

Manjul Bhushan
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Microelectronic Test Structures for CMOS Technology

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Steven H. Voldman



Microelectronic Test Structures For Cmos Technology:

Microelectronic Test Structures for CMOS Technology Manjul Bhushan, Mark B. Ketchen, 2011-08-26 *Microelectronic Test Structures for CMOS Technology and Products* addresses the basic concepts of the design of test structures for incorporation within test vehicles scribe lines and CMOS products The role of test structures in the development and monitoring of CMOS technologies and products has become ever more important with the increased cost and complexity of development and manufacturing In this timely volume IBM scientists Manjul Bhushan and Mark Ketchen emphasize high speed characterization techniques for digital CMOS circuit applications and bridging between circuit performance and characteristics of MOSFETs and other circuit elements Detailed examples are presented throughout many of which are equally applicable to other microelectronic technologies as well The authors overarching goal is to provide students and technology practitioners alike a practical guide to the disciplined design and use of test structures that give unambiguous information on the parametrics and performance of digital CMOS technology CMOS Test and Evaluation Manjul Bhushan, Mark B. Ketchen, 2014-12-03 *CMOS Test and Evaluation A Physical Perspective* is a single source for an integrated view of test and data analysis methodology for CMOS products covering circuit sensitivities to MOSFET characteristics impact of silicon technology process variability applications of embedded test structures and sensors product yield and reliability over the lifetime of the product This book also covers statistical data analysis and visualization techniques test equipment and CMOS product specifications and examines product behavior over its full voltage temperature and frequency range *Tradeoffs and Optimization in Analog CMOS Design* David Binkley, 2008-09-15 Analog CMOS integrated circuits are in widespread use for communications entertainment multimedia biomedical and many other applications that interface with the physical world Although analog CMOS design is greatly complicated by the design choices of drain current channel width and channel length present for every MOS device in a circuit these design choices afford significant opportunities for optimizing circuit performance This book addresses tradeoffs and optimization of device and circuit performance for selections of the drain current inversion coefficient and channel length where channel width is implicitly considered The inversion coefficient is used as a technology independent measure of MOS inversion that permits design freely in weak moderate and strong inversion This book details the significant performance tradeoffs available in analog CMOS design and guides the designer towards optimum design by describing An interpretation of MOS modeling for the analog designer motivated by the EKV MOS model using tabulated hand expressions and figures that give performance and tradeoffs for the design choices of drain current inversion coefficient and channel length performance includes effective gate source bias and drain source saturation voltages transconductance efficiency transconductance distortion normalized drain source conductance capacitances gain and bandwidth measures thermal and flicker noise mismatch and gate and drain leakage current Measured data that validates the inclusion of important small geometry effects like velocity saturation vertical field

mobility reduction drain induced barrier lowering and inversion level increases in gate referred flicker noise voltage In depth treatment of moderate inversion which offers low bias compliance voltages high transconductance efficiency and good immunity to velocity saturation effects for circuits designed in modern low voltage processes Fabricated design examples that include operational transconductance amplifiers optimized for various tradeoffs in DC and AC performance and micropower low noise preamplifiers optimized for minimum thermal and flicker noise A design spreadsheet available at the book web site that facilitates rapid optimum design of MOS devices and circuits Tradeoffs and Optimization in Analog CMOS Design is the first book dedicated to this important topic It will help practicing analog circuit designers and advanced students of electrical engineering build design intuition rapidly optimize circuit performance during initial design and minimize trial and error circuit simulations

The ESD Handbook Steven H. Voldman, 2021-03-02 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

Matching Properties of Deep Sub-Micron MOS Transistors
Jeroen A. Croon, Willy M Sansen, Herman E. Maes, 2006-06-20 Matching Properties of Deep Sub Micron MOS Transistors examines this interesting phenomenon Microscopic fluctuations cause stochastic parameter fluctuations that affect the accuracy of the MOSFET For analog circuits this determines the trade off between speed power accuracy and yield Furthermore due to the down scaling of device dimensions transistor mismatch has an increasing impact on digital circuits The matching properties of MOSFETs are studied at several levels of abstraction A simple and physics based model is presented that accurately describes the mismatch in the drain current The model is illustrated by dimensioning the unit current cell of a current steering D A converter The most commonly used methods to extract the matching properties of a technology are bench marked with respect to model accuracy measurement accuracy and speed and physical contents of the

extracted parameters The physical origins of microscopic fluctuations and how they affect MOSFET operation are investigated This leads to a refinement of the generally applied 1 area law In addition the analysis of simple transistor models highlights the physical mechanisms that dominate the fluctuations in the drain current and transconductance The impact of process parameters on the matching properties is discussed The impact of gate line edge roughness is investigated which is considered to be one of the roadblocks to the further down scaling of the MOS transistor Matching Properties of Deep Sub Micron MOS Transistors is aimed at device physicists characterization engineers technology designers circuit designers or anybody else interested in the stochastic properties of the MOSFET

SOC Design Methodologies Michel Robert, Bruno Rouzeyre, Christian Pigué, Marie-Lise Flottes, 2013-03-15 The 11 th IFIP International Conference on Very Large Scale Integration in Montpellier France December 3 5 2001 was a great success The main focus was about IP Cores Circuits and System Designs 55 years ago in late 1947 the transistor was invented and everybody knows that it was by William Shockley John Bardeen and Walter H Brattain Bell Telephone Laboratories which received the Nobel Prize in Physics in 1956 Probably everybody thinks that it was recognized immediately as a major invention

RF and Time-domain Techniques for Evaluating Novel Semiconductor Transistors Keith A. Jenkins, 2021-12-15 This book presents a variety of techniques using high frequency RF and time domain measurements to understand the electrical performance of novel modern transistors made of materials such as graphene carbon nanotubes and silicon on insulator and using new transistor structures The author explains how to use conventional RF and time domain measurements to characterize the performance of the transistors In addition he explains how novel transistors may be subject to effects such as self heating period dependent output non linearity susceptibility to short term degradation DC invisible structural defects and a different response to DC and transient inputs Readers will understand that in order to fully understand and characterize the behavior of a novel transistor there is an arsenal of dynamic techniques available In addition to abstract concepts the reader will learn of practical tips required to achieve meaningful measurements and will understand the relationship between these measurements and traditional conventional DC characteristics

ESD Steven H. Voldman, 2011-04-04 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

Measurement, Instrumentation, and Sensors Handbook John G. Webster, Halit Eren, 2017-12-19 The Second Edition of the bestselling Measurement Instrumentation and Sensors Handbook brings together all aspects of the design and implementation of measurement instrumentation and sensors Reflecting the current state of the art it describes the use of instruments and techniques for performing practical measurements in engineering physics chemistry and the life sciences and discusses processing systems automatic data acquisition reduction and analysis operation characteristics accuracy errors calibrations and the incorporation of standards for control purposes Organized according to measurement problem the Electromagnetic Optical Radiation Chemical and Biomedical Measurement volume of the Second Edition Contains contributions from field experts new chapters and updates to all 98 existing chapters Covers sensors and sensor technology time and frequency signal processing displays and recorders and optical medical biomedical health environmental electrical electromagnetic and chemical variables A concise and useful reference for engineers scientists academic faculty students designers managers and industry professionals involved in instrumentation and measurement research and development Measurement Instrumentation and Sensors Handbook Second Edition Electromagnetic Optical Radiation Chemical and Biomedical Measurement provides readers with a greater understanding of advanced applications *Functional Nanostructures and Sensors for CBRN Defence and Environmental Safety and Security* Anatolie Sidorenko, Horst Hahn, 2020-03-17 Over the last decade techniques for materials preparation and processing at nanometer scale have advanced rapidly leading to the introduction of novel principles for a new generation of sensors and detectors At the same time the chemical industry transport and agriculture produce huge amounts of dangerous waste gases and liquids leading to soil air and water contamination One more modern threat international terrorism demands that scientists make efforts to apply new principles and technologies to protect society against chemical biological radiological and nuclear CBRN attacks

and to develop novel effective technologies for the remediation of large contaminated areas Accordingly the main goal of this book is to bring together experts theorists experimentalists engineers and technologists for an extensive discussion covering novel principles for functional nanostructures and detector fabrication and implementation the development of novel technologies for the deactivation of CBRN agents their experimental realization and their application in novel monitoring and control systems and technological processes for soil and water remediation with a view to environmental protection and defence against CBRN based terrorism In keeping with the book s main goal the following topics are highlighted and discussed Sensors and detectors detection of chemicals principles of artificial nose and chemical micro lab on a chip design surface and underground water quality monitoring systems molecular electronics superconducting electronic devices quantum detectors and Qubits Environmental protection and CBRN detection of infrared microwave X ray and terahertz radiation Principles for novel IR UV and Terahertz wave devices for the detection of low contrast objects Novel technological processes for CBRN destruction and deactivation All these topics are strongly interrelated both with regard to fundamental aspects and to fabrication and implementation technologies in addition they are highly promising for application in novel functional devices computer logics sensing and detection of low concentration chemicals weak and extremely weak magnetic and microwave fields infrared and ultraviolet radiation Given its scope the book will be a useful and interesting guide for a broad readership of engineers scientists PhD students and experts in the area of defence against environmental terrorism

Measurement, Instrumentation, and Sensors Handbook, Second Edition John G. Webster, Halit Eren, 2014-02-03 The Second Edition of the bestselling Measurement Instrumentation and Sensors Handbook brings together all aspects of the design and implementation of measurement instrumentation and sensors Reflecting the current state of the art it describes the use of instruments and techniques for performing practical measurements in engineering physics chemistry and the life sciences and discusses processing systems automatic data acquisition reduction and analysis operation characteristics accuracy errors calibrations and the incorporation of standards for control purposes Organized according to measurement problem the Electromagnetic Optical Radiation Chemical and Biomedical Measurement volume of the Second Edition Contains contributions from field experts new chapters and updates to all 98 existing chapters Covers sensors and sensor technology time and frequency signal processing displays and recorders and optical medical biomedical health environmental electrical electromagnetic and chemical variables A concise and useful reference for engineers scientists academic faculty students designers managers and industry professionals involved in instrumentation and measurement research and development Measurement Instrumentation and Sensors Handbook Second Edition Electromagnetic Optical Radiation Chemical and Biomedical Measurement provides readers with a greater understanding of advanced applications

Microelectronics Manufacturing Diagnostics Handbook Abraham Landzberg, 2012-12-06 The world of microelectronics is filled with cusses measurement systems manufacturing many success stories From the use of semi control

techniques test diagnostics and failure analysis It discusses methods for modeling conductors for powerful desktop computers to their use in maintaining optimum engine performance and reducing defects and for preventing performance in modern automobiles they have defects in the first place The approach described clearly improved our daily lives The broad while geared to the microelectronics world has usability of the technology is enabled how applicability to any manufacturing process of similar complexity The authors comprise some ever only by the progress made in reducing their cost and improving their reliability De of the best scientific minds in the world and defect reduction receives a significant focus in our are practitioners of the art The information modern manufacturing world and high quality captured here is world class I know you will diagnostics is the key step in that process find the material to be an excellent reference in of product failures enables step function Analysis your application tion improvements in yield and reliability which works to reduce cost and open up new Dr Paul R Low applications and technologies IBM Vice President and This book describes the process of defect reduction in the microelectronics world

Mobility-based Time References for Wireless

Sensor Networks Fabio Sebastiano, Lucien J. Breems, Kofi A Makinwa, 2012-08-09 This book describes the use of low power low cost and extremely small radios to provide essential time reference for wireless sensor networks The authors explain how to integrate such radios in a standard CMOS process to reduce both cost and size while focusing on the challenge of designing a fully integrated time reference for such radios To enable the integration of the time reference system techniques are proposed and analyzed several kinds of integrated time references are reviewed and mobility based references are identified as viable candidates to provide the required accuracy at low power consumption Practical implementations of a mobility based oscillator and a temperature sensor are also presented which demonstrate the required accuracy over a wide temperature range while drawing 51 uW from a 1.2 V supply in a 65 nm CMOS process

Publications of the National Institute of Standards and Technology ... Catalog

National Institute of Standards and Technology (U.S.), National Institute of Standards and Technology (U.S.). Information Resources and Services Division, 1994 **Smart Power ICs** Bruno Murari, 2002-06-13 This book provides a survey of the state of the art of technology and future trends in the new family of Smart Power ICs and describes design and applications in a variety of fields ranging from automotive to telecommunications reliability evaluation and qualification procedures The book is a valuable source of information and reference for both power IC design specialists and to all those concerned with applications the development of digital circuits and with system architecture

Introduction to Magnetic Random-Access Memory Bernard Dieny, Ronald B. Goldfarb, Kyung-Jin Lee, 2016-12-12 Magnetic random access memory MRAM is poised to replace traditional computer memory based on complementary metal oxide semiconductors CMOS MRAM will surpass all other types of memory devices in terms of nonvolatility low energy dissipation fast switching speed radiation hardness and durability Although toggle MRAM is currently a commercial product it is clear that future developments in MRAM will be based on spin transfer torque which

makes use of electrons spin angular momentum instead of their charge MRAM will require an amalgamation of magnetics and microelectronics technologies However researchers and developers in magnetics and in microelectronics attend different technical conferences publish in different journals use different tools and have different backgrounds in condensed matter physics electrical engineering and materials science This book is an introduction to MRAM for microelectronics engineers written by specialists in magnetic materials and devices It presents the basic phenomena involved in MRAM the materials and film stacks being used the basic principles of the various types of MRAM toggle and spin transfer torque magnetized in plane or perpendicular to plane the back end magnetic technology and recent developments toward logic in memory architectures It helps bridge the cultural gap between the microelectronics and magnetics communities **Non-logic**

Devices in Logic Processes Yanjun Ma, Edwin Kan, 2017-03-29 This book shows readers how to design semiconductor devices using the most common and lowest cost logic CMOS processes Readers will benefit from the author's extensive industrial experience and the practical approach he describes for designing efficiently semiconductor devices that typically have to be implemented using specialized processes that are expensive time consuming and low yield The author presents an integrated picture of semiconductor device physics and manufacturing techniques as well as numerous practical examples of device designs that are tried and true

Analog-to-Digital Conversion Marcel J.M. Pelgrom, 2022-03-15 This textbook is appropriate for use in graduate level curricula in analog to digital conversion as well as for practicing engineers in need of a state of the art reference on data converters It discusses various analog to digital conversion principles including sampling quantization reference generation Nyquist architectures and sigma delta modulation This book presents an overview of the state of the art in this field and focuses on issues of optimizing accuracy and speed while reducing the power level This new fourth edition emphasizes novel calibration concepts the specific requirements of systems the consequences of advanced technology and the need for a more statistical approach to accuracy Pedagogical enhancements to this edition include additional new exercises solved examples to introduce all key new concepts and warnings remarks and hints from a practitioner's perspective wherever appropriate Considerable background information and practical tips from designing a PCB to lay out aspects to trade offs on system level complement the discussion of basic principles making this book a valuable reference for the experienced engineer

ISTFA 2018: Proceedings from the 44th International Symposium for Testing and Failure Analysis ASM International, 2018-12-01 The International Symposium for Testing and Failure Analysis ISTFA 2018 is co located with the International Test Conference ITC 2018 October 28 to November 1 in Phoenix Arizona USA at the Phoenix Convention Center The theme for the November 2018 conference is Failures Worth Analyzing While technology advances fast and the market demands the latest and the greatest successful companies strive to stay competitive and remain profitable

Semiconductor Measurement Technology United States. National Bureau of Standards, 1983

Microelectronic Test Structures For Cmos Technology: Bestsellers in 2023 The year 2023 has witnessed a remarkable surge in literary brilliance, with numerous engrossing novels enthralling the hearts of readers worldwide. Lets delve into the realm of bestselling books, exploring the captivating narratives that have charmed audiences this year. The Must-Read : Colleen Hoover's "It Ends with Us" This heartfelt tale of love, loss, and resilience has captivated readers with its raw and emotional exploration of domestic abuse. Hoover skillfully weaves a story of hope and healing, reminding us that even in the darkest of times, the human spirit can succeed. Uncover the Best : Taylor Jenkins Reids "The Seven Husbands of Evelyn Hugo" This captivating historical fiction novel unravels the life of Evelyn Hugo, a Hollywood icon who defies expectations and societal norms to pursue her dreams. Reids absorbing storytelling and compelling characters transport readers to a bygone era, immersing them in a world of glamour, ambition, and self-discovery. Microelectronic Test Structures For Cmos Technology : Delia Owens "Where the Crawdads Sing" This mesmerizing coming-of-age story follows Kya Clark, a young woman who grows up alone in the marshes of North Carolina. Owens spins a tale of resilience, survival, and the transformative power of nature, entrancing readers with its evocative prose and mesmerizing setting. These popular novels represent just a fraction of the literary treasures that have emerged in 2023. Whether you seek tales of romance, adventure, or personal growth, the world of literature offers an abundance of captivating stories waiting to be discovered. The novel begins with Richard Papen, a bright but troubled young man, arriving at Hampden College. Richard is immediately drawn to the group of students who call themselves the Classics Club. The club is led by Henry Winter, a brilliant and charismatic young man. Henry is obsessed with Greek mythology and philosophy, and he quickly draws Richard into his world. The other members of the Classics Club are equally as fascinating. Bunny Corcoran is a wealthy and spoiled young man who is always looking for a good time. Charles Tavis is a quiet and reserved young man who is deeply in love with Henry. Camilla Macaulay is a beautiful and intelligent young woman who is drawn to the power and danger of the Classics Club. The students are all deeply in love with Morrow, and they are willing to do anything to please him. Morrow is a complex and mysterious figure, and he seems to be manipulating the students for his own purposes. As the students become more involved with Morrow, they begin to commit increasingly dangerous acts. The Secret History is a masterful and gripping novel that will keep you wondering until the very end. The novel is a cautionary tale about the dangers of obsession and the power of evil.

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