A Novel PML Implementation for the ADI-FDTD Method with Reduced Reflection Error

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The Alternating-Direction Implicit Finite Difference Time Domain (ADI-FDTD) method has been shown to be an attractive alternative to the standard FDTD in some problems due to its unconditional stability with moderate computational overhead. The ADI-FDTD can be particularly useful for problems involving devices with fine geometric features that are much smaller than the wavelength(s) of interest. In order to be applied for unbounded domain problems, the ADI-FDTD requires the use of appropriate absorbing boundary conditions, such as the perfectly matched layer (PML). The PML has been extended to the ADI-FDTD method previously and it has been shown that while the PML can still provide very small reflections at small Courant numbers, its performance gradually deteriorates for large Courant numbers.

Because the ADI-FDTD method is most useful for large (greater than unity) Courant numbers, a PML implementation that does not deteriorate for large Courant numbers is highly desirable. Here we introduce a novel PML implementation for the ADI-FDTD for this purpose. The proposed PML relies on successively applying forward and backward differencing in time for the conduction terms in the ADI-FDTD update, instead of center difference scheme used in the traditional PML implementation for the ADI-FDTD. As a result, the proposed PML maintains almost the same low level refection error for large Courant numbers.

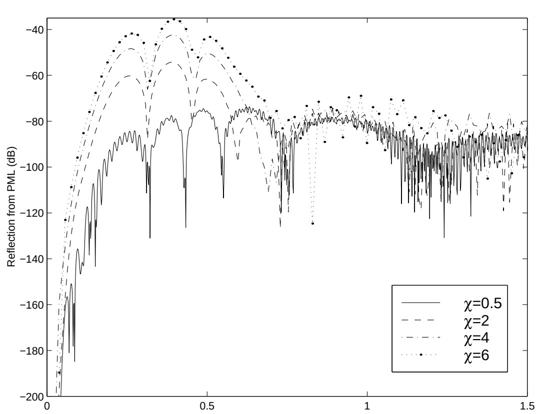

Fig. 1. Reflection error from the PML-ADI-FDTD method with traditional PML implementation.

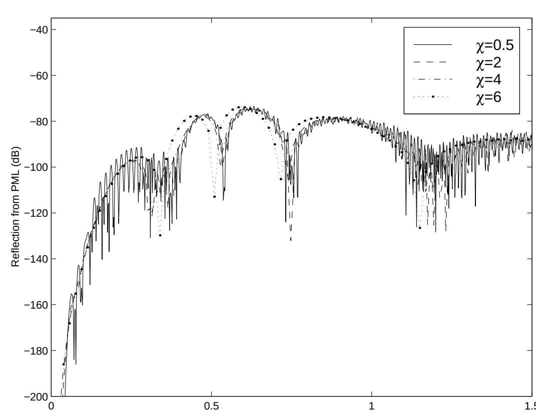

Fig. 2. Reflection error from the PML-ADI-FDTD method with improved PML implementation.