



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF GRID FREQUENCY AND ANALYSE THE DATA IN REAL TIME

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

by

MOHAMAD SAFWAN BIN MD SAZALI

B071210080

910329-01-5105

FACULTY OF ENGINEERING TECHNOLOGY

2015

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: DEVELOPMENT OF GRID FREQUENCY AND ANALYSE THE DATA IN REAL TIME

SESI PENGAJIAN: **2015/16 Semester 1**

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DECLARATION

I hereby, declared this report entitled “Development of Grid Frequency and Analyse the Data in Real Time” is the results of my own research except as cited in references.

Signature :.....

Name : **MOHAMAD SAFWAN BIN MD SAZALI**

Date : **9.12.2011**

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) (Hons.). The member of the supervisory is as follow.

.....
(Mohd Firdaus Bin Mohd Ab Halim)
(Supervisor)

ABSTRAK

Projek ini bertujuan untuk membangunkan alat peranti mengukur frekuensi dan memantau frekuensi dari utility. Utiliti di Malaysia telah menetapkan bekalan frekuensi yang berukuran 50Hz, tetapi ianya tidak stabil dan mempunyai toleransi. Peranti yang direka ini membolehkan pengguna mengukur nilai frekuensi dengan lebih tepat dan dijangka mencapai resolusi 0.005Hz. Peranti ini boleh digunakan di rumah dengan menyambungkannya pada soket alir keluar. Pengguna juga boleh membaca frekuensi setiap saat dan boleh melihat sejauh mana kestabilan frekuensi yang dibekalkan utiliti. Kajian ini akan menunjukkan cara-cara menggunakan dan cara-cara untuk mereka bentuk peranti ini. Segala data dan kajian yang diukur daripada soket alir keluar direkodkan di dalam laporan ini. Akhirnya data dianalisis. Objektif kedua projek akan selesai setelah analisis data dilaksanakan. Analisis yang dibuat akan menentukan kestabilan bekalan frekuensi. Alat peranti pengukuran menggunakan arduino sebagai microcontroller untuk mengukur frekuensi. Analisis data diterbitkan dalam masa nyata melengkapkan objektif projek ini. Peranti ini juga murah berbanding alat peranti lain di pasaran.

ABSTRACT

Purpose for this project is to develop frequency measurement device and test the device at our country, utility supplies 50Hz frequency but it has some tolerance and it is not stable. This project consists of the developing a precise in frequency measurement device and that can achieve up to 0.5Hz resolution. The frequency measurement device can be implemented and tested on a wall socket outlet. The devices can also read the frequency every second and the user can see the stability of the grid frequency. This project will demonstrate the method used to develop frequency measurement device. This related data is recorded and collected from wall socket outlet. Finally the data is analyzed. The second objectives of the project were fulfilled once the analysis data was done. The analysis done can determine the stability the grid frequency. The frequency measurement device used arduino as the microcontroller to measure the frequency. The analysis data is publish in real time to complete the objective of this project. The device also cheap compare to other device in the market.

DEDICATIONS

I dedicate my dissertation work to my family and all my friends. A special gratitude to my loving parents, Md Sazali and Pn. Zaidah whose give me endless love of encouragement and supports. To my sibling, Sofea and Saiful whose never always accompany me all time.

I also dedicate this dissertation to my special friends, the classmates of BETI, the 2nd Cohort FTK for helping me through the process of completing this project. I will always appreciate all the help, especially Fazrin Salleh for helping me develop my software and hardware skills, Ryzwan for the many words of support, and PSM BETI Gang for helping me to master Arduino.

Thank you for everything. May Allah bless all their effort.

ACKNOWLEDGMENTS

Thank to Allah for giving me the opportunity in completing this report "Projek Sarjana Muda I" with success after went through the obstacle patiently. I would like to thank to my supervisor Mr Mohd Firdaus Bin Mohd Ab Halim, for guiding me in completing this project and report. Many thing he has taught while i was making mistake. Thank to all lecturer and technician that have giving me a guidance and share thier experiance throughtout this project.

To my mother, Zaidah bte Mohktar, a special thank to her for giving me the opportunity to study here.

Finally i would like to thanks to all my beloved friend that always spend some time help me finish this project. Thank for everything. May ALLAH bless all of you.

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LIST OF SYMBOLS AND ABBREVIATIONS

TNB	=	Tenaga Nasional Berhad
Ω	=	ohm
f	=	frequency

CHAPTER 1

INTRODUCTION

1.0 Introduction

This chapter will cover the objective of this project, introduction and problem statement. From that, the conclusion will be determined based on the problem. Objectives and scope are very important towards this project because it will give guidance throughout whole the process.

1.1 Background

Grid frequency that supply by TNB (Tenaga Nasional Berhad) in Malaysia is 50Hz. But in reality the grid frequency sometimes shifted slightly, it will increase or declining a little from 50Hz. The stability of the frequency is an indicator of the quality of electricity. In develop of energy source, this resource must to integrated efficiently and cost effectively with existing infrastructure of the power grid. Amount of electricity generated by power plant usually equal to the amount of the energy that is taken from the grid by the consumer. If power demand increase higher from power that supplied by generator, it will effect to the grid frequency and it will cause the frequency to fluctuate.

1.2 Problem statement

Usually meter that we use to measure frequency will bring the result in 1 decimal place usually we can get 50Hz. We don't know if the value really accurate with the grid. Actually, frequencies that supply from utility have tolerance and it not accurate with 50Hz. Everyone know that meter that use to measure frequency very expensive in global market, not many people can buy it.

1.3 Objective

There are 4 main objectives for this project.

1. To develop frequency measurement device with high accuracy.
2. To collect and monitor the frequency data from power outlet.
3. To analyse the grid frequency stability.
4. To relate frequency data with real time clock.

1.4 Scope

The scope will focus on developing measurement frequency device. All data collected are from 13A socket outlet at home and shown in arduino IDE.

Equipment

1. Arduino.
2. Adaptor AC/AC, Laptop.

Observation

1. Frequency.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter will discuss about information, principle, and theories about frequency. Other researchers also will discuss in this chapter.

2.1 Frequency analysis

Frequency is the rate of repetition of the cyclic or periodic event. In physics, we can observe periodicity in rotations, oscillation and waves. For analogue or digital waveform, we can invert the signal period to obtain the frequency. The smaller the period, the higher the frequency will produce. The standard unit of frequency is hertz, and the unit symbol is Hz.

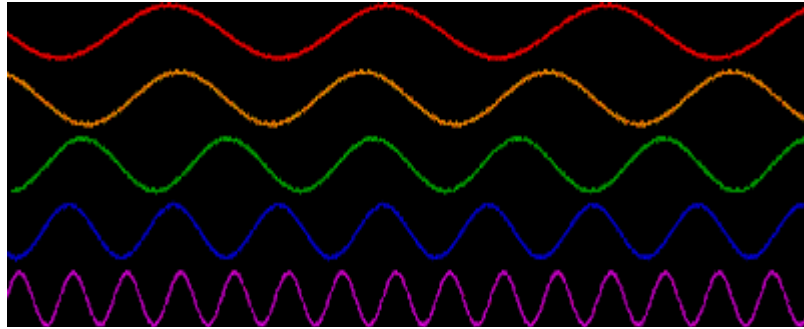


Figure 2.1: Waveform with frequency increasing from top to bottom.

Figure 2.1 above show the top waveform having lowest frequency and the bottom waveform show the highest frequency. Periodic analog signal in real application are complex and can rarely represent by simple sinusoid. Fourier analysis is used to decompose any complex waveform into some of simple function, either sines and cosine or complex exponentials.

(Source: <http://www.ni.com/tutorial/7111/en/> 15.5.2015).

2.2 Time period

Time period is the duration of one cycle of a repeating event. The SI unit is in second and the symbol used is T.

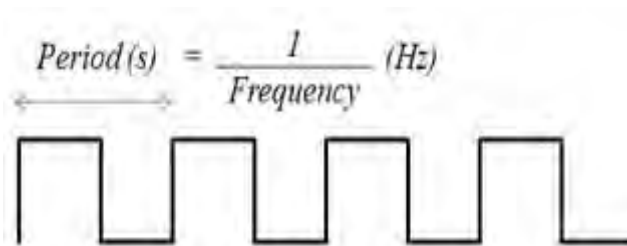


Figure 2.2: Digital waveform.

Figure 2.2 above show simple digital signal, the period is simply the time between rising edges, or even falling edges. If the time between rising or falling edges fluctuating, we need more cycle or period to determine the real frequency.

2.3 Measuring frequency method

Some frequency measurement will use the zero crossing detectors. It happened when 2 consecutive zero crossovers were detected. The timer will start when it detect the first crossover. When the adjacent zero crossovers were reached, the timer will stop and the time will record. The time will repeat process. The time recorded can be sure to be the half the time period of the signal.

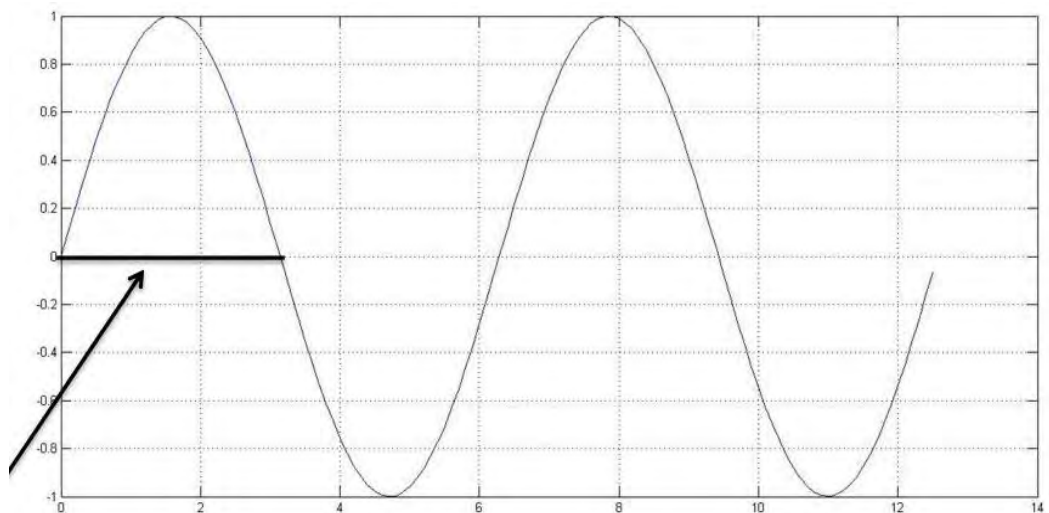


Figure 2.3: Example sinusoidal wave with zero crossovers detected.

From figure 2.3 we can see a sinusoidal wave with zero crossovers detected just in half time period. Frequency can be determine when complete 1 cycle period but with the zero crossovers the frequency also can be calculate with multiply T with 2 and the formula for calculating the frequency will be,

$$f = \left(\frac{1}{2 * T}\right).$$

2.4 Thesis about previous project

2.4.1 Design of Virtual Power Frequency Meter Based on IEC 61000-4-30 Power Quality Standard.

This thesis present the design of power frequency meter based on IEC 61000-4-30 standard using virtual instrument approach. The virtual power frequency meter hardware consists of a zero crossing detection circuitry and a low cost USB data acquisition card. The proposed virtual power frequency meter design utilizes the zero crossing detection circuitry and the counter unit of the data acquisition card to count the number of zero crosses produces by the power system sinusoidal waveform (Rodney H.G. Tan, S. K. Wong, T. C. Wong. 2013). This project using computer system clock to keep track the total number of zero crosses counted in every 10 second interval to computes the power frequency which can achieve up to 0.05Hz resolution. The system overview of the proposed virtual frequency meter is shown in figure 2.4.

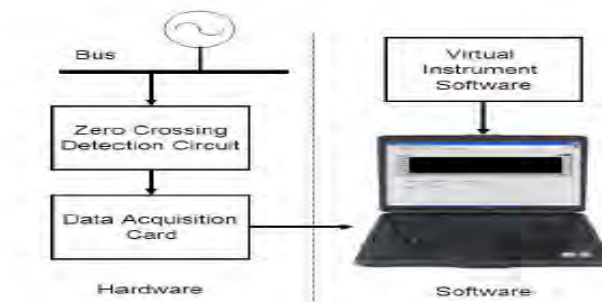


Figure 2.4:Proposed virtual frequency meter system overview.

- Zero crossing detector.

There is many zero crossing detection method for 50/60 Hz. The component of zero crossing circuit consist 5 diodes, 2 resistors, a capacitor and a transistor. For the circuit use in this project for zero crossing detection as shown in figure 2.5 consist of a step down transformer, a bridge rectifier, a blocking diode, a capacitor, two resistor and bipolar transistor.

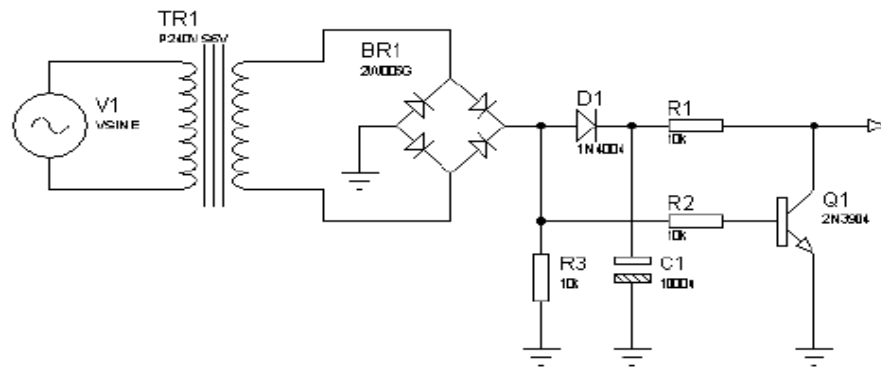


Figure 2.5: zero crossing detection circuit.

- Data Acquisition Card

The data acquisition card was selected by this project to interface with the zero crossing detectors to computer. The proposed frequency meter utilizes only the counter of the data acquisition card to keep track the number of zero crosses within a given time interval. (Rodney H.G. Tan,2013)

- Virtual instrument software development.

This project using LabView platform to developed the virtual power frequency platform. LabVIEW is a graphical programming platform and allows the measurement method to easily implemented by connecting functional block together as shown in figure above.

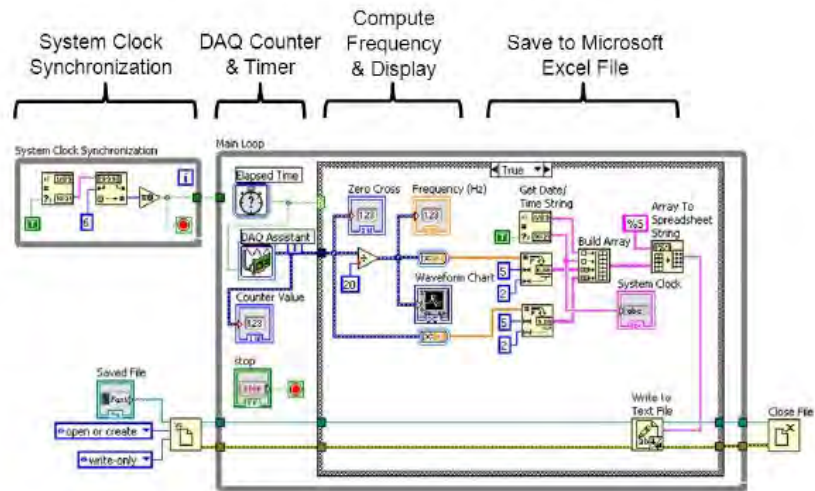


Figure 2.6: LabVIEW block diagram virtual power frequency meter.

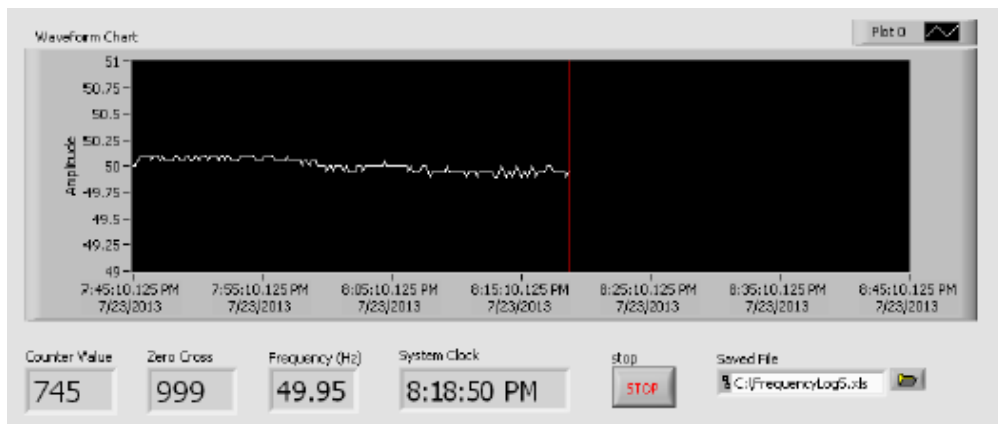


Figure 2.7: User interface of the proposed virtual power frequency meter.

Figure 2.7 show the virtual power frequency meter. The virtual power frequency meter consists of a trend chart counter value, zero crossing, frequency, system clock indicators, stop button and text field for user to key in save filename. The trend chart plots the one hour measurement window.

2.4.2 A New Method for Measuring Power System Frequency

This thesis describes a new method of calculating frequency using sample data. The proposed algorithm has been implemented in many numerical relays to obtain the actual value of the line frequency during operation (Dr. Tevfik Sezi,1999). The new frequency calculation algorithm present by this thesis is precise and the simulation test and field experience have shown a high accuracy of approximately 10mHz.

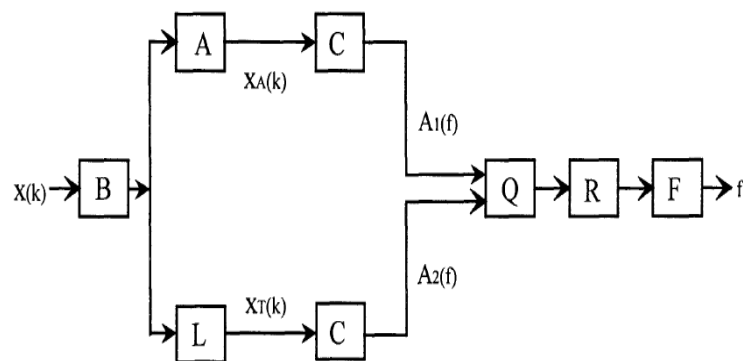


Figure 2.8: Block diagram of the frequency measurement.

Figure 2.8 shows the block diagram stages of the frequency measurement. The sampled data $X(k)$ is first filters by a bandpass-filter. The bandpass filter is a two-cycle FIR fourier filter with triangle windowing. The other filters will connected to the output of bandpass filter. One of them is (A) is an all pass-filter, this filter will change the phase angle, but not amplitude of sinusoidal signal. The other filter (L) is a low pass filter. This filter will change the amplitude of the signal, while changing the phase angle of the signal in exactly same way as the A-filter.