# Power Supply Station (PSS) for MV Switching Substation

This global standard defines the characteristics of the Power Supply Station (PSS) for auxiliary DC power source in the MV Switching Substation (e. g. EasySAT)

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# 1 ACRONYMS

a. **AC** Alternating Current

b. **AGM** Absorbed Glass Mat

c. **DC** Direct Current

d. **EMC** Electromagnetic Compatibility

e. **F** Frequency

f. **GS** Enel Global Standard

g. **In** Nominal current

h. **Indc** Nominal current (Direct Current)

i. **LAN** Local Area Network

j. **PSC** Power switchgear and controlgear assembly

k. **PSS** Power Supply Station

l. **RD1/RD2** Rectifier n°1/2

m. **TCA** Technical Conformity Assessment

n. **THD** Total Harmonic Distortion

o. **Vel** Nominal voltage of battery element

p. **VnAC** Nominal Voltage

q. **VnDC** Nominal Voltage (Direct Current)

r. **Vnc** Nominal Voltage charged

s. **Vncm** Nominal Voltage maintenance charge

t. **VRLA** Valve-Regulated Lead-Acid battery

## 2 LIST OF COMPONENTS, PRODUCT FAMILY OR SOLUTIONS TO WHICH THE GS APPLIES

The Power supply station (PSS) described in this GS can be classified in the product family provided in Table 1.

**Table 1 – GSTZ10X product family and description**

| GSTZ10X type | Product family code | Description |
|---|---|---|
| GSTZ101 | GSTZ10X | Power Supply Station (PSS) for auxiliary DC power source in the MV Switching Substation (e. g. EasySAT). |
| GSTZ102 | GSTZ10X | Power switchgear and controlgear assembly (PSC) for auxiliary DC and AC power source in the MV Switching Substation (e. g. EasySAT). |

# 3 NORMATIVE REFERENCES AND BIBLIOGRAPHY

All the references in this GS are intended in the last revision or amendment.

## 3.1 For all countries

| | |
|---|---|
| IEC 62485-2 | Safety requirements for secondary batteries and battery installations - Part 2: Stationary batteries |
| IEC 60068-2-1 | Environmental testing - Part 2-1: Tests - Test A: Cold |
| IEC 60068-2-14 | Environmental testing - Part 2-14: Tests - Test N: Change of temperature |
| IEC 60068-2-2 | Environmental testing - Part 2-2: Tests - Test B: Dry heat |
| IEC 60068-2-30 | Environmental testing - Part 2-30: Tests - Test Db: Damp heat, cyclic (12 h + 12 h cycle) |
| IEC 60068-2-78 | Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state |
| IEC 60068-3-1 | Environmental testing - Part 3-1: Supporting documentation and guidance - Cold and dry heat tests |
| IEC 60068-3-4 | Environmental testing - Part 3-4: Supporting documentation and guidance - Damp heat tests |
| IEC 60146-1-1 | Semiconductor converters - General requirements and line commutated converters - Part 1-1: Specification of basic requirements |
| IEC 60146-1-3 | Semiconductor convertors - General requirements and line commutated convertors - Part 1-3: Transformers and reactors |
| IEC 60204-1 | Safety of machinery - Electrical equipment of machines - Part 1: General requirements |
| IEC 60255-26 | Measuring relays and protection equipment - Part 26: Electromagnetic compatibility requirements |
| IEC 60255-27 | Measuring relays and protection equipment - Part 27: Product safety requirements |
| IEC 60255-5 | Electrical Relays - Part 5: Insulation coordination for measuring relays and protection equipment - Requirements and tests |
| IEC 60309-1 | Plugs, socket-outlets and couplers for industrial purposes - Part 1: General requirements |
| IEC 60309-2 | Plugs, socket-outlets and couplers for industrial purposes - Part 2: Dimensional interchangeability requirements for pin and contact-tube accessories |
| IEC 60384-1 | Fixed capacitors for use in electronic equipment - Part 1: Generic specification |
| IEC 60384-4 | Fixed capacitors for use in electronic equipment - Part 14: Sectional specification - Fixed capacitors for electromagnetic interference suppression and connection to the supply mains |
| IEC 60529 | Degrees of protection provided by enclosures (IP Code) |
| IEC 60896 | Stationary lead-acid batteries |
| IEC 60947-1 | Low-voltage switchgear and control gear - Part 1: General rules |
| IEC 60947-2 | Low-voltage switchgear and control gear - Part 2: Circuit-breakers |
| IEC 60947-3 | Low-voltage switchgear and control gear - Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units |
| IEC 60947-4-1 | Low-voltage switchgear and control gear - Part 4-1: Contactors and motor-starters - Electromechanical contactors and motor-starters |

| | |
|---|---|
| IEC 61010-1 | Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements |
| IEC 61056 | General purpose lead-acid batteries (valve-regulated types) |
| IEC 61204-6 | Low-voltage power supplies, DC output - Part 6: Requirements for low-voltage power supplies of assessed performance |
| IEC 61204-7 | Low-voltage switch mode power supplies - Part 7: Safety requirements |
| IEC 61810-1 | Electromechanical elementary relays - Part 1: General and safety requirements |
| IEC 61810-2 | Electromechanical elementary relays - Part 2: Reliability |
| IEC 61810-7 | Electromechanical elementary relays - Part 7: Test and measurement procedures |
| IEC 62477-1 | Safety requirements for power electronic converter systems and equipment - Part 1 |
| IEC 61000-4-3 | Electromagnetic compatibility (EMC) - Part 4-3 : Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test |
| IEC 61000-4-4 | Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test |
| IEC 61000-4-5 | Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test |
| IEC 61000-4-6 | Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields |
| IEC 61000-4-8 | Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test |
| IEC 61000-4-10 | Electromagnetic compatibility (EMC) - Part 4-10: Testing and measurement techniques - Damped oscillatory magnetic field immunity test |
| IEC 61000-4-11 | Electromagnetic compatibility (EMC) - Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests |
| IEC 61000-4-12 | Electromagnetic Compatibility (EMC) - Part 4-12: Testing and measurement techniques - Ring wave immunity test |
| IEC 61000-4-16 | Electromagnetic compatibility (EMC) - Part 4-16: Testing and measurement techniques - Test for immunity to conducted, common mode disturbances in the frequency range 0 Hz to 150 kHz |
| IEC 61000-4-29 | Electromagnetic compatibility (EMC) - Part 4-29: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations on DC input power port immunity tests |
| IEC 61000-6-5 | Electromagnetic compatibility (EMC) - Part 6-5: Generic standards - Immunity for equipment used in power station and substation environment |
| IEC 61000-6-4 | Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments |
| IEC 62271-207 | High-voltage switchgear and controlgear - Part 207: Seismic qualification for gas-insulated switchgear assemblies for rated voltages above 52 kV |
| IEC TS 60815-1 | Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 1: Definitions, information and general principles |
| ISO 2081 | Metallic and other inorganic coatings - Electroplated coatings of zinc with supplementary treatments on iron or steel |
| GSCG002 | Technical Conformity Assessment |
| GSTX001 | Quality Control Activities – Contractual requirements for Automatic Test Systems (ATS) |
| GSTZ102 | Power switchgear and controlgear assembly (PSC) for MV Switching Substation |

| | |
|---|---|
| GSTZ101_A1 | Electrical Diagrams for the Power Supply Station (PSS) for MV Switching Substation |
| GSTZ102_A1 | Electrical Diagrams for the Power switchgear and controlgear assembly (PSC) for MV Switching Substation |

## 3.2 For EU countries

| | |
|---|---|
| EN 55011 | Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement |
| EN 50178 | Electronic equipment for use in power installations |
| EU directive 2006/95/CEE | Low Voltage directive |
| EU directive 93/68/CEE | CE marking directive |

## 3.3 For Colombia

| | |
|---|---|
| NSR-10 | Reglamento colombiano de construcción sismo resistente |
| RETIE | Reglamento técnico de instalaciones eléctricas |

## 3.4 For Brazil

| | |
|---|---|
| NR-10 | Segurança em instalações e serviços em eletricidade |
| NBR-5410 | Instalações Elétricas de Baixa Tensão |

## 3.5 For Chile

| | |
|---|---|
| ETGI-1020 | Especificaciones técnicas generales - Requisitos de diseño sísmico para equipo electrico |

## 4 REPLACED STANDARDS

| | |
|---|---|
| DV1775A3 | Stazione di Alimentazione per Quadri Servizi Ausiliari |

# 5 APPLICATION FIELDS

This document standardizes the functional, construction and testing requirements of the Power Supply Station (PSS) for auxiliary DC power source in the MV Switching Substation (e. g. EasySAT).

The auxiliary DC power source fed fault detection devices, breakers, RTU and other critical devices in the substation, for that reason it must be redundant to assure the adequate reliability. The PSS assures a reliable supply to auxiliary equipment and consists of batteries, rectifiers, distribution system, switching and protective devices and additional monitoring equipment.

This device work in conjunction with the power switchgear and controlgear assembly (PSC) defined in the GSTZ102. For the electrical diagrams, refer to GSTZ101_A1 and GSTZ102_A2

# 6 MAIN REQUIREMENTS

The PSS must fed the auxiliary services of the MV switching substation with the VnDC = 24Vdc and also guarantee the recharging and maintenance of a VRLA batteries pack

The PSS is divided into the following types:

**Table 2 – PSS type**

| Type | VnAC | F | DC level |
|---|---|---|---|
| GSTZ101-A1 | 400/230Vac ± 20% | 50 Hz ± 5% | 24Vdc ±20% |
| GSTZ101-A2 | | | |
| GSTZ101-A3 | | | |
| GSTZ101-B1 | 380/220Vac ± 20% | | |
| GSTZ101-C1 | 380/220Vac ± 20% | 60 Hz ± 5% | |
| GSTZ101-C2 | 220/127Vac ± 20% | | |
| GSTZ101-C3 | 208/120Vac ± 20% | | |

The sign plate must be written in the local language of the destination Countries (chapter 8.2).

The PSS is made up of individual modules whose technical characteristics are described in the following chapters. The manufacturer, on the basis of his experience and construction technology, can propose technical solutions that combine more than one typology in a PSS, always maintaining the functional specifications foreseen by this document and respecting the voltage levels indicated.

The supplier, based on its technology, can provide its proposal which must be approved by enel.

Auxiliary Power depends from installation site: during the procurement process, the information about the operating conditions will be shared. (Par. 8.2).

The two single-phase rectifiers must be connected to the power source with the following configuration according to the voltage level and frequency:

**Table 3 – Power Supply Connections**

| Power Supply | Breaker IC1 | Breaker IC2 |
|---|---|---|
| 380/220Vac ± 20% | L1-N | L2-N |
| 400/230Vac - ± 10% | L1-N | L2-N |
| 220/127Vac ± 20% | L1-L2 | L2-L3 |
| 208/120Vac ± 20% | L1-L2 | L2-L3 |

The PSS must be able to start and operate correctly even without a battery or with the battery completely discharge (in this condition it must be able to recharge the batteries).

AC source over range:

a. Continue: 1.2Vn;

b. Transient [1s]: 2Vn.

The values refer to the maximum rated voltage applicable in AC. The maximum applicable rated value means Vac + 20% in continue mode and Vac + 50% in transient mode.

The PSS configuration is in a rack, containing:

a. two AC/DC single-phase rectifiers;

b. a distribution, supervision and communication unit;

c. two temperature probes that detect the ambient temperature (probe n°1) and the temperature of the batteries (probe n°2);

d. the battery pack.

The battery pack contains two 12V 150Ah VRLA, by according to the IEC 60896-21 and the IEC 60896-22; each battery must be front access with dimension L ≤ 562 mm, W ≤ 127 mm and H ≤ 284 mm.

Enel GS (if available) or local standard subordinately should be used to purchase these batteries that have normally an own specification process, this GS recall the main characteristics only for interoperability needs.

Figure 1 shows the functional diagram and Figure 2 shows the illustrative diagram of the auxiliary services power system.

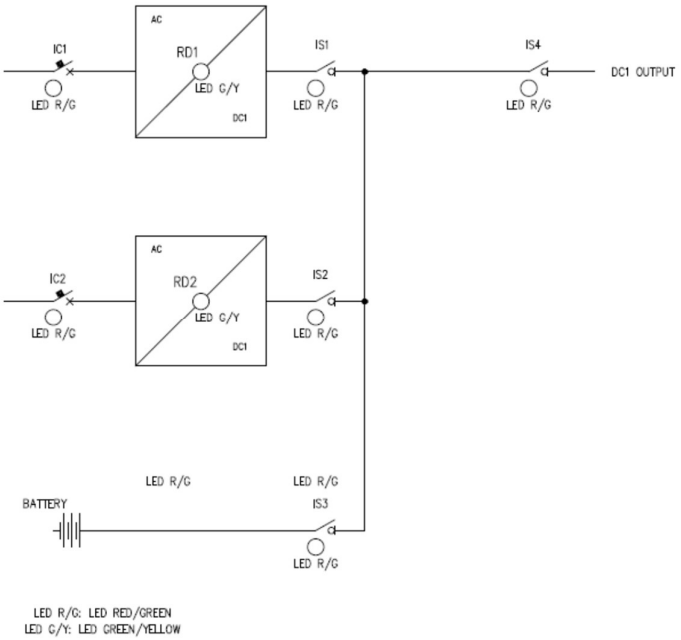


**Figure 1 - Functional diagram**

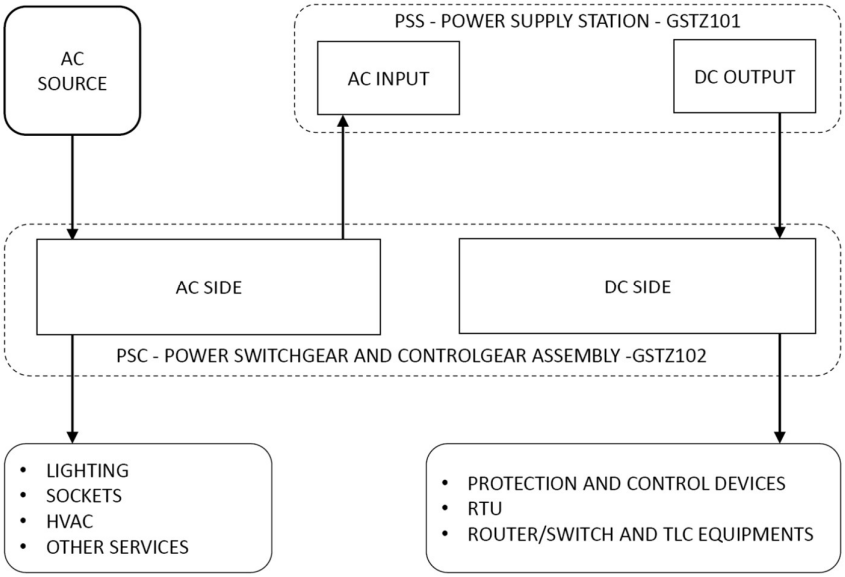


**Figure 2 – Illustrative Diagram**

The operation of the PSS must be supervised and managed by a microprocessor that makes the diagnosis of the rectifiers and the batteries pack as well as of the measurements of current, voltage and temperature.

It must be possible to set:

a. the number of elements of the batteries pack

b. the voltage of the single battery element

c. the type of the batteries.

Depending on the number and type of connected batteries, the PSS must automatically set itself to the voltage values described below for the maintenance charge and for the recharge.

The batteries pack must be able to supply auxiliary services with the following conditions:

a. Absence of AC power supply to the PSS

b. Rectifiers failure

c. Insertion of transient or starting loads.

All supervision and control circuits including the microprocessors must be located in the distribution, supervision and communication unit.

## 6.1 Operation and commissioning

As already indicated, the PSS must be installed in MV switching substations and must guarantee the supply of all the DC services of the substation.

For this reason, the operation of the PSS described in the following chapters must be guaranteed even in the case of non-normal situations, for example failure of part of the internal components or absence of an external network VnAC.

The supplier must implement all the necessary actions to allow continuity of the service in the event of an anomaly of one of the components without the manual intervention of personnel on site.

The supplier must provide a "First Start-up Procedure" which describes in detail each action to be performed for the complete commissioning of the PSS; in particular for each action it is necessary to indicate:

a. Initial situation of the action

b. Action to be performed by the operator

c. Effect of the action of the operator (for example LED lighting or display message)

d. Any waiting times between the passage of one action to the next

At the end of the "First Start-up Procedure" the PSS must not present any anomalies and must be able to function correctly on the basis of what is prescribed in this functional specification.

**In the event that the First Start-up Procedure is not respected, the PSS must not present hardware failures or breakages of the internal components**.

The PSS First Start-up Procedure must be written in local language (see chapter 8.2), as well as in the use and maintenance documentation supplied with the PSS, also on a separate plate positioned on the front or inside the PSS itself, in order to facilitate personnel intervention.

Furthermore, in the following cases the PSS must be able to correctly resume operation without any intervention in praise by personnel:

a. Return of the power supply VnAC with batteries in normal state and regularly connected to the PSS

b. Return of the power supply VnAC with inefficient batteries and regularly connected to the PSS.

In the second case, when the service is resumed, the PSS must privilege the DC services by limiting the supply of current to the batteries (with residual battery voltage $\geq$80% of DC).

The supplier, based on its technology, can provide its proposal which must be approved by Enel.

## 6.2 Operating conditions

Exact conditions depend from installation site, during the procurement process (Par. 8.2) the information about the operating conditions will be shared.

**Table 4 – PSS reference environmental conditions**

| PV-IES type | Operating range | On storage and transport range |
|---|---|---|
| Temperature | -25 °C ÷ 70 °C | -40 °C ÷ 80 °C |
| Humidity | 0 % ÷ 95% RH, non condensing | |
| Atmospheric pressure | 860 hPa ÷ 1060 hPa | |
| Altitude | 0 m ÷ 2700 m | |
| Pollution degree (IEC TS 60815-1) | Very Heavy | |
| Seismic qualification (IEC 62271-207) | AF5 response spectrum | |

With reference to the expected environmental conditions, is admitted:

a. Derating of the power supplied by the PSS components starting from 55 °C up to 70 °C with a linear reduction of the power supplied to reach a value> 50% at 70 °C. The manufacturer must submit a proposal, accompanied by the relative operating diagram which will be approved by Enel. This derating must not be applied to the DSU (Distribution, Supervision and Communication Unit), to the management, control, monitoring and measurement components which must be able to operate correctly for the entire temperature range indicated.

b. No derating is foreseen for temperature ranges below zero.
c. When normal conditions are restored, the PSS must return to normal operation in full power automatically, without personnel intervention.
d. The derating and the achievement of the temperatures that cause its activation must be signaled with a specific alarm.

The operating ranges are applicable at the PSS perimeter, the on storage and transport ranges must be applied at each PSS component.

The design and the characterization of the seismic protection of the PSS must be done using the AF5 response spectrum provided by the IEC 62271-207 usually adopted to qualify the high-voltage switchgear and control gear in seismic prone areas; the PSS must stay fully operative and maintaining the previous operating mode in continuity before, during and after the earthquake.

## 6.3 Environmental requirements

### 6.3.1 Rack

All the equipment that composed the PSS must be mounted on a rack 19” (by according to IEC 60297) with the follow dimensions and characteristic:

a. Height: Industry standard rack cabinet 42U tall; internal rack unit ≥42U
b. Width: 600 mm,
c. Depth: 600 mm;
d. The PSS must guarantee IP3X while maintaining natural ventilation. Cooling grids on the sides are not allowed because the PSS must be mounted next to other protection cabinets. The PSS must have a rubber profile around the perimeter of the side panels, the ceiling and the cabinet door to prevent the entry of dust;
e. IK code resistance to shocks (by according to IEC 62262): IK08;

The rack must be entirely of sheet steel press-folded 20/10 mm thick. The external coating must be made to obtain excellent resistance to wear according to the following cycle:

a. sheet washing;
b. phosphating based on non-crystalline iron salts (amorphous);
c. drying in tunnel at 100 ° C;
d. internal and external painting with electrostatic application of enamel in thermosetting powder with epoxy-polyester binders, RAL 7032 color, total thickness 70 µm.
e. Polymerization in oven at 180 ° C.

The part dedicated to the battery must be subjected to antacid and anticorrosive treatment.

The access at the elements of the PSS must be only on the front and no access from the rear side is allowed as the PSS can be mounted on the wall.

The rack 19” must also be divided in 2 parts:

a. Upper part, where all the components of the PSS will be mounted;
b. Bottom part, where the batteries will be mounted in a compartment segregated from the rest of the PSS.

The part dedicated to the assembly of the batteries must have correct ventilation (aeration grill with a degree of protection IP 30) and suitable shelves.

The rack, without sheet metal on the bottom, must have on the base n° 4 holes ø12 for fixing to the floor and n° 4 removable eyebolts on the upper frame. The sides of the cabinets must not have protrusions.

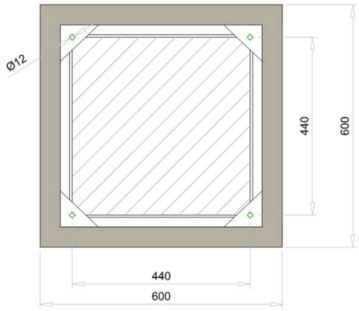


**Figure 3 - Holes on the base**

The protection against direct contacts of dangerous internal parts during maintenance or updating must be performed; where not possible the supplier must provide for the isolation of all the active parts.

The input of the electric connection cables is in the lower part, therefore it is necessary to provide a dedicated and segregated path from the batteries (for examples with 100x60 cable ways mounted on the sides of the rack). Due to the connection of cables through the floor, the PSS must have a seals system that prevents access to the rats.

With reference to the layout of rack, Enel must previously approve any solution.

An example of the layout is shown in the following figure:

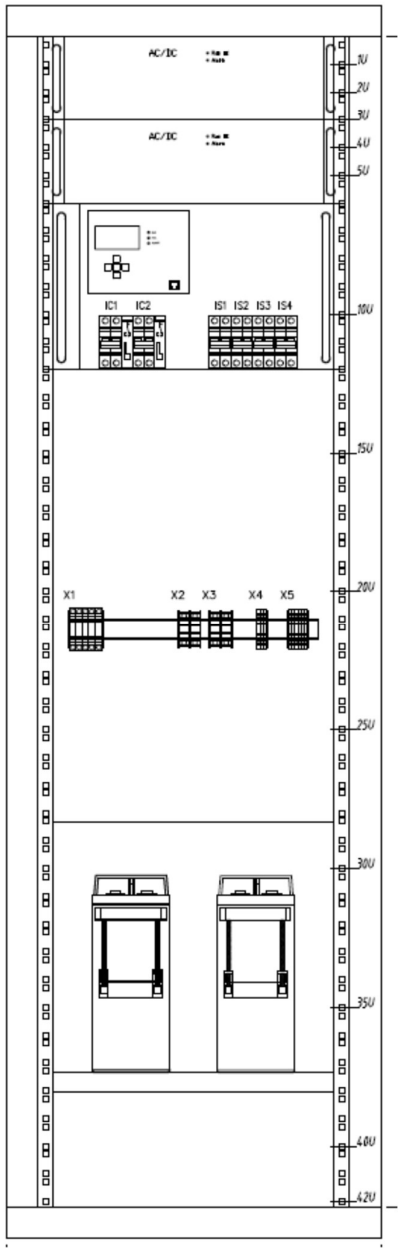


**Figure 4 - Rack 19" example layout**

**The layout is indicative: The supplier, based on its technology, can provide its proposal which must be approved by Enel**

### 6.3.2 Enclosures

Rectifiers and distribution and supervision unit must be contained in a separated enclosure, closed on all sides and suitable for mounting on a standard 19" rack frame unit. Each enclosure must be fixed to the 19" rack frame by four screws on the front panel; to facilitate assembly and disassembly operations two aluminum or steel handles must be fitted on the front of the box, in an appropriate position; plastic handles are not allowed.

Ventilation slots are only allowed in the lower and upper part. The heatsinks must be aluminum and preferably placed in the rear part; it is also possible to install dispersing surfaces on the side of the enclosures.

With reference to the rack layout, any solution must be previously approved by Enel and must provide the study of the thermal flows that are established inside and outside the various enclosures.

The enclosures must be galvanized steel according to the ISO 2081 standard with a thickness ≥ 1 mm or of an equivalent material in terms of EMC, mechanical stiffness (metalized plastic is not acceptable) and oxidation protection. The internal and external painting must be performed with electrostatic application of enamel in thermosetting powder with epoxy-polyester binders, RAL 7032 color, and total thickness 70 µm.

The supplier may propose its own technical solution for each type of module; the technical solution must be previously submitted to the Enel technical evaluation which will approve its use if deemed suitable

## 6.4 Electrical characteristics

### 6.4.1 Electrical Diagram

The wiring diagram GSTZ101_A1 attached to this GS is only indicative and has the purpose of illustrating the structure of the PSS.

The manufacturer must supply all the equipment and components indicated in this document.

### 6.4.2 Protection against transient overvoltage

The PSS must be installed in MV switching substations and therefore it is necessary to provide protection against transitory overvoltages.

This protection can be performed through the use of an isolation transformer or an SPD device.

The supplier must propose its own technical solution which must be submitted to Enel's technical evaluation which will approve its use if deemed suitable.

### 6.4.3 Electrical connections

The electrical connections can be positioned both on the front and on the rear side of the boxes: in this case, quick-fit connectors must be chosen due to guarantee a secure electrical connection.

The electrical connections must have the following characteristics:

**Table 5 - Characteristics of the electrical connections**

| Type of circuit | Phase | Color | Section |
|---|---|---|---|
| AC power circuits | L1 | | ≥ 6 $mm^2$ |
| | L2 | | ≥ 6 $mm^2$ |
| | L3 | | ≥ 6 $mm^2$ |
| | N | | ≥ 6 $mm^2$ |
| DC power circuits | + | | ≥ 10 $mm^2$ |
| | - | | ≥ 10 $mm^2$ |
| Auxiliary connections | | | ≥ 1,5 $mm^2$ |
| Ground connections | | | ≥ 4 $mm^2$ |
| LAN connections | | | ≥ 0,75 $mm^2$ |

The colors of the cables (phase, neutral, DC +, DC-, auxiliary and ground connections) will be shared during the procurement process. (Par. 8.2).

### 6.4.4 Circuit Breaker and switch-disconnector

The circuit-breakers must comply with the IEC 60947-1, IEC 60947-2 standards, for use in alternating current for IC1 and IC2 and for use in direct current for all the others.

The switch-disconnectors must comply with the IEC 60947-3 standard, for non-automatic direct current applications.

On the basis of its evaluations and the executive project, the manufacturer must verify the most suitable characteristics of the components to be used and submit the solution to Enel that will decide on the admissibility. In any case, the manufacturer must provide for the use of switches and disconnectors to guarantee protection intervention and an untimely non-intervention on the energy transients.

**Table 6 – Circuit breaker (IC) and switches (IS)**

| Acronym | Description | Aux contact | Vn [V] | In [A] | Caract. | Poles | Icn [Ka] | Icu [Ka] |
|---|---|---|---|---|---|---|---|---|
| IC1 | Input Rectifier 1 | X | 400 | 10 | Z | 2P | 10 | 10 |
| IC2 | Input Rectifier 2 | X | 400 | 10 | Z | 2P | 10 | 10 |
| IS1 | Output Rectifier 1 | | 400 | 32 | | 2P | | |
| IS2 | Output Rectifier 2 | | 400 | 32 | | 2P | | |
| IS3 | Battery | | 400 | 32 | | 2P | | |
| IS4 | 24Vdc | | 400 | 32 | | 2P | | |

### 6.4.5 Terminal Boards

The terminal board must be mounted in an accessible position and must be easily identified.

The sequence of the six terminal boards is not mandatory and it is possible to use clamps screw-type, spring-type or push in-type, according to the indications of each Country; during the procurement process, the information about the terminal boards will be shared. (Par.8.2).

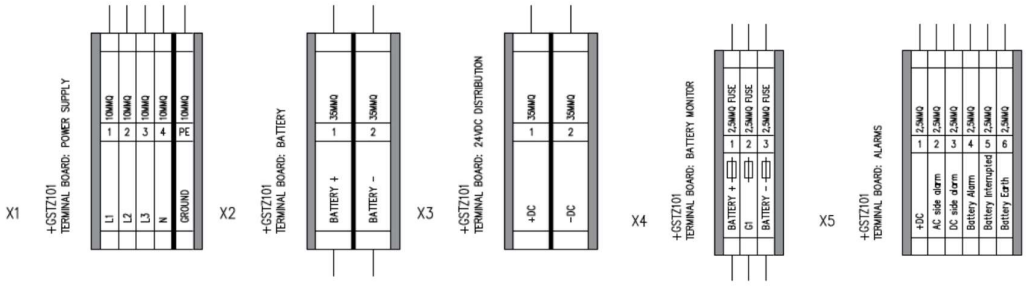


**Figure 5 - Terminal Boards**

## 6.5 Converter requirements

The technical characteristics of each rectifier are in Table 7.

| **Table 7 – Rectifier AC/DC** | | |
|---|---|---|
| **AC INPUT** | | |
| Description | Symbol | Value |
| Nominal Voltage | VnAC | Table 2 |
| Total Harmonic Distortion (current) | THDi | < 3% |
| Power factor at maximum load | cosφ | > 0,99 |
| Inrush current | | ≤ 2 In |
| Protection | | Fuse, Varistor,<br>$V_{AC}$ out of range (block with automatic reset) |
| **DC OUTPUT** | | |
| Description | Symbol | Value |
| Nominal Voltage | VnDC | 24Vdc |
| Adjustment range | ΔVnDC | 21 ÷33Vdc |
| Nominal Current | Indc | 25 A |
| Permanent overload | | 105 % |
| Stating regulation | | ≤ 0,5 % |
| Dynamic regulation | | ≤ 5 % |
| Polarity grounded | | ---- |
| Ripple | | ≤ 20 mV<br>≤ 2 mV psophometric (CCITT-A) |
| Yeld | η | ≥ 0,75 with load 25% |
| | | ≥ 0,85 with load 100% |
| Protection | | Overvoltage, Under voltage, Overload, Over temperature, output power limitation |
| Cooling | | Air natural |

The manufacturer must provide physical protection devices against polarity reversal on the battery connections and to the DC outputs.

The two single-phase rectifiers must be connected to the power source with the configuration according to the table Table 3.

The two AC / DC rectifiers must have identical characteristics and must operate:

a. contemporaneously with an automatic load distribution, so each rectifier is loaded with half of the total load required on the DC side, the maximum allowed difference between the two loads is 10%;

b. alternatively, one in operation and the second in hot stand-by, that means without serving any load, but able to serve the full load in 80 ms after the failure of the first one.

The choice between the two above modes must be made by the user through the supervision unit (par. 6.6), the default is the alternative mode. In case of alternative mode, the two rectifiers must be programmed to switched automatically every week in order to assure the same operational time for both; during the switching procedure, the output voltage quality and any other performances must remain inside the limits requested in this GS.

The supplier must propose an executive design to Enel, that will decide about the admissibility.

In case of failure of the control logic, the rectifier must in any case guarantee the maintenance charge with current limitation and maximum voltage control.

In the event of a short-circuit at the output terminals, each rectifier must limit the current supplied at its nominal value and must automatically reset when the short circuit is removed.

The two rectifiers must be able to access at the measurements of the two temperature probes that detect the ambient temperature (probe n°1), and the temperature of the battery (probe n°2).

Each rectifier must be controlled by the microprocessor to manage the various operating modes and redundancy in case of failure.

Each rectifier must be able to monitor measure and transmit the following electrical quantities to the supervision and control unit:

a. AC input voltage (VnAC);

b. AC input current (In);

c. DC output voltage (VnDC);

d. DC output current (Indc).

Each module must be equipped with output blocking diodes.

On the front of the unit must be mounted two LEDs for signaling:

a. Run OK (Green LED);

b. Rectifier Alarm (Red LED).

## 6.6 Distribution, Supervision and Communication Unit

This unit must guarantee the following functions:

a. Monitoring the power supply of 24Vdc;

b. Maintenance charge of the battery;

c. Recharge of the battery;

d. Monitor battery status (diagnostics)

e. Protection of the maximum and minimum AC voltage (ref. Table 8)

f. Protection of the maximum and minimum DC voltage (ref. Table 8)

g. Protection of the polarity earth (ref. Table 8)

h. Supervision and control of the PSS;

i. Alarm management of rectifiers

j. Position of circuit breaker signed with IC* (see Table 6) with auxiliary contact

**Any update, reset or modification of the parameters must not cause the PSS to switch off.**

On the front of the unit must be mounted:

a. Graphic LCD display with a resolution of four rows (as minimum). An energy saving function with configurable parameters must be provided. The expected service life of the display must be at least 105 h.

b. Navigation-selection buttons or rotary selector / confirmation, which allow the operator full access to the functions. They must be compliant with IK01 mechanical strength rating (solutions based on capsule or touch-screen technologies are precluded). The setting/configuration of the PSS must only be possible via software application running on a PC connected to the PSS.

As an alternative to the display and controls, it will be possible to use a touchscreen with a size of not less than 7 ". Through the touchscreen it must be possible to perform any measurement, functionality check, alarms and setup consultation provided in the document

a. Button for Alarm Rest

b. Button for Test Led

c. Button for recharge operating mode (Par. 6.7.2)

d. Ethernet 100 BASE-TX with an RJ45 connector (independently addressable at the MAC level) to facilitate the local configuration, including all the FW updates (Par. 6.6.1)

e. Ethernet 100 BASE-FX with a LC connector (independently addressable at the MAC level) available for remote connection to the substation LAN.

f. Three LEDs for signaling:

- Run OK (Green LED)
- PSS Alarm (Red LED)
- Battery Alarm (Red LED )

g. Two aluminum or steel handles

h. Circuit breaker as follow:

**Table 8 – Protections**

| Type | Vn | Range | Delay Time | Default Settings |
|---|---|---|---|---|
| IEEE 59 (59-AC) | Table 2 | (1÷1,4)Vn step 0,1Vn | (0,05÷5)s step 0,05s | 1,2Vn / 1s |
| IEEE 27 (27-AC) | Table 2 | (0,7÷1)Vn step 0,1Vn | (0,05÷5)s step 0,05s | 0,8Vn / 1s |
| IEEE 59 (59-DC) | 24Vdc | (1÷1,4)Vn step 0,05Vn | (0,05÷5)s step 0,05s | 1,1Vn / 1s |
| IEEE 27 (27-DC) | 24Vdc | (0,7÷1)Vn step 0,05Vn | (0,05÷5)s step 0,05s | 0,9Vn / 1s |
| IEEE 64 (64-DC) On DC output bus | 24Vdc | (10-400kΩ) step di 5kΩ | (0,05÷5)s step 0,05s | 180 kΩ / 1 s |

Each functions are enabled by default; it must be able to be excluded from software configuration.

***Security by design is mandatory for any devices developed to be installed in the ENEL premises; the Enel requirements will be declared during the procurement process (par. 8.2).***

### 6.6.1 Interface for Local Connection and Configuration

The PSS must have an Ethernet 100 BASE-TX with an RJ45 connector on the front to facilitate the local configuration, including all the FW updates of the boards (for all components of the PSS). The local maintenance interface is Ethernet native so serial/Ethernet adapters/ converters are not allowed.

The PSS must have a second Ethernet 100 BASE-FX with a LC connector available for connection to the substation LAN.

The software application must be compatible with the operating system homologated in ENEL at the procurement time (Par. 8.2).

The software must not require user license and must have two level passwords: one for visualization and one for configuration.

Security by design is mandatory for any devices developed to be installed in the ENEL premises; the Enel requirements will be declared during the procurement process (par. 8.2).

### 6.6.2 Requirements for the Communication

The communication unit must natively support both Internet Protocol IPV4 and IPV6.

The PSS must have, at the same time but on different Ethernet interfaces:

a. A static IP address (192.168.1.1) for local connection, not associated with any gateway;

b. An additional IP address that can be configured as static

Therefore, the operator (with the local configuration SW) has to configure the following fields:

a. PSS IP address, if static,

b. Subnet mask,

c. Default gateway.

The following services must be available:

a. WEB server,

b. NTP client,

c. SSH server,

d. SNMP server,

e. SFTP server

The Ethernet 100 BASE-FX to the LAN substation can be used for the following communication protocols:

a. Slave DNP 3.0 TCP

b. Slave modbus TCP

c. prepared for IEC 61850 Server.

For DNP 3.0 TCP and modbus TCP protocols it must be possible to configure the basic link parameters and all the signals, states, measurements and alarms of the PSS.

### 6.6.3 Alarms and Signals

The DSU must control the operation of the PSS, manage the alarms and HW redundancies in order to ensure the operation of the PSS in the event of failure of one of the component modules.

A register with non-volatile memory must be provided for storing at least 500 sequences of events. The stored events must be visible on the display, exported to a PC, and saved in txt or cvs format.

The file structure must be implemented as follows:

a. name event_hour: minutes: seconds_day. month. year

The station must have five dry contacts connected to a dedicated terminal board (X5) with the following characteristics (Vn = 24 VDC; L / R = 40ms; 0.5A):

**Table 9 - Alarms**

| Relay | Description | Causes of anomalies |
|---|---|---|
| K1 | AC side PSS alarm | - No Power Supply<br>- Phase-to-phase overvoltage protection function IEEE 59 (59-AC)<br>- Phase-to-phase under voltage protection function IEEE 27 (27-AC)<br>- Absence of power supply or fault of logic control |
| K2 | DC side PSS alarm | - Fault of rectifier<br>- 24Vdc overvoltage protection function IEEE 59 (59-DC)<br>- 24Vdc under voltage protection function IEEE 27 (27-DC)<br>- Intervention of a protection indicated in Table 7 (AC Input and DC Output)<br>- Max DC Voltage in recharging mode<br>- Min or Max DC Voltage in maintenance charge mode<br>- Max time of charging<br>- Lack of power supply or fault of logic control<br>- derating |
| K3 | Battery Alarm | - minimum battery capacity<br>- Low DC Battery<br>- Over temperature battery pack |
| K4 | Battery Interrupted | - Battery interrupted (Par.6.6.4) |

| | | |
|---|---|---|
| K5 | Polarity Earth | - Polarity Earth function IEEE 64 |

In presence of anomaly, it must be possible via PC to disable the alarm, even if the fault is not repaired.

This eventuality is necessary to avoid that a second alarm of the same type is not reported.

For example, in case of failure of the rectifier RD1 and the replacement is not immediately possible, the PSS can continue to operate with relative alarm disabled. In this way, the next alarm of the RD2 is visible again.

### 6.6.4 Battery management

The state of charge of the battery must be entirely managed by microprocessor.

The battery management must follow the requirement from the IEC 60896-21 and the IEC 60896-22.

The power supply station must provide a diagnosis of the charge and efficiency status of the battery pack

The supplier must propose an implementation of the requested function to Enel that will decide about the admissibility.

The selection of the state of charge of the battery must be implemented according to the following logic:

a. The maintenance status is the initial setup of the PSS. Depending on the current absorbed by the battery, the control unit determines the possible change of state from maintenance to recharge;

b. The current that determines the passage from maintenance to recharge must be able to be set in the range 0.02-0.08 $C_{10}$ (step of 0.01) with default equal to 0.04 $C_{10}$;

c. During the recharging phases the PSS must be able to measure the recharge time and the current that has been absorbed by the battery in order to estimate the Ah supplied to the battery and the state of charge of the battery;

d. The transition from the recharging state to the maintenance state must be set in the range of 0.01-0.04 $C_{10}$ (step of 0.01) with a default of 0.03 $C_{10}$.

The continuity in battery internal/external connection must be monitored by measuring:

a. the current supplied by the battery;

b. the voltage between the positive and negative poles and an intermediate measurement named “G1”.

Some continuity interruption in the batteries connection may not be detected if the current from the batteries is too small; in order to detect such situations a possible procedure is:

a. regulate the output voltage of the acting converters to 19 Vdc;

b. it is expected that the batteries voltages is more of 19 Vdc, so the batteries will start to feed the load;

c. if possible continuity interruption will rise (because of the current), they will be detected and the converter will be ready to feed the loads;

d. in case of problem detection alarms and warnings must be generated and treated (par. 6.6);

e. in any case, after this procedure the voltage from converters must return to nominal values.

Alternative procedures may be proposed by the supplier and they will be approved by Enel.

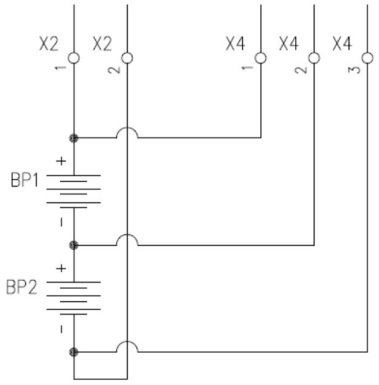


**Figure 6- X4 Terminal board connection for battery monitoring**

## 6.7 Operating modes

The output voltage values for the different operating modes must be programmable in the indicated ranges and show the default values provided for VRLA batteries.

### 6.7.1 "Maintenance charge" operating mode

The PSS can remain in this state for an indefinite time according to what is established by the control logic.

The voltage to be applied at the batteries will be determined according to the type and temperature of the battery pack.

### 6.7.2 "Recharge" operating mode

The recharge is carried out in two phases:

a. First phase with constant current: 0.25 C10 and increasing voltage up to 2.35V / elem.

b. Second phase at constant voltage 2.35V/elem and decreasing current

The charging curve must be able to be programmed differently from the default parameters shown above by a PC.

The duration of the charge must not exceed 12 hours.

It must be possible to charge the battery with a manual command (button in front of the panel) or by PC.

## 6.8 Safety considerations

With reference to safety issues, when applicable, the provision from IEC 62485 series, IEC 61010-1, IEC 61508 series, IEC 62061 and IEC 62477 series must be respected. The candidate must also respect any additional safety requirement from other applicable standards recalled in this GS or from standard/law in force in the installation field.

# 7 TESTING AND CERTIFICATIONS

All the requirements from this chapter must be respected. ENEL has the right to ask a prototype for any kind of verification testing. These tests must be performed in the provider factory or third party laboratories (by according to ENEL or relevant standards provision), with no cost participation by ENEL.

The PSS will be subjected to an ENEL Technical Conformity Assessment (TCA) process, by according to GSCG002 that is intended to verify if the supplied device meets regulatory standards and specifications.

## 7.1 Overview Technical Conformity Assessment (TCA) Process

The information of this paragraph are only indicative and may change by according with ENEL TCA management; final TCA organization will be discussed during the TCA kick off meeting.

### 7.1.1 TCA documents

The ENEL technical organization unit in charge of the Technical Conformity Assessment of the PSS will supervise the technical documentation and the execution of the tests required to receive the “Statement of Conformity”, according to GSCG002 prescriptions.

All the technical documentation required during that process shall be in English or in the local language of ENEL technical organization unit in charge of the TCA.

The TCA documents that shall be delivered include:

a. Type A documentation (Not confidential documents used for product manufacturing and management from which it is possible to verify the product conformity to all technical specification requirements, directly or indirectly).

b. Type B documentation (Confidential documents used for product manufacturing and management where all product project details are described, in order to uniquely identify the product object of the TCA). This type of documentation must be delivered only to the ENEL technical organization unit in charge of the TCA

c. TCA dossier (Set of final documents delivered by the Supplier for the TCA) on digital support.

### 7.1.2 Quality

During the TCA, the supplier shall provide the technical documentation listed in ENEL Quality Specification for Electronic Assemblies during the procurement process (Par. 8.2) more information will be shared.

### 7.1.3 Safety warnings on Plate

The safety warnings required in the plate of the PSS and its components must be written in the local language of the destination Countries.

### 7.1.4 Tests required to complete the TCA

The manufacturer must have a valid and product specific homologation before he may supply PSS to ENEL. In compliance with this technical specification, the manufacturer must satisfactorily pass all the type tests described in the following sections.

Once these tests have been successfully completed, an approved manufacturer’s PSS will be subject to ad-hoc reception tests.

In addition, ENEL reserves the right to request the repetition of the type tests at any time to ensure that the PSS continue to meet the standards achieved by the initial testing and certification programs at the time the contact was awarded.

Type tests will be carried out in Official Laboratories or Laboratories recognized by ENEL, or in the workshops of the manufacturer. ENEL reserves the right to attend any or all of these tests and must be kept informed of the manufacturer’s testing programs, schedules and result.

The manufacturer will bear the cost for type tests and for pilot installation tests.

### 7.1.5 Type test list

a. Visual examination and control of geometric characteristics, It is mandatory to verify the absence of visible manufacturing defects, the highest build-quality and precision of manufacture, the compliance of the rack/box dimensions with those indicated in the present specification;

b. Verification of all functions,

c. Insulation tests,

d. Electromagnetic compatibility tests (ref. to par.7.1.7),

e. Mechanical compatibility tests (ref. Table 10),

f. Environmental compatibility tests (ref. Table 10),

g. Thermic operating tests:

The over temperature measurements must be carried out under thermic regime conditions with reference to the ambient temperature of 30° C and with the station in operation for at least 60 minutes.

The operating conditions of the rectifier must be the following:

a. Power supply: ref. to Table 2

b. Output DC: 24VDC 50A

The over temperature values measured at the thermic regime must be the following:

c. Core and winding transformers and inductances <65 ° C

d. Various components according to the limits guaranteed by the manufacturers

e. Environment inside the rack <45 ° C

The temperature inside the rack must be measured at 15 cm below the rack cover.

f. Stabilization limits tests:

The test of the stabilization limits must be carried out on the 24 VDC output with a load between 0 and 100%. The test must be performed without battery.

g. Noise level tests:

It must be verified that the noise level at a distance of 1 meter must be <60 dB.

h. Short Circuit tests:

The short-circuit test must be performed with the power supply station supplied in the reference conditions without battery.

The following short circuits must be performed:

- downstream of RD1 and RD2

The test is considered surpassed if no damage to any component occurs and the PSS resumes normal service.

i. Testing of the auxiliary control relays (making and breaking capacity) and signaling,

j. Power supply interruptions,

k. Influence of auxiliary voltage value,

l. Final verification of the PSS operation.

The supplier must retain all the documentation proving the successful results of the type tests and all data must be made available to ENEL in real time.

At ENEL's discretion, these tests may be completely or partially repeated during the lifetime of the contract as continuing evidence of type conformity.

### 7.1.6 Acceptance tests

Acceptance tests can be performed using specially designed automatic test systems (ATS). Each PSS must be accompanied by a report stating that all tests have been successfully completed.

The acceptance tests are those indicated in Par.7.1.5 Clause a, b, c and l; in particular, the following tests are scheduled:

a. Visual examination and control of geometric characteristics as indicated in the chapter 6.3.1;
b. Check the electrical connections and the composition of terminal blocks (chapter 6.4.5)
c. Check for signs of internal / external damage;
d. Check the " First start-up procedure" indicated by the supplier;
e. Test of the correspondence between switch position and LED signals;
f. Compliance of circuit breakers/components with the GS and manufacturer's documentation;
g. Regular indication of components;
h. Presence of all the advertising plates provided and the user manual in the local language
i. Switching on the PSS with the power supply;
j. Switching on the PSS with efficient battery (without VnAC power supply);
k. Data setting on the control panel;
l. Start-up of RD1 and RD2 rectifiers
m. Test of the operating logic of the Rd1 and RD2 rectifiers (alternative or in parallel)
n. Measurement of electrical input / output quantities on all components (RD1, RD2);
o. Current limitation test supplied by the rectifiers;
p. Discharge operation and mains power recovery;
q. Limitation test of the battery charge current value;
r. Thermal probe test;
s. Test of the stabilization limits RD1, RD2;
t. Measurement of the AC component on DC output on RD1and RD2;
u. Check the protections provided and tests on their operation (Table 8);
v. Check signals on Kx boards;
w. Test on display alarm signals;
x. Check closing of alarm contacts on terminal block;
y. Function test following VnAC failure with charged batteries connected;
z. Function test following VnAC failure with connected non-efficient batteries;
aa. Equipment energization test to check circuit-breaker features.

### 7.1.7 Type test levels

The test level for each requested environmental compatibility test and the relevant standard, where applicable, is shown in Table 10.

Furthermore the PSS must comply with the EMC standards IEC 61000-6-4 and IEC 61000-6-5.

**Table 10 - Tests Level**

| Type | Description | Test Level/Note | Standard |
|---|---|---|---|
| Insulation and EMC | Impulse withstand voltage | Overvoltage category IV | IEC 60664-1 |
| | Dielectric strength | Test Voltage = 2 kV for the circuits in AC. | IEC 60255-27 |
| | Insulation resistance | ≥100 MΩ a 500 $V_{DC}$ | IEC 60255-27 |
| | Electrostatic discharges | Contact discharge level 3<br>Air discharge level 3 | IEC 61000-4-2<br>IEC 60255-26 |
| | Ring wave | Test level 3 | IEC 61000-4-12 |
| | Damped oscillatory wave | Test level 3 | IEC 61000-4-18<br>IEC 60255-26 |
| | Electrical fast transient/burst | Test level 4 | IEC 61000-4-4<br>IEC 60255-26 |

| | | | | |
|---|---|---|---|---|
| | Voltage surges 1.2/50ms – Current surges 8/20ms | | Test level 3 | IEC 61000-4-5 |
| | Power frequency Magnetic field | | Test level 5 | IEC 61000-4-8 |
| | Damped oscillatory magnetic field | | Test level 5 | IEC 61000-4-10 |
| | Radiated, radio-frequency, electromagnetic field | | Test level 3 | IEC 61000-4-3<br>IEC 60255-26 |
| | Radiated, radio-frequency, electromagnetic field from digital radio telephones | | Test level 3 | |
| | Short interruptions on DC input power port | | level 0% t = 0,05 s | IEC 61000-4-29 |
| | Voltage dips on DC input power port | | level 50% t = 0,1 s | |
| | Voltage variations on DC input power port | | Un ± 20%; t = 10 s | |
| | Power frequency voltage | | Test level 3 | IEC 61000-4-16<br>IEC 60255-26 |
| | Conducted disturbances in the frequency range 0 Hz to 150 kHz | | Test level 3 | |
| | Conducted disturbances, induced by radio-frequency fields | | Test level 3 | IEC 61000-4-6<br>IEC 60255-26 |
| Environment | Non powered equipment | Dry heat | (+70 ± 2)°C; duration 16 hour | IEC 60068-2-2 |
| | | Damp heat | (40±2)°C; (93±3)% RH; duration 4 days | IEC 60068-2-78 |
| | | Cold | (-25 ± 3)°C; duration 16 hour | IEC 60068-2-1 |
| | | Change of temperature | TA = -25°C; TB =70°C; duration 3 hour + 3 hour | IEC 60068-2-14 |
| | Powered equipment | Dry heat | (+70 ± 2)°C; duration 16 h | IEC 60068-2-2 |
| | | Damp heat | (40±2)°C; (93±3)% RH; duration 4 days | IEC 60068-2-78 |
| | | Cold | (-25 ± 3)°C; duration 16 hour | IEC 60068-2-1 |
| | | Change of temperature | TA = -25°C; TB =70°C; duration 3 hour + 3 hour | IEC 60068-2-14 |
| Mechanical | Vibration immunity | | Inf. limit 10 Hz<br>Sup. limit 500 Hz<br>Acceleration 10 m/s$^2$<br>Displacement amplitude 0,075 mm | IEC 60068-2-6 |
| | Broadband random Vibrations | | | IEC 60068-2-64 |

## 7.2 Certifications and self-certifications

About the compliance of all the requirements/standards recalled in this GS, a certificate or self-certificate must be provided.

Regional laws or standards may requires additional certifications or self-certifications.

Certifications and self-certifications must be made according to the relevant standards or laws (including the template format).

# 8 MISCELLANEOUS

This chapter include further requirements, recommendations and additional information.

## 8.1 Required documentation

The following documents (in pdf format) must be provided:

a. PSS data sheet with layout and weight;
b. Installation, operation and maintenance manuals, with instructions on the installation and interfacing procedures;
c. List of pre-installation checks to ensure that the components have been delivered correctly;
d. Maintenance procedures;
e. Troubleshooting guide;
f. Quick installation and set-up guide;
g. Software need to operation;
h. Parts list;
i. Required but not included parts list;
j. Spare parts list;
k. Recommended Tool List;
l. One-wire diagrams (also in DWG/DXF formats);
m. Electrical diagrams (also in DWG/DXF formats);
n. Mechanical diagrams (also in DWG/DXF formats);
o. Component specification literature;
p. General description of functions, functional schema, wiring diagrams, power consumption requirements, etc.,
q. Detailed diagrams of the PSS,
r. Lists of references,
s. Exceptions to this specification,
t. Instructions for the installation, adjustment and commissioning of the PSS,
u. Examples of adjustment and configuration,
v. Instructions for checking and maintenance.

These documents must be made according to IEC 61010-1 and they must be approved by ENEL.

## 8.2 Clarification during procurement process

By summarizing, during the procurement process the following clarification will be provided to the supplier:

a. Auxiliary Power Supply (Table 2 – PSS type);
b. Clarification about operating conditions (Table 4);
c. Colors of the cables (Table 5);
d. Terminal boards type (par. 6.4.5);
e. Clarification about cybersecurity (par. 6.6);
f. Information about operating system homologated in ENEL (par. 6.6.1);
g. Language for embedded sw, documentations and label;
h. Details about unique serial identifier, serial code and other labeling.

## 8.3 Receipt of material

The information of this paragraph are only indicative and may change by according with ENEL product management; final procurement approach will be issued by entrusted ENEL units.

### 8.3.1 Reception tests

Part of the process of accepting delivery of a manufacturer's devices will include the proof of having successfully passed previously performed acceptance tests (Par.7.1.6).

Then, the reception tests will be carried out in Official Laboratories or Laboratories accredited by ENEL, or in the workshops of the manufacturer. ENEL reserves the right to attend any or all of these tests and must be kept informed of the manufacturer's testing programs, schedules and results. If the assistance of an ENEL representative is not available, the provisional reception procedure will be conducted when tests protocols are received.

In the event the documentation has undergone modifications with reference to the actual devices delivered, the manufacturer must provide the updated documentation before the reception procedure will be deemed to have been completed.

### 8.3.2 Warranty

The manufacturer will commit to providing a guarantee of the PSS for a minimum period of 24 months, which will commence immediately following a successful reception.

The guarantee will be legally binding for any device/component faults and/or defects that occur within the guarantee period: accordingly, the PSS and/or components will be replaced. Further, the manufacturer will undertake to continue, free of charge, the software and firmware development and provide the updates to ENEL for the lifetime of the devices.

If during the contract term the manufacturer fails to address in a prompt and timely manner any functional anomalies or defects in the device behavior or manufacture (hardware or firmware).

ENEL reserves the right to block the necessary positions on the contract, staged payments and/or alter the payment schedules as necessary until the anomalies have been resolved to the complete satisfaction of ENEL.