DC DISTRIBUTION SYSTEM FOR HOME AND OFFICE

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This thesis is special dedicated

to my beloved wife mother and father,

my wife and daughter,

my siblings and my colleagues

for endless love,

support and encouragement.

Thanks for everything.

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ABSTRACT

Direct current (dc) electrical distribution system has been very popular recently due to several advantages inherent in the system compared to conventional alternating current (ac) distribution system. Increasing number of dc appliances in our home and office, and the renewable energy generation which mostly generate dc are some of the reason. This project provides a design framework of dc powered house. Initially, Homer software is used to find the most optimum combination of electrical sources wheather a hybrid system or stand alone power sources system. Homer simulation result is used to implement and design the power electronics system. The design of the complete power electronics converter that intergates the source with the dc distributed system is done in Matlab/Simulink. Load test simulation is performed to show the effect of load changes. The simulation also shows the effect of the system with or without controller to regulate the output voltage.

ABSTRAK

Sistem pembahagian elektrik arus terus (at) telah menjadi sangat popular akhir-akhir ini disebabkan oleh beberapa kelebihan yang ada pada sistem tersebut berbanding dengan sistem konvensional pembahagian elektrik arus ulang-alik (au). Peningkatan bilangan peralatan di rumah dan pejabat yang menggunakan at dan penjanaan tenaga diperbaharui yang kebanyakannya menjana at adalah sebahagian daripada sebabnya. Projek ini menyediakan kerangka rekabentuk rumah dikuasakan oleh at. Pada permulaannya, perisian Homer digunakan untuk mencari kombinasi sumber kuasa elektrik paling optimum sama ada sistem hibrid atau sistem sumber kuasa tunggal. Keputusan simulasi Homer digunakan untuk implementasi dan rekabentuk sistem elektronik kuasa. Rekabentuk keseluruhan penukar elektronik kuasa yang mengintegrasi sumber kuasa dengan sistem pembahagian at dilakukan menggunakan perisian Matlab/Simulink. Simulasi pengujian beban dilakukan untuk menunjukkan kesan perubahan beban. Simulasi juga menunjukkan kesan kepada sistem dengan menggunakan atau tanpa menggunakan kawalan untuk mengawal voltan keluaran.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	DECLARATION	ii
	DEDICATION	iii
	ACKNOWLEDGEMENT	iv
	ABSTRACT	v
	ABSTRAK	vi
	TABLE OF CONTENTS	vii
	LIST OF TABLES	xi
	LIST OF FIGURES	xii
	LIST OF ABBREVIATIONS	xvi
	LIST OF SYMBOLS	xvii
1	**INTRODUCTION**	1
	1.1 Introduction	1
	1.2 Problem statements	3
	1.3 Objective of Project	4
	1.4 Scopes of Project	4
	1.5 Thesis Outline	5
2	**LITERATURE REVIEW**	6
	2.1 Ac and dc Power System	6
	2.2 Dc Microgrid	8
	2.3 Related Research	13

3	**METHODOLOGY**		19
	3.1	Project Flow	19
	3.2	Simulation in Homer Software	21
		3.2.1 Photovoltaic Solar Panel	24
		3.2.2 Inverter	26
		3.2.3 Grid	26
		3.2.4 Homer Simulation Result	28
	3.3	Dc-dc Converter Selection	32
	3.4	Simulation in Matlab/Simulink	34
		3.4.1 Boost Converter	35
		3.4.2 Full Bridge Converter	36
4	**RESULT AND DISCUSSION**		37
	4.1	Boost Converter	38
	4.2	Full Bridge Converter	39
	4.3	Controller Design	41
		4.3.1 Voltage Mode Control	42
		4.3.2 Small Signal Analysis	42
		4.3.3 Compensation for Voltage Mode Feedback Controller	45
		4.3.4 Control Loop Stability	46
		4.3.5 SISO Design Tool	47
		4.3.6 Converter With Feedback Controller	47
5	**CONCLUSION AND RECOMMENDATION**		
	5.1	Conclusion	63
	5.2	Recommendation	64
REFERENCES			65 - 67

LIST OF TABLES

TABLE NO.	TITLE	PAGE
2.1	List of institute and standard voltage level	18
3.1	Daily power consumption of electrical appliances	20
3.2	Major system components	22
3.3	Solar PV panel data sheet	26
3.4	Specification for the first DC-DC converter	33
3.5	Specification for the second DC-DC converter	33

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE
2.1	Schematic diagram of ac distribution system	9
2.2	Simple ac circuit	9
2.3	Schematic diagram of dc home	12
2.4	Simple dc circuit	12
2.5	Net metered of ac house and dc house power system configuration	15
2.6	Concept of ac and dc distribution integration system	16
2.7	Block diagram of energy conversion station and grid energy distribution	16
3.1	Process flow in implementing the project	20
3.2	Schematic diagram in Homer	22
3.3	Daily load profile	23
3.4	Estimated monthly load profile by Homer	23
3.5	Scaled annual average load	24
3.6	Grid section parameter	27
3.7	Grid section emission factor	28
3.8	Simulation result in Homer	29
3.9	Cost summary for most optimize result	29
3.10	Electrical generation result from Homer	30
3.11	Detail of solar PV section result	31
3.12	Detail of grid section result	31
3.13	Emission result from Homer	32

3.14	Boost converter in Matlab/Simulink	34
3.15	Full bridge converter in Matlab/Simulink	34
4.1	Output waveform of boost converter	38
4.2	Output waveform of boost converter when load varies	39
4.3	Output waveform of full bridge converter	40
4.4	Output waveform of full bridge converter when load varies	41
4.5	Block diagram of converter circuit with feedback control	42
4.6	LC filter circuit of full bridge converter used to derive full bridge control-to-output transfer function	44
4.7	Circuit diagram of Type III compensation network	46
4.8	Bode plot of boost converter	48
4.9	Bode plot of compensation network circuit after tuned in SISO design tool interface	48
4.10	Closed loop frequency response of boost converter and compensation network	49
4.11	Closed loop step response of boost converter and compensation network	49
4.12	Output waveform of boost converter with feedback controller	50
4.13	Bode plot of full bridge converter	51
4.14	Bode plot of compensator network after tuned in SISO design tool interface	51
4.15	Closed loop frequency response of full bridge converter and compensation network	52
4.16	Closed loop step response of full bridge converter and compensation network	53
4.17	Output waveform of full bridge converter with feedback controller	53

4.18	Circuit diagram of boost converter combined with full bridge converter both without voltage mode controller	54
4.19	Output waveform of boost converter combined with full bridge converter both without voltage moed controller	55
4.20	Circuit diagram of boost converter with voltage mode controller combined with full bridge converter without voltage mode controller	56
4.21	Output waveform of boost converter with voltage mode controller combined with full bridge converter without voltage mode controller	57
4.22	Circuit diagram of boost converter without voltage mode controller combined with full bridge converter with voltage mode controller	58
4.23	Output waveform of boost converter without voltage mode controller combined with full bridge converter with voltage mode controller	59
4.24	Circuit diagram of boost converter and full bridge converter both with voltage mode controller	60
4.25	Output waveform of boost converter and full bridge converter both with voltage mode controller	61
4.26	Output Waveform of boost converter and full bridge converter both with voltage mode controller	62

LIST OF ABBREVIATIONS

DC	-	Direct Current
AC	-	Alternating Current
LED	-	Light Emitting Diode
RE	-	Renewable Energy
IEC	-	International Electrotechnical Commission
LVDC	-	Low Voltage Direct CUrrent
DG	-	Distributed Generation
NPC	-	Net Present Cost
PV	-	Photovoltaic
CCM	-	Continuous Conduction Mode

LIST OF SYMBOLS

V	-	Voltage
A	-	Ampere
Hz	-	Hertz
kV	-	Kilo-volts
ms	-	mili-second
%	-	Percentage
°	-	Degree

CHAPTER 1

INTRODUCTION

1.1 Background

The demand for electricity is growing proportionally with the economic growth in a country. Concept of electricity supply has changed from luxury to basic needs. This has increased the electricity demand and consequently the generation plant. However the conventional electricity generation is mostly dependent on fossil fuel such as coal, natural gas and etc which is harmful to the environment and the source may deplete in the future. Another issue regarding the fossil fuel is the price fluctuation due to the instability to the major production country. Therefore an alternative energy sources provide a solution to overcome the issues.

Renewable energy which becomes a main focus recently is an alternative to the fossil fuel based power generation. It is safe and clean for environment. Therefore many countries has taken an action to encourage the renewable energy power generation such as by introducing a policy regarding the renewable energy power generation. For

example Malaysia has introduced a policies such as a Five-fuel Diversification Policy in 2000 which introduce renewable energy as a fifth fuel source [1]. This has indirectly encourage the development of renewable energy as an energy source.

Most of the renewable energy sources generate electricity in direct current (dc) form such as solar photovoltaic and biogas or using an ac to dc converter and dc to ac converter to regulate the ac supply such as wind turbine [2]. In addition, renewable energy source usually needs an energy storage device such as battery, fuel cell and ultracapacitor. The output of this device however is also in the form of dc voltage.

Today, most of the electrical home appliances is using dc power, such as LED TV, computer, telephone, radio, LED lighting and etc. Therefore in conventional system, it is absolutely needs an ac to dc converter to convert the ac supply from grid to dc to operate the equipment. Ac to dc converter is not only used by dc powered equipment, but also needed by equipment which operate in high frequency other than the line frequency. Equipment such as high frequency fluorescent light, air conditioning with inverter and variable speed pump is equipped with two stage voltage conversion such as ac-dc and dc-ac conversion process to stabilize and to convert to the high frequency. This has shown that, dc power is an essential in electrical home appliances.

As both energy generated in dc and load also in dc form, this has led to the concept of dc distribution system especially for the home and office. In that way, dc based distributed generation system and energy storage device would be easily connected to the bus line. An energy storage device can also be charged/discharged with the dc bus and loads [3]. Dc distribution system is more efficient as it eliminate the process of ac to dc conversion as in conventional ac distribution system. Hence it reduce losses which is very high at the conversion process [4-5]. This is due to the absence of

reactive current component. Development in power electronic has also contribute to the efficient system.

For a medium system, dc microgrid can be a possible solution to the issue in conventional ac power system. The proposed of renewable energy generation system connected to the dc grid within a small or medium distribution area can minimize the losses and problem in ac power system. In dc microgrid, power generated from the distributed generation which is normally in dc form is fed directly to the load without the conversion process such as ac to dc and dc to ac conversion.

The U.S. Department of Energy (DOE) and the California Energy Commission (CEC) has endorsed a report from Navigant Consulting in 2005 the definition of microgrid which is "microgrid consist of interconnected distributed energy resources capable of providing sufficient and continuous energy to a significant portion of internal load demand. A microgrid possesses independant controls, and intentional islanding takes place with minimal service interruption (seamless transition from grid-parallel to islanded operation) [6].

1.2 Problem Statement

Depletion in fossil fuel source in future and concern on the environment has lead to increase renewable energy (RE) power generation. Unfortunately most of RE power generation generate energy in dc form. Therefore in conventional system dc power generated by RE power generation has to be converted to ac in order to transmit using ac grid system.

On the load side, the demand for dc powered electrical load has increased recently. Many modern electronic loads such as LED light, TV, computer and refrigerator operates in dc powerthus need a conversion process from ac to dc to operate the devices. However ac to dc conversion process contribute to the significant system losses and power degradation. Therefore dc distribution system may eliminate the conversion from ac to dc. In addition evolve in power electronic makes the dc-dc conversion efficient.

1.3 Objective of the Project

The objectives of this project are :

a) To investigate the optimal electrical sources using Homer software.
b) To design a dc home system using dc-dc converter.
c) To perform a load test to see the system stability for variation load level for dc home.

1.4 Scope of Project

The scope of this project is to design a dc distribution system consist of dc-dc converter and dc load. This project will only designed dc-dc converter regardless of the sources. If the source is ac, it is assumed that a rectifier has rectify the ac so that, dc-dc

converter is to regulate to the suitable system voltage. Common load in a typical home is assumed to be dc form. All components in this converter is assumed to be ideal.

1.5 Thesis Outline

This thesis is divided into five chapters. There are:

i. Introduction - The first chapter describe the background of this project, the problem statement, the objectives, and the scope of works.
ii. Literature Review - The second chapter concentrate on other works has been done by other researches which related to this project. It is also explain the concept and operation of dc-dc converter.
iii. Methodology - This chapter discussed in detail project methodology used in order to complete this project.
iv. Result and Analysis - This chapter discussed the result of the simulation and some discussion on the result.
v. Conclusion and Future Work - The last chapter describe the conclusion and recommendation on the future works.

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