A Minor Project Report

On

METAL DETECTOR

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF DEGREE OF BACHELOR OF TECHNOLOGY

in

ELECTRICAL ENGINEERING

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JALANDHAR

JANUARY-JUNE 2023

CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the project entitled "METAL DETECTOR " by Shiwang, Baldev Kainth, Harninder Singh, Kamalpreet Singh, RohitKumar, Hardeep Singh in partial fulfillment of requirements for the award of degree of Bachelor of Technology (Electrical Engineering) submitted to the department of Electrical Engineering at Sant Baba Bhag Singh University, Jalandhar, is an authentic record of our own work carried out during the period from January 2023 to June2023.The matter presented in this project has not been submitted to any other University/Institute for the award of Bachelor of Technology (Electrical Engineering) degree.

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This is to certify that the above statement made by the candidate's is correct to the best of my /our knowledge.

The Minor Project Viva-Voce Examination of this group has been held on 26/05/19 and accepted.

Signature of Internal Examiner

Signature of External Examiner

ACKNOWLEDGEMENTS

I would like to express my special thanks of gratitude to Dr. Gurmanik Kaur (Associate Professor & Head, EE, UIET) who gave me the golden opportunity to do this wonderful project on the topic "METAL DETECTOR". We are deeply grateful to our Project Guide Prof (Dr.) Vijender Kumar Jain for his guidance, patience and support

Secondly we would also like to thank my parents and friends who helped me a lot in finalizing this project within the limited time frame.

Lastly, I like to thank all my supporters who have motivated me to complete this project before the timeline.

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CONTENTS

CHAPTER 1

Introduction

The first industrial metal detector was developed in the year 1960 and was used for mineral prospecting and other industrial applications. A metal detector is an electronic device that includes an oscillator which produces AC that passes through a coil producing an alternating magnetic field. If a part of the metal is near to the coil, eddy current will be induced in the metal and this produces a magnetic field of its own. If another coil is used to measure the magnetic field, the change in the magnetic field, the change in the magnetic field due to the metallic object can be detected.

The metal detectors are used to detect the weapons like guns, knives in the airports, and also used in the construction industry to detect steel reinforcing bars in wires, concrete, pipes buried in floors and walls [1].

CHAPTER 2

Circuit Diagram and Description of Components Used

2.1 Circuit Diagram

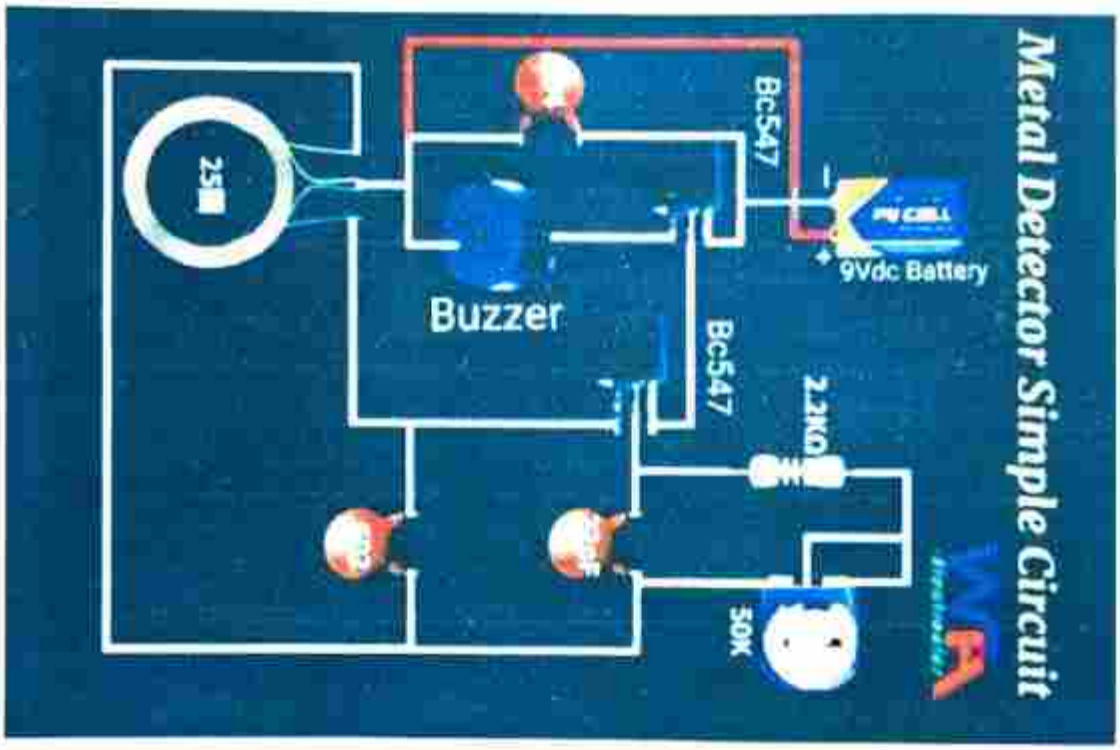

Figure 2.1- Circuit Diagram of Metal Detector

2.2 Component Used

a) Copper Coil
b) BC 547npn Transistor
c) Capacitor (22pf ceramic disc)
d) Resistor (2.2K ohm)
e) Buzzer
f) Battery (9V)

2.3 Description of Components

2.3.1 Resistor

The Resistor is a passive electrical component with two terminals that are used for either limiting or regulating the flow of electric current in electrical circuits.

The main purpose of resistor is to reduce the current flow and to lower the voltage in any particular portion of the circuit. It is made of copper wires which are coiled around a ceramic rod and the outer part of the resistor is coated with an insulating paint. The SI unit of resistor is Ohm. Figure 2.2 shows the symbol of a fixed resistor:

Figure 2.2 – Symbol of a fixed resistor.

❖ **Types of Resistors**

Resistors are available in different shapes and sizes. Common types that are available are through-hole and surface mount. A resistor might be static, standard resistor, special, or a pack of variable resistors.There is two basic types of resistors as follows:

1) Linear resistors

2) Non-linear resistors

1) Linear resistors: The resistors whose values change with change in applied temperature and voltage are known as linear resistors. There are two types of linear resistors:

a) **Fixed resistors:** These resistors have a specific value and these values cannot be changed. Following are the different types of fixed resistors:
   - Carbon composition resistors
   - Wire wound resistors
   - Thin film resistors
   - Thick film resistors

b) **Variable resistors**: These resistors do not have a specific value and the values can be changed with the help of dial, knob, and screw. These resistors find applications in radio receivers for controlling volume and tone. Following are the different types of variable resistors:
   - Potentiometers
   - Rheostats
   - Trimmers

2) Non-linear resistors: The resistor values change according to the temperature and voltage applied and is not dependent on ohms law. Following are the different types of non-linear resistors [2]:

- Thermisters
- Varisters
- Photo resistors

Figure 2.3 shows how to determine the resistance and tolerance for resistors. It can also be used to specify the color of the bands when the values are known.

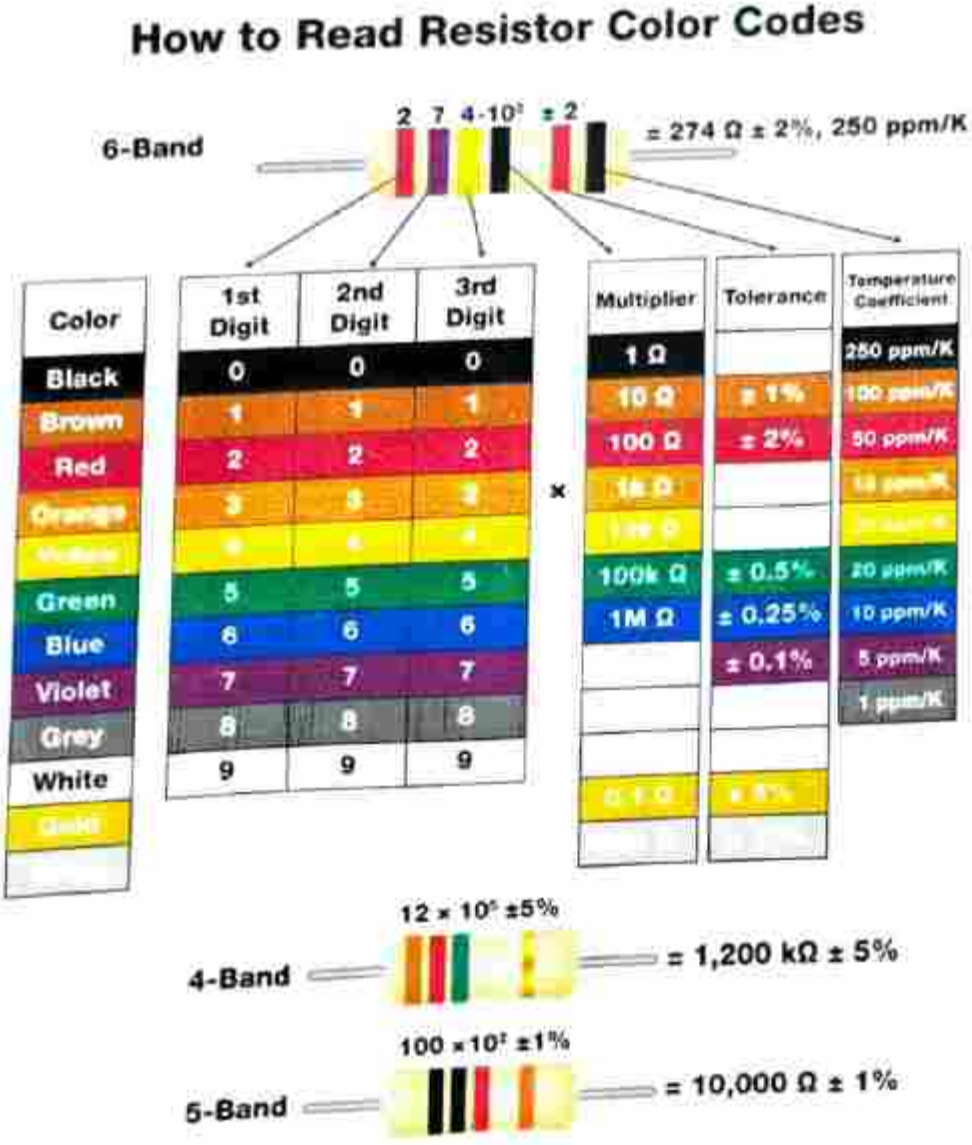

Figure 2.3- Resistor color codes.

2.3.2 Transistors and its working

A transistor is an electronic component that is used in circuits to either amplify or switch electrical signals or power, allowing it to be used in a wide array of electronic devices. A transistor consists of two PN diodes connected back to back. It has three terminals namely emitter, base and collector. The basic idea behind a transistor is that it lets you control the flow of current through one channel by varying the intensity of a much smaller current that's flowing through a second channel. Figure 2.4 shows the structure of a transistor. A transistor is a semiconductor device with three terminals, capable of amplification and rectification.

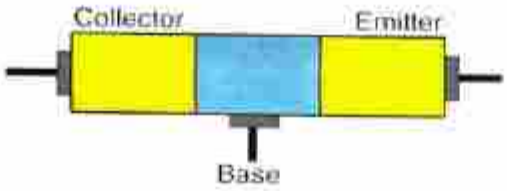

Figure 2.4 – Structure of a Transistor.

A transistor is composed of three terminals: emitter, collector, and base. The base serves as a gate controller device for a larger electric supply. The collector is a larger electrical supply and the outlet of that supply is the emitter. The current flowing through the gate from the collector can be regulated by sending varying levels of current from the base. In this manner, a very small amount of current can be used to control a large amount of current like in amplifiers. Transistor works as a switch or as an amplifier. The physical characteristics of the transistor terminals are:

Emitter – This segment is on the left side of the transistor. It is moderately sized and heavily doped.

Base – This segment is at the center of the transistor. It is thin and lightly doped

Collector – This segment is on the right side of the transistor. It is larger than the emitter and is moderately doped.

There are many types of transistors and each transistor specializes in its application. But, the main classification of transistors is as follows:

Bipolar Junction Transistor

A bipolar junction transistor, shortly termed as BJT is a current controlled device that consists of two PN junctions for its function. It is configured in two ways as **NPN** and **PNP**. Among the two, NPN transistor is the most preferred for the sake of convenience. The NPN

transistor is made by placing a p-type material between two n-type materials. Likewise, the PNP transistor is made by placing an n-type material between two p-type materials.

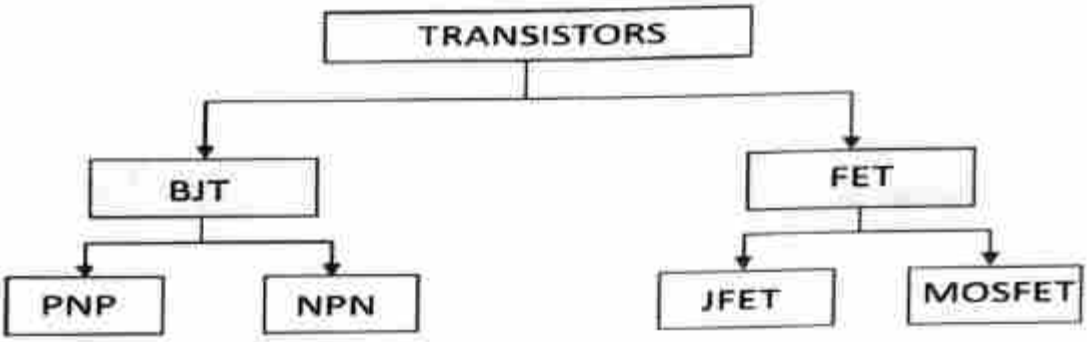

Figure 2.5 – Classification of Transistors.

❖ **Field Effect Transistor**

A field-effect transistor shortly termed as FET is a voltage-controlled device, unlike BJT which is a current controlled device. The FET is a unipolar device, which means that it is made using either p-type or n-type material as the main substrate. One of the many of its advantages is that it has very high input impedance, which is in the order of Mega Ohms. It has many other advantages such as low heat dissipation and low power consumption.

❖ **Transistor as an Amplifier and a Switch**

Transistor as an amplifier serves as an energy booster. It comes in useful things like hearing aids, which is one of the prior gadgets people use for a transistor. Hearing aids consist of a tiny microphone that picks up sounds for your world and converts them into varying electric currents. Microphones are also fed into a transistor that boosts a tiny loudspeaker, and you hear a much louder version of sound around you.

Transistors also work as switches. A small electric current flowing through one part of a transistor can make a much larger current flow through the other part. This is how all computer chips work. For instance, a memory chip includes hundreds of transistors, each of which can be switched on or off individually. Since every transistor can be in two separate states, it can store two numbers zero and one separately. A chip can store billions of zeros and ones with billions of transistors and as many letters and numbers [3].

❖ **Followings are the key features of BC547 transistor:**

- BC547 is a bipolar junction transistor (BJT)
- It is kind of an NPN transistor
- It has three terminals: Emitter, Collector and Base
- The maximum current gain of BC547 is 800A
- The Collector–Emitter Voltage is 65V
- The Collector-Base Voltage is 80V
- The Emitter-Base voltage is 8V

2.3.3 Capacitor and its working

The capacitor is an electric component that has the ability to store energy in the form of electrical charges that creates a potential difference, which is a static voltage, much like a small rechargeable battery.

The most basic design of a capacitor consists of two parallel conductors (Metallic plate), separated with a dielectric material. When a voltage source is attached across the capacitor, the capacitor plate gets charged up. The metallic plate attached to the positive terminal will be positively charged, and the plate attached to the negative terminal will be negatively charged. Figure 2.6 shows the structure of a capacitor.

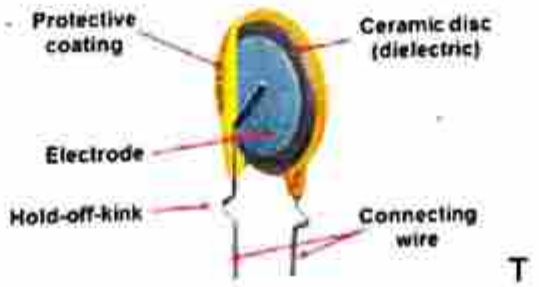

Figure 2.6- Structure of a Capacitor

❖ **Symbol of a Capacitor:** Figure 2.7 shows the symbol of a capacitor.

Figure 2.7- Symbol of a Capacitor.

❖ **Types of Capacitors**

- **Film Capacitors:** Film capacitors are the ones that use plastic film as the dielectric medium. They are available in nearly any value and voltages up to 1500 volts. They range from 10% to 0.01% in any tolerance. Additionally, film condensers arrive in a combination of shapes and case styles. There are two types of film condensers, radial type lead, and axial type lead.
- **Ceramic Capacitors:** Ceramic capacitors are the ones that use ceramic as the dielectric material. It is used in high-frequency circuits such as audio to RF. In ceramic capacitors, one can develop both high capacitance and low capacitance by altering the thickness of the ceramic disc.
- **Electrolytic Capacitors:** Electrolytic capacitors are the ones that use the oxide layer as the dielectric material. It has a wide tolerance capacity. There are mainly two types of electrolytic capacitors, tantalum, and aluminum. They are available with working voltages of up to approximately 500V, but the maximum capacitance values are not available at high voltage, and higher temperature units are available but are rare.
- **Variable Capacitor:** Variable capacitors mostly use air as the dielectric medium. A Variable Capacitor is one whose capacitance can be mechanically adjusted several times. For example, this form of the capacitor is used to set the resonance frequency in LC circuits to change the radio to match impedance in antenna tuner devices.

❖ **Uses of Capacitor**

- The capacitors have both electrical and electronic applications. They are used for several things such as filters, energy storage systems, engine starters, signal processing devices, etc.
- Capacitors are used for storing energy, which can be used by the device for temporary power outages whenever they need additional power.
- Capacitors are used for blocking DC current after getting fully charged and yet allow the AC current to pass through the circuit of a circuit.

- Capacitors are used as sensor for several things like measuring humidity, fuel levels, mechanical strain, etc.

Capacitors can be used in a time-dependent circuit. This could be connected to any LED or loudspeaker system, and it's likely that any flashing light/regular beeping uses a timing capacitor [4].

2. 3.4 Battery

A battery is a device that stores chemical energy and converts it to electrical energy. The chemical reactions in a battery involve the flow of electrons from one material (electrode) to another, through an external circuit. The flow of electrons provides an electric current that can be used to do work. Figure 2.8 shows the symbol of battery:

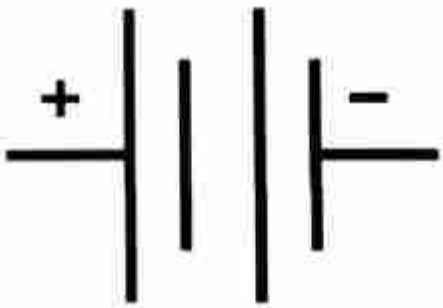

Figure 2.8- Symbol of Battery

To define a battery in another way, it is an arrangement whereby an "electrochemical" reaction can made to take place so that the "electrical" part of the reaction proceeds via the metallic path of the external circuit, while the "chemical" part of the reaction occurs via ionic conduction through electrolyte. The type of chemical reaction that can be used in an electrochemical cell is known as an "oxidation reduction" reaction - a reaction in which one chemical species gives electrons to another. By separation the two species and controlling the flow of ions between them, battery engineers make devices in which essentially all of these electrons can be made to flow through an external circuit, thereby converting mechanical of the chemical energy to electrical energy during the discharge of the cell [5].

2.3.5 Buzzer and its symbols

An audio signaling device like a beeper or buzzer may be electromechanical or piezoelectric or mechanical type. The main function of this is to convert the signal from audio to sound. Generally, it is powered through DC voltage and used in timers,

alarm devices, printers, alarms, computers, etc. Based on the various designs, it can generate different sounds like alarm, music, bell & siren. Figure 2.9 shows symbol of a buzzer.

Figure 2.9- Symbol of a buzzer.

It includes two pins namely positive and negative. The positive terminal of this is represented with the '+' symbol or a longer terminal. This terminal is powered through 6V whereas the negative terminal is represented with the '-'symbol or short terminal and it is connected to the GND terminals [5].

Buzzer Specifications: The specifications of the buzzer include the following.

- Color is black
- The frequency range is 3,300Hz
- Operating Temperature ranges from – 20° C to +60°C
- Operating voltage ranges from 3V to 24V DC
- The sound pressure level is 85dBA or 10cm
- The supply current is below 15mA

Types Of Buzzer: A buzzer is available in different types which include the following.

- Piezoelectric
- Electromagnetic
- Mechanical
- Electromechanical
- Magnetic

Applications of Buzzer: Applications of the buzzer are:

- Communication Devices
- Electronics used in Automobiles
- Alarm Circuits
- Portable Devices
- Security Systems
- Timers
- Household Appliances
- Electronic Metronomes
- Sporting Events

CHAPTER 3

Working of Metal Detector

3.1 Working of Metal Detector

The working of metal detector is based on the principle of electromagnetic induction. In the circuit we used battery, two npn transistor, capacitor, variable resistance & coil. The first npn transistor emitter is connect to the negative terminal of the battery and capacitor, the collector is connect to the negative terminal of buzzer & positive terminal of buzzer is connect to the emitter without base connect with positive terminal of battery the circuit is incomplete. We used another BC547 npn transistor .The emitter terminal of 2nd transistor is connect to the base terminal of 1st transistor.The base of 2nd transistor is connect to a variable resistance. The variable resistance works same as a potentiometer to control the range. The main function of all the capacitor present in the circuit is to filter the voltage ripples. The 2nd npn transistor base is connect with the variable resistance & coil first end. The collector is connect with the last turn of coil .The supply is given to the coil through central tap. When any object is detected the eddy current induce in the coil the eddy current induce their own magnetic field , which generate opposite cuurent in the coil, which induce a signal indicating the presence of metal. The circuit is complete and the buzzer gives sound when any metal detected.

CHAPTER 4

Advantages Disadvantages and Applications of Metal Detector

4.1.1 Advantages of Metal Detector

Metal Detectors are metal sensitive, hence, they immediately detect whenever a metal substance whether ferrous, non-ferrous or stainless steel comes in their proximity. Here are their advantages:

- Low cost
- Circuit is simple
- Easy to use
- Can be operated for long time without requiring much maintenance.

4.1.2 Disadvantage of Metal Detector

- Detection range is low
- Can detect iron only

4.1.3 Applications of Metal Detector

- This simple Metal Detector can be used to detect iron only.
- Since it is a simple project, we can use this in our home to scan for nails, metal scraps etc. which are not easily spotable by naked eye.

CHAPTER 5

PRECAUTIONS

5.1 Precautions

Mount the components at the appropriate places before soldering. Follow the circuit description and components details, leads identification etc. Do not start soldering before making it confirm that all the components are mounted at the right place.

a) Do not use a spread solder on the board, it may cause short circuit
b) Do not sit under the fan while soldering.
c) Position the board so that gravity tends to keep the solder where you want it.
d) Do not over heat the components at the board. Excess heat may damage the components board.
e) The board should not vibrate while soldering otherwise you have a dry or a cold joint.
f) Do not put the kit under or over voltage source. Be sure about the voltage either is d.c. or ac while operating the gadget.
g) Do spare the bare ends of the components leads otherwise it may short circuit with the other components. To prevent this use sleeves at the component leads or use sleeved wire connections.
h) Does not use old dark colour soldering iron. It may give dry joint. Be sure that all the joints are clean.

CHAPTER 6

REFERENCES

[1] https://en.wikipedia.org/wiki/Metal_detector

[2] https://byjus.com/physics/resistor/

[3] https://byjus.com/physics/transistor-working/

[4] https://en.wikipedia.org/wiki/Capacitor

[5] https://en.wikipedia.org/wiki/Electric_battery

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CANDIDATE'S DECLARATION

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Signature of Internal Examiner

Signature of External Examiner

CONTENTS

CHAPTER 1

INTRODUCTION

1.1 Introduction

Motion detection using a PIR sensor circuit can be used for providing security to home, shopping malls etc, as the PIR sensor used in this system detects the motion of human around this circuit. With the help of buzzer, we can identify the motion of human which was detected by the sensor. This system can be used at any place where security is needed. Security is needed by everyone in the society now-a-days to protect their property or confidential information from others which is sensor sense a human motion and then transmit the signal wirelessly.

However, this project will relate to auto power ON light and fun system. When the sensor senses a human motion in the sensor's detection area, sensor will be triggered and then the room's light will automatically switch ON. It is useful for us when we cannot find the switch in the dark condition.

For the fan's function, it is depends on the room temperature, when the temperature is higher, fan will run when the PIR had detect motion in the detection area. When the room temperature is low, fan will not run. Degree of temperature is measure by the temperature sensor and temperature will show on a LCD display (2x16). Light and fan will automatically OFF when the user was going out from the room. As long as PIR sensor does not detect motion in the detection area, light and fans are not function and the fan is depends on the room temperature. Once the sensor is triggered, system will have around 2 minutes to run the function. After 2 minutes and sensor does not detect any motion, light and fans will be switched OFF automatically.

CHAPTER 2

COMPONENTS USED, CIRCUIT DIAGRAM AND WORKING

2.1 Description of components used

- Passive Infrared (PIR) sensor (HC-SR501)
- Relay (5V)
- Transistor (BC547)
- Diode (1N4007)
- Resistor (1K)
- Battery (9V)

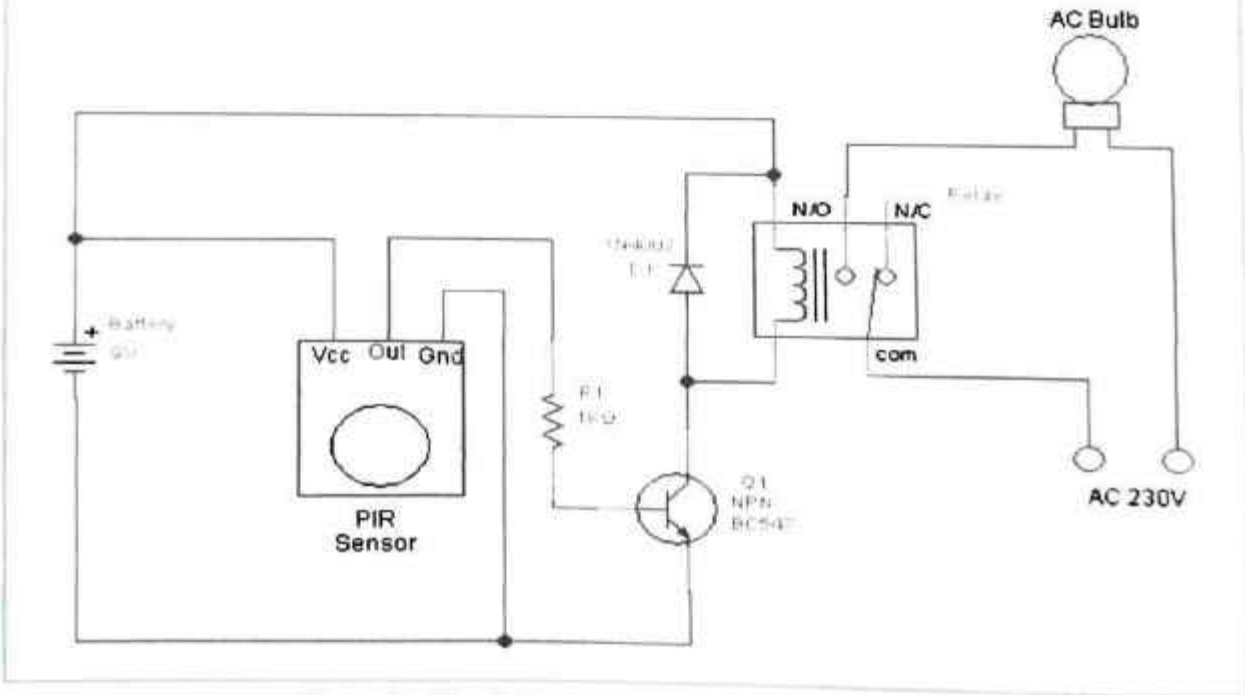

Figure 2.1- Circuit Diagram of PIR Motion Detection Circuit

PIR sensor, and its typical pin configuration which is quite simple to understand the pin-outs. The pin configuration of PIR sensor is shown in Figure 2.5.

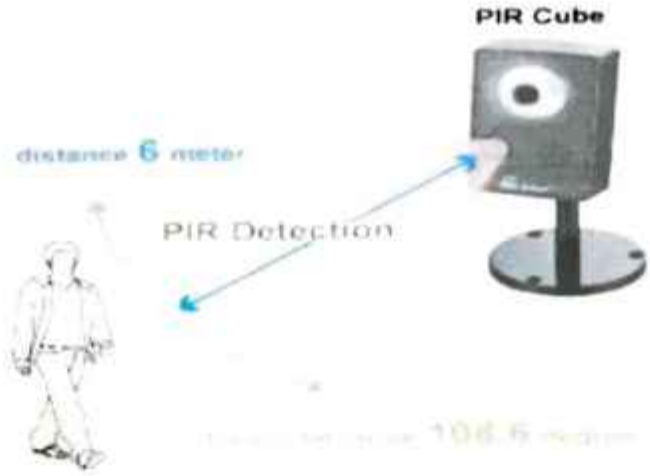

Figure 2.3- Passive Infrared Sensor.

Figure 2.4 PIR Sensor.

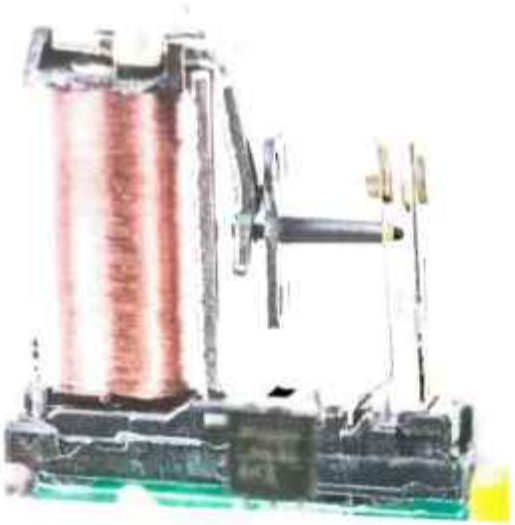

Figure 2.6- Structure of a Relay.

❖ Use of Relay

- **Control Systems**: Relays are used to control the operation of motors, lights, solenoids, valves, and other devices in industrial automation, building automation, and other control systems.
- **Power Distribution:** Relays are employed in power distribution systems to switch and control the flow of electrical power between different circuits, transformers, or sources.
- **Protection and Safety**: Relays are used for protection purposes, such as overcurrent protection, voltage regulation, and circuit breakers. They can detect abnormal conditions and interrupt the circuit to prevent damage to equipment or ensure safety.
- **Signal Amplification:** In electronic circuits, relays can be used to amplify or isolate signals, enabling compatibility between systems with different voltage levels or impedance.
- **Timing and Sequencing:** Relays can be used to control the timing and sequencing of operations in various applications, such as in control panels, motor starters, and timing circuits.
- **Automotive Applications:** Relays are extensively used in automotive systems for controlling lights, wipers, power windows, ignition systems, and other functions.

❖ Types of Relays

- Electromagnetic Relays.

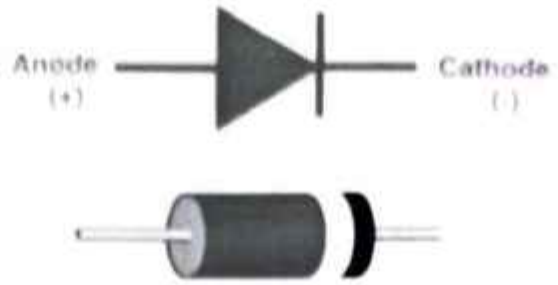

Figure5.1 Diode

2.1.5. Resistor 1KΩ

A passive electrical component with two terminals that are used for either limiting or regulating the flow of electric current in electrical circuits. The main purpose of resistor is to reduce the current flow and to lower the voltage in any particular portion of the circuit. It is made of copper wires which are coiled around a ceramic rod and the outer part of the resistor is coated with an insulating paint.

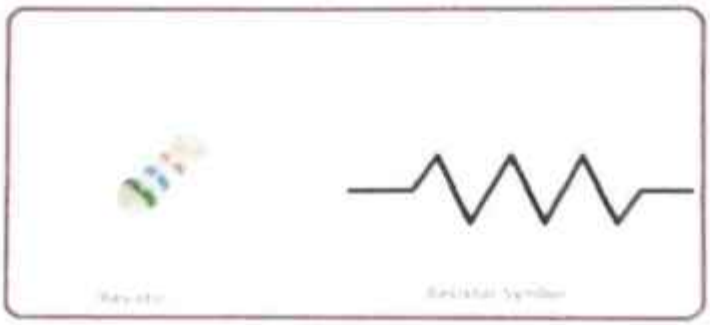

Figure5.2 Resistor

❖ **Resistor Color Code**

CHAPTER 5

APPLICATIONS

5.1 APPLICATIONS:

- Common staircases.
- For parking lights.
- For garden lights.
- For changing rooms in shop.
- For corridors.
- Security alarms and many more.

5.2. CONCLUSION

In this project, we have successfully implemented a PIR sensor circuit using a BC547 transistor and a 5V relay to control other devices based on motion detection. This circuit can be used for a variety of applications such as automatic lights, security systems, etc.