

Comparative Evaluation of Advanced 3-level Inverter/Converter Topologies against 2-level Systems

M. Schweizer, T. Friedli and J.W. Kolar

ETH Zurich
Power Electronic Systems Laboratory
schweizer@lem.ee.ethz.ch
www.pes.ee.ethz.ch



Outline

- Introduction
- 3-level T-type converter topology
- 3-level NPC topology with SiC diodes
- Modulation and DC-link balancing
- Comparison of passives
- Comparison of semiconductor chip area
- Optimization potential
- Summary

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Advanced and Intelligent Control in Power Electronics and Drives Teresa Orłowska-Kowalska, Frede Blaabjerg, José Rodríguez, 2014-01-08 Power electronics and variable frequency drives are continuously developing multidisciplinary fields in electrical engineering and it is practically not possible to write a book covering the entire area by one individual specialist Especially by taking account the recent fast development in the neighboring fields like control theory computational intelligence and signal processing which all strongly influence new solutions in control of power electronics and drives Therefore this book is written by individual key specialist working on the area of modern advanced control methods which penetrates current implementation of power converters and drives Although some of the presented methods are still not adopted by industry they create new solutions with high further research and application potential The material of the book is presented in the following three parts Part I Advanced Power Electronic Control in Renewable Energy Sources Chapters 1 4 Part II Predictive Control of Power Converters and Drives 5 7 Part III Neurocontrol and Nonlinear Control of Power Converters and Drives 8 11 The book is intended for engineers researchers and students in the field of power electronics and drives who are interested in the use of advanced control methods and also for specialists from the control theory area who like to explore new area of applications

Advanced Multilevel Converters and Applications in Grid Integration Ali Iftekhar Maswood, Hossein Dehghani Tafti, 2018-10-09 A comprehensive survey of advanced multilevel converter design control operation and grid connected applications Advanced Multilevel Converters and Applications in Grid Integration presents a comprehensive review of the core principles of advanced multilevel converters which require fewer components and provide higher power conversion efficiency and output power quality The authors noted experts in the field explain in detail the operation principles and control strategies and present the mathematical expressions and design procedures of their components The text examines the advantages and disadvantages compared to the classical multilevel and two level power converters The authors also include examples of the industrial applications of the advanced multilevel converters and offer thoughtful explanations on their control strategies Advanced Multilevel Converters and Applications in Grid Integration provides a clear understanding of the gap difference between research conducted and the current industrial needs This important guide Puts the focus on the new challenges and topics in related areas such as modulation methods harmonic analysis voltage balancing and balanced current injection Makes a strong link between the fundamental concepts of power converters and advances multilevel converter topologies and examines their control strategies together with practical engineering considerations Provides a valid reference for further developments in the multilevel converters design issue Contains simulations files for further study Written for university students in electrical engineering researchers in areas of multilevel converters high power converters and engineers and operators in power industry Advanced Multilevel Converters and Applications in Grid Integration offers a comprehensive review of the core principles of advanced multilevel converters

with contributions from noted experts in the field

Analysis, Optimization and Control of Grid-Interfaced Matrix-Based Isolated AC-DC Converters Jaydeep Saha, 2022-11-05 This book presents novel contributions in the development of solid state transformer SST technology both for medium voltage MV and low voltage LV utility grid interfaces which can potentially augment the grid modernization process in the evolving power system paradigm For the MV interface a single stage AC DC SST submodule topology has been proposed and its modulation and soft switching possibilities are analysed experimentally validated and adequately benchmarked A control scheme with power balance capability among submodules is developed for MV grid connected single stage AC DC SST for smooth operation under inevitable parameter drift scenario and experimental validation shows excellent performance under drastic load change conditions A novel machine learning aided multi objective design optimization framework for grid connected SST is developed and experimentally validated which equips a power electronics design engineer with meagre computational resources to find out the most optimal SST design in a convenient time frame This book has also contributed towards the development of dual active bridge DAB type and non DAB type LV grid interfaced isolated AC DC converters by providing solutions to specific topology and modulation related shortcomings in these two types of topologies A comprehensive comparison of the DAB and non DAB type LVAC LVDC converters reveals the superiority of DAB type conversion strategy

Modular Multilevel Converters Sixing Du, Apparao Dekka, Bin Wu, Navid Zargari, 2018-02-22 An invaluable academic reference for the area of high power converters covering all the latest developments in the field High power multilevel converters are well known in industry and academia as one of the preferred choices for efficient power conversion Over the past decade several power converters have been developed and commercialized in the form of standard and customized products that power a wide range of industrial applications Currently the modular multilevel converter is a fast growing technology and has received wide acceptance from both industry and academia Providing adequate technical background for graduate and undergraduate level teaching this book includes a comprehensive analysis of the conventional and advanced modular multilevel converters employed in motor drives HVDC systems and power quality improvement Modular Multilevel Converters Analysis Control and Applications provides an overview of high power converters reference frame theory classical control methods pulse width modulation schemes advanced model predictive control methods modeling of ac drives advanced drive control schemes modeling and control of HVDC systems active and reactive power control power quality problems reactive power harmonics and unbalance compensation modeling and control of static synchronous compensators STATCOM and unified power quality compensators Furthermore this book Explores technical challenges modeling and control of various modular multilevel converters in a wide range of applications such as transformer and transformerless motor drives high voltage direct current transmission systems and power quality improvement Reflects the latest developments in high power converters in medium voltage motor drive systems Offers design guidance with tables charts graphs and MATLAB simulations Modular Multilevel

Converters Analysis Control and Applications is a valuable reference book for academic researchers practicing engineers and other professionals in the field of high power converters It also serves well as a textbook for graduate level students

Multilevel Converters Salman Ahmad, Farhad Ilahi Bakhsh, P. Sanjeevikumar, 2024-07-03 Discover the deep insights into the operation modulation and control strategies of multilevel converters alongside their recent applications in variable speed drives renewable energy generation and power systems Multilevel converters have gained attention in recent years for medium high voltage and high power industrial and residential applications The main advantages of multilevel converters over two level converters include less voltage stress on power semiconductors low dv dt low common voltage reduced electromagnetic interference and low total harmonics distortion among others Better output power quality is ensured by increasing the number of levels in the synthesized output voltage waveform Several multilevel topologies have been reported in the literature such as neutral point clamped NPC flying capacitor FC cascaded H bridge CHB hybrid cascaded H bridge asymmetrical cascaded H bridge modular multilevel converters MMC active neutral point clamped converters ANPC and packed U cell type converters and various reduced device counts and a reduced number of source based topologies have been proposed in literature The multilevel converter although a proven and enabling technology still presents numerous challenges in topologies modulation and control as well as in need based applications Since multilevel converters offer a wide range of possibilities research and development in the areas of multilevel converter topologies modulation and control in various applications are still growing To further improve multilevel converter energy efficiency reliability power density and cost many research groups across the world are working to broaden the application areas of multilevel converters and make them more attractive and competitive compared to classic topologies Multilevel Converters intends to provide deep insight about multilevel converter operation modulation and control strategies and various recent applications of multilevel converters such as in variable speed drives renewable energy generation and power systems *Proceedings of the IEEE International Conference on Industrial Technology (ICIT ...)*, 2002 *Annual Report* Iowa State University. Department of Electrical and Computer Engineering, 1997

Multilevel Converters for Industrial Applications Sergio Alberto Gonzalez, Santiago Andres Verne, Maria Ines Valla, 2013-07-22 Modern semiconductor devices have reached high current and voltage levels and their power handling limits can be extended if they are used in multilevel converter configurations To create high performance and reliable control designs however engineers need in depth understanding of the characteristics and operation of these topologies Multilevel Converters for Industrial Applications presents a thorough and comprehensive analysis of multilevel converters with a common DC voltage source The book offers a novel perspective to help readers understand the principles of the operation of voltage source multilevel converters as power processors and their capabilities and limitations The book begins with an overview of medium voltage power converters and their applications It then analyzes the topological characteristics of the diode clamped multilevel converter the flying capacitor multilevel converter and the

asymmetric cascaded multilevel converter For each topology the authors highlight particular control issues and design trade offs They also develop relevant modulation and control strategies Numerous graphical representations aid in the analysis of the topologies and are useful for beginning the analysis of new multilevel converter topologies The last two chapters of the book explore two case studies that analyze the behavior of the cascade asymmetric multilevel converter as a distribution static compensator and shunt active power filter and the behavior of the diode clamped topology configured as a back to back converter These case studies demonstrate how to address the associated control problems with advanced control and modulation schemes Examining recent advances this book provides deep insight on the design of high power multilevel converters and their applications It is a valuable reference for anyone interested in medium voltage power conversion which is increasingly being used in industry and in renewable energy and distributed generation systems to improve efficiency and operation flexibility

Analysis, Design and Implementation of a High Efficiency Multilevel Converter for Renewable Energy Systems Sérgio Daher,2006 **Advanced Power Electronics Converters for Future Renewable Energy Systems** Neeraj Priyadarshi,P. Sanjeevikumar,Farooque Azam,C. Bharatiraja,Rajesh Singh,2023-03-31 This book narrates an assessment of numerous advanced power converters employed on primitive phase to enhance the efficiency of power translation pertaining to renewable energy systems It presents the mathematical modelling analysis and control of recent power converters topologies namely AC DC DC DC and DC AC converters Numerous advanced DC DC Converters namely multi input DC DC Converter Cuk SEPIC Zeta and so forth have been assessed mathematically using state space analysis applied with an aim to enhance power efficiency of renewable energy systems The book Explains various power electronics converters for different types of renewable energy sources Provides a review of the major power conversion topologies in one book Focuses on experimental analysis rather than simulation work Recommends usage of MATLAB PSCAD and PSIM simulation software for detailed analysis Includes DC DC converters with reasonable peculiar power rating This book is aimed at researchers graduate students in electric power engineering power and industrial electronics and renewable energy

Power Converters for Medium Voltage Networks Md. Rabiul Islam,Youguang Guo, Jianguo Zhu,2014-09-15 This book examines a number of topics mainly in connection with advances in semiconductor devices and magnetic materials and developments in medium and large scale renewable power plant technologies grid integration techniques and new converter topologies including advanced digital control systems for medium voltage networks The book s individual chapters provide an extensive compilation of fundamental theories and in depth information on current research and development trends while also exploring new approaches to overcoming some critical limitations of conventional grid integration technologies Its main objective is to present the design and implementation processes for medium voltage converters allowing the direct grid integration of renewable power plants without the need for step up transformers

Multilevel Converters: Control Techniques for Renewable Energy Resources Sudhakar Babu Thanikanti,Sudhakar

Natarajan, Umashankar Subramaniam, Sam Sichilalu, 2022-01-13 **Advanced Control of Power Converters** Hamed Nademi, 2014 Power Electronic Converters in Advanced Co-Phase Traction Power Supply System Zeliang Shu, 2025-12-14

This book focuses on analysis modulation simulation and prototype verification of the power electronic converters in advanced co phase traction power supply systems Firstly the grid connected characteristic is introduced in the grid connected traction power supply system Then the detailed circuits analysis control and modulation of grid connected three phase converter single phase converter clamped multi level three phase to single phase converter modular multi level three phase to single phase converter and two phase to single phase converter in advanced co phase system are analyzed and discussed in different chapters separately It s also serves as an excellent reference for the study and research of power electronics related specialties *Multilevel Converter for Grid Connected PV Applications* Mostafa Mosa, 2013 As the world s energy use continues to grow the development of clean distributed generation becomes increasingly important Solar cells are an environmentally friendly renewable energy source that can be used in a wide range of applications and are ideal for distributed power applications This book investigates the interfacing between photovoltaic power systems and the utility grid It focuses on the design of Switched Inductor Multilevel Boost Converter SIMLBC the efficiency of the Power Conditioning System PCS and reliability issues related to such intelligent power electronic interface This book is interesting to engineering students beginners and advanced researchers who are involved in state of art renewable energy technologies and power conversion To assist the validity of the proposed system a low power prototype system has been designed and implemented analytical simulation and experimental results have been provided Several experimental case study tests have been executed to validate the proposed analyses Simulation and hardware results have been presented **Design, Control and Application of Modular Multilevel Converters for HVDC Transmission Systems** Kamran Sharifabadi, 2016 **Control of Modular Multilevel Converter for Photovoltaic Power Systems** Mohamad Azuan Fauzuddin, 2015 **Modular Multilevel Converters for Electric Transportation Applications** Deepak Ronanki, Sheldon Williamson, 2025-01-21 A comprehensive overview of the fundamentals the technical challenges and the control aspects of modular multilevel converters Modular multilevel converters MMCs have emerged in recent years as the newest breed of multilevel converters and have received wide acceptance both in industry and academia The benefits and desirable features of MMCs are manifold modularity high quality output waveforms absence of dc link capacitance and lower electromagnetic interference MMCs rely on transformerless operation and can be a multi motor operation so it can be scaled to higher power and voltage levels resulting in high efficiency and tolerate faults to a greater degree than other systems Modular Multilevel Converter offers a uniquely wide range of topics relating to MMCs from electrical machines to control theory to electronics and power electronics The book provides the reader with information to strengthen their understanding of basic concepts as well as the latest technologies in propulsion systems power supplies and battery charging infrastructure The scope of this resource is

comprehensive with detailed discussions on different submodule design diverse modeling approach pulse width modulation schemes and voltage balancing methods It also examines charge balancing control techniques circulating current suppressing control schemes and reliability enhancement features Most significantly the text reflects the latest technologies in electric transportation electric railway traction battery charging infrastructure and marine applications and is aligned to current industry requirements Modular Multilevel Converter readers will also find Discussion of the fundamentals and important concepts with the simulations in PLECS platform and OPAL RT real time digital simulator Coverage of the global standards such as IEC and IEEE for each application and their requirements A series of case studies that highlight aspects of MMC application A companion website that provides self explanatory demo simulation models of MMC with different variants of carrier based pulse width modulation schemes Modular Multilevel Converter isa useful reference for academic researchers design engineers graduate courses and other professionals in the field of electric transportation

Multi-terminal High-voltage Converter Bo Zhang, Dongyuan Qiu, 2018-11-29 An all in one guide to high voltage multi terminal converters this book brings together the state of the art and cutting edge techniques in the various stages of designing and constructing a high voltage converter The book includes 9 chapters and can be classified into three aspects First all existing high voltage converters are introduced including the conventional two level converter and the multi level converters such as the modular multi level converter MMC Second different kinds of multi terminal high voltage converters are presented in detail including the topology operation principle control scheme and simulation verification Third some common issues of the proposed multi terminal high voltage converters are discussed and different industrial applications of the proposed multi terminal high voltage converters are provided Systematically proposes for the first time the design methodology for high voltage converters in use of MTDC grids also applicable to constructing novel power electronics converters and driving the development of HVDC which is one of the most important technology areas Presents the latest research on multi terminal high voltage converters and its application in MTDC transmission systems and other industrially important applications Offers an overview of existing technology and future trends of the high voltage converter with extensive discussion and analysis of different types of high voltage converters and relevant control techniques including DC AC AC DC DC DC and AC AC converters Provides readers with sufficient context to delve into the more specialized topics covered in the book Featuring a series of novel multi terminal high voltage converters proposed and patented by the authors Multi terminal High Voltage Converters is written for researchers engineers and advanced students specializing in power electronics power system engineering and electrical engineering

Control and Modulation of Modular Multilevel Converters Ricard Picas Prat, 2017 The integration of renewable energy sources in the electrical grid is reducing our dependence on fossil fuels However to ensure feasibility and reliability of distributed energy generation more efficient and higher power converters are required The modular multilevel converter 07C is a modern topology of multilevel converter that is very attractive for

medium and high voltage power applications including high voltage direct current transmission systems and high power motor drives. The main features of the 07C are modularity, scalability to different power and voltage levels, redundancy, and high quality output voltages and currents. However, the operation of the 07C is complex and there are some issues that still have to be further investigated. One of these issues is the voltage ripples of the submodule SM capacitors. The voltage ripples define the minimum value of the capacitances needed for the converter and therefore its overall size and cost. The use of a proper circulating current controller can reduce the voltage ripples. In this thesis, three techniques for calculating the circulating current reference are presented: two techniques based on optimization functions for minimizing the capacitor voltage ripples and a fast processing technique that provides results close to optimal. The capacitor voltage ripples can also be reduced by adding a zero sequence signal to the modulation signals. In this thesis, the application of discontinuous modulation to the 07C is proposed for the first time. This technique is based on the injection of a discontinuous zero sequence signal and highly reduces the switching power losses and capacitor voltage ripples. Real applications of the 07C are composed of a high number of SMs. This implies a challenge in the control system, including the data acquisition system. A new technique for measuring the capacitor voltages with only a few sensors has been presented in this thesis. From the output voltage provided by a group of SMs, the individual voltage of each one of them can be acquired. Since acquisition cannot be performed at each sampling time, the capacitor voltages are calculated between samples using an estimation algorithm. Reliability is a feature required in industrial applications. The structure of the 07C facilitates the existence of redundant SMs, but faults need to be detected and localized for deactivating the faulty component. This thesis presents a robust and fast strategy for detecting, localizing, and correcting faults in SMs and voltage sensors. The technique is based on three additional sensors per arm which measure the output voltage of a group of SMs and compare it with the expected voltage. Capacitance differences between the SMs can appear due to component tolerance or ageing of the capacitors. Capacitance mismatches cause uneven distribution of the power losses, thus increasing the thermal stress of some semiconductors and therefore their probability of failure. A power loss balancing technique has been proposed, equalising the losses in all the SMs and therefore avoiding the concentration of power losses in some SMs. Application of the 07C to motor drive applications has also been studied in this thesis. The operation of the 07C at low motor speeds/frequencies is still a challenge since the capacitor voltage ripples are inversely proportional to the current frequency. In this thesis, it has been demonstrated that discontinuous modulation can help to reduce capacitor voltage ripples in motor drive applications, achieving very low speed operation. The technique is compared with other state-of-the-art methods, and it achieves similar capacitor voltage ripples and a significant reduction in power losses. All the control and modulation techniques proposed in this thesis have been studied by simulation in the MATLAB Simulink environment and corroborated experimentally on low power laboratory prototypes.

The Enigmatic Realm of **Advanced Multilevel Converter Systems Ecpe**: Unleashing the Language is Inner Magic

In a fast-paced digital era where connections and knowledge intertwine, the enigmatic realm of language reveals its inherent magic. Its capacity to stir emotions, ignite contemplation, and catalyze profound transformations is nothing in short supply of extraordinary. Within the captivating pages of **Advanced Multilevel Converter Systems Ecpe** a literary masterpiece penned by way of a renowned author, readers set about a transformative journey, unlocking the secrets and untapped potential embedded within each word. In this evaluation, we shall explore the book's core themes, assess its distinct writing style, and delve into its lasting impact on the hearts and minds of those who partake in its reading experience.

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Table of Contents Advanced Multilevel Converter Systems Ecpe

1. Understanding the eBook Advanced Multilevel Converter Systems Ecpe
 - The Rise of Digital Reading Advanced Multilevel Converter Systems Ecpe
 - Advantages of eBooks Over Traditional Books
2. Identifying Advanced Multilevel Converter Systems Ecpe
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Advanced Multilevel Converter Systems Ecpe
 - User-Friendly Interface
4. Exploring eBook Recommendations from Advanced Multilevel Converter Systems Ecpe
 - Personalized Recommendations
 - Advanced Multilevel Converter Systems Ecpe User Reviews and Ratings
 - Advanced Multilevel Converter Systems Ecpe and Bestseller Lists

5. Accessing Advanced Multilevel Converter Systems Ecpe Free and Paid eBooks
 - Advanced Multilevel Converter Systems Ecpe Public Domain eBooks
 - Advanced Multilevel Converter Systems Ecpe eBook Subscription Services
 - Advanced Multilevel Converter Systems Ecpe Budget-Friendly Options
6. Navigating Advanced Multilevel Converter Systems Ecpe eBook Formats
 - ePub, PDF, MOBI, and More
 - Advanced Multilevel Converter Systems Ecpe Compatibility with Devices
 - Advanced Multilevel Converter Systems Ecpe Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Advanced Multilevel Converter Systems Ecpe
 - Highlighting and Note-Taking Advanced Multilevel Converter Systems Ecpe
 - Interactive Elements Advanced Multilevel Converter Systems Ecpe
8. Staying Engaged with Advanced Multilevel Converter Systems Ecpe
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Advanced Multilevel Converter Systems Ecpe
9. Balancing eBooks and Physical Books Advanced Multilevel Converter Systems Ecpe
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Advanced Multilevel Converter Systems Ecpe
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Advanced Multilevel Converter Systems Ecpe
 - Setting Reading Goals Advanced Multilevel Converter Systems Ecpe
 - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Advanced Multilevel Converter Systems Ecpe
 - Fact-Checking eBook Content of Advanced Multilevel Converter Systems Ecpe
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning

- Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
- Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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