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On the unreasonable influence of the maximum measured value on the field uniformity assessment made using the IEC 61000-4-21 reverberation chamber standard

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In this communication, we show the influence of the maximum value of a rectangular component of the electric field on the field uniformity assessment made using the protocol recommended by the IEC standard [1] about reverberation chambers (RC). In the case of field-probe measurements, this is done by measuring the three rectangular components of the electric field for a large number of stirring configurations (i.e., a number of mode stirrer positions in the case of a mechanically stirred RC) on the 8 points delimiting the working volume. The idea is to compute the standard deviation of the maximum value obtained for all the points and for each component taken separately (i.e. σ_x, σ_y, σ_z) and also grouped together (i.e. σ_{24}). The standard deviation obtained is then compared to frequency dependent normative thresholds.

In this study, random samples (representing “virtually" the measurements collected by the IEC procedure) have been generated on $S = 10000$ sets of $M = 8$ by $P = 50$ samples where M and P respectively represent the number of measurement points and the number of mode stirrer positions. The generated samples, following the ideal Rayleigh distribution [2], correspond to the magnitude of the rectangular components of the electric field. S represents a number of acquisitions made for instance at different independent frequencies in a single RC or collected on different RCs (of same volume). The numerical random generation of samples gives the possibility to generate a larger number of samples with respect to what we could measure in a real RC.

For all the sets of data, the standard deviation σ_x is included in the range from 0.5 to 2 dB. To go further, the plot in Fig. 1 of the standard deviation σ_x as a function of the highest value of the 400 $|E_x|$ samples (normalized with respect to the average obtained for the 400 samples) for each run S shows that the field uniformity (in the sense of the standard) is directly related to this maximum value.

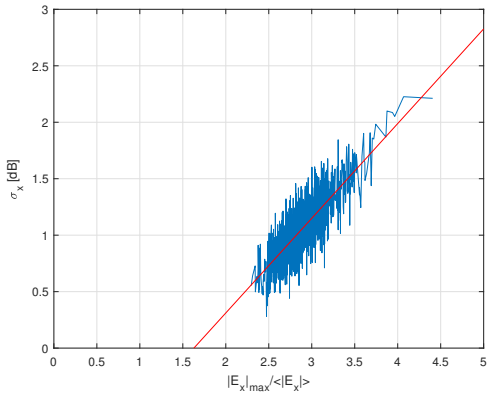

Figure 1. Standard deviation σ_x as a function of the maximum value of the 400 $|E_x|$ samples obtained for each run (in the case of the Rayleigh distribution).

In other terms, σ_x has a linear dependence with $|E_x^{max}|$ which is only one of the 400 samples collected. This single value is responsible of a shift of 1.5 dB on σ_x (from 0.5 to 2 dB), even when the samples follow the Rayleigh distribution. The field uniformity metric appears therefore to be unreasonably dependent of the extremum measured value. In the case where the 3 dB threshold is exceeded, it is therefore difficult to distinguish if this is in reason of a lack of field uniformity obtained in the RC or because the maximum sample measured is statistically less probable.

References

[1] Reverberation Chamber Test Methods, IEC 61000-4-21:2011, Jan. 2011.

[2] D. A. Hill, “Plane wave integral representation for fields in reverberation chambers,” IEEE Trans. Electromagn. Compat., vol. 40, no. 3, pp. 209–217, Aug. 1998.