SINGLE-PHASE AC-AC MATRIX CONVERTER USING SINUSOIDAL PULSE WIDTH MODULATION (SPWM)

Thesis is presented in partial fulfillment for the award of the

Bachelor of Engineering (Honours) in Electrical

UNIVERSITI TEKNOLOGI MARA

AZIZUL BIN ABD. KARIM

FACULTY OF ELECTRICAL ENGINEERING

UNIVERSITI TEKNOLOGI MARA

40450 SHAH ALAM, SELANGOR

ACKNOWLEDGEMENT

All praises be to Allah, Lord of Universe, the Merciful and Beneficent Salam to Nabi Muhammad S.A.W., his friends, companion and the people who follow his path.

Thanks to Allah who has given me the strength and ability to completed this final project and thesis. With this opportunity I would like to express my deep sense of gratitude and appreciation to my project advisor, Mr. Mustafar Kamal bin Hamzah for his continued guidance, and invaluable advice, which has helped me tremendously in completing this project. Also I wish to thanks to Dr. Ahmad Maliki bin Omar for his time and valuable information towards the accomplishment of this project especially on the Xilinx software.

Also my deepest and warmest gratitude to my parents for being so understanding to me and also for giving me the support in completing this final year project. For without them, I would never have one this far.

I would also like to thank all my colleagues who have been given me advice and contribution to finish this project. Only Allah SWT could pay back their kindness and we will appreciate it till the rest of my life. Last but not least, all that good come from Allah SWT and all which bad are come from me.

Azizul bin Abd. Karim
Faculty of Electrical Engineering
Universiti Teknologi MARA

ABSTRACT

Single-Phase AC-AC Matrix Converter is a special type of Cycloconverter. Using the bi-directional switches any phase of the load can be connected to any phase of the input voltage, e.g., the zero value of the load phase voltages is maintained by connecting all the load phases to the same input phase. Using pulse-width modulation techniques, the load voltage and the load frequency are controlled from zero to their maximum values. The maximum voltage is usually close to the input voltage, but the maximum frequency can be several times that the input frequency and is only limited by practical considerations. The bi-directional switches must be capable of permitting current flow in either direction.

The target of this project is to generate the Sinusoidal Pulse Width Modulation switching pattern using FPGA that is suitable to control the Single-Phase Matrix Converter. The Xilinx software is the world's largest supplier o programmable logic solutions, including industry-leading device architectures and world-class design software. It contains many enhancements and addition, one of the most significant of which is new device implementation technology. As a result this product provides hardware designers with an improved suite of tools for implementing Programmable Logic Devices.

TABLE OF CONTENTS

CHAPTER			PAGE
1	**INTRODUCTION**		
	1.1	Introduction	1
	1.2	Review of converter technology	1
		1.2.1 Classification of converters	1
		1.2.2 AC-AC Converter	2
	1.3	Scope of the thesis	4
	1.4	Organization of the thesis	4
2	**MATRIX CONVERTER**		
	2.1	Introduction	6
	2.2	Matrix Converter as Power Converters	7
	2.3	Single-phase Matrix Converter	10
	2.4	Switching Strategy of Matrix Converter	12
3	**SWITCHING DEVICES AND GATE DRIVERS**		
	3.1	The choice of Switching Devices	16
		3.1.1 Thyristors	16
		3.1.2 Gate Turn-Off Thyristors (GTO)	17
		3.1.3 Bipolar Junction Transistors (BJTs)	18
		3.1.4 MOSFETs	18
		3.1.5 IGBT	19
	3.2	Bi-direction Switch Configurations	22

CHAPTER 1

INTRODUCTION

1.1 Introduction

Power electronics refers to control and conversion of electrical power-by-power semiconductor devices where these devices operate as switches. The task is to process and control the flow of electric energy by supplying voltages and currents in a form that is optimally suited for user loads. Power electronics has applications that span the whole field of electrical power systems, with the power range of these applications extending from a few VA/Watts to several MVA/MW.

1.2 Review of converter technology

1.2.1 Classification of converters

The general term for a power electronic apparatus is 'Electronic power converters' or, for short, 'converters'. A converter is an operative unit, consisting of semiconductor devices (electronic valves) and necessary auxiliaries; used for changing one or more of an electric power system. It can thus change voltage and current level, frequency, and number of phases. Electronic switches are also regarded as converters.

The term 'converter' is also used to designate one member of the converter family, which historically is the most prominent one, namely an apparatus which links a dc network to an ac one. If the flow of power is directed from the ac side to the dc side, the converter operates as a rectifier. With the opposite direction of the flow of power, the converter operates as an inverter.