

GSM BASED LOW COST AUTOMATIC ENERGY METER READING SYSTEM

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ABSTRACT

Smart India needs smart devices. The most commonly used energy meter reading system (which employs traditional electro-mechanical energy meter) in India is prone to errors and is also time consuming. The electricity board has to send a representative every month to note down the reading of the energy meter. Then these readings are processed and accordingly the bill is generated. Thus, there is chance of human error while noting down the reading. The project provides an efficient and convenient alternative to tackle this problem and hence saves a lot of time and human labour.

In this meter reading system, the reading from the energy meter is sent to the microcontroller where appropriate calculations are done to generate the bill. The generated bill is sent directly to the consumer via SMS through a SIM loaded GSM Modem. Also, the system incorporates the concept of home automation. By simply sending SMS to the GSM modem, the consumer can switch OFF/ON the load according to his/her requirements, thus providing convenience. If there is overloading, then the system will disconnect the load to prevent damage to the circuit board. Hence, this system provides a variety of useful features and proves to be the smart alternative to the conventional billing system for energy consumption in India.

Keywords: SMS (Short Message Service), GSM (Global Sytem for Mobile Communication), Microcontroller, SIM (Subscriber Identity Module).

I. INTRODUCTION

In India, the traditional mechanical energy meters are employed in most of the houses. Hence, the billing system is a manual procedure and not automated. Each month, at the end of billing cycle, a representative from the electricity service provider goes to every consumer's house and takes the meter reading manually. These meter readings are processed for electricity bill calculation and generated bill is sent to consumer's house which is usually done by post.

The traditional electro-mechanical energy meter is still used in India and it has a lot of disadvantages. The technical issues arise when the moving parts of an electro-mechanical energy meter cause wear and tear in the context of its magnetic component whose working depends on the temperature. Due to this technical problem, the accuracy and reliability of the energy meter gets degraded over time. Also, many social and management

problems are associated with the conventional metering system. The reading is taken manually, therefore, issues like human error in reading, excess billing, irregularities in billing time, etc. can occur. This system is also prone to tampering and this puts the consumer at the risk of fraudulent activities. Misplacing of the paper bill is also a problem which is related to this type of metering system.

The energy metering system proposed will automatically read the energy meter reading and send the corresponding bill directly to the consumer and the electricity provider via SMS. It uses a GSM modem for this purpose. In case of any payment related issue, the proposed system provides the facility to disconnect the supply. GSM network is widely known for its vast coverage and cost effectiveness.

II. STRUCTURE OF ENERGY METER READING SYSTEM

The proposed system consists of key components such as voltage transformer, current transformer, microcontroller and GSM modem. The voltage and current transformers together are known as instrument transformers. To find the energy reading, we need three components i.e. voltage, current and time. The energy meter reading, once obtained, is sent to the microcontroller where the bill is generated. The generated bill is sent to the consumer via SMS using the GSM modem.

2.1 Voltage Transformer

A step-down transformer (9-0-9V) is used in the system. The voltage transformer gives the voltage component needed to find the energy consumed. The transformer steps-down the AC main supply to 9V supply which is then passed through a network of diodes, resistors and capacitors (filtering stage). After this, the supply is sent to the ADC pin of the microcontroller.



Figure 1. Step-Down Transformer

2.2 Current Transformer

A current transformer or CT in short, is an electrical device that generates a current in its secondary winding proportional to the alternating current in the primary winding. The current component needed to find the energy consumed is obtained using the current transformer.



Figure 2. Commercial Current Transformer

2.3 Microcontroller Unit

The microcontroller unit used in the system is ATmega16. It is an 8-bit microcontroller by Atmel. The IC has 40 pins. It consists of four ports namely A, B, C and D. The port A is the ADC port of the microcontroller.

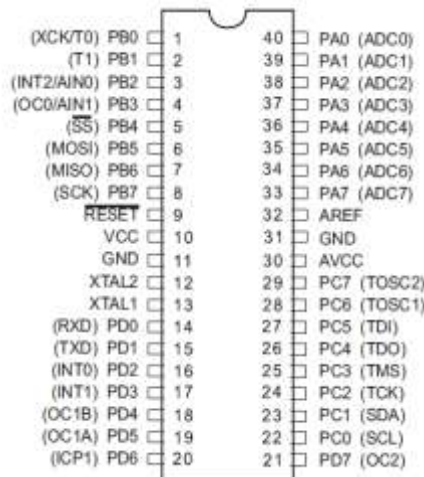


Figure 3. ATmega16 Pin Diagram (Source: Atmel)

2.4 GSM Modem

The model used in this system is SIM900A. A SIM card is inserted in the GSM Modem. It is used to send the generated bill over the GSM network via SMS service. GSM Modem is interfaced with the microcontroller.



Figure 4. GSM Module

III. WORKING OF THE SYSTEM

Electric energy is defined as the energy made available by the flow of moving charges in a conductor. Power is defined as energy flow per unit time.

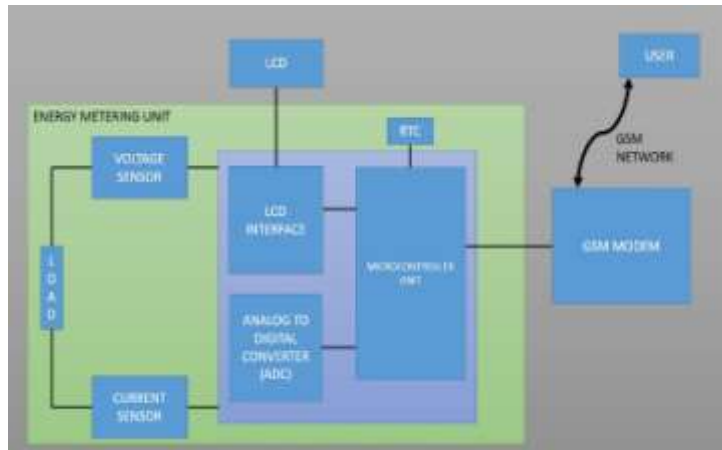


Figure 5. Detailed Block Diagram

We know that,

$$\text{Power} = \text{Voltage} \times \text{Current}$$

Thus, Energy can be written as

$$\text{Energy} = \text{Power} \times \text{Time}$$

$$\text{Energy} = \text{Voltage} \times \text{Current} \times \text{Time}$$

The voltage and current readings are using the voltage and current transformers, respectively. The time component is calculated using the internal clock of the microcontroller. All the three components are then multiplied to get the energy meter reading. This reading is sent to the microcontroller where appropriate calculations are done to generate the bill. This bill is sent to the consumer via SMS using the GSM modem which is interfaced with the microcontroller through MAX232 chip and DB9 connector.

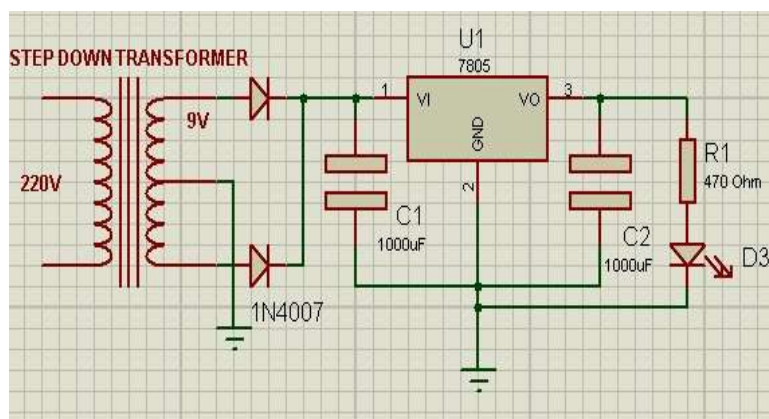


Figure 6. Power Supply Section

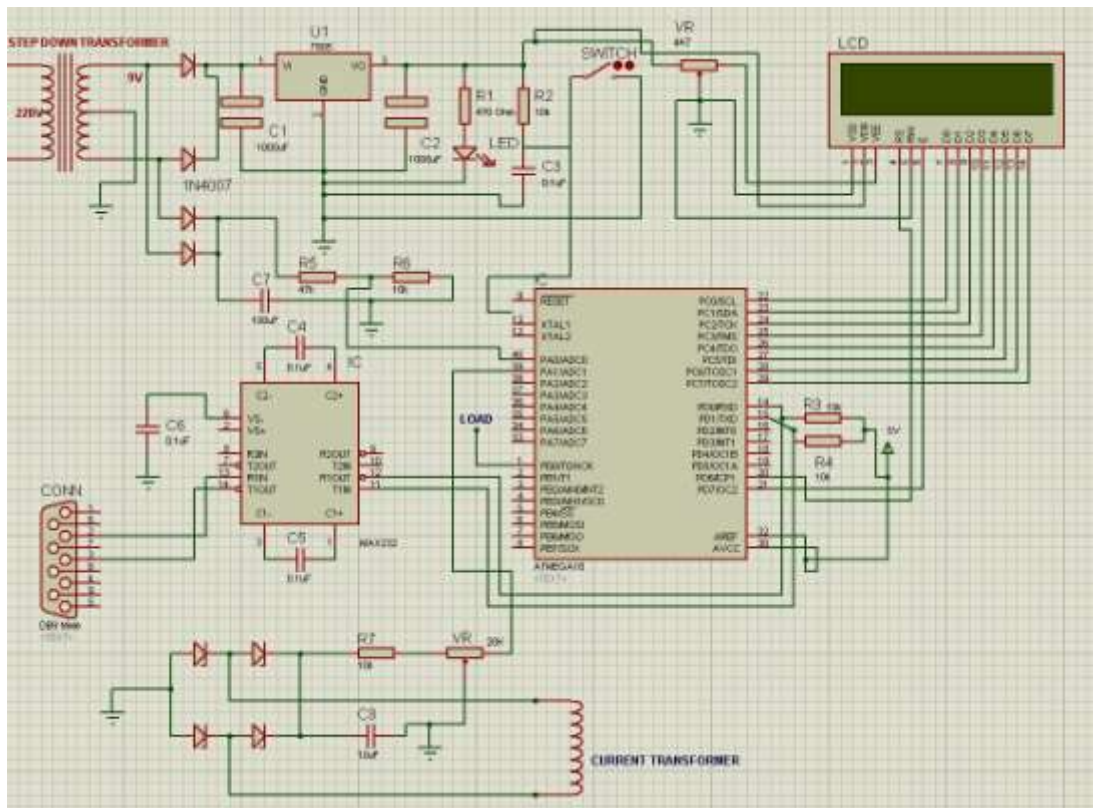


Figure 7. Complete Circuit Diagram

As can be seen from figure 9, the microcontroller ATmega16 is the heart of the system. The 9V supply obtained from the voltage transformer is passed through a network of resistors and capacitors (filtering stage).

After this, it is sent to PIN 40 of the microcontroller. PIN 40 is the ADC pin which converts the analog value of voltage to digital value. Similarly, the current from the CT (current transformer) is sent to the PIN 39 of ATmega16 which is also an ADC pin which converts it to digital value.

The microcontroller is used to calculate the energy consumed using these two values and hence the bill is generated. The LCD display is connected to PORT C of the microcontroller. The GSM modem is interfaced with ATmega16 using MAX232 chip to facilitate serial communication. PIN 14 and 15 of microcontroller are the RXD and TXD pins respectively. The load is connected through a relay to PIN 1 of ATmega16 chip.



Figure 8. Experimental Set-Up

IV. CONCLUSION

The proposed system provides numerous advantages over the conventional energy meter reading system used in majority of households in India. First of all, a lot of time and energy is saved. Also, as there is very less human intervention, there is less chance of error in noting down the energy meter reading.

The bill is generated automatically and is sent directly to the consumer. The system requires only a mobile device with SMS services at the user end. The system consists of many other features also. The consumer can switch ON/OFF the load by simply sending SMS to GSM modem. If the consumer sends 'blboff' or 'blbon', the load will automatically switch OFF/ON, respectively. Also, if there is excess of load, the system will automatically cut off the supply and also send SMS to the user, "Limit Exceeding. Powering Off."

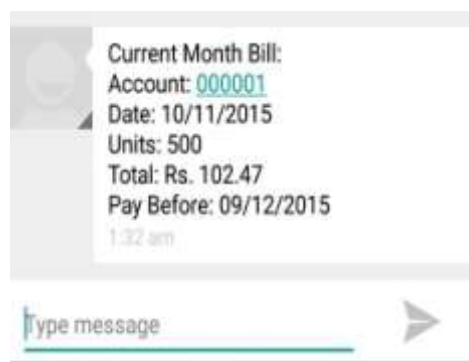


Figure 9. Sample Bill

Further, many more features can be added to this system such as protection from tampering, a dedicated e-billing software, or a prepaid metering system. Along with this, there is another promising aspect of this system. An energy saving feature can be added which will allow the customer to reduce the load with the help of simple SMS sent from the mobile to the modem according to the usage requirement.

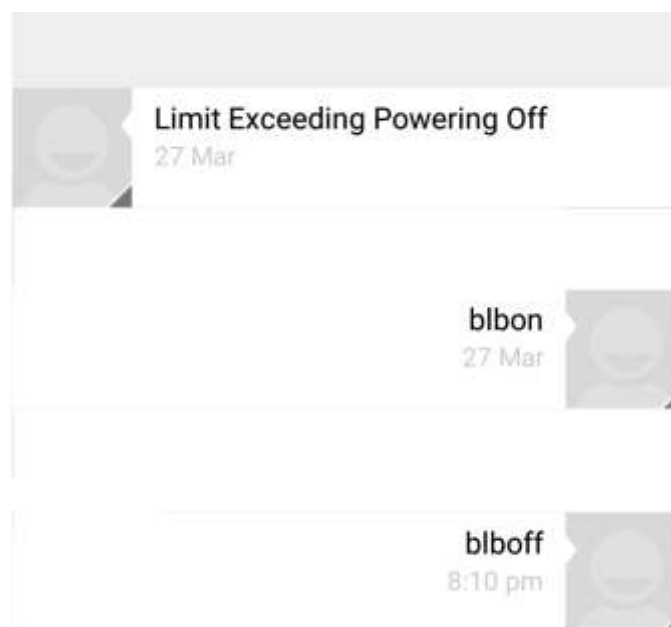


Figure 10. Other Features of the System

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