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Prepaid Energy Meter

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Abstract: *The present system of energy billing is error prone and also time and labor consuming. Errors get introduced easily like errors with electro-mechanical meters and human errors while noting down the meter readings. The solution to avoid these errors is prepaid energy meter. Also, the revenue losses can be reduced by using prepaid energy meters. A prepaid energy meter enables power utilities to collect energy bills from the consumers before the usage of power by providing only as much as electricity what has been paid for. This paper suggests a prepaid energy meter behaving like a prepaid mobile phone. The main drawback of previously used traditional meters is that they do not provide information to the consumers, which can be overcome with the help of prepaid energy meter.*

1. Introduction

Electric energy meter is used to measure amount of energy consumed by a residence. The electromechanical meter operates by counting the number of revolutions of a non-magnetic metal disc, which is made to rotate at speed proportional to the power passing through it. The conventional electromechanical meters have been replaced by the new electronic meters to improve accuracy in meter reading and increase functionality since electronic meter can also record other parameters such as maximum and instantaneous rate of usage demand, voltages, power factor and reactive power use. Even though more accurate and faster meters are introduced, but still the bill payment is based on an old procedure. This traditional billing system is inaccurate many times, slow and lack in flexibility as well as in reliability [1]. The electricity billing department requires an individual to come down to customer place and note down the meter readings and report the amount that one has to pay to the household.

The power quality monitoring systems manufacturers are taking the advantage of the advances in semiconductor chip and are using them in making new meters.

The networking technologies are enhanced because of the demand for interconnection of computer users across the world [2]. The power monitoring systems are using these advances to expand the monitoring systems. A prepaid energy meter enables power utilities to collect electricity bills from the consumers before its consumption. It also helps the customer to have consumption details on their cellphones from time to time. The idea of prepaid energy metering will play a very important in making any grid smarter than it is now. The United Kingdom is the only country in Europe which has deployed in large scale prepaid meters [3]. The electronic token prepayment metering has been widely used in UK for customers with poor record of payment [4].

Another paper suggests a design of a system which can be used for data transmission between the personal computer and smart card. The device will transmit the data in half-duplex mode [5]. In Northern Ireland, distributors prefer prepaid meters because energy prices on these meters are lower than conventional meter. For this reason, 25% households have prepaid electricity. Password technology is being used there and the users have to enter a unique code number using the numeric keypad on the meter. The code also includes information about tariffs.

There is a paper which features a smart card secure solution for a prepaid electricity system consisting an IP-based controller in addition to a power meter, providing efficient online control of the amount of electricity consumed by the user [6]. Pre-payment electricity metering systems have also been developed consisting of a card reader based energy meter [7].

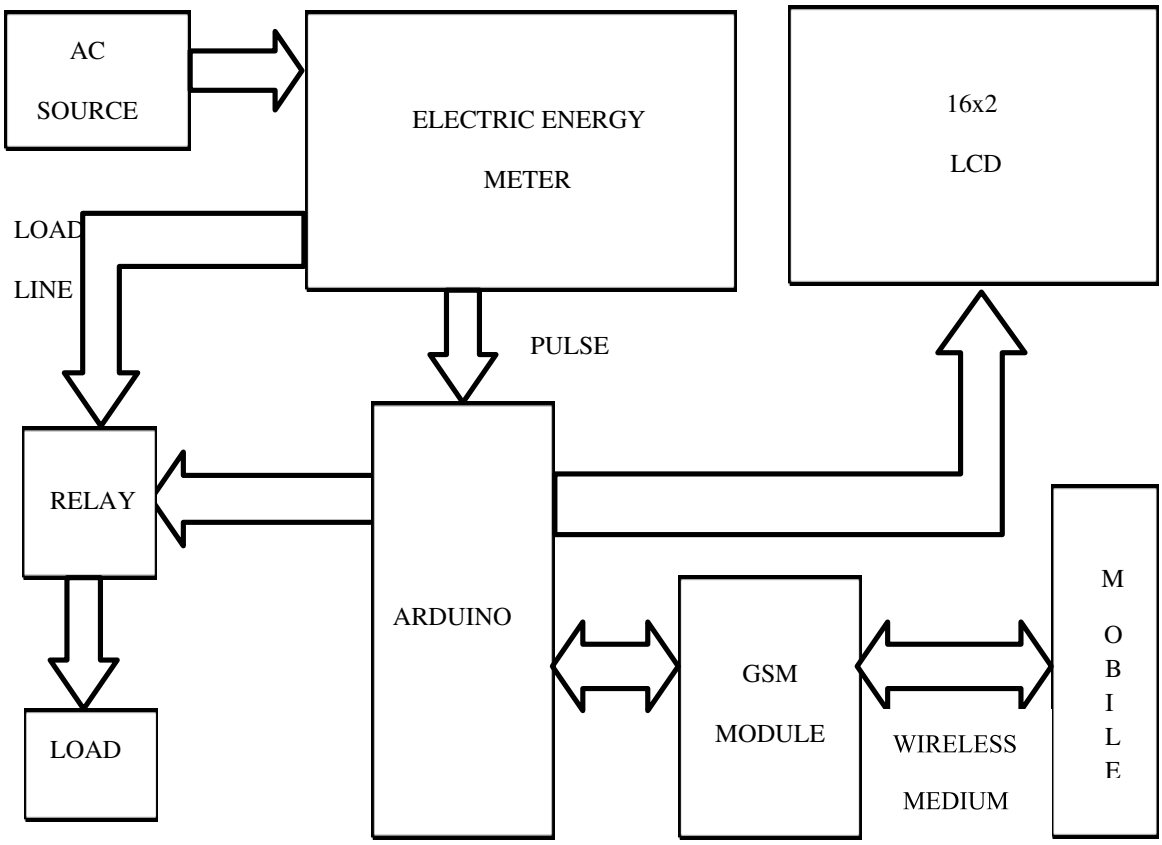
In this paper, we are using GSM module to remotely recharge as well as to provide the energy consumption details back to customers.

2. Working Scheme

The arduino takes the pulses from the energy meter, calculate units and displays the reading on LCD. This reading is stored in EEPROM so at the time of power failure, the information regarding the previous reading can be saved and when we power up the system then it can analyze the previous value of units stored in the EEPROM. The reading of the energy meter is also sent to the cell phone of the user by a message at the

time of low balance through GSM modem. In this project we have also used relay and relay driver ics, so that if recharge amount gets emptied, it automatically disconnect power supply to the user and also send the information about it by a message through a gsm module. This project is powered by an external power supply that is fed to arduino and gsm modem.

When we power up the system, arduino reads previous values of rupees stored in EEPROM and restores them into the variables, then checks the available balance with the predefined value and take actions according to them. For example, if available balance is greater than 15 rupees, then arduino turns ON the electricity of home or office by using relay. And if balance is less than 15 rupees, then it sends a SMS to the user's phone regarding low balance alert and requests to recharge soon. And if balance is less than 5 rupees, then it turns OFF the electricity connection of home and sends a SMS to user's phone for 'Supply Cut', requesting to recharge soon. Fig. 1 describes about the working scheme of different components.



3. Calculations

There are two pulse rates of energy meter. First is 1600 imp/kwh and second is 3200 imp/kwh. Here we are using 3200 imp/kwh pulse rate energy meter. So, we need to calculate the Pulses for 100 watt bulb, means how many times calibration LED will blink in a minute, for the load of 100 watts.
Pulses= (3200*100*60)/(1000*3600)

Pulses = ~5.33 pulse per minute

Power factor of a single pulse means how much electricity will be consumed in one pulse:

PF=watt/(hour*pulse) PF=100/60*5.33
PF=0.3125 watt in a single pulse Units= PF*Total pulses/1000 Total pulses in an hour is around 5.33*60=320
Units = 0.3125*320/1000
Units = 0.1 per hour
If a 100 watt bulb is lighting for a day then it will consume :-
Units=0.1*24 Units = 2.4 Units
And suppose unit rate is 10 rupees per unit then we have to pay for 2.4 Units Rs:
Rupees=2.4*10=24 rupees

Table 1. Comparison of GSM with other methods

Coin Meters	Tokens, Passwords	Memory Cards	GSM
Security can be violated by making duplicate coins.	Necessary for the distribution companies to know the meter's key for providing the secure code.	Low encryption. Hackers can be easily violate the security by easily hacking the phone.	GSM maintains end-to-end security by retaining the confidentiality of calls and sms of the GSM subscriber. The privacy of the communication is maintained by applying encryption algorithms and by assigning the temporary identification numbers to subscriber's number.
Payment can be collected in the form of cash into counters, which can be stolen if not secured.	Only credit can be recharged. Consumption details from the meter is not collected back.	Need of phone for calculating the amount of units consumed according to the calling minutes.	The recharge can be done by using electronic money transcations & details can be collected about the meter's consumption.
Outdated technology since 1980's [8].	Single token is specific for a single meter, cannot be used in another meter.	Low cost due to the competition between many manufacturers lead to the low level security.	GSM can be re-programmed to be used on the another meter.

4. Conclusion

This paper presents a model for prepaid energy meter which can help the power utilies to collect the bills.

This is an effort towards upgrading existing bills prior to consumption of energy and also it will improve the revenue collection by reducing the theft of electricity which is also the major cause of increasing the cost per unit of electricity.

The prepaid energy meter never allow the customer to consume more than what he has paid for and consumer is also entitled to request a recharge for continued supply of electricity.

GSM based prepaid energy meter can improve the transparency in distribution of electricity & collection of electric bills by sending sms on the mobile through the GSM modem attached to it about the number of units consumed and associated costs with it.

The system consists of the electricity meter which measures the electricity bill and the arduino which coordinates the whole system with the help of its different components connected to it. This embedded system can be used to measure more complex and high voltage systems which consume a high load of electricity.

The information regarding the consumption can also be send to customer email, whatsapp and facebook .The major benefit of proposed prepaid meter is that it doesn't require replacing the already installed energy meter, it can easily be upgraded into prepaid energy meter.

This proposed prepaid meter will be very useful for the power utilities in countries like India which has large population of ordinary energy meters that can be easily upgrade into prepaid energy meter with the attachment of proposed circuit which can be very economical instead of replacing them fully with another prepaid meters.

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