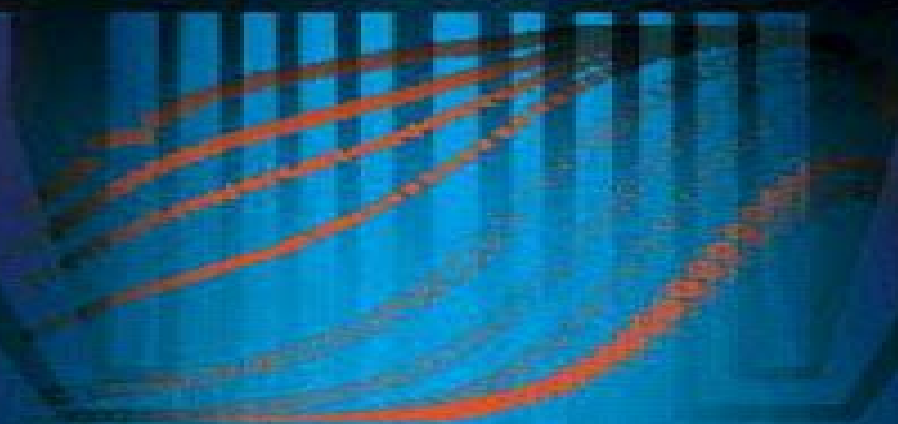


# RADIATION EFFECTS AND SOFT ERRORS IN INTEGRATED CIRCUITS AND ELECTRONIC DEVICES

Editors

**R. D. Schrimpf**

**D. M. Fleetwood**



**World Scientific**

# Radiation Effects And Soft Errors In Integrated Circuits And Electronic Devices

**Ronald Donald Schrimpf, Dan M.  
Fleetwood**



## **Radiation Effects And Soft Errors In Integrated Circuits And Electronic Devices:**

**Radiation Effects and Soft Errors in Integrated Circuits and Electronic Devices** Ronald Donald Schrimpf, Dan M. Fleetwood, 2004 This book provides a detailed treatment of radiation effects in electronic devices including effects at the material device and circuit levels The emphasis is on transient effects caused by single ionizing particles single event effects and soft errors and effects produced by the cumulative energy deposited by the radiation total ionizing dose effects Bipolar Si and SiGe metal oxide semiconductor MOS and compound semi conductor technologies are discussed In addition to considering the specific issues associated with high performance devices and technologies the book includes the background material necessary for understanding radiation effects at a more general level      **Special Issue: Radiation Effects and Soft Errors in Integrated Circuits and Electronic Devices** D. M. Fleetwood, R. D. Schrimpf, 2004      **Semiconductor Devices in Harsh Conditions** Kirsten Weide-Zaage, Malgorzata Chrzanowska-Jeske, 2016-11-25 This book introduces the reader to a number of challenges for the operation of electronic devices in various harsh environmental conditions While some chapters focus on measuring and understanding the effects of these environments on electronic components many also propose design solutions whether in choice of material innovative structures or strategies for amelioration and repair Many applications need electronics designed to operate in harsh environments Readers will find in this collection of topics tools and ideas useful in their own pursuits and of interest to their intellectual curiosity With a focus on radiation operating conditions sensor systems package and system design the book is divided into three parts The first part deals with sensing devices designed for operating in the presence of radiation commercials of the shelf COTS products for space computing and influences of single event upset The second covers system and package design for harsh operating conditions The third presents devices for biomedical applications under moisture and temperature loads in the frame of sensor systems and operating conditions      **Soft Errors** Jean-Luc Autran, Daniela Munteanu, 2017-12-19 Soft errors are a multifaceted issue at the crossroads of applied physics and engineering sciences Soft errors are by nature multiscale and multiphysics problems that combine not only nuclear and semiconductor physics material sciences circuit design and chip architecture and operation but also cosmic ray physics natural radioactivity issues particle detection and related instrumentation Soft Errors From Particles to Circuits addresses the problem of soft errors in digital integrated circuits subjected to the terrestrial natural radiation environment one of the most important primary limits for modern digital electronic reliability Covering the fundamentals of soft errors as well as engineering considerations and technological aspects this robust text Discusses the basics of the natural radiation environment particle interactions with matter and soft error mechanisms Details instrumentation developments in the fields of environment characterization particle detection and real time and accelerated tests Describes the latest computational developments modeling and simulation strategies for the soft error rate estimation in digital circuits Explores trends for future technological nodes and emerging devices Soft Errors From Particles to Circuits

presents the state of the art of this complex subject providing comprehensive knowledge of the complete chain of the physics of soft errors The book makes an ideal text for introductory graduate level courses offers academic researchers a specialized overview and serves as a practical guide for semiconductor industry engineers or application engineers Terrestrial Radiation Effects in ULSI Devices and Electronic Systems Eishi H. Ibe, 2015-03-02 This book provides the reader with knowledge on a wide variety of radiation fields and their effects on the electronic devices and systems The author covers faults and failures in ULSI devices induced by a wide variety of radiation fields including electrons alpha rays muons gamma rays neutrons and heavy ions Readers will learn how to make numerical models from physical insights to determine the kind of mathematical approaches that should be implemented to analyze radiation effects A wide variety of prediction detection characterization and mitigation techniques against soft errors are reviewed and discussed The author shows how to model sophisticated radiation effects in condensed matter in order to quantify and control them and explains how electronic systems including servers and routers are shut down due to environmental radiation Provides an understanding of how electronic systems are shut down due to environmental radiation by constructing physical models and numerical algorithms Covers both terrestrial and avionic level conditions Logically presented with each chapter explaining the background physics to the topic followed by various modelling techniques and chapter summary Written by a widely recognized authority in soft errors in electronic devices Code samples available for download from the Companion Website This book is targeted at researchers and graduate students in nuclear and space radiation semiconductor physics and electron devices as well as other areas of applied physics modelling Researchers and students interested in how a variety of physical phenomena can be modelled and numerically treated will also find this book to present helpful methods **Breakdown Phenomena in Semiconductors and Semiconductor Devices** Michael Levinshtein, Juha Kostamovaara, Sergey Vainshtein, 2005 Impact ionization avalanche and breakdown phenomena form the basis of many very interesting and important semiconductor devices such as avalanche photodiodes avalanche transistors suppressors sharpening diodes diodes with delayed breakdown as well as IMPATT and TRAPATT diodes In order to provide maximal speed and power many semiconductor devices must operate under or very close to breakdown conditions Consequently an acquaintance with breakdown phenomena is essential for scientists or engineers dealing with semiconductor devices The aim of this book is to summarize the main experimental results on avalanche and breakdown phenomena in semiconductors and semiconductor devices and to analyze their features from a unified point of view Attention is focused on the phenomenology of avalanche multiplication and the various kinds of breakdown phenomena and their qualitative analysis **High Performance Devices - Proceedings Of The 2004 Ieee Lester Eastman Conference** Robert Leoni, 2005-04-26 This volume presents state of the art works from top academic and research institutions in the areas of high performance semiconductor materials devices and circuits A broad coverage of topics relating to high performance devices and circuits is featured here There are 46 contributed papers covering a wide

range of materials device types and applications These papers describe the results of ongoing research in three general areas high speed technologies for advanced mixed signal and terahertz applications advanced technologies for high performance optical links and light sources and high power density and high efficiency technologies for next generation microwave front ends and power electronics

*Nano-Semiconductors* Krzysztof Iniewski, 2018-09-03 With contributions from top international experts from both industry and academia Nano Semiconductors Devices and Technology is a must read for anyone with a serious interest in future nanofabrication technologies Taking into account the semiconductor industry's transition from standard CMOS silicon to novel device structures including carbon nanotubes CNT graphene quantum dots and III V materials this book addresses the state of the art in nano devices for electronics It provides an all encompassing one stop resource on the materials and device structures involved in the evolution from micro to nanoelectronics The book is divided into three parts that address Semiconductor materials i e carbon nanotubes memristors and spin organic devices Silicon devices and technology i e BiCMOS SOI various 3D integration and RAM technologies and solar cells Compound semiconductor devices and technology This reference explores the groundbreaking opportunities in emerging materials that will take system performance beyond the capabilities of traditional CMOS based microelectronics Contributors cover topics ranging from electrical propagation on CNT to GaN HEMTs technology and applications Approaching the trillion dollar nanotech industry from the perspective of real market needs and the repercussions of technological barriers this resource provides vital information about elemental device architecture alternatives that will lead to massive strides in future development

*Soft Error Mechanisms, Modeling and Mitigation* Selahattin Sayil, 2016-02-25 This book introduces readers to various radiation soft error mechanisms such as soft delays radiation induced clock jitter and pulses and single event SE coupling induced effects In addition to discussing various radiation hardening techniques for combinational logic the author also describes new mitigation strategies targeting commercial designs Coverage includes novel soft error mitigation techniques such as the Dynamic Threshold Technique and Soft Error Filtering based on Transmission gate with varied gate and body bias The discussion also includes modeling of SE crosstalk noise delay and speed up effects Various mitigation strategies to eliminate SE coupling effects are also introduced Coverage also includes the reliability of low power energy efficient designs and the impact of leakage power consumption optimizations on soft error robustness The author presents an analysis of various power optimization techniques enabling readers to make design choices that reduce static power consumption and improve soft error reliability at the same time

*Mitigating Process Variability and Soft Errors at Circuit-Level for FinFETs* Alexandra Zimpeck, Cristina Meinhardt, Laurent Artola, Ricardo Reis, 2021-03-10 This book evaluates the influence of process variations e g work function fluctuations and radiation induced soft errors in a set of logic cells using FinFET technology considering the 7nm technological node as a case study Moreover for accurate soft error estimation the authors adopt a radiation event generator tool MUSCA SEP3 which deals both with layout features and electrical properties

of devices The authors also explore four circuit level techniques e g transistor reordering decoupling cells Schmitt Trigger and sleep transistor as alternatives to attenuate the unwanted effects on FinFET logic cells This book also evaluates the mitigation tendency when different levels of process variation transistor sizing and radiation particle characteristics are applied in the design An overall comparison of all methods addressed by this work is provided allowing to trace a trade off between the reliability gains and the design penalties of each approach regarding the area performance power consumption single event transient SET pulse width and SET cross section

*Dependable Multicore Architectures at Nanoscale* Marco Ottavi, Dimitris Gizopoulos, Salvatore Pontarelli, 2017-08-28 This book provides comprehensive coverage of the dependability challenges in today's advanced computing systems It is an in depth discussion of all the technological and design level techniques that may be used to overcome these issues and analyzes various dependability assessment methods The impact of individual application scenarios on the definition of challenges and solutions is considered so that the designer can clearly assess the problems and adjust the solution based on the specifications in question The book is composed of three sections beginning with an introduction to current dependability challenges arising in complex computing systems implemented with nanoscale technologies and of the effect of the application scenario The second section details all the fault tolerance techniques that are applicable in the manufacture of reliable advanced computing devices Different levels from technology level fault avoidance to the use of error correcting codes and system level checkpointing are introduced and explained as applicable to the different application scenario requirements Finally the third section proposes a roadmap of future trends in and perspectives on the dependability and manufacturability of advanced computing systems from the special point of view of industrial stakeholders Dependable Multicore Architectures at Nanoscale showcases the original ideas and concepts introduced into the field of nanoscale manufacturing and systems reliability over nearly four years of work within COST Action IC1103 MEDIAN a think tank with participants from 27 countries Academic researchers and graduate students working in multi core computer systems and their manufacture will find this book of interest as will industrial design and manufacturing engineers working in VLSI companies

**Terahertz Science And Technology For Military And Security Applications** Dwight L Woolard, R Jennifer Hwu, James O Jensen, 2007-09-27 The inherent advantages and potential payoffs of the terahertz THz regime for military and security applications serve as an important driver for interest in new THz related science and technology In particular the very rapid growth in more recent years is arguably most closely linked to the potential payoffs of THz sensing and imaging THz S I This book presents some of the leading fundamental research efforts towards the realization of practical THz S I capabilities for military and security applications Relevant subjects include theoretical prediction and or measurement of THz spectroscopic phenomenon in solid state materials such as high explosives e g HMX PETN RDX TNT etc carbon fiber composites biological agents e g DNA RNA proteins amino acids and organic semiconductor nanostructures Individual papers also address the effective utilization of state of the art THz frequency

technology in military and security relevant scenarios such as standoff S I screening of packages and personnel and perimeter defense Technical papers introduce novel devices and or concepts that enhance THz source and detector performance enabling completely new types of sensor functionality at THz frequency e g detection at nanoscale molecular levels and defining new and innovative sensing modalities e g remote personnel identification for defense and security Therefore the collective research presented here represents a valuable source of information on the evolving field of THz S I for military and security applications

Physics and Modeling of Tera- and Nano-devices Maxim Ryzhii, Victor Ryzhii, 2008

Physics and Modeling of Tera and Nano Devices is a compilation of papers by well respected researchers working in the field of physics and modeling of novel electronic and optoelectronic devices The topics covered include devices based on carbon nanotubes generation and detection of terahertz radiation in semiconductor structures including terahertz plasma oscillations and instabilities terahertz photomixing in semiconductor heterostructures spin and microwave induced phenomena in low dimensional systems and various computational aspects of device modeling Researchers as well as graduate and postgraduate students working in this field will benefit from reading this book

Sample Chapter s

Semiconductor Device Scaling Physics Transport and the Role of Nanowires 784 KB Contents Semiconductor Device Scaling Physics Transport and the Role of Nanowires D K Ferry et al Polaronic Effects at the Field Effect Junctions for Unconventional Semiconductors N Kirova Cellular Monte Carlo Simulation of High Field Transport in Semiconductor Devices S M Goodnick Nanoelectronic Device Simulation Based on the Wigner Function Formalism H Kosina Quantum Simulations of Dual Gate MOSFET Devices Building and Deploying Community Nanotechnology Software Tools on nanoHUB org S Ahmed et al Positive Magneto Resistance in a Point Contact Possible Manifestation of Interactions V T Renard et al Impact of Intrinsic Parameter Fluctuations in Nano CMOS Devices on Circuits and Systems S Roy et al HEMT Based Nanometer Devices Toward Terahertz Era E Sano Plasma Waves in Two Dimensional Electron Systems and Their Applications V Ryzhii et al Resonant Terahertz Detection Antenna Utilizing Plasma Oscillations in Lateral Schottky Diode A Satou et al Terahertz Polarization Controller Based on Electronic Dispersion Control of 2D Plasmons T Nishimura Higher Order Plasmon Resonances in GaN Based Field Effect Transistor Arrays V V Popov et al Ultra Highly Sensitive Terahertz Detection Using Carbon Nanotube Quantum Dots Y Kawano et al Generation of Ultrashort Electron Bunches in Nanostructures by Femtosecond Laser Pulses A Gladun et al Characterization of Voltage Controlled Oscillator Using RTD Transmission Line K Narahara et al Infrared Quantum Dot Detectors with Diffusion Limited Capture N Vagidov et al Magnetoresistance in Fe MgO Fe Magnetic Tunnel Junctions N N Beleskii et al Modeling and Implementation of Spin Based Quantum Computation M E Hawley et al Quantum Engineering for Threat Reduction and Homeland Security G P Berman et al Strong Phase Shift Mask Manufacturing Error Impact on the 65nm Poly Line Printability N Belova Readership Academics graduate and postgraduate students in the field of physics and modeling of novel electronics and optoelectronic devices

Extreme Environment

Electronics John D. Cressler, H. Alan Mantooth, 2017-12-19 Unfriendly to conventional electronic devices circuits and systems extreme environments represent a serious challenge to designers and mission architects The first truly comprehensive guide to this specialized field Extreme Environment Electronics explains the essential aspects of designing and using devices circuits and electronic systems intended to operate in extreme environments including across wide temperature ranges and in radiation intense scenarios such as space The Definitive Guide to Extreme Environment Electronics Featuring contributions by some of the world's foremost experts in extreme environment electronics the book provides in depth information on a wide array of topics It begins by describing the extreme conditions and then delves into a description of suitable semiconductor technologies and the modeling of devices within those technologies It also discusses reliability issues and failure mechanisms that readers need to be aware of as well as best practices for the design of these electronics Continuing beyond just the paper design of building blocks the book rounds out coverage of the design realization process with verification techniques and chapters on electronic packaging for extreme environments The final set of chapters describes actual chip level designs for applications in energy and space exploration Requiring only a basic background in electronics the book combines theoretical and practical aspects in each self contained chapter Appendices supply additional background material With its broad coverage and depth and the expertise of the contributing authors this is an invaluable reference for engineers scientists and technical managers as well as researchers and graduate students A hands on resource it explores what is required to successfully operate electronics in the most demanding conditions

**Soft Errors in Modern Electronic Systems** Michael Nicolaidis, 2010-09-24 This book provides a comprehensive presentation of the most advanced research results and technological developments enabling understanding qualifying and mitigating the soft errors effect in advanced electronics including the fundamental physical mechanisms of radiation induced soft errors the various steps that lead to a system failure the modelling and simulation of soft error at various levels including physical electrical netlist event driven RTL and system level modelling and simulation hardware fault injection accelerated radiation testing and natural environment testing soft error oriented test structures process level device level cell level circuit level architectural level software level and system level soft error mitigation techniques The book contains a comprehensive presentation of most recent advances on understanding qualifying and mitigating the soft error effect in advanced electronic systems presented by academia and industry experts in reliability fault tolerance EDA processor SoC and system design and in particular experts from industries that have faced the soft error impact in terms of product reliability and related business issues and were in the forefront of the countermeasures taken by these companies at multiple levels in order to mitigate the soft error effects at a cost acceptable for commercial products In a fast moving field where the impact on ground level electronics is very recent and its severity is steadily increasing at each new process node impacting one after another various industry sectors as an example the Automotive Electronics Council comes to publish qualification requirements on soft errors research and



technology developments and industrial practices have evolve very fast outdated the most recent books edited at 2004

**Spectral Sensing Research for Water Monitoring Applications and Frontier Science and Technology for Chemical, Biological and Radiological Defense** Dwight Woolard, Janet L. Jensen, 2008 This book provides unique perspectives on both state of the art hyperspectral techniques for the early warning monitoring of water supplies against chemical biological and radiological CBR contamination effects as well as the emerging spectroscopic science and technology base that will be used to support an array of CBR defense and security applications in the future The technical content in this book lends itself to the non traditional requirements for point and stand off detection that have evolved out of the US joint services programs over many years In particular the scientific and technological work presented seeks to enable hyperspectral based sensing and monitoring that is real time in line low in cost and labor and easy to support maintain and use in military and security relevant scenarios

**Spectral Sensing Research For Surface And Air Monitoring In Chemical, Biological And Radiological Defense And Security Applications** Jean-marc Theriault, James O Jensen, 2009-08-11 This book provides unique perspectives on the state of the art in multispectral hyperspectral techniques for early warning monitoring against chemical biological and radiological CB low in cost and labor requirements and easy to support maintain and use in military and security relevant scenarios

**VLSI Design and Test for Systems Dependability** Shojiro Asai, 2018-07-20 This book discusses the new roles that the VLSI very large scale integration of semiconductor circuits is taking for the safe secure and dependable design and operation of electronic systems The book consists of three parts Part I as a general introduction to this vital topic describes how electronic systems are designed and tested with particular emphasis on dependability engineering where the simultaneous assessment of the detrimental outcome of failures and cost of their containment is made This section also describes the related research project Dependable VLSI Systems in which the editor and authors of the book were involved for 8 years Part II addresses various threats to the dependability of VLSIs as key systems components including time dependent degradations variations in device characteristics ionizing radiation electromagnetic interference design errors and tampering with discussion of technologies to counter those threats Part III elaborates on the design and test technologies for dependability in such applications as control of robots and vehicles data processing and storage in a cloud environment and heterogeneous wireless telecommunications This book is intended to be used as a reference for engineers who work on the design and testing of VLSI systems with particular attention to dependability It can be used as a textbook in graduate courses as well Readers interested in dependable systems from social and industrial economic perspectives will also benefit from the discussions in this book

Noise Contamination in Nanoscale VLSI Circuits Selahattin Sayil, 2022-08-31 This textbook provides readers with a comprehensive introduction to various noise sources that significantly reduce performance and reliability in nanometer scale integrated circuits The author covers different types of noise such as crosstalk noise caused by signal

switching of adjacent wires power supply noise or IR voltage drop in the power line due to simultaneous buffer gate switching events substrate coupling noise radiation induced transients thermally induced noise and noise due to process and environmental Coverages also includes the relationship between some of these noise sources as well as compound effects and modeling and mitigation of noise mechanisms      *Frontiers In Electronics* Sorin Cristoloveanu, Michael S Shur, 2009-08-06 *Frontiers in Electronics* contains the selected best papers presented at the Workshop on Frontiers in Electronics WOFE 07 This meeting was the fifth in the series of WOFE workshops and strongly reinforced the tradition of scientific quality and visionary research The issues addressed ranged from THz and infrared electronics to nanoelectronics and photonics The papers focused on the fabrication characterization and applications of nanodevices wide band gap structures and state of the art FETs The participants also discussed the device physics and processing issues including aspects related to SOI and germanium on insulator technologies TFTs and advanced CMOS and MOSFETs It is this cross pollination between different but related fields that made this conference very special This book which goes beyond the publication of the WOFE Proceedings includes full length invited papers selected at the conference and reviewed by international leaders The book is divided into four distinct sections with the common denominator throughout being the nano device present under various metamorphoses in the wide CMOS and optoelectronics arena a

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