VOL. 11, NO. 11, JUNE 2016 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

AN OVERVIEW ON THE MEASUREMENT UNCERTAINTY EVALUATION OF ELECTROMAGNETIC COMPATIBILITY TEST

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ABSTRACT

Electromagnetic Compatibility (EMC) plays an important role in the current electronic industrial market. To fulfill the standard of laboratory accreditation in the EMC field based on the ISO 17025 standard, the proficiency test (PT) or the inter-laboratory participation is mandatory towards the accreditation requirements. One of the essences of the laboratory assessment is the measurement uncertainty (MU). Recent research trends show that there are MU works on the data validation, hardware, and signal reference source. This paper highlights a summary of recent related works on the MU improvement and recommendation, which will result in the possible future directive reviews.

Keywords: measurement uncertainty, electromagnetic compatibility, electromagnetic interference, radiated emission, conducted emission.

1. INTRODUCTION

Since the EMC is one of the biggest major subject in the current electronic industrial market, every single electronic devices including the pre-production small circuitry is a source of electromagnetic interference (EMI) to the other systems or nearby equipment and vice versa. It has been understood as the perfect harmonic operation at the same nearby environment without jeopardizing the expected functionalities of each other mentioned in [1], [2], [3]. For instance, the telecommunication equipment and any related telco devices it must be certified for EMC compliance as regulated to the designated government bodies such as Federal Communication Commission (FCC) in USA or CE in Europe and Malaysia Commission for Multimedia and Communication (MCMC) together with SIRIM in Malaysia. Assessing the competence level of the accredited laboratories is one of the growing concern in the metrology and community specifically in EMC field in Malaysia.
TEXT

In the sense of the laboratory accreditation, ISO/IEC 17025 standard in [1], established a general requirements that need to be fulfilled for the competence of either testing or calibration laboratories. Among them, are the proficiency testing (PT) or the inter-laboratory comparison for the EMI measurement. The PT is the common assessment technique which involves the laboratory performance by using the inter-laboratory comparisons, in which the participated laboratory needs to undergo certain tests using the standard source and compare with other laboratory.

1.1. Median value of a measurement uncertainty evaluation

In the PT program, both of the conducted and radiated emission (CE) and (RE) test are instructed to assess the technical proficiency of the participated test laboratories. To evaluate the data, the deviation from the median value submitted data is considered in addition of the Z-Score specified in the standards. These exercises which was studied by Osabe and Kato [3], [4] to investigate all the submitted data for the RE test on 3 and 10 m. The signal source is the comb generator which was used as the artifact to be circulated as an equipment under test (EUT). For the RE test, the electric field comb generator was measured at 3 meters or 10 meters from the artifact.

In the standards, the mains power supply is fed through the limited impedance stabilization network (LISN) to stabilize the common mode AC power supply [5]. It was carried out by reading disturbance voltage from the switching generator of power supply circuit artifact via the LISN. The reference value will be defined to a median value of all collected data. A Z-Score is a normalized value which gives a score to each result relative to the numbers in the data set. A standard form for the calculation of Z-Score is

$$\left(Z_i = \frac{X_i - \bar{X}}{s} \right) \tag{1}$$

where, Zi is Z-score in each test laboratory, Xi is the submitted data from the laboratory, X is a median value of all data and s is normalized or standard deviation of the population.

1.2. Measuring antenna of a measurement uncertainty evaluation

The RE measurement is regulated by standards such as the CISPR25:2008 or the MIL-STD 461F because the associate disturbance is considered as an external noise that can interfere with the environment or nearby equipment. These standards specify the test setup for the radiated emission measurement in the frequency range 30

VOL. 11, NO. 11, JUNE 2016 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

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MHz to 1000 MHz. However, different measurement antenna for the frequency range 200 MHz to 1000 MHz has been specified. C. Qiang and L. Yinghua [6] had illustrate the influence of the different measurement antenna on the RE measurement. These measurement antennas include the log periodic antenna and double ridge horn antenna as shown in Figure-1.

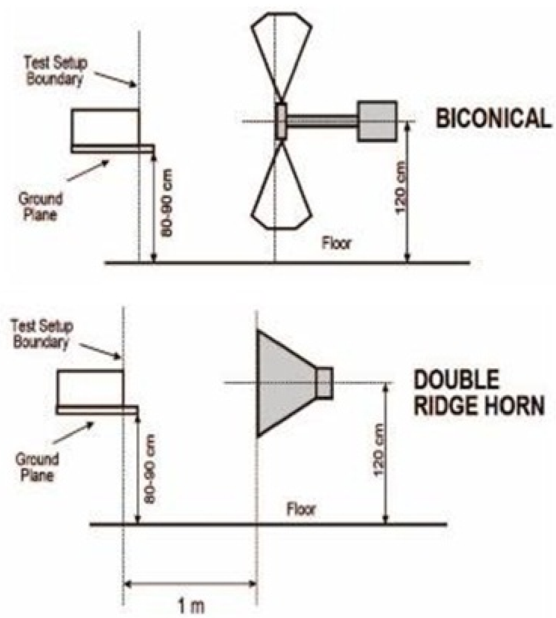

Figure 1. Bi-conical and double ridge horn antenna positioning. Adapted from "The Influence of Different Measurement Antennas on the Radiated Emission Measurement" by C. Qiang and L. Yinghua, 2011, International Conference on Electronics, Communications and Control (ICECC), pp. 4010

RE measurement was conducted by using a personal computer (PC) as a EUT. The test site was done in the semi anechoic chamber (SAC). The EUT has been placed on the top of the EUT table on the top of the conductive ground plane. The height of the table is 80 cm according to the standard. A set of different antennas has been used and the antenna directivity and phase center have the important influence on the RE test which is classified as one of the main input quantity.

1.3. Reference source of a of a measurement uncertainty evaluation

Some work and analysis on the PT for the testing round with the major EMC laboratories in Brazil has been done by Guimaraes [7] in seven laboratories conducted in RE measurement under the coordination of an independent third party supervised by the Brazilian accreditation body, INMETRO. The guidelines of the international standards such as the ISO 17043 [8] and product specific standard CISPR 22 [9] were followed. The multi-tone signal generator was specifically designed and assembled for the present PT conditions.

It has been used in heterogeneous EMC facilities. The test facilities included six semi-anechoic chambers and a GTEM cell. Data gathered from the GTEM cell are correlated to the field strengths that would be measured at a 10 m range OATS, adopting the algorithm based in [10] which is also based from the [11, 12]. Five tones were used in the PT at the maximum electric field strength reported by the mentioned laboratories. The strongest measured signal observed: 82, 165, 246, 359 and 717 MHz as shown in Figure-2.

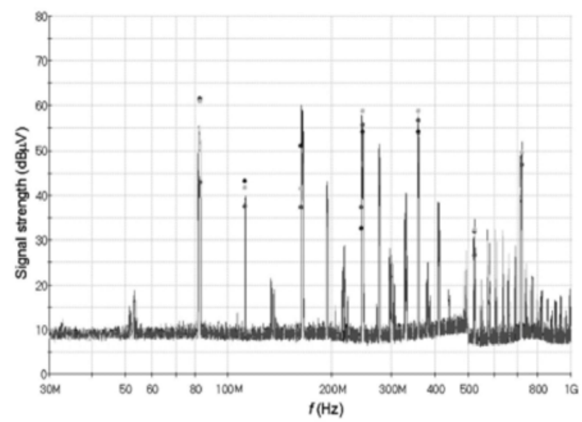

Figure-2. Output spectrum from the multi-tone generator for the PT.

2. DISCUSSIONS

Several proposals have been raised in order to the improvement of the MU values and the application to the EMC measurement. A few approaches are as follows:

1. Deviation on the median values
2. Equipment measurement techniques
3. Standard signal source for EMC facilities

These three factors are essential for the characterization of the MU for EMC measurement. Based on the deviation of the median value, some Z-score of the RE measurement has exceed the limit. It has been raised that the possibility of the MU is known to be high and may affect the EMC measurement. On the other hand, changes to the techniques on the measuring equipment will influence the MU especially on the RE test which will requires an antenna. The difference in the type of antenna (bi-conical, log periodic and horn antenna) to cover the wide spectrum of test (30 – 1000 MHz) require a different set of antenna factors and gain which will influence the value of the input quantity. The other approach towards the MU evaluation is the standard reference source which to be used during the PT exercise. On various type of chambers and sizes, a suitable type of standard reference source to cater the heterogeneous EMC test facilities must be carefully designed to retain the uniformity of the test as much as possible.

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3. CONCLUSIONS

For the last 5 years, some recommendation or suggestion of improvement to the EMC directive specifically on MU have been raised since it will however reflect the performance criteria of an EMC accredited laboratory. There are some interest have been shown to that aspect since the factor of the MU greatly depend on the system setup as a whole. A potential of an improvement to the judgment criteria of an EMC test status can be employed by incorporating the MU interval to the final value of the test result.

ACKNOWLEDGEMENT

The authors would like to thank the Office of Research, Innovation, Commercialization and Consultancy Management (ORICC) University Tun Hussein Onn Malaysia for funding this research under Research Contract Grant (Project No: A033)

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