

**SUBOSCILLATION METHOD FOR 3PHASE  
INVERTER**

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# **SUBOSCILLATION METHOD FOR THREE PHASE INVERTER**


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**This Report Is Submitted In Partial Fulfillment of Requirement For The Degree Of  
Bachelor In Electrical Engineering (Power Electronic And Drives)**


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"I hereby declared that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Power Electronic and Drive)"

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"I hereby declare that this report is a result of my own work except for the excerpts  
that have been cited clearly in the references."

Signature :  : .....  
Name : MOHAMAD FADZLI BIN AHMAD RADZI  
Date : MAY 2007

## **DEDICATION**

For my beloved mother and my father

## **ACKNOWLEDGEMENT**

Alhamdullillah, thanks to the All Mighty, with his gracious that I finally finished my Projek Sarjana Muda II in a whole semester time. The report is the outcome of the project and it has submitted following the due date time.

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## ABSTRACT

Pulse Width Modulation has many kinds to produce .such as *single pulse width modulation*, *multiple pulse width modulation* and *sinusoidal pulse width modulation*. In this project revealed one of the methods to produces *Pulse Width Modulation (PWM)* that is *sinusoidal pulse width modulation (SPWM)*. Other inverter, Sines waves and triangular make an important part in produces PWM Sines wave will compare with triangular wave which it is become input for inverter and produces PWM. For three phases inverter sines wave must be shifted by  $120^\circ$  for each phase and output can be changing with change the amplitude and frequency of sines waves which for amplitude known as *modulation index* and frequency is *modulation ratio*. Every change of amplitude will make *Total Harmonic Distortion* for voltage and current change too. The output voltage is varied by the *pulse width control*, and the harmonic are profiled by *modulation of pulse width* or *switching frequency* due to very to improved harmonic profiling compatibility. The *Sine PWM* technique is popular in modern inverter compare Square wave inverter. In this report will explain all results that will be obtained and explain the theoretical to produces PWM

## ABSTRAK

*Pulse Width Modulation (PWM)* mempunyai pelbagai cara untuk menghasilkannya seperti *Single pulse width modulation*, *multiple pulse width modulation* dan *sinusoidal pulse width modulation*. Didalam projek ini mendedahkan salah satu cara untuk menghasilkan *Pulse Width Modulation(PWM)* iaitu *sinusoidal pulse width modulation (SPWM)*. Gelombang sinus dan segitiga merupakan bahagian yang paling penting dalam menghasilkan PWM selain penukar. Gelombang sinus akan dibandingkan dengan gelombang yang berbentuk segitiga yang mana voltan keluaran merupakan gelombang masukan ke dalam penukar dan seterusnya untuk menghasilkan *PWM*. Bagi penukar 3 fasa gelombang bagi sinus haruslah mempunyai peralihan sebanyak  $120^\circ$  bagi setiap fasa dan keluaran boleh diubah dengan mengubah amplitud dan frekuensi bagi gelombang sinus yang mana setiap perubahan bagi amplitud dikenali sebagai *modulation index* dan frekuensi adalah *modulation ratio*. Setiap perubahan amplitud juga akan menyebabkan berlakunya perubahan *Total Harmonic Distortion* bagi voltan dan arus. Voltan keluaran juga boleh berubah dengan menggunakan *pulse width control* dan gambaran atau bentuk harmonic dengan *modulation of pulse width* atau *switching frequency* yang mana sangat sesuai untuk memperbaiki persuisan gambaran harmonic. *Sine PWM* adalah teknik sangat popular didalam penukar yang moden berbanding penukar berbentuk segitiga. Didalam laporan ini menyatakan keseluruhan keputusan yang telah diperolehi dan menerangkan secara teori yang berkaitan untuk menghasilkan PWM.



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## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 INTRODUCTION OF PROJECT**

Dc-ac converter is known as inverters. Inverter is one of the devices that can change a dc input voltage to a symmetrical ac output voltage of the desired magnitude and frequency. General block diagram shown in figure 1. The frequency and output voltage might be the fixed or variable frequency. A variable output voltage can be obtained by varying the input dc voltage and maintaining the gain of the inverter constant. The gain can be control by Pulse width modulation control with the inverter. This inverter gain may be defined as the ratio of the AC output voltage to DC voltage. Output voltage waveform of an ideal inverter should be sinus. However the wave form of practical inverter is non-sinusoidal and certainly contains harmonics. Therefore to obtain a quality output voltage waveform with a minimum amount of ripple of harmonic content.

Pulse width modulation (PWM) is usually used to get a variable output by varying the gain of the inverter. There is much method to get pulse width modulation and one of the methods is by using Sinusoidal Pulse Width Modulation. Sinusoidal Pulse width Modulation (SPWM) is commonly used in industrial applications such as variable speed AC motor drive, induction heating, standby power supplies, ac appliances run from an automobile battery and un-interruptible power supply (UPS)

The frequency of reference signal  $F_r$  determines the inverter output frequency  $F_o$  and its peak amplitude  $A_r$  control the modulation index  $M$  and then in turn the rms output voltage  $V_o$ . For 3-phase inverter, there are 3 sinusoidal reference wave each shifted by  $120^\circ$ . A carrier wave which is a triangular wave is compared with the reference signal corresponding to a phase to generate the gating signals for the phase. The reason for this is to get the fundamental voltage. To control the speed of pulse width modulation, the switching frequency at the inverter should be change. This Inverter has high efficiency in sending power to the load. Other than that the inverter compatibility with multi motor applications and ability to ride through a 3 to 5 Hz power loss.

The switching that is used is from metal oxide semiconductors field-effect transistors (MOSFET) type that has the criteria that is needed for the project. For the record, power MOSFET is a voltage controlled device and require only a small input current. In this report, the early result is provided by using simulation. Other than that, there is also theories related to Pulse Width Modulation also components that is used to make the circuit.

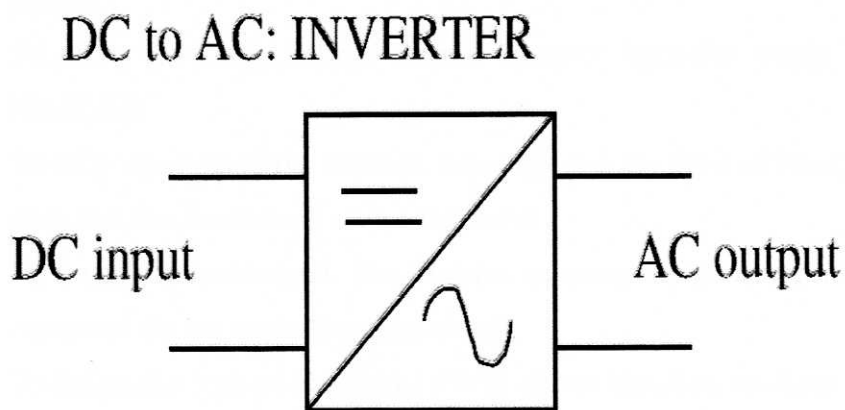


Figure 1.1: Basic of inverter

## 1.2. OBJECTIVES

- i. To investigate and analyze PWM technique
- ii. To model and design 3 phase PWM voltage source inverter using MATLAB
- iii. To study the parameters and operation of the 3 phase voltage source inverter.
- iv. To design and built a 3 phase sinusoidal output signals.
- v. To implement the sub oscillation for 3-phase inverter.

## 1.3. SCOPE OF PROJECT

This project build based on knowledge of Electrical Engineering. This project is to control load for example for motor, conveyer and etc that uses sinusoidal *pulse* width modulation. The scope of this project is divided into two parts which is software and hardware as follows

- i. To design and built an electronic circuit for 3 phase sinusoidal output signals.
- ii. To study 3 phase voltage source inverter behavior using simulink MATLAB
- iii. To fully understand the concept, topology and the need of inverter, apart from that the function of each component
- iv. To learn and understand the function of each component because it is important during assembling the circuit
- v. To design the 3 phase sinusoidal PWM circuit based on op-Amp

#### 1.4. PROBLEM STATEMENT

:

Pulse Width modulation has been used applications such as motor applications, conveyer and electric vehicle. In this problem statement a few problem that arise in finish this project. Here a few problem why this project must be design

- i. This inverter is better than the square wave output which contains much harmonic and the Total harmonic distortion is high.
- ii. Higher efficiency than square wave inverter
- iii. Dc bus voltage is not fully utilize therefore insufficient power to drive high load (torque produce must be large)
- iv. Switching losses in high power application.

A few problems also occur during finish this project.

- i. The most problems occur in hardware which hardware cannot get the expected results and it is entail several troubles shooting
- ii. Problem in design the phase shift of sines wave which require resistance value that accurate.

Other than that the problem occurs in this project is that it have many harmonic component during low frequency. Because of many harmonic, it is very difficult to design filter that can minimized the number of harmonic components particularly for low harmonics components reduction such as 1, 3 and 5 that requires large bandwidth filter so that producing better fundamental output signals. Apart from that, it is very difficult to design an inverter that able to producing variable voltage and variable frequency.



## **CHAPTER 2**

### **METHODOLOGY**

#### **2.1 INTRODUCTION**

In the making of a certain project into a successful project, there is must be a plan to ease the working capabilities based on method and objective that set. This research is guide towards a few stages that is recognizing problem and obey with research, invent the circuit and hardware, testing circuit and analyze based on planning schedule to finish this project. In this project it encircle hardware implementation, and circuit. Then all steps should be follow the planning for shunt any problem occurs. A few methods which already make to finish this project.

- i. Identify problem
- ii. Study and solve the problem.
- iii. Literature review and project background simulation
- iv. Understand the circuit and operation
- v. Simulation
- vi. Hardware design and implementation

## **2.2 IDENTIFY PROBLEM**

Before starting the project, early step to do is research the problem occurs and why do this project. The identify problem not only encircle problem when result of implementer but take the problem by this system. In this project all the information of the project must be identify such as identify circuit and component which is suitable, material of the project that use and cost estimate.

## **2.3 STUDY AND SOLVE THE PROBLEM**

Then second step after identify the problem that occurs in this project the step is study and solve the problem. This step does it with do the research by internet source, books and journals. Other than that discuss with supervisor can help in study and solve the problem.

## **2.4 LITERATURE REVIEW AND PROJECT BACKGROUND INVESTIGATION**

At this step, focus to information from by internet source, books and journals can help to research and analyze about the project. In this project research is done to the how to generate sinusoidal wave and triangular and the components use

## **2.5 UNDERSTAND THE CIRCUIT AND OPERATION**

After circuit, component and software identify and all the theory was learn, the next step is to fully understand the circuit and software. To understand the circuit and software must be discuss with supervisor and find and learn all information through

internet source. Then learning about characteristic of inverter to fully understand the model and character of sinusoidal pulse width modulation

## **2.6 SIMULATION**

This step which research and invert the circuit. In this project matlab is using to simulate the circuit .After the circuit has finish invert. The simulation is use to get the early result which can be a guide to the guide ware result. This process will ease the analysis during simulations test others than the real hardware test.

## **2.7 HARDWARE DESIGN AND IMPLEMENTATION**

Hardware implementation is a final step to finish this project. In this step the component of this project assemble to the street board. The operation of the circuit must be testing for get the expected result