POWER PARAMETERS MONITORING SYSTEM

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Bachelor of Electrical Engineering
(Industrial Power) with Honours

May 2014

“I hereby declare that I have read through this report entitle “Power Parameters Monitoring System” and found that it has comply the partial fulfilment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)”

Signature : …….

Supervisor’s Name : Dr. Abdul Rahim Bin Abdullah

Date : …….

POWER PARAMETERS MONITORING SYSTEM

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A report submitted in partial fulfilment of the requirements for the degree of Bachelor of Electrical Engineering (Industrial Power)

Faculty of Electrical Engineering
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2014

"I declare that this report entitle "Power Parameters Monitoring System" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree".

Signature	:	…….
Name	:	Siti Syahirah Binti Abdul Mutalib
Date	:	…….

To my beloved mother and father...

ACKNOWLEDGEMENT

In the name of Allah, Most Gracious, Most Merciful. Peace and blessings be upon Prophet Muhammad, son of Abdullah Muhammad, the holy family and his companions selected.

First of all, I am grateful, with His blessings and grace, giving me a strength and spirits to fulfil and completing this project. This project could not be accomplished without a help from my family, colleagues, lecturers and most of all, my supervisor. I would like to take this opportunity to express my gratitude to some of them.

Millions thanks and appreciation goes to my supervisor, Dr. Abdul Rahim Bin Abdullah, for his continuous encouragement and guidance. His generosity of providing unlimited knowledge is very much helpful towards completing this project. Without his support, this project might be incompletely successful.

Also, credit of appreciation goes towards all my lecturers of Faculty Electrical Engineering for their knowledge shared, to all technicians and staffs contributing in this project.

Finally, to my dear mother and father, sisters and brothers for their endless support, prayers and loves. The inspiration and motivation given are invaluable and unforgettable. To all my friends and those indirectly contributed in this research, thank you.

ABSTRACT

The growth of renewable energy as an alternative source of power supply nowadays has been widely discovered and used. In fact, most consumers tend to install one of the renewable energy that is known as solar photovoltaic. This solar PV is installed in their houses and also industrial sectors since government had introduced and providing the subsidy funding via Feed-in-Tariff (FiT). The solar photovoltaic has a feature that the energy stored by solar supply into the battery is decreasing at anytime. Therefore, a monitoring system need to be developed in order to measure power consumption based on the type of source currently in use, either main grid utility or solar supply. In this project, a system for monitoring the performance of green energy is developed with an appropriate measurement of power line. The information and data collected are obtained by monitoring parameters including voltage, current, frequency, active power, reactive power, apparent power and the power factor. The entire system is designed with the implementation of data acquisition (DAQ card), personal computer (PC) as well as the utilization of Visual Basic 2010. Visual Basic 2010 is used to display the data via graphical user interface (GUI) development. The user-friendly software is developed in terms of managing and controlling the system via interface designed. A laboratory testing is conducted to determine system performance after the combination of software and hardware prior practically applied. At the end of this project, the monitoring system are used and applied especially in residences and industrial sector in order to enable the measurement on performance of solar energy.

ABSTRAK

Pembangunan tenaga boleh diperbaharui sebagai sumber alternatif bekalan kuasa pada masa kini telah ditemui dan digunakan secara meluas. Malah, kebanyakan pengguna telah mulai cenderung untuk memasang salah satu tenaga boleh diperbaharui dikenali sebagai solar photovoltaic (PV). Solar PV ini dipasang di kediaman dan juga sektor-sektor industri setelah kerajaan memperkenal dan menyediakan pembiayaan subsidi melalui 'Feed-in-tariff' (FiT). Solar PV mempunyai cirri iaitu tenaga yang disimpan daripada tenaga solar ke dalam bateri akan berkurangan pada bila-bila masa. Oleh demikian itu, satu sistem pemantauan perlu dibangunkan untuk mengukur penggunaan kuasa berdasarkan jenis bekalan kuasa yang sedang digunakan pada ketika itu, sama ada bekalan kuasa utama (TNB) ataupun bekalan kuasa solar. Dalam projek ini, satu sistem untuk memantau prestasi tenaga hijau telah dibangunkan dengan pengukuran yang sesuai untuk parameter talian kuasa. Maklumat dan data yang dikumpul diperolehi dengan memantau parameter-parameter termasuk voltan, arus, frekuensi, kuasa aktif, kuasa reaktif, kuasa ketara dan juga faktor kuasa. Sistem keseluruhan telah direka dengan pelaksanaan perolehan data (kad DAQ), komputer peribadi (PC) serta penggunaan Visual Basic 2010. Visual Basic 2010 digunakan untuk memaparkan data-data melalui pembangunan antara muka pengguna grafik (GUI). Perisian mesra pengguna dari segi menyusun dan mengawal sistem dibuat melalui antara muka. Pengujian makmal dijalankan bagi menentukan prestasi sistem selepas gabungan perisian dan juga perkakasan sebelum digunakan secara praktikal. Di akhir projek ini, sistem pemantauan ini akan digunakan dan diaplikasikan terutamanya di kediaman dan juga sektor industri untuk membolehkan pengukuran terhadap prestasi tenaga solar.

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INTRODUCTION

1.1 Research Background

Electricity supply nowadays is not strictly focused on the main grid utility. In fact, the electrical sector handling the power supply has discovered various types of energy sources that could contribute as alternative electricity supply known as Green Energy (G.E). It is known so as its characteristics of the energy are free of environmental pollution and also a non-harmful energy that would not give any bad impact of its surroundings. Green energy holds the facts that it is different compared with current generated energy used nowadays that mostly fossil fuel generated electricity including coal, oil and so on**.**

With the facts that these source of energy may soon be run out, it cause that these energy becoming more expensive. Researchers around the world started their finding of alternative energy sources including Malaysian government. A few types of energy were selected as this country's alternative energy including solar photovoltaic (PV). Solar photovoltaic energy is one of the most abundant resources, widely distributed, renewable and does not pollute the environment [1].

Malaysian government had encouraged the renewable energy usage including solar photovoltaic installation. This is done by giving out an incentive known as Feed-in-Tariff (FiT) depending on amount of power consume per month. The development of renewable energy in this country is been made by the government with involvement from Sustainable Energy Development Authority Malaysia, SEDA as an Advisor in all matters relating to sustainable energy [2]. However, the green energy are depending on their ability of storing as much

energy as they may run out at any particular time and other factors that cause them of having an optimum capacity of energy being stored. Since solar energy depends on the expected time dependence of solar radiation availability and other factor, it causes the solar PV having an optimum capacity of the energy storage [3]. Once the electrical energy produced by solar PV become lower due to the reaching of their maximum point, electrical energy from power line will take over the electricity supply. The public are already aware of the advantages of applying GE in their daily lives and they had started to have an expert to consult and installing solar PV at their residences and in industry as well.

A monitoring system of this solar PV is needed and compulsory to provide information of solar PV and also main grid utility's performance. It would give adequate information to consumers to let them acknowledge an amount they could save by using solar PV. Hence, this project had been developed to measure and monitor the power line parameters including voltage and current that also lead to a measurement of power (Watt), apparent power (VA), reactive power (Var), power factor (pf), frequency (Hz) as well as the power consumption (kWh) in both solar PV and utility grid power line.

The significant of all parameters stated to be monitored is to facilitate consumers with easy and self-monitored power consumption. According to SEDA [2], the average time of solar photovoltaic generation is 3.5 hours per day depending on the weather condition. Hence, with this monitoring system, consumers will be able to identify their total power consumption daily instead of monthly referring to the electricity bills. This will also help them in predicting their total saving in terms of electricity usage.

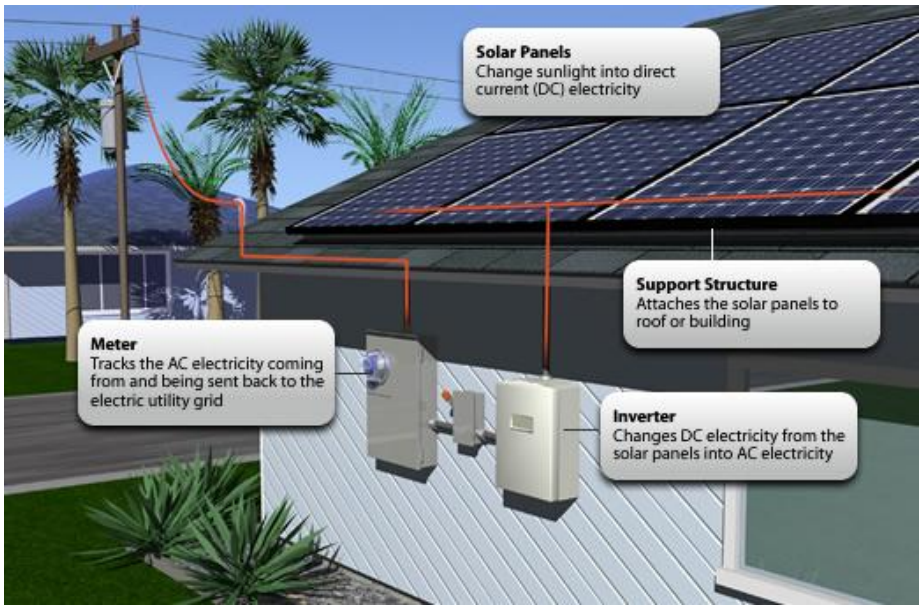

Figure 1.1 : Solar photovoltaic installed on the rooftop

1.2 Problem Statements

The use of solar energy in terms of renewable energy has been emphasized in most of the country. The output of photovoltaic (PV) solar systems varies instantaneously with changes in radiation [4]. Stand alone solar photovoltaic as known as off-grid solar system store the energy by using batteries. The energy stored or currently supplied to the consumers would decrease as the unavailable of the sun and the energy stored might run out at any time. Previous up to present days, people used to monitor and record the signal captured from solar power line manually by using digital multimeter and record the reading. This would cause an error and inaccurate reading taken and the data analyze using waveforms is inappropriate.

Furthermore, the equipments used in obtaining the data are not well-monitored and have inappropriate data storage. A lot of studies found that monitoring system in solar energy is essential to improve the performance of energy supplied. However, these researcher's findings mostly focuses on large scale solar power plant [5]. Solar photovoltaic installations in recent days are highly demanded by consumers. Hence, there will be two power supply sources in

their residences that are solar energy and main grid power line. Unfortunately, the power consume in real time per month will not be constant as a change in the weather including environmental affect [1]. Thus, the idea of this monitoring system is developed so that consumers could self-monitor power line parameters in order to determine their power consumption in both power supplies accordingly.

1.3 Objectives of the project

There are several objectives that need to be achieved in order to achieve the aim of this project:

i. To develop a monitoring system that can measure power line parameters from solar photovoltaic (PV) supply as well as main grid utility (TNB) power line.
ii. To design user-friendly graphical user interface (GUI) with Visual Basic 2010 application.
iii. To verify the performance of the monitoring measurement in terms of accuracy.

1.4 Scopes of the project

This project is developed by utilizing NI USB 6009 DAQ Card and also Visual Basic 2010 program. The scope of this project consists of:

1. This system is built by using Microsoft Visual Basic 2010 software and data acquisition card, NI USB 6009 (DAQ Card).
2. This system can measure and monitor power line parameters including voltage (rms and average), current (rms and average), frequency, active power, reactive power, apparent power, power consumption and also power factor of solar and main grid power line as well.

3. Voltage and current signals are measured between 0 to 500 V (rms) and 0 to 300 A (rms) for single phase power line.

The data measured are then will be recorded and stored in the computer.

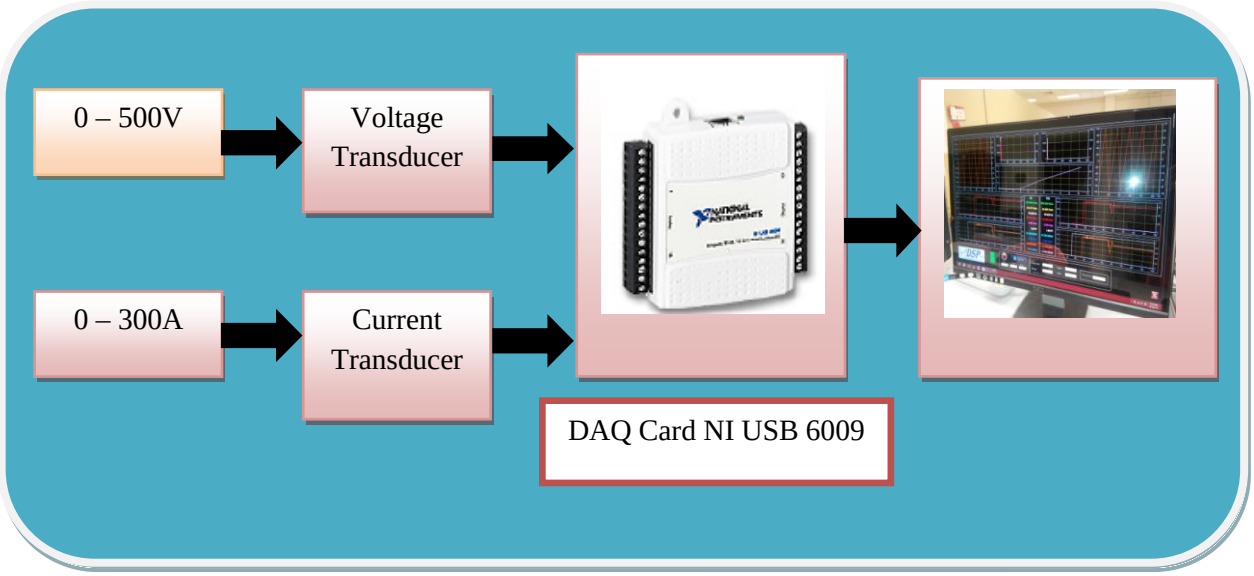

Figure 1.2 : System Block Diagram

1.5 Thesis Outline

Chapter 2 : Literature Review

In this chapter, the content is aiming in reviewing the idea and also the understanding about solar monitoring system. Previous researches relating to monitoring system also studied and summarized. Also, the equipments involved are discussed.

Chapter 3 : Methodology

In chapter 3 which is methodology, several approaches and procedures are discussed. It is including the development process step, flowchart of overall project as well as software and hardware development. Many aspects are taken into account in order to achieve the objectives and completing this project successfully.

Chapter 4 : Result, Analysis and Discussion

The analyzed results and performance data verification of this project are discussed in this chapter. The program is built and written by using Visual Basic 2010 and simulated. It is then interfaced by DAQ Card, NI USB 6009 to be linked with the hardware part. Prior conducting test with hardware part, the system is simulated in the computer. After that, the testing on system functional and system performance analysis are carried out.

Chapter 5 : Conclusion and Recommendation

In this chapter, the whole project are summarized and concluded together including several considerations and recommendations for future development. Basically, the objectives of this project are achieved. This project will help user by providing them with information of monitored data in a simple and attractive system designed.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

This chapter will cover on the previous research finding of power parameters monitoring systems used to monitor signal parameters from solar energy mainly in photovoltaic (PV) solar. There are several methods that researcher's had developed to be applied in monitoring the signals. As in this project, the Visual Basic 2010 version is applied to display the monitored data. The use of data acquisition is also necessary in order to process a measurement of electrical parameters that are voltage, current, frequency, active power, reactive power, apparent power as well as the power factor. The type of data acquisition (DAQ card) used to feed the data into the PC also will be discussed further in this chapter.

2.2 Researches on Monitoring Systems

The performance parameters of distributed solar panels has been measured and monitored by applying Wireless Sensors Network as in article [5]. The system is designed by the authors using the wireless sensor network together with automated data logging computed in the laboratory. The system built by understanding the characteristics of particular panel under various light conditions to determined the performance of panel or an array of the panels. This is accomplished by tracing the I-V characteristics under certain conditions. It is also stated that to provide maximum power produce, the maximum power point of the

solar panel has to be found. This research is conducted by applying wireless network by taking ZigBee communication as a medium of sending and receiving data monitored.

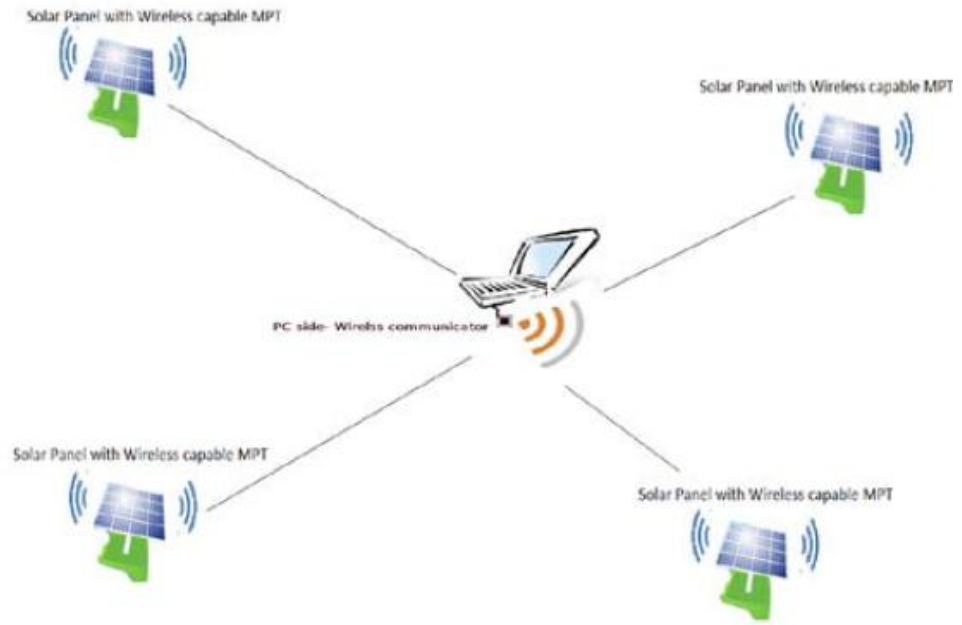

Figure 2.1 : Wireless monitoring on solar panel performance concept.[5]

The monitoring system has also being developed for standalone photovoltaic solar with monitoring parameters including average battery's temperature, voltage and current [6]. These parameters are fed to the PC with DAQ as an interface. The system is developed in order to quantify the potential for performance improvement purpose in standalone photovoltaic (PV) solar systems by creating the prototype of the systems. To create a standalone photovoltaic (PV) system to be tested and simulated, the integration of personal computer, data acquisition, a battery array and also solar array simulator (SAS) are involved. In addition, LabVIEW software is utilized as a programming of the inter-instrument communication which creating the graphical user interface (GUI) for data acquisition (DAQ) as well as the solar array simulator (SAS). The experimental set-up for this research as shown in Figure 2.2 below with combination of instruments involved.

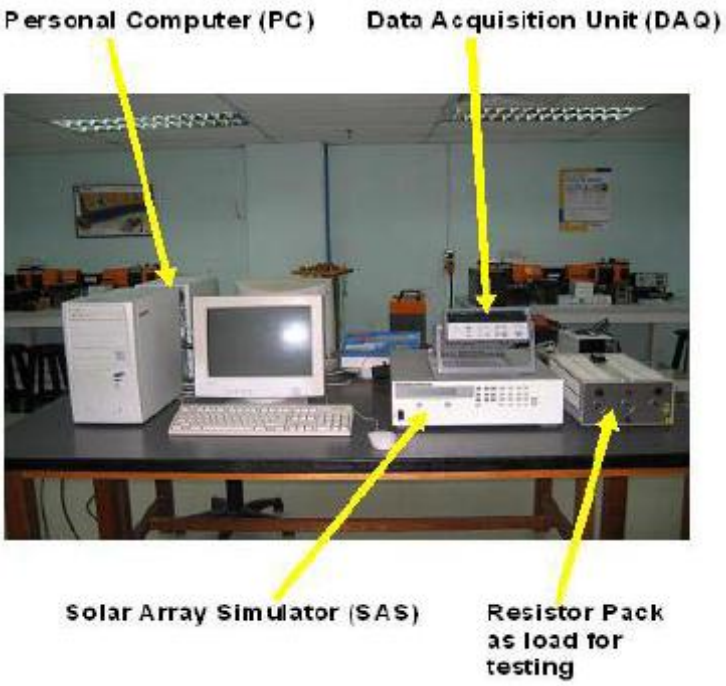

Figure 2.2 : Experimental Set-Up for Standalone PV.[6]

On the other hand, a wireless Zigbee microcontroller has been applied to determine the performance monitoring systems for solar photovoltaic (PV). Previous research has found that under non-ideal conditions, there are degradation of performance in Maximum Power Point Trackers (MPPT) and also the output power decreasing significantly. This will led to monitoring and detection system of non-ideal conditions in PV modules. The system developed by applying Zigbee-enable microcontroller with back end embedded programming and front end graphical user interface (GUI) providing remote monitoring of an array PV modules real-time parameters that are voltage, current as well as the power. Other than developing systems for monitoring purpose, this system also allow fault detection as well [7]. This development can be represented as in block diagram shown in Figure 2.3 below.

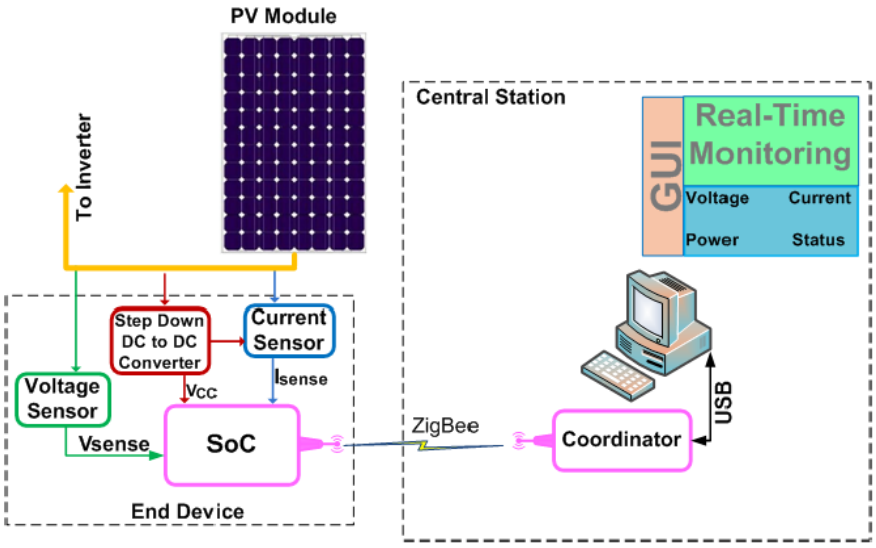

Figure 2.3 : Photovoltaic module performance monitoring system block diagram. [7]

A monitoring PV power stations by novel approach as developed in article written by E.M Natsheh, E.J Blackhurs and A.Albarbar. The monitoring system is been conducted by calculating the difference in residual between estimated model and actual measured parameters so that the system degradation early determination is enables. Derivation of the models has been accomplished with Matlab/Simulink software implementation. A dialog box also designed to enable the user input of PV system parameters respectively. The performance development of this monitoring system achieved via examination and validation under various operating condition and faults including dust, shadow and so on. Furthermore, the simulation and analysis of the results has been completed under environmental parameters of temperature and irradiance [8].