Study of Electromagnetic Field Radiation from Apertures using the Alternating-Direction Implicit Finite-Difference Time-Domain (ADI-FDTD) Method

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Metal enclosures with apertures are typically used as chasses for high-speed computer systems. As the clock frequency increases, the metal wire and interconnects on printed circuit boards can act as antennas or radiators, whose radiation intensity increases with frequency. Apertures present on the enclosures are primarily intended for thermal management. Li and Ramahi [IEEE APS/URSI Symposium, 2002] proposed a novel structure to reduce field leakage from apertures by coating a layer of conducting material (of much smaller conductivity) on top of the metallic aperture. The coating works to reduce radiation, especially at frequencies at or close to the natural resonance of the aperture. In this work, we developed an alternating-direction implicit finite-difference time-domain (ADI-FDTD) method that is capable of providing a more accurate definition of the electromagnetic fields within the very thin coating layer surrounding the aperture. This multi-grid ADI-FDTD algorithm can efficiently model the problem of a radiating object in the presence of an aperture coated with a thin film material. The thickness of the film can be substantially smaller than that of the metallic surface. We validated our algorithm by comparison to results using other well-established commercial tools. We investigated the effect of textured and/or thin-film material inclusion on the enhancement or reduction of the field in the exterior of an enclosure containing the aperture. Mitigation of transmitted radiation sees critical applications in the field of electromagnetic interference, enhancing radiation, on the other hand, is important in a wide range of applications form maximizing efficiency of antennas to improving the effectiveness of near field optical microscopes. We will present results showing current distribution on the material surrounding the aperture, and present a discussion on the physical aspects of the aperture radiation phenomenon.