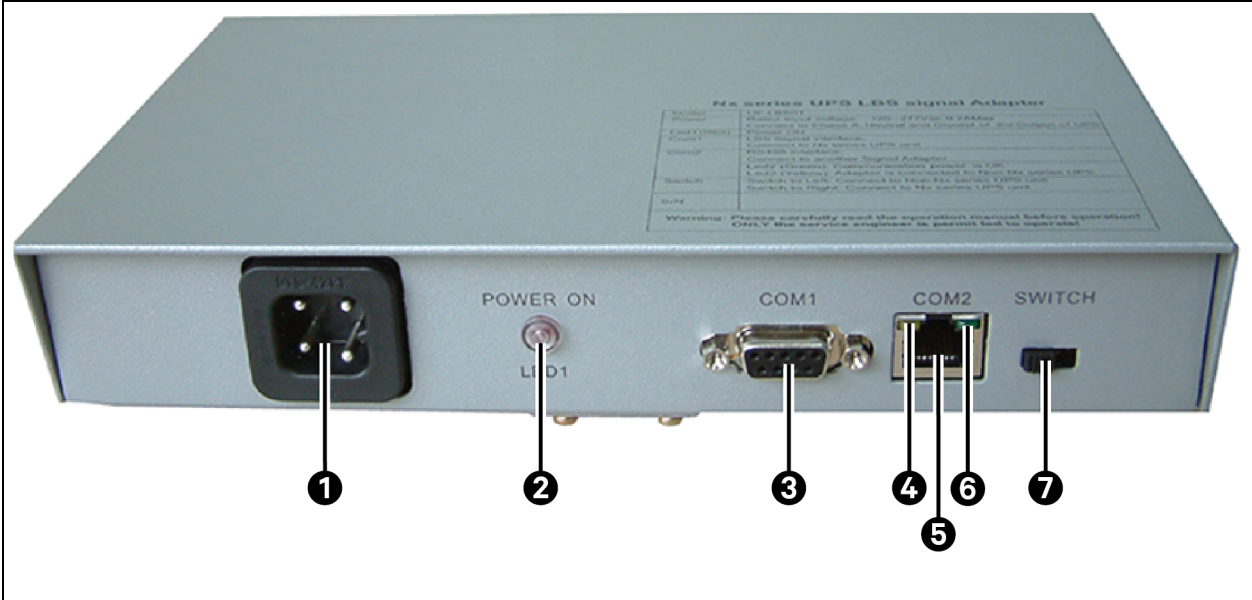
9.2.7 Load Bus Synchronization Cable

Shielded and double-insulated parallel control cables (LBS1 and LBS2) available in lengths of 32.8 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 LBS1 and LBS2 of any UPS modules, as shown in **Figure 8.7** on page 115, **Figure 8.8** on page 116, and **Figure 8.9** on page 116.

9.2.8 Load Bus Synchronization Extender

The LBS Extender, as shown in **Figure 9.6** below is designed to extend the LBS function up to 492.2 ft. (150 m) between the 2 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 9.6 LBS Extender



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 **Dual Bus UPS LBSTM Expander/Adapter Installation Manual SL-71017**.

10 Communication

This chapter provides information about the compatible communication protocols.

Vertiv™ Liebert® APM2 Supports:

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

10.1 SNMP Protocol Communication

Vertiv Vertiv™ Liebert® IS-Unity-DP support SNMP protocol that helps to monitor the UPS through network.

IRM series sensor can also be connected to 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 simple network management system 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 4.7** on page 53 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> available at www.vertiv.com.

10.2 Modbus Protocol Communication

The Modbus (RTU) protocol communication is supported by the Vertiv™ 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 Liebert® 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 SL-26100**.

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 remote EPO. 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.
- REPO input port.

For the functions and detailed information of these ports, see [Signal Cable Wiring](#) on page 52.

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 disconnect device before maintenance, and check whether the UPS is powered on.



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. unlock (unlock switch) 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 put 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 executes 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 years life)	5 years	3 years to 4 years	6 months
VRLA battery (10 years 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.

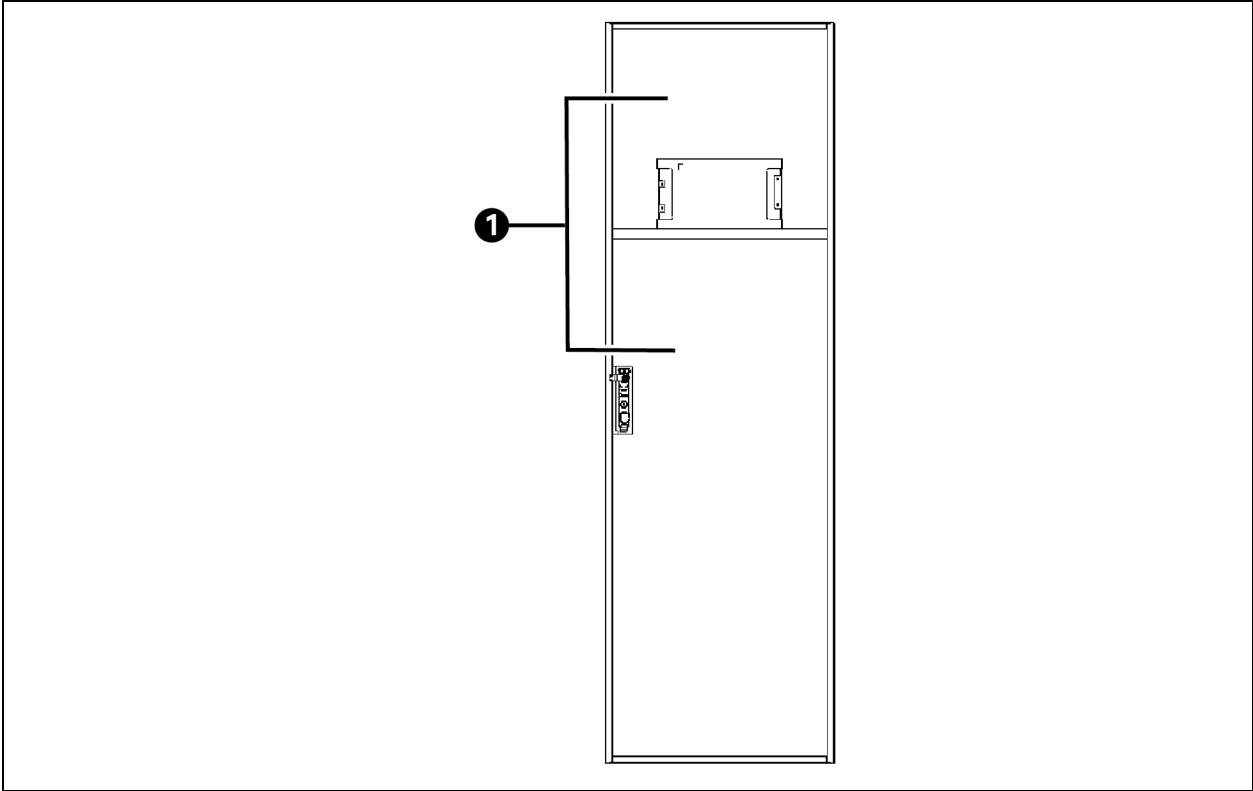
The UPS has air filters mounted on the rear side of the front door of the cabinet. The filters can be replaced while the UPS is operational.

The air filters are fixed by bars on both the sides. See **Figure 11.1** on the facing page 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 bars 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.

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 manufacturer's Battery maintenance manual.

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 cUL approval.

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

12.2 Environmental Characteristics

Table 12.1 Environmental Characteristics

Item	Normative Reference	Rated Power (kVA)		
		Liebert® APM2 150 kVA 208 V	Liebert® APM2 300 kVA 400 V Liebert® APM2 300 kVA 480 V	Liebert® APM2 600 kVA 400 V Liebert® APM2 600 kVA 480 V
Noise within 3.3 ft. (1 m) (in the front)	dB (A)	≤65		≤ 70
Altitude	ft. (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	°F (°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	°F (°C)	Storage: -13 °F to 131 °F (-25 °C to +55 °C) transportation: -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, IT, HRG		

12.3 Mechanical Characteristics

Table 12.2 Mechanical Characteristics

Item		Unit	Rated Power (kVA)		
			Vertiv™ Liebert® APM2 150 kVA 208 V	Liebert® APM2 300 kVA 400 V Liebert® APM2 300 kVA 480 V	Liebert® APM2 600 kVA 400 V Liebert® APM2 600 kVA 480 V
Power module Dimensions (W × D × H)	power	kVA	30 kVA 208 V	60 kVA 480 V	
	Packing excluded	in. (mm)	15.8 x 24.9 x 5.2 (400 x 630 x 130)	15.8 x 24.9 x 5.2 (400 x 630 x 130)	
	Packing included	in. (mm)	22.6 x 34 x 10.8 (572 x 862 x 272)	22.6 x 34 x 10.8 (572 x 862 x 272)	
	Net weight	kg (lbs)	36 (79.4)	36 (79.4)	
	Gross weight	kg (lbs)	40 (88.2)	40 (88.2)	
System Dimensions (W × D × H)	Packing excluded	in. (mm)	23.7 x 40.6 x 78.8 (600 x 1030 x 2000)	23.7 x 40.6 x 78.8 (600 x 1030 x 2000)	47.3 x 40.6 x 78.8 (1200 x 1030 x 2000)
	Packing included	in. (mm)	44.1 x 48.1 x 84.7 (1120 x 1220 x 2150)	44.1 x 48.1 x 84.7 (1120 x 1220 x 2150)	70.9 x 48.1 x 84.7 (1800 x 1200 x 2150)
	Net weight (not include power module)	kg (lbs)	332 (732)	332 (732)	640 (1411)
	Gross weight (not include power module)	kg (lbs)	410 (903.9)	410 (903.9)	800 (1763.7)
Color		Black			
Protection degree, IEC (60529)		IP20 (front door open or closed)			

12.4 Electrical Characteristics (Input Rectifier)

Table 12.3 Electrical Characteristic

Item	Unit	Rated Power (kVA)		
		Liebert® APM2 150 kVA 208 V	Liebert® APM2 300 kVA 400 V Liebert® APM2 300 kVA 480 V	Liebert® APM2 600 kVA 400 V Liebert® APM2 600 kVA 480 V
Rated AC input voltage	VAC	208/220 4-wire (3-phase + N +PE)	380/400/415 4-wire (3-phase + N +PE) 480 4-wire (3-phase + N +PE) 480 3-wire (3-phase +PE)	
Input voltage range	VAC	177 to 249 (full load) 125 to 177 (with derating)	408 to 528 (full load) 288 to 408 (with derating)	
Frequency	Hz	60 (range: 40 to 70)		

Table 12.3 Electrical Characteristic

Item	Unit	Rated Power (kVA)		
		Liebert® APM2 150 kVA 208 V	Liebert® APM2 300 kVA 400 V Liebert® APM2 300 kVA 480 V	Liebert® APM2 600 kVA 400 V Liebert® APM2 600 kVA 480 V
Power factor	kW/kVA, full load (half load)	0.99		
Input current	A	510	552 (for 400) 444 (for 480)	1134 (for 400) 910 (for 480)
Total current harmonic distortion	%	3		

12.5 Electrical Characteristics (Battery Bus)

Table 12.4 Battery

Item	Unit	Rated Power (kVA)		
		Vertiv™ Liebert® APM2 150 kVA 208 V	Liebert® APM2 300 kVA 400 V Liebert® APM2 300 kVA 480 V	Liebert®APM2 600 kVA 400 V Liebert®APM2 600 kVA 480 V
Max. charging current	A	600	600	1200
Quantity of lead-acid cells (nominal)	Block	16 to 24 jars 20 to 24 jars without derating	30 to 50 jars 40 to 50 jars without derating	
Battery Bus Voltage	V	192 to 288 default 288	360 to 600 default 480	
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 25 °C or 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) 8 hours safety time timeout (selectable from 8 hours to 100 hours) Boost mode inhibit also selectable		
EOD voltage	V/cell (VRLA)	EOD Lower Voltage: 1.60 Vpc to 1.67 Vpc, 1.63 Vpc default for lead-acid battery EOD Upper Voltage: 1.67 Vpc to 1.85Vpc, 1.75 Vpc default for lead-acid battery		

12.6 Electrical Characteristics (Inverter Output)

Table 12.5 Inverter Output (to Critical Load)

Item	Unit	Rated Power (kVA)		
		Vertiv™ Liebert® APM2 150 kVA 208 V	Liebert® APM2 300 kVA 400 V Liebert® APM2 300 kVA 480 V	Liebert® APM2 600 kVA 400 V Liebert® APM2 600 kVA 480 V
Rated AC voltage	VAC	208/220 4-wire (3-phase + N +PE)	380/400/415 4-wire (3-phase + N +PE) 480 4-wire (3-phase + N +PE) 480 3-wire (3-phase +PE)	
Frequency	Hz	60		
Power factor		0.99		
Overload	%	<105%, continuous; <110%, ≤60 minute; <125%, ≤10 minute; <150, ≤1 minute; >150, ≤200 millisecond		
Maximum short circuit current of inverter	A	200% rated output current, 200 millisecond		
Non-linear load capability	kVA	24		
Steady state voltage stability	%	±1		
Transient voltage response	%	±5		
Total voltage harmonic distortion	%	< 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		
¹ Factory set to 380 V to 400 V, or 415 V can be selected by service engineer at site.				
² Factory set to 50 Hz to 60 Hz can be selected by service engineer at site. The system frequency can be changed only when the UPS is on bypass. It is strictly prohibited to change the system frequency when the UPS is on inverter.				
³ EN 50091-3 (14.58) crest factor 3:1, non-linear load.				

12.7 Electrical Characteristics (Bypass Input)

Table 12.6 Bypass Input

Item	Unit	Rated Power (kVA)		
		Vertiv™ Liebert® APM2 150 kVA 208 V	Liebert® APM2 300 kVA 400 V Liebert® APM2 300 kVA 480 V	Liebert® APM2 600 kVA 400 V Liebert® APM2 600 kVA 480 V
Rated AC voltage ¹	VAC	208/220 4-wire (3-phase + N +PE)	380/400/415 4-wire (3-phase + N +PE) 380/400/415 3-wire (3-phase +PE) 480 4-wire (3-phase + N +PE) 480 3-wire (3-phase +PE)	
Rated current	A	438	467 (for 400) 373 (for 480)	939 (for 400) 753 (for 480)
Frequency ²	Hz	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 I _{2T}	A2S	335000	450,000	1445,000
Bypass KAIC fuse ³ I _{2T}	A2S	1250000	180,000	1150,000
¹ Factory set to 380 V to 400 V or 415 V can be selected by service engineer at site.				
² Factory set to 50 Hz to 60 Hz can be selected by service engineer at site.				
³ The short time withstand current of the bypass thyristor is from one of the manufacturers.				

12.8 Efficiency, Loss, and, Air Exchange

Table 12.7 AC/AC Efficiency, Loss and, Air Exchange for Liebert® APM2 150 kVA 208 V 4-Wire System

AC /AC Efficiency	Data							
Rated Power (kVA)	60 to 150							
Dual conversion mode efficiency (%)	95.8% Maximum							
ECO mode efficiency (%)	98.8% Maximum							
VI mode efficiency (%)	98.5% Maximum							
Heat Losses and Air Exchange								
Rated Power (kVA)	60	75	80	90	100	120	140	150
Rated normal mode (full load) loss (kW)	3.66	4.11	4.5	5.54	5.56	7.54	7.96	9.22
Rated normal mode (no load) loss (kW)	0.2	0.3	0.3	0.3	0.4	0.4	0.5	0.5
ECO mode (full load) loss (kW)	0.72	0.98	1.06	1.20	1.44	1.92	2.32	2.52

Table 12.7 AC/AC Efficiency, Loss and, Air Exchange for Liebert® APM2 150 kVA 208 V 4-Wire System

AC /AC Efficiency	Data							
Maximum Forced Air Cooling (Back Air Flow), CFM (m ³ /hr)	1343 (2282)	2015 (3423)	2015 (3423)	2015 (3423)	2686 (4564)	2686 (4564)	3357 (5703)	3357 (5703)
Maximum Forced Air Cooling (Top Fan), CFM (m ³ /hr)	1207 (2050)	1207 (2050)	1207 (2050)	2413 (4100)	2413 (4100)	2413 (4100)	2413 (4100)	2413 (4100)
Heat Dissipation, BTU/Hr (kWh)	13905 (4)	17381 (5)	18540 (5.4)	20858 (6.1)	23175 (6.8)	27810 (8.1)	32445 (9.5)	34763 (10.1)

Table 12.8 AC/AC Efficiency, Loss, and Air Exchange for Vertiv™ Liebert® APM2 300 kVA 480 V 3-Wire System

AC /AC Efficiency	Data								
Rated Power (kVA)	60 to 300								
Dual conversion mode efficiency (%)	97.5% Maximum								
ECO mode efficiency (%)	99.4% Maximum								
VI mode efficiency (%)	99.1% Maximum								
Heat Losses and Air Exchange									
Rated Power (kVA)	60	120	150	180	200	225	240	250	300
Rated normal mode (full load) loss (kW)	1.86	3.70	4.43	5.65	5.96	6.88	7.75	7.51	9.57
Rated normal mode (no load) loss (kW)	0.2	0.4	0.6	0.6	0.8	0.8	0.8	1	1
ECO mode (full load) loss (kW)	0.36	0.70	0.96	1.13	1.33	1.48	1.76	1.92	2.29
Maximum Forced Air Cooling (Back Air Flow), CFM (m³/hr)	672 (1141)	1343 (2282)	2015 (3423)	2015 (3423)	2686 (4564)	2686 (4564)	2686 (4564)	3357 (5703)	3357 (5703)
Maximum Forced Air Cooling (Top Fan), CFM (m³/hr)	1207 (2050)	1207 (2050)	1207 (2050)	2413 (4100)	2413 (4100)	2413 (4100)	2413 (4100)	2413 (4100)	2413 (4100)
Heat Dissipation, BTU/Hr (kWH)	6812 (2)	13623 (4)	17029 (5)	20435 (6)	22705 (6.6)	25543 (7.5)	27246 (8)	28382 (8.3)	34058 (9.9)

Table 12.9 AC/AC Efficiency, Loss and Air Exchange for Vertiv™ Liebert® APM2 600 kVA 480 V 3-Wire System

AC /AC Efficiency	Data											
Rated Power (kVA)	60 to 600											
Dual conversion mode efficiency (%)	97.5% Maximum											
ECO mode [MR1] efficiency (%)	99.4% Maximum											
VI mode [MR2] efficiency (%)	99.1% Maximum											
Heat Losses and Air Exchange												
Rated Power (kVA)	60	120	180	240	300	360	400	420	480	500	540	600
Rated normal mode (full load) loss (kW)	1.86	0.36	5.65	7.75	9.24	11.34	12.31	13.39	15.26	15.55	17.13	19.75
Rated normal mode (no load) loss (kW)	0.2	0.4	0.6	0.8	1.0	1.2	1.2	1.4	1.6	1.6	1.8	2
ECO mode (full load) lose (kW)	0.36	0.70	1.13	1.76	1.72	2.12	2.40	2.51	3.12	3.32	3.62	4.09
Maximum Forced Air Cooling (Back Air Flow), CFM (m³/hr)	672 (1141)	1343 (2282)	2015 (3423)	2686 (4564)	3357 (5703)	4029 (6845)	4029 (6845)	4700 (7986)	5372 (9127)	5372 (9127)	6045 (10270)	6716 (11410)
Maximum Forced Air Cooling (Top Fan), CFM (m³/hr)	0 (0)	2413 (4100)	2413 (4100)	2413 (4100)	2413 (4100)	4826 (8200)	4826 (8200)	4826 (8200)	4826 (8200)	4826 (8200)	4826 (8200)	4826 (8200)
Heat Dissipation, BTU/Hr (kWH)	6441 (1.9)	12881 (3.8)	19322 (5.6)	25763 (7.5)	32203 (9.4)	38644 (11.3)	42938 (12.5)	45085 (13.2)	51525 (15)	53672 (15.7)	57966 (16.9)	64407 (18.8)

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Appendices

Appendix A: Technical Support and Contacts

A.1 Technical Support/Service in the United States

Vertiv Group Corporation

24x7 dispatch of technicians for all products.

1-800-543-2378

Liebert® 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
EPO	Emergency power off
LBS	Load bus synchronizer
RCCB	Residual current circuit breaker
RCD	Residual current detector
REPO	Remote emergency power off
STS	Static transfer switch
UPS	Uninterruptible power system
VRLA	Valve regulated lead-acid

Appendix C: Hazardous Substances and Content

Parts	Hazardous Substances					
	Plumbum	Mercury	Cadmium	Chrome ⁶⁺	Polybrominated Biphenyls	Polybrominated Diphenyl Ethers
	(Pb)	(Hg)	(Cd)	Cr (VI)	(PBB)	(PBDE)
Hex copper stud	x	○	○	○	○	○
PCBA	x	○	○	○	○	○
AC Capacitor	x	○	○	○	○	○
DC Capacitor	x	○	○	○	○	○
Fan	x	○	○	○	○	○
Cables	x	○	○	○	○	○
LCD	x	x	○	○	○	○
Sensors	x	○	○	○	○	○
Large-medium power magnetic components	x	○	○	○	○	○
Circuit breaker/rotating switch	x	○	○	○	○	○
Semiconductors	x	○	○	○	○	○
Battery (if applicable)	x	○	○	○	○	○
Insulation monitoring device (if applicable)	x	○	○	○	○	x
<p>NOTE: This table is prepared based on the regulation of SJ/T 11364.</p> <p>Content of the hazardous substances in all the average quality materials of the parts is within:</p> <p>○ : The specified limits.</p> <p>x: Outsides specified the limits.</p> <p>About battery: Generally, follow the environmental protection use period of the battery, otherwise five years.</p> <p>The Hazardous Substances and Content mentioned are applicable to Vertiv™ Liebert® APM2 30 to 120 kVA UPS.</p>						

Appendix D: ESS System Configurations

Table A.1 Vertiv™ APM2 FR 3 Series UL9540 ESS System Configurations

UPS Power Scalability (Voltage/Ratings kVA/kW)		ESS Model	Model Configuration	Minimum Cabinets	Maximum Cabinets
480/400/415 VAC	60, 120, 150, 180, 200, 225, 240, 300	Vertiv™ EnergyCore Lithium 5 series	16 and 18 Module	1	4
208 VAC	30, 60, 75, 80, 90, 100, 120, 140, 150	EnergyCore Lithium 5 series	10 Module	1	4

Table A.2 APM2 FR 4 Series UL9540 ESS System Configurations

UPS Power Scalability (Voltage/Ratings kVA/kW)		ESS Model	Model Configuration	Minimum Cabinets	Maximum Cabinets
480/400/415 VAC	60, 120, 180, 240, 300, 360, 400, 420, 480, 500, 540, 600	Vertiv™ EnergyCore Lithium 5 Series	16 and 18 Module	1	4

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