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THE HEAD OF SMART METER
Gianni Ceneri

1. DOCUMENT AIMS AND APPLICATION AREA

This document briefly defines the general characteristics of Quantum Edge device and its functionalities, it is used for DSO's markets, meter reading systems and/or smart grids protections.

1.1 RELATED ORGANIZATIONAL DOCUMENTS TO BE IMPLEMENTED AT COUNTRY LEVEL

Within the corresponding geographical perimeter, each I&N country shall issue, under the supervision of Global I&N, a detailed document in accordance with the provisions of this document.

2. DOCUMENT VERSION MANAGEMENT

Version	Date	Main changes description
1	[01/04/2021]	Issuing of Global Infrastructure and Networks – I&I - Smart Meter

3. UNITS IN CHARGE OF THE DOCUMENT

Responsible for drawing up the document:

- Global Infrastructure and Networks: I&I - SM

Responsible for authorizing the document:

- Global Infrastructure and Networks: Head of Smart Meter
- Global Infrastructure and Networks: Head of Quality Systems and Processes Unit

4. REFERENCES

- Enel Group Code of Ethics;
- The Enel Group Zero Corruption Tolerance (ZCT) Plan;
- Organizational and management model as per Italian Legislative Decree no. 231/2001 or equivalent documents adopted in the Countries;
- Enel Human Rights Policy;
- Stop Work Policy;
- Enel Global Compliance Program (EGCP);
- Global Infrastructure and Networks RACI Handbook;
- QEd_Global_Ver05

5. ORGANIZATIONAL PROCESS POSITION IN THE PROCESS TAXONOMY

Value Chain /Process Area: [xxx]

Macro process: [xxx]

Process: [xxx]

6. DEFINITIONS AND ACRONYMS

Acronym and Key words	Description
QEd	Quantum Edge
PSU	Power Supply Unit
LVM	Low Voltage Manager
RTC	Real Time Clock
SiP	System in Package
AI	Artificial Intelligence
ARM	Advanced RISC Machine
DSP	Digital Signal Processing
PMIC	Power Management Integrated Circuit
LV	Low Voltage
MV	Medium Voltage
EV	Electric Vehicle
SCADA	Supervisory Control And Data Acquisition
API	Application Programming Interface
RES	Renewable Energy Source
THD	Total Harmonic Distortion
UP	Unità Periferica (Peripheral Unit)
RGDM	Rilevatore di Guasto e Di Misura (Protection and Control Device for MV Substation)
OS	Operating System

7. DESCRIPTION

7.1 Scope

QEd is a new generation device designed for indoor installations in secondary substations (MV/LV) or for pole installations and it is based on an ARM SoC and a Linux-based operating system. Its goal is to replace the existing technologies for monitoring, protection, and control of the electricity grid, merging them into a single device. The applications can be developed and downloaded from a brand-store as well as the OS and the kernel security upgradings thus getting the QEd upgradable in field and reliable. The purpose of the apps running on the QEd is the virtualization of the functionalities currently executed by different physical devices (protection, monitoring and so on) thus just a single device could integrate multiple substation equipment. The QEd operates on both 400Vac@50-60Hz (3x230Vac) and 220Vac@50-60Hz (3x127Vac) electric power networks, it includes a battery backup supply that allows operations even without power voltage supply.

7.2 Technical characteristics

7.2.1. Processor Unit

The QEd is equipped with an automotive grade SiP based on an ARM technology which represent the core of entire platform. The device includes 8GB RAM memory, PMICs, AI Engine, enhanced Peripheral Subsystem, Wlan Subsystem, DSPs.

7.2.2. Storage

The Storage function is based on Flash Memory devices with the following characteristics:

- UFS 2.1 I/F
- 64GB - 128GB memory device

7.2.3. Interfaces

The QEd has the following interfaces:

- 9x ETH (4 Optic – 5 Copper)
- 4x opto-isolated digital input ports
- 4x opto-isolated digital output ports

7.2.4. Analog Input Channels

The QEd is equipped with 7x RJ45 for the acquisition of 15 analog channels, which are used for voltages and current (MV side) analysis for basic and advanced automation and protection functionalities in the secondary substation.

7.2.5. RTC & Tampering

RTC

The Clock-Calendar function is achieved by an RTC module. It follows CEI EN 62054-21 standard, the accuracy is 0.5 s/day in standard condition.

Tampering

The function is covered by a mechanical switch placed between the cover and the case of the QEd mechanical structure. When the cover will be opened a detection alert will be available toward the SiP.

The anti-tampering mechanism also must be powered by the battery and the tampering information has to be stored even if the QEd is not powered. Same switch-over power supply circuit provides for RTC can be used for anti-tampering circuit.

7.2.6. Balance Meter Module

This module oversees the energy measurements of the Low Voltage side of the substation. It takes the LV voltage phases (L1, L2, L3, N) and the line currents (I1, I2, I3, scaled by suitable current transformers) and it computes all the relevant energy quantities as well as useful measurands:

- Active positive and negative energy (imported/exported).
- Total reactive energy in all quadrants ((R+L, R+C, R-L and R-C).
- Active power measurement total and for single phases (L1, L2 and L3).
- Reactive power measurement total and for single phases (L1, L2 and L3).
- RMS phase currents, RMS phase voltages, power factor ($\cos\phi$) and phase angle instantaneous values.
- Line frequency.
- Load profile recording for active and reactive energy in all four quadrants total and for single phases.
- THD and harmonics measurements of line voltage and line currents.
- Accuracy (active energy): Class C (EN50470).
- Accuracy (reactive energy): Class I (IEC/CEI EN 62053-23).
- RMS voltage and current measurements: 1% (better than).

7.2.7. Power Line Communication Module

This module oversees the power line communication with the smart meters for AMM (Advanced Meter Management) purposes, operating within the CENELEC "A-Band" (3-95kHz). It consists of the PLC System-on-chip (MODEM and MCU) and the PLC coupling circuits to the LV powerline.

The isolation requirement is: Overvoltage Category IV, 300V.

A suitable circuit provides the three L-N zero-crossing signals to the SiP. This section provides galvanic (safety) isolation as well.

7.2.8. RF Module and BLE 5x

The RF module is a custom module by Enel - CR107 DCR Module – fully compliant with European Wireless MBus protocol of EN 13757-3 and EN13757-4(mode N), it could work on double channel at same time. It is dedicated to Wireless MBUS application, its output power up 500mW in 169.400 to169.475 MHz ISM band. External antenna will be provided.

7.2.9. RF IoT Module LoRa (optional)

The IoT Lora/Lora Wan proposal is based on SOC from ST.

7.2.10. Power Supply Unit

The Power Supply Unit (PSU) provides the main DC supply for the complete device (peripherals and modules included). The PSU is supplied by both the three-phase AC L.V. mains and by an auxiliary DC supply (nominal 24-48V) available at the substation. The PSU should switch between the two power sources (from mains AC to aux. DC and vice versa) without any “voltage dip” at the output in case of sudden outage of one of the two sources. In case of simultaneous outage of both AC and DC power sources, a supercap battery will provide enough energy to allow a safe CPU switch off.

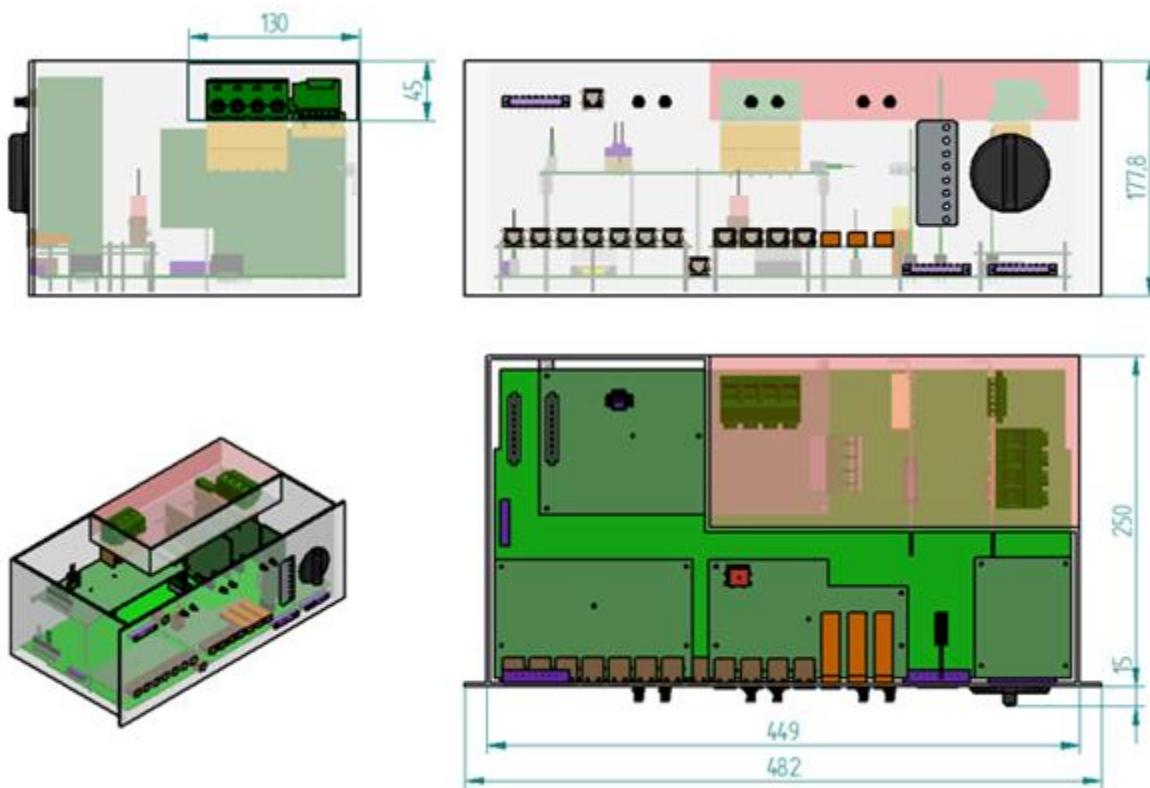
7.2.11. Cybersecurity

- HW components: mass production status only.
- Core components longevity equal or more than 10 years.
- The device only uses Industrial Grade components.
- Use of packages without direct access to the pins (like QFN, DFN, TFBGA, CSP).
- Programming and/or debugging interfaces must be blocked at HW level during the operation of the device.
- If required, all wireless interfaces must be turned off and activated only for the time frame they are needed.

7.2.12. Mechanical

The enclosure of the device is compliant with IEC 60297-3-101 to make it suitable for rack-mounting in a standard 19", with size:

- L = 482,6 mm,
- W = 250 mm,
- H = 177,8 mm.



7.3 Configurations

The QEd device will have three levels of configuration, including different features:

Basic Configuration:

- LVM (including LAST-GASP) Smart metering
- Integrated energy balance
- LV power quality
- LV Power quality measurement
- Sensors management (transformer monitoring, environmental and access)
- Ext temperature sensor included
- Multi-service support (support the monitoring of electricity, gas, and water meters through an RF channel)
- Local Wi-Fi support (a Wi-Fi module for local connection to the device, might be used for the initial configuration, for monitoring of Wi-Fi sensors or any other application with Wi-Fi support)
- Supporting Edge Computing (metering data validation and reconstruction, local model for energy load flow analysis and forecast, artificial Intelligence for anomaly and fraud detection, etc.)

This level of configuration needs additional components, such as:

- Router
- Sensors
- CT (current transformers)

Medium Configuration (starting from the basic configuration):

- Remote Control

This configuration needs power supply and backup battery and additional components, such as:

- UP RIO Module (Remote Input Output), one for each circuit breaker

Advanced Configuration (starting from the medium configuration):

- Basic and advanced automation
- Protection functionalities
- Partial discharge analysis
- Network status analysis

This level of configuration needs additional components, such as:

- Protection and Control Device RIO Module (Remote Input Output), one for each circuit breaker
- Smart terminations or CT/CV/sensors

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