VERTIV

Liebert® Trinergy™ Cube

from 150 kW to 3.4 MW

UPS CATALOGUE

Liebert® Trinergy™ Cube

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1. Scope

This specification describes a continuous duty three-level solid state, full IGBT (Insulated Gate Bipolar Transistor), three dynamic functioning modes uninterruptible power supply (UPS) system. 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 continuity of conditioned electric power will be delivered for the time period defined by the battery system.

The rectifier, the inverter, and other mission-critical converters within the UPS, are driven by vector control algorithms running on dedicated digital signal processor (DSP) systems operating in combination with the Liebert® Trinergy™ Cube algorithm.

Liebert Trinergy Cube claims additional patents as part of its innovative technology:

- Static Transfer Switch Off Detection and Transfer Management (PCT/IB2013/058549)
- Uninterruptible Power Supply System with Fast Transfer for Under-voltage Source Line Failures (PCT/IB2013/058548)
- Techniques For Communicating Data Amongst Controllers in a Power Supply System (PCT/IB2014/059766)
- Plus another 5 patent applications currently pending.

2. General Requirements

2.1 Applied standards

Vertiv operates Quality Management Systems which comply with ISO 9001, as well as Environmental Policies and Management Systems that comply with ISO 14001.

Liebert Trinergy Cube carries the CE mark in accordance with the following technical Directives:

- Electromagnetic Compatibility 2004/108/EC
- Low Voltage Equipment 2006/95/EC.

Liebert Trinergy Cube is designed and manufactured in accordance with the following international standards:

- IEC/EN62040-1 general and safety requirements
- IEC/EN62040-2 EMC requirements
- EC/EN62040-3 operating requirements
- Classification according to IEC/EN 62040-3: VFI-SS-111.

2.2 Safety

In terms of general and safety requirements, the UPS conforms to the IEC/EN 62040-1 standard, governing use in unrestricted access locations.

2.3 EMC and surge suppression

Electromagnetic effects will be minimized in order to ensure that computer systems and other similar electronic loads will neither be adversely affected by, nor affect the UPS. The UPS will be designed to meet the requirements of EN 62040-2, class C3.

The manufacturer and customer in partnership agree to ensure the essential EMC protection requirements for the specific resulting installation.

2.4 Neutral connection and grounding

Liebert Trinergy Cube's output neutral will be electrically isolated from the UPS chassis. The input and output neutral connections are the same, i.e. they are solidly tied together. Therefore the UPS will not modify the state of the upstream neutral, in any operating mode, and the neutral state of the distribution downstream the UPS is imposed by that of the mains.

In addition to that Liebert Trinergy Cube allows for both three and four wire connections, increasing system flexibility and ensuring effortless replacement of legacy equipment.

Liebert Trinergy Cube can be used in any TN, TT, or IT installation; for further details please contact the technical support team.

2.5 Materials

All materials and components comprising the UPS will be new and of current manufacture.

3. System Description

3.1 The system

Continuous availability, unparalleled operating efficiency, optimized installation space, smart capacity and minimized electrical infrastructure costs make Liebert® Trinergy™ Cube the ultimate UPS solution with an optimized TCO and rapid return on investment, delivering unsurpassed performance to enterprise data centers. Liebert Trinergy Cube is designed around the IT space and is ready to evolve with growing business demands.

It offers the highest level of power availability as well as reduced TCO, minimum energy consumption and CO_2 emissions. Liebert Trinergy Cube is the only unit in the market which allows for hot scalability from 150 kW up to 3.4 MW in a single UPS, thus providing significant electrical infrastructure and space savings. Furthermore, its high power density running up to 200 kW or 400 kW per core, allows customers to maximize the number of racks and servers housed in their data center, thus granting more space for IT equipment.

Liebert Trinergy Cube's highly efficient technology and TCO capabilities also come from Vertiv's expertise in the area of thermal management.

An in-depth study of the ventilation system and internal aerodynamics of the unit has brought extraordinary results in terms of power density and power adaptability for efficient operation in all climates.

The UPS will provide high quality AC power supply for electronic equipment loads and will offer the following features:

- Latest generation IGBT
- Three-level NPC2 rectifier and inverter topology
- Liebert Trinergy Cube technology
- Highest average operating efficiency in the industry 99%
- Hot scalability up to 3.4 MW in a single unit and up to 27 MW in a parallel system
- Unprecedented levels of installation flexibility
- Smart capacity - adaptive power rating
- Full input Power Factor Correction (PFC) and very low THDi
- Li-ion battery option to adapt to all scenarios
- Full compatibility with any TN and IT installation
- Full compatibility with any standby power generator
- Full compatibility with all types of loads with PF up to 1 without derating
- Power blackout protection
- Advanced battery care
- Transformer free design
- Vertiv™ LIFE™ Services Remote Diagnostic and Preventive Monitoring.

The UPS will automatically provide continuity of electrical power, within defined limits and without interruption, upon failure or degradation of the commercial AC source.

In a single UPS Liebert Trinergy Cube can provide a parallel of up to ten CORES (3.4 MW) operating in parallel for capacity or redundancy.

The Liebert Trinergy Cube system can leverage two different CORE ratings: a full 200 or 400 kW power module, which intelligently adapts to load power supply to respond to the environmental conditions of the installation site, providing increased performances down to 20° C.

3.2 Models available

Liebert Trinergy Cube is a high power, modular UPS and is made up of one central I/O Box with a total of up to ten CORES that can be connected to it. Liebert Trinergy Cube can be customized from 150 kW up to 3.4 MW in one single system. Depending on its capacity, each I/O Box will have the possibility to connect a maximum number of CORES according to the table below.

3.3 I/O Box

The central I/O Box is a common interface for power connection and user interaction. The central I/O Box is available in six different ratings: 600 A, 1200 A, 2400 A, 3000 A, 4000 A and 5000 A. A maximum number of ten CORES can be connected to the I/O Box in parallel power, depending on its rating according to the table below. For redundant parallel configuration (N+1) the single maximum parallel power configuration described above can be upgraded with an additional CORE.

The modular architecture of Liebert Trinergy Cube allows CORES to be added without the need for any modification to the current installation and without any temporary disconnection of the power supply to the load, thanks to Liebert Trinergy Cube's hot scalable features.

I/O Box	Max N° of 200 kW CORE Connected	Max N° of 400 kW CORE Connected
600 A	**2 (+1)***	**1 (+1)***
1200 A	4 (+1)*	2 (+1)*
2400 A	8 (+1)*	4 (+1)*
3000 A	on demand	6 (+1)*
4000 A	on demand	8 (+1)*
5000 A	on demand	10 (+1)*

**(+1) indicates additional redundant core*

The central I/O Box can be configured in three different versions depending on the number of switches located on the front of this box:

- the I/O Box full switch version includes the following switches:
  - mains input
  - bypass input
  - bypass output
  - maintenance bypass
  - output
- the I/O Box value switch version includes the following switches:
  - bypass input
  - bypass output
- the I/O Box no switch version does not include a switch.

This high degree of flexibility of the I/O Box allows any maintenance work to be carried out without disconnecting the load.

The Liebert® Trinergy™ Cube centralized bypass is located in the I/O Box completely segregated from the rest and is concurrently maintainable thanks to the input and output bypass switches located in the I/O Box.

Input and output terminals are located in the central I/O Box which allows for top or bottom cable entry.

For I/O Box ratings of 3000 A and above it is highly recommended to use power connections via flanges which are available on demand and customized for the specific flange type.

The Liebert Trinergy Cube I/O Box also includes the CORE disconnector switches located in another independent and segregated cabinet. The number of CORE disconnector cabinets depends on the maximum number of CORES connected to the central I/O Box and the power connection to CORES is done via flexible cables.

The CORE disconnector cabinet includes the following switches:

- input switch
- output switch
- battery switch.

The battery connection on the I/O Box rated 600, 1200 and 2400 A can be either centralized or distributed with top/bottom cable entry through the CORE disconnector cabinet. With higher I/O Box ratings it is highly recommended to use a distributed battery only with cable entry from the bottom. Liebert Trinergy Cube new generation architecture and connection types a llow to deliver unprecedented levels of installation flexibility and an easy hot-scalability system.

Liebert Trinergy Cube system can thus be configured into a vast range of layouts, whether it be a straight row, L-shape or back-to-back, the system easily adapts to available floor space. The Liebert Trinergy Cube architecture and flexibility features deliver significant infrastructure upgrade cost savings, easily adapting to new or existing installations without impacting power infrastructure.

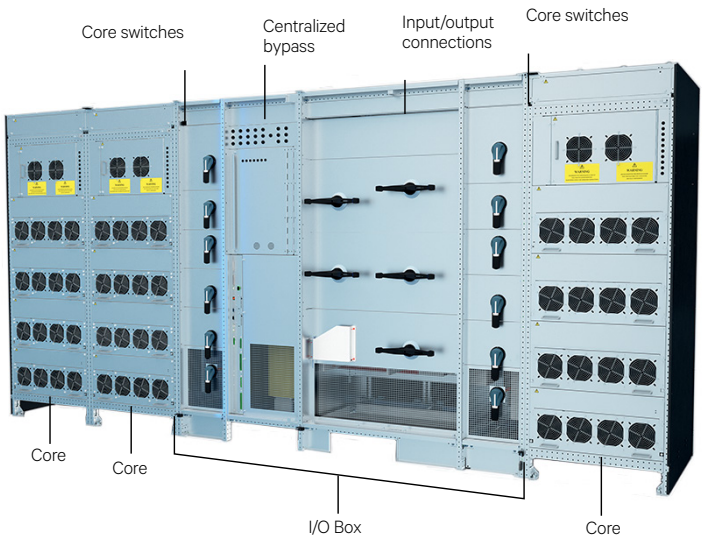


***Figure 1:** Liebert® Trinergy™ Cube*

The central I/O Box houses a 12.1 inch touch screen display which allows for easy monitoring of the system and individual CORES. Single points of failure are completely eliminated as all the power components, as well as the control boards, are distributed in each CORE, and the central LCD touch screen display can be completely replaced on site without changing the UPS functioning mode and without affecting the Liebert Trinergy Cube system availability and reliability.

3.4 CORES (power modules)

Each of the Liebert Trinergy Cube CORES has four separate drawers which allow for improved serviceability of the individual CORES. The CORE contains:

- Full IGBT rectifier
- IGBT Booster/battery charger
- IGBT inverter
- Power control.

Each CORE has no internal switches, since they are located in the CORE disconnector cabinet part of the central I/O Box. These switches will make it possible to completely isolate a single CORE for maintenance or service operation and even to allow system hot scalability for future power upgrade.

As a result, there will be no interruption to the power of the critical load when it is necessary to take a CORE out of service for maintenance or repair or, viceversa, when it is necessary to add a new CORE for system power upgrade

Isolation will be complete and all serviceable components such as fuses, internal power functional modules, control boards, etc, will be isolated and easily accessible from the front ensuring a very low MTTR (Mean Time To Repair).

Remaining CORES will continue to power the load making it possible to perform maintenance operation on the system,while maintaining the highest level of power protection and avoiding the need to switch the whole system to manual maintenance bypass.

3.5 Microprocessor control and diagnostics

Operation and control of the UPS will be provided through the use of a micro-processor-controlled logic. Indications, measurements and alarms, together with battery autonomy, will be shown on a graphic touch screen display. The procedures for start up, shutdown and manual transfer of the load to and from bypass will be explained in clear step-by-step sequences on the display.

3.6 Control and diagnostics

Control of the electronic CORES will be optimized in order to provide:

- Optimum three-phase supply and conditioning of the load
- Controlled battery charging
- Minimum effects upon the supply network.

Liebert® Trinergy™ Cube houses an advanced digital control platform present inside each CORE that combines the advantages of a double DSP, which executes all the vector control algorithms and a Microcontroller giving maximum communication flexibility, whilst interfacing all internal and external signals. As a result of this platform, Liebert Trinergy Cube achieves the most powerful control in the UPS industry.

3.6.1 Vector control & Liebert Trinergy Cube algorithm

To ensure the quick and flexible processing of measuring data, special arithmetic algorithms will be implemented in DSP, rapidly generating controlled variables as a result. This will thus make the real-time control of the inverter electronics possible, resulting in obvious advantages in the performance of power converters.

These advantages will be:

- Improvement of short circuit behaviour as individual phases can be controlled faster
- Synchronism or phase angle precision between UPS output and bypass supply even in the case of a distorted mains voltage
- High flexibility in parallel operation: load sharing between multiple CORES and parallel Liebert Trinergy Cube systems.

Several algorithms included in the vector control firmware are covered by patents owned by Vertiv (95 P3875, 95 P3879 and 96 P3198).

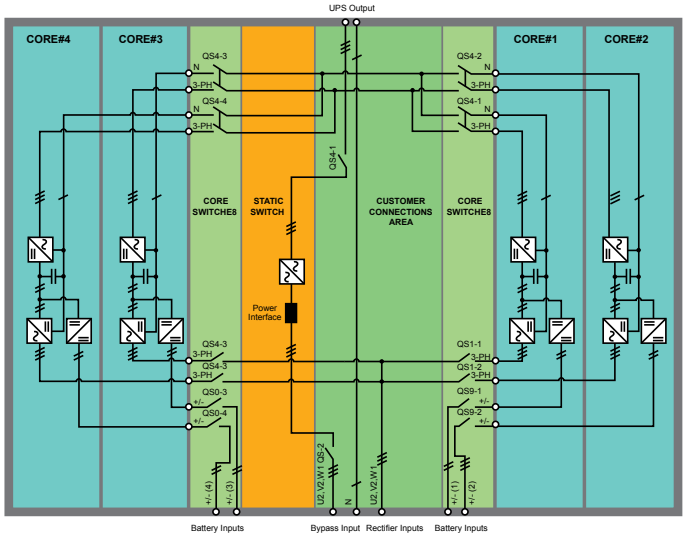
The precise control of Liebert Trinergy Cube allows it to quickly and seamlesslyactivate one of the three industry standard functioning modes (VFI, VFD and VI as per IEC 62040-3) of the UPS in order to accomplish the highest efficiency and effectiveness while maintaining first class performance and power protection of a Class 1 (IEC 62040-3) UPS to the load, together with perfect input power conditioning for the upstream distribution.

The UPS system is a Voltage and Frequency Independent (VFI-SS-111) system where the UPS output is independent of supply (utility/generator) voltage variations, and by which frequency variations are controlled within EN 62040-3:2011 limits.

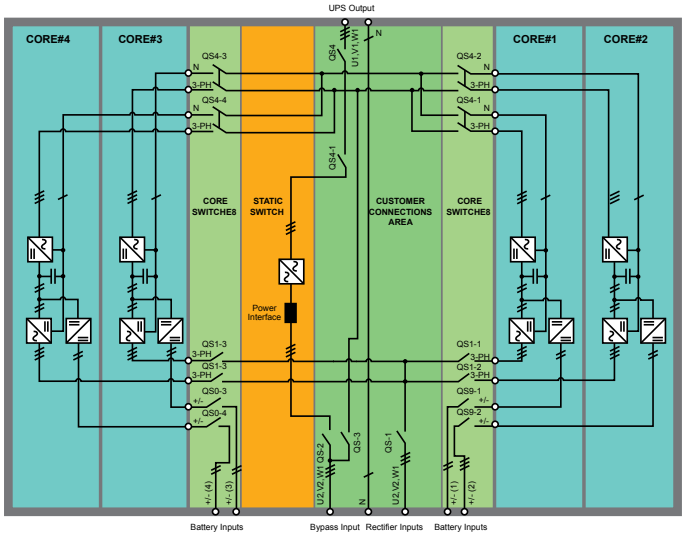
3.6.2 Preventive monitoring

In order to maximize the reliability of the system, the control unit will monitor a wide number of operating parameters for the rectifier, inverter and battery.

All vital operating parameters, such as temperatures, frequency and voltage stability at the system input and output, load parameters and internal system values will be constantly monitored and controlled for irregularities.



Value Switch configuration



Full Switch configuration

***Figure 2:** Liebert® Trinergy™ Cube single line diagram*

The system will react automatically before a critical situation arises either for the UPS or the load, in order to ensure the supply of the load even in these difficult conditions.

3.6.3 Telediagnosis and telemonitoring

In all the above modes of operation, the UPS may be monitored and controlled from a remote location such as a service center, in order to maintain system reliability at nominal levels.

Even during complete shutdown of the UPS, information relating to the operating parameters will not be lost thanks to non volatile memory.

3.6.4 Serviceability and commissioning

Liebert® Trinergy™ Cube is designed for easy installation and serviceability as a result of its drawer-based design, making it a full modular service solution and considerably minimizing the time needed for repairs. All functional modules can be removed by extracting the drawers from the front of the machine.

In addition to that, each individual module has been designed in a modular way to allow all the major components such as fans, power boards, AC capacitors and inductors can be easily accessed from the front and disassembled independently minimizing the MTTR.

Each UPS will be equipped with an ID card, including all main UPS working parameters. This card reduces the MDT shortening service and commissioning operations.

3.7 Parallel Configuration

3.7.1 Paralleling principle

The Liebert Trinergy Cube series of uninterruptible power supply systems will be connectable in parallel for multi-module configurations. The maximum number of CORES that can be connected to the I/O Box is ten, providing 3.4 MW of power in one single Liebert Trinergy Cube UPS.

The maximum number of Liebert Trinergy Cube UPS possible in parallel configuration is eight in order to reach a maximum power capacity of 27 MW.

The parallel connection of UPS will increase reliability and power.

Reliability

If the installation requires a redundant configuration, the power of each UPS should not be lower than $P_{tot}/(N-1)$ where:

P_{tot} = Total load power

N = Number of CORES in parallel

1 = Minimum coefficient of redundancy

Under normal operating conditions, the power delivered to the load will be shared between the number of CORES connected to the parallel bus. In case of overload, the configuration may deliver P^{ov} x N without transferring the load onto the reserve, where:

P^{ov} = Max overload power of a single CORE

N = Number of CORES in parallel

In the event of failure of one of the CORES, the faulty CORE will be completely isolated and the load will be supplied from the remaining units without any break in supply continuity. Internal redundancy allows maintenance to be carried out on specific CORES while other CORES continue to provide full protection to the load with enormous advantages on the availability of the whole system.

A maximum of eight Liebert Trinergy Cube UPS may be connected in parallel.

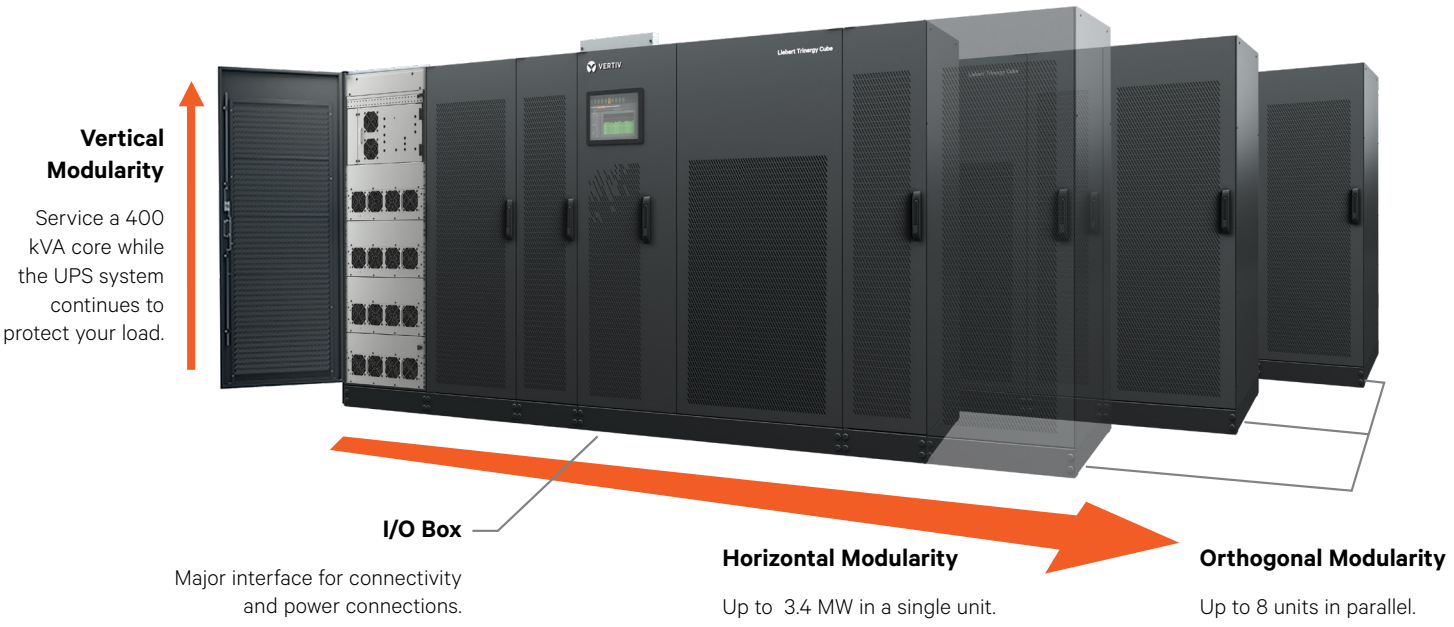


Figure 3: Liebert® Trinergy™ Cube three dimensions of modularity, single system up to 3.4 MW parallel system up to 27 MW

3.7.2 Modular Parallel

The Liebert Trinergy Cube UPS will be capable of operating in a modular parallel configuration.

The parallel option will simply consist of shielded data cables connected to the neighboring UPS systems (closed loop ring bus).

A multi-module system will be controlled and monitored automatically by controlling the individual CORES.

The parallel system control is distributed between the units (no master/slave architecture).

The centralized bypass line and inverters included in each Liebert Trinergy Cube unit share the load. The load sharing among the UPS parallel system ("load on inverter" mode) will be achieved with a tolerance of less than 3% at nominal load.

The loop ring bus will allow the parallel to share the system load even with an interruption in the data cable (first failure proof system).

3.7.3 Centralized Parallel with MSS

Centralized paralleling architecture enables UPS with inhibited bypass to be connected in parallel. Therefore, the reserve supply to the loads works with one central piece of equipment (MSS). For further details please contact Technical Support.

3.7.4 Circular Redundancy

Circular redundancy is able to optimize the efficiency of the UPS even at partial loads. In the case that the total number of CORES is not necessary to power the output load, Liebert® Trinergy™ Cube will evaluate the real number of CORES required (maintaining also the level of redundancy requested) to power the actual load. As soon as an increase of the load is verified, the CORE will be started up.

Circular redundancy powers only the minimum number of inverters required at that level of load, ensuring a periodic turnover of all the available CORES.

This feature ensures that the highest level of efficiency is maintained at all times.

3.7.5 Safe Capacity Test Mode

With the safe capacity test Liebert Trinergy Cube can test its entire power train, including the rectifier, inverter, contactors, fuses, power busses, cabling,bypass static switch, magnetics and filter capacitors, all without an external load connected.

This feature saves time and money during startup, commissioning tests and also after a system upgrade or repair, thanks to the ability to use the rectifier and inverter in a closed loop power circulation that allows the UPS to perform the safe capacity test at full load.

Figure 4: *Liebert® Trinergy™ Cube, L-shape configuration*

4. AC/DC IGBT Converter (Rectifier)

4.1 Primary input

The three-phase current taken from the commercial AC source will be converted to a regulated DC voltage by the three-level IGBT rectifier of each CORE. In order to protect the power components within the system, each phase of the rectifier input will be individually fitted with a fast-acting fuse. The IGBT rectifier will provide DC power to the DC/AC output converter (three-level IGBT inverter) and to the DC/DC battery converter (booster/battery charger) when the latter is working in battery charger mode.

4.2 Total Input Harmonic Distortion (THD) and Power Factor (PF)

The maximum voltage THD (THDv) permitted on the rectifier input (either from the utility or generator) will be 8%. The maximum current THD injected into the mains (THDi) will be less than 3% at maximum input power and input voltage THDv < 1% (nominal input voltage and current). The input power factor (PF) will be > 0.99. Under other input conditions and with other output load fractions the THDi will be < 5%.

This means that the Liebert® Trinergy™ Cube will be seen by the primary mains sources and distribution as a resistive load (i.e. it will absorb only active power and the current waveform will be practically sinusoidal), thus ensuring total compatibility with any power source.

4.3 Operation with diesel generator

In order to obtain the required THD on input voltage, the coordination between a diesel generator and UPS will be based on the generator's subtransient reactance, as opposed to its short-circuit reactance.

4.4 Soft start

With the UPS logic properly powered, after applying the input voltage the rectifier starts an additional programmable current soft start (1-90 seconds). This procedure results in a gradual and soft walk-in of the current taken from the input voltage supply network. This ensures that any standby generator is gradually introduced into the UPS input, as shown in Figure 5.

To avoid the simultaneous start-up of different rectifiers, it is possible to program a hold-off dedicated start delay (1-90 seconds) for each unit.

In addition, the UPS includes an 'on generator' function which, when activated via floating contact, provides the possibility of inhibiting either battery charging, synchronization of the inverter to the direct line supply or transfer to the direct line and forces the unit to work in double conversion mode.

When the UPS is operating with a Flywheel system, the corresponding hold off and soft start parameters must be set according to the requirements of the genset.

Please contact the Technical Support team for more information.

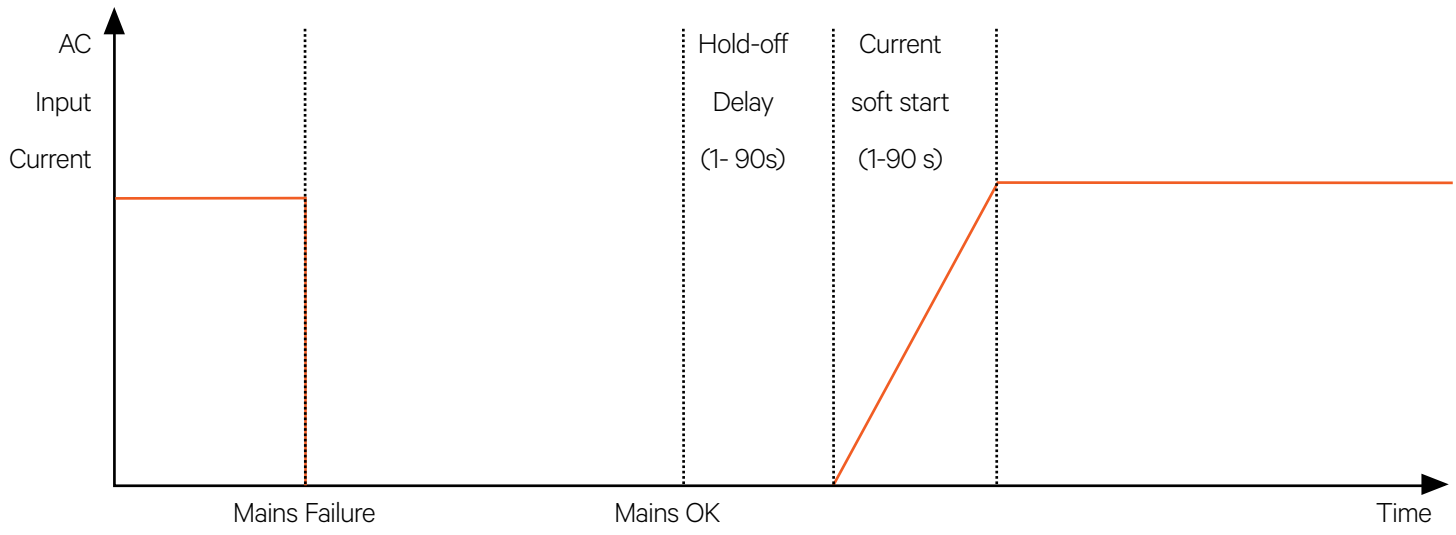


Figure 5: *Rectifier soft start*

5. DC/DC IGBT Converter (Booster/Battery Charger)

5.1 Booster/Battery Charger

This bidirectional IGBT DC/DC converter will have 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 suitable full DC power, taken from the batteries, to the IGBT output inverter if the primary mains is unavailable.

When the primary mains is not suitable to supply the rectifier, the DC/DC converter (booster mode) will provide the required power to the inverter using the energy stored in the battery.

After the discharge of the battery and when the input AC power is restored, the rectifier will power the inverter and recharge the batteries through the DC/DC converter in battery charger mode.

5.2 Battery charger mode

This converter will be operable with the following types of batteries:

- Sealed Lead Acid
- Lead Acid (VRLA)
- Li - ion
- Ni - Cd.

The selection of the optimum charging method will be completely managed by the microprocessor. Several different charging methods are available.

5.3 Voltage regulation, temperature compensation

In order to ensure optimum battery charging, float voltage will be automatically adjusted to the ambient temperature. The IGBT rectifier will be capable of supplying the battery charger with DC voltage at rated power, even if the UPS input AC voltage is below the nominal voltage specified.

A further reduction of the input AC voltage (within specified limits which are dependent also on the output power requested by the load) will inhibit the battery charger but will not require the discharging of the batteries. See Figure 6 for details.

5.4 Residual ripple filtering

The battery charger output will have a residual voltage ripple of <1%.

5.5 Over voltage protection

The battery charger will automatically switch off if the DC battery voltage exceeds the maximum value associated with its operational status.

5.6 Battery management

Using advanced battery care (ABC) the Liebert® Trinergy™ Cube series will maximize battery running time by up to 50%. The main battery care features are described as follows.

5.6.1 Operating parameters

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

- End of discharge voltage (V) 1.65
- Shutdown imminent alarm (V) 1.75
- Minimum battery test voltage (V) 1.9
- Nominal voltage (V) 2.0
- Battery discharging alarm (V) 2.20 @ 20° C
- Float voltage (V) 2.27 @ 20° C
- High voltage alarm (V) 2.4.

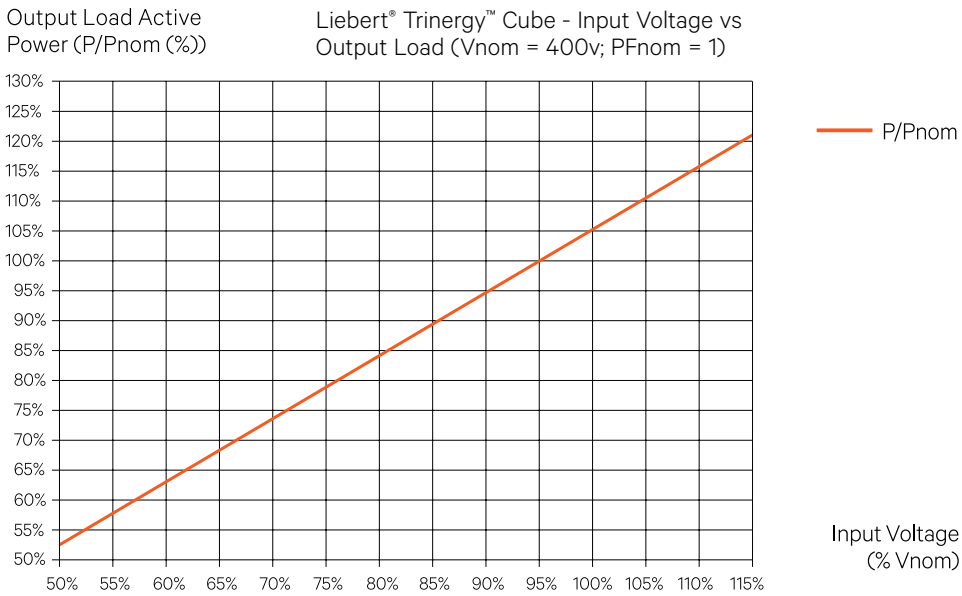


Figure 6: *Input Voltage in relation to the Output Load percentage*

5.6.2 Automatic battery test

The operating condition of the batteries will be automatically tested by the control unit at selectable intervals, e.g. weekly, fortnightly or monthly.

The battery test can be performed in each of the different functioning modes. A short-time discharge of the battery will be made to confirm that all the battery blocks and connecting elements are in good working order.

In order to preclude a faulty diagnosis, the test, at the earliest, will be launched 24 hours after the latest battery discharge.

The battery test will be performed without any risk to the load, even if the battery is completely defective. Users will be alerted of a detected battery fault. The battery test will not cause any degradation in terms of the battery system life expectancy.

5.6.3 Ambient temperature compensated battery charger

The float voltage will be automatically adjusted as a function of the temperature in the battery compartment (-0.11% per °C) in order to maximize battery operating life.

5.6.4 Time compensated end of discharge voltage

When the discharge time exceeds one hour, the shutdown voltage will be automatically increased, as shown in Figure 7 for VRLA, to avoid prolonged battery discharge as a result of a light load.

5.6.5 Remaining battery life

Liebert® Trinergy™ Cube uses sophisticated algorithms to determine the remaining battery W based on real operating conditions such as temperature, discharge and charging.

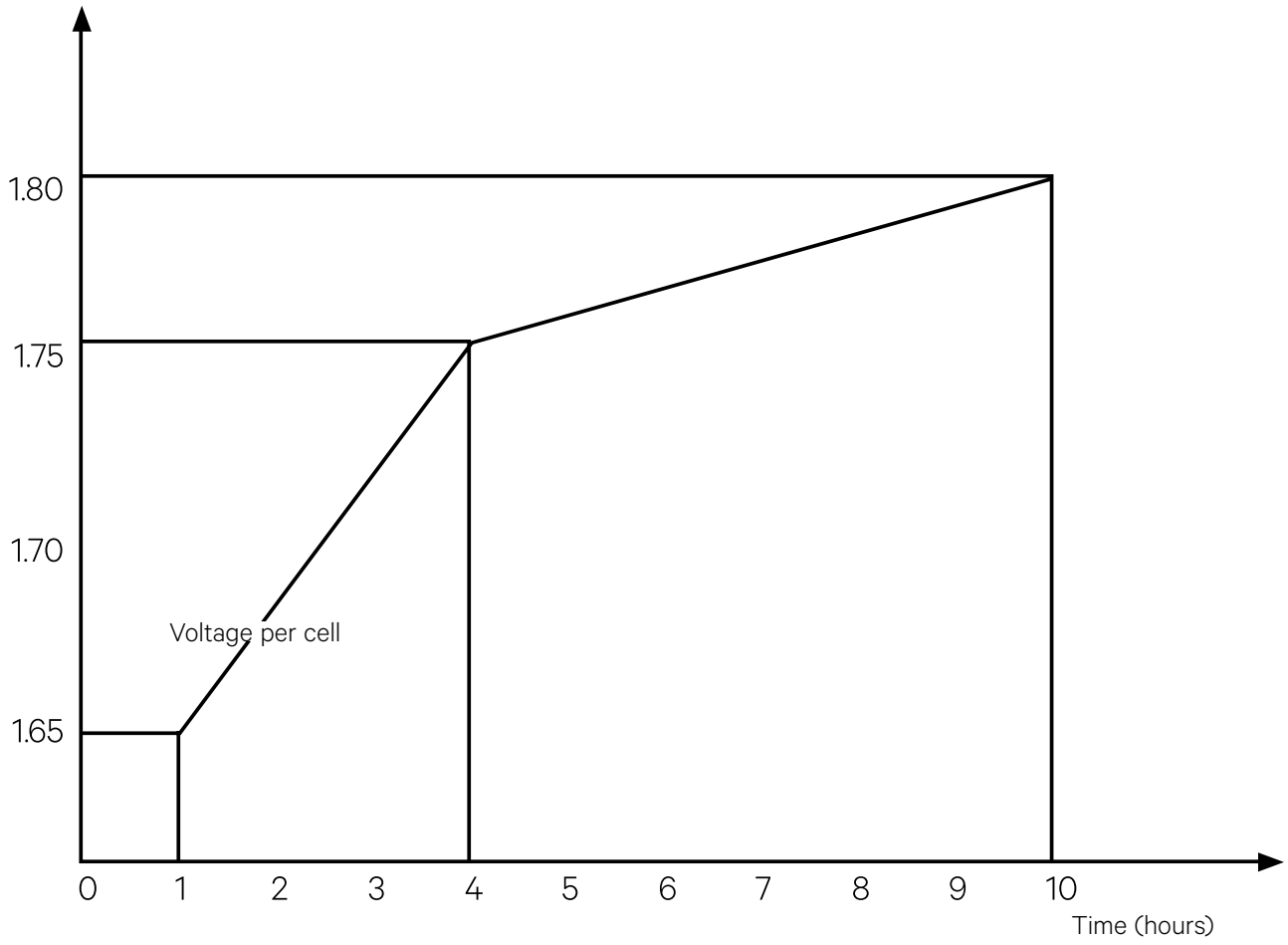


Figure 7: *End-of-discharge voltage in relation to discharge time*

6. DC/AC IGBT Converter (Inverter)

6.1 AC voltage generation

From the DC voltage of the intermediate circuit the inverter will generate sinusoidal AC voltage for the user load on the basis of pulse-width modulation (PWM). By means of the digital signal processor (DSP) of the control unit, the three-level IGBT of the inverter will be controlled so that DC voltage is divided up into pulsed voltage packets. Thanks to a low-pass filter, the pulse width modulated signal will be converted into sinusoidal AC voltage.

No isolation transformer is needed for the IGBT inverter, with the great benefits of energy conversion efficiency and reduction in physical size and weight of the CORES.

6.2 Voltage regulation

The inverter output voltage on the three phases will be individually controlled to achieve the following performances:

- The inverter steady state output voltage will not deviate by more than ±1% in a steady state condition for input voltage and load variations within the quoted limits
- The inverter transient voltage will not exceed Class 1 limits when subjected to application or removal of 100% load as defined by IEC/EN62040-3.

6.3 Frequency regulation

The inverter output frequency will be controlled to achieve the following performances:

- The inverter steady-state output frequency, when synchronized to bypass supply, will not deviate by more than ±1% adjustable to ±2%, ±3%, ±4%
- The frequency slew rate will be <1 Hz per second
- The output frequency of the inverter will be controlled by a quartz oscillator which can be operated as a free running unit or as a slave for synchronized operation with a separate AC source. The accuracy of the frequency control will be ±0.1% when free-running.

6.4 Total Harmonic Distortion

The inverter will provide harmonic neutralization and filtering to limit the THD on the voltage to less than 1% with a linear load. For reference non-linear load (as defined by IEC/EN62040-3) the THD will be limited to less than 3%.

6.5 Overload

For the specific inverter overload level at 125% and 150% please refer to the dedicated Liebert® Trinergy™ Cube Smart Selection APP, since it depends on the Liebert Trinergy Cube Smart Capacity features (see section 6.10) considered in the real environment conditions of the installation site. Contact the Technical Support team for further details.

6.6 Inverter shutdown

In the event of an internal failure the inverter will be immediately shut down by the control unit. The UPS device or the parallel-operated UPS systems will continue to supply the load from the bypass supply without interruption, if it is within permissible limits.

6.7 Output voltage symmetry

The inverter will guarantee the symmetry of the output voltages at ±1% for balanced loads and ±3% for 100% unbalanced loads.

6.8 Phase displacement

The phase angle displacement between the three-phase voltages will be:

- 120° ± 1° for balanced loads
- 120° ± 3° for unbalanced loads (0, 0, 100%).

6.9 Short circuit

For the specific inverter short circuit capacity please refer to the dedicated Liebert® Trinergy™ Cube Smart Selection APP, since it depends on the real UPS rating and environment conditions of the installation site.

6.10 Smart Capacity - Adaptive Performance

Liebert Trinergy Cube intelligently adapts load power supply to respond to the environment conditions of the installation site. The system's I/O Box and CORES are rated to operate continuously up to 55°C and provide increased performance down to 20°C. Furthermore, the maximum input current is adjustable to meet specific protection rating requirements.

Please refer to the dedicated Liebert Trinergy Cube Smart Selection APP for further details or contact the Technical Support team.

Liebert Trinergy Cube's smart capacity ensures the best possible usage of physical infrastructure, providing maximized power to the load and optimizing each individual configuration based on the specific site conditions.

6.11 Power Factor Output Diagram

Depending on the environmental temperature on the installation site the full three-level IGBT inverter is able to supply all kinds of loads (leading and lagging) with a Power Factor up to 1.

This behavior is achieved thanks to the perfect dimensioning of all components of the output stage, supporting any kind of load, from 0.4 lagging to 0.7 leading, without derating, as shown in Figure 8.

Thanks to this inverter design and to the Smart capacity feature, which is unique in the market, Liebert® Trinergy™ Cube offers maximum flexibility and compatibility with each installation and this means that the customer doesn't have to worry about future modifications of the loads with a different Power Factor.

6.12 Active Filtering Capacity in Dynamic Online Mode

The DC/AC IGBT inverter by means of the digital signal processor (DSP) of the control unit will be controlled so that it can operate as a series and parallel active filter if this allows a higher efficiency level to be achieved.

- Inverter as a parallel active filter: the inverter will work as a current controlled generator, generating a current that compensates for the reactive and harmonic content of the load
- Inverter as a series active filter: the current of the active filter will have a shape intended to compensate the bypass line voltage in order to be able to remain inside the tolerance limits. This is possible by operating together with the Power Interface containing a series inductance that will serve one main purpose: adding a small line impedance for the active voltage compensation by interacting with the current of the active filter generated by the inverter.

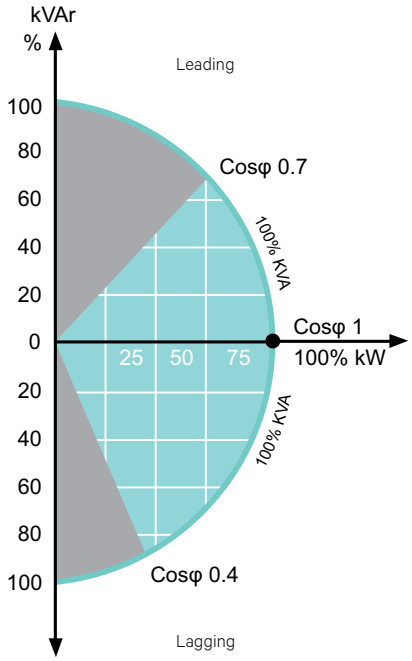


Figure 8: *Power Factor Output Diagram*

7. Power Interface/Electronic Static Switch (Bypass)

7.1 General

The Power Interface is made up of a bypass static transfer switch with an upstream choke. This interface will power the load whenever the load and network conditions allow it to be able to take advantage of the Maximum Energy Saving mode (VFD) and the High Efficiency & Power Conditioning Dynamic Online mode (VI).

In interactive mode the inverter is able to operate as a series active filter together with the Power Interface to compensate small out of tolerance.

The bypass static switch will be a fully rated, high speed, solid-state transfer device rated for continuous duty operation.

The following transfer and retransfer operations will be provided by the electronic static switch:

- Uninterrupted automatic transfer to the bypass supply in the event of:
  - inverter output overload
  - battery voltage outside limits in backup mode
  - over-temperature
  - inverter failure
- If inverter and bypass supply are not synchronised at the time of a necessary transfer, a switching delay can be set to protect the critical load. This prevents possible damage to the load by unintentional phase shift (a delay of 20ms is the preset standard value)
- Uninterrupted manual transfer/ retransfer to and from the bypass supply will be initiated from the control panel
- Uninterrupted automatic transfer/ retransfer to and from the bypass supply by activation of the digital interactive mode
- Uninterrupted automatic retransfer from the bypass supply as soon as the inverter regains the capacity to supply the load.
- The uninterrupted transfer from the inverter to the bypass supply will be inhibited in the following situations:
  - bypass supply voltage outside limits
  - failure of electronic bypass switch
- The uninterrupted automatic retransfer may be inhibited in the following situations:
  - manual switching to bypass supply via the maintenance switch
  - UPS output overload.

7.1.1 Voltage

The default voltage of the bypass line will be 230/400 V RMS. Any transfer from inverter to the bypass line will be inhibited if the voltage is beyond a limit of ±10% (standard setting) of the nominal voltage.

7.1.2 Transfer time (double conversion)

The switching time for a transfer from the inverter to the bypass supply or vice versa will be less than 0.5ms when synchronized.

The system will ensure that the inverter is stable and operating normally before permitting a retransfer of the load back to the inverter. The transfer time when out of synchronization will be defined by a preset parameter to prevent damage to the load by phase reversal.

7.1.3 Overload

For the specific bypass static switch overload level please refer to the dedicated Liebert® Trinergy™ Cube Smart Selection APP, since it depends on the real environment conditions of the installation site.

Otherwise, contact the Technical Support team for further details.

7.2 Backfeed protection

When the UPS bypass input line is powered off, normally there is no dangerous voltage/current/power present on the UPS bypass input. However, when there is a fault in the bypass static switch there is the risk that electric power will appear on the UPS bypass input terminals.

In this case the inverter powers the critical load and the upstream input power line.

This unexpected potentially dangerous power 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.

Liebert® Trinergy™ Cube ratings up to 2400 A may include integrated backfeed protection device on request.
Please contact the technical support team for further information.

8. Functioning Modes

Liebert® Trinergy™ Cube incorporates the three existing standard topologies in one transformer-free UPS delivering up to 99.5% maximum efficiency, thus reducing operating costs to a minimum.

The Class 1 fast transfer ensures the quickest response time under various conditions:

- Network fault (voltage variation, high/low impedance mains failures)
- Load fault (short circuit downstream the UPS)
- Type of load connected (PDU transformer)

The unit is able to discriminate between the various types of interferences and rapidly respond, while at the same time ensure compatibility with downstream equipment such as servers, transformers, STS or mechanical loads.

The Liebert Trinergy Cube dynamic functioning modes are:

- **Maximum Power Control mode (IEC 62040-3 VFI):**
  is the double conversion mode which provides the highest level of power conditioning.
  It protects the load from all types of electrical network disturbances using a greater amount of energy.
  Efficiency with the latest transformer free technology is up to 97%
- **Maximum Energy Saving mode (IEC 62040-3 VFD):**
  in this mode Liebert Trinergy Cube detects when the mains energy supplied is of an ideal quality and there is limited need for conditioning, allowing energy flow to pass through the bypass line. In this case efficiency is over 99%
- **High Efficiency & Power Conditioning Dynamic Online Mode (IEC 62040-3 VI):**
  Dynamic Online is a high efficiency mode of operation to allow an increase in efficiency without compromising reliability. Dynamic Online mode offers up to 99% efficiency without decreasing reliability. In fact, while operating in Dynamic Online the UPS is able to maintain the output voltage within the IEC 62040-3 Class 1 specification in all operating conditions.
  When the quality of the supply network is within tolerances the UPS activates Dynamic Online mode. In this mode the energy is supplied by the network to the load through the static bypass switch and the UPS inverter will function as an active filter, providing the reactive power necessary to compensate load THDi and load Power Factor. In case of network parameters outside tolerances the UPS will instantly activate double conversion mode (VFI) with a Class 1 transfer

The precise control of Liebert Trinergy Cube allows it to quickly and seamlessly activate one of the three different functioning modes in order to accomplish the efficiency and effectiveness of each of the standard configurations. At the same time, Liebert Trinergy Cube continues to maintain the performance and power protection of a Class 1 (IEC 62040-3) UPS for the load and perfect input power conditioning for the upstream distribution.

The activation of one of the three different functioning modes is based on real time power tracking of the main parameters related to the input network and to the output load. If the observed variables listed above are outside the ranges described, the UPS will activate a different functioning mode.

Parameters can be modified by the customer engineer upon request.
These conditions refer to full output load.

8.1 Double Conversion Mode (VFI)

8.1.1 Normal (VFI)

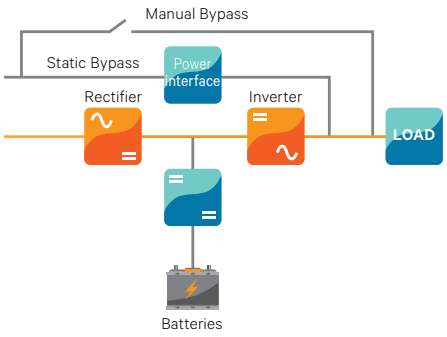
The UPS inverter continuously supplies the critical AC load.

The rectifier derives power from the commercial AC source and converts it into DC power for the inverter and the battery charger.

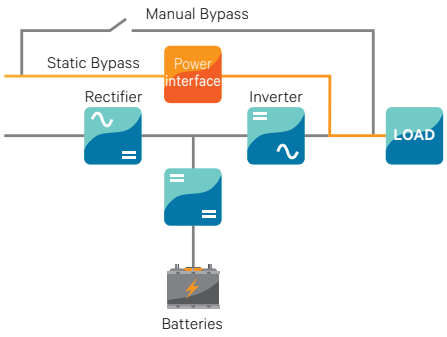
The battery charger keeps the battery in a fully charged and optimum operational condition. The inverter converts the DC power into clean and regulated AC power which is supplied to the critical load (conditioned line) and is synchronized with the bypass supply frequency.

This ensures that any automatic transfer to the bypass supply (due to an overload etc.) is frequency synchronized and does not cause interruption to the critical load.

Maximum Power Control (VFI)



Maximum Energy Saving (VFD)



High Efficiency & Power Conditioning Dynamic Online (VI)

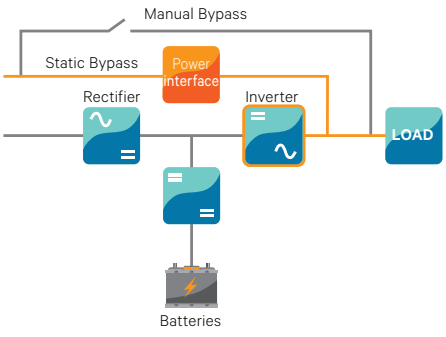


Figure 9: Liebert® Trinergy™ Cube operating modes

8.1.2 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.

8.1.3 Emergency (VFI)

Upon failure or reduction of the commercial AC source the inverter will supply the critical load, drawing power from the associated 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.

8.1.4 Recharge (VFI)

Upon restoration of the commercial AC source, even in the case that the batteries are completely discharged, the rectifier will restart automatically (walk in) and gradually take over both the inverter and battery charger. This function will be fully automatic and will cause no interruption to the critical load.

8.2 Maximum Energy Saving mode (VFD)

This operational mode allows significant energy savings by increasing the overall AC/AC efficiency of the UPS up to 99,5%.

8.2.1 Normal (VFD)

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 in this time frame, the direct line will provide continuous supply to the critical AC load through the power interface.

The IGBT inverter control will remain in constant synchronization with the direct line without driving the IGBT. This ensures that the load can be transferred to the conditioned line without any break in supply where there is a deviation from the selected input power tolerance levels. If the direct line failure rate has been outside permitted parameters in this timeframe, Liebert® Trinergy™ Cube will supply the load from the conditioned line.

The battery charger supplies the energy necessary for maintaining maximum charge to the battery.

8.2.2 Transfer to VFI Emergency (due to mains supply failure or variance beyond tolerance limits)

If Liebert Trinergy Cube is supplying the load via the direct line and the bypass mains supply varies beyond tolerance levels (adjustable using the software), the load will be transferred from the direct line to the conditioned line. The load is powered from the mains via the rectifier and inverter, (provided the input mains remains within the tolerances stated in chapter 12). Should the input mains fall below the lowest limit, the batteries will be used to power the load via the inverter.

8.2.3 Return to VFD

When the mains supply returns to within tolerance limits, Liebert Trinergy Cube 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 Trinergy Cube returns to normal operation. The battery charger automatically begins to recharge the battery so that maximum autonomy is guaranteed in the shortest possible time.

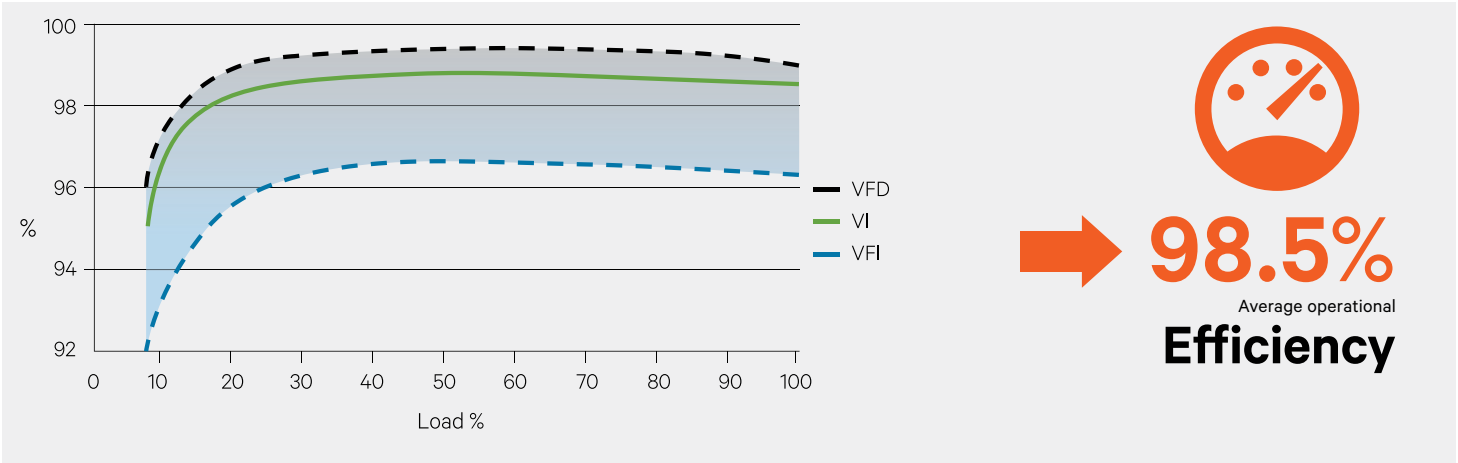


Figure 10: Liebert® Trinergy™ Cube efficiency curve

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

This functioning mode allows significant energy savings by operating with a typical efficiency above 99% while providing power conditioning to the load.

8.3.1 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, the current harmonic distortion and the voltage harmonic distortion guaranteeing optimum power conditioning to the load while maintaining the highest level of efficiency.

8.3.2 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 12). Should the input mains fall below the lowest limit, the batteries will be used to power the load via the inverter.

8.3.3 Return to VI

When the mains supply returns within tolerance limits, Liebert® Trinergy™ Cube 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 Trinergy Cube 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.

9. Monitoring and Control, Interfaces

9.1 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.

9.2 Touch Screen display

Liebert® Trinergy™ Cube features a standard touch screen display, allowing for easy interaction with the UPS. A high level of security is provided for both, users and customer engineers via different separate password access privilege levels. Intelligent operation:

- Monitors user-defined thresholds for load power margin and phase imbalance
- Logs data and event histories regarding power, load, battery, and other system conditions Information tracking
- Overall system and CORE readiness, with informational, warning and critical status indicators
- CORE level alerts for all major subsystems including rectifier, inverter, batteries, static switch, and bypass
- Power path status via animated single-line mimic display
- System voltages and power - input, output and bypass, all phases
- Load vs capacity indicator
- Load phase balance indicator
- System temperature gauge
- Battery charge indicator
- Service history logs.

A single-line diagram of the UPS is continuously displayed on the default page. The main functional blocks and power paths of the UPS are displayed using simple universal technical symbols, instantly communicating the overall status of the UPS.

The same screen also permanently displays the output load percentage measurement in dashboard style (one for each output phase). In the event that the UPS is not in normal functioning mode, it is possible to access the Event Log summary page directly from the default page. Warnings and alarms will be identified by text strings and codes. In battery operation, the display will switch between warning code and estimated backup time in minutes.

After 30 seconds of inactivity (i.e. no contact with screen/buttons) the display reverts to the screen saver page which shows the status of the UPS (Normal, Warning, Alarm).

The text displayed by the touch screen will be with the following languages: English, Italian, French, German, Spanish, Portuguese, Turkish, Polish, Swedish, Norwegian, Finnish, Czech, Russian, Arabic, Chinese, all selectable by the user.

For further details on the touch screen display please refer to the User Manual.

9.3 Diagnostic and Uptime

Liebert Trinergy Cube makes your mission critical space a peaceful place through its advanced diagnostic capability, data tracking, measuring and logging, as well as predictive maintenance and event analysis features.

- **Remote Diagnostics:**
  Vertiv™ LIFE™ Services Remote Diagnostic and Preventive Monitoring (see section 9.6), increases uptime and operational efficiency by continuously monitoring and tracking performance trends.
- **Predictive Maintenance:**
  Liebert Trinergy Cube is capable of verifying the health of its IGBT, capacitors, fans, contactors and batteries to determine maintenance needs and ensure critical continuity.
- **Event Analysis:**
  Precise event tracking, waveform capturing and harmonic spectrum analyses allow the detection of external phenomena that have the potential of impacting data center availability.
- **Data Logging:**
  Liebert Trinergy Cube is capable of capturing all relevant data from efficiency to uptime parameters. Access to this information allows data center managers to control their physical space, optimize its usage and independently calculate PUE.

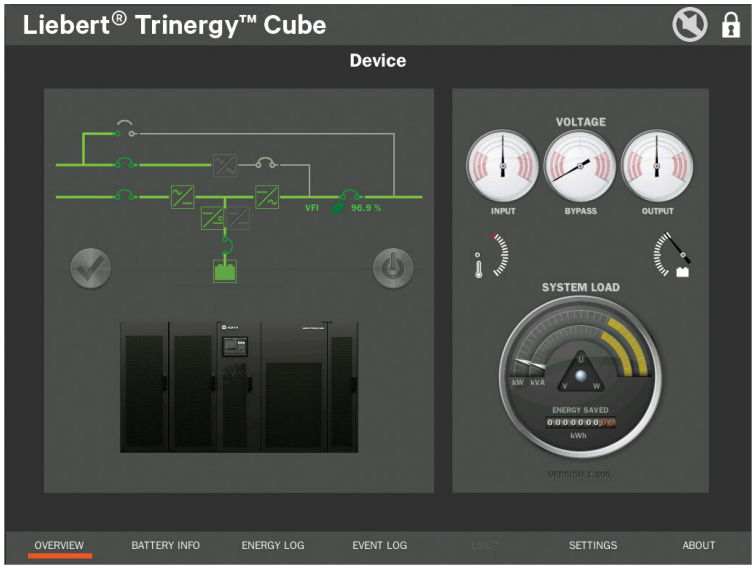


Figure 11:
Touch screen display

9.4 Start and Stop Inverter

The Start and Stop push buttons are integrated in the touch screen display.

The control will incorporate a safety feature to prevent inadvertent operation yet still allow for rapid shutdown in the event of an emergency.

9.5 Interfaces

9.5.1 Ethernet RJ45 Interface

Liebert® Trinergy™ Cube will be equipped with an RJ45 Ethernet interface.

This interface is a 10/100 MBit autonegotiation full/half duplex RJ45 Ethernet interface for LAN communication with service software PPVis. It allows the setup of UPS parameters during commissioning and maintenance.

9.5.2 Remote Monitoring LAN/SNMP/ MODBUS

The touch screen display will ensure monitoring and control of the networked UPS through TCP/IP protocol. The adapter permits:

- UPS monitoring from NMS via SNMP
- UPS monitoring from PC via a Web browser
- Dispatch of e-mail messages on occurrence of events

It also allows users to customise the management of the network power simplifying the integration of UPS systems with Building Monitoring and Automation Systems via MODBUS RTU or MODBUS/TCP.

9.5.3 RS232 Service port (X3)

Liebert Trinergy Cube will be equipped with one D type female connector (9 pin) for serial RS232 communication for service purposes only.

9.5.4 Input and output contacts

Liebert Trinergy Cube is equipped with 8 digital input and 6 output contacts.

Output contacts can operate at 230V. This interface is SELV isolated from the UPS primary circuits.

For further details please refer to the user manual.

9.6 Vertiv™ LIFE™ Services

Vertiv™ LIFE™ Services Remote Diagnostic and Preventive Monitoring provides
early warning of UPS conditions and out of tolerances.

This allows effective proactive maintenance, fast incident response and remote trouble shooting, in order to increase the overall availability of the Liebert Trinergy Cube system, giving customers complete security and peace of mind.

The Vertiv LIFE Services communication kit, used to provide connection to Vertiv LIFE Services Remote Diagnostic, is available as standard within the Liebert Trinergy Cube unit allowing the remote diagnosis of the UPS through an internet connection acting as an HTTP internet client connection or by means of a telephone line (PSTN).

The HTTP internet client connection, here on named Vertiv LIFE Services over IP, can be obtained simply connecting an Ethernet (CAT5 or above) to the RJ45 port located on the display, while the Vertiv LIFE Services connection over the telephone line (PSTN) is available thanks to the dedicated modem card already present in one of the two Vertiv™ Intellislot bays included in Liebert Trinergy Cube I/O Box.

The RJ45 port on the display can be also used with other standard communication protocols (i.e. Modbus and SNMP) when Vertiv LIFE Services over IP is enabled.

In case the customer likes to have the Vertiv LIFE Services over IP on a separated virtual or physical network infrastructure then the Vertiv LIFE Services over IP connection can be available via UPS integrated board in order to keep these communications separated. Please contact the technical support team for further details.

The monitoring will be a real 24-hour, 365 day service thanks to 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 potential short-term future problems. In addition, it will be possible to control the UPS remotely.

The communication of UPS data to the Vertiv™ LIFE™ Services Command Center will be transmitted via the integrated modem at the following intervals:

- 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 informing them of the UPS operational condition and any critical states.

The Vertiv™ LIFE™ Services center allows the possibility of activating the Vertiv™ 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.

With Vertiv LIFE Services customers will benefit from:

- **Uptime Assurance:** Constant monitoring of UPS parameters, thus maximizing the system's availability.
- **First Time Fix Rate:** Pro-active monitoring and data measuring ensure that when our customer engineers are dispatched on-site, they arrive prepared for first time resolution.
- **Proactive Analysis:** From Vertiv LIFE Services centers, our experts proactively analyze the data and trends of your equipment, to recommend actions to ensure their best performance.
- **Minimized Total Cost of Ownership of Your Equipment:** The continuous monitoring of all relevant parameters in turn maximizes unit performance, reduces on-site maintenance and extends the life of your equipment.
- **Fast Incident Response:** Vertiv LIFE Services allows for immediate definition of the best course of action, as a result of the regular communication between your Liebert® Trinergy™ Cube system and our Vertiv LIFE Services centers.
- **Reporting**: Customer will receive a comprehensive report detailing the working order of your equipment and its operational performance.

9.7 Vertiv™ Nform

Vertiv Nform will monitor the Liebert Trinergy Cube 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 locations 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.

9.8 Vertiv™ SiteScan™

Vertiv SiteScan is a centralized site monitoring system which ensures maximum visibility and availability of critical operations. Vertiv™ SiteScan™ Web allows users to virtually monitor and control any piece of critical support equipment. Its features include real-time monitoring and control, data analysis, trend reporting, and event management.

9.9 Vertiv™ Trellis™ platform

Vertiv Trellis platform is a real-time infrastructure optimization platform that enables the unified management of data center 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.

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.

10. Mechanical Data

10.1 Enclosure

The UPS will be housed in a space-saving modular enclosure with front doors and removable panels (protection as per IP 20 standard). The enclosure will be made of zintec coated sheet steel and the doors will be lockable. Different degrees of IP protection are available on request.

10.2 Ventilation

Forced redundant air cooling will ensure that all the components are operated within their specification. Airflow will be controlled according to load demand. The UPS will be immediately notified of the fan failure condition via all the user interfaces and through the Vertiv™ LIFE™ Services.

The cooling air entry will be on the front and the air exit at the top of the device. The enclosure will be installed with at least 500 mm of free space between the device and roof of the enclosure in order to allow unhindered exit of cooling air.

10.3 Cable entry

Cable entry will be available as standard from the BOTTOM or from the TOP of the central I/O Box.

10.4 Enclosure design

All surfaces of the enclosure will be finished with an electrostatically applied epoxy coat. The coating will have a thickness of at least 60 microns. The standard colour of the enclosure will be RAL 7021.

10.5 Access to integrated subassemblies

All internal subassemblies will be accessible from the front of the unit via hinged doors to allow for ease of maintenance. Rear access will not be required for installation or servicing.

11. Environmental Conditions

The UPS will be capable of withstanding any combination of the environmental conditions listed below.

It will operate without mechanical or electrical damage or degradation of operating characteristics.

11.1 Ambient temperature

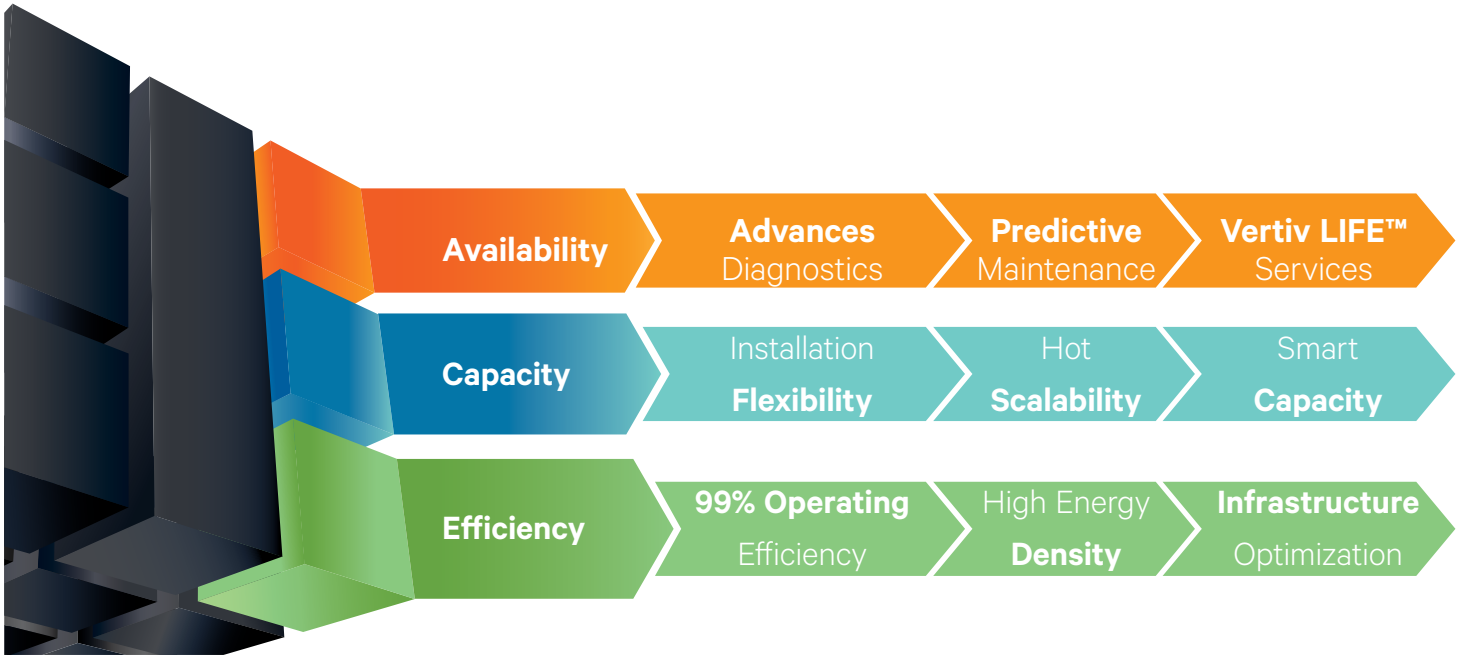
0° to 55° C , continuous operation.

11.2 Relative humidity

Up to 95% (non condensing) for temperature of 20° C.

11.3 Altitude

The maximum altitude without derating will be 1000 metres above sea level (for higher altitudes Liebert® Trinergy™ Cube complies with IEC/EN 62040-3).



12. Technical Data

LIEBERT® TRINERGY™ CUBE	200 kW CORE	400 kW CORE
MAX Number of Cores (for parallel power)	Up to 8	Up to 10
Nominal ratings	Up to 200 kVA / 200 kW	Up to 400 kVA / 400 kW
Primary Input		
Nominal voltage[3] (Vrms)	400 (3 ph + N + PE) or 400 (3 ph + PE)	400 (3 ph + N + PE) or 400 (3 ph + PE)
Input voltage range @ nominal load w/o battery discharge (Vrms)	200[4] to 460	200[4] to 460
Nominal frequency (Hz)	50 (60 Hz selectable)	50 (60 Hz selectable)
Frequency range (Hz)	45 Hz - 55 Hz for 50 Hz (55 Hz - 65 Hz for 60 Hz)	45 Hz - 55 Hz for 50 Hz (55 Hz - 65 Hz for 60 Hz)
Power factor @ nominal load & nominal input conditions[2]	≥ 0.99	≥ 0.99
Max input current (A)	Up to 315	Up to 630
Input current distortion @ nominal input conditions[2] & max input current[5] (%)	< 3	< 3
Walk in/Soft start (s)	15 (1 to 90 selectable)	15 (1 to 90 selectable)
Rectifier Hold-Off (s)	10 (1 to 90 selectable)	10 (1 to 90 selectable)
Inrush current/Imax input	≤1	≤1
Battery		
Permissible battery voltage range (V)	396 to 700	396 to 700
Recommended no. of cells:		
• VRLA	240-300	240-300
• WET	240-300	240-300
• NiCd	375-468	375-468
Float voltage range for VRLA @ 20°C (V/cell)	2.27	2.27
EOD Voltage for VRLA (V/cell)	1.65	1.65
Float voltage temperature compensation	-0.11% per °C	-0.11% per °C
DC ripple current in float mode for a 10 min autonomy as per VDE0510	$<0.05C_{10}$	$<0.05C_{10}$
Float Voltage stability in steady state condition (%)	≤1	≤1
DC ripple voltage without battery (%)	≤1	≤1
Battery temperature range (°C)	15 to 25 (or per battery manufacturer)	15 to 25 (or per battery manufacturer)
Recharge-current setting range for 240 cells @ Nom conditions (A)	Up to 18	Up to 37
Recharge-current setting range for 264 cells @ Nom conditions (A)	Up to 17	Up to 34
End battery voltage for 240 cells (V)	396	396

LIEBERT® TRINERGY™ CUBE	200 kW CORE	400 kW CORE
Inverter Output		
Nominal apparent power (kVA)	up to 200	up to 400
Nominal active power (kW)	up to 200	up to 400
Nominal output current (A)	up to 290	up to 577
Permitted Load Power Factor	up to 1, any PF leading or lagging	up to 1, any PF leading or lagging
Overload at nominal output voltage for 125%[8]	see Trinergy Cube APP dynamic specification	see Trinergy Cube APP dynamic specification
Overload at nominal output voltage for 150%[8]	see Trinergy Cube APP dynamic specification	see Trinergy Cube APP dynamic specification
Short circuit current for 200ms (%)	650 A	1300 A
Nominal output voltage (Vrms)	400 (3 ph + N + PE) or 400 (3 ph + PE)	400 (3 ph + N + PE) or 400 (3 ph + PE)
Selectable output voltage (Vrms)	380, 415	380, 415
Nominal output frequency (Hz)	50 (60 selectable)	50 (60 selectable)
Output wiring	(3 ph + N + PE) or (3 ph + PE)	(3 ph + N + PE) or (3 ph + PE)
Voltage stability in steady state condition for input (AC & DC) variations and step load (0 to Nominal load) (%)	± 1	± 1
Voltage stability in dynamic condition for input variation (AC & DC) and step load (0 to Nominal load and vice versa) (%)	IEC 62040 - 3 Class 1	IEC 62040 - 3 Class 1
Voltage stability in steady state for 100% load imbalance (0, 0, 100) (%)	± 2	± 2
Output frequency stability		
• synchronized with bypass mains (%)	±2 (1, 2, 3, 4, 5 selectable)	±2 (1, 2, 3, 4, 5 selectable)
• synchronized with internal clock (%)	±0.1	±0.1
Frequency slew rate (Hz/s)	<1 Default (selectable up to 5 Hz)	<1 Default (selectable up to 5 Hz)
Output voltage distortion with 100% linear load (%)	< 1.5	< 1.5
Output voltage distortion @ reference non linear load as for IEC/EN 62040-3 (%)	< 5	< 5
Load crest factor handled without derating the UPS (Ipk/Irms)	3:1	3:1
Phase angle precision with balanced loads (deg)	±1	±1
Phase angle precision with 100% unbalanced loads (deg)	±3	±3
Efficiency on battery	96.2%	96.2%

LIEBERT® TRINERGY™ CUBE		200 kW CORE	400 kW CORE
System Data			
AC/AC efficiency VFI without charging current @ nominal input conditions [1] [2] with resistive load:			
• 25% load		Up to 96.1%	Up to 96.1%
• 50% load		Up to 96.8%	Up to 96.8%
• 75% load		Up to 96.7%	Up to 96.7%
• 100% load		Up to 96.3%	Up to 96.3%
AC/AC efficiency with dynamic online (VI) without charging current @ nominal input conditions[1] [2] with maximum resistive load:		Up to 99%	Up to 99%
Heat dissipation @ nominal input conditions and maximum output load:			
• Float mode	(kW)	7.7	15.4
	(Btu/h)	26219	52438
• Recharge mode on VFI	(kW)	8.3	16.6
	(Btu/h)	28339	56678
Mechanical dimensions:			
• Height	(mm)	1950	1950
• Width	(mm)	500	675
• Depth	(mm)	910	910
No. of cabinets		1	1
Frame colour	(RAL scale)	7021	
Net Weight	(kg)	465	610
Floor area	(m^2)	0.445	0.615
Floor loading	(kg/m^2)	1132	1073
Cable entry		Top	Top
Airflow	(m^3/h)	1487	2975

Liebert® Trinergy™ Cube from 150 kW to 3.4 MW

LIEBERT® TRINERGY™ CUBE	200 kW CORE	400 kW CORE
Environmental		
Location	Indoor (free from corrosive gases and conductive dust)	
UPS Operating Temperature (°C)	0-55 continuously	
Maximum relative humidity @ 20°C (non condensing) (%)	up to 95	
Max altitude above sea level without derating (m)	1000 (for higher altitudes refer to User Manual)	
Communication		
Slots	2 Intellislots	
Protocols	SNMP, MODBUS TCP/IP, MODBUS RTU	
Inputs/Outputs	9/8 Programmable	
Accessories	External Battery Cabinets with Long-life Batteries, Li-Ion Batteries and Flywheel on Request, Intellislot Connectivity, Maintenance Bypass Switch	
Compliance with Standards		
Safety	IEC 62040-1, IEC 60950-1	
EMC	IEC 62040-2	
Performance	IEC 62040-3	

(1) For tolerance see IEC/EN 60146-1-1 or DIN VDE 0558. The data refers to 25°C ambient temperature.
(2) At nominal voltage, nominal frequency.
(3) In case of a split input configuration, the primary input and bypass mains must have a common neutral reference.
(4) Referred to derated load conditions.
(5) With input voltage at nominal value and Voltage Distortion THDv ≤ 1%.
(6) An additional inductance of 2% (on the bypass line) must be taken into consideration when analyzing the selectivity of the installation.
(7) Other configurations on request.
(8) Overload applied under typical steady state conditions. In case of different levels of overload please contact Technical Support.

LIEBERT® TRINERGY™ CUBE	IO Box 600 A	IO Box 1200 A	IO Box 2400 A	IO Box 3000 A	IO Box 4000 A	IO Box 5000 A
MAX Number of 400 kW Cores (for parallel power)	NA	2	4	6	8	10
MAX Number of 200 kW Cores (for parallel power)	2	4	8	-	-	-
Ratings	600 A	1200 A	2400 A	3000 A	4000 A	5000 A
Primary Input						
Nominal voltage (Vrms)	400 (3 ph + N + PE) or 400 (3 ph + PE)					
Input voltage range @ nominal load w/o battery discharge (Vrms)	200(4) to 460					
Nominal frequency (Hz)	50 (60 Hz selectable)					
Static Bypass [6]						
Nominal bypass voltage[1] (Vrms)	400 (3 ph + N + PE) or 400 (3 ph + PE)					
Selectable output voltage (Vrms)	380, 415					
Nominal frequency (Hz)	50 (60 selectable)					
Nominal output current (A)	up to 600	up to 1200	up to 2400	up to 3000	up to 4000	up to 5000
Frequency Tracking Range (%)	±1 (2, 3, 4 selectable)					
Voltage Range (%)	±10 (5 to 15 selectable)					
Withstand rating (kIAC)[10]	50	100	100	100	100	100
Maximum overload capacity:						
• For 10 minutes (%)	125%					
• For 1 minute (%)	150%					
Transfer time with inverter synchronous to bypass:						
• Inverter to Bypass (ms)	No Break					
• Bypass to Inverter (ms)	< 2					
Transfer time with inverter not synchronous to Bypass (ms)	<20					
System Data						
AC/AC efficiency VFD without charging current @ nominal input conditions [1] [2] with resistive load:						
• 25% load	99.2%					
• 50% load	99.4%					
• 75% load	99.2%					
• 100% load	99.0%					
Max. Noise @ 1 metre as per ISO 3746 (dBA ± 2 dBA)	up to 76 dBA full system noise					
System average Noise @ 1 metre as per ISO 3746 (dBA ± 2 dBA)	65 dBA (at partial load)					
Protection degree with open doors	IP20					

Liebert® Trinergy™ Cube from 150 kW to 3.4 MW

LIEBERT® TRINERGY™ CUBE	IO Box 600 A	IO Box 1200 A	IO Box 2400 A	IO Box 3000 A	IO Box 4000 A	IO Box 5000 A
System Data						
Mechanical dimensions:						
• Height (mm)			1950			
• Width[9] (mm)	1150	1625	2150	3800[7]	2650 (back to back configuration)[7]	2650 (back to back configuration)[7]
• Depth (mm)	910	910	910	910	1820 (back to back configuration)[7]	1820 (back to back configuration)[7]
No. of cabinets		1			2	
Frame colour (RAL scale)			7021			
Net Weight[9] (kg)	800	1190	1575	2820	3945	4085
Floor area (m²)	1.047	1.479	1.957	3.458	4.823	4.823
Floor loading (kg/m²)	764	805	805	815	921	921
Cable entry			Top / Bottom			
Access			Front and Top			
Cooling			Forced Ventilation, front air intake, top air outlet			
Airflow (m^3/h)	626	1253	2505	3254	4339	5424
Environmental						
Location			Indoor (free from corrosive gases and conductive dust)			
UPS Operating Temperature (°C)			0-55 continuously			
Maximum relative humidity @ 20°C (non condensing) (%)			Up to 95			
Max altitude above sea level without derating (m)			1000 (for higher altitudes complies with IEC/EN 62040-3)			
Communication						
Slots			2 Intellislots			
Protocols			SNMP, MODBUS TCP/IP, MODBUS RTU			
Inputs/Outputs			9/8 Programmable			
Accessories			External Battery Cabinets with Long-life Batteries, Li-Ion Batteries and Flywheel on Request, Intellislot Connectivity, Maintenance Bypass Switch			
Compliance with Standards						
Safety			IEC 62040-1, IEC 60950-1			
EMC			IEC 62040-2			
Performance			IEC 62040-3			

[1] For tolerance see IEC/EN 60146-1-1 or DIN VDE 0558. The data refers to 25°C ambient temperature.
[2] At nominal voltage, nominal frequency.
[3] In case of a split input configuration, the primary input and bypass mains must have a common neutral reference.
[4] Referred to derated load conditions.
[5] With input voltage at nominal value and Voltage Distortion THDv ≤ 1%.
[6] An additional inductance of 2% (on the bypass line) must be taken into consideration when analyzing the selectivity of the installation.
[7] Other configurations on request.
[8] Overload applied under typical steady state conditions. In case of different levels of overload please contact Technical Support.
[9] Includes Core Disconnectors needed for a typical configuration.
[10] Values with fuses, for additional information please refer to User Manual.

13. Options

13.1 Isolation transformer

Liebert® Trinergy™ Cube can be customized to provide full galvanic isolation for specific load requirements by adding an external isolation transformer.

The isolation transformer option will provide full galvanic isolation for medical and “most critical” applications or specific voltage adaptation.

For further details please contact the technical support team.

13.2 Remote Battery Interface (RBI)

Liebert Trinergy Cube includes as standard one RBI kit which incorporates temperature sensor and battery disconnector status monitoring.

Additional RBI kits are available as option allowing for up to 16 separate RBI’s to be connected to the I/O Box to manage also the most complex battery systems either centralized or distributed.

RBI kit doesn’t need any calibration also in case of different cable lengths.

13.3 Parallel configurations

Liebert Trinergy Cube can be connected with up to eight units in parallel reaching the maximum system capacity of 27 MW, without the need for an additional parallel board, allowing maximum reliability and flexibility.

A single unit can be upgraded to a parallel system at any time through a parallel cable used for the communication between the UPS connected in parallel. One parallel cable kit is required for each unit to be paralleled.

13.4 Battery management modules (only upon request)

With measuring modules connected to the battery blocks, enhanced battery management will be possible offering the following features:

- Measurement of the condition of each individual battery block by means of separate battery measuring modules (BMM)
- Analysis of each battery block with measurement of the minimum and maximum voltage values, temperature and impedance.

13.5 Seismic Anchor Kit

A seismic anchor kit is available as option. For further details please contact the technical support team.

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.

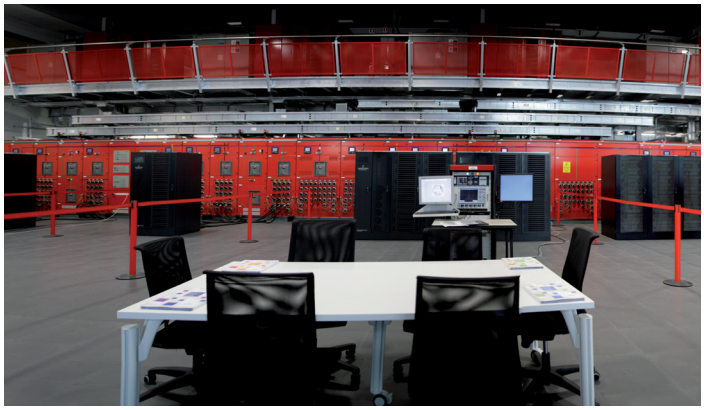
Testing is also customized based on the complexity, size and number of UPS components in the configuration.

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.

1 **Showroom**

2 **Meeting Area**



3 **Customer Validation Area**

4 **The Academy**

Vertiv.com | **Vertiv Infrastructure Limited,** George Curl Way, Southampton, SO18 2RY, VAT Number: GB188146827

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