NEAR EAST UNIVERSITY

Faculty of Engineering

Department of Electrical and Electronic Engineering

A FM Radio Design & Audio Amplifier

Graduation Project
EE 400

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ABSTRACT

As the human mind is unlimited, as the technology never stopped and inventing goes on without a limit, the radio has played an important role in our life. Radio is portable, reaching people at home, in their automobile, in their office, and many other places, thereby allowing radio advertisers to influence audiences immediately prior to their making decisions, as it works extremely well whether used as a stand alone medium or in combination with complementary media (i.e. Television, Newspaper, Outdoor, & Transit).

One of Radio's greatest strengths of all is that it's Local, offering local news and local community information on a daily basis. Radio creates awareness, moves customers, sells products and/or services and influences listeners, so there are a lot of reasons that makes this device important in our life.

This project presents the design, construction and modification of an FM radio receiver and an audio amplifier. Problems encountered during the project preparation and their solution will be presented.

ACKNOWLEDGMENT

In the name of Allah

We would like to express our deepest appreciation to Allah who stood beside us all the time, who supported us in all our achievements and who has given us the power and patience to finish our university studies successfully.

*And we feel proud to pay our special regards to our project advisor" **Assoc. Prof. Dr. ADNAN KHASHMAN**". He never disappointed us in any affair. He delivered us a lot of information and did his best efforts to complete our project. We are really thankful to our doctor. As well as thanks to our electronic lab assistant ENG. KAMEL DIMILILER for his help. Not to forget to give our thanks to the NEAR EAST UNIVERSITY education staff especially to the electrical and electronic engineering doctors for their help to take this degree and to achieve this level.*

First of all we would like to thank our parents and pay special regards for guiding us through our studies and for enduring these all expenses and supporting us in all events. We are nothing without them. They also encouraged us in god. We shall never forget their sacrifices for our education so that we can enjoy our successful life as they are expecting.

We would like to thank all persons especially for group 2003, to all the people who helped us complete this project might.

At the end, we will never forget the days that we have been in Cyprus, from the University to the good friends from all around the world that we have enjoyed during our studying period with them. We would like to thank them for their kindness in helping us to complete our project.

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INTRODUCTION

The radio design uses simple technology that is being used widely in the communication sector, without it the most basic communication would not have been possible. The whole world is covered by radio waves and signals holding millions of transmissions which are received by an uncountable number of people.

Radios gives us the opportunity to keep up to date and connected with the latest news, music and almost anything out there, it is unimaginable to live without it, radios has become an essential part of our life

The purpose of this project is to design, build and test a FM radio circuit and audio amplifier with its basic elements.

Chapter one will present components which will be used in building the circuit of the radio. Their characteristics, properties and functions will also be discussed. Also safety guidelines, which must be kept in mind when working on electronic projects, will be described.

Chapter two will present frequencies which are used in radio and other purposes are described of course FM transmission is included; differences and applications are also mentioned.

Chapter three will present in detail the operation of the circuit, starting with the input and how it is processed, through each component until it is ready to leave the circuit as a sound.

Chapter four will present the most probable problems counted, and also will indicate a suitable solution for each problem.

CHAPTER ONE

ELECTRONIC COMPONENTS

1.1 Overview

This chapter includes an introduction to electronic components that are commonly used in hardware projects like some semiconductors, capacitors and resistors. Additionally safety guidelines for electronic projects will be presented.

1.2 Introduction to Electronic 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 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:

20R = 20 ohms
20k = 20 kilo ohms = 20 000 ohms
5k5 = 5.5 kilo ohms = 5 500 ohms

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

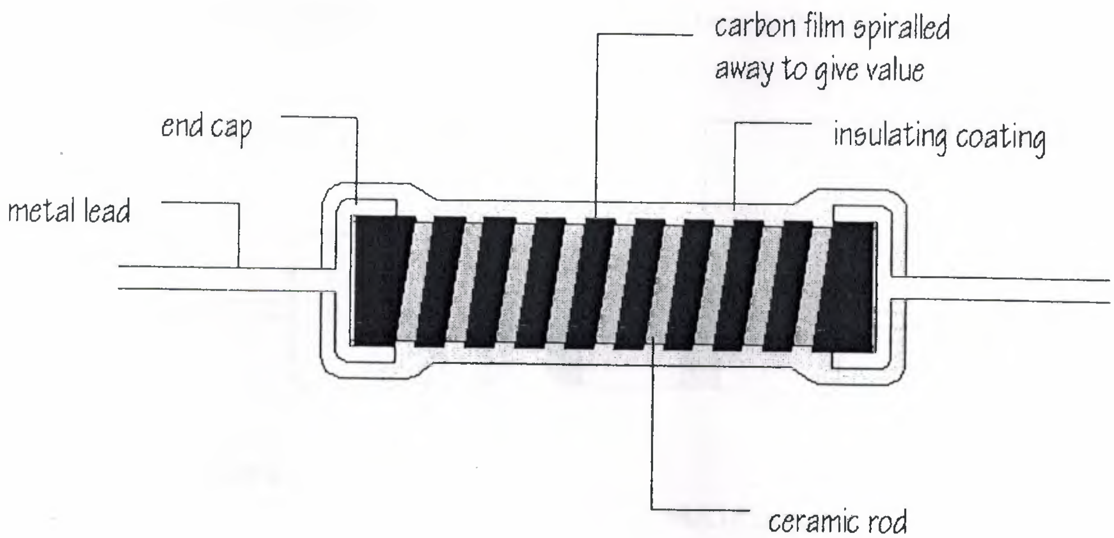


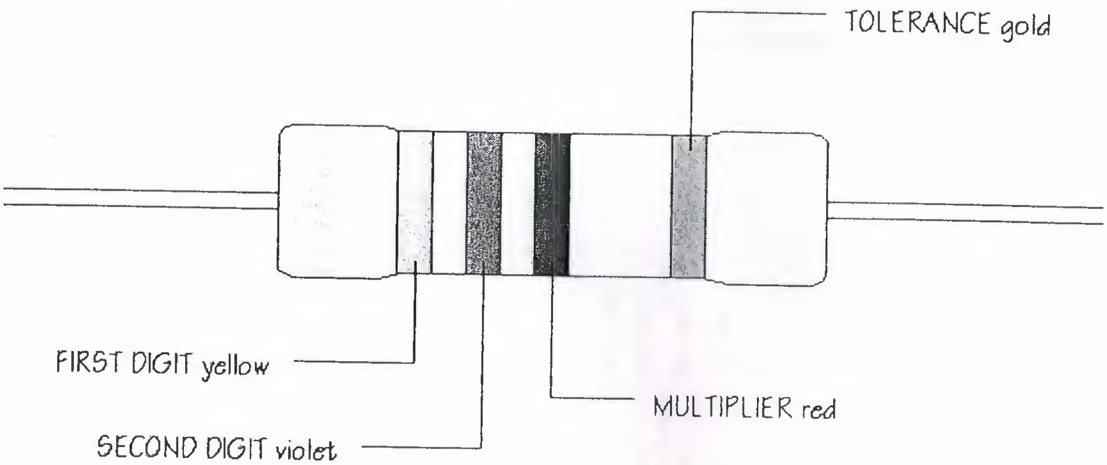
Figure 1.1: The diagram shows the construction of a carbon film resistor [3].

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 MultiMate's, 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 kilo Ohms.



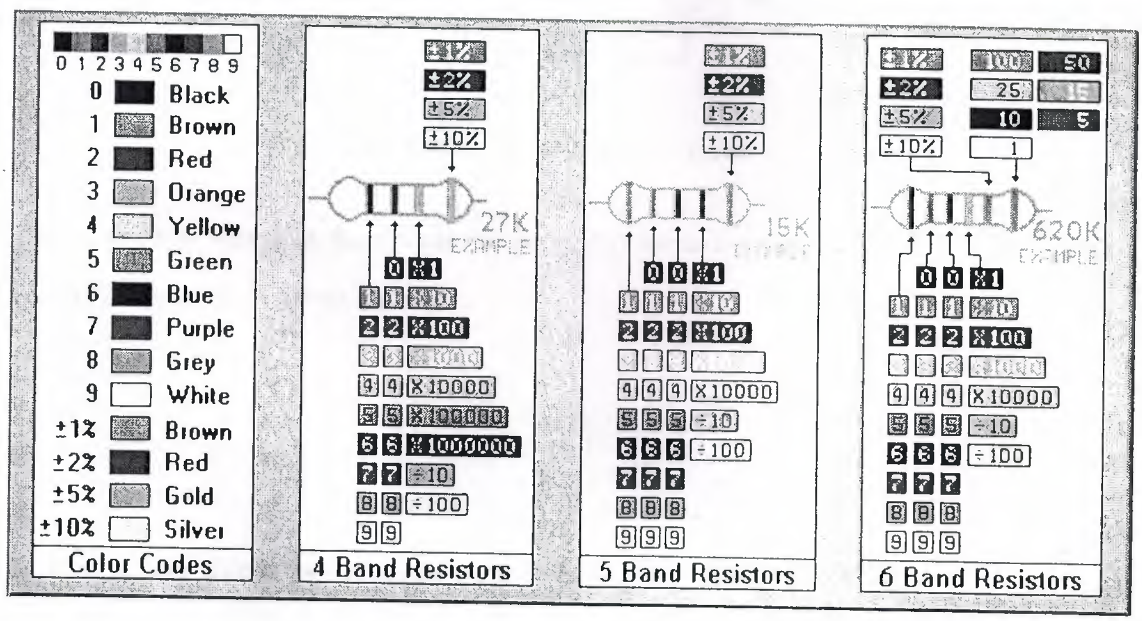


Figure 1.2: Color code identification [4].

While these codes are most often associated with resistors, and 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, and 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:

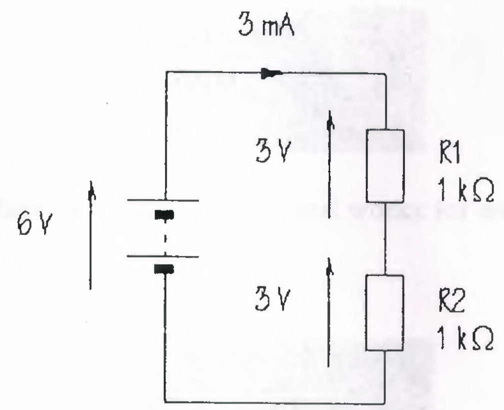


Figure 1.3: Resistors in series.

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:

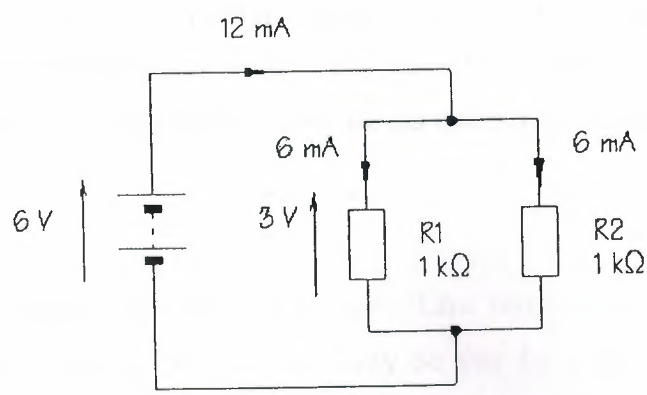


Figure 1.4: Resistors in parallel.

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

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

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

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

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 flow 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.

The 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 plates have bigger capacitance. To stop capacitors becoming impractically large however they are often rolled up like Swiss rolls.

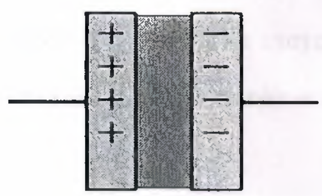


Figure 1.5: Capacitor contains

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 "µ" 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.

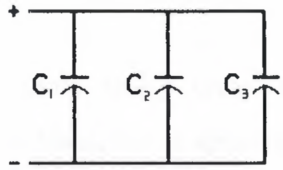
When a capacitor is connected to a battery it begins to charge. The current flows rapidly at first. Charge builds up on the two plates, negative charge on one plate and the same amount of positive charge on the other. The positive charge results from electrons leaving one of the plates and leaving positively-charged 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.

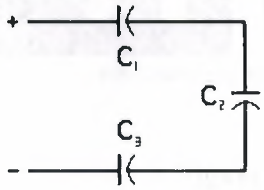
An alternating current (A.C.) however can flow through a capacitor. An alternating current is one which is continually changing its direction. Mains are A.C. and change its direction 50 times a second. An alternating current continually charges and discharges a capacitor and hence is able to keep flowing.

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.



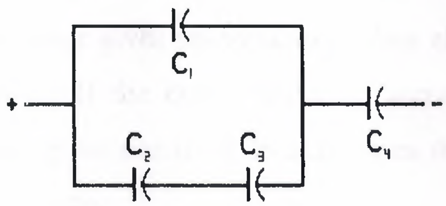
$$C = C_1 + C_2 + C_3$$

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

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.

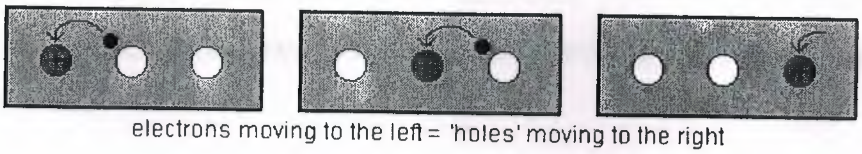


Figure 1.7: Moving of electrons.

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).

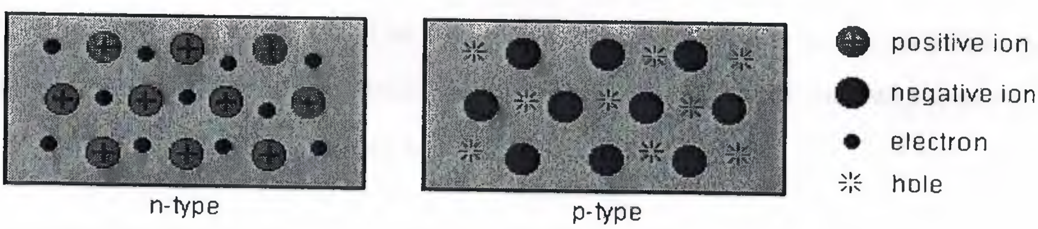


Figure 1.8: The tow types of semiconductors.

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.

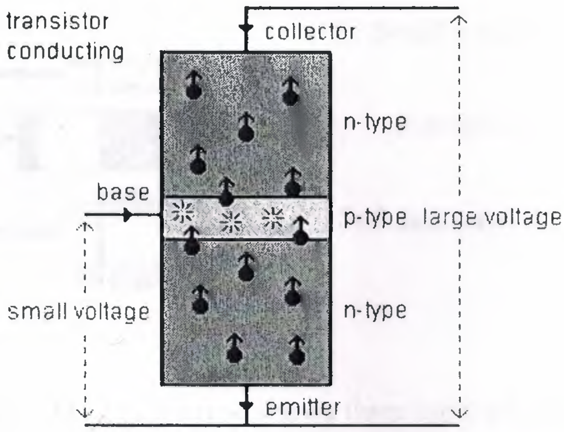
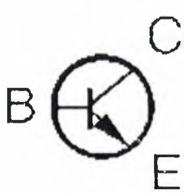


Figure1.9: Transistor conducting.

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.

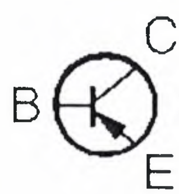


Figure 1.10: The difference between PNP and NPN transistors.

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.

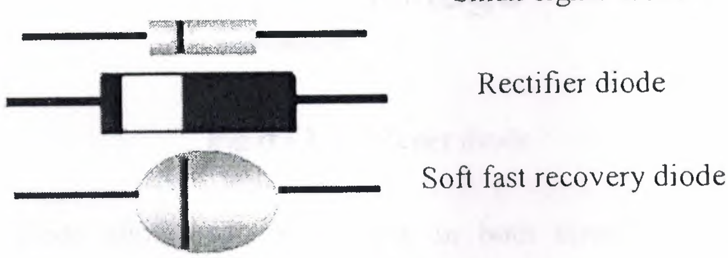


Figure 1.11: The picture shows three types of diodes.

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:

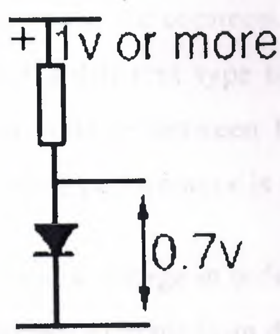


Figure 1.12: A diode forward voltage drop.

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.

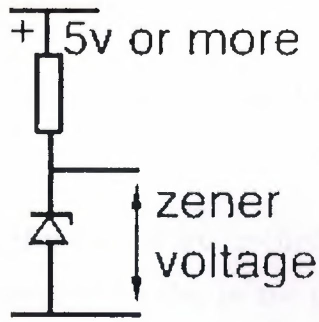


Figure 1.13: Zener diode

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.

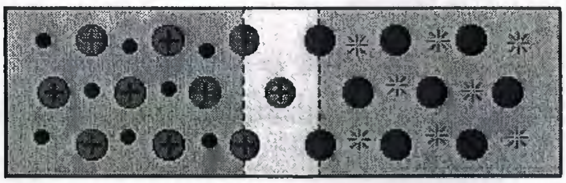


Figure 1.14: Depletion layer.

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.

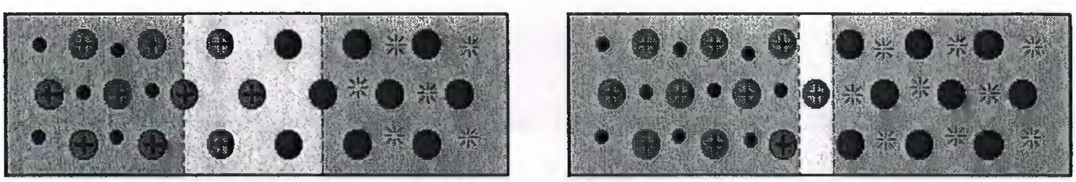


Figure 1.15: Reducing the depletion layer.

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.

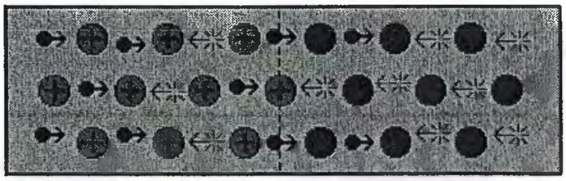


Figure 1.16: Diode conducting.

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 LM380N

The LM380N is a power audio amplifier for consumer application, in order to hold system cost to a minimum, gain is internally fixed at 34 dB.

A unique input stage allows inputs to be ground referenced. The output is automatically self centering to one half the supply voltages; the output is short circuit proof with internal thermal limiting.

The package outline is standard dual-in-line. A copper lead frame is used with the center three pins on either side comprising a heat sink. This makes the device easy to use in standard p-c layout.

Uses include simple phonograph amplifiers, intercoms, line drivers, teaching machine outputs, alarms, ultrasonic drivers, TV sound systems, AM-FM radio, small servo drivers, and power converters.

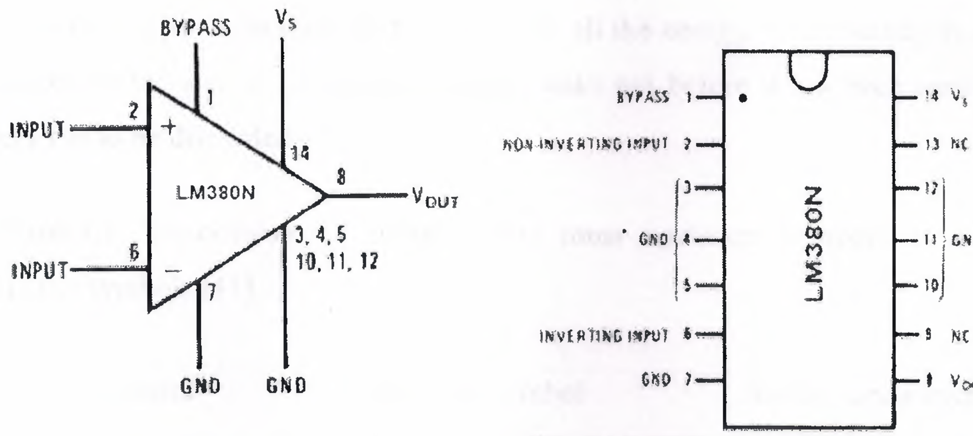


Figure 1.17: IC_LM380N form.

1.2.5 Batteries

Battery is electric device that converts chemical energy into electrical energy, consisting of a group of electric cells that are connected to act as a source of direct current.

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.

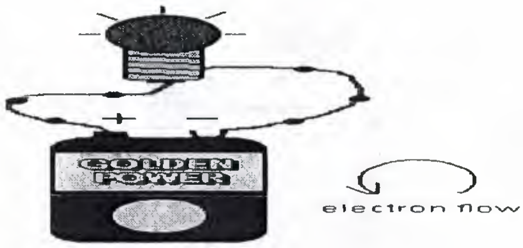
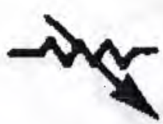
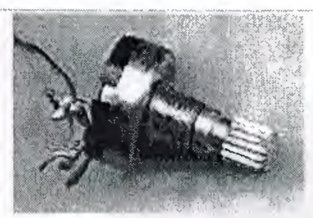
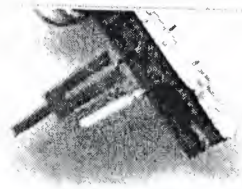
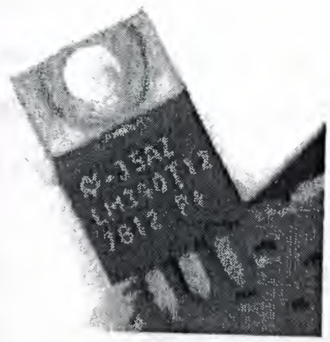
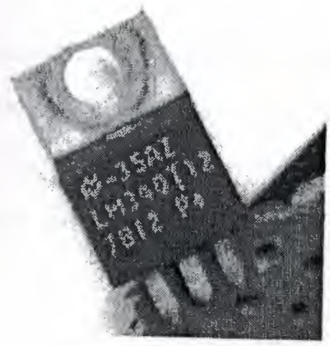


Figure 1.18: Battery

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.

Table1.1: Description of some of the most common components and their schematic symbols [11].

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 Guidelines

1- Be careful with the polarities of the power source (battery) when we connect it in any circuit.

2- Read and apply the data sheet of any electrical instrument before using it in the circuit.

3- Be careful with electrical components (capacitors, resistors and led) not to break them.

4- Be careful with chip pins (IC380N) when we plant them in the board not to break them.

5- Be careful with the arrangement of the transistor pins (base, emitter, and collector) not to break and mix them which cause damage to the transistor.

6- Discharge capacitors in equipment before working on the circuits, because large capacitors found in many laser flash lamps and other systems are capable of storing lethal amounts of electrical energy and pose a serious danger even if the power source has been disconnected.

7- Be careful when shifting probes in a live/active circuit; be sure to shift using only one hand: It is best to keep the other hand off other surfaces and behind your back.

8- When you are working on a design project and planning to work for higher voltage equal to or greater than 50 volts, notify your instructor and obtain their approval before proceeding.

9- Be careful with the power source to turn it off after we finished using it.

1.4 Summary

This chapter presented an introduction to electronic components that are commonly used in hardware projects and how they function and how they must be connected. By applying the safety guidelines, the circuit should work smoothly.

CHAPTER TWO

RADIO WAVE PROPAGATION AND ITS FRQUENCIES

2.1 Overview

This chapter describes the propagation of radio waves and the effect of atmosphere layers on it, how a radio wave travels and the types of propagation. As this chapter presents classifications of frequencies which are used in radio and other purposes, and describe of course FM and AM modulation, differences and application will also be mentioned.

2.2 Electromagnetic Waves and Radio Propagation

Radio waves are a form of electromagnetic wave and obey the basic laws that govern this type of wave. In order to understand how radio waves propagate it is necessary to look at the basic properties of electromagnetic waves and also the medium in which they travel, i.e. the atmosphere.

Radio signals exist as a form of electromagnetic wave. These radio signals are the same form of radiation as light, ultra-violet, infra-red, etc., differing only in the wavelength or frequency of the radiation.

Electromagnetic waves have two elements. They are made from electric and magnetic components that are inseparable. The planes of the fields are at right angles to each other and to the direction in which the wave is traveling as in figure 2.1.

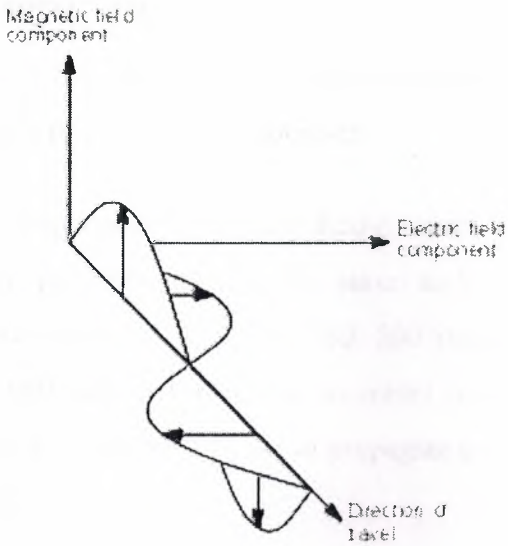


Figure 2.1 An electromagnetic wave

It is useful to see where the different elements of the wave emanate from to gain a more complete understanding of electromagnetic waves. The electric component of the wave results from the voltage changes that occur as the antenna element is excited by the alternating waveform. The lines of force in the electric field run along the same axis as the antenna, but spreading out as they move away from it. This electric field is measured in terms of the change of potential over a given distance, e.g. volts per meter, and this is known as the field strength. This measure is often used in measuring the intensity of an electromagnetic wave at a particular point. The other component, namely the magnetic field is at right angles to the electric field and hence it is at right angles to the plane of the antenna. It is generated as a result of the current flow in the antenna.

Like other forms of electromagnetic wave, radio signals can be reflected, refracted and undergo diffraction. In fact some of the first experiments with radio waves proved these facts, and they were used to establish a link between radio waves and light rays.

2.2.1 Wavelength, Frequency and Velocity

There are a number of basic properties of electromagnetic waves, or any repetitive waves for that matter that are particularly important.

One of the first that is quoted is their speed. Radio waves travel at the same speed as light. For most practical purposes the speed is taken to be 300 000 000 meters per second although a more exact value is 299 792 500 meters per second. Although exceedingly fast, they still take a finite time to travel over a given distance. With modern radio techniques, the time for a signal to propagate over a certain distance needs to be taken into account.

Another major element of a radio wave is its wavelength. This is the distance between a given point on one cycle and the same point on the next cycle as shown in figure 2.2.The easiest points to choose are the peaks as these are the easiest to locate.

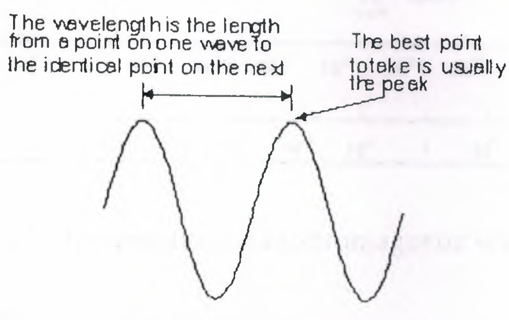


Figure 2.2 Wavelength of an electromagnetic wave

Finally the frequency of a radio signal or electromagnetic wave is of great importance. This is the number of times a particular point on the wave moves up and down in a given time (normally a second). The unit of frequency is the Hertz and it is equal to one cycle per second. This unit is named after the German scientist who discovered radio waves. The frequencies used in radio are usually very high. Accordingly the prefixes kilo, Mega, and Giga are often seen. 1 kHz is 1000 Hz, 1 MHz is a million Hertz, and 1 GHz is a thousand million Hertz i.e. 1000 MHz. Originally the unit of frequency was not given a name and cycles per second (c/s) were used.

2.2.2 Electromagnetic and the Radio Spectrum

Electromagnetic waves and the radio spectrum have an enormous range, and as a result it is very convenient to see where each of the different forms of radiations fits within the spectrum as a whole. It can be seen that radio signals have the lowest frequency, and hence the longest wavelengths. Above the radio spectrum, other forms of radiation can be found. These include infra red radiation, light, ultraviolet and a number of other forms of radiation as shown in figure 2.3.

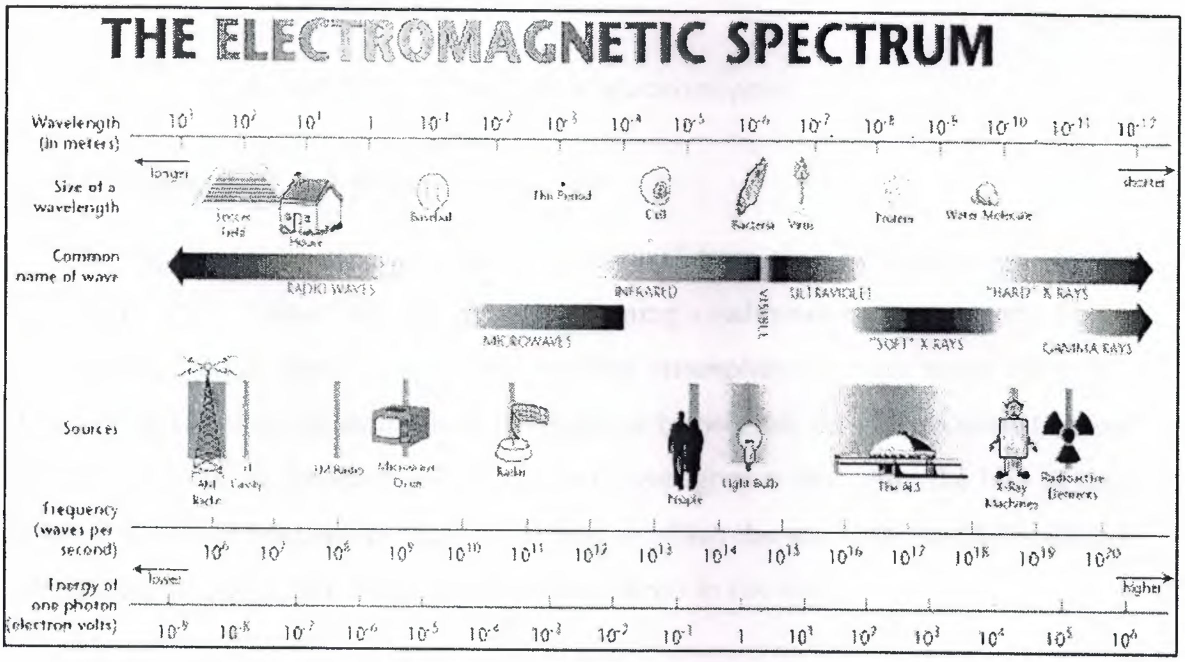


Figure 2.3 The spectrum of electromagnetic waves [9]

Even within the radio spectrum there is an enormous range of frequencies. It extends over many decades. In order to be able to categorize the different areas and to split the spectrum down into more manageable sizes, the spectrum is split into different segments as shown in figure 2.4.

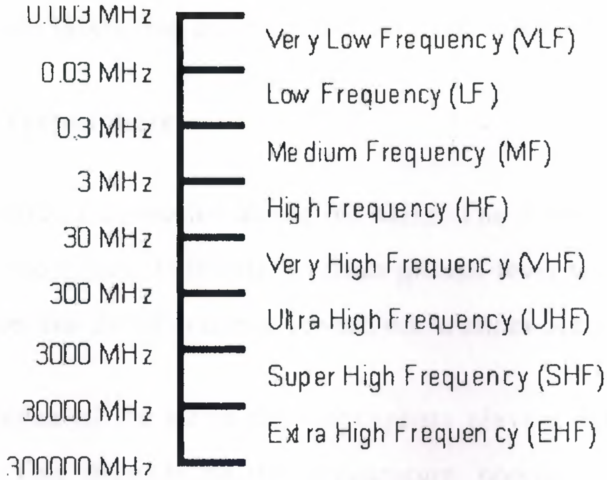


Figure 2.4 The spectrum of electromagnetic waves

2.3 The Atmosphere and Radio Propagation

The way that radio signals propagate, or travel from the radio transmitter to the radio receiver is of great importance when planning a radio network or system. This is governed to a great degree by the regions of the atmosphere through which they pass. Without the action of the atmosphere it would not be possible for radio signals to travel around the globe on the short wave bands, or travel greater than only the line of sight distance at higher frequencies. In fact the way in which the atmosphere effects radio is of tremendous importance for anyone with an interest in the topic.

2.3.1 Layers of the Atmosphere

The atmosphere can be split up into a variety of different layers according to their properties. As different aspects of science look at different properties there is no single nomenclature for the layers. The system that is most widely used is that associated with. Lowest is the troposphere that extends to a height of 10 km. Above this at altitudes between 10 and 50 km is found the stratosphere. This contains the ozone layer at a height of around 20 km. above the stratosphere, there is the mesosphere extending from an altitude of 50 km to 80 km, and above this is the thermosphere where temperatures rise dramatically.

There are two main layers that are interest from a radio viewpoint.

- **The first is the Troposphere**

That tends to affect frequencies above 30 MHz. The lowest of the layers of the atmosphere is the troposphere. This extends from ground level to an altitude of 10 km. It is within this region that the effects that govern our weather occur.

The refractive index of the air in the troposphere plays a dominant role in radio signal propagation. This depends on the temperature, pressure and humidity. When radio signals are affected this often occurs at altitudes up to 2 km.

- **The second is the Ionosphere**

The ionosphere is an area where there is a very high level of free electrons and ions. It is found that the free electrons affect radio waves. Although there are low levels of ions and electrons at all altitudes, the number starts to rise noticeably at an altitude of around 30 km. However it is not until an altitude of approximately 60 km is reached that rises to a sufficient degree to have a major effect on radio signals.

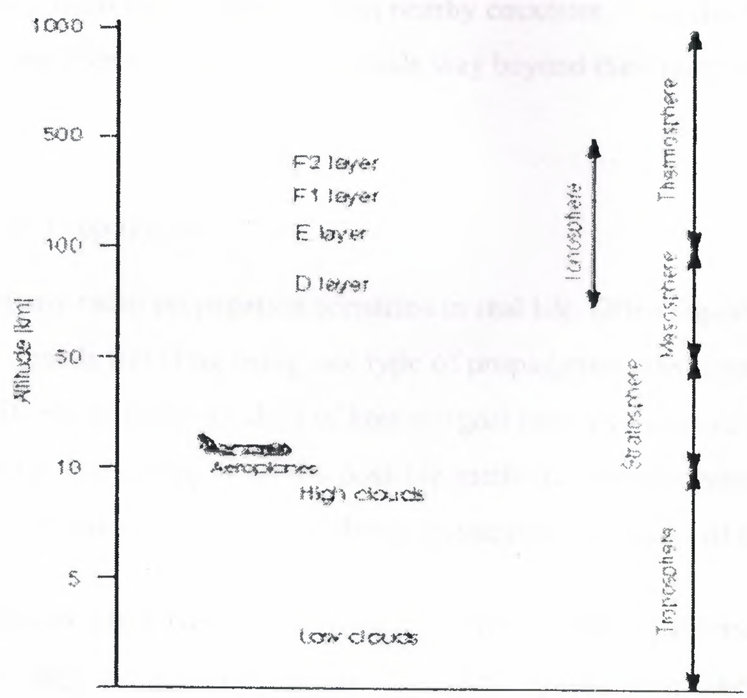


Figure 2.5 Regions of the Atmosphere

This is region which crosses over the boundaries of the meteorological layers and extends from around 60 km up to 700 km. Here the air becomes ionized, producing ions and free electrons. The free electrons effect radio waves at certain frequencies, often bending them back to earth so that they can be heard over vast distances around the world as the figure above 2.5

2.4 How a Radio Wave Travels

All radio signals will have their own coverage area. The coverage area of a radio transmitter will depend on several things like how much power is being transmitted from the antenna, and the terrain around the transmitter - hilly or mountainous ground will restrict signals coverage. Within the coverage area, the signal will be strong and easy to receive. Moving further away from the transmitter will result in the signal getting weaker and reception is degraded. On a stereo FM station for instance the signal will become noisy. On a television picture there will be a snowy appearance and perhaps a loss of color.

The weather can play a big part in reception. Yet even an object as far away as the sun, over 93 million miles away from the earth, can affect the way radio signals behave. Signals can travel further over sea paths and this is why people at coastal locations may be able to receive radio or TV stations from nearby countries. Even the trails of meteors in the night sky are able to bounce radio signals way beyond their normal coverage area.

2.5 Radio Signal Propagation

There are many radio propagation scenarios in real life. Often signals may travel by several means, signals traveling using one type of propagation interacting with another. However to build up an understanding of how a signal reaches a receiver, it is necessary to have a good understanding of all the possible methods. By understanding these, the interactions can be better understood and by understanding the layers of the atmosphere.

Radio signals are affected in many ways by objects in their path and by the media through which they travel. This means that radio signal propagation is of vital importance to anyone designing or operating a radio system. The properties of the path by which the radio signals will propagate governs the level and quality of the received signal. Reflection, refraction and diffraction may occur.

The resultant signal may also be a combination of several signals that have traveled by different paths. These may add constructively or destructively, and in addition to this the signals traveling via different path may be delayed causing distorting of the resultant signal. It is therefore very important to know the likely radio propagation characteristics that are likely to prevail.

2.5.1 Radio Propagation Categories

There are a number of categories into which different types of radio propagation can be placed. These relate to the effects of the media through which the signals propagate.

- **Free Space Propagation**

Here the radio signals travel in free space, or away from other objects which influence the way in which they travel. It is only the distance from the source which affects the way in which the field strength reduces. This type of radio propagation is encountered with signals traveling to and from satellites.

- Ground Wave Propagation

When signals travel via the ground wave they are modified by the ground or terrain over which they travel. They also tend to follow the earth's curvature. Signals heard on the medium wave band during the day use this form of propagation.

- **Ionosphere Propagation**

Here the radio signals are modified and influenced by the action of the free electrons in the upper reaches of the earth's atmosphere called the ionosphere. This form of radio propagation is used by stations on the short wave bands for their signals to be heard around the globe.

- **Troposphere Propagation**

Here the signals are influenced by the variations of refractive index in the troposphere just above the earth's surface. Troposphere radio propagation is often the means by which signals at VHF and above are heard over extended distances.

2.6 Radio Frequencies

Radio frequency, or RF, refers to that portion of the electromagnetic spectrum in whi(electromagnetic waves can be generated by alternating current fed to an antenna. Such frequenci(account for the following parts of the spectrum as shown in the table 2.1.

Table 2.1 Radio Frequency Classification

Frequency	Band Number	Classification	Abbreviation
3 - 30 Hz	1	Extremely Low Frequencies	ELF
30 - 300 Hz	2	Super low frequency	SLF
300 - 3000 Hz	3	Ultra Low Frequencies	ULF
3 - 30 KHz	4	Very Low Frequencies	VLF
30 - 300 KHz	5	Low Frequencies	LF
300 - 3000 KHz	6	Medium Frequencies	MF
3 - 30 MHz	7	High Frequencies	HF
30 - 300 MHz	8	Very High Frequencies	VHF
300 - 3000 MHz	9	Ultra High Frequencies	UHF
3 - 30 GHz	10	Super High Frequencies	SHF
30 GHz -- 300 GHz	11	Extremely High Frequency	EHF

ELF is only used by some submarines and to carry AC over power lines. Otherwise, its main use is of course to carry the sound of low and mid frequencies as well infrasonic vibrations (animals).

VLF is also the carrier of sound up to about 20 kHz. This band is also used for long distance communications (few thousands km) and experimentation by scientists and the Navy.

LF is mainly used for regional broadcasting purposes while MF is used for worldwide broadcasting. HF are of our concern, these are formerly frequencies ranging from 1.8 to 30 MHz (160-10 m bands). Know as "short waves", these bands are very appreciated by all radio services and operators as they allow long distance communications, broadcasting and Tran's horizon radar operations.

VHF and UHF begin at 30 MHz (10 m) to end well above 1 GHz and are mainly used for radio and TV broadcasting as well as mobile communications over short distances (a few hundreds km) and more recently by cell phones.

2.7 Modulation

Modulation is the process of varying a carrier signal in order to use that signal to convey information. The three key parameters of a sinusoid are its amplitude, its phase and its frequency, all of which can be modified in accordance with an information signal to obtain the modulated signal.

There are several reasons to modulate a signal before transmission in a medium. These include the ability of different users sharing a medium (multiple access), and making the signal properties physically compatible with the propagation medium. A device that performs modulation is known as a modulator and a device that performs the inverse operation of demodulation is known as a demodulator. A device that can do both operations is a modem (a contraction of the two terms).

In digital modulation, the changes in the signal are chosen from a fixed list (the modulation alphabet) each entry of which conveys a different possible piece of information (a symbol). The alphabet is often conveniently represented on a constellation diagram.

In analog modulation, the change is applied continuously in response to the data signal. The modulation may be applied to various aspects of the signal as the lists below indicate.

Modulation is generally performed to overcome signal transmission issues such as to allow

- Easy (low loss, low dispersion) propagation as electromagnetic waves
- Multiplexing — the transmission of multiple data signals in one frequency band, on different carrier frequencies.
- Smaller, more directional antennas Carrier signals are usually high frequency electromagnetic waves.

2.7.1 Frequency Modulation

FM is a form of modulation which represents information as variations in the instantaneous frequency of a carrier wave. (Contrast this with amplitude modulation, in which the amplitude of the carrier is varied while its frequency remains constant.) In analog applications, the carrier frequency is varied in direct proportion to changes in the amplitude of an input signal. Digital data can be represented by shifting the carrier frequency among a set of discrete values, a technique known as frequency-shift keying.

FM is commonly used at VHF radio frequencies for high-fidelity broadcasts of music and speech (see FM broadcasting). Normal (analog) TV sound is also broadcast using FM. A narrowband form is used for voice communications in commercial and amateur radio settings. The type of FM used in broadcast is generally called wide-FM, or W-FM. In two-way radio, narrowband narrow-fm (N-FM) is used to conserve bandwidth. In addition, it is used to send signals into space.

FM is also used at intermediate frequencies by most analog VCR systems, including VHS, to record the luminance (black and white) portion of the video signal. FM is the only feasible method of recording video to and retrieving video from magnetic tape without extreme distortion, as video signals have a very large range of frequency components — from a few hertz to several megahertz, too wide for equalizers to work with due to electronic noise below -60 dB. FM also keeps the tape at saturation level, and therefore acts as a form of noise reduction, and a simple limiter can mask variations in the playback output, and the FM capture effect removes print-through and pre-echo. A continuous pilot-tone, if added to the signal — as was done on V2000 and many Hi-band formats — can keep mechanical jitter under control and assist time base correction.

FM is also used at audio frequencies to synthesize sound. This technique, known as FM synthesis, was popularized by early digital synthesizers and became a standard feature for several generations of personal computer sound cards.

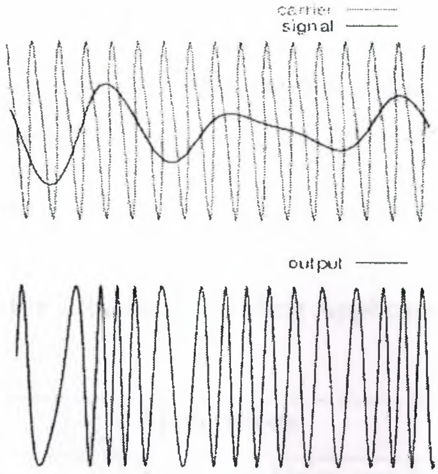


Figure 2.6 Frequency Modulation [9]

2.7.2 Amplitude Modulation.

AM is a form of modulation in which the amplitude of a carrier wave is varied in direct proportion to that of a modulating signal. (Contrast this with frequency modulation, in which the frequency of the carrier is varied; and phase modulation, in which the phase is varied.).

AM is commonly used at radio frequencies and was the first method used to broadcast commercial radio. The term "AM" is sometimes used generically to refer to the AM broadcast (medium wave) band.

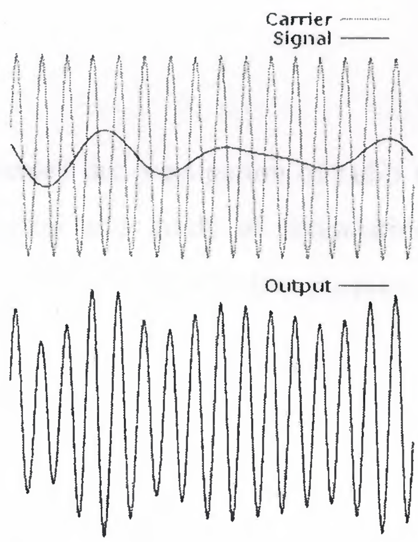


Figure 2.7 Amplitude Modulation [9]

2.8 Application

Each band of frequency has its own applications which are used in our life, these application are shown in table 2.2.

Table 2.2 Bands and their Applications

Band	Applications
X-rays	X-ray machines, sun flare
Extreme ultraviolet	UV, ionosphere ionization
Visible (red - violet)	Visible spectrum, light
Super High Frequency,	Microwaves, satellite
Ultra High Frequency	Microwaves, GSM
Very High Frequency	FM Radio, Television channels
High Frequency	SW Radio, Emergency services radio
Medium Frequency	AM Radio
Low Frequency	Beacons, AM, LW Radio
Very Low Frequency	Sound, Navy, geophysics
Extreme Low Frequency	Sound, power, Navy

2.9 Summary

This chapter presented the propagation of radio waves, how a radio wave travels, the types of propagation and kinds of modulations. Additional classifications of frequencies which are used in radio and other purposes were presented.

CHAPTER THREE

HARDWARE APPROACH

3.1 Overview

This chapter presents the components used in the circuit and the circuit diagram. The operation of each part of the circuit will be described.

3.2 Introduction

In the modern world of communications, the FM band that spreads between 88 and 108 MHz has an outstanding place. It is a quite interesting electromagnetic band to explore, especially if you explore this narrow band with a receiver that you have built yourself. In searching FM stations, you will experiment the sensation of surprise when you realize the great number of radio transmitters packed into the span dial of your receiver.

3.3 FM Circuit Diagram

To build an FM receiver, luckily enough, you don't have to resort to complicated super heterodyne systems with the bothering of intermediate frequency transformer alignments and other really difficult points to adjust. What you have is a handy special integrated circuit that solves all these problems and brings you a receiver of quick and easy construction....the TDA 7000 IC.

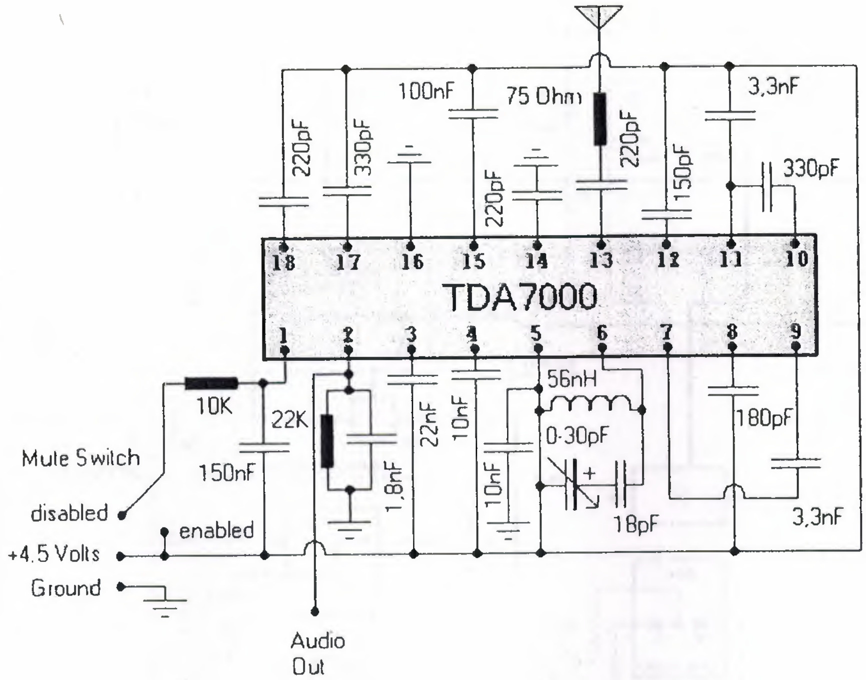


Figure 3.1 Circuit diagram of Fm Radio [14]

3.4 TDA7000 Structure

The TDA7000 which integrates a mono F.M. radio all the way from the aerial input to the audio output. This IC in itself is a complete super heterodyne receiver with all the problems of alignment previously solved by the constructing engineers. It's consists of a local-oscillator and a mixer, a two-stage active if. Filter followed by an I.F. Limiter/amplifier, a Quadrate FM. Demodulator, and an audio Muting circuit controlled by an I.F. wave form correlate. As shown in figure 3.2.

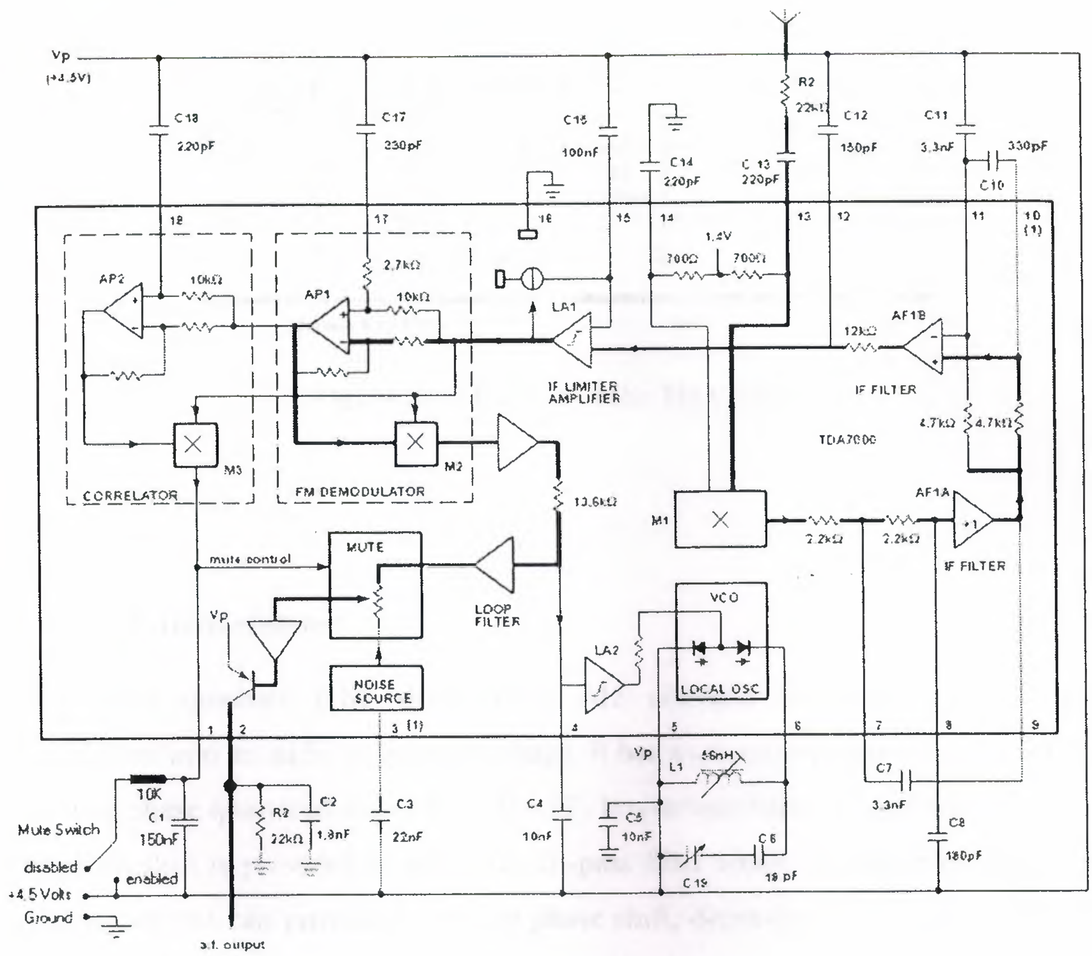


Figure 3.2 TDA7000 [16]

3.4.1 Active I.F. Filter

The first section of the I.F. filter (AFIA) is a second-order low-pass Sullen-Key circuit with its cut-off frequency determined by internal 2.2 k resistors and external capacitors C7 and C8. The second section (AFIB) consists of a first-order band pass filter with the lower limit of the pass band determined by an internal 4.7 K ohm resistors and external capacitor C11. The upper limit of the pass band is determined by an internal 4.7 K.ohm resistors and external capacitor C10. The final section of the I.F. filter consists of a first-order low-pass network comprising an internal 12 K resistor and external capacitor C12. The overall I.F. filter therefore consists of a fourth-order low-pass section and a first-order high-pass section.

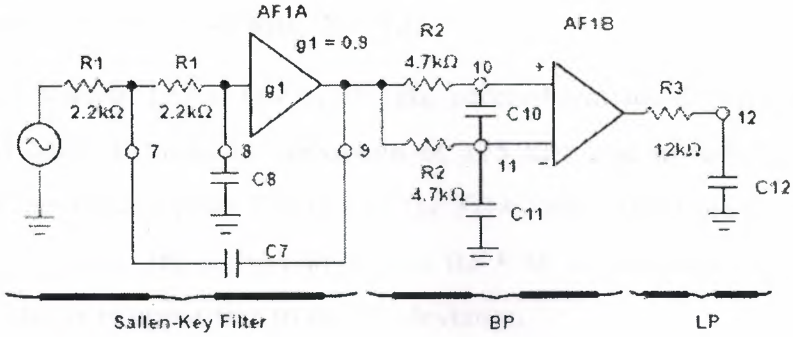


Figure 3.3 I.F Filter of the TDA7000 [17]

3.4.2 F.M. Demodulator

The quadrate F.M. demodulator M2 converts the I.F. variations due to modulation into an audio frequency voltage. It has a conversion gain of -3.6 V/MHz and requires phase quartered inputs from the I.F. limiter/amplifier. As shown in Fig.3.4, the 90' phase shift is provided by an active all-pass filter which has about unity gain at all frequencies but can provide a variable phase shift, dependent on the value of external capacitor C 17.

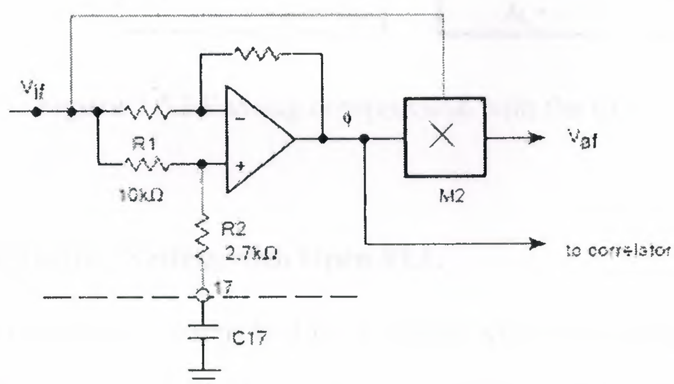


Figure 3.4 F.M. demodulator phase shift circuit all pass filter

3.4.3 I.F. Swing Compression with the FLL

With a nominal I.F. as low as 70 kHz, severe harmonic distortion of the audio output would occur with an I.F. deviation of ±75 kHz due to full modulation of a received F.M. broadcast signal. The FLL of the TDA7000 is therefore used to compress the I.F. swing by using the audio output from the F.M. demodulator to shift the local-oscillator frequency in opposition to the I.F. deviation.

The principle is illustrated in Fig.3.5, which shows that an I.F. deviation of 75 kHz is compressed to about 15 kHz. The THD is thus limited to 0.7% with ±22.5 kHz modulation, and to 2.3% with ±75 kHz modulation.

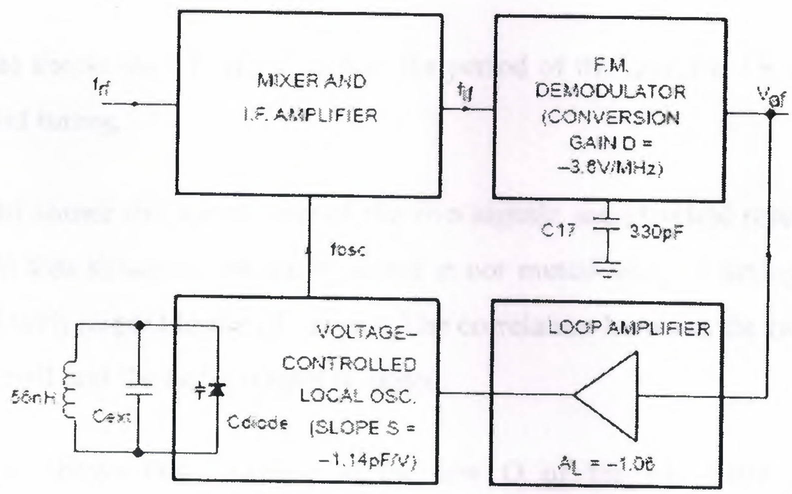


Figure 3.5 I.F swing compression with the FLL

3.4.4 Correlation Muting System with Open FLL

The muting system is controlled by a circuit which determines the correlation between the waveform of the I.F. signal and an inverted version of it which is delayed (phase shifted) by half the period of the nominal if. (180°). A noise generator works in conjunction with the muting system to give an audible indication of incorrect tuning.

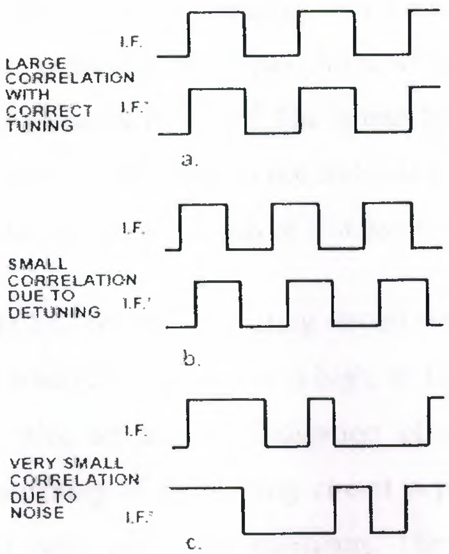


Figure 3.6 Function of the correlation muting system

Fig.3.6 (a) shows the I.F. sepal by half the period of the nominal I.F. and inverting it. With correct tuning.

Fig.3.6 (b) shows the waveforms of the two signals are identical resulting in large correlation. In this situation, the audio signal is not muted with de tuning signal IF' is phase-shifted with respect to the I.F. signal. The correlation between the two waveforms is therefore small and the audio output is muted.

Fig.3.6 (c) shows that, because of the low Q of the I.F. filter, noise causes considerable fluctuations of the period of the I.F. signal waveform. There is then small correlation between the two waveforms and the audio is muted.

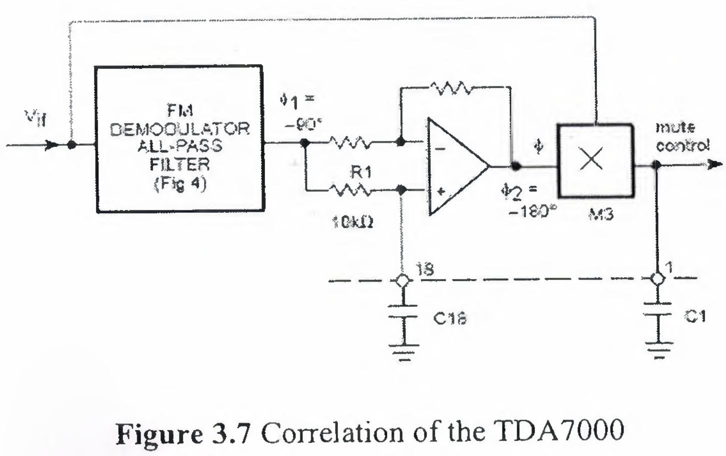


Figure 3.7 Correlation of the TDA7000

As shown in Fig.3.7. The correlation muting circuit consists of all-pass filter AP2 connected in series with fm. demodulator all-pass filter AP1 and adjusted by an external capacitor to provide a total phase shift of 180°. The output from AP2 is applied to mixer M3 which determines the correlation between the undeleted limited I.F. signal at one of its inputs and the delayed and inverted version of it at its other input.

The output from mixer M3 controls a muting circuit which feeds the demodulated audio signal to the output when the correlation is high, or feeds the output from a noise source to the output to give an audible indication of incorrect tuning when the correlation is low. The switching of the muting circuit is progressive (soft muting) to prevent the generation of annoying audio transients. The output from mixer M3 is available externally at pin 1 and can also be used to drive a detuning indicator.

3.4.5 Components' List

In the first chapter we described the components and the practical use of each one were given, but in this section, the value, type and the job for each component, is shown in Table 3.1.

Table 3.1 FM Radio Component

Symbol	Value	The functions of the peripheral components of Figure 3.2
C1	150nF	Determines the time constant required ensuring muting of Audio transients due to the operation of the FLL.
C2	1.8nF	Together with R2 determines the time constant for audio de-emphasis
C3	22nF	The output level from the noise generator during muting Increases with increasing value of C3.
C4	10nF	Capacitor for the FLL filter. It eliminates IF harmonics at the Output of the FM demodulator. It also determines the time constant For locking the FLL and influences the frequency response.
C5	10nF	Supply decoupling capacitor which must be connected as close as possible to Pin 5 of the TDA7000
C6	18pF	depend on the required tuning range and on the value of tuning capacitor C20
C7,C9	3.3nF	Filter and demodulator capacitors. The values shown are for an IF of 70kHz.
C10	330pF	The upper limit of the pass band is Determined by an internal 4.7kΩ resistor and external capacitor C10.
C11	3.3nF	The second section (AF1B) consists of a first-order band pass filter with the lower limit of the pass band determined by an internal 4.7kΩ resistor and external capacitor C11
C12	150pF	The final section of the IF filter consists of a first-order low-pass Network comprising an internal 12kΩ resistor and capacitor C12.
C13	220pF	It give RF band pass filter its values
C14	220pF	Same job of c7
C15	100nF	Decouples the DC feedback for IF limiter/amplifier LA1.
C17	330pF	Decouples the reverse RF input. It must be connected to the common return via a good quality short connection to ensure a Low-impedance path. Inductive or capacitive coupling between C14 and the local oscillator circuit or IF output components must be Avoided.
C18	220pF	Decouples the DC feedback for IF limiter/amplifier LA1.
C19	0-30pF	Turning capacitor
R2	22K	The load for the audio output current source. It determines the audio output level, but its value must not exceed 22kΩ for VCC = 4.5V, or 47kΩ for VCC = 9V.
L1	56nh	The values given are for an RF band pass filter
R1	10K	It give RF band pass filter its values

3.5 Summary

This chapter has presented the circuit design and components used in the circuit and the circuit diagram, the operation of each part of the circuit have also been described.

But it is not guaranteed 100 % to work properly using exactly the theoretical way of connection as described, because practical work has very different circumstances than theoretical one, and so many problems may occur. Chapter four will discuss the most problems probable to happen and it presents some suggested solutions.

CHAPTER FOUR

PROBLEMS & SOLUTIONS

4.1 Overview

This chapter presents the problems that we have faced in this project and solutions we used. The radio should work properly now, on the other hand, in practical electronic hardware projects there will always be problems and probable solutions.

4.2 Electrical Components

In chapter one information about electronics components where discussed but in this chapter there are new components that has been used on the hardware of the FM radio.

4.2.1 LM 386 IC

As mentioned in chapter one we are going to use LM380 (14 pins) to amplifier the audio gain from the FM circuit, But it's not available here (in Cyprus). So we found that the best alternative IC is LM386 and its work properly.

The LM386 is a power amplifier designed for use in low voltage consumer applications. The gain is internally set to 20 to keep external part count low, but the addition of an external resistor and capacitor between pins 1 and 8 will increase the gain to any value from 20 to 200.

The inputs are ground referenced while the output automatically biases to one-half the supply voltage. The quiescent power drain is only 24 mill watts when operating from a 6 volt supply, making the LM386 ideal for battery operation.

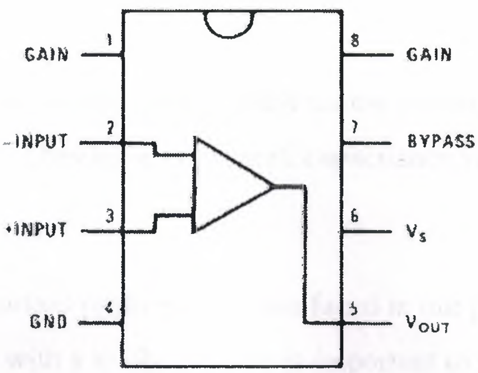


Figure 4.1 Top view of LM380 IC [18]

There are different types of connection for LM380 but the schematic that had been chosen is the best for FM audio gain and less noise. As shown in Fig. 4.2

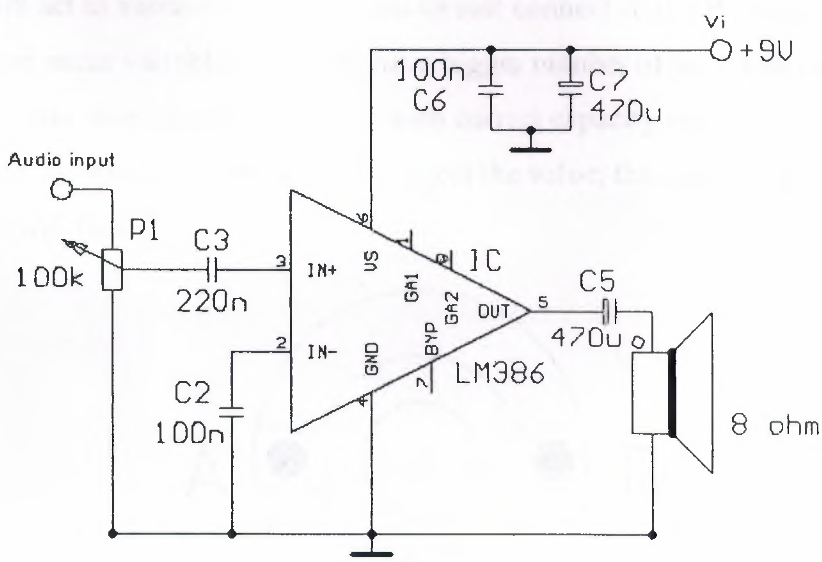


Figure 4.2 Audio Amplifier Circuits [18]

4.2.2 Variable Capacitor

Variable capacitors are mostly used in radio tuning circuits and they are sometimes called 'tuning capacitors'. They have very small capacitance values, typically between 100pF and 500pF.

One of the most important problems that we faced in our project that the variable capacitor does not come with a knob. A knob is important to keep your hand away from the capacitor and coil when you tune in stations.

The second problem was how to determine which two of the three lead-out pins will be connected, variable capacitors designed to be facilitated in two ways, first it can be used as fixed value capacitor (normal capacitor), it will be in the maximum value of possible capacitance for this capacitor, and the other way, it can be used as variable one, but how to make it function in the way needed?

As shown in Fig. 4.3 which shows variable capacitor from below, if pin A or pin B are connected to the source voltage (or positive side) and pin C connected to earth, the capacitor will act as variable capacitor, you cannot connect A and B to the same side in the same time, some variable capacitors have bigger number of pins with ranges of the capacity, to make sure which pair of pins with correct capacity value sought you can use trial and error by using an ammeter. The biggest the value; the bigger collection of radio channel you will find.

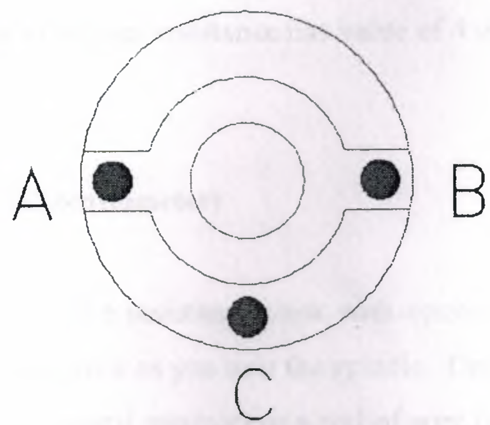


Figure 4.3 Bottom view of Variable Capacitor

4.2.3 Polarized Capacitors

Here, the problem while setting up the circuit is how to determine the positive and negative sides of the polarized capacitor. Polarized capacitors usually have a marker which indicates the polarity, but if there is no marker, how polarity can be decided?

Unfortunately, it is not possible by using ammeter or any other measuring instrument. So the solution is to observe the two lead-out pins, as it is shown in Fig. 4.4 it is clear that there is one pins is shorter than the other, shorter one is the negative one and the longer is the positive, and usually a dark line is placed a side of the negative pin.

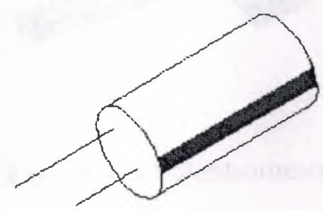


Figure 4.4 Polarized Capacitor

4.2.4 Loud Speaker

The problem we faced in the audio amplifier circuit that the required loud speaker with 8 ohms, but our speaker with 4 ohms resistance so to solve this problem we connected it in series with a constant resistance has value of 4 ohms.

4.2.5 Variable Resistors (Potentiometer)

Variable resistors consist of a resistance track with connections at both ends and a wiper which moves along the track as you turn the spindle. The track may be made from carbon, cermets (ceramic and metal mixture) or a coil of wire (for low resistances).

The track is usually rotary but straight track versions, usually called sliders, are also available. Variable resistors used as potentiometers have all three terminals connected.

This arrangement is normally used to vary voltage, for example to set the switching point of a circuit with a sensor, or control the volume (loudness) in an amplifier circuit.

If the terminals at the ends of the track are connected across the power supply then the wiper terminal will provide a voltage which can be varied from zero up to the maximum of the supply.

Figure 4.5 Potentiometer

4.3 Aerial

Radio station launches a radio wave by moving electric charges rhythmically up and down their antenna. As this electric charge accelerates back and forth, it produces a changing electric field a structure in space that pushes on electric charges and a changing magnetic field a structure in space that pushes on magnetic poles. Because the electric field changes with time, it creates the magnetic field and because the magnetic field changes with time, it creates the electric field. The two travel off across space as a pair, endlessly recreating one another in an electromagnetic wave that will continue to the ends of the universe. However, when this wave encounters the antenna of your radio, its electric field begins to push electric charges up and down on that antenna. Your radio senses this motion of electric charges and thus detects the passing radio wave.

The antenna that used in this project is very simple as clothes hook as shown in Fig 4.6

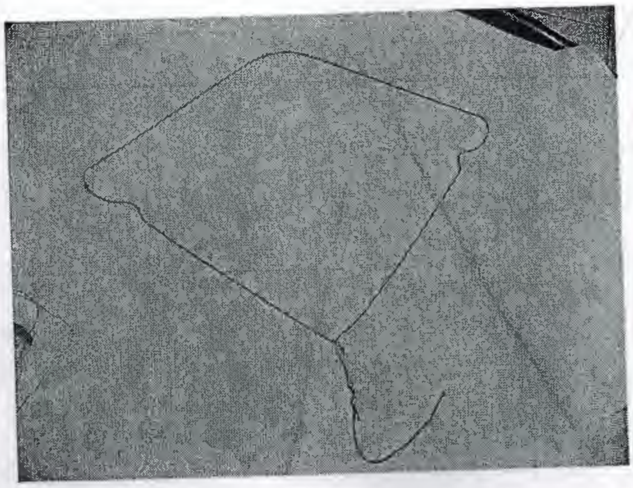


Figure 4.6 Antenna of FM circuit

4.4 FM Circuit

The photograph below shows the final result of FM radio circuit connected to amplifier.

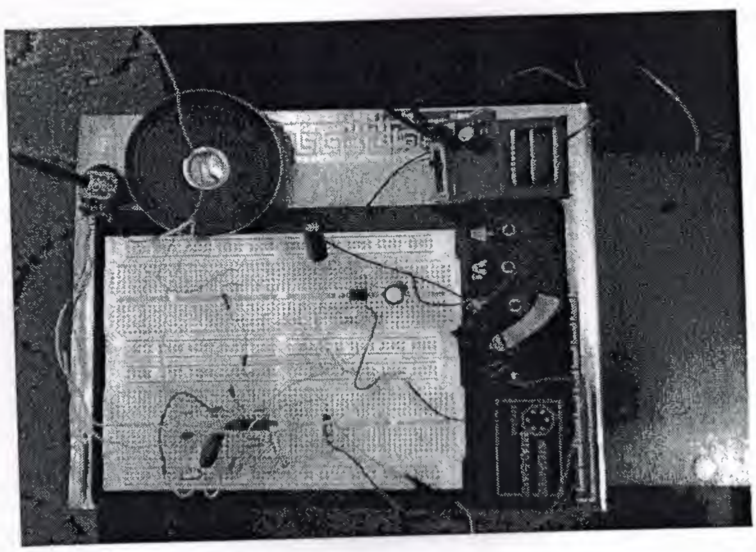


Figure 4.7 FM project photograph.

4.5 The Completed FM Radio

The photograph below shows the completed FM radio.

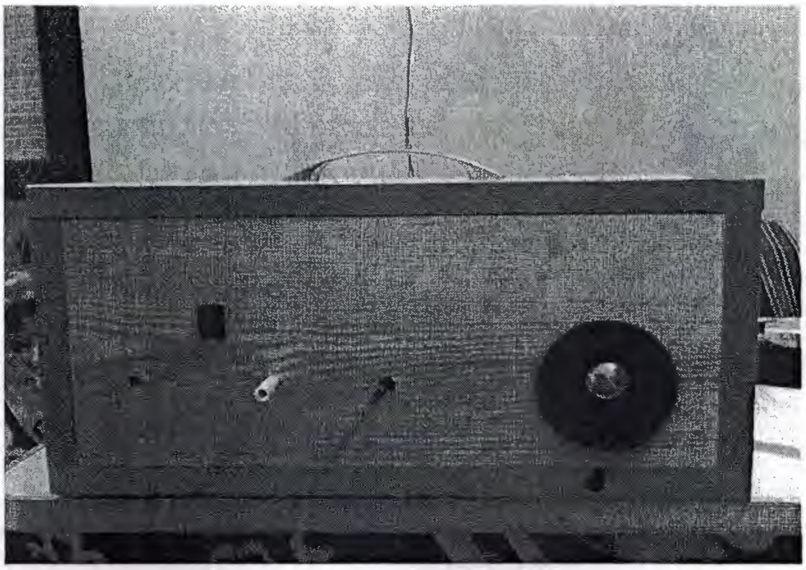


Figure 4.8 The completed FM radio

4.6 Summary

In this chapter we have illustrated the problems that we faced in this project and the practical solutions we used, the radio should work properly now, and the results for this will be shown in the next chapter which will be fully as a conclusion for the whole work.

CONCLUSION

After a lot of working on preparing this project theoretically and practically, we have concluded how much knowledge we gained and how much techniques we learned in receiving, filtering and amplifying the input signal in FM radio, and how to manage in having many alternatives for not available components, and how to enhance filtering process, to understand amplifying one.

This project consists of four chapters; each chapter presented a specific aspect of FM radio subject as a working principle, components which the radio circuit consists of and more.

Chapter one, presented sought components in details, how they are functioned and how they must be connected. Also safety guidelines for electronics projects are mentioned to prevent possible mistakes that may damage the circuit.

Chapter two, showed the techniques of transmission, propagations, and the frequencies which are used as channels to transmit information as radio waves in specific and electromagnetic waves in general, kinds of propagation and modulation.

Chapter three was the most important chapter of this project, it has presented the operation of the circuit and how it does affect the behavior of the input signal by filtering and amplifying processes with used techniques. Also describe the contribution of each component in mentioned processes.

Chapter four was the section where we presented the problems that we faced in setting up the circuit, and suggesting suitable solution for each problem by give better explanation of the job of a component or how it must be connected to the circuit, or how to use an alternatives for some components.

The main aims of this project were:

- To design, build and test a working FM radio.
- To gain experience as much as we could with practical electronics projects.
- To sort out problems within the circuits and suggest modifications, to overcome the problems.
- To get information about the kinds of frequencies, modulation, propagation and the main application of each kind of the frequency bands.
- Connecting transformers where it converts the 220V to 9V and 4.5V where the 4.5V is the voltage that the circuit is powered and the 9V is for the Opamp.

While connecting the components we face some problem but we solve it and after that succeed we could find 3 radio station like BRTradio, and Turkish and many Greek stations with good sound quality from the amplifier that modified with the main FM circuit

While connecting the radio circuit; and during some of unpleasant conclusions we realized that we were doing mistakes in some positions. By trial we got more careful and aware while we were working, and also gave us the motivation and determination to make the circuit work.

The main problem was when a component was not available and since the market in North Cyprus is too limited we were forced to find alternative components by using the internet or some references and also by asking some advices from experienced people and our instructor who gave us great deal of advices.

In summary, a great experience and knowledge of hands-on work with electronic projects have been gained. Problem solving skills where also developed through out working on this project.

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