

Research Article

Multiresolution Time-Domain Scheme for Terminal Response of Two-Conductor Transmission Lines

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This paper derives a multiresolution time-domain (MRTD) scheme for the two-conductor lossless transmission line equations based on Daubechies' scaling functions. And a method is proposed to generate the scheme at the terminal and near the terminal of the lines. The stability and numerical dispersion of this scheme are studied, and the proposed scheme shows a better dispersion property than the conventional FDTD method. Then the MRTD scheme is extended to the two-conductor lossy transmission line equations. The MRTD scheme is implemented with different basis functions for both lossless and lossy transmission lines. Numerical results show that the MRTD schemes which use the scaling functions with high vanishing moment obtain more accurate results.

1. Introduction

The multiresolution time-domain (MRTD) scheme proposed by [1] provides an efficient algorithm for electromagnetic field computation and shows excellent capability to approximate exact solution with low sampling rates. However, the Battle-Lemarie wavelet function used in [1] is not compact supported, which means the iterative equations contain infinite terms. We must cut off the iterative equations in the actual computation and this may introduce truncation errors. So different wavelet bases, which are compact supported with some numbers of vanishing moments, have been used to improve this method [2–5]. This makes a great development for MRTD schemes. As a kind of numerical method, the MRTD schemes show great advantages in numerical dispersion properties [6–9]; meanwhile, these schemes need a more rigorous stable condition than the conventional FDTD method [10]. For containing more terms in the iterative equations, the terminal conditions or absorbing boundary conditions are more complicated to process in MRTD schemes; this disadvantage has limited the application of the MRTD scheme. To overcome this limitation, some works on the perfect match layer have been made [11–13]; however, other terminal conditions also need to be analyzed specifically. For the transmission lines equations, the resistive

terminal conditions could be equivalent as a general Thevenin circuit; this paper will solve this kind of terminal condition in the MRTD scheme.

Since the appearance of the telegraph equations, studies on transmission lines have had a considerable development. Several equivalent forms of transmission line theory have been proposed to describe the influence of the incident electromagnetic field to the transmission lines [14–16]. In [17], the classical theory of the transmission line has been summarized and the theory on the high frequency radiation effects to the transmission lines is introduced. In the monograph [18], the multiconductor transmission lines (MTL) theory has been comprehensively studied in detail. For the two-conductor lossless transmission lines, there are several methods, which contain the series solution, the SPICE solution, the time-domain to frequency-domain (TDFD) transformation method, and the FDTD method [18]. However, the MRTD scheme has not been used to calculate the terminal response of transmission lines. In this paper we will derive a MRTD scheme for this problem.

In this paper, we focus on the calculation of the terminal response of two-conductor transmission lines equations by using MRTD scheme. In Section 2, the MRTD scheme is derived based on Daubechies' scaling functions for the two-conductor lossless transmission line equations, and, for

Multiresolution Time Domain Scheme For Electromagnetic Engineering

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Parallel Finite-difference Time-domain Method Wenhua Yu, 2006 The finite difference time domain FDTD method has revolutionized antenna design and electromagnetics engineering This book raises the FDTD method to the next level by empowering it with the vast capabilities of parallel computing It shows engineers how to exploit the natural parallel properties of FDTD to improve the existing FDTD method and to efficiently solve more complex and large problem sets Professionals learn how to apply open source software to develop parallel software and hardware to run FDTD in parallel for their projects The book features hands on examples that illustrate th

RF and Microwave Circuits, Measurements, and Modeling Mike Golio, Janet Golio, 2018-10-08 Highlighting the challenges RF and microwave circuit designers face in their day to day tasks RF and Microwave Circuits Measurements and Modeling explores RF and microwave circuit designs in terms of performance and critical design specifications The book discusses transmitters and receivers first in terms of functional circuit block and then examines each block individually Separate articles consider fundamental amplifier issues low noise amplifiers power amplifiers for handset applications and high power power amplifiers Additional chapters cover other circuit functions including oscillators mixers modulators phase locked loops filters and multiplexers New chapters discuss high power PAs bit error rate testing and nonlinear modeling of heterojunction bipolar transistors while other chapters feature new and updated material that reflects recent progress in such areas as high volume testing transmitters and receivers and CAD tools The unique behavior and requirements associated with RF and microwave systems establishes a need for unique and complex models and simulation tools The required toolset for a microwave circuit designer includes unique device models both 2D and 3D electromagnetic simulators as well as frequency domain based small signal and large signal circuit and system simulators This unique suite of tools requires a design procedure that is also distinctive This book examines not only the distinct design tools of the microwave circuit designer but also the design procedures that must be followed to use them effectively

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This reference provides a survey of options for the reduction of the electromagnetic field levels in prescribed areas This is a resource for practicing telecommunications and electrical engineers as well as researchers in industry and academia who are involved in the design and analysis of electromagnetic shielding structures Jacket *Physics of Multiantenna Systems and Broadband Processing* T. K. Sarkar, Magdalena Salazar-Palma, Eric L. Mokole, 2008-06-30 An analysis of the physics of multiantenna systems Multiple Input Multiple Output MIMO technology is one of the current hot topics in emerging wireless technologies This book fills the important need for an authoritative reference on the merits of MIMO systems based on physics and provides a sound theoretical basis for its practical implementation The book also addresses the important issues related to broadband adaptive processing Written by three internationally known researchers Physics of Multiantenna Systems and Broadband Processing Provides a thorough discussion of the physical and mathematical principles involved in MIMO and adaptive systems Examines the electromagnetic framework of wireless communications systems Uses Maxwell's theory to provide a system based framework for the abstract concept of channel capacity Performs various numerical simulations to observe how a typical system will behave in practice Provides a mathematical formulation for broadband adaptive processing and direction of arrival estimation using real antenna arrays Integrates signal processing and electromagnetics to address the performance of realistic multiantenna systems With Physics of Multiantenna Systems and Broadband Processing communication systems engineers graduate students researchers and developers will gain a thorough scientific understanding of this important new technology *Optical Switching* Georgios I. Papadimitriou, Chrisoula Papazoglou, Andreas S. Pomportsis, 2007 While much has been published on the subject in individual articles this text is the first to cohesively present optical switching in a single book The three authors examine and discuss all the challenges

involved in the commercialization of optical switching Readers are brought up to date with the latest advances in research as well as the technological hurdles that researchers

The Stripline Circulator Joseph Helszajn, 2008-06-30 Stripline circulator theory and applications from the world's foremost authority The stripline junction circulator is a unique three port non reciprocal microwave junction used to connect a single antenna to both a transmitter and a receiver Its operation relies on the interaction between an electron spin in a suitably magnetized insulator with an alternating radio frequency magnetic field In its simplest form it consists of a microwave planar gyromagnetic resonator symmetrically coupled by three transmission lines This book explores the magnetic interaction involved in the stripline circulator's operation the nature of the microwave resonator shape and the network problem that arises in coupling the microwave resonator to the microwave circuit The stripline circulator is an important device met across a wide range of industries including wireless military radar and satellite communications The book's design tables are a unique feature offering valuable design support Written by an international authority on non reciprocal microwave circuits and devices the book is organized into logical blocks of chapters that focus on specific effects and circuit aspects of the stripline circulator Among the highlights of coverage are Spatial shape demagnetizing factors of magnetic insulators Standing wave solutions of wye gyromagnetic planar resonators Lumped element circulators Negative permeability tracking and semi tracking circulators Four port single junction circulators Fabrication of very weakly and weakly magnetized microstrip circulators The final chapter explores important and continuing discrepancies between theoretical models and actual practice For designers building circulators isolators and phase shifters researchers working on the limitation of ferrite devices and graduate students intending to work in the field Dr Helszajn's insights and perspectives are invaluable

2000 IEEE Antennas and Propagation Society International Symposium IEEE Antennas and Propagation Society. International Symposium, IEEE Antennas and Propagation Society, 2000 Electron Beams and Microwave Vacuum Electronics Shulim E. Tsimring, 2007 This book focuses on a fundamental feature of vacuum electronics the strong interaction of the physics of electron beams and vacuum microwave electronics including millimeter wave electronics The author guides readers from the roots of classical vacuum electronics to the most recent achievements in the field exploring both the physics and the theory underlying electron beams and devices of vacuum high frequency electronics Special attention is devoted to the physics and theory of relativistic beams and microwave devices Readers gain a deep understanding of the topic as well as the theory and applications of specific devices

BOOK JACKET Radio Propagation and Adaptive Antennas for Wireless Communication Links Nathan Blaunstein, Christos Christodoulou, 2007 Antennas and Propagation for Wireless Communication covers the basics of wireless communication system design with emphasis on antennas and propagation It contains information on antenna fundamentals and the latest developments in smart antennas as well as the radiation effects of hand held devices Antennas and Propagation for Wireless Communication provides a complete discussion of all the topics important to the design of wireless communication systems Written by

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MRTD (Multi Resolution Time Domain) Method in Electromagnetics Nathan Bushyager, Manos M. Tentzeris, 2022-05-31 This book presents a method that allows the use of multiresolution principles in a time domain electromagnetic modeling technique that is applicable to general structures The multiresolution time domain MRTD technique as it is often called is presented for general basis functions Additional techniques that are presented here allow the modeling of complex structures using a subcell representation that permits the modeling discrete electromagnetic effects at individual equivalent grid points This is accomplished by transforming the application of the effects at individual points in the grid into the wavelet domain In this work the MRTD technique is derived for a general wavelet basis using a relatively compact vector notation that both makes the technique easier to understand and illustrates the differences between MRTD basis functions In addition techniques such as the uniaxial perfectly matched layer UPML for arbitrary wavelet resolution and non uniform gridding are presented Using these techniques any structure that can be simulated in Yee FDTD can be modeled with in MRTD

Asymmetric Passive Components in Microwave Integrated Circuits Hee-Ran Ahn, 2006-07-31 The only reference available on the new important technology of asymmetric passive components for miniaturized microwave passive circuits Asymmetric Passive Components in Microwave Integrated Circuits examines the new design of asymmetric passive microwave integrated circuits

Time-domain Numerical Techniques for the Analysis and Design of Microwave Circuits Emmanouil M. Tentzeris, 1998 **IEEE Antennas and Propagation Society International Symposium** IEEE Antennas and Propagation Society, 1996 **Index to IEEE Publications** Institute of Electrical and Electronics Engineers, 1997

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