Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF HYBRID CONTROL OF DC-DC ZETA CONVERTER IN DISCONTINUOUS CONDUCTION MODE

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Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours

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A project report submitted
in partial fulfillment of the requirements for the degree of
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I declare that this project report entitled "Development of Hybrid Control of DC- DC Zeta Converter in Discontinuous Conduction Mode" is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Date : 21/1/2022

APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours.

Signature :

Supervisor Name : DR. HAFEZ BIN SARKAWI

Date : 28/1/2022

DEDICATION

Personally, dedicated to my family and my supervisor who helped me to complete my final years report

ABSTRACT

Because of the fast growth of the Internet of Things (IoT), it is now necessary to have a reliable power source for the use of IoT devices. Any IoT gadget will require power to function. A gadget will always require a certain amount of voltage and current, whether it comes from a power outlet or a battery. Power is the result of these two variables (voltage and current). The device's energy is defined as the quantity of power utilised during a given time. Some of these devices consume small power and this led to discontinuous conduction mode (DCM) operation of a dc- dc converter. Therefore, a dc- dc zeta converter working in DCM is suggested, and the converter is stabilised using a hybrid control method based on the control Lyapunov function. A Lyapunov function is a scalar function defined on the phase space that may be used to verify an equilibrium point's stability. Circuit design and development, as well as microcontroller programming will be conducted for this project. The project expected that a stable output voltage will be produced although the changes at the input voltage and load.

ABSTRAK

Oleh kerana perkembangan Internet-of-Things (IoT) yang pesat pada masa kini, terdapat keperluan untuk mempunyai bekalan kuasa yang stabil untuk penggunaan peranti IoT. Mana-mana peranti IoT memerlukan elektrik untuk berfungsi. Sama ada dari soket kuasa atau bateri, peranti akan memerlukan voltan dan arus tertentu. Produk kedua (voltan dan arus) dipanggil kuasa. Kuasa yang digunakan dalam jangka masa tertentu adalah tenaga peranti. Sebilangan peranti ini menggunakan tenaga yang kecil dan ini membawa kepada operasi mod konduksi berterusan (DCM) penukar DC-DC. Oleh itu, dicadangkan penukar DC-DC Zeta yang beroperasi di DCM dan algoritma kawalan hibrid berdasarkan fungsi Lyapunov kawalan digunakan untuk menstabilkan penukar. Fungsi Lyapunov adalah fungsi skalar yang ditentukan pada ruang fasa, yang dapat digunakan untuk membuktikan kestabilan titik keseimbangan. Reka bentuk dan pengembangan litar, serta pengaturcaraan mikrokontroler akan dilakukan untuk projek ini. Projek ini menjangkakan voltan keluaran yang stabil akan dihasilkan walaupun perubahan pada voltan input dan beban.

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Ω	-	Ohm
°C	-	Celsius

LIST OF ABBREVIATIONS

V	-	Voltage
DC	-	Direct current
DCM	-	Discontinuous conduction module
PWM	-	Pulse- Width Modulation
Hz	-	Hertz

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CHAPTER 1

INTRODUCTION

1.1 Background

According to Hafez Sarkawi and Yoshito Ohta, Hybrid controller is presented that is applicable to dc–dc series converters and small signal approximation.[1] A variable switching frequency controller is also known as hybrid control.[1]

Nowadays, dc-dc converter is widely used as power supply in electronic systems. The dc output current of a switch-mode converter fluctuates in response to load variations. Pulse width modulation (PWM) is a frequently used method to control the output power of a power switch by altering the ON and OFF. The duty cycle is the ratio of ON time to switching period time. The PWM Zeta converter is a noninverting polarity step up/down converter that may be designed to generate low-ripple output current using either connected inductors or separate inductors.[2] The duty ratio range of the Zeta converter is wider than any other converter. Improved power factor, low input current distortion, low output current ripple, and a wide output-power range are all features of this converter.[2]

1.2 Problem Statement

The study of develop hybrid control for dc dc converters had been study by most of the researcher.[3][4] However, the project was only cover by using simulation environment. Hence, a hybrid control based on DC DC Zeta converter in DCM circuit design and development, as well as microcontroller programming should be study.

Lastly, if tOFF lasts long enough for the primary inductor to entirely discharge, the current in the inductor will be zero for a period of time. This is known as discontinuous conduction mode, because it causes both the diode and the MOSFET to be turned off (DCM).[5] So, dc-dc converters with zeta topology and control Lyapunov function should be study to ensures the output voltage is stable.

1.3 Project Objective

The main aim of this project is to propose a stable output voltage even there are changes of input voltage and load. Specifically, the objectives are as follows:

a) To design a prototype of DC-DC Zeta converter

b) To analysis the output voltage of the zeta converter

1.4 Scope of Project

The scope of this project are as follows:

a) Design a dc- dc zeta topology converter with voltage and current sensors by using Proteus software.

b) A prototype of zeta converter is constructed and tested.

c) A hybrid control algorithm based on control Lyapunov function is used to stabilize the converter.

d) Output voltage will be analysis.

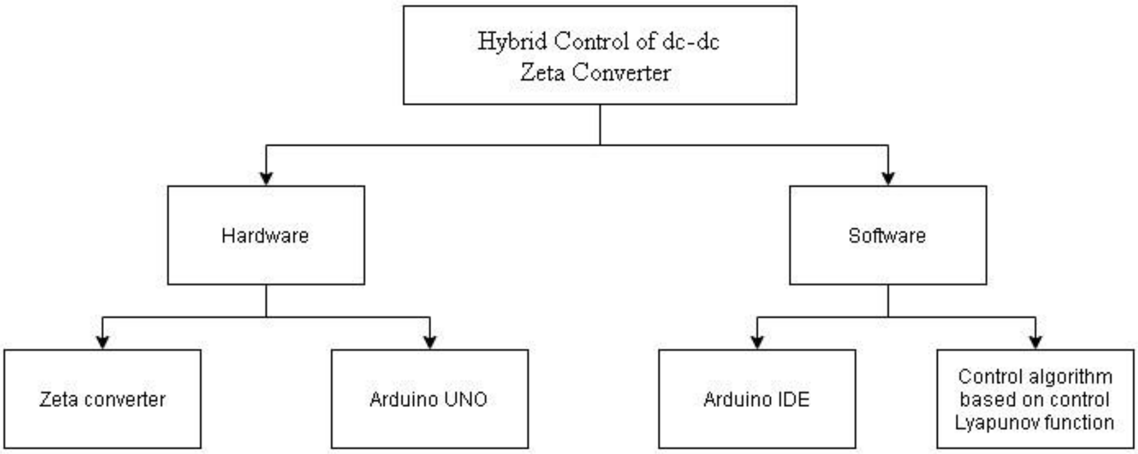

Figure 1.1 Scope of works block diagram

1.5 Organization Structure

This report focuses on development of hybrid control of dc- dc zeta converter in discontinuous conduction mode. This report consists of five major sections: introduction, background study, methodology, results, and discussion, followed by a conclusion and future work.

Chapter 2 discusses the literature research introduction and other related studies to this project by different researchers that contain the basics of FPGA, solar panel, DC-DC converter, and the analysis fundamental.

Next, Chapter 3 discusses the methodology used to achieve the project objectives and scope of work. The specifications and flowcharts needed for the research summary to track the project flow will be studied. All data and results from the study are provided in chapter 4.

All the observations and conclusions are discussed and observed in chapter 4. For the study of device performance, this chapter will present the findings in an appropriate diagram. Lastly, in Chapter 5, the results are concluded along with future job explanations.

All the observations and conclusions are discussed and observed in chapter 4. For the study of device performance, this chapter will present the findings in an appropriate diagram. Finally, in Chapter 5, the results are concluded along with future job explanations

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discussed all the information to this study of summarization from trustworthy resources in books or journals. Moreover, in this chapter, the conventional converter system’s overview and the ideal method will be discussed. A briefly discuss the theories of dc- dc converter, PIC, and sensors will also be addressed in this chapter.

2.2 Hardware

2.2.1 DC- DC converter

A dc-dc converter is frequently used as a power source in today's electronic systems. In current portable electronic devices and systems, a dc-dc converter is widespread. The converter takes a constant voltage from the batteries and transforms it into a wide range of values depending on the charge state. The voltage may dip below the battery voltage at low charge levels, preventing the load from receiving steady voltage.[6] There for it needs to be regulated. Many studies have been conducted on the performance and control of direct voltage converters. A zeta converter is a dc-dc converter that can boost (step- up) and lower (step- down) input voltage levels and produce low ripple and positive output voltage.[7]

2.2.1.1 Buck Converter

A buck converter is used to lower (step- down) the output voltage level from a DC input voltage. It has simplicity and low-cost advantages against the other type of converter.[8] The buck converter's operation is controlled by a switch or MOSFET.[9] The

Buck Converter circuit is shown in Figure 2.1

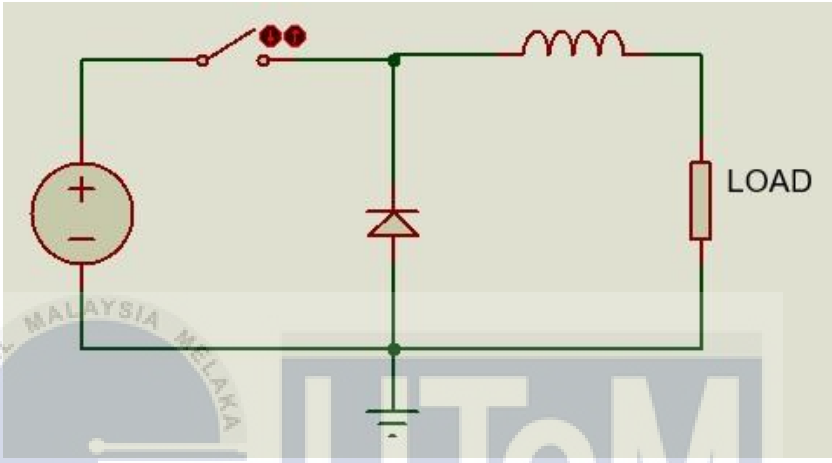

Figure 2.1 Buck Converter circuit diagram

Figure 2.2 Buck Converter module

A lower DC output voltage than the input voltage is required in some SMPS circuits. This can be accomplished with the use of a tool called the Buck Converter. From a rectified AC source or any DC source, the DC input can be used. When electrical isolation between the switching circuit and the output is not required, this design is preferable. As long as the

AC source and the rectifier are kept apart, it is possible to use a mains isolation transformer for the input.

The key region when utilising switching MOSFETs is the MOSFET switching losses must be balanced to avoid loss at peak efficiency, and the MOSFET thermal resistance must be minimised to achieve great circuit conductivity.[10]

The switching transistor that connects the Buck Converter's input and output is constantly flipping on and off at an extremely fast rate. In order to keep the load running when the switching transistor is not in operation, the circuit makes use of the energy stored in the inductor L during the transistor's on periods. The Flywheel Circuit, as it is frequently referred as, is responsible for the circuit's operation. This is due to the fact that the circuit functions similarly to a mechanical flywheel. When it receives regular pulses of energy, it maintains a smooth rotation (and hence produces energy) at a constant pace. This is due to the fact that the circuit functions similarly to a mechanical flywheel.

2.2.1.2 Boost Converter

In a variety of applications, switched-mode power supply, such as DC to DC conversion, can be used to provide power. Although a direct current (DC) supply, such as a battery, is easily available in many circumstances, the voltage provided is insufficient for the system to which it is being supplied. Electric automobile motors, for example, require voltages in the range of 500V, which are significantly more than what can be produced by a single rechargeable battery. Although several batteries may be used, the additional weight and space required would be prohibitively expensive and impractical to transport. The