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ELECTROMAGNETIC FIELDS WITHIN AN ENCLOSURE

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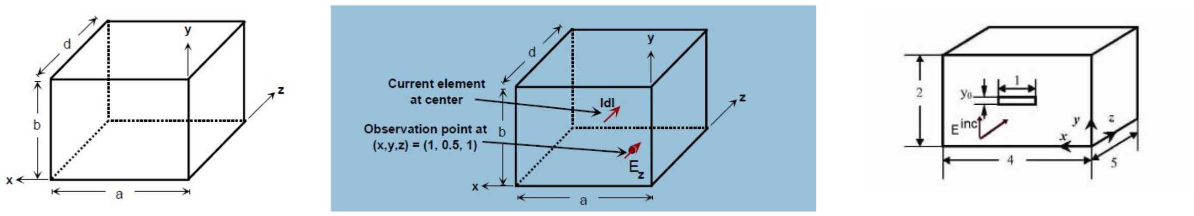
This paper examines the nature of electromagnetic fields that are induced in a shielded enclosure (e.g., a cavity) by either an internal or external source. These fields are described by frequency-independent cavity modes, which when added together, provide a frequency dependent representation for the total internal field. The resulting cavity fields are seen to have a strong resonance and antiresonance behavior, with a variation of more that 40 dB in the E-field in some cases. This large variation makes it difficult to measure the internal fields using conventional techniques that are required by MIL-STD-188-125 or IEEE 299. To identify an alternative measurement procedure for such cavity fields, the existing measurement specifications are first summarized and their deficiencies for such measurements identified. Then an alternative measurement approach, based on a statistical representation of the shielding effectiveness, is suggested [1].

Majority of the Nuclear Electromagnetic Pulse (NEMP) related standards pertain to the testing of equipment enclosures with electrical conductors connected; investigating the behavior of large enclosures is not generally considered. With the increasing interest in higher frequency EM fields and effects, however, there is an interest in the behavior of EM fields within large enclosures. By "large", we mean an enclosure that can measure several wavelengths, or more, on a side.

We consider a rectangular cavity as shown in Figure 1 (a). We also introduce a current element inside the cavity as indicated in Figure 1 (b) and monitor fields . In addition we have also considered a narrow rectangular slot in one of the faces of the rectangular cavity as shown in Figure 1 (c).



(a) (b) (c)

Figure 1. (a) A rectangular cavity (b) Rectangular cavity with a current element inside
(c) Rectangular cavity with a narrow slot on one face

The overall conclusion that can be drawn from the work presented in this paper is that the traditional deterministic measurement methods are not practical for electrically large enclosures, where there can be large and unpredictable response variations and significant sensitivity to the electrical configuration. By separating the problem into a deterministic and a statistical component, ref. [2] has suggested one can obtain a simpler and more useful model for the electromagnetic behavior of such enclosures. In their paper, the authors have found that a simple coupling model, combined with a reverberation-chamber-type statistical model, can describe illumination pattern characteristics of the enclosure. The combined model can be used to predict the behavior of a physical, electrically large system.

References

[1] F. M. Tesche, D. V. Giri and M. Nyffeler, "On the Behavior and Measurement of Electromagnetic Fields within an Enclosure", Interaction Note 633, 19 November 2019. Can be downloaded from: http://ece-research.unm.edu/summa/notes/In/IN633.pdf

[2] J. M. Ladbury , T. H. Lehman, and G. H. Koepke, "Coupling to Devices in Electrically Large Cavities, or Why Classical EMC Evaluation Techniques are Becoming Obsolete", Digest of the 2002 IEEE EMC Symposium, Minneapolis, MN, August, 2002, pp 648-655.