DESIGN AND CONSTRUCTION OF AN FM RECEIVER

By

AGWU TOCHUKWU
99/8057EE

A PROJECT
SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF ENGINEERING (B. Eng) DEGREE IN ELECTRICAL AND COMPUTER ENGINEERING

To The

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA.

NOVEMBER, 2005

DECLARATION

This is to certify that this project was carried out by Agwu Tochukwu of the department of electrical/computer engineering of the school of engineering and engineering technology of the Federal University of Technology Minna, under the supervision of Engr. M.S. Ahmed for the award of Bachelor of Engineering (B.Eng).

______________	6/12/05
Engr. M.S. Ahmed	
(project supervisor)	Date
______________	06/02/06
Engr. M.D Abdullahi	
(HOD)	Date
______________	______________
External Supervisor	Date

DEDICATION

I dedicate this work to the Glory of God and to my parents, brothers and sister who God used to bless me with a Bachelor of Engineering.

ACKNOWLEDGEMENT

Without any reservation, I give all the praises and honor to my Father in Heaven, who through his infinite mercies and grace made me survive through out my short stay in this university "vision without mission they say is a waste", with respect to this adage, my sojourn in this university would not have been a reality if not for the moral and financial support of the following people who through their various ways have contributed to my success. My profound gratitude goes first to my parents MR& Mrs. P.O Agwu who supported financially, morally and through prayers. My gratitude also goes to my brothers Mr. Nestor, Eng Chinedu ,Ejike and Eng Louis in particular for financial assistance and my sisters who were in their own little ways contributed to my success. My special thanks also goes to my supervisor ENGR.M.S. Ahmed who guided me during this project. I am also grateful to my friends Barry, Emmanuel Dawak, Fikayo and especially *Stanley Ezumezu* whose contribution typing and drawing the circuits cannot be quantified.

ABSTRACT

The design and construction of FM radio receiver has been designed and constructed. One way to maximize the gain of an amplifier is to design a circuit that lets the operator control the gain with sufficient positive feedback, a circuit can be designed that has lots of gain but will oscillate if its gain is set too high.

This type of circuit is called a regenerative amplifier. If a regenerative amplifier includes Q tuned circuit, then that amplifier can act as a regenerative detector for FM. Regenerative detectors can be quite inexpensive, easy to assemble and give surprisingly good results. Going by design consideration, locally available cheap, simple discrete components were used in the construction. The project consists of a regenerative amplifier, an oscillating circuit, filter circuit, audio amplifier and a power source

TABLE OF CONTENTS.

CHAPTER ONE

INTRODUCTION

Broadcast band frequency modulation (FM) radio , that is radio used in the mode of 88MHz -108MHz VHF broadcast band, was invented to solve existing problems with noise and fidelity on the amplitude modulation (AM) broadcast band. that is 0.54 - 1.6MHz. Broadcast band. Anyone who has tuned an fm receiver has probably noticed the "quieting" of background noise characteristic of FM reception. Thus the first FM receivers were quite complex in design, employing a super heterodyne converter, a wideband IF, a limiter stage and a discriminator. Unlike the first AM radio sets, the earliest FM radio sets did not use the simplest possible methods for receiving signals but it was not until much after the introduction of commercial broadcast FM that simple FM receivers were published and sold. This design includes among others, super regenerative FM detector. These designs generally have low component counts; however the design or construction may have been far from simple.

1.0 FM DETECTION

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 curve 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.

1.1 THE FOSTER-SEELEY DETECTOR

This detector or its variant, the "ratio detector". Using a single tuned circuit in fiendishly clever diode arrangements to give a linear curve of amplitude versus frequency over the IF band pass. The discriminators are superior to the simple slope detector

1.2 PHASE LOCKED LOOP (PLL) DETECTOR.

This is a 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.

1.3 PHASED DETECTOR.

The quadrature detector splits FM into two pathways and phase shifts each path so that a 90 degree phase difference exists between the two signals. The two signals are fed into a balanced modulator FM signals (or phase modulated signals) mix the modulator and because they are 90 degrees out of phase from each other, that produce and amplitude variation that is proportional to modulation frequency.

1.4 BALANCED QUADRATURE DETECTOR

This is a combination of phase detector and phase shifting network. The IF signals is passed through a network that produces a shift varying linearly with frequency across the IF pass band (an LC circuit). The resultant signal and the original signal are compared in a phase detector, giving and output that vary with relative phase. That output is the desired audio signal.

1.5 SUPERREGENERATIVE DETECTOR.

This is an amazing circuit invented by Armstrong that uses a super regenerative amplifier. There are two basic types, self-quenched and externally quenched

The work here is for the self-quenched type.

OPERATON:

The super regenerative circuit acts as a mixer, amplifier, and FM detector. Choose a regenerative amplifier circuit configuration that requires more current during oscillations than when no oscillating. Adjust the regenerative amplifier to oscillate. Add a small circuit that uses the current of the amplifier to charge a capacitor while oscillations are taking place Once the capacitor is charged, the voltage on the capacitor is used to kill the oscillations of the circuit. (Technically, the capacitor voltage shifts the operating point of the amplifier to reduce its gain and stop the oscillations). When the oscillations stop, the capacitor discharges (through a resistor). Once the capacitor is discharged the oscillations begin again.

A super heterodyne amplifier thus oscillates at two frequencies. It oscillates at the tuned frequency of the amplifier and it has this secondary stop-start-stop-start oscillation. If the primary oscillation is at 100MHz, the secondary should be at 30 KHz for optimal performance. The 30 KHz is above audio frequencies, so the listener does not hear noise associated with either oscillation. The super regenerative technique does not work well at lower radio frequencies because; the optimal frequency of the secondary oscillation ends up in the audio frequency range.

CHAPTER TWO

LITERATURE REVIEW

Modernization is today at its peak to one's ability to pass information was done by sense of sight, hearing and by the written word using some form of accepted language which was not fast due to its means and range of distance covered.

In electronics, communication means processing information from the source sending, processing and reception of information which could be in different forms like voice, written message and picture. In summary it is equipment used for the processing of information from the source through a medium to a processor.

The pre and early history of radio is the history of its technology. Later the history is dominated by programming and contents which is closer to general history.

The identity of the original inventor of radio at the time called wireless telegraphy is contentious.

In 1820, HANS CHRISTIAN ORSTEN discovered the relationship between electricity and magnetism in a very simple experiment. He demonstrated that a wire carrying a current was able to deflect a magnetized compass needle

In 18831 MICHAEL FARADAY began a series of experiments in which he discovered electromagnetic induction. The relation was mathematically modeled by FARADAY'S LAW, which subsequently became one of the Maxwell's equations. Faraday proposed that electromagnetic forces extended into the empty space around the conductor but did not complete his work involving that proposal. The theoretical basis of the propagation of electromagnetic waves was first described in 1873 by JAMES CLERK MAXWELL. In 1878 DAVID E.

HUGHES was the first to transmit and receive radio waves when he noticed that his induction balance caused noise in the receiver of his homemade telephone. He demonstrated his discovery to the royal society in 1980but was told it was merely induction. It was HEINRICH RUDOLF HERTZ who between 1886 and 1888 first validated Maxwell's theory through experiment, demonstrating that radio radiation had all the properties of waves (now called Hertzian waves). Claims have been made that Nathan Stubble FIELD invented radio before other inventors, but his devices seems to have worked by induction transmission rather than radio transmission. In 1893 in St. Louis Missouri. Tesla described and demonstrated in detail the principles of radio communication. The apparatus that he used contained all the elements that were incorporated into radio systems before the development of the vacuum tube. He initially used sensitive electromagnetic receivers, unlike the less responsive coherers used by MARCONI.

On 19 August 1894, British physicist Sir Oliver Lodge demonstrated the reception of Morse code signaling using radio waves using detecting device called a coherer.

In 1895, MARCONI sent a telegraph message with wires but he did not send voice over the airwaves. REGINALD FESSENDEN, in 1900 accomplished that and made a weak transmission on Christmas Eve, 1906, using his heterodyne principle. FESSENDEN transmitted the first radio broadcast in history from Brant rock, Massachusetts; ship at sea heard a broadcast that included Fessenden playing song "O Holy Night" on the violin.

The world's first radio news programme was broadcast August 31, 1920 by station 8Mk in Detroit Michigan. The world's first regular wireless broadcasts for entertainment commenced in 1922 from the MARCONI Research Centre at writtle near Chelmsford, England. Early radios ran the entire power of the transmitter through a carbon microphone while some early radios used some type of amplification through electric current or battery. through the mid 1920s the most common type of receiver was the crystal set.

In the 1920s, amplifying vacuum tubes revolutionized both receivers and transmitters.

Invention of the triode amplifier, generator and detector enables audio radio. The invention of amplitude modulated (AM) radio, so that more than one station can send signals.

CHARLES DAVID HERROLD an electronics instructor in San Jose California constructed the first broadcasting station. It was the spark-gap technology but modulated the carrier frequency with human voice and later music. The station "San Jose calling" was first established in April 1909 and has continued an unbroken lineage to eventually become today's KCBS in San Francisco.

Herrold, he son of a Santa Clara valley farmer coined the terms "narrowcasting" respectively to identify transmissions destined for a single receiver such that on board a ship and those transmissions destined for a general audience.

The term "broadcasting "had been used in farming to define the tossing of seed in all directions.

CHARLES HERROLD did claim to be the first to conduct "broadcasting" to facilitate the spreading of the radio signals in all directions; he designed omni-directional antennas, which he mounted on the roof tops of various building in San Jose.

The invention of frequency-modulated (FM) radio so that an audio signal can avoid "static" that is interference from electrical equipment and atmospheric was EDWIN H. ARMSTRONG and LEE DE FOREST.

CHAPTER THREE

SYSTEM DESIGN AND ANALYSIS

In a radio receiver the unwanted signal frequency is converted into a constant frequency known as the intermediate frequency.

The basic block design of radio receiver is shown in figure 3.1.

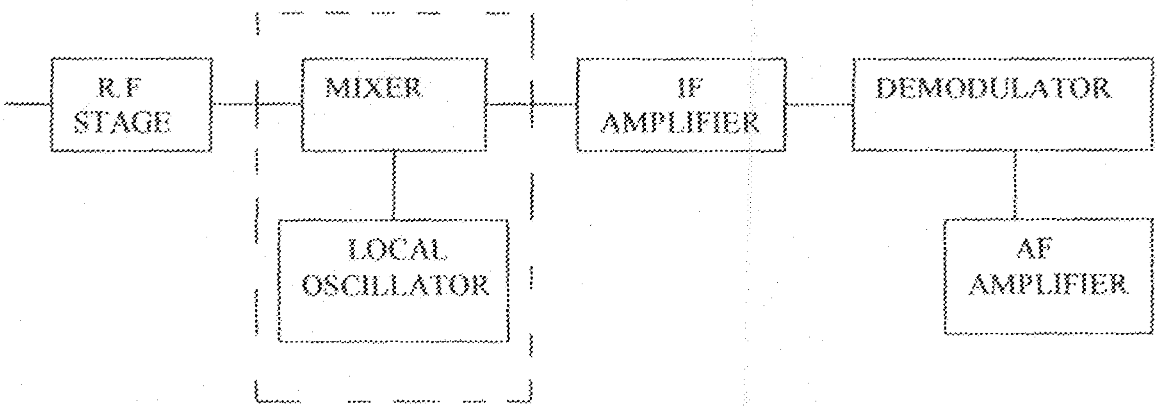


Figure 3.1

3.1 THE RADIO FREQUENCY STAGE.

The radio frequency stage of a radio receiver performs the following functions.

1. It must couple the aerial to the receiver in an efficient manner
2. It must suppress signals at intermediate frequencies.
3. It must operate linearly to avoid the production of cross-modulation.

MIXER AND LOCAL OSCILLATOR

The function of the mixer stage is to convert the unwanted signal frequency into the intermediate frequency of the receiver. This process is carried out by mixing the signal frequency with the output of the local oscillator and selecting the resultant difference frequency.

The local oscillator must be capable of tuning to any frequency in the band to which the receiver is tuned plus the intermediate frequency $f_0 = f_s + f_i$. The ability of a receiver to remain tuned to a capacitor frequency without drifting upon the frequency of its local oscillator.

Receivers operating at one or more fixed frequencies can use a crystal oscillator, frequency changes involving crystal switching. When a receiver is to be tunable over a band of frequencies an L-C oscillator with automatic frequency control must be used. Fig 8.2 shows L-C oscillator diagram.

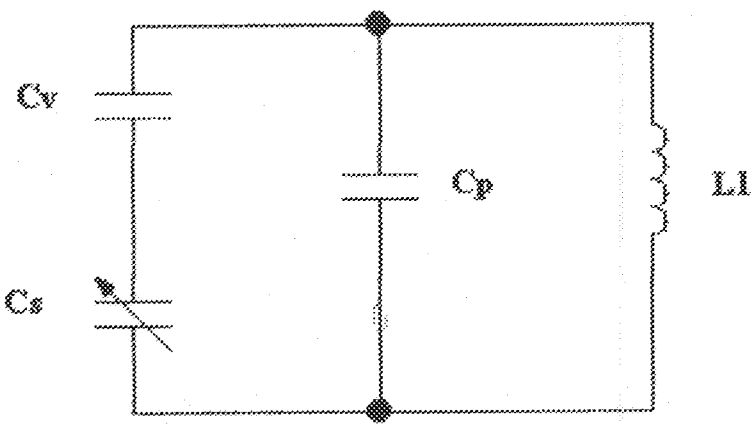


Fig. 3.2 Cv ans Cs connected in series

Cv and Cs are connected in series

$1/Cv + 1/Cs$

$(Cs + Cv)/(CvCs) = (CvCs)/(Cv + Cs)$

$(CvCs)/(Cv + Cs) + Cp$

$= [(CvCs) + (Cv + Cs)Cp] / (Cv + Cs) = Zeq$

$F_0 = 1 / (2\pi\sqrt{LZeq})$

3.3 THE INTERMEDIATE FREQUENCY AMPLIFIER

The purpose of the intermediate frequency amplifier in a radio receiver is to provide most of the gain and the selectivity of the receiver. Most broadcast receivers utilize the impedance / frequency characteristic of a single or double tuned circuits to obtain the required selectivity but many receivers use ceramic filters. In this construction SALLEN AND KEY FILTER was used. Shown in fig. 3.3 is the circuit diagram.

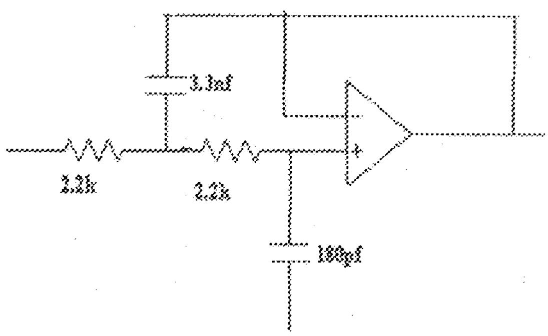


Fig 3.3 Sallen & Key filter(Lowpass filter)

R1 = R2

The frequency = $1 / (2 \prod \sqrt{R_1 * R_2 * C_1 * C_2})$

C1 = 3.3nf

C2 = 180pf

R1 = 2.2kΩ

F = 1 / (2 ∏√2.2 * 1000 * 2.2 * 1000 *3.3 * 10-9 * 180 * 10-12) = 93.912KHz

The circuit of IF filter is shown below

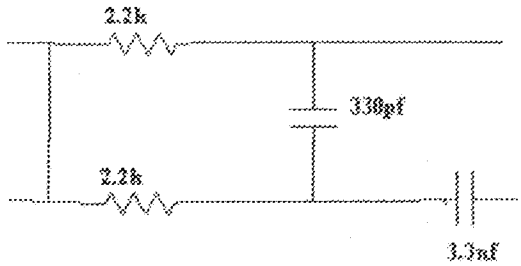


Fig 3.4 LF Filter

The frequency = 1 / ∏√4700 * 4700 * 3.3 * 330 *10^-21

The main factor to be considered when choosing the intermediate frequency of a radio receiver are:The required intermediate frequency bandwidth

(a) Interference signals

(b) The required intermediate frequency gain and stability

(c) The adjacent channel selectivity

DEMODULATION STAGE.

The function of the demodulator in a radio receiver is to recover the information modulated unto the carrier wave appearing at the output of the IF amplifier. Most AM broadcast receivers use the diode detector because of its simplicity and good performance. Most frequency modulated broadcast receivers use the ratio detector but high quality receivers may use the Foster-seeley preceded by a circuit stage. When the demodulator stage is part of an integrated circuit, the quadrature or phase locked loop detector is used. The phase locked loop frequency detector is shown below.

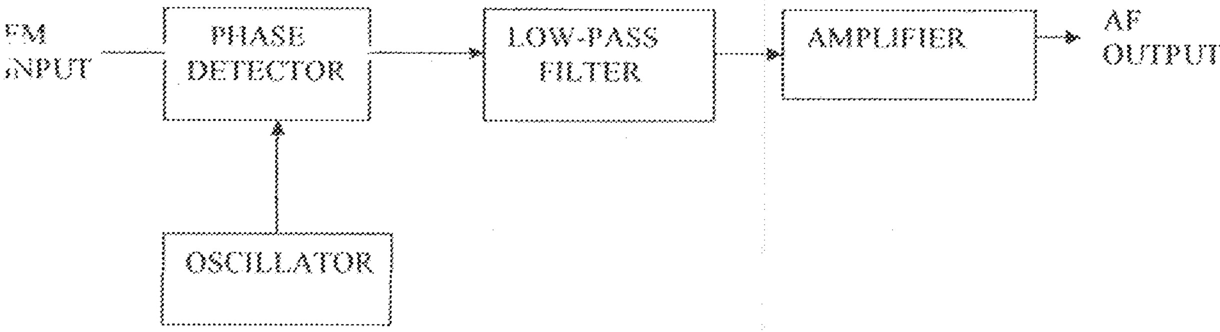


Fig. 3.4

If a signal at a constant frequency is applied to the input terminals of the circuit, the phase detector produces an output voltage that is proportional to the instantaneous phase difference between the signal and oscillator voltages. The error voltage is filtered and amplified before it is applied to the input of the voltage controlled oscillator. The error voltage varies the oscillation frequency in the direction which reduces the frequency difference between signal and oscillator frequency. This action continues until the oscillator frequency is equal to the signal frequency. The oscillator is then said to be locked.

When the input signal is frequency modulated, the error voltage will vary in the same way as the required modulating signal and so the circuit of an integrated P.L.L FM demodulator. C1 and C2 couple the previous stage in the radio receiver to the detector and C3 is the tuning capacitor of the voltage controlled oscillator. C5 is a part of the low-pass filter between the phase detector and the amplifier. C4 and R1 are the de-emphasis components.

ANALYSIS

Telecommunication system is an equipment used for the processing of information from he source through a medium to a processor. This information which consists of a series of compressions and refractions is transited into tiny varying electric current into with the help of transducers known as INPUT TRANSDUCER. The frequency of variation of this current lies in the audio range (AUDIO FREQUENCY) signal. The audio frequency signal cannot be radiated out from the antenna directly because transmission at audio frequency AF is not feasible. An oscillator with very high frequency is needed for this purpose. The electromagnetic waves produced are of constant amplitude but of extremely high frequency which travel through space with the velocity of light

($3* 10^8$ m/s). The AF (audio-frequency) signal to be broadcast is then superimposed on the waves, which are known as CARRIER WAVES. The carrier wave will now carry it to the destination (receiver) where the signal is received.

CARRIER WAVE

It is a high frequency undamped radio wave produced by radio frequency oscillators. The output of these oscillators is first amplified and then passed on to an antenna. This antenna radiates out the high frequencies (electromagnetic) waves into space. These waves have constant amplitude and travel with velocity of light. Definitely, their function is to carry the signal (audio) from transmitting station to the receiving station causing modulation of the carrier wave.

NEED FOR MODULATION.

Modulation is a process whereby a parameter (amplitude, phase, frequency) of a carrier wave which has a much higher frequency than the message signal is modified. The combination of audio-frequency (af) signal with a radio frequency

(RF) carrier wave. The AF is also called the modulating wave and the resultant wave produced is called modulated wave.

i. One reason for modulation is to aid channel assignment

ii. Multiplexing (sending series of messages through the same channel) could be frequency multiplexing or time multiplexing.

iii. To overcome equipment limitations

iv. To reduce noise

v. For easy radiation and reception.

For efficient radiation of signal, the minimum length of an antenna is one-quarter wavelength.(\\ 4)

The length L is connected with the frequency of the signal wave by the relation:

$L = (75 * 10^6 / F)$ meter

Now transmitting an audio signal F = 100Hz

$L = (75 * 10^6 / 10^3) = 75000 = 75km$

FRQUENCY MODULATION

Obviously, the carrier waveform can be varied by varying any of its three parameters, which determines the type of receiver. Varying the amplitude we have AMPLITUDE MODULATION (AM). A situation whereby it is frequency results in FREQUENCY MODULATION (FM).

In frequency modulation, it is only the frequency of the carrier that is changed. This is a form of angle modulation in which the frequency of the carrier wave is linearly varied with respect to the instantaneous value of the modulating signal.

MATHEMATICAL EXPRESSION

Using the waveform below

$W(t) = Wc + K_f e_m (t)$ --------- [3.0]

K_f = frequency sensitivity of the modulator circuit measured in rad/volt depending on the unit of the instantaneous value of the modulating signal.

Converting the above equation [3.0] into the phase angle, we integrate as thus:

$\int W(t)\,dt = \int Wc\,dt + \int K_f e_m(t)dt$

$\Theta(t) = Wct + K_f \int e_m(t)dt$

$em\ (t) = Em \cos \Theta t$

$\Theta(t) = Wct + K_f E_m \int \cos Wm\ dt$

$= Wct + (KfEm \sin Wm(t))/Wm$

$e_{fm}\ (t) = Ec \cos [Wct + (K_f E_m \sin Wm(t))/Wm]$

FREQUENCY DEVIATION AND CARRIER SWING

The frequency of an FM transmitter without signal input is called the resting or center frequency which is the carrier frequency of the transmitter. In simple words, it is the carrier frequency on which a station is allowed to broadcast. When a signal is applied it causes the carrier frequency to deviate up and down from its destine point F_o.

The change or shift either above or below the resting frequency is called the FREQUENCY DEVIATION (DF)

Mathematical expression of (DF)

$W(t) = Wc + K_f em(t)$ ----------- [3.1]

$= Wc + K_f Em \cos Wmt$

$= Wc + \Delta W \cos Wmt$

Where $\Delta W = K_f Em$

From equation 3.1 we can substitute for W

2[][f(t) = 2[][fc + Δ2[][fcos Wmt

f (t) = fc + Δf cos Wmt

This gives the instantaneous frequency for FM wave. The total variation in frequency from the lowest to the highest attained by the FM signal is called "CARRIER SWING"

= 2ΔF

MODULATION INDEX

Mathematical expression:

Considering the equation

Θ (t) = Wct + (K_fEm sin Wmt)/ Wm

Θ(t) = Wct + (ΔW/Wm)sin Wmt

Θ(t) = 2[][fct + (2[][ΔF/2[][Fm) sin Wmt

= 2[][fct + (ΔF/ Fm) sin Wmt

= 2[][fct + βsinWmt

Where ΔF/ Fm = β is the modulating index measured in radians

β = (frequency deviation / modulation frequency) = ΔF/ Fm

It is important to note the following properties of the modulating index.

i. The higher the modulating frequency (fm) the smaller the modulation index.

ii. The greater the frequency deviation the greater the modulation index.

iii. Modulation index is dependent on the amplitude and frequency of the carrier signal.

iv. The greater the amplitude of the modulating signal the greater the modulation index.

Modulation index can be greater than unity knowing the value of modulation index β we can calculate the number of significant sidebands and the bandwidth of the FM signal.

PERCENT MODULATION

This is the ratio of the actual frequency deviation to the maximum allowed frequency deviation.

Percent Modulation = [(ΔF) actual / (ΔF) maximum] * 100

Obviously 100% modulation corresponds to the case when actual deviation equals the maximum allowable frequency deviation. When value of percent modulation equals zero, corresponds to zero deviation that is unmodulated wave.

CONSTRUCTION OF FM WAVES

Figures 3.6 and 3.7 show the modulating signal and the carrier signal waveforms respectively, both being sinusoidal signals. In order to obtain the FM waveform the instantaneous frequency of the carrier is increased as the instantaneous value of the modulating signal increases. FM signal frequency is maximum when the modulating signal reaches its positive peak value. It is minimum when the modulating signal reaches its minimum peak value. The FM signal frequency remains unchanged when the instantaneous value of the modulating signal is zero. The resulting FM signal is shown in figure 3.8

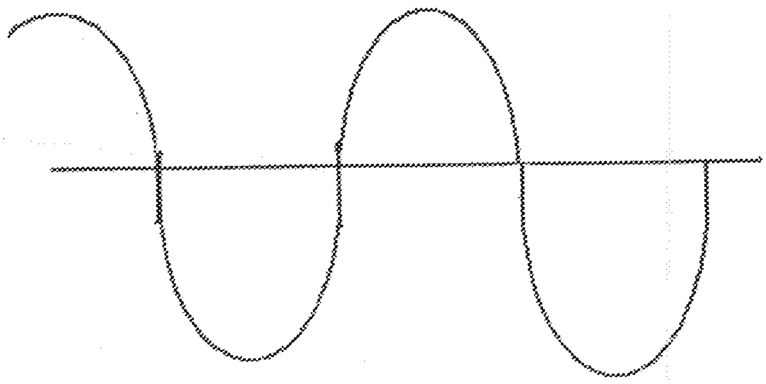


Figure 3.6

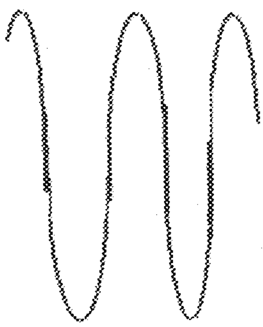


Figure 7

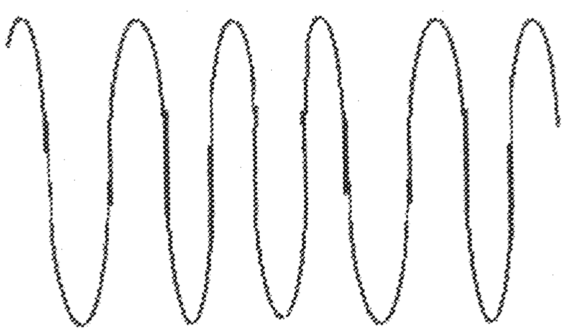


Figure 3.8

GENERATION AND SPECTRUM OF AN FM WAVE

Two types of FM can be distinguished, depending on the value of the modulation index β.

When β is very small ($\beta << 1$ radian) then we have narrow-band frequency modulation (NBFM).

When β is very high ($\beta >> 1$ radian) then we have wide band frequency modulation (WBFM).

NARROW BAND FM.

For Narrow band FM wave, using the mathematical expression.

$e_{fm}(t) = Ec \cos [Wct + \beta \sin Wmt]$

Applying the compared formula index and the series expansion.

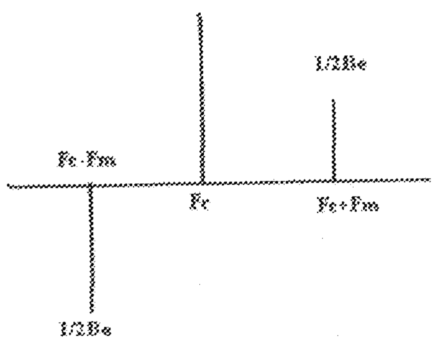
$e_{fm}(t) = Ec \cos Wct - \beta Ec \sin Wct. \sin Wmt$

since $\beta << 1$ rad

$\cos (\beta \sin Wmt) \equiv 1$

$\sin (\beta \sin Wmt) \equiv \beta \sin Wmt$

therefore $e_{fm}(t) = Ec \cos Wct + ½ \beta Ec \cos (Wc + Wm)t - ½ \beta Ec \cos (Wc - Wm)t$



Narrow side band FM spectrum

WIDE BAND FREQUENCY MODULATION (WBFM)

If the value of β is further increase beyond the WBFM region by increasing em or decreasing fm the amplitude of the frequency component at fc decreases and the result is more additional frequency components spaced at ±2fm, ±3fm etc. Thus causing an infinite number side –frequencies. WBFM contain the following frequency components.

i) The carrier frequency

ii) First order side frequencies, fc + fm

iii) The higher-order side frequencies fc ± nfm n = 2,3 …

The largest value of n depends on how large the value of β is. This means that the required transmission bandwidth is infinite. In practice, the expression that is generally used to determine the transmission bandwidth, B, occupied by a wide-band FM wave is the Carson`s formular

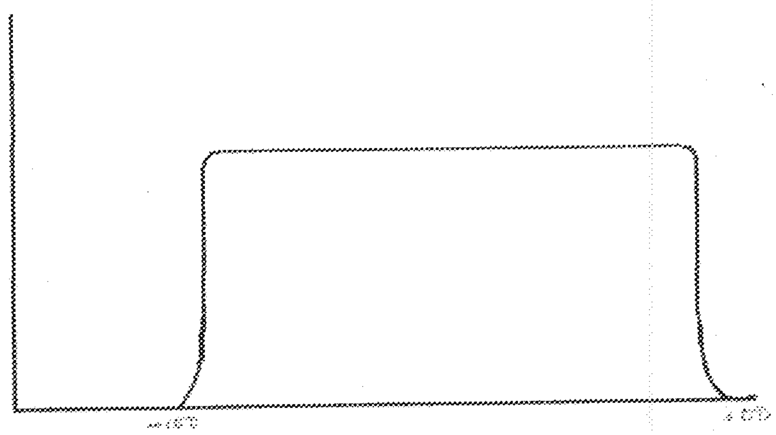
$B = 2(\Delta f + w)$

Δf = frequency deviation

W = bandwidth or maximum frequency component of the modulating signal.

SELECTIVITY

The selectivity of the radio receiver is its ability to determine the wanted signal and all the other signals pulsed up by the aerial, particularly the adjacent –channel signals. The selectivity of a receiver is usually quoted by means of a graph showing the output of the receiver in db relative to the maximum output plotted against the number of KHz off-time. Fig 3 shows a typical selectivity curve for FM broadcast receivers.



SENSITIVITY

The sensitivity of a radio receiver is its ability to pick up and reproduce weak signals. It is determined by the value of high-frequency voltage that must be fed to the receivers input in order to secure normal output power. The lower the necessary input voltage for normal operation the higher the sensitivity. Modern radio receivers sensitivity values range from several microvolts to several mill volts.

Higher sensitivity can be achieved by increasing the number of amplification stages at the same time units in order to reduce noise and distortion.

CHAPTER FOUR

CONSTRUCTION

Using a field effect transistor (FET BF245B) connected as shown below to from the regenerative amplifier and the detector. The source lead is connected to capacitor C2 in parallel with inductor L2, drain used connected to the inductor L1 lead.

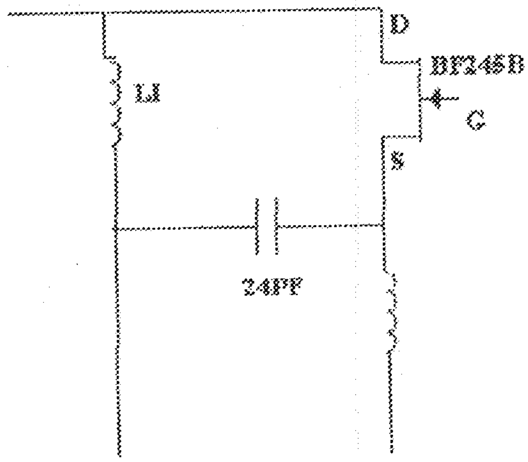


fig 4.1 Regenerative Amplifier

The function of L1 and L2 is to form the positive feedback to the amplifier.

The tuned circuit was constructed using a variable capacitor C3, capacitor C1 and inductor L1. The combination of C1, C3 and L1 form the tuned ciorcuit (oscillator tank) where L1 is the primary frequency selector, C3 is a used for secondary frequency selection.

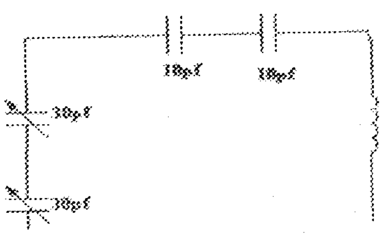


Fig 4.2 Oscillator Circuit

CONSTRUCTION OF BANDPASS FILTER

The connection of R4, C7 and L2 forms a band pass filter, where L2 acts ac the radio frequency choke. RFC functions as open circuit to resonant frequency and hence allows path for bias current but does not allow the power supply to short out the a.c signal. Capacitor C7 prevents direct current from flow to be tank.

$F_0 = 1/(2\prod\sqrt{LC})$

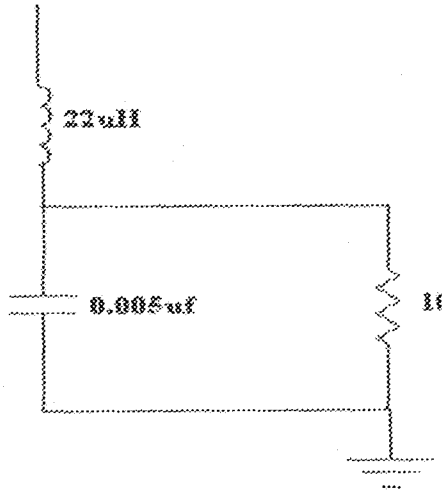


Fig 4.3 Band pass filter

$\frac{1}{2} * 3.14\sqrt{22 * 10^{-6} * 0.005 * 10^{-6}}$

= 480KHz

HIGH PASS AND LOW PASS FILTER

The circuit diagram below is a high pass and low pass filter respectively and by connecting as shown in the diagram .

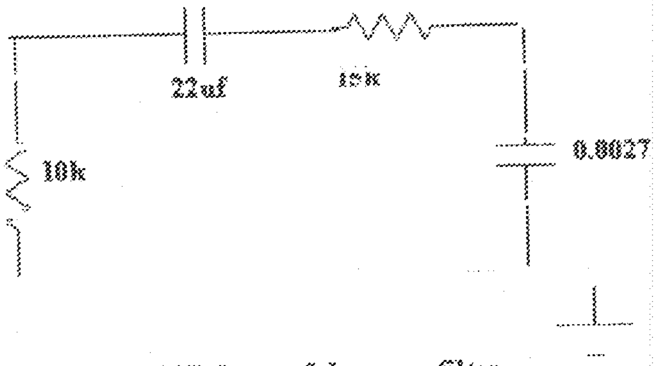


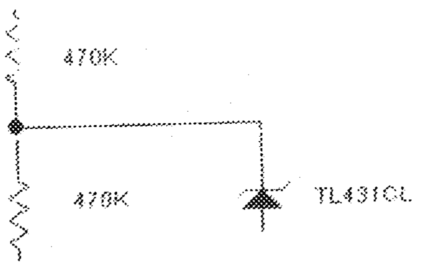
Fig 4.4 High pass & low pass filter

F= 1/2∏RC = 1 / 2 * 3.14 * 10000 * 22 * 10^{-6}

= 0.72Hz

AUDIO AMPLIFIER

The combination of R1 and R2 connected as shown in the fig 4.5 are used as voltage divider for the bias of D1 (TL431CL) which is serving as the audio amplifier.



Inductor L1 is a solid wire that was wound 6 turns on a panel, which is under ½ inch in diameter. After winding, it was removed and spread to make a length of ¾ inch.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

In this project, I presented hat the principle of operation of FM receiver is based on the conversion of all incoming radio frequency signals to INTERMEDIATE FREQUENCY (IF), which is kept fixed.

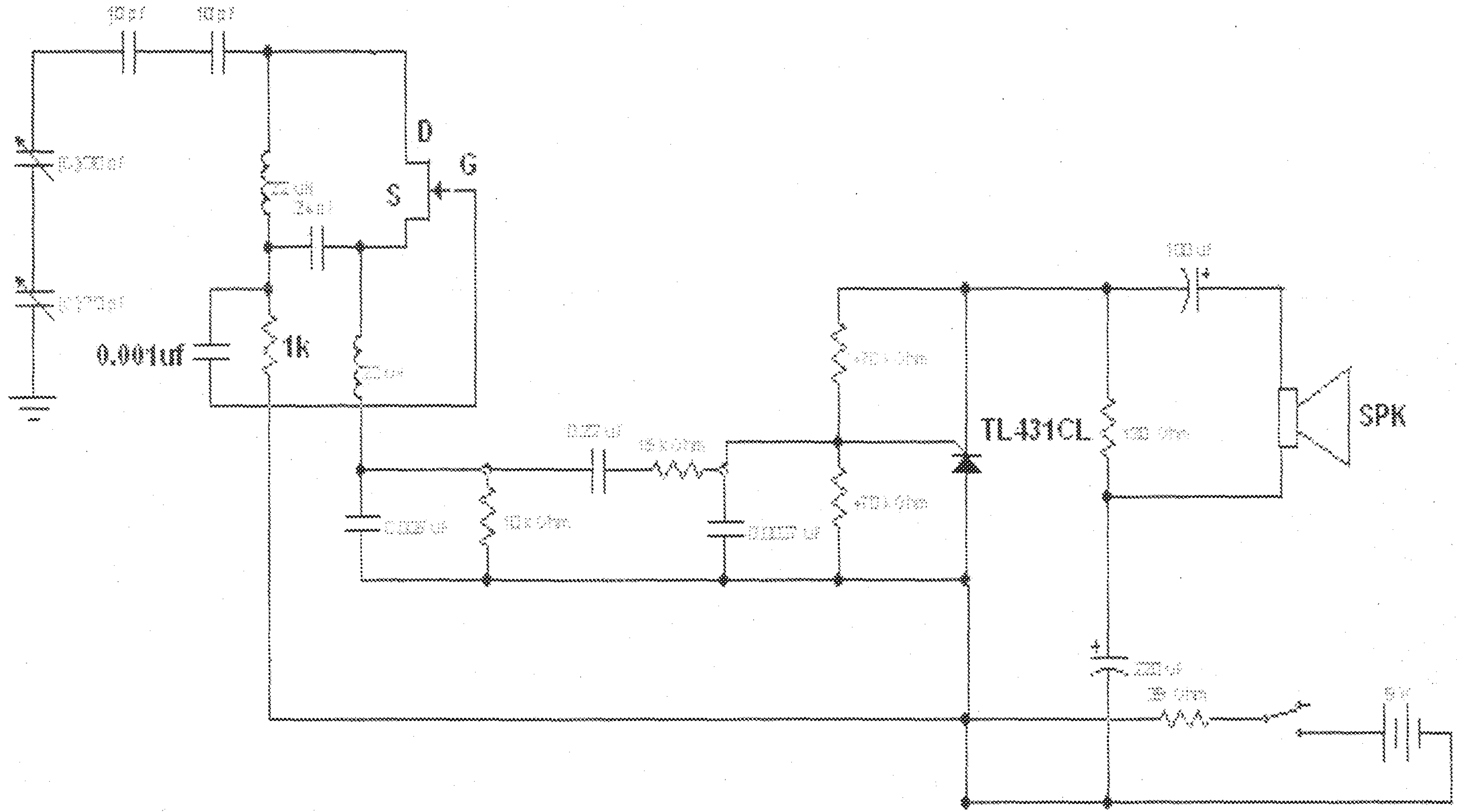
Amplifiers used in radio receivers circuit operate with maximum stability , selectivity and sensitivity.

The RF amplifier selects the required frequency band signals from the various signals intercepted by the antenna. The amplified RF is coupled to the input of a mixer stage which mix together two frequency signals. Mixer circuit is so defined that it can conveniently combine two radio frequencies. One fed into it by RF amplifier and the other by a local oscillator.

The local oscillator is an RF oscillator whose frequency of oscillation can be controlled by varying the capacitance of its capacitor. Hence, the timing capacitor of the oscillator is ganged with capacitor of the input circuit so that the difference in the frequency of the selected signal and oscillator frequency is always constant.

5.2 RECOMMENDATION

One of the problems with construction of FM receiver is tuning to a particular station when a discrete component is used. The use of integrated circuits (IC) for construction of digital fm receiver should be a topic for future project.



CIRCUIT DIAGRAM FOR THE FM RECEIVER

Reference:

1. Alex Romanonity & Russelle Puckett

Introduction to electronics second edition

Wiley International edition pp404-408

2. A. Bruce Carlson

Communication systems: An Introduction to signals and noise in electrical communication

Third edition 1986 pp 232-233, 285

3 H.G. Brierley

Telecommunication engineering 1986, Edward Arnold series

pp197-201

4. Clayton R. Paul

Electromagnetic compatibility Wiley series in microwave & optical engineering

pp43 – 45

5. Ralph J. Smith & Richard C. Dorf

Circuit devices and systems fifth edition

John Wiley and Sons inc pp557

6. Moms Shuraberg, William Osterfheld

Essentials of communication electronics

Third edition Mcgraw-Hill Book Company

Pp 689-717

7 P.H. Smale

Telecommunication systems second edition

pp 21-22 pitman press

8 Betls J.A

Signal processing modulation and noise pp34-40

9. D.C. Green radio systems for technicians

Pp18-19, 168-197

10. Dr Y.A. ADEDIRAN

Telecommunication principle