

## **Title: Traceability routes for electrical power quality measurements**

### **Abstract**

Increasing demands for power and power quality measurements to support the diversification of power generation have driven recent metrological research in this field. Some NMIs have developed power and power quality measurement systems based on the sampling techniques however due to the complexity, and the knowledge and resources required for each NMI, a number of these are not yet complete or operational. Joint effort in this field would provide the opportunity to develop a new open system for sampled power and power quality measurements based on the knowledge of both more experienced NMIs and those NMIs/DIs with specialist expertise, which would reduce the burden of parallel development of similar power meters in all NMIs/DIs. Knowledge transfer between NMIs/DIs in this field would increase the research capacity in power and power quality measurements for every participating NMI/DI.

### **Keywords**

Power measurement, power quality measurement, current transducers, voltage transducers, analogue-to-digital converters

### **Background to the Metrological Challenges**

With the diversification of power generation to include sources such as solar and wind, the measurement of electrical power and power quality has become more important. Conventional power measurements based on thermal converters are very accurate but only provide information about the RMS value on the fundamental frequency. Due to new approaches to energy distribution, multipoint generation and bidirectional supply (smart grid), the power quality parameter also needs to be measured. Power and power quality metrology requires the measurement of tens of quantities and covering the measurement of all of these quantities is only possible using sampling techniques. Improvements in power and power quality measurement will assist policy makers and energy suppliers to guarantee a stable and secure energy supply to the customers, and more careful grid monitoring will facilitate reductions in energy consumption and losses.

In recent years digital sampling techniques have been a focus of the scientific and metrological community. One driver for AC metrology is to ensure a direct link from the sampled voltage measurements to the SI representation of the volt as realised via the Josephson Effect and this will impact on power and power quality metrology. The iMERA-Plus Power and Energy project developed the first systems for the calibration of power quality quantities up to 100 kHz. The EMRP project ENG04 SmartGrids I demonstrated that for smart energy distribution additional important grid parameters need to be measured and new instruments (either on the grid or at home) calibrated, and developments continue in the EMRP project ENG52 SmartGrid II.

Over recent years several NMIs have developed measurement systems for sampled electrical power and power quality parameters measurements, whilst other NMIs are developing their own digital sampling power meters based on digitisers, transducers and signal processing software. Sampling power meters comprise a number of parts, however it takes time and significant resource for a single institute to develop and calibrate every part of a sampling power meter. This means that each institute develops the parts and capability themselves rather than learning from institutes that have already developed the same sampling power meter parts.

A number of institutes have fully or partially developed sampling power meter systems, however are unable to perform a full calibration of all the parts of the system. Other institutes excel in data processing but need to

improve their transducers, whilst other institutes do not yet have sampling power meters and need to obtain in-depth knowledge.

Joint work in this field would provide the possibility to complete the development of sampling power meters and to develop research potential for participating institutes in the field of electrical power quality. If access to the design of a jointly developed sampling power meter is open, all other metrological institutes, development companies or even individuals, could benefit. This approach would reduce the burden of parallel development of similar power meters in all NMIs/DIs, establish the ability to measure various power and power quality parameters with a shared setup at participating NMIs and to maintain full traceability of power meters in NMIs/DIs, speed up the measurements by remote control and automated data processing to reduce calibration time and costs.

## 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 metrological capacity in electrical power and power quality sampling measurements.

The specific objectives are

1. To design a simplified modular measurement setup for sampled electrical power and power quality parameters measurements, including a review of existing measurement and calibration methods and associated hardware and software.
2. To develop and validate a setup based on the design of the simplified modular setup for sampled electrical power and power quality parameters measurements, which will be available for most of the NMIs.
3. To develop an open source software analysis tool for the calculation of electrical power and power quality parameters with full uncertainty estimation.
4. To define a good practice guide for the calibration of all power meter parts and modules to establish full traceability to the SI of the electrical power and power quality parameters measured.
5. For each participant, to develop an individual strategy for the long-term operation of the capacity developed, including regulatory support, research collaborations, quality schemes and accreditation. They should also develop a strategy for offering calibration services from the established facilities to their own country and neighbouring countries. The individual strategies should be discussed within the consortium and with other EURAMET NMIs/DIs, to ensure that a coordinated and optimised approach to the development of traceability in this field is developed for Europe as a whole.

Proposers should outline how their proposal will take into account developments within the EMRP projects SmartGrid I, SmartGrid II and the iMERA-Plus Power and Energy project.

Joint Research Proposals submitted against this SRT should identify

- the particular metrology needs of stakeholders in the region,
- the research capabilities that should be developed (as clear technical objectives),
- the impact this will have on the industrial competitiveness and societal needs of the region,
- how the research capability will be sustained and further developed after the project ends.

The development of the research potential should be to a level that would enable participation in other TPs.

Proposers should note that the programme funds the activity of researchers to develop the capability, not the required infrastructure and capital equipment, which must be provided from other sources.

EURAMET has defined an upper limit of 500 k€ for the EU Contribution to any project in this TP, and a minimum of 100 k€.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 10 % of the total EU Contribution to the project. Any deviation from this must be justified.

## 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,
- Provide a lasting improvement in the European metrological capability and infrastructure beyond the lifetime of the project,
- Facilitate improved industrial capability or improved quality of life for European citizens in terms of personal health or protection of the environment,
- Transfer knowledge to the power generation and distribution sector and the metrology community.

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

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.