UNIVERSITI TEKNOLOGI MARA
CAWANGAN PULAU PINANG

DESIGN AND IMPLEMENTATION OF DIGITAL SYSTEM FOR DC-DC BOOST CONVERTER

MUAZ ZABIR BIN MOHAMMAD SUHAIMI

BACHELOR OF ENGINEERING (HONS) ELECTRICAL AND ELECTRONIC ENGINEERING

JULY 2020

AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations, Universiti Teknologi MARA, regulating the conduct of my study and research.

Name of Student	:	Muaz Zabir bin Mohammad Suhaimi
Student I.D. No.	:	2016263846
Programme	:	Bachelor of Engineering (Hons) Electrical and Electronic Engineering – EE200
Faculty	:	Electrical Engineering
Thesis	:	Design and Implementation of Digital System for DC-DC Boost Converter
Signature of Student	:	……..
Date	:	July 2020

ABSTRACT

This project presents a design and simulation of DC/DC boost converter by implementing the digital system. DC/DC boost converter is an electronic device that step up its input voltage to a higher output voltage. This system has a nonlinear dynamic behaviour, as it works in switch-mode. In this project, the user will choose desired output voltage and hence, the system will automatically calculate the duty cycle and produce the PWM signal according to that duty cycle. The PWM signal will be injected into power MOSFET and the desired output voltage will be produced by varying the duty cycle. PWM has been designed by using two methods: analog and digital. PWM generator was designed analogously using Matlab / Simulink software, while the digital controller of the PWM was designed by using the Verilog Hardware Description Language (HDL). The performance of the both techniques were compared in term of their steady state and transient response. Matlab/Simulink was also used to create test signals and software test benches for Verilog code to validate the effectiveness of the system being designed. The system was tested by varying the duty cycles at 40%, 70% and 80%. The control design, analysis and simulation results were presented in this project to confirm the performance of the digitally controlled boost converter. To conclude, all the objective of this project had been achieved which is designing and testing the digital controller of boost converter. The design process of digital controller by using Verilog HDL has also been achieved successfully and meet all the requirement. It has also been tested for its effectiveness by implemented into design in Matlab/Simulink using co-simulation process. The results between analog and digital controller of boost converter also have been compared. Among these two systems, digital control was producing good performance compared to analog system.

ACKNOWLEDGEMENT

First and foremost, I would like to express my utmost gratefulness to God Almighty Allah for giving me strength, wisdom and perseverance to successfully complete this Final Year Project thesis for this course. I wish to express my gratitude to all the people who has given me their support and knowledge during this period of written this thesis.

I would like to express my deep gratitude to Dr Ahmad Asri Abd Samat, my final year project supervisor, for his patient guidance, enthusiastic encouragement and useful critiques of this proposed work. I would also like to thank him, for advising and assistance in keeping my progress on schedule.

I also would like to thank to any anonymous reviewers including my friends for their comment which very useful in improving the quality and presentation of this paper. Last but not least, I wish to express my love and gratitude to my beloved parents and families for their moral support and encouragement throughout my study

TABLE OF CONTENTS

		PAGE
AUTHOR'S DECLARATION		**i**
ABSTRACT		**ii**
ACKNOWLEDGEMENT		**iii**
TABLE OF CONTENTS		**iv**
LIST OF TABLES		**vii**
LIST OF FIGURES		**viii**
LIST OF APPENDICES		**x**
LIST OF SYMBOLS		**xi**
LIST OF ABBREVIATIONS		**xii**
CHAPTER 1 INTRODUCTION		**1**
1.1	Research background	1
1.2	Problem statement	1
1.3	Objective	2
1.4	Scope of work	2
	1.4.1 DC-DC boost converter	2
	1.4.2 Digital implementation	3
	1.4.3 Data Analysis	3
1.5	Thesis organisation	3
CHAPTER 2 LITERATURE REVIEW		**5**
2.1	Introduction	5
2.2	Power Converter	5
2.3	Switch mode power supply (SMPS)	6
2.4	Pulse Width Modulation (PWM)	6
2.5	Converter classification	7
	2.5.2 DC-DC converter	8

2.5.3 DC-AC converter 8
2.5.4 AC-DC converter 8
2.5.5 AC-AC converter 9
2.6 DC-DC conversion method 9
2.6.1 Buck converter 10
2.6.2 Boost converter 10
2.6.3 Buck-boost converter 12
2.7 Digital Implementation 13

CHAPTER 3 METHODOLOGY 15
3.1 introduction 15
3.2 Design flow methodology 16
3.3 Procedure and overall design flow 18
3.3.1 Design procedure of boost converter 18
3.3.2 Overall design flow 18
3.4 System operation 22
3.5 Internal architecture of digital system 22
3.6 Simulation flow for Modelsim 24
3.7 DATA ANalysis 25
3.7.1 Underdamped 26
3.7.2 Critically damped 26
3.7.3 Overdamped 26

CHAPTER 4 RESULTS AND DISCUSSIONS 27
4.1 Overview 27
4.2 MATLAB/simulink simulation using PWM generator 27
4.2.1 40% Duty cycle 28
4.2.2 80% Duty cycle 30
4.2.3 70% Duty Cycle 32
4.3 Digital System HDL simulation 34
4.3.1 40% of duty cycle 35
4.3.2 80% of duty cycle 37

4.3.3 70% of duty cycle 39
4.4 Comparison between Analog and Digital System 41

CHAPTER 5 CONCLUSION AND RECOMMENDATION 43
5.1 Conclusion 43
5.2 Future recommendation 44

REFERENCES 45
APPENDICES 48