

**DESIGN AND CONSTRUCTION OF
SW/FM RADIO RECEIVERS**

BY

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DEPARTMENT OF ELECTRICAL AND COMPUTER
ENGINEERING,
SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY,
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MINNA, NIGER STATE.

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A PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENT FOR THE AWARD OF BACHELOR OF
ENGINEERING (B.ENG) DEGREE IN THE DEPARTMENT OF
ELECTRICAL AND COMPUTER ENGINEERING, SCHOOL
OF ENGINEERING TECHNOLOGY.

**FEDERAL UNIVERSITY OF TECHNOLOGY MINNA,
NIGERIA.**

NOVEMBER, 2004

CERTIFICATION

We certify that we have supervised read and approved this project work. We have also found it adequate in scope and quality for the partial fulfillment of the Award of Bachelor's Degree in Electrical and Computer Engineering (B. Eng.).

.....

**ENGR. ASULA
SUPERVISOR**

..... 18/12/2004

SIGN/DATE

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**ENGR. M.D. ABDUALLIH
HEAD OF DEPARTMENT**

..... 16/12/2004

SIGN/DATE

.....

EXTERNAL EXAMINER

.....

SIGN/DATE

DECLARATION

I USMAN SALAUDEEN hereby declare that this is an original work of mine, and that it has never been present in any form for the award of either Diploma or a degree certificate anywhere.

All information obtained from published and unpublished works been acknowledge edge.



Signed
DATE 2004

DEDICATION

I whole earthly dedicated this project to the man who gave Birth to me, sent me to school, discovered my potential, encouraged and advice me on how to wisely and carefully combine my resources to achieve success in life and hereafter.

You've gone and couldn't see the reality of thee good work you started in me. I can't prevent the tragedy (death) from occurring but can preserve your good name; ALIYU USMAN, may his soul rest in peace (Amen).

ACKNOWLEDGEMENT

All forms of blessing, favour, assistance, guidance, and protection on me come only from ALLAH (SWT). My greatest gratitude goes to Almighty ALLAH for sparing my life to be able to achieve this task successfully (Alhamdulillah).

My appreciation also goes to my supervisor Engineer Asula for his advice and directives, which contributed to the success of this project.

With much due respect I salute the effort of my mummy Hajiya Zainab Aliyu Usman and my Elder Brother Mallam Ibrahim Usman (BOJJA) for everything they've done for me (Jazakal- lahu haira).

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I am also very grateful for the immeasurable contribution of the entire family members of Mallam Muhammed Muhammed (YABANKA), His wife Mallama Amina Muhammed (Ya-mina); my children/pals in the house ;Ya Rekiya, Aisha, Khadijat, Hassana, Hajiya Amina, Muhammed and Fatima. Thanks for accepting me.

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Finally, I want to express my gratitude to my beloved brothers and sisters Ya-kulu (R.I.P), Ya-Fatima, Yinusa, Amina, Yahaya (Bala), Maryam, Haruna, Muhammed (baba), Taye, Ahmed, Aunty Hauwa and little Ismail. ALLAH in his infinite mercy will see each and every one of us through successfully in life (Amen).

ABSTRACT

The FM/SW Radio Receiver was design to receives the wanted and desired signal presence in space. The receiver selects and recovers the wanted signal from the various radio frequency signal that Arrives at the receiving antenna.

Basically, the receiver extracts and process the desired signal from the various signal received. The preliminary process in the receiver includes raising the voltage level of the received weak signal. The processing function includes conversion of the selected signal to a form suitable for the output transducer. This includes demodulation [opposite of modulation] and Amplification [of voltage and/or power] if the received signal is weak.

The radio receiver circuitry is made up of different types of fillers and amplifiers performing specific as well as well as detector circuit that does the conversion from RF to AF signal.

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CHAPTER ONE

1.1 INTRODUCTION

The functions of a Radio Receivers are to select the wanted signal from all those signals picked up by the Aerial, to extract the information which has been Modulated on to the wanted signal, and to amplify the signal to the level necessary to operate the Loud speaker or other Receiving Device.

A Radio Receiver may be Designed to Receive sound Broadcast signals using Amplitude Modulation (AM) or using Frequency modulation (FM) or Both AM and FM.

Radio Receiver can be use with land, Maritime or Aero-mobile systems using Amplitude or Frequency Modulation; or for use in a multi channel point-to point Radio link. For any Reasons used for, Radio Receiver are of the superheterodyne Type.

The short-wave (SW) Receiver is an Amplitude Modulated (AM) Receiver, whose Frequency Ranges from 2MHZ – 22MHZ. The technology of the short-wave Receiver is based on superheterodyne technique whose principle of operation involves mixing two very close Frequencies of Radio signals to produce a fixed and strengthened lower Frequency called The Beat/Intermediate Frequency (IF).

The Frequency Modulated (FM) Receiver Operates in the very High Frequently (VHF) of 88MHZ – 108MHZ. It has an IF of 10.7MHZ with a band pass of 2X75KHZ.

1.2 LITERATURE REVIEW

The Development of Radio Communication started with the Discovery of the Radio Wave (The Electromagnetic Waves). The Existence of Radio Wave was predicted long before they were actually Discovered.

James Clerk Maxwell made the prediction in 1864. The Great English Mathematical physicist in 1885 a German Physicist Henrys Hertz (1857-1894) – Demonstrated that the Wave actually does exist and they Travel through space.

An English Physicist Ernest Rutherford (1871-1937) succeeded in sending signal for 3/4 mile. Another basic principle of turning, but the most successful of all the Radio pioneer was G. Marconi (1874-1937) an Italian, who went to England to work and later became the father of Radio Communication.

In 1904, the first Vacuum tube was made by John Ambrose Fleming (1864-1943), an English Electrical Engineer. This tube was a diode, that is, it has two electrical parts.

In 1906, an American inventor Lee de Forest (1873 – 1961) added a third part to Fleming Vacuum tube. This New Vacuum tube was called a Triode or Audio, it was much like the Vacuum tube used today.

The first Radio Broadcast was Head on Christmas Eve 1906. The Radio Operator saying "IF YOU HAVE HARD THIS PROGRAMME" write to R.A Feasen den al Brant Rock.

The band pass is a resonant circuit which is turned to pass a certain range of Frequencies while rejecting all Frequencies below and above this range.

The FM is stable, hence used for local station Broadcasting. The Sw Travels a long distance and is used for International Broadcasting . the lower the Frequency, the Greater the ease for Amplification (i.e. to increase the strength and intensity of the sound), that is why SW with lower Frequency is used for long Distance International Radio Broadcasting e.g. Voice of America (VOA, British Broadcasting Co-operation (BBC) e.t.c.

1.3 THE MODERN COMMUNICATION SYSTEM

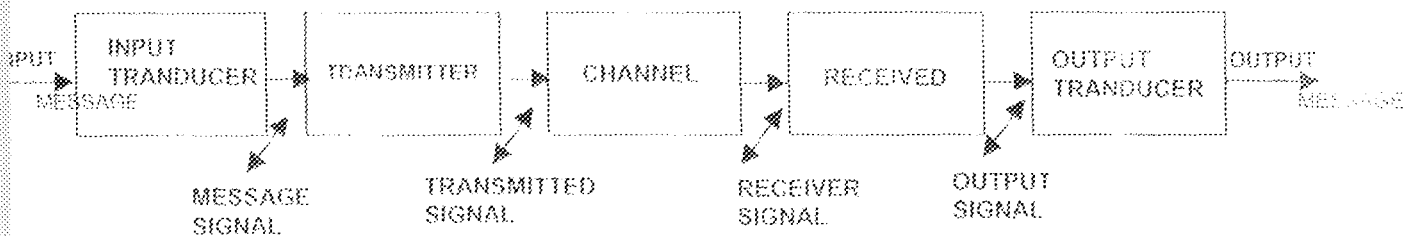


Fig 1 BLOCK DIAGRAM OF A MODERN COMMUNICATION SYSTEM

The Input Transducer: The input message which may be Analogue or digital, must be converted from it's original form into an electrical signal to enable it to be proceed by the Necessary electrical/electronic equipment.

The Transmitter: The transmitter couples the message to the channel. it is at the transmitter that, if necessary a carries Wave is modulated by the message signal. Modulation means modification of one of the parameters (Amplitude, Frequency or phase) of the carrier Wave, usually of much higher frequency than that of the message signal. The parameter to be

modified or modulated varies from one system to another, depending on the system requirements.

Channels: This is the medium through which the transmitted signal gets to the Receiver. It may have many different forms, ranging from the Ground, underground, overhead cables, sky and space. Therefore, the transmitter can be either Hard or Non-Wire (wireless to the Receiver). A common characteristics of all channel is that the signal passing through them undergoes degradation due to Noise, Interference, Distortion, Fading, multiple transmission path, filtering e.t.c.

Receiver: Basically, the Receiver in a communication system extracts and proceeded the desired signal from the various signal received at the channel output.

The processing function includes conversion of the selected signal to a form suitable for the output transducer. This includes, detection or demodulation and Amplification (of voltage and/or power) if the received signal level is low.

It may be also be necessary or desired to delay the Received signal. A good Receiver should be able select "WELL" the desired signal and reject "WELL" and unwanted signal.

Output Transducer: This is an element or device that converts the electrical output signal of the receiver into the form desired by the user. For example a loud speaker converts electrical signal to sound waves for the user to hear. Among other common transducer are cathode-ray –

tubes (CRT), teletypewriters, meters (Analogue or digital) and Oscilloscopes.

1.4 THE AIMS AND OBJECTIVES

This project is aimed at designing and construction of both the AM (SW) AND FM Receiver.

The SW frequency Range will be between 2MHz - 22MHZ. while the FM is of frequency Range of 88MHZ – 108MHZ.

CHAPTER TWO

2.0 THE MODERN SUPERHETERODYNE RECEIVER

In a superheterodyne Radio Receiver, the wanted signal Frequency is converted into a constant Frequency-known as the Intermediate frequency-at which most of the Gain and the selectivity of the Receiver is provided.

The wanted signal, at Frequency f_s , is passed together with many other unwanted frequencies, by the Radio-frequency stage to the mixer (or frequency changer).

In the mixer stage, the input frequencies are combine with the local Oscillator, at a frequency f_o , to Generate components at a large number of New Frequencies. The New frequencies are components of the sum and difference of the wanted signal and the local Oscillator frequencies, i.e. at $f_o \pm f_s$.

The Difference frequency $f_o - f_s$ is known as the INTERMEDIATE FREQUENCY and is selected by the intermediate frequency (I.f) Amplifier. The intermediate frequency is a fixed frequency and this means that, when a receiver is turned to Receive a signal at a particular frequency, the Local Oscillator frequency is adjusted so that the correct different frequency is obtained.

In the Detector stage, the amplified output of the if amplifier is applied and it is here that the information contained in the modulated signal recovered.

The Detected signal is amplified to the required power level by the Audio-frequency amplifier and then fed to the loud speaker or other output Devices.

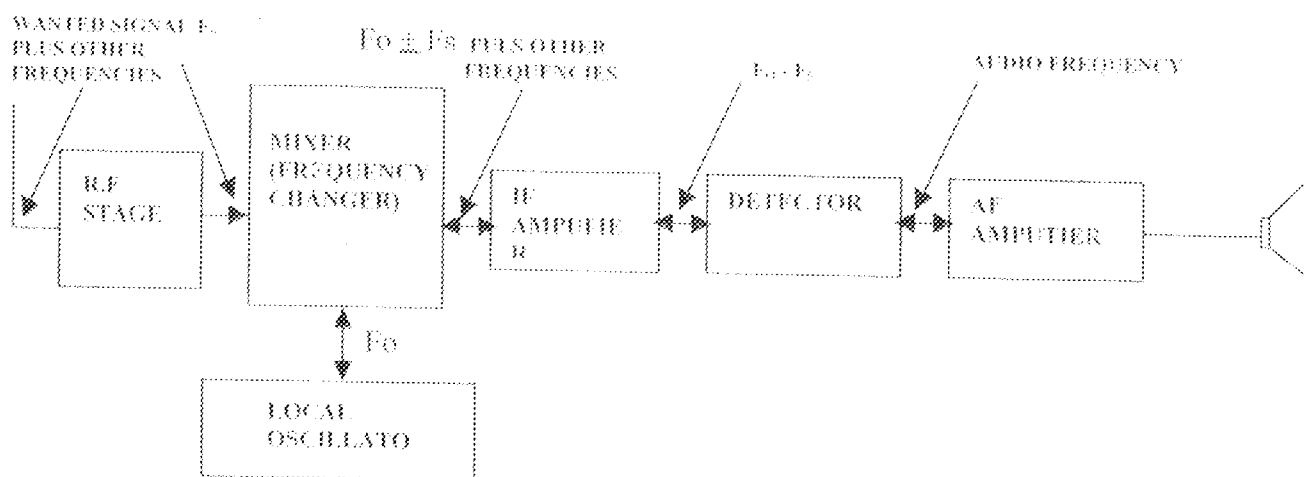


Fig 2 BLOCK DIAGRAM OF THE MODERN SUPERHETERODYNE RADIO RECEIVER

2.1 PRARAMETERS OF RADIO RECEIVERS.

There are many things to be taken into consideration for a Good Radio Receiver. The basic parameter are sensitivity, selectivity, output power, frequency range of operation and Quality of reproduction.

2.1.1 SENSITIVITY

This is the ability to pick up and reproduce a weak signal. It is determined by the value of High frequency voltage fed into the Receiver input circuit to secure normal power output. The lower the input voltage, the Higher the sensilivity.

2.1.2 SELECTIVITY

This is the ability of a Radio Receiver to pick up the required Radio Station and reject the unwanted adjacent station. This is to reduce the interference in the Receiver.

2.1.3 OUTPUT VOLTAGE

This is the level of Output voltage developed across the loudspeaker

2.1.4 OUTPUT POWER

This is the level or amount of Audio-frequency power that the output stage of the Receiver delivers to the loudspeaker.

2.1.5 QUALITY OF REPRODUCTION

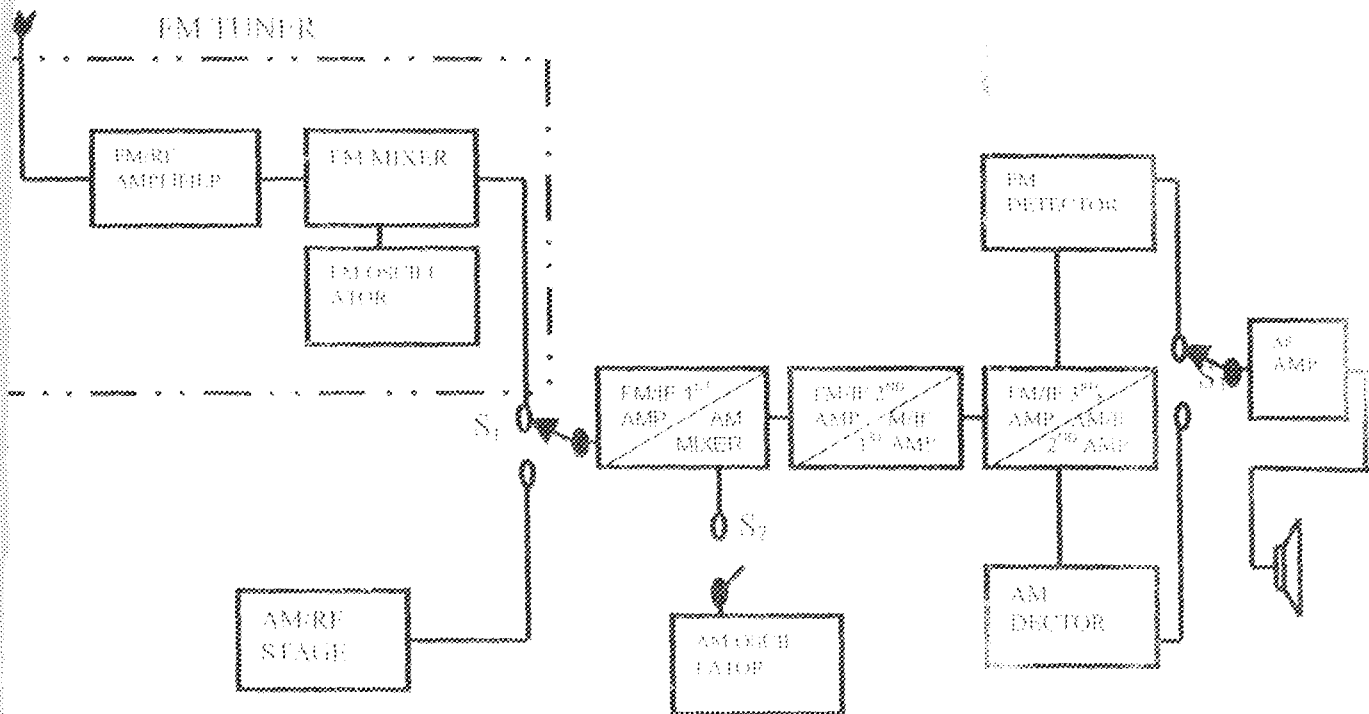
This is determined by the level of distraction introduced by the Radio Receiver. The lower the Distortion, the Higher the quality of reproduction.

2.1.6 WAVE LENGTH RANGE.

The wavelength range requirements of a Radio Receiver demand that receiver can be tuned to any radio station within that range.

2.2 THE FM/AM SUPERHETERODYNE RADIO RECEIVER

Most frequency modulated (FM) Receives are also capable of the reception of Amplitude Modulated (AM) signals; when separate components are used as shown in the Arrangement below.



The switches are in their F.M Positions. The wanted F.M signal is converted to the intermediate frequency by the FM TUNER and then delivered to the first common stage of the if amplifier. This stage has the Dual function of first i.f amplifier for FM Signals and mixer stage for AM Signals.

The wanted FM Signal is selected by the first if amplifier. The amplified FM is then passed on to the Next stage of the if amplification.

The amplified F.M. Signal is then applied to the detector where its information content is extracted and then passed to the A.F Amplifier.

When amplitude Modulated (AM) signals are to be received, all AM MIXER. The Amplitude modulated signal is selected by the second I.F Amplifier stage, which now acts as the first I.F Amplifier and the applied to

the AM detector where the information content is extracted and then passed to the AF Amplifier.

2.3 ELEMENTS OF FM AND AM RADIO RECEIVERS.

2.3.1 INTERMEDIATE FREQUENCY AMPLIFIER

The purpose of the intermediate frequency (IF) amplifier in a super heterodyne Radio is to provide most of the Gain and the selectivity of the Receiver. Most Receivers utilize the impedance/frequency characteristics of single or double tuned circuit to obtain the required selectivity.

The main factors to be considered when choosing the intermediate frequency for a superheterodyne Radio Receiver are:-

- a. The required IF bandwidth
- b. Interference signal
- c. The required IF gain and stability
- d. The required adjacent channel selectivity.

The intermediate frequency should not lie within the tuning range of the receiver, so that the Radio frequency stage (RF) can include an IF trap to prevent IF interference. However, to simplify the design and construction of the IF amplifier, the intermediate frequency should be as low as possible.

2.3.2 AUTOMATIC GAIN CONTROL

The field strength of the wanted signal at the Aerial is not constant but fluctuates widely because of changes in propagation conditions. Automatic gain control (AGC) is applied to Radio Receiver to maintain the carrier level at the input of the detector a more or less constant value even though the level at the Aerial may vary constantly.

AGC ensure that a large receiver gain can be made available for the reception of weak signals without overloading of the RF amplifier stages, with consequent distortions by strong signals. Further, a reasonable constant output level is obtained as the receiver is tuned from one station to another.

The AGC systems are either of the simple or the delay type, for Economics reasons the majority of broadcast receivers use simple AGC.

In a simple AGC system, the AGC Voltage is developed immediately a carrier voltage appears at the output of the IF amplifier. This means that the gain of the receiver is reduced below its maximum value when the wanted signal is weak and the full receiver gain is really wanted.

2.3.3 AUDIO FREQUENCY STAGE (AUDIO AMP)

The function of the audio-frequency stage of a Radio Receiver is to develop sufficient audio frequency (A.F) power to operate the loudspeaker or other receiving Apparatus.

The A.F stage will include a volume control and sometimes tone and base controls.

2.3.4 THE RADIO FREQUENCY STAGE

The Radio frequency stage of RADIO Receiver performs the following function:-

- a. It couples the Aerial to the receiver in an efficient manner.
- b. It suppress signals and the intermediate frequencies.

- c. It operate linearly in other to avoid the production of cross modulation

2.3.5 AUDIO FREQUENCY AMPLIFIER (AF AMPLIFIER)

The AF Signal developed at the output of the detector is next amplified in the Radio frequency amplifier. This will increase the signal power and gain of the AF signal before it is finally fed to the speakers. The AF amplifier finally boosts the low frequency signal to a level high enough to drive the loud speaker. In this Design LM386 IC is used as an Audio Amplifier.

2.3.6 FILTERS

The term as used in communication system, is a frequency selective network designed to operate on an input signal to produce a desired output signal. That is, a filter passes signal of certain frequencies and blocks signals of other frequencies, the passed signals having a certain range or ranges of frequencies are referred to as the BAND PASS and the suppressed signals of other frequencies.

Filters are usually categories according to their behaviour in the frequency domain and are specified in terms of their magnitude or transfer response. Filters are classified as low pass, High pass, Band pass and based on phase characteristics as an Audio Amplifier.

2.3.7 SPEAKER

The amplified signal is fed into a loud speaker which is an output Transude to convert the electrical energy to sound wave (Acoustic waves).

The loud speaker used in this Design employs a moving coil (Electrodynamics) unit composed of the following parts: A cone, front suspension, Alloy mounting voice coil and a permanent magnet.

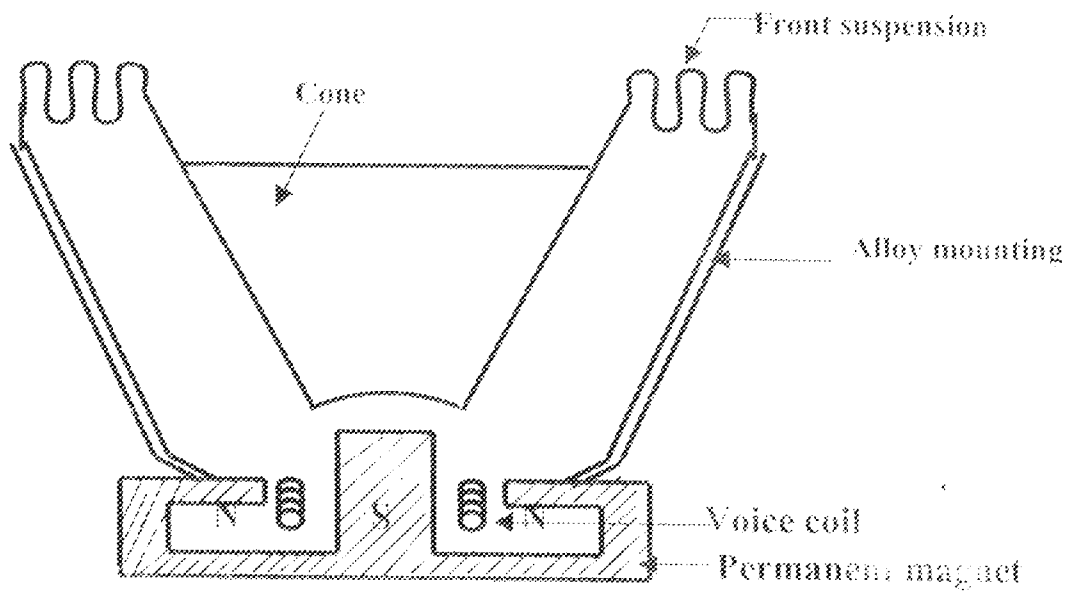


Fig 4 Speaker

CHAPTER THREE

3.0 COMPONENTS DESIGN AND ANALYSIS

As it is been done in any Design and construction layout project, the various component Design and use for the project work has to be properly analyse to give the depth insight of the whole process. This lead or give better understanding of the project.

Most of the components used in this project were according to the conventional value rating (standard manufacturer specification from data sheet) which doesn't need to be calculated.

3.1 THE VARIOUS COMPONENTS USE ARE:-

- FM/SW SWITCH
- POWER INDICATOR
- SPEAKER (1 WATTS 4)
- RESISTORS (4,33K, 50K)
- CRYSTALS 10.7MHZ FOR FM
- CRYSTAL 455KHZ FOR SW
- DIODE (4 IN 4001)
- INTEGRATED CIRCUIT (IC)
LM 386
KA 2297
- CAPACTTOR (VARIABLE CAPACITOR)
- RECTIFIER
- AERIAL
- TRANSFORMER

ANALYSIS

3.1.1 FM/SW SWITCH

This switch is used for the reception of both AM (SW) and FM. This is done only by switching the FM/SW mode ON or OFF. When it is ON, FM modes/reception is activated. When it is OFF, SW reception is activated.

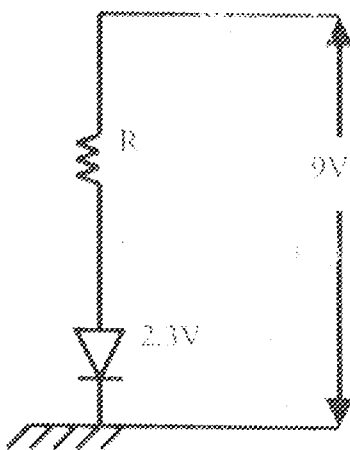
3.1.2 POWER INDICATOR.

The power indicator is a LED (light Emitting diode). It is connected in series with current limited Resistor.

Light Emitting diodes are designed for voltage maximum of about 2.3V any Excess voltage supply is set to damage the light emitting diode.

The series resistors in the power indicator is usually in range of 470Ω to $1k\Omega$

If the light Emitting diode potential be 2.3V and a supply Voltage of 9V.



The voltage across the Resistor is = $9 - 2.3$
= $6.7V$

From $V = IR$

= $r = V/i$

assuming $7mv$ (conventional rating) flows in the circuit

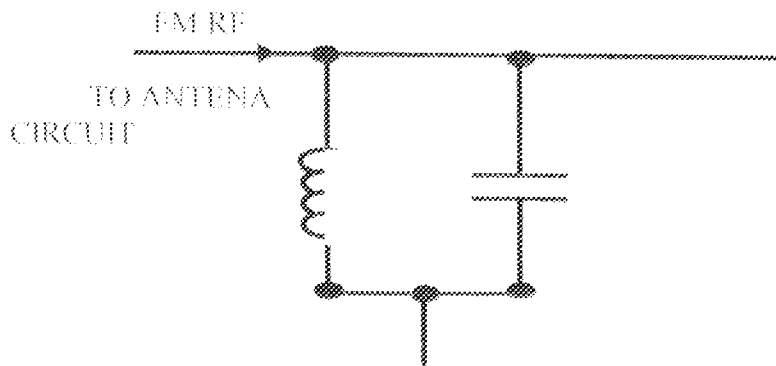
$$R = \frac{6.7}{7 \times 10^{-3}}$$
$$= 957\Omega$$

957 gotten from calculation is within the specific range of 47 to $1k\Omega$.

3.1.3 CRYSTAL (10.7MHZ)

The crystal's only permits frequency at its resonated frequency pass through it to the integrated circuit (IC).

FOR FM RECEIVER.



The FM RF is a LC Circuit. Therefore, any frequency in resonance with LC tanks is tuned or selected. Only that frequency passes into the IC.

$$F_0 = \frac{1}{2\pi\sqrt{LC}}$$

L = 2MH

While capacitor (c) is variable from 100 μ f – 350 μ f

Varying the value of C makes the frequency ranges from 88 – 108 MHZ which is the conventional band of commercial FM radio.

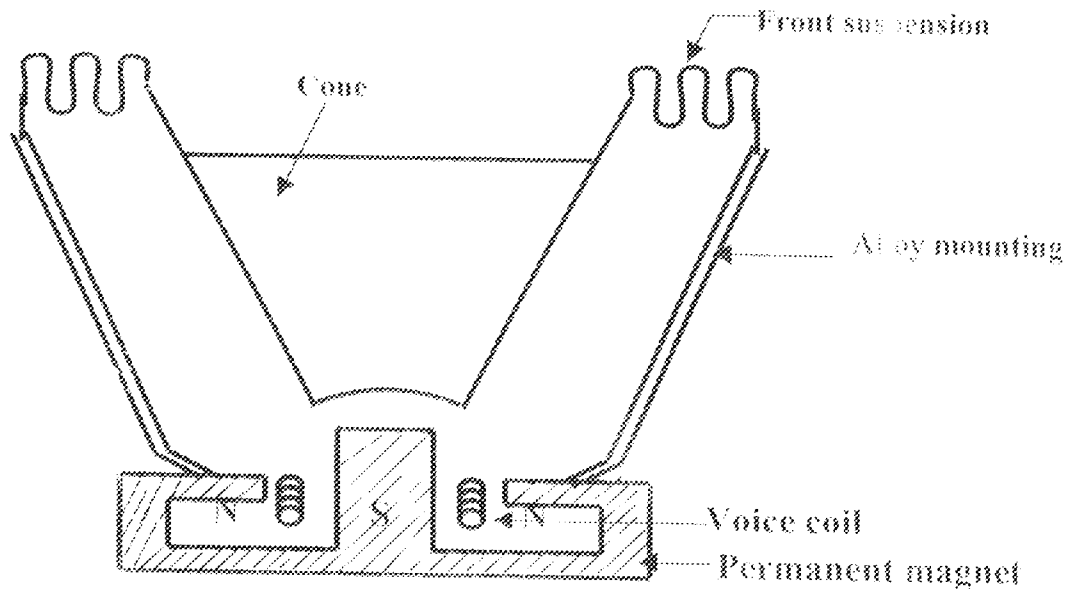
3.1.4 FOR AM (SW) RECEIVER

The frequency ranges is from 1MHZ to about 22MHZ. The crystal type is 455KHZ.

3.1.5 SPEAKER

The amplified AF Signal is fed into a low speaker which is an output Transducer to convert the Electrical Energy to sound wave (ACOUSTIC WAVE).

The loud speaker used in the Design is 1 watt 4 speaker. It employs a moving coil (Electrodynamics) unit composed of the following parts. A cone, A front suspension, Alloy mounting voice coil and a permanent magnet.



3.1.6 RESISTORS

The resistors used provides a path for the capacitor to discharge when power supply is off. Without the resistor, the capacitor will retain it's charge for quite sometime even when the power supply is switched off.

The resistor improves voltage regulation of the supply. The 33kΩ is a current limiting resistor which values ranges from 1kΩ to 100kΩ from specification.

The volume resistor in LM 386 is 50kΩ which is also the conventional value.

3.1.7 RECTIFIER

The rectifier used is the Bridge Rectifier which is most frequently used circuit for electronic dc power supplies. It requires four diode but the Transformer used is not centre tapped.

The Rectifier is designed to convert the out coming AC potential from the 9V Transformer to Equivalent D.C potential.

The Rectifier embodies four IN4001 rectifying diodes, one 1000NF 16V Electrolyte capacitor and one 0.01 NF ceramic capacitor.

The ceramic capacitors of range 0.001NF – 0.047NF are usually used for filtering or smooth electronic circuit, especially Radio Related circuit.

The output of the rectifier is usually connected in series with a power switch which is used to turn ON or OFF the device.

3.1.8 CAPACITOR

A Capacitor essentially consist of two conducting surfaces separated by a layer of an insulating medium called dielectric. The conducting surface may be in the form of either circular plates, spherical or cylindrical shape.

The purpose of a capacitor is to store electrical energy by electrostatic stress in the dielectric. The property of a capacitor to store electricity may be called its capacitance(c).

$$C = \frac{Q}{V}$$

Q is the charge, while V is the potential difference. The unit of Capacitance is coulomb/volt.

1 farad = 1 coulomb/volt.

Variable capacitance air capacitors are widely used in Radio Work. Ceramic capacitors of $0.001\mu\text{F}$ to $0.047\mu\text{F}$ are usually used for filtering or smooth –electronic circuit, especially Radio Related Circuit. The 0.01NF capacitor used is for coupling the output through the volume Resistor to the input of the audio amplifier.

3.1.9 AERIAL

An antenna or Aerial is a structure that couples the input of a Receiver to space. Either converts High-frequenting current into Electromagnetic waves for Radiation (TRANSMITTING ANENNA) or convert Electromagnetic waves into High frequency current (RECEIVING ANTENNA).

Antenna can be used for either transmission or reception of radio waves or Even, for both Hence, Antenna are Reciprocal devices.

3.1.10 TRANSFORMER.

A Transformer is a static pieces of Apparatus by means of which electric power in one circuit is Transformed into electric power of the same frequency in another circuit. It can raise or lower the voltage in a circuit but with a corresponding decrease or increase in current.

The simple Elements of a transformer consist of two coils having mutual inductance and laminating steel core. The two coils are insulated from each other and the steel core.

In all types of transformers, the core is constructed of transformer sheet steel lamination assembled to provide a continuous magnetic path with a minimum air-gap included.

Constructionally, the Transformers are two general types, distinguished from each other merely by the manner in which the primary and secondary coils are placed around the limited core.

The two types are known as

1. CORE TYPE
2. SHELL TYPE

Another recent development is spiral-core wound-core type.

VOLTAGE TRANSFORMATION RATIO

$$\frac{E_2}{E_1} = \frac{N_2}{N_1} = K$$

This constant K is known as voltage Transformation Ratio

E_2 = No of EMF in secondary winding.

E_1 = EMF in the primary winding

N_1 = No of turns in primary

N_2 = No of turns in secondary

If $N_2 > N_1$ i.e. $K > 1$, then Transformer is called step-up Transformation.

If $N_2 < N_1$ i.e. $K < 1$, the transformer is known as step-down Transformer.

For an ideal Transformer

Input VA = Output VA

$$V_1 I_1 = V_2 I_2$$

Or

$$I_2/I_1 = V_1/V_2 = 1/K$$

The primary to secondary ratio of the Transformer can be calculated as follows. Choosing 12V for the secondary side.

$$V_{\text{peak}} = 12V$$

$$\dots V_{\text{rms}} = V_{\text{peak}}/2$$

$$= 12/2$$

$$= 9V$$

Hence, step down Transformer of 220/9V is used
integrated circuit (IC) LM386.

3. 1. 11 INTEGRATED CIRCUIT

The LM386 is a power amplifier for use in low voltage consumer applications. The inputs are ground reference while the output automatically bias to one – half the supply voltage.

It is use in Am – FM radio amplifier and it is ideal for both battery – operation. The supply wide voltage range for its operation is 4V – 12V or 5V – 18V.

The input resistance (R_{in}) is 50k Ω , thus the volume which is a conventional value.

To make the LM 386 a more versatile amplifier, two pin (1 and 8) are provided for gain control. The gain is set at 20 if pins 1 and 8 are open. If a capacitor is put from pin 1 and 8, the gain will increase from 20 to any value up till 200.

Pin 2 is ground and it is inverting input. Pin 3 of the IC is the non-inverting input.

Pin 4 is the Negative terminal while pin 6 is the positive terminal.

Pin 7 is the by-pass terminal connected to a ground 100nF/ 16V.

Pin 1 and 8 are used for gain control as it was said earlier On.

Pin 5 is the Amplifier Audio Output connected to a 1 watt 4Ω speaker.

The IC is used both for Am (SW) and FM reception.

KA 2297

KA 2297 is the same as TA 8164. TA is a Toshiba design while KA is Samsung design. Both IC have the same configuration and operation KA 2297 is used on the board.

Pin 1 and 2 are connected to the antenna circuit, from which the manufacturer specification range of 20 to 30pF capacitor is applied to such position and a coil of 4 Turns are connected as a RF choke. Eg minimises the Radio frequency signal entering the power supply.

Pin 3 is the FM IF (Intermediate frequency) output. Along with other three frequency from the FM mixer.

The mixer of the FM receiver is designed to mix the incoming frequency from the RF (radio frequency) and the fm oscillator.

Normally the FM RF has much frequencies in space. The Oscillator is designed so that at any frequency the RF is, the Oscillator frequency is always 10.7MHz above (Remember that is only for FM Radio)

When the mixer combined two frequencies, four frequencies are produced

Let RF Frequency = F_2

Intermediate frequency = $F_2 - F_1 = F_0$

Additional frequency = $F_2 + F_1 = F_3$

F_3 is the weakness frequency, while $F_0 = F_2 - F_1$ is the intermediate frequency. A strong frequency from the constructive interference of the F_1 and F_2 . Therefore, intermediate frequency is normally called a BEAT.

A beat is attributed to the mixture of two close frequencies. More over, the mixer output for FM modes is Pin 3. Only 10.7MHz that is the intermediate frequency required. Therefore, the signal is passed through a 10.7 MHz crystal (X_1) which filters out only 10.7MHz into Pin 8 which further amplification is done on the intermediate frequency.

Pin 10 holds another 10.7 MHz FM I.F for internal amplification of the intermediate frequency. 45PF capacitor is a assigned value by the manufacture for coupling Pin 10 to the intermediate frequency Transformer.

For short wave (AM) Side, pin 16 is related to the SW (AM) RF.

Short is the band for higher Amplitude modulation frequencies ranges from 1MHz to about 27MHz.

Normally AM receiver is attributed to frequency range of 531 to 1605 KHZ.

Short wave is still AM but Higher frequency band and clearly in reception.

The IF selects a particular frequency through the Antenna and the incoming frequency is mixed with a SW (AM) Oscillator having frequency 455KHZ greater than the incoming RF (Radio frequency).

Therefore, the intermediate frequency of the short wave band is 455HZ. A crystal only permits frequency at its resonance frequency to pass through it. IF usually has three Terminal Input, Output and positive Terminal.

The filtered IF (455KHZ) is fed to pin 7 which is then detected and comes out of Pin 11.

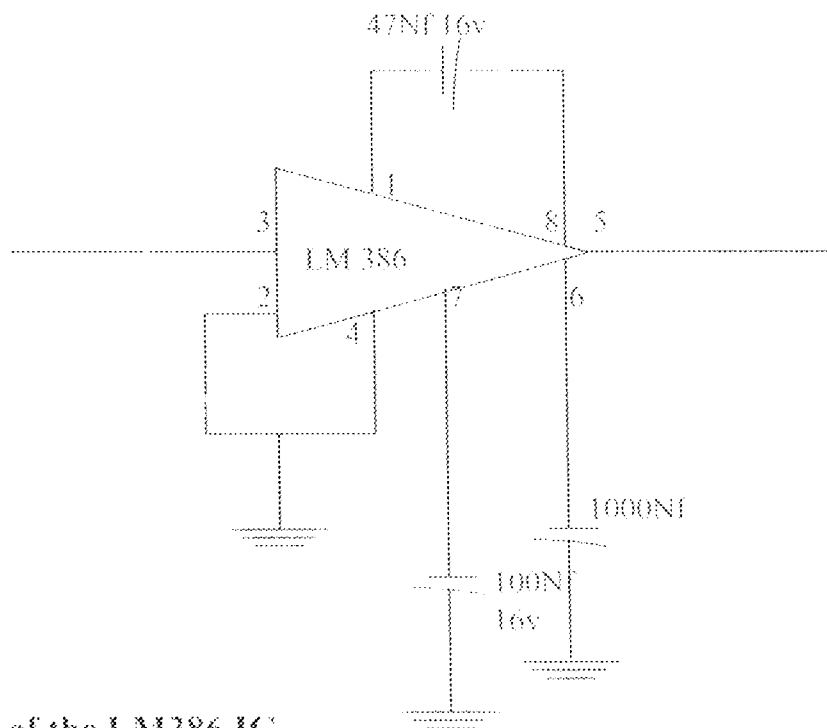
Pin 14 is designed in a manner that when it is positive, FM is the mode and when left open SW is selected.

Both FM and SW have common Pin 11 demodulated/detector output Pin 5 has a 33NF 16V capacitor specified by the manufacture to smoothen the internal operation of the integrated circuit (KA 2297).

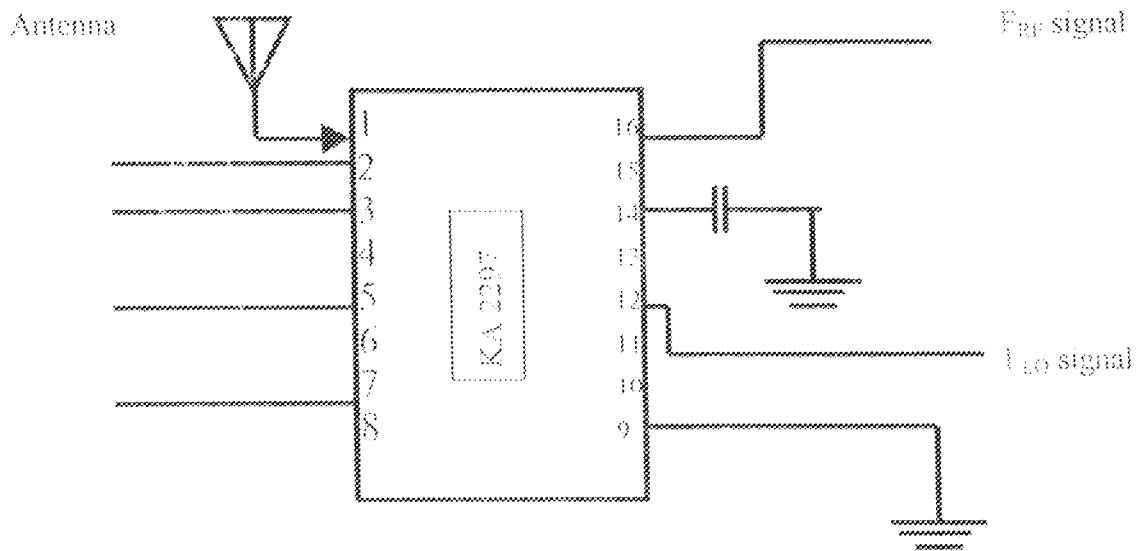
Pin 11 (Audio Output) is connected to a 33K Ω Resistor and capacitors values 0.001NF and 0.01NF.

33k Ω is a current limiting Resistor which value ranges from 10 to 100M from specification.

0.001NF is a smoothen type and 0.01NF capacitor is used for coupling the output through the volume rectifier to the input of the Audio amplifier.



5 diagram of the LM386 IC



6 configuration of KA2297IC

3.4 POWER SUPPLY UNIT

Power supply unit is an Electrical circuit that supplies the device with Electrical Energy. It can either be a battery or a Rectified a.c as used in this project.

The power supply unit consist of the main source, the 12 V transformer, a Bridge Rectifier circuit, a Regulator circuit, a smoothing circuit for power regulation and an indication system consisting of a light Emitting diode to indicate when ON. The main source supplies the a.c signal, which is then converted to d.c signal that is used to operate the constructed project.

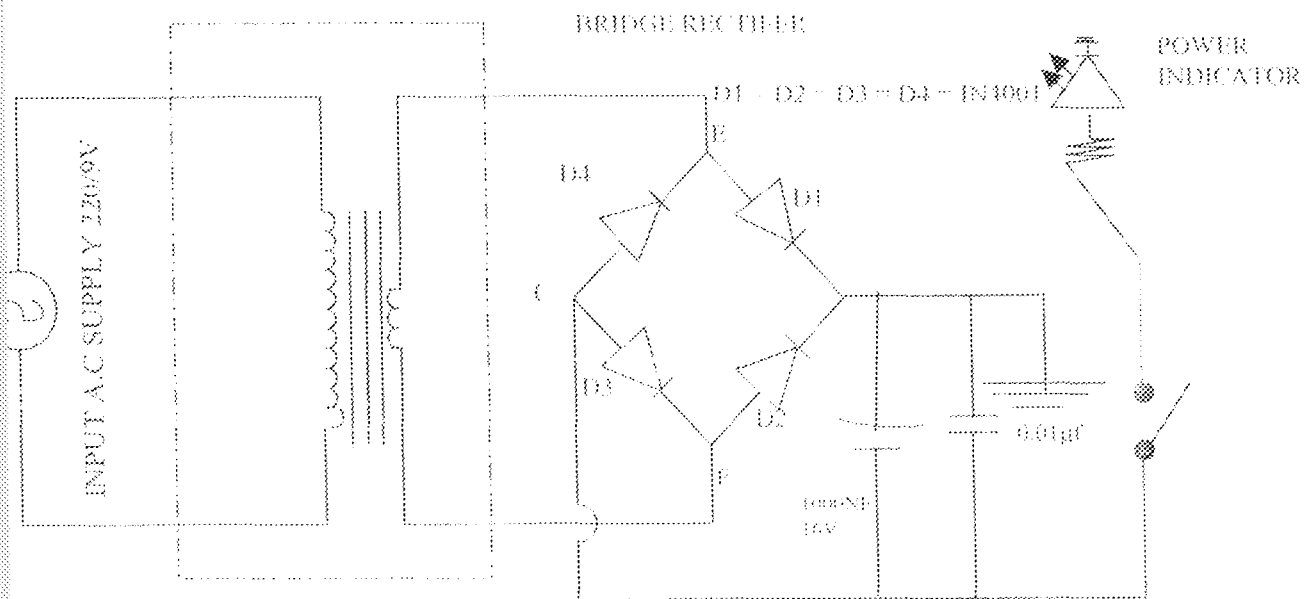


FIG 6 POWER SUPPLY UNIT

CHAPTER FOUR

4.0 CIRCUIT CONSTRUCTION

The circuit construction started with metric layout of components on paper, which was checked and cross checked before transferring to the Bread board according to the metric plan.

From the breadboard, the components were transferred into Vero board and all necessary interconnection of lines were run. This was also cross checked before final soldering.

During the soldering process, Extra care was taken not to over heat the components, because it could leads to loss of rating or total damage to some of the components.

4.1 THE TOOLS AND EQUIPMENT USED

Some of the Electronic equipment used are discussed below.

I). VERO BOARD

This is a board in which the circuit was built on. All the Electronic components where soldered on it, using a connecting leads and blade to make and break continuity.

II) CONNECTING LEADS.

These are wires used to connect the components in the circuit.

III) SCRIPPERS: Wire scrapper was used to scrip off the insulation from solid standard hook up wires.

IV. SOLDERING IRON:

A soldering iron of 40W heating Element was used to solder the compounds together.

V. SOLDER: Flux core was the type used in the soldering of various electronic component.

VI. SOLDERING STAND

This was used for keeping the soldering iron in a safe and upright position in order not to damage the plastic or metallic materials.

VII. WIRE CUTTERS

Wire cutters were used to cut the wire to a required length.

VIII LEAD SUCKER

This was used to remove bad component from the Vero board and to suck all the molten solder.

IX. DIGITAL MULTMETER

This was used many time at different stage in the Experiment. It was used to perform the following function.

- 1) It was used to measure the voltage at each stage of the experiment.
- 2) To know the terminal of the Transistor.
- 3) Used to test the containing of each line on the Vero board.
- 4) It was to measured the secondary voltage of the transformer

4.2 CONSTRUCTION DETAILS

The circuit was carefully planned to simplify the wiring, minimizing errors and to make the troubleshooting easier.

All the circuit were connected in parallel position to conform with the scheme diagram of the circuit.

The ICS used in the design were position in the same direction from the dot which makes it easy to keep track of Pin Numbers during wiring and troubleshooting. The continuity of the Vero board was always cut with the aid of Razor blade when necessary.

4.3 THE CONNECTION OF POWER CIRCUIT

The secondary of the Transformer was connected to the diodes in such away to form a bridge rectifier. 100NF capacitor was connected across the load to filter the output voltage.

4.4 CONNECTION OF LM 386 IC

Pin 5 of the IC was connected to the positive pole of the source while pin 2 was connected to the Negative pole. Capacitor 47/N/16V was connected in series to Pin 1 and 8 to increase the gain. Pin 3, 4 and 7 were grounded while Pin 5 was connected to capacitor for filtering and coupling to the loud speaker.

4.5 CONNECTION OF KA 2297 IC

The RF signal from the Antenna circuit was connected to Pin 6 and pin 16, for AM and FM flow respectively Pin 14 was connected to the positive side of the source, pin 2 and 5 were grounded.

The output from pin 3 was connected to the intermediate frequency filtering circuit before it was connected to pin 8. Pin 4 and pin 8 have the same Relationship.

The RF Coil was constructed by carefully winding a very thin wire round a ferrite rod while the ganged capacitor was mounted on the Vero board by drilling holes that connects the three legs of the gang capacitor and the nub for tuning.

A hole was also drilled in the casing to fix the Aerial.

4.6 TESTING AND RESULT.

Various tests were carried out at each stage of the project. The tests were carried out to be able to get the desired result.

TESTING

1. A known radio station was tuned to so as to know the frequency of operation and for adjusting the frequency dial.

A radio station like British Broadcaster Corporation (BBC) and crystal FM (MINNA) of a known frequency was used.

2. The reception of the Receiver was carefully compared with factory made type receiver so as to have an acceptable response.
3. The Audio output was observed for noise and distortion.
4. The frequency range for the receiver was carefully examined for conventional ones.

RESULT

The result of the construction were as follows:

1. The selectivity was High
2. The Distortion was low and acceptable

3. The Noise was minimal
4. The sensitivity was High
5. The reception was at an acceptable level relative to the conventional radio set.

4.7 PRECAUTION TAKEN DURING THE CONSTRUCTION

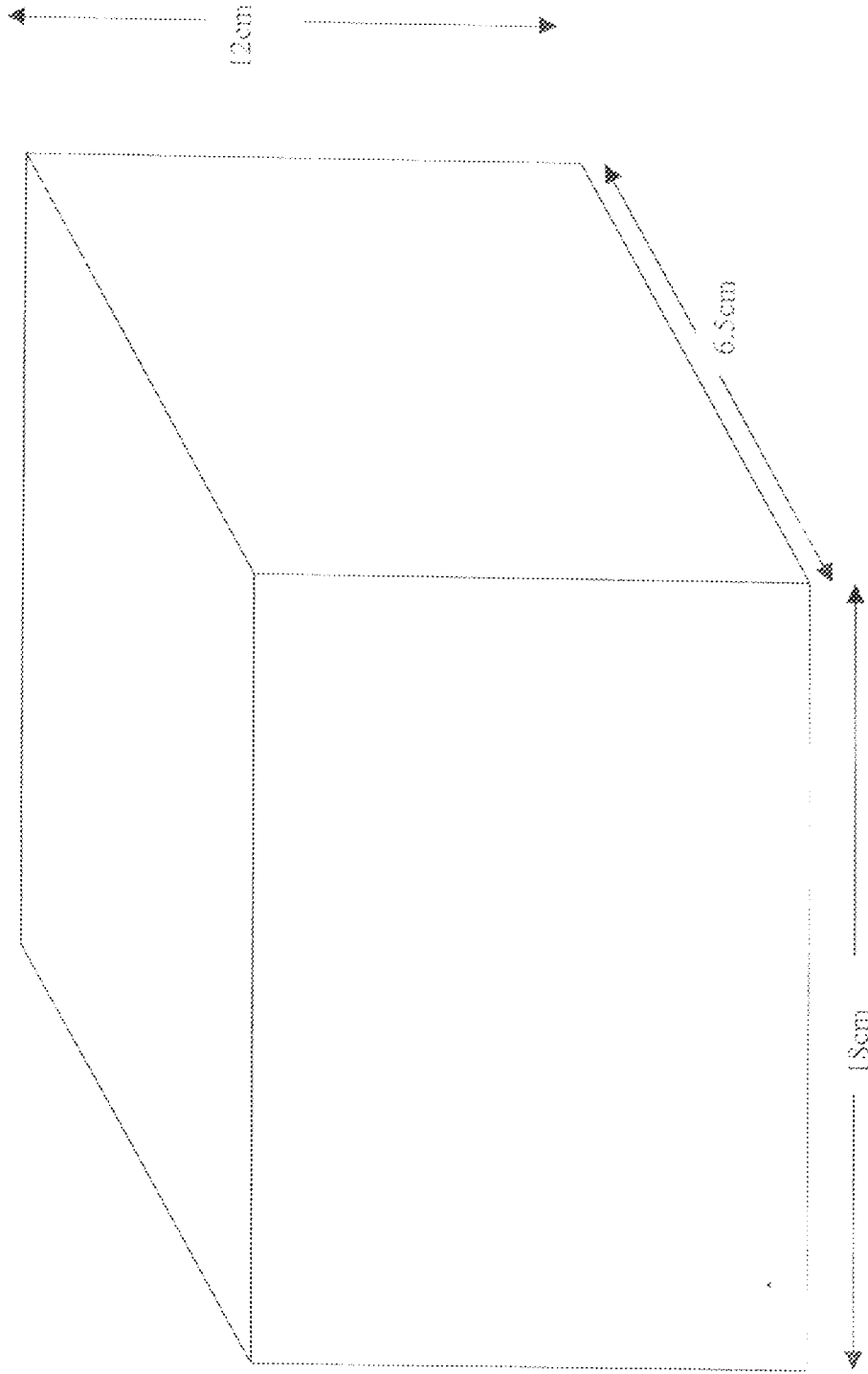
The precautions taken during the construction are as follows:-

- (i) The Breadboard was extensively used for the test construction.
- (ii) The Vero board was carefully checked and tested for continuity.
- (iii) Care was taken during soldering of the components to avoid over heating.
- (iv) Off-target solder splashes were carefully removed to avoid short circuiting.
- (v) Re-checks were made more often to ascertain the right position of components.
- (vi) The power supply unit was normally put off from the circuit when mounling or removing component during the text construction and final construction.
- (vii) The polarities of capacitors and the configuration of discrete components such as Transistor were ensured with multimeter before they were finally soldered on the Vero board.
- (viii) Due to the High frequency involved in the circuit, the soldering was made very small to minimized interference.

4.8 CASING

The casing of the Radio Receiver was based on the size of the fabricated components. The design was made to accommodated the speaker, length of the fabricated components, power supply unit and the Aerial.

DIMENSION OF CASING



- iii) Electronic tools and equipments should be made available in the laboratory for student use.
- iv) Students should be taught how to analyse circuit and how to solder and desolder on Vero board.
- v) Electronic design textbook should be purchased proportional to about 100 copies, so that student designing projects will have materials to work with.
- vi) The Department should Organise a little Electronic component shop (Technical Unit). Where Electronic components will be sold at a low prices to the students.

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