Time domain finite element analysis of the transient electric field penetration through thin slit apertures on rectangular enclosures

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Abstract

A time domain finite element technique is presented to determine the transient electromagnetic fields present resulting from thin slit aperture penetration on rectangular conducting enclosures. The purpose of the study is twofold: 1) A comparison of the resulting transient fields is done using a Fourier transform methods of the results and contrasting them to a method of moments solutions (MOM), and other methods for both verification purposes and to investigate the possible presence of highly damped transient evanescent modes. 2) Investigation of the shielding effectiveness of a rectangular enclosures for typical transient events on enclosures with thin slit apertures (e.g., lightning and EMP).

Determination of the electromagnetic fields in within the cavity assumes the electromagnetic wave is normally incident on the enclosure with and has a Gaussian temporal structure but otherwise consistent with standard plane wave excitation. Maxwell's equations are solved with the appropriate boundary conditions for the unknown aperture transient fields. Numerical data of EM shielding effectiveness of a rectangular box with a single aperture and multiple apertures is discussed in addition to earlier published data.

Several simulations forced a restriction that allowed only the dominant modes to develop in the cavity. Both time domain and frequency domain FEM simulations were done and the results of these simulations were found to be in excellent agreement with the published the work of Desphande [*Digital Avionics Systems Conference, 1999*]. An Expansion of this method to investigate the behavior of multiple apertures and aperture sizes is also done and resulting transient field signatures are discussed and compared to previous work and measurements. The complete solution without restrictions allowed the development of higher order modes and showed excellent agreement with corresponding measurements. Analysis of the problem results in a system of time-dependent partial differential equations in Cartesian coordinate forms. The system of equations is solved with the positive definite normal equations of the forms A**T*A*x = A**T*b and a least squares finite element method used for the solution.

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