UNIVERSITI TEKNOLOGI MARA

THE DEVELOPMENT OF HIGH VOLTAGE DC CONVERTER USING AMPWM SWITCHING PATTERN CONSIDERING HARMONICS REDUCTION

KHAIRUL SAFUAN BIN MUHAMMAD

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

Faculty of Electrical Engineering

August 2007

ABSTRACT

This thesis presents a development of high voltage dc converter using AMPWM switching pattern considering harmonics reduction. The digital controller is developed using Complex Programmable Logic Devices (CPLD). The proposed system utilizes a single-phase AC input supply. The power switching devices in the controlled bridge are controlled by the Alternate Multiple-pulse Pulse Width Modulation (AMPWM) switching pattern that will minimize the low order harmonics presence on the AC side of the converter. Five types of PWM patterns were analyzed and compared to determine the patterns that produce high voltage gain and good power quality aspect i.e. less low order harmonic in the input supply current using PSpice. From the simulation results obtained, the best switching pattern is selected and implemented in the Xilinx Complex Programmable Logic Devices (CPLD) chip. A high frequency transformer with 1:1 ratio is used in the design to provide galvanic isolation for better circuit performance and protection. The optimum operation of transformer core in four quadrant of B-H curve is also considered in the proposed converter topology. A laboratory prototype of the converter has been developed and tested. Experimental results were compared with respect to the simulation results to illustrate the effectiveness of the proposed technique.

ACKNOWLEDGEMENTS

In the name of Allah S.W.T, the Most Gracious, the Ever Merciful. It hardly seems possible to reach the end of this long process without the support from many others, who had helped me in so many ways along the way.

I would like to take this opportunity to sincerely express my highest gratitude to my supervisor Assoc. Prof. Dr Ahmad Maliki Omar for his mentoring, support, guidance, and advice during this research and also to my co-supervisor Dr Ngah Ramzi Hamzah.

I was supported during my study by the Ministries of Science, Technology and Innovation and I wish to express my gratitude to this organization.

My sincere gratitude also goes to my colleagues for their aid, ideas and advice, and my friends who had helped me directly or indirectly.

Finally, special thanks extended to my beloved wife Siti Nattrah Alias and my family for their patience, support and prayed for my success.

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

1.0 Introduction

The field of power electronics has gone through rapid technological advancement in the last four decades. Its applications are expanding in industrial, commercial, residential and military environments. The important benefits of incorporating power electronic systems into many engineering applications are energy conservation and reduced operating cost. There are several striking features of power electronics, the foremost among them being the extensive use of inductors and capacitors as intermittent energy storage. In many applications of power electronics, an inductor may carry a high current at a high frequency. The capacitors are also stressed where they usually operate at high frequency with current surges passing through them periodically. These factors have made power electronics an exciting and challenging field in which the scope of the applications is growing at a fast pace. Unfortunately, the widespread use of power electronics is now one of the sources of the increasing electrical pollutions (a form of harmonics or electromagnetic noises) [1]-[5]. These devices cause distortion and fluctuating current that can disturb not only other utilities indirectly connected to the polluting device, but also the device itself. They also generate high-frequency conducted and radiated noise due to the sharp edges of the waveform characteristics of the switching power processors employed in them. The miniaturization of power converters to reduce the total cost i.e. by higher switching frequencies and high density packaging increases the importance of noise problems.

Like many engineering areas in the real world, all power electronic devices suffer from both internal and external disturbances. The growing applications of power electronics demand better performance, high functionality, and more reliable solutions, therefore taking the noise problem into account has become critically important. Most of the past works in power electronics have used a deterministic