EMPIR Call 2018 – Health, SI Broader Scope, Normative and Research Potential

Selected Research Topic number: **SRT-n05**
Version: 1.1

Title: Grid measurements of 2 kHz - 150 kHz harmonics to support normative emission limits for mass-market electrical goods

Abstract

Interference in the mostly unregulated supraharmonic spectrum (2 to 150 kHz) is causing mass-market electrical goods to malfunction and can reduce their life time considerably. As more interfering renewables, electric vehicle (EV) chargers and energy-efficient goods are added to the grid, the situation worsens and the need to limit emissions through regulation is urgent. Yet no normative method exists to measure supraharmonics in the grid due to difficulties with time varying impedances and emissions. In order to set enforceable supraharmonic limits in future standards, research is needed to develop rigorous, credible and agreed methods for grid compliance assessment and critically to verify how well present testing apparatus represents real grid conditions.

Keywords

Power quality, supraharmonics, EM emissions, EM compatibility, impedance measurements, transducers, waveform metrology, waveform transforms, algorithms.

Background to the Metrological Challenges

Advances in power electronics for the energy efficiency, renewable inverters, EVs and functionality of the latest electrical appliances, have led to increased emissions to the grid in the mostly unregulated “supraharmonic” 2 to 150 kHz spectrum. In December 2017, the worsening problem led IEC to establish a joint working group of TC77A and CISPR SC/H with a view to introducing requirements for the regulation of supraharmonic emissions to ensure the compatibility of electrical products.

In order to develop emissions limits, compatibility levels are presently defined taking only the laboratory testing environment into account. How well this assumption compares to real grid conditions and resulting behaviour of appliances must be confirmed. This requires measurements of real products when connected to a line impedance stabilisation network (LISN), as well as in a representative selection of different electricity grids that present a range of source and sink impedances to the appliance.

Whilst CISPR 16 has proposed a method to measure supraharmonic emission of individual equipment using LISNs in the laboratory, there is no normative method to measure the actual emission levels in real grids. A normative extension to IEC 61000-4-30 is required to facilitate supraharmonic measurements. Once a method is developed and standardised, it can then also be used to measure the actual response of appliances when grid connected. This is an essential step to ensure the credibility of the laboratory LISN approach with the CISPR 16 method, which can be adapted for routine appliance compliance testing to a new limit regime. As the LISN characteristics are critical, further validity can be obtained by directly measuring the source impedance of various grids at harmonic frequencies. Once a technique is established, it can then be used to directly measure the source impedance frequency response at a selection of grid connection terminals. This can then be compared with the LISN impedances in order to determine whether LISNs represent typical conditions in the grid.

To enable supraharmonic regulation, there is a clear need to develop a measurement framework which is robust, credible and acceptable to industry (manufacturers and utilities) suitable to ensure the correct operation of consumer appliances.

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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 development of a measurement framework for supraharmonics such that realistic, credible and measurable procedures for electricity grid compliance assessment can be incorporated into normative standards.

The specific objectives are

1. To formulate and validate a new normative method to measure supraharmonics (2 kHz to 150 kHz) in electricity grids suitable for inclusion in IEC 61000-4-30 Edition 4, and which should be compatible with the method defined by CISPR 16, which is only appropriate for equipment emission measurements in a laboratory. In addition, to implement and validate the new grid method using suitable portable and traceable instrument(s) to measure voltage and current in the supraharmonic frequency range with accuracies of ≤ 1 %.
2. To determine the suitability of supraharmonic compatibility levels (as defined in IEC 61000-2-2) for grid compliance measurements by conducting a laboratory comparison of the new grid method with the CISPR 16 laboratory method, using the CISPR line impedance stabilisation network (LISN) to represent the impedance of the grid, and examining emissions from a selection of electrical appliances.
3. To use grid measurements to determine the suitability of the LISN approach as a realistic laboratory representation of grid conditions, and to apply the new grid measurement method and instruments to on-site measurements of emissions from the selection of electrical appliances in a representative selection of electricity grids, and to compare the grid results with the laboratory tests.
4. To verify and improve the applicability of the LISN characteristics by measuring and comparing the source impedance of the grid in a number of typical electricity networks, using measurements below 9 kHz to verify the IEC61000-4-7 line impedance and measurements in the range 9 kHz to 150 kHz to validate the CISPR 16 LISN.
5. To contribute to the standards development work of the technical committees IEC SC77A WG 1, 8 and 9, and CISPR 16 providing recommendations on improvements to supraharmonic measurement methods (4-30), and the normative specification for the LISN in-line impedances (4-7 and 2-2) as well as on how these new methods should be applied to compare levels measured in the grid with supraharmonic compatibility levels (2-2), and to ensure that the outputs of the project are aligned with their needs, communicated quickly to those developing the standards and to those who will use them, and in a form that can be incorporated into the standards at the earliest opportunity.

The proposed research shall be justified by clear reference to the measurement needs within strategic documents published by the relevant Regulatory body or Standards Developing Organisation or by a letter signed by the convenor of the respective TC/WG. EURAMET encourages proposals that include representatives from industry, regulators and standardisation bodies actively participating in the projects. The proposal must name a “Chief Stakeholder”, not a member of the consortium, but a representative of the user community that will benefit from the proposed work. The “Chief Stakeholder” should write a letter of support explaining how their organisation will make use of the outcomes from the research, be consulted regularly by the consortium during the project to ensure that the planned outcomes are still relevant, and be prepared to report to EURAMET on the benefits they have gained from the project.

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

In particular, proposers should outline the achievements of the EMRP project ENG52 SmartGrid2 and how their proposal will build on it.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 0.6 M€, and has defined an upper limit of 0.8 M€ for this project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 30 % of the total EU Contribution across all selected projects in this TP.

Any industrial partners that will receive significant benefit from the results of the proposed project are expected to be unfunded partners.

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 network operators, and to industry (manufacturers and utilities).

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.