

IMPLEMENTATION OF ADVANCED ENERGY MANAGEMENT SYSTEM

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Abstract— This paper is concerned with the design of an advanced energy management system which involves automatic billing of energy consumption, automatic detection of energy theft in the system, termination of connection if the consumer fails to pay the electricity bill and re-connecting the connection with the consumer terminal when needed. The purpose of this project is to simplify the existing electricity billing process by implementing automatic billing system using a Zigbee network, detection of electricity theft in the system with the help of current sensors and to employ wireless termination and activation of the electricity connection using electromagnetic relays.

I. INTRODUCTION

This project is proposed to create an automatic reading and billing system along with termination and reactivation of connection and power theft detection.

Automatic reading and billing

The system uses Zigbee technology to send the energy usage reading wirelessly to the control terminal (Electricity Board). Control terminal are local units where data (meter reading) are delivered. After receiving the data, the control terminal updates the data base. Then the bill amount for each individual meter is calculated based on tariff rate of the service provider. After which the bill amount is then sent back through the same Zigbee network and is displayed on the LCD present in the consumer terminal so that the end user can view their bill amount in their own energy meter. This process is cost effective compared to the current human operator meter reading method. Frequent monitoring of the power usage also helps to check on the amount of load connected and saves a lot of time.

Automatic termination and re-activation of connection :

The Electricity board controls the relay present in the consumer terminal through the Zigbee network with the help of a microcontroller. If the customer fails to pay the electricity bill, the Electricity board opens the circuit with the help of relay. Re-activation of connection can be done on payment of bill. Zigbee network is used to transmit signals between the Electricity Board and Consumer terminal.

Manuscript received Dec 16, 2014

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Power theft detection

This system doesn't require human operators to go to individual houses. Hence a consumer can easily bypass the energy meter and consume electricity without any change in the meter reading. To overcome this problem, two Current sensors are used in the consumer terminal. One will be inside the meter; the second will be present between the EB line and the energy meter. Both are connected to the microcontroller which notes and compares both the readings continuously. If there occurs a discrepancy in values then the Electricity Board is notified of possible theft of electricity through the Zigbee network.

II. BLOCK DIAGRAM

The block diagram is divided into two parts. The first part is the consumer terminal side. The block diagram of the consumer board terminal is shown in the Fig.1. The consumer terminal has a microcontroller which controls the buzzer, LCD, Zigbee trans-receiver, relay and the two current sensors. Two loads are connected to the system. One acts as the house load while the other is the theft load, as input which is used to calculate the electricity consumed by the user. The microcontroller is interfaced with the liquid crystal display. This LCD is used to display the number of units consumed, the current consumed by the house load and also the electricity bill of the user. It can also be used to display text information sent from the Electricity board. This part of the circuit sends information to the Electricity board with the help of the Zigbee trans-receiver. The Zigbee network is used to transfer the number of units consumed, to alert the Electricity board if theft occurs and to receive information regarding the electricity billing, connection, termination and other information.

The microcontroller is also interfaced with a relay. The relay is used to connect and disconnect the house load. The house load can be disconnected in case of failure to pay the bill and also in the case of theft. The relay can be switched ON and OFF by the microcontroller.

Two current sensors Current sensor 1 and Current sensor 2 are connected to the microcontroller which acts as an input. Current sensor 1 is connected to the house load which is used to measure the units consumed by the load. The theft load is connected between the Current sensor 1 and Current sensor 2. The microcontroller constantly compares both the inputs of Current sensor 1 and Current sensor 2. If the readings of both remain the same then there is no theft involved in the system. When the theft load is switched ON i.e. when the consumer tries to connect a theft load, the values of Current sensor 1 and Current sensor 2 will differ from each other. This will be noticed by the microcontroller PIC 18F45K22 which notifies the Electricity board through the Zigbee network.

The Current sensor 1 is used to measure the current consumed by the user. This is sent to the microcontroller. The second part is the Electricity board terminal. Fig.2 represents the block diagram of the electricity board.

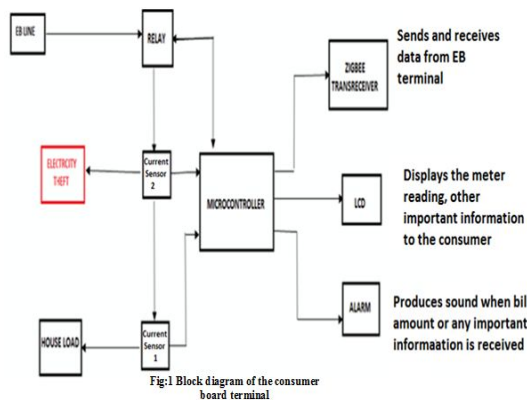


Fig:1 Block diagram of the consumer board terminal

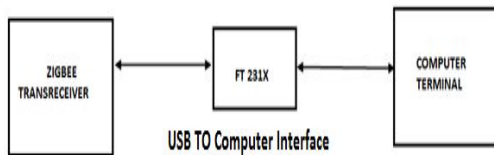


Fig. 2 Block diagram of the electricity board terminal

In the Electricity board terminal a computer is used, which acts as the Electricity board control panel in this project. It is used to monitor and control all the activities in the consumer terminal. A Zigbee module is connected to the computer through FT231x. The computer receives the number of units consumed by the load and calculates the corresponding bill amount and sends it back to the consumer side where the bill is displayed in the LCD. It can also be used to connect or disconnect the house load when needed i.e., it can control the relay with the help of the Zigbee network and microprocessor. Other than that it can be used to send any information to the user through the Zigbee network.

III. HARDWARE IMPLEMENTATION

The circuit diagram of the hardware is explained in this chapter. There are two parts of the circuit. One is the electricity board terminal and another is the consumer terminal. The consumer terminal is shown in the Fig.3 and the electricity board terminal is shown in the Fig. 4

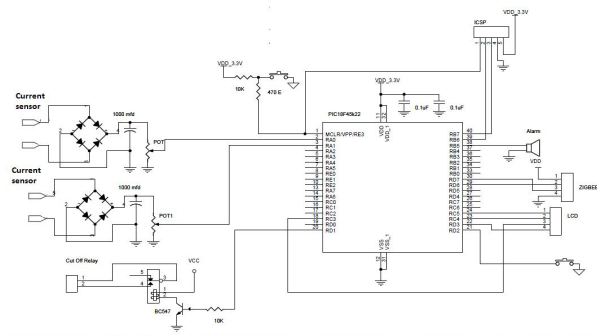


Fig.3 Consumer terminal

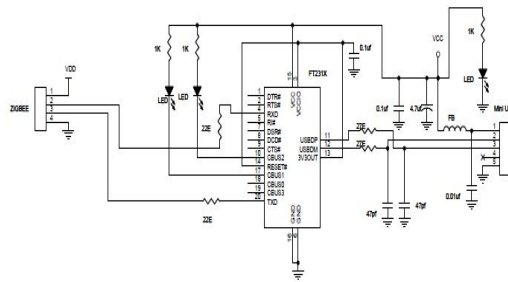


Fig. 4 Electricity board terminal

In order to demonstrate the project we use two bulbs, one as the consumer load and the other as the theft load. One bulb load is connected to the current sensor 1 and the other bulb load is connected to the current sensor 2. Initially when the consumer load bulb is switched ON, the LCD displays the current and the units consumed by the bulb. The VB program acts as the Electricity Board. The program has CALCULATE option. When it is selected, the VB program calculates the bill amount and sends it to the consumer terminal. The bill amount is displayed in the LCD.

The Microcontroller constantly compares both the current sensor values. When the theft bulb is switched ON, the microcontroller senses the change in the values and notifies the electricity board through the Zigbee network. The Visual Basic program displays that theft is detected. The VB program has CONNECT and DISCONNECT option which controls the relay operation with the help of Zigbee and microcontroller. Form design of the Visual Basic program is given below in the Fig.5 When DISCONNECT option is selected, the relay operates and the supply to the bulb is cut off. When CONNECT option is selected, the supply to bulb is restored.

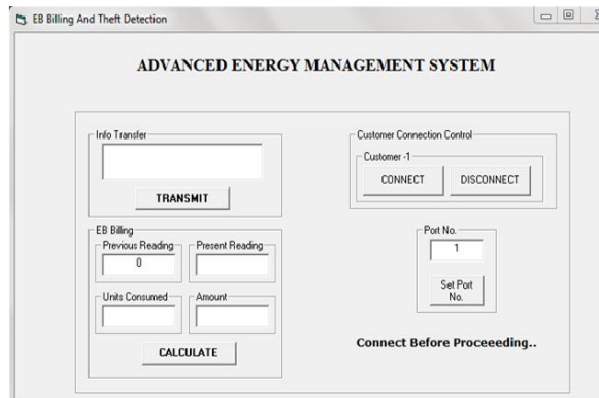


Fig.5 Form

CONCLUSION

An advanced energy management system is designed for automatic billing of energy consumption, automatic detection of energy theft in the consumer terminal, termination of connection if the consumer fails to pay the electricity bill and re-connecting the connection with the consumer terminal whenever needed. In this project microcontroller is designed to organize the entire operation of the system and Visual Basic software is developed as the control panel of electricity board.

This paper simplifies the existing electricity billing process by implementing automatic billing system using a Zigbee

network, detection of electricity theft in the system with the help of current sensors and to employ wireless termination and activation of the electricity connection using electromagnetic relays.

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