Fixed installed indoor Power Quality Instrument

This global standard defines the characteristics of the fixed installed indoor Power Quality Instrument (according to IEC 62586-1) and accessories for measurement of power quality parameters in a.c. distribution systems with a declared fundamental frequency of 50 Hz or 60 Hz.

Countries' I&N – NT/RCP	Elaborated by	Verified by	Approved by
Argentina	-	-	**Marcelo Denicola**
Brasil	-	-	**Victor Manuel Galvao Macedo Cost**
Chile	-	-	**Hans Christian Rother Salazar**
Colombia	-	**Raul Ernesto Moreno Zea**	**Cesar Augusto Rincon Alvarez**
Iberia	*See Global I&N – NT Iberia – Solution Development Center*		
Italy	**Stefano Riva**	**Roberto Calone**	**Lilia Consiglio**
Peru	-	-	**Roberto Leonidas Sanchez Vargas**
Romania	-	-	**Marius Mihai Domnicu**

	Elaborated by	Verified by	Approved by
Global I&N – NT/RCP	**Christian Noce**	**Christian Noce**	**Giorgio Di Lembo**
Global I&N – NT Iberia – Solution Development Center	**Jose Maria Romero Gordon**	**Jose Maria Romero Gordon**	**Maria Avery Fernandez**

Revision	Data	List of modifications
00	13.11.2015	First version
01	29.01.2016	Approved first version

Index

Figures

Tables

1 ACRONYMS

- **PQ** Power Quality
- **PQI** Power Quality Instrument according to IEC 62586-1
- **PQIA** Power Quality Instrument Accessories
- **GPS** Global Positioning System
- **GPSR** GPS Receiver Time Syncro Receiver
- **M3G** Modem GSM – GPRS – UMTS (2G + 3G)
- **RTU** Remote Terminal Unit
- **PQMS** Power Quality Management System
- **1PPS** A pulse per second signal
- **SIM** Subscriber Identity Module
- **SMA** SubMiniature connector version A
- **CLI** Caller Line Identification
- **NTP** Network Time Protocol
- **PIMS** PQI management system
- **HMI** Human-Machine Interface
- **UPS** Uninterruptible Power Supply
- **VS** Voltage Sensor
- **CS** Current Sensor
- **DNP3** Distributed Network Protocol
- **REST** Representational State Transfer
- **RADIUS** Remote Authentication Dial-In User Service
- **APN** Access Point Name

- **VPN** Virtual Private Network
- **COMTRADE** Common format for Transient Data Exchange for power systems
- **DNS** Domain Name System
- **DHCP** Dynamic Host Configuration Protocol
- **DHCPv6** Dynamic Host Configuration Protocol (IPv6)
- **JSON** JavaScript Object Notation
- **CSV** Comma-separated values
- **TCP** Transmission Control Protocol
- **HTTP** Hypertext Transfer Protocol
- **HTTPS** Hypertext Transfer Protocol Secure

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

The Power Quality Instrument (PQI) described in this GS is inside the category PQI-A-FI1-H by according to IEC 62586-1 and it can be classified in three classes provided in Table 1.

Table 1 – PQI product family and description

PQI type	Product family code	Description
PQI type R	PQI-A-FI1-H	PQI rack 19” mounting
PQI type W	PQI-A-FI1-H	PQI wall mounting with plugs
PQI type D	PQI-A-FI1-H	PQI top hat rail 35 X 15 mounting

All the PQI can be equipped with the accessories provided in Table 2.

Table 2 – PQI accessories

PQI accessory id	Product family	Description
8.1.a	Cables	Power supply cable, with first termination according to the PQI power supply input and the second according to country plugs;
8.1.b	Cables	One cable for each digital/analog input/output with both termination according to the specific terminal block.
8.2.a	Modem kit	Modem 2G/3G (M3G);
8.2.b	Modem kit	Cellular antenna with magnetic mount, 10 m RG-174U cable and termination SMA male connector.
8.3.a	GPS kit	GPS receiver (GPSR);
8.3.b	GPS kit	20 m cable for connection to PQI, both termination in RJ12;
8.3.c	GPS kit	GPS antenna with magnetic mount and/or wall plugs, with 5 m cable, with L bracket;
8.3.d	GPS kit	extra bracket for wall mounting.

3 NORMATIVE REFERENCES AND BIBLIOGRAPHY

All the references are intended in the last revision or amendement.

3.1 For all countries

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 60068-2-6	Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal)
IEC 60068-2-64	Environmental testing - Part 2-64: Tests - Test Fh: Vibration, broadband random and guidance
IEC 60068-2-78	Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state
IEC 60255-27	Measuring relays and protection equipment - Part 27: Product safety requirements
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 61000-4-18	Electromagnetic compatibility (EMC) - Part 4-18: Testing and measurement techniques - Damped oscillatory wave immunity test
IEC 61000-4-2	Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test
IEC 61000-4-29	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	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 60529	Degrees of protection provided by enclosures (IP code)
CISPR 22	Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement (international standard);
IEC 61000-6-4	Electro-magnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments;
IEC 61000-4-30	Electromagnetic compatibility (EMC) – Part 4-30: Testing and measurement techniques – Power quality measurement methods.
IEC 61000-3-8	Electromagnetic compatibility (EMC) – Part 3: Limits – Section 8: Signalling on low-voltage electrical installations – Emission levels, frequency bands and electromagnetic disturbance levels.
IEC 61000-4-7	Electromagnetic compatibility (EMC) – Part 4-7: Testing and measure¬ment techniques – General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto.
IEC 61000-4-15	Electromagnetic compatibility (EMC) – Part 4-15: Testing and measurement techniques – Flickermeter – Functional and design specifications.

IEC 61180 (all parts)	High-voltage test techniques for low voltage equipment
IEC 62586-1	Power quality measurement in power supply systems – Part 1: Power quality instruments (PQI).
IEC 62586-2	Power quality measurement in power supply systems – Part 2: Functional tests and uncertainty requirements.
IEC 61010-1	Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements.
IEC 61010-2-032	Safety requirements for electrical equipment for measurement, control and laboratory use - Part 2-032: Particular requirements for hand-held and hand-manipulated current sensors for electrical test and measurement
IEC 61000-6-2	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments
IEC 61000-6-3	Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments
IEC 61000-2-4	Electromagnetic compatibility (EMC) - Part 2-4: Environment - Compatibility levels in industrial plants for low-frequency conducted disturbances
IEC 60297 (all parts)	Mechanical structures for electronic equipment.
IEEE 1159.3	IEEE Recommended Practice for the Transfer of Power Quality Data.
NMEA 0183	National Marine Electronics Association electrical signal requirements, data transmission protocol and time, and specific sentence formats for a 4800-baud serial data bus
ISO/IEC 7810	Identification cards - Physical characteristics
GSTQ003	Power Quality Management System
GSTQ002	Extended Power Quality Data Interchange Formats
IEC 60870-5-104	Telecontrol equipment and systems - Part 5-104: Transmission protocols - Network access for IEC 60870-5-101 using standard transport profiles
IEC 62749	Assessment of power quality - Characteristics of electricity supplied by public networks
IEC 60715	Dimensions of low-voltage switchgear and controlgear. Standardized mounting on rails for mechanical support of electrical devices in switchgear and controlgear installations
IEC 17025	General requirements for the competence of testing and calibration laboratories
IEC 17065	Conformity assessment - Requirements for bodies certifying products, processes and services

3.2 For EU countries

EN 50160	Voltage characteristics of electricity supplied by public distribution systems.
EU directive 2004/108/CEE	EMC directive
EU directive 2006/95/CEE	Low Voltage directive
EU directive 93/68/CEE	CE marking directive

3.3 For Italy

RSE 12004159	Specifiche tecnico-funzionali delle apparecchiature di monitoraggio della qualità della tensione per le reti MT.
[1]	R. Chiumeo, M. de Nigris, L. Garbero, C. Gandolfi, L. Tenti, E. Carpaneto, “Implementation of a New Method for an Improved Voltage Dips Evaluation by the Italian Power Quality Monitoring System in Presence of VT Saturation Effects”, International Conference on Renewable Energies and Power Quality (ICREPQ’10), Granada (Spain), 23rd to 25th March, 2010.
ARG/elt 198/11	Testo integrato della qualità dei servizi di distribuzione e misura dell’energia elettrica per il periodo di regolazione 2012-2015

4 REPLACED STANDARDS

Codification	Country	Title
DV908	Italy	Apparecchiatura di monitoraggio della qualita' della tensione delle reti elettriche MT

5 APPLICATION FIELDS

The PQI will be installed in the high/medium/low voltage distribution grids in order to measure all the relevant PQ parameters. The relevant PQ parameters are defined in IEC 61000-4-30, IEC 62749 and EN 50160.

The installation will be a substation or another indoor premise in a country where one or more utilities are under Enel control.

The PQI must include RTU functionalities in order to allow data exchange (according to GSTQ002) with the PQMS. The PQMS is the Power Quality Management System (according to GSTQ003), including data acquisition from PQI.

6 PQI BASILAR REQUIREMENTS

According to IEC 62586-1 all the requirements for PQI-A-FI1-H must be respected, just the particular requirements for the PQ parameter “mains signalling voltage” can be intended as advanced requirements (par. 7.7).

Additional requests are present in this chapter.

6.1 Enclosure

With reference to the enclosure, three alternatives are possible (the choice will be declared during the procurement process par. 10.2):

a. Rack 19” mounting according to IEC 60297 (named PQI type R);
b. Wall mounting with plugs (named PQI type W);
c. Top hat rail 35 X 15 mounting according to IEC 60715 (named PQI type D).

The enclosure must contains all the PQI and accessories (when specified). Commercial name, trademark, CE mark (in EU), product number and serial number must be visible and not removable.

6.2 Power supply

The supply voltage must be compliant with all or some of the followings ranges (the choice will be declared during the procurement process par. 10.2):

a. 90 ÷ 130 Vdc;
b. 207 ÷ 253 Vac with 50 Hz or 60 Hz as rated frequency (according to IEC 61000-6-2 and IEC 61236-1, the 4 kV immunity level for fast transients and surges is required);
c. 20 ÷ 28 Vdc;
d. 90 ÷ 130 Vac with 50 Hz or 60 Hz as rated frequency (according to IEC 61000-6-2 and IEC 61236-1, the 4 kV immunity level for fast transients and surges is required).

According to the IEC 61000-4-30 and IEC 62586-1, the PQI is called to work also in presence of power quality disturbances affecting also the power supply.

Adeguate protection must be present against the accidental supply with not standard voltages.

6.3 Input channels

The electrical quantities to be measured may be either directly accessible, as it is generally the case in low voltage systems, or accessible via measurement sensor like VS or CS. All the inputs/outputs must be synchronized.

Type	N° of channels	Range	Permanent overload	Impedance	Terminal blocks
Voltage input channels	4	Single range up to 600 Vac/dc (phase to phase)	+100%	> 1MΩ	pitch 7,62 mm, pluggable
Current channels from transducers	4	0 ÷ 3 Vac/dc	+50%	> 1MΩ	pitch 3,81 mm, pluggable
Insulated digital inputs	12	24 ÷ 130 Vdc	-	-	pitch 3,81 mm, pluggable

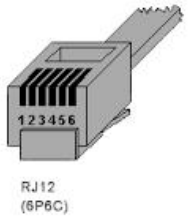
With reference to voltage input channels, according to IEC 61000-6-2 and IEC 61236-1, the 4 kV immunity level for fast transients and surges is required.

6.4 Other ports and expansion slots

The following ports must be present in the rear of the PQI (for type R) or in front (for types W and D):

a. Ethernet (RJ45) 10/100 Mbps for data exchange with the PQMS;
b. Ethernet (RJ45) 10/100 Mbps for local configuration (in front for all type);
c. RJ12 (Figure 1) including RS 422/485 physical interface (TX+ TX- pins), 1PPS digital input pins and external supply for GPSR (par. 8.3);
d. USB 2.0 type microB female (in front for all type) for local data upload/download;
e. Voltage free contact for system fault indication (this output may also be supplied by a semiconductor relay).

With reference to 5.4.b and 5.4.d, Enel will evaluate possible merging solution proposed by the suppliers.



RJ11 6P6C (RJ12)	
Pin	**Description**
1	Vcc (5÷12 Vdc)
2	GND
3	PPS+
4	RS422 TX+
5	RS422 TX-
6	PPS-

Figure 1 – PQI RJ12 pinouts

The PQI must be equipped with at least 1 expansion slot, that will allow:

f. The inclusion in the PQI of new accessories (particularly the M3G of par. 8.2), without the change of the dimension of PQI types W and D;
g. The inclusion in the PQI of new accessories (particularly the M3G of par. 8.2), without the violation of rack standard dimension for PQI type R and avoiding to hide any embedded connector creating trouble in cabling;
h. The replication of all the port of the new accessories;
i. The complete data exchange between new accessories and PQI;
j. The power supply of new accessories.

6.5 PQI management system

The PQI must be equipped with an internal PQI management system (PIMS) with web server. Security policy based on username and password must be implemented in order to avoid not desiderable accesses.

The HMI with the PIMS must be possible connecting a PC to the Ethernet port and presenting hit as a web client; MS Internet Explorer v7 (or more) and Google Chrome v41 (or more) must be allowed.

The PIMS must allow:

a. To configure the installation code;
b. To visualize all the measurement performed by the PQI in real time (including the fasorial diagrams);
c. To manage all the data stored in the PQI internal data storage (par. 6.6);
d. To manage the data exchange and communication issues;
e. To perform all possible settings (including the VS and CS ratio);
f. To manage PQI system alarms and warnings.

Configuration settings must be also uploaded as a single file/request by means of the PIMS, SFTP and REST servers (when required according to par. 7.5).

The PIMS must allow to define which field signals are received trough the digital inputs (by selection from drop-down menu), particularly the following cases must be covered:

g. Events from network protection devices, the PIMS must allow the configuration of the protection code;
h. Open/close of a breakers/switches, the PIMS must allow the configuration of the breaker/switch code;
i. Open/close of busbars couplers, the PIMS must allow the configuration of the couplers code and the codes of the two busbar coupled.

The list of protection/breaker/switch/coupler codes will be shared by Enel and inserted in the drop-down menu by the supplier.

The PIMS must allow to define which measurements (by selection from drop-down menu) are available trough the analog output (when required according to par. 7.3); the selectable measures are all the available (according to IEC 61000-4-30). Also the refresh time of the measures must be configurable according to Table 1.

The PIMS must allow to define which internal signal is available trough the digital output (by selection from drop-down menu), particularly the following case must be covered:

j. All the internal system warnings/alarms;
k. Over/under voltage/current events.

The PIMS must include also the automatic routine to exchange data with the PQMS:

l. Scheduled data exchange;
m. Data exchange after events.

6.6 Internal data storage

The PQI must include an internal data storage >30 Gb completely dedicated to store the power quality registration (the memory usable must be configurable by the PIMS).

The data must be preserved also in case of 1 month PQI deenergization.

6.7 Phisical buttons and leds

The following physical buttons and leds must be available in front of the PQI:

a. Power button (on/off of the PQI);
b. Reset button;
c. Power on led (green if PQI is turned on);
d. Battery (par. 7.1) status (red if the battery is low, is not in charge or have another warning).

6.8 Communication requirements and data format

The PQI must include RTU functionalities in order to allow data exchange with a PQMS and time synchronization with GPSR.

The PQI must be compliant with the following standards:

a. NMEA 0183, that is a combined electrical and data specification adopted for communication between GPSR and the PQI, for the synchronization of the PQI internal clock.
b. 1PPS, that is a pulse per second electrical signal (that has a width of less than one second and a sharply rising or abruptly falling edge that accurately repeats once per second) adopted to improve the synchronization between GPSR and PQI obtained by NMEA 0183.
c. NTP, that is a protocol for network synchronization adopted in alternative to NMEA 0183 + 1PPS, in case the PQI is inside a network with NTP server; the PQI must also behave as an NTP server when synchronizing by means of NMEA/1PPS signals.

d. PQDIF (according to IEEE 1159.3 and to GSTQ002), that is is a binary file format adopted to exchange PQ measurements and events between PQI and PQMS.

The requested communication mode are the followings:

e. PQI must be configured as a IPv4/IPv6 network node;
f. PQI must be configured in point to point communication using GPRS/PSTN network, by using the phone number;
g. The PQI must be able to operate as a SFTP client or a SFTP server (the SFTP certified connection must be managed just with username and password).

With reference to IP configuration, following alternatives must be implemented:

h. IPv4 – fixed configuration (ip address, netmask, default gateway and DNS server);
i. IPv4 – auto configuration (DHCP);
j. IPv6 – fixed configuration (ip address, prefix length, default gateway and DNS server);
k. IPv6 – stateless auto configuration;
l. IPv6 – stateful auto configuration (DHCPv6).

The inbuilt SFTP server must allow:

m. Folders and filenames list;
n. Get/delete a single file;
o. Put a configuration file.

In case of communication problems or any other issue that prevents the data exchange with the PQMS, the PQI must repeat the sending procedure every 15 minutes.

The mode 5.8.e and 5.8.g are possible with wired LAN connection or with virtual LAN connection, also using the M3G (VPN, APN management). Just HTTPS must be used when the M3G is employed. RADIUS is the networking protocol that provides centralized Authentication, Authorization, and Accounting management for PQI who connect and use the network service needs to data exchange with PQMS.

The mode 5.8.f must be possible just with the M3G.

6.9 Scheduled data exchange

The scheduled data exchange is made in a random instant of a configurable range of the day. The PIMS must allow to configure this range from 00:00 to 24:00, granularity 1h; the default is a random from 01:00 to 06:00, in order to avoid that all the PQI will be set to send at the same moment.

The PQI must create just a single PQDIF including all the PQ measure and events (par. 6.11, 6.12 and 6.13) detected in the last day; then PQI must start a SFTP connection (as a SFTP client) with the PQMS delivering the file. For example at 02:00 of Monday the PQDIF must create and send the PQDIF for the entire Sunday.

The name of the PQDIF file must have a formatting as “Prefix_SeedFileName_yyyyMMdd_hhmmss.pqd”, where Prefix indicates the manufacturer (2 char), SeedFileName is the unique identifier of the name installation code of PQI (max 16 char, must not contain the character '_' and the space character ' '), yyyyMMdd_hhmmss is the creation date (year 4-digit, month 2-digit, dd day 2-digit) and time (hour 2-digit, minutes 2-digit, second 2-digits).

6.10 Asyncronous data exchange

The asyncronous data exchange is made immediately after a configurable event, trend (over a certain limit) or transient.

The PQI must create just a single PQDIF including all these PQ trends, transients and triggered events (that caused the asyncronous data exchange); then PQI must start a SFTP connection (as a SFTP client) with the PIMS delivering the file.

The asyncronous data exchange is also made when the internal data storage occupation (par. 6.6) overcome a configurable occupation (default 80%), by sending all data stored.

6.11 Trends registration

According to IEC 61000-4-30 and Table 3, the PQI must provide trend registration (data exchange between PQI and PQMS must be according GSTQ002).

All the configurations must be done in the PIMS.

Table 3 – Trends registration

PQ parameter	Activable trends
Power frequency	10/12 cycles measurement (that is also the default) or multiples (just for the analog outputs), accuracy 0.01 Hz. 10 s measurement. Aggregation from 10 minute to 2 hours (step 10 minute, default 10 minutes).
Magnitude of the supply voltage Magnitude of current	10/12 cycles measurement (default for the analog outputs). 150/180 cycles aggregation measurement. Aggregation from 10 minutes to 2 hours (step 10 minute, default 10 minutes).
Supply voltage unbalance Current unbalance	10/12 cycles measurement (default for the analog outputs). 150/180 cycles aggregation measurement. Aggregation from 10 minutes to 2 hours (step 10 minute, default 10 minutes).
Voltage/Current harmonics	10/12 cycles measurement (default for the analog outputs). 150/180 cycles aggregation measurement. Aggregation from 10 minutes to 2 hours (step 10 minute, default 10 minutes).
Voltage/Current inter-harmonics	10/12 cycles measurement (default for the analog outputs). 150/180 cycles aggregation measurement. Aggregation from 10 minutes to 2 hours (step 10 minute, default 10 minutes).
Under/over deviation	10/12 cycles measurement (default for the analog outputs). 150/180 cycles aggregation measurement. Aggregation from 10 minutes to 2 hours (step 10 minute, default 10 minutes).
Flicker	10 minutes computation for P_{st} (default for the analog outputs). 2 hours computation for P_{lt} (default for the analog outputs). Aggregation according to IEC 61000-4-15.

With reference to the analog outputs (if the advanced requirement in par. 7.3 is requested), the output current range (4 ÷ 20 mA) must be optimized according to Table 4, in case of power frequency measurement.

Table 4 – Analog outputs current in case of power frequency	
Power frequency [f]	**Analog outputs current [mA]**
f < 45 Hz	4 mA
45 Hz ≤ f ≤ 48.75 Hz	1.0667f – 44
48.75 Hz < f < 51.25 Hz	3.2f – 148
51.25 Hz ≤ f ≤ 55 Hz	1.0667f – 38.6667
f > 55 Hz	20 mA

6.12 Triggered events registration

According to IEC 61000-4-30 and Table 5, the PQI must provide a triggered events registration (data exchange between PQI and PQMS must be according GSTQ002).

Table 5 – Triggered events registration	
PQ parameter	**Data registered for each event**
Supply voltage dips	Event id. Time stamp with date, 1 cs of precision. Duration. Residual voltage. Voltage phases involved (R, S, T, RS, ST, TR). Vero, Falso, ND (if the advanced requirement in par. 7.4 is requested). Correlation with events detected by digital inputs. Wafeforms with < 0.5 ms samples. ½-cycle RMS recordings. Dips detection as a triggered event.
Supply voltage interruptions	Event id. Time stamp with date, 1 cs of precision. Duration. Residual voltage. Voltage phases involved (R, S, T, RS, ST, TR). ½-cycle RMS recordings. Correlation with events detected by digital inputs. Interruption detection as a triggered event.

Supply voltage swells	Event id. Time stamp with date, 1 cs of precision. Duration. Max voltage. Voltage phases involved (R, S, T, RS, ST, TR). Correlation with events detected by digital inputs. Wafeform with < 0.5 ms samples. ½-cycle RMS recordings. Correlation with events detected by digital inputs. Swell detection as a triggered event.
Power frequency	Wafeforms with < 0.5 ms samples. ½-cycle RMS recordings. Frequency over range as a triggered event.
Magnitude of the supply voltage Magnitude of current	Wafeforms with < 0.5 ms samples. ½-cycle RMS recordings. Voltage/Current over range as a triggered event.

All the configuration must be done in the PIMS. The number of waveforms to register after each event must be also configurable, the default is to register the related event wafeform (for example, if the event is a voltage dip the waveform will be the related voltage affected).

The events from digital inputs are correlated if detected in a time range around the PQ parameter detection; ±100ms as a default value, step 20 ms configuration must be possible to enlarge that range (low limit and high limit must have independent configuration).

However all the events from digital inputs must be also exchanged with the PQMS, as independent events (according to GSTQ002).

The waveform registration is disabled for default, eccept for power frequency where is enabled after a certain event-time (Figure 2); the minimum event time must be configurable between 20 ms ÷ 1 s (default 200 ms).

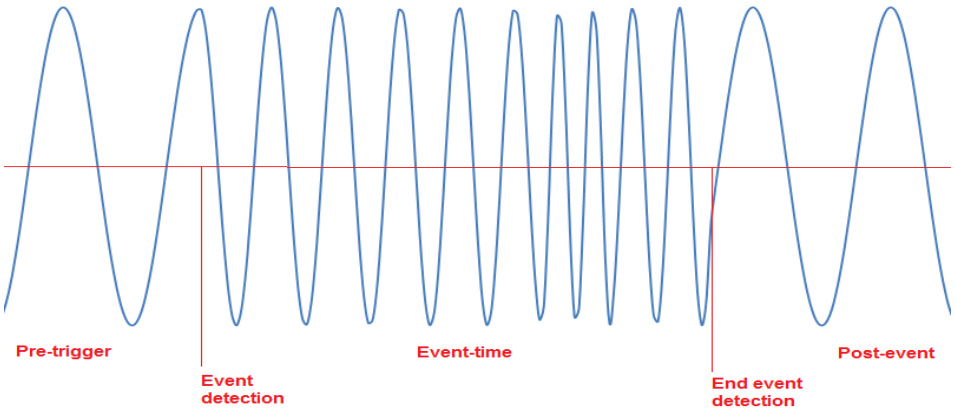


Figure 2 – Pre-trigger and post-event times

The voltage/current waveform registration must be automatically activated after the triggered event with the following settings (Figure 2):

a. Pre-trigger time from 20 ms to 1 s, step 20 ms and default 60 ms;
b. Full event-time registration;
c. Post-event time from 100 ms to 60 s, step 100 ms and default 300 ms;
d. A wafeform registration cannot overcome 90 s of duration;
e. Trigger range for over/undervoltages and over/under frequency are ±10% around the rated values as a default value, step 0.2% configuration must be possible to enlarge that range (low limit and high limit must have independent configuration).
f. Trigger range for over/undercurrents must be fully configurable.

6.13 Crucial system events registration

According to par. 6.5.f the PIMS must manage system warnings and alarms in term of recording and data exchange with the PQMS (according GSTQ002).

Following crucial events must be approached as follow:

a. NO GPS SYNCHRONIZATION, due to a recognition of a no synchronized time base (typically on start before engaging the GPS or absence/interruption connection to GPSR) the PIMS must record an event of "time base of sync", identifying the instant of start and the duration of this condition.
b. MEMORY FULL, when the internal data storage occupation (par. 6.6) overcome the 80% of filling, identifying the instant of happening.
c. VOLTAGE ANOMALY, due the persistence (at least 6 hours) of the voltage measurement in the range ± 10% Vn for one or two channels of the PQI and the voltage measuring over the range ± 30% Vn for the remaining channels (two or one, respectively). Identifying the instant of start and the duration of this condition. After the first recording (after 6 hours of the occurrence of the fault condition), the event is repeated at most once a day, for the duration of the fault condition. Note that the absence of voltage on all channels of the apparatus is not considered an anomaly voltage channels. Furthermore, the management of this event is significant only if the device is configured for three-phase measures, while not provided for single-phase measures.

6.14 Safety

By complementing and clarifying the requirements of the IEC 62586-1, basic insulation is not a sufficient protection, double insulation (IEC 61010-1 class 2) is mandatory.

7 PQI ADVANCED REQUIREMENTS

The requirements from this chapter must be respected just if expressely requested during the procurement process (par. 10.2).

7.1 Power supply

A battery must be present to assure a continuity of the measurements at least for 30 minutes of interruption of any other power supply disturbance (UPS function).

7.2 Input channels

The electrical quantities to be measured may be either directly accessible, as it is generally the case in low voltage systems, or accessible via measurement sensor like VS or CS. All the inputs/outputs must be synchronized.

Type	N° of channels	Range	Permanent overload	Impedance	Terminal blocks
Current direct input channels	3	0 ÷ 10 A	+100%	-	pitch 7,62 mm, pluggable

7.3 Output channels

All the inputs/outputs must be synchronized.

Type	N° of channels	Range	Permanent overload	Impedance	Terminal blocks
Analog current outputs	4	4 ÷ 20 mA	-	-	pitch 7,62 mm, pluggable
Insulated digital outputs	1	24 ÷ 130 Vdc	-	-	pitch 3,81 mm, pluggable

7.4 Voltage dip monitoring according to Italian Regulation

The PQI must be fully compliant with the technical specification RSE 12004159, in order to be inserted in the Italian voltage dip monitoring survey promoted by regulation ARG/elt 198/11.

Particularly the voltage dip validation described in [1] must be implemented in the PQI, this process must be disabled in PIMS configuration (it is enabled for default).

7.5 PQI management system and communication requirements

The PQI must have an inbuilt REST server with the following capabilities:

a. Folders and filenames list;
b. Get/delete a single file;
c. Get/delete a complete folders structure;
d. Put a single file;
e. Download a complete set of periodic measurements for a given time interval and requested variables (in order to deploy a fully distributed architecture);
f. Download a set of waveforms or 10 ms RMS recordings for a given event id.
g. Input parameters inside the GET or POST request;
h. Inbuilt IEC 60870-5-104, DNP3 or MODBUS TCP/RTU server for enabling straightforward integration into existent SCADA solutions.

With reference to the fully distributed architecture, by querying the PQI and getting a complete set of periodic or event-triggered measurements, a fully distributed architecture without a centralized database can be deployed. Upon request the centralized system would query a single PQI, retrieve periodic

measurements and translate them into viewable information. This architecture must be highly scalable, parallelizable, fault tolerant, robust and transparent to the end user.

Output format must be JSON or CSV. In case of a POST request a JSON input dictionary is requested.

Input parameters must be:

i. Start timestamp;
j. End timestamp;
k. Requested periodic variables or event id.

The basic GET commands for remote control of the device must be, at least:

l. Cold or hard restart;
m. Cold or hard shutdown;
n. Formatting of internal data storage;
o. Reload of configuration files.

7.6 Measure of energy

The PQI must include energy meter functionalities according to IEC 62053-22-30 Class 0.2S.

7.7 Mains signalling voltage

According to IEC 62586-1 all the requirements for the PQ parameter “mains signalling voltage” must be also respected.

8 PQI ACCESSORIES

The accessories from this chapter must be included just if expressely requested during the procurement process (par. 10.2).

8.1 Cables

The following cables must be included for PQI power supply and for connection of the trasducers:

a. Power supply cable, with first termination according to the PQI power supply input and the second according to country plugs;
b. One cable for each digital/analog input/output with both termination according to the specific terminal block.

With reference to 8.1.b, Table 6 shows the minimal requirements (the outer diameter must be also compatible with the terminal blocks).

Table 6 – Digital/analog input/output cables

Requirements	Voltage input channels	Current direct input channels	Analog current outputs Insulated digital inputs/outputs Current channels from transducers
Insulation	PVC	PVC	PVC
Nominal cross section	0.75 mm^2	2.5 mm^2	0.5 mm^2
Outer diameter	3.9 mm	3.9 mm	2 mm
Insulation design	Double	Double	Single
Rated voltage	1500 V	1500 V	500 V
Test voltage	8000 V	8000 V	2200 V
Rated current	15 A	32 A	10 A
Temperature operating range	-10°C ÷ 70°C	-10°C ÷ 70°C	-10°C ÷ 70°C

8.2 Modem kit

The Modem kit is made by:

a. Modem 2G/3G (M3G);
b. Cellular antenna with magnetic mount, 10 m RG-174U cable and termination SMA male connector.

The M3G must have the followings characteristics:

c. Compatible with cellular frequiences 2G (GSM850, GSM900, DCS1800, PCS1900) and 3G (B1-2100, B2-1900, B5-850, B8-900);
d. Installable in the PQI expansion slot (par. 6.4);
e. Compatible with SIM or mini SIM, according to ISO/IEC 7810;
f. SMA female connector for external antenna;
g. Compatible with CLI.

The antenna and cable in 8.2.b must assure >2.5dB gain and certified for indoor operation.

8.3 GPS kit

The GPS kit is made by:

a. GPS receiver (GPSR);
b. 20 m cable for connection to PQI, both termination in RJ12;
c. GPS antenna with magnetic mount and/or wall plugs, with 5 m cable, with L bracket;
d. extra bracket for wall mounting.

The GPSR must be >20 channels parallel tracking GPS receiver designed to operate with the L1 frequency, Standard Position Service, Coarse Acquisition code.

GPSR must be able to synchronize up to 10 devices, like PQI or other devices that need accurate synchronization signal, according to IEC 61010-1, IEC 61000-2/3/4, NMEA 0183. It must have at least 10 RJ12 connectors (Figure 1), each one providing:

e. RS422/485 serial connection (just TX+ TX- pins) with NMEA 0183 protocol;
f. open-collector pulse-per-second (PPS+, PPS- pins) output synchronization signal;
g. GPSR external power input (Vdc, GND pins).

The power supply input can be provided equally by each of the 10 devices connected to the receiver, without the need to assign to a single device the function of power source and exclude all other.

The power supply characteristics must be:

h. 9 ÷ 14 Vdc;
i. <3 VA;
j. 24 V MAX, 5 mA MAX of electrical range.

The 1PPS characteristics must be:

k. >0.5 s of signal duration;
l. ±100 ns of signal precision;
m. <24 V, <5 mA of electrical range.

The cable in 8.3.b must have the both terminations in RJ12 (Figure 1).

The antenna and cable in 8.3.c must assure >20dB gain and certified for outdoor operation, also in term of environmental/safety/EMC requirements.

9 TESTING AND CERTIFICATIONS

According to IEC 62586-1 and IEC 62586-2 all the requirements from this chapter must be respected. Enel has the right to ask a prototipe for any kind of verification testing. These tests can be performed in the provider factory or laboratories, with no cost participation by Enel.

9.1 Testing

Functional, environmental and safety type tests must be made according to IEC 62586-1.

Routine tests must be made according to IEC 62586-1.

Functional and uncertainty tests must be made according to IEC 62586-2.

Compliance to GSTQ002 must be demonstrated in the Enel test centers.

For the tests not expressly covered by IEC 62586-1, IEC 62586-2 or IEC 61000-4-30 the provider must propose a test plan to Enel.

9.2 IEC 61000-4-30 certification

The certificate of conformity to IEC 61000-4-30 class A must be provided.

The certificate must summarizes the results of a compliance report (based on compliance tests), that must be also provided; the compliance tests must be made according to IEC 62586-2.

The certificate and the report must be signed by a third party entity, qualified according to ISO/IEC 17025 and ISO/IEC 17065; however the final decision about the validity of the certification is made by Enel.

9.3 Certifications or self-certifications of calibration

A certificate or selfcertificate of calibration must be provided, it must be valid for the first 3 years from the delivery.

So this document must certificate that no further calibration/verification is needed for the first 3 years after PQI delivery. During this period the PQI must preserve its metrological qualities (included the IEC 61000-4-30 Class A certification).

9.4 Other certifications and self-certifications

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

Certifications and self-certifications must be made according to IEC 62586-1 and IEC 62586-2 (including the template format).

9.5 RSE certification

This certificate of conformity must be provided if the advanced requirement in par. 7.4 is requested.

The Italian institution Ricerca sul Sistema Energetico SpA (RSE) is the only entity that can certificate the PQI according to this requirement.

10 MISCELLANEOUS

This chapter include further requirements, recommendations and additional information.

10.1 Required documentation

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

a. User's manual;
b. Maintenance manual;
c. Quick installation and set-up guide;
d. Administrator's manual, for proper integration of PQI into communication and IT networks (this document should describe any network service the PQI is supplying);
e. Installation and one-wire diagrams (also in DWG/DXF formats);
f. PQI data sheet with snapshots;
g. All software need to PQI operation.

This documents must be made according to IEC 61010-1 and they must be approved by Enel.

A copy of these documentation must be accessible by the PIMS HMI.

10.2 Clarification during procurement process

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

a. Choice about enclosure (par. 6.1);
b. Choice about power supply (par. 6.2);
c. Advanced requirement to include (chap. 7);
d. Accessories included (chap. 8);
e. Language for embedded sw and documentations.

10.3 Amendement

Because of the earlier stage of some international standards used in this GS, Enel may derogate some prescriptions.

Possible derogations must be requested by the provider just during the procurement process.

10.4 PQI delivery form

PQI, accessories etc. must be included in a single box, with adeguate mechanical protection against vibrations and bumps; also the immunity to bad weather must be adeguate. These boxes will be included in a main box.

The main box must be compliant with the selected transportation way.

The main box must have a external and well visible sticker with:

a. PQI commercial name;
b. Trademark;
c. CE mark (in EU);
d. Product number and serial number;
e. Number of PQI included;
f. Enel contract reference number.

Enel will provide all the detailed specifications before the field delivery.