MODULATION STRATEGY FOR NEW ASYMMETRICAL MULTILEVEL INVERTER TOPOLOGY USING NEAREST DC LEVEL MODULATION TECHNIQUE

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DEDICATION

This project report is dedicated to my father, who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my mother, who taught me that even the largest task can be accomplished if it is done one step at a time.

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ABSTRACT

Multilevel inverters (MLI) have an important portion in power processing in power systems. These inverters have some inherent advantages such as ability to operate with high power and voltage, improved output waveform quality, and flexibility, which make them attractive and more popular. In recent years, research on multilevel inverters with reduction of components is gaining interest. The reduction offers plenty of advantages namely, the reliability, volume and control simplicity. In this project, Nearest DC Level Control (NLC) modulation technique will be studied and designed for a newly developed multilevel inverter with reduction in components. The proposed NLC modulation is a fundamental frequency switching technique that may have some advantages when applied to multilevel inverters as compared to conventional carrier based PWM modulation. For the study, new topology of nine-level asymmetrical multilevel inverter model will be developed using MATLAB. A proposed NLC techniques will be also developed. The inverter model will be simulated using the same resistor load value. The discussion will be on the shape of the harmonics profile and Total Harmonic Distortion (THD) value.

ABSTRAK

Inverter pelbagai peringkat mempunyai bahagian penting dalam pemprosesan kuasa dalam sistem kuasa. Inverter ini mempunyai beberapa kelebihan yang wujud seperti keupayaan untuk beroperasi dengan kuasa tinggi dan voltan, keluaran kualiti gelombang yang lebih baik, dan fleksibiliti, yang menjadikannya menarik dan lebih popular. Dalam tahun-tahun kebelakangan ini, penyelidikan mengenai Inverter pelbagai peringkat dengan pengurangan komponen semakin banyak. Pengurangan komponen menawarkan banyak kelebihan iaitu kesederhanaan, kelantangan dan kawalan kesederhanaan. Dalam projek ini, teknik modulasi Tahap Kawalan Terdekat (NLC) akan dikaji dan direka untuk penyongsang bertingkat yang dikembangkan dengan pengurangan komponen. Modulasi NLC yang dicadangkan adalah teknik penukaran kekerapan asas yang mungkin mempunyai kelebihan apabila diterapkan kepada inverter pelbagai peringkat berbanding dengan modulasi PWM berasaskan pembawa konvensional. Untuk kajian ini, topologi baru sembilan tahap asimetrik model Inverter pelbagai peringkat akan dibangunkan menggunakan Matlab. Cadangan teknik NLC juga akan dibangunkan. Model inverter akan disimulasikan menggunakan nilai beban perintang yang sama. Perbincangan ini akan membentuk profil harmonik dan nilai THD.

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LIST OF ABBREVIATIONS

UTM	-	Universiti Teknologi Malaysia
MLI	-	Multilevel Inverter
NLC	-	Nearest Level Control
THD	-	Total Harmonic Distortion
EMI	-	Electro Magnetic Interference
DC	-	Direct Current
PWM	-	Pulse Width Modulation
NPC	-	Neutral Point Clamp
FC	-	Flying Capacitor
AC	-	Alternating Current
CHB	-	Cascaded H-Bridge
STATCOM	-	Static Synchronous Compensator
SVPWM	-	Space Vector Pulse Width Modulation
NC	-	Nearest Control
NSVC	-	Nearest Space Vector Control
PD	-	Phase Disposition
APOD	-	Alternate Phase Opposition Disposition
POD	-	Phase Opposition Disposition
SHE	-	Selective Harmonic Elimination
IGBT	-	Insulated-Gate Bipolar Transistor
MOSFET	-	Metal-Oxide-Semiconductor Field-Effect Transistor
IEEE	-	Institute of Electrical and Electronics Engineers
PV	-	Photovoltaic

LIST OF SYMBOLS

V	-	Voltage
R	-	Resistor
L	-	Inductor
cm	-	Centimetre
m	-	mili
K	-	Kilo
A	-	Ampere
C	-	Capacitor
T,t	-	Time
H	-	Harmonic

CHAPTER 1

INTRODUCTION

1.1 Overview of Multilevel Inverter

Power electronic inverters are extensively used in industrial power conversion systems each for utility and drives functions. As the power level increases, the voltage level additionally will increase as a consequence to gain best efficiency [1].

Multilevel Inverters have attracted attention in recent years because of high power quality, high voltage capability, low switching losses and low Electro Magnetic Interference (EMI) issues and are planned because the most suitable option in many medium and high voltage applications[2]. Multilevel inverter will switch their output between several voltage or current levels and have some current voltage or current source that just use capacitors or inductors as part of their structure.

In terms of direct current (DC) sources, multilevel inverters are divided into symmetrical and asymmetrical inverters. If the DC voltage sources are the same, the multilevel inverter is referred to as the symmetric multilevel inverter [3]. If the DC voltage source is in a different value, the multilevel inverter calls as a multilevel asymmetrical inverter.

In addition, to reduce the amount of switching and increase reliability by using low switching frequency technique. There are two modulated of fundamental switching pulse width modulation (PWM) techniques and nearest level control (NLC) technique that acceptable the multilevel inverter.

This project aims to study on the asymmetrical of multilevel inverter. The fundamental of switching method of multilevel inverter such as PWM technique and NLC method will be used. On the other hand, the nine-level output level from nine switches will be developed and analysed by using Matlab Software.

1.2 Problem Statement

The problem statement of this research can be stated as below:

The concept of multilevel inverter with separate dc sources is very attractive for many reasons. A multilevel inverters has many advantages over conventional inverters. However, they suffer from low reliability such as problems in increasing voltage level in power switching devices, switching losses, high value of THD, too complex implementation procedure and circuit complexity and expensive costing requirements. Also, increasing the number of no of power devices tends to reduce the performance and efficiency of the overall power converter.

For example, in cascaded multilevel inverter, if the desire number of level output is n=9, the number of power switches is can be calculated as 2(n-1) = 16, therefore, if required number is n=25, that's mean the number of switches is 2(n -1) = 48. The increment is in exponential pattern. Its same situation for other conventional multilevel inverter which is Neutral Point Clamp (NPC) and Flying Capacitor (FC) [4].

In this research work, a new topology asymmetrical multilevel inverter was described. The inverter generates nine voltage level with only nine switching devices. Hence, the Total Harmonic Distortion (THD) decrease and also less number of component in the same time inverter performances improved.

1.3 Objective

The main aim of this research is to develop modulation strategy for multilevel inverter that reduce number of power electronic components by using low switching strategy. The specific objectives of this study are listed as follows:

(a) To develop a new topology for asymmetrical multilevel inverter by using low switching strategy nearest DC level modulation scheme

(b) To carry out simulation using the Matlab simulation

(c) To validate performance of proposed new topology

1.4 Scope of Research

Scope is used to definite the project to a certain limit. Thus, the scopes for this project are as follows:

(d) Switching algorithm is for nine level asymmetrical multilevel inverter.

(e) Using nearest DC level control modulation technique.

(f) Simulation work using Matlab software.

(g) The proposed MLI is operated in open loop mode and different load condition are assumed.

1.5 Methodology

The methodology of this research can be summarized as below:

1.5.1 Model development

The new multilevel topology is proposed that is capable to produce nine level output with reduce component. The idea is to arrange available switches and DC sources in a fashion such that maximum combination of addition and subtraction of the input DC sources can be achieved. The optimized techniques (arrangement of switching) to enhance performance of topology and simplify the applying procedure are also used.

1.5.2 Simulation work using Matlab software

Matlab software is used to simulation the proposed new topology multilevel inverter and then to compute nearest DC level control for proposed new topology multilevel inverter.

1.5.3 Topology validation

To validate the proposed topology multilevel inverter, it can be extendable to achieve any number of level by adding extra unit. From this, it can be summarized to general expression of number of switches, DC source and value of the DC source for general n-level inverter.

1.6 Thesis Outline

This thesis is dividing into five main chapters. Firstly, Chapter 1 is the introduction of the whole project including problem statement, objectives, scope of project and methodology. Besides, includes the overview of multilevel inverter.

Chapter 2 will cover about symmetrical multilevel inverter, fundamental switching modulation technique, nearest DC level method and other related topics.

Method and analysis techniques will be discussed in Chapter 3. The analysis includes the operation of basic unit for new topology multilevel inverter. The suitable analysis technique for nearest DC level technique will be employed in analyzing the result. Chapter 4 will cover expected results. The simulation results analysis for NLC method by using a new proposed topology multilevel inverter will be describe in this chapter.

Finally, Chapter 5 will explain the conclusion and recommendations of this project. The conclusion is about brief a summary of this project and the recommendations are other alternative or suggestion to improve the lacks that might occur through this project.

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