

Title: Development of RF and microwave metrology capability II

Abstract

In recent years, the requirements from industrial and other sectors for the reliable measurement of radio frequency (RF) and microwave (MW) parameters have increased as technology has developed and become more innovative. However, the capability to address the requirements of these stakeholders only exists in a limited form in some national metrology institutes (NMIs) and designated institutes (DIs) with emerging capabilities. Proposers addressing this topic should focus on developing a robust and sound approach for the measurement of RF & MW quantities and the evaluation of the associated measurement uncertainties, that goes beyond the achievements in the EMPIR project 15RPT01 RFMicrowave.

Keywords

Antenna measurements, RF power, Attenuation, Electromagnetic field intensity, Electromagnetic compatibility, Measurement uncertainty

Background to the Metrological Challenges

New technologies in the fields of health care, security, traffic management, environmental monitoring, advanced industrial production, electromagnetic compatibility (EMC), quality testing and communications require novel measurement methods and devices. The frequencies, complexity of systems and data rates are increasing which brings new challenges to the underpinning metrology. The necessary progress in radio frequency (RF) to THz metrology on the European level is only achievable through effective cooperation between European NMIs and DIs. There are several crucial fields, such as RF power and related quantities measurements (e.g. attenuation), electromagnetic field intensity and antenna parameters measurements which influence the measurement capability and traceability in many other areas.

The range of complex measurements required in both the time-and-frequency domains will continue to grow. In addition to establishing traceability and reducing the uncertainty of existing quantities, there are measurements and metrology challenges not even supported by more experienced NMIs and DIs. Such challenges include new nano-devices, on-wafer measurements, nonlinear measurements, performance evaluation of alternative EMC test methods, efficient antenna calibration algorithms, high-speed differential measurements and signal integrity, over-the-air measurements in communications and many others. These challenges have been identified, e.g., by the EURAMET Technical Committee for Electricity and Magnetism (TCEM) or the Consultative Committee for Electricity and Magnetism (CCEM).

The capability level of NMIs/DIs in particular areas differ across countries for historical and economic reasons. Metrology supporting state-of-the-art technologies in RF and microwave field currently exists in only few European countries, with several top-level NMIs undertaking research in the field of S-parameters, RF power, antenna measurements and other areas. Effective cooperation between European NMIs/DIs on these big challenges and the development of new and improved measurement techniques requires the capability gap among NMIs/DIs to be reduced.

A unified approach to the measurement uncertainty evaluation is needed to compare results of inter-laboratory comparisons and to enable robust uncertainties to be claimed for commercial calibration services providing traceability. Transfer of knowledge and expertise from more experienced institutes to those with less experience, enabling them to master the basic RF & MW and EMC metrology skills, is therefore essential to decrease the capability gap among institutes and improve their ability to fulfil the needs of fast-growing local industries in some countries. The EMPIR project 15RPT01 RFMicrowave laid the initial foundations, enabling several NMIs/DIs with less experience in the measurement of particular RF & MW quantities (S-parameters, RF power, EMC) to gain expertise from top-level NMIs/DIs, but there are still NMIs and DIs that need to improve

their metrology capabilities to be better able to address stakeholder needs and to undertake collaborative research.

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 metrology capability in RF and microwave measurements.

The specific objectives are

1. To develop traceable targeted RF and MW metrology capability for RF/MW power, attenuation and reflection/return loss in the frequency range up to at least 18 GHz in institutes with less experience. This development should be tailored to the defined industrial and economic needs those institutes intend to cover (such as developing calibration procedures including software automation using available instrumentation) and the research to be undertaken in the project to address these needs must be clearly described in the proposal.
2. To develop measurement and calibration capabilities for antenna parameter measurements in the fields covering communications and electromagnetic compatibility (EMC) in the frequency range up to at least 18 GHz in institutes with less experience. This should also cover electromagnetic field intensity measurement. Target parameters (such as antenna factor, electric field intensity etc.) and an explanation of their selection should be included. The research should prepare NMIs/DIs for the future calls of the European Partnership on Metrology.
3. To develop a unified approach to measurement uncertainty evaluation that should reflect the state-of-the-art methods currently being developed in the framework of other European research projects. The approach shall cover full uncertainty evaluation for all developed metrology capability from the first two objectives.
4. To facilitate the take up and long-term operation of the capabilities, technology and measurement infrastructure for RF & MW and EMC measurements developed in the project, by the measurement supply chain (NMIs/DIs, calibration and testing laboratories), and end users (e.g. industry, instrument manufacturers, regulators). The approach should be discussed within the consortium and with other EURAMET NMIs/DIs, e.g. via EURAMET TC-EM and MATHMET EMN, 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.

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

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 EMPIR project 15RPT01 RFMicrowave and how their proposal will build on those.

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 selected projects in this TP to be 0.5 M€, and has defined an upper limit of 0.9 M€ for this project.

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 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 industries utilising measurements of RF power and electromagnetic field intensity, including the communications, electronics, and health protection sectors 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 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.