Modal Analysis of a Parallel-Plate Waveguide Containing an Internal Perforated Sheet

Nick J. Krull* [(1)(2)], Edward F. Kuester[(1)]
(1) Department of Electrical, Computer and Energy Engineering,
University of Colorado, 425 UCB, Boulder, CO, USA 80309
(2) Electronic Expertise, 1928 Mariposa, Boulder, CO,
http://www.electronicexpertise.com

The open planar parallel-plate waveguide is a classic structure where two infinite conducting plates are separated by a fixed distance, *d.* A well-documented analytical solution for the TEM and higher-order guided modes exists when the guide is homogeneously filled. Modifying this homogeneous fill in any way makes a closed form solution more challenging. Inserting a perforated conducting sheet affords the potential of surface-wave and other unusual modes, opening up a variety of unique applications to communications and sensors.

In this paper, the planar parallel plate structure is used as a starting point to explore the utility of the Generalized Sheet Transition Condition (GSTC) in analyzing the placement of a perforated screen placed between infinite PEC parallel plates. This technique uses the concept of electromagnetic porosities to model the transparencies of the screen's periodic perforations.

This model is used to show classic guided waves, as well as revealing surface waves. The approach utilizes a GSTC and affords a way to easily introduce the perforated separator. Propagation constants as well as fields on either side of the perforated sheet can be quickly computed for all types of guided modes.

Numerical and analytical results will be presented over a range of screen perforation ratios. Most of the computed results for the propagation constants agree within 1%. Additionally, the field distributions over the cross-section of the waveguide will also be presented.

The analytical approach presented here computes modes in approximately 30 seconds over a range of frequencies on a standard PC, which is important when solution speed is an issue. The finite-element numerical approach requires minutes, and in some cases hours, to accomplish a complete frequency sweep. It is seen that the approximate method presented here, using the GSTC boundary condition to model the modes of a parallel plate guide, reveals guided-wave characteristics both quickly and accurately.