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# Design and Development of SMS Prepaid Energy Meter

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***ABSTRACT:*** *This paper presents a prepaid energy meter to facilitate energy consumption measurement and to know consumer's maximum demand. 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 energy billing system used nowadays are labour and time consuming. Errors are inevitable at every stage of billing, some are human errors while noting down the meter readings, errors while processing the paid bills and the due bills. There is no proper way to know the consumer's maximum demand, usage details. This paper demonstrates the use of prepaid energy meter system. If we use this system it will be beneficial for the consumer to manage power. It is easy to operate and cost effective. Another advantage of the prepaid system is that the human errors in taking meter readings and processing bills can be reduced to a large extent.*

***Keywords:*** *Billing, Volatge, Current, LCD, AVR, Microcontroller*

## I. Introduction

Electricity meters operate by continuously measuring the instantaneous voltage (volts) and current (amperes). The product of which gives the instantaneous electrical power (watts) which is then integrated against time to give energy used . 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; Omijeh, 2012)

In recent years, Nigerian power sector has been facing a serious problem of lean revenue collection with respect to energy supplied due to energy thefts and network losses. It is observed that one of the faulty subsystems is the metering and meter-reading system, which has to improve, if revenue collection is to be increased (Nwaoko, 2006).

Electric energy meters is the direct billing interface between utility grid and consumers and it undergone several advancements in the last decade. The trend of the time has always been in favor of that technology which finally become cost effective as well as an elegant one. Traditional meter reading is done by the human operator, this require a more number of labor operator and long working hour to achieve the complete area data reading and billing. The major drawback of traditional billing system is power and energy theft. In postpaid system, there is no control use of electricity from the consumer's side, and there is a lot of wastage of power in the consumer's side due to lack of planning of electrical consumption in an efficient way This drawback is reduced by using a prepaid energy meter which is based on the concept "Pay first and then use it" (Schwendtner, 1996; Jawarkar, 2008). Due to the increase in the development of residential and commercial buildings, the meter reading task increases which requires more number of human operators. In order to achieve efficient meter reading, reduce billing error and operation cost, automatic meter reading system play an important role.

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 Works

(Zhang, et al, 1998) utilized a DSP-based meter to measure the electricity consumption of multiple users in a residential area. A Personal Computer (PC) at the control centre was used to send commands to a remote meter, which in turn transmitted data back, using the power Line Communication (PLC) technique. The major problem with this system is that it cannot detect tampering by consumers.

(Koay et al, 2003) in their work, designed and implemented a Bluetooth energy meter where several meters are in close proximity, communicated wirelessly with a Master PC. Distance coverage is a major set-back for this kind of system because the Bluetooth technology works effectively at close range.

In their paper, (Scaradozzi, 2003) viewed home- automation systems as Multiple Agent Systems (MAS). Home automation system was proposed where by home appliances and devices are controlled and maintained for home management. It is only a home management system and does not measure the amount of energy consumed by users.

(Hong et al, 2005) in their paper**,** proposed the use of Automatic Meter Reading (AMR) using wireless networks. Some commercial AMR products use the internet for data transmission.

(Stanescu et al, 2006) present a design and implementation of SMS -based control for monitoring systems. The paper has three modules involving sensing unit for monitoring the complex applications. The SMS is used for status reporting such as power failure. Issues on billing system for electricity board usage were not considered.

(Malik et al,2009) in their paper, mainly focused on the controlling of home appliances remotely and providing security when the user is away from the place using an SMS- based wireless Home Appliance Control.

## III. Methodology

The following algorithm were used for the implementation

### 3.1 Algorithm for Energy Metering system at consumer's end

1. Start
2. Initialize the display and RTC.
3. Display date and time.
4. Check GSM Connection and set to Text Mode.
5. If GSM disconnected, display that on LCD and turn LED OFF, otherwise turn ON.
6. Receive User number and set it for communication.
7. Decide whether the number of units in Microcontroller is sufficient or not. If the balance is insufficient then disconnect the load from supply and send message to user number notifying of balance recharge otherwise connect to the load to supply.
8. Count the number of pulses initiated from inbuilt ADC when the load consumes power.
9. Measure time with the help of timer1.
10. Calculate power, $P$ =3000x$X$ using this equation, where X denotes the frequency of pulses that is produced by the microcontroller.
11. Calculate energy
12. Store energy and power reading into the EEPROM of ATmega32 Microcontroller for future use.
13. Check for updates from GSM for rate updates according to real time.

### 3.2 Development of the Software

For the software part we use an algorithm and is given below

i) The controller continuously scans the ports which receive inputs from maximum demand section and optical section.
ii) 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.
iii) When the total unit finishes, after that the tripping relay is activated to disconnect the power.
iv) If the maximum demand section gives a pulse then it activates the tripping mechanism.

Continuously the controller rechecks the maximum demand section and regains the power when load is reduced

### 3.3 Algorithm used for the implementation

Step 1. Initialize display
Step 2. Check balance (B) stored in EEPROM. If B=0, go to Step13.
Step 3. Count no. Of pulse initiated from IC AD7751 with the help of counter and time by timer.
Step 4. Calculate power (P) and Energy (E) units.
Step 5. Perform B=B-E and stored B in EEPROM.
Step 6. If B=50, go to step11, otherwise go to step2.
Step 7. If SMS received check the no. From which SMS came.
Step 8. If SMS coming from unknown number go to step12.

Step 9. If SMS from known number with valid command, form B=B+R and stored B in EEPROM, where R= recharge amount.
Step 10. Sent SMS to Customer "Recharge Successful" and go to step12.
Step 11. Sent SMS to customer "Keep Sufficient balance to avail uninterrupted service".
Step 12. Delete SMS. Go to step2.
Step 13. Stop relay. Sent SMS to customer"Power off due to zero balance".

### 3.4 DESIGN OF A VOLTAGE SENSING DEVICE.

The voltage sensor is needed to measure voltage and the phase angle of the voltage across the load accurately, and is expected to behave linearly in some specific voltage range. The voltage sensor module was designed to be connected to the main power on the input side and to the Energy Meter IC on the output side

### 3.5 DESIGN OF A CURRENT SENSING DEVICE

The current sensor is needed to monitor the current flow by measuring and reporting the actual current usage and the current phase angle to the microcontroller. It is also needed to operate accurately and linearly in order to obtain the accurate usage and consequently the accurate power usage. It is expected to be able to hold the maximum current of 10 Amperes. The current sensor was designed to connect directly to the load on the input side and to the Energy Meter IC on the output side. The input to the entity is the value of the voltage drop across a shunt resistor and the output to the meter IC is the voltage that is proportional to the input voltage. The ratio of the input and output voltage would depend on the model of the current transformer used in the circuit

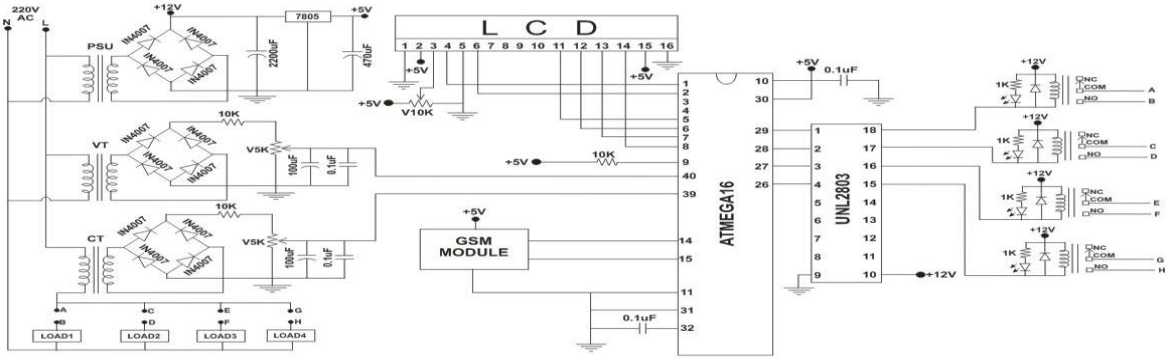


Figure 1: Complete Circuit Diagram of the SMS Prepaid Energy Meter
Source: designed and impleneted with Labview (www.labview.com)

## 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 one 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 by proposed prepaid Energy meter. Here power =60 watt
Table 1: Energy Output

| Time (Sec) | Measiured Energy Value (kw) | Intelligent EnergyValue(kw) |
|---|---|---|
| 0 | 0 | 0 |
| 10 | 120 | 125 |
| 20 | 235 | 245 |
| 30 | 350 | 355 |
| 40 | 495 | 485 |
| 50 | 6000 | 6000 |
| 60 | 7100 | 7200 |
| 70 | 8500 | 8400 |
| 80 | 8700 | 8650 |
| 90 | 9000 | 8970 |
| 100 | 9800 | 9824 |

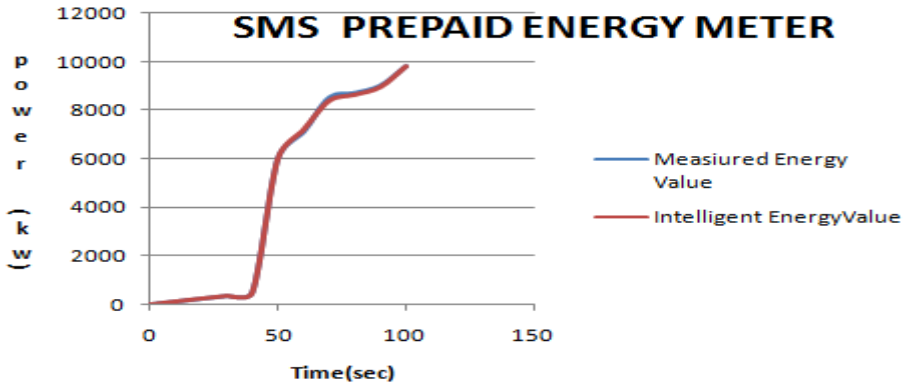


Figure 2: Power output Analysis

From Figure 2 above, the blue symbol (expected energy) is the measured value, the system calculate the energy consumption automatically by using current sensor to get the current readings and voltage sensor to get the voltage readings. The result was then store in log over certain period of time to get the energy consumption. The brown symbol is the intelligence. It can be proved that the intelligence shows slight variation with the manual system

## V. CONCLUSION AND RECOMMENDATION

### 5.1 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.

### 5.2 Recommendation

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 paper incorporates these features to address the problems faced by both the consumers and the distribution companies.

## Reference

[1]. Amit, J. and Mohnish, B. (2011). A prepaid meter using mobile communication. *International Journal of Engineering, Science and Technology-Vol. 3( No. 3), pp. 160- 166.*

[2] Farhangi, H. (2010).The path of the smart grid. *Power and Energy Magazine, IEEE. Vol. 8*,pp 58.

[3] Hong. L. and Ning.L. (2004). Design and Implementation of Remote Intelligent Management System for City Energy Resources base on Wireless Network. *Study of Computer Application Vol 12* pp 237-239.

[4] Kistler R., , Knauth S., and Klapporth, A. *EnerBee (*2008).– *Example of an Advanced Metering Infrastructure based on ZigBee.* Munich, Germany : s.n.,. pp. 1-11.

[5] Koay .B.S, Cheah.S.S, Sng .Y.H,Chong. P.H.J, Shun.P,Tong.Y.C (2003) . Design and implementation of a Blue tooth energy meter. *proceedings of the Joint 4th International Conference on Information, Communication and Signal Processing and the 4th Pacific Rim Conference on Multimedia* .3: 1474-1477.

[6] Long Z.X., Yuan F.M and Qingdao, Y.N. (2010) Impact of smart metering on energy efficiency. *International Conference on Machine Learning and Cybernetics*(ICMLC). pp. 3213 - 3218 .

[7] Maheswari, C; Jejanthi, R (2009). Implementation of Energy Management Structure for street Lighting System. *A Journal of Modern Applied Science* 5:6-10.

[8] Malik S.H ., Aihab. K, and Erum .S (2009). SMS Based Wireless Home Appliance Control System (HACS) for Automating Appliances and Security. *Issue in informing Science and Information Technology* 6:887-894.

[9] Nwaoko K.J. (2006).*Electrical Energy Accounting methods*, Lagos: Impressed publishers pp30-40

[10] Rodney, H. G., Lee, C.H. and Mok V. H. (2007), Automatic power meter Reading System Using GSM IEEE 8th International power engineering conference.

[11] Scaradozzi, D. and Conte, G. (2003). Viewing home automat ion systems as multiple agents systems. *RoboCUP2003*, Padova, Italy. Retrieved from http://www.robosiri.it/ROBOCUP_2003/ROBOCUPSITOSIRI/articles/pdf/Conte.pdf

[12] Shang L.W. 2009, Development of a smart power meter for AMI based on ZigBee communication . Taipei : IEEE, 2-5 Nov. *International Conference on Power Electronics and Drive Systems.* pp. 661 – 665

[13] Shwehdi.M.H. and Jackson.C (1996). A microprocessor based digital wattmeter system design. *proceedings of the 31st Intersociety Conference on Energy Conversion Engineering* 31 pp 1840-1845.

[14] Stanescu, D., Ciubotaru-Petrescu, B., Chiciudean, D., Cioarga, R.. (2006). Wireless Solutions for Telemetry in Civil Equipment and Infrastructure Monitoring. *3rd Romanian-Hungarian Joint Symposium on Applied Computational Intelligence (SACI)* . Retrieved from http://www.bmf.hu/conferences/saci2006/Ciubotaru.pdf

[15] Sharma.S and Shoeb.S. (2011)- Design and Implementation of wireless automatic meter reading system . *International Journal of Engineering Science and Technology (IJEST)*- Vol. 3, No. 3,March 2011, pp. 2329-2334.

[16] Zhang.J, Oghanna and Bai.C.L (1998). DSP based electricity meter with remote reading. *proceedings of the 4th International Conference on Signal Processing* 2 :1581-1584