POWER MONITORING SYSTEM

MUHAMMAD SYAFIQ BIN RAHMAT

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To my beloved family and fellowship friend

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ABSTRACT

The purpose or objective of this project is to develop a hardware system that accurately measure and tell us how much power or energy that an electronic device consumes. Usually, the amount of power or energy of electricity that have been used in a day or a week or a month does not accumulate. Therefore, to solve and overcome this problem a hardware system has been developed and it calls “Power Monitoring System”. This project has been separate into four main parts. The first is the component identification for the entire main and other component that will use in this project and then design and constructs all the circuits that use in this project. Then, the PIC was programming for the signal processes and data displaying. For the final part is to create the software interface for displaying the data in PC. Actually, this hardware system is look alike a digital multimeter but the different are the hardware system can display the value of power, voltage and current in AC and RMS value. It is also can display the value for the total in a day or a week or a month with the button function. This hardware system can also transfer the data by using the flash memory or flash drive. The data will display then in the PC in the LabVIEW software. The software is just the interface for displaying the data in analog signal in power and voltage value.

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ABSTRAK

Tujuan atau objektif projek adalah untuk menghasilkan satu sistem perkakasan yang dapat mengukur dan memberitahu berapa jumlah sebenar kuasa atau tenaga yang digunakan oleh sesuatu alat elektronik. Pada kebiasaannya, bilangan atau jumlah kuasa atau tenaga elektrik yang telah kita gunakan dalam masa sehari atau seminggu atau sebulan tidak dapat dihimpunkan. Justeru itu untuk menyelesaikan masalah ini, sebuah sistem perkakasan yang dinamakan "Power Monitoring System" telah dihasilkan. Projek ini telah dibahagikan kepada empat bahagian utama. Pertama, semua komponen utama dan komponen-komponen yang berkaitan yang digunakan dalam projek ini di kenal pasti dan seterusnya ialah mereka dan menghasilkan kesemua litar yang digunakan dalam projek ini. Selepas itu, PIC diprogramkan untuk memproses isyarat dan memaparkan data dalam bentuk digital. Untuk bahagian terakhir dalam proses penghasilan system perkakasan ini adalah bahagian menghasilkan antaramuka dalam perisian LabVIEW untuk memaparkan data-data dalam komputer. Sistem perkakasan ini seakan serupa dengan multimeter tetapi yang membezakannya adalah sistem perkakasan ini mampu memaparkan nilai kuasa, voltan dan arus dalam nilai AC dan RMS. Selain itu, sistem ini dapat memaparkan jumlah kuasa atau tenaga yang digunakan dalam masa sehari atau seminggu atau sebulan dengan bantuan fungsi butang. Sistem ini dapat menghantar data kepada komputer dengan menggunakan "flash drive" atau "flash memory". Data-data akan dipaparkan pada komputer di dalam perisian LabVIEW. Perisian tersebut adalah sekadar antaramuka untuk memaparkan data dalam bentuk isyarat analog dalam nilai voltan dan kuasa.

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CHAPTER 1

INTRODUCTION

The electricity power or energy usage has become uncontrolled even though the energy prices have increased and become a larger influence on the balance sheet, many people do not take advantage of opportunities to better manage these expenses. This project consist a system that senses voltage and current and converts it from analog to digital signal to display at the LCD display and store the data.

1.7 Project Introduction

Power or energy of electricity is the one of the important element that used in our day life. It used for the electric and electronic device to be function. Basically, this project of power monitoring system is a system based on the PIC microcontroller that can accurately tell us how much power each the device consumes. This is a method to know how much the power consumes for each device. With this information we can take advantages to manage the power consumption efficiently and understand the energy usage. The power monitoring system would be able to provide accurate measurements as well as display the data on a LCD panel, store it in a flash memory and transfer the data using flash drive to a computer.

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1.8 Project Objective

The main objectives of producing this project are including developing a system of power monitoring based on PIC controller that to process the signal from analog to digital signal so that it can be display on LCD in digital value. Besides that, it can recall the data and transfer it by using flash drive and then monitor all the data in PC by using LabVIEW software.

1.9 Problem Statement

Currently, to measure a power for any device, we use a Multimeter or any meter to measure and determine how much power the device consumes to operate. This situation sometimes leads to the human error and not accurate measurement. In order to overcome this problem, this project was being develop to provide an accurately measurement where it can tell how much the power actually each device consumes. This system converts the analog signal that consumes by the device connect to it into digital signal so that it can display the digital value on the LCD display. There is no other device system or method that capable to provide an accurately measurement, thus this project is proposed to clear the problem about the device power consumption.

1.10 Scope of Work

Make the research about the project with find and gathering all the information and requirements needed to accomplish this project. Basically, the information is about the circuit, how to calculate the signal for sampled in the A/D converter, the programming, and all the related information from the internet, journals, books and thesis.

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Then the next step of project development will be proceeding based on the project methodology such as circuit designing and constructing, programming and other related method process.

This project has been separated into four main parts. The first part is to identify the internal and external hardware that will use such as voltage sensor, current sensor, LCD, and USB port. The voltage and current sensor use to detect the input supply and compare with the op-amp before process in the Microcontroller Unit (MCU). In this project the PIC16F877A use to process the signal by controls all the operations such as the A/D conversion of input signal, calculation, until the measurement is completed and control the output. The measurement will appear on the LCD.

The second part is to design the circuits that include the voltage sensor, current sensor, the amplifiers, and the Microcontroller Unit. The voltage and current sensor actually is use to sense and step down the input supply to a value that want to use in the circuit. The amplifier is use as a summer to introduce a DC offset in the voltage swing as it compare so that it has no negative value before be sampling by the Microcontroller Unit. Then Microcontroller Unit will sampling the analog signal that send from the amplifier to convert it from analog to digital signal using ADC that is on – chip in the microcontroller.

The third part is to program the microcontroller to process all the signal and data so that it can be monitors and display the power of the any electronic device consumes. The microcontroller will receive a signal from the amplifier and convert it to digital signal so that the value can be display on the LCD. When the voltage signal is compare and converts to digital signal from the amplifier and Microcontroller, the actual power value that consumes by the electronic device will be display on the LCD and save in the external memory. So at this point the measurement value can be obtained. All the process controlled by PIC and the measurement is now finished.

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For the last part is the transferring data to the PC using flash memory. From the PC the data will be display in the LabVIEW software in the waveform.

Basically, this project combined the hardware and programming to control the input and the output so, there are some software that use for the simulation such as MultiSim 2001 for Amplifier and voltage regulator simulation, Proteus 7 and PIC C Compiler to program the PIC and the LabVIEW software for the interface to display the data in waveform.

1.11 Project Methodology

In this part, there are several methods that identified to finish the project. First is the literature reviewing that to identify all the components and the function of the component. The component that identify and used are Microcontroller Unit, PC board, push button, switch, LCD, voltage and current transformer, amplifier (op-amp), 0V to 5V Voltage regulator, resistors, capacitors, LED, and USB port.

Then, hardware design to a portable device, unique, small and decrease the production cost. PIC programmed to control the hardware and combined circuit to display the result on the LCD. The code separate into two parts that are for measurement of comparator and AD converting and the other one is for the displaying the data. The circuit, hardware and program should integrate and testing to analyze the error occurs. This part is very important to know the malfunction of the circuit and PIC programmed.

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1.12 Outline of Thesis

This thesis consists of five chapters that including the Introduction, Literature Review, Methodology, Result and Discussion, and Conclusion and Recommendation. The first chapter discusses about the introduction of the project, the main objective, problem statement, scope of the project and the methodology that use to complete the project. Then, in the Chapter 2 will discuss more on theory and literature reviews that have been done. This part also consists of voltage comparator, the measurement method and calculation that will use and the others components that use to design this project included hardware and software.

In Chapter 3, the discussion will be on the methodology that how the hardware and software be implemented. The result and discussion that show the result of project and problem occur in the process will be discussed and presented in Chapter 4. In the Chapter 5, the conclusion and recommendation of this project and the future work and progress that can be done will be discussed.

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In order to execute this project, literature review must be done to comprehend the whole system and decide the best inputs, outputs and devices. This chapter will discuss about the components; including hardware and software that are being used to develop this project. The testing and analysis of the components and circuits concerning about the advantage and disadvantage for equipment and part manuals include information such as dimension, operation and specification.

2.2 Sensor

Sensor actually use to detect or sense movement, light, temperature, rain, and many others related to sensor [6]. In this project, the sensor is used to sense the AC current flowing to the load. Therefore, to sense the AC current, the voltage and current transformer circuit used in this project to make the signal can be sampled by the A/D converter so that can be display at the LCD display [10].

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2.2.1 Voltage Transformer Circuit

This circuit will be placed in parallel from the load with the current transformer circuit. In this circuit there are two main components:

a) Voltage Transformer (TX2):

Voltage transformer (F1X-60) transfer energy from one circuit to another circuit by magnetic coupling. The magnetic flux produced in the primary coil is coupled to the secondary coil. This produces a voltage in the secondary coil proportional to the voltage in the primary coil. We need a voltage transformer to step down the line voltage from 120Vrms to 2.5Vrms which can be sampled by an A/D [10].

b) OP-AMP (LM358):

Before sampling, we use an Op-Amp (LM358) as a summer to introduce a DC offset in the voltage swing so that it has no negative values [10].

2.2.2 Current Transformer Circuit

The AC 1010 current transformer used to sense the AC current flowing to the load. The current transformer work exactly like a voltage transformer but the difference is that they function with respect to current ratios rather than voltage ratios. Since the input power is equal to the output power just like a regular transformer, I found that the current ratios are inverses of the voltage ratios. Eventually, to produce a voltage at the output so that it can be sampled by an A/D, so the secondary coil of current transformer was being terminated with an appropriate burden resistor (R1) to convert the current information to voltage [11].

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2.3 LM358 Amplifier

Actually, the exactly op-amp for this project cannot be found and doesn't have in Malaysia electronic shops. So, the LM358 is the compatible amplifier that can replace the initial op-amp HA-5154.

Before sampling, the LM358 is use as a summer to introduce a DC offset in the voltage swing so that it has no negative values as the function of an Op Amp (HA-5154) [10].

The op-amp LM358 is the LM158 series that consists of two independent, high gains, internally frequency compensated operational amplifiers which were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage. Application areas include transducer amplifiers, dc gain blocks and all the conventional op amp circuits which now can be more easily implemented in single power supply system [8].
For example, the LM358 can be directly operated off of the standard +5V power supply voltage which is used in digital systems and will easily provide the required interface electronics without requiring the additional ±15V power supplies [8].

2.3.1 Unique Characteristics

The LM358 have unique characteristic that compatible with the op-amp HA-5154. The unique characteristics of LM358 are shown as in the Table 2.1 and these characteristics are shown that what actually make the LM358 is very special and what its function, frequency and input.

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Table 2.1: The unique characteristics of LM358

1	In the linear mode the input common-mode voltage range includes ground and the output voltage can also swing to ground, even though operated from only a single power supply voltage.
2	The unity gain cross frequency is temperature compensated.
3	The input bias current is also temperature compensated.

2.3.2 Advantages

LM358 have many of advantages that make it special and suitable to replace the initial op-amp. The advantages of LM358 are it has two of internally compensated op amps; it can eliminates the need for dual supplies; it allows direct sensing near GND and VOUT also goes to GND; it compatible with all forms of logic; and it has the power drain suitable for battery operation [8].

2.3.3 Features

The LM358 has the features that what shows what it has and what it can support and the features are being shown in the Table 2.2. For example, the LM358 is available in 8-Bump micro SMD chip sized package that show it size is smaller.

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Table 2.2: The features of LM358

a)	Available in 8-Bump micro SMD chip sized package, (See AN-1112)
b)	Internally frequency compensated for unity gain
c)	Large dc voltage gain: 100 dB
d)	Wide bandwidth (unity gain): 1 MHz (temperature compensated)
e)	Wide power supply range: — Single supply: 3V to 32V — Dual supplies: ±1.5V to ±16V
f)	Very low supply current drain (500 μA)—essentially independent of supply voltage
g)	Low input offset voltage: 2 mV
h)	Input common-mode voltage range includes ground
i)	Differential input voltage range equal to the power supply voltage
j)	Large output voltage swing

2.3.4 Other about LM358

The pad location and connection diagram of op-amp LM358 is the location for the pin number of the LM358. This location guide where to connect the entire pin and the pad location shown in the Table 2.3 and Figure 2.1. For example, the pin number 4 and number 8 is for the ground connection and input voltage connection.

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Table 2.3: The Pad location

Pad N	Pad Name	Coordinates, mkm	
		X	Y
1	#1 OUT	85	625
2	#1 IN-	182	88
3	#1 IN+	518	88
4	GND	845	88
5	#2 IN+	1045	88
6	#2 IN-	1381	88
7	#2 OUT	1478	625
8	V_{CC}	909	720

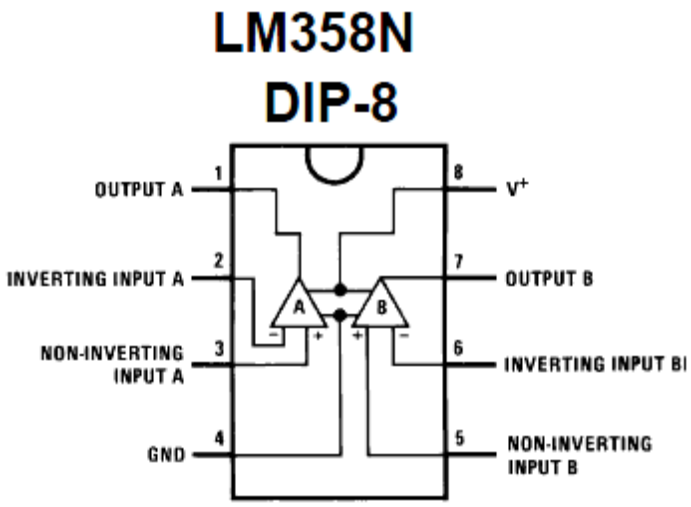

Figure 2.1: The connection diagram

LM358 has many of function that makes it special, suitable and compatible for using in the circuit to replace the HA-5154. One of the functions that suitable and compatible with the HA-5154 is the comparator function that use for compare the voltage and current signal before sampling it through the PIC microcontroller and it been shown in the Figure 2.2.

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