

LLC Resonant Converter for Battery Charging Applications

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ABSTRACT

In this paper, sepic converter was used to improve battery performance without affecting the volume of charger by giving the constant output voltage when input voltages are low or high. The resonant tank was used to present better performance LLC multi resonant dc-dc converter in a two-stage smart battery charger for neighborhood electric vehicle applications. The performance characteristics and its multi resonant converter have been analysed are implemented. It eliminates both high and low frequency current ripple on the battery.

INDEX TERMS—Battery, LLC resonant converter, DC-DC converter

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1. INTRODUCTION

The efficiency plays a major role at present current global energy crisis is focus and electronic products are facing the daunting challenge to deliver high performance, at the same time as consuming less power. Various governmental agencies around the world have or are looking to increase their efficiency standards for numerous products in their respective specifications, as a result of this crisis. It will be difficult to meet these efficiency specifications with conventional hard switched converters. Power supply designers will require considering soft switching topologies to increase the efficiency as well as to allow for better frequency operation. Practical design considerations and resonant tank design procedure are offered for a better performance LLC multi resonant dc-dc converter in a two-stage smart battery charger for neighborhood electric vehicle applications.

The LLC resonant topology permits the zero voltage switching of the main switches thereby considerably lowering switching losses and improving efficiency. LLC resonant converters can be achieved with efficiencies of 93 to 96%. It will be illustrate the operation of the LLC resonant topology and show how such high efficiencies can be attained.

A smart charger is a battery charger that can act in response to the condition of a battery, and modify the battery charging actions compare to the battery algorithms. Conversely, a standard or simple battery charger supplies a pulsed dc or constant dc power source to a battery being charged. The charge on the battery and its output depends on time does not alter in a simple charger. Therefore, smart chargers are preferred for NEV battery charging application

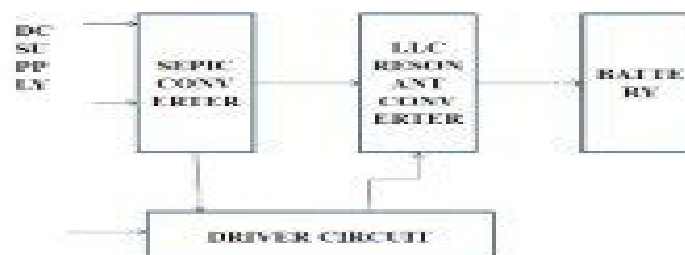


Fig 1: Block Diagram of LLC with SEPIC converter

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**Natarajan Balasubramanian Muthu
Selvan,Venkatraman
Thiyagarajan,Cheng Siong Chin**

Llc Resonant Converter For Battery Charging Applications:

Power Electronics for Electric Vehicles and Energy Storage Dharavath Kishan,Ramani Kannan,B Dastagiri Reddy,Prajof Prabhakaran,2023-05-16 This text will help readers to gain knowledge about designing power electronic converters and their control for electric vehicles It discusses the ways in which power from electric vehicle batteries is transferred to an electric motor the technology used for charging electric vehicle batteries and energy storage The text covers case studies and real life examples related to electric vehicles The book Discusses the latest advances and developments in the field of electric vehicles Examines the challenges associated with the integration of renewable energy sources with electric vehicles Highlights basic understanding of the charging infrastructure for electric vehicles Covers concepts including the reliability of power converters in electric vehicles and battery management systems This book discusses the challenges emerging technologies and recent development of power electronics for electric vehicles It will serve as an ideal reference text for graduate students and academic researchers in the fields of electrical engineering electronics and communication engineering environmental engineering automotive engineering and computer science

Intelligent Computing Systems and Applications Sivaji Bandyopadhyay,Valentina Emilia Balas,Saroj Kumar Biswas,Anish Kumar Saha,Dalton Meitei Thounaojam,2024-09-19 The book includes peer reviewed papers presented at the 2nd International Conference on Intelligent Computing Systems and Applications ICICSA 2023 The book discusses the most recent advances in artificial intelligence machine learning data science natural language processing computer vision image processing embedded systems robotics IoT computer networking and communications optimization security and cryptography among other topics It also discusses several application areas and modeling methodologies in many fields This book will be useful for researchers and academics working in relevant fields

Modern Power Converters for Renewable Energy Applications Natarajan Balasubramanian Muthu Selvan,Venkatraman Thiyagarajan,Cheng Siong Chin,2025-09-02 As the world transitions toward sustainable energy solutions power converters have become indispensable in enabling the efficient integration and operation of renewable energy systems Modern Power Converters for Renewable Energy Applications Modeling Analysis Design and Control offers a comprehensive guide to the modeling analysis design and control of these critical technologies tailored for solar photo voltaic wind energy and energy storage applications This book delves into the unique challenges and requirements of power converters with detailed coverage of DC DC DC AC and multilevel converter technologies Readers will gain insights into advanced control strategies for ensuring system stability and reliability under varying conditions Bridging theory and practice this book is packed with case studies simulation examples and design methodologies to help readers transition from conceptual understanding to practical implementation Using industry standard tools readers can analyze converter performance optimize designs and address real world challenges in renewable energy systems Key topics include grid synchronization power quality improvement and compliance with international standards

equipping readers to handle the complexities of modern power grids This book also explores the integration of energy storage systems emphasizing their role in stabilizing renewable outputs and enhancing system flexibility Ideal for researchers engineers and students this book provides the expertise needed to excel in power electronics for renewables Whether advancing research driving innovation or solving practical challenges *Modern Power Converters for Renewable Energy Applications Modeling Analysis Design and Control* is the definitive resource for mastering the technologies shaping the future of sustainable energy

Analysis and Design of Power Converter Topologies for Application in Future More Electric Aircraft Amit Kumar Singh, 2018-04-20 This thesis proposes new power converter topologies suitable for aircraft systems It also proposes both AC DC and DC DC types of converters for different electrical loads to improve the performance these systems To increase fuel efficiency and reduce environmental impacts less efficient non electrical aircraft systems are being replaced by electrical systems However more electrical systems requires more electrical power to be generated in the aircraft The increased consumption of electrical power in both civil and military aircrafts has necessitated the use of more efficient electrical power conversion technologies This book presents a comprehensive mathematical analysis and the design and digital simulation of the power converters Subsequently it discusses the construction of the hardware prototypes of each converter and the experimental tests carried out to verify the benefits of the proposed solutions in comparison to the existing solutions

Electric Vehicle Propulsion Drives and Charging Systems Kundan Kumar, Ambrish Devanshu, Sanjeet K. Dwivedi, 2024-06-18 This book covers the introduction theory development and applications of hybrid and electric vehicles and their charging infrastructures It also discusses the real applications of power converters and electric drives to give the readers a flavour of how to design propulsion drives and fast charging systems for electric vehicles It further covers important topics such as static and dynamic wireless charging systems battery management and battery swapping systems for electric vehicles This book Presents comprehensively different types of electric vehicles and their powertrain architecture Highlights modern optimization techniques such as genetic algorithms simulated annealing particle swarm optimization and ant colony optimization Discusses different charging methods such as wired and wireless for a variety of batteries including lead acid lithium ion and vanadium redox Covers grid to vehicle vehicle to grid and vehicle to vehicle bidirectional power flow analysis Showcases power 2X technologies such as power to ammonia power to chemicals power to fuel power to gas and power to hydrogen The text is primarily written for senior undergraduate and graduate students as well as academic researchers in the fields of electrical engineering electronics and communications engineering

Advanced Battery Technologies Manuela González, David Anseán, 2021-08-31 In recent years lithium ion batteries LIBs have been increasingly contributing to the development of novel engineering systems with energy storage requirements LIBs are playing an essential role in our society as they are being used in a wide variety of applications ranging from consumer electronics electric mobility renewable energy storage biomedical applications or aerospace systems Despite the remarkable

achievements and applicability of LIBs there are several features within this technology that require further research and improvements In this book a collection of 10 original research papers addresses some of those key features including battery testing methodologies state of charge and state of health monitoring and system level power electronics applications One key aspect to emphasize when it comes to this book is the multidisciplinary nature of the selected papers The presented research was developed at university departments institutes and organizations of different disciplines including Electrical Engineering Control Engineering Computer Science or Material Science to name a few examples The overall result is a book that represents a coherent collection of multidisciplinary works within the prominent field of LIBs

The Proceedings of the 19th Annual Conference of China Electrotechnical Society Qingxin Yang,Zhaohong Bie,Xu Yang,2025-01-03 This book compiles exceptional papers presented at the 19th Annual Conference of the China Electrotechnical Society CES held in Xi an China from September 20 to 22 2024 It encompasses a wide range of topics including electrical technology power systems electromagnetic emission technology and electrical equipment The book highlights innovative solutions that integrate concepts from various disciplines making it a valuable resource for researchers engineers practitioners research students and interested readers

Recent Advances in Power Electronics and Drives Om Hari Gupta,Simanta Kumar Samal,Ranjit Mahanty,Bhim Singh,Ilhami Colak,2025-01-02 This book entitled Recent Advances in Power Electronics and Drives select proceedings of EPREC 2024 provides the rigorous discussions case studies and recent developments in the emerging areas of power electronics especially power inverter and converter electrical drives regulated power supplies electric vehicle and its charging infrastructure etc There are two main problems with the electric vehicle EVs technology which are associated with the range anxiety charging spot and time These problems can be taken care of with having a good charging infrastructure which provides ways to improve the environmental conditions and make sure to mitigate these issues The same issues would be addressed via this book The readers would be benefited in enhancing their knowledge and skills in the domain areas Also this book may help the readers in developing new and innovative ideas The book can be a valuable reference for beginners researchers and professionals interested in advancements in power electronics and drives

Practical Design Considerations for Isolated DC-DC Converters Alexander Isurin,Mark J. Scott,2025-08-03 This book is for design engineers building isolated DC DC converters for commercial products It provides guidance and recommendations to help engineers make decisions that prevent mistakes during product development ensure the design process is as predictable as possible create more reliable and cost effective hardware and do their designs in a shorter period The authors focus on converters that operate at 2 kW and above have high conversion ratios and have at least one low voltage terminal that conducts several 100 A s or more These operating characteristics satisfy critical automotive aerospace military manufacturing and telecommunication needs Coverage includes guidelines for successfully using silicon carbide SiC and gallium nitride GaN power devices including techniques for gate drive design printed circuit board layout and failure

mechanisms This practical reference manual shows professional engineers how to consider the whole picture of a power conversion system during their design process It is also a valuable guide for researchers and graduate students working in the field of power electronics if supportLists Posits an Engineering Philosophy that focuses on system level considerations rather than component level considerations if supportLists Creates Figure of Merits for comparing power convertors and demonstrates how they are used to develop power conversion systems if supportLists Helps designers avoid common pitfalls during the engineering process

Hybrid Electric Vehicles Chris Mi,M. Abul Masrur,2025-12-22 Introduction to all types of hybrid electric vehicles HEVs with coverage of fundamentals applications and the latest industry technologies Hybrid Electric Vehicles Principles and Applications with Practical Perspectives provides an introduction to hybrid vehicles from hybrid electric hybrid hydraulic and plug in hybrid electric vehicles to fuel cell vehicles and off road hybrid vehicular systems The book focuses on the propulsion systems for these vehicles including issues related to power and energy management Other topics covered include hybrid vs pure electric hybrid electric vehicle HEV system architecture including plug in charging control and hydraulic safety and EMC storage technologies vehicular power and energy management diagnostics and prognostics and electromechanical vibration issues This Third Edition has been updated to address the latest industry trends and technologies impacting HEVs such as more detailed discussions on planetary gear synchronous reluctance motors fast charging methods for batteries and matters pertaining to cybersecurity in vehicles The latest HEV industry data and examples highlighting automakers current HEV models are featured throughout the book Topics discussed in Hybrid Electric Vehicles Principles and Applications with Practical Perspectives include Specific state of the art HEVs including the Toyota Prius the Honda Civic and the Ford Escape with additional coverage of two mode hybrid vehicles HEV fundamentals covering performance powertrain component sizing gradability requirements and selection of gear ratios Cold start emissions reduction and cold hot weather performance enhancement Electric and hybrid ships aircraft and locomotives with discussion on industrial utilization of other types of vehicles Military applications of HEVs covering ruggedness issues dismounted soldier applications and electromagnetic launchers Fast charging of batteries in electrified vehicles Cybersecurity issues in electrified vehicles Hybrid Electric Vehicles Principles and Applications with Practical Perspectives is an essential up to date reference on the subject for engineers working in the automotive industry including at automakers vehicle OEMs and component suppliers as well as students and instructors in upper level undergraduate or graduate courses related to HEVs and electric propulsion

Electric Vehicle Charging Infrastructures and its Challenges Ashutosh K. Giri,Madhusudan Singh,2025-02-15 The book presents basic terminologies of charging infrastructures such as types levels and suitable power converters applications Various energy storage technologies such as lithium ion batteries charging strategies and battery management system BMS and battery swapping are discussed in the book In this book some guidelines by the Ministry of Power and Ministry of Housing Government of India are discussed which can help an individual to set up a charging

infrastructure at their end Also the novel idea and concepts developed by the researchers academia and practicing engineers working in the domain of the EV charging infrastructures are incorporated The active and reactive power control strategy along with other parameters estimation and control are also included to make this book popular among the readers

Power Converters for Electric Vehicles L. Ashok Kumar,S. Albert Alexander,2020-12-10 Power Converters for Electric Vehicles gives an overview topology design and simulation of different types of converters used in electric vehicles EV It covers a wide range of topics ranging from the fundamentals of EV Hybrid EV and its stepwise approach simulation of the proposed converters for real time applications and corresponding experimental results performance improvement paradigms and overall analysis Drawing upon the need for novel converter topologies this book provides the complete solution for the power converters for EV applications along with simulation exercises and experimental results It explains the need for power electronics in the improvement of performance in EV This book Presents exclusive information on the power electronics of EV including traction drives Provides step by step procedure for converter design Discusses various topologies having different isolated and non isolated converters Describes control circuit design including renewable energy systems and electrical drives Includes practical case studies incorporated with simulation and experimental results Power Converters for Electric Vehicles will provide researchers and graduate students in Power Electronics Electric Drives Vehicle Engineering a useful resource for stimulating their efforts in this important field of the search for renewable technologies **Proceedings of the 4th International Conference on Electronic Engineering and Renewable Energy Systems—Volume 1** Bekkay Hajji,Antonio Gagliano,Adel Mellit,Abdelhamid Rabhi,Michele Calì,2025-03-19 This book includes papers presented at the 4th International Conference on Electronic Engineering and Renewable Energy ICEERE 2024 held in Saidia Morocco which focus on the application of artificial intelligence techniques emerging technology and the Internet of things in electrical and renewable energy systems including hybrid systems micro grids networking smart health applications smart grid mechatronics and electric vehicles It particularly focuses on new renewable energy technologies for agricultural and rural areas to promote the development of the Euro Mediterranean region Given its scope the book is of interest to graduate students researchers and practicing engineers working in the fields of electronic engineering and renewable energy The book represents Volume 1 for this conference proceedings which consist of a 2 volume book series **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

Emerging Technologies & Applications in Electrical Engineering Anamika Yadav,K Chandrasekaran,V Hari Priya,D Suresh,2024-07-08 The First International Conference on Emerging Technologies and Applications in Electrical Engineering ETAEE 2023 was hosted and organized by the Department of Electrical Engineering National Institute of Technology Raipur held on 21st to 22nd December 2023 with CRC Press Taylor and Francis as publication partner ETAEE 2023 aims to emerge as a platform for in depth discussions knowledge sharing and collaborative efforts The main theme of the conference was Sustainable Energy Future With professionals from academia industry and reputable research institutions coming together the conference underlined the importance of staying at the forefront of technical breakthroughs to ensure a sustainable energy future The presentations were delivered by participants on various topics such as Renewable Energy Smart Grid High Voltage Technologies Power Electronics and Drives Electric Transportation Systems Instrumentation Control and IoT Applications in Electrical Engineering Esteemed academicians chaired these sessions fostering in depth discussions and knowledge exchange

Holistic Design of Resonant DC Transformer on Constant Voltage Conversion, Cascaded Stability and High Efficiency Xin Zhang,Fanfan Lin,Hao Ma,Bin Zhao,Jingjing Huang,2023-03-06 This book is devoted to the optimum design of the DCT in a hybrid AC DC microgrid which takes into account not only the influence of different inductors capacitors values but also numerous design goals i e VCG efficiency stability and so on This book examines the DCT s design problem in detail It begins by reviewing existing DCTs in the hybrid AC DC microgrid and their design problems Following that this book proposes a family of DCT optimization design approaches to ensure that the designed DCT has good power transmission and voltage regulation ability in the hybrid AC DC microgrid even when the actual inductors capacitors values

fluctuate with practical power and temperature Following that this book provides a family of multi objective optimization design methodologies for the DCT to guarantee that it concurrently achieves the requirements of VCG efficiency and system stability This book also covers how to control the DCT in a hybrid AC DC microgrid optimally and generically *Emerging Technologies for Electric and Hybrid Vehicles* Jesús Manuel González Pérez, 2018-10-17 This book is a printed edition of the Special Issue Emerging Technologies for Electric and Hybrid Vehicles that was published in *energies* **Smart Grid Handbook, 3 Volume Set**, 2016-08-01 Alles Wissenswerte rund um Smart Grids umfassend und interdisziplinär beschrieben von internationalen Experten aus Forschung und Praxis Dieses Buch trägt dem Wunsch nach einem hochkarätigen Referenzwerk zur Smart Grid Technologie Rechnung eine Technologie die bei der Entwicklung einer umweltfreundlichen Energieinfrastruktur eine zentrale Rolle spielt Das dreibändige Smart Grid Handbook mit insgesamt 83 Artikeln ist in sechs Abschnitte unterteilt Vision and Drivers Vision und Einflussgrößen Transmission Übertragung Distribution Verteilung Smart Meters and Customers intelligente Zähler und Kunden Information and Communications Technology Informations und Kommunikationstechnik Socio Economic Issues sozial ökonomische Aspekte Wichtige Merkmale Geschrieben von einem Team das sich mit Smart Grids auskennt und seine Erfahrung aus den folgenden Bereichen einbringt Forschung Entwicklung Technikeinsatz Standards Branchenpraxis und sozial ökonomische Aspekte Der Abschnitt Vision and Drivers beschäftigt sich mit Vision Definitionen der Weiterentwicklung und globalen Entwicklung von Smart Grids sowie mit neuen Technologien und Standards Der Abschnitt Transmission erläutert Branchenpraxis Erfahrung im operativen Bereich Standards Cybersicherheit und Grid Codes Im Abschnitt Distribution werden Verteilungssysteme und Systemkonfigurationen in verschiedenen Ländern sowie verschiedene Lasten die über das Netz bedient werden vorgestellt Der Abschnitt Smart Meters and Customers untersucht wie Kunden über Smart Meter mit dem Stromnetz interagieren können *Advanced Concepts and Technologies for Electric Vehicles* Akshay Kumar Rathore, Arun Kumar Verma, 2023-08-30 This book explains the basic and advanced technology behind the Power Electronics Converters for EV charging and their significant developments and introduces the Grid Impact issues that underpin the grid integration of electric vehicles Advanced Concepts and Technologies for Electric Vehicles reviews state of the art and new configurations and concepts of more electric vehicles and EV charging mitigating the impact of EV charging on the power grid and technical considerations of EV charging infrastructures The book considers the environmental benefits and advantages of electric vehicles and their component devices It includes case studies of different power electronic converters used for charging EVs It offers a review of PFC based AC chargers WBG based chargers and Wireless chargers The authors also explore multistage charging systems and their possible implementations The book also examines the challenges and opportunities posed by the progressive integration of electric drive vehicles on the power grid and reported solutions for their mitigation The book is intended for professionals researchers and engineers in the electric vehicle industry as well as advanced students in electrical engineering who benefit from this comprehensive

coverage of electric vehicle technology Readers can get an in depth insight into the technology deployment in EV transportation and utilize that knowledge to develop novel ideas in the EV area *Mechatronics and Automation Technology*

Jinyang Xu,2024-02-15 Mechatronics and automation technology has led to technological change and innovation in all engineering fields affecting various disciplines including machine technology electronics and computing It plays a vital role in improving production efficiency reducing energy consumption and improving product quality and safety and will be central to the further advancement of technology and industry bringing convenience and innovation to even more areas This book presents the proceedings of ICMAT 2023 the 2nd International Conference on Mechatronics and Automation Technology held as a virtual event on 27 October 2023 The aim of the conference was to provide a platform for scientists scholars engineers and researchers from universities and scientific institutes around the world to share the latest research achievements in mechatronics and automation technology explore key challenges and research directions and promote the development and application of theory and technology in this field A total of 121 submissions were received for the conference of which 77 were ultimately accepted after a rigorous peer review process The papers cover a wide range of topics falling within the scope of mechatronics and automation technology including smart manufacturing digital manufacturing additive manufacturing robotics sensors control electronic and electrical engineering intelligent systems and automation technology as well as other related fields Providing an overview of recent developments in mechatronics and automation technology the book will be of interest to all those working in the field

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Llc Resonant Converter For Battery Charging Applications Introduction

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