Penetration through a Slotted Screen into a Semi-Elliptic Channel: Simple Integral Equation with an Eigenseries Kernel

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In this paper we formulate a single, simple integral equation whose solution can be used to determine the field penetration through a slot in a screen into a semi-elliptical channel adjoined to the back of the screen, and we develop an efficient method for solving the integral equation. The channel backs the slot, and the excitation is specified to be transverse electric and invariant along the axes of the slot and channel. The region in front of the screen and exterior to the channel is a semi-infinite half-space filled with a homogeneous medium, while the medium inside the channel is homogeneous but may be different from that in the exterior. The excitation is due to a TE source which may be located either in the exterior region or within the channel.

The integral equation Green's function can be interpreted as the sum of two terms, each of which is an axially-directed magnetic field radiated by a unity-strength, axially-directed magnetic line current. One contribution is the magnetic field due to the line current in infinite, homogeneous space filled with the medium of the exterior region and the other is the magnetic field in the channel caused by the unity-strength magnetic line current in the channel. The second term contains an eigen series of products of radial and angular Mathieu functions. The formulation of the Green's function is outlined and the numerical solution of the integral equation is described.

Solutions of the integral equation are obtained for various slot widths, for selected excitations, and for specified channel dimensions and material. Data are presented for several cases of interest and are compared with data available in the literature for the special case that the exterior region and channel media are isorefractive. These data, which arise from the solution of the simple integral equation with a closed-form kernel, should be of interest to those who wish to test the accuracy of corresponding data obtained by purely numerical solution methods applied to the class of problems addressed in this paper.