Journal of Chemical and Pharmaceutical Sciences ISSN: 0974-2115

PLC Based Smart Meter for Effective Energy Management

P.RajaRajeswari, M.Devi, Dr.M.Sasikumar
EEE Department Jeppiaar Engineering College, Anna University, Chennai,India
***Corresponding author: E.mail:praji81@yahoo.co.in,**

ABSTRACT

This paper deals with the design of a power line communication based smart- meter for measuring the energy consumption in home. PLC based smart meter replaces the current GSM based smart meter which requires a separate network. PLC does not require a separate communication line and can be easily installed by power line infrastructure. So PLC communication can be used for remote meter reading and in automatic control. The smart-meter saves the cost of human meter reader and the resulting mistakes and also the cost of laying separate lines for remote meter reading or modem. We can also interface our laptop our computer with the smart-meter which gives us details of electrical usage, quality of power(lag or lead) consumed and it also gives us guidelines about efficient usage of power. The smart meter is also designed to automatically switch over the phases for efficient consumption of energy.

Keywords: Power line carrier communication; GSM; smart meter

INTRODUCTION

The major problem our country facing today is power crisis. Even though many power plants are being constructed, the effective way of usage of power forms a major concern. The chronic shortage of power in India has resulted in many blackouts recently. Now the gap between the generation and load demand has increased more than 10%. Considering losses, the non-technical losses can be reduced to greater extent by effective management of energy. Losses are of two type technical and non-technical losses, in which a high proportion of non-technical losses are caused due to electricity theft and faulty energy meter that under estimate the actual consumption of energy. The present existing system can't cope up with the non-technical losses incurred. In order to effectively use the present energy there are many technologies available like inclusion of renewable resources in home, advance metering infrastructure and others.

Smart meter (S.Nthin, 2009) is a type of advance metering infrastructure. It automates most of the metering centered repetitive activities. Deploying a smart-metering infrastructure is an early step of grid modernization. Compared with traditional meters more important data could be measured and stored using smart meters. Smart-metering is not a single technology but an integration of many technologies that provide an intelligent connection between the consumers and system operators. Electrical theft forms a major part of non-technical losses which can be totally reduced by smart-meters. It is more convenient to implement the smart meter using Power Line Communication (PLC) because it is devoid of the requirement of separate communication lines and it can be easily installed. Smart-meter is enabled by two way communication between the meter and the central system (sub -station).

Proposed system: An innovative replacement to this conventional energy meter is smart meter. Smart meter is an infrastructure of metering systems. It automates most of the metering centered repetitive activities. Deploying a smart-metering infrastructure is an early step of grid modernization. Compared with traditional meters more important data could be measured and stored using smart meters. Smart-metering is not a single technology but an integration of many technologies that provide an intelligent connection between the consumers and system operators. Electrical theft forms a major part of non-technical losses which can be totally reduced by smart-meters. It is more convenient to implement the smart meter using Power Line Carrier Communication (PLCC) because it is devoid of the requirement of separate communication lines and it can be easily installed. Smart-meter is enabled by two way communication between the meter and the central system (sub -station). It also involves in real time sensors, power outage notification and power-quality monitoring.

Block diagram: The smart meter is controlled by the control signals given by the micro-controller. The micro-controller is so programmed according to the specifications and features needed. It performs real time monitoring of all the necessary conditions of the smart meter and displays it directly in the sub-station.

Features of smart meter: The smart meter (Sungwook Kim, 2011) is designed using Power line carrier communication. It is used to transfer information between substation and home. PLCC can be easily installed using

Journal of Chemical and Pharmaceutical Sciences ISSN: 0974-2115

power line infrastructure and there is no need of separate communication line. The features of smart meter are explained below.

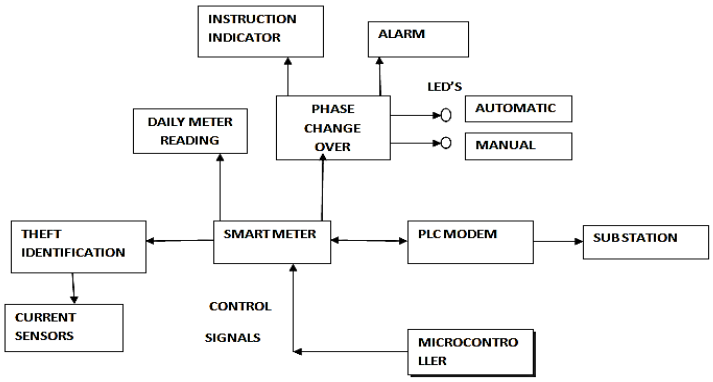

Figure.1.Block Diagram of smart meter controller

(a)Daily meter reading: Like conventional meters, Smart Meters also measures the amount of energy consumption. But whereas conventional meters must be read manually, and the consumption calculated since the last reading, Smart Meters provide specific information on how much energy was consumed, when it was consumed and at what tariff – a continuous calculation that conventional meters are incapable of. Provided with detailed operational data the network operator is also able to decrease the cost to serve, by targeting investment in the network more accurately and thus maximizing the benefits of system reinforcement. This is an important function of smart meter. The consumer is able to know his daily consumption of energy from the LCD display on hourly basis. Based upon this the consumer can himself manage the load for effective energy management. Smart Metering will revolutionize the availability and usefulness of consumption data. It will empower consumers, raise customers' awareness of their energy and water use and allow them to make informed decisions on heating, lighting and appliance upgrades. Ultimately this will lead to a significant change in consumer behavior towards sustainable consumption patterns.

(b) Phase change over: This is managing energy networks by better shifting consumption of energy to other phases for demand side management. The smart meter is able to detect the overload in a phase and it can automatically switch over to other phases in which there is low consumption of energy. By doing this the load will be equally distributed in all phases so that the reliance on single phase is reduced and it leads to effective management of energy. The meter communications is used to warn customers in advance before peak rates apply.

(c) Online billing: Smart meter enables to read the consumption data remotely and tariffs can be updated remotely. Smart Metering provides a communication gateway that functions as an interface between devices in the home and provides customers with real time data. More quantities and larger amounts of data can be stored until collected and meters can also be re-programmed or re-configured remotely. Smart meter can be interfaced with computer and the customers can view their bills with website portals. With data provided by Smart Metering technologies these can be made much richer environments where customers can benchmark their consumption and carry out analysis on energy-saving investments.

(d)Online feedback: Smart Metering will provide new energy consumption feedback routes. The local communications interface allows data to be streamed directly to displays in the houses through Lab view software application. This data can be provided in real time at very short intervals so that customers can immediately see the effect of turning individual appliances on and off. This will enable customers to understand in much greater detail the way they use energy and the relative impact of different appliances. The data can also be converted to currency to increase its relevance to the customer. Alarms are set that alert the consumers when there is unusually high consumption. Giving customers direct feedback on their energy usage will enable them to reduce their consumption without affecting their quality of life. Using this information, consumers can understand and modify their relationship to energy use and take control

(e) Theft identification: Apart from technical losses, non-technical losses are of major concern. Electricity theft is one type of non-technical losses which has drastic impact on the distributed energy. The smart metering technology

is used for theft identification. The secondary of the distribution transformer is connected with a controller, which has an account of the energy distributed from the transformer and compares the value with the sum of the readings from the smart meter neglecting the negligible losses. Thus it gives the theft occurring signal to individual homes and to the substation.

Simulation results:

(a) Phase change over:

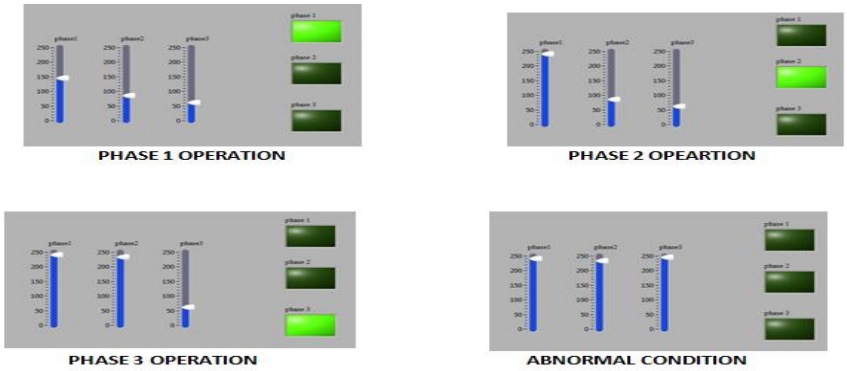

Fig.2.Phase change over

Normally it operates in phase 1, if the load on the phase 1 exceeds a threshold limit, it automatically switches over to phase 2. Similarly if the load on the phase 2 exceeds a limit, then it switches over to phase 3. If the loads on all the three phases are high usually under abnormal conditions, the whole supply is cutoff.

(b) Theft detection:

Figure.3.Theft Detection

The theft is detected by connecting two current sensors at both the ends of the smart meter. The current at both the ends are measured, if unequal amount is suspected, then theft occurring signal is given.The smart meter is controlled by the control signals given by the micro-controller. The micro-controller is so programmed according to the specifications and features needed. It performs real time monitoring of all the necessary conditions of the smart meter and displays it directly in the sub-station.

Hardware working model:

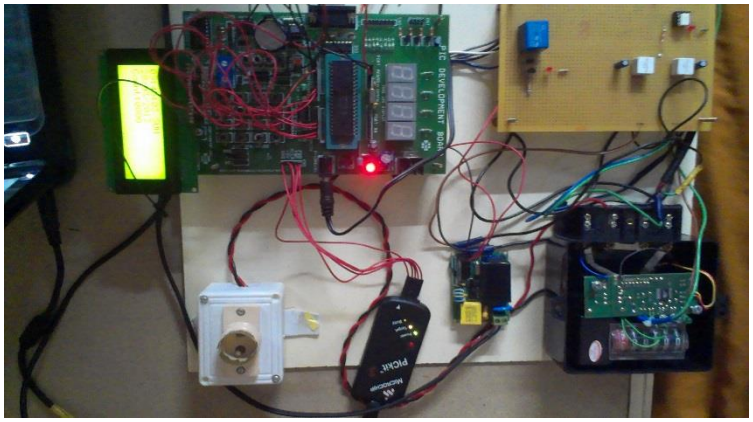

Figure.4.Hardware prototype

Future scope: With the introduction of OFDM (Orthogonal Frequency Division Multiplex) PLC, the communication speed of smart metering applications will increase dramatically. While today's PLC technologies offer a physical layer throughput of 2 to 5kbps, the new OFDM PLC will have its throughput increased by a factor

of 10.

REFERENCES

Kwang-il Hwang, "Fault-tolerant ZigBee-based Automatic Meter Reading Infrastructure", Journal of Information Processing Systems, Vol.5, No.4, pp. 221-228, 2009

Kwang-il Hwang, Doo Soon Park, Sang-Soo Yeo, Jong Hyuk Park, "Energy-Efficient Meter Data Aggregation Protocol for (AMR) Automatic Meter Reading Networks", In Proceedings of 4th International Conference on Embedded and Multimedia Computing, Em-Com 2009, pp. 1-6, 2009

Li Quan-Xi, Li Gang, "Design of remote automatic meter reading system based on ZigBee and GPRS", In Proceedings of Third International Symposium on Computer Science and Computational Technology (ISCSCT' 10), pp. 186-189, 2010

Priya S. Kamble, Sonali T. Bodkhe, "A new approach for design and implementation of AMR in Smart Meter", International Journal of Advanced Engineering Sciences and Technologies, Vo. 2, Issue 1, pp. 57-61, 2010

Tat-Wai Chan, Tian-Yew Lim, "Automating KWH Meter Reading Through Power Lines for High-Rise Public Housing Estates in Singapore", Journal of Electrical&Electronics Engineering, Vol. 21, Issue 1, pp. 1-6, 2001

Yasser Fathi, Tamer A. Kawady, Ahmed Husein, Mohamed El-Geziry, "Practical Issues of Power Line Communication for Automatic Meter Reading Systems", In Proceedings of 14th International Middle East Power System Conference (MEPCON' 10), pp. 634-640, 2010