Proc. Annual Symposium on Research & Industrial Training, 02(2015) 159-164
Department of Electronics – Wayamba University of Sri Lanka

SMART ELECTRICAL METER

D.M.E.P.B. Dassanayaka*, L.D.R.D. Perera

Department of Electronics, Wayamba University of Sri Lanka, Kuliyapitiya, Sri Lanka
*eranga102013@gmail.com**

ABSTRACT

The measurement of electricity usage in all aspects is a very important factor due to the high cost of electricity bills. At the end of a month, each traditional analog meter and prepare the electricity bill after reading the meter.The main problem is until the bill is received customers cannot see their monthly usage and cost of electricity. The requirement has arisen since the power wastage is getting higher in this modern society which has been identified as a main problem in all nations. Therefore identifying the unit consumptions will facilitate house owners to manage and reduce their monthly electricity usage and the bill. Smart electrical meter is a flexible, cost effective and durable electricity consumption meter. In this work phase current transformer sensing technology was used to detect and monitor a magnetic field around our household electricity power cable. It measures the usage of current in amperes. The phase wire of the current line was attached to the sensor and read all the values to a microcontroller.The calculation of the amount of power usage was done by reference to the system voltage and the current. Those values were displayed in a LCD screen attached to the microcontroller. The microcontroller was programmed to display the total current being used and monthly electricity bill.Smart electricity meter is a very useful application for electricity users since it will notify the user daily electricity usage and the cost by short message services (SMSs) with the aim of reducing the overall electricity usage of the nation.

Keywords: Electricity usage, Smart electricity meter, Microcontroller, Current sensor

1. INTRODUCTION

The main purpose of this project is to find solutions for an existing higher electricity consumption problem to obtain better outcome. The objective of the project is to design a "low cost electrical meter" which will satisfy customer requirements by identifying the electricity consumption and the monthly bill[1]. House owners can reduce the bill by switching off unnecessary lamps and electrical appliances in the house.

The primary objective of this project was to develop a product to provide a solution to reduce the wastage of electricity by observing how much power is consumed. The intended objectives, which expected to be achieved on the completion of the project, are to make a unit to measure the usage of electricity in day today life.

The residences, business or electrical power uses need to measure their electrical energy consumption by using an electrical meter. Electricity meters are typically calibrated in billing units, the most common one being the kilowatt hour. Periodic readings of electrical meters establish billing cycles and energy used during a cycle. Most of them are analog electricity meters. But in this project is expected to develop digital electrical meter which replaces typical analog electrical meter to monitor the consumption of electricity in a house.

Low cost "Smart Electrical Meter" helps house owners to view their monthly bill on their own. So it will motivate house owners to consume low electricity and thereby reduce their monthly electricity bill which will limit the unnecessary electricity usage.

This unit can be used to demonstrate the functionality of a real system. The deliverables can be fulfilled after the finishing the project. Following functions are delivered throughout the project.

1. The system is designed to display the values on LCD screen.
2. Display the usage of current and voltage.
3. The mains voltage is almost constant and therefore system is designed to display the usage of power.
4. To display the number of units consumed.
5. By using some calculations how much is bill being updated.
6. Daily usage is informed to the house owner by sending a SMS.
7. The device can control (ON / OFF) using the house owner's mobile phone.

2. EXPERIMENTAL

The Smart Meter measures both the current and voltage of the test circuit. Two types of sensors are used in this project in order to measure the voltage and current.They are the voltage sensor and the current sensor. Then this voltage travels across bridge rectifier which does AC to DC conversion. The system overview is shown in figure01.

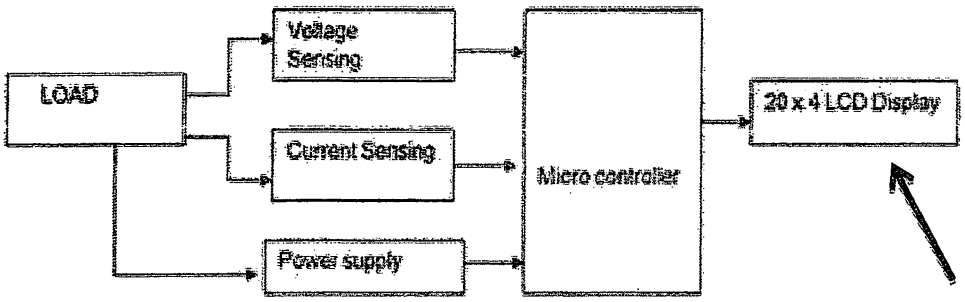

Figure 1: System overview

The output signal then adjust to 0-5V voltage level by using variable resistor, this provides an interface into the microprocessor. Current in the same way down to 5A by using current transformer and adjusted to 0-5V level, and it make an interface into the microcontroller.
In the interface both current and voltage signals are input into two channels of the on-board 13-bit ADC. Digital data for the input ports is used to calculate the power factor, which is calculated by the designed firmware. Results obtained again used to calculate the number of power units 1 unit = 1kWh. Here some calibration needs to be done. Using number of units rupee value of energy consumed is calculated. At last 20x4 LCD display connect to the microcontroller to display the number of units and the rupee value of the consumed energy.

3. RESULTS AND DISCUSSION

Hardware and software testing of the system were done separately. Hardware testing was done by simulating the circuit design in the Proteus software. Proteus Ares was used to develop the printed circuit board (PCB) layout of the system. Chemical etching process using $FeCl_3$ can be employed to etch the PCB design. The regulator output was 5V and it was fed to the microcontroller. In the bridge circuit capacitor is used to smooth the AC (alternative current) signal it is also observed with an oscilloscope.Simple program was written with C compiler and run and identified whether the LCD is working. And the program required for

the project was written in C language. ATMEGA328P microcontroller[2] basically controls the functionalities of the system. TC35 module[3] can be used to control systems through short message services (SMSs). ACS712[4] current sensor and LM2596 voltage sensor[5] can be used for the systems to measure current and voltage measurements respectively since these two sensors have adequate accuracy for cost effective systems. Finally real time testing was done and the output was observed on the LCD screen. Block diagram of the circuit of the system is shown in figure 02 below.

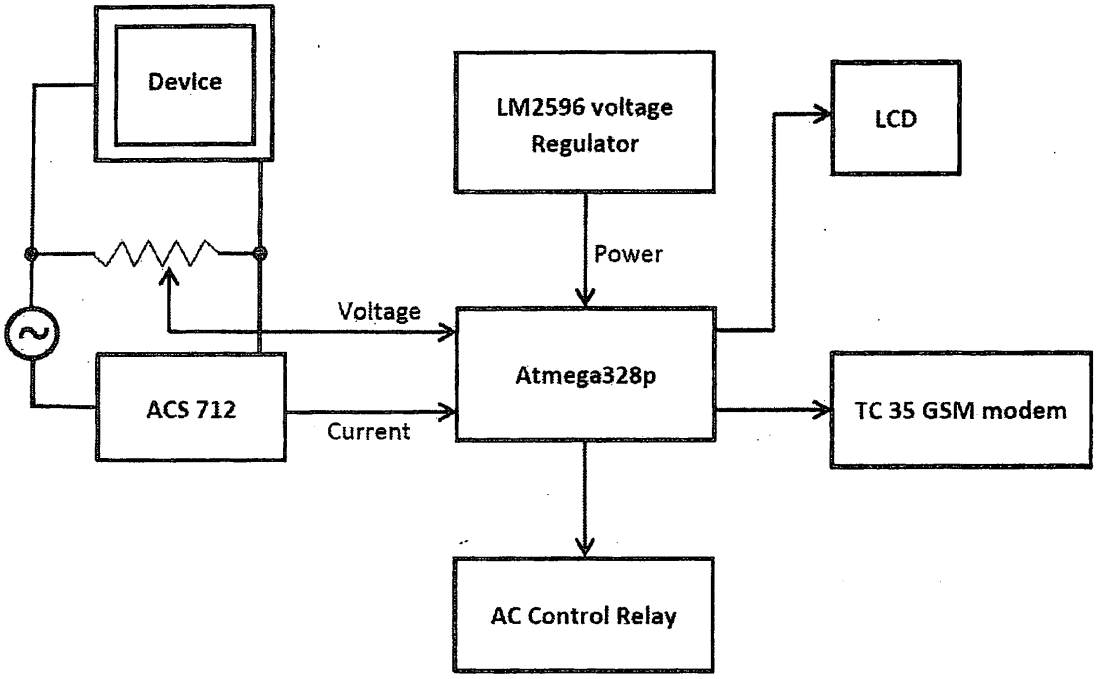

Figure 2: Circuit diagram of the system

Resolution of the system can be calculated as $2^{10} = 1024$. Step size of the analog to digital voltage conversion can be calculated as the 5 V / 1024 = 0.00488V and step size of the analog to digital current conversion can be calculated as 20 A / 1024 = 0.0195A. The measurable maximum voltage of the system was 500 V. So step size of the measurable voltage can be formulated as 500 V / 1024 = 0.488 V.

The calculation of the amount of power usage is done by reference to the system voltage and the current. Those values are displayed in a LCD screen attached to the microcontroller. The microcontroller is programmed to display the total current being used. By using several commands and by using some buttons attached to the advanced electric meter house owner can see the electricity usage and the monthly electricity bill.

The circuit design of the smart electrical meter is shown in figure 03.

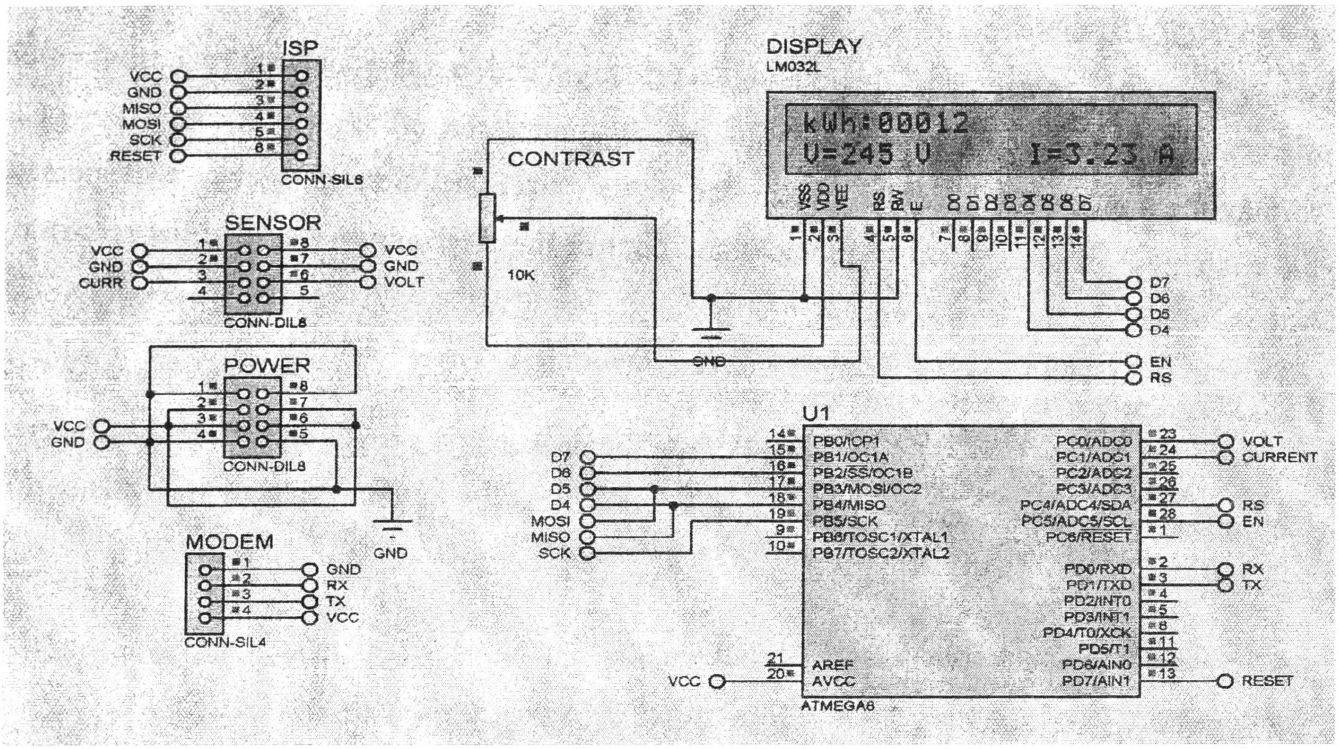

Figure 3: Designed Circuit

Smart electrical meter is a flexible, cost effective and durable electricity consumption meter.Generating a text messages about the electricity consumption as a short message service is a very useful feature of the project since it can help user to have an idea about his electricity consumption and the electricity cost. It will help the user to manage the monthly electricity usage while saving power. Further the user can get to know the electricity usage time by the text messages.This system can be applied to the industrial companies as well to monitor and control the electricity usage. The developed system can comfortably be used to measure the electricity usage with its smaller device and circuit size. This system can be plugged to the places where electricity is used with maximum of 20A. At the same time, this can be identified as a drawback of the project as well since this system cannot be applied to the places in where current of the system is more than 20A. Developed system cannot be employed at the places where three phase electricity is used and which can be identified as another disadvantage of the system.

As the future improvements, the developed system can be upgraded to use this system in places where three phase electricity is used. Further this system can be improved by developing a database to store users' electricity usage data and those data can be used in decision making regarding electricity consumption and electricity usage predictions.

4. CONCLUSION

Smart electrical meter is a flexible, cost effective and durable electricity consumption meterwith which electricity consumption can be monitored effectively.Through the LCD display the analyzed data of the system can be viewed. Short message service will increase the usefulness of the system to monitor and control the electricity usage and the electricity bill.

Phase current transformer sensing technology is used to detect and monitor a magnetic field around our household electricity power cable. It measures the usage of current in amperes. The phase wire of the current line is attached to the sensor and read all the values to a microcontroller.

ACKNOWLEDGEMENTS

Authors wish to express their gratitude to the staff of Department of Electronics, Faculty of Applied Sciences, Wayamba University of Sri Lanka.

REFERENCES

[1]. M.Haque, K.Hossain, M.Ali, R.I.Sheikh, *Microcontroller Based Single Phase Digital Prepaid Energy Meter for Improved Metering and Billing System,* International Journal of Power Electronics and Drive System,2(2011)141-143.

[2]. Atmel Corporation, *ATmega48P/88P/168P/328P*, Atmel Corporation, 2009.

[3]. http://www.robotshop.com/media/files/pdf/datasheet-gsm-tc35.pdf

[4]. https://www.sparkfun.com/datasheets/BreakoutBoards/0712.pdf

[5]. http://www.ti.com/lit/ds/symlink/lm2596.pdf