

# *Real Time AMR & Control of Household Energy Meter with Zigbee communication*

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**Abstract** – In today's world almost all industrial systems are based on wireless communication, as it has many advantages. This paper presents the design and implementation of Automatic Meter Reading (AMR) and Energy meter control using Zigbee communication. The design presents a novice method of combined Zigbee and Global System for Mobile communication (GSM) technology to monitor the power consumption and controlling of the meters remotely. This system avoids the human intervention in power management. If the consumer doesn't pay the bill in time, the user is informed through sms system using GSM. If still user does not pay the bill then after the designed late consideration, the power connection will be disconnected from the remote server automatically. It displays the corresponding billing information on LCD and sends data to the server through the Zigbee Module. The entire programming is based on VB Language. The developed mechanism provides efficient monitoring of meter reading, power control mechanism, avoiding the billing error and reduces the maintenance cost.

**Keywords** – Automatic Meter Reading (AMR), Global System for Mobile communication (GSM), Liquid Crystal Display (LCD), Short Message Service (SMS), Visual basic (VB), Zigbee

## I. INTRODUCTION

In present scenario the human operator goes to the consumer's house, takes the photograph of meter reading and produces the bill. If the consumer is not available, the billing process will be pending and human operator again needs to re-visit the pending houses. Going to each and every consumer's house and generating the bill is a laborious task and requires lot of time. It becomes very difficult especially in rainy season. If any consumer did not pay the bill, the operator needs to go to their houses to disconnect the power supply. AMR is a process of automatically collecting consumption, diagnostic, and status data from energy metering devices and transferring that data

to a central database for billing, troubleshooting, and analyzing [9]. This technology mainly saves power supply providers to reduce the expenses of periodic trips to each physical location to read a meter. Another advantage as mentioned is that billing can be based on near real-time consumption rather than on estimates based on past or predicted consumption. This timely information coupled with analysis can help both utility providers and consumers for better control & use of Electrical energy. AMR technologies include handheld, mobile and network technologies based on telephony platforms [2] (wired and wireless), RF (Radio Frequency) [1], [5] or power line transmission. Various AMR methods and technologies are developed using SCADA (Supervisory Control and Data Acquisition), Zigbee [12], GPRS and GPS [7], [8] etc. The main drawback of AMR or automatic meter reading is controlling. The operator in the control room is unable to control the power consumption, as well as unable to control the devices manually, i.e. tripping of the power to the consumers those who had not paid any bill for a long time, displaying the amount. Thus this paper provides a solution to reach the above constraints.

## II WIRELESS COMMUNICATION TECHNOLOGY

Choosing an appropriate Wireless Communication System is one of main task in this work. At present, most AMR systems are generally based on media such as RF (Radio Frequency) [1], [5], PLCC (Power Line Carrier Communication) [1], GPRS (General Packet Radio Service) [7], [8], HFC (Hybrid Fiber-Coaxial) and so on, to transfer data between power meters and manage center. All the above communication media have both merits and shortcomings as well in many aspects like short transmission distance, high transmission & communication

cost [7], maintenance difficulty and unsafe data transmission. By considering zigbee module, it is recently developed two-way wireless communication protocol system. Zigbee is designed for low power consumption and at low cost. Zigbee Alliance group defined the higher protocol layers while lower layers of the stack (MAC, PHY) are being defined by the IEEE 802.15 working group 4 (802.15.4)[12]. This can achieve the data of 250kbps in the 2.4GHz bands. Zigbee has been developed to meet the growing demand for capable wireless networking between numerous low-power devices. So by considering all these points, we can apply Zigbee Wireless communication system, which is popularly used in the world, to transmit power data [9]. In developed system, Zigbee based wireless communication subsystem is responsible for receiving and transferring data & GSM modem is used for sending SMS. The generated bill can be send to consumer in the form of E-mail by using GSM modem [6].

### III. DEVELOPED ZIGBEE BASED SYSTEM

This developed system of AMR gives a solution to power transfer control and visualization of power units consumed. The consumer meter is connected to zigbee transmitter module & microcontroller with LCD display. The central processing authority will have PC and zigbee receiver module. Data transmission takes place from consumer to central utility & controlling commands will execute from utility to consumer.

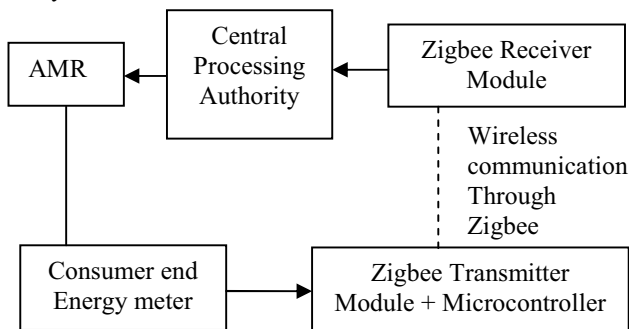


Fig.1: Outline of developed system

**Transmitter Module** – The regulated power supply of 5V DC is given to all blocks as shown in Fig.2. The functionality of power supply is to drive the energy meter. The transmitter module contains following parts.

#### A. Transmitter Section

##### i) Energy Meter -

It supplies the electric power to the electric load. The power variations in energy meter are in accordance with electric load. The energy meter is integrated with electric load and which produces the analog signal can be converted into digital signal and that digital signal in the form of pulses.

##### ii) Signal Conditioning -

These pulses from meter are given to the microcontroller via optocoupler by using transistor. Transistor is a low current

low voltage device and used for general purpose switching and amplification. Thus after signal conditioning the microcontroller receives the interrupt pulse.

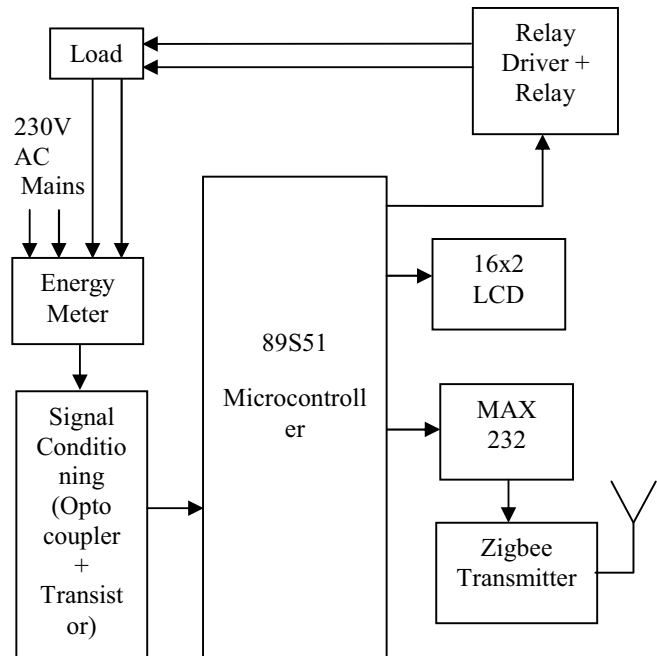


Fig.2: Transmitter Block Diagram

##### iii) Microcontroller -

AMR Continuously monitor and record the energy meter. This can be achieved by using microcontroller. The AT89S51 is a low-power, high-performance CMOS 8-bit microcontroller with 4K bytes of in-system programmable flash memory. The AT89S51 provides 128 bytes of on chip RAM, 4K bytes of flash Memory, 32 I/O lines, two data pointers, two 16-bit timer/counters, a full duplex serial port, on-chip oscillator, and clock circuitry.

##### iv) Relay Control Unit –

Relay control unit is interfaced with the energy meter and microcontroller. If the consumer doesn't pay the bill in time, then after the designed late consideration, the power connection will be disconnected from the remote server automatically by using the relay control unit. Whenever the consumer pays the bill the power connection is resumed by the relay control unit. Depending on the information received from the remote station, the relay driver can control the Relay unit to disconnect or resume the power connection.

##### v) Liquid crystal display -

A Liquid crystal display is interfaced to microcontroller and is used to display the meter reading, power status etc

##### vi) MAX 232 –

MAX232 IC is interfaced with the microcontroller for the serial communication with PC with baud rate of 9600 baud.

#### B. Receiver Section

Zigbee receiver module received the data from the zigbee transmitter module through wireless communication.

Depending on the information received from the zigbee receiver module, control unit decide the power connection status i.e. disconnect or resume the power connection. The controlling can be done by tripping, i.e. power connection is going to on/off automatically without visiting the consumer's pending houses again and again.

i) GSM Modem –

To implement AMR system we used GSM modem and which is helpful for the wireless communication with the control unit. Using Serial communication protocol we communicate with the GSM modem. It supports the AT command sets. As GSM modem supports the AT command set, AT command is send to the modem and modem returned with an OK signal in the same baud rate of 9600baud. Also we have used Subscriber Identification Module (SIM) in the modem through which we can send the various SMS to the consumers. GSM used is Tri-Band GSM of 900/1800/1900 MHz [11].

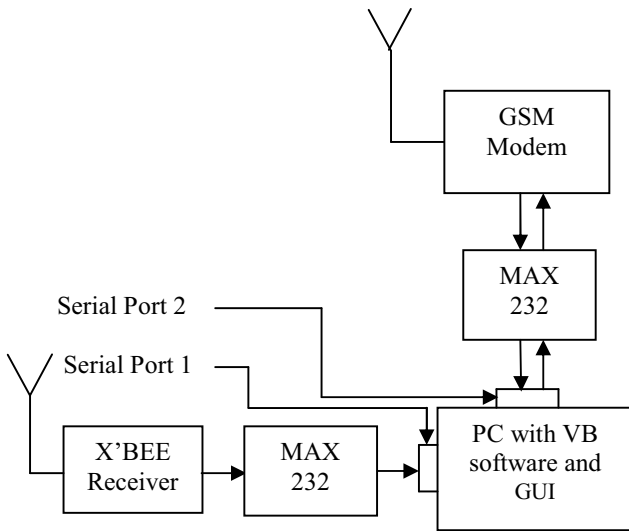


Fig.3: Receiver Block Diagram

#### IV. SYSTEM HARDWARE

Microcontroller based hardware unit is developed with Zigbee module of wireless communication. Data is collected with the zigbee module and then it is transferred to central computer using GSM communication modem [10]. The software is developed in Visual basic 6.0 to display the developed billing procedure.LCD display is also provided which display power consumption details The basic hardware model for Transmitter Section and Receiver Section is shown in following Fig.6.

The developed AMR system is divided into two sections i.e. transmitter section and receiver section. The working of AMR can be explained through following flowcharts.

#### A. Transmitter Section Flowchart

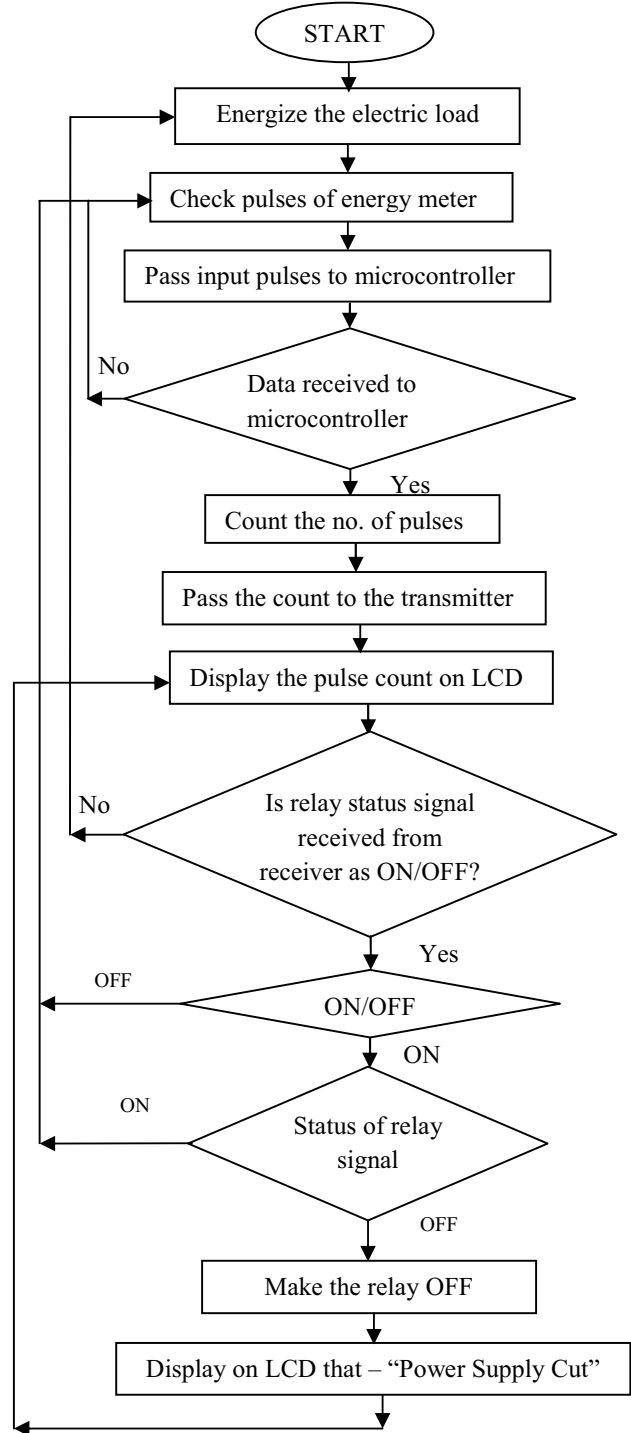


Fig.4: Flowchart for Transmitter Section

**B Receiver Section Flowchart**

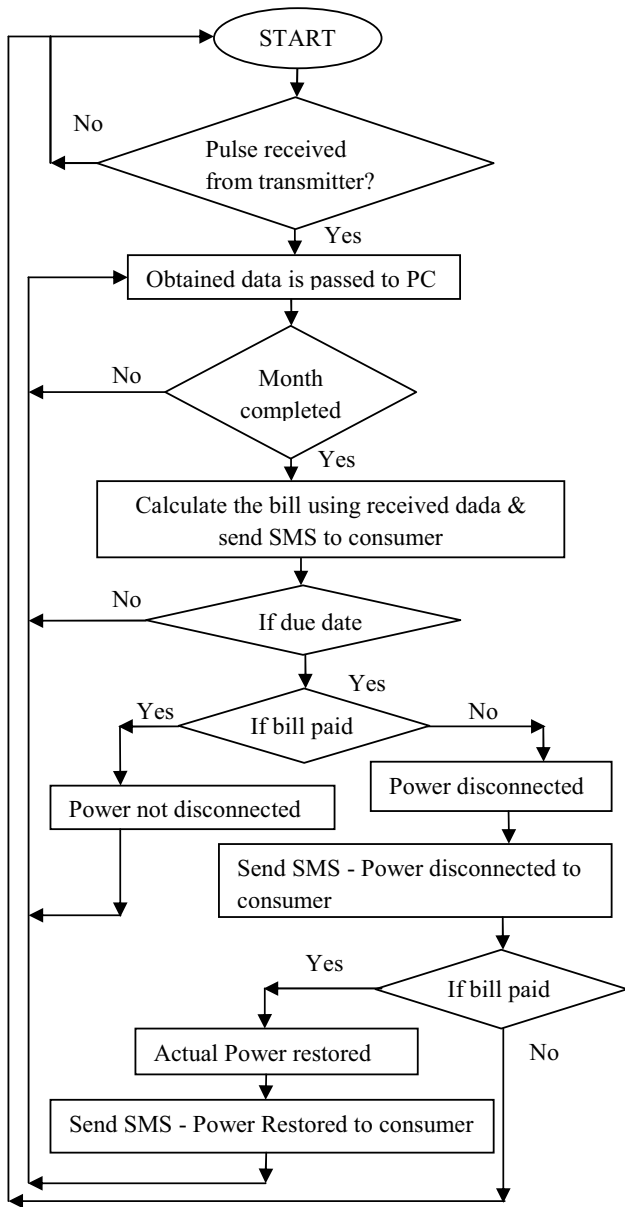


Fig.5: Flowchart for Receiver Section



Fig.6: System hardware with Transmitter and Receiver Sections

**V. SOFTWARE DETAILS**

The system software VB6.0 is used for editing, compiling and debugging. Database can be generated to store the details of the customer in the form of history for further use. Pages are created in VB for billing information and smart communication with the customer. This detailed information is then sent via SMS.

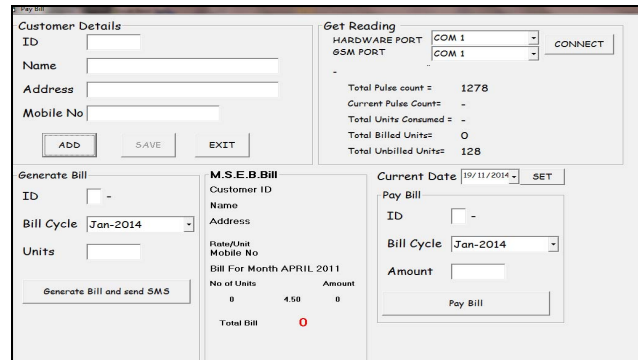


Fig.7: GUI developed for customer database and bill generation

**VI. OBSERVATIONS AND ANALYSIS**

The developed system is tested in the place of conventional power meter and achieved excellent performance. Fig. 8 to 14 shows the actual photographs of the developed system. The microcontroller is interfaced with Zigbee modules, GSM module, Energy meter module, Relay Control Unit.

For demonstration purpose, 40Watt bulb is used as a load. The meter reading is received through microcontroller & transmission section. The controlling actions are validated by giving commands through PC to the controller. Fig.8, 9, 10 shows the details.



Fig.8: AMR Transmitter unit when the load is ON



Fig.9: AMR Receiver Unit

Fig.9 shows receiver section used to assert the controlling signals.



Fig.10: LCD showing energy consumption data

Fig.10 shows the LCD display which is used to show the power consumption details so that the human manipulation on energy meter can be avoided.



Fig.11: Bill Generation alert



Fig.12: Bill Paid alert

Fig.11 shows the SMS of generated bill i.e. bill for month, units, and amount and due date send through GSM modem to the consumer mobile. When consumer pay the bill, GSM modem send a SMS of the bill paid and electricity restored to the consumer as shown in Fig.12.

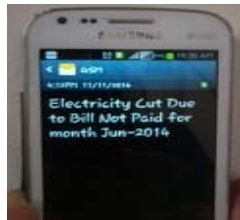


Fig.13: Power Disconnect alert



Fig.14: Power Restored alert

Depending upon the payment or non-payment of bill the controlling action can be taken and SMS is sent to the consumer as shown in Fig.13 & 14.

## VII. CONCLUSION

In the presented work Zigbee based Automatic Meter Reading (AMR) unit is designed to continuously monitor the energy meter reading and to disconnect the power connection remotely whenever the consumer fails to pay the bill after the warning period is lapsed and power reconnect after bill payments, It avoids the human intervention, provides efficient meter reading, avoid the billing error and

reduce the maintenance cost. It displays the corresponding information on LCD for user notification. The generated bill can also be send to consumer through E-mail. Thus the complete process of monitoring of energy meter, theft detection, and bill calculation, notification of due date, meter disconnection or reconnection can be automated efficiently with better performance and less manpower.

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