Liebert® TRINERGY™ CUBE UPS

GUIDE SPECIFICATIONS
For a 400-1600 kVA 480V 60Hz
Single-Module or Multi-Module (Distributed Static Switch)
Uninterruptible Power System

1.0 GENERAL

1.1 SUMMARY

These specifications describe requirements for a continuously rated, solid state, modular, scalable Uninterruptible Power System (UPS) optimized for maximum efficiency and power density. The UPS utilizes a double-conversion, transformer-free topology, whereby the output power supplied is derived directly from the UPS without the need for an internal step-up output transformer. The UPS will be used to operate in conjunction with the existing building supplies and shall provide high quality power distribution for critical loads. All performance values specified shall be for the equipment needed to operate at the same voltage as the electrical system. The UPS, with the exception of the battery system and maintenance bypass, shall be factory-assembled and tested at the specified system voltage and reconnected on site without addition of field-supplied power conductors.

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 shall include all equipment to integrate the AC power source to the intended load and be designed for unattended operation.

1.2 STANDARDS

The UPS and all associated equipment and components shall be manufactured in accordance with the following applicable standards:

- The UPS shall be UL listed per UL Standard 1778, latest edition, Uninterruptible Power Supplies, and shall be CSA certified.
- The UPS shall be provided with a Short Circuit Withstand Rating label denoting the maximum level of short circuit current the UPS can withstand. The withstand rating shall be independently verified by a nationally recognized third-party lab. Self-certification shall not be acceptable.
- The UPS shall withstand input surges to both the rectifier and bypass, when configured as a dual-input unit, without damage per the criteria listed in ANSI/IEEE C62.41, Category B3 (6kV). The manufacturer shall provide evidence of compliance and test data upon request.
- (Optional) The UPS shall comply with FCC Rules and Regulations, Part 15 Subpart B §15.107 Conducted Limits Class A. This compliance is legally required to prevent interference with adjacent equipment. The UPS shall have a label stating FCC compliance. The manufacturer shall provide evidence of compliance upon request.
- 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. Overcurrent devices provided in the UPS shall include trip functions as indicated on the project drawings. Provisions shall be made in the cabinets to permit installation of input, output and external control cabling, using raceway or conduit for top and bottom access to input, output, bypass and DC connections. Connection cabinets shall provide for wiring gutter and wire bend radius as defined by the NEC and UL.
- The UPS shall be seismically certified in accordance with the 2015 International Building Code (IBC), 2016 California Building Code (CBC), and American Society of Civil Engineers (ASCE) Minimum Design Loads, with seismic performance of Sds=1.2, Ip=1.5 and z/h=1.0. Optional seismic brackets shall be available from the UPS manufacturer for use in compliance with this certification.
- The matching VRLA Battery Cabinets shall be certified to the International Building Code (IBC) 2012 with seismic performance of Sds=2.00, Ip=1.5 and z/h=1.0. 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 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.

1.3 SYSTEM DESCRIPTION

1.3.1 Design Requirements

The UPS shall be sized to provide a minimum of _____kVA/kW output (unity load power factor rating) and shall be scalable up to _____kVA/kW.

The UPS shall be able to supply all required power to full rated output kVA loads with power factor from 0.7 leading to 0.4 lagging.

Load voltage and bypass line voltage shall be 480VAC, three-phase, three-wire plus ground. Input voltage shall be 480VAC, three-phase, three-wire plus ground. The UPS shall not require nor use an input neutral for normal operation. The design intent shall be to maintain reliability while delivering maximum efficiency as indicated in Section 1.3.5 AC Output - E.

The AC input source shall be a solidly grounded wye service or grounded through an HRG system. Dual asynchronous AC input sources shall not be acceptable.

The VRLA battery shall support the UPS at 100% rated kW load for at least _____ minutes at startup (initial run time) and _____ minutes at end of life (EOL run time) at 77°F (25°C).

The Samsung Lithium-ion battery shall support the UPS at 100% rated kW load for at least _____ minutes at startup (initial run time) and _____ minutes at end of life (EOL run time) at 77°F (25°C).

The Vertiv HPL Lithium-ion battery shall support the UPS at 100% rated kW load for at least _____ minutes at startup (initial run time) and _____ minutes at end of life (EOL run time) at 77°F (25°C).

The Vertiv HPL Lithium-ion battery shall support the UPS at 100% rated kW load for at least _____ minutes at startup (initial run time) and _____ minutes at end of life (EOL run time) at 86°F (30°C).

The UPS shall have an active power factor corrected three-level IGBT rectifier, capable of maintaining input power factor and input THDi within specifications without an additional input filter.

The UPS shall be of transformer-free design, requiring no internal transformer in the main power path for the basic operation of the module. Optional transformers in cabinets or otherwise external to the basic UPS module shall be permissible to provide isolation and/or voltage transformation.

The UPS shall be hot-serviceable and allow for replacement of serviceable components in the core modules without switching the load from inverter to bypass.

(Optional) The UPS shall be hot-scalable and allow connecting additional core modules up to the maximum system capacity without switching the load from inverter to bypass.

(Optional) The UPS shall provide one internal redundant core. In the event of a malfunction of one of the UPS cores the specific core affected will be automatically isolated from the system and the remaining UPS cores shall continue to support the load.

1.3.2 Modes of Operation

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

A. Normal (VFI Mode): The critical AC load shall be continuously powered by the UPS inverter. The rectifier shall derive power from the utility AC source and supply DC power to the inverter and DC-DC converter, which simultaneously float charges the battery. Float charging shall be continuous without cycling to be in compliance with the battery manufacturer's published float service warranty requirements.

B. Intelligent ECO Mode (VFD Mode): The system control shall offer a method to increase maximum efficiency when enabled and conditions permit by automatically placing the load on the bypass source when the voltage and frequency of that source are within acceptable parameters. The UPS will return to double

conversion mode without interruption should the bypass source deviate outside acceptable parameters. The UPS must maintain a constant float voltage to the batteries during this mode.

C. **High Efficiency and Power Conditioning (VI) Mode:** The system control shall offer an additional method to increase efficiency when enabled and conditions permit. VI mode is a high efficiency mode of operation providing an increase in efficiency up to 99%. When the quality of the supply network is within tolerances the UPS activates VI mode. In this mode energy is supplied by the utility to the load through the static bypass switch and the UPS will compensate for utility disturbances such as voltage sags and swells, as well as provide reactive power necessary to compensate for load Power Factor and provide active filtering to minimize THDi. In case the bypass source deviates outside acceptable parameters the UPS will return to double conversion mode (VFI) with a Class 1 transfer. The UPS must maintain a constant float voltage to the batteries during this mode.

D. **Dynamic Online:** The system control shall offer an additional method to increase efficiency when enabled and conditions permit. Dynamic Online is a high efficiency mode of operation providing an increase in efficiency up to 99% without compromising availability. While operating in Dynamic Online mode the UPS will maintain the output voltage within the IEC 62040-3 Class 1 specification. When the quality of the supply network is within tolerances the UPS activates Dynamic Online mode. In this mode energy is supplied by the utility to the load through the static bypass switch and the UPS will compensate for utility disturbances such as voltage sags and swells, as well as provide reactive power necessary to compensate for load Power Factor and provide active filtering to minimize THDi. In case the bypass source deviates outside acceptable parameters the UPS will return to double conversion mode (VFI) with a Class 1 transfer. The UPS must maintain a constant float voltage to the batteries during this mode.

E. **Circular Redundancy:** The system control shall offer a method to increase efficiency when enabled and conditions permit by automatically adapting power capacity to meet immediate load requirements. This is to be accomplished by switching excess cores to standby mode, while ensuring continued system availability. Circular redundancy shall allow each core in a system to operate in standby mode for an equal length of time, ensuring equal lifespans of module components, and will optimize efficiency at partial load operation.

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

G. **Recharge:** Upon restoration of the utility AC source, the rectifier shall derive power from the utility AC source and supply DC power to the inverter, and DC-DC converter which simultaneously float charges the battery. This shall be an automatic function and shall cause no interruption to the critical AC load.

H. **Bypass:** If the UPS must be taken out of service for maintenance or repair, the static bypass switch shall transfer the load to the bypass source. The transfer process shall cause no interruption in power to the critical AC load. An optional external wrap-around maintenance bypass shall be used to ensure full isolation of the unit for the service of internal components.

I. **Battery Unavailable:** If the battery is unavailable, the UPS shall continue to function and meet all the specified steady-state performance criteria except for the power outage backup time capability.

1.3.3 Performance Requirements

The UPS shall be able to support 100% critical load and maintain full battery charging when the following conditions exist simultaneously:

- Any altitude, within the specified operating range up to an elevation of 3300 ft. (1000 m)
- Any ambient temperature, within the specified operating range of 32°F to 95°F (0°C to 35°C)
- Any input voltage within the specified range
    - +10% to -10% at 100% load
    - +10% to -15% at 95% load
- Air filters 50% blocked per the criteria included in UL1778

1.3.4 AC Input

A. Overload Capacity: With nominal input voltage and without the battery connected, the rectifier shall be capable of supplying the inverter with the power needed to operate over the full inverter overload range.

B. Voltage: Rectifier and Bypass AC Input shall be 480V, three-phase, three-wire-plus-ground

C. Voltage Range:

1. +10%, -10% at 100% load without discharging batteries
2. +10%, -15% at 95% load without discharging batteries

D. Frequency Range: ±5Hz

E. Rectifier Walk-In: 0% to 100% of full rated load over 1-90 seconds (adjustable)

F. Rectifier Start Delay: Programmable from 0-240 seconds before walk-in begins (adjustable)

G. Maximum Inrush Current: UPS inrush current shall not exceed four times the nominal input current for a maximum of 10 milliseconds

H. Power Factor: Minimum 0.99 at full load with nominal input voltage

I. Current Distortion: Less than or equal to 3% input current THD at full load input current (nominal input voltage, <1% input voltage THD, and <1% input voltage imbalance)

J. Rectifier and Bypass Surge Protection: Sustains input surges without damage per criteria listed in ANSI/IEEE C62.41, category B3 (6kV)

K. Withstand Rating: Units shall carry a 100kA standard short circuit withstand rating with fuses. All withstand ratings shall be UL-tested and certified, and a label shall be applied to the unit clearly identifying this rating as required by the National Electric Code.

1.3.5 AC Output

A. Load Rating:

- 400 kVA/kW continuous load rating per core at 95°F (35°C) for any load from 0.7 leading to 0.4 lagging
- 375 kVA/kW continuous load rating per core at 104°F (40°C) for any load from 0.7 leading to 0.4 lagging
- 290 kVA/kW continuous load rating per core at 113°F (45°C) for any load from 0.7 leading to 0.4 lagging
- 275 kVA/kW continuous load rating per core at 122°F (50°C) for any load from 0.7 leading to 0.4 lagging
- 250 kVA/kW continuous load rating per core at 131°F (55°C) for any load from 0.7 leading to 0.4 lagging

B. Voltage Regulation:

- < 1% RMS average for a balanced three-phase load
- < 2% RMS average for 50% unbalanced load for line-to-line imbalances

C. Voltage Adjustment Range: ±5% for line drop compensation adjustable by factory service personnel

D. Frequency Regulation: ±0.1%

E. Efficiency: Defined as output kW/input kW at 1.0 power factor load, measured at 25%, 50%, 75%, and 100% of nominal load, with energy storage disconnected or at float, DC-DC converter running.

Rating (kVA/kW)	25% Load	50% Load	75% Load	100% Load
400	≥ 96.4%	≥ 96.6%	≥ 96.5%	≥ 96.3%
800	≥ 96.4%	≥ 96.6%	≥ 96.5%	≥ 96.3%
1200	≥ 96.4%	≥ 96.6%	≥ 96.5%	≥ 96.3%
1600	≥ 96.4%	≥ 96.6%	≥ 96.5%	≥ 96.3%

F. Phase Imbalance:

- Balanced loads: 120° ±1°
- 50% unbalanced loads: 120° ±2°

G. Voltage Transients (Average of All Three Phases):

Voltage transients shall be limited to a maximum deviation from nominal system output volts as specified below, with recovery to within 2.5% of output voltage within four (4) electrical cycles for each of the below conditions. Limits shall apply to any UPS load within the UPS rating, and frequency shall be maintained at 60 Hz ±0.1 Hz. The system shall not transfer to bypass under these conditions.

- Add or remove module from parallel system: ±6% (RMS average for one cycle)
- 100% load step: ±6% (RMS average for one cycle)
- 50% load step: ±2% (RMS average for one cycle)
- Loss of/return to AC input power: ±2% (RMS average for one cycle)

H. Voltage Harmonic Distortion:

- Maximum 1.5% RMS total (linear load)
- Maximum 5% RMS total for a 100 kVA non-linear load, per IEC 62040-3

I. Overload at Nominal Output Voltage with ±1% Voltage Regulation:

- 110% of full load continuously at 77°F (25°C) ambient
- 125% of full load for 10 minutes at 77°F (25°C) ambient
- 150% of full load for a minimum of 60 seconds at 77°F (25°C) ambient
- 200% of full load for a minimum of 200 milliseconds at 77°F (25°C) ambient

J. Current Limit: Up to 200% of full load current

K. Fault Clearing:

- **Inverter Only:** 200% of normal full load current for 200 milliseconds. UPS performance shall be selectable by certified factory service personnel based on an output current limit setting.
- **Bypass Available:** 700% for (10) cycles in inverter pulse-parallel operation when bypass is available for more rapid fault clearance downstream of the UPS.

1.3.6 Grounding

The AC input source shall be a solidly grounded wye service or grounded through an HRG system. The UPS chassis shall have an equipment ground terminal.

1.4 ENVIRONMENTAL CONDITIONS

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

A. Operating Ambient Temperature

UPS: 32°F to 95°F (0°C to 35°C) without de-rating at 100% load. 1.5% maximum kW de-rating per °C up to 122°F (50°C). 131°F (55°C) absolute maximum with de-rating.

Lead-Acid Battery: 72°F to 82°F (22°C to 28°C)

Samsung Lithium-ion Battery: 64°F to 77°F (18°C to 25°C)

Vertiv HPL Lithium-ion Battery: 72°F to 86°F (22°C to 30°C)

B. Storage/Transport Ambient Temperature

-13°F to 158°F (-25°C to 70°C)

C. Relative Humidity

0 to 95%, non-condensing

D. Altitude

Operating: To 3300 ft. (1000m) above mean sea level without de-rating. Above 3300 ft. power derating factor applies per IEC/EN 62040-3.

Altitude	Derating Factor

3300 ft. (1000m)	1.000
3900 ft. (1200m)	0.990
4900 ft. (1500m)	0.975
6600 ft. (2000m)	0.950
8200 ft. (2500m)	0.925
9800 ft. (3000m)	0.900
11500 ft. (3500m)	0.875
11800 ft. (3600m)	0.870
13100 ft. (4000m)	0.850
13800 ft. (4200m)	0.840
14800 ft. (4500m)	0.825
16400 ft. (5000m)	0.800

Storage/Transport: To 50,000 ft. (15,000m) above mean sea level.

1.5 PARALLEL SYSTEMS

A. Parallel Configurations

Up to eight (8) UPS module outputs may be connected in parallel to provide up to 8X maximum output for capacity and 7X maximum output with redundancy.

B. Inter-Module Communications

The UPS module shall communicate via a redundant cable system based on a bi-directional loop such that any single break or disconnection of the cable system shall generate an alarm but shall not interfere with the parallel operation of the system.

C. Paralleling Switchgear

The outputs of the UPS modules shall be connected to an output switchboard containing a common output bus. The switchboard shall be provided with Module Output Breakers (MOB) for each module to permit isolating any module from the output bus. Each MOB shall be equipped with 1A/1B auxiliary contacts to communicate breaker status. The MOB shall be selected to work with current levels that may occur when switching a module onto the active bus. Breakers with adjustable instantaneous settings shall be adequate to achieve this. As an option, paralleling switchgear may be integrated with UPS modules at the factory for system testing.

D. Load Sharing on Inverter

When multiple UPS modules are connected in parallel and powering a common load, load sharing shall not differ by more than 5% for each UPS module.

E. Load Sharing on Bypass

Load sharing when on bypass is solely controlled by the impedance (measured from the bypass source connection to the critical bus connection) difference between parallel modules. This sharing difference could cause sharing transients when the critical bus is transferred from bypass to the inverter. Poorly matched bypass path impedances may also cause one or more modules to inhibit a transfer to inverter due to being overloaded. The UPS shall provide an internal inductor in the bypass path to balance impedances between parallel modules operating in bypass.

Vertiv recommends carefully controlling the cabling differences so that the maximum difference does not exceed 5% of total length.

The individual phase power shall also be balanced within ±10% on any given module. Module-to-module individual phase power shall be within 15%.

- Phase A Percent Load Sharing = (Module Phase A kW – Average Phase A kW)/Average Phase A kW * 100%

- Phase B Percent Load Sharing = (Module Phase B kW – Average Phase B kW)/Average Phase B kW * 100%
- Phase C Percent Load Sharing = (Module Phase C kW – Average Phase C kW)/Average Phase C kW * 100%

1.6 SUBMITTALS

1.6.1 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 short circuit withstand rating 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, including any overcurrent device in the bypass, and the manufacturer's part number or trip curve
- Size and weight of shipping units to be handled by contractor

1.6.2 Order Submittals

Submittals produced for the order shall include:

- All the documentation presented with the proposal, per Section 1.6.1 above.
- Detailed installation drawings including all terminal locations.
- Interconnect wiring diagrams showing terminal numbers for each wire.

1.6.3 UPS Delivery Documents

Submittals upon UPS delivery shall include:

- A complete set of submittal drawings
- The latest installation manual is available via the Vertiv.com product Web page. Each UPS module serial label includes a QR code and instructions for accessing the product Web page. Manuals shall include receiving and handling instructions.
- The latest user manual is available via the Vertiv.com product Web page. Each UPS module serial label includes a QR code and instructions for accessing the product Web page. Manuals shall include a functional description of the equipment, safety precautions, instructions, step-by-step operating procedures and routine maintenance guidelines, including illustrations.

1.7 WARRANTY

1.7.1 UPS Warranty

The UPS manufacturer shall warrant the unit against defects in workmanship and materials for 12 months after initial startup or 18 months after the shipping date, whichever comes first.

1.7.2 Warranty - End User

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

1.8 QUALITY ASSURANCE

1.8.1 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.

1.8.2 Factory Testing

Before shipment, the manufacturer shall test the UPS fully and completely 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 both part-load and the full kW rating of the unit.

Operational discharge and recharge tests shall be performed to ensure guaranteed rated performance.

System operations such as startup, shutdown and transfers shall be demonstrated.

Additional optional factory testing for single module and distributed bypass UPS systems shall include the following:

- Switchgear integration testing with single module and distributed bypass UPS systems
- Factory witness testing (multiple levels of testing available depending on needs)
- Custom factory witness testing
- Factory heat run testing
- Factory burn-in testing (with or without data logging)

A certified copy of test results shall be available for each system as indicated on the order.

2.0 PRODUCT

2.1 FABRICATION

2.1.1 Materials

All materials of the UPS shall be new, of current manufacture and high-grade. They 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 operator safety and protection from heat.

2.1.2 Capacitor Assemblies

All power, AC and DC capacitors shall be mounted allowing field replacement of the capacitors separately from power switching controls and components. All AC and DC capacitors shall have a 15-year design life.

2.1.3 UPS Internal Wiring

Internal power wiring shall be extra flexible terminated with compression type lugs. Lugs shall be attached with a hardware method that ensures long-life integrity. All factory-installed electrical power connections shall be torqued to the required value and marked with a visual indicator. All power connections not serviceable from the front or top of the unit shall be permanent, without any need for periodic tightening.

2.1.4 Field Wiring

Wiring practices, materials and coding shall be in accordance with the requirements of the National Electrical Code, OSHA and applicable local codes and standards. All bolted connections of busbars, lugs and cables shall be in accordance with requirements of the National Electric Code and other applicable standards.

All field wiring power connections shall be to tin-plated copper busbars for connection integrity. Busbars shall have adequate space to allow two-hole, long-barrel, 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. In conformance with NEC, connection cabinets shall provide for adequate wire bend radius.

Control wiring shall be stranded tinned conductors.

2.1.5 Construction and Mounting

The UPS shall be in a NEMA Type 1 enclosure, designed for floor mounting. The UPS shall be structurally adequate and have provisions for hoisting, jacking and forklift handling. Maximum cabinet height for all UPS power ratings shall be 80.3 in. (2040mm). UPS power ratings up to 1600kVA capacity shall have a maximum cabinet width of 202 in. (5130mm). UPS power ratings up to 1600kVA with one internal redundant core shall have a maximum cabinet width of 245.3” (6230mm).

The UPS shall be NEMA Type 1-compliant, with front doors open to enable safe change of air filters without the need for shutdown.

2.1.6 Cooling

Forced redundant air cooling will ensure that all the components are operated within their specification. Airflow will be controlled according to load demand. The UPS will be capable of preserving normal operations even with multiple cooling fans out of operation (due to failure) with 100% of the output nominal load at 86°F (30°C) ambient temperature as long as there is only one failed fan per converter cell. If these conditions are not met (with one failed fan per converter cell), the UPS will supply the load through the static bypass if an overheating of the converters occurs. The failed fan condition will be immediately notified by the UPS through all the user interfaces and through Vertiv™ LIFE™ Services. The cooling air entry will be on the front and the air exit at the top of the UPS. The UPS will be installed with at least 24 inches of overhead clearance in order to allow cooling air to exit unhindered.

An internal, factory-mounted sensor for room ambient temperature shall be provided to give an alarm if the temperature of the inlet air to the UPS is above specified limits.

Air filters shall be located at the point of air inlet and shall be changeable. No service clearance or ventilation shall be required in the rear of the system.

2.1.7 Long-Life Components

The UPS shall incorporate long life components to streamline maintenance, maximize uptime and minimize total cost of ownership.

2.2 EQUIPMENT

2.2.1 UPS System

The UPS system shall consist of an IGBT power factor-corrected rectifier, DC-DC converter and three-phase, transformer-free inverter, bypass static transfer switch, bypass synchronizing circuitry, protective devices and accessories as specified. The inverter and rectifier shall be of three-level converter design for maximum efficiency. The specified system shall also include a battery disconnect breaker and battery system.

2.2.2 System Efficiency

The UPS module shall be provided with high-efficiency modes of operation to increase the module efficiency when the bypass source is within voltage and frequency tolerance of the load. When the bypass power quality goes outside the adjusted limits, the inverter shall assume the load in a seamless fashion without any interruption. During operation in ECO mode (VFD mode) the rectifier shall continuously charge the battery and the inverter shall demonstrate synchronism with the bypass. During operation in Dynamic Online mode (VI mode) the inverter shall continuously charge the battery and shall demonstrate synchronism with the bypass. The inverter is not isolated from the load by mechanical means during high-efficiency mode operation.

2.2.3 System Protection

A. Surge Protection

The UPS shall have built-in protection against surges, sags and overvoltage from the AC source. The protection shall meet the requirements of ANSI/IEEE C62.41 B3 including:

- 6kV, 100kHZ ring wave, line-to-line, line-to-neutral, line-to-ground and neutral-to-ground
- 6kV, combined wave, line-to-line, line-to-neutral, line-to-ground and neutral-to-ground

B. Output Protection

The UPS shall be protected against sudden changes in output load and overload at the output terminals. The UPS shall have built-in protection against permanent damage to itself and to 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 without any interruption for an internal UPS malfunction. The status of protective devices shall be indicated on a graphic display screen on the front of the unit.

C. AC Ground Fault Detection

The UPS is a three-wire system and shall have the capability to detect and annunciate AC phase-to-ground faults when the UPS is powering the load from the battery or other DC sources. If an AC ground fault occurs between a phase and ground, a message shall be displayed on the operator screen indicating that the fault condition exists. The UPS shall also have as standard the ability to indicate this condition via a programmable contact in order to actuate a third-party device, such as a warning light or audible alarm system.

D. (Optional) DC Battery Ground Fault Detection

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.

E. Disconnects

A backfeed disconnect shall be integrated within the UPS cabinet and controlled by a shunt trip mechanism. As required by UL1778 and CSA, the internal backfeed disconnect shall isolate backfeed voltage from the upstream source during a bypass power outage, eliminating the need for a shunt trip accessory in the external upstream UPS bypass input breaker. The UPS shall provide an interface to monitor remote breakers (furnished by others) located in external switchgear. Remote breakers shall be equipped with 1A/1B auxiliary contacts to report status via control wiring to the UPS input contacts.

F. Automatic Transfer Switches

If the UPS is fed from an automatic transfer switch, the UPS shall be capable of transferring to and from an alternate out-of-phase source in double conversion mode without applying a break-before-make delay to the automatic transfer switch operation.

G. Power Converter Fault Containment

The UPS, under normal operating conditions, shall provide adequate containment to prevent propagation of a fault to the rest of the system in the event of a catastrophic failure. Each power converter module shall have adequate mechanical and electrical insulation to guarantee fault containment. Internal failures in any power converter module shall cause the module to shutdown with minimum damage to the module and with no fault propagation to other power converter modules.

H. Conformal Coating

All circuit boards critical to UPS operation shall be treated with conformal coating to protect them from harsh environments including high humidity, airborne contaminants and high temperatures.

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 the DC-DC converter. The DC output of the rectifier shall meet the input requirements of the inverter without the battery being connected.

A. 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 THD shall be less than or equal to 3% at full rated output load with nominal input voltage.

B. AC Input Current Limiting

The rectifier shall include a circuit to limit AC input current to a factory-set level of 110% (adjustable) of the full input current rating.

C. Input Current Walk-In

The rectifier shall provide a feature that limits the total initial power requirement at the input terminals to 0% of rated load and gradually increases power to 100% of full rating over the 130-second (adjustable) interval.

D. Rectifier Fuse Protection

Each rectifier AC phase shall be individually fused with fast-acting fuses so that loss of any semiconductor shall minimize cascading failures. Fuses shall be bolted to busbars at both ends to ensure mechanical and electrical integrity. The display panel on the front of the unit shall indicate a blown fuse occurring on any phase of the rectifier.

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, shall be 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 DC-DC converter shall not exceed 1% RMS of the float voltage. Each power core shall have its own DC-DC converter, allowing either a distributed (one battery system per core) or centralized (one battery system shared by all cores) battery system.

A. Battery Recharge

In addition to supplying power for the load, the rectifier shall be capable of supplying 10% of the module full load power rating for recharging the battery. After the battery is recharged, the rectifier/charger shall maintain the battery at full charge until the next emergency operation. Charging technologies that do not maintain constant float charge during normal operating conditions shall not be acceptable.

B. 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 0 to 200 hours. A method shall be available to deactivate this feature for valve-regulated battery systems.

C. Battery Charge Current Limiting

The DC-DC converter shall include a circuit to limit battery charging current to an adjustable level of 0% to 10% of nominal input current. A second circuit shall provide an additional selection (0% to 10%) when signaled by an external contact (e.g., operation of generator). Battery charge current limit shall be factory-set at 10% for normal operation and 0% for generator operation. The DC-DC converter shall use full float charging technology. Charging technologies that do not maintain constant float charge during normal operating conditions shall not be acceptable.

D. Thermal Runaway Protection and Battery Charger Control (Lead-Acid Batteries Only)

The UPS shall provide temperature-compensated charging. This function requires that the UPS be equipped with temperature sensors in each cabinet and an interface scheme provided by the UPS manufacturer. The UPS shall adjust the battery charging voltage based on the battery temperature reported from external battery temperature sensors. Temperature sensors shall be monitored for faulty measurements and shall be ignored if a fault is detected to prevent overcharging or undercharging the battery. 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. In addition, the UPS shall be programmable so that a battery over-temperature condition can be detected in any single battery cabinet and a three-stage response shall be initiated:

- When the temperature in the cabinet reaches 100°F (38°C) (adjustable), battery charging shall not increase, and a warning shall be generated.
- When the temperature in the cabinet reaches 109°F (43°C) (adjustable), the charger will shut off completely and the UPS can be configured to trip open the circuit breaker for any individual overtemperature battery cabinet or string to isolate that cabinet or string only and retain reduced battery protection for the UPS. This condition shall be displayed on the UPS HMI screen and in the event log.
- Once the breaker on the affected cabinet or string has been tripped, the UPS shall resume normal charging with the remaining battery cabinets or strings.

The system shall meet the requirements of the IFC 2012 for preventing thermal runaway battery protection for the UPS. This condition shall be displayed on the UPS HMI screen, and in the event log.

Battery charging may also be stopped by an external signal that may be activated by a contact closure to indicate “on generator” operation or other condition (including battery overtemperature, presence of excessive hydrogen, or failure of the room ventilator fan) under which battery charging is undesirable or inadvisable.

E. 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 via the DC breaker(s) in the battery string.

F. Battery Load Testing (Lead-Acid Batteries Only)

The UPS shall be capable of performing battery load testing under operator supervision. To accomplish this, the rectifier shall reduce charging voltage to force the batteries to carry the load for a short time. If the curve of battery voltage drop indicates diminished battery capacity, the UPS shall display an alarm message. If the voltage drop indicates battery failure, the UPS shall terminate the test immediately and annunciate the appropriate alarms.

2.3.3 Inverter

The term *inverter* shall denote the equipment and controls to convert direct current from the rectifier or battery via the DC-DC converter to precise alternating current to power the load. The inverter shall be solid-state and capable of providing rated output power. The inverter shall be a pulse-width-modulated design and shall utilize insulated gate bipolar transistors (IGBTs). The inverter shall be fully self-protected from load changes and an output short circuit. To further enhance reliable performance and efficiency, the inverter shall not require an inverter output series static switch/isolator for the purposes of overload or fault isolation or transfers to bypass.

A. Overload Capability

The inverter shall be able to sustain an overload across its output terminals while supplying full rated voltage for up to 150% for 60 seconds at nominal voltage and 77°F (25°C) ambient. The inverter shall be capable of at least 200% current for short-circuit conditions including phase-to-phase, phase-to-ground and three-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.

B. Transformer Energization

The UPS features a rugged inverter design such that a like size transformer can be energized while the UPS is operating on inverter. When the bypass source is available, the UPS will perform Dynamic Line Support for up to 700% of nominal input current for up to 800 milliseconds where the bypass is used in parallel with the inverter to help source the transformer inrush current. When the bypass source unavailable, the inverter will source up to 200% of nominal current for up to 200 milliseconds.

The UPS shall support multiple downstream transformers being energized one at a time with a recommended 5-second break between transformer startups. The maximum recommended connected transformer kVA is not to exceed twice the rating of the total connected UPS kVA. When energizing multiple downstream transformers, it is recommended that these transformers be designed for low inrush.

Contact your Vertiv representative for more information or for application specific questions.

C. Output Frequency

The inverter shall track the bypass continuously, provided that the bypass source maintains a frequency of 60Hz ±0.1%. The inverter shall change its frequency (slew rate) at 0.1Hz (adjustable 0.1 to 5.0Hz) to maintain synchronous operation with the bypass. This shall allow make-before-break manual or automatic transfers. If the bypass fails to maintain proper frequency, the inverter shall revert to an internal oscillator, which shall be temperature-compensated and shall hold the inverter output frequency to 0.1% from the rated frequency for steady-state and transient conditions. Drift shall not exceed 0.1% during any 24-hour period. Total frequency deviation, including short-term fluctuations and drift, shall not exceed 0.1% from the rated frequency.

D. Phase-to-Phase Balance

The inverter shall provide a phase-to-phase voltage displacement of no worse than ±2° with a 50% unbalanced load and up to 125% of the system output rating.

E. 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.

2.3.4 Bypass Static Switch

When maintenance is required or when the inverter cannot maintain voltage to the load due to inadequate DC power, 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 the following:

- Input choke for sags and transient filtering
- Continuous-duty bypass static switch
- Fuses to protect SCRs
- Backfeed detection circuit as specified by UL1778 and CSA
- Backfeed disconnect (BFD) to isolate the bypass static switch from the bypass source.

The bypass static switch shall be a solid-state device consisting of two reverse-paralleled SCR's (silicon-controlled rectifiers) per phase that can automatically and instantaneously connect the alternate AC source to the load or isolate the load from the bypass source.

A. 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.

B. 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 time in excess of 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. The UPS system logic shall allow up to five retransfers (adjustable) within any one-hour period to prevent cyclical transfers caused by overloads.

C. Momentary Overloads

In the event of a load current inrush, such as energizing a load with high inrush current or branch load circuit fault in excess of the inverter's total rating, the bypass static switch shall connect the alternate AC source to the load for at least 200 milliseconds, allowing up to 700% of the normal rated output current to flow. Additionally, the bypass static switch will support up to 1000% of the normal rated output current for 100 milliseconds. 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 10-cycle 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 shall be completed.

D. Backfeed Protection

As required by UL 1778 and CSA, the static bypass transfer switch shall not back feed UPS power to the bypass input terminals and, therefore, to the 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 internal automatic backfeed disconnect (BFD) and an alarm message shall be annunciated at the UPS control panel. The load shall remain on conditioned and protected power after detection of a shorted SCR and isolation of the static bypass switch. A device that cycles due to loss of utility and is, therefore, at a higher risk of failure than a device that normally remains closed, is not acceptable. The backfeed prevention disconnect interrupting capacity shall be equal to or greater than the UPS withstand rating. Switching devices with a lower rating or series-rated devices are not acceptable.

E. Intelligent ECO Mode (VFD Mode) Operation

ECO mode operation shall be provided and shall be selectable by the user.

When enabled and conditions permit, this mode of operation shall transfer the load to the bypass source and remain as long as the bypass source frequency, slew rate and voltage are within the adjustable operating parameters. While in this mode, the inverter shall remain operating to provide the ability to instantaneously

assume the load without interrupting the output voltage. The UPS shall maintain a constant float voltage to the batteries during this mode. 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 without an interruption of the output voltage.

Operating adjustments shall include:

- Limit the frequency of transfer into ECO Mode caused by an out-of-tolerance bypass source.
- Enable and disable ECO Mode operation.

F. Dynamic Online Mode (VI Mode) Operation

Dynamic Online Mode operation shall be provided and shall be selectable by the user.

Dynamic Online is a high efficiency mode of operation providing an increase in efficiency up to 99% without compromising availability. While operating in Dynamic Online the UPS will maintain the output voltage within the IEC 62040-3 Class 1 specification. When the quality of the supply network is within tolerances the UPS activates Dynamic Online mode. In this mode energy is supplied by the network to the load through the static bypass switch and the UPS inverter will function as an active filter, providing the reactive power necessary to compensate load THDi, load Power Factor, and voltage sags and swells. In case of network parameters outside tolerances the UPS will return to double conversion mode (VFI) with a Class 1 transfer. The UPS shall maintain a constant float voltage to the batteries during this mode.

Operating adjustments shall include:

- Limit the frequency of transfer into Dynamic Online Mode caused by an out-of-tolerance bypass source.
- Enable and disable Dynamic Online Mode operation.

2.3.5 Display and Controls

A. UPS Control Panel

The UPS shall be provided with a microprocessor-based control panel for operator interface (may also be referred to as *user interface*, or *UI*) to configure and monitor the UPS. The control panel shall be located on the front of the unit where it can be operated without opening the hinged front door. A backlit, menu-driven, full-graphics, color touchscreen liquid crystal display shall be used to display system information, metering information, a one-line diagram of the UPS and battery, active events and event history. No mechanical push buttons shall be used to control the interface. Mechanical EPO push buttons are acceptable.

B. Logic

UPS system logic and control programming shall reside in a microprocessor-based control system with nonvolatile flash memory. Rectifier, inverter, DC-DC converter, static switch and system control logic shall utilize high-speed digital signal processors (DSPs). CANbus 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.

C. Metered Values

A microprocessor shall control the display and memory functions of the monitoring system. All three phases of three-phase parameters shall be displayed simultaneously. All voltage and current parameters shall be monitored using true RMS measurements for accurate (±1.5%) representation of non-sinusoidal waveforms typical of computers and other sensitive loads. These parameters shall be displayed:

- Input voltage, line-to-line
- Input current
- Input frequency
- Input kVA/kW
- Battery voltage, each battery string
- Battery charging/discharging current
- Battery temperature, each battery string

- Battery state of charge
- Battery run time
- Bypass input voltage, line-to-line
- Bypass input frequency
- Output voltage, line-to-line
- Output frequency
- Output current
- Output kVA/kW, total and percentage of full load
- Overload time remaining
- Ambient temperature
- Total operating hours

D. Power Flow Indications

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

- AC input circuit breaker (remote)
- Battery circuit breaker, each breaker (remote)
- Inverter output circuit breaker (remote)
- Core rectifier input switch (internal)
- Core inverter output switch (internal)
- Backfeed disconnect (internal)
- Static switch input circuit breaker (remote)
- Maintenance bypass cabinet breakers (when used)

E. Main Display Screen

The following UPS status indicators 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)
- Maint. 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)

F. Event Log

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

G. Battery Status Indicator

A battery status indicator shall display DC alarm conditions, temperature, battery state of charge, the present battery voltage and battery time remaining during discharge.

The UPS shall provide the operator with controls to perform the following functions:

- Configure and manage manual battery test

- Start battery test
- Monitor test status and progression
- Stop battery test
- Battery test status

H. Events

The control panel shall report the system-level events listed below. All events shall be displayed in text form.

Component	Severity	Text Display
I/O Box	Warning	Backfeed Disconnect Switch Open
I/O Box	Warning	Batt.Temp.Sensor Warning
Core	Warning	Batt.Temp.Sensor Warning
Core	Warning	Battery BCB breaker is open
I/O Box	Warning	Battery Breaker Open
Core	Warning	Battery Charge Low
Core	Warning	Battery Core Switch Open
Core	Warning	Battery Cubicle Switch Open
Core	Info	Battery Detection In Progress
Core	Info	Battery Detection Request
Core	Fault	Battery GND Fault
Core	Fault	Battery Overcurrent Fault
Core	Info	Battery Recharge In Process
Core	Info	Battery Test Finished OK
Core	Info	Battery Test Not Allowed
Core	Info	Battery Test Running
Core	Info	Battery Test Stopped
I/O Box	Info	BMS Rack Is Offline
Core	Warning	Booster - Charger over voltage
I/O Box	Warning	Bypass Input Bad
Core	Warning	Bypass Input Bad
I/O Box	Warning	Bypass Input Switch Open
Core	Warning	Bypass Input Switch Open
I/O Box	Info	Bypass Mains Out Of Tolerance
Core	Info	Bypass Mains Out Of Tolerance
I/O Box	Warning	Bypass Warning
Core	Warning	Bypass Warning
I/O Box	Warning	CAN Communication Warning

Core	Warning	CAN Communication Warning
I/O Box	Fault	CCB Parallel Cable Missing
Core	Fault	CCB Parallel Cable Missing
I/O Box	Info	Circular Redundancy Active
I/O Box	Warning	Core amount mismatch system configuration
Core	Warning	Core amount mismatch system configuration
Core	Info	Core in Active Standby Mode
Core	Warning	DC Bus Overvoltage
Core	Warning	Do Not Close Battery Switch
I/O Box	Info	Dynamic Online / VI
I/O Box	Fault	EPO Activated
Core	Fault	EPO Activated
Core	Info	Fan Test In Progress
Core	Fault	Fuse Failure
I/O Box	Fault	General Fault
Core	Fault	General Fault
I/O Box	Fault	General Supply Fault
Core	Fault	General Supply Fault
I/O Box	Warning	General Warning
Core	Warning	General Warning
I/O Box	Info	High Efficiency and Power Conditioning (VI)
I/O Box	Warning	Input Air Temperature Out Of Tolerance
Core	Warning	Input Air Temperature Out Of Tolerance
Core	Warning	Input Voltage Out Of Tolerance
Core	Info	Intelligent ECO Enabled
Core	Info	Intelligent Parallel Enabled
Core	Warning	Inverter DC over voltage
Core	Warning	Inverter Off
Core	Warning	Inverter Off Command Pending
Core	Info	Inverter On Command Pending
I/O Box	Warning	Load Bank Breaker Closed
Core	Warning	Load Not Supplied
I/O Box	Warning	Load On Battery

I/O Box	Warning	Load On Bypass
I/O Box	Warning	Load On Maintenance Bypass
Core	Warning	Load On Maintenance Bypass
I/O Box	Warning	Maintenance Isolation Breaker Open
I/O Box	Info	Maximum Energy Saving (VFD)
I/O Box	Warning	MOB System Output Breaker Open
I/O Box	Warning	Module Not Supplying Load
I/O Box	Warning	MSBM Synch Warning
Core	Warning	MSBM Synch Warning
Core	Info	ON GENERATOR
I/O Box	Fault	Output Out Of Tolerance
I/O Box	Warning	Overload
Core	Warning	Overload
I/O Box	Fault	Overload Stop
Core	Fault	Overload Stop
I/O Box	Warning	QS1 System Input Switch Open
I/O Box	Warning	QS4 Load Output Switch Open
Core	Warning	QS4 Load Output Switch Open
I/O Box	Warning	QS44 STS Output Switch Open
Core	Warning	Rectifier DC over voltage
I/O Box	Warning	Rectifier Feed Breaker Open
Core	Warning	Rectifier Input Switch Open
Core	Warning	Rectifier Mains Failure
Core	Info	Rectifier Mains Out Of Tolerance
I/O Box	Warning	Remote Backfeed Breaker Open
I/O Box	Warning	SBB STS Output Switch Open
I/O Box	Warning	Service / Commissioning / Test Mode
Core	Warning	Service / Commissioning / Test Mode
Core	Warning	Service Check: Battery Connection
Core	Warning	Service Check: Battery Temperature Warning
Core	Warning	Service Check: Battery Warning
I/O Box	Fault	Service Check: Bypass Fault
Core	Fault	Service Check: Bypass Fault

Core	Warning	Service Check: Fan
Core	Warning	Service Check: Temperature Warning
Core	Fault	Service Required: Battery Fault
I/O Box	Fault	Service Required: Bypass
Core	Fault	Service Required: Bypass
Core	Fault	Service Required: Charger
I/O Box	Fault	Service Required: General Fault
Core	Fault	Service Required: General Fault
I/O Box	Warning	Service Required: General Warning
Core	Warning	Service Required: General Warning
I/O Box	Fault	Service Required: Internal Communication Failure
Core	Fault	Service Required: Internal Communication Failure
I/O Box	Fault	Service Required: Temperature Fault
Core	Fault	Service Required: Temperature Fault
I/O Box	Warning	Static Switch Input Breaker Open
I/O Box	Warning	Trinergy amount mismatch system configuration

I. Controls

System-level control functions shall be:

- Start Inverter (and transfer to inverter)
- Stop Inverter (after transferring to bypass)
- Startup Screen
- Configure Manual Battery Test
- Initiate Manual Battery Test
- Alarm Silence Command
- Fault Reset Command
- ECO mode
- (Optional) Emergency Power Off Push Button with Protective Cover

Administrative control functions shall be:

- System Settings (Time, Date, Language, Password)
- Permissions Settings
- Network Settings

J. Manual Procedures

- Load Transfers: HMI buttons (INVERTER ON, INVERTER OFF) shall provide the means for the user to transfer the load to bypass and back onto the UPS.

2.3.6 Self-Diagnostics

- Event Log File - The control system shall maintain a log of the event conditions that have occurred during system operation. Each log shall contain the event name, event time/date stamp and a set/clear indicator.

2.3.7 Remote Monitoring Capability

A. Network Communication

The UPS shall be equipped with provisions for remote communication. IP20 isolation, to avoid exposure to any energized part, shall be provided during installation and configuring of the communication card.

Standard communication protocols shall be Vertiv Protocol, Remote Service Delivery Protocol and HTTP Web. Communication shall be compatibility with DCIM Trellis platform and Liebert Nform® management software.

Two of three optional protocols shall be supported with simultaneous communication - SNMP, BACnet IP, Modbus IP/485.

2.3.8 Optional Features

A. Remote Service Delivery

The UPS manufacturer shall provide remote monitoring capability with a user-supplied (outbound only) secure internet connection for remote diagnosis and monitoring of the UPS system to provide early warning of UPS and single module alarm conditions and out-of-tolerance conditions. The UPS manufacturer shall maintain a monitoring center staffed by trained experts 24 hours a day, 7 days a week, 365 days per year. The experts on staff shall be capable of interpreting reports from the UPS and assessing areas in need of attention. This shall allow effective, proactive maintenance and fast incident response. First year operation remote monitoring service shall be included.

Liebert IntelliSlot Unity-DP web card shall be provided to deliver SNMP, SMS text messaging, Telnet and Web-based management capability for enhanced communication as well as a choice of any two of the following protocols:

- SNMP
- Modbus over IP or RS-485
- BACnet

B. Liebert IntelliSlot 485 Card

A communication card shall be provided to interface Liebert devices to a Building Management System or Liebert SiteScan SiteLink modules for remote monitoring and control via Modbus RTU or Vertiv proprietary protocol.

C. Single Input Jumpers

The UPS shall be equipped with busbars connecting the rectifier and bypass inputs, enabling the UPS to be fed from a single 3-phase AC input source.

D. DC Battery Ground Fault Detection

The UPS shall be equipped with DC battery ground fault detection that can detect and annunciating (through the UPS control panel) battery DC ground faults in order to facilitate proactive resolution of such ground faults for 2014 NEC compliance.

E. Emergency Power Off

The UPS control panel shall be equipped with a push button with protective cover for emergency situations that require shutdown of the UPS. The emergency power-off push button provides a local method to turn Off the UPS power conversion and bypass.

F. FCC Compliance Filter Compatibility

The UPS shall comply with FCC Part 15, Class A.

G. Load Bus Sync Interface

The Load Bus Sync Interface shall enable independent UPS units to remain synchronized when operating on battery or on unsynchronized input sources.

H. Seismic Anchorage Kits

Seismic anchorage kits shall be provided with the UPS unit, and if included the (optional) Matching Battery Cabinet, for use in seismic restraint as required for IBC 2015 certification.

I. Non-Matching Module Battery Disconnect (MBD)

The MBD is an external battery circuit breaker that is used to isolate the UPS module from the battery system. One MBD can be used to disconnect one or more battery strings. Battery Isolation Switches (BIS) are recommended when more than one battery string is used with a common MBD. MBD's can also be provided for each battery string. A non-matching MBD requires a battery interface box (BIB) to monitor breaker position and to control breaker tripping. When battery charging temperature compensation is needed, a Temperature Sensor can be connected to the BIB associated with the MBD.

J. Non-Matching Battery Isolation Switch (BIS)

The BIS is an external battery circuit breaker used to isolate individual battery strings. When one or more BIS is used, then only a single MBD can be used. The non-matching BIS requires a battery interface box (BIB) to monitor breaker position. When battery charging temperature compensation is needed, a Temperature Sensor can be connected to the BIB associated with the BIS.

K. Battery Interface Box (BIB)

The Battery Interface Box contains a Battery Interface Board. The Battery Interface Box is required when a UPS module is installed with any non-Liebert battery cabinet, non-matching MBD or Battery Isolation Switch (BIS). One Battery Interface Box is required for each MBD or BIS. Liebert battery cabinets incorporate Battery Interface Boards and do not require a separate Battery Interface Box.

L. Temperature Sensor

This sensor is needed only for battery solutions utilizing a non-Vertiv battery cabinet, non-matching module battery disconnect (MBD) or battery isolation switch (BIS). Liebert battery packs have built-in temperature sensors. The Temperature Sensor option includes a remote sensor that must be field-installed.

M. Centralized Battery DC Switchboard (DCSB)

The DC Switchboard is used for centralized battery systems (all cores share the same battery system) and provides core-level isolation from the centralized DC bus via integrated Module Battery Disconnects (MBD). The DCSB breaker sections contain busbars for termination of DC power cables coming from the Core Disconnects in the UPS lineup. A tie cabinet section of the DC Switchboard contains busbars for termination of DC power cables coming from the centralized battery system.

N. Hot-Scalable 400 kVA Power Cores

The hot scalability option will include a termination cabinet to land AC and DC power cable terminations from the core disconnect. The termination cabinet will be located in the Trinergy Cube lineup in place of the future core. The DC switchboard shall provide DC cable terminations for the future core battery system. The DC cables from the core disconnect to the DC switchboard for the future core must be installed initially. This configuration shall provide full AC and DC power isolation for the future core and battery cabinets via the AC switches in the core disconnect and the DC breaker in the DC switchboard. Note that only common battery systems are supported.

O. Battery Junction Cabinet

The Junction Cabinet is used as an intermediate landing point for some battery configurations involving multiple cabinets. It provides additional landing space for the cables from the battery cabinets while reducing the number of cables needed to connect to the UPS. Unlike the DC Switchboard, the Junction Cabinet does not provide core-level isolation from centralized battery systems (no breakers). Refer to the Installation Manual for information about different configurations.

P. BIB Control Power Interface (non-Liebert Junction Cabinets)

Required for centralized Lead Acid and Samsung battery systems (configuration C-3) using non-Liebert (non-matching) junction cabinets. The BIB control power interface sources power from the battery bus in the non-Liebert junction cabinet to supply control power to the CAN communication bus from the I/O Box to the battery interface boxes.

Q. Integrated Battery Monitoring, Albér® BDSUi

This integrated battery monitoring solution extends and optimizes useful battery life, reduces maintenance costs and increases safety. The monitoring system reports all critical battery parameters, including internal resistance, total voltage, cell voltage, temperature and discharge events. One Liebert IS-Unity-DP™ monitoring card is included in the Control Module.

3.0 STORED ENERGY SYSTEMS

The UPS system shall be provided with a stored energy system that shall comply with the specifications of:

- Flooded-Cell Battery System,
- Valve-Regulated, Lead-Acid Battery System, or
- Lithium-Ion Battery System

Specifications describing the requirements for the customer-specified stored energy system are contained in SL-25418GS, available at the Vertiv Website.

4.0 EXECUTION

4.1 FIELD QUALITY CONTROL

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

A. 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 ground conductors are properly sized and configured per the manufacturer's requirements as noted in the manufacturer's drawings supplied with installation manuals or submittal package.
- Inspect electrolyte level in cells (flooded cells only).
- Inspect all cell cases.
- Inspect each cell for proper polarity.
- Verify that all printed circuit boards are configured properly.

B. Mechanical Inspection

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

C. 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 string(s).

D. 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.

4.2 MANUFACTURER'S FIELD SERVICE

A. 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 four 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.

B. LIFE™ Services

The UPS manufacturer shall provide LIFE services, 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 shall be able to 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 center shall be staffed with factory-trained service personnel who are capable of receiving, analyzing and interpreting the communicated events and data. The remote service center personnel shall also be capable of dispatching factory-trained field service personnel to the location of the UPS.

C. 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 national parts center Customer Support Parts Coordinator shall be on call 24 hours a day, 7 days a week, 365 days a year for immediate parts availability.

D. Maintenance Contracts

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