

Implementation of GSM Based Prepaid Smart Energy Meter for Monitoring for Domestic and Industrial Applications

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Abstract -The conventional Electrical billing system where the Electric Power bill given at the end of the month can be paid at Power distribution offices or at e-seva centers. This billing system is quite time consuming and even expensive (in issuing bills at door to door). In this project it will continuously calculates the number of units are consumed and generates the bill and send the message to the corresponding person. Most of the developing countries are shifting their conventional energy management practices to the modern one by replacing the old and conventional energy meters with the smart meters outfitted with the prepaid facility to quantify the power consumption so as to decrease the income deficits looked by utilities because of customer unwillingness to make consumed energy payments on time.

Our proposed design embedded with Arduino and GSM technology is advancement over conventional energy meter, which enables consumer to effectively manage their electricity usage. The system performance is good with the acquired results. An earlier charging will undoubtedly get rid of the issues of unpaid bills and human mistakes in meter readings, along these lines guaranteeing justified income for the utility.

Key Words: Smart Energy Meter, Electric board, Aurdino, GSM

1. INTRODUCTION

The cost of electrical energy has been increasing over the years. This creates a concern among home users regarding the energy usage efficiency of the electrical appliances that they are using. Thus, there is a need to design and implement a Prepaid Energy meter System to control the amount of energy supply. The purpose of this project is to design and implement a Prepaid Energy Meter System to control the amount of energy supply based only on the prepaid amount. This facility can be used in shared environments and the consumer utilized the energy supply based accordingly

to its available credit which can be topped-up. Prepaid Energy Metering System referring to the concept 'First Come First Serve' but for this project the concept is 'First Pay First Serve'. All electricity can be only generated once people pay money or reload first before use. After a reload, the credit is activated and from that, all of the electricity will start being used.

2. BLOCK DIAGRAM

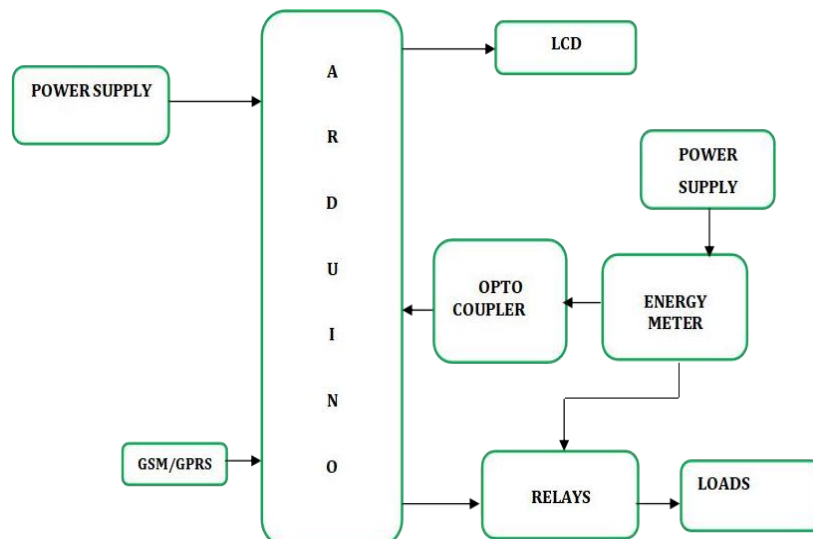


Fig.2.1. Block diagram of proposed system

2.1. POWER SUPPLY

All digital circuits require regulated power supply. A **regulated power supply** is an embedded circuit; it converts unregulated AC (Alternating Current) into a constant DC. With the help of a rectifier it converts AC supply into DC. Its function is to supply a stable voltage (or less often current), to a circuit or device that must be operated within certain power supply limits. The output from the regulated power supply may be alternating or unidirectional, but is nearly always DC. In this article we are going to learn how to get a regulated positive supply from the main supply.

2.2. LCD MODULE

To display interactive messages we are using LCD Module. We examine an intelligent LCD display of two lines, 16 characters per line that is interfaced to the controllers. The protocol (handshaking) for the display is as shown. Whereas D0 to D7th bit is the Data lines, RS, RW and EN pins are the control pins and remaining pins are +5V, -5V and GND to provide supply. Where RS is the Register Select, RW is the Read Write and EN is the Enable pin.

2.3. RELAY

A **relay** is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations. Many relays use an electromagnet to operate a switching mechanism, but other operating principles are also used.

2.4. GSM MODULE

The words, "Mobile Station" (MS) or "Mobile Equipment" (ME) are used for mobile terminals Supporting GSM services. A call from a GSM mobile station to the PSTN is called a "mobile originated call" (MOC) or "Outgoing call", and a call from a

fixed network to a GSM mobile station is called a “mobile Terminated call” (MTC) or “incoming call”. GSM (Global System for Mobile communications) is an open, digital cellular technology used for transmitting mobile voice and data services. GSM supports voice calls and data transfer speeds of up to 9.6 kbit/s, together with the transmission of SMS (Short Message Service).

2.5. ARDUINO

Arduino is a prototype platform (open-source) based on an easy-to-use hardware and software. It consists of a circuit board, which can be programmed (referred to as a Micro-controller) and a ready-made software called Arduino IDE (Integrated Development Environment), which is used to write and upload the computer code to the physical board.

Why ARDUINO board than other controller?

The key features are –

- Arduino boards are able to read analog or digital input signals from different sensors and turn it into an output such as activating a motor, turning LED on/off, connect to the cloud and many other actions.
- You can control your board functions by sending a set of instructions to the Micro-controller on the board via Arduino IDE (referred to as uploading software).
- Unlike most previous programmable circuit boards, Arduino does not need an extra piece of hardware (called a programmer) in order to load a new code onto the board. You can simply use a USB cable.
- Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program.
- Finally, Arduino provides a standard form factor that breaks the functions of the micro-controller into a more accessible package.

2.6. OPTOCOUPLER

An opto-isolator (also called an optocoupler, photocoupler, or optical isolator) is an electronic component that transfers electrical signals between two isolated circuits by using light. Opto-isolators prevent high voltages from affecting the system receiving the signal. Commercially available opto-isolators withstand input-to-output voltages up to 10 kV and voltage transients with speeds up to 25 kV/ μ s.

2.7. ENERGY METER

An electricity meter or energy meter is a device that measures the amount of electric energy consumed by a residence, a business, or an electrically powered device. Electric utilities use electric meters installed at customers' premises for billing and monitoring purposes. They are typically calibrated in billing units, the most common one being the kilowatt hour (kWh). They are usually read once each billing period.

3. 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 rates 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 100 watt, means how many times Pulse LED will blink in a minute, for the load of 100 watts.

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

So pulses for 100 watt 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**:

$$\text{PF} = \text{watt} / (\text{hour} * \text{Pulse})$$

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

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

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

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

$$= 0.3125 * 320 / 1000$$

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

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

$$= 0.1 * 24$$

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

And suppose unit rate is at your region is 5 rupees per unit then you have to pay for 2.4 Units

$$\text{Rs:Rupees} = 2.4 * 5 = 12 \text{ rupees}$$

4. RESULTS

The overview of the project kit shows the components present in the kit . The components used are Energy meter, Relay, LCD, GSM Module, Optocoupler, Arduino uno, Load(bulb).These Components are connected according to the circuit diagram discussed in chapter-3.The Fig.5.2 shows the output of the System,As we know the aim of the proposed system is to monitor the load and to recharge the energy meter.The Energy Meter is Recharged and the Load is Monitored.This Process can be obtained by programming the Arduino uno , The Source Code and its Explanation is discussed in Previous Chapter.

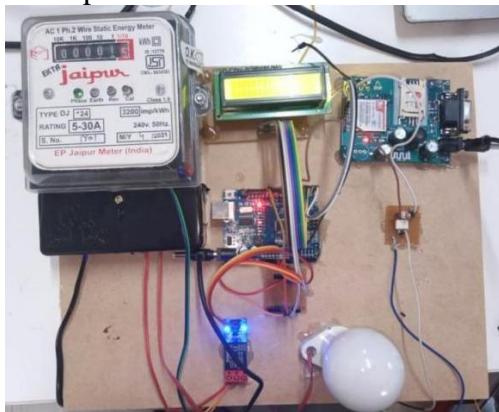


Fig.4.1. Project model

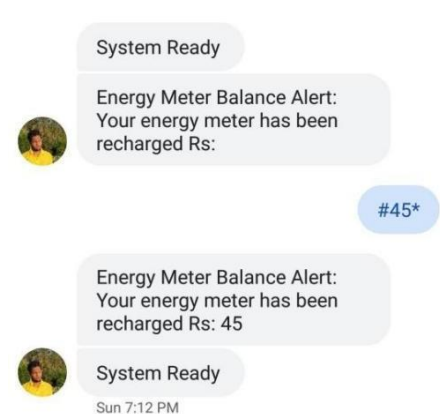


Fig.4.2. SMS in user mobile

4.1. Advantages

- 1) Complete elimination of manpower.
- 2) Can handle heavy loads up to 7A.
- 3) System can be switched into manual mode when even required.
- 4) Highly Sensitive, Low cost and Reliable circuit.
- 5) Works according to the soil condition.

5. CONCLUSION

The advancement in power distribution system is non-stop process and new technology is always in progress. In this paper, an Arduino and a GSM based smart prepaid energy meter has been proposed. Units are purchased by using GSM technology and those units are deduced according to electricity usage. This project presents a single-phase energy meter for domestic consumers with prepayment billing method. The significant preferred standpoint is the capacity of this system to update the current conventional meters into smart prepaid meters with a connection of Arduino and GSM (Prepaid Module). This kills the need of totally supplant the energy meters.

Cost is the main important factor of this work which is quite high but will reduce from 3 to 4 times after implementation of this project. Nowadays as power supply companies need labour for meter reading after implementing this, there will be no need of so many meter readers and lots of money will be saved. The idea of prepayment electricity bill prior its usage is being gradually accepted around the world, and that's why the market for prepaid energy metering is growing. After having many advantages, this project still needs more safety check and modification especially the GSM module for the network coverage of SIM which is being used, should be strong so that the GSM can work properly.

6. FUTURE SCOPE

In the present time of 21st century we have no space for errors or faults either in any technical system or in general applications. Prepaid energy meter is an advantages concept for the further. It's facilitates the exemption from electricity bills. Electricity coupons will be available at nearby shops. The word prepaid means pay before use one of the advantageous feature of this concept prepaid energy meter is used to prepaid the ongoing supply of electricity to homes, offices etc.

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