The Art Of Analog Layout

In the 11th edition in this successful series, the topics are structured-mixed-mode design, multi-bit sigma-delta converters and short range RF circuits. The book provides valuable information and excellent overviews of analogue circuit design, CAD and RF systems.

This book covers modern analog components, their characteristics, and interactions with process parameters. It serves as a comprehensive guide, addressing both the theoretical and practical aspects of modern silicon devices and the relationship between their electrical properties and processing conditions. Based on the authors' extensive experience in the development of analog devices, this book is intended for engineers and scientists in semiconductor research, development and manufacturing. The problems at the end of each chapter and the numerous charts, figures and tables also make it appropriate for use as a text in graduate and advanced undergraduate courses in electrical engineering and materials science. Enables engineers to understand analog device physics, and discusses important relations between process integration, device design, component characteristics, and reliability; Describes in step-by-step fashion the components that are used in analog designs, the particular characteristics of analog components, while comparing them to digital applications; Explains the second-order effects in analog devices, and trade-offs between these effects when designing components and developing an integrated process for their manufacturing.

Analog integrated circuits are very important as interfaces between the digital parts of integrated electronic systems and the outside world. A large portion of the effort involved in designing these circuits is spent in the layout phase. Whereas the physical design of digital circuits is automated to a large extent, the layout of analog circuits is still a manual, time-consuming and error-prone task. This is mainly due to the continuous nature of analog signals, which causes analog circuit performance to be very sensitive to layout parasitics. The parasitic elements associated with interconnect wires cause loading and coupling effects that degrade the frequency behaviour and the noise performance of analog circuits. Device mismatch and thermal effects put a fundamental limit on the achievable accuracy of circuits. For successful automation of analog layout, advanced place and route tools that can handle these critical parasitics are required. In the past, automatic analog layout tools tried to optimize the layout without quantifying the performance degradation introduced by layout parasitics. Therefore, it was not guaranteed that the resulting layout met the specifications and one or more layout iterations could be needed. In Analog Layout Generation for Performance and Manufacturability, the authors propose a performance driven layout strategy to overcome this problem. In this methodology, the layout tools are driven by performance constraints, such that the final layout, with parasitic effects, still satisfies the specifications of the circuit. The performance degradation associated with an intermediate layout solution is evaluated at runtime using predetermined sensitivities. In contrast with other performance driven layout methodologies, the tools proposed in this book operate directly on the performance constraints, without an intermediate parasitic constraint generation step. This approach makes a complete and sensible trade-off between the different layout alternatives possible at runtime and therefore eliminates

the possible feedback route between constraint derivation, placement and layout extraction. Besides its influence on the performance, layout also has a profound impact on the yield and testability of an analog circuit. In Analog Layout Generation for Performance and Manufacturability, the authors outline a new criterion to quantify the detectability of a fault and combine this with a yield model to evaluate the testability of an integrated circuit layout. They then integrate this technique with their performance driven routing algorithm to produce layouts that have optimal manufacturability while still meeting their performance specifications. Analog Layout Generation for Performance and Manufacturability will be of interest to analog engineers, researchers and students.

The Art of Analog LayoutPrentice Hall

As biosensors comprise a prospective alternative to traditional chemical analyses, enabling fast on- and in-line measurements with sufficient selectivity, the field is expanding rapidly and is offering new ideas and developments every day. This book aims to cover the present state of the art in the biosensor technology and introduce the general aspects of biosensor- based techniques and methods. The book consists of 13 chapters by 44 authors and is divided into 3 sections, focused on bio-recognition techniques, signal transduction methods and signal analysis.

It is a great honor to provide a few words of introduction for Dr. Georges Gielen's and Prof. Willy Sansen's book "Symbolic analysis for automated design of analog integrated circuits". The symbolic analysis method presented in this book represents a significant step forward in the area of analog circuit design. As demonstrated in this book, symbolic analysis opens up new possibilities for the development of computer-aided design (CAD) tools that can analyze an analog circuit topology and automatically size the components for a given set of specifications. Symbolic analysis even has the potential to improve the training of young analog circuit designers and to guide more experienced designers through second-order phenomena such as distortion. This book can also serve as an excellent reference for researchers in the analog circuit design area and creators of CAD tools, as it provides a comprehensive overview and comparison of various approaches for analog circuit design automation and an extensive bibliography. The world is essentially analog in nature, hence most electronic systems involve both analog and digital circuitry. As the number of transistors that can be integrated on a single integrated circuit (IC) substrate steadily increases over time, an ever increasing number of systems will be implemented with one, or a few, very complex ICs because of their lower production costs.

An introduction to the design of analog VLSI circuits. Neuromorphic engineers work to improve the performance of artificial systems through the development of chips and systems that process information collectively using primarily analog circuits. This book presents the central concepts required for the creative and successful design of analog VLSI circuits. The discussion is weighted toward novel circuits that emulate natural signal processing. Unlike most circuits in commercial or industrial applications, these circuits operate mainly in the subthreshold or weak inversion region. Moreover, their functionality is not limited to linear operations, but also encompasses many interesting nonlinear operations similar to those occurring in natural systems. Topics include device physics, linear and nonlinear circuit forms, translinear circuits, photodetectors, floating-gate devices, noise analysis, and process technology.

This book explains the application of recent advances in computational intelligence – algorithms, design methodologies, and synthesis techniques – to the design of integrated circuits and systems. It highlights new biasing and sizing approaches and optimization techniques and their application to the design of high-performance digital, VLSI, radio-frequency, and mixed-signal circuits and systems. This first of two related volumes addresses the design of analog and mixed-signal (AMS) and radio-frequency (RF) circuits, with 17 chapters grouped into parts on analog and mixed-signal applications, and radio-frequency design. It will be of interest to practitioners and researchers in computer science and electronics engineering engaged with the design of electronic circuits.

This book introduces readers to a variety of tools for analog layout design automation. After discussing the placement and routing problem in electronic design automation (EDA), the authors overview a variety of automatic layout generation tools, as well as the most recent advances in analog layout-aware circuit sizing. The discussion includes different methods for automatic placement (a template-based Placer and an optimization-based Placer), a fully-automatic Router and an empirical-based Parasitic Extractor. The concepts and algorithms of all the modules are thoroughly described, enabling readers to reproduce the methodologies, improve the quality of their designs, or use them as starting point for a new tool. All the methods described are applied to practical examples for a 130nm design process, as well as placement and routing benchmark sets.

This book presents an innovative methodology for the automatic generation of analog integrated circuits (ICs) layout, based on template descriptions and on evolutionary computational techniques. A design automation tool, LAYGEN II was implemented to validate the proposed approach giving special emphasis to reusability of expert design knowledge and to efficiency on retargeting operations.

As the frequency of communication systems increases and the dimensions of transistors are reduced, more and more stringent performance requirements are placed on analog circuits. This is a trend that is bound to continue for the foreseeable future and while it does, understanding performance trade-offs will constitute a vital part of the analog design process. It is the insight and intuition obtained from a fundamental understanding of performance conflicts and trade-offs, that ultimately provides the designer with the basic tools necessary for effective and creative analog design. Trade-offs in Analog Circuit Design, which is devoted to the understanding of trade-offs in analog design, is quite unique in that it draws together fundamental material from, and identifies interrelationships within, a number of key analog circuits. The book covers ten subject areas: Design methodology, Technology, General Performance, Filters, Switched Circuits, Oscillators, Data Converters, Transceivers, Neural Processing, and Analog CAD. Within these subject areas it deals with a wide diversity of trade-offs ranging from frequency-dynamic range and power, gain-bandwidth, speed-dynamic range and phase noise, to tradeoffs in design for manufacture and IC layout. The book has by far transcended its original scope and has become both a designer's companion as well as a graduate textbook. An important feature of this book is that it promotes an intuitive approach to understanding analog circuits by explaining fundamental relationships and, in many cases, providing practical illustrative examples to demonstrate the inherent basic interrelationships and trade-offs. Trade-offs in Analog Circuit Design draws together 34 contributions from some of the world's most eminent analog circuits-and-systems designers to provide, for the first time, a comprehensive text devoted to a very important and timely approach to analog circuit design. Improving the performance of existing technologies has always been a focal practice in the development of computational systems. However, as circuitry is becoming more complex, conventional techniques are becoming outdated and new research methodologies are being

implemented by designers. Performance Optimization Techniques in Analog, Mix-Signal, and Radio-Frequency Circuit Design features recent advances in the engineering of integrated systems with prominence placed on methods for maximizing the functionality of these systems. This book emphasizes prospective trends in the field and is an essential reference source for researchers, practitioners, engineers, and technology designers interested in emerging research and techniques in the performance optimization of different circuit designs.

A comprehensive and in-depth review of analog circuitlayout, schematic architecture, device, power network and ESDdesign This book will provide a balanced overview of analog circuitdesign layout, analog circuit schematic development,architecture of chips, and ESD design. It will start atan introductory level and will bring the reader right up to thestate-of-the-art. Two critical design aspects for analog and powerintegrated circuits are combined. The first design aspect coversanalog circuit design techniques to achieve the desired circuitperformance. The second and main aspect presents the additionalchallenges associated with the design of adequate and effective ESDprotection elements and schemes. A comprehensive list of practicalapplication examples is used to demonstrate the successfulcombination of both techniques and any potential designtrade-offs. Chapter One looks at analog design discipline, including layoutand analog matching and analog layout design practices. Chapter Twodiscusses analog design with circuits, examining: singletransistor amplifiers; multi-transistor amplifiers; active loadsand more. The third chapter covers analog design layout (alsoMOSFET layout), before Chapters Four and Five discuss analog designsynthesis. The next chapters introduce the reader to analog-digitalmixed signal design synthesis, analog signal pin ESD networks, andanalog ESD power clamps. Chapter Nine, the last chapter, covers ESDdesign in analog applications. Clearly describes analog design fundamentals (circuitfundamentals) as well as outlining the various ESDimplications Covers a large breadth of subjects and technologies, such asCMOS, LDMOS, BCD, SOI, and thick body SOI Establishes an "ESD analog design" discipline thatdistinguishes itself from the alternative ESD digital designfocus Focuses on circuit and circuit design applications Assessible, with the artwork and tutorial style of the ESD bookseries PowerPoint slides are available for university facultymembers Even in the world of digital circuits, analog and power circuitsare two very important but under-addressed topics, especially fromthe ESD aspect. Dr. Voldman's new book will serve as anessential and practical guide to the greater IC community. Withhigh practical and academic values this book is a"bible" for professionals, graduate students, deviceand circuit designers for investigating the physics of ESD and forproduct designs and testing.

This text addresses the design methodologies and CAD tools available for the systematic design and design automation of analogue integrated circuits. Two complementary approaches discussed increase analogue design productivity, demonstrated throughout using design times of the different design experiments undertaken.

Verbal explanations are favored over mathematical formulas, graphs are kept to a minimum, and line drawings are used in this user-friendly book. Clear guidance and advice are provided for those professionals who lay out analog circuits. KEY TOPICS: Matching of resistors and capacitors: Includes causes of mismatch, particularly the hydrogen effect and package shift. MOS Transistors: Covers a brief history of floating gate devices, EPROM and EEPROM. Applications of MOS transistors: Expands information on failure mechanisms, including BVdss/Bvdii, SILC, NBTI/PTBI and GIDL and the difference between electrical and electrothermal SOA. Consideration of failure mechanisms as crucial to layout: Integrates further information into many chapters covering various devices. Standard bipolar, polygate CMOS and analog BiCMOS: Covers all three fundamental processes. MARKET: A valuable reference for professional layout designers.

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This book presents a detailed summary of research on automatic layout of device-level analog circuits that was undertaken in the late 1980s and early 1990s at Carnegie Mellon University. We focus on the work behind the creation of the tools called KOAN and ANAGRAM II, which form part of the core of the CMU ACACIA analog CAD system. KOAN is a device placer for custom analog cells; ANANGRAM II a detailed area router for these analog cells. We strive to present the motivations behind the architecture of these tools, including detailed discussion of the subtle technology and circuit concerns that must be addressed in any successful analog or mixed-signal layout tool. Our approach in organizing the chapters of the book has been to present our algo rithms as a series of responses to these very real and very difficult analog layout problems. Finally, we present numerous examples of results generated by our algorithms. This research was supported in part by the Semiconductor Research Corpora tion, by the National Science Foundation, by Harris Semiconductor, and by the International Business Machines Corporation Resident Study Program. Finally, just for the record: John Cohn was the designer of the KOAN placer; David Garrod was the designer of the ANAGRAM II router (and its predeces sor, ANAGRAM I). This book was architected by all four authors, edited by John Cohn and Rob Rutenbar, and produced in finished form by John Cohn.

This book tackles challenges for the design of analog integrated circuits that operate from ultra-low power supply voltages (down to 0.5V). Coverage demonstrates the signal processing circuit and circuit biasing approaches through the design of operational transconductance amplifiers (OTAs). These amplifiers are then used to build analog system functions including continuous time filter and a sample and hold amplifier.

The tools and techniques you need to break the analog design bottleneck! Ten years ago, analog seemed to be a dead-end technology. Today, System-on-Chip (SoC) designs are increasingly mixed-signal designs. With the advent of application-specific integrated circuits (ASIC) technologies that can integrate both analog and digital functions on a single chip, analog has become more crucial than ever to the design process. Today, designers are moving beyond hand-crafted, one-transistor-at-a-time methods. They are using new circuit and physical synthesis tools to design practical analog circuits; new modeling and analysis tools to allow rapid exploration of system level alternatives; and new simulation tools to provide accurate answers for analog circuit behaviors and interactions that were considered impossible to handle only a few years ago. To give circuit designers and CAD professionals a better understanding of the history and the current state of the art in the field, this volume collects in one place the essential set of analog CAD papers that form the foundation of today's new analog design automation tools. Areas covered are: Analog synthesis Symbolic analysis Analog layout Analog modeling and analysis Specialized analog simulation Circuit centering and yield optimization Circuit testing Computer-Aided Design of Analog Integrated Circuits and Systems is the cutting-edge reference that will be an invaluable resource for every semiconductor circuit designer and CAD professional who hopes to break the analog design bottleneck.

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In this companion text to Analog Circuit Design: Art, Science, and Personalities, seventeen contributors present more tutorial, historical, and editorial viewpoints on subjects related to analog circuit design. By presenting divergent methods and views of people who have achieved some measure of success in their field, the book encourages readers to develop their own approach to design. In addition, the essays and anecdotes give some constructive guidance in areas not usually covered in engineering courses, such as marketing and career development. *Includes visualizing operation of analog circuits *Describes troubleshooting for optimum circuit performance *Demonstrates how to produce a saleable product

The exploration of the subnuclear world is done through increasingly complex experiments covering a wide range of energies and in a large variety of environments OCo from particle accelerators and underground detectors to satellites and space laboratories. For these research programs to succeed, novel techniques, new materials and new instrumentation need to be used in detectors, often on a large scale. Hence, particle physics is at the forefront of technological advancement and leads to numerous applications. Among these, medical applications have a particular importance due to the health and social benefits they bring. This volume reviews the advances made in all technological aspects of current experiments in the field."

This book constitutes the refereed proceedings of the 23st International Symposium on VLSI Design and Test, VDAT 2019, held in Indore, India, in July 2019. The 63 full papers were carefully reviewed and selected from 199 submissions. The papers are organized in topical sections named: analog and mixed signal design; computing architecture and security; hardware design and optimization; low power VLSI and memory design; device modelling; and hardware implementation.

The essentials of analog circuit design with a unique all-region MOSFET modeling approach.

This book describes new tools for front end analog designers, starting with global variation-aware sizing, and extending to novel variation-aware topology design. The tools aid design through automation, but more importantly, they also aid designer insight through automation. We now describe four design tasks, each more general than the previous, and how this book contributes design aids and insight aids to each. The ?rst designer task targeted is global robust sizing. This task is supported by a design tool that does automated, globally reliable, variation-aware s- ing (SANGRIA),and an insight-aiding tool that extracts designer-interpretable whitebox models that relate sizings to circuit performance (CAFFEINE). SANGRIA searches on several levels of problem dif?culty simultaneously, from lower cheap-to-evaluate "exploration" layers to higher full-evaluation "exploitation" layers (structural homotopy). SANGRIAmakes maximal use of circuit simulations by performing scalable data mining on simulation results to choose new candidate designs. CAFFEINE accomplishes its task by tre- ing function induction as a tree-search problem. It constrains its tree search space via a canonical-functional-form grammar, and searches the space with grammatically constrained genetic programming. The second designer task is topology selection/topology design. Topology selection tools must consider a broad variety of topologies such that an app- priate topology is selected, must easily adapt to new semiconductor process nodes, and readily incorporate new topologies. Topology design tools must allow designers to creatively explore new topology ideas as rapidly as possible.

The microelectronics market, with special emphasis to the production of complex mixed-signal systems-on-chip (SoC), is driven by three main dynamics, time-- market, productivity and managing complexity. Pushed by the progress in na- meter technology, the design teams are

facing a curve of complexity that grows exponentially, thereby slowing down the productivity design rate. Analog design automation tools are not developing at the same pace of technology, once custom design, characterized by decisions taken at each step of the analog design flow, - lies most of the time on designer knowledge and expertise. Actually, the use of - sign management platforms, like the Cadences Virtuoso platform, with a set of - tegrated CAD tools and database facilities to deal with the design transformations from the system level to the physical implementation, can significantly speed-up the design process and enhance the productivity of analog/mixed-signal integrated circuit (IC) design teams. These design management platforms are a valuable help in analog IC design but they are still far behind the development stage of design automation tools already available for digital design. Therefore, the development of new CAD tools and design methodologies for analog and mixed-signal ICs is ess- tial to increase the designer's productivity and reduce design productivitygap. The work presented in this book describes a new design automation approach to the problem of sizing analog ICs.

Genetic Programming Theory and Practice III provides both researchers and industry professionals with the most recent developments in GP theory and practice by exploring the emerging interaction between theory and practice in the cutting-edge, machine learning method of Genetic Programming (GP). The contributions developed from a third workshop at the University of Michigan's Center for the Study of Complex Systems, where leading international genetic programming theorists from major universities and active practitioners from leading industries and businesses meet to examine and challenge how GP theory informs practice and how GP practice impacts GP theory. Applications are from a wide range of domains, including chemical process control, informatics, and circuit design, to name a few.

"Electrostatic discharge (ESD)"--Page xxi.

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Globalization of the integrated circuit (IC) supply chains led to many potential vulnerabilities. Several attack scenarios can exploit these vulnerabilities to reverse engineer IC designs or to insert malicious trojan circuits. Split manufacturing refers to the process of splitting an IC design into multiple parts and fabricating these parts at two or more foundries such that the design is secure even when some or all of those foundries are potentially untrusted. Realizing its security benefits, researchers have proposed split fabrication methods for 2D, 2.5D, and the emerging 3D ICs. Both attack methods against split designs and defense techniques to thwart those attacks while minimizing overheads have steadily progressed over the past decade. This book presents a comprehensive review of the state-of-the-art and emerging directions in design splitting for secure split fabrication, design recognition and recovery attacks against split designs, and design techniques to defend against those attacks. Readers will learn methodologies for secure and trusted IC design and fabrication using split design methods to protect against supply chain vulnerabilities. Provides the first book on Split Manufacturing methods, attacks and defenses for integrated circuits; Serves as single-source reference to all advances to-date on split manufacturing methods and design splitting techniques for 2D, 2.5D and 3D integrated circuits, design recovery attacks and defense methods; Covers design constraint based attacks and satisfiability based attacks to reverse engineer split designs or to insert hardware trojans; Covers design-for-trust defense techniques to thwart both reverse engineering and trojan insertion attacks; Discusses the security benefits and cost penalties of various split design methods; Includes challenges and emerging research directions.

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Analog circuit and system design today is more essential than ever before. With the growth of digital systems, wireless communications, complex industrial and automotive systems, designers are being challenged to develop sophisticated analog solutions. This comprehensive source book of circuit design solutions aids engineers with elegant and practical design techniques that focus on common analog challenges. The book's in-depth application examples provide insight into circuit design and application solutions that you can apply in today's demanding designs. This is the companion volume to the successful Analog Circuit Design: A Tutorial Guide to Applications and Solutions (October 2011), which has sold over 5000 copies in its the first 6 months of since publication. It extends the Linear Technology collection of application notes, which provides analog experts with a full collection of reference designs and problem solving insights to apply to their own engineering challenges Full support package including online resources (LTSpice) Contents include more application notes on power management, and data conversion and signal conditioning circuit solutions, plus an invaluable circuit collection of reference designs

This book presents a framework for the reuse-based design of AMS circuits. The framework is founded on three key elements: (1) a CAD-supported hierarchical design flow; (2) a complete, clear definition of the AMS reusable block; (3) the design for a reusability set of tools, methods, and guidelines. The book features a detailed tutorial and in-depth coverage of all issues and must-have properties of reusable AMS blocks. ?????????????????????????

This book covers the fundamental knowledge of layout design from the ground up, addressing both physical design, as generally applied to digital circuits, and analog layout. Such knowledge provides the critical awareness and insights a layout designer must possess to convert a structural description produced during circuit design into the physical layout used for IC/PCB fabrication. The book introduces the technological know-how to transform silicon into functional devices, to understand the technology for which a layout is targeted (Chap. 2). Using this core technology knowledge as the foundation, subsequent chapters delve deeper into specific constraints and aspects of physical design, such as interfaces, design rules and libraries (Chap. 3), design flows and models (Chap. 4), design steps (Chap. 5), analog design specifics (Chap. 6), and finally reliability measures (Chap. 7). Besides serving as a textbook for engineering students, this book is a foundational reference for today's circuit designers.

In this book, innovative research using artificial neural networks (ANNs) is conducted to automate the placement task in analog integrated circuit layout design, by creating a generalized model that can generate valid layouts at push-button speed. Further, it

exploits ANNs' generalization and push-button speed prediction (once fully trained) capabilities, and details the optimal description of the input/output data relation. The description developed here is chiefly reflected in two of the system's characteristics: the shape of the input data and the minimized loss function. In order to address the latter, abstract and segmented descriptions of both the input data and the objective behavior are developed, which allow the model to identify, in newer scenarios, sub-blocks which can be found in the input data. This approach yields device-level descriptions of the input topology that, for each device, focus on describing its relation to every other device in the topology. By means of these descriptions, an unfamiliar overall topology can be broken down into devices that are subject to the same constraints as a device in one of the training topologies. In the experimental results chapter, the trained ANNs are used to produce a variety of valid placement solutions even beyond the scope of the training/validation sets, demonstrating the model's effectiveness in terms of identifying common components between newer topologies and reutilizing the acquired knowledge. Lastly, the methodology used can readily adapt to the given problem's context (high label production cost), resulting in an efficient, inexpensive and fast model.

This book introduces a design methodology that can help to bridge the productivity gap. Two different types of designs, depending on the design challenge, have been identified. To validate the presented methodologies, the authors have selected and designed accordingly three different industrial-strength applications.

This book introduces readers to a variety of tools for automatic analog integrated circuit (IC) sizing and optimization. The authors provide a historical perspective on the early methods proposed to tackle automatic analog circuit sizing, with emphasis on the methodologies to size and optimize the circuit, and on the methodologies to estimate the circuit's performance. The discussion also includes robust circuit design and optimization and the most recent advances in layout-aware analog sizing approaches. The authors describe a methodology for an automatic flow for analog IC design, including details of the inputs and interfaces, multi-objective optimization techniques, and the enhancements made in the base implementation by using machine leaning techniques. The Gradient model is discussed in detail, along with the methods to include layout effects in the circuit sizing. The concepts and algorithms of all the modules are thoroughly described, enabling readers to reproduce the methodologies, improve the quality of their designs, or use them as starting point for a new tool. An extensive set of application examples is included to demonstrate the capabilities and features of the methodologies described.

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