EMPIR Call 2018 – Health, SI Broader Scope, Normative and Research Potential

Selected Research Topic number: **SRT-n16**
Version: 1.0

Title: EMF exposure compliance for 5G and IoT devices

Abstract

Fifth generation (5G) mobile communications systems will achieve lower latency, faster data rates and higher spectrum efficiency than current Long Term Evolution (LTE) systems. However, for this deployment to be successful, it is essential that the public has confidence in the safety of these technologies, which can only be achieved if 5G and Internet of Things (IoT) devices are compliant with Electromagnetic Field (EMF) exposure limits. Proposals addressing this SRT should provide the required metrology for the development of 5G EMF exposure compliance standards for power density from 6 GHz to 100 GHz, both in terms of measurement and computational compliance.

Keywords

5G, Internet of Things (IoT), Electromagnetic Field (EMF) compliance, Power density, Low power exclusion

Background to the Metrological Challenges

5G testbeds are nowadays being set up in many countries worldwide with the aim of accelerating the full deployment of 5G networks from 2020 onwards. The 5G system utilises three transmission bands: i) low band (0.6 GHz to 2.6 GHz using existing networks), ii) middle band (3.10 GHz to 4.99 GHz) and iii) high band (typically 26 GHz, 28 GHz, 38 GHz and 42 GHz, and potentially 86 GHz). For EMF compliance purposes, the low and middle bands are covered by existing measurement standards for specific absorption rate (SAR), which is the applicable exposure limit to 6 GHz. However, above 10 GHz the applicable limit is power density and there are no standards for assessing power density in close proximity to the transmitters. IEC has published a technical report on power density assessment in the 6 GHz to 100 GHz range (IEC TR 63170 ED1) and has initiated the development of two standards, which are being drafted by IEC TC106-WG11 and IEC TC106-WG12, and are due for publication in 2020.

During the development of this technical report, it became apparent that significant additional work is required. Traceability of nearfield power density measurements to national standards must be provided, which requires the development of tests and procedures to assess whether devices are compliant when touched or held. Low power exclusion criteria are covered by the generic standard IEC/EN 62479 but this does not specially address exclusion criteria for power density in close proximity (<200 mm) of the devices. In addition, low power exclusion criteria are not specified in IEC TR 63170 ED1, even though these could remove or greatly reduce the requirement for compliance testing for many low power devices. For computational compliance assessment, the effects of anisotropy of materials has not been assessed, and reliable data is not available.

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 metrology research necessary to support standardisation in EMF exposure compliance for 5G and IoT devices.

The specific objectives are

1. To provide traceability and uncertainty for nearfield power density measurement from 6 GHz to 100 GHz, with < 1.5 dB expanded uncertainty. This should include the establishment of calibration systems and methods for E-field probes for use in nearfield power density measurements that is traceable to primary SI units and with quantified uncertainties. Methods

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for establishing known E-fields and power densities at these frequencies should be evaluated and the most suitable method selected, which should enable the establishment of a calibration service for these probes.

2. To develop test protocols to establish whether a transmitting device is safe to touch, and to quantify the effects of the nature of the measurement plane, measurement distance, back propagation errors in the method. Methods of phase reconstruction based on measurement of E-field on two planes at different distances from the source should be considered as well as direct phase measurement using time domain probes for both conformal and flat evaluation planes. This should include the development of models for the back propagation process that allow error sensitivity coefficients to be determined from Monte Carlo type simulations.

3. To establish statistically-based low power exclusion criteria for internet of things (IoT) devices. The distributions of the power outputs from a range of devices during normal usage should be evaluated and statistical methods should be developed to determine the power level to use in exposure assessments in order to provide a 95 % confidence level. In addition, to provide rigorous criteria for low power exclusions for power density.

4. To support computational compliance assessment by developing methods and systems for determining complex permittivity of anisotropic material properties in at least two orthogonal axis for the 26.4 GHz to 40 GHz band with a target expanded uncertainty of 10 % for both real permittivity and loss tangent. In addition, to provide comparison results for a range of reference samples and PCB substrate materials and establish clear guidance on the need for inclusion of material anisotropy and uncertainty in numerical compliance standards for EMF.

5. To contribute to the standards development work of different technical committees (e.g. IEC/IEEE TC106 WG11 and WG12) to ensure that the outputs of the project are aligned with their needs, communicated quickly to those developing the standards and to those who will use them, and in a form that can be incorporated into the standards at the earliest opportunity.

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.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 0.6 M€, and has defined an upper limit of 0.8 M€ for this project.

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

Any industrial partners that will receive significant benefit from the results of the proposed project are expected to be unfunded 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 telecommunications sector.

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 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.