DESIGN AND CONSTRUCTION OF A SIMPLE RADIO RECIEVER (AMPLITUDE MODULATION(

BY

SALE TUMBADI
CST/ND/SLT/2010106

BEING A PROJECT SUBMITTED TO THE DEPARTMENT OF SCIENCE LABORATORY TECHNOLOGY, COLLEGE OF SCIENCE AND TECHNOLOGY, ADAMAWA STATE POLYTECHNIC, YOLA.

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DECEMBER, 2012

APPROVAL PAGE

This project entitles 'DESIGN AND CONSTRUCTION OF A SIMPLE RADIO RECIEVER (AMLITUDE MODULATION)' by Sale Tumbadi; meets the regulation governing the award of National Diploma in Science Laboratory Technology.

..... 11/02/2013

Mr. Offong A.O
(Project Supervisor) Date

..... 14/03/13

Mr. Zaro L. Barsisa
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Mr. Samuel K. Fariku
(Director C.S.T) Date

DECLARATION OF ORIGINALITY

I Sale Tumbadi with Registration No. CST/ND/SLT/2010106 declares that this project is an original work and was carried out by me under the supervision of Mr. Affong A.O in the department of Science Laboratory Technology Adamawa State Polytechnic, Yola.

Sale Tumbadi

Date

DEDICATION

The project is dedicated to God Almighty for his guidance and protection throughout my study; also to my beloved parents and to the entire family members.

ACKNOWLEDGEMENT

I thank the Almighty God for his abundant blessing, mercies and compassion in making my dream a reality. I acknowledge with thanks the effort of Mr, Offong A.O who supervised this work, the H O D (SLT) Department Mr, Zaro L Barsisa, Mallam H Bellel and the entire staff of the Department of Science Laboratory Technology (SLT), Adamawa State Polytechnic Yola. My profound gratitude goes to my closed friends Yusuf Aminu, Abdulrasheed Yahya, Muhammad B. Muhammad, Isaac Laku, and all my family for their support and care.

Finally my special thanks go to Ardo Tumbadi, Mallam Yahya Gudusu, and Alhaji T Gudusu who's assisted me in one way or the other, may Allah Almighty bless them all. Amen.

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ABSTRACT

This project was to design and construct a simple radio receiver whose function was to select the wanted signal from the signal picked up by the aerial while rejecting all others; to extract the intelligence contained in modulated signal and to produce an audio frequency output. A balance modulator contained two parts; the carrier frequency of 10 MHz was generated at the carrier input while 4 KHz was generated at the modulating signal input. The output of the balanced modulator was a modulated wave form. The receiver was connected to an oscilloscope (Oscillo-graph). This audio wave form was observed on the scope and was found to be 2.5 KHz. The radio receiver was tested using multiple D C power supply unit constructed by another student (Yusuf A.Aminu).

CHAPTER ONE

1.0 INTRODUCTION TO COMMUNICATION SYSTEM

According to Bernard (1980) communication is a process whereby information or intelligence is transferred from one place to another; there are several types of communication systems; some of which include: telephone, television and radio etc. Communication from one person to another is carried out within minimum period of time with the mentioned instruments.

Radio receivers in particular have played a vital role in the world of communication by quick dissemination of information. They are designed to receive sound broadcast signals using a double side band amplitude modulation. The radio receivers are of super heterodyne type.

Radio receivers work on the principle of modulation and implementation.

1.1 THEORY OF MODULATION

Modulation is defined as the process by which one of a carrier wave is modified in accordance with its modulating signals. It is represented mathematically by:

$V_c = V \sin (W_c + \theta)$.....(1)

$V_m = V \sin W_m t$ .....(2)

W here, V_c = carrier wave

V_m = modulating signal

V_c = Amplitude of carrier wave

V_m = Amplitude of modulating signal

θ = Phase angle

$W_c = 2\pi V_c$ = angular carrier frequency

W_m = $2\pi V_m$ = Angular modulating signal

The modulating signal is given by:

$V = (V_c + V_m \sin W_m t) \sin W_c t$.....(3)

But $\sin W_c t \sin W_m t = \frac{1}{2} (\cos (W_c t + W_m)t - \cos (W_c - W_m)t)$

Therefore,

$V = V_c \sin W_c + \frac{V_m}{2} \cos 2\bar{n}(V_2 + V_m)t \ \frac{V_m}{2}$ $\frac{W_m}{2}(OS2\bar{n}-(V_c - V_m)$

The expression above shows that the amplitude modulated carrier wave contains the frequency components. The frequency of

the first term is the carrier frequency. That of second term is the upper side band.

$V_c + V_m$ - Upper side band (U.S.B)

$V_c - V_m$ - Lower side Band (L.S.B)

Modulated index $m = \frac{Vm}{Vc}$

1.1 Where, $V_c + V_m$ = Maximum amplitude and $V_c - V_m$ = minimum amplitude.

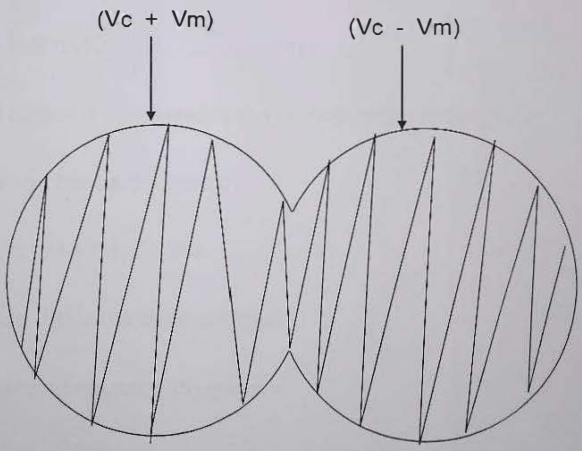


Fig 1.1 AMPLITUDE MODULATED WAVE

1.2 THEORY OF DEMOLDULATION

Demodulation is defined as the process of extracting or recording the information from a modulated signal. In the case of amplitude modulated signal, there are different demodulation techniques which depend on whether modulated signal is analogue or digital.

1.3 PROCESS OF DEMODULATION

Let the modulated signal be:

$V_c = A \sin W_c t$ ..... (4)

The carrier is reinserted in the demodulation process.

This can be represented by:

$V_c \sin W_c t = F(t) \sin W_c t$ ..... (5)

Where F(t) is the original signal

Expanding equation (5) gives

$Vc \sin Wct = \frac{1}{2} F(t) + \frac{1}{2} F(t) \sin 2W_c t$ ..... (6)

The result or the output is obtained by taking the fourier transform of both side of equation..... (6)

$$F(VcSinWct) = \frac{1}{2}F(w) + \frac{1}{4}F(w) + 2W_c + \frac{1}{4}F(w - 2W_ct) - (7)$$

A low pass filter is used to separate the double frequency term which is seen from the output express (7), hence original signal is obtained (Green, 1978).

1.4 AMPLITUDE MODULATION

Amplitude modulation means the high frequency carrier characteristics can be altered by the amplitude of the message signal. In this modulation, the phase and frequency of the carrier signal is constant.

According to the Wikipedia, the free encyclopedia; amplitude modulation is a technique in electronic communication most commonly transmitting information via a radio carrier wave. Amplitude modulation (AM) IS the encoding of carrier wave by variation of its amplitude in accordance with an input signal (www.answers.com, 2012).

The process of varying carrier in amplitude modulation is called modulation.

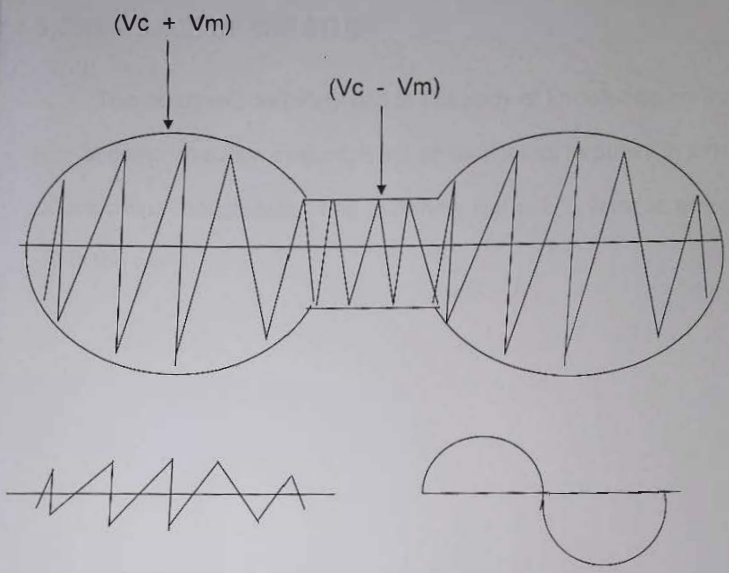


Fig.1.2 Amplitude Modulating Wave

1.5 STATEMENT OF THE PROBLEM

Despite the importance of communication in today's business and corporate world, most people seem not to recognize its value. Most of the public have not been productive largely because of poor communication.

1.6 AIM AND OBJECTIVE OF THE STUDY

To design and construct a simple radio received Amplitude Modulation (AM).

1.7 SIGNIFICANCE OF THE STUDY

This study will definitely add to the body of knowledge on the role of communication system. It will be useful tool to public in term of educating, enlightening and informing the public what is going on in the world.

CHAPTER TWO

2.0 PRINCIPLE OF TRANSISTOR

A transistor is a semi-conductor device used to amplify and switch electronic signal and electrical power. Transistors help to amplify and switch electronic signal. When current is given to the transistor it changes the current that is flowing through other transistor. These can be found in television, microwaves, as well as computer (www.Google.com, 2012)

According to (www.ask.com 2012). Transistor is a semi-conductor that transform into power to go to the appliance or lines for the electricity to run through. It controls the feed by signal. Transistor is a small electronic device that contains a conductor and at least three wires used as contact. The circuit amplifiers, detects or is used as a switch to turn something on and off. A transistor is a current amplifier. It is a three terminal device contracted from three layers of p and n-semi-conductors. There are respectively called the Emitter (E), Base (B) and collector (c). There are two possible type npn or pnp. In a pnp transistor, the emitter is p- types, the base is n-type, and the collector is p-type

while in the npn transistor, the emitter is n-type, the base is p-types and collector is n-types. Current flow in the transistor is due to the movement of both hole and electron.

In normal use as a linear amplifying device, a transistor is used with the emitter to base junction in forward bias and with the collector to base junction in reverse bias that is for the case of common base amplifier.

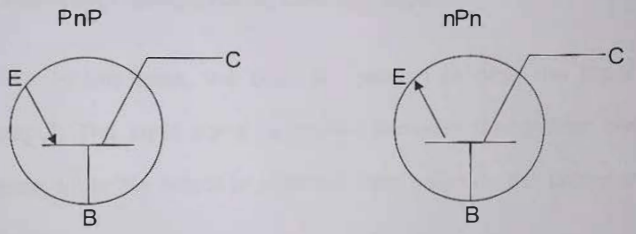


Fig. 2.1 Transistors

2.1 TRANSISTORS AS AN AMPLIFIER

As mentioned above a transistor serves as amplifying device. There are several transistor amplifiers among which have the common base, common emitter and common collector (emitter flower) amplifiers respectively; a brief discussion of them below.

COMMON BASE AMPLIFIER.

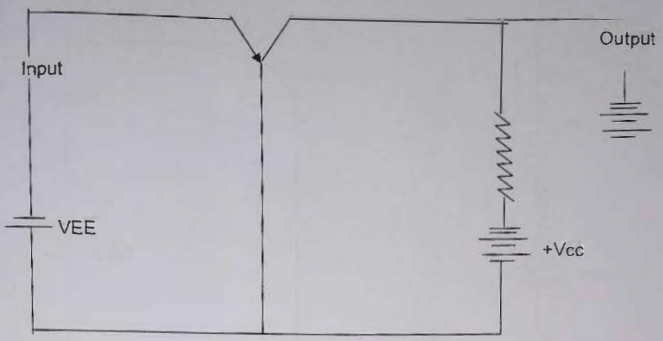


FIG. 2.2 COMMON BASE CIRCUIT (npn)

In this case, the base is common to both the input and output. The input signal is applied between the emitter and the base while the output is obtained from between the collector and base.

COMMON EMITTER AMPLIFIER

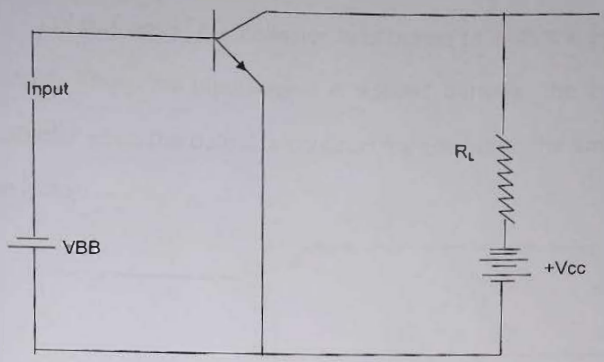


Fig 2.3: COMMON EMITTER CIRCUIT (CEC).

In common emitter, circuit input voltage is applied to base instead of the emitter, which is now the grounded electrode. The output is taken from the collector with its RI. The Vcc is positive for reverse on the n collector.

The common emitter amplifiers have the following characteristic:

i. Input resistance is low
ii. Output resistance is high
iii. Current gain is high
iv. Voltage gain is high

COMMON COLLECTOR (Emitter flower) AMPLIFIER

In this case, the collector is common to both the input and output. Thus, the input signal is applied between the base and collector while the output is obtained from between the emitter and collector.

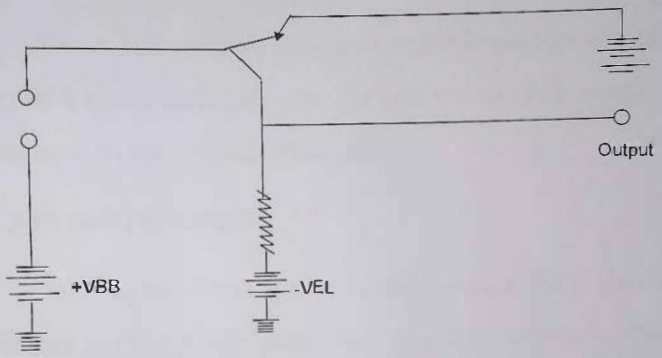


Fig 2.4 COMMON COLLECTOR CURCIUT (ccc)

2.2 CLASSES OF AMPLIFIER

Transistor amplifier stages are divided into four categories according to the location on the operation point.

CLASS A, AMPLIFIER

The amplifier stage is based so that the magnitude of the collector current is greater than zero at all times and the signals nay swing in equal amount above and below the operating point.

CLASS B AMPLIFIER

This is the operating point such that the average collector current is nearly zero (cut – off). The collector current increase in magnitude as the input signal increases.

CLASS (AB) AMPLIFIER

This has the operating point located between that of class A and that of class B operations. The magnitude of the collector current must be above the cut-off for appreciation more that half but less than entire cycle of the input signal voltage or current.

CLASS C AMPLIFIER:

Class C amplifier stage has the operating point below the cut-off value and the magnitude of the collector current is greater than zero for applicability less than half of a cycle of input signal voltage. Class c amplifiers are usually formal amplifier.

2.3 PRINCIPLE OF TUNED CIRCUITS

The tuning circuit is that part of a receive which selects the signal frequency. This consists of a capacity and an inductor one of which is variable. The capacitor and inductors maybe connected either in series or parallel as tuning device.

2.3.1 SERIS TUNED CIRCUITS

The purpose of a series connection of capacitor and inductors is to select one frequency and to reject all others. Generally, by varying the value of the capacitor, the circuit can be made to select different frequencies (Bernard, 1980).

Fig 2.4: SERIES LC TUNDE CIRCUIT

2.3.2 PARALLEL TUNDE CIRCUITS

A parallel tuned circuit can be used to reject one frequency and pass all others. Hence, by varying the capacitor, the circuit can also be made to select a number of frequencies while rejecting unwanted signals. Bellow is the LC parallel tuned circuit.

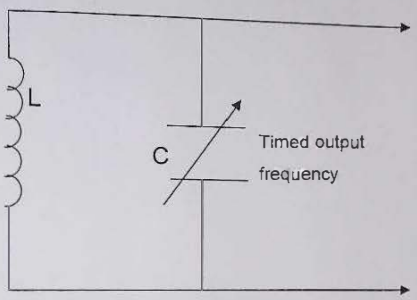


FIG. 2.5. PARALLEL TUNED CIRCUIT

2.4 RESONANCE FREQUENCY (f_0).

This is the frequency at which the capacitive reactance (X_c) equal to the conductive reactance (X_L).The current is maximum at resonance. This frequency is expressed as.

$X_L = w_L$

$=2\pi f_L$

$X_c = 1/w$

$= 1/2\pi f_c$

For resonance,

$X_L = 1/w$

$2\pi f_L = 1/2\pi fc$

$4\pi^2 f_O^2 L_C = 1$

$$f_o^2 = \frac{1}{4\pi^2 L_c}$$

$$f_o = \sqrt{\frac{1}{4\pi^2 L_c}}$$

$$f_o = \frac{1}{2\pi\sqrt{L_c}}$$

Where,

C, is capacitance of the capacitor

L is inductance of the inductor

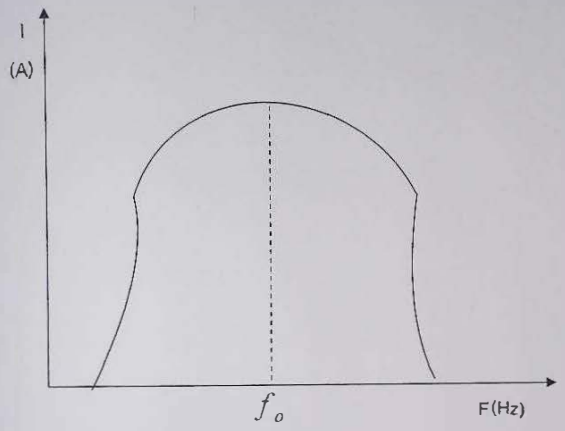


FIG: 2.6 RESONANCE FREQUENCY

2.5 TUNED AMPLIFIER is one which is referred to handle a relatively narrow band of frequencies centered about particular radio frequency. It has two main functions.

i. To provide a specified gain over a given frequency band

ii. To provide the selectivity necessary to ensure that frequencies outside the wanted band are not amplified.

The tuned selectivity refers to a receiver ability to pick up one frequency and reject all others; the higher the selectivity of a receiver, the better the tuning circuit.

CHAPTER THREE

3.0 STUDY SITE

This research was done within Jimeta metropolis which is located at Yola North. Yola, the Adamawa state capital is situated in the north-eastern part of Nigeria, which lies between the latitude of 8^0N and 11^0N and longitude of 11.5^0E and is 395^0C. The average minimum temperature recorded is 15.2^0C while the minimum is 39.7^0C. It is located at the North Sudan Savannah. The occupation of the people is farming, fishing, trading and civil Servant. (Roger, 2012).

3.1 RESEARCH DESIGN

The research design adopted for the study was construction method.

3.2 MATERIAL AND EQUIPMENT

The materials used for the construction in this project were as follows:

1. Board
2. Ferrite rod

3. Copper wire

4. Capacitor

5. Inductor

6. Resistor

7. Conductor

8. Batteries

9. Diode

10. Headphone

11. Transistor.

3.3. THEORY OF RADIO RECIEVER

The function of a radio receiver is to selected the wanted signal from all the signal picked up by Arial while rejecting others; extract the information contained in the modulated power and to produce an audio frequency output of sufficient power to operate the loudspeaker or other receiving device.

Fig 3.0 is a circuit for the simplest types of a radio receiver.

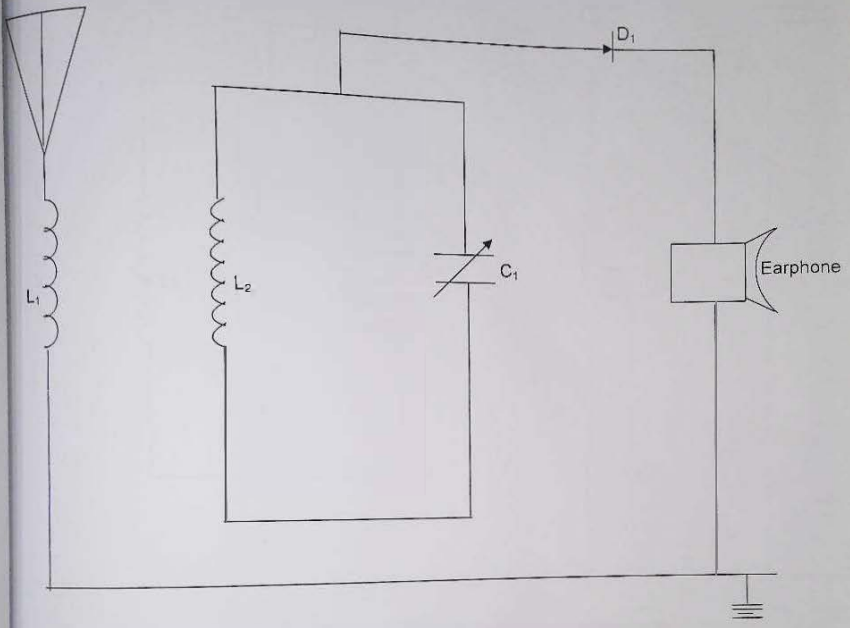


FIG. 3.0 SIMPLE RADIO RECIEVER

In this receiver, selection is obtained by varying capacitor to give resonance at the counted signal frequency.

The diode extracts the radio frequency which passed through the ear phone for conversion into sound.

Other types of receivers are the basic one transistor radio receiver. Here the A.F amplifier is used to improve the A.F power

of this simple receiver. The circuit of this basic one transformer radio is shown below.

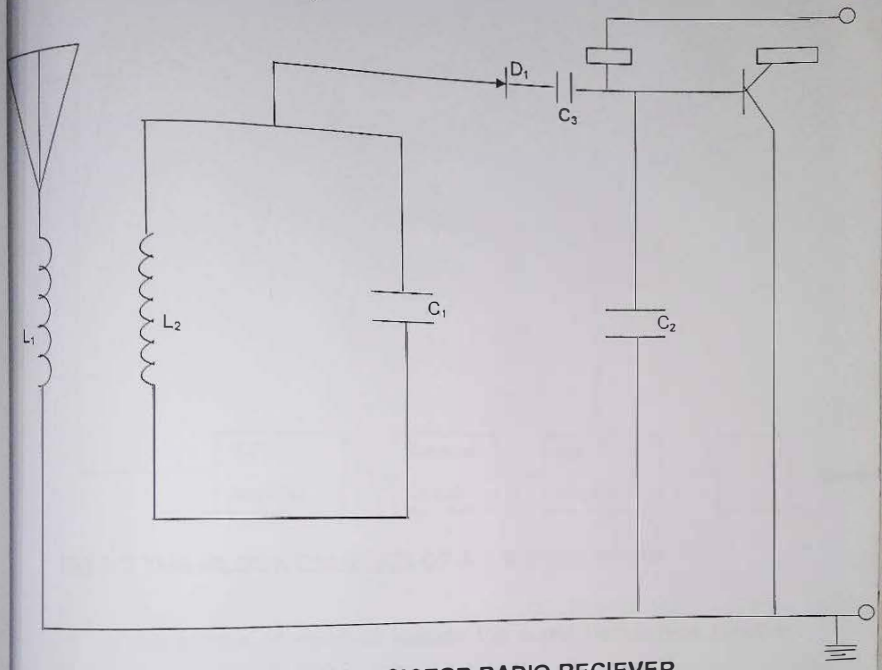


Fig 3.1 BASIC ONE TRANSISTOR RADIO RECIEVER

Also among the radio receiver is the turned radio frequency (T.R.F) radio receiver, the type of radio receiver employed one or more stage of radio frequency (R.F) gain. The block diagram of a T.R.F radio frequency is shown in fig 3.2.

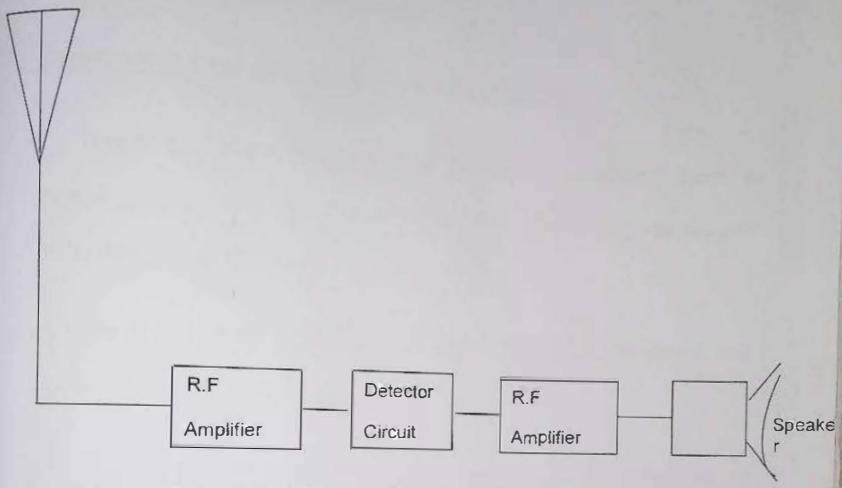


Fig 3:2 THE BLOCK DIAGRAM OF A T.R.E RECEIVER

Others type of receiver include the super heterodyne receiver which employs two or intermediate frequency (I.F) stage and communication receivers.

3.4 CLASSIFICATION OF RADIO RECEIVER

i. AMPLITUDE MODULATED (A.M) RECIEVER

They are used for receiving broadcast signals which would be speech, music etc. on long medium and short waves. The frequency of broadcasting ranges from 540KHz to 1600KHZ. In AM

receiver, the R.F amplifier has a constant bandwidth of 10KHz. They also have a constant bandwidth in case of I.F amplifiers. There is absence of limiter circuits.

ii. FREQUENCY MODULATED (F.M) RECEIVERS.

These are used for receiving broadcast programs from a transmitted of very high frequency. V.H.F. The broadcast ranges from 88MHZ to 108 MHZ.

The R.F and I.F amplifier have higher bandwidth of about 150 KHz and 12 MHZ respectively.

There is presence of limiter circuit which limits the amplifiers of F.M. signals so that there is constant amplitude.

iii. TELEVISION RECEIVER

These are used for receiving television broadcast on VHF/UFH range. The television antenna picks up the transmitted television signal, and the receiver reproduces the audio (sound) and video part of the signal. The audio part of signal is frequency modulated, while the video part is amplitude modulated. Below is a 6MHz television signal.

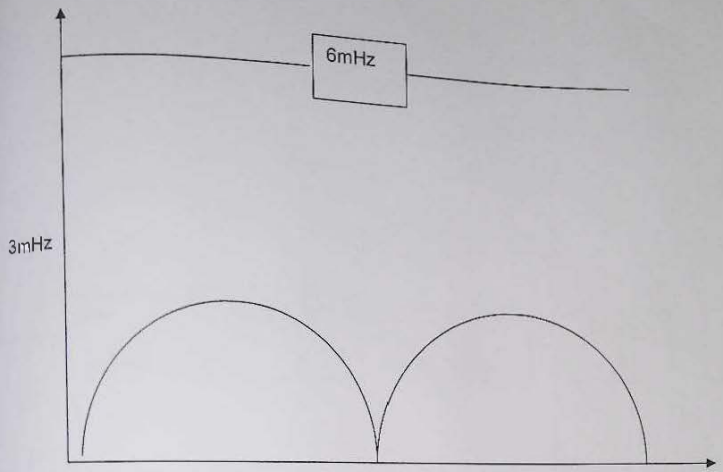


Fig. 3.3 6MHz Television Signal

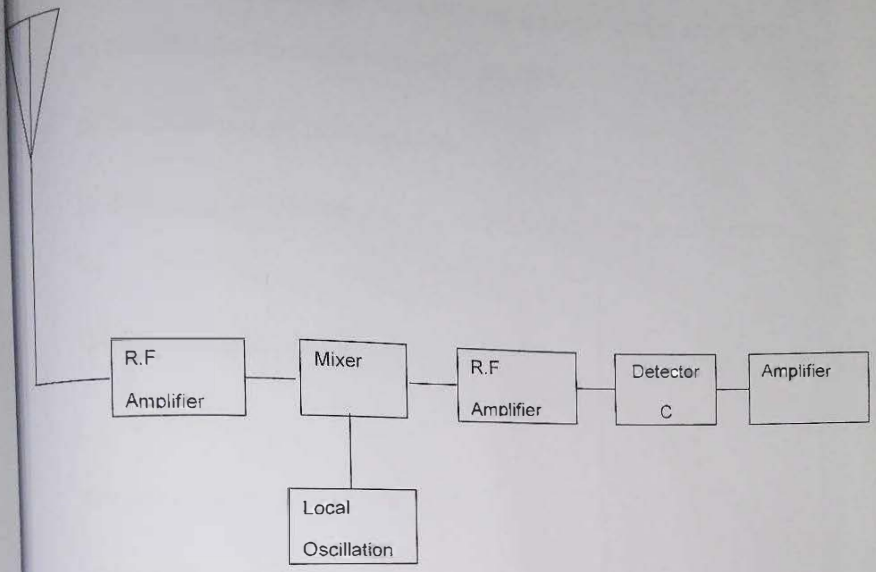


FIG. 3.4. THE BLOCK DIAGRAM OF A SUPER HETEODYNE RECEIVER

The basic principle behind the super heterodyne receiver is that tuned R.F is mixed with another signal generated in the receiver by the local oscillator; from the output of the mixed stage. One frequency with the same modulation pattern as the R.F signal is tuned. The new Tuned is called the I.F. the I.F amplifiers. The I.F amplifiers provide most of the carrier amplifier respectively.

The detector circuit suppresses the negative portion of the modulated waveform and transmits only the positive portion of the

modulated waveform, the output of the detector circuit undergoes amplification in the audio frequency amplifier.

3.5 DESIGN OF AN INDUCTOR COIL

In designing an inductor coil we ought to know the quality factor, Q.

$$Q = \frac{\text{Resonant frequency}}{\text{Bandwidth}}$$

The inductance L is obtained from

$$W L = R/D$$

R is the total shrink resistance if maximum power is not registered for maximum.

$$L = R/W\ (1/2Q - 1/Qp)$$

The number of term is obtained using expression

$$L = n_2 r_2 + 9$$

Where, r means radius of the coil in lines L-length of the coil inches.

3.6 RECEIVER CIRCUITS

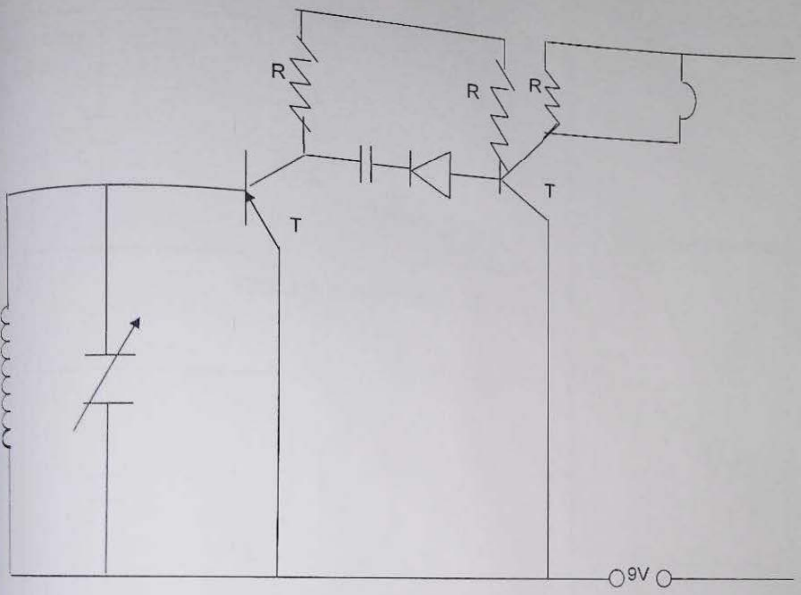


Fig. 35: Receiver with R.F Amplifier

FIG. 3.5 RECEIVER WITH R.F AMPLIER

3.7 DIODE DETECTOR CIRCUITS (AM)

There are two types of diode detector circuit namely the series diode detector and the shunt-diode detector.

The function of both is to abstract information while may be replica of the original modulating waveform.

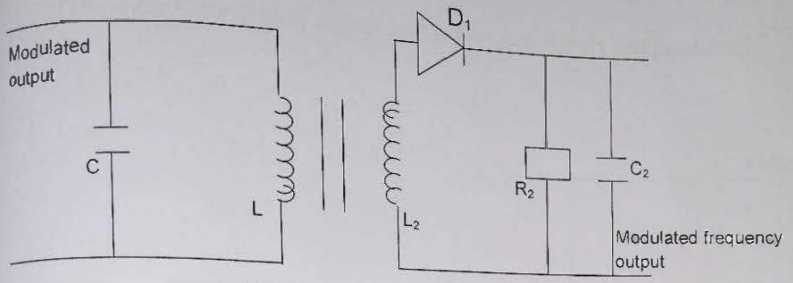


FIG. 3.6 DIODE DETECTOR

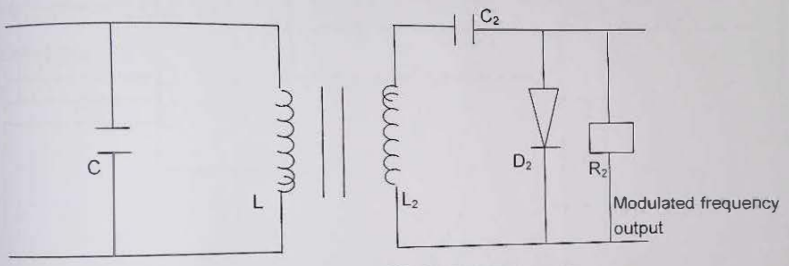


FIG. 3.7 SHUNT-DIODE DETECTOR

3.8 BALANCE MODULATOR

A balance modulator circuit can be used to generate only two side band, the carrier wave being eliminated. The I.C balance modulator offers exceptional good carrier suppression. Figure 3.8 below shows an integrated double balance modulator. The variable R, provides for adjustment of the carrier leaks appearing at the output terminals to a minimum value. R_2 is a bias component and capacitor C, and C_2 decouple the positive and negative power

supply lines. When a complex modulating signal is applied to any of the modulator circuit, upper and lower side bands are produced.

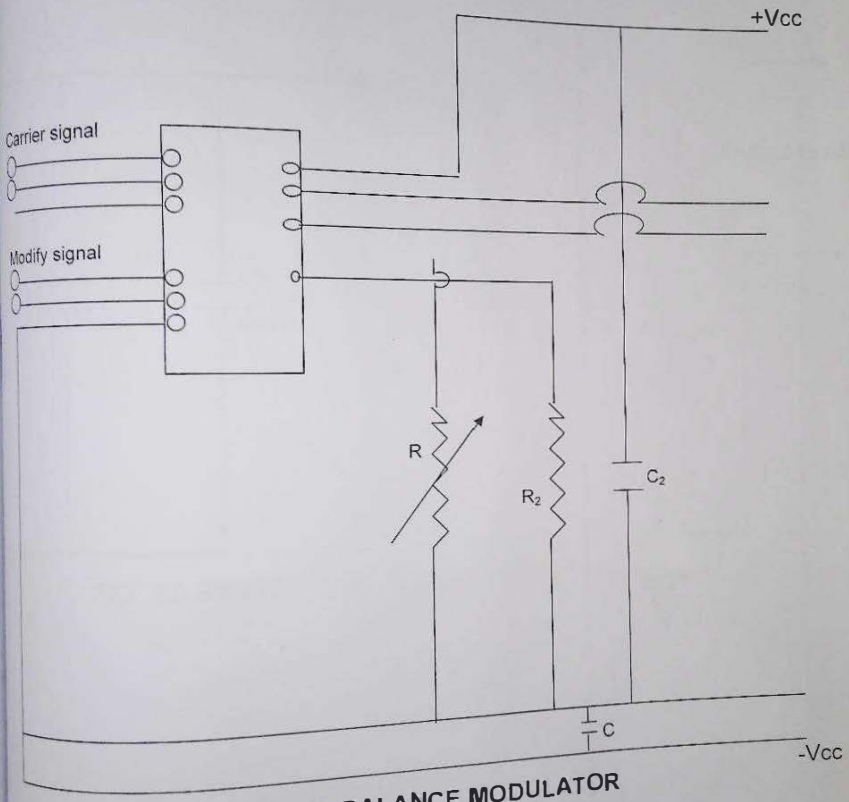


Fig 3.8 INTERGRATED BALANCE MODULATOR

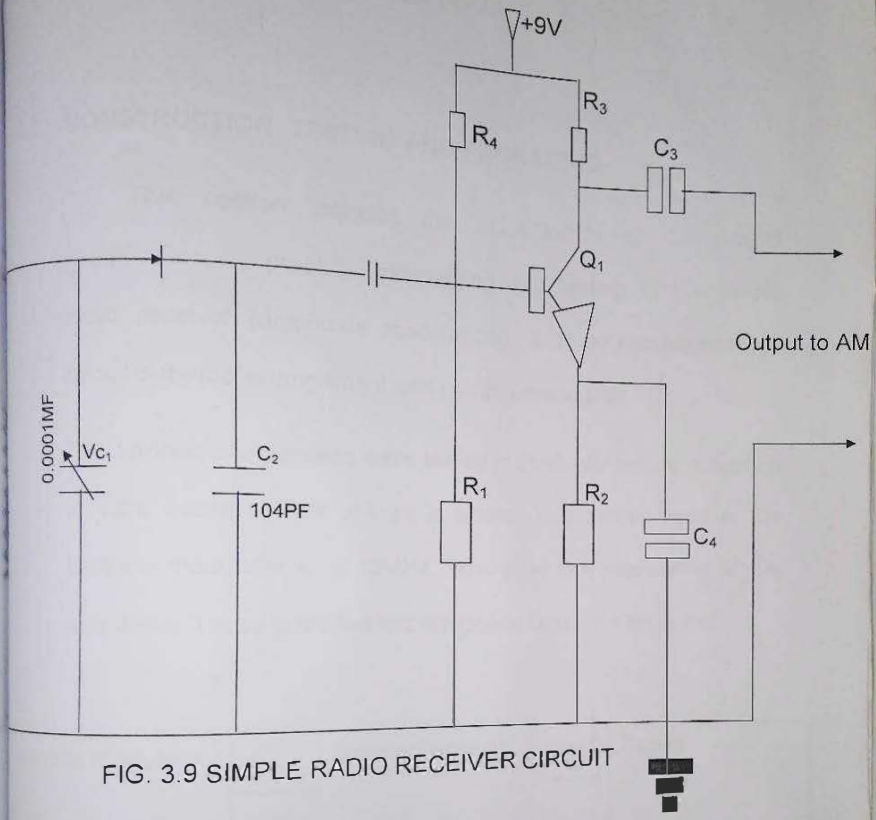


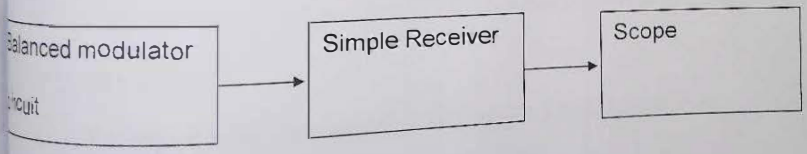
FIG. 3.9 SIMPLE RADIO RECEIVER CIRCUIT

CHAPTER FOUR

4.0 CONSTRUCTION, TESTING AND PACKAGING

This section includes the actualization of the project specification by practical assembling and testing of the simple radio receiver (amplitude modulation). It also incorporates the circuit onboard arrangement and component values.

The various components were tested individually before mounting in Vero board to test unit as a whole. The carrier input of the balance modulator was 10MHz, where as the modulating signal was 4Hkz. These were fed into a receiver to obtain an output.



4.1 TESTING AND RESULT

After the construction was carried out the project was tested by successfully using the d.c power supply constructed by anther student,(Yusuf A. Aminu). The output obtained from the scope

was a sinusoidal wave with little distortions. The frequency of the output measured using the scope was 2.5 kHz

4.2 PACKAGING

In packaging this project work, wood work and rubber were used and necessary holes were made for other accessories on the cabinet include:

i. Antenna:- is an electrical device which converts electrics power to into radio wave and vice versa. It changes radio signal in the air into electricity

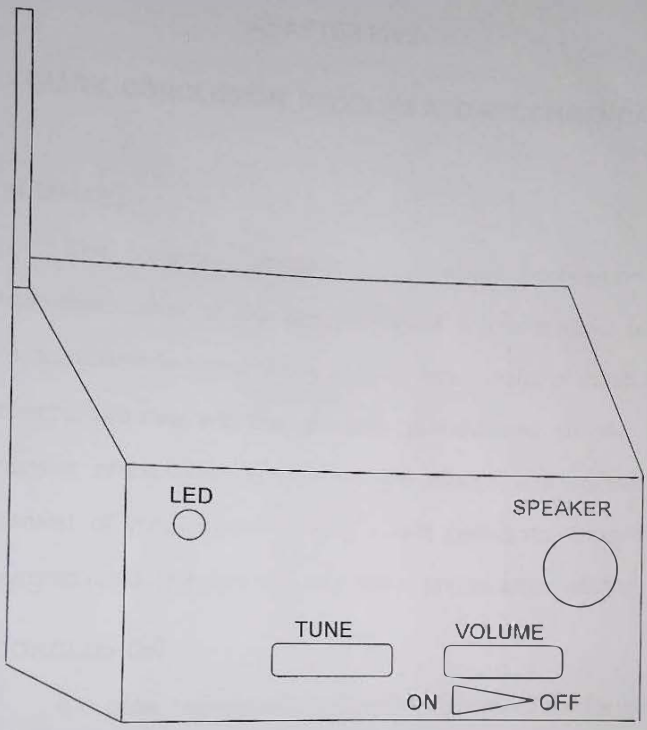
ii. Socket:- used both battery and A.C were used when there is P H C N (electricity).

iii. Power switch ON/OFF: - it was used for on and off of the radio.

iv. Light indicator:- it was used to indicate the presence of power in the radio.

v. Tuning:- it was used to select a frequency and it consist of capacitor and inductor one of which is variable.

vi. Volume:- it was responsible for increase or decrease of volume of the radio.



F.G. 4.2 COMPLETE DIAGRAM OF THECONSTRUCTED RADIO

CHAPTER FIVE

SUMMARY, CONCLUSION, PROBLEM AND RECOMMENDATION

5.0 SUMMARY

This chapter comprise of summary, conclusion and recommendation of the construction of a simple radio recover (amplatidemodalation). While chapter one consist of introduction, chapter two deal with the principle of transistors, chapter three consist of the theory of radio receiver (design) and chapter four consist of construction, Testing and packaging. Chapter five summaries on the chapters, conclusion and recommendation.

5.1 CONCLUSION

It is quite necessary to compare the obtained results with the expected value. The output of the simple receiver was a pure sinusoidal wave. It has little distortion. The distortion was found to be due the insufficient gain of the receiver. The selectivity of the receiver is achieved by use of the tuning circuit. The radio receiver was successfully constructed and tested using the D.C power supply constructed by another student (Yusuf A Aminu).

The receiver designed and constructed was a simple radio receiver. This was as a result of time factor and fund. However, if given time and the necessary components complex types of radio receiver (AM and FM) can be designed and constructed.

PROBLEM

In the construction of this project work a number of problems were experienced and were solved.

(i) The electricity was not available therefore I used generator for soldering the components or devices.

(ii) During the connection some components likes resistors and capacitors were burned due to high power, so with a careful and experience process the connection was successfully done.

5.2 RECOMMENDATION

For the use of this radio receiver, both the Batteries (DC) and AC can be used. It can be used in the public for receiving information in AM station in the world.

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