DESIGN AND HARDWARE CONSTRUCTION OF SERIES-PARALLEL RESONANT DC-DC CONVERTER

This project is presented in partial fulfillment for the award of the

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ACKNOWLEDGEMENT

First and foremost, I would like to thank to God for allowing me to complete this final year project thesis successfully. Without God's blessing, I believe that I could not complete this project on time.

I would like to express my deepest gratitude and appreciation to my supervisor Dr. Muhammad Nawawi bin Seroji for his information, guidance, opinion and advice in order to complete this project and thesis. Without his help, I might not be able to cope with the certain problems in this project. Besides, I also like to extend my appreciation to my friends for their direct and indirect contribution in completing this project.

Last but not least, hopefully this project would give some preview and exposure about resonant converter in term of its benefit to industry. Last word, thank you and best regards from me.

ABSTRACT

With the rapid growth of microelectronic technology, high performances of Integrated Circuits (ICs) bring huge challenge to design the power supplies. Fast loop response is required to handle the high transient current of devices [1]. Nowadays, the smaller sizes of power components is demanded in order to reduce the size of integrated circuits. The best way to meet these harsh requirements is by increasing the switching frequency of the power supplies [1]. But, by increasing the switching frequency the switching loss and gate charge loss will increase proportionally. Therefore, the resonant switching or soft switching was introduced in order to minimize and mitigate these problems.

This thesis describes the topology of resonant converter which is to minimize the switching losses. This project focuses to analyze the topology of Series-Parallel Resonant DC-DC Converter (SPRC). The main objective of this project is to design and construct the prototype of Series-Parallel Resonant Converter (SPRC) to provide 9V, 0.45A output for 10 kHz application. The advantages and disadvantages of these resonant converter and SPRC are presented. The details methods of designing the gate driver and SPRC are provided. The thesis also includes the results obtained from PSIM simulation and experimentation.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Since the birth of power electronics in the late 1950s, the subject has grown rapidly. Power electronics devices have many advantages over the traditional power devices in many aspects such as converting performance, size and weight, and hence the cost. Nowadays the power electronics devices are widely used in drives, electro-heat, lighting control systems, automotive and power supply systems, especially in telecommunication and computing system. Over the last twenty years, the fundamental approach to electronic power conversion in telecommunication and computing system has steadily moved toward "high-frequency" [1].

This move is mainly motivated by the rapid progress in microelectronics technology. Increasing the frequency of operation of power converters is desirable, as it allows the size of circuit magnetic and capacitors to be reduced, leading to cheaper and more compact circuits. However, increasing the frequency of operation also increases switching losses and hence reduces system efficiency. One solution to this problem is to replace the "chopper" switch of a standard SMPS topology (Buck, Boost etc.) with a "resonant" switch, which uses the resonances of circuit capacitances and inductances to shape the waveform of either the current or the voltage across the switching element, such that when switching takes place, there is no current through or voltage across it, and hence no power dissipation. A circuit employing this technique is known as a resonant converter [2].

Resonant converter, which were been investigated intensively in the 80's, can achieve very low switching loss thus enable resonant topologies to operate at high switching frequency. In resonant topologies, Series Resonant Converter (SRC),