European Partnership on Metrology
Call 2022 – Digital Transformation, Health, Integrated European Metrology, Normative and Research Potential

Selected Research Topic number: **SRT-n01**
Version: 1.0

Title: Characterisation of AC and DC MV instrument transformers in extended frequency range up to 150 kHz

Abstract

High Frequency Measurements (HFM) are important due to the proliferation of new generation switching power converters which are connected directly to AC and DC Medium Voltage (MV) grids. Their emissions, up to hundreds of kilohertz, are able to interfere with vital grid operations, giving rise to the need for MV HFM. However, instrument transformer (IT) standards which are currently in-force, give requirements only up to 20 kHz and lack test procedures above 50/60 Hz. Therefore, proposals are sought to develop specific HF-relevant parameters to assess IT accuracy, test procedures and reference setups, including recommendations to IEC TC38 standards.

Keywords

Instrument Transformer (IT), Low Power Instrument Transformers (LPIT), Digital Low Power Instrument Transformers (DLPIT), High Frequency (HF), Emissions, Calibration, Power Quality (PQ), Test Procedures, Reference Setup, Uncertainty Evaluation.

Background to the Metrological Challenges

Currently there is no specific standard that could serve as a reference guide for the accuracy verification of AC and DC ITs for MV grids, at least from 20 kHz up to 150 kHz. The standards issued by the International Electrotechnical Commission (IEC) TC 38 Instrument Transformers do not deal with possible reference instrumentation or uncertainty evaluation. Therefore, the characterisation of ITs used for High Frequency (HF) measurements (HFM) in AC and DC MV grids, up to 150 kHz, is a priority need (IEC/TC 38/SC 0 / WG 0). Even though instrumentation for measuring electrical quantities up to hundreds of kHz, or above, is already on the market and its performance verification is already available, standards for accuracy verification of ITs at frequencies far above power frequency are missing.

In recent years, the electrical grid is experiencing an increasing presence of switching devices (inverters, bulky power electronic converters, active filters, etc.), both as loads as well as part of generators, especially from renewable energy sources. Moreover, the current trend is to realise power converters that can be connected directly to Medium Voltage (MV) grids. Consequently, there is a proliferation of conducted disturbances on grid voltage and current, also at MV level and up to hundreds of kilohertz, due to the harmonics of the spectral components around the switching frequency. This fact extends to MV grids, measurement needs that Low Voltage (LV) grids already experienced. These needs, in turn, ask for new and improved performance of measuring instruments and ITs, both in terms of accuracy as well as a wide frequency range.

The IEC 61869 part 6, focused on AC and DC low power ITs for MV and High Voltage (HV) grids, gives accuracy requirements at power frequency, but also at frequencies up to 20 kHz. However, it does not give indications on measurement methods and test procedures above power frequency. Thus, it cannot guarantee repeatable and reproducible verification of the prescribed accuracy requirement, leaving eventual unsolved legal disputes between the manufacturer and final user. It leaves the user unable to compare the performance of products from two different manufacturers.

The accurate measurement of disturbances present in AC and DC grids, up to 150 kHz, would also provide other Standard Development Organisations (SDOs), working for example in the standardisation of grid operation, compatibility levels planning, PQ measurements, etc., with the means for correct identification of the characteristics of the disturbances.

Moreover, the standardisation of measurement assets features, and of ITs in particular, is a key requirement for common policies of mitigation of disturbances and efficient control of power networks at a European level. The improvement of HF measurements in distribution systems is highly important for regulators and energy suppliers in all European countries to provide a stable, secure and efficient energy supply due to the grid connecting multiple European countries.

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 Instrument Transformers used for high frequency measurements in AC and DC medium voltage (MV) grids.

The specific objectives are:

1. To identify performance requirements both for Instrument Transformers as well as for the measuring instruments connected to them, based on disturbances in AC and DC MV grids (system voltage < 36 kV) and on future measurement needs in the frequency range up to 150 kHz.
2. To establish suitable parameters for the definition of the accuracy of voltage and current transformers in the frequency range up to 150 kHz. To define suitable calibration conditions and procedures for the accuracy evaluation.
3. To facilitate the laboratory set up to generate test voltage (AC or DC at <36 kV system voltage) and test current (AC or DC at <2 kA). Preference should be for generation of the power frequency quantity with superimposed components with frequencies up to 150 kHz, but at a fraction of the magnitude of the power frequency components.
4. To develop reference measuring systems for the calibration of Instrument Transformers in the frequency range up to 150 kHz at voltage level up to 36 kV system voltage and current levels up to 2 kA and to develop traceable calibration chains for these new systems.
5. To contribute to a revision of written standards by providing the data, methods, guidelines and recommendations, which are necessary for the accuracy verification of Instrument Transformers used up to 150 kHz, to IEC TC 38 Instrument Transformers. Outputs should be in a form that can be incorporated into standards (IEC/TC 38/SC 0/WG0, IEC 61869 and JWG 55 of TC 38) at the earliest opportunity and communicated through a variety of media to the standards community and to end users (Transmission system operators, distribution system operators, customers). In addition, to interact with the European Metrology Network on Smart Electricity Grids.

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 Smart Grids II and EMPIR projects 16ENG04 MyRailS and 18NRM05 SUpraEMI and how their proposal will build on those.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 0.8 M€ and has defined an upper limit of 1.2 M€ for this project.

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

Any industrial beneficiaries that will receive significant benefit from the results of the proposed project are expected to be beneficiaries without receiving funding or associated 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 the electronics and instrumentation sectors, and operators of electrical grids.

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 the Partnership 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] *Call 2021 016 IEC TC38 instrument transformers AC DC grids 36kV to 150kHz*
https://www.metpart.eu/go/need16