LNMIIT

The LNM Institute Of Information Technology

Course Project: Principles Of Communication

AMPLITUDE MODULATION: DOUBLE SIDEBAND

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March 25, 2012

Jaipur.

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Chapter 1

Abstract

This is the project report of the 'Principles Of Communication' course. In our project we have implemented Amplitude Modulation (AM):DSB scheme in Matlab, Multisim and Hardware. Our goal from this project is to modulate the baseband signals using AM and then recover the original signals by demodulation of the modulated AM signal. We have successfully implemented this modulation scheme at all the three platforms- Hardware, Matlab and Multisim. Related theory and all the results, simulation, graphs and circuits are included in this report.

Chapter 2

Introduction

Baseband signals are not always suitable for direct transmission therefore, these signals are usually further modified to facilitate the transmission. This process of conversion is known as **Modulation**. A carrier signal is a sinusoid signal of high frequency. One of the method of modulation is **Amplitude Modulation**, where the carrier signal's amplitude is varied in accordance with the information bearing signal. The amplitude modulated signal's envelope or boundary embeds the information bearing signal.

The Process of recovering the original signal from the modulated signal is referred to as **demodulation** or **detection.** At the destination, demodulation takes place in which the carriers are separated, the data is extracted from each, and then the data is combined into the original modulating information.

There are many examples of AM in real life for example- Tone modulation, Frequency mixer etc.

2.1 Readings and Literature survey

The literature is mainly taken from the book Modern Digital and Analog Communication Systems- *B.P. Lathi.* However, we also took help of google to find out: Phase shifter circuit, summing amplifier, multiplier circuit etc. Further, we referred to a pdf available on net on Quadrature amplitude modulation by Roshni A Chaudhari (ME EC). For MATLAB coding, we took help of the lecture delivered in the class about Amplitude Modulation. We made the Multisim part and the hardware part, using the Lab Experiment 5 (We expanded this to QAM).

2.2 Theory

Modulation:

In Amplitude modulation (AM), the carrier wave is chosen as A $\cos(w_c t + \Theta_c)$ and amplitude A of carrier wave is varied in proportion to the baseband signal m(t) which is the modulating signal. Here, the frequency w_c and phase Θ_c are constant. We can assume $\Theta_c = 0$ without a loss of generality.

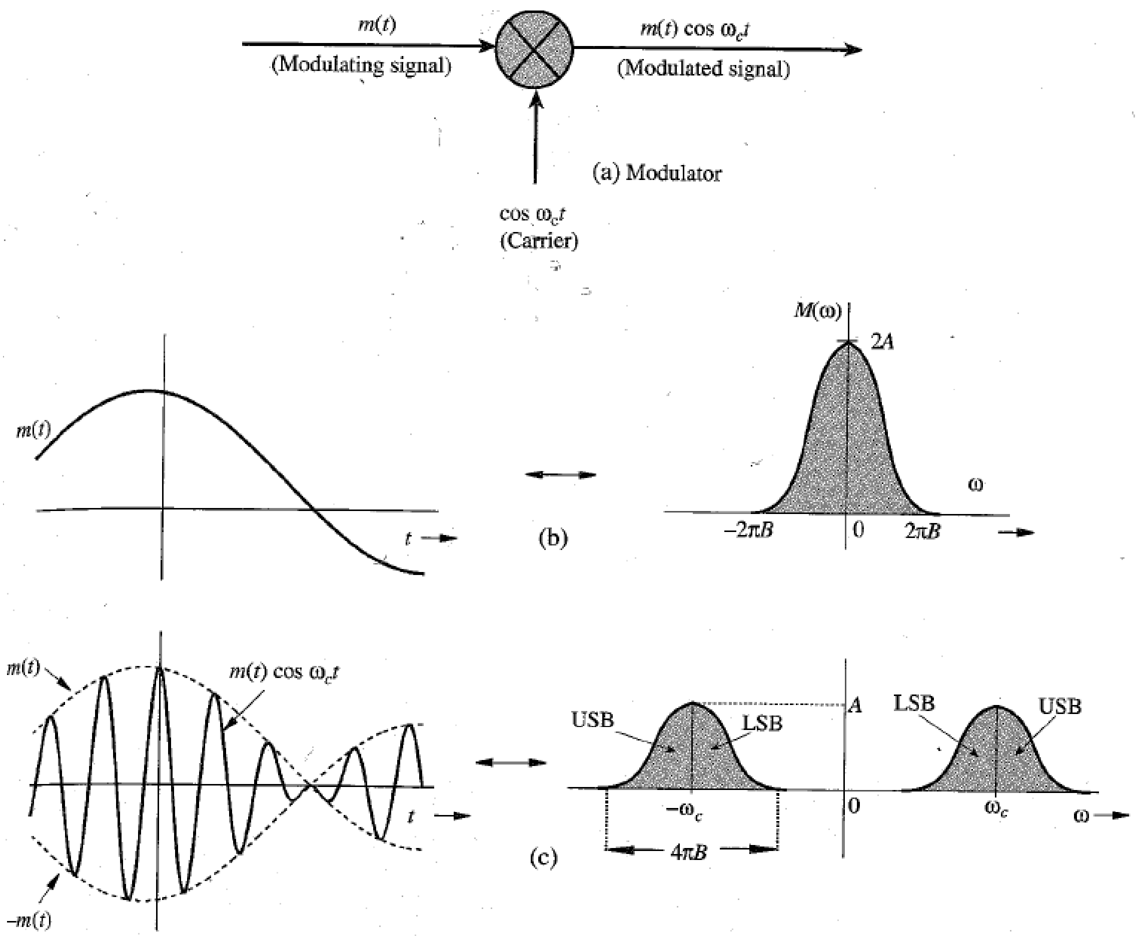
If we assume transform of m(t) in frequency domain is M(w) then-

$$m(t) \leftrightarrow M(w)$$

and if the carrier amplitude A is made directly proportional to modulating signal m(t), then the modulated signal is $m(t) \cos w_c t$. Again, the transform of modulated signal in frequency domain is-

$$m(t) \cos w_c t \leftrightarrow \frac{1}{2}[M(w + w_c) + M(w - w_c)]$$

So, we can see that this scheme of modulation simply shifts the spectrum of m(t) to the left and right by carrier frequency w_c .



The bandwidth of modulated signal is twice the bandwidth of modulating signal. We also observe that spectrum of modulated signal centered at w_c is composed of two parts: a portion that lies above $w_c$known as Upper side band (USB) and a portion that lies below w_c, known as the lower side band (LSB). Same is the case for spectrum centered at $-w_c$.

Demodulation:

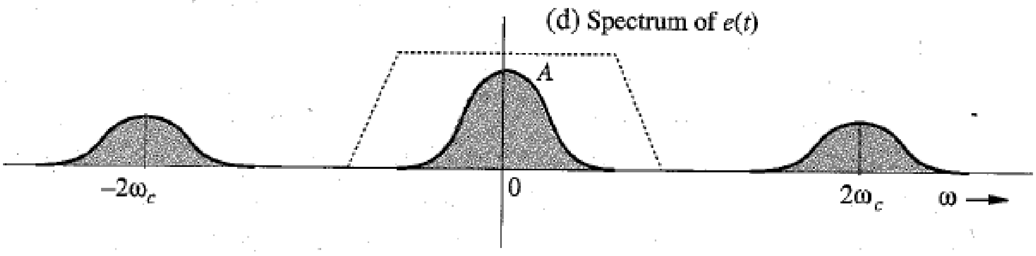
For demodulation if we shift the modulated signal spectrum left and right by w_c (and multiply by ½) then we obtain the desired baseband spectrum and plus an unwanted spectrum at $\pm 2w_c$, which can be suppressed if we pass that signal through the low pass filter. So,

$$e(t) = m(t) \cos^2 w_c t$$

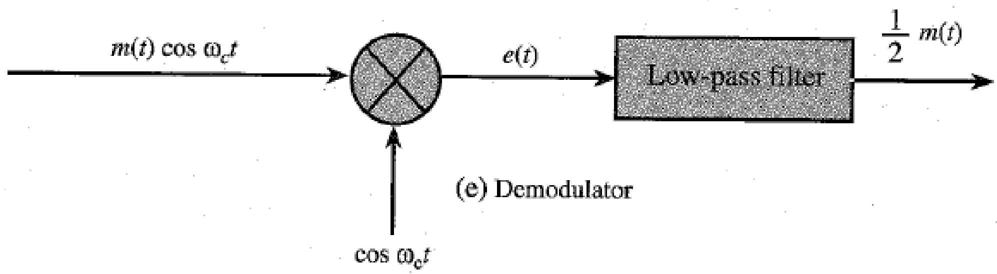
$$= \frac{1}{2}[m(t) + m(t)\cos 2w_c t]$$

The fourier transform of the signal e(t) is –

$$E(w) = \frac{1}{2}M(w) + \frac{1}{4}[M(w + 2w_c) + M(w - 2w_c)]$$



(d) Spectrum of $e(t)$



(e) Demodulator

Thus,e(t) consists of two components (1/2)m(t) and (1/2)m(t)cos $2w_c t$. If we pass the signal e(t) through a low pass filter, the we get the output as (1/2)m(t), we can get rid of the inconvenient fraction ½ in the output by using a carrier 2 $\cos w_c t$ instead of $\cos w_c t$.

In this method of recovering the baseband signal, we use a carrier of exactly the same frequency (and phase) as carrier used for modulation. This type of demodulation scheme is called Synchronous detection or coherent detection.

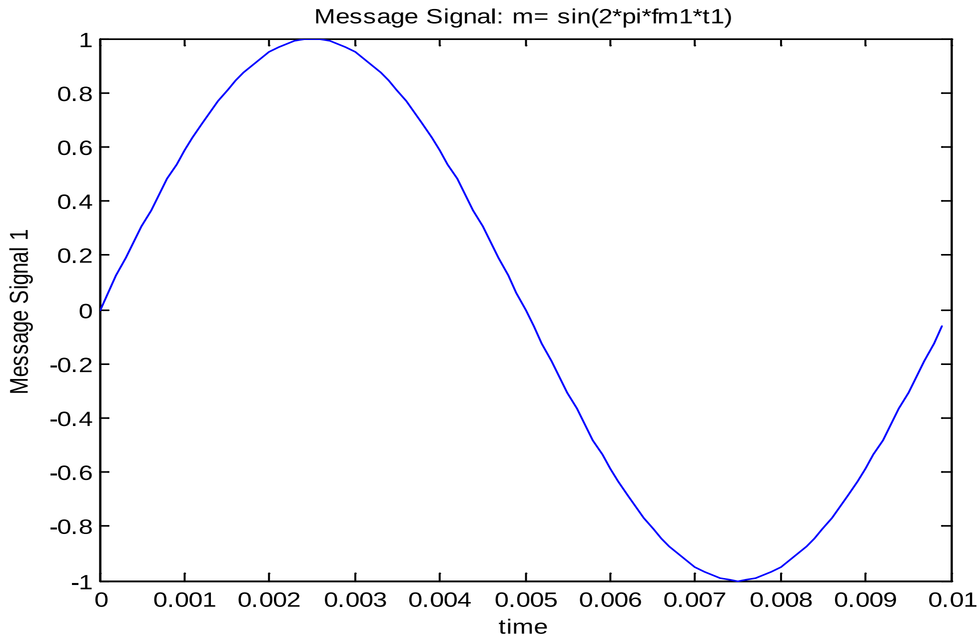
Above method of modulation of baseband signal and then demodulation of the modulated signal at receiver is called as Amplitude Modulation(AM).

Chapter 3

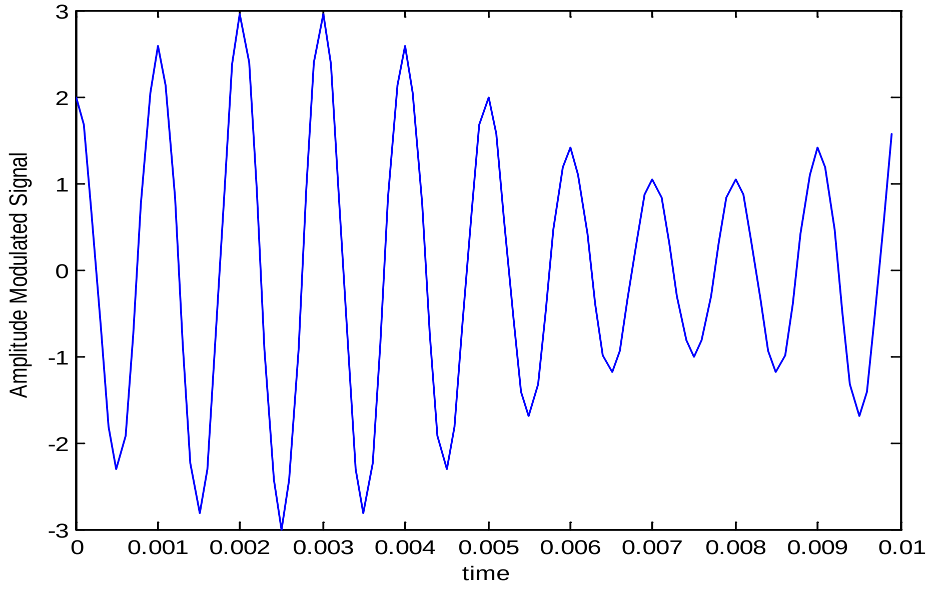
Matlab based simulation

The MATLAB based simulations are as follows:

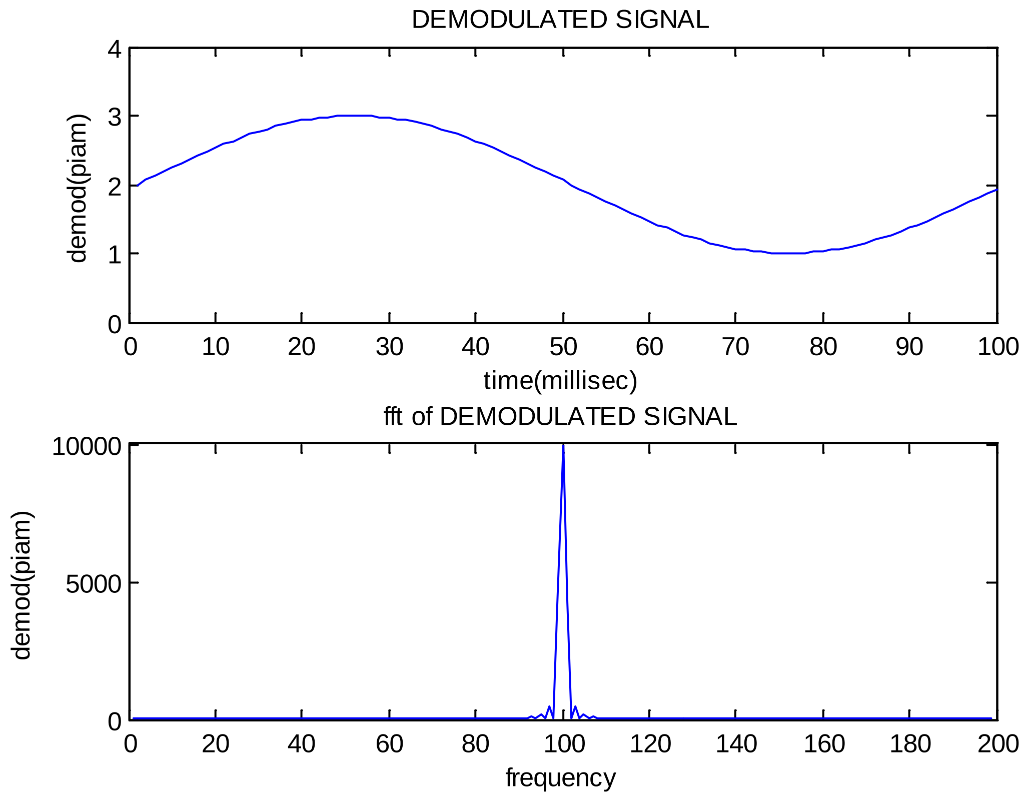
1> The Message Signal:



2> The Amplitude Modulated Signal:



3> The output from the Envelope Detector and Low Pass Filter :

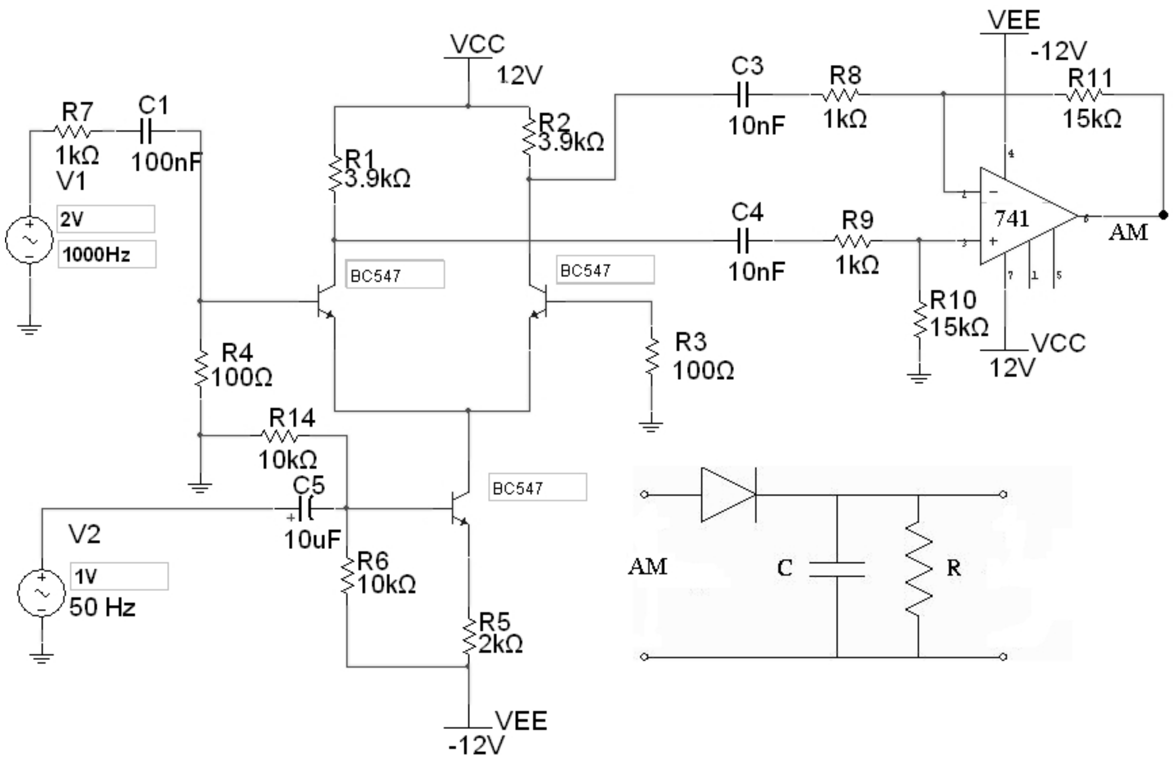


The MATLAB simulations are somewhat adequate compared to the desired values. Proper estimations further could help in improving the systems. The Amplitude modulated waves can be generated and Demodulated with the help of MATLAB.

Chapter 4

Circuit details

The circuit diagram implementation of the amplitude modulation schema:



The amplitude modulation can be performed by the above circuit. However, the demodulation takes place with the help of an envelope detector followed by a low pass filter.

4.1 Analysis

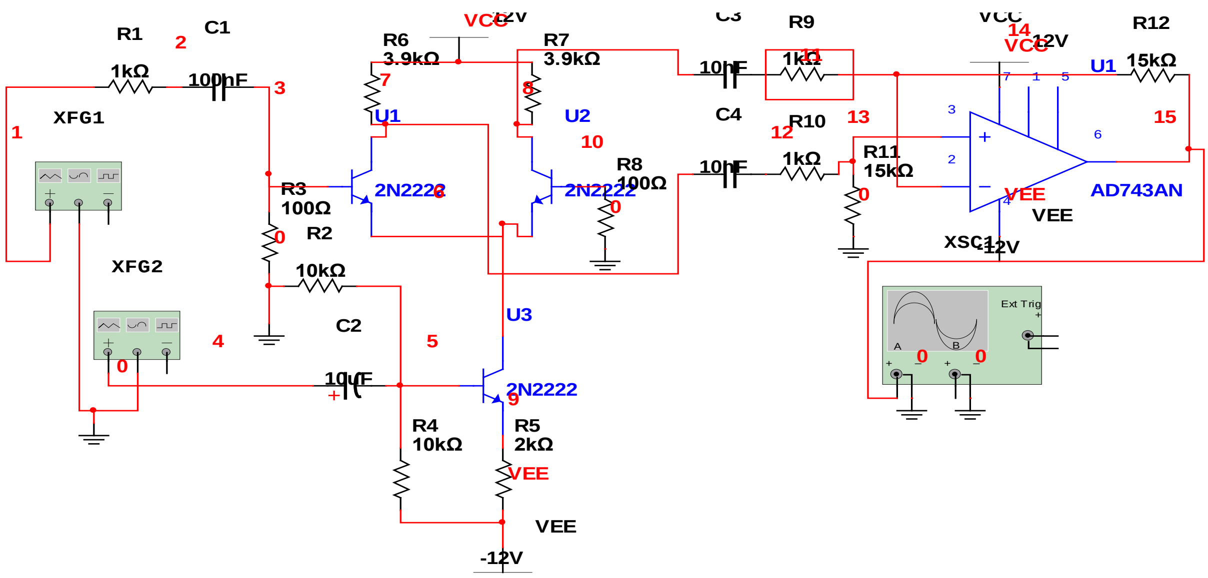
The **Amplitude Modulation** schema comprises of a **message** signal and a **carrier** signal. The message signal is modulated with high frequency carrier wave. The modulation is performed and a DSB-SC type signal is obtained. This DSB-SC type signal is the amplitude modulated wave. Then, this amplitude modulated wave is demodulated using an **Envelope Detector** followed by a **Low-Pass Filter**.

4.2 Working

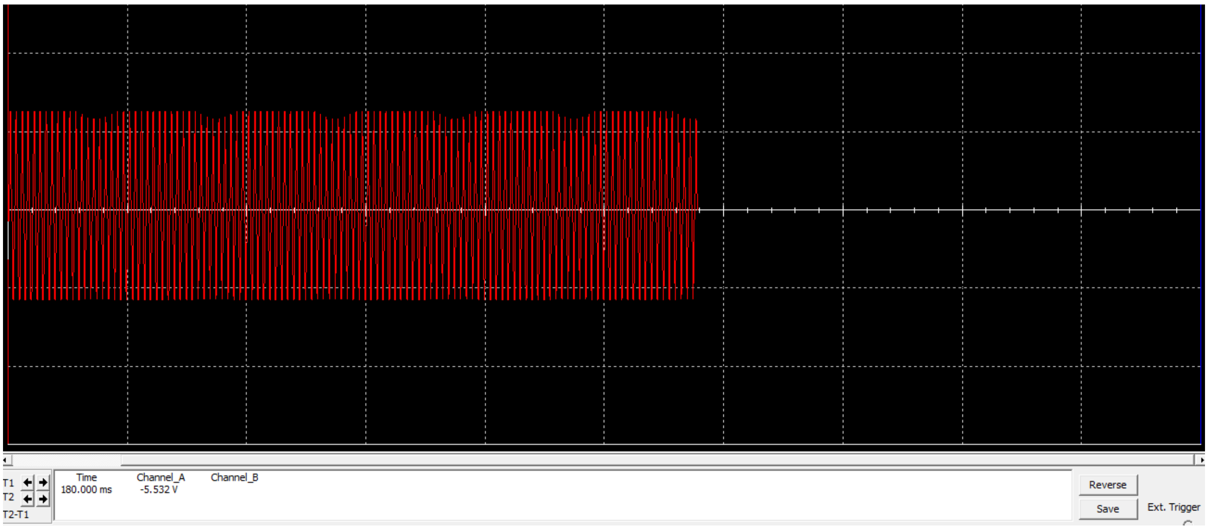
- The Amplitude Modulation works on the principle of superimposing a low frequency message signal to a very high frequency carrier wave and perform modulation.
- Initially, a message signal – cosine wave of frequency 50 Hz and amplitude 1V peak-to-peak is chosen.
- Then a very high frequency carrier wave – cosine wave of frequency about 1kHz is chosen.
-The two waves are used for Amplitude Modulation.
-The output waveform is of a DSB-SC type and is called Amplitude Modulated Wave.
-The Amplitude modulated wave is demodulated using an envelope detector followed by a low pass filter.
-The message signal is regenerated.

4.3 Circuit simulation

The following circuit was simulated in Multisim software:



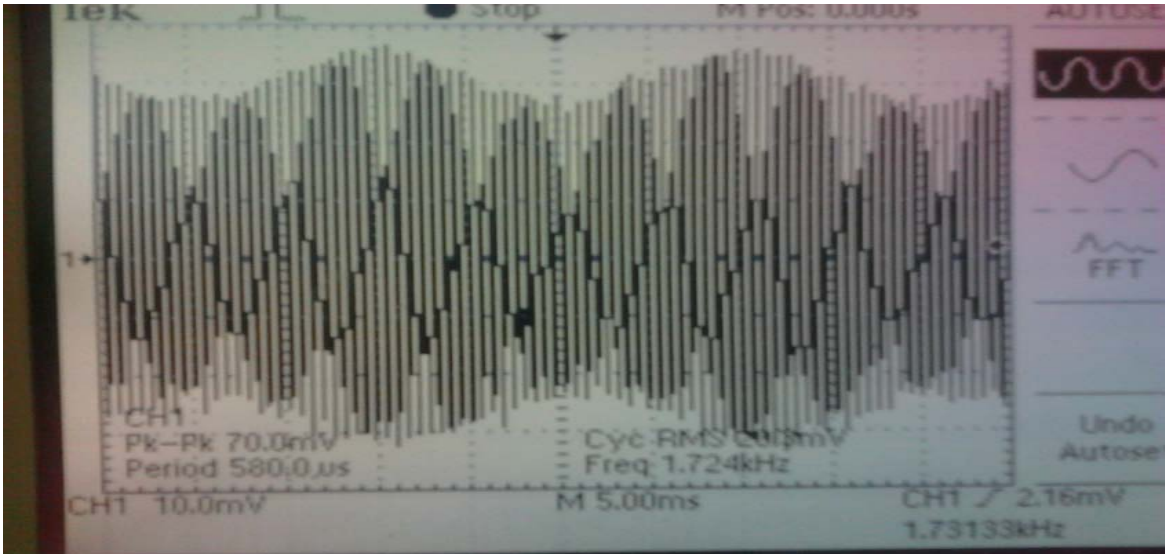
The output waveform of the simulated wave at the output with message signal : cosine wave (50 Hz, 1V) and Carrier wave: cosine wave(1 kHz,2V) is as follows:

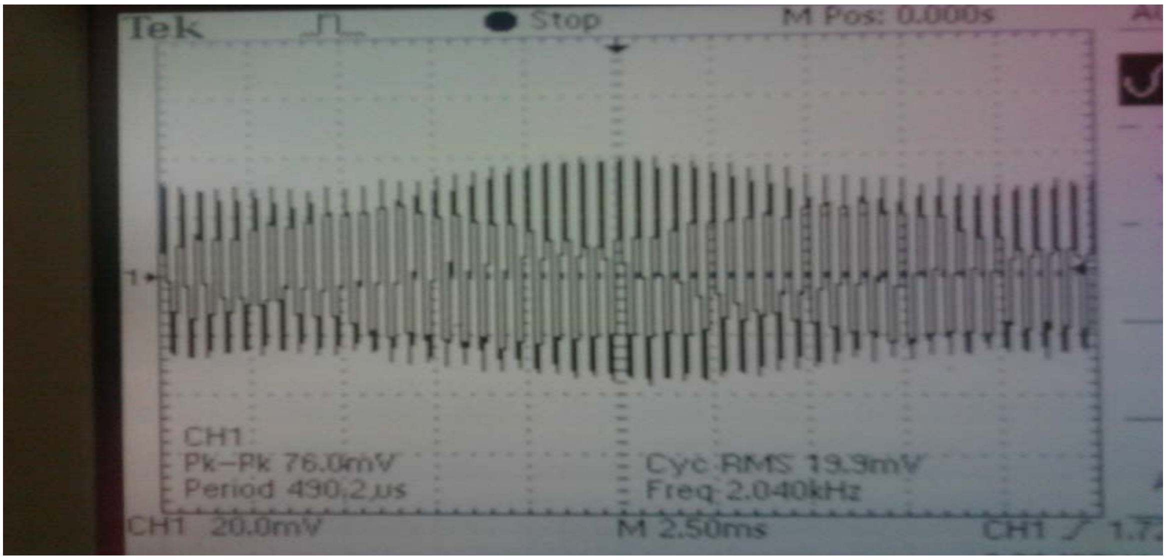


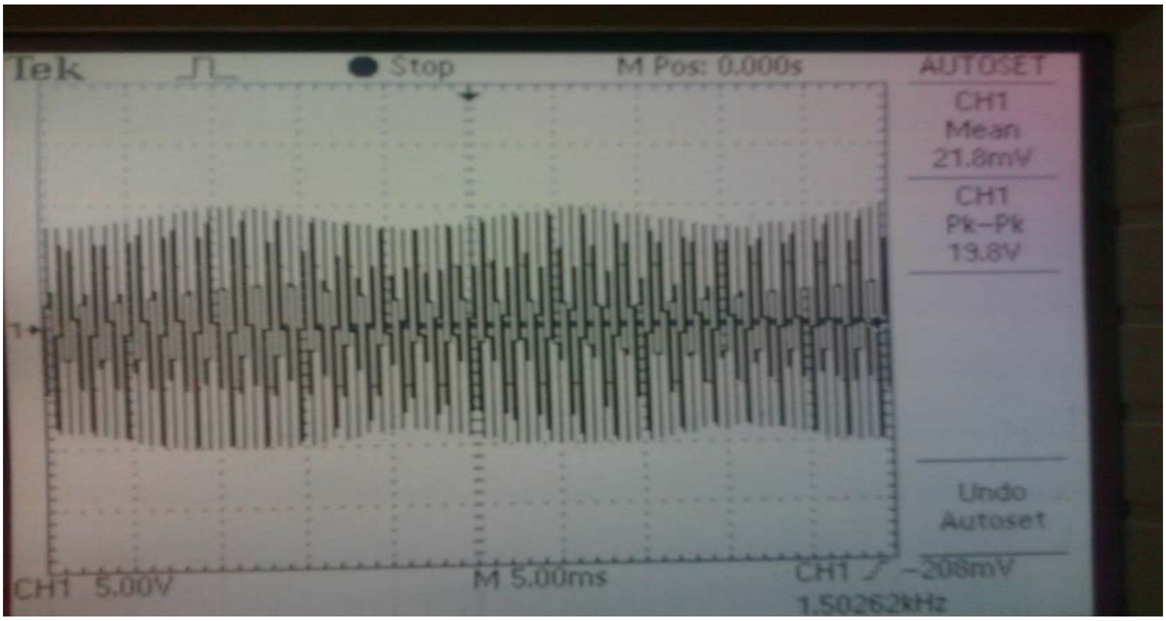
Chapter 5

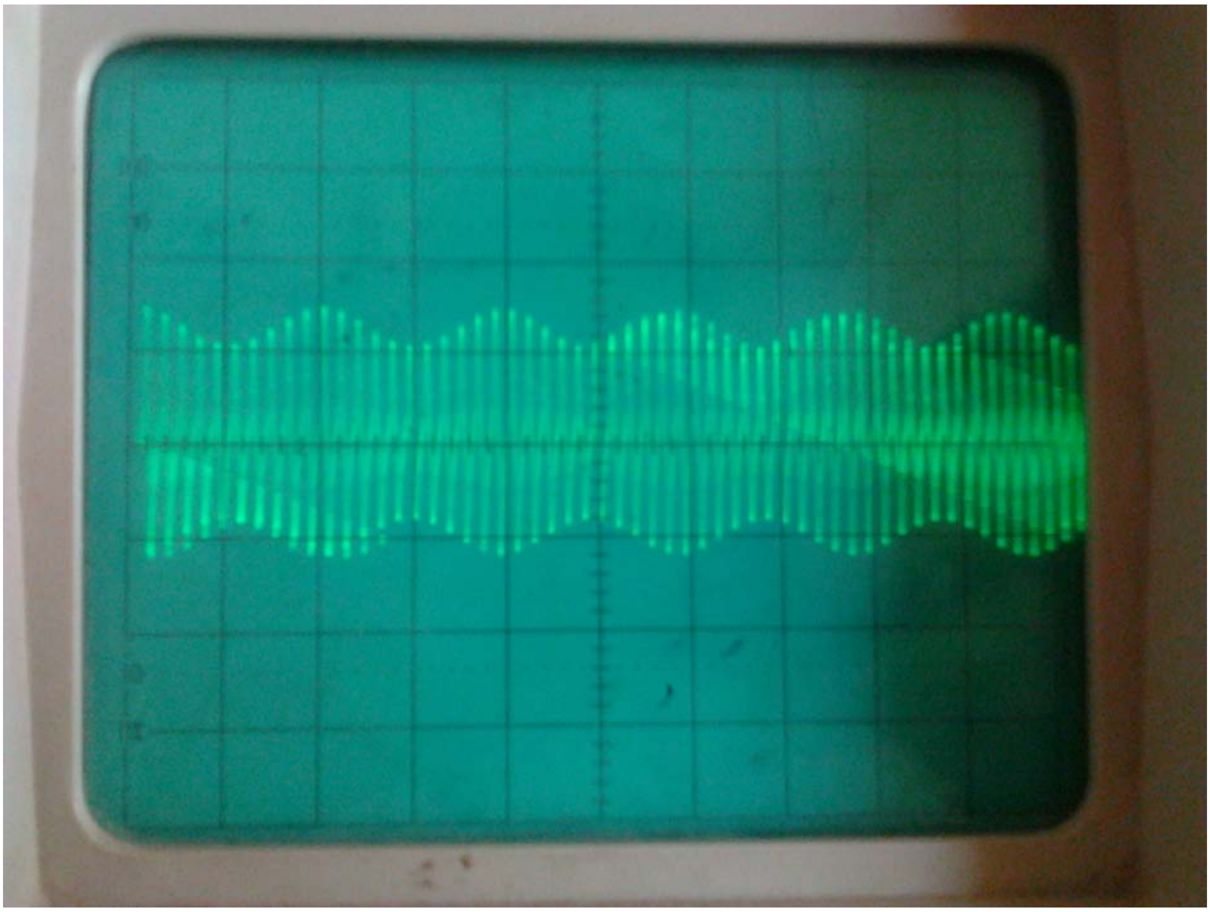
Hardware Implementation

5.1 Observations






Tek
Stop
M Pos: 0.000s
AUTOSET
CH1
Mean
21.8mV
CH1
Pk-Pk
19.8V
Undo
Autoset
CH1 5.00V
M 5.00ms
CH1 -208mV
1.50262kHz



Chapter 6

Conclusion

Modulation is necessary to facilitate the transmission of baseband signals over a given channel. AM is one of the available modulation schemes to modulate the baseband signal.
AM is one of the basic and easily implementable modulation scheme. We have implemented AM on all the three platforms and have shown the results in this report. We have also verified the fact that amplitude of carrier is varied in proportion to the baseband signal, which is the basis of Amplitude modulation. The results are quite similar at all the platforms, thus they verify each other.

Bibliography

[1] Modern Digital and Analog Communication Systems- *B.P. Lathi*
[2] Wikipedia(only basics)
[3] Principles of Communication Lab Manual