Vertiv™ Liebert® EXM2

from 100 to 250 kW

Highly Reliable and Efficient UPS designed to provide industry-leading performance

Liebert EXM2

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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. The UPS will automatically provide continuity of electrical power, within defined limits and without interruption, upon failure or degradation of the commercial AC source. The duration of autonomy (i.e. back up power time) in the event of network failure will be determined by the battery capacity.

2 Relevant Directives and Reference Standards

The UPS is CE marked in accordance with:

- Directive 2014/35/EU,
- Directive 2014/30/EU,
- Directive 2011/65/EU (with amendment Directive (EU)2015/863)

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 the UPS: EN 62040-1:2008+A1:2013

2.2 EMC

Electromagnetic compatibility (EMC) requirements of EN 62040-2:2006; EN 50121-1:2006 EN 50121-5:2017.

- 614000-4-2 Electrostatic discharge, Level 3 based on B
- 61000-4-3 Radiated E-RFI fields, Level 3 based on A
- 61000-4-4 Fast E transients,AC port:4kV/5kHz based on B;DC port and signal ports: 2kV/5kHz based on B
- 61000-4-5 Surges/Lightning, AC port: Level 4(4kV), line to earth, Level 3(2kV) line to line;
- 61000-4-6 Conducted RFI, 10V based on A

2.3 Performance

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

2.4 Central Power Supply System (CPSS)

Liebert® EXM2 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.

** Subject to additional prescriptions*

3 System Description

3.1 Models Available

The Liebert® EXM2 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

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

Table 1

RATING (KVA)	INPUT	OUTPUT
100 kVA	380-400-415V 3 Ph+N	380-400-415V 3 Ph+N
120 kVA	380-400-415V 3 Ph+N	380-400-415V 3 Ph+N
160 kVA	380-400-415V 3 Ph+N	380-400-415V 3 Ph+N
200 kVA	380-400-415V 3 Ph+N	380-400-415V 3 Ph+N
250 kVA	380-400-415V 3 Ph+N	380-400-415V 3 Ph+N

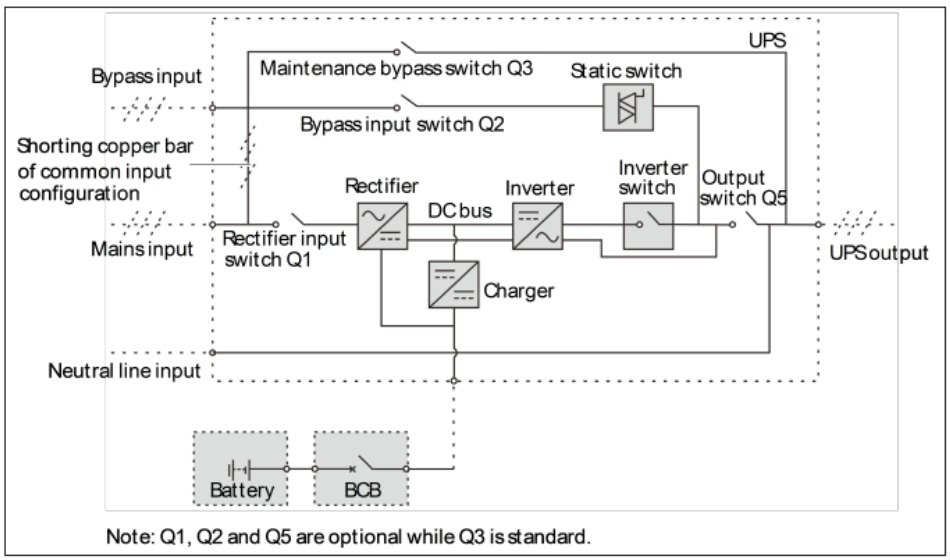


Figure 1: Liebert® EXM2 Single Line Diagram

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, 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® EXM2 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 EXM2 includes all of the performances offered by load active filtering devices as standard.

3.4 Battery Charger (DC/DC Converter)

The 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 EXM2 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 condition
- 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 2.25V
- Boost Voltage selectable from 2.3 to 2.35V (default 2.35V)
- End of discharge (EoD) voltage automatically regulated according to back up time - see Figure 2
- Shutdown imminent alarm value depends on selected EoD voltage (1.67 V)
- Temperature compensation selectable from 0 to -5.0 mV/ºC/ Cell (default -3.0 mV/ºC/Cell) or inhibit

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 6 UPS connected in parallel (see section 4.6 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 willnot require the discharging of the battery. See Figure 3 for details.

Figure 2 Automatic EoD Adjustment VS Back up time

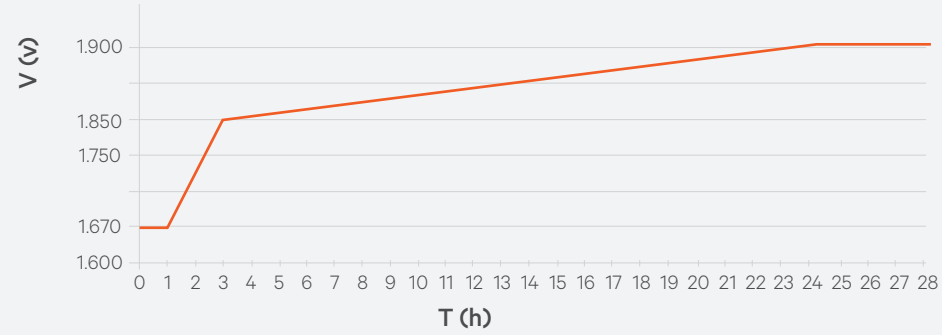
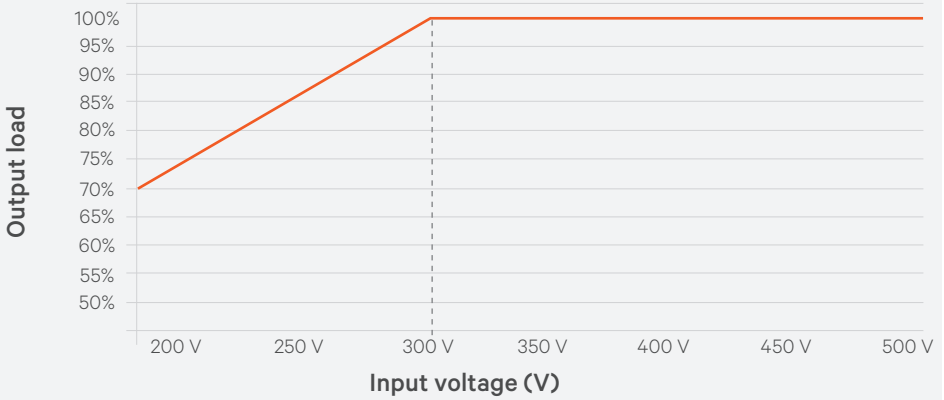


Figure 3 Output load % without switching to battery mode



3.4.6 Remote Battery Disconnect Option

Vertiv recommends using a proprietary battery breaker control option to remotely trip the battery breaker and safely disconnect the battery when an undervoltage / short circuit/EPO conditions is detected. Please contact Vertiv Technical Support for more information.

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 T-type Converter Topology

The three-level t-type topology adopted for the conversion stages of the Liebert® EXM2 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.

3.5.5 Overload

The inverter is capable of supplying an overload current as specified in section 9. 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.

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 (optional)

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 contactor which activates an optional internal isolating device upon backfeed detection. Two internal isolating devices such as at mains input and at bypass input can be configured internally to protect against backfeed.

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 4.

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.

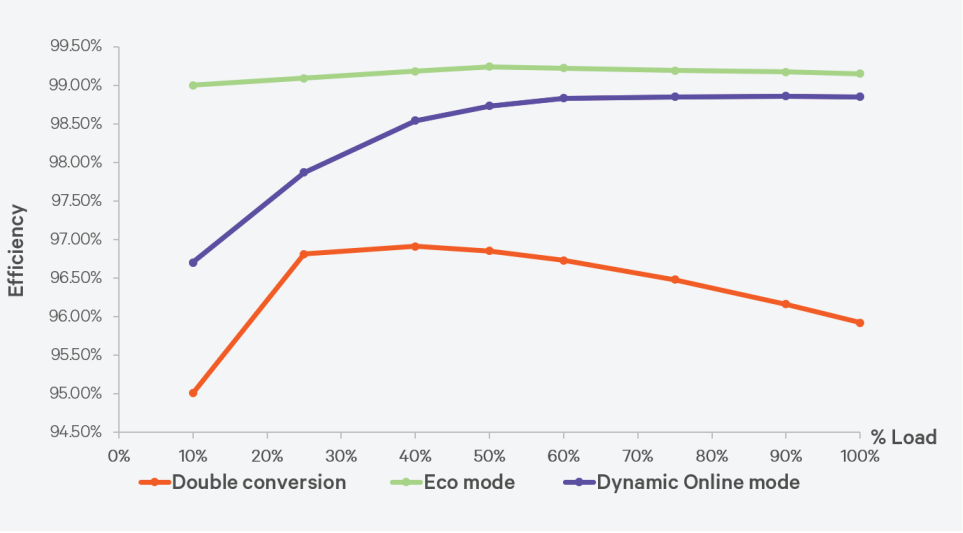


Figure 4: Liebert® EXM2 Efficiency Curve

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 case the inverter fails, the inverter overload capacity is exceeded, or the inverter is manually turned off by the user.

A protection window and a synchronization window (see section 9) 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 5).

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 6 for details).

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 external battery 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.

Figure 5

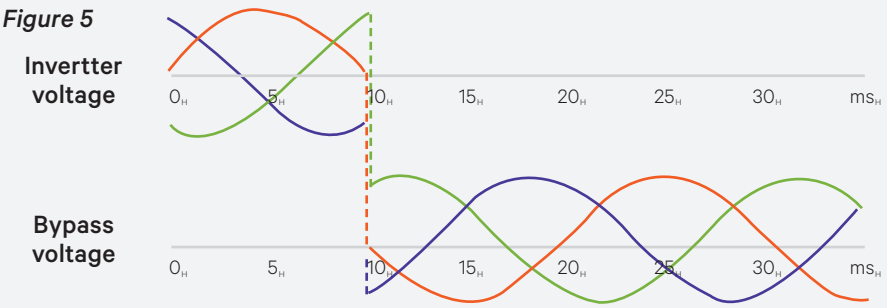
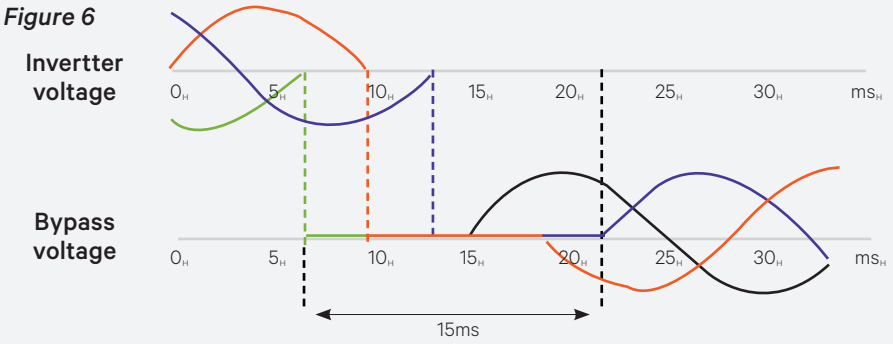


Figure 6



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 available for parallel UPS installation as well.

4.5 Dynamic Online, High Efficiency & Power Conditioning (VI)

This functioning mode allows significant energy savings by operating with a typical efficiency above 98.8% while providing power conditioning to the load.

4.5.1 Normal (VI)

The operating mode will depend on the quality of the mains supply in the short-term past and on the electrical characteristic of the load. If the line quality remains within permitted tolerance parameters and the load needs power conditioning, (THDi, THDv, PF) the power interface will provide continuous supply to the critical AC load while the inverter operates as series and parallel active filter. The IGBT inverter will be able to compensate the power factor of the load and the current harmonic distortion guaranteeing optimum power conditioning to the load while maintaining the highest level of efficiency.

4.5.2 Fast Transfer to VFI

Emergency (due to mains supply failure or variance beyond tolerance limits) if the bypass mains supply varies beyond tolerance levels (adjustable using the software) that cannot be compensated through the active filter, the load will be transferred from the direct line to the conditioned line, with Class 1 output performace. The load is powered from the mains via the rectifier and inverter, (provided the input mains remains within the tolerances stated in section 9).Should the input mains fall below the lowest limit, the batteries will be used to power the load via the inverter.

4.5.3 Return to VI

When the mains supply returns within tolerance limits, Liebert EXM2 will continue to supply the load via the conditioned line for a period of time dependant on the direct line failure rate (the conditioned line draws power from the mains not the battery). When the direct line has stabilized, Liebert® EXM2 returns to normal VI operation. The battery charger automatically begins to recharge the battery so that maximum autonomy is guaranteed in the shortest possible time.

4.6 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® EXM2 is able to connect up to six 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.

4.6.1 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.

4.6.2 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.

4.6.3 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.

4.7 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.

4.8 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.

4.9 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.

4.10 Intelligent Paralleling Mode

Activating the Liebert® EXM2 intelligent paralleling feature optimizes efficiency at partial load, thus achieving superior running cost savings. Enabling this feature for both distributed or centralized parallel designs allows the system to automatically adapt capacity to meet immediate load requirements by switching excess units to standby mode, while ensuring continued system availability and also keeping the level of redundancy requested. As soon as an increase of the load occurs the UPS units in standby until then will be started up in few milliseconds. Furthermore, the Intelligent Paralleling feature powers only the minimum number of Liebert EXM2 units required at that load level, in order to allow each unit to operate in standby mode for the same amount of time, ensuring an equal life-span of module components. This intelligent paralleling feature further maximizes Liebert EXM2's double conversion efficiency at partial load and allows for a lower energy dissipation and TCO reduction.

5 Monitoring and Control, Interfaces

5.1 General

The UPS will incorporate the necessary controls, instruments and indicators to allow the operator to monitor the system status and performance, and take action where appropriate. Furthermore, interfaces allowing extended monitoring and control, in addition to service functions, will be available.

5.2 Touch Screen Display

The control panel of the Liebert® EXM2 includes a touch screen display for complete UPS monitoring and control. The main page of the touch screen displays a single-line diagram of the UPS along with the input and output measurements and information indicating the system status. The system status is indicated by three different icons; the tick icon indicates when the status is normal (OK), the triangle icon notifies of a system warning and the cross icon is activated when a fault is present. Below the single-line diagram there are four command buttons; one for starting and another for stopping the inverter, one for resetting faults (this becomes red when there is a system fault), and a buzzer/mute button for silencing/ activating the acoustic signal in the case of an alarm (for details see Figure 7). Below these four commands there are six navigation buttons which link each to a dedicated information page:

Warning/fault: this page contains information regarding various anomalies concerning power converters such as the bypass, rectifier, inverter and booster charger. In addition to this there is also warning and fault information relating to the battery and the load.

Events log: displays the date and time of important UPS events, alarms and other warnings.

Measurements: this page holds the full set of measurements for each functional block (rectifier, bypass, booster/charger, batteries, inverter and load).

Battery: displays the battery status/ values including temperature, cell voltage, capacity and run time as well as commands for allowing the user to configure battery testing.

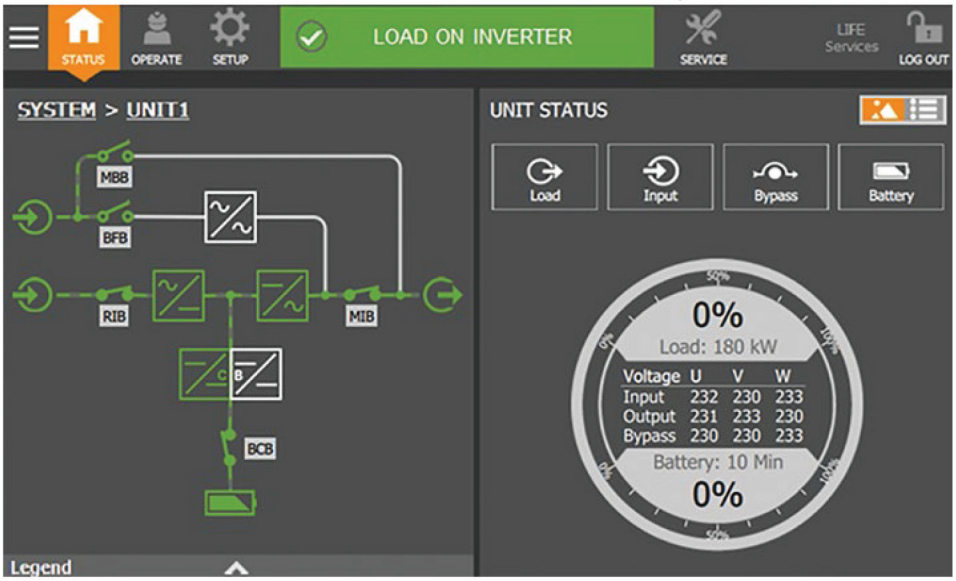


Figure 7: Touch Screen Display for Liebert® EXM2 100-250 kW

Vertiv™ LIFE™ Services: contains information about the status of the Vertiv LIFE Services connections, calls and call types.

Tools: this page allows users to customize the settings of the touch screen display and to select the desired language. Each of these sub pages is programmed to revert back to the main page after 30 seconds of inactivity. The text displayed by the touch screen is available in the following languages: English, Italian, French, German, Spanish, Portuguese, Turkish, Polish, Swedish, Norwegian, Finnish, Czech and Russian, all selectable by the user.

5.2.1 Start and Stop Buttons

The touch screen display features two separate buttons for starting and stopping the inverter. The start/stop control incorporates a safety feature for preventing inadvertent operation. In fact, when selecting the start or stop functions for the inverter a pop-up window will appear asking for confirmation of the action selected. This pop up feature will be implemented for every command that results in a permanent change being made to the UPS settings.

5.3 Communication and Signal Interfaces

5.3.1 Parallel Port

As standard, Liebert® EXM2 comes with serial ports, allowing up to six 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 EXM2 comes 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.

5.3.3 Remote Emergency Power Off Port

Liebert EXM2 can be remotely powered off in the case an external signal is sent to this port.

5.3.4 Vertiv™ IntelliSlot™

The Liebert EXM2 is equipped with independent intellislot bays available for communication cards such as SNMP, Modbus and Relay cards. The two numbers of Vertiv IntelliSlot bays are provided.

5.3.6 Programmable dry contacts

Liebert EXM2 includes two output dry contacts set to:

- Mains input backfeed
- Bypass input backfeed

It also includes following input dry contacts, which can be set to:

- Input switch status
- Bypass switch status
- Generator status
- Internal battery temperature
- Maintenance bypass switch status
- Output switch status
- One configurable input dry contact
- Battery room temperature status

Rated capacity of dry contact is 24V/10mA.

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-LIFE

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 also allows monitoring and control of Vertiv UPS through Vertiv SiteScan® Web or any existing Building Management System. Vertiv Intellislot UNITY-DP card also 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™ 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® EXM2 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.

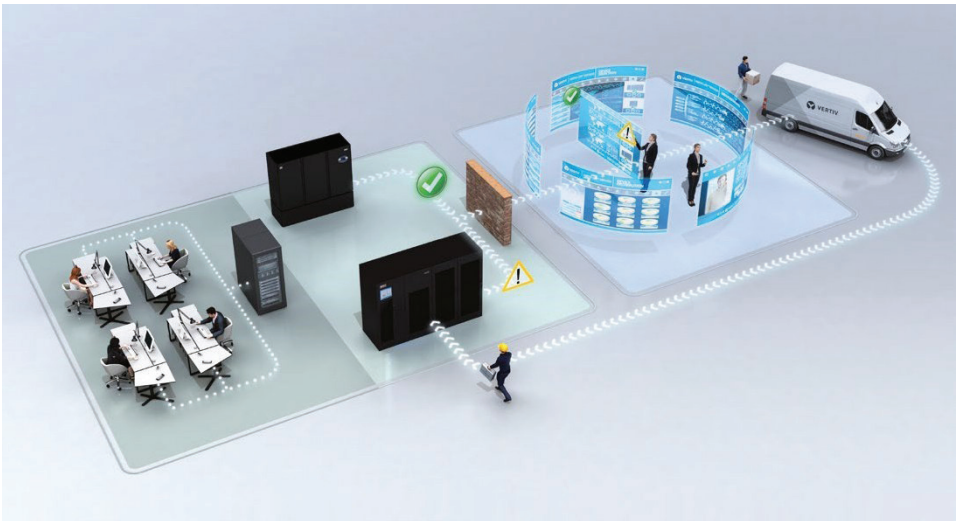
5.7 Vertiv™ LIFE™ Services

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.

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.

- For standard product, the cooling air entry will be from the front and 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.
- With the optional top fan kit, the cooling air entry will be from the front and exit will be from the top of the unit. The enclosure can be installed against the wall but necessary height shall be provided at the top of the unit to allow unhindered exit of cooling air.

6.3 Cable Entry

In a standard product, the cable entry is from bottom of the UPS. Top cable entry can be optionally considered with the side cabinet.

7 Serviceability and Commissioning

The Liebert® EXM2 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.

9 Technical Specifications

Regional and international standards

General and safety requirements for UPS	IEC 62040-1
EMC requirements for UPS	IEC 62040-2
UPS classificaiton according to IEC EN 62040-3	VFI-SS-111
Agent certification approval	CE
Central power supply systems (CPSS) applications[1]	EN 50171
Rail applications[1]	EN 50121-1; EN 50121-5

Note:
1. Conditions apply

Nominal Ratings (kVA/kW)		100 kVA	120 kVA	160 kVA	200 kVA	250 kVA
Environmental characteristics						
Noise within 1 m (in the front) according to ISO7779	dBA	60			62	
Altitude	m	1500m no derating, 1500-3000m derate power by 1% per each 100m increase				
Relative humidity	%RH	0 -95, non condensing				
Operating temperature	°C	0 to 50 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	-	-20 to 30				
Over-voltage level	-	Degree 2				
EMC Class	-	C3 (C2 optional)				
EMI Class	-	C3 (C2 optional)				
Pollution level	-	Degree 2				
Mechanical characteristics						
Net Dimensions[1] (W × D × H)		600 x 850 x 1600			600 x 850 x 2000	
Shipping Dimensions[1] (W x D x H)		800 x 1000 x 1800			800 x 1000 x 2180	
Net Weight[1]	kg	315	350	350	412	447
Shipping Weight[1]	kg	345	380	380	443	478
Color	-	RAL7021				
Protection degree, IEC(60529)	-	Standard- IP20 Optional-IP21 and IP31 (derating factor 0.8 is applicable for IP31)				

Note:
1. Without side cabinet and top fan subassembly

Rectifier AC input (mains)

Nominal input voltage [1]	Vac	380 / 400 / 415 (three-phase and sharing neutral with the bypass input)				
Input voltage range @ 100% nominal load without battery discharge	Vac	176 - 276				
Input voltage range @ 70% nominal load without battery discharge	Vac	132 - 176				
Nominal frequency	Hz	50 / 60				
Input frequency range [2]	Hz	40 to 70				
Input power	kW Nominal[3]	104.0	125.0	166.0	208.0	260.0
	kW maximum[4]	123.0	153.0	194.0	245.0	307.0

Nominal Ratings (kVA/kW)			100 kVA	120 kVA	160 kVA	200 kVA	250 kVA
Rectifier AC input (mains)							
Input current		Amps Nominal[3]	151.0	181.0	241.0	302.0	378.0
		Amps maximum[6]	200.0	240.0	318.0	398.0	496.0
Input power factor	Full load	kW / kVA	0.99	0.99	0.99	0.99	0.99
	Half Load	kW / kVA	0.98	0.98	0.98	0.98	0.98
Input THDi at linear load [5]		-	<3% (full load), 4% (half load)				
Input THDi at full non linear load [5]		-	<5%				
Duration of progressive power walk-in		s	10 seconds to reach full rated current (selectable from 5 to 30 seconds in 5 second intervals)				

Note:

1. Rectifier operates at any of the Nominal supply voltages and frequencies without further adjustment.
2. In the input frequency is within this range the UPS is allowed to switch to bypass if needed.
3. EN 62040-3 / 50091-3: at Nominal load and input voltage 400V, battery charged
4. EN 62040-3 / 50091-3: at Nominal load and input voltage 400V, battery charging at maximum Nominal power.
5. Calculated at input THDv <2%
6. Input voltage 176V

Battery

Battery bus voltage		Vdc	Range: 360V to 528V				
Battery bus wires configuration		-	2N				
Quantity of lead-acid cells (nominal) without power deration		Blocks	30, 32, 34, 36, 38, 40, 42, 44 (12 Vdc)				
Default float voltage	VRLA	V/cell	2,25				
Float voltage selectable range	VRLA	V/cell	2.2 to 2.3				
Recommended battery operation temperature	VRLA	°C	25				
Float voltage temperature Compensation	VRLA	mV/°C/Cell	-3.0(selectable 0 to -5.0 around 25°C or 20°C or inhibit)				
Ripple voltage		% V float	≤1				
Ripple current[1]		% C10	≤5				
Boost voltage (default)	VRLA	V/cell	2.35				
Boost voltage selectable range	VRLA	V/cell	2.30-2.40				
Boost current limit (default)	VRLA	% C10	20				
Boost current limit selectable range	VRLA	% C10	10 to 25				
Automatic EOD voltage adjustment	VRLA	V/Cell	Lower limit: 1.63 (selectable between 1.60 V/cell and 1.67 V/cell) Upper limit: 1.75 (selectable between 1.67 V/cell and 1.85 V/cell) Automatic inverse, EOD voltage x discharge current mode (the EOD voltage increases at low discharge currents)				
Max battery charging power		kW	18.6	27.9	27.9	37.2	46.5

Nominal Ratings (kVA/kW)			100 kVA	120 kVA	160 kVA	200 kVA	250 kVA
Max charging current [2]		A	30	45	45	60	75
Battery mode efficiency	100% load	%	95.6	95.8	95.6	95.7	95.8
	90% load	%	95.9	96.0	95.8	95.9	95.9
	80% load	%	96.0	96.1	95.9	96.0	96.0
	75% load	%	96.0	96.1	96.0	96.1	96.1
	70% load	%	96.1	96.1	96.0	96.1	96.1
	60% load	%	96.1	96.2	96.1	96.2	96.2
	50% load	%	96.1	96.2	96.1	96.1	96.1
	40% load	%	95.9	96.0	95.9	96.0	95.9
	30% load	%	95.9	95.7	95.9	95.9	95.9
	25% load	%	95.8	95.5	95.9	95.9	95.9

Note:

1. In Float Mode for 10 minute autonomy, as per VDE0510
2. At mimimum admissible battery number and EoD = 1.67V

Inverter output (to critical load)

Nominal output voltage[1]		Vac	380 / 400 / 415 (three-phase and sharing neutral with the bypass input)				
Steady state voltage stability	100% balanced load (100,100,100)	%	±1				
	100% unbalanced load (0,0,100)	%	±5				
Transient voltage stability	Input variation (main/battery/ bypass)	%	±5				
	0-100% linear load step	%	±5				
Transient recovery time		ms	60				
Nominal output frequency[2]		Hz	50 / 60				
Frequency stability	Synchronised with internal clock	%	±0.05				
	Synchronised with bypass	%	±0.25				
Frequency slew rate (max change rate of synchronized frequency)		Hz/s	Setting range: 0.1 ~ 3 , default:0.6				
Voltage range synchronized with bypass		% of nominal	380V voltage grade:-20%~+15% 400V/415V voltage grade:-15%~+10%				
Frequency range synchronized with bypass		% of nominal f	Upper synchronization selections: 0.5HZ,1HZ,2HZ,3HZ, +10%; default +10%. Lower synchronization selections: -0.5HZ, -1HZ, -2HZ, -3HZ, -10%; default -10%				
Phase angle displacement accuracy	100% balanced load (100,100,100)	degrees	±1.0				
	100% unbalanced load (0,0,100)	degrees	±1.5				
Nominal apparent Power		kVA	100	120	160	200	250
Nominal active Power[3]		kW	100	120	160	200	250
Range of load power factor handled without apparent power derating[3]		-	0.5 lagging to 0.5 leading				
Automatic Active Power adjustment with temperature	@ 40°C	kW	100	120	160	200	250
	@ 45°C	kW	90	108	144	180	225
	@ 50°C	kW	80	96	128	160	200

Nominal Ratings (kVA/kW)			100 kVA	120 kVA	160 kVA	200 kVA	250 kVA
Overload[3]	105%	min			Continuous		
	110%	min			60		
	125%	min			10		
	150%	min			1		
	>150%	ms			200		
Three phase short circuit current in battery mode		A_{RMS}	380	582	582	776	970
Phase to neutral short circuit current in battery mode		A_{RMS}	398	597	597	796	995
Short circuit current duration before inverter shut down		ms			200		
Neutral conductor sizing		A	225	280	280	310	380
Non-linear load capability[4]		kVA			100		
Load crest factor handled without derating					3:1 (according to IEC 62040-3)		
Permissible Load unbalance		%			100		
Total harmonic voltage distortion with 100% linear load (THDv)		%			1		
Total harmonic voltage distortion with reference non linear load as per IEC EN 6240-3		%			3		

Note:

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. At 30°C
4. IEC 62040-3, annex E (crest factor 3:1)

Bypass input

Nominal voltage[1]		Vac	380 / 400 / 415 (three-phase and sharing neutral with the bypass input)				
Voltage tolerance range[2]		%Vac	"Upper limit: +10,+15, or +20, default: +15 Lower limit: -10, -20, -30, -40, default: -20"				
Nominal Frequency[3]		Hz	50/60				
Frequency tolerance range[2]		%	±10				
Transfer time with inverter synchronous to bypass		ms	0				
Transfer delay time with inverter not synchronous to bypass			<20 (40, 60, 80, 100, selectable)				
Neutral conductor sizing		A	360	360	360	450	450
Overload	110%	min	continuous operation				
	125%	min	10				
	150%	min	≤1				
	>150%	ms	200				
SCR[4]	I^2T @ Tvj =25°C, 10ms	A^2s	135200			450000	
	ITSM @ Tvj =25°C, 10ms	kA	5.2			9.5	

Note:
1. Factory set to 400 V. 380 V or 415 V selectable by commissioning engineer.
2. Outside this protection range the switch to bypass is hinibited
3. Factory set to 50 Hz. 60 Hz selectable by commissioning engineer.
4. If current sharing inductor are installed an additional inductance of 10% must be taken into consideration when analizing the selectivity of the installation"

Nominal Ratings (kVA/kW)			100 kVA	120 kVA	160 kVA	200 kVA	250 kVA
Efficiency, heat losses and air exchange							
Overall efficiency							
Normal mode (double conversion) with linear load at 230V system	100% load	%	95.9	96.4	95.8	95.9	95.8
	90% load	%	96.2	96.5	96.0	96.2	96.1
	80% load	%	96.4	96.7	96.2	96.4	96.4
	75% load	%	96.5	96.7	96.3	96.5	96.4
	70% load	%	96.6	96.8	96.5	96.6	96.6
	60% load	%	96.7	96.9	96.6	96.7	96.7
	50% load	%	96.8	96.9	96.8	96.8	96.8
	40% load	%	96.9	96.9	97.0	96.9	96.9
	30% load	%	96.8	96.8	96.9	96.9	96.9
	25% load	%	96.7	96.1	96.8	96.8	96.8
	20% load	%	96.3	96.7	96.7	96.4	96.4
	10% load	%	94.9	94.3	95.3	95.0	95.1
ECO mode	100% load	%	99.3	99.2	99.2	99.2	99.2
Dynamic online mode		%			98.8		
Heat losses & air exchange							
Normal mode and battery charged		kW	4	4.8	6.4	8	10
Normal mode and battery boost charging		kW	4.8	6.0	8.6	9.6	12.0
Eco mode and battery charged		kW	1	1.2	1.6	2	2.5
Eco mode and battery boost charging		kW	1.8	2.4	2.8	3.6	4.5
No load		kW	0.41	0.60	0.60	0.80	0.96
Maximum forced air cooling (front intake, rear exhaust)		L/sec	100	150	150	200	250

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

10 Customer Experience Center

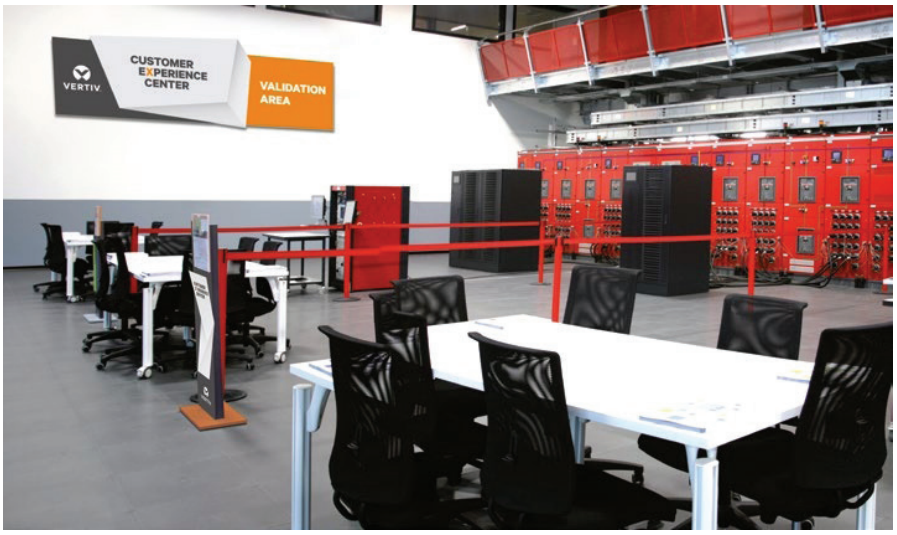
Vertiv's state-of-the-art Customer Experience Center located in Castel Guelfo (Bologna - Italy), enables our customers to experience first-hand a wide variety of data center technologies, supported by constant consultation from R&D and engineering specialists.

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.



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