Time-Domain Boundary-Value Electromagnetic Problems for Planar Interfaces at Normal Incidence

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A general framework for the solution of time-domain boundary-value electromagnetic problems for planar interfaces at normal incidence is presented and then applied to derive some simple, exact solutions.

The method utilizes the operational calculus in conjunction with the transmission line model. General operational solutions are provided in terms of a generic load impedance. Then three specific examples of planar interfaces are examined: the half-space, the metal-backed slab, and the slab in free space.

The operational solutions are expanded through long division and summation. For a delta-function incident source, time-domain solutions are obtained through use of Laplace transform tables. A number of special cases are investigated, e. g. zero contrast between the different media and also media which exhibit distortionless transmission. Simple examples are provided to illustrate the use of the method. The more complex examples contain exponential and modified Bessel functions. The work extends earlier results by incorporating a magnetic conductivity term. Also, the zero contrast solutions for the slab structures do not appear to have been published prior to this investigation. Previous work (Kish, University of Illinois at Chicago, 1995) provided numerical results to illustrate the dependence of the solutions on the various parameters of the problem. The method presented is general enough to provide a framework for investigating associated problems with slabs composed of DNG (double negative) metamaterials. These structures of current interest could be solved through the appropriate characterization of the transmission line parameters.

The original research (Kish, UIC 1995) was completed under the direction of Professor Piergiorgio Uslenghi. It is presented at the special session in honor of Professor Uslenghi as an example of work directed by him at the University of Illinois at Chicago within the Department of Electrical Engineering and Computer Science.