International Journal of Recent Research in Mathematics Computer Science and Information Technology
Vol. 1, Issue 1, pp: (28-31), Month: April - June 2014, Available at: www.paperpublications.org

Design and Implementation of Wireless Sensor Node for WSN for Automatic Meter Reading

[1]A. M. Pawar, [2]S. N. Patil, [3]B. P. Ladgaonkar

Embedded System Design Laboratory, Post Graduate Department of Electronics Shankarrao Mohite Mahavidyalaya, Akluj, Solapur, India

Abstract: **Deploying an embedded technology, a wireless sensor node is designed and implemented for establishment of Wireless Sensor Network (WSN) for automatic meter reading. The amount of power consumed by the load is extracted by passing the respective current through 1Ohm resistor. The analog voltage observed across it is digitized by employing on chip ADC of AVR Atmega 8L microcontroller. The ADC of 10 bit resolution helps to enhance preciseness in the data. Using principle of energy meter, the power consumed is determined and depicted in the terms of watts and units as well. An embedded firmware is developed by employing CodeVisionAVR, the IDE, which is dedicated for AVR family of microcontrollers. Employing an ubiquitous technology, the Zigbee technology, RF communication is established at 2.4GHz of ISM band. The Zigbee RF module is interfaced to the system and programmed by using X-CTU. Each node (End Devices) is assigned with its own ID and disseminates the data to the co-ordinator node, which is interfaced to the base station. The present wireless sensor network is operating in star technology and following IEEE 802.15.4 standards, it is operating with great reliability. The WSN is suitable for electric power distribution and control boards**.

Keywords: **Automatic Meter Reading, AVR Microcontroller, Embedded technology, IEEE802.15.4, WSN, Zigbee technology.**

1. INTRODUCTION

Recently, an embedded technology is playing vital role in enhancement of intelligence of electronic instruments. Due to great reliability and preciseness in data processing, it exhibit wide spectrum of the application potential in diverse field. Due to advancement in the communication technology the field of Wireless Sensor Network (WSN) is becoming more pervasive. Confluence of these two technologies may results into revolutionary development in the electronic sectors. On deployment of wireless sensor network the field such as, agriculture, medical, defense, security, environmental monitoring, traffic monitoring, habitat monitoring, automations in the automobiles, home automations, consumer and domestic appliances etc could be significantly modernized.

Electrical Power has become indispensable to human survival and progress. Increasing gap between demand and supply made every nation explore ways and means to enhance power generation capabilities from both conventional as well as non-conventional means. Apart from efforts to meet growing demand, loss of power in distribution is another challenge being faced by utilities across the world. Moreover, to aggregate the data regarding power consumption by the consumer is tedious and less reliable job. During early days, the Electric Energy Meters (EEM) are based on electromechanical principle, which depicts many problems. Now days these meters are replaced by electronic meters, wherein embedded technology is deployed [1]. However, reading of these electric meters is carried out through the representative of the power distribution company. Reading these meters manually causes wastage of man power and time as well. Moreover, the data aggregation is rather less reliable due human intervention. This traditional method also suffers from intrusion of the electric power. In the wake of technology up gradation and automation in the Energy Distribution, a new idea of Automated Meter Reading (AMR) or Meter Data Acquisition and Management is evolving. Therefore, it is proposed develop sophisticated system for meter reading automatically.

Embedded systems, comprising both hardware and firmware, developed about smart microcontrollers deserve the significant place in the electronic instrumentation [2]. Advanced microcontroller AVR AT mega 8L is having promising on-chip resources deploying which one can develop a system with good salient features. Therefore, many embedded designers are choosing this controller for embedded design of their own interest. The current sink as well as current sourcing capacity of this controller is sufficiently high. Therefore, interfacing of devices becomes easier. Moreover, it is low cost and low power as well. Using this technology the wireless senor node is designed and presented in this paper.

2. DESIGNING OF THE WS NODE FOR AMR

The present wireless sensor is wired about AVR ATmega8L microcontroller. The node is designed and presented through Hardware and software. For design electronic meter, reading electric power consumed by the load is the challenging job. During early days, this data is extracted by deploying the principle of the ferriwheel [4]. However, this leads not only to produce unreliable data but also intrusion of the power. An embedded technology provides the sustainable solution on this problem.

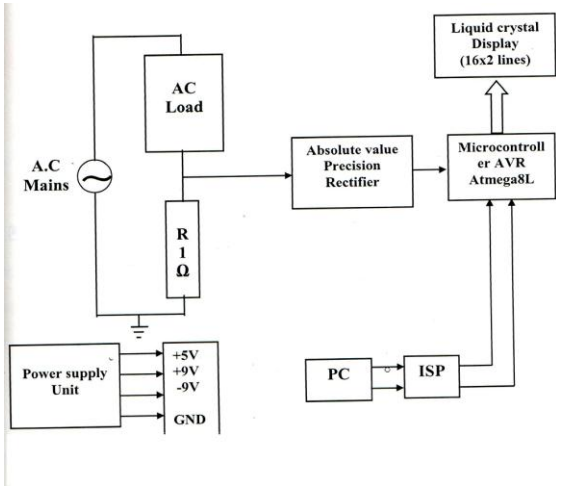

Figure 1: Block diagram of the sensor node designed for WSN for AMR

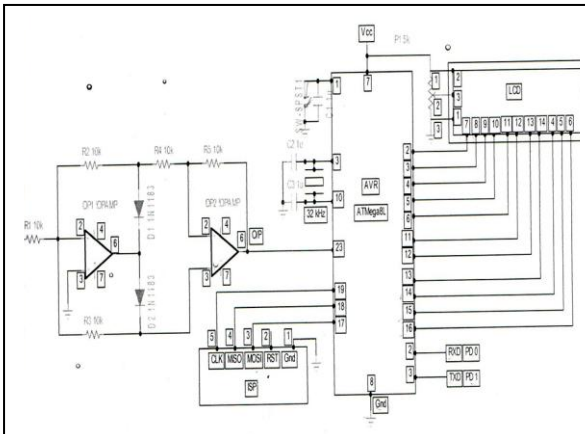

Figure 2 : Schematic of the sensor node designed for WSN for AMR

The hardware of the present node is depicted through block diagram in figure 1. Moreover, the circuit schematic is presented in figure 2.

As shown in the Figure 2, the present WS node consist of following sections

A. Extraction of the power consumption.
B. Wireless communication.

A. Extraction Of The Power Consumption

To extract power consumed following procedure is adopted. As shown in the schematic, a resistor of R_1 (1Ohm) is kept in the series of the load. The load is supposed to be the utilization of the power in typical home. For laboratory testing an incandescent lamp of 1000W is employed as the load. The electrical terms, voltage is measured in Volt (V), current in Ampere (A), power in watt (W) and energy in Kilo Watt Hour (KWh). For billing purpose energy is measured in BOT (Board Of Trade) unit (1 unit=1000WH). That mean if 1000 W of power is consumed by a load for 1 hour (3,600,000 Joules second), then it is said that, 1 BOT unit energy is consumed[4]. Using this basic principle of electricity meter is designed. Electricity meter reflects the power consumed by electrical appliances with time consideration. The current (I) consumed by the load is passed through R_1, which causes to produce the emf (Vi) given by $Vi = I \times R_1$. This expression is processed into microcontroller and converted the power consumed into BOT units. Figure 2 also comprises the absolute value precision rectifier, which is wired about operational amplifier 741. It is deployed, to read the ac emf and rectify the same as the microcontroller need DC analog voltages for ADC. The signal is digitized by employing on chip ADC of Microcontroller AVR ATmega 8L. It is having 10 bit resolution. By configuring reference voltage to 2.56 volt, the resolution of 2.56 mV is obtained. The LCD (16 x 2 lines from Hitachi) is employed to ensure digital read out of meter

reading. The present node realizes the embedded design, which essentially comprises the firmware designed to operate the present system standalone. The necessary software is designed by following the design flow of an IDE CodeVisionAVR.

B. Wireless Communication

Establishment of wireless communication between nodes and the based station is the facet of any wireless sensor network. Therefore, wireless transceiver, the Zigbee RF module is employed to ensure wireless communication. The RF module [Figure 3] Zigbee is launched by Digi corporation and working with the standards laid down by the IEEE 802.15.4. It is operating at 2.4 GHz of ISM band. IEEE 802.15 is a working group for the standardization of WPAN (Wireless Personal Area Network)[5]. IEEE 802.15.4 is one of the seven task groups which are included in it. The first edition of the 802.15.4 standard was released in May 2003. IEEE 802.15.4 specifies the physical layer (PHY) and media access control (MAC) for low-rate WPAN. WPANs are used to convey information over relatively short distances. It focuses on low-cost, low-speed ubiquitous communication between devices. Unlike wireless local area networks (WLANs), connections effected via WPANs involve little or no infrastructure. This feature allows small, power-efficient, inexpensive solutions to be implemented for a wide range of devices. The basic framework conceives a 10-meter communication range with a transfer rate of 250 kbit/s. Important features include real-time suitability by reservation of guaranteed time slots, collision avoidance through CSMA/CA and integrated support for secure communications. Devices also include power management functions such as link quality and energy detection [6]. ZigBee is a standards-based technology that addresses the unique requirements of most remote monitoring and control and sensory network applications. ZigBee builds upon the physical layer and medium access control defined in IEEE 802.15.4 for low-rate WPANs. The specification goes on to complete the standard by adding four main components: network layer, application layer, ZigBee device objects (ZDOs) and manufacturer defined application objects which allow for customization and favor total integration. The core ZigBee specifications define smart, cost-effective and energy-efficient mesh networks. It is a self-configuring, self-healing system of redundant, low-cost, very low-power nodes. ZigBee is available as two feature sets, ZigBee PRO and ZigBee. Both feature sets define how the ZigBee mesh networks operate [7].

Figure 3: RF Module Zigbee

Thus, with the assigned ID the node disseminates the packets data regarding amount power consumed to the base station where another Zigbee module is working. The X-CTU is used to configure the zigbees. This module is configured in Co-ordinator mode. The co-ordinator node by handshaking with the respective node through Becon request receives the data and by unpacketing, the same is communicated to the computer via serial port. Thus the data is made available at the central computer for further processing.

Thus, wireless sensor node is designed and prototype of this node is presented in figure 4.


Figure 4 : Test bed for Laboratory Testing

3. IMPLEMENTATION AND CONCLUSION

A Wireless sensor node is designed to ensure automatic meter reading. Employing standard relations between voltage, current, power, resistance, energy, BOT unit and time etc, in the firmware the calculations are performed. However, it is essential to calibrate the system in units of BOT. For calibration, the typical test bench is designed and implemented. Figure 5 depict the test bench designed in the laboratory.

It is having different switches and plug for connection of the different valued loads. The current flowing through the circuit is equal to the voltage drop across 1 Ohm resister. As load connected changes the current flowing through the circuit is also changes. The applied input voltage is fixed to be 230 V by Dimmerstat. On extraction of the emf, the computations are performed converted the same in real BOT unit. It can be concluded that, the wireless sensor node designed to ensure development of wireless sensor network for automatic meter reading successfully operates and broadcast the data towards the base station precisely.

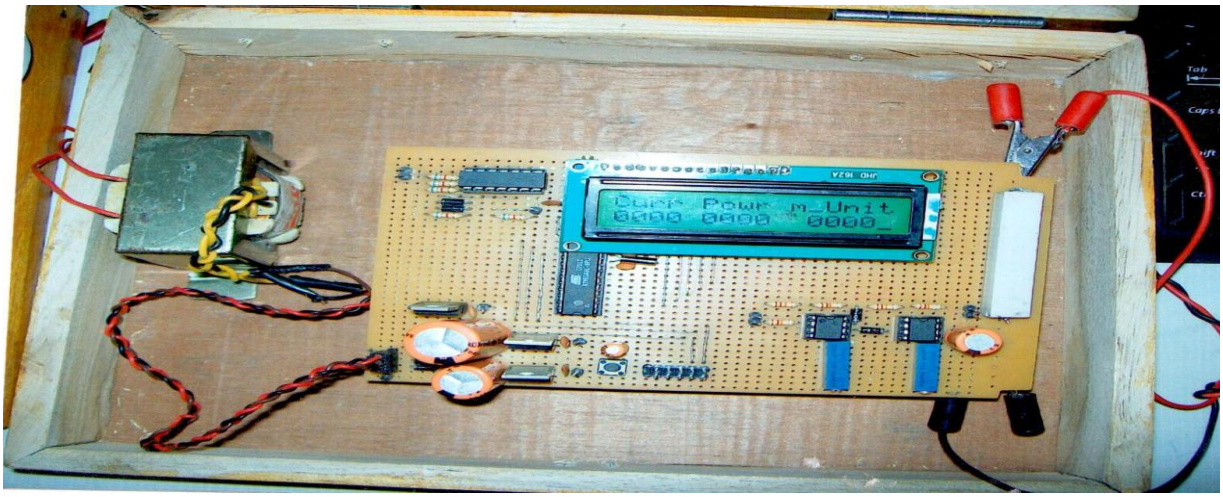

Figure 5: Prototype of the node

REFERENCES

[1] M. Bocca, L. M. Eriksson, A. Mahmood, R. Jäntti, J. Kullaa, "A Synchronized Wireless Sensor Network for Experimental Modal Analysis in Structural Health Monitoring" Computer-Aided Civil and Infrastructure Engineering, 26 7 (2011) , 483–499.

[2] H. Shen, X. Jin, H.Hu, J. Tang, "AMR System Adopting Routing Algorithm of Wireless Sensor Networks" Wireless Communications, Networking and Mobile Computing, 2008. WiCOM '08. 4th International Conference on (2008) 1-4

[3] Z. Shunyang X. Du, J. Yongping and W. Riming, "Realization of Home Remote Control Network Based on ZigBee", Proceedings of the 8th International Conference on Electronic Measurement and Instruments, (2007), August 16-18, Xian, China.

[4] A Fang, X. Xu, W. Yang and L. Zhang, "The Realization of Intelligent Home by ZigBee Wireless Network Technology", Proceedings of the 2009 Pacific-Asia Conference on Circuit, Communications and System, (2009), May 16-17, Chengdu, China.

[5] Y. Ha, "Dynamic Integration of Zigbee Home Networks into Home Gateways Using OSGi Service Registry", IEEE Transactions on Consumer Electronics, vol. 55, no. 2, (2009).

[6] J. W. H. Qin, "The Design of Wireless Intelligent Home System Base on ZigBee", Proceedings of the 11th International Conference on Communication Technology, (2008), November 10-12, Hangzhou, China.

[7] Yan and Z. Dan, "ZigBee-based Smart Home System Design", Proceedings of the 3rd International Conference on Advanced Computer Theory and Engineering, (2010), August 20-22, Chengdu, China.