Analysis and Applications of Compact ADI-FDTD Method for Guided Wave Structures

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The signal propagation on integrated circuit (IC) interconnects are of importance to both microwave/RF circuit designers and high-speed digital circuit engineers. The accurate characterization of interconnects frequency dependent behavior is often required in order to optimize a circuit design. To efficiently extract interconnect frequency dependent behavior, numerical simulations are often used. The compact finite difference time domain (FDTD) method has been successfully used to perform such extractions for general guided wave structures. However, the time step size constrain of this algorithm has limited its application to electrically small IC interconnects.

To improve the computational efficiency of the ADI-FDTD algorithm, an alternating-direction-implicit FDTD algorithm has been proposed. The algorithm is unconditional stable and the computational overhead is on the same order of the traditional FDTD algorithm. Recent work has shown that although the ADI-FDTD method is unconditional stable, its accuracy degrades as its time step size increases. There exists a maximum step size for ADI-FDTD method in order to maintain the same accuracy level as traditional FDTD method.

In this work, we will first investigate the accuracy level associated with the compact ADI-FDTD method. Since typical IC structures are electrical small and the boundary condition may have significant effect on the accuracy of the simulations, we will investigate both the dispersion errors associated with this algorithm and the error introduced by boundary reflections. We will also apply the non-uniform grids to further increase the spacing between the absorption boundary and IC interconnects. Based on the results of our accuracy analysis, we will apply this technique to study several interconnect structures.