power electronics converters applications and design 3rd edition

Power Electronics Converters Applications and Design 3rd Edition: A Deep Dive into Modern Power Conversion

power electronics converters applications and design 3rd edition serves as a cornerstone reference for engineers, researchers, and students delving into the intricate world of power electronics. This field, pivotal in today's energy-efficient and renewable-focused landscape, revolves around converting and controlling electrical power effectively. The third edition of this comprehensive work not only updates foundational theory but also integrates the latest advancements in converter topologies, control strategies, and practical applications. Whether you're designing converters for electric vehicles, industrial drives, or renewable energy systems, understanding the nuances in this latest edition is invaluable.

Understanding Power Electronics Converters: The Essentials

Power electronics converters are devices that transform electrical energy from one form to another — for example, converting AC to DC, DC to AC, or altering voltage and frequency levels. The third edition of this text emphasizes both the theoretical underpinnings and practical design considerations, making it a go-to resource for anyone working in the field.

Why the Third Edition Matters

The 3rd edition reflects the rapid evolution of power semiconductor devices, such as IGBTs, MOSFETs, and the newer SiC and GaN technologies, which enable higher switching frequencies, improved efficiency, and more compact converter designs. It also includes updated chapters on digital control techniques and thermal management — aspects critical to modern converter performance.

By integrating cutting-edge research with hands-on design examples, the book bridges the gap between academic theory and real-world applications, which is essential for emerging engineers aiming to innovate in sectors like renewable energy, electric transportation, and smart grids.

Applications of Power Electronics Converters

One of the most compelling reasons to explore the "power electronics converters applications and design

3rd edition" is its comprehensive coverage of practical applications across industries. Let's explore some key sectors where power electronics converters are making a transformative impact.

Renewable Energy Systems

The integration of solar and wind power into electrical grids relies heavily on efficient power converters. In solar photovoltaic (PV) systems, converters manage the DC output from solar panels and invert it to AC for grid compatibility. The third edition delves into advanced Maximum Power Point Tracking (MPPT) methods and grid-tied inverter designs that optimize energy harvest and ensure stability.

Similarly, wind turbines use power converters to regulate variable frequency AC generated by the turbine's rotor and convert it to grid-compatible AC power. The book explains how back-to-back converter topologies and vector control strategies enhance performance and reliability in wind energy conversion systems.

Electric Vehicles and Transportation

The rise of electric vehicles (EVs) has placed power electronics converters front and center in automotive design. From onboard chargers to traction inverters and DC-DC converters, efficient power conversion dictates vehicle range, performance, and safety.

The 3rd edition provides detailed insights into designing converters that handle high power densities and thermal stresses typical in automotive environments. It also covers emerging trends like silicon carbide (SiC) devices, which contribute to lighter, more efficient EV powertrains.

Industrial Motor Drives

Industrial automation heavily depends on variable frequency drives (VFDs) and motor controllers, which rely on power electronics converters to control motor speed and torque. The book's updated material on PWM (Pulse Width Modulation) techniques and digital control algorithms helps engineers design drives that reduce energy consumption and improve process precision.

Power Supplies and Energy Storage

From data centers to consumer electronics, reliable and efficient power supplies are essential. The third edition addresses design aspects of switched-mode power supplies (SMPS), uninterruptible power supplies (UPS), and battery management systems, highlighting how modern converters ensure stable voltage

outputs and prolong battery life.

Design Principles Covered in the Third Edition

Designing power electronics converters is a multifaceted challenge that balances efficiency, cost, thermal management, and electromagnetic compatibility. The third edition of this book offers a structured approach to these challenges.

Converter Topologies and Selection

A significant portion of the book focuses on various converter topologies — from basic buck, boost, and buck-boost converters to complex multi-level inverters and resonant converters. It guides readers on selecting appropriate topologies based on application requirements such as voltage levels, power ratings, and switching frequencies.

Control Techniques and Strategies

Effective control is vital to the performance of power converters. The third edition covers classical control methods like PI and PID controllers as well as advanced digital control techniques, including model predictive control and adaptive control. These sections provide practical examples and simulation models that help engineers optimize dynamic response and stability.

Thermal and Reliability Considerations

Heat dissipation and device reliability are critical in converter design. This edition expands on thermal modeling approaches, heatsink selection, and cooling techniques to ensure longevity and safe operation under varying load conditions.

EMI and Filtering

Electromagnetic interference (EMI) can degrade performance and cause regulatory issues. The book's updated chapters offer strategies for EMI mitigation, including layout best practices, snubber circuits, and filter design — essential topics for engineers aiming to meet stringent standards.

Practical Tips and Insights for Designers

Beyond theory, the “power electronics converters applications and design 3rd edition” provides hands-on guidance that can make a real difference in projects.

- **Start with simulation:** Using tools like MATLAB/Simulink or PLECS allows designers to model converter behavior before hardware implementation, saving time and resources.
- **Focus on device selection:** Choosing the right semiconductor devices based on switching speed, voltage, and current ratings impacts overall efficiency and cost.
- **Consider modularity:** Designing converters with modular components can simplify maintenance and scalability.
- **Thermal design early:** Incorporate cooling solutions from the initial design stages to avoid costly redesigns.
- **Test thoroughly:** Employ comprehensive testing under different load and fault conditions to ensure reliability.

Why This Book Stands Out in Power Electronics Literature

Many books address power electronics, but the “power electronics converters applications and design 3rd edition” stands apart due to its balanced blend of theory, practical design, and real-world applications. It recognizes the evolving technology landscape and addresses challenges faced by modern engineers.

The inclusion of emerging semiconductor technologies, digital control advancements, and application case studies makes it relevant not just for academic learning but also as a professional reference. Its clear explanations and updated examples help readers grasp complex concepts intuitively.

Exploring topics like grid integration of renewable sources, electric vehicle powertrains, and advanced motor drives within a single volume offers a holistic perspective often missing in other texts.

Navigating the complex world of power electronics converters requires resources that keep pace with fast-changing technologies and diverse application demands. By engaging with the insights provided in the third edition of this seminal book, professionals can enhance their design skills, improve system

performance, and contribute meaningfully to the future of energy conversion and management.

Frequently Asked Questions

What are the key topics covered in 'Power Electronics Converters: Applications and Design, 3rd Edition'?

The book covers fundamental principles, converter topologies, control techniques, applications in renewable energy systems, motor drives, power quality, and design methodologies for power electronics converters.

How does the 3rd edition improve upon previous editions of 'Power Electronics Converters: Applications and Design'?

The 3rd edition includes updated content with recent advancements in wide bandgap semiconductor devices, enhanced design examples, new chapters on emerging applications, and improved coverage of control and modulation techniques.

Who is the target audience for 'Power Electronics Converters: Applications and Design, 3rd Edition'?

The book is intended for electrical engineering students, researchers, and practicing engineers involved in power electronics design and applications.

Does the book include practical design examples for power electronics converters?

Yes, the 3rd edition provides numerous practical design examples and case studies to help readers apply theoretical concepts to real-world converter design challenges.

What types of power electronics converters are discussed in the book?

The book discusses various converters including DC-DC converters, AC-DC rectifiers, DC-AC inverters, AC-AC converters, and their applications in industrial and renewable energy systems.

Are control strategies for power electronics converters covered in this edition?

Yes, the book covers a range of control techniques including pulse width modulation (PWM), feedback control, and advanced control methods to enhance converter performance.

How does the book address renewable energy applications in power electronics?

The 3rd edition includes dedicated sections on integrating power electronics converters with renewable energy sources such as solar photovoltaic systems and wind turbines, highlighting design and control challenges.

Is simulation and modeling of power electronics converters included in the 'Power Electronics Converters: Applications and Design, 3rd Edition'?

Yes, the book discusses simulation techniques and modeling approaches to analyze converter behavior and optimize design using tools like MATLAB/Simulink.

Additional Resources

Power Electronics Converters Applications and Design 3rd Edition: A Comprehensive Review

power electronics converters applications and design 3rd edition stands as a critical resource for engineers, researchers, and students involved in the evolving field of power electronics. This edition builds on its predecessors by offering updated content that reflects the rapid advancements in semiconductor devices, converter topologies, and control strategies. In the realm of power electronics, where efficiency, reliability, and innovation are paramount, this book provides a thorough exploration of converter designs and their practical applications across various industries.

In-depth Analysis of Power Electronics Converters Applications and Design 3rd Edition

The third edition of "Power Electronics Converters Applications and Design" is an authoritative text that addresses both foundational concepts and contemporary developments in power electronics. It expertly bridges theoretical principles with industrial applications, making it relevant for a broad audience. Key updates in this edition include expanded coverage of wide bandgap semiconductors, such as silicon carbide (SiC) and gallium nitride (GaN), which are revolutionizing power converter efficiency and thermal management.

One of the standout features of this edition is its comprehensive treatment of converter topologies, ranging from basic DC-DC converters to complex multi-level inverters. The book delves into the design considerations for each topology, emphasizing the trade-offs in efficiency, cost, and complexity. Moreover, it incorporates discussions on digital control techniques, which are increasingly prevalent in modern power electronics systems due to their flexibility and precision.

Applications Explored in the 3rd Edition

The scope of applications covered in this edition is wide-ranging, encompassing renewable energy systems, electric vehicles, industrial motor drives, and power supplies for telecommunications. The book meticulously examines how power electronics converters are tailored to meet the specific demands of these sectors.

- **Renewable Energy Integration**: The text explores how converters are essential for interfacing solar photovoltaic arrays and wind turbines to the grid. It discusses maximum power point tracking (MPPT) algorithms and grid synchronization techniques that optimize energy harvest and ensure stability.

- **Electric Vehicles (EVs)**: Detailed explanations of traction inverters, onboard chargers, and battery management systems illustrate the pivotal role of converters in EV performance and efficiency. The book also touches on emerging trends such as wireless charging and bidirectional converters for vehicle-to-grid (V2G) applications.

- **Industrial Motor Drives**: Power electronics converters are vital in controlling speed and torque in industrial motors. This edition highlights methods for minimizing harmonic distortion and improving power factor, which are critical in industrial settings to enhance energy efficiency and equipment longevity.

Design Methodologies and Practical Insights

What differentiates this edition is its balanced approach between theoretical models and practical design guidelines. Readers gain insights into component selection, thermal management, electromagnetic interference (EMI) mitigation, and reliability considerations. The inclusion of real-world design examples and case studies enables practitioners to apply concepts effectively.

The book emphasizes the importance of simulation tools such as MATLAB/Simulink and PLECS in the design process, allowing engineers to validate converter performance under diverse operating conditions. It also addresses emerging software platforms that integrate hardware-in-the-loop (HIL) testing, enhancing the robustness of power converter designs before physical prototyping.

Comparative Perspective on Power Electronics Literature

When compared to other seminal works in the field, such as Rashid's "Power Electronics: Circuits, Devices, and Applications" or Mohan's "Power Electronics: Converters, Applications, and Design," this third edition carves out a niche by marrying detailed application scenarios with an updated focus on new semiconductor technologies. Its pedagogical structure is both rigorous and accessible, making it suitable for graduate-level

coursework and professional reference.

Unlike some texts that focus heavily on theory or device physics, "Power Electronics Converters Applications and Design 3rd Edition" prioritizes the practical implementation challenges faced by engineers today. This includes addressing the complexities of thermal design in high-power converters and the integration of smart control algorithms to enhance system adaptability and fault tolerance.

Strengths and Areas for Enhancement

The book's strengths lie in its exhaustive coverage of converter topologies and application domains, combined with up-to-date insights into emerging technologies. It provides a valuable resource for understanding the nuances of modern power electronics design, including the transition toward electrification and decarbonization.

However, some readers might find the mathematical treatment in certain chapters dense, particularly those less familiar with advanced control theory. Additionally, while the book introduces digital control concepts, deeper exploration of machine learning and artificial intelligence applications in power converters could further enrich future editions, given their growing significance.

Impact on Industry and Academic Circles

The third edition's influence extends beyond academia into industrial research and development. Power electronics engineers engaged in designing converters for high-efficiency renewable systems or next-generation electric vehicles often cite this book as a practical guide. Its detailed analysis of wide bandgap devices aligns well with current industry trends focused on reducing losses and improving power density.

Academically, the book serves as a foundational text for courses on power converter design, enabling students to grasp both fundamental principles and real-world applications. Its inclusion of problem sets and design exercises facilitates active learning and critical thinking.

In summary, "Power Electronics Converters Applications and Design 3rd Edition" remains a pivotal contribution to the literature, reflecting the dynamic nature of power electronics technology. Its blend of theoretical depth and practical relevance ensures that it will continue to be an essential reference for those shaping the future of energy conversion and control systems.

Power Electronics Converters Applications And Design 3rd

Edition

power electronics converters applications and design 3rd edition: *Power Electronics Handbook* Muhammad H. Rashid, 2010-07-19 Power electronics, which is a rapidly growing area in terms of research and applications, uses modern electronics technology to convert electric power from one form to another, such as ac-dc, dc-dc, dc-ac, and ac-ac with a variable output magnitude and frequency. Power electronics has many applications in our every day life such as air-conditioners, electric cars, sub-way trains, motor drives, renewable energy sources and power supplies for computers. This book covers all aspects of switching devices, converter circuit topologies, control techniques, analytical methods and some examples of their applications.* 25% new content* Reorganized and revised into 8 sections comprising 43 chapters* Coverage of numerous applications, including uninterruptable power supplies and automotive electrical systems* New content in power generation and distribution, including solar power, fuel cells, wind turbines, and flexible transmission

power electronics converters applications and design 3rd edition: *Power Electronics* Ned Mohan, Tore M. Undeland, William P. Robbins, 2003 CD-ROM contains PSpice based simulation to illustrate basic concepts; magnetic component design program; PowerPoint slides to summarise topics. companion web site available.

power electronics converters applications and design 3rd edition: Power Electronics Fang Lin Luo, Hong Ye, 2018-01-02 Power Electronics is a large size technology, mainly covering four categories: the AC/DC rectifiers, DC/DC converters, DC/AC inverters, and AC/AC converters. This book offers approximately 100 novel topologies of all four. The applications are used in sustainable energy generation areas, such as distributed generation (DG), micro-grid (MG), smart grid (SG) systems, and electrical vehicles (EV). With case studies from GE, AEG, Simplatroll Ltd, and Chinese Power Manufacturing Co., the reader will be exposed to practical applications in industry and real-world settings. This new edition features an entirely new chapter on best switching angles to obtain lowest THD for multilevel DC/AC inverters. Additionally, all chapters have been updated and include homework problems throughout.

power electronics converters applications and design 3rd edition: *Power Electronics* Issa Batarseh, Ahmad Harb, 2017-12-22 This fully updated textbook provides complete coverage of electrical circuits and introduces students to the field of energy conversion technologies, analysis and design. Chapters are designed to equip students with necessary background material in such topics as devices, switching circuit analysis techniques, converter types, and methods of conversion. The book contains a large number of examples, exercises, and problems to help enforce the material presented in each chapter. A detailed discussion of resonant and softswitching dc-to-dc converters is included along with the addition of new chapters covering digital control, non-linear control, and micro-inverters for power electronics applications. Designed for senior undergraduate and graduate electrical engineering students, this book provides students with the ability to analyze and design power electronic circuits used in various industrial applications.

power electronics converters applications and design 3rd edition: Advanced Electric Drive Vehicles Ali Emadi, 2014-10-24 Electrification is an evolving paradigm shift in the transportation industry toward more efficient, higher performance, safer, smarter, and more reliable vehicles. There is in fact a clear trend to move from internal combustion engines (ICEs) to more integrated electrified powertrains. Providing a detailed overview of this growing area, Advanced

Electric Drive Vehicles begins with an introduction to the automotive industry, an explanation of the need for electrification, and a presentation of the fundamentals of conventional vehicles and ICEs. It then proceeds to address the major components of electrified vehicles—i.e., power electronic converters, electric machines, electric motor controllers, and energy storage systems. This comprehensive work: Covers more electric vehicles (MEVs), hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), range-extended electric vehicles (REEVs), and all-electric vehicles (EVs) including battery electric vehicles (BEVs) and fuel cell vehicles (FCVs) Describes the electrification technologies applied to nonpropulsion loads, such as power steering and air-conditioning systems Discusses hybrid battery/ultra-capacitor energy storage systems, as well as 48-V electrification and belt-driven starter generator systems Considers vehicle-to-grid (V2G) interface and electrical infrastructure issues, energy management, and optimization in advanced electric drive vehicles Contains numerous illustrations, practical examples, case studies, and challenging questions and problems throughout to ensure a solid understanding of key concepts and applications Advanced Electric Drive Vehicles makes an ideal textbook for senior-level undergraduate or graduate engineering courses and a user-friendly reference for researchers, engineers, managers, and other professionals interested in transportation electrification.

power electronics converters applications and design 3rd edition: Power Electronics, A First Course Ned Mohan, Siddharth Raju, 2023-01-12 POWER ELECTRONICS A FIRST COURSE Enables students to understand power electronics systems, as one course, in an integrated electric energy systems curriculum Power Electronics A First Course provides instruction on fundamental concepts related to power electronics to undergraduate electrical engineering students, beginning with an introductory chapter and moving on to discussing topics such as switching power-poles, switch-mode dc-dc converters, and feedback controllers. The authors also cover diode rectifiers, power-factor-correction (PFC) circuits, and switch-mode dc power supplies. Later chapters touch on soft-switching in dc-dc power converters, voltage and current requirements imposed by various power applications, dc and low-frequency sinusoidal ac voltages, thyristor converters, and the utility applications of harnessing energy from renewable sources. Power Electronics A First Course is the only textbook that is integrated with hardware experiments and simulation results. The simulation files are available on a website associated with this textbook. The hardware experiments will be available through a University of Minnesota startup at a low cost. In Power Electronics A First Course, readers can expect to find detailed information on: Availability of various power semiconductor devices that are essential in power electronic systems, plus their switching characteristics and various tradeoffs Common foundational unit of various converters and their operation, plus fundamental concepts for feedback control, illustrated by means of regulated dc-dc converters Basic concepts associated with magnetic circuits, to develop an understanding of inductors and transformers needed in power electronics Problems associated with hard switching, and some of the practical circuits where this problem can be minimized with soft-switching Power Electronics A First Course is an ideal textbook for Junior/Senior-Undergraduate students in Electrical and Computer Engineering (ECE). It is also valuable to students outside of ECE, such as those in more general engineering fields. Basic understanding of electrical engineering concepts and control systems is a prerequisite.

power electronics converters applications and design 3rd edition: Power Converters, Drives and Controls for Sustainable Operations S. Ganesh Kumar, Marco Rivera Abarca, S. K. Pattanaik, 2023-07-25 POWER CONVERTERS, DRIVES AND CONTROLS FOR SUSTAINABLE OPERATIONS Written and edited by a group of experts in the field, this groundbreaking reference work sets the standard for engineers, students, and professionals working with power converters, drives, and controls, offering the scientific community a way towards combating sustainable operations. The future of energy and power generation is complex. Demand is increasing, and the demand for cleaner energy and electric vehicles (EVs) is increasing with it. With this increase in demand comes an increase in the demand for power converters. Part one of this book is on switched-mode converters and deals with the need for power converters, their topologies, principles

of operation, their steady-state performance, and applications. Conventional topologies like buck, boost, buck-boost converters, inverters, multilevel inverters, and derived topologies are covered in part one with their applications in fuel cells, photovoltaics (PVs), and EVs. Part two is concerned with electrical machines and converters used for EV applications. Standards for EV, charging infrastructure, and wireless charging methodologies are addressed. The last part deals with the dynamic model of the switched-mode converters. In any DC-DC converter, it is imperative to control the output voltage as desired. Such a control may be achieved in a variety of ways. While several types of control strategies are being evolved, the popular method of control is through the duty cycle of the switch at a constant switching frequency. This part of the book briefly reviews the conventional control theory and builds on the same to develop advanced techniques in the closed-loop control of switch mode power converters (SMPC), such as sliding mode control, passivity-based control, model predictive control (MPC), fuzzy logic control (FLC), and backstepping control. A standard reference work for veteran engineers, scientists, and technicians, this outstanding new volume is also a valuable introduction to new hires and students. Useful to academics, researchers, engineers, students, technicians, and other industry professionals, it is a must-have for any library.

power electronics converters applications and design 3rd edition: Advances in Induction and Microwave Heating of Mineral and Organic Materials Stanisław Grundas, 2011-02-14 The book offers comprehensive coverage of the broad range of scientific knowledge in the fields of advances in induction and microwave heating of mineral and organic materials. Beginning with industry application in many areas of practical application to mineral materials and ending with raw materials of agriculture origin the authors, specialists in different scientific area, present their results in the two sections: Section 1-Induction and Microwave Heating of Mineral Materials, and Section 2-Microwave Heating of Organic Materials.

power electronics converters applications and design 3rd edition: High-Power Converters and AC Drives Bin Wu, Mehdi Narimani, 2017-01-17 A comprehensive reference of the latest developments in MV drive technology in the area of power converter topologies This new edition reflects the recent technological advancements in the MV drive industry, such as advanced multilevel converters and drive configurations. It includes three new chapters, Control of Synchronous Motor Drives, Transformerless MV Drives, and Matrix Converter Fed Drives. In addition, there are extensively revised chapters on Multilevel Voltage Source Inverters and Voltage Source Inverter-Fed Drives. This book includes a systematic analysis on a variety of high-power multilevel converters, illustrates important concepts with simulations and experiments, introduces various megawatt drives produced by world leading drive manufacturers, and addresses practical problems and their mitigations methods. This new edition: Provides an in-depth discussion and analysis of various control schemes for the MV synchronous motor drives Examines new technologies developed to eliminate the isolation transformer in the MV drives Discusses the operating principle and modulation schemes of matrix converter (MC) topology and multi-module cascaded matrix converters (CMCs) for MV drives, and their application in commercial MV drives Bin Wu is a Professor and Senior NSERC/Rockwell Automation Industrial Research Chair in Power Electronics and Electric Drives at Ryerson University, Canada. He is a fellow of Institute of Electrical and Electronics Engineers (IEEE), Engineering Institute of Canada (EIC), and Canadian Academy of Engineering (CAE). Dr. Wu has published more than 400 papers and holds more than 30 granted/pending US/European patents. He co-authored several books including Power Conversion and Control of Wind Energy Systems and Model Predictive Control of Wind Energy Conversion Systems (both by Wiley-IEEE Press). Mehdi Narimani is a Postdoctoral Research Associate with the Department of Electrical and computer Engineering at Ryerson University, Canada, and Rockwell Automation Canada. He is a senior member of IEEE. Dr. Narimani is author/co-author of more than 50 technical papers and four US/European patents (issued/pending review). His current research interests include power conversion, high power converters, control of power electronics, and renewable energy systems.

power electronics converters applications and design 3rd edition: Recent Developments on Power Inverters Ali Saghafinia, 2017-06-21 This book develops some methods and structures to improve the power inverters for different applications in a single-phase or three-phase output in recent years. The reduction of the switching devices and multilevel inverters as changing structure for the power inverters and PDM and PWM methods as changing control methods for the power inverter are studied in this book. Moreover, power inverters are developed to supply open-ended loads. Furthermore, the basic and advanced aspects of the electric drives that are control based are taught for induction motor (IM) based on power inverters suitable for both undergraduate and postgraduate levels. The main objective of this book is to provide the necessary background to improve and implement the high-performance inverters. Once the material in this book has been mastered, the reader will be able to apply these improvements in the power inverters to his or her problems for high-performance power inverters.

power electronics converters applications and design 3rd edition: Simulation technischer linearer und nichtlinearer Systeme mit MATLAB/Simulink Josef Hoffmann, Franz Quint, 2014-08-19 Das Buch behandelt praxisrelevante Beispiele zur Simulation linearer und nichtlinearer Systeme mit MATLAB/Simulink. Mit der leistungsfähigen MATLAB-Software werden Systeme beschrieben, die weit über die üblichen Anwendungen aus den Vorlesungen hinausgehen und relativ einfach sind, so dass sie per Hand gelöst werden können. Die Simulationen sind hauptsächlich mit der Erweiterung Simulink durchgeführt. Das Modell wird graphisch durch Verbindung verschiedener Funktionsblöcke gebildet und stellt dadurch eine Abbildung des Systems dar. Die Vorgänge im Modell können dann verständlich und anschaulich verfolgt werden. Der Einsatz von Simulink unterscheidet dieses Buch von den Konkurrenzwerken, die MATLAB-Simulationen enthalten.

power electronics converters applications and design 3rd edition: Hybrid Electric Vehicle System Modeling and Control Wei Liu, 2017-04-17 This new edition includes approximately 30% new materials covering the following information that has been added to this important work: extends the contents on Li-ion batteries detailing the positive and negative electrodes and characteristics and other components including binder, electrolyte, separator and foils, and the structure of Li-ion battery cell. Nickel-cadmium batteries are deleted. adds a new section presenting the modelling of multi-mode electrically variable transmission, which gradually became the main structure of the hybrid power-train during the last 5 years. newly added chapter on noise and vibration of hybrid vehicles introduces the basics of vibration and noise issues associated with power-train, driveline and vehicle vibrations, and addresses control solutions to reduce the noise and vibration levels. Chapter 10 (chapter 9 of the first edition) is extended by presenting EPA and UN newly required test drive schedules and test procedures for hybrid electric mileage calculation for window sticker considerations. In addition to the above major changes in this second edition, adaptive charging sustaining point determination method is presented to have a plug-in hybrid electric vehicle with optimum performance.

power electronics converters applications and design 3rd edition: On the perspectives of SiC MOSFETs in high-frequency and high-power isolated DC/DC converters Eial Awwad, Abdullah, 2020-08-11 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 MOSFETs are commercially available from several manufacturers. Although technology affiliated with SiC MOSFETs 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 SiC MOSFETs from two different manufacturers are evaluated. The effects of different biasing voltages, DC link voltages, and temperatures are analysed. The characterisation results show that the devices exhibit superior switching performances under different operating conditions. Moreover, several aspects of

using the SiC MOSFET’s body diode in a DC/DC 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. Based 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 SiC 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 MHz. Thereafter, the SiC MOSFETs are operated in a continuous mode in a 10 kW / 100-250 kHz 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 paralleling of SiC MOSFETs is investigated before comparing the devices in continuous converter operation. In this regard, the impact of the most common mismatch parameters on the static and dynamic current sharing of the transistors is evaluated, showing that paralleling of SiC MOSFETs is feasible. Subsequently, an analytical model of SiC MOSFETs for switching loss optimisation is proposed. The analytical model exhibits relatively close agreement with measurement results under different test conditions. The proposed model tracks the oscillation effectively during both turn-on and –off transitions. This has been achieved by considering the influence of the most crucial parasitic elements in both power and gate loops. In the second part, a comprehensive short-circuit ruggedness evaluation focusing on different failure modes of the planar and double-trench SiC devices is presented. The effects of different biasing voltages, DC 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 SiC MOSFETs 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. Die steigende Nachfrage nach Effizienz und Leistungsdichte bringt Si-basierte eistungsbauteile an einige inhärente Materialgrenzen, die unter anderem mit der Temperaturbelastung, der Schaltfrequenz und der Blockierspannung in Zusammenhang stehen. In jüngster Zeit sind SiC-basierte Leistungsbauelemente vielversprechende Kandidaten für Hochleistungs- und Hochfrequenzanwendungen. Aktuell 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 statische und die transiente Charakterisierung der aktuellen 1,2 kV Planarund 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 internen SiC-Bodydioden in einem DC/DC-Wandler untersucht, wobei die Unterschiede zwischen Planar- und Doppeltrench-Bauteilen aufgezeigt werden. Das Reverse-Recovery-Verhalten

wird unter Berücksichtigung der Gehäusetemperatur, der Schaltgeschwindigkeit, des Durchlassstroms und der angelegten Spannung bewertet. Anhand der Messergebnisse 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 die Synchrongleichrichtung, die Verwendung der internen Diode und die Verwendung einer externen Schottky-Diode verglichen. Außerdem wird die Parallelisierung von SiC-MOSFETs untersucht, bevor die Parallelschaltung der verschiedenen Bauelemente ebenso im kontinuierlichen Konverterbetrieb 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 enge Übereinstimmung mit den Messergebnissen unter verschiedenen Testbedingungen. Das vorgeschlagene Modell bildet die Schwingungen sowohl beim Ein- als auch beim Ausschalten effektiv nach. Dies wurde durch die Berücksichtigung 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 Kurzschlussfähigkeit ausgewertet und die zugehörigen Fehlerfälle werden analysiert. Anschließend wird die Auslegung und Prüfung von zwei verschiedenen Verfahren zum Überstromschutz evaluiert. Die „Desaturation"-Technik wird auf SiC-MOSFETs angewendet und mit einer zweiten Methode verglichen, welche die parasitäre Induktivität der Bauelemente nutzt. Schließlich wird der Nutzen des Einsatzes von SiC-Bauteilen in kontinuierlichen Hochfrequenz-Hochleistungs-DC/DC-Wandlern experimentell untersucht. In diesem Zusammenhang wird eine Designoptimierung eines Hochfrequenztransformators vorgestellt und der Einfluss verschiedener Kernmaterialien, Leiterausführungen und Wicklungsanordnungen wird bewertet. Es wird ein unidirektionaler ZVZCS Vollbrücken-DC/DC-Wandler vorgestellt, der nur die parasitäre Streuinduktivität des Transformators verwendet. Experimentelle Ergebnisse für einen 10 kW, (100-250) kHz Prototyp zeigen einenWirkungsgrad von bis zu 98,1% für den gesamten Umrichter. Abschließend wird ein optimiertes Regelverfahren verwendet, welches auf einem modifizierten Dual-Phase-Shift-Regelverfahren basiert, um den Kreisstrom im isolierten bidirektionalen Dual-Aktiv-Brücken-DC/DC-Wandler zu minimieren. Diese Regelmethode wird experimentell mit der herkömmlichen Single-Phase-Shift-Regelung verglichen. Hierbei zeigt sich eine deutliche Effizienzsteigerung durch die neue Regelmethode. Die experimentellen Ergebnisse bestätigen die theoretische Analyse und zeigen, dass die vorgeschlagene Regelung den Gesamtwirkungsgrad des Umrichters erhöhen und den ZVZCS-Bereich erweitern kann.

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