"I admit that to have read this report and it has follow the scope and quality in Partial Fulfillment of Requirements for the Degree of Bachelor Of Electronic Engineering (Industrial Electronic)"

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DEVELOP LOW VOLTAGE POWER INVERTER USING PWM SIGNAL

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"I here by admit that the paper is my own work except some of the parts which have been cited accordingly."

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For all……

I dedicate this book to my beloved mother and father.
And last but not least, to all my KUTKM lecturer and friends.

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ABSTRACT

This project is regarding to the process develop low voltage power inverter that is from the DC supply changed to the 3 phase of AC current. It involves a circuit of 12V DC supply which is converted to the 3 phase of AC supply using PWM signal to transfer power supply so that the motor can be operated successfully. This system that will be building is used software and hardware it used a voltage supply, power inverter, 3 phases of AC motor and PWM circuit. It also used 6 of switches from the IGBT type which separate to 3 parts to changes the current to the 3 phase of AC voltage. PWM signal that is been produce have high and low output. It will control 6 switches of IGBT in the inverter circuit. The wave of PWM will be received by the circuit that is developed from the switch IGBT. Then the circuit will be converted to the 3 phase of AC voltage to operate the motor.

ABSTRAK

Projek ini adalah berkaitan dengan proses pembangunan penukar kuasa bervoltan rendah iaitu dari bekalan arus terus (DC) ditukarkan kepada bekalan 3 fasa arus ulang alik (AC). Ia melibatkan litar yang mempunyai bekalan 12V DC diubah kepada bekalan AC 3 fasa dengan menggunakan isyarat PWM bagi menghantar bekalan kuasa untuk membolehkan motor beroperasi dengan baik. Sistem yang akan dibangunkan ini melibatkan penggunaan software dan juga hardware iaitu terdiri daripada bekalan voltan, penukar kuasa, motor 3 fasa AC dan litar PWM. Litar penukar kuasa ini pula menggunakan 6 suis dari jenis IGBT yang dibahagikan kepada 3 bahagian bagi mengubah arus kepada 3 fasa voltan AC. Isyarat PWM yang terhasil mempunyai keluaran tinggi dan rendah dan ia akan mengawal 6 suis IGBT dalam litar penukar. Gelombang yang dihantar PWM akan dapat diterima oleh litar penukar kuasa yang dibina daripada transistor IGBT seterusnya ia akan ditukar kepada arus 3 fasa AC voltan untuk menggerakkan motor.

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CHAPTER I

INTRODUCTION

1.0 Introduction Project

An inverter is a device that takes a Direct Current input and produces a sinusoidal Alternating Current output. An inverter needs to be designed to handle the requirements of an energy hungry household yet remain efficient during periods of low demand. Inverters can be designed in a number of topologies depending on the situation and its requirements. The efficiency of the inverter is highly dependent on the switching device, topology and switching frequency of the inverter. The aim of this thesis is to develop low voltage power inverter using PWM signal.

Power electronic systems are used widely to convert electric energy from one form to other using electronic devices. Four basic power electronics functions are AC to DC conversion, DC to AC conversion, DC to DC conversion and AC-AC conversion. These basic functions are used to build power supplies, DC transmission systems, electric drives and others.

In this thesis also were discuses how to developed inverter using switching IGBT. The IGBT has the output switching and conduction characteristics of a bipolar transistor but is voltage-controlled like a MOSFET. IGBTs have been the preferred device under these conditions:

a) Low duty cycle
b) Low frequency
c) Narrow
d) Small line
e) Load variations
f) High-voltage applications
g) Operation at high junction temperature is allowed
h) Above 5kW output power

Because of their versatility for high frequency switching, high voltage and high power application, there has been a significant growth in the use of IGBTs. Sample IGBT applications include:

a) Motor control because the frequency below 20kHz, short circuit protection
b) Uninterruptible power supply (UPS) that is constant load, typically low frequency
c) For welding because high average current and low frequency about below 50 kHz.
d) Low-power lighting because the frequency is below 100 kHz.

IGBTs can be found in applications from Kilo to Megawatts operating at switching frequencies of the order of kilohertz. These posses a challenge in terms of handling power losses and the effect on system performance

1.1 Objective Project

In this thesis, the aim is to achieve the project:

a) To design electronic circuits that will be used to convert the DC circuit voltage to 3-phase AC circuit voltage using inverter in purpose to operate 1 unit AC inductive motor.
b) To learn how to build a power electronic system.
c) To familiarize the function, operation and characteristic of electronic components.
d) To used the PWM signal concept in inverter circuit to get the sinusoidal wave which is more stable and less harmonic.

1.2 Scope of Project

The scope of the project indicated the electronic circuit which is used as a switch to control the 3 phase of AC motor. This circuit will use an IGBT switch type.
The important thing to make this project successfully done is to make sure there is no problem appears in the switching application like the over limit of current which will make it damage. The scope of work is as followed:

a) Pulse Width Modulation (PWM) is used to transfer the signal to the power inverter circuit.
b) Using a power supply and oscilloscope to connect the circuit.

c) DC supply is converting to AC supply that is controlled by PWM signal. While the PWM control six IGBT switches.

d) The PWM signal is transfer to the inverter circuit that contains six IGBT switches.

e) To observe the IGBT switches function or not.

1.3 Problem of Project

During the process to build low voltage power inverter that is have some problem were identified. The problem is related with the IGBT switches. First, must make sure that is no problem regarding to switching such as over current in the circuit. This problem could damage the IGBT switch. It also having a problem to make sure the connection IGBT switch can function or not.

Furthermore, must to understand and study the DSP application and must to know how to make connection to the inverter circuit. Other problem is the possibility for the data connection using cable is not function. So must make sure this problem is not happen. The last problem is difficulty to buy the component because the value of component is too high and not sold at electronic shop. So the component must be order with supplier.

1.4 Outline of the Report

Chapter II

Will begin with a literature review on all relevant recent articles written on the subject of both power inverters and their control and will give a theoretical outline to all concepts behind the design and implementation of the entire system.

Chapter III

This chapter will explain the design and implementation of both stages of the inverter and the control system.

Chapter IV

In this chapter it will list the methodology to complete the project including flow chart, circuit and explanation.

Chapter V

Will explain the results of testing on both stages of the inverter implementation, with particular focus on stability and efficiency also include about analysis project

Chapter VI

Will be include the purpose of the project and attempt to draw appropriate conclusions based on the experimentation. It will also look into future implications of this research.

CHAPTER II

LITERATURE REVIEW

2.0 Pulse-Width Modulation (PWM)

Pulse-Width Modulation technique is widely used in variable-speed motor drives, especially after the high power rating, fast switching IGBT come up, which enables a higher switching frequency and thus better performance in dynamic response and reduction in the size, weight and acoustic noise of the system are achievable. The PWM is very flexible.

The purpose of the PWM component of the controller is to generate pulses that trigger the transistor switches of the inverter. The pulse-width modulated signal is created by comparing a fundamental sine wave from a sine-wave generator with a carrier triangle wave from a triangle wave generator. The variable width pulses from the PWM drives the gates of the switching transistors in the inverter and controls the duration and frequency that these switches turn on and off. Figure 2.1 is triangle generator combine with modulation generator.

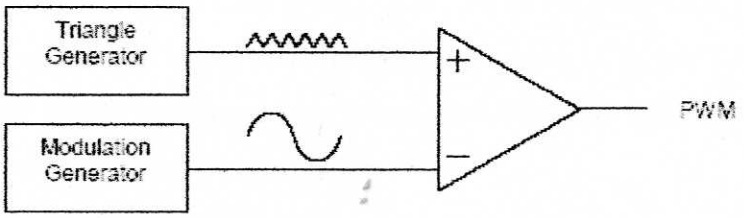

Figure 2.1: PWM Generator

The frequency of the fundamental sine wave of the PWM determines the frequency of the output voltage of the inverter. The frequency of the carrier triangle wave of the PWM determines the frequency of the transistor switches and the resulting number of square notches in the output waveform of the inverter.

Figure 2.2 is V1 compared to V carrier. For each time period, T, a square pulse operates the switch of the inverter to output the fundamental waveform. PWM waveforms are comparing together with the resulting pulse. The square pulse from the PWM is superimposed on the sine and triangle waves. The pulse is high during the interval when the sine wave is greater than the triangle wave.

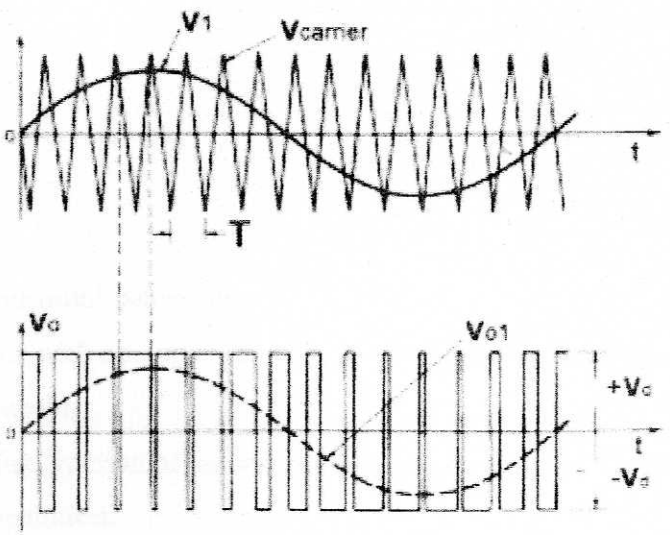

Figure 2.2: PWM Operation.

The square pulse waveform that is formed from the sine and triangle waves drive the gates of the transistor switches in the inverter and control the duration and frequency that these switches turn on and off. The dotted line sine wave in figure 2.2 represents both the low voltage PWM generated sine wave, and also the high voltage output waveform from the inverter that drives the motor.

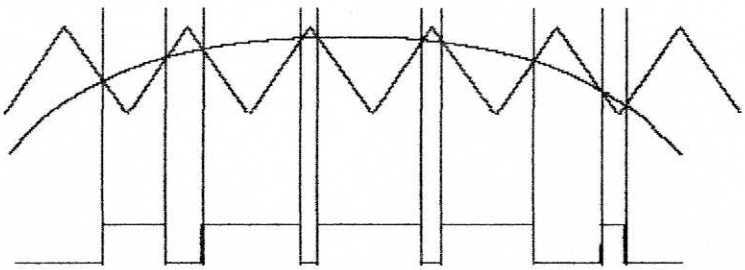

Figure 2.3: Output of PWM Generator

Figure 2.3 show combining a triangle wave and a sine wave produces the output voltage waveform. The triangular signal is the carrier or switching frequency of the inverter. The modulation generator produces a sine wave signal that determines the width of the pulses, and therefore the RMS voltage output of the inverter.

2.1 PWM Types

1. Natural (sinusoidal) sampling
   – Problems with analogue circuitry, as Drift and sensitivity.
2. Regular sampling
   – Simplified version of natural sampling that results in simple digital implementation.
3. Optimized PWM

– PWM waveform are constructed based on certain performance criteria, like THD.

4. Harmonic elimination/minimization PWM
   – PWM waveforms are constructed to eliminate some undesirable harmonics from the output waveform spectra.
   – Highly mathematical in nature
5. Space-vector modulation
   – A simple technique based on volt-second that is normally used with three-phase inverter motor-drive.

2.2 IGBT (Insulated Gate Bipolar Transistor)

The IGBT is an MOS gate-controlled power switch with a very low on-resistance. It is similar in structure to the MOS-gated thyristor, but maintains gate control of the anode current over a wide range of operating conditions. The low on-resistance feature of the IGBT is due to conductivity modulation of the n epitaxial layer grown on a p+ substrate. The on-resistance values have been reduced by a factor of about 10 compared with those of conventional n-channel power MOSFETs of similar size and voltage capability.

Changes to the epitaxial structure and the addition of recombination centers are responsible for the reduction in the fall time and an increase in the latching current level of the IGBT. Fall times as low as 0.1ms and latching currents as high as 50A can be achieved, while retaining on-resistance values is below 0.2W for a 0.09cm2 chip area.

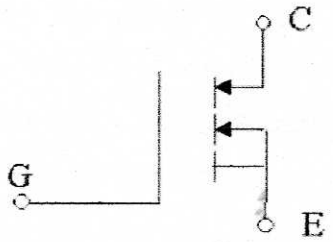

Figure 2.4: IGBT Symbol

2.2.1 IGBT Advantages

An IGBT have many advantage, because of this it can be one choice to make inverter circuit.

a) Lower Switching Losses

The key benefit of the IGBT technology is the minimal power required to switch the transistor on and off. As a result IGBTs provide lower power switching losses and consumes less power overall, thereby providing higher operating efficiencies resulting in annual utility cost savings.

b) Smaller Component Size

The IGBT component and associated drive circuitry that makes up the UPS inverter is significantly smaller than on older SCRs and bi-polar transistors inverters. The smaller inverter modules ultimately translate to a smaller overall UPS footprint and easier of serviceability.