UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ANALYSIS OF CASCADE H BRIDGE MULTILEVEL INVERTER FOR ASYMMETRICAL CONFIGURATION

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours.

by

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APPROVAL

This report is submitted to the Faculty of Electrical and Electronic Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours. The member of the supervisory is as follow:

Signature: …….

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ABSTRAK

Tujuan projek ini adalah untuk menganalisis penyongsang bertingkat jambatan untuk konfigurasi asimetri dari segi voltan keluaran output dengan mengurangkan bilangan suis. Projek ini akan memberi tumpuan kepada penyongsang jambatan tujuh peringkat dan akan membandingkan antara konfigurasi asimetri dan simetri. Konfigurasi asimetri mampu menghasilkan voltan keluaran n-level dengan jumlah komponen yang kurang berbanding dengan konfigurasi simetri. Persembahan simulasi litar jambatan berperingkat peralatan simulasi dibandingkan dengan pelbagai pembolehubah seperti bilangan suis, bilangan sumber DC, bilangan jambatan, faktor puncak, faktor bentuk dan jumlah penyelewengan harmonik. Perisian Matlab / Simulink digunakan untuk membina dan mensimulasikan hasil reka bentuk litar topologi yang dicadangkan untuk inverter multilevel cascade tujuh tingkat antara simetri dan simetri.

ABSTRACT

The purpose of this project is to analyze the cascade h bridge multilevel inverter for asymmetrical configuration in terms of the output voltage waveform with reducing number of switches. This project will focus on seven level cascade h bridge multilevel inverter and will compare between the asymmetrical and symmetrical configuration. The asymmetrical configuration is capable of producing n-level output voltage with less number of component compare to symmetrical configuration. The performances of cascade h bridge multilevel inverter simulation device are compared based on various variables such as number of switches, number of DC sources, number of bridges, crest factor, form factor and total Harmonic Distortion. Matlab / Simulink software is used to build and simulate the outcome of the proposed topology circuit design for a seven level cascade h bridge multilevel inverter between asymmetrical and symmetrical.

DEDICATION

To my beloved parent who always there for me

Hasimah Binti Hasan and Ruslan Bin Abdul Aziz

To my siblings

Muhammad Hafiz Bin Ruslan

Muhammad Hanif Bin Ruslan

To my Supervisor for their supervision and encouragement

A Shamsul Rahimi Bin A Subki

To my friends for their unconditionally support

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MLI	Multi Level Inverter
CHB	Cascaded H-Bridge
CHBMLI	Cascaded H-Bridge Multi Level Inverter
PD	Phase Disposition
APOD	Alternate Phase Opposition Disposition
POD	Phase Opposition Disposition
PWM	Pulse Width Modulation
IGBT	Insulated Gate Bipolar Transistor
RL	Resistor Load
THIPWM	Total Harmonic Injection Pulse Width Modulation
DF	Distortion Factor
LOH	Lower Order Harmonic
SPWM	Sinusoidal Pulse Width Modulation
DC	Direct Current
LSPWM	Level Shift Pulse Width Modulation
THD	Total Harmonic Distortion
FF	Form Factor
CF	Crest Factor
AC	Alternating Current

CHAPTER 1

INTRODUCTION

1.1 Introduction

For this chapter is to provide an overview about the analysis of multilevel inverter of cascade H-bridge asymmetrical configuration to upgrade the quality of voltage output. Then, a little bit description of a background and a problem statement about multilevel inverter of cascade H-bridge asymmetrical configuration. Later than, it will be followed by an objectives of research and scope that involves for the analysis of cascade H-bridge multilevel inverter for asymmetrical configuration. It will focus more on the operation of the cascade H-bridge multilevel inverter for asymmetrical configuration for 7 level. More than that, on how to control the switching switch for 7 level of cascade H-bridge.

1.2 Background

Figure 1.1: Diagram of basic inverter

The electronics branch dealing with electrical power conversion and control is called power electronics. Many of electronics device are designed to work with AC, but DC is normally generated by a power generator. An inverter need to be used to converts low voltage of direct current (DC) to high voltage of substituting current (AC). Ideally,

output voltage should be variable magnitude and variable frequency sinusoidal wave. In order to produce smoothly varying AC output from a DC input, inverters can be used.

Multilevel inverters are the industry's preferred choice for high voltage and high power application. In the field of high power medium voltage energy control, multilevel inverter technology has recently emerged as a very important alternative. It can be easily interface with renewable energy sources for various high power applications. The input DC voltage sources are obtained from batteries, capacitor, renewable energy system and others. There are several benefit from using multilevel inverter such as in improving the power quality, reduce size of harmonic, stair case wave form quality, lower dv/dt variations, minimized losses due to switching, increased number of voltage levels produces better voltage waveform and enhanced electromagnetic interference. Two level inverter is the most common type of inverter used to generate AC voltage from DC voltage. An inverter of two levels creates two different load voltages. For example, V is provide as an input to a two level inverter then it will provide +V/2 and -V/2 on output. Usually these two newly generated voltages are switched to create an AC voltage. The multilevel inverter (MLI) idea is a type of two level inverter modification or improvement. To create a smoother stepped output waveform, more than two voltages level need to be combined together. When the voltage level increase, the waveform turn into more smoother but the complexity is enhanced because the smoothness of the waveform is proportional to the voltage level.

There are various configurations of multilevel inverter such as Cascade H-Bridge (CHB) inverter, Flying Capacitors (FCs) inverter and the later invention are Diode Clamped (DC). The multilevel inverter Cascaded H-Bridge is using capacitor and switches. The combination of capacitors and switches pair is called H-bridge. It is made up of H-bridge cells and each cell can supply three different voltages such as zero, positive DC and negative DC voltages. The main advantages of Cascaded H-Bridge multilevel inverter is output voltages levels are doubled the number of source, easy and quick manufacturing, packaging and layout is modularized, can control easily with a transformer and inexpensive. For the disadvantages, every H-bridge need a separate DC source and application are limited due to the large number of source. The popular application for cascade H-bridge multilevel inverter such as motor drivers, active filter, electric vehicle drives, power factor compensators and interfacing with renewable energy resources. Compared to other multilevel inverters, the cascaded multilevel inverter control method is very easy because it requires no clamping diode and flying capacitor. The number of level-m CHBMLI can be implemented by cascading (m-1)/2 full –bridges.

1.3 Problem Statement

The converters are designed to achieve a quality output voltage or a current waveform with a minimum ripple content. However, in high power and high voltage applications the conventional two level inverters has some limitations. The limitations in high frequency operation primarily due to switching losses and power device rating constraints. In recent years, many industrial applications have started to require high power devices. The conversion of electrical power from one form to another is necessary for the control of electrical power or power conditioning and the switching features of the

power devices allows these conversion. Due to this issues an analysis is needed to identify the best way to improve the efficiency of the multilevel inverter and improving the quality of the output voltage waveform with a reduction in number of switches. Multi-level inverter is introduced to extract power from different sources of renewable energy. As a solution to the problem arises, the topology of cascade h bridge multilevel inverter has been proposed. (Noman, Al-Shamma'a, Addoweesh, Alabduljabbar, & Alolah, 2018) Stated that the Cascade H Bridge topology for inverter has known as the most efficient and also more commonly used instead of other two topologies. Cascade H Bridge inverters use fewer and cost-effective switching components and they do not need diodes of clamping and capacitors of balancing. The cascaded H-bridge inverter has a straightforward layout, severe modularity, easy construction, control, and no difficulties with the voltage balance issues and its needs less components to generate the same voltages level compared to the other multilevel topologies. There is proof that Asymmetrical has a greater number of advantages than Symmetrical, due to Asymmetrical utilize less gadgets. For Asymmetrical Cascade H Bridge is utilizing the imbalanced size of dc voltage sources, while Symmetrical Cascade H Bridge utilizing the identical dc voltage sources. By utilizing less exchanging segments and diverse dc sources in asymmetrical inverter, high number of level can be reach. The control techniques which will be utilized for this topology is pulse width modulation (PWM) that is the least complex balance procedure and simple to control. The outcomes that will be accomplish dependent on the proposed topology with the appropriate control method is the multilevel inverter yield voltage waveform with fewer harmonic twisting.

At last, the circuit will deliver waveform that practically sinusoidal without utilizing filtering circuit and produce waveform output voltage with diminished switch.