GREEN'S FUNCTION ANALYSIS OF AN IDEAL HARD SURFACE RECTANGULAR WAVEGUIDE

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In this paper, we study a rectangular waveguide with an ideal hard surface boundary conditions, which is modeled by alternating longitudinal perfect electric conductor (PEC) and perfect magnetic conductor (PMC) strips with vanishing widths. Compared to PEC and PMC rectangular waveguides, which can support only TM and TE modes, the most important feature of this ideal hard surface rectangular waveguide is that it allows a propagation of the TEM mode with a zero-cutoff frequency, which can provide new applications for this type of guided-wave structure. Whereas the TM and TE modes see the waveguide as a PEC and PMC waveguide, respectively, the TEM mode sees the ideal hard surface waveguide as a combination of PEC and PMC waveguides modeled by alternating PEC/PMC strips with vanishing widths, and it satisfies the boundary conditions on the ideal hard surface partially contributed by PEC and PMC waveguides.

The purpose of the present paper is to develop an electric dyadic Greens function for the modal analysis of an ideal hard surface rectangular waveguide excited by an arbitrarily-oriented electric current source. A decomposition of the hard surface waveguide into PEC and PMC waveguides allows the representation of dyadic Greens function as a superposition of TM and TE waveguide modes, respectively. In addition, a term corresponding to the TEM mode is obtained analytically as the solution of vector Helmholtzs equation in the zero-cutoff limit subject to the boundary conditions for the electric field on the ideal hard surface. The electric Greens dyadic of the ideal hard surface waveguide consists of solenoidal and irrotational parts, where the solenoidal part is obtained in the eigenmode expansion form in terms of TM, TE, and TEM modes of the hard surface waveguide and it is understood in the principal value sense. The irrotational part includes a depolarizing dyadic, which is associated with a slice-pillbox principal exclusion volume. The main singularity of the Greens function is contained in the solenoidal part and represents a source-plane singularity.

Numerical results for field distributions are demonstrated for the TEM mode and a few representative TM and TE modes propagating in a rectangular waveguide with ideal hard surface boundary conditions due to an arbitrarily-oriented electric dipole source. It is shown that the TEM mode of the ideal hard surface waveguide has uniform field distribution over the waveguide cross-section, and the polarization of the mode necessarily depends on the polarization of the electric dipole source.

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2. B - Fields and Waves
3. (a)
4. C - Contributed Paper
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