Technical Specification

SAFEPOWER MODULAR

80-1560 kVA SPM THREE-PHASE/THREE-PHASE

On-Line Double Conversion Technology (VFI)

Modular

TABLE OF CONTENTS:

PURPOSE

These specifications define the technical characteristics of the **Safepower Modular – SPM** series of 3 phase Uninterruptible Power Systems (UPS). a device that supplies clean energy to the connected load, without interruptions, regardless of the conditions of the power supply.

To view the other products available, refer to the website www.sielups.com.

DESCRIPTION OF THE SYSTEM

The **SPM** series is available in 80(40+40)-1560 kVA models with On-Line Double Conversion topology, compliant with VFI-SS-111 classification, in accordance with IEC EN 62040-3, and with expandable modular design.

SPM is compliant with the most demanding industrial and Information Technology (IT) installations, thanks to its performance level:

a) True modular architecture, based on 40 kVA power modules, with vertical and horizontal expandable scalability;

b) Plug-in UPS modules and monitoring units with hot-swap capability;

c) Possibility of configuring the system with internal N+X redundancy;

d) Possibility of connecting several SPM units in parallel to enhance the capacity/redundancy;

e) Fully compatible with diesel generator and network
- low input current distortion up to 3% and power factor >0.99;
- *Power walk-in* and sequential start-up of modules to reduce the need for generator oversizing and ensure the compatibility with any power supply, even with limited power installed.

f) Accurate Battery Care
- adjustable for batteries with 32 / 34 / 36 / 38 / 40 x 12V monoblocs per string;
- two voltage level recharge according to the IU characteristic, as an alternative;
- temperature compensated battery recharge;
- suitable to charge extended back-up battery sets;
- immediate detection of battery disconnection;
- Battery test function to detect potential battery deterioration.

g) Possibility to power inductive and capacitive loads and to deliver the necessary active power (kW) for the load with a proper configuration of the number of modules;

h) Technological high-performance project and component solutions that guarantees an overall efficiency OVER 95% (On-Line Double Conversion Mode) and >98% for the ECO-MODE operation, with possibility of setting the most suitable mode for the load;

i) Automatic high-efficiency parallel module system which places the excess modules in "SLEEP MODE", allowing a maximum performance operation;

j) Backfeed Protection;

k) Flexible structure, which allows:
   - Easy separation of the emergency bypass input supply from the rectifier power input supply
   - Wide choice of communication options
   - Possibility of electrical isolation through the optional transformer.

The **Safepower Modular – SPM** series, with a compact architecture based on high-density technology, where the height of the single modules is 3U and where they are arranged in a rack, as specified, includes the following models:

MODEL	DESCRIPTION
SPM 200 kVA	200 kVA cabinet: can house up to 5 modules
SPM 320 kVA	320 kVA cabinet: can house up to 8 modules
SPM 400 kVA	400 kVA cabinet: can house up to 10 modules
SPM 520 kVA	520 kVA cabinet: can house up to 13 modules
SPM 800 kVA	800 kVA cabinet: can house up to 20 modules
SPM 1040 kVA	1040 kVA cabinet: can house up to 26 modules
SPM 1280 kVA	1280 kVA cabinet: can house up to 32 modules
SPM 1560 kVA	1560 kVA cabinet: can house up to 39 modules

REFERENCE STANDARDS

The company's Quality Management System is certified according to ISO 9001/2000 Standard, covering all company functions, from design and manufacture to sales services.

This certification gives a greater reliability to the client, for the following reasons:
- use of high quality materials;
- strictness during production and testing phases;
- constant support to the client.

Apart from the company's certification, the product is classifies as VFI-SS-111, pursuant to Standard EN 62040-3, and complies to the following UPS Standards:

- **IEC EN62040-1:** Uninterruptible power systems (UPS): General and safety requirements;
- **IEC EN 62040-2:** Electromagnetic compatibility requirements (EMC), C2 category;
- **EN 62040-3:** Method of specifying the performance and test requirements;

The **SPM** range complies also to the following general standards, where applicable and indicated in the previous standards:

- **IEC 60529:** Degrees of protection provided by enclosures;
- **IEC 60664:** Insulation for equipment within low-voltage systems;
- **IEC 60755:** General requirements for residual current operated protective devices;

- **IEC 60950:** General requirements for Information Technology Equipment;
- **IEC 61000-2-2:** Electromagnetic compatibility immunity standards;
- **IEC 61000-4-2:** Electrostatic discharges immunity test;
- **IEC 61000-4-3:** Radio frequency, magnetic field Immunity test;
- **IEC 61000-4-4:** Transient overvoltage immunity test;
- **IEC 61000-4-5:** Overvoltage immunity test;
- **IEC 61000-4-11:** Voltage dips, short interruptions and voltage variations immunity test.
- **IEC 61000-3-12:** Limits for harmonic current emissions (equipment input current > 16 A ≤ 75)

European Directives and CE marking:

LV 2014/35/EU
Low Voltage Directive: regulates the safety risks of the equipment and imposes the **CE marking** obligation since January 1st 1997.

EMC 2014/30/EU
Electromagnetic Compatibility Directive: regulates the UPS immunity and emissions in its installation environment and imposes the **CE marking** obligation since January 1st 1996.

APPLICATIONS

The **Safepower Modular – SPM** series of UPS are compatible for a wide variety of applications where protection of the critical load is required, from simple installations to the most demanding ones, with higher reliability and low maintenance requirements.

LAN, Server and Data Center: the 0.9 output power factor allows a higher active power availability for the powered units, guaranteeing several sizing options for the UPS in relation to the load to be powered.

e-business and Telecommunications: the continuity system can be expanded along with the company business, thanks to the possibility of adding up to four units in parallel, without compromising the initial investment.

Industrial Processes and Medical Systems: the uninterruptible power supply is perfectly suitable to ensure the quality of the supply for any type of load, from industrial processes to medical applications. This is possible thanks to the carefully designed technical features, which guarantee the following properties:

- Optimum technical input features, with zero impact on the power supply source
- high short-circuit and overload capacity
- high battery recharge capacity with the option to use a variety of battery types (sealed valve regulated and open-vented) even for long back-up times.

Emergency Systems: the UPS can be set-up according to the Standard EN 50171 (Centralized Supply Systems), by selecting the correct battery type, back-up and recharge times.

ARCHITECTURE AND CONFIGURATIONS

True Modular Design. Safepower Modular SPM is based on true modular architecture. Each 40 kVA UPS module, is housed in a single 19" plug-and-play drawer with hot-swap capability, each module contains all the associated hardware and software necessary for the full operation of the system. The modules do not share any component: each module is virtually a complete UPS, including the static by-pass and a control panel. Single points of failure are thus eliminated (de-centralised architecture). In the event a module needs to be replaced, it can be hot-swapped without affecting the operation of the other active modules, with a temporary power reduction of maximum 40 kVA.
This allows a Mean Time to Repair (MTTR) of practically zero for the maintenance (no downtime and no transfer to the emergency by-pass).
The display control panel and the self-diagnostic features installed on each module facilitate the rapid identification of any failed module and of the specific fault.

N+X Multiple Redundancy. The UPS of this series, comprising several modules in parallel with N+X redundancy within the UPS, allows to choose different levels of redundancy depending on the load priority, in order to enhance the availability and the reliability of the power supplied to the load. Through the settings on the LCD display, you are able to set the quantity of redundant modules. When the load connected is too high compared to the redundancy level set, the UPS will immediately initiate a redundancy loss alarm. All active modules operate simultaneously equally sharing the connected load.
The UPS can operate with faulty modules, up to a maximum of X, corresponding to a maximum load power of

$$P_{out} = P_{nom} \frac{(N - X)}{N}$$

P_{nom} is the UPS rated power

P_{out} is the maximum power supplies to the load with X faulty modules

N is the number of modules installed on the UPS

X is the maximum number of faulty modules which are allowed, which corresponds to the set redundancy level.

All the UPS modules within a unit share the same *common battery*: the deactivation of one or more modules does not result in a reduction of the run time in battery mode (mains failure).

Scalability (Hot Expansion). Since the operating modularity coincides with the assembly modularity (each module is virtually a complete UPS by itself), it's easy to add power: the 3U-high plug-n-power drawers can be *hot-swapped* allowing a vast *vertical expansion* (by populating the cabinet vertically) and *horizontal expansion* (by populating several columns). In order to do this, it is not necessary to implement changes to the structure or to use any special tools: the UPS continues to supply the load without changing its status. A further expansion can be achieved by placing several units (cabinets) in parallel, as shown below.

Sleep mode: is a function which can be activated from the front user panel, that allows a high-efficient system operation by placing the excess modules in "SLEEP MODE ", allowing the remaining active modules to operate at the maximum efficiency point.

- The active modules are placed in sleeping mode when the load connected is lower than 30% of the rated power; this operation is executed when the condition endures for at least one hour, to avoid status variations due to excessive load fluctuations;
- The modules involved are placed in sleep mode one at a time, at one minute intervals, and remain in stand-by mode without powering the load;
- When the load powered by the remaining active modules increases above 70% of the rated power, the modules in sleep mode are immediately reactivated to power the load;

- Each month, every module in sleeping mode are alternated with an active one, facilitating a rotation in module use;

The available configurations are the following:

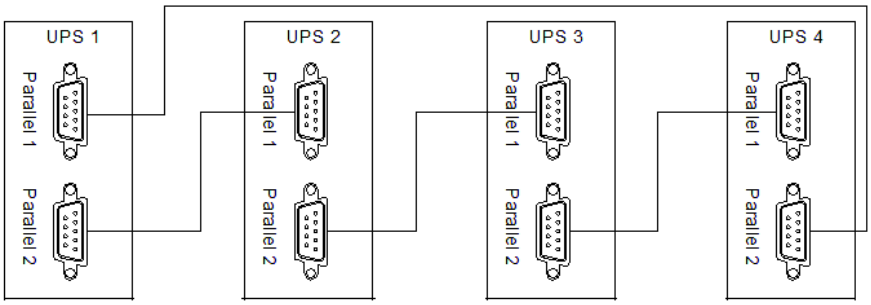
Single UPS

The UPS can be installed as a single modular unit, with a minimum number of 2x40 kVA modules and up to a maximum number of modules depending on the system frame capability, keeping in mind also the internal redundancy level required (N+X). The models described above indicate how many modules can be added in the cabinet, according to the system design.
The unit can be configured with a common input for both the rectifier input and by-pass input, or with two *separate inputs*, one for the rectifier and the other for the emergency by-pass (through the removal of the provided internal power links).
A further expansion can be obtained by placing a maximum of 4 units in parallel, to meet the load power increase requirements or to introduce an additional redundancy level, as indicated below.

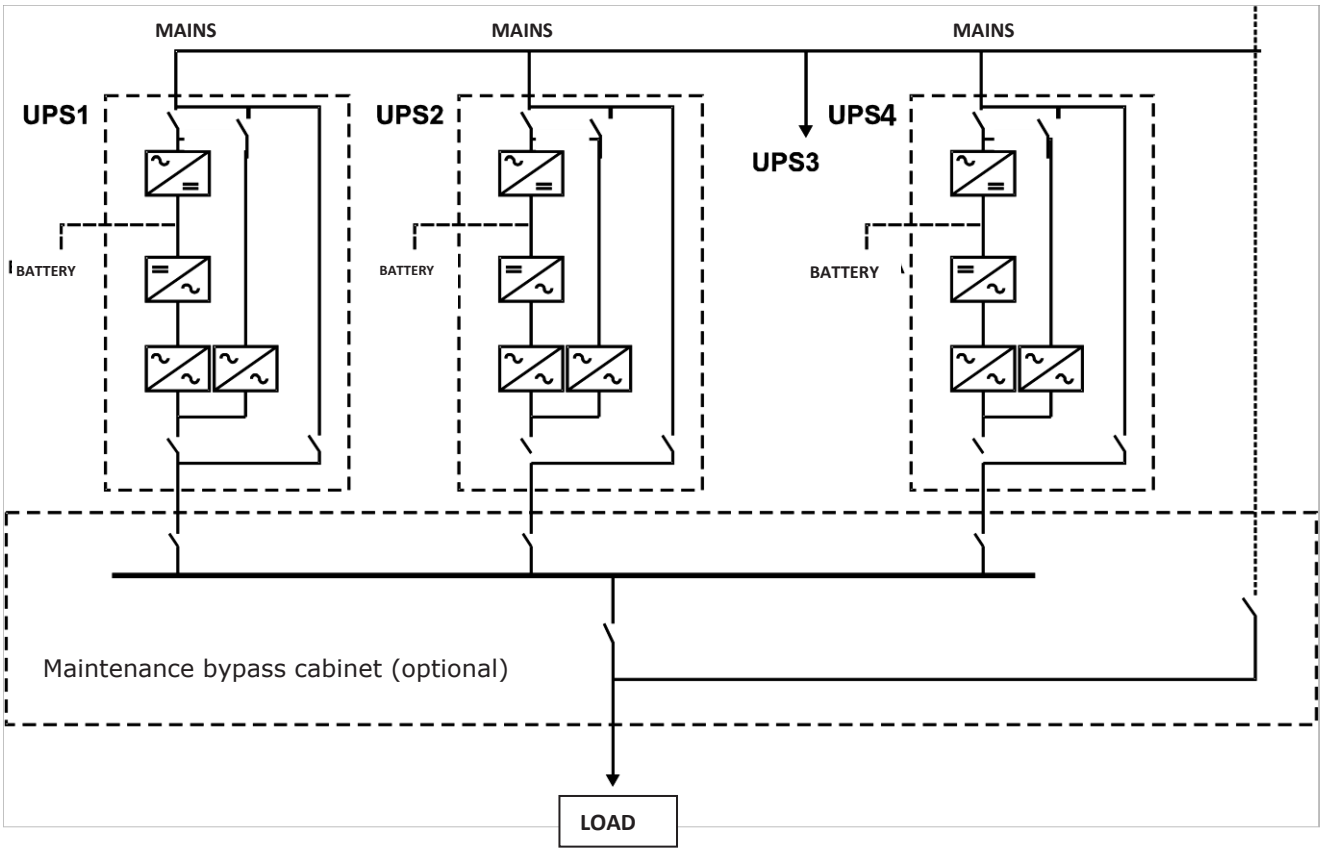
Parallel Configuration

The UPS units can be connected in parallel, up to a maximum of 4 units, to increase the system's power (capacity parallel) or to increase its reliability (redundancy parallel).
The system is defined as "redundant parallel" when the interruption of one or more UPS does not affect the load protection.
All the UPS power the connected load simultaneously, with automatic current sharing.

The units share information on the operational status and the sync signals through the connections in a loop with dual redundancy. These are connected through double-insulation shielded control cables, as shown below, with the parallel control boards, installed on each UPS, visible. The connection loop guarantees a highly reliable control configuration, even in the event of accidental interruption of both the connections, only the UPS subject to such interruption is automatically excluded, while the others continue to function without any perturbation.



Thanks to the "**Hot Expansion**", it is possible to expand the system with the addition of a further UPS System (up to a max of 4), while the remaining units are still on-line and powering the load from the inverter.
The additional UPS will automatically configure itself with the other units, without affecting the load in any way.



Each parallel UPS unit can be configured with its own battery (see table above) or, as an alternative, with a **common battery**.

DLBS (Dual Load Bus Synchronization)

The bus synchronization function is used to maintain the outputs of two independent UPS systems (single units or parallel systems of multiple units) in sync even when the two systems are not equipped with a common power supply source (i.e., in case of battery operation).

This function is usually employed to power the two inputs of Static Transfer Switches (STS), in order to power the "dual bus" critical loads, ensuring sync switching between the two sources in zero time.

Safepower Modular SPM does not require any additional hardware to operate in DLBS mode: the UPS units are equipped with signal cables to ensure a correct operation.

UPS DESCRIPTION

6.1 Operating principles

The uninterruptible power supply can be set based on three main operating modes: ON-LINE, Smart Energy Saving - ECO MODE or Frequency converter, in their different variants, as described below.

Mode: ON–LINE

Normal Operation: the PCF rectifier, drawing power from the mains power supply, supports the Inverter and charges the batteries; the load is powered by the Inverter which provides a clean and secure supply, synchronised to the bypass supply. In this way, a **double conversion** is achieved, with the maximum separation between the UPS input voltage and output voltage.

Battery Operation: when the mains power supply exceeds the pre-set limits, the rectifier is shut down and the Inverter is powered by the battery for the remaining back-up time, without disruption to the load. When the mains power supply is reactivated, the rectifier gradually starts working again, charging the batteries and powering the Inverter.

Automatic By-Pass Operation: if an Inverter overload exceeds permitted limits (or is manually shut down), the load automatically transfers to the emergency bypass via the static switch and without disruption to the load.

Mode: Smart Energy Saving – ECO MODE

Normal Operation: The load is normally powered from the mains power supply (direct power supply) through the power interfaces, while the rectifier charges the batteries. When the mains power supply exits the restricted voltage and frequency ranges, the system switches automatically to the **double conversion mode**, with the load powered by the Inverter.

Battery Operation: When the mains power supply exits the voltage and frequency ranges allowed by the rectifier, the unit switches to the battery-operated mode.
When the mains power supply is suitable again, the system switches to the direct power supply. The decision is made based on statistical calculations performed based on the quality of the mains power supply: if it remains suitable for a certain period, the unit selects ECO mode, otherwise it remains in double conversion mode.

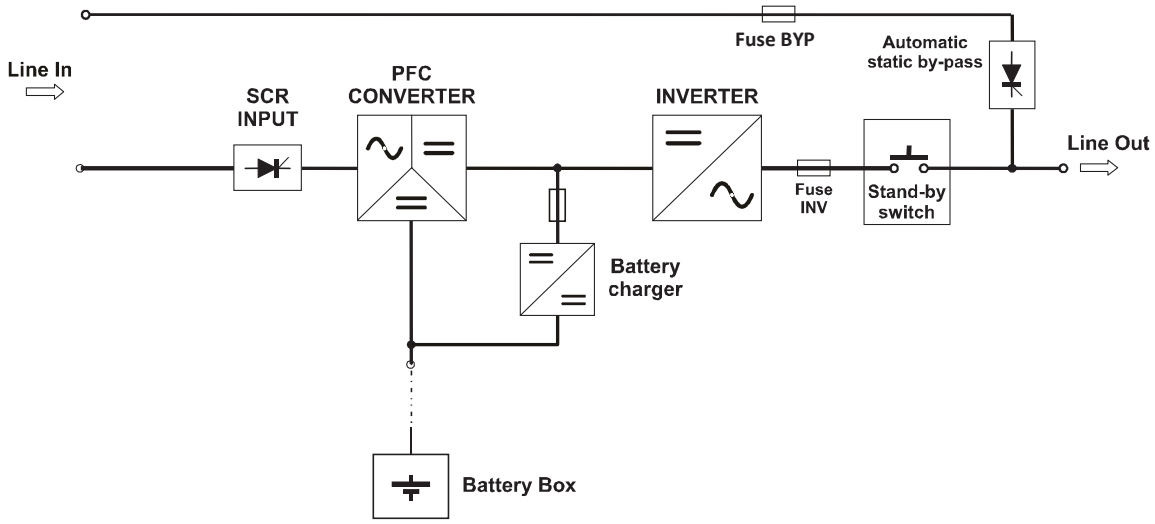
Note: for maintenance needs, under each of the modes described above, it's possible to switch manually to the **maintenance by-pass** mode. The load will be powered by input mains power supply through the maintenance section (internal or external to the UPS cabinet), as described below.

Mode: FREQUENCY CONVERTER

The UPS can be configured as a frequency converter (through front panel) with input frequency at 50Hz and output frequency at 60Hz and vice versa (the automatic by-pass is deactivated in this mode). The "frequency converter" configuration can be operated with or without batteries.

6.2 Power module: operation

40 kVA UPS power module block diagram is as follows:



It comprises the following operational blocks:

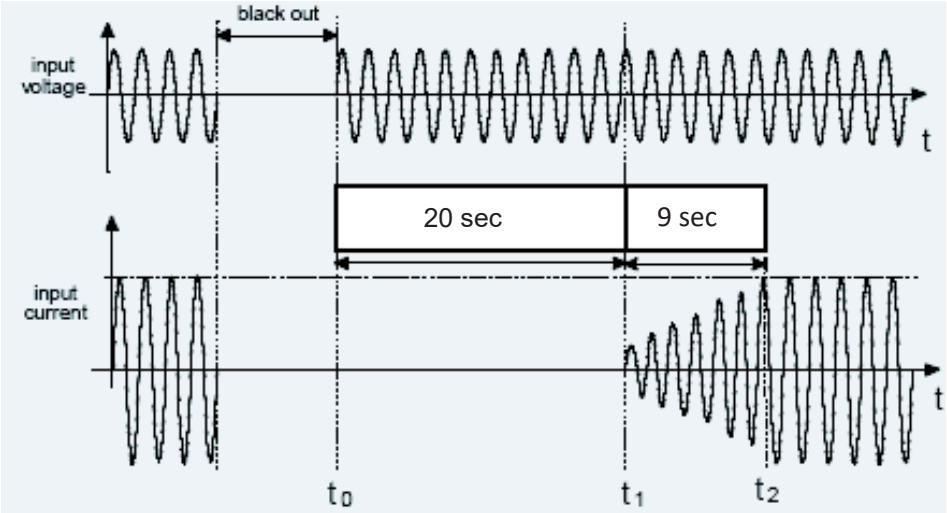
- PFC converter (rectifier) and booster
- Battery charger
- Inverter
- Static switch (automatic by-pass)

6.2.1 PFC Converter (rectifier) and booster

The PFC Converter converts the AC voltage into a DC supply to power the Inverter; if the mains or alternative power supply fails, the Converter will raise the battery voltage (booster) to a value suitable to power the Inverter. The PFC control technology, using Digital Signal Processing (DSP) microprocessors and IGBT power semiconductors, achieves a low impact on the power supply source, low harmonic distortion and high input power factor. The converter/rectifier achieves a zero impact on the supply source thanks to the following characteristics:

- **Input Harmonics:** rating of upstream generators and transformers (including distribution) can be reduced due to the negligible input harmonic distortion of 3% and high input power factor > 0.99;

- **Progressive rectifier start-up (*Walk-in*):** when the mains power supply returns, power absorption from the mains power supply progressively reaches the rated value (walk-in) within approximately 9 seconds, after an initial hold-off of about 20 seconds. The start-up of the single power modules within the unit occurs in succession, with the start-up of a module each second.



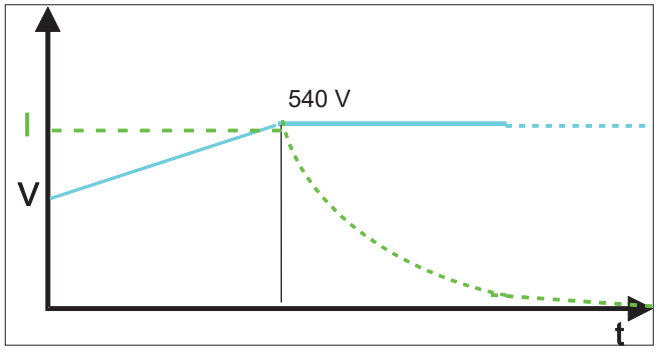
The **booster** maintains the bus voltage stable within the modules, regardless of the battery voltage variations. On the other hand, the bus voltage variations due to rapid dynamic changes of the load do not affect the battery voltage directly.

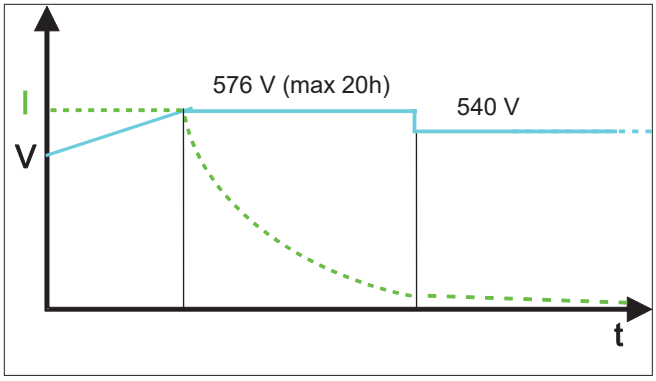
6.2.2 BATTERY CHARGER (Accurate Battery Care)

"Accurate Battery Care" is a set of functions designed to help extend the working life the battery set and optimise its performance.

a) **Battery Rated Voltage**: The SPM can be used with a different number of sealed lead batteries (2Vpc) per string, depending on the back-up needs desired: ±192 V / ±204 V / ±216 V / ±228 V / ±240 Vdc (equal to 32 / 34 / 36 / 38 / 40 12V monoblocs); in case of faulty monobloc, the battery voltage can be temporary reduced until the monobloc is replaces, without interruptions to the line;

b) **Battery recharging:** the SPM can be used with sealed lead batteries (VRLA), and, after proper forming charge, even with open-vented and NiCd batteries. Dependant to the type of battery used, several recharge methods are available:

Recharging modes	SPM Configurations
	**One-level recharge**: the charge state of the battery is continuously monitored; when the mains power supply is present, the batteries are charged at a preset constant current (if the discharge has been deep) and then the batteries are kept at a preset voltage level (floating). The constant current is adjustable and is generally set at $0.1C_{10}$ up to a maximum of 10A (up to 18A with nominal Vin) of recharge for each UPS module. The floating voltage has a range of 2.20-2.29 Vpc (2.25x6x40=540V).



Two-level recharge: this recharge is at limited current with two levels of voltage. After an initial constant current phase (if the discharge has been deep), a fast recharge voltage phase begins (boost), followed by a floating recharge phase. This type of charging is mainly used with open-vented batteries or other types when an accelerated recharge time is required.
The boost voltage is comprised between 2.30-2.4 Vpc (2.4x6x40=576V).
The boost voltage phase starts as soon as the voltage raises to such level, at the end of the constant current phase, and lasts for the set time (up to 20 hours). The constant current level and the floating voltage level are indicated above.

It is possible to set the type of battery installed and the different recharge modes from the front touchscreen panel.

c) It is possible to install an external **temperature sensor** which activates the temperature compensated recharge as a function of the battery temperature 0.003V (0.001÷0.007V / cell / 1°C).

d) **Connected battery**: the UPS detects whether the battery is connected or not. If the battery is not properly connected to the correct terminals on the UPS (i.e. reversed polarity), the UPS issues a warning and protects itself from any possible damage. The UPS must always operate with the batteries properly connected; if the same are missing, a warning is issued and the role of the UPS is affected.

e) **Battery Test**: a battery operation test can be set and activated.
Manual test: its duration can be set at 10 seconds, 10 minutes or complete discharge.
Periodic automatic test: once a month, at 20% of battery capacity.
If the test returns a negative result a warning is displayed on the UPS panel and remotely, if installed.

f) **Protection against deep discharges**: in case of extended discharges until the limit of battery capacity, the battery is protected by stopping the discharge to an adjustable voltage level (1.6-1.9Vpc) as recommended by the battery manufacturers to avoid damages to the batteries. The end of discharge is preceded by a pre-warning (louder than the battery discharge warning) which activates at end-of-discharge+0.15Vpc.

g) **Ripple current**: recharge ripple current (residual AC component) is one of the most important causes of poor battery reliability and reduced operating life. the SPM, thanks to its high-frequency battery charger, decreases this value to a negligible level, increasing the battery life and maintaining a high level of performance for a long time.

h) **Cold Start:** This feature allows the Inverter to be switched on and the load to be powered by the battery, when the mains power supply is not present. It can be activated by manually switching on all the power modules through the ON switch on the front.

6.2.3 INVERTER

The DC/AC Converter (Inverter) converts the direct current into a stabilised sinusoidal alternating current to power the load. When the UPS is in ON-LINE mode, the load is always powered by the Inverter.
This Inverter is an IGBT (*Isolated Gate Bipolar Transistor*) based three-phase structure; the IGBT is a transistor that allows high switching frequencies (> 18kHz) and, as a result, the Inverter provides a high quality output voltage, with low noise levels and high operating efficiency. In addition, the DSP microprocessor controls, guarantee static and dynamic performance and a high-quality output waveform, under any operating condition:

Voltage Adjustment

The output voltage can be adjusted using the independent phase control and DSP microprocessor; this enables a better static and dynamic response. In detail:

a) **static condition:** : the Inverter output voltage remains within ±1% for all variations of the input voltage within the accepted limits;
b) **dynamic condition :** for load variations from 0 to 100%, the output voltage remains within ± 5%, (within the values defined by class 1 of the EN 62040-3 standard).

Frequency Adjustment

The Inverter output frequency is independently generated by an internal oscillator, in synchronisation with the bypass supply. Frequency stability depends on operating conditions:

a) **Frequency Stability**
   a. With mains power present: the internal oscillator follows any frequency variations in the bypass supply, depending on the preset value, which is generally equal to ±1% / ±2% / ±4% / ±5% / ±10% (adjustable).
   b. With no mains power present: the Inverter generates the frequency of the output voltage with a stability of ±0.1Hz.
b) **Slew Rate**
   The maximum Inverter output frequency variation (slew rate) to lock to that of the bypass supply is set to 1 Hz/s.

Distortion of the output voltage

The Inverter adjustment guarantees a distortion of the output voltage with a linear load within 2%. With a non-linear load, as defined by the EN 62040-3 standard, output voltage distortion does not exceed 5%.

Overload

The inverter is sized to provide a power overload for a limited length of time (see the limits indicated in the "**Technical Specification table**")
When the time period or power limits are exceeded, the load is transferred to the bypass supply.

Short circuit capacity

If a short circuit occurs whilst the UPS is operating from the batteries, the Inverter will carefully analyse the output voltage and current.

- During battery operation (mains power supply failure) the Inverter can supply a limited current for 200ms (values indicated in "**Technical Specification table")**.
- When the mains power supply is present, the Inverter will switch to the automatic bypass.

The table below recommends the sizing of the various protection devices located downstream of the UPS in order to guarantee their selectivity even in the event of a power failure

Output protections (values recommended for selectivity)	
rapid fuses (GI)	In (Nominal current)/7
regular switches	In (Nominal current)/7
ultra-rapid fuses	In (Nominal current)/2

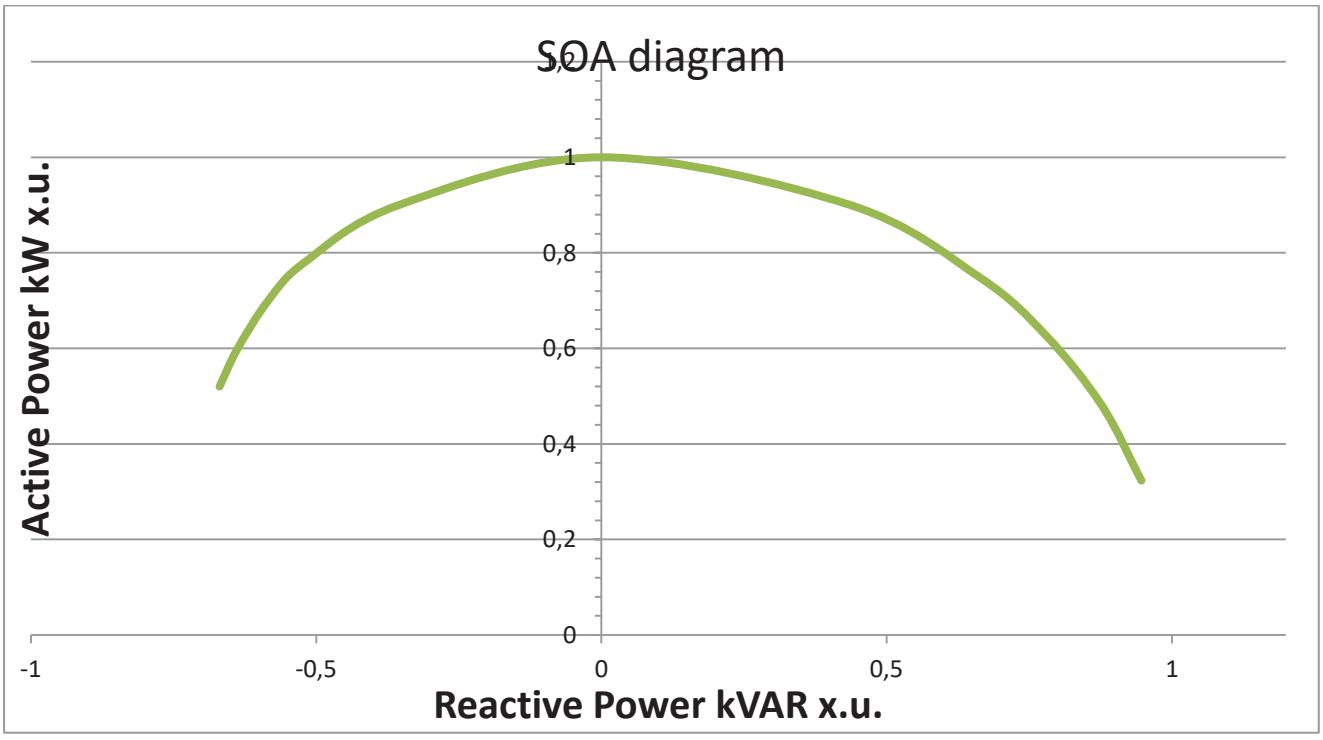
Output voltage symmetry

Under all conditions, output voltage symmetry is maintained within ± 1% for balanced loads and ± 2% for 100% unbalanced loads (e.g. one phase with nominal load, the other two with no load).

Phase shift angle

The three-phase Inverter output voltages have a guaranteed phase shift angle of 120° ± 1° for balanced loads and 100% unbalanced loads.

Performance of 3-phase Inverter with reactive loads



6.2.4 STATIC SWITCH (Automatic Bypass)

A static switch is an electronic device that can automatically transfer the load to the bypass supply without any disruption under the following conditions:

a) manual shut down of the Inverter;
b) Inverter overload limits are exceeded;
c) internal over temperature limits are exceeded;
d) the Inverter has an fault;
e) DC voltage outside of the permitted range.

If at the time of switchover, the inverter voltage is not synchronised with bypass voltage, the transfer will take place with a delay of around 20ms; in consideration of the various types of loads, this delay can be set at 10ms or the switchover can be inhibited if there is no synchronism.

Bypass supply voltage

Transfer to the bypass supply only takes place if the voltage and the frequency are considered 'suitable' for the load. The limits for transfer can be set on-site by the user, depending on the load connected:

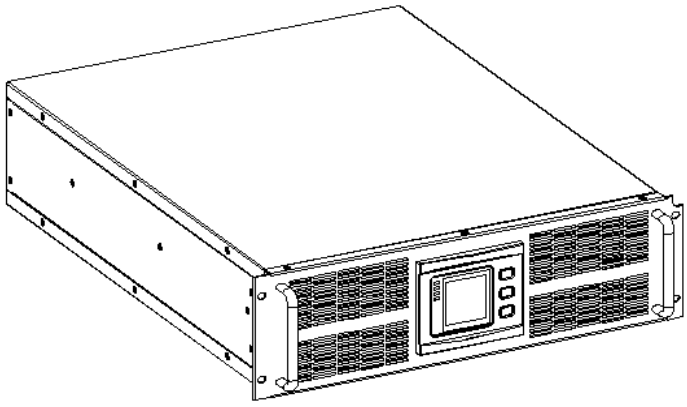
- Voltage range: ± 10% (settable from -10, -20, -30, -45% to +10, +15, +20%);
- Frequency range: ± 10% (settable as +-1, 2, 3, 4, 5 %).

Overload

The UPS static switch is sized to support the overload as per the following Technical Specification table.

6.3 Power module: structure

Each UPS power module is contained in a 19" rack drawer.
It weighs 34 kg.
The module has a height of 3U, with dimensions 443x580x131mm.



The module can be easily hot swapped (inserted or extracted) through plug-in connectors located on the back.
The ventilation features variable speed fans which vary depending on the load and on the internal temperature of the components.

Each module is equipped with an LCD display, control keys and status/alarms LEDs. The description of status, alarms module measures can be seen on the display.
The control pushbuttons include the ON key, also switching on from the battery, and the OFF key.
There are two temperature monitoring points: module internal temperature and air inlet temperature to the module inlet.

GENERAL CONTROL PANEL

The general control panel, located in front of the main UPS cabinet, comprises a LCD touchscreen display and a keypad.

1. LCD touchscreen: monitoring of all the parameters measured, UPS and battery status, events and alarms log
2. LEFT key: to scroll left or up
3. ENTER key: to enter items or confirm selection
4. ESC key: to exit from an item or delete
5. UP key: to scroll up
6. RIGHT key: to scroll right or up
7. DOWN key: to scroll down

Messages are available in the following languages: Italian, English. The panel can be set to other languages, such as French, Russian, Polish, Chinese, Turkish and Korean.

At the centre of the control panel there is a wide-screen touchscreen display providing a detailed real-time overview of the UPS operational status. From the control panel the user can switch the UPS on/off, read electrical measurements - mains, output, battery, etc, monitor the status of each power module and set the main operational parameters.

The display has several screens, each one with a specific function.

1 GENERAL INFORMATION

A screen permanently showing the date and time and, according to the level of display, either the machine model or the title of the menu active at that time.
An animated *mimic* display represents the energy flow, the machine status, and the active, inactive or alarm status of components in real-time.

2 DATA DISPLAY/NAVIGATION MENU

The main screen of the display shows key UPS measurements (constantly updated in real-time), related to input, output and battery. The user can also select and view various menus using the appropriate function keys. After

selecting the required menu, this part of the display shows one or more pages containing all the data relevant to that menu.

3 UPS STATUS, ALARMS – FAILURES, CONTROLS

A screen in which the UPS and single modules' operating status is constantly shown, also in a graphic form; it also shows any possible UPS warning/failure and the type of error/failure detected. It is also used to activate several functions, such as the battery test.

4 DATA LOG

A menu screen provides access to all events recorded in chronological sequence, due to inadequate plant and environment conditions (supply voltage out of range, high temperature, overload, etc.) or internal failures.
The log records 500 events in FIFO (First In First Out) mode and the string contains the following information: Event Code, Event Description, Date and Time.
Data is displayed through the graphical display using the scroll keys.
A *larger data log* (5000 events), downloadable through serial port, is available in the "monitoring module" described below.

5 VERSION AND SET–UP

In addition to showing the Firmware version, several other menus allow access to set several measurements (i.e. battery data, bypass voltage acceptance range).

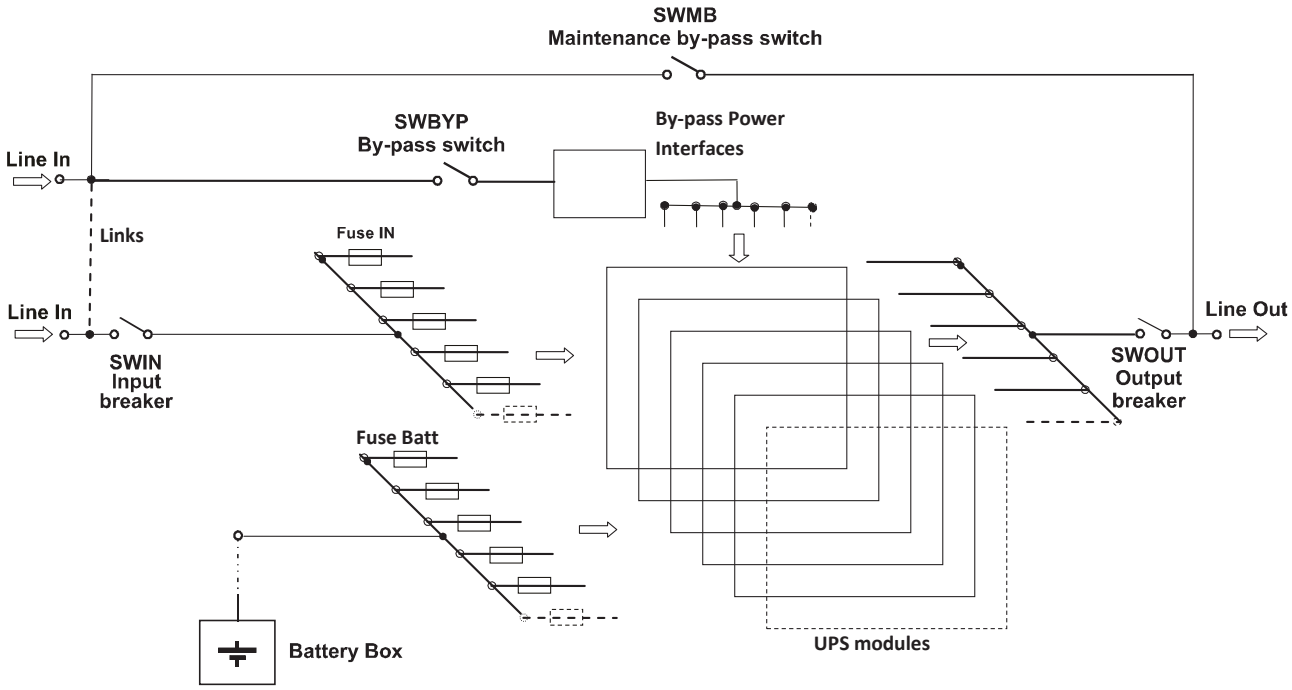
When an alarm appears an audible warning will sound.

Measurements

- Input voltage, current and frequency
- By-pass voltage and frequency
- Output voltage, current and frequency
- Output power (kVA, kW and %)
- Output peak current
- Battery voltage
- Battery current (charge/discharge)
- Cabinet internal temperature
- External battery temperature (via optional probe located at the battery)
- Battery status and back-up time
- Output voltage, current and frequency and bus voltage for each module.

UPS CABINET AND ISOLATING SWITCHES

The **Safepower Modular – SPM** UPS is housed in 19" rack cabinets with slots housing the power modules, arranged in one or more columns.
The cabinet is made of galvanized steel with IP20 protection, even with the open front door. The *forced ventilation* is located on-board of the single power modules: the air inlet is located in the front and the outlet on the back. The ventilation grids on the front doors are equipped with **anti-dust filters**.
Components with high heat dissipation, e.g. the power modules, are individually monitored by **double temperature sensors**.
The single line diagram highlights the main components.



The UPS is equipped with the following isolating switches located at front and/or rear of the cabinet and accessible opening the door:

① SWMB
Manual bypass switch

② SWOUT
Output switch

③ SWIN
Input switch

④ SWBYP
Bypass switch

The power supply to and from these switches, as well as the DC power supply from the terminals of the (external) battery, is then internally distributed to the single power modules.
Special **fuse holder** drawers, which can be extracted easily, one per module, contain the input and battery fuses.
On the automatic (static) bypass line, there is a multiple power interface which filters the line and equally shares the current among the static switches of the modules. The automatic static switch system is distributed (as described in the above section) to the single modules, in order to achieve a completely modular UPS.

Main **terminations** are provided for the mains input, load and battery:
Rectifier input L1, L2, L3, N;
Output L1, L2, L3, N;
Positive, neutral, negative battery terminal;
Bypass input L1, L2, L3, N;
Ground terminal.

The input terminals can be arranged for a **single or dual input**: if the supply source is common, internal links are provided, if the rectifier input and bypass input are separate, the links are removed.

Maintenance bypass operation, by activating the related isolating switch: it is only possible to effect this operation after removal of the *protective cover*. By removing this cover, auxiliary contact forces the load to transfer to the static bypass line, if this has not already been executed manually. This prevents an erroneous operation with consequent direct connection of the power supply generated by the inverters to the mains upstream.

The input terminals are equipped with **surge protectors** for protection against potentially dangerous voltage surges. These are type 2 protectors, tested for Class II according to IEC EN 61643-11 (In 20 kA, Imax 40 kA). They are plug-in modules which can be replaced in case of tripping.

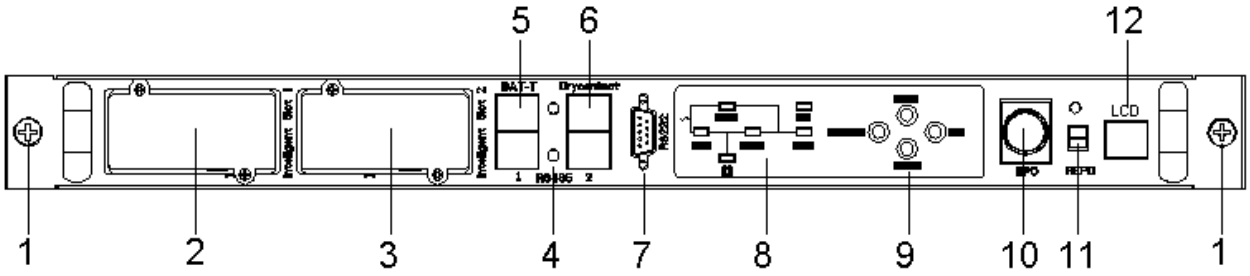
For user interface purposes (communication ports, monitoring and control touchscreen display), the UPS is equipped with a "**Monitoring Module**" which collects all the information, sends the commands to and from the power module communication bus, manages the output/user communication ports as described below.
The monitoring module powers and communicates with the touchscreen **General control panel** located on the front door and previously described.

The system is equipped with "**Backfeed Protection**". In order to avoid any possible electric shock at the input terminals due to a failure of the electronic static switch, the internal device is capable of detecting such failure and generating a command to ensure that the faulty line is adequately disconnected, in accordance with Standard IEC/EN 62040-1.

MONITORING AND COMMUNICATION

For user access purposes (communication ports, monitoring and control touchscreen display), the UPS is equipped with a Monitoring Module. This module too, just as in the case with the power modules, can be hot swapped, without interruption to the services or status change in the UPS or switching to the bypass. The parameters and calibrations memorized in the monitoring module are stored as a copy on the UPS power modules and, in case of replacement, they are automatically copied in the new monitoring module.

Monitoring module



(1) Monitoring module fixing screw

(2) Intelligent slot 1: inset a SNMP board or a dry contact board

(3) Intelligent slot 2: inset a SNMP board or a dry contact board

(4) RS485 1/2 port

(5) BAT_T 1/2 port: connect the battery temperature sensor

(6) Dry contacts: port for Backfeed protection control + input port

(7) RS232 port

(8) LED mimic panel

(9) Function keys

(10) EPO key

(11) REPO port: remote EPO connection port

(12) LCD port: connected to the general LCD panel

The monitoring module can be accessed by opening the front door.
Once the door is opened, a small LED mimic panel duplicates the main functions of the general touchscreen display.

COMMUNICATION PORTS

The following communication ports are present:

- Serial port with RS232 connector;
- 2 intelligent expansion slots for additional interface cards;
- Double RS485 RJ45 communication port with Modbus/RTU protocol to monitor the UPS by the BMS (Building Management System);

At the rear of the UPS cabinet, there are two additional RS485 DB9 ports.

COMMUNICATION SLOTS

The UPS has two expansion slots for slot-in interface accessories that can be used for a variety of communications options.
Some examples:

- Second RS232 port
- Ethernet network agent with TCP/IP protocol, HTTP and SNMP
- Relay board with terminal block or DB9

9.1 EMERGENCY SHUTDOWN (E.P.O. and R.E.P.O.)

In case of emergency, activation via the EPO button ("Emergency Power Off", E.P.O.) located on the monitoring module and adequately protected against accidental activation, the UPS goes in stand-by mode, shutting off the power supply to the load, in accordance with the requirements of Standard IEC/EN 62040-1.
An isolated input port is also available to shut off the UPS remotely in case of emergency.
Thus the UPS is equipped with the "Remote Emergency Power Off" (R.E.P.O.) terminals. At installation, the terminals have to be connected to the remote shutdown device , using a double-insulated cable.
When activated remotely, the R.E.P.O connection opens and the UPS switches to stand-by mode. The UPS no longer powers the load.
The R.E.P.O circuit is supplied with SELV type circuits. No external supply voltage is required.
After an emergency shutdown, the UPS will return to on-line operating mode only after the UPS is completely without power supply.

9.2 MONITORING AND CONTROL SOFTWARE

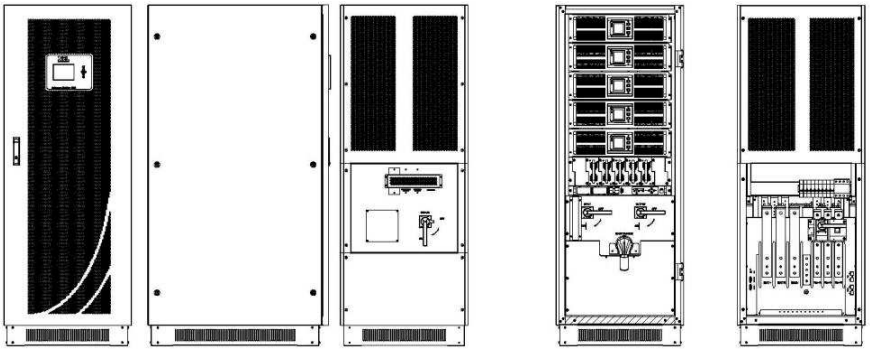
The UPS is supplied with UPS monitoring and control software to provide the following:

- Chronological event recording;
- Event management;
- E-mail, modem, SNMP agent support;
- Sequential shutdown of all the PC/clients within a network environment, while saving the active work of the most common Network Management Systems:
  Windows
  Linux
  HP Open View
  SUN SunNet Mgr
  IBM NetView
  Novell NMS
  Accton AccView
  MegaTec SNMPView

UPS RACK CABINETS AND SIZES

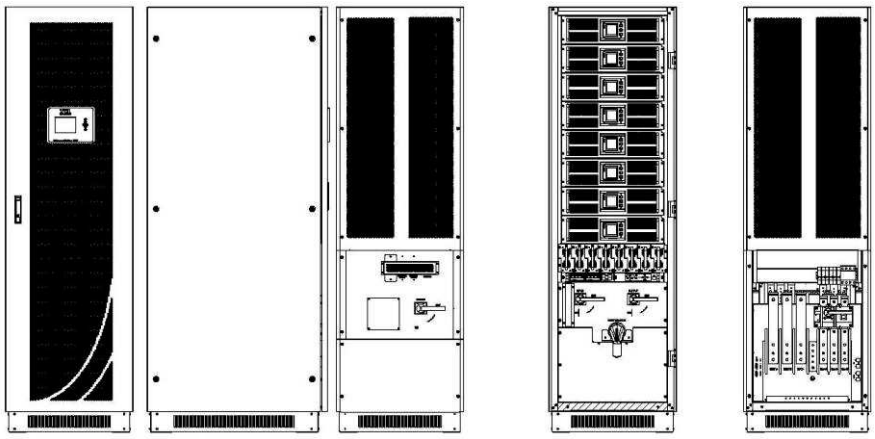
The cabinet is made of galvanized steel with IP20 protection, even with the open front door. The forced ventilation is guaranteed by fans positioned in the UPS modules; the air inlet is located on the front and the outlet on the back.
The components with an higher heat dissipation, e.g. the power modules, are individually monitored by temperature sensors and protection thermostats. Furthermore, the cabinet internal air temperature is monitored and shown on the user display.

Safepower Modular SPM. Cabinet **200 kVA** (max. 5x40kVA modules).
Dimensions (LxDxH = 600x860x1600 mm), weight 375 kg



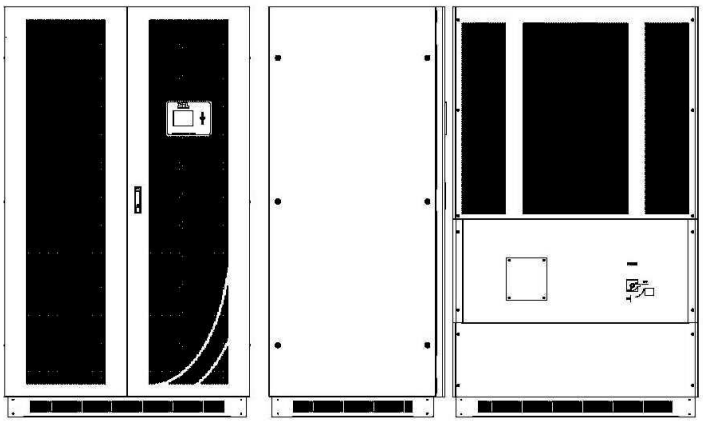
Closed (front, side, back) Open (front, back)

Safepower Modular SPM. Cabinet **320 kVA** (max. 8x40kVA modules).
Dimensions (LxDxH = 600x860x2000 mm), weight 582 kg

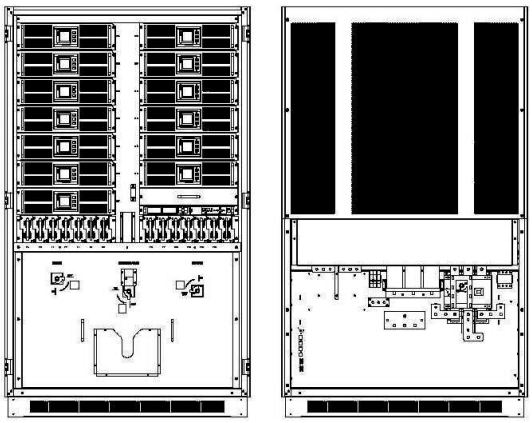


Closed (front, side, back) Open (front, back)

Safepower Modular SPM. Cabinet **400 kVA / 520 kVA** (max. 13x40kVA modules).
Dimensions (LxDxH = 1200x860x2000 mm), weight 790/892 kg

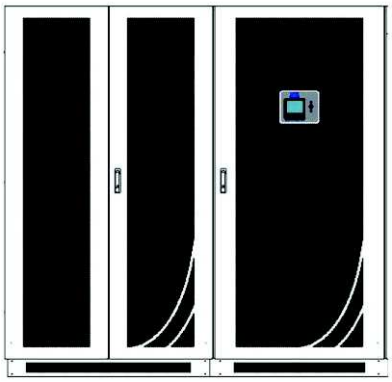


Closed (front, side, back)



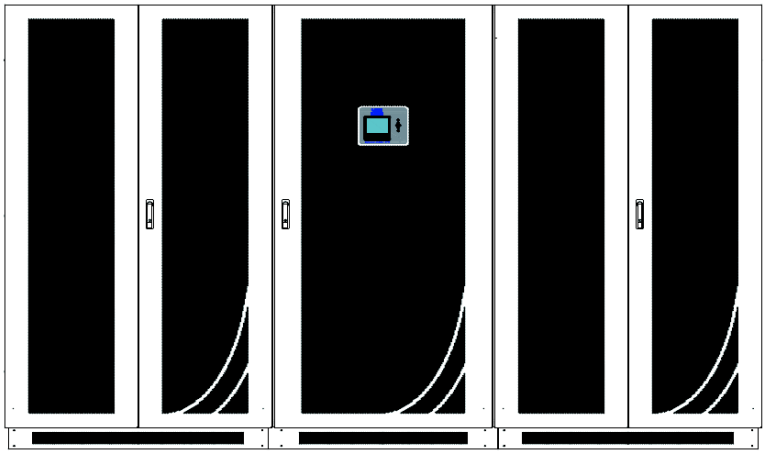
Open (front, back)

Safepower Madular SPM. Cabinet **800 kVA** (max 20x40kVA modules).
Dimensions (LxDxH = 2000x860x2000 mm), weight 1580 kg



Closed (front)

Safepower Modular SPM. Cabinet **1040/1280 kVA** (max. 32x40kVA modules).
Dimensions (LxDxH = 3400x860x2000 mm), weight 2676/2880 kg
Cabinet **1560 kVA** (max. 39x40kVA modules).
Dimensions (LxDxH = 4800x1100x2000 mm), weight 3400 kg



Closed (front)

OPTIONS

11.1 COMMUNICATION

The two expansion slots can house two of the following communication options:

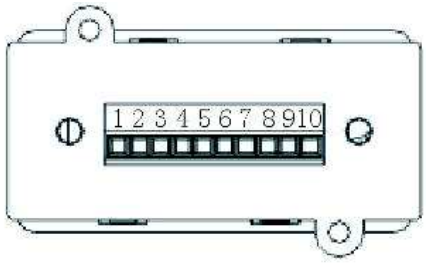
Network interface controller / SNMP adaptor (basic or advanced)

a) network agent to manage the UPS directly connected to 10/100 Mbps LAN, using the main network communication protocols (TCP/IP, HTTP and SNMP). It is possible to connect also a modem to the same device.
b) network agent to manage the UPS as indicated above with an additional environmental monitoring port (humidity, temperature, presence of smoke or gas) and modem/GSM port.

Relay board (terminal block or DB9)

It supports a 10 pin terminal block suitable for the following signals: bypass, mains failure, inverter ON, low battery power, UPS failure, UPS alarm and UPS stop.

The relay communication board includes six dry contact outlets and one dry contact inlet. The outlets and inlets are factory programmed based on the functions indicated in the table. The contacts are NO (normally open).



Port		Function
1	Outlet	Mains failure
2		/
3		Low battery
4		Activated bypass
5		UPS failure
6		Inverter ON
7		UPS warning
8		COM
9	Inlet	Activation
10		Deactivation

As an alternative to the terminal block, it is possible to have the signals via the DB9 connector.

11.2 EXTERNAL BATTERY TEMPERATURE SENSOR

The Monitoring Module is equipped with a RJ45 input port for remote measurement of the battery temperature. The temperature is indicated via the UPS display.
Once installed, the battery external temperature measurement function has to be enabled from the panel.
The battery voltage recharge compensation level, adjustable from the panel, is indicated in the special section on the battery charger.

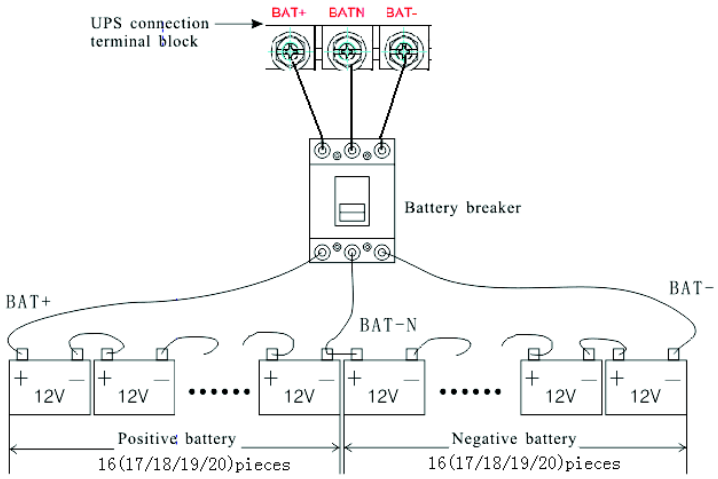
11.3 EXTERNAL MAINTENANCE BYPASS

An external manual maintenance bypass can be installed, which will provide complete isolation or the UPS and if required facilitate complete UPS replacement without power disruption to the load.
It is essential to connect the maintenance bypass auxiliary contacts located inside the UPS in series to an auxiliary NO contact of the external maintenance bypass switch. Closure of the SERVICE BYPASS switch opens this auxiliary contact and informs the UPS of its closure. If such a connection is not made, operation of the remote maintenance bypass may disrupt the supply of power to the load and damage the UPS.

Note: Always check that the remote maintenance bypass installation is compatible with any transformer options selected for the UPS. (see paragraph 11.6 Optional Transformers)

11.4 BATTERY CABINETS

The battery cabinet contains the batteries necessary for the UPS operation in case of power outage. The number of batteries housed within the cabinet varies according to UPS size (and load) and run time desired, as well as the capacity of every single element.
In order to select exactly the requested run time or in the necessity to use a pre-existing battery, the total string, divided into two sub-strings, can comprise a number of blocks (12V rated lead batteries) from 32 to 40, as already specified in the battery recharge section.
For technical reasons, the battery comprises two internal sub-strings, one with positive voltage and the other with negative voltage with respect to the central neutral clamp (N).
The battery cabinet is equipped with an internal switch (isolating switch with fuses) or with a switch located in a special box.
The battery cabinet configuration for connection to the UPS is shown below.



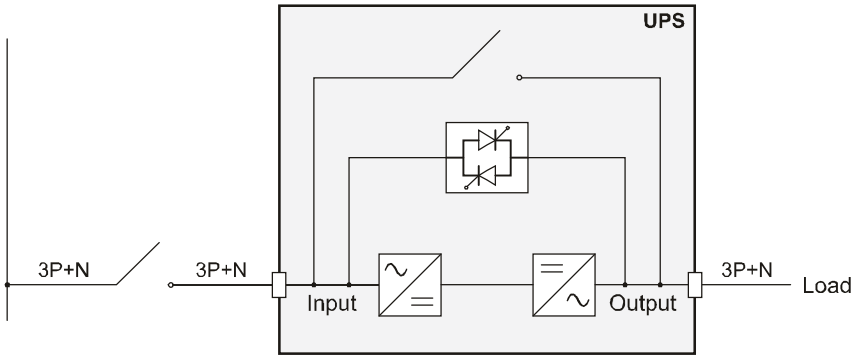
11.5 OPTIONAL TRANSFORMERS

The UPS can be equipped with external transformers used to recreate the power neutral where it is not available, to change its arrangement or to adapt the UPS output voltage.

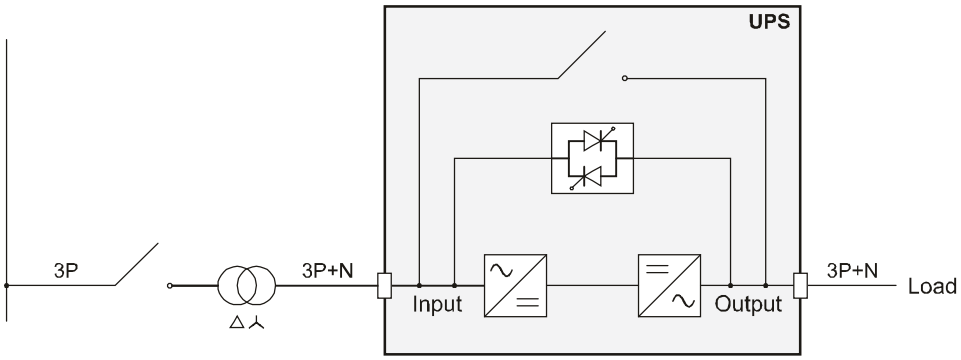
ELECTRIC CONNECTIONS DIAGRAMS

Note: An external transformer will modify the neutral arrangements of the installation. Therefore, if a "remote maintenance bypass" is installed for UPS insulation, it must be sited downstream of the transformer (for an input-side transformer) or upstream (for an output-side transformer).

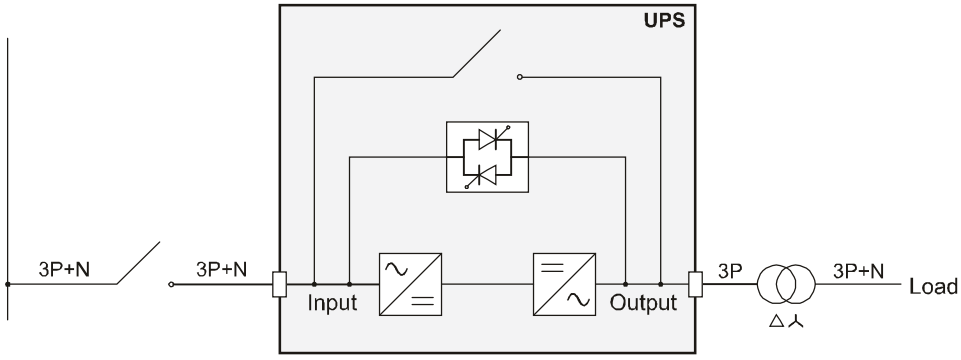
UPS without variation of the neutral arrangement



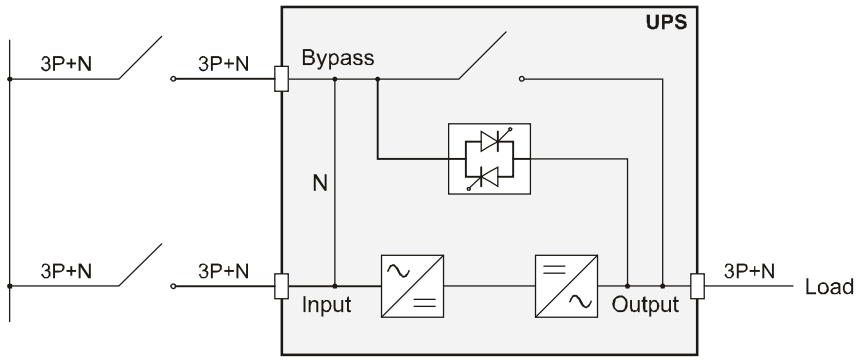
UPS with galvanic isolation on the input



UPS with galvanic isolation on the output

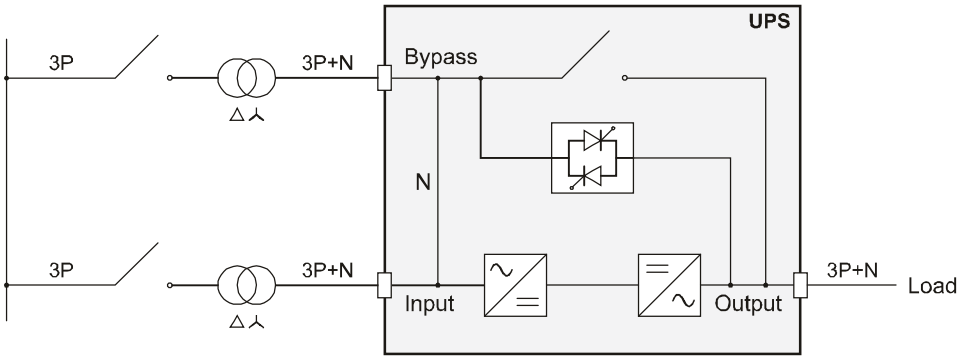


UPS without variation of the neutral arrangements and with a separate bypass supply input



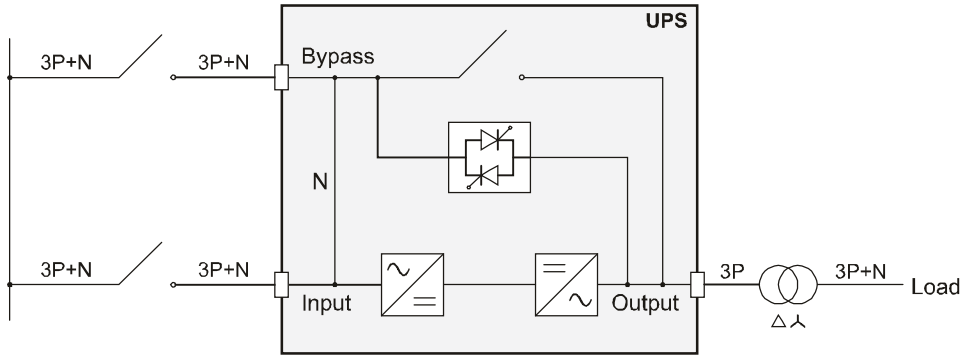
After removal of the links for separate inputs (see 11.6)

UPS with galvanic isolation on the input and with a separate bypass supply input



After removal of the links for separate inputs (see 11.6)

UPS with galvanic isolation on the output and with a separate bypass supply input



After removal of the links for separate inputs (see 11.6)

Separate bypass on separated lines upstream:
Note: the neutral of the input line and that of the bypass are joined inside the equipment, therefore they will refer to the same potential. If the two mains supplies are different, it is necessary to use an isolation transformer on one of the inputs.

11.6 SEPARATED LINE INPUT

All the UPS versions in the 80-1560KVA range are configured for a common input. The simple removal of internal links facilitate the connection of separate Rectifier & Reserve inputs.
This facility provides means of isolation via the two switches present within the UPS (SWIN and SWBYP).

ENVIRONMENTAL CONDITIONS

UPS room ambient temperature	0 ÷ 40° C
Recommended operating temperature for optimum battery performance	20 ÷ 25° C
Storage temperature	- 25° to +55 °C
Altitude-operating (Metres ASL)	<1500 m (with - 1% de-rating every 100m over 1500m)

TECHNICAL DATA 200-520 KVA

Mechanical characteristics	UPS power (kVA)			
	200	320	400	520
Dimensions (mm)				
• Width	600	600	1200	
• Depth	860	860	860	
• Height	1600	2000	2000	
Weight (kg) (with max. number of modules) (weight of each module 34 kg)	375	582	790	892
Ventilation	Forced through internal fans			
Cabinet IP rating	IP20			
Cable inlet	From the bottom/ from the front-back			
Colour	RAL 9005			
Max. quantity of UPS modules	5	8	10	13

Electrical data	UPS power (kVA)			
	200	320	400	520
INPUT				
Nominal voltage	380-400-415 Vac Three-Phase plus neutral			
Input current (nom./max.)	274/391 A	438/626 A	548/782 A	712/1017 A
Voltage range (without switching to battery power)	208÷478 Vac at 100% of the load			
Nominal frequency	50 or 60Hz			
Input frequency tolerance (without switching to battery power)	40 to 70Hz			
Total Harmonic distortion (THDi) and power factor with full load	THDi 3 % , 0.99 Pf			
Rectifier progressive start-up (*Power Walk-in duration*)	9 sec., with UPS modules start-up in progression			
Delayed start-up (*Start-up delay*)	20 sec., with UPS modules start-up in progression			

Electrical data	UPS power (kVA)			
	200	320	400	520
DC BUSBAR AND BATTERY SET				
Number of battery cells	96+96 / 102+102 / 108+108 / 114+114 / 120+120			
Float voltage (2,25 V/el. , adjustable)	270+270 Vdc			
Boost voltage (2,4 V/el. , adjustable)	288+288 Vdc			
End of discharge voltage (1,65 V/el, adjustable 1,6-1,9V/el)	198+198 Vdc			
Standard battery charger (max. 10 A per module, up to 18A with nominal Vin)	50 A	80 A	100 A	130 A

Electrical data	UPS power (kVA)			
	200	320	400	520
INVERTER				
Nominal power (kVA)	200	320	400	520
Active power with p.f. 1 (kW)	200	320	400	520
Nominal voltage	380/400/415 Vac Three-Phase plus neutral			
Nominal frequency	50 / 60Hz			
Static stability	± 1%			
Dynamic variation	± 5%			
Recovery time within ± 2%	20ms In compliance with standard EN 62040-3, class 1			
Crest factor (Ipeak/Irms as per EN 62040-3)	3:1			
Voltage distortion with linear and distorting load (EN 62040-3)	≤ 2% with linear load ≤ 5% with distorting load			
Inverter frequency stability without by-pass supply synchronisation	± 0.1 Hz			
Slew rate	1Hz/sec			
Voltage phase dissymmetry with balanced and unbalanced loads	± 1% / ± 2%			
Voltage phase shift with balanced and unbalanced loads	120 ± 1 °			
Inverter overload	>101% ÷ ≤110% 60 min. >110% ÷ ≤125% 10 min. >125% ÷ ≤150% 1 min. >150% protection			
Short circuit current	180A per module			
Efficiency on battery operation (%)	≥95%			
Bus input voltage	370+370 Vdc			

Electrical data	UPS power (kVA)			
	200	320	400	520
BY–PASS				
Nominal voltage	380-400-415 Vac Three-Phase plus neutral			
Output nominal current (A)	290	460	580	750
Bypass voltage range	Max. voltage: 380V:+25%(adjustable +10%,+15%,+20%); 400V:+20%(adjustable +10%,+15%); 415V:+15%(adjustable +10%); Min. voltage: -45%(adjustable -10%,-20%,-30%)			
Nominal frequency	50 ÷60Hz			
Bypass input frequency range	± 10% (adjustable ± 1% to ± 10%)			
Transfer time from By-pass to Inverter (UPS in "ECO mode")	2 ms typical			
Transfer delay to Inverter from By-pass	4 sec			
Overload capability on bypass line	>101% ÷ ≤110% 60 min. >110% ÷ ≤125% 10 min. >125% ÷ ≤150% 1 min. 1000% 800 ms 1500% 50ms			

Electrical data	UPS power (kVA)			
	200	320	400	520
SYSTEM				
AC/AC Efficiency (On line)				
• Full load	95,5			
• 75% load	96,0			
• 50% load	96,5			
• 25% load	95,6			
Efficiency with UPS in ECO mode	≥98.6%			
Audible noise at 1mt (dBA)	50-71 dB (A) Depending on the load			
Max. dissipated power	9,42 kW 8100 kcal/h	15 kW 12900 kcal/h	18.84 kW 16200 kcal/h	24.5 kW 21072 kcal/h
UPS on-board fan capacity	3600 mc/h	5760 mc/h	7200 mc/h	9360 mc/h
Max current leaked to earth *	≤250mA			

***** The dispersion current of the load is added to that of the UPS on the ground protection conductor.

TECHNICAL DATA 800-1560 kVA

Mechanical characteristics	UPS power (kVA)			
	800	1040	1280	1560
Dimensions (mm) • Width • Depth • Height	 3400 860 2000	 3400 860 2000	 3400 860 2000	 4800 1100 2000
Weight (kg) (with max. number of modules) (weight of each module 34 kg)	1580	2476	2680	3400
Ventilation	Forced through internal fans			
Cabinet IP rating	IP20			
Cable inlet	From the bottom/ from the front-back			
Colour	RAL 9005			
Max. quantity of UPS modules	20	26	32	39

Electrical data	UPS power (kVA)			
	800	1040	1280	1560
INPUT				
Nominal voltage	380-400-415 Vac Three-Phase plus neutral			
Input current (nom./max.)	1,095/1,564 A	1,424/2,033 A	1,752/2,503 A	2,136/3,050 A
Voltage range (without switching to battery power)	208÷478 Vac at 100% of the load			
Nominal frequency	50 or 60Hz			
Input frequency tolerance (without switching to battery power)	40 to 70Hz			
Total Harmonic distortion (THDi) and power factor with full load	THDi 3 % , 0.99 Pf			
Rectifier progressive start-up (*Power Walk-in duration*)	9 sec., with UPS modules start-up in progression			
Delayed start-up (*Start-up delay*)	20 sec., with UPS modules start-up in progression			

Electrical data	UPS power (kVA)			
	800	1040	1280	1560
DC BUSBAR AND BATTERY SET				
Number of battery cells	96+96 / 102+102 / 108+108 / 114+114 / 120+120			
Float voltage (2,25 V/el. , adjustable)	270+270 Vdc			
Boost voltage (2,4 V/el. , adjustable)	288+288 Vdc			
End of discharge voltage (1,65 V/el, adjustable 1,6-1,9V/el)	198+198 Vdc			
Standard battery charger (max. 10 A per module, up to 18A with nominal Vin)	200 A	260 A	320 A	390 A

Electrical data	UPS power (kVA)			
	800	1040	1280	1560
INVERTER				
Nominal power (kVA)	800	1040	1280	1560
Active power with l.p.f. 1 (kW)	800	1040	1280	1560
Nominal voltage	380/400/415 Vac Three-Phase plus neutral			
Nominal frequency	50 / 60Hz			
Static stability	± 1%			
Dynamic variation	± 5%			
Recovery time within ± 2%	20ms In compliance with standard EN 62040-3, class 1			
Crest factor (Ipeak/Irms as per EN 62040-3)	3:1			
Voltage distortion with linear and distorting load (EN 62040-3)	≤ 2% with linear load ≤ 5% with distorting load			
Inverter frequency stability without by-pass supply synchronisation	± 0.1 Hz			
Slew rate	1Hz/sec			
Voltage phase dissymmetry with balanced and unbalanced loads	± 1% / ± 2%			
Voltage phase shift with balanced and unbalanced loads	120 ± 1 °			
Inverter overload	>101% ÷ ≤110% 60 min. >110% ÷ ≤125% 10 min. >125% ÷ ≤150% 1 min. >150% protection.			
Short circuit current	180A per module			
Efficiency on battery operation (%)	≥95%			
Bus input voltage	370+370 Vdc			

Electrical data	UPS power (kVA)			
	800	1040	1280	1560
BY–PASS				
Nominal voltage	380-400-415 Vac Three-Phase plus neutral			
Output nominal current (A)	1160	1500	1850	2250
Bypass voltage range	Max. voltage: 380V:+25%(adjustable +10%,+15%,+20%); 400V:+20%(adjustable +10%,+15%); 415V:+15%(adjustable +10%); Min. voltage: -45%(adjustable -10%,-20%,-30%)			
Nominal frequency	50 ÷60Hz			
Bypass input frequency range	± 10% (adjustable ± 1% to ± 10%)			
Transfer time from By-pass to Inverter (UPS in "ECO mode")	2 ms typical			
Transfer delay to Inverter from By-pass	4 sec			
Overload capability on bypass line	>101% ÷ ≤110% 60 min. >110% ÷ ≤125% 10 min. >125% ÷ ≤150% 1 min. 1000% 400 ms 1500% 4ms			

Electrical data	UPS power (kVA)			
	800	1040	1280	1560
SYSTEM				
AC/AC Efficiency (On line)				
• Full load	95,5			
• 75% load	96,0			
• 50% load	96,5			
• 25% load	95,6			
Efficiency with UPS in ECO mode	≥98.6%			
Audible noise at 1mt (dBA)	50-71 dB (A) Depending on the load			
Max. dissipated power	37.69 kW 32418 kcal/h	49 kW 42144 kcal/h	60.3 kW 51870 kcal/h	73.5 kW 63215 kcal/h
UPS on-board fan capacity	14400 mc/h	18720 mc/h	23040 mc/h	28080 mc/h
Max current leaked to earth *	≤400mA			

***** The dispersion current of the load is added to that of the UPS on the ground protection conductor.

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