UNIVERSITI TEKNIKAL MALAYSIA MELAKA

AN INVESTIGATION OF POWER QUALITY ISSUE IN CAMPUS TECHNOLOGY, UTeM

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Industrial Power) with Honours.

by

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FACULTY OF ENGINEERING TECHNOLOGY

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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TAJUK: **An Investigation of Power Quality Issue in Campus Technology, UTeM.**

SESI PENGAJIAN: **2017/18 Semester 2**

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

……

(Project Supervisor: Muhammad Faizal bin Yaakub)

ABSTRAK

Isu kualiti kuasa adalah perkara yang sangat penting yang perlu disiasat dengan serius dalam sistem kuasa elektrik. Ini kerana kualiti tenaga yang baik memberikan bekalan elektrik stabil kepada pengguna dan juga menunjukkan tiada gangguan dalam sistem kuasa. Tujuan utama penyiasatan ini adalah untuk memantau dan mengesan jenis isu kualiti kuasa yang berlaku di *factory 2*, untuk mengenalpasti keadaan kualiti tenaga di dalam teknologi kampus dan untuk menghasilkan suatu pangkalan data yang berkaitan dengan kualiti kuasa di *factory 2*. Untuk menyelesaikan penyiasatan ini , pengumpulan data peranti elektrik di setiap makmal diambil terlebih dahulu. Setelah selesai pengumpulan data, *PW3198 Power Quality Analyzer* digunakan untuk mengesan dan memantau masalah kualiti kuasa yang berjalan di *factory 2*. Akhir sekali, pangkalan data yang berkaitan dengan kualiti tenaga dihasilkan sebagai rujukan pada masa akan datang. Berdasarkan penyiasatan, terdapat banyak makmal yang terdiri daripada alat peranti elektrik bukan linier yang boleh memberi gangguan pada sistem tenaga elektrik. Semua gangguan ini memberi kesan terhadap kualiti bekalan kuasa. Disamping itu, terdapat 5 pristivw yang dikesan semasa 2 minggu poses pemerhatian. Sebagai kesimpulan, kebanyakan masalah yang dikesan adalah disebabkan oleh peranti elektrik yang disambungkan ke bekalan kuasa.

ABSTRACT

Power quality issue is very improtant thing that should take seriusly investigation in electrical power system. This is because a good power quality give a stable of electrical supply to the consumer and also shows there is no disturbance in power system. The main propose of this investigation is to monitor and detect type of power quality issue running in factory 2, to identify the conditon of the power quality in campus technology and to poduce a database relating to the power quality in factory 2. To complete this investigation, firstly data collection of electrical device in each of laboratories are taken. After done the data collection, the Power Quality Analyzer PW3198 are used to detect and monitor the power quality problem running in factory 2. Lastly a database relating to the power quality are produce for as a refferences in future. Finding of the investigation, there are many laboratories are consists of non linear electrical devices that can give disturbance in electrical power system. All this disturbance give an effect of the quality of power supply. Besides that, there are 5 types of event are deteced during 2 weeks monitoring process. As a conclusion, most of the event detected are because of the electrical devices connected to the power supply.

DEDICATION

To my beloved parents

ACKNOWLEDGEMENT

I would like to express my appreciations for those who have help me to accomplish my project especially to my supervisor, Mr Muhammad Faizal bin Yaakub for guiding me through the whole process of this project.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

A	-	Ampere
CAD	-	computer aided design
DFRs	-	Digital Faults Recorder
FKM	-	Faculty of Mechanical Engineering
GPS	-	Global Positioning Satellite
JTKE	-	Department of Electrical Engineering Technology
JTKEK	-	Department of Electronic Computer Engineering Technology
JTKM	-	Department of Mechanical Engineering Technology
JTKP	-	Department of Manufacturing Engineering Technology
kA	-	kilo-Ampere
PQA	-	Power Quality Analyzer
RMS	-	root mean square
SLT	-	Slantlet Transform

SVM	-	Support Vector Machine
V	-	Voltage
W	-	Watt
Y	-	Star and Wye connection
Δ	-	Delta Connection

CHAPTER 1

INTRODUCTION

1.0 Introduction

In this chapter the report is covered some topics. There are the project background, problem statement, objective of this project, project scopes and conclusion of the chapter one.

1.1 Project Background

Nowadays, many technologies depend upon the application of power electronic in turn about power quality is use to make life easier. According to (Khalid and Dwivedi 2011)the increasing quantities of non-linear loads being added to electrical systems, it has become necessary to establish criteria for limiting problems from system voltage degradation. In automated industries and sensitive load centers, power quality has become a critical issue. The voltage quality is the most important part of the power quality for customers. Based on (Olikara, Management, and Rockwell n.d.) said the voltage disturbances is related to fluctuations in the electrical supply in the form of momentary interruptions, voltage sags or swells, transients, harmonic distortion, electrical noise, and flickering lights, among others can cause huge financial losses and damage the application or the protection device.

The “quality” of the power becomes more important as we connect more electronic devices to our power systems. Modern technology in non-linear loads usually creates disturbance in power quality. In the industrial sector, most of them use the electrical machine in their production system. Some of the electrical machines they use more power than other electrical machine which is also can make the disturbance in the power quality. “Quality” can be defined many ways. Based on Stable voltages and undistorted waveforms are two characteristics which are very desirable in power systems. Grounding affects voltage stability, and more importantly, is critical to personal safety. Referring to (Khalid and Dwivedi 2011)in the IEEE 100 Authoritative Dictionary of IEEE Standard Terms defined power quality is the concept of powering and grounding electronic equipment in a manner that is suitable to the operation of that equipment and compatible with the premise wiring system and other connected equipment Utilities may want to define power quality as reliability.

This project is about to investigate the condition of power quality running in factory 2 at Campus Technology, UTeM either the RMS voltage variation, the repetitive variation in RMS and the voltage drops or rises and analyzing the database for the power quality. By using the power quality analyzer, it will detect the condition of the power quality that is running in Factory 2. The analyzer will produce multiple data which will be tabulated to detect issues on power quality and then it will be compiled into a database for future references.

1.2 Problem Statement

Sensitive equipment and non-linear loads are now more commonplace in both the industrial commercial sectors and the domestic environment. If there is a problem with the power quality, it can produce problems upon consumers. All Power quality problems are related to grounding, ground bonds, and neutral to ground voltages, ground loops, ground current or other ground associated issues.

At Faculty of Engineering Technology’s some of the laboratories use machines or

electrical devices can affect the power quality. At times during laboratory sessions, the lights would be blinking and the supply in the factory would possibly trip unexpectedly. This situation can disturb the class session and make it difficult for the students when the lecturer is evaluating the students during lab test session. At some laboratories that have computers they are having problems for example the computers were shuted down or restarted unexpectedly. This would cause data that were collected to be lost.Based on a survey that has been done; there are machines in the laboratory that could not be used or fail to function properly after affected by power quality event.

In 2013, at Computer-aided Design (CAD) studio had changed all the equipment to new equipment which then creates more problems upon the power quality. The equipment made some 3-pin sockets burnt due to overflow current.

1.3 Project Objective

The objective of this project is:

1. To monitor and detect the types of power quality running in Factory 2.
2. To identify the condition power quality in Technology Campus.
3. To produce a database of electrical equipment that relating to the power quality in Factory 2.

1.4 Project Scope

This investigation is carried out in Factory 2 located at Faculty of Engineering Technology in factory 2. Factory 2 consists of laboratories that use the electrical supply for computers, electronic devices, motors, wiring bay and other high power consumption electrical devices. The main equipment used for this investigation is the Hioki Power Quality Analyzer.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter will focuses on the condition of three phase power system, the balance and unbalance condition of power system, definition of the power quality, types of power quality event, the factor of power quality and the importance of power quality. Power quality event occurs due to the kind of equipment that connected to the supply. This kind of information is obtained from journals, books, thesis and others from former studied.

2.1 Three Phase Electrical Power Systems

Three phase electrical power system is a common method for alternating current electric power generation, transmission and distribution. This three phase system is a polyphase system and most common used by electric grids worldwide to transfer power. The principle in three phase systems, there are three conductors that carrying same magnitude alternating current of frequency and voltage but with a different of one third the period. Because of these different phases, any conductor will reach the voltage peak at one third of a cycle after one of the other conductors and one third of a cycle before the remaining conductor. This phase delay gives constant power transfer to a balanced linear load. In a three-phase system feeding a balanced and linear load, the sum of the instantaneous currents of the three conductors is zero. In other words,

the current in each conductor is equal in magnitude to the sum of the currents in the other two, but with the opposite sign. The return path for the current in any phase conductor is the other two phase conductors.

Some of three phase system is build with fourth wire. The fourth wire is known as the neutral wire. These neutral wires are allowed the three separate single phases provide a constant voltage to the load. This system usually used in a building that has domestic properties which are single phase loads. The connection is designed as far as possible to supply equal power for each phase. In distribution system, the current usually well balanced. Three-phase supplies is very desirable in electric power distribution systems because the phase current are tend to cancel out one another in order to make a linear balanced load. This is because to reduce the size of the neutral conductor from carrying current. With the balanced load condition, all the three phase will carry the same amount of current.

At power station, transformers change the voltage from generators to a level suitable for transmission in order to minimize the losses. A transformer connection has two types which is delta (Δ) connection and wye or star (Y) connection. Figure 2.1 show the two types of transformer connections.

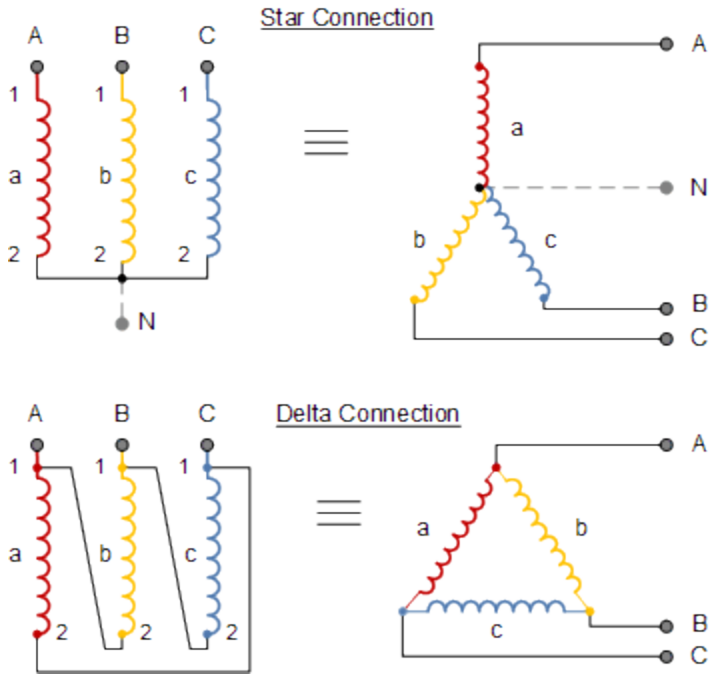

Figure 2.1: Star and Delta Connection

2.1.1 Balanced and Unbalanced Load

In balanced system each line system will carry same magnitude of voltage in equally phase angle spaced from each other. For example by using angle notation set the V_1 as reference and V_3 lagging V_2 lagging V_1 and V_{LN} is the voltage line to neutral phase will produce and equation as below:

$$V_1 = V_{LN}\angle 0^\circ,$$
$$V_2 = V_{LN}\angle -120^\circ,$$
$$V_3 = V_{LN}\angle +120^\circ.$$

In wye connection, the voltage is depending to the load connected from the power supply so to calculate the voltage in each phase will use this formula:

$$I_1 = \frac{V_1}{|Z_{\text{total}}|}\angle(-\theta),$$
$$I_2 = \frac{V_2}{|Z_{\text{total}}|}\angle(-120^\circ - \theta),$$
$$I_3 = \frac{V_3}{|Z_{\text{total}}|}\angle(120^\circ - \theta),$$

In Kirchhoff's Current Law, wye connection was satisfying the definition of the law which is at neutral node; the three phase current sum is equal to the current in neutral line.

$$I_1 + I_2 + I_3 = I_{\text{N}} = 0.$$

In delta connection, loads are connected to the line and each voltage line will depend on the two connected line. To calculate the voltage line-to-line voltage, the equation as below:

$$\begin{aligned}
V_{12} &= V_1 - V_2 = (V_{\text{LN}}\angle 0^\circ) - (V_{\text{LN}}\angle -120^\circ) \\
&= \sqrt{3}V_{\text{LN}}\angle 30^\circ = \sqrt{3}V_1\angle(\phi_{V_1} + 30^\circ), \\
V_{23} &= V_2 - V_3 = (V_{\text{LN}}\angle -120^\circ) - (V_{\text{LN}}\angle 120^\circ) \\
&= \sqrt{3}V_{\text{LN}}\angle -90^\circ = \sqrt{3}V_2\angle(\phi_{V_2} + 30^\circ), \\
V_{31} &= V_3 - V_1 = (V_{\text{LN}}\angle 120^\circ) - (V_{\text{LN}}\angle 0^\circ) \\
&= \sqrt{3}V_{\text{LN}}\angle 150^\circ = \sqrt{3}V_3\angle(\phi_{V_3} + 30^\circ).
\end{aligned}$$

Or

$$I_{12} = \frac{V_{12}}{|Z_\Delta|}\angle(30^\circ - \theta),$$
$$I_{23} = \frac{V_{23}}{|Z_\Delta|}\angle(-90^\circ - \theta),$$
$$I_{31} = \frac{V_{31}}{|Z_\Delta|}\angle(150^\circ - \theta),$$

Compared to the wye connection, to calculate line current in delta connection at each delta node gives:

$$\begin{aligned}
I_1 &= I_{12} - I_{31} = I_{12} - I_{12}\angle 120^\circ \\
&= \sqrt{3}I_{12}\angle(\phi_{I_{12}} - 30^\circ) = \sqrt{3}I_{12}\angle(-\theta)
\end{aligned}$$