

## Design of SMS Prepaid Energy Meter for a Cashless Economy with Recharge Option and Bypass

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**ABSTRACT:** *With the current trend of Information Technology in our present time, the lot in our daily life is developing accordingly, and energy meters are no exception to this phenomenon. An intelligent GSM based prepaid energy meter is developed to be able to accurately calculate the amount of consumed energy by a certain building, display the remaining energy available from a pre-purchase of electricity, by which is done by the means of recharge through SMS service. The energy meter provide the utility company with regular status of the meter on a predefined interval, and also display a real time on the user's account update, which contributes to the retrieval of the balance of the meter, as well as keeping log of the consumed energy and remaining electricity of each user by the means of SMS. It also provide utility company the ability to send updated consumption rates according to the Time of Day Tariff (TDF) to the meter on pre-defined intervals*

*The methodology used is embedded system with control system. The prepaid energy meter concept is shown by Proteus 8 software simulation. The major components are AVR microcontroller, Voltage and Current transformer, LCD, Relay and a load. Electricity has become one of the basic requirements for people and widely used for domestic, industrial and agricultural purposes.*

*The software for this system was implemented with the use of embedded system code written onto the microcontroller. And the designed and implementation is an efficient way to collect billings for electricity consumptions, which further facilitate the recharge process of meters currently being used to the generalization and the acceptability in other to revolutionaries the entire metering system used in the 21<sup>st</sup> century.*

**Keywords:** *Intelligent GSM, Prepaid energy meter, and Microcontroller*

### I. INTRODUCTION

A Prepaid Energy Meter enables power utilities to collect electricity bills from the consumers prior to its consumption. The prepaid meter is also attributed with prepaid recharging ability and information exchange with the utilities pertaining to customer's consumption details.. Literature has witnessed quite an amount of work in this area (Nwaoko, 2006). Now a day's power consumption is become a huge problem. Even though there are many new IT services, these cause another types of problems. There are increases in the diversity of services and service quality, but there is also much higher energy consumption. Electrical power has become indispensable to human survival and progress

The system is installed with an embedded operating system to provide a user friendly environment with the help of alphanumeric Liquid Crystal Display (LCD).The GSM based recharge prepaid energy meter presented in this paper take advantage of available GSM infrastructure nationwide coverage in the country (Rodney et al, 2007)

The present power usage reading is made manually by moving to the consumer locations. This requires large number of labor operators and long working hours to accomplish the task. Manual billing is sometimes restricted and delayed by bad weather conditions. The printed billing also has the tendency of getting lost. Over the last few years, Smart (Prepaid) Energy Meter has been proposed as an innovative solution aimed at facilitating affordability and reducing the cost of utilities. This mechanism essentially requires the users to pay for the electricity before its consumption. In this way, consumers hold credit and then use the electricity until the credit is exhausted. If the available credit is exhausted then the electricity supply is cutoff by a relay. Readings made by human operators are prone to errors. This project addresses the above mentioned problems. These drawbacks of the present prevailing metering systems are motivations into this work. They include:

- i) Inaccurate calculation of voltage, current and power by the energy meter.
- ii) Inability of query request about the working condition of the energy meter from distant locations.
- iii) Consumers have to form long queues to buy credit for their Energy Meters.

- iv) Those who do not use the prepaid meter have to wait for several days for them to be re- connected whenever there is disconnection.
- v) Some of the prepaid payment points are very far from the consumers.

## II. REVIEW OF RELATED WORK

Mr. Nazir Bin Abdullah (2012) developed an automatic meter reading system (Automation of Residential Electricity Cut off Using Embedded Controller) In 2012 for domestic user. In this project he used GSM modem for transmitting and receiving information, both sides means user side and energy provider side. The heart of this project is a embedded device (microcontroller unit) which control the main power switch and update the data in data base with help of this project user shows their energy consumption and billing information.

(Mr. Hung Cheng Chen, 2012) proposed a wireless automatic meter reading system in 2012. In this project he used zigbeemodul on both sides. This technology is chip and low cost.

(Mr. Alauddin Al Omary,2011) develop an automatic meter reading system using GPRS technology In 2011 .This paper the design of secure low cost AMR system that calculate and transmit the total electrical energy consumption to main server using GSM technology .The AMR system perform the main three function such as taking meter reading ,transmission facility and billing information.

(MR.LI Quan Xi, 2010) design a automatic meter system based on ZigBee and GPRS System Mr. H.G.RodneyTanDevelop an automatic power meter reading system using GSM network in 2007.In this system GSM digital power meter installed in every consumer unite and electricity ebillingsystem at the energy provider side.

(Mr. Mejbau Haque,2011) develop a microcontroller based single phase digitalprepaid energy meter for improved meter and billing system .In this paper he present a single phase energy meterIC.This digital prepaid meter does not have any rotating part .The energy is calculated using the output pulse ofenergy meter and the counter of microcontroller.

(Amit jain, 2011),proposed a prepaid meter using mobilecommunication in2011.In this system he used controller unite,prepaid card and communication module .The prepaidcard is the most important addition to the design .The power utility sets the amount in the prepaid card to a measurethat the consumer recharges the cards ,called fixed amount.The tariff rates are already programmed and fed into thecard.

(Fawzi Al-Naina and BahaaJalil, 2010),Built a prototyping prepaid electricity meter system based on RFID .Thissystem is divided into two part such as client and server .The client consist of a digital meter based on amicrocontroller and an RFID reader and the server consist of a PC with MySQL database server.The client installedin each house and the server installed in local substation.

(Vijayarajet *et al*, 2010) the paper titled as "Automated EB Billing System Using GSM and Ad-Hoc Wireless Routing" In our system the central EB office has immediate access to all consumer homes in a locality withthe help of an RF system. The EB meter present in each house is connected by wireless network with the EB officewhich periodically gets updates from the meter. The EB office using a backend database calculates the amount to bepaid according to the number of units consumed and sends it back to the meter for display and also to the user's mobile phone

(Quazi *et al*, 2011) the paper titled as" Prepaid Energy Meter based on AVR Microcontroller" In this paper, the idea of pre-paid energy meter using AVR controller have been introduced. In this method 8051 has been replaced by AVR controller because, it is energy efficient i.e. it consume less power, it is fastest among all the microcontroller families, it has inbuilt ADC and have advanced RISC architecture. In this paper, energy metershave not been replaced which is already installed at our houses, but a small modification on the already installed meters can change the existing meters into prepaid meters,so this meters are very cheaper. The use of GSM moduleprovides a feature of pre-paid through SMS

(Md. Mejbaul Haque1 *et al* , 2011)the paper titled as"Microcontroller Based Single Phase Digital Prepaid EnergyMeter for Improved Metering and Billing System" In thisproject used two micro controllers and one energy meter IC.It's not like traditional one. They have used AT mega chip tocalculate the energy consumption; it is have one smart cardto recharge the amount and utilize it.

(A.Vijayarajet *et al*, 2004)the paper titled as"GSM and adhocwireless routing" In this proposed system through whichelectricity billing becomes fully automated andcommunication is made possible via wireless networks. Theexisting manual system in India has major drawbacks. Thissystem is prone to errors and can also be easily manipulated.The prevailing manual system also requires lot of humanworkforce. The major disadvantage in this system is that themeter cannot be accessed by the meter reader if the customeris not present at home.In our system the central EB office hasimmediate access to all consumer homes in a locality with thehelp of an RF system. The EB meter present in each house isconnected by wireless network with the EB office whichperiodically gets updates from the meter. The EB office usinga backend database calculates the amount to be paidaccording to the number of units consumed and sends it backto the meter for display and also

to the user's mobile phone. The advantages of the proposed system make the existing system incompetent. It is possible to connect to remote areas even when there is a power failure as it employs wireless technology. The new system is user friendly, easy to access and far more efficient than the existing system.

### III. METHODOLOGY

#### 3.1 Block Diagram

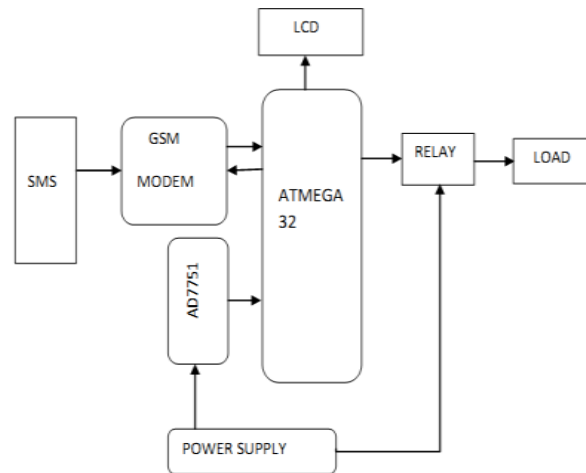


Figure 3.1: Block diagram of the prepaid energy meter with rechargeable option

#### 3.2 Complete Circuit Diagram

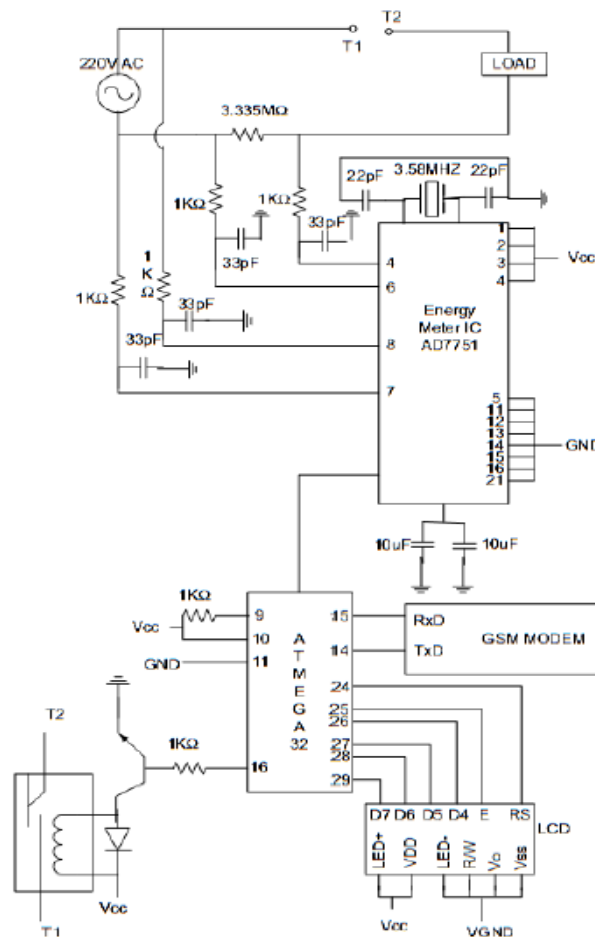


Figure 3.2 Circuit diagram of the prepaid energy meter

### 3.3 Algorithm used for the implementation

- Step1. Initialize display  
 Step2. Check balance (B) stored in EEPROM. If B=0, go to Step13.  
 Step3. Count no. Of pulse initiated from IC AD7751 with the help of counter and time by timer.  
 Step4. Calculate power (P) and Energy (E) units.  
 Step5. Perform B=B-E and stored B in EEPROM.  
 Step6. If B=50, go to step11, otherwise go to step2.  
 Step7. If SMS received check the no. From which SMS came.  
 Step8. If SMS coming from unknown number go to step12.  
 Step9. If SMS from known number with valid command, form B=B+R and stored B in EEPROM, where R= recharge amount.  
 Step10. Sent SMS to Customer "Recharge Successful" and go to step12.  
 Step11. Sent SMS to customer "Keep Sufficient balance to avail uninterrupted service".  
 Step12. Delete SMS. Go to step2.  
 Step13. Stop relay. Sent SMS to customer "Power off due to zero balance"

### Programming of the Software

For the software part we use an algorithm and are given below:

- The controller continuously scans the ports which receive inputs from maximum demand section and optical section.
- If the optical pickup receives a pulse then the counter increments and display the unit consumed in LCD. Then count is compared to display the warning for recharging.
- When the total unit finishes, after that the tripping relay is activated to disconnect the power.
- If the maximum demand section gives a pulse then it activates the tripping mechanism.
- Continuously the controller rechecks the maximum demand section and regain the power when load is reduced.

## IV. RESULT AND DISCUSSION

### 4.1 Calculation and Result

Energy is the total power delivered or consumed over a time interval,

That is Energy = Power x Time

Power = voltage x current x power factor

The Energy Meter was tested with four Electric bulb of 220 volt was used as a load with 0.4A current. The supply voltage was between 210 V and 230 V. Energy measurement process is described step by step. Table 1 test result of Energy measurement byproposed prepaid Energy meter. Here power =60 watt

#### First Bulb

TIME(Sec)	Expected Energy Meter Output (Watt-Sec)	Energy Output from Measurement
0	0	0
10	60	58
20	120	123
30	156	160
40	230	235
50	267	245

#### Second Bulb

TIME (Sec)	Expected Energy Meter Output (Watt-Sec)	Energy Output from Measurement
0	0	0
20	120	125
40	235	245
60	350	355
80	495	485

## V. CONCLUSION

This proposed simple and economic digital prepaid energy meter controlled by GSM based communication can cover rural area as well as urban areas. This is an effort about improving the present conventional electromechanical meters through the fusion of analog and digital circuits which have aim of collecting bills for consumption of power thus improved the revenue collection for scheduled supply. This is

beneficial for Nigeria like developing country which having huge population for improving economic through power utility.

The distribution company is unable to keep track of the changing maximum demand for domestic consumers. The consumer is facing problems like receiving due bills for bills that have already been paid as well as poor reliability of electricity supply and quality even if bills are paid regularly. The remedy for all these problems is to keep track of the consumers load on a timely basis, which will help assure accurate billing, track maximum demand, and detect online theft. These are all the features to be taken into account for designing an efficient energy billing system. The present project incorporates these features to address the problems faced by both the consumers and the distribution companies.

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