EMC Testing Education According to the ISO/IEC 17025 Quality System Requirements

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Abstract - In the last years, the accreditation of EMC laboratories has taken on increasing importance and all national accreditation bodies have adopted ISO/IEC 17025 as a way to ensure standardization. In this context, the implementation of an ISO/IEC 17025 quality system in a faculty environment represents a difficult task, but certainly has positive impact on the academic studies, research and university – industry collaboration. For this reason, the Electrical Engineering Faculty of Iasi started the accreditation process for SR EN 61000-4-2 Electrostatic Discharge Immunity Test, relating to equipment, systems, subsystems and peripherals, which may be affected by static electricity discharges owing to environmental and installation conditions. Some implementing issues and the most important benefits for the academic content will be discussed in this paper.

Keywords - electromagnetic compatibility (EMC), electrostatic discharge (ESD) immunity, testing, education, ISO/IEC 17025 quality system, academic content.

1. EMC TESTING AREA

The electromagnetic compatibility represents the capability of electrical and electronic systems, equipments and devices to operate in their intended electromagnetic environment within a defined margin of safety, and at design levels or performance, without suffering or causing unacceptable degradation as a result of electromagnetic interference. Because the EMC is an important compliance issue for equipment manufacturers, the EMC tests are required by many authorities throughout the world.

The EMC testing is used to confirm that particular equipment meets the specific standards. It divides broadly into emission testing and susceptibility (or immunity) testing. Generally, the emission testing requires measuring the electromagnetic energy from a product, while the immunity testing requires measuring the effect of electromagnetic energy from other sources on the performance of a product.

In the European Union, the electrical and electronic devices must meet specified limits for both emissions and immunity. These and other requirements are documented in EU directives. The EMC Directive (2004/108/EC) applies to all products except those covered by other directives and regulations which have their own EMC requirements, such as radio equipment and telecommunications terminal equipment, aeronautical parts, products and appliances, radio equipment used by radio amateurs, medical devices, motor vehicles, etc.

Two methods can be followed by manufacturers to demonstrate compliance with the requirements of the EMC Directive: Technical File Route, by performing a technical EMC assessment of the product, and Standards Route, by using the EMC Harmonised Standards, published in the Official Journal of the European Union. If there is a dedicated product or product family standard, then this standard must be applied, otherwise an appropriate generic standard, which contains precise immunity or emission requirements for equipment working in specific environments, can be used.

In Romania, accredited EMC testing is currently performed by a small number of public and private laboratories that have been setup and extended in the last decade. At the same time, education on EMC is provided by the main technical universities, which, in response to the industry developments and market trends, have been established specialized laboratories. In certain conditions, these labs may also apply for accrediting particular EMC tests.

2. EMC EDUCATION AND RESEARCH AT OUR FACULTY – PREMISE FOR CONTINUOUS DEVELOPMENT

For educating engineers in the EMC field, there are several possibilities: university courses, in-house training for industry and joint activities between universities and industry. Starting with 1980’s, when the first, well documented, EMC courses have been established, universities all over the world continue to provide fundamental and advanced EMC courses [1].

Manuscript received August 17, 2009.
In the Electrical Engineering Faculty of Iasi, complementary to the research activities on EMC, specific chapters have been introduced since 1994. The EMC Laboratory of our faculty played a leading role in the electromagnetic compatibility and electromagnetic measurements curriculum development, for both the undergraduate and graduate programs. It also ensured a properly environment for research activities performed by staff members, graduate and PhD students.

Today, our courses dealing with EMC aim to provide students with knowledge covering most of the field of EMC engineering: European standards and regulations, testing for EMC compliance, EMC diagnostic and troubleshooting, EMC equipment design, computational electromagnetic modelling, etc. In addition, the laboratory sessions offer live computer simulations and hands-on experiments devoted to important EMC concepts, such as electromagnetic coupling phenomena and effects, EMC measurements and troubleshooting techniques.

By attending these courses, future engineers working in electric and electronic equipment development can benefit from acquired knowledge of electromagnetic compatibility and, particularly, they will better understand the EMC tests applying to their equipment. Such knowledge is also an advantage to engineers performing measurements by using in-house facilities as well as those accompanying their equipment to a third party laboratory.

A second key method for students to improve their EMC skills is by engaging in research activities, especially at Master and PhD level. By establishing collaborative programs with other universities, research institutes and industry organizations, our EMC Laboratory offer these students a unique opportunity to participate in research projects and explore scientific subjects related to important EMC problems. They are also encouraged to disseminate their research results by publishing them in journals, at conferences and workshops, etc.

3. ESTABLISHING A UNIVERSITY LABORATORY FOR EMC / ESD TESTING ACCORDING TO THE ISO/IEC 17025 STANDARD

ISO/IEC 17025:2005 is the quality standard for testing and calibration laboratories, being extensively used for EMC testing labs accreditation [2], [3], [4]. It requires these labs to demonstrate that they [5]:

- operate a quality system covering processes, documentation and management;
- generate technically valid results taking into account equipment, procedures and personnel.

ISO/IEC 17025 should not be confused with ISO 9000, which only relates to a laboratory’s quality system and does not specifically evaluate the technical competence of the laboratory. Supplementary to the quality system, documentation and personnel requirements, ISO/IEC 17025 dictates calibration and testing laboratories to assure the quality of the results by validating and verifying the test equipment and test methods.

This standard also directs the testing labs to:
- produce uncertainty budgets for each accredited test;
- incorporate the uncertainty into the test procedure and/or test limits;
- provide the uncertainties with the test report and results.

Reporting the uncertainty qualifies the accuracy of the measurement and allows trustful comparisons when results from different laboratories are considered. The participation in inter-laboratory comparisons should be a regular activity because it is not only a key criterion for accreditation, but is also a vital investment in reliability, operational certitude and personnel confidence.

There are many university laboratories performing testing activities for outside organizations or as a part of the research programs and grants. These activities often involve state-of-the-art equipment, being carried out by highly qualified personnel. Therefore, trying to bring university laboratories to ISO/IEC 17025 compliance is a logical consequence.

Establishing an ISO/IEC 17025 quality system in a university environment is certainly not a new attempt. Such achievements are reported in the scientific literature, many of them being related to chemistry or medical laboratories [6], [7], [8]. Further, we’ll very shortly present our experience in setting up an EMC/ESD testing laboratory according to the ISO/IEC 17025 requirements and we’ll highlight some of its benefits for the academic content.

3.1. Implementation issues

Our activities have started in the framework of Romanian CEEX Program, Module IV, Infrastructure development for conformity evaluation and certification, coordinated by Romanian Accreditation Association, RENAR, which is a full member of European Cooperation for Accreditation (EA) and International Laboratory Accreditation Cooperation (ILAC).

Since the equipment for EMC testing is very expensive, especially when semi-anechoic or fully-anechoic chambers are needed, establishing a university laboratory able to perform a large amount of EMC testing is, in most cases, impossible. However, we consider that particular tests can be accredited and the certification can become feasible. At the moment, our efforts are directed to gain accreditation for SR EN 61000-4-2 Electrostatic Discharge Immunity Test, relating to equipment, systems, subsystems and peripherals, which may be affected by static electricity discharges owing to environmental and installation conditions [9].

Implementing a quality system based on ISO/IEC 17025 had a powerful impact on the laboratory...
organization and operation. A quality manual and a number of procedures covering all sections of the ISO/IEC 17025 standard have been developed. Requirements of the applicable standards have been determined and established in the test methods and procedures. Instructions on the use, operation and maintenance of all relevant equipment and on the handling and preparation of items for testing also have been prepared. Quality records are maintained for ensuring system compliance. The laboratory members are fully aware of the relevance and importance of their activities for the achievement of the objectives of the management system.

3.2. Benefits for the academic content

The experience of working under an ISO/IEC 17025 compliant quality system in a university environment will certainly play an effective role in the education of our students. They can develop and improve both technical and generic skills, while getting in touch with a very important aspect required by the actual needs of the industry – the quality assurance. An accredited laboratory is not only a modality for acquiring practical competencies on EMC testing, but also a solution for learning or better understanding concepts which are systematically correlated, such as:

- quality assurance / quality control,
- calibration,
- method validation,
- measurement traceability,
- measurement uncertainty.

The capability to perform “in-house” testing is probably the most important advantage for teaching EMC. By applying the recent developments and updates in standards and regulations, we can bring the EMC curriculum closer to the industry requirements.

In order to become familiar with the EMC testing practice, at the end of the semester, small groups of third-year undergraduate students will work under the careful supervision of a lab specialist. For diminishing their dependence on university staff while still being under supervision, they are given as much autonomy as possible.

The testing activities conducted by students are intended only for training. However, using the same equipment as that used for EMC testing, in conditions similar to those specified in standards and procedures, they will be able to acquire valuable hands-on experience.

A practical session consists of 3 or 4 hours, depending on the complexity of the test program, usually established by a laboratory member. Before scheduling any test activities, appropriate documentation is distributed to students and, if required, a preliminary tutorial session is intended to give them a comprehensive understanding of their tasks. In laboratory, the students are provided with the opportunity to have full access to standards and procedures, operation instructions of the test and auxiliary instrumentation, technical information of the equipment under tests (EUTs), etc.

Typically, a laboratory session starts with the preparation of the test setup, in accordance with the instructions from standard and taking into account the particular aspects regarding the operation of the equipment under test. Since the EUT is properly configured, the lab coordinator will provide students with the necessary support for applying the appropriate test method.

During the experiment, each member of the group has clear responsibilities, established before starting the lab. Good communication among students is very important as they need to pass and share information, data and calculations.

After completion of the laboratory, the students have to write a simplified test report, whose structure conforms to the main requirements in ISO/IEC 17025. Such a report will include, inter alia, the identification of the test method, a short description of the EUT, the test results with the units of measurement, the names of the students “authorizing” the report, information on environmental conditions, etc.

Because the EMC testing is a process of taking measurements, each test report will also include a statement on the estimated uncertainty. For achieving this purpose, the students will receive guidance in applying the uncertainty estimation procedure accompanying the test method, which has been developed in accordance with relevant international guidelines [10], [11].

It is not the first time that third-year undergraduate students are experiencing with measurement
uncertainties. During the first part of the semester, uncertainty budgets for common EMC measurements have been studied as distinct topic within the EMC course. Moreover, a solid background on measurement uncertainty is provided for students by other courses, such as Metrology and Testing Techniques and Electrical Measurements.

Similarly, “measurement traceability”, “calibration” and other terms associated with ISO 17025 might have already been discussed, but this is a good opportunity to effectively interact with such issues and to fully understand their impact on the laboratory activity. On the other hand, new concepts like “published methods”, “laboratory developed methods”, “method validation” “quality assurance of test results”, “inter-laboratory comparisons / proficiency tests”, “replicate tests”, “retesting of retained items”, etc. will allow future engineers to enhance their learning outcomes in the field of calibration and testing services.

By testing the same equipments, results obtained by different groups of students are jointly analyzed for monitoring their validity and, if necessary, further discussions and investigations will be intended to correct any situation. Once again, we emphasize that the only goal of the tests performed by students is to expose them to the actual requirements of the industry.

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The impact of ISO/IEC 17025 on the entire activity of a compliant laboratory is analyzed section by section. After presenting the benefits of ISO/IEC 17025, the management requirements are discussed in detail, including: organizational requirements, the quality system, the document control, contracting issues and the treatment of complaints, the non-conforming testing and / or calibration work, corrective and preventive actions, internal audits and management reviews.

The analysis of the technical requirements starts with personnel considerations, with special attention being paid to the training and job descriptions. Accommodation and environmental conditions, test and calibration methods, validation of methods and the equipment control are subsequently explained. Finally, the last topics covered by the course will include: measurement traceability, measurement uncertainty, sampling, assuring the quality of test and calibration results and test reports.

4. CONCLUSIONS

The answer to properly training engineers in electromagnetic compatibility depends to a large extent on education. By implementing a university laboratory for EMC / ESD testing that complies with ISO/IEC 17025, we can bring the EMC curriculum closer to the industry requirements. For our faculty, a recognized laboratory allows a superior involvement in the industry projects and offers higher visibility; for students, it represents a good opportunity to clearly understand the actual market demands by getting in touch with a “real” quality system.

REFERENCES


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