SUPERHETERODYNE AM RADIO

Project Report submitted in partial fulfillment of the requirement for the degree of

Bachelor of Technology

In

Electronics and Communication Engineering

Under the Supervision of

Prof. Dr Sunil V. Bhooshan

By

Chencho Dorji (081147)

Tashi Dorji (091066)

Pema Namgyel (091067)

To

विद्या तत्त्व ज्योतिसम

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

Jaypee University of Information and Technology

Waknaghat, Solan – 173234, Himachal Pradesh

Certificate

This is to certify that project work entitled "Superheterodyne AM Radio" submitted by Chencho Dorji(081147),Tashi Dorji(091066),Pema Namgyel(091067) in partial fulfillment for the award of degree of Bachelor of Technology in Electronics and Communication Engineering to Jaypee University of Information Technology, Waknaghat, Solan has been carried out under my supervision.

This work has not been submitted partially or fully to any other University or Institute for the award of this or any other degree or diploma.

PROJECT SUPERVISOR

Prof. Dr. Sunil Bhooshan

Head of Department

Department of Electronics and Communication, JUIT

Date:

Acknowledgement

We would like to take this opportunity to express our sincere gratitude and thanks to all those who helped in the progress of the project entitled "Superheterodyne AM Radio". Of all the persons who helped us,we would first of all like to thank Prof. Sunil Bhooshan, under whose able guidance we have worked on our project.

Date:

Name of the students:

Chencho Dorji(081147)

Tashi Dorji(091066)

Pema Namgyel(091067)

B.Tech(ECE)

Jaypee University of Information Technology

Table of Contents

Certificate……………………………………………………………i

Acknowledgement……………………………………………………ii

List of figures………………………………………………………iv

Abstract………………………………………………………………vi

CHAPTER 1: GENERATION OF AM WAVE……………………………1

CHAPTER 2: SINGLE TUNED RF AMPLIFIER…………………………5

CHAPTER 3: LOCAL OSCILLATOR DESIGN……………………………9

3.1 The Amplifier Stage……………………………………10

3.2 The Feedback Network…………………………………14

3.3 The Complete Local Oscillator Stage……………………16

CHAPTER 4: MIXER DESIGN……………………………………………19

CHAPTER 5: IF AMPLIFIER DESIGN……………………………………22

CHAPTER 6: DEMODULATION OF AM WAVE……………………………27

CHAPTER 7: AUDIO AMPLIFER…………………………………………29

CONCLUSION……………………………………………………………32

BIBLOGRAPHY…………………………………………………………33

APPENDIX: SOFTWARE USED…………………………………………34

List of Figures

Fig 1 Superheterodyne Receiver Model vii
Fig 1.1 Amplitude Modulator 3
Fig 1.2 AM waveform 4
Fig 1.3 AM spectral response 4
Fig 2.1 Single tuned RF amplifier 6
Fig 2.2 RF Input Output waveform 8
Fig 2.3 RF amplifier frequency response 8
Fig 3.1 Feedback model for oscillator 9
Fig 3.2 FET circuit for obtaining Transfer Characteristic 10
Fig 3.3 Transfer Characteristic of FET 11
Fig 3.4 Amplifier Stage 12
Fig 3.5 Input Output Voltages of Amplifier Stage 13
Fig 3.6 Beta Network 14
Fig 3.7 Beta network circuit response 15
Fig 3.8 Local Oscillator (Amplifier stage and Beta network) 16
Fig 3.9 LO output 18
Fig 3.10 Spectrum of LO output 18
Fig 4.1 Mixer 19
Fig 4.2 Mixer circuit 21
Fig 4.3 Mixer output waveform 21
Fig 5.1 IF amplifier 23

Fig 5.2 Input waveform 25
Fig 5.3 Output waveform 25
Fig 5.4 IF resonant curve 26
Fig 6.1 Envelope Detector 27
Fig 6.2 Envelope Detector circuit 28
Fig 6.3 Demodulated AM waveform 28
Fig 7.1 Audio amplifier circuit 30
Fig 7.2 Audio amplifier output waveform 31

Abstract

Advances in technology have given people more ways to access an increasing amount of information worldwide. Radio broadcasts can provide real-time information, broadcasted 24 hours a day to provide the most recent updates to listeners. Stations have the ability to reach across borders and become a source of information where reliable news is scarce. Radio remains accessible when other modes of communication go down in emergencies and has proved to be easily accessible source of information during disasters and natural calamities.

The basic requirement for any communications receiver is to have the ability to select a signal of desired frequency, while rejecting closely adjacent frequencies (Selectivity) and provide sufficient amplification to recover the modulating signal (Sensitivity). A receiver with good selectivity will isolate the desired signal in the RF spectrum and eliminate all other signals. This can be achieved using tuned LC circuits resonating at the desired frequency. LC circuits with a high Q value have narrower bandwidths and hence have better selectivity.

Recent development in the field of technology has gave birth to integrated circuit(IC) approach in designing circuits with specific functionality. However in our project entitled "Superheterodyne AM Radio", we have designed circuits using basic electronic components (like transistors, diode, resistors, capacitors and inductors) inorder to learn the circuit design mechanism rather than circuit connection.

There are two types of communications receiver; the Tuned Radio Frequency (TRF) receiver and the Superheterodyne receiver. Although the TRF system is a straightforward concept at high frequencies it becomes difficult to build, is less efficient, has small gain and suffers bandwidth changes. For these reasons among others the Superheterodyne receiver has become the model for all receivers; AM, FM, television, satellite, radar etc. It was developed during WW1 by Edwin Armstrong but did not become popular until the 1930s.

The block diagram of a superheterodyne receiver is given below.

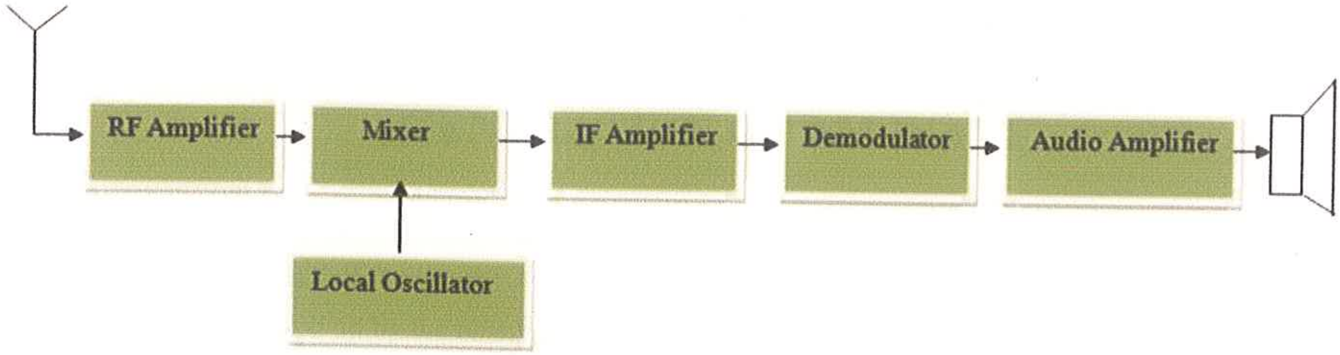

Fig 1 Superheterodyne Receiver Model

Firstly we designed a circuit for AM wave generation with a carrier frequency of 1MHz and a modulating frequency of 5kHz (i.e. a 10kHz bandwidth). The AM signal was fed to an RF amplifier via an antenna for signal amplification and the resonant frequency was set to 1MHz. A signal was generated at the local oscillator stage having a frequency of 1455KHz and when "mixed" or heterodyned with the RF signal produced the difference or intermediate frequency. This difference frequency at 455kHz was amplified by the IF stages (most of the sensitivity and selectivity found here). The IF stage is resonating at 455KHz. The AM detector now detected this signal. The detector also detected the modulating frequency at 5kHz. The audio amplifier amplified both the difference frequency and the modulating frequency in order to drive the loud speaker.

CHAPTER 1

GENERATION OF AM WAVE

The first stage of the project is to generate an AM signal and to simulate this signal, which is to be picked up by the receiving antenna.

Modulation is the process of changing some characteristics (e.g. amplitude, frequency or phase) of a carrier wave in accordance with the intensity of the signal is known as *modulation.*

In Amplitude Modulation the amplitude of the carrier wave varies in accordance with the amplitude of the modulating signal and the carrier frequency and phase remain unaffected. An increase or decrease in the amplitude of the modulating signal causes a corresponding change in the carrier amplitude. The pattern of amplitude variations is known as the envelope. The information is carried in the envelope and an AM demodulator or envelope detector recovers the information from the envelope. The amplitude of the modulating signal (E_m) must be less than the amplitude of the carrier signal (E_c). The relationship between the two is called the Modulation Index (m).

$$m = \frac{E_m}{E_c}$$

This has values between 0 and 1.

Values over unity, called over-modulation, (i.e. $E_m > E_c$) lead to distortion and loss of information. The instantaneous amplitude value of a carrier modulated by a sinusoidal signal is given as (in volts):

$$y(t) = [E_c + E_m cos2\pi f_m t]cos2\pi f_c t$$

$$y(t) = [E_c cos2\pi f_c t] + E_m cos2\pi f_m t cos2\pi f_c t$$

From the expression $cosA\ cosB = [\frac{1}{2}(cosA - B) + cos(A + B)]$

we get (in volts):

$$y(t) = E_c cos2\pi f_c t + \frac{E_m}{2} cos2\pi(f_c - f_m)t + \frac{E_m}{2} cos2\pi(f_c + f_m)t$$

$$y(t) = E_c cos2\pi f_c t + \frac{mE_c}{2} cos2\pi(f_c - f_m)t + \frac{mE_c}{2} cos2\pi(f_c + f_m)t$$

The AM signal contains three components. The first component is the original (unmodulated) carrier wave and the other two are the Sidebands (Upper SB and Lower SB), located symmetrically on either side of the carrier.

In an AM signal the information is carried in the sidebands only and both sidebands are identical in information content. Therefore transmission of an AM signal with all its information requires transmission of a range of frequencies from the lower sideband to the upper sideband. The bandwidth is:

$$Bandwidth = BW = (f_c + f_m) - (f_c - f_m) = 2f_m$$

The figure shows the electronics circuit of a simple am modulator. It is essentially a CE amplifier having a voltage gain of A. The carrier signal is the input to the amplifier. The modulating signal is applied in the emitter resistance circuit.

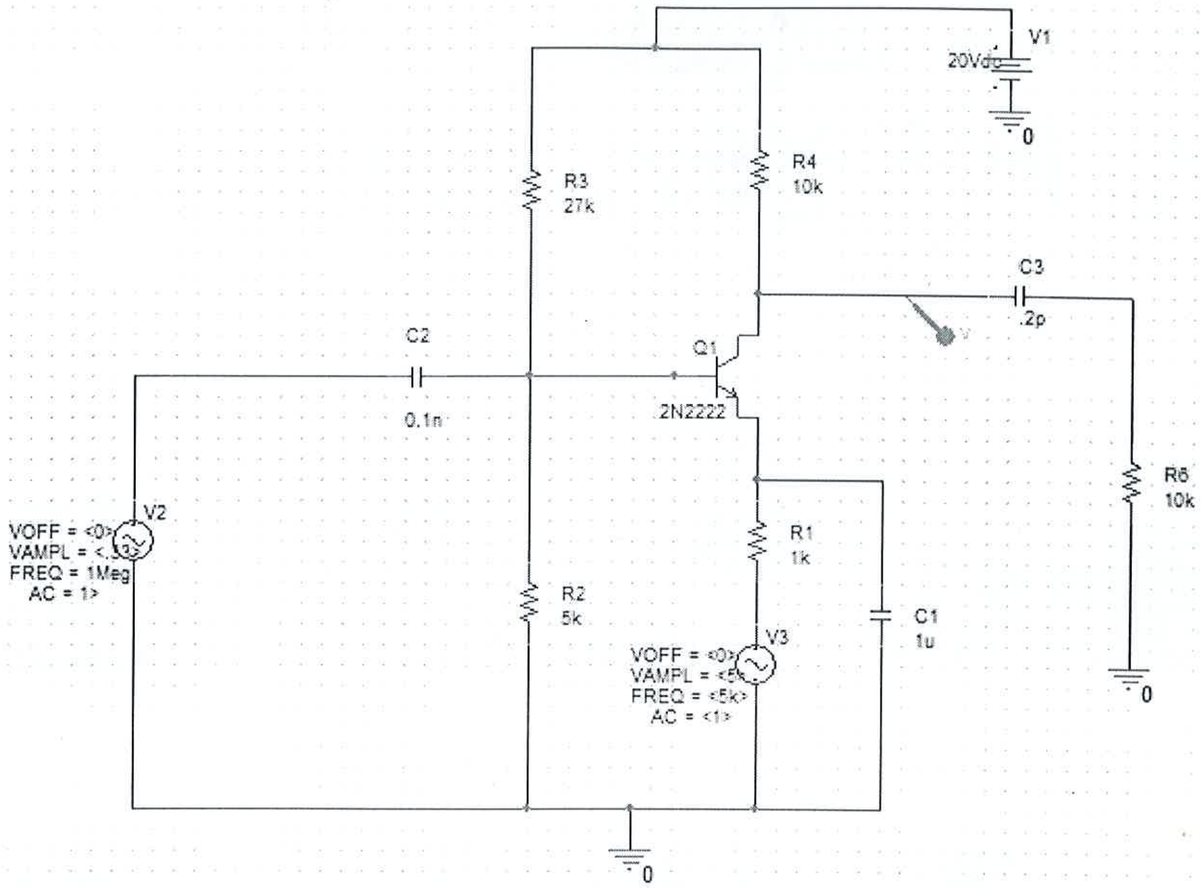

Fig 1.1 Amplitude Modulator

The carrier(V2 as seen on the above circuit) is applied at the input of the amplifier and the modulating signal(i.e V3) is applied in the emitter resistance circuit.

The amplifier circuit amplifies the carrier by a factor A, so that the output is A_{es}. Since the modulating signal is a part of the biasing circuit, it produces low frequency variations in the emitter circuit. This in turn causes variations in "A".

The result is that amplitude of the carrier varies in accordance with the strength of the signal. Consequently, amplitude modulated output is obtained across R_L. It may be noted that carrier should not influence the voltage gain A; only the modulating signal should do this. To achieve this objective, carries should have a small magnitude and signal should have a large magnitude.

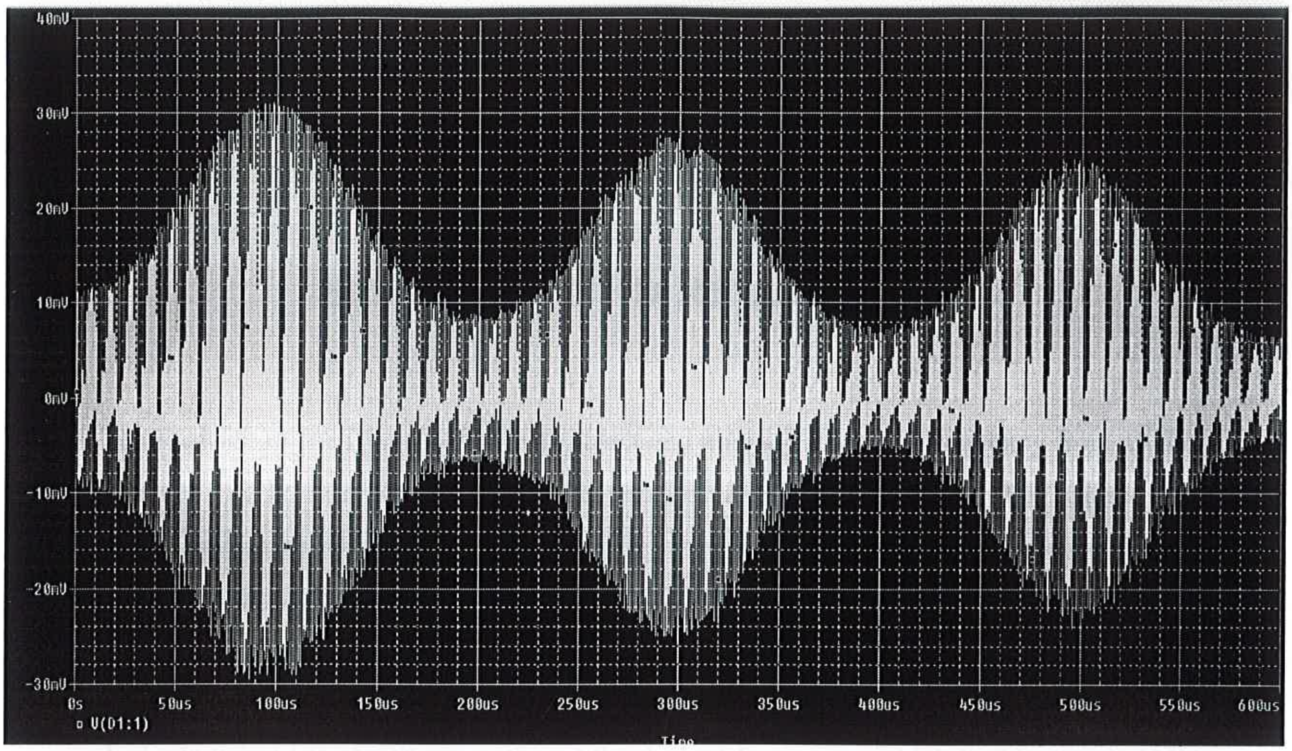

Fig 1.2 AM Waveform

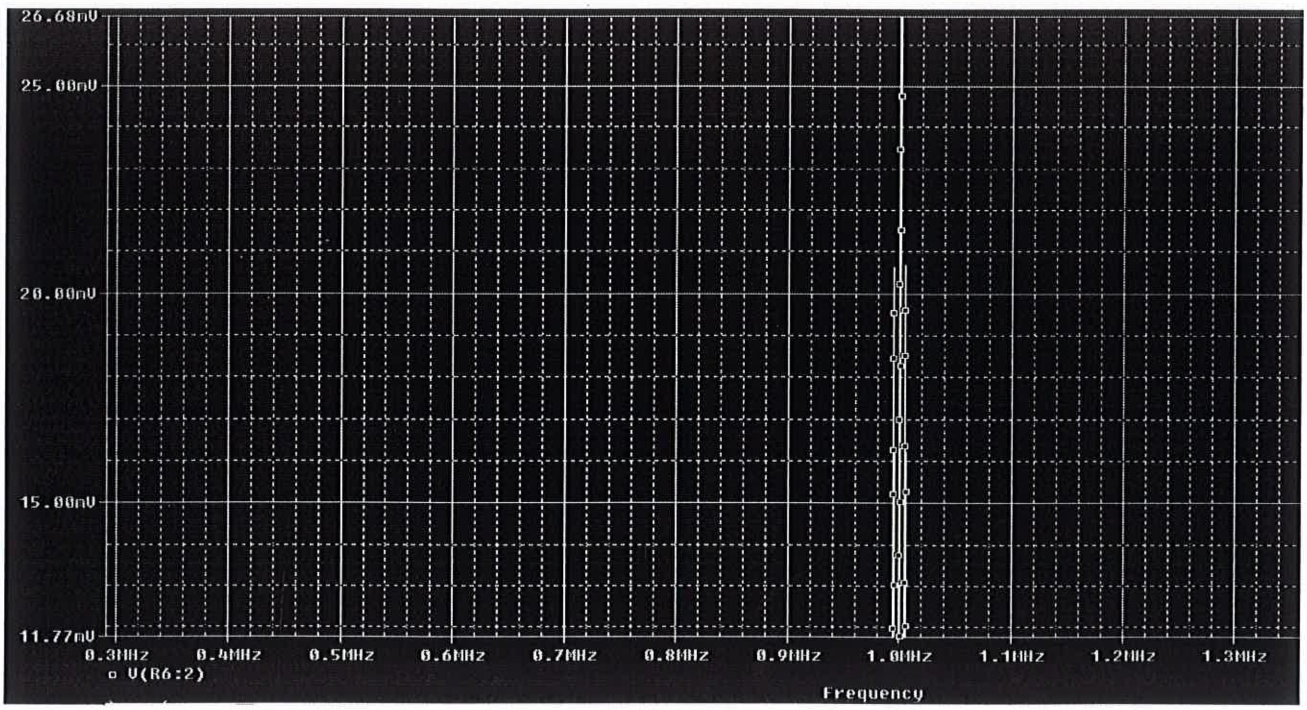

Fig 1.3 AM spectral response

CHAPTER 2

SINGLE TUNED RF AMPLIFIER

The function of the RF amplifier is to select and amplify a desired frequency from all those received while rejecting all other frequencies. Figure 2.1 shows a BJT single stage configured as an RF amplifier with a single tuned load. Since it is a tuned amplifier, it is highly frequency selective and attenuates sufficiently all signals but not the one to which it is tuned. The amplified AM signal from the RF amplifier is then fed to the mixer where it is combined with the output from the local oscillator.

A single tuned LC circuit resonating at the desired frequency, which in this case is 1MHz, forms the load. The RF amplifier should have a –3dB bandwidth of 10kHz in,order that the entire AM signal is passed. The AM signal has a bandwidth of 10kHz, therefore an RF amp with a –3dB bandwidth of 10kHz resonant at 1MHz will pass both sidebands and the carrier.

$$Q = \frac{f_0}{BW} = \frac{10^6}{10 * 10^3} = 100$$

$$\frac{\omega_0 L}{R_S} = 100$$

$$\frac{L}{R_S} = \frac{100}{2\pi * 10^6}$$

Assuming $R_S = 2\Omega$ (a very small resistance)

$$L = \frac{100 * 2}{2\pi} = 32uH$$

Since the Q factor is greater than 10 we can say that:

$$f_0 \cong 1/(2\pi\sqrt{LC})$$

Therefore: $C = 1/(4\pi^2 f_0^2\ L) = 710pF$

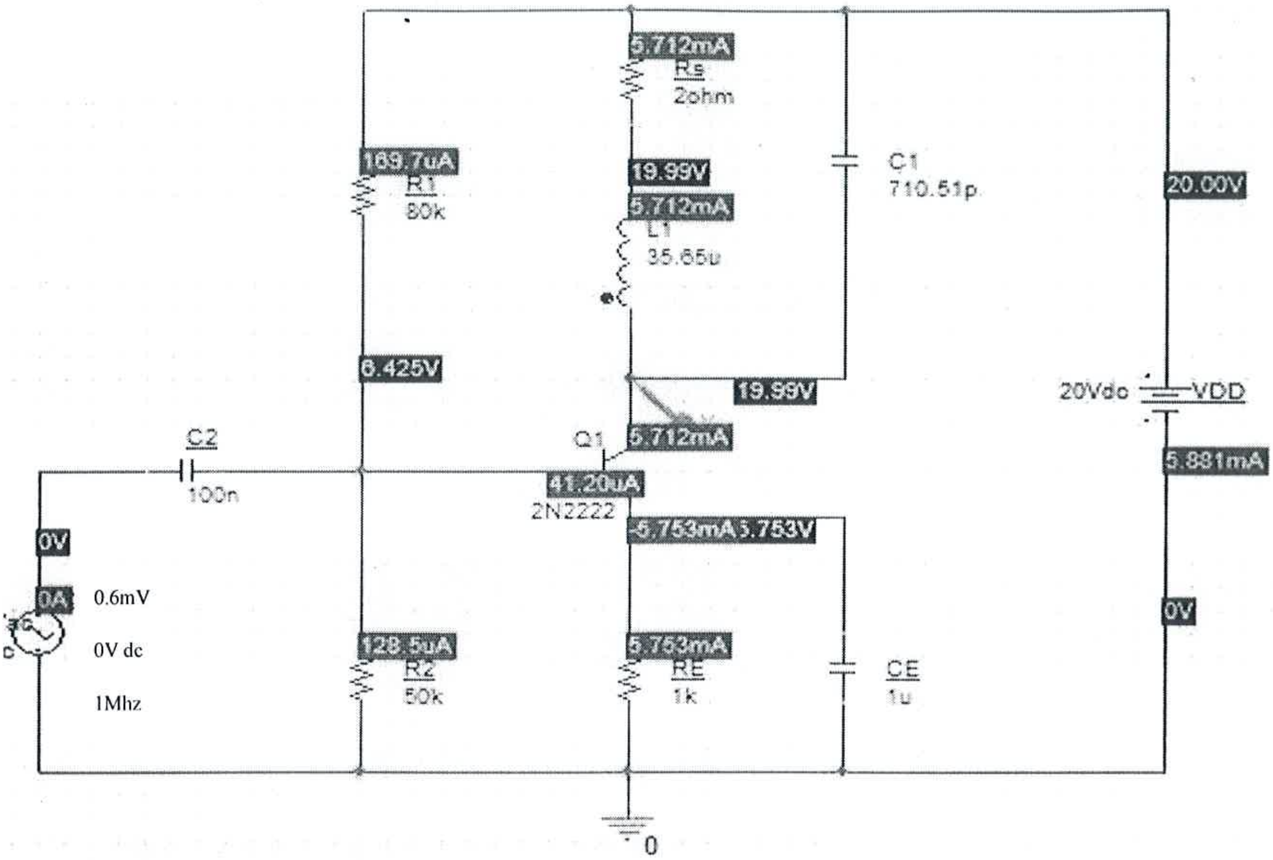

Fig 2.1 Single tuned RF amplifier

In the Pspice library Q2N2222 refers to an NPN transistor. The dc bias voltage forward biases the base emitter junction and reverse biases the base collector junction.

The ratio of dc collector current, I_C , to dc base current, I_B , is called the dc beta, β_{DC}, which is the dc current gain of the transistor (typical values range from 20 to 200 or higher). Taking current values from Pspice:

$$\beta_{DC} = \frac{I_C}{I_B} = \frac{5.712 * 10^{-3}}{41.20 * 10^{-6}} = 138.64$$

The ratio of I_C to dc emitter current, I_E, is the dc alpha, α_{DC} (this value is always less than 1).

$$\alpha_{DC} = \frac{I_C}{I_E} = \frac{5.712 * 10^{-3}}{5.753 * 10^{-3}} = 0.992$$

Other important dc conditions include:

$$V_B = \frac{R_2}{R_1 + R_2} V_{DD} = \frac{50k}{80k + 50k} 20V = 7.7V$$

$$V_E = V_B - V_{BE} = (7.7 - 0.7)V = 7V$$

$$I_E = \frac{V_E}{R_E} = \frac{7V}{1K} = 7mA$$

The internal resistance of the transistor: $r_e^{'} = 25mV/I_E = 3.6$

Voltage gain: $A_V = {}^{V_0}/_{V_{IN}} = {}^{R_L}/_{r_e^{'}} = {}^{L1/C1Rs}/_{r_e^{'}} = 6259.78$

where the load resistance is the dynamic impedance of the tuned LC circuit.

The voltage gain expressed in dBs: 20log(6259.78) =76 dB.

Power gain = current gain X voltage gain = 138.64 X 6259.78 = 867855.9

Input Impedance of the transistor: $R_{IN} = {}^{V_B}/_{I_B} = {}^{7.7V}/_{41.20 * 10^{-6}} = 187K\Omega$

$$R_{IN}^{Total} = R1 \parallel R2 \parallel R_{IN} = 80K \parallel 50K \parallel 187K = 26.4K\Omega$$

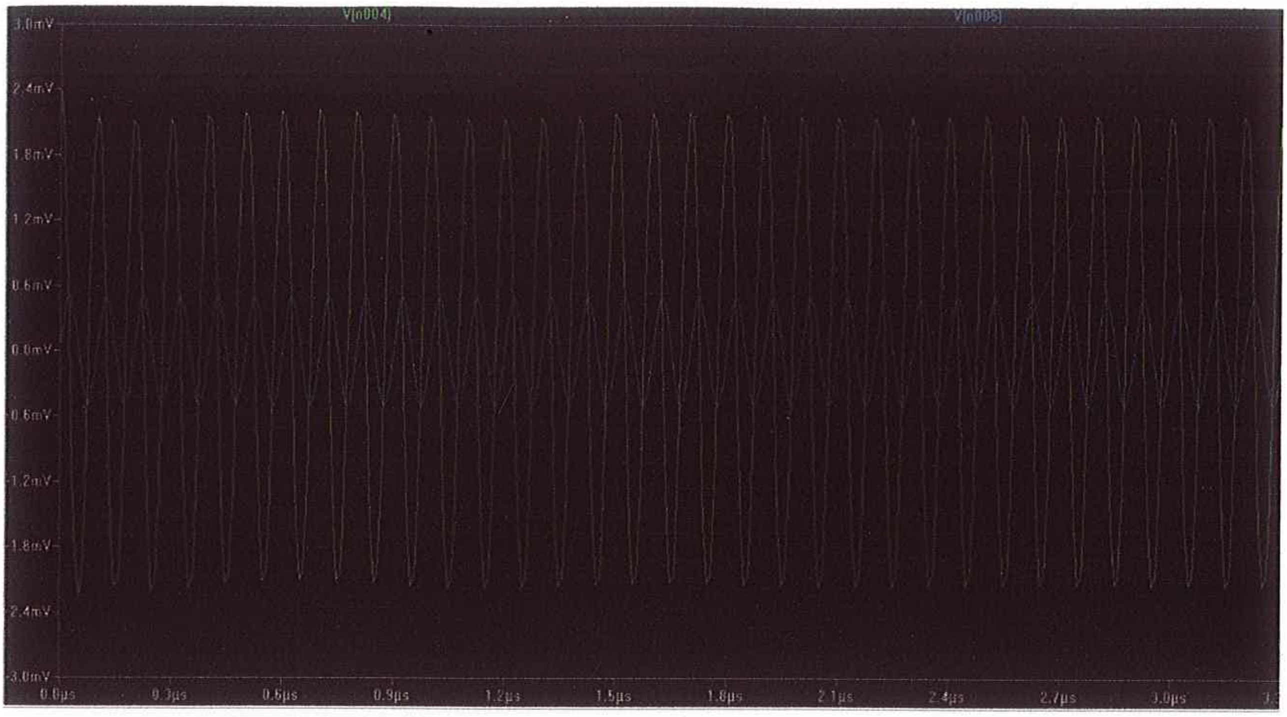

Fig 2.2 RF input output waveform

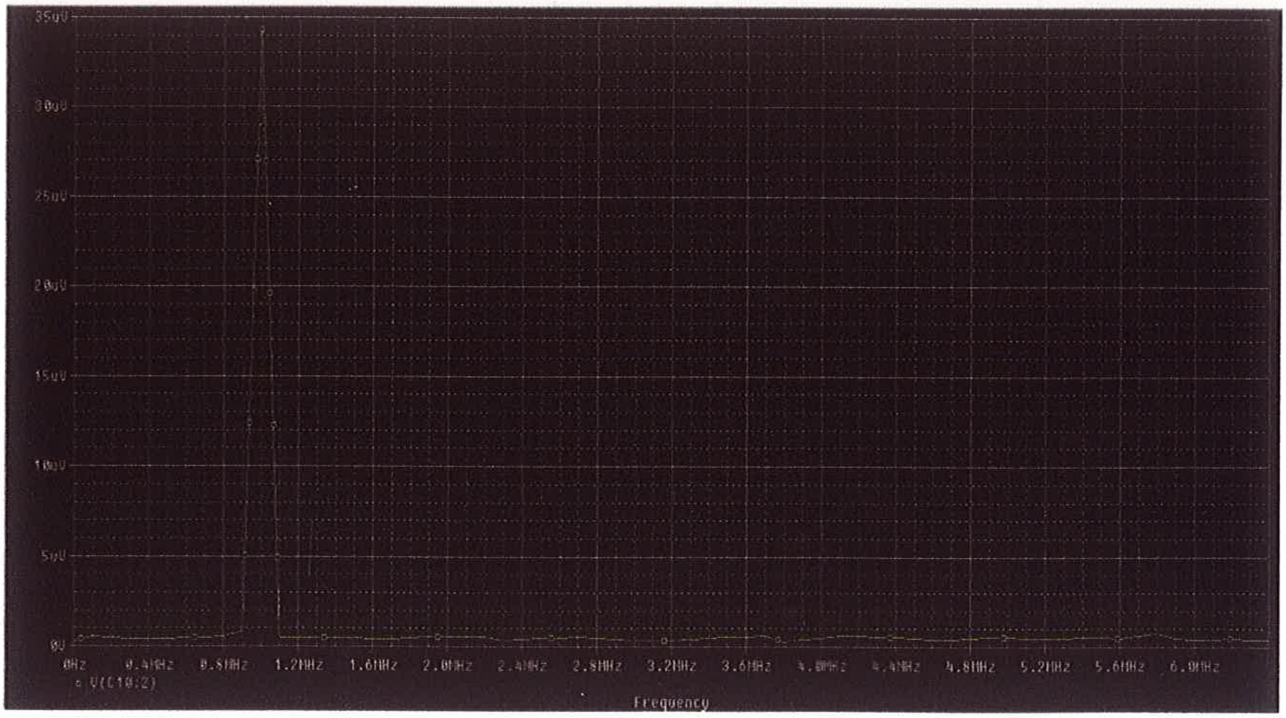

Fig 2.3 RF amplifier frequency response

CHAPTER 3

LOCAL OSCILLATOR DESIGN

An oscillator is a feedback system which conforms to, two criteria (the Barkhausen criteria):

1. The feedback signal must be in phase with the original input signal at the loop closure point (the total phase around the loop should be 0 or 360 degrees), and
2. The overall steady state gain around the feedback loop must be equal to or greater than unity (A β)

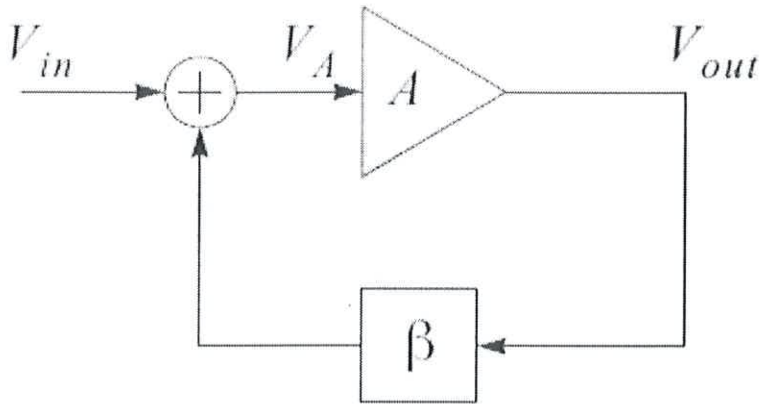

Fig 3.1 Feedback model for oscillator

The transfer function for the amplifier with feedback can be calculated using the following equation

$$V_{out} = A * V_A$$

$$V_A = V_{IN} + \beta * V_{out}$$

$$A_f = V_{out} / V_{IN} = A/(1 - \beta * A)$$

If $|A*\beta| = 1$ and $\angle(A*\beta) = 0°$ the feedback gain will become infinite and the system will perform continuous oscillation.

3.1 The Amplifier Stage:

The amplifier is obtained using a FET. To calculate the gain of the amplifier the transfer characteristic of the FET shown below in Fig 3.2 is plotted. It was assumed that the drain-source resistance of the FET is much greater than the load so no loading takes place. A value for the transfer transconductance, g_m can be obtained. This value is important since the gain of the amplifier stage above is given by,

$$V_{out} = -g_m V_{gs} R_L$$

$$A_v = \frac{V_{out}}{V_{gs}}$$

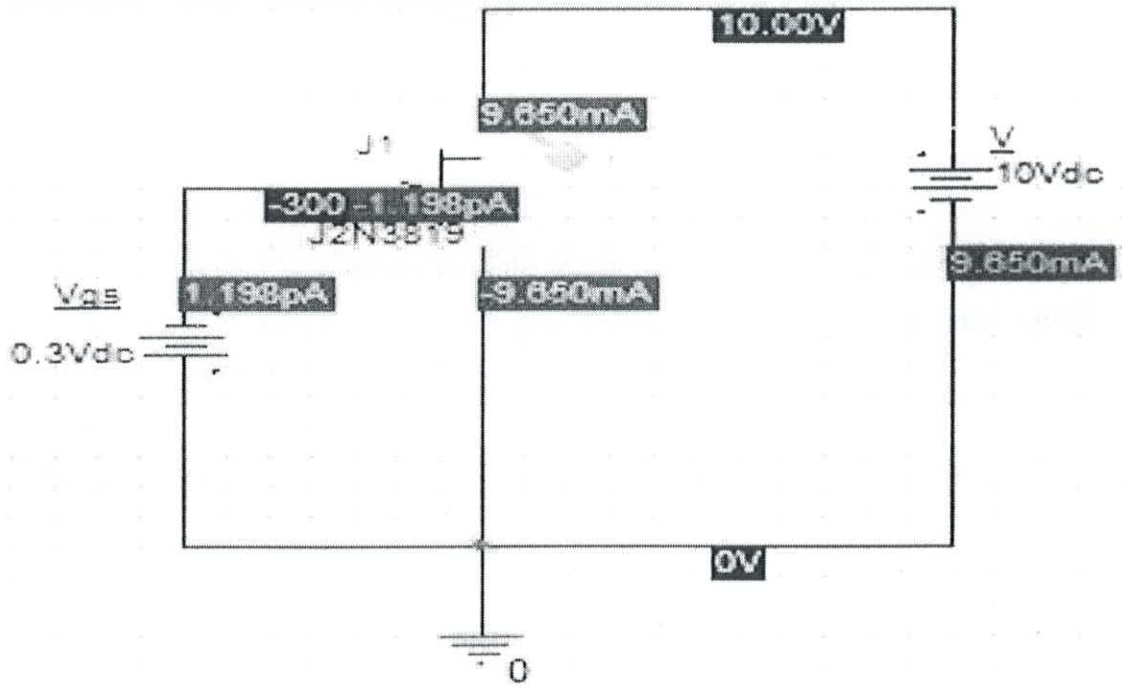

Fig 3.2 FET circuit for obtaining Transfer Characteristic

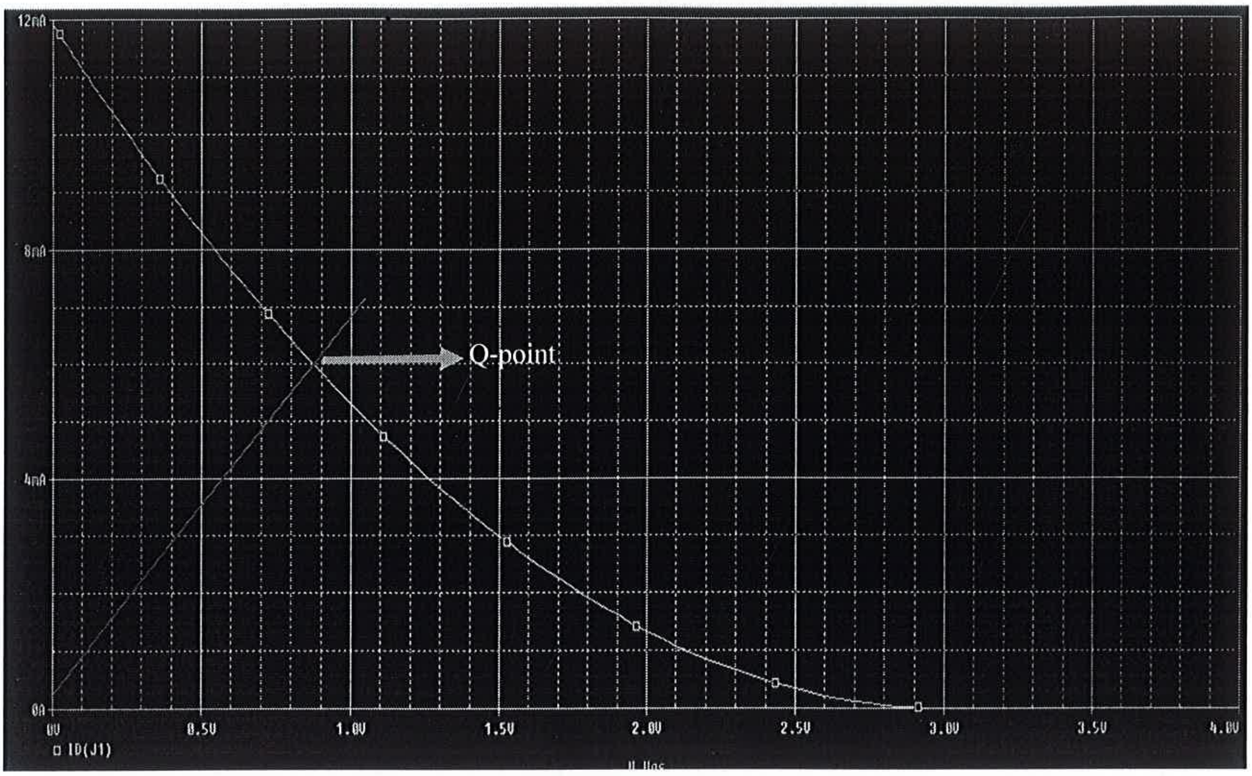

Fig 3.3 Transfer Characteristic of FET

Several parameters may be obtained from the transfer characteristic. The cut off voltage is 3V and the drain to source current with gate shorted (i.e. the maximum drain current regardless of the external circuit) is 12mA.

$V_{G_{OFF}} = 3\text{V}$

$I_{DSS} = 12\text{mA}$

To allow a maximum drain current swing (i.e. between I_{DSS} and 0) the FET is biased at the midpoint of the curve (i.e. where $I_D = \frac{I_{DSS}}{2}$). Therefore I_{DSQ} is chosen to be 6mA. The self-bias dc load line is drawn through the Q point. The transconductance, g_m, is the change in drain-source current for a given change in gate-source voltage with the drain-source voltage constant. In other words is the inverse of the slope of the load line.

The transconductance:

$$g_m = \frac{\Delta I_{DS}}{\Delta V_{GS}}$$

$$g_m = \frac{8*10^{-3}-4*10^{-3}}{1.26-0.542} = 5.56mS$$

The gain of the amplifier:

$$|A_V| = g_m R_L = 5.56 * 10^{-3} * 1 * 10^{-3} = 5.56$$

The frequency of the Local Oscillator is equal to the frequency of the RF (1MHz) plus the frequency of the IF (Already stated that the standard value is 455kHz).

The FET in amplifier stage is shown below:

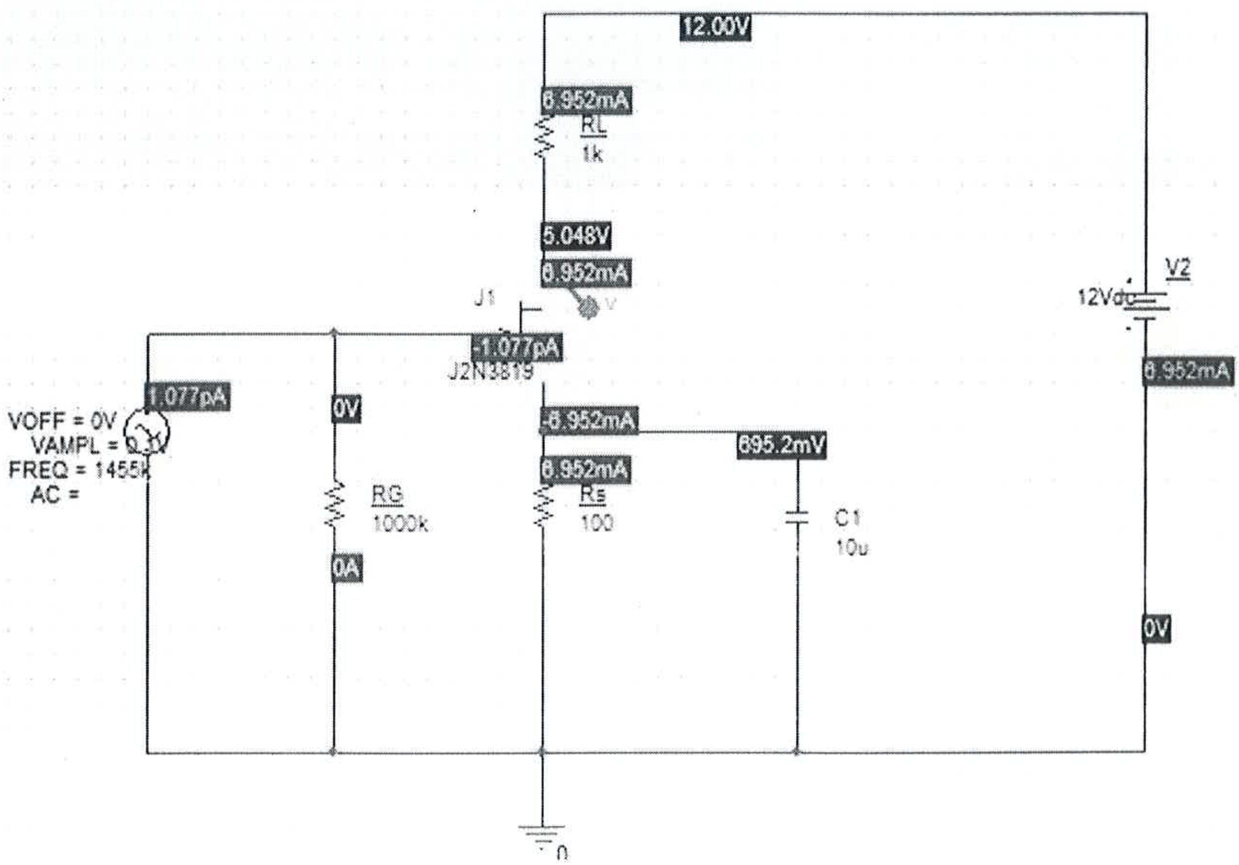

Fig 3.4 Amplifier Stage

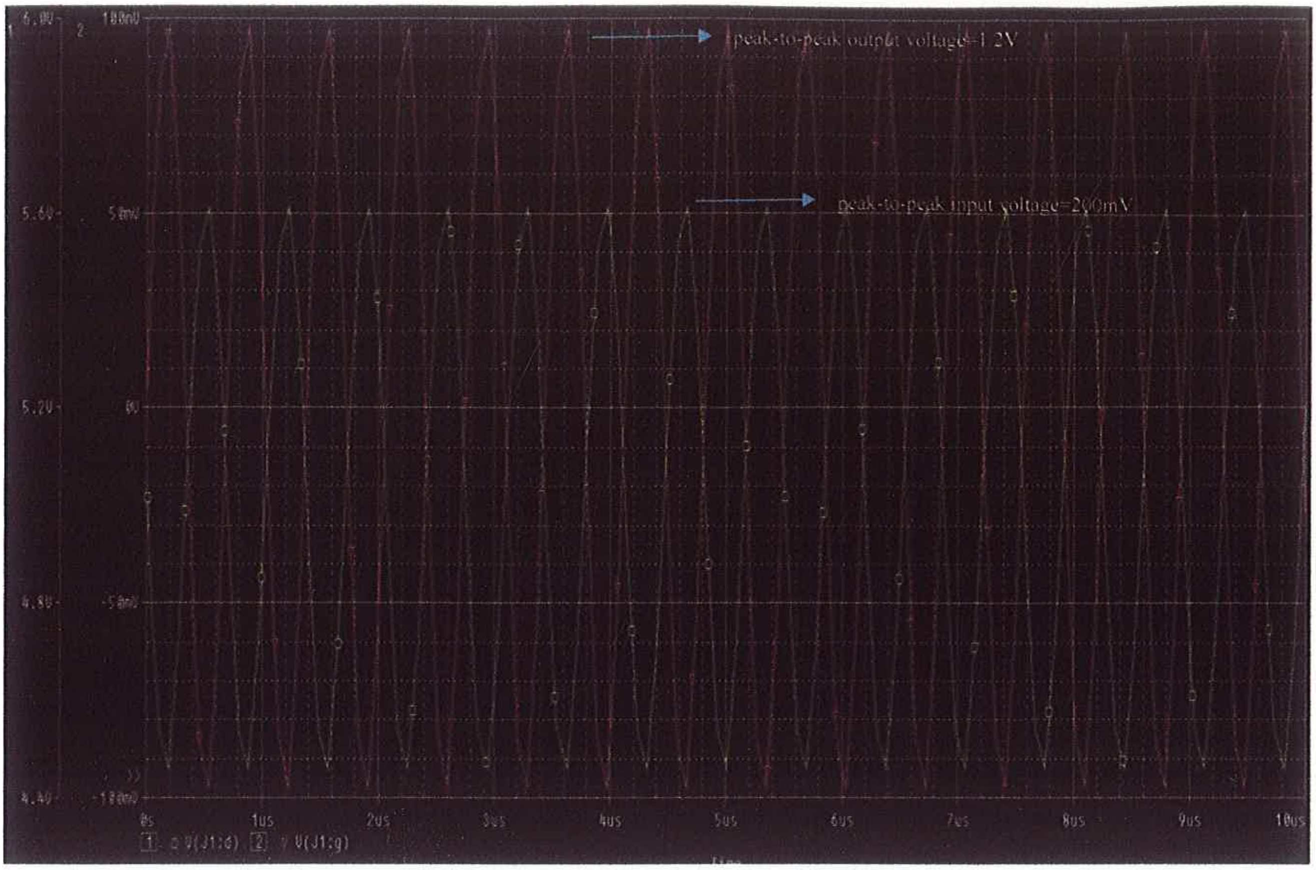

Figure 3.5 Input Output Voltages of Amplifier Stage

3.2 The Feedback Network:

The beta network is shown in the figure below,

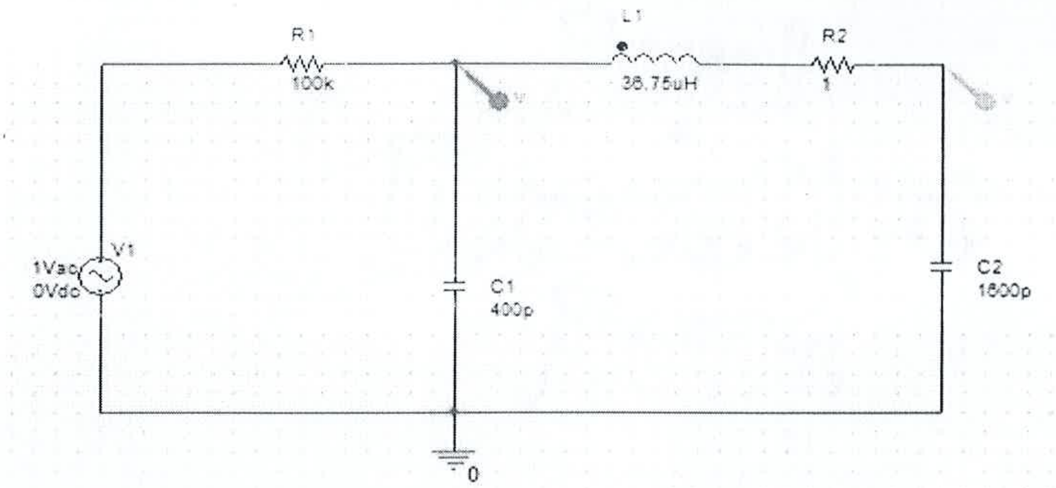

Fig 3.6 Beta Network

Using the potential divider principle the transfer function of this network is given by:
(Note: R2 may be ignored since: $R2 \ll j\omega L$)

$$\beta = \frac{\frac{1}{j\omega C_2}}{j\omega L + \frac{1}{j\omega C_2}} = \frac{1}{j\omega L\omega C_2 + 1} = \frac{1}{1 - \omega^2 LC_2}$$

However the total capacitance has to be taken into consideration for the resonance frequency,

$$C_T = C_1 + C_2$$

Substituting for $\omega^2 = \frac{1}{LC_T}$

$$\beta = \frac{1}{1-{}^{1}/_{LC_T}LC_2} = \frac{1}{1-\frac{C_2}{C_1+C_2}} = \frac{C_1+C_2}{C_1}$$

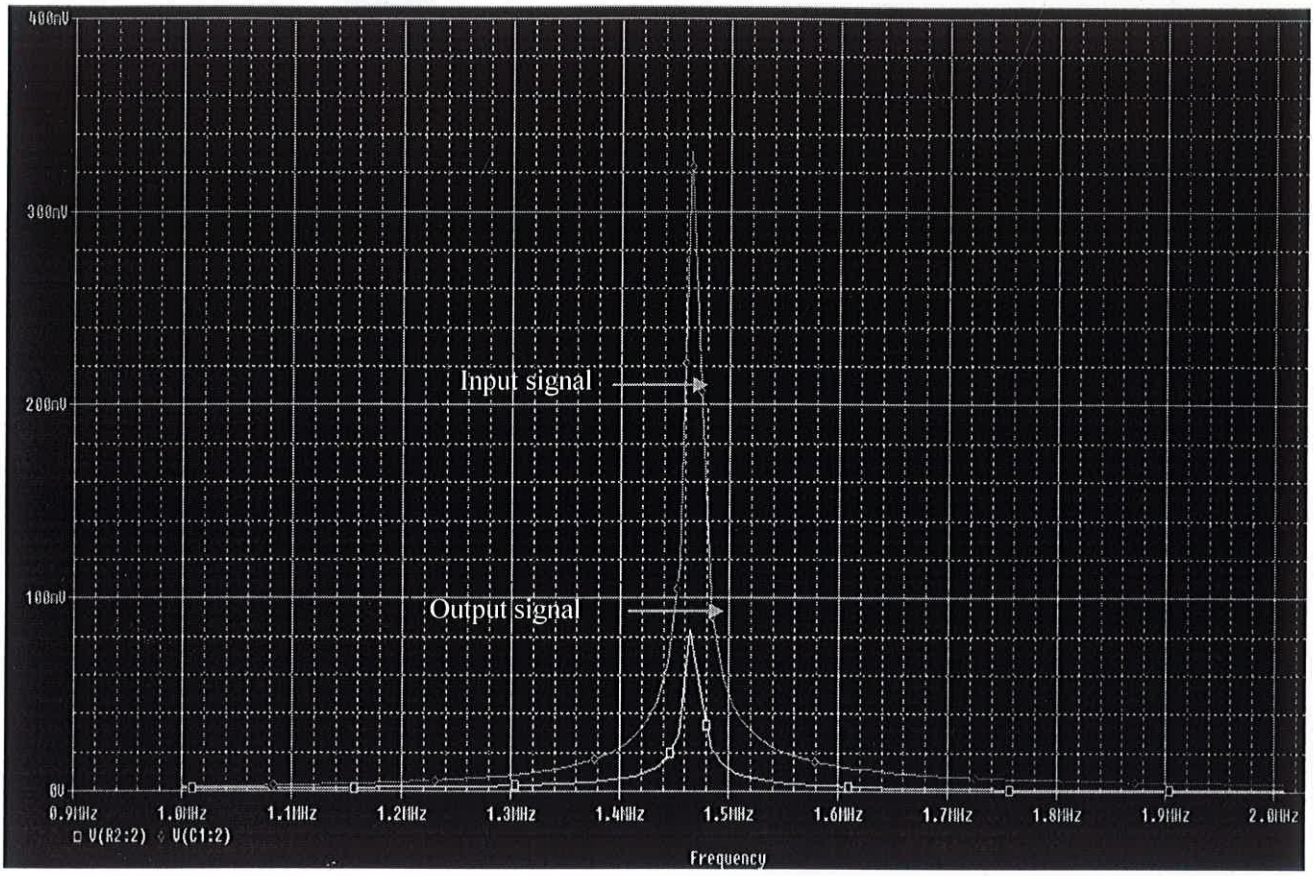

Fig 3.7 Beta network circuit response

From Fig 3.7 it can be seen that the resonant frequency lies at 1455kHz and that the beta value is obtained from dividing the peak value of the input by the peak of the output (i.e. 4), which has already been calculated by the capacitor ratio. The two sections of the Local Oscillator are joined together to get our complete circuit as shown below in Fig 3.8.

3.3 The Complete Local Oscillator Stage:

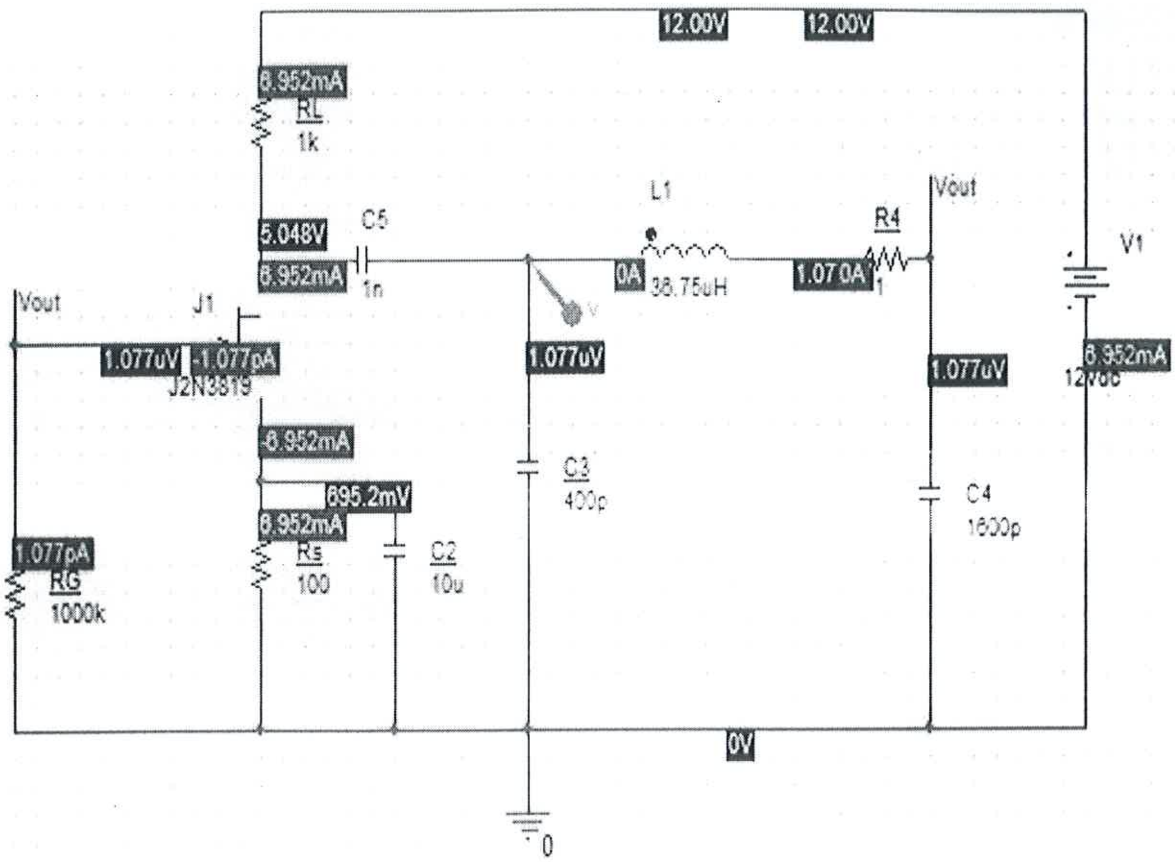

Fig 3.8 Local Oscillator (Amplifier stage and Beta network)

DC conditions from the above circuit:

$V_{GS} = V_G - V_S$

Since there is no voltage at the input we can say that the gate voltage is 0V and that the source and drain currents are equal (i.e.$V_G = 0V$ and $I_S = I_D$).

Therefore: $V_{GS} = 0 - V_S = -I_D R_S$

From Pspice the drain current is displayed as 7.028mA

$$V_{GS} = -7.028m * 100 = -0.7V$$

Since the JFET operates with the gate-source junction reverse bias the value of I_{GSS} is very small (a few nano amps) which can be obtained from data sheets. Assuming a value of 1nA the value of the input resistance will be very large.

$$R_{IN} = \frac{V_{GS}}{I_{GSS}} = \frac{0.7}{1*10^{-9}} = 700M\Omega$$

Also : $I_D = I_{DSS}(1 - \frac{V_{GS}}{V_{GS\,OFF}})^2 = 12 * 10^{-3}(1 - \frac{0.7}{3})^2 = 7.053mA$

$$V_D = V_{DD} - I_D R_D = 20V - (7 * 10^{-3} * 1 * 10^3) = 13V$$

Since : $V_S = I_D R_S$

$$V_{DS} = V_D - V_S = V_{DD} - I_D(R_D + R_S) = 20V - 7 * 10^{-3}(1 * 10^{-3} + 100) = 12.3V$$

The plot of the Local Oscillator's output and its spectrum is given below.

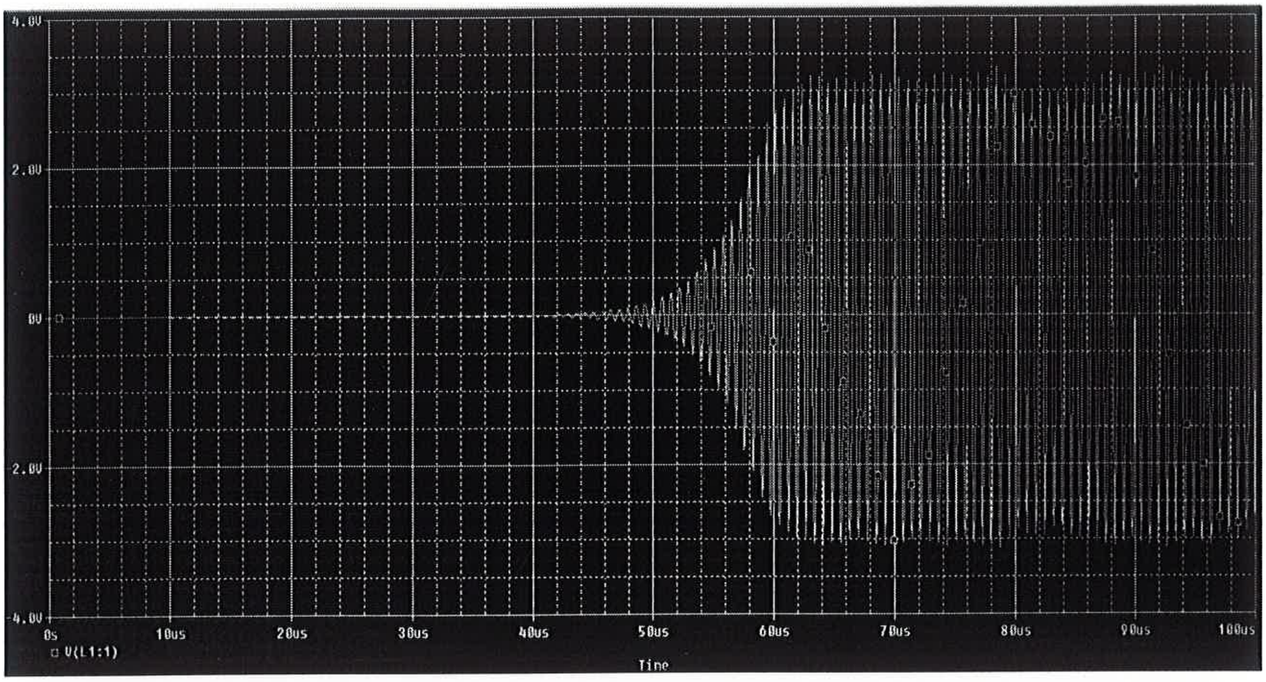

Fig 3.9 LO output

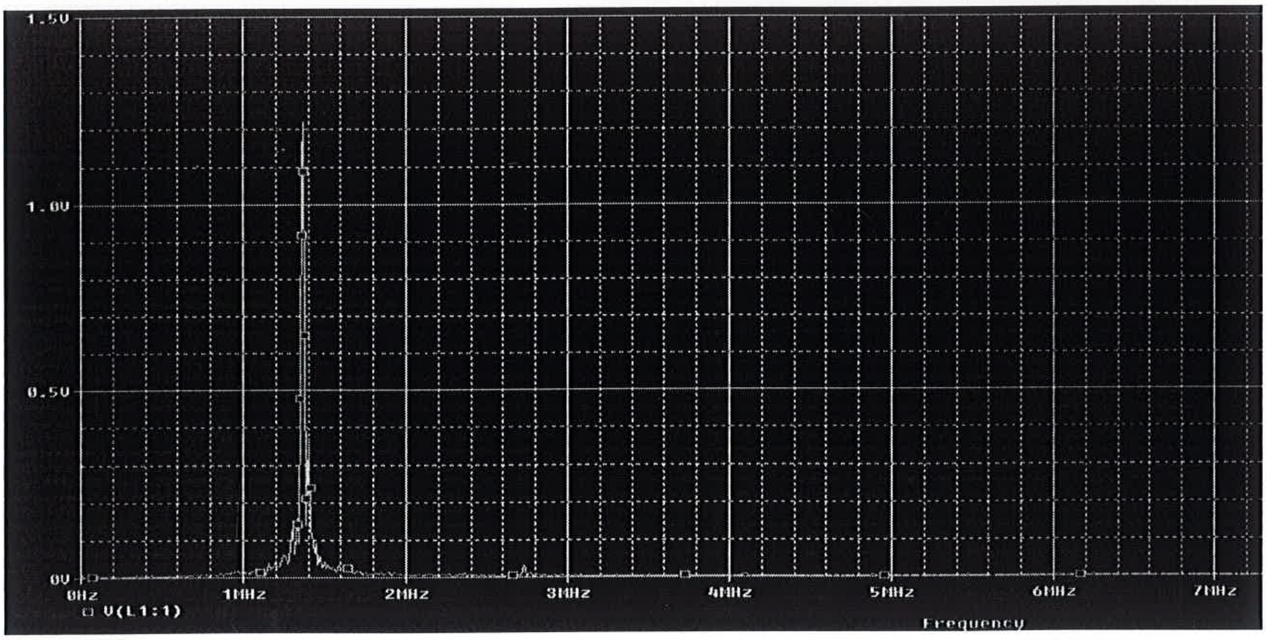

Fig 3.10 Spectrum of LO output

CHAPTER 4

MIXER DESIGN

Mixers are three port active or passive devices, are designed to yield both a sum and a difference frequency at a single output port when two distinct input frequencies are inserted into the other two ports. This process, called *frequency conversion (or heterodyning)*, is found in most communication gear, and is used so that we may increase or decrease a signal's frequency. One of the two input frequencies will normally be a CW wave, produced within the radio by a local oscillator (LO), while the other input will be the RF signal received from the antenna.

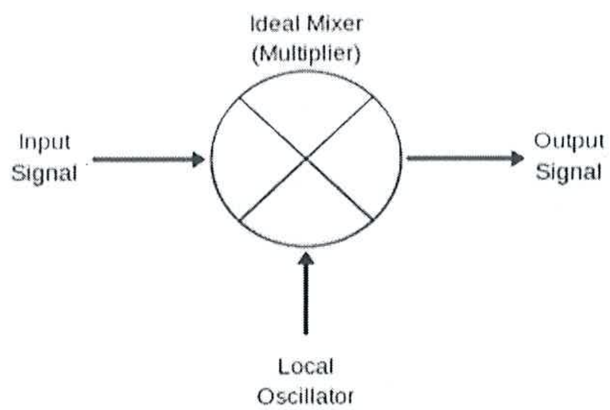

Fig 4.1 Mixer

If we would like to produce an output frequency within the mixer circuit that is lower than the input RF signal, then this is called *down conversion* and if we would like to produce an output signal that is at a higher frequency than the input signal, it is referred to as *up conversion*.

Indeed, most AM, SSB, and digital transmitters require mixers to convert up to a higher frequency for transmission into space, while superheterodyne receivers require a mixer to convert a received signal to a much lower frequency. This lower received frequency available at the mixer's output port is called the *intermediate frequency* (IF). Receivers use this lower-frequency IF signal because it is much easier to efficiently amplify and filter with all the IF stages tuned and optimized for a single, low band of frequencies, which increases the receiver's gain and selectivity. Again, the frequency conversion process within the nonlinear mixer stage produces the intermediate frequency by the RF input signal heterodyning, or beating, with the receiver's own internal LO. This heterodyning mixer circuit will consist of either a diode, BJT, or FET that is overdriven, or biased to run within the nonlinear area of its operation. However, the beating of the mixer's RF and LO input signals yields not only the RF, the LO, and the sum and difference frequencies of these two primary signals, but also many spurious frequencies at the mixer's output port. Most of these undesired frequencies will be filtered out within the receiver's IF stages, resulting in the new desired signal frequency, consisting of the converted carrier and any sidebands, now at the difference frequency. This new, lower difference frequency will then be amplified and further filtered as it passes through the fixed-tuned IF strip.

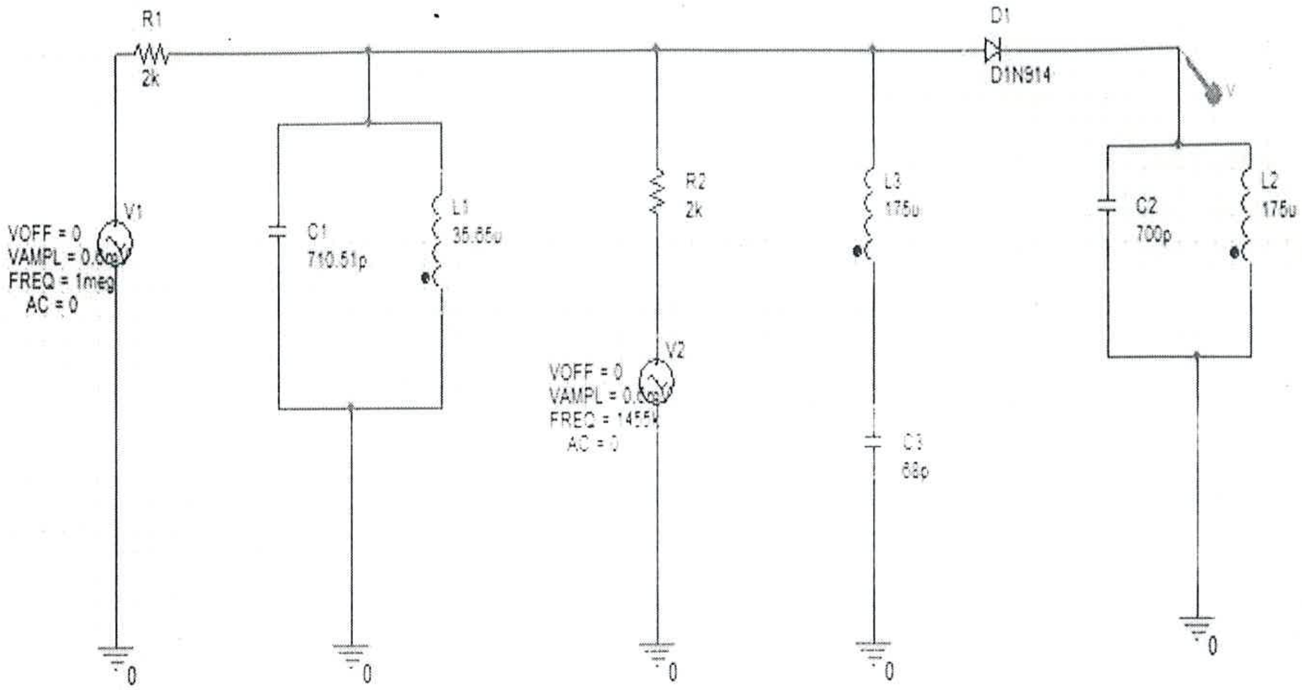

Fig 4.2 Mixer circuit

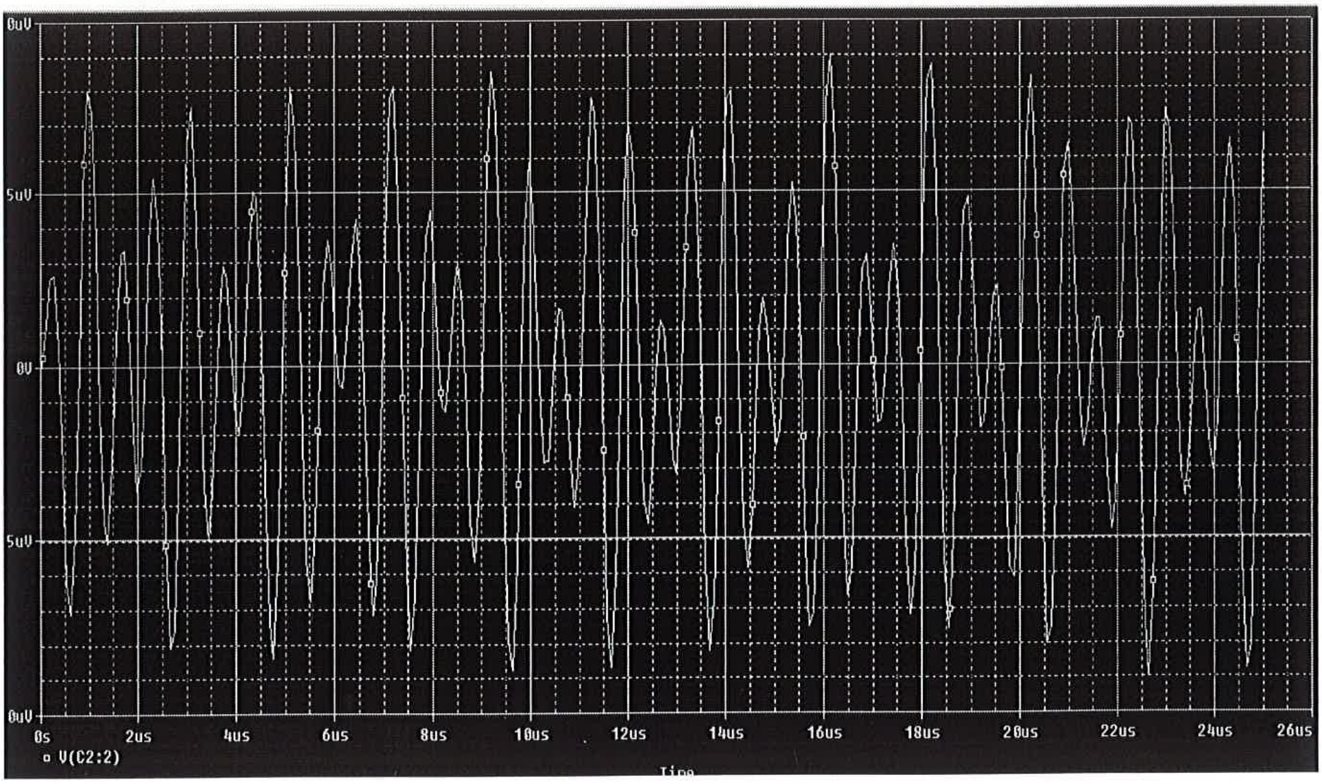

Fig 4.3 Mixer output waveform

CHAPTER 5

IF AMPLIFIER DESIGN

In communications engineering, an intermediate frequency (**IF=455KHz**), is a frequency to which a carrier frequency is shifted as an intermediate step in transmission or reception. The intermediate frequency is created by mixing the carrier signal with a local oscillator signal in a process called heterodyning, resulting in a signal at the difference or beat frequency. Intermediate frequencies are used in superheterodyne radio receivers, in which an incoming signal is shifted to an IF for amplification before final detection is done.

Conversion to an intermediate frequency is useful for several reasons. When several stages of filters are used, they can all be set to a fixed frequency, which makes them easier to build and to tune. Lower frequency transistors generally have higher gains so fewer stages are required. It's easier to make sharply selective filters at lower fixed frequencies.

Consider the tuned LC circuit.
If Q>10 then we can approximate:

$$f_0 = \frac{1}{2\pi\sqrt{LC}} = 455kHz$$

Therefore, $C = \frac{1}{4\pi^2 f_0^2 L}$

Choosing L=175uH then we get C=700pF from above.

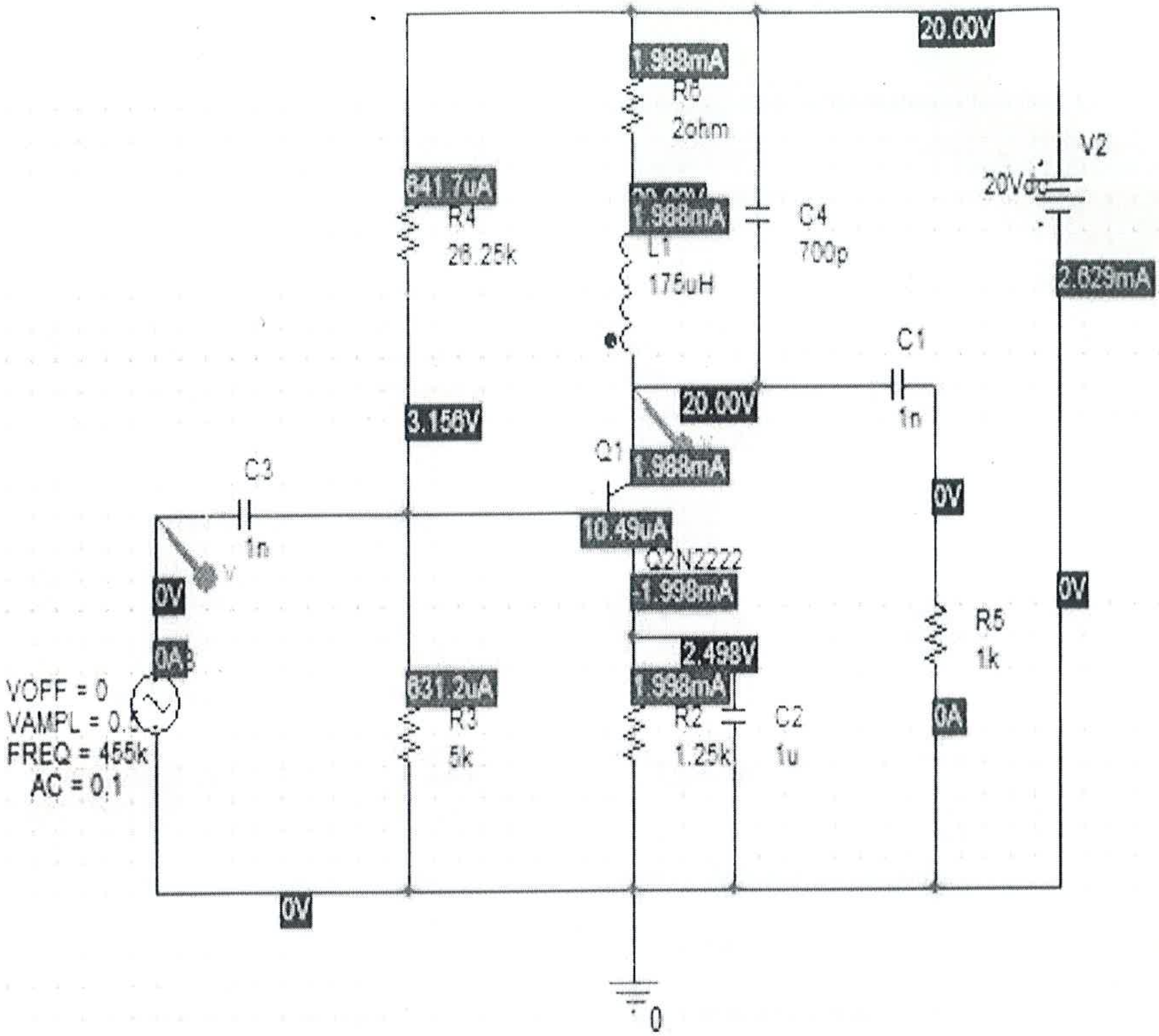

Fig 5.1 IF amplifier

The ratio of dc collector current, I_C, to dc base current, I_B, is called the dc beta, β_{DC}, which is the dc current gain of the transistor (typical values range from 20 to 200 or higher). Taking current values from Pspice:

$$\beta_{DC} = \frac{I_C}{I_B} = \frac{1.988 * 10^{-3}}{10.49 * 10^{-6}} = 189.5$$

The ratio of I_C to dc emitter current, I_E, is the dc alpha, α_{DC} (this value is always less than 1).

$$\alpha_{DC} = \frac{I_C}{I_E} = \frac{1.988 * 10^{-3}}{1.998 * 10^{-3}} = 0.994$$

Other important dc conditions include:

$$V_B = \frac{R_3}{R_4 + R_3} V_{DD} = \frac{5k}{26.25k + 5k} 20V = 3.2V$$

$$V_E = V_B - V_{BE} = (3.2 - 0.7)V = 2.5V$$

$$I_E = \frac{V_E}{R_E} = \frac{2.5V}{1.25K} = 2mA$$

The internal resistance of the transistor: $r_e' = 25mV/I_E = 12.5\Omega$

Voltage gain: $A_V = {}^{V_0}/_{V_{IN}} = {}^{R_L}/_{r_e'} = {}^{L1/C1Rs}/_{r_e'} = 10000$

where the load resistance is the dynamic impedance of the tuned LC circuit.

The voltage gain expressed in dBs: 20log(10000) = 80dB.

Power gain = current gain X voltage gain = 189.5 X 10000 = 1895000

Input Impedance of the transistor: $R_{IN} = {}^{V_B}/_{I_B} = {}^{3.2V}/_{10.49 * 10^{-6}} = 305K\Omega$

The input,output waveform and the resonant curve graphs for the circuit of fig 5.1 are given as follows.

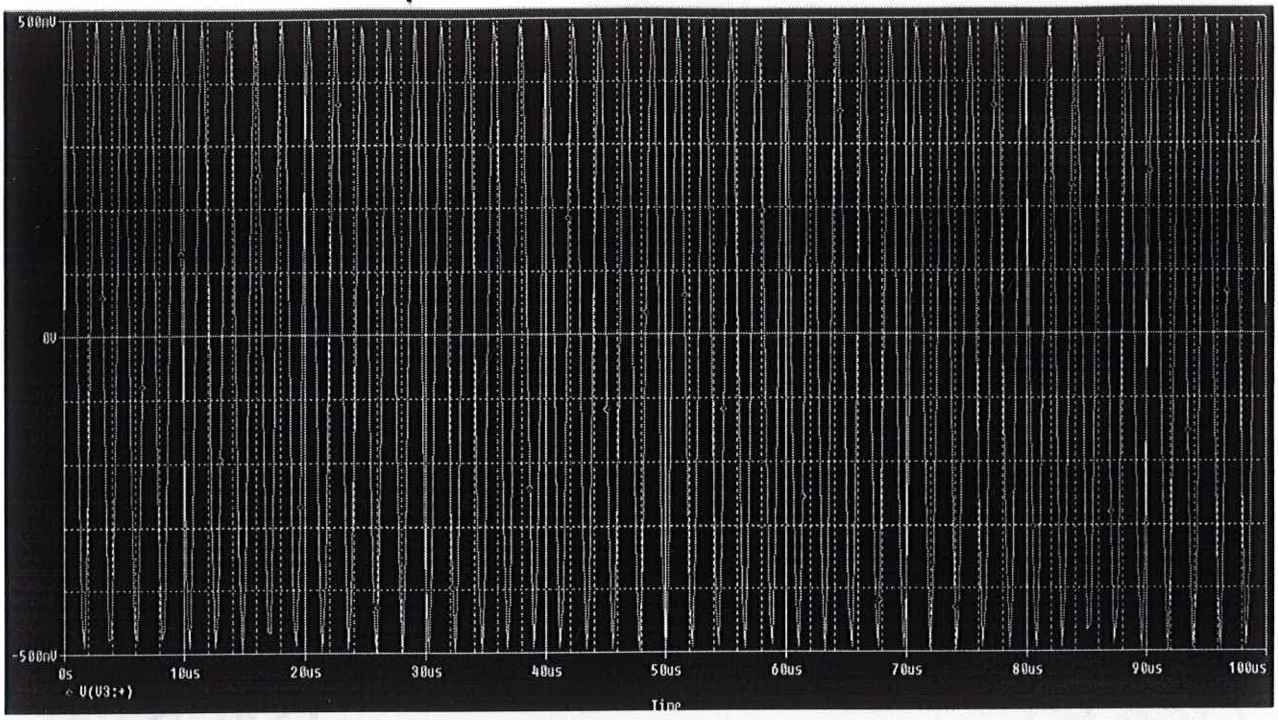

Fig 5.2 Input waveform

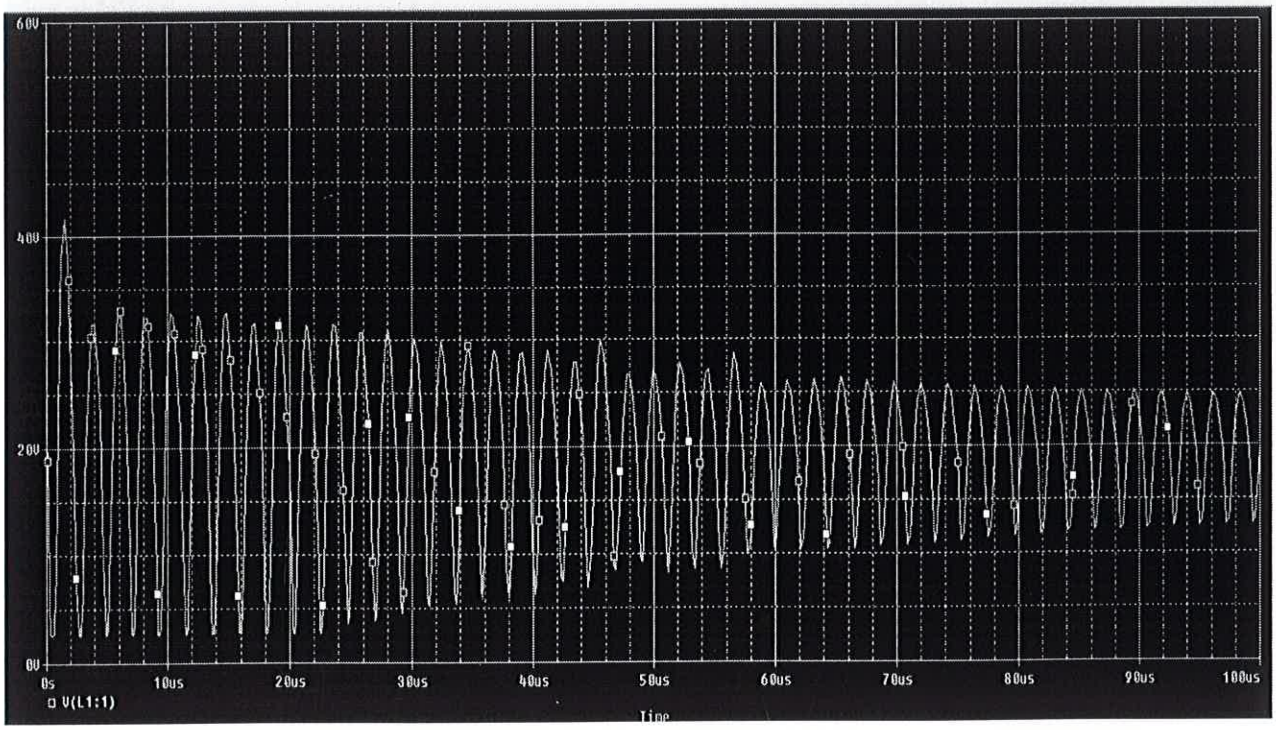

Fig 5.3 Output waveform

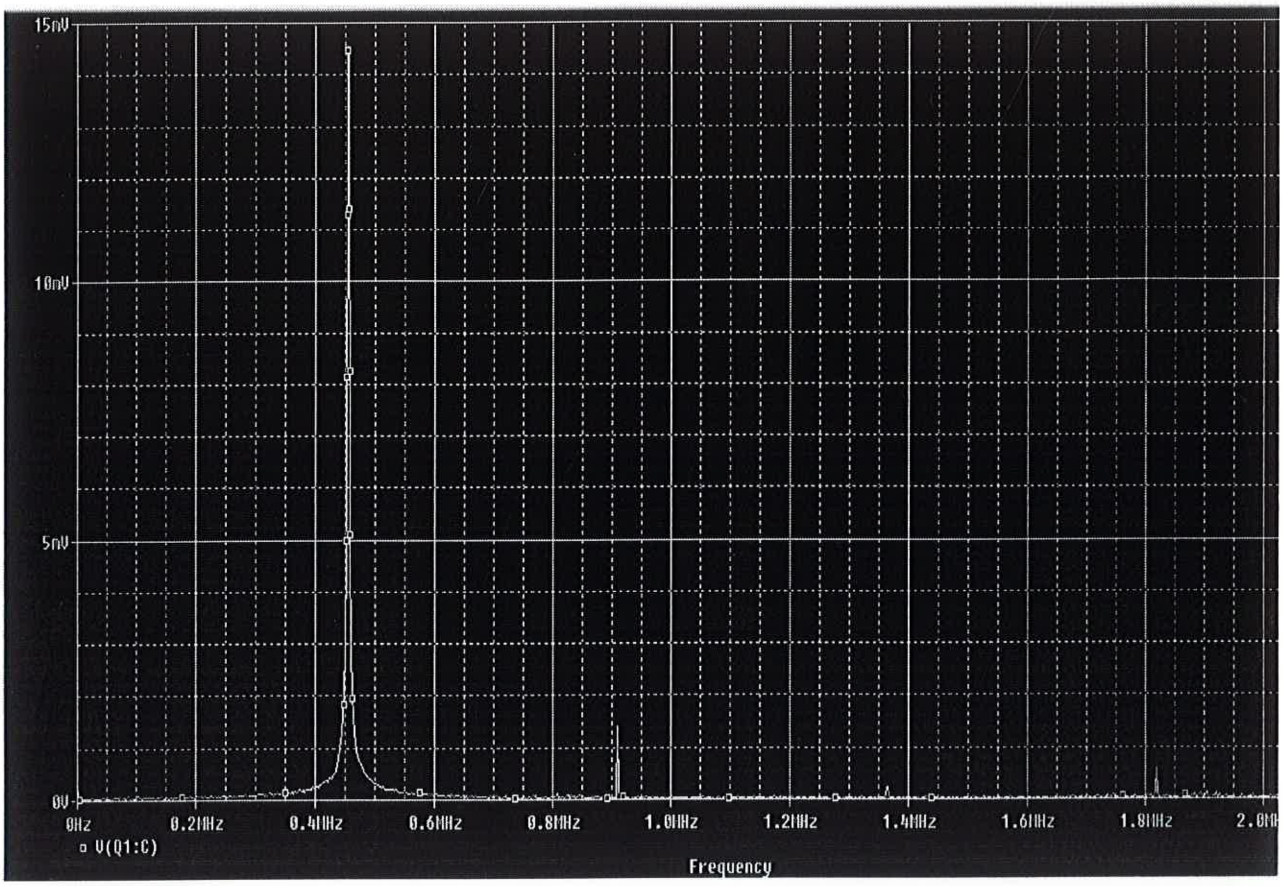

Fig 5.4 IF resonant curve

CHAPTER 6

DEMODULATION OF AM WAVE

An envelope detector is an electronic circuit that takes a high-frequency signal as input and provides an output which is the envelope of the original signal. The capacitor in the circuit stores up charge on the rising edge, and releases it slowly through the resistor when the signal falls. The diode in series rectifies the incoming signal, allowing current flow only when the positive input terminal is at a higher potential than the negative input terminal.

An envelope detector can be used to demodulate a previously modulated signal by removing all high frequency components of the signal. The capacitor and resistor form a low-pass filter to filter out the carrier frequency. Such a device is often used to demodulate AM radio signals because the envelope of the modulated signal is equivalent to the baseband signal.

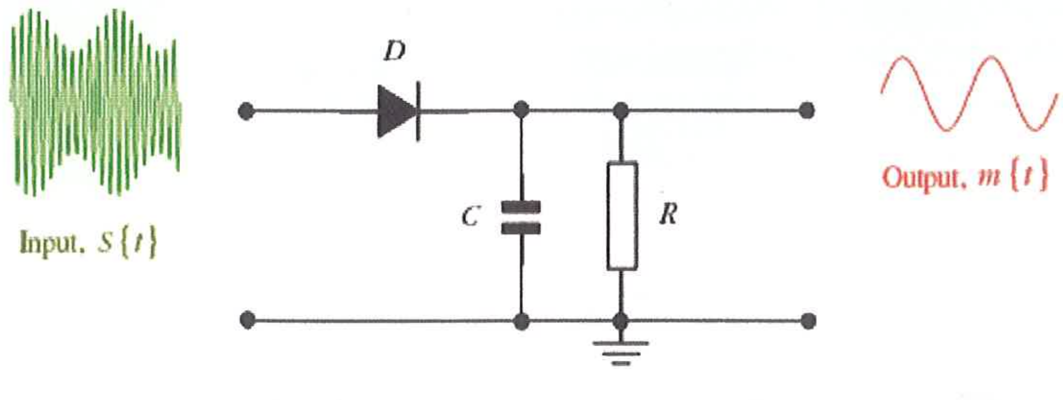

Fig 6.1 Envelope Detector

The simplest form of envelope detector is the diode detector which is shown above. A diode detector is simply a diode between the input and output of a circuit, connected to a resistor and capacitor in parallel from the output of the circuit to the ground. If the resistor and capacitor are correctly chosen, the output of this circuit should approximate a voltage-shifted version of the original (baseband) signal. A simple filter can then be applied to filter out the DC component.

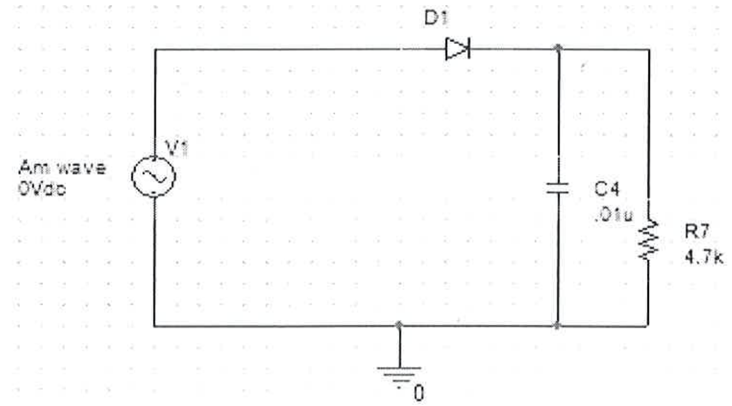

Fig 6.2 Envelope detector circuit

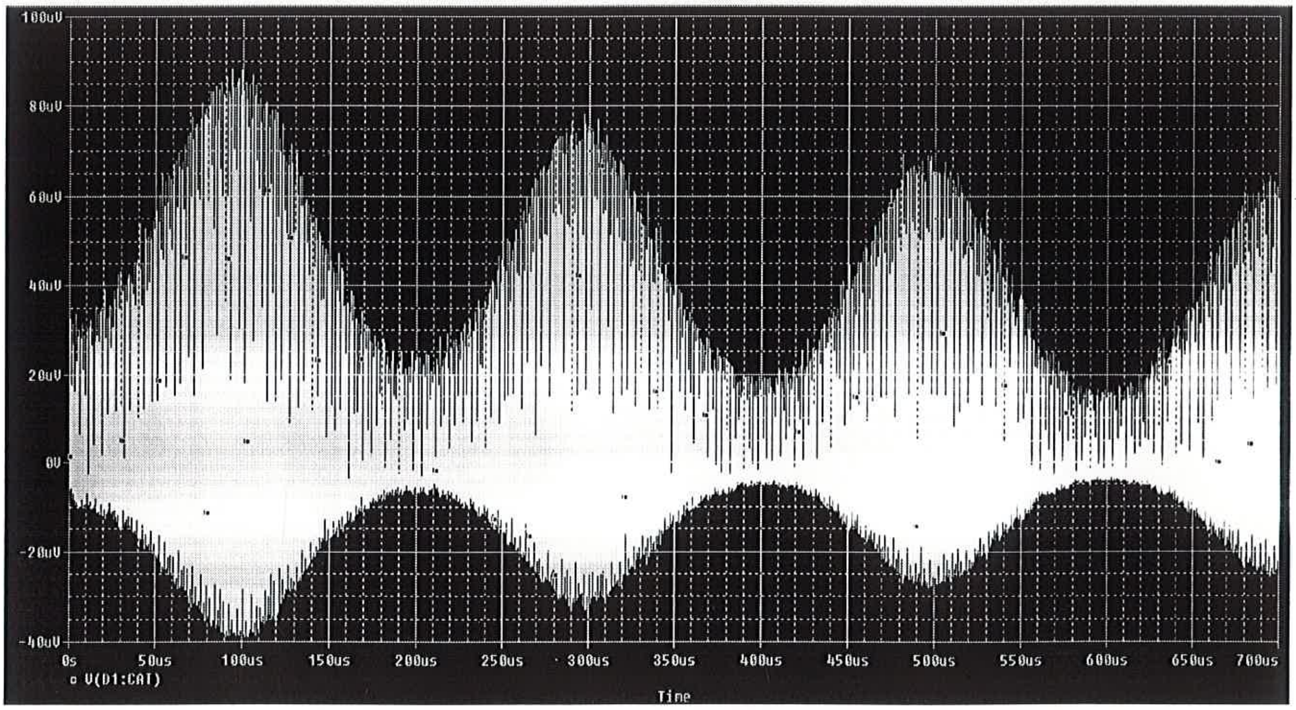

Fig 6.3 Demodulated AM waveform

APPENDIX: SOFTWARE USED

[i] OrCAD Capture CSI lite 16.6 - By Cadence Design System,Inc.

[ii] Microsoft Word 2007

[iii] Microsoft Windows Version 6.1(Build 7600)

[iv] LTspice IV