URSI GASS 2021, Rome, Italy, 28 August - 4 September 2021

Propagation through a Slotted Wall in a Parallel-Plate Waveguide

Giorgio Carnevali* and Piergiorgio L. E. Uslenghi
Department of Electrical and Computer Engineering, University of Illinois at Chicago, USA
giorgio.carnevali@gmail.com, uslenghi@uic.edu

The metallic structure examined herein consists of a parallel-plate waveguide that is truncated by a slotted wall perpendicular to the plates and to the direction of electromagnetic energy propagation inside the guide. The edges of the rectangular slot in the truncating wall extend from one plate of the guide to the other plate. The slot may be backed by a metal elliptic semi-cylinder whose foci coincide with the slot edges. The media on the two sides of the truncating wall are linear, homogeneous, isotropic and possibly isorefractive to each other. The aim of this work is to derive an exact solution to the electromagnetic field on either side of the truncating wall when the incident field propagating inside the guide is a TEM, TE, or TM mode. The analysis is conducted in the phasor domain with a time-dependence factor $exp(+j\omega t)$ omitted throughout.

The first step in obtaining the solution is the determination of the field scattered by a plane wave incident perpendicularly to a metal plane with a slot of infinite length, when the electric or magnetic field is parallel to the slot edges; in the former case, this is also the solution to our problem for propagation of the TEM mode inside the parallel-plate guide. The solution is obtained in terms of an infinite series of elliptic-cylinder wavefunctions, and is a particular case of a more general result [1]. For a TE or TM mode, the second step consists in decomposing the incident field into the sum of two plane waves, then extending to each plane wave the result obtained in the first step by going to oblique incidence and truncation by one of the parallel plates of the guide, by making use of a known general method [2], and finally combining the two results. Particular attention is devoted to the exact expressions for the surface current density on all metal surfaces of the structure. Numerical results for the surface current densities are presented and discussed.

The results presented herein were developed in a MS thesis authored by the first author under the guidance of the second author [3].

References

[1] P.L.E. Uslenghi, *IEEE Trans. Antennas Propag.*, **52**, 6, pp. 1473-1480, June 2004.

[2] P.L.E. Uslenghi, *IEEE Trans. Antennas Propag.*, **63**, 5, pp. 2228-2236, May 2015.

[3] G. Carnevali, "Electromagnetic propagation through a slotted wall inserted in a parallel-plate waveguide", MS Thesis, University of Illinois at Chicago, September 2019.