

**Vertiv™ Liebert® PSI5 Lithium-Ion UPS
Guide Specifications
1500VA to 3000VA, 120VAC
Single-phase Uninterruptible Power Supply Systems**

1.0 GENERAL

1.1 Summary

This specification defines the electrical and mechanical characteristics and requirements for a continuous-duty single-phase, solid-state, uninterruptible power system. The uninterruptible power system hereafter referred to as the UPS, provides high-quality AC power for sensitive electronic equipment loads. The UPS provides reliable power protection for servers, critical nodes, network workstations, large network peripherals, network routers, bridges, hubs and other electronic equipment.

1.2 Standards

The UPS is designed in accordance with the applicable sections of the current revision of the following documents. Where a conflict arises between these documents and statements made herein, the statements in this specification will govern.

Item	Specifications/Certifications
Agency	<ul style="list-style-type: none"> • UL • c-UL • FCC • NOM
Safety	<ul style="list-style-type: none"> • UL 1778 5th Edition • CSA 22.2 No. 107.3:2014 • UL 1973 (LiFePO₄ Battery Pack) • UL 1642 (LiFePO₄ Battery Cell)
Surge Rating/Capacity	ANSI C62.41, Category A, Level 3
ESD	EN61000-4-2
Susceptibility	EN61100-4-3, Level 2
Electrical Fast Transient	EN61100-4-4, Level 2
Surge Protection	EN61000-4-5
Environmental	<ul style="list-style-type: none"> • RoHS2 • REACH • WEEE
Transportation	ISTA 2A

1.3 System Description

1.3.1 Modes of Operation

The UPS is designed to operate as a line-interactive system in the following modes:

Off Mode

The UPS input is plugged into a stable, nominal source, but the outlets are turned off. The internal batteries are charging.

On/Normal Mode

The UPS input is plugged into a stable, nominal source, and the outlets are turned on. The internal batteries are charging.

On/Automatic Voltage Regulation (AVR)/Boost Mode

The UPS input is plugged in, but the voltage source is abnormally low (brown-out). The UPS automatically corrects the low voltage and allows the outlets to be on with the normal, expected voltage. The internal batteries are charging.

On/Automatic Voltage Regulation (AVR)/Buck Mode

The UPS input is plugged in, but the voltage source is abnormally high. The UPS automatically corrects the high voltage and allows the outlets to be on with the normal, expected voltage. The internal batteries are charging.

On/Battery Mode

The UPS input is not plugged in, or the voltage source has become extremely low or high and unusable. The UPS automatically switches to the internal battery to provide normal, usable voltage to the outlets.

Fault Mode

An error or fault condition has occurred. The outlets are shut off.

Battery Self-test Mode

The UPS enters a cycle of approximately 10 seconds during which it tests the internal battery. The outlets are still temporarily powered by the internal battery. Self-test mode occurs at the following instances:

- At start-up turning the UPS On.
- Automatically every 8 weeks as a self-check.
- Manually: pressing and holding the ON/Mute button for 3 sec. when the unit is On.

1.3.2 Design Requirements

1. Voltage

Input/output voltage specifications of the UPS are:

- Input, 120V Units: 0-150 VAC, 60/50 Hz, single-phase, 2-wire-plus-ground
- Output, 120V Units: 100/110/120/125 VAC $\pm 1.5\%$ (on battery), 60 Hz $\pm 1\%$ (on battery), single-phase, 2-wire-plus-ground. (DIP Switch selectable)
- Output voltages shall be user-configurable. The Factory Default is 120VAC.

2. Output Load Capacity

Maximum specified output load capacity of the UPS, regardless of load power factor, is below:

UPS Models	Input Voltage				
	125V	120V	115V	110V	100V
PSI5-1500RT120LI	1500VA/1350W	1440VA/1350W	1380VA/1350W	1275VA/1147W	1200VA/1147W
PSI5-2200RT120LI	1920VA/1920W	1920VA/1920W	1840VA/1840W	1632VA/1632W	1600VA/1600W
PSI5-3000RT120LI	3000VA/2700W	2880VA/2700W	2760VA/2700W	2550VA/2295W	2400VA/2295W
PSI5-1500MT RT120LI	1500VA/1350W	1440VA/1350W	1380VA/1350W	1275VA/1147W	1200VA/1147W

3. Internal Battery

The internal battery consists of maintenance-free, sealed, Lithium-ion (LiFePO₄) cells. The internal battery is user-replaceable and hot-swappable.

4. Battery Reserve Time

- 1500VA Units – 7.5 min minimum at full load with 77°F ambient temperature
- 2200VA Units – 8.6 min minimum at full load with 77°F ambient temperature
- 3000VA Units – 8.9 min minimum at full load with 77°F ambient temperature

5. Battery Recharge

The UPS contains a battery recharge rate designed to prolong battery life. Recharge time is 2-3 hours typical to 90% capacity at nominal input voltage.

1.3.3 Performance Requirements

AC Input to UPS

1. Voltage Configuration: The UPS operates at these values without drawing power from the batteries
120 Volt Units:

- 100 VAC setting: single phase, 2-wire-plus-ground: 75-146 VAC (±5VAC)
 - Buck compensation: 110VAC (±5VAC)
 - Boost compensation: 90VAC (±5VAC)
- 110 VAC setting: single phase, 2-wire-plus-ground: 75-146 VAC (±5VAC)
 - Buck compensation: 121VAC (±5VAC)
 - Boost compensation: 99VAC (±5VAC)
- 115 VAC setting: single phase, 2-wire-plus-ground: 75-146 VAC (±5VAC)
 - Buck compensation: 127VAC (±5VAC)
 - Boost compensation: 104VAC (±5VAC)
- 120 VAC setting: single phase, 2-wire-plus-ground: 75-146 VAC (±5VAC)

- Buck compensation: 132VAC (± 5 VAC)
- Boost compensation: 108VAC (± 5 VAC)
- 125 VAC setting: single phase, 2-wire-plus-ground: 75-146 VAC (± 5 VAC)
 - Buck compensation: 138VAC (± 5 VAC)
 - Boost compensation: 113VAC (± 5 VAC)
- 2. Frequency: The UPS automatically senses the input frequency and operates within 55-65 Hz (± 0.5 Hz) without drawing power from the batteries.

AC Output

1. Voltage Configuration: The UPS nominal voltage output shall be selectable via the local HMI and PC Configuration tool and remote SNMP connection. This setting will change the transfer point (Low and High) of the UPS. The factory default setting is 120 VAC for the 120VAC units.
2. Voltage Regulation: $\pm 1.5\%$ on battery backup
3. Frequency Regulation: ± 1.0 Hz on battery
4. Load Power Factor Range: 0.5 lagging to 1.0 (unity)
5. Output Voltage Distortion:
 - 2%THD at 100% linear load
 - 5% THD at 100% nonlinear load
 - 12% THD max at overload alarm point
6. Inverter Overload Capability: Overload Warning (visual and audible alarms) occurs between 100%-120% of rated capacity, continuous duty.
 - 100% - 110% load: alarm warning
 - 111% - 120% load: alarm warning and shutdown after 10 seconds
 - 121% or greater load: immediate shutdown
7. Transfer Time: user selectable
 - 4-6ms typical, 10ms max: Setting 09 ST1 (default)
 - 6-8ms typical, 11ms max: Setting 09 ST2
 - 8-10ms typical, 13ms max: Setting 09 ST3
8. Efficiency with resistive load:
 - $>97.1\%$ (Normal mode)
 - $>93.9\%$ (Buck/Boost mode)
 - $>90.0\%$ (Battery mode 75% load)
 - $>89.0\%$ (Battery mode 50% load)
 - $>82.7\%$ (Battery mode 25% load)

1.4 Environmental Conditions

1. Ambient Temperature

- a. Operating:
 - 32°F-104°F (0°C-40°C) for altitude 10,000ft max (3,000m) above sea level.
 - 77 °F (25°C) for optimum battery performance.
 - b. Storage:
 - 14°F to 113 °F (-10°C to 45°C) with batteries 68°F (20°C) for optimum battery storage.
 - -4°F to 122°F (-20°C to 50°C) without batteries
2. **Relative Humidity:** 0-90% non-condensing for storage, 8-90% non-condensing for operation.
 3. **Altitude:** 10,000 ft.(3,000 m max.), without power derating when operated within the temperature specified in section 1.4.A. Ambient temperature is de-rated 9° F (5°C) for each additional 1640 ft (500m).
 4. **Audible Noise:** Noise generated by the UPS during normal operation does not exceed the following values when measured at 1 meter from the surface of the UPS. In normal mode unit measures 40dB max, and in battery-mode the units measure 45dB max in normal/line mode, 55dB max in battery mode.

1.5 User Accessories And Packaging

The specified UPS system is supplied with one (1) Quick installation Guide. The guide includes installation drawings and instructions, a functional description of the equipment, safety precautions, illustrations and operating procedures. The Rack/Tower (RT) UPS models are also supplied with one (1) USB cable (6ft; 1.8m), one (1) set of tower stands, one (1) 4-post fixed rail kit including one (1) pair of rack mount handles, mounting hardware, and one (1) pair of 4-post fixed rails. The Mini Tower (MT) model is also supplied with one (1) USB cable (6ft; 1.8m).

NOTE: Full User Manuals are available from manufacturer website.

1.6 Warranty

The manufacturer warrants the UPS against defects in materials and workmanship for five (5) years. The warranty covers all parts.

1.7 Quality Assurance

1.7.1 Manufacturer Qualifications

Vertiv Corporation provides more than thirty years of experience in the design, manufacturing, and testing of solid-state UPS systems and the company is certified to ISO 9001:2000.

1.7.2 Factory Testing

Before shipment, the product is tested to assure compliance with the specification.

2.0 PRODUCT

2.1 Fabrication

All materials and components making up the UPS are new, of current manufacture, and have not been in prior service except as required during factory testing.

2.1.1 Wiring

Wiring practices, materials, and coding are in accordance with the requirements of the standards listed in section 1.2. All wiring is copper.

2.1.2 Cabinet

The UPS unit comprised of: TVSS & EMI/RFI Filters, Relay, Automatic Voltage Regulator, Battery Charger, Battery consisting of the appropriate number of sealed battery cells.

UPS Model	Unit Dimensions W x D x H in (mm)	Unit Weight lbs (kg)
PSI5-1500RT120LI	17.2 x 16.2 x 3.5 (438 x 410 x 88)	28.3 (12.9)
PSI5-2200RT120LI	17.2 x 20.1 x 3.5 (438 x 510 x 88)	39.7 (18.0)
PSI5-3000RT120LI	17.2 x 24.8 x 3.5 (438 x 630 x 88)	53.6 (24.3)
PSI5-1500MT120LI	6.2 x 15.6 x 8.7 (158 x 397 x 220)	28.0 (12.7)

2.1.3 Cooling

Air intake is through the front of the unit and exhausted out the rear of the unit. The UPS has smart fan speed control which slows the fan down or turns the fan off when the UPS does not require cooling. Fan speeds will be greater at higher loads and when running or charging the batteries.

2.2 Components and Operation

2.2.1 Surge Protection

120 VAC PSI5 UPS units can withstand input surges of up to 1372J without damage per criteria listed in ANSI C62.41, Category A, Level 3. Additionally, the PSI5 UPS units are supplied with one pair of Data Line Surge Protection Connectors to provide phone, fax, or modem line surge protection via RJ-45/RJ-11 connectors. These Data Line Ports provide transmission for 10/100 Base-T Ethernet connection.

2.2.2 Input Protection

The UPS has built-in protection against under-voltage, overcurrent, and over-voltage conditions including low-energy lightning surges introduced on the primary input power source. The UPS is provided with a resettable input circuit breaker.

2.2.3 Input Connections

- The 120 VAC Rack/Tower units have an attached input cord 10 feet (3 meters) in length.
- The 120V VAC Mini Tower units have an attached input cord of 6ft (1.8 meters) in length.

UPS Model	Input Plug Type
PSI5-1500RT120LI	NEMA 5-15P (offset 90-degree type)
PSI5-2200RT120LI	NEMA L5-20P L5-20 to NEMA 5-20 adapter included
PSI5-3000RT120LI	NEMA L5-30P
PSI5-1500MT120LI	NEMA 5-15P (offset 90-degree type)

2.2.4 Bi-Directional Converter

General

The Bi-Directional Converter incorporates solid-state devices and control circuitry to convert AC power to regulated DC power to “float charge” the battery during normal mode; and convert DC power from the battery to regulated and conditioned sinewave AC power for supporting the critical load during battery mode. The Bi-Directional Converter is a pulse width modulated (PWM) design. The Bi-Directional Converter operates in the following modes:

In Normal mode of operation, the Bi-Directional Converter maintains the battery at a float charge.

In Battery mode of operation, the Bi-Directional Converter converts DC power from the battery, through the DC-to-DC Converter, to regulated and conditioned sinewave AC power for supporting the critical load.

In the recharge mode of operation, the Bi-Directional Converter converts AC power to regulated DC power to recharge the battery.

Battery Recharge

The UPS contains a battery recharge rate designed to prolong battery life. The battery is constant voltage charged to recharge and maintain the battery in a fully charged state.

Bi-Directional Converter DC Protection

The following DC shutdown levels protect the UPS:

- DC Overvoltage Shutdown
- DC Under-voltage Shutdown (End of Discharge)
- DC Under-voltage Warning (Low Battery Reserve)

Output Protection

For output faults including short circuits and overloads, the UPS is protected by the input circuit protector during Normal mode and by electronic current limiting during Battery mode. The UPS control logic senses and disconnects the UPS from the critical AC load and clears the protective circuit breaker during Normal mode.

Overload

The UPS is capable of supplying power for overloads exceeding 100% and up to 110% of full load rating, continuously. A visual indicator and audible alarm indicate overload operation. For greater current demands, the UPS employs circuit protector and electronic current-limiting protection to prevent damage to components. The UPS is self-protecting against any magnitude of connected output overload.

Output Frequency

An oscillator controls the output frequency of the UPS when on battery. The oscillator maintains the output frequency to $\pm 1\%$ Hz of nominal.

Battery Over-Discharge Protection

To prevent battery damage due to excessive discharge levels, the UPS control logic automatically monitors the battery voltage and load level and switches off the output at the predetermined battery shutdown voltage set point.

2.2.5 Display and Controls

General

The UPS shall include an intuitive LCD display capable of communicating UPS status and operating conditions. Typical UPS performance metrics shall be visible on the screen and include but not limited to Load, Battery Capacity, Event Notification and Local Alarms. The local HMI shall be capable of basic configuration settings by the user.

System Indicators

A row of Load Level indicators that display the approximate electrical load placed upon the UPS. A row of Battery Level indicators shall display the approximate battery capacity.

ON / MUTE

This button controls output power to connected load(s) and has three functions:

- ON - When the UPS is off, pressing the ON/MUTE/Battery Test button for more than 3 seconds will start the UPS, and an audible alarm sounds briefly will continue until user releases ON button. The UPS is capable of starting on battery.
- Alarm Silence – Audible alarms via an internal beeper will be used in conjunction with the visual indicators to indicate to the operator a change in UPS operation status. Once the audible alarm is silenced, the audible alarm will not sound, unless a new alarm condition is present. The audible alarm level will be a minimum of 60dBA at a distance of one-meter (3ft).

NOTE: Only ON Battery Alarm can be silenced. Other alarms, warnings, and faults cannot be silenced.

- Manual Self Diagnostic Battery Test - To initiate a manual battery test, press the ON/MUTE button for 3 seconds or more while operating from utility power with no alarm conditions present. The UPS is also provided with an automatic and remote self-diagnostic test feature. The tests ensure the capability of the battery and will detect any internal UPS failures. If the battery/UPS fails the test, the UPS will display a warning to indicate the batteries need replaced.

OFF/ENTER Button

When the UPS is on (in either Normal or Battery mode), pressing the OFF button for more than one (1) second will shut down the UPS. An audible alarm sounds briefly.

2.2.6 Internal Battery

Lithium-ion (LiFePO₄) battery cells are used as a stored-energy source for the specified UPS system. The batteries are as per specified in LiFe-485000 and LiFe-722500. The battery cells are housed internal to the UPS cabinet and sized to support the inverter at rated load and power factor, with ambient temperature of 77 °F (25 °C) for a minimum of 7.1 minutes reserve time. The expected life of the battery is 5 - 10 years.

2.2.7 Output Distribution

Output distribution is integral to the UPS and is located on the rear of the unit.

2U Rack/Tower Units	Output Receptacles
PSI5-1500RT120LI	(6) NEMA 5-15R
PSI5-2200RT120LI	(6) NEMA 5-15/20R (1) NEMA L5-20R
PSI5-3000RT120LI	(6) NEMA 5-15/20R (1) NEMA L5-30R
PSI5-1500MT120LI	(6) NEMA 5-15R

2.2.8 Communications

Any Mode Shutdown – EPO Connector

EPO shall be capable of flexible configuration for NO or NC operation via user settings. With EPO active; the UPS output is shut off regardless of what mode the UPS is operating in. The UPS cannot be started if the signals are active. When the signal is removed, the UPS output can be enabled by pressing the ON/MUTE button.

USB Interface Port

The UPS will have (1) USB Interface Port. The USB connector a standard 4 pin Type B. The USB interface port will always be active. The UPS will communicate system status and system shutdown via the USB. Hardware will support and allow operating system communication for Windows 98 and newer. USB port will communicate via the USBHID standard protocol.

Data Line Protection Connectors

Data line (in and out) RJ-45/RJ-11 connectors are on the rear of the UPS and provide transient voltage surge suppression (TVSS) for Phone/Fax/DSL/Internet/Modem devices. These ports are not included on 1U Rack Mount Models

UPS Intelligent Communications

- The UPS shall be equipped with the ability to provide advanced communication and monitoring options such as SNMP or other protocol.
- The UPS shall be able to monitor environmental sensors such as temperature, humidity and leak detection with optional equipment.