

A Hybrid Formulation for EMC/EMI Problems of Metallic Enclosures with Apertures

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ABSTRACT

The fast current transients which characterize the operation of high speed switching electronic devices cause undesirable electromagnetic emissions to be generated. These unwanted emissions can interfere with the operation of other electronic devices or biological bodies constituting the broader problem known as electromagnetic compatibility (EMC). On the other hand, the fast switching devices can produce, in particular, radiation emissions from their sources that interfere with electric circuits/systems leading to Electromagnetic Interference (EMI). Presently, regulations have been established to ensure that all electronic devices adhere to set standards regarding the emissions levels to mitigate EMC problems.

Over the years, many approaches have been adopted to limit the level of EMI. These include structural-like, such as shielding enclosures and covering-like such as covering coatings and conducting paints. Although new techniques continue to appear, shielding enclosures have stood out as the most preferred option for most problems encountered in EMC engineering. This is because with this method, the shielding system is isolated from the functional part of the product thereby affording flexibility in shield design. The enclosures normally have various apertures for ventilation, cabling and display purposes. The apertures adversely affect the ability of the enclosure to provide the required electromagnetic shielding. It is for this reason that the design of shielding enclosures has taken a prominent role in EMC analysis and electronic system design.

In this work a hybrid Method-of-Moments/Finite-Difference-Time-Domain (MoM/FDTD) formulation for the analysis of metallic enclosures with apertures is developed. The equivalence principle is used to divide the problem into two electromagnetically separate regions each of which is treated separately. The induced aperture magnetic currents are obtained via a MoM solution of the magnetic field integral equation (MFIE) using the generalized network formulation and triangular patch modeling. The computed magnetic current is directly incorporated into FDTD formulations as a source to determine the fields in the interior of the enclosure. The formulations are implemented in a computer code and used to analyze a typical problem of a rectangular enclosure with an aperture. The results are validated using data available in literature. The proposed method has the advantage that it is more adaptable to a wide range of enclosure problems compared to other techniques.

Keywords: Electromagnetic shielding, Shielding effectiveness, metallic enclosures, method of moments, finite difference time domain, EMI/EMC.