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Design of a phase angle : power factor meter with
matching output for computer interface / Nur Hidayah
Shahudin.

**DESIGN OF A PHASE ANGLE/ POWER FACTOR METER WITH
MATCHING OUTPUT FOR COMPUTER INTERFACE**

NUR HIDAYAH BT SHAHUDIN

MAY 2006

“I hereby verify that I have read this report and I find it sufficient in terms of quality and scope to be awarded with the Bachelor’s Degree in Electrical Engineering (Industrial Power).”

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Date : 4/5/06

**DESIGN OF A PHASE ANGLE/ POWER FACTOR METER WITH MATCHING
OUTPUT FOR COMPUTER INTERFACE**

NUR HIDAYAH BINTI SHAHUDIN

**This Report Is Submitted In Partial Fulfillment of Requirements for The Bachelor's
Degree in Electrical Engineering (Industrial Power)**

**Fakulti Kejuruteraan Elektrik
Kolej Universiti Teknikal Kebangsaan Malaysia**

May 2006

“It is hereby declared that all materials in this thesis are the effort of my own work and materials which are not the effort of my own work have been clearly acknowledged.”

Signature :

Name : **NUR HIDAYAH BINTI SHAHUDIN**

Date :

**For my beloved parents, Jamilah Binti Tajuddin & Shahudin Bin Ton, and
dearest siblings Saiful Firdaus, Mohd Zulfiqar & Nurul Fathihah**

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ABSTRACT

A phase angle/ power factor meter with matching output for computer interface is proposed. Usually, a set of instruments composed by a voltmeter, an ammeter and a wattmeter, is used as the power factor (PF) standard system. The PF is then calculated from that value being, in a derived magnitude. Using the proposed phase angle meter, the phase angle can be read directly based on the measurement of the time signals between current and voltage zero crossing. The voltage and current are sampled from the main supply. The number of pulse between the current and voltage zero crossing, will go through a 3-digit up counter. The 7-segment digital read-out will display the phase angle.

ABSTRAK

Sebuah meter untuk mengira sudut/ faktor kuasa dan output bagi nilai sudut di keluarkan dalam bentuk 'computer interface' telah di cadangkan untuk dibina. Kebiasannya, peralatan pengujian seperti meter voltan, meter arus dan meter kuasa digunakan untuk mendapatkan bacaan bg faktor kuasa. Nilai yang diperolehi dikira menggunakan formula tertentu untuk mendapatkan faktor kuasa. Meter yang dicadangkan ini amat mudah diperolehi komponennya dan sesuai untuk tujuan pengajaran kepada pelajar-pelajar. 'Comparator' digunakan untuk membaca gelombang voltan dan gelombang arus. Gelombang voltan dan arus diambil sampel dari litar utama. Bilangan signal diantara arus dan voltan yang memintas nilai kosong, akan melalui '3-digit up counter'. '7-segment digital read-out' akan memaparkan bacaan bagi sudut fasa.

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CHAPTER 1

PROJECT INTRODUCTION

1.1 PROJECT INTRODUCTION

The impedance phase angle for any component is the phase shift between voltage across that component and current through that component. For a perfect resistor, the voltage drop and current are *always* in phase with each other, and so the impedance angle of a resistor is said to be 0° , it is can be seen in Figure 1.1. For a perfect inductor, voltage drop always leads current by 90° , and so an inductor's impedance phase angle is said to be $+90^\circ$, it is can be seen in Figure 1.2. For a perfect capacitor, voltage drop always lags current by 90° , and so a capacitor's impedance phase angle is said to be -90° , it is can be seen in Figure 1.3. It is mean phase angle is varies, and we have more procedures to get that value. My proposed project is to get that value in easy way. With only use the several components we can measure the value of phase angle.

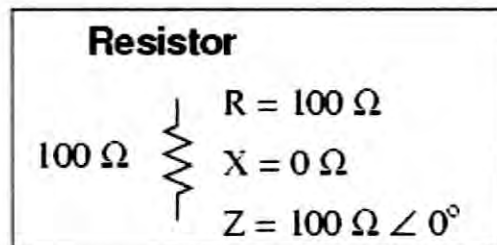


Figure 1.1: Impedance Angles of Resistor

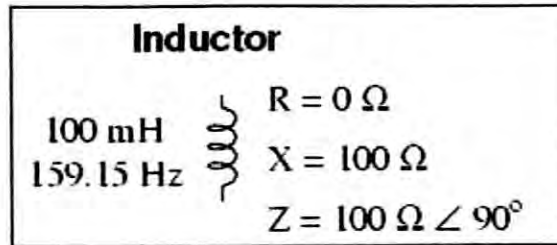


Figure 1.2: Impedance Angles of Inductor

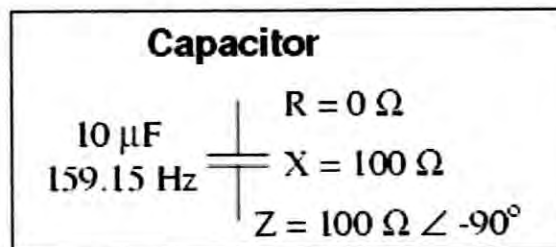


Figure 1.3: Impedance Angles of Capacitor

1.2 PROJECT OBJECTIVE

The main objectives of this project are:

- To design a phase angle/ power factor meter to measure phase angle directly without use voltmeter and ammeter;
- To get the output which will match for computer interface;
- To design a one part system in mini power system;

1.3 PROBLEM STATEMENT

Nowadays, more patent of phase angle meter were used. The phase angle meter in market is a complicated circuit and all ready to use. The phase angle meter that were design is to fulfill the procedures of a learning process in colleague or university. The designing is very simple, the component is easy to found and student can learning from the circuit. It is also the one part in of a bigger project in the mini power system.

1.4 PROJECT SCOPE

Designing of a phase angle/ power factor meter with will match the output for computer interface. This phase angle/ power factor meter is design for complete a one part of mini power system. This meter is use to measure phase angle directly without use voltmeter and ammeter. Student also can use this project in learning process because components in this project are easy to found. Beside that it is can improve my knowledge in electronic circuit.

1.5 PROJECT OVERVIEW

The first stage of the project, it was based on research for the data and information is obtained through internet, journal from IEEE and other sources.

The purpose of the study is to study phase angle, voltage, current, the operation of counter and digital 7-segment. To study how the circuit works, some research about the function of every component were doing.

After understand about the function, the component were implement on the strip board to test either it is running or not. More steps must be completed when doing this project.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

As electric utilities have grown in size and the number of interconnections has increased, planning for future expansion has become increasingly complex. The increasing cost of additions and modifications has made it imperative that utilities consider a range of design options, and perform detailed studies of the effects on the system of each option, based on a number of assumptions: normal and abnormal operating conditions, peak and off –peak loadings, and present and future years of operation. [1]

Phase angle meter is an important equipment to use in electric utilities. This project is to design phase angle meter which student also can use this project in learning process because components in this project are easy to found. Phase angle is calculated by finding the ratio of reactance divided by resistance, and taking the arctangent of that ratio. Phase angle is normally expressed in degrees. The phase angle meter is a valuable tool for verifying the proper installation of medium- and high-voltage primary metering equipment and sophisticated protective relays that receive input from Potential and Current Transformers. Phase angle meters are also used to verify the correct connection of three-phase transformer banks which must be paralleled with an existing electrical bus or high voltage line.

This equipment is also used for conducting electrical system load and power factor studies. The system power factor is equal to the cosine of the phase angle (expressed as a percent) that exists between the system voltage and current. Once the system power factor is determined, the system power triangle (true power in watts, apparent power in volt-amperes, and reactive power in vars) can be developed and analyzed. Phase angle measurement is also employed to analyze the operation of AC synchronous generators and synchronous motors to verify the proper operation of field regulators and synchronizing equipment.

Nowadays, we were use the modern phase angle meter as in Figure 2.1, but that is very complicated for student in learning process. In learning process, student must know briefly all about the circuit of the phase angle meter. A phase angle/ power factor meter with matching output for computer interface is proposed.



Figure 2.1: Phase Angle Meter

2.2 LITERATURE REVIEW

In doing this project, some research was done about the phase angle. Nowadays, there have more phase angle in market. Some research was get from internet such as:

Clarke-Hess Communication Research Corporation:

A four arm bridge has a single generator, and at least two arms are adjusted to produce the minimum output. With the Phase Standard, two outputs exist with an adjustable phase shift between them. This means that two arms are sufficient for the bridge. The bridge can be balanced by adjusting the relative amplitude of the two generators and the phase angle between them. If the two impedance arms of the bridge have identical phase angles, the bridge will balance when the phase angle between the two bridge inputs is exactly 180° , and each input amplitude divided by the magnitude of the impedance connected to its input has the same value. All of the bridges are designed and constructed so that the two impedances have identical phase angles over a broad range of frequencies.

Unlike the standard meter and the standard Volt, there is no standard Phase Angle at any of the national laboratories. Because of this, one has to rely on the properly constructed bridge set as an intrinsic standard to verify the proper performance of phase generating devices at an angle of 180°

Tony Thorne Applications Engineering Xantrex Technology Inc.

SW Series products are a flexible and versatile platform used in multiple applications. Access to the phase angle adjustment is required to properly correct the inverter's output voltage zero crossing and the utility voltage zero crossing point. The 'PWM phase angle adjustment' is located in a key-code protected, factory only tech menu. The PWM phase angle is set as default in firmware and is not accessible by the end user.

Special test equipment is typically used to measure phase shift and power factor when adjustments are needed to solve a local issue. The PWM setting is only used by qualified technicians under the supervision of Xantrex technology.

2.3 SUMMARY OF CHAPTER 2

The conclusion of this chapter is that the proposed phase angle meter is very flexible compared to the phase angle meter that has been in market. This phase angle meter is very useful to be used in learning process since the circuit created is very simple. Besides that student can understand more about this meter and the components of this meter are easy to found. The next chapter will discuss about the working planning that is used to complete this project.

CHAPTER 3

WORKING PLANNING

3.1 INTRODUCTION

This chapter is discussed more about the procedures that will be used to complete this project such as project methodology, methodology selection justification, component/equipment requirement and some testing that was be done to troubleshoot this project. The testing was being done to make sure the circuit that was created is running. It is also to avoid any mistaken when putting the component at the strip board. More difficulties were facing when using the electronics component and by understand the components will be avoiding any mistaken.

3.2 METHODOLOGY SELECTION JUSTIFICATION

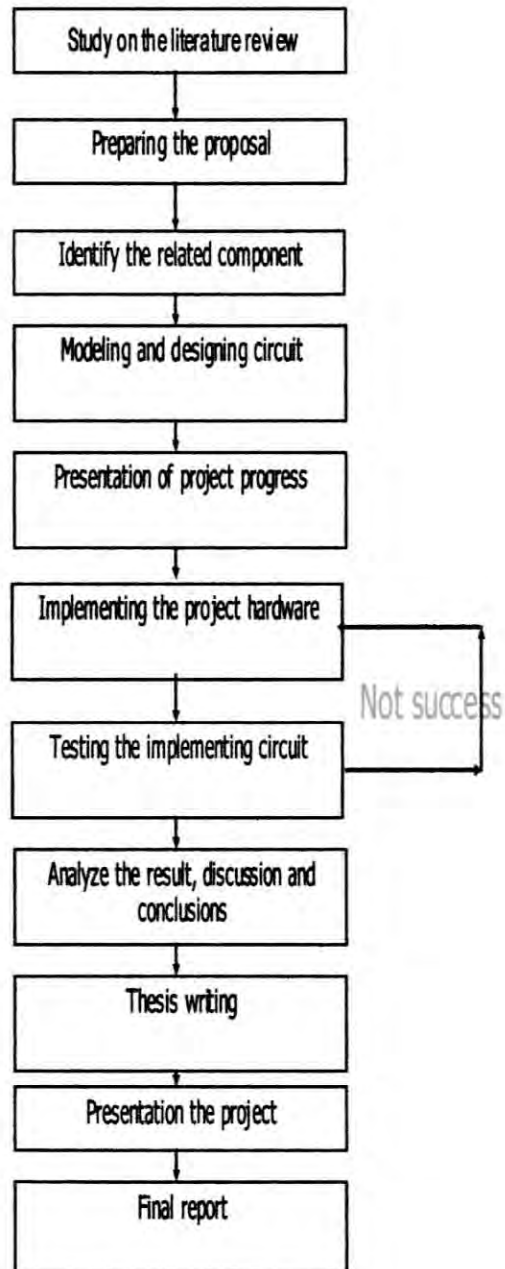


Figure 3.1: Flow Chart

The Flow Chart in Figure 3.1 shown the methodology selection justification were done to make this project completed. This step was started on the first semester in fourth year. The first step is study the literature review about phase angle and phase angle meter. Understanding about the phase angle is the major thing in this project. Then, to starting this project, proposal was being done and then will be approved by supervisor (Prof Madya Md. Noah Bin Jamal). After that, with helping from supervisor the circuit was being modeling and designing. Then the related component was been defined to implement this circuit.

After get several component that are needed, the circuit were implemented. Then, every connection at the circuit must be checking the continuity. There have two parts in this project. Every part has some stage to be done and must be test to make sure the circuit is running. If both of this part success, the result will be analyzed, and then making discussion and conclusions. If not success, the troubleshoot must be done and the circuit will implement again. In the same time, thesis is in progress.

3.3 COMPONENT/ EQUIPMENT REQUIREMENT

From this time, there are instruments that measure phase angle/ power factor directly. Based on the measurement of the phase angle between current and voltage, through the signal enter the comparator. Then, the output of the comparator will go to a 3- digit up counter circuit and the phase angle will display at the 7-segment display.

The component mentioned below is those related component are using for every main part in this project.