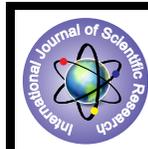


Design and Implementation of Wireless Automatic Electricity Meter Reading System Using ZIGBEE with Theft Detection Application



Engineering

KEYWORDS : ZigBee; Electricity e-Billing ;

1Mr.Pandurang G. Kate

Lecturer, Department of Electrical Engineering, MIT, Polytechnic, Aurangabad

2Mr. Jitendra R. Rana

Assistant Professor, Department of Electrical, Electronics & Power, Jawaharlal Nehru Engineering College, Aurangabad

ABSTRACT

Traditional method for meter reading forelectricity consumption and billing is done byhuman operator from building to building. This requires large number of man power and long working time to achieve complete area data reading and billing. Human operator billing may have error . This concept is to reduce the time delay ,errors and theft of electricity. .The power management system is consists of Zigbee Digital Power meters installed in every consumer unit and an Electricity e-Billing system at the energy provider side. The ZigBee is used since the application don't need high speed data rate, need to be low powered and low cost .The Zigbee Digital Power meters utilize the Wireless sensor network to send its power usage reading using information back to the energy provider wirelessly. This wireless system is also used to overcome the theft of electricity via bypassing the energy meter and hence it also controls the revenue losses and utility of the electricity authorized agency.

INTRODUCTION

The wide proliferation of wireless communication propose and explore new possibilities for the next generation Automatic Meter Reading (AMR) whose goal is to help collect the meter measurement automatically and possibly send commands to the meters. Automation ranges from Connecting to a meter through an RS-232 interface for transmitting the meter measurements all the way from the meter to the utility company via ZIGBEE.

The theft of the electricity is the major concern of the transmission and distribution losses in the supply of the electricity worldwide. Mainly the electricity is being stolen via bypassing the energy meter therefore this wireless system is utilizes to overcome this type of the theft of the electricity and is very beneficial for the authorized agency to control its revenue loss as all of us know that the cost of fuel is increasing day by day hence the intensity of stealing the electricity and using it as a substitute is also

increasing therefore it is needed much to design a system that can detect the theft of the electricity.

There are two types of techniques to deliver the information to the authorized agency to control the theft of the electricity via bypassing the energy meter.

Wired techniques-

- Electrical cables
- Coaxial cable
- Optical fiber

Wireless techniques-

- ZIGBEE technology
- GSM technique
- WI-FI
- Infrared
- Wi-max
- Bluetooth

Here this system utilizes the technique named ZIGBEE because all the problems associated with the wired techniques. There are a lot of problems related with the wired techniques such as installation problem, complexity and cost also matters in the case of long haul. The main problem associated is about the rural areas where it's really very much difficult to install the wired system to convey the information. The ZIGBEE module provides an efficient way to convey this information to the authorized offi-

cial at low cost as compare to that of the GSM Modem and also utilizes a cell-phone to send the message to the officials having a long battery life. The other wireless techniques such as Bluetooth, infrared etc are having the limitations of range and also of the efficiency. The wireless system based on GSM/GPRS is well known. But the fee is needed of using GSM/GPRS network, and also the cost of hardware system is very high. In this system ZIGBEE technology which works in international free frequency band and access self organization function is adapted to solve the problem in this wireless electricity theft detection system.

History of Meters

With the development of country's economy and the improvement of national power, the power requirement is still ever increasing due to use of improper power management systems and the conventional energy metering system. Over the past years, metering devices have gone through much improvement, and are expected to become even more sophisticated, offering more and more services. Meters in the past, and today in a few countries, were electromechanical devices with poor accuracy and lack of configurability. Theft detection was also a challenge. Such meters are limited to providing the amount of energy consumption on site.

Recent developments in this direction seem to provide opportunities in implementing energy efficient metering technologies that are more precise and accurate, error free, etc. The implementation of WAMRS provides with many vital features as compared with the analog utility meter reading with man power. Some of these features are listed below,

- Higher speed.
- Improved load profile.
- Automatic billing invoice.
- Real time energy cost.
- Load management.
- Alarm warning.
- Remote power switches on/off.
- Tamper detection.

WAMRS provides a two way communication between the electricity company and the load by sending in a lot of power parameters and control signal to reach the goal of load management and power demand control. Using WAMRS on distribution automation can supply many capabilities such as efficient meter-reading, distribution, power monitoring and control, load management and time-of-use rate. With rapid growth of mobile

communication network, future application service will gradually concentrate on data transmission service. GSM has been developed maturely and has many practical applications at present. It has many advantages such as more stable network with robust features, covers virtually all parts of the world, maintenance and security of data transmission. It satisfies the need of speed for data transmission required for automatic meter reading system.

ZIGBEE TECHNOLOGY

An IEEE 802.15.4 standard ZIGBEE is used for data communications with business and consumer devices in free frequency band. It is designed around low-power consumption allowing the batteries to essentially last forever. Operating on Top of the IEEE 802.15.4 Medium Access Control (MAC) and Physical Layer (PHY) wireless standard the ZIGBEE standard provides network security and application support services. Employing a suite of technologies it enables scalable, self-organizing, self-healing networks that can manage various data traffic patterns. ZIGBEE is a low-cost, low-power, wireless mesh networking standard. The low cost allows the technology to be widely deployed in wireless control applications; the low power-usage allows longer life with smaller batteries, while the mesh network provides high reliability and larger range of operation. ZIGBEE has been developed to meet the growing demand for capable wireless networking between various low power consuming devices. The ZIGBEE alliance is working with the IEEE to ensure an integrated, complete, and interoperable network for the competitive market. The ZIGBEE Alliance will also serve as the official test and certification group for ZIGBEE devices. ZIGBEE is the only standards based technology that addresses the needs of most remote monitoring and control and sensory network applications. The 802.15.4 specification only covers the lower networking layers (MAC and PHY). To achieve inter-operability over a wide range of ZIGBEE module it follows wireless mesh network topology. It's low cost made this to be widely deployed in wireless control and monitoring application worldwide. It uses very low power and hence has a very long battery life. It uses unlicensed 2.4 GHz ISM band which is available worldwide. ZIGBEE has range between 10 m to 2 km and it works well with networks such as Wi-Fi, Ethernet and GPRS and also provides scalable networking solution which makes it suitable to be used in controlling and monitoring application.

It is having 3 types of device-

I. ZIGBEE Coordinator device-

It is the device of ZIGBEE which starts the signal. It coordinates the signal at the transmitting time in which signal are easily transmitted.

- There is one and only one coordinator per ZIGBEE network.
- This device has the unique responsibility network tree and might bridge to other networks.
- There is exactly one ZIGBEE coordinator in each network.
- It is able to store information about the network, including acting as the repository for security keys.

II. ZIGBEE Router device-

- It is provided the path to the signal at the signal transmitting time.
- A ZIGBEE is a logical device type that can route messages from one node to another.
- Routers can act as an intermediate router, passing data from other devices.

III. ZIGBEE End device-

- This is a ZIGBEE term that indicates the device in question has no routing capability.
- It can only send and receive information for its own use.
- An end device functions as a leaf node in a cluster tree network.

work.

- Then nodes in a star network are all end devices except for the coordinator.
- It is used for long battery life.
- A complete mesh network would not contain any end devices, but in practice a design may call for one or more of them.
- It is present at the end.
- It contains just enough functionality to talk to its parent node (either the coordinator or a router); it cannot relay data from other devices.
- It requires the least amount of memory, and therefore can be less expensive to manufacture than a ZR or ZC.

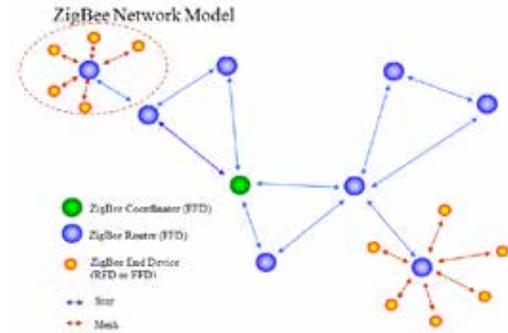


Figure :Zigbee network

ZIGBEE Module

ZIGBEE is the standards-based wireless technology designed to address the unique needs of low-cost, low-power wireless sensor and control networks in just about any market. ZIGBEE can be used almost anywhere, is easy to implement and needs little power to operate. With hundreds of members around the globe, ZIGBEE uses the 2.4 GHz radio frequency to deliver a variety of reliable and easy-to-use standards anywhere in the world. ZIGBEE is a specification for a suite of high level communication protocols using small, low-power digital radios based on the IEEE 802.15.4-2003 standard for wireless home area networks (WHANs), such as wireless light switches with lamps, electrical meters with in-home-displays, electronic equipments via short-range radio. The technology defined by the ZIGBEE specification is intended to be simpler and less expensive than other WPANs, such as Bluetooth. ZIGBEE is targeted at radio-frequency (RF) applications that require a low data rate, long battery life, and secure networking.

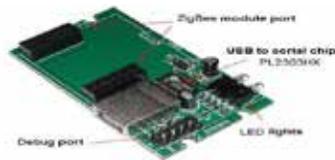
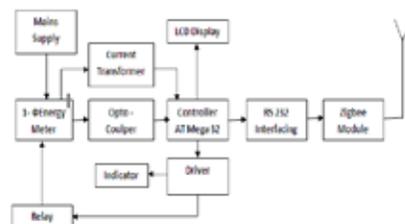
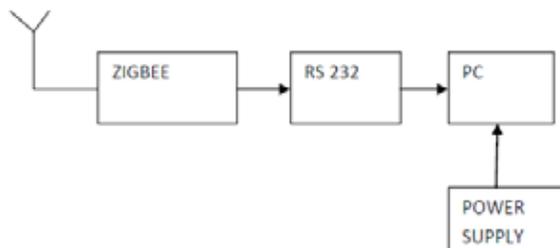


Figure :Zigbee module SYSTEM OVERVIEW



BlockDiagramofConsumerModule



Block Diagram of EB Side Module

EXISTING SYSTEM

A ZigBee Advance Metering infrastructure (ZAMI) is an existing one for automatic meter data collection and energy auditing and management. In the ZAMI, the system operates with multiple channels and frequency hopping and coexists with potential interferers. By incorporating dual channels, the

delay is improved by 30% to 50%. In this method if any tariff variation occurs, the new tariff rate will be changed only through reprogramming the controller otherwise the previous tariff rate will be displayed on the LCD display. This may cause major problems in billing. Here, there are no intimations given by the electricity board to the consumers about the status of energy consumption. There are no details about the previous month-consumption, the amount of bill paid and energy theft detection. We are focusing about these drawbacks and overcome in our project "Design and Implementation of Wireless Automatic Electricity Meter Reading System Using ZIGBEE with Theft Detection Application."

PROPOSED SYSTEM

In order to overcome the above mentioned drawbacks, we are proposing a new method „Automatic Energy Calculation Through Wireless Smart Meter Using Zigbee“ which is having the advantages such as no need of manpower, errorless tariff calculation, tripping can be done from the EB side in case of not paying the bill and intimation about tariff variation, amount to be paid and due date for payment. This system is designed with two modules which are as follows:

- Consumer module in the system
- EB module in the system

Consumer Module

The consumer side is equipped with an energy meter, micro controller, LCD display, indication unit (can be an indication lamp). The microcontroller continuously monitors the energy meter reading and calculates the amount till last usage. These details can be viewed in the LCD display and also it will be sent to the EB server during each month through the Zigbee transmitter. The indication unit is provided for the attention of the consumer in case of exceeding normal usage, delaying the payment and in case of any tariff variation by the EB. The consumer side is equipped with an energy meter, micro controller, LCD display, indication unit (can be an indication lamp). The microcontroller continuously monitors the energy meter reading and calculates the amount till last usage. These details can be viewed in the LCD display and also it will be sent to the EB

Server during each month through the Zigbee transmitter. The indication unit is provided for the attention of the consumer in case of exceeding normal usage, delaying the payment and in case of any tariff variation by the EB. The consumer side is equipped with an energy meter, micro controller, LCD display, indication unit (can be an indication lamp). The microcontroller

continuously monitors the energy meter reading and calculates the amount till last usage. These details can be viewed in the LCD display and also it will be sent to the EB server during each month through the Zigbee transmitter. The indication unit is provided for the attention of the consumer in case of exceeding normal usage, delaying the payment and in case of any tariff variation by the EB.

EB Side Module

The block diagram of the EB side module used in the system is represented in the above figure. The detailed explanation of each of the block along with the components used is explained in the following chapters. The PIC 16F877A is the basic component in both the modules designed for the system of the automatic energy meter reading using Zigbee wireless communication for the electricity board.

The Zigbee is attached with both the modules. The data from the Zigbee transceiver in home module passes to the EB Office module through Zigbee network. In the office side a similar module receives the data. The prototype design consist of the elements: Electronic meter attached to the consumer module, EB side module. The PIC controller uses PIC IT programmer in embedded C as per needs.

Working of the EB Side Module

The EB side module is designed to work as follows. The receiver module is interfaced with a sys which is monitored by the officials in the electricity board. The Zigbee transceiver on the EB module receives the data and displays it in the terminal C window of the system interfaced with it. The home module will be reset by the EB officials as the bill is paid. The thing to be noted here is that only when the command is given, board will supply power to the particular customer. Else the supply will be disconnected until the payment of the bill. Thereby we contribute a small part to prevent the power crises as well.

IV. HARDWARE DESCRIPTION

Working of the EB Side Module

The EB side module is designed to work as follows. The receiver module is interfaced With a system which is monitored by the Officials in the electricity board. The Zigbee Transceiver on the EB module receives the data and displays it in the terminal C window of the System interfaced with it. The home module will be reset by the EB officials as the bill are paid. The thing to be noted here is that only when the command is given, board will supply power to the particular customer. Else the supply will be disconnected until the payment of the bill. Thereby we contribute a small part to prevent the power crises as well.

IV. HARDWARE DESCRIPTION

LCD DISPLAY

Liquid Crystal cell Displays (LCDs) are used in similar applications where LEDs are used. These applications are display of numeric and alphanumeric characters in dot matrix and segmental displays.

LCDs are of two types:

- I. Dynamic scattering type
- II. Field effect type In our project we are using 16 x 2 dynamic scattering type LCD displays. These display units are connected with PIC 16F877A microcontroller. These LCD displays are used for displaying the information to the consumer, i.e., the messages send by the EB regarding due date, tariff variation, previous month's consumption and the amount to be paid etc. will be shown in the LCD display.

LCD INTERFACING WITH MICROCONTROLLER

In this project ATMEGA32 microcontroller has an **important role as it is used to calculate tariff, display** messages, due

date, number of units consumed and amount to be paid in the LCD display connected with it. This ATMEGA32microcontroller having an In built EEPROM memory. So there is no need of an external memory to store the information\ previous month-s amount. We are using Zigbee transceiver to send and receive data between the EB side and the consumer side, of an external memory to store the information previous month"s amount. We are using Zigbee transceiver to send and receive data between the EB side and the consumer side.

RS 232:

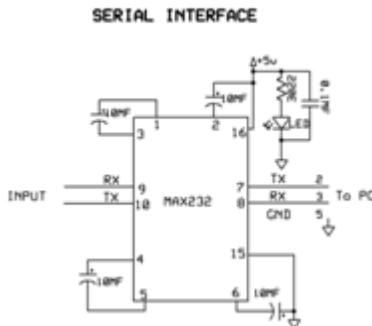


figure 4.8: Serial Interface of MAX 232

This unit is used to send and receive the signals given by the microcontroller /Zigbee. It is used for the serial communication between externalZigbee and microcontroller. It also converts the data into serial manner and send to the microcontroller as well as Zigbee transceiver.

Description

The MAX232 is an integrated circuit

that converts signals from an RS-232 serial port to signals suitable for use in TTL compatible digital logic circuits. The MAX232

is a dual driver/receiver and typically converts the RX, TX, CTS and RTS signals.

The drivers provide RS-232 voltage level outputs (approx. ± 7.5 V) from a single + 5 V supply via on-chip charge pumps and external capacitors. This makes it useful for implementing RS-232 in devices that otherwise do not need any voltages outside the 0 V to + 5 V range, as power supply design does not need to be made more complicated just for driving the RS-232 in this case.

The receivers reduce RS-232 inputs which may be as high as ± 25 V), to standard 5 V TTL levels. These receivers have a typical threshold of 1.3 V, and a typical hysteresis of 0.5 V.

The later MAX232A is backwards compatible with the original MAX232 but may operate at higher baud rates and can use smaller external capacitors – 0.1 μ F in place of the 1.0 μ F capacitors used with the original device.

6.Conclusion

Today is era of modern technology every thing is going to be digital and wireless.In this era we are usingoutdated electrical energy meter that need more manpower and accuracy is less.so by implementing this project its possible to avoid man power wastage and theft detection using wireless technology.

REFERENCE

- [1] R. Galvan, A. Elices, A. Munoz, T. Czernichow, | and M. A. Sanz-Bobi, "System for Detection of | Abnormalities and Fraud in Customer Consumption" | inProc. of the Electric Power Conference, Nov. 1998. | [JRG 1998] | [2]http://www.freescale.com/files/abstract/press_ | release/MAX-STREAM_ZIGBEE_PR.html | [3]http://www.digi.com/xbee/ | [4]http://www.digi.com/learningcenter/video/player.js | p ?videoid=ZIGBEE-at-vs-api-commands | [5]Louis J. Romeo, "Electronic Theft Detection | Systems: A Survey", Library & Archival Security, | Volume 3, Issue 3 & 4 January 1982 , pages 1 – 22. | [LJR 1982] | [6]I. H. Cavdar, "A Solution to Remote Detection of | Illegal. Electricity Usage via Power Line | Communications", IEEE Transactions on power | delivery, June2007Vol. 19[IHC 2007] | [7] R. Jiang, H. Tagaris, A. Lachs, and M. Jeffrey, | "Wavelet Based FeatureExtraction and Multiple | Classifiers for Electricity Fraud Detection" inProc.of | IEEE/PES Transmission and Distribution Conference | andExhibition 2002: Asia Pacific, Vol. 3, pp. 2251- | 2256.[RJ,HT 2002] | [8]Theodore | S. | Rappaport,"WIRLSS | COMMUNICATIONS, Principals and Practice"II | Edition. | [9] ZIGBEE Alliance, | December 1. | 2006, | www.ZIGBEE.org | ZIGBEE | [online] | Specification | available: | [10] ZigBee Alliance, ZigBee Specification Version | 1.0, http:// www.ZigBee.org, December 14th, 2004 | [11] Microchip Technology Inc. Microchip Stack for | theZigBee TM | [12] ZigBee Document 075356r08ZB, Advanced | Metering Initiative Profile Protocol Specification | Version 08, November 13th, 2007. | [13] ZigBee Document 074994r08, ZigBee AMI | Technical Requirements Document Version 08, | september19th, 2007. | [14]Chih-Hung Wu, Etc,(2004) "Design of a Wireless | Arm Based Automatic Meter Reading and Control | System ", Power Engineering Society General | Meeting.IEEE 6-10, Vol.1, pp.957-962. | [15] Bo Chen; Mingguang Wu; Shuai Yao; Ni Binbin, | (2006) "Zigbee Technology and its Application on | Wireless | Meter-Reading System", Industrial | Informatics IEEE International Conference on, vol., | no., pp.1257-1260,16-18 doi:10.1109/INDIN.275820. | [16] Zigbee Development Kit Users Guide (2008), | MeshNetics Doc. S-ZDK-451-01 v.1.10. | [17]K.F.Tsang,H .Y.Tung,K.L.Lam,(2009)"Zigbee | :From Basics to Designs and Applications",Prentice | Hall. | [18]Li, Xianguang Hu, (2009) "Design of anArm- | Based Power Meter Having Wifi Communication | Module" IEEE. |