Final Publishable JRP Summary for IND60 EMC
Improved EMC Test Methods in Industrial Environments

Overview

Testing electromagnetic compatibility (EMC) to comply with the EMC Directive is essential for all electrical and electronic products. It must be guaranteed that unintentional generation, propagation and reception of electromagnetic energy does not cause interference or damage the product itself, or those nearby. EMC measurement and validation are necessary during product development, as well as for commercial products. The standard EMC tests are: conducted emission, conducted immunity, radiated emission and radiated immunity including GSM (Global System for Mobile Communications) immunity.

Industry can either carry out these tests in their own standardised EMC measurement facility or use a third-party EMC laboratory. Neither of these solutions is possible for large and/or stationary equipment or high current equipment, so industry has developed a range of non-standard alternative EMC test methods, but there is little information available on their performance, characterisation, validations or traceability. In addition, there is no correlation of these alternative methods with the standard tests or uncertainty calculations.

This project improved the existing test methods, developed new methods and produced reference devices to verify the tests, linked them to the standards and compared measurements from different sources.

Need for the project

Emission tests assess the electromagnetic energy emitted or released into the environment, either deliberately or accidently. These can be conducted emission, referring to emissions via cables, power, communication or other, or radiated emission. Immunity tests assess the ability of the equipment to function correctly when exposed to unwanted electromagnetic energy or disturbance signals, again either through cables or through the air.

There are only a few standards that specifically detail EMC testing of large equipment, and they emphasise the need for in-situ measurements. The standard EN 55011 details on-site radiated emission measurement techniques based on moving the receiving antenna around the equipment and measurements that can be made from the outside wall of a building housing the equipment. Despite the fact that EN 55011 emphasises the need of measurements in industrial environments it only refers to radiated emissions. The current standards which deal with on-site tests, do not cover conducted emission, conducted immunity and radiated immunity tests. The major aim of this project was to fill this gap, by improving and developing test methods for industry.

There are existing non-standard alternative EMC test methods used in industry, instead of the laboratory tests, but most of these methods are not supported by any European standard and there is no satisfactory validation or correlation between these alternative methods and the standard laboratory methods. Understanding the performance and evaluation of existing alternative EMC test methods currently being used in industry and the development of new alternative methods are crucial for European industry. The correlation between the alternative methods in industry and the standard methods is necessary so that traceable measurements in industrial environments can be carried out.

In addition, the standard EN ISO 17025 (for accredited calibration activities) provides a set of requirements to assure the quality of test results of the laboratories by inter-laboratory comparison of EMC tests. However there are no adequate EMC test devices available for large scale in-situ measurements, particularly for immunity testing where there are no test devices. Therefore, the project will develop concepts and EMC test devices that may be used for inter-laboratory comparisons for both emission and immunity tests.

EMRP
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Scientific and technical objectives

The main aim of this project was to focus on the performance, characterisation and improvement of existing alternative test methods, and then establish correlation between them and the standard test methods, together with the uncertainty calculations. This project also developed new alternative test methods in accordance with the needs of industry for all types of EMC tests. This will lead to traceability in measurements taken in industrial environments. The EMC measurements include emission and immunity measurements in the frequency range from 9 kHz to 18 GHz, in conducted and radiated disturbance measurement set-ups.

The project addresses the following scientific and technical objectives;

- To evaluate, improve and develop alternative test and measurement methods for **conducted emission** tests in industry.
- To evaluate, improve and develop alternative test and measurement methods for **conducted immunity** tests in industry
- To evaluate, improve and develop alternative test and measurement methods for **radiated emission** tests in industry
- To evaluate, improve and develop alternative test and measurement methods for **radiated immunity** tests in industry
- To evaluate correlations between alternative test methods and those defined in standards
- To develop test specimens and tools for the EMC tests which can be used in inter-laboratory comparisons for both emission and immunity tests.
- To evaluate the traceability of these existing and newly developed alternative EMC test methods
- To provide guidance documents for application of improved and newly developed alternative EMC tests in industry, including calculations of uncertainty and usage of correlation data.

Results

Conducted emission tests

For conducted emission tests, correction factors that will link industry to the test laboratory were successfully obtained for equipment such as a drill and a UPS (Uninterruptible Power Supply), which is based on impedance measurements of the equipment under test (EUT) and the power supply.

A Line Impedance Stabilisation Network (LISN) is a device used in conducted emission tests to isolate the equipment from the power source or provide a known impedance value, which cannot be used for high current EUTs under normal circumstances. It was demonstrated that the simple dummy LISN, alias LISN simulation, which has been developed in the project can be used together with a voltage probe as an alternative conducted emission test method in circumstances with high current.

Several conducted emission alternative test methods (such as current and voltages probes) were evaluated and the benefits and constraints of each method were assessed. In addition, a new time-domain conducted emission alternative test method based on an oscilloscope was successfully developed and tested. This new testing method is fast and reliable.

Time domain emissions measurements allow the reduction in the time needed to cover all the frequency range required by the standards. The one shot oscilloscope measurement is very useful in difficult measuring scenarios, for example industrial in situ measurements. Also, new impedance measurement methods have been developed to be used in industry to assist in evaluation of conducted emissions. Uncertainty calculations have been completed for the improved and developed conducted emission test methods. Finally, new coaxial-type to banana adaptors for precise LISN calibrations to obtain traceability have been developed and successfully tested in LISN calibrations.

Conducted immunity tests

For conducted immunity tests, loop impedance values on the standard conducted immunity setup and non-standard setups were measured and correction factors were produced between the standard setup with CDNs (Coupling Decoupling Network) and the alternative setups without CDNs like in industrial environment. Consequently, the first efficient link between the standard and alternative methods has been established for conducted immunity testing. The impact of the induced impedance of the used current probes on the conducted immunity test results was also taken into account. In addition, the multi-CDN method has been developed to allow the use of CDNs also for high-current EUTs. With the multi-CDN method, the high EUT current can be split into several parts that one CDN can handle and subsequently CDNs become available also for high-current EUTs.

Radiated emission tests

For radiated emission tests, a report on "*How the Q value of the on-site facility can be increased and definition of related rules*" has been prepared. The report summarises the information from the literature study and experience from measurements in different environments. In addition, a report "Method for alternative radiated emission test involving changing Q value in the absence of OATS (Open Area Test Site) or anechoic chamber" was developed to show how to determine the Q value when an industrial site environment has relevant similarities with a reverberation chamber. Furthermore, the alternative close-distance radiated emission test method and the surface sense wire methods have been extensively investigated and they have been concluded with promising results and an acceptable tolerance of around 5 dB in most of the frequency range up to 1 GHz. The time domain measurement system developed in the project was also employed for the measurement of the radiated EMI. For the measurement of radiated electromagnetic interference a broad-band antenna was used. The developed time domain methodology was applied to a real in-situ scenario providing a successful measurement campaign in a huge automatic storage. Finally, a background cancellation method was proposed to accomplish in-situ measurements in the presence of strong neighbour disturbance noise sources and background noise (BGN). BCI probes along with loop antennas have been efficiently integrated into alternative radiated emission test methods and three novel-type alternative radiated emission test methods which include the use of BCI probes have been developed.

Radiated immunity tests

For radiated immunity tests, BCI probes have been efficiently investigated with a conclusion that the closed loop method is proposed as an efficient method that should be adopted by industry and finally alternative test methods with the use of BCI probes up to 1 GHz were developed. In addition, construction that includes a metallic monopole structure which facilitates field uniformity with the aid of a BCI probe has been developed and verified for alternative radiated immunity testing. In addition, an alternative method for improved alternative on-site radiated immunity testing using antennas at close range to EUTs and research on effects of non-standard measurement distance and near-field effects on radiated immunity tests have been finalised. In this context, the project compared three radiated immunity test methods which are widely used in laboratories and in industry. Also, in an extensive scale, the 3D balloon patterns and the 2D patterns of several actual mobile phones have been experimentally measured along with some useful extra information such as directivity and radiation power, for the purpose of alternative EMC testing. The project consortium has also introduced a non-standard coil with a 3 dB uniform area which has a 3dB uniform magnetic field volume. It has been shown that by using a simple self made one turn coil a magnetic field uniform volume can be easily generated and hence complies with requirement of the standard (EN 61000-4-8). Ultimately, the method of using the surface wire was investigated as an alternative method for radiated immunity tests and high efficieny of surface wires in terms of electromagnetic injection was shown in comparison to the standard field uniformity method.

General conclusion for emission and immunity tests

The existing testing methods were characterised and improved. New methods were also developed. This means that all large or high power equipment can now be tested with confidence, to ensure compliance with the EMC directive. Correlations were made between the alternative test methods and the standard test

methods. The traceability of these existing and newly developed alternative EMC test methods was evaluated. Test specimens and tools were developed for the EMC tests which can be used in inter-laboratory comparisons for both emission and immunity tests. Guidance documents were developed for the application of improved and newly developed alternative EMC tests in industry, including calculations of uncertainty and usage of correlation data.

Comparison of emission and immunity tests

For the comparison measurements and reference devices, a report "*The analysis of the available validation methods and their use in the project*" and a piece of software to perform the comparison using the different measurement have been produced. In addition, the concept and prototype for a conducted immunity reference source were completed and the first inter-laboratory conducted immunity comparison tests have been performed with the participation of 8 laboratories. A concept and a prototype for a conducted emission reference source with a wide diversity of emission spectra and levels were also designed. Finally, a frequency adaptive harmonic current generator with many novel features has been designed for the purpose of generation and measurement of defined harmonics. All the developed reference sources were measured by the project partners in three inter-laboratory comparison tests held internally.

Actual and potential impact

Dissemination of results

The project outputs have been shared widely with the metrology, instrumentation and industrial communities. Workshops disseminated the project outputs and liaised with stakeholders in the industrial, standards and research communities. Around 50 papers reflecting the project were presented at a variety of prestigious EMC conferences and journals. The work contributed to the standardisation activities of CISPR meetings, and the time domain measurements, in particular, were taken up by industry.

Input to standards and tests

CISPR is a part of the International Electrotechnical Commission (IEC) which sets standards for controlling electromagnetic interference, or EMC, in electrical and electronic devices. The project results were presented in the meeting of the subcommittee CISPR/I/WG2 which oversees the important CISPR standards that are relevant to large, distributed or high current equipment, as in the scope of the project. There was also interest from the subcommittee CISPR/A/WG1/A (on measurement of radio interference and statistical methods) which has decided to create a working group to work on LISN calibration issues. Subsequently LNE has become a member of this working group.

The time-domain methodology developed by Universitat Politècnica de Catalunya has been included in Annex B of IEC 62920 standard. This is one of the most important outputs of the project because IEC 62920 covers EMC requirements for solar photovoltaic energy systems that are usually large and distributed, and especially need improved or developed EMC test methods. The standardisation activities will continue with the support of the IEC members, and will try to incorporate the new time-domain methodologies into the new edition of CISPR 11. The project covered test methods which are jointly utilised by several EMC standards, and the testing methodology is similar and common to most of EMC standards. Therefore contributing to EMC standards via CISPR/A and CISPR/I will mean that in due course the project's contributions will be disseminated to the other subcommittees and put into other relevant standards. This means that the project will have an impact on all the other EMC standards which are likely to be applied large and high-current EUTs.

Most of these international standards produced by CISPR are then adapted for European (EN) standards by one of recognised European standardization organizations: CEN, CENELEC or ETSI for the targeted directive such as the European EMC directive. Therefore these standards are key to complying with the EMC Directive.

Actual impact

LISN manufacturers and laboratories such as a manufacturer from France and a company from Turkey have shown great interest in LISN adaptors produced during the project and would like to purchase adaptors. Laboratories and manufacturers also have been showing great interest in the conducted immunity round robin device and harmonic reference device which have been developed in the project.

Many laboratories were keen to purchase the conducted immunity devices and to participate in conducted immunity inter-laboratory comparison tests, because there had been no opportunity for this in the past.

The alternative conducted emission test methods improved in the scope of the project have been evaluated and employed by one of the stakeholders in Turkey and found very efficient.

Finally, the time-domain measurement method developed in the project was successfully utilised in in-situ emission measurements of a large fixed installation in the premises of one of the company Mecalux S.A. The excellent results achieved at the in-situ measurements highlight the benefits of this novel time-domain measurement method.

Potential impact

The results of this project will have an impact directly on industrial manufacturers who need on-site EMC testing due to the size of their products and/or high currents, and also on EMC testing laboratories which often have to perform non-standard EMC tests on site. It will help industry, especially SMEs, to evaluate their products during the design stage. This will ultimately allow companies to have confidence that their products conform to the EMC directive and can enter the marketplace.

List of publications

- M. Pous, F. Silva, “Prediction of the impact of transient disturbances in real-time digital wireless communication systems”, IEEE Electromagnetic Compatibility Magazine, 2014, Vol. 3, no: 3, pp. 76-83.
- M. Pous, F. Silva, “Full-Spectrum APD Measurement of Transient Interferences in Time Domain”, IEEE Transactions on Electromagnetic Compatibility, 2014, Vol. 56, no: 6, pp. 1352 - 1360.
- M. Kokalj, B. Pinter, M. Lindic and F. Ziade, “Development of coaxial adapter for calibration of EMC devices”, in Proc. 2014 Precision Electromagnetic Measurements Conf., 2014, pp. 586-587.
- G. Costa, M. Pous, A. Atienza and F. Silva, “Time-Domain Electromagnetic Interference Measurement System for intermittent disturbances”, in Proc. 2014 International Symposium on Electromagnetic Compatibility (EMC Europe), 2014, pp.833-837
- R. Jauregui, M. Pous and F. Silva, “Use of reference limits in the Feature Selective Validation (FSV) method”, in Proc. 2014 International Symposium on Electromagnetic Compatibility (EMC Europe), 2014, pp. 1031-1036.
- M. Pous and F. Silva, “APD radiated transient measurements produced by electric sparks employing time-domain captures”, in Proc. 2014 International Symposium on Electromagnetic Compatibility (EMC Europe), 2014, pp. 813-817.
- S. Cakir, O. Sen, M. Cinar and M. Cetintas, “Alternative conducted emission measurements for industry”, in Proc. 2014 International Symposium on Electromagnetic Compatibility (EMC Europe), 2014, pp. 1037-1042.
- D. Zhao; G. Teunisse and F. Leferink, “Design and implementation of conducted emission reference source”, in Proc. 2014 IEEE International Symposium on Electromagnetic Compatibility, 2014, pp.12-17.
- B.J.A.M. van Leersum, R.B.Timens, F.J.K. Buesink and F.B.J. Leferink, “Time domain methods for the analysis of conducted interference on the power supply network of complex installations”, in Proc. 2014 International Symposium on Electromagnetic Compatibility (EMC Europe), 2014, pp. 605-610.
- C. Keyer, Timens, R.B.Timens and F.B.J. Leferink, “In-situ measurement of high frequency emission caused by photo voltaic inverters”, in Proc. 2014 International Symposium on Electromagnetic Compatibility (EMC Europe), 2014, pp. 74-78.
- R.A. Vogt-Ardatjew, G.S. van de Beek and F.B.J. Leferink, “Experimental extreme field strength investigation in reverberant enclosures”, in Proc. 2014 International Symposium on Electromagnetic Compatibility (EMC Europe), 2014, pp. 332-336.
- M. A. Azpúrua, M. Pous and F. Silva, “Decomposition of Electromagnetic Interferences in Time Domain”, IEEE Transactions On Electromagnetic Compatibility, Vol. 58, No. 2, April 2016
- M.A. Azpurua, M. Pous, S. Cakir, M. Cetinta and F. Silva, “Improving time-domain EMI measurements through digital signal processing”, IEEE Electromagnetic Compatibility Magazine, vol. 4, no. 2, pp. 82-91, 2015.

- Sen, O., Cakir, S., Cinar, M., Pous, M., Silva, F., Cetintas, M., "Alternative Conducted Emission Measurements On Mains Without LISNs", IEEE, Electromagnetic Compatibility Magazine, 4:4 (2015) : 58-65
- F. Ziade, M. Kokalj, M. Ouameur, B. Pinter, D. Belieres, A. Poletaeff, D. Allal, “Improvement of LISN Measurement Accuracy Based on Calculable Adapters”, IEEE Transactions on Instrumentation & Measurement, Vol. 65, pp. 365 - 377, Feb 2016.
- J. Tan, D. Zhao and J.A. Ferreira, “A method for in-situ measurement of grid impedance and load impedance at 2 k - 150 kHz”, in Proc. 9th International Conf. on Power Electronics and ECCE Asia (ICPE 2015-ECCE Asia), 2015, pp. 443-448.
- M.Kokalj, B.Pinter, M. Lindič, B. Voljč, Z. Svetik, R. Lapuh, “Numerical method for calculation of transfer matrix for non typical adapters used for calibration of EMC devices”, Proceedings of the 24th International Electrotechnical and Computer Science Conference
- O. Sen, S. Cakir, S. Acak and M. Cetintas, “Alternative Conducted Emission Measurements with LISN Simulation & CISPR16 probe”, in Proc. IEEE International Symposium on Electromagnetic compatibility and EMC Europe, 2015, pp. 1243-1247.
- S. Cakir, O. Sen, S. Acak and M. Cetintas, “Alternative Conducted Immunity Testing with Multiple CDNs and Wire Winding”, in Proc. IEEE International Symposium on Electromagnetic compatibility and EMC Europe, 2015, pp. 1060-1065.
- E. Tas and F. Pythoud, “A new Conducted Immunity Test Device for Inter-laboratory Comparisons”, in Proc. IEEE International Symposium on Electromagnetic compatibility and EMC Europe, 2015, pp.855-860.
- M. Pous, M.A. Azpurua and F. Silva, “Radiated Transient Interferences Measurement Procedure to Evaluate Digital Communication Systems”, in Proc. IEEE International Symposium on Electromagnetic compatibility and EMC Europe, 2015, pp.456-461.
- M.A. Azpurua, M. Pous and F. Silva, “A Measurement System for Radiated Transient Electromagnetic Interference Based on General Purpose Instruments”, in Proc. IEEE International Symposium on Electromagnetic compatibility and EMC Europe, 2015, pp.1189-1194.
- R.A. Vogt-Ardatjew, A.E. Sowa and F.B.J. Leferink, “The effect of magnetic dielectric absorbing coating on unsymmetrical antenna cables”, in Proc. 2015 Asia-Pacific Symposium on Electromagnetic Compatibility (APEMC), 2015, pp.624-627.
- B.J.A.M. van Leersum, F.J.K. Buesink and F.B.J. Leferink, “Quantification of minimal needed cable terminations”, in Proc. 2015 Asia-Pacific Symposium on Electromagnetic Compatibility (APEMC), 2015, pp.470-473.
- A. Ubin, R.A. Vogt-Ardatjew, F.B.J. Leferink, M.Z.M. Jenu and G.S. Van De Beek, “Statistical analysis of three different stirrer designs in a reverberation chamber”, in Proc. 2015 Asia-Pacific Symposium on Electromagnetic Compatibility (APEMC), 2015, pp.604-607.
- R.A. Vogt-Ardatjew and A.E. Sowa, “Accurate Experimental Field Mapping in the Close Vicinity of a Pyramidal Absorber Using the Monostatic Optically Modulated Scatterer Technique”, IEEE Transactions on Electromagnetic Compatibility, vol. PP, no. 99, pp. 1-7, 2015.
- F. Ziadé, M. Ouameur, D. Bélières, A. Polétaeff, D. Allal, M. Kokalj and B. Pinter, “Adapter and method for improving the LISN input impedance measurement accuracy”, in Proc. IEEE International Symposium on Electromagnetic compatibility and EMC Europe, 2015, pp. 1254-1259.
- Azpurua, M.A.; Pous, M.; Silva, F., “On the Statistical Properties of the Peak Detection for Time-Domain EMI Measurements, IEEE Transactions on Electromagnetic Compatibility”, Vol. 57, Issue. 6, 2015, 1374 - 1381
- Pous, M.; Azpurua, M.A.; Silva, F., “Measurement and Evaluation Techniques to Estimate the Degradation Produced by the Radiated Transients Interference to the GSM System”, IEEE Transactions on Electromagnetic Compatibility”, Vol. 57, Issue. 6, 2015, 1382 – 1390
- B. van Leersum, J.K. vd Ven, F. Buesink and F. Leferink, “Protection against common-mode currents on exposed cables”, in Proc. IEEE International Symposium on Electromagnetic compatibility and EMC Europe, 2015, pp. 1478-1483
- R.A. Vogt-Ardatjew and F.B.J. Leferink, “Experimental plane wave and random field coupling to uniform and non-uniform transmission lines”, in Proc. IEEE International Symposium on Electromagnetic compatibility and EMC Europe, 2015, pp. 767-772

- Osman Şen, Soydan Çakır, Murat Celep, Mehmet Çınar, Ramiz Hamid, Mustafa Çetintaş, “Influence of Dielectric Support on Military Radiated Emission Tests Above 30 MHz”, in Proc. APEMC 2016 Conference, Shenzhen, China
- Dongsheng Zhao ; S. Cakir ; O. Sen, “Uncertainty Evaluation of an Alternative Conducted Emission Test Method”, in Proc. APEMC 2016 Conference, Shenzhen, China
- Sen, O., Tektas, C.B., Cakir, S., Cetintas, M., "Alternative Radiated Emission Measurements at Close Distance in Industry", International Journal of RF and Microwave Computer-Aided Engineering, 26:4 (2016) : 294-303
- Azpurua, M.A.; Pous, M.; Silva, F, “On-board compact system for full time-domain electromagnetic interference measurements”, in Proc. 2016 ESA Workshop on Aerospace EMC (Aerospace EMC), 2016.
- Bahadır Tektaş, Osman Şen, Soydan Çakır, Mustafa Çetintaş, “Improvements in Alternative Radiated Emission Test Methods With Surface Wire”, in Proc. EMC Europe 2016 Conference, Wroclaw, Poland
- Mohammed A. Salhi, Soydan Çakır, Mehmet Çinar, Bahadir Tektaş, and Mustafa Çetintaş, “GTEM cell as an Alternative Method for Radiated Immunity Tests”, in Proc. EMC Europe 2016 Conference, Wroclaw, Poland
- Mohammed A. Salhi, Osman Şen, Soydan Çakır, and Mustafa Çetintaş, “3D/2D Radiation Pattern Measurement of Different GSM Phones for EMC Applications”, in Proc. EMC Europe 2016 Conference, Wroclaw, Poland
- Tas, Emrah; Cakir, Soydan; Cetintas, Mustafa; Hamouz, Pavel; Isbring, Thomas; Kokalj, Miha; Lopez, Daniel; Lundgren, Urban; Mandaris, Dwi; Pinter, Borut; Poriz, Martin; Pous, Marc; Pythoud, Frederic; Sen, Osman; Silva, Ferran; Svoboda, Marek; Trincaz, Braise; Zhao, Dongsheng, “Proficiency Testing for Conducted Immunity with a new Round Robin Test”, in Proc. EMC Europe 2016 Conference, Wroclaw, Poland
- Azpurua, M.A.; Pous, M.; Silva, F, “On-board compact system for full time-domain electromagnetic interference measurements”, in Proc. 2016 ESA Workshop on Aerospace EMC (Aerospace EMC), 2016.
- Azpurua, M.A.; Pous, M.; Silva, F, “On-board compact system for full time-domain electromagnetic interference measurements“, 2016 ESA Workshop on aerospace EMC
- Bart van Leersum, Jan-Kees van der Ven, Hans Bergsma, Frits Buesink,Frank Leferink, “Protection Against Common Mode Currents on Cables Exposed to HIRF or NEMP“, IEEE Transactions on EMC
- Robert Vogt-Ardatjew, Stefan van de Beek, Frank Leferink “Influence of reverberation chamber loading on extreme field strength“, Proceedings of the 2014 International Symposium on Electromagnetic Compatibility, EMC 2014, Tokyo, Japan
- C. Keyer, I. Setiawan, F. Leferink “Drawbacks of a medium sized, grid coupled Photo Voltaic Array“, Proceedings of the International Conference on Renewable Energy And Power Quality (ICREPQ) Madrid
- Dwi Mandaris, Niek Moonen, Stefan Van de Beek, Frits Buesink, Frank Leferink, “Validation of a Fully Anechoic Chamber“, Proceding of the 7th Asia Pacific International Symposium on EMC
- I. Setiawan, C.H. Keyer, M. Azpurua, F. Silva, F.B.J. Leferink, “Time-domain Measurement Technique to Analyze Cyclic Short-Time Interference in Power Supply Networks“, Proceding of the 7th Asia Pacific International Symposium on EMC

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