Technology

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

Pre-Defense

Professorial Dissertation

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 .

Imprint:

ISBN: 9783656646396

This book at GRIN:

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

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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。

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论文计划及开题报告

<table>
<tr><td>计划论文题目</td><td colspan="3">A Novel Battery Charger System & Appended ZCS (PWM) Resonant Converter Dc-Dc Buck</td></tr>
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3、国家自然科学基金项目（ ）；
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6、省，市，自治区项目（ ）；
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<tr><td>预计完成日期</td><td colspan="3">(Expected Date of dissertation) 2013 October</td></tr>
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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）

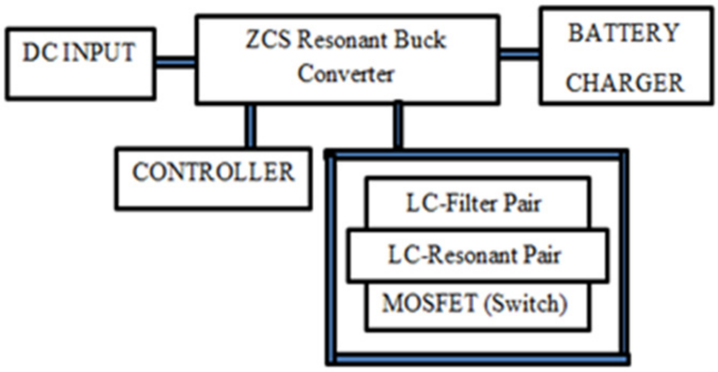
The main study innovation-objective of this thesis is to develop a novel high-efficiency battery charger with ZCS PWM buck topology which has simple circuit structure, low switching losses, easy control and high charging efficiencies. Beside, this project is about to investigate the action of efficient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

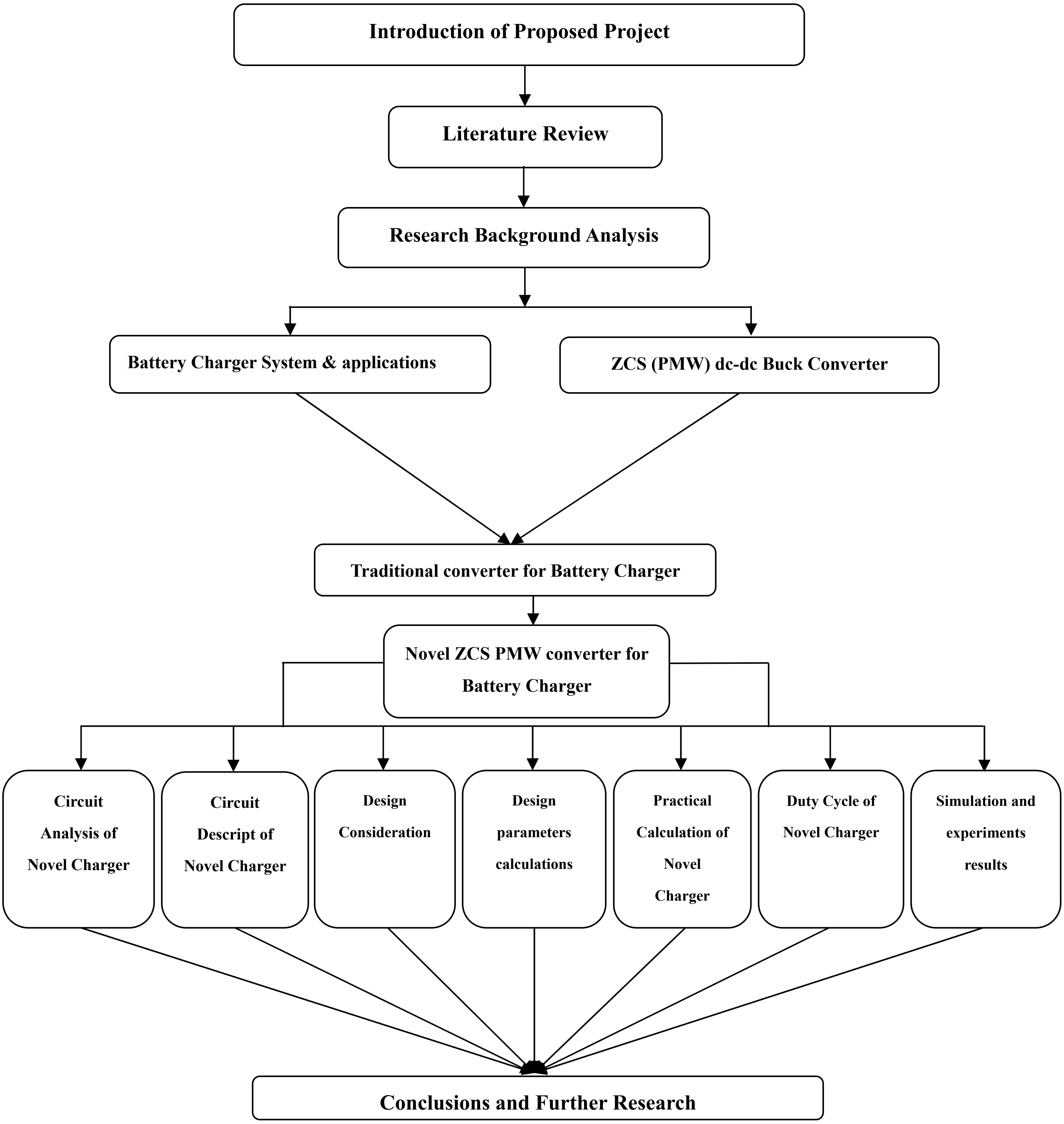
Key Issue of Proposed Project:

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)



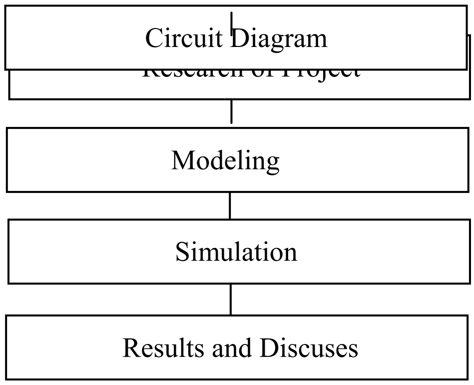
The Flow chart of the whole Research Work Plan

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

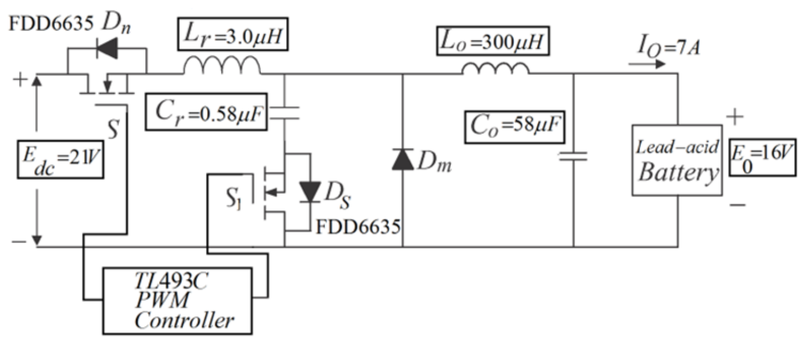
The Outline of Research Methodology has been given below:

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.

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