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Semiconductor Power Devices

Physics, Characteristics, Reliability
Second Edition

Semiconductor Power Devices Physics Characteristics Reliability

Alhussein Albarbar, Canras Batunlu



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.

Semiconductor Power Devices Josef Lutz, Heinrich Schlangenotto, Uwe Scheuermann, 2011-03-30

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.

Wide Bandgap Semiconductors for Power Electronics Peter Wellmann, Noboru Ohtani, Roland Rupp, 2022-01-10 Wide Bandgap Semiconductors for Power Electronics: 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

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

Power Electrical Systems Faouzi Derbel, Nabil Derbel, Olfa 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

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

Switching Power Converters Dorin O. Neacsu, 2017-12-19 An examination of 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 Switching Power Converters Medium and High Power Second Edition discusses the actual use of industrial technology and its related subassemblies and components covering facets of implementation otherwise overlooked by theoretical textbooks The updated Second Edition contains many new figures as well as new and or improved chapters on Thermal management and reliability Intelligent power modules AC DC and DC AC current source converters Multilevel converters Use of IPM within a network of switches concept Power semiconductors Matrix converters Practical aspects in building power converters Providing the latest research and development information along with numerous examples of successful home appliance aviation naval automotive electronics industrial motor drive and grid interface for renewable energy products this edition highlights advancements in packaging technologies tackles the advent of hybrid circuits able to incorporate control and power stages within the same package and examines design for reliability from the system level perspective

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

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

Understanding Power Electronics via Simulations S. Raghuram Naidu, 2025-08-05 This book introduces Power Electronics by emphasizing computer simulation using the Python programming language It is primarily a senior undergraduate text but can also be used for a post graduate course on DC DC switch power mode converters It is also a reference for practicing engineers Theoretical analysis

of the circuits and approximate calculations precede the simulations and the reader is taken by hand through the numerical analysis. Finally when the programs are presented they are simple and easy to understand. Python is a computational language that is easy to learn and has the libraries necessary for simulations. The author has observed that students' interest in Power Electronics is enhanced when they learn to simulate the circuits without depending on a general purpose program. This book encourages the reader to run the programs and perform numerical experiments. Quite a few simulations in the later chapters have been left as exercises for the reader. Many feedback control issues have been extensively discussed in the chapter on non isolated DC DC converters.

Telecom Power Systems Dorin O. Neacșu, 2017-12-12 This book addresses topics specific to the application of power electronics to telecom systems. It follows the power flow from national grid down to the last low voltage high current requirement of a processor. Auxiliary equipment requirements such as uninterruptible power supplies, storage energy systems or charging systems are explained along with peculiar classification or suggestions for usage. The presentation of each telecom power system is completed with a large number of practical examples to reinforce new material.

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,

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

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 the 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

Design, Control, and Application of Modular Multilevel Converters for HVDC Transmission Systems Kamran Sharifabadi, Lennart Harnefors, Hans-Peter Nee, Staffan Norrga, Remus Teodorescu, 2016-08-22 Design Control and Application of Modular Multilevel Converters for HVDC Transmission Systems is a comprehensive guide to semiconductor technologies applicable for MMC design component sizing control modulation and

application of the MMC technology for HVDC transmission Separated into three distinct parts the first offers an overview of MMC technology including information on converter component sizing Control and Communication Protection and Fault Management and Generic Modelling and Simulation The second covers the applications of MMC in offshore WPP including planning technical and economic requirements and optimization options fault management dynamic and transient stability Finally the third chapter explores the applications of MMC in HVDC transmission and Multi Terminal configurations including Supergrids Key features Unique coverage of the offshore application and optimization of MMC HVDC schemes for the export of offshore wind energy to the mainland Comprehensive explanation of MMC application in HVDC and MTDC transmission technology Detailed description of MMC components control and modulation different modeling approaches converter dynamics under steady state and fault contingencies including application and housing of MMC in HVDC schemes for onshore and offshore Analysis of DC fault detection and protection technologies system studies required for the integration of HVDC terminals to offshore wind power plants and commissioning procedures for onshore and offshore HVDC terminals A set of self explanatory simulation models for HVDC test cases is available to download from the companion website This book provides essential reading for graduate students and researchers as well as field engineers and professionals who require an in depth understanding of MMC technology

Reliability of High-Power Mechatronic Systems
2 Abdelkhalak El Hami, David Delaux, Henri Grzeskowiak, 2017-10-17 This second volume of a series dedicated to the reliability of high power mechatronic systems focuses specifically on issues testing and analysis in automotive and aerospace applications In the search to improve industrial competitiveness the development of methods and tools for the design of products is especially pertinent in the context of cost reduction This book proposes new methods that simultaneously allow for a quicker design of future mechatronic devices in the automotive and aerospace industries while guaranteeing their increased reliability The reliability of these critical elements is further validated digitally through new multi physical and probabilistic models that could ultimately lead to new design standards and reliable forecasting Presents a methodological guide that demonstrates the reliability of fractured mechatronic components and devices Includes numerical and statistical models to optimize the reliability of the product architecture Develops a methodology to characterize critical elements at the earliest stage in their development

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