Dyadic Green's Function Numerical-Analytical Techniques for Computing IEMI Fields through Layered Media

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Intentional electromagnetic interference (IEMI) produced by high power electromagnetic devices poses a serious threat to communication systems and other infrastructure that depends heavily on real-time data. In recent years many new devices of all sizes (e.g., suitcase-size radiators) have been built to test the susceptibility of computers, supervisory control and data acquisition (SCADA) systems, discrete-event dynamic systems (DEDS), and hybrid control systems against IEMI. While the desirability of testing systems is unquestioned, only a limited combination of tests can be performed because of funding and time constraints. However, much can be learned from theoretical models that are based on a rigorous foundation and that treat novel radiation systems in combination with dispersive propagation media found in office buildings and in factories. We have found that the dyadic Green's function technique, using wave vector functions, is well suited to the task of computing the electromagnetic fields that propagate through layered structures and into enclosures from unconventional electromagnetic sources. The targets of such sources may lie within the near field and may be subjected to highly non-planar wavefronts. After formulating exact expressions for three dimensional electromagnetic fields in terms of the wave vector functions in cylindrical geometry, we examine a number of methods for evaluating these fields. These include: numerical algorithms, branch-cut integration approaches, asymptotic approximations, analytical approximations to integrals based on radiation conditions, and bounding approximations. The results of these analyses provide a preliminary estimate of the uncertainty of the theoretical predictions. This information is also useful for planning experiments that assess system susceptibility to IEMI.