Vertiv™ Liebert® PPC

GUIDE SPECIFICATIONS
400 kVA to 1000 kVA Power Distribution Unit

1.0 GENERAL

1.1 Summary

These specifications outline the requirements for a complete power distribution unit (PDU) that supplies computer-grade power to sensitive loads. The specified system should provide isolation, distribution, and monitoring of AC power. It shall include all equipment to properly interface the AC power source to the intended load.

1.2 Standards

The specified system shall be designed, manufactured, tested, and installed in compliance with:

- American National Standards Institute (ANSI)
- Canadian Standards Association (CSA)
- U.S. Department of Energy (DOE)
- Federal Information Processing Standards Publication 94 (FIPS Pub 94)
- Institute of Electrical and Electronics Engineers (IEEE)
- ISO 9001
- National Electrical Code (NEC - NFPA 70)
- National Electrical Manufacturers Association (NEMA)
- National Fire Protection Association (NFPA 75)
- Underwriters Laboratories (UL)

The system shall be UL listed as a complete system under UL60950/UL62368 Standard for Information Technology Equipment.

The specified system shall comply with latest FCC Part 15 EMI emission limits for Class A computing devices and the emission and immunity limits of EN50081-2/EN550022 Class A and EN50082-2.

The system withstands the following conditions without misoperation or damage:

- Transient voltage surges on the AC power input as defined by ANSI/IEEE C62.41 for Category B3 locations (high surge exposure industrial and commercial facilities).
- Electrostatic discharges (ESD) up to 10 kV at any point on the exterior of the unit.
- Electromagnetic fields from portable transmitters within 3 ft. (1 m) of the unit.

1.2.1 Electrical Requirements

- The rated capacity shall be selectable from 400, 500, 600, or 750 kVA.
- Input voltage shall be 480/600 V AC, 60 Hz, three-phase, three-wire-plus-ground.
- Output voltage shall be 208Y/120V, 400Y/230V, 415Y/240V, Volts AC, three-phase, four-wire-plus-ground, wye configuration.

1.2.2 Environmental Requirements

1. **Storage temperature range:** -67 °F to 185 °F (-55 °C to 85 °C).
2. **Operating temperature range**: 32 °F to 104 °F (0 °C to 40 °C). If 1000 AT subfeed breakers are selected for distribution, the maximum operating temperature shall be limited from 32 °F to 95 °F (0 °C to 35 °C).
3. **Relative humidity:** 0% to 95% without condensing.
4. **Operating altitude:** Up to 6600 ft. (2000 m) above mean sea level. Derated for higher altitude applications.
   a. <3300 ft. (1000 m) at full capacity rating and at 104 °F (40 °C) operating temperature.
   b. 3301 ft. to 4000 ft. (1000 m to 1200 m) at 99.5% capacity rating or reduce operating temperature to 102.2 °F (39 °C).
   c. 4001 ft. to 5000 ft. (1200 m to 1500 m) at 99.0% capacity or reduce operating temperature to 99.5 °F (37.5 °C).
   d. 5001 ft. to 6000 ft. (1500 m to 1829 m) at 98.5% capacity or reduce operating temperature to 96.8 °F (36 °C).
   e. 6001 ft. to 6600 ft. (1829 m to 2000 m) at 98.1% capacity or reduce operating temperature to 94.3 °F (34.6 °C).
5. **Storage/Transport:** Up to 40000 ft. (12200 m) above mean sea level.
6. **Audible noise level:** Under normal operation noise level shall not exceed the NEMA ST-20 standard for transformers.

1.3 Documentation

1.3.1 Equipment Manual

The manufacturer shall furnish an installation manual with installation, startup, operation and maintenance instructions for the specified system.

1.3.2 Drawings

Wiring diagrams and drawings of major components shall be furnished.

1.3.3 Spare Parts

A list of recommended spare parts shall be supplied at the customer's request.

1.3.4 User's List

An in-service user's list shall be furnished upon request.

1.4 Warranty

The manufacturer shall provide a warranty against defects in material and workmanship for 12 months after initial startup or 18 months after ship date, whichever occurs first. Refer to the Warranty Statement for details.

1.5 Quality Assurance

The specified system shall be factory-tested before shipment. Testing shall include but shall not be limited to: Quality Control Checks, “Hi-Pot” Test (two times rated voltage plus 1000 V, per UL requirements) and Metering Calibration Tests. The system should be designed and manufactured according to world-class quality standards. The manufacturer shall be ISO 9001 certified.

2.0 PRODUCT

2.1 Components

2.1.1 Frame Construction and Enclosure

The frame shall be constructed of fully welded or hybrid (mix of welded/riveted) steel to provide a strong substructure. The unit shall have removable input and output cable trays. All installation and service shall be capable of being performed with access to the front only. Retrofitting additional power distribution cables shall require access to the front of the unit only. A tool shall be required to remove the exterior panels, which protect the hazardous voltage area of the unit. To ensure grounding integrity and for static protection and EMI/RFI shielding, the removable exterior panels shall be grounded to the frame. Hinged front doors shall provide access to the main input circuit breaker and all output circuit breakers. The color of the exterior panels shall be the manufacturer's standard color, black gray matte (ZP-7021).

The unit shall be naturally convection-cooled. No fans for forced-air cooling system shall be used. The convection cooling method shall allow continuous full-load operation without activation of overtemperature circuits. Heat rejection shall be through a screened top. Degree of protection for the enclosure shall be IP-20.

The standard unit measures 60 in. (1524 mm) width × 82 in. (2083 mm) height × 48 in. (1219 mm) depth for the standard offering. Other sizes are available with engineered to order configurations.

2.1.2 Input Power Connections

Copper busbars for two-hole lugs shall be provided for connection of the input power conductors. A copper ground busbar shall be provided for connection of a parity-sized insulated ground conductor.

2.1.3 Main Input Circuit Breaker

The specified unit shall be equipped with a main input circuit breaker to provide overcurrent protection and a means for disconnecting all power to the unit. The main input circuit breaker shall be a three-pole molded case circuit breaker, sized according to the rated input current based on the kVA rating, and input voltage. The main input circuit breaker shall include a 24 VDC shunt trip mechanism to interface with unit controls, Emergency power off (EPO) buttons and other remote controls as required by the NEC and local codes.

2.1.4 Isolation Transformer

The unit shall contain an electrostatically shielded isolation transformer with a rating as described in Section 1.3. The transformer shall be a dry-type, double-shielded, three-phase, common-core, convection air-cooled transformer. The transformer shall conform to UL1561, with 300 °F (150 °C) maximum temperature rise. All transformer windings shall be copper. The transformer shall be energy efficient and meet DOE standards TP-1 2016.

- **Rating:** 400/500/600/750 kVA
- **Primary-side voltage:** 480/600 VAC
- **Secondary-side voltage:** 208/400/415 VAC
- **K-factor:** K4/K13/K20
- **Temperature rise:** 302 °F (150 °C) 428 °F (220 °C) insulation class)/239 °F (115 °C) (optional)
- **Inrush:** 8-10X (standard)/Low Inrush (4-5X) (optional)
- **Windings material:** Copper (standard)/aluminum (optional)

The unit shall be provided with additional thermal overload protection for the transformer. An alarm shall notify personnel if the transformer temperature reaches 356 °F (180 °C). The unit shall automatically shut down if the transformer temperature reaches 392 °F (200 °C). Temperature sensors shall be in each coil of the three-phase windings.

2.1.5 Automatic/Manual Restart

The specified unit shall be equipped with a manual restart feature to allow for an orderly supervised startup after power failure. The control circuit shall automatically energize the shunt trip mechanism of the main input breaker upon sensing output voltage failure. A field-selectable auto-restart mode shall be provided to deactivate the manual restart function, if desired.

2.1.6 Emergency Power Off

The local EPO shall include a covered EPO push button. Pressing the EPO switch shall immediately shut down the unit by activating the shunt trip of the main input circuit breaker. As part of the EPO circuit, an interface shall also be provided for connecting one or more normally open or normally closed remote EPO switches to the EPO circuit. For flexibility in meeting shutdown control schemes, the local EPO (unit shutdown) circuit shall be isolated from the remote EPO (room shutdown) circuit. The remote EPO circuit shall be designed to allow direct connection of multiple units with single and multiple shutdown control contacts.

2.1.7 Grounding System

The specified system shall include a single-point ground in accordance with computer manufacturers' recommendations, IEEE Std. 1100 and the requirements of the NEC. The transformer output neutral shall be solidly grounded in accordance with NEC article 250-26. Grounding conductors shall be sized in accordance with IEC 364-HD-384 and applicable national and local codes.

2.1.8 Output Distribution Breakers

The specified unit shall be equipped with 600 AF (80%) 1200 AF (100%) rated 35 kAIC at 480 V LSI trip subfeed circuit breakers for distribution to the intended loads. The UL-listed interrupting rating for the distribution circuit breakers shall be 35000 RMS symmetrical amperes at 480 VAC.

The number of breakers will vary based on the rating selected, as follows:

- Up to 8 subfeed breakers:
  - 600 AF/250 AT (80% or 100%)
  - 600 AF/400 AT (80% or 100%)
  - 600 AF/600 AT (80%)
- Up to 4 subfeed breakers:
  - 1200 AF/600 AT (100%)
  - 1200 AF/800 AT (80% or 100%)
  - 1200 AF/1000 AT (80% or 100%)

Note: If 1000 AT subfeed breakers are selected for distribution, the maximum operating temperature shall be limited to 95 °F (35 °C).

2.2 Power Monitoring System (Transformer Only)

Provide an interface for solid-state digital power monitoring as shown on the electrical one-line diagrams, communications block diagrams, and in accordance with installation instructions.

The specified system shall be equipped with a microprocessor-based power monitoring system. The monitoring system shall gather and process information from electrical and environmental sensors, relays, and switches both internal and external to the unit. The monitored parameters and alarms shall be displayed on the unit control panel/display and shall also be available for communication to a centralized monitoring system.

2.2.1 Monitored Parameters

The monitoring system shall monitor and display all the following parameters:

- Frequency
- Input voltage, line-to-line for all three phases
- Output voltages, line-to-line for all three phases
- Output voltages, line-to-neutral for all three phases
- Output current for all three phases
- Output neutral current
- System ground current
- Output current loads for all three phases
- Output real power
- Output apparent power
- Output apparent power load
- Output power factor for all three phases and total
- Output energy
- Output peak current for all three phases
- Output peak demand
- Output current crest factor (peak/RMS) for all three phases
- Output current harmonic K-factor for all three phases
- Output current total harmonic distortion (THD) for all three phases
- Output current 3^{rd}, 5^{th}, 7^{th}, and 9^{th} order harmonic distortion components for all three phases
- Input voltage THD for all three phases, which includes 3^{rd}, 5^{th}, 7^{th}, and 9^{th} order harmonics
- Output voltage THD for all three phases, which includes 3^{rd}, 5^{th}, 7^{th}, and 9^{th} order harmonics

All three phases of the three-phase parameters shall display simultaneously. All voltage and current parameters shall be monitored using true RMS measurements to accurately represent non-sinusoidal waveforms typical of computers and other sensitive loads.

2.2.2 Alarm Annunciation

The monitoring system shall detect and announce by audible alarm and alarm message the following conditions:

- Output overvoltage
- Output undervoltage
- Phase overcurrent
- Neutral overcurrent
- Ground overcurrent
- Voltage distortion
- Frequency deviation
- Phase sequence error
- Phase loss
- Transformer high temperature

All alarm thresholds for monitored parameters shall be adjustable by graphical user interface (GUI) or USB Port to match site requirements. The factory set points for the alarms shall be as follows:

- **Output overvoltage:** Voltage exceeds +6% of nominal.
- **Output undervoltage:** Voltage falls below -13% of nominal.
- **Output overcurrent:** Current exceeds 95% of full load amperes.
- **Neutral overcurrent:** Current exceeds 95% of full load amperes.
- **Ground overcurrent:** Current exceeds 30 A.
- **Output voltage distortion:** Output voltage THD exceeds 10%.
- **Frequency deviation:** Output frequency exceeds ±0.5 Hz of nominal.

To facilitate troubleshooting, all alarms shall be stored in (non-volatile) memory until reset to protect against erasure by a power outage. Alarms shall be able to be manually reset after the alarm condition has been corrected either at the unit or by way of the central monitoring system.

2.2.3 Custom Alarm Annunciation

The monitoring system shall be capable of providing alarm annunciation for up to two contact closures (two NO and NC).

A custom alarm message up to 29 characters shall be provided for each contact.

Alarm messages shall be programmable by the GUI or USB port to match site requirements.

2.2.4 Summary Alarm Contact

A Form C (one NO and NC) summary alarm contact shall be provided for remote alarm status. The contacts shall change state upon occurrence of any alarm and shall rest upon alarm silence.

2.2.5 Control Panel/Display

The PDU shall be provided with a microprocessor-based control panel for operator interface (may also be referred to as GUI) to configure and monitor the PDU. The control panel shall be located on the front of the unit where it can be operated without opening the hinged front door.

A 9 in. (229 mm), 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 PDU, active events and event history.

Mechanical push buttons shall not be used for interface control, except for EPO functions.

Control panel logic:

- PDU system logic and control programming shall reside in a microprocessor-based control system with nonvolatile flash memory.
- System control logic shall utilize high speed digital signal processors (DSPs). CANbus shall be used to communicate between 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 PDU logic by relays or optical isolation.

The control panel/display shall monitor the base transformer cabinet and any attached ancillary cabinets.

2.2.6 Remote Monitoring Communication

Two Vertiv™ Liebert® IntelliSlot™ ports shall be provided to allow communication to remote monitoring systems using Liebert® IntelliSlot™ cards.

Equipped RDU101 Cards, for remote communication, can use up to two of the following protocols:

- HTTP/HTTPS, Vertiv protocol, email, SMS, SNMP v1/v2c/v3, BACnet IP and Modbus TCP output.
- BACnet/MSTP and Modbus/RTU support will require a USB to RS-485 adapter. The adapter is available as an accessory.

Note: Two of the 3rd party protocols (SNMP, Modbus, or BACnet) may be configured and used simultaneously.

Modbus RTU and BACnet MSTP cannot both be enabled simultaneously.

3.0 SUPPLEMENTAL ACCESSORIES/OPTIONS

3.1 Additional Options

1. **Skirt kits:** Skirt kits are provided in forced air/raised floor applications: the PDU must have an open floor stand to allow forced air cooling to proliferate through the PDU. Refer to submittal TFX-24-S05x for required static pressure (SP).
2. **IR scan ports:** IR scan ports are required for monitoring the following internal components like transformer taps, ground and neutral installer connections, and main input circuit breaker connections.

3.1.1 Alternate Option 1: System Surge Rating

The specified system shall comply with ANSI/IEEE C62.41 Category B2 (4 kV maximum surge rating).

1. AC input surge protection shall include:
    - A surge arrester to divert high-voltage input power surges quickly and safely to ground.
        - The surge arrester shall be mounted ahead of all electrical components to provide maximum protection of the unit insulation and wiring.
        - The surge arrester shall be capable of repeated operations and have a surge current rating of 40 kA/phase and short circuit current rating of 200 kA and discharge current rating of 10 kA. It has UL1449 4th edition certification and UL96A lightning protection.
2. AC output surge protection shall include:
    - A surge suppression module to eliminate high speed, high-energy transients and to filter high frequency noise. The surge suppression module shall be mounted on the output of the unit. The surge suppressor components shall be recognized by UL.
        - The surge suppressor shall utilize high-energy metal oxide varistors (MOV). Peak current handling capability shall be at least 6500 A based on an 8X20 microsecond waveform. Energy absorption capability shall be at least 80 J for L-N and 130 J for L-L.

3.1.2 Alternate Option 2: System Surge Rating

The specified system shall comply with ANSI/IEEE C62.41 Category B3 (6 kV maximum surge rating).

1. Alternate surge protection
    a. AC input surge protection to include:
        - The system shall be equipped with a surge arrester to divert high-voltage input power surges quickly and safely to ground.
        - The surge arrester shall be mounted ahead of all electrical components to provide maximum protection of the unit insulation and wiring.
        - The surge arrester shall be capable of repeated operations and have a surge current rating of 40 kA/phase and short circuit current rating of 200 kA and discharge current rating of 10 kA. It shall have UL1449 4th edition certification and UL96A lightning protection.

b. Output surge suppression (TVSS)

- The unit shall be equipped with a high-energy, UL1449 listed TVSS module connected to the unit output with minimal interconnecting wiring for maximum surge suppression.
- The TVSS shall be UL1449 4th edition listed. designed, manufactured and tested consistent with:
    - ANSI/IEEE C62.41.1-2002, C62.41.2-2002, C62.45-2002, C62.62-2010, C62.72-2016, and IEEE SA.
    - 1100-2005 (Emerald Book).
    - NEC Article 285.
    - NEC Articles 620.51 (E), 645.18, 670.6, 695.15, 700.8, and 708 requiring SPDs.
    - UL96A and NFPA 780 lightning protection.
    - IEC 61643, CE.
- The surge arrester shall be capable of repeated operations and have a surge current rating of 100 kA/phase and short circuit current rating of 200 kA and discharge current rating of 20 kA.
- The maximum continuous operating voltage shall be at least 150 VAC for a 120/208 V system
- An alarm contact of the TVSS module shall be connected to the unit monitoring system to announce any TVSS failure.

2. Alternate main breaker

a. Dual main input breaker.

- The specified unit shall be equipped with two main input circuit breakers to provide overcurrent protection from two independent sources while also supplying a means for disconnecting all power to the unit. The main input circuit breakers shall be a three-pole molded case circuit breaker sized for 125% of the specified full load input current and rated for 600 VAC. The minimum UL-listed interrupting rating for the main input circuit breakers shall be 35000 RMS or 65000 RMS symmetrical amperes at 480 VAC. The main input circuit breakers shall include a 24 VDC shunt trip mechanism to interface with unit controls, EPO button and other remote controls as required by the NEC and local codes.
- The dual MICB provides a kirk-key configuration for a break-before-make configuration.

b. No main breaker

- The specified unit shall be equipped without a main input circuit breaker; the customer is responsible for providing overcurrent protection upstream. Refer to the submittal for breaker requirements.

3.2 Power Monitoring (Transformer and Distribution) and Controls (Alternate)

Provides interface for solid-state digital power monitoring as shown on the electrical one-line diagrams, communications block diagrams, and in accordance with installation instructions.

The specified system shall be equipped with a microprocessor-based power monitoring system. The monitored parameters and alarms shall be displayed on the unit control panel/display and shall also be available for communication to a centralized monitoring system.

The monitoring system shall monitor and display all the following primary side input and secondary side output parameters:

- Frequency
- Input voltage, line-to-line for all three phases
- Output voltages, line-to-line for all three phases
- Output voltages, line-to-neutral for all three phases
- Output current for all three phases
- Output neutral current
- System ground current
- Output current load for all three phases
- Output real power (kW)
- Output apparent power (kVA)
- Output apparent power load
- Output power factor for all three phases and total
- Output energy (kWh)
- Output peak current for all three phases (kW)
- Output peak demand (kW)
- Output current crest factor (peak/RMS) for all three phases
- Output current harmonic K-factor for all three phases
- Output current THD for all three phases, which includes monitoring the 3^{rd}, 5^{th}, 7^{th}, and 9^{th} order harmonics
- Input voltage THD for all three phases, which includes monitoring the 3^{rd}, 5^{th}, 7^{th}, and 9^{th} order harmonics
- Output voltage THD for all three phases, which includes monitoring the 3^{rd}, 5^{th}, 7^{th}, and 9^{th} order harmonics

The monitoring system shall monitor and display all the following panel board main and/or sub-feed breaker parameters.

- Phase current
- Neutral current
- Ground current
- Current load percentage

- Voltage line-to-line
- Voltage line-to-neutral
- Frequency
- Real power (kW)
- Apparent power (kVA)
- Power factor
- Energy (kWh)
- Peak current (A)
- Peak demand (kW)
- Current crest factor
- Current THD in total THD includes 3rd, 5th, 7th, and 9th order harmonics
- Voltage THD in total THD includes 3rd, 5th, 7th, and 9th order harmonics

Circuit identification and status of each breaker shall be displayed.

The sub-feed breakers or panel board mains shall be monitored using 5W (3PH+N+G) 4W (3PH+N) current transformer (CT) kits.

The monitoring system shall monitor and display all the following panel board branch breaker parameters.

- Phase current
- Percent load
- Real power (kW)
- Power factor
- Energy (kWh)
- Peak current (A)
- Peak demand (kW)

Circuit identification of each breaker shall be displayed

All three phases of the three-phase parameters shall be displayed simultaneously. All voltage and current parameters shall be monitored using true RMS measurements for accurate representation of non-sinusoidal waveforms typical of computers and other sensitive loads.

The monitoring system shall detect and annunciate by audible alarm and alarm message the following conditions:

- Output overvoltage
- Output undervoltage
- Phase overcurrent
- Neutral overcurrent
- Ground overcurrent
- Voltage distortion

- Frequency deviation
- Phase sequence error
- Phase loss
- Transformer high temperature
- Sub-feed or panelboard mains equipped with alarm switches shall indicate tripped status.
- Sub-feed or panelboard mains equipped with auxiliary switches shall indicate accessory fail if the aux switch fails.
- Summary alarm

All alarm thresholds for monitored parameters shall be adjustable by GUI or USB Port to match site requirements. The factory set points for the alarms shall be as follows:

- **Output overvoltage:** Voltage exceeds +6% of nominal.
- **Output undervoltage:** Voltage falls below -13% of nominal.
- **Output overcurrent:** Current exceeds 80% of full load amperes.
- **Neutral overcurrent:** Current exceeds 95% of full load amperes.
- **Ground overcurrent:** Current exceeds 10 A for 150 kVA to 225 kVA or 15 A for 250 kVA to 300 kVA.
- **Output voltage distortion:** Output voltage THD exceeds 10%.
- **Frequency deviation:** Output frequency exceeds ±0.5 Hz of nominal.

To facilitate troubleshooting, all alarms shall be stored in (non-volatile) memory until reset to protect against erasure by a power outage. Alarms shall be able to be manually reset after the alarm condition has been corrected either at the unit or by way of the central monitoring system.

3.2.1 Custom Alarm Annunciation

The monitoring system shall be capable of providing alarm annunciation for up to two contact closures (two NO and NC).

A custom alarm message up to 29 characters shall be provided for each contact.

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A 9 in. (229 mm), 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 PDU, active events, and event history.

In addition to measuring and recording numerical values for voltage and current, the PDU shall be able to also capture sinusoidal waveform data. The captured current and voltage waveform provides additional information for analyzing the power quality of system.

No mechanical push buttons shall be used to control the interface. Mechanical EPO push buttons are acceptable.

Control panel logic:

- PDU system logic and control programming shall reside in a microprocessor-based control system with nonvolatile flash memory.
- System control logic shall utilize high speed DSP. CANbus shall be used to communicate between 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 PDU logic by relays or optical isolation.

The control panel/display shall monitor the base transformer cabinet and any attached ancillary cabinets.

3.2.4 Remote Monitoring Communication

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- BACnet/MSTP and Modbus/RTU support will require a USB to RS-485 adapter. The adapter is available as an accessory.

Note: Two of the 3rd party protocols (SNMP, Modbus, or BACnet) may be configured and used simultaneously.

Note: Modbus RTU and BACnet MSTP cannot both be enabled simultaneously.

3.3 Alternate 2: No Power Monitoring and No Controls

The no-monitoring option shall have transformer overtemperature and EPO circuits only.

The transformer overtemperature circuit shall include a visual alarm if any internal transformer winding temperature reaches 356 °F (180 °C).

4.0 EXECUTION

Factory startup, preventive maintenance, and full service for the specified system shall be available and included upon request. The manufacturer shall directly employ a nationwide service organization consisting of factory-trained field service personnel dedicated to the startup, maintenance, and repair of the manufacturer's power equipment. The manufacturer shall maintain a national dispatch center operating 24 hours a day, 365 days a year, to minimize service response time and maximize the availability of qualified service personnel.