EMRP Call 2013 – Energy and Environment

Selected Research Topic number: **SRT-g20**
Version: 1.0

Title: Non-conventional voltage and current sensors for future power grids

Abstract

Instruments for measurement of electrical power have seen tremendous improvements since the introduction of sampling systems. These modern instrumentation or protection devices are connected to the low voltage side of installed current or voltage transformers with limited bandwidth.

Novel, non-conventional sensors, e.g. optical Faraday effect based sensors, hybrid electrical/optical sensors and air core Rogowski coils for current measurement; and voltage divider or optical Pockels effect based systems for voltage measurement, provide technologies for direct voltage and current measurement. Many of these technologies are already used in practice, promising wider bandwidth, and lighter weight, but they are not yet of the required metrological accuracy.

Conformity with the Work Programme

This Call for JRPs conforms to the EMRP Outline 2008, section on “Grand Challenges” related to Energy and Environment on pages 10, 23, and 31.

Keywords

Non-conventional instrument transformers, high voltage transmission, medium voltage distribution, power quality, harmonics, energy metering, electricity transport, smart grid.

Background to the Metrological Challenges

Significant recent advances have been made in voltage and current measurement on power grids, however the sensors used for conversion of high voltage and high current signals still rely mainly on traditional iron core voltage and current transformers. The connection of distributed renewable energy sources such as wind farms implies a higher presence of harmonics, and a greater need to know these voltages and currents. This development poses new requirements for the measurement infrastructure associated with the generation, delivery, and protection of the electrical network.

Conventional inductive voltage transformers are widely used in MV, HV and EHV networks to measure harmonic voltages. Accuracy of voltage transformers at frequencies other than the nominal frequency (50Hz/60Hz) are not defined by standards, but may significantly influence the overall accuracy of harmonic measurements, and a reliable compliance verification of compatibility levels, planning levels or emission limits (e.g. according to IEC 61000-2-12, 61000-3-6) may become difficult. This has been recognised by the IEC [1].

The traceability for calibration and assessment of instrument transformers is usually done by test centres which are optimised for the testing of conventional current and voltage transformers, yet instrument transformers with digital output based on EN 61850[2] are currently being used in real service conditions. The necessary traceability infrastructure for instrument transformers with digital output needs to be developed.

There is a clear potential for novel sensor solutions to contribute to delivering a modern power system calibration and measurement infrastructure.

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Scientific and Technological 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 JRP-Protocol.

The JRP shall focus on the traceable measurement and characterisation of non-conventional voltage and current sensors for future power grid control.

The specific objectives are to:

1. Develop traceable, wide bandwidth, reliable transmission side technology for electrical current measurement up to 10 kA using novel sensor techniques based for example on: the Faraday effect; hybrid electro/optical sensors or Rogowski coils. Other suitable technologies may be relevant.
2. Develop traceable, wide bandwidth, reliable transmission side technology for voltage measurement (> 1 kV) using novel sensor techniques based for example on: voltage dividers for onsite power quality measurements; and calibration techniques to enable testing of conventional and non-conventional voltage transformers under polluted grid conditions. Other suitable technologies may be relevant.
3. Develop traceability for new commercially available non-conventional instrument transformer test sets
4. Simplify the multiplexing and networking of current and voltage measurements for example by: using fibre Bragg grating optical grating readout methods.
5. Develop traceability and calibration services for transformers with digital output

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 R&D work, the involvement of the user community such as industry, and standardisation and regulatory bodies, as appropriate, is strongly recommended.

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 projects: ENG04 SmartGrids; and ENG07 HVDC, and how their proposal will build on those.

EURAMET expects the average size of JRPs in this call to be between 3.0 to 3.5 M€, and has defined an upper limit of 5 M€ for any project. Any proposal received for this SRT is expected to be significantly below 3.0 M€. The available budget for integral Research Excellence Grants is 30 months of effort.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community. This may be through the inclusion of unfunded JRP partners or collaborators, or by including links to industrial/policy advisory committees, standards committees or other bodies. Evidence of support from the “end user” community (eg letters of support) is encouraged.

You should detail how your JRP results are going to:

- feed into the development of urgent documentary standards through appropriate standards bodies
- transfer knowledge to the future sensors for power grid electrical current and voltage measurement sector.

You should detail other impacts of your proposed JRP as detailed in the document “Guide 4: Writing a Joint Research Project”

You should also detail how your approach to realising the objectives will further the aim of the EMRP to develop a coherent approach at the European level in the field of metrology and includes 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 Member States and countries associated with the Seventh Framework Programme whose metrology programmes are at an early stage of development to be increased
- outside researchers & research 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] IEC TR 61869-103: 2012," Instrument transformers - Use of instrument transformers for PQ measurements"

[2] IEC 61850, "Communication networks and systems in substations"