Design and Implementation of IoT based Digital Energy Meter for Remote Monitoring

M.Indhumathi¹
¹National Engineering College, Department of ECE, Indumahe5393@gmail.com

T.Devakumar²
²National Engineering College, Department of ECE, tdkece@nec.edu.in

Abstract—Electricity has become one of the basic requirements for human life, being widely used for domestic, industrial and agricultural purposes. In our work, we propose a digital energy meter which measures the energy consumption and the energy measured is transmitted periodically to the remote server or user or electricity board so that energy consumption can be monitored from remote end. Additionally an important concept used here is the IoT (Internet of Things). IoT is an emerging system with unique identifiers and having the ability to transfer data over a network without human-to-human or human-to-computer interaction. Here using IoT the meter readings are uploaded into our specific web page for remote monitoring.

Index Terms—Electricity, energy meter, remote server, Internet of things (IoT), web page

1 INTRODUCTION

Digital signal processor or high performance microprocessors are used in digital electric meters. Similar to the analog meters, voltage and current transducers are connected to a high resolution ADC. Once it converts analog signals to digital samples, voltage and current samples are multiplied and integrated by digital circuits to measure the energy consumed. There are many methods of error correction in digital electricity meters which are usually based on the known methods of A/D converters error correction. Most of these methods use software correction based on calibration process. While in digital electricity meter, percentage error could be as low as 0.01%. On the other hand consumers are also not satisfied with the services of power companies. Most of the time they have complaints regarding statistical errors in their monthly bills. Thus we are trying to present an idea towards minimization of technical errors and to reduce human dependency at the same time. With the help of this project we are aiming to send the total energy consumption in the form of SMS from the remote location directly to the consumer and electricity board via modem. And an additional thing, we have to create a separate web page and upload the meter readings to the page.

2 SYSTEM ARCHITECTURE

At present, the need and demand for electricity goes on increasing. In spite of very well developed sources for electricity, there are a lot of problems with distribution, metering and monitoring of energy consumption. The problem worsens further in collecting the meter readings. In earlier days the energy was measured using electromechanical meter. Usage of this meter leads to inaccuracy while taking readings and allows energy theft. To overcome this disadvantage the above meter was slowly replaced by digital energy meter but this implementation also consumes more time and needs manpower for collecting the meter readings periodically. So we are designing a digital energy meter which is IoT compatible. Here we are using the GSM module for sending the meter readings to the consumer and uploading it on the webpage.

3 PROPOSED METHOD

In our proposed digital energy meter we are using the voltage and current measuring circuits that measures the voltage and current and it is given to the Arduino microcontroller. This microcontroller is already programmed for calculating values such as amount of power utilized by the consumer and also the energy.

Fig.1 Block diagram of the proposed method

3.1 VOLTAGE MEASUREMENT

For voltage measurement we are using a potential transformer. The transformer works on the principle of mutual induction of two coils. When current in the primary coil is changed the flux linked to the secondary coil also changes. Consequently an EMF is induced in the secondary coil. The voltage of the consumer is measured by means of a Potential transformer and is given to attenuator circuit.
3.2 ATTENUATOR CIRCUIT
A full-wave rectifier converts the whole of the input waveform to one of constant polarity (positive or negative) at its output. It converts both polarities of the input waveform to pulsating DC (direct current). Two diodes and a filter capacitor are needed for this purpose. The voltage obtained from this is given to the potential divider, which is used to provide arduino compatible voltage. Resistors R1 and R2 form a voltage divider that scales down the AC voltage.

3.3 CURRENT MEASUREMENT
For current measurement we are using a CT sensor. The current sensor module is a device that is used for making current measurements. ACS 712 allows measurement of current direct or alternating flowing in a conductor. The desired measured current generates a magnetic field which the sensor converts to a proportional output voltage using the hall effect. This voltage in turn is read by a microcontroller system to an A/D converter to calculate its peak value and the corresponding RMS value of the load current.

3.4 GSM MODULE
The main goals of GSM is to improve spectrum efficiency, international roaming, low-cost mobile sets and base stations, high-quality speech and QoS. The power level of a transmitter within a single cell must be limited to reduce the interference with the neighboring cells. There are several types of cells classified based on their area coverage Macro cells (3 to 35 km), Microcells(0,1 to 1 km), Picocells (0,01 to 1km), Nanocells (1m to 10m). Here 2 readily made GSM modules are bought and kept as transmitter and receiver. The GSM module at the user end is connected to the computer with the help of the USB to serial cable converter.

3.5 ARDUINO UNO
Arduino Uno board is based on ATmega328P Microcontroller. It has 14 digital pins, 6 analog inputs, 16MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. The size of
the flash memory is 32KB which is used for storing code. The voltage and current input is given to the controller separately and this microcontroller is already programmed for calculating values such as amount of power utilized by the consumer and also the energy. The calculated values can be viewed through the serial monitor and these values are then transmitted to the consumers as SMS via GSM. These meter readings are uploaded in our specific web page too.

Following are the steps involved in programming an Arduino UNO:

1. Open the Arduino IDE
2. Go to Tools>Board menu and choose Arduino UNO.
3. Make sure that the Arduino UNO is connected to the USB of the computer that you are working in.
4. Type the program which you want to dump in to the controller.
5. Save the file and verify by clicking the top left button.
6. Upload the code into the board by clicking the REFERENCE upload button near the verify button.
7. In case of trouble, by pressing the RESET button on the board, the code will start to execute from the first line.

4 SOFTWARE
Arduino IDE:
Arduino IDE is an Integrated Development Environment used for Arduino family. It supports both C and C++ programming languages. Arduino supplies the software library, which provides some common input and output procedure. This is an open source board which allows easy coding and upload.

5 RESULT AND CONCLUSION
The growth and technology about power distribution system is a non-stop process. New things and new technology are in progress. This paper is intended to present overview of wireless energy meter which is very efficient for power measurement, because inaccuracy is greatly reduced.

The energy meter was tested by using an electric light bulb of 60 watts, which is driven by a supply voltage of 230v, that draws a current up to amperes. The energy consumption is calculated and the information is uploaded to the webpage using IoT.

ACKNOWLEDGEMENT
I gratefully acknowledge this institution that has provided infrastructure and environment which helps me to do this project. I would like to thank my guide Mr.T.Devakumar M.E., Assistant Professor (SG), Department of Electronics and Communication Engineering, for his valuable guidance, encouragement and support towards the successful completion of the project work.

REFERENCES


AUTHOR PROFILE:
- M.Indhumathi is currently pursuing Masters’ Degree program in Electronics and Communication Engineering in National Engineering College, India.
  E-mail: indumahe5393@gmail.com
- T.Devakumar is working as an Assistant Professor (SG), Department of Electronics and Communication Engineering in National Engineering College, India. E-mail:tdkece@nec.edu.in