NEAR EAST UNIVERSITY

Faculty of Engineering

Department of Electrical and Electronic Engineering

SOUND ACTIVATED SWITCH

Graduation Project
EE – 400

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ABSTRACT

Sound is an amazing thing. All of the different sounds that we hear are caused by minute pressure differences in the air around us. What's amazing about it is that the air transmits those pressure changes so well, and so accurately, over relatively long distances, and by converting it to an electrical signal it could be used in much application, voice activated switches one of those applications which introduce a controlled switch by sound.

This mini- voice operated switch and relay - is based on a circuit published in *Silicon Chi*p, 9/1994, p31. We have improved it by putting an on-board Koa potentiometer in order to adjust the sensitivity. The idea behinds a voice activated switch is that instead of the user pressing a switch to activate a relay, the sound of the users voice itself activates the relay. This gives hands-free control over devices like tape recorders.

Where voice operated switch operation is desired. It may be used with virtually any type of microphone. The circuit itself draws only 10 mA at 12 volts DC and will directly switch low voltage loads up to 100 mA. Numerous small and inexpensive relays are available to permit switching of higher voltage and current. The voice operated switch may be used to control ham radio transmitters, CB transceivers, and similar equipment for other radio services. In addition, it can be used to control tape recorders or any other device for which you envision voice-operated switching.

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INTRODUCTION

Sound is an amazing thing. All of the different sounds that we hear are caused by minute pressure differences in the air around us. What's amazing about it is that the air transmits those pressure changes so well, and so accurately, over relatively long distances, and by converting it to an electrical signal it could be used in much application, voice activated switches one of those applications which introduce a controlled switch by sound.

In this project we are going to design, build and test voice activated switches. How to turn the switches on and off,. Suggestion into where these switches can be used will be made.

The first chapter of this project is the background chapter, which include electronic component especially the components were used in this project (light and dark activated switches) with some explanation and the characteristic of them. And Safety guideline when doing electronic project because of any electric component it has a guideline safety, if you do not know what is it you will burn, or break the component so that before doing any electric project you have to be care about this chapter.

Chapter two is about switches, with some information about types of switches, how they work? How we can use them? And the contact material used for making switches.

The third chapter is the most important chapter, which explains the hardware project in details, how we built it, How it work, what its input and output? With the circuit diagrams of voice activated switches, Assembly Instructions of them, the diagram of the first second and third stage circuits also will be shown. And the components for all of them were listed.

The aims of this project are:

- To design and build a voice activated switch.
- To gain hands-on experience in electronic hardware project.
- To modify the original circuit where possible.
- To suggest potential real-life use of switches.

CHAPTER ONE

ELECTRONICS COMPONENTS

1.1 Overview

The main problem for someone starting electronics as a hobby is simply that of identifying the various components used in projects. Before proceeding to the projects a brief description of the components used in them will be given so that even a complete beginner should have no difficulty in sorting out which component is which, and connecting each component into circuit correctly.

1.2 1ntroduction to Electronics Components

Electronics gets its name from the electron, a tiny particle which forms part of all atoms, which, as everybody knows, make up everything in the world. Atoms contain other types of particles - protons and neutrons - but it is the electrons which will be interesting us here.

Electrons and protons have the electrical property of charge. Protons have positive charge and electrons have negative charge and they normally balance each other out. We don't really need to know what charge is. It's just a property like weight or color, but it is this property which makes the whole of electronics happens. But keep in mind the fact that opposite charges attract and similar charges repel.

When electrons move together in a unified way we say there is a current flowing. Electrons are actually moving all the time in materials like metals but moving in a random disordered way. A current is when they all move together in one particular direction.

When you touch a lift button having walked across a synthetic carpet and you feel a shock that is electrons flowing through you to the ground. That's all a current is, simply the movement of electrons in a particular direction.

Electrons can't flow through every material. Materials that allow a current to flow easily are called conductors. Materials that don't allow a current to flow are called non-conductors or insulators. Metals are the most common conductors, plastics are typical insulators.

Conductor's	non-conductors
Gold	plastic
Copper	wood
Carbon	air

Copper is a good conductor. Copper tracks are used on the printed circuit boards to connect the components together. Solder is another good conductor. The solder makes the actual join between the leg of the component and the track.

The plastic that a printed circuit board is made of is an insulator. Currents can only flow up and down the copper tracks and not jump from one to another. For the same reason wires are surrounded by plastic coatings to stop them conducting where they shouldn't.

There are certain materials that are between the two extremes of conductor and non-conductor; we will come to them later.

A battery supplies the 'force' that makes the electrons move. This force is called the voltage. The bigger the voltage the more force. Mains electricity which is 240 volts is more powerful than an ordinary 9 volt battery.

Currents are measured in amps, and voltages are measured in volts (after the scientists Ampere and Volta). Voltages are sometimes called potential differences, or electromotive forces, but we won't use these terms here.

There is a big confusion for many people as to the difference between voltage and current. They talk about so many volts going through something when they really mean amps. So let's think about things in a different way.

Imagine water flowing through a pipe filling up a pond. The water represents the electrons and the pipe represents the wire. A pump provides the pressure to force the water through the pipe. The pump is the battery. How much water flows out the end of the pipe each second is the current. How hard the water is being pumped is the voltage.

A narrow pipe will take a long time to fill the pond, whereas a broad pipe will do it much faster using the same pump. Clearly the rate of flow depends on the thickness of the pipe. So we have the situation where the same voltage (pump pressure) can give rise to different currents (flow rate) depending on the pipe. Try to guess what the thickness of the pipe represents in this model of things (answer later).

An electric current requires a complete path - a circuit - before it can flow. In a circuit with a battery, the battery is both the starting flag and the finishing line for the electrons. A chemical reaction in the battery releases electrons which flow around the circuit and then back into the battery. The battery keeps the current flowing, feeding electrons in at one end and collecting them at the other. It takes energy to do this and so after a while the battery wears out.

Current flows into a component and the same amount of current always flows out of the component. It is not 'used up' in any way. As the current passes through components things happen (an LED lights up for instance).

1.2.1 Resistors

Electrons move more easily through some materials than others when a voltage is applied. In metals the electrons are held so loosely that they move almost without any hindrance. We measure how much opposition there is to an electric current as resistance.

Resistors come somewhere between conductors, which conduct easily, and insulators, which don't conduct at all. Resistance is measured in ohms after the discoverer of a law relating voltage to current. Ohms are represented by the Greek letter omega.

Think back to the model of water flowing in a pipe. The thickness of the pipe must represent the resistance. The narrower the pipe the harder it is for the water to get through and hence the greater the resistance. For a particular pump the time taken to fill the pond is directly related to the pipe thickness. Make the pipe twice the size and the flow rate doubles, and the pond fills in half the time.

The resistors used in the kits are made of a thin film of carbon deposited on a ceramic rod. The less carbon the higher the resistance. They are then given a tough outer coating and some colored bands are painted on.

The main function of resistors in a circuit is to control the flow of current to other components. Take an LED (light) for example. If too much current flows through an LED it is destroyed. So a resistor is used to limit the current.

When a current flows through a resistor energy is wasted and the resistor heats up. The greater the resistance the hotter it gets. The battery has to do work to force the electrons through the resistor and this work ends up as heat energy in the resistor.

An important property to know about a resistor is how much heat energy it can withstand before it's damaged. resistors can dissipate about a 1/4 Watt of heat (compare this with a domestic kettle which uses up to 3 000 Watts to boil water).

It's difficult to make a resistor to an exact value (and in most circuits it is not critical anyway). Resistances are given with a certain accuracy or tolerance. This is expressed as being plus or minus so much of a percentage. A 10% resistor with a stated value of 100 ohms could have a resistance anywhere between 90 ohms and 110 ohms. The resistors are 5% (that's what the gold band means) which is more than enough accuracy.

Real resistances vary over an enormous range. In the *Lie Detector* there is a 1 000 000 ohms resistor alongside a 470 ohms resistor. In circuit diagrams you will often see an 'R' instead of omega to represent ohms. This is a convention that dates from before the days of computers and laser printers when Greek letters were rarely found on typewriters. The letter 'k' means a thousand and its position shows the position of the decimal point.

Here are some examples:

10R = 10 ohms

10k = 10 kilohms = 10 000 ohms

4k7 = 4.7 kilohms = 4 700 ohm

1.2.1.1 Fixed value resistors

During manufacture, a thin film of carbon is deposited onto a small ceramic rod. The resistive coating is spiraled away in an automatic machine until the resistance between the two ends of the rod is as close as possible to the correct value. Metal leads and end caps are added; the resistor is covered with an insulating coating and finally painted with colored bands to indicate the resistor value

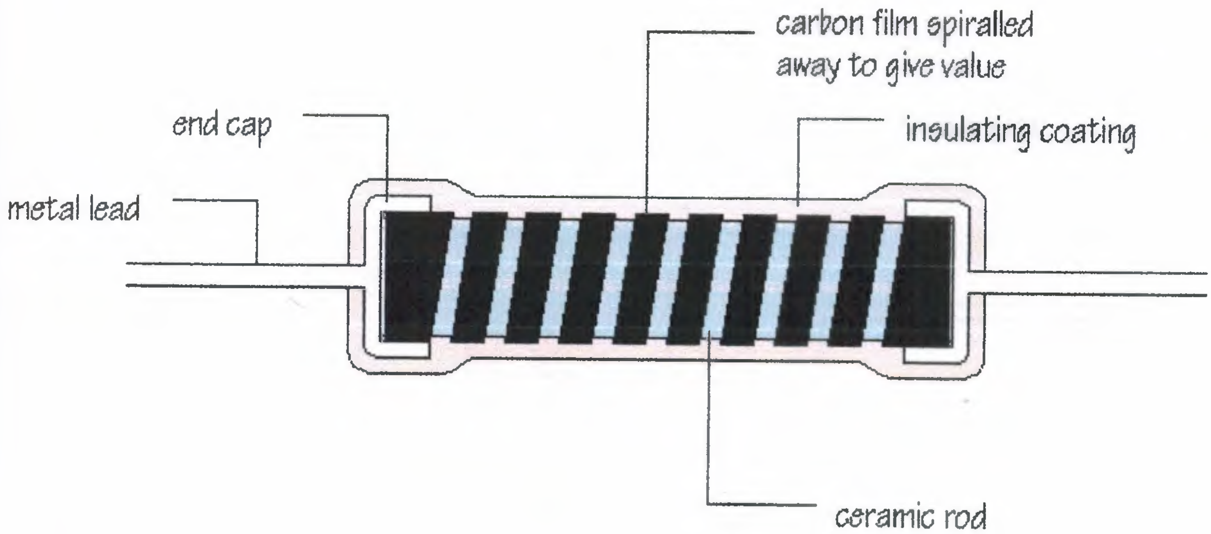


Figure 1.1 The diagram shows the construction of a carbon film resistor.

Carbon film resistors are cheap and easily available, with values within ±10% or ±5% of their marked, or 'nominal' value. Metal film and metal oxide resistors are made in a similar way, but can be made more accurately to within ±2% or ±1% of their nominal value. There are some differences in performance between these resistor types, but none which affect their use in simple circuits.

Wire wound resistors are made by winding thin wire onto a ceramic rod. They can be made extremely accurately for use in multimeters, oscilloscopes and other measuring equipment. Some types of wire wound resistors can pass large currents without overheating and are used in power supplies and other high current circuits

1.2.1.2 Resistor Color Code

The resistor color code is a way of showing the value of a resistor. Instead of writing the resistance on its body, which would often be too small to read, a color code is used. Ten different colors represent the numbers 0 to 9. The first two colored bands on the body are the first two digits of the resistance, and the third band is the 'multiplier'. Multiplier just means the number of zeroes to add after the first two digits. Red represents the number 2, so a resistor with red, red, red bands has a resistance of 2 followed by 2 followed by 2 zeroes, which is 2 200 ohms or 2.2 kilohms.

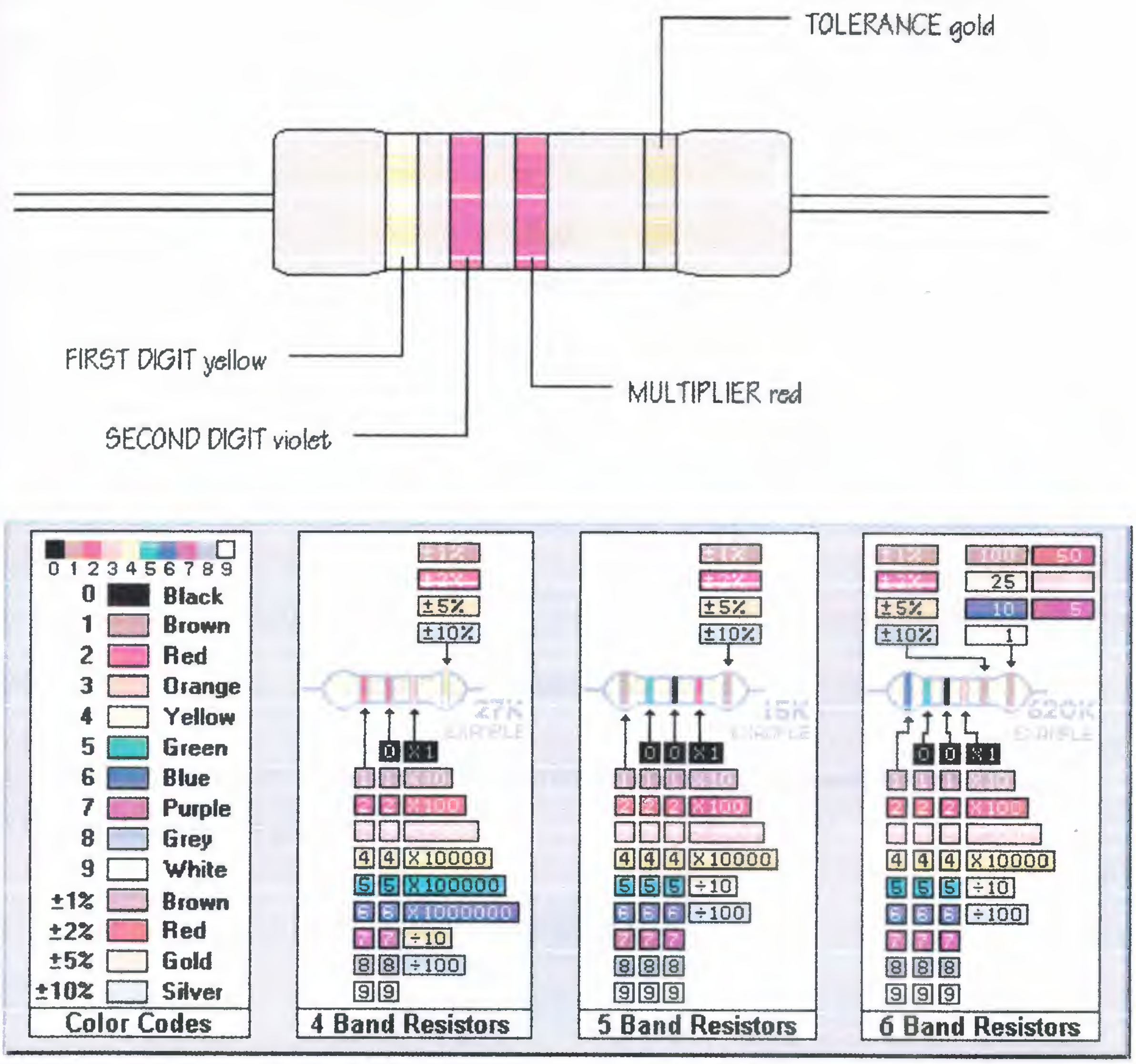


Figure 1.2 Color code identification.

While these codes are most often associated with resistors, then can also apply to capacitors and other components.

The standard color coding method for resistors uses a different color to represent each number 0 to 9: black, brown, red, orange, yellow, green, blue, purple, grey, white. On a 4 band resistor, the first two bands represent the significant digits. On a 5 and 6 band, the first three bands are the significant digits. The next band represents the multiplier or "decade".

1.2.1.3 Resistors in series and parallel

In a series circuit, the current flowing is the same at all points. The circuit diagram shows two resistors connected in series with a 6 V battery:

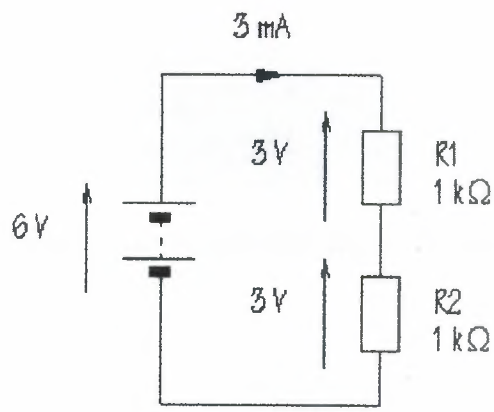


Figure 1.3 Resistors in series.

It doesn't matter where in the circuit the current is measured; the result will be the same. The total resistance is given by:

$$R_{total} = R_1 + R_2$$

The next circuit shows two resistors connected in parallel to a 6 V battery:

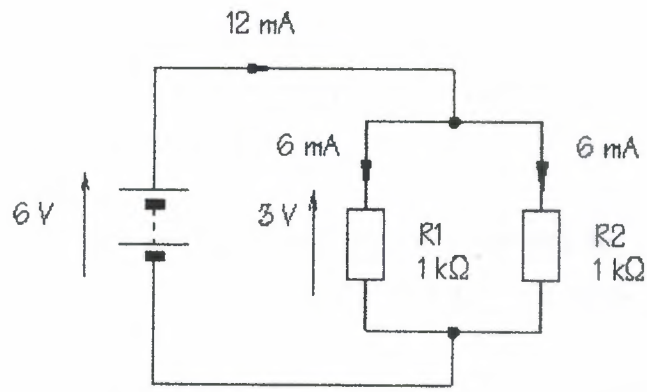


Figure 1.4 Resistors in parallel.

Parallel circuits always provide alternative pathways for current flow. The total resistance is calculated from:

$$R_{total} = \frac{R_1 \times R_2}{R_1 + R_2}$$

This is called the product over sum formula and works for any *two* resistors in parallel. An alternative formula is:

$$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2}$$

This formula can be extended to work for more than two resistors in parallel, but lends itself less easily to mental arithmetic. Both formulae are correct.

1.2.1.4 Variable Resistors

Unsurprisingly, variable resistors are resistors whose resistance can be varied. The variable resistors (called presets) have a metal wiper resting on a circular track of carbon. The wiper moves along the track as the preset is turned. The current flows through the wiper and then through part of the carbon track. The more of the track it has to go through the greater the resistance.

presets have three legs. The top leg connects to the wiper and the other two legs to the two ends of the track. Generally only one of the track legs is actually used.

Variable resistors are used in circuits to vary things that need changing, like volume etc.

1.2.2 Capacitors

Capacitors are stores for electrical charges. Like tiny batteries they can cause a current to flow in a circuit. But they can only do this for a short time; they cannot deliver a sustained current. They can be charged up with energy from a battery, then return that energy back later. The capacitance of a capacitor is a measure of how much energy or charge it can hold.

In its simplest form a capacitor consists of two metal plates separated by a small gap. Air or another non-conductor fills the gap. The bigger the plates the bigger the capacitance. To stop capacitors becoming impractically large however they are often rolled up like Swiss rolls.

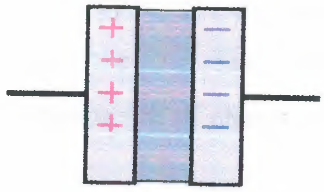


Figure 1.5 consists of capacitor.

Another way of increasing the capacitance is to put some non-conducting material between the plates. This is called a dielectric. When the capacitor charges up the protons and electrons in the dielectric separate out a little which allows more charge to be stored on the plates than usual. Dielectrics are made of various materials. Ceramic dielectrics are common and are used in the capacitors.

Capacitance is measured in Farads after the scientist Michael Faraday. A Farad is quite a big unit. The capacitors in a *Flashing Lights* have capacitances of about 50 millionths of a Farad (and they're quite powerful capacitors). The symbol for a millionth is the Greek letter mu which you will often see represented as a 'u' (the closest to the Greek letter on an ordinary typewriter).

Capacitors come in two flavors, electrolytic and non-electrolytic. Electrolytic capacitors use a special liquid or paste which is formed into a very thin dielectric in the factory. Non-electrolytic capacitors have ordinary dielectrics.

Electrolytic capacitors can store more charge than non-electrolytic capacitors but there are a couple of problems. They must be connected the right way around in a circuit or they won't work (anyone who has soldered a capacitor in a *Flashing Lights* backwards will know this). They also slowly leak their charge, and they have quite large tolerances. A 47uF capacitor might actually be as high as 80uF or as low as 10uF. In the *Flashing Lights* kit the capacitors control how fast the lights flash. You might have noticed that the rate can vary quite a lot from board to board and this is the reason.

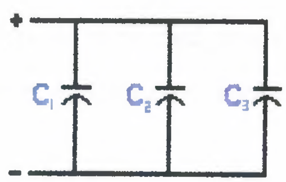
When a capacitor is connected to a battery it begins to charge. The current flows rapidly at first. Charge builds up on the two plates, negative charge on one plate and the same amount of positive charge on the other. The positive charge results from electrons leaving one of the plates and leaving positively-charged protons behind. But as the capacitor fills with charge it starts to oppose the current flowing in the circuit. It is as if another battery were working against the first. The current decreases and the capacitor charges more slowly. The plates become full of charge and it takes practically forever to squeeze the last drop in.

If a capacitor is shorted then it discharges. Charge flows out of the capacitor rapidly at first, then progressively more slowly. The last little drop just trickles out. The speed at which the capacitor empties depends on the resistance that connects across it. If a simple wire shorts out a capacitor then it empties in a flash, often with a spark if it's a big capacitor.

We've seen that when a capacitor is fully charged the current stops. In other words a continuous current cannot flow for ever through a capacitor. A continuous current is called a direct current or d.c.

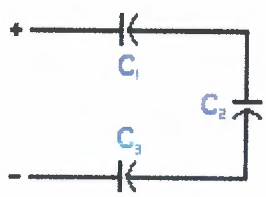
An alternating current (a.c.) however can flow through a capacitor. An alternating current is one which is continually changing its direction. Mains are a.c. and change its direction 50 times a second. An alternating current continually charges and discharges a capacitor and hence is able to keep flowing.

Here are some basic formulas for wiring capacitors in series or parallel. These are useful when you cannot find a component with the exact value that you are looking for.



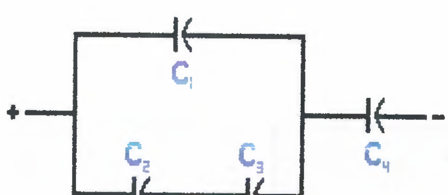
$$C=C_1+C_2+C_3$$

Capacitors in parallel.



$$C=\frac{1}{\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}}$$

Capacitors in series.



$$C=\frac{1}{\frac{1}{C_1+\frac{1}{\frac{1}{C_2}+\frac{1}{C_3}}}+\frac{1}{C_4}}$$

Capacitors in series and parallel.

Figure 1.6 Capacitors wiring.

1.2.3 Semiconductors

Now we come to what is probably the most important discovery in electronics this century. Without this discovery we wouldn't have televisions, computers, space rockets or transistor radios. Unfortunately it's also one of the hardest areas to understand in electronics. But don't lose heart, read the section through a few times until you've grasped the ideas.

Recall that the reason that metals are such good conductors is that they have lots of electrons which are so loosely held that they're easily able to move when a voltage is applied. Insulators have fixed electrons and so are not able to conduct. Certain materials, called semiconductors, are insulators that have a few loose electrons. They are partly able to conduct a current.

The free electrons in semiconductors leave behind a fixed positive charge when they move about (the protons in the atoms they come from). Charged atoms are called ions. The positive ions in semiconductors are able to capture electrons from nearby atoms. When an electron is captured another atom in the semiconductor becomes a positive ion.

These behaviors can be thought of as a 'hole' moving about the material, moving in just the same way that electrons move. So now there are two ways of conducting a current through a semiconductor, electrons moving in one direction and holes in the other. There are two kinds of current carriers.

The holes don't really move of course. It is just fixed positive ions grabbing neighboring electrons, but it appears as if holes are moving.

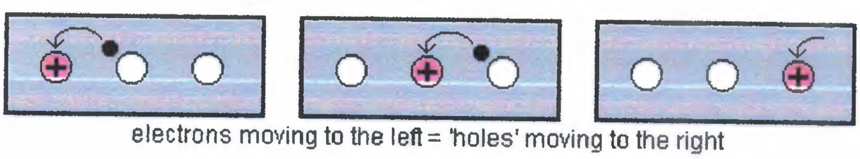


Figure 1.7 Moving of electrons.

In a pure semiconductor there are not enough free electrons and holes to be of much use. Their number can be greatly increased however by adding an impurity, called a donor. If the donor gives up some extra free electrons we get an n-type semiconductor (n for negative). If the donor soaks up some of the free electrons we get a p-type semiconductor (p for positive). In both cases the impurity donates extra current carriers to the semiconductor.

In n-type semiconductors there are more electrons than holes and they are the main current carriers. In p-type semiconductors there are more holes than electrons and they are the main current carriers. The donor atoms become either positive ions (n-type) or negative ions (p-type).

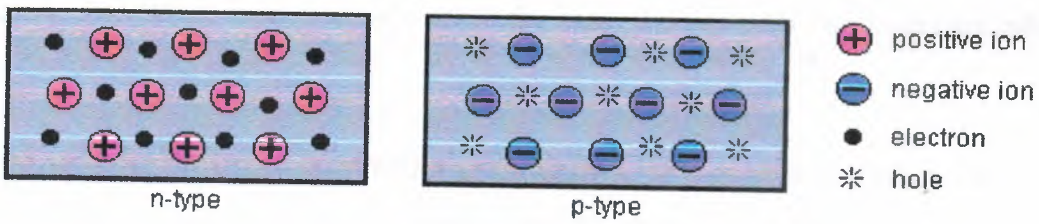


Figure 1.8 The tow types of semiconductors.

The most common semiconductors are silicon (basically sand) and germanium. Common donors are arsenic and phosphorus.

When we combine n-type and p-type semiconductors together we make useful devices, like transistors and diodes and silicon chips.

1.2.3.1 Transistors

Transistors underpin the whole of modern electronics. They are found everywhere - in watches, calculators, microwaves, hi-fi's. A Pentium(tm) computer chip contains over a million transistors!

Transistors work in two ways. They can work as switches (turning currents on and off) and as amplifiers (making currents bigger). We'll only be looking at them as switches here. To understand them as amplifiers would involve a little mathematics.

Transistors are sandwiches of three pieces of semiconductor material. A thin slice of n-type or p-type semiconductor is sandwiched between two layers of the opposite type. This gives two junctions rather than the one found in a diode. If the thin slice is n-type the transistor is called a p-n-p transistor, and if the thin slice is p-type it is called a n-p-n transistor. The middle layer is always called the base, and the outer two layers are called the collector and the emitter.

We will consider the (more common) n-p-n transistor here, as used in the circuits. In a n-p-n transistor electrons are the main current carriers (because n-type material predominates).

When no voltage is connected to the base then the transistor is equivalent to two diodes connected back to back. Recall that current can only flow one way through a diode. A pair of back-to-back diodes can't conduct at all.

If a small voltage is applied to the base (enough to remove the depletion layer in the lower junction), current flows from emitter to base like a normal diode. Once current is flowing however it is able to sweep straight through the very thin base region and into the collector. Only a small part of the current flows out of the base. The transistor is now conducting through both junctions. A few of the electrons are consumed by the holes in the p-type region of the base, but most of them go straight through.

Electrons enter the emitter from the battery and come out of the collector. (Isn't that rather illogical you might say, electrons emitted from the collector? Yes it is, but the parts of a transistor are named with respect to conventional current, an imaginary current which flows in the opposite direction to real electron current.)

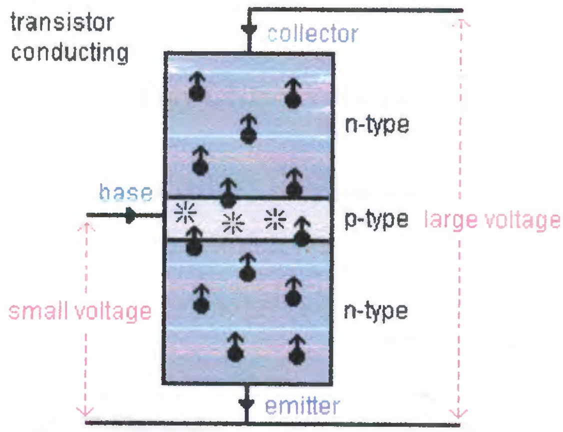
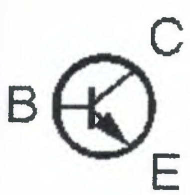


Figure1.9 Transistor conducting.

The difference between PNP and NPN transistors is that NPN use electrons as carriers of current and PNP use a lack of electrons (known as "holes"). Basically, nothing moves very far at a time. One atom simply robs an electron from an adjacent atom so you get the impression of "flow". It's a bit like "light pipes". In the case of "N" material, there are lots of spare electrons. In the case of "P" there aren't. In fact "P" is gasping for electrons.

Now we can see how a transistor acts as a switch. A small voltage applied to the base switches the transistor on, allowing a current to flow in the rest of the transistor.



This is the symbol used to represent an "NPN" transistor.

You can distinguish this from a "PNP" transistor (right) by the arrow which indicates current flow direction.

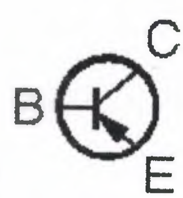


Figure 1.10 The difference between PNP and NPN transistors.

1.2.3.2 Diodes

A diode allows current to flow in only ONE direction.

If the cathode end (marked with a stripe) is connected so it is more negative than the anode end, current will flow.

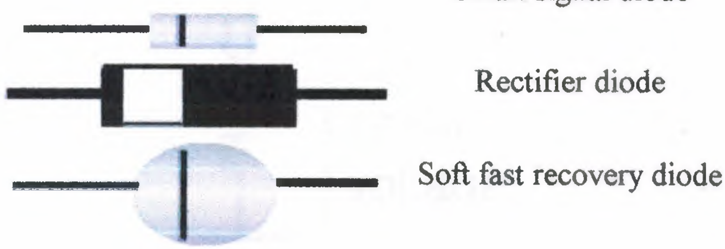


Figure 1.11 The picture shows three types of diodes.

A diode has a forward voltage drop. That is to say, when current is flowing, the voltage at the anode is always higher than the voltage at the cathode. The actual Forward Voltage Drop varies according to the type of diode. For example:

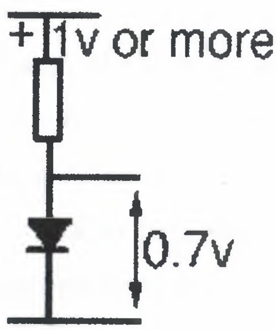


Figure 1.12 A diode forward voltage drop.

Silicone	diode	=	0.7v
Schottky	diode	=	0.3v
Germanium	diode	=	0.2v

In addition, the voltage drop increases slightly as the current increases so, for example, a silicon rectifier diode might have a forward voltage drop of 1 volt when 1 Amp of current is flowing through it.

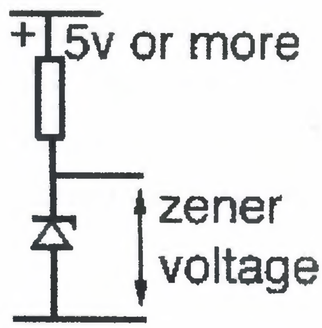


Figure 1.13 Zener diode.

A ZENER diode allows current to flow in both directions. In the "forward" direction, no current will flow until the voltage across the diode is about 0.7 volts (as with a normal diode). In the reverse direction (cathode more positive than the anode) no current will flow until the voltage approaches the "zener" voltage, after which a LOT of current can flow and must be restricted by connecting a resistor in series with the zener diode so that the diode does not melt!

Within a certain supply voltage range, the voltage across the zener diode will remain constant. Values of 2.4 volts to 30 volts are common. Zener diodes are not available in values above around 33 volts but a different type of diode called an AVALANCHE diode works in a similar way for voltages between 100v and 300v. (These diodes are often called "zener" diodes since their performance is so similar).

Zener diodes are used to "clamp" a voltage in order to prevent it rising higher than a certain value. This might be to protect a circuit from damage or it might be to "chop off" part of an alternating waveform for various reasons. Zener diodes are also used to provide a fixed "reference voltage" from a supply voltage that varies. They are widely used in regulated power supply circuits

1.2.3.2.1 Light Emitting Diodes (LEDs)

A diode consists of a piece of n-type and a piece of p-type semiconductor joined together to form a junction.

Electrons in the n-type half of the diode are repelled away from the junction by the negative ions in the p-type region, and holes in the p-type half are repelled by the positive ions in the n-type region. A space on either side of the junction is left without either kind of current carriers. This is known as the depletion layer. As there are no current carriers in this layer no current can flow. The depletion layer is, in effect, an insulator.

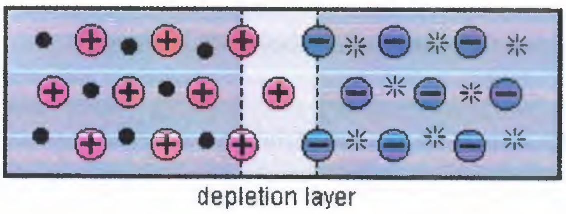
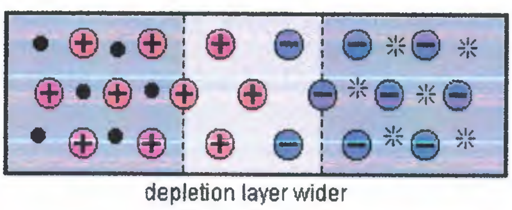


Figure 1.14 Depletion layer.

Now consider what would happen if we connected a small voltage to the diode. Connected one way it would attract the current carriers away from the junction and make the depletion layer wider. Connected the other way it would repel the carriers and drive them towards the junction, so reducing the depletion layer. In neither case would any current flow because there would always be some of the depletion layer left.



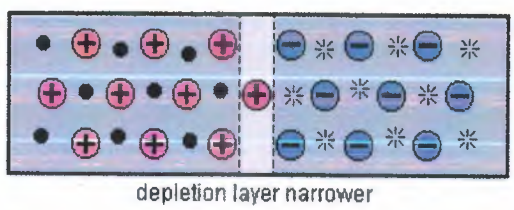


Figure 1.15 Reducing the depletion layer.

Now consider increasing the voltage. In one direction there is still no current because the depletion layer is even wider, but in the other direction the layer disappears completely and current can flow. Above a certain voltage the diode acts like a conductor. As electrons and holes meet each other at the junction they combine and disappear. The battery keeps the diode supplied with current carriers.

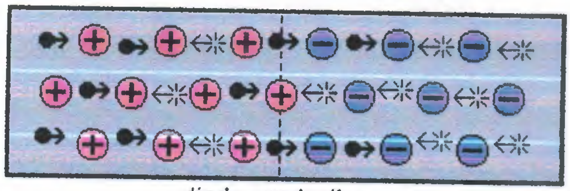


Figure 1.16 Diode conducting.

Thus a diode is a device which is an insulator in one direction and a conductor in the other. Diodes are extremely useful components. We can stop currents going where we don't want them to go. For example we can protect a circuit against the battery being connected backwards which might otherwise damage it.

Light emitting diodes (LEDs) are special diodes that give out light when they conduct. The fact that they only conduct in one direction is often incidental to their use in a circuit. They are usually just being used as lights. They are small and cheap and they last practically forever, unlike traditional light bulbs which can burn out.

The light comes from the energy given up when electrons combine with holes at the junction. The color of the light depends on the impurity in the semiconductor. It is easy to make bright red, green and yellow LEDs but technology has not cracked the problem of making cheap blue LEDs yet.

1.2.4 Relay Driver

A relay is an electro-magnetic switch which is useful if you want to use a low voltage circuit to switch on and off a light bulb (or anything else) connected to the 220v mains supply.

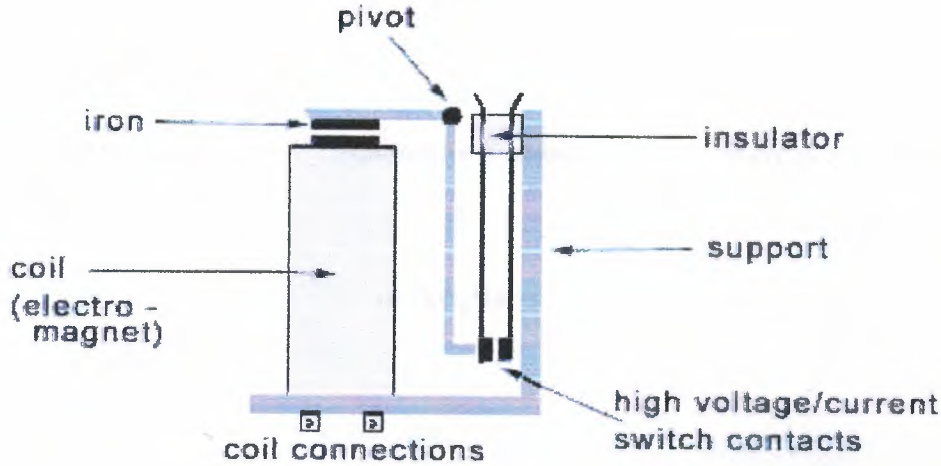


Figure1.17 A typical relay (with "normally-open" contacts).

1.2.5 Batteries

Batteries provide the power for the circuits. The source of this power is a chemical reaction. Chemicals within the battery react with each other and release electrons. These electrons flow around the circuit connected to the battery and make things happen. Electrons flow out of the negative terminal of the battery, through the wires and components of the circuit, and then back into the positive battery terminal.

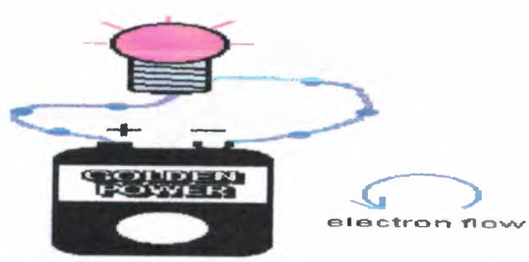
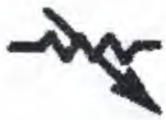
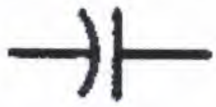


Figure 1.18 Battery.

It takes energy to do this and so eventually all the energy in the battery is used up. Occasionally the acid in the battery messily leaks out before it has been used and the battery has to be discarded.

Table 1.1 Description of some of the most common components and their schematic symbols.

Component	Schematic Symbol	Actual appearance
Resister		
Variable Resister		
Capacitor		
Diode		
Light emitting diode (LED)		
Chassis Ground		This is just a connection to ground.
Earth Ground		This is just a connection to ground.

NPN Bipolar Transistor		
PNP Bipolar Transistor		

1.3 Safety

1- We have taken care about chip pins when we plant it in the board to not be broken.

2- Be aware while soldering to not heat up the chip by the soldering iron long time on the pins.

3- While soldering be aware not be let to pins to be soldering together and check after soldering the pins in between space.

4- Be aware of the soldering iron position while stand by.

5- Be aware when turns up side down the board after the chip plant that the pins arrangement will be different.

CHAPTER TWO

SWITCHES

2.1 Overview

An electrical switch is any device used to interrupt the flow of electrons in a circuit. Switches are essentially binary devices, they are either completely on ("closed") or completely off ("open"). There are many different types of switches, and we will explore some of these types in this chapter.

2.2 Series and Parallel Connections

There are two ways of connecting components.

2.2.1 Series

So that each component has the same current.

The battery voltage is divided between the two lamps each lamp will have half the battery voltage if the lamps are identical.

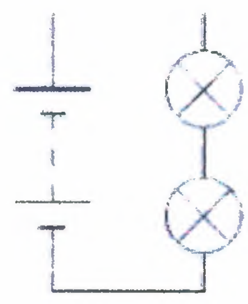


Figure 2.1 Series lamps.

2.2.2 Parallel

So that each component has the same voltage.

Both lamps have the full battery voltage across them. The battery current is divided between the two lamps, shown in figure 2.2.

2.2.3 Most circuits contain a mixture of series and parallel connections

The terms *series circuit* and *parallel circuit* are sometimes used, but only the simplest of circuits are entirely one type or the other. It is better to refer to specific components and say they are *connected in series* or *connected in parallel*.

For example: the circuit on the right shows a resistor and LED connected in series (on the right) and two lamps connected in parallel (in the centre). The switch is connected in series with the two lamps, shown in figure 2.2.

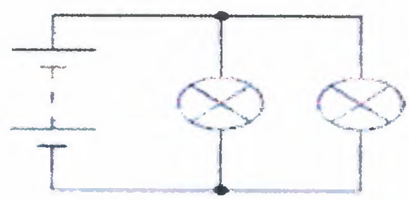


Figure 2.2 parallel lamps.

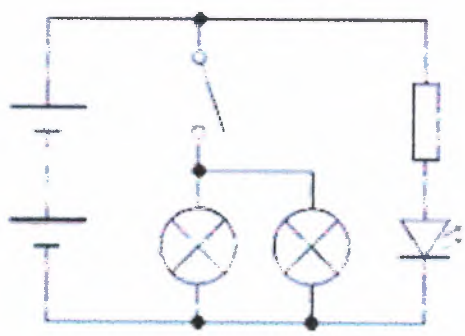


Figure 2.3 Mixtures of series and parallel connections

2.2.4 Lamps in Series

If several lamps are connected in series they will all be switched on and off together by a switch connected anywhere in the circuit. The supply voltage is divided equally between the lamps (assuming they are all identical). If one lamp blows all the lamps will go out because the circuit is broken, shown in figure 2.4.

Christmas tree Lights

The lamps on a Christmas tree are connected in series.

Normally you would expect all the lamps to go out if one blew, but Christmas tree lamps are special! They are designed to short circuit (conduct like a wire link) when they blow, so the circuit is not broken and the other lamps remain lit, making it easier to locate the faulty lamp. Sets also include one 'fuse' lamp which blows normally.

If there are 20 lamps and the mains electricity voltage is 240V, each lamp must be suitable for a 12V supply because the 240V is divided equally between the 20 lamps: $240V \div 20 = 12V$.

WARNING! The Christmas tree lamps may seem safe because they use only 12V but they are connected to the mains supply which can be lethal. Always unplug from the mains before changing lamps. The voltage across the holder of a missing lamp is the full 240V of the mains supply! (Yes, it really is!)

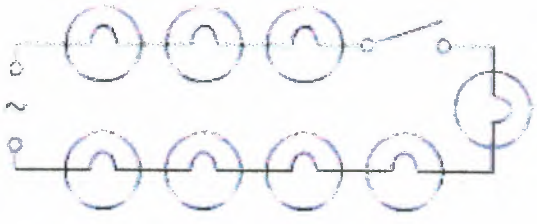


Figure 2.4 Lamps in Series.

2.2.5 Lamps in Parallel

If several lamps are connected in parallel each one has the full supply voltage across it. The lamps may be switched on and off independently by connecting a switch in series with each lamp as shown in the circuit diagram. This arrangement is used to control the lamps in buildings.

This type of circuit is often called a *parallel circuit* but you can see that it is not really so simple - the switches are in series with the lamps, and it is these switch and lamp pairs that are connected in parallel, shown in figure 2.5.

2.2.6 Switches in Series

If several on-off switches are connected in series they must all be closed (on) to complete the circuit.

The diagram shows a simple circuit with two switches connected in series to control a lamp, shown in figure 2.6.

Switch S1 **AND** Switch S2 must be closed to light the lamp.

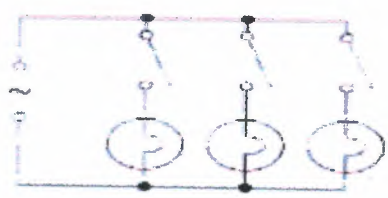


Figure 2.5 Lamps in Parallel.

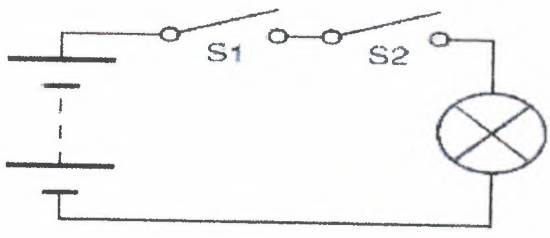


Figure 2.6 Switches in Series.

2.2.7 Switches in Parallel

If several on-off switches are connected in parallel only one need to be closed (on) to complete the circuit.

The diagram shows a simple circuit with two switches connected in parallel to control a lamp.

Switch S1 **OR** Switch S2 (or both of them) must be closed to light the lamp.

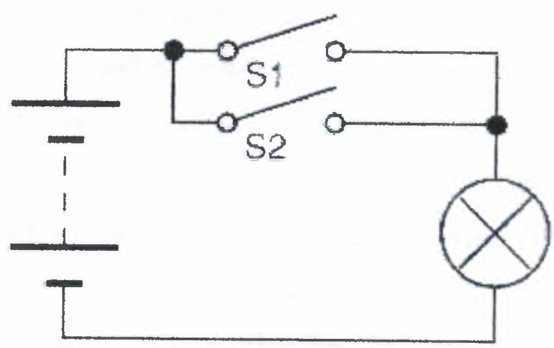


Figure 2.7 Switches in Parallel.

2.3 Electronics Control circuit Description

2.3.1 The Sound Switch

The "sound" switch changes the amplifier type in the circuit. This alternative amplifier creates a different sound. In the "Fat" mode has a much higher level of second and third harmonic distortion than in the non fat setting. The amount of color heard will depend on the type of signal and the operating level. With some material the change will be heard with the flip of the switch: and with other material more listening may be required. Hearing a color change may take time and some ear training. With the second harmonic being an octave it can have small or great effect depending on the purity of the sound. For example, it will be easier to hear second harmonic distortion on a flute than on a guitar chord. The main use of the sound switch is to fatten, thicken and warm up sound. If the idea of distortion seems a bit scary, remember that the reason two different amplifiers with the same frequency response sound different is because of their distortion characteristics. With careful circuit design we have created distortion that sound pleasing. The types of distortion that the "fat" setting generates are similar to the distortion that tubes generate.

The sound switch is very useful on vocals, bass, drums, and any other instrument that could benefit from a richer sound. Vocal arrangements may require a thicker sound on some parts but not on others. As an example; using the fat sound for the lead line and the harmonies, but not on the high vocal line can help separate the parts in a vocal mix comprised of a lead vocal, vocal harmonies, and a high answer/echo line.

A trick that can be tried in order to get more color is to turn up the gain switch by 6 db, and attenuate the output by 6 db. The higher signal level in the fat amplifier will result in more harmonic content being generated. This same idea holds true with the iron amplifier.

Note that the sound switch changes both channels. An audible pop may be heard when the switch is flipped. This occurs because a different amplifier is being switched into the audio path. Be aware that flipping this switch during a recording take is not advised. At any other time the audible pop is merely a momentary nuisance. Changing the circuit to eliminate the pop would compromise the audio path.

2.3.2 Ultrasonic switch

The circuit described generates (transmits) ultrasonic sound of frequency between 40 and 50 kHz. As with any other remote control system this circuit comprises of a mini transmitter and a receiver circuit. Transmitter generates ultrasonic sound and the receiver senses ultrasonic sound from the transmitter and switches on a relay.

The ultrasonic transmitter uses a 555 based a stable multivibrator. It oscillates at a frequency of 40-50 kHz. An ultrasonic transmitter transducer is used here to transmit ultrasonic sound very effectively. The transmitter is powered from a 9-volt PP3 single cell. The ultrasonic receiver circuit uses an ultrasonic receiver transducer to sense ultrasonic signals. It also uses a two-stage amplifier, a rectifier stage, and an operational amplifier in inverting mode. Output of op-amp is connected to a relay through a complimentary relay driver stage. A 9-volt battery eliminator can be used for receiver circuit, if required. When switch S1 of transmitter is pressed, it generates ultrasonic sound. The sound is received by ultrasonic receiver transducer.

It converts it to electrical variations of the same frequency. These signals are amplified by transistors T3 and T4. The amplified signals are then rectified and filtered. The filtered DC voltage is given to inverting pin of op-amp IC2. The non- inverting pin of IC2 is connected to a variable DC voltage via preset VR2 which determines the threshold value of ultrasonic signal received by receiver for operation of relay RL1. The inverted output of IC2 is used to bias transistor T5. When transistor T5 conducts, it supplies base bias to transistor T6. When transistor T6 conducts, it actuates the relay. The relay can be used to control any electrical or electronic equipment.

Important hints:

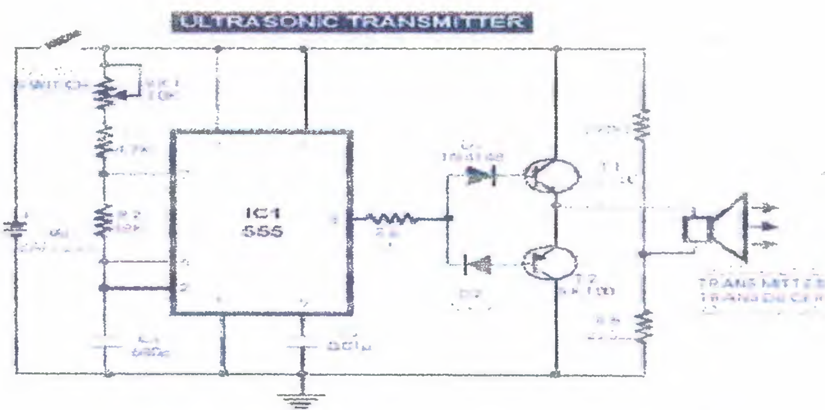
1. Frequency of ultrasonic sound generated can be varied from 40 to 50 kHz range by adjusting VR1. Adjust it for maximum performance.

2. Ultrasonic sounds are highly directional. So when you are operating the switch the ultrasonic transmitter transducer of transmitter should be placed towards ultrasonic receiver transducer of receiver circuit for proper functioning.

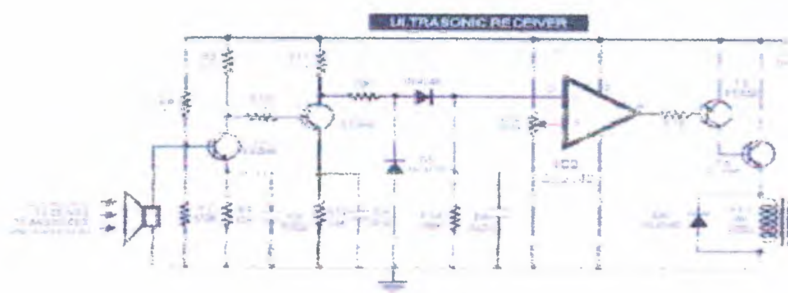
3. Use a 9-volt PP3 battery for transmitter. The receiver can be powered from a battery eliminator and is always kept in switched on position.

4. For latch facility use a DPDT relay if you want to switch on and switch off the load. A flip-flop can be inserted between IC2 and relay. If you want only an 'ON-time delay' uses a 555 only at output of IC2. The relay will be energized for the required period determined by the timing components of 555 constable multivibrator.

5. Ultrasonic waves are emitted by many natural sources. Therefore, sometimes, the circuit might get falsely triggered, especially when a flip-flop is used with the circuit, and there is no remedy for that.



(A) transmitter.



(B) Receiver.

Figure 2.8 Ultrasonic switch circuit diagram. (A) transmitter. (B) Receiver.

2.3.3 The Iron Switch

"Iron" has a different distortion characteristic than an amplifier. Iron will distort low frequencies and not higher frequencies. The amount of iron in the component will determine how much signal level at a specific frequency that the component can handle before its distortion levels start rising. This means that a signal level which will produce 5% distortion at 40Hz may only produce a distortion level of .5% at 120 Hz. In recording a bass, for example, the distortion would be increasing the harmonic content of its low notes, but would not have much effect on its high notes. Thus the low notes would be easier to hear because of their increased harmonic content. The iron setting can be used on anything with low frequency content. Above 400 Hz the setting has little effect.

Note that the "iron" switch changes both channels. An audible pop may be heard when the switch is flipped because a different amplifier is being switched into the audio path. Be aware that flipping this switch during a recording take is not advised. Changing the circuit to eliminate the pop would compromise the audio path.

Using the "iron" and "fat" settings together on vocals and low frequency instruments creates a vintage type sound.

2.3.4 The Gain Switch

The gain switch is a stepped switch with a 6 db change per step starting with 6 db of gain and with a maximum gain of 66 db. This approach was chosen for those who do stereo recording and would like to have matched gain of the stereo channels.

2.3.5 The Attenuator

The attenuator is continuously variable to allow gain trim when needed. The gain range is from maximum gain as set by the gain switch to no output.

Some engineers like to be able to pull down the pre-amplifier's output at the end of takes to prevent recording unwanted room noise. This is easily done with the attenuator.

An additional function that can be done is to increase the pre-amplifiers gain with the gain switch and turn down the attenuator to allow for over drive of the fat or iron amplifiers. In some cases this will allow an increased level of fatness in the sound however, in some cases this may not be useable.

2.3.6 The Phase Switch

The phase switch allows phase reversal of each channel with the "+" symbol indicating no phase change through the channel. Each channel has a separate switch.

2.3.7 The Phantom Power Switch

This switch allows the user to supply or not supply 48 volts to the microphone. Each channel has a separate switch.

2.3.8 The Meter

The meter is an LED bar graph with 22 led's and follows a VU type scale with +4 dbm considered to be)VU. The clip light indicates clipping in the input stage of the pre-amp and is calibrated to turn on at .5 db below clipping.

2.4 Electromechanical Relays

2.4.1 Relay construction

An electric current through a conductor will produce a magnetic field at right angles to the direction of electron flow. If that conductor is wrapped into a coil shape, the magnetic field produced will be oriented along the length of the coil. The greater the current, the greater the strength of the magnetic field, all other factors being equal, shown in figure2.9.

Inductors react against changes in current because of the energy stored in this magnetic field. When we construct a transformer from two inductor coils around a common iron core, we use this field to transfer energy from one coil to the other. However, there are simpler and more direct uses for electromagnetic fields than the applications we've seen with inductors and transformers. The magnetic field produced by a coil of current-carrying wire can be used to exert a mechanical force on any magnetic object, just as we can use a permanent magnet to attract magnetic objects, except that this magnet (formed by the coil) can be turned on or off by switching the current on or off through the coil.

If we place a magnetic object near such a coil for the purpose of making that object move when we energize the coil with electric current, we have what is called a *solenoid*. The movable magnetic object is called an *armature*, and most armatures can be moved with either direct current (DC) or alternating current (AC) energizing the coil. The polarity of the magnetic field is irrelevant for the purpose of attracting an iron armature. Solenoids can be used to electrically open door latches, open or shut valves, move robotic limbs, and even actuate electric switch mechanisms. However, if a solenoid is used to actuate a set of switch contacts, we have a device so useful it deserves its own name: the *relay*.

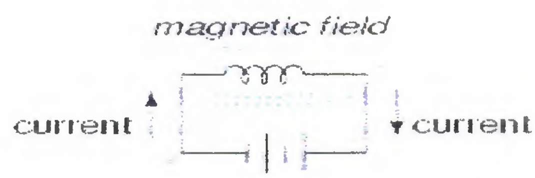


Figure 2.9 produced magnetic field.

Relays are extremely useful when we have a need to control a large amount of current and/or voltage with a small electrical signal. The relay coil which produces the magnetic field may only consume fractions of a watt of power, while the contacts closed or opened by that magnetic field may be able to conduct hundreds of times that amount of power to a load. In effect, a relay acts as a binary (on or off) amplifier.

Just as with transistors, the relay's ability to control one electrical signal with another finds application in the construction of logic functions. This topic will be covered in greater detail in another lesson. For now, the relay's "amplifying" ability will be explored.

In the above schematic, the relay's coil is energized by the low-voltage (12 VDC) source, while the single-pole, single-throw (SPST) contact interrupts the high-voltage (480 VAC) circuit. It is quite likely that the current required to energize the relay coil will be hundreds of times less than the current rating of the contact. Typical relay coil currents are well below 1 amp, while typical contact ratings for industrial relays are at least 10 amps.

One relay coil/armature assembly may be used to actuate more than one set of contacts. Those contacts may be normally-open, normally-closed, or any combination of the two. As with switches, the "normal" state of a relay's contacts is that state when the coil is de-energized, just as you would find the relay sitting on a shelf, not connected to any circuit.

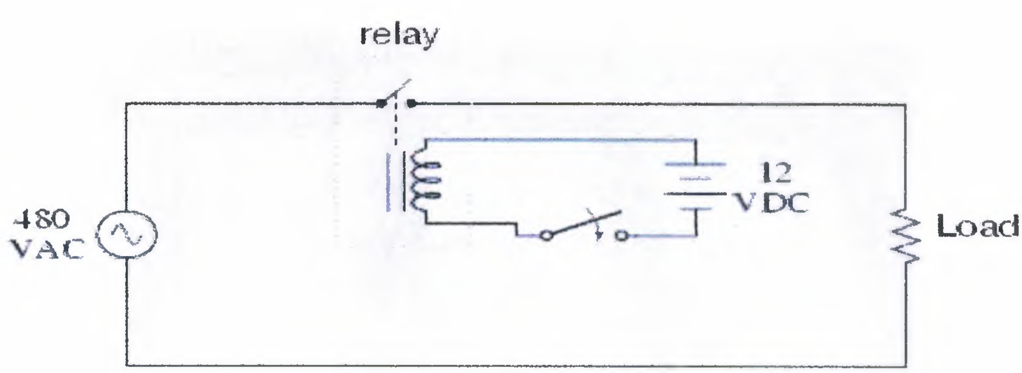


Figure 2.9 Control of large amount of current and/or voltage with a small electrical signal.

Relay contacts may be open-air pads of metal alloy, mercury tubes, or even magnetic reeds, just as with other types of switches. The choice of contacts in a relay depends on the same factors which dictate contact choice in other types of switches. Open-air contacts are the best for high-current applications, but their tendency to corrode and spark may cause problems in some industrial environments. Mercury and reed contacts are sparkles and won't corrode, but they tend to be limited in current-carrying capacity.

The relay units shown here are called "octal-base," because they plug into matching sockets, the electrical connections secured via eight metal pins on the relay bottom. The screw terminal connections you see in the photograph where wires connect to the relays are actually part of the socket assembly, into which each relay is plugged. This type of construction facilitates easy removal and replacement of the relay(s) in the event of failure.

Aside from the ability to allow a relatively small electric signal to switch a relatively large electric signal, relays also offer electrical isolation between coil and contact circuits. This means that the coil circuit and contact circuit(s) are electrically insulated from one another. One circuit may be DC and the other AC (such as in the example circuit shown earlier), and/or they may be at completely different voltage levels, across the connections or from connections to ground.

Shown here are three small relays (about two inches in height, each), installed on a panel as part of an electrical control system at a municipal water treatment plant:

Figure 2.10 relays installed on a panel.

While relays are essentially binary devices, either being completely on or completely off, there are operating conditions where their state may be indeterminate, just as with semiconductor logic gates. In order for a relay to positively "pull in" the armature to actuate the contact(s), there must be a certain minimum amount of current through the coil. This minimum amount is called the *pull-in* current, and it is analogous to the minimum input voltage that a logic gate requires to guarantee a "high" state (typically 2 Volts for TTL, 3.5 Volts for CMOS). Once the armature is pulled closer to the coil's center, however, it takes less magnetic field flux (fewer coils current) to hold it there. Therefore, the coil current must drop below a value significantly lower than the pull-in current before the armature "drops out" to its spring-loaded position and the contacts resume their normal state. This current level is called the *drop-out* current, and it is analogous to the maximum input voltage that a logic gate input will allow to guarantee a "low" state (typically 0.8 Volts for TTL, 1.5 Volts for CMOS).

The hysteric's, or difference between pull-in and drop-out currents, results in operation that is similar to a Schmitt trigger logic gate. Pull-in and drop-out currents (and voltages) vary widely from relay to relay, and are specified by the manufacturer.

- **REVIEW:**
- A *solenoid* is a device that produces mechanical motion from the energization of an electromagnet coil. The movable portion of a solenoid is called an *armature*.
- A *relay* is a solenoid set up to actuate switch contacts when its coil is energized.
- *Pull-in* current is the minimum amount of coil current needed to actuate a solenoid or relay from its "normal" (de-energized) position.
- *Drop-out* current is the maximum coil current below which an energized relay will return to its "normal" state.

2.4.2 Protective relays

A special type of relay is one which monitors the current, voltage, frequency, or any other type of electric power measurement either from a generating source or to a load for the purpose of triggering a circuit breaker to open in the event of an abnormal condition. These relays are referred to in the electrical power industry as *protective relays*.

The circuit breakers which are used to switch large quantities of electric power on and off are actually electromechanical relays, themselves. Unlike the circuit breakers found in residential and commercial use which determine when to trip (open) by means of a bimetallic strip inside that bends when it gets too hot from over current, large industrial circuit breakers must be "told" by an external device when to open. Such breakers have two electromagnetic coils inside: one to close the breaker contacts and one to open them. The "trip" coil can be energized by one or more protective relays, as well as by hand switches, connected to switch 125 Volt DC power. DC power is used because it allows for a battery bank to supply close/trip power to the breaker control circuits in the event of a complete (AC) power failure.

Protective relays can monitor large AC currents by means of current transformers (CT's), which encircle the current-carrying conductors exiting a large circuit breaker, transformer, generator, or other device. Current transformers step down the monitored current to a secondary (output) range of 0 to 5 amps AC to power the protective relay. The current relay uses this 0-5 amp signal to power its internal mechanism, closing a contact to switch 125 Volt DC power to the breaker's trip coil if the monitored current becomes excessive.

Likewise, (protective) voltage relays can monitor high AC voltages by means of voltage, or potential, transformers (PT's) which step down the monitored voltage to a secondary range of 0 to 120 Volts AC, typically. Like (protective) current relays, this voltage signal powers the internal mechanism of the relay, closing a contact to switch 125 Volt DC power to the breaker's trip coil is the monitored voltage becomes excessive.

There are many types of protective relays, some with highly specialized functions. Not all monitor voltage or current, either. They all, however, share the common feature of outputting a contact closure signal which can be used to switch power to a breaker trip coil, close coil, or operator alarm panel. Most protective relay functions have been categorized into an ANSI standard number code. Here are a few examples from that code list:

ANSI protective relay designation numbers

```
12 = Over speed
24 = Over excitation
25 = Syncrocheck
27 = Bus/Line under voltage
32 = Reverse power (anti-motoring)
38 = Stator overtemp (RTD)
39 = Bearing vibration
40 = Loss of excitation
46 = Negative sequence undercurrent (phase current imbalance)
47 = Negative sequence under voltage (phase voltage imbalance)
49 = Bearing overtemp (RTD)
50 = Instantaneous over current
51 = Time over current
51V = Time over current -- voltage restrained
55 = Power factor
59 = Bus over voltage
60FL = Voltage transformer fuse failure
67 = Phase/Ground directional current
79 = Autoreclose
81 = Bus over/under frequency
```

- **REVIEW:**
- Large electric circuit breakers do not contain within themselves the necessary mechanisms to automatically trip (open) in the event of over current conditions. They must be "told" to trip by external devices.
- *Protective relays* are devices built to automatically trigger the actuation coils of large electric circuit breakers under certain conditions.

2.4.3 Solid-state relays

As versatile as electromechanical relays can be, they do suffer many limitations. They can be expensive to build, have a limited contact cycle life, take up a lot of room, and switch slowly, compared to modern semiconductor devices. These limitations are especially true for large power contactor relays. To address these limitations, many relay manufacturers offer "solid-state" relays, which use an SCR, TRIAC, or transistor output instead of mechanical contacts to switch the controlled power. The output device (SCR, TRIAC, or transistor) is optically-coupled to an LED light source inside the relay. The relay is turned on by energizing this LED, usually with low-voltage DC power. This optical isolation between inputs to output rivals the best that electromechanical relays can offer, shown in figure 2.11.

Being solid-state devices, there are no moving parts to wear out, and they are able to switch on and off much faster than any mechanical relay armature can move. There is no sparking between contacts, and no problems with contact corrosion. However, solid-state relays are still too expensive to build in very high current ratings, and so electromechanical contactors continue to dominate that application in industry today.

One significant advantage of a solid-state SCR or TRIAC relay over an electromechanical device is its natural tendency to open the AC circuit only at a point of zero loads current. Because SCR's and TRIAC's are thyristors, their inherent hysteresis maintains circuit continuity after the LED is de-energized until the AC current falls below a threshold value (the *holding current*). In practical terms what this means is the circuit will never be interrupted in the middle of a sine wave peak.

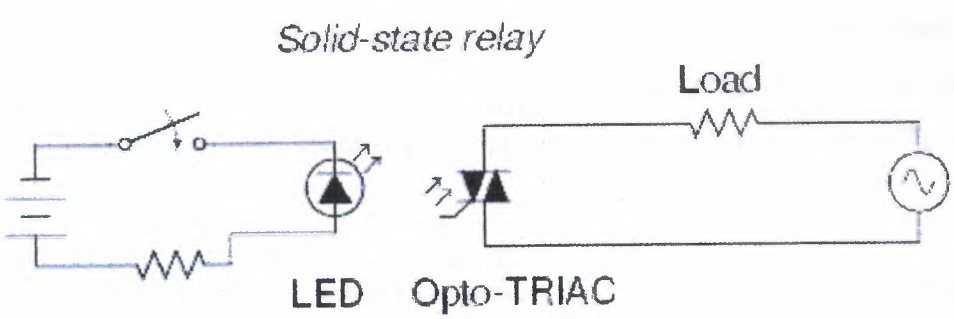


Figure 2.11 Solid-state relays.

Such untimely interruptions in a circuit containing substantial inductance would normally produce large voltage spikes due to the sudden magnetic field collapse around the inductance. This will not happen in a circuit broken by an SCR or TRIAC. This feature is called - zero crossover switching.

One disadvantage of solid state relays is their tendency to fail "shorted" on their outputs, while electromechanical relay contacts tend to fail "open." In either case, it is possible for a relay to fail in the other mode, but these are the most common failures. Because a "fail-open" state is generally considered safer than a "fail-closed" state, electromechanical relays are still favored over their solid-state counterparts in many applications.

2.5 Switch Types

Though it may seem strange to cover this elementary electrical topic at such a late stage in this book series, I do so because the chapters that follow explore an older realm of digital technology based on mechanical switch contacts rather than solid-state gate circuits, and a thorough understanding of switch types is necessary for the under taking. Learning the function of switch-based circuits at the same time that you learn about solid-state logic gates makes both topics easier to grasp, and sets the stage for an enhanced learning experience in Boolean algebra, the mathematics behind digital logic circuits.

The simplest type of switch is one where two electrical conductors are brought in contact with each other by the motion of an actuating mechanism. Other switches are more complex, containing electronic circuits able to turn on or off depending on some physical stimulus (such as light or magnetic field) sensed. In any case, the final output of any switch will be (at least) a pair of wire-connection terminals that will either be connected together by the switch's internal contact mechanism ("closed"), or not connected together ("open").

Any switch designed to be operated by a person is generally called a hand switch, and they are manufactured in several varieties, shown in figure 2.12.

Toggle switches are actuated by a lever angled in one of two or more positions. The common light switch used in household wiring is an example of a toggle switch. Most toggle switches will come to rest in any of their lever positions, while others have an internal spring mechanism returning the lever to a certain normal position, allowing for what is called "momentary" operation, shown in figure 2.12.

Pushbutton switches are two-position devices actuated with a button that is pressed and released. Most pushbutton switches have an internal spring mechanism returning the button to its "out," or "unpressed", position, for momentary operation. Some pushbutton switches will latch alternately on or off with every push of the button. Other pushbutton switches will stay in their "in," or "pressed," position until the button is pulled back out. This last type of pushbutton switches usually has a mushroom-shaped button for easy push-pull action, shown in figure 2.13.

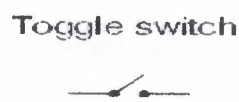


Figure 2.12 Toggle witch.

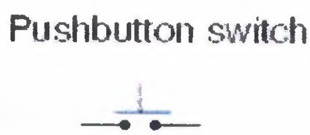


Figure 2.13 pushbutton switches.

Figure 2.14 Selector switch.

Selector switches are actuated with a rotary knob or lever of some sort to select one of two or more positions. Like the toggle switch, selector switches can either rest in any of their positions or contain spring-return mechanisms for momentary operation, shown in figure 2.14.

A joystick switch is actuated by a lever free to move in more than one axis of motion. One or more of several switch contact mechanisms are actuated depending on which way the lever is pushed, and sometimes by how far it is pushed. The circle-and-dot notation on the switch symbol represents the direction of joystick lever motion required to actuate the contact. Joystick hand switches are commonly used for crane and robot control.

Some switches are specifically designed to be operated by the motion of a machine rather than by the hand of a human operator. These motion-operated switches are commonly called limit switches, because they are often used to limit the motion of a machine by turning off the actuating power to a component if it moves too far. As with hand switches, limit switches come in several varieties, shown in figure 2.15.

Figure 2.15 Joystick switch.

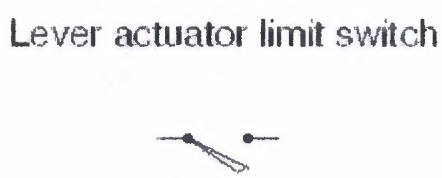


Figure 2.16 Lever actuator limit switch.

These limit switches closely resemble rugged toggle or selector hand switches fitted with a lever pushed by the machine part. Often, the levers are tipped with a small roller bearing, preventing the lever from being worn off by repeated contact with the machine part, shown in figure 2.16.

Proximity switches sense the approach of a metallic machine part either by a magnetic or high-frequency electromagnetic field. Simple proximity switches use a permanent magnet to actuate a sealed switch mechanism whenever the machine part gets close (typically 1 inch or less). More complex proximity switches work like a metal detector, energizing a coil of wire with a high-frequency current, and electronically monitoring the magnitude of that current. If a metallic part (not necessarily magnetic) gets close enough to the coil, the current will increase, and trip the monitoring circuit. The symbol shown here for the proximity switch is of the electronic variety, as indicated by the diamond-shaped box surrounding the switch. A non-electronic proximity switch would use the same symbol as the lever-actuated limit switch.

Another form of proximity switch is the optical switch, comprised of a light source and photocell. Machine position is detected by either the interruption or reflection of a light beam. Optical switches are also useful in safety applications, where beams of light can be used to detect personnel entry into a dangerous area.

In many industrial processes, it is necessary to monitor various physical quantities with switches. Such switches can be used to sound alarms, indicating that a process variable has exceeded normal parameters, or they can be used to shut down processes or equipment if those variables have reached dangerous or destructive levels. There are many different types of process switches, shown in figure 2.17.

Figure 2.17 Proximity switch.

These switches sense the rotary speed of a shaft either by a centrifugal weight mechanism mounted on the shaft, or by some kind of non-contact detection of shaft motion such as optical or magnetic, shown in figure 2.18.

Gas or liquid pressure can be used to actuate a switch mechanism if that pressure is applied to a piston, diaphragm, or bellows, which converts pressure to mechanical force, shown in figure 2.19.

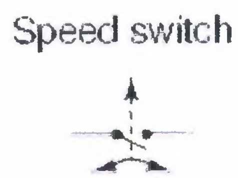


Figure 2.18 Speed switch.

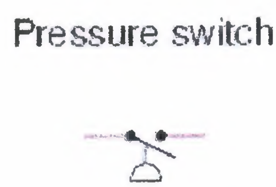


Figure 2.19 Pressure switch.

Figure 2.20 Temperature switch.

An inexpensive temperature-sensing mechanism is the "bimetallic strip:" a thin strip of two metals, joined back-to-back, each metal having a different rate of thermal expansion. When the strip heats or cools, differing rates of thermal expansion between the two metals causes it to bend. The bending of the strip can then be used to actuate a switch contact mechanism. Other temperature switches use a brass bulb filled with either a liquid or gas, with a tiny tube connecting the bulb to a pressure-sensing switch. As the bulb is heated, the gas or liquid expands, generating a pressure increase which then actuates the switch mechanism, shown in figure 2.20.

2.6 Switches Elementary Circuits

Figure 2.21 illustrates an extremely simple circuit. (For the moment, ignore the dotted line and the points A and B). The battery is represented by 4 lines (the longer line being positive and the shorter one negative). Starting from the negative end of the battery, electrons "circle" through one wire, pass through the light bulb, pass through the other wire and then return to the battery thereby completing the circuit.

This is all well and good but there are 2 drawbacks to this circuit 1) the light always stays on and 2) the power is constantly being used. How can we turn the light bulb 'off'? Well, we could unscrew the bulb from the socket but in the real world this is very inconvenient. (Light bulbs are inside fixtures, on ceilings and so on). Perhaps we could disconnect the power at the source. This too is very inconvenient. You would have to go down to your basement to shut the power off. Or - much more dangerous - you would have to disconnect the electrical supply wire before it reaches the light socket.

Switches are the safe way to interrupt the electron flow without physically touching the wire.

The inside of a typical household wall switch has a strip of metal (B), making contact with point 'A', completing the circuit and thereby conducting electricity to the light. This would obviously be the 'ON' position. When the insulated lever is moved down to the 'OFF' position, it pushes the metal strip away from point 'A', breaking the circuits and turning the light 'OFF', shown in figure.2.22

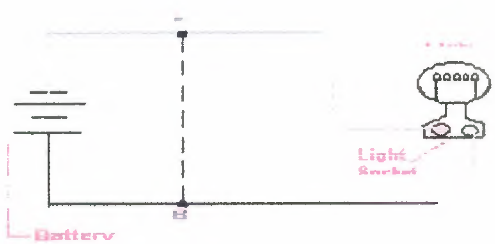


Figure 2.21 simple lighting circuits.

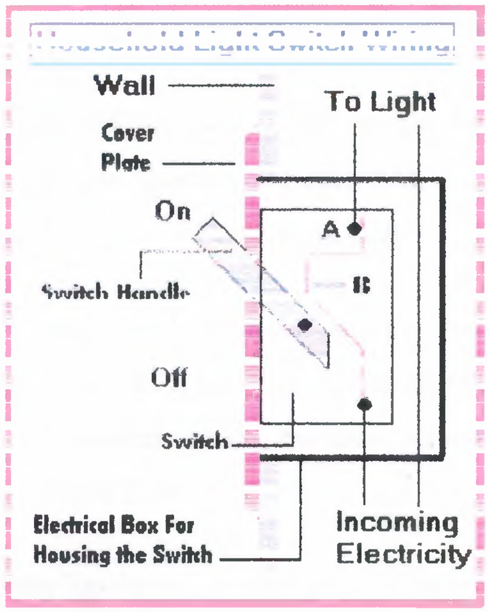


Figure 2.22 Household light switch wiring.

This type of switch (having a lever which "flips" it on and off) is called a toggle switch.

Because of being well-insulated and mounted in a box, household switches are a safe way for turning electrical devices on and off.

Finally, let's talk about that dotted line in Diagram 1. Now what would happen if point A and point B were to touch OR if they were connected with a wire or other conductor? Well, the light bulb would turn 'off', the wires and the battery would get very warm very fast and the electrons would simply travel from the battery to point A to point B and then back to the battery. Notice that in this new circuit, the electrons are traveling a path (or circuit) that is shorter than the original one. Hence you have just learned what a "short circuit" is and how its name is derived! Short circuits are dangerous. They cause wires to heat, circuit breakers to 'trip' and can even start fires.

2.6.1 Switches Wiring

There are many different types of switches: toggle, rotary, pushbutton, "rocker", "pull-chain", slide, magnetic, mercury, timer, voice-activated, "touch-sensitive", and many others. Heck, even the Clapper is another type of switch.

The "knife switch" (rarely seen nowadays) is the type that most easily demonstrates the functioning of a switch. Old sci-fi movies ("Frankenstein (1931)" or "Young Frankenstein (1974)", for example), made extensive use of these switches in the laboratory scenes, shown in figure 2.24.

Today, use of knife switches has been confined to 1) heavy-duty industrial applications and 2) demonstration purposes - science projects for example. The knife switch has a metal lever, insulated at the 'free end' that comes into contact with a metal 'slot'. Since the electrical connections are exposed, knife switches are never seen in household wiring, sown in figure 2.23.

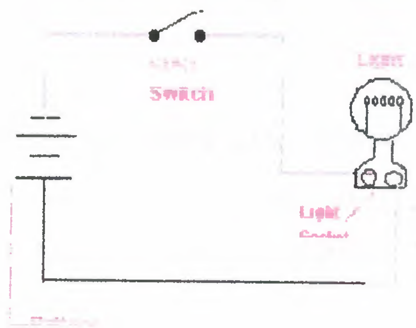


Figure 2.23 Light switch circuit.

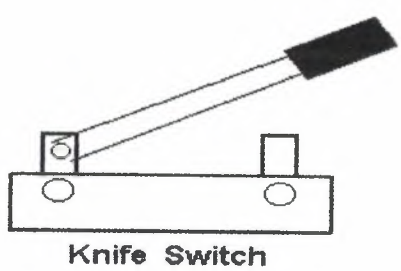


Figure 2.24 Knife switch.

Referring to Figure 2.23, the wiring is very similar to Diagram 1 except a switch has been added. Compare this to the Typical Household Light Switch diagram. Pretty much the same principle at work wouldn't you say? This type of switch is a Single Pole Single Throw (or SPST). This means that it controls one wire (pole) and it makes 1 connection (a throw). Yes, this is an on/off switch, but a 'throw' only counts when a connection is made. 'Off' is not considered a 'throw'. Also notice that only 1 wire has to be switched. (Following the circuit from one end of the battery to the other you can see why this is so).

As it is, this circuit alone could be your science project. A variation could be substituting a push-button switch and putting a 'buzzer' or 'doorbell' where the light is. Now you have a good demonstration of how a doorbell is wired. Pushbutton switches are *usually* "momentary on". That is to say the connection is made only when you press the button. There are "momentary off" pushbutton switches, but using one in a doorbell circuit would mean the bell would be constantly on until someone pressed the button. Impractical don't you think? (The comedian Tim Conway joked that his father wired a doorbell in just this way. When there was silence someone would say "Hey somebody's at the door").

A practical use of the momentary off switch is the "mute button" on your telephone. If a momentary on switch were used, it would be very annoying to press the button constantly as you talked and released it only for muting. This shows how each type of switch has its specific applications.

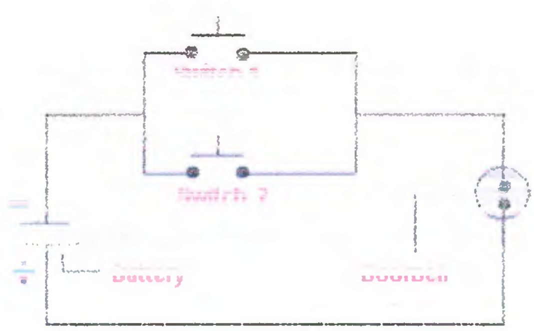


Figure 2.25 Dual button doorbell wiring.

Figure 2.25 shows an interesting variation of doorbell wiring. The 2 doorbell buttons do not have to be right next to each other. One button could be at a front door and the other at a side door. If you follow the circuit, you can see that pressing either button will cause the doorbell to ring. The 2 switches are said to be wired in parallel.

The burglar alarm circuit shown in figure 2.26 employs magnetic switches. These switches and their associated magnets are generally mounted on doors and windows. Notice that Switch 1 and Switch 2 are wired in series. Both switches must be closed in order for the circuit to be complete and for the bulb to light. (This would indicate the 'armed' status of this burglar alarm.) Magnetic switches come in 2 varieties - "Normally Closed" and "Normally Open". These 2 terms describe the state of the switch when it is NOT being controlled by the magnet. The switches in this diagram are the "Normally Open" type and because the magnets are far enough away, the switches are in the 'open' state. If the magnets were brought closer, the bulb would go on and the circuit would be "armed". At this point, moving either magnet would make the bulb go out and the alarm would be triggered. (For the sake of simplicity, the activated alarm circuit has not been drawn). An important point to note is that cutting the wires at any point would also make the bulb go out and trip the alarm, shown in figure 1.6.

The next type of switch (no diagram) is the Double Pole Single Throw (DPST). These switches are used when there are 2 'live' lines to switch but can only turn on or off (single throw). These switches are not used much and are usually found in 240 volt applications.

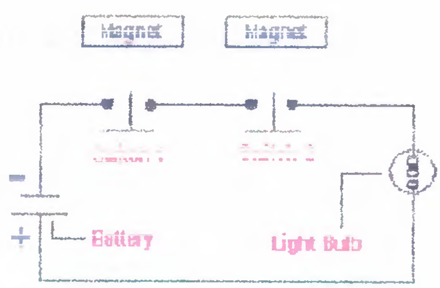


Figure 2.26 Burglar alarm circuit.

2.6.2 Single Pole Double Throw Switches Wiring

Figure 2.28 use of the Single Pole Double Throw Switch. The common terminal is the middle terminal in the SPDT Knife Switch or if you are using a household switch, it would be the brass colored terminal. (The other 2 would be silver colored). This circuit clearly demonstrates what happens when the SPDT switch is moved back and forth. Light A goes on and B goes off, B goes on and A goes off and so forth. You can see that this popular switch would have many practical applications: the transmit/receive button on a "2-way" radio, the "high/low beam" switch for your car headlights, the pulse/tone dialing switch on your telephone, and so on.

If you are using the SPDT knife switch, you have a "center off" position, which an ordinary wall switch would NOT have in which case you will need to add an SPST switch for shutting this circuit off. (In electronics work, many SPDT switches have a middle position in which the electricity is turned off to BOTH circuits. It is an SPDT center off switch. Also, some electronic SPDT switches have a "center on" position. The best example of this type of switch is the "pickup" selector on an electric guitar which can choose the rhythm, treble or both pickups for 3 varieties of sounds).

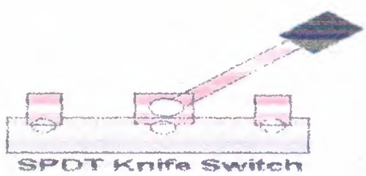


Figure 2.27 Single pole double throw knife.

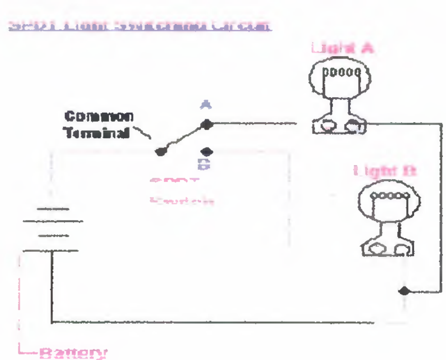


Figure 2.28 Single pole double throw light switching circuit.

2.6.3 The Double Pole Double Throw Switch Wiring

A simple way to think of this switch is imagining 2 SPDT switches side by side with the 'handles' attached to each other. Perhaps the most popular use for this switch is 'phase or polarity reversal'. So, how does the DPDT switch accomplish this? First, *you* have to wire the 2 'top' and 2 'bottom' terminals in a 'criss-cross' fashion. The top 2 terminals become the input and the middle two terminals become the output. Now, referring to the bottom left diagram, the switch is in the 'up' position, W & Y is connected, as are X & Z. The polarity is maintained because the input and output are directly connected, shown in figure 2.30.

Now let's see what happens when the switch is in the 'down' position (right diagram). The + input goes from the 'W' terminal, down to the lower right and then up to the 'Z' terminal. The negative input goes from the 'X' terminal and out through the 'Y' terminal. See what has happened? With one flip of a switch, polarity has been reversed. What applications does this have? For one thing, electric guitar players use this type of switch to put one pickup out of phase with the other, producing a thin, and 'squawky', 'inside-out' kind of sound. In the 'old days' before 3 prong plugs, power switches on some electrical devices used this switching arrangement to switch polarity in case the plug was in the outlet the "wrong way".

Another important (though not very common) use is to put this switch between 3-way switches so that the same light may be switched from many different locations. Referring to Diagram 4, if A & B and E & F were connected, the bulb would be off. But now think of the wires going from A to D and C to F. If their connections were reversed, (A to F, C to D), the light bulb would turn on again. So, how would we be able to reverse the polarity of these 2 wires? By using the polarity reversing switch, shown in figure 2.31.

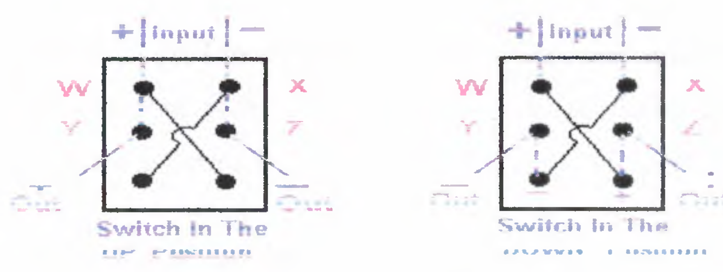


Figure 2.30 The double pole double throw switch.

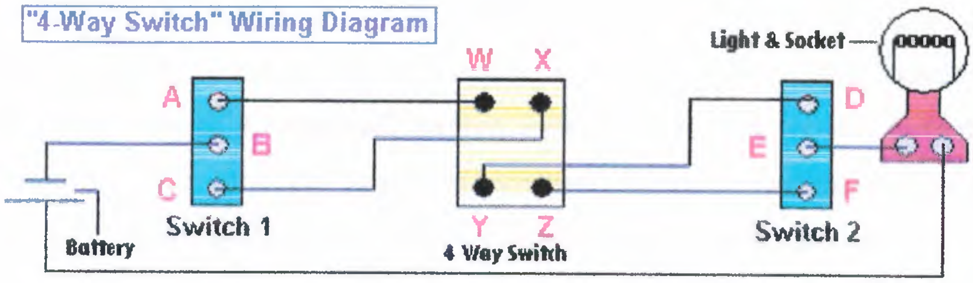


Figure 2.31 Four-way switches wiring diagram.

Incidentally, electricians have once again stuck us with another misnomer by calling this a "4-way" switch. Can you see what the 4-way switch is? It is a DPDT switch, wired for phase reversal without the bottom 2 terminals exposed (they don't have to be). If you can buy a 4-way switch, great. If not, you know how to make one right? Also, you don't have to limit yourself to using just one 4-way switch. If you were to attach another 4-way switch from the 'Y' 'Z' terminals to the 'W' 'X' terminals of the next switch, you could have the same light switched from a 4th location.

2.7 Contact "bounce"

When a switch is actuated and contacts touch one another under the force of actuation, they are supposed to establish continuity in a single, crisp moment. Unfortunately, though, switches do not exactly achieve this goal. Due to the mass of the moving contact and any elasticity inherent in the mechanism and/or contact materials, contacts will "bounce" upon closure for a period of milliseconds before coming to a full rest and providing unbroken contact. In many applications, switch bounce is of no consequence: it matters little if a switch controlling an incandescent lamp "bounces" for a few cycles every time it is actuated. Since the lamp's warm-up time greatly exceeds the bounce period, no irregularity in lamp operation will result.

However, if the switch is used to send a signal to an electronic amplifier or some other circuit with a fast response time, contact bounce may produce very noticeable and undesired effects, shown in figure 2.32.

A closer look at the oscilloscope display reveals a rather ugly set of makes and breaks when the switch is actuated a single time, shown in figure 2.33.

If, for example, this switch is used to provide a "clock" signal to a digital counter circuit, so that each actuation of the pushbutton switch is supposed to increment the counter by a value of 1, what will happen instead is the counter will increment by several counts each time the switch is actuated. Since mechanical switches often interface with digital electronic circuits in modern systems, switch contact bounce is a frequent design consideration. Somehow, the "chattering" produced by bouncing contacts must be eliminated so that the receiving circuit sees a clean, crisp off/on transition, shown in figure 2.34.

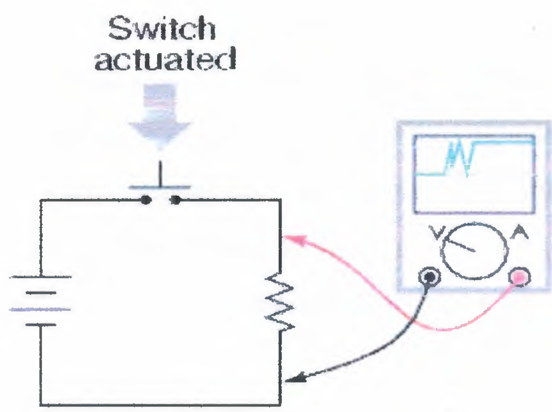


Figure 2.32 Bounce switches operations.

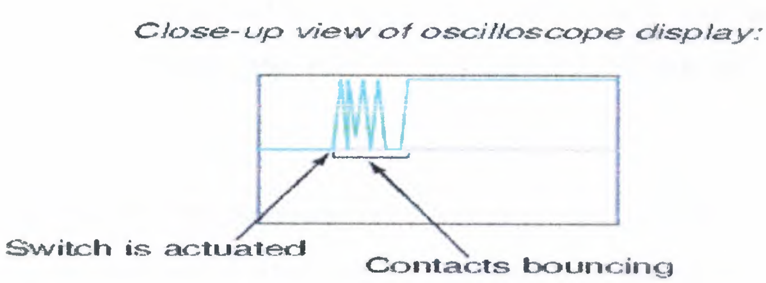


Figure 2.33 Close-up view of oscilloscope display.

Figure 2.34 Bounce less switch operations.

Switch contacts may be debounced several different ways. The most direct means is to address the problem at its source: the switch itself. Here are some suggestions for designing switch mechanisms for minimum bounce:

- Reduce the kinetic energy of the moving contact. This will reduce the force of impact as it comes to rest on the stationary contact, thus minimizing bounce.
- Use "buffer springs" on the stationary contact(s) so that they are free to recoil and gently absorb the force of impact from the moving contact.
- Design the switch for "wiping" or "sliding" contact rather than direct impact. "Knife" switches designs use sliding contacts.
- Dampen the switch mechanism's movement using an air or oil "shock absorber" mechanism.
- Use sets of contacts in parallel with each other, each slightly different in mass or contact gap, so that when one is rebounding off the stationary contact, at least one of the others will still be in firm contact.
- "Wet" the contacts with liquid mercury in a sealed environment. After initial contact is made, the surface tension of the mercury will maintain circuit continuity even though the moving contact may bounce off the stationary contact several times.

Each one of these suggestions sacrifices some aspect of switch performance for limited bounce, and so it is impractical to design all switches with limited contact bounce in mind. Alterations made to reduce the kinetic energy of the contact may result in a small open-contact gap or a slow-moving contact, which limits the amount of voltage the switch may handle and the amount of current it may interrupt. Sliding contacts, while non-bouncing, still produce "noise" (irregular current caused by irregular contact resistance when moving), and suffer from more mechanical wear than normal contacts.

Multiple, parallel contacts give less bounce, but only at greater switch complexity and cost. Using mercury to "wet" the contacts is a very effective means of bounce mitigation, but it is unfortunately limited to switch contacts of low capacity. Also, mercury-wetted contacts are usually limited in mounting position, as gravity may cause the contacts to "bridge" accidentally if oriented the wrong way.

If re-designing the switch mechanism is not an option, mechanical switch contacts may be debounced externally, using other circuit components to condition the signal. A low-pass filter circuit attached to the output of the switch, for example, will reduce the voltage/current fluctuations generated by contact bounce, shown in figure 2.35.

Switch contacts may be debounced electronically, using hysteretic transistor circuits (circuits that "latch" in either a high or a low state) with built-in time delays (called "one-shot" circuits), or two inputs controlled by a double-throw switch. These hysteretic circuits, called multivibrators, are discussed in detail in a later chapter.

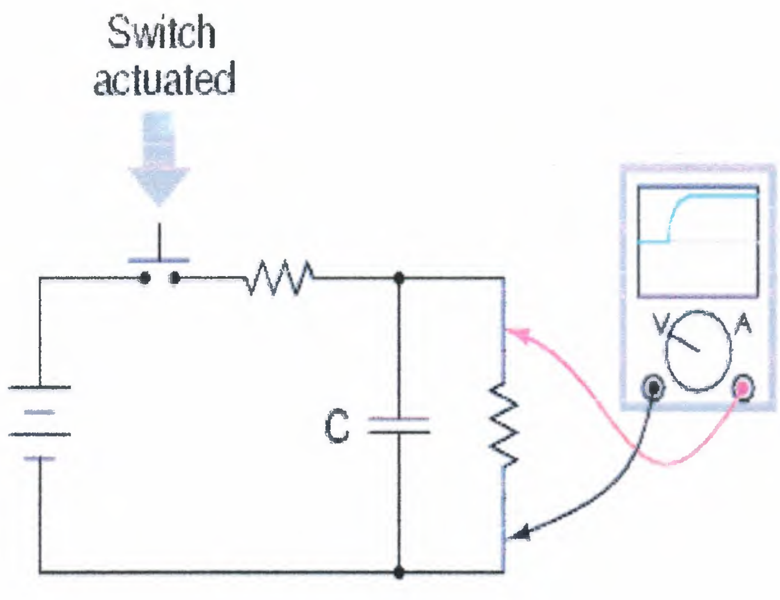


Figure 2.35 Debounced switch operations.

2.8 Summary

In this chapter we have discussed switches, the type of switches we have many types of switches, the effect of the circuit parameter on life-time of switches. Also the contact material, terminology of switches, and the bounce material, and the use of the switches in the hostile environment were been discussed.

CHAPTER THREE
SOUND ACTIVATED SWITCH

3.1 Overview

In this chapter we will explain the design of Sound Activated Switch circuit, what are the uses of it? With assembly instructions and a brief explanation about every stage of the circuit and the component of that stage and how to combine each stage to the other , what is the function of each stage? And the problem facing the circuit after being built and the changes that we have done to solve that problem and to make it more suitable to use also we include the using instruction.

3.2 Introduction

The Sound activated switch module which may be used in any application where Sound activated switch operation is desired. It may be used with virtually any type of microphone. The circuit itself draws only 10 mA at 9 volts DC and will directly switch low voltage loads up to 100 mA. Numerous small and inexpensive relays are available to permit switching of higher voltage and current. The VS- 1 Sound activated switch may be used to control ham radio transmitters, CB transceivers, and similar equipment for other radio services. In addition, it can be used to control tape recorders or any other device for which you envision voice-operated switching.

This is a multi sensitive, sound or voice activated switch which plugs into the REMOTE plug of a tape recorder and turns it on when it detects a reselected level of sound. If the sound continues then the switch will self-trigger and remain on. Once the sound goes away then a delay in the circuit will turn off the tape recorder after about 6 seconds.

It is ideal for hands-free operation of a tape recorder, eg, for taking notes. The Kit can be calibrated to turn on at the slightest sound or at a much high sound level. Note that this Kit does not improve the sensitivity of the tape recorder itself. It is just a switch which turns the recorder on. So that the sound which turns ON the tape recorder may not be picked up by the tape recorder if the microphone in the tape recorder is not sensitive enough. The kit is constructed on a single-sided printed circuit board (Bread Board). Portal Autocrat and Schematic were used to design the board.

3.3 Assembly Instructions

Assembly is straight forward and components may be added to the Bread Board in any order. Note that the electrets microphone should be inserted with the pin connected to the metal case connected to the negative rail (that is, to the ground or zero voltage side of the circuit). It is generally best to add the lowest height components first for ease of soldering. Be sure to put the electrolytic capacitors and the diodes in the correct way as indicated.

3.3.1 Components of sound activated switch circuit

1) Resistors: all 1/3 watt 5 %(10% over 1MΩ)

R1 1K ohm resistors [brown-black-red-gold]

R2 100K ohm [brown-black-yellow-gold]

R3 100K ohm resistors [brown-black-yellow-gold]

R4 10M ohm resistors [brown-black-blue-silver]

R5 100K ohm resistors [brown-black-yellow-gold]

R6 1 Mega ohm resistor [brown-black-green-gold]

2) Capacitors:

C1 1μF 63 V electrolytic

C2 2.2μF 63 V electrolytic

C3 4.7μF 63 V electrolytic

C4 10μF 25 V electrolytic

C5 100 nF polyester [brown-black-yellow- black-red]

C6 100μF 10 V electrolytic

3) Semiconductors:

IC1 TL081CP (U1)

IC2 LM380N (U2)

D1 0A90

D2 0A90

D3 1N4148 diode

4) Switch:

S1 SPST miniature toggle type

5) Relay:

RLA 6/12 volt coil having a resistance of 185 ohms or more and contacts of adequate rating and correct type

6) Battery:

8×1.5 V AA size battery

7) Loudspeaker (microphone):

LS1 Miniature type having impedance in the range 40to 80 ohms

8) Miscellaneous:

Vero bloc

Wire

Bread Board

3.4 How it works

An explanation about each stage function of the circuit, what does the components contribute to the stages, and how does they work together by giving the desired output.

3.4.1 How microphones work

Microphones just convert a real sound wave into an electrical audio signal. In order to do so, they have a small, light material in them called the diaphragm. When the sound vibrations through the air reach the diaphragm, they cause the diaphragm to vibrate. This in turns will somehow cause an electrical current in the microphone to vary, whereupon it is sent out to a mixer, preamplifier or amplifier for use. Microphones are typically classified according to how the diaphragms produce sound.

3.4.2 Sound amplification stage

Figure 3.2 shows the circuit diagram of the first stage for the sound activated switch this is the sensor or we con call it the receiver stage when the sound is entering to the microphone and change to an electric signal it goose to the IC1 which is used as a straightforward inverting amplifier having a voltage gain of approximately 80 dB (10,000 times), although the gain is substantially less than this at higher audio frequencies since IC1 simply is not able to give such a high voltage gain at these frequencies. It is necessary to use this large amount of amplification due to the very low signal voltage provided by the microphone, which will normally be less than a millivolt.

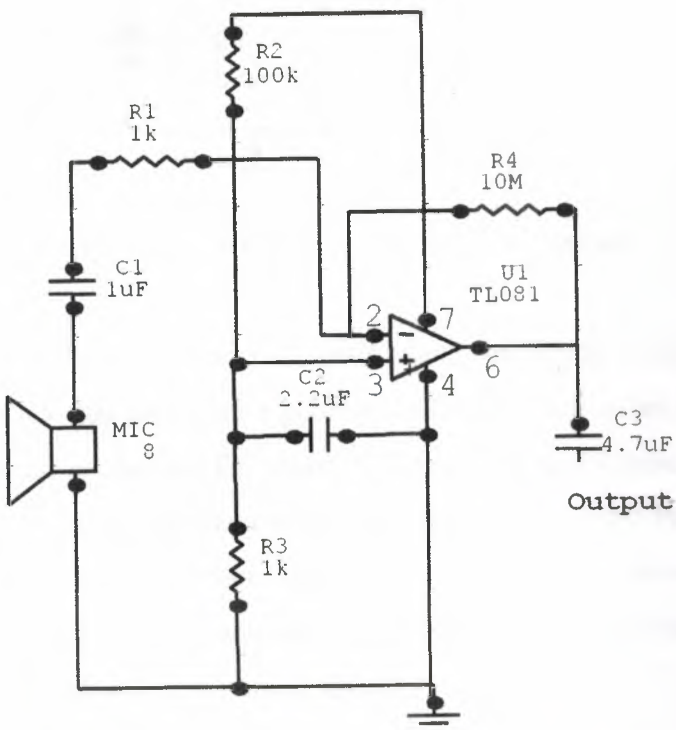


Figure 3.1 Sound amplification stage circuit diagram.

3.5.3 Diodes Rectifying Stage

The output from IC1 is coupled by C3 to a rectifier and smoothing circuit which consist of D1, D2, C4, and R5.This produces a positive DC bias which is fed to the inverting input of IC2.This circuit produces a DC signal that has a fast attack time so that the unit quickly responds to the commencement of an input signal and almost instantly switches on the controlled equipment. However, the decay time is much slower, and this is advantageous since it prevents the controlled equipment from being switched off during brief pauses of the type that occur in normal speech.

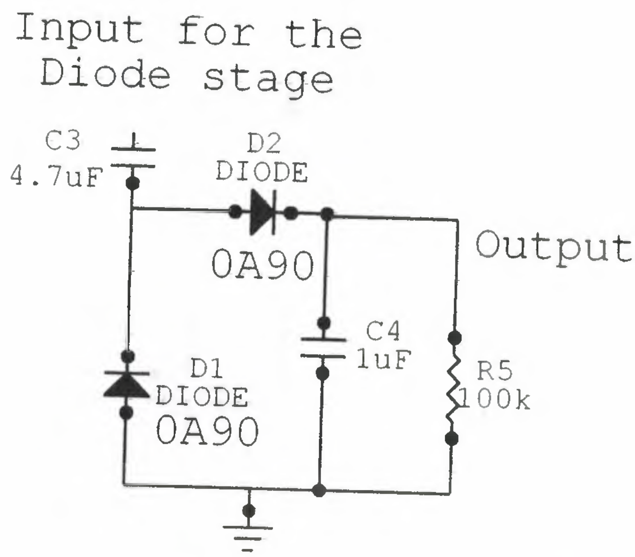


Figure 3.2 Diodes Rectifying Stage circuit diagram.

The output from IC1 is coupled by C3 to a rectifier and smoothing circuit which consist of D1, D2, C4, and R5.This produces a positive DC bias which is fed to the inverting input of IC2.This circuit produces a DC signal that has a fast attack time so that the unit quickly responds to the commencement of an input signal and almost instantly switches on the controlled equipment. However, the decay time is much slower, and this is advantageous since it prevents the controlled equipment from being switched off during brief pauses of the type that occur in normal speech.

3.4.4 Audio Power Amplifying Stage

IC2 is used as the relay driver, and R6 provides a small positive bias to the non-inverting input of this device. This keeps the output in the high state and the relay switched off until a suitably strong input signal produces a strong enough bias at the inverting input of IC2 to send the output low and thus switch on the relay.

The unit is capable of controlling practically any item of electronic or electrical equipment, but make sure that the relay we use has contact that are up to the task and are not being over loaded. In its bread boarded from the unit can not control a piece of mains-operated equipment if it is constricted as a permanent project and the necessary safety precautions are observed. However, it would be inadvisable for inexperienced constructor to use the unit to control mains powered equipment.

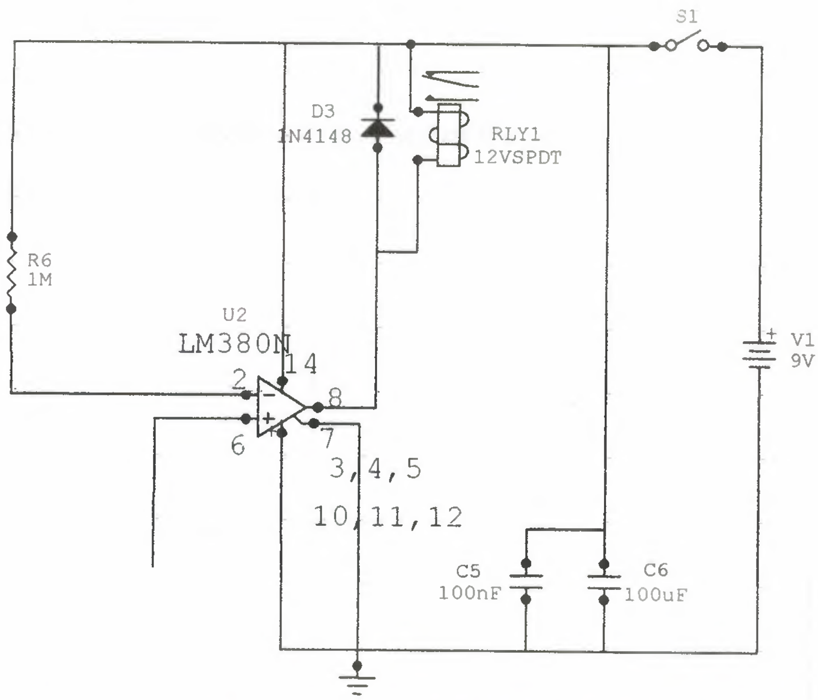


Figure 3.3 Audio Power Amplifying Stage circuit diagram.

3.4.4.1 LM380 2.5W Audio Power Amplifier General Description

The LM380 is a power audio amplifier for consumer applications. In order to hold system cost to a minimum, gain is internally fixed at 34 dB. A unique input stage allows ground referenced input signals. The output automatically self-centers to one-half the supply voltage. The output is short circuit proof with internal thermal limiting.

The package outline is standard dual-in-line. The LM380N uses a copper lead frame. The center three pins on either side comprise a heat sink. This makes the device easy to use in standard PC layouts. Uses include simple phonograph amplifiers, intercoms, line drivers, teaching machine outputs, alarms, ultrasonic drivers, TV sound systems, AM-FM radio, small servo drivers, power converters, etc. A selected part for more power on higher supply voltages is available as the LM384. For more information see AN-69.

Features

- Wide supply voltage range: 10V-22V
- Low quiescent power drain: 0.13W (VS = 18V)
- Voltage gain fixed at 50
- High peak current capability: 1.3A

- Input referenced to GND
- High input impedance: 150kW
- Low distortion
- Quiescent output voltage is at one-half of the supply voltage
- Standard dual-in-line package

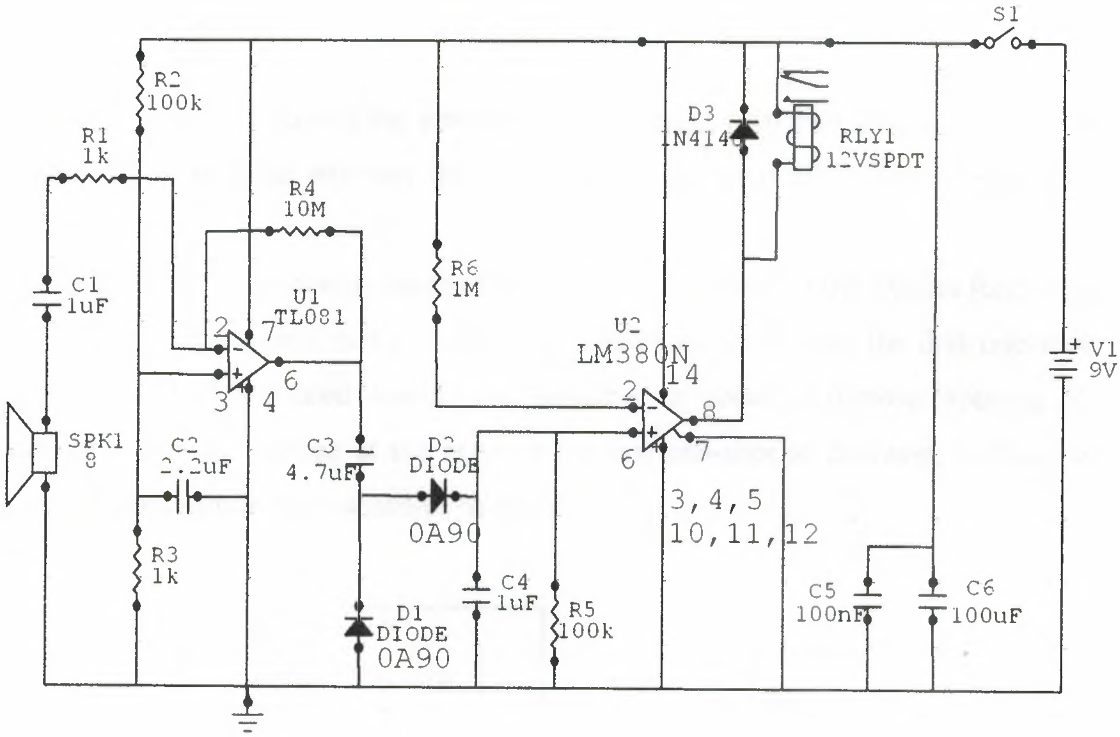


Figure 3.4 voice activated switch circuit diagram.

3.5 Circuit problems and solutions

The problems that face constructing the voice activated switch circuit and the solution for that problems will be presented at this section, also the development that occur on the circuit to enhance it and to make it suitable for different uses.

3.5.1 Rectifier Stage

While we were collecting circuit components the desired diodes (D1 and D2) that carry the number (0A90) were not found at the market. Therefore we check the components equivalents book and found an alternative diodes carrying the number (2N2222) and made replacement to do the same function.

3.5.2 Noise interference

When the circuit was built and switched on, the result was switching by it self regardless the input status, the assumption a highly responds for noise interference.

The cause of the noise interference due to the separation of the components therefore we made them closer to each other.

3.5.3 Sensitivity

The selector switch S1 adjusts the sensitivity of the Sound activated switch. Varying the resistance of the amplifier will vary the DC voltage at the input of the Diodes Rectifying Stage.

Rotating S1 counter-clockwise causes the voltage at the input of the Diodes Rectifying Stage increase. This means that a louder clap is required to activate the first one-shot, making the Sound activated switch less sensitive to sound. Likewise, rotating S1 clockwise causes the voltage at the input of the first one-shot to decrease, making the Sound activated switch more sensitive to sound.

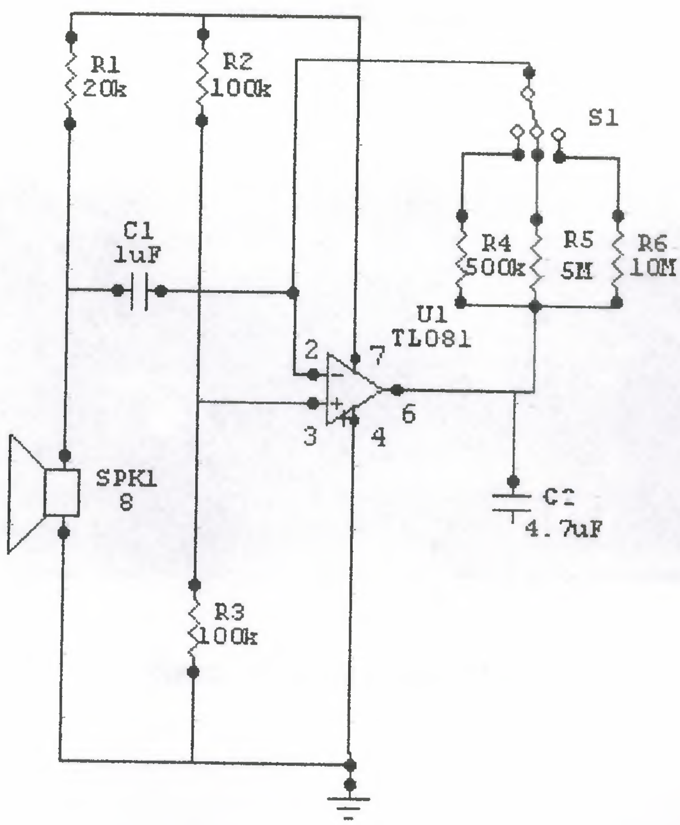


Figure 3.5 Sound amplification stage and the selector switch circuit diagram.

3.5.4 RC Timer

The duration of sound activated switch off delay is controlled by the values of C3 and the combination of R8 and R7. The 500K R7 variable resistor will provide excellent adjustment delay range. Another factor which you may wish to control is "Sound activated switch Gain", which is different from "Mike Gain" of the transmitter or other device controlled by the Sound activated switch circuit.

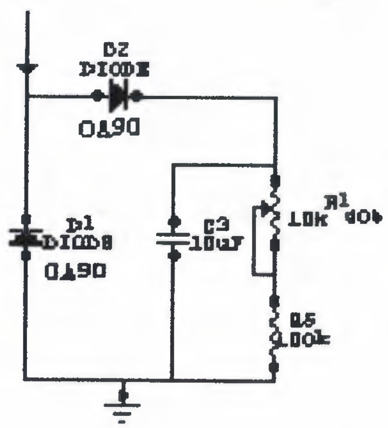


Figure 3.6 RC timer circuit.

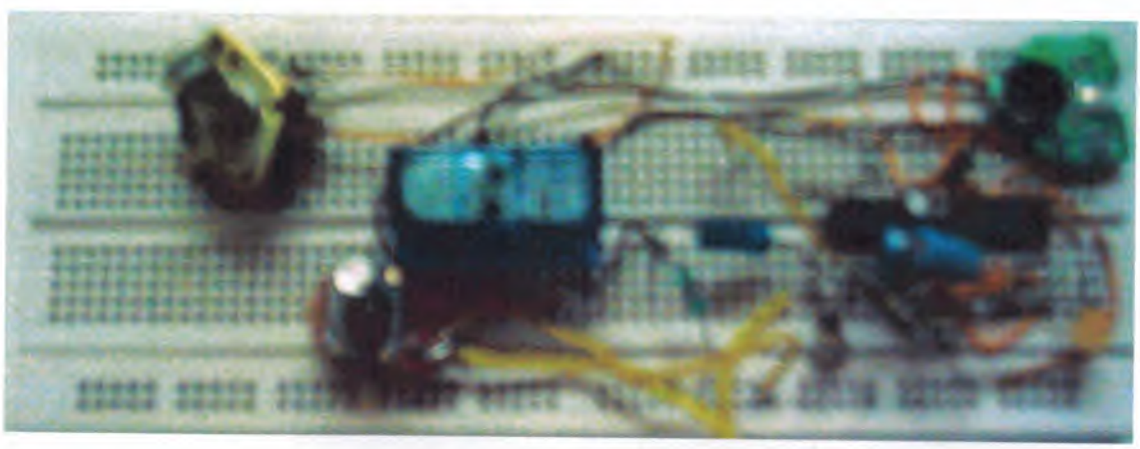


Figure 3.7 Total circuit on the board.

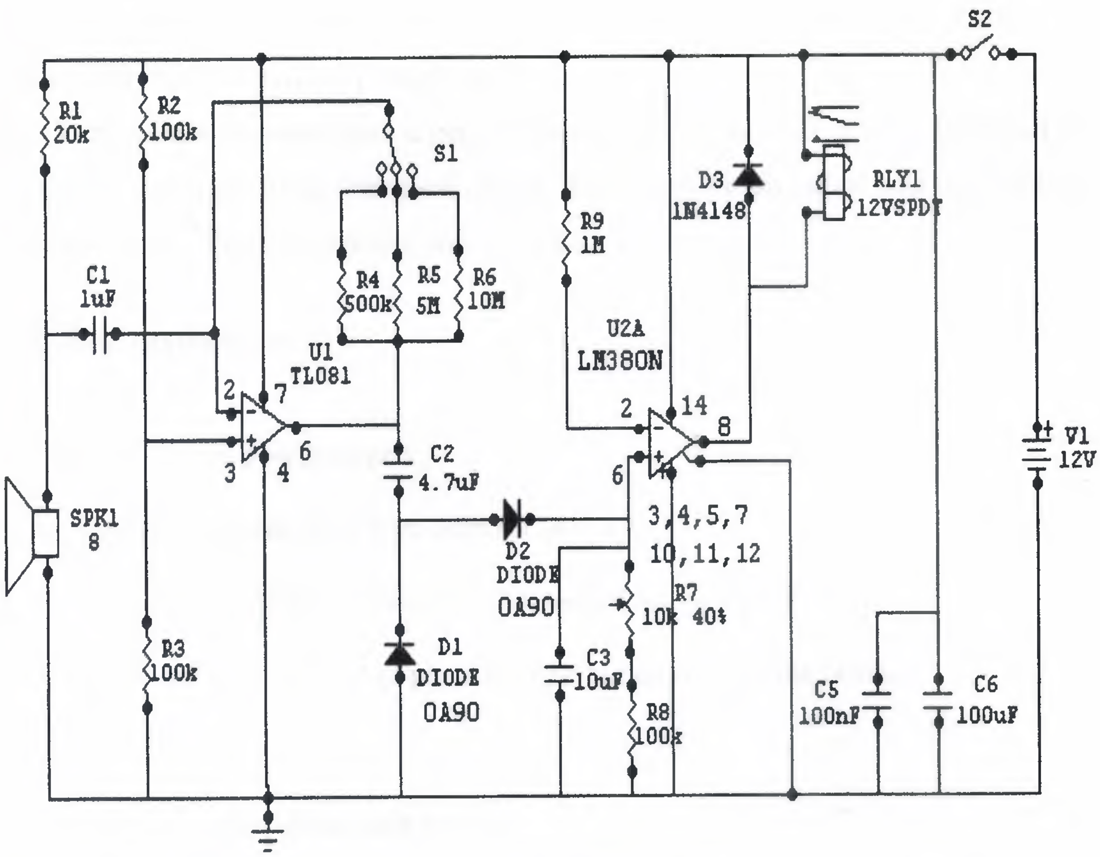


Figure 3.8 Complete improved voice activated switch circuit diagram.

3.6 Block diagram

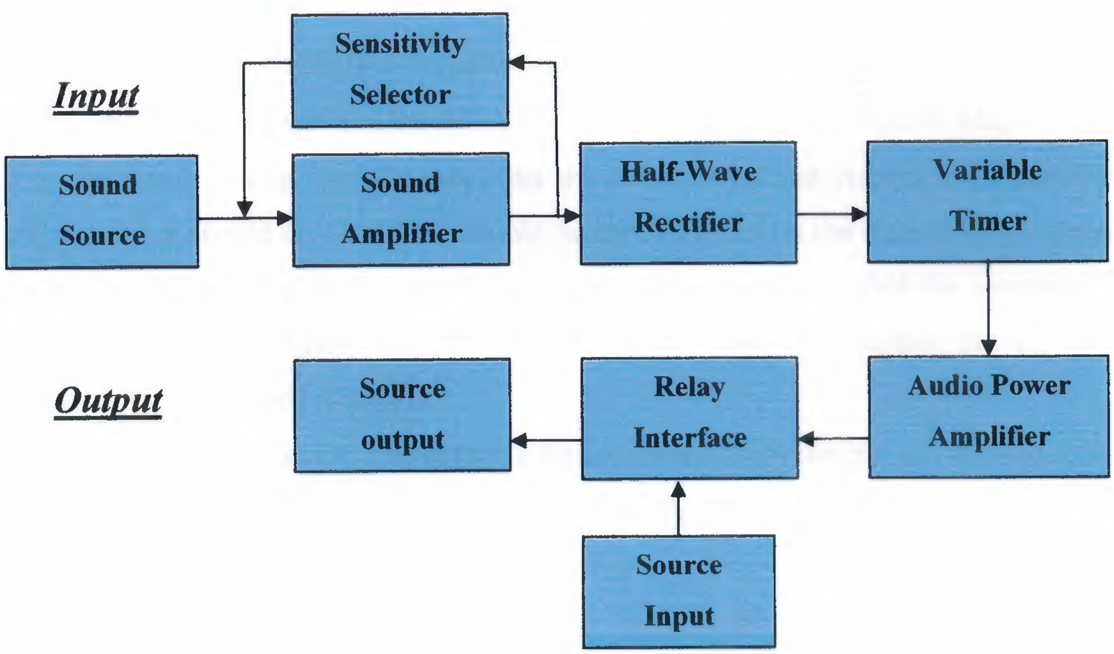


Figure 3.9 A block diagram of the voice activated switch circuit stages.

An explanation about each step and stage operation of the voice activated switch circuit will be given to show how it operates.
A block diagram will simply give a general idea about the steps of getting the sound and how does it changes to an electrical signal which will be amplified and rectified and enter to the audio Power Amplifier and from it to the relay.

3.7 Using instructions

1- Turn ON the power switch.
2- Adjust the sensitivity-(from selector switch).
3- Adjust the variable resistance to the desired time switching delay.
4- When resetting the circuit press the rest button to reset the circuit.

3.8 What to do if it does not work

Check that all components are in their correct position on the bread board, follow the track with a voltmeter to check the potential differences at various parts of the circuit particularly across the ICs and components.

- A check list of other items:
- Are the IC in the correct way.
- Are the electrolytic capacitors and diodes in the correct way.
- Are the 2 wires in the REMOTE socket shorting out inside the plug.

For the circuit before the IC checks that the collector-ground voltage for T1 is about 2V. For T2 it should be 4V. There should be about 1V across the electrets microphone. At the IC pin 3 taken to ground by a jumper wire should turn ON the recorder. So should pin 1 taken HIGH to the12V track. If this does not happen the IC or its attachment to the board is at fault.
Microphones have polarity. The negative lead is always from the pad and shorted to the case. The PC board is marked to show the lead positioning.

3.9 Uses and Features

A simple gain control hookup is indicated as optional on the schematic diagram. Another feature of Sound activated switch circuits is called "anti-trip" or "anti- Sound activated switch ". This is useful in communications equipment to prevent the signals or noise coming from the speaker from tripping the Sound activated switch. Effective anti-sound activated switch requires additional differential amplifier or comparator circuitry that is beyond the purposes of the simple sound activated switch. To minimize unwanted tripping, keep both the suggested Sound activated switch gain control and speaker volume as low as possible or maximize the distance between the radio's speaker and the sound activated switch microphone.

If controlling a tape recorder motor is your intended application, test the motor's current requirement in mA with voltmeter. If it is less than that 100 mA, the switch can control the motor directly. If you have any hesitation, use a relay. Finally, we note that some people have thought that with sound activated switch they can use it to switch a device such as a computer or appliance or lamp on and off by voice command or other sound. Obviously, such "latching" or "toggling" functions are not the primary applications for which the output circuit of the sound activated switch was designed. Can it be done? Yes, if you would like to explore the capabilities of flip-flop IC's such as the 4013.. A simple latch circuit can be made with a relay as illustrated, but you would have to turn it off manually, not by **sound**. In "rigging up" the sound activated switch to control circuits not discussed in this booklet, particularly any AC-line powered device such as a lamp, please remember that the direct switching output is intended only for DC loads under 30 volts and under 100 mA. When wiring a relay to control other loads, particularly 230 Volt AC circuits, please observe all standard electrical safety precautions.

3.10 Summary

In this chapter the Sound activated switch circuits were presented. Also in this chapter we have explained the three stages of circuit and Assembly Instructions of them, the diagram of the first second and third stage circuits also showed. And the components for all of them were listed; block diagram will simply give a general idea about the steps of functions of stages, also we include the Uses and Features of the voice activated switch circuit.

CONCLUSION

We could build sound activated switch combining the analog components, analog components such as resistors, capacitors and diodes, also we used some ICs like the operational amplifier and audio Power Amplifier, with a relay at the out put.

Far from this project we have accomplished our aims that were:

- To design and build a sound activated switch.
- To gain hands on experience in electronic hardware project
- To modify the original circuit where possible
- To suggest potential real-life use of switches
- How to use the electronic parts description book

In the first chapter we have seen different types of electronic components and the safety way of using them in any electric circuit, also we learned how to measure them without expecting an error.

In the second chapter we have discussed switches the type of switches we have seen many types of switch, the effect of the circuit parameter on the life time of switches. Also the contact material, terminology of switches, and the use of the switches in the hostile environment were been discussed.

The third chapter was as introduction about sound activated switch, where we can use it. Also in this chapter we have explained three stages of the circuits, with a diagram of each circuit and the components of it, with assembly instruction, the uses of sound activated switch in real life application.

How to solve problems that face constructing the voice activated switch circuit, like the Rectifier Stage, Noise interference, and the improvements that occur on the circuit, like the Sensitivity and RC Timer to make it suitable for varies application cause the sound activated switch is designed for general use prepossess and that problems will be presented in chapter three with full explination, also the development that occur on the circuit to enhance it and to make it suitable for different uses.

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