A New Impedance Boundary Condition for FDTD Mesh Truncation

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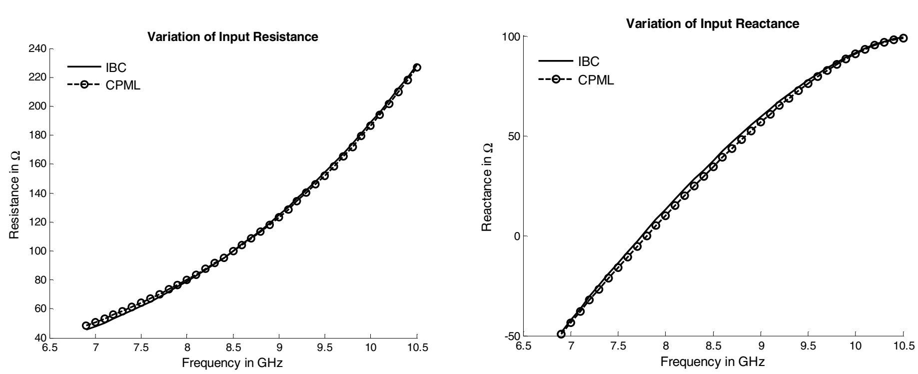
It is well known that suitable absorbing boundary conditions (ABCs) are needed to truncate the mesh in the FDTD computational domain, and that the effectiveness of these boundary conditions affects the accuracy and efficiency of the FDTD simulations. The simplest and computationally inexpensive ABC is the MUR boundary condition (G. MUR, IEEE Trans. on Electromagnetic Compatibility, vol. 23, 1981). However, the accuracy of this boundary condition is good only for the normal incidence case, and the Mur ABC often causes reflections for oblique angles of incidence above an acceptable level. One of the widely used truncation condition is the Convoluted Perfectly Matched Layer, or more commonly known as CPML (W. Yu, R. Mittra, T. Su, Y. Liu and X. Yang, Parallel Finite-Difference Time Domain Method, Boston: Artech House, 2006). The performance of the CPML is superior to that of the MUR boundary condition, since the former is better able to suppress the reflections from the boundary; however, the CPML is computationally expensive. In this paper, we present an alternative to CPML by introducing a novel approach to FDTD mesh truncation, which is based on the use of an impedance boundary condition (IBC) for updating the fields at the boundaries of the computational domain. In this approach, the tangential E-Fields at the end of the computational domain are calculated from the H-fields based on the impedance relationship:

$$E_{tan} = \eta \hat{n} \times \vec{H}$$

where η is a suitably chosen impedance value. The H-fields at the boundaries of the computational domain are updated by using the conventional FDTD equations, but the E-fields are derived by using the IBC. The results presented below illustrate the accuracy of the proposed algorithm, which requires much less CPU time and memory than those needed by the CPML.



(a) (b)

Fig. 1. Comparison of Input Impedance for the PEC Dipole Antenna (a) Input Resistance and (b) Input Reactance.