DESIGN AND CONSTRUCTION OF FREQUENCY MODULATION (FM) TRANSCIEVER

BY

ADEGWU BENEDICTA EMIRY

2005/22109EE

A THESIS SUBMITTED TO THE DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING,

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, NIGER STATE, NIGERIA.

NOVEMBER, 2008

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DEDICATION

I dedicate this work to the Glory of God and to my parents, brother and sisters, who God used to bless me with a Bachelor of engineering, love you all.

DECLARATION

This is to certify that this project "Design and Construction of Frequency Modulation (FM) Trransceiver" was carried out by ADEGWU BENEDICTA EMIRY under the supervision of ENGR. E. ERONU and submitted to the Department of Electrical and Computer Engineering of Federal University of Technology, Minna for the award of Bachelor of engineering (B.ENG) degree in Electrical and Computer Engineering

ADEGWU BENEDICTA EMIRY

(Name of Student)

7/11/2008

Date and Signature

ENGR. E. ERONU

(Supervisor)

Date and Signature

ENGR. Y.A ADEDIRAN

(Head of Department)

Date and Signature

(External Supervisor)

Date and Signature

ACKNOWLEDGEMENT

I wish to express my gratitude to the Almighty God for making this project a success and to my parents Mr. and Mrs. Adegwu, and Chief Engr Ikwu and Family, my uncles, Mr. Thomas Ihakwu, Mr Joseph Ajah, Mr. Joseph Ajah and to my cousins, Agama Joel, Adegwu paul, Adegwu Thomas. for their moral and financial support throughout my stay in the university.

To my supervisor Engr. E. Eronu for his guidance in the course of the construction and design process. I also acknowledge the efforts made by all lecturers of electrical and computer engineering in trying to impact as much knowledge as is humanly possible in me.

Finally my profound gratitude goes to my friend and colleague Ajayi L. Oluwatimilehin, Salami sarah John and Emma Umolu for helping out with valuable solutions in solving problems that came up during construction and carrying out the test.

ABSTRACT

This project is on design and construction of a Frequency Modulation (FM) Transceiver system. It involves both the transmitter and receiver for sending and receiving signal.

In FM, the Audio Frequency nergy coming from the Microphone or transducer is amplified to the required power level by low distortion amplified operating on class A.

The receiver antenna picks up energy from the transmitter whose output passes through its intercept area .Selection of the desired signal or station is accomplished by resonant L-C circuit at receiver input. The antenna furnishes one of the signals to be mixed and a "local" oscillator furnishes the other. The difference frequency (IF), which is the new carrier frequency. The IF further demodulated and required audio is amplified which is the required signal through a transducer

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CHAPTER ONE

INTRODUCTION

Broadcast band frequency modulation (FM radio, that is radio used in the mode of 88 MHz – 108 MHz VHF broadcast band, was invented to solve existing problems with noise and fidelity on the amplitude modulation (AM broadcast band that is 0.54 – 1.6 MHz a communication system is therefore, a technique or equipment that is used to send, process and receive messages. This may take the form of telephone network, radio links, satellite and optical fibres, among other communication system. Any communication process must have an information source. This is the origin of the information to be communicated. Next, the information must be encoded or converted to an electrical signal. The second stage is often referred to as the transmitter. From the encoder or transmitter, the communication message is fed through some "channel". This can be electromagnetic waves, wires, air or some other medium. After this message is fed through the particular channel, it is to be decoded. This stage picks up the transmitter message and converts it into some intelligent form in sound or picture (video).

Many a times the decoder stage is known as receiver. Lastly, the information is fed to the destination, which could be a person or machines.

In the design, noise can interrupt or break communication. Noise in communication System can be defined as any unwanted or desired signal interfering with the reception and processing of the desired signal. It can be classified into two broad categories, depending on source – internal or external noise. The most common place where noise enters the ɔmmunication process is in the message channel.

.1 Aim and Objective

The aim and objectives of this project is to design and construct a frequency modulator ᶠm) transceiver that will transmit and receive an audio signal. This means speech or ıessage signal will be transferred from a source to a medium or channel to a known estination.

ʟadio receivers and transmitters are part of devices used in communication system. Notably he main function of a transmitter in a radio communication and broadcasting is to deliver ɜnough radio frequency (RF) power for radiation by the transmitting antenna to a receiver ʋhich selects and recovers the original message from the various RF signals that arrives at he receiving antenna.

Гhe transmitting process includes modulating a high frequency carrier with the message signal for ease of radiation while the preliminary processing in the receiver also includes raising the voltage level of the received weak signal. The recovery of the original message involves demodulation, which is an opposite operation to that at the transmitter.

1.2 FM DETECTION

1.2.1 Slope Detector

A "slope detector" which is nothing more than a parallel LC circuit tuned off to one side of the IF frequency, as a result it has a rising of response versus frequency across the IF bandwidth, then converting Am to Fm. A standard envelope detector converts Am to audio.

There are improved versions of the slope detector involving a balanced pair of LC circuits tuned symmetrically to either side of center frequency.

1.2.2 Phase lock loop (pll) detector.

This device that varies the frequency of a voltage controlled oscillator to match an input frequency. If the input is the intermediate frequency (IF) signal, the control voltage generated by the PLL is linear in frequency that is, it is the audio output.

1.2.3 Super regenerative Detector.

This is an amazing circuit invented by Armstrong that uses a super regenerative amplifier. There are two basic types, self – quenched and external quenched. The work here is for the self – quenched type.

The Block Diagram is shown below

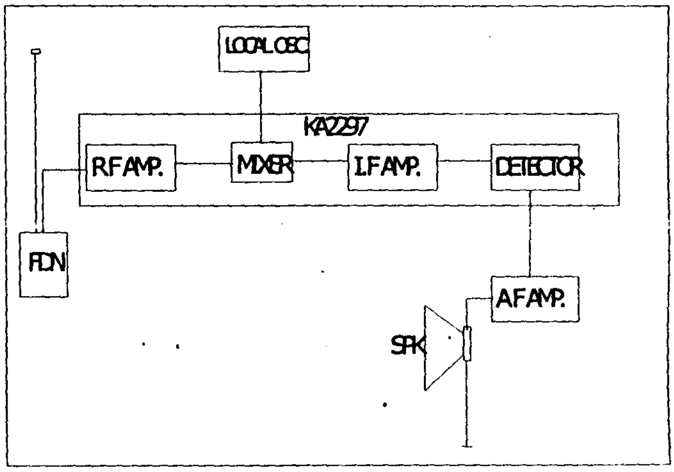


Fig 1.1 Block Diagram of a Receiver

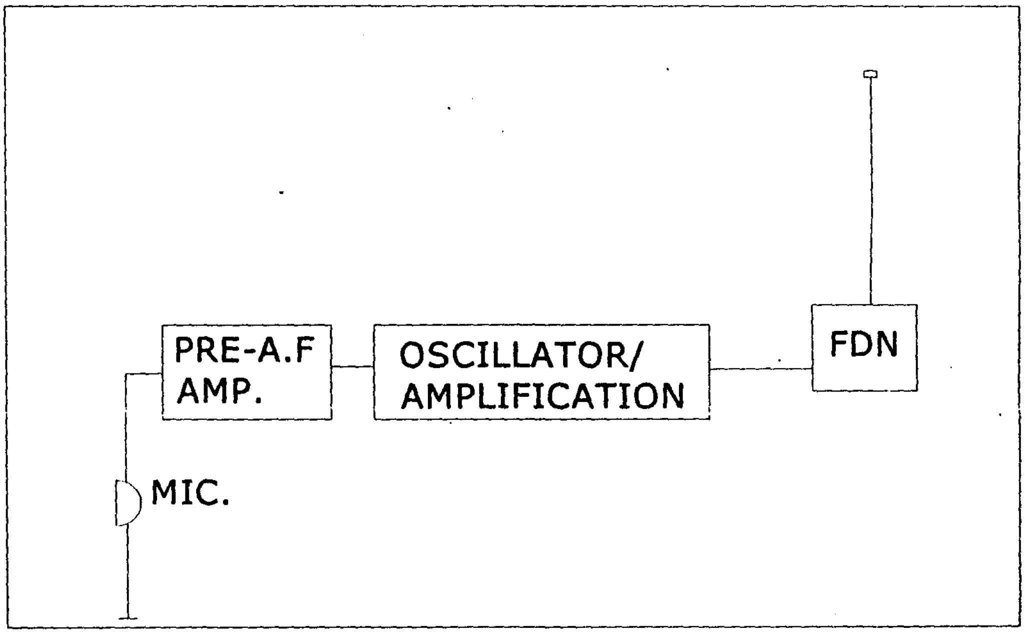


Fig 1.2 Block Diagram of a Transmitter

CHAPTER TWO

RELEVANT LITERATURE REVIEW

2.1 HISTORICAL BACKGROUND

The development of radio in the 1800's revolutionized communication. At the time, people use other means of quick long – distance communication – telegraph and telephone. But the signal sent by both devices had to travel through wires. As a result, telegraph and telephone communication was possible only between places that had been connected by wires.

Radio signal on the other hand pass through the air. Thus, radio enabled people to communicate quickly between any two points on land, at sea, and – later in the sky and even in space.

Prediction of radio existence was made in 1864 by James Clerk Maxwell (1831 – 1879) the great English mathematical physicist.

In 1888, a German physicist Heinrich Hertz (1857 – 1894) demonstrated that waves do actually exist and they travel through space.

In 1871 – 1937 an English physicist Ernest Rutherford succeeded in sending signal over a range of ¾ mile.

Another English man Oliver Lodge (1851 – 1940) developed the basic principle of tuning.

Notably, in 1895, Guglielmo Marconi an Italian inventor combined early ideas and his own ideas and sent the first radio communication signal through the air. He used electromagnetic waves to sent telegraph code signals a distance of more than 1 miles (1.6 kilometers)

There are many claims to broadcast of human speech over the air.

Most historian give credit to Reginald A. Fessenden, a Canadian – born physicist.

In 1906, Fessenden spoke by radio from Brant Rock, Massachusetts, to ship offshore in the Atlantic Ocean saying, "if you have heard this programme, write to R. A. Fessenden at Brant Rock".

An America inventor Edwin H. Armstrong did much to improve radio receivers. In 1918, he developed the super – Heterodyne circuit in 1933, he discover how to make FM broadcasts.

In 1904, the first vacuum tube was made by John Ambrose Fleming (1849 – 1945) an English electrical engineer.

This tube was a diode that had two electrical parts.

In 1906 an American inventor Lee De Forest (1873 – 1961) added a third part to Fleming's vacuum tube. This new vacuum tube was called triode or audion; it was much like vacuum used today.

The first practical use of "wireless" which was then called was for ship – to – ship – to – shore communication.

2.2 THEORITICAL BACKGROUND

The above great men and their respective effort were to come about how signal can be transmitted and received. The transmitter can be AM or FM.

FM transmitter are basically similar to AM transmitter while virtually all receivers AM, FM, TV, Short Wave and so on are termed super heterodyne because of the way in which they process the signal.

It is worth pointing out here that "tele" is derived from Greek word for "at a distance "phone" means sound or speech, "graph" means writing or drawing. So the following well known terms have emerged:

(a) Telecommunication – communicating at a distance

(b) Telephone – speaking at a distance

(c) Television – seeing at a distance

(d) Telegraph – writing at a distance

CHAPTER THREE

3.0 Design and Analysis of the Circuit

The design and construction of frequency modulation (FM) transmitter is based on six main stages, which are

1. Power supply unit.
2. Transmitter Unit
3. Pre-Amplifier Unit.
4. Amplifier/Oscillator Unit.
5. Tank (FDN) Unit.
6. Receiver Unit.

So we are going to describe in detail the entire component that make up those circuit.

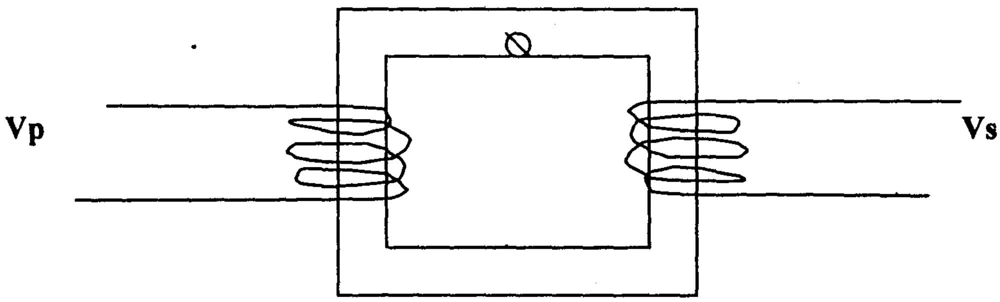
3.1 The Power Supply System

Electronic circuit needs energy to work. In most cases a circle called the power supply provides this energy. A power supply failure will affect all the other circuits. The supply is a key part of any electronic system. All electronic equipment requires a suitable power supply; most often they take the form of a rectifier and filter arrangement. Power supplies use rectifier diode to convert alternating current to direct current. The aim of conversion is achieved by the purpose of the power supply. The A.C supplies available at ordinary wall out let 230V, 50hertz.Electronic circuit often requires lower voltages. Transformers can be used to step down the voltage to the level needed.

The D.C. output of a power supply meets the following requirements detailed by the needs of the equipment served.

1. It must be of the proper voltage level and current capacity.
2. It must be adequately filtered and regulated.

3.1.1 Ideal Transformer



Fig; 3.1 Ideal Transformer

Q is the flux in the core.

Vp is the primary voltage.

Vs is the secondary voltage.

Ep is the primary e.m.f. and

Es is the secondary e.m.f.

Let N1 and N2 represent the number of the turns of the primary coils and the secondary coils respectively.

Then $$\frac{Vp}{Vs} = \frac{N1}{N2}$$

Thus $$Vs = \frac{Vp \times N2}{N1}$$

In this project, a standard 15V transformer is used.

3.1.2 Rectification

Rectification is the conversion of alternating current to direct current i.e. D.C. In this project work, a full wave bridge system of rectification was adopted. With this method, there is no need for a center tapped power transformer. The output is twice that of center tap circuit for the same secondary voltage.

The arrangement is shown in fig 3.2 below .It contains two diode D1 and D2 connected to form bridge. During the positive input half cycle, terminal P of the secondary is positive and Q is negative. Diodes D1 become forward biased (i.e. ON) whereas D2 are reverse biased (OFF). During the negative input half-cycle, secondary terminal Q becomes positive and P negative.

The waveform of the secondary voltage to the bridge rectifier is A.C. input.

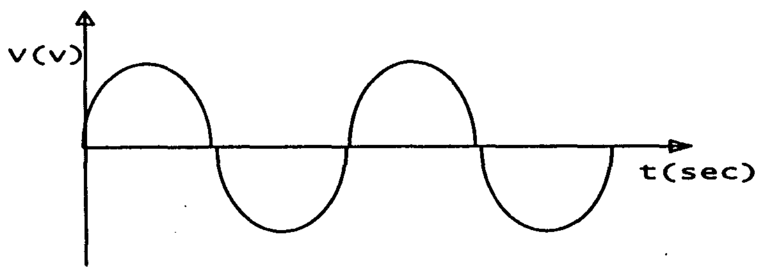


Fig. 3.2 Input waveform of AC supply

The output is a DC output. The waveform is as shown below in fig 3.3.

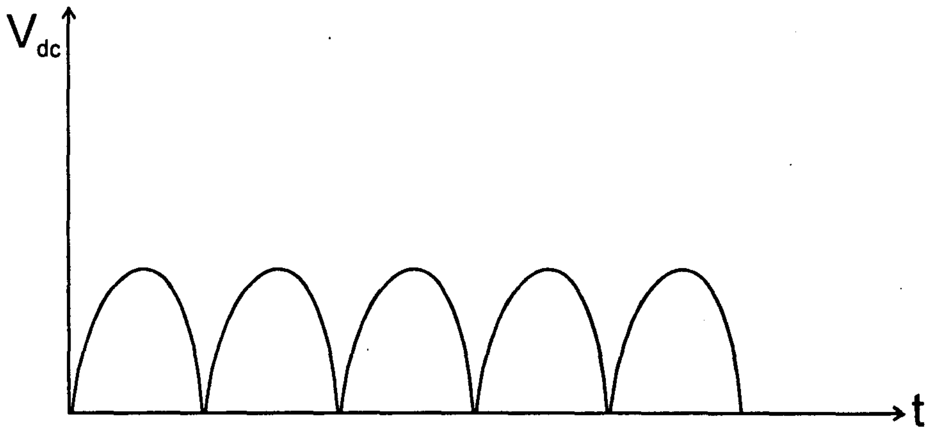


Fig 3.3 the rectifier output waveform

The full wave rectification efficiency can be calculated using

$$\eta = \frac{0.812R}{r_d + R_l}$$

Where R_l = load resistance and

r_d = diode resistance.

After full wave rectification, the relation below gives the D.C voltage with peak amplitude

$$Vdc = (Vrms\sqrt{2} - 1.4) \quad \text{.......(3.1)}$$

For 9V rms input, the peak D.C voltage is therefore. $Vdc = (9\sqrt{2} - 1.4) = 12.6V$.

3.1.3 Filtering and Smoothing

The output waveform of fig 3.2 comprises of both A.C components.

The A.C component in a D.C power supply, a ripple voltage, is removed through filtering or smothered project work; the D.C voltage was smothered by a 50V 1000UF capacitor and fed in to the charger circuit.

3.1.4 Regulating Circuit

The regulating circuit enables the power supply unit to supply constant output voltage under varying input voltage or varying load current condition. An IC voltage regulator was employed to provide the regulated power supply. Table output voltage of 9V was obtained using 7809 with permissible load current of 1A respectively.

Two microfarad, 160V capacitors were filtted at the output of the regulator to keep the circuit constant at high frequency. Finally, the circuit diagram of the power the supply is shown below.

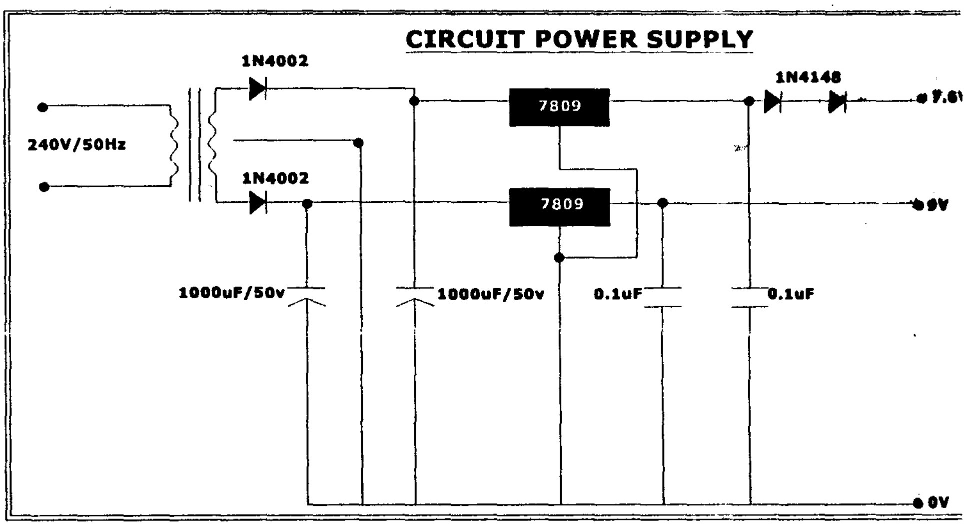


Fig 3.4 Power supply Circuit

3.2 TRANSMITTER:

A transmitter is a device that transmits a RF signal in a sinusoidal waveform to the atmosphere through ionosphere that is found to be responsible for RF transmission.

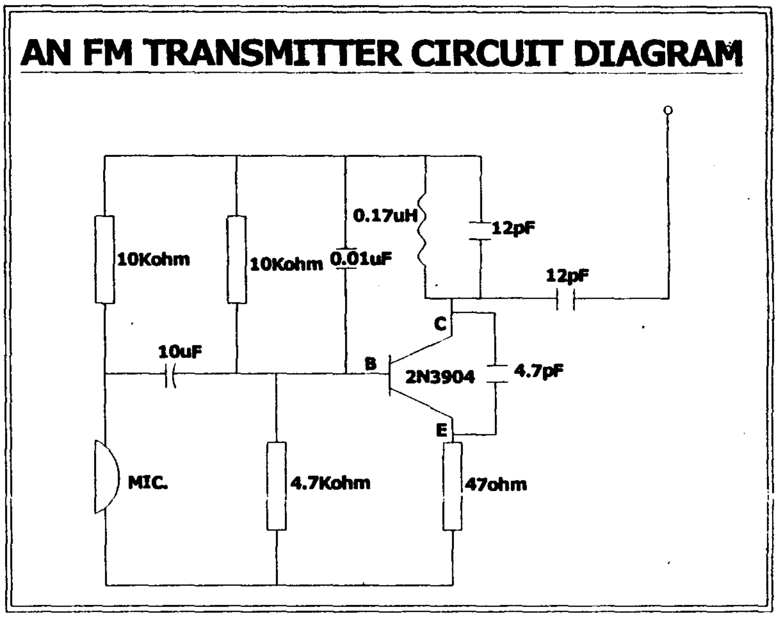


Fig 3.5 Transmitter Circuit

3.2.1 INPUT STAGE {MICROPHONE STAGE}:

A microphone is a transducer device that converts sound energy received from an external source to an electric energy (i.e. electric current or voltage). This device having a small resistance value forms a voltage divider with a resistor R1. The resultant voltage drop across the micro

phone varies in sympathy with the input signal. It is practically proven that the louder the sound energy that falls on the microphone coil, the lower the value of resistance from the initial resistance value of the microphone. The varying voltage or current is then coupled through a d.c blocking capacitor C1 that impedes the d.c current, which in turns, causes an A.C current to flow to the base of the AF-Amplifier transistor. A good design consideration takes voltage drop across the condenser microphone. To be ONE TENTH of its source voltage (i.e., 1/10 Vcc).

For this transmitter circuit, the resistance value of condenser mic. Was 100000 ohm and R1 was taken to be 10000 ohm (10k-ohm).

From the above,

Rmic = 100000 ohm

R1 = 10000 ohm

Vcc = 9v

Voltage drop across mic. is given as,

$$V_{mic} = \frac{V_{cc} * R_{mic}}{(R_{mic} + R1)} = \frac{100000 * 9}{(100000+10000)} = \frac{900000}{110000} = 8.1820V = \underline{8.18V}$$

Voltage drop = 9 - 8.18 = 0.8 V

3.2.2 PRE-AMPLIFICATION STAGE:

Signal collected through C1 is fed to the amplifier from it's base region. Q1 offers the first amplification to the weak signal. A linear amplification is necessary so as to prevent the distortion of the input signal. Distortion in amplifiers refers to as the differences between the output and input of an amplifier, due to unequal amplification of different frequencies present in the input signal. The above amplifier is based on the following descriptions:

1. Input: small-signal input.
2. Output: power amplifier.
3. Frequency response: audio-frequency (AF) amplifier.
4. Basing condition: class-A.
5. Transistor configuration: common-emitter (CE) amplifier.

Both transistors Q1 and Q2 are both NPN low power transistors with data number 2N3904 (TO-92) style. There parameters are a follows:

Vce MAX = 60 v

Imax = 0.2A

Po max = 0.5 watt

Cut off frequency = 250 MHZ

3,2,3 TRANSISTOR BAISING CALCULATIONS:

$$B\ d.c = \frac{Ic}{Ib}$$

For a good class-A Amplifier, Vc should be half Vcc and Vce, about one third (1/3) Vcc.

Vce = 1/3 Vcc = 9/3 = 3V

Vc = 1/2 Vcc = 9/2 = 4.5V

Given that,

Vce = Vc - Ve

Ve = Vc - Vce = 4.5 - 3 = 1.5V

But Vbe = 0.7V for silicon transistor,

And Given that, $Vbe = Vb - Ve$

$Vb = Ve - Vbe = 1.5 - 0.7 = 0.8V$

From the diagram,

$Rb = 4700ohm$, $Vb = 0.8V$

$Ib = Vb/Rb = 0.8/4700 = 0.17mA$.

Collector current is given as,

Given that,

$B\ d.c = 175$, $Ib = 0.17mA$

$Ic = B \times Ib = 175 \times 0.17 = 29.75mA$

Collector Resistance Rc is,

$$Rc = \frac{Vcc - Vc}{Ic} = \frac{9 - 4.5}{29.75 \times 0.001} = \frac{4.5}{0.02975} = 151\ Ohm$$

Emitter current (I.e.) = $Ib + Ic = 0.17 + 29.75 = 29.92mA$

$$Re = \frac{1.5}{29.92 \times 0.001} = 50\ Ohm.$$

Prove:

Given that $Vcc = IcRc + Vce + IeRe$

And $V = I \times R$ (ohm law), then $IcRc = Vc$ and $IeRe = Ve$

Therefore,

$Vcc = Vc + Vce + Ve = 4.5 + 3 + 1.5 = 9V$

$P_D = V_{CE} \times I_C$

$P_D = 3 \times 29.75 = 89.25mW$

3.2.4 AMPLIFIER/ OSCILLATOR CIRCUIT:

The modulating signal is coupled through C2 to the base of Q2. C1 and C2 are the same in value of 10uF, but C3 which 0.1uF bypasses the A.C signal at the emitter. The capacitor and resistor network at emitter region prevent degeneration of the vibrating frequency. For this stage, a frequency determination network, i.e. a low resistant coil with a variable c apacitor are connect in parallel with each other at the collector region of the circuit which resonance at a frequency which is given by the formula,

$$f = \frac{1}{2 \times 3.142\ LC}$$

Where f = oscillating frequency (Hz)

L= self inductance (Henry)

C= tank capacitor (Farad)

3.2.5 SELF-INDUCTANCE:

The inductor used has a value determined by its radius (r), length (l), and number of turns (n).

$$L = \frac{n^2 \times r^2}{9r + 10x}$$

When,

n=5, r=0.13, x=0.25

Therefore, $L = \frac{(5)^2 \times (0.13)^2}{9(0.13) + 10(0.25)}$ (μH) , L= 0.17μH or 0.00000017H

3.2.6 TANK (FDN) STAGE

The tank circuit also known as the FDN which is the frequency determination network, have two elements which are connect in parallel with each other, i.e. the self-made inductor and a capacitor. The inductor having a reactance value of 2πLC, and the capacitor, having a reactance value of 1/2πfc operates in three basic modes, i.e

1. When the current across capacitor (C) is high, then that of L is Low.
2. When the current across inductor (L) is high, then that of C will be low.
3. Or, the current across C will be equal to that of L

From the above,

If V=I x R (according to ohms law)

Then $I = \frac{V}{R}$

Given that the reactance of Capacitor C = 1/2πfc (ohms)

And inductive reactance L= 2πfL (ohms)

If $I_C = I_L$

Then,

$$\frac{V_C}{} = \frac{Vl}{2\pi fL}$$

$$Vc = \frac{1}{2\pi fc}$$

$$2\pi fL \times Vc = VL/2\pi fc$$

$$4\pi^2 f^2 LC = \frac{V_L}{Vc}$$

$$F^2 = \frac{1}{4\pi^2 LC}$$

Given that, L= 0.000000017H,

And F= 108MHz, Then

$$C = \frac{1}{4(3.142)^2 \times (108 \times 10^6)^2 \times 0.000000017} = 1.26 \times 10^{-11} = 12.6pF$$

3.3 RECEIVER

The receiver, as the name implies, receives the RF signal that is transmitted from the transmitter station. The RF signal is picked up with the aid of an antenna which is known to be ¼ the wavelength of transmission. [5]

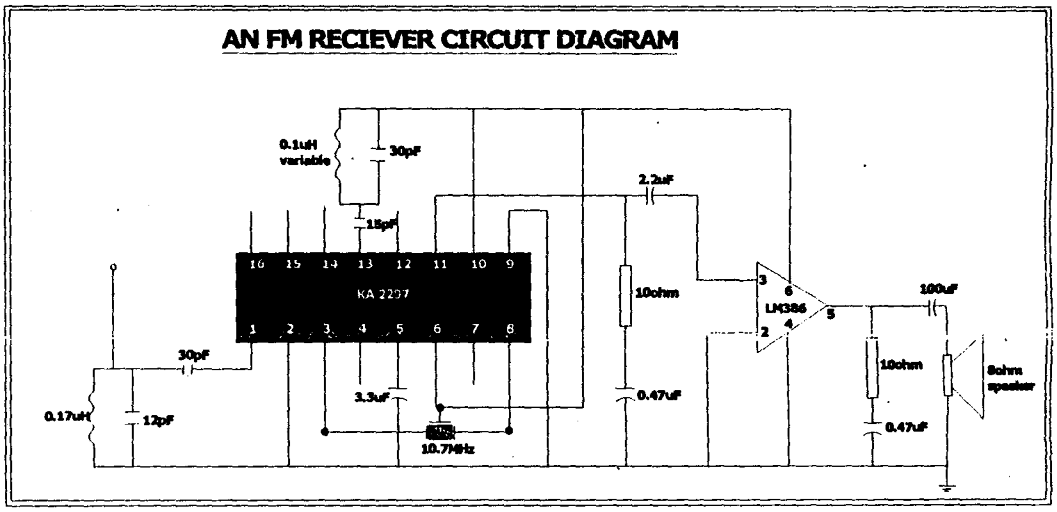


Fig 3.8 Receiver Circuit

3.3.1 ANTENNA LENGTH

If we recall back, antenna length was said to be ¼ the wavelength of transmission.

Using the formula

$v = \lambda \times f$

Where v= velocity of light

λ= wavelength

f= frequency of oscillation

Then,

$$\lambda \text{ (wavelength)} = \frac{v \text{ (velocity of light)}}{f \text{ (frequency of oscillation)}}$$

Given that,

$v = 3 \times 10^8$ m/s^{-2}, f= 108×10^6 H_z,

$$\lambda = \frac{3 \times 10^8}{108 \times 10^6}$$

$\lambda = 2.78$ m

Therefore antenna length = ¼ x 2.78 = 0.69 m

This is about 27.3 inches in length.

3.3.2 THE FDN VARIABLE CAPACITOR

Using the same value of inductance used at the transmitter FDN circuit, i.e. 0.17μH,

When f= 88MH

$$C = \frac{1}{4(3.142)^2 \times (88 \times 10^6)^2 \times 0.17 \times 10^{-6}}$$

$C_{max} = 1.9 \times 10^{-11}$F

$C_{max} = 19$pF

When f= 108MH_z

$C_{min} = \frac{19 \times 10^{-12}}{\frac{(108 \times 10^6)^2}{(88 \times 10^6)^2}}$

$C_{min} = 1.26 \times 10^{-11}F$

$C_{min} = 12.6pF$

The variable capacitor is = 12.6 – 19pF

3.3.3 OPERATION OF I.C (KA2297) FROM THE RECEIVER BLOCK DIAGRAM

1. **Vcc (SUPPLY VOLTAGE):** the minimum to maximum voltage required for the proper operation is from 3-8V with respect to the ground.
2. **FM RADIO FREQUENCY (RF) IN:** the received signal from the FDN is coupled through a capacitor C (30pf) and fed to the RF input of the monolithic I.C used. The FM RF input consists of a RF amplifier transistor that amplifies the received signal. From this stage, comes the FM mixer.
3. **FM LOCAL OSCILLATOR:** the FM local oscillator also consists of a vibrating circuit usually a crystal oscillator or an FDN vibrator circuit consisting of an inductor and a capacitor in parallel. The local oscillator vibrating frequency used was about 98.7-118.7MH_z. these frequencies, where achieved using the formula, $f=1/2\pi\sqrt{LC}$.[3] It is known that, the local oscillator vibrates at frequencies higher than the incoming frequency. This is because, local oscillators performs the function of frequency stability in circuits. So in cases where, there is a frequency decay or frequency drop, caused by battery voltage drop. The local oscillator keeps the circuit vibrating at its fixed frequency.

4. **FM MIXER:** the mixer stage performs the function of combining the RF and LOCAL OSCILLATOR frequencies. This stage consists of a low noise transistor e.g. the BC547 or the BF244 NPN transistor.

The mixed frequencies, provides two basic conditions i.e. ($f_o + f_s$) or ($f_o - f_s$), where f_o is the oscillating frequency and f_s is the incoming signal frequency.

The sum of the two frequencies is filtered using a crystal filter with a value of 10.7MH$_z$ above oscillating frequency (98.7-118.7MH$_z$). The difference in their frequencies is known as the Intermediate Frequency (IF).

5. **IF (INTERMIDIATE FREQUENCY):** the difference in their frequency which 10.7MH$_z$ is amplified with an IF transistor, e.g. C2570. The amplified IF signal is then coupled to the detector stage.

6. **DETECTOR STAGE (PIN 10):** the detector stage consists of a signal diode that detects the incoming signal and then rectified. The rectified signal is further filtered with a capacitor-resistor-capacitor type of filter. But for the detector stage of the above receiver, a 10.7MH$_z$ was used to detect the signal.

7. **DETECTOR OUT (PIN 11):** The detector out is coupled through a capacitor C (100μF), which then fed to resistor R (50k variable). The resistor here is used to control the volume.

8. **OPERATIONAL AMPLIFIER:** The incoming AF signal from the detector stage via variable resistor and coupling capacitor is fed to the non-inverting input of the op-amp. The op-amp used was the LM386 type. It has 8 pins. Here are some uses of the op-amp pin configuration;

Pin1- NC

Pin2- Inverting input.

Pin3- Non-inverting input.

Pin4- Ground.

Pin5- Output.

Pin6- Vcc input.

Pin7/8- NC

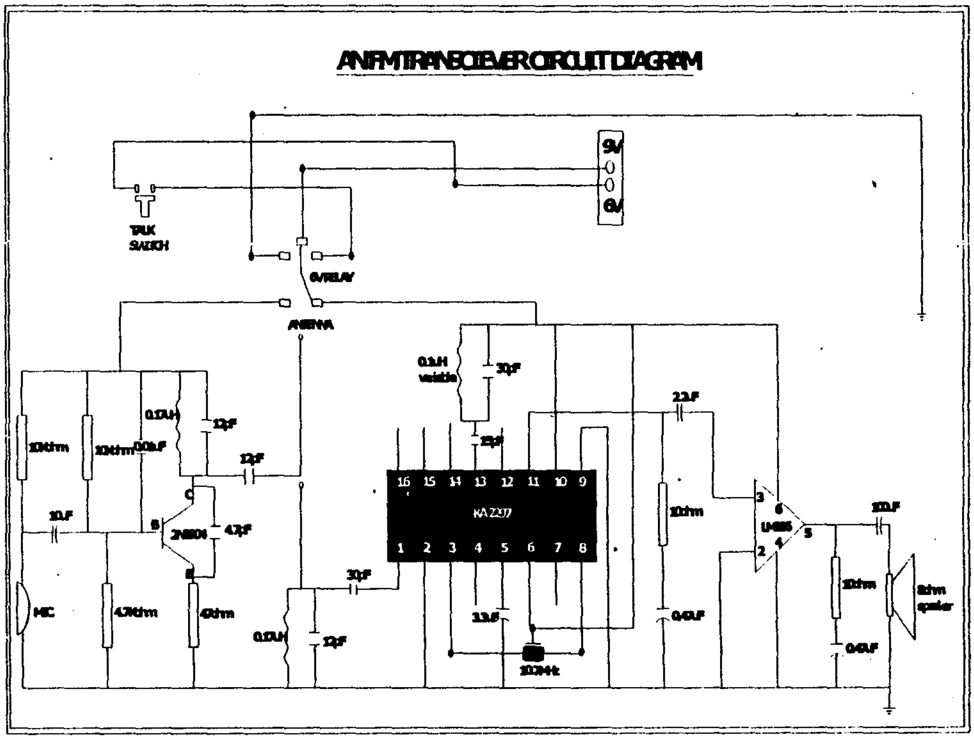


Fig 3.8 Transceiver Circuit

CHAPTER FOUR

CONSTRUCTION, TESTING AND RESULT

Construction simply means the practical aspect, which involves the assembly of the components and testing. The project work consists of both the electronics and the casing parts.

The electronics part consist of audio amplifier, modulator and the oscillator at the transmitter's section, and Radio frequency amplifier, mixer, oscillator, intermediate frequency, demodulator network, the audio frequency amplifier to the transducer at the receiver's section. All these were constructed one after the other as designed and analyzed in the design aspect of the project in chapter two.

After all the calculation and the design completed, the components with the preferred values were bought, then the components were arranged on a breadboard starting with the crystal microphone which is the first stage. Then up to the antenna stage, which launches the signal to space thereby, intercepted the receiver circuit whose stages of signal processes were constructed one after the other.

While on the breadboard, the output of the transmitter part was tested with digital multimeter and with conventionally general receivers in the market. The oscilloscope available in the school laboratory could not be use to display the output waveform because of high frequency response needed in the work.

Similarly, the receiver part was subjected to the same test with digital meter and we try to use it to receive any nearby transmitter and FM station example 91.2 crystals FM Minna.

After the whole connection on the breadboard, the system was tested and it function well, the stages in both transmitter and receiver were transferred and soldered on vero- board using soldering iron and soldering lead.

4.1 Components Selection

4,1.1 Components Selection (Power Supply)

Capacitor 0.1Uf

1000uF/50V

Diode IN4001

IN4148

Transformer 240/09V

Regulator Voltage 7809

4.1.2 Components Selection (Transmitter)

Resistor 10kohm

4.7kohm

470kohm

Capacitor 0.01uF

0.17uF

10uF

4.7uF

12uF

Transistor 2N3904

4.1.3 Components Selection (Fm Receiver)

Resistor 10kohm

4.7kohm

Capacitor 12pF

30pF

3.3uF

15uF

2.2uF

0.4uF

100uF

0.47uF

Integrated circuit (I C)

LM386

KA2297

Variable inductor 0.1uH

0.17uF

Speaker 8ohms

4.2 Casing Of The Network

After the construction was completed and tested and the workability of the transceiver ascertained, the circuit board was cased using PVC materials as a box. The reason for this was because it was cost effective. The casing was also perforated for proper passage of the speech signal to the transducer inside for effective communication. However, antenna switch which connected the system one at a time to transmitter or receiver mode as well as the volume control and power switch where used on the side panel.

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