



**Faculty of Electrical Engineering**

**DESIGNING OF FAULT'S PATTERN FOR 3 PHASE INVERTER USING  
VB**

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USING VB**

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**A thesis submitted  
in fulfilment of the requirements for the degree of Electrical Engineering**

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## DECLARATION

I declare that I have read through this thesis entitle “Designing of fault’s pattern for 3 phase inverter using VB” 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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## **APPROVAL**

I declare that this report entitle “Designing of fault’s pattern for 3 phase inverter using VB” is the result of my own research except as cited in the references. The report has not been accepted for any degrees and is not concurrently submitted of any other degree.

Signature : .....

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Date : .....

## **DEDICATION**

To my beloved mother and late father

## ACKNOWLEDGEMENT

Thank you to Allah, I would never have been able to finish my report without certainty from Allah s.w.t. My appreciation also goes to the guidance of my committee members, help from friends, and support from my family.

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Thank you so much.

## ABSTRACT

The purpose of this project is to designing fault's pattern for three phase inverter using Visual Basic. As already known, the usage of inverter is widely important in the industry. Due the operation frequently, there are many type of fault may occur in the three phase inverter. The study of fault is extremely important and quite difficult to determine. The failure of switching also cannot be determine earlier. Therefore, the cost of maintenance and repairing the system is increased besides the other system is affected if the fault is failed or late to be determined. In order to determine the fault happen in the inverter, by designing in visualization is given clearer overview. Focusing in two main faults frequently are happened, which are open circuit of damage and short circuit of damage, the aspect including the characteristics and the position of fault may occur in the inverter is considered at first. The process to design the pattern the fault is facilitated. As an introduction, the current value of open switch in phase be zero for either the positive or negative half-cycle and the short circuit happen when switches is short circuited, basically happen when a wrong gate voltage. This project also represented the parameter is consider in the fault of three phase converters which are average current, RMS current and total harmonic distortion. The ideal signal of three phase inverter is represented in the visualization at first to give some overview. Usually, the investigation only diagnose the fault occur in the inverter. So, overalls, the goal of this project is achieved by the coding is run using Visual basic that the clearer for a good display of the fault is given. Some calculations are needed in process to design and the pattern of fault is created. The visualization is plotted in sine wave signal to give clearer pattern of faults three phase inverter.

## ***ABSTRAK***

Tujuan projek ini adalah untuk mereka bentuk corak kerosakan untuk penyongsang tiga fasa menggunakan Visual Basic. Seperti yang telah diketahui, penggunaan penyongsang secara meluas penting dalam industri. Oleh kerana operasinya yang kerap, terdapat banyak jenis faktor boleh mengakibatkan kerosakan dalam penyongsang tiga fasa. Kajian daripada kerosakan adalah sangat penting dan agak sukar ditentukan. Kegagalan pensuisan juga tidak boleh ditentukan lebih awal. Oleh itu, kos penyelenggaraan dan membaik pulih sistem ini meningkat selain sistem lain terjejas jika kerosakan itu gagal atau lewat akan ditentukan. Untuk menentukan kerosakan berlaku dalam penyongsang, dengan mereka bentuk dalam visualisasi memberi gambaran yang lebih jelas. Memberi tumpuan dalam dua kerosakan utama yang sering berlaku adalah, kerosakan litar terbuka dan kerosakan litar pintas, aspek yang penting termasuklah ciri-ciri dan kedudukan boleh mengakibatkan kerosakan dalam penyongsang dikesan pada awal kerosakan. Proses untuk mereka bentuk corak yang bersalah itu dipermudahkan. Sebagai pengenalan, nilai semasa suis terbuka dalam fasa sifar untuk sama ada separuh kitar positif atau negatif dan litar pintas berlaku apabila suis dipintaskan, pada dasarnya berlaku apabila voltan suis yang salah. Projek ini juga menggunakan parameter yang dipertimbangkan dalam kerosakan penukar tiga fasa iaitu arus purata semasa, arus RMS semasa dan jumlah herotan harmonik. Isyarat yang ideal bagi tiga fasa inverter diwakili dalam visualisasi pada mulanya untuk memberikan beberapa gambaran. Biasanya, siasatan hanya mendiagnosis kerosakan berlaku dalam penyongsang. Jadi, matlamat projek ini dicapai dengan pengekodan dijalankan dengan menggunakan Visual asas yang lebih jelas untuk paparan yang baik daripada kesalahan itu telah diberikan. Beberapa pengiraan yang diperlukan dalam proses untuk mereka bentuk dan corak bersalah dicipta. Visualisasi diplotkan dalam isyarat gelombang sinus untuk memberi corak yang lebih jelas kesilapan tiga fasa penyongsang.



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## LIST OF ABBREVIATIONS

TFD	-	Time Frequency Distribution
RMS	-	Root Mean Square
THD	-	Total Harmonic Distortion
TWD	-	Total Waveform Distortion
TFR	-	Time Frequency Representation
VB	-	Visual Basic
GUI	-	Graphic User Interface
DC	-	Direct Current
AC	-	Alternating Current
VSI	-	Voltage Source Inverter
P.U	-	Per-unit System
IDE	-	Integrated Development Environment

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## CHAPTER 1

### INTRODUCTION

#### 1.1 Overview

DC-AC inverters are electronic devices that widely used to produce AC power from low voltage DC energy in industry. Inverter do their job to perform two functions which are converts the DC into AC then set up the resulting AC to mains voltage level using the transformer. One of the inverter is the three phase inverters that are used for variable frequency drive application. It has been predicted that voltage-fed inverters will eventually replace all other types of converters in the near future[1]. The performance and effects are the important factor in industry, especially the usage power inverter, switching and control circuit. The inverters performance in their operation sometimes will cause the faults. The knowledge about the fault mode behavior of inverter extremely important to improved the system design, performance, quality operation and protection. There are various types may happen. In order to determine the faults that happen in the inverter, by designing the faults pattern in visual that will give clearer overview about the pattern of possible faults.

The design of fault's pattern inverter that proposed, the inverter fault detects the faults occurrence and isolates the faulty leg[2]. After identifying the faults modes, related technique will use to analysis the faults. The analysis has been made for the key fault types which are open circuit fault or short circuit fault conditions. As awareness, a short circuit fault is a critical problem, because such a fault will cause permanent damage of the system[3]. The software of visual basic was selected because the potential to displaying the visualization fault clearly.



## 1.2 Problem statement

This project is designing the fault's pattern for three phase inverter. Inverters are widely utilized to drive of ac motor. About 38% failures that found in the application of power inverter and mostly that come from power switches [4]. Unfortunately, the conditions of fault's pattern in the inverter only receive a little attention compared with fault diagnostic. This is because the faults happen in three phase inverter is difficult to determine. The failure of the switching inverter cannot detect earlier, it also will interrupt the other operation of the system such as can cause the thermal rating of the system. If this condition is happen, it will increase the cost of maintenance and need other process to analysis the failure. Other than that, without visualization, the faults happen in the inverter difficult to classify. It is because, there are many various types of faults that may possibly happen in the inverter.

## 1.3 Objective

The main objective in this project is to design a system that can display the fault of three phase inverter. In order to achieve the goal of this project and solve the current problem, the objectives of this project are:

1. To design the fault's pattern of the 3 phase inverter using LabVIEW software as a tool in Visual Basic.
2. To analyze and evaluate the fault characteristic and relevant parameters in 3 phase inverter.

## **1.4 Scope of project**

In producing a successful analysis, work, and some project, the scope is required to assist and set the directions of the project development. These scope should be identified and planned appropriately. For the scope of this project are, the fault's pattern during open circuit damage and short circuit damage for three phase inverter. The program coding is run in visual basic which will displaying the pattern of faults using LabVIEW by National Instrument library. The faults will be displayed are open circuit fault and short circuit fault only.

## **1.5 Contribution of research**

As stated before, the knowledge and information about the behavior of the inverter is important to improve design and protection. The study of fault performance is extremely complex. The important faults types are identified in the beginning that is then followed by preliminary analysis [5]. Focusing in open circuit damage of switch and short-circuit damage of switch, these two faults was usually happen in the inverter. As designing the fault's pattern for three phase inverter by using visual basic, it will give clearer overview in form of gating signal switching devices. This project also can be use for learning session, because the faults in inverter were something that never gets attention in study of power electronic.

## 1.6 Report outlines

In the first chapter, stated the introduction about the project. Briefly, it described about the overview or project background, problem statement, objectives, scope and contribution of research. The part of overview was explained about the current situation and correlation problem that related of fault inverter because, nowadays, the inverter used as drivers system in industry. The problem statement stated a concise description of the issued that need to be addressed before the designing of fault pattern is to be design. For the objective, it stated a specific result that this project aimed to achieve like to study and knowing about the faults types and to design the faults pattern. While the scope is focused only on two types of faults that will be design by using the proposed software which is Visual Basic.

For the chapter two, it was explain about the project literature review of three phase inverter and the study in faults types that may happen in the inverter. The focused explanation is in open circuit damage of switch and short circuit damage of switch. The related previous works for this project mostly more focused in diagnosis and analysis in faults types. It also stated in chapter two.

The flowchart, analytical approach is introduced in chapter three. This chapter includes the framework of the project progress. It gives a lot of help in process to accomplish this project. To give a description, this chapter also included the software design and development.

The chapter four stated covered the discussions of results on the performance analysis for the time frequency distribution and developed system. This thesis ends with the conclusion and recommendations for further research as presented in Chapter 5

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Introduction

Nowadays, the potential performance of driver will give the advantages to the system. The better performance of specifications and productivity interest lead to demand operating the operation in industry or any engineering system. The requirement to maintain the operation of the system is very important in order to ensure the efficiency, productivity and safety aspect are always under control. In developing the system of driver, a critical problem is a fault that always occurs whether we realize or not. Even the small disturbance may cause the failure of the system. The fault diagnosis of such devices play vital role in industry.

Although the type of faults can be prevented during the design stage, they are always having possibility of system failure due to device. The needed for fault detection at an early stage is very important. This automatically will avoid total system failure which can have serious consequences.

This chapter presents the introduction and basic topology to the three phase inverter and type of fault. The fault may occur in such driver system may open circuit switch, short circuit switch, intermittent misfiring and others. But, for this project, it focused on open circuit switch and short circuit switch only.

### 2.1.1 The three phase VSI topology

The inverter is an electronic device or circuitry that changes direct current (dc) to alternating current (AC) [1]. It can be entirely electronic or may be a combination of mechanical effects and electronic circuitry. The input and output voltage also the frequency and overall power handling are depend on the design of the specific device. Inverters are used in applications such as adjustable-speed ac motor drives, running ac appliances from an automobile battery and others.

The three phase voltage-fed inverters are recently showing growing popularity for industrial drive application. Variable voltage and frequency supply to ac drives is invariably obtained from a three-phase voltage source inverter (VSI). The three phase VSI topology shows in figure 2.1 consists with six switches and three-load phase terminals whereas a single-phase inverter has only one pair of load terminals. The current supplied to the inverter switches is referred as dc link current and has been shown as  $i_{dc}$ , hence the power transfer is determine by relation between  $E_{dc}$  and the magnitude and the magnitude and the polarity of the equivalent average value of  $e_L (wt)$ .

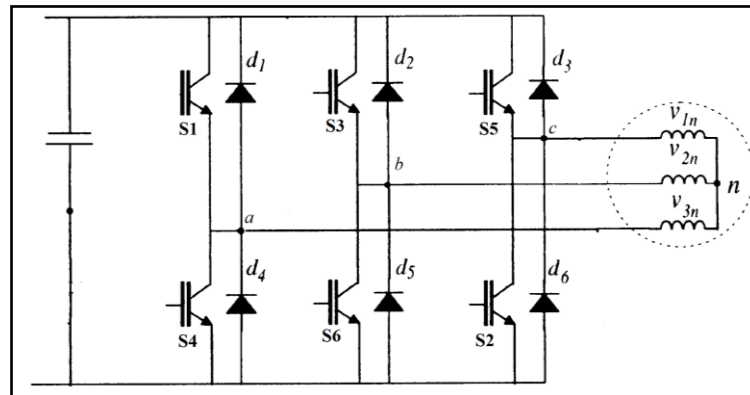


Figure 2.1: The three phase VSI [5]

The magnitude of dc link current usually changes in step (and sometimes its direction also changes) as the switching are turned on and off.

Two types of control signals can be applied to the switches:  $180^\circ$  conduction or  $120^\circ$  conduction. The  $180^\circ$  conduction has better utilization of the switches. For  $180^\circ$  conduction, three switches remain on at any instant of time. Thus two switches of the same leg are prevented from conducting simultaneously. The duration of each mode is  $60^\circ$  intervals and there are six modes of operation. For an example, when switch  $S_1$  is switched on, terminal  $a$  is brought to the dc input voltage. When switch  $S_4$  is switched on, terminal  $a$  is brought to the negative terminal of the dc source. The gating will be shifted by  $60^\circ$  to obtain three-phase balance.

The inverter is divided with two switches, which are upper and lower switches. When the upper switch of the corresponding arm conducts, the potential of a load terminal with respect to the common reference point 0, it will result in  $+V$ . When the lower switch is conduct, it is zero. The three-position maybe synthesized by two unidirectional electronic switches. A MOSFET has a built-in body diode that serves as the path for the current from the source to the drain. However, an IGBT requires an external diode.

However, there are some limitations in three phase inverter. The switches of any leg of the inverter cannot be switched on simultaneously, it will cause result in short circuit across link the dc link voltage supply. Same like when the switches of any leg of the inverter switched off simultaneously, it would result in voltage that depends on the respective line current polarity. This situation will cause undefined state thus undefined ac output line voltages.

### **2.1.2 Fault of the drive system**

The VSI is used in most of the industrial application the asynchronous machine. The switches operation failure may cause the faults in inverter. When these faults occur, the drive system has to be stopped from operation and an unprogrammed maintenance schedule.

There are some steps as a strategy to detect the fault in inverter:[11]

- a) Fault detection
- b) Fault identification
- c) Remedial action

A few various types of fault can be developed in inverter. It may: [5]

- a) Dc link short circuit to ground
- b) Dc link capacitor bank short circuit
- c) Open circuit damage of switch.
- d) short-circuit damage of switch
- e) line to line short-circuit at machine terminal
- f) single line to ground fault at machine terminal

Others faults also will occur inside the asynchronous machine cause by winding insulation failure due to excessive voltage or current stress. But, the ac machine faults are not considered in this project.

The figure 2.2 below shows the gating signals of the inverter in an ideal case, while the switching voltage is presented in Table 2.1. Where voltage line to line:

$$V_{ab} = V_{AN} - V_{BN}$$

$$V_{bc} = V_{BN} - V_{CN}$$

$$V_{ca} = V_{CN} - V_{AN}$$

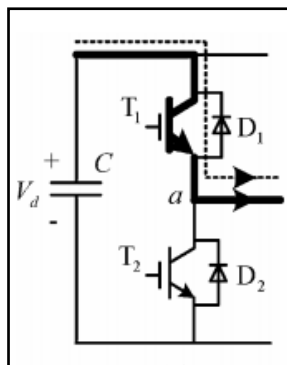


Figure 2.2: Gating signals of the inverter in an ideal case [2]

Table 2.1: Switching voltage possibilities 3 phase VSI

State	S1	S3	S5	$V_{ab}$	$V_{bc}$	$V_{ca}$	$V_{AN}$	$V_{BN}$	$V_{CN}$
Null	0	0	0	0	0	0	0	0	0
1	0	0	1	0	$-V_{DC}$	$V_{DC}$	$-1/3$	$-1/3$	$2/3$
2	0	1	0	$-V_{DC}$	$V_{DC}$	0	$-1/3$	$2/3$	$-1/3$
3	0	1	1	$-V_{DC}$	0	$-V_{DC}$	$-2/3$	$1/3$	$1/3$
4	1	0	0	$V_{DC}$	0	$-V_{DC}$	$2/3$	$-1/3$	$-1/3$
5	1	0	1	$V_{DC}$	$-V_{DC}$	0	$1/3$	$-2/3$	$1/3$
6	1	1	0	0	$V_{DC}$	$-V_{DC}$	$1/3$	$1/3$	$-2/3$
Null	1	1	1	0	0	0	0	0	0

### 2.1.2 (a) Open circuit damage of switch

Focusing only on open circuit damage and short-circuit damage of switch, the open circuit damage switch may happen due to lifting of bonding wires caused by thermic cycling [6]. An open circuit fault in VSI makes the current in phase be zero for either the positive or negative half-cycle depending on whether it occurs to the upper or lower switch. [2] Figure 2.3 shows the open circuit damage of switch in upper switch of three phase inverter.

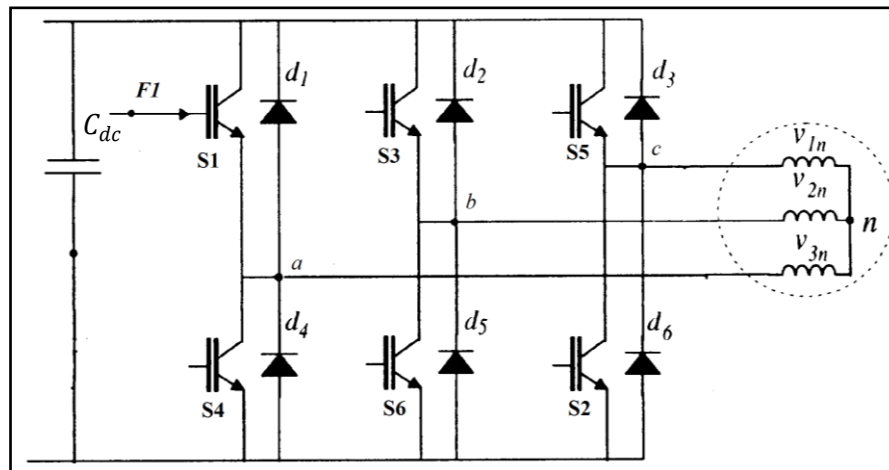


Figure 2.3: Open circuit damage of switch in 3 phase inverter [7]