

Design Techniques For Integrated Cmos Class D Audio Amplifiers Advanced Series In Electrical And Computer Engineering

Thanks to the advance of semiconductor and communication technology, the wireless communication market has been booming in the last two decades. It evolved from simple pagers to emerging third-generation (3G) cellular phones. In the meanwhile, broadband communication market has also gained a rapid growth. As the market always demands hi- performance and low-cost products, circuit designers are seeking hi- integration communication devices in cheap CMOS technology. The phase-locked loop frequency synthesizer is a critical component in communication devices. It works as a local oscillator for frequency translation and channel selection in wireless transceivers and broadband cable tuners. It also plays an important role as the clock synthesizer for data converters in the analog-and-digital signal interface. This book covers the design and analysis of PLL synthesizers. It includes both fundamentals and a review of the state-of-the-art techniques. The transient analysis of the third-order charge-pump PLL reveals its locking behavior accurately. The behavioral-level simulation of PLL further clarifies its stability limit. Design examples are given to clearly illustrate the design procedure of PLL synthesizers. A complete derivation of reference

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spurs in the charge-pump PLL is also presented in this book. The in-depth investigation of the digital CA modulator for fractional-N synthesizers provides insightful design guidelines for this important block.

Welcome to the proceedings of PATMOS 2004, the fourteenth in a series of international workshops. PATMOS 2004 was organized by the University of Patras with technical co-sponsorship from the IEEE Circuits and Systems Society. Over the years, the PATMOS meeting has evolved into an important European event, where industry and academia meet to discuss power and timing aspects in modern integrated circuit and system design. PATMOS provides a forum for researchers to discuss and investigate the emerging challenges in design methodologies and tools required to develop the upcoming generations of integrated circuits and systems. We realized this vision this year by providing a technical program that contained state-of-the-art technical contributions, a keynote speech, three invited talks and two embedded tutorials. The technical program focused on timing, performance and power consumption, as well as architectural aspects, with particular emphasis on modelling, design, characterization, analysis and optimization in the nanometer era. This year a record 152 contributions were received to be considered for possible presentation at PATMOS. Despite the choice for an intense three-day meeting, only 51 lecture papers and 34 poster papers could be accommodated in the single-track technical program. The Technical Program Committee, with the assistance of additional expert reviewers, selected the 85 papers to

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be presented at PATMOS and organized them into 13 technical sessions. As was the case with the PATMOS workshops, the review process was anonymous, full papers were required, and several reviews were received per manuscript.

This book provides readers with detailed explanation of the design principles of CMOS integrated circuits for wireless medical and health care, from the perspective of two successfully-commercialized applications. Design techniques for both the circuit block level and the system level are discussed, based on real design examples. CMOS IC design techniques for the entire signal chain of wireless medical and health care systems are covered, including biomedical signal acquisition, wireless transceivers, power management and SoC integration, with emphasis on ultra-low-power IC design techniques.

This book is a step-by-step tutorial on how to design a low-power, high-resolution (not less than 12 bit), and high-speed (not less than 200 MSps) integrated CMOS analog-to-digital (AD) converter, to respond to the challenge from the rapid growth of IoT. The discussion includes design techniques on both the system level and the circuit block level. In the architecture level, the power-efficient pipelined AD converter, the hybrid AD converter and the time-interleaved AD converter are described. In the circuit block level, the reference voltage buffer, the opamp, the comparator, and the calibration are presented. Readers designing low-power and high-performance AD converters won't want to miss this invaluable reference. Provides an in-depth introduction to the newest

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design techniques for the power-efficient, high-resolution (not less than 12 bit), and high-speed (not less than 200 MSps) AD converter; Presents three types of power-efficient architectures of the high-resolution and high-speed AD converter; Discusses the relevant circuit blocks (i.e., the reference voltage buffer, the opamp, and the comparator) in two aspects, relaxing the requirements and improving the performance. This book provides a detailed analysis of all aspects of capacitive DC-DC converter design: topology selection, control loop design and noise mitigation. Readers will benefit from the authors' systematic overview that starts from the ground up, in-depth circuit analysis and a thorough review of recently proposed techniques and design methodologies. Not only design techniques are discussed, but also implementation in CMOS is shown, by pinpointing the technological opportunities of CMOS and demonstrating the implementation based on four state-of-the-art prototypes. As the requirements for low power consumption and very small physical dimensions in portable, wearable and implantable medical devices are calling for integrated circuit design techniques using MOSFETs operating in the subthreshold regime, this book first revisits some well-known circuit techniques that use CMOS devices biased in subthreshold in order to establish nanowatt integrated circuit designs. Based on these findings, this book shows the development of a class-AB current-mode sample-and-hold circuit with an order of magnitude improvement in its figure of merit compared to other state-of-the-art designs. Also, the concepts and design procedures of 1) single-

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branch filters 2) follower-integrator-based lowpass filters and 3) modular transconductance reduction techniques for very low frequency filters are presented. Finally, to serve the requirement of a very large signal swing in an energy-based action potential detector, a nanopower class-AB current-mode analog multiplier is designed to handle input current amplitudes of more than 10 times the bias current of the multiplier circuit. The invented filter circuits have been fabricated in a standard 0.18 μ CMOS process in order to verify our circuit concepts and design procedures. Their experimental results are reported.

This book begins with the premise that energy demands are directing scientists towards ever-greener methods of power management, so highly integrated power control ICs (integrated chip/circuit) are increasingly in demand for further reducing power consumption. A timely and comprehensive reference guide for IC designers dealing with the increasingly widespread demand for integrated low power management Includes new topics such as LED lighting, fast transient response, DVS-tracking and design with advanced technology nodes Leading author (Chen) is an active and renowned contributor to the power management IC design field, and has extensive industry experience Accompanying website includes presentation files with book illustrations, lecture notes, simulation circuits, solution manuals, instructors' manuals, and program downloads

Praise for CMOS: Circuit Design, Layout, and Simulation Revised Second Edition

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from the Technical Reviewers "A refreshing industrial flavor. Design concepts are presented as they are needed for 'just-in-time' learning. Simulating and designing circuits using SPICE is emphasized with literally hundreds of examples. Very few textbooks contain as much detail as this one. Highly recommended!" --Paul M. Furth, New Mexico State University "This book builds a solid knowledge of CMOS circuit design from the ground up. With coverage of process integration, layout, analog and digital models, noise mechanisms, memory circuits, references, amplifiers, PLLs/DLLs, dynamic circuits, and data converters, the text is an excellent reference for both experienced and novice designers alike." --Tyler J. Gomm, Design Engineer, Micron Technology, Inc. "The Second Edition builds upon the success of the first with new chapters that cover additional material such as oversampled converters and non-volatile memories. This is becoming the de facto standard textbook to have on every analog and mixed-signal designer's bookshelf." --Joe Walsh, Design Engineer, AMI Semiconductor CMOS circuits from design to implementation CMOS: Circuit Design, Layout, and Simulation, Revised Second Edition covers the practical design of both analog and digital integrated circuits, offering a vital, contemporary view of a wide range of analog/digital circuit blocks, the BSIM model, data converter architectures, and much more. This edition takes a two-path approach to the topics: design

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techniques are developed for both long- and short-channel CMOS technologies and then compared. The results are multidimensional explanations that allow readers to gain deep insight into the design process. Features include: Updated materials to reflect CMOS technology's movement into nanometer sizes Discussions on phase- and delay-locked loops, mixed-signal circuits, data converters, and circuit noise More than 1,000 figures, 200 examples, and over 500 end-of-chapter problems In-depth coverage of both analog and digital circuit-level design techniques Real-world process parameters and design rules The book's Web site, CMOSedu.com, provides: solutions to the book's problems; additional homework problems without solutions; SPICE simulation examples using HSPICE, LTspice, and WinSpice; layout tools and examples for actually fabricating a chip; and videos to aid learning

This 2nd edition provides an in-depth, up-to-date, unified, and comprehensive treatment of the fundamentals of the theory of active networks and its applications to feedback amplifier design. The main purpose is to discuss the topics that are of fundamental importance that transcends the advent of new devices and design tools. Intended primarily as a text in circuit theory in electrical engineering for senior and/or first year graduate students, the book also serve as a reference for researchers and practicing engineers in industry. A special

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feature of the book is that it bridges the gap between theory and practice, with abundant examples showing how theory solves problems. These examples are actual practical problems, not idealized illustrations of the theory. The topic on topological analysis of active networks is also expanded to benefit more discerning readers.

Design Techniques for Integrated CMOS Class-D Audio Amplifiers Second Edition World Scientific Publishing Company

The 802.11n wireless standard uses 64-state quadrature amplitude modulation (64-QAM) to achieve higher spectral efficiency. Consequently, the transmitter and receiver require a higher signal to noise ratio with the same level of error rate performance. This book offers a fully-analog compensation technique without baseband circuitry to control the calibration process. Using an 802.11g transceiver design as an example, it describes in detail an auto-calibration mechanism for I/Q gains and phases imbalance.

This book provides in-depth coverage of transformer-based design techniques that enable CMOS oscillators and frequency dividers to achieve state-of-the-art performance. Design, optimization, and measured performance of oscillators and frequency dividers for different applications are discussed in detail, focusing on not only ultra-low supply voltage but also ultra-wide frequency tuning range and

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locking range. This book will be an invaluable reference for anyone working or interested in CMOS radio-frequency or mm-Wave integrated circuits and systems.

This compendium contains 10 chapters written by world renowned researchers with expertise in semantic computing, genome sequence analysis, biomolecular interaction, time-series microarray analysis, and machine learning algorithms. The salient feature of this book is that it highlights eight types of computational techniques to tackle different biomedical applications. These techniques include unsupervised learning algorithms, principal component analysis, fuzzy integral, graph-based ensemble clustering method, semantic analysis, interolog approach, molecular simulations and enzyme kinetics. The unique volume will be a useful reference material and an inspirational read for advanced undergraduate and graduate students, computer scientists, computational biologists, bioinformatics and biomedical professionals.

Top-down approach to practical, tool-independent, digital circuit design, reflecting how circuits are designed.

This book presents state-of-the-art analog and power management IC design techniques for various wireless power transfer (WPT) systems. To create elaborate power management solutions, circuit designers require an in-depth understanding of

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the characteristics of each converter and regulator in the power chain. This book addresses WPT design issues at both system- and circuit-level, and serves as a handbook offering design insights for research students and engineers in the integrated power electronics area.

This invaluable textbook covers the theory and circuit design techniques to implement CMOS (Complementary Metal-Oxide Semiconductor) class-D audio amplifiers integrated circuits. The first part of the book introduces the motivation and fundamentals of audio amplification. The loudspeaker's operation and main audio performance metrics explains the limitations in the amplification process. The second part of this book presents the operating principle and design procedure of the class-D amplifier main architectures to provide the performance tradeoffs. The circuit design procedures involved in each block of the class-D amplifier architecture are highlighted. The third part of this book discusses several important design examples introducing state-of-the-art architectures and circuit design techniques to improve the audio performance, power consumption, and efficiency of standard class-D audio amplifiers. This book describes the structured design and optimization of efficient, energy processing integrated circuits. The approach is multidisciplinary, covering the monolithic integration of IC design techniques, power electronics and control theory. In particular, this book enables readers to conceive, synthesize, design and implement integrated circuits with high-density high-efficiency on-chip switching power regulators. Topics

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covered encompass the structured design of the on-chip power supply, efficiency optimization, IC-compatible power inductors and capacitors, power MOSFET switches and efficient switch drivers in standard CMOS technologies.

Monolithic Microwave Integrated Circuit (MMIC) is an electronic device that is widely used in all high frequency wireless systems. In developing MMIC as a product, understanding analysis and design techniques, modeling, measurement methodology, and current trends are essential. *Advances in Monolithic Microwave Integrated Circuits for Wireless Systems: Modeling and Design Technologies* is a central source of knowledge on MMIC development, containing research on theory, design, and practical approaches to integrated circuit devices. This book is of interest to researchers in industry and academia working in the areas of circuit design, integrated circuits, and RF and microwave, as well as anyone with an interest in monolithic wireless device development.

Fuzzy logic has virtually exploded over the landscape of emerging technologies, becoming an integral part of myriad applications and a standard tool for engineers. Until recently, most of the attention and applications have centered on fuzzy systems implemented in software. But these systems are limited. Problems that require real-time operation, low area, or low power consumption demand hardware designed to the fuzzy paradigm - and engineers with the background and skills to design it. *Microelectronic Design of Fuzzy Logic-Based Systems* offers low-cost answers to issues that software

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cannot resolve. From the theoretical, architectural, and technological foundation to design tools and applications, it serves as your guide to effective hardware realizations of fuzzy logic. Review fuzzy logic theory and the basic issues of fuzzy sets, operators, and inference mechanisms Explore the trade-offs between efficient theoretical behavior and practical hardware realizations Discover the properties of the possible microelectronic realizations of fuzzy systems - conventional processors, fuzzy coprocessors, and fuzzy chips Investigate the design of fuzzy chips that implement the whole fuzzy inference method into silicon Analyze analog, digital, and mixed-signal techniques Reduce your design effort for fuzzy systems with CAD tools - learn the requirements they should meet and survey current environments. Put it all together - see examples and case studies illustrating how all of this is used to solve particular problems related to control and neuro-fuzzy applications

RF CMOS Power Amplifiers: Theory Design and Implementation focuses on the design procedure and the testing issues of CMOS RF power amplifiers. This is the first monograph addressing RF CMOS power amplifier design for emerging wireless standards. The focus on power amplifiers for short is distance wireless personal and local area networks (PAN and LAN), however the design techniques are also applicable to emerging wide area networks (WAN) infrastructure using micro or pico cell networks. The book discusses CMOS power amplifier design principles and theory and describes the architectures and tradeoffs in designing linear and nonlinear power amplifiers. It

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then details design examples of RF CMOS power amplifiers for short distance wireless applications (e, g., Bluetooth, WLAN) including designs for multi-standard platforms. Design aspects of RF circuits in deep submicron CMOS are also discussed. RF CMOS Power Amplifiers: Theory Design and Implementation serves as a reference for RF IC design engineers and RD and R&D managers in industry, and for graduate students conducting research in wireless semiconductor IC design in general and with CMOS technology in particular.

High-speed, power-efficient analog integrated circuits can be used as standalone devices or to interface modern digital signal processors and micro-controllers in various applications, including multimedia, communication, instrumentation, and control systems. New architectures and low device geometry of complementary metaloxidesemiconductor (CMOS) technologies have accelerated the movement toward system on a chip design, which merges analog circuits with digital, and radio-frequency components.

A frequency synthesizer is one of the most critical building blocks in any wireless transceiver system. Its design is getting more and more challenging as the demand for low-voltage low-power high-frequency wireless systems continuously grows. As the supply voltage is decreased, many existing design techniques are no longer applicable. This book provides the reader with architectures and design techniques to enable CMOS frequency synthesizers to operate at low supply voltage at high frequency with good phase noise and low power consumption. In addition to updating the reader on many of these techniques in depth, this

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book will also introduce useful guidelines and step-by-step procedure on behaviour simulations of frequency synthesizers. Finally, three successfully demonstrated CMOS synthesizer prototypes with detailed design consideration and description will be elaborated to illustrate potential applications of the architectures and design techniques described. For engineers, managers and researchers working in radio-frequency integrated-circuit design for wireless applications.

Low-Voltage CMOS Log Comanding Analog Design presents in detail state-of-the-art analog circuit techniques for the very low-voltage and low-power design of systems-on-chip in CMOS technologies. The proposed strategy is mainly based on two bases: the Instantaneous Log Comanding Theory, and the MOSFET operating in the subthreshold region. The former allows inner compression of the voltage dynamic-range for very low-voltage operation, while the latter is compatible with CMOS technologies and suitable for low-power circuits. The required background on the specific modeling of the MOS transistor for Comanding is supplied at the beginning. Following this general approach, a complete set of CMOS basic building blocks is proposed and analyzed for a wide variety of analog signal processing. In particular, the covered areas include: amplification and AGC, arbitrary filtering, PTAT generation, and pulse duration modulation (PDM). For each topic, several case studies are considered to illustrate the design methodology. Also, integrated examples in 1.2um and 0.35um CMOS technologies are reported to verify the good agreement between design equations and experimental data. The resulting analog circuit topologies exhibit very low-voltage (i.e. 1V) and low-power (few tenths of uA) capabilities. Apart from these specific design examples, a real industrial application in the field of hearing aids is also presented as the main

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demonstrator of all the proposed basic building blocks. This system-on-chip exhibits true 1V operation, high flexibility through digital programmability and very low-power consumption (about 300uA including the Class-D amplifier). As a result, the reported ASIC can meet the specifications of a complete family of common hearing aid models. In conclusion, this book is addressed to both industry ASIC designers who can apply its contents to the synthesis of very low-power systems-on-chip in standard CMOS technologies, as well as to the teachers of modern circuit design in electronic engineering.

The Integrated Circuits industry has been a major driver of the outstanding changes and improvements in the modern day technology and life style that we are observing in our day to day life. The continuous scaling of CMOS technology has been one of the major challenges and success stories. However, as the CMOS technology advances deeply into the deep sub-micron technology nodes, the whole industry (both manufacturing and design) is starting to face new challenges. One major challenge is the control of the variation in device parameters. Lithography variations result from the industry incapability to come up with new light sources with a smaller wavelength than ArF source (193 nm wavelength). In this research, we develop better understanding of the photo-lithography variations and their effect on how the design gets patterned. We investigate the state-of-the-art mask correction and design manipulation techniques. We are focusing in our study on the different Optical Proximity Correction (OPC) and design retargeting techniques to assess how we can improve both the functional and parametric yield. Our goal is to achieve a fast and accurate Model Based Re-Targeting (MBRT) technique that can achieve a better functional yield during manufacturing by establishing the techniques to produce more lithography-friendly targets. Moreover, it can be

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easily integrated into a fab's PDK (due to its relatively high speed) to feedback the exact final printing on wafer to the designers during the early design phase. In this thesis, we focus on two main topics. First is the development of a fast technique that can predict the final mask shape with reasonable accuracy. This is our proposed Model-based Initial Bias (MIB) methodology, in which we develop the full methodology for creating compact models that can predict the perturbation needed to get to an OPC initial condition that is much closer to the final solution. This is very useful in general in the OPC domain, where it can save almost 50% of the OPC runtime. We also use MIB in our proposed Model-Based Retargeting (MBRT) flow to accurately compute lithography hot-spots location and severity. Second, we develop the fast model-based retargeting methodology that is capable of fixing lithography hot spots and improving the functional yield. Moreover, in this methodology we introduce to the first time the concept of distributed retargeting. In distributed MBRT, not only the design portion that is suffering from the hot-spot is moving to get it fixed but also the surrounding designs and design fragments also contribute to the hot-spot fix. Our proposed model-based retargeting methodology also includes the multiple-patterning awareness as well as the electrical-connectivity-awareness (via-awareness). We used Mentor Graphics Calibre Litho-API c-based programming to develop all of the methodologies we explain in this thesis and tested it on 20nm and 10nm nodes.

Technology developments have made CMOS a strong candidate in high-frequency applications because of its low power, low cost and higher-level integration. However, as an essential element in an RF building block, a CMOS device is not as good as a BJT device in terms of speed and a HEMT device in terms of noise performance. Therefore, conventional low-

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frequency design techniques for CMOS circuits may not satisfy the requirements for high-frequency applications wherein the operating frequencies get close to the cut-off frequency of a CMOS device. This research work explores design techniques for various high-frequency circuits at 10 GHz, 60 GHz and up to 110 GHz. Individual building blocks including low-noise amplifiers, voltage-controlled oscillators, high-frequency true-single-phase-clock frequency dividers, and mm-wave amplifiers are studied thoroughly using both theoretical analysis and practical circuit designs. Related fundamental techniques, such as MOS device modeling and de-embedding techniques, are also explored. Furthermore, as a prototype of system-level integration, a Ku-band LNB front-end is implemented for the application of a satellite receiver. "The third edition presents a unified, up-to-date and detailed account of broadband matching theory and its applications to the design of broadband matching networks and amplifiers. A special feature is the addition of results that are of direct practical value. They are design curves, tables and explicit formulas for designing networks having Butterworth, Chebyshev or elliptic, Bessel or maximally flat group-delay response. These results are extremely useful as the design procedures can be reduced to simple arithmetic. Two case studies towards the end of the book are intended to demonstrate the applications to the practical design of modern filter circuits."--

This book provides the most comprehensive and in-depth coverage of the latest circuit design developments in RF CMOS technology. It is a practical and cutting-edge guide, packed with proven circuit techniques and innovative design methodologies for solving challenging problems associated with RF integrated circuits and systems. This invaluable resource features a collection of the finest design practices that may soon drive the system-on-chip

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revolution. Using this book's state-of-the-art design techniques, one can apply existing technologies in novel ways and to create new circuit designs for the future.

With vastly increased complexity and functionality in the "nanometer era" (i.e. hundreds of millions of transistors on one chip), increasing the performance of integrated circuits has become a challenging task. Connecting effectively (interconnect design) all of these chip elements has become the greatest determining factor in overall performance. 3-D integrated circuit design may offer the best solutions in the near future. This is the first book on 3-D integrated circuit design, covering all of the technological and design aspects of this emerging design paradigm, while proposing effective solutions to specific challenging problems concerning the design of 3-D integrated circuits. A handy, comprehensive reference or a practical design guide, this book provides a sound foundation for the design of 3-D integrated circuits. * Demonstrates how to overcome "interconnect bottleneck" with 3-D integrated circuit design...leading edge design techniques offer solutions to problems (performance/power consumption/price) faced by all circuit designers * The FIRST book on 3-D integrated circuit design...provides up-to-date information that is otherwise difficult to find * Focuses on design issues key to the product development cycle...good design plays a major role in exploiting the implementation flexibilities offered in the 3-D * Provides broad coverage of 3-D integrated circuit design, including interconnect prediction models, thermal management techniques, and timing optimization...offers practical view of designing 3-D circuits

"This exceptionally comprehensive tutorial presentation of complementary metal oxide semiconductor (CMOS) integrated circuits will guide you through the process of implementing a chip from the physical definition through the design and simulation of the finished chip.

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CMOS: CIRCUIT DESIGN, LAYOUT, AND SIMULATION provides an important contemporary view of a wide range of circuit blocks, the BSIM model, data converter architectures, and much more. Outstanding features of this text include: * Phase- and delay-locked loops, mixed-signal circuits, and data converters * More than 1,000 figures, 200 examples, and over 500 end-of-chapter problems * In-depth coverage of both analog and digital circuit-level design techniques * Real-world process parameters and design rules * Information on MOSIS fabrication procedures, and other key topics of interest * Information and directions on submitting chips of MOSIS * Tutorial presentation of material suitable for self study or as a university textbook * Numerous examples and homework problems For more information and links related to CMOS design, go to <http://cmosedu.com>. Professors: To request an examination copy simply e-mail collegeadoption@ieee.org." Sponsored by: IEEE Solid-State Circuits Council/Society, IEEE Circuits and Systems Society.

This unique book provides an overview of the current state of the art and very recent research results that have been achieved as part of the Low-Power Initiative of the European Union, in the field of analogue, RF and mixed-signal design methodologies and CAD tools. The fourth edition of CMOS Digital Integrated Circuits: Analysis and Design continues the well-established tradition of the earlier editions by offering the most comprehensive coverage of digital CMOS circuit design, as well as addressing state-of-the-art technology issues highlighted by the widespread use of nanometer-scale CMOS technologies. In this latest edition, virtually all chapters have been re-written, the transistor model equations and device parameters have been revised to reflect the significant changes that must be taken into account for new technology generations, and the material has been reinforced with up-to-date

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examples. The broad-ranging coverage of this textbook starts with the fundamentals of CMOS process technology, and continues with MOS transistor models, basic CMOS gates, interconnect effects, dynamic circuits, memory circuits, arithmetic building blocks, clock and I/O circuits, low power design techniques, design for manufacturability and design for testability.

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