Diffraction by a material-loaded tandem slit

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The diffraction of a plane electromagnetic wave by a tandem slit is an important diffraction problem in both theory and application. This geometry has found numerous applications in microwave and optical instrumentation (microwave passive filters, couplers, etc). Previous solutions of the tandem slit configuration include diffraction of an oblique plane wave incident on (1) a tandem slit in air (*S. C. Kashyap and M. A. K. Hamid, IEEE Trans Antennas Propag, 19,499-501, 1971*) using the Weiner-Hopf technique and (2) a tandem impedance slit in air (*B. Polat, A. Buyukaksoy and G. Cinar, PIER, 34, 29-61, 2001*) using a combination of Weiner-Hopf and Mode Matching techniques. However, diffraction from a material-loaded tandem slit has not been explored mathematically. This analysis is motivated by applications in shielding effectiveness and/or dielectric constant measurement for homogenous materials. Also, the analysis is useful to study the variation of the diffracted fields as a function of material parameters (ε_r and μ_r).

In this study, we consider diffraction of E_z-polarized plane waves by a tandem slit loaded with a lossy material as shown in figure 1. The boundary value problem is formulated into a pair of simultaneous Weiner-Hopf equations via Fourier transformation. After decoupling these equations by elementary transformation, each modified Weiner-Hopf equation is reduced to a Fredholm integral equation of the second kind. The integral equation is then solved approximately to yield the Fourier transform of the diffracted field for the case when the width of the slit is large compared to wavelength. The inverse transform is evaluated asymptotically to yield the diffracted far field. The derived expressions are independent of the thickness of the material and material parameters. Some computational results illustrating the effects of different media and different material thicknesses on the diffraction phenomenon are presented. In addition, the analytic results are compared with simulations (Ansoft HFSS) and measurements.

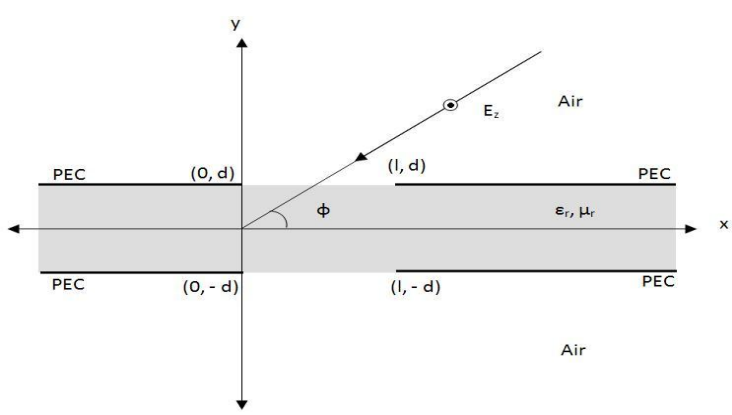

Figure 1. Tandem Slit loaded with a homogeneous material.