TECHNICAL SPECIFICATION

Modular Uninterruptible Power System

RATED POWER: up to 1200 kVA/kW – Three-phase

10 min autonomy at 200 kW

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# TERMS and ABBREVIATIONS

For the purpose of this document, we have used the following terms and standard abbreviations:

UPS Uninterruptible Power System

UPS System UPS compose by one or multiple UPS unit(s)

UPS unit UPS composed by one or multiple power module(s)

Power module Double conversion and battery management power converters

Power slot Pre-connected bay ready for module hot plug-in

IGBT Insulated Gate Bipolar Transistor

DSP Digital Signal Processor

THDU [Total Harmonic Distortion Voltage](http://www.allacronyms.com/Total_Harmonic_Distortion_Voltage/abbreviated) (Phase/Phase)

THDI [Total Harmonic Distortion](http://www.allacronyms.com/Total_Harmonic_Distortion_Voltage/abbreviated) in Current

VFI Voltage and Frequency Independent (according IEC/EN 62040-3)

AC Alternative Current

DC Direct Current

N Neutral; Generic symbol used for neutral conductor

VRLA Valve Regulated Lead Acid

AGM Absorbent Glass Mat

EMC Electro Magnetic Compatibility

IEC International Electrotechnical Commission

EC European Conformity

EN European Norms

# USER GUIDE

Paragraphs shown in red refer to options. They should be deleted if these options are not relevant to the current project.

Text in grey is to be completed, edited or selected according to the needs of the project.

# PURPOSE OF THE SPECIFICATION DOCUMENT

This specification document describes a double conversion MODULAR Uninterruptible Power System (hereafter referred to as UPS). This solution is specified to provide high quality power, improve the overall availability and energy efficiency of power systems dedicated to protect sensitive and very critical loads.

This MODULAR UPS and installation shall allow a high grade of serviceability; such that all UPS modifications can be carried out in a simple, fast and secured way.

The equipment shall allowing easy power scalability (when required), minimize MTTR and allow Power Module(s) swapping without interrupting the operations of the live systems, without transferring on the static by-pass line and without any cabling operation.

The system will be composed of …N…. UPS Unit(s)

A UPS unit(s) will be composed initially of …n…. numbers of double conversion power module of 200kVA/kW and be pre-configured with pre-interconnected frames ready to plug-in 200kVA/kW modules, in a scalable array architecture in which maximum power is …xx…. kVA with unity power factor

The technical reference is SOCOMEC *MODULYS XL* UPS or as a similar solution approved by us.

*If case of several UPS units connected in parallel, please make sure you clearly specify the number of Units (and the power of each, if heterogeneous) included in the system.*

*If case of several parallel systems, please make sure you clearly specify the number of systems.*

# DIRECTIVES AND STANDARDS CONFORMITY

The UPS covered by this specification must have the EU marking, in accordance with European directives and standards:

* Low voltage directive (LVD) : 2014/35/EU.
* Electromagnetic compatibility directive (EMC): 2014/30/EU.
* Restriction of the use of certain hazardous substances (RoHS): 2011/65/EU.
* WEEE - Electrical and electronic equipment waste (WEEE): 2012/19/EU.
* Safety UPS standard (LV): EN/IEC 62040-1.
* EMC Emissions UPS standard: EN/IEC 62040-2 class C3.
* EMC Immunity UPS standard: EN/IEC 62040-2 classes C2-C3.
* Test and performances UPS standard: EN/IEC 62040-3.
* Environmental aspects UPS standard: EN/IEC 62040-4.

Relevant documentation and certificates must be made available on request.

Compliance related to the Safety standard shall be certified by independent laboratory.

# ORIGIN

The system (including power modules) shall be developed, manufactured and tested in a European country (France). The development and the production site must be certified according to ISO14001 (Environmental management system) and ISO 9001 (Quality management system).

# GENERAL DESCRIPTION OF THE MODULAR UPS

An inherent feature of the UPS is the requirement for multiple power modules facilitating load matched power provision and UPS module scalability.

# UPS architecture

Each UPS Unit will consist of the following parts:

* Input, output and DC energy storage connection area, although capable of accepting busbar flanges when required.
* By-pass line and transfer switching feature, for which the compatibility with the electrical environment is not related to the number of installed power modules.
* Pre-connected power slots for easy plug-in-out of 200 kW power module(s), providing intrinsic scalability through easy and safe addition -or removal- of power modules and the ability to vary the number of power modules during on-line use.
* One or more 200 kW Power Modules pluggable in one of the installed power slots, where each power module includes single and full rated rectifier, DC/DC converter (battery management), inverter and double conversion side by-pass device.
* A control, monitoring and indication incorporating a colour touch screen HMI.

# General UPS Unit Characteristics

* Storage temperature range : -20°C to + 70°C
* Operating temperature range, without derating: 0°C to + 40°C
* Altitude, without derating: ≤1000m,
* Maximum relative humidity: 95 % at room temperature, without condensation

|  |  |
| --- | --- |
| Apparent rated power and configuration of the UPS unit(s) | 200 / 400 / 600 / 800 / 1000 / 12000 kVA (N)  200 / 400 / 600 / 800 / 1000 kVA (N+1) |
| Rated output power factor design | PF=1 (with no de-rating up to 40°C) |
| type of network (input/output) | Three-phase / Three-phase |
| UPS classification according EN/IEC 62040-3 | VFI - SS - 111 |
| Rated input voltage | 400 V |
| Rated input frequency | 50 Hz |
| Rated output voltage | 400 V sinusoidal |
| Rated output frequency | 50 Hz |
| Power feeders for rectifier and bypass | Common input / Separate inputs |
| Input(s) and Output AC power connection | Top entry / Bottom entry |
| Protection Index according to EN/IEC 60529-2 | IP 20 |

# UPS grade of modularity

The equipment and installation shall be such that a high grade of service is achieved.

* All modifications shall be carried out in double conversion mode (online), without reducing the UPS behaviours.
* The UPS unit shall be scalable without the need to modify the installation.
* The system shall be designed to provide high resilience.
* The inherent design of the UPS shall provide fast and secure maintenance as well as low MTTR and short fix time rate.

# UPS design resiliency

The specified Modular UPS will be designed to provide high MTBF through an appropriated power granularity and a distributed control management.

The solution shall be designed with mechanical segregation between each of the modules and the static bypass which will be in its own frame within the UPS unit.

Any combination of power modules may be possible, without operation being predicated: the static bypass and each module will have their own controller to allow autonomous operation and avoid any single point of failure.

Compliance with the general following requirements will be evaluated:

* Each module shall be rated 200kW, where the rectifier, inverter and DC/DC converter will be single and fully rated; a combination of multiple sub-converters - in parallel into each single module - will not be accepted.
* UPS unit shall be provided with a static switch, sized for a permanent operation at the maximum rated power the system. Architecture where the static switch for the bypass line is part of the power modules will not be accepted.
* The double conversion side’s bypass shall be integrated in each power module, allowing safe transfers and avoiding single point of failure.
* Each Power module shall have all the hardware and software required for autonomous operation of its rectifier, inverter and DC/DC converter.
* Power modules will operate intelligently on a peer-to-peer basis ensuring load sharing (active and reactive power), synchronisation and selective tripping capabilities together with a coordination of static bypass control.
* Operating and protection parameters are to be firmware controlled with no requirement for manual adjustment.
* Firmware logic including test capabilities for inherent self-diagnostic and troubleshooting functionality.
* Presence of contactors together with fast acting fuse protections at each module’s input and output stage, to allow each single module to be manually or automatically isolated from the running UPS unit.
* The user control panel consists of an interface to the systems and does not embed any intelligence that may affect the system control upon failure.

When required to parallel two or more UPS units, it will be possible to vary the number of power modules present in each of the 4 UPS units. All active modules will share the load, without any constrain of location or units power capability symmetry. The design shall allow their static bypasses to be connected in parallel and ensure their coordination through a ring-design communication CAN-bus.

# Power Scalability

The UPS will be designed for straightforward power scalability by allowing a single person to be able to plug-in a new power module. It shall be possible to plug-in and bring online a new power module neither with the need of manufacturer’s software nor specific mechanical/handling tools. Power modules shall have integral wheels form movement into position across a level floor.

Incrementing the UPS rated power by adding a new module shall be available while keeping the load protected by the other(s) module(s) working in on-line mode. It shall be possible to electrically connect a new module, without the need for any cabling and in safe conditions.

Compliance with the general following requirements will be evaluated:

* The system must comprise prewired sufficient frames for future power module extension. It will have to be designed for secure operation during extension operation and provide easy handling for the future power modules.
* Plug-in, connection and start-up of a single power module by one person in less than 5minutes, with all other power modules continuing to support the critical load in on-line mode.
* Straightforward power upgrade, without the need of dedicated UPS supplier’s software/hardware tools.
* No need of power or control cables connection, making a module addition easier and secure
* Galvanic disconnectors allow a module’s power paths to remain isolated during the connection, to prevent electrical arcs.
* Firmware auto-alignment and self-configuration parameters, ensures that the system will run with the customer firmware configuration. A new module can be inserted without prior checks or changes to its firmware being required.
* Power module carries out a self-test prior to it connecting to the running system.
* Via HMI, the user is required only to select new module(s) purpose; either power scalability or redundancy level adjustment

# Risk-free maintenance

The UPS is designed for risk-free maintenance activities by allowing fast and easy maintenance or repair of each part of the system, while all others continue to protect the critical load.

Compliance with the general following requirements will be evaluated:

* Electrical and physical isolation of a single power module, by one person in less than 5minutes, with all other power modules continuing to support the critical load in on-line mode.
* No reduction in UPS functionality (besides capacity) related to power module extraction.
* The power module, when extracted, is designed to allow its functional and full power heat-run testing (200kW) - without the need of an external load bank – this is achieved by supplying the module with a dedicated auxiliary power supply sized for 3x 63A.
* The system will have straightforward means to electrically isolate (input/output/DC) and physically extract the power module which is to be maintained or repaired. This removes any risk of potential fault propagation of in-situ hardware operations or modifications.
* Straightforward swapping with another module, without the need of dedicated UPS supplier’s software/hardware tools and without cabling operation.
* Isolation means of the modules automatic to switch off of the concerned module to prevent any electrical arc during the electrical disconnection.
* Embedded means to isolate the Static bypass and associated cooling maintenance from the load bus, keeping power modules supplying the load.
* PCB replacement is possible with no requirement for recalibration.

The above requirements, together with the automatic configuration and firmware alignment of a plugged-in module, will allow a single person to guarantee first time fix rate, by swapping a faulty module with another available module. The intent of easy of accurate pre-test is to remove all consequences related to component issues or human error before to fitting back in to the online system.

# AUTOMATIC STATIC BYPASS

The UPS shall be provided with an automatic static bypass ensuring the system switching between the power modules and the auxiliary source without any interruption in power. User initiated transfer from double conversion inverter operation to utility via the static bypass must be available through soft commands at the control HMI.

Each UPS Unit shall be designed with:

* A static bypass in the auxiliary source branch sized for a permanent operation at the rated power of the UPS unit - connected in parallel of the each module’s integrated bypass circuit.
* The bypass line static switch size and short-circuit capability is not related to the number of installed power modules.
* No protections in series with the static bypass or, if present, fully coordinated with upstream and downstream plant protection in order not to compromise the coordination/selectivity design of the plant
* Control logic ensuring a no break transfer to static bypass in case of overload, inverter failure or downstream short circuit.

The static bypass of each UPS Unit will comply with the following key technical specifications:

|  |  |
| --- | --- |
| Switching with inverter synchronized to the auxiliary source | No interruption |
| Static bypass overload capability:   * 1 hour * 10 minutes * 1 minute * 20 sec | 110 %  125 %  150 %  200 % |
| Short circuit capability (without damaging the static switch) | ≥ 38000 Apeak  ≥ 7 220 000 A²s |
| Short-circuit withstanding(ICW) | 100kA symmetrical |
| Static bypass cooling | Forced with redundant fan |

# POWER MODULE

Each power module includes the following sub-assemblies:

* Rectifier
* DC/DC converter (battery management)
* Inverter
* Module’s independent control
* Input and output contactors and fast arcing fuses
* Mechanical and electrical plug-in means

# General characteristics

Each power module unit will be protected by a group of electronic circuits, fuses and contactors to guarantee its disconnection (input and output) in case of internal failure.

The power module shall be designed to supply the latest generation of loads with unity output power factor (pf =1), without derating or operating in ambient temperature. It must comply with the following key technical specifications:

|  |  |
| --- | --- |
| Rated power at 40°C | 200 kVA/kW |
| Type of network (input/output) | Three-phase / Three-phase |
| Classification according EN/IEC 62040-3 | VFI - SS – 111 |
| AC/AC efficiency in double conversion mode (VFI mode) | Up to 97 % |
| Rated input voltage / frequency | Aligned to the system specification |
| Rated output voltage / frequency | Aligned to the system specification |
| Protection Index according to EN/IEC 60529-2 | IP 20 |
| Module handling means | Built-in wheels |

# Rectifier

The rectifier has to be protected by a current limiter and it must be possible to operate the rectifier with an incorrect input phase rotation.

The rectifier will comply with the following key technical specifications:

|  |  |
| --- | --- |
| Rectifier bridge technology and topology | DSP control - three level IGBT |
| Rated voltage | 400 V - 3 ph (without required neutral) |
| Max voltage tolerance | 480V |
| Min voltage tolerance (without the use of batteries) | 400V -10% at 200 kW  400V -20 % at 180 kW  400V -50 % at 100 kW |
| Frequency range | 45 - 65 Hz |
| Input power factor at full load  (without active or passive filters) | ≥ 0.99 |
| Input Harmonic distortion (THDi) at full load  (without active or passive filters) | ≤ 2.5 % |
| Soft-start current ramp-up for generator compatibility (power walk-in) | configurable from 10 to 1000 A/sec per module |

# DC/DC converter

The system must have a DC/DC converter that manages the battery according to the battery manufacturer’s recommendations. A sensor to measure the temperature of the battery room shall be provided and connected to UPS.

To maximize the battery lifetime, its voltage must be independent from DC bus which is generated by the rectifier and must have the following performances:

|  |  |
| --- | --- |
| Battery connection | 2 Wires (+ / -) |
| Charging current | Adjusted according to battery manufacturer recommendation |
| Floating voltage | Adjusted according to temperature |

The Power Module will be capable of charging the battery in sustained floating mode and will automatically switch to intermittent charging mode if necessary. The temperature threshold for switching from one mode to the other will be configurable; this function can also be inhibited.

# Energy Storage

Energy accumulator will provide a backup time of … minutes at end of life at a load of … kW.

It will be a sealed lead-acid and maintenance-free battery (VRLA) / AGM technology / sealed lead-acid and maintenance-free battery (VRLA) gel technology / lead-acid unsealed battery / NiCd battery / Lithium-ion battery with a rated life of 10-12 years according to EUROBAT / > 12 years according to EUROBAT at 20°C

Batteries will be supplied and installed in a separate metallic cabinet / on shelves with an acid container / on shelves without an acid container / open steel racks. The battery calculation sheet will be attached to the offer, specifying the rated output power (kW), the inverter efficiency and the voltage at the end of discharge.

The UPS unit will be compatible with distributed batteries, where each 200 kW module can have its own battery set / common batteries, where each UPS unit will be connected to a set of batteries shared between all installed modules.

# Periodic battery discharge tests

A system with distributed batteries should include the ability to perform battery discharge tests, on each individual power module separately, without the use of an external resistive load or any dedicated switchboard.

The power module will therefore be able to inject the energy stored in the batteries to its upstream, to be absorbed by other modules. The test will be performed at a constant power (full power or partial load, configurable through the manufacturer's maintenance software) to validate battery back-up time or availability.

During the test phase, it shall be possible to keep the tested unit supplying the load in online double conversion mode.

The energy to be fed back upstream through the rectifier will correspond to the difference between the discharged power and the load consumption. For specific needs, it shall be possible to do the test while the unit is not connected to the output bus.

To ensure safe site operation, the system will take into account the network status and automatically terminate the test in the absence of mains power. When the output is powered by the unit under test, a termination of the battery test will provide continuity of power to the critical application, using the remaining stored energy.

The use of this function is conditioned, conditional upon by the capability to locally absorb the feedback energy fed back.

# Three Level IGBT Inverter

The inverter must use IGBT technology with DSP control and high switching frequency in order to support step changes in the output load. It must be equipped with its own current limiting algorithm, so components are not damaged in case of an output short-circuit. The power module must provide a signal making possible to trip the battery protection at the end of the discharge or in case of emergency stop activation.

The inverter must feature fast acting internal protection preventing transposition of dc current to the critical load in the event of an IGBT failure.

The inverter must comply with the following specifications:

|  |  |
| --- | --- |
| Inverter topology and technology | IGBT – Thee level |
| Rated output voltage | 3 x 400 V with neutral |
| Rated frequency and tolerance | 50 / 60 Hz ± 5Hz |
| Permanent rated power available at 40°C | 200 kVA/kW |
| Load management without derating within the limits of the rated apparent and active power | Any load with a power factor from  inductive to 0.9 capacitive |
| Output voltage stability in dynamic conditions according to IEC/EN 62040-3 | Class 1 (VFI-SS-111) |
| Frequency stability (in battery mode or while auxiliary mains is absent) | ± 0.01 Hz |
| Line synchronisation range (auxiliary mains present) | ± 0.5 Hz to ± 5 Hz (configurable) |
| Output voltage stability in static mode between 0 to 100% load | ± 1 % Vn |
| Total output voltage distortion with a linear load at rated power | THDU ≤ 2 % |
| Average peak short circuit current limitation of each module  (while the auxiliary mains or bypass line is not available) | 820 A from 0 to 20ms  650 A from 20 to 100ms |
| Overload capacity for 1 hour | 220 kW |
| Overload capacity for 10 minutes | 250 kW |
| Overload capacity for 1 minute | 300 kW |

# External Maintenance Manual Bypass

The UPS Unit(s) will be ready to monitor the position of an external manual maintenance bypass. This information will be managed by the UPS system for safe operation and maintenance activities. Transfer from the bypass static switch to the manual maintenance bypass switch will be without power interruption.

# CONSTRUCTION SPECIFICATION

The entire UPS will not exceed 2200 mm height and 1000 mm depth. The manufacturer will provide the UPS width in accordance to here-in specified features and functionalities.

The UPS must have no requirement for rear and side rear clearance, allowing installation against a wall or back to back, with no detrimental impact to installation, operating and servicing.

* The power and control cables must be connected by the front.
* The cooling will be assured by forced ventilation: the air inlet will be on the front panel and the outlet vent will be at the top of the cabinet.
* Noise level will not exceed 75 dB(A), according to ISO 3746
* Maintenance operations will be carried out with front access only and the replacement of components for preventive maintenance will be easy to minimise the mean time to repair.
* The power module plug-in must be facilitated by an easy and safe handling without particular handling tool, all from the front
* AC input and output interconnections will be ensured by copper bars arranged in a way to avoid installation mistakes.

# USER INTERFACE, CONTROLS AND ALARMS

The user interface on the UPS Unit must have a touchscreen colour graphic display of at least 7” and must provide the following controls/alerts:

* Synoptic with power module, unit’s input/output state and energy flow representation;
* A USB port for updating language and downloading the event/alerts log;
* Display of the following parameters:

input and output voltages, currents and frequencies;

battery voltage;

battery charge / discharge current;

apparent and active power;

output load rate.

* Three-colour backlighted slots number giving instantaneous view of the module presence and status

In the event of a parallel configuration, displays must support the configuration of the entire system and provide measurements, events and alarm data of the concerned module or for the entire system.

With its dedicated input terminal blocks, the system will be able to manage the following external devices/signals:

* External Emergency stop in order to activate following functions :
  + UPS stop and separation by opening the inverter downstream contactor
  + Static by-pass stop
  + Battery protection tripping (if equipped with a trigger device)
* Genset, with the option to inhibit battery recharge;
* Battery protection (open/closed), taking into account the status on the display;
* Battery temperature, to display on the screen and manage the battery charge;
* External maintenance bypass (open/closed), to secure manual and automatic operations ;
* Report the upstream backfeed isolation device position;
* Trigger the upstream backfeed isolation device if a fault is detected

The system will provide an alarm synthesis of any faults that could appear on the UPS unit (general alarm). The following interfaces could be supplied with the UPS or installed later:

* Ethernet connection card – compliant with the OWASP security recommendation / ISO27002:2013 standard - supporting the following communication protocols:

SNMP v1 / v3,

HTTP(s) (web page),

SMTP/TLS (secured email alerts),

* MODBUS over TCP-IDA / PROFIBUS / PROFINET / BACnet
* RS485 serial communication cards;
* In/Out programmable card, with at least 3 inputs and 4 outputs (VFC) by card;

Card programming must allow affecting to each output a state or an alarm available inside the system.

* Remote display - touchscreen colour graphic display of at least 7”;

# FACTORY TESTING AND INSPECTION

The supplier of the equipment must be able to offer factory acceptance tests which may be witnessed by the customer.

All tests will be carried out with appropriate measuring instruments, their accuracy demonstrated by a certificate of calibration.

Following the positive outcome of the test procedure, the manufacturer shall prepare a certificate listing the tests performed and the results obtained.

# COMMISSIONING

After installing the equipment (the complete system and the power modules required at the beginning) and its power supply, commissioning will be carried out by technicians trained and certified by the UPS manufacturer.

The following steps must be performed on the supplied equipment:

* Visual inspection of the equipment,
* Check electrical and mechanical connections,
* Functional and operational tests,
* Full Load-testing using heat-run test functionality, avoiding the use of a dummy load test bench,
* Install and verify the transfer of data to the supervision station
* Basic training for system users: \* General description of how to use the system

\* Instructions on use and maintenance

At the end of the commissioning procedure, the technician will create a full report on the undertaken work.

# MAINTENANCE AND SERVICE

The UPS manufacturer must be able to ensure the maintenance of the installed equipment, by means of a maintenance contract. This should be done by technicians trained and certified by the manufacturer of the equipment. The manufacturer must be able to provide a remote monitoring and diagnostic service 24/7/365. The remote connection shall be secured and use specific proxy server account, managed by local IT department. Remote controls and parameter modification shall not be possible.

The UPS manufacturer will quote a spare module, allowing fast and secured 1rst fix time rate. To avoid accelerated capacitors ageing, the module shall always be supplied through a three-phase auxiliary power supply, rated for 3x63 A.