EMPIR Call 2017 – Industry, Fundamental, Normative and Research Potential

Selected Research Topic number: **SRT-i07**
Version: 1.0

Title: EMC intermediate facilities for compliance testing in industry

Abstract
Currently, electro-magnetic compatibility (EMC) requirements, in particular for large and high voltage equipment, cannot be fulfilled by industry. This is often due to products not being able to be brought to EMC laboratories for compliance testing due to their large size or because of power limitations. In-situ EMC compliance testing is an alternative, however this is often very expensive and the results are inaccurate. Therefore, Intermediate Test Facilities (ITF) for outdoor EMC compliance testing need to be developed in order to provide a similar level of accuracy to EMC testing laboratories. Such ITF will need use novel methods to correct for the influence of broadcasting signals and other Radio Frequency (RF) noise as well as novel impedance correlation techniques to provide the same traceability found in EMC testing laboratories. A traceable link between ITF and EMC testing laboratories also needs to be demonstrated through cross-validation as well as improvement in the traceability and uncertainty calculations for conventional EMC testing components.

Keywords
Electro-magnetic compatibility (EMC), electromagnetic interference (EMI), emissions, equipment under test (EUT), traceability, large-scale equipment, EMC test, conformity, in-situ test, uncertainty, intermediate test facilities (ITF), open area test sites (OATS), receivers, line impedance stabilisation network (LISN), artificial mains network (AMN), coupling & decoupling networks for emission (CDNE), common mode absorbing devices (CMAD), fast Fourier transform (FFT)

Background to the Metrological Challenges

All equipment in the EU is required to meet the requirements of the EMC Directive 2014/30/EU [1] and European Standards Organisations are requested by the EC to develop appropriate standards [2]. Compliance is usually demonstrated in emission and immunity tests at specialised laboratories. However, it is not always attained in industry as the laboratories are not usually equipped to test large (e.g. lorries, buses) or high voltage equipment. In addition, current standards do not cover worst-case conditions, e.g. transients, as the measurement campaigns are too expensive and Time Domain (TD) full spectrum measurements are not used.

Therefore, in order for large, and high voltage, equipment to meet EMC standards Intermediate Test Facilities (ITF) need to be developed to accurately measure the conducted electromagnetic disturbances generated by equipment under test (EUT). EMC testing laboratories currently define and stabilise the impedance of the mains using a Line Impedance Stabilisation Network (LISN) for conducted emissions. Thus an ITF, with real time methods for the characterisation and measurement of the impedance of the mains network needs to be developed in order to correct the voltage measurement (as LISNs cannot be used). Standard outdoor uncertainties will also need to be reduced from 15 dB to ~2 to 4 dB, and, a reliable ITF for EMC testing in the frequency band below 150 kHz is needed to address the effect of the environment on EMC testing.

In addition an ITF, based on open area test sites (OATS), needs to be developed for testing radiated electromagnetic emissions. The traceability of this ITF needs to be the same as in EMC testing laboratories. Therefore, traceable and validated testing and verification methods, to correct for the influence of broadcasting signals and other RF noise, will be required. Currently frequency domain instruments like super-heterodyne electromagnetic interference (EMI) receivers are used for in-situ measurements; however, new instruments capable of full spectrum time domain measurements are needed. This is because the sweep time of spectrum measurements is not currently rapid enough to measure the short duration of worst case emissions and the background noise can mask the emissions of the EUT. This can be addressed using novel time domain instruments that combine oscilloscope captures and signalling post-processing to obtain EMI emissions measurements. However, these need to be further developed to ensure compliance with the EMC Directive (i.e. a corrected noise floor of at least 6 dB below the radiated emissions limits for the measured frequency range and an associated suppression efficiency of +20 dB).

Once such ITF are developed, a traceable link to EMC testing laboratories needs to be provided through cross-validation. In addition, the traceability and uncertainty calculations for conventional EMC testing needs to be improved, and could be achieved through improvements in Artificial Mains Network (AMN) input impedance values, using new adapters for V-type and delta-type networks. Improved and traceable calibration methods and reference devices (up to 300 MHz) will also be needed for Coupling Decoupling Networks (CDN) and CDN for Emission measurements (CDNE). Further to this, Common Mode Absorbing Devices (CMAD) used for the measurement of disturbance power and for the measurement of radiated emission up to 1 GHz, require validated methods for measuring common mode S-Parameters (up to 1 GHz) and for the calibration of CMAD including the calibration jig.

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 development of metrological capacity for EMC intermediate facilities used for compliance testing in industry.

The specific objectives are

1. To accurately measure the conducted electromagnetic disturbances generated by equipment under test (EUT) at Intermediate Test Facilities (ITF). This should include (i) improved methods for mains impedance characterisation in order to meet the limits established in the European EMC Directive 2014/30/EU, (ii) a reduction in standard outdoor uncertainties from 15 dB to ~2-4 dB (i.e. the levels found in test laboratories), (iii) an assessment of the operating modes and worst case emissions of different EUT using frequency, time and mixed domain electromagnetic interference (EMI) measurements.
2. To develop a reliable ITF for EMC testing in the frequency band below 150 kHz. The facility should be equipped with frequency, time and mixed domain EMI measurement capabilities and should address the effect of the environment on such EMC testing.
3. To develop a novel ITF, based on open area test sites (OATS), for testing radiated electromagnetic emissions. For the ambient radio frequency environment, this should include (i) the development of traceable and validated testing and verification methods to correct for the influence of broadcasting signals and other RF noise, (ii) a corrected noise floor of at least 6 dB below the radiated emissions limits for the measured frequency range and an associated suppression efficiency of +20 dB, and (iii) measurement of worst case emission modes using full time domain spectrum measurements.
4. To establish a traceable link between ITF and EMC testing laboratories through the cross-validation of EMC testing methods. In addition to improve the traceability of conventional EMC testing used by accredited EMC testing laboratories. This should include: (i) improved Artificial Mains Network (AMN) input impedance measurements including new adapters for V-type and delta-type networks, (ii) improved and traceable calibration methods and reference devices (up to 300 MHz) for Coupling Decoupling Networks (CDN) and Coupling and Decoupling Networks for Emission measurements (CDNE), (iii) validated methods for measuring common mode S-Parameters (up to 1 GHz) and for the calibration of Common Mode Absorbing Devices (CMAD) including the calibration jig, (iv) novel and traceable calibration procedures and reference standards for EMI measuring receivers based on a fast Fourier transform (FFT) methods, (v) an assessment of existing EMC calibration methods including their uncertainty and repeatability.
5. To facilitate the take up of the technology and measurement infrastructure developed in the project by the measurement supply chain (accredited laboratories, instrument manufacturers), standards developing organisations (e.g. CISPR/CIS/B/WG1, CENELEC TC 210, IEC TC 82, and those associated with the European EMC Directive 2014/30/EU) and end users (EMC test equipment manufacturers and EMC testing laboratories).

Proposers shall give priority to work that meets documented industrial needs and include measures to support transfer into industry by cooperation and by standardisation. An active involvement of industrial stakeholders is expected in order to align the project with their needs – both through project steering boards and participation in the research activities.

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 project IND60 EMC Industry and how their proposal will build on those.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 1.5 M€, and has defined an upper limit of 1.8 M€ for this project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 30 % of the total EU Contribution to the project.

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 EMC testing and EMC equipment manufacturing 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.

Additional information

The references were provided by PRT submitters; proposers should therefore establish the relevance of any references.

[1] Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility.

[2] European Commission, M/552 EN, COMMISSION IMPLEMENTING DECISION C(2016) 7641 final of 30.11.2016 on a standardisation request to the European Committee for Standardisation, to the European Committee for Electrotechnical Standardisation and to the European Telecommunications Standards Institute as regards harmonised standards in support of Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility, Brussels, 8 July 2016.