Vertiv™ Liebert® STS2 / Vertiv™ Liebert® PDU
GUIDE SPECIFICATIONS
Static Transfer Switch Power Distribution Unit
250A - 800A

1.0 GENERAL

1.1 Summary

This specification describes the requirements for a combination automatic static transfer switch and power distribution unit. The Liebert® STS2 / Liebert® PDU shall include two isolation transformers connected to a solid-state, three-pole, dual-position static transfer switch designed to switch automatically and manually between two synchronized three-phase AC power sources without an interruption of power to the load longer than 4 milliseconds (1/4 cycle). Input, output, bypass circuit breakers and a distribution section shall be included to form an integrated system in a single freestanding enclosure. The system shall be designed with no rear access required for installation and normal maintenance.

The input power shall be supplied from two different AC power sources, which are nominally synchronized, of the same voltage level, phase rotation and frequency. The primary purpose of the Liebert® STS2 / Liebert® PDU is to allow virtually uninterrupted transfer from one source to the other in case of failure of one source or by manual initiation for test or maintenance. The switching action shall not connect together the two sources of power that would allow back feeding one source to the other. The Liebert® STS2 / Liebert® PDU shall allow for either source to be designated as the preferred source. The switch will automatically transfer to the preferred source and remain so until manually initiated to transfer or until the selected source fails. If the selected source fails, the Liebert® STS2 / Liebert® PDU shall transfer without interruption greater than 4 milliseconds (1/4 cycle) to the other source, or to an alternate source. The Liebert® STS2 / Liebert® PDU shall be furnished with key-interlocked static switch isolation and bypass breakers to each source, which allow uninterrupted manual transfer to and from either source for maintenance.

1.2 Standards

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

- American National Standards Institute (ANSI)
- Canadian Standards Association (CSA)
- Department of Energy (DOE)
- Institute of Electrical and Electronics Engineers (IEEE)
- ISO 9001
- National Electrical Code (NEC)
- National Electrical Manufacturers Association (NEMA)
- National Fire Protection Association (NFPA)
- Underwriters Laboratories (UL) (ULc)
- CE Marked

The Liebert® STS2 / Liebert® PDU shall be UL and ULc listed per UL Standard 891, Standard for Switchboards. The unit shall also meet Standard for Automatic Transfer Switches UL1008, Standard for Panelboard UL67 and Standards for dry type general-purpose transformers UL1561.

The Vertiv™ Liebert® STS2 / Vertiv™ Liebert® PDU shall comply with EN 60947-6-1, Specification for Low-voltage Switchgear and Automatic Transfer Equipment and IEC 62310, Static Transfer Equipment.

The Liebert® STS2 / Liebert® PDU shall comply with the latest FCC Part 15 EMI emission limits for Class A computing devices and the emission limits of EN61000-6-2:1999 Class A.

The Liebert® STS2 / Liebert® PDU shall safely withstand without misoperation or damage:

- Transient voltage surges on either 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. (1m) of the unit

The Liebert® STS2 / Liebert® PDU shall comply with the immunity requirements of EN50082-2 Class A.

1.3 Definitions

- **STS -** Static Transfer Switch
- **SCR -** Silicon Controlled Rectifier
- **MTBF -** Mean Time Between Failure is the actual arithmetic average time between failures of the critical AC output bus.
- **Circuit breaker -** An overcurrent device that has automatic thermal and magnetic overload trip elements for overload and short-circuit/fault protection
- **Non-automatic circuit breaker -** A circuit breaker that has no automatic thermal overload trip element but does have a magnetic trip element for short-circuit/fault protection. Overload protection must be provided by an upstream overcurrent device.

1.4 System Description

1. **Ratings.** (250) (400) (600) (800) A. (400A, 600A and 800A not available if input is 208V) (600A and 800A not available if input/output is 380V, 400V or 415V).
2. **Input Voltage.** Input voltage specifications of the Liebert® STS2 / Liebert® PDU shall be (208) (380) (400) (415) (480) (600) volts, three-phase, (50) (60) Hz, three-wire plus ground.
3. **Output Voltage.** Output voltage specifications of the Liebert® STS2 / Liebert® PDU shall be (208/120) (380/220) (400/230) (415/240) volts, three phase, (50) (60) Hz, four-wire plus ground.
4. **Output Load Capacity.** Specified output load capacity of the Liebert® STS2 / Liebert® PDU shall be (250) (400) (600) (800) A. The Liebert® STS2 / Liebert® PDU shall be continuous rated to carry a full 100% load.

This specification is for ( ) complete units.

1.5 Submittal Requirements

The information with the bid shall include the following items.

- Technical proposal, including system one-line diagram, specification, unit ratings, transformer ratings, frame size and current ratings of circuit breakers.
- Complete product data sheet (catalog sheet or brochure)
- Outline and installation drawings showing dimensions and weight of the equipment, along with external power cable connections and recommended cable entrances and exits. Details of recommended service clearances.
- All listing numbers showing that the equipment has been tested and certified to Underwriters Laboratory (UL) standards.
- One (1) set of recommended spare parts for the specified system shall be furnished upon request.
- Provide the following information with regard to maintenance service:
  - Name of service organization
  - Address and phone number of service facility
  - Location of nearest parts depot

1.6 Delivery Submittal

Outline and installation drawings showing dimensions and weight of the equipment, along with external power cable connections and recommended cable entrances and exits. Outline and installation drawings shall also show details of recommended service clearances.

The manufacturer shall supply two (2) copies of User Manual, that include a functional description of the equipment with illustration, block diagrams, safety precautions, instructions, step-by-step startup and operating procedures and routine maintenance guidelines.

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

1.7 Warranty

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

1.8 Quality Assurance

1.8.1 Manufacturer Qualifications

A minimum of five year's experience in the design, manufacture and testing of Vertiv™ Liebert® STS2 / Vertiv™ Liebert® PDU systems is required. The specified system shall be completely 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 volts, per UL requirements), transfer tests and metering calibration tests. The system shall be designed, manufactured and tested according to world-class quality standards. The manufacturer shall be ISO 9001 certified.

Acceptable manufacturers shall be Emerson Network Power.

2.0 PRODUCT

2.1 Electrical Requirements

1. **Nominal Input Voltage**: (208) (380) (400) (415) (480) (600) volts three-phase, three-wire-plus-ground
2. **Voltage Range**: ±10% of nominal
3. **Frequency**: (50) (60) Hz. ±0.5 Hz
4. **Nominal Output Voltage**: 208/120 volts three-phase, four-wire-plus-ground
5. **Maximum Continuous Current**: (250) (400) (600) (800) amps (400A, 600A and 800A not available if input and output is 208V; 800A not available if input is 380V and output is 208V)
6. **Load Power Factor Range**: 0.75 to 1.0, leading or lagging
7. **Load Crest Factor**: Up to 3.5
8. **Source Voltage Distortion**: Up to 10% THD with notches and ringing transients
9. **Surge Protection**: Sustains input surges without damage per criteria listed in ANSI C62.41 Category A and B
10. **Sensing and Transfer Time**: 4 ms
11. **Overload Capability**:
    - 125% for 30 minutes (250-400A)
    - 125% for 10 minutes (600-800A)
    - 150% for 2 minutes
    - 500% for 0.25 seconds
12. **Short Circuit Withstand Capability**:

	208V	380-480V	600V
250A	200kA	100kA	65kA
400-600A	-	100kA	65kA
800A	-	65kA	25kA

2.2 Environmental Conditions

1. **Storage Temperature Range**: -40° to 176°F (-40° to +80°C)
2. **Operating Temperature Range**: 32° to 104°F (0° to 40°C)
3. **Relative Humidity**: 0 to 95% without condensation
4. **Operating Altitude**: Up to 4000 ft. (1200m) above sea level without derating. Above 4000 ft. (1200m), output current is derated by 6% per 1000 ft. (18% per 1000m).
5. **Storage/Transport Altitude**: Up to 40,000 ft. (12,200m) above sea level
6. **Audible Noise:** Less than 60 dBA at 5 ft. (1.5m) with audible alarm off

2.3 Enclosure Requirements

1. The Vertiv™ Liebert® STS2 / Vertiv™ Liebert® PDU shall be housed in a single freestanding NEMA Type 1 enclosure. Enclosure shall be constructed of galvanized steel and pop-riveted to provide a strong substructure. Doors and removable exterior panels shall be a minimum of 18GA steel and be properly cleaned and finished. The finish shall be of a suitable texture enamel finish paint and the color shall be the manufacturer's standard color. Key lock hinged doors shall provide access to the Liebert® STS2 / Liebert® PDU, circuit breakers and distribution. All doors shall be keyed alike. Opening of an exterior door shall not provide access to any live parts. A tool shall be required to remove exterior panels that expose hazardous voltages. All removable panels shall be grounded to the frame for safety and EMI/RFI protection. The enclosure shall be structurally designed to be moved with a forklift from the base.
2. The Liebert® STS2 / Liebert® PDU shall require front, top and side access only for all installation, operations and normal maintenance, including infrared scanning of bussing and breakers. All normal operating controls and instrumentation shall be located on the front of the enclosure. Input and Liebert® STS2 / Liebert® PDU breakers shall be located on the front of the unit with output distribution breakers or panelboards located on the (right) (left) side. All breakers shall be mounted behind closed doors. No rear access shall be required.
3. **Cooling** - The Liebert® STS2 / Liebert® PDU shall utilize forced air-cooling. All fans shall be redundant so that a single fan failure will not cause temperature to increase beyond acceptable limits. Heat rejection shall be through screened protective openings in the top of the unit. Air filters shall be located in the front of the unit at the point of air inlet. The air filters shall be easy to replace without exposure to hazardous voltages.
4. An equipment temperature sensor shall be located inside the enclosure to provide thermal overload protection. This thermal device shall initiate an Equipment Overtemp alarm.
5. Panels that must be opened to provide normal maintenance shall be hinged or designed to allow for easy access and reduce the likelihood of accidental outages associated with the removal and reinstallation of metallic parts on energized equipment. All accent panels shall be held in place by captive screws.
6. The enclosure shall include removable conduit/cable termination plates in the bottom and top (top exit not available on units with inline panelboards) of the enclosure for termination of the two inputs and output conduits, raceways or cables. The enclosure shall provide ample space for input and output cabling and conduits.
7. Provide nameplates for all devices used by the customer in normal operation of the unit, such as circuit breakers and customer connections. Nameplates shall be plastic or polyester with black letters on an off-white background. Nameplates shall be secured with adhesive.
8. The Liebert® STS2 / Liebert® PDU shall be constructed of replaceable subassemblies that can be easily changed without exposing personnel to high voltage. Printed circuit assemblies shall be plug connections.
9. The Liebert® STS2 / Liebert® PDU shall include a computer-grade single-point ground in accordance with the requirements of the NEC. The AC output neutral shall be electrically isolated from the chassis. The unit shall be designed to operate from sources that are solidly or impedance grounded. The unit shall not be used on corner-grounded delta systems.
10. Each Liebert® STS2 / Liebert® PDU enclosure shall be designed for mounting on raised and non-raised floor (units with inline panelboards can not be installed on a non-raised floor). The Liebert® STS2 / Liebert® PDU shall be constructed so that all input and output customer connections can be made from either the front or from the side of the unit. Rear access shall not be required for installation.

11. The complete Liebert® STS2 / Liebert® PDU shall have maximum dimensions of (77 in./1956mm [250 amps]), (73 in./1854 mm [400A-600A,]), (96 in./2438mm [800A]) wide by 48 in. (1219mm) deep by 77 in. (1950mm) high.
12. The maximum distributed floor weight shall be less than 260 lb./ft^2 (118 kg/m^2).
13. The Vertiv™ Liebert® STS2 / Vertiv™ Liebert® PDU shall be designed so that it can be tipped 15 degrees in any direction without falling over.
14. **(250A only)** The frame shall include eight heavy-duty swivel casters for ease of installation and eight permanent leveling feet for final installation.

2.4 Main Input Circuit Breakers

1. The Liebert® STS2 / Liebert® PDU shall include two (2) input main circuit breakers to provide both system protection and a means of disconnecting input power. The input main circuit breaker output shall be connected to the isolation transformer primary.
2. The input main circuit breakers shall be 600 volt rated, three-pole thermal magnetic molded case, plug-in circuit breakers sized to handle the Liebert® STS2 / Liebert® PDU's full load current rating. Circuit breakers shall be removable from the front of the Liebert® STS2 / Liebert® PDU without requiring the output of the Liebert® STS2 / Liebert® PDU to be de-energized; load is supported by the other source. Circuit breakers with plug-in bases shall be utilized; the plug-in feature of the breaker shall include an interlock, which prevents the breaker from being unplugged without being in the Off (open) position.
3. Each input circuit breaker shall be equipped with N.O. and N.C. auxiliary switches for monitoring of the circuit breaker positions. Two sets of auxiliary switches shall be provided per breaker.
4. The input main circuit breakers shall have a minimum interrupting rating of (200,000 AIC @ 208V) (65,000 AIC @ 480VAC) (25,000 AIC @ 600 VAC).
5. To increase reliability of the Liebert® STS2 / Liebert® PDU the input main circuit breakers shall not contain a shunt trip mechanism nor shall the enclosure have a local Emergency Power Off (EPO) push button. This shall prevent the system from being shut down accidentally.

2.5 Isolation Transformers

1. The system shall contain two (2) electrostatically shielded isolation transformers for both voltage step-down and isolation purposes. The transformer shall be a dry-type, double-shielded, three-phase, common-core, convection air-cooled transformer. The transformer shall conform to UL1561. All transformer windings shall be copper. The isolation transformer shall be provided with six full-capacity compensation taps at 2-1/2% increments to accommodate field adjustment to match the source voltage. These compensation taps shall be easily accessible from the front. Tap changes shall include: two above nominal voltage (upper range limit of +5%), nominal voltage and four below nominal voltage (lower range limit of -10%).
2. The isolation transformers shall each have the following electrical and construction characteristics:
   - **Rated kVA: (**100 [for 250A]) (150 [for 400A]) (225 [for 600A]) (300 [for 800A]) kVA
   - **Primary Voltage:** (208) (380) (400) (415) (480) (600) VAC, three-phase, three-wire plus ground
   - **Secondary Voltage:** (208Y/120) (380/220) (400/230) (415/240) VAC, three-phase, four-wire plus ground
   - **Frequency:** (50) (60) Hz
   - **Percent Impedance**: 3.4% minimum
   - **Percent Reactance**: 3.0% minimum

- **Harmonic Distortion:** 0.5% maximum additive
- **Full Load Efficiency**: 97.8% minimum
- **Insulation Class:** Class “R”, 220°C
- **Temperature Rise**: 302°F (150°C)
- **Rating:** (Standard) (K20)

3. The neutral of the isolation transformer shall be rated 1.732 times the system full load amps rating to handle high nonlinear loads.
4. Transformers shall contain no thermal devices or temperature sensors that would initiate an automatic shutdown or alarm due to an overtemperature condition. This is to prevent a faulty temperature sensor from causing an unnecessary shutdown or alarm.
5. The transformers shall be mounted on rubber isolation pads to prevent noise and vibration transmission.

2.6 Static Transfer Switch

2.6.1 Description

The Static Transfer Switch shall be a three-pole, double-throw; solid-state, automatic transfer switch that is fed from two AC power sources. One source shall be designated as the preferred source while the other shall be the alternate source. Selection of which input source is preferred shall be user-selectable from the operator control panel. All transfers shall be a fast break-before-make with no overlap in conduction from one source to the other. All transfers, including sense and transfer times, shall have less than 4-milliseconds (1/4 cycle) interruption in power to the load.

The Static Transfer Switch is fuseless and consists of six pairs of Silicon Controlled Rectifiers (SCRs) connected in an AC switch configuration. The brick-type SCRs are continuous rated to carry 100% of the Vertiv™ Liebert® STS2 / Vertiv™ Liebert® PDU rated load while operating within the Liebert® STS2 / Liebert® PDU specifications. The SCRs shall be rated to prevent hazardous device failure in power systems with available fault currents listed in Section 2.1, Item L.

The Static Transfer Switch logic shall power up automatically when connected to the power source. The control panel shall be active as long as one input to the Liebert® STS2 / Liebert® PDU is energized. The Liebert® STS2 / Liebert® PDU shall be supplied with factory default settings; mechanical trim pots shall not be used to calibrate or adjust settings. Adjustable setting must be adjusted/configured from the LCD.

2.6.2 Modes of Operation

1. **Normal Mode** - The unit shall be fed by two sources with the output connected to the load. In normal operation, the load shall be connected to the preferred source as long as all phases of the preferred source are within the acceptable limits. Upon failure of the preferred source, the load shall be transferred to the alternate source until such time as the preferred source returns to within the acceptable limits. Transfer voltage limits shall be ±10% of the nominal input voltage for steady state conditions, with low voltage transfer limits having an inverse time relationship that is within the IEEE Std. 446 computer voltage tolerance envelope. After the preferred source returns to within the acceptable voltage limits for at least the preset adjustable retransfer time delay (typically 3 seconds) and is in phase with the alternate source, the load shall be retransferred automatically to the preferred source. The automatic retransfer to the preferred source can be disabled if so selected by the user from the operator control panel. When the automatic retransfer is disabled, emergency transfers from the alternate source to the preferred source shall not be disabled upon alternate source failure.

2. **Load Current Inhibit** - The Vertiv™ Liebert® STS2 / Vertiv™ Liebert® PDU shall sense the load current and, if the load current exceeds an adjustable preset level deemed to represent a load inrush or fault condition, the Liebert® STS2 / Liebert® PDU shall disable the automatic transfer even if the voltage on the selected source exceeds the transfer limits. The load current transfer inhibit shall be [(automatically) (manually)] reset after the current returns to normal to allow for continued protection against a source failure.
3. **Manual Transfer** - The Liebert® STS2 / Liebert® PDU shall allow manually initiated transfers between the two sources, providing the alternate source is within acceptable voltage limits and phase tolerances with the preferred source. Allowable phase differences between the sources for manually initiated transfers shall be adjustable from the operator control panel. The Liebert® STS2 / Liebert® PDU shall be capable of tolerating transfers up to 180 degrees out of phase for emergency conditions. However, the user-adjustable phase synchronization window shall be limited to ±30 degrees. If the transfer is manually initiated, the Liebert® STS2 / Liebert® PDU shall transfer between the two sources without interruption of power to the load greater than 1 millisecond, provided that both sources are available and synchronized within the user-adjustable phase synchronization window. For sources where the two frequencies are not identical (as would be the case between a utility and a standby generator source), manually initiated transfers shall be delayed by the Liebert® STS2 / Liebert® PDU until the two sources are within the user-adjustable phase synchronization window.
4. **Emergency Transfer** - In an effort to maintain power to the load upon loss of the source that the load is connected to, the Liebert® STS2 / Liebert® PDU shall transfer automatically to the other source in less than 1/4 cycle, overriding any retransfer time delays or other inhibits except load overcurrent, providing that the other source is available. If one source is shorted upstream, which causes an undervoltage condition on that source, the Liebert® STS2 / Liebert® PDU shall sense the undervoltage and transfer to the alternate source.
5. **SCR Failure** - The Liebert® STS2 / Liebert® PDU shall continuously monitor the status of the SCR switching devices for proper operation. In the event of a shorted SCR on the source powering the load, the Liebert® STS2 / Liebert® PDU shall automatically annunciate an alarm and trip open the other source isolation breaker. In the event of a shorted SCR on the other source, the Liebert® STS2 / Liebert® PDU shall automatically annunciate an alarm and trip open the other source isolation breaker. In the event of an open SCR, the switch shall automatically annunciate an alarm and transfer to the other source. All open and shorted SCR alarm conditions shall be latched and require the system to be repaired and reset to restore normal operation.
6. **Maintenance Bypass** - The Liebert® STS2 / Liebert® PDU shall be furnished with key-interlocked maintenance bypass breakers that allow the Liebert® STS2 / Liebert® PDU power, controls and monitoring electronics to be bypassed to either input source for maintenance without interruption of power to the load. The packaging of the Liebert® STS2 / Liebert® PDU shall have all electronics isolated from the input, output and bypass connections to allow safe servicing of any components without access to hazardous voltages when the unit is in maintenance bypass.

2.6.3 Electrical Characteristics

The Static Transfer Switch shall have the following electrical characteristics:

- **Operating Voltage:** (208/120) (380/220) (400/230) (415/240) volts, three-phase
- **Maximum Continuous Current:** (250) (400) (600) (800) amps
- **Source Frequency**: (50) (60) Hz

2.6.4 Power Supply

Redundant power supplies shall be provided to prevent any single-point power supply failure mode. The Vertiv™ Liebert® STS2 / Vertiv™ Liebert® PDU shall have two completely separate power supplies mounted on separate boards to permit replacing a power supply while the load is on bypass. There shall be two separate DC buses, one from each power supply, to provide redundancy throughout the controls.

2.6.5 Logic

Control logic shall be triple redundant. Each of the three logic modules shall have it's own separate power connection to each power supply bus. Each logic module shall be fused to prevent it from shorting the power supplies if an internal failure occurs. Gating and control logic shall be partitioned so that failure of one source's gating or sensing logic does not prevent the switch from transferring to the other source.

2.6.6 Components

All electrical components requiring normal maintenance or repair shall be replaceable without de-energizing the load, assuming that at least one source is available. Solid-state switching devices shall be packaged to allow safe repair of the switching devices without having to de-energize the load. All control and logic components shall be mounted separate from the power components.

2.6.7 Fuseless

No fuses are to be used to protect the solid-state power switching devices. The use of fuses for protection is not permitted due to possible fuse clearing in an out-of-phase transfer. All solid-state power switching devices shall be rated to prevent hazardous device failure in power systems with available fault currents up to (100,000 amps @208V)(65,000 amps @380-415V).

2.6.8 Access

The Liebert® STS2 / Liebert® PDU shall be designed for front access only. The Liebert® STS2 / Liebert® PDU shall be designed so that all installation, repair and maintenance can be done from the front or top of the unit. The Liebert® STS2 / Liebert® PDU shall be designed to minimize the exposure of hazardous voltages to allow safe servicing of the unit while the load is energized.

2.6.9 Non-Automatic Circuit Breakers

The Vertiv™ Liebert® STS2 / Vertiv™ Liebert® PDU shall be equipped with (five) (six) plug-in non-automatic circuit breakers. (Three) (Four) of the breakers shall provide for total isolation of the solid-state switching devices with an input breaker for each source and (one) (two) load isolation breaker(s). Two of the breakers shall provide for maintenance bypassing of the solid-state switching devices to either input source. Key interlocks shall be provided on the breakers to prevent improper maintenance bypassing of the solid-state switch. A bypass breaker cannot be closed unless the solid-state switch is connected to the same input source and only one bypass breaker can be closed at a time. The breakers shall be UL listed and IEC rated for use at the system voltage. The plug-in feature of the breaker shall include interlock, which prevents the breaker from being unplugged without being in the Off (open) position. All breakers shall be equipped with N.O. and N.C. auxiliary switches for monitoring of the breaker positions. Two sets of auxiliary switches shall be provided per breaker.
The two input breakers for the static switch also shall be equipped with 48VDC shunt trips to allow for control by the Liebert® STS2 / Liebert® PDU logic.

2.7 Liebert® STS2 / Liebert® PDU Control Panel

The Liebert® STS2 / Liebert® PDU shall be provided with a microprocessor-based control panel for operator interface to configure and monitor the Liebert® STS2 / Liebert® PDU. The control panel shall be located on the front of the unit and can be operated without opening the hinged front door. The display shall not be mounted to the front door so the door can be easily removed for maintenance. A backlit, menu-driven, full graphics, color touchscreen Liquid Crystal Display (LCD) shall be used to display system information, status information, a one-line diagram of the Liebert® STS2 / Liebert® PDU, active alarms, alarm history information, startup and bypass instructions. No mechanical pushbuttons shall be used.

The mimic panel screen shall indicate the power flow, the status of all molded-case automatic and non-automatic circuit breakers, the preferred source and the Liebert® STS2 position (connected to Source 1 or Source 2) as well as active alarms.

Pop-up boxes selected from the menu bar shall be provided for operator interface to the LCD control panel for menu selection, control of the preferred source, manual transfer initiation, auto/manual retransfer selection and other system setpoints. In addition, an operator shall be able to silence and reset the audible alarm. To facilitate Liebert® STS2 / Liebert® PDU operation, help text, step-by-step startup, transfer and maintenance bypass procedures shall be displayed on the LCD screen. For manual transfers, a syncscope shall display the leading or lagging real-time phase difference between the two input sources.

The control panel shall be equipped with an internal RS232 port and flash memory to allow a factory-trained customer engineer to upgrade the Liebert® STS2 / Liebert® PDU software without shutting off power to the load.

To facilitate diagnostics, an event log of the last 512 alarm events shall be stored in non-volatile memory and displayed on the LCD. Two history logs, each having 64 frames of unit status frozen upon an alarm condition designated as a freeze fault, shall be stored in non-volatile memory and displayable on the LCD. A frame shall be acquired every 4 milliseconds, with 40 frames before the fault and 23 frames after the fault. Each frame shall contain metering data, active alarms/faults and unit status. A system calendar and real-time clock shall be included to time-stamp all stored events. Monitored parameters shall be acquired once per 4-millisecond frame.

CANbus shall be used to communicate between the logic and the control panel as well as any installed options.

For remote monitoring, a serial RS-232 port shall provide present switch status information, alarm history information and the history of status screens that are triggered upon a major alarm event.

2.7.1 Metering

The following metering parameters shall be displayed:

- Input AC voltage both sources, line-to-line for all three phases
- AC voltage STS1 and STS2, line-to-line for all three phases
- AC current for STS1 and STS2 all three phases
- Frequency for STS1 and STS2
- Input frequency for both sources
- Output AC voltage line-to-line average and all three phases
- Output kVA
- Output KW

- Output voltage Total Harmonic Distortion (THD) average and all three phases
- Output current Total Harmonic Distortion (THD) average and all three phases
- Output current crest factor (peak/RMS) average and all three phases
- Output current harmonic K-factor average and all three phases
- Output Power Factor average and all three phases
- Output neutral current average and all three phases
- Ground current average and all three phases
- Output kW-hours
- Percent load kVA
- Date
- Time
- Number of switch transfers
- Synchronization phase angle

All voltages and currents shall be measured using true-RMS techniques for accurate representation of non-sinusoidal waveforms associated with computers and other electronic loads. The metering parameters shall have an accuracy of ±2% between 5% - 100% of unit rating.

2.7.2 Alarm Messages

Active alarms shall be monitored and displayed simultaneously as part of the LCD event panel. The following alarm messages shall be displayed:

Source 1 Failure	CB1 (STS 1) Open	Auto Retransfer Inhibit
Source 2 Failure	CB2 (STS 2) Open	Power Supply S1 AC Failed
Sources Out of Sync	CB3 (Output) Open	Power Supply S2 AC Failed
Source 1 Overvoltage	CB3A Open (if used)	Power Supply DC A Failed
S1 Undervoltage (fast)	CB4 (S1 Bypass) Closed	Power Supply DC B Failed
S1 Undervoltage RMS (slow)	CB5 (S2 Bypass) Closed	Power Supply Logic Failed
Source 2 Overvoltage	Input 1 CB6 Open	S1 Voltage sense module failed
S2 Undervoltage (fast)	Input 2 CB7 Open	S2 Voltage sense module failed
S2 Undervoltage RMS (slow)	CB1 Shunt trip fail	S1 SCR sense module failed
Source 1 Overcurrent	CB2 Shunt trip fail	S2 SCR sense module failed
Source 2 Overcurrent	S1 SCR Open	S1 Current sense module failed
Source 1 Over/Under Frequency	S2 SCR Open	S2 Current sense module failed
Source 2 Over/Under Frequency	S1 SCR Shorted	S1 Gate drive module failed
Source 1 Phase Rotation Error	S2 SCR Shorted	S2 Gate drive module failed
Source 2 Phase Rotation Error	Primary fan failure	Internal comm failed
Input 1 Surge Failure (TVSS)	Control Module Failed	External comm failed
Input 2 Surge Failure (TVSS)	S1 I-peak	Output voltage sense module failed

Input 1 Overvoltage	S2 I-peak	Heatsink Overtemp
Input 1 Undervoltage	Load on Alternate Source	Equipment Overtemp
Input 2 Overvoltage	Load Voltage THD	Equipment Fan Failed
Input 2 Undervoltage	Manual Transfer to S1	Transfer Inhibited
Output Undervoltage	Manual Transfer to S2	History Log Frozen
Ground Overcurrent	Input 1 OF/UF	Configuration Setpoint Modified
Neutral Overcurrent	Input 2 OF/UF	Password Changed
Load Overcurrent	Date Reprogrammed	Time Reprogrammed
Event Log Cleared	History Log Cleared	Transfer Counter Cleared

An audible alarm shall be activated when any of the alarms occurs. All alarms shall be displayed in text form. Alarm functions (auto-dial, audible enable/disable, latched) shall be settable from the LCD.

2.8 Output Distribution (250A)

The Vertiv™ Liebert® STS2 / Vertiv™ Liebert® PDU shall contain an output circuit breaker for distribution to the intended loads. The breaker shall be totally enclosed with a removable accent panel that provides access to breaker without exposing other portions of the unit. A separate isolated neutral busbar and safety-ground busbar shall be included for the neutral and safety-ground connections.

The circuit breaker shall be 600V rated; three-pole thermal magnetic molded case size to handle the full load rating of the unit. Breaker shall have an overall short-circuit current rating of 100,000 @ 208V AIC. Circuit breaker shall be removable from the front of the cabinet. Circuit breaker with plug-in base shall be utilized; the plug-in feature of the breaker shall include an interlock, which prevents the breaker from being unplugged without being in the Off (open) position.

Removable conduit/cable termination plates shall be provided in the bottom and top (top exit not available on units with inline panelboards) of the distribution cabinet for termination of the output conduits or cables.

2.9 Output Distribution Cabinet (400-800A)

The output distribution cabinet shall be mounted to the (right) (left) side of the Vertiv™ Liebert® STS2 / Vertiv™ Liebert® PDU. It shall be a full height section with hinged doors to allow for easy access. The doors shall be key lockable.

The output distribution cabinet shall contain a circuit breaker for distribution to the intended loads. The breaker shall be totally enclosed with a removable accent panels that provides access to breaker without exposing other portions of the unit. A separate isolated neutral busbar and safety-ground busbar shall be included for the neutral and safety-ground connections.

The circuit breaker shall be 600V rated; 3-pole thermal magnetic molded case size to handle the full load rating of the unit. Breaker shall have an overall short-circuit current rating of (100,000 @ 208V) (65,000 @ 380-415V) AIC. Circuit breaker shall be removable from the front of the cabinet. Circuit breaker with plug-in base shall be utilized; the plug-in feature of the breaker shall include an interlock, which prevents the breaker from being unplugged without being in the Off (open) position.

Removable conduit/cable termination plates shall be provided in the bottom and top (top exit not available on units with inline panelboards) of the distribution cabinet for termination of the output conduits or cables.

2.10 Fabrication

2.10.1 Materials

All materials of the Vertiv™ Liebert® STS2 / Vertiv™ Liebert® PDU shall be new, of current manufacture, high grade and free from all defects and shall not have been in prior service except as required during factory testing.

The maximum working voltage, current and di/dt of all solid-state power components and electronic devices shall not exceed 75% of the ratings established by their manufacturer. The operating temperature of solid-state component subassembly shall not be greater than 75% of their ratings.

2.10.2 Wiring

Wiring practices, materials and coding shall be in accordance with the requirements of the National Electrical Code (NFPA 70). 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 are to be torque to the required value and marked with a visual indicator.

Provision shall be made for power and control cables to enter or leave from the top or bottom of the Liebert® STS2 / Liebert® PDU cabinet.

All customer input and output power connections shall accommodate 2 hole lugs.

2.10.3 MTBF

The Liebert® STS2 / Liebert® PDU shall be designed for high reliability and high availability with an MTBF exceeding 1,000,000 hours. To the fullest extent practical, redundant circuits and components shall be used to eliminate single points of failure.

2.11 Accessories (Optional Components and Services)

2.11.1 Input Surge Suppression

The Liebert® STS2 / Liebert® PDU shall be equipped with two high-energy, UL 1449 and UL 1283 listed, Transient Voltage Surge Suppressors (TVSS), one connected to each input for maximum surge suppression.

Each TVSS shall consist of multiple metal oxide varistor (MOV) arrays with the MOVs having their clamping voltages matched to within 1% and arranged for surge current sharing. Each MOV shall be individually fused to protect against MOV failure while still allowing rated surge current to flow without fuse operation. The fuses shall have an interrupting capacity of at least 100 kA at 480VAC. Each array shall withstand at least 1250 IEEE C62.41 category C3 surges (20 kV, 10 kA) without failure. Each TVSS shall have a total surge current capacity of 80 kA per phase (480VAC and below) and 50 kA per phase (above 480VAC) based on a standard 8 x 20-microsecond surge waveform. Each TVSS shall also provide electrical noise attenuation of 25 dB from 100 kHz to 100 MHz based on MIL 220A and 50-ohm impedance.

Each TVSS shall be monitored by the Liebert® STS2 / Liebert® PDU control panel and displayed an alarm if either TVSS fails. The alarm shall be Input 1 Surge Fail or Input 2 Surge Fail.

2.11.2 Programmable Relay Board

A Programmable Relay Board with eight sets of isolated Form C contacts shall be provided to indicate a change of status of any of the alarm conditions. Any alarm can be programmed onto any channel or channels. (One) (Two) Programmable Relay boards shall be installed in the Liebert® STS2 / Liebert® PDU. Programming is performed through the touchscreen display. Each contact shall be rated 1 Amp @ 30VDC or 250mA @ 125VAC.

2.11.3 Input Contact Isolator Board

An Input Contact Isolator Board with eight relay inputs (normally open dry contacts) shall be provided for customer alarm messages. The customer through the touchscreen display can program the alarm messages.

2.11.4 Comms Board

The Vertiv™ Liebert® STS2 / Vertiv™ Liebert® PDU shall be provided with a Comms Board that can communicate with a Vertiv™ Liebert® SiteScan™ monitoring system and/or an external modem.

The Liebert® STS2 / Liebert® PDU shall be equipped with an RS-422 communication port for communication to a Liebert® SiteScan™ monitoring system using a two-wire twisted pair for reliable communication up to 3281 ft. (1000m). Information available from the RS-422 port shall include the present switch status information, all monitoring parameters and all active alarms.

The Liebert® STS2 / Liebert® PDU shall be equipped with a modem interface for remote reporting of the present switch status information, alarm history information and the history of status screens that are triggered upon a major alarm event. The monitoring system software shall also support an auto-dial feature that allows the system to automatically dial programmed phone numbers by way of the modem to report designated alarm conditions. (External modem is supplied by others.)

2.11.5 Vertiv™ Liebert® IntelliSlot Web/485 Card with Adapter

The Liebert® STS2 / Liebert® PDU shall have a Liebert® IntelliSlot network card that enables the Liebert® STS2 / Liebert® PDU to communicate with a network management system (NMS). The Liebert® IntelliSlot Web/485 Card with Adapter (Vertiv™ Liebert® IS-WEB485ADPT) will include internal hardware and software to communicate (via SNMP and HTTP) to any I.P.-based Ethernet network through a RJ-45 connector. The Liebert® IS-WEB485ADPT shall provide redundant paths for communication that make it possible to connect to a Building Management System (BMS) using Vertiv™ Liebert® Modbus while simultaneously communicating with an NMS through SNMP and HTTP. A terminal block shall be provided to connect to Liebert® Modbus.

2.11.6 Remote Source Selection

The Liebert® STS2 / Liebert® PDU shall be furnished with Remote Source Selection board to remotely select the preferred source. Closure of one of the two N.O. dry contacts (by others) shall cause the selected source to be the preferred source to which the Liebert® STS2 / Liebert® PDU will connect the load as long as the source is available in the same manner as the local source transfer selection. If both input contacts are closed, the currently selected preferred source shall be retained. If the unit preferred source selection and remote source selection are active at the same time, the Liebert® STS2 / Liebert® PDU shall follow the last request for a preferred source change, regardless of whether it was from the local or remote source select controls.

2.11.7 Key Lockout Switch

A key lockout switch shall be provided that activates a software lockout of the touchscreen display to prevent manual transfers and configuration changes. When locked out, the touchscreen becomes a read-only display; a key is required to do manual transfers or change settings. The alarm silence button shall not be disabled when in the lockout position. The switch shall be behind the front door but can be operated without opening the front door.

2.11.8 Transfer Inhibit

Transfer Inhibit shall prevent the Liebert® STS2 / Liebert® PDU from transferring under certain conditions. When a closed dry contact provided by others is connected to the Input Contact Isolator board, the Liebert® STS2 / Liebert® PDU shall not transfer and shall remain on its present source even if the source is no longer supplying power.

2.11.9 Redundant Output Breaker

A redundant output plug-in non-automatic circuit breaker shall be provided and connected in parallel with the output plug-in non-automatic circuit breaker to provide redundancy in the static transfer switch output power path. The redundant non-automatic circuit breaker shall be of the same rating and type as the output breaker. (For 250A units, the output distribution cabinet option is needed.)

2.11.10 Output Distribution Cabinet with Inline Panelboards

- The output distribution cabinet shall be mounted to the (right) (left) side of the Vertiv™ Liebert® STS2 / Vertiv™ Liebert® PDU. It shall be a full height section with hinged doors to allow for easy access. The doors shall be key-lockable.
- Output distribution panelboards shall be as manufactured by (Square D) (General Electric). Substitutions shall not be considered.
- The output distribution cabinet shall contain (two [on 250A unit]) (four [on 400A-800A unit]) 42-pole vertically mounted in-line panelboards for distribution to the intended loads. Each panelboard shall be totally enclosed with a hinged accent panel that provide access to that panelboard without exposing the other panelboards or portions of the unit. The hinged accent panels shall be removable and include mechanical adjustments for proper fit over the branch breakers. The panelboard shall have a rating of 225 amperes, with an overall short-circuit current rating of 10,000 AIC. The panelboards shall provide a total of (84) (168) single-pole branch circuit breaker positions. Each panelboard shall include separate isolated neutral busbar and safety-ground busbar for the neutral and safety-ground connections for at least 42 output circuits.
- The panelboards shall employ copper busbars and shall be capable of accepting one-, two- and three-pole (bolt-in) (plug-in) type circuit breakers up to 100 amps.
- Each output distribution panelboard shall be individually protected by a 225A, 240V, three-pole (plug-in) panelboard main circuit breaker with an overall short-circuit current rating of 10,000 AIC.
- Removable bottom conduit/cable plates shall be provided for termination of the output conduits or cables. Each panelboard shall have a pre-punched output cable-landing plate with a minimum of 42 openings to provide ample space for output load cables. Plastic plugs shall be provided for unused cable openings. Stamped metal knockouts are not acceptable.
- The output distribution cabinet shall be of dead-front construction, with plastic fillers provided for unused circuit breaker positions.
- Permanent metal branch breaker ID holder shall be provided for each panelboard. Blank strips shall be included.
- The neutral busbar and wiring shall be sized for at least 1.73 times the panelboard full load rating to accommodate high harmonic neutral currents associated with single-phase nonlinear loads.
- The load distribution cabinet shall have ample output cable space for both immediate and future cabling requirements. The cabinet shall be designed so that installing and connecting future loads can be safely accomplished.
- In addition to the panelboards, provide (one) (two (225A only)) (plug-in) subfeed circuit breaker(s). The subfeed breakers will be three-pole, 240V, (225) (400 [400-800A units only]) A rated with an overall short-circuit current rating of 10,000 AIC. Customer connections shall be located on the front of the Liebert® STS2 / Liebert® PDU for easy access.
- Removable conduit/cable plates shall be provided in the bottom and top for termination of the input and control conduits or cables.

2.11.11 Output Distribution Cabinet With I-Line Panelboard

- The output distribution cabinet shall be mounted to the (right) (left) side of the Vertiv™ Liebert® STS2 / Vertiv™ Liebert® PDU. It shall be a full height section with hinged doors to allow for easy access. The doors shall be key-lockable.
- Output distribution panelboard shall be as manufactured by Square D. Substitutions will not be considered.
- The output distribution cabinet shall contain one vertically mounted I-line panelboard for distribution to the intended loads. The panelboard shall be totally enclosed with an accent cover that provide access to the panelboard without exposing other portions of the unit. The panelboard shall have a rating of (400) (600) (800) amperes, with an overall short-circuit current rating of 65,000 AIC. The panelboard shall provide space for 100A through 250A (through 400A on 800A) three-pole branch circuit breakers. The panelboard shall include separate isolated neutral busbar and safety-ground busbar for the neutral and safety-ground connections.
- The output distribution cabinet shall be of dead-front construction, with fillers plates provided for unused circuit breaker positions.
- The panelboard shall employ copper busbars and be capable of accepting plug in type circuit breakers up to three-pole (250A) (400A [800A units only]).
- Removable conduit/cable plates shall be provided in the bottom and top for termination of the input, output and control conduits or cables.
- Circuit breaker ID number shall be provided for each breaker installed.
- The neutral busbar and wiring shall be sized for at least 1.73 times the panelboard full load rating to accommodate high harmonic neutral currents associated with nonlinear loads.
- The load distribution cabinet shall have ample output cable space for both immediate and future cabling requirements. The cabinet shall be designed so that installing and connecting future loads can be safely accomplished.
- Provide ( ) (100) (125) (150) (225) (300) (350) (400) A 3-pole circuit breakers. The fault current withstand rating for the circuit breakers shall be 22,000 AIC. Total of 10 breakers up to 250A can be specified. 800A panelboard can accommodate three 300-400A and six 100-250A breakers.

2.11.12 Certified Test Report

A certified copy of the factory test report shall be provided for each unit.

2.11.13 Factory Witness Test

The owner and/or the owner's representative shall attend a factory test of each unit. The factory shall perform its standard witness test to demonstrate that the unit meets the Liebert® STS2 / Liebert® PDU specification.

2.11.14 Export Crating

Heavy-duty solid wood crating with vapor barriers and desiccant shall be provided to meet international requirements regarding package strength and markings for overseas shipments.

3.0 EXECUTION

3.1 Packing and Shipment

The Vertiv™ Liebert® STS2 / Vertiv™ Liebert® PDU shall be provided with adequate packaging and braced to prevent damage to the unit while in transport by truck. Each section shall be bolted to a skid and enclosed in a protective covering. Shipping split shall be used to make handling easier (800A only).

3.2 Factory Testing

The complete Liebert® STS2 / Liebert® PDU system shall be inspected and tested in the manufacturer's plant to demonstrate full compliance with manufacturer's standard test procedures.

Factory testing shall include:

- A complete visual inspection of the equipment, both internally and externally
- A complete test of the equipment including static switch transfers and operations
- A complete test of all controls and control panel including verification of proper operation of all metering and monitoring parameters
- A complete Hi-Pot test of the power components
- Equipment load test

3.2.1 Factory Witness Test (Optional)

A factory witness test shall be scheduled to allow tests on (all) ( ) Liebert® STS2 / Liebert® PDUs to be witnessed by the Engineer, Owner and other Representatives during a factory visit.

The manufacturer shall completely pretest all equipment prior to commencement of the witnessed tests.

Submit to the Engineer prior to factory testing all test procedures for approval and notify the Engineer two weeks prior to commencement of any tests. Indicate the approximate duration of the tests.

Provide copies of the factory test reports upon completion of the factory testing.

3.3 Field Testing

Factory-trained field service personnel during the Liebert® STS2 / Liebert® PDU startup shall perform the following inspections and test procedures.

3.3.1 Visual Inspection

- Inspect equipment for signs of damage
- Verify installation per drawings
- Inspect cabinets for foreign objects
- Verify neutral and ground conductors are properly sized and configured
- Verify all printed circuit boards are configured properly

3.3.2 Mechanical Inspection

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

3.3.3 Electrical Inspection

- Check all fuses for continuity.
- Confirm input voltage and phase rotation is correct.
- Verify control transformer connections are correct for voltages being used.

3.3.4 Equipment Startup

A complete functional test of one Vertiv™ Liebert® STS2 / Vertiv™ Liebert® PDU unit shall be performed at the site, after completion of installation, to confirmation that the installation is in accordance with the manufacturer's standard site test procedures.

Provide sufficient operation and maintenance instruction for building operators, with on-the-job, factory-trained personnel representing the manufacturers. The instruction shall be scheduled at time of the startup.

3.4 MANUFACTURER'S FIELD SERVICE

3.4.1 Service Personnel

The Liebert® STS2 / Liebert® PDU manufacturer shall directly employ a nationwide service organization, consisting of factory-trained field service personnel dedicated to the startup, maintenance and repair of UPS and power equipment. The organization shall consist of regional and local offices.

The manufacturer shall provide a fully automated 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, 365 days/year. If emergency service is required, response time shall be 20 minutes or less.

An automated procedure shall be in place to ensure that the manufacturer is dedicating the appropriate technical support resources to match escalating customer needs.

3.4.2 Replacement Parts

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

Recommended spare parts shall be fully stocked by local field service personnel with backup available from the national parts center and the manufacturing location. The national parts center shall be on call 24 hours/day, 7 days/week, 365 days/year for immediate parts availability. Parts from the national parts center shall be shipped within 4 hours on the next available flight out and delivered to the customer's site within 24 hours.

3.4.3 Maintenance Training

Maintenance training courses for customer employees shall be available by the Liebert® STS2 / Liebert® PDU manufacturer. This training shall be in addition to the basic operator training conducted as a part of the system startup.

The training course shall cover Liebert® STS2 / Liebert® PDU theory, location of subassemblies, safety and Liebert® STS2 / Liebert® PDU operational procedures. The course shall include control, metering and feedback circuits to the Printed Circuit Board (PCB) level. Troubleshooting and fault isolation using alarm information and internal self-diagnostics shall be stressed.

3.4.4 Maintenance Contracts

A complete offering of preventive and full service maintenance contracts for the Liebert® STS2 / Liebert® PDU shall be available. An extended warranty and preventive maintenance package shall be available. Factory-trained service personnel shall perform warranty and preventive maintenance service.