Volume No:4, Issue No:5 (May-2019) ISSN No : 2455–7595 (Online)
International Journal of Research in Management Studies
A Peer Reviewed Open Access International Journal
www.ijrms

AMR and GSM based Energy smart meter reading for billing purpose

M Shankar[1] K Rajesh Kumar[2] G Satish Goud[3] D Nilima Rani[4]

[1]Associate professor, Dept.of EEE, Siddhartha Institute of Engineering & Technology, Ibrahimpatnam, Hyderabad, Telangana, India.
[2]Associate professor, Dept.of EEE, Siddhartha Institute of Engineering & Technology, Ibrahimpatnam, Hyderabad, Telangana, India.
[3]Associate professor, Dept.of EEE, Siddhartha Institute of Engineering & Technology, Ibrahimpatnam, Hyderabad, Telangana, India.
[4]Student, Dept.of EEE, Siddhartha Institute of Engineering & Technology, Ibrahimpatnam, Hyderabad, Telangana, India.

Abstract

Energy theft is a very common problem in countries like India where consumers of energy are increasing consistently as the population increases. Utilities in electricity system are destroying the amounts of revenue each year due to energy theft. The newly designed AMR used for energy measurements reveal the concept and working of new automated power metering system but this increased the Electricity theft forms administrative losses because of not regular interval checkout at the consumer's residence. This research study proposed the design and construction of a microcontroller based electric energy metering system using the Global System for Mobile communication (GSM) network. This system provides solution to the irregularities posed by the traditional metering technique by allowing the utility provider have access to remote monitoring capabilities, full control over consumer load, and remote power disconnection in the case of energy theft. Proteus simulation software was used to model the system hardware and the software was obtained by using embedded C programming and visual basic. It was observed that the system could remotely take accurate energy readings, provided full control over consumer loads and execute remote disconnection in case of energy theft. The system provides high performance and high accuracy in power monitoring and power management.

Keywords: GSM, Automatic Energy metering, Load Control, Energy Theft.

I. INTRODUCTION

Utility billing is yet unavoidable in the World as for concern post-paid energy meter. In Pakistan, utilities are using a conventional way of billing. A meter reader goes Home to home takes the meter reading and note down it, manually. These readings are brought to utility administration office. The criterion of utility billing is applied according to the utility service rules and regulations. The employee of the utility goes door to door again and gave the bill slips of the utility to the respective consumer. [1-3]

Detailed load flow can be provided by smart energy meters to the consumers so they can manage their load effectively [4]. Smart energy meter are used for Automatic Meter Reading (AMR) to increase the accuracy of meter reading. For instance, a utility person might not read the correct value of the total energy consumed that is displayed on energy meter or may intentionally give lower value than the exactly read one [5]. Power Line Communication (PLC) can also be used for obtaining the meter readings but interference and noise makes it inadequate.

Cite this article as: M Shankar, K Rajesh Kumar, G Satish Goud & D Nilima Rani, "AMR and GSM based Energy smart meter reading for billing purpose", International Journal of Research in Management Studies, Volume 4 Issue 5, 2019, Page 15-21.

Volume No:4, Issue No:5 (May-2019) ISSN No : 2455–7595 (Online)
International Journal of Research in Management Studies
A Peer Reviewed Open Access International Journal
www.ijrms

Metering information can be transmitted via Wi-Fi and Zig-Bee but their range is limited and they do not provide a cost effective solution [6]. However for lager remote distance GSM communication system is much efficient than others.

Auto billing is one of the suitable ways to overcome the flaws of conventional billing; since conventional billing contains wastage of time and resources as well. In auto billing there is no more need of manual meter reading and bill slips.

1.1 FLAWS IN CONVENTIONAL BILLING

There are many flaws and errors in conventional billing. Some human mistakes may also occur in manual billing. Analysing the conventional billing some of the common observed errors and mistakes are:

- It's a time consuming procedure
- There is always a chance of human error while taking the manual meter reading
- There is no check and balance and verification procedure of this meter reading
- There is always a chance of theft and corruption
- Extra human power is required
- Consumer is not updated of his usage
- Consumer may not get the bill slip within due date

II. SMART ENERGY METER

The size of smart meters and traditional meters is same and smart meters are digital [7]. Smart Energy Meter measures more detailed readings than Kwhr so that utility can plan the expansion of network and power quality [8], [9],[10]. The Smart Energy Meter is designed so that it measures voltage and load currents by the use of voltage and current sensors instead of potential and current transformers and then feeds these values of voltage and current into power factor controller IC and energy metering IC the power factor and power calculations respectively [11].

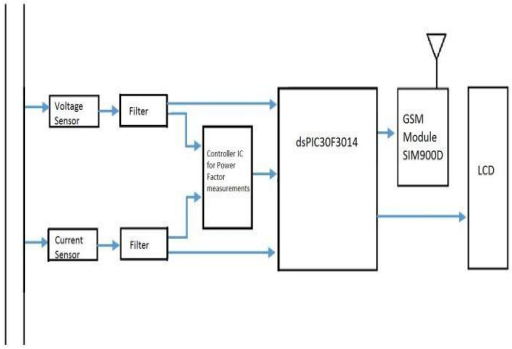

Figure 1. Simple block diagram of Smart Energy Meter.

The design of Smart Energy Meter involves the measuring of load current and voltage using sensors and then feeding them to energy metering IC which converts it into the real power consumed by the load. Power factor is measured by measuring the phase shift between voltage and load current. Microcontroller used to perform the calculations related to power and energy consumed and shows the reading on LCD as well as it sends the reading of Smart Energy Meter with the help of GSM modem [12]. Active power, reactive power, voltage, load current, power factor and units (kWh) are measured and displayed successfully. Meter reading are sent from GSM modem and received on mobile successfully. Two-way communication is done by smart energy meter between the meter and utility administration as well as between meter and customer so that customer is able to check the status of his consumed energy units and can manage his load accordingly to reduce his bill. [13], [14]. The main

Volume No:4, Issue No:5 (May-2019) ISSN No : 2455–7595 (Online)
International Journal of Research in Management Studies
A Peer Reviewed Open Access International Journal
www.ijrms

features of smart energy meter are listed as follows;

- Get automatic reading of Energy Meter and sent it to consumer as well as to utility.
- In reading it measures Voltage, Load Current, Real power, Reactive power, Power factor and units consumed.
- Utility is able to cut off/restore the supply of the defaulter through SMS.
- Smart Energy Meter responds to the SMS and sends you back the readings whenever it is asked.
- Consumer is able to check the status of his load from anywhere in the world by SMS.

Working of Smart Meter

GSM communications network is used to transfer the electricity consumed data to the utility administration as well as to the customer when demanded. Antenna, attached on or near meter box, can be used for improvement of signal strength in GSM communication.

Smart metering communication is centralized meter reading, so meter readers don't need to visit each customer for data collection. However, for testing and maintenance meters may need to observe occasionally.

The main duty of Smart Energy Meter is to measure the meter reading and sends it to utility when demand as well as to costumer. The voltage and current sensors measure the RMS values of voltage and current and feed them to microcontroller, where calculations for active and reactive power are performed. In Smart Energy Meter we used sensors to measure voltage and current instead of current and voltage transformers. The reading from Utility administration SMS is being received by smart energy meter programmable interface and the action is performed by the meter according to provided information.

A major feature of Smart Energy Meter is that utility company can cut off and reconnect the connection of energy of any user with the help of SMS without sending the person to perform the task manually [15]. It can be utilized in case when the utility company needs to disconnect a consumer due to non-payment of bills or some other reasons. Another major feature of Smart energy meter is that it gives alarm when the consumer load is exceeding the upper limit for which he got the utility connection. In case consumer does not reduce his load meter automatically cut off the consumer connection. GSM communications network is used to transfer the electricity consumed data to the utility administration as well as to the customer when demanded. Antenna, attached on or near meter box, can be used for improvement of signal strength in GSM communication.

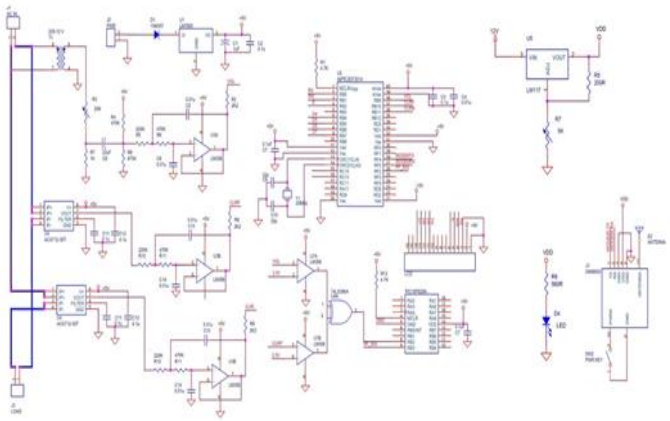

Figure 2: Detailed Circuit diagram of Smart Energy Meter

Volume No:4, Issue No:5 (May-2019)
ISSN No : 2455–7595 (Online)
International Journal of Research in Management Studies
A Peer Reviewed Open Access International Journal
www.ijrms

Smart Energy Meter is comprised of three main parts:

A. Voltage and current measurements
B. Power factor measurements
C. GSM portion

A) Voltage and current measurements.

In our project we used current and voltage sensor to measure voltage and load current. We used ACS712ELC-20A as current sensor that gives us RMS value of currents. Both AC and DC signals current measurement is precisely obtained by this current sensor. Current is measured by this sensor up to 20A. Overall power consumption, metering and measurements are taken by these sensors. Sensitive measurements of current are handled by using OPAMP stage. By adjusting the gain we measure very small currents. ACS712ELC-20A output voltage has linear variation with measured currents. Similarly we measured voltage by ACS712ELC-20A.

B) Power factor measurements.

Power factor is the cosine of angle between voltage and current. It actually measures how effectively the power is being converted into useful work. In our project we measured it by taking XOR of voltage and current waves with the help of microcontroller and LM358. We used LM 358 to convert weak sinusoidal signals to large square signals.

After XOR we get signal of double frequency as shown in figure 4 (c). We calculated the time of XOR signal and it is the power factor [16]. For 50Hz the output of XOR can be 10 ms if power factor is 0. And "0" if power factor is unity. So the output of XOR lies between 0 -1 for a certain value of power factor.

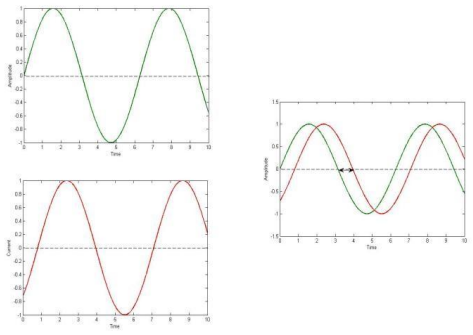

Figure 3(a) Figure 3(b

Figure 3(a) The sine wave of voltage and current.
Figure 3(b) Showing the phase difference between voltage and current

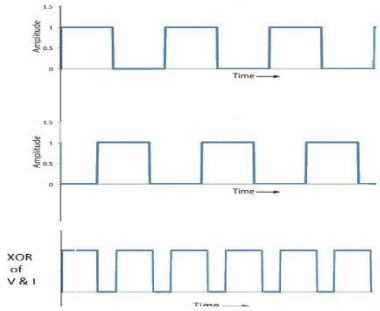

Fig. 4 (a,b & c). The square wave of voltage and current and their resultant after XOR operation.

C) Wireless portion.

There are many technologies that are being used for AMR as Power Line Carrier (PLC) communications, Supervisory Control And Data Acquisition (SCADA), telephone modem, internet, Ethernet, Embeded RF Module, WiFi, Bluetooth, and ZigBee.

Volume No:4, Issue No:5 (May-2019)
ISSN No : 2455–7595 (Online)
International Journal of Research in Management Studies
A Peer Reviewed Open Access International Journal
www.ijrms

Power Line Carrier (PLC) and Telephone Line Network are the example of wire-based AMR system and GSM and Bluetooth are the examples of wireless AMR system. The transmission system of Smart Energy Meter utilizes the existing GSM network. A GSM modem is used as mobile equipment/ Data Communication Equipment to send the information regarding the numbers of units of electricity consumed to our desired mobile number. We used SIM900 GSM modem in our project. A SIM is used inside the modem for data communication. Power Line Communication (PLC) can also be used for obtaining the meter readings but interference and noise makes it inadequate. Metering information can be transmitted via Wi-Fi and ZigBee but their range is limited and they do not provide a cost effective solution. However for lager remote distance GSM communication system is much efficient.

III. GSM-Wed Services based Automatic Metering System

Xiaoliang et al. (2010) designed a GPRS and web based automatic metering system. The system utilizes the internet and GSM modules to monitor electricity consumption. The strength of the work is the ability to obtain real time data from energy meters and its supports for wide coverage area communication and easy maintenance. The system is however, capital intensive due to the cost of managing and maintaining a web services.

Automatic Metering System

Based on WIMAX Technology a WIMAX technology based Automatic Metering System. The system was divided into four units and the strength include: high performance, high data rate and high coverage area. The WIMAX technology provides AMRS process with good efficiency and reliability, however it is complex to implement and capital intensive.

Power Line Carrier-Based Automatic Metering System

A PLC-based automatic metering system which allows data from energy meter to be sent over existing electric power lines. The strength of the system is the usage of limited cables for communication since it allows the use of existing electric power cables. Therefore, controlling, monitoring, and transfer of consumers energy data is made possible via existing power lines. The major disadvantage of PLC technology is signal interference and the inability to transmit data on high voltage side of a power system. However, our proposed system was designed to mitigate the following limitations as identified by existing literatures: (1) Reduces management, maintenance, and startup cost significantly. (2) Incorporating energy theft detection system through remote disconnection. (3) Effective data transfer speed with better coverage when compared with Bluetooth and ZigBee technology. (4) Reduces design complexity and easy to deploy when compared with the microprocessor-based AMS.

IV. TESTING AND RESULTS

The accuracy of Smart Energy Meter is checked by comparing the readings that are displayed on the LCD of SEM and that are received by SMS. Smart Energy Meter is also checked by connecting and disconnecting the customer's connection. We connected different loads 100W, 200W, and 1000W and checked its performance.

Volume No:4, Issue No:5 (May-2019) ISSN No : 2455–7595 (Online)
International Journal of Research in Management Studies
A Peer Reviewed Open Access International Journal
www.ijrms

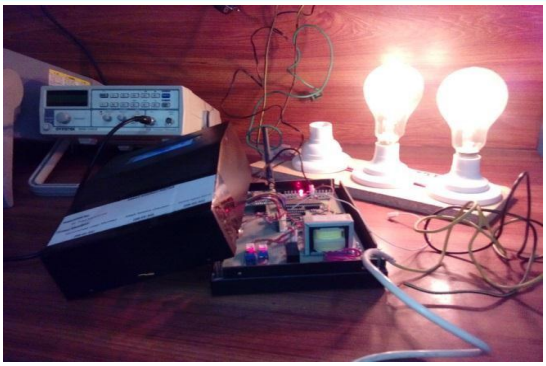

Figure 5: Smart Energy Meter in working

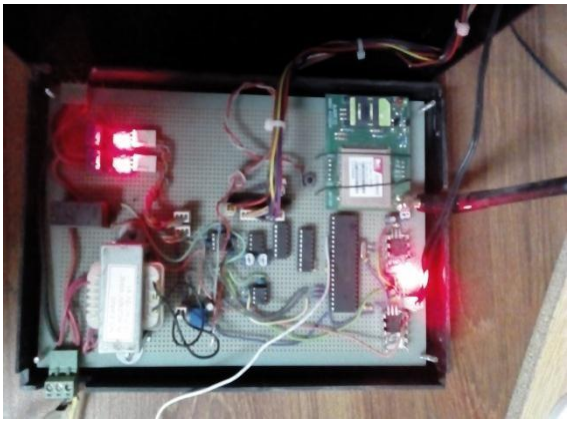

Figure 6: The internal circuitry of Smart Energy Meter.

The testing of SEM provided accurate results, hence verifying the performance and accuracy of the system.

V. CONCLUSION

An Automatic metering system using GSM technology (AMS_GSM) was designed, implemented and tested. This system gives a revolutionary advancement in the innovation of energy metering which considers the concept of a two-way wireless communication technique and accurate measurement of electric energy used by a consumer load. The testing shows the accuracy of the practical testing values to the expected testing values hence, energy meter could have better accuracy reading and energy calculations. Therefore, this study also contributes to the development of smart grids to make the delivery of electric energy reliable and properly accounted for. Challenges encountered during the implementation are the difficulty in analyzing and calculating the necessary values and results required for this study. Future research can be carried out by using smart energy metering IC such as ADE7166 or ADE7169 to interface directly to an LCD thereby eliminating the use of a microcontroller which can be difficult to program and incorporating method like inspection and comparison energy theft detection instead of bypass detection used in this research study**.**

REFERENCES

[1]. Vinu V Das, "Wireless Communication System for Energy Meter Reading*" International Conference on Advances in Recent Technologies in Communication and Computing 2009.*

[2]. Ashna.k , Sudhish N George. "GSM Based Automatic Energy Meter Reading System with Instant Billing" *978-1-4673-5090-7©2013 IEEE*

[3]. Liting Cao, Jingwen Tian and Dahang Zhang "Networked Remote MeterReading System Based on Wireless Communication Technology" *IEEE*

[4]. *International Conference on Information Acquisition, August 20 - 23, 2006, Weihai, Shandong, China*

[5]. A. Arif , Muhannad AI-Hussain, Nawaf AI-Mutairi, "Experimental Study and Design of Smart Energy Meter for the Smart Grid" *978-1-4673-63747©2013 IEEE*

[6]. Ashna.k ,Sudhish N George. "GSM Based Automatic Energy Meter Reading

System with Instant Billing" *978-1-4673-5090-7©2013 IEEE.*

[7]. Adnan Rashdi, R. Malik, S. Rashid, A. Ajmal, S. Sadiq , "*Remote Energy*

[8]. *Monitoring, Profiling and Control Through GSM Network", International Conference on Innovations in Information Technology (IIT) 2012.*

[9]. Smart meter Implementation Strategy Prospectus. July 2010. DECC, Ofgem/Ofgem E-Serve.

[10]. T. Chandler, "The technology development of automatic metering and monitoring systems," in *IEEE International Power Eng. Conf., Dec. 2005.* [9] G. T. Heydt, "Virtual surrounding face geocasting in wireless ad hoc and sensor networks," *Electric Power Quality: A Tutorial Introduction, vol. 11, no. 1, pp. 15–19, Jan. 1998.*

[11]. M. Faisal and A. Mohamed, "A new technique for power quality based condition monitoring," *in 17th Conf. Electrical Power Supply Industry, Oct. 2008.*

[12]. P. RakeshMalhotra, Dr.R.Seethalakshmi "Automatic Meter Reading and Theft Control System by Using GSM P*".RakeshMalhotra et al. / International Journal of Engineering and Technology (IJET).*

[13]. H. Tan, H. Lee, , and V. Mok, "Automatic power meter reading system using GSM network," in *IEEE International Power Eng. Conf., Dec. 2007.*

[14]. J. Surrat, "Integration of cebus with utility load management and automatic meter reading," in *IEEE Trans. Consumer Electron., vol. 37,no. 3, Aug. 1991, pp. 406–412.*

[15]. A. Abdollahi, M. Dehghani, and N. Zamanzadeh, "SMS-based reconfigurable automatic meter reading system," *in IEEE International Conf. Control Appl., Oct. 2007.*

[16]. Tarek Khalifa, Kshirasagar Naik and Amiya Nayak "A Survey of Communication Protocols for Automatic Meter Reading Applications" in *IEEE Communications Surveys & Tutorials, vol. 13, no. 2, second quarter 2011.*