An embedded electric meter based on ARM9 and zigbee technology

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Abstract— **We design an embedded electric meter based on Zigbee data acquisition system in view of the complicated cables and accident potential in the process of data acquisition of electric meter. Combined wireless Zigbee communication technology with data acquisition system, we build wireless data acquisition system based on ARM9 processor and zigbee chip in the embedded electric meter which can reduce the cable connections. This system, which is comprised of ZigBee network and database management system, has many important advantages such as low cost, low power Consumption, and low date rate. During the design process of embedded electric meter, we select the appropriate shunt to eliminate or reduce the effect of ESD before it connects with sensitive units . The major difference between Zigbee data acquisition system and other data collector is that it realizes wireless data transmission after the A/D conversion. Furthermore, the system is simpler, integrated, anti-interference, stronger mobility and practicability. The system dedicates to automatic meter data collection and energy auditing and management.**

Index Terms— **ESD(Electrostatic Discharge), ADC(Analog to digital convertor), FFD(Full function device) .**

I. INTRODUCTION

Traditionally, the electricity meters are installed on consumer's premises and the consumption information is collected by meter-readers on their fortnightly or monthly visits to the premises. Over the past years, metering devices have gone through improvements and are expected to become even more sophisticated, offering more and more services. Meters in the past, and today in a few countries are electromechanical devices with poor accuracy and lack of configurability. Theft detection is also a challenge. Such meters are limited to providing the amount of energy consumption on site. This method of billing is also not suitable for the electricity supply company because it gives inaccurate account of the overall electricity consumption in

the consumer's area and may ultimately result in errors in future planning of the company. Recent developments in this direction seem to provide opportunities in implementing energy efficient metering technologies that are more precise accurate and error free. Automatic Electric Meter reading is one method reading and processing data automatically with computer and communication. It relieves reading person's labor intensity and reduces the reading mistake. Through researching the characteristic of main wireless communication protocol, ZigBee is chosen as lower layer communication protocol. With these applications, the Standard is optimized for low data rate, low power consumption, security and reliability.ARM9 is used to maintain high accuracy along with energy metering IC AD7755. The 230V input signal is applied to the energy metering IC AD7755.It has a very high Accuracy, supports 50/60Hz, low consumption of 15mW.The output is fed to ADC; The digital signal is then applied to ARM controller. The ARM Controller LPC2900 is programmed such that it accurately measures the amount of power consumed. LPC2900 has 125 MHz operation, Up to 768 KB Flash memory and Up to 56 KB SRAM, Two I2C-bus interfaces, Supports USB2.0 and CAN 2.0. The Zigbee module CC2500 is interfaced to ARM controller. The Zigbee module CC2500 is Small size 4x4 mm package with 20pins, Low current consumption -13.3 mA , Frequency range: 2400-2483.5 MHz. This transmitter transmits the RF signal which is then received by the Zigbee module receiver which is connected to PC. The energy consumed can then observed and stored on PC. The software to calculate the bill is stored on PC which then calculates the bill in Rupees depending on the tariff. [2]

ARM9 provides following advantages:
1) High Performance.
2) Very low power consumption.
3) Compressive on-chip debug.
4) Design flexibility and scalability.
5) Optimal price
6) Fast growing support eco-system.

During the design process of embedded electric meter, we select the appropriate shunt, eliminate or reduce the effect of ESD before it connects with sensitive units so as to narrow the broadband circuit and isolate sensitive units, access the varistor in the power supply circuit to eliminate or reduce EFT. The major difference between Zigbee data acquisition system and other data collector is that it realizes wireless data transmission after the A/D conversion.[7]
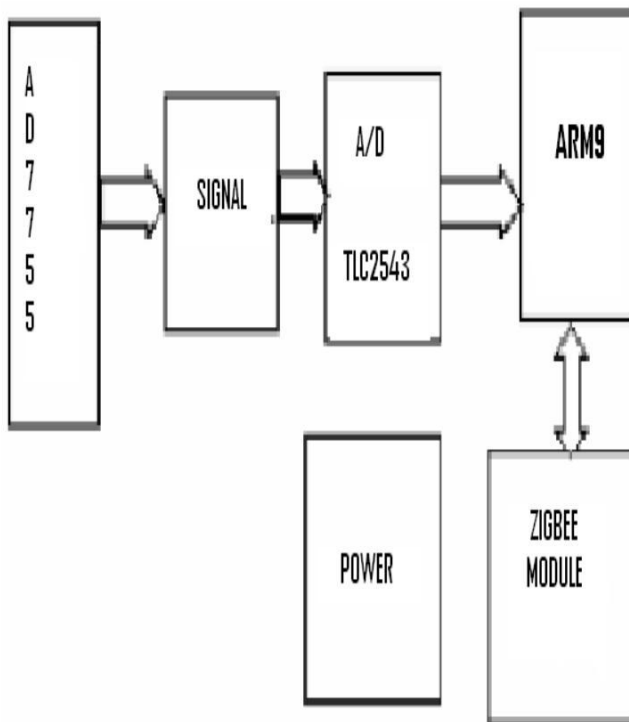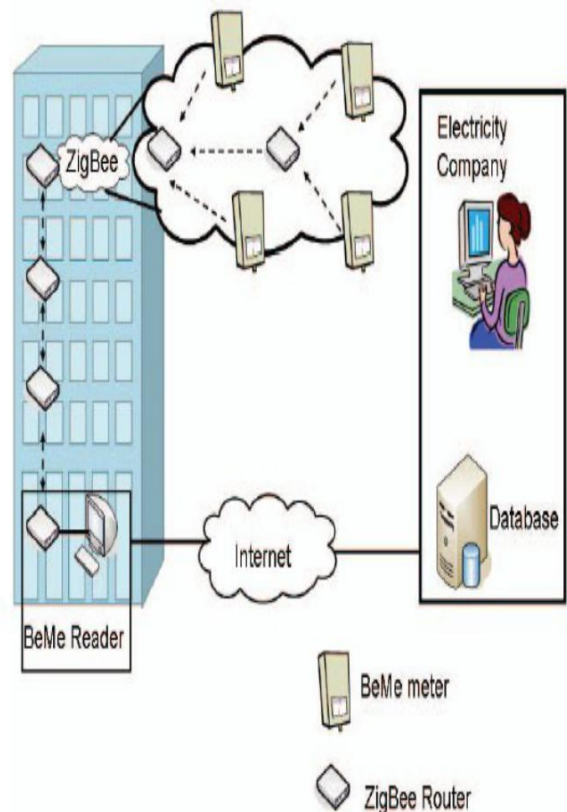
Figure 1. Block Diagram of the System

Figure 2. Energy Meter System for Flat System (Tower)

II. IMPLEMENTATION SCHEMES

In this System we connect embedded energy meter with Zigbee Transmitters outside each house. The meter reading obtained is transmitted to a PC where the receiver is connected .The Software to calculate the bill is stored in the PC. After the end of each month system generates a message of the bill automatically and can be sent to the user's mobile number. This reduces large cable connections and accidental potential due complex of cables.Zigbee, namely IEEE802.15.4 technology standard, is one of WPAN standards. Zigbee aims at short distance double direction communication with lower complexity, lower cost and lower speed. It works in three frequency regions-2.2 GHz internationally, 868MHz in Europe and 915MHz in America. It has two kinds of devices-FFD (Full Function Device) and RFD (Reduced Function Device).FFD can be a router, repeater or coordinator. RFD is terminal network node.RFD can only communicate with FFD. RFD cannot communicate with RFD as it has no routing and repeating function.[5]

The above concept can be extended to energy auditing in a factory. In it we connect number of meters in the factory at various locations. We can obtain meter readings for various part of the factory and can analyze which part consumes more power than expected.
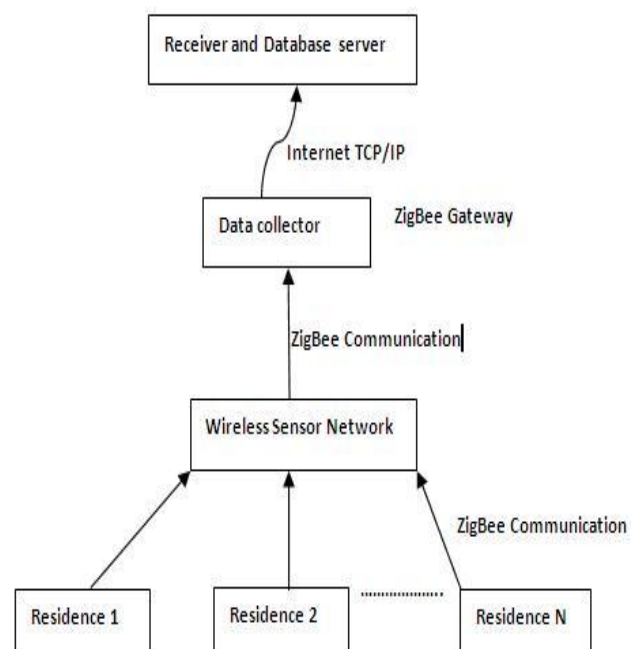

Figure 3. Energy Meter System for N number of residences.

III. ALGORITHM AND FLOWCHART

1) Start

2) Initialize the Microcontroller.

3) Sense power and send it to Microcontroller.

4) Microcontroller will process the data.

5) ZIGBEE module will transmit the processed data.

6) ZIGBEE module connected to PC will collect the data and prepare the bill.
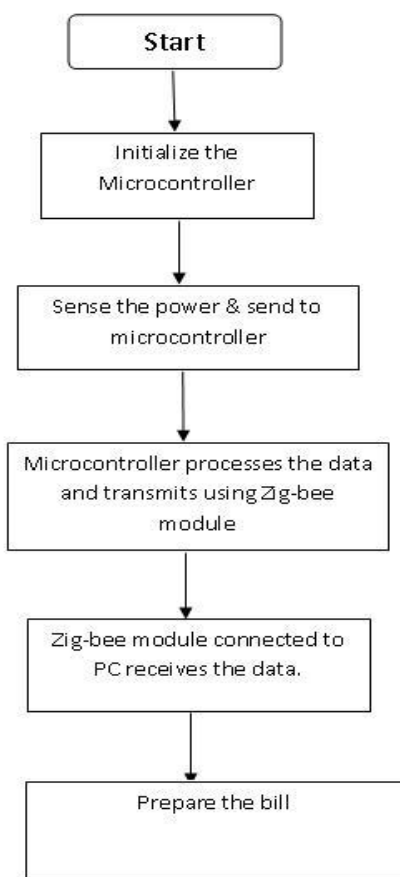
7) The data will be displayed graphically.

8) Stop.

Figure 4. Flowchart of system operation

IV. COMPARATIVE ANALYSIS

A. Comparison between proposed and conventional energy meter[6]

	Conventional Proposed	Conventional Proposed
Manual/ Automatic	Manual	Fully automatic
Reading error	Probability of reading error is quite large.	Minimum
Speed of response	It is a slow process	It is very fast.
Man power	Huge man power required.	No man power required
Cost	Effective cost is very high.	Comparatively small
Safety	No safety	Safety and secure.
Man m/c interface	Not possible	Possible

Table 1.Proposed energy meter v/s conventional energy meter

B. Relationship between Power and Distance Covered [6]

Sr. No.	Parameters	Bluetooth	ZigBee
1.	**Protocol Stack**	250Kb	<32Kb
2.	**Range**	10-100meters	30-100meters
3.	**Link Rate**	1 Mbps	250Kbps
4.	**Battery**	Rechargeable	Non-rechargeable
5.	**Devices**	8	2^{16}
6.	**Air Interface**	FHSS	DSSS
7.	**Network Join Time**	Long	Short
8.	**Extendibility**	No	Yes
9.	**Security**	PIN, 64 bit,128bit	129bit , AES

Table 2. Bluetooth v/s ZigBee

V. ADVANTAGES OF THE SYSTEM

1) High Accuracy

2) Reduced ESD and EFT

3) High Efficiency

4) High Reliability

5) High speed

6) Tamper detection is also possible

7) Reduction of manpower and reduction in wastage of time

8) Simpler and highly practicable

9) Reduction in complicated cables and accident potential in the process of data acquisition of electric meter

VI. APPLICATIONS OF THE SYSTEM

1) Wireless Automatic Meter Reading System is useful in energy consumption measurement and Billing for residential complex, Industries, Schools, and Malls etc.

2) It is useful in Energy Management and Energy Audit.

3) It also finds application where it is difficult to obtain meter readings.[8]

VII. CONCLUSION

In this paper, a remote wireless Automatic meter Reading System based on ARM9 and Zigbee Technology is proposed. Short distance Zigbee transmission can be achieved with high accuracy and reliability. The system presented has many significant excellences such as networked, wireless, moveable, low power consuming, high accuracy. The use of embedded system improves stability of wireless data transmission. The proposed system has a broad application foreground in the real application field to remotely measure and manage electric power. The system is simpler, integrated, anti-interference, stronger mobility and practicability. It has many important advantages such as low cost, low power Consumption, reduction in cables. The system dedicates to automatic meter data collection and energy auditing and management.

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