Analysis of the Shielded Electromagnetic Bandgap Structures Using Multiconductor Transmission-Line Theory

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The electromagnetic bandgap (EBG) structures are increasingly utilized in modern electronic circuits as a means of power/ground plane noise suppression. In such applications, the EBG structure is incorporated in the power distribution network (PDN) of printed circuit boards by replacing one of the reference voltage planes; thus creating a shielded, i.e. parallel-plate waveguide, structure (R. Abhari and G. V. Eleftheriades, *IEEE trans. MTT*, **51**, 1629--1639, 2003). Primarily, the transverse resonance technique was utilized for analysis of this geometry. In this method the EBG structure was represented by an effective sheet impedance. This technique predicts an approximate 1-D dispersion diagram in a matter of few seconds. The accuracy of the generated band diagrams were further improved by other fast analytical techniques which combined the application of Floquet theorem and lumped component modeling of the EBG structure. Recently, a 1-D multiconductor transmission-line (MTL) analysis method (F. Elek and G. V. Eleftheriades, *IEEE Microw. Wireless Compon. Lett.*, **14**, 434-–436, 2004) has been presented that predicts the bandgap region as well as the dispersion characteristics of the lower order TM modes. In that work, the shielded Sievenpiper's mushroom-type EBG structure is investigated by applying Floquet analysis to the MTL structure formed by the parallel-plate conductors and mushroom patches. Application of periodic analysis to this geometry yields the eigen-mode solutions and the dispersion curves. In this paper, a similar approach is utilized to investigate a number of shielded EBG structures that can be used in the PDN of electronic circuits. Simulation results for a shielded cross-shaped EBG structure as well as the shielded mushroom structure are presented. MTL analysis allows for rapid production of dispersion diagrams with accuracy comparable to Finite element method (FEM) simulations.

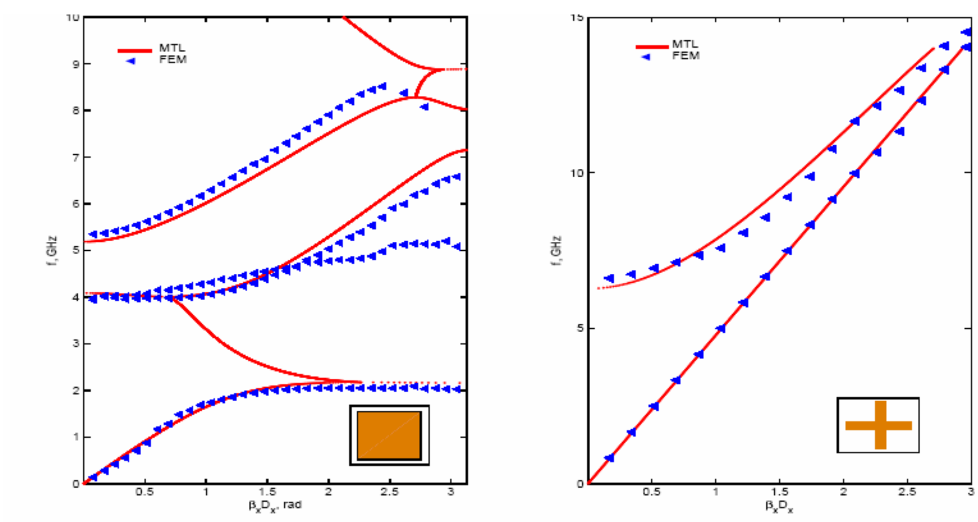

Figure 1: Dispersion curves: (a) shielded mushroom, (b) shielded cross-shaped geometries.