Esd Design For Analog Circuits

Electrical Overstress (EOS) continues to impact semiconductor manufacturing, semiconductor components and systems as technologies scale from micro- to nano-electronics. This bookteaches 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

Page 1/37

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.

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) 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.

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-synthesizisng 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 Gallim 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 are of RF ESD design. In addition, it will appeal to graduate students in RF microwave technology and RF circuit design.

Circuit Design, Layout, and Simulation
Op Amps for Everyone
Circuit Design for RF Transceivers
Analog Circuits and Design
Parasitic Substrate Coupling in High Voltage Integrated Circuits
Design Reference

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. 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. 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.
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.

CMOS Current-Mode Circuits for Data Communications

Mixed A/D Circuit Design, Sensor Interface Circuits and Communication Circuits

CMOS

The Art and Science of Analog Circuit Design

High Temperature Electronics

This volume presents an integrated treatment of ESD, I/O, and process parameter interactions that both I/O designers and process designers can use. It examines key factors in I/O and ESD

design and testing, and helps the reader consider ESD and reliability issues up front when making I/O choices. Emphasizing clarity and simplicity, this book focuses on design principles that can be applied widely as this dynamic field continues to evolve.

The development of electronics that can operate at high temperatures has been identified as a critical technology for the next century. Increasingly, engineers will be called upon to design avionics, automotive, and geophysical electronic systems requiring components and packaging reliable to 200 °C and beyond. Until now, however, they have had no single resource on high temperature electronics to assist them. Such a resource is critically needed, since the design and manufacture of electronic components have now made it possible to design electronic systems that will operate reliably above the traditional temperature limit of 125 °C. However, successful system development efforts hinge on a firm understanding of the fundamentals of semiconductor physics and device processing, materials selection, package design, and thermal management, together with a knowledge of the intended application environments. High Temperature Electronics brings

together this essential information and presents it for the first time in a unified way. Packaging and device engineers and technologists will find this book required reading for its coverage of the techniques and tradeoffs involved in materials selection, design, and thermal management and for its presentation of best design practices using actual fielded systems as examples. In addition, professors and students will find this book suitable for graduate-level courses because of its detailed level of explanation and its coverage of fundamental scientific concepts. Experts from the field of high temperature electronics have contributed to nine chapters covering topics ranging from semiconductor device selection to testing and final assembly.

ESDAnalog Circuits and DesignJohn Wiley & Sons

This textbook deals with the analysis and design of analog CMOS integrated circuits, emphasizing recent technological developments and design paradigms that students and practicing engineers need to master to succeed in today's industry. Based on the author's teaching and research experience in the past ten years, the text follows three general principles:

(1) Motivate the reader by describing the significance and application of each idea with real-world problems; (2) Force the reader to look at concepts from an intuitive point of view, preparing him/her for more complex problems; (3) Complement the intuition by rigorous analysis, confirming the results obtained by the intuitive, yet rough approach.
Circuits and Devices
Electrostatic Discharge Protection
Design Note Collection
From Semiconductor Manufacturing to Product Use
An IC Design Perspective
On the Analysis, Design, and Modeling of Electrostatic Discharge Protection Devices for Analog and Radio-frequency Integrated Circuits

An authoritative single-volume reference on the design and testing of electrostatic discharge (ESD) structures Electrostatic discharge (ESD) is a serious challenge to the reliability of semiconductors, integrated circuits (ICs), and microelectronic systems—on-chip ESD protection is a vital component of smartphones, laptops, tablets, and other electronic devices. Practical ESD Protection Design provides comprehensive and systematic guidance on all major aspects of on-chip ESD protection for integrated circuits (ICs). Written for students and

**practicing engineers alike, this one-stop
resource covers essential theories, hands-on
design skills, computer-aided design (CAD)
methods, ESD failure testing and analysis,
and more. Detailed chapters examine an array
of topics ranging from fundamental to
advanced, including ESD phenomena, ESD
protection devices and circuits, ESD design
layout and technology effects, emerging ESD
protection designs, and circuit simulation
modelling. Based on the author's decades of
design, teaching, and research experience,
Practical ESD Protection Design: Features
numerous real-world examples of electrostatic
discharge (ESD) protection designs and skills
Describes the design methodology for high-
performance mixed-signal ICs and broadband
radio-frequency (RF) ICs Discusses CAD-based
ESD protection design using existing tools
such as Technology Computer-Aided Design
(TCAD) and SPICE simulation Addresses new ESD
CAD algorithms and tools for full-chip ESD
physical design verification Explores the
disruptive future outlook of ESD protection
Practical ESD Protection Design is a valuable
reference for industrial engineers and
academic researchers in the field, and an
excellent textbook for electronic engineering
courses in semiconductor microelectronics and
integrated circuit design.
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.

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 Assessible, 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.
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.
Mixed-Signal Circuits
Electrical Overstress (EOS)
ESD Design for Analog Circuits
CMOS Analog and Mixed-Signal Circuit Design
Digital Systems
Analog Circuit Design
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.
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 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.

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.

Analog Circuit Design with Structural Methodology

ESD

Low-Voltage SOI CMOS VLSI Devices and Circuits

EMC of Analog Integrated Circuits

Analog Circuit Design Volume Three

Devices, Circuits and Systems

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

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.

Praise for CMOS: Circuit Design, Layout, and SimulationRevised 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 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.

On-Chip ESD Protection for Integrated Circuits

ESD in Silicon Integrated Circuits
LNA-ESD Co-Design for Fully Integrated CMOS
Wireless Receivers
Edn Series for Design Engineers
ESD Basics
Fractional-N Synthesizers, Design for Robustness, Line
and Bus Drivers

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.

"Electrostatic discharge (ESD)"--Page xxi.
Electrostatic discharge (ESD) continues to impact semiconductormanufacturing, semiconductor components and systems, astechnologies scale from micro- to nano electronics. This bookintroduces the fundamentals of ESD, electrical overstress (EOS),electromagnetic interference (EMI), electromagnetic compatibility(EMC), and latchup, as well as provides a coherent overview of thesemiconductor manufacturing environment and the final systemassembly. It provides an illuminating look into the integration ofESD protection networks followed by examples in specifictechnologies, circuits, and chips. The text is unique in covering semiconductor chip manufacturingissues, ESD semiconductor chip design, and system problemsconfronted today as well as the future of ESD phenomena andnano-technology. Look inside for extensive coverage on: The fundamentals of electrostatics, triboelectric charging, andhow they relate to present day manufacturing environments ofmicro-electronics to nano-technology Semiconductor manufacturing handling and auditing processing toavoid ESD failures ESD, EOS, EMI, EMC, and

latchup semiconductor component andsystem level testing to demonstrate product resilience from humanbody model (HBM), transmission line pulse (TLP), charged devicemodel (CDM), human metal model (HMM), cable discharge events (CDE),to system level IEC 61000-4-2 tests ESD on-chip design and process manufacturing practices andsolutions to improve ESD semiconductor chip solutions, alsopractical off-chip ESD protection and system level solutions toprovide more robust systems System level concerns in servers, laptops, disk drives, cellphones, digital cameras, hand held devices, automobiles, and spaceapplications Examples of ESD design for state-of-the-art technologies,including CMOS, BiCMOS, SOI, bipolar technology, high voltage CMOS(HVCMOS), RF CMOS, smart power, magnetic recording technology,micro-machines (MEMs) to nano-structures ESD Basics: From Semiconductor Manufacturing to ProductUse complements the author's series of books on ESDprotection. For those new to the field, it is an essentialreference and a useful insight into the issues that confront moderntechnology as we enter the Nano-electronic Era.

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.

System Level ESD Protection

Analog BiCMOS Design

RF Technology and Circuits

The ESD Handbook

Operational Amplifier Speed and Accuracy Improvement

Practices and Pitfalls

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 cro- disciplinary knowledge required to

excel in the ESD ?eld. 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 parall 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 simpli?ed trial version of commercial mixed- TM mode simulation software from Angstrom Design Automation. The DECIMM (Device Circuit Mixed-Mode) simulator tool and complementary to the book s- ulation examples ca be downloaded from www.analogesd.com. The simulation examples prepared by the authors support t speci?c examples discussed across the book chapters. key idea behind this project is to provide an opportunit to not only study the book material but also gain a mu deeper understanding of the subject by direct experien through practical simulation examples.

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 know for its practical no nonsense approach and our design content is in keepin

with that tradition. This material has been chosen base
on its timeliness and timelessness. Designers will find
inspiration between these covers highlighting basic
design concepts that can be adapted to today's hottes
technology as well as design material specific to what
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 fo
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 desigr
examples get you off and running on your current
project

Environmental electromagnetic pollution has drastically
increased over the last decades. The omnipresence of
communication systems, various electronic appliances
and the use of ever increasing frequencies, all contribu
to a noisy electromagnetic environment which acts
detrimentally on sensitive electronic equipment.
Integrated circuits must be able to operate satisfactor
while cohabiting harmoniously in the same appliance,
and not generate intolerable levels of electromagnetic
emission, while maintaining a sound immunity to
potential electromagnetic disturbances: analog
integrated circuits are in particular more easily
disturbed than their digital counterparts, since they do
have the benefit of dealing with predefined levels
ensuring an innate immunity to disturbances. The

objective of the research domain presented in EMC of Analog Integrated Circuits is to improve the electromagnetic immunity of considered analog integrated circuits, so that they start to fail at relevant higher conduction levels than before. A practical, comprehensive survey of SOI CMOS devices and circuitsfor microelectronics engineers The microelectronics industry is becoming increasingly dependent onSOI CMOS VLSI devices and circuits. This book is the first toaddress this important topic with a practical focus on devices andcircuits. It provides an up-to-date survey of the current knowledgeregarding SOI device behaviors and describes state-of-the-artlow-voltage CMOS VLSI analog and digital circuit techniques. Low-Voltage SOI CMOS VLSI Devices and Circuits covers the entirefield, from basic concepts to most advanced ideas. Topicsinclude: * SOI device behavior: fundamental and floating body effects, hotcarrier effects, sensitivity, reliability, self-heating, breakdown,ESD, dual-gate devices, accumulation-mode devices, short channeleffects, and narrow channel effects * Low-voltage SOI digital circuits: floating body effects, DRAM,SRAM, static logic, dynamic logic, gate array, CPU, frequencydivider, and DSP * Low-voltage SOI analog circuits: op amps, filters, ADC/DAC,sigma-delta modulators, RF circuits, VCO, mixers, low-noiseamplifiers, and high-temperature circuits With over 3OO references to the state of the art and over 3OOimportant figures on low-voltage SOI CMOS devices

and circuits,this volume serves as an authoritative,
reliable resource forengineers designing these circuits i
high-tech industries.

Design of Analog CMOS Integrated Circuits
Troubleshooting Analog Circuits
Advances and Applications
Analog Circuits
Practical ESD Protection Design
Practices and Innovations

**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. 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.

Troubleshooting Analog Circuits is a guidebook for solving product or process related problems in analog circuits. The book also provides advice in selecting equipment, preventing problems, and general tips. The coverage of the book includes the philosophy of troubleshooting; the modes of failure of various components; and preventive measures. The text also deals with the active components of analog circuits, including diodes and rectifiers, optically coupled devices, solar cells, and batteries. The book will be of great use to both students and practitioners of electronics engineering. Other professionals dealing with electronics will also benefit from the text, such as electric technicians.

* Examines the various methods available for

circuit protection, including coverage of the newly developed ESD circuit protection schemes for VLSI circuits. * Provides guidance on the implementation of circuit protection measures. * Includes new sections on ESD design rules, layout approaches, package effects, and circuit concepts. * Reviews the new Charged Device Model (CDM) test method and evaluates design requirements necessary for circuit protection.
Nano-CMOS Circuit and Physical Design
Design and Synthesis
Basic ESD and I/O Design
Minority and Majority Carriers Propagation in Semiconductor Substrate

Applicable for bookstore catalogue
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.