B V RAJU INSTITUTE OF TECHNOLOGY

Vishnupur, Narsapur,Medak Dist.

(UGC Autonoumous)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

VISHNU
UNIVERSAL LEARNING

Analog and Digital Communications Laboratory

(Course code:A351Q)

RECORD BOOK

ACY: 2020-2021

(R18 - Regulation)

Name:
Roll No:
Section:
Branch:
Year & Semester:

ANALOG & DIGITAL COMMUNICATIONS LAB

COURSE OBJECTIVES: The objective of this course is to give experimental exposure to the students about analog and digital modulation techniques.

LIST OF EXPERIMENTS:

Note: Minimum 12 (Part-1& Part-2) experiments should be conducted: All these experiments are to be simulated first using MATLAB, Comsim or any other simulation package and then to be realized in hardware.

PART-I (Analog Communications)-Min 6 should be conducted

1. Amplitude modulation & demodulation.
2. DSB-SC modulator & Detector.
3. SSB-SC Modulator & Detector (Phase shift Method)
4. Frequency modulation & demodulation.
5. Frequency response of Pre-emphasis & De-emphasis circuit
6. Pulse Amplitude Modulation & Demodulation.
7. Pulse Width Modulation & Demodulation.
8. Pulse Position Modulation & Demodulation.

PART-II (Digital Communications) -Min 6 should be conducted

1. Time Division Multiplexing & De multiplexing
2. PCM Generation and Detection
3. Delta Modulation
4. Frequency Shift Keying: Generation & Detection
5. Phase Shift Keying: Generation & Detection
6. QPSK: Generation & Detection
7. DPSK: Generation & Detection

Equipment required for the Laboratory:

1. CRO - 0-20 MHz
2. Function Generator - 0-1 MHz
3. Lab Experimental kits for Analog Communication and Digital communications
4. Any simulation Software

COURSE OUTCOMES

Upon completion of the course, students will be able to

1. Generate and analyze Analog Modulated and demodulated Signals.
2. Test & observe the outputs of different types of detectors.
3. Test and analyze output signals of different sections of AM & FM Receivers.
4. Use MATLAB/Simulink tool for simulating Analog &Demodulation techniques.

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CERTIFICATE

This is to certify that the laboratory work entitled **"Analog and digital Communications Lab"** is a bonafied work carried out by Mr./Ms. ____bearing **Roll No.____________________** in the **III Year I Semester** for the degree of **Bachelor of Technology in ECE** during the Academic year 2020-2021.

Internal Examiner

Head of the Department

External Examiner

INDEX

S.No.	Name of the Experiment	Page No.	Date of Experiment	Date of Submission	Remarks

PART- A **EXPERIMENT NO:1**

AMPLITUDE MODULATION AND DEMODULATION

DATE:

AIM:

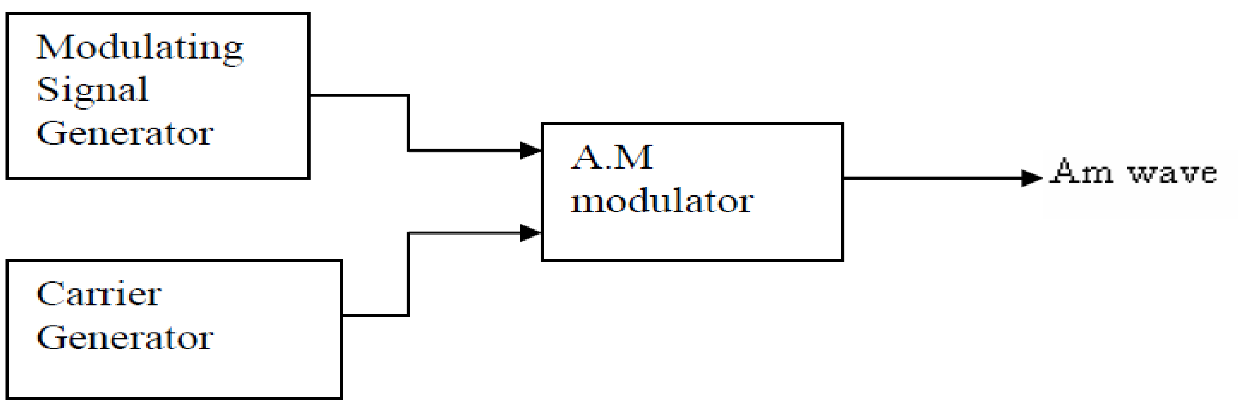
1. To generate Amplitude modulated signal and determine the percentage modulation for different values of message amplitudes.
2. To Demodulate the AM signal using envelope detector.

APPARATUS:

1. Amplitude Modulation and Demodulation Trainer Kit
3. Oscilloscope (20MHz)
4. Connecting cords & CRO probes

BLOCK DIAGRAM:

AM GENERATION:

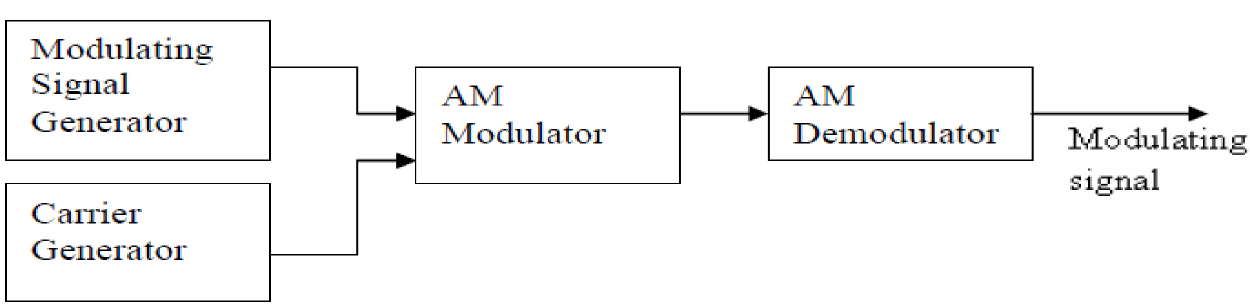


Generation methods:

(a) Square law Modulator:

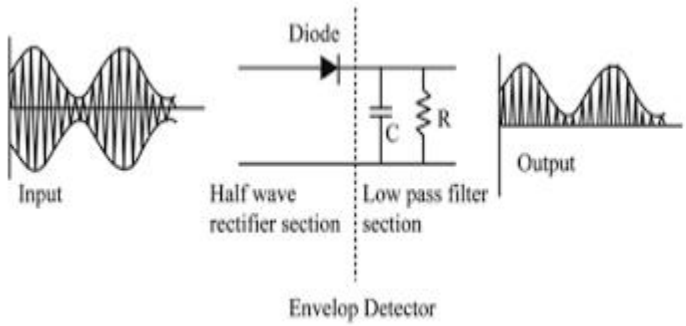
(b) Switching modulator:

AM Demodulation:



CIRCUIT DIAGRAM:

Simple AM Detector (Envelope Detector)



AM DEMODULATOR (Envelope Detector followed by low pass filter)

THEORY:

Amplitude modulation (AM) is defined as a process in which the amplitude of the carrier wave c(t) is varied about a mean value, linearly with the base band signal m(t).

An AM wave may thus be described, in its most general form, as a function of time as follows.

$$S(t)=A_C\,[1+K_a m(t)]\,\mathrm{Cos}\,(2\Pi f_C t)$$

The magnitude $K_a m(t)$ is always less than unity, that is $|K_a m(t)| < 1$ for all t

It ensures that the function $1+K_a m(t)$ is always positive. When the amplitude sensitivity K_a of the modulator is large enough to make $|K_a m(t)| > 1$ for any t, the carrier wave becomes over modulated, resulting in carrier phase reversals, whenever the factor $1+K_a m(t)$ crosses zero.

The absolute maximum value of $K_a m(t)$ multiplied by 100 is referred to as the percentage modulation.

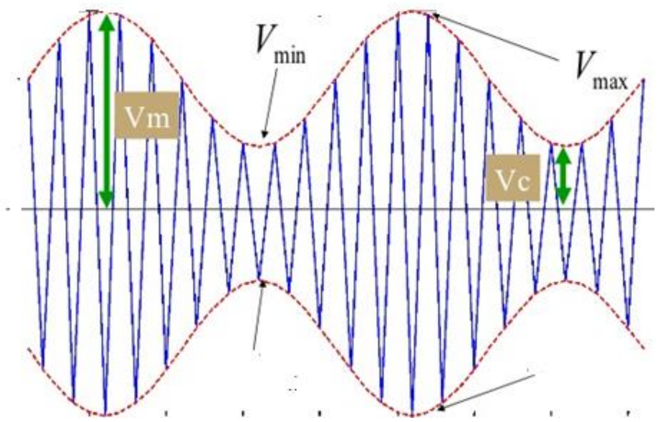
The demodulation circuit is used to recover the message signal from the incoming AM wave at the receiver. An envelope detector is a simple and yet highly effective device that is well suited for the demodulation of AM wave, for which the percentage modulation is less than 100%. Ideally, an envelope detector produces an output signal that follows the envelope of the input signal wave form exactly; hence, the name. Some version of this circuit is used in almost all commercial AM radio receivers.

PROCEDURE:

1. Check the outputs of AF(Audio Frequency) generator (message signal) and RF (Radio Frequency) generator (carrier signal). Make sure that the signal generators are giving sinusoidal signals correctly.

2. Connect the AF signal and RF signals to the inputs of the AM generator circuit.
3. Observe the output of the AM circuit. Adjust the amplitude knob of the AF signal and RF signal such that we get the under modulated signal. Now note down the Amplitude and time periods of AF signal and RF signal.
4. Measure the maximum and minimum P-P voltage of the modulated signal (Vmax & Vmin)
5. Find the modulation index by the following formula.

$$\mu = \frac{V_{max} - V_{min}}{V_{max} + V_{min}}$$



6. Apply the output of the AM signal to the input of the detector circuit and observe the output signal, measure the amplitude and time period of the demodulated signal. Compare this signal with the AF signal which we applied to the modulator.
7. Now change the amplitude of the message signal such that you get exact modulated signal and over modulated signal. Repeat the steps 3 to 6.

   Note: once you set the carrier amplitude don't change its amplitude for other cases

Observations:

Carrier signal Amplitude=____________

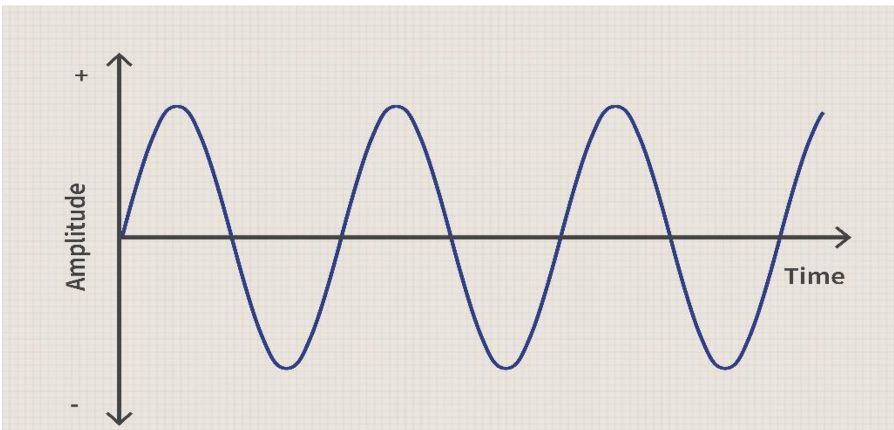
Carrier signal Frequency=___________

Message signal Frequency=__________

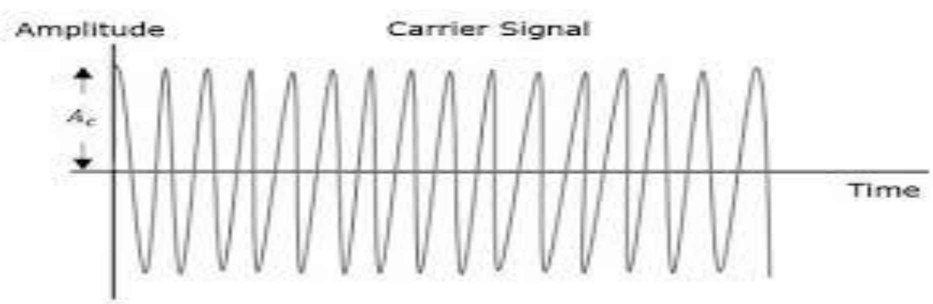
Type of modulation	A_m (Volts)	V_{max} (Volts)	V_{min} (Volts)	Modulation Index	Demodulated signal frequency	Demodulated signal Amplitude
Under modulation						
Exact modulation						
Over modulation						

EXPECTED WAVEFORMS:

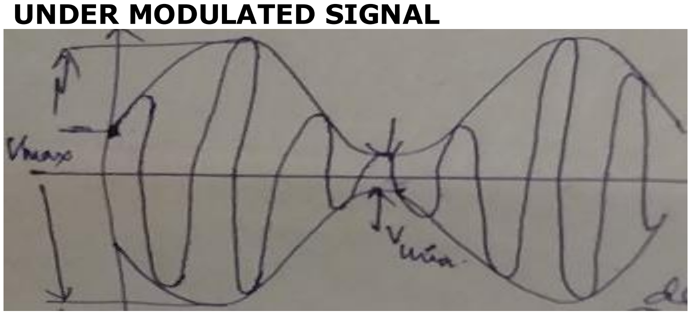
MODULATING SIGNAL (AF Signal)



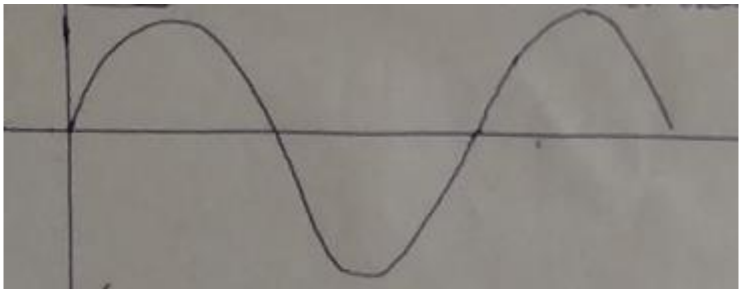
CARRIER SIGANAL (RF Signal)



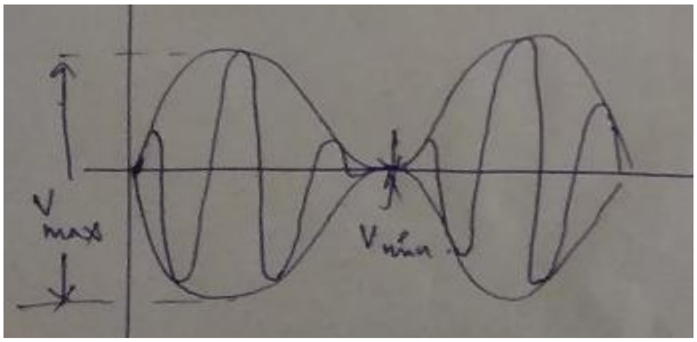
UNDER MODULATED SIGNAL



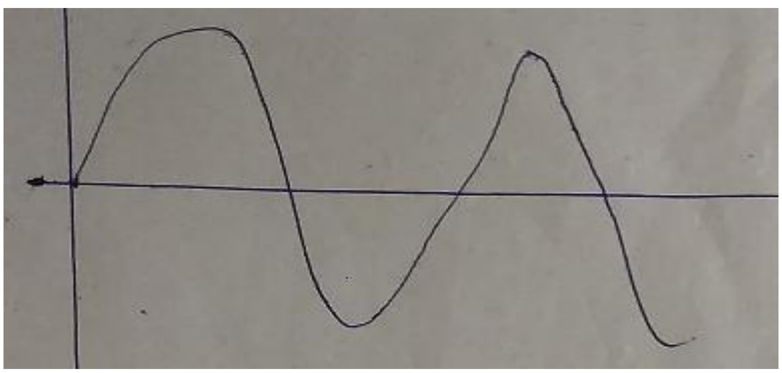
DEMODULATED SIGNAL



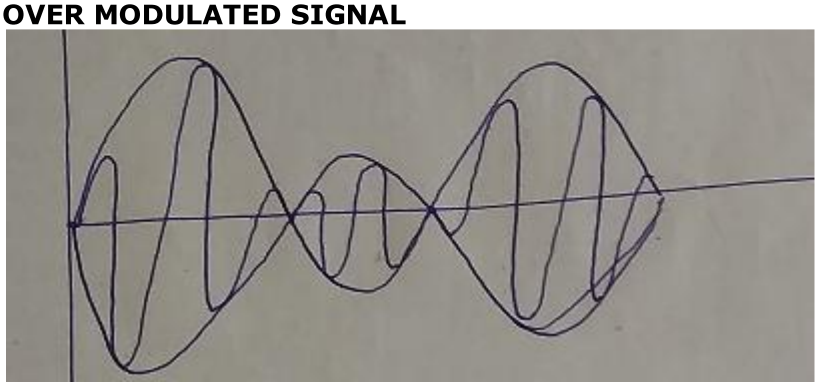
PERFECT MODULATION



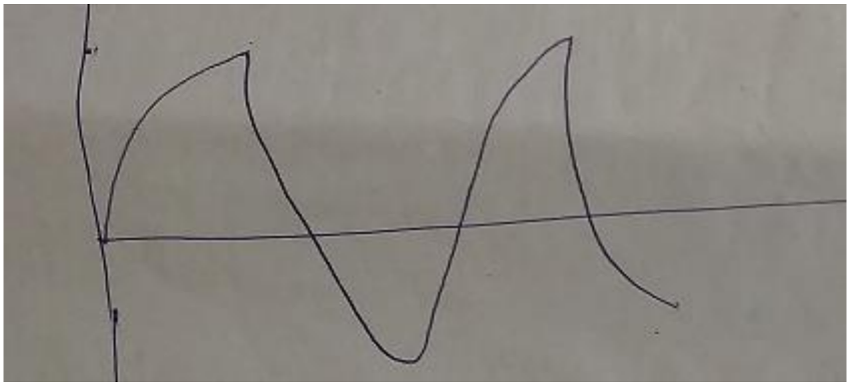
DEMODULATED SIGNAL



OVER MODULATED SIGNAL



DEMODULATED SIGNAL



Result:

Amplitude modulated wave is observed for different modulation indexes and observed that the demodulated signals frequency and shape is retained for the under modulated case only.

Viva Questions:

1. Define AM and draw its spectrum?
2. Draw the phasor representation of an amplitude modulated wave?
3. What are the generation methods of AM?
4. what is the transmission bandwidth of AM signal if the message bandwidth is ‘W’?
5. What are the demodulation methods of AM?
6. Explain about the envelope detector?

Write Matlab code using following steps:

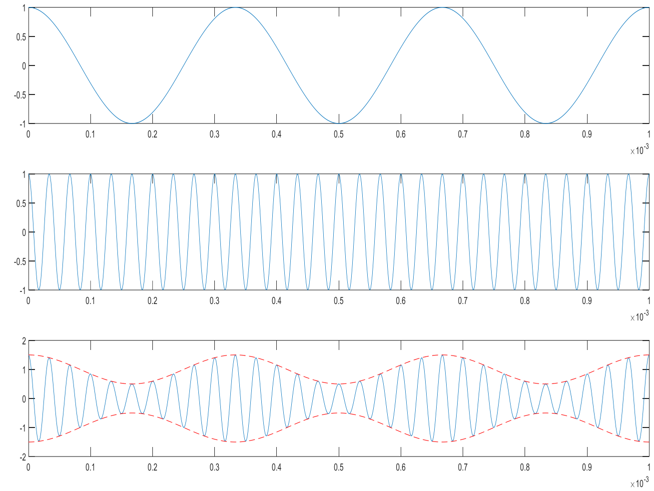
1. Define sampling frequency as well as message and carrier frequencies along with amplitudes.
2. Generate the sinusoidal message and carries signals using defined frequencies, respectively.
3. Choose Amplitude sensitivity factor (Ka) and there by calculate modulation index (Ka * Message Amplitude)
4. By making use of AM Equation define modulated signal and plot it with appropriate labelling
5. Repeat from step3 for different values of message amplitude for cases viz. under-modulation, over-modulation, and exact modulation
6. For demodulation multiply the under-modulated signal with carrier signal and pass it through the low pass filter

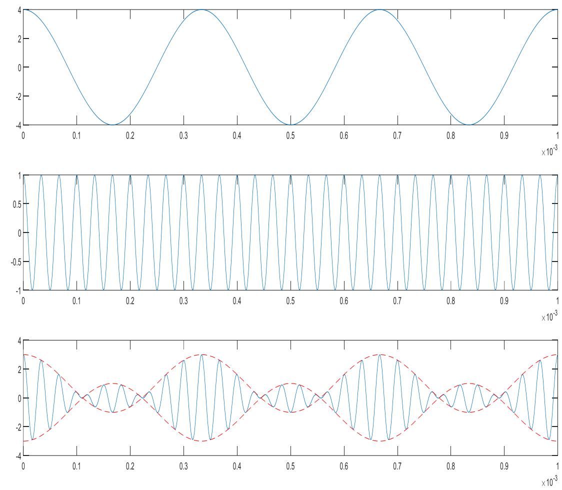
Note: filter design keyword in MATAB

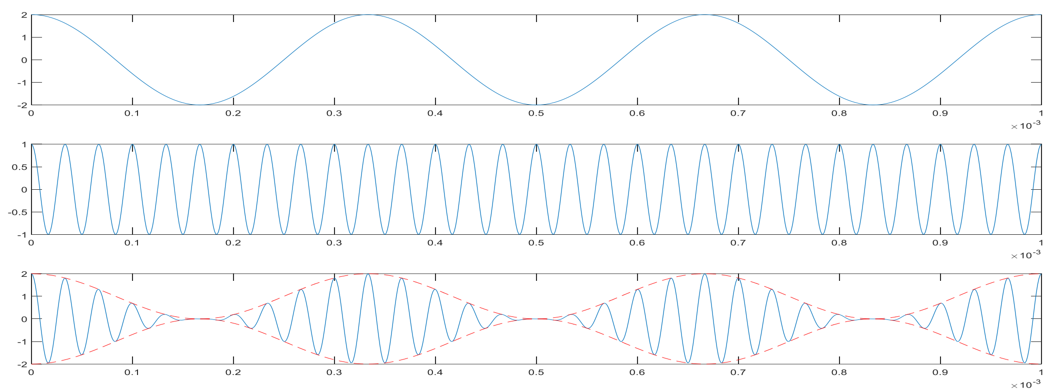
- Butter: for Filter coefficients
- filter: to process the filtering Action

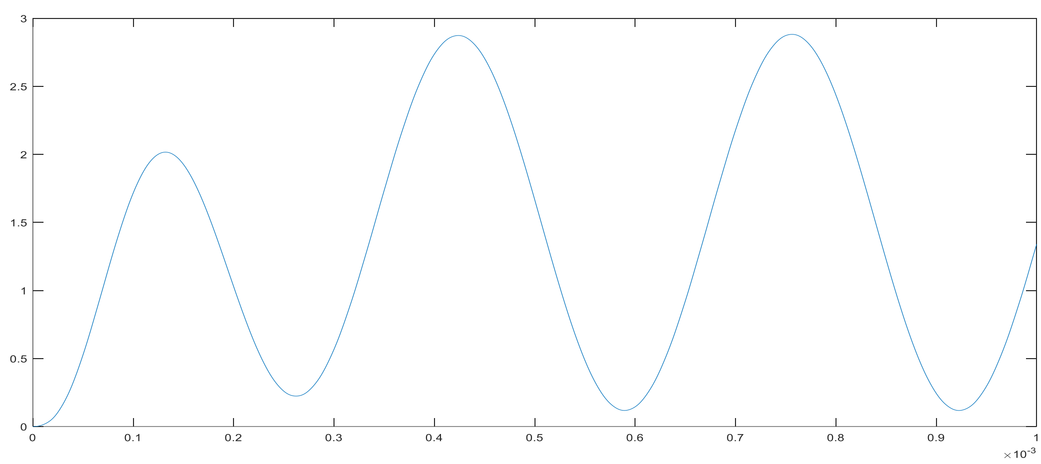
MATLAB Code:

Sample Simulated Wave forms for AM









PART-A **EXPERIMENT NO: 2**

DSB-SC MODULATION & DETECTION

DATE:

AIM:

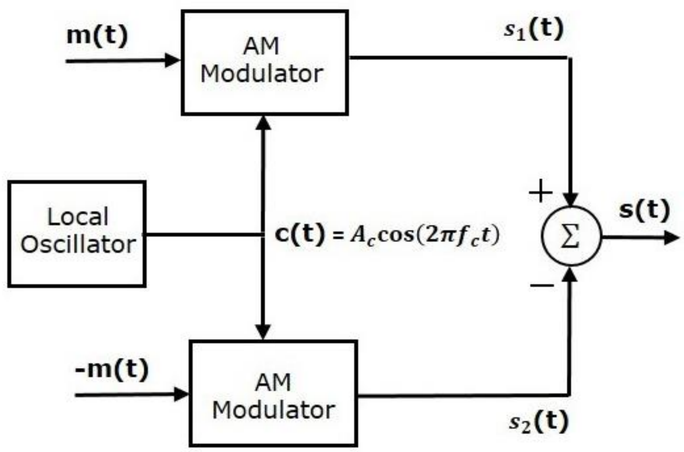
To generate and detect DSB-SC signals using balanced modulator (Product modulator)

APPARATUS:

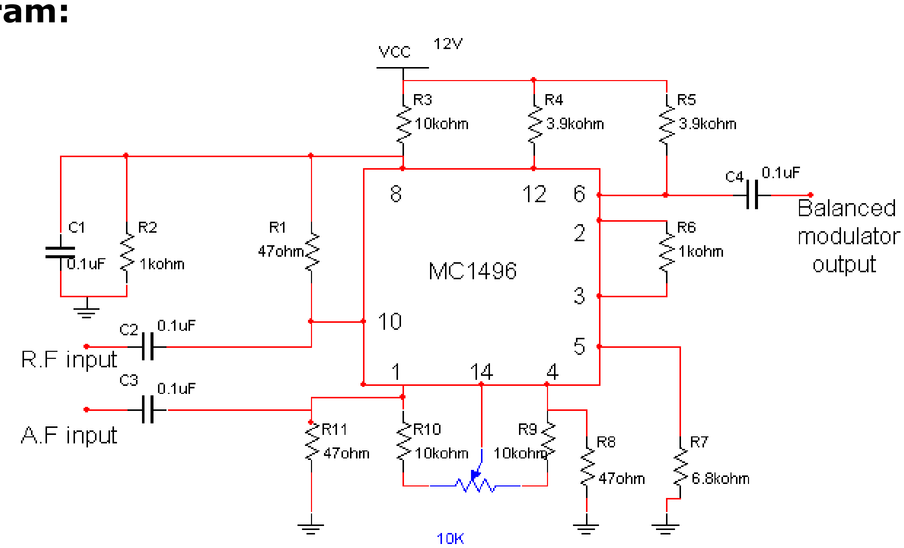
1. DSB-SC Trainer kit
2. CRO
3. Connecting wires & probes.

CIRCUIT DIAGRAM:

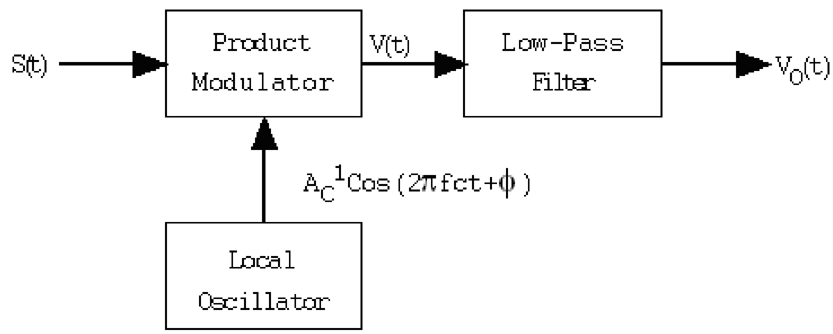
Modulator:



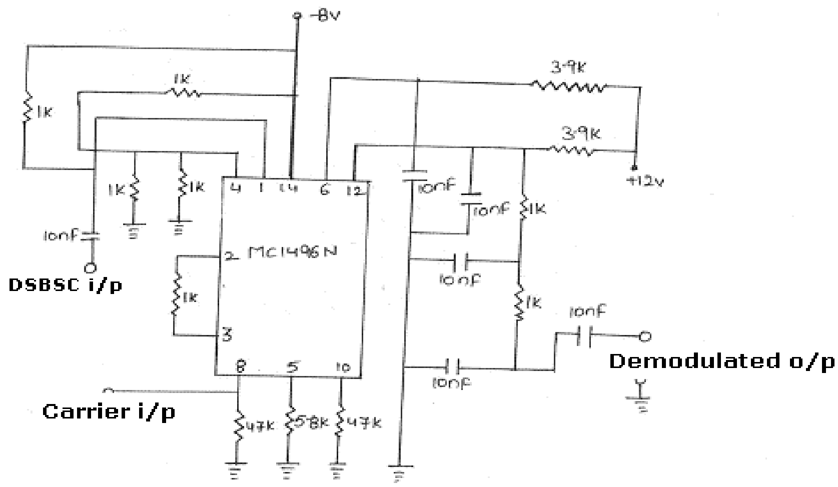
Circuit diagram:



Demodulator: (Synchronous Detector):



Circuit Diagram:



THEORY:

In AM the carrier wave does not convey any information and no information is conveyed by the carrier. In AM most of the power is wasted in the form of carrier transmission. If the carrier is suppressed, only the side bands remains and a saving of two third powers can be achieve at 100% modulation such suppression of carrier doesn't affect the massage signal in any way. This idea has resulted in the evolution of suppressed carrier modulation. Thus, the short coming of the conventional AM in regard of power wastage is overcome by suppressing the carrier from the modulated wave resulting in double side band suppressed carrier modulation.

A balanced modulator is used to generate DSBSC wave. A DSBSC signal is basically the product of the base band signal and the carrier wave.

S(t) = m(t) X C(t)

Where m(t) is base band signal

C(t) is carrier signal

$C(t) = A_c \cos 2\Pi f_c t$

The modulated wave under goes a phase reversal whenever base band signal m(t) crosses zero. The Spectrum of DSB-SC signal is given by

$$S(f) = A_c/2 \left[(M(f-f_c) + M(f+f_c) \right]$$

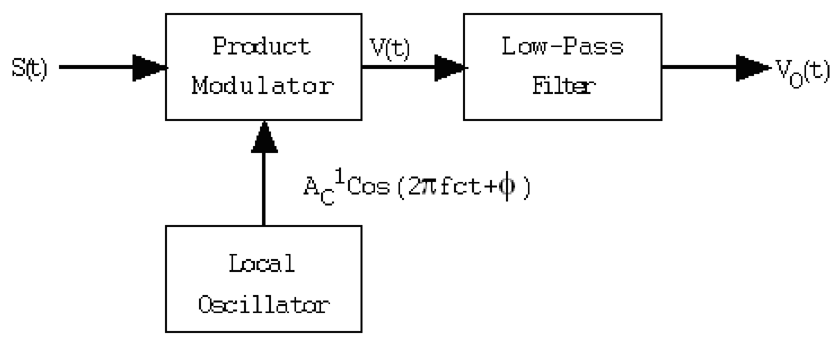
Where M (f) is the fourier transform of m(t)

A_c is carrier amplitude

And f_c is frequency of the carrier.

The band width of DSBSC signal is same as that of conventional AM i.e., 2W.

The base band signal m(t) can be uniquely recovered from a DSB-SC wave S(t) by first multiplying s(t) with a locally generated sinusoidal wave and then low-pass filtering the product, as in fig. below. It is assumed that the local oscillator signal is exactly coherent or synchronized, in both frequency and phase, with the carrier wave C(t) used in the product modulator to generate S(t). This method of demodulation is known as Coherent or Synchronous demodulation.

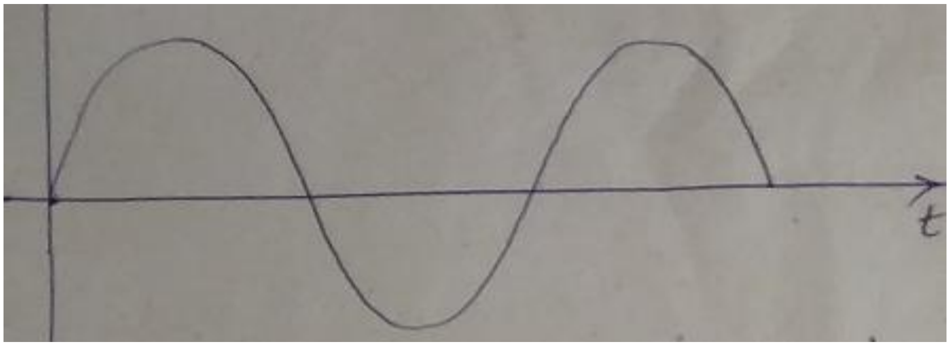


PROCEDURE:

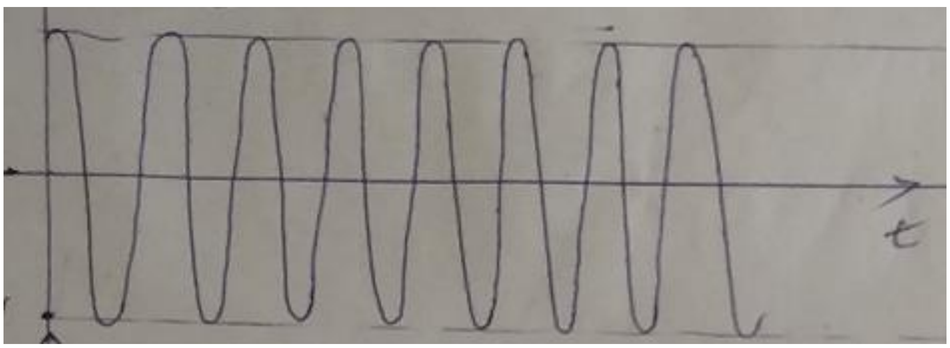
1. Check the outputs of AF generator (message signal) and RF generator (carrier signal). Make sure that the signal generators are giving sinusoidal signals correctly.
2. Connect the AF signal and RF signals to the inputs of the AM generator circuit.
3. Observe the output of the balanced modulator circuit. Adjust the Carrier null knob such that we get the equal sizes of lobes. Now note down the Amplitude and time periods of AF signal and RF signal.
4. Apply the DSB-SC output to the input of the synchronous detector of input.
5. Apply the RF carrier signal to another input of the synchronous detector.
6. Observe the output of the synchronous detector. Note down the time period and amplitude of the demodulated signal.

EXPECTED WAVE FORMS:

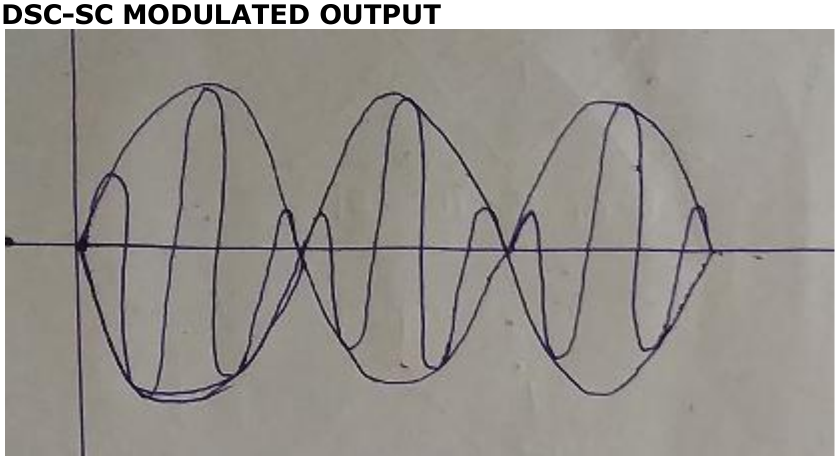
MODULATING SIGNAL (AF Signal)



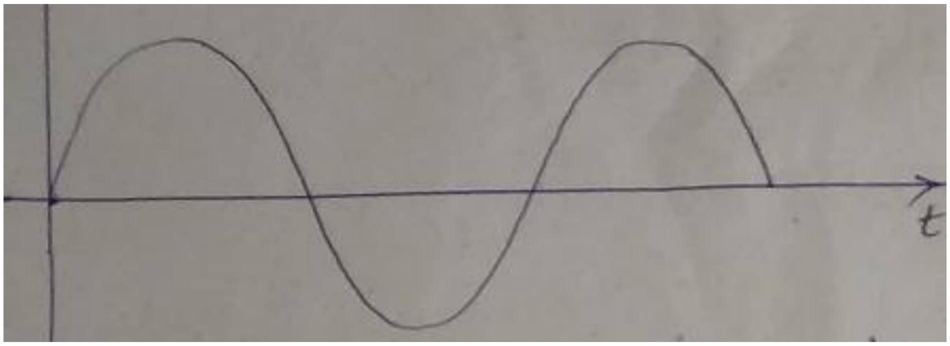
CARRIER SIGANAL (RF Signal)



DSC-SC MODULATED OUTPUT



Demodulated Signal:



PROCEDURE:

1. Apply DSB-SC signal to DSB-SC signal input of the synchronous detector and RF generator output to RF input of synchronous detector.
2. Observe the synchronous detector output on CRO and compare it with the original AF signal.

RESULT:

DSB-SC modulated wave is observed, and demodulation is performed by using synchronous detector.

VIVA Questions:

1. What are the two ways of generating DSB_SC.
2. What are the applications of balanced modulator?
3. What are the advantages of suppressing the carrier?
4. What are the advantages of balanced modulator?
5. What are the advantages of Ring modulator?
6. Write the expression for the output voltage of a balanced modulator?
7. Give any two methods to avoid errors in synchrouns demodulator?
8. What is quadrature null effect in synchronous demodulator?
9. What is beats in synchronous detector?
10. Give the block diagram of synchronous detector?
11. Give the working principle of coastas receiver.
12. What is squaring loop?

Write MATLAB code using following steps:

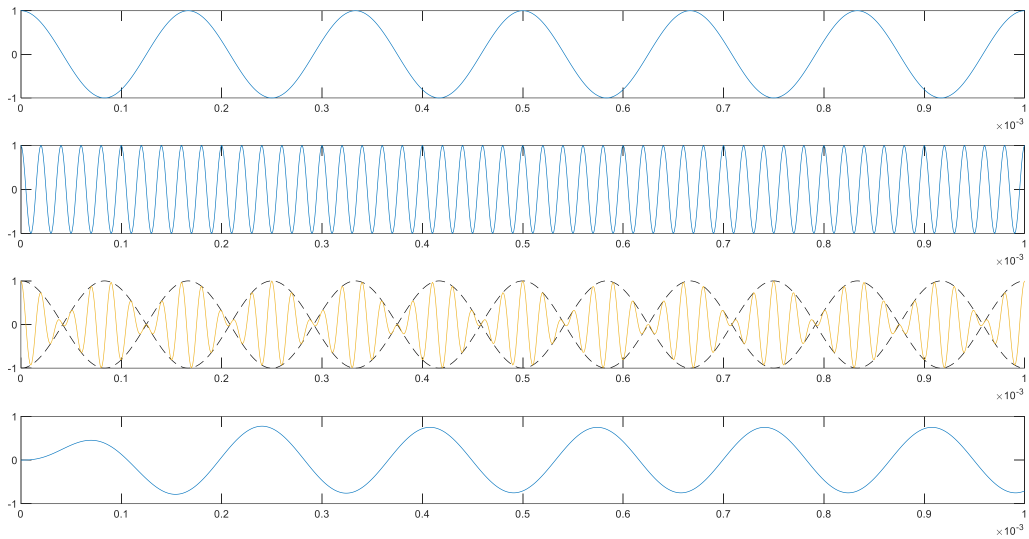
1. Define sampling frequency as well as message and carrier frequencies along with amplitudes.
2. Generate the sinusoidal message and carries signals using defined frequencies respectively.
3. By making use of DSB-SC Equation define modulated signal and plot it with appropriate labelling
4. For demodulation multiply the modulated signal with carrier signal and pass it through the low pass filter

Note: filter design keyword in MATLAB

- Butter: for Filter coefficients
- filter: to process the filtering Action

MATLAB Code:

Sample Simulated Wave forms for DSB-SC



PART-A **EXPERIMENT NO: 3**

SSB-SC MODULATOR & DETECTOR (PHASE SHIFT METHOD)

DATE:

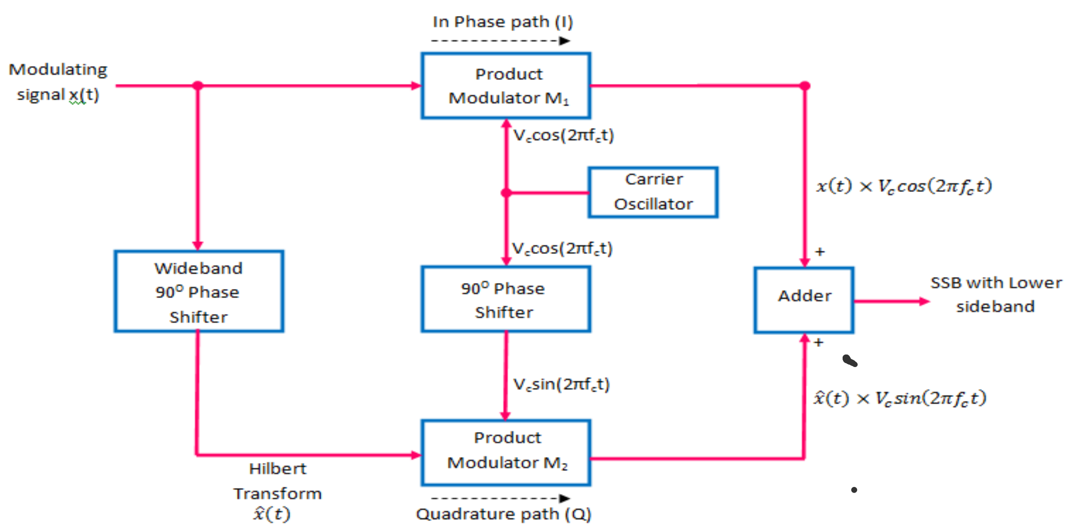
AIM:

To generate SSB-SC signal using phase Shift method and demodulate the SSB-SC signal using Synchronous detector.

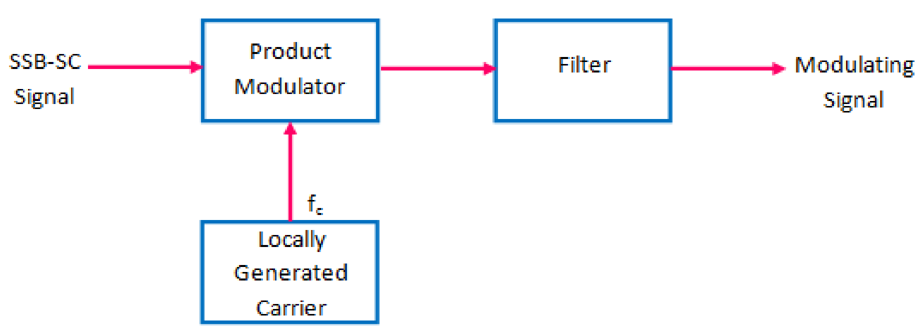
APPARATUS:

1. SSB trainer kit
2. C.R.O (20MHz)
3. Function Generator (1MHz).

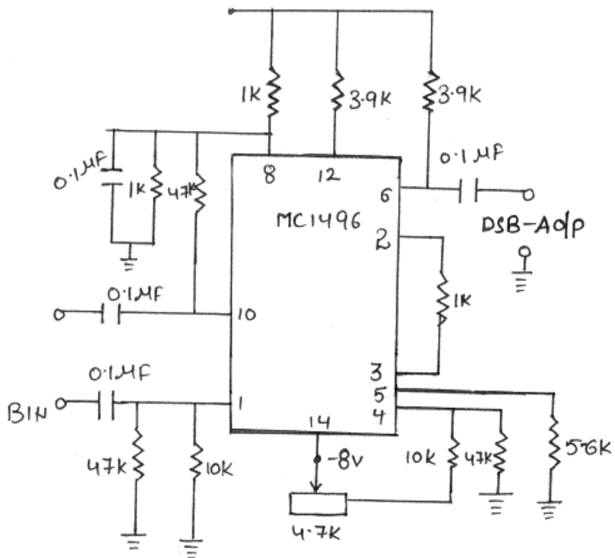
BLOCK DIAGRAM: (Phase Shift method)

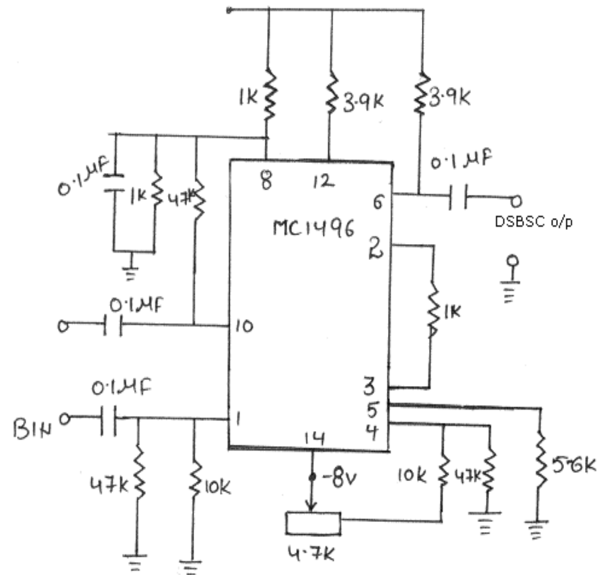


SSB DEMODULATION

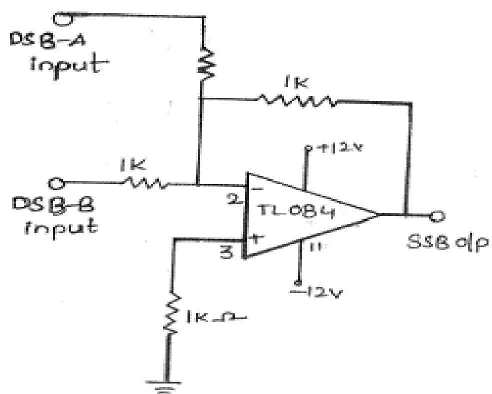


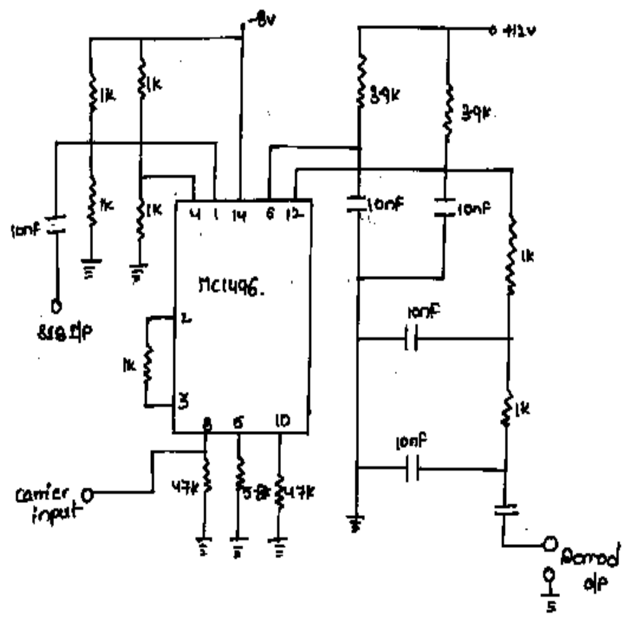
CIRCUIT DIAGRAMS:





DSB-SC A Modulator **DSB-SC B Modulator**





SUMMER **DEMODULATOR**

THEORY:

An SSB signal is produced by passing the DSB signal through a highly selective band pass filter. This filter selects either the upper or the lower sideband. Hence transmission bandwidth can be cut by half if one sideband is entirely suppressed. This leads to single-sideband modulation (SSB). In SSB modulation bandwidth saving is accompanied by a considerable increase in equipment complexity.

The phase shift method makes use of two balanced modulators and two phase shift networks as shown in fig. One of the modulators receives the carrier signal shifted by 90^0 and the modulating signal with 0^0 (sine)phase shift, whereas the other receives modulating signal shifted by 90^0 (co-sine) and the carrier (RF) signal with 0^0 phase shift voltage.

Both modulators produce an output consisting only of sidebands. It will be shown that both upper sidebands lead the input carrier voltage by 90^0. One of the lower sidebands leads the reference voltage by 90^0, and the other lags it by 90^0. The two lower sidebands are thus out of phase, and when combined in the adder, they cancel each other. The upper sidebands are in phase at the adder and therefore they add together and give SSB upper side band signal. When they combined in the subtractor, the upper side bands are canceling because in phase and lower side bands add together and gives SSB lower side band signal.

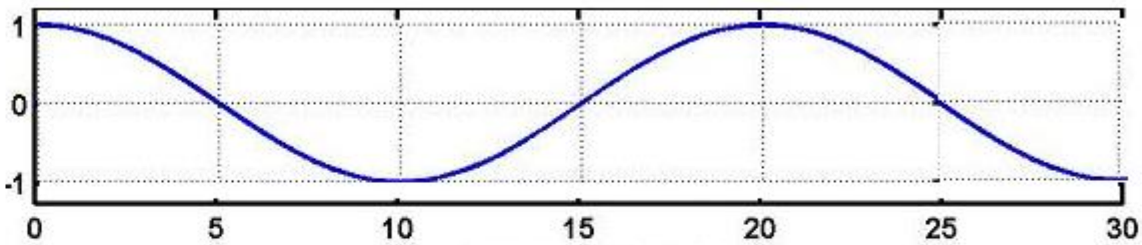
PROCEDURE:

SSB Modulation

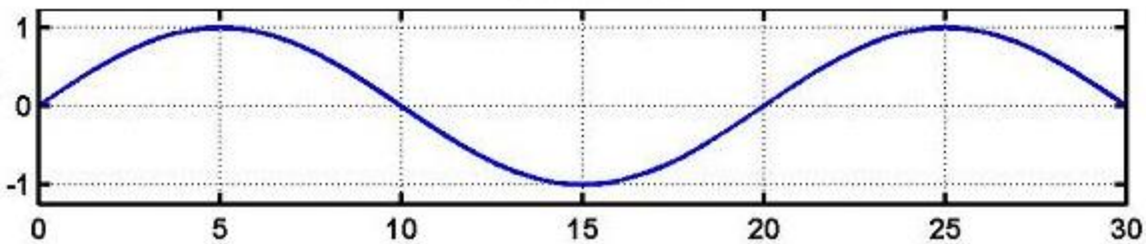
1. Check the outputs of AF generators (0^o & 90^ol) and RF generator (0^o & 90^ol). Make sure that the signal generators are giving sinusoidal signals correctly with the given phases.
2. Connect the AF signal (0^o) and RF signals (0^o) to the inputs of the DSB-SC-A circuit.
3. Observe the output of the balanced modulator circuit. Adjust the Carrier null knob such that we get the equal sizes of lobes. Now note down the Amplitude and time periods of AF signal and RF signal.
4. Connect the AF signal (90^o) and RF signals (90^o) to the inputs of the DSB-SC-B circuit.
5. Observe the output of the balanced modulator circuit. Adjust the Carrier null knob such that we get the equal sizes of lobes. Now note down the Amplitude and time periods of AF signal and RF signal.
6. Now you can observe that the two balanced modulators outputs have exactly 90^o phase shift.
7. Apply the outputs of DSB-SC A and DSB-SC-B signals to the input of an adder circuit, which will add the two signals and should give a sinusoidal signal with frequency equal to [$\cos 2\pi f_m t \cos 2\pi f_c t + \sin 2\pi f_m t \sin 2\pi f_c t = \cos 2\pi(f_c - f_m)t$] $f_c - f_m$, which will give us the lower side band frequency.
8. Now draw a sinusoidal signal with frequency equal to $f_c - f_m$.
9. Apply the output of the adder circuit to one of the inputs of the synchronous detector, and apply carrier signal to another input of the circuit.
10. Observe the output of the synchronous detector and note down the amplitude and time period of the demodulated signal.

EXPECTED WAVEFORMS:

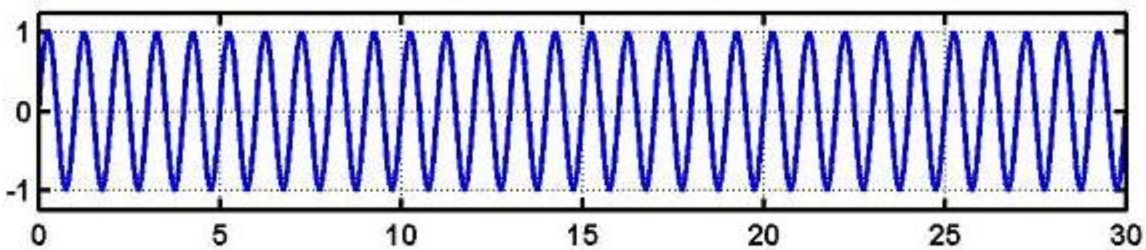
AF MODULATING SIGNAL(0 ^{0})



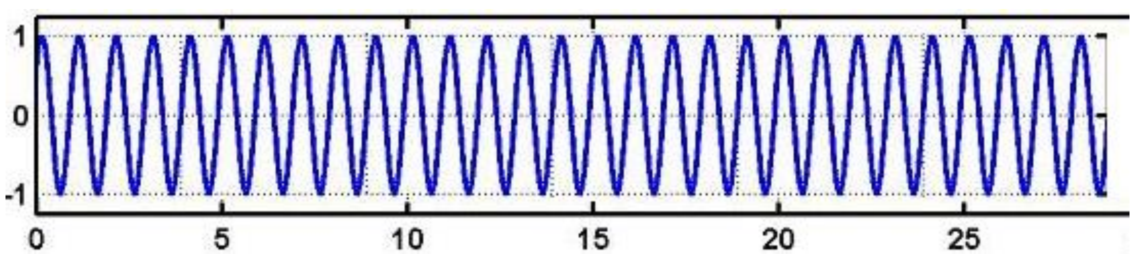
AF MODULATING SIGNAL(90 ^{0})



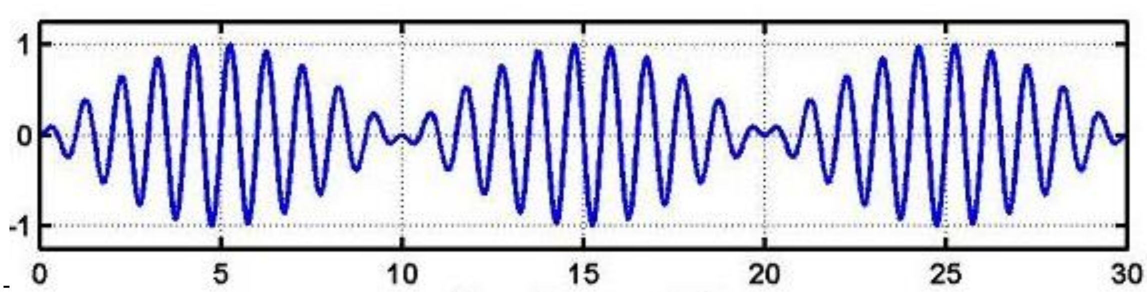
RF MODULATING SIGNAL(0 ^{0})



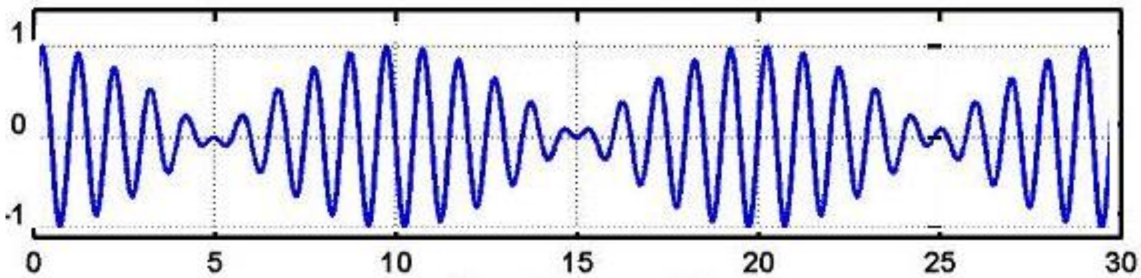
RF MODULATING SIGNAL(90 ^{0})



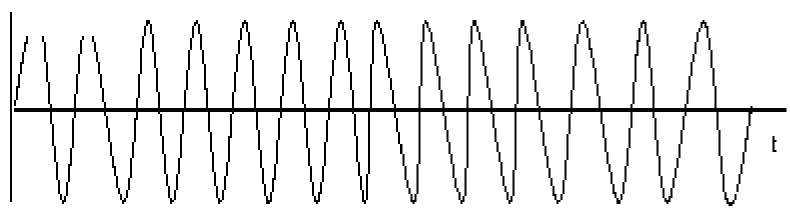
DSB-SC-A Output



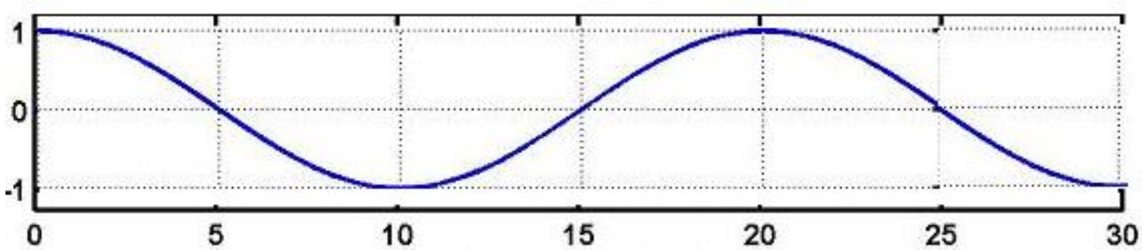
DSB-SC-B Output



SSB-SC Output (Adder output)



Demodulated Output



OBSERVATIONS:

NOTE:

- Update the following readings upon getting the required waveforms as shown in model graphs ONLY
- Amplitude of all Message signals should be same. Follow the same for the amplitude of carrier signals.

Message signal Amplitude (0^0, 90^0) =____________

Message signal Time Period =__________

Message signal Frequency=__________

Carrier signal Amplitude (0^0, 90^0) =____________

Carrier signal Time Period=___________

Carrier signal Frequency=___________

DSB-SC-A Signal Amplitude _____________________

DSB-SC-A Signal Time Period _____________________

DSB-SC-B Signal Amplitude _____________________

DSB-SC-B Signal Time Period ______________________

SSB-SC Signal Amplitude ______________________

SSB-SC Signal Time Period ______________________

NOTE*: Draw a sinusoidal signal with frequency $fc \pm fm$ with arbitrary magnitude

Reference:

Sine and Cosine Addition and Subtraction Formulas

$$\sin(a+b) = \sin a \cos b + \cos a \sin b$$

$$\sin(a-b) = \sin a \cos b - \cos a \sin b$$

$$\cos(a+b) = \cos a \cos b - \sin a \sin b$$

$$\cos(a-b) = \cos a \cos b + \sin a \sin b$$

Demodulated Signal Amplitude ______________________

Demodulated Signal Time Period ______________________

Demodulated Signal Frequency ______________________

Result:

SSB-SC modulation and demodulation is observed.

VIVA Questions:

1. What are the two ways of generating SSB?
2. What are the advantages of suppressing the sideband?
3. What are the advantages of phase discrimination method?
4. Write the expression for the output voltage of a SSB modulator?
5. What is the bandwidth required for SSB?
6. What is the power required for SSB?

Write MATLAB code using following steps:

1. Define sampling frequency as well as message and carrier frequencies along with amplitudes.
2. Generate the sinusoidal message as well as carries signals with 0- and 90-degree phase shifts using defined frequencies.
3. By making use of DSB-SC Equation define modulated signal-A and B and plot them with appropriate labelling
4. Add/subtract generated DSB-SC signals A and B to get SSB-SC signal and plot it.
5. For demodulation multiply the modulated signal with carrier signal and pass it through the low pass filter

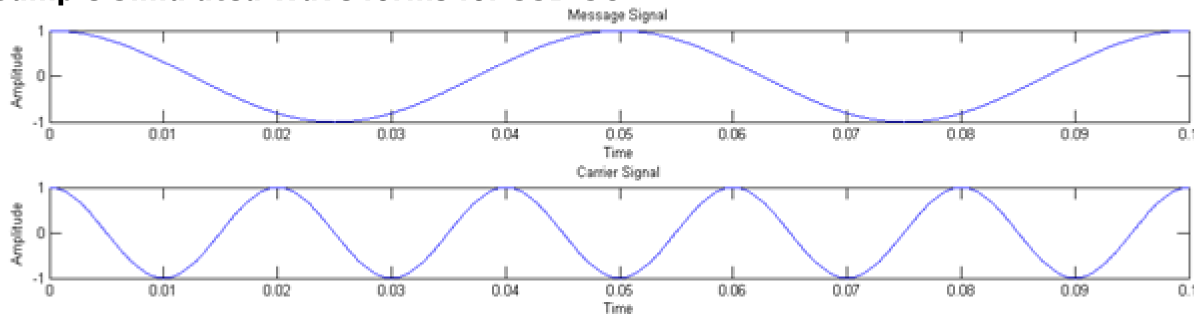
Note: filter design keyword in MATLAB

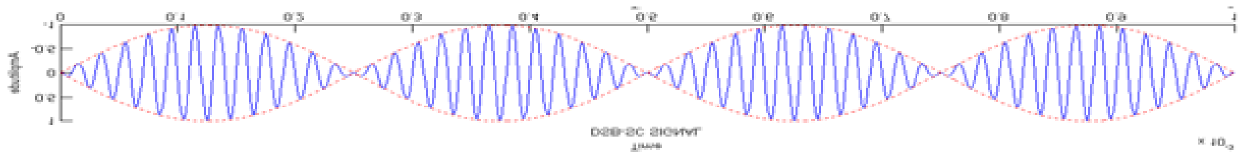
Butter: for Filter coefficients

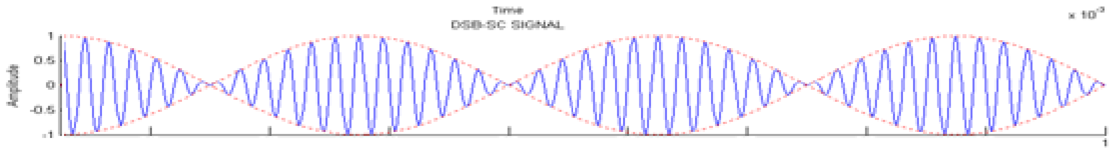
filter: to process the filtering Action

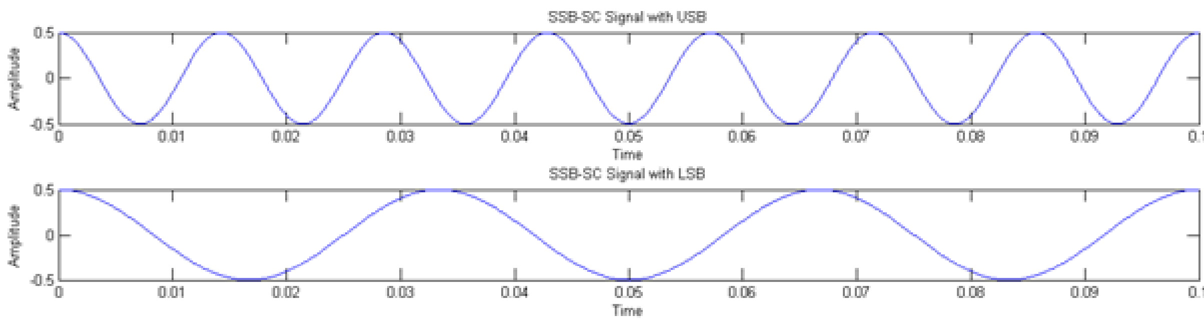
MATLAB Code:

Sample Simulated Wave forms for SSB-SC









PART-A **EXPERIMENT NO: 4**

FREQUENCY MODULATION & DEMODULATION

Date:

AIM:

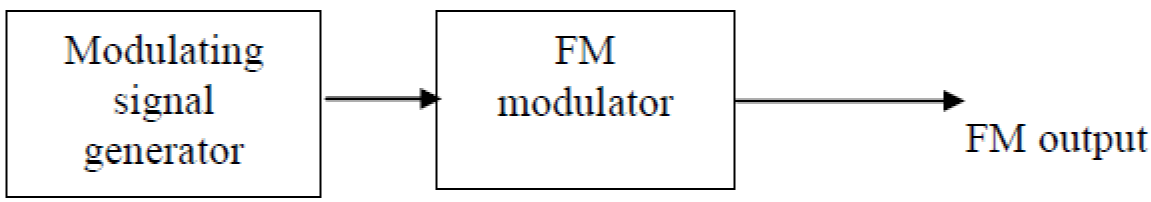
To study observe the wave forms of frequency modulated signals, thereby calculate the modulation index for different values of modulating signal voltages. Able to demodulate the FM signals using PLL circuit.

APPARATUS:

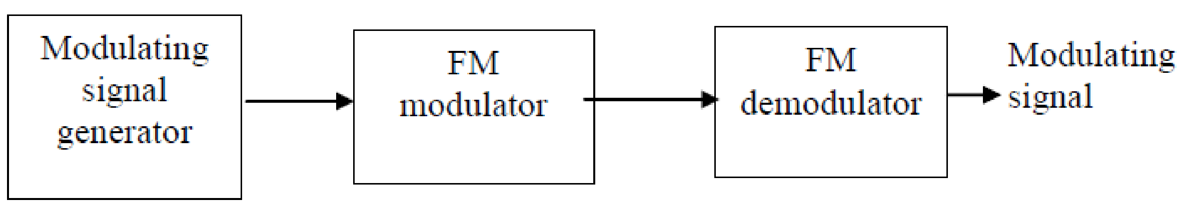
1. Frequency modulation & demodulation trainer kit.
2. C.R.O (20MHz)
3. Function generator (1MHz).
4. Connecting chords & probes.

BLOCK DIAGRAMS:

Modulation



Demodulation



THEORY:

FM is a system in which the amplitude of the modulated carrier is kept constant, while its frequency and rate of change are varied by the modulating signal.

By the definition of FM, the amount by which the carrier frequency is varied from its unmodulated value, called the deviation, is made proportional to the instantaneous amplitude of the modulating voltage. The rate at which this frequency variation changes or takes place is equal to the modulating frequency.

FM is that form of angle modulation in which the instantaneous frequency $f_i(t)$ is varied linearly with the message signal m(t), as

$$\mathbf{f_i(t) = f_C + k_f\, m(t)}$$

The term f_C represents the frequency of the unmodulated carrier, and the constant K_f represents the frequency sensitivity of the modulator expressed in Hertz per volt.

Unlike AM, the spectrum of an FM signal is not related in a simple manner to that of modulating signal, rather its analysis is much more difficult than that of an AM signal.

PROCEDURE:

1. Switch on the power supply of the kit (without making any connections).
2. Measure the frequency of the carrier signal at the FM output terminal with input terminals open and plot the same on graph.
3. Connect the circuit as per the given circuit diagram.
4. Apply the modulating signal of 500HZ with 1Vp-p.
5. Trace the modulated wave on the C.R.O & plot the same on graph.
6. Find the modulation index by measuring minimum and maximum frequency deviations from the carrier frequency using the CRO.

$$Mr = \frac{S}{f} = \frac{\text{maximum Frequency deviation}}{\text{modulating signal frequency}}$$

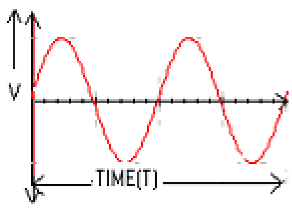
7. Repeat the steps 5& 6 by changing the amplitude and /or frequency of the modulating Signal.
8. For demodulation apply the modulated signal as an input to demodulator circuit and compare the demodulated signal with the input modulating signal & also draw the same on the graph.

TABULAR COLUMN:

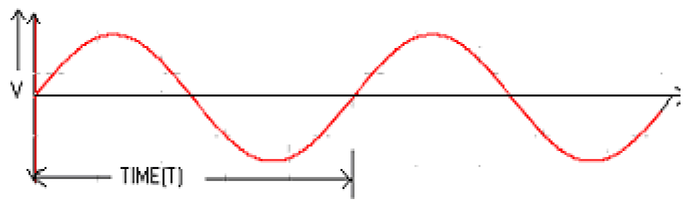
S.No.	Message Signal Frequency (fm)	Message Signal amplitude	t1	f_1	t2	f_2	Frequency deviation $\Delta f = f_1 \sim f_2$	Modulation index $\beta = \Delta f / fm$	FM Bandwidth $B=2(\beta+1)$ fm
1.									

EXPECTED WAVEFORMS:

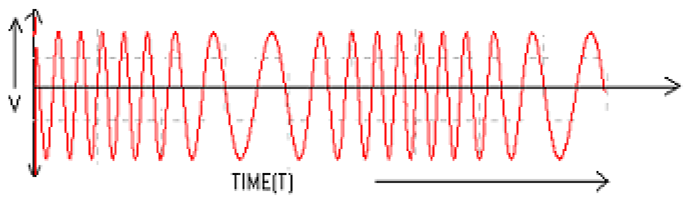
CARRIER SIGNAL



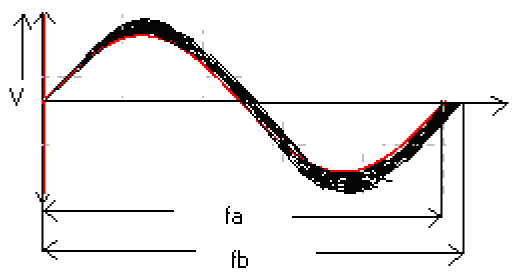
MODULATING SIGNAL



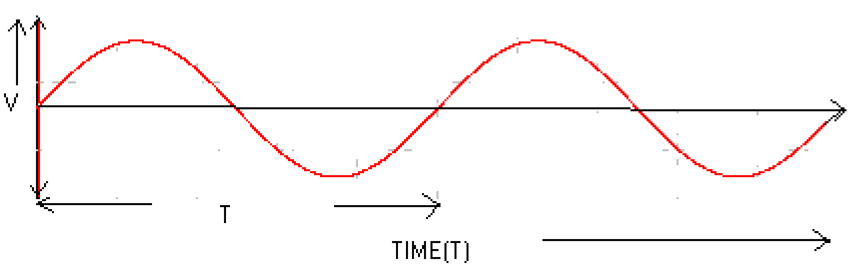
MODULATED SIGANAL



FREUUENCY DEVIATION FOR ONE COMPLETE CYCLE



DEMODULATED SIGNAL



Result: Frequency modulated wave is observed for different modulation indexes

VIVA Questions:

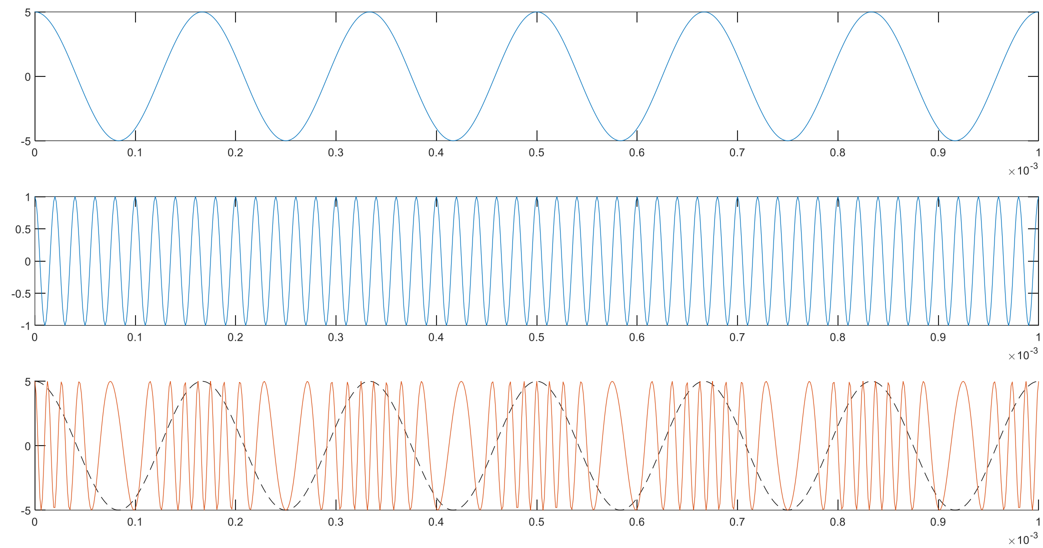
1. What are the two ways of generating FM.
2. What are the differences between NBFM and WBFM?
3. What is the transmission band width of FM?
4. What is the power required for FM?

Write Matlab code using following steps:

1. Define sampling frequency as well as message and carrier frequencies along with amplitudes.
2. Generate the sinusoidal message and carries signals using defined frequencies, respectively.
3. Define modulation index (generally > 1)
3. By making use of FM Equation define modulated signal and plot it with appropriate labelling
4. For demodulation use ‘demod’ function with relevant arguments in MatLAB

MATLAB Code

Sample Simulated waveforms for FM



PART-A **EXPERIMENT NO:5**

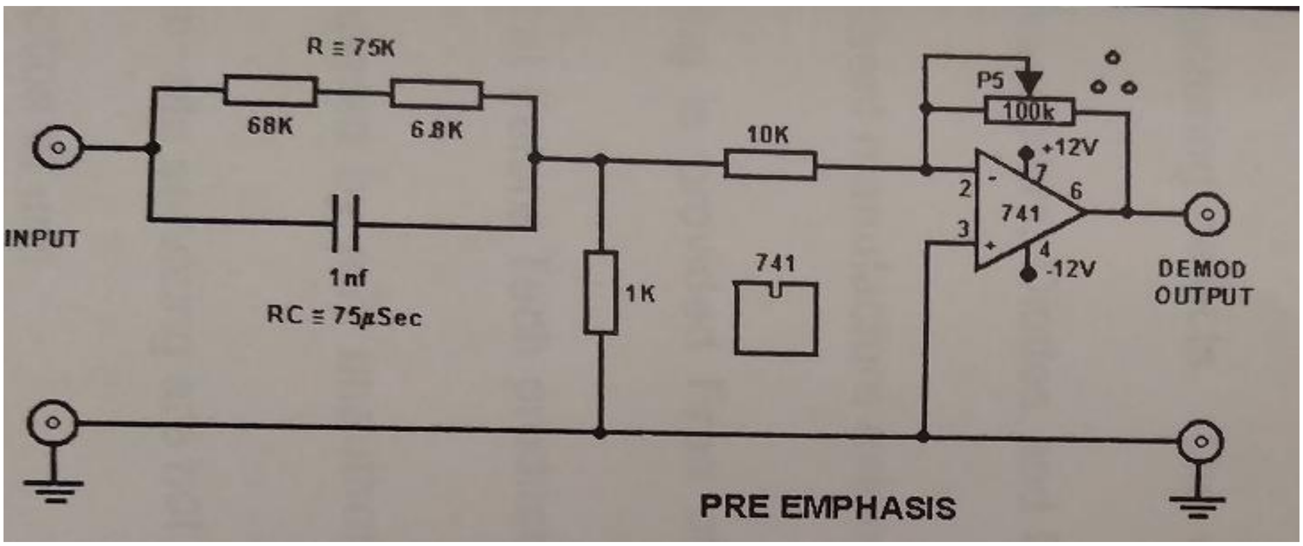
FREQUENCY RESPONSE OF PRE-EMPHASIS & DE-EMPHASIS CIRCUIT

APPARATUS:

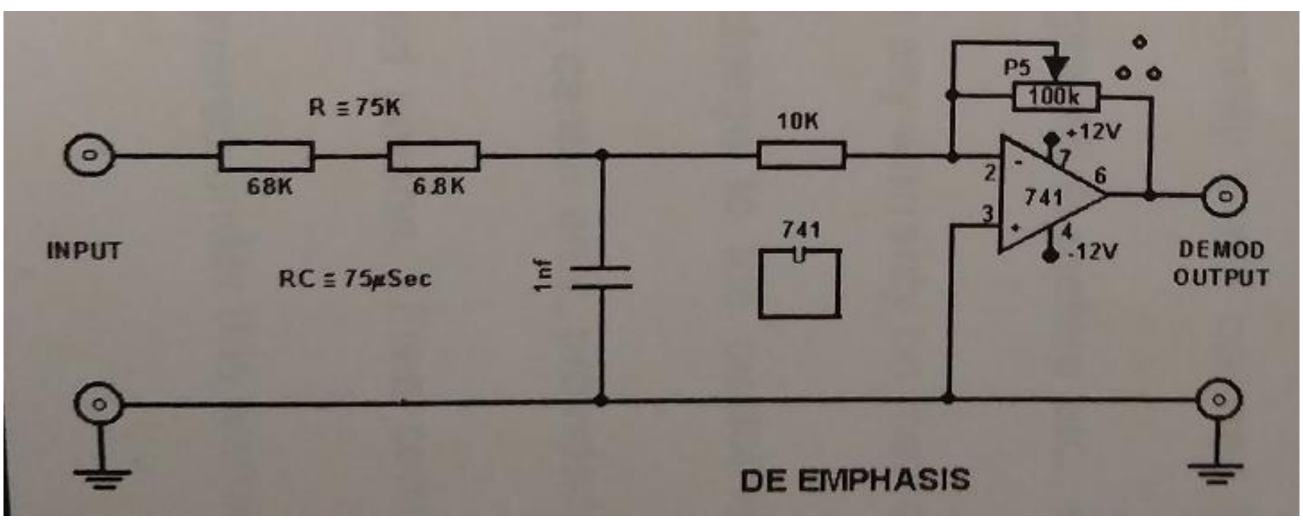
1. Pre-emphasis & De-emphasis trainer kits.
2. C.R.O (20MHz)
3. Function generator (1MHz).
4. Patch chords and Probes.

CIRCUIT DIAGRAMS:

PRE-EMPHASIS CKT



DE EMPHASIS CKT



THEORY:

Frequency modulation is much more immune to noise than amplitude modulation and is significantly more immune than phase modulation. The threshold effect is more serious in FM as compared to AM, because in FM, the signal to noise ratio at the input of a detector, at which threshold effect starts, is higher. Lower the threshold level, better is the system because threshold can be avoided at a comparatively lower ratio, and a small signal is needed to avoid threshold for an equivalent noise power. Hence, it is desirable to lower the threshold level in the FM receivers. The process of lowering the threshold level is known as threshold improvement, or threshold reduction. Two methods are used for the improvement of the threshold.

1. Pre-Emphasis and De-Emphasis circuits.
2. FMFB (Frequency Modulation with Feed Back.)

PRE-EMPHASIS AND DE-EMPHASIS:

The noise triangle shows, noise has a greater effect on the higher modulating frequencies than on the lower ones. Thus, if the higher frequencies were artificially boosted at the transmitter and correspondingly cut at the receiver, an improvement in noise immunity could be expected, thereby increasing the signal-to-noise ratio. This boosting of the higher modulating frequencies, in accordance with a prearranged curve, is termed pre-emphasis, and the compensation at the receiver is called de-emphasis.

PROCEDURE:

PRE-EMPHASIS:

1. Connect the circuit as per the circuit diagram
2. Apply a sine wave of 50mV (V_I) from the function generator to the input of Pre-emphasis circuit.
3. By varying the input frequency from 100HZ to 15KHZ, note down the output amplitude (Vo) of the pre emphasis circuit and tabulate the readings. observe that as the input frequency increases the output voltage will increase linearly.
4. Calculate the gain using the formula

   Gain = 20 log (V_O/ V_I) db

   Where V_O = output voltage in volts.

   V_I = Input voltage in volts.
5. Plot the frequency response.

DE-EMPHASIS:

1. 1. Apply a sine wave of 2V (V_I) from the function generator to the input of De-emphasis circuit.
2. By varying the input frequency from 100HZ to 15KHZ, note down the output amplitude (Vo) of the pre emphasis circuit and tabulate the readings. Observe that as the input frequency increases the output voltage will decrease linearly.
3. Calculate the gain using the formula

   Gain = 20 log (V_O/ V_I) db

   Where V_O = output voltage in volts.

   V_I = Input voltage in volts.

5. Plot the frequency response.

TABULAR FORM:

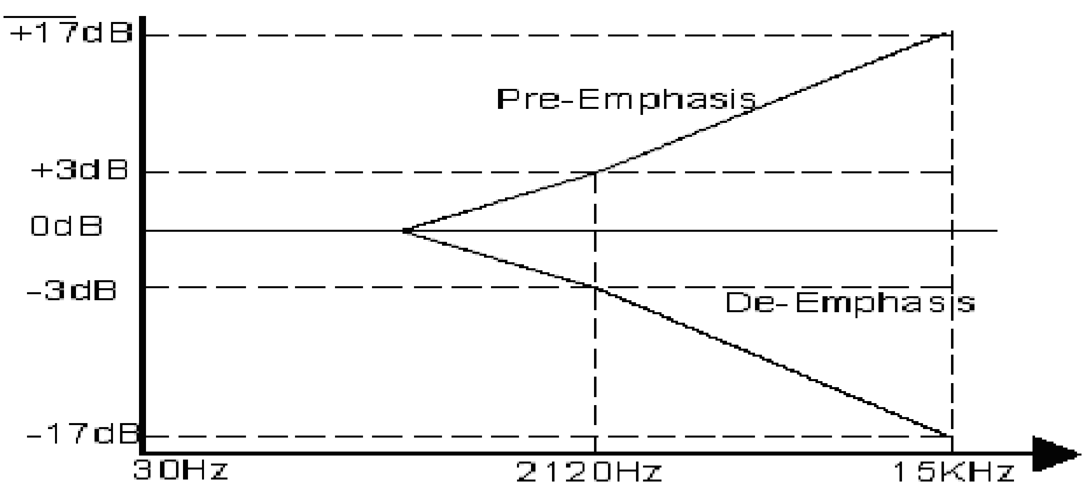
Pre-emphasis (V_I =50mV)

S.No	Input Frequency (100Hz to 15KHz)	Output voltage (Vo) (volts)	GAIN 20 log (V_O/ V_I) db

De-emphasis (V_i = 2V)

S.No	Input Frequency (30Hz to 15KHz)	Out put voltage (Vo) (volts)	GAIN 20 log (V_O/ V_I) db

EXPECTED WAVEFORMS:



Result:

The functioning of pre-emphasis and de-emphasis is observed and frequency response plot have been plotted.

VIVA Questions:

1. What is the need for pre-emphasis and de-emphasis?

2. What is noise triangle of FM?

3. What is normalized frequency?

4. How PSD of noise characteristics will be changed according to the variation in modulation index of FM?

PART –A **EXPERIMENT NO: 6**

PULSE AMPLITUDE MODULATION (PAM) & DEMODULATION

Date:

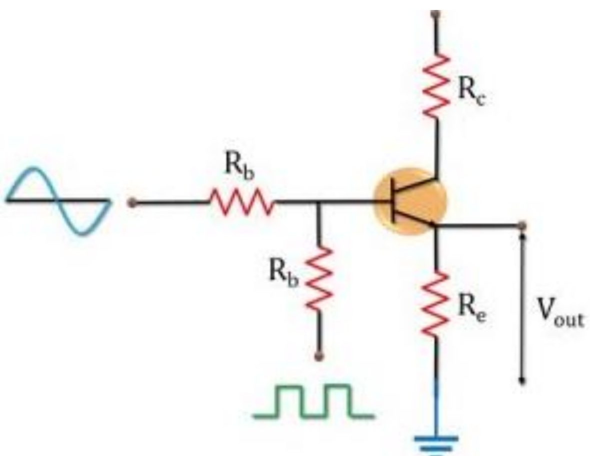
AIM:

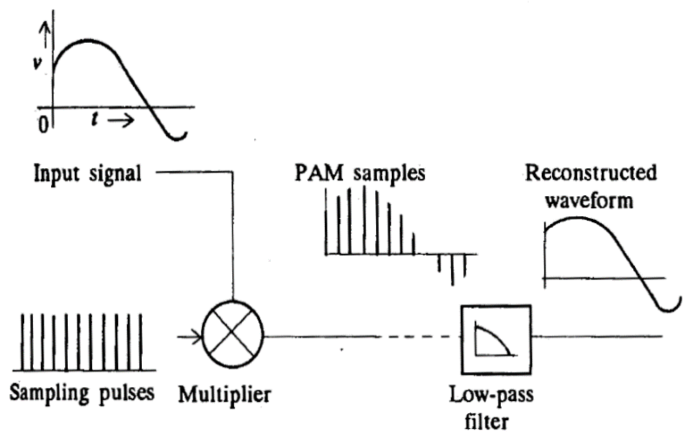
To study Pulse Amplitude modulation and demodulation process with relevant waveforms.

APPARATUS:

1. Pulse amplitude modulation and demodulation kit
2. CRO
3. Signal generator
4. BNC probes, connecting wires

PAM Generation Circuit diagram:





THEORY:

In amplitude and angle modulation, some characteristic of the carrier amplitude, frequency, or phase is continuously varied in accordance with the modulating information. However, in pulse modulation a small sample is made of the modulating signal and then a pulse is transmitted. In this case, some characteristic of the pulse is varied in accordance with the sample of the modulating signal. The sample is actually a measure of the modulating signal at a specific time.

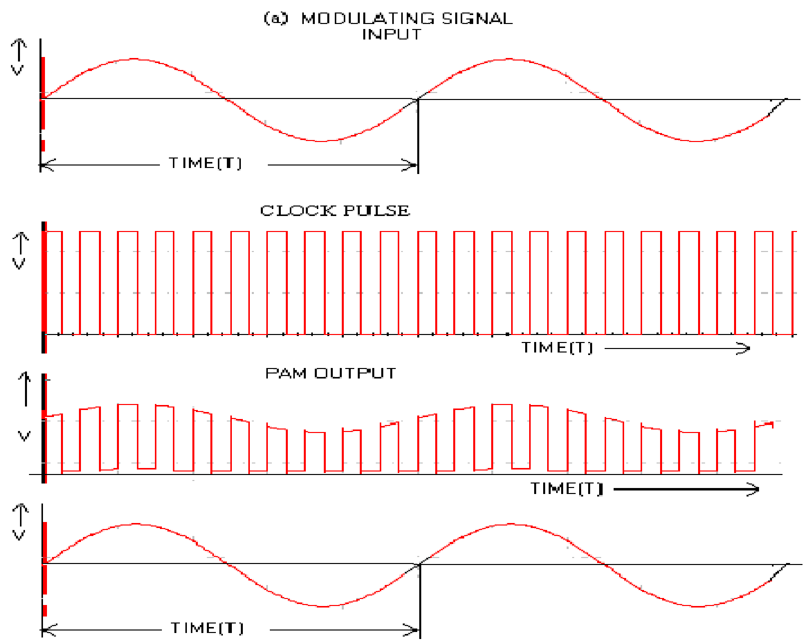
There are several types of pulse modulating systems. Some common types are; pulse amplitude modulation (PAM), pulse duration modulation (PDM) and pulse position modulation (PPM). In each of these systems, a characteristic of the pulse such as amplitude, duration, or position is continuously varied in accordance with the modulating signal.

In PAM, the amplitude of the periodic pulse is varied in accordance with the amplitude of the message signal. There are two different forms of PAM namely single polarity PAM and double polarity PAM.

PROCEDURE:

1. Switch ON the trainer.
2. Observe the outputs of the message signal generator and pulse signal generator, and measure its amplitude and frequency.
3. Adjust the potentiometer to vary the amplitude of the modulating signal. Also adjust the frequency of the pulse signal to obtain stable display on the oscilloscope.
4. Vary the amplitude and frequency of the sine wave signal and observe the change in the output waveform.
5. Connect the modulated output to the input of the demodulator.
6. Connect channel 1 of the dual trace oscilloscope to the demodulator output and channel 2 to the input sine wave.
7. Compare the two waveforms you will find that they are with the same frequency.

Expected waveforms:



Observations and readings:

Message signal Amplitude =_____________

Message signal Time Period =___________

Message signal Frequency=___________

Pulse signal Amplitude =_____________

Pulse signal Time Period=____________

Pulse signal Frequency=____________

Demodulated signal Amplitude=________

Demodulated signal Time period =_________

Demodulated signal Frequency=_________

Result:

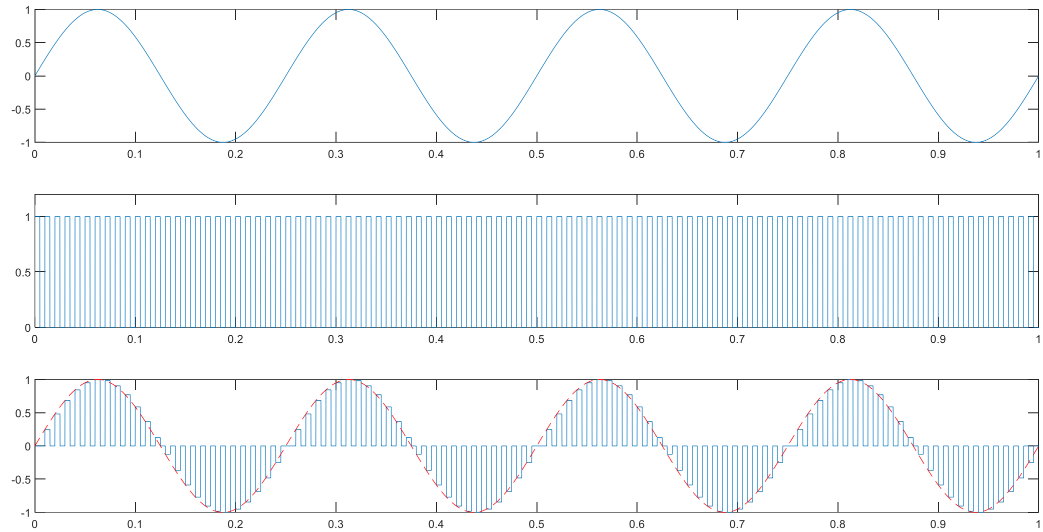
Pulse amplitude modulation and demodulation is observed and their respective wave forms are plotted.

VIVA Questions:

1. TDM is possible for sampled signals. What kind of multiplexing can be used in continuous modulation systems?
2. What is the minimum rate at which a speech signal can be sampled for the purpose of PAM?
3. What is cross talk in the context of time division multiplexing?
4. Which is better, natural sampling or flat-topped sampling and why?
5. Why a dc offset has been added to the modulating signal in this board? Was it essential for the working of the modulator? Explain.
7. Study about the frequency spectrum of PAM signal and derive mathematical expression for it?
8. Explain the modulation circuit operation?
9. Explain the demodulation circuit operation?

MATLAB CODE PAM:

Sample Simulated waveforms for PAM:



PART- A **EXPERIMENT NO: 7**

PULSE WIDTH MODULATION AND DEMODULATION

Date:

AIM: -

To generate the pulse width modulated and demodulated waves.

APPARATUS: -

1. PWM trainer kit
2. BNC probes and connecting wires

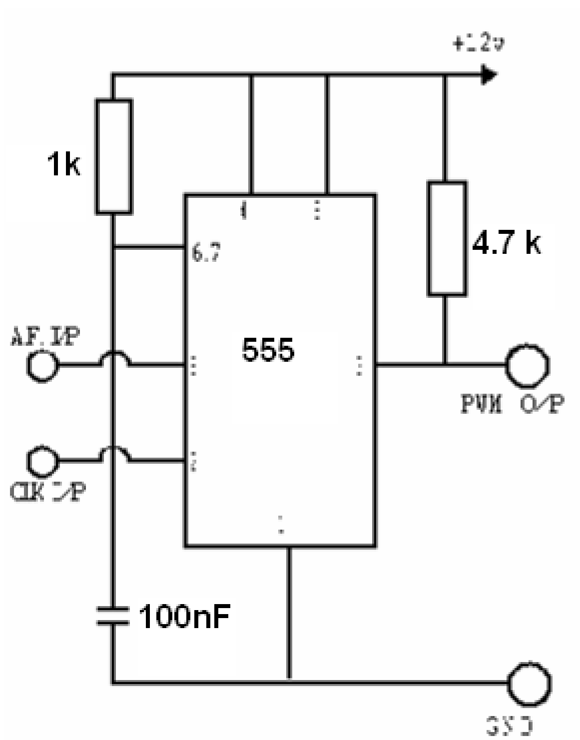
THEORY:

PWM is a pulse analog modulation method. In this, we have a fixed amplitude and starting time of each pulse, is made proportional to the amplitude but the width of each pulse of the modulating signal at that instant.

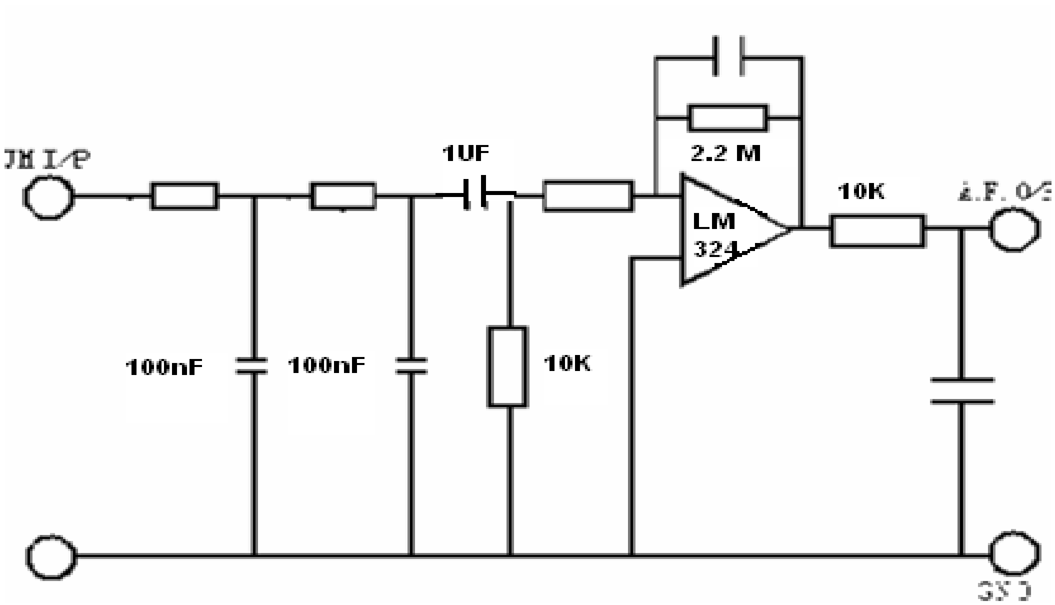
A monostable multivibrator can generate PWM. The 555IC is connected in monostable mode. The sampling clock is given to pin 2 of 555 IC and modulating signal is given to the pin 5. The output is obtained at pin 3. If the amplitude of modulating signal is varied, the width of each pulse is also varied. The demodulated wave is obtained by low pass filter, whose amplitude at any time is proportional to the pulse width modulation at that time.

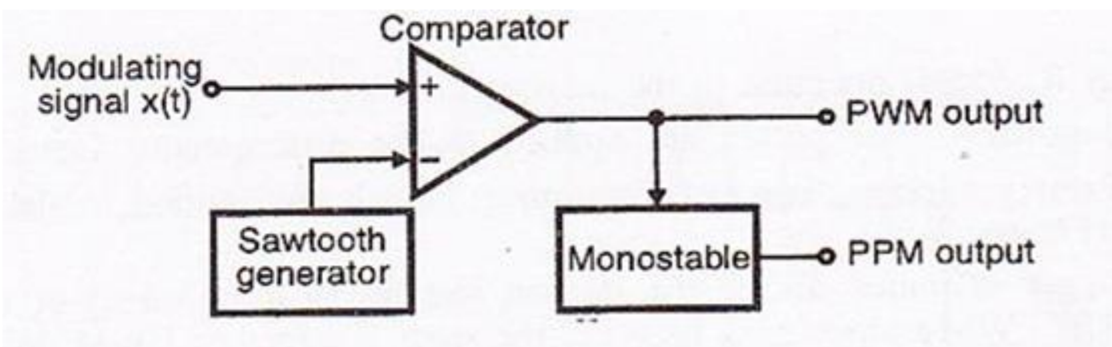
CIRCUIT DIAGRAM:-

PWM Modulator



PWM Demodulator





PROCEDURE: -

1. Switch "ON" the experimental kit.
2. Observe the clock generator output & modulating signal outputs.
3. Connect clock generator output to the clock input point of PWM modulator
4. Observe the outputs of Modulating signal and PWM generator output on dual channel mode of CRO.
5. Vary the amplitude of the modulating signal and observe the variation in the width of PWM signal.
6. Apply the PWM signal to the input of the demodulator circuit.
7. compare the demodulator output frequency with the modulating signal frequency. Bothe frequencies will be same.
8.Draw the waveforms as shown in the figure with noted readings

Observations and Readings

Message signal Amplitude =____________

Message signal Time Period =__________

Message signal Frequency=__________

Pulse signal Amplitude =____________

Pulse signal Time Period=___________

PWM signal Amplitude=___________

PWM signal Time Period=___________

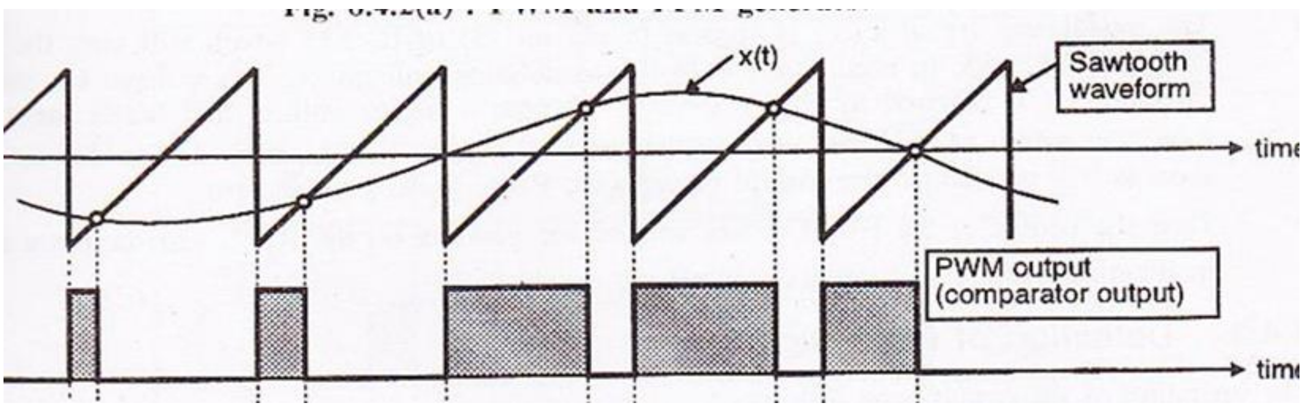
PWM signal Frequency=___________

Demodulated signal Amplitude=_______

Demodulated signal Time period =________

Demodulated signal Frequency=________

EXPECTED WAVEFORMS:



Result:

Pulse width modulation and demodulation is observed, and their respective wave forms are plotted.

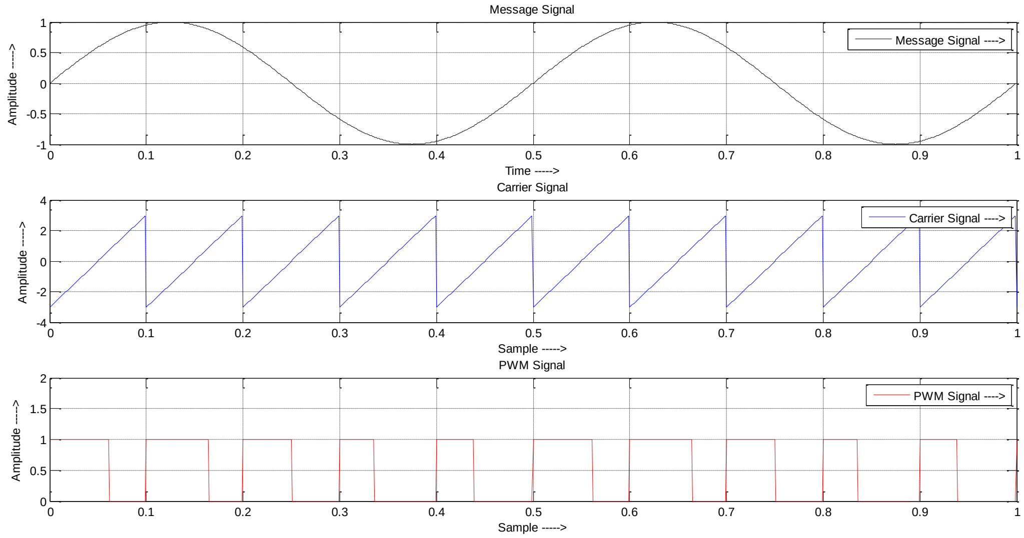
VIVA Questions:

1. An audio signal consists of frequencies in the range of 100Hz to 5. 5KHz.What is the minimum frequency at which it should be sampled in order to transmit it through pulse modulation?
2. Draw a TDM signal which is handling three different signals using PWM?
3. What do you infer from the frequency spectrum of a PWM signal?
4. Clock frequency in a PWM system is 2.5 kHz and modulating signal frequency is 500Hzhowmany pulses per cycle of signal occur in PWM output? Draw the PWM signal?
5. Why should the curve for pulse width Vs modulating voltage be linear?

6. What is the other name for PWM?
7. What is the disadvantage of PWM?
8. Will PWM work if the synchronization between Tx and Rx fails?
9. Why integrator is required in demodulation of PWM?
10. What kind of conversion is done in PWM generation?

MATLAB CODE FOR PWM:

Sample Simulated waveforms:



PART – A **EXPERIMENT NO: 8**

PULSE POSITION MODULATION AND DEMODULATION

Date:

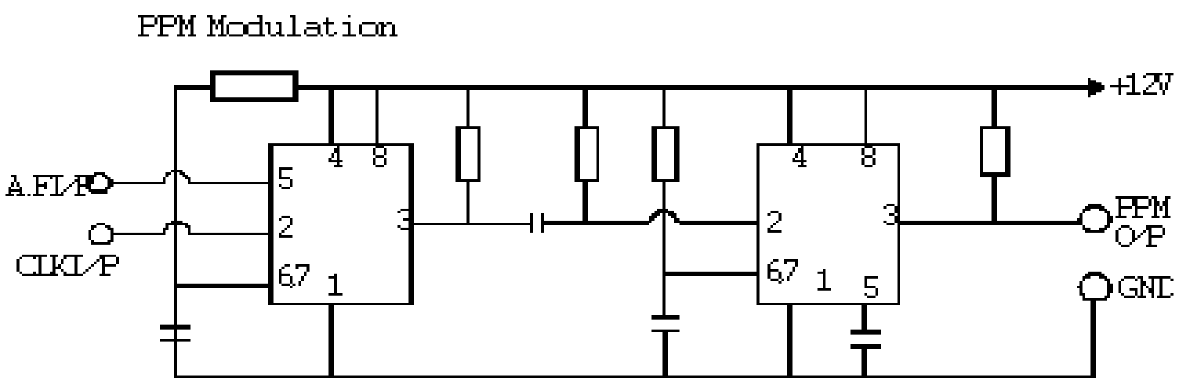
AIM:

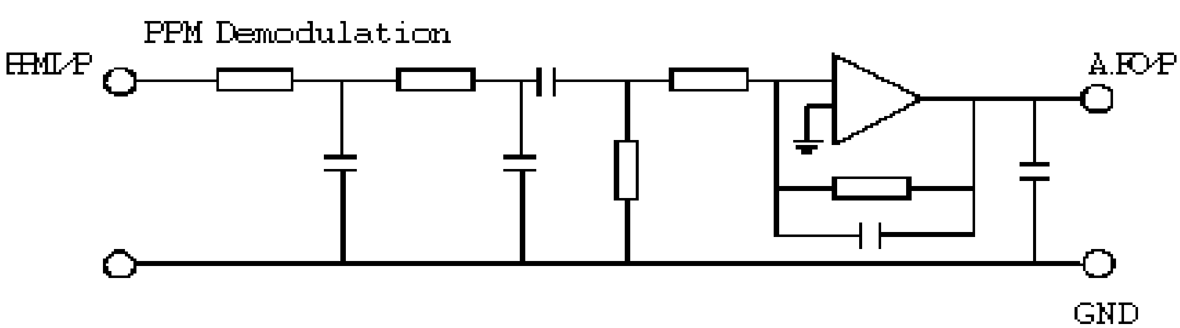
To study the pulse position modulation and demodulation circuit.

APPARATUS:

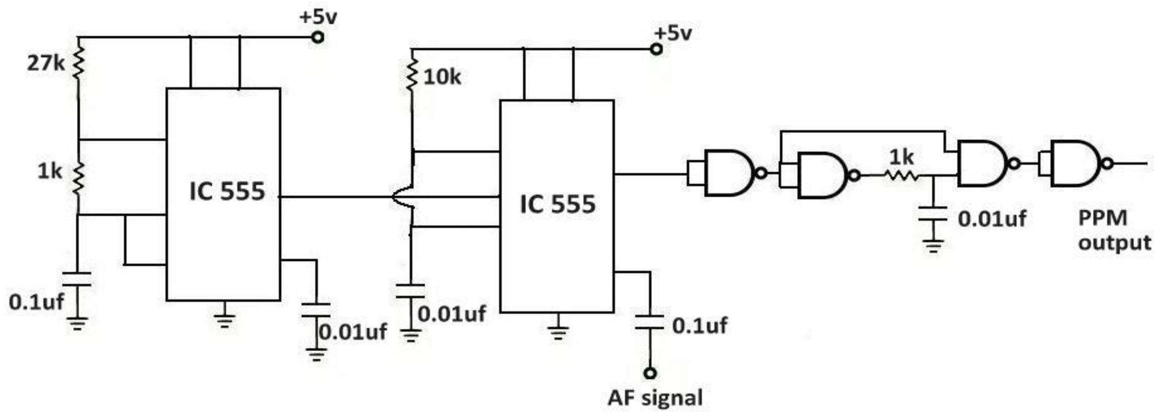
1. Trainer kit of PPM.
2. BNC probes and connecting wires.

Circuit Diagram :

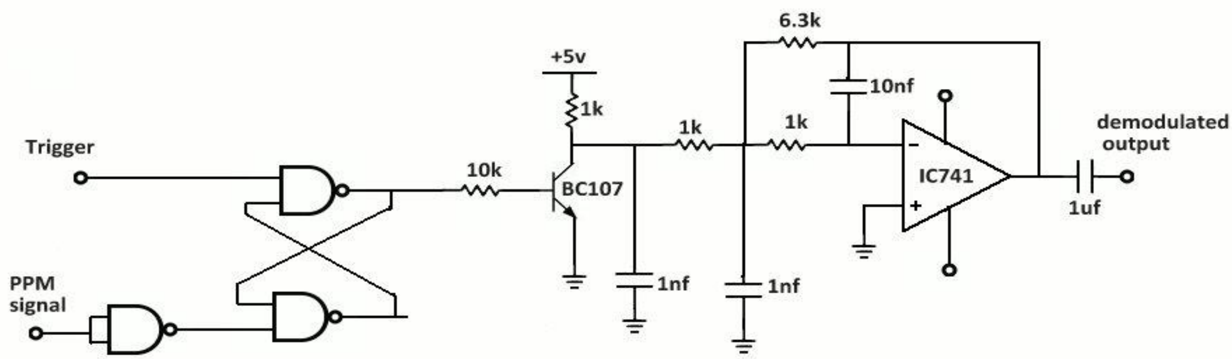




(OR)
Modulation



Demodulation



THEORY:

Pulse modulation is used to transmit analog information, such as continuous speech or data. The data is sent at sampling times, with synchronizing pulses. The pulse position modulation is an analog modulation method, where in we have fixed amplitude of each pulse, but the position of each pulse is made proportional to the amplitude of the modulating signal at that instant. PPM is derived from the pulse width modulated signal. To demodulate the PPM signal, it is fed to an integrating RC circuit (LPF) to obtain the modulating signal.

PROCEDURE:

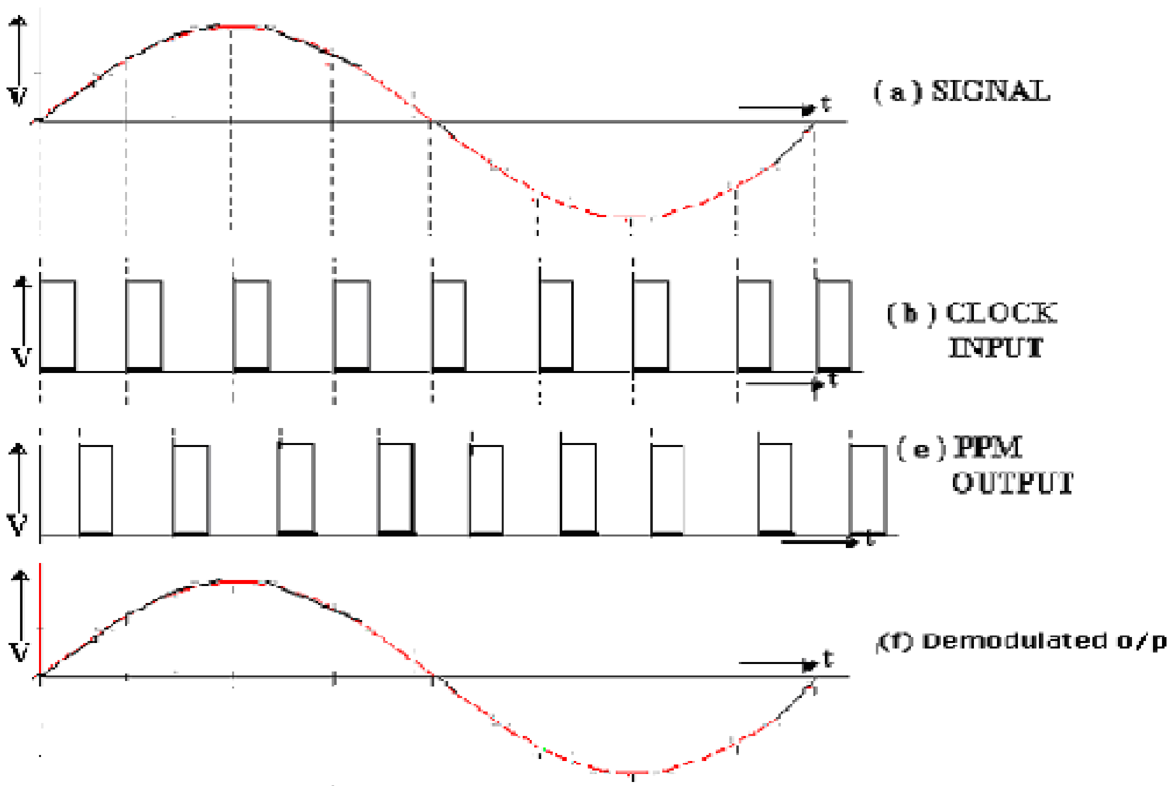
MODULATOR:

1. Switch On the experimental kit.
2. Observe the clock generator output and modulating signal outputs.
3. Connect the clock generator output to the clock input point of PPM modulator and observe the same clock on CH1 of dual trace CRO.
4. Trigger the CRO w.r.t CH1.
5. Apply a variable D.C voltage of 8-12V from any external regulated power supply.
6. Observe the PPM output on CH2.
7. By varying the modulating voltage, PPM output changes position, but the width is maintained constant.

DEMODULATOR:

1. Apply PPM signal to the PPM demodulator and observe the output.
2. The output almost coincides with modulating signal.

EXPECTED WAVE FORMS:



INFERENCE:

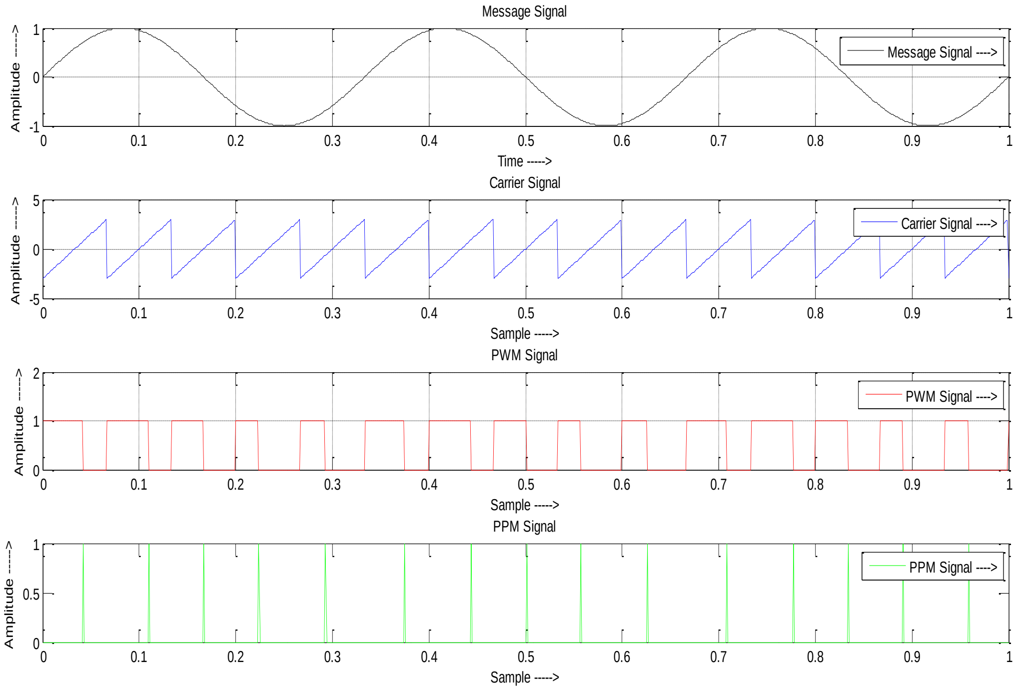
Pulse position modulation and demodulation is observed and their respective wave forms are plotted.

CRITICISM:

1. Define and describe PPM?
2. Explain with waveforms how PPM is derived from PWM.
3. What is the fundamental difference between pulse modulation, on the one hand, and frequency and amplitude modulation on the other?

MATLAB Code:

Sample Simulated waveforms for PPM:



PART – B **EXPERIMENT NO: 1**

TIME DIVISION MULTIPLEXING AND DE MULTIPLEXING

Date:

AIM:

1. Study of 4 channel analog multiplexing and demultiplexing techniques.
2. To Study the effect of sampling frequency variation on the output.
3. Study of input signal amplitude on the output.

APPARATUS:

1. Time division multiplexing and demultiplexing trainer kit
2. Oscilloscope -30 MHz dual channel
3. Patch chords

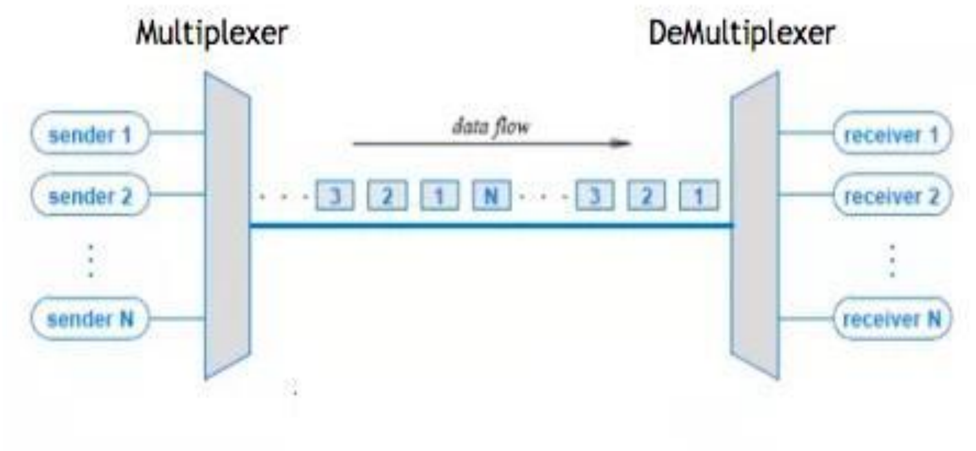
THEORY:

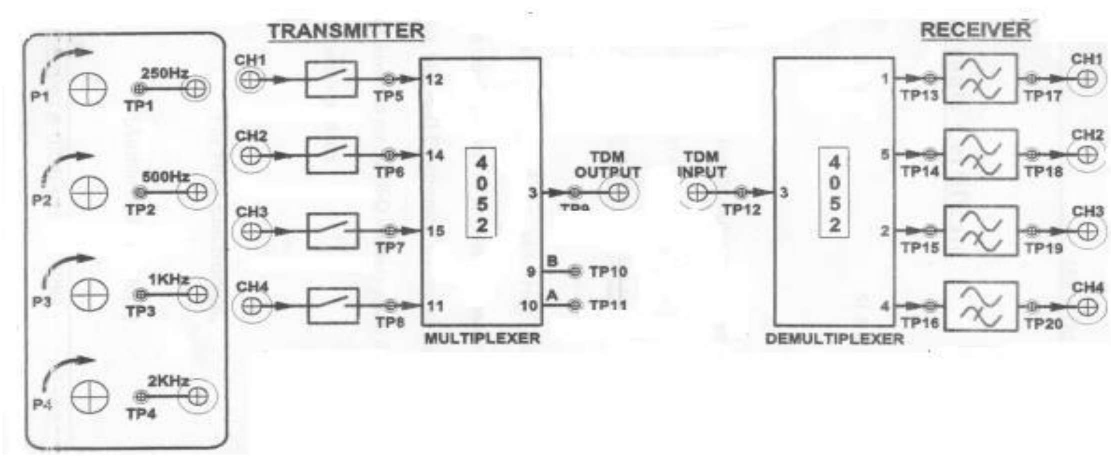
Multiplexing is the process of transmitting several separate information channels over the same communications circuit simultaneously without interference. There are two basic types of multiplexing: Time Division Multiplexing (TDM) and Frequency Division Multiplexing (FDM).

The TDM is used for transmitting several analog message signals over a communication channel by dividing the time frame into slots, one slot for each message signal. The four input signals, all band limited by the input filter are sequentially sampled , the output of which is a PAM waveform containing samples of the input signals periodically interlaced in time . The samples form adjacent input message channels are separated by Ts/M, where M is the no. of input channels. A set of M pulses consisting of one sample from each of the input M input channels is called a frame. At the receiver the samples from individual channels are separated by carefully synchronizing.

TDM is the digital multiplexing technique. In TDM, the channel/link is not divided on the basis of frequency but on the basis of time. Total time available in the channel is divided between several users and each user is allotted a particular a time interval called time slot or time slice during which the data is transmitted by that user. Thus each sending device takes control of entire bandwidth of the channel for fixed amount of time. In TDM the data rate capacity of the transmission medium should be greater than the data rate required by sending or receiving devices. In TDM all the signals to be transmitted are not transmitted simultaneously. Instead, they are transmitted one-by-one. Thus, each signal transmitted for a very short time. One cycle or frame is said to be complete when all the signals are transmitted once on the transmission channel. The TDM system can be used to multiplex analog or digital signals, however it is more suitable for the digital signal multiplexing

Block Diagram:





PROCEDURE:

Multiplexing:

1. Connect the circuit as shown in diagram 1.
2. Set the amplitude of each modulating signal as 5v peak-peak.
3. Observe the outputs at test points.
4. Observe the outputs by varying the duty cycle.
5. Vary the amplitude of modulating signal corresponding each channel by using amplitude pots .Observe the effect on all outputs.
6. Observe the TDM output.

Demultiplexing:

1. Connect TDM output of Transmitter to the TDM input of the Receiver.
2. Observe the demultiplexed outputs.

OBSERVATIONS:

Signal-1 Time Period =___________ **Signal-2 Time Period =___________**

Signal-3 Time Period =___________ **Signal-4 Time Period =___________**

Signal-1 Amplitude =___________ **Signal-2 Amplitude =___________**

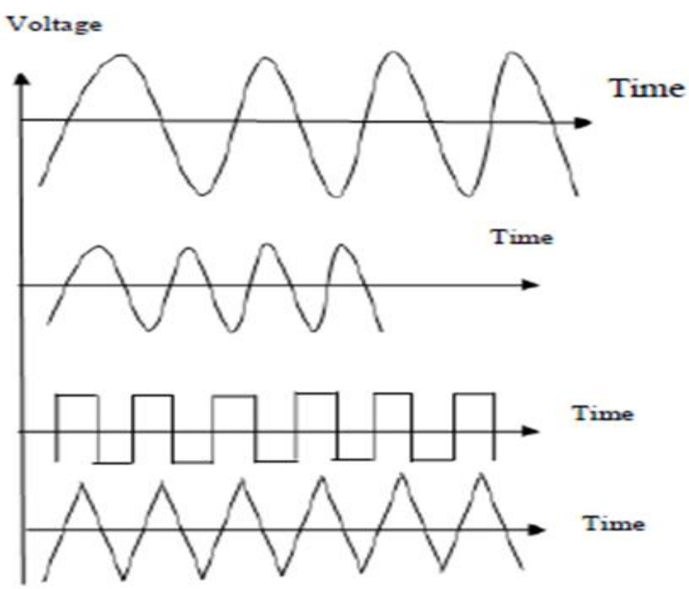
Signal-3 Amplitude =___________ **Signal-4 Amplitude =___________**

Signal-1 Frequency =___________ **Signal-2 Frequency =___________**

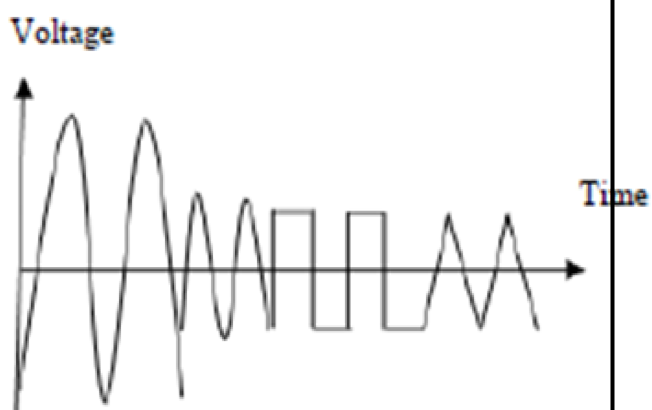
Signal-3 Frequency =___________ **Signal-4 Frequency =___________**

EXPECTED WAVEFORMS:

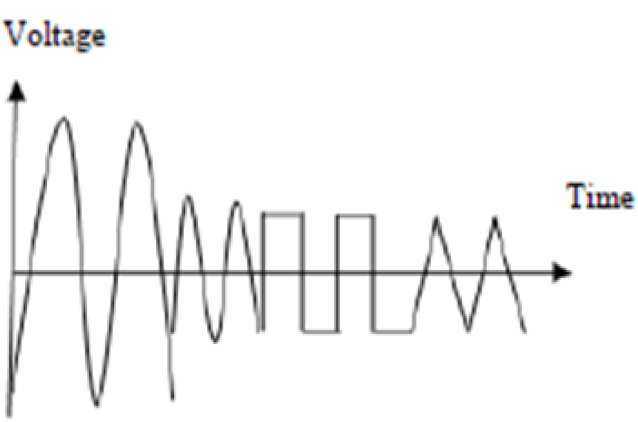
Individual input Signals:



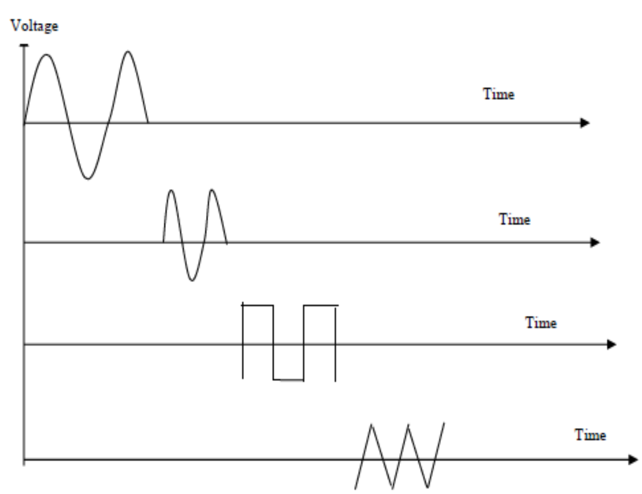
Multiplexed output:



De-multiplexed INPUT

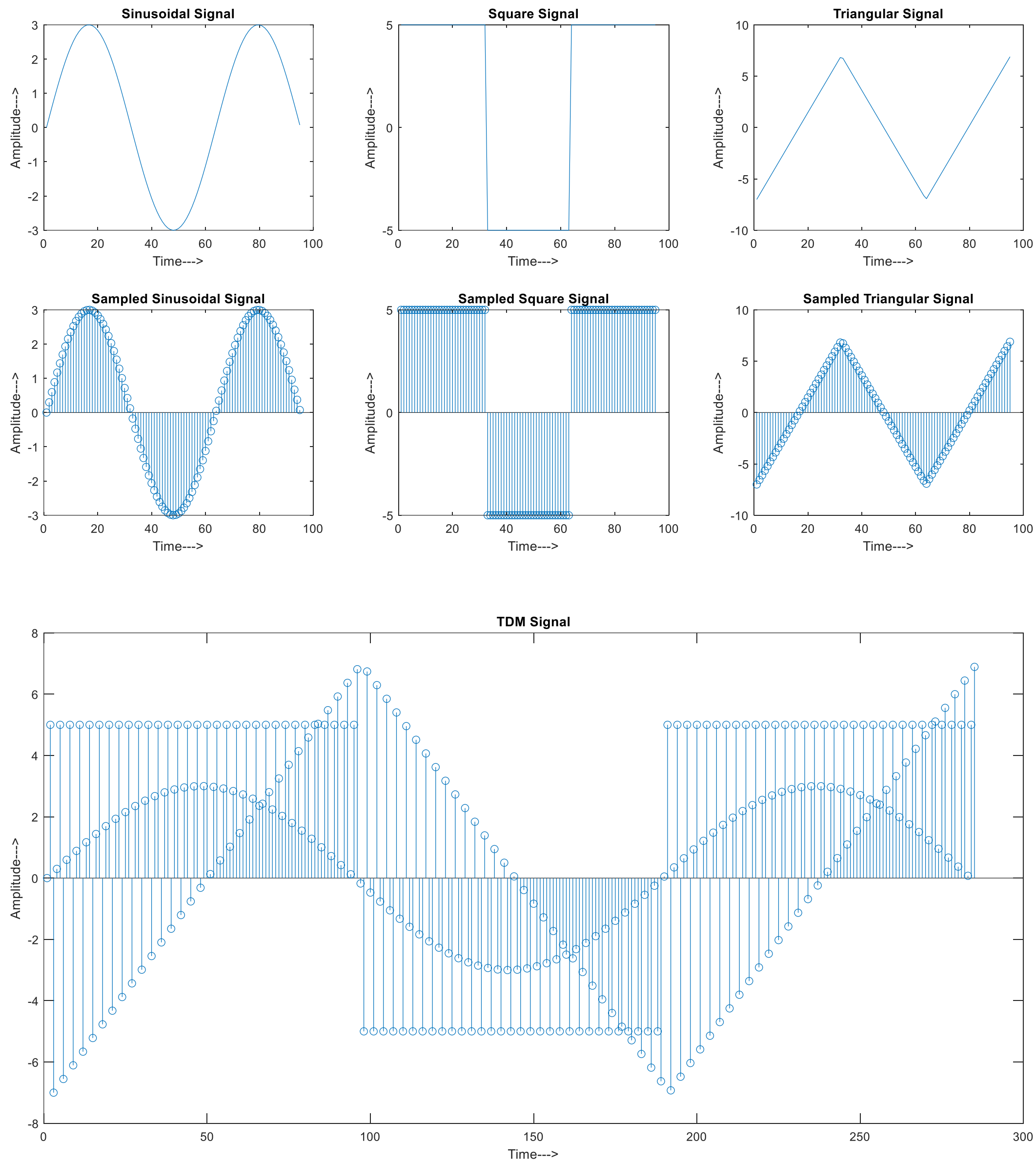


De-multiplexed: OUTPUT:



MATLAB Program:

Sample Simulated waveforms:



PART – B **EXPERIMENT NO: 2**

Binary Phase Shift Keying

Date:

AIM:

To study the various steps involved in generating the phase shift keyed signal at the modulator end and recovering the binary signal from the received PSK signal.

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COMPONENT AND EQUIPMENT:

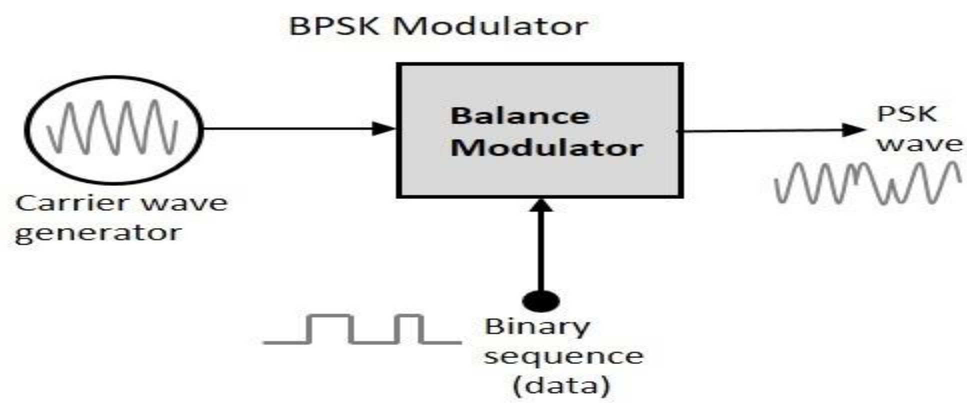
1. PSK trainer kit
2. CRO (0-30MHz)
3. Connecting wires
4. CRO probes

THEORY:

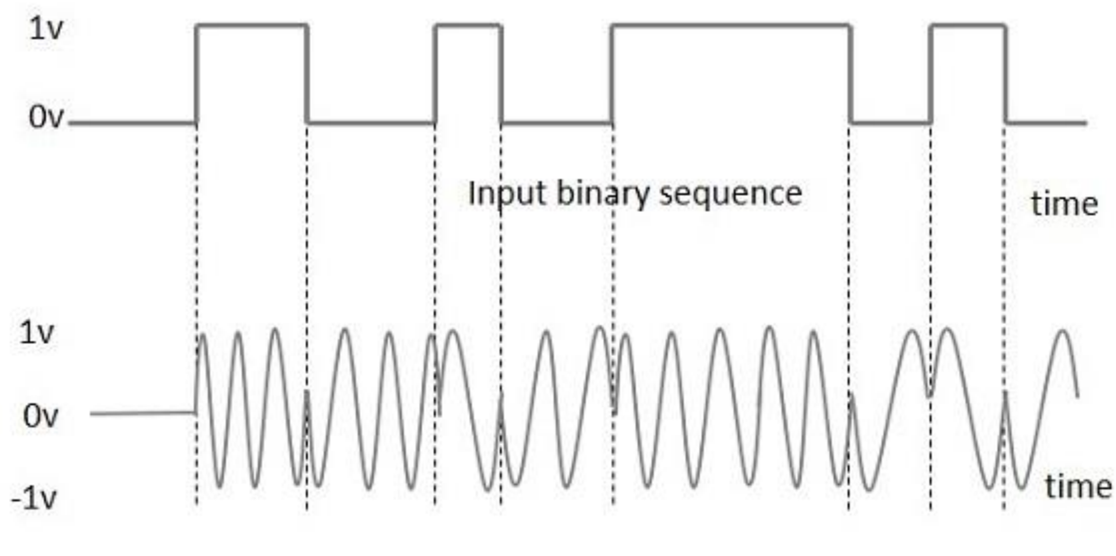
Phase Shift Keying PSKPSK is the digital modulation technique in which the phase of the carrier signal is changed by varying the sine and cosine inputs at a particular time. PSK technique is widely used for wireless LANs, bio-metric, contactless operations, along with RFID and Bluetooth communications. This is also called as 2-phase PSK or Phase Reversal Keying. In this technique, the sine wave carrier takes two phase reversals such as 0° and 180°.

BPSK Modulator

The block diagram of Binary Phase Shift Keying consists of the balance modulator which has the carrier sine wave as one input and the binary sequence as the other input. Following is the diagrammatic representation.



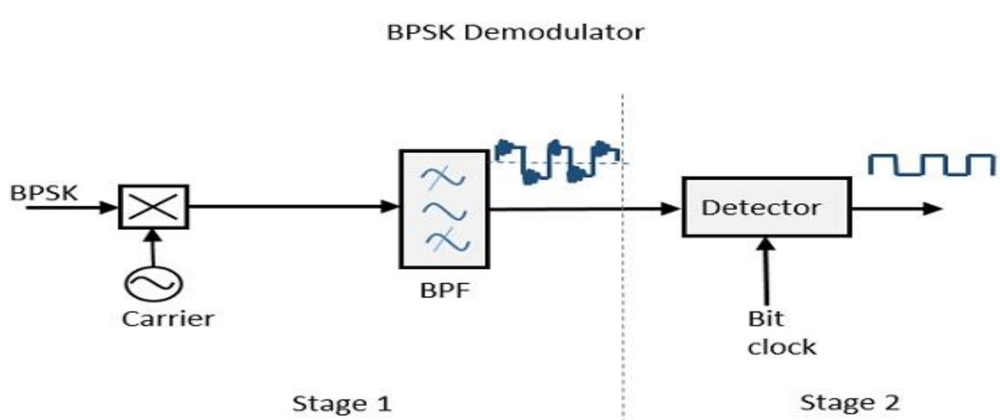
The modulation of BPSK is done using a balance modulator, which multiplies the two signals applied at the input. For a zero-binary input, the phase will be **0°** and for a high input, the phase reversal is of **180°**.



BPSK Modulated output wave

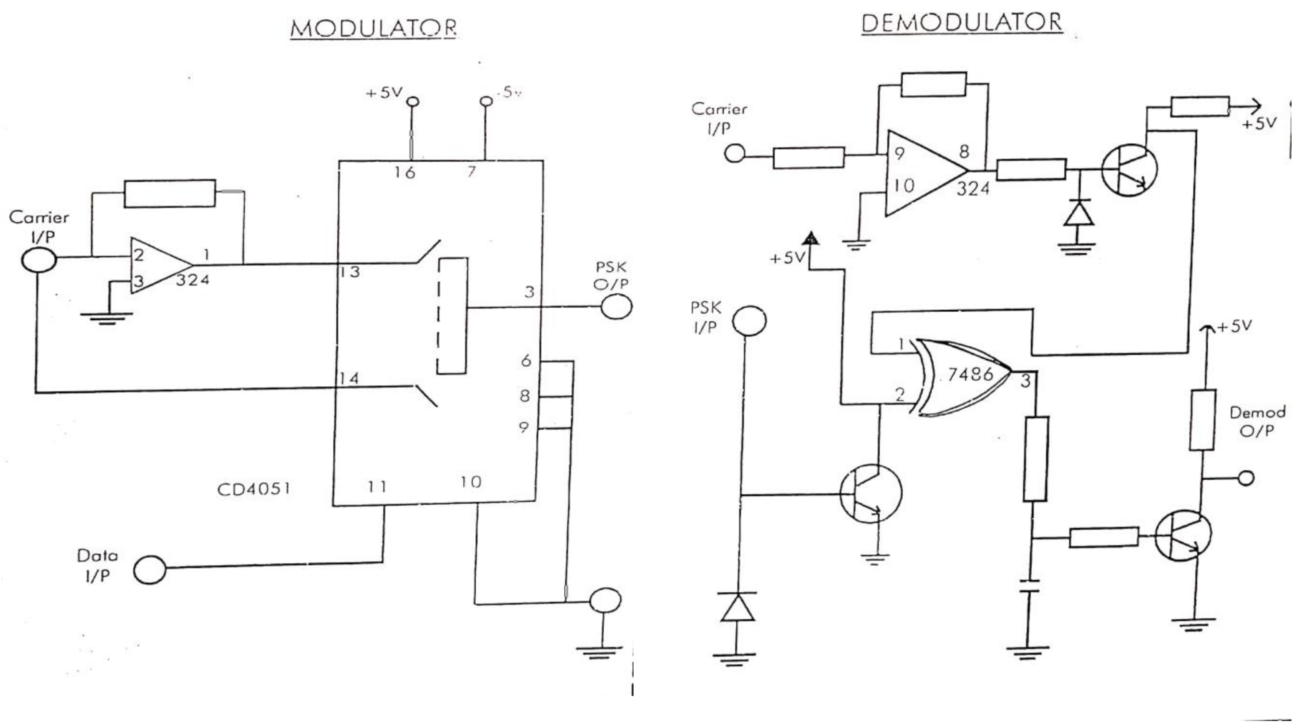
BPSK Demodulator

The block diagram of BPSK demodulator consists of a mixer with local oscillator circuit, a bandpass filter, a two-input detector circuit. The diagram is as follows.



By recovering the band-limited message signal, with the help of the mixer circuit and the band pass filter, the first stage of demodulation gets completed. The base band signal which is band limited is obtained and this signal is used to regenerate the binary message bit stream.

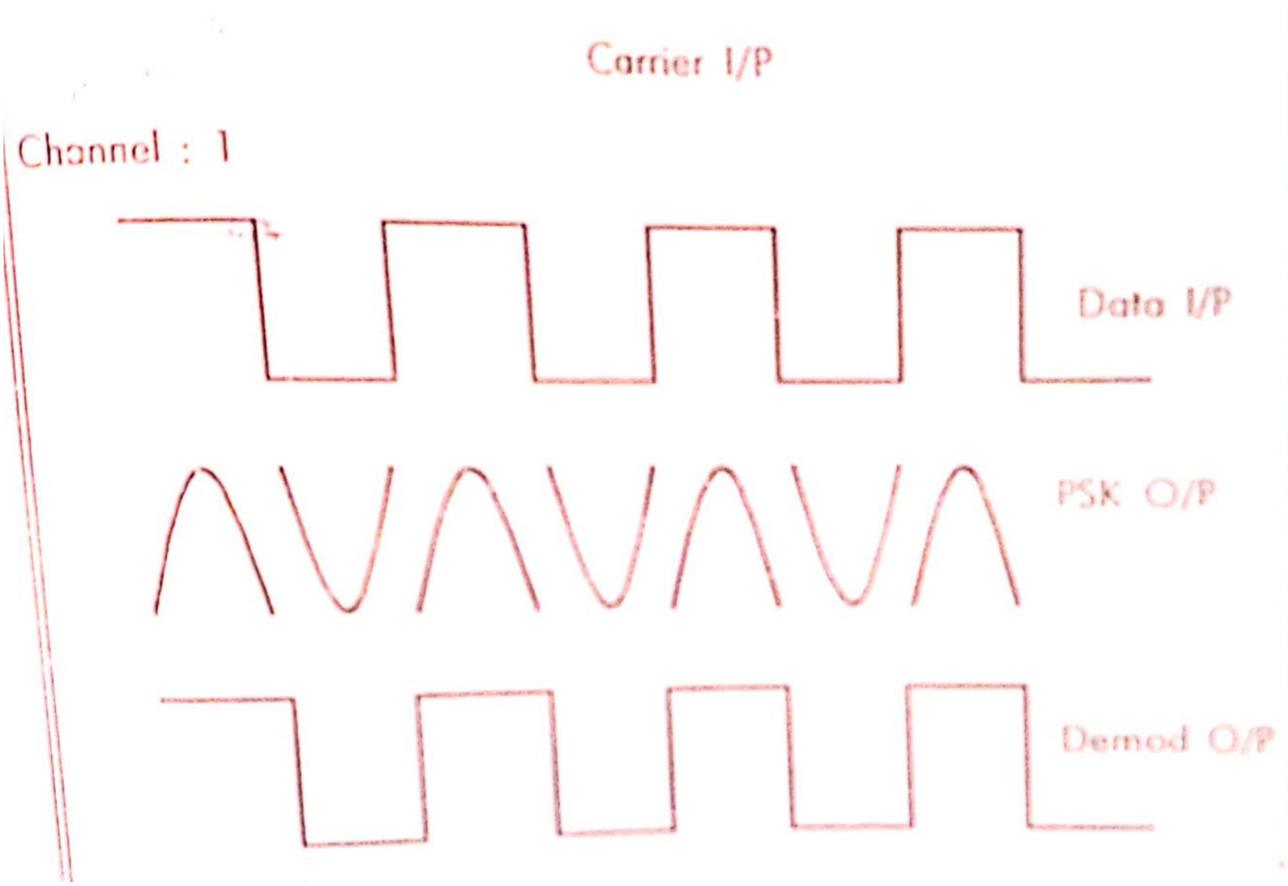
In the next stage of demodulation, the bit clock rate is needed at the detector circuit to produce the original binary message signal. If the bit rate is a sub-multiple of the carrier frequency, then the bit clock regeneration is simplified. To make the circuit easily understandable, a decision-making circuit may also be inserted at the 2nd stage of detection.



PROCEDURE:

1. Switch on PSK modulation and demodulation trainer.
2. Connect the carrier O/P of carrier generator to the carrier I/P of modulation.
3. Connect the data O/P of Data generator to the Data I/P of Modulator.
4. Connect CRO terminals to the PSK O/P of modulator.
5. Observe the PSK modulator output on channel 1 of CRO.
6. Connect the PSK O/P of modulator to the PSK I/P of demodulator.
7. Connect the carrier O/P of carrier generator to carrier I/P of demodulator.
8. Observe the PSK demodulated output on Channel 2 of CRO by connecting the second channel terminals to Demos O/P of demodulator.

Sample waveforms:



Observations and readings:

Clock Signal Amplitude=______________, Clock signal Time period=____________

Clock Signal Frequency=_________

Transmitted Data bits:

Carrier signal amplitude=________, Carrier signal Time Period=___________

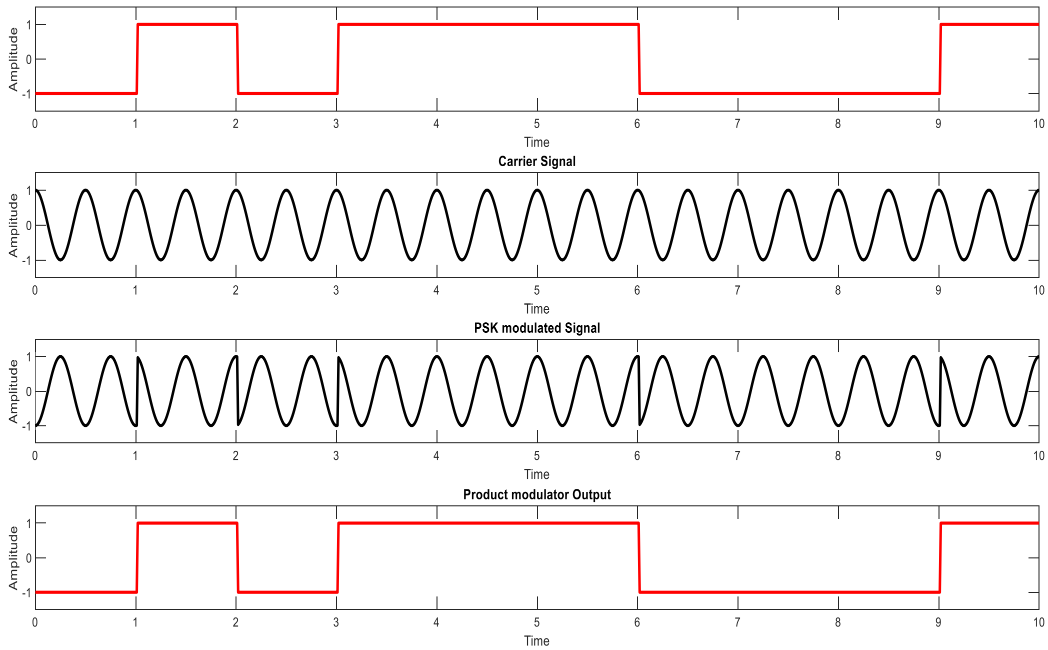
Carrier signal Frequency=___________

Received or demodulated data bits:

RESULT: Binary Phase shift keying modulated, and demodulated signals were observed and plotted the corresponding waveforms.

MATLAB Program:

Sample Simulated waveforms:



PART – B **EXPERIMENT NO: 3**

FSK Modulation and Detection

Date:

AIM:

To study the various steps involved in generating the Frquency shift keyed signal at the modulator end and recovering the binary signal from the received FSK signal.

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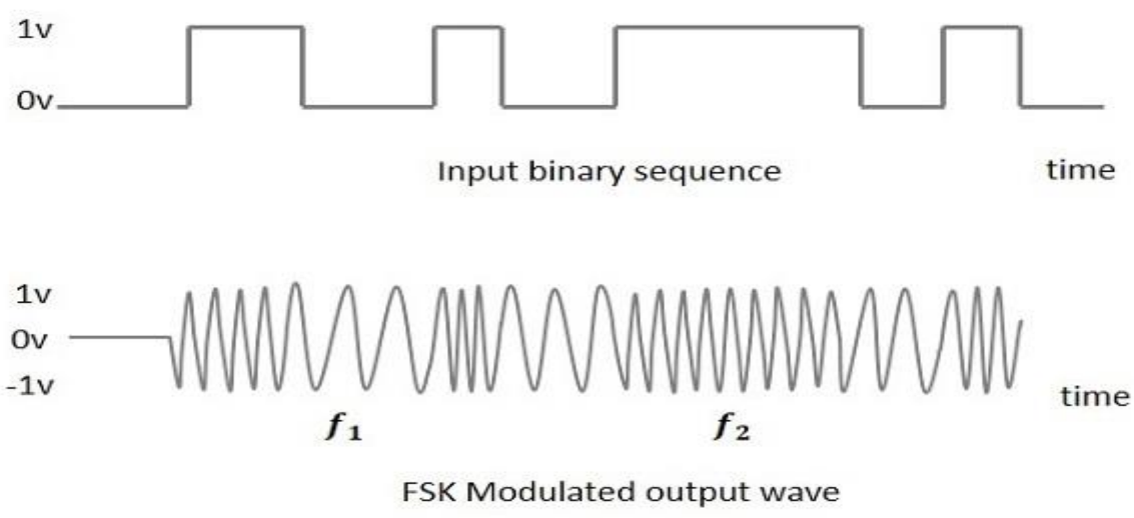
COMPONENT AND EQUIPMENT:

1. PSK trainer kit
2. CRO (0-30MHz)
3. Connecting wires
4. CRO probes

THEORY:

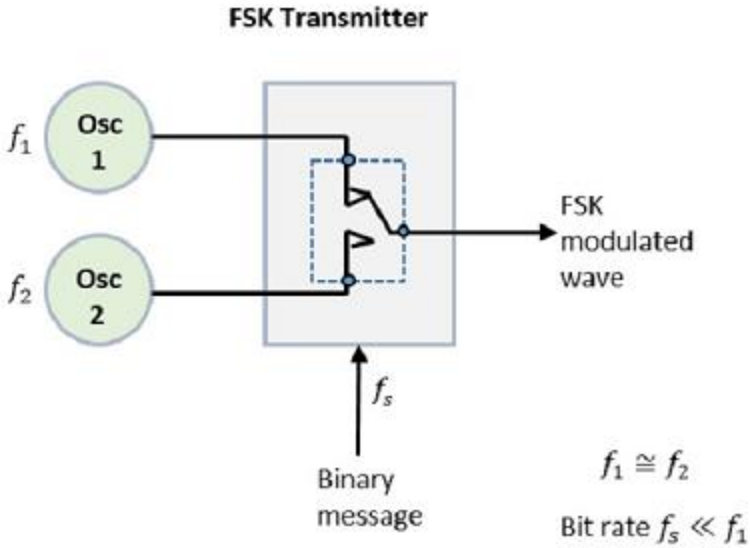
FSK is the digital modulation technique in which the frequency of the carrier signal varies according to the digital signal changes. The output of a FSK modulated wave is high in frequency for a binary High input and is low in frequency for a binary Low input. The binary 1s and 0s are called Mark and Space frequencies.

The following image is the diagrammatic representation of FSK modulated waveform along with its input.



FSK Modulator

The FSK modulator block diagram comprises of two oscillators with a clock and the input binary sequence. Following is its block diagram.



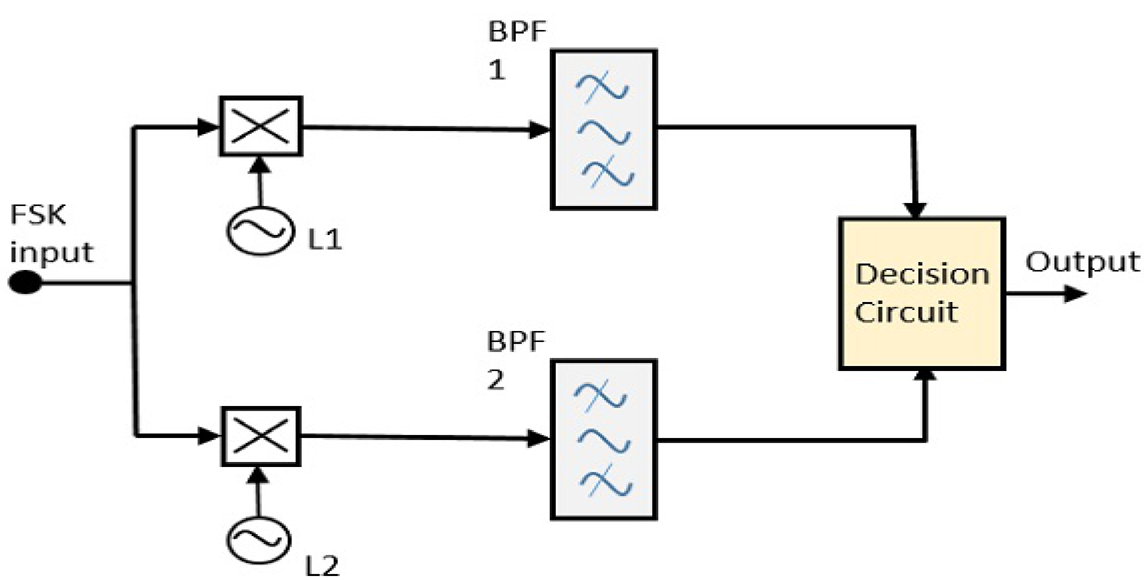
The two oscillators, producing a higher and a lower frequency signals, are connected to a switch along with an internal clock. A clock is applied to both the oscillators, internally. The binary input sequence is applied to the transmitter so as to choose the frequencies according to the binary input.

FSK Demodulator

There are different methods for demodulating a FSK wave. The main methods of FSK detection are Coherent detector and Non-Coherent detector.

Synchronous FSK Detector

The block diagram of Synchronous FSK detector consists of two mixers with local oscillator circuits, two band pass filters and a decision circuit. Following is the diagrammatic representation.

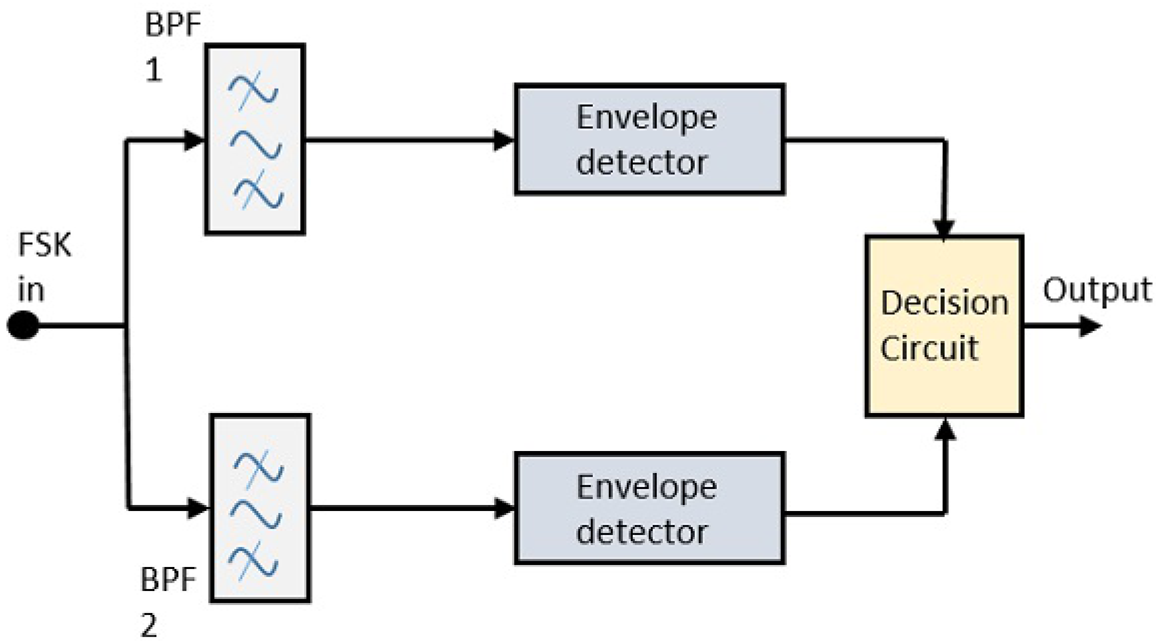


The

FSK signal input is given to the two mixers with local oscillator circuits. These two are connected to two band pass filters. These combinations act as demodulators and the decision circuit chooses which output is more likely and selects it from any one of the detectors. The two signals have a minimum frequency separation.

Asynchronous FSK Detector

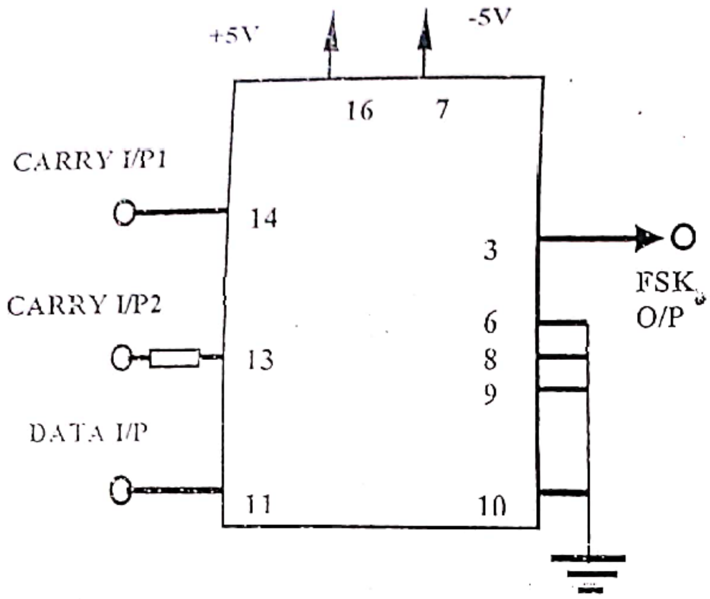
The block diagram of Asynchronous FSK detector consists of two band pass filters, two envelope detectors, and a decision circuit. Following is the diagrammatic representation.

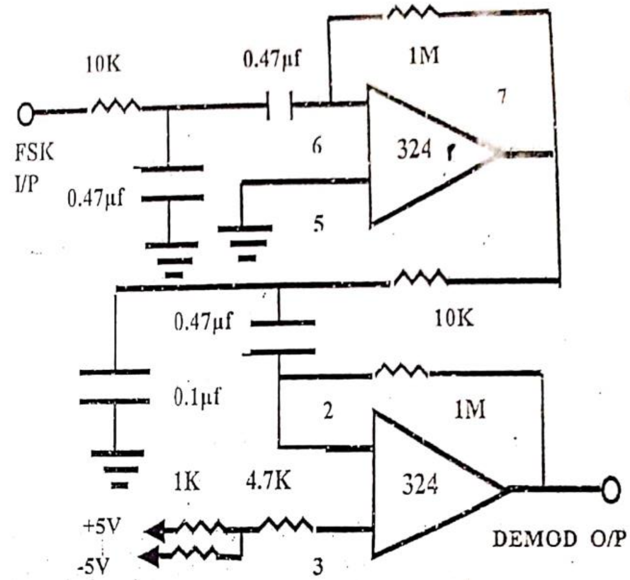


The FSK signal is passed through the two Band Pass Filters BPFs, tuned to **Space** and **Mark** frequencies. The output from these two BPFs look like ASK signal, which is given to the envelope detector. The signal in each envelope detector is modulated asynchronously.

The decision circuit chooses which output is more likely and selects it from any one of the envelope detectors. It also re-shapes the waveform to a rectangular one.

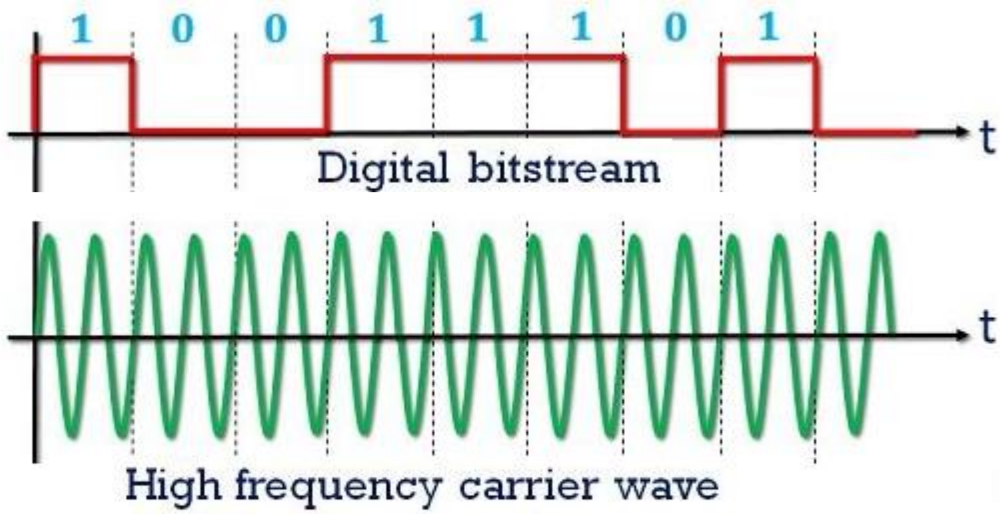
Modulator **Demodulator**

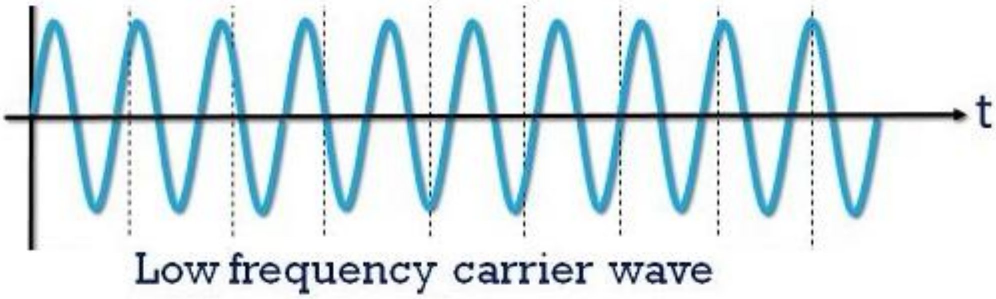


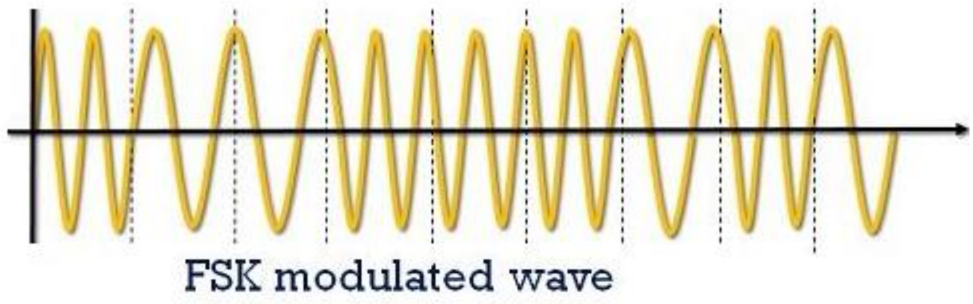


PROCEDURE:

1. Connect the output of the carrier O/P provided on kit to the input of carrier I/P 1 terminal.
2. Also connect one of the Data O/P to the Data I/P terminal provided on kit.
3. Connect sine wave of certain frequency (2.5KHz, 1V P-P Amplitude) to the carrier I/P 2 terminal (use function generator)
4. Observe the FSK O/P by connecting it to CRO. Thus, FSK Modulation can be achieved.
6. For FSK Demodulator, connect FSK O/P terminal to the FSK I/P terminal of Demodulation.
7. Observe the Demodulated wave at Demodulated O/P terminal by connecting it to CRO







Observations and readings:

Clock Signal Frequency=_________

Transmitted Data bits:

Carrier signal-1amplitude=________, Carrier signal-1Time Period=___________

Carrier signal-1 Frequency=___________

Carrier signal-2amplitude=________, Carrier signal-2Time Period=___________

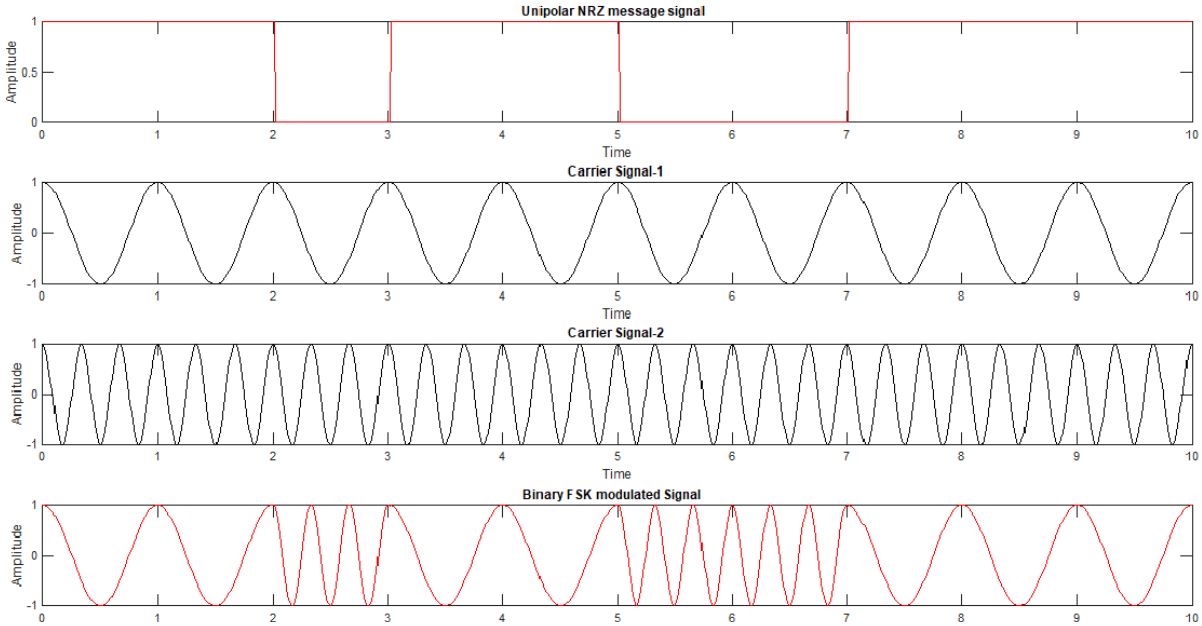
Carrier signal-2 Frequency=___________

Received or demodulated data bits:

RESULT: Binary Frequency shift keying modulated, and demodulated signals were observed and plotted the corresponding waveforms.

MATLAB Code:

Sample Simulated waveforms:



PART – B **EXPERIMENT NO: 4**

DELTA MODULATION

Date:

AIM: An experiment is conducted to study the operation and performance of suitably constructed delta modulator and demodulator.

COMPONENT AND EQUIPMENT:

1.Delta modulation and demodulation trainer kit

2 CRO (0-30MHz) : 1 no

3. Connecting wires

4. CRO probes

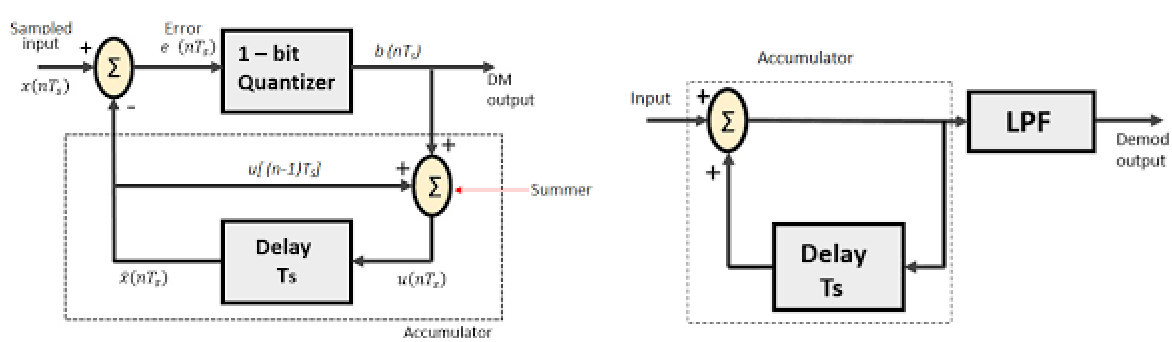
THEORY:

By the delta modulation technique, an analog signal can be encoded into bits. Hence, in one sense a delta modulation (DM) is also a PCM.AS the information regarding the difference of the two signals $\Delta(t)=m(t)-m'(t)$ is transmitted I this method, it is known as delta modulation.

The difference from the difference amplifier is applied to the modulator. The modulator output is the input pulse train is multiplied by the + 1 or – 1 depending upon the polarity of the difference signal. The output is positive pulse, if $\Delta(t)$ is the positive and it is negative pulse if $\Delta(t)$ is the negative.

At the receiver side the quantizer is takes the decisions whether the received pulse is + Ve or – Ve. Hence assuming no error, the output of the quantizer is the same as the wave form and is fed to the integrator and gives the wave form m'(t). This is applied to the LPF, then, smoothens the output of the integrator, and gives a wave form m'(t) which is similar to the signal m(t).

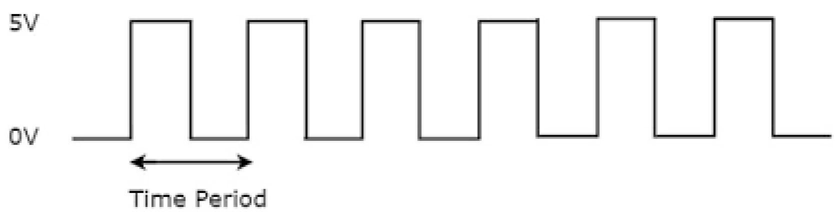
Block Diagram:



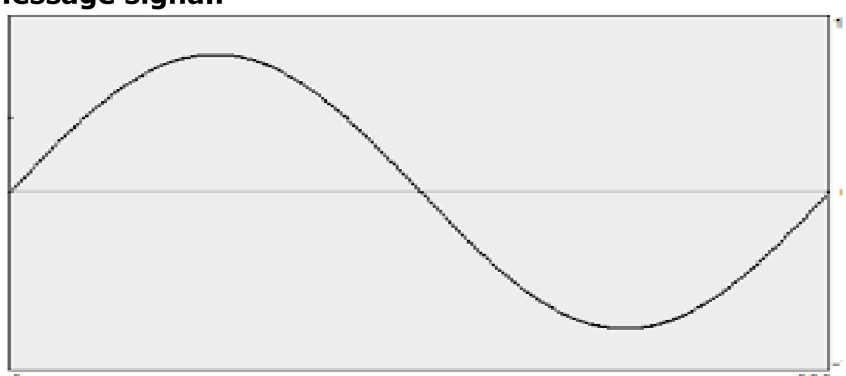
EXPECTED WAVEFORMS

EXPECTED WAVEFORMS:

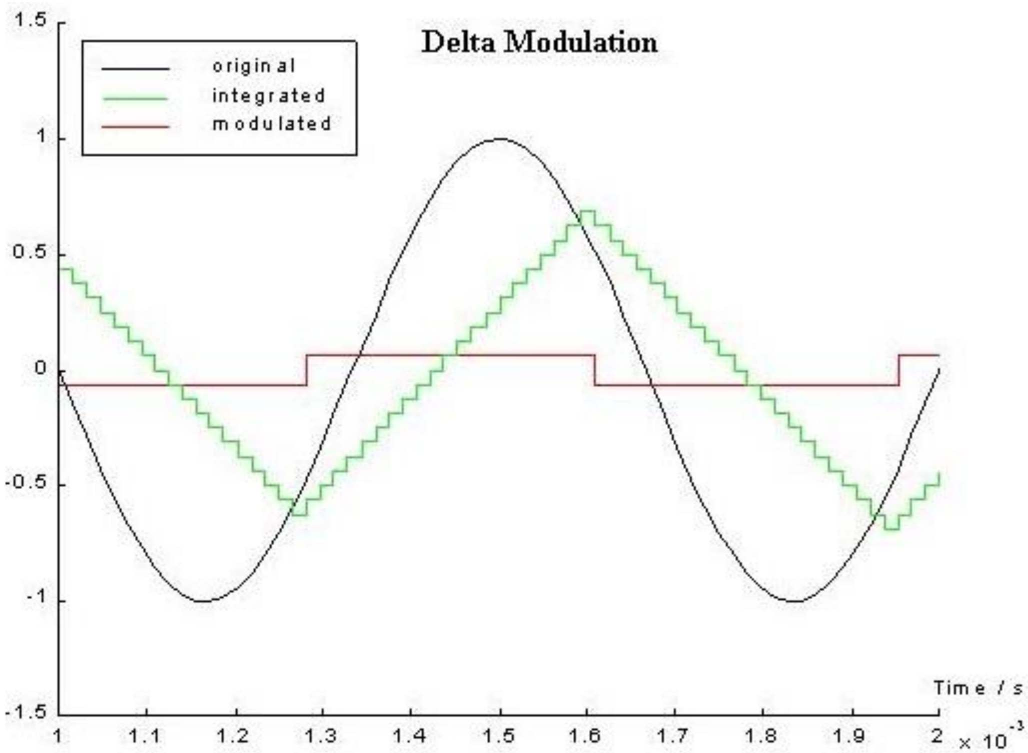
Clock signal:



Message signal:



DM Siganl:



PROCEDURE:

1. The circuit is energized by switching on power supply
2. Observe and note down the clock signal frequency and amplitude.
3. Observe and note down the message signal frequency and amplitude. You can change the amplitude of the message signal by the potential meter provided on the board.
4. Apply Message signal and clock signal to the message signal and bit clock input terminals of the experimental kit.
5. Observe the stairs case signal at TLo84 IC Pin-04, and not down the signal values.
6. You can observe and note down the Delta modulated signal encoded bits , at DM output terminal.
7. Apply the DM output signal to the input of the DM input terminal in the experimental kit.
8. By applying the bit clock at the demodulator

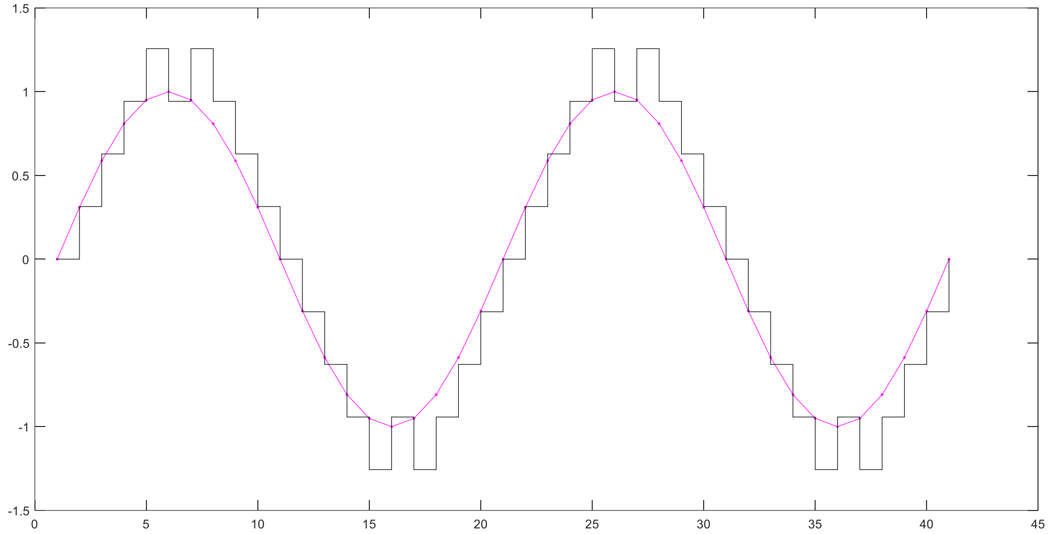
OBSERVATIONS:

1. Amplitude of AF signal fin = -----------
2. Frequency of AF signal = --------
3. Frequency of clock signal = --------------
4. Amplitude of a recovered audio signal = ----------
5. Frequency of a recovered audio signal = ----------

RESULT:

MATLAB PROGRAM

Sample simulated waveforms:



PART – B **EXPERIMENT NO: 5**

PULSE CODE MODULATION AND DEMODULATION

Date:

AIM: The PCM and demodulation is studied using CODEC IC's ADC 0804, DAC 0808.The demodulated output wave form is compared with modulating signal the circuit tested with different sampling frequencies.

COMPONENT AND EQUIPMENT:

1. Pulse code modulation and demodulation trainer kit
2. CRO (0-30MHz) :1 no
3. Connecting wires
4. CRO probes
5. Digital Multimeter : 2nos

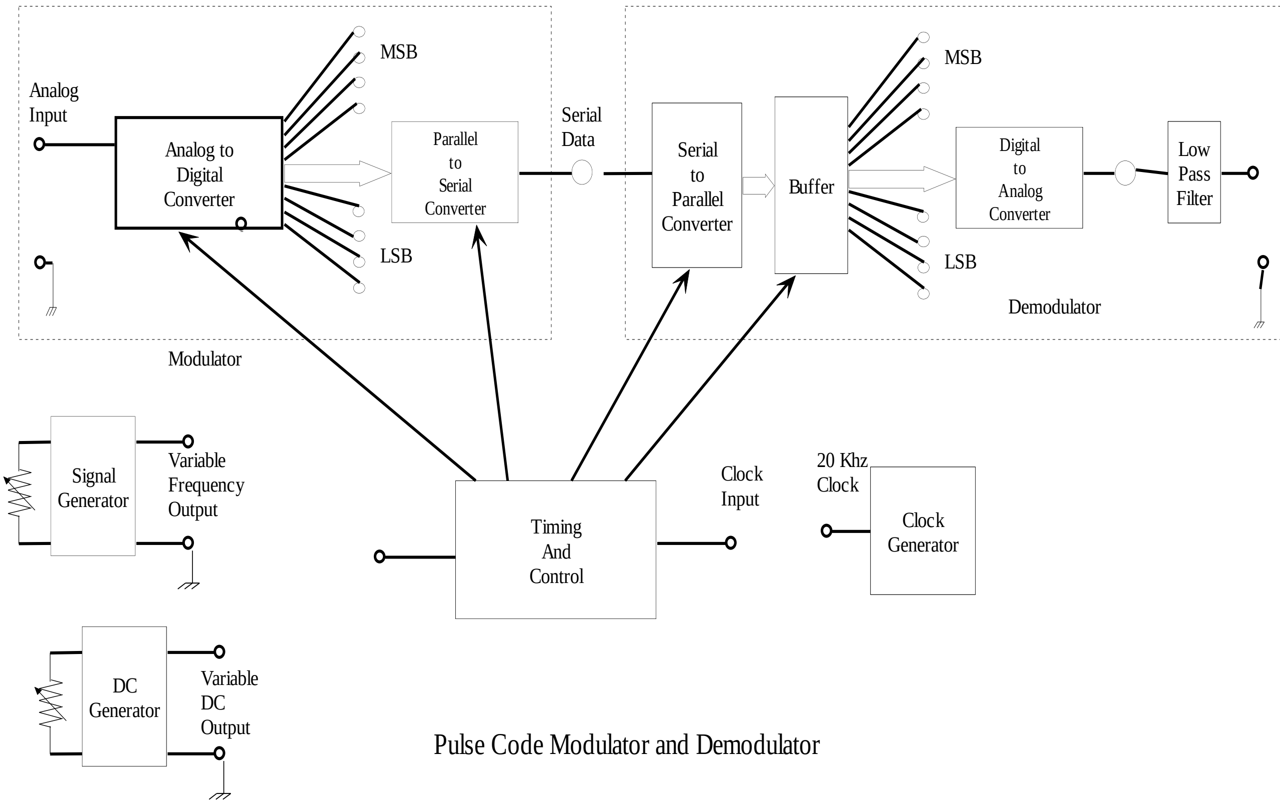
THEORY:

The pulse modulation systems are not completely digital, as amplitude, width or position of the pulse transmitted may vary continuously in accordance with the base band signal variations. PAM is the simplest pulse modulation system. For this reason, the PAM signals are used to generate the digital signal.

The base band signal is sampled at nyquist rate by the sample. This is the PAM signal. The PAM signal is then quantized in the quantizer. The encoder encodes these quantized pulses into bits which are then transmitted over the channel.

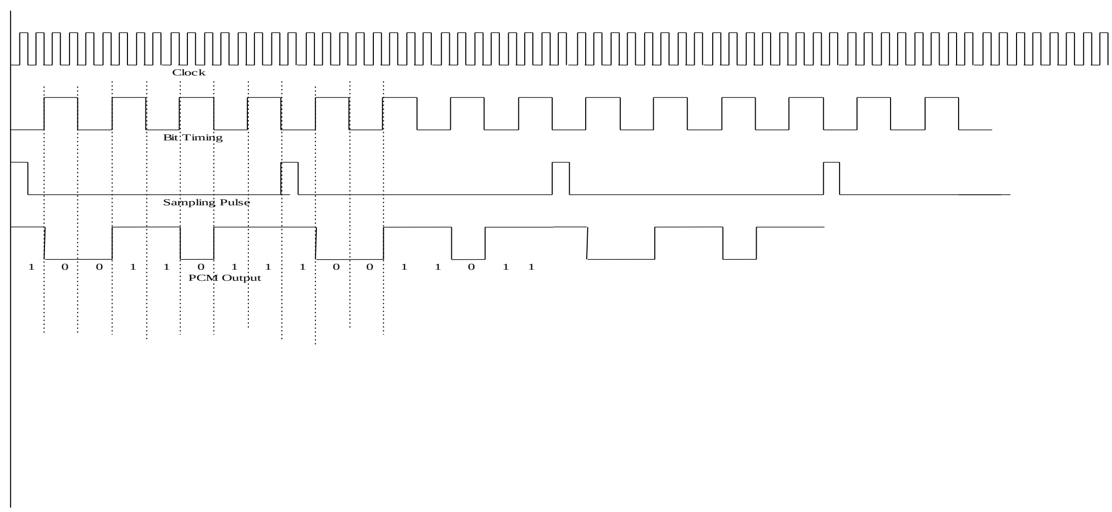
At the PCM receiver, the first block is the quantizer. But this quantizer is different from the transmitter quantizer because it has to take the decision about the presence of the pulse or the absence of the pulse. He output of the quantizer goes to the decoder which is the A/D converter that performs the inverse operation of encoder. The decoder output is the sequence of the quantized pulse. The original Base band signal is reconstructed in the holding circuit and LPF filter.

CIRCUIT DIAGRAM

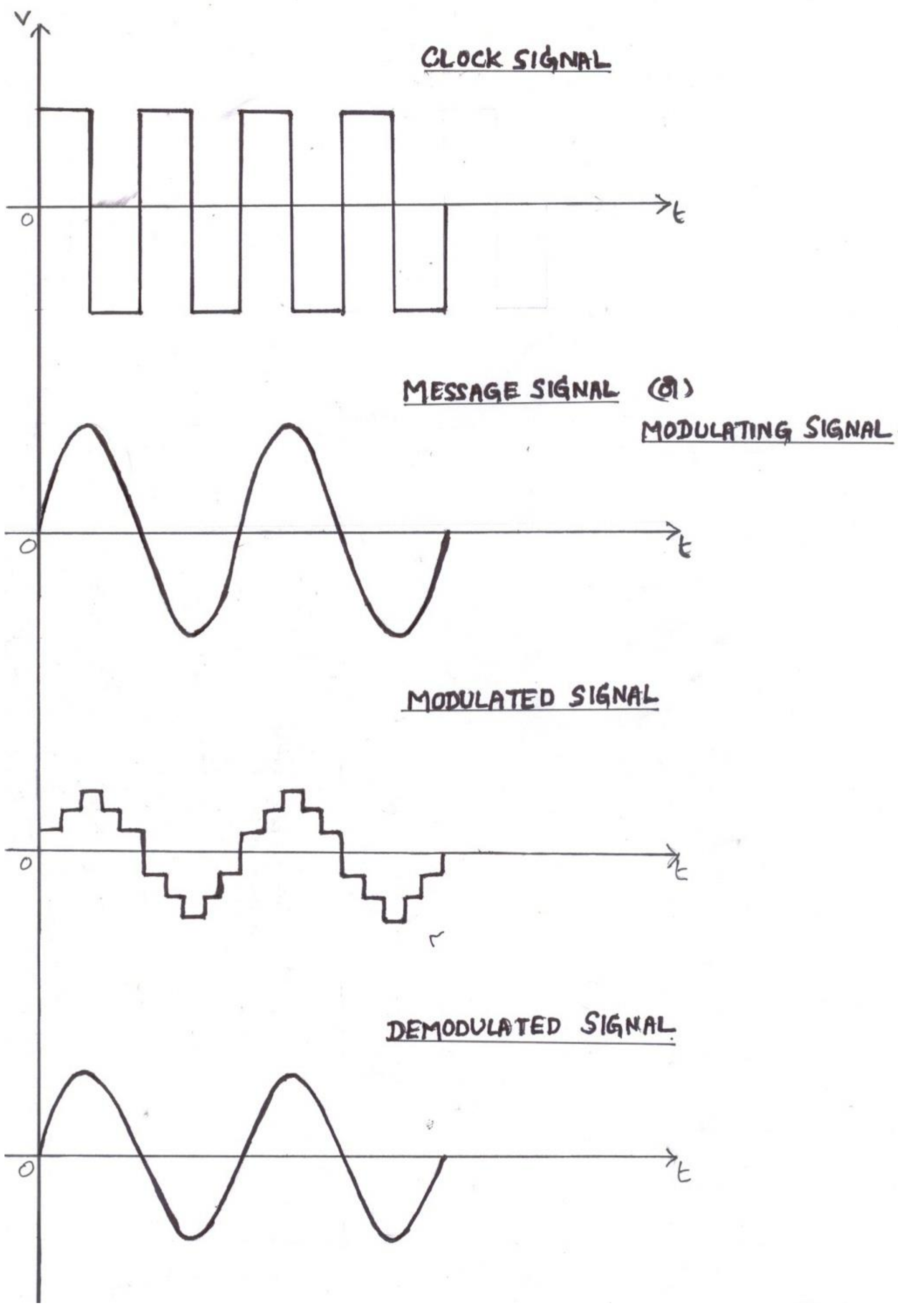


Pulse Code Modulator and Demodulator

EXPECTED WAVEFORMS:



DELTAMODULATION AND DEMODULATION



PROCEDURE:

9. The circuit is energized by switching on power supply
10. The clock signal of frequency 20 KHz is applied to the Delta modulator and demodulator. It is also traced
11. An audio signal is applied to the input of Delta modulator and traced.
12. The output of a Delta modulator is observed in CRO and traced.
13. The Delta modulator output signal is applied to the input of demodulator

14. The output of a demodulator with and without RC filter on CRO.
15. The experiment is repeated with two or more audio signals.

OBSERVATIONS:

6. Amplitude of AF signal fin = -----------
7. Frequency of AF signal = --------
8. Frequency of clock signal = --------------
9. Amplitude of a recovered audio signal = ----------
10. Frequency of a recovered audio signal = ----------

RESULT:

MATLAB PROGRAM

Sample Simulated waveforms: