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Plane Wave Diffraction by a Slit in a Material Screen

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The analysis of the scattering by a slit in an infinite screen is an important subject in electromagnetic theory and radar cross section (RCS) studies. A number of scientists have analyzed the slit diffraction problem using various analytical and numerical methods [1, 2]. In [3, 4], we have analyzed the plane wave diffraction by a thin material strip for H and E polarizations using the Wiener-Hopf technique together with approximate boundary conditions, and obtained a rigorous, high-frequency asymptotic solution. In particular, it has been shown that our final solution is valid for the case where the strip width is not too small compared with the wavelength. In this paper, we shall consider a slit in an infinite material screen, and analyze the H-polarized plane wave diffraction with the aid of the Wiener-Hopf technique by following a procedure similar to that employed in our previous papers [3, 4].

The geometry of the slit is shown in Figure 1, where μ_r and ε_r denote the relative permeability and the relative permittivity of the material, respectively, and ϕ^i is the incident field of H polarization. Introducing the Fourier transform of the scattered field and applying approximate boundary conditions [5] in the transform domain, the problem is formulated in terms of the simultaneous Wiener-Hopf equations, which are solved exactly via the factorization and decomposition procedure. However, the solution is formal since branch-cut integrals with unknown integrands are involved. We shall further employ a rigorous asymptotic method to derive a high-frequency solution to the Wiener-Hopf equations. The scattered field is evaluated asymptotically by taking the inverse Fourier transform and applying the saddle point method.

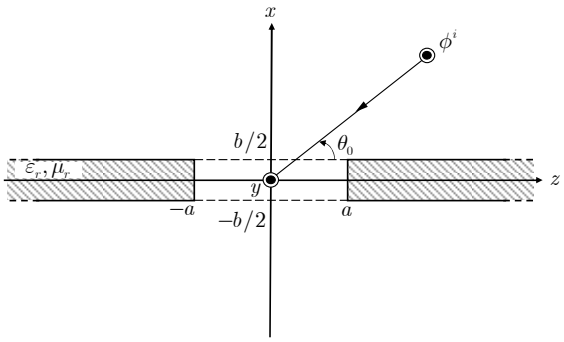

Figure 1. Geometry of the problem.

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