

Esd Analog Circuits And Design By Steven H Voldman

Electrical Overstress (EOS) continues to impact semiconductor manufacturing, semiconductor components and systems as technologies scale from micro- to nano-electronics. This book teaches the fundamentals of electrical overstress and how to minimize and mitigate EOS failures. The text provides a clear picture of EOS phenomena, EOS origins, EOS sources, EOS physics, EOS failure mechanisms, and EOS on-chip and system design. It provides an illuminating insight into the sources of EOS in manufacturing, integration of on-chip, and system level EOS protection networks, followed by examples in specific technologies, circuits, and chips. The book is unique in covering the EOS manufacturing issues from on-chip design and electronic design automation to factory-level EOS program management in today's modern world. Look inside for extensive coverage on: Fundamentals of electrical overstress, from EOS physics, EOS time scales, safe operating area (SOA), to physical models for EOS phenomena EOS sources in today's semiconductor manufacturing environment, and EOS program management, handling and EOS auditing processing to avoid EOS failures EOS failures in both semiconductor devices, circuits and system Discussion of how to distinguish between EOS events, and electrostatic discharge (ESD) events (e.g. such as human body model (HBM), charged device model (CDM), cable discharge events (CDM), charged board events (CBE), to system level IEC 61000-4-2 test events) EOS protection on-chip design practices and how they differ from ESD protection networks and solutions Discussion of EOS system level concerns in printed circuit boards (PCB), and manufacturing equipment Examples of EOS issues in state-of-the-art digital, analog and power technologies including CMOS, LDMOS, and BCD EOS design rule checking (DRC), LVS, and ERC electronic design automation (EDA) and how it is distinct from ESD EDA systems EOS testing and qualification techniques, and Practical off-chip ESD protection and system level solutions to provide more robust systems Electrical Overstress (EOS): Devices, Circuits and Systems is a continuation of the author's series of books on ESD protection. It is an essential reference and a useful insight into the issues that confront modern technology as we enter the nano-electronic era.

ESD Protection Device and Circuit Design for Advanced CMOS Technologies is intended for practicing engineers working in the areas of circuit design, VLSI reliability and testing domains. As the problems associated with ESD failures and yield losses become significant in the modern semiconductor industry, the demand for graduates with a basic knowledge of ESD is also increasing. Today, there is a significant demand to educate the circuits design and reliability teams on ESD issues. This book makes an attempt to address the ESD design and implementation in a systematic manner. A design procedure involving device simulators as well as circuit simulator is employed to optimize device and circuit parameters for optimal ESD as well as circuit performance. This methodology, described in ESD Protection Device and Circuit Design for Advanced CMOS Technologies has resulted in several successful ESD circuit design with excellent silicon results and demonstrates its strengths.

THE LATEST ANALOG IC DESIGN TECHNIQUES Fully revised and expanded to meet the emerging demands of mixed-signal systems, Analog IC Design with Low-Dropout Regulators, Second Edition, teaches analog IC concepts and explains how to use them to design, analyze, and build linear low-dropout (LDO) regulator ICs with bipolar, CMOS, and biCMOS semiconductor process technologies. The book draws physical insight from topics presented and illustrates how to develop and evaluate analog ICs for today's expanding wireless and mobile markets. Practical examples and end-of-chapter review questions reinforce important concepts and techniques developed in this cutting-edge guide. LEARN HOW TO: Evaluate power-supply systems Predict and specify how linear regulators perform and respond to variations in their supplies, loads, and other working conditions Work with semiconductor devices--resistors, capacitors, diodes, and transistors Combine microelectronic components to design current mirrors, differential pairs, differential amplifiers, linear low-dropout regulators, and their variants Close and stabilize feedback control loops that regulate voltages and currents Design circuits that establish reliable bias currents and reference circuits Determine the small-signal dynamics of analog ICs and analog systems Establish independent, stable, noise-free, and predictable power-supply voltages Implement overcurrent, thermal, reverse-battery, and ESD protection Test, measure, and evaluate linear regulator ICs

A comprehensive and in-depth review of analog circuit layout, schematic architecture, device, power network and ESD design This book will provide a balanced overview of analog circuit design layout, analog circuit schematic development, architecture of chips, and ESD design. It will start at an introductory level and will bring the reader right up to the state-of-the-art. Two critical design aspects for analog and power integrated circuits are combined. The first design aspect covers analog circuit design techniques to achieve the desired circuit performance. The second and main aspect presents the additional challenges associated with the design of adequate and effective ESD protection elements and schemes. A comprehensive list of practical application examples is used to demonstrate the successful combination of both techniques and any potential design trade-offs. Chapter One looks at analog design discipline, including layout and analog matching and analog layout design practices. Chapter Two discusses analog design with circuits, examining: single transistor amplifiers; multi-transistor amplifiers; active loads and more. The third chapter covers analog design layout (also MOSFET layout), before Chapters Four and Five discuss analog design synthesis. The next chapters introduce the reader to analog-digital mixed signal design synthesis, analog signal pin ESD networks, and analog ESD power clamps. Chapter Nine, the last chapter, covers ESD design in analog applications. Clearly describes analog design fundamentals (circuit fundamentals) as well as outlining the various ESD implications Covers a large breadth of subjects and technologies, such as CMOS, LDMOS, BCD, SOI, and thick body SOI Establishes an "ESD analog design" discipline that distinguishes itself from the alternative ESD digital design focus Focuses on circuit and circuit design applications Assessable, with the artwork and tutorial style of the ESD book series PowerPoint slides are available for university faculty members Even in the world of digital circuits, analog and power circuits are two very important but under-addressed topics, especially from the ESD aspect. Dr. Voldman's new book will serve as an essential and practical guide to the greater IC community. With high practical and academic values this book is a "bible" for professionals, graduate students, device and circuit designers for investigating the physics of ESD and for product designs and testing.

As we enter the nanoelectronics era, electrostatic discharge (ESD) phenomena is an important issue for everything from micro-electronics to nanostructures. This book provides insight into the operation and design of micro-gaps and nanogenerators with chapters on low capacitance ESD design in advanced technologies, electrical breakdown in micro-gaps, nanogenerators from ESD, and theoretical prediction and optimization of triboelectric nanogenerators. The information contained herein will prove useful for for engineers and scientists that have an interest in ESD physics and design.

This book enables readers to design effective ESD protection solutions for all mainstream RF fabrication processes (GaAs pHEMT, SiGe HBT, CMOS). The new techniques introduced by the authors have much higher protection levels and much lower parasitic effects than those of existing ESD protection devices. The authors describe in detail the ESD phenomenon, as well as ESD protection fundamentals, standards, test equipment, and basic design strategies. Readers will benefit from realistic case studies of ESD protection for RFICs and will learn to increase significantly modern RFICs' ESD safety level, while maximizing RF performance.

Newnes has worked with Robert Pease, a leader in the field of analog design to select the very best design-specific material that we have to offer. The Newnes portfolio has always been known for its practical no nonsense approach and our design content is in keeping with that tradition. This material has been chosen based on its timeliness and timelessness. Designers will find inspiration between these covers highlighting basic design concepts that can be adapted to today's hottest technology as well as design material specific to what is happening in the field today. As an added bonus the editor of this reference tells you why this is important material to have on hand at all times. A library

must for any design engineers in these fields. *Hand-picked content selected by analog design legend Robert Pease *Proven best design practices for op amps, feedback loops, and all types of filters *Case histories and design examples get you off and running on your current project

With the growth of high-speed telecommunications and wireless technology, it is becoming increasingly important for engineers to understand radio frequency (RF) applications and their sensitivity to electrostatic discharge (ESD) phenomena. This enables the development of ESD design methods for RF technology, leading to increased protection against electrical overstress (EOS) and ESD. ESD: RF Technology and Circuits: Presents methods for co-synthesizing ESD networks for RF applications to achieve improved performance and ESD protection of semiconductor chips; discusses RF ESD design methods of capacitance load transformation, matching network co-synthesis, capacitance shunts, inductive shunts, impedance isolation, load cancellation methods, distributed loads, emitter degeneration, buffering and ballasting; examines ESD protection and design of active and passive elements in RF complementary metal-oxide-semiconductor (CMOS), RF laterally-diffused metal oxide semiconductor (LDMOS), RF BiCMOS Silicon Germanium (SiGe), RF BiCMOS Silicon Germanium Carbon (SiGeC), and Gallium Arsenide technology; gives information on RF ESD testing methodologies, RF degradation effects, and failure mechanisms for devices, circuits and systems; highlights RF ESD mixed-signal design integration of digital, analog and RF circuitry; sets out examples of RF ESD design computer aided design methodologies; covers state-of-the-art RF ESD input circuits, as well as voltage-triggered to RC-triggered ESD power clamps networks in RF technologies, as well as off-chip protection concepts. Following the authors series of books on ESD, this book will be a thorough overview of ESD in RF technology for RF semiconductor chip and ESD engineers. Device and circuit engineers working in the RF domain, and quality, reliability and failure analysis engineers will also find it a valuable reference in the rapidly growing area of RF ESD design. In addition, it will appeal to graduate students in RF microwave technology and RF circuit design.

Design Note Collection, the third book in the Analog Circuit Design series, is a comprehensive volume of applied circuit design solutions, providing elegant and practical design techniques. Design Notes in this volume are focused circuit explanations, easily applied in your own designs. This book includes an extensive power management section, covering switching regulator design, linear regulator design, microprocessor power design, battery management, powering LED lighting, automotive and industrial power design. Other sections span a range of analog design topics, including data conversion, data acquisition, communications interface design, operational amplifier design techniques, filter design, and wireless, RF, communications and network design. Whatever your application -industrial, medical, security, embedded systems, instrumentation, automotive, communications infrastructure, satellite and radar, computers or networking; this book will provide practical design techniques, developed by experts for tackling the challenges of power management, data conversion, signal conditioning and wireless/RF analog circuit design. A rich collection of applied analog circuit design solutions for use in your own designs. Each Design Note is presented in a concise, two-page format, making it easy to read and assimilate. Contributions from the leading lights in analog design, including Bob Dobkin, Jim Williams, George Erdi and Carl Nelson, among others. Extensive sections covering power management, data conversion, signal conditioning, and wireless/RF.

Analog Circuit Design contains the contribution of 18 tutorials of the 14th workshop on Advances in Analog Circuit Design. Each part discusses a specific todote topic on new and valuable design ideas in the area of analog circuit design. Each part is presented by six experts in that field and state of the art information is shared and overviewed. This book is number 14 in this successful series of Analog Circuit Design, providing valuable information and excellent overviews of analog circuit design, CAD and RF systems. Analog Circuit Design is an essential reference source for analog circuit designers and researchers wishing to keep abreast with the latest development in the field. The tutorial coverage also makes it suitable for use in an advanced design course. The operational amplifier ("op amp") is the most versatile and widely used type of analog IC, used in audio and voltage amplifiers, signal conditioners, signal converters, oscillators, and analog computing systems. Almost every electronic device uses at least one op amp. This book is Texas Instruments' complete professional-level tutorial and reference to operational amplifier theory and applications. Among the topics covered are basic op amp physics (including reviews of current and voltage division, Thevenin's theorem, and transistor models), idealized op amp operation and configuration, feedback theory and methods, single and dual supply operation, understanding op amp parameters, minimizing noise in op amp circuits, and practical applications such as instrumentation amplifiers, signal conditioning, oscillators, active filters, load and level conversions, and analog computing. There is also extensive coverage of circuit construction techniques, including circuit board design, grounding, input and output isolation, using decoupling capacitors, and frequency characteristics of passive components. The material in this book is applicable to all op amp ICs from all manufacturers, not just TI. Unlike textbook treatments of op amp theory that tend to focus on idealized op amp models and configuration, this title uses idealized models only when necessary to explain op amp theory. The bulk of this book is on real-world op amps and their applications; considerations such as thermal effects, circuit noise, circuit buffering, selection of appropriate op amps for a given application, and unexpected effects in passive components are all discussed in detail. *Published in conjunction with Texas Instruments *A single volume, professional-level guide to op amp theory and applications *Covers circuit board layout techniques for manufacturing op amp circuits.

This book enables design engineers to be more effective in designing discrete and integrated circuits by helping them understand the role of analog devices in their circuit design. Analog elements are at the heart of many important functions in both discrete and integrated circuits, but from a design perspective the analog components are often the most difficult to understand. Examples include operational amplifiers, D/A and A/D converters and active filters. Effective circuit design requires a strong understanding of the operation of these analog devices and how they affect circuit design. Comprehensive coverage of analog circuit components for the practicing engineer Market-validated design information for all major types of linear circuits Includes practical advice on how to read op amp data sheets and how to choose off-the-shelf op amps Full chapter covering printed circuit board design issues Electrostatic discharge (ESD) continues to impact semiconductor components and systems as technologies scale from micro- to nano-electronics. This book studies electrical overstress, ESD, and latchup from a whole-chip ESD design synthesis approach. It provides a clear insight into the integration of ESD protection networks from a generalist perspective, followed by examples in specific technologies, circuits, and chips. Uniquely both the semiconductor chip integration issues and floorplanning of ESD networks are covered from a 'top-down' design approach. Look inside for extensive coverage on: integration of cores, power bussing, and signal pins in DRAM, SRAM, CMOS image processing chips, microprocessors, analog products, RF components and how the integration influences ESD design and integration architecturing of mixed voltage, mixed signal, to RF design for ESD analysis floorplanning for peripheral and core I/O designs, and the implications on ESD and latchup guard ring integration for both a 'bottom-up' and 'top-down' methodology addressing I/O guard rings, ESD guard rings, I/O to I/O, and I/O to core classification of ESD power clamps and ESD signal pin circuitry, and how to make the correct choice for a given semiconductor chip examples

of ESD design for the state-of-the-art technologies discussed, including CMOS, BiCMOS, silicon on insulator (SOI), bipolar technology, high voltage CMOS (HVCMOS), RF CMOS, and smart power practical methods for the understanding of ESD circuit power distribution, ground rule development, internal bus distribution, current path analysis, quality metrics ESD: Design and Synthesis is a continuation of the author's series of books on ESD protection. It is an essential reference for: ESD, circuit, and semiconductor engineers; design synthesis team leaders; layout design, characterisation, floorplanning, test and reliability engineers; technicians; and groundrule and test site developers in the manufacturing and design of semiconductor chips. It is also useful for graduate and undergraduate students in electrical engineering, semiconductor sciences, and manufacturing sciences, and on courses involving the design of ESD devices, chips and systems. This book offers a useful insight into the issues that confront modern technology as we enter the nano-electronic era.

LNA-ESD Co-Design for Fully Integrated CMOS Wireless Receivers fits in the quest for complete CMOS integration of wireless receiver front-ends. With a combined discussion of both RF and ESD performance, it tackles one of the final obstacles on the road to CMOS integration. The book is conceived as a design guide for those actively involved in the design of CMOS wireless receivers. The book starts with a comprehensive introduction to the performance requirements of low-noise amplifiers in wireless receivers. Several popular topologies are explained and compared with respect to future technology and frequency scaling. The ESD requirements are introduced and related to the state-of-the-art protection devices and circuits. LNA-ESD Co-Design for Fully Integrated CMOS Wireless Receivers provides an extensive theoretical treatment of the performance of CMOS low-noise amplifiers in the presence of ESD-protection circuitry. The influence of the ESD-protection parasitics on noise figure, gain, linearity, and matching are investigated. Several RF-ESD co-design solutions are discussed allowing both high RF-performance and good ESD-immunity for frequencies up to and beyond 5 GHz. Special attention is also paid to the layout of both active and passive components. LNA-ESD Co-Design for Fully Integrated CMOS Wireless Receivers offers the reader intuitive insight in the LNA's behavior, as well as the necessary mathematical background to optimize its performance. All material is experimentally verified with several CMOS implementations, among which a fully integrated GPS receiver front-end. The book is essential reading for RF design engineers and researchers in the field and is also suitable as a text book for an advanced course on the subject.

Focused on the field of knowledge lying between digital and analog circuit theory, this new text will help engineers working with digital systems shorten their product development cycles and help fix their latest design problems. The scope of the material covered includes signal reflection, crosstalk, and noise problems which occur in high speed digital machines (above 10 megahertz). This volume will be of practical use to digital logic designers, staff and senior communications scientists, and all those interested in digital design.

A practical and comprehensive reference that explores Electrostatic Discharge (ESD) in semiconductor components and electronic systems The ESD Handbook offers a comprehensive reference that explores topics relevant to ESD design in semiconductor components and explores ESD in various systems. Electrostatic discharge is a common problem in the semiconductor environment and this reference fills a gap in the literature by discussing ESD protection. Written by a noted expert on the topic, the text offers a topic-by-topic reference that includes illustrative figures, discussions, and drawings. The handbook covers a wide-range of topics including ESD in manufacturing (garments, wrist straps, and shoes); ESD Testing; ESD device physics; ESD semiconductor process effects; ESD failure mechanisms; ESD circuits in different technologies (CMOS, Bipolar, etc.); ESD circuit types (Pin, Power, Pin-to-Pin, etc.); and much more. In addition, the text includes a glossary, index, tables, illustrations, and a variety of case studies. Contains a well-organized reference that provides a quick review on a range of ESD topics Fills the gap in the current literature by providing information from purely scientific and physical aspects to practical applications Offers information in clear and accessible terms Written by the accomplished author of the popular ESD book series Written for technicians, operators, engineers, circuit designers, and failure analysis engineers, The ESD Handbook contains an accessible reference to ESD design and ESD systems.

Praise for CMOS: Circuit Design, Layout, and Simulation Revised Second Edition 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 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 Integrated circuits (ICs) don't always work the first time. Many things can and do go wrong in analog circuit designs. There are a number of common errors that often require costly chip redesign and refabrication, all of which can be avoided when designers are aware of the pitfalls. To realize success, IC designers need a complete toolbox-a toolbox filled not only with a solid background in electronics, design concepts and analysis skills, but also with the most valuable

tool of all: experience. Analog BiCMOS Design offers IC design engineers the learning equivalent to decades of practical experience. Culled from the careers of practicing engineers, it presents the most effective methods and the pitfalls most frequently encountered in the design of biCMOS integrated circuits. Accessible to anyone who has taken a course in electronics, this book covers the basic design of bandgap voltage references, current mirrors, amplifiers, and comparators. It reviews common design errors often overlooked and offers design techniques used to remedy those problems. With its complete coverage of basic circuit building blocks, full details of common design pitfalls, and a compendium of design and layout problems and solutions, Analog BiCMOS Design is the perfect reference for IC designers and engineers, fledgling and experienced alike. Read it to reinforce your background, browse it for ideas on avoiding pitfalls, and when you run into a problem, use it to find a solution.

This Book and Simulation Software Bundle Project Dear Reader, this book project brings to you a unique study tool for ESD protection solutions used in analog-integrated circuit (IC) design. Quick-start learning is combined with in-depth understanding for the whole spectrum of cross-disciplinary knowledge required to excel in the ESD field. The chapters cover technical material from elementary semiconductor structure and device levels up to complex analog circuit design examples and case studies. The book project provides two different options for learning the material. The printed material can be studied as any regular technical textbook. At the same time, another option adds parallel exercise using the trial version of a complementary commercial simulation tool with prepared simulation examples. Combination of the textbook material with numerical simulation experience presents a unique opportunity to gain a level of expertise that is hard to achieve otherwise. The book is bundled with simplified trial version of commercial mixed-mode simulation software from Angstrom Design Automation. The DECIMM (Device Circuit Mixed-Mode) simulator tool and complementary to the book simulation examples can be downloaded from www.analogesd.com. The simulation examples prepared by the authors support the specific examples discussed across the book chapters. A key idea behind this project is to provide an opportunity to not only study the book material but also gain a much deeper understanding of the subject by direct experience through practical simulation examples.

This comprehensive and insightful book discusses ESD protection circuit design problems from an IC designer's perspective. On-Chip ESD Protection for Integrated Circuits: An IC Design Perspective provides both fundamental and advanced materials needed by a circuit designer for designing ESD protection circuits, including: Testing models and standards adopted by U.S. Department of Defense, EIA/JEDEC, ESD Association, Automotive Electronics Council, International Electrotechnical Commission, etc. ESD failure analysis, protection devices, and protection of sub-circuits Whole-chip ESD protection and ESD-to-circuit interactions Advanced low-parasitic compact ESD protection structures for RF and mixed-signal IC's Mixed-mode ESD simulation-design methodologies for design prediction ESD-to-circuit interactions, and more! Many real world ESD protection circuit design examples are provided. The book can be used as a reference book for working IC designers and as a textbook for students in the IC design field.

Mixed-Signal Circuits offers a thoroughly modern treatment of integrated circuit design in the context of mixed-signal applications. Featuring chapters authored by leading experts from industry and academia, this book: Discusses signal integrity and large-scale simulation, verification, and testing Demonstrates advanced design techniques that enable digital circuits and sensitive analog circuits to coexist without any compromise Describes the process technology needed to address the performance challenges associated with developing complex mixed-signal circuits Deals with modeling topics, such as reliability, variability, and crosstalk, that define pre-silicon design methodology and trends, and are the focus of companies involved in wireless applications Develops methods to move analog into the digital domain quickly, minimizing and eliminating common trade-offs between performance, power consumption, simulation time, verification, size, and cost Details approaches for very low-power performances, high-speed interfaces, phase-locked loops (PLLs), voltage-controlled oscillators (VCOs), analog-to-digital converters (ADCs), and biomedical filters Delineates the respective parts of a full system-on-chip (SoC), from the digital parts to the baseband blocks, radio frequency (RF) circuitries, electrostatic-discharge (ESD) structures, and built-in self-test (BIST) architectures Mixed-Signal Circuits explores exciting opportunities in wireless communications and beyond. The book is a must for anyone involved in mixed-signal circuit design for future technologies.

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.

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 challenged to develop sophisticated analog solutions. This comprehensive source book of circuit design solutions will aid systems designers with elegant and practical design techniques that focus on common circuit design 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. Covers the fundamentals of linear/analog circuit and system design to guide engineers with their design challenges Based on the Application Notes of Linear Technology, the foremost designer of high performance analog products, readers will gain practical insights into design techniques and practice Broad range of topics, including power management tutorials, switching regulator design, linear regulator design, data conversion, signal conditioning, and high frequency/RF design Contributors include the leading lights in analog design, Robert Dobkin, Jim Williams and Carl Nelson, among others Analog Circuit Design contains the contribution of 18 experts from the 13th International Workshop on Advances in Analog Circuit Design. It is number 13 in the successful series of Analog Circuit Design. It provides 18 excellent overviews of analog circuit design in: Sensor and Actuator Interfaces, Integrated High-Voltage Electronics and Power Management, and Low-Power and High-Resolution ADC's. Analog Circuit Design is an essential reference source for analog circuits designers and researchers wishing to keep abreast with the latest developments in the field. The tutorial coverage also makes it suitable for use in an advanced design course.

The purpose of this book is to provide a complete working knowledge of the Complementary Metal-Oxide Semiconductor (CMOS) analog and mixed-signal circuit design, which can be applied for System on Chip (SOC) or Application-Specific Standard Product (ASSP) development. It begins with an introduction to the CMOS analog and mixed-signal circuit design with further coverage of basic devices, such as the Metal-Oxide Semiconductor Field-Effect Transistor (MOSFET) with both long- and short-channel operations, photo devices, fitting ratio, etc. Seven chapters focus on the CMOS analog and mixed-signal circuit design of amplifiers, low power amplifiers, voltage regulator-reference, data converters, dynamic analog circuits, color and image sensors, and peripheral (oscillators and Input/Output [I/O]) circuits, and Integrated Circuit (IC) layout and packaging. Features: Provides practical knowledge of CMOS analog and mixed-signal circuit design Includes recent research in CMOS color and image sensor technology Discusses sub-blocks of typical analog and mixed-signal IC products Illustrates several design examples of analog circuits together with layout Describes integrating based CMOS color circuit

Electrostatic discharge (ESD) is one of the most prevalent threats to electronic components. In an ESD event, a finite amount of charge is transferred from one object (i.e., human body) to another (i.e., microchip). This process can result in a very high current passing through the microchip within a very short period of time. Thus, more than 35 percent of single-event chip damages can be attributed to ESD events, and designing ESD structures to protect integrated circuits against the ESD stresses is a high priority in the semiconductor industry. Electrostatic Discharge Protection: Advances and Applications delivers timely coverage of component- and system-level ESD protection for semiconductor devices and integrated circuits. Bringing together contributions from internationally respected researchers and engineers with expertise in ESD design, optimization, modeling, simulation, and characterization, this book bridges the gap between theory and practice to offer valuable insight into the state of the art of ESD protection. Amply illustrated with tables, figures, and case studies, the text: Instills a deeper understanding of ESD events and ESD protection design principles Examines vital processes including Si CMOS, Si BCD, Si SOI, and GaN technologies Addresses important aspects pertinent to the modeling and simulation of ESD protection solutions Electrostatic Discharge Protection: Advances and Applications provides a single source for cutting-edge information vital to the research and development of effective, robust ESD protection solutions for semiconductor devices and integrated circuits.

Operational Amplifier Speed and Accuracy Improvement proposes a new methodology for the design of analog integrated circuits. The usefulness of this methodology is demonstrated through the design of an operational amplifier. This methodology consists of the following iterative steps: description of the circuit functionality at a high level of abstraction using signal flow graphs; equivalent transformations and modifications of the graph to the form where all important parameters are controlled by dedicated feedback loops; and implementation of the structure using a library of elementary cells. Operational Amplifier Speed and Accuracy Improvement shows how to choose structures and design circuits which improve an operational amplifier's important parameters such as speed to power ratio, open loop gain, common-mode voltage rejection ratio, and power supply rejection ratio. The same approach is used to design clamps and limiting circuits which improve the performance of the amplifier outside of its linear operating region, such as slew rate enhancement, output short circuit current limitation, and input overload recovery.

This book introduces a new approach to model and predict substrate parasitic failures in integrated circuits with standard circuit design tools. The injection of majority and minority carriers in the substrate is a recurring problem in smart power ICs containing high voltage, high current switching devices besides sensitive control, protection and signal processing circuits. The injection of parasitic charges leads to the activation of substrate bipolar transistors. This book explores how these events can be evaluated for a wide range of circuit topologies. To this purpose, new generalized devices implemented in Verilog-A are used to model the substrate with standard circuit simulators. This approach was able to predict for the first time the activation of a latch-up in real circuits through post-layout SPICE simulation analysis. Discusses substrate modeling and circuit-level simulation of parasitic bipolar device coupling effects in integrated circuits; Includes circuit back-annotation of the parasitic lateral n-p-n and vertical p-n-p bipolar transistors in the substrate; Uses Spice for simulation and characterization of parasitic bipolar transistors, latch-up of the parasitic p-n-p-n structure, and electrostatic discharge (ESD) protection devices; Offers design guidelines to reduce couplings by adding specific protections.

This book provides an approach toward the applications and principle theory of digital signal processing in modern intelligent systems, biological engineering, telecommunication, and information technology. Assuming the reader already has prior knowledge of signal processing theory, this book will be useful for finding novel methods that fit special needs in digital signal processing (DSP). The combination of signal processing and intelligent systems in hybrid structures rather than serial or parallel processing provide the best mechanism that is a better fit with the comprehensive nature of human. This book is a practical reference that places the emphasis on principles and applications of DSP in digital systems. It covers a broad area of digital systems and applications of machine learning methods including convolutional neural networks, evolutionary algorithms, adaptive

filters, spectral estimation, data compression and functional verification. The level of the book is ideal for professional DSP users and useful for graduate students who are looking for solutions to their design problems. The theoretical principles provide the required base for comprehension of the methods and application of modifications for the special needs of practical projects. This volume concentrates on three topics: mixed analog--digital circuit design, sensor interface circuits and communication circuits. The book comprises six papers on each topic of a tutorial nature aimed at improving the design of analog circuits. The book is divided into three parts. Part I: Mixed Analog--Digital Circuit Design considers the largest growth area in microelectronics. Both standard designs and ASICs have begun integrating analog cells and digital sections on the same chip. The papers cover topics such as groundbounce and supply-line spikes, design methodologies for high-level design and actual mixed analog--digital designs. Part II: Sensor Interface Circuits describes various types of signal conditioning circuits and interfaces for sensors. These include interface solutions for capacitive sensors, sigma--delta modulation used to combine a microprocessor compatible interface with on chip CMOS sensors, injectable sensors and responders, signal conditioning circuits and sensors combined with indirect converters. Part III: Communication Circuits concentrates on systems and implemented circuits for use in personal communication systems. These have applications in cordless telephones and mobile telephone systems for use in cellular networks. A major requirement for these systems is low power consumption, especially when operating in standby mode, so as to maximise the time between battery recharges.

This book deals with the analysis and design of CMOS current-mode circuits for data communications. CMOS current-mode sampled-data networks, i.e. switched-current circuits, are excluded. Major subjects covered in the book include: a critical comparison of voltage-mode and current-mode circuits; the building blocks of current-mode circuits: design techniques; modeling of wire channels, electrical signaling for Gbps data communications; ESD protection for current-mode circuits and more. This book will appeal to IC design engineers, hardware system engineers and others.

Number 12 in the successful series of Analog Circuit Design provides valuable information and excellent overviews of analogue circuit design, CAD and RF systems. The series is an ideal reference for those involved in analogue and mixed-signal design.

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

A comprehensive and in-depth review of analog circuit layout, schematic architecture, device, power network and ESD design. This book will provide a balanced overview of analog circuit design layout, analog circuit schematic development, architecture of chips, and ESD design. It will start at an introductory level and will bring the reader right up to the state-of-the-art. Two critical design aspects for analog and power integrated circuits are combined. The first design aspect covers analog circuit design techniques to achieve the desired circuit performance. The second and main aspect presents the additional challenges associated with the design of adequate and effective ESD protection elements and schemes. A comprehensive list of practical application examples is used to demonstrate the successful combination of both techniques and any potential design trade-offs. Chapter One looks at analog design discipline, including layout and analog matching and analog layout design practices. Chapter Two discusses analog design with circuits, examining: single transistor amplifiers; multi-transistor amplifiers; active loads and more. The third chapter covers analog design layout (also MOSFET layout), before Chapters Four and Five discuss analog design synthesis. The next chapters introduce the reader to analog-digital mixed signal design synthesis, analog signal pin ESD networks, and analog ESD power clamps. Chapter Nine, the last chapter, covers ESD design in analog applications. Clearly describes analog design fundamentals (circuit fundamentals) as well as outlining the various ESD implications. Covers a large breadth of subjects and technologies, such as CMOS, LDMOS, BCD, SOI, and thick body SOI. Establishes an "ESD analog design" discipline that distinguishes itself from the alternative ESD digital design focus. Focuses on circuit and circuit design applications. Assessable, with the artwork and tutorial style of the ESD book series. PowerPoint slides are available for university faculty members. Even in the world of digital circuits, analog and power circuits are two very important but under-addressed topics, especially from the ESD aspect. Dr. Voldman's new book will serve as an essential and practical guide to the greater IC community. With high practical and academic values this book is a "bible" for professionals, graduate students, device and circuit designers for investigating the physics of ESD and for product designs and testing.

This book addresses key aspects of analog integrated circuits and systems design related to system level electrostatic discharge (ESD) protection. It is an invaluable reference for anyone developing systems-on-chip (SoC) and systems-on-package (SoP), integrated with system-level ESD protection. The book focuses on both the design of semiconductor integrated circuit (IC) components with embedded, on-chip system level protection and IC-system co-design. The readers will be enabled to bring the system level ESD protection solutions to the level of integrated circuits, thereby reducing or completely eliminating the need for additional, discrete components on the printed circuit board (PCB) and meeting system-level ESD requirements. The authors take a systematic approach, based on IC-system ESD protection co-design. A detailed description of the available IC-level ESD testing methods is provided, together with a discussion of the correlation between IC-level and system-level ESD testing methods. The IC-level ESD protection design is demonstrated with representative case studies which are analyzed with various numerical simulations and ESD testing. The overall methodology for IC-system ESD co-design is presented as a step-by-step procedure that involves both ESD testing and numerical simulations.

Based on the authors' expansive collection of notes taken over the years, Nano-CMOS Circuit and Physical Design bridges the gap between physical and circuit design and fabrication processing, manufacturability, and yield. This innovative book covers: process technology, including sub-wavelength optical lithography; impact of process scaling on circuit and physical implementation and low power with leaky transistors; and DFM, yield, and the impact of physical implementation.

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