# DESIGN AND CONSTRUCTION OF AN FM TELEPHONE BUG TRANSMITTER

BY

ODAUDU ENOKELA
2004/18993EE

A THESIS SUBMITTED TO THE DEPARTMENT OF

ELECTRICAL AND COMPUTER ENGINEERING

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA,

NIGER STATE

IN PARTIAL FULFILMENT OF THE

REQUIREMENT FOR THE AWARD OF BARCHELORS

OF ENGINEERING DEGREE (B.ENG) ELECTRICAL

AND COMPUTER ENGINEERING.

DECEMBER 2009

# Dedication

This project is dedicated first and foremost to God Almighty, who has giving me the wisdom and understanding from the beginning till this precious minuets. And also to my kind father in person of Mr. Odaudu Isegbe Okwoli who, single handedly has been so supportive and interested in me attaining this long awaited stage of my life. I pray Almighty God grant him long life and feature endeavors.

## Attestation/ Declaration

I, ODAUDU ENOKELA of electrical/ computer engineering, hereby declare that this work was done by me and has never been presented anywhere for the award of degree. I hereby relinquish the copy right to the Federal University of Technology, Minna.

Odaudu Enokela
..................................
(Name of Student)

28/01/2010
..................................
(Signature and date)

Mr. U.N Galadima
..................................
(Name of Supervisor)

28/01/2010
..................................
(Signature and date)

Engr. (Dr) Y.A Adediran
..................................
(Name of H.O.D)

(May 6, 2010)
..................................
(Signature and date)

DR. (MRS) B. A. ADEGBOYE
..................................
(Name of external examiner)

..................................
(Signature and date)

## Acknowledgement

I want to start by thanking God Almighty for the life, strength, kwowledge, wisdom and understanding he has granting me since the beginning of my existence till this special moment of my life.

I also acknowledge my wonderful father in person of Mr. Odaudu Isegbe Okwoli. I tell you sincerely that words are not enough to express my gratitude to you. I appreciate this great future you have built for, once more I say thank you.

I will definitely not conclude on this acknowledgement without appreciating the emotional consolidation giving to me by Mr. and Mrs. Yakubu Viva. I appreciate you all and I pray God Almighty grant you all your heart desires.

My great thanks go to my supervisor in person of Mr. U.S Galadima for his Untiring effort in ensuring that his students get the best knowledge available. Thank you very much sir.

I want to thank my sister's and brothers for their great encouragement, most especially Mrs. Oya-Viva Yakubu and my little but fast growing Odaudu Elaipu, God bless you all.

My thanks also go to most of the departmental lecturers in person of Dr Raji, Dr Tsado, and the host of others.

My thanks also go to my numerous friends whose names are not mentioned here, you guys have contributed immensely to my success.

# ABSTRACT

In our society today, security has posed great challenges to a lot of individuals, where there have been several cases of people passing illegal messages through phones and also commit all sort of illegal crimes through phones. This project is aimed at keeping such records for immediate or future uses.

The project design obtain it source of power from the phone line to which it is connected with the help of full wave bridge rectifier to rectify the input voltage from the phone lines. The modulator and oscillator help to generate the carrier frequency and at the same time, supper imposing the low frequency modulating signals (audio) with the high frequency generated carrier waves for amplification.

The amplifier circuit helps to boost the power for radiation and the amplified signal is coupled into the free space with the aid of a ferrite rod antenna for omni directional radiation. The transmission band of this project falls between 88MHz to 108.5MHz but signals are stronger at 96.0MHz. With this design interfaced with a single telephone line, every communication can be heard and recorded for security reasons without the concept of the callers through a dedicated FM bands. The design couples both audio and power from the channel.

# TABLE OF CONTENT

## LIST OF FIGURES

# CHAPTER ONE

## 1.1 Introduction

Communication is very essential in life because it helps in information dissemination. Communication therefore, is the exchange of information from one end to another.

The Telephone bug FM transmitter is a simple transmitter that when connected in series to a phone line transmits any thing on that line to any FM radio tuned to the required frequency. It is also an electronic device that monitors a particular telephone line without the knowledge of the Person whose line is bugged. It is secretly connected to a telephone line either at the distribution panel or at an exchange and the conversation made through that line is heard.

The transmitter when connected to the phone consequently collects power from the phone line and transmits both sides of the conversation over the telephone to an FM radio when tuned to the desired frequency ranges. The transmitter comprises of units which are segmented into three different parts namely, the audio input, FM modulator/oscillator and the power amplifier units which are coupled together to achieve a desired aims and objectives. Each units of the FM bug can be explained separately.

The name telephone comes from a Greek word tele meaning "from afar" and phone meaning "voice" or "voiced sound". In general term, a telephone is an electronic device that converts sound into electrical signals that can be transmitted over distances and converts received signals back. It can also be defined as an electronic device used for two ways talking with other people. The medium of could be through wireless mobile phone cable lines. The cable lines are guided while the wirelesses is unguided. [9]

In communication, the principle of transmission of the audio message from the source of the signal to the distribution is the same for both the wireless mobile phones and the cable lines.

The message communicated from the source reaches its destination through stages and consequently, the destination is able to understand and interpret the transmitted signals when received. When the audio messages leave the source, it passes through an input transducer which eventually constitutes an input signal to the communication channel. The communication channel finally communicates the signal to the output transducer from where it gets to its destination.

The telephone bug work on the same like the telephone only that it performs more functions. When connected in series to the telephone line, it detects the incomplete circuit, when the hand set is lifted up and transmits the conversation through an antenna to the FM radio tuned to the required frequency.

A simple two telephone point circuit uses a single pair of wires connected in series to one another. With all the handset hanging on the hook switches, the signaling circuit is complete. Putting the switch ON at one set (by dialing a number) will cause ringing tone to be sent to another end of a network when the handset is picked up, the exchange automatically triggers up to provide a common +Vcc voltage to the two amplifiers thus conversation is established between people.

The transmitted signals normally undergo modulation and the most required modulation technique for this project design is the frequency modulation technique (FM) which requires that the carrier signals is varied in accordance to the frequency of the modulating signals which is the audio message that is to be transmitted.

Since the aim of this project is to transmit the audio message or the conversation over a telephone line, when the transmitter is connected in series to an existing telephone line, the transmitter uses several techniques for its tap to seize power from the phone line. This wire tap are actually of four types namely the hard- wired wire tap, the soft wire tap, the record wire tap and the transmit wire tap.

The hard -wired wire tap requires physical access to the section of wire that a signal is traveling on. A second set of wire is attached and the signal is then sent back to a secured location. Once detected, this kind of phone wire tap is fairly easy to trace back and is very popular among police department through out the country.

The soft wire tap is the preferred phone tap method because it is difficult to locate in the phone company's system. It is sometimes called a remote observation (REMOBS). This type of phone tap is very popular with the large law enforcement agencies, intelligence agencies and larger corporations who are worried about competitions. This kind of wire tap is actually very simple to obtain.

The record wire tap is nothing more than a tape recorder wired into the phone line and is very easy to find on inspection. This is very common among private investigators, but it is a risky option due a long history of eavesdroppers being caught red-handed.

The transmitter wire tap is a radio frequency transmitter connected to a wire. This kind of phone tap is very popular, however; the RF energy it produces radically increases the chance that a component "Bug sweeping" specialist will detect it.

A wire tap is the preferred method of obtaining intelligence for quality reasons. The process of wire tapping involves tying into a wire or other conductors that is used for communications. This wire can be telephone line, a PBX cable, a local area network (LAN), a CCTV video system, an alarm system or any other communications medium.

Wire tapping is aimed at obtaining a high quality of information while minimizing the possibility of the eavesdropping being discovered.

## 1.2 Objectives of the Project

The project design finds application in the following areas stated below-

1. It is designed to be used specifically for security agents to check and combat crime committed through telephones.

2 It may be required for the intelligence department of the security operatives to keep recorded backup information of every communication.

3 This is also used to provide security alertness to various security posts when ever the security of a place is threatened provided every security post of a security network has her radio tuned to the required FM band.

4 In an industrial lay out, where the control room is far from the men at work, it may be required to disseminate certain instructions that need to be executed; this device can provide the service of reaching them without stress.

5 This project was carried out in order to develop a cheap, efficient device that will monitor successfully a telephone line with out a person knowing.

## 1.3 Methodology.

The circuit connects in series with either the tips or the ring of a telephone line and the power for the circuit is a full wave bridge rectifier placed on the phone lines to provide power.

The transmitter is a system of connection of capacitors and inductors to form an FM oscillator that operates at specified frequencies. Owing to the clarity of signals, variable capacitors are used to adjust the FM band between specified ranges. In other words, the variable capacitors allow the frequency of the oscillator to be selected.

The audio signals generated from the phone line is coupled for modulation with the oscillator's frequency, after this process has been accomplished, the modulated signals is ready to be transmitted through a radio frequency shunt that decouples direct current power and the audio from the amplifier circuit of the FM transmitter.

## 1.4 The Scope of the Project

The project focuses on monitoring of a telephone line without detection. The project is also targeted for 38 meter range of distance. The distance range of the telephone bug can be increased by attaching antenna and increasing the RF stages.

# CHAPTER TWO

## 2.1 Literature Review/ Theoretical Background.

## 2.2 History of Communication.

The earliest form of Communication was the archaic cave paintings and has gradually evolved to the rapid new age Communications. Communication is a process that started perhaps even before we knew how to spell or write the word "Communication". It is dated back to the advent of life itself. It evolved from simple body language or pictorial messages carved on rocks into channels of communications like the telephones, television and off course the World Wide Web that brought the world as close as it could get. [1]

Early communication started with body languages, speech, writing, symbols, cave paintings, petroglyphs, alphabets and telecommunications.

(a) BODY LANGUAGES -A friendly handshake, a gracious smile or even warm hug. Body language is communication through simple body gestures. The time of emergence of body language can not be accurately calculated, however, the use body language as a means of communication has always been compared to communication modes used by animals. [1]

(b) SPEECH -Modern adaptation for speech appeared somewhere between 500,000 and 1.5 million years ago. The dynamics of evolution of speech acquisition is complex since it is influenced by factors like culturally transmitted sounds and genetic evolution.

(c) WRITTING –The history of writing dates back to the various writing system that evolved in the early Bronze Age (late fourth millennium BC) out of Neolithic proto writing. Writing is said to have evolved from proto-writing which means pictorial messages/symbols/scribbles that can not be called "actual-writing".

(a) CAVE PAINTING- The upper Paleolithic cave paintings, which are a type of rock art are the oldest known symbols. Homosapien's first crack at communicating information was painting. The oldest known cave painting is that of the chauvet cave dating back to 30,000 BC. [1]

Communication evolves from cave painting to petroglyphs (rock caving) dated back to 10,000 BC from petroglyphs to pictograms, to ideograms, to alphabets, to telecommunications, radio which was invented in 1872 by Williams, Henry ward, telephone, television which was first demonstrated in 1926 by a Scottish inventor by name John Logie Baird. From television, the first computer was developed in 1945 called electronic numerical integrator and computer. The most widely used means of communication (internet) was formulated in 1973 and published in 1974. It took as many as ten years to bring the idea into reality and the internet was set up in n1983.

## 2.3 The History of Telephone

A telephone as earlier defined is an electronic device that converts sounds into electrical signals that can be transmitted over distances and then convert received signals back to sound. [3]

Although there were several disputes surrounding the claim to the invention of the telephone. An Italian scientist known as Antonio Meucci was acknowledged by US congress on 11th June 2002 for his contributions to the invention of the telephone.

In the 1780s, two inventors Elisha gray and Alexander graham bell both independently designed devices could transmit speech electrically (telephone). Both men rushed their respective designs to the patent office within hours of each other; Alexander

Graham Bell patented his telephone first. Elisha Gray and Alexander Graham Bell entered into a famous legal battle over the invention which bell won.

## 2.4 Alexander Graham Bell's Evolution of the Telegraph Into the Telephone.

The telegraph and the telephone are both wire based electrical systems. When Bell began experimenting with electrical signals, the telegraph had been an established means of communication for some 30 years. Although a highly successful system, the telegraph was basically limited to receiving and sending one message at a time. Bell's extensive knowledge of the nature of sound and his understanding of music enabled him to conjecture the possibility of transmitting multiple messages over the same wire at the same time. Although, the idea of multiple telegraphs has been in existence for some times, Bell offered his own musical or harmonic approach as a possible practical solution. His "Harmonic telegraph" was based on the principle that several notes could be sent simultaneously along the same wire if the notes or signals differed in pitch.

By October 1874, Bell's research had progressed to the extent that he could inform his future father in law about the possibility of a multiple telegraph, his in law who saw the potential for breaking such a monopoly instantly gave him the financial back up he needed. Bell then proceeded with his work on the multiple telegraphs but he did not tell his in law that he was working with Thomas Watson, a young electrician.

While Graham Bell and Thomas Watson worked on the harmonic telegraph at the insistent urging of Hubbard and other backers, Bell's nonetheless met in March 1875 with Joseph Henry, the respected director of the Smithsonian institute. By June

1875 the goal of creating a device that would transmit speech electrically was about to be realized. They had proven that different tones would vary the strength of an electrical current in a wire. To achieve success they therefore needed only to build a working transmitter with a membrane cable of varying electronic currents and a receiver that would reproduce these variations in audible frequencies. [4].

On June 2, 1875, Alexander Graham Bell while experimenting with his technique called "Harmonic Telegraph" discovered he could hear sound over a wire. The sound was that of a Twanging clock spring.

Bell's greatest success was achieved on March 10, 1876, when he invented telephone which took over multiple telegraph.

Alexander Graham Bell's note book entry of 10 March 1876 described his successful experiment with telephone. Speaking through the instrument to his assistant, Thomas Watson in the next room, Bell utters these famous first words,

"Mr. Watson---- come here---- I want to see you. [3]

## 2.5 History of Wireless Communication.

The word "radio" was coined in 1897 by a French physicist named Edoud Brandy in the sense of wireless transmission. In 1907 the word appeared in an article written by Lee de Forest and was adopted by the United States Navy in 1912 and became very common by the first commercial broadcast in the united states in 1920s. [ 5 ]

David E Huges in 1878 was the first to transmit and receive radio waves when he noticed that his induction balance caused noise in the receiver of his home made telephone. The theoretical basis of propagation of electromagnetic waves were first described by James Clerk Maxwell in 1873. James Clerk Maxwell theory was first validated by Heinrich Hertz, between 1886 and 1888 through experiment demonstrating that radio radiation had all the properties of waves. [1]

Marconi, in 1898 made his well publicized demonstration of wireless communication from a boat to the Isle of Wight in the English Channel. Marconi has better public relations and is widely cited as the inventor of wireless communication receiving a noble prize in 1909.

## 2.6 Theoretical background of Telephone/Transmitters

In every elementary telephone system, there exist three elements which include the followings-:

(a). The equipment that is located at each subscribers which convert sound to electrical signals and back and which allows the subscriber to answer or make a call.

(b). A central switching facility which interconnects all the subscribers.

(c). The wiring or other means to connect the subscriber to the central switching facility.

A telephone subscriber may be connected to the network of telephone In three principal ways namely,

(a) By physical wire connections which run in over head or under ground cables.

(b) By voice over network protocols telephone which use broadband internet connections.

(c) By radio as in cordless, cellular, satellite or radio telephone.

## 2.7 Modulation

The process of varying one waveform in relation to another waveform. [ ] In telecommunication, modulation is used to convey message or a musician may modulate the tone from a musical instrument by varying its volume, timing and pitch. Often, a high frequency sinusoidal waveform is used as carrier signal to convey a lower frequency signal.

The three key parameters of a sine wave are its amplitude (volume), its phase (timing) and its frequency (pith), all of which can be modified in accordance with a low frequency information signal to obtain the modulated signal.

## 2.8 Aims of Modulation

The aims of digital modulation is to transfer a digital bit stream over an analogue pass band channel, for example over the public switch telephone network (where a band filter limits the frequency range to between 300 and 3400HZ) or over a limited radio band.

The aim of analogue modulation is to transfer an analogue base band (or low pass) signal, for example an audio signal or TV signal over an analogue pass band channel, for example a limited radio frequency band or a cable TV network channel 1.

Both analogue and digital modulation facilitate frequency division multiplexing (FDM), where several low pass information signals are transferred simultaneously over the same shared physical medium, using separate pass band channels.

## 2.9 Frequency Modulation

Frequency modulation is a type of modulation where the frequency of the carrier is varied in accordance with the modulating signals. The amplitude of the carrier remains constant. This information bearing signal (modulating Signal) changes the instantaneous frequency of the carrier since the amplitude is kept constant; FM modulation is a low noise process and provides a high quality modulation technique which is used for music and speech in hi-fidelity broadcasts. FM techniques are used for other important consumer's applications such as audio synthesis and recording the luminance portion of a video signal with less distortion.

There are several devices that are capable of generating FM signals such as a vco or a reactance modulator.

# CHAPTER THREE

## 3.1 Design, Construction and Implementation.

## 3.2 Design Block Diagram and Operation Principles.

The telephone bug system comprises the following substances;

(i) Power supply

(ii) Fm modulator /oscillator

(iii) 3- Stage RF amplifier.

The system block diagram is given bellow in figure 3.1

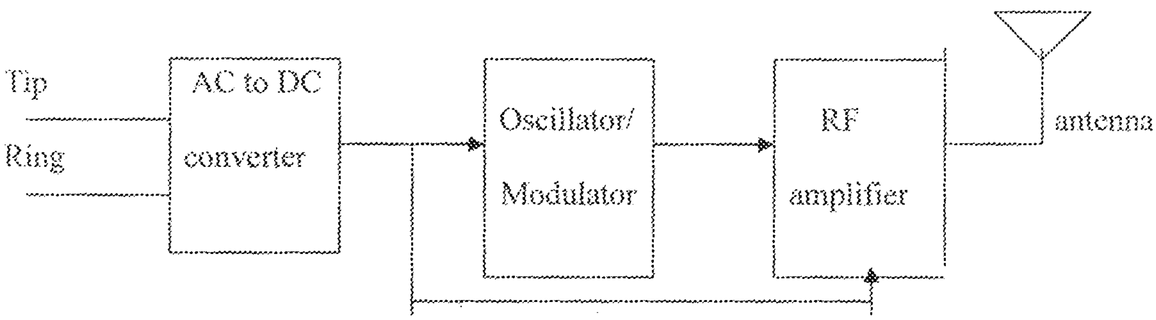



Fig 3.1:The System Block Diagram.

## 3.3 Power Supply Unit

Due to the availability of ac voltage on the tip and the ring wires of the telephone exchange, the human voice is super imposed on an Ac voltage between the ranges of 48V to 86V dc. The required dc power source was derived from the phone. The power scheme is given below:

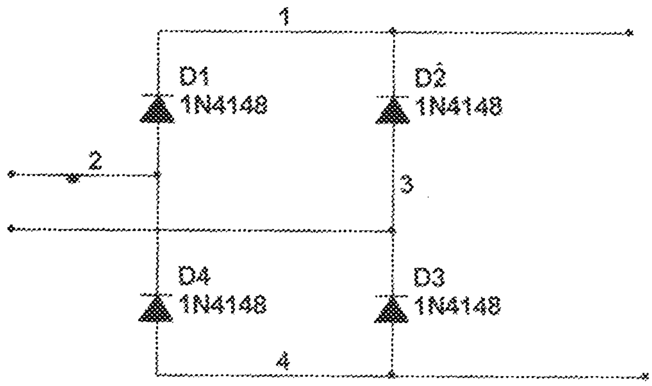



Fig. 3.2 System Power Supply

A full wave bridge rectifier was placed on the phone lines to provide system power. The output dc voltage is given by the expression

$Vdc = (Vrms\sqrt{2} - 1.4)$

$Vdc = 48\ \sqrt{2} - 1.4)$

Vdc = 66.48v.

The instantaneous system supply voltage is therefore directly determined by the Ac voltage on the communication line. No smoothening capacitance was placed across the power lines as such would shunt the audio voice signal to the ground leaving the generated RF carrier unmodulated.

Due to the exclusion of the smoothening capacitance, the system supply potential therefore varies linearly with the analogue signal level on the power modulating the system supply current and directly altering the current required by the modulator to shift it's frequency from the centre value resulting in a frequency deviation that is a direct function of the analogue audio level on the tip and the ring lives.

3.4 **FM Modulator / Oscillator**

A single transistor amplifier coupled as a common base oscillator was used to effect frequency generation and modulation. For simplicity, a base reactance modulation was adopted. In this modulation type, the frequency deviation, $\Delta F$, component of the modulated RF output is supplied by the inter electrode capacitance of the active element used i.e. C9014 transistors

A base reactance oscillator like any other oscillator, generate a frequency given by the expression:

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

Where,

L = Tank circuit inductance,

C =tank circuit capacitance.

Given that the tank circuit inductance = 10 Pf

$$X_L = X_C = \frac{1}{2\pi FL}$$

At resonance $XL = X_C$

$$X_C = \frac{1}{2\pi Fc}$$

$$X_C = \frac{1}{2\pi \times 96\,000\,000 \times 10 \times 10^{-12}}$$

$X_C =$ 165.79ohm

In an ideal resonance circuit $I_L = I_C$ but usually opposite in phase and will cancel each other [ 10 ] [ 11 ].

*

Since $X_L = X_C = \frac{1}{2\pi FL}$

$\therefore L = \frac{XL}{2\pi F}$

Given that $X_L$ = 165.79ohm

$\therefore L = \frac{165.79}{2\pi \times 96000\,000}$

L = 275nH

L value is 0.275nH

The numbers of turn of the inductor can be calculated as follows

$L = \frac{N^2 \mu A}{L}$

μ = permittivity of air

L = inductance in Henry

A = area of cross section

L = length of copper wire used

$N = \left(\frac{L \times l}{\mu A}\right)^{1/2}$

Where $\mu = 4\pi \times 10^{-7}$ wb / Am.

$A = \frac{\pi d^2}{4}$

The diameter of coil is 0.5cm equivalent to $5 \times 10^{-3}$ mm and the length of copper wire is1.3cm equivalent to 0.013mm

Therefore $A = \pi x \frac{(5 \times 10^{-3})^2}{4}$

$A = 19.634m^2$

$$N = \left( \frac{275nH \times 0.013mm}{4\pi \times 10^{-7} \times 19.634 \times 10^{-6}} \right)^{1/2}$$

$N = (144)^{1/2}$

N = 12 turns, but 7 turn was used and the same time extended to achieve the centre frequency of 96.0 MHz. An example of oscillator is diagramed bellow;

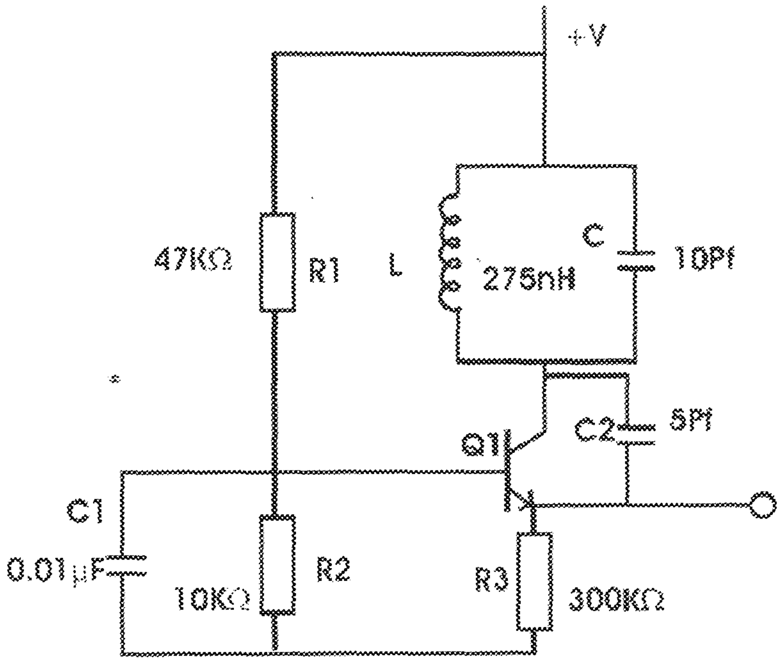
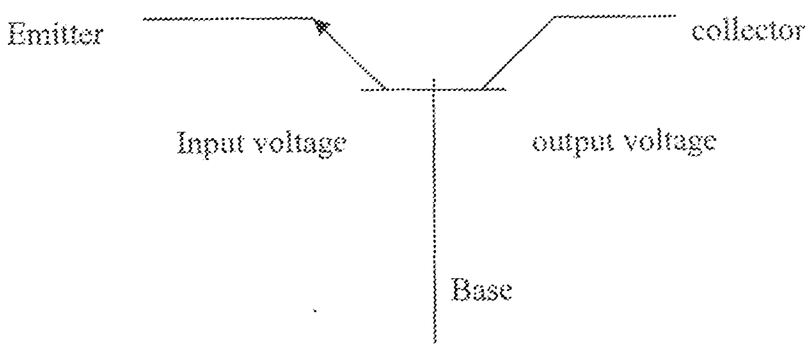



Fig 3.3 Common Base Oscillator

Resistor R1 and R2 are necessary DC-biasing requirements. C1, connected across RB, provides an AC path to ground, effectively short circuiting the base, which is referred to as the common base configuration as depicted below.



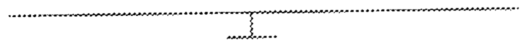


Fig 3.4 CB Amplifier Configuration

In a CB arrangement the input signal is fed into the emitter circuit, and the output taken from the collector as in fig3.4. Without the capacitor C1, the oscillator behaves merely as an amplifier. LC in the collector circuit determines the centre frequency generation by the oscillator. Capacitor C2 between the collector and emitter, provides a positive feedback path necessary to sustain oscillators. The current through R3 develops a voltage which is then inputted into the emitter circuit.

It should be noted that for a CB arrangement there is no phase inversion, therefore, the phase inversion of the output waveform at the collector is in harmony with the waveform injected into the input circuit of Q1, resulting in a positive feedback.with no modulating signal into the base circuit the oscillator produces a carrier frequency given by the equation for the frequency of an LC oscillator. The deviation in frequency is obtained by altering the Cce as shown below

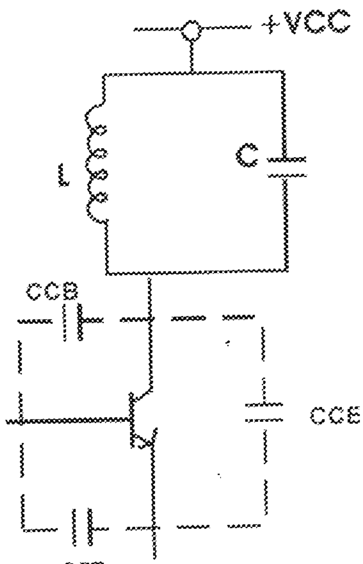



Fig 3.5 Transistor Junction Capacitance.
Since the power supply is short at high frequency, the collector emitter

capacitance, Cce, appears in parallel with LC tuned circuit as shown below.

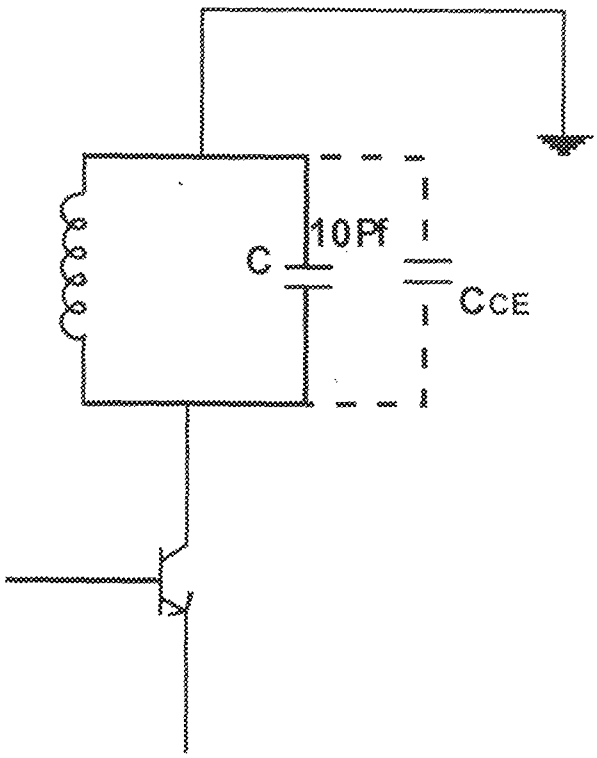



Fig 3.6 Collector Emitter Modelling At High Frequency

The effective value of Cce is directly related to the collector current Ic, which when attended by an base current, directly varies as base current does. The variation in base current is caused by the modulation input into the base emitter circuit. For low frequency the transistor emulates a common emitter amplifier.

The change in Cce, causes a change in the tank circuit capacitance C1 giving rise to the change in capacitance components. The frequency of oscillation, $F_O$ with no modulation input is given as:

$$F_o = \frac{1}{2\pi\sqrt{L_c + C_{CE}}}$$

With a modulating input

$$F_o + \Delta F = \frac{1}{2\pi\sqrt{L(C+\Delta C)}}$$

Where $\Delta C = \Delta C_{CE}$

The change in frequency component contains the transmitted modulating signals. A frequency range between 88MHz and 108MHz was chosen for operation. A frequency of about 96MHz was selected as it falls roughly mid way in the FM3 band. The required inductance was derived using 6 to 7 turns of 22 gauge copper wire. The tank circuit capacitance was chosen to be 10Pf.

The biasing current (I biasing) = Vdc/Rb,

Where Rb = biasing resistor,

biasing current = 48/47000

biasing current =1.02×10^-3mA.

The oscillator/ Modulator is given in fig 3.7

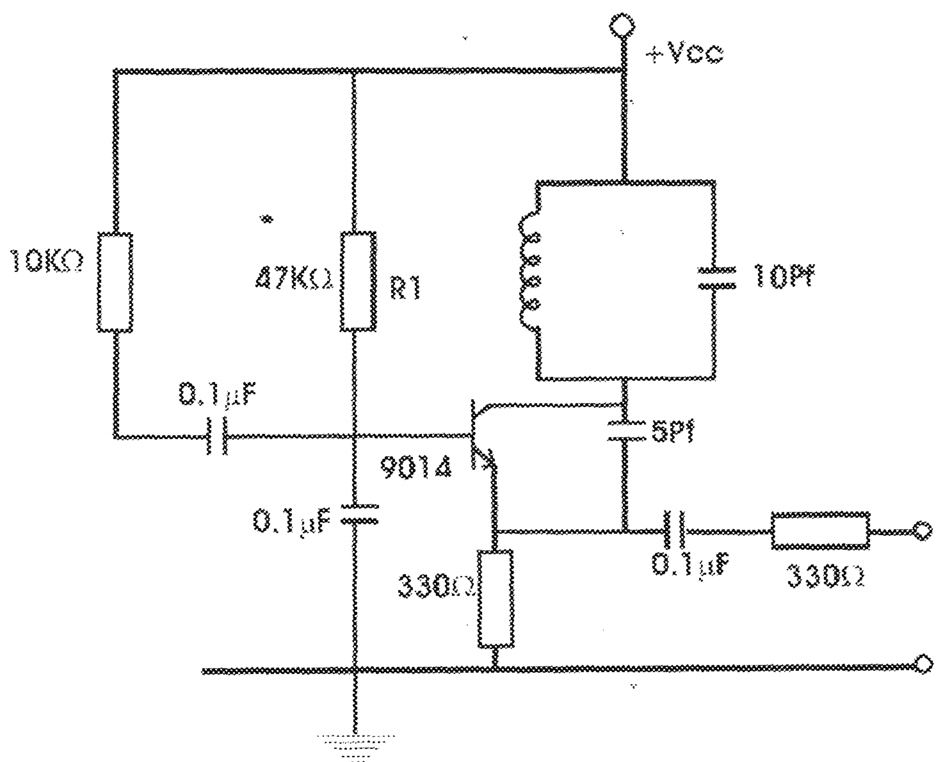


Fig 3.7 FM Carrier Generator.

The modulating input was derived from the Ac component of the power Supply i.e., the imposed audio content. The frequency output is taken across re via a 0.1 Micro farad capacitor. This was further more amplified by a two stage amplifier before radiation via an antenna.

## 3.5 RF Amplifier

A two stage RF amplifier was used to boost the low level carrier frequency. The amplifiers were constructed around C 9014 NPN high frequency transistors.

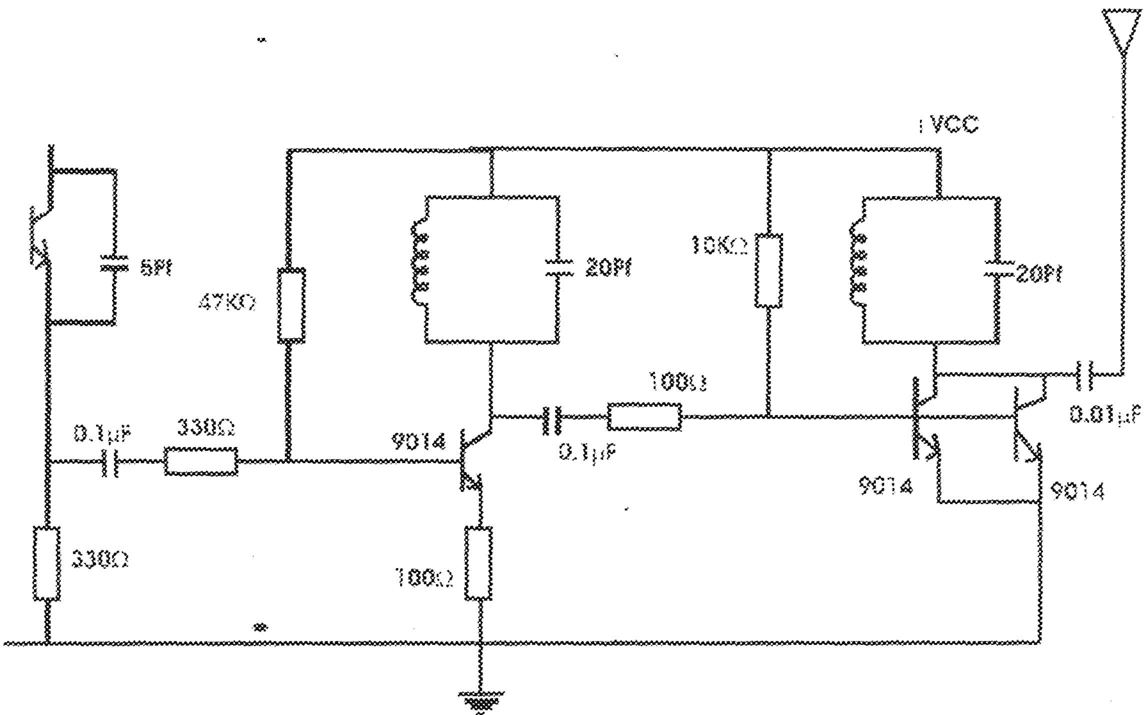



Fig 3.8 RF Power Amplifier.

Stage one was run at a lower collector current to minimize distortion. The tank circuit capacitance was 20 Pico farad to allow for band width adjustment by altering the value of the inductance.

The amplified input was fed into the power RF amplifier comprising two paralleled 9014 devices and associaed circuit elements. It was radiated over a 36.063cm antenna via a 0.01 microfarad DC blocking / AC coupling capacitor.

## 3.6 Power Supply Indicator

An LED was incorporated to provide indication of correction / system operation. The Indicator was wired as in fig 3.8 below.

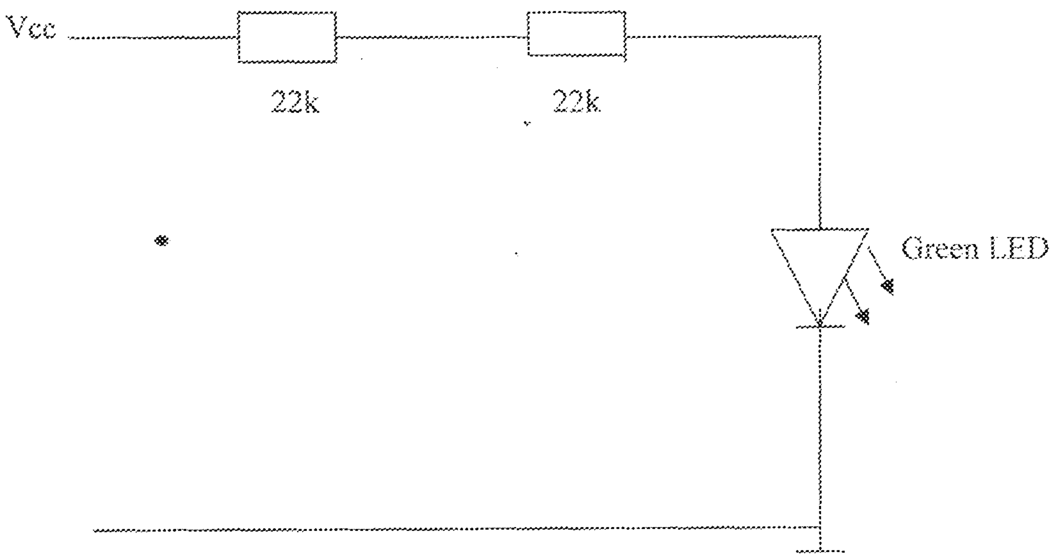



Fig 3.9 System Supply Indicator.

Due to the high system supply voltage, a 44 kilo ohm resistance was incorporated as the diode current limiting element. A green LED was used with a forward voltage of 2.3V. Diode current (Id) is calculated below;

Diode current = $V = IR$

$I = \frac{V}{}$

R

Where R = 44kilo-ohm

$V = 2.3v.$

$$I = \frac{2.3}{44 \times 10^3} = 5.23 \times 10^{-5} mA$$

## 3.7 Antenna

An antenna is a transducer designed to transmit or receive electromagnetic waves. In other words, antennas convert electromagnetic waves into electrical currents and vice Versa. [8]

Antennas are used in systems such as radio, television, transmitters, wireless LAN and radar etc. [6]

Physically, an antenna is simply an arrangement of one or more conductors usually called elements in this context. In transmission, an alternating current is Created In the elements by applying a voltage at the terminals causing the elements to radiate electromagnetic waves into the free space while in reception, the electromagnetic waves from another source are converted to electrical current (AC) in the elements and a corresponding voltage at the terminals. [6]

An antenna must be tuned to the same frequency band that the transmitter which it is connected to operates. If an antenna is not tuned to the same frequency as the transmitter, transmission or reception impair may occur.

At 96MHZ operating at resonant frequency, the operating wavelength is

$$\lambda = \frac{V}{f}$$

given that $V$ = speed of light = $3 \times 10^8$ m/s

$\lambda$ = wave length in meter

$F$ = resonant frequency ≈ 96 MHz

$$\lambda = \frac{3 \times 10^8 \text{ m/s}}{96 \times 10^6}$$

$$\lambda = \frac{3 \times 10^8}{96{,}000{,}000} \approx \frac{300{,}000{,}000}{96{,}000{,}000}$$

$\lambda$ = 3.125 meters

For efficient radiation antenna length (L) must be greater than ¼ $\lambda$ i.e. L. [> ¼]$\lambda$.

L = 1/8 $\lambda$ was used

L = (1/8 x 3.125) cm

L = (1/8 x 312) cm

L = 0.125 x 312.5) cm

L = 39. 063cm.

Antenna characteristics are essentially the same whether an antenna is sending or receiving electromagnetic energy. This property is called reciprocity. [ 7 ]

An antenna will radiate power in all directions but typically doe not perform equally well in all directions. [7]

## 3.8 Power Radiated By Antenna

$$\frac{P}{4\pi r^2} = \frac{E^2}{120\pi} \quad \ldots\ldots\ldots\ldots\ldots \; 3.10$$

$$P = \frac{E^2 r^2}{30} \quad \ldots\ldots\ldots\ldots\ldots \; 3.11$$

= where P = power radiated by the transmitting antenna in watts

R = maximum radius of the effectiveness of the system

I = current flowing through it in amperes

E = electric field strength at receiver antenna in v/m

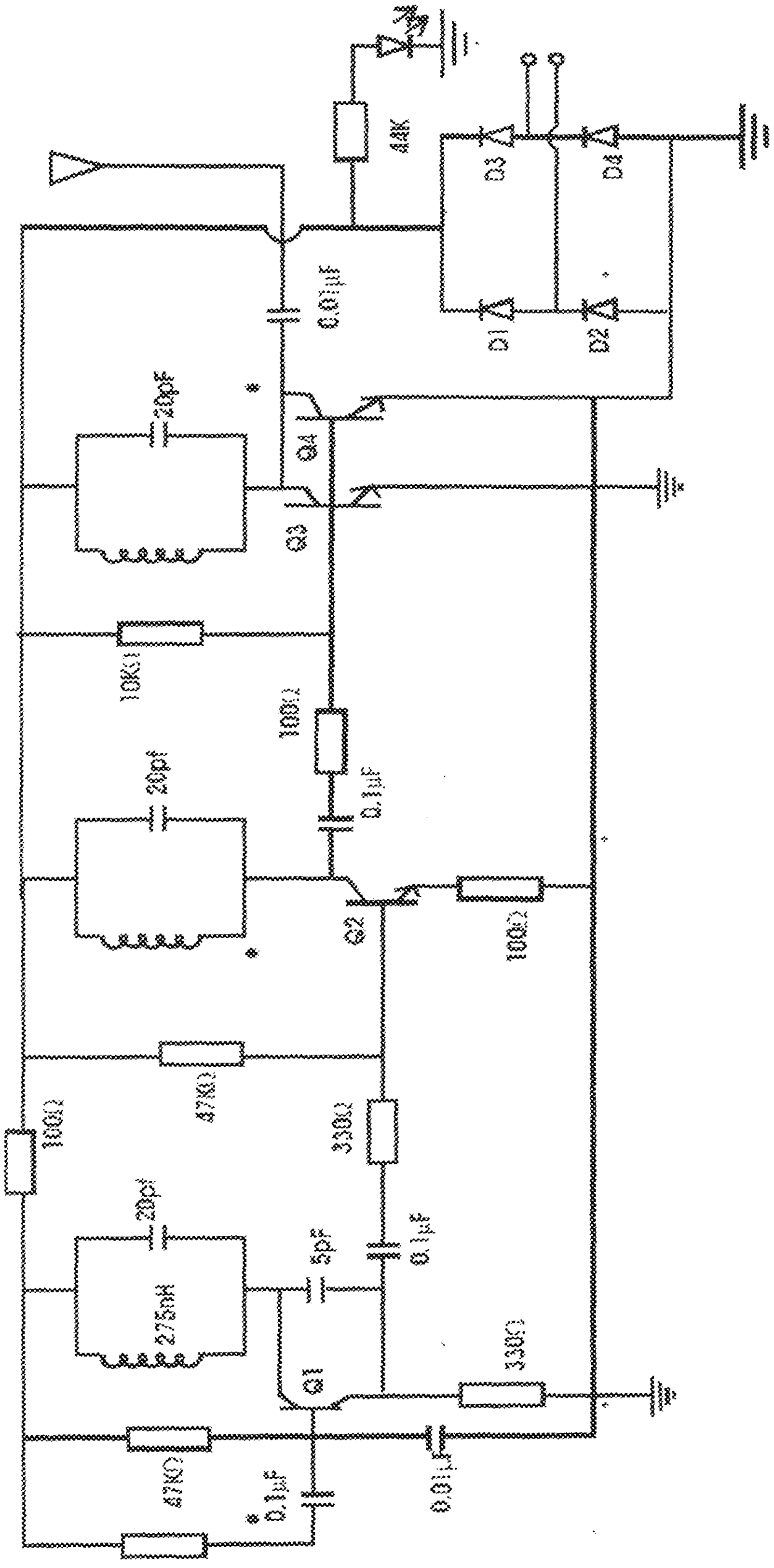
$$I = \sqrt{\frac{P}{R}} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad 3.12$$

$$I = \sqrt{\frac{E^2 r^2}{30}} \text{ amperes} \quad \ldots\ldots\ldots\ldots\ldots 3.1$$

Let r = 50metres and E = 3000 x $10^{-6}$ v/m.

$$P = \left(\frac{(3000 \times 10^{-6} \times 50)^2}{30}\right)^{1/2}$$

P = 0.27w.



10KΩ
47KΩ
0.1μF
0.01μF
Q1
275nH
20pf
5pF
330Ω
0.1μF
100Ω
47KΩ
Q2
100Ω
20pf
0.1μF
100Ω
10KΩ
Q3
Q4
20pF
0.01μF
D1
D2
D3
D4
4.4K

# CHAPTER FOUR

## 4.1 Test and Discussion of Results

The completed project work was tested using a frequency of 50 Hz from an AC 220V socket outlet stepped down to 12V by a step down transformer. The 12V 50 Hz from the secondary side of the step down transformer was connected to the rectifier input module of the project. The intention was to use the 50Hz frequency to modulate the oscillator as the assumed carrier frequency. The result of the above test was that a fuming of the AC voltage signal applied was heard on an FM radio (carrier) tuned to the desired frequency.

The design was carried out using 96MHz as the carrier frequency and based on the preliminary test conducted as explained above, signals were received on 88.2MHz to 108.1MHz but more stronger on 96.0MHz with a maximum range of transmission of about 38 meters from line of sight.

## 4.2 Completed Circuit Tests.

After the project has been finally packaged, the final test was conducted in the main distribution frame of NITEL. The various tests that were conducted include;

(a) Test on the DC voltage level of the phone lines

(b) Test on the effective range of transmission.

(c) Test on the quality of reception of the receiver.

(d) Picking of dialing tones.

## 4.3 Tests on the Range of Transmission.

The audio signals were picked with the receiver at a distance of about 38 meters on a flat open space within line of sight. When the same test was conducted in a building with walls constituting barriers to the transmitter and the receiver, the distance was reduced to about 34 meters. This test was made possible with the use of digital transistor radio.

## 4.4 Tests on the Quality of Reception.

During this test, a digital transistor radio was used to determine the spot at which reception of signals was high or less. The closer you are to the transmitter, the higher the reception of signals and the further you move from the transmitter, the fainter the reception of signals.

## 4.5 Tests on the Power Supply Stage.

The standardized DC voltage level of the phone line was tested using analogue meter. The required result was 48V DC and this was the result obtained from the test.

## 4.6. The Alignment Stage.

At this stage, some basic tools were employed for optimum result: namely

(a) The telephone

(b) The cutting pliers.

(c) The crocodile clips.

(d) The audio/transistor radio.

## 4.7. Procedures.

The crocodile clips were attached to the extended ends of the connecting coaxial cable of the device, this was followed by cutting the phone lines and the analogue meter was placed to test the voltage.

Having tested the voltage level, the bug was interfaced with the line and powered with an LED indicator indicating that the device was ready.

The antenna of the telephone FM transmitter was extended and walking away from the transmitter, the antenna of the transistor radio receiver was also extended and the radio was turned on. With the FM band tuned to 88.2MHz and 108.2MHz, signals were received, however, the signals were found to be more stable at 96.0MHz.

## 4.8 Further Discussion of Results.

(i) From the result obtained from the test, it was discovered that the state of the design was in good condition.

(ii) The voltage level was perfect at 48V.

## 4.9 Limitations.

(a) Difficulties in getting the exact components, hence equivalent components was used

(b) The problem of getting an RF meter which was needed to determine the power coupled into space of the RF stage.

(c) The inability to test frequency at various levels using spectrum analyzer.

(d) Inability to test the device with DC power source because audio signals are always superimposed on an AC signals from which the device get it power source.

## 4.10 Trouble Shooting.

(1) If the receiver, (transistor radio) is not responding, check if the connection between phone line and the transmitter is intact and fine tune the receiver as well.

(2) If the transmitter does not come on, check if the LED is powered on.

# CHAPTER FIVE

## 5.1 Summary

The telephone FM bug transmitter is a simple transmitter that when connected in series to a phone line transmits any thing on that line to any FM radio tuned to the required frequency. The telephone bug FM transmitter comprises of three sections, namely, the power supply/ audio unit, the oscillator / modulator stage and the power amplifier stage.

The power for the design is obtained from the phone after rectification by the full wave bridge rectifier. The oscillator stages generate the carrier wave / frequency while the modulator supper imposes the modulating signal (audio) on the carrier signal for amplification.

The modulated signal is coupled to the amplifier stage through a coupling capacitor where the power of the signal is amplified high enough to be radiated by the ancomtenna to the free space (electromagnetic wave) for reception by radio receiver tuned to the desired frequency band.

The modulation technique adopted for the design is the base reactance modulation technique, this is because the design requires high frequency for transmission.

## 5.2 Problems Encountered

During the course of constructing the project, some problems were encountered,

(i) Difficulties in testing the constructed device using the DC power inter comm.

(ii) Telephone.

Difficulties in obtaining the required components.

Difficulties in proper soldering of the components to the circuit board.

Instability in the variation of electromagnetic waves which really possed some challenges as to what frequency should be specified

## 5.3 Areas of Improvements.

(1) The increase in effective range of transmission by incorporating various RF stages in the design.

(2) Building the device with personal inbuilt`memory device for voice record inplace of external tape recorder .

(3) Incorporating an inbuilt antenna for radiation instead of external antenna to enhance portability.

## 5.4 Recommendations.

For the purpose of future design and construction of this same project, the followings are recommended;

(1) Practical classes should be well organized so as to enable each students have direct access to equipments in the lab.

(2) Courses like communication principle, analogue electronics and digital electronics should be made practicable for the benefit of the students.

(3) Every lecturers/ lab attendants should be friendly with their students in all practical classes to encourage the students.

# REFERENCES


[1] http://www. The telephone man-NM.com

[2] Andrees .F. molisch 2005 wireless communication pp4

[3] Wikimedia foundation Inc telephone
http://en.citizendium.org/wiki/telephone

[4] History AT & T 2006 http://www.corp.att.com/ history milestone

[5] http:// history accused. Edu/gen/media/history of radio. Htm

[6] BL Theraja and B.K Theraja. Text book of electrical technology

[7] Dr E.N. Onwuka. Communication system Antennas and propagation pp61.pp62

[8] http://. Netgear.com/app/answers/detail/a-id/231

[9] Dr E.N Onwuka. Communication system pp29, pp30.

[10] Poptronix Handbook http://www.poptronix.com.pp1.pp3

[11] M.L Anent 2000 Electronics principles devices and circuits(1st edition).

# APPENDICE

The operational manual

•

•

•

# APPENDICE ONE

## 1.0 The Operational Manual

Connect your transmitter to the phone line and tune to the desire frequency.

Turn on your transistor radio and tune to the desired frequency.

Pick up the phone and you will hear a ring tune.

Fine tune the radio for better reception.