Chapter 4 Circuit Characterization And Performance Estimation

The appropriate interconnect model has changed several times over the past two decades due to the application of aggressive technology scaling. New, more accurate interconnect models are required to manage the changing physical characteristics of integrated circuits. Currently, RC models are used to analyze high resistance nets while capacitive models are used for less resistive interconnect. However, on-chip inductance is becoming more important with integrated circuits operating at higher frequencies, since the inductive impedance is proportional to the frequency. The operating frequencies of integrated circuits have increased dramatically over the past decade and are expected to maintain the same rate of increase over the next decade, approaching 10 GHz by the year 2012. Also, wide wires are frequently encountered in important global nets, such as clock distribution networks and in upper metal layers, and performance requirements are pushing the introduction of new materials for low resistance interconnect, such as copper interconnect already used in many commercial CMOS technologies. On-Chip Inductance in High Speed Integrated Circuits deals with the design and analysis of integrated circuits with a specific focus on on-chip inductance effects. It has been described throughout this book that inductance can have a tangible effect on current high speed integrated circuits. For example, neglecting inductance and using an RC interconnect model in a production 0.25 mum CMOS technology can cause large errors (over 35%) in estimates of the propagation delay of on-chip interconnect. It has also been shown that including inductance in the repeater insertion design process as compared to using an RC model improves the overall repeater solution in terms of area, power, and delay with average savings of 40.8%, 15.6%, and 6.7%, respectively. On-Chip Inductance in High Speed Integrated Circuits is full of design and analysis techniques for RLC interconnect. These techniques are compared to techniques traditionally used for RC interconnect design to emphasize the effect of inductance. emOn-Chip Inductance in High Speed Integrated Circuits will be of interest to researchers in the area of high frequency interconnect, noise, and high performance integrated circuit design.

The first comprehensive overview describing the effects of ionizing radiation on MOS devices, as well as how to design, fabricate, and test integrated circuits intended for use in a radiation environment. Also addresses process-induced radiation effects in the fabrication of high-density circuits. Reviews the history of radiation-hard technology, providing background information for those new to the field. Includes a comprehensive review of the literature and an annotated listing of research activities in radiation-hardness research.

This work presents a comprehensive modeling strategy for advanced large-size AlGaN/GaN HEMTs. A 22-element equivalent circuit with 12 extrinsic elements, including 6 capacitances, serves as small-signal model and as basis for a large-signal model. ANalysis of such capacitances leads to original equations, employed to form capacitance ratios. BAsic assumptions of existing parameter extractions for 22-element equivalent circuits are perfected: A) Required capacitance ratios are evaluated with device's top-view images. B) Influences of field plates and source air-bridges on these ratios are considered. The large-signal model contains a gate charge's non-quasi-static model and a dispersive-IDS model. THe extrinsic-to-intrinsic voltage transformation needed to calculate non-quasi-static parameters from small-signal parameters is improved with a new description for the measurement's boundary bias points. ALl IDS-model parameters, including time constants of charge-trapping and self-heating, are extracted using pulsed-DC IV and IDS-transient measurements, highlighting the modeling strategy's empirical character.

A triennial summation of the state of the art in radio science This book is the fourth in the modern series of triennial reviews prepared by the International Union of Radio Science to further communication and understanding of the status and future of radio science, both for those working in the field, and for those who want to know what is of current importance in this area. The International Union of Radio Science, URSI (Union Radio-Scientifique Internationale), has divided the subject of "Radio Science" according to the ten topics of the Scientific Commissions that make up URSI. This volume consists of thirty-eight original, peer-reviewed papers. Each paper provides a critical, in-depth review of–and, in many cases, tutorial on–advances and research that have been of significant importance within the area of interest of the Commissions during the past three to four years. Among the topics covered are: Electromagnetic metrology Fields and waves Signals and systems Electronics and photonics Electromagnetic noise and interference Wave propagation and remote sensing Ionospheric radio and propagation Waves in plasmas Radio astronomy Electromagnetics in biology and medicine With an included CD-ROM of the full book text, allowing the user to do full-text searching of all the papers, the Review of Radio Science: 1999—2002 is a resource of vital importance to anyone working in, or with an interest in, radio science.

Predicting noise in RF systems at the design stage is extremely important. This book concentrates on developing noise simulation techniques for RF circuits. The authors present a novel approach of performing noise analysis for RF circuits.

High-Frequency Characterization of Electronic Packaging will be of interest to researchers and designers of high-frequency electronic packaging. Understanding high-frequency behavior of packaging is of growing importance due to higher clock-speeds in computers and higher data transmission rates in broadband telecommunication systems. Basic knowledge of the high-frequency behavior of packaging and interconnects is, therefore, indispensable for the design of future telecommunication and computer systems. High-Frequency Characterization of Electronic Packaging gives the reader an insight into how high-frequency characterization of electronic packaging should be done and describes the problems that have to be tackled, especially in performing accurate measurements on modern IC-packages and in determination of circuit models. High-Frequency Characterization of Electronic Packaging is conceived as a comprehensive guide for the start of research and to help in performing high-frequency measurements. Important notions in high- frequency characterization such as S-parameters, calibration, probing, de-embedding and measurement-based modeling are explained. The described techniques are illustrated with several up-to-date examples.

RRAM technology has made significant progress in the past decade as a competitive candidate for the next generation non-volatile memory (NVM). This lecture is a comprehensive tutorial of metal oxide-based RRAM technology from device fabrication to array architecture design. State-of-the-art RRAM device performances, characterization, and modeling techniques are summarized, and the design considerations of the RRAM integration to large-scale array with peripheral circuits are discussed. Chapter 2 introduces the RRAM device fabrication techniques and methods to eliminate the forming process, and will show its scalability down to sub-10 nm regime. Then the device performances such as programming speed, variability control, and multi-level operation are presented, and finally the reliability issues such as cycling endurance and data retention are discussed. Chapter 3 discusses the RRAM physical mechanism, and the materials characterization techniques to observe the conductive filaments and the electrical characterization techniques to study the electronic conduction processes. It also presents the numerical device modeling techniques for simulating the evolution of the conductive filaments as well as the compact device modeling techniques for circuit-level design. Chapter 4 discusses the two common RRAM array architectures for large-scale integration: one-transistor-one-resistor (1T1R) and cross-point architecture with selector. The write/read schemes are presented and the peripheral circuitry design considerations are discussed. Finally, a 3D integration approach is introduced for building ultra-high density RRAM array. Chapter 5 is a brief summary and will give an outlook for RRAM’s potential novel applications beyond the NVM applications.

This groundbreaking book is the first to give an introduction to microwave de-embedding, showing how it is the cornerstone for waveform engineering. The authors of each chapter clearly explain the theoretical concepts, providing a foundation that supports linear and non-linear measurements, modelling and circuit design. Recent developments and future trends in the field are covered throughout,

including successful strategies for low-noise and power amplifier design. This book is a must-have for those wishing to understand the full potential of the microwave de-embedding concept to achieve successful results in the areas of measurements, modelling, and design at high frequencies. With this book you will learn: The theoretical background of high-frequency de-embedding for measurements, modelling, and design Details on applying the de-embedding concept to the transistor's linear, non-linear, and noise behaviour The impact of de-embedding on low-noise and power amplifier design The recent advances and future trends in the field of high-frequency de-embedding Presents the theory and practice of microwave de-embedding, from the basic principles to recent advances and future trends Written by experts in the field, all of whom are leading researchers in the area Each chapter describes theoretical background and gives experimental results and practical applications Includes forewords by Giovanni Ghione and Stephen Maas

CMOS PLLs and VCOs for 4G Wireless is the first book devoted to the subject of CMOS PLL and VCO design for future broadband 4th generation wireless devices. These devices will be handheld-centric, requiring very low power consumption and small footprint. They will be able to work across multiple bands and multiple standards covering WWAN (GSM,WCDMA) ,WLAN(802.11 a/b/g) and WPAN(Bluetooth) with different modulations, channel bandwidths , phase noise requirements ,etc. As such, this book discusses design, modeling and optimization techniques for low power fully integrated broadband PLLs and VCOs in deep submicron CMOS. First, the PLL and VCO performances are studied in the context of the chosen multi-band multi-standard, radio architecture and the adopted frequency plan. Next a thorough study of the design requirements for broadband PLL/VCO design is conducted together with modeling techniques for noise sources in a PLL and VCO focusing on optimization of integrated phase noise for multi-carrier OFDM 64-QAM type applications. Design examples for multi-standard 802.111a/b/g as well as for GSM/WCDMA are fully described and experimental results from 0.18 micron CMOS test chips have demonstrated the validity of the proposed design and optimization techniques. Equally important the work describes techniques for robust high volume production of RF radios in general and for integrated PLL/VCO design in particular including issues such as supply sensitivity, ground bounce and calibration mechanisms. CMOS PLLS and VCOs for 4G Wireless will be of interest to graduate students in electrical and computer engineering, design managers and RFIC designers in wireless semiconductor companies.

Modeling and Design of Electromagnetic Compatibility for High-Speed Printed Circuit Boards and Packaging presents the electromagnetic modelling and design of three major electromagnetic compatibility (EMC) issues related to the high-speed printed circuit board (PCB) and electronic packages: signal integrity (SI), power integrity (PI), and electromagnetic interference (EMI). The emphasis is put on two essential passive components of PCBs and packages: the power distribution network and the signal distribution network. This book includes two parts. Part one talks about the field-circuit hybrid methods used for the EMC modeling, including the modal method, the integral equation method, the cylindrical wave expansion method and the de-embedding method. Part two illustrates EMC design methods and explores the applications of novel metamaterials and two-dimensional materials on traditional EMC problems. This book is designed to enhance worthwhile electromagnetic theory and mathematical methods for practical engineers and to train students with advanced EMC applications.

Nanowires are an important sector of circuit design whose applications in very-large-scale integration design (VLSI) have huge impacts for bringing revolutionary advancements in nanoscale devices, circuits, and systems due to improved electronic properties of the nanowires. Nanowires are potential devices for VLSI circuits and system applications and are highly preferred in novel nanoscale devices due to their high mobility and high-driving capacity. Although the knowledge and resources for the fabrication of nanowires is currently limited, it is predicted that, with the advancement of technology, conventional fabrication flow can be used for nanoscale devices, specifically nanowires. Innovative Applications of Nanowires for Circuit Design provides relevant theoretical frameworks that include device physics, modeling, circuit design, and the latest developments in experimental fabrication in the field of nanotechnology. The book covers advanced modeling concepts of nanowires along with their role as a key enabler for innovation in GLSI devices, circuits, and systems. While highlighting topics such as design, simulation, types and applications, and performance analysis of nanowires, this book is ideally intended for engineers, practitioners, stakeholders, academicians, researchers, and students interested in electronics engineering, nanoscience, and nanotechnology.

Design for Manufacturability and Statistical Design: A Comprehensive Approach presents a comprehensive overview of methods that need to be mastered in understanding state-of-the-art design for manufacturability and statistical design methodologies. Broadly, design for manufacturability is a set of techniques that attempt to fix the systematic sources of variability, such as those due to photolithography and CMP. Statistical design, on the other hand, deals with the random sources of variability. Both paradigms operate within a common framework, and their joint comprehensive treatment is one of the objectives of this book and an important differentation.

A highly comprehensive summary on circuit related modeling techniques and parameter extraction methods for heterojunction bipolar transistors Heterojunction Bipolar Transistor (HBT) is one of the most important devices for microwave applications. The book details the accurate device modeling for HBTs and high level IC design using HBTs Provides a valuable reference to basic modeling issues and specific semiconductor device models encountered in circuit simulators, with a thorough reference list at the end of each chapter for onward learning Offers an overview on modeling techniques and parameter extraction methods for heterojunction bipolar transistors focusing on circuit simulation and design Presents electrical/RF engineering-related theory and tools and include equivalent circuits and their matrix descriptions, noise, small and large signal analysis methods

This book presents case studies to illustrate that careful modeling of the assembly characteristics and layout details is required to bring simulations and measurements into agreement. Engineers learn how to use a proper combination of isolation structures and circuit techniques to make analog/RF circuits more immune to substrate noise. Topics include substrate noise propagation, passive isolation structures, noise couple in active devices, measuring the coupling mechanisms in analog/RF circuits, prediction of the impact of substrate noise on analog/RF circuits, and noise coupling in analog/RF systems.

This book illustrates a variety of circuit designs on plastic foils and provides all the information needed to undertake successful designs in large-area electronics. The authors demonstrate architectural, circuit, layout, and device solutions and explain the reasons and the creative process behind each. Readers will learn how to keep under control large-area technologies and achieve robust, reliable circuit designs that can face the challenges imposed by low-cost low-temperature high-throughput manufacturing.

This book presents a wide-band and technology independent, SPICE-compatible RLC model for through-silicon vias (TSVs) in 3D integrated circuits. This model accounts for a variety of

effects, including skin effect, depletion capacitance and nearby contact effects. Readers will benefit from in-depth coverage of concepts and technology such as 3D integration, Macro modeling, dimensional analysis and compact modeling, as well as closed form equations for the through silicon via parasitics. Concepts covered are demonstrated by using TSVs in applications such as a spiral inductor and inductive-based communication system and bandpass filtering.

To design and develop fast and effective microwave wireless systems today involves addressing the three different ‘levels’: Device, circuit, and system. This book presents the links and interactions between the three different levels rather than providing just a comprehensive coverage of one specific level. With the aim of overcoming the sectional knowledge of microwave engineers, this will be the first book focused on explaining how the three different levels interact by taking the reader on a journey through the different levels going from the theoretical background to the practical applications. Explains the links and interactions between the three different design levels of wireless communication transmitters: device, circuit, and system Presents state-of-the-art, challenges, and future trends in the field of wireless communication systems Covers all aspects of both mature and cutting-edge technologies for semiconductor devices for wireless communication applications Many circuit designs outlining the limitations derived from the available transistor technologies and system requirements Explains how new microwave measurement techniques can represent an essential tool for microwave modellers and designers

Advances in the semiconductor technology have enabled steady, exponential im provement in the performance of integrated circuits. Miniaturization allows the integration of a larger number of transistors with enhanced switching speed. Novel transistor structures and passivation materials diminish circuit delay by minimizing parasitic electrical capacitance. These advances, however, pose several challenges for the thermal engineering of integrated circuits. The low thermal conductivities of passivation layers result in large temperature rises and temperature gradient magni tudes, which degrade electrical characteristics of transistors and reduce lifetimes of interconnects. As dimensions of transistors and interconnects decrease, the result ing changes in current density and thermal capacitance make these elements more susceptible to failure during brief electrical overstress. This work develops a set of high-resolution measurement techniques which de termine temperature fields in transistors and interconnects, as well as the thermal properties of their constituent films. At the heart of these techniques is the thermore flectance thermometry method, which is based on the temperature dependence of the reflectance of metals. Spatial resolution near 300 nm and temporal resolution near IOns are demonstrated by capturing transient temperature distributions in intercon nects and silicon-on-insulator (SOl) high-voltage transistors. Analyses of transient temperature data obtained from interconnect structures yield thermal conductivities and volumetric heat capacities of thin films.

There are continuous efforts focussed on improving road traffic safety worldwide. Numerous vehicle safety features have been invented and standardized over the past decades. Particularly interesting are the driver assistance systems, since these can considerably reduce the number of accidents by supporting drivers’ perception of their surroundings. Many driver assistance features rely on radar-based sensors. Nowadays the commercially available automotive front-end sensors are comprised of discrete components, thus making the radar modules highly-priced and suitable for integration only in premium class vehicles. Realization of low-cost radar fro- end circuits would enable their implementation in inexpensive economy cars, c- siderably contributing to traffic safety. Cost reduction requires high-level integration of the microwave front-end c- cuitry, specifically analog and digital circuit blocks co-located on a single chip. - cent developments of silicon-based technologies, e.g. CMOS and SiGe:C bipolar, make them suitable for realization of microwave sensors. Additionally, these te- nologies offer the necessary integration capability. However, the required output power and temperature stability, necessary for automotive radar sensor products, have not yet been achieved in standard digital CMOS technologies. On the other hand, SiGe bipolar technology offers excellent high-frequency characteristics and necessary output power for automotive applications, but has lower potential for - alization of digital blocks than CMOS.

For the first time, this up-to-date text combines the main issues of the hardware description language VHDL-AMS aimed at model representation of mixed-signal circuits and systems, characterization methods and tools for the extraction of model parameters, and modelling methodologies for accurate high-level behavioural models.

This book deals with the challenge of exploiting ambient vibrational energy which can be used to power small and low-power electronic devices, e.g. wireless sensor nodes. Generally, particularly for low voltage amplitudes, low-loss rectification is required to achieve high conversion efficiency. In the special case of piezoelectric energy harvesting, pulsed charge extraction has the potential to extract more power compared to a single rectifier. For this purpose, a fully autonomous CMOS integrated interface circuit for piezoelectric generators which fulfills these requirements is presented. Due to these key properties enabling universal usage, other CMOS designers working in the field of energy harvesting will be encouraged to use some of the shown structures for their own implementations. The book is unique in the sense that it highlights the design process from scratch to the final chip. Hence, it gives the designer a comprehensive guide of how to (i) setup an appropriate harvester model to get realistic simulation results, (ii) design the integrated circuits for low power operation, (iii) setup a laboratory measurement environment in order to extensively characterize the chip in combination with the real harvester and finally, (iv) interpret the simulation/measurement results in order to improve the chip performance. Since the dimensions of all devices (transistors, resistors etc.) are given, readers and other designers can easily re-use the presented circuit concepts.

Cancer has long been cured in mice but not in people. Why? Successful laboratory treatments and cures for one species don't necessarily result in cures for humans. But, because practice has become economically entrenched within medical industry, animal experimentation -against all medical evidence- continues.The human benefits of animal experimentation- a bedrock of the scientific age- is a myth perpetuated by an amorphous but insidious network of multibillion-dollar special interests: research facilities, drug companies, universities, scientisits, and even cage manufacturers.C.Ray Greek, MD, and veterniary dermatologist, Jean Swingle Gree, DMV, show how the public has been deliberately misled and blow the lid off the vested-interest groups whose hidden agendas put human health at risk.

Together with the internet site, this book is ideally suited for independent and remote study Web site is kept to date and guest educational institutions are invited to join in creating their own lab modules on different device aspects First such program Reputation of the authors who are leaders in the field of semiconductor electronics

As device dimensions decrease, hot-carrier effects, which are due mainly to the presence of a high electric field inside the device, are becoming a major design concern. On the one hand, the

detrimental effects-such as transconductance degradation and threshold shift-need to be minimized or, if possible, avoided altogether. On the other hand, performance such as the programming efficiency of nonvolatile memories or the carrier velocity inside the devices-need to be maintained or improved through the use of submicron technologies, even in the presence of a reduced power supply. As a result, one of the major challenges facing MOS design engineers today is to harness the hot-carrier effects so that, without sacrificing product performance, degradation can be kept to a minimum and a reli able design obtained. To accomplish this, the physical mechanisms re sponsible for the degradations should first be experimentally identified and characterized. With adequate models thus obtained, steps can be taken to optimize the design, so that an adequate level of quality assur ance in device or circuit performance can be achieved. This book ad dresses these hot-carrier design issues for MOS devices and circuits, and is used primarily as a professional guide for process development engi neers, device engineers, and circuit designers who are interested in the latest developments in hot-carrier degradation modeling and hot-carrier reliability design techniques. It may also be considered as a reference book for graduate students who have some research interests in this excit ing, yet sometime controversial, field.

This unique new book is your single resource for all issues related to intermodulation and multi-tone distortion in microwave and wireless circuits. Beginning with an overview of the general concepts of distortion in microwave and wireless devices, it delves into the theory and practical aspects of nonlinear distortion, tools for nonlinear analysis, mathematical representations of wireless circuits and devices, and design methods for minimizing distortion.

Uncertainty in key parameters within a chip and between different chips in the deep sub micron area plays a more and more important role. As a result, manufacturing process spreads need to be considered during the design process. Quantitative methodology is needed to ensure faultless functionality, despite existing process variations within given bounds, during product development. This book presents the technological, physical, and mathematical fundamentals for a design paradigm shift, from a deterministic process to a probability-orientated design process for microelectronic circuits. Readers will learn to evaluate the different sources of variations in the design flow in order to establish different design variants, while applying appropriate methods and tools to evaluate and optimize their design.

Since the second half of the 1980s asynchronous circuits have been the subject of a great deal of research following a period of relative oblivion. The lack of interest in asynchronous techniques was motivated by the progressive shift towards synchronous design techniques that had much more structure and were much easier to verify and synthesize. System design requirements made it impossible to eliminate totally the use of asynchronous circuits. Given the objective difficulty encountered by designers, the asynchronous components of electronic systems such as interfaces became a serious bottleneck in the design process. The use of new models and some theoretical breakthroughs made it possible to develop asynchronous design techniques that were reliable and effective. This book describes a variety of mathematical models and of algorithms that form the backbone and the body of a new design methodology for asyn chronous design. The book is intended for asynchronous hardware designers, for computer-aided tool experts, and for digital designers interested in ex ploring the possibility of designing asynchronous circuits. It requires a solid mathematical background in discrete event systems and algorithms. While the book has not been written as a textbook, nevertheless it could be used as a reference book in an advanced course in logic synthesis or asynchronous design.

The ability to provide highly accurate performance evaluations of photovoltaic devices has never been more important given the recent, and anticipated, progress in photovoltaics. The lowest possible measurement uncertainties are required for reliably assessing technological advances and reducing investment uncertainty. As the further reduction of these uncertainties within conventional solar cell measurements is often hindered by the measurement setups themselves, innovative approaches in the development of new measurement facilities are vital. This thesis addresses such demand by applying ultrashort laser pulses for highly accurate solar cell characterization. Based on a detailed investigation of pulse-solar cell interaction, a setup for spectral responsivity measurements is developed. This cutting-edge measurement setup substantially outperforms current state-of-the-art facilities in terms of measurement accuracy. Furthermore, a novel measurement approach is presented that takes advantage of spectrally shaped supercontinuum radiation. Imitating standard solar spectra with the shaped supercontinuum radiation promises a quicker and more accurate measurement of the solar cell s short circuit current than is presently possible using conventional methods.

To surmount the continuous scaling challenges of MOSFET devices, FinFETs have emerged as the real alternative for use as the next generation device for IC fabrication technology. The objective of this book is to provide the basic theory and operating principles of FinFET devices and technology, an overview of FinFET device architecture and manufacturing processes, and detailed formulation of FinFET electrostatic and dynamic device characteristics for IC design and manufacturing. Thus, this book caters to practicing engineers transitioning to FinFET technology and prepares the next generation of device engineers and academic experts on mainstream device technology at the nanometer-nodes.

Three-Dimensional Integrated Circuit Design, Second Eition, expands the original with more than twice as much new content, adding the latest developments in circuit models, temperature considerations, power management, memory issues, and heterogeneous integration. 3-D IC experts Pavlidis, Savidis, and Friedman cover the full product development cycle throughout the book, emphasizing not only physical design, but also algorithms and system-level considerations to increase speed while conserving energy. A handy, comprehensive reference or a practical design guide, this book provides effective solutions to specific challenging problems concerning the design of three-dimensional integrated circuits. Expanded with new chapters and updates throughout based on the latest research in 3-D integration: Manufacturing techniques for 3-D ICs with TSVs Electrical modeling and closed-form expressions of through silicon vias Substrate noise coupling in heterogeneous 3-D ICs Design of 3-D ICs with inductive links Synchronization in 3-D ICs Variation effects on 3-D ICs Correlation of WID variations for intra-tier buffers and wires Offers practical guidance on designing 3-D heterogeneous systems Provides power delivery of 3-D ICs Demonstrates the use of 3-D ICs within heterogeneous systems that include a variety of materials, devices, processors, GPU-CPU integration, and more Provides experimental case studies in power delivery, synchronization, and thermal characterization

Annotation In today's globally competitive wireless industry, the design-to-production cycle is critically important. The first of a two-volume set, this leading-edge book takes a practical approach to RF (radio frequency) circuit design, offering a complete understanding of the fundamental concepts practitioners need to know and use for their work in the field.

Carbon Nanotube Field Effect Transistor (CNFET) technology has received a lot of attention in the past few years as a promising extension to silicon-CMOS for future digital logic integrated

circuits. While recent research has advanced CNFET technology past many important milestones, robust and scalable solutions must be developed to realize the full potential of CNFETs. Thus, this thesis aims to develop a suite of techniques, spanning from material synthesis to circuit solutions, compatible with very-large-scale integration (VLSI). Specifically, to enable the real-world engineering of carbon nanotube integrated circuits, this thesis presents (1) wafer-scale aligned CNT growth, (2) wafer-scale CNT Transfer, (3) wafer-scale device and circuit fabrication techniques, and (4) ACCNT, a VLSI-compatible circuit design solution to surmounting the problem of metallic CNTs. These techniques culminated in the successful demonstration of CNT transistors, inverters, and NAND logic gates on a wafer scale. Furthermore, this thesis sheds light on important design considerations for the demonstration of a simple CNT "computer" and suggests a few critical directions for future work in the field of carbon nanotube technology. In contributing the above, this thesis hopes to propel carbon nanotube technology forward towards the vision of robust, large-scale integrated circuits using high-density carbon nanotubes.

An advanced textbook giving a broad, modern view of the computational complexity theory of boolean circuits, with extensive references, for theoretical computer scientists and mathematicians.

The ultimate handbook on microwave circuit design with CAD. Full of tips and insights from seasoned industry veterans, Microwave Circuit Design offers practical, proven advice on improving the design quality of microwave passive and active circuits-while cutting costs and time. Covering all levels of microwave circuit design from the elementary to the very advanced, the book systematically presents computer-aided methods for linear and nonlinear designs used in the design and manufacture of microwave amplifiers, oscillators, and mixers. Using the newest CAD tools, the book shows how to design transistor and diode circuits, and also details CAD's usefulness in microwave integrated circuit (MIC) and monolithic microwave integrated circuit (MMIC) technology. Applications of nonlinear SPICE programs, now available for microwave CAD, are described. State-of-the-art coverage includes microwave transistors (HEMTs, MODFETs, MESFETs, HBTs, and more), high-power amplifier design, oscillator design including feedback topologies, phase noise and examples, and more. The techniques presented are illustrated with several MMIC designs, including a wideband amplifier, a low-noise amplifier, and an MMIC mixer. This unique, one-stop handbook also features a major case study of an actual anticollision radar transceiver, which is compared in detail against CAD predictions; examples of actual circuit designs with photographs of completed circuits; and tables of design formulae.

Test and Design-for-Testability in Mixed-Signal Integrated Circuits deals with test and design for test of analog and mixed-signal integrated circuits. Especially in System-on-Chip (SoC), where different technologies are intertwined (analog, digital, sensors, RF); test is becoming a true bottleneck of present and future IC projects. Linking design and test in these heterogeneous systems will have a tremendous impact in terms of test time, cost and proficiency. Although it is recognized as a key issue for developing complex ICs, there is still a lack of structured references presenting the major topics in this area. The aim of this book is to present basic concepts and new ideas in a manner understandable for both professionals and students. Since this is an active research field, a comprehensive state-of-the-art overview is very valuable, introducing the main problems as well as the ways of solution that seem promising, emphasizing their basis, strengths and weaknesses. In essence, several topics are presented in detail. First of all, techniques for the efficient use of DSP-based test and CAD test tools. Standardization is another topic considered in the book, with focus on the IEEE 1149.4. Also addressed in depth is the connecting design and test by means of using high-level (behavioural) description techniques, specific examples are given. Another issue is related to test techniques for well-defined classes of integrated blocks, like data converters and phase-locked-loops. Besides these specification-driven testing techniques, fault-driven approaches are described as they offer potential solutions which are more similar to digital test methods. Finally, in Design-for-Testability and Built-In-Self-Test, two other concepts that were taken from digital design, are introduced in an analog context and illustrated for the case of integrated filters. In summary, the purpose of this book is to provide a glimpse on recent research results in the area of testing mixed-signal integrated circuits, specifically in the topics mentioned above. Much of the work reported herein has been performed within cooperative European Research Projects, in which the authors of the different chapters have actively collaborated. It is a representative snapshot of the current state-of-the-art in this emergent field.

Now in a newly updated and revised edition, this timely resource provides you with complete and current details on the theory, design, and applications of wireless antennas for on-body electronic systems. the Second Edition offers readers brand new material on advances in physical phantom design and production, recent developments in simulation methods and numerical phantoms, descriptions of methods for simulation of moving bodies, and the use of the body as a transmission channel. You also find a completely revised chapter on channel characterization and antenna design at microwave frequencies. This cutting-edge volume brings you the state-of-the-art in existing applications like Bluetooth headsets together with detailed treatment of techniques, tools, and challenges in developing on-body antennas for an array of medical, emergency response, law enforcement, personal entertainment, and military applications on the horizon. the book briefs you on energy propagation around and into the body and how to estimate performance of on-body wireless links, and then dives into the nuts-and-bolts of designing antenna systems that deliver the goods. It covers on-body communication channels at microwave frequency bands and at low frequency bands, as well as ultra wideband systems for WPANs and WBANs. You get details on body-centric UWB antennas and channels, as well as advances in wearable mobile, EBG, and "smart fabric" antennas for cellular and WLAN communications. Chapters on telemedicine applications, such as remote diagnoses, and implantable medical devices cover crucial propagation issues and other obstacles that need to be addressed. Rounding out the coverage is a section on antenna design for body-sensor networks and their emerging military and space applications. Packed with hands-on guidance from noted experts, this volume will be

indispensable for your efforts in designing and improving body-centric communication systems.
Lab on the WebRunning Real Electronics Experiments via the InternetJohn Wiley & Sons
The increasing demand for electronic devices for private and industrial purposes lead designers and researchers to explore new electronic devices and circuits that can perform several tasks efficiently with low IC area and low power consumption. In addition, the increasing demand for portable devices intensifies the call from industry to design sensor elements, an efficient storage cell, and large capacity memory elements. Several industry-related issues have also forced a redesign of basic electronic components for certain specific applications. The researchers, designers, and students working in the area of electronic devices, circuits, and materials sometimesneed standard examples with certain specifications. This breakthrough work presents this knowledge of standard electronic device and circuit design analysis, including advanced technologies and materials. This outstanding new volume presents the basic concepts and fundamentals behind devices, circuits, and systems. It is a valuable reference for the veteran engineer and a learning tool for the student, the practicing engineer, or an engineer from another field crossing over into electrical engineering. It is a must-have for any library.
This book addresses the theoretical and practical circuit and system concepts that underpin the design of reliable and reproducible, high performance, monolithic feedback circuits. It is intended for practicing electronics engineers and students who wish to acquire an insightful understanding of the ways in which open loop topologies, closed loop architectures, and fundamental circuit theoretic issues combine to determine the limits of performance of analog networks. Since many of the problems that underpin high speed digital circuit design are a subset of the analysis and design dilemmas confronted by wideband analog circuit designers, the book is also germane to high performance digital circuit design.
Very Large Scale Integration (VLSI) has become a necessity rather than a specialization for electrical and computer engineers. This unique text provides Engineering and Computer Science students with a comprehensive study of the subject, covering VLSI from basic design techniques to working principles of physical design automation tools to leading edge application-specific array processors. Beginning with CMOS design, the author describes VLSI design from the viewpoint of a digital circuit engineer. He develops physical pictures for CMOS circuits and demonstrates the top-down design methodology using two design projects - a microprocessor and a field programmable gate array. The author then discusses VLSI testing and dedicates an entire chapter to the working principles, strengths, and weaknesses of ubiquitous physical design tools. Finally, he unveils the frontiers of VLSI. He emphasizes its use as a tool to develop innovative algorithms and architecture to solve previously intractable problems. VLSI Design answers not only the question of "what is VLSI," but also shows how to use VLSI. It provides graduate and upper level undergraduate students with a complete and congregated view of VLSI engineering.