UNIVERSITI TEKNIKAL MALAYSIA MELAKA

A NEW INVESTIGATION METHOD OF POWER QUALITY BEHAVIOR AND IMPROVE BY USING LOW SINGLE PHASE INVERTER

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

by

SITI MAHFUZAH BINTI YAHAYA

B071310093

900525016122

FACULTY OF ENGINEERING TECHNOLOGY

2016

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **A NEW INVESTIGATIONMETHOD OF POWER QUALITY BEHAVIOR AND IMPROVEBY USING LOW SINGLE PHASE INVERTER**

SESI PENGAJIAN: **2016/17 Semester 1**

Saya **SITI MAHFUZAH BINTI YAHAYA**

mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (✓)

☐	SULIT	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)
☐	TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☑	TIDAK TERHAD	

Disahkan oleh:

_____ _____

Alamat Tetap:
2, JALAN LADING 22,
TAMAN PUTERI WANGSA,
81800, ULU TIRAM, JOHOR.

Cop Rasmi:

Tarikh: _____ Tarikh: _____

** Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I hereby, declared this report entitled “A New Investigation Method of Power Quality Behavior And Improve by Using Low Single Phase Inverter” is the results of my own research except as cited in references.

Signature	:	…….
Author’s Name	:	SITI MAHFUZAH BINTI YAHAYA
Date	:	25. JANUARY. 2017

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Engineering Technology (Department of Electronics & Computer Engineering Technology) (Bachelor's Degree in Electronics Engineering Technology (Industrial Electronics) with Honours). The member of the supervisory is as follow:

……

(EN. IR. NIK AZRAN BIN AB. HADI)

ABSTRAK

Projek ini mengambil berat tentang reka bentuk projek untuk penyongsang (inverter) litar penukar DC-AC satu fasa. Banyak kertas kerja sebelum ini yang berkaitan mengenai penukar kuasa yang penyongsang. Penyongsang statik adalah litar yang digunakan untuk tujuan menukar kuasa AT sumber AU pada nilai tertentu voltan keluaran dan kekerapan. Memandangkan keupayaan litar ini, ia digunakan secara meluas dalam aplikasi industri. Antara aplikasi yang boleh disenaraikan sebagai kelajuan pengawal untuk motor. Pemanasan kawalan jauh dan unit bekalan tidak terganggu (UPS). Secara umumnya, terdapat dua jenis penyongsang yang sumber penyongsang voltan (Voltage Source Inverter). Untuk menjana isyarat denyutan lebar modulasi (PWM). Penyongsang adalah untuk membekalkan kuasa dari litar utama kepada beban, sebelum ini terdapat masalah yang berkaitan dengan kualiti kuasa yag dalam sistem. Masalah yang dibangkitkan dalam kertas ini adalah seperti harmonik, faktor kuasa dan juga fliker. Kajian ini dilakukan didalam makmal untuk menyiasat masalah yang terjadi di dalam makmal. Kesimpulannya, keluaran penukar DC-AC direka dalam projek ini adalah dalam bentuk AC gelombang persegi and voltan keluaran di akhir projek ini menunjukkan voltan AC.

ABSTRACT

The project is concerned with the design of the project to the inverter (inverter) DC-AC converter circuit single phase. Many papers before the relevant converter power inverter. Static inverter is a circuit used for changing the dc power source AU in particular the output voltage and frequency. Given the ability of this circuit, it is widely used in industrial applications. Among the applications that can be registered as speed controller to the motor. Remote control heating and uninterrupted supply unit (UPS). Generally, there are two types of inverter voltage source inverter (Voltage Source Inverter). To generate the signal pulse width modulation (PWM). The inverter is supplying power to the load of the main circuit, before there are problems associated with the quality of the power system. Issues raised in this paper are as harmonics, power factor and functions are. This study was conducted in the laboratory to investigate the problems that occur in the laboratory. In conclusion, the output of the DC-AC converter designed in this project is in the form of a square wave and voltage AC output at the end of this project shows the AC voltage.

DEDICATION

Thank you to Allah S.W.T to give me a chance to finished this project even I have a lot of problem during project. To my beloved parent, my mother Che Hasmah binti Che Hussin for the soul that she gives, my dad Yahaya bin Hassan to the spirit word for me and all my sibling for their understanding.

Mohd Khairolnizam Binti Yahaya
Mohd Fadilrollah bin Yahaya
Mohd Sharhan bin Yahaya
Siti Noor Aishah binti Yahaya
Siti Zubaidah binti Yahaya
Siti Maisarah binti Yahaya
Siti Noor Albaiyah binti Yahaya

ACKNOWLEDGEMENT

I would like to thank En Nik Azran bin Ab. Hadi as my supervisor for her guidance on completing this project. I would also like to thank all my friends that support me during working on this project.

All praise to Allah S.W.T for giving me with health and opportunity to gain this treasure of knowledge and experience to complete this project. First and foremost, I would like to thank to our Universiti Teknikal Malaysia Melaka (UTeM) for helping me funding this project.

Besides, I would like to thank to Universiti Teknikal Malaysia Melaka (UTeM) especially to the Department of Electronics & Computer Engineering Technology (JTKEK), Faculty of Engineering Technology (FTK) for providing us with good environment and facilities to complete this project. Thanks also to the Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) librarian and related staff for providing us valuable information through the project.

TABLE OF CONTENT

LIST OF TABLE

LIST OF FIGURES

LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

AC	-	Alternating Current
DC	-	Direct Current
PWM	-	Pulse Width Modulation
THD	-	Total Harmonics Distortion
PCB	-	Individual Total Harmonics Distortion
DF	-	Distortion Factor
STC	-	Standard Test Condition
UPS	-	Uninterrupted Power Supply
AH	-	Ampere Hour
PCC	-	Point of Common Coupling
CSI	-	Current Source Inverter
VSI	-	Voltage Source Inverter
TDD	-	Total Demand Distortion
PF	-	Power Factor
SPWM	-	Sinusoidal Pulse Width Modulation
CCA	-	Cold Cranking Ampere
CA	-	Cranking Ampere
BJT	-	Bipolar Junction Transistor
MOSFET		Metal Oxide Semiconductor Field Effect. Transistor
IGBT	-	Insulated Gate Bipolar Transistor
AVR	-	Automatic Voltage Regulator
TNB	-	Tenaga Nasional Berhad

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

This chapter is overall view about this project. It was included the project background, the problem statement, objective, and scope of this project.

1.1 PROJECT BACKGROUND

Power electronics industries is growing faster in the Electrical Engineering field. Application of solid-state is to conversion and control the electric power [1]. This research is referring to the electrical and electronic engineering design, control, computation. Electrical power is divided into two (2) types which are Alternating Current (AC) and Direct Current (DC). These two types of power can be converted through four different methods. These methods include AC to DC, DC to AC, DC to DC and AC to AC. The conversion of DC to AC can be done through an inverter circuit while a rectifier (full bridge) is an electronic circuit that will convert AC power to DC power.

The other two methods require either a DC to DC convert or an AC to AC converter only convert the input to another voltage level for output without changing the type of input. As the world becomes more innovative, each of four different type of circuit can be further expanded depending on what output is desired. There are many methods of building an inverter such as multilevel inverter, half bridge inverter and full bridge

converter (H-bridge) with using a low pass LC filter to get the smoothest of sinusoidal output. And the only way to control the switching is only using generating signals.

For low power inverter, it can be done by combinations of 555 timer and flip flop, also can generate using PIC microcontroller since it has their own PWM in the package. But for high power of inverter, PWM is widely used to control the switching especially for induction motor, photovoltaic solar power etc. PWM technique is divided into two ways includes unipolar and bipolar inverters method.

This study is to identify issues that may occur in the laboratory. Laboratory equipment is often damaged by power quality such as over voltage, under voltage, flicker, and others. Because of that, the equipment in the lab is often damage and the performance of that equipment decreases and do not save the maintenance cost of the equipment.

The project is closely linked to the inverter. Inverters are devices used to convert DC-AC supply. This project in its early stages, there is a rectifier circuit that converts AC-DC power supply is then converted back to AC supply via the inverter and there is also a back-up supply of batteries. The battery acts as the power supply which powers the circuit so that no damage occurred as happened to the equipment in the lab.

In addition, the project is also related to the power quality. Where it is needed in the analysis of the project and that funding should solve a problem from the problem statement on that project and it will achieve the objectives of the research project.

1.2 PROBLEM STATEMENT

The project is about the investigation of power quality behaviour. The equipment in the laboratory is often damaged because of power quality issues. Existing equipment does not have stabilizers and any backup to prevent the equipment from power quality

behaviour issues. For the project, it needs to find a suitable technique for DC to AC converter or inverter and study the principle operation of that method.

In addition, for the previous project, the battery is not used as a backup to the main supply. Within the project, the design of the inverter will be designed with the aim to reduce disturbance when the power supply with battery as a backup. The project is designed to reduce variability in the circuit, and to minimize the damage and maintenance cost.

1.3 OBJECTIVE

• To study the behaviour in power quality in electrical supply. Study about the factor that make the power quality in electrical supply faulty.

• To define the switching technique for DC-AC converter or inverter and knows as the principle operation. Learn about the inverter DC-AC technique and the way of the operations.

• To learn the method for analysing and designing the inverter with battery as a backup. Study the best method and analysis the method and the design of the inverter with the other supply as the backup.

1.4 SCOPE

For the work scope of this project are also use AC-DC converter(rectifier) as a supply to the battery. After that, use the DC-AC converter, which is inverter to ensure this project works as specified in the objectives based on a that use a technique for inverter based on the objectives and solve the problem

1.5 PROJECT SIGNIFICANCE

This project will benefit students who use the lab as well as to reduce the level of damage to the equipment in the lab. Therefore, it is very useful to a lot of parties, in the future this project can be widely used in laboratory, especially for addressing the issue of power quality.

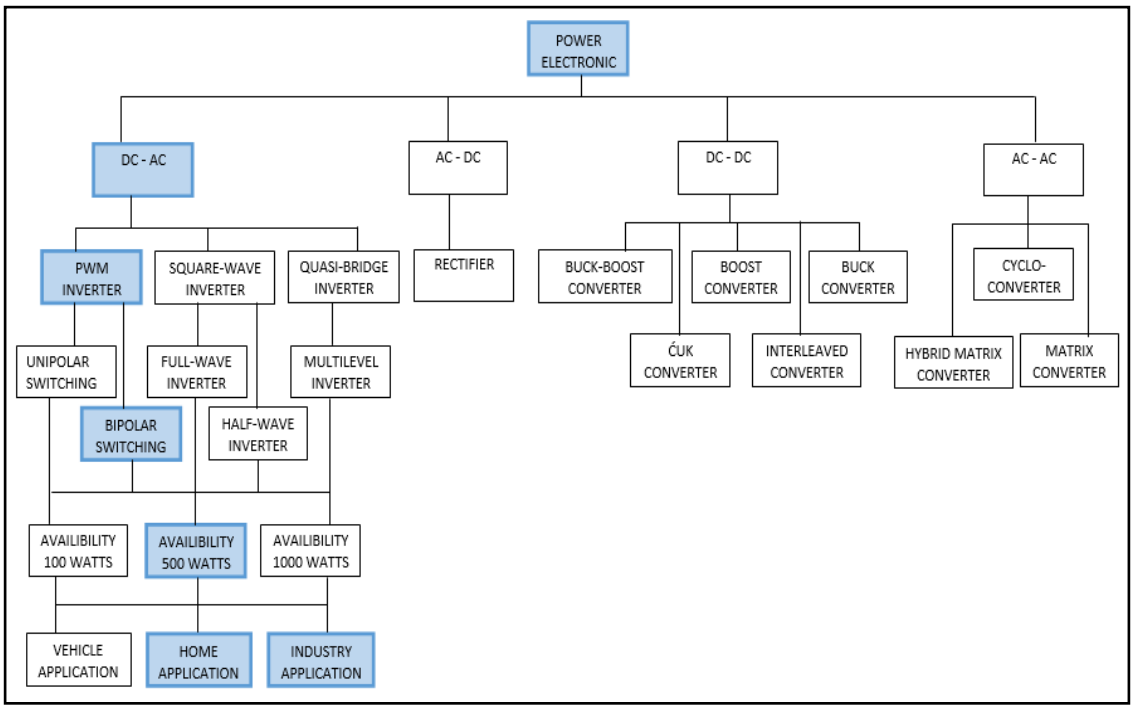

Figure 1.1: K-Chart of the technique and system

From the K-chart above, the power electronics are divided into four (4) type, which is DC-AC, AC-DC, DC-DC and AC-AC. DC-AC was used in this project because from the battery it converts the supply to the AC supply(220V). Type of inverter that has been choosing was based on the capability of power, producing the sinusoidal voltage AC and the most important is the costs to build up the inverter.

CHAPTER 2
LITERATURE REVIEW

2.0 INTRODUCTION

This chapter is summarized about the literature review of this project. To complete this project also, some researches about the previous system also been studied and explore. It is a frame of text that aims to review critical pint of current knowledge for any related information and reviews on Inverter and awareness about power quality system. These chapters also consist of aim to show all related studies, formula, result, history, type and function of Inverter to show the relationship with this project

2.1 POWER QUALITY

According to the paper from the Department of Electrical and Computer Engineering, Nicosia, Cyprus by Minas PATSALIDES, George E. Georghiou and Andreas Stavrou, Venizelos Efthimiou present on power quality issues in the theory of common standard of power quality used IEEE Standard 519-1992, EN 50160 and IEC 61000 -4-30. Standard EN 50160 has been prepared to the recommended level of power quality parameters. Based on the European standard EN (IEC 50160), total harmonic distortion limits must not exceed 8% up to the 40th harmonic. IEEE 519-1992 standard specifies the recommended practices and requirements Harmonics

Power Control System is to determine the limits for voltage harmonics. The coupling is between the utility distributions to the end user. The standard is applied requiring the two sides. The prescribed standard is 5% of the amount of current and voltage distortion for each customer. The maximum individual harmonic components of low voltage from 69kV to be 3%. The inverter output, total harmonic distortion allowed less than 5% and not less than 25% for individual harmonics of odd harmonic limits should be lower.

2.2 HARMONICS

Nowadays, common power electronic equipment has led to harmonic distortion in the power system. Main concerns that led to the distortion caused significant harmonic distortion can be in electronic equipment, electrical machinery, and transformer. In an easy word, harmonics distortion is the corruption of the fundamental sine wave at frequencies that are multiples of the fundamental. In addition, potential occurrence of harmonic resonance is when the network has a capacitor bank.

From paper Harmonics treatment in industrial power system by Abu Baker Abd Alrahman Basher Elmileeh from Faculty of Engineering University of Khartoum. Harmonics limited in the electrical system voltages and currents have led to deviate from the original form of a sine wave. Non-linear loads linked to the distribution system has led to harmonic currents occur. Non-linear load current does not have the same waveform as the supply voltage will be withdrawn and the flow of harmonic currents through the voltage harmonic impedance has recognized that where the supply voltage has been distorted.

Table 2 1: Table of Voltage, Individual Harmonics and Total Harmonics Distortion

Bus voltage V at PCC*	Individual Harmonics (%)	Total Harmonics Distortion THD(%)
V ≤ 1.0kV	5.0	8.0
1kV ≤ V ≤ 69kV	3.0	5.0
69kV ≤ V ≤ 161kV	1.5	2.5
161kV < V	1.0	1.5[1]

[1] high-voltage systems can have up to 2.0% THD where the cause is an HVDC terminal whose effects will have attenuated at points in the network where future users may be connected.

*PCC is Point of Common Coupling. It is the location of the harmonics voltage and current distortion to be calculated or measured.

Table 2 2: Table of Current Distortion Limits at sTC

Current Distortion Limits at STC* (IEC 61727)	
Odd harmonics	Distortion limit
3rd through 9th	Less than 4.0%
11th through 15th	Less than 2.0%
17th through 21st	Less than 1.5%
23rd through 33rd	Less than 0.6%
Even harmonics	Distortion Limit
2nd through 8th	Less than 1.0%
10th through 32nd	Less than 0.5%
Current Distortion	Limit at STC*
Total Harmonics Distortion	Less than 5.0%

*STC – Standard Test Condition