Comparison of FETD and FDTD to Simulate Micro-strip Structures on PCBs

Karl, Hollaus, Oszkár, Bíró, Gernot, Matzenauer, Kurt, Preis, Christian, Stockreiter, Bernhard, Weiß, Institute for Fundamentals and Theory in Electrical Engineering, IGTE, Graz University of Technology, Kopernikusgasse 24, 8020 Graz, Austria.
Peter, Caldera, Gerhard, Paoli, Infineon Technologies, Microelectronic Design Centers, Austria GmbH, Siemensstrasse 2, 9500 Villach, Austria.

Abstract

The aim of this work is to investigate the numerical effort to simulate the electromagnetic field of simple structures on printed circuit boards (PCB) fast and accurately by the finite element time domain (FETD) method and by the finite difference time domain (FDTD) method. In contrast to calculations of electromagnetic wave equations in the frequency domain, the solution has been calculated in the time domain using time stepping schemes. One significant difference between FDTD and FETD is in the choice of the time step Δt. In case of FDTD an approximate solution of the unknown electric field intensity $\mathbf{E}$ and magnetic field intensity $\mathbf{H}$ has been determined by discretizing the problem region with Yee-cells and by applying the "leapfrog scheme" in an explicit time stepping procedure. For FETD, hexahedral edge and nodal finite elements of second order have been employed to approximate the magnetic vector potential $\mathbf{A}$ and the electric scalar potential V, respectively. The potential formulation is not gauged. The system of equations arising from the Newmark time stepping method has been solved by a preconditioned conjugate gradient method. The input impedance of a lossy loop-shaped micro-strip structure on a PCB has been studied in the frequency range between 100MHz and 1GHz. Simulation results and measurement data are presented. A good agreement between them can be observed. Although the number of time steps required by FDTD is extremely large, the simulation times by FDTD and FETD are almost equal. The number of coefficients for FDTD is clearly smaller than that for FETD.

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e-mail: karl.hollaus@TUGraz.at