This document describes the outdoor installations of the UP 2015, the Remote Terminal Unit for telecontrol and supervision of Medium Voltage distribution network; it provides functional and construction requirements for the provision.

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1 ACRONYMS

- **DCE:** Data Circuit-terminating Equipment
- **DCS** Digital Cellular Service
- **DTE:** Data Terminal Equipment
- **DFPI** Directional Fault Passage Indicator
- **FPI** Fault Passage Indicator
- **SD:** Switch Disconnector
- **SG:** Switchgear
- **PSBC** Power supply/ battery charger of the RTU
- **PSTN:** Public Switched Telephone Network
- **RGDAT:** directional fault passage and voltage loss indicator
- **RGDM:** directional fault passage indicator with measuring acquisition
- **BVI** mains failure, Busbar Voltage Indicator
- **RC:** Remote Control
- **RTU** Remote Terminal Unit
- **TM:** Tele-Metering/Tele-Measurement
- **RS:** Remote Signalling
- **TR** Transformer
- **UE** Processing Unit panel of the RTU apparatus

2 NORMATIVE REFERENCIES

IEC 60068-2-1:2007	Environmental testing - Part 2-1: Tests - Test A: Cold
IEC 60068-2-14:2009	Environmental testing - Part 2-14: Tests - Test N: Change of temperature
IEC 60068-2-2:2007	Environmental testing - Part 2-2: Tests - Test B: Dry heat
IEC 60068-2-6:2007	Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal)
IEC 60068-2-64:2008	Environmental testing - Part 2-64: Tests - Test Fh: Vibration, broadband random and guidance
IEC 60068-2-78:2012	Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state
IEC 60255-27:2013	Measuring relays and protection equipment - Part 27: Product safety requirements
IEC 61000-4-12:2006	Electromagnetic compatibility (EMC) - Part 4-12: Testing and measurement techniques - Ring wave immunity test
IEC 61000-4-16:1998 +AMD1:2001 CSV Consolidated version	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 61000-4-18:2006	Electromagnetic compatibility (EMC) - Part 4-18: Testing and measurement techniques - Damped oscillatory wave immunity test
IEC 61000-4-2:2008	Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test
IEC 61000-4-29:2000	Electromagnetic compatibility (EMC) - Part 4-29: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations on d.c. input power port immunity tests
IEC 61000-4-3:2006	Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test
IEC 61000-4-3:2006/ ISH1:2008	Interpretation sheet 1 - Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test
IEC 61000-4-4:2012	Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test
IEC 61000-4-5:2014	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test
IEC 61000-4-6:2013	Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields
IEC 61000-4-8:2009	Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test
IEC 60870-5-101: 2003	Telecontrol equipment and systems - Part 5-101: Transmission protocols - Companion standard for basic telecontrol tasks
IEC 60870-5-104: 2006	Telecontrol equipment and systems - Part 5-104: Transmission protocols - Network access for IEC 60870-5-101 using standard transport profiles
IEC 60529: 1989	Degrees of protection provided by enclosures (IP code)
CISPR 22: 2008	Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement (international standard);
CEI EN 55022: 2014-02	Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement (instead of CISPR 22 for CENELEC Countries).
IEC 61000-6-4: 2006-07	Electro-magnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments;

3 INTRODUCTION

The central Remote Control System (Center, in the remainder) of the medium voltage distribution network is composed of:

- a Central Unit;
- a Front-end for communication with peripheral devices;
- operating stations;
- etc.

The central unit is intended to perform the following functions :

- validation and transmission of the commands given by the operator to the Remote Terminal Units (RTU);
- acquisition, processing, and storage of data coming from the RTUs;
- selection of the faulty branches;
- configuration and remote diagnostics of the RTUs;
- synchronization of the clocks of the RTUs.

This document describes the functions of the RTU devoted to medium voltage distribution network, and provides, nonetheless, the construction requirements for the provision.

The Center is capable to use all of the communication systems available on the market (public switched telephone networks, mobile networks, etc.), or those which can be implemented *ad hoc* (dedicated radio networks), which ensure messages transit times compatible with the System requirements.

The RTUs are expected to carry out the following functions:

- communicate with the central system and ensure the forwarding to the field, this last made up of Switch Disconnectors (SDs), Secondary Substation Circuit-Breakers (SSCBs), reclosers and Low Voltage motor-driven Circuit Breakers (LVCB) in the secondary substations (switchgears in their general acceptation), of the remote controls received by the Center;
- detect the status of the switchgears and the diagnostics of each RTU, and make them available to the Center;
- detect the fault signal from the fault passage indicators (RGDM, RGDAT), installed within the SD on the feeder branches to be monitored, and subsequentely store them, stamped with the date/time of occurrance, in order to make them available to the Central Unit;
- implement automatic procedures for the selection of the faulty branches;
- acquire field measurements (indoor temperature of the substation, currents, etc.), and make them available to the Center.

The RTUs can also be utilized as a part of the so-called Satellite Centers, or MV/MV switching substations, where they remotely control the circuit breakers, and acquire the signals and measurements from the related protection and control panels.

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

The RTU consists of a rack mounted processing unit device, namely UE, and a rack mounted power supply/battery charger, namely PSBC, suitable for ether indoor or outdoor cabinet containers, described in the **GSTR001/2** and **GSTR001/3** specifications, respectively.

The RTU is composed of two functional blocks, both housed in a cabinet container, as shown in Table 1 - Functional blocks of the RTU:

Device	Product family code	Description
PSBC		Power supply/ battery charger of the RTU, switchgears and auxiliary devices (modem, router, etc.)
UE8		Apparatus for teleoperation for 8 switchgears
UE16		Apparatus for teleoperation for 16 switchgears

Table 1 - Functional blocks of the RTU

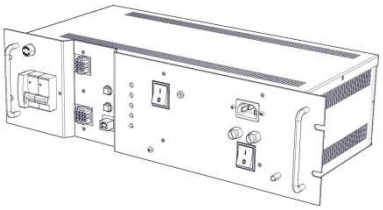


Figure 1 – PSBC

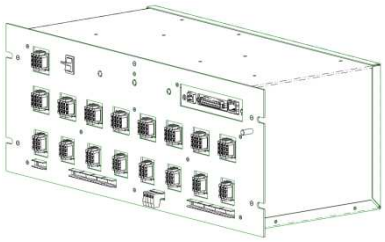


Figure 2 – UE8

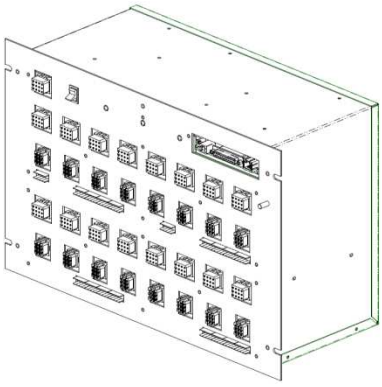


Figure 3 – UE16

The UE and the PSBC devices are equipped with the accessories provided in Table 2:

Accessories	Id Code	Device	Description	Included in the supply
Cable connecting UE to PSBC		UE8/UE16	The cable is composed of 11 conductors, with section equal to 1,5mm^2, terminated with two 12 pin loating connectors (see Figure 9).	Yes
RS232 cable for DCE connection		UE8/UE16	It is a DB9 Female/DB25 Male Modem Cable of length equal to1.5m.	Yes
Mains three pole plug		PSBC	It is a three-pole plug (type IEC C13 according to IEC 60320 standard) for the termination of the cable (not included) of the AC power supply	Yes

Table 2 - Accessories of the UE and PSBC devices

5 TECHNICAL CHARACTERISTICS OF THE UE

5.1 Construction characteristics

The UE functional blocks must be realized as a chassis suitable for mounting onto a 19” normalized frame rack. The size of the chassis must be the following:

- a height equal to 4U, as to the UE8 version;
- a height equal to 7U, as to the UE16 version;
- a depth equal at most to 25 cm for both the UE8 and UE16 versions, in accordance with what is reported in Figure 4.

The UE8 and UE16 devices are made of steel or an equivalent material in terms of electromagnetic compatibility and rigidity of the structure.They are supported only by the screws of the front panel. The UE must ensure an IP30 degree of protection (EN 60529).

Front panels must be provided with a 6MA grounding bolt.

5.2 FUNCTIONS

The UE must be provided with commands that have configurable actuation times, in order to be able to remotely control the different types of existing switchgears (switch disconnectors, LV circuit breakers, reclosers, and MV circuit-breakers).

For each switchgear, double permanent signals for its status (open and closed) must be acquired.

In the case of switched line\GSM channel communication between the UE and the central system:

- it must be possible that the UE independently establishes the connection with the Center (spontaneous calls), as a result of appropriately configured events or when analog measurements exceed configured thresholds. The Center must be provided with the possibility of excluding the spontaneous call function by means of a remote command ;
- the UE must manage a phone list consisting of three numbers to call in case of spontaneous call event.

Communication between the Center and the UE can also be permanent:

- on the dedicated line, by using EC 60870-5-101 protocol;
- on IP network using IEC 60870-5-104 protocol and both the Ethernet port or the serial port (provided on the front).

The UE must be able to perform the following monitoring functions related to the MV network operation:

- chronological recording of fault current flows;
- measurements;
- faulty branch selection;
- auxiliary functions.

5.2.1 Chronological recording of fault current flows

The UE must perform the chronological recording of all of the passages of fault currents due to short circuits (phase overcurrents) or ground faults (zero sequence currents), detected by special fault passage indicators (RGDM, RGDAT), installed on the feeder departures , in the secondary substation.

In order to discriminate the fault events that can occur even over a short time (three tenths of a second) due to rapid reclosing, it is expected that the UE records fault current flows with a temporal precisionof about one tenth of a second.

These events must be generated only during transition of the signal from the idle status to the active one.

Chronological recording of fault current flows must be made available to the Central Unit, which can use it:

- in real time, when permanent faults occur, for the selection of the faulty branch;
- in deferred time, in order to facilitate maintenance operations.

5.2.2 Measurements

The UE is equipped with analogue inputs for the measurement of significant parameters of the secondary substation. A dedicated input for a PT100 sensing element must be provided in order to measure the ambient temperature.

5.2.3 Faulty branch selection

The UE must implement a series of local automatisms. Depending upon the status of given inputs, these automatisms generate the opening and/or closing commands of the switchgears aimed at the search for the faulty branch. Upon the occurrence of well-defined events, or particular status transitions, the UE must generate spontaneous calls to the Center. The functions of spontaneous call and/or exclusion of the automatisms must be individually excludable on command from the Center.

The specification describing the Automatisms will be delivered in its final version only after the contract is awarded. During the tender, an extract is provided, which is sufficient for a technical/economic assessment.

5.2.4 Auxiliary functions

5.2.4.1. Communication

Communication between the Center and the UE must be provided, through the following kinds of vector:

- Switched Telephone Network (PSTN);
- 4-wire dedicated analog channels (4W Leased);
- GSM and DCS 1800 mobile network;
- IP networks;
- Satellite network;
- Radio network.

Hardware and software architecture of the device must allow easy interchangeability among communication systems under consideration, as explained in the remainder.

5.2.4.2. Diagnostics

The UE must implement functions of control, management, and local and remote reporting of anomalies in the operation of its functional parts.

5.2.4.3. Date/time clock function

The UE must be equipped with an internal low drift and high resolution date/time clock. Any fault current detection or other system events must be stored in the internal buffer with a date/time stamp, according to a timing resolution of one tenth of a second.

5.2.4.4. Configuration and Programming

The UE must be able to be fully configured and programmed either locally, by means of a PC (not included in the supply), connected to the USB port, or remotely, via the DCE or the Ethernet network.

The UE configuration, either locally or remotely, is described into Annex 1.

Annex 2 contains the overall list of the UE configuration parameters.

Annex 3 provides the list of the Information Object Addresses (IOAs), compliant with the IEC 60850-5-101/104 protocols, related to the signals, measurements, controls, statuss of the automatisms stored into the UE database.

The addition or modification of any record in the UE database must be allowed by updating the device application firmware and reconfiguring it from the Center (i.e. local reconfiguration must not be required).

All of the user application softwares provided must meet the following requirements:

- Compatibility with OS Windows 10;
- Availability of “silent-mode” installation and update through Software Delivery.

A mobile application (ANDROID 4.2) must be also provided, useful to either configure the UE or update the firmware locally, by means of the UE USB port. In order to facilitate the user in the configuration via mobile, the application will be provided with a set of standard configurations.

5.2.4.5. Configuration uploading

Any change of any parameter must be made starting from the configuration actually installed on the UE, in order to avoid the risk of operating on outdated data. As a consequence, at the beginning of each connection with the UE, the existing configuration must be uploaded, before proceeding with any local or remote configuration of the RTU.

5.2.4.6. Downloading of the firmware

It is mandatory to provide the possibility to update locally the firmware of either the UE or the PSBC to the latest version (local downloading), through the same software utilized also for configuration.

Nonetheless, the possibility to perform remote downloading for one or more UE (management of lists of devices) is also required. This operation may performed either from the Center, by means of the same communication apparatus normally utilized for remote control, or from a standard PC with a modem or LAN. For this purpose, a suitable software module must be provided to be installed on a PC.

5.3 TECHNICAL DETAILS

The UE is equipped with connectors and terminals which interface with the controlled/monitored devices.

Two versions of the UE must be provided (UE8 and UE16), which are able to handle 8 and 16 switcgears respectively.

The UE8 version is equipped on the front with:

- 8 male 12-socket connectors and 8 male 9-socket connectors (Figure 4), corresponding to the floating connectors respectively utilized on the switchgears and the fault passage indicators;
- 20 terminals for 10 Remote Signals (RSs):
    - 8 spare RSs;
    - 1 RS for substation door opening detection;
    - 1 RS for the transformer switch opening detection;
- 20 terminals for 9 Telemeasurements (TM):
    - 1 Telemeasurement of ambient temperature (Tamb- 4-wire PT100 sensing element);
    - 8 spare TMs.

The UE16 version is equipped on the front with:

- 16 female 12-socket connectors and 16 female 9-socket connectors (Figure 4), corresponding to the floating connectors respectively utilized on the switchgears and the fault passage indicators;
- 36 terminals for 18 Remote Signals (RSs):
    - 16 spare RSs;

- 1 RS for substation door opening detection ;
- 1 RS for the transformer switch opening detection.

- 20 terminals for 17 Telemeasurements (TM):
  - 1 Telemeasuring of ambient temperature (Tamb- 4-wire PT100 sensing element);
  - 16 spare TMs.

The list of all of the signals, controls, telemesurements and digital outputs are provided in Table 8, Table 12 and Table 16 of the Appendix.

Terminals must clamp conductors with a diameter equal to 1.5 mm^2.

The digital outputs consist of an open collector PNP transistor, characterized by a maximum current equal 50mA. Each digital output, configurable as a “stable output” or “pulse output”, must be associated to the relative internal variable ISV (see GSTR001/1/A1 for details): ISV=1, high digital output; ISV=0, low digital output. In the case of RGDM or RGDAT, the digital output is utilized as “stable output” to control the inversion of the direction of the fault detection.

The UE is further equipped with:

- A Local/Remote-control rotary switch to enable devices installed in the secondary substation to local electrical control (in the L position) or to remote control (in the T position). It provides local indication and remote alarm to be sent to the Center. The selector also control the switch of the auxiliary supply, +A, from the + L to the +T position (see Figure 6).
- 3 diagnostic LED;
- a reset button of the apparatus;
- a 2.0 USB interface for local programming;
- a DB25 RS232 connector for the DCE connection;
- a RJ45 Ethernet port;
- a male 12-socket connector for connection of the supply circuits (signal and supply).

The connection between the UE and the PSBC is performed via a multiple cable terminated at both ends with a floating 12-socket connector (of the same type as those used for the connection of the switchgears). The section of each cable must be equal to 1,5mm^2, whereas the pinout is described in Table 18.

5.3.1 Connectors

The coupling of the fixed and floating parts of each connector must be facilitated by polarization rails, and secured by elastic locking devices.

The connectors will be equipped with the only necessary contacts needed to perform the functions specified in the wiring diagrams.

The contacts utilized must ensure to have the characteristics shown below, while also considering the surface treatment and finishing:

- withstand voltage: 2 kV_{AC} -
- rated capacity 13 A
- voltage drop on a male-femaile terminal pair, traversed by a 5 A current ≤ 50 mV
- insertion-extraction force: 0,40 ÷ 10 N/contact

The arrangement of connectors on the front of the UE (the provision shown in Figure 4 is merely indicative) must allow the easy insertion and extraction of the connectors themselves.

If the connectors' plate is directly made by the printed circuit board, suitable reinforcements must be provided in order to allow the insertion and the extraction of the connectors without excessive bending of the plate itself.

5.3.2 Input terminals

The input terminals must clamp conductors with a diameter equal to 1.5 mm^2.

5.3.3 Power supply

The UE is supplied by a 24V -15%, + 20% PSBC made as instructed below.

The UE must be immunized against transient reductions of the supply voltage from 24 V to 12 V, for a 100 ms time interval.

The UE must provided with a protection against the reverse polarity of the power supply wires.

The UE delivers the $24V_{DC}$ power supply (by means of the pins +M e -M of the 12 socket connectors, see Figure 7) to all of the switchgears in connection with it. The internal conductors of the UE (either cables or patterns of the printed circuit boards), related to the power supply of the motors, must be of equivalent section not less than $2mm^2$.

5.3.4 Remote controls

Each command must be sent to the field by means of actuator relays with voltage free contacts. The equivalent section and isolation of the conductive patterns and wires must be suitable enough to withstand a continuous current equal to 5A and a voltage equal to 110V; the relays must have the following characteristics:

- Rated current of the contacts: 5 A.
- Voltage Surge between coils and contacts: 3 kV.
- Limiting breaking capacity: 0.5A with time constant equal to 40ms.
- Electrical endurance: $1x10^5$ operations at the rated breaking capacity.

The on time (output pulse length) of each output relay must be programmable at least between 0.1 and 2 seconds, in steps of 0.1 s.

The local/remote-control rotary switch, located on the front panel of the UE, must disable the actuator relays.

A double safety must be guaranteed in the execution of an output command and 1/N verification must be done.

In particular, the execution procedure must include three steps:

1. 1/N verification;
2. selection of the channel of the switchgear to be operated;
3. execution of the command.

Each step must be followed by a verification upon the succesfull completion of the previous one (a single fault must not cause, in any case, the execution of unwanted commands.).

The impedance value to be verified during the 1/N preparation step must be in the range of 5-5000 Ω. Outside of this range, the step is considered failed and the related alarm is generated.

The overall time for the execution of a control (double safety procedure included) must be limited within 30 ms.

5.3.5 Remote signals

UE8 and UE16 versions must be provided with 49 and 89 digital input signals, respectively.

There must be the possibility to configure each digital input of the UE, as either a simple or double signal, i.e. associated to the status of an additional digital input (as an example, the signalling of the open/closed position of the switchgears). In addition, there must be the possibility to configure:

- the idle status of the signal;

- the generation of an event associated to a signal;

- the type of event to be generated (“impulsive” or “status”);

- the generation of a spontaneous call to the Center;

The configuration of the signals must also be adjustable from the Center or remote configurator software.

Upon the occurrence of an alarm condition on one of the inputs programmed as described above, the UE sends a call to one of the three configured telephone numbers of the control Center. Once the connection with the Center is established, the UE transfers a message, containing the status’s change that caused the spontaneous call.

If the above connection is not established correctly, the transmission attempts must be repeated until the UE receives confirmation of the regular reception of the message. The number of attempts, and the time interval between two consecutive attempts must be programmed remotely. This is in order to prevent a continuous commitment of the transmission channels, which would result incompatible with the proper operation of the network.

The spontaneous calls can be disabled via a remote control sent from the Center.

Each digital input of the UE will be provided with a debounce filter, which must be singularly programmable within the range of 10÷5000ms, with a step of 10ms.

The scan rate of all UE inputs must be equal to 10 ms, in the worst case.

The events generated by the input signals (particularly those which are related to fault currents) must be stored in a circular buffer with a storage capacity of 200 records at least. The data to be stored for each event generation pertain to the status of the digital input which generated the event, with associated date – time stamp of generation (according to an accuracy to the tenth of a second).

5.3.6 Measurements

The analogue inputs (9 or 17 TM, depending upon the UE version) must be balanced-type and allow the reset of the measurement offset for each individual channel.

The UE acquires current signals, with the possibility of setting two different scales:

± 5 mA DC

4 ÷ 20mA DC.

The analog measurement related to the temperature probe differs from the other analog inputs as the signal transducer is integrated in the UE itself.

Each analog input must be protected against overload from values which exceed 20% of the maximum value.

The resolution of the analog/digital conversion must be ≥12 bit (over the entire input range); the accuracy of the entire chain of conversion must be ≤1%.

The analog inputs must be sampled according to the following frequencies:

- at least once a second when there is a telemeasurement session on going;
- at least once per minute in the case of automatic monitoring (normal working condition with no telemeasurement session activated)).

There must be the possibility to associate an alarm condition to one or more inputs when a minimum and/or maximum threshold limit that has been exceeded. The exceeding of one of these limits can produce a spontaneous alarm call, if programmed, similarly to what happens for the digital inputs.

The telemeasurement session is activated in order to update the measurements displayed to the operator by the Center.

In the case of automatic monitoring, incoming data will be managed by the RTU, which will process and store the average values at intervals of 10 minutes (according to CEI EN 50160, §2.2). The stored average values will be transmitted to the Center upon specific interrogation.

Local memory areas must be provided, so as to store the average values for a period of at least 2 weeks.

The measurement trends, downloaded at the Center via file transfer, must be in the format described in the GSTR001/1/A3.

5.3.7 Data buffering mode

The events generated by the UE will be stored in different buffers, each related to a type of signal (SP Single Point, DP Double Point, etc…), according to a chronological order. Doing so, during the phase of data transfer to the Center, the response packets to the polling will contain the maximum amount of data (except for the last packet, for each type, whose size can be partial

The obvious advantage of this data buffering mode is the minimization of the number of packets (and therefore of transmission time) required to transfer information to the Center, especially when many heterogeneous type events are generated, which is the typical case of the automation cycles. The correct chronological reconstruction of the events is the responsibility of the central system, utilizing the time-stamps associated with such events.

During the General Interrogation phase, the events are always sent by type, although, in this case, without the time-stamp.

5.3.8 Diagnostics

Communication and transmission

For the diagnosis of communicationit is necessary to refer to the instructions listed in the standards CEI EN60870-5-101 and EN60870-5-104.

Hardware malfunctions

In the case of hardware malfunctions detected by online diagnostics of the UE, appropriate error codes must be issued.

Local optical signalling

The UE must be provided with led, which are placed on the front of the panel, showing:

- the presence of a 24 V_{DC} power supply;
- RTU warnings/DCE communication status;
- RTU failure.

The UE must be provided with a reset button, as well.

Watch-dog circuit

The UE must be equipped with a watch-dog circuit for the automatic reset, in the case program execution is blocked.

5.3.9 Features of the date-time clock

The clock-calendar must have a resolution of one tenth of a second and a maximum drift of less than 5 ppm, within a temperature range of -10 ÷ 55 °C, sufficient to ensure the right execution of all of the provided functions.

The synchronization must be carried out with a proper message, which is periodically sent by the Center; after this synchronization, the maximum residual misalignment must be less than 100ms.

In the reply message to the synchronization, the UE must return the couple date/time it had before the resynchronization, according to the CP56 Time2a format described in the specification CEI EN60870-5.

Upon UE startup, the clock and calendar must be initialized as follows:

- time 00:00:00,
- date 01/01/2000.

6 TECHNICAL CHARACTERISTICS OF THE PSBC

The PSBC charges the batteries which supply power to the components that are installed in the secondary substations:

- switchgears: motor driven switch disconnectors (SD), secondary substation circuit-breakers (SSCB), LV circuit breakers, recloser;
- directional fault passage indicators (RGDM or RGDAT);
- UE;
- DCE.

6.1 CONSTRUCTION CHARACTERISTICS

The PSBC functional block must be realized as a box panel suitable for mounting onto a 19” normalized frame rack. The panel size must have:

- a height equal to 3U;
- a depth equal to 25 cm at most, in accordance to what is reported in Figure 4.

The PSBC panel is made of steel, or an equivalent material in terms of electromagnetic compatibility and rigidity of the structure. It is supported only by the screws of the front panel. It must ensure a degree of protection IP30 (EN 60529).

The PSBC is also provided on the front with two handles, in order to facilitate the operations of assembly and disassembly from the cabinet container.

Side panels are provided with ventilation holes (Figure 4).

Front panel must be provided with a 6MA grounding bolt.

The PSBC must be provided on the front of a USB 2.0 port for the connection to a PC.

6.2 ELECTRICAL CHARACTERISTICS

The power supply, whose circuit diagram is shown in Figure 5, must consist of a rectifier section, a battery charger section, an electronic card with functions of self-diagnosing and control of the power supply itself, as well as protection, switching, adjustment and signaling devices.

Under normal operating conditions, the PSBC will contribute in providing the energy needed to supply the above mentioned loads, and to keep the battery charged.

In the case of a loss or a temporary fault of the mains , the PSBC must provide the DC power supply. by means of the battery, until the system is restored to normal operating condition, preserving loads from any power interruption. The PSBC must be made up of a power isolation transformer, rated at 50 Hz/60 Hz (with a grounded electrostatic shield interposed between the primary and secondary windings), a rectifier bridge with silicon diodes, a circuit of adjustment and stabilization type “switching” and a decoupling diode from the battery.

In case of pole mounted installations, the input voltage of PSBC can be provided by a transformer having the following characteristics:

- Primary winding voltage: it depends on the MV nominal voltage of the involved network/country;
- Secondary winding voltage: 230 V_{AC} or 100 V_{AC};
- Nominal power: 250 VA.
- Insulation voltage: 10 kV industrial frequency.

The choice between a 100 V and 230 V_{AC} power supply must be made by means of a suitable selection switch, positioned at the rear (the power supply must be provided with the selector switch set to 230 V_{AC}).

The characteristics of the power supply must be the following:

- Rated voltage: 100/230 V_{AC}.
- Voltage range: -10%÷20% of the rated voltage
- Rated frequency: 50/60 Hz (compatibility with a 60 Hz operation must be guaranteed)
- Rated output voltage: 24 V_{DC}
- Output voltage adjustment range: 23÷28 V_{DC}
- Maximum output current (fixed): 5A ± 5% (for varying values of the input voltage within the prescribed range)
- Efficiency: ≥ 75% ± 3% (at the maximum output current equal to 5 A and at the rated voltage equal to 24 V_{DC})
- Steady state stability (for simultaneous variations of the mains voltage from 90% to 120% of the rated voltage, under any loading condition from 0% to 100%): ±1%
- Dynamic state stability (for load steps of ¼, ½, ¾ of the maximum output current): ±5%
- Ripple at the maximum output current ±2%

The output voltage of the PSBC must be set (with regulating step of ±0,02V) equal to the rated voltage indicated by the battery manufacturer (normally 27.24V, equal to 2.27 V/cell, at 20 °C).

The PSBC must charge the absorbed electrolyte batteries. In this case, the value of the charging voltage must change automatically as a function of the value of the temperature assumed by the battery.

For this purpose, the PSBC must be equipped with a temperature probe (supplied with connection cable length equal to 0.5m without terminals interposition), to be placed near the batteries.

The voltage output must be modified according to this function:

$$V_{ch}(T) = (27.96 - 0{,}036T) \pm 1\%$$

(where, T is the measured temperature, in °C and V_{ch} is the charging voltage).

The on and off switching of the rectifier with neither load nor battery must not lead to overvoltages at the output exceeding 5% of the rated value.

All control and verification of the set values must be available via software.

6.3 CONTROL OF THE MAINS, POWER SUPPLY AND BATTERY VOLTAGES

Mains power, battery voltage and all of the PSBC functionalities must be continuously monitored by means of electronic circuits which, with reference to the circuit diagram of Figure 5, must carry out the following functions:

1) Switch off the local signalling of "MAINS" and generate a remote alarm "Mains failure/BVI" when the supply voltage at 230 V_{AC} (V_n) takes a value ≤20%Vn ±10% for a time interval ≥200 ms ±10%. The previous alarm must be reset when the mains voltage assumes a value ≥80%Vn ±10% for a time interval ≥ 250ms ±10%. The mains voltage monitoring must be upstream of the fuses.
2) Generate an alarm, with local and remote signaling of "LOW V_{DC}", when the battery voltage value is *≤23.5V ±1%*, for a time interval of 30s ±10%. The alarm is reset when the voltage assumes a value *≥ 24,5V ±1%*. The “alarm” and “alarm reset” thresholds, as well as the duration of the debounce filter must be programmable, according to a range of 20÷30V_{DC} with step of 0.1V, and a range of 0÷60s with step 1s, respectively.
3) Switch off the normally-on local signaling of "V_{DC} ON" when the measured voltage has a value ≤21.6V±1% for a time interval ≥ 30s ±10%, and disconnect all of the auxiliary circuits (by de-energizing the A relay – Figure 5). The maximum current consumption of the system, after the switch-off of the auxiliary circuits, must be ≤ 50mA. The restoration process of the load is starting automatically when the battery voltage assumes a value of 22.8V±1% and the led "V_{DC} ON" is on.
4) Generate an alarm, with a local signal of "MAXIMUM V_{DC}" and a remote signal of "RECTIFIER FAILURE", and disconnect (by setting the bistable B relay) from the mains supply when the output voltage on the rectifier (measured upstream of the decoupling diode) assumes a value ≥ 29.1V ± 10% for a time interval ≥ 5s ± 10%. The restoration of the mains supply must occur automatically, after 30 min ±10%, while the restoration of the remote signal of "RECTIFIER FAILURE" must take place after 10 min ±10% from the eventual successful restoration. The restoration must be also possible via the "RESET" button. Local signaling of "MAXIMUM V_{DC}" must be restorable manually via the "RESET" button only. The “alarm” and “alarm reset” thresholds, as well as the duration of the debounce filter must be programmable, according to a range of 25÷35V_{DC} with step of 0.1V, and a range of 0÷60s witch step 1s, respectively.
5) Generate a remote alarm of "RECTIFIER FAILURE" at the intervention of the 230 V_{AC} power supply fuses.
6) Generate a local alarm of " BATTERY FAILURE" and enable the remote signal of "Battery Fail", when the efficiency test of the battery fails. This alarm must be reset manually, using the reset button "RESET” only.

6.3.1 TEST OF THE BATTERY EFFICIENCY

A circuit must provide the verification of the battery efficiency; it must be activated by a configurable timer inside the power supply, and a " BATTERY TEST" button on the front of the power supply. During the test run, the "BATTERY FAILURE" LED, located on the front panel, must blink.

The test must reduce the power supply output voltage to an appropriate level, and perform a discharge of the battery by supplying a resistive load of 13.5 ohms, for a maximum time interval of 15 min ±10%.

The test modalities must not cause any alarm issue (LOW V_{DC}, RECTIFIER FAILURE, etc.) while the same test is successful.

The threshold voltage ($V_{threshold}$) used to distinguish the outcome of the test must be programmable via sotware from 22.45 to 25 V_{DC} (according to a step equal to 0.05), possessing a default value equal to 23.75V.

The test must be carried out periodically (with a programmable frequency, set by default to "weekly", and must be excluded via software).

6.3.2 Specification of the DCE power supply section

The PSBC must provide the DCE with a 12V DC ±10% direct current power output, isolated from the UE power supply (24V with grounded positive terminal) through the interposition of a DC/DC converter with a supply capacity of at least 8W with no interruption. The DCE (GSM/GPRS/DCS type) which is normally used by ENEL, has the following power characteristics:

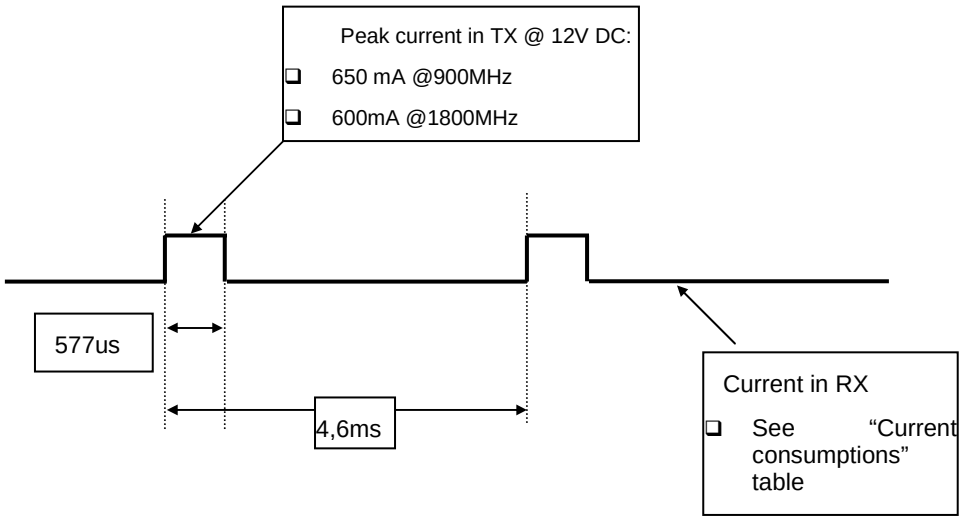
Condition		Value	Effect
Minimum voltage	900/1800MHz	< $8V_{DC}$	Operation is not guaranteed
Maximum voltage	900/1800MHz	> $36V_{DC}$	Overvoltage protections are triggered

Table 3 - Absolute Limits

A fuse which is positioned on the supply cable guarantees the permanent overvoltage protection.

Parameters	GSM 900			DCS 1800			Unit
	Min.	Typ.	Max	Min.	Typ.	Max.	
Supply voltage	9,6	12	28.8	9,6	12	28.8	V_{DC}
Peak current			2,5			1	A

Table 4 - Operating Limits



Peak current diagram

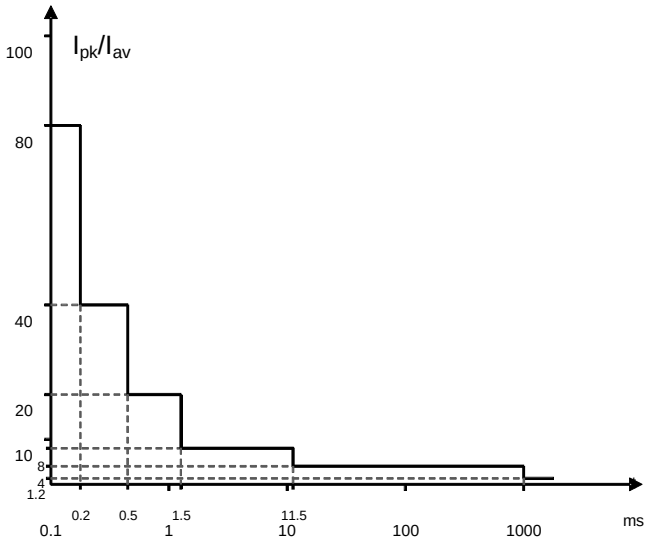
In case of 2G/3G modules the constaraints are the followings:

- Voltage range: 9.6 to 30 VDC; max ripple of ±10%;

- maximum power absorbed in all conditions: ≤ 8 W, excluding instantaneous peaks;
- instantaneous peak absorptions: within the limits specified by the following Table 5.

Supply voltage	Average current in RX	Average current in TX (GSM900)	Average current in TX (DCS1800)
9,6V	80mA	310mA	230mA
12V	65mA	250mA	180mA
19,2V	40mA	150mA	110mA
24V	35mA	120mA	90mA
28.8V	30mA	100mA	75mA

Table 5 - Current Consumption



(I_{pk} = peak current; I_{av} = average current)

DCE module can be also supplyed directly by 24V_{DC}; in this case DCE must by compliant with grounded positive pole of battery section.

6.3.3 CONFIGURATION, SIGNALLING AND PROTECTION DEVICES.

On the front of the panel, as shown in Figure 4 the following items are mandatory:

- n°5 LEDs for the local signalling of:
  - MAINS, green led (relay 27);
  - V_{DC} ON, green led (relay A);
  - LOW V_{DC},red led (relay 80);
  - MAXIMUM V_{DC}, red led (relay 45);
  - BATTERY FAILURE, red led;
- a button (RESET) to restore the operation of the PSBC;
- a BATTERY TEST button to activate the test;
- adisconnector and delayed fuses (phase and neutral) on the 230 V_{AC} power supply, with the following characteristics:

- rated voltage: 230 V_{AC}
- rated current (disconnector): ≥5 A
- rated current (fuse): 2,5 A;

• a delayed fuse on the output (negative terminal) towards the battery, with the following characteristics:

- rated voltage: 24 V
- rated current: 20 A;

• a bipolar circuit breaker (42-M), compliant with the Standard IEC 60947-2, with the following characteristics:

- rated operating voltage: 24V
- rated current (disconnector): 20A
- tripping curve: C
- breaking capacity ≥4,5 kA
- opposite auxiliary contact 1 A at 24 V_{DC}

The opposite auxiliary contact will be used to send the remote alarm signal of "MOTOR FAILURE";

• a bipolar switch (42-I) with the following characteristics:

- ratedoperating voltage: 24 V_{DC}
- rated current: 2 A
- breaking capacity: 2,5 kA;

• a 12 socket connector for the exchange of the circuits with the UE (Table 18);

• a 9 socket connector (Table 19) for the connection to the batteries and the terminal board of the RTU cabinet container;

• a three-pole plug for the AC power supply input (connector type IEC C13 according to IEC 60320 standard).

The three-pole plug for the termination of the cable of the AC power supply is included in the supply.

The PTC thermistor (Figure 5) must be used instead of conventional fuse to the protect auxiliary electronic circuits against overcurrents.

A switch must be placed at the rear of the power supply, for the selection of the AC voltage (100V/230 V) of the power supply.

The internal power supply connections must be chosen so as to avoid that the conductors can assume temperatures that exceed the set thresholds.

The wires must be N07V-K type according to CENELEC HD361:

- insulation voltage Uo/U equal to 450/750V;
- Material: common PVC;
- Flexibility: flexible for stable installations, according to class 5 – IEC 228);

having non propagating fire characteristics, in compliance with IEC 60332-3 or CEI 20-22 (Italy only).

All connections should be marked with a collar marked with the reference to the corresponding terminal.

In particular, the connections to the battery poles, red for the positive and black for the negative, must have: a section ≥ 3mm^2 (2x1,5 mm^2), a length ≥ 80cm and, on the battery side, a collar label indicating the respective polarity. The ends for the connection to the battery poles must be left unterminated (appropriately isolated from each other and to the earth), since they will be terminated at the time of installation of the battery.

7 COMMUNICATION PROTOCOLS AND TRANSMISSION EQUIPMENT

A detailed description is provided in the document GSTR001/1/A3 (further details will be delivered after the tender has been awarded).

Some significant excerpts are recalled below, sufficient for a technical/economic evaluation of the topic.

The RTU can communicate with the Center by adopting one of the two following communication protocols:

- IEC 60870-5-101, to the serial RS232 port;
- IEC 60870-5-104, to the Ethernet or serial RS232 port.

7.1 IEC 60870-5-101 protocol

It is mandatory to refer to the profile detailed in the IEC 870-5-101 [profile structured according to three OSI layers: 7 (Application), 2 (Data-Link) e 1 (Physical)] for the "unbalanced transmission mode" and in compliance with the following clarifications/changes/additions:

Level 1:

The RTU apparatus uses the following transmission networks:

- GSM 900 network;
- DCS - 1800 network;
- PSTN network;
- Direct interconnection to dedicated circuits (4W Leased Line);
- Radio;
- Satellite network.

The DTE (RTU) must interface with these transmission networks by means of a physical interface to an external modem (external DCE).

In the case of PSTN, GSM, and 1800 DCS networks, a mechanism for connection restoration (with relating time-out) is provided, in case the line falls down.

Level 2:

- The Center and the RTU will respectively play the role of “Master” and “Slave”;
- the address field must consist of two octets;
- the “single control character” must not be used;
- In the case of GSM/DCS and PSTN transmission networks:
  - the parity bit of each character of 11 bits must be omitted (violation of the rule R2, each character will then be composed of 10 bits) with the activation of:
    - inthe case of GSM/DCS, a “non-trasparent” data transmission mode;
    - inthe case of PSTN, a V.42 error correction;
  - starting idle character must be omitted (violation of the rule R1);
  - During data reception, there must be discontinuity between the characters of the same frame (inter-character time window), according to the typical time-out of the GSM/DCS and PSTN transmission networks, as a function ofthe set out conditions of use.

- In the case of spontaneous call (level 1) of the RTU, the "Master" launches an identification procedure for the recognition of the "Slave" and the subsequent start of data exchange;
- The standard time-outs provided are valid starting from the validation time of the physical connection (level 1).

Level 7:

- The application protocol must be implemented according to the instructions provided in the standard and according to the interoperability profile inside the reference document;
- the chosen subset of messages, selected from the overall set provided in the standard, supports the implementation of the application activities, as illustrated in the reference document;

7.2 IEC 60870-5-104 protocol

For the management of the IEC 60870-5-104 protocol, different alternative methods of communication can beadopted, by means of local configuration:

1. communication via Ethernet port, or
2. communication via modem GPRS on RS232 serial port.

In the case 2, the RTU can be configured with TCP/IP and PPP protocol management.In this case, the Gprs modem is used as a simple transmission medium adapter (ISO/OSI level 1): the RTU must manage any upper ISO/OSI layer.

Level 1:

The RTU apparatus utilizes the following transmission networks:

- IP Ethernet network;
- GPRS network;

See the transmission equipment paragraph for further information.

Level 2:

- The Center and the RTU will respectively play the role of “Master” and “Slave”;
- the address field must consist of two or three octets (in according to the interoperability profile) ;
- the “single control character” must not be used;
- The time-out provided in the standard are valid starting from the validation time of the physical connection (level 1).

Level 7:

- The application protocol must be implemented according to the instructions documented in the standard and according to the interoperability profile as inside the reference document;
- the chosen subset of messages, selected from the overall set as detailed in the standard, supports the implementation of the application activities, as illustrated in the reference document;

7.3 Transmission equipment (DCE)

The RTU must be able to communicate with the Center via various means of communication (switched fixed telephone networks, 4-wire dedicated fixed telephone links, 900 MHz GSM networks or 1800 MHz DCS networks, radio networks, etc.). For each of the above mentioned systems, it might be necessary to adopt a different type of DCE. The RTUs must be implemented in order to make the DCE interchangeability as easy as possible; for this reason, the UE local reconfiguration actions, for varying items of the adopted DCE, must be minimized, or rather, reduced to zero. All of the tools which are useful to ENEL in order to interface the apparatus with the DCE of the latest generation must be made available.

7.3.1 GSM/GPRS modem

Physical interface to an external modem

The physical interface for the connection to an external modem must contain the following features:

- Type: ITU-T V.24/V.28;
- Connector: ISO 2110, D type, 25-pole, male;
- Managed interchange circuits: see Appendix.

Data interchange with the modem

In order to realize the data interchange between the RTU and the modem, the following instuctions must be adhered to:

- Transmission rate of reference data: 9600bps; nonetheless, the RTU must be designed to operate at higher speeds also, up to a maximum of 115.2 kbps, whereasother transmission systems and technologies are able to support them.
- Data format: asynchronous transfer mode, 1 start bit, 8 bit data, no parity bit, 1 stop bit.
- Flow control: software, by using DC1 – DC3 (XON - XOFF) characters, and hardware, by using C.106 (CTS) and C.105 (RTS) circuits.

Modem management

Modem functionalities must be handled by the RTU according to a standard mode:

- AT issues (GSM 07.05, GSM 07.07, V.25ter);
- V.25bis.

The DCE GSM/DCS connection cable, which is always included in the supply of each UE, must be at least 2m long, and must include the following:

- a D25 type connector, female poles, on the RTU side;
- a D9 type connector, male poles, on the GSM modem side;

To the modem (9 pin type D Male)		**To the RTU (25 pin type D female)**	
Pin	**Signal denomination**	**Signal denomination**	**Pin**
3	103	103	2
2	104	104	3
7	105	105	4
8	106	106	5
6	107	107	6
5	102	102	7
1	109	109	8
4	108	108	20
9	125	125	22

Table 6 – Signal pinouts between DTE and DCE, in the case of use of GPS/GPRS Modem

The DCE connection cable, with a length equal to 1m at least, must be included with the following:

- a D25 type connector, female poles, on the RTU side;
- a D25 type connector, male poles, on the PSTN Modem side.

The DCE (PSTN type) connection cable must be provided as long as it is requested in the related order.

To the modem (25 pin type D Male)		**To the RTU (25 pin type D Female)**	
Pin	**Signal Denomination**	**Signal Denomination**	**Pin**
2	103	103	2
3	104	104	3
4	105	105	4
5	106	106	5
6	107	107	6
7	102	102	7
8	109	109	8
9	+ V_{DC}	+ V_{DC}	9
10	- V_{DC}	- V_{DC}	10
15	114	114	15
17	115	115	17
18	141	141	18
20	108	108	20
21	140	140	21
22	125	125	22
24	113	113	24
25	142	142	25

Table 7 Signal pinouts between DTE and DCE, in the case of use of PSTN Modem

8 TESTING AND INSPECTION

The following tests must be executed onto each component (UE e PSBC) of the RTU:

1) Visual inspection;
2) Tests of insulation and dielectric strength;
3) Check of all of the functionalities;
4) Stability check (PSBC only);
5) Electromagnetic interference immunity test;
6) Thermal behavior test (PSBC only);
7) Climatic tests;

The above listed tests must be performed in laboratories accredited according to the current standards.

Testing procedures can be distinguished by:

a) type test, with the aim to verify the perfect compliance of a production specimen with the technical specifications detailed in the present document;

b) acceptance test, with the aim to control the essential characteristics of each device of the supply.

8.1 Type tests

The type tests are comprehensive of those which are indicated in the previous paragraph (1 trough 7), including the software tests that are used for the calibrations and check of the various thresholds.

The supplier must keep and provide ENEL access to the documentation which attests to the success of the execution of the type tests.

8.1.1 Visual inspection

It is mandatory to verify the absence of visible manufacturing defects, the accuracy of construction, the compliance of the dimensions of all of the RTU components with those indicated in the present specification as well as the prescribed degree of protection.

An appropriate inspection must be performed on the power connectors, in order to verify that the insulating parts were manufactured well.

8.1.2 Tests of insulation and dielectric strength

The aim of the tests is to verify the dielectric strength amongst the independent circuits of the power supply.

Each test must be performed by applying a voltage (of a value corresponding to the level specified for each circuit) to each couple of circuits that are listed below, whereas the remaining circuit is grounded (the voltage level must be equal to the prescribed value for each circuit):

a) AC power supply input (level 4);

b) Signalling output and 24 V_{DC} power supply output (level 3);

The prescribed tests are all of those which are listed below and executed according to the methods and values which are defined in the corresponding reference standard:

Impulse withstand test	Overvoltage category 4	AC power supply inputs,	PSBC
Impulse withstand test	Overvoltage category 3	Inputs, outputs and 24V_{DC} input	PSBC\UE
Dielectric strength test	AC test voltage 2 kV	AC power supply input	PSBC
Measurement of the Insulation resistance	≥100 MΩ to 500 V_{DC}	AC Power supply	PSBC
Measurement of the Insulation resistance	≥10 MΩ to 500 V_{DC}	Inputs, outputs, DC Power supply	PSBC\UE

Table 8 - Insulation Tests in compliance with EN 60255-5

8.1.3 Check of all of the functionalities

The regular performance of all of the prescribed functions must be verified, as well as the correct issue of the related signals, in correspondence to the prescribed intervention/non intervention limits.

8.1.3.1. UE

All the functional characteristics described either in the present document must be controlled. In particular, it is important to verify the apparatus integration with the central system that implements each specific IEC 60870-5 profile: STM for the Italian profile and Spectrum for the Iberian prifile.

All these tests must be performed in the laboratory located in Milan, in Bari, in Barcelona or in any other place indicated by Enel), at the expense of the supplier.

The supplier will organize the test plan as well as a detailed list of all of the tests, which must be approved by Enel. This is to be completed in order to proceed to a systematic and nearly complete check of the implemented functionalities.

8.1.3.2. PSBC

This type of test must be executed at the rated voltage and without any loads or batteries connected.

In the case of voltage interruptions (the first for a duration of 0.3 s, and the second for 180 s), it must also be verified that the rectifier returns to its normal operating mode, without overvoltages exceeding the prescribed threshold.

In particular, it must be verified that the maximum value of the supplied current, and its alternate component percentage, do not exceed the prescribed threshold, by supplying a dummy load.

The check of the functionality of either the circuit which controls the maximum voltage of the rectifier, or those which supply the rectifier itself, must be performed by connecting an appropriate battery to the power supply.

All of the functions, for which a software control is prescribed, must be also verified. For example, this is the case of the functions of regulation and testing of the output voltage, regulation and testing of the battery threshold test, exclusion/enabling of the battery test, etc.

8.1.4 Stability check (PSBC only)

The check of the stabilization limits must be carried out on the basis of the information reported in the table below:

Steady state stability (for simultaneous variations of the grid voltage from 90% to 120% of the rated value, under any loading condition from 0% to 100%):	±1%
Dynamic state stability (for load steps that are equal to ±25% of half of the PSBC rated current):	±5%

Table 9 - Stability check

8.1.5 Electromagnetic interference immunity test

The aim of these tests is to verify the correct operation of either the PSBC or the UE, which are subjected to the application of various electromagnetic phenomena.

Emission limit tests must follow hereinafter, and be compliant with the following:

Ring Wave	level 2	IEC 61000-4-12:2006	Local ports
Ring Wave	level 3	IEC 61000-4-12:2006	Field ports
Damped oscillatory waves	level 2	IEC 61000-4-18:2006	Field ports, Local ports, AC & DC Power supply
Fast transient/burst	level 3	IEC 61000-4-4:2012	Local ports, Ground, AC&DC input and Output
Fast transient/burst	level 4		Field ports
Surge 1,2-50/8-20	level 3	IEC 61000-4-5:2014	AC&DC input and Output
Power frequency magnetic field	level 3	IEC 61000-4-8:2009	DC input and Output
Power frequency magnetic field	level 3	IEC 61000-4-8:2009	Local ports
Power frequency magnetic field	level 4	IEC 61000-4-8:2009	Field ports
Radiated, radio-frequency, electromagnetic field	level 3	IEC 61000-4-3:2006 +AMD1:2007 CSV	Field and local ports, Ground, AC&DC inputs and outputs

		Consolidated version	
Radiated, radio-frequency, electromagnetic field (digital radio telephones)	level 3	IEC 61000-4-3:2006/ ISH1:2008	
Test voltage level at main frequency	level 3	IEC 61000-4-16:1998n+AMD1:2001 CSV Consolidated version	Field and local ports, Ground, AC&DC inputs and outputs
Conducted common mode disturbances in the frequency range 0 Hz to 150 kHz			
Conducted disturbances induced by radio-frequency fields	level 3	IEC 61000-4-6:2013	Field and local ports, Ground, AC&DC inputs and outputs

Table 10 - EMC Reference Standards

The EMC tests must be performed in laboratories which are accredited according to the current standards.

8.1.5.1. UE

With reference to the above mentioned Standards, the tests to be performed onto the UE refer to the port classification listed below:

- USB port, RJ45, RS232 to DCE, power port must be intended as local ports;
- RC output ports, RS and TM ports, field power port must be intended as field ports.

8.1.5.2. PSBC

With reference to the above mentioned Standards, the tests to be performed onto the PSBC refer to the port classification listed below:

- the 24 V_{DC} output port, the USB port must be intended as local ports;
- the 230/100 V_{AC} input port must be intended as field ports.

8.1.6 Thermal behavior test (PSBC only)

The power supply thermal map must be measured at the prescribed maximum values of the input/output parameters; the test must be executed under standard climatic conditions, as reported below:

- Temperature: 15 ÷ 35 °C;
- Atmospheric pressure: 86 ÷ 106 kPa;
- Relative humidity: 45 ÷ 75 %

The overtemperature values, closely measured to each device, must be utilized in order to verify that, at the prescribed maximum value of the operating temperature, the maximum permissible operating temperature is not exceeded for the same device.

The thermal map must also be utilized in order to define the time thermal constant, which is useful for the temperature variation test, as described in the following paragraph.

8.1.7 Climatic Tests

The tests to be executed on the RTU as well as the methodology of the execution of these tests are described within the standards recalled in the following.

Two different tests must be executed, with the PSBC switched off and on, respectively.

During the tests, the clock stability must be verified.

Switched off and rated powered equipment	Dry heat	+55 °C ± 2 °C (16 hours)	IEC 60068-2-2:2007	Environmental testing - Part 2-2: Tests - Test B: Dry heat
	Damp heat	+40 °C ± 2 °C, RH = 93% ± 3% (4 days)	IEC 60068-2-78:2012	Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state
	Cold	(-10 ± 3)°C (16 hours)	IEC 60068-2-1:2007	Environmental testing - Part 2-1: Tests - Test A: Cold
	Change of temperature	TA = -10°C; TB =55°C; (3 hours+3 hours)	IEC 60068-2-14:2009	Environmental testing - Part 2-14: Tests - Test N: Change of temperature

Table 11 - Climatic Tests

At the start and the end of each test, as well as every 4h, during the execution of a single test, two issues (with a duration of 30s each) of supply at the maximum current must be caused.

During the N test, the above mentioned issues must be caused at the end of each evolution of the temperature from the minimum to the maximum value, and vice versa.

The maximum interval between two consecutive tests must not exceed 3 days, except for the humid heat and cold tests, for which the maximum interval must not exceed 2 hours, including the stabilization process.

With the goal to verify the correct operation of the power supply after the execution of all of the prescribed type tests, the following tests must be repeated:

1) Visual inspection;
2) Tests of insulation and dielectric strength;
3) Check of all of the functionalities;

8.1.8 Mechanical tests

The tests to be executed on the RTU, as well as the related methodology of the execution, are described within the standards recalled in the following:

Vibration (sinusoidal)	lower frequency 10 Hz upper frequency 500 Hz acceleration amplitude 10 m/s2 displacement amplitude 0,075 mm	EN 60068-2-6
Vibration, broad-band random (digital control) and guidance		EN 60068-2-64

Table 12 - Mechanical test

8.2 Acceptance tests

Within the overall set of type tests, a subset of tests will be selected (for example, the insulation and dielectric strength tests), useful for the acceptance of each specimen of supply.

For each device supplied, a certificate must be provided, which attests to the success in the execution of the acceptance test.

For this purpose, the manufacturer must provide specific equipment to perform the automatic test of each specimen. All of the checks within the automatic test must be agreed upon in advance with ENEL, and will also include a check of the PC connection functionality.

8.2.1 Preliminary checks

Check of the RTU 24V DC supply voltage:

- tolerance check, with powered base unit.

Check of the motors 24V DC supply voltage:

- tolerance check with maximum load.

Upload of the testing configuration:

- the testing configuration must be performed in order to verify all of the available input and output

Check of correct RTU initialization:

- link which opens on the visualization channel, with request and check of the internal diagnostic status.

8.2.2 Functional check

Serial port check:

- the basic electrical functionality of the port must be verified.

Remote signal check:

- electrical functionality check in open/close conditions.

Remote control check:

- check of the electrical functionality of closing remote controls and relative execution time (the latter to be done only on the first remote control).

Telemetering check:

- parametric check of the single remote measurements to the following values: -6mA, 4mA, 0mA, 6mA, 20mA.

8.2.3 Automatic test equipment

An automatic test equipment must be produced so as to allow for the test on either the single RTU components (PSBC and UE), as described in the paragraphs 8.2.1. and 8.2.2, or the overall RTU.

The same automatic test equipment apparatus can thus be utilized in order to perform the automatic test even on spare parts.

The supplier must provide a detailed list of the tests to be executed automatically, which will be checked and approved by ENEL.

The compliance of the automatic test equipment with the documentation provided by the supplier and subsiquently approved by ENEL must be certified by an **accredited third-party authority**.

9 SUPPLY REQUIREMENTS

In case of pole mounted installations, the input voltage to PSBC can be provided by a transformer having the following characteristics:

- Primary winding voltage: it depends on the MV nominal voltage of the involved network/country;
- Secondary winding voltage: 230 V_{AC} or 100 V_{AC};
- Nominal power: 250 VA.

The choice between a 100 V and 230 V_{AC} power supply must be made by means of a suitable selector switch, positioned at the rear (the power supply must be provided with the selector switch set to 230 V_{AC})

The characteristics of the power supply must be the following:

- Grid voltage: 100/230 V_{AC}.
- Voltage range: -10%÷+20%
- Rated frequency: 50Hz and 60 Hz (compatibility with a 60 Hz operation must be guaranteed)

10 AMBIENT OPERATING CONDITIONS

The apparatus provided must be in compliance with the operating conditions listed below:

- Ambient temperature limit in the range of -10 ÷ 55 °C;
- Atmospheric pressure in the range of 70 ÷ 106 kPa;
- Humidity limit of 93% at the max ambient temperature;
- Storage temperature in the range of -25 ÷ 70 °C.

11 ELECTROMAGNETIC COMPATIBILITY

11.1 Immunity requirements

The UE and the PSBC panels must be in compliance with the current standards on EMC.

11.2 Emission limits

The Power supply must be in compliance with the current regulations on electromagnetical noise emission limits, and in particular the UE must be in compliance with:

- **CISPR 22:2008**: Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement (international standard);
- **CEI EN 55022:2014-02**: Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement(instead of CISPR 22 for CENELEC Countries).
- **IEC 61000-6-4:2006-07:** Electro-magnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments;

12 SAFETY REQUIREMENTS

Each component of the RTU, including the non electrical ones, must be in compliance with all of the current safety regulations (if applicable).

13 SOFTWARE

13.1 Remote connection with the Center

The supplier must interface with the Center via the software package, made available by ENEL.

The procedures of data exchange, relating to each required activity, must fully operate automatically and without operator involvement.

Arrangements (in the processes of exchange and/or coding of data) must be adopted, which can provide a level of data integrity equivalent to I_3 (CEI-EN 60870-5-1) for the execution of remote controls.

Each activity must include the opening and closing procedure of the Communication Session; this procedure must be performed automatically also, without any operator involvement, and it must be

performed also to prevent unwanted access to the system, by using a security procedure based on the exchange of dynamic passwords, which will be provided especially by ENEL.

13.2 Remote programming and configuration

A suitable software module must be provided to perform remote configuration / upgrade for one or more UEs (management of lists of devices) is also required, by means of both the Center and the modem normally used for remote control or of a standard PC with a modem.

13.3 Local programming and configuration

The local operations of diagnostics, programming and configuration of the UE will be carried out through a USB 2.0 port, positioned in front.

For this purpose, an appropriate program "RTU Configurator" (see Annex 1) must be provided, which is suitable to be run on a laptop PC equipped with Windows 10, allowing communication with the UE, via the local port of configuration (USB).

Monitoring input/output signals and automatisms

A "RTU Viewer" program must be available through the configuration/programming laptop, which allows the activation of the following functions at least:

- status monitoring of the digital inputs;
- status monitoring of the analog inputs;
- status monitoring of the control outputs (relay);
- status monitoring of the digital outputs;
- on-line monitoring of the transitions between states of the automatisms for each switchgear (with visualization and recording of the transition sequence);
- control launch for the opening/closing of the IMS/switches and the switching-off of the automation sistems;
- local downloading of the Events-and-Measures Buffer;
- monitoring of the operating status of the link (Initializationin progress, waiting for a connection, connected)

The user interface must be represented by a screen which includes the following information at least:

1. the status of the various signals (opening/closing of each switchgear, intervention of the associated RGDM or RGDAT, feeder and busbar voltage Presence/Absence, etc..)
2. online values of the measurements;
3. the possibility of sending commmands:
    - opening/closing of a switchgear;
    - switching-off of the automation systems corresponding to the selected IMS;
    - downloading Events Buffer;
    - downloading Measurements Buffer.
4. Significant information related to automation:
    - switched on/off automation systems;
    - temporary inhibition of Automatic Opening;
    - Second reclosing from UP;

- Inhibited automation system.

Switchgear opening and closing commands sent from the screen must be treated, for automatisms and controls, as remote controls from the Center (when the substation islocally operatedit must not be possible to control any switchgearmovement fromthe screen).

The implementation of commands (open/close of switchgear; automatisms switch-off; Download buffer) sent from the screen must cause the emission of a spontaneous call which cannot be disabled.

The download of the events from the local file system and/or measurements buffer must not clear its content, which, nonetheless, will be sent back to the Center in the event of a subsequent positive connection.

During the download process of the Buffer, the related virtual control led on the screen must blink,in order to enable the user to check the progress of the operation.

For on-line monitoring of the transitions between automatisms states, for each IMS, (with visualization and possibility of recording the sequence of transitions) a proper man/machine interface must be agreed upon with ENEL.

14 GENERAL PRESCRIPTIONS

14.1 Reliability

14.1.1 Normative references

The following terminology is defined in the standard IEC 50. IEC standards published by TC56 prescribe, in a detailed manner, methodologies to be applied in order to define, standardize and verify the reliability requisites of the various equipment, as well as of the items/systems in their entirety.

14.1.2 Formulation of the reliability requirements

In the remainder, the "useful life" of the apparatus is the time that elapses between the end of the period of "early failures" and the beginning of the "faults for aging" one. The duration of the useful life coincides, therefore, with the "period of constant failure rate."

The period of early failures is intended to be zero, or terminated at the time of delivery. This is because the Supplier must implement and provide documentary evidence of all of the possible measurements which are useful to eliminate child mortality.

- The supplier must therefore certify that the equipment was already in the constant failure rate period since the time of delivery.
- The failure rate must be declared by the Supplier, according to the data of the project (by the calculation shown in the documentation) and must not exceed 3.5% per annum for the power supply/battery charger, and 2.5% per annum for the UE, having operated within the prescribed climatic and environmental conditions.
- The minimum period of constant failure rate, i.e. of the useful life, must be at least 10 years.
- For the purposes of the analysis of failure data, it is intended that any restoration (ie repair or maintenance) does not change the failure rate during the useful life.

For the reliability analysis during the useful life, the failures which are not attributable to improper use, or incorrect operation, are deemed to be "relevant failures"; in this regard, the Supplier must define, in detail, the scope of use and the eligible maneuvers for the product.

14.1.3 Verification tests of compliance with the declared failure rates

ENEL will agree to the modalities of analysis and verification of all of the data needed to monitor the reliability required throughout the period of useful life.

In this regard, the modalities of logging, classifying (relevant or irrelevant failures), and certifying the maintenance and repair interventions performed by the Supplier will be defined,

In accordance with ENEL, the Supplier must put a computerized archive in place and provide quarterly data on the failure rate, which is measured on the supplied equipment.

ENEL is equipped with an archive where the records (preventive or following a failure) of maintenance interventions are held, in order to perform control checks.

14.2 Project technical documentation

Before the installation of the equipment, the supplier must prepare a project documentation to be submitted to ENEL for approval. This project documentation must list in detail all of the solutions adopted by the supplier in order to ensure the required functionality and reliability.

14.3 Spare parts

The spare parts will be defined in the request for proposal. All of the spare parts of the supplied equipment (including firmware and software) must be available for at least 10 years after the expiration of the warranty period.

14.4 Equipment documentation

The provider must produce detailed documentation of the operation, configuration and maintenance of the equipment, accompanied by either the wiring and topographic diagrams, or the lists of components. These documentation must be provided electronically.

15 APPENDIX

ID_IN	PIN	Connector	Description	UE8	UE16
0	-	L/R selector	Local operating mode	1	1
1	-	L/R selector	Remote operationg mode	1	1
2	-	input terminal Door Op	substation door opening	1	1
3	-	input terminal TR SD	transformer switch opening	1	1
4	7	PSBC/UE connector	Motor failure	1	1
5	8	PSBC/UE connector	MAINS failure/BVI	1	1
6	9	PSBC/UE connector	rectifier failure	1	1
7	10	PSBC/UE connector	Low V_{DC}	1	1
8	11	PSBC/UE connector	Battery Failure	1	1
9	5/4	i^{th} SG connector	switch disconnector closed	8	16
10	5/9	i^{th} SG connector	switch disconnector open	8	16
11	1/2	i^{th} FPI connector	Overcurrent detection (FPI_{ov})	8	16
12	1/5	i^{th} FPI connector	Zero sequence current detection (FPI_0)	8	16
13	1/3	i^{th} FPI connector	remote signal	8	16
	-	remote signal input terminal			
			Total	49	89

Table 13 – Remote Signals

ID_OUT	PIN	Connector	Description	UE8	UE16
0	12/8	i^{th} SG Connector	Remote Closing Control	8	16
1	12/7	i^{th} SG Connector	Remote Opening Control	8	16
2	7/8	i^{th} FPI Connector	Digital Output	8	16
			Total	24	48

Table 14 – Remote Controls/Digital outputs

ID_MEAS	PIN	Position	Description	UE8	UE16
0		T_{amb} Input/output terminal	4 wire PT100 terminal for ambient temperature measurement	1	1
1	4/6	i^{th} FPI connector	Telemeasuring enabled	8	16
	-	Telemeasuring input terminal			
			Total	9	17

Table 15 – Telemeasurement Signals

AT COMMANDS OF THE DUAL–BAND MODEM GSM900/DCS1800

The following AT commands (in alphabetical order) are included among the features, performance, and requirements of the dual-band GSM900/DCS1800modem:

- +CME Mobile equipment result codes
- +CMS Message service failure result codes
- A/ Re-execute last command
- AT&C Set DCD signal
- AT&D Data Terminal Ready options
- AT&F Restore default configuration
- AT&S Set DSR signal
- AT&T Autotest
- AT&V Display current configuration
- AT&W Save current configuration
- AT+CBST Bearer type selection
- AT+CEER Displays why last call was disconnected
- AT+CLCK Facility lock
- AT+CMGD Delete messages
- AT+CMGF Message format
- AT+CMGL List messages
- AT+CMGR Read message
- AT+CMGS Send messages
- AT+CMGW Write message to memory
- AT+CMSS Send messages from storage
- AT+CNMI New message indication to terminal equipment
- AT+COPS Operator selection
- AT+CRLP Radio Link Protocol parameters
- AT+CSQ Display signal strength
- AT+ICF Character framing
- AT+IFC Local flow control
- AT+ILRR Display local port rate
- AT+IPR Set terminal equipment data rate
- ATA Manual answer an incoming call
- ATD Dial a telephone number
- ATDL Redial last telephone number
- ATE Echo
- ATH Hang up
- ATO Change from command mode to data mode
- ATS0 Auto-answer mode
- ATS3 Set the command termination character

- ATV DCE response format
- ATZ Load user profile.

DATA EXCHANGE CIRCUITS

C.102	Signal Ground or Common Return
C.103	Transmitted Data
C.104	Received Data
C.105	Request to send
C.106	Ready for sending (Clear to Send)
C.107	Data set ready
C.108/2	Data terminal ready
C.108/1	Connection data set to line
C.109	Carrier detector
C.113	Transmitter signal element timing (DTE source) [optional]
C.114	Transmitter signal element timing (DCE source) [optional]
C.115	Receiver signal element timing (DCE source) [optional]
C.125	Ring Indicator.

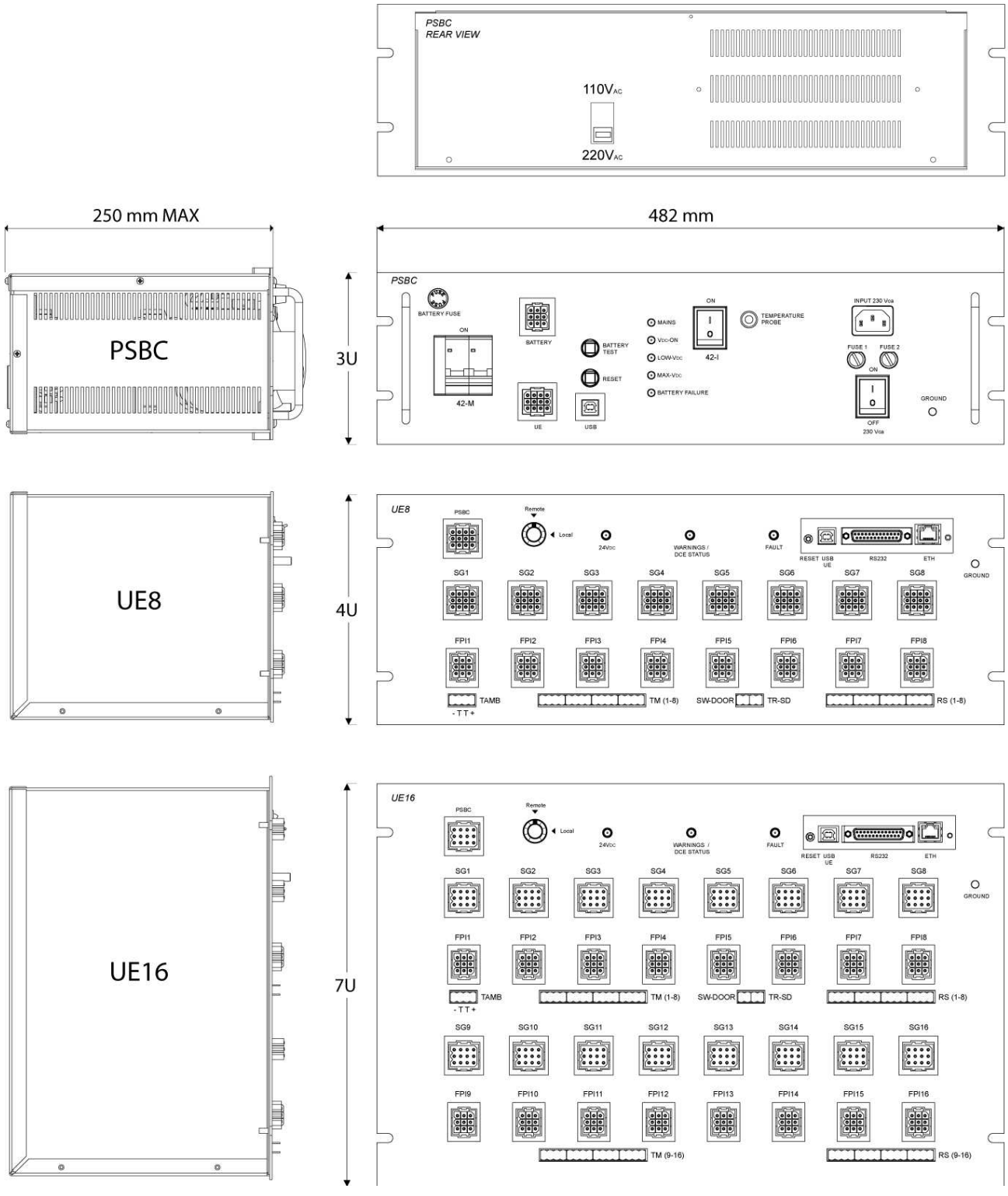


Figure 4 – Views of the chassis of the UE8, UE16 and PSBC

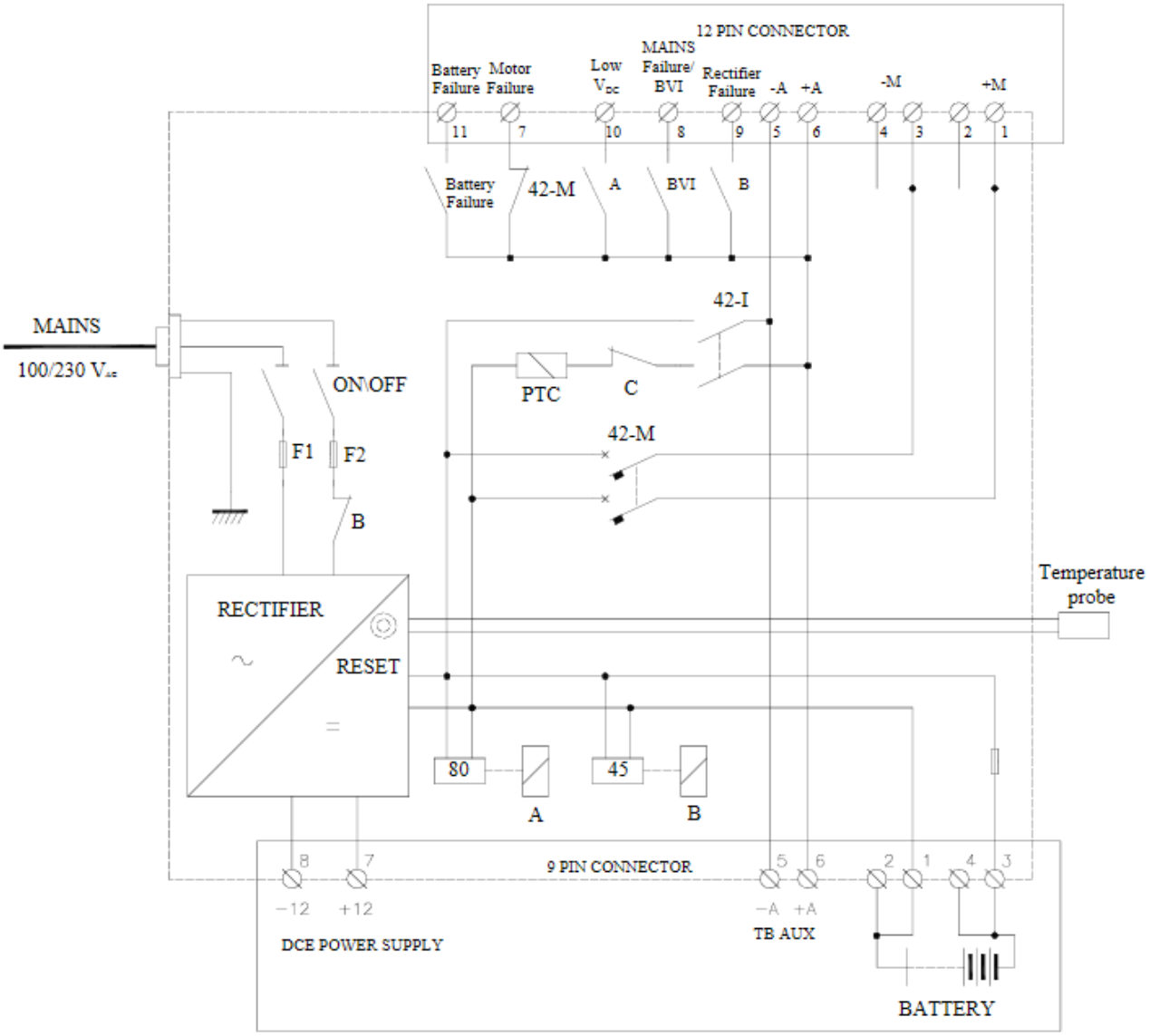


Figure 5 – Circuit diagram of the power supply

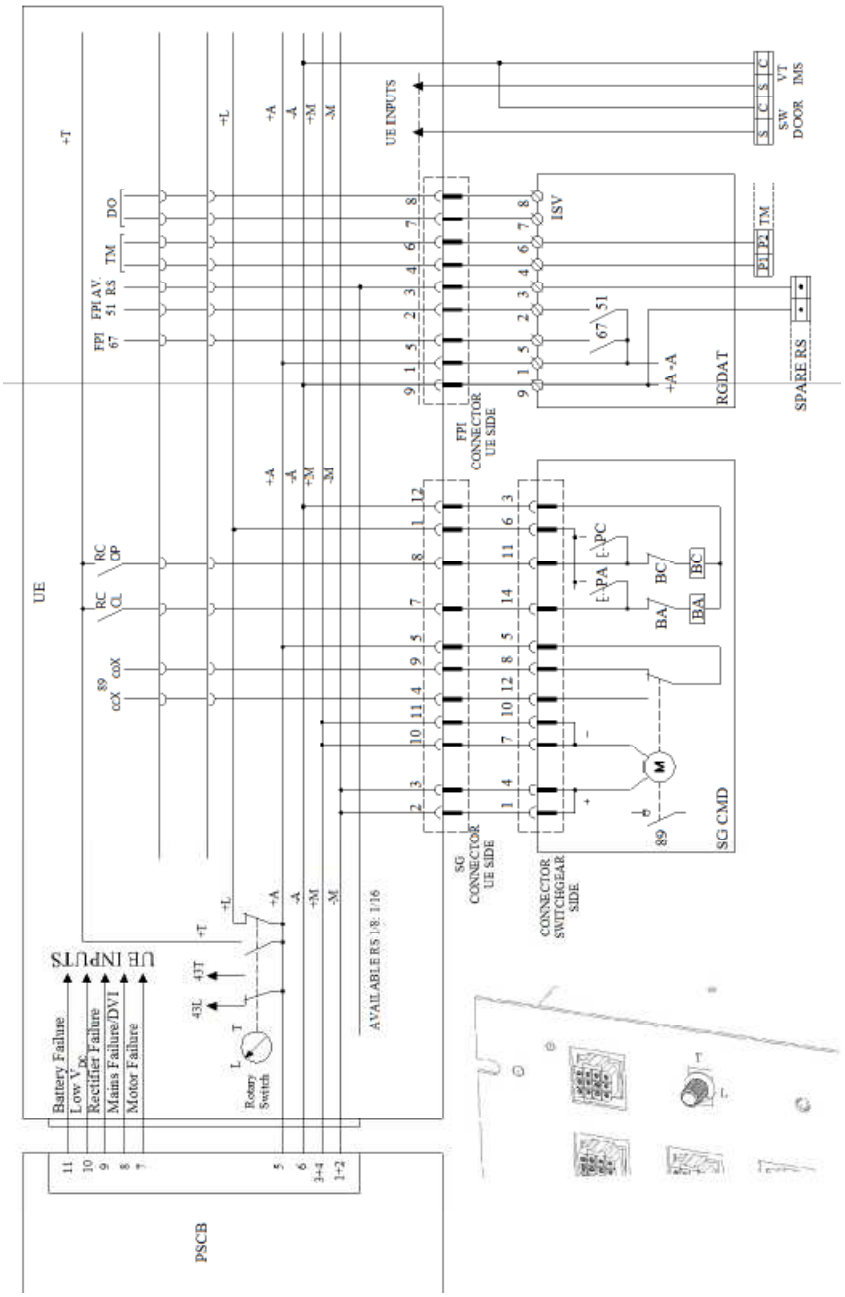


Figure 6 – Circuit diagram of the PSBC/UE field connections and rotary switch datail

Pin	Name	Description	Pin	Name	Description
1	+L	Local controls power supply (+24 V_{DC})	**7**	OP	Remote control opening
2	+M	Motor power supply (+24 V_{DC})	**8**	CL	Remote control closing
3	+M	Motor power supply (+24 V_{DC})	**9**	89 cax	Remote signal of end position open SG
4	89 ccx	Remote signal of end position closed SG	**10**	-M	Motor power supply (-24 V_{DC})
5	RS Com	RS Common of the Swichgear	**11**	-M	Motor power supply (-24 V_{DC})
6		Not in use	**12**	-A	(-24 V_{DC}) Controls Common

Table 16 – SG connector pinout (FLOATING PART)

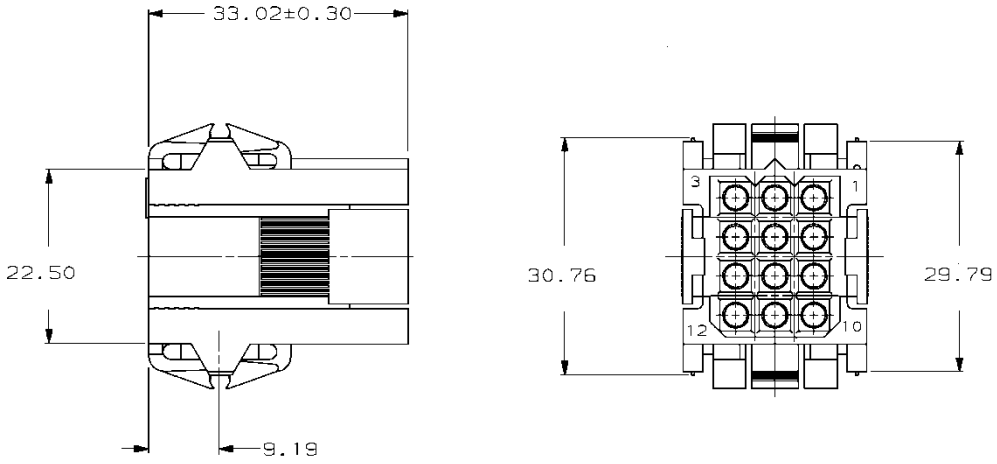


Figure 7 – Dimensional characteristics of the female 12 pin connector from swtchgear

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Pin	Name	Description
1	RS Com	Power supply (+24 V_{DC}) and Commmon
2	RS_{ov}	Overcurrent operate condition
3	RS	Spare RS
4	TM+	Analog input (pole 1)
5	RS_0	Zero sequence current operate condition
6	TM-	Analog input (pole 2)
7	DO COM	Digital Output Common
8	DO	Digital Output
9	-	Power supply (-24 V_{DC})

Table 17 – FPI connector pinout (FLOATING PART)

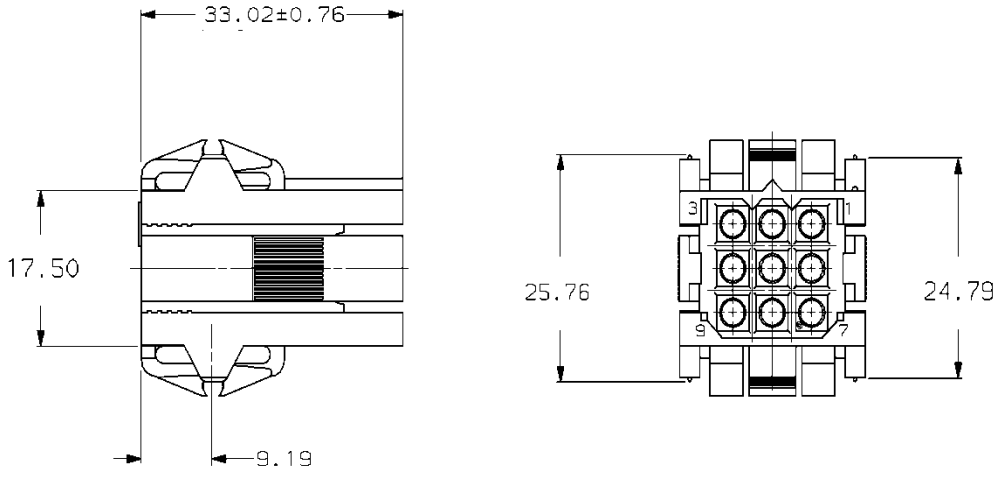

Figure 8 – Dimensional characteristics of the female 9 soket connector from RGDAT/RGDM

Pin	Name	Description	Pin	Name	Description
1	+M	Motor Power supply (+24 V_{DC})	**7**	Mot Fail	Motor Failure
2	+M	Motor Power supply (+24 V_{DC})	**8**	Mains fail/BVI	Mains failure/BVI
3	-M	Motor Power supply (-24 V_{DC})	**9**	Rect Fail	Rectifier Failure
4	-M	Motor Power supply (-24 V_{DC})	**10**	Low V_{DC}	Low V_{DC}
5	-A	UE Power supply (-24 V_{DC})	**11**	Batt Fail	Battery Failure
6	+A	UE Power supply (+24 V_{DC})	**12**	-	-

Table 18 – Pinout (floating and fixed part of the 12 pin connector, either power supply side or RTU side)

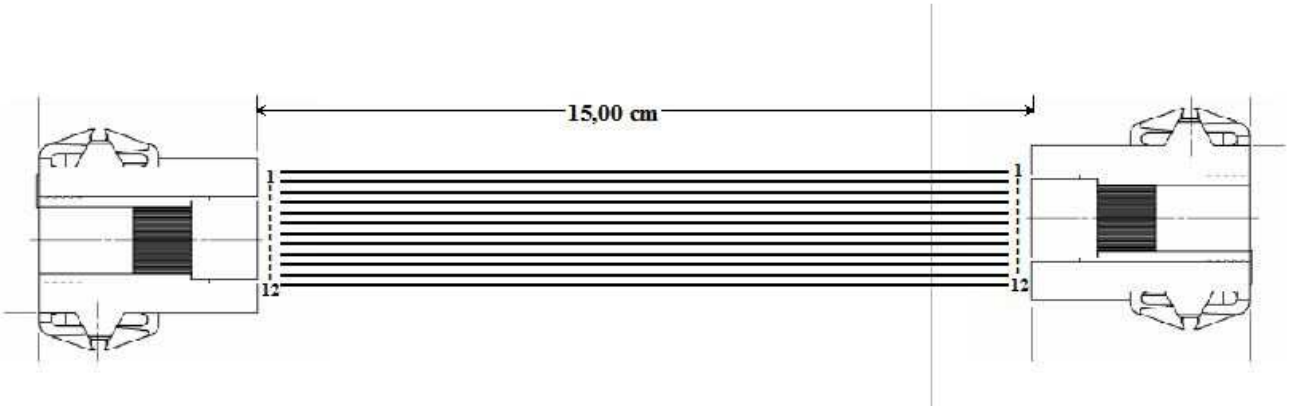

Figure 9 – Connection between PSBC and UE

Pin	Name	Description
1	+ Batt	Battery positive terminal(+24 V_{DC})
2	+ Batt	Battery positive terminal(+24 V_{DC})
3	-Batt	Battery negative terminal(-24 V_{DC})
4	-Batt	Battery negative terminal (-24 V_{DC})
5	+A	Auxiliary Power supply
6	-A	Auxiliary ower supply
7	+12 V_{DC}	DCE Power supply(+12 V_{DC})
8	-12 V_{DC}	DCE Power supply(-12 V_{DC})
9	-	-

Table 19 – Pinout (floating and fixed part of the 9 pin connector, power supply side)