I. INTRODUCTION

1.1 GENERAL

Many countries which have proposed energy conservation projects use both existing information and communication technology to control or manage electric appliances to save power. This design proposes a remote power on-off control of various electric outlets in the household using embedded board and ZigBee communication technology. Remote power on-off control refers to the means of controlling and monitoring power at an electric outlet from a distance. We aim to apply this method of control for the various electric appliances at home in order to manage power effectively. Since the control is from a remote area, we need to use wireless communication for transmission and reception of associated signals. The most commonly used wireless communication technologies are infrared, Bluetooth, ZigBee and RF wireless module. Of these, we choose to use ZigBee communication technology. ZigBee is a low-cost, low-power, wireless mesh networking standard. First, the low cost allows the technology to be widely deployed in wireless control and monitoring applications. Second, the low power-usage allows longer life with smaller batteries. Third, the mesh networking provides high reliability and more extensive range. Hence it is 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.

II. ARCHITECTURE FOR REMOTE POWER ON/OFF CONTROL

In this chapter, we are going to discuss about the hardware architecture used to build the circuit for remote power on/off control of electric home outlets.

2.1 HARDWARE LAYOUT FOR REMOTE POWER ON/OFF CONTROL

The whole power management system for the electric outlet consists of three parts as shown in Figure 2.1:

- The ZERCM
- The home server
- The remote control module

2.2 ZERCM

The ZERCM consists of MCU, a ZigBee module, a relay and a current transducer. The sensor of the ZERCM detects the electric current being used. The MCU handles the ID, turns the electric outlets On/Off and then sends a control message to the other end of the ZigBee module through the ZigBee interface. The MCU provides a bi-directional control mechanism: one direction for current measurement and the other for On/Off control. We can then detect the status of many electric home appliances.

Figure 2.2 shows the ZERCM module architecture. It consists of a CT coil and a simple bridge rectification circuit as a sensor detecting module. We put an amplifier at the end to amplify the signal which is sent to the MCU. The SSR will handle the on/off of the power outlet depending on o/p of the MCU.

Figure 2.3 depicts the circuit of a Power supply circuit employed in the design. A CT coil is used to
Remote Power On-Off Control For Home Electric Outlets Using Zigbee Control

International Journal of Advanced Computational Engineering and Networking, ISSN: 2320-2106, Volume-1, Issue-10, Dec-2013

55

detect current in a circuit. When current in a circuit is too high to directly apply to measuring instruments, it produces a reduced current accurately proportional to the current in the circuit, which can be conveniently connected to measuring and recording instruments. Further, it isolates the measuring instruments from what may be very high voltage in the monitored circuit. The output of the CT is AC current. It is converted in DC using a diode bridge rectifier as shown in the diagram. It provides full-wave rectification from a two-wire AC input, resulting in lower cost and weight. The essential feature of this rectifier is that the polarity of the output is the same regardless of the polarity at the input. The output is however not pure DC as it consists of harmonics. In order to smoothen the DC waveform, an RC filter is incorporated. The output at this stage is pure DC. This however is a weak signal and cannot drive the MCU. In order to impart a sufficient power and gain, the signal is amplified using an amplifier as shown.

**Solid State Relay**

A solid-state relay is an ON-OFF control device in which the load current is conducted by one or more semiconductors - a power transistor, an SCR, or a TRIAC (refer Figure 2.4). It requires relatively low control circuit energy to switch the output state from OFF to ON, or vice versa. Its sensitivity is often significantly higher than that of an EMR of comparable output rating.

Voltage applied to the control line of an SSR causes the LED to shine on the photo-sensitive diode. This produces a voltage between the MOSFET source and its gate, causing the MOSFET to turn on. In this design, the SSR is used to either switch on or off the current in the power outlet based on the command coming from the MCU coupled to the socket through the CT.

**Microcontroller Unit**

The MCU or the microcontroller unit is the brain of the network. It receives the output signal of the current detector. In this way, it senses the current status at every node and checks for overload condition. Depending on the result obtained it issues two commands:

- It calculates the power consumed and sends the status to the user if there is no overload.
- It cuts off the power supply at the socket using SSR and sends the current status to the user if overload occurs.

The choice of microcontroller mainly depends on the following factors:
- Speed of operation (Frequency)
- Nature of application
- Availability of ports as per requirement
- Cost efficiency
- Power consumption

Keeping in mind all the above mentioned factors, we choose to use PIC 16F877a microcontroller for the project. The pin diagram of PIC16F877a is given in Figure 2.5.

**ZigBee Module**

The ZigBee wireless module is a chip or a USB that is used to transmit and receive data between the ZERCM and the home server. Because it performs both the functions, it is referred to as a “ZigBee transceiver” at both the ends. The ZigBee module can communicate between the sending and receiving ends using the IEEE address or short-address. It establishes a link among the various nodes through binding and then communicates through cluster information and endpoint information.

**2.3 HOME SERVER**

The embedded home server module contains a ZigBee module and an embedded board. The ZigBee module receives and transmits the control signal and the current measurement signal. There are several functions of the home server module:

- It determines the present state of the home electric outlets.
- It calculates the total time that the electric home appliances are used.
- It controls the On/Off function of the electric outlets.
Remote Power On-Off Control For Home Electric Outlets Using Zigbee Control

International Journal of Advanced Computational Engineering and Networking, ISSN: 2320-2106, Volume-1, Issue-10, Dec-2013

6. Using Visual Basic, the software is matched with the home server, which provides a user-friendly and machine-compatible interface. The measurement data for the use of current and voltage are stored in the embedded board. The checking software module not only examines the operation conditions with respect to the presetting values but also determines when to send the message to the circuit breaker to avoid any overload. To connect with more groups of electric outlets we can easily extend the design by adding a field for establishing IP addresses and sending control messages to the Internet ports. Our design also provides settings for an IP address, On/Off, scan rate, and service time. The control module has an option to establish the ZigBee module as the receiver and dispatcher. The setting module also examines the processes of all equipment in the ZigBee network.

2.4 REMOTE CONTROL

The remote control unit is at the user’s end. It is the GUI peripheral that enables the user to interact with the home network. The different types of remote control systems used are mobile phone, PC or a PDA. These display devices not only show the status of the network to the user, but also allows him to make desired changes in the home network from a remote place. In this way, an efficient monitor and control of home network is achieved from a remote place.

2.5 OVERLOAD DETECTION PROCEDURE

1. Start.
2. Sense current status at every node in the n/w using CT.
3. Check for overload condition by comparing actual and preset value in the MCU.
4. If there is no overload, go to next step. Else, go to step 6.
5. Calculate the power consumed and status to the user.
6. Calculate the power consumed, send the status to the user and automatically cut off power supply from the outlet.
7. Stop.

III. ALGORITHM FOR IMPLEMENTATION OF OVERLOAD DETECTION PROCEDURE

1. Start.
2. Sense current status at every node in the n/w using CT.
3. Check for overload condition by comparing actual and preset value in the MCU.
4. If there is no overload, go to next step. Else, go to step 6.
5. Calculate the power consumed and status to the user.
6. Calculate the power consumed, send the status to the user and automatically cut off power supply from the outlet.
7. Stop.

2.6 EMBEDDED HOME SERVER

![Figure 2.7 Flowchart for implantation of embedded home server program](image)

IV. ALGORITHM FOR IMPLEMENTATION OF THE EMBEDDED HOME SERVER PROGRAM

1. Start
2. Set limit of n (no. of devices).
3. For n=1, read the consumption of n, i.e., D(n).
4. If D(n)==0, display “device is off” and store the value in a variable “total power”.
5. If D(n)==max, display “overload” and cut off power supply to appliance from outlet.
6. If D(n)<max, display “no overload”.
7. Advance to next device, i.e., n=n+1.
8. Check if n>maximum limit.
9. If no, go to step 4. Else, go to next step.
10. Stop.

REFERENCE:


Remote Power On-Off Control For Home Electric Outlets Using Zigbee Control

57