

Mosfet Modeling For Vlsi Simulation Theory And Practice

Multi-Level Simulation for VLSI Design Advanced Simulation and Test
Methodologies for VLSI Design MOSFET Models for VLSI Circuit
Simulation Technology Computer Aided Design Multilevel Representation and
Simulation for VLSI Design Unified Methods for VLSI Simulation and Test
Generation Mosfet Modeling For Vlsi Simulation: Theory And Practice An Integrated
Simulation for VLSI Design Environment Gallium Arsenide Digital Circuits Models for
Large Integrated Circuits Steady-State Methods for Simulating Analog and
Microwave Circuits Iterative Identification and Restoration of Images Subband Image
Coding Nonlinear Digital Filters ASIC System Design with VHDL: A Paradigm Low-
Noise Wide-Band Amplifiers in Bipolar and CMOS Technologies Simulation of
Semiconductor Devices and Processes Ships. High-Level Process Simulation for
VLSI (Very Large Scale Integrated) Manufacturing Applied Simulation and
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and background 1 1 cad specification and simulation computer aided design cad is today a widely used expression referring to the study of ways in which computers can be used to expedite the design process this can include the design of physical systems architectural environments manufacturing processes and many other areas this book concentrates on one area of cad the design of computer systems within this area it focusses on just two aspects of computer design the specification and the simulation of digital systems vlsi design requires support in many other cad areas including automatic layout ic fabrication analysis test generation and others the problem of specification is unique however in that it is often the first one encountered in large chip designs and one that is unlikely ever to be completely automated this is true because until a design's objectives are specified in a machine readable form there is no way for other cad tools to verify that the target system meets them and unless the specifications can be simulated it is unlikely that designers will have confidence in them since specifications are potentially erroneous themselves in this context the term target system refers to the hardware and or software that will ultimately be fabricated

on the other hand since the functionality of a vlsi chip is ultimately determined by its layout geometry one might question the need for cad tools that work with areas other than layout

metal oxide semiconductor mos transistors are the basic building block of mos integrated circuits. In very large scale integrated vlsi circuits using mos technology have emerged as the dominant technology in the semiconductor industry over the past decade the complexity of mos ic s has increased at an astonishing rate this is realized mainly through the reduction of mos transistor dimensions in addition to the improvements in processing today vlsi circuits with over 3 million transistors on a chip with effective or electrical channel lengths of 0.5 microns are in volume production designing such complex chips is virtually impossible without simulation tools which help to predict circuit behavior before actual circuits are fabricated however the utility of simulators as a tool for the design and analysis of circuits depends on the adequacy of the device models used in the simulator this problem is further aggravated by the technology trend towards smaller and smaller device dimensions which increases the complexity of the models there is extensive literature available on modeling these short channel devices however there is a lot of confusion too often it is not clear what model to use and which model parameter values are important and how to determine them after working over 15 years in the field of semiconductor device modeling i have felt the need for a book which can fill the gap between the theory and the practice of mos transistor modeling this book is an attempt in that direction

responding to recent developments and a growing vlsi circuit manufacturing market technology computer aided design simulation for vlsi mosfet examines advanced mosfet processes and devices through tcad numerical simulations the book provides a balanced summary of tcad and mosfet basic concepts equations physics and new technologies related to tcad and mosfet a firm grasp of these concepts allows for the design of better models thus streamlining the design process saving time and money this book places emphasis on the importance of

modeling and simulations of vlsi mos transistors and tcad software providing background concepts involved in the tcad simulation of mosfet devices it presents concepts in a simplified manner frequently using comparisons to everyday life experiences the book then explains concepts in depth with required mathematics and program code this book also details the classical semiconductor physics for understanding the principle of operations for vlsi mos transistors illustrates recent developments in the area of mosfet and other electronic devices and analyzes the evolution of the role of modeling and simulation of mosfet it also provides exposure to the two most commercially popular tcad simulation tools silvaco and sentaurus emphasizes the need for tcad simulation to be included within vlsi design flow for nano scale integrated circuits introduces the advantages of tcad simulations for device and process technology characterization presents the fundamental physics and mathematics incorporated in the tcad tools includes popular commercial tcad simulation tools silvaco and sentaurus provides characterization of performances of vlsi mosfets through tcad tools offers familiarization to compact modeling for vlsi circuit simulation r d cost and time for electronic product development is drastically reduced by taking advantage of tcad tools making it indispensable for modern vlsi device technologies they provide a means to characterize the mos transistors and improve the vlsi circuit simulation procedure the comprehensive information and systematic approach to design characterization fabrication and computation of vlsi mos transistor through tcad tools presented in this book provides a thorough foundation for the development of models that simplify the design verification process and make it cost effective

the design of integrated circuits has become almost impossible without circuit and system level simulation programs simulators at the circuit level produce performance data that allows the circuits to be functionally verified optimized and their performance evaluated the size and complexity of integrated circuits has increased tremendously since the first circuit simulators were designed because the large circuits need to be simulated as thoroughly as smaller ones the time

spent simulating larger circuits has increased dramatically consequently simulation tools that can efficiently simulate large circuits are needed in this regard work under this contract has focussed on the improvement of the mixed circuit logic simulator samson as well as the development of new approaches to simulation at the system level simulators also produce data that allow the system architecture to be functionally verified optimized and evaluated because of the ever larger systems being designed for implementation on an integrated circuit chip there is a need for higher performance system level simulators in this regard work under this contract has also focussed on the development of new approaches to system level simulation a study of the use of hardware accelerators in this application is described

a reprint of the classic text this book popularized compact modeling of electronic and semiconductor devices and components for college and graduate school classrooms and manufacturing engineering over a decade ago the first comprehensive book on mos transistor compact modeling it was the most cited among similar books in the area and remains the most frequently cited today the coverage is device physics based and continues to be relevant to the latest advances in mos transistor modeling this is also the only book that discusses in detail how to measure device model parameters required for circuit simulations the book deals with the mos field effect transistor mosfet models that are derived from basic semiconductor theory various models are developed ranging from simple to more sophisticated models that take into account new physical effects observed in submicron transistors used in today s 1993 mos vlsi technology the assumptions used to arrive at the models are emphasized so that the accuracy of the models in describing the device characteristics are clearly understood due to the importance of designing reliable circuits device reliability models are also covered understanding these models is essential when designing circuits for state of the art mos ics

gallium arsenide technology has come of age gaas integrated circuits are available

today as gate arrays with an operating speed in excess of one gigabits per second special purpose gaas circuits are used in optical fiber digital communications systems for the purpose of regeneration multiplexing and switching of the optical signals as advances in fabrication and packaging techniques are made the operating speed will further increase and the cost of production will reach a point where large scale application of gaas circuits will be economical in these and other systems where speed is paramount this book is written for students and engineers who wish to enter into this new field of electronics for the first time and who wish to embark on a serious study of the subject of gaas circuit design no prior knowledge of gaas technology is assumed though some previous experience with mos circuit design will be helpful a good part of the book is devoted to circuit analysis to the extent that is possible for non linear circuits the circuit model of the gaas transistor is derived from first principles and analytic formulas useful in predicting the approximate circuit performance are also derived computer simulation is used throughout the book to show the expected performance and to study the effects of parameter variations

a modern microelectronic circuit can be compared to a large construction a large city on a very small area a memory chip a dram may have up to 64 million bit locations on a surface of a few square centimeters each new generation of integrated circuit generations are measured by factors of four in overall complexity requires a substantial increase in density from the current technology added precision a decrease of the size of geometric features and an increase in the total usable surface the microelectronic industry has set the trend ultra large funds have been invested in the construction of new plants to produce the ultra large scale circuits with utmost precision under the most severe conditions the decrease in feature size to submicrons 0.7 micron is quickly becoming available does not only bring technological problems new design problems arise as well the elements from which microelectronic circuits are built transistors and interconnects have different shape and behave differently than before phenomena

that could be neglected in a four micron technology such as the non uniformity of the doping profile in a transistor or the mutual capacitance between two wires now play an important role in circuit design this situation does not make the life of the electronic designer easier he has to take many more parasitic effects into account up to the point that his ideal design will not function as originally planned

the motivation for starting the work described in this book was the interest that hewlett packard s microwave circuit designers had in simulation techniques that could tackle the problem of finding steady state solutions for nonlinear circuits particularly circuits containing distributed elements such as transmission lines examining the problem of computing steady state solutions in this context has led to a collection of novel numerical algorithms which we have gathered along with some background material into this book although we wished to appeal to as broad an audience as possible to treat the subject in depth required maintaining a narrow focus our compromise was to assume that the reader is familiar with basic numerical methods such as might be found in dahlquist⁷⁴ or vlach⁸³ but not assume any specialized knowledge of methods for steady state problems although we focus on algorithms for computing steady state solutions of analog and microwave circuits the methods herein are general in nature and may find use in other disciplines a number of new algorithms are presented the contributions primarily centering around new approaches to harmonic balance and mixed frequency time methods these methods are described along with appropriate background material in what we hope is a reasonably satisfying blend of theory practice and results the theory is given so that the algorithms can be fully understood and their correctness established

one of the most intriguing questions in image processing is the problem of recovering the desired or perfect image from a degraded version in many instances one has the feeling that the degradations in the image are such that relevant information is close to being recognizable if only the image could be sharpened just a little this monograph discusses the two essential steps by which

this can be achieved namely the topics of image identification and restoration more specifically the goal of image identification is to estimate the properties of the imperfect imaging system blur from the observed degraded image together with some statistical characteristics of the noise and the original uncorrupted image on the basis of these properties the image restoration process computes an estimate of the original image although there are many textbooks addressing the image identification and restoration problem in a general image processing setting there are hardly any texts which give an indepth treatment of the state of the art in this field this monograph discusses iterative procedures for identifying and restoring images which have been degraded by a linear spatially invariant blur and additive white observation noise as opposed to non iterative methods iterative schemes are able to solve the image restoration problem when formulated as a constrained and spatially variant optimization problem in this way restoration results can be obtained which outperform the best results of conventional restoration filters

this book concerns a new method of image data compression which will may supplant the well established block transform methods that have been state of the art for the last 15 years subband image coding or sbc was first performed as such in 1985 and as the results became known at first through conference proceedings and later through journal papers the research community became excited about both the theoretical and practical aspects of this new approach this excitement is continuing today with many major research laboratories and research universities around the world investigating the subband approach to coding of color images high resolution images video including video conferencing and advanced tele vision and the medical application of picture archiving systems much of the fruits of this work is summarized in the eight chapters of this book which were written by leading practitioners in this field the subband approach to image coding starts by passing the image through a two or three dimensional filter bank the two dimensional 2 d case usually is hierarchical consisting of two

stages of four filters each thus the original image is split into 16 subband images with each one decimated or subsampled by 4x4 resulting in a data conservation the individual channel data is then quantized for digital transmission in an attractive variation an octave like approach herein tenned subband pyramid is taken for the decomposition resulting in a total of just eleven subbands

the function of a filter is to transform a signal into another one more suit able for a given purpose as such filters find applications in telecommunica tions radar sonar remote sensing geophysical signal processing image pro cessing and computer vision numerous authors have considered deterministic and statistical approaches for the study of passive active digital multidimen sional and adaptive filters most of the filters considered were linear although the theory of nonlinear filters is developing rapidly as it is evident by the numerous research papers and a few specialized monographs now available our research interests in this area created opportunity for cooperation and co authored publications during the past few years in many nonlinear filter families described in this book as a result of this cooperation and a visit from john pitas on a research leave at the university of toronto in september 1988 the idea for this book was first conceived the difficulty in writing such a mono graph was that the area seemed fragmented and no general theory was available to encompass the many different kinds of filters presented in the literature however the similarities of some families of nonlinear filters and the need for such a monograph providing a broad overview of the whole area made the pro ject worthwhile the result is the book now in your hands typeset at the department of electrical engineering of the university of toronto during the summer of 1989

beginning in the mid 1980 s vlsi technology had begun to advance in two directions pushing the limit of integration ulsi ultra large scale integration represents the frontier of the semiconductor processing technology in the campaign to conquer the submicron realm the application of ulsi however is at present largely confined in the area of memory designs and as such its impact on

traditional microprocessor based system design is modest if advancement in this direction is merely a natural extrapolation from the previous integration generations then the rise of asic application specific integrated circuit is an unequivocal signal that a directional change in the discipline of system design is in effect in contrast to ulsi asic employs only well proven technology and hence is usually at least one generation behind the most advanced processing technology in spite of this apparent disadvantage asic has become the mainstream of vlsi design and the technology base of numerous entrepreneurial opportunities ranging from pc clones to supercomputers unlike ulsi whose complexity can be hidden inside a memory chip or a standard component and thus can be accommodated by traditional system design methods asic requires system designers to master a much larger body of knowledge spanning from processing technology and circuit techniques to architecture principles and algorithm characteristics integrating knowledge in these various areas has become the precondition for integrating devices and functions into an asic chip in a market oriented environment but knowledge is of two kinds

analog circuit design has grown in importance because so many circuits cannot be realized with digital techniques examples are receiver front ends particle detector circuits etc actually all circuits which require high precision high speed and low power consumption need analog solutions high precision also needs low noise much has been written already on low noise design and optimization for low noise very little is available however if the source is not resistive but capacitive or inductive as is the case with antennas or semiconductor detectors this book provides design techniques for these types of optimization this book is thus intended firstly for engineers on senior or graduate level who have already designed their first operational amplifiers and want to go further it is especially for engineers who do not want just a circuit but the best circuit design techniques are given that lead to the best performance within a certain technology moreover this is done for all important technologies such as bipolar cmos and bicmos

secondly this book is intended for engineers who want to understand what they are doing the design techniques are intended to provide insight in this way the design techniques can easily be extended to other circuits as well also the design techniques form a first step towards design automation thirdly this book is intended for analog design engineers who want to become familiar with both bipolar and cmos technologies and who want to learn more about which transistor to choose in bicmos

very large scale integration fabrication is a complex set of operations set within a rapidly changing technology environment it is subject to chance variations in process parameters poor understanding and control of many parameters and subtle interactions between them at the same time processing times and costs are increasing the natural side effect of these is that ic manufactures must require more evidence that the predicted and actual process characteristics will be within a tight tolerance the prevailing means to verify process performance is through simulation unfortunately while traditional process simulation tools such as suprem iii have become pervasive in the ic industry as design aides for process development they are not suited to the problems of manufacturing level process simulation what is required is a high level process simulation tool that can introduce abstractions that reduce complexity and algorithms that reduce simulation costs we have built such a tool called ships which stands for stanford high level incremental process simulator the ships tool provides a high level process description language a structured user interface and a new simulation algorithm for reducing the number of modules that must be simulated in analyzing the manufacturability of a process

this book covers algorithmic aspects of computer aided circuit design for vlsi of large circuits the large scale aspect of vlsi requires a reorientation towards new and more efficient techniques many algorithms have survived the test of time while others are suffering from the usual problem of polynomial or exponential running time complexity and storage requirements the approaches presented in

this book are techniques which were developed in response to the vlsi problems the most recent exact circuit analysis and simulation techniques are presented such as waveform relaxation and timing simulation the book concentrates on the analysis and simulation of large circuits which exceed the capabilities of general purpose analyzers in both compute time and storage also discussed are circuit models for switch level simulation techniques and circuit models for interconnections capacitance and inductances and optimization techniques the language and notation have been kept uniform throughout the book to help the reader to maintain the continuity between the topics discussed in the different chapters all algorithms are written in a pascal style the terminology used should reflect the emerging language used in most of the vlsi circuit design community the book includes proven approaches as well as techniques which are presently in a research state

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