NEAR EAST UNIVERSITY

Faculty of Engineering

Department of Electrical and Electronic Engineering

A MW Radio Design & Construction

Graduation Project
EE- 400

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TABLE OF CONTENTS

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ABSTRACT

The faster the life the more need for information is applied, and that is why radios now are almost covering the planet, radios are everywhere they are a part of our lives now, because in general a radio is a cheap equipment, not expensive in maintenance and easy to place and use.

Nowdays, radio broadcasting corporations are all around the world competing each other by being faster to cover or announce the important live events or news. And also competing in entertainment field, broadcasting the newest songs, interviews with big stars and more. More and more aspects give radio a big importance in our modern life, gradually it is hard to imagine how the life will look like without the radio invention.

The work presented within this group project is about designing, building and testing a working MW radio. Various transmission frequencies will also be described.

INTRODUCTION

Radio communication these days, considered as one of the most popular and important way of keeping in touch with the world around us. It is used almost anywhere and everywhere, from the bedroom to the living room and sometimes in the kitchen to the car and also in the work place. Also mobile phones manufacturer are competing by adding a radio circuits into their phones as additional function.

It is almost unimaginable to live without it anymore, radios become a part of our modern life.

We decided to do this project for its importance –as mentioned above- and to explore the electronics applications and techniques, to know the principle idea of the radio and how does it work, also how to enhance the job of a radio.

The purpose of this project is to design, build and test a MW radio circuit with its basic elements. Five chapters will lead the reader into making him/her able to start his own MW radio.

Chapter one will discuss 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 discuss 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 discuss the most probable problems encounted, and also will indicate a suitable solution for each problem.

Chapter five will conclude the results of our work in this project.

CHAPTER ONE
COMPONENTS

1.1 Overview

In this chapter components which will be used in building the circuit of the radio will be described. 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.

1.2 Components

In this section, a detailed explanation will be given for each hardware component will be used in setting up the radio circuit.

1.2.1 Resistors

These are small cylindrical components having a lead-out protruding from each end. The value is not marked in numbers and letters, but is indicated by four colored bands around the body of the component, the value is in units called "ohms", and resistors often have values of many thousands of ohms, or even a few million ohms. In order to avoid constantly losing very large numbers it is common for resistance to be specified in kilohms (k) and megohms (M). These are equal to a thousand ohms and a million ohms respectively. Thus a resistor having a value of 33,000 ohms would normally be said to have a value of 33 k, and a resistor having a value of 2,700,000 ohms would normally have its value given as 2.7 M. it is common these days for the unit's symbol to be used to indicate the decimal point as well. This sometimes farther shortens a value in its written form, and there is no danger of a decimal point being overlooked due to poor quality printing or something of this nature. In our two examples given above the value of 33 k would not be altered since the "k" already indicates the position of the decimal point, but 2.7 M would be altered to 2M7. The resistor color code is very straightforward, with the first two bands giving the first two digits of the value, the third band giving a multiplier, and the forth band showing the tolerance of the component. The resistor color code is detailed in table (1.1).

Resistors also have a power rating, and this is not usually marked on the component (except on the case of high power types where the value and wattage may both be written on the component, no color codes being used). Higher power resistors are not really suitable, and this is due to there physical rather than electrical characteristics. Higher wattage resistors are physically quit large and would be difficult to fit into the available space, and some have very thick lead-out wires which will not fit easily into the bread board.

Incidentally, in order to aid the selection of a resistor of the correct value, all components lists have the color code for each resistor alongside the value. Thus, even if you do not understand the resistor color-coding system you should still be able to pick out the appropriate resistors with the aid of the components lists.

Table 1.1 Resistor color code

Color	**1st/2nd Band**	**3rd Band**	**4th Band**
Gold	not used	0.1	5%
Black	0	0	not used
Brown	1	10	1%
Red	2	100	2%
Orange	3	1000	not used
Yellow	4	10,000	not used
Green	5	100,000	not used
Blue	6	1,000,000	not used
Violet	7	not used	not used
Gray	8	not used	not used
White	9	not used	not used
Silver	not used	0.01	10%
No Band	not used	not used	20%

1.2.2 Capacitors

Most capacitors used to look much the same as resistors but were normally a little larger and had the value written on there body rather than marked using a color code. Modern capacitors are still generally somewhat larger than resistors, but they often have both lead-out wires coming from the same end of the component as this makes them more convenient for use with printed circuit boards. Also, they often have rectangular rather than tubular bodies.

In this project several type of capacitor are used, including electrolytic types. These are available as axial (with the lead-out wires coming from opposite ends of the component) and printed circuit types. Axial electrolytics were used when developing the project, and the layout drawings show the electrolytics as axial components, but printed circuit mounting types can be fitted into the layouts with no difficulty.

An important point to bear in mind with electrolytic capacitors is that they are polarized, and most be connected to the circuit the right way round (resistors, and most other types of capacitor can be connected either way round). In the component layout given in this project, the lead-out wires are identified "+" and "-" signs on the bodies of the components. Additionally, axial types usually have an indentation around one end of the component's body, and this indicates the end of the component from which the positive (+) lead-out emerges.

One of the capacitors may used in other applications is a tantalum bead type, and like an electrolytic capacitor this is a polarized component. Tantalum capacitors are normally small, bead shaped components (which is sometimes called tantalum bead capacitors) which have both lead-out wires coming from the same end of the body. The positive lead-out wire should be identified by the appropriate sign marked on the body of the component. Be careful to connect the tantalum capacitor the right way round as capacitors of this type are easily damaged by a voltage of the wrong polarity.

Another type of capacitors may used is a ceramic plate or disc ceramic type, either type is suitable, and the only physical difference between the two is that the plate type is rectangular while the disc type is obviously circular.

The other fixed value capacitor may used are of the polyester variety, and the mullard C280 type (or any similar type) will fit into the component lay outs most readily. These are rectangular, printed-circuit-mounting capacitors, and are unusual in that the value is marked using a color code. There are five colored bands around the component, the first three give the value of the component in the same way as the resistor color code. However, the value is in picofarads rather than ohms. The last two bands show the tolerance and maximum working voltage of the component respectively. For the values used the last two bands will probably be black (20% tolerance) and red (250 volts DC maximum), but other colors are sometimes encountered, such as white (10%) and yellow (400 volts DC maximum). This is of know consequence, and any C280 polyester capacitors are suitable for use in any application.

Where polyester components are specified in a components list, the appropriate color code is given to aid the selection of the correct component.

The radio circuits use a variable capacitor, and this is in fact the tuning control. The specified type is a solid dielectric component having a maximum capacitance of 300pF, but any variable capacitors having a maximum value of about 200pF to 300pF is suitable from the electrical point of view.

1.2.3 Semiconductors

Semiconductors have 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.

1.2.4 Integrated Circuits

Integrated circuits have a wide variety of packages, but here we are only concerned with one type of integrated circuit that it is the LM380N audio power amplifier. The LM380N has a 14-pins DIL plastic package.

1.2.5 Diodes

Two types of ordinary diodes are used in the project, the 0A90 germanium type and the 1N4148 silicon. Physically these are very much the same, the 0A90 type being somewhat larger than the 1N4148 device. The main point to note about diodes is that they are polarized components and must be connected into circuit the right way round if the circuit is to function properly. The cathode (+) lead of a diode is normally marked by a band around the appropriate end of the component's body.

One minor complication is that there are few diodes around which for no obvious reason, have the band marked around the wrong end of the component! Therefore, if a circuit which uses diodes fails to work it would be advisable to check the diodes with some sort of component tester if this is possible. Another minor complication is that some diodes have a number of bands marked around there bodies, and in such cases the manufacturer uses these bands to indicate the diode type number rather than simply marking the type number on the component. In such cases the bands are normally offset towards the end of the component for which the cathode (+) lead-out wire emanates.

1.2.6 Potentiometers

These are available in a number of different types, but in this project common carbon type that are available from virtually any electronic component retailer. Wire-wound types are electrically suitable, but are often physically rather large and more expensive and are not recommended. Rotary types are preferable to slider types as the later are usually much more difficult to mount.

Potentiometers are available with a linear law or with algorithmic law, and circuits will work if the wrong type is used (provided it has the right value of course). However, if we take a volume control as a simple example, algorithmic type would normally be utilized in this application, and using this type of potentiometer gives an apparently smooth and easily controlled increase in volume as the control is advanced. If a linear type used there is an apparent sudden increase in volume as the control is advanced from zero, with very little apparent change in volume over the major part of the control's adjustment range. It is possible to set the volume at any desired level, but the volume level is comparatively difficult to control accurately. Thus it is advisable to use a potentiometer of the type specified in the appropriate component list.

1.2.7 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 172 mm 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 also been 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 aerial coil has the small coupling windings.

1.2.8 Switches

It is not important to use specific type of switches due to the similarity of doing the job. Two types are discussed in this section, and there is little chance of confusion since one is a push-button type and the other is a miniature toggle switch (i.e. it is operated via a small lever). The push-button switch must be a push-to-make type and not push-to-break type, and it must not be a latching type. In other words, the two tags are connected together when the switch is operated, and disconnected when the push-button is released. There should be no problem in obtaining a switch of the correct type as these are the most common and cheapest types of push-button switch although a miniature toggle switch was used when testing the prototype projects, a standard size toggle switch is also suitable, but a much larger mounting hole will be required, (usually about 13 mm or 0.5 inch in diameter). In the components list the toggle switch is specified as an SPST type, and this means a single-pole, single-throw type. In the other words, it is just a simple on/off type switch, and switches of this type are sometimes advertised as on/off switches rather than SPST types.

1.2.9 Loudspeaker

There should be no difficulty in identifying the loudspeaker which will have a diaphragm made from a paper-like substance, and about 50 to 75 mm in diameter (depending on what size loudspeaker you purchase). A part of the diameter of the loudspeaker, advertisements will also quote and impedance in ohms. The size of loudspeaker is not of great importance in this case and any miniature type will do, but it is important to use a type having the correct impedance. In this project a high impedance loudspeaker is required, and any impedance in the range 40 to 80 ohms is suitable. Somewhat higher impedance would be satisfactory, but loud speakers having an impedance of more than 80 ohms do not seem to be available. Loudspeakers should be treated carefully since the diaphragm is easily damaged, and you should always hold a loudspeaker by the magnet housing at the rear of the component.

1.3 Safety

In this project, a low voltage application is used. Thus, safety guidelines are not in concern of human safety but in components safety.

First, we have the polarized capacitors used in the circuit, the polarity must be in mind when they are connected. Second thing to bear in mind is the I.C., it is quite sensitive so it must be connected in the order of the manufacturer's instructions which explain how to use the chip, in order to keep it working and functioning properly. Other thing to take care of is to observe and control –if needed- to the input signal of this op-amp, because if it is higher than the acceptable value, the output signal may damage up next components of the circuit.

Thirdly the loudspeakers. Loudspeakers should be treated carefully since the diaphragm is easily damaged, loudspeakers are one component which may be damaged by bad output signal from the I.C. .

The last important thing to take care of, is the voltage supplied to the circuit, when the circuit is fully constructed, the power supply should not be connected until one is sure of the voltage value supplied to the circuit.

1.4 Summary

Now it is possible to start constructing the circuit, after the needed components are described in detail, how they function, how they must be connected. By applying the safety guidelines, the circuit should work smoothly.

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

CHAPTER TWO

TRANSMISSION FREQUENCIES

2.1 Overview

In this chapter frequencies which are used in radio and other purposes are described of course MW transmission is included, differences and applications are also mentioned.

2.2 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 below.

2.2.1 LF Low Frequencies

This is the segment between 30 – 300 kHz. 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 2000 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.

2.2.2 MF Medium Frequencies

This segment of the 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 the 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 may be 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 [1]. 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 see fig 2.1 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 TransWorld Radio programs) has a MW relay in Southern Cyprus (1233 KHz) [1]. Lower and upper ends of MW band are allocated for navigation, direction finding and wireless communication. 2182 KHz.

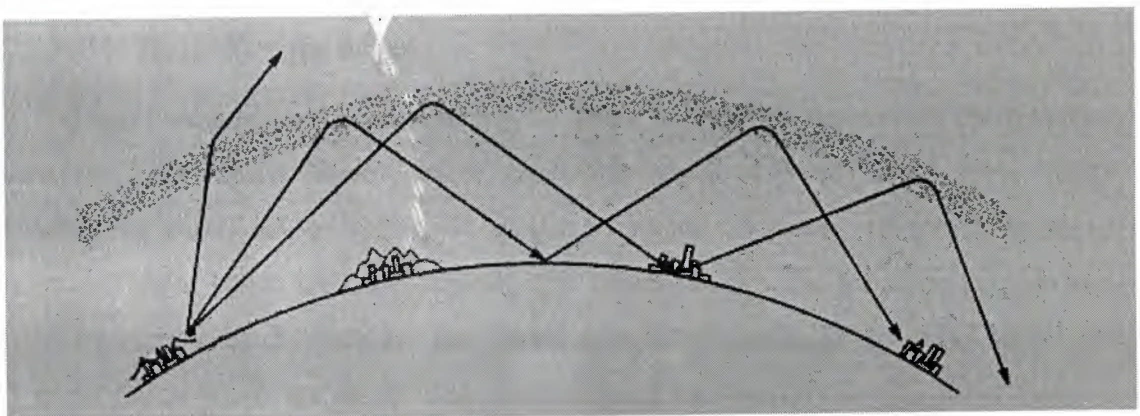

Figure 2.1 Radio wave reflection from ionosphere

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 receivers

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 receivers receive wider bandwidth (low selectivity) while improved receivers receive narrow (exact) bandwidth (high selectivity).

Each transmitter produces harmonic frequencies, which also carry 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 waste some frequencies.

It is not (normally) possible to use the same 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 these factors 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 today is based on the allocation of 1977 WARC [1].

2.2.3 HF High Frequencies

High Frequencies are between 3 – 30 MHz. Within this segment of the spectrum there are Short Wave Bands. Most commonly used of these Short Wave radio-broadcasting bands are 49 meter, 41 meter, 31 meter, 25 meter, 19 meter, 16 meter bands and these bands are used basically for international radio broadcasting services. Apart from these bands there are also bands such as 60 meter, 21 meter, 13 meter and 11 meter bands which are rarely used since most of the receivers do not cover them. In between the SW bands there are frequency sections that are allocated for several telecommunications services such as maritime telephone, aviation communications, citizen band (CB) radio service etc. SW bands have a channel spacing of 5 KHz and AM (Amplitude Modulation) is used as the modulation technique. Most of the international broadcasters (such as BBC, Voice of America, Radio Moscow etc.) use short wave bands because they are reflected from the ionosphere easily to reach very long distances [1]. However the reflection of ionosphere depends on many factors including the frequency and time of the day and the year. Due to this broadcasters usually use more than one frequency for each of their programs so that they try to guaranty better reception conditions at their target areas. A broadcaster usually transmits on three to five different frequencies simultaneously and these frequencies change to comply with the ionosphere reflection characteristics. As a result of this, frequencies on short waves are demanded highly and shortage is very high. Some broadcasters, in order to solve the frequency shortage problem, use off-band frequencies (frequencies that are below or above the defined band) to guaranty better reception.

History of international radio broadcasting is full of attempts of jamming, the action of transmitting noise or any disturbing sound on the same frequency of the undesired transmission. Jamming prevents the reception of undesired transmissions at the target area. Jamming actions are usually aimed at “illegal” broadcasts. However it is not easy to define which broadcast is illegal. The official government of a particular country generally backs its legal international broadcaster. For instance Voice of America, BBS World Service, Deutche Welle, Radio Moscow are official broadcasters recognized by the international community since their respective governments back them [1]. However there are also some broadcasters, which are not overtly (openly) backed by any official government. However it is known that some governments covertly (secretly) backs these broadcasters. For example Radio Free Europe and Radio Liberty (broadcasters targeting the ex-Soviet Union States and Allies in Eastern Europe) were never overtly backed by the USA government while it supported these broadcasts secretly by some organizations such as CIA. After the cold war ended, it is now clear that the USA government had backed these broadcasters. Similarly Radio Free Asia is supported covertly by the USA government. The target country not wanting to be exposed to the propaganda usually calls such broadcasts surrogate broadcasts, which are generally jammed [1].

2.2.4 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.

2.2.5 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.

2.2.6 SHF Super High Frequencies

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

2.2.7 EHF Extremely High Frequencies

They are between 30 – 300 GHz. Some radars and military communication equipment and experimental devices use these frequency segment.

2.3 Summary

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

In this chapter the components used in the circuit and the circuit diagram will be presented. The operation of each section of the circuit will be described.

3.2 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 are given, see table 3.1

3.3 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.

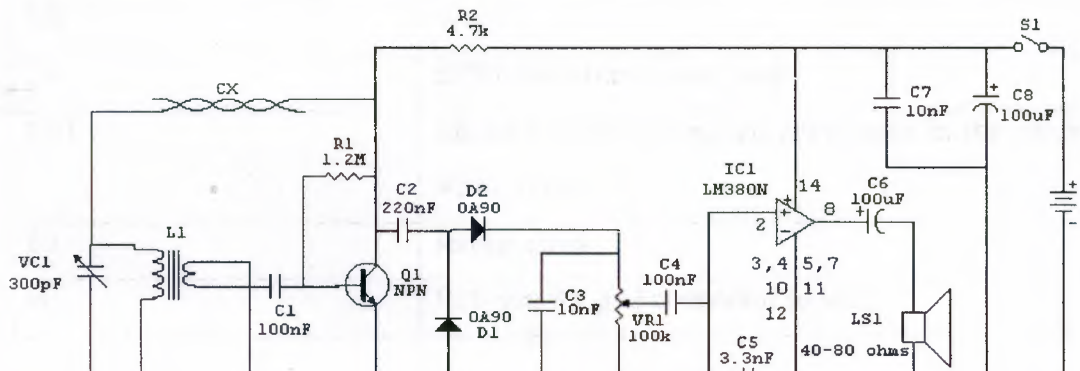

Figure 3.1 Circuit diagram of MW radio

3.3.1 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 (VC1) 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

Table 3.1 Components' list

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, 10V electrolytic
VC1	300pF solid dielectric
TR1	BC101C
IC1	LM380N
D1	0A90
D2	0A90
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

frequencies, so the connection between it and VC1 is introduced to pass the desired frequency. But how is that happens?

$$f_o = \frac{1}{CL\omega} \tag{3.1}$$

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 VC1 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 if it is made of germanium -0.3V is the needed voltage to trigger D1.

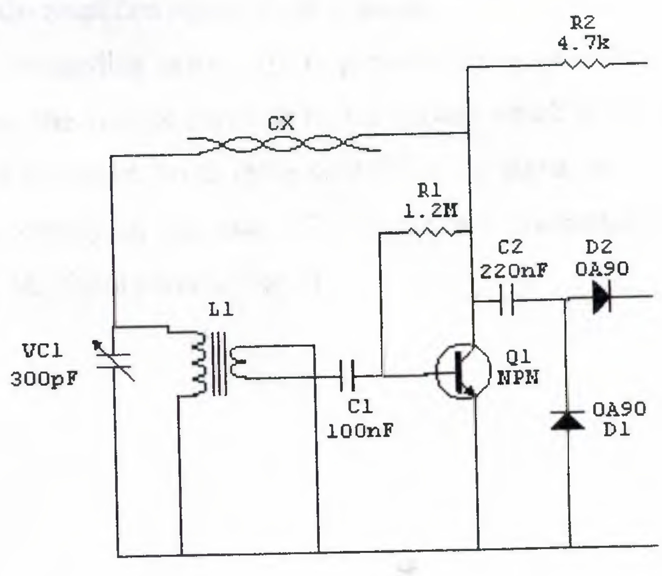

Figure 3.2 Oscillating part diagram of MW radio

3.3.2 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.

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.

From Ohms Law which is shown below (3.2), it is seen that if the voltage is constant and the resistance decreases then the current increases, that means the voltage on the other side of the variable resistance will be higher if resistance increases. That is what happens when the level of volume is changed, when the volume is getting higher that means that the resistance is being decreased, and vice versa.

$$V = I \cdot R \tag{3.2}$$

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.

After that the AC signal will be amplified, it will have again a DC voltage from the amplifying process, so C6 to make sure that the AC signal will be clean from this DC voltage and pass the amplified signal to the speaker.

As the voltage demanding across Q1 in pre-amplifying process and LM380N in the amplifying process, the voltage supplied by the battery which is 9V is slightly varies and a small AC signal is created, so to make sure this noisy signal does not enter in pre-amplifying and also amplifying process, C7 and C8 are connected in parallel with battery to cancel any AC signal coming from it.

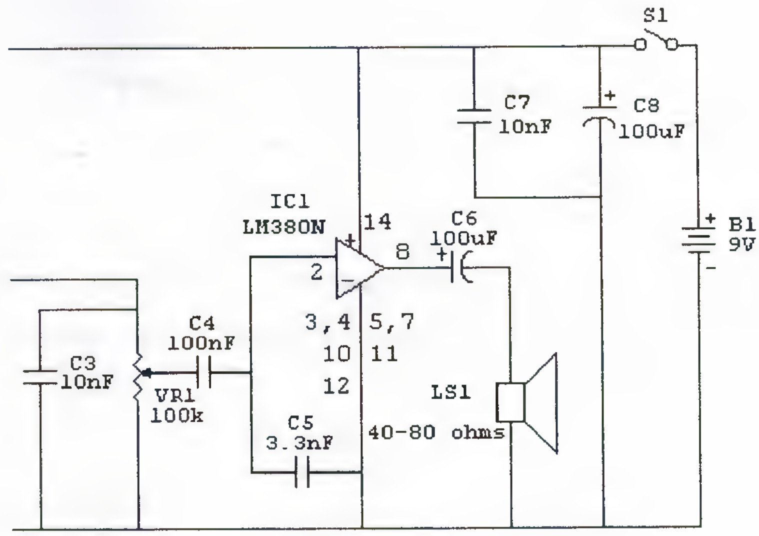

Figure 3.3 Amplifying part diagram of MW radio

3.4 Summary

Now, after each component is well know, and the function of each one, and how does it contribute in the process of filtering and amplifying, it is possible to connect the circuit and have MW radio circuit as shown in fig 3.4.

But it is not guaranteed 100 % to work properly as it is been connected as described, because practical work has a very different environment than theoretical one, and so many problems may occur. Chapter four will discuss the most probable to happen problems, and present some suggested solutions.

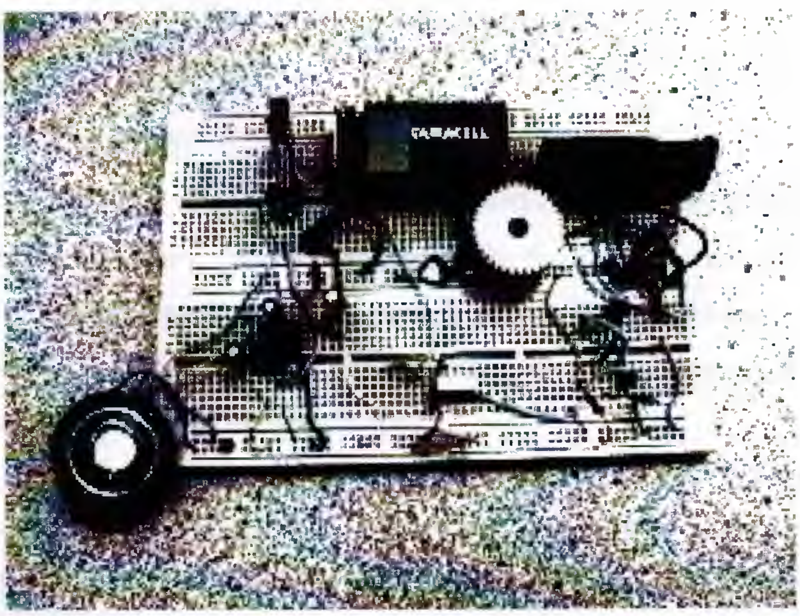

Figure 3.4 MW project photograph

CHAPTER FOUR
PROBLEMS & SOLUTIONS

4.1 Overview

In practical electronic hardware projects there will always be problems. In this chapter we will illustrate the problems that we faced in this project and solutions we used.

4.2 Polarized Capacitors

In 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 4.1 it is clear that there is one pins is shorter than the other, shorter one is the negative one and the longer is the positive, and usually a dark line is placed a side of the negative pin.

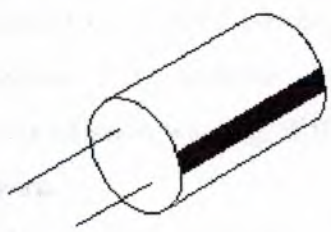

Figure 4.1 Polarized capacitor

4.3 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 4.2 which shows variable capacitor from below, if pin A or pin B connected to the source voltage (or positive side) and pin C connected to earth, the capacitor will act as variable capacitor, but if pin A is connected to a side and pin B connected to the other, the capacitor will act as fixed capacitor, and its value will be the maximum possible value of this capacitor.

To make sure you can use trial and error by using an ammeter.

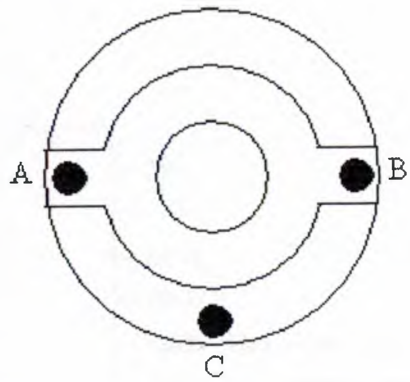

Figure 4.2 Below view of variable capacitor

4.4 Ferrite Aerial

Ferrite aerial has four lead-out wires, actually it is 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.

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.

4.5 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 is 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 4.3.

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 4.4.

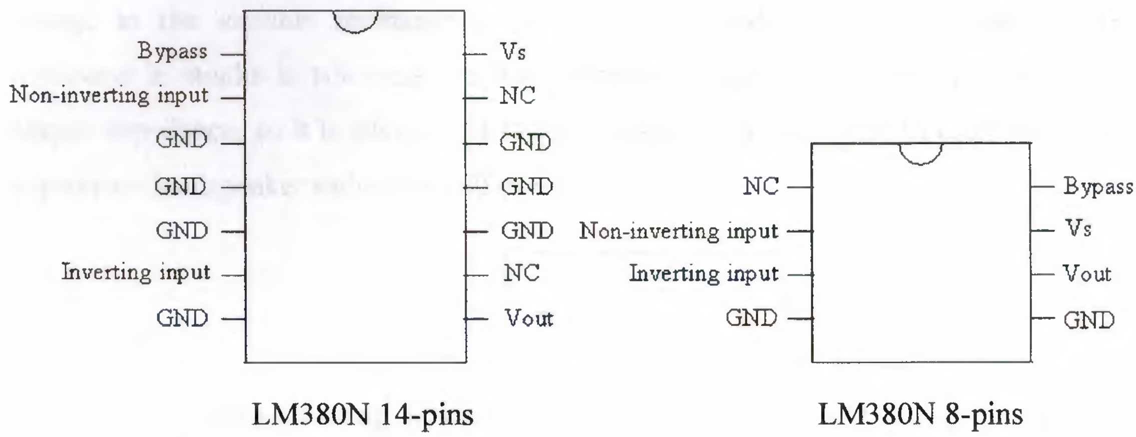

Figure 4.3 detailed lead-out pins of LM380N 14-pins and LM380N 8-pins.

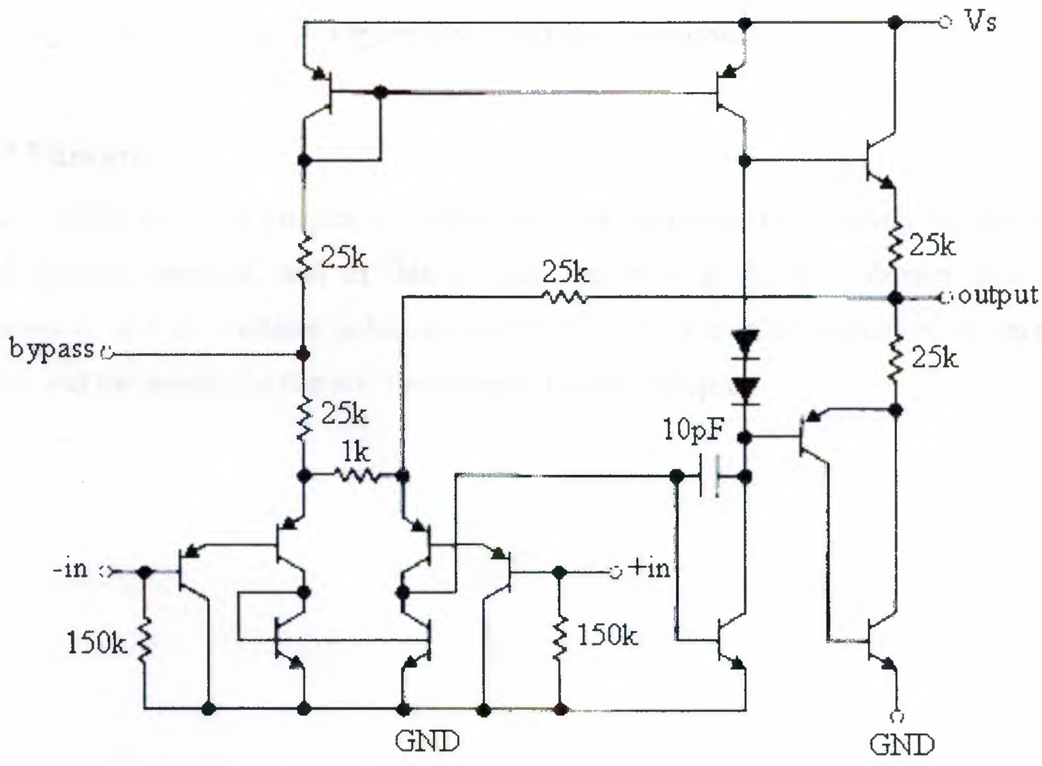

Figure 4.4 Circuit diagram of LM380N chip.

4.6 LM386

Another solution for amplifying problem, if again the amplifying solutions which given above do not work, LM386 comes as a suitable alternative for the LM380N chip, see fig 4.5.

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 10kohms variable resistance. And also LM386 must has a low output impedance, so it is advised if LM386 is installed to the circuit to connect 4 ohms impedance loudspeaker rather than 80 ohms.

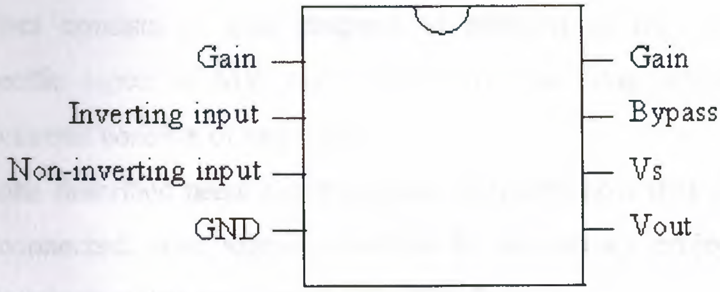

Figure 4.5 LM386 chip diagram

4.7 Summary

In the previous chapter an explanation has been given for setting up the circuit and how it operates, and in this chapter the most probable problems have been discussed, and the suitable solutions we have given. The radio should work properly now, and the results for this will be shown in the next chapter.

CHAPTER FIVE

CONCLUSION

After working on this project, we have had a hands-on experience and learned the joy of working in electronics projects. We also learned some techniques used 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 in addition to this one, each chapter discussed a specific aspect of MW radio subject as a working principle, components which the radio circuit consists of and more.

Chapter one described needed 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 explained the techniques of transmission, the frequencies which are used as channels to transmit information as radio waves in specific and electromagnetic waves in general.

Chapter three was the main chapter of this project, it described 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 for mentioning 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 must it connected to the circuit, or how to use an alternative for some components.

The main objectives of this project were:

- To design, build and test a working MW radio.
- To gain hands-on experience with hardware electronics projects.
- To pin-point problems within the circuits and suggest modification, to overcome the problems.

First, before the building was in progress, we took a look for the components which are used in the project, then we started connecting the circuit as planned.

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

Also while we were testing the circuit, it was burnt by mistake. Since then we get more careful and aware while we are working, and also gave us the motivation and determination to make the circuit work.

The main problem was when a component was not available, we forced to find alternative components by using the internet or some references and also by asking some advices from experienced people.

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