Preface

The purpose of this hybrid book is to provide a comprehensive collection of topics relating to the application of the Finite-Difference Time-Dornain (FDTD) method to microwave struc-tures. Important subjects such as numerical issues, geometry de-scription, vector and parallel processing, methods to reduce the requirements for computational resources, and illustrative ex-amples which demonstrate the range of application and level of numerical accuracy are covered. Each chapter consists of two parts: the first is a monograph on the specific subject written in a self-sustaining fashion; the second is a collection of selected reprints illustrating the state-of-the-art publication on the sub-ject matter. It is our belief that this hybridization provides sub-stantial utilities to the readers. Readers may study the fundamentals of the topics discussed in each chapter on one hand, and, on the other hand, they are exposed to the broad range of reference materials which by themselves have created mile-stones in the technology. Additionally, for busy scientists and engineers, the volume provides a quick reference. The FDTD papers have appeared in many different publications due to the popularity and variety of applications of the subject. As such, a search for the vast size of information is quite time-consuming for anyone; this volume was created to save such effort. Chapter 1 begins with an overview of the FDTD algorithm. The Maxwell's equations in the Cartesian coordinate system are given, along with the corresponding finite-difference equations. The difference equations are the result of the center-difference approach which results in the leap-frog FDTD algorithm. A block diagram of the FDTD algorithm is also presented illus-trating the sequence of operations for a time-domain simulation, including excitation, electromagnetic field updates, treatment of dielectric discontinuity and perfect electric conductors, and the absorbing boundary conditions.
Chapter 2 covers the fundamental theoretical and numerical aspects of the FDTD algorithm. The difference equations for all components of the electric and magnetic fields are derived from the time-domain Maxwell's equations. This chapter covers nu-merical stability, numerical dispersion, and the excitation issues

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for the FDTD algorithm. The absorbing boundary condition (ABC) is also discussed and detailed treatment of the Berenger's ABC is presented.
Chapter 3 describes the Conformal FDTD methods. The mo-tivation for employing these methods is the added flexibility in the geometry representation. This chapter covers the local mesh refinement, curvilinear, and non-orthogonal grid. In addition, the finite element and finite volume formulation are also de-scribed. The numerical accuracy, stability, and computation cost for implementation of these formulations are also presented. Chapter 4 covers the computation efficiency of the FDTD al-gorithm on various computer platforms ranging from RISC-based workstations to vector and parallel computers. This chapter first addresses the implementation of the FDTD algo-rithm on RISC-based workstations and vector processors. Then, the implementation of this algorithm on parallel computers is presented.
Chapter 5 addresses the issue of reduction in computational requirements for the FDTD algorithm. Computational require-ments consist of memory and CPU time allocations. Signal processing algorithms are applied to the FDTD generated wave-forms in order to efficiently extract parameters of interest such as ^-parameters and resonant frequencies. The FDTD Diakoptics reduces the memory requirements by representing segments of the FDTD computation domain by their impulse re-sponses. The formulation and numerical issues associated with these methodologies are presented.
Chapter 6 presents the application of the FDTD analysis tech-nique to the simulation of the electromagnetic fields and the de-sign of microwave integrated circuits. The use of the FDTD algorithm is demonstrated through a number of examples. The issues of excitation, absorbing boundary conditions, mesh re-finements, and application of the signal processing methods are presented.
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