UNIVERSITI TEKNOLOGI MARA

OPERATION OF SINGLE-PHASE DIRECT AC-AC CONVERTER USING SINGLE PHASE MATRIX CONVERTER

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MSc

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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.

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ABSTRACT

In these work basic investigations are carried out on the operation of a proposed single-phase direct AC-AC converter using single phase matrix converter (SPMC) topology without the use of a DC-link. Three different categories of operation, namely; a) AC-AC converter, b) frequency changer (increased frequency) and c) decreased frequency (cycloconverter) are performed. The power circuit uses a common emitter mode with a pair of back-to-back IGBT with diode in series to realize its required bi-directional operation. A new safe commutation technique is proposed that uses simple switching scheme to avoid generation of damaging voltage spikes. Open-loop control was realised using the Sinusoidal Pulse Width Modulation (SPWM) implemented using digital techniques with Xilinx FPGA at the heart of its control electronics. Basic loads are used during operation to ascertain the behaviour. Prior to its practical realization a computer simulation model is developed to investigate the behaviour of the SPMC using Matlab/Simulink (MLS) incorporating SimPowerSystem and Pspice circuit simulation. An experimental test-rig was then constructed to verify the operation; incorporated with digital control, gate drives and power circuits. It will be presented that the proposed direct AC-AC converter using SPMC had been theoretically developed, conceived and successfully realized complete with safe commutation strategies.

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CHAPTER 1

INTRODUCTION

1.0 Introduction

In recent years, the field of power electronics has experienced intense developments in semiconductor devices, circuit topologies, control methods and computer-aided analyses. The task of power electronics can also be described as the control of the flow of power by shaping the utility supply voltage by means of semiconductor devices wherein these devices operate as switches. The process of switching the electronic devices in power electronic converters from one state to another is called modulation, and the development of optimum strategies to implement this process has been the subject of intensive research over the years.

The four main forms of basic electric power conversions are:

- AC-to-DC conversion
- DC-to-AC conversion
- DC-to DC conversion
- AC-to-AC conversion

In this thesis a review was carried out on basic AC-AC converter configurations for energy conversion; including advanced converter configurations of matrix converter with the use of pulse width modulation (PWM) technique for control. Amongst the many matrix converter research; focused has been found mainly on the three-phase matrix converter, whilst the single-phase variant is receiving less attention. Various switching devices are outlined with IGBT as the preferred choice for controllable switching device in the light of recent semiconductor developments.