NEAR EAST UNIVERSITY

Faculty of Engineering

Department of Electrical and Electronic Engineering

A FM Radio Design & Amplifier

Graduation Project
EE 400

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In the name of Allah

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ABSTRACT

We humans have infinite thoughts, one of the things that we can't even imagine to live without is the radio, for one thing it is the most portable and simplest technology man has, almost every house has one or two radios in their house, automobiles, work place, some are even built-in to mobile phones. A radio allows advertisers to reach a far wider audience then most other means of medium such as television, newspapers, etc.

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.

INTRODUCTION

The radio is an incredibly simple technology, with just a couple of electronic components that costs almost nothing. Such a technology 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 presents an introduction to electronic components that are commonly used in hardware projects. Additionally, safety guideline for electronics project will be presented in this chapter.

1.2 Components

Everyone today is exposed to electronic devices in one way or another.
In this section the reader will know all details about the components used, explaining of each component.

1.2.1 Resistors

Resistors are a two-terminal electrical or electronic component that resists an electric current by producing a voltage drop between its terminals in accordance with Ohm's law.

$$R = \frac{V}{I}$$

The electrical resistance is equal to the voltage drop across the resistor divided by the current that is flowing through the resistor. Resistors are used as part of electrical networks and electronic circuits.

Resistors, like diodes and relays, are another of the electrical components that should have a section in the installer's parts bin.

They have become a necessity for the mobile electronics installer, whether it is for door locks, timing circuits, remote starts, or just to discharge a stiffening capacitor.

Resistors are components that resist the flow of electrical current. The higher the value of resistance (measured in ohms) the lower the current will be. Resistors are color coded. To read the color code of a common 4 band 1K ohm resistor with a 5% tolerance, start at the opposite side of the GOLD tolerance band and read from left to right.

Write down the corresponding number from the color chart below for the 1st color band (BROWN). To the right of that number, write the corresponding number for the 2nd band (BLACK).

Now multiply that number (you should have 10) by the corresponding multiplier number of the 3rd band (RED) (100). Your answer will be 1000 or 1K. As shown in figure 1.1.

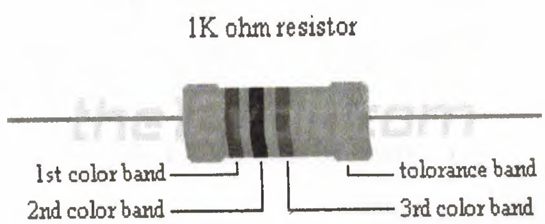

Figure 1.1 1K Resistor

How to read resister color codes:

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Band Color	1st Band #	2nd Band #	*3rd Band #	Multiplier x	Tolerances ± %
Black	0	0	0	1	
Brown	1	1	1	10	± 1%
Red	2	2	2	100	± 2%
Orange	3	3	3	1000	
Yellow	4	4	4	10,000	
Green	5	5	5	100,000	± 0.5 %
Blue	6	6	6	1,000,000	± 0.25 %
Violet	7	7	7	10.000.000	± 0.10 %
Grey	8	8	8	100,000,000	± 0.05 %
White	9	9	9	1,000,000,000	
Gold				0.1	± 5 %
Silver				0.01	± 10 %
None					± 20 %

Table 1.1 Resistor color code [1]

If a resistor has 5 color bands, write the corresponding number of the 3rd band to the right of the 2nd before you multiply by the corresponding number of the multiplier band. If you only have 4 color bands that include a tolerance band, ignore this column and go straight to the multiplier.

The tolerance band is usually gold or silver, but some may have none. Because resistors are not the exact value as indicated by the color bands, manufactures have included a tolerance color band to indicate the accuracy of the resistor. Gold band indicates the resistor is within 5% of what is indicated. Silver = 10% and None = 20%. Others are shown in the chart below. The 1K ohm resistor in the example above, may have an actual measurement any where from 950 ohms to 1050 ohms. If a resistor does not have a tolerance band, start from the band closest to a lead. This will be the 1st band. If you are unable to read the color bands than you'll have to use your millimeter. Be sure to zero it out first.

1.2.1.1 Types of Resistor

- **Fixed resistors**

Some resistors are cylindrical, with the actual resistive material in the centre (composition resistors, now obsolete) or on the surface of the cylinder (film) resistors, and a conducting metal lead projecting along the axis of the cylinder at each end(axial lead). There are carbon film and metal film resistors.

The photo above right shows a row of common resistors. Power resistors come in larger packages designed to dissipate heat efficiently. At high power levels, resistors tend to be wire wound types. Resistors used in computers and other devices are typically much smaller, often in surface-mount packages without wire leads. Resistors are built into integrated circuits as part of the fabrication process, using the semiconductor as the resistor.

Most often the IC will use a transistor-transistor configuration or resistor-transistor configuration to obtain results. Resistors made with semiconductor material are more difficult to fabricate and take up too much valuable chip area.

- **Variable resistors**

The variable resistor is a resistor whose value can be adjusted by turning a shaft or sliding a control. These are also called potentiometers or rheostats and allow the resistance of the device to be altered by hand. Rheostats are for anything above 1/2 watt. Variable resistors can be inexpensive single-turn types or multi-turn types with a helical element. Some variable resistors can be fitted with a mechanical display to count the turns.

Variable resistors can sometimes be unreliable, because the wire or metal can corrode or wear. Some modern variable resistors use plastic materials that do not corrode and have better wear characteristics.

- **Metal oxide resistor (MOV)**

Special type of resistor that changes its resistance with rise in voltage: a very high resistance at low voltage (below the trigger voltage) and very low resistance at high voltage (above the trigger voltage). It acts as a switch. It is usually used for short circuit protection in power strips or lightning bolt "arrestors" on street power poles, or as a "snubber" in inductive circuits.

- **Carbon film resistor**

Cheap general purpose resistor, works quite well also on high frequencies, resistance is somewhat dependent on the voltage over resistor (does not generally have effect in practice).

- **Composite resistor**

Usually some medium power resistors are built in this way. Has low inductance, large capacitance, poor temperature stability, noisy and not very good long time stability. Composite resistor can handle well short overload surges.

- **Metal film resistor**

Good temperature stability, good long time stability, cannot handle overloads well.

- **Thick film resistor**

Similar properties as metal film resistor but can handle surges better, and withstand high temperatures,

1.2.1.2 Applications

In general, a resistor is used to create a known voltage-to-current ratio in an electric circuit. If the current in a circuit is known, then a resistor can be used to create a known potential difference proportional to that current. Conversely, if the potential difference between two points in a circuit is known, a resistor can be used to create a known current proportional to that difference.

Current-limiting. By placing a resistor in series with another component, such as a light-emitting diode, the current through that component is reduced to a known safe value.

1.2.2 Capacitors

A capacitor is a passive electronic component that stores energy in the form of an electrostatic field.

A capacitor consists of two electrodes or plates, each of which stores an opposite charge. These two plates are conductive and are separated by an insulator or dielectric. The charge is stored at the surface of the plates, at the boundary with the dielectric. Because each plate stores an equal but opposite charge, the total charge in the capacitor is always zero. As shown in figure 1.2.

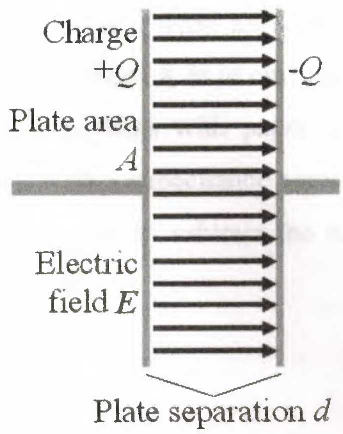


Figure 1.2 simplest type of capacitor [2]

In an ideal capacitor, the voltage is proportional to the charge, and the constant of proportionality is the capacitance C. That is, Q = CV, or C = Q/V. Most capacitors are close to ideal if the voltage does not vary too rapidly, and is not excessive. Unit capacitance results when unit charge means unit voltage.

In the practical system, unit charge is 1 coulomb, and unit voltage is 1 volt, or 1 joule/coulomb. The corresponding unit of capacitance is the farad, which is one coulomb per volt. This happens to be an absurdly large unit, so the microfarad, μF, is commonly used.

In Gaussian or electrostatic units (esu), the unit of charge is the esu (or stat coulomb; 9×10^9 esu = 1 C) and the unit of potential is the stat volt, which is about 300 volt. The unit of capacitance is then the centimetre, or one esu per stat volt. From these figures, it follows that 1 cm = 1.11×10^{-12} F = 1.11 pF.

A capacitor can be made from two conducting sheets, each of area A, separated by a distance d. normally, the separation d is maintained by a sheet of dielectric of this thickness, which has a dielectric constant κ. The capacitance of this parallel-plate capacitor is given by $C = \varepsilon_0 \kappa A/d$ F, where A is in m^2 and d is in meters.

The constant $\varepsilon_o = 4\pi/c^2 = 8.854 \times 10^{-12}$ F/m, an embarrassment of the SI system of units, in centimeters, $C = \kappa A/4\pi d$, where A is in cm^2 and d is in cm. It is very easy to make some capacitors like this, perhaps with paper, $\kappa = 3$ and $d = 0.015$ cm, as dielectric, and to measure them with a capacitance meter. Most high-end DMM's now have a capacitance scale. Don't forget to subtract the reading before the capacitor is connected.

1.2.2.1 Applications

The difference between a capacitor and a battery is that a capacitor can dump its entire charge in a tiny fraction of a second, where a battery would take minutes to completely discharge itself. That's why the electronic flash on a camera uses a capacitor -- the battery charges up the flash's capacitor over several seconds, and then the capacitor dumps the full charge into the flash tube almost instantly. This can make a large, charged capacitor extremely dangerous -- flash units and TVs have warnings about opening them up for this reason. They contain big capacitors that can, potentially, kill you with the charge they contain.

- **Capacitors are used in several different ways in electronic circuits:**

I. Sometimes, capacitors are used to store charge for high-speed use. That's what a flash does. Big lasers use this technique as well to get very bright, instantaneous flashes.

II. Capacitors can also eliminate ripples. If a line carrying DC voltage has ripples or spikes in it, a big capacitor can even out the voltage by absorbing the peaks and filling in the valleys.

III. A capacitor can block DC voltage. If you hook a small capacitor to a battery, then no current will flow between the poles of the battery once the capacitor charges (which are instantaneous if the capacitor is small). However, any alternating current (AC) signal flows through a capacitor unimpeded. That's because the capacitor will charge and discharge as the alternating current fluctuates, making it appear that the alternating current is flowing.

1.2.2.2 Capacitance

The net charge on a capacitor is zero, but equal and opposite charges ±Q are found on the two plates, and the "charge on the capacitor" is usually the absolute value of the charges, Q. The electrodes of a capacitor are called "plates" even though they are usually not plates at all, but surfaces of various forms.

If we mark one terminal of a capacitor with a polarity marking, say a +, then $Q > 0$ means that a positive charge Q is on the corresponding plate, and if $Q < 0$, then a negative charge is on that plate. If a current $i = dQ/dt$, then a positive current flows into the marked terminal and causes the voltage V across the capacitor to increase. The voltage V is the potential difference between the two plates, positive if the potential of the marked plate is higher than the potential of the other. These sign conventions are easy to understand, and are essential if confusion is to be avoided.

1.2.3 Semiconductor

A semiconductor is a material with an electrical conductivity that is intermediate between that of an insulator and a conductor. A semiconductor behaves as an insulator at very low temperature, and has an appreciable electrical conductivity at room temperature although much lower conductivity than a conductor. Commonly used semiconducting materials are silicon, germanium, gallium arsenide and indium phosphate.

A semiconductor can be distinguished from a conductor by the fact that, at absolute zero, the uppermost filled electron energy band is fully filled in a semiconductor, but only partially filled in a conductor. Semiconductor materials do not follow Ohm's law, i.e. the electrical resistance changes with voltage and intensity.

The distinction between a semiconductor and an insulator is slightly more arbitrary. A semiconductor has a band gap which is small enough such that its conduction band is appreciably thermally populated with electrons at room temperature, whilst an insulator has a band gap which is too wide for there to be appreciable thermal electrons in its conduction band at room temperature.

1.2.3.1 Diodes

A diode is a component that restricts the direction of movement of charge carriers. It allows an electric current to flow in one direction, but essentially blocks it in the opposite direction.

Thus the diode can be thought of as an electronic version of a check valve.A two-terminal semiconductor (rectifying) device that exhibits a nonlinear current-voltage characteristic.

The function of a diode is to allow current in one direction and to block current in the opposite direction. The terminals of a diode are called the anode and cathode as can you see in figure 1.3

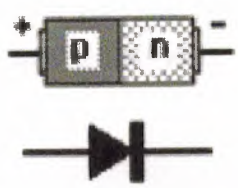


Figure 1.3 Diode [3]

1.2.3.1.1 Types of semiconductor diode:

There are several types of semiconductor junction diodes:

A. Forward-bias:

Occurs when the P-type block is connected to the positive terminal of a battery and the N-type block is connected to the negative terminal, as figure 1.4 below.

With this set-up, the 'holes' in the P-type region and the electrons in the N-type region are pushed towards the junction. This reduces the width of the depletion zone. The positive charge applied to the P-type block repels the holes, while the negative charge applied to the N-type block repels the electrons. As electrons and holes are pushed towards the junction, the distance between them decreases. This lowers the barrier in potential.

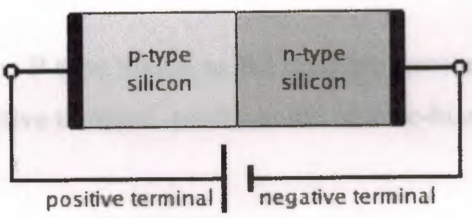


Figure 1.4 A silicon p-n junction in Forward-bias [4]

With increasing bias voltage, eventually the non-conducting depletion zone becomes so thin that the charge carriers can tunnel across the barrier, and the electrical resistance falls to a low value. The electrons which pass the junction barrier enter the P-type region (moving leftwards from one hole to the next, with reference to the above diagram).

This makes an electric current possible. An electron starts flowing around from the negative terminal to the positive terminal of the battery. It starts at the negative terminal, moving towards the N-type block. Having reached the N-type region it enters the block and makes its way towards the p-n junction.

The junction barrier can no longer keep the electron in the N-type region due to the forward-bias effect (in other words, the thin depletion zone produces very little electrical resistance against the flow of electrons). The electron will therefore cross the junction and move ahead into the P-type block.

Once inside the P-type region, the electron, being thermally free (from bonding) or mobile will move through the rest of the crystal, making its way to the positive terminal of the power supply. Please note that the electron does not jump from one hole to the next in the p-region.

This actually qualifies as electron-hole recombination which immobilizes both hole and electron. The electron can move freely through the crystal without needing to jump into holes which are what happens when electrons do cross the depletion layer. This process will be repeated over and over again, producing a complete circuit path through the junction.

B. Reverse bias:

Occurs by Connecting the P-type region to the negative terminal of the battery and the N-type region to the positive terminal, produces the reverse-bias effect. The connections are illustrated in figure 1.5.

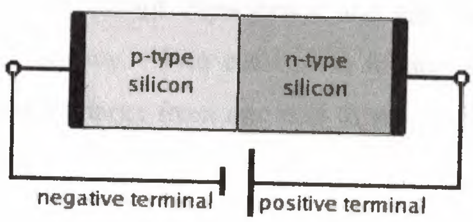


Figure 1.5 A silicon p-n junction in Reverse-bias [4]

Because the P-type region is now connected to the negative terminal of the power supply, the 'holes' in the P-type region are pulled away from the junction, causing the width of the non-conducting Depletion Zone to increase. Similarly, because the N-type region is connected to the positive terminal, the electrons will also be pulled away from the junction. This effectively increases the potential barrier and greatly increases the electrical resistance against the flow of charge carriers. For this reason there will be no (or minimal) electric current across the junction.

At the middle of the junction of the p-n material, a depletion region is created to stand-off the reverse voltage. The width of the depletion region grows larger with higher voltage. The electric field grows as the reverse voltage increases. When the electric field increases beyond a critical level, the junction breaks down and current begins to flow by avalanche breakdown.

1.2.3.2 Inductors

Inductors are usually made with coils of wire. The wire coils are wound around iron cores, ferrite cores, or other materials except in the case of an air core inductor where there is no core other than air. The inductor stores electrical charge in magnetic fields. When the magnetic field collapses it induces an electrical charge back into the wire.

Inductors are associated with circuit capacitance and can form a tuned circuit and resonate at a particular frequency. Two coils close to one another, as they are in a transformer, literally transfer charge from one coil to the other. This is called mutual inductance as you see in figure 1.6

Figure 1.6 inductors [5]

1.2.3.3 Transistor.

The transistor is a solid state semiconductor device which can be used for amplification, switching, voltage stabilization, signal modulation and many other functions. It acts as a variable valve which, based on its input voltage, controls the current it draws from a connected voltage source.

Bipolar transistors, having 2 junctions, are 3 terminal semiconductor devices. The three terminals are emitter, collector, and base. A transistor can be either NPN or PNP. See the schematic representations in figure 1.7

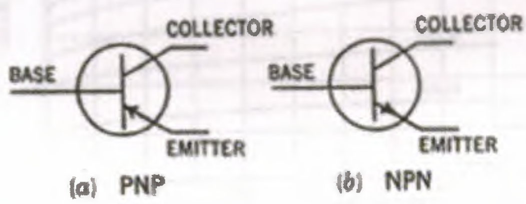
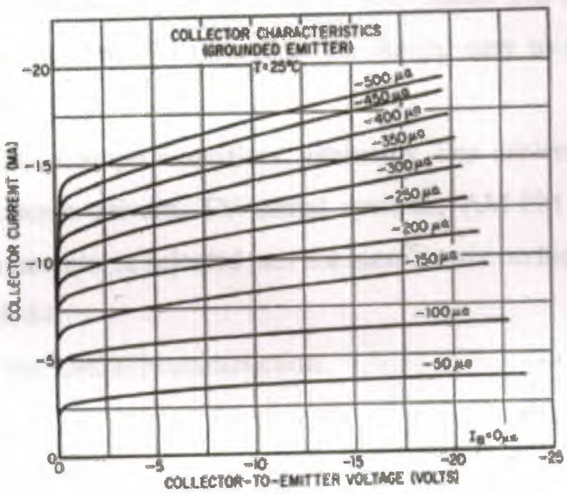


Figure 1.7 PNP and NPN semiconductor [6]

Note that the direction of the emitter arrow the type transistor. Biasing and power supply polarity is positive for NPN and negative for PNP transistors. The transistor is primarily used as a current amplifier. When a small current signal is applied to the base terminal, it is amplified in the collector circuit. This current amplification is referred to as H_{FE} or beta and equals Ic/Ib.

As with all semiconductors, breakdown voltage is a design limitation. There are breakdown voltages that must be taken into account for each combination of terminals.

I.e. Vce, Vbe, and Vcb. However, Vce (collector-emitter voltage) with open base, designated as Vceo, is usually of most concern and defines the maximum circuit voltage. Also as with all semiconductors there are undesirable leakage currents, notably Icbo, collector junction leakage; and Iebo, emitter junction leakage. A typical collector characteristic curve is shown below:



Typical collector characteristic curves for a transistor.

Figure 1.8

Note that the negative collector-emitter voltage tells you that the transistor is PNP. Also that the output current increases with input or base current and varies very little with collector-emitter voltage.

1.2.3 LM380

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.

The figure 1.8 shows the LM380N construction.

```
                 +--()--+
          BYPASS | 1  14| VCC
   NON-INV INPUT | 2  13| NC
             GND | 3  12| GND
             GND | 4  11| GND
             GND | 5  10| GND
 INVERTING INPUT | 6   9| NC
             GND | 7   8| VOUT
                 +------+
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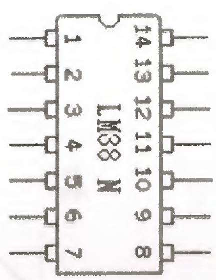

Figure 1.9 The LM380N construction.

1.2.4 Loudspeaker Details.

An enormous amount of engineering work has gone into the design of today's dynamic loudspeaker. A light voice coil is mounted so that it can move freely inside the magnetic field of a strong permanent magnet.

The speaker cone is attached to the voice coil and attached with a flexible mounting to the outer ring of the speaker support. Because there is a definite "home" or equilibrium position for the speaker cone and there is elasticity of the mounting structure, there is inevitably a free cone resonant frequency like that of a mass on a spring.

The frequency can be determined by adjusting the mass and stiffness of the cone and voice coil, and it can be damped and broadened by the nature of the construction, but that natural mechanical frequency of vibration is always there and enhances the frequencies in the frequency range near resonance. Part of the role of a good enclosure is to minimize the impact of this resonant frequency, as shown in figure 1.9.

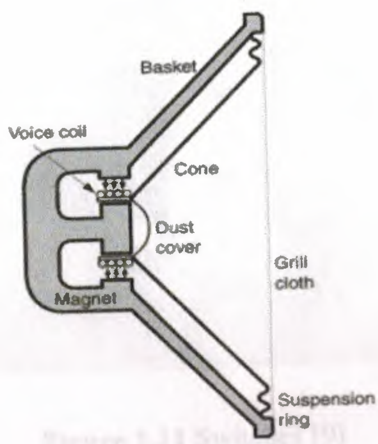

Figure 1.10 Loudspeakers [8]

1.2.5 Switches.

Slide Switches are available in a large variety including ultra miniature, sub miniature, miniature, and standard. These are available for panel mounting or PCB mounting with a large combination of switching contacts from the simple on/off to multiple versions with a large choice of switching currents and operating voltages. There are also varied types of actuators.

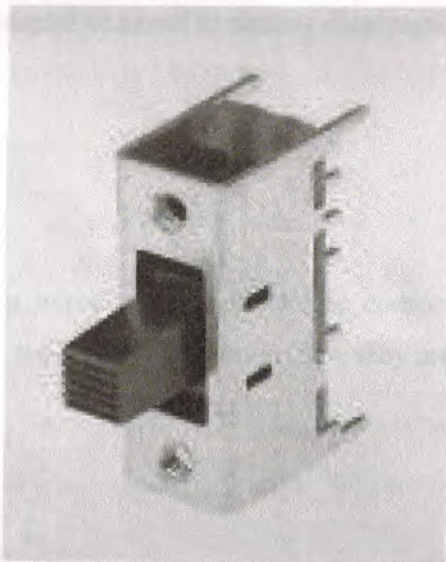

Figure 1.11 Switches [9]

1.3 Safety Guideline

In this project, low voltage applications are used. Thus, safety guidelines are not in concern of human safety but in components safety, although we cannot avoid the technical mistakes witch can occur during connecting parts and soldering them to the circuit, so we have to be careful from current and heat.

- One of the components which are used in this circuit is the chemical capacitor, this element has two poles and when connected to the circuit we have to care about its polarity so as to avoid damaging it.
- One other component is the I.C., which is so sensitive, so while connecting its pins to the circuit they have to be attached in accordance with the manufacturing instructions layouts in order to keeping it working properly and without damaging it.
- An other component used in this circuit is loudspeaker, which has to be chosen suitable to the out put signal so as not to destroy diaphragm.

1.4 Summary

This chapter presented an introduction to electronic components that are commonly used in hardware projects and how they function, how they must be connected.

CHAPTER TWO

RADIO WAVE PROPAGATION AND ITS FRQUENCIES

2.1 Overview

This chapter describes the propagation of radio waves and the affect 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.*

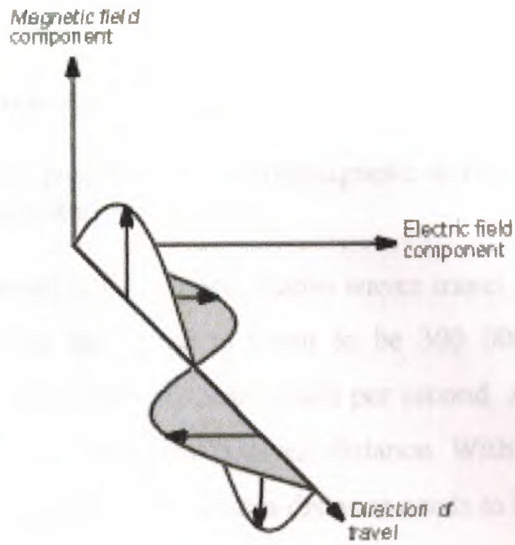

Figure 2.1 An electromagnetic wave [10]

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.

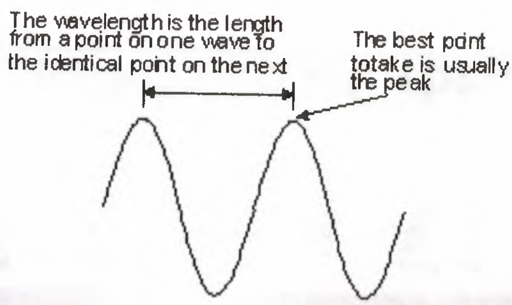

Figure 2.2 Wavelength of an electromagnetic wave [10]

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.

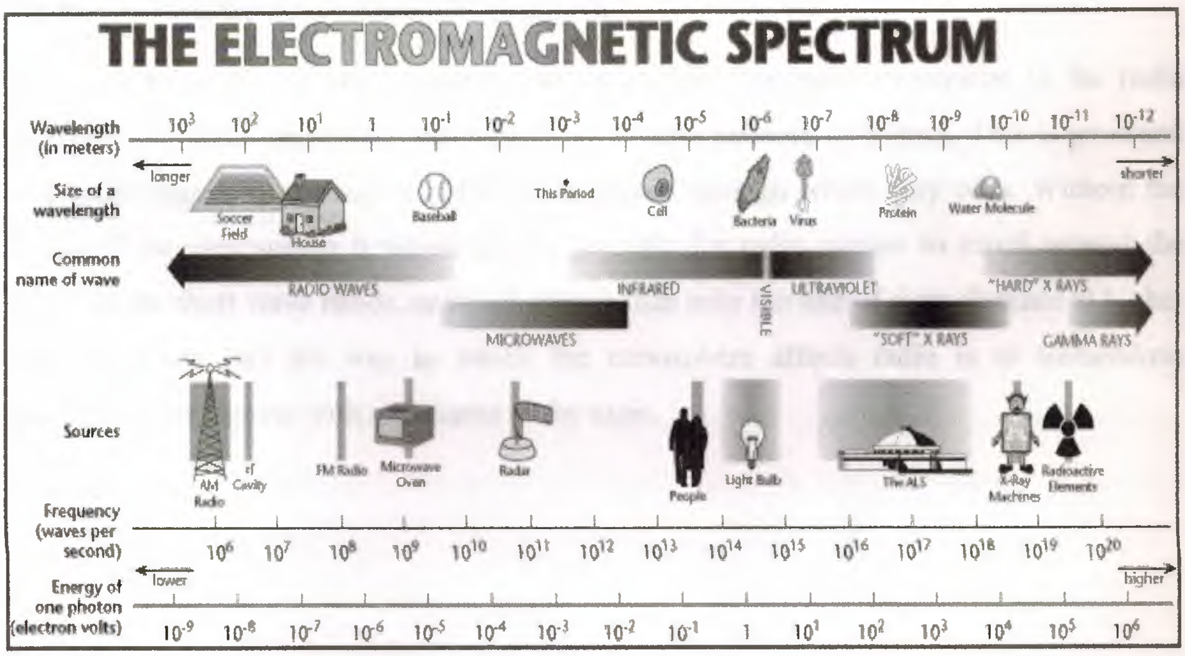

Figure 2.3 The spectrum of electromagnetic waves [11]

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.

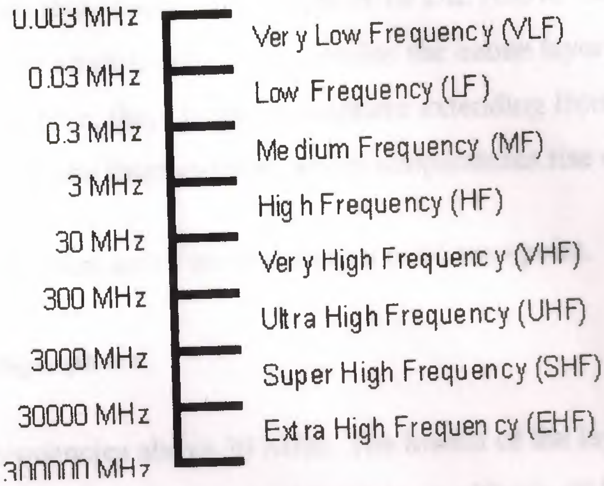

Figure 2.4 The spectrum of electromagnetic waves

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 affects 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 of 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.

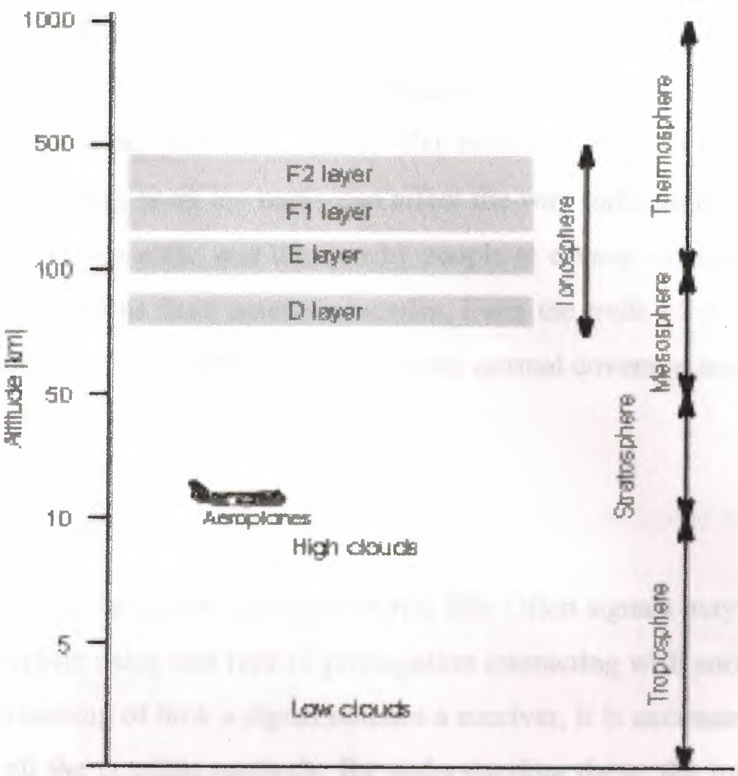

Figure 2.5 Regions of the Atmosphere [12]

This 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 affect 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 paths 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 which electromagnet waves can be generated by alternating current fed to an antenna. Such frequencies account for the following parts of the spectrum as shown in the table 2.1.

Table 2.1 Radio Frequency Classification [13]

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 are 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.

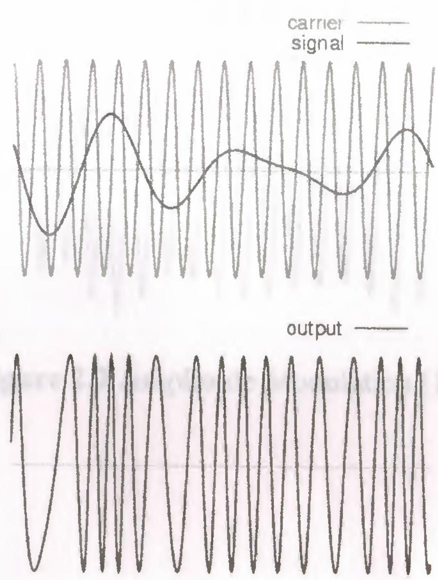

Figure 2.6 Frequency Modulation [14]

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.

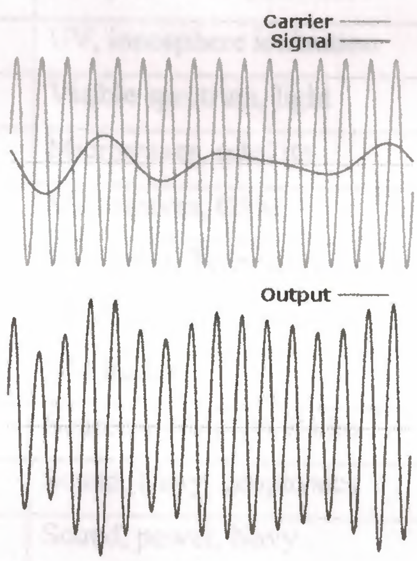

Figure 2.7 Amplitude Modulation [15]

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 its Applications [16]

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. As we presented classifications of frequencies which are used in radio and other purposes.

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.

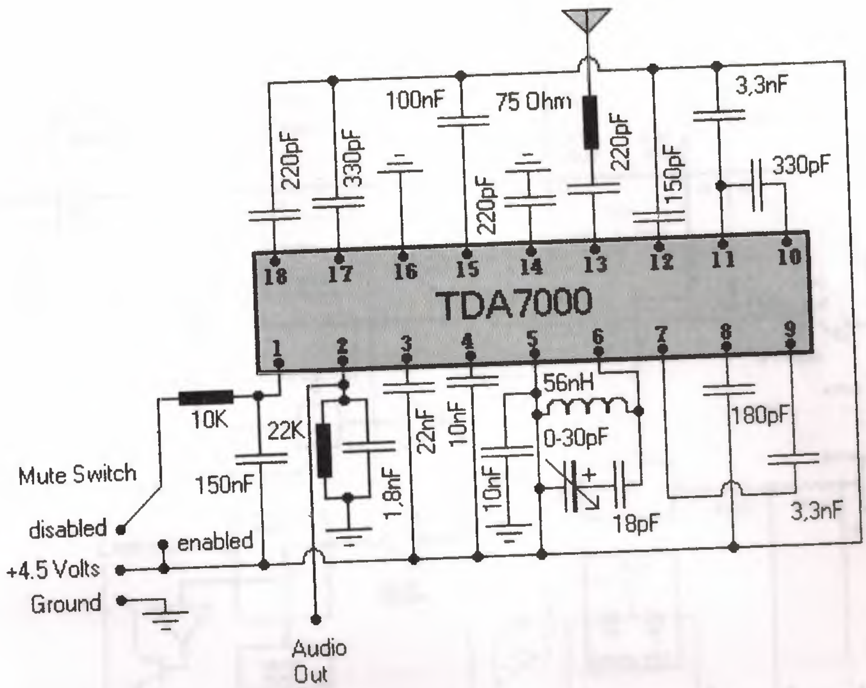

Figure 3.1 Circuit diagram of Fm Radio [16]

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.

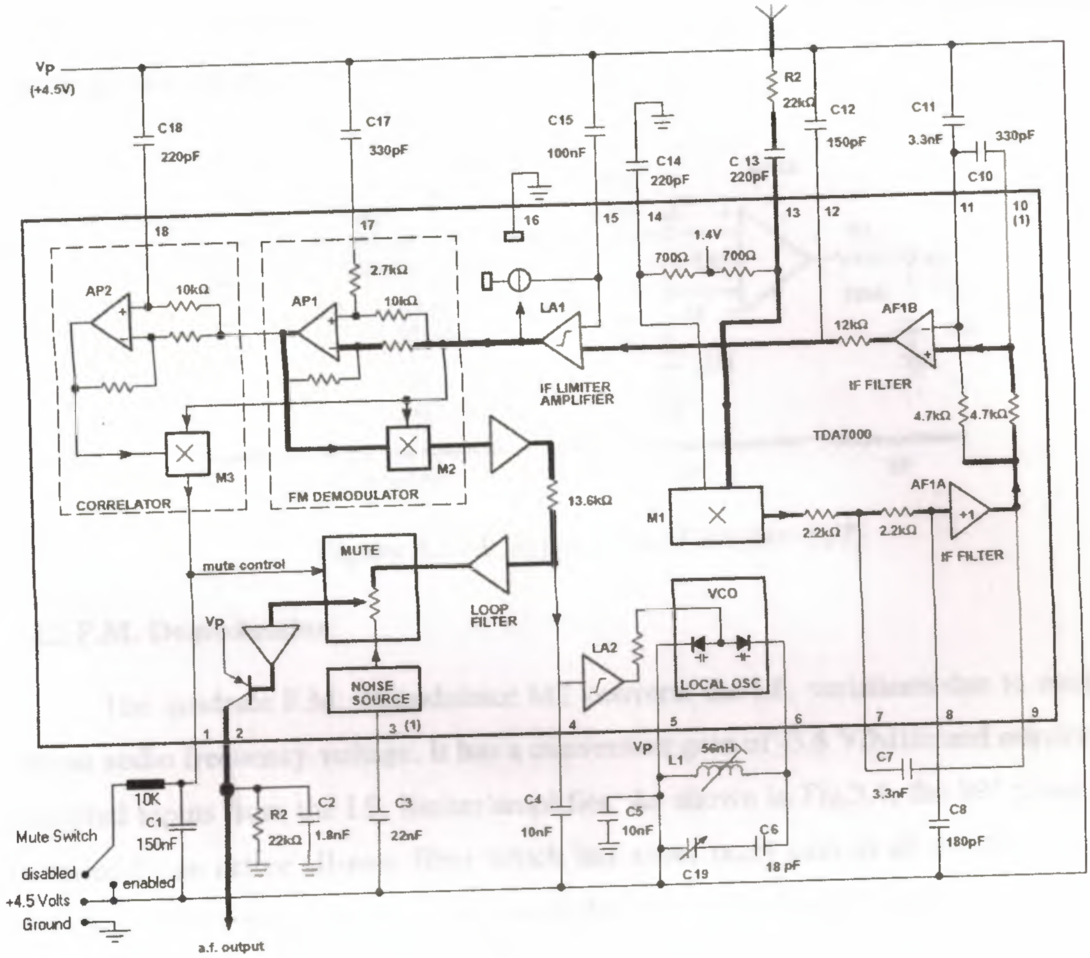

Figure 3.2 TDA7000 [17]

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 Kohm resistor and external capacitor C11. The upper limit of the pass band is determined by an internal 4.7 K.ohm resistor 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.

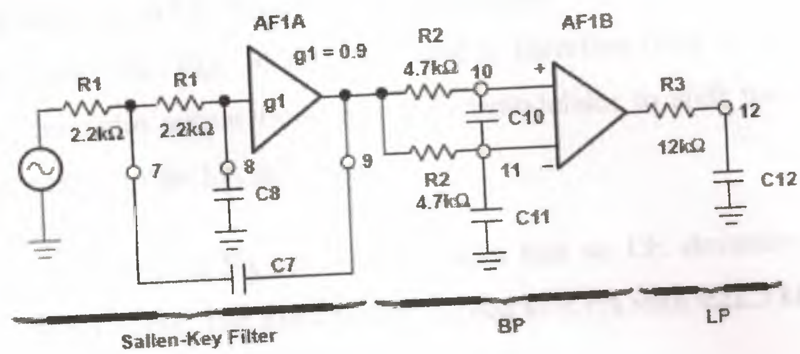

Figure 3.3 I.F. Filter of the TDA7000 [17]

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.

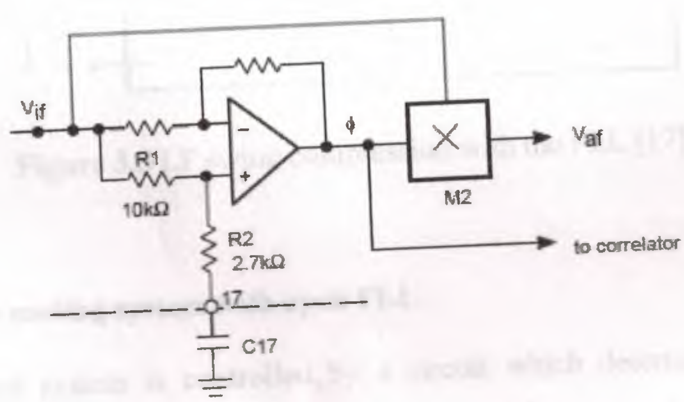

Figure 3.4 F.M. demodulator phase shift circuit all pass filter [17]

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.

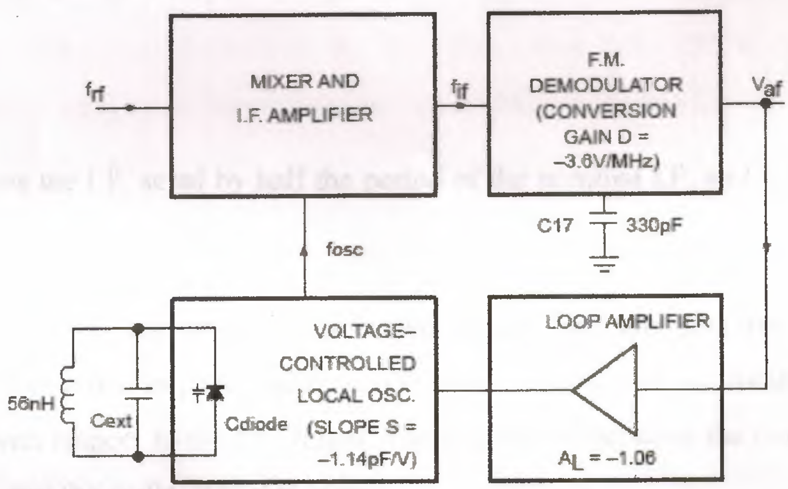

Figure 3.5 I.F swing compression with the FLL [17]

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.

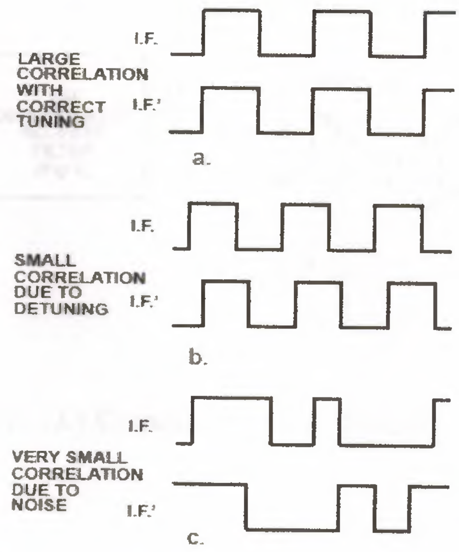

Figure 3.6 Function of the correlation muting system [17]

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.

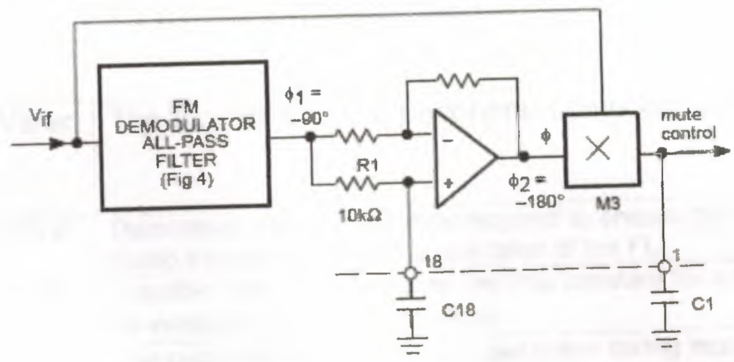

Figure 3.7 Correlation of the TDA7000 [17]

As shown in Fig.3.6. The correlation muting circuit consists of all-pass filter AP2 connected in series with fm. demodulator all-pass filter API 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 [17]

Symbol of the component	Value	The functions of the peripheral components of Figure 3.2
C1	150nF	Determines the time constant required to ensure 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 (e.g., R2C2 = 40μs.
C3	22nF	The output level from the noise generator during muting Increases with increasing value of C3. If silent mute is required, C3 Can be omitted.
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. For other intermediate frequencies, the values of these capacitors must be changed in Inverse proportion to the IF changes.
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 external 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 present 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 milliwatts when operating from a 6 volt supply, making the LM386 ideal for battery operation.

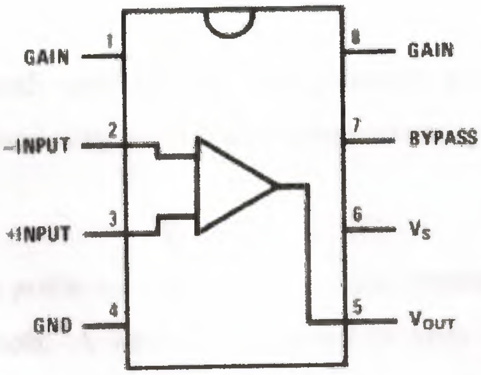

Figure 4.1 Top view of LM380 IC [18]

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

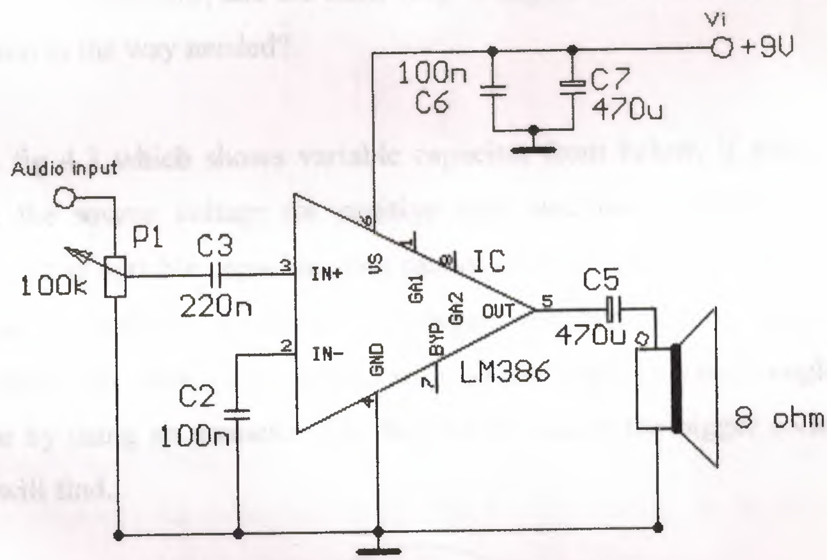

Figure 4.2 Audio Amplifier Circuit [18]

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.

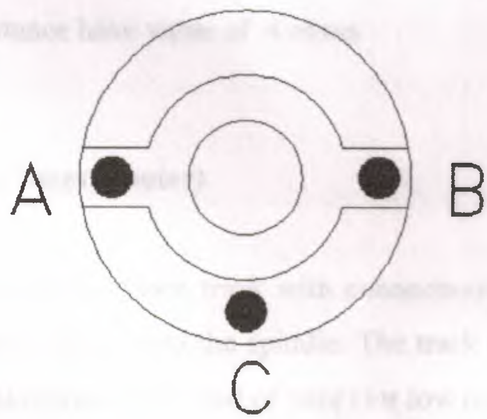

Figure 4.3 Bottom view of Variable Capacitor

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 4.2 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.

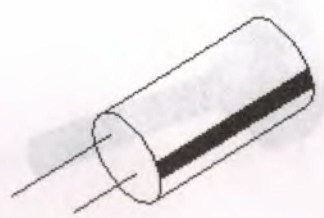

Figure 4.4 Polarized Capacitor

4.2.4 Loud Speaker

The problem that 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 have 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 bellow shows the final result of FM radio circuit connected to amplifier.

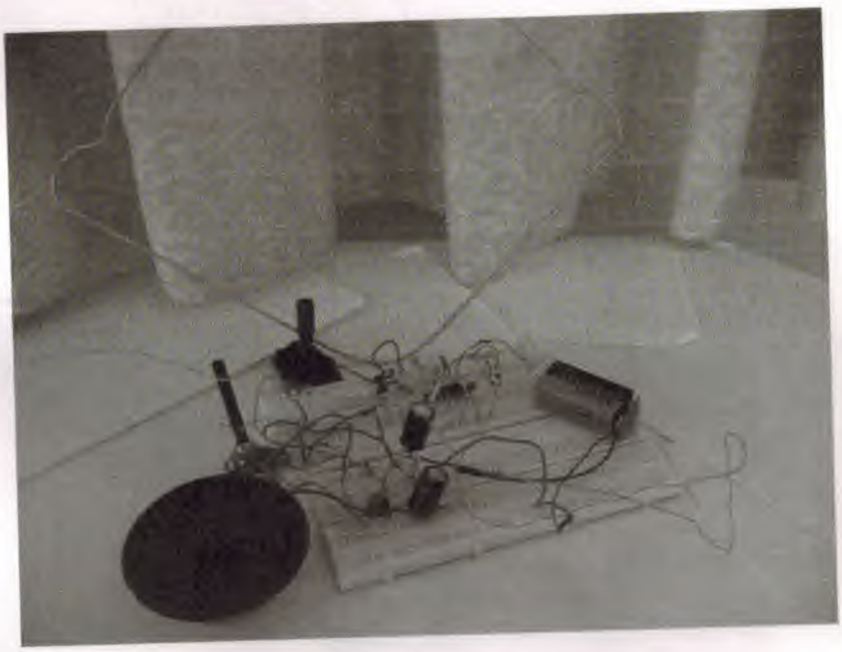

Figure 4.7 FM project photograph.

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 conclude 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 guidelines 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.

While connecting the components we face some problem but we solve it and after that succeed we cold find 5 radio station like BRTradio, KSA radio and many Greek station and Turkish 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.

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