NEAR EAST UNIVERSITY

Faculty of Engineering

Department of Electrical and Electronic Engineering

A MW Radio design & Amplifier

Graduation Project
EE 400

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Nicosia - 2005

IN THE NAME OF ALLAH, MOST GRACIOUS, MOST MERCIFUL.

I would like to express my deepest appreciation to my god who stood beside me all the time, who supported me in all my achievements and who has given me the power and patience to finish my college studies successfully.

Firstly I would like to thank my parents and pay special regards for guiding me through my studies, which are enduring these all expenses and supporting me in all events. I am nothing without their prayers. They also encouraged me in crises. I shall never forget their sacrifices for my education so that I can enjoy my successful life as they are expecting. They may get peaceful life in Heaven.

And I feel proud to pay my special regards to my project adviser" Assoc. Prof. Dr. Adnan Khashman". He never disappointed me in any affair. He delivered me too much information and did his best of efforts to make me able to complete our project. He has Devine place in my heart and I am less than the half without his help. I am really thankful to my doctor. As well as thanks to our electronic lab assistant ENG. KAMEL for his help. Not to forget to give my thanks to the NEAR EAST UNIVERSITY education staff especially to electrical and electronic engineering doctors for their help to take this degree and to achieve this level.

And I want to honor those all persons who have supported me or helped me in our project starting with my partner MURAD ALKURDI and my best friends, ASEM SAIED, HANI ESSA, KHALDUN AL JAZZAZI. I also pay my special thanks to my all friends in Jordan, MOHMMAD AL MOMANI, RAMI SHARAB, ABDULLAH ALOMARI, and my brothers engineer ZAKI ABDULLAH ,lawyer AMJAD ABDALLAH.

AHMAD ABDALLAH

ABSTRACT

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

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

This project presents a hardware electronic project which is designing and building an MW radio. The design is going be modified to receive FM signals in the future.

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INTRODUCTION

The radio has been widely used for communications purposes in almost all life parts; as it has been installed in some other products as an additional option; to give the opportunity to people to keep up dated and well 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.

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 four will present the problems, test results and future modification of the MW radio where connecting a simple FM radio with the AM circuit using a three pin ON-OFF-ON switch will be explained in this chapter, as well as the differences between the FM radios and AM one.

CHAPTER ONE

ELECTRONIC COMPONENTS

1.1 Overview

This chapter is going to be about describing electronic components that are used commonly and widely in hardware projects. In addition safety guidelines are going to be well explained.

1.2 Introduction

What is electricity? This question is impossible to answer because the word "Electricity" has several contradictory meanings. These different meanings are incompatible, and the contradictions confuse everyone. If a person does not understand electricity, he/she is not alone. Even teachers, engineers and students have a hard time grasping the concept.

Electricity is a mysterious incomprehensible entity which is invisible and visible at the same time. It is both matter and energy. It's a type of low-frequency radio wave which is made of protons. It is a mysterious force which looks like blue-white fire and yet cannot be seen. It moves forward at the speed of light... yet it vibrates in the AC cord without flowing forwards. It's totally weightless, yet it has a small weight. When electricity flows through a light bulb's filament, it gets changed entirely into light. Yet no electricity is ever used up by the light bulb, and every bit of it flows out of the filament and back down the other wire. College textbooks are full of electricity, yet they have no electric charge. Electricity is a class of phenomena which can be stored in batteries! If a person wants to measure a quantity of electricity, what units should he/she use? Why Volts of course. And also Coulombs, Amperes, Watts, and Joules, all at the same time. Yet "electricity" is a class of phenomena; it's a type of event. Since we can't have an amount of an event, we can't really measure the quantity of electricity at all.

1.3 Resistors

These are small cylindrical components having a leadout protruding from each end where the magnitude of opposition to the flow of current is called the resistance of the resistor. A larger resistance value indicates a greater opposition to current flow. The resistance is measured in ohms. An ohm is the resistance that arises when a current of one ampere is passed through a resistor subjected to one volt across its terminals, the simplest resistors are made from carbon rod with end caps and wire leads, other types are carbon film which is a thin layer of carbon on a ceramic rod, and metal oxide and metal glaze on glass rods. The 'box' symbol for a fixed resistor is popular in the UK and Europe. A 'zig-zag' symbol is used in America and Japan:

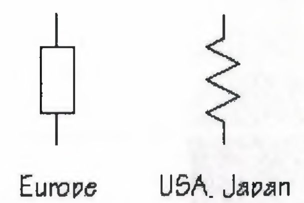


Figure 1.1 US and EU resistors [1]

Resistors are used with transducers to make sensor subsystems. Transducers are electronic components which convert energy from one form into another, where one of the forms of energy is electrical. A light dependent resistor, or LDR, is an example of an input transducer. Changes in the brightness of the light shining onto the surface of the LDR result in changes in its resistance. As will be explained later, an input transducer is most often connected along with a resistor to to make a circuit called a potential divider. In this case, the output of the potential divider will be a voltage signal which reflects changes in illumination.Microphones and switches are input transducers. Output transducers include loudspeakers, filament lamps and LEDs. Can you think of other examples of transducers of each type?In other circuits, resistors are used to direct current flow to particular parts of the circuit, or may be used to determine the voltage gain of an amplifier. Resistors are used with capacitors to introduce time delays.

1.3.1 Colour code

How can the value of a resistor be worked out from the colours of the bands? Each colour represents a number according to the following scheme:

Table 1.1 Resistor color codes.

Number	*Color*
0	black
1	brown
2	red
3	orange
4	yellow
5	green
6	blue
7	violet
8	grey
9	white

The first band on a resistor is interpreted as the firest digit of the resistor value. For the resistor shown below, the first band is yellow, so the first digit is 4:

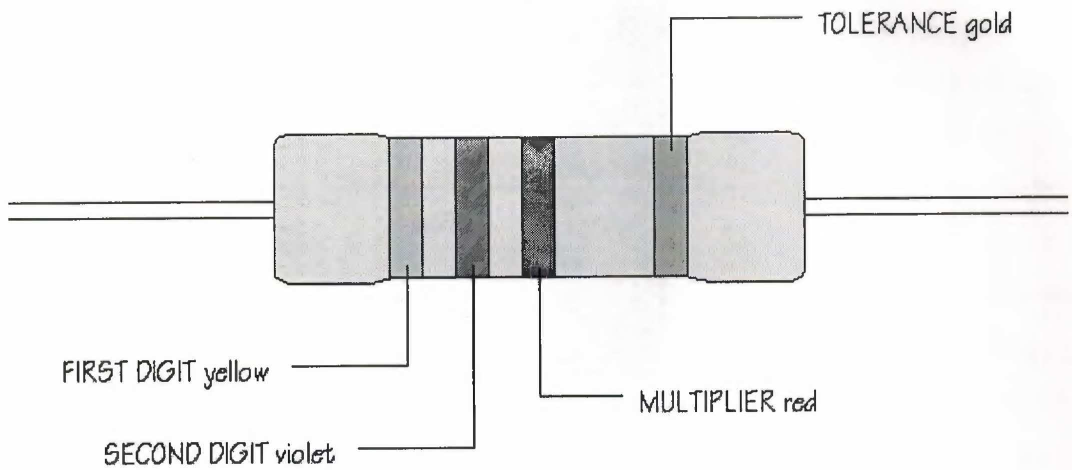


Figure 1.2 Resistor [2]

The second band gives the SECOND DIGIT. This is a violet band, making the second digit 7. The third band is called the MULTIPLIER and is not interpreted in quite the same way. The multiplier tells you how many noughts you should write after the digits you already have. A red band tells you to add 2 noughts. The value of this resistor is therefore 4 7 0 0 ohms, that is, 4 700 Ω, or 4.7 $k\Omega$. Work through this example again to confirm that you understand how to apply the colour code given by the first three bands.The remaining band is called the TOLERANCE band. This indicates the percentage accuracy of the resistor value. Most carbon film resistors have a gold-coloured tolerance band, indicating that the actual resistance value is with + or - 5% of the nominal value. Other tolerance colours are:

Table 1.2 Resistor color code.

Tolerance	Color
±1%	brown
±2%	red
±5%	gold
±10%	silver

1.3.2 Types of Resistors

1. **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).
2. **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.
3. **Metal film resistor:** good temperature stability, good long time stability, cannot handle overloads well.
4. **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.

5. **Thick film resistor:** similar properties as metal film resistor but can handle surges better, and withstand high temperatures.
6. **Thin film resistor:** good long time stability, good temperature stability, good voltage dependently rating, low noise, not good for RF, low surge handling capacity.
7. **Wire wound resistor:** used mainly for high power resistors, can be made curate for measuring circuits, high inductance because consists of wound wire
8. **Variable Resistors:** the variable resistor is a very important component that is found in many electrical for such things as tone and bass controls as well as volume. This is due to the fact that resistors can be joined together with other components to form filters for a desired levels. They can also be found in computer monitors for color or positioning as well as the dimming switch for your lamps. This is done through digital to analog and analog to digital circuits, one great advantage to this is that you are able to turn a knob instead of typing a value in every time you want to change the tint or brightness. The schematic for the variable resistor has stayed the same for quite some time and can be seen at the illustration to the upper right .

1.4 Capacitor

A capacitor is a device that stores energy in the electrical field created between a pair of conductors on which equal but opposite electric charges have been placed. A capacitor is occasionally referred to using the older the old term condenser.

Figure 1.3 Various types of capacitors [1]

1.4.1 History of the capacitor

We do know from the reports of the lost writings of Thales of Miletus (around 600bc) that the ancient Greeks knew how to generate sparks by rubbing balls of amber on spindles. This is the turboelectric effect, the mechanical separation of charge in a dielectric.

Figure 1.4 Old capacitor [2]

1.4.2 Physics of the capacitor

A capacitor consists of two electrodes or plates, each of which stores an opposite charge. These two plates are conductive and separated by an insulator or dielectric. A charge is stored at the surface of the plates, at the boundary with the dielectric. Each plate stores an equal but opposite charge. When electric charge accumulates on the plates, an electric field is created in the region between the plates that is proportional to the amount of accumulated charge. This electric field creates a potential difference V = E*D between the plates of this simple parallel plate capacitor.

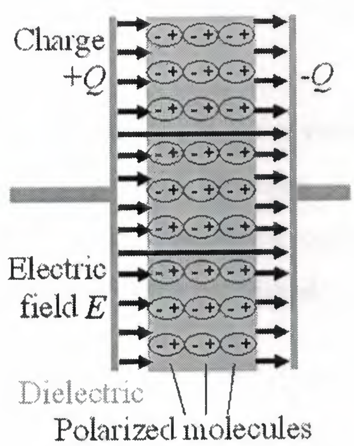
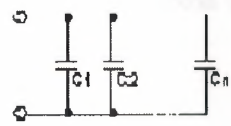


Figure 1.5 Charge flow in the capacitor [3]

1.4.3 Capacitors in series and pr parallel

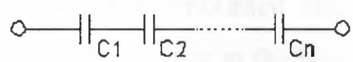
Capacitors in a parallel configuration each have the same potential difference (voltage). To find their total equivalent capacitance (Ceq):



$$C_{eq} = C_1 + C_2 + \cdots + C_n$$

Figure 1.6 Capacitors in parallel connection [4]

Current through capacitors in series stays the same, voltage across each capacitor can be different. The sum of the potential differences (voltage) is equal to the voltage. To find their capacitance:



$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \cdots + \frac{1}{C_n}$$

Figure 1.7 Capacitors in series connection [5]

One possible reason to connect capacitors in series is to increase the overall voltage rating. In practice, a very large resistor might be connected across each capacitor to divide the total voltage appropriately for the individual ratings.

1.4.4 Stored energy

As electric charge accumulates on the plates of a capacitor, a voltage develops across the capacitor due to the electric filed of the accumulated charge. Ever increasing work must be done against this ever increasing field as more charge accumulates. The energy (measured in joules) stored in a capacitor is equal to the amount of work required to establish the voltage across the capacitor, and therefore the electric field. The energy stored is given by:

$$E_{stored} = \frac{1}{2}CV^2$$

where V is the voltage across the capaitor

1.4.5 Variable capacitors

There are two distinct types of variable capacitor, whose capacitance maybe intentionally and repeatedly changed over the life of the device:

- Those that use a mechanical construction distance between plates, or the amount of plate surface area which overlaps. These devices are called tuning capacitors or simply "variable capacitors", and are used in telecommunication equipment for tuning and frequency control. Small variable capacitors which are mounted directly to PCBs (for instance, to precisely set a resonant frequency at the factory and then never be adjusted again) are called trimmer capacitors.

- Those that use the fact that the thickness of the depletion layer of the diode varies with dc voltage across the diode. These diodes are called variable capacitance diodes, varactors or varicaps. Any diode exhibits this effect, but devices specifically sold as varactors have a large junction area and doing profile specifically designed to maximize capacitance.

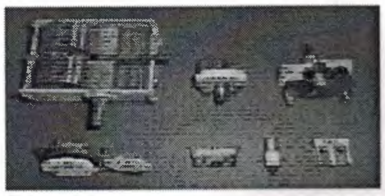


Figure 1.8 Variable capacitors [6]

1.5 Diodes

Diodes are devices that allow electricity to flow in only one direction. The arrow of the circuit symbol shows the direction in which the current can flow. Diodes are the electrical version of a valve and early diodes were actually called valves.

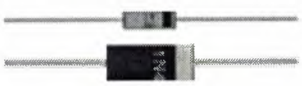
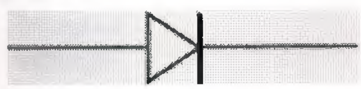
Example:  Circuit symbol: 

Figure 1.9 Diode circuit symbols [7]

1.5.1 Signal diodes (small current)

Signal diodes are used to process information (electrical signals) in circuits, so they are only required to pass small currents of up to 100mA. General purpose signal diodes such as the 1N4148 are made from silicon and have a forward voltage drop of 0.7V. Germanium diodes such as the OA90 have a lower forward voltage drop of 0.2V and this makes them suitable to use in radio circuits as detectors which extract the audio signal from the weak radio signal. For general use, where the size of the forward voltage drop is less important, silicon diodes are better because they are less easily damaged by heat when soldering, they have a lower resistance when conducting, and they have very low leakage currents when a reverse voltage is applied.

1.5.2 Rectifier diodes (large current)

Rectifier diodes are used in power supplies to convert alternating current (AC) to direct current (DC), a process called rectification. They are also used elsewhere in circuits where a large current must pass through the diode. All rectifier diodes are made from silicon and therefore have a forward voltage drop of 0.7V. The table shows maximum current and maximum reverse voltage for some popular rectifier diodes. The 1N4001 is suitable for most low voltage circuits with a current of less than 1A.

Table 1.3 Diode max current and reverse voltage rates.

Diode	Maximum Current	Maximum Reverse Voltage
1N4001	1A	50V
1N4002	1A	100V
1N4007	1A	1000V
1N5401	3A	100V
1N5408	3A	1000V

1.5.3 Bridge rectifiers

There are several ways of connecting diodes to make a rectifier to convert AC to DC. The bridge rectifier is one of them and it is available in special packages containing the four diodes required. Bridge rectifiers are rated by their maximum current and maximum reverse voltage. They have four leads or terminals: the two DC outputs are labelled + and -, the two AC inputs are labelled ~. The diagram shows the operation of a bridge rectifier as it converts AC to DC. Notice how alternate pairs of diodes conduct.

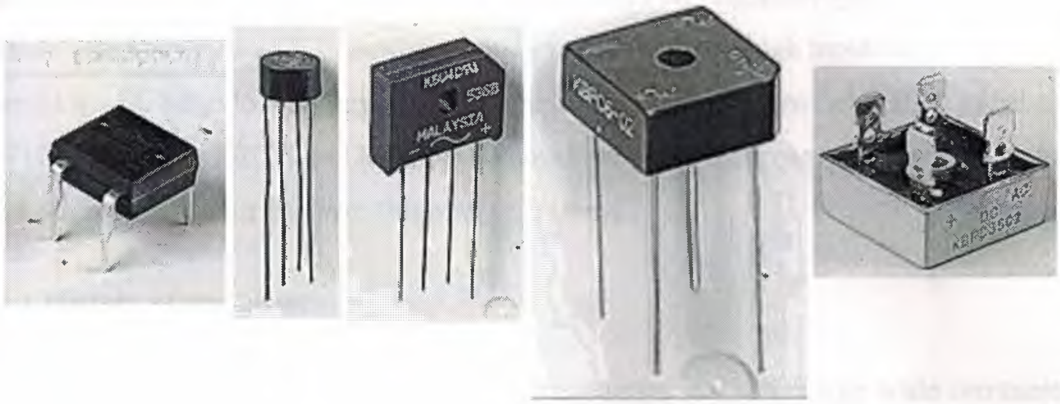


Figure 1.10 Various types of bridge rectifier [8]

1.5.4 Zener diodes

Zener diodes are used to maintain a fixed voltage. They are designed to 'breakdown' in a reliable and non-destructive way so that they can be used in reverse to maintain a fixed voltage across their terminals. The diagram shows how they are connected, with a resistor in series to limit the current. Zener diodes can be distinguished from ordinary diodes by their code and breakdown voltage which are printed on them. Zener diode codes begin BZX... or BZY... Their breakdown voltage is printed with V in place of a decimal point, so 4V7 means 4.7V for example.

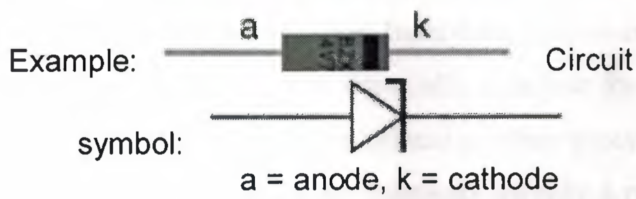


Figure 1.10 Zener diode circuit symbols [8]

1.6 Transistors

Generally transistors fall into the category of bipolar transistor, either the more common NPN bipolar transistors or the less common PNP transistor types. There is a further type known as a FET transistor which is an inherently high input impedance transistor with behaviour somewhat comparable to valves. Modern field effect transistors or FET's including JFETS and MOSFETS now have some very rugged transistor devices. I am often asked about the term "bipolar" - see later.

1.6.1 History of transistors

The transistor was developed at Bell Laboratories in 1948. Large scale commercial use didn't come until much later owing to slow development. Transistors used in most early entertainment equipment were the germanium types. When the silicon transistor was developed it took off dramatically. The first advantages of the transistor were relatively low power consumption at low voltage levels which made large scale production of portable entertainment devices feasible. Interestingly the growth of the battery industry has paralleled the growth of the transistor industry. In this context I include integrated circuits which of course are simply a collection of transistors grown on the one silicon substrate.

1.6.2 How do holes and electrons conduct in transistors

Some very interesting points emerge here. As depicted in figure 1 above a junction of p and n types constitutes a rectifier diode. Indeed a transistor can be configured as a diode and often are in certain projects, especially to adjust for thermal variations. Another behaviour which is often a limitation and at other times an asset is the fact that with zero spacing between the p and n junctions we have a relatively high value capacitor. This type of construction places an upper frequency limit at which the device will operate. This was a severe early limitation on transistors at radio frequencies. Modern techniques have of course overcome these limitations with some bipolar transistors having Ft's beyond 1 Ghz. The capacitance at the junction of a diode is often taken advantage of in the form of varactor diodes. See the tutorial on diodes for further details. The capacitance may be reduced by making the junction area of connection as small as possible. This is called a "point contact".Now a transistor is merely a "sandwich" of these devices. A PNP transistor is depicted in the figure below.

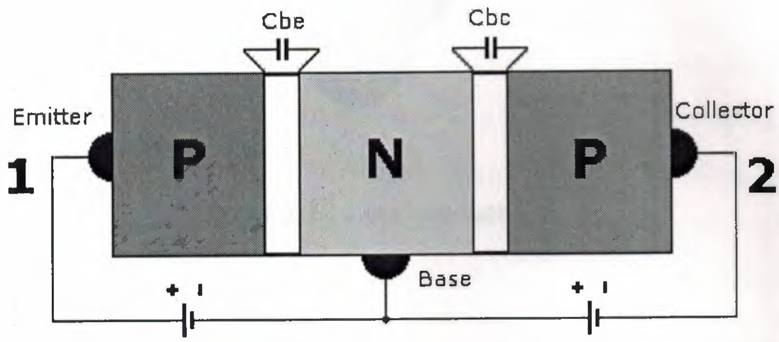


Figure 1.11 Sandwich construction of a PNP transistor [1]

1.7 Loudspeaker

A speaker is essentially the final translation machine -- the reverse of the microphone. It takes the electrical signal and translates it back into physical vibrations to create sound waves. When everything is working as it should, the speaker produces nearly the same vibrations that the microphone originally recorded and encoded on a tape, CD, LP, etc. Loudspeakers have Impedance, typically 4 or 8 ohms. This must be matched to the output impedance of the amplifier. Loudspeakers are mounted in enclosures (boxes). The design of enclosures is very complicated. Large speakers cannot reproduce high frequencies and small ones cannot reproduce low frequencies. Therefore two speakers are used, a large one (a Woofer) for low frequencies, and a small one (a Tweeter) for high frequencies. Most circuits used to drive loudspeakers produce an audio (AC) signal which is combined with a constant DC signal. The DC will make a large current flow through the speaker due to its low resistance, possibly damaging both the speaker and the driving circuit.

Figure 1.12 Loudspeaker [1]

1.8 Battery Clips and Holders

The standard battery clip fits a 9V PP3 battery and many battery holders such as the 6 × AA cell holder shown. Battery holders are also available with wires attached, with pins for PCB mounting, or as a complete box with lid, switch and wires. Many small electronic projects use a 9V P.P3 battery but if you wish to use the project for long periods a better choice is a battery holder with 6 AA cells. This has the same voltage but a much longer battery life and it will work out cheaper in the long run. Larger battery clips fit 9V PP9 batteries but these are rarely used now.

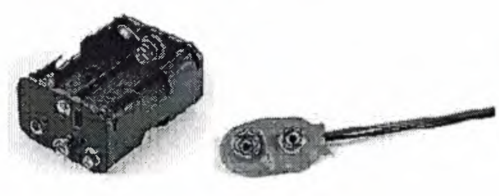


Figure 1.13 Battery clip and holder [1]

1.9 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.

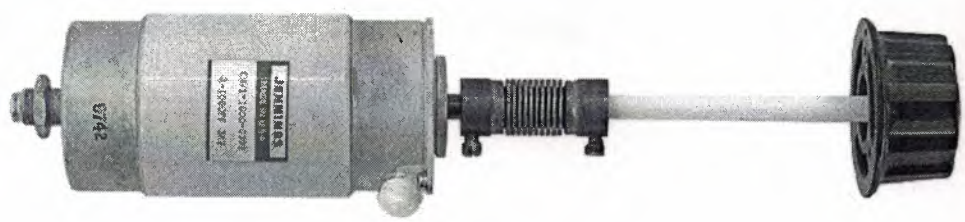


Figure 1.14 Ferrite aerial [1]

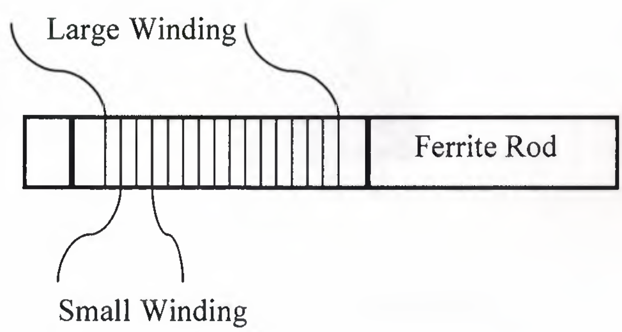


Figure 1.15 Ideal ferrite aerial [2]

1.10 Switches

A switch a device for making connection between two contacts. With some switches (such as keys on keyboard). A person presses the switch and it is on until he/she releases the switch: these are called momentary switches. Other switches (such as push-buttons on audio equipment) `latch` or `toggle` from off to on, and then from on to off, each time a person presses and releases the switch.

1.10.1 Switch Contacts

Several terms are used to describe switch contacts:

1. Throw - number of conducting positions, single or double.
2. Way - number of conducting positions, three or more.
3. Momentary - switch returns to its normal position when released.
4. Pole – number of switch contact sets.
5. Open –Off position, contacts not conducting.

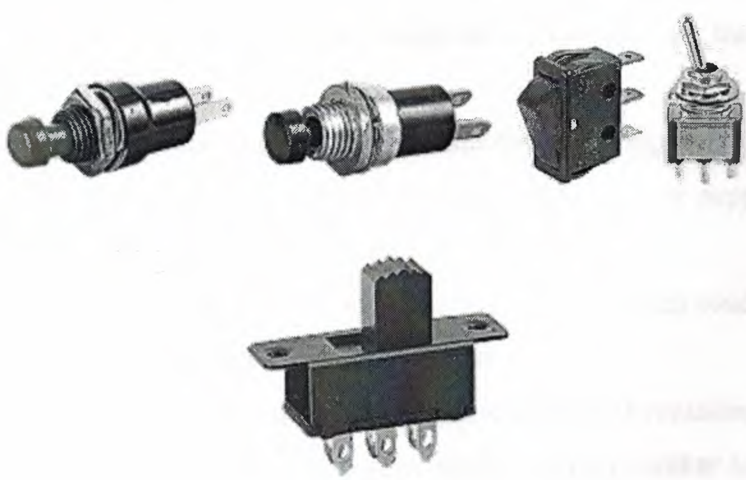


Figure 1.16 Switches [1]

1.11 Safety Guidelines

The danger of injury through electric shock is possible whenever electrical power is present. When a person's body completes a circuit and thus connects a power source with the ground, an electrical burn or injury is imminent. Most fatal injuries result from high voltage exposure; however, people can sustain severe injuries from low voltage power if it has a high current flow. In addition, overloaded circuits and poorly maintained electrical equipment and connections can lead to fires. Electrical fires are obviously capable of causing injuries and usually result in significant damage to facilities.

1.11.1 Some safety guidelines

Some electrical and electronic safety guidelines are used pertaining engineers to take care about them.

1. Turn off power and unplug from the wall before working on electric or electronic circuits, except when absolutely necessary.
2. Complete all your wiring and check it carefully before turning on the power supply.
3. When a setup or circuit is to be reconfigured or rewired, turn the power supply off.

   It is also a good practice to disconnect it from the power supply.
4. When you are done with an experiment, turn off the power supply first before disassembling the circuit.
5. Do not work on electrical equipment in a wet area or when touching an object that may provide a hazardous earth ground path.
6. Turn off power and unplug equipment before checking or replacing fuses. Locate and correct the cause of a blown fuse or tripped circuit breaker before replacing the fuse or resetting the circuit breaker.
7. Immediately report and do not use defective cords and plugs. Inspect cabling for defects such as frayed wiring, loose connections, or cracked insulation.
8. Remove metal jewelry, watches, rings, etc., before working on electrical circuits.

9. Always check the electrical ratings of equipment you use and be sure you use that equipment within its ratings.
10. Never overload circuits.
11. Never leave unprotected systems unattended.
12. Never place containers of liquid on electrical systems.
13. Never defeat the purpose of a fuse or circuit breaker. Never install a fuse of higher amperage rating than that specifically listed for your circuit.
14. Make sure equipment chassis or cabinets are grounded. Never cut off or defeat the ground connection on a plug.
15. Safely discharge capacitors in equipment before working on the circuits. Why? Because, large capacitors found in many laser flash lamps and other systems are capable of storing lethal amounts of electrical energy and pose a serious danger even if the power source has been disconnected.
16. When shifting probes in a live/active circuit, be sure to shift using only one hand: It is best to keep the other hand off other surfaces and behind your back.
17. If you are working on a design project and you plan to work with voltages equal to or abo ve 50 volts, notify your instructor and obtain their approval before proceeding.

1.12 Summary

This chapter presents the components used in this project and the most common followed safety guidelines used in the world of electricity and electronic devices well.

CHAPTER TWO

RADIO WAVE PROPAGATION AND ITS FREQUENCIES

2.1 Overview

This chapter presents the propagation of radio waves and the effect of atmosphere layers on it, how a radio wave travels and types of propagation. As this chapter presents the classification of frequencies which are used in radio and other purposes, and describes of course MW and VHW transmission, the differences between both kinds and frequency applications.

2.2 Introduction

Electromagnetic waves are formed when an electric field couples with a magnetic field. The magnetic and electric fields of an electromagnetic wave are perpendicular to each other and to the direction of the wave. Radio waves have the longest wavelengths in the electromagnetic spectrum. These waves can be longer than a football field or as short as a football. Radio waves do more than just bringing music to a radio. They also carry signals for the television and cellular phones.

2.3 Waves and the electromagnetic spectrum

We do not know exactly what really electromagnetic waves are, excepting that they look sometimes like waves, sometimes like particles (quanta). The simplest representation of a wave is a three dimensional structure made of an electric and a magnetic field crossed-polarized in both vertical and horizontal planes. Its energy is moving back and forth from one field to the other; this phenomenon is known as oscillation. If the signal is omni directional, this complex field evolves evenly into space like waves that we observe on the water surface or still better, like a sphere that gradually become more a larger. If the signal is directional the sphere becomes a cardio more or less extended in the propagation direction.

Radio waves are a form of electromagnetic radiation sensible to charged particles like free electrons. In free space they travel in straight line (in fact following geodesics) at the velocity of light (300000 km/s) and reduce a bit in denser medium. Their intensity is defined in volts per meter (practically in µV/m); in effective or peak values like AC current or by reference to the signal strength expressed in dB an other dBW unit.

The wavelength is defined as the distance between two points of equal phase or period taken as unit of time measurement. It is also defined as the ratio between the velocities of the wave to the current field frequency (f). For a free space wave the wave length is λ

$$\lambda(m) = \frac{300}{f(MHZ)}$$

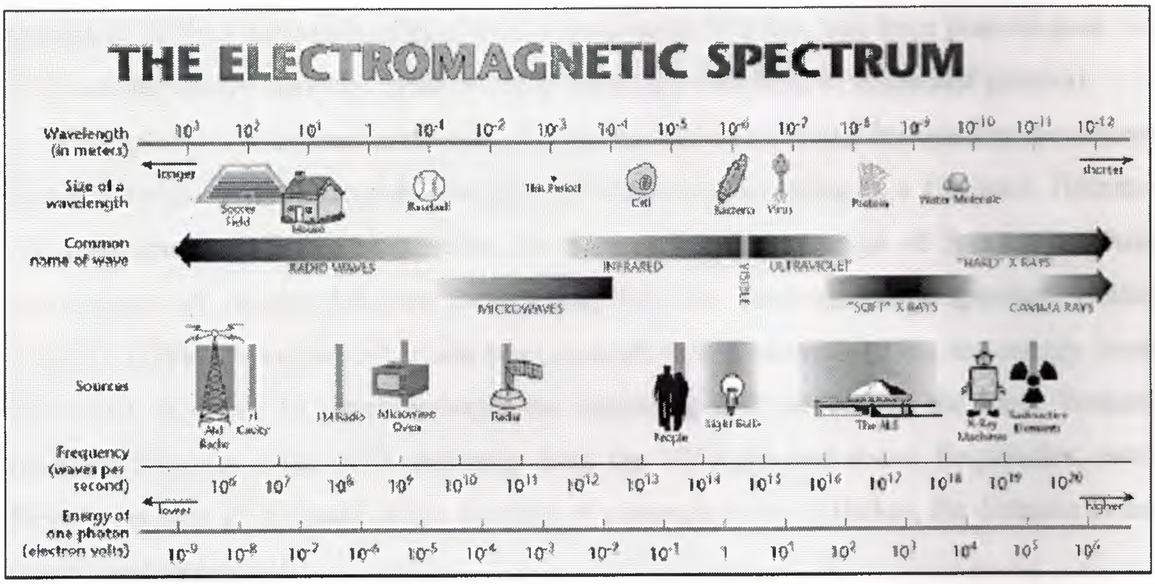


Figure 2.1 The electromagnetic spectrum [1]

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 Frequencies

Radio frequencies are ranging from a few hertz, wavelengths of several thousands of km from peak-to-peak for brain waves, subsonic and oscillating at less than one cycle per second, to several thousands of gigahertz, wavelengths of a few mm from peak-to-peak for microwaves. Above we enter in the world of light (IR, visible, UV, X-ray and gamma).

This spectrum is divided in octaves, the natural way to represent frequencies. An octave represents eight diatonic degrees or a gradual frequency increasing of a 10-factor. Humans can hear sounds (vibrations) between 20 Hz and 20 kHz, a range of 3 octaves. Their wavelengths are ranging between 1500 and 15 km. The electromagnetic spectrum is also arbitrary divided into "bands". Each band extends over 3 octaves or so, the energy level increasing of about 10 times between the beginning and the end of the band. Natural radiation becomes a health hazard only from the UV light and above frequencies, even though, because all depends on the duration of exposure to the radiation, the distance to the source, and its intensity.

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

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

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

Above these frequencies we find cent metric and mill metric waves, the famous microwaves. We know them essentially through home devices like microwave ovens (Short or S-band), wireless LAN (compromise or C-band), and some satellite and radar transmissions (Kurtz or K-bands). Then close your ears and open your eyes, you enter in the near infrared and visible parts of the spectrum! Over it, wear your anti UV-glasses to protect you against ultraviolet radiations. At last take your lead protection, we enter the world of X and γ rays.

Most services work in the lower bands of the electromagnetic spectrum, the only one frequency able to transport information on long distances with a very simple technology and low energy.

Each band requests special receivers and aerials according to the frequency used and the type of waves (ground, space, ionosphere, etc). However these waves are affected by the medium in which they propagate its electronic density and its dielectric constant.
In this project MWand VHW transmissions will be discussed in detail.

2.5.1 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.

Due to the ionospheric reflection 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.

2.5.2 VHF Very High Frequencies

Very high frequency (VHF) is the radio frequency range from 30 MHz (wavelength 10 m) to 300 MHz (wavelength 1 m). Frequencies immediately below VHF is HF, and the next higher frequencies are known as Ultra high frequency (UHF). Common uses for VHF are FM radio broadcast at 88–108 MHz and television broadcast (together with UHF). VHF is also commonly used for terrestrial navigation systems (VOR in particular) and aircraft communications. VHF frequencies' propagation characteristics are ideal for short-distance terrestrial communication, with a range generally somewhat farther than line-of-sight from the transmitter (see formula below). Unlike high frequencies (HF), the ionosphere does not usually reflect VHF radio and thus transmissions are restricted to the local area (and don't interfere with transmissions thousands of kilometres away). VHF is also less affected by atmospheric noise and interference from electrical equipment than low frequencies. Whilst it is more easily blocked by land features than HF and lower frequencies, it is less bothered by buildings and other less substantial objects than higher frequencies. Two unusual propagation conditions can allow much farther range than normal. The first, tropospheric ducting, can occur in front of and parallel to an advancing cold weather front, especially if there is a marked difference in humidities between the cold and warm air masses. A duct can form approximately 150 miles (240 km.) in advance of the cold front, much like a ventilation duct in a building, and VHF radio frequencies can travel along inside the duct, bending or refracting, for hundreds of miles. For example, a 50-watt Amateur FM transmitter at 146 MHz can talk from Chicago, Illinois, to Joplin, Missouri, directly, and to

Austin, Texas, through a repeater. The second type, much more rare, is called Sporadic-E, referring to the E-layer of the ionosphere. A sunspot eruption can pelt the Earth's upper atmosphere with charged particles, which may allow the formation of an ionized "patch" dense enough to reflect back VHF frequencies the same way HF frequencies are usually reflected (skywave). For example, TV channel 2 (54–60 MHz) from Midland, Texas was seen in Chicagoland, pushing out Chicago's own TV channel 2. These patches may last for seconds, or extend into hours. FM stations from Miami, Florida; New Orleans, Louisiana; Houston, Texas and even Mexico were heard for hours in central Illinois during one such event.

Figure 2.2 Radio [1]

Table 2.1 Radio bands [1]

Band	Abbreviation	Frequency	Wavelength	Energy
X-rays	X-rays	30.3 PHz - 3 EHz	10 - 0.1 nm	125 - 12.5 keV
Extreme ultraviolet	EUV	4.5 - 30.3 PHz	70 - 10 nm	18 - 125 eV
Visible (red - violet)	....	398 - 750 THz	800 - 400 nm	1.6 - 3.1 eV
Super High Frequency,	SHF	3 - 30 GHz	10 - 1 cm	13 - 132 μeV
Ultra High Frequency	UHF	300 MHz - 3 GHz	100 - 10 cm	1.1 - 13 μeV
Very High Frequency	VHF	30 - 300 MHz	10 - 1 m	132 neV - 1.1 μeV
High Frequency	HF	3 - 30 MHz	100 - 10 m	13 - 132 neV
Medium Frequency	MF	300 kHz - 3 MHz	1000 - 100 m	1.3 - 13 neV
Low Frequency	LF	30 - 300 kHz	10 - 1 km	120 peV - 1.3 neV
Very Low Frequency	VLF	3 - 30 kHz	100 - 10 km	13 - 120 peV
Extreme Low Frequency	ELF	30 Hz - 3 kHz	10000 - 100 km	125 - 13 peV

2.6 Propagation of waves

Propagation is defined as the travel of waves through or along a medium. In practice this medium is the earth's atmosphere which is divided up into layers those of main importance being the Troposphere and the ionosphere.

The success or the failure of a radio transmission depends on the way that radio signals travel around the earth. Basically there are five types of propagation:

1. **Ground waves**: also called evanescent or surface waves, these waves propagate along the earth surface, close to the ground, and never reach the ionosphere. Typically signals carried by ground waves can be heard up to a distance of 160 km or more during the daytime. They are however subject to a high attenuation throughout HF bands to reach distances less than 15 km at 30 MHz.. Therefore these surface waves are mainly used at low frequencies below 1.8 MHz (MW, LW and VLF) by geophysicists and the U.S Navy (submarines).
2. **Tropospheric waves:** below 10 km or so of the atmosphere, where weather patterns and temperature inversions form, VHF can be refracted permitting short distances contact (a few thousands km). This activity will be shortly discussed as well as the atmospheric ducting, also induced by temperature inversions.
3. **Space waves:** these waves travel directly from an antenna to another without reflection on the ground. This phenomenon occurs when both antennas are within line of sight of each another. This distance is longer that the line of sight because most space waves bend near the ground and follows practically a curved path. In the field we must also add the effects of the atmospheric refraction and diffraction near the earth surface that extend this distance of about 20% in the lowest bands. On V/UHF on the contrary diffraction is very small and signals tend to drop off quite rapidly at a shorter distance. In this way of propagation antennas must display a very low angle of emission in order that all the power is radiated in direction of the horizon instead of escaping in the sky. A high gain and horizontally polarized antenna is thus highly recommended.
4. **Sky waves:** They essentially concern frequencies below 30 MHz (longer than 10 meters) and V/UHF in a less extent that are able to escape into free space (that begins over 800 km aloft). Called sky waves these waves are however stopped in their travel by the ionospheric layers and, under low incidence angles, they are reflected to the ground. These waves are then called ionospheric waves. They are very influenced by the presence of electrons gas and plasma in the upper atmosphere of the Earth. Under certain conditions these layers reflect or refract

short waves, permitting amateurs to reach stations located on the other side of the Earth in a succession of jumps between the ground and the ionosphere, called multihops. We will develop this subject in depth on the next page as they are the most used by radio amateurs. In another article we will deal about perturbations affecting sky waves propagation in the ionosphere.

5. **Free space waves:** they are the most common but the less used! We encounter them working in VHF or UHF where, due to their very high frequency, at incidence angles higher that the critical angle, short waves escape into space instead of be reflected by ionospheric layers.

If waves travel in straight line and at the velocity of light in free space, on Earth, the ground, the air and the ionosphere affect wave propagation; radio waves do no more travel from one point to another in straight line and their signals are often altered. The fading is probably the alteration, Radio waves are mainly subject to four effects and they are Attenuation, Reflection, Refraction and Diffraction.

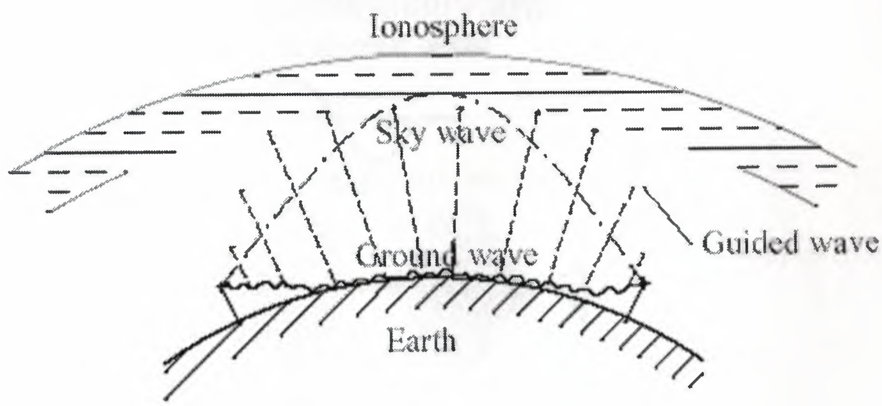


Figure2.3 Wave propagation [1]

2.7 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.

2.7.1 (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. 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.

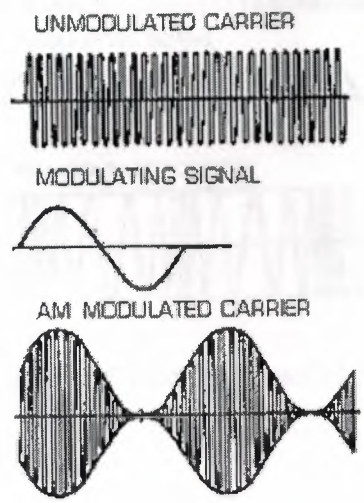


Figure 2.4 Amplitude modulation [1]

2.7.2 (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. 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.

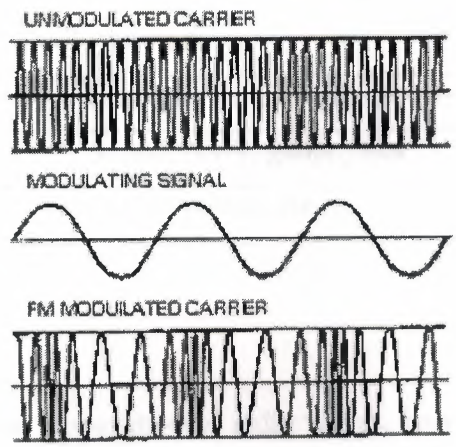


Figure 2.5 Frequency modulation [1]

2.8 Application

Each band of frequency has its own applications which are used in our lives; these applications are shown in table 2.2.

Table 2.2: bands and their Applications [1]

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 presents the propagation of radio waves, how a radio wave travels, types of propagation and kinds of modulations. As we present the classification of frequencies which are used in radio and other purposes.

CHAPTER THREE

HARDWARE APPROACH OF THE MW RADIO

3.1 Overview

This chapter will present the circuit diagram of the AM radio where it consists of two parts which are the AM radio circuit and the audio amplifier circuit. The operation of each part 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.

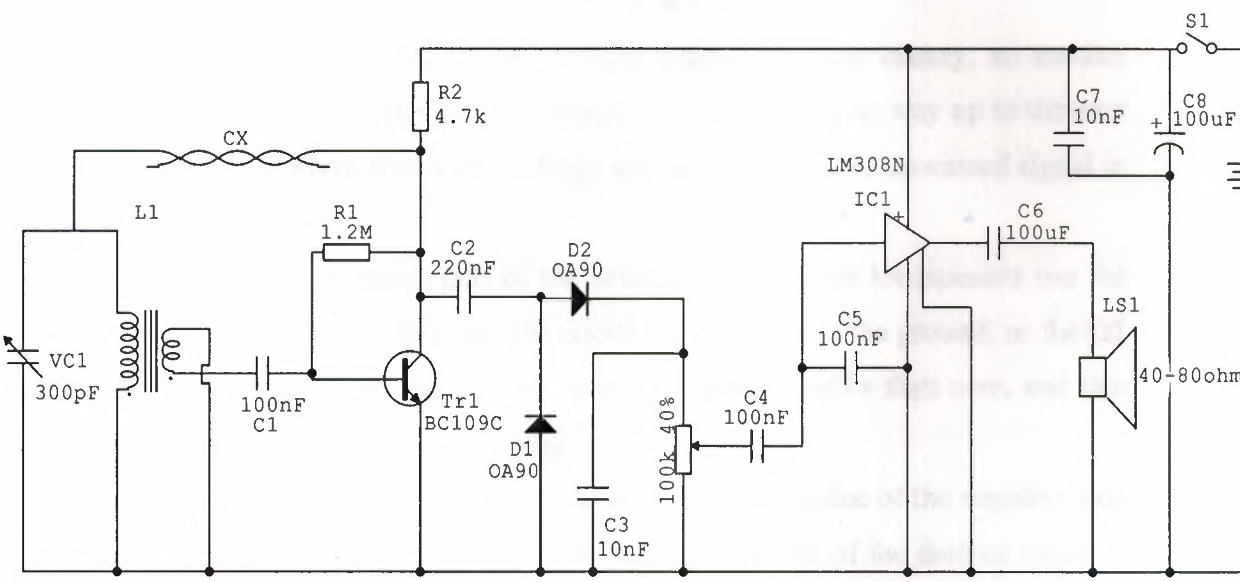


Figure 3.1 Circuit diagram of MW radio [13].

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 that happens?

$$f_0 = \frac{1}{CLW} \quad (3.1)$$

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.

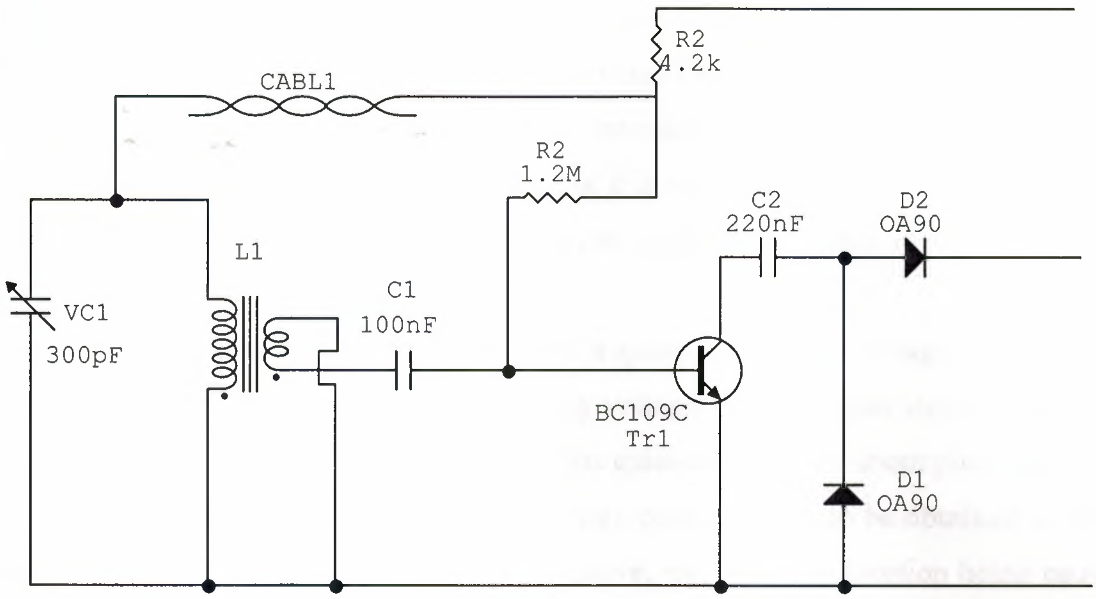


Figure 3.2 Oscillating part diagram of MW radio.

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.

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 pickup 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

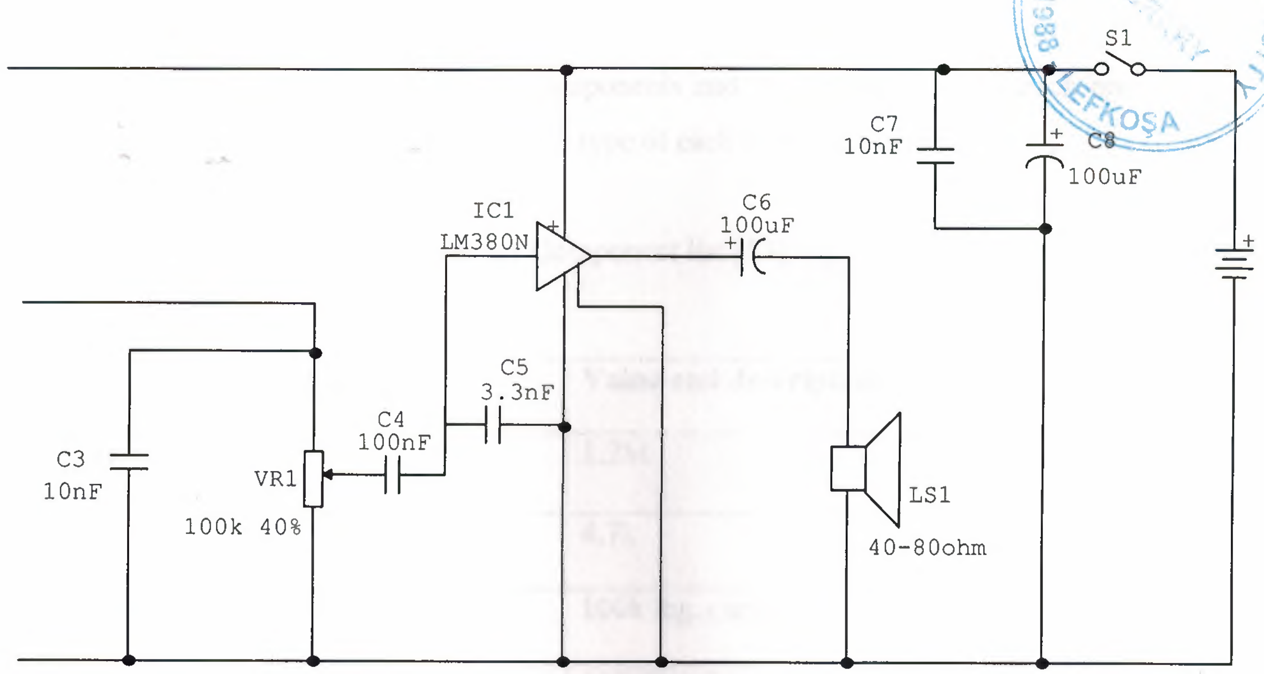


Figure 3.3 Amplifying part diagram of MW radio

3.3 Modification Recommendation

There are many ways that we can modify the MW radio such as adding FM radio so that there will be an (on-off –on) switch between them, also a small lamp or a fan can be added to the circuit so that if we listen music the lamp or the fan can be on or off by using (on-off) switch .

3.4 Component List of the project

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.

Table 3.1 Component list [13]

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 but as the diodes where not found the alternative is AA114
D2	OA90 ⟶ AA114
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

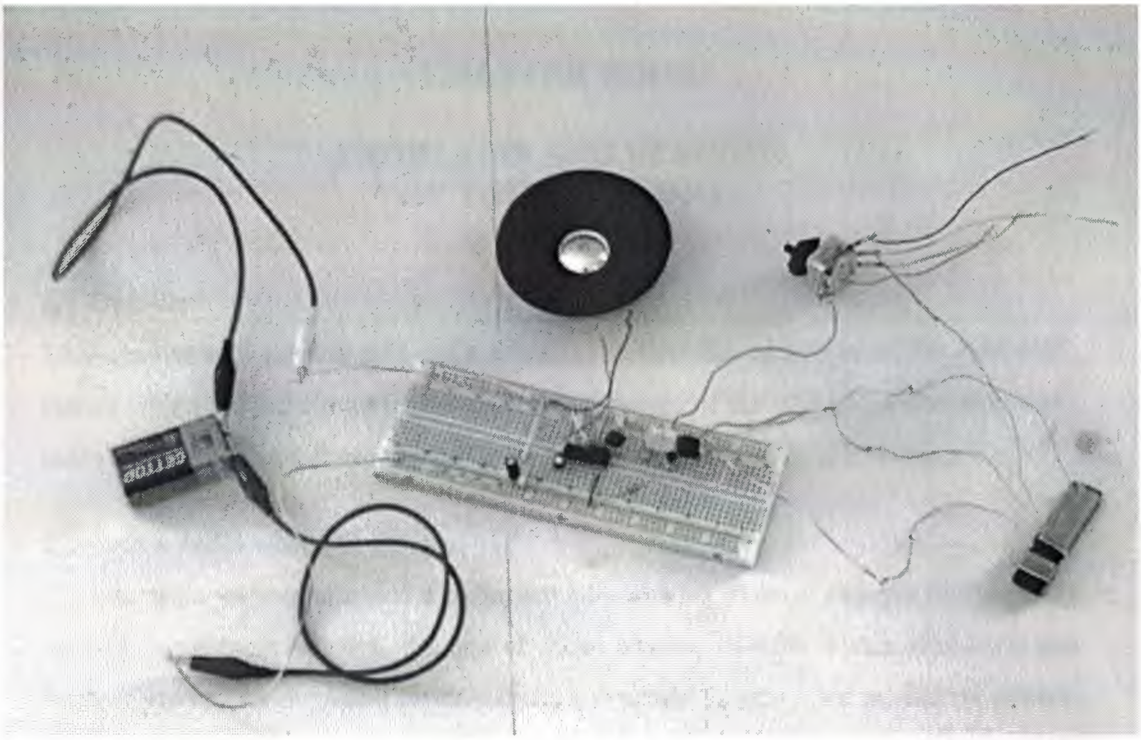


Figure 3.4 MW Radio after connection

3.5 Summary

This chapter has presented the components of the radio and amplifier circuit and the function of each component, and how it contributes in the process of filtering and amplifying, it is possible to connect the circuit and have a MW radio circuit as shown in fig 3.4.

With using exactly the theoretical way of connection as described possible errors may occur, because the practical work has very different circumstances than the theoretical one, in addition some other problems may occur.

CHAPTER FOUR

PROBLEMS AND RESULTS OF THE AM RADIO

4.1 Overview

This chapter will present two main things related to the operation of the AM radio circuit which are the circuit problems and test results of the AM radio, also the way a radio works and the differences between the AM radio circuit and FM one.

4.2 How a radio works in general

The radio station launches a radio wave by moving electric charges rhythmically up and down their antenna. As one of these electric charges 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

To convey audio information (sound) to your radio, the radio station makes one of several changes to the radio wave it transmits. In the AM or Amplitude Modulation technique, it adjusts the amount of charge it moves up and down its antenna, and hence the strength of its radio wave, in order to signal which way to move the speaker of your radio.

These movements of the speaker are what cause your radio to emit sound. In the FM or Frequency Modulation technique, the radio station adjusts the precise frequency at which it moves charge up and down its antenna. Your radio senses these slight changes in frequency and moves its speaker accordingly.

4.3 The differences between an FM and an AM radio

These days, radios just look like electronic circuit boards inside AM and FM is both techniques whereby the radio station tells your radio which way to move the diaphragm of its speaker and by how much, in order to make sound. In the AM or Amplitude Modulation technique, the station raises or lowers the power of its radio wave to tell your radio to move its speaker diaphragm toward you or away from you, respectively. The higher the power of the radio wave, the more your radio pushes its diaphragm toward you. In the FM or Frequency Modulation technique, the station raises or lowers the frequency of its radio wave slightly to tell your radio to move its speaker diaphragm toward you or away from you, respectively. The more it raises the frequency of its radio wave, the more your radio pushes its diaphragm toward you.

4.4 AM radio

The AM band covers 535KHZ to 1.7MHZ .There are signals from thousands of radio transmitters on many different frequencies inducing signal voltages in the aerial. The RF filter selects the desired station from the many. It is adjustable so that the selection frequency can be altered. This is called TUNING. The selected frequency is applied to the mixer; the output of an oscillator is also applied to the mixer. The mixer and oscillator form a FREQUENCY CHANGER circuit. The output from the mixer is the intermediate frequency (i.f.) .The i.f. is a fixed frequency of about 455 kHz. No matter what the frequency of the selected radio station is, the i.f. is always 455 kHz. The i.f. signal is fed into the i.f. amplifier. The advantage of the i.f. amplifier is that its frequency and bandwidth are fixed, no matter what the frequency of the incoming signal is. This makes the design and operation of the amplifier much simpler. The amplified i.f. signal is fed to the demodulator. This circuit recovers the audio signal and discards the R.F. carrier. It usually incorporates a diode in the circuit. Some of the audio is fed back to the i.f. amplifier as an AUTOMATIC GAIN CONTROL voltage. This ensures that when tuning from a weak station to a strong one, the loudness from the loudspeaker stays the same. The audio signal voltage is increased in amplitude by a voltage amplifier. The power level is increased sufficiently to drive the loudspeaker by the power amplifier.

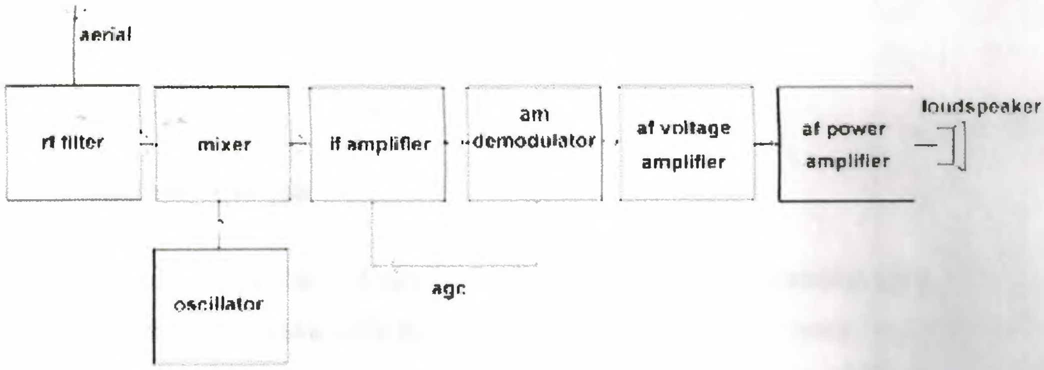


Figure 4.1: AM receiver block diagram [1]

4.5 For FM radio future modification

For modifying our AM radio a simple FM radio circuit could be added to our am circuit that consists of tow transistors, a coil, a resistor of 12 k ohms, a battery, a capacitor of 220 nf., a variable capacitor, a loudspeaker, a switch and an antenna where the battery, capacitor of 220 nf., variable capacitor, loudspeaker, switch and the antenna can all be shared or common with the AM circuit and the switch ought to be a three pin one between AM and FM, as shown in figure 4.2 the following FM circuit could be used in the future as a modification circuit.

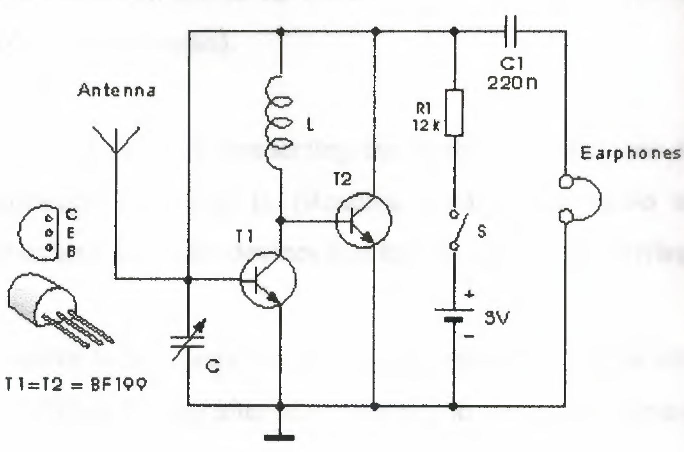


Figure 4.2 simple FM radio circuit [2]

4.6 Results and Analysis

After constructing the AM circuit we found that its most important parts were its diodes which were not available in the market but from using the books we could find the alternatives, the Ferrite Aerial connection was the most difficult part in constructing the circuit of the radio, by using the digital millimeter the resistance of each resistor was measured in order to sort the resistors and from the information that was presented in chapter one regarding this aerial we could connect it well. There was an effect of the variable resistor in increasing or decreasing the voice so it was connected as the volume control device, when we finished constructing the circuit and turned it on we heard two channels only and that was because of band limit of our circuit.

4.7 Problems and Solutions

- Having a low output voice of the speaker.

(Using an IC called an lm386 IC which was not found in Cyprus to amplify the speaker volume of the radio).

- Having a problem with connecting the ferrite aerial because of having a lack of knowledge regarding it. (Reading books about radio aerials, variable capacitors and any other devices that can be used for improving the radio).

- Being unable to find some important devices needed for the circuit in northern Cyprus. (Either finding alternative devices in northern Cyprus or from another country).
- Finding the prices of the components or devices needed very expensive in Cyprus which as a result made us forced to buy or bring them from another country.

- Difficulties in finding the polarities of the capacitors from the circuit diagram. (Reading books and using the internet for getting more information about capacitors).

- Burning the electrical components while welding them and connecting them to the board. (Asking our assistants and supervisor about what to avoid while constructing the circuit).
- Problems with the way of connecting some electrical components such as (Ferrite Aerials, variable capacitors and switches).(having help of some books).

4.8 Summary

This chapter has presented the AM radio, its problems, the results we obtained from analyzing and understanding the problems, some future solutions for them, and the differences between the FM radio and MW radio in general.

CONCLUSION

After a great deal of working together as a whole project group and preparing this project theoretically and practically; we found out that we had had much knowledge and learnt many circuit operation techniques about receiving, filtering and amplifying the input signal in the MW radio, and how to manage to have alternatives for not available components, how to connect the our circuit components without having problems.

This project consists of four chapters; each chapter presented a specific aspect of the subject MW radio as a working principle.

Chapter one presented many 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 propagation, 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 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 described the contribution of each component in the mentioned processes above.

Chapter four was about the problems, test results and future modification of the MW radio where connecting a simple FM radio with the AM circuit using a three pin ON-OFF-ON switch was explained in this chapter, as well as the differences between the FM radio and AM one.

The main guidelines of this project were:

1. To design, build and test a working MW radio

2. To gain experience as much as we could with practical electronics projects.
3. To sort out problems within the circuit and make modifications, to overcome the problems.
4. To get information about the kinds of frequencies, modulations, propagation and the main application of each kind of frequency band.

Firstly while the project was being done, 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 which were preventing the circuit from working properly.

While constructing the radio circuit and during unpleasant circumstances we realized that some times we made mistakes in some positions. By testing 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 always when a component was not available and since the market in North Cyprus did not have all the components we needed we were forced to find alternative components by using the internet or some references, getting some components from Istanbul in case of being unable to find the alternatives needed and also by asking for advice from experienced people.

In summary, a great experience and knowledge about working on electronic projects were gained during the preparation of this project also problem solving skills were developed through out working on this project.

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