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Solar Photovoltaic System Applications

A transistor-level, design-intensive overview of high speed and high frequency monolithic integrated circuits for wireless and broadband systems from 2 GHz to 200 GHz, this comprehensive text covers high-speed, RF, mm-wave and optical fiber circuits using nanoscale CMOS, SiGe BiCMOS and III-V technologies. Step-by-step design methodologies, end-of-chapter problems and practical simulation and design projects are provided, making this an ideal resource for senior undergraduate and graduate courses in circuit design. With an emphasis on device-circuit topology interaction and optimization, it gives circuit designers and students alike an in-depth understanding of device structures and process limitations affecting circuit performance.

Japanese Technical Periodical Index

This book presents bond graph model-based fault detection with a focus on hybrid system models. The book addresses model design, simulation, control and model-based fault diagnosis of multidisciplinary engineering systems. The text begins with a brief survey of the state-of-the-art, then focuses on hybrid systems. The author then uses different bond graph approaches throughout the text and provides case studies.

Mini-Grids for Rural Electrification of Developing Countries

Proceedings of the Annual Conference of the IEEE Industrial Electronics Society

Power electronics technology is still an emerging technology, and it has found its way into many applications, from renewable energy generation (i.e., wind power and solar power) to electrical vehicles (EVs), biomedical devices, and small appliances, such as laptop chargers. In the near future, electrical energy will be provided and handled by power electronics and consumed through power electronics; this not only will intensify the role of power electronics technology in power conversion processes, but also implies that power systems are undergoing a paradigm shift, from centralized distribution to distributed generation. Today, more than 1000 GW of renewable energy generation sources (photovoltaic (PV) and wind) have been installed, all of which are handled by power electronics technology. The main aim of this book is to highlight and address recent breakthroughs in the range of emerging applications in power electronics and in harmonic and electromagnetic interference (EMI) issues at device and system levels as discussed in robust and reliable power electronics technologies, including fault prognosis and diagnostic technique stability of grid-connected converters and smart control of power electronics in devices, microgrids, and at system levels.

High-Frequency Integrated Circuits

Presenting a complete guide for the planning, design and implementation of solar PV systems for off-grid applications, this book features analysis based on the authors' own laboratory testing as well as their in the field experiences. Incorporating the latest developments in smart-digital and control technologies into the design criteria of the PV system, this book will also focus on how to integrate newer smart design approaches and techniques for improving the efficiency, reliability and flexibility of the entire system. The design and implementation of India's first-of-its-kind Smart Mini-Grid system (SMG) at TERI premises, which involves the integration of multiple renewable energy resources (including solar PV) through smart controllers for managing the load intelligently and effectively is presented as a key case study. Maximizing reader insights into the performance of different components of solar PV systems under different operating conditions, this book will be of interest to graduate students, researchers, PV designers, planners, and practitioners working in the area of solar PV design, implementation and assessment.

Power Electronics
Currently strain engineering is the main technique used to enhance the performance of advanced silicon-based metal-oxide-semiconductor field-effect transistors (MOSFETs). Written from an engineering application standpoint, Strain-Engineered MOSFETs introduces promising strain techniques to fabricate strain-engineered MOSFETs and to methods to assess the characteristics of the devices. The book provides the background and physical insight needed to understand new and future developments in the modeling and design of n- and p-MOSFETs at nanoscale. This book focuses on recent developments in strain-engineered MOSFETs implemented in high-mobility substrates such as, Ge, SiGe, strained-Si, ultrathin germanium-on-insulator platforms, combined with high-k insulators and metal-gate. It covers the material's aspects, principles, and design of advanced devices, fabrication, and applications. It also presents a full technology computer-aided design (TCAD) methodology for small-engineering in Si-CMOS technology involving data flow from process simulation to process variability simulation via device simulation and generation of SPICE process compact models for manufacturing for yield optimization. Microelectronics fabrication is facing serious challenges due to the introduction of new materials in manufacturing and fundamental limitations of nanoscale devices that result in increasing unpredictability in the characteristics of the devices. The down scaling of CMOS technologies has brought about the increased variability of key parameters affecting the performance of integrated circuits. This book provides a single text that combines coverage of the strain-engineered MOSFETs and their modeling using TCAD, making it a tool for process technology development and the design of strain-engineered MOSFETs.

Atonomous Control of Unmanned Aerial Vehicles

This two-volume book presents an unusually diverse selection of research papers, covering all major topics in the fields of information and communication technologies and related sciences. It provides a wide-angle snapshot of current themes in information and power engineering, pursuing a cross-disciplinary approach to do so. The book gathers revised contributions that were presented at the 2018 International Conference: Sciences of Electronics, Technologies of Information and Telecommunication (SETIT'18), held on 20–22 December 2018 in Hammamet, Tunisia. This eighth installment of the event attracted a wealth of submissions, and the papers presented here were selected by a committee of experts and underwent additional, painstaking revision. Topics covered include: · Information Processing · Human-Machine Interaction · Computer Science · Telecommunications and Networks · Signal Processing · Electronics · Image and Video This broad-scope approach is becoming increasingly popular in scientific publishing. Its aim is to encourage scholars and professionals to overcome disciplinary barriers, as demanded by current trends in the industry and in the consumer market, which are rapidly leading toward a convergence of data-driven applications, computation, telecommunication, and energy awareness. Given its coverage, the book will benefit graduate students, researchers and practitioners who need to keep up with the latest technological advances.

Technology Reports of the Y amaguchi University

High-Frequency Oscillator Design for Integrated Transceivers covers the analysis and design of all high-frequency oscillators required to realize integrated transceivers for wireless and wired applications. This includes the design of oscillator types as single-phase LC oscillators, I/Q LC oscillators, multi-phase LC oscillators, and ring oscillators in various LC technologies such as bipolar, BiCMOS, CMOS, and SOI (silicon on insulator). Starting from an in-depth review of basic oscillator theory, the authors discuss key oscillator specifications, numerous oscillator circuit topologies, and introduce the concepts of design figures of merit (FDMs) and benchmark FDMs, which assist the oscillator designer during the overall design cycle. Taking advantage of behavioral modeling, the elementary properties of LC oscillators and ring oscillators are analyzed first. A detailed analysis of oscillator properties at circuit level follows taking parasitic elements and other practical aspects of integrated oscillator design into account. Special attention is given to advantages and limitations of linear time-invariant (LTI) phase noise modeling, leading to the concept of optimum coupling in I/Q LC oscillators and a simulation method for fast and efficient phase noise optimization in oscillators. In addition, all modern linear time variant (LTV) phase noise theories are covered. As not only phase noise is of high importance to the designer, but optimization of other oscillator properties as well, additional subjects such as various tuning methods of LC oscillators are analyzed, too. Design examples of integrated LC and ring oscillators in the frequency range of 100 MHz up to 11 GHz are thoroughly discussed throughout the book. The clear and structured discussion of basic oscillator properties make High-Frequency Oscillator Design for Integrated Transceivers an excellent starting point for the inexperienced oscillator designer. The detailed analysis of many oscillator types and circuit topologies, the discussion of numerous practical design issues together with fast optimization methods, and more than 200 carefully selected literature references on oscillator literature, LC oscillator and ring oscillator designs make this book a very valuable resource for the experienced IC designer as well.

GaN Transistors for Efficient Power Conversion

Alternative Energy in Power Electronics

High-Frequency Oscillator Design for Integrated Transceivers

This book analyzes multi-M Hz high frequency resonant DC-DC power converters with operating frequencies ranging from several M Hz to tens of M Hz in detail, aiming to support researchers and engineers with a focus on multi-M Hz high frequency converters. The inverter stage, rectifier stage, matching network stage are analyzed in detail. Based on the three basic stages, typical non-isolated and isolated resonant DC-DC converters are depicted. To reduce the high driving loss under multi-M Hz, resonant driving methods are introduced and improved. Aalso, the design and selection methods of passive and active component under multi-M Hz frequency are described, especially for aircore inductor and transformer. Furthermore, multi-M Hz resonant converter provides an approach for achieving flexible system.

Gallium Nitride and Silicon Carbide Power Technologies 4
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Because of the demand for higher efficiencies, smaller output ripple, and smaller converter size for modern power electronic systems, integrated power electronic converters could soon replace conventional switched-mode power supplies. Synthesized integrated converters and related digital control techniques address problems related to cost, space, flexibility, energy efficiency, and voltage regulation—the key factors in digital power management and implementation. Meeting the needs of professionals working in power electronics, as well as advanced engineering students, Integrated Power Electronic Converters and Digital Control explores the many benefits associated with integrated converters. This informative text details the boost type, buck type, and buck-boost type integrated topologies, as well as other integrated structures. It discusses concepts behind their operation as well specific applications. Topics discussed include: Isolated DC-DC converters such as flyback, forward, push-pull, full-bridge, and half-bridge Power factor correction and its application Definition of the integrated switched-mode power supplies Steady-state analysis of the boost integrated flyback rectifier energy storage converter Dynamic analysis of the buck integrated forward converter Digital control based on the use of digital signal processors (DSPs) With innovations in digital control becoming ever more pervasive, system designers continue to introduce products that integrate digital power management and control integrated circuit solutions, both hybrid and pure digital. This detailed assessment of the latest advances in the field will help anyone working in power electronics and related industries stay ahead of the curve.

POWER ELECTRONICS

MOSFET Technologies for Double-Pole Four-Throw Radio-Frequency Switch

Recent Advances in Power Electronics and Drives

Terahertz Biomedical Science and Technology

SiC based Miniaturized Devices

This book provides analysis and discusses the design of various MOSFET technologies which are used for the design of Double-Pole Four-Throw (DP4T) RF switches for next generation communication systems. The authors discuss the design of the (DP4T) RF switch by using the Double-Gate (DG) MOSFET, as well as the Cylindrical Surrounding double-gate (CSDG) MOSFET. The effect of HFO2 (high dielectric material) in the design of DG MOSFET and CSDG MOSFET is also explored. Coverage includes comparison of Single-gate MOSFET and Double-gate MOSFET switching parameters, as well as testing of MOSFETs parameters using image acquisition.

Multi-MHz High Frequency Resonant DC-DC Power Converter

This second edition includes updated treatments of many topics, including discontinuous-current characteristics of converters, the short-circuit and overload characteristics of rectifiers, the total voltage drop of converters and rectifier equipment flyback DC-to-DC converters.

Design and Control of Power Converters 2019

Unmanned aerial vehicles (UAVs) are being increasingly used in different applications in both military and civilian domains. These applications include surveillance, reconnaissance, remote sensing, target acquisition, border patrol, infrastructure monitoring, aerial imaging, industrial inspection, and emergency medical aid. Vehicles that can be considered autonomous must be able to make decisions and react to events without direct intervention by humans. Although some UAVs are able to perform increasingly complex autonomous manoeuvres, most UAVs are not fully autonomous; instead, they are mostly operated remotely by humans. To make UAVs fully autonomous, many technological and algorithmic developments are still required. For instance, UAVs will need to improve their sensing of obstacles and subsequent avoidance. This becomes particularly important as autonomous UAVs start to operate in civilian airspaces that are occupied by other aircraft. The aim of this volume is to bring together the work of leading researchers and practitioners in the field of unmanned aerial vehicles with a common interest in their autonomy. The contributions that are part of this volume present key challenges associated with the autonomous control of unmanned aerial vehicles, and propose solution methodologies to address such challenges, analyse the proposed methodologies, and evaluate their performance.

Integrated Power Electronic Converters and Digital Control

This textbook, designed for undergraduate students of electrical engineering, offers a comprehensive and accessible introduction to state-of-the-art power semiconductor devices and power electronic converters with an emphasis on design, analysis and realization of numerous types of systems. Each topic is discussed in sufficient depth to expose the fundamental principles, concepts, techniques, methods and circuits, necessary to thoroughly understand power electronic systems.

Proceedings of the 8th International Conference on Sciences of Electronics, Technologies of Information and Telecommunications (SETIT'18)
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Memos of the Faculty of Engineering, Kobe University

This book deals with energy delivery challenges of the power processing unit of modern computer microprocessors. It describes in detail the consequences of current trends in miniaturization and clock frequency increase, upon the power delivery unit, referred to as voltage regulator. This is an invaluable reference for anybody needing to understand the key performance limitations and opportunities for improvement, from both a circuit and systems perspective, of state-of-the-art power solutions for next generation CPUs.

Gallium Nitride-enabled High Frequency and High Efficiency Power Conversion

Containing chapter contributions from over 130 experts, this unique publication is the first handbook dedicated to the physics and technology of X-ray imaging, offering extensive coverage of the field. This highly comprehensive work is edited by one of the world’s leading experts in X-ray imaging physics and technology and has been created with guidance from a Scientific Board containing respected and renowned scientists from around the world. The book’s scope includes 2D and 3D X-ray imaging techniques from soft-X-ray to megavoltage energies, including computed tomography, fluoroscopy, dental imaging and small animal imaging, with several chapters dedicated to breast imaging techniques. 2D and 3D industrial imaging is incorporated, including imaging of artworks. Specific attention is dedicated to techniques of phase contrast X-ray imaging. The approach undertaken is one that illustrates the theory as well as the techniques and the devices routinely used in the various fields. Computational aspects are fully covered, including 3D reconstruction algorithms, hard/software phantoms, and computer-aided diagnosis. Theories of image quality are fully illustrated. Historical, radioprotection, radiation dosimetry, quality assurance and educational aspects are also covered. The handbook will be suitable for a very broad audience, including graduate students in medical physics and biomedical engineering; medical physics residents; radiographers; physicists and engineers in the field of imaging and non-destructive industrial testing using X-rays; and scientists interested in understanding and using X-ray imaging techniques. The handbook’s editor, Dr. Paolo Russo, has over 30 years’ experience in the academic teaching of medical physics and X-ray imaging research. He has authored several book chapters in the field of X-ray imaging, is Editor-in-Chief of an international scientific journal in medical physics, and has responsibilities in the publication committees of international scientific organizations in medical physics. Features: Comprehensive coverage of the use of X-rays both in medical radiology and industrial testing. The first handbook published to be dedicated to the physics and technology of X-rays. Handbook edited by world authority, with contributions from experts in each field.

Voltage Regulators for Next Generation Microprocessors

Among the various factors greatly influencing the development process of future powertrain technologies, the trends in climate change and digitalization are of huge public interest. To handle these trends, new disruptive technologies are integrated into the development process. They open up space for diverse research which is distributed over the entire vehicle design process. This book contains recent research articles which incorporate results for selecting and designing powertrain topology in consideration of the vehicle operating strategy as well as results for handling the reliability of new powertrain components. The field of investigation spans from the identification of ecologically optimal transformation of the existing vehicle fleet to the development of machine learning-based operating strategies and the comparison of complex hybrid electric vehicle topologies to reduce CO2 emissions.

Strain-Engineered MOSFETs

This second edition has been substantially expanded to keep students and practicing power conversion engineers ahead of the learning curve in GaN technology advancements. Acknowledging that GaN transistors are not one-to-one replacements for the current MOSFET technology, it serves as a practical guide for understanding basic GaN transistor construction, characteristics, and applications. Included are discussions on the fundamental physics of these power semiconductors, layout and other circuit design considerations, as well as specific application examples demonstrating design techniques when employing GaN devices. Topics include: discussions on device-circuit interactions; practical guidance on formulating specific circuit designs when constructing power conversion systems using GaN transistors.

Chemical Abstracts

In recognition of the fact that billions of people in the developing world do not have access to clean energies, the United Nations launched the Sustainable Energy for All Initiative to achieve universal energy access by 2030. Although electricity grid extension remains the most prevalent way of providing access, it is now recognized that the central grid is unlikely to reach many remote areas in the near future. At the same time, individual solutions like solar home systems tend to provide very limited services to consumers. Mini-grids offer an alternative by combining the benefits of a grid-based solution with the potential for harnessing renewable energies at the local level. The purpose of this book is to provide in-depth coverage of the use of mini-grids for rural electrification in developing countries, taking into account the technical, economic, environmental and governance dimensions and presenting case studies from South Asia. This book reports on research carried out by a consortium of British and Indian researchers on off-grid electrification in South Asia. It provides state-of-the art technical knowledge on mini-grids and micro-grids including renewable energy integration (or green mini-grids), smart systems for integration with the central grid, and standardization of systems. It also presents essential analytical frameworks and approaches that can be used to analyze the mini-grids comprehensively including their techno-economic aspects, financial viability and regulatory issues. The case studies drawn from South Asia demonstrate the application of the framework and showcase various successful efforts to promote mini-grids in the region. It also reports on the design and implementation of a demonstration project carried out by the team in a cluster of villages in Odisha (India). The book’s multi-disciplinary approach facilitates understanding of the relevant practical dimensions of mini-grid systems, such as demand creation (through interventions in livelihood generation and value chain development), financing, regulation, and smart system design. Its state-of-the-art knowledge, integrated methodological framework, simulation exercises and real-life case analysis will allow the reader to analyze and appreciate the mini-grid related activities in their entirety. The book will be of interest to researchers, graduate students, practitioners and policy makers working in the area of rural electrification.
On the perspectives of SiC MOSFETs in high-frequency and high-power isolated DC/DC converters

Today, there is a great deal of attention focused on sustainable growth worldwide. The increase in efficiency in the use of energy may even, in this historical moment, bring greater benefit than the use of renewable energies. Electricity appears to be the most sustainable of energies and the most promising hope for a planet capable of growing without compromising its own health and that of its inhabitants. Power electronics and electrical drives are the key technologies that will allow energy savings through the reduction of energy losses in many applications. This Special Issue has collected several scientific contributions related to energy efficiency in electrical equipment. Some articles are dedicated to the use and optimization of permanent magnet motors, which allow obtaining the highest level of efficiency. Most of the contributions describe the energy improvements that can be achieved with power electronics and the use of suitable control techniques. Last but not least, some articles describe interesting solutions for hybrid vehicles, which were created mainly to save energy in the smartest way possible.

Bond Graph Model-based Fault Diagnosis of Hybrid Systems

A number of applications including scientific spectroscopy, security screening, and medical imaging have benefitted from the development and utilization of new and emerging terahertz (THz) generation and detection techniques. Exploring recent discoveries and the advancements of biological behaviors through THz spectroscopy and imaging and the development of THz medical techniques. Terahertz Biomedical Science and Technology contains contributions from scientists and researchers in the terahertz biomedical field and is exclusively dedicated to new and emerging terahertz biomedical research and applications. This text offers an assessment of terahertz technology, and provides a compilation of fundamental biological studies conducted using terahertz waves. It introduces THz electromagnetic waves as a new tool for convergent studies, includes laser-based generation techniques and solid-state devices, contains a number of detectors, and discusses high-field generation methods. The material covers recent advancements in terahertz imaging for medical applications—most specifically in cancer diagnosis—reviewing the current status of the THz imaging technique for diagnosing cancers, and exploring the potential medical applications of THz radiation. It also considers the development of future medical applications using terahertz technology. Summarizes the recent progress made in THz waveguides, which are absolutely essential in the development of THz endoscopes Describes the dynamic imaging of drug absorption in skin, exploiting the sensitivity of THz waves to pharmaceutical materials Explores the principle and applications of THz molecular imaging techniques using nanoparticle probes Scientists and engineers involved in biological research and medical applications using optical techniques, as well as graduate students and instructors in optics, physics, electrical engineering, biology, chemistry, and medicine can benefit from this text which highlights new and emerging biomedical studies utilizing novel THz wave techniques.

Handbook of X-ray Imaging

This new resource is a practical overview of designing, testing and troubleshooting power electronics in alternative energy systems, providing you with the most important information on how power electronics components such as inverters, controllers and batteries can play a pivotal role in the successful implementation of green energy solutions for both stand-alone and grid-connected applications. You will learn how to choose the right components for diverse systems, from utility-scale wind farms to photovoltaic panels on single residences, how to get the most out of existing systems, and how to solve the tough challenges particular to alternative energy applications. Whether you are a renewables professional who needs to understand more about how power electronics impact energy output, or a power engineer who is interested in learning what new avenues the alternative energy revolution is opening for your work, start here with advice and explanations from the experts, including equations, diagrams and tables designed to help you understand and succeed. Provides a thorough overview of the key technologies, methods and challenges for implementing power electronics in alternative energy systems for optimal power generation Includes hard-to-find information on how to apply converters, inverters, batteries, controllers and more for stand-alone and grid-connected systems Covers wind and solar applications, as well as ocean and geothermal energy, hybrid systems and fuel cells

Energy Efficiency in Electric Motors, Drives, Power Converters and Related Systems

MEMS devices are found in many of today’s electronic devices and systems, from air-bag sensors in cars to smart phones, embedded systems, etc. Increasingly, the reduction in dimensions has led to nanometer-scale devices, called NEMS. The plethora of applications on the commercial market speaks for itself, and especially for the highly precise manufacturing of silicon-based MEMS and NEMS. While this is a tremendous achievement, silicon as a material has some drawbacks, mainly in the area of mechanical fatigue and thermal properties. Silicon carbide (SiC), a well-known wide-bandgap semiconductor whose adoption in commercial products is experiencing exponential growth, especially in the power electronics arena. While SiC MEMS have been around for decades, in this Special Issue we seek to capture both an overview of the devices that have been demonstrated to date, as well as bring new technologies and progress in the MEMS processing area to the forefront. Thus, this Special Issue seeks to showcase research papers, short communications, and review articles that focus on: (1) novel design, fabrication, control, and modeling of SiC MEMS and NEMS based on all kinds of actuation mechanisms; and (2) new developments in applying SiC MEMS and NEMS in consumer electronics, optical communications, industry, medicine, agriculture, space, and defense.

Applications of Power Electronics

This book presents select proceedings of the Electric Power and Renewable Energy Conference 2020 (EPREC-2020). It provides rigorous discussions, case studies, and recent developments in the emerging areas of power electronics, especially, power inverter and converter, electrical drives, regulated power supplies, operation of FACTS & HVDC, etc. The readers would be benefited in enhancing their knowledge and skills in these domain areas. The book will be a valuable reference for beginners, researchers, and professionals interested in advancements in power electronics and drives.
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Thermal Energy

In this book, 20 papers focused on different fields of power electronics are gathered. Approximately half of the papers are focused on different control issues and techniques, ranging from the computer-aided design of digital compensators to more specific approaches such as fuzzy or sliding control techniques. The rest of the papers are focused on the design of novel topologies. The fields in which these controls and topologies are applied are varied: M C M S, photovoltaic systems, supercapacitors and traction systems, L E D S, wireless power transfer, etc.

Systems Approach to Social Engineering.


IAENG Transactions on Engineering Technologies

Provides a concise and thorough reference for designing electrical and electronic systems that employ adjustable speed drives Electrical and electronic systems that employ adjustable speed drives are being increasingly used in present-day automation applications. They are considered by many application engineers as one of the most interfering components, especially in a contempory faceted industrial environment. This book fills the gap between the high-level academic knowledge in the electromagnetic compatibility (EMC) field and the recommended practical rules for assuring electromagnetic compatibility margin. It focuses on finding and formulating the issues that often occur with the generation and propagation of conducted emission in A C motor drives fed by frequency converters, rather than proposing specific solutions for dealing with them. It also features explanations of selected academic backgrounds of EMC and presents practical case studies. The book starts with an introduction to conducted emission in adjustable speed drives. It then goes on to offer in-depth chapters covering conducted emission origins in switch-mode power converters; conducted emission generation by frequency converter in adjustable speed drives (A S D); propagation of motor side originated conducted emission towards the power grid; modeling of conducted emission in A S D; broadband behavior of A S D components; and impact of a motor feeding cable on C M currents generated in A S D. In addition, this resource: Presents state-of-the-art analysis of undesirable high frequency phenomena accompanying A C motor speed control Discusses the fundamentals of phenomena of electromagnetic interference (EMI) generation in switch mode static converters Provides methodology of modeling-conducted E M I generation and propagation in A S D High Frequency Conducted Emission in A C M otors Drives Fed B y Frequency Converters: Sources and Propagation Paths will appeal to scholars and a wide range of professionals who are involved in the stages of development, design, and application of adjustable speed drives in accordance with ever-increasing EMC requirements.

Electric, Electronic and Control Engineering

The book details sources of thermal energy, methods of capture, and applications. It describes the basics of thermal energy, including measuring thermal energy, laws of thermodynamics that govern its use and transformation, modes of thermal energy, conventional processes, devices and materials, and the methods by which it is transferred. It covers B sources of thermal energy: combustion, fusion (solar) fission (nuclear), geothermal, microwave, plasma, waste heat, and thermal energy storage. In each case, the methods of production and capture and its uses are described in detail. It also discusses novel processes and devices used to improve transfer and transformation processes.

Proceedings of 1995 International Conference on Power Electronics and Drive Systems

Increasing demand for efficiency and power density pushes Si-based devices to some of their inherent material limits, including those related to temperature operation, switching frequency, and blocking voltage. Recently, SiC-based power devices are promising candidates for high-power and high-frequency switching applications. Today, SiC M O S F E T S are commercially available from several manufacturers. Although technology affiliated with SI C M O S F E T S is improving rapidly, many challenges remain, and some of them are investigated in this work. The research work in this dissertation is divided into the three following parts. Firstly, the static and switching characteristics of the state-of-the-art 1.2 kV planar and double-trench S IC M O S F E T S from two different manufacturers are evaluated. The effects of different biasing voltages, D C link voltages, and temperatures are analysed. The characterisation results show that the devices exhibit superior manufacturing performance under different operating conditions. Moreover, several aspects of using the S IC M O S F E T S body diode in a D C/D C converter are investigated, comparing the body-diodes of planar and double-trench devices. Reverse recovery is evaluated in switching tests considering the case temperature, switching rate, forward current, and applied voltage. Basing on the measurement results, the junction temperature is estimated to guarantee safe operation. A simple electro-thermal model is proposed in order to estimate the maximum allowed switching frequency based on the thermal design of the S I C devices. Using these results, hard- and soft-switching converters are designed, and devices are characterised as being in continuous operation at a very high switching frequency of 1 M H z. Thereafter, the S IC M O S F E T S are operated in a continuous mode in a 10 k W / 100-250 k H z buck converter, comparing synchronous rectification, the use of the body diode, and the use of an external Schottky diode. Further, the parallel operation of the planar devices is considered. Thus, the parallelization of S IC M O S F E T S is investigated in continuous converter operation. In this regard, the impact of the most common mismatch parameters on the static and dynamic current sharing of the parallel and double-trench S IC devices is presented. The effects of different biasing voltages, D C link voltages, and gate resistances are evaluated. Additionally, the temperature-dependence of the short-circuit capability is evaluated, and the associated failure modes are analysed. Subsequently, the design and test of two different methods for overcurrent protection are proposed. The desaturation technique is applied to the S IC M O S F E T S and...
compared to a second method that depends on the stray inductance of the devices. Finally, the benefits of using SiC devices in continuous high-frequency, high-power DC/DC converters is experimentally evaluated. In this regard, a design optimisation of a high-frequency transformer is introduced, and the impact of different core materials, conductor designs, and winding arrangements are evaluated. A ZVZCS Phase-Shift Full-Bridge unidirectional DC/DC converter is proposed, using only the parasitic leakage inductance of the transformer. Experimental results for a 10 kW, (100-250) kHz prototype indicate an efficiency of up to 98.1% for the whole converter. Furthermore, an optimized control method is proposed to minimise the circulation current in the isolated bidirectional dual active bridge DC/DC converter, based on a modified dual-phase-shift control method. This control method is also experimentally compared with traditional single-phase-shift control, yielding a significant improvement in efficiency. The experimental results confirm the theoretical analysis and show that the proposed control can enhance the overall converter efficiency and expand the ZVZCS range. The stated impact on efficiency and Leistungsdichte brings Si-basierte Leistungsbaulemente an einige inhärente Materialeigenschaften, die unter anderem mit der Temperaturbelastung, der Schaltfrequenz und der Blockierspannung in Zusammenhang stehen. In jüngster Zeit sind SiC-basierte Leistungsbaulemente vielversprechende Kandidaten für Hochleistungs- und Hochfrequenzanwendungen. A künftig sind SiC-MOSFETs von mehreren Herstellern im Handel erhältlich. Obwohl sich die Technologie der SiC-MOSFETs rasch verbessert, werden viele Herausforderungen bestehen bleiben. Einige dieser Herausforderungen werden in dieser Arbeit untersucht. Die Untersuchungen in dieser Dissertation gliedern sich in die drei folgenden Teile: Im ersten Teil erfolgt die statiache und die transient Charakterisierung der aktuellen 1.2 kV Planar/Doubletrench SiC-MOSFETs verschiedener Hersteller. Die Auswirkungen unterschiedlicher Gatespannungen, Zwischenkreisspannungen und Temperaturen werden analysiert. Die Ergebnisse der Charakterisierung zeigen, dass die Bauteile überlegene Schaltleistungen unter verschiedenen Betriebsbedingungen aufweisen. Darüber hinaus wird der Einsatz der inneren SiC-Bodydioden in einem DC/DC-Wandler untersucht, wobei die Unterschiede zwischen Planar- und Doubletrench-Bauteilen aufgezeigt werden. Das Reverse-Recovery-Erhalten wird unter Berücksichtigung der Gehäusetemperatur, der Schaltgeschwindigkeit, des Durchlassstroms und der angelegten Spannung bewertet. Anhand der Messeignisse wird die Sperrschichttemperatur geschätzt, damit ein sicherer Betrieb gewährleistet ist. Ein einfaches elektrothermisches Modell wird vorgestellt, um die maximal zulässige Schaltfrequenz auf der Grundlage des thermischen Designs der SiC-Bauteile abzuschätzen. Anhand dieser Ergebnisse werden hart- und weichschaltende Umrichter konzipiert und die Bauteile werden im Dauerbetrieb mit einer sehr hohen Schaltfrequenz von 1 MHz untersucht. Danach werden die SiC-MOSFETs im Dauerbetrieb in einem 10 kW / 100-250 kHz-Tiefsetzsteller betrieben. Dabei wird der Stromkreisverbrauch, die Wirkungsgradenergie der internen Diode und der Verbrauch an externer Schalt-Diode verglichen. Außerdem wird die Parallelisierung von SiC-MOSFETs untersucht, bevor die Parallelisierung der verschiedenen Bauelemente im kontinuierlichen K onverterbetrieb verglichen wird. Es wird der Einfluss der häufigsten Parametervariationen auf die statische und dynamische Stromaufteilung der Transistoren analysiert, was zeigt, dass eine Parallelisierung von SiC-MOSFETs möglich ist. Anschließend wird ein analytisches Modell der SiC-MOSFETs zur Schaltverlustoptimierung vorgeschlagen. Das analytische Modell zeigt eine relativ geringe Übereinstimmung mit den Messergebnissen bei verschiedenen Testbedingungen. Das vorgeschlagene Modell bildet die Schwingungen sowohl beim Ein- als auch beim Ausschal gen effektiv nach. Dies wurde durch die Realisierung der wichtigsten parasitären Elemente in Strom- und Gatekreisen erreicht. Im zweiten Teil wird eine umfassende Bewertung der Kurzschlussfestigkeit mit Fokus auf verschiedene Ausfallmodi der planaren und double-trench SiC-Bauelemente vorgestellt. Die Auswirkungen unterschiedlicher Gatespannungen, Zwischenkreisspannungen und Gate-Widerstände werden ausgewertet. Zusätzlich wird die temperaturabhängige Kurzschlussfahigkeit ausgewertet und die zugehörigen Fehlerfälle werden analysiert. Anschließend wird die Auslegung und Vergleich von zwei verschiedenen Verfahren zum Überstromschutz evaluiert. Die „Desaturation“-Technik wird auf SiC-MOSFETs angewendet und mit einer zweiten Methodologie verglichen, welche die parasitäre Induktivität der Bauelemente nutzt. Schließlich wird der Einfluss des Einsatzes von SiC-Bauelementen in kontinuierlichen Hochfrequenz-Hochleistungs-DC/DC-Wandlern experimentell untersucht. In diesem Zusammenhang wird eine Desaktivierung eines Hochfrequenztransformators vorgestellt und der Einfluss der Parameter Variationen auf die Leistungsauslegung analysiert. Es wird ein einrichten Zwischenkreis mit einem bidirektionalen DC/DC-Wandler vorgestellt, der die parasitäre Leistungsauslegung der Transformatoren verwendet. Experimentelle Ergebnisse für einen 10 kW, (100-250) kHz Prototyp zeigen einen Wirkungsgrad von bis zu 98.1% für den gesamten Umrichter. Es zeigt sich, dass die parasitäre Leistungsauslegung in einem bidirektionalen DC/DC-Wandler zu minimieren. Diese Regelverfahren werden experimentell mit einer herkömmlichen Single-Phase-Shift-Regelung verglichen. Hierbei zeigt sich eine deutliche Effizienzsteigerung durch die neue Regelverfahren. Die experimentellen Ergebnisse bestätigen die theoretische Analyse und zeigen, dass die vorgeschlagene Regelung den Gesamtwirkungsgrad des Umrichters erhöhen und den ZVS-Bereich erweitern kann.

Future Powertrain Technologies

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A New Introduction to Power Electronics

This book demonstrates to readers why Gallium Nitride (GaN) transistors have a superior performance as compared to the already mature Silicon technology. The new GaN-based transistors here described enable both high frequency and high efficiency power conversion, leading to smaller and more efficient power systems. Coverage includes: i) GaN substrates and devices physics; ii) innovative GaN -transistors structure (lateral and vertical); iii) reliability and robustness of GaN-power transistors; iv) impact of parasitic on GaN based power conversion; v) new power converter architectures and vi) GaN in switched mode power conversion. Provides single-source reference to Gallium Nitride (GaN)-based technologies, from the material level to circuit level, both for power conversions architectures and switched mode power amplifiers. Demonstrates how GaN is a superior technology for switching devices, enabling both high frequency, high efficiency and lower cost power conversion; Enables design of smaller, cheaper and more efficient power supplies.

High Frequency Conducted Emission in A C M otor Drives Fed By Frequency Converters

applications. The book offers the state of art of tremendous advances in engineering technologies and physical science and applications, and also serves as an excellent reference work for researchers and graduate students working on engineering technologies and physical science and applications.

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