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Advanced Electromagnetic Field Uniformity in Reverberation Chamber

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Abstract. This paper presents the field uniformity characteristics in a triangular prism reverberation chamber and a rectangular reverberation chamber that can be substituted for an open area test site or an anechoic chamber to measure electromagnetic interference. To improve size problems of a stirrer that is an essential unit to generate a uniform field in the reverberation chamber, we suggest a diffuser of Quadratic Residue Sequence method. To validate the substitution of a diffuser for a stirrer, a diffuser is designed for 1–3 GHz, and five types of equilateral triangular prism reverberation chambers and three types of rectangular reverberation chambers are modeled. Afterwards, the field distributions in these eight reverberation chambers are simulated and tested. Using XFDTD 6. 2 of finite difference time domain method, field deviations of each structure are simulated and compared to each other. An evaluation of field uniformity is done by cumulative probability distribution as specified in the IEC 61000-4-21. The result shows that the field uniformity in the chamber is within ±6 dB tolerance and also within ±3 dB standard deviation, which means a diffuser can satisfy the requirement of international standards.

Keywords: electromagnetic compatibility, electromagnetic interference, electric field uniformity.

1 Introduction

A reverberation chamber is a chamber that is designed to make a diffuse or random incidence electric field. It is used for a uniform distribution of electromagnetic energy and random direction of electromagnetic incidence over a short time period. Usually, reverberation chambers are large rooms for the electric field to be more diffused with increased path length and have very hard metal surfaces. The change of impedance (compared to the air) these surfaces present to incident sound is so large that virtually all of the acoustic energy that hits a surface is reflected back into the room. Arranging

[1] Please note that the LNCS Editorial assumes that all authors have used the western naming convention, with given names preceding surnames. This determines the structure of the names in the running heads and the author index.

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the room surfaces (including the ceiling) to be non-parallel helps inhibit the formation of standing waves - additional acoustic diffusers are often used to create more reflecting surfaces and further encourage even distribution of any particular sound field [1, 2].

Reverberation chambers are used in acoustics as well as in electrodynamics, such as for measurement microphone calibration, measurement of the sound power of a source, and measurement of the absorption coefficient of a material. All these techniques assume the sound field in the chamber to be diffuse, and will normally use a broadband sound source (e.g. white noise or pink noise) so that the resulting sound field contains acoustic energy across the whole audible range.

An electromagnetic reverberation chamber (also known as a reverb chamber (RVC) or mode-stirred chamber (MSC)) is an environment for electromagnetic compatibility (EMC) testing and other electromagnetic investigations. Electromagnetic reverberation chambers have been introduced first by H.A. Mendes in 1968 [1]. A reverberation chamber is screened room with a minimum of absorption of electromagnetic energy. Due to the low absorption very high field strength can be achieved with moderate input power. A reverberation chamber is a cavity resonator with a high Q factor. Thus, the spatial distribution of the electrical and magnetic field strength is strongly inhomogeneous (standing waves). To reduce this inhomogeneity, one or more tuners (stirrers) are used. A tuner is a construction with large metallic reflectors that can be moved to different orientations in order to achieve different boundary conditions. The Lowest Usable Frequency (LUF) of a reverberation chamber depends on the size of the chamber and the design of the tuner. Small chambers have a higher LUF than large chambers [3, 4].

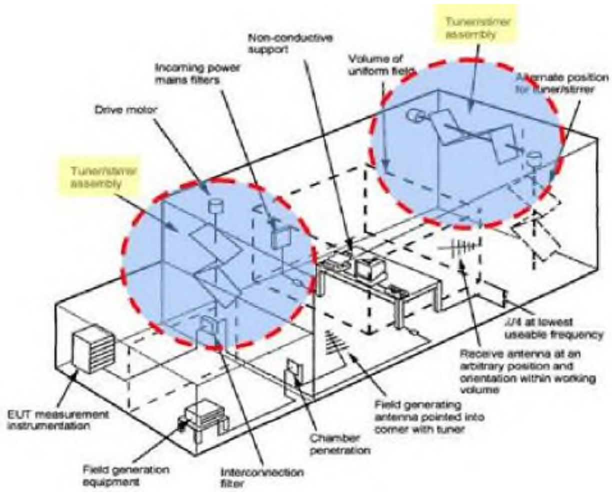

Fig. 1. Reverberation chamber and stirrer.

2 Stirrer

Today, a diffuser in acoustics made of wood or masonry is used to increase the diffusion of sound in theaters and recording studios. In general, the diffuser made from a deformation of the surface has two important limitations. The first is to have more than one surface of the protrusions and into place, as shown in Figure 2 to provide a good diffusion at a low frequency. Secondly, there is no objective method for determining the extent of scattering produced by this diffuser. A diffuser to overcome this limitation is Quadratic Residue Sequence (QRS) diffuser, and this is with a theoretical study by acoustic scholar M.R. Schroeder, Germany [5].

3 Field Analysis

Using MATLAB 6.1, the analysis for extracting data of the electric field strength is done, which includes a numerical analysis and statistical approach. With attaching the diffuser to the reverberation chamber, the simulation results of the electric field intensity distribution for the each test plane are shown as Figure 2. Using the numerical analysis results of the case, the 80 field strength values in the test volume, maximum value, minimum value, standard deviation, and tolerance results are analyzed [6-8].

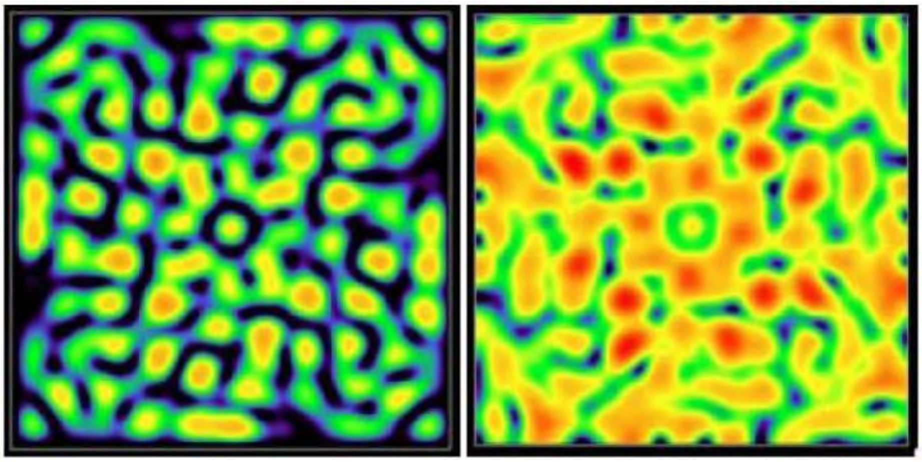

Fig. 2. Field distribution in the reverberation chamber.

4 Conclusion

With the application of the diffuser, 75 % of sampled data from the test volume was analyzed to evaluate the electric field characteristics inside of the reverberation chamber. The result shows that the field uniformity in the chamber is within ±6 dB tolerance and also within ±3 dB standard deviation, which means a diffuser can satisfy the test requirements of international standards.

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