

# DISTRIBUTED POWER SYSTEM USING ZIGBEE TECHNOLOGY

## Project - II

Submitted in partial fulfillment of the requirements for the degree of  
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## CERTIFICATE OF APPROVAL

**Project Title: Distributed power system using ZigBee Technology**

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In partial fulfillment of the degree of B.E. in “Electronics & Telecom” is approved

Guide(s):

Examiner (s):

1. Internal \_\_\_\_\_

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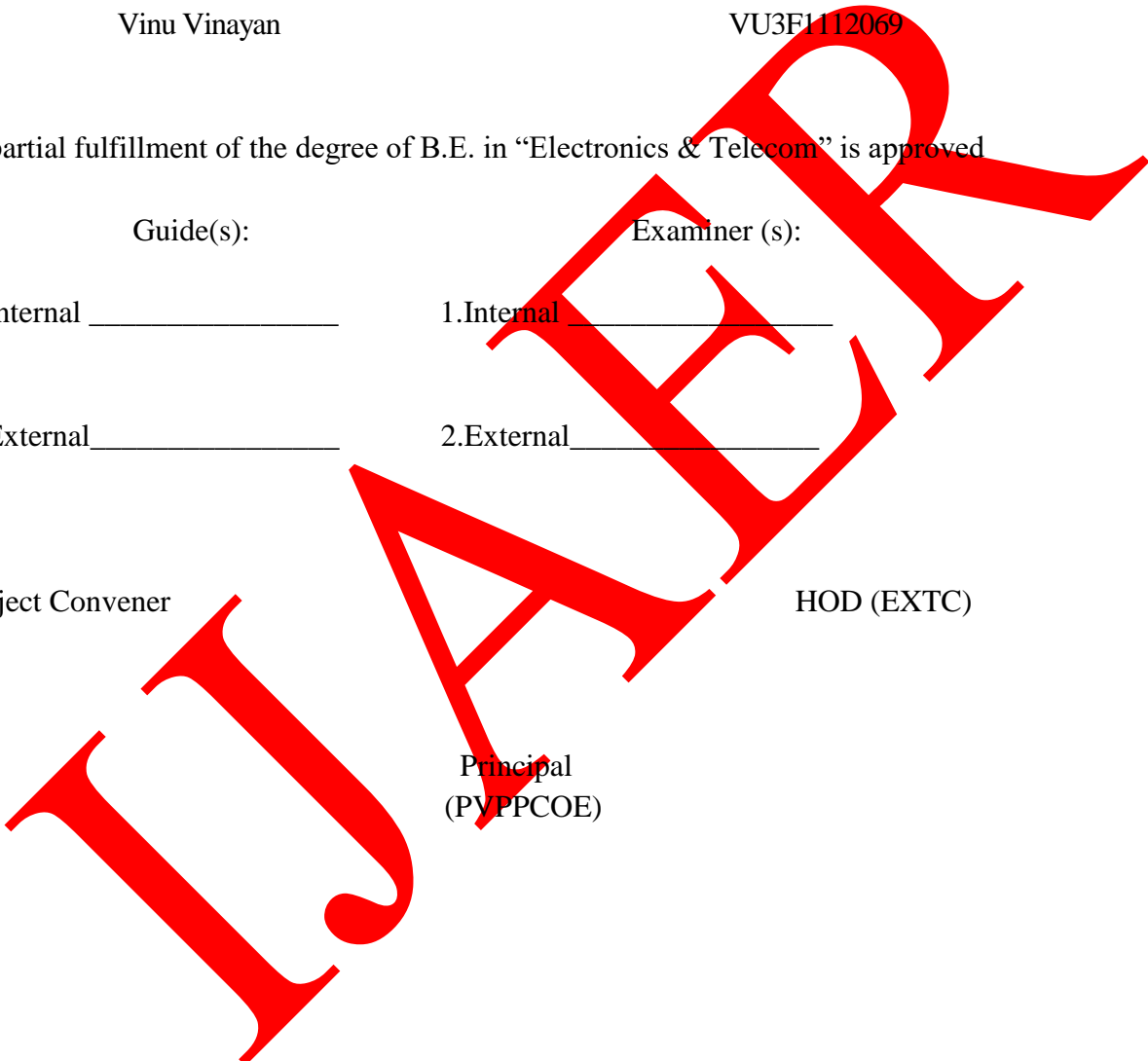
2. External \_\_\_\_\_

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Project Convener

HOD (EXTC)

Principal  
(PYPPCOE)



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## ABSTRACT

Nowadays every load (light, fan, etc) has same priority which is controlled by humans. Hence we can use any amount of power as per our wish and there is no limitation on it. Amount of power cannot be controlled as per the requirement which leads to a huge amount of power loss. Also there is an increase in human intervention in current system. Government has introduced time based load shedding which is an act or process of disconnecting the electricity for a stipulated period of time for units (society, town, city, etc) when the demanded power consumption becomes greater than the supply in order to reduce energy consumption.

Objective of proposed project is to design a wireless energy saver system that can modulate power of individual loads (light, fan, etc) inside a unit (home/office, building, society, town, city, etc) using load priority based algorithm. If sufficient power is not available, the load shedding automatically shuts down or limits the current to low-priority loads. It enables to restores the balance between available power and power consumed, enabling uninterrupted operation of high-priority loads. This can be achieved by creating a mesh network of motes(or Xbee enabled sensors) and Nodes for regulating power, depending on priority algorithm.

Thus our system will help to save energy by introducing priority based load shedding. This system will help to put a restriction on the energy consumed thus making it available for the coming generation.

**Keywords:** - XBees, Passive Infrared (PIR) sensor, Infrared (IR) sensor, Temperature Sensors, LDR's, Power Modulation Circuit, Microcontroller.

## Chapter 1

### Introduction

#### 1.1 Definition

##### 1.1[A] Existing Systems

Saving Energy is not a new concept but this area still has plenty of room available for improvement. The methodology and technology used by each of these existing systems is different. Here we have categorized the existing systems according to the methodology used; for instance the medium for communication between the unit (house, office, building etc) and user. For systems that labor a similar methodology as this system, we have gone to the depth of studying the technologies.

##### 1) Categorization based on controlling mechanism

##### Controlling through remote controllers

These devices basically require the user to be within the premises in order to control the equipments.

Different types of controllers are used and following controllers are more common in most of the applications.

- Bluetooth
- Radio Frequency (RF)
- Infrared (IR)

There are weaknesses associated with these systems based on the limitations inherent to each of these technologies.

##### 1.1[B] Limitation of Current System

Human intervention is the main hurdle faced by the current systems. There are chances that human being may not take corrective action even if the system informs him/her about the wastage of energy.

#### 1.2 Aim Of The Project

This project aims at developing a highly cost-effective energy saver system. To design a wireless energy saver system that can modulate power of individual loads inside a unit (home/office, building, society, town, city, etc) using load priority based algorithm. The main objective to build a system based on load shedding which automatically shuts down or limits the current to low-priority loads. It enables to restores the balance between available power and power consumed, enabling uninterrupted

operation of high-priority loads. This can be achieved by creating a mesh network of motes and nodes for regulating power, depending on priority algorithm. It can easily be customized as per requirements and available resources to suit the needs of different customers.

### **1.3 Organization of Report**

The problem definition and the aim of our project are described in chapter 1. The chapter 2 consists of the Literature Survey where the various methods of implementing the project are described and the previous work done on energy saver system using priority based load shedding. Chapter 3 consists of block diagram with their explanation and the hardware and software used designing the project. The chapter 4 gives a description of the work completed and the work that is remaining to be done. Last chapter deals with the conclusion derived from the project and final lists the various references for the literature survey

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## Chapter 2

### Literature Survey

#### 2.1 Introduction

##### 2.1.1 Existing Systems

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##### 2.1.2 Limitation of Current System

Human intervention is the main hurdle faced by the current systems. There are chances that human being may not take corrective action even if the system informs him/her about the wastage of energy.

##### 2.1.3 Concept of Energy saver system using priority based load shedding

The proposed system automatically modulates power between loads according to the conditions and priority set. This system helps in implementing priority based load shedding instead of time based load shedding.

#### 2.2 Previous Work Done

In the paper “Automate and Secure Your Home Using Zigbee Technology” presented by Nausheen Belim, Harshada Bhambure, Priyanka Kumbhar and Simranjit Tuteja explains how Zigbee, microcontroller and gsm modem can be used for home automation and to save the energy that is being consumed[1]

In another paper “Automatic detection of human and energy saving based on Zigbee Communication” presented by Chinnam Sujana and Addanki Purna explains on how to use Zigbee , sensors and microcontroller to sense the presence of human in a room and to save energy accordingly.[2]

**Conclusion :**

After the survey we have done on the energy saver system, we decided to use Xbee S2 for wireless communication and a VFD to modulate power .After further survey it was concluded to use Arduino development board for implementing the project.

In next chapter we have discussed the complete implementation process of the project. The whole process is divided into two parts software and hardware implementation. Each of the implementation process is explained thoroughly.

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## Chapter 3

### Methodology and Implementation

#### 3.1 Block Diagram :

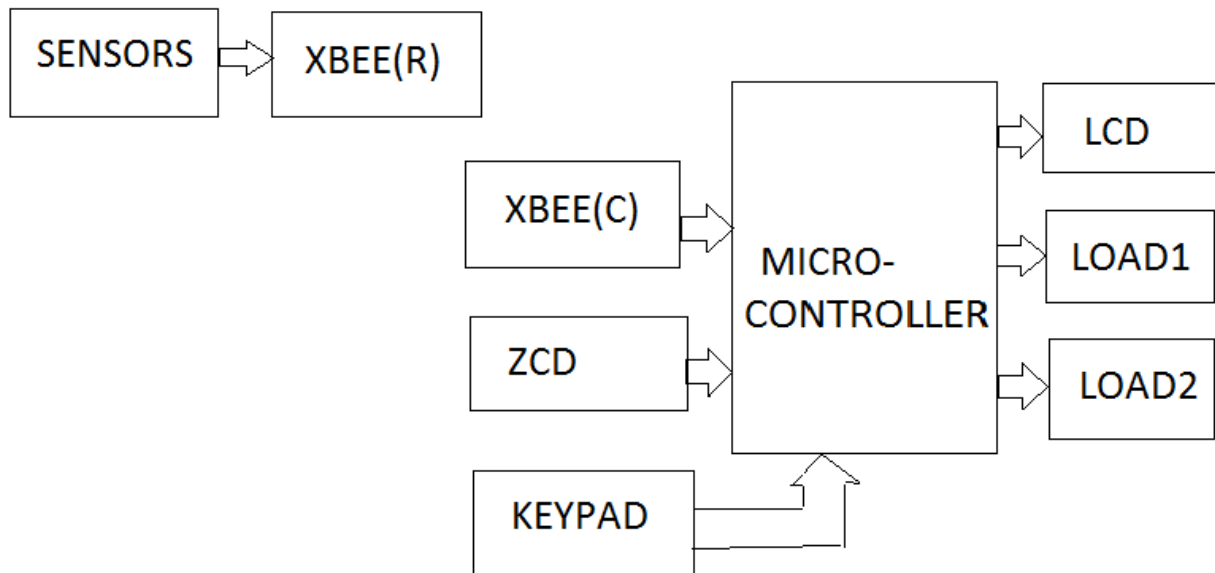


Fig 3.1.1 Block Diagram

The above block diagram shows how the system will work. The value of sensor will be send to Micro-controller by using Xbees. There is keypad to set priority of loads. There is power measurement circuit, which will measure power and Power Modulation will take place if instance power is more than predefine power.

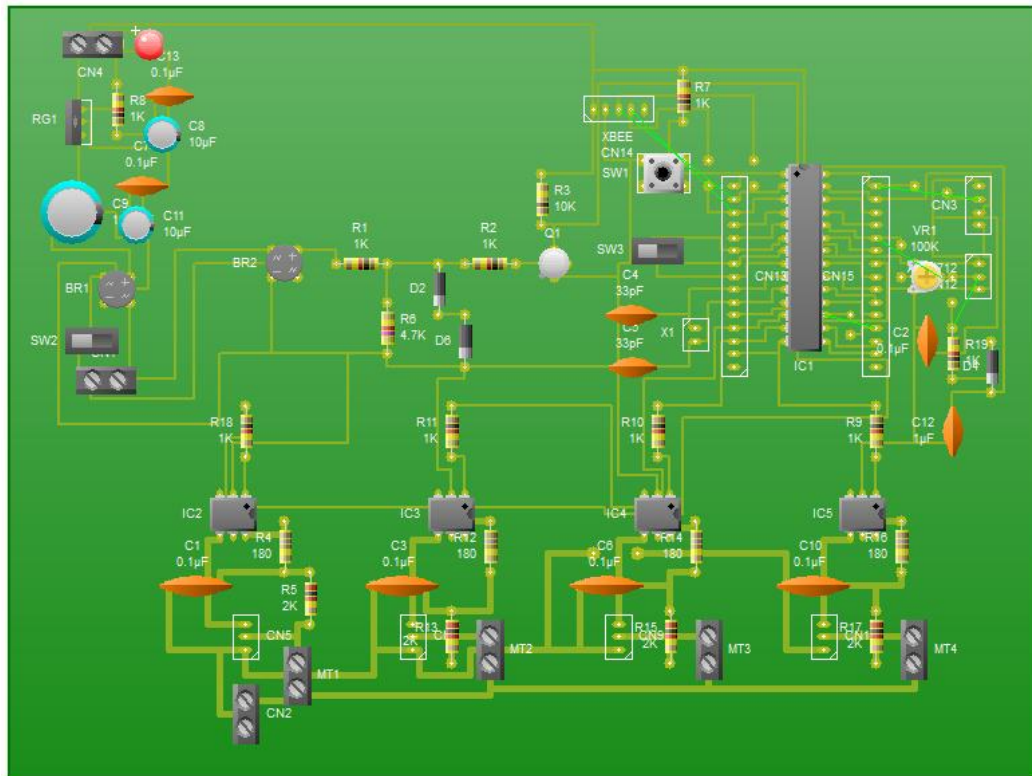


Fig 3.1.3 Real view of Circuit Diagram

### 3.1.1 BLOCK DIAGRAM DESCRIPTION

The block diagram consist of following parts \*\*\*\*\*

- 1.Mote- It is a sensor node which collects information from the environment and sends it to the node.
- 2.Node:- It is a computational unit which receives information from the mote and computes the value according to priority based algorithm.
- 3.VFD:- A variable frequency drive (VFD) (also termed adjustable-frequency drive, variable-speed drive, AC drive, micro drive or inverter drive) is a type of adjustable-speed drive used in electro-mechanical drive systems to control AC motor speed and torque by varying motor input frequency and voltage.
4. Load :- In our case it may be fan, light, etc.

## 3.2 PCB Preparation Technique

### 3.2.1P.C.B. CONSTRUCTION

A Printed Circuit Board (P.C.B) can be defined as an insulating base material to which is permanently attached a flat metallic network of conducting paths whose dimensions depends upon

the current that can be handled by them. The P.C.B may be either single sided or double sided. The P.C.B used for this project is single sided one.

The basic material used may be resin coated papers, fibre glass, ceramic and the flat board configuration however is most widely used and it may be of the nature of the single "Mother Board" into which smaller boards are plugged by the especially designed connectors which ensures adequate and permanent low resistance coupling.

PCB designing is the most important and requires great care during work. In this case great care must be taken while tracing the circuit or layout on the board. Because once PCB is designed, it is virtually impossible to alter it. While designing a circuit, designer should take care to avoid crossing of conducting paths (tracks) as possible. Crossover are unavoidable then only of the jumpers can be used. A circuit board carrying copper on both sides can also help to solve this problem when circuit is complicated.

The next stage lies in proportion to designing i.e. to prepare "Master Diagram ", which is commonly made twice as the finished circuit, since this makes the working on that much easier, especially when circuit is complicated photography eventually reduces the size of diagram to that of the circuit, before proceeding we must know some rules regarding the designing.

1. The space between the conductors must be strictly controlled to avoid the possibility of electrical discharge or unwanted capacitance. The amount by which the master diagram is to reduce in size is thus a critical design feature.
2. The conductor must be wider in those parts of the circuits that are going to handle large currents must be handle without undue temperature of conductors.
3. The minimum width of copper should not generally be less than about 1.5mm. This is related to mechanical strength rather than the electrical properties and it also ensures that strips remains securely bounded to the base material.
4. The points where the components holes for lead wires occurs must be sited to suit the dimensions of the components and dimensions between lead-out wires, so that, the components can be situated correctly on finished board. The conductor is also men large at the point of holes.

When the master diagram probable twice the size of real PCB has been evolved, the text major step consist of etching or dissolving the unwanted metal from copper cladded board to create the circuit as depicted by master diagram. It must be stressed that very accurate checking of master is essential at this stage. Then, the master point is mounted on a special frame on easy facing of a larger camera and with the aid of the very powerful illumination a master diagram is clearly photographed on a glass sensitive plate. This is developed to give photographic negative. Next so called "step and repeat camera." Is brought into operation. This comprises the camera body mounted so that sideways after each exposure. In this way number of copies of the original master diagram is set out exactly to cover standard sheet of copper clad laminate laboratory method of making PCB.

There are several important factors that need not be taken into account, if the finished device is to work properly we must consider gain factor and ensure that the input and output parts are sufficiently well isolated to avoid the possibility. We must also ensure that conductors and components carrying high frequency current are well separated from these parts of the circuits. We are also to make sure that all components need to return to earth are properly connected and that possibility of common impedance arising in earth returned. Other factors that have to successfully studied include availability of adequate return points on board and it's mounting from accessibility of switch connections made for mechanical fixing ventilation effect of vibration.

The copper side of the board must be thoroughly cleaned before Circuit plan is transferred to it. This is very important because even slightest trace of graze (from figure of instance) will impure the etching process and When the circuit plan has been neatly transferred to copper in this manner the board is held under, running tap and the allowed to dry before resist is applied.

Now, once cleaning is done plan has to transfer on copper surface of PCB material. A convenient way to do this is simply put a carbon paper between a copper surface of the board and working plan and carefully trace the lines of original plan with a ball pen.

Resist is nothing more than a substrate that is unaffected by presence etching chemicals. It is usually coloured so that, it can be easily seen the copper surface. When plan is clearly worked on clean copper then that are to be left in fact as the copper conductors must be covered when resists the leaguer type of paints possess good resist properties but disadvantages of relatively long time taken for drying. It is essential to resist through hardening before etching is started. Nail polished are better as they quickly and are less difficult to remove. Now-a-days etching taps along with IC pads are commonly used. To this, chances of short circulating due to paints are completely the avoid etching tapes and pads are available in different sizes.

When a result has been thoroughly hardened any errors that have been made can usually be corrected by gently scratching away with knife. To ensure clear out lines round edges of copper conductors on board the resist must be applied with steady band. Next comes etching of unwanted copper and whether a small single is all that is required as quantity of board to be produce certain precautions must be taken before operation is commenced the most etch ant I ferric chloride and to this is added small quantity of HCL to accelerate, But not critical as lab construction is concerned. Mixing 10 grams of ferric chloride and 25 grams of HCL with 15 grams of water can produce a good etchant.

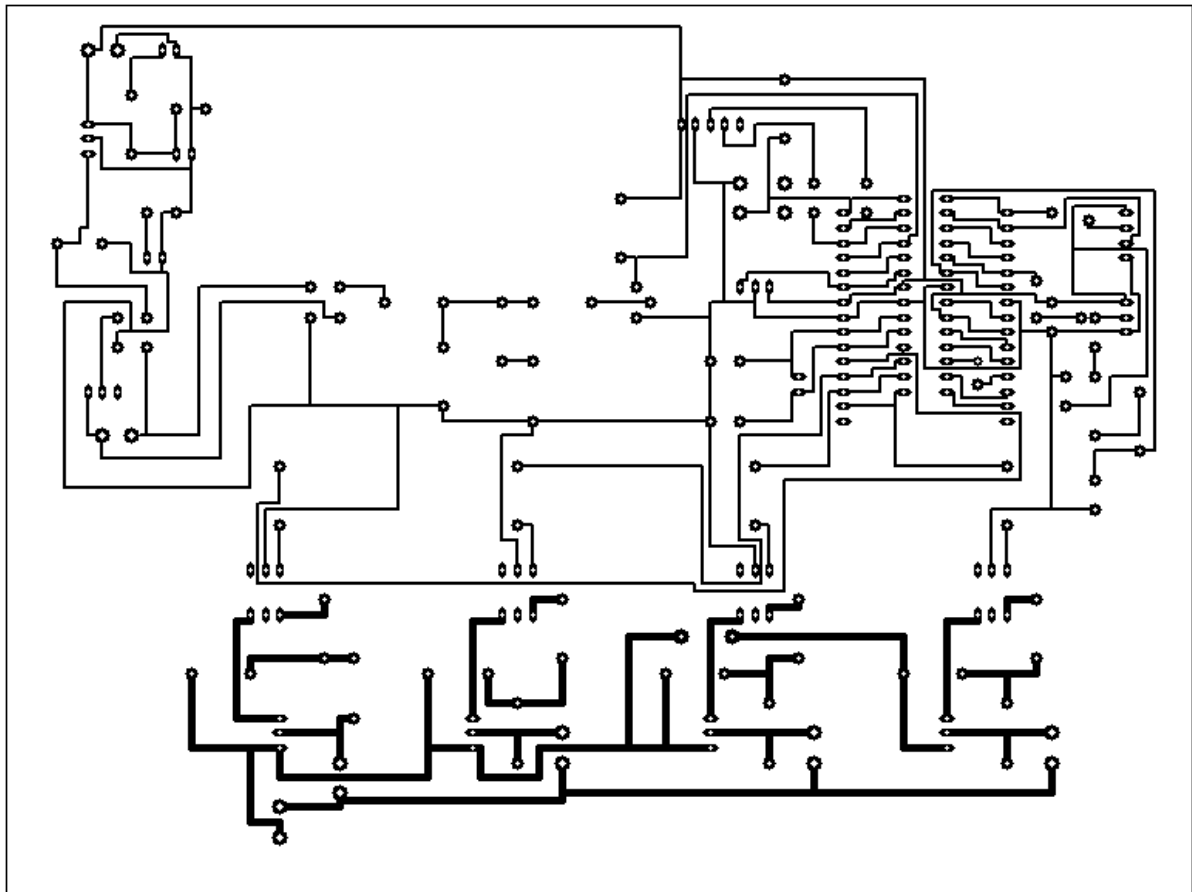
Small plastic bath is ideal for storing the etchant process. The Depth of liquid must be sufficient to completely cover laminate, the laminated board carrying the resist pattern circuit is then dropped into etchant bath and the gentle agitation takes 5 to 20 minutes to complete depending on the strength of the etchant temperature and thickness of copper foil.

When all unwanted copper is dissolved from areas between conductors, board should be taken from an etchant and washed in water. The resist must be removed using proper solvent. After this the copper surface must be polished with any kind of cleaner. It should be seen that there is no slight incomplete etching between the conducting paths of the PCB. The PCB's are coated coating material for protection in lab coating material itself is a solder. This process is called Tinning. This process of

coating involves tracks with solder. Advantage of tinning the effect of environment of conductors, then PCB is drilled i.e. holes for filling and mounting the components on PCB are drilled with suitable drill bit.

After the holes are drilled, the components have to be assembled on PCB before assembling the components it is necessary to clean soldering iron in order to get easy and accurate soldering. Removing impurity particles that are gathered on iron bit due to repetitive use cleans soldering iron.

**PCB Layout**



**Fig. 3.x PCB Layout of Circuit**

**3.3 Components List**

Component	Value	Quantity	Rate	Total
Bridge Converter		2		
Resistor	180 Ω, 5W	4	6	24
	2k Ω, 5W	4	6	24

	1 K $\Omega$	9	1	9
	4.7K $\Omega$	1	1	1
	10 K $\Omega$	1	1	1
Capacitor	1 $\mu$ F	4	1	4
	1 $\mu$ F, AC	4	5	20
	10 $\mu$ F	2	3	6
	1000 $\mu$ F	1	10	10
	33 pF	2	1	2
LED	Green	1	1	1
Diode	1N4007	2	1	2
Oscillator	16 MHz	1	10	10
Voltage Regulator	IC 7805	1	24	24
Microcontroller	Atmel 328	1	180	180
Xbee	S2	3	1200	3600
Optocoupler	MOC 3021	4		
ACS 712	5A	1	300	300
16 X 2 LCD	JHD 162A	1	180	180
Variable Resistor	10K $\Omega$	1	5	5

Zener Diode	BTA 16	1		
Transistors	2N2222	1	3	3
PIR Sensor		1	180	180
LDR		1	10	10
LM 35		1	50	50
Channel Input		7	3	21
Switches	Push to On	1	2	2
	Toggle	2	5	10

**Table 3.1 Component List**

### 3.4 Software Implementation

We use different software in our project which as follows:

#### PCB Wizard:

PCB Wizard is used for designing of circuit and PBC Layout. It provides a comprehensive range of tools covering all the traditional steps in PCB production, including schematic drawing, schematic capture, component placement, automatic routing, Bill of Materials reporting and file generation for manufacturing.

#### XCTU:

XCTU is a free multi-platform application designed to enable developers to interact with Digi RF modules through a simple-to-use graphical interface. It includes new tools that make it easy to set-up, configure and test [XBee® RF modules](#).

XCTU includes all of the tools a developer needs to quickly get up and running with XBee. Unique features like graphical network view, which graphically represents the XBee network along with the signal strength of each connection, and the XBee API frame builder, which intuitively helps to build

and interpret API frames for XBees being used in API mode, combine to make development on the XBee platform easier than ever.

Other highlights of XCTU include the following features:

- You can **manage and configure multiple RF devices**, even remotely (over-the-air) connected devices.
- The **firmware update** process **seamlessly** restores your module settings, automatically handling mode and baud rate changes.
- Two specific **API and AT consoles**, have been designed from scratch to communicate with your radio devices.
- You can now **save your console sessions** and load them in a different PC running XCTU.
- XCTU includes a set of embedded tools that can be executed without having any RF module connected:
  - **Frames generator**: Easily generate any kind of API frame to save its value.
  - **Frames interpreter**: Decode an API frame and see its specific frame values.
  - **Recovery**: Recover radio modules which have damaged firmware or are in programming mode.
  - **Load console session**: Load a console session saved in any PC running XCTU.
  - **Range test**: Perform a range test between 2 radio modules of the same network.
  - **Firmware explorer**: Navigate through XCTU's firmware library.

Arduino Uno:

The Arduino [integrated development environment](#) (IDE) is a [cross-platform](#) application written in [Java](#), and derives from the IDE for the [Processing programming language](#) and the [Wiring](#) projects. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as [syntax highlighting](#), [brace matching](#), and automatic indentation, and is also capable of compiling and uploading programs to the board with a single click. A program or code written for Arduino is called a "sketch".

### Algorithm for the circuit

1] Start.

In this step after switching on the power supply the circuit gets on and LED glows showing that the circuit is properly working.

2] Formation of Wireless network using Xbees.

We have used Xbees for wireless communication and to get the information of sensor wirelessly.

3] Connecting different sensor with Xbees and wireless network

We are using different sensor which are connected with Xbees and the information of sensor are send to Micro-controller wireless by the use network made using Xbees.



#### 4] Priority selection of loads.

The end user can set priority to the load according to demand of the person.

#### 5] Power Measurement

We have developed a power measurement circuit, to know the amount of power being consumed at the instance. The Micro-controller will be able to know the amount of power being consumed at an instance.

#### 6] PWM

A Predefined amount of power is set in the micro-controller. If the power Measured from power measurement circuit exceeds the predefined amount of power, then PWM will be done. The load with lowest priority will be modulated first and so on.

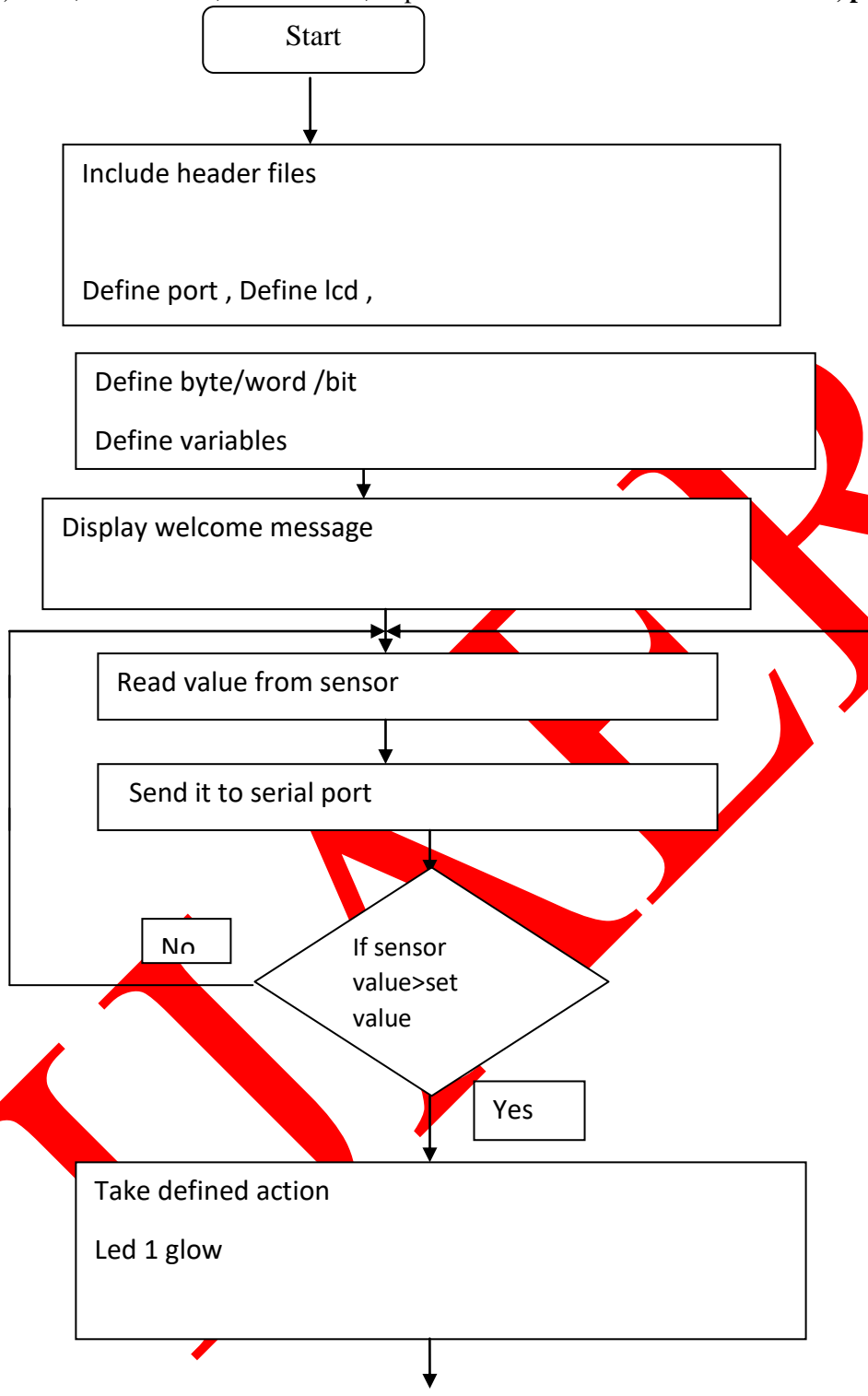
#### 5] Automation

Depending on the information of sensor, coming from xbees wireless, Micro-controller will perform Automation i.e automatic turning on and off of loads.

#### 3.5 Flowchart

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**Fig. 3.10 Flowchart of Operation**

The flowchart shown in fig. describes the complete functioning of the project Gesture controlled home appliances. This prototype of the Gesture controlled home appliances was efficiently designed. The LED of circuit gets on after switching on the power supply. This prototype has facilities to be integrated with a display board thus making it truly mobile. The sensor detects various gestures, controls switching of the relays and notifies everyone by displaying it on LCD module. The gesture is

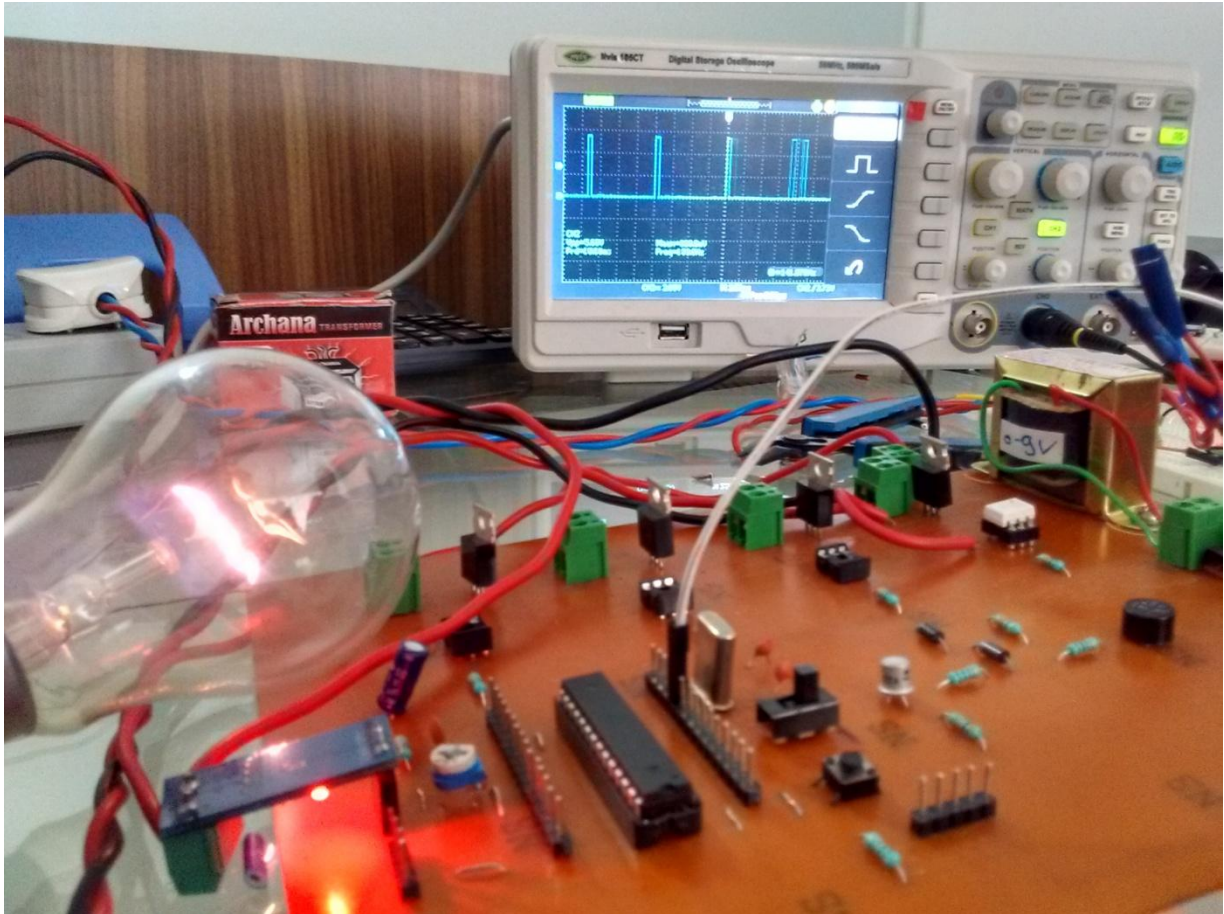
detected from the Accelerometer each time it is changed, and it again change the device status, thus change in the message on the LCD module. In this case, it can solve the problem of instant switching of appliances in the home.

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## Chapter 4

### Results And Discussions

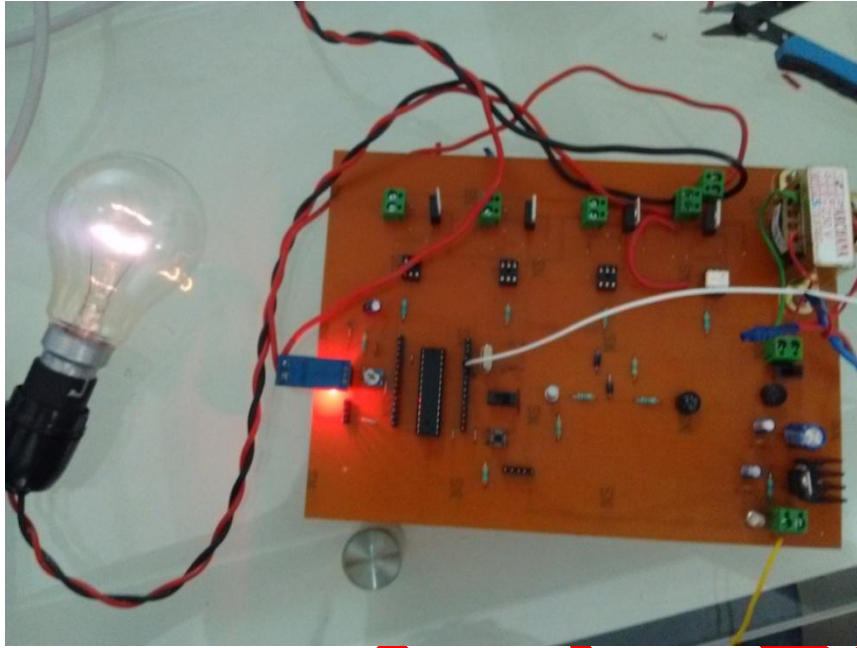
#### 4.1 Hardware Result



**Fig 4.1 Output of Zero CROSSING Detector and PWM.**

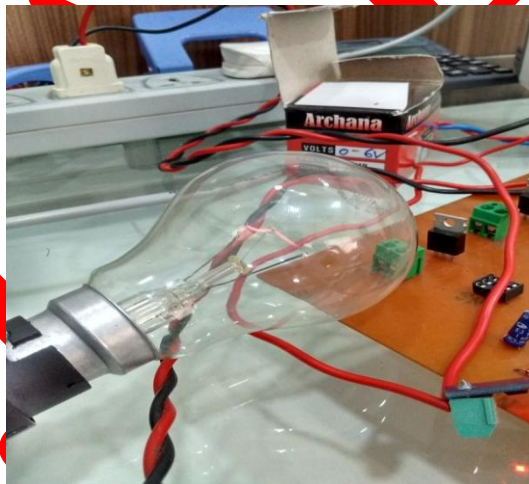
The sensor value is acquired by the xbee and it is transmitted to another xbee depending on that the power is modulated. The keypad is used to set the priorities to the load. Depending on the priorities the power on the load will be modulated and the amount of power that is measured using ACS712 is being displayed on the LCD. The above images shows that the we have successfully got Zero Crossing detector and PWM.

The output can seen in DSO.



**Fig 4.2 Output of PWM.**

The above image shows that the circuit is working properly and the bulb is on and PWM is done by small amount.



**Fig. 4.3 Output of PWM with Low Intensity**

The above shows that circuit is working properly and we are getting proper output and the image shows that we have done Modulation and the intensity of bulb is reduced.

#### **4.2 Software Result**

The input from Zero crossing detector goes as interrupt to the microcontroller, as soon as the microcontroller receives it reads the value that is being received by the xbee and accordingly it sends the pulse to optocoupler. According to the input at keypad matrix the priorities of the load is set i.e. some percentage of power modulation takes place.

## Chapter 5

### Conclusion

#### 5.1 Summary

The project Development of “**Distributed power system using ZigBee Technology**” is an effective system for controlling home and office appliances. The system is small, simple and good for appliances control.

The System “**Distributed power system using ZigBee Technology**” will help constrain power consumption without human intervention. It will help to restrain electricity bill (threshold can be decided by the user). Using this system energy consumption data can be monitored and audited for devising future power consumption strategies. System can be controlled from a remote location due to internet connectivity.

#### 5.2 Future Scope

This idea can be extended to loads connected in multiple rooms even up to the entire building. This system can be made applicable in Smart Cities where systems are controlled from a remote location. This system will help us to maintain the database of energy consumption in different units. This will be major step in automation and will have tremendous future scope of development and applications.

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