

Title: Development of precise non-invasive measuring capabilities of high-current DC power

Abstract

The move towards greener energy and the expansion of new DC current sources (e.g., photovoltaic power systems), battery storages and new rapidly developing electric vehicle sector has created an urgent need to measure high-current DC power. This proposal will expand metrology capabilities through the development and distribution of a non-invasive measurement system that will enable realisation, transfer and measurement of high-current DC power and energy. The main emphasis will be put on the development and characterisation of a new type of non-invasive high DC current sensor, which can be installed and used on-site. Calibration process for working standards or similar devices will be established, emphasising the potential for in-house calibrations.

Keywords

High-current DC power and energy measurement, traceability of DC power, high-current non-invasive DC sensor, magnetic fibre, working standard.

Background to the Metrological Challenges

Expansion of new DC current sources (e.g., photovoltaic power systems), battery storages and new rapidly developing electric vehicle sector has created an urgent need to measure high-current DC power. There are also other big consumers of electric power like public transport providers that uses electric vehicle (trains, trams) and the raw material industry. All these domains use DC current and consequently the measurement of DC power is increasingly required. Related devices (like photovoltaic modules, EV charging stations, manufacturing facilities, etc.) are usually not moveable and re-verification and calibration is needed to be performed on-site. It requires a portable measurement device with suitable construction with sufficient range and accuracy. Not only are the accurate measuring devices themselves crucial but associated good practice guides for maintaining accuracy and evaluation of uncertainties when measurements are performed on-site are also urgently needed.

There is an increasing number of sources and devices connected to the AC grid that use DC current. The grid is therefore becoming more complex and decentralised. A reliable, traceable and accurate system for the measurement of DC power and energy is therefore an essential part of the future infrastructure and is crucial for control, safe operation and protection of any electricity grid. However, the implementation of DC measurement systems, especially in existing circuits, is often problematic as existing solutions are often affected by the surrounding ambient conditions or influences from other circuits. Therefore, the measurement device must be based on a principle that is negligibly affected by the surrounding environment. Moreover, operation of the grid requires both permanent and portable measuring devices.

Current solutions are based on the principle of nonlinear response which depends on ambient conditions. They also have one or more of the following disadvantages: not openable, heavy or bigger construction, not sufficient ranges or accuracy, higher price, high power consumption which could be an obstacle for field measurement. As mentioned before, laboratories have capabilities to measure high DC current and voltage and also have ensured traceability to their primary standards of DC voltage and resistance. However, a complete system for calibration, measurement and evaluation of DC power and energy on-site is missing. This is especially true for field measurements.

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 proposal shall focus on the development of metrology capability for the calibration, measurement and evaluation of high current DC power and energy.

The specific objectives are:

1. To develop and characterise a traceable and reliable non-invasive portable device for measuring high current DC power and energy in ranges 1 A – 1200 A and 1 V – 1000 V, with a relative expanded uncertainty of ± 0.1 %. This will include the development of calibration procedures and an uncertainty budget for the device (and other similar devices) considering current laboratory capabilities.
2. To perform short and long-term measurements of high current DC power and energy under various laboratory conditions using the device from Objective 1, (e.g., changes in temperature, humidity, response to fast changes of DC current) and to optimise the device for use in at least two field applications (e.g., railways, photo-voltaic systems, electric vehicle charging station (EVCS), DC network). This will also include the development of uncertainty budgets and the measurements should confirm stability against disturbances and influences from the AC network.
3. To conduct an inter-laboratory comparison (ILC) using the optimised device from Objective 2 to ensure reliability and accuracy. Based on the ILC, good practice guides for the use of the device and guidelines with basic principles and recommendations for laboratories on how to calibrate the device in-house will be developed.
4. To facilitate the take up and long-term operation of the capabilities, technology and measurement infrastructure for high accuracy non-invasive DC power measurements developed in the project, by the measurement supply chain (NMIs/DIs, calibration and testing laboratories), and end users (instrument manufacturers, regulators). The approach should be discussed within the consortium and with other EURAMET NMIs/DIs, e. g. via EURAMET TC-EM, CCEM and EMN Smart Electricity Grids, to ensure that a coordinated and optimised approach to the development of traceability in this field is developed for Europe as a whole.

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 area for which the capabilities will be built (Green Deal, Digital Transformation, Health, Integrated European Metrology, Industry, Normative or Fundamental Metrology) and in which future main call the developed research capabilities are planned to be employed,
- the impact the developed research capabilities 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.

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

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 expects the average EU Contribution for the selected JRPs in this TP to be 0.7 M€ and has defined an upper limit of 0.9 M€ for this proposal.

EURAMET also expects the EU Contribution to the external funded beneficiaries to not exceed 20 % 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 proposal's 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, protection of the environment and the climate, or energy security,
- Transfer knowledge to the energy and transport 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 (JRPs)"

You should also detail how your approach to realising the objectives will further the aim of the Metrology 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.

Timescale

The project should be of up to 3 years duration.

Additional information

The links provided in this section are only correct at the time of publication up until the end of the Call year.

These references have been provided by EURAMET.

- [1] *EMN Smart Electricity Grids Strategic Research Agenda*
<https://www.euramet.org/research-innovation/metrology-partnership/strategic-research-and-innovation-agendas>