Analysis of Thick Metallic Dichroic Screens with Arbitrarily Shaped Apertures by a Hybrid Mode Matching - Finite Elements Technique

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Thick conducting screens periodically perforated with apertures are frequently used as inductive Frequency Selective Surfaces (FSSs), i.e., structures with the property of selectively reflecting or transmitting electromagnetic waves at certain frequency bands. The aim of this communication is to present a hybrid Mode Matching (MM) - Finite Elements (FE) technique to analyze inductive FSSs with arbitrarily shaped apertures, illuminated by a plane wave impinging on the structure at oblique incidence, even in the presence of inhomogeneous fillings of the apertures. As a first step, the electromagnetic field in the free-space region is expanded in a complete set of Floquet modal basis functions, with unknown complex coefficients. Next, the transverse electromagnetic fields inside each arbitrarily shaped aperture, considered as a section of a metallic waveguide, are represented by a complete set of waveguide modes obtained via the FE approach. In the case of inhomogeneous fillings, the complete set of complex hybrid modes is taken into account. Moreover, the problem of the spurious solutions is avoided by the use of both Whitney's Edge elements to interpolate transverse field components and Lagrange polynomials to reconstruct the longitudinal ones. Then, boundary conditions are applied at the interface between these two regions. Through the computation of the unknown modal coefficients, the Generalized Scattering Matrix (GSM) of the free-space/waveguide interface is determined. Finally, the GSM of the entire screen is obtained by considering the cascade connection of the lit face, the waveguide section, and the shadow face, then combining the corresponding matrices in accordance with the standard formulas for microwave circuits (A. Monorchio et al., "Analysis of waveguide discontinuities using edge elements in a hybrid Mode Matching/Finite Elements approach", *IEEE Microwave and Wireless Components Letters,* vol.11, pp. 379 -381, Sept. 2001).

The proposed hybrid scheme combines the MM and the FE method in order to retain the advantages of the two techniques, i.e., the numerical efficiency and the accuracy of the MM and the capability of the FE method to analyze complex and irregular structures. Some numerical results will be presented to demonstrate the accuracy and the effectiveness of this hybrid approach, with specific reference to the convergence rate of the technique.