Vertiv™ Liebert® APM2 UL Modular UPS

GUIDE SPECIFICATIONS
10 kVA to 60 kVA 208 V
20 kVA to 120 kVA 480 V

1.0 GENERAL

1.1 Summary

The specifications mentioned in this document describe the requirements for a Modular, Scalable, & Digital Uninterruptible Power Supply (UPS) optimized for maximum efficiency. UPS architecture consists of one or more single power module units connected in parallel inside a standard frame. The UPS shall automatically maintain AC power within specified tolerances to the critical load, without interruption (for specified duration as per battery run time), during failure or deterioration of the mains power supply. The UPS system shall be expandable by inserting additional modules of the same rating, to provide for module redundancy or load growth requirements. The manufacturer shall design and furnish all materials and equipment to be fully compatible with electrical, environmental and space conditions at the site. The UPS includes all equipment to properly interface the AC power source to the intended load and will be designed for unattended operation.

1.2 Standards

The modular UPS system along with the associated equipment and components will be manufactured in accordance with the following applicable standards:

General safety requirements for UPS	UL 1778 and CSA C22.2 NO.107.3, Fifth Edition
EMC requirements for UPS	FCC PART 15 ANSI C62.41
Method of specifying the performance and test requirements of UPS	VFI-SS-111
Environmental aspects, requirements, and reporting	GB/T2423-IEC 60068
Operating modes	VFI, VI, VFD (ECO) IEC 62040-3 Section 5.3.4
Surge protection	ANSI C62.41 B3 including C62.41.1, and C62.41.2 Category B
Electronic device regulations	FCC Rules and Regulations, Part 15, Subclass B, Class A. The UPS shall have a label stating FCC compliance
Wiring practices and materials	The UPS shall be compatible with the wiring practices, materials, and coding in accordance with the requirements of the National Electrical. Code, OSHA, and applicable local codes and standards
Energy star	The UPS shall comply with Energy Star 2.0 requirements for Uninterruptable Power Suppliers (UPSs)
Seismic rating requirements	IBC 2021 Sds=1.33, Ip=1.5, and z/h=1 IBC 2021 Sds=1.61, Ip=1.5, and z/h=0 Optional seismic brackets shall be available from the UPS manufacturer for use in compliance with this certification

The Quality System for the engineering and manufacturing facility certificated to conform to Quality System Standard ISO 9001 for the design and manufacture of power protection systems for computers and other sensitive electronics.

1.3 System Description

1.3.1 Design Requirements

- For non-redundant operation (applicable, not applicable), the complete integrated UPS system shall be sized to provide a maximum of ___ kVA/kW quality power output at ≥104 °F (40 °C) at automatic derating N.
- For redundant operation (applicable, not applicable), the complete integrated UPS system shall be sized to provide a maximum of ___ kVA/kW quality power output at ≥104 °F (40 °C) at full performance and ≥104 °F to 122 °F (40 °C to 50 °C) with automatic derating N±1.
- Models available in one single frame for compatible voltage and ratings:

Product	Power Scalability	Optional
10 kVA to 60 kVA, 208 V/220 V	10, 15, 20, 25, 30, 40, 45, 50, 60	N +1 Power Module
20 kVA to 120 kVA, 480 V	20, 30, 40, 50, 60, 80, 90, 100, 120	N +1 Power Module

- 208V and 480V frame configurations provide capability up to 60kVA 208v or 120kVA 480V both including N+1 Power Module redundancy (optional).
- Load voltage and bypass line voltage shall be 208 VAC and 480 VAC, 3-phase, 3-wire/4-wire plus ground.
- Input voltage shall be 208 VAC, 3-phase, 4-wire plus ground.
- Input voltage shall be 480 VAC, 3-phase, 4-wire/3-wire plus ground.
- The AC input source and bypass input source shall each be a solidly grounded wye service.
- It will be able to supply all required power to full rated output kVA loads with power factor from 0.5 lagging to 0.5 leading without any deration.
- The battery will support the UPS a capacity of ___ kW load for at least ___ minutes at 77 °F (25 °C) at startup.

1.3.2 Modes of Operation

The UPS shall operate as an on-line reverse transfer/double conversion system in the following modes:

1. Normal

The UPS inverter continuously supplies the critical AC load. The rectifier draws power from the commercial AC source and converts it into DC power for the inverter and the battery charger. The battery charger maintains the battery in a fully charged and optimum operational condition. The inverter converts the DC power into clean and regulated AC power which is supplied to the critical load (conditioned line).

2. ECO Mode

The critical AC load shall be continuously powered by the bypass with the inverter available to power the load if the bypass source voltage or frequency exceeds adjustable parameters of power quality. This feature shall also be available in parallel operation.

3. Dynamic Online Mode

If this mode is selected, all power switches (configured internally or externally) and the battery switches are closed except for the maintenance bypass switch, and the system prefers to put the load on the bypass, to achieve the aim of energy-saving. When the load power is fed by bypass supply, the inverter is in the mode of power quality compensation for the bypass voltage. When the voltage of the bypass supply is beyond the pre-defined and adjustable limits, the system will transfer to the inverter output. In this mode, the system can normally charge the battery. This feature shall also be available in parallel operation.

4. Intelligent Paralleling Mode

Allows the system to automatically adapt capacity to meet immediate load requirements by measuring the system output current and the real power needed by the load downstream, in order to switch excess units to standby mode sleep mode, while ensuring continuous system availability. When units are running in an idle state, they are not completely switched off but they still have the inverter control active and synchronized, as well as the DC bus charged in order to be ready to start up in case of load increase. The activation time of idle units is less than 5 milliseconds and during this quick transitory phase/step, the remaining active units will continue to supply the load without any interruption supporting a temporary overload condition. Intelligent Paralleling mode allows each UPS unit to operate in standby (parallel configurations) for the same amount of time, ensuring an equal lifespan of module components.

5. Battery

Upon failure of utility AC power, the critical load shall be powered by the inverter, which, without any switching, shall obtain its power from the battery plant through the DC-DC converter. There shall be no interruption in power to the critical load upon failure or restoration of the utility AC source.

6. Recharge

Upon restoration of the utility AC source, the rectifier shall supply power to the output inverter and to the DC-DC converter, which shall simultaneously recharge the batteries. This shall be an automatic function and shall cause no interruption to the critical load.

7. Bypass

If the UPS must be taken out of service, the static transfer switch shall transfer the load to the bypass source. The transfer process shall cause no interruption in power to the critical load. An optional external wrap-around maintenance bypass shall be used to ensure full isolation of the unit for the service of internal components while providing safety from arc flash.

8. Off-Battery

If the battery is taken out of service, it shall be disconnected from the DC-DC converter by means of an external disconnect circuit breaker. The UPS shall continue to function and meet all the specified steady-state performance criteria, except for the power outage backup time capability. If multiple battery strings are used, each string shall be capable of being electrically isolated for safety during maintenance.

9. Peak Shaving

The UPS should be capable of powering the load by supplying part of the energy from the battery and part of the energy from the rectifier.

10. 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 voltage (EOD). 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.

11. Paralleling Operation

The UPS shall have the vertical and horizontal scalability option for redundancy or capacity expansion.

1. **Vertical Scalability:** UPS shall be capable to accommodate additional power modules within the same rack (limited to its maximum frame capacity) online without dropping the connected load. It shall be designed based on discrete control logic platform i.e. each power and static switch module shall have its own intelligent DSP controller to avoid single point of failure.

2. **Horizontal Scalability:** UPS shall have option to connect the four UPSs in parallel configuration for redundancy or capacity expansion. Under normal operating conditions, the power delivered to the load will be equally shared between number of UPS power modules connected to the parallel bus with a tolerance of 5%. In the event of an overload, the system will transfer to the bypass source.

12. Online Maintenance

If the UPS needs to be maintained or repaired, all UPS power modules and static switch module bypass module in the system should be replaceable online hot swappable without shutting the system down. Additionally, the UPS should also be equipped with maintenance bypass for full system maintenance.

13. Common Battery

UPS shall be capable to support common battery configuration when multiple UPSs are connected in parallel. In this mode, each UPS can use the same battery to feed the required load.

14. Regen Mode

The UPS rack system shall have the ability to perform self-test for full rated capacity without using any external load banks. In this mode, UPS rectifier, inverter, and static bypass shall be tested up to full load capacity without any failure. Power consumption in this mode shall only be full load losses of UPS. This mode shall also be available in parallel UPS configuration.

1.3.3 Performance Requirements

The solid-state power components, magnetics, electronic devices, and overcurrent protection devices shall operate within the manufacturer's recommended temperature when the UPS is operating at 100% critical load and maintain battery charging under either of the following conditions:

- Any altitude within the specified operating range ≤9843 ft. (3000 m).
- Any ambient temperature within the specified operating range of 32 °F to 122 °F (0 °C to 50 °C).

1.3.4 Input

1. **Voltage:** Input voltage specifications of the UPS shall be,
   - Rectifier AC Input:
     - 208/220 V, 4-wire (3-phase + N +PE).
     - 480 V, 4-wire (3-phase + N +PE).
     - 480 V, 3-wire (3-phase +PE).
   - Bypass AC Input:
     - 208/220 V, 4-wire (3-phase + N +PE).
     - 480 V, 4-wire (3-phase + N +PE).
     - 480 V, 3-wire (3-phase +PE).

2. **Voltage Range:**

- For 480V, operation line voltage 288 V to 528 V.

  Line voltage 408 V to 528 V at 100% load, 288 V to 408 V with linear derating.

- For 208V/220V, operation line voltage 125~249V (L-N 72 V to 144 V).

  Line voltage 177 V to 249 V (102 V to 144 V) at 100% load, 125 V to 177 V(72 V to 102 V) with linear derating.

3. **Frequency Range:** 40 Hz to 70 Hz.
4. **Maximum Inrush Current:** UPS inrush current not to exceed 1.5 times rated input current.
5. **Power Factor:**

   For all voltage grade Modules:
   Input power factor will be ≥0.99 for being <50% load.
   Input power factor will be ≥0.98 for being <25% load.

   Input power factor will be ≥0.98 for being >50% load for 480 frames inserted only one power module,

   Input power factor will be ≥0.96 for being >25% load for 480 frames inserted only one power module.

   And input inactive power will <15% rated power.

6. **Total Current Harmonic Distortion:** The total harmonic distortion of input current introduced by the rectifier will be less than or equal to 10% for 25% linear load, 3% for 100% linear load and 5% for 100% nonlinear load.
7. **Power Walk-in Period:** Need to support power walk-in function. All the power modules start at same time, 0% to 100% of full rated load over 1 to 30 seconds (default 5 seconds) per module.
8. **Surge Protection:** Withstands input surges of 4 kV (line to ground) without damage as per criteria listed in EN 61000-4-5:1995.
9. **Short Circuit Current Rating:** Units shall carry as standard 65 kA Short Circuit Withstand Rating. All ratings shall be certified, and a label shall be applied to the unit clearly identifying this rating as required by the National Electrical Code.

1.3.5 AC Output

1. **AC Output Voltage:**
   - 208/220 V, 4-wire (3-phase + N +PE).
   - 480 V, 4-wire (3-phase + N +PE).
   - 480 V, 3-wire (3-phase +PE).
2. **Load Rating:** 100% of load rating for any load from 0.5 lagging to 0.7 leading.
3. **Inverter Voltage Distortion:** The inverter output is a sinusoidal waveform with a total harmonic distortion of 1% for 100% linear loads of all voltage grade, 3% for 100% nonlinear loads of 480 V, 5% for 100% nonlinear loads of 208 V/ 220 V.
4. **Voltage Stability:**

- ±1% RMS average for a 100% balanced 3-phase load.
- ±3% RMS average for a 100% unbalanced load.

5. **Voltage Adjustment Range:** ±5% for line drop compensation adjustable by factory service personnel.
6. **Voltage Distortion:** 1% total harmonic distortion (THDv) maximum into a 100% linear load, 3% THDv maximum into a 100% non-linear load with crest factor ratio of 3:1.
7. **Bypass Frequency Synchronization Range:** ±0.5, 1.0, 2.0, 3.0 Hz, adjustable by factory service personnel, ±2.0 Hz default setting.
8. **Frequency Slew Rate:** Single module system 0.1 Hz/sec to 3 Hz/sec, 0.6 Hz/sec default setting, parallel system 0.6 Hz/sec.
9. **Frequency Stability:** The inverter frequency regulation will be ±0.1% of rated frequency.
10. **System Efficiency:** Defined as output kW/input kW at rated lagging load power factor; and not less than the values listed below.
    - **In Double Conversion Mode:** For 480 V, up to 97 ±0.2% for 30 kVA/2 U frames. For 208 V, up to 95 ±0.2% for 30 kVA/3 U frames.
    - **In Dynamic Online Mode:** For 480 V, up to 98±0.1%. For 208 V, up to 97±0.1%.
    - **In Eco Mode:** For 400 V/480 V, up to 99±0.1%. For 208 V, up to 98.4±0.1%.

kVA Rating 208 V/220 V	Maximum Efficiency Double Conversion (%)	kVA Rating 480V	Maximum Efficiency Double Conversion (%)
10	94.7	20	96.7
15	94.6	30	96.8
20	95	40	96.8
25	95	50	96.8
30	95	60	96.8
40	95	80	96.9
45	95.1	90	96.9
50	95.1	100	96.9
60	95	120	96.9

11. **Phase Imbalance:**
    - **Balanced Loads:** 120° ±1°.
    - **100% Unbalanced Loads:** 120° ±1.5°.
12. **Voltage Transients (Average of All Three Phases):**
    - 0 to 100% or 100% to 0%.

      Response Meets IEC 62040-3:2010.

      Figure 2 Curve 1, Class 1 Meets ITIC and CBEMA Curve Requirements Output voltage recovery to ±2% tolerance band is within 20mS per IEC62040-3.

13. Inverter Output Overload at Full Output Voltage:

Table 1.1 Inverter Overload Duration

Load	Duration Inverter will Support Rated Load
≤105%	Continuous
105% to 125%	10 minutes
125% to 150%	60 seconds
150% to 200%	Minimum 200 milliseconds

14. Bypass Output Overload at Full Output Voltage:

Table 1.2 Bypass Overload Duration

Load	Duration bypass will Support Rated Load
≤110%	Continuous
110% to 125%	10 minutes
125% to 150%	60 seconds
>150% (impact load)	200 milliseconds
1000%	10 milliseconds

The bypass circuit is protected by the bypass input circuit breaker. The breaker curves will be provided to assist in determining the maximum load and duration. Bypass will close when bypass overcurrent timeout.

1.3.6 Grounding

The UPS chassis shall have an equipment ground terminal.

1.3.7 Battery Management

1. Battery Autonomy Time Remaining

The UPS will predict the battery autonomy time remaining based on the percentage charge on the battery prior to discharge, the end cell voltage, and the loading on the system. There will be an approximate indication on battery autonomy time remaining through LCD and SNMP communications.

2. Temperature-Compensated Charging

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.

3. **Battery Load Testing**

The UPS shall be capable of performing battery load testing under operator supervision. The UPS shall be capable of testing the battery without risk of disrupting power to the critical load. The UPS shall display and log the result of the test with appropriate alarms if reduced battery capacity or battery failure is detected.

1.4 Environmental Conditions

The UPS shall be able to withstand the following environmental conditions without damage or degradation of operating characteristics:

1. **Operating Ambient Temperature**
   - **UPS:** 32 °F to 104 °F (0 °C to 40 °C) full performance, 104 °F to 122 °F (40 °C to 50 °C) with automatic derating. 104 °F to 113 °F (40 °C to 45 °C) derating 0.9, 113 °F to 122 °F (45°C to 50 °C) derating 0.8.
   - **Battery Temperature Compensation:** -3.0 (selectable from 5.0 to -5.0 around 25°C).
2. **Storage/Transport Ambient Temperature**
   - **Storage without Battery:** -40 °F to 158 °F (-40 °C to 70 °C).
   - **Storage with Battery:** 5 °F to 86 °F (-15 °C to 30 °C).
3. **Relative Humidity**
   - 0 to 95%, non-condensing.
4. **Altitude**
   - ≤3000 m, derate power by 1% per 100 m between 1500 m and 3000 m.
5. **Audible Noise Level at 100% Load**
   - <65±2 dBA measured 1 m from the surface of the unit.

1.5 Warranty

1.5.1 UPS Warranty

The UPS manufacturer shall warrant the unit against defects in workmanship and materials for eighteen months after the shipping date. Product shipment date is determined only from the bill of lading (refer document **SL-71249_ Limited Warranty_3-Phase AC Power Product**).

1.5.2 Warranty—End User

Warranties associated with items not manufactured by the UPS supplier but included as part of the system shall be passed through to the end user.

1.6 Quality Assurance

1.6.1 Manufacturer's Qualifications

The manufacturer shall have a minimum of 30 years of experience in the design, manufacture and testing of solid-state UPS systems. The quality system for the engineering and manufacturing facility shall be certified to conform to Quality System Standard ISO 9001 for the design and manufacture of power protection systems for computers and other sensitive electronics.

1.6.2 Factory Testing

- Before shipment, the manufacturer shall fully and completely test the UPS unit to ensure compliance with the specification.
- The UPS unit shall be tested at the system-specified capacity. Testing shall be done using load banks at part-load and the full kW rating of the unit.
- Operational discharge and recharge tests shall be conducted to ensure performance.
- System operations such as startup, shutdown, and transfers shall be demonstrated.
- A certified copy of the test results shall be available for each system as indicated on the order.

1.7 Submittals

1.7.1 Proposal Submittals

Submittals with the proposal shall include:

- Descriptions of equipment to be furnished, including deviations from these specifications.
- Document stating compliance with FCC requirements.
- Document stating listing to UL, including edition used for listing.
- Document showing compliance with required SCCR and labeling.
- System configuration with single-line diagrams.
- Detailed layouts of customer power and control connections.
- Functional relationship of equipment, including weights, dimensions, and heat dissipation.
- Information to allow distribution system coordination.
- Size and weight of shipping units to be handled by contractor.

1.7.2 Order Submittals

Submittals supplied at time of order shall include:

- All the documentation presented with the proposal.
- Detailed installation drawings including all terminal locations.
- Interconnect wiring diagrams showing conduit wiring with terminal numbers for each wire.

1.7.3 UPS Delivery Submittals

Submittals upon UPS delivery shall include:

- A complete set of submittal drawings.
- One set of instruction manuals. Manuals shall include a functional description of the equipment, safety precautions, instructions, step-by-step operating procedures, and routine maintenance guidelines, including illustrations.

2.0 PRODUCT

2.1 Fabrication

2.1.1 Materials

All materials of the UPS shall be new, of current manufacture, high grade, and shall not have been in prior service except as required during factory testing. All active electronic devices shall be solid-state. All power semiconductors shall be sealed. Control logic and fuses shall be physically isolated from power train components to ensure operational safety and to protect from heat. Minimum estimated life of the major components used in the UPS (includes fan and bus capacitors) shall not be less than 7 years.

2.1.2 UPS Internal Wiring

Wiring practices, materials, and coding shall be in accordance with the requirements of the National Electrical Code and applicable local codes and standards. All bolted connections of bus bars, lugs, and cables shall be in accordance with requirements of the National Electric Code and other applicable standards. All electrical power connections shall be torqued to the required value and marked with a visual indicator.

2.1.3 Field Wiring

All field wiring power connections shall be to tin-plated copper bus bars for connection integrity. Bus bars shall have adequate space to allow two-hole, long-barrel, and compression type lugs forming a permanent connection between field wiring and field- installed lugs.

Provisions shall be made in the cabinets to permit installation of input, output and external control cabling using raceway or conduit. Provision shall be made for top and bottom access to input, output, bypass, and DC connections as per the technical specifications. In conformance with the NEC, connection cabinets shall provide for adequate wire bend radius.

2.1.4 Construction and Mounting

The UPS shall be housed in an NEMA Type 1 (IEC 60529, IP20) enclosure, designed for floor mounting. The UPS shall be structurally adequate and have provisions for forklift handling. Maximum cabinet height shall be 78.7 in. (2000 mm) for all UPS range.

2.1.5 Cooling

Forced air cooling shall be provided to ensure that all components are operated well within temperature ratings. Airflow shall be controlled according to load demand. If one of the cooling fans experiences a fault, the UPS shall be immediately notified of the condition through the user interface and through remote monitoring services.

2.2 Equipment

2.2.1 UPS System

The UPS system shall consist of an IGBT power factor-corrected rectifier, DC-DC converter and 3-phase, transformer-free I-type inverter, bypass static transfer switch, bypass synchronizing circuitry, protective devices, and accessories as specified. The specified system shall also include a battery disconnect breaker and battery system.

2.2.2 Surge Protection

The UPS shall have built-in protection against surges, sags, and overcurrent from the AC source. The protection shall meet the requirements of conducted radiation emission of FCC PART 15, ANSI C62.41.1 B3 including C62.41.1 and C62.41.2 and lightning protection requirements of YD/T944 and YD/T1095.

2.2.3 Output Protection

The UPS shall be protected against sudden changes in output load and short circuits at the output terminals. The UPS shall have built-in protection against permanent damage to itself and the connected load for all predictable types of malfunctions. Fast-acting, current-limiting devices shall be used to protect against cascading failure of solid-state devices. Internal UPS malfunctions shall cause the module to trip off-line with minimum damage to the module and provide maximum information to maintenance personnel regarding the reason for tripping off-line. The load shall be automatically transferred to the bypass line uninterrupted for an internal power modules malfunction. The status of protective devices shall be indicated on a graphic display screen on the front of the unit.

2.3 Components

2.3.1 Rectifier

The term rectifier shall denote the solid-state equipment and controls necessary to convert alternating current to regulated direct current to supply the inverter and charge the battery. The DC output of the rectifier shall meet the input requirements of the inverter without the battery being connected.

1. Input Current Harmonic Distortion

The rectifier shall actively control and reduce input current distortion over the full operating range of the UPS without the need for an additional passive input filter. Input current THDi shall be less than 3% at rated linear loads and nominal voltage in double-conversion mode.

2. Dynamic Current Input Limit Reduction

The rectifier, in conjunction with the other UPS controls and circuitry, shall adjust the current demanded for battery charging as a function of UPS wattage load and input voltage level.

2.3.2 DC-DC Converter

The term DC-DC converter shall denote the equipment and controls to regulate the output of the rectifier to the levels appropriate for charging the battery and to boost the battery voltage to the level required to operate the inverter. The DC-DC converter shall be solid-state, capable of providing rated output power and, for increased performance, shall be a pulse width- modulated design and shall utilize insulated gate bipolar transistors (IGBTs). The DC-DC converter shall control charging of the battery. The AC ripple voltage of the charger DC shall not exceed 1.4% RMS of battery voltage.

1. Battery Recharge

The rectifier/charger shall be capable of supplying an additional 15% power for recharging a fully discharged DC stored energy source for charging current with UPS at full load and input voltage at nominal. After the stored energy source is recharged, the rectifier/charger shall maintain the source at full charge until the next emergency operation.

2. Battery Equalize Charge

A manually initiated equalize charge feature shall be provided to apply an equalize voltage to the battery. The duration of equalize charge time shall be adjustable from 8 to 100 hours. A method shall be available to deactivate this feature for valve regulated battery systems.

3. Stop Battery Charging Function

Battery charging may be stopped by a shunt trip of the battery cabinet breaker when over temperature is sensed in the battery cabinet, on generator or when environmental contact is closed.

4. Overvoltage Protection

There shall be DC overvoltage protection so that if the DC voltage rises to the pre-set limit, the UPS shall shut down automatically and initiate an uninterrupted load transfer to bypass or shall disconnect the battery through the DC breakers in the battery string.

5. Temperature-Compensated Charging

The UPS shall adjust the battery charging voltage based on the battery temperature reported from external battery temperature sensors. When multiple sensors are used, the voltage shall be based on the average temperature measured. Excessive difference in the temperature measurements shall be reported and the charging voltage adjusted to protect the batteries from excessive current.

6. Battery Load Testing

The UPS shall be capable of performing battery load testing under operator supervision. The UPS shall be capable of testing the battery without risk of disrupting power to the critical load. The UPS shall display and log the result of the test with appropriate alarms if reduced battery capacity or battery failure is detected.

2.3.3 Inverter

The term inverter shall denote the equipment and controls to convert direct current from the rectifier or battery through the DC-DC converter to precise alternating current to power the load. The inverter shall be solid-state, capable of providing rated output power and, for increased performance, the inverter shall be a pulse-width-modulated design and shall utilize insulated gate bipolar transistors (IGBTs).

1. Overload Capability

The inverter shall be able to sustain an overload across its output terminals while supplying full rated voltage of up to 150% for 60 seconds. The inverter shall be capable of at least 250% current for short-circuit conditions including phase-to-phase, phase-to-ground, and 3-phase faults. After the fault is removed, the UPS shall return to normal operation without damage. If the short circuit is sustained, the load shall be transferred to the bypass source and the inverter shall disconnect automatically from the critical load bus.

2. Output Frequency

The inverter shall track the bypass continuously, providing the bypass source maintains a frequency of Nominal ±10%.

3. Phase-to-Phase Balance

The inverter shall provide a phase-to-phase voltage displacement of no worse than ±1.5 degrees with a 100% unbalanced load.

4. Inverter Fault Sensing and Isolation

The UPS shall be provided with a means to detect a malfunctioning inverter and isolate it from the critical load bus to prevent disturbance of the critical load voltage beyond the specified limits.

5. Battery Protection

The inverter shall be provided with monitoring and control circuits to protect the battery system from damage due to excessive discharge. Inverter shutdown shall be initiated when the battery voltage has reached the end of discharge voltage. The battery end-of-discharge voltage shall be calculated and automatically adjusted for partial load conditions to allow extended operation without damaging the battery. Automatic shutdown based on discharge time shall not be acceptable.

2.3.4 Inverter Bypass Operation

When maintenance is required or when the inverter cannot maintain voltage to the load due to sustained overload or malfunction, a bypass circuit shall be provided to isolate the inverter output from the load and provide a path for power directly from an alternate AC (bypass) source. The UPS control system shall constantly monitor the availability of the inverter bypass circuit to perform a transfer. The inverter bypass circuit shall consist of a continuous duty bypass static switch and an overcurrent protection device to isolate the static bypass switch from the bypass utility source. The bypass static switch shall denote the solid-state device incorporating silicon-controlled rectifiers (SCRs) that can automatically and instantaneously connect the alternate AC source to the load.

1. Static Bypass Switch Rating

The static bypass switch shall be rated for continuous duty operation at full rated load for highest reliability without the use of mechanical devices as used with a momentary rated device.

2. Manual Load Transfers

A manual load transfer between the inverter output and the alternate AC source shall be initiated from the control panel. Manually initiated transfers shall be make-before-break, utilizing the inverter, and the bypass static switch.

3. Automatic Load Transfers

An automatic load transfer between the inverter output and the alternate AC source shall be initiated if an overload condition is sustained for a period more than the inverter output capability or due to a malfunction that would affect the output voltage. Transfers caused by overloads shall initiate an automatic retransfer of the load to the inverter only after the load has returned to a level within the rating of the inverter source and the alarm has been acknowledged.

4. Momentary Overloads

In the event of a load current inrush or branch load circuit fault more than the inverter rating, the bypass static switch shall connect the alternate AC source to the load for at least 100 milliseconds, allowing up to greater than 400% of the normal rated output current to flow. Output voltage shall be sustained to the extent the alternate AC source capacity permits. If the overload condition is removed before the end of the 100 milliseconds period, the bypass static switch shall turn Off and the load shall remain on inverter power. If the overload remains, then a transfer to the alternate AC source is to be completed.

5. Back-Feed Protection

As required by UL1778 and CSA, the static transfer switch shall not back-feed UPS power to the bypass distribution system while the UPS is operating on battery during a bypass power outage. The purpose of this requirement is to prevent the risk of electrical shock on the distribution system when the normal source of power is disconnected or has failed. If a shorted SCR is detected, the static transfer switch shall be isolated by an external contactor-based circuit breaker and an alarm message shall be annunciate at the UPS control panel. The load shall remain on conditioned and protected power after detection of a shorted SCR and isolation of the bypass static switch.

6. ECO-Mode

When selected, this mode of operation shall transfer the load to the bypass source and maintain it there if the bypass source frequency, slew rate, and voltage are within the adjusted operating parameters. While in this mode, the inverter shall remain operating to demonstrate the ability to instantaneously assume the load without interrupting the output voltage. Should the bypass source go outside the adjusted limits, the bypass static switch shall turn Off, isolating the load from the bypass while the inverter assumes the full critical load. The load shall be transferred from the bypass source to the inverter while maintaining the output voltage within the ITIC and CBEMA curves. There is provision to activate this function through touch screen display.

2.3.5 Dynamic Online Mode

This functioning mode allows significant energy savings by operating with a typical efficiency above 98.9 ±0.2% while providing power conditioning to the load.

1. Normal (VI)

The operating mode will depend on the quality of the mains supply in the short-term past and on the electrical characteristic of the load. If the line quality remains within permitted tolerance parameters and the load needs power conditioning, (THDi, THDv, PF) the power interface will provide continuous supply to the critical AC load while the inverter operates as series and parallel active filter. The IGBT inverter will be able to compensate the power factor of the load and the current harmonic distortion guaranteeing optimum power conditioning to the load while maintaining the highest level of efficiency.

2. Fast Transfer to VFI

Emergency (due to mains supply failure or variance beyond tolerance limits) if the bypass mains supply varies beyond tolerance levels (adjustable using the software) that cannot be compensated through the active filter, the load will be transferred from the direct line to the conditioned line, with Class 1 output performance. The load is powered from the mains through the rectifier and inverter, (provided the input mains remains within the tolerances stated in technical specifications). If the input mains fall below the lowest limit, the batteries will be used to power the load through the inverter.

3. Return to VI

When the mains supply returns within tolerance limits, the UPS will continue to supply the load through the conditioned line for a period dependent on the direct line failure rate (the conditioned line draws power from the mains not the battery). When the direct line has stabilized, the UPS returns to normal VI operation. The battery charger automatically begins to recharge the battery so that maximum autonomy is guaranteed in the shortest possible time.

2.3.6 Display and Controls

1. UPS Control Panel

Each UPS module shall be equipped with a 9 in. (229 mm) touch screen, graphical LCD display. That will automatically provide all information relating to the status of current of the UPS as well as display metered values. The display shall be menu-driven, permitting the user to easily navigate through operator screens. The flexibility shall also be provided to change the display arrangement and information displayed as per the user requirement.

2. Logic

UPS system logic and control programming shall reside in a microprocessor-based control system with non-volatile flash memory. Rectifier, inverter, and system control logic shall utilize high-speed digital signal processors (DSPs). CAN bus shall be used to communicate between the logic and the User Interface as well as the options. Switches, contacts, and relays shall be used only to signal the logic system as to the status of mechanical devices or to signal user control inputs. Customer external signals shall be isolated from the UPS logic by relays or optical isolation.

3. Metered Values

A microprocessor shall control the display and memory functions of the monitoring system. All three phases of 3-phase parameters shall be displayed simultaneously. All voltage and current parameters shall be monitored using true RMS measurements for accuracy to ±2% of AC voltage, ±5% AC current, ±0.1% AC frequency, ±5% battery voltage, and ±5% battery current.

The following parameters shall be displayed:

- Input voltage, line-to-line.
- Input current per phase.
- Input frequency.
- Input power factor.
- Battery voltage.
- Battery charging/discharging current.
- Output voltage, line-to-line.
- Output frequency.
- Bypass input voltage, line-to-line.
- Bypass input frequency.
- Load current.
- Load real power (kW), total and percentage.
- Load apparent power (kVA), total, and percentage.
- Load percentage of capacity.
- Battery temperature, each battery string.
- Battery state of charge.
- Real time efficiency curve
- Crest Factor

4. Power Flow Indications

A power flow diagram shall graphically depict whether the load is being supplied from the inverter, bypass or battery and shall provide, on the same screen, the status of the following components:

- AC Input Circuit Breaker (optional).
- Battery Circuit Breaker, each breaker connection of complete battery complement, complete disconnection, and partial connection (one or more, but not all breakers open).
- Maintenance Bypass Status.

5. Main Display Screen

The following UPS status messages shall be displayed:

- Rectifier (Off/Soft Start/Main Input On/Battery Input On).
- Input Supply (Normal Mode/Battery Mode/All Off).
- Battery Self-Test (True/False).
- Input Disconnect (Open/Closed).
- EPO (True/False).
- Charger (On/Off).
- Output Disconnect (Open/Closed).
- Maintenance Disconnect (Open/Closed).
- Bypass Disconnect (Open/Closed).
- Inverter (Off/Soft Start/On).
- Bypass (Normal/Unable to Trace/Abnormal).
- Output Supply (All Off/Bypass Mode/Inverter Mode/Output Disable).
- Inverter On (Enable/Disable).

6. HMI Control Buttons

Buttons shall be provided to start and stop the inverter. A pop-up message requesting confirmation shall be displayed whenever a command is initiated that would change the status of the UPS. Other buttons shall be provided to reset faults and silence the alarm buzzer.

7. Event Log

This menu item displays the list of events that have occurred recently while the UPS was in operation. The Event Log stores up to 4096 records, with the oldest events being overwritten first if the log's capacity is reached.

8. Battery Status Indicator

A battery status indicator displays DC alarm conditions, temperature, battery state of charge, the present battery voltage, total discharge time, status of last battery test, and battery time remaining during discharge.

The UPS provides the operator with controls to perform the following functions:

- Configure and manage manual battery test.
- Modify test duration and minimum voltage.
- Start battery test.
- Monitor test status and progression.
- Stop battery test.
- Battery test status.

9. Alarms

The following alarm messages shall be displayed:

- Mains Voltage Abnormal.
- Mains Under voltage.
- Mains Frequency Abnormal.
- Charger Fault.
- Battery Reversed.
- No Battery.
- Parallel Common Fail.
- Bypass Unable to Track.
- Bypass Abnormal.
- Inverter Asynchronous.
- Fan Fault.
- Control Power Fail.
- Unit Overload.
- System Overload.
- Bypass Phase Reversed.
- System overload.
- Transfer Time-Out.
- Load Sharing Fault.
- Bypass Over Current.
- DC Cap Life Pre-warning.
- DC Cap Life Warning.
- Fan Life Pre-warning.
- Fan Life Warning.
- Intelligent Parallel Mode Active.
- Input Neutral Lost.
- Loss of Redundancy.
- Multi Module System Inverter Manual ON

10. Controls

System-level control functions are:

- Start Inverter (and transfer to inverter).
- Stop Inverter (after transferring to bypass).
- Startup Screen.
- Battery Test Set Point Adjustment.
- Configure Manual Battery Test.
- Initiate Manual Battery Test.
- System Settings (Time, Date, Language, LCD Brightness, Password, and Audio Level).
- Alarm Silence Command.
- Fault Reset Command.
- Energy Saving Modes.
- Warning and Critical Thresholds of Load and Battery.

11. Manual Procedures

- **Load Transfers:** HMI buttons (START INVERTER and STOP INVERTER) provides the means for the user to transfer the load to bypass and back on UPS.

12. Self-Diagnostics

- **Event Log File:** The control system shall maintain a log of the event conditions that have occurred during system operation. Each log contains the event name, event time/date stamp, and a set/clear indicator.
- **Fault Waveform Capturing:** Records 3 cycles data of voltage/current of rectifier/inverter/bypass when fault triggers, in 3 cycles of recorded data, 2 cycle of data shall be captured before trigger point, 1 cycle of data shall be captured after fault trigger point.

2.3.7 Remote Monitoring and Integration Capabilities

Vertiv™ LIFE™ Services 24×7 Remote Monitoring Services: The UPS manufacturer shall provide as an optional service, which provides 24x7 continuous monitoring of events and parametric data, event and data analysis reports, and dispatch of factory trained field service personnel. The UPS can initiate periodic and critical event-driven communication with a remote service center to transfer event and parametric data for analysis and action. The remote service centers are staffed with factory-trained service personnel who can receive, analyzing, and interpreting the communicated events and data. In case of any anomalies, the remote service center personnel will dispatch factory-trained field service personnel with necessary tools and accessories to the location of the UPS to fix the problem.

1. **Communication Cards:** The UPS can be equipped with following communication cards including:

- **Optional Vertiv™ Liebert® IntelliSlot™ IS-UNITY-DP Communication card:** This card provides Web access, environmental sensor data, and third-party customer protocols for the UPS and manage a wide range of operating parameters, sending data over ethernet networks through secure HTTPS protocol and alarms and notifications through SNMP traps or Modbus protocol. It is also capable to integrate with any existing building management system.
- **Optional Software:** Provided to support the monitoring of multiple number of UPS systems at single console platform.
- **Relay Card:** Dry contact outputs are provided for Summary Alarm, Bypass Active, Low Battery, and AC Input Failure.

2. **Customer Input Contacts:** The UPS shall have four discrete input contacts available for the input and display of customer-provided alarm points or to initiate a pre-assigned UPS operation. Each input can be signalled by an isolated, external, normally open contact.
   When an assembly is selected as a pre-assigned UPS operation, the following actions should be initiated:

   - **On Generator:** Provides selectable choices to enable or disable battery charging and enable or disable ECO Mode operation while on generator.
   - **Transfer to Bypass:** Manual command to transfer from inverter operation to static bypass operation.
   - **Fast Power Off:** Emergency Module Off (EPO) command to stop UPS operation.
   - **Acknowledge Fault:** Acknowledge a UPS alarm condition and present faults will be reset.
   - **Bypass/Inverter Off:** Emergency Power Off (EPO) command to stop UPS operation.
   - External Maintenance Bypass Breaker (MBB) status (open or closed).

2.3.8 Battery Disconnect Breaker

The battery cabinet shall have a properly rated circuit breaker to isolate it from the UPS. This breaker will be in a separate enclosure or in a matching UPS/battery cabinet. When this breaker is open, there shall be no battery voltage in the UPS enclosure. The UPS will be automatically disconnected from the battery by a shunt trip of the battery cabinet breaker when signalled by other control functions.

2.3.9 UPS Integrated Maintenance Bypass Breakers (Optional)

The UPS system shall incorporate a four breakers maintenance bypass breaker system (RIB, MIB, BIB, and MBB) with mechanical interlock for breaker sequence safe operation providing power isolation to top power section (power input top entry) of UPS. User can safely maintain critical maintenance components including control module, power module, static switch (bypass module), and internal battery modules. Includes mechanical interlock with safety switch for safe operation transfer to bypass mode.

2.3.10 Maintenance Bypass Cabinet (Optional)

The UPS system shall incorporate a matching cabinet to house a wraparound maintenance bypass with the following features:

- 3 or 4 breakers for complete electrical isolation of the UPS with system voltage.
- Optional Kirk Key Interlock interface with solenoid key release unit (SKRU).

2.3.11 Valve-Regulated, Lead Acid Battery VRLA (Optional)

- The UPS system shall be provided with a valve-regulated, lead acid battery plant.
- The battery shall be fully charged per the manufacturer's instructions during startup and shall demonstrate the specified operating time.

External VRLA Traditional Battery Cabinet

- The battery cabinet shall be same height and depth as UPS module and provide capability for mechanical connection to the UPS and include castors for ease of installation.
- The battery cabinet shall consist of sealed, valve-regulated batteries, a circuit breaker for isolating the battery from the UPS and a control interface to the UPS module.
- The circuit breaker shall be sized to allow discharge at the maximum published rating of the battery. The interface to the UPS module shall provide status and thermal data to allow the UPS

to regulate the charging voltage and inhibit the conditions associated with battery thermal runaway. If the temperature measurement in a battery cabinet indicates that thermal runaway is occurring, then the UPS controls shall isolate the cabinet from the charger by tripping the battery breaker in that cabinet while leaving the other battery cabinets connected to allow UPS operation during a loss of power to the rectifier.

- The battery cabinet shall be rated NEMA 1, matching the UPS style and design.
  - **Battery Cabinets Connected Directly to the UPS:** The manufacturer shall provide all power and control parts necessary to connect the UPS to the battery cabinets.
  - **Battery Cabinets Separated from the UPS:** The manufacturer shall provide all power and control parts necessary to interconnect the battery cabinets. The installer shall provide all cabling necessary to interconnect the UPS and the battery cabinets.
- Both overhead and under-floor site installed cabling shall be accommodated. Cable installation shall not require removal of batteries or any other battery cabinet assemblies.
- The battery system shall be sized to support a ___ kW load for ___ minutes. The battery system shall provide 100% initial capacity upon delivery.
- The battery shall be lead-calcium, sealed, valve-regulated type with a minimum three years full warranty and a seven years pro rata warranty under full float operation. The battery design shall utilize absorbent glass mat (AGM) technology to immobilize the electrolyte.

Internal Modular VRLA Battery and Battery Cabinet (optional)

- The 60kVA 208V and 120kVA 480V frame shall feature internal VRLA factory integrated battery modules containing a series of eight 9Ah VRLA batteries connected in series into a hot swappable modular design.
- Each battery string shall provide self-isolation. In the event of a fault, it shall be contained within the string and remaining strings shall be operable to provide capacities available.
- VRLA battery design meet UL 94V2 flame retardant compliance.
- The UPS module shall be configured in series of two modules per string 208V UPS from 2 to 16 total modules and four modules per string 480V from 4 to 16 battery modules.
- Each battery module shall contain individual battery circuit breaker (BCB).
- UPS module shall include central battery management system (BMS) and shall report voltage and temperature to UPS HMI including thermal runaway controls to control module of UPS.
- The matching modular VRLA battery cabinet (600mm) shall match same height, depth, and look and feel of UPS module and be capable for mechanical attachment to UPS module with integrated wiring provided by factory or standalone configuration.
- Modular Battery Cabinet shall contain main battery circuit breaker (BCB), IP 20 rating, and shall house 2 to 32 VRLA battery modules.

UPS Voltage	Module String Count	Nominal Vdc	Battery aH/Vdc	kWH per string
208 V	Two	192	9/12	1.728
480 V	Four	384	9/12	3.456

Internal Modular Lithium Ion Battery (optional)

For more information of Lithium-Ion Battery module refer to **Vertiv Liebert APM2 Lithium Battery Module SL-71173**.

- The 60kVA 208V and 120kVA 480V frame features modular designed ultra-high density internal lithium-ion ternary battery module containing 14 aH 3.326 kwH high rate configured in series of one 237.6 V, capacity 14 Ah per string 208 V UPS configured between one to eight, or two 475.2 V, capacity 14 Ah for 480V UPS per string configured between two to eight. Lithium Module shall comply with UL9540A.
- Internal battery module communications with UPS through CAN communications, ensures real time exchange of operating data, and intelligent protection and monitoring, program upgrade feature is available with UPS HMI over RS-485 communication mode.
- The battery management system (BMS) of APM2 lithium battery module works independently when ups communication is abnormal and protects battery system to provide managed, predictable, and uninterrupted power supply to critical equipment. BMS is designed with redundancy including independent module BMS and control module housed in UPS module.
- Lithium battery module is a redundant design that supports quick online maintenance and can be replaced in less than 5 minutes.

UPS Voltage	Module String Count	Nominal Vdc	Battery aH/Vdc	kWH per string
208V	One	192	14/237.5	3.326
480V	Two	384	14/475.2	6.652

2.3.12 Reliability and Serviceability

Mean time between failure (MTBF)

The calculated mean time between failure for the UPS is expected to meet or exceed 170k hours when operated at an ambient temperature of 77 °F (25 °C) and a 100% resistive load.

Mean time to repair (MTTR)

The UPS will be designed for an approximately 0.5 hours replacement MTTR by the service engineer at the customer site.

Service Access

Front only, all standard configuration serviceable parts shall be from the front of the UPS with door open 90 degrees.

Expected Operational Life Critical Components

- UPS Life 15 to 20 years of life.
- **AC caps:** 20 years of life for 100% load (77 °F (25 °C), humidity: 50%).
- **DC caps:** 15 years of life for 100% load (77 °F (25 °C), humidity: 50%).
- Fans 5 to 7 years of life.
- Battery System History and Life Information, UPS shall maintain for each battery string the install dates, number of discharges, and duration of discharges to determine the life of the battery string and overall battery system.

- Power Module and Battery String Management, The UPS shall maintain the history of each power module and battery string for the life of the UPS. Only the installed modules and existing battery strings are used in the UPS life calculation.
- Power Module History and Life Information, UPS shall maintain the power module install date, number of run hours, and duration of elevated ambient temperatures which reduce the life of the UPS.

2.3.13 Optional Accessories and Features

1. Load Bus Sync

The Load Bus Sync (LBS) enables two independent single-module UPS units to stay in sync when operating on battery or unsynchronized input sources. The LBS determines the master and slave relationship between UPS units. The LBS will be installed within each single-module UPS.

2. Seismic Anchorage Kits

Seismic anchorage kits will be provided with the UPS unit, and if included the optional matching battery cabinet, for use in seismic restraint as required for IBC 2021 or OSHPD certification.

3. DC Ground Fault

The UPS shall provide a method to detect and annunciate battery DC ground faults, in order to facilitate proactive resolution of such ground faults. The UPS can be configured to allow the circuit breaker to open or remain closed upon detection of a ground fault.

3.0 EXECUTION

3.1 Field Quality Control

The following inspections and test procedures shall be performed by factory-trained field service personnel during the UPS startup.

1. **Visual Inspection**

- Inspect equipment for signs of damage.
- Verify installation per drawings supplied with installation manuals or submittal package.
- Inspect cabinets for foreign objects.
- Verify that neutral and ground conductors are properly sized and configured per OEM requirements as noted in OEM drawings supplied with installation manuals or submittal package.
- Inspect each battery jar for proper polarity.
- Verify that all printed circuit boards are configured properly.

2. **Mechanical Inspection**

- Check all control wiring connections for tightness.
- Check all power wiring connections for tightness.
- Check all terminal screws, nuts, and/or spade lugs for tightness.

3. **Electrical Inspection**

- Check all fuses for continuity.
- Confirm input and bypass voltage and phase rotation are correct.
- Verify control transformer connections are correct for voltages being used.
- Verify connection and voltage of the battery strings.

3.2 Unit Startup

- Energize control power.
- Perform control/logic checks and adjust to meet the manufacturer’s specification.
- Verify DC float and equalize voltage levels.
- Verify DC voltage clamp and overvoltage shutdown levels.
- Verify battery discharge, low battery warning, and low battery shutdown levels.
- Verify fuse monitor alarms and system shutdown.
- Verify inverter voltages and regulation circuits.
- Verify inverter/bypass sync circuits and set overlap time.
- Perform manual transfers and returns.
- Simulate utility outage at no load.
- Verify proper recharge.

3.3 Manufacturer's Field Service

1. Service Personnel

The UPS manufacturer shall directly employ a nationwide service organization, consisting of factory-trained field service personnel dedicated to the startup and maintenance of UPS and power equipment.

The manufacturer shall provide a national dispatch center to coordinate field service personnel schedules. One toll-free number shall reach a qualified support person 24 hours/day, 7 days/week, and 365 days/year. If emergency service is required, on-site response time shall be 4 hours or less within 150 miles of a Vertiv Services center.

Two local customer engineers shall be assigned to the site with a regional office as a backup. Escalation procedures shall be in place to notify Power Technical Support if a site is not functioning within 24 hours.

2. Replacement Parts Stocking

Parts shall be available through an extensive network to ensure round-the-clock parts availability throughout the continental United States.

Spare parts shall be stocked by local field service personnel with backup available from regional parts centers and the manufacturing location. A customer support parts coordinator shall be on call 24 hours a day, 7 days a week, 365 days a year for immediate parts availability.

3. Maintenance Contracts

A complete offering of preventive and full-service maintenance contracts for both the UPS system and battery system shall be available.

4.0 UNINTERRUPTIBLE POWER SYSTEM TECHNICAL DATA

	Make			
	Model			
A	General Characteristics			Suppliers Data
1	Continuous duty three phase double conversion uninterruptible power system (UPS), The UPS shall utilize a standard 2U size rack mountable power module and scalable array architecture.			
2	Hot swappable power module should have its own controller and contains a full rated rectifier, full rated inverter, and battery charging circuit.			
3	UPS comprises a user replaceable centralized continuous duty hot swappable bypass static switch module.			
4	Standard configuration of UPS footprint shall not exceed 600×1030×2000 mm for 120 kW 480 V or 60 kVA 208 V.			
5	All the conformal coated PCBs shall be used in the modules.			
6	External battery circuit breaker with necessary shunt tripping shall be provided for external battery banks.			
B	System Characteristics			
	Item	Unit	Specifications	
	Dimensions, W×D×H	mm	For 120 kVA 408 V or 60 kVA 208 V: Full Breaker Assembly - 600×1030×2000 mm	
	Weight	kg	For 120 kVA 408 V or 60 kVA 208 V: Full Breaker Assembly (4 breaker) – 480 kg	
	Noise within 1 m	dBA	For 120 kVA 408 V or 60 kVA 208 V: ≤65	
	Operating temperature	°C	32 °F to 104 °F (0 °C to 40 °C) full performance, 104 °F to 122 °F (40 °C to 50 °C) with automatic derating	
	Relative humidity	%RH	0 to 95%, non-condensing	
	Efficiency at Double conversion mode	%	For 208 V, up to 95±0.2% for 30 kVA/2U frames, 100% load is greater than 94%. For 480 V, up to 97±0.2% for 30 kVA/2U frames, 100% load is greater than 96.3%.	
	Efficiency at Eco mode	%	Up to 99±0.1%	
	Efficiency at dynamic online mode	%	Up to 98.9±0.1%	

	Protection degree, IEC (60529)	N/A	IP20	
C	Input Characteristics			
	Rated AC input voltage	VAC	208/220 V 4-wire (3-phase + N +PE) 480 V 4-wire (3-phase + N +PE) 480 V 3-wire (3-phase +PE) TN/TT/IT/HRG power distribution system)	
	Input voltage tolerance	VAC	For 208 V/220 V, Line 177 V to 249 V (102 V to 144 V) at 100% load, 125 V to 177 V (72 V to 102 V) with linear derating For 480 V, Line 408 V to 528 V at 100% load, 288 V to 408 V with linear derating	
	Frequency	Hz	50/60 (tolerance: 40 to 70)	
	Power factor	kW/kVA	0.99 (50 to 100% Load)	
	Maximum Input current	A rated (maximum)	For 208 V/220 V 60 kVA, 211 A. For 480 V 120 kVA, 178 A.	
	Harmonic current distortion	THDi%	≤3 with linear load at full load operation	
	Power walk-in duration	s	All the power modules start at same time, 0% to 100% of full rated load over 1 to 30 seconds (default 5 seconds) per module	
D	Intermediate DC Circuit			
	Battery bus voltage	Vdc	For 208 V UPS Range: 192 V to 288 V. For 480 V UPS Range: 360 V to 528 V.	
	Total Battery Capacity (as per above backup time)	AH	480V 40 to 50 block of 12V at full load, 38 block derated to 95%, 36 block derated to 90%, 34 block derated to 85%, 32 block derated to 80%, 30 block derated to 75%) 208V 20-24 block of 12V at full load, 18 block derated to 90%, 16 block derated to 80%)	
	Maximum battery charging current	A	140 A	
	Charging Mode		Constant current and constant voltage	
	Float voltage	V/cell (VRLA)	2.27 V/cell (selectable from 2.2 V/cell to 2.3 V/cell)	

	Temperature compensation	mV/°C/cl	-3.0 (selectable from 5.0 to -5.0 around 77 °F (25°C))	
	Ripple voltage	% V float	≤1.414	
	Ripple current	% C10	≤5	
E	UPS Output characteristics			
	Rated AC voltage	Vac	208/220 V 4-wire (3-phase + N +PE) 480 V 4-wire (3-phase + N +PE) 480 V 3-wire (3-phase +PE)	
	Frequency	Hz	60	
	Overload	%	<105% Continuous	
			105% to 110% for 60 min	
			110% to 125% for 10 min	
			125% to 150% for 1 min	
			>150% for 200 ms	
	Non-linear load capability	%	100%	
	Steady state voltage stability	%	±1 (balanced load), ±3 (100% unbalanced load)	
	Transient voltage response	%	±5	
	Total harmonic voltage	%	<1 % (100% linear load), <3% (100% non-linear load)	
	Synchronization window	Hz	Upper limit: 0.5 Hz, 1 Hz, 2 Hz, 3 Hz, +10%, Default: +10%. Lower limit: -0.5 Hz, -1 Hz, -2 Hz, -3 Hz, -10%, Default: -10%	
	Slew rate (max change rate of synchronization frequency)	Hz/s	0.6, setting range: 0.1 to 3	
	Transfer time	ms	Frequency converter mode: transfer without interruption 0ms, transfer with interruption ≤ 5 ms ECO mode: 4 ms, Dynamic online mode: 0 ms	
F	Bypass Input Characteristics			
	Rated AC voltage	VAC	208/220 V 4-wire (3-phase + N +PE) 480 V 4-wire (3-phase + N +PE) 480 V 3-wire (3-phase +PE)	

	Overload	%	≤110% for continuous	
			110% to 125% for 10 min	
			125% to 150% for 1 min	
			>150% for 200 ms 1000% for 10ms	
	Frequency	Hz	60	
	Bypass voltage tolerance	%VAC	Upper limit: +10% VAC, +15% VAC, or +20% VAC Default: +15% VAC	
			Lower limit: -10% VAC, -15% VAC, -30% VAC, or -40% VAC Default: -15% VAC	
	Bypass frequency tolerance	%	±10	
G	Conformity and Standards			
	General and safety requirements for UPS used in operator access areas		UL1778 and CSA C22.2 NO.107.3	
	Electromagnetic compatibility (EMC) requirements for UPS		FCC PART 15 ANSI C62.41	
	Method of specifying the performance and test requirements of UPS		IEC 62040-3 (VFI SS 111)	
	Environmental aspects, requirements and reporting		GB/T2423-IEC 60068	