UNIVERSITI TEKNOLOGI MARA

FOUR QUADRANT SINGLE PHASE MATRIX CONVERTER

SITI ZALIHA BINTI MOHAMMAD NOOR

Thesis submitted in fulfillment of the requirements
for the degree of
Master of Science

Faculty of Electrical Engineering

June 2008

CANDIDATE'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 result of my own work, unless otherwise indicated or acknowledged as referenced work. This topic has not been submitted to any other academic institution or non institution for any other degree or qualification.

In the event that my thesis be found to violate the conditions mentioned above, I voluntarily waive the right of conferment of my degree and agree be subjected to the disciplinary rules and regulations of Universiti Teknologi MARA.

Name of Candidate	:	SITI ZALIHA BINTI MOHAMMAD NOOR
Candidate's ID No.	:	2004360026
Programme	:	MASTER OF SCIENCE IN ELECTRICAL (EE780)
Faculty	:	FACULTY OF ELECTRICAL ENGINEERING
Thesis Title	:	FOUR QUADRANT SINGLE PHASE MATRIX CONVERTER

Signature of Candidate : .....

Date : 28TH JUNE 2008

ABSTRACT

In this work the Single-phase Matrix Converter (SPMC) is investigated as a basic four-quadrant single-phase converter with basic DC chopper operation. This is then extended to the operation of a single-phase inverter; without any change in the basic converter topology except with the switch control sequence. An outline of the basic principles of operation is defined. This follows the development of a computer simulation model using MATLAB and PSpice to study the basic behaviour. This is then verified on an experimental test-rig in the laboratory. Uniform pulse width modulation (UPWM) was used for the DC chopper control, whilst the well-known Sinusoidal pulse width modulation (SPWM) was used in inverter control. IGBTs are used for its power circuits, with Xilinx FPGA at the heart of its control electronics employing the use of digital techniques. Investigations into basic loads in operation are carried out to ascertain the behaviour. It presented that the SPMC is capable of performing four-quadrant operation as a basic DC chopper and an inverter; theoretically developed, conceived and successfully realized complete with safe commutation strategies.

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

1.0 Introduction

Electric power is the muscle of the modern industry and power electronics make its utilization smarter. The objective of power electronics is to improve the quality and utilization of electric power. Power Electronics have revolutionized the concept of power control for power converters and for control of electric motor drives. They are based primarily on the switching of power semiconductor devices.

Converter systems comprised switches, reactive component such as inductance, capacitance and transformers. They may be classified into four basic form of power conversion that includes; a) AC to DC Conversion, b) AC to AC Conversion, c) DC to AC Conversion and d) DC to DC Conversion. There are cases where it is convenient to generally define these converters in terms of its four quadrant operation.

In this thesis, a review was carried out on basic single phase converter and its four quadrant operation for energy conversion including advanced converter topology; offering many advantages over traditional topologies such as ability to regenerate energy back to the utility [1] and are fully controllable. Recently there has been considerable interest in the potential benefits of matrix converter technology, especially for applications where size, weight and long-term reliability are important factors [2]. Amongst the many matrix converter research; focused has been found mainly on the three phase matrix converter, whilst the single phase matrix converter received less attention. Various switching devices are outlined with IGBT as the preferred choice.