EMPIR Call 2019 – Energy, Environment, Normative and Research Potential

Selected Research Topic number: **SRT-g08**
Version: 1.0

Title: Broadband EMI measurements for future electricity networks

Abstract

Defining and controlling the broadband electro-magnetic (EM) disturbance environment in electricity grids is essential for the stable integration of renewables, storage and electric vehicles. New traceable measurement and calibration methods are needed to enable utilities to manage and mitigate broadband (dc to 500 kHz) conducted interference in grids caused by sustainable technologies. This includes the development of new methods for measuring the interactions between source and sink impedances to understand resonance and damping of grid interference. This can be used to plan and control EM disturbance levels together with measurements of the proliferation, propagation and location of broadband grid EM interference.

Keywords

Electro-Magnetic Interference (EMI), Power Quality (PQ), EM Emissions, EM compatibility (EMC), Power Line Communications (PLC), Impedance measurements, transducers.

Background to the Metrological Challenges

The 2050 Energy Strategy [1] details the integration of large proportions of renewable energy sources (RES), the rapid proliferation of electric vehicles (EV) and the introduction of high efficiency appliances containing fast switching power electronics as challenges for electricity grids. In highly interconnected grids, power lines are not only providing energy between sources but are also a path of interference. As a result, a rapid increase of Electro-Magnetic Interference (EMI) and interoperability problems causes a deterioration in power quality (PQ) and unpredictable malfunction of grid connected electrical equipment. In conventional grids, power quality is guaranteed by the utilities. In future grids, it will be necessary to manage the risk of EM interference and provide mitigation by active interventions.

Highly variable grid impedance, which determines the transmission of EM interference, must be measured but this is difficult to do due to fast load and source fluctuations caused by power electronics. To take into account modern electrical equipment impedance must be characterised and traceable measurement techniques developed over an extensive frequency range from dc to 500 kHz. In addition, coupling devices used between measurement equipment and the grid need to be characterised and coupling methods have to be clearly defined. Such measurements are challenging due to unwanted coupling by parasitic elements such as mutual inductance and stray capacitance. Large grid connected installations such as renewable power parks, storage banks or groups of smaller devices such as EVs have the capacity to shift the grid impedance to potentially unstable conditions at certain frequencies. The introduction of unexpected resonance points or the sudden loss of damping, cause dangerous surges in current and voltage that seriously damage to grid infrastructure leading to power outages. The capability to measure the input impedance spectrum of large loads or aggregated installations is an important step to introduction of permitted input impedance levels to safeguard the reliable operation of future grids. For a given grid topology, utilities need to know how effectively interference transfers between different voltage levels and the spatial distance it propagates. Understanding the mechanism of propagation is the basis for revising the way of sharing the EM compatibility allocation between voltage levels and between customers in a single network. New propagation measurement methods can then be used by utilities for the real time determination of customer hosting capacity and grid planning levels for the future connections. The characteristics and size of a new grid load or source connection has the potential to become a tipping point for grid stability. In order to guarantee the PQ in high RES grids, utilities need new methods to locate EMI disturbances for diagnostics and enforcement.

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Objectives

Proposers should address the objectives stated below, which are based on the PRT submissions. Proposers may identify amendments to the objectives or choose to address a subset of them in order to maximise the overall impact, or address budgetary or scientific / technical constraints, but the reasons for this should be clearly stated in the protocol.

The JRP shall focus on the traceable measurement and characterisation of broadband EMI measurements for future electricity networks.

The specific objectives are

1. To develop and verify new measurement methods for fast fluctuating grid impedance from dc to 500 kHz with a target uncertainty of 10 % in different frequency bands with associated calibration capabilities for the instruments and associated coupling devices.
2. To develop and demonstrate measurement techniques for fast fluctuating four-quadrant impedance of individual and multiple grid connected equipment and aggregated impedance of customer installations, including the definition and representation of equipment impedance. The boundary conditions for equipment impedance required to protect the grid from interactions with grid impedance will be determined.
3. To develop and apply synchronised measurement methods for voltage and current propagation in grids. Focus will be on how emission propagates between voltage levels in the low frequency range and the distance of propagation in the high frequency range. To define the impact of connected equipment using propagation measurements in conjunction with theoretical models.
4. To develop and extend existing measurement methods for locating the sources of significant EM disturbances and determine their impact on the grid.
5. To facilitate the take up of the technology and measurement infrastructure developed in the project by the measurement supply chain, standards developing organisations (CENELEC, IEC 77A, IEC TC85) and end users (electricity generators, network operators, utility companies).

These objectives will require large-scale approaches that are beyond the capabilities of single National Metrology Institutes and Designated Institutes. To enhance the impact of the research, the involvement of the appropriate user community such as industry, standardisation and regulatory bodies is strongly recommended, both prior to and during methodology development.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this.

In particular, proposers should outline the achievements of the EMRP project ENG52 and EMPIR project 18NRM05 and how their proposal will build on those.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 2.0 M€, and has defined an upper limit of 2.3 M€ for this project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 35 % of the total EU Contribution across all selected projects in this TP.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community, describing how the project partners will engage with relevant communities during the project to facilitate knowledge transfer and accelerate the uptake of project outputs. Evidence of support from the “end user” community (e.g. letters of support) is also encouraged.

You should detail how your JRP results are going to:

- Address the SRT objectives and deliver solutions to the documented needs,
- Feed into the development of urgent documentary standards through appropriate standards bodies,
- Transfer knowledge to the energy sector.

You should detail other impacts of your proposed JRP as specified in the document “Guide 4: Writing Joint Research Projects (JRPs)”

You should also detail how your approach to realising the objectives will further the aim of EMPIR to develop a coherent approach at the European level in the field of metrology and include the best available contributions from across the metrology community. Specifically, the opportunities for:

- improvement of the efficiency of use of available resources to better meet metrological needs and to assure the traceability of national standards
- the metrology capacity of EURAMET Member States whose metrology programmes are at an early stage of development to be increased
- organisations other than NMIs and DIs to be involved in the work.

Time-scale

The project should be of up to 3 years duration.

Additional information

The references were provided by PRT submitters; proposers should therefore establish the relevance of any references.

[1] 2050 Energy Strategy, available on line at: https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/2050-energy-strategy, accessed 05/02/19.