Absorbing boundary conditions for FDTD analysis of rectangular waveguide with Non-uniform dielectric inclusions

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When the finite-difference time-domain method is used for analysis of waveguide structures, incident waves are needed for calculating electromagnetic parameters and effective absorbing boundary conditions are required for terminating open waveguide structures.

In this work we consider two effective methods based on absorbing boundary conditions for finite-difference time domain analysis of waveguide structures. A condition based on transverse mode, applicable to single mode rectangular waveguides is presented as well as an enhanced CPML method for multi-modal wave propagation. These conditions attenuate evanescent waves and waves near cutoff frequencies. The existence of such waves in numerical experiments limits the accuracy of the electric and magnetic fields computed using the finite-difference time-domain method.

In this work, we are using three dimensional finite-difference time-domain solver EMWSolver3D. Based on Maxwell equations approximation in integral form on Yee lattice, it provides numerical solution in time domain. EMWSolver3D supports multi-core single processors machines and provides hybrid MPI / Open MP support for IBM Blue Gene/ P supercomputer series. Pure scattered field method is used to specify waveguide mode with respect to numerical dispersion. This solver aims at propagation factors estimation of filters created on the base of single-layered parallel-plane dielectric diaphragms in waveguides of rectangular cross section with dielectric inclusions.

Both types of boundary conditions are implemented in conservative FDTD solver. Comparison of these two methods with analytical solution for empty rectangular waveguide and waveguide with dielectric slab is performed. Numerous calculations with different parameters of complex frequency shifted perfectly matched layer is performed.