# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## Study and improve of power efficiency in FTK laboratory by using full
## bridge inverter.

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

by

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# DECLARATION

I hereby, declared this report entitled “Study and improve of power efficiency in FTK laboratory by using full bridge inverter.” is the results of my own research except as cited in references.

| | | |
|---|---|---|
| Signature | : | …………………………………………. |
| Author’s Name | : | ………………………………………… |
| Date | : | ………………………………………… |



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# 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 Electronics Engineering Technology (Industrial Electronics) with Honours. The member of the supervisory is as follow:

……………………………….

Ir. Nik Azran Bin Ab. Hadi

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# ABSTRAK

Projek ini bertujuan adalah untuk mereka inverter dengan bantuan bateri sebagai bekalan kuasa tidak terganggu. Disebabkan kegunaan terhadap bekalan kuasa semakin meningkat pada masa kini, terdapat beberapa masalah kualiti kuasa atau isu yang akan menyebabkan masalah kepada peralatan elektrik. Peralatan elektrik mengalami akan kerosakan akibat daripada kesan isu kualiti kuasa tersebut dan menyebabkan lebih banyak penyelenggaraan dilakukan terhadap peralatan elektrik. Projek ini akan dijalankan untuk menyelesaikan masalah bekalan kuasa beberapa makmal Fakulti Teknologi Kejuteraan Universiti Teknikal Malaysia Melaka. Bekalan kuasa di makmal tersebut akan dianalisis dan pengumpulan data akan dibuat di makmal yang menghadapi masalah bekalan kuasa. Kajian terhadap masalah kualiti kuasa akan dibuat untuk memahami masalah dari bekalan kuasa makmal tersebut dan mencari jalan penyelesaian untuk menyelesaikan masalah ini. Simulasi litar inverter akan dibuat sebelum perkakasan inverter dibina. Selepas itu, analisis bekalan kuasa akan dibuat terhadap makmal masalah bekalan kuasa tersebut dengan bantuan inverter yang dibina. Data yang dikumpul akan dianalisis dan dibuat bandingkan dengan data yang dikumpul sebelum inverter digunakan.



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# ABSTRACT

This project aims is to design a full bridge inverter with the aid of backup battery as a uninterruptible power supply. Due to the reliability toward power supply is increasing nowadays, there are several power quality problem or issue that cause problem to the electrical equipment. Electrical equipment suffer from the damage from power quality issue effect and cause more maintenance to those equipment. The inverter from this project will build in order to solve the power supply problem of a few of laboratory Fakulti Teknologi Kejuteraan Universiti Teknikal Malaysia Melaka. Power supply analysis and data collection was made in the power supply problem laboratory. Studies about power quality problem were made in order to understand the problem from the power supply and find the solution to solve the issue. Simulation of inverter was made before the hardware of inverter was construct. Power supply analysis will be made towards the power supply problem laboratory with the aid of inverter design. Data collected was analyse and compare to the data collect before inverter was used.



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# DEDICATIONS

To my beloved parents,

All my lectures, especially my supervisor, Mr. Ir. Nik Azran Bin Ab. Hadi

All my friends and relatives.

Thousands of thanks and appreciates for their supports,

encouragements and understands.



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# LIST OF FORMULAS

Equation 1: $V,\ I_{rms} = \frac{V\ ,\ I_m}{\sqrt{2}}$

Equation 2: $VTHD = \frac{\sqrt{\sum_n Vrms\ value\ of\ harmonic_n^2}}{Vrms_1, fundamental\ signal}$

Equation 3: $Vrms = \frac{Vm}{\sqrt{2}}$

Equation 4: $K = \frac{I_m}{I_{rms}}\ OR\ \frac{V_m}{V_{rms}}$

Equation 5: $K = \frac{\sqrt{\sum_h (I_h^2 h^2)}}{\sqrt{\sum_h I_h^2}}$

Equation 6: $power(watt) = \frac{energy\ (\ joule\ )}{time\ (\ second\ )}$

Equation 7: $power(watt) = \frac{energy\ (\ watt\ hour\ )}{time\ (\ hour\ )}$

Equation 8: $Sinusoidal\ reactive\ power = V.I.sin\ \phi$

Equation 9: $\text{Non} - \text{sinusoidal reactive power} = \sum_h V_h\ I_h \sin\phi_h$

Equation 10: $\cos\emptyset = \frac{active\ power, P}{apparent\ power, S}$

Equation 11: $Apparent\ power, S = VI$

Equation 12: $I_L = \frac{p}{\sqrt{3}V_L \cos\phi}$

Equation 13: $f = \frac{1}{4.4RC}$



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# LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATUR

| | | |
|---|---|---|
| V | - | Voltage |
| Vrms | - | Voltage root mean square |
| Irms | - | Current root mean square |
| FTK | - | Faculty of Engineering Technology |
| AC | - | Alternating Current |
| DC | - | Direct Current |
| VDC | - | Voltage Direct Current |
| UPS | - | Uninterruptible Power Supply |
| Hz | - | Hertz |
| u | - | micro |
| F | - | Farad |
| AVR | - | Automatic Voltage Regulator |



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# CHAPTER 1
# INTRODUCTION

## 1.0 Introduction

Nowadays, human being are relied more on electrical appliance or equipment. Therefore, a clean and stable power supply are very important in order to make those electrical equipment work properly without failure. Power quality problems like voltage sags, swell, under voltage, over voltage, and spike are happened regularly. When reliability towards power became more, more electrical equipment is used. Thus, with those power quality issues, there are a lot of problem will be faced when we using our electrical equipment. Problems like damage to electrical equipment or data loss when sudden shut down of computer are the issues we may face. Then, we have to replace those equipment with new one or do some maintenance works. This will slow down our work life efficiency since many big factory will having temporary shutdown for maintenance and it may also cost a lot to buy new equipment. In order to make sure we have a stable power supplied to our equipment and get rid of the power quality issues, inverter, automatic voltage regulator, and rectifier are created. In my university life, there are several laboratories in FTK have been found out having an unstable power supply problem, it may cause inconvenience to students when there are having their lab session there. Thus, this project is going to have a test for the power supply stability without the voltage regulator in labs first. Then, the power supply also will be test by using the readily available voltage regulator and in those labs. After results are collect, an analysis will be made to both of the results to see whether there are any different when the voltage regulator in lab is use. Next, a full bridge inverter will be designed with smart Uninterruptible power supply (UPS) in order to solve those problems. The smart UPS design is to prevent any instant computer data lost when there a power failure at those labs. It may provide some times to save data first. A



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transformer less rectifier also will be designed to supply DC voltage to the inverter. But at the same time, the DC voltage produce will also be charge to a backup battery. The backup battery will act like a DC power supply to the inverter when the main power source is breakdown or failure. Then, the design inverter will also be tested in those laboratories. Data will be collected from the two tests and compare whether which one is more stable. Other than that, smart UPS also will be tested to determine how much time will it be able to supply power to the inverter and then to the appliance in the laboratory. A stabilizer also will be designed to stabilize and maintain the DC voltage from the rectifier at a desired value and then supply to the full bridge inverter and backup battery.

## 1.1 Problem Statement

1. There are several laboratories in FTK having electrical behavior problem or not function properly.
2. The sudden breakdown or failure of the electrical behavior had caused damage to electronic appliances.
3. The price of pure sine wave inverter in the market is too expensive.

## 1.2 Objective

1. To study the electrical behavior in FTK power supply problem laboratory.
2. To develop a full bridge inverter with backup battery that provides enough times for the computer to shut down properly after power supply failure.
3. To design and develop a low cost full bridge inverter.



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### 1.3 Scope of Work

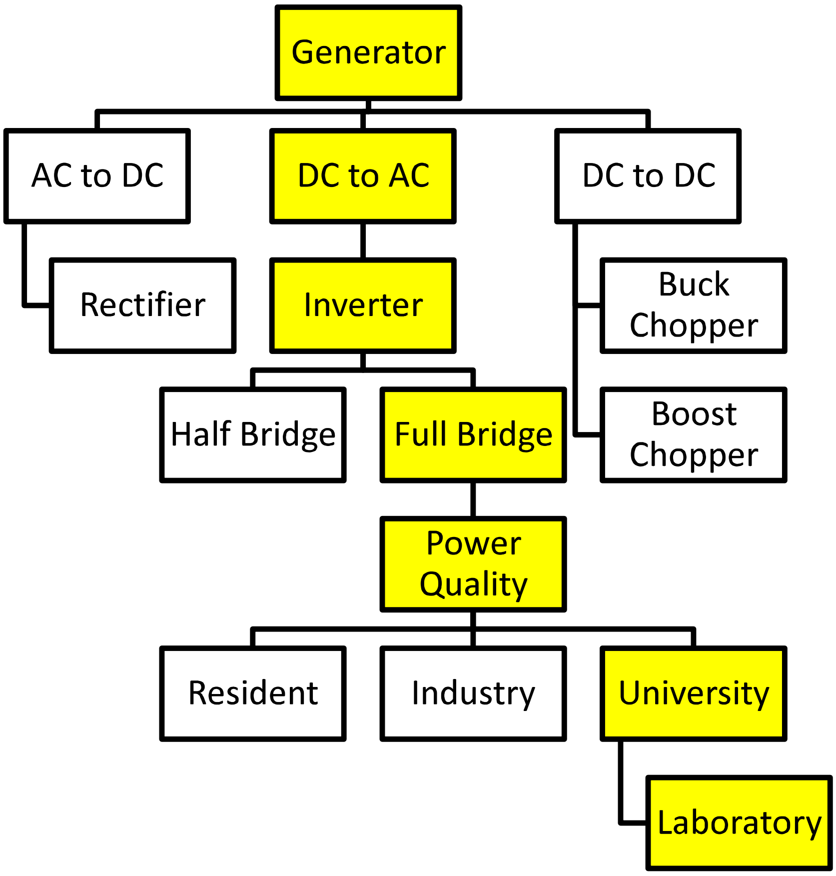


**Figure 1.1: K-Chart.**

This project will cover the design of transformerless rectifier and a full bridge inverter with backup battery. Then all the design will be run in PROTEUS and POWERSIM first for simulation. After completing the simulation and all the circuit work properly, printed circuit board will be created based on the completed simulation circuit and solder. The laboratory with power supply problem that mention by lab assistant will be tested with the device CA8220 Chauvin Arnoux Metrix. This device can detect the value of root mean square voltage/current, frequency, voltage/current crest factor, total harmonic distortion voltage/current, K-factor, power in Watt and etc. But this project will focus on the stability of the voltage. Finally the product will be tested in power supply problem laboratory in Faculty of Engineering Technology (FTK) for example like Microprocessor and



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microcontroller laboratory. The data will be collected from the main power supply of the lab, test the automatic voltage regulator (AVR) from the lab with adjustable AC power supply and also test the performance of the inverter build.



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# CHAPTER 2
## LITERATURE REVIEW

### 2.0 Introduction

In this chapter, literature review of inverter and power quality will be concerned more. With the knowledge of inverter and power quality issues, issues happened to the power supply will be known and a high efficiency inverter can be construct to solve the power quality issues in daily life.



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## 2.1 Power Quality

**Table 2.1: Power Quality Disturbance (IEEE. 1159-2009).**

| Category | Typical Spectral Client | Typical Duration | Typical Voltage Magnitude |
|---|---|---|---|
| 1. Transients | | | |
| 1.1 Impulsive transient | | | |
| 1.1.1 Nanosecond | 5 ns rise | < 50 ns | |
| 1.1.2 Microsecond | 1 us rise | 50 ns – 1 ms | |
| 1.1.3 Milisecond | 0.1 ms rise | >1 ms | |
| 1.2 Oscillatory Transient | | | |
| 1.2.1 Low Frequency | <5 kHz | 0.3 – 50 ms | 0 – 4 per unit |
| 1.2.2 Medium Frequency | 5 – 5000 kHz | 20 us | 0 – 8per unit |
| 1.2.3 High Frequency | 0.5 – 5 MHz | 58 us | 0 – 4 per unit |
| 2. Short Duration Variations | | | |
| 2.1 Instantaneous | | | |
| 2.1.1 Sag | | 0.5 – 30 cycles | 0.1– 0.9 per unit |
| 2.1.2 Swell | | 0.5 – 30 cycles | 1.1 – 1.8 per unit |
| 2.2 Momentary | | | |
| 2.2.1 Interruption | | 0.5 – 30 cycles | < 0.1 per unit |
| 2.2.2 Sag | | 30 cycles – 3 s | 0.1– 0.9 per unit |
| 2.2.3 Swell | | 30 cycles – 3 s | 1.1 – 1.4 per unit |
| 2.3 Temporary | | | |



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| | | | |
|---|---|---|---|
| 2.3.1 Interrupt | | 3 s – 1 min | < 0.1 per unit |
| 2.3.2 Sag | | 3 s – 1 min | 0.1– 0.9 per unit |
| 2.3.3 Swell | | 3 s – 1 min | 1.1 – 1.2 per unit |
| 3. Long Duration Variation | | | |
| 3.1 Sustained Interruption | | > 1 min | 0 per unit |
| 3.2 Under-voltage | | > 1 min | 0.8 – 0.9 per unit |
| 3.3 Overvoltage | | > 1 min | 1.1 – 1.2 per unit |
| 4. Voltage Imbalance | | Steady State | 0.5 – 2 % |
| 5. Waveform Distortion | | | |
| 5.1 DC offset | 0-100$^{th}$ harmonic | Steady state | 0 – 0.1 % |
| 5.2 Harmonics | 0 - 6 KHz | Steady state | 0 – 20 % |
| 5.3 Inter – harmonics | | Steady state | 0 – 2 % |
| 5.4 Notching | | Steady state | |
| 5.5 Noise | Broadband | Steady state | 0 – 1 % |
| 6. Voltage Fluctuations | < 25 Hz | Intermittent | 0.1 – 7 % |
| 7. Frequency Variation | | < 10 s | |

From the view of worldwide, there are having totally different view. Hence, the definitions about power quality also varies. For example, some may define power quality as the reliability. They may also show a statistic that their system is 99.98% reliable (R C Dugan. 2004). When a load equipment company define power quality, they will define that it is the quality of power supply that enable their product load equipment to function completely fine and efficiently (R C Dugan. 2004). There also some others people define power quality by the measure of quality of voltage and the quality of current (Ewald Fuchs，Mohammad A. S. Masoum. 2015). Therefore, there are also definitions state that the power quality is the



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happening of the power problem that involve the voltage, current and frequency that cause the load equipment to operate abnormal and failure in function (R C Dugan. 2004).

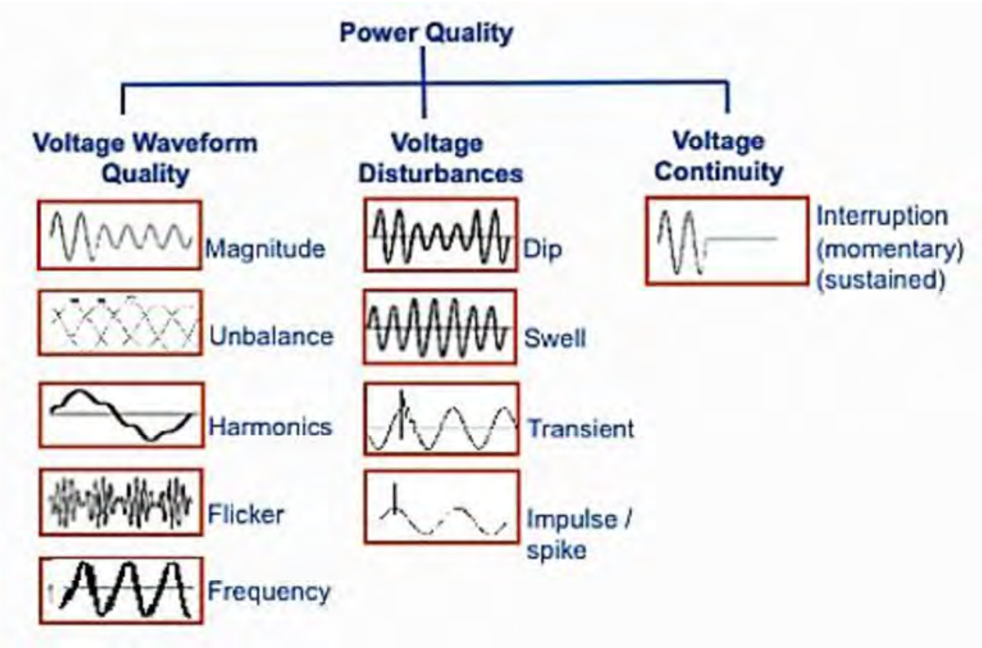


**Figure 2.1: Power Quality Problems and Issues.**



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