Analysis of the Late-Time Transient Field Scattered by a Line Source Above a Grounded Dielectric Slab

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It is desirable in many situations to reduce the radar cross section of air vehicles by coating the surface of the vehicle with absorbing materials to reduce the scattered field strength. Since the properties of these materials may change over time in response to exposure to the elements of nature or material decay, it is desirable to find a method of measuring their characteristics through non-invasive testing procedures. One approach is to examine the response of the material to a transient excitation.

Several different studies have been undertaken to investigate the transient response of layered materials due to an incident plane wave in both the frequency and time domains. It has been shown (J. Oh, et. al., Journal of Electromagnetic Waves and Applications, vol. 17, no. 5, pp. 673-694, 2003) that for a transient plane wave incident upon a planar slab, the late-time portion of the reflected field can be characterized as a natural mode series. Other studies (e.g., H. Vollmer and E. Rothwell, IEEE Trans. on AP, vol. 52, no. 8, pp. 2186-2189, August 2004) have also obtained a natural mode series representation for a transient plane wave incident upon a curved material.

In this paper we shall examine the fields scattered by a cylindrical wave incident upon a simple planar layered medium consisting of a grounded dielectric slab. Both electric and magnetic line source excitations are considered. Using these sources, we compute the time-domain impulse response via the inverse fast Fourier transform of the frequency-domain reflected field, and determine if the late-time component can be characterized as a natural mode series, similar to the response of these materials to a plane wave. An investigation of the scattered fields will be presented as a function of various geometrical parameters - permittivity, permeability, conductivity, and thickness of the layer.