

**Vertiv™ Liebert® NX UPS**  
**GUIDE SPECIFICATIONS**  
**40-80kVA, 80-120kVA and 160-200kVA Scalable**  
**Three-Phase Uninterruptible Power System**

**1.0 GENERAL**

**1.1 Summary**

This specification defines the electrical and mechanical characteristics and requirements for a continuous-duty three-phase, solid-state, scalable (field-upgradable) uninterruptible power system (UPS). The UPS shall provide high-quality AC power for sensitive electronic equipment.

**1.2 Standards**

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

- UL Standard 1778
- CSA 22.2, No. 107.1
- FCC Part 15, Class A
- IEC 61000-4-5
- National Electrical Code (NFPA-70)
- NEMA PE-1
- ISTA\_1H

The UPS shall be UL and cUL listed per UL Standard 1778.

**1.3 System Description**

**1.3.1 Design Requirements - UPS Module**

1. **Voltage:** Input/output voltage specifications of the UPS shall be:
  - Rectifier Input: 480 volts, three-phase, 3-wire-plus-ground
  - Bypass Input: 480 volts, three-phase, 3-wire-plus-ground
  - Output: 480 volts, three-phase, 3-wire-plus-ground
2. **Output Load Capacity.** Specified output load capacity of the UPS shall be (\_\_\_\_) kVA at 0.9 lagging power factor.
3. **Scalable Output Capacity.** UPS rated output capacity will be scalable by means of a software update which will require no hardware modifications to the UPS. Models will be available in capacity ranges of 40, 60, 80, 100, 120, 160 and 200kVA.
  - 40kVA model will be scalable from 40k to 60kVA to 80kVA.
  - 80kVA model will be scalable from 80kVA to 100kVA to 120kVA.
  - 160kVA model will be scalable from 160kVA to 200kVA

4. **Parallel Operation.** Up to four (4) UPS module outputs may be connected together in parallel to provide up to 3X maximum output capacity with redundancy.
5. **Current Sharing:** When multiple UPS modules are connected in parallel and powering a common load, each UPS module output current will not differ by more than 5% of the rated full load current of one UPS module.

### 1.3.2 Modes of Operation

The UPS shall be designed to operate as an on-line, double-conversion, reverse-transfer system with the following operating modes:

1. **Normal** - The critical AC load is continuously supplied by the UPS inverter. The rectifier/charger derives power from an AC source and supplies DC power to the inverter while simultaneously float-charging the reserve battery.
2. **Emergency** - Upon failure of utility AC power, the critical AC load is supplied by the inverter, which obtains power from the battery. There shall be no interruption in power to the critical load upon failure or restoration of the utility AC source.
3. **Recharge** - Upon restoration of utility AC power after a utility AC power outage, the rectifier/charger shall automatically restart and assume the inverter and battery recharge loads.
4. **Bypass** - If the UPS must be taken out of service for maintenance or repair or if the inverter overload capacity is exceeded, the static transfer switch shall perform a reverse transfer of the load from the inverter to the bypass source with no interruption in power to the critical AC load.
5. **Eco-Mode** - When this mode is enabled by service personnel the UPS will power the critical load through the UPS static bypass. If the bypass source becomes unqualified the UPS will switch to Normal mode of operation as defined above. Utility power is considered unqualified when either the input voltage varies more than +10% of rated voltage or the input frequency varies beyond +10% of 60Hz. Ten (10) minutes after the bypass source becomes qualified the UPS will automatically transfer to Eco-Mode of operation.

### 1.3.3 Performance Requirements

#### AC Input to UPS

1. **Voltage Configuration for Standard Units:** 480V, three-phase, three-wire plus ground
2. **Voltage Range:** +15%, -20% of nominal without derating
3. **Frequency:** 57-66 Hz
4. **Power Factor:**
  - >0.99 at nominal input voltage and full-rated UPS output load
  - >0.98 at nominal input voltage and half-rated UPS output load
5. **Inrush Current:** UPS inrush current not to exceed 1.5 times rated input current. Maintenance bypass and distribution cabinet inrush current not to exceed 8 times rated input current.
6. **Current Limit:** 140% of nominal AC input current maximum
7. **Current Distortion:** <3% reflected THD maximum at full load
8. **Surge Protection:** Sustains input surges without damage per criteria listed in IEC 1000-4-5

**AC Output, UPS Inverter**

1. **Voltage Configuration:** Three-phase, 3-wire plus ground
2. **Voltage Regulation:**
  - $\pm 1\%$  three-phase RMS average for a balanced three-phase load for the combined variation effects of input voltage, connected load, battery voltage, ambient temperature and load power factor
  - $\pm 2\%$  three-phase RMS average for a 100% unbalanced load for the combined variation effects of input voltage, connected load, battery voltage, ambient temperature and load power factor
3. **Frequency:**
  - Nominal frequency  $\pm 0.05\%$  for single unit
  - $\pm 0.25\%$  for paralleled units
4. **Frequency Slew Rate:**
  - Selectable from 0.1Hz/sec to 3.0Hz/sec maximum for single unit
  - Fixed maximum of 0.2Hz/sec for paralleled units
5. **Phase Displacement:**
  - $\pm 0.5$  degree for balanced load
  - $\pm 1.0$  degrees for 100% unbalanced load
6. **Bypass Line Sync Range:**  $\pm 2.0$  Hz, field-selectable  $\pm 0.5$  to 5.0 Hz
7. **Voltage Distortion:**
  - 1% total harmonic distortion (THD) for linear loads
  - $< 5\%$  THD for 100% nonlinear loads (3:1 crest factor) without kVA/kW derating
8. **Load Power Factor Range:** 0.7 lagging to 1.0 leading without derating
9. **Output Power Rating:** Rated kVA at 0.9 lagging power factor
10. **Overload Capability:**
  - 110% for 1 hour
  - 125% for 10 minutes
  - 150% for 1 minute
11. **Voltage Transient Response:**

100% load step	$\pm 5.0\%$
Loss or return of AC input power	$\pm 1.0\%$
12. **Transient Recovery Time:** to within 2% of output voltage within one cycle
13. **Voltage Unbalance:** 100% unbalanced load,  $\pm 2\%$

## 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 Module:** 32°F to 104°F (0°C to 40°C)
  - **Battery:** 77°F ±9°F (25°C ±5°C)
2. Storage/Transport Ambient Temperature
  - **UPS Module:** -13°F to 158°F (-25°C to 70°C)
  - **Battery:** -4°F to 92°F (-20°C to 33°C)
3. Relative Humidity
  - 0 to 95%, non-condensing
4. Altitude
  - **Operating:** to 6,562 ft. (2000m) above mean sea level without derating. Linearly derated from 100% load at 6,562 ft. (2000m) to 88% load at 9,843 ft. (3000m).
  - **Storage/Transport:** to 40,000 ft. (12,200m) above mean sea level.
5. Audible Noise
  - Less than 61dB for 40-80kVA model
  - Less than 63dB for 100-120kVA model
  - Less than 69dB for 160-200kVA model

## 1.5 Submittals

### 1.5.1 Proposal Submittals

Submittals with the proposal shall include:

- System configuration with single-line diagrams
- Functional relationship of equipment including weights, dimensions and heat dissipation
- Descriptions of equipment to be furnished, including deviations from these specifications
- Size and weight of shipping units to be handled by installing contractor
- Detailed layouts of customer power and control connections
- Detailed installation drawings including all terminal locations

### 1.5.2 UPS Delivery Submittals

Submittals upon UPS delivery shall include a complete set of submittal drawings and one (1) set of instruction manuals that shall include a functional description of the equipment with block diagrams, safety precautions, instructions, step-by-step operating procedures and routine maintenance guidelines, including illustrations.

## **1.6 Warranty**

### **1.6.1 UPS Module**

The UPS manufacturer shall warrant the UPS module against defects in materials and workmanship for 12 months after initial startup or 18 months after ship date, whichever period expires first.

### **1.6.2 Battery**

The battery manufacturer's standard warranty shall be passed through to the end user.

## **1.7 Quality Assurance**

### **1.7.1 Manufacturer Qualifications**

A minimum of 20 years' experience in the design, manufacture and testing of solid-state UPS systems is required. The system shall be designed and manufactured according to world-class quality standards. The manufacturer shall be ISO 9001:2000 certified.

### **1.7.2 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 to ensure guaranteed rated performance.
- System operations, such as startup, shutdown and transfers, shall be demonstrated.
- 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 and shall not have been in prior service except as required during factory testing. All active electronic devices shall be solid-state. All power semi-conductors shall be sealed. Control logic and fuses shall be physically isolated from power train components to ensure operator safety and protection from heat. All electronic components shall be accessible from the front without removing sub-assemblies for service access.

#### 2.1.2 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 Electrical Code and other applicable standards. All electrical power connections shall be torqued to the required value and marked with a visual indicator.

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. All copper busbars for customer power connections shall be tin plated for connection integrity.

#### 2.1.3 Construction and Mounting

The UPS shall be in NEMA Type 1 enclosures, designed for floor mounting. The UPS shall be structurally adequate and have provisions for hoisting, jacking and forklift handling. Maximum cabinet height shall be 78.7 in. (2000mm).

#### 2.1.4 Cooling

Cooling of the UPS shall be by forced air using a redundant fan configuration. Fan power shall be provided by the UPS.

The thermal design, along with all thermal and ambient sensors, shall be coordinated with the protective devices before excessive component or internal cabinet temperatures are exceeded. Air filters shall be located at the point of air inlet and be changeable.

### 2.2 Components

#### 2.2.1 Rectifier/Charger

##### General

The term rectifier/charger shall denote the solid-state equipment and controls necessary to convert AC to regulated DC for input to the inverter and for charging the battery.

##### AC Input Current Limiting

The rectifier/charger unit shall be provided with AC input current limiting whereby the maximum input current shall be limited to 140% of the full input current rating. Input current limit will be adjustable by service personnel to allow the UPS to be used with undersized feeder breakers.

**DC Filter**

The rectifier/charger shall have an output filter to minimize ripple current into the battery. The AC ripple voltage of the rectifier DC output shall not exceed 1% RMS of the float voltage. The filter shall be adequate to ensure that the DC output of the rectifier/charger will meet the input requirements of the inverter without the battery connected.

**Automatic Rectifier Restart**

Upon restoration of utility AC power, after a utility AC power outage and prior to a UPS automatic end-of-discharge shutdown, the rectifier/charger shall automatically restart and assume the inverter and battery recharge loads.

**Overvoltage Protection**

There shall be DC overvoltage protection so that if the DC voltage rises to the preset limit, the UPS will shut down automatically and initiate an uninterrupted load transfer to the static bypass line.

**2.2.2 Inverter****General**

The term inverter shall denote the equipment and controls to convert DC from the rectifier/charger or battery to precise AC 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 utilize insulated gate bipolar transistors (IGBTs).

**Overload Capability**

The inverter shall be capable of supplying current and voltage for overloads exceeding 100%. The inverter is to provide 150% of full load for 1 minute, 125% of full load for 10 minutes and 110% of full load for 1 hour. A status indicator and audible alarm shall indicate overload operation. The UPS shall transfer the load to bypass when overload capacity is exceeded.

**Fault Clearing and Current Limit**

The inverter shall be capable of supplying an overload current of 150% of its full-load rating for one minute. For greater currents or longer time duration, the inverter shall have electronic current-limiting protection to prevent damage to components. The critical load will be transferred to the static bypass automatically and uninterrupted. The inverter shall be self-protecting against any magnitude of connected output overload. Inverter control logic shall sense and disconnect the inverter from the critical AC load without the requirement to clear protective fuses.

**Step Load Response****Voltage Distortion**

- Total harmonic distortion in the output voltage will not exceed 1% for 0% to 100% linear loads.
- Total harmonic distortion in the output voltage will not exceed 4% for 0% to 100% non-linear loads.
- Total harmonic distortion in the output voltage will not exceed 5% for 0% to 100% non-linear, unbalanced loads.

**Phase Balance**

Electronic controls shall be provided to regulate each phase so that an unbalanced loading will not cause the output voltage to go outside the specified voltage unbalance or phase displacement. With 100% load on one phase (and 0% load on the other two phases) or 100% load on two phases (and 0% load on the other phase), the voltage balance is to be within 2% and the phase displacement is to be 120 degrees within  $\pm 1.5$  degrees.

### **Inverter Shutdown**

For rapid removal of the inverter from the critical load, the inverter control electronics shall instantaneously turn off the inverter transistors. Simultaneously, the static transfer switch shall be turned on to maintain continuous power to the critical load.

### **Inverter DC Protection**

The inverter shall be protected by the following disconnect levels:

- DC Overvoltage Shutdown
- DC Undervoltage Warning (Low Battery Reserve) - pre-warning time is adjustable
- DC Undervoltage Shutdown (End of Discharge)

### **Output Frequency**

The output frequency of the inverter shall be controlled by a high-speed DSP capable of holding the inverter output frequency to within  $\pm 0.05\%$  during steady state and transient conditions. Total deviation from the rated frequency, including short time fluctuations and drift, shall not exceed 0.05%.

## **2.2.3 Display and Controls**

### **Monitoring and Control**

The UPS shall be provided with a microprocessor-based unit status display and controls section designed for convenient and reliable user operation. A graphical liquid crystal display (LCD) shall be used to show a single-line diagram of the UPS and shall be provided as part of the monitoring and controls sections of the UPS. All operator controls and monitors shall be located on the front of the UPS cabinet. Monitoring functions such as metering, status and alarms shall be displayed on the graphical LCD. Additional features of the monitoring system shall include:

- Menu-driven display with pushbutton navigation
- Real-time clock (time and date)
- Alarm history with time and date stamp
- Memory with battery backup

### **Metering**

The following parameters shall be displayed:

- Input AC voltage line-to-line
- Input AC current for each phase
- Input frequency
- Battery voltage
- Battery charge/discharge current
- Output AC voltage line-to-line
- Output AC current for each phase
- Output frequency
- Apparent power
- Active power
- Battery time left during battery operation

### Selectable Input Contacts

The UPS shall have these available selectable input contacts:

- On Generator
- Fast Power Off
- MBB Auxiliary Contacts
- Start Battery Test
- Fault Acknowledge
- Bypass and Inverter Off
- Stop Battery Test

### Alarm Messages

The following alarm messages shall be displayed:

- Mains Voltage Abnormal
- Mains Undervoltage
- Mains Freq. Abnormal
- Charger Fault
- Battery Reversed
- No Battery
- Control Power 1 Fail
- Parallel Comm. Fail
- Bypass Unable To Track
- Bypass Abnormal
- Inverter Asynchronous
- Fan Fault
- Control Power 2 Fail
- Unit Over Load
- System Over Load
- Bypass Phase Reversed
- Transfer Time-Out
- Load Sharing Fault
- Parallel Connect Fault
- Bypass Over Current
- Output Ground Fault

## Status Messages

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)
- 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)

## Controls

UPS startup, shutdown and maintenance bypass operations shall be accomplished through pushbutton controls on the front panel. Menu-driven user prompts shall be provided to guide the operator through system operation without the use of additional manuals. Pushbuttons shall be provided to display the status of the UPS and to test and reset visual and audible alarms. A mimic screen shall be available on the LCD to depict a single-line diagram of the UPS with switch positions and power flow.

## On-Line Battery Test

The UPS shall be provided with a menu-driven On-Line Battery Test feature. The test shall ensure the capability of the battery to supply power to the inverter while the load is supplied power in the normal mode.

## 2.2.4 Static Transfer Switch

### General

A static transfer switch and bypass circuit shall be provided as an integral part of the UPS. The static switch shall be a naturally commutated high-speed static (SCR-type) device rated to conduct full load current continuously. The switch shall have an overload rating to clear a 20-ampere load branch circuit breaker.

The static transfer switch control logic shall contain an automatic transfer control circuit that senses the status of the inverter logic signals and operating and alarm conditions. This control circuit shall provide an uninterrupted transfer of the load to an alternate bypass source without exceeding the transient limits specified herein, when an overload or malfunction occurs within the UPS or to bypass the UPS for maintenance.

**Uninterrupted Transfer**

The transfer control logic shall automatically turn on the static transfer switch, transferring the critical AC load to the bypass source, after the transfer logic senses any of the following conditions:

- Inverter overload capacity exceeded
- Critical AC load overvoltage or undervoltage
- UPS fault condition

The transfer control logic shall inhibit an automatic transfer of the critical load to the bypass source if any of the following conditions are present:

- Bypass frequency out of limits
- Bypass out-of-synchronization range with inverter output

**Uninterrupted Retransfer**

Retransfer of the critical AC load from the bypass source to the inverter output shall be automatically initiated unless inhibited by manual control. The transfer control logic shall inhibit an automatic retransfer of the critical load to the inverter if one of the following conditions exists:

- Bypass out of synchronization range with inverter output
- Inverter/bypass voltage difference exceeding preset limits
- Overload condition exists in excess of inverter full load rating
- UPS fault condition present

**2.2.5 Maintenance Bypass Switch****General**

A manually operated maintenance bypass switch shall be incorporated into the UPS cabinet to directly connect the critical load to the bypass AC input power source, bypassing the rectifier/charger, inverter and static transfer switch.

**2.2.6 Optional Accessories****Vertiv™ Liebert® IntelliSlot Web Card (ISWEB-LB)**

Provides communication outputs to indicate a change of status of the UPS. Outputs are provided for:

- SNMP
- HTML - Web page
- Allow use of Vertiv™ Liebert® Nform and or network management systems

**Matching Maintenance Bypass and Distribution Cabinet**

A make-before-break maintenance bypass with Solenoid Key Release Unit (SKRU) interlock shall be available in a cabinet that matches and may be bolted up to the UPS. Installation of the cabinet shall not affect the cooling ability of the UPS. Thermal-magnetic breakers shall be provided for bypass and maintenance isolation.

### Remote Alarm Panel

The remote alarm panel shall have LED alarm lights. An audible alarm shall sound upon any alarm condition. The surface- or flush-mounted NEMA 1 enclosed panel shall indicate:

- Load on UPS LED
- Load on Bypass LED
- Battery Discharging LED
- Low Battery Warning LED
- UPS Alarm Condition LED
- New Alarm Condition LED (For a Second UPS Alarm Condition)
- Audible Alarm with Reset pushbutton
- Lamp Test/Reset pushbutton

### 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,
- Lithium-Ion Battery System or
- Vycon Flywheel Energy Storage System.

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

## 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.

#### 4.1.1 Visual Inspection

1. Inspect equipment for signs of damage.
2. Verify installation per drawings.
3. Inspect cabinets for foreign objects.
4. Verify neutral and ground conductors are properly sized and configured.
5. Inspect battery cases.
6. Inspect battery for proper polarity.
7. Verify all printed circuit boards are configured properly.

#### 4.1.2 Mechanical Inspection

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

#### 4.1.3 Electrical Inspection

1. Check all fuses for continuity.
2. Confirm input voltage and phase rotation is correct.
3. Assure connection and voltage of the battery string(s).

### 4.2 Manufacturer's Field Service

#### 4.2.1 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 a day, 7 days a week, 365 days a 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.

#### 4.2.2 Replacement Parts Stocking

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

Spare parts shall be stocked by local field service personnel with backup available from national parts center 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.

#### **4.2.3 Maintenance Contracts**

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

#### **4.2.4 Automated Site Monitoring**

The UPS manufacturer shall provide as an option an automated site-monitoring service. This service shall be staffed by a qualified support person 24 hours a day, 7 days a week, 365 days a year. At the detection of an alarm within the UPS, the controls shall initiate communications with the monitoring service. The monitoring service shall be capable of interpreting the communicated alarms to allow dispatch of a service engineer.