Abstracts

The Wave-Equation FD-TD Method for the Efficient Eigenvalue Analysis and S-Matrix Computation of Waveguide Structures

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A new finite-difference time-domain (FD-TD) method is presented for the efficient computation of both the hybrid-mode eigenvalues and the scattering parameters of waveguide structures. The FD-TD formulation is based on the direct discretization of the vector wave equation, and requires advantageously only one grid (instead of two displaced grids in the commonly used curl equation approach). Moreover, merely the solution of three (instead of six) coupled equations is necessary. For 2D eigenvalue problems, the utilization of actual 2D grids and graded meshes yields a further reduction in the computational requirements, and, e.g., the whole dispersion characteristic (including evanescent modes) may be calculated very efficiently. For the S-parameter calculation, an excitation with a sinusoidally modulated Dirac impulse train is utilized. This combines the efficiency of frequency-domain methods with the flexibility of the standard FD-TD method. Typical numerical examples, such as the resonance frequencies for an inhomogeneously filled waveguide resonator, the hybrid-mode propagation characteristics of dielectric waveguiding structures, and the scattering parameters of the discontinuity of a dielectric slab of finite length in a rectangular waveguide, demonstrate the efficiency of the method. The theory is verified by comparison with results obtained by other methods.

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