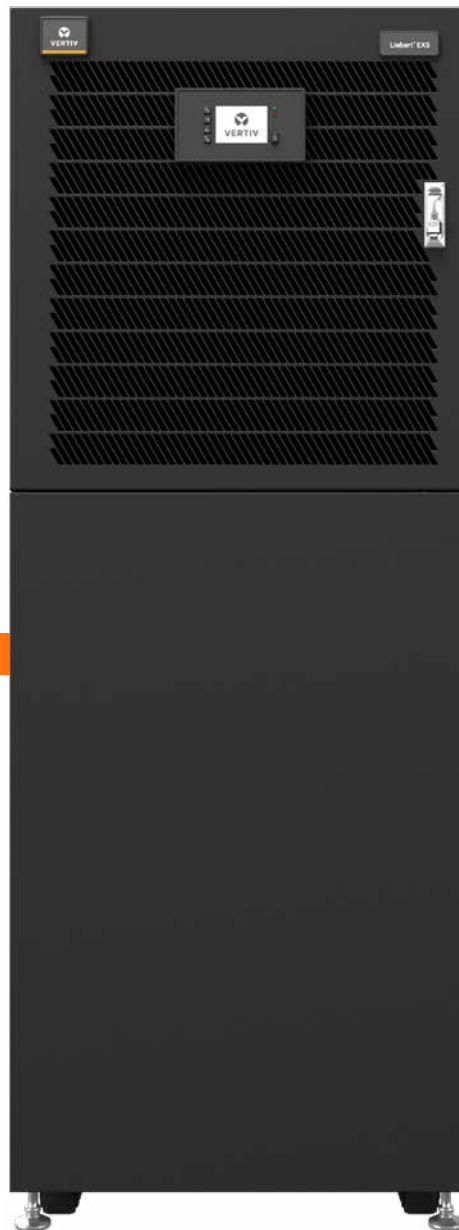




Liebert® EXS from 10 to 80 kVA

Optimized and integrated
three-phase UPS solution
with high efficiency
power protection



Scope	3
2.1 Safety	3
2.2 EMC and Surge Suppression	3
2.3 Performance	3
2.4 Central Power Supply System (CPSS)	3
2.5 Rail	3
Relevant Directives and Reference Standards	3
2.2 EMC and Surge Suppression	3
2.3 Performance	3
2.4 Central Power Supply System (CPSS)	3
2.5 Rail	3
System Description	3
3.1 Models Available	3
3.2 The System	3
3.3 IGBT Rectifier (AC/DC Converter)	4
3.4 IGBT Battery Charger (DC/DC Converter)	4
3.5 DC/AC IGBT Converter (Inverter)	5
3.5 DC/AC IGBT Converter (Inverter)	5
3.6 Electronic Static Switch (Bypass)	6
3.7 Manual Maintenance Bypass	6
Operating Modes	7
4.1 Double Conversion Mode (VFI)	7
4.2 Static Bypass Mode	7
4.3 Energy Stored Mode (Battery Mode)	8
4.4 ECO Mode	8
4.5 Parallel Mode	8
4.6 Dual Bus Mode	8
4.7 Maintenance Mode	8
4.8 Black Start Mode	8
Control and Diagnostics	9
5.1 Operator Control and Display Panel	9
5.2 LCD Display Menu Page Descriptions	10
5.3 Communication and Signal Interfaces	10
5.4 Optional Communication Cards	11
5.5 Monitoring	11
5.6 Vertiv <i>Trellis</i> ™ Platform	11
5.7 Vertiv™ LIFE™ Services	12
Mechanical Data	13
6.1 Enclosure	13
6.2 Ventilation	13
6.3 Cable Entry	13
Serviceability and Commissioning	13
Options	13
8.1 Integrated Isolation Transformer (T version)	13
8.2 Battery Cubicle	13
8.3 Remote LED Panel	13
Technical Data 10 to 80 kVA	14
Customer Experience Center	18

1. Scope

This specification describes the operation and functionality of a continuous-duty, transformer-free, Uninterruptible Power Supply (UPS) system, classified as VFI-SS-111 according to IEC/EN 62040-3.

2. Relevant Directives and Reference Standards

The UPS is CE marked in accordance with:

- Low Voltage Directive 2014/35/UE repealing the previous Directive 2006/95/EC.
- Directive 2014/30/UE relating to electromagnetic compatibility and repealing the previous Directive 2004/108/EC.
- The UPS is designed, tested and specified in accordance with the current revision of the following standards:

2.1 Safety

General and safety requirements for UPS: EN 62040-1:2008+A1:2013 incorporating requirements of IEC/EN 60950-1.

2.2 EMC and Surge Suppression

Electromagnetic compatibility (EMC) requirements of EN 62040-2: 2006.

2.3 Performance

Method of specifying the performance and test requirements: IEC/EN 62040-3.

2.4 Central Power Supply System (CPSS)

Liebert® EXS can be used for CPSS applications* as defined in the EN 50171 standard, and is hence capable of supplying the necessary emergency power to essential safety equipment.

2.5 Rail

Liebert EXS can be used for railways applications* as defined in the EN 50121 standard, and it's hence capable of supplying power to specific systems in urban stations and ensure high reliability to critical buildings.

* Subject to additional prescriptions

3. System Description

3.1 Models Available

The Liebert® EXS range includes the ratings and input/output configurations presented in Table 1.

3.2 The System

The UPS includes the following operational components:

- Rectifier
- Battery Charger
- Inverter
- Static Bypass Switch
- Maintenance Bypass
- Internal Battery (optional for 10-60 kVA).

The single-line diagram of the UPS is shown in Figure 1, and Figure 2.

3.2.1 Neutral Connection

The Liebert EXS output neutral is electrically isolated from the UPS chassis. The input and output neutral are solidly tied together; therefore the UPS will not modify the state of the upstream neutral in any operating mode. As a consequence the neutral state of the distribution downstream from the UPS is imposed by the mains and distribution switchgear.

RATING (kVA)	INPUT	OUTPUT
10 kVA	380-400-415V 3 Ph+N	380-400-415V 3 Ph+N or 220-230-240V 1 Ph+N
15 kVA	380-400-415V 3 Ph+N	380-400-415V 3 Ph+N or 220-230-240V 1 Ph+N
20 kVA	380-400-415V 3 Ph+N	380-400-415V 3 Ph+N or 220-230-240V 1 Ph+N
30 kVA	380-400-415V 3 Ph+N	380-400-415V 3 Ph+N
40 kVA	380-400-415V 3 Ph+N	380-400-415V 3 Ph+N
60 kVA	380-400-415V 3 Ph+N	380-400-415V 3 Ph+N
80 kVA	380-400-415V 3 PH+N	380-400-415V 3 PH+N

Table 1: Liebert EXS configurations.

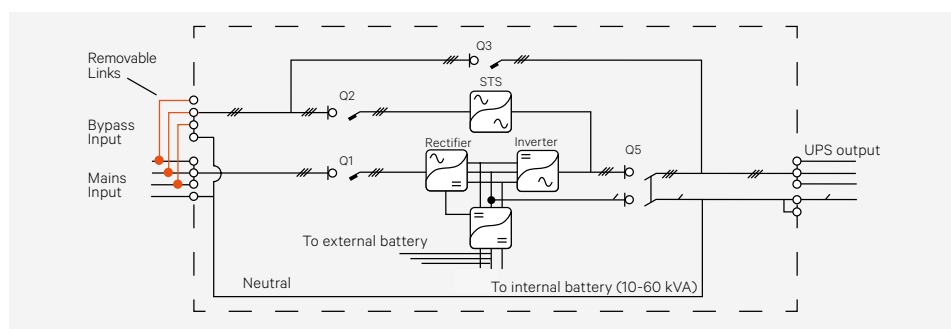


Figure 1. Liebert EXS 10-80 kVA: Three-phase input / three-phase output

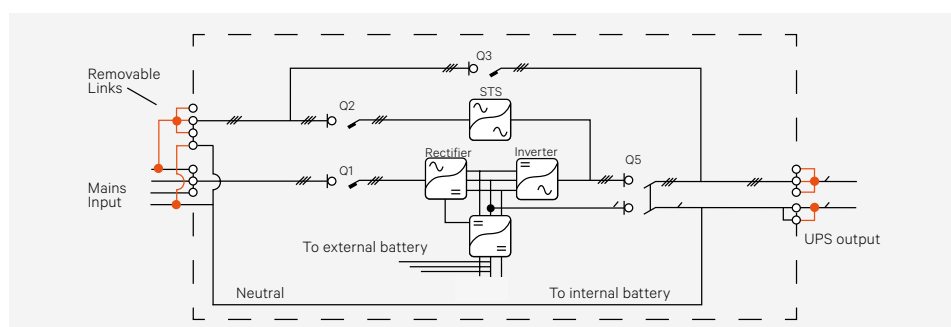


Figure 2. Liebert EXS 10-20 kVA: Three-phase input / single-phase output

3.3 IGBT Rectifier (AC/DC Converter)

3.3.1 Primary Input

The three-phase current taken from the commercial AC source is converted to a regulated DC voltage by the IGBT rectifier. In order to protect the power components within the system, each phase of the rectifier input is individually fitted with a fast-acting fuse.

As shown in Figure 1, 2 and 3 (Page 5), the IGBT rectifier will provide DC power to the DC/AC output converter (IGBT inverter) and to the DC/DC battery converter (booster / battery charger) when the UPS is working in “normal mode”. The latter will also boost the DC voltage to the correct level required by the Inverter when working in “battery mode”.

3.3.2 Total Input Harmonic Distortion (THDi) and Power Factor (PF)

The extremely low current distortion injected into the mains (THDi) and the close to unity input power factor (see section 9) means that Liebert® EXS will be seen by the primary mains source and distribution as a resistive load. It will absorb only active power and the current waveform will be practically sinusoidal, thus ensuring total compatibility with any power source. To this extent the Liebert EXS includes all of the performances offered by load active filtering devices as standard.

3.4 IGBT Battery Charger (DC/DC Converter)

The IGBT DC/DC converter has the following functions:

- To recharge the batteries, taking the power from the DC bus, when the primary input mains is within the given tolerances
- To provide the DC power, taken from the batteries, to the IGBT output inverter if the primary mains is unavailable.

3.4.1 Charging Method

Initially the battery is charged at a constant current rate until the cell voltage reaches a preset value (“bulk charge” stage). At the end of the bulk charge stage, the battery will have reached almost 80% of its capacity.

Following the bulk charge stage, the charger switches to the constant voltage “boost charge” stage. In this phase the battery allows the remaining capacity to be charged while the current drawn by the battery gradually reduces until it reaches the relevant preset level. The boost charge stage may be disabled if it is not compatible with the battery type.

The final charging stage reached will be the “float charge” stage. In this stage the charger maintains the battery voltage at a constant level (lower than the boost voltage), where it is safe for preserving long-term battery function/charge, while at the same time preventing self-discharge.

3.4.2 Battery Management

Using advanced battery management, the Liebert EXS series maximizes battery running time up to 50%. The main battery management features are described as follows:

- To avoid battery over discharge as a result of a light load, the UPS will automatically adjust the end of discharge voltage according to the back up time
- In order to ensure optimum battery charging it will be possible to automatically adjust battery float voltage as a function of ambient temperature measured by a dedicated probe
- The UPS will calculate the remaining battery autonomy time during discharge
- It will be possible to test the battery by performing a partial battery discharge either manually initiated or at programmable intervals. A brief discharge of the battery will be made to confirm that all the battery blocks and connecting elements are in good working order

- The partial battery discharge test results are also used to determine the remaining battery life resulting from the real operating conditions such as temperature, discharge and charging cycles, as well as discharge depth
- The UPS provides DC overvoltage protection: if the DC voltage exceeds the maximum value associated with its operational status, the microprocessor will automatically switch off the battery charger and initiate an uninterrupted load transfer to the static bypass line.

3.4.3 Operating Parameters

When operating with maintenance free, valve regulated lead acid batteries (VRLA), the parameters per cell will be as follows:

- Nominal voltage (V) 2.0
- Float voltage selectable from 2.2 to 2.3V, default 2.27V
- Boost Voltage selectable from 2.3 to 2.4V (default 2.35V)
- End of discharge (EoD) voltage automatically regulated according to back up time - see Figure 4
- Shutdown imminent alarm value depends on selected EoD voltage.

3.4.4 Operations with Shared Battery Bank

Although this configuration is not recommended due to the lack of battery bank redundancy, it is possible to share a common battery bank between up to 4 UPS connected in parallel (see section 4.5 for details of parallel systems).

The automatic battery test will be effective if the parallel load is equal to or greater than 20%.

3.4.5 Operation with Reduced Input Voltage

The IGBT rectifier will be capable of supplying the battery charger with DC voltage at rated power, also if the UPS AC input voltage is below the nominal voltage specified.

A further reduction of AC input voltage (within specified limits) will inhibit the battery charger but will not require the discharging of the battery. See Figure 5 for details.

3.5 DC/AC IGBT Converter (Inverter)

3.5.1 AC Voltage Generation

From the DC voltage of the intermediate circuit, the inverter generates sinusoidal AC voltage for the user loads on the basis of three-level pulse-width-modulation (PWM). By means of the digital signal processor (DSP), the IGBT of the inverter is controlled so that DC voltage is divided into pulsed voltage packets. A low-pass filter converts the pulse-width modulated signal into sinusoidal AC voltage. No isolation transformer is needed for the inverter with great benefits in terms of energy conversion efficiency, physical size and weight of the modules.

3.5.2 Three-level Converter Topology

The three-level topology adopted for the conversion stages of the Liebert® EXS has proven to be both the most reliable and efficient. The increased reliability offered is a direct result of the three voltage switching levels which reduce the voltage stress of the UPS semiconductors, thus ensuring prolonged life of the critical components. At the same time the switching losses also decrease in proportion to the voltage switching level, resulting in a higher efficiency.

3.5.3 Voltage Regulation

The advanced vector control algorithm enables the real-time control of the individual phases with consequent improvement of transient responses, short circuit behaviour and synchronisms between UPS output and bypass supply in the case of distorted mains voltage.

3.5.4 Parallel Operation

When multiple UPS are connected in parallel powering a common load, the DSP control ensures that each UPS output current will not differ by more than 5% of the rated full load current of the UPS.

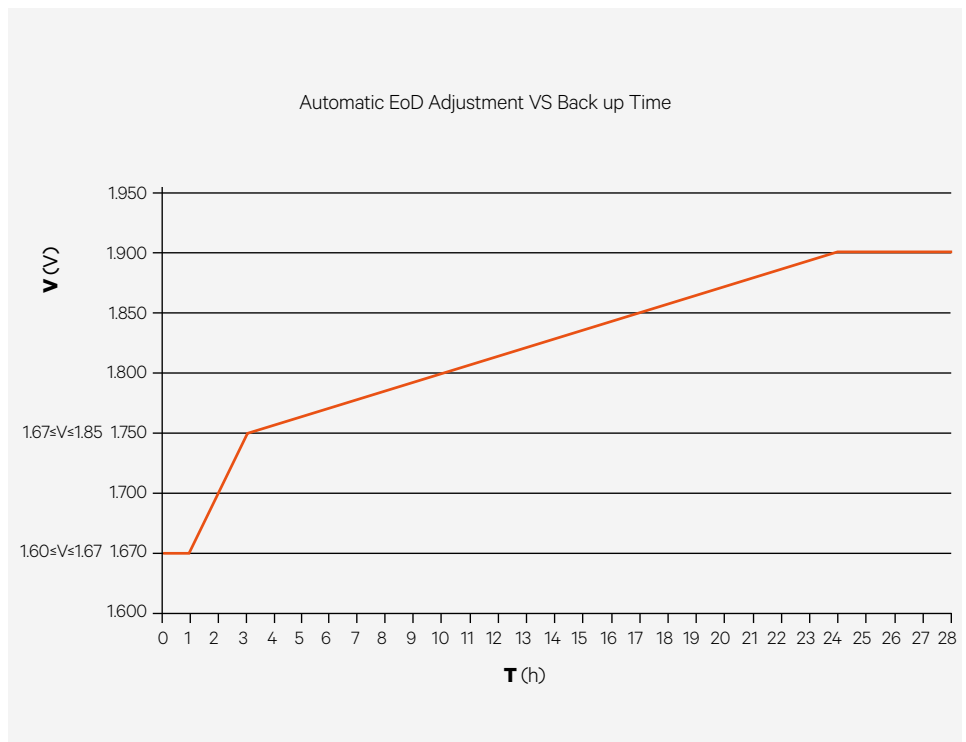


Figure 4: End of discharge voltage in relation to discharge time

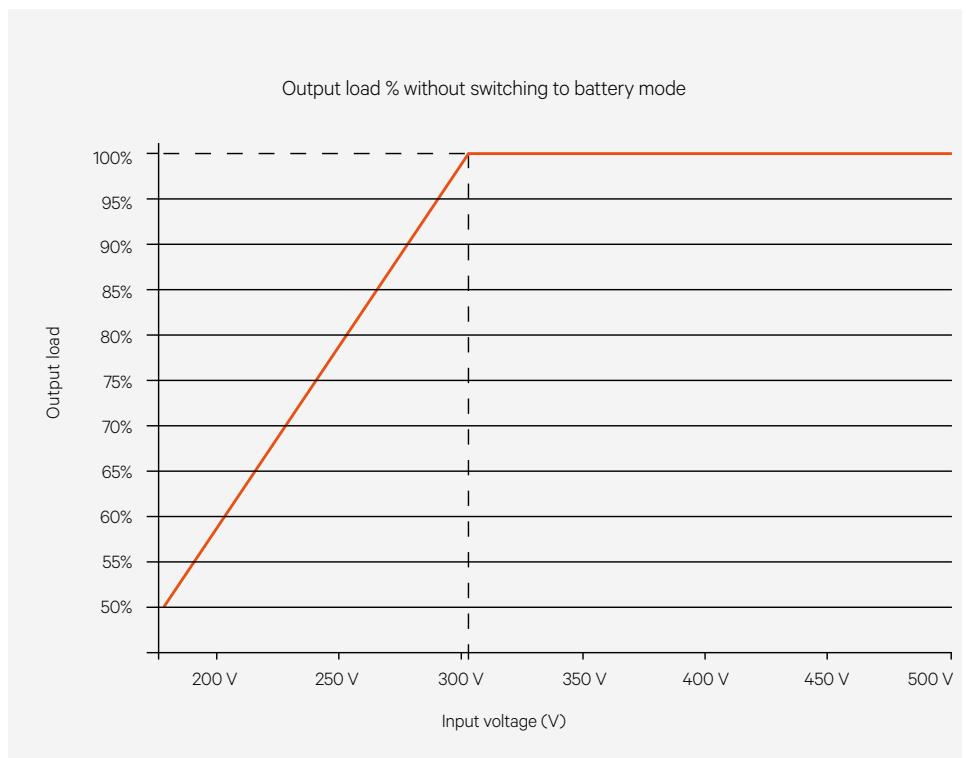


Figure 5: Input voltage in relation to output load percentage

3.5.5 Overload

The inverter is capable of supplying an overload current as specified in section 9.7. For greater currents or longer time duration, to prevent damage to components, the inverter will be self-protecting by means of electronic current-limitation.

The control logic will disconnect the inverter from the critical AC load without the need to clear protective devices and the critical load will be transferred to the static bypass automatically.

3.6 Electronic Static Switch (Bypass)

The UPS comes complete with a Silicon Controlled Rectifier (SCR) static transfer switch rated to conduct full load current continuously in the maximum overload conditions as specified in section 9.6.

The input feed of the bypass can be either the same as the rectifier or independent, provided they share the same neutral. The control logic will be managed by digital algorithms (using vector control techniques), similar to those used for the rectifier and the inverter, sensing the status of the inverter logic signals as well as operating and alarm conditions. If the bypass is within the specified synchronization window, the control logic will automatically transfer the critical AC load to the bypass source, after any of the following conditions:

- Inverter overload
- Output voltage abnormal
- DC bus voltage abnormal
- Parallel system transfer
- UPS fault condition
- End of discharge reached.

3.6.1 Backfeed Protection

When the UPS bypass input line is powered off, there is normally no dangerous voltage/current/power present on the UPS bypass input. However, when there is a fault in the bypass static switch (short circuit) there is the risk that electric power appears on the UPS bypass input terminals. In this case the inverter powers the critical load and the upstream input power line.

This unexpected hazardous energy can propagate in the upstream distribution through the faulty bypass line. Backfeed protection is a safety device which prevents any potential risk from electric shock on the UPS bypass input AC terminals, in the event of a failure of the bypass static switch SCR.

The control circuit will include a contact (available for the user) which activates an external isolating device, such as an electromechanical relay or a tripping coil, upon backfeed detection. This requirement can be implemented with the use of an A.C. input line isolation device external to the UPS for permanent connected UPS.

3.7 Manual Maintenance Bypass

The UPS will be fitted with a manually operated maintenance bypass switch enabling the direct connection of the critical load to the bypass AC input power source. This manual operation will bypass the rectifier/charger, inverter and static transfer switch to provide an alternative path for power flow from the alternate AC supply to the critical load. As a result, it will be possible to implement a manual uninterrupted bypass of the complete system in order to enable maintenance work to be carried out while the bypass supply continues to feed the load.

3.7.1 Transfer/Retransfer of the Critical Load

After the automatic synchronization of the inverter to the bypass supply, the transfer/retransfer of the critical load may be accomplished by paralleling the inverter with the bypass source and then closing/opening the bypass switch as appropriate. Transfer/retransfer of the critical load may be accomplished by automatic synchronization of the UPS to the bypass supply and by paralleling the inverter with the bypass source before opening or closing the bypass switch as appropriate. A maintenance bypass interlock prevents potentially dangerous cross-feed between inverter and bypass paths in the case of accidental operation of the maintenance bypass switch while the load is fed by inverter.

4. Operating Modes

4.1 Double Conversion Mode (VFI)

4.1.1 Normal (VFI)

The UPS inverter continuously supplies the critical AC load. The rectifier draws power from the commercial AC source and converts it into DC power for the inverter and the battery charger. The battery charger maintains the battery in a fully charged and optimum operational condition. The inverter converts the DC power into clean and regulated AC power which is supplied to the critical load (conditioned line). The static switch monitors and ensures that the inverter tracks the bypass supply frequency. In this condition any automatic transfer to the bypass supply (due to an overload etc.) is frequency synchronized and does not cause interruption to the critical load. The conversion efficiency in this operating mode is shown below in Figure 6.

4.1.2 Overload (VFI)

In the event of an inverter overload, manual stop or failure, the static switch will automatically transfer the critical load to the bypass line without interruption.

4.1.3 Emergency (VFI)

Upon failure or degradation of the commercial AC source (outside the tolerances indicated in Section 9.4) the inverter will supply the critical load, drawing power from the battery through the battery booster. There will be no interruption to the critical load upon failure, reduction or restoration of the commercial AC source. While the UPS is powered by the batteries, indications will be provided of actual autonomy time remaining as well as the duration of the mains failure.

4.2 Static Bypass Mode

The static bypass is used to allow a controlled transfer of the load between the inverter output and the bypass source in the case the inverter fails, the inverter overload capacity is exceeded, or the inverter is manually turned off by the user.

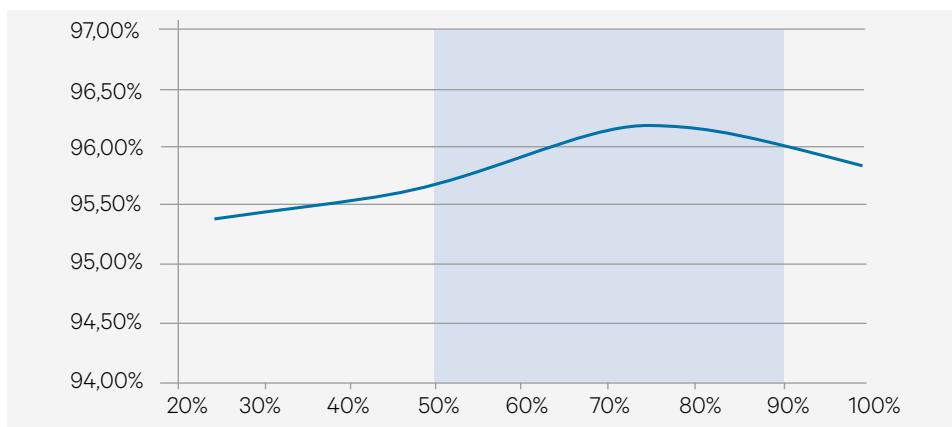


Figure 6: Liebert EXS 10-20 kVA efficiency curve in double-conversion mode

A protection window (see section 9.6) and a synchronization window (see section 9.7) can be set up to control how the unit behaves in the case of transfer to bypass or retransfer to inverter.

4.2.1 Transfer to Static Bypass

If the bypass is within the synchronization window and the inverter is phase-locked with the bypass source, the transfer will be instantaneous. During the transfer the output waveform will not exceed the limit set by IEC/EN 62040-3 for a UPS classified as VFI-SS-111 (Figure 7).

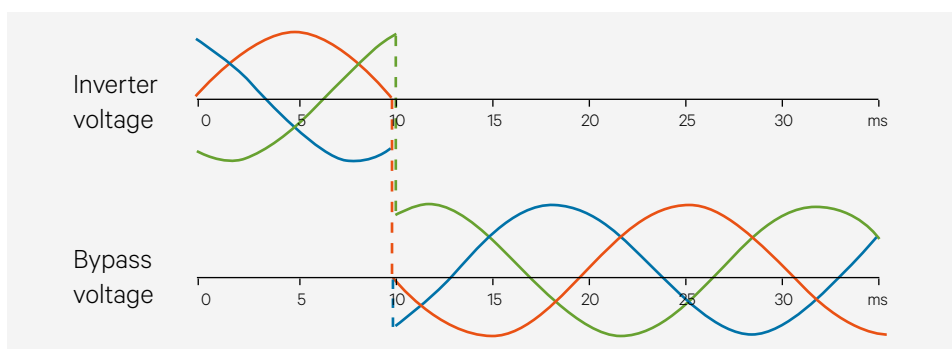


Figure 7: Synchronized transfer

If the bypass is within the protection window but inverter cannot be synchronized with the bypass source, (the phase difference exceeds 3 degrees or frequency is outside the synchronization window), in order to avoid hazardous cross currents, the inverter/bypass changeover is triggered only after a few milliseconds from when the inverter is disconnected from the load. The interruption will be always <20ms remaining within in the synchronization windows (see Figure 8 for details).

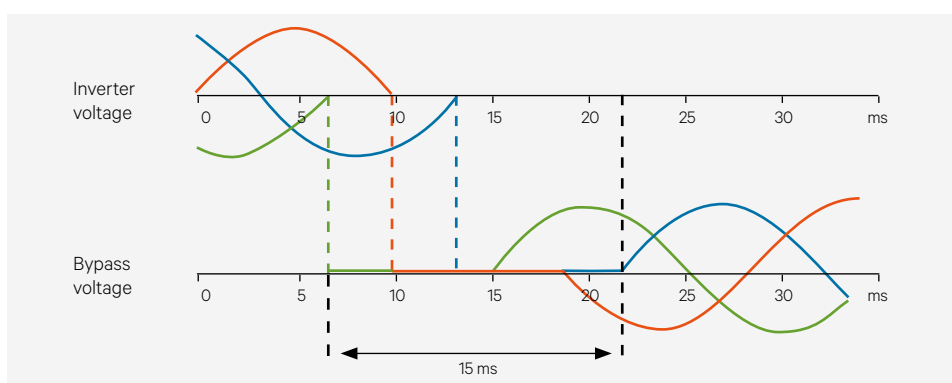


Figure 8: Protected transfer

If the bypass source is outside the protection window, the control logic will inhibit an automatic transfer of the critical load to the bypass source. If an attempt to transfer the load from the inverter output to the bypass is manually initiated, a load disconnection message will appear and the user will be asked to acknowledge before proceeding.

4.2.2 Retransfer to Inverter

Once the condition causing the transfer to bypass has been resolved, retransfer of the critical AC load can be manually initiated as soon as the inverter is synchronized with the bypass source. During the re-transfer the output waveform will not exceed the limit set by IEC/EN 62040-3 for a UPS classified as VFI-SS-111. If the bypass is within the synchronization window, but inverter cannot be synchronized with the bypass source when a re-transfer is manually initiated, an alert message will appear. If the operation is confirmed (in order to avoid hazardous cross current), the bypass/inverter changeover will be triggered only after a few milliseconds from when bypass has been disconnected from the load. Provided the bypass source remained in the protection windows, the interruption will be always <20ms.

4.3 Energy Stored Mode (Battery Mode)

Upon failure or degradation of the primary AC source, the load will be supplied through the inverter drawing power from the battery. Visible and audible signals will alert the user during this operating state. The remaining autonomy time will be calculated by a diagnostic algorithm. Once the end of discharge (EoD) voltage is reached, the UPS will automatically disconnect the battery (internal or external) without the need for external devices.

4.3.1 After a Utility AC Power Outage

If the primary AC source returns within tolerance limits prior to a UPS automatic end of discharge shutdown, the rectifier

will recommence powering the inverter and simultaneously recharging the battery through the battery converter. When the inverter has synchronized with the bypass, the UPS will recommence operating in double conversion mode without any break (0 ms) in the supply to the load.

If the primary AC source does not return within tolerance limits and the UPS performs an automatic end of discharge shutdown, the UPS will recommence operating in bypass mode until it is manually transferred to the inverter. Alternatively, it can be set to start in static bypass mode and automatically transfer to double conversion mode after a time delay, from the moment the rectifier start is complete and the bypass source is back within the synchronization windows.

The time delay is selectable between 1 and 999 seconds (default: 10 seconds). During the selected delay, the UPS will charge the battery and phase-lock the inverter with bypass. If the inverter is unable to phase-lock the bypass at the end of the selected window, the load will remain fed by the bypass and the user will be prompted to confirm or cancel an interrupted transfer.

4.4 ECO Mode

If ECO mode is selected for the purpose of saving energy, the bypass is the preferred source. Only when the voltage and/or frequency of the bypass supply are/is beyond the pre-defined threshold, the critical AC load is transferred to the inverter. If the inverter is synchronized with the bypass source, the transfer will be instantaneous and during the transfer the output waveform will not exceed the limits set by IEC/EN 62040-3 for a UPS classified as VI-SS-111.

If the inverter is not synchronized with the bypass, in order to avoid hazardous cross current, bypass / inverter changeover is triggered only after a few milliseconds (maximum 20ms) from when the bypass is disconnected from the load. After bypass frequency and voltage have returned and remained

within the predefined limits for at least 5 minutes, the load is automatically and instantaneously transferred back to the bypass source. In this mode the system can charge the battery as normal. Eco mode is not available for parallel UPS installation.

4.5 Parallel Mode

For higher capacity and/or reliability, the outputs of multiple UPS (of the same rating) can be set up in parallel with a built-in controller ensuring automatic load sharing. Liebert® EXS is able to connect up to four units in parallel without the need for an additional parallel board, allowing maximum reliability and flexibility. At anytime, a single unit can be upgraded to parallel. The parallel option consists of screened data cables connecting one unit to the next in a loop ring bus.

The loop ring bus will allow the parallel configuration to correctly share the system load even in the case of an interruption in the data cable.

4.5.1 Parallel Configuration for Redundancy

The number of UPS in parallel is greater than the minimum number of UPS necessary to supply the load. Under normal operating conditions, the power delivered to the load will be equally shared between the number of UPS units connected to the parallel bus with a tolerance of 5%.

In the event of failure of one of the UPS units, the affected unit will be disconnected from the parallel bus and the load will be supplied from the remaining units without any break in continuity. In the case that a single UPS overload limit is exceeded, the configuration may deliver the required power without transferring the load to the bypass source.

4.5.2 Parallel Configuration for Capacity

The number of UPS in parallel is equal to the minimum number of UPS necessary to supply the load. Under normal operating conditions, the power

delivered to the load will be equally shared between the number of UPS units connected to the parallel bus with a tolerance of 5%. In the event of a unit failure or overload, the system will transfer the load to the bypass source.

4.5.3 Common Battery

When UPS are connected in parallel, each UPS can use the same battery, achieving cost and space savings.

It should be noted that in a parallel redundant system using common battery mode, the batteries are not redundant and the availability is consequently reduced. Common battery banks cannot be used in the Dual Bus mode.

4.6 Dual Bus Mode

A dual bus system is a high reliability architecture consisting of two independent UPS systems. Each system includes one UPS, which feeds two independent load buses, while a built-in controller ensures the two buses are synchronized.

The dual bus system is suitable for loads with multiple power inputs. For single-input loads, an STS (Static Transfer Switch) can be installed to power the load.

4.7 Maintenance Mode

If the UPS needs to undergo maintenance or be repaired, after the inverter is turned off and the load is transferred to bypass, the internal maintenance bypass can be turned ON. This directly connects the critical load to the bypass AC input power source, bypassing the rectifier/charger, inverter and static transfer switch. In this operating mode the UPS may be shutdown for maintenance purposes.

4.8 Black Start Mode

The UPS can be turned ON also in the absence of utility input power. This can be done by holding down the dedicated button and then pushing the “Inverter ON” button to start the inverter.

5. Control and Diagnostics

5.1 Operator Control and Display Panel

The operator control and display panel are located on the front of the UPS. The control panel of Liebert EXS includes a 320x240 pixel multi-lingual, graphic Liquid Crystal Display (LCD), allowing the user to operate and control the UPS checking parameters, as well as UPS and battery status and retrieve up to 2500 events/alarm logs for reference and diagnosis. Complete access to all LCD menus is possible through four software-assigned buttons located below the display. The on-screen icons above the buttons clearly explain the function of the button within each menu. Two LED indicators show the current working state of the UPS as described below in Table 2.

INDICATOR	STATUS	DESCRIPTION
Inverter indicator	Solid green	Load powered by the inverter
	Flashing green	Inverter turning on, starting up, synchronizing or in stand-by state (ECO mode)
	Off	Inverter off
Alarm indicator	Solid red	Rectifier not ready or critical fault (for example: inverter relay short circuit, bypass STS short circuit, bypass backfeed and inverter fault, etc.)
	Flashing red	General fault (for example, module overload, battery disconnected, fan failure and parallel load sharing failure, etc.)
	Off	No fault

Table 2: LED status indicators.

5.2 LCD Display Menu Page

Descriptions

In order to maximize the reliability of the system, the control unit will monitor a large volume of real-time data for the rectifier, inverter and battery. All vital operating conditions will be constantly monitored and controlled for irregularities. The system will react automatically before a critical situation arises, either for the UPS or the load, ensuring load supply despite the difficult operating conditions.

By using the appropriate soft-keys, it will also be possible to access real-time data and set a number of system parameters via the following menu pages:

Mains

This page will display line to neutral voltages and currents, line to line voltage, frequency and power factor for each phase of the main line supplying the rectifier.

Bypass

This page will display line to neutral voltages and currents, line to line voltage and frequency for each phase of the bypass line.

Output

This page will display line to neutral voltage and current, frequency, line to line voltage and load power factor.

Load

For each phase, this page will display apparent, active and reactive power supplied to the load, load percentage and crest factor.

System

In the case of a parallel set up of two or more UPS, this page will display the total apparent, active and reactive power.

Battery

This page will display battery bus voltage and current battery temperature, remaining battery back up time, percentage of battery life when compared to a new battery, battery boost or float charging status.

Events

This page will display the events that resulted in the current mode of operation, ignoring transient conditions that have been resolved.

Records

This page will display the complete history log of the past events.

Settings

This page will enable the operator to set parameters such as date, time, communication settings, system password, contrast and display.

Commands

This page will enable the operator to start/stop or schedule programmed battery and system tests, or force battery charge equalization from 1 to 36 hours.

Efficiency Curve

This page will show the load level and the actual system efficiency on a graphical representation of the efficiency curve.

Runtime

This menu will show the total time the UPS has run from inverter and from bypass, since the last counter reset.

Version

This page will show the firmware of all UPS components such as monitor board, rectifier, inverter and bypass.

5.3 Communication and Signal Interfaces

5.3.1 Parallel Port

As standard, Liebert® EXS comes complete with serial ports, allowing up to four units to intercommunicate in order to work effectively as a parallel system. The control logic is integrated in the unit so that no additional board or options are needed apart from the serial cable. The parallel cable configuration forms a closed loop to avoid the possibility of a single point of failure.

5.3.2 Dual Bus Port

As standard, Liebert EXS comes complete with serial ports to allow UPS to communicate and synchronize with each other in a dual bus system. The control logic is integrated in the unit so that no additional board or option is needed a part from the serial cable. The dual bus configuration forms a closed loop to avoid the possibility of a single point of failure.

5.3.3 Service and Commissioning Port

Liebert EXS is equipped with a RS232 and/or a USB port to allow the Customer Engineer to set the most appropriate system parameters during commissioning or subsequent phases. It also enables the complete history log to be downloaded when system status checks are necessary, facilitating trouble shooting during maintenance.

5.3.4 Remote Emergency Power Off Port

Liebert EXS can be remotely powered off in the case an external signal is sent to this port.

5.3.5 Vertiv™ IntelliSlot®

The Liebert EXS is equipped with independent intelligislot bays available for communication cards such as SNMP, Modbus and Relay cards. The number of Vertiv IntelliSlot bays is up to two.

5.3.6 Programmable dry contacts

Liebert EXS includes input and output programmable dry contacts. Please refer to the User Manual for additional informations about programmable dry contacts.

5.4 Optional Communication Cards

5.4.1 IS-UNITY-DP and IS-UNITY-SNMP

Vertiv™ IntelliSlot UNITY-DP card provides Web access, environmental sensor data, and third-party customer protocols for Vertiv UPS.

The cards manage a wide range of operating parameters, sending data over Ethernet networks via secure HTTPS protocol and alarms and notification via SNMP traps.

Vertiv IntelliSlot UNITY cards allow also monitoring and control of Vertiv UPS through Vertiv SiteScan® Web or any existing Building Management System.

Vertiv IntelliSlot UNITY-DP card delivers also MODBUS and BACNET protocol via the EIA-485 or Ethernet port.

Vertiv IntelliSlot UNITY cards provide:

- Compatibility with Vertiv shutdown software
- A dedicated web page for monitoring the UPS
- Interface with Vertiv Nform™ alarm notification software
- Ease of integration with industry standard open protocol
- Interface with Vertiv SiteScan Web software
- Proactive analysis of parametric data to ensure facility uptime.

5.4.2 IS-RELAY

Vertiv IntelliSlot IS-RELAY card provides contact closures for remote monitoring of alarm conditions of Vertiv UPS.

Through a set of FORM C relay outputs the card notifies the following status:

- On battery
- Low battery
- On bypass
- Summary alarm
- On UPS.

5.5 Monitoring

5.5.1 Vertiv Trellis Power Insight

The Trellis™ Power Insight Application is designed to monitor your Liebert® UPS devices and provides real-time trending for critical UPS performance including voltage and current utilization.

Other capabilities include:

- Consolidated view of distributed UPS equipment
- Automated device discovery
- Alarm views that are sorted or filtered
- Summary view of individual devices with specific device metrics
- Access to individual device Web Interface

5.5.2 Vertiv Nform Centralized Monitoring Software

Vertiv Nform will monitor the UPS via SNMP protocol. Authenticated alarm management, trend analysis and event notification delivers a comprehensive monitoring solution. Available in a variety of versions to suit anything from small computer rooms to multiple location distributed IT networks, Vertiv Nform enables:

- Condition based system state recording
- Alarm event exporting to disk
- SMTP email
- Execution of external program
- Shut down clients.

5.5.3 Vertiv Sitescan Web Enterprise Monitoring System

Vertiv Sitescan Web allows users to monitor and control virtually any piece of critical facility support equipment - whether it is located in the next room, or in a facility on the other side of the globe.

The web based system provides centralized supervision of Vertiv precision cooling, UPS and distribution units as well as any other analog or digital third party devices through a network of microprocessor based control modules. Features include real-time enhanced trend reporting and event management.

5.6 Vertiv Trellis™ Platform

Liebert® EXS can be integrated in Vertiv's *Trellis* platform. A real-time infrastructure optimization platform that enables the unified management of data centre IT and facilities infrastructure. The Vertiv *Trellis* platform software can manage capacity, track inventory, plan changes, visualize configurations, analyze and calculate energy usage, and optimize cooling and power equipment as well as enable for virtualization.

The Vertiv *Trellis* platform monitors the data center, providing a thorough understanding of system dependencies to help IT and facilities organizations keep the data center running at peak performance. This unified and complete solution, delivers the power to see the real situation in your data center, make the right decision and take action with confidence.

Liebert® EXS from 10 to 80 kVA

5.7 Vertiv™ LIFE™ Services

In order to increase the overall availability of the system, Liebert EXS will be compatible with an optional Vertiv LIFE Services communication kit, providing connection to the Vertiv LIFE Services diagnostic service center.

Vertiv LIFE Services will allow the remote diagnosis of the UPS through a TCP/IP connection (Internet connection), telephone lines or GSM link in order to ensure maximum availability of the UPS throughout its operational life. The monitoring will be a real 24-hour, 365 day service as a result of a unique feature that allows trained Customer Engineers to remain in constant electronic contact with the service center, and therefore the UPS. The UPS will automatically dial up the service center at defined intervals to provide detailed information that will be analyzed in order to predict short-term problems.

The communication of UPS data to the Vertiv LIFE Services command center will be transmitted in the following conditions:

- **ROUTINE:** settable at intervals of between five minutes and two days (typically once a day)
- **EMERGENCY:** when a problem occurs or parameters are beyond tolerance limits
- **MANUAL:** following a request from the command center.

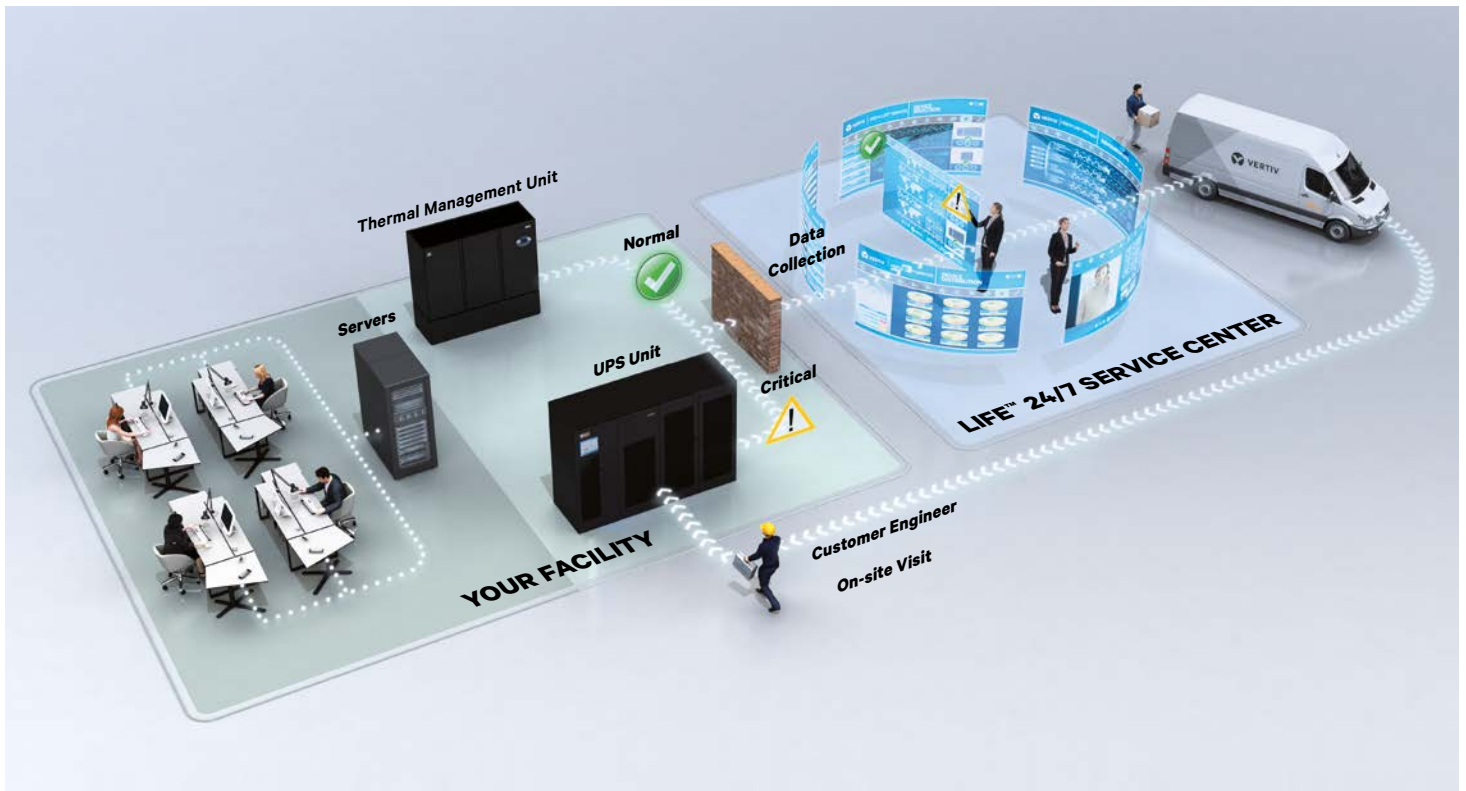
During the call the command center will:

- Identify the UPS connected
- Request the data stored in the UPS memory since the last connection
- Request real-time information from the UPS (selectable).

The service center will analyze historical data and issue a regular detailed report to the customer containing information of the UPS operational condition and any critical states.

The Vertiv LIFE Services center allows LIFE SMS delivery system option, where the customer may receive SMS notification which will be activated in the event of one of the following:

- Mains power failure
- Mains power recovery
- Bypass line failure
- Load supplied by reserve.



6. Mechanical Data

6.1 Enclosure

The UPS will be housed in a space-saving enclosure with front doors and removable panels. The standard degree of protection is IP 20. The standard color of the enclosure will be RAL-7021.

The UPS will be equipped with casters to facilitate installation and ease of movement/relocation of the unit.

6.2 Ventilation

Forced air cooling will ensure that all components operate within defined specifications. Airflow will be controlled according to load demand. In the event that one of the cooling fans experiences a fault, the UPS will be immediately notified of the condition via the user interface and through the Vertiv™ LIFE™ Services. The cooling air entry will be from the front and air exit will be at the back of the unit. The enclosure will be installed with at least 200 mm of free space between the device and back wall in order to allow unhindered exit of cooling air.

6.3 Cable Entry

The cable entry is from rear of the UPS.

7. Serviceability and Commissioning

The Liebert® EXS is designed for easy installation and serviceability as a result of its extractable drawer design, making it a fully modular service solution which considerably minimizes the time needed for repairs.

8. Options

Where options described in this chapter are added to the UPS, the data presented in the standard technical data tables may vary. Some options may not be available simultaneously on the same UPS.

8.1 Integrated Isolation Transformer (T version)

Liebert EXS can be customized to provide full galvanic isolation for specific load requirements by adding an isolation transformer that can be housed in the UPS cabinet.

The transformer can be connected to the input or to the output of the UPS.

These options will provide the following benefits:

- Full galvanic isolation for medical and other critical applications
- Installation in distribution without neutral
- Installation with two independent input sources with different neutrals
- Load protection in installations with 4-pole switching devices.

8.2 Battery Cubicle

Matching battery cubicles will be available. UPS/battery connection cables will be available on request.

8.3 Remote LED Panel

A remote alarm panel will be available to display important messages from the UPS relay card. The length of the connecting cable must not exceed 100m.

9. Technical Data 10 to 80 kVA

NOMINAL POWER (KVA)		10	15	20	30	40	60	80
9.1 European and International Standards								
General and safety requirements for UPS	-	EN/IEC/AS 62040-1						
EMC requirements for UPS	-	EN/IEC/AS 62040-2						
UPS classification according to CEI EN 62040-3	-	VFI-SS-111						
9.2 Environmental Characteristics								
Noise within 1 m (in the front) according to ISO7779	(dBA)	≤56	≤56	≤58	≤56	≤58	≤60	
Altitude	(m)	≤3000 above sea level, derate power by 1% per each 100m increase			≤1500 above sea level, derate power by 1% each 100m increase			
Relative humidity	(%RH)	0 to 95, non condensing						
Operating temperature	(°C)	0 to 40 without de-rating and 40 to 50 with derating. Battery life is halved for every 10°C increase above 20°C 577 x 650 x 1300 (extended version)			0 - 40 without derating. Battery life is halved for every 10°C increase above 20°C			
Storage and transport temperature for UPS	(°C)	-40 to 70						
Recommended battery storage temperature	(°C)	-20 to 30						
Over-voltage level	-	Degree 2						
EMC class	-	C3 (C2 optional ⁽⁷⁾)						
Pollution level	-	Degree 2						
9.3 Mechanical Characteristics								
Dimensions (W × D × H)	(mm)	335 x 650 x 1300 (standard version) 577 x 650 x 1300 (extended version)			440 x 750 x 1600		600 x 850 x 1600	600 x 850 x 1600
Net / Shipping Weight (excluding battery)	(kg)	85/115 (standard version) 135/165 (extended version)			200/250		215/265	230/270
Net / Shipping Weight (including batteries)	(kg)	285/315 (standard version including 2x32 battery blocks) 535/565 (extended version including 4x32 battery blocks)			600/650		615/665	NA
Colour	-	Black RAL7021						
Protection degree, IEC (60529)	-	IP20						
9.4 Rectifier AC Input (mains)								
Nominal input voltage ⁽¹⁾	(V)	380 / 400 / 415 (three-phase and sharing neutral with the bypass input)						
Earthing distribution systems compatibility		TN, TT and IT ⁽⁸⁾						
Input voltage range at 100% nominal output power without battery discharge	(V)	305 to 498			305 to 475			
Input voltage range at derated load conditions without battery discharged	(V)	173 ⁽²⁾ to 498			228 ⁽²⁾ to 475			
Nominal frequency	(Hz)	50 or 60						
Input frequency range ⁽³⁾	(Hz)	40 to 70						
Input power factor full load ⁽⁶⁾	(kW/kVA)	0.98	0.99	0.99	0.99	0.99	0.99	0.99
Input power factor half load ⁽⁶⁾	(kW/kVA)	0.97	0.98	0.98	0.98	0.98	0.98	0.98
Input power	(kW Nom. ⁽⁴⁾ (kW Max ⁽⁵⁾)	10.7 14,9	15.5 22.3	20.8 29,7	31.5 34.9	42.2 44.5	63.3 66.7	84.8 88.9
Input Breaker / Switch (Q1)		3 Pole Breaker 50 A Type C			3 Pole Breaker 100 A		3 Pole Breaker 125 A	3 Pole Switch 160 A
Current THD at full linear load ⁽⁶⁾	(THDI%)	<3% (3/3) <10% (3/1)			<3%			

1. Rectifier operates at any of the Nominal supply voltages and frequencies without further adjustment.

2. Calculated at 50% load.

3. If the input frequency is within this range the UPS is able to switch to bypass if needed.

4. EN 62040-3: at Nominal load and input voltage 400V, battery charged.

5. EN 62040-3: at Nominal load and input voltage 305V, battery charging at maximum Nominal power.

6. Calculated at input THDv <1%.

7. Available for the 3/3 configuration only.

8. IT configuration is achievable with the use of 4P breakers upstream and downstream the UPS

NOMINAL POWER (KVA)	10	15	20	30	40	60	80
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9.5 Battery

Battery bus voltage (V)	Range: 320 to 576			312 to 576						
Number ⁽¹⁾ of lead-acid cells per string the unit can work without derating	-			Max: 240=[40×6-cell] Min: 192=[32×6-cell]						
Max charging current (A)	13			25						
Ripple voltage ⁽²⁾ (%)	≤3			≤1.4						
Bulk charge current limit (% C ₁₀)	10 default; limit selectable range: 10 to 25									
Boost voltage (V/cell)	2.35; selectable range: 2.30 to 2.40									
Float voltage (V/cell)	2.27; selectable range: 2.20 to 2.30									
Boost Control	Float to boost trigger: from 0.02C ₁₀ to 0.08C ₁₀ ; default 0.05C ₁₀ Boast to float trigger: from 0.01C ₁₀ to 0.05C ₁₀ ; default 0.02C ₁₀ Safety time-out from 5 to 24h, default 12h Boost mode inhibit also selectable			Float to boost trigger: from 0.01C ₁₀ to 0.07C ₁₀ ; default 0.05C ₁₀ Boast to float trigger: from 0.01C ₁₀ to 0.025C ₁₀ ; default 0.02C ₁₀ Safety time-out from 8 to 30h, default 8h Boost mode inhibit also selectable						
Automatic E.o.D voltage adjustment (V/Cell)	Lower limit: 1.63 (selectable between 1.60 and 1.67) Upper limit: 1.75 (selectable between 1.67 and 1.85) Automatic inverse, EOD voltage x discharge current mode (the EOD voltage increases at low discharge currents)									
Recommended battery operation temperature (°C)	<25									
Voltage temperature compensation (mV/°C/Cell)	-3.0 (selectable 0 to -5.0 around 25°C or 20°C or inhibit)									
Battery mode efficiency	100% load (%)	75% load (%)	50% load (%)	25% load (%)	96.5	96.2	95.3	95.2	94.7	94.7
					95.8	96.5	96.2	95.3	95.1	95.1
					94.5	95.8	96.5	95.3	95.2	95.2
					92.0	93.5	94.5	94.4	94.6	94.6

9.6 Bypass

Nominal voltage ⁽³⁾ (Vac)	380 /400 /415 (three-phase and sharing neutral with the rectifier input) 220/230/240 (single-phase with neutral reference to the rectifier neutral)			380 /400 /415 (three-phase and sharing neutral with the rectifier input)			
Voltage protection windows ⁽⁴⁾ (%Vac)	Upper limit: +10,+15, or +20, default: +20 Lower limit: -10, -20, -30, -40, default: -40 (delay time to accept steady bypass voltage: 10 sec)			Upper limit: +10,+15, or +20, default: +15 Lower limit: -10, -20, -30, -40, default: -20 (delay time to accept steady bypass voltage: 10 sec)			
Nominal frequency ⁽⁵⁾ (Hz)	50/60						
Frequency protection window ⁽⁴⁾ (%)	±10 (±5 selectable)						
Rated current @400 V (A)	14.4	21.7	28.9	43.2	57.7	86.5	
Bypass Input breaker/switch (Q2)	3 Pole Breakers 50 A Type C			3 Pole Breakers 100 A		3 Pole Breaker 125 A	3 Pole Breaker 160 A
Maintenance Input breaker/switch (Q3)	4 Pole Breakers 100 A Type C			3 Pole Breakers 100 A		3 Pole Switch 100 A	3 Pole Breaker 160 A
Transfer time with inverter synchronous to bypass (ms)	≤2						
Transfer delay time with inverter not synchronous to bypass (ms)	≤20 (40, 60, 80, 100, selectable)						
Overload	105% (min)	125% (min)	150% (sec)	>150% (ms)	Continuous		Continuous
					5		10
					60		300
					<200		<200
SCR ⁽⁶⁾	I ² T @ Tvj =125°C, 8.3 -10 ms	(kA ² s)	1.76	0.6	9.1	9.1	16.2
	ITSM @ Tvj =125°C, 10 ms	(kA)			1.35	1.35	1.8

1. 12V Battery block per string number must be 24, 32 or 40 (10-20 kVA) and 26, 28, 30, 32, 34, 36, 38 or 40 (30-80 kVA).

2. In Float Mode for 10 minute autonomy, as per VDE0510.

3. Factory set to 400 V, 380 V or 415 V selectable by commissioning engineer.

4. Outside this range the switch to bypass is inhibited.

5. Factory set to 50 Hz, 60 Hz selectable by commissioning engineer.

6. If current sharing inductors are installed an additional inductance of 10% must be taken into consideration when analyzing the selectivity of the installation.

Liebert® EXS from 10 to 80 kVA

NOMINAL POWER		10	15	20	30	40	60	80	
9.7 Inverter AC Output									
Nominal output voltage ⁽¹⁾	(V)	380/400/415 (three-phase) or 220/230/240 (single-phase)			380/400/415 (three-phase)				
Total harmonic voltage distortion with 100% linear load (THDv)	(%)				2				
Total harmonic voltage distortion with reference to non linear load (THDv)	(%)				5				
Steady state voltage stability	100% balanced load				±1				
	100% unbalanced load				±1				
Transient voltage stability	Input variation								
	(Main/Battery/Bypass)	±6			±5				
	0-100% linear load step	±6			±5				
	0-100% non linear load step	±7			±5				
Transient recovery time	(ms)				60				
Nominal output frequency ⁽²⁾	(Hz)				50/60				
Frequency stability	Synchronized with internal clock				±0.25				
	Synchronized with bypass				±0.25				
Frequency slew rate (Max change rate of synch frequency)	(Hz/s)	Setting range: 0.2 to 0.5			Setting range: 0.1 to 0.3				
Frequency synchronization window ⁽³⁾	(%)	Nominal ± 5			Nominal ± 10				
Maximum phase error for synchronization with bypass	(deg)	3			6				
Phase angle displacement accuracy	100% balanced load (100, 100, 100)	±1.0			±1.0				
	100% unbalanced load (0, 0, 100)	±1.0			±1.5				
Nominal apparent power	(kVA)	10	15	20	30	40	60	80	
Nominal active power	(kW)	10	15	20	30	40	60	80	
Range of load power factor		0.5 lagging to 0.5 leading ⁽⁴⁾			0.5 lagging to 0.8 leading ⁽⁴⁾				
Nominal output current @ 400 V three phase output	(A)	14.4	21.7	28.9	43.1	57.2	85.8	114.4	
Nominal output current @ 230 V single phase output	(A)	43.3	65.0	86.6	NA	NA	NA	NA	
Output Switch (Q5 / Q6)		3 Pole Breakers 50 A			4 Pole Breakers 100 A				4 Pole Switch 250 A
Automatic active power adjustment with temperature	@ 30°C	10	15	20	30	40	60	80	
	@ 35°C	10	15	20	30	40	60	80	
	@ 40°C	10	15	20	30	40	60	80	
	@ 45°C	9	13.5	18	NA	NA	NA	NA	
	@ 50°C	8	12	16	NA	NA	NA	NA	
Overload	105%	60			60				
	125%	5			10				
	150%	1			1				
	>150%	<200			<200				
Three phase short circuit current in battery mode	(A rms)	64			152		335	335	
Phase to neutral short circuit current in battery mode	(A rms)	64			152		335	335	
Short circuit current duration before inverter shut down	(ms)	120			200				
Non-linear load capability ⁽⁵⁾	(%)				100				
Load crest factor handled without derating	-				3:1				
Permissible load unbalance	(%)				100				

1. Factory set to 400 V, 380 V or 415 V selectable by commissioning engineer.

2. Factory set to 50 Hz, 60 Hz selectable by commissioning engineer. Note that the system frequency can be changed only when the UPS is on bypass. It is strictly prohibited to change the system frequency when the UPS is on inverter.

3. If bypass frequency is outside this window the inverter cannot be synchronized.

4. From 0.5 to 0.9 leading de-rating is applied.

5. IEC 62040-3, annex E (crest factor 3:1).

NOMINAL POWER (KVA)	10	15	20	30	40	60	80
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9.8 Efficiency and Heat Losses

Overall Efficiency

Normal mode (double-conversion)								
100%	(%)	95.7	96.2	95.8	95.9	95.6	95.6	95.6
75%	(%)	95.5	95.7	96.2	96.0	95.9	95.9	95.9
50%	(%)	95.7	95.5	95.7	95.5	96.1	96.1	96.1
25%	(%)	93.0	94.0	95.4	94.5	95.0	95.0	95.0
ECO Mode	(%)	99.0						

Heat losses & Air Exchange

Normal mode and battery charged	(kW)	0.4	0.7	0.9	1.5	2.5	3.0	3.6
Normal mode and battery boost charging	(kW)	0.9	1.2	1.4	1.8	2.8	3.2	4.0
Eco mode and battery charged	(kW)	0.1	0.2	0.3	0.4	0.6	0.6	0.98
Eco mode and battery boost charging	(kW)	0.7	0.9	1.1	0.8	0.9	1	1
No load	(kW)	0.18			0.27		0.43	0.58
Maximum forced air cooling (front intake, rear exhaust)	L/sec	208			120		370	370

Note: 400 Vac input and output, battery fully charged, full-Nominal linear load

Customer Experience Center

Vertiv™ state-of-the-art Customer Experience Center located in Castel Guelfo (Bologna - Italy), enables our customers to experience first-hand a wide variety of data center technologies, supported by constant consultation from R&D and engineering specialists.

Customers visiting the center will be able to witness pre-installation demonstrations, covering the technical performance, interoperability and efficiency of Vertiv UPS systems under real field conditions.

These processes can be experienced from the facility's control room, where real-time performance measurements and reporting will be available while providing full visibility of the demonstration area. The center can host simultaneous tests at full load of up to 4000 A.

The customer validation area specifically dedicated to UPS consists of four testing stations, each one providing up to 1.2 MVA of capacity.

Testing includes individual modules, as well as complete power systems, with the added possibility of the customer's switchgear support systems being connected, thus guaranteeing smooth, rapid installation and commissioning of large power systems.

Testing is also customized based on the complexity, size and number of UPS components in the configuration.

Our Customer Experience Center offers three validation experiences:

- **Demo** - carried out on new products to demonstrate UPS performance
- **Standard** - validation test showing UPS standard technical performances in compliance with UPS catalogue and IEC 62040-3 standards
- **Customized** - session tailored to validating customer's specific technical performance needs.

