NEAR EAST UNIVERSITY

Faculty of Engineering

Department of Computer Engineering

A MW Radio design & Amplifier

Graduation Project
COM 400

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ABSTRACT

As the human mind is unlimited, as the technology never stopped and the inventing is still goes on without a limit. This small machine has played a very important role in our life, in our home, office, car, picnics and even our mobiles and maybe it could be a good friend too especially when you are crossing faraway streets, its the radio.

The radio played an important role in our life no body on this earth could ignore it, there are a lot of reasons that made this machine an important part of our life like its small volume, cheap, easy to use.

This project is talking about a special kind of radios which is the MW radio, and its components also a special modification have been done on its amplifier with graphics to explain everything about this kind of radios.

ACKNOWLEDGEMENTS

"First I would like to thank my supervisor Assoc. Prof. Dr. Adnan Khashman for his great advice and recommendations to finish this work properly.

Although I faced many problem in collections data and parts but he has guided me the appropriate references.

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INTRODUCTION

World wide we can see that radios have the most flourishing production and usage, all the planet is covered by radio waves and signals holding millions of programs which are listened regularly by people in cars, houses, work places, markets,etc.

The radio was used within this century widely in the communication purposes in almost the all life parts; as it was installed in some other products as an additional option; to give the opportunity to people to keep up dated and connected to latest news and other life branches. It is almost unimaginable to live without it anymore; radios become a part of our modern life.

The purpose of this project is to design, build and test a MW radio circuit with its basic elements. In five chapters we tried to show the work we have done clear as the theoretical and method in a simple way for readers to get the maximum usage and gain.

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 MW 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 ONE

ELECTRONIC COMPONENTS

1.1 Overview

This chapter contains an introduction to the electronic components that they are commonly been in used in hardware projects. Safety guidelines that must be observed when working on hardware projects will also be provided.

1.2 Components

We will present some explanation about each hardware component used in setting up the electronic circuit projects in generally.

1.2.1 Resistors

The resistor's function is to reduce the flow of electric current. This symbol is used to indicate a resistor in a circuit diagram, known as a schematic. Resistance value is designated in units called the "Ohm." A 1000 Ohm resistor is typically shown as 1K-Ohm (kilo Ohm), and 1000 K-Ohms is written as 1M-Ohm (megohm). In other word resistors are electronic components used extensively on the circuit boards of electronic equipment to limit current.

They are color coded with stripes to reveal their resistance value (in ohms) as well as their manufacturing tolerance.

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: Resistor

How to read resister color codes:

Table 1.1: Resistor color code

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 %

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 multimeter. Be sure to zero it out first [7].

1.2.1.1 Types of Resistor

- **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.
- **Metal oxide resistor:** mostly similar features as metal film resistor but better surge handling capacity, higher temperature rating them metal film resistor, low voltage dependently, low noise, better for RF than wire wound resistor but usually worse temperature stability

- **Thick film resistor:** similar properties as metal film resistor but can handle surges better, and withstand high temperatures,
- **Thin film resistor:** good long time stability, good temperature stability, good voltage dependently rating, low noise, not good for RF, low surge handling capacity.
- **Wire wound resistor:** used mainly for high power resistors, can be made curate for measuring circuits, high inductance because consists of wound wire.

1.2.2 Capacitors

In 1745 a new physics and mathematics professor at the University of Leyden (spelled Leiden in modern Dutch), Pieter van Musschenbroek (1692 - 1791) and his assistants Allmand and Cunaeus from the Netherlands invented the 'capacitor' (electro-static charge or capacitance actually) but did not know it at first. His condenser was called the 'Leyden Jar' (pronounced: LY'duhn) and named so by Abbe Nollet. This Leyden jar consisted of a narrow-necked glass jar coated over part of its inner and outer surfaces with a conductive metallic substance; a conducting rod or wire passes through as insulating stopper (cork) in the neck of the jar and contacts the inner foil layer, which is separated from the outer layer by the glass wall. The Leyden jar was one of the first devices used to store an electric charge. If the inner layers of foil and outer layers of foil are then connected by a conductor, their opposite charges will cause a spark that discharges the jar. Actually, van Musschenbroek's very first 'condenser' was nothing more than a beer glass! [2]

A capacitor is an electronic device which consists of two plates (electrically conductive material) separated by an insulator. The capacitor's value (its 'capacitance') is largely determined by the total surface area of the plates and the distance between the plates (determined by the insulator's thickness). A capacitor's value is commonly referred to in microfarads, one millionth of a farad. It is expressed in micro farads because the farad is such a large amount of capacitance that it would be impractical to use in most situations. The figure 1.2 shows the capacitor in electronic circuit.

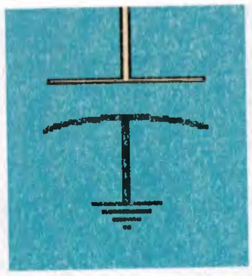

Figure 1.2: Capacitor shape in electronic circuit

1.2.2.1 Capacity

This analogy should help you better understand capacity. In the following diagram (Figure 1.3), you can see 2 tanks (capacitors) of different diameter (different capacitance). You should readily understand that the larger tank can hold more water (if they're filling to the same level (voltage)). The larger capacitor has more area in which to store water. Just as the larger capacitor's larger plate area would be able to hold more electrons.

1.2.2.2 Capacitor and DC voltage

When a DC voltage source is applied to a capacitor there is an initial surge of current, when the voltage across the terminals of the capacitor is equal to the applied voltage, the current flow stops. When the current stops flowing from the power supply to the capacitor, the capacitor is 'charged'. If the DC source is removed from the capacitor, the capacitor will retain a voltage across its terminals (it will remain charged). The capacitor can be discharged by touching the capacitor's external leads together. When using very large capacitors (1/2 farad or more) in your car, the capacitor partially discharges into the amplifier's power supply when the voltage from the alternator or battery starts to fall. Keep in mind that the discharge is only for a fraction of a second. The capacitor can not act like a battery. It only serves to fill in what would otherwise be very small dips in the supply voltage [2].

1.2.2.3 Capacitors and AC voltage

Generally, if an AC voltage source is connected to a capacitor, the current will flow through the capacitor until the source is removed. There are exceptions to this situation and the A.C. current flow through any capacitor is dependent on the frequency

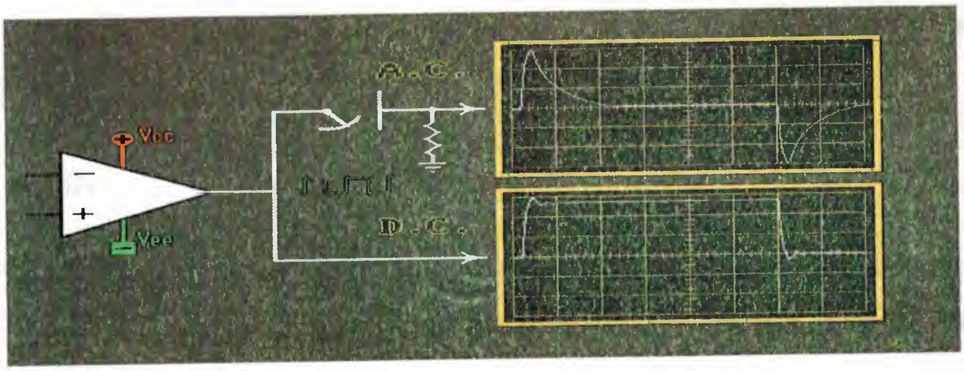

Figure 1.3: Ac and Dc signals [3]

of the applied A.C. signal and the value of the capacitor. The figure 1.3 shows the Dc and Ac signals.

1.2.3 Semiconductor

Since the late 1950's, the discovery and invention of new electronic semiconductor materials and the drastic reduction in the size of electronic devices has moved at a rapid pace. As a result, the speed of electronic devices (particularly electron device production, his predictions have been met or exceeded. The push for smaller dimensions, which allow for increased functionality and faster devices, also creates problems of long term reliability and heat dissipation. New device designs, new materials, and lower voltages are being employed to make the next generation of devices. [2]

Semiconductor has a large amount of types. Transistors have three lead-out wires are called the base, emitter and conductor. It is essential that these are connected correctly, as there is no chance of project working if they are not. Fortunately modern transistors are not easily damaged, and incorrect connection is not likely to damage a device (or other components in the circuit) only one type is used in this project.

One extremely important area of semiconductor technology is the field of telecommunications. The new "Information Super Highway" requires technology which can transmit and receive information at high rates. One approach which is already being applied to this area is optoelectronics or the use of light to transmit information. Electrons are used to transfer information within computers, but most information sent over long distances uses light pulses traveling through fiber optic cables. The laser diodes which create these pulses and semiconductor receivers that detect the pulses are areas of intensive research.

1.2.3.1 Diodes

Diodes are non-linear circuit elements. It is made of two different types of semiconductors right next to each other. Qualitatively we can just think of an ideal diode has having two regions: a conduction region of zero resistance and an infinite resistance non-conduction region. For many circuit applications, the behavior of a (junction) diode depends on its polarity in the circuit. If the diode is reverse biased (positive potential on N-type material) the current through the diode is very small. The following figure is shown the characteristic of diode. See figure 1.4.

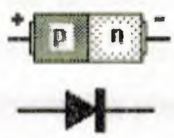

Figure 1.4: Diode

- **Forward Biased P-N Junction:** forward biasing the **p-n junction** drives holes to the junction from the **p-type** material and electrons to the junction from the **n-type** material. At the junction the electrons and holes combine so that a continuous current can be maintained.
- Reverse Biased P-N Junction: the application of a reverse voltage to the p-n junction will cause a transient current to flow as both electrons and holes are pulled away from the junction. When the potential formed by the widened depletion layer .

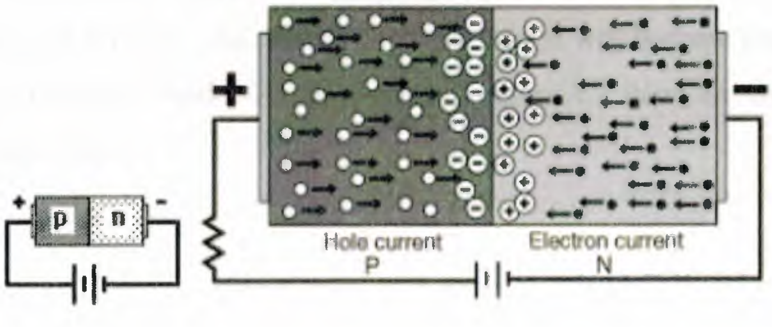

Figure 1.5: Forward Biased P-N Junction

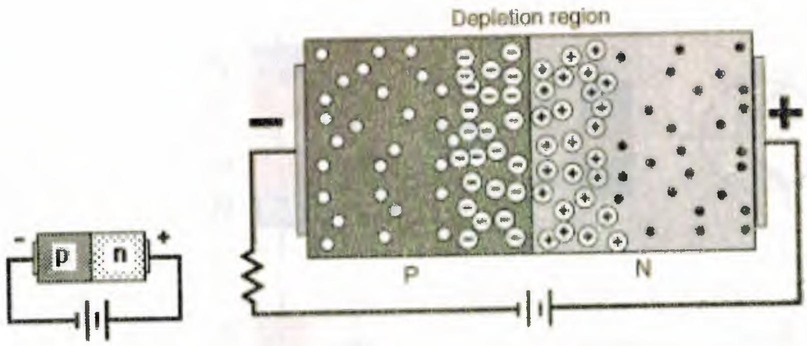

Figure 1.6: Reverse Biased P-N Junction

- Equals the applied voltage, the current will cease except for the small thermal current [3].

The first use for the diode was the demodulation of Amplitud modulated (AM) radio broadcasts. The history of this discovery is treated in depth in the radio article. In summary, an AM signal consists of alternating positive and negative peaks of current, whose Amplitude or 'envelope' is proportional to the original audio signal, but whose average value is zero. The diode rectifies the AM signal (i.e. it eliminates the negative peaks), leaving a signal whose average amplitude is the desired audio signal. The average value is extracted using a simple filter and fed into a transducer (originally a crystal earpiece, now more likely to be a loudspeaker), which generates sound.

1.2.3.2 Transistors

A Bipolar Transistor essentially consists of a pair of PN Junction Diodes that are joined back-to-back. This forms a sort of a sandwich where one kind of semiconductor is placed in-between two others. There are therefore two kinds of bipolar sandwich, the NPN and PNP varieties. The three layers of the sandwich are conventionally called the Collector, Base, and Emitter. The reasons for these names will become clear later once we see how the transistor works. As shown in the figure 1.7 there are two symbol of type of bipolar transistors.

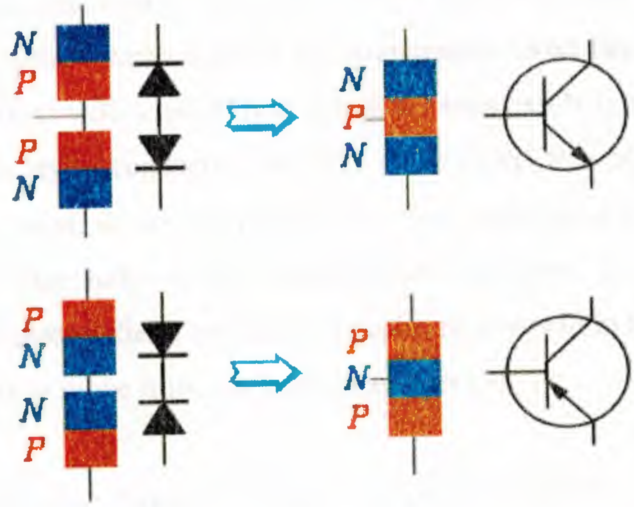

Figure 1.7: Symbol of NPN and PNP transistors

Some of the basic properties exhibited by a Bipolar Transistor are immediately recognizable as being diode-like. However, when the 'filling' of the sandwich is fairly thin some interesting effects become possible that allow us to use the Transistor as an amplifier or a switch. To see how the Bipolar Transistor works we can concentrate on the NPN variety. The figure 1.8 shows the energy levels in an NPN transistor.

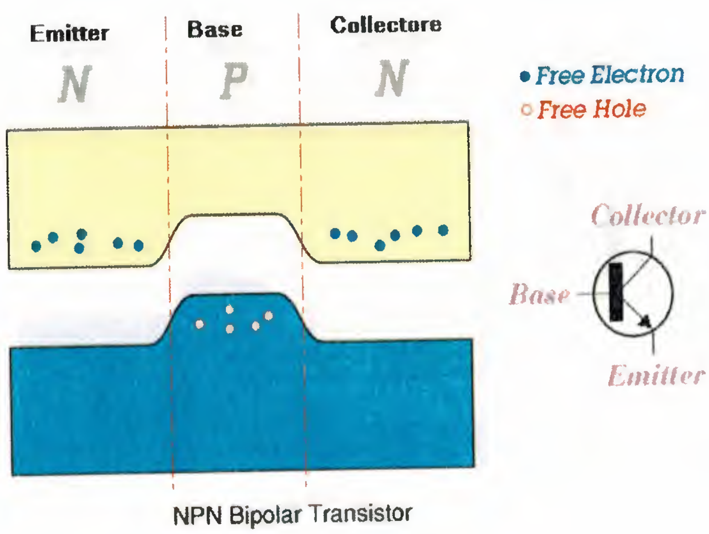

Figure 1.8: the energy levels in an NPN transistor

Figure 1.8 shows the energy levels in an NPN transistor when we aren't externally applying any voltages. We can see that the arrangement looks like a back-to-back pair of PN Diode junctions with a thin P-type filling between two N-type slices of 'bread'. In each of the N-type layers conduction can take place by the free movement of electrons in the conduction band. In the P-type (filling) layer conduction can take place by the movement of the free holes in the valence band. However, in the absence of any externally applied electric field, we find that depletion zones form at both PN-Junctions, so no charge wants to move from one layer to another [3].

Consider now what happens when we apply a moderate voltage between the Collector and Base parts of the transistor. The polarity of the applied voltage is chosen to increase the force pulling the N-type electrons and P-type holes apart. (i.e. we make the Collector positive with respect to the Base.) This widens the depletion zone between the Collector and base and so no current will flow. In effect we have reverse-biased the Base-Collector diode junction. The precise value of the Base-Collector voltage we choose doesn't really matter to what happens provided we don't make it too big and blow up the transistor! So for the sake of example we can imagine applying a 10 Volt Base-Collector voltage. As shown in the figure 1.9 the applying collector-base voltage.

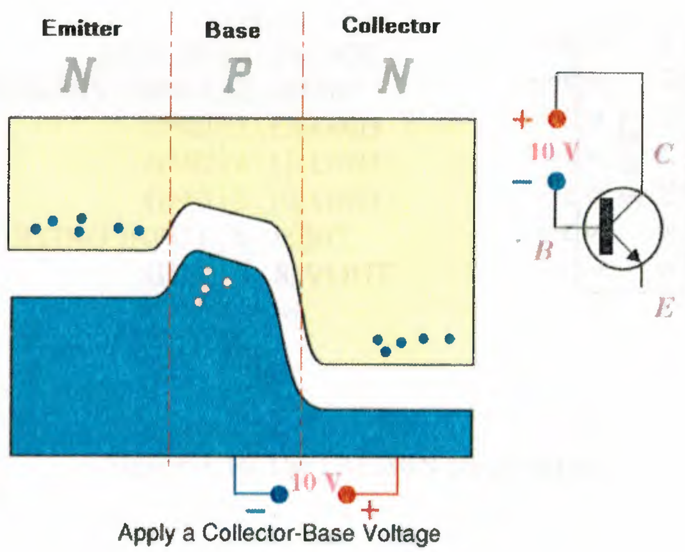

Figure 1.9: The applying collector-base voltage

1.2.3.3 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 1.10 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
                 +------+
```

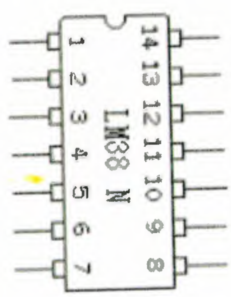

Figure 1.10 The LM380N construction

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 [4].

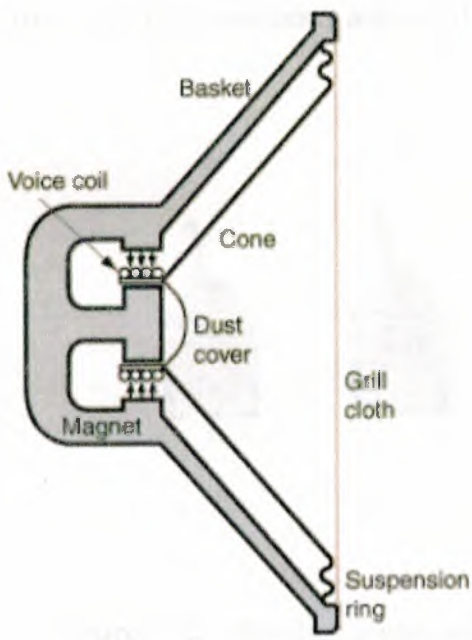

Figure 1.11: Loudspeaker.

1.2.5 Switches

It is not important to use a specific type of switches due to the similarity of creating a circuit. In this section the switch type which is used in the project is cleared as type and general information, MINIATURE TOGGLE SWITCH, a range of low coast panel mounting miniature toggle switches providing exceptional value available in single pole and double pole options including momentary biased options, as shown in figure 1.12.

- Contact rating: 6A, 125V, 3A 250V AC.
- Initial contact resistance: <20mΩ.
- Insulation resistance: >100mΩ at 500V DC.
- Contact material: copper alloy with silver inlay silver plated.
- Body material: flame retardant alkyd.
- Electrical life: > 1 x 104 cycles at full load (min.).
- Operating temperature -20°C to +65°C.

For biased switches (on) indicates momentary action [5].

Figure 1.12: Miniature toggle switches.

1.2.6 Ferrite Aerial

The radio receiver in this project uses a medium-wave ferrite aerial, and a suitable type is MW5FR.like all ferrite aerials, this consists of a coil of wire on a piece of ferrite. In the case of the MW5FR the piece of ferrite is a rod measuring about 172mm x 9.5 mm and there are two coils of wire on a paper former which is slipped onto the rod. The two coils are a large (tuned) winding and a smaller (coupling) winding. They are wound using wires of different colors so that it is easy to determine which lead-outs come from which windings. The coils are wound using lids wire (a number of thin enameled copper wire twisted together and given an overall layer of insulation as well),and the ends of the lead-out wires are ready-tinned with solder so that they should fit into the breadboard without too much difficulty.

It is not essential to use MW5FR aerial, and the circuits have been also tested using an MWC2 aerial coil on a 140 mm x 9.5 mm ferrite rod. However, this aerial coil has tag connections rather than lead-out wires, the leads must either be soldered to the tags or connecting using small crocodile clips. The circuits should work properly using any other standard medium-wave ferrite aerial provided the coil has the small coupling windings. As shown in figure 1.13 the ferrite aerial [10].

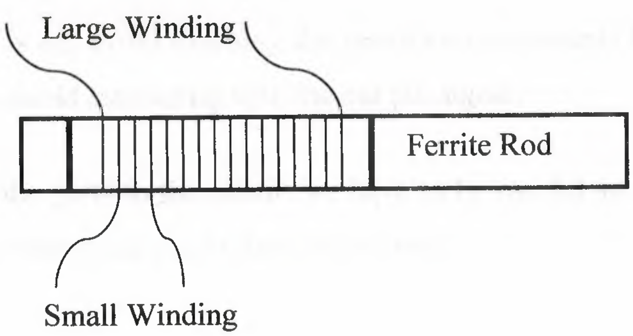

Figure 1.13: Ferrite aerial

1.3 Safety Guidelines.

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.
- While connecting the circuit components to the power supply we have to be aware of misconnecting its polarity to assure the safety of used components.
- While the circuit is on, avoid touching the sensitive components like the transistor, diodes and I.C. to avoid interfering with the out put signal.
- While soldering the parts to the circuit we have to be careful so as not to burn the parts which are sensitive and can be harmed by heat.

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. By applying the safety guidelines, the circuit should work smoothly.

In the next chapter, Modulating frequencies and transmitting radio waves and other used frequencies will be presented.

CHAPTER TWO

RADIO COMMUNICATION

2.1 Overview

In this chapter the spot light is on an interesting element in our life which has been played an important an important role in our life to make it easier and more relax able, it's the radio communications.

At the beginning of the 20th century, Guglielmo Marconi transmitted the first transatlantic radio signals from England to Newfoundland. Since then, radio communications have continually improved. Radio communication and principles are often taken for granted in these modern times; it is so commonplace!

Televisions, cordless phones, garage-door openers, Radio-Controlled model airplanes and cars, pagers, cellular phones, and security systems are all examples of commonplace radio communication technology.

2.2 Radio waves

Let's have a look at how radios work! What Are Radio Waves? Radio waves are part of a general class of waves known as electromagnetic waves. In essence, they are electrical and magnetic energy which travels through space in the form of a wave. They are different from sound waves (which are pressure waves that travel through air or water, as an example) or ocean waves (similar to sound waves in water, but much lower in frequency and a LOT bigger). The wave part is similar, but the energy involved is electrical and magnetic, not mechanical.

Electromagnetic waves show up as many things: At certain frequencies, they show up as radio waves. At much higher frequencies, we call them infrared light. Still higher frequencies make up the spectrum known as visible light. This goes on up into ultraviolet light, and x-rays, things that radio engineers rarely have to worry about. For our discussions, we'll leave light to the physicists, and concentrate on radio waves.

Radio waves have two important characteristics that change. One is the amplitude, or strength of the wave. This is similar to how high the waves are coming into shore from the ocean. The bigger wave has higher amplitude. The other thing is frequency. Frequency is how often the wave occurs at any point. The faster the wave repeats itself, the higher the frequency. Frequency is measured by the number of times in a second that the wave repeats itself. Old timers remember when frequency was described in units of cycles per second. In more recent times we have taken to using the simplified term of hertz (named after the guy who discovered radio waves). Metric prefixes are often used, so that 1000 hertz is a kilohertz, one million hertz is a megahertz, and so on.

2.2.1 Modulation

The important thing in any communications system is to be able to send information from one place to another. This means we have to find a way to impress that information on the radio wave in such a way that it can be recovered at the other end. This process is known as modulation. In order to modulate a radio wave, we have to change either or both of the two basic characteristics of the wave: the amplitude or the frequency.

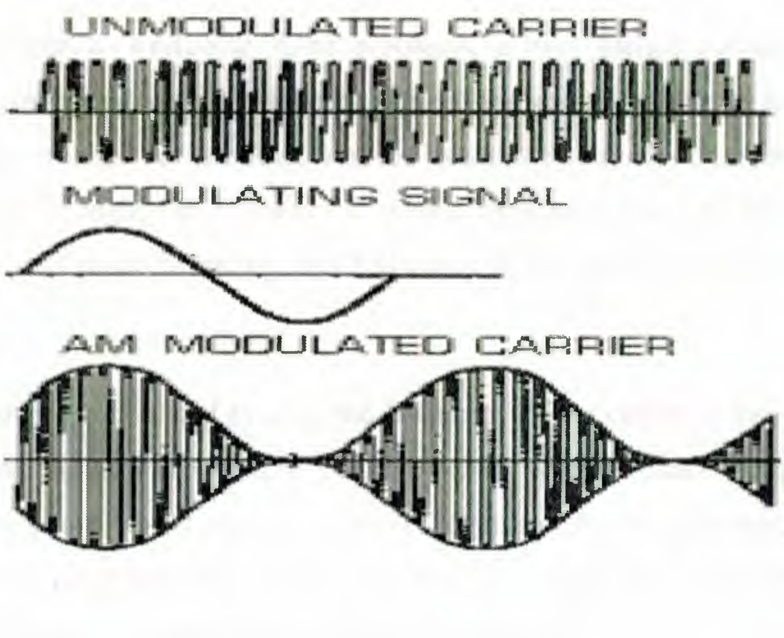

Figure 2.1: Modulating signals [5]

2.2.2 AM (Amplitude Modulation)

If we change the amplitude, or strength, of the signal in a way corresponding to the information we are trying to send, we are using amplitude modulation, or AM. The earliest means of radio communications was by Morse code, and the code key would turn the transmitter on and off. The amplitude went from nothing to full power whenever the key was pressed, a basic form of AM.

Modern AM transmitters vary the signal level smoothly in direct proportion to the sound they are transmitting. Positive peaks of the sound produce maximum radio energy, and negative peaks of the sound produce minimum energy. See the figure 2.1.

The main disadvantage of AM is that most natural and man made radio noise is AM in nature, and AM receivers have no means of rejecting that noise. Also, weak signals are (because of their lower amplitude) quieter than strong ones, which requires the receiver to have circuits to compensate for the signal level differences.

2.2.3 FM (Frequency Modulation)

In an attempt to overcome these problems, a man named Edwin H. Armstrong invented a system that would overcome the difficulties of amplitude noise. Instead of modulating the strength (or amplitude) of the transmitted signal, or carrier, he modulated the frequency. Though many engineers at that time said that FM was not practical, Armstrong proved them all wrong, and FM today is the mainstay of the broadcast radio services. [5]

In a frequency modulated system, the frequency of the carrier is varied according to the modulating signal. For example, positive peaks would produce a higher frequency, while negative peaks would produce a lower frequency. At the receiving end, a limiting circuit removes all amplitude variations from the signal, and a discriminator circuit converts the frequency variations back to the original signal.

In this way, the effects of amplitude noise are minimized. Since the recovered audio is dependent only on the frequency, and not the strength, no compensation for different signal levels is required, as is the case with AM receivers.

2.2.4 Other Types of Modulation

There are many types of modulation, but all are variations of AM or FM. AM variations include Single Sideband (SSB), Double Sideband (DSB), and Vestigial Sideband (VSB, commonly used in television). FM variations include Phase Shift Keying (PSK), Minimum Shift Keying (MSK) and others. There are hybrid systems as well, which combine both kinds of modulation. [5]

2.3 Propagation of radio waves

Propagation is the mechanics which affect how a radio signal travels. Under "normal" conditions the signal will not stray beyond its coverage area. However, occasionally, these signals can travel well beyond their usual range, possibly hundreds or even thousands of miles further. The signal has been propagated, by one of several ways.

Long distance propagation of radio waves depends on an invisible layer of charged particles, which envelops the Earth. This layer of charged particles known as the ionosphere has been in existence for millions of years. For those, who pioneered the long distance radio communication during the early part of the twentieth century, the ionosphere came as a boon. During the formative days of radio communication, radio scientists could not come to a definite conclusion about how radio waves propagated round the world. Both Radio and Television utilize radio wave, a form of electromagnetic wave that travels at a velocity of 300000 km per second in vacuum. Its velocity gets changed very negligibly in a different medium, which is insignificant, because the earth is a very small place with a radius of only 6000-km. Communication between any two points on the earth is thus almost instantaneous. But electromagnetic waves travel in straight lines until they are deflected by something. A long time ago, it was known that except for very short distances, the radio waves did not follow the natural curvature of the earth. Earth's curvature is a direct block to line-of-sight communication. When enough distance separates the two radio stations so that their antennas fall behind the curvature, the Earth itself blocks the transmitted signals from the receiver. There are certain radio frequencies, which can travel only in the line-of-sight. This means that higher the antenna of the radio transmitter, greater the distance covered by its transmission.

That explains why television transmission towers are made as high as possible. Radio frequencies in the range of 30 to 300 MHz (known as Very High Frequency) normally propagate only in the line-of-sight. The frequencies in the range of 300 MHz (Mega Hertz) to 3000 MHz (known as Ultra High Frequency) also propagate in line-of-sight. To receive radio signals in these ranges at a far away place from their place of origin, we need some kind of a reflector in between. You might have noticed big metallic plates on the mountain tops, which have a similarity to the roadside signboards. These are passive reflectors, which reflect VHF and UHF signals to far away places. A passive reflector is an object, which is not equipped with any kind of electronic circuitry to relay the radio signal. The moon, which had been in orbit for some 5 million years or more, was used as a natural passive reflector. This type of radio communication is known as Moon bounce radio communication. Ham radio operators refer to it as E.M.E., i.e. Earth-Moon-Earth and this describes exactly what happens; the radio signal leaves the earth, is reflected back off the moon, and comes back to earth. The reflected signal spreads out, and can be received at any place on earth where the moon is above the horizon. In case of using passive reflector to reflect VHF and UHF radio signals, large signal loss takes place between the transmitter and the reflector and an equal loss between the reflector and receiving station. It requires significant amount of power to assure a strong enough signal back on earth after the reflection process has taken effect. So, radio communication via artificial communication satellites, equipped with active electronic circuitry, which can re-transmit the received signal with an amplified power. The wavelength of the radio frequency used was approximately 915 meters. The formula to calculate wavelength of an electromagnetic wave is Wavelength in meters = 300/frequency In Mega Hertz. The dial of a radio receiver also marks either wavelength or frequencies or both [8].

On frequencies below 30 MHz, long distance radio communication is the result of refraction (bending) of the wave in the ionosphere. Under normal atmospheric circumstances, frequencies above 30 MHz do not propagate beyond the line sight. These signals penetrate the ionosphere and are lost into space. There must be some kind of reflecting medium in the upper atmosphere that caused the radio waves to be returned to Earth at considerable distances from the transmitter. Under the action of solar radiation and the hail of meteorites, an ionized layer is formed in the upper part of the Earth's atmosphere. In this layer, the neutral air molecules are decomposed into ions and electrons and the whole layer presents a chaos of charged particles. Short wave radio signals (radio signals which fall in the range of 3 to 30 MHz) are reflected from this layer just as light rays are reflected from the surface of a mirror, or sound wave from a barrier, likewise, this layer can be compared to the edge of a billiard table. Communication specialists use this layer like the edge of a billiard table: if the ball does not go straight into the pocket, it can be directed on the rebound. In the same way, the short wave signals radiated by distant radio stations get to our receiver on the rebound. They can continue traveling to several places round the world.

Unlike the short wave or high frequencies (HF), the frequencies ranging from 300 kHz to 3000 kHz, are known as medium frequencies and the band is known as Medium Wave band. There is very little daytime reflection of medium wave radio signal from the ionosphere resulting in coverage of about 100 kms only. The ionosphere is located above the troposphere, starting at an altitude of 30 miles above the surface of the earth and extending up to an altitude of 260 miles. The troposphere is the region of the earth's atmosphere immediately adjacent to the earth's surface and extending upward for some tens of kilometers. Radio waves are refracted or bent slightly, when traveling from one medium to another. Refraction is caused by a change in the velocity of a wave when it crosses the boundary between one propagating medium and another. If this transition is made at an angle, one portion of the wave-front slows down or speeds up before the other, thus bending the wave slightly. Radio waves are commonly refracted when they travel through different layers of the atmosphere, whether it is highly charged ionospheric layers 100 km and higher or weather-sensitive area near the Earth surface. When the ratio of the refractive indices of two media is great enough, radio waves can be reflected, just like light waves striking a mirror.

The role of ionosphere in radio wave propagation can be discussed only in terms of the different radio frequencies available for communication and in the light of the existence of different ionospheric layers.

Despite the fact that the introduction of artificial communication satellites for long distance radio communication made communication more reliable and there is very little role left to be played by the ionosphere in the professional telecommunication networks, it still draws the attention of communication enthusiasts, arm forces, spies and ham radio operators. Ionosphere is a gift of nature. Unlike the costly artificial satellites, we need not subscribe to anybody to get access to a facility, which can transfer our radio messages to distant parts of the world. It is worthwhile for a radio user to learn more about the ionosphere [8].

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 [5]

2.5 Types of Propagation

There are three basic types of propagation, line-of-sight, ground-wave, and sky-wave. When you're working at VHF or higher frequencies, line-of-sight propagation is the mode you'll need to understand. At HF, ground and sky-wave propagation is usually more important. There are other types of propagation, but these will do for now.

2.5.1 Line-of-Sight Propagation

Line-of-sight propagation requires a path where both antennas are visible to one another and there are no obstructions. VHF and UHF communication typically use this path. Unless you are VERY close to your destination, you need to keep the antenna as high as possible. Because radio waves follow a straight-line in this mode, they simply go off into space as the curvature of the earth causes the ground to drop away beneath the radio waves.

As we elevate the antenna, the distance to the horizon gets further and further away. With enough power to reach the other antenna and a high enough antenna to see it, we can talk without problems. VHF repeaters are usually mounted on high buildings or mountain tops for this very reason. When you are operating with a small VHF hand held, your signal must be able to travel in a straight-line to the repeater or your signal will be lost to someone beyond line-of-sight [8].

2.5.2 Ground-Wave Propagation

Ground-wave propagation is not a variation of line-of-sight propagation. In fact, ground-waves will travel further because the curved surface of the earth pulls the signal down and keeps it along the ground. You can reach an antenna which is below the horizon with ground-wave propagation, one you can't 'see' by line-of-sight propagation. BUT, since the signal interacts with the ground, it loses a lot of energy as it travels, severely limiting its range [8].

2.5.3 Sky-Wave Propagation

In this mode, the signal you send out radiates UP towards the ionosphere, 30 to 250 miles above the surface of the earth. Depending on how ionized it is and the frequency you're using, it will act more or less like a mirror to reflect your signal back to the earth some distance away. Your signal will literally SKIP over a wide section of country and come back down to earth many miles away. At this point, it can be reflected again to bounce a second time (and some times even more) back to earth again. It's like shining a searchlight up and having it reflected back to illuminate the ground many miles from the light. You can only talk to those people in the patch of earth that your antenna is 'illuminating' with it's signal. The place that the signal skipped over is called the skip zone.

What actually happens in the ionosphere is that the signal is bent (or refracted) by the ionosphere. Below the MUF (Maximum Usable Frequency), there is so much bending that the signal emerges from the bottom of the ionosphere pointed back at the ground. It's not REALLY a mirror and it doesn't REFLECT the signal [8].

2.6 Spectrum of frequencies

The frequencies which are used in transmission in unguided media occupies a large domain in the spectrum, they start from 30 KHz up to 300 GHZ. Of course this long domain is divided into smaller categories, and they are explained as in table 2.1 shown below.

Table 2.1 Frequency Classification

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

2.6.1 LF Low Frequencies

This is the segment between 30 – 300KHZ.within this segment of the spectrum there exists long wave radio broadcasting band, which is between 150 – 280 kHz. This band is rarely affected from ionosphere and therefore waves can travel only as terrestrial waves. Due to this characteristic, long waves are mainly used for domestic (national) radio broadcasting services.

One single powerful transmitter may cover a large section of a country. The transmitter powers are up to 200 KW in this band. Channel spacing is 9 kHz. Long waves are mainly used in continental Europe, central Asia and the Middle East. In the north and South America LW is not used for radio broadcasting services [1]. Lower and upper ends of the LF segment are generally used for navigation purposes.

2.6.2 MF Medium Frequencies

This segment of spectrum is between 300-3000 KHz. Within this segment there is Medium Wave radio broadcasting band which is between 520-1610 KHz.
Channel spacing is 9 kHz for Continental Europe and the Middle East and 10 kHz for north and south America. MW is quite different than LW as to reflection effect of ionosphere. Half of MW frequencies below 1000 kHz are almost similar to LW frequencies; however frequencies above 1000 kHz are almost similar to short wave frequencies in the high frequency segment of the frequency spectrum. Especially at night, MW frequencies maybe reflected from the ionosphere and may reach to far distances. For instance many Middle Eastern MW transmitters can be received in Turkey while Turkish MW transmitters can be received at far distances such as Cairo. This characteristic requires that MW frequencies are not purely domestic frequencies and they have to be regionally planned. Such plans must be realized with close relationship of neighboring countries. In the history of MW broadcasting there had been many instances of tense relationships between the countries with hostile positions [1].

Due to the ionospheric reflection see fig 2.2 possibilities of MW frequencies, MW is a band not only for domestic radio broadcast but also for international radio broadcast. This may easily be seen in the relays that carry a program of a far distanced transmitter. VOA (Voice of America has MW relays in Rhodes while BBC has in Southern Cyprus

(1323 KHz. Radio Monte Carlo (relays also Trans World Radio program) has a MW relay in Southern Cyprus (1233 KHz). Lower and upper ends of MW band are allocated for navigation finding and wireless communication 2182 KHz [1].

Why frequencies are scarce resources?

The spectrum is limited in practice, it is not possible to produce unlimited number of frequencies, and only some portions of the spectrum are allocated for certain services. And also each transmission requires a bandwidth. The bandwidth required depends upon the data transmitted and the modulation technique of the transmission. For example for LW and MW requires a bandwidth of 9/10 KHz.

Also the receiving end (the receiver) plays an important role in defining the bandwidth. Simple receiver receive wider bandwidth (low selectivity) wile improved receivers receive narrow (exact) bandwidth (high selectivity).

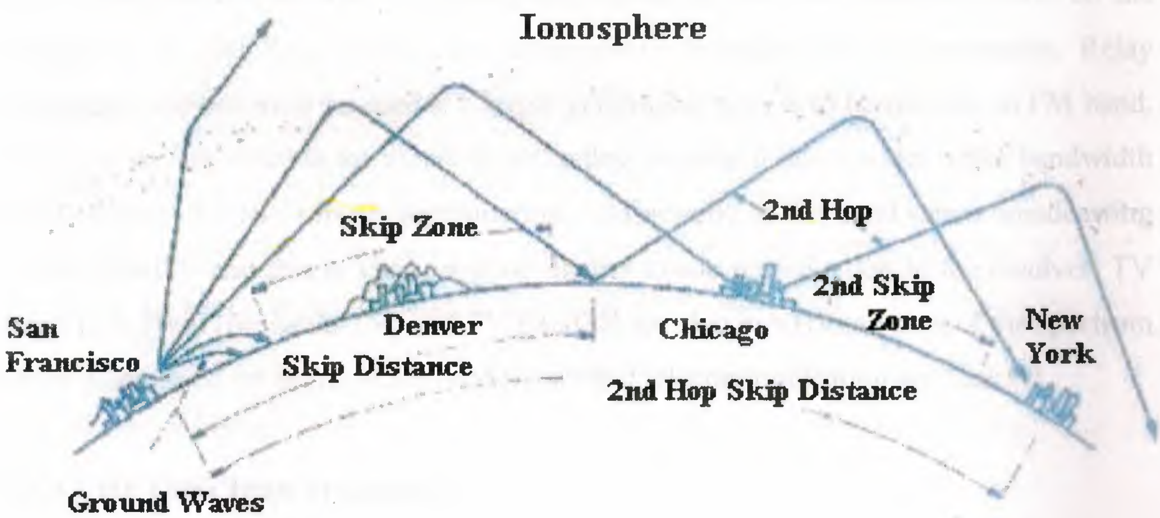

Figure 2.2 radio wave reflections from ionosphere

Each transmitter produces harmonic frequencies, witch also carries the same data, and these frequencies are useless and therefore wasted. Also some receivers receive some shadow frequencies of the transmission frequency and therefore they the west some frequencies. It is not (normally) possible to use the some frequency in the same geographic location. Therefore the second transmitter in the same location must use a different frequency. This also limits the possible number of frequencies to be used.

Because of this factor frequencies are limited and they are treated as scarce resources. Therefore they are of economical and political importance. ITU with its WARC manages the spectrum allocation plans on international level. The spectrum plan we use to they is based on the allocation of 1977 WARC [1].

2.6.3 VHF Very High Frequencies

They range between 30-300 MHz. Within this segment of the spectrum there exist FM radio broadcast band between 88 and 108 MHz. FM radio band is usually for local radio broadcasters since the electromagnetic waves on this band can only travel on the surface up to 100 Km. if there are no physical obstacles such as mountains. Relay (repeaters) stations must be used if a larger geographic area is to be covered in FM band. FM band is very suitable for music broadcasting because it has a wider audio bandwidth nearly enough for Hi-Fi music reproduction. Additionally in FM band stereo broadcasting is also possible and this is vital for good quality music reproduction in the receiver. TV Band I, S- Band (for cable-TV) and TV Band III are also in VHF segment of the spectrum. Other portions of the segment are used for several telecommunication services [9].

2.6.4 UHF Ultra High Frequencies

This is the segment between 300-3000 MHz. TV Band IV and V are in this segment. N.M.T., between 425 - 430 MHz. G.S.M. phones frequencies are also within this segment, 900 MHz and 1.8 GHz [6].

2.6.5 SHF Super High Frequencies

They are between 3 to 30 GHz. Satellite band C (4 GHz), Ku (11 GHz) and Ka (17 GHz) are in this segment. [6]

2.6.6 EHF Extremely High Frequencies

They are between 30 - 300 GHz. Some radars and military communication equipment and experimental devices use these frequency segments. As shown in the table 2.2 the classification of frequencies bands. And we can see some uses of the different frequencies and their classifications down in (table 2.2) [6].

Table 2.2 Radio Frequency - Classification and Use [6]

Category	Frequency	Use
Low-Med (LF-MF)	3-535 kHz	Maritime and aeronautical navigation and communication.
Medium (MF)	535-1605 kHz	Standard AM broadcast
High (HF)	27 MHz	Citizens Band (CB) radio
Very High (VHF)	30-50 MHz	Emergency services radio
	50-54 MHz	Amateur 6-meter band
	54-216 MHz	Television channels 2-13
	88-108 MHz	Standard FM radio broadcast
Ultra high (UHF)	470-890 MHz	UHF Television channels 14-83
	1.3-1.6 GHz	Radar
Super high (SHF)	4-8.5 GHz	Satellite communication
Extra high (EHF)	30-300 GHz	Experimental and amateur radio

2.6 Summary

This chapter presented the radio waves, its modulation, its propagation, the affect of atmosphere layers on it, and how a radio wave travels and the types of propagation, as we presented classifications of frequencies which are used in radio and other purpose.

Now after reviewing the techniques of transmission, and already an explanation of the necessary components for the circuit is given. It is the time to start setting up the circuit.

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 Radio Circuit

The circuit as shown in fig. 3.1 is a bit complicated and it is difficult to understand the function of each component, so it is better to separate the circuit into two sides, each side has specific job to do, oscillating side and amplifying one.

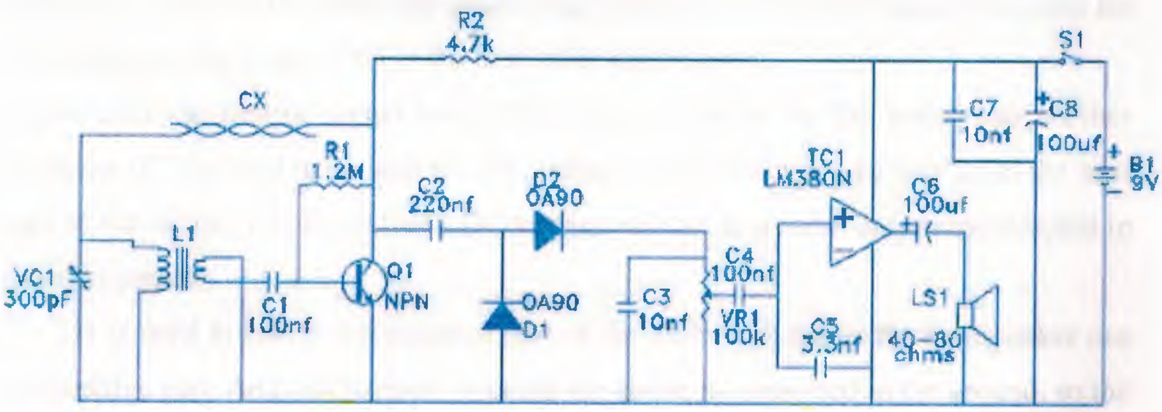

Figure 3.1 Circuit diagram of MW radio.

3.2.1 Oscillating Part

The oscillating part as shown in fig 3.2 is quit smoother than it was shown above. Here the connection between variable capacitor (VC 1) and the ferrite aerial (L1) is the receiving part of the radio, the ferrite aerial is the component which converts the radio waves into electrical signals, but it is convert all waves in the MW transmission frequencies, so the connection between it and VC1 is introduced to pass the desired frequency. But how is that happens?

$$f_0 = \frac{1}{CLW} \tag{3.1}$$

The above equation gives the output of a capacitor and inductor connected in parallel, this frequency is called resonance frequency. And when the resonance frequency equal to transmission frequency, the transmitter radio signal enter to the circuit as electrical signal and passed into the circuit through the LC connection.

After the desired signal enters through the parallel connection between VC 1 and L1, the signal reaches C1, which is used to filter any DC voltage carried with desired signal, which is an AC type.

After the signal has been filtered out from any undesired DC voltage it is ready to enter the phase of pre-amplifying process. This process is performed by the NPN transistor and R1 which is used as feedback path, it is know in general that the larger the feedback resistance the better the amplifying process, but this rule has a limit, and for this transistor, the value of R1 is the best value can be used.

Again after the desired signal has a DC voltage supplied by the battery, so another capacitor (C2) is used to prevent this DC voltage from continuing its way up to the next part of the circuit (it is know that a DC voltage will act as a noise or unwanted signal in the loudspeaker).

D1 is used to cancel the negative part of the desired signal as the loudspeaker use the positive part. And that happens because the anode is connected to the ground, so the D1 is not in the forward bias until the cathode becomes more negative than zero, and that means the negative side of the desired signal. D2 has a minor role compared to D1; its role is to cancel the residue of the negative side of the desired signal, as D1 allow a small value of negative side of the desired signal to reach D2. That happens due to the triggering voltage which is needed to change the statues of D1 from isolator to conductor, and this voltage depends on the type of the diode, so if the diode is made of silicon, this needed voltage equal to -0.7V, and Wit is made of germanium -0.3V is the needed voltage to trigger D1.

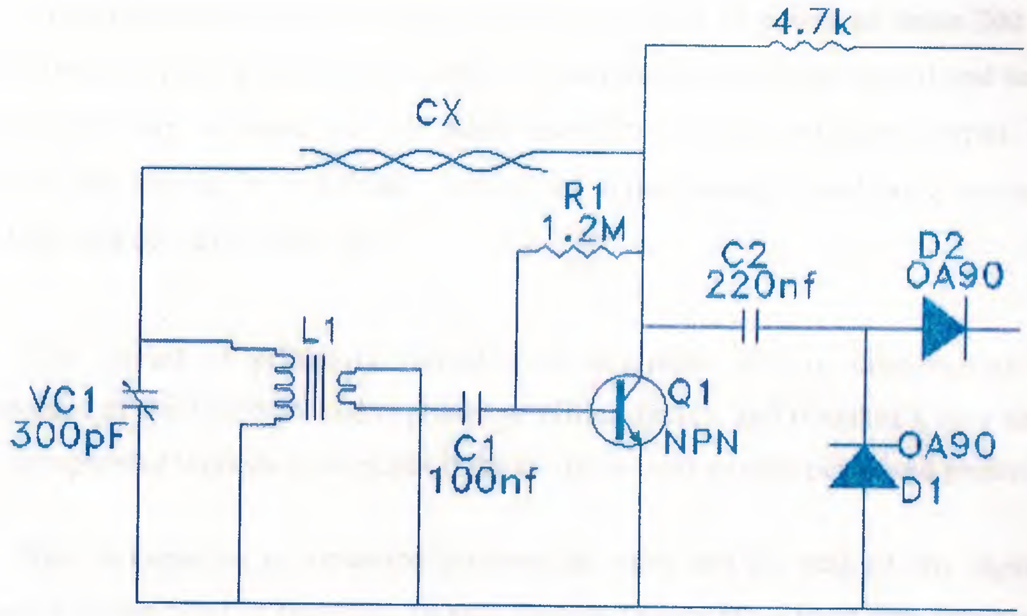

Figure 3.2 Oscillating part diagram of MW radio.

3.2.2 Amplifying part

After the desired signal is cleanly out of the huge number transmission frequencies, and prepared to be amplified by filtering any DC voltage from it, it is almost ready to enter to the amplifying phase, see fig.3.3.

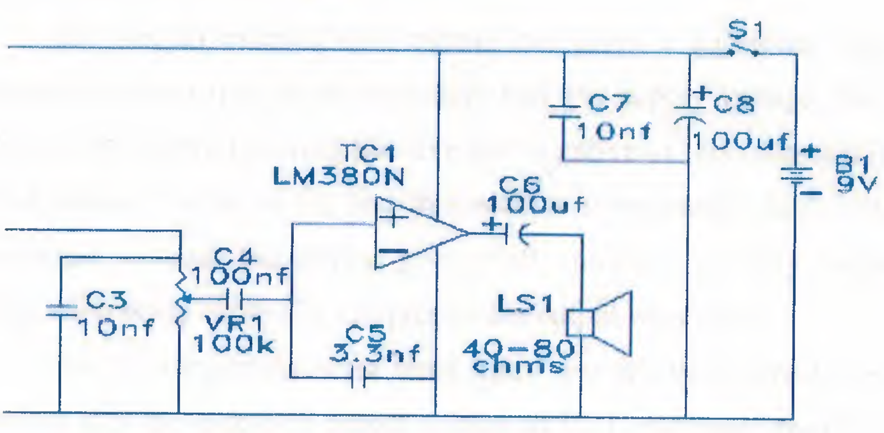

Figure 3.3 Amplifying part diagram of MW radio

This extremely simple circuit provides an output of power of about 200 mW RMS (about equal in volume to a small or medium-size transistor radio) and has an input sensitivity of about 50 mV RMS into 100 kΩ for maximum output. This enables the unit to be fed from a variety of signal sources, such as a crystal or ceramic pickup, radio tuner, etc.

The circuit is primarily intended as a simple one to demonstrate the properties of the LM380N audio-power amplifier device, and it makes a very useful and inexpensive workshop amplifier if the circuit is built as a proper, cased project.

When a capacitor is connected between the earth and the path of any signal, it allows a certain band of frequency to pass through (it acts like a band pass filter), so to make sure that no any other radio waves entered to the circuit, C3 is used to let only the desired signal to pass, the values of the capacitance and the impedance of C3 control the range of allowed frequencies to pass, in MW it allows frequencies up to 3000 kHz. VRl is the volume control resistance; by tuning it we can control the input signal going to IC (LM308N) and coming in from the radio circuit and which has been filtered by the C3 capacitor which is connected parallel with VR1.

As a final assurance of eliminating any DC voltage C4 is used, so that almost pure AC will enter to the amplifier from pin-2 (the non inverting input pin).

C5 has not a vital role in filtering process, but it is important for LM380N's gain value determining, actually the gain of this amplifier varies as the value of C5 change, the gain range is from 34 dB to 40 dB.

IC1 has an internal bias circuit that gives a quiescent output voltage at the output terminal (pin 8) of nominally half the supply voltage, the AC input signal causes the output to swing positive and negative of this quiescent level by about plus and minus 3 volts or so, and this enables a reasonably high output power to be obtained without the output going fully positive or fully negative, and serious distortion being caused by clipping of the output waveform.

If a DC component on the input signal was allowed to reach the input of IC 1 this would alter the quiescent output voltage of IC 1, and could result in the output going almost fully positive or negative. Only a very small output power would then be possible without the signal becoming badly distorted.

C6 provides DC blocking at the output so that loudspeaker only receives the varying output voltage from IC 1, and not the quiescent (DC) output voltage, which would Give a high standing current through the loudspeaker produce a very high level of current consumption.

The LM380N has a class AB output stage, and this means that the average current consumption of the device (which is around 10 mA) remains virtually constant at low and medium output powers, but increases somewhat at high output powers. This gives reasonable battery economy, and a PP6 or larger 9-volt battery makes a suitable power source. There is some variation in the supply voltage due to variations in the loading on the battery by IC 1 as the output power inevitably fluctuates quite rapidly and over a fairly wide range with any practical input signal This can result in a loss of performance or instability, and decoupling capacitors C7 and C8 are included to prevent either of these occurring.

As finally the C7 and C8 are connected in parallel with battery to cancel any AC signal coming from it.

An additional decoupling capacitor can be added from pin 1 of IC 1 to the negative supply, and this decouples the supply to the preamplifier stages of the device.

This is not normally necessary when the LM380N is employed with a battery supply, and is a facility give a high standing current through the loudspeaker produce a very high level of current consumption.

An additional decoupling capacitor can be added from pin 1 of 10 to the negative supply, and this decouples the supply to the preamplifier stages of the device.

This is not normally necessary when the LM380N is employed with a battery supply, and is a facility that is normally only required when the device is used with a mains power supply that has high ripple content. You might be confused by the fact that one lead to IC1 in Fig. 3.3 is marked "3, 4, 5, 7, 10, 11, and 12". This lead is marked with six pin numbers merely because these six pins are internally interconnected, and a connection to one of them is a connection to the other five.

The case should ideally be an all-metal type so that it screens the Circuitry from stray pick-up of mains hum and similar electrical signals, and the case should be earthed to the negative supply. With most types of audio socket, this chassis connection will be automatically provided through the earth lead to the socket. The test leads should use screened cable (the outer braiding connecting to the chassis of the amplifier).

An interesting feature of the LM380N device is that it has two inputs, pin 2 is the non-inverting input and pm 6 is the Inverting input. An input signal to pin 6 produces a change in output voltage that is of the opposite polarity, whereas an input to pin 2 gives a change in output voltage that is of the same polarity as the input signal.

There is no audible difference between the two, and the fact that the signal is inverted through IC 1 if the input at pin 6 is used is not really of any practical importance. The circuit works equally well whichever of the two inputs is used and this fact can easily be demonstrated in practice.

3.3 Project's Components' List

In chapter one, a description of the components and the practical use of each one were given, but in this section, the value and type of each component, see table 3.1.

3.4 Analysis

Although the output sound from this project is very low; 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.

3.5 Summary

This chapter has presented the components of the radio and amplifier circuit and the function of each component, and how does it contributes in the process of filtering and amplifying, it is possible to connect the circuit and have MW radio circuit.

The modification is done on this project by changing the amplifier that had been used with another one stronger to be better. In Chapter four a new amplifier will be used and a discussion about it, also the most problems probable to happen and it presents some suggested solutions for this project.

Table 3.1: Components and their Descriptions

Symbol of the component	Value and description
R1	1.2M
R2	4.7k
VR1	100k log. carbon
C1	100nF, polyester
C2	220nF, polyester
C3	10nF, polyester
C4	100nF, polyester
C5	3.3nF, ceramic
C6	100µF, 10V electrolytic
C7	10nF, polyester
C8	100µF,10 electrolytic
VC1	300pF solid dielectric
TR1	BC101C
IC1	LM380N
D1	OA90
D2	OA90
S1	SPST miniature toggle type
LS1	Miniature type having an impedance in the range 40-80 ohms
L1	Ferrite aerial
B1	PP6 size 9V and connector to suit

CHAPTER FOUR
PROBLEMS, SOLUTIONS & RESULTS

4.1 Overview

In this chapter we will illustrate the problems that we have faced in this project and solutions we used the radio should work properly now, and especially the sound problem that had been modified by changing the Amplifier by using another new IC which it called LM386.

In general practical electronic hardware projects there will always be problems and probable solutions.

4.2 Problems & Solutions

4.2.1 Variable Capacitor

Again the 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 4.1 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

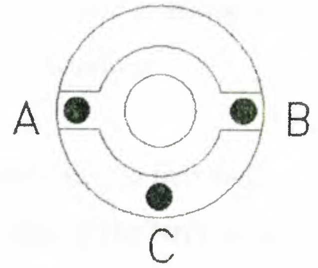

Figure 4.1: Below view of variable capacitor

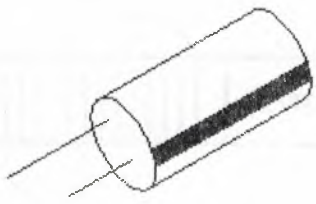

Figure 4.2: Polarized capacitor

4.2.2 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.

4.2.3 Ferrite Aerial

Ferrite aerial has four lead-out wires, actually it consists of two windings, large and small one, it is quite hard to decide which of them is connected to the other because of the aerial delicate manufacturing, to determine which wires are connected to each other, ammeter is used and adjusted to measure the existence of a connection by put the function controller to diode position, if the ammeter shows any value, that means the two tested wires are the two ends of same winding, if the ammeter shows nothing that means it is time to test another wire. By using the ohmmeter we test two wires out of four, in case of reading the smallest value it shows the small winding, in case of reading the biggest value it shows the large winding.

Usually red and green colored wires are the two ends of the small winding, and skin and black colored wires are the two ends of the large winding as shown in figure 4.3 Ferrite aerial.

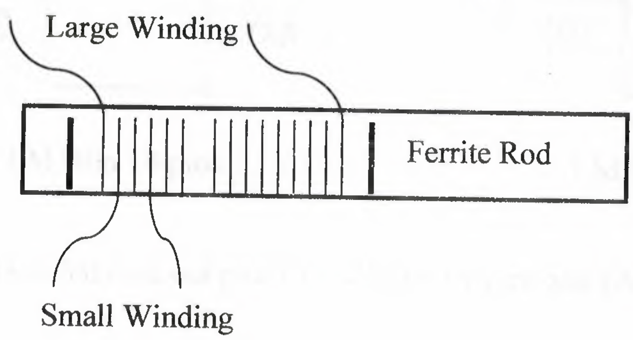

Figure 4.3 Ferrite aerial.

4.2.4 LM380N

LM380N is an ordinary operational amplifier I.C. so it is not a big deal to know how to connect it, but what if the required LM380N 14-pins are not available.
The alternative chip is LM380N 8-pins can be used instead, but of course a new connection method is applied, to know better about what each pin in the 14-pins and 8-pin represent see fig 4.4.

So each pin represent a specific job, so if the 14-pins chip connection is reconnected to 8-pins chip by the right configuration, the same job well be done.

But, what if there is no chip LM380N at all? The solution of this problem is to build a circuit that will do the function of this chip; the circuit diagram is shown in fig 4.5.

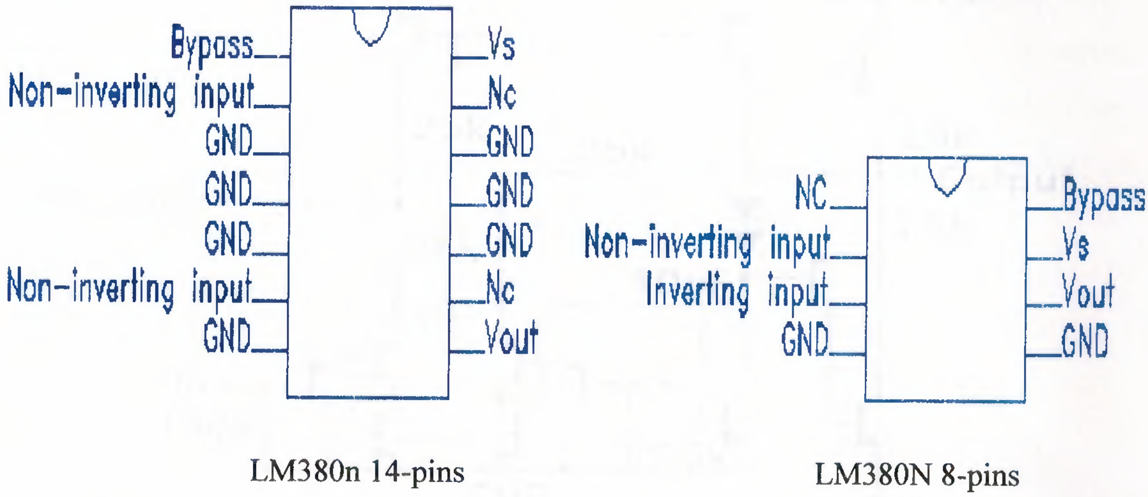

Figure 4.4: Detailed lead-out pins of LM380N 14-pins and LM380N 8-pin

4.2.5 LM386

The modification that has been done on our circuit by changing our old amplifier that used the LM380N IC by more powerful IC which is suitable with our project its name is (Low voltage amplifier) or LM386 IC, see fig 4.6. [9]

It is an 8-pins chip with the same gain but less input impedance value, so a change in the variable resistance must take place, and the best available variable resistance in stocks is 10k ohms variable resistance. And also LM386 must have low output impedance, so it is advised if LM386 is installed to the circuit to connect 4 ohms impedance loudspeaker rather than 80 ohms. [11]

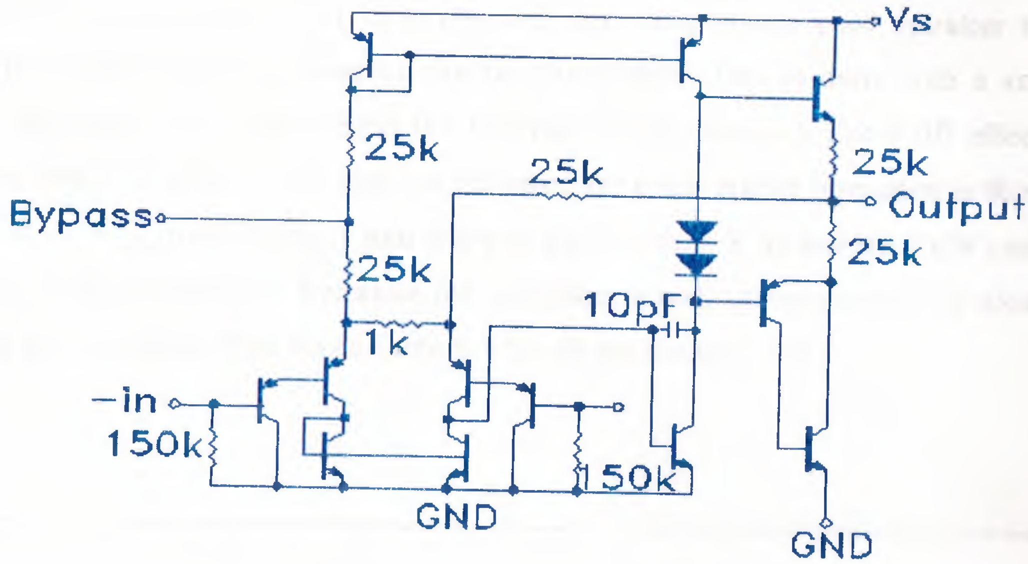

Figure 4.5 Circuit diagram of LM380N chip [10]

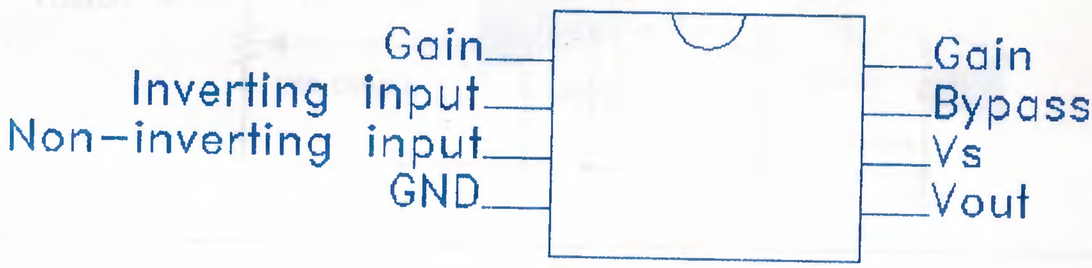

Figure 4.6 LM 386 chip diagram [9]

To avoid oscillation of the circuit, it is a must to connect a 100uF electrolytic capacitor between pin #6 and ground. This capacitor is shunted in parallel with another one of 0.1uF. It can be either ceramic or Mylar see Figure 4.7.

To make the LM386 a more versatile amplifier, two pins (1 and 8) are provided for gain control. With pins 1 and 8 open the 1.35 kW resistors sets the gain at 20 (26 dB). If a capacitor is put from pin 1 to 8, bypassing the 1.35 kW resistors, the gain will go up to 200 (46 dB). If a resistor is placed in series with the capacitor, the gain can be set to any value from 20 to 200. Gain control can also be done by capacitive coupling a resistor (or FET) from pin 1 to ground. Additional external components can be placed in parallel with the internal feedback resistors to tailor the gain and frequency response for individual applications. For example, we can compensate poor speaker bass response by frequency shaping the feedback path. This is done with a series RC from pin 1 to 5 (paralleling the internal 15 kW resistor). For 6 dB effective bass boost: R with 15 kW, the lowest value for good stable operation is R = 10 kW if pin 8 is open. If pins 1 and 8 are bypassed then R as low as 2 kW can be used. This restriction is because the amplifier is only compensated for closed-loop gains greater than 9 see table 8.1 for all pin details. [12]

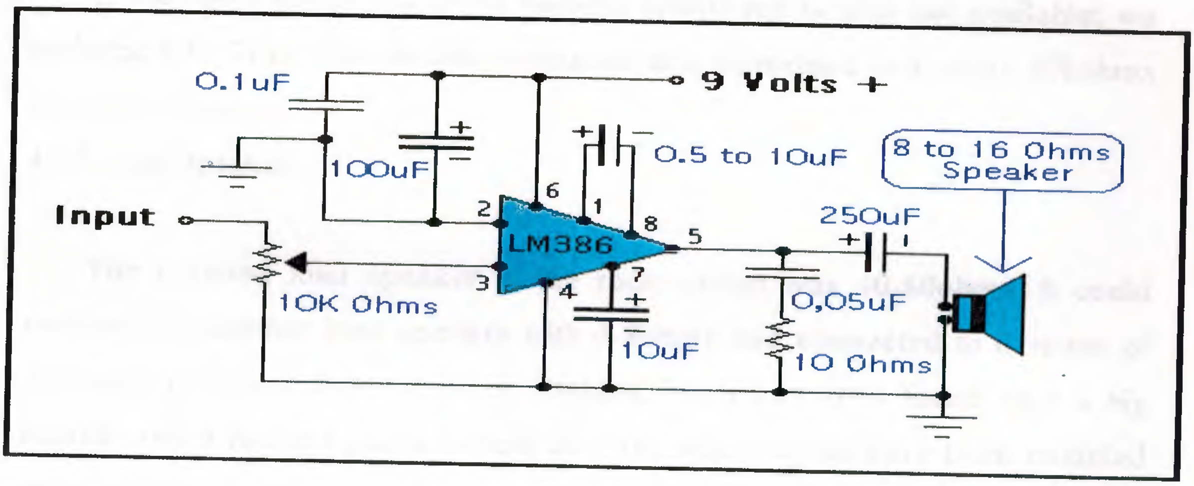

Figure 4.7: LM386 General

Table 4.1: LM386 Components & Description

Pin	Name	Description
1		Gain set
2		Inverting Input
3		Non Inverting Input
4	GND	Ground
5		Output
6	Vcc	Positive Voltage Input
7		Bypass
8		Gain set

4.2.6 Diodes

In the radio circuit the given diodes values are not available in the market, by searching in the references we founded other values of the diodes that can come instead of the diodes mentioned in the circuit.

4.2.7 Variable Resistance

In the radio circuit the given variable resistance is also not available; we replaced it by 20kohms variable resistance and connected to it series 80kohms constant resistance.

4.2.8 Loud Speaker

The required loud speaker in the radio circuit was 40-80ohms; It could replaced by another loud speaker with 4-8ohms and connected to it series of constant resistance have value of 70ohms, but it had been found after a big search, and it doesn't give a benefit after the whole circuit have been modified with our new amplifier.

4.3 Results

After a hard wok the first test gave us undefined volume from the speaker, they were working but there is something wrong. The ferrite cables hadn't been connected in a good way. After connected it the second test was successful. And our new general circuit after replacing the amplifier you can see it on figure 4.8.

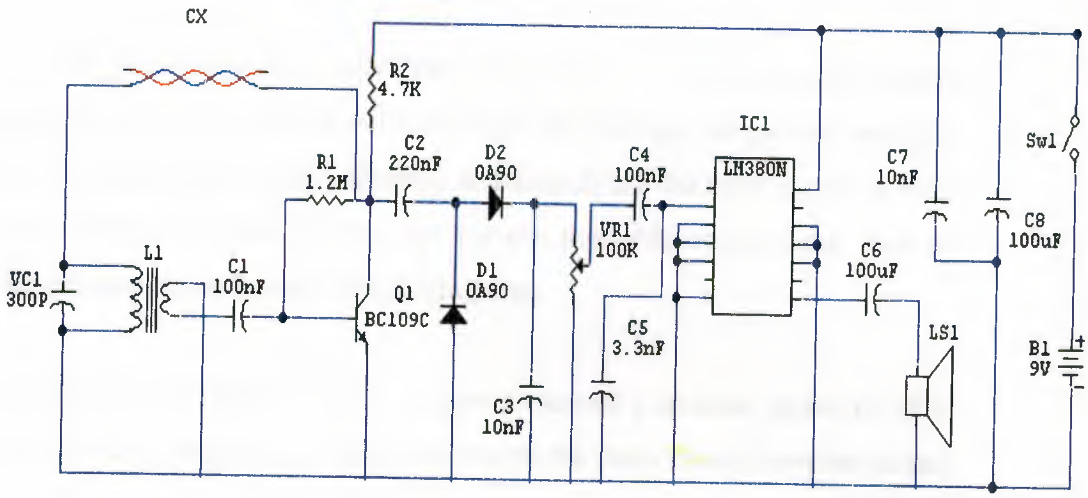

Figure 4.8: The complete circuit after modifying

4.4 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, you can see the figure of the project on figure 4.9.

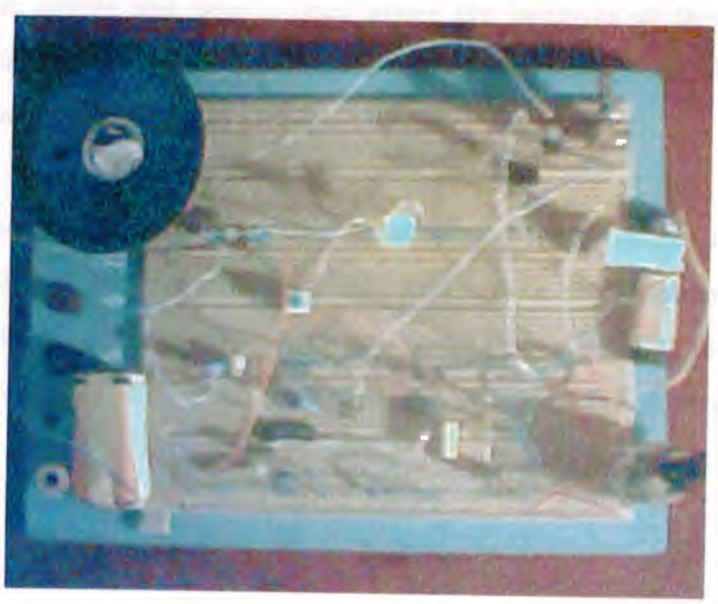

Figure 4.9: My Project

CONCLUSION

After a great deal of working over this experiment of preparing this project theoretically and practically; we found out how much knowledge we gained and how much techniques we learnt in receiving, filtering and amplifying the input signal in MW radio, and how to manage to have alternatives for not available components, how to enhance filtering process, to understand amplifying one.

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

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

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

Chapter three was the most important chapter of this project, it 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 components 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, also contain the results after the modification.

The main guidelines of this project were:

- To design, build and test a working MW radio.
- To gain experience as much as we could with practical electronics projects.
- To sort out problems within the circuits and make modifications, to overcome the problems.

Firstly while the project was in progress, we realized the components which were supposed to be used in the project, then we started connecting the circuit as planned.

When the circuit got ready, we started testing the circuit and detecting the problems were preventing circuit from working properly.

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 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 tutor who gave me great deal of advices.

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