Maximum Working Volume Evaluation in a Non-Canonical Reverberation Chamber

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Abstract — This paper presents a procedure for evaluating the performance of reverberation chambers, by approximating the maximum working volume in a given configuration. The evaluation of this volume is based on the geometrical and physical constraints, like the ones related to the internal E-field distribution recommended by standards. The importance of the present work is related to the development of a non-canonical reverberation chamber configuration, whose excitation is carried out by transmission lines, instead of antennas plus paddles.

I. THE NON-CANONICAL REVERBERATION CHAMBER

A reverberation chamber is a shielded room often used to perform electromagnetic immunity tests [1]. Although a set of EMC measurement procedures are recommended for a frequency range from 80 MHz up to 1 GHz, other procedures are required for a lower frequency operation. In conventional reverberation chambers, the resulting electromagnetic environment can be experimented within a certain frequency range of operation by using antennas and mechanical tuners, which excite and stir the TE and TM common modes within the chamber working volume. The lowest usable frequency (LUF) of the chamber is related to its dimensions: the larger the dimensions are, the lower is the LUF. It results in additional constraints, if low frequencies are considered. In this work, the reverberation chamber excitation is carried out through wires (fit uniformity fields). It should be mentioned that, as wires support TEM fields, this approach allows to excite, besides the TE and TM common modes, the TEM mode within the chamber [2]. This widens the generated frequency range regarding the resulting LUF. In order to evaluate the chamber performance, the resulting internal field homogeneity is taken into account. The field within a Mode Stirred Chamber (MSC) is considered uniform if the standard deviation of the E-Field samples satisfies the following conditions: 4 dB in the range from 80 MHz until 100 MHz, decreasing linearly to 3 dB at 400 MHz, and 3 dB from 400 MHz up to 1 GHz [1]. It should be mentioned that values below 80 MHz are not considered in this regulation. Fig. 1 shows one of the proposed chamber configurations (5.20 x 4.55 x 2.70 m), which wires are placed along the x, y and z-axis [2].

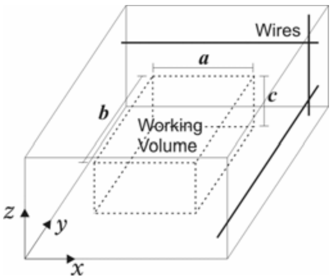

Fig. 1. Sketch of the three-wire reverberation chamber configuration

II. METHODOLOGY

The working volume is the recommended test volume where the equipment will be placed. It is considered by standards as a parallelepiped in which the electric field homogeneity should satisfy pre-defined limits. In our case, it was assumed the value 4 dB, for frequencies below 80 MHz. The final objective of the proposed methodology is the maximization of this volume, by modifying the configuration of the chamber, while the present paper is devoted to the efficient evaluation of the maximum working volume, for a given configuration of the chamber. Here, due to the asymmetry of the chamber excitation, the "working volume" can result as not being placed at the center of the chamber. Its axis could also be non-parallel to the chamber's walls. The finite integration technique was used for E-field computation [2], [3]. Moreover, instead of analyzing a parallelepiped, its inscribed ellipsoid is considered, since it allows a straightforward process to evaluate if a point is inside or outside it. Then the problem of evaluation of the maximum working volume is turned into the maximization of the volume of an ellipsoid defined by seven variables: three radii, three parameters associated to the ellipsoid translation from the chamber's center, and the ellipsoid rotation (only in the equatorial plane). Furthermore, the problem has geometrical constraints and the physical constraint (here 4 dB) as imposed by the standards. A Genetic Algorithm [4] with a constrained Pattern Search Method has been used to detect the maximum feasible ellipsoid [5]. Table I shows some values defined in [1], concerning the chamber configuration given by Fig.1, which working volume resulting from the aforementioned process is a parallelepiped of dimensions 2.30 x 1.73 x 0.70 m, at the frequency equal to 10 MHz.

TABLE I WORKING VOLUME CHARACTERISTICS

Parameter	Direction x	Direction y	Direction z	Combined E-Values
Average E- Field (V/m)	0.4177	0.4676	0.1954	0.3602
Standard Deviation (dB)	3.4846	2.8145	3.9991	3.9959

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III. REFERENCES

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