

Josef Lutz
Heinrich Schlangenotto
Uwe Scheuermann
Rik De Doncker

Semiconductor Power Devices

Physics, Characteristics, Reliability
Second Edition

Semiconductor Power Devices Physics Characteristics Reliability

Dorin O. Neacsu



Semiconductor Power Devices Physics Characteristics Reliability:

Semiconductor Power Devices Josef Lutz, Heinrich Schlangenotto, Uwe Scheuermann, Rik De Doncker, 2011-01-15

Semiconductor power devices are the heart of power electronics. They determine the performance of power converters and allow topologies with high efficiency. Semiconductor properties, pn junctions and the physical phenomena for understanding power devices are discussed in depth. Working principles of state of the art power diodes, thyristors, MOSFETs and IGBTs are explained in detail as well as key aspects of semiconductor device production technology. In practice, not only the semiconductor but also the thermal and mechanical properties of packaging and interconnection technologies are essential to predict device behavior in circuits. Wear and aging mechanisms are identified and reliability analyses principles are developed. Unique information on destructive mechanisms including typical failure pictures allows assessment of the ruggedness of power devices. Also parasitic effects such as device induced electromagnetic interference problems are addressed. The book concludes with modern power electronic system integration techniques and trends.

Semiconductor Power Devices Josef Lutz, Heinrich Schlangenotto, Uwe Scheuermann, Rik De Doncker, 2018-02-16 Halbleiter

Leistungsbaulemente sind das Kernstück der Leistungselektronik. Sie bestimmen die Leistungsfähigkeit und machen neuartige und verlustarme Schaltungen erst möglich. In dem Band wird neben den Halbleiter Leistungsbaulementen selbst auch die Aufbau- und Verbindungstechnik behandelt: von den physikalischen Grundlagen und der Herstellungstechnologie über einzelne Bauelemente bis zu thermomechanischen Problemen, Zerstörungsmechanismen und Störungseffekten. Die 2. bearbeitete Auflage berücksichtigt technische Neuerungen und Entwicklungen.

Integrated Power Devices and TCAD Simulation Yue Fu, Zhanming Li, Wai Tung Ng, Johnny K.O. Sin, 2017-12-19 From power electronics to power integrated circuits, PICs, smart power technologies, devices and beyond. Integrated Power Devices and TCAD Simulation provides a complete picture of the power management and semiconductor industry. An essential reference for power device engineering students and professionals, the book not only describes the physics inside integrated power semiconductor devices such as lateral double diffused metal oxide semiconductor field effect transistors, LDMOSFETs, lateral insulated gate bipolar transistors, LIGBTs and super junction LDMOSFETs, but also delivers a simple introduction to power management systems. Instead of abstract theoretical treatments and daunting equations, the text uses technology computer aided design (TCAD) simulation examples to explain the design of integrated power semiconductor devices. It also explores next generation power devices such as gallium nitride power high electron mobility transistors, GaN power HEMTs. Including a virtual process flow for smart PIC technology as well as a hard-to-find technology development organization chart, Integrated Power Devices and TCAD Simulation gives students and junior engineers a head start in the field of power semiconductor devices while helping to fill the gap between power device engineering and power management systems.

Thermal Reliability of Power Semiconductor Device in the Renewable Energy System Xiong Du, Jun Zhang, Gaoxian Li, Yaoyi Yu, Cheng Qian, Rui

Du,2022-07-08 This book focuses on the thermal reliability of power semiconductor device by looking at the failure mechanism thermal parameters monitoring junction temperature estimation lifetime evaluation and thermal management Theoretical analysis and experimental tests are presented to explain existing reliability improvement techniques This book is a valuable reference for the students and researchers who pay attention to the thermal reliability design of power semiconductor device Applications in Electronics Pervading Industry, Environment and Society Alessandro De Gloria,2017-01-02 This book provides a thorough overview of cutting edge research on electronics applications relevant to industry the environment and society at large It covers a broad spectrum of application domains from automotive to space and from health to security while devoting special attention to the use of embedded devices and sensors for imaging communication and control The book is based on the 2015 ApplePies Conference held in Rome which brought together researchers and stakeholders to consider the most significant current trends in the field of applied electronics and to debate visions for the future Areas addressed by the conference included information communication technology biotechnology and biomedical imaging space secure clean and efficient energy the environment and smart green and integrated transport As electronics technology continues to develop apace constantly meeting previously unthinkable targets further attention needs to be directed toward the electronics applications and the development of systems that facilitate human activities This book written by industrial and academic professionals represents a valuable contribution in this endeavor *Advancing Silicon Carbide Electronics Technology I* Konstantinos Zekentes,2018-09-25 The rapidly advancing Silicon Carbide technology has a great potential in high temperature and high frequency electronics High thermal stability and outstanding chemical inertness make SiC an excellent material for high power low loss semiconductor devices The present volume presents the state of the art of SiC device fabrication and characterization Topics covered include SiC surface cleaning and etching techniques electrical characterization methods and processing of ohmic contacts to silicon carbide analysis of contact resistivity dependence on material properties limitations and accuracy of contact resistivity measurements ohmic contact fabrication and test structure design overview of different metallization schemes and processing technologies thermal stability of ohmic contacts to SiC their protection and compatibility with device processing Schottky contacts to SiC Schottky barrier formation Schottky barrier inhomogeneity in SiC materials technology and design of 4H SiC Schottky and Junction Barrier Schottky diodes Si SiC heterojunction diodes applications of SiC Schottky diodes in power electronics and temperature light sensors high power SiC unipolar and bipolar switching devices different types of SiC devices including material and technology constraints on device performance applications in the area of metal contacts to silicon carbide status and prospects of SiC power devices *Investigation of Reliability Aspects of Power Semiconductors in Photovoltaic Central Inverters for Sunbelt Regions* Christian Felgemacher,2018-03-23 High reliability and system lifetimes in the range of 30 years are essential for renewable energy systems such as photovoltaic power plants to minimise costs for the generated electric energy At the same

time such systems are used in regions with high solar irradiance and also harsh environmental conditions Therefore designs for photovoltaic inverters need to meet not only the key design criteria of high conversion efficiency but also need to be very robust and at the same time meet challenging cost targets In this dissertation aspects concerning the lifetime and reliability of power semiconductors in photovoltaic central inverters are investigated On key topic of the dissertation is the measurement of the voltage dependent failure rate due to cosmic radiation induced single event burnout of SiC and Si power semiconductors The second topic is the development of a system level simulation to quantify the stress on the power semiconductors in a PV central inverters in various regions of the world Further topics are the investigation of improved control concepts for the cooling system of PV central inverters and the monitoring of IGBT temperatures during converter operation

Switching Power Converters Dorin O. Neacsu, 2025-08-28 The Third Edition of *Switching Power Converters* goes beyond the design and analysis of conventional power converter circuits to discuss the actual use of industrial technology covering facets of implementation otherwise overlooked by theoretical textbooks This edition uniquely presents the historical and market evolution of each technology allowing the reader to follow trends Power electronics represents a mature technology with a variety of products concurrent on the market designed and launched from the 1990s to 2020s The theoretical aspects presented in the book are supported with many examples diligently exemplifying this market complexity It highlights advancements in new semiconductor devices and packaging technologies design for reliability or computer utilization in the design development and validation of new technical solutions It also examines all of the multidisciplinary aspects of medium and high power converter systems including basic power electronics digital control and hardware sensors analog preprocessing of signals protection devices and fault management and pulse width modulation PWM algorithms Similar to the previous two editions the Third Edition of *Switching Power Converters* remains the go to book for understanding all aspects related to the PWM used in the control of power converters This book is one of the most comprehensive presentations of PWM algorithms with illustrations of practical results for optimization or implementation on each analog software digital hardware or Gbit flash memory platform

Reconfigurable Switched-Capacitor Power Converters Dongsheng Ma, Rajdeep Bondade, 2012-07-25 This book provides readers specializing in ultra low power supply design for self powered applications an invaluable reference on reconfigurable switched capacitor power converters Readers will benefit from a comprehensive introduction to the design of robust power supplies for energy harvesting and self power applications focusing on the use of reconfigurable switched capacitor based DC DC converters which is ideal for such applications Coverage includes all aspects of switched capacitor power supply designs from fundamentals to reconfigurable power stages and sophisticated controller designs

Integration of AI, Quantum Computing, and Semiconductor Technology Mishra, Brojo Kishore, 2024-10-29 The integration of artificial intelligence AI quantum computing and semiconductor technology offers improved innovation to redefine computational power and capabilities As AI drives advances

in machine learning and data processing quantum computing revolutionizes problem solving with its ability to handle complex calculations at improved speeds Advancements in semiconductor technology push the limits of processing efficiency and miniaturization Continued exploration on this convergence may accelerate breakthroughs in various fields such as cryptography material science and healthcare Integration of AI Quantum Computing and Semiconductor Technology explores the intersection of artificial intelligence AI and semiconductor technology within the context of quantum computing It offers a comprehensive analysis of the current advancements challenges and potential applications resulting from this convergence This book covers topics such as cyber security healthcare monitoring and machine learning and is a useful resource for computer engineers energy scientists business owners healthcare administrators environmental scientists academicians and researchers

The Proceedings of the 17th Annual Conference of China Electrotechnical Society Jian Li,Kaigui Xie,Jianlin Hu,Qingxin Yang,2023-03-31 This book gathers outstanding papers presented at the 17th Annual Conference of China Electrotechnical Society organized by China Electrotechnical Society CES held in Beijing China from September 17 to 18 2022 It covers topics such as electrical technology power systems electromagnetic emission technology and electrical equipment It introduces the innovative solutions that combine ideas from multiple disciplines The book is very much helpful and useful for the researchers engineers practitioners research students and interested readers

Power Electrical Systems Faouzi Derbel,Nabil Derbel,Olf Kanoun,2018-07-23 Power Electrical Systems are an indispensable feature of the exploitation and diagnostics of electrical machines and energy resources The Volume presents extended and peer reviewed papers from the international conference on PES in Barcelona 2014 Among the topics dealt with are electrical machines design voltage and control automotive power drives electromagnetic compatibility monitoring and diagnostics renewable energy systems The International Conference on Power Electrical Systems PES is a forum for researchers and specialists in different fields of electrical engineering related to Hybrid Renewable Energy Systems HRES Power Electronics in Renewable Energy Systems Topologies and Control of Power Electronics Converters Used in Renewable Energy Systems Electric machines modelling and control Automotive electrical systems Electric machine design Monitoring and diagnostics Special machines Power systems Power electronic converters Renewable energy systems Variable speed drives Electromagnetic compatibility Variable speed generating systems Transformers

Wide Bandgap Semiconductors for Power Electronics Peter Wellmann,Noboru Ohtani,Roland Rupp,2022-01-10 Wide Bandgap Semiconductors for Power Electronic A guide to the field of wide bandgap semiconductor technology Wide Bandgap Semiconductors for Power Electronics is a comprehensive and authoritative guide to wide bandgap materials silicon carbide gallium nitride diamond and gallium III oxide With contributions from an international panel of experts the book offers detailed coverage of the growth of these materials their characterization and how they are used in a variety of power electronics devices such as transistors and diodes and in the areas of quantum information and hybrid electric vehicles The book is filled with the most recent developments in the

burgeoning field of wide bandgap semiconductor technology and includes information from cutting edge semiconductor companies as well as material from leading universities and research institutions By taking both scholarly and industrial perspectives the book is designed to be a useful resource for scientists academics and corporate researchers and developers This important book Presents a review of wide bandgap materials and recent developments Links the high potential of wide bandgap semiconductors with the technological implementation capabilities Offers a unique combination of academic and industrial perspectives Meets the demand for a resource that addresses wide bandgap materials in a comprehensive manner Written for materials scientists semiconductor physicists electrical engineers Wide Bandgap Semiconductors for Power Electronics provides a state of the art guide to the technology and application of SiC and related wide bandgap materials

Thermal Analysis of Power Electronic Devices Used in Renewable Energy Systems Alhussein Albarbar,Canras Batunlu,2017-07-19 This book analyzes the thermal characteristics of power electronic devices PEDs with a focus on those used in wind and solar energy systems The authors focus on the devices used in such applications for example boost converters and inverters under different operating conditions The book explains in detail finite element modeling techniques setting up measuring systems data analysis and PEDs lifetime calculations It is appropriate reading for graduate students and researchers who focus on the design and reliability of power electronic devices

Proceedings of 2019 Chinese Intelligent Systems Conference Yingmin Jia,Junping Du,Weicun Zhang,2019-09-07 This book showcases new theoretical findings and techniques in the field of intelligent systems and control It presents in depth studies on a number of major topics including Multi Agent Systems Complex Networks Intelligent Robots Complex System Theory and Swarm Behavior Event Triggered Control and Data Driven Control Robust and Adaptive Control Big Data and Brain Science Process Control Intelligent Sensor and Detection Technology Deep learning and Learning Control Guidance Navigation and Control of Aerial Vehicles and so on Given its scope the book will benefit all researchers engineers and graduate students who want to learn about cutting edge advances in intelligent systems intelligent control and artificial intelligence

Reliability, Safety and Hazard Assessment for Risk-Based Technologies Prabhakar V. Varde,Raghu V. Prakash,Gopika Vinod,2019-08-30 This volume presents selected papers from the International Conference on Reliability Safety and Hazard It presents the latest developments in reliability engineering and probabilistic safety assessment and brings together contributions from a diverse international community and covers all aspects of safety reliability and hazard assessment across a host of interdisciplinary applications This book will be of interest to researchers in both academia and the industry

Gallium Nitride and Silicon Carbide Power Technologies 7 M. Dudley,M. Bakowski,N. Ohtani,B. Raghothamachar,K. Shenai, **Three-phase AC-AC Power Converters Based on Matrix Converter Topology** Paweł Szcześniak,2013-02-28 AC voltage frequency changes is one of the most important functions of solid state power converters The most desirable features in frequency converters are the ability to generate load voltages with arbitrary amplitude and frequency sinusoidal currents and voltages waveforms the

possibility of providing unity power factor for any load and finally a simple and compact power circuit Over the past decades a number of different frequency converter topologies have appeared in the literature but only the converters with either a voltage or current DC link are commonly used in industrial applications Improvements in power semiconductor switches over recent years have resulted in the development of many structures of AC AC converters without DC electric energy storage Such converters are an alternative solution for frequently recommended systems with DC energy storage and are characterized by a lower price smaller size and longer lifetime Most of these topologies are based on the structure of the matrix converter Three Phase AC AC Power Converters Based On Matrix Converter Topology Matrix reactance frequency converters concept presents a review of power frequency converters with special attention paid to converters without DC energy storage Particular attention is paid to nine new converters named matrix reactance frequency converters which have been developed by the author and the team of researchers from Institute of Electrical Engineering at the University of Zielona G ą ra The topologies of the presented matrix reactance frequency converters are based on a three phase unipolar buck boost matrix reactance chopper with source or load switches arranged as in a matrix converter This kind of approach makes it possible to obtain an output voltage greater than the input one similar to that in a matrix reactance chopper and a frequency conversion similar to that in a matrix converter Written for researchers and Ph D students working in the field of power electronics converters and drive systems Three Phase AC AC Power Converters Based On Matrix Converter Topology Matrix reactance frequency converters concept will also be valuable to power electronics converter designers and users R and readers needing industry solutions in variable speed drive systems such as automation and aviation **Parasitic**

Substrate Coupling in High Voltage Integrated Circuits Pietro Buccella, Camillo Stefanucci, Maher Kayal, Jean-Michel Sallese, 2018-03-14 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 **Silicon Carbide Power Devices** Yuan Gao, Yan Zhang, 2025-10-02 This book provides comprehensive technical information on SiC

power devices from multiple perspectives covering topics from device research and development to system applications Chapters 1 to 4 focus on the characteristics of SiC devices initially outlining the limitations of Si power devices and explaining why SiC has superior properties at the material level It then offers updates on the latest developments in the SiC industry chain and products innovations along with a detailed discussion of the characteristics and specifications of SiC Diodes and MOSFETs Chapters 5 and 6 zoom in on SiC device testing and evaluation techniques including CP testing FT testing system application testing reliability assessment failure analysis and double pulse testing Chapters 7 to 12 focus on SiC device application technology addressing common challenges in real applications and providing solutions This includes voltage spikes during turn off crosstalk common mode current common source inductance and driver circuits concluding with case studies of SiC device applications in various scenarios The book can serve as a textbook for higher education and vocational training as well as a reference material for engineers in the power semiconductor and electrical electronics industries To make the book genuinely helpful for readers the authors have invested significant effort in content and data selection First the chosen technical points come from real world requirements in device R D and applications Second the book emphasizes practicality while integrating cutting edge developments detailing research outcomes with industrial potential Third the book offers a wealth of data and waveforms most of which are actual measurements to bridge the gap between theory and practice Lastly extensive further reading materials are provided at the end of each chapter for broader and deeper exploration

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