Technology

Irfan Jamil

A Novel Battery Charger System & Appended ZCS (PWM) Resonant Converter Dc-Dc Buck

Pre-Defense

Professorial Dissertation

GRIN

YOUR KNOWLEDGE HAS VALUE



- We will publish your bachelor's and master's thesis, essays and papers

- Your own eBook and book - sold worldwide in all relevant shops

- Earn money with each sale

Upload your text at www.GRIN.com and publish for free

GRIN

Bibliographic information published by the German National Library:

The German National Library lists this publication in the National Bibliography; detailed bibliographic data are available on the Internet at http://dnb.dnb.de .

This book is copyright material and must not be copied, reproduced, transferred, distributed, leased, licensed or publicly performed or used in any way except as specifically permitted in writing by the publishers, as allowed under the terms and conditions under which it was purchased or as strictly permitted by applicable copyright law. Any unauthorized distribution or use of this text may be a direct infringement of the author s and publisher s rights and those responsible may be liable in law accordingly.

Imprint:

Copyright © 2014 GRIN Verlag
ISBN: 9783656646396

This book at GRIN:

https://www.grin.com/document/272401

Irfan Jamil

A Novel Battery Charger System & Appended ZCS (PWM) Resonant Converter Dc-Dc Buck

Pre-Defense

GRIN Verlag

GRIN - Your knowledge has value

Since its foundation in 1998, GRIN has specialized in publishing academic texts by students, college teachers and other academics as e-book and printed book. The website www.grin.com is an ideal platform for presenting term papers, final papers, scientific essays, dissertations and specialist books.

Visit us on the internet:

http://www.grin.com/

http://www.facebook.com/grincom

http://www.twitter.com/grin_com

请用蓝黑或碳素墨水书写 (Pre-Defense Dissertation)

河海大学

硕士研究生学位论文
工作计划及开题报告书

学　　号 M 2011018

研究生姓名 IRFAN JAMIL

学科、专业 Power System & Automation

研究方向 Dc-Dc power Converter

培养学院 College of Energy & Electrical Engineering

开题报告时间 2012. 10.

说　明

1. 学位论文计划应在导师的指导下按照培养方案要求制定。

2.开题报告一般安排在第三学期，开题报告在负责培养的学院进行，由导师主持并邀请同行专家参加。

3. 开题报告的时间、地点须提前三天公布，欢迎师生参加旁听。

4. 论文计划书及开题报告书（空白表）由负责培养的学院于研究生入学后的第三学期初发放，第四学期初交学院汇总后存档，以备研究生院审查。

5. 本材料系永久性档案，请用蓝黑、碳素墨水或墨汁等耐久材料书写。

6. 本表可以下载打印，打印时请使用 A4 纸正反打印，不得改变表格内容及格式。签名部分必须由签名者亲笔签署。

7.有关详细规定请查阅《河海大学研究生工作手册》。

论文计划及开题报告

计划论文题目	**A Novel Battery Charger System & Appended ZCS (PWM) Resonant Converter Dc-Dc Buck**		
选题来源 选择打（√）	1、国家计委、科委项目（ ）； 2、国家经贸委项目（ ）； 3、国家自然科学基金项目（ ）； 4、国务院其它部委项目（ ）；	5、主管部门（部委级）项目（ ）； 6、省，市，自治区项目（ ）； 7、学校 级项目（ ）； 8、自选项目（ ）；9、其它（ ）。	预 计 经 费 约 元
预计完成日期	(Expected Date of dissertation) 2013 October		

论文题目：

A Novel Battery Charger System & Appended ZCS (PWM) Resonant Converter Dc-Dc Buck

1 选题背景与研究意义（Background and the importance of research）

The main study innovation-objective of this thesis is to develop a novel high-efficiency battery charger with ZCS PWM buck topology which has simple circuit structure, low switching losses, easy control and high charging efficiencies. Beside, this project is about to investigate the action of efficient performance in charging shaping to gain the high output charging efficiency of the battery charger.

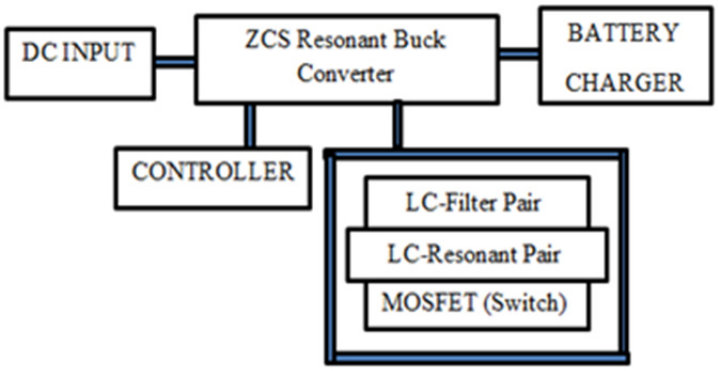
The scopes of this project are:

- Study of Battery Charger
- Study the operation of buck converter.
- Study the operation of PWM step down techniques.
- Design the buck converter power stage circuit.
- Design the PWM controller stage circuit.
- Simulation of ZCS PWM buck converter by using MATLAB software's
- Testing and calibration of the completed ZCS PWM buck converter with battery to confirm the actual response with the theoretical predictions.
- Observation of various voltage, current waveforms through inductor, capacitor of the converter
- published a Research article in International journal according to the project work

Problem Statement:

Today's technologies have shown a drastic extreme changing in all section due to its developments and achievements. Many systems had been created for this purpose. In the battery industries, there are lot of battery charger that been developed to drive a good charging process. However there are still many chargers that are not suitable to use that may damage the battery itself or the user. A bad charging process may shorten the lifetime of the battery and more dangerous is the battery may explode. In order to achieving high efficiency in

battery charger, append the traditional battery charger with the technique of ZCS (Zero-Current- Switching) resonant buck topology which delivered the efficient performance in charging shaping. Accordingly, a ZCS converter with a wide input voltage or load range has a wide frequency range. This work presents a ZCS PWM converter for battery charger to solve the foregoing problems.



Block diagram of proposed project

Key Issue of Proposed Project:

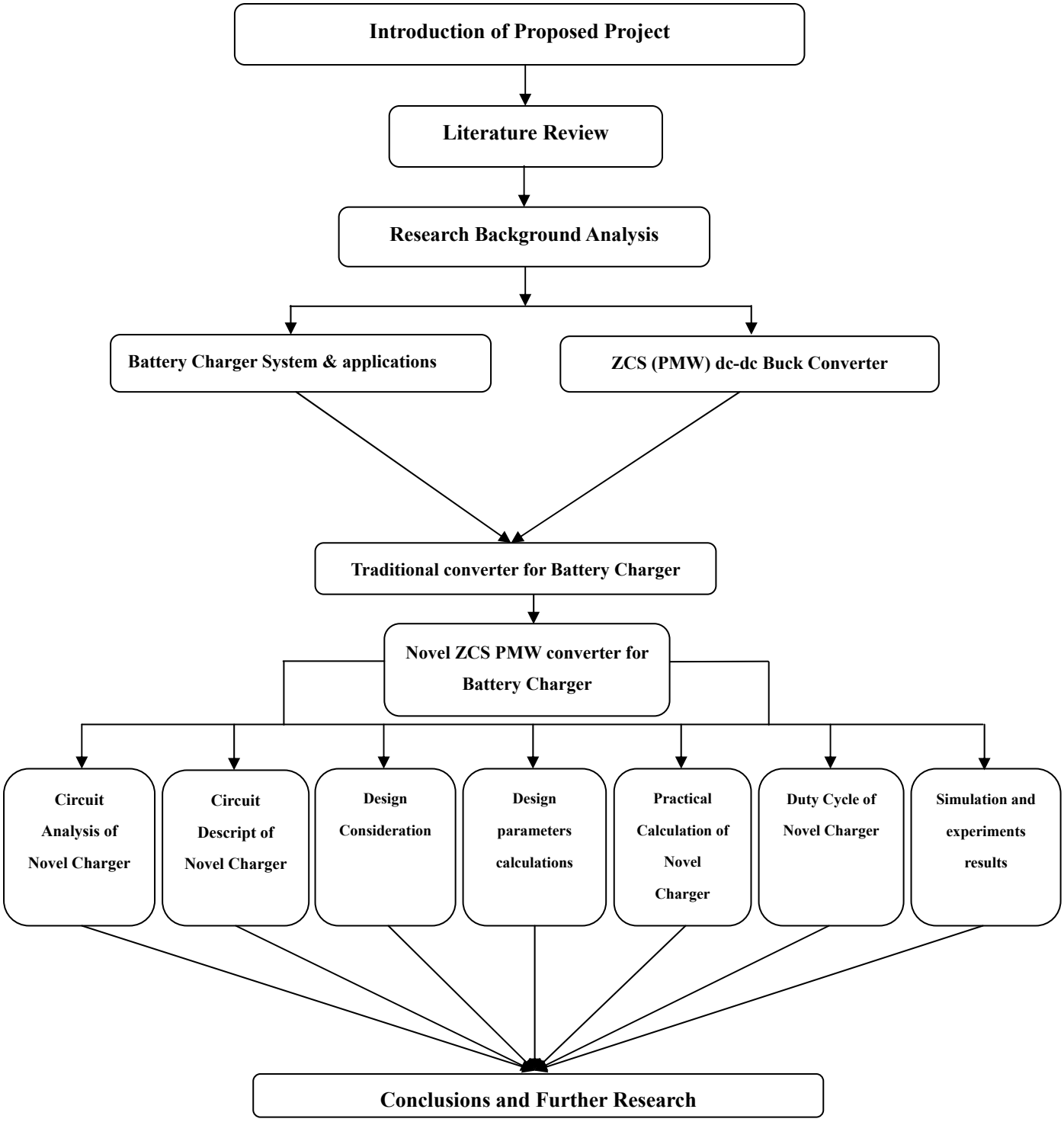
In recent years, with the enhancement of power electronics technology and control strategies in power electronics devices coupled with the increasing demand of high efficiency in battery charger system has invoked enormous attention from the research scholars around the world. Battery charger system technology is currently being incorporated in urban industrial areas to maintain with these demands lot of work is on towards. Therefore, many battery chargers with different ratings and functionalities are being developed for high output efficiency since few years. The battery charger usually works to globalize the energy saving and to serve in fast transportation systems. The use of battery charger brings convince life solution during the traveling from urban to rural areas. Many techniques were fetched out by the scientists since battery charger device was developed for renewable energy generation, electronic communication power supplies, electric vehicles, UPS or an uninterruptible power supplies, PV systems and portable electronics products. Many charging methods have been developed to improve the battery charger efficiency in the last few decades. In order to achieving high efficiency in battery charger, append the traditional battery charger with the technique of ZCS (Zero-Current- Switching) resonant dc-dc buck topology which delivered the efficient performance in charging shaping. This work looks at the issues which associates ZCS PWM (Zero-Current-Switching Pulse width Modulation) converter, buck topology with the battery charger. This paper develops a novel high-efficiency battery charger with ZCS PWM buck topology which has simple circuit structure, low switching losses, easy control and high charging efficiencies. Zero Current Switching resonant buck converter is analyzed and mode of operation is also studied. Various waveforms & charging curve period were noted down during the piratical examine using MATLAB software. The curve of charging efficiency during the charging period shows 89% charging output efficiency of novel proposed prototype. The proposed novel charger not only provides the advantages of both hard switching and resonant converters but also further yields a constant-frequency control, reducing the resonant time. The switch components in the novel charger are all operated at zero current, yielding high charging efficiency and large switching loss reduction.

2 文献综述 research comprehension

Batteries are extremely convenient energy devices that continuously switch between charge and discharge modes and can be used repeatedly many times. Batteries cause little environmental pollution and are much more widespread than conventional dry cells that must be disposed of when depleted. Batteries are employed everywhere in daily life, in energy storage, lighting, household appliances and portable electronic devices. They also provide power for vehicles, boats, ships and airplanes. Saving electric energy is important [43]. Although traditional buck converters can meet the requirements of simplicity of structure, high efficiency and reduced voltage, they can be operated only with low-frequency switching. The switching frequency of switches must be increased to reduce the circuit volume, producing excessive switching losses. However, such an increase also substantially reduces the overall efficiency of the buck converter. Accordingly, a buck converter is at best only a highly efficient buck charger for use in low-frequency switching and is not suitable for high-frequency switching. Conventional buck converters are sufficient for some industrial applications. However, the stringency of requirements associated with high-frequency switching is increasing with rapid industrial development. Resonant approaches for turning switches on or off under zero-voltage or zero-current conditions are then applied to minimize the overall efficiency reduction that is associated with severe switching losses that are caused by high-frequency switching in traditional buck converters. The buck zero-current-switching (ZCS) converter is adopted to charge the battery, clearly increasing the switching frequency of the switches. The resonant approach permits the use of switches under zero-current conditions, not only reducing the circuit volume, but also preserving the high efficiency of a traditional buck converter. However, the circuit that charges the battery still raises a difficulty: since only one switch is used, a high charging current increases the circuit resonance. Under the enlarged resonance, the switch components have a shorter service life because they have to endure higher temperatures. Additionally, the battery charges the resonant capacitor, whereas the buck ZCS converter charges the battery before the switches are turned on. The electric charge that remains on the resonant capacitor is present before the switches are turned on, and the remnant electricity affects the accuracy of the circuit resonance. The charge mode significantly affects the battery life and capacity. Charging methods are utilized to return energy to a battery so that it can continue to function as a normal power supply to a load. The conventional battery charger with a large volume suffers from power dissipation during charging and is well known to have poor efficiency. Choosing the best charging method is essential to increase the charging efficiency and extend the battery life. The traditional hard switching pulse-width-modulated (PWM) converters are still extensively used in battery chargers. However, the traditional hard-switching PWM rectangular voltage and current waveforms cause turn on and turn-off losses that limit the operating frequency. The inability of traditional hard-switching PWM battery chargers to operate efficiently at very high frequencies imposes a limit on the size of the reactive components of the charger circuits, thereby on power density. Seeking chargers that are capable of operating at higher frequencies, power electronic engineers have begun to develop charger topologies that shape either the sinusoidal current or the sinusoidal voltage waveform, markedly reducing the switching losses. The underlying idea is to use a resonant circuit. Unlike traditional hard-switching PWM battery chargers, resonant chargers can be designed to be small and low weight. Numerous resonant schemes have been proposed to improve the switching behavior of the battery chargers. Among various resonant topologies, the zero-voltage-switching (ZVS) and ZCS can be applied to eliminate switching losses. The voltage of the power switch in a ZVS battery charger is set to zero prior to turn on, eliminating turn-on switching losses and the Miller effect. However, the traditional ZVS procedure has many limitations. First, the power switch in a ZVS converter suffers from high voltage stress which is proportional to the load range. Hence, a high voltage power switch accompanied by high on resistance and large input capacitance must be used, substantially increasing conduction losses and

gate driver losses. Second, a wide switching frequency range is required for a ZVS converter to operate with wide input voltage and load ranges. The wide frequency range makes difficult the optimization of the input filter, the output filter, the control circuit and the driver circuit. However, the ZCS method eliminates the voltage and current overlap by forcing the power switch current to zero before the switch voltage rises. Therefore the ZCS converter is deemed more effective than ZVS in reducing switching losses. For high-frequency applications, the ZCS converter is the most commonly used. However, one of the major limitations of the ZCS converter is that high circulating energy is produced by the resonant inductor, which is in series with the power switch. The second shortcoming is severe parasitic ringing on the power switch. The third shortcoming is a variable frequency operation, since the ZCS converters operate with constant on-time control. The proposed battery charger adds an auxiliary switch to the resonant loop, dominating the resonance time accurately. In the ZCS PWM converter, resonance does not occur between the inductor and the capacitor until the auxiliary switch is turned on; then, the inductor begins to resonate with the capacitor. After the resonance brings the inductor current to zero, the main power switch is turned off with ZCS. Hence, the function of the auxiliary switch is to hold off the resonance for a period. The on-time of the power switch can be varied by controlling this hold-off period, enabling the ZCS PWM converter to regulate the output while the circuit is operated at a fixed switching frequency.

3 研究内容及相关概念的界定 (The content of dissertation and the delimitation of relative concept, highlighting Outlines/Main points)



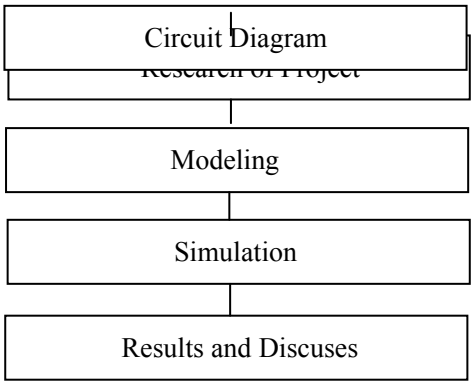
The Flow chart of the whole Research Work Plan

4 技术路线与研究方法 (Outline and Research Methodology)

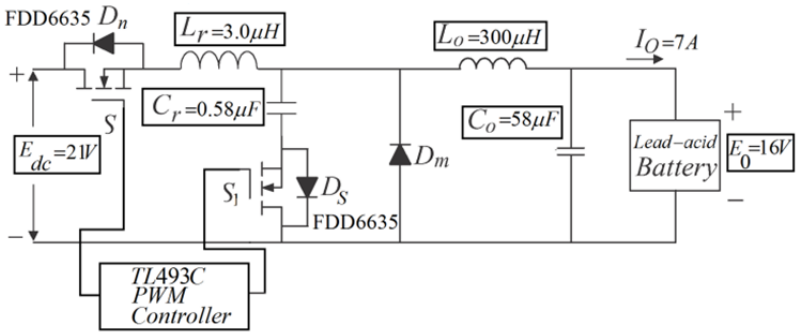
The Outline of Research Methodology has been given below:

Research Methodology:

This chapter discusses the research methodology and procedures as well as equipment and software's in the entire and initial work process. The methodology describes how the flows of the project work and procedures the project topic was divided into different phases-sections and how to the work involved in each phase.



Practical Circuit Prototype of Novel Battery Charger:



Experiment Results:

In order to understanding the operation of novel design requires a clear knowledge of the transient behavior of current and voltage waveforms for each and every circuit element at every instant in time. To aid the understanding of the circuit's transient response computer aided simulation software MATLAB/SIMULINK is used. A prototype ZCS PWM converter dc-dc buck for battery charger is established. The experiment results were confirmed through MATLAB software as simulation tool is used in this paper.

5 拟解决问题与技术创新 (The problems solved in the research and the innovations/The value of the research)

This Research has four major contributions

1. Firstly, the technique of ZCS PWM (Zero Current Switching Pulse width Modulation) resonant Converter dc-dc buck append with battery charger circuit which demonstrates the effectiveness of developed methodology
2. Secondly, the research methodology of ZCS PWM converter for novel battery charger relates the idea to gain high efficiency, low circuit volume, minimum switching losses and satisfactory performance in charging shaping.
3. Thirdly, the simulation results are cited for its 89% efficiency that occurs during charging period of proposed novel prototype. The practical examine is agreed the theoretical predictions.

6 参考文献 (References)

[1]. Y.C. Chuang, Y.-L. Ke, "High Efficiency battery charger with a buck zero-current-switching pulse-width-modulated converter" IET Power Electron., 2008, Vol. 1, No.4, pp. 433-444.

[2]. KOTTICK D., BLAU M., EDELSTEIN D.: 'Battery energy storage for frequency regulation in an island power system', IEEE Trans. Energy Convers., 1993, 8, (3), pp. 455 – 459

[3]. KOUTROULIS E., KALAITZAKIS K.: 'Novel battery charging regulation system for photovoltaic applications', IEE Proc., Electr. Power Appl., 2004, 151, (2), pp. 191 – 197

[4]. A. Nasiri, Z. Nie, S. B. Bekiarov, and A. Emadi, "An on-line UPS system with power factor correction and electric isolation using BIFRED con- verter," IEEE Trans. Ind. Electron., vol. 55, no. 2, pp. 722–730, Feb. 2008.

[5]. L. R. Chen, J. J. Chen, N. Y. Chu, and G. Y. Han, "Current-pumped battery charger," IEEE Trans. Ind. Electron., vol. 55, no. 6, pp. 2482–2488, Jun. 2008.

[6]. L. R. Chen, C. S. Liu, and J.-J. Chen, "Improving phase-locked battery charger speed by using resistance-compensated technique," IEEE Trans. Ind. Electron., vol. 56, no. 4, pp. 1205–1211, Apr. 2009.

[7]. S. Abinaya, A. Sivaranjani and S. Suja "Methods of Battery Charging with buck Converter using soft-Switching Techniques" Bongfing International Journal of Power Systems and Integrated Circuits, Vol. 1, Special Issue, December 2011.

[8]. Ying-Chun Chuang, "High-Efficiency ZCS Buck Converter for Rechargeable Batteries" IEEE Transactions on Industrial Electronics, Vol. 57, NO. 7, July 2010.

[9]. Helio Leaes Hey, Lourenco Matias and Joao Batista Viera Junior "A Buck ZC-ZVS PWM Converter" Power Electronics Specialists Conference PESC '94 Record. 25th Annual IEEE June 1994.

[10]. Suzanne Foster Porter, Haresh Kamath, Tom Geist, "Draft 2 Energy Efficiency Battery Charger System Test Procedure: A Technical Primer." February 28, 2006. Published by the California Energy Commission through the Public Interest Energy Research (PIER) Program, available at http://www.efficientpowersupplies.org

[11]. Tom Geist, Haresh Kamath, Suzanne Foster Porter, Peter May-Ostendorp "Designing Battery Charger Systems for Improved Energy Efficiency: A Technical Primer." September 28, 2006. Published by the California Energy Commission through the Public Interest Energy Research (PIER) Program, available at http://www.efficientpowersupplies.org

[12]. Shahab Ahmad and K.P.Singh "Simulation of Step-Down/Step-Up Converter Implemented with ZCS Soft Switching" VSRD-IJEECE, Vol.2 (9), pp 695-704, 2012.

[13]. Yu-Lung Ke, Ying-Chun Chuang, Shao-Wei Huang "Application of Buck Zero-Current-Switching Pluse-Width-Modulated Converter in Battery Chargers" Industrial and Commercial Power Systems Technical Conference 2007.

[14]. Naseem Zaidi, Aziz Ahmad "Anaylsis, Design and Control of Zero Current Switching DC To DC Buck Converter" International Journal of Scientific and Research Publications, Vol. 2, Issue 7, July 2012.

[15]. Helio Leaes Hey, Lourenco Matias and Joao Batista Viera Junior "A Buck ZC-ZVS PWM Converter" Power Electronics Specialists Conference PESC '94 Record. 25th Annual IEEE June 1994.

[16]. A. Emrani, H. Farzanehfard " A New Zero Current Switching Resonant Buck Converter "the 24th Canadian Conference on Electrical and Computer Engineering, CCECE 2011, Niagara Falls, Ontario, Canada, 8-11 May, 2011.

[17]. K. Narasimha Rao, Dr V.C. Verra Reddy, "Implementation of FM-ZCS-Quasi Resonant Converter Fed DC Servo Drive" Journal of theoretical and applied Information Technology, In Proceedings of the Second International Conference on Emerging Trends in Engineering & Technology, ICETET 2009.

[18]. Sondeep Bassan and Gerry Moschopoulos "Zero-Current-Switching Techniques for Buck-Type AC-DC Converters" Telecommunications Energy International Conference - INTELEC , 2007.

[19]. Vaman B Gudil, Dr. H N Nagaraj, Dr. Paramesh, Basavaraj V Madiggond "Design Issues in Single Stage Synchronous Buck Converter" International Journal Of Emerging Technology and Advanced Engineering Vol. 2, Issue 4, April 2012.

[20]. Nanda R Mude, Prof. Ashish Sahu, "Adaptive Control Schemes For DC-DC Buck Converter" International Journal Of Engineering Research and Application Vol. 2, Issue 3, PP. 463-467, May-Jun 2012.

[21]. Yu-Lung Ke, Ying-Chun Chuang, Shao-Wei Huang "Application of Buck Zero-Current-Switching Pulse-Width-Modulated Converter in Battery Chargers" Industrial and Commercial Power Systems Technical Conference 2007.

[22]. G. Hua and fred C. Lee, "Soft-Switching Techniques in PWM Converters" IEEE Trans. Industrial Electronics, Vol.42, no. 6. PP. 595-60, Dec 1995.

[23]. Naseem Zaidi, Aziz Ahmad "Analysis, Design and Control of Zero Current Switching DC To DC Buck Converter" International Journal of Scientific and Research Publications, Vol. 2, Issue 7, July 2012.

[24]. FOSTER M.P., SEWELL H.I., BINGHAM C.M., STONE D.A., HOWE D.: 'Methodologies for the design of LCC voltage-output resonant converters', IEE Proc., Electr. Power Appl., 2006, 153, (4), pp. 559 – 567

[25]. ABE H., SAKAMOTO H., HARADA K.: 'A noncontact charger using a resonant converter with parallel capacitor of the secondary coil', IEEE Trans. Ind. Appl., 2000, 36, (2), pp. 444 – 451

[26]. FOSTER M.P., SEWELL H.I., BINGHAM C.M., STONE D.A., HOWE D. "Methodologies for the design of LCC voltage-output resonant converters'" IEE Proc., Electr. Power Appl., 2006,153, (4), pp. 559 – 567

[27]. ABE H., SAKAMOTO H., HARADA K. "A noncontact charger using a resonant converter with parallel capacitor of the secondary coil" IEEE Trans. Ind. Appl., 2000, 36, (2), pp. 444 – 451.

[28]. M.D Singh, K B Khanchandani, Electrical & Electronics Engineering series, 2rd ed., TATA McGraw-Hill, 2008, pp.775-778.

[29]. Daniel W. Hart, Introduction to Power Electronics International Edition, Prentice-Hall International, Inc, 1997.

[30]. Y. B. Chuang, Power Electronics, Gau Lih Book Co., Ltd., 1998.
[31]. I. C. Sun, "Design and Implementation of Resonant-Switch Converters for Battery Chargers," Master Thesis, Kun Shan University, June 2004.
[32]. K. C. Shi, "Design and Implementation of Battery Charger with Zero-Voltage-Switching Resonant Converter for Photovoltaic Arrays," Master thesis, Dept. Electrical Eng., Kun Shan University, July 2005.
[33]. Ned Mohan, Tore M. Undeland, and William P. Robbins, Power Electronics Converters, Applications and Design, 2nd ed., John Wiley & Sons Inc, 1995.
[34]. L. C. deFreitas and P. R, C. Gomes, "A ZVT Buck Converter Using a Feedback Resonant Circuit," in 1993 Fifth European Conference on Power Electronics and Applications, pp. 30-35.
[35]. G. Hua, "Soft-switching technique for PWM converters," Ph.D. dissertation, Dept. Electrical Eng., Virginia Polytechnic Institute and State University, Blacksburg, VA, 1994.
[36]. G. Hua and Fred C. Lee, "Soft-Switching Techniques in PWM Converters" IEEE Trans. Industrial Electronics, vol. 42, no, 6, Dec.1995. pp. 595-603,
[37]. V, Grigone, J . Kyyra "A 500W (50V @10A) ZVT Forward Converter" in Proceedings of the 13th IEEE Applied Power Electronics Conference, APEC'98, Anaheim, CA, USA, 1998, pp. 614-619.
[38]. P.Hemachander, Dr.P.Ajay-DVimalRaj, Dr.M.Sudhakaran,"Analysis Design and Implementation of Soft Single Switched Boost Converter" International Journal of Computer Application Vol. 26- No.11, July 2011.
[39]. Ivo Barbi, Julio C. O. Bolacell, Denizar C. Martins, Fausto B. Libano, "Buck Quasi-Resonant Converter Operating at Constant Frequency: Analysis, Design, and Experimentation" IEEE Transactions on Power Electronic. Vol.5. NO. 3, July 1990.
[40]. COOK G.M., SPINDLER W.C., GREFE G.: 'Overview of battery power regulation and storage', IEEE Trans. Energy Convers., 1991, 6, (1), pp. 204 – 211
[41]. YANG F.C., CHEN C.C., CHEN J.J., HWANG Y.S., LEE W.T.: 'Hysteresis- current-controlled buck converter suitable for Li-ion battery charger '. 2006 Int. Conf. Communications, Circuits and Systems Proc., June 2006, vol. 4, pp. 2723 – 2726
[42]. BARSALI S., CERAOLO M.: 'Dynamical models of lead-acid batteries: implementation issues', IEEE Trans. Energy Convers., 2002, 17, (1), pp. 16 – 23

YOUR KNOWLEDGE HAS VALUE



- We will publish your bachelor's and master's thesis, essays and papers

- Your own eBook and book - sold worldwide in all relevant shops

- Earn money with each sale

Upload your text at www.GRIN.com and publish for free

GRIN