

Abstract

The objective of this thesis is to develop a systematic framework for modeling electromagnetic wave propagation in a printed circuit board (PCB) assembly and related structures. The PCB assembly contains discrete components (both active and passive), integrated circuits, copper traces, sockets and connectors. Related structures imply this framework can be generalized to environments such as Monolithic Microwave Integrated Circuit (MMIC) and the semiconductor itself. The proposed method-of-choice for approximating a solution to the Maxwell's equations for this environment is the Finite-Difference Time-Domain (FDTD) approach, which was originally proposed by K. S. Yee in 1966 (Yee 1996). The method approximates the differentiation operators of the Maxwell equations with finite difference operators in time and space. This method is suitable for finding the approximate electric and magnetic field in a complex three-dimensional structure in the time domain. This thesis puts forward a collection of algorithms, mathematical tools and a computer program for approximating the Maxwell's equations with a finite-difference counterpart under various conditions encountered in a typical PCB assembly. The author consolidates the results obtained by previous researchers in this area, puts forward a few improvements and also derives new stability theorems suitable for a general PCB model. The stability theorems are intended to check whether the numerical algorithm is 'well-behaved' or not. This is important for the FDTD approach, which like many iterative numerical methods, are susceptible to a condition where the solution gradually increases without limit as simulation progresses. The computer program developed in this thesis can be used to simulate various microwave circuits before actual prototyping, thus cutting down the cost and saving valuable time. This project is self-encompassing, it provides the theoretical basis for the method, the details of the implementation on a digital computer and finally the software itself.