

Prepaid Energy Meter Using GSM Technology

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Abstract—The present system energy billing in India is facing the problem about collecting electrical revenue from their consumer by metering and billing. This result in high cost per unit as the expenses for metering, billing and collecting dues became complex and also it is inaccurate and slow. To overcome this problem a prepaid energy meter using GSM technology is designed. It is a good concept in which we can recharge its balance, like we do in our mobile phones. In this project we are building an automatic system using Arduino and GSM module. We can recharge the electricity balance through this system, just by sending a SMS. It can also disconnect the home power supply connection, if there is low or zero balance in this system. And this system will reads the energy meter readings and automatically sends some updates to user's mobile phone like low balance alert, cut off alert and recharge alert.

Introduction

In postpaid system, there is no control use of electricity and a lot of waste of power from the consumers side due to lack of planning of electricity consumption. By using prepaid energy meter, it would help to create a better understanding and awareness regarding the importance of electrical energy and saving electricity.

Traditional meter reading is done by manual operation; this requires more number of labour operator and long operating time to get complete area data reading and billing. Replacing this system by 'GSM Technology Based Prepaid Energy Meter', we can achieve automatic meter reading and billing which reduces operating time and does not requires more number of labors. The overall design of the energy meter consists primarily of an arduino and a GSM module along with a liquid crystal display(LCD) used for receive messages about the consumption of power in watts by using Arduino and if it reaches the low balance, it would automatically alert the consumer to recharge.

Methodology

Hardware Description:

GSM (Global system for mobile communications):

The GSM is a digital mobile telephony system that is widely used in EUROPE. The GSM uses a variation of time division multiple access. It operates at either 900MHZ/180MHZ frequency band.

LCD(Liquid crystal display):

LCD is an electronic display module which uses liquid crystal to produce a visible image. We are using 16X2 LCD display(2 lines, 16 characters). It displays the units of power consumed.

Energy meter:

Energy meter is an instrument which measures the amount of electrical energy used by the consumers. It measures the instantaneous voltage and current and calculates its product and gives instantaneous power.

Optocoupler:

The optocoupler is a device containing light-emitting and light sensitive components. It can transfer the electrical signals between two isolated circuits by using light.

Arduino:

It is tool for making computer that can sense and control more of the physical world than that of the desktop computers. Arduino can be used to develop interactive objects taking inputs from variety of switches.

Software Description:

Arduino IDE:

It contains a text editor for writing code. It has a toolbar with buttons for common functions. It connects to the main arduino hardware to upload programs.

Arduino IDE parts:

The applications where the user write the code to program the arduino is called Arduino IDE parts. It is divided into 3 parts.

1. Global variable
2. Void variable
3. Void loop

Global variable:

These variables which remain active throughout the code,(or) they are not local variables. Hence we can use them in any functions. The value of this is not change until another operation is done on the same variable.

Void setup:

The code enclosed in this gets executed only once. That's the compiler executes the code in the setup and moves to the void loop.

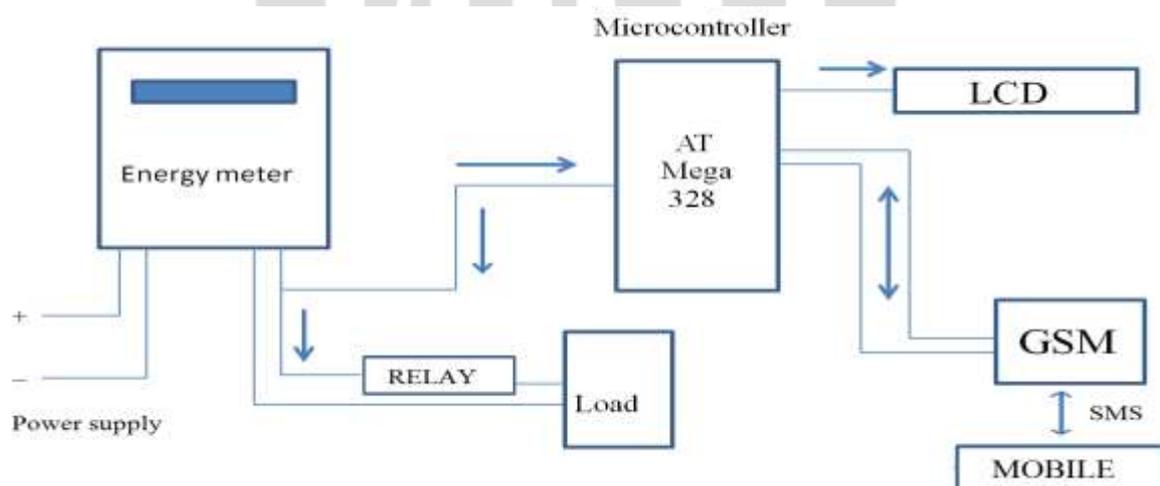
Void loop:

The code enclosed in this region gets executed again and again when the code in the void setup is executed, the control moves to the void loop, code in it is executed line by line until the end is reached.

WORKING:

The microcontroller and the GSM unit are interfaced with the energymeter of each house. Every house has a separate number, which is given by the corresponding authority. The GSM unit is fixed in the energymeter. The amount of consumption is stored in the Arduino's memory and available to the authority as SMS. Using this software, SMS can be sent through the GSM Modem to that particular number which is assigned by these authorities and wait for the response.

Block diagram of the desired prepaid energy meter as shown in figure 1. This system is designed based on Arduino ATmega328 microcontroller which acts as a data processing and transmission system. Main supply is given to the transformer. Transformer steps down the voltage level according to our requirement. The output from the transformer is also taken as input of a full wave bridge rectifier to convert 12V A.C. voltage to a 12V D.C. voltage. The rectifier voltage is then passed through a network of some capacitors, voltage regulator to obtain a voltage of 9V, which is sufficient as the working voltage for the used components. The LCD is used for the purpose displaying the power consumed Units remain in balance. And also displays zero balance message.



When we power up the system then it reads previous value of rupees and restores them, then checks the available balance with the predefined value and take action according to them, like if available balance is greater than 1 rupee then Arduino turns ON the electricity by using relay. If balance is less than 1 rupee then Arduino sends a SMS to user phone regarding low balance alert and requesting recharge soon. If balance is zero, then Arduino turns off the electricity connections and sends a SMS (power cut due to zero balance) to user's phone for Power Cut alert and requesting to recharge soon. GSM Module has been used to send and receive messages.

Calculation of pulses and units:

Before proceeding for the calculations, first we have to keep in mind the pulse rate of energy meter. There are two pulse rate of energy meter first is 1600 imp/kwh and second is 3200 imp/kwh. So here we are using 3200 imp/kwh pulse rate energy meter.

So first we need to calculate the pulses for 100watts, means how many times pulse LED will blink in a minute, for the load of 100watts.

$$\text{Pulse} = (\text{pulse_rate} * \text{watt} * \text{time}) / (1000 * 3600)$$

So pulses for 100 watts bulb in 60 seconds, with energy meter of 3200 imp/kwh pulse rate can be calculated as below:

$$\text{Pulses} = 3200 * 100 * 60 / 1000 * 3600$$

$$\text{Pulses} = \sim 5.33 \text{ pulse per minute}$$

Now we need to calculate power factor of a single pulse, means how much electricity will be consumed in one pulse:

$$\text{PF} = \text{watts} / (\text{hour} * \text{pulse})$$

$$\text{PF} = 100 / 60 * 5.33$$

$$\text{PF} = 0.3125 \text{ watt in a single pulse}$$

$$\text{Units} = \text{PF} * \text{Total pulse} / 1000$$

$$\text{Total pulse in an hour is around } 5.33 * 60 = 320$$

$$\text{Units} = 0.3125 * 320 / 1000$$

$$\text{Units} = 0.1 \text{ per hour}$$

If a 100 watt bulb is lighting for a day then it will consume

$$\text{Units} = 0.1 * 24$$

$$\text{Units} = 2.4 \text{ units}$$

And suppose unit rate is at our region is 5 rupees per unit then we have to pay for 2.4 units of Rupees = $2.4 * 5 = 12$ rupees

Result:

The energy meter was tested by using an electric light bulb. In this paper, we used energy meter to measure the power consumed by the load. The energy will be consumed and the amount of energy consumed will be displayed on the LCD. Then Arduino sends the information to the GSM, the GSM text the message to the consumer mobile phones, if there is a zero balance the power will be cut until the further recharge and GSM send the message to the consumer to recharge the SIM.



Conclusion:

In this project we have designed a system based on Arduino ATmega328 microcontroller, so we can manage and control the voltage and current of a distribution transformer. The proposed GSM based system which has been designed to control demand growth and to provide the automatic meter reading and billing system. This paper is intended to present an overview of prepaid energy meter which can control the usage of electricity on consumer side. It is a good concept to minimize the electricity bills and it can reduce the problems associated with billing consumers and it is most friendly.

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