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PERFORMANCE ANALYSIS OF 100 W BOOST CONVERTER

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PERFORMANCE ANALYSIS OF 100 W BOOST CONVERTER

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A thesis submitted in fulfilment of the requirements for the degree of Bachelor of Electrical Engineering

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2014

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I declare that this report entitled “Performance Analysis of 100 W Boost Converter” is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :.....

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Date : .....

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Dedicated especially in order to express my appreciation to

my supervisor, Mr. Musa Yusup Lada

my beloved father, Halim bin Ishak

my beloved mother, Noorziati binti Embi

my brothers and sisters,

my friends, lecturers

and every individual,

who have inspired me throughout this long road no visible end.

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ABSTRACT

DC-DC converters are widely used in regulated switch mode DC power supplies. The input of these converters is an unregulated DC voltage and therefore it will fluctuate due to the disturbances in the system. The output voltage regulation in DC-DC converter is achieved by constantly adjusting the amount of energy absorbed from the source and that injected into the load, which is in turn controlled by the relative durations of the absorption and injection intervals. The objectives of this project are to design a DC-DC boost converter and to make the hardware implementation of the circuit. This system utilized basic open-loop and closed-loop control configurations of the boost converter. The parameter of component values for hardware design can be obtained through some calculation from the theoretical formulae and analysis on MATLAB Simulink software. The methodology of designing the hardware circuit is presented in details. All the simulation results will be verified by the hardware design. The process involved are simulating the boost converter circuit, designing the circuit layout, making the printed circuit board (PCB), testing the PCB board, analysing the data on hardware and drawing conclusion. Hardware implementations have been done in order to verify the operation of the boost converter. From this project, the output voltage obtained in hardware is slightly different compared to the simulation due to some unresolved issues. Other than that, the acceptable results are valid for PWM and gate driver. The efficiency of the boost converter is almost to 1 which is close to the ideal when tested with load variation.

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ABSTRAK

Penukar DC-DC digunakan secara meluas dalam mod suis terkawal bekalankuasa DC. Input penukar ini adalah voltan DC yang tidak dikawal dan oleh itu ia akan naik turun disebabkan oleh gangguan dalam sistem. Peraturan voltan keluaran di penukar DC-DC dicapai dengan sentiasa menyesuaikan jumlah tenaga yang diserap dari sumber dan yang disuntik ke dalam beban, seterusnya dikawal oleh tempoh masa relative penyerapan dan suntikan selang. Objektif projek ini adalah untuk mereka bentuk penukar rangsangan DC-DC dan membuat pelaksanaan perkakasan litar. Sistem ini digunakan untuk konfigurasi asas penukar rangsangan kawalan gelung terbuka dan kawalan gelung tertutup. Nilai-nilai parameter komponen untuk reka bentuk perkakasan boleh didapati melalui beberapa pengiraan daripada formula teori dan analisis pada perisian MATLAB Simulink. Metodologi mereka bentuk litar perkakasan dibentangkan secara terperinci. Semua keputusan simulasi akan disahkan oleh reka bentuk perkakasan. Proses ini terlibat secara simulasi rangsangan penukar litar, mereka bentuk susun atur litar, membuat papan litar bercetak (PCB), menguji papan PCB, menganalisis data pada perkakasan dan membuat keputusan. Pelaksanaan perkakasan telah dilakukan untuk mengesahkan operasi rangsangan penukar. Daripada projek ini, voltan output yang didapati dalam perkakasan adalah sedikit berbeza berbanding simulasi kerana beberapa isu-isu yang tidak dapat diselesaikan. Selain daripada itu, keputusan yang boleh diterima adalah sah untuk PWM dan pemandu pintu. Kecekapan rangsangan penukar adalah hampir kepada 1 yang berhampiran dengan ideal apabila diuji dengan perubahan beban.

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LIST OF ABBREVIATIONS

A	-	Ampere
C	-	Capacitor
D	-	Duty Ratio
DC	-	Direct Current
f	-	Frequency
Hz	-	Hertz
IC	-	Integrated Circuit
L	-	Inductor
PCB	-	Printed Circuit Board
PWM	-	Pulse Width Modulation
R	-	Resistor
T	-	Time
V	-	Voltage
V_L	-	Voltage Inductor
V_O	-	Voltage Output
V_S	-	Voltage Source
μF	-	Micro Farad
μH	-	Micro Henry

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Ω	-	Ohm
DC-DC	-	Direct Current to Direct Current
MOSFET	-	Metal-Oxide-Semiconductor Field-Effect-Transistor
CMC	-	Current Mode Control
VMC	-	Voltage Mode Control
PV	-	Photovoltaic

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CHAPTER 1

INTRODUCTION

1.1 Background

Converters required power electronic circuit in order to match the voltage and current requirements of the load to those of the source. Converters are classified by the relationship between input and output [1].

DC-DC converters are used to convert the unregulated DC input to a controlled DC output with a desired voltage output. It is classified as a regulator and it is useful when a load requires a specified DC voltage or current but the source is at a different or unregulated DC value. It is used widely in DC motor drive application and it provides smooth acceleration control, high efficiency and fast dynamic response [2].

Control system has been designed in order to compensate any disturbance or error in the converter system. Control design for any system involves a mathematical description of the relation among inputs to the process, state variables, and output. These control parameters will be presented in the form of mathematical equations which describe behaviour of the system called as model of the system.

The advantages and primary reasons of building control system are to get power amplification, remote control, convenience of input form and compensation for disturbance [3].

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1.2 Problem Statement

DC-DC boost converter also known as a regulator is a design of power electronics which capable to regulate unregulated DC input to a desired voltage output. There are two basic configurations applied in boost converter system, namely open-loop and closed-loop respectively. Open-loop system is simpler manual modelling where as closed-loop system is automatic control system modelling. The DC-DC boost converter needs four external components: inductor, electronic switch, and diode and output capacitor.

The converter operates in two different modes depending on its energy storage capacity and the relative length of the switching period. These two operating modes are known as the discontinuous conduction mode (DCM) and continuous conduction mode (CCM). If the energy storage capacity of the converter is too small or the switching period is relatively too long, then the converter would transmit all the stored energy to the load before the next cycle begins.

Therefore, the boost converter circuit undergo debugging, testing the parameters and collecting data for the implementation of hardware circuit. This hardware is designed using OrCAD software to make the hardware more convenient and efficient.

1.3 Project Objectives

There are four objectives to be covered in this project:

1. To model the open-loop and closed-loop boost converter.
2. To design the hardware of open-loop and closed-loop boost converter.
3. To develop calculations for determining relative circuit parameters for the design of boost converter.
4. To verify the performance of open-loop and closed-loop boost converter.

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1.4 Scope of the Project

The scope of this project is to create a boost converter in continuous current mode (CCM) by applying the theoretical concepts and the simulation designs into hardware implementation. The basic theoretical about fundamental behaviour of boost converter, pulse width modulation and gate driver been studied in order to achieve the objectives of this project. In this project, MOSFET power switch will be used as a switching device. The simulation of DC-DC boost converter will be simulated by using MATLAB Simulink software to analyze the optimum performance characteristics of the boost converter. The PCB of boost converter circuit will be designed using OrCAD software.

1.5 Report Outlines

This report is organized in five chapters; **Chapter 1** offers a preface about power electronic converters focusing on boost converter. Besides, the objectives, problem statement and scope of the project are also addressed.

Chapter 2 provides the discussion based on theories and literature reviews that have been done Then, the basic knowledge to the specific converter that is the boost converter been introduced. The theoretical analysis of the boost converter describes in detail in order to understand all the important parameters related to the system.

Chapter 3 explains on the methods implement to carry out the analysis of the boost converter. The introduction of flowchart, milestones and Gantt chart make ease the sequence of the project operation. Other than that, the simulation approach and hardware implementation are stated in this chapter. The boost converter will be tested in open-loop system and closed-loop system. The simulation is verified under MATLAB Simulink environment, while the hardware implementation describes the design procedures of PCB circuit.

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Chapter 4 represents the design analysis of boost converter using the simulation and hardware implementation approaches. The experimental results and analysis for boost converter in open loop and closed loop system are also included in this part.

Chapter 5 concludes the overall achievement of the boost converter project. This chapter conclude all the data that been gathered and collected. A summary is reviewed to finalize the outcome of the project.

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter review the existing project created to get an idea about the boost converter by following conception, specification and any information that related to the project. In later of this chapter, some review about the proposed design of boost converter to fulfil this project will be reported.

2.2 Converters

Converters serve as an interface between the source and load as shown in Figure 2.1. It convert one type or level of a voltage or current waveform to another and classified by the relationship between input signal and output signal as shown in Table 2.1 [12].

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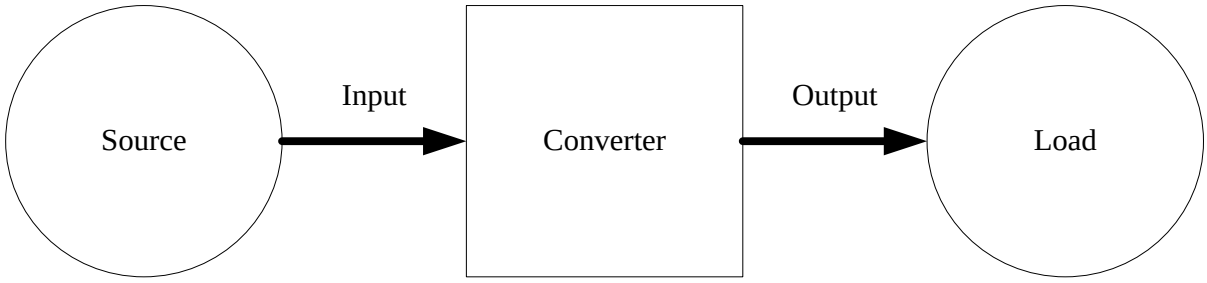

Figure 2.1: Basic converter system [12].

Converter circuits capable to operate in different mode, depending on electronic circuit used, high frequency switching semiconductor and applied control system. Thus, converters are capable to operate in multiple stages in a process with different type of converter involves in Figure 2.2 [12].

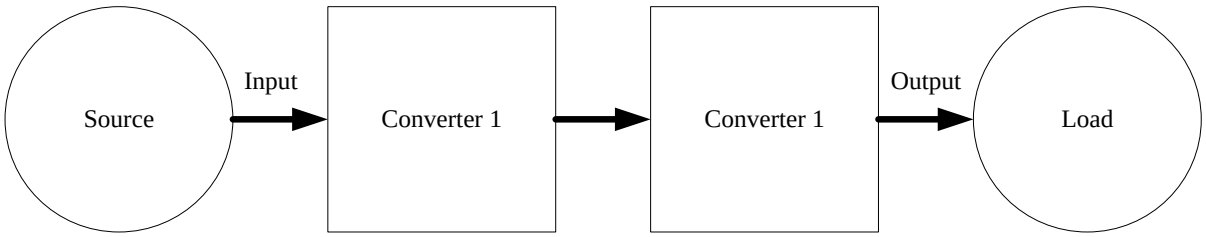

Figure 2.2: Two converters are used in a multistep process [12].

Table 2.1: Classification of converters [12].

Type of converter	Functions
AC input/DC output	The AC/DC converter that produces a DC output from an AC input. It classified as a rectifier.
DC input/AC output	The DC/AC converter that produces a AC output from a DC input. It classified as a inverter.
DC input/DC output	The DC/DC converter that produces a DC output from a DC input. It classified as a regulator.

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AC input/AC output	The AC/AC converter that produces a AC output from an AC input. It used to change the level and/or frequency of an AC signal.

2.3 DC-DC Converter

DC-DC converters are used to convert the unregulated DC input to a controlled DC output at a desired voltage output. It is classified as a regulator and it is useful when load requires a specified DC voltage or current but the source input is at a different or unregulated DC value [12]. Generally, DC-DC converter block diagram is shown in Figure 2.3.

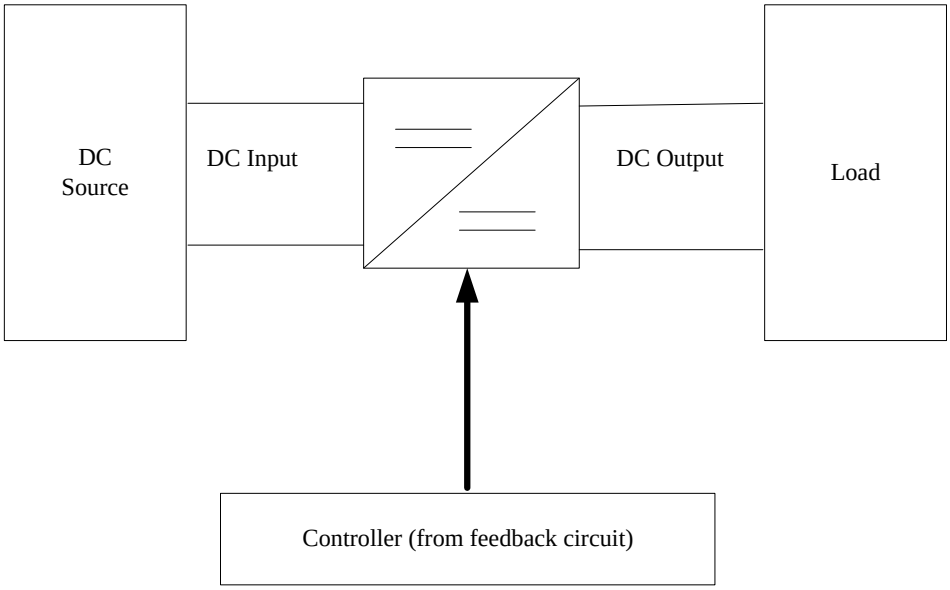

Figure 2.3: General DC-DC converter block diagram [12].

DC-DC converters include buck converters, boost converters, buck-boost converters, Ćuk converters and full-bridge converters [9]. Switched DC-DC converters offer a method to increase or decrease an output voltage depend on application or system.

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