JB Institute of Engineering &Technology
(UGC Autonomous)
Accredited by NAAC & NBA, Approved by AICTE, Permanently
Affiliated to JNTUH, HYDERABAD

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

ANALOG & DIGITAL COMMUNICATIONS LAB MANUAL
(R-22)

VISION OF THE INSTITUTE

To be a center of excellence in engineering and management education, research and application of knowledge to benefit society with blend of ethical values and global perception.

MISSION OF THE INSTITUTE

- To provide world class engineering education, encourage research and development.
- To evolve innovative applications of technology and develop entrepreneurship.
- To mould the students into socially responsible and capable leaders.

VISION OF THE PROGRAM (E.C.E) DEPARTMENT

To be a guiding force enabling multifarious applications in Electronics and Communication Engineering, promote innovative research in the latest technologies to meet societal needs.

MISSION OF THE DEPARTMENT

- To provide and strengthen core competencies among the students through expert training and industry interaction.
- To promote advanced designing and modeling skills to sustain technical development and lifelong learning in ECE.
- To promote social responsibility and ethical values, within and outside the department.

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

PEO1: Practice Technical skills widely in industrial, societal and real time applications.

PEO2: Engage in the pursuit of higher education, delve into extensive research and development endeavours, and explore creative and innovative ventures in the domains of science, engineering, technology.

PEO3: Exhibit professional ethics and moral values and capability of working with professional skills to contribute towards the need of industry and society.

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

9. **Individual and teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOS):

PSO1: Carry out the Analysis and Design different Analog & Digital circuits with given specifications.

PSO2: Construct and test different Communication systems for various applications.

LIST OF THE EXPERIMENTS

EXPERIMENT NO-1

AMPLITUDE MODULATION & DEMODULATION

AIM: To study the function of Amplitude Modulation & Demodulation (under modulation, perfect modulation & over modulation) and to calculate the modulation index.

APPARATUS:

1. Amplitude Modulation & De modulation trainer kit.
2. C.R.O (20MHz)
3. Function generator (1MHz).
4. Connecting cords & probes.

THEORY:

Amplitude modulation (AM) is defined as a process in which the amplitude of the carrier wave c(t) varies about a mean value, linear 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 [1+Kam(t)] Cos (2πfct) The amplitude of Kam(t) is always less than unity, that is |Kam(t)| =1 for any t, the carrier wave becomes over modulated, resulting in carrier phase reversals. whenever the factor 1+Kam(t) crosses zero. The absolute maximum value of Kam(t) multiplied by 100 is referred to as the percentage modulation.

BLOCK DIAGRAM:

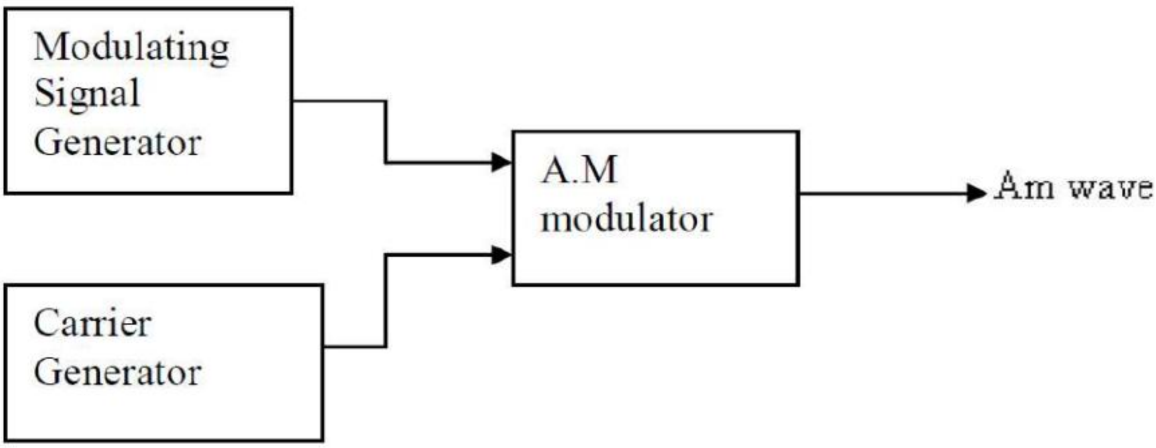


Fig.1: AM MODULATOR

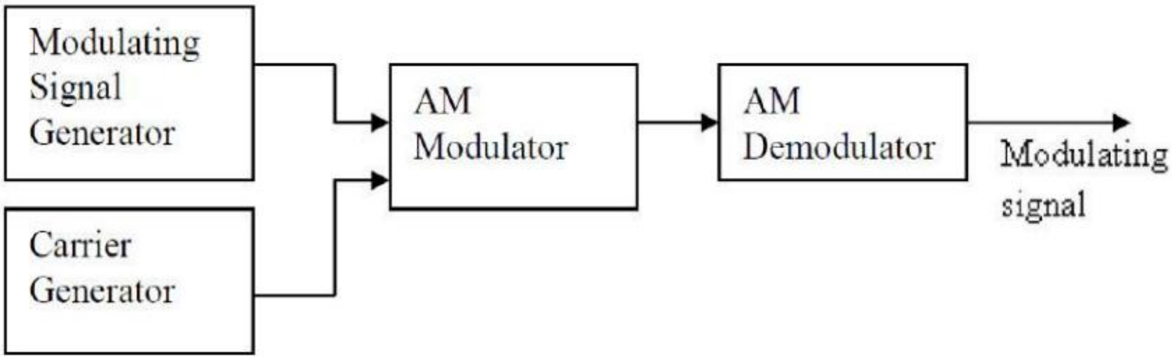


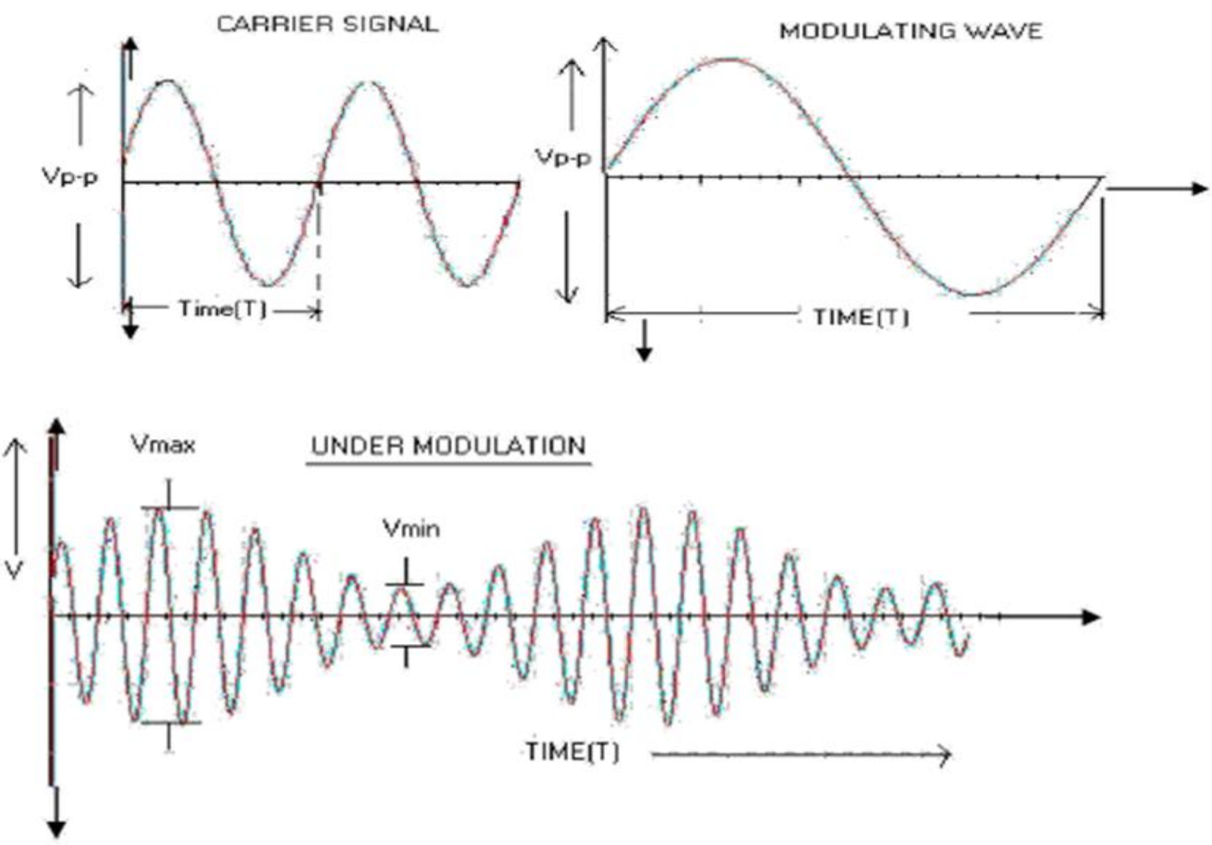
Fig.2: AM DEMODULATOR

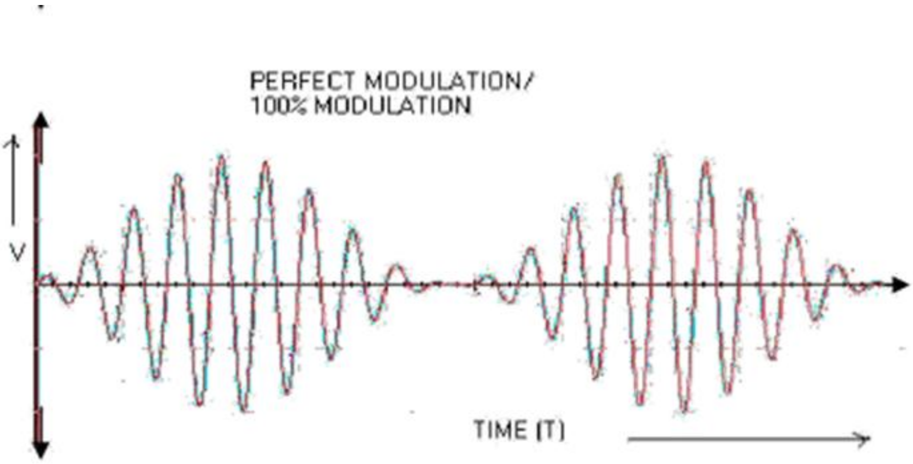
PROCEDURE:

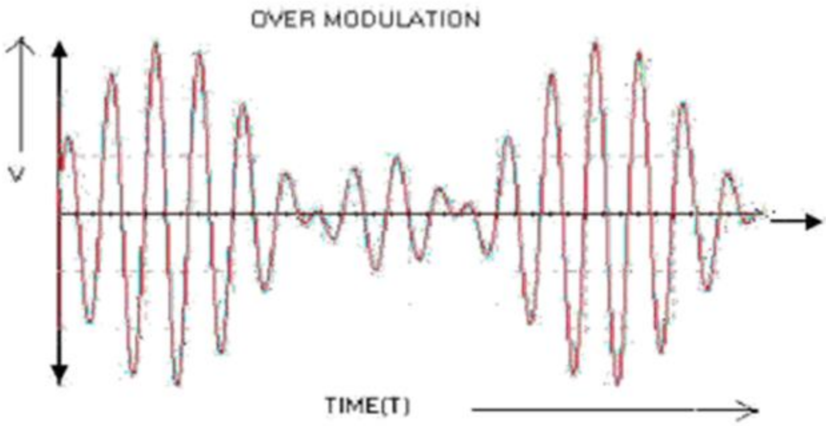
1. Connect the AC Adapter to the mains and the other side to the Experimental Trainer. Switch "ON" the power.
2. Observe the carrier and modulating waveforms and note their frequencies. (Carrier frequency is around 100 KHz and amplitude is variable from 0 -8Vp-p, modulating signal is 1KHz).
3. Connect the carrier and modulating signals to the modulator circuit.
4. Observe the amplitude modulated wave.
5. Connect Carrier I/P to ground and apply a 2V peak to peak AF Signal input to (modulating I/P) and adjust PI in anti-clockwise position to get minimum AC Output.
6. Connect modulating I/P to ground and apply a 3V peak to peak carrier signal tocarrier I/P and adjust P2 in clockwise direction to get minimum A.C output.
7. Connect modulating input &carrier input to ground and adjust P3 for zero D.Coutput.
8. Make modulating i/p 2 Vpp and carrier i/p 3 Vpp peak to peak and adjust potentiometer P4 for maximum output.
9. Calculate maximum and minimum points on the modulated envelope on a CRO and calculate the depth of modulation.
10. Observe that by varying the modulating voltage, the depth of modulation varies.

11. During demodulation connect this AM output to the input of the demodulator.
12. By adjusting the RC time constant (i.e., cut off frequency) of the filter circuit weget minimum distorted output.
13. Observe that this demodulated output is amplified has some phase delay becauseof RC components.
14. Also observe the effects by changing the carrier amplitudes.
15. In all cases, calculate the modulation index.

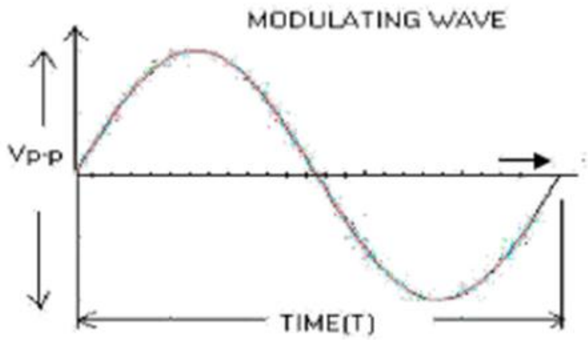
EXPECTED WAVEFORM:







Demodulated signal



OBSERVATIONS:

MODULATION

V_C	Vm	Vmax	Vmin	m= $(Vmax - Vmin)/(Vmax + Vmin)$	m= V_m/V_c

DEMODULATION:

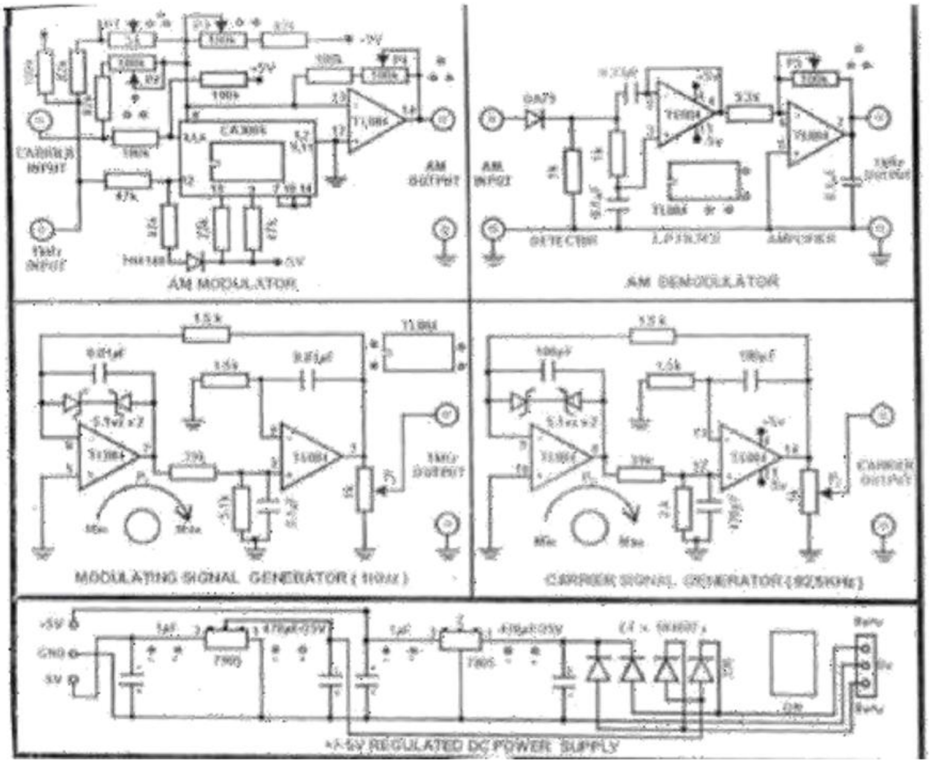
Modulating signal Frequency (fm)	Demodulated output signal frequency

RESULT:

QUESTIONS

1. Define AM and draw its spectrum?
2. Draw the phase's representation of an amplitude modulated wave?
3. Give the significance of modulation index?
4. What are the different degrees of modulation?
5. What are the Limitations of square aw modifier.
6. Compare linear and nonlinear modulators?
7. Compare base modulation and emitter modulation?
8. Explain how AM wave is detected?
9. Define detection process?
10. What are the different types of distortions that occur in an gpyglpp detector?
11. can they be eliminated?
12. What is the condition of for over modulation?
13. Define modulation & demodulation?
14. What are the different types of linear modulation techniques?
15. Explain the working of carrier wave generator.
16. Explain the working of modulator circuit.

PANEL LAYOUT DIAGRAM:



EXPERIMENT NO-2

FREQUENCY MODULATION AND DEMODULATION

AIM: To study the process of frequency modulation and demodulation and calculate the depth of modulation by varying the modulating voltage.

APPARATUS:

1. FM modulation and demodulation kit
2. Dual trace CRO
3. CRO probes
4. Patch cards

THEORY:

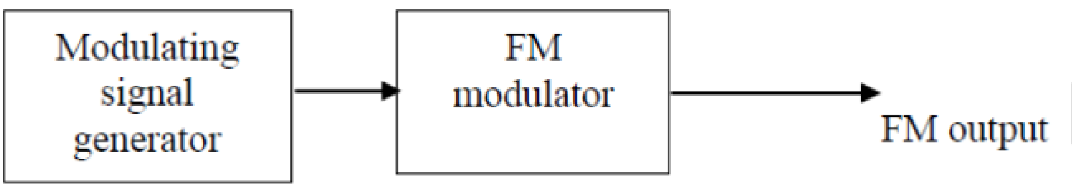
The modulation system in which the modulator output is of constant amplitude, in which the signal information is super imposed on the carrier through variations of the carrier frequency.

The frequency modulation is a non-linear modulation process. Each spectral component of the base band signal gives rise to one or two spectral components in the modulated signal. These components are separated from the carrier by a frequency difference equal to the frequency of base band component. Most importantly the nature of the modulators is such that the spectral components which produce decently on the carrier frequency and the base band frequencies. The spectral components in the modulated wave form depend on the amplitude. The modulation index for FM is defined as

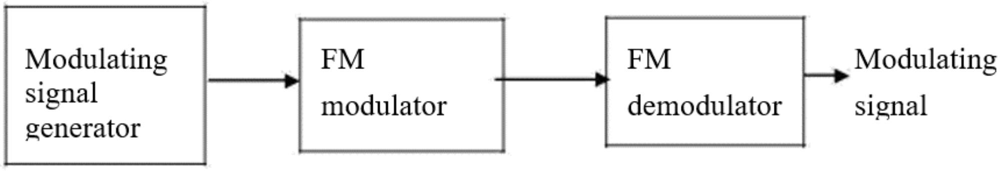
m_f = max frequency deviation/ modulating frequency.

BLOCK DIAGRAM;

MODULATION:



Demodulation



PROCEDURE:

1. Switch on the experimental board.
2. Observe the FM modulator output without any modulator input which is the carrier Signal and note down its frequency and amplitude
3. Connect modulating signal to FM modulator input and observe modulating Signal and FM output on two channels of the CRO simultaneously.
4. Adjust the amplitude of the modulating signal until we get less distorted FM output.
5. Apply the FM output to FM demodulator and adjust the potentiometer in demodulation until we get demodulated output.

OBSERVATION:

MODULATION:

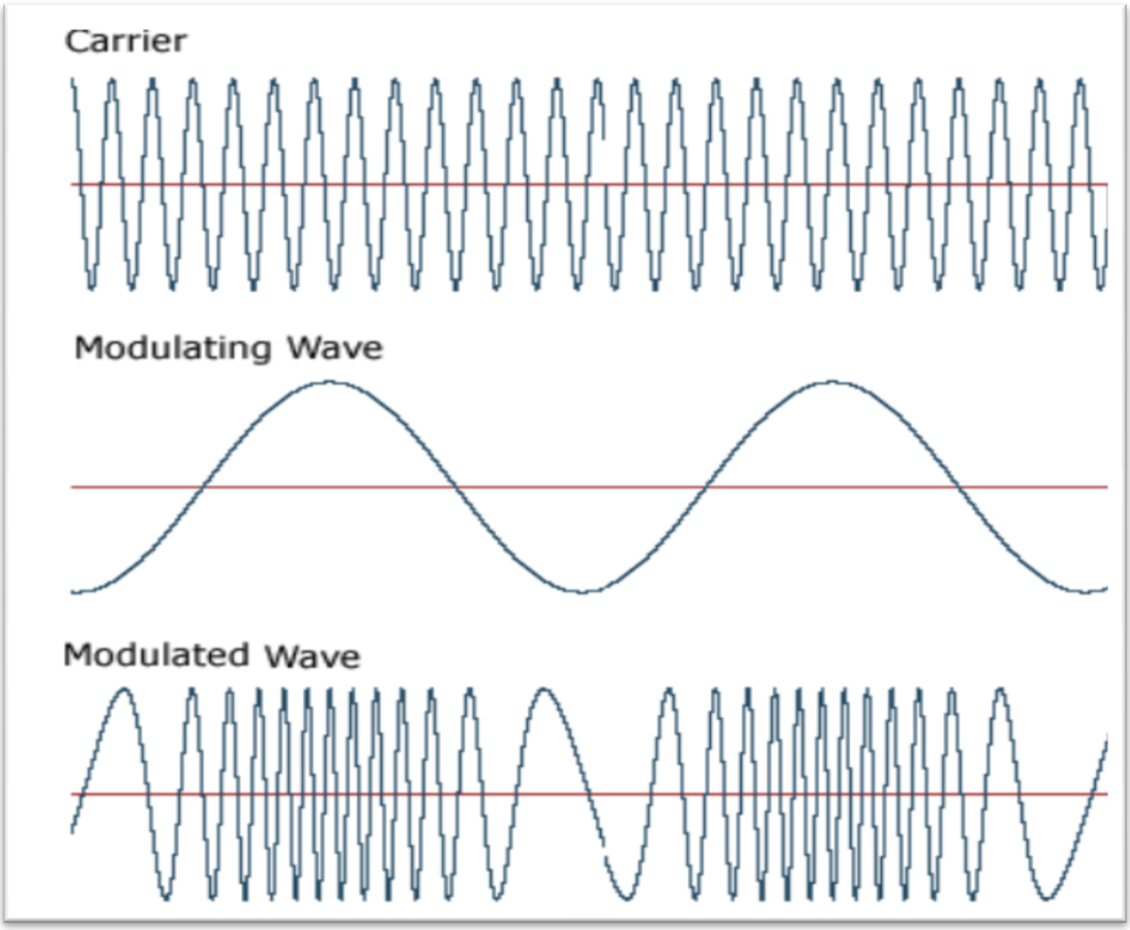
Vm	F1	F2	Frequency Deviation, fd=(f1-f2)	Modulation index, $m_{f=}$(f1-f2)/fm	Band width= 2(fd+fm)

DEMODULATION:

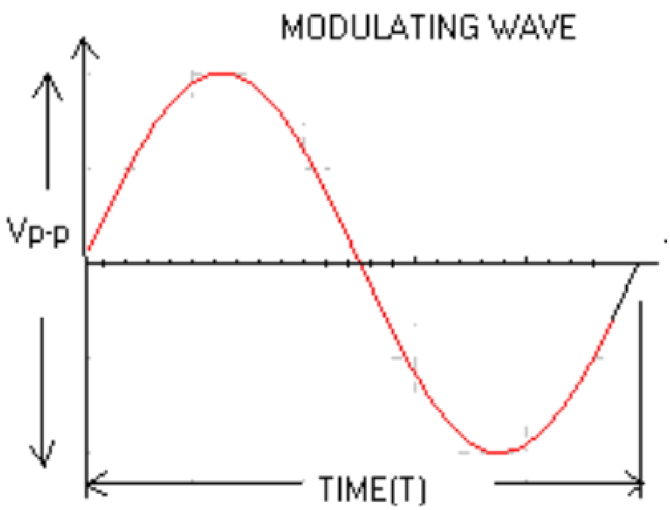
Modulating signal Frequency	Demodulating signal frequency

EXPECTED WAVEFORM:

MODULATION:

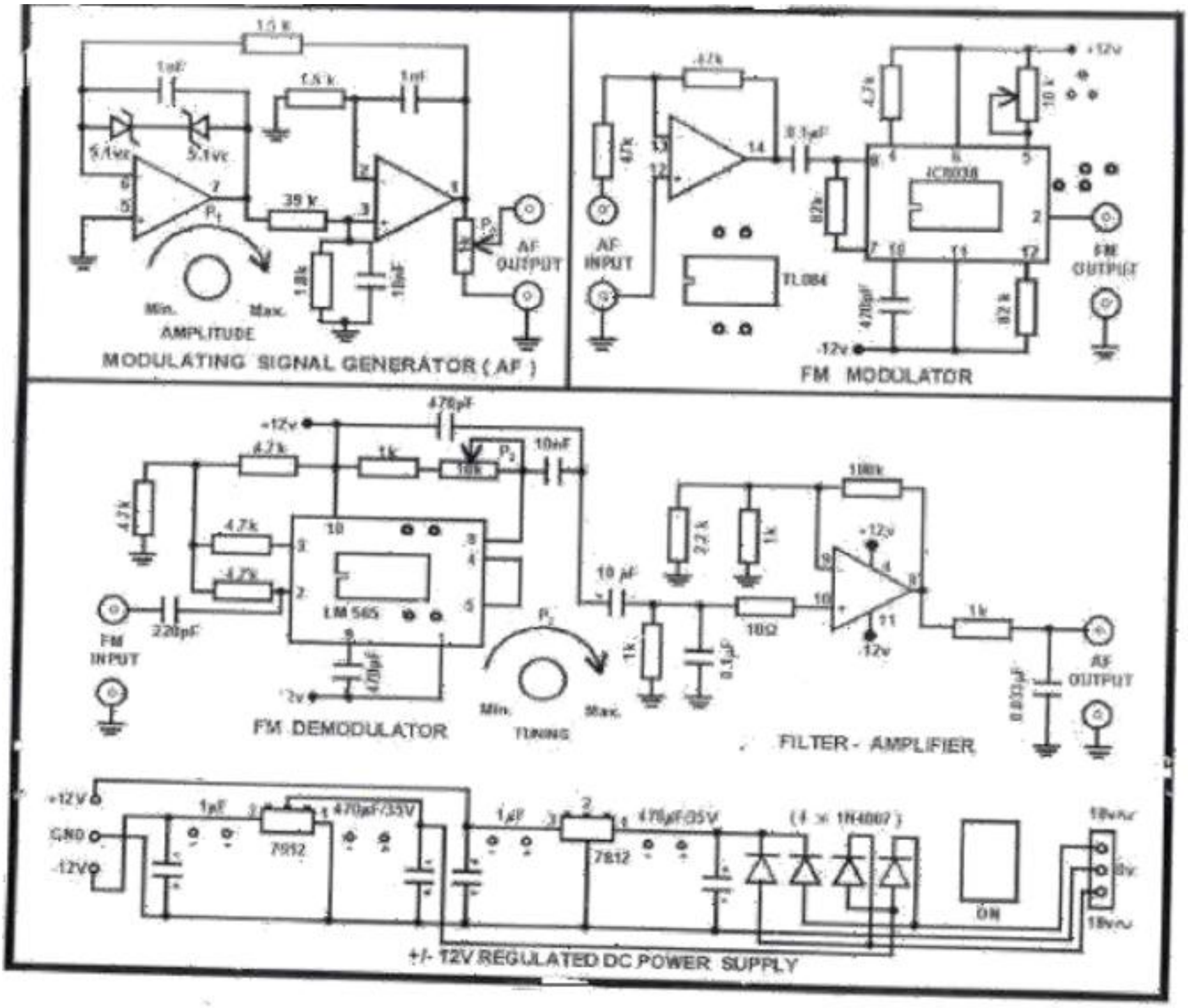


DEMODULATION:



RESULT:

PANEL DIAGRAM



QUESTIONS:

1.Define FM & PM.

2.What are the advantages of Angle modulation over amplitude modulation?

3.What is the relationship between PM and FM?

4.With a neat block diagram explain how PM is generated using FM.

EXPERIMENT NO -3

DSB-SC MODULATOR & DEMODULATOR

AIM: To study the working of the Balanced Modulator and demodulator.

APPARATUS:

1. Balanced modulator trainer kit
2. C.R.O (20MHz)
3. Connecting cords and probes
4. Function generator (1MHz)

THEORY:

Balanced modulator circuit is used to generate only the two side bands DSB-SC. The balanced modulation system is a system is a system of adding message to carrier wave frequency there by only the side bands are produced. It consists of two AM modulators arranged in a balanced configuration. The AM modulator is assumed to beidentical. The carrier input to the two modulators is same.

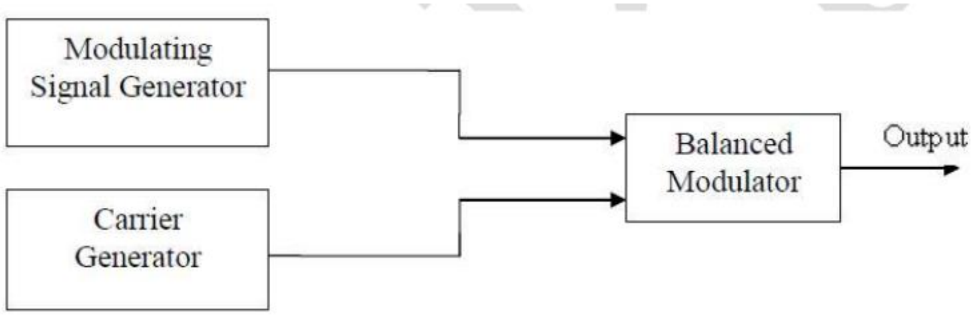
If we eliminate or suppress the carrier, then the system becomes suppressed carrier D SB-SC. In this we need reinsert the carrier is complicated and costly. Hence the suppressed carrier DSB system may be used in point-to-point communication system.

Generation of suppressed carrier amplitude modulated volt balanced modulator may be of the following types.

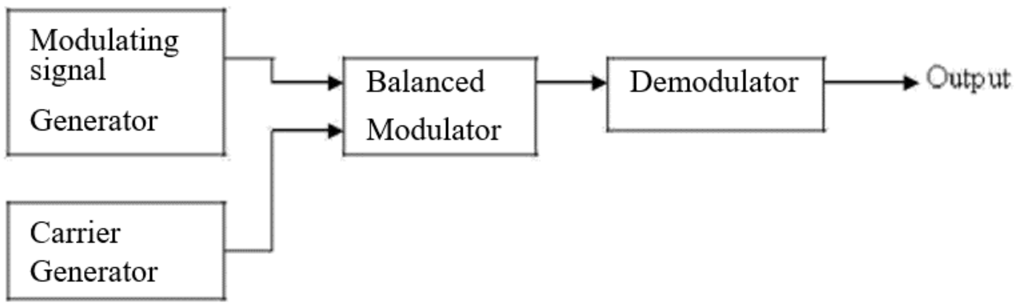
1. Using transistors or FET.
2. Using Diodes

BLOCK DIAGRAM:

MODULATION.



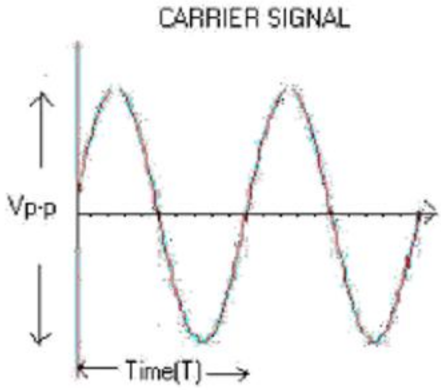
DEMODULATION:

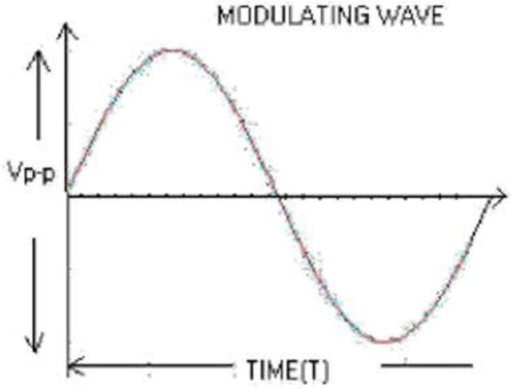


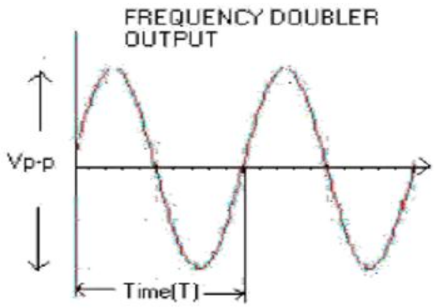
PROCEDURE:

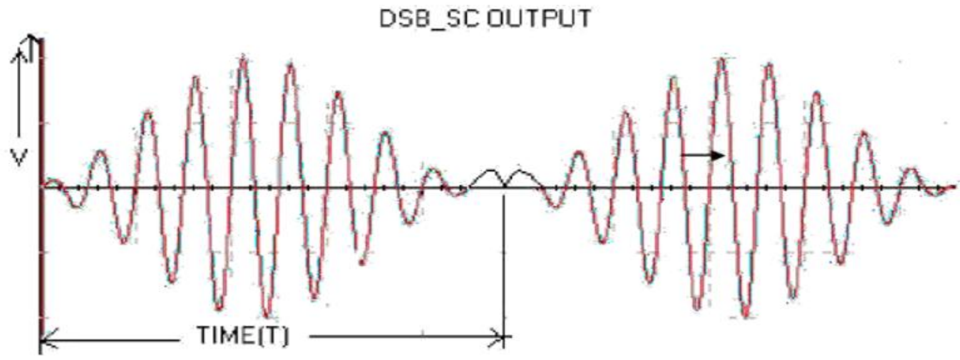
1. Connect the circuit as per the given circuit diagram.
2. Switch on the power to the trainer kit.
3. Apply a 100KHz, 0.1 peak sinusoidal to the carrier input and a 5KHz, 0.1 peaksinusoidal to the modulation input.
4. Measure the output signal frequency and amplitude by connecting the output toCRO.
5. And note down the output signals.

EXPECTED WAVEFORM:









OBSERVATION:

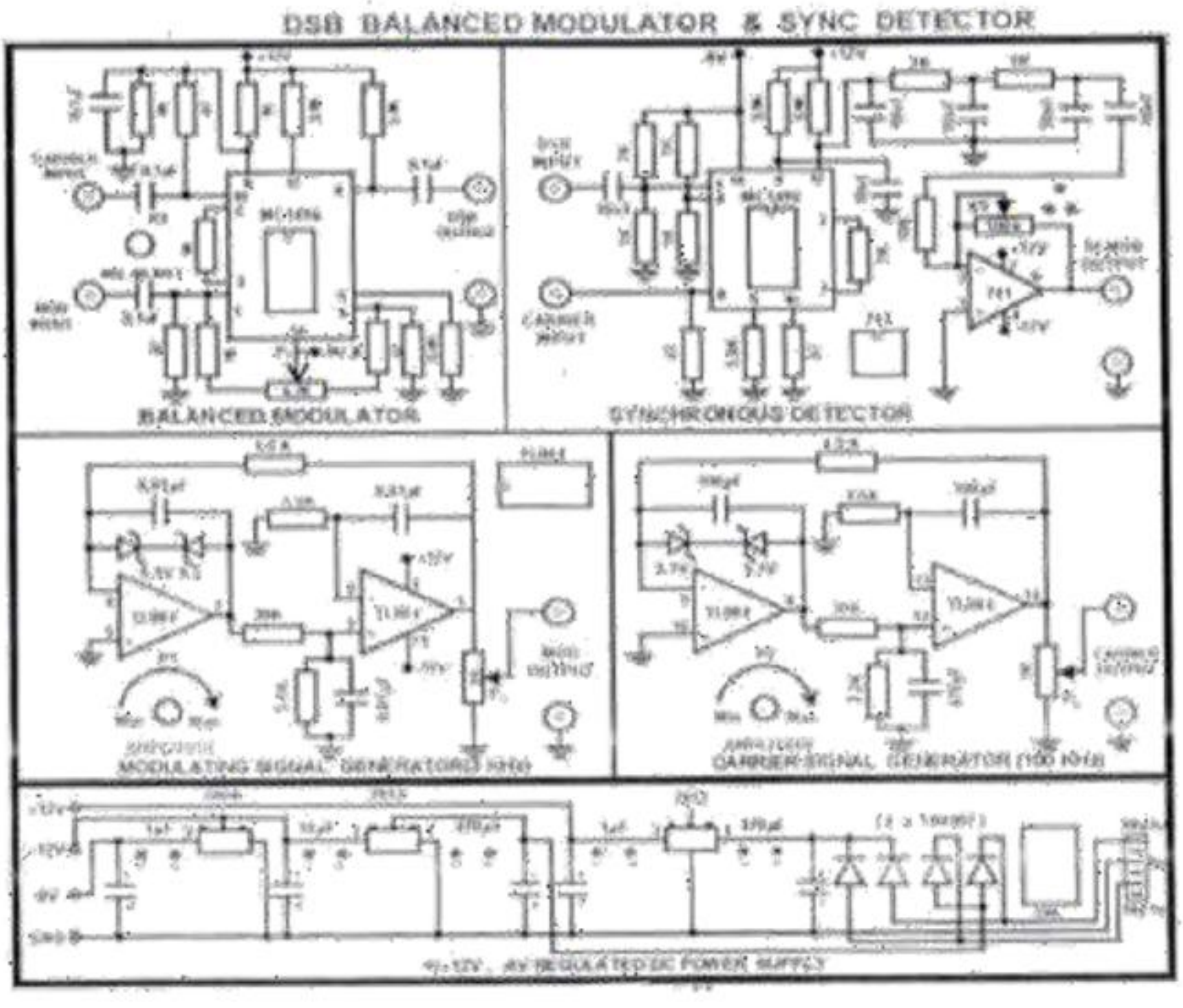
Carrier input		Message signal		Modulated or output Signal	
fc(Hz)	Vc(volts)	fm(Hz)	Vm(v)	fo(Hz)	Vo(v)

RESULT:

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. Explain the working of balanced modulator and Ring Modulator using diodes

PANEL LAYOUT DIAGRAM:



EXPERIMENT NO-4

SSB-SC MODULATOR & DEMODULATOR

(PHASE SHIFT METHOD)

AIM: To generate SSB using phase method and detection of SSB signal using Synchronous detector.

APPARATUS:

1. SSB trainer kit
2. C.R.O (20MHz)
3. Patch cards

4.CRO probe

THEORY:

AM and DSBSC modulation are wasteful of band width because they both require a transmission bandwidth which is equal to twice the message bandwidth In SSB only one side band and the carrier is used. The other side band is suppressed at the transmitter, but no information is lost. Thus, the communication channel needs to provide the same band width, when only one side band is transmitted. So, the modulation system is referred to as SSB system.

The base band signal may not be recovered from a SSB signal using a diode modulator. The bae band signal can be recovered if the spectral component of the output i.e. either the LSB or USB is multiplied by the carrier signal.

Consider the modulating signal.

$m(t)=A_m \cos W_mt$

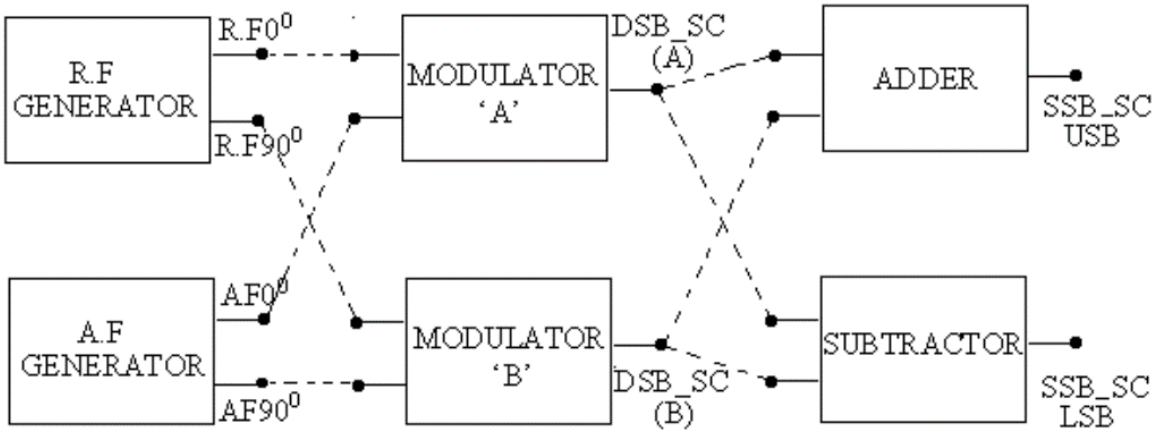
$c(t)=A_c \cos W_ct$

$m(t)c(t)= A_cA_m \cos W_mt \cos W_ct$

The above signal when passed through a filter, only one of the above components is obtained which lays the SSB signal.

BLOCK DIAGRAM:

SSB MODULATION



SSB DEMODULATION/SYNCHRONOUS DETECTOR

PROGRAM:

PROCEDURE:

SSB MODULATION:

1. Connect the Adaptor to the mains and the other side to the Experimental Trainer Switch "ON" the power.
2. (a) Connect carrier f_c 90^0 to A_{in} of Balanced Modulator –A and adjust its amplitude to 0.1Vpp.

   (b). Connect modulating signal f_m 0^0 5Vpp to B_{in} of the Balanced Modulator A.
3. Observe the DSB-A output on CRO.
4. Connect fc 0^0 at 0.1 Vpp at C_{in} of Balanced Modulator B. Connect fm 90^0 at 5 Vpp at D_{in} of Balanced Modulator B.
5. Connect the DSB-A output and DSB-B output to the summing amplifier. Observe the output (SSB output) on the spectrum analyzer. This gives single side band (upper) only while the lower side band is cancelled in the summing Amplifier.

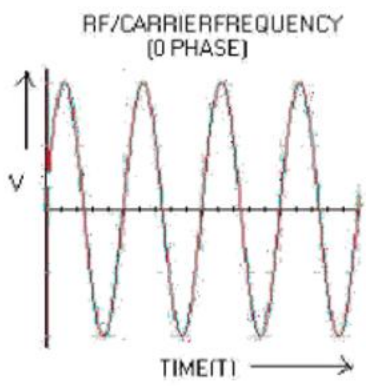
SSB DEMODULATION:

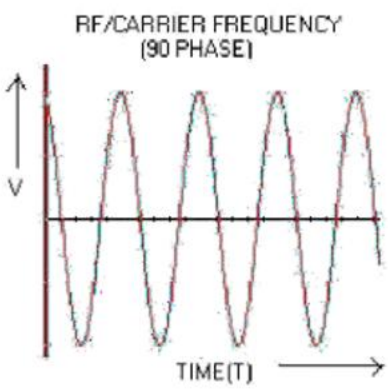
1. Connect the carrier fc 0^0 and SSB output to the synchronous detector.
2. Connect the demodulator output on the oscilloscope which is the recovered modulating.

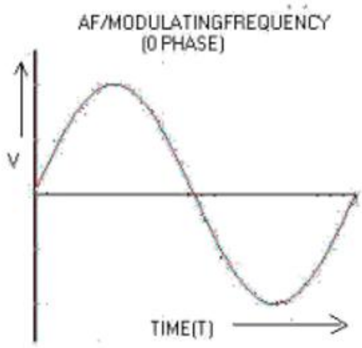
OBSERVATION:

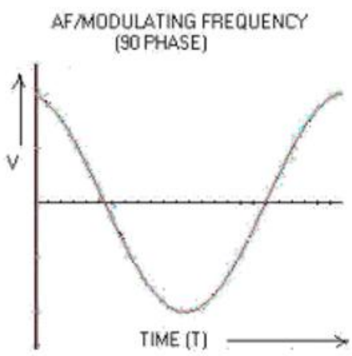
Carrier signal		Modulating signal		Balanced modulator A		Balanced modulator B		Synchronous Detector	
fc	Vc	fm	Vm	Vmax	Vmin	Vmax	Vmin	fd	Vd

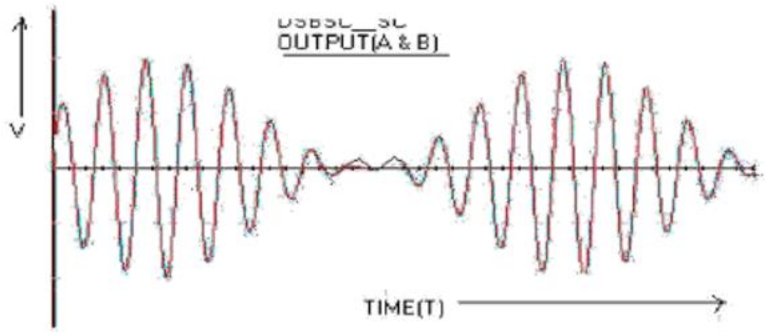
EXCEPTED WAVEFORM:

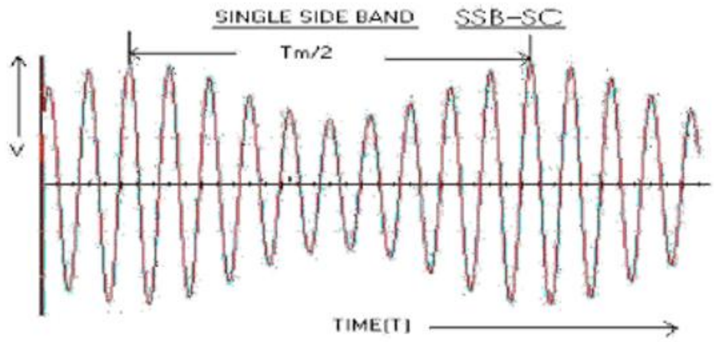


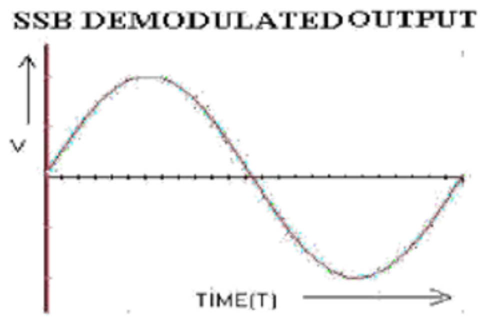










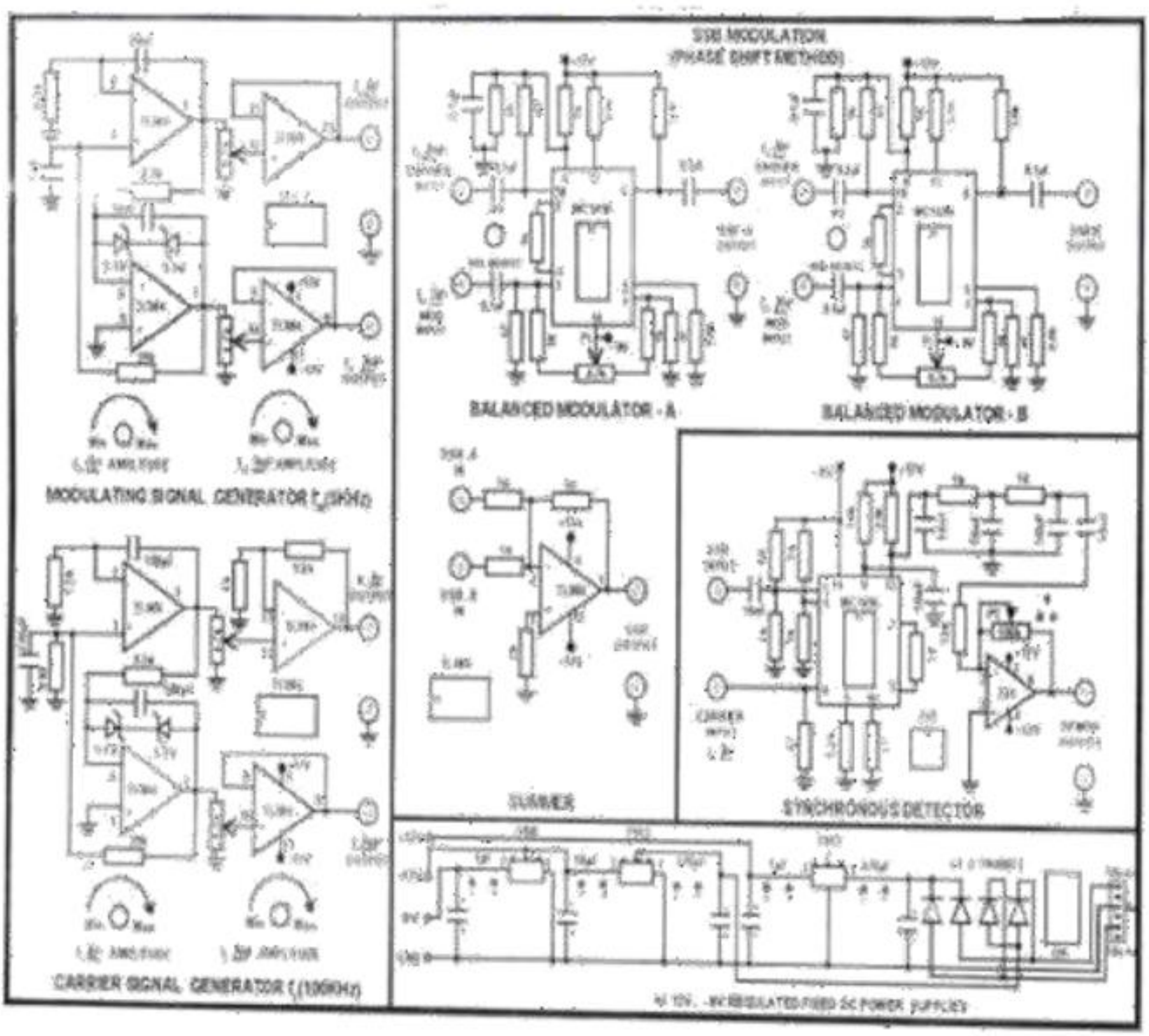


RESULTS:

QUESTIONS:

1. What are the different methods to generate SSB-SC signal?
2. What is the advantage of SSB-SC over DSB-SC?
3. Explain Phase Shift method for SSB generation.
4. Why SSB is not used for broadcasting?
5. Give the circuit for synchronous detector?
6. What are the uses of synchronous or coherent detector?
7. Give the block diagram of synchronous detector?
8. Why the name synchronous detector?

PANEL LAYOUT DIAGRAM:



EXPERIMENT NO: 5

FREQUENCY DIVISION MULTIPLEXING & DEMULTIPLEXING

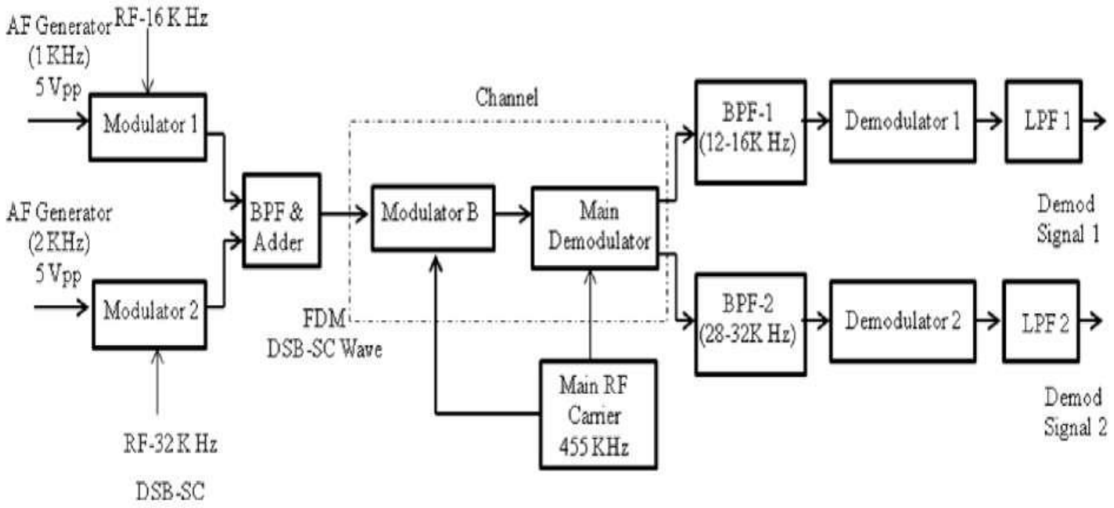
AIM: To study the frequency division multiplexing and Demultiplexing Techniques.

APPARATUS:

1. Frequency Division Multiplexing & Demultiplexing Trainer Kit.
2. CRO (20MHz)
3. Patch Chords.

THEORY: Frequency division multiplexing is a multiplexing technique in which multiple separate information signals can be transmitted over a single communication channel by occupying different frequency slots within common channel bandwidth.

Block Diagram:



Procedure:

1. Connect the circuit as shown in the figure.
2. Switch ON the power supply.
3. Set the amplitude of each modulating signal as 5Vp-p and frequency of each AF signal to 1KHz and 2KHz respectively.
4. Monitor the outputs at signal-1, signal-2, (RF-16KHz, RF-32KHz), modulation -1 modulator-2, BPF & adder.
5. Set output frequency of RF oscillator to 455KHz and amplitude to 10Vp-p.
6. Monitor the output FDM DSB-SC wave will be observed.

FDM Demultiplexing & LPF:

1. Connect the FDM DSB-SC to Demultiplexer and observe the output of main demodulator.
2. Connect the main demodulator output to BPF1 and BPF2.
3. Connect the output of BPF ‘s to the respective demodulator and then to LPF’s.
4. Monitor the demodulated signal1 and demodulated signal2.

Result:

EXPERIMENT NO-6

PULSE AMPLITUDE MODULATION & DEMODULATION

AIM:

1. To study the Pulse amplitude modulation & demodulation Techniques.
2.To study the effect of amplitude and frequency variation of modulating signal on the output.

APPARATUS:

1. Pulse amplitude modulation & demodulation Trainer.
2. Dual trace CRO.
3. Patch chords.

THEORY:

Pulse modulation is used to transmit analog information. In this system continuous wave forms are sampled at regular intervals. Information regarding the signal is transmitted only at the sampling times together with syncing signals. At the receiving end, the original waveforms may be reconstituted from the information regarding the samples.

The pulse amplitude modulation is the simplest form of the pulse modulation. PAM is a pulse modulation system is which the signal is sampled at regular intervals, and each sample is made proportional to the amplitude of the signal at the instant of sampling. The pulses are then sent by either wire or cables are used to modulated carrier.

The two types of PAM are i) Double polarity PAM, and ii) the single polarity PAM, in which a fixed dc level is added to the signal to ensure that the pulses are always positive. Instantaneous PAM sampling occurs if the pulses used in the modulator are infinitely short.

Natural PAM sampling occurs when finite-width pulses are used in the modulator,
but the tops of the pulses are forced to follow the modulating waveform. Flat-topped sampling is a system quite often used because of the ease of generating the modulated wave. PAM signals are very rarely used for transmission purposes directly. The reason for this lies in the fact that the modulating information is contained in the amplitude factor of the pulses, which can be easily distorted during transmission by noise, crosstalk, other forms of distortion. They are used frequently as an intermediate step in other pulse- modulating methods, especially where time-division multiplexing is used.

CIRCULT DESCRIPTION:

PULSE AND MODULATION SIGNAL GENERATOR

A 4.096 MHz clock is used to derive the modulating signal, which is generated by an oscillator circuit comprising a 4.096MHz crystal and three 74HC04(U9) inverter gates. This 4.096MHz clock is then down in frequency by a factor of 4096, by binary counter 74HC4040(U10), to produce 50% duty cycle, 1 KHz square wave on pin no.1 of U10, and 2KHz square wave on pin no.15. the frequency is selectable by means of SW1. this goes to input of fourth order low pass filter U11(TL072) is used to produce sine wave from the square wave. The amplitude of this sine wave can be varied.

The square wave which is generated by the oscillator is buffered by inverter 74HC04(U9), to produce 32KHz square wave at pin no.4 of the 74HC4040(U10). This pulse is given to the monostable multi to obtain the 16 KHz and 32 KHz square wave at the output which are selected by the frequency pot.

MODULATION:

The ICDG211 (U3) is used as a pulse amplitude modulation in this circuit. The modulation signal & pulse signals are given to TL074 (U2) & 7400(U1) IC"s respectively. These outputs are fed to the inputs the D4211 (U3).

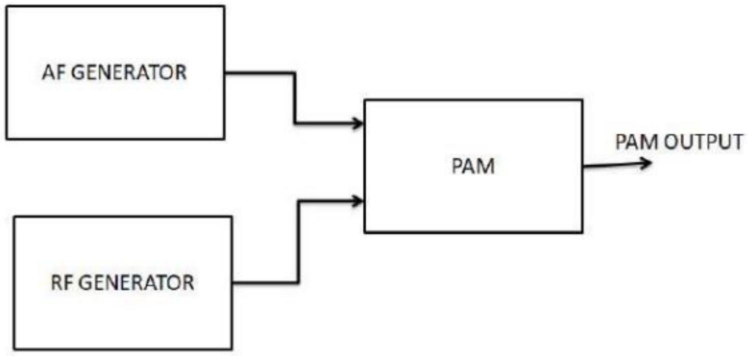
The sampled output is available at the pin no 2 of DG211 and it is buffered by using TL074 (U2) and then output is available at TP5. Similarly, the sample & hold output and the flat top output are available at pin no.15 &10 of DG211 respectively. These are buffered by TL074 (U2) and then output is available at TP6&TP7 respectively.

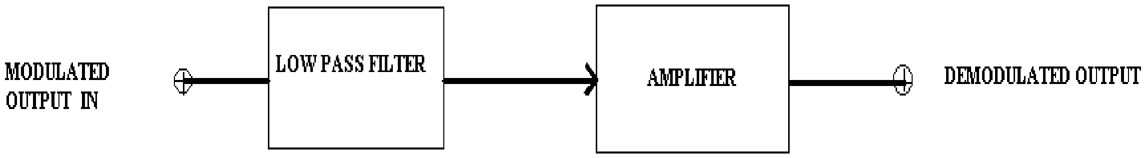
DEMODULATION:

The demodulation section comprises of fourth order low pass filter and an AC amplifier. The TL074(U5) is used as a low pass filter and AC amplifier. The output of the modulator is given as the input to the low pass filter. The low pass filter output is obviously less, and it is fed to the AC amplifier which comprises of a single op amp and whose output is amplified.

CIRCUIT:

Modulator:





PROCEDURE:
DOUBLE POLARITY:
MODULATION:

1. Connect the circuit as shown in diagram 1
   a. The output of the modulating signal generator is connected to the modulating signal input TP2 keeping the frequency switch in 1KHz position, and amplitude knob to max position.
   b. 16KHz pulse output to pulse input TP1. (Keep the frequency in minimum position in pulse generator block).
2. Switch ON the power supply.
3. Monitor the outputs at TP5, TP6 & TP7. And observe the outputs also by varying amplitude pot (Which is in modulation signal generator block).
4. Now vary the frequency selection which position in modulating signal generator block to 2 KHz, amplitude pot to max position.
5. Observe the output at TP5, TP6 & TP7 and observe the outputs also by varying amplitude pot (Which is in modulation signal generator block).
6. Repeat all the above steps for the pulse frequency 32KHz (By varying the frequency pot in the pulse generator block).
7. Switch OFF

SINGLE POLARITY PAM:

9. Connect the circuit as shown in diagram 2
   a) The output of the modulating signal generator is connected to the modulating signal input TP2 keeping the frequency switch in 1KHz position, and amplitude knob to max position.
   b) 16KHz pulse output to pulse input TP1.Switch ON the power supply.
10. Repeat the above step 3 to 6 and observe the outputs.
11. Vary DC output pot until you get single polarity PAM at TP5, TP6, TP7.
12. Switch OFF the power supply.

DEMODULATION:

1.Connect the circuit as shown in diagram 3.
   a) The output of the modulating signal generator is connected to the modulating signal input TP2 keeping the frequency switch in 1KHz position, and amplitude knob to max position
   b) 16KHz pulse output to pulse input TP1.
   c) sample output, sample and hold output and flat top outputs Respectively to the input of low pass filter (TP9) and LPF output (TP10) to AC amplifier input (TP11).

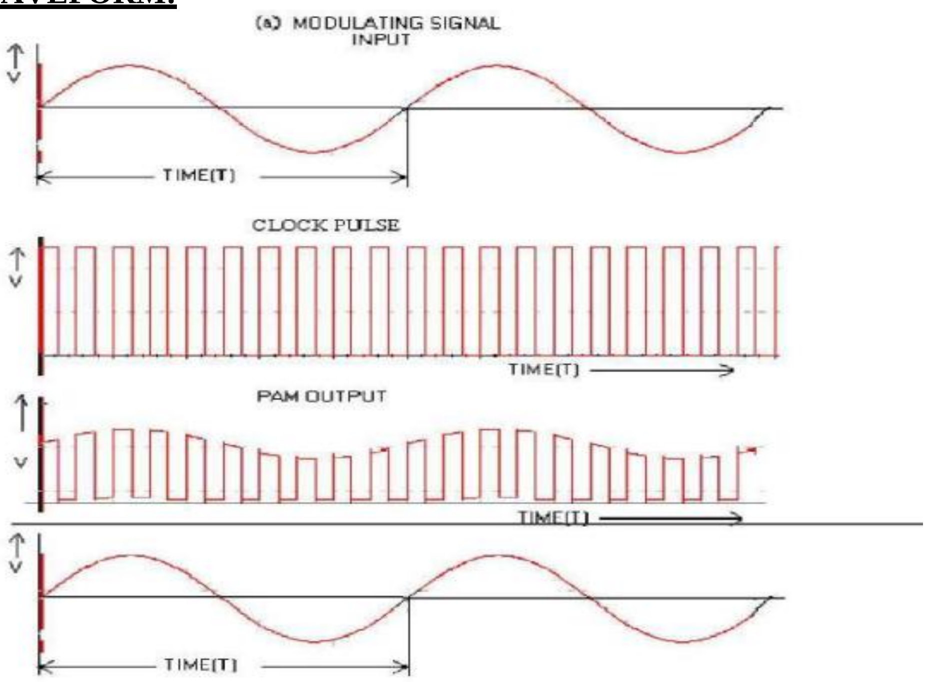
2.Observe the output of LPF and AC amplifier at TP10,TP12 respectively, corresponding to inputs from TP5,TP6 &TP7. The outputs will be the true replica of the input.

3.Now, set the switch position in modulating signal generator to 2KHz and observe the outputs at TP10&TP12 respectively, corresponding to inputs from TP5, TP6& TP7.

4.Vary the frequency of pulse to 32KHz (By varying the frequency pot (Put in max position) in pulse generator block) and repeat the above steps 2&3.

5.Switch OFF the power supply.

EXPECTED WAVEFORM:



RESULT:

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?
6. If the emitter follower in the modulator section saturates for some level of input signal, then what effect it will have on the output?
7. Derive the mathematical expression for frequency spectrum of PAM signal.
8. Explain the modulation circuit operation?
9. Explain the demodulation circuit operation?
10. Is PAM & Demodulation sensitive to Noise?

EXPERIMENT NO-7

PULSE WIDTH MODULATION & DEMODULATION

AIM:

1. To study the Pulse Width Modulation (PWM) and Demodulation Techniques.
2. To study the effect of Amplitude and Frequency of Modulating Signal on PWM output.

APPARATUS:

1. PWM trainer kit
2. C.R.O(30MHz)
3. Patch Chords

THEORY:

Pulse modulation is used to transmit analog information. In this system continuous wave forms are sampled at regular intervals. Information regarding the signal is transmitted only at the sampling times together with synchronizing signals.

At the receiving end, the original waveforms may be reconstituted from the information regarding the samples. Pulse Width Modulation of the PTM is also called as the Pulse Duration Modulation (PDM) & less often Pulse length Modulation (PLM). In pulse Width Modulation method, we have fixed and starting time of each pulse, but the width of each pulse is made proportional to the amplitude of the signal at that instant.

This method converts amplitude varying message signal into a square wave with constant amplitude and frequency, but which changes duty cycle to correspond to the strength of the message signal. Pulse-Width modulation has the disadvantage, that its pulses are of varying width and therefore of varying power content. This means that the transmitter must be powerful enough to handle the maximum-width pulses. But PWM still works if synchronization between transmitter and receiver fails, whereas pulse-position modulation does not.

Pulse-Width modulation may be generated by applying trigger pulses to control the starting time of pulses from a mono stable multivibrator, and feeding in the signal to be sampled to control the duration of these pulses. When the PWM signals arrive at its destination, the recovery circuit used to decode the original signal is a sample integrator (LPF).

CIRCUIT DESCRIPTION:

PULSE &MODULATION SIGNAL GENERATOR:

A 4.096MHz clock is used to derive the modulating signal, which is generated by an oscillator circuit comprising a 4.096MHz crystal and three 74HC04(U9) inverter gates.

This 4.096MHz clock is then divided down in frequency by a factor of 4096, by binary counter 74HC4040(U2), to produce 50% duty cycle, 1KHz square wave on pin no.1 of U4, and 2KHz square wave on pin no.15. the frequency is selectable by means of SW1.

This goes to input of fourth order low pass filter U3 is used to produce sine wave from the square wave. The amplitude of this sine wave can be varied. The square wave which is generated by the oscillator is buffered by inverter 74HC04, to produce 32KHz square wave at pin no.4 of the 74HC4040(U2). This pulse is given to the monostable multi to obtain the 16KHz and 32KHz square wave at the output which are selected by the frequency pot.

MODULATION:

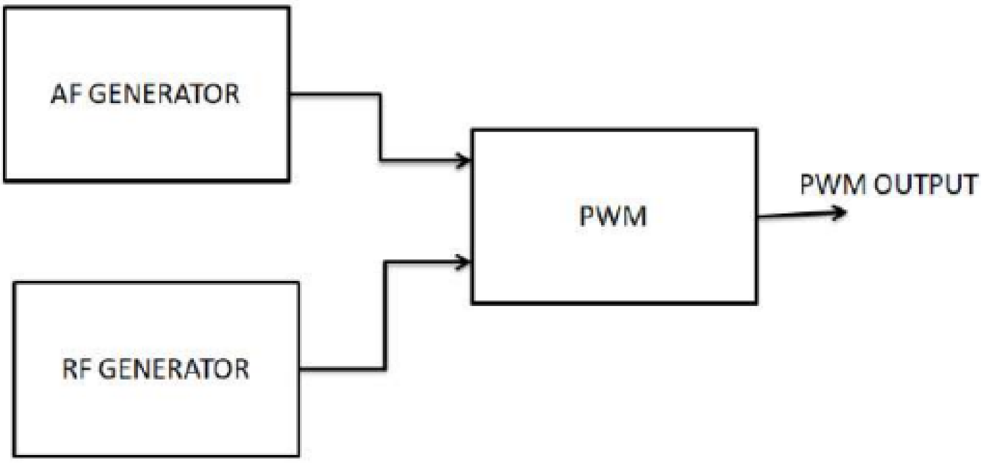
The PWM circuit uses the 555 IC(U1) in monostable mode. The Modulating signal input is applied to pin no.5 of 555IC, and their Pulse input is applied to pin no.2.
the output of PWM is taken at the pin no.3 of 555IC i.e., TP3.

DEMODULATION:

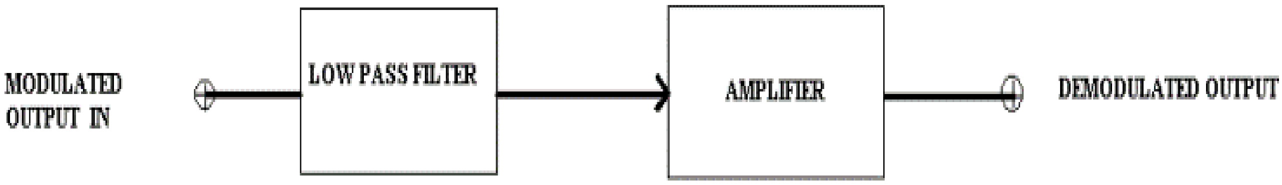
The demodulation section comprises of a fourth order low pass filter and an AC amplifier. The TL074(U5) is used as a low pass filter and an AC amplifier. The output of the modulator is given as the input to the low pass filter.

The low pass filter output is obviously less, and it is feed to the AC amplifier which comprises of a single op amp and whose output is amplified.

CIRCUIT:
MODULATION:



DEMODULATION:



PROCEDURE:

MODULATION:

1. Connect the circuit as shown in the diagram 1.
2. Switch ON the power supply.
   a) The output of the modulating signal generator is connected to the modulating signal input TP2 keeping the frequency switch in 1KHz position and amplitude knob to max position.
   b) 16KHz pulse output (by varying the frequency pot (put it min position) in pulse generator block) from pulse
3. Vary the modulating signal generator frequency by switching the frequency selector switch to 2 KHz.
4. . Now, again observe the PWM output at TP3. (By varying the amplitude pot).
5. Repeat the above steps (3 to 5) for the pulse frequency of 32KHz (by varying the frequency pot(put in max position) in pulse generator block.
6. Switch OFF the power supply.

DEMODULATION:

1. Connect the circuit as shown in diagram 2.
   a) The output of the modulating signal generator is connected to the modulating signal input TP2 keeping the frequency switch in 1KHz position, and amplitude knob to max position.
   b) 16KHz pulse output (put frequency pot minimum) from pulse generator block to pulse input TP1.
   c) PWM output to LPF input
   d) LPF output to AC amplifier input
2. Switch ON the power supply.
3. Observe the output of low pass filter and AC amplifier respectively at TP6 & TP8. The output will be the true replica of the input.
4. Now vary the position of the switch in modulating signal generator to 2 KHz and observe the outputs at TP6 & TP8.
5. Repeat the steps 10& 11 for pulse frequency 32 KHz (By varying the frequency pot (put in max). in pulse generator block). Observe the output waveforms.
6. Switch OFF the power supply.

EXPECTED WAVEFORM:

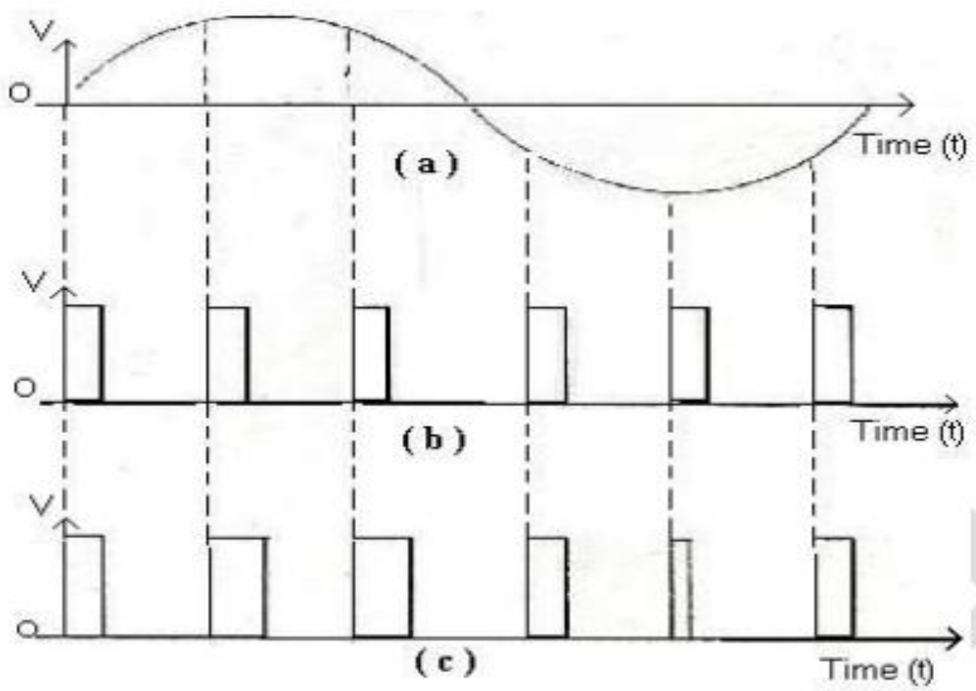


Fig (2) PULSE WIDTH MODULATION
(a) Signal
(b) Unmodulated pulses
(c) PWM

RESULT:

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

EXPERIMENT NO-8

PULSE POSITION MODULATION AND DEMODULATION

AIM:

1. To study the generation Pulse Position Modulation (PPM) and Demodulation.

2. To study the effect of Amplitude and the frequency of modulating signal on its output and observe the wave forms.

APPARATUS:

1. Pulse Position Modulation (PPM) and demodulation Trainer.
2. C.R.O(30MHz)
3. Patch chords.

THEORY:

Pulse Modulation is used to transmit analog information in this system continuous wave forms are sampled at regular intervals. Information regarding the signal is transmitted only at the sampling times together with synchronizing signals.

At the receiving end, the original waveforms may be reconstituted from the information regarding the samples. Pulse modulation may be subdivided into two types analog and digital. In analog the indication of sample amplitude is the nearest variable. In digital the information is a code. Pulse position modulation is one of the methods of the pulse time modulation. PPM is generated by changing the position of a fixed time slot. The amplitude& width of the pulses is kept constant, while the position of each pulse, in relation to the position of the recurrent reference pulse is valid by each instance sampled value of the modulating wave. Pulse position modulation into the category of analog communication. Pulse-Position modulation has the advantage of requiring. constant transmitter power output, but the disadvantage of depending on transmitter ˳ receiver synchronization.

Pulse-position modulation may be obtained very simply from PWM. However, in PWM the locations of the leading edges are fixed, whereas those of the trailing edges are not. Their position depends on pulse width, which is determined by the signal amplitude at that instant. Thus, it may be said that the trailing edges of PWM pulses are, in fact, position modulated. This has positive-going narrow pulses corresponding to leading edges and negative-going pulses corresponding to trailing edges. If the position corresponding to the trailing edge of an unmodulated pulse is counted as zero displacement, then the other trailing edges will arrive earlier or later. They will therefore have a time displacement other than zero; this time displacement is proportional to the instantaneous value of the signal voltage. The differentiated pulses corresponding to the leading edges are removed with a diode clipper or rectifier, and the remaining pulses are position modulated.

CIRCUIT DESCRIPTION:

MODULATION SIGNAL GENERATOR:

A 4.096 MHz clock is used to derive the modulating signal, which is generated by an oscillator circuit comparing a 4.096MHz crystal and three 74HC04(U9) inverter gates.

This 4.096 MHz clock is then divided down in frequency by a factor of 4096, by binary counter 74HC4040(U4), to produce 50% duty cycle, 1 KHz square wave on pin no.1 of U4, and 2 KHz square wave on pin no.15. The frequency is selectable by means of SW1.

This goes to input of fourth order low pass filter U3 (TL072) is used to produce sine wave from the square wave. The amplitude of this sine wave can be varied.

MODULATION:

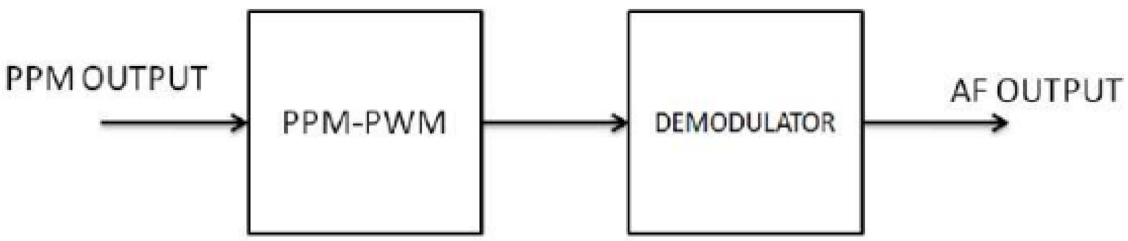
The circuit uses the IC 555(U1) a Mono stable Multivibrator to perform the pulse position Modulation action.

The Modulating signal is given to Pin No. 5 at Pin No.2 the pulse is 32 KHz which is connected internally.

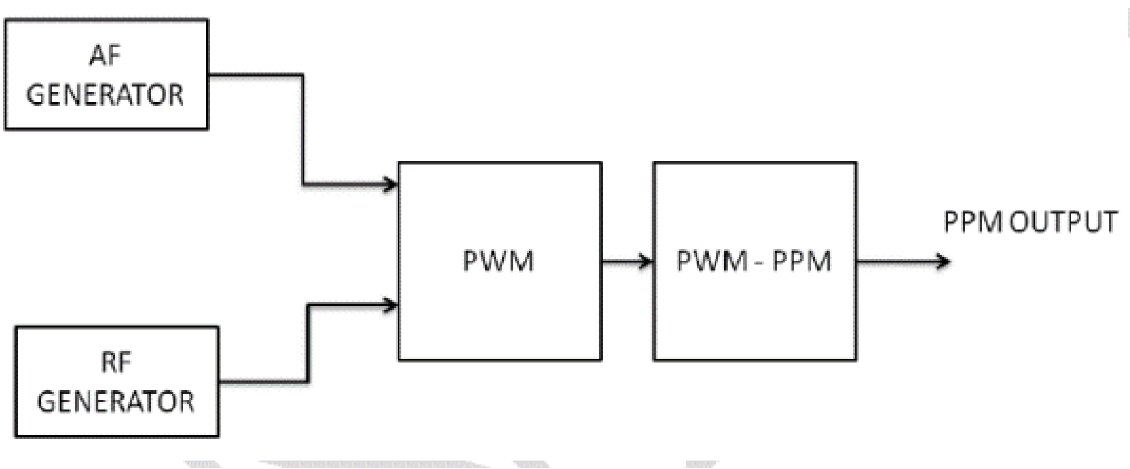
The PWM is available at TP2; this PWM output is differentiated by using differentiated circuit. This differentiated output is available at TP8. This differentiated output is fed to the 555 IC (U2) (Mono stable Mode) Pin No.2. The PPM output is available at TP3.

CIRCUIT DIAGRAM:

MODULATION:



DEMODULATION:



PROCEDURE

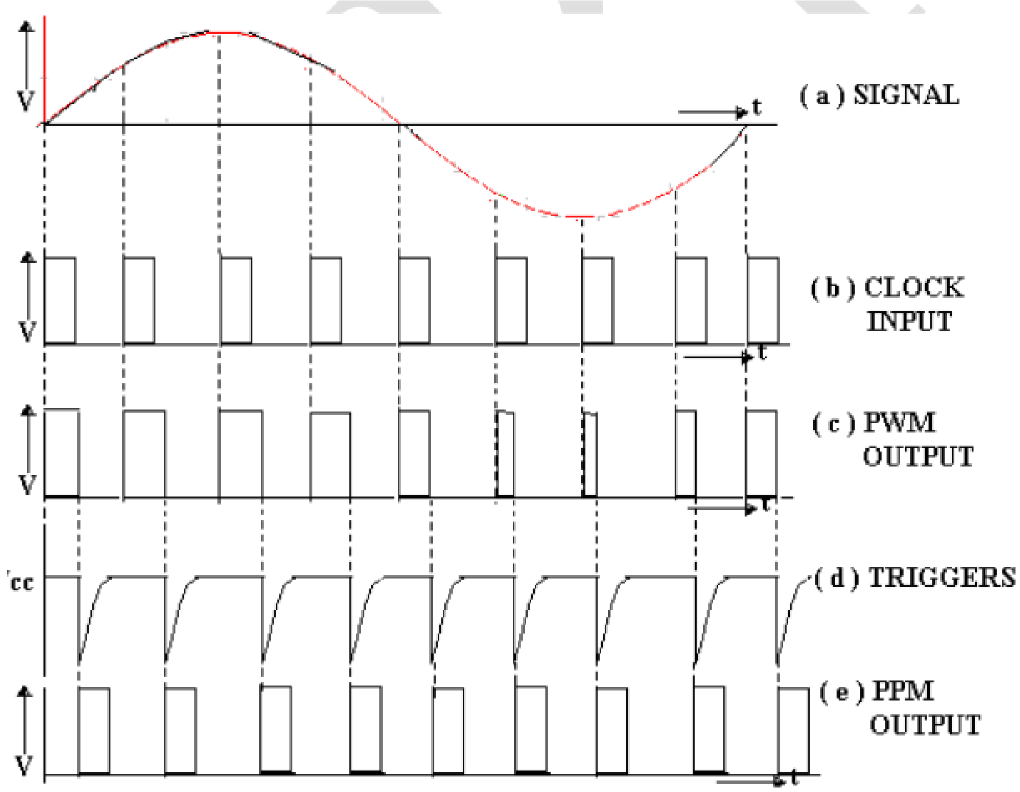
MODULATION:

1. Connect the circuit as shown in diagram 1.
    a) Connect the modulating signal generator output to modulating signal input (TP1) in PPM block.
    b) Keep the switch in 1 KHz position and amplitude pot in max position.
2. Switch ON the power supply
3. Observe the PWM output at TP2, and the differentiated output signal at TP8.
4. Now, monitor the PPM output at TP3.
5. Try varying the amplitude and frequency of sine wave by varying amplitude pot.
6. Repeat Step 5 for frequency of 2 KHz and observe the PPM output.
7. Switch OFF the power supply.

DEMODULATION:

8. Connect the circuit as shown in diagram2.
    a) Connect the modulating signal generator output to modulating signal input (TP1) in PPM block.
    b) Keep the switch in 1 KHz position and amplitude pot in max position.
    c) Connect the PPM output (TP3) to input of LPF(TP4).
9. Switch ON the power supply
10. Observe the demodulated signal at the output of LPF at TP5.
11. Thus, the recovered signal is true replica of the input signal As the output of LPF has less amplitude
    a) connect the output of LPF to the input of an AC amplifier (TP5 to TP6).
    b) Observe the demodulated out put on the oscilloscope at TP7 and observe the amplitude of demodulated signal by varying gain pot. This is amplitude demodulated output.
13. Repeat the steps (7 to 9) for the modulating signal for frequency 2 KHz.
14. Switch OFF the power supply.

EXPECTED WAVEFORMS:



RESULT:

QUESTIONS:

1. What is the advantage of PPM over PWM?
2. Is the synchronization is must between Tx and Rx
3. Shift in the position of each pulse of PPM depends on what?
4. Can we generate PWM from PPM?
5. Why do we need 555 timers?
6. Does PPM contain derivative of modulating signal compared to PWM?
7. For above scheme, do we have to use LPF and integrator in that order?
8. If we convert PPM to PWM & then detect the message signal, will the o/p has less distortion?
9. Is synchronization critical in PPM?
10. How robust is the PPM to noise?

EXPERIMENT NO-9

PULSE CODE MODULATION & DEMODULATION:

AIM:

To Study & understand the operation of the Pulse code modulation & Demodulation.

EQUIPMENT REQUIRED:

1. PCM Modulator trainer
2. PCM Demodulator trainer
3. Storage Oscilloscope
4. Digital multimeter
5. 2 No's of co-axial cables (standard accessories with trainer) Patch chords

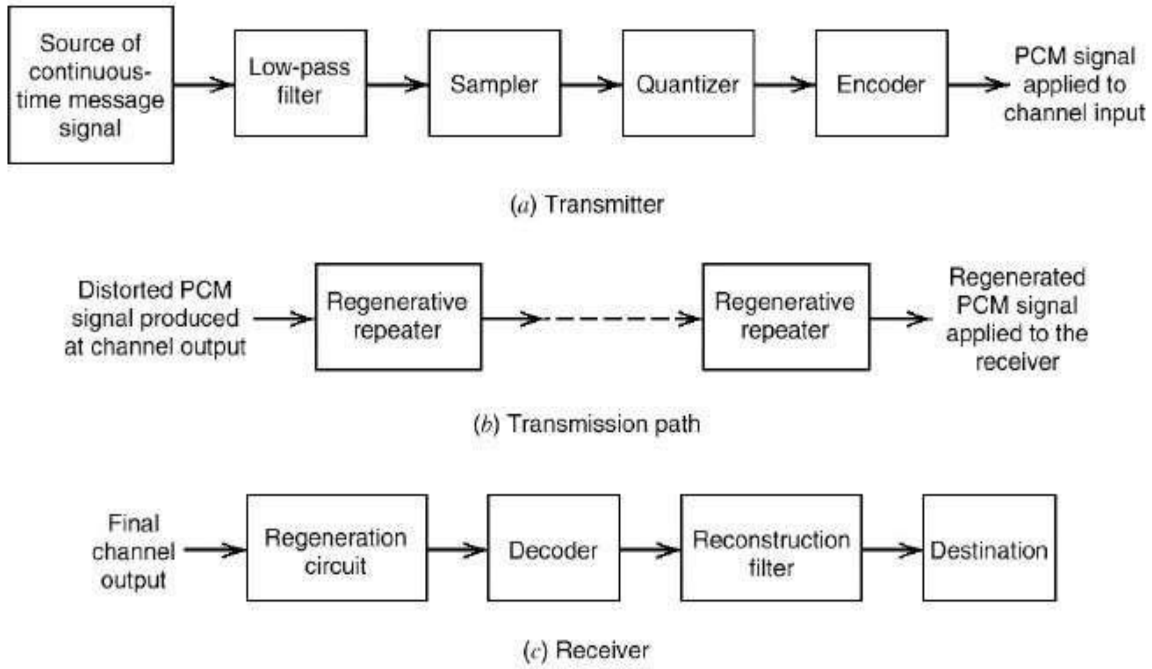
Note: Storage oscilloscope is desired for satisfactory observation of PCM wave forms

THEORY:

Pulse modulation:
A form of modulation in which a pulse train is used as the carrier. Information is conveyed by modulating some parameter of the pulses with a set of discrete instantaneous samples of the messages signal. The minimum sampling frequency is the minimum frequency at which the modulating waveform can be sampled to provide the set of discrete values without a significant loss of information.

PCM: In pulse code modulation (PCM) only certain discrete values are allowed for the modulating signals. The modulating signal sampled, as in other forms of pulse modulation. But any sample falling within a specified range of values is assigned a discrete value. Each value is assigned a pattern of pulses and the signal transmitted by means of this code. The electronic circuit that produces the coded pulse train from the modulating waveform is termed a coder or encoder. A suitable decoder must be used at the receiver in order to extract the original information from the transmitted pulse train.

CIRCUIT DIAGRAMS:



PROCEDURE:

1. Connect the trainer (Modulator) to the mains and switch on the power supply.
2. Observe the output of the AF generator using CRO; it should be a Sine wave of 200Hzfrequencywith3V_{P-P}amplitude.
3. Verify the output of the DC source with multimeter / scope, output should vary from 0 to +5V.
4. Observe the output of the Clock generator using CRO, they should be 64kHz and 4kHz frequency of square wave with 5V_{P-P}amplitude.
5. Connect the trainer (De Modulator) to the mains and switch on the power supply.
6. Observe the output of the clock generator using CRO; it should be 64 kHz square wave with 5V_{P-P}amplitude.

PCM OPERATION(WITH DC INPUT):
MODULATION:

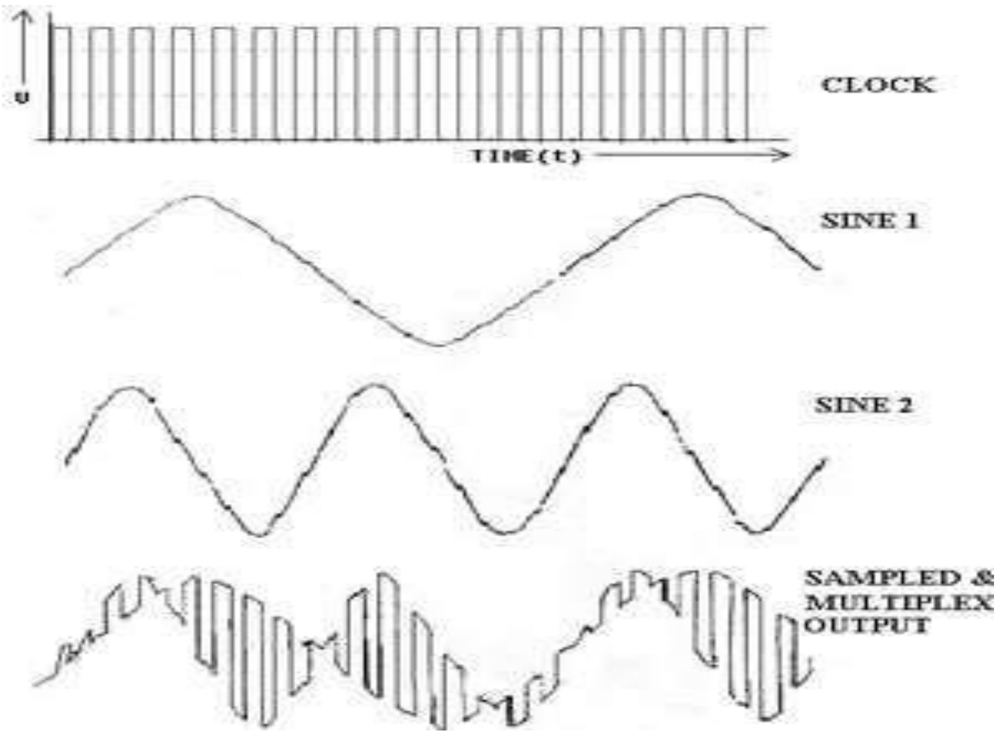
1. Set DC source to some value say 1 V with the help of multimeter and connect it to the A/D converter input and observe the output LED's.
2. Note down the digital code i.e., output of the A/D converter and compare with the theoretical value.

Note: From this wave form you can observe that the LSB bit enters the output first.

DEMODULATION:

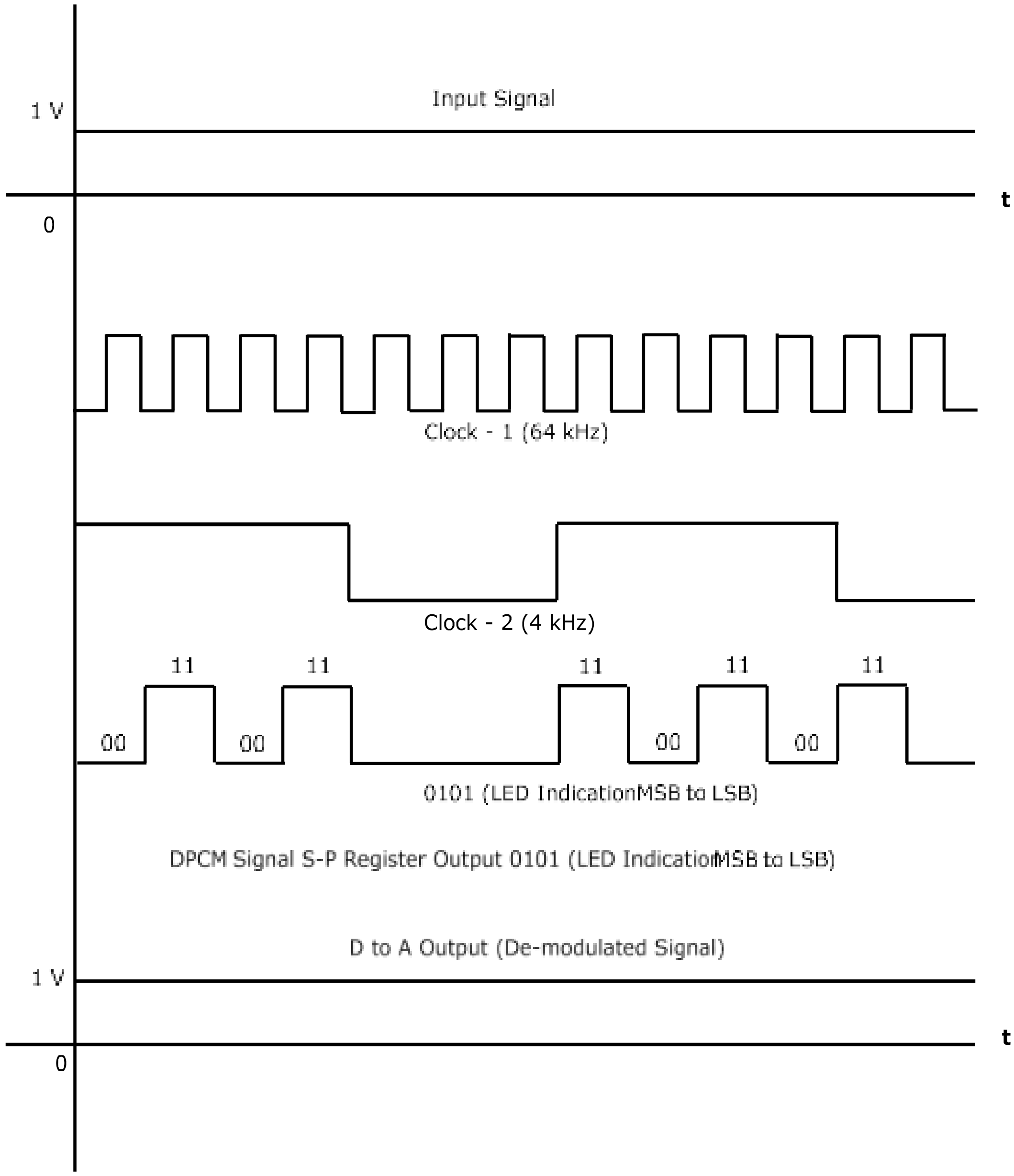
1. Connect PCM signal to the demodulators (S-P Shift register) from the PCM modulator withhelp of coaxial cable (supplied with the trainer).
2. Connect clock signal (64 kHz) from the transmitter to the receiver using coaxial cable.
3. Connect transmitter clock to the timing circuit. Observe and note down the S-P shift register output data and compare it with the transmitted data (i.e., output A/D converter at transmitter. Notice that the output of the S-Pshift register is following the A/D converter output in the modulator.
4. Observe D/A converter output (demodulated output) using multimeter /scope and compare it with the original signal and you can observe that there is no loss in information in process of conversion and transmission.
5. Similarly you can try for different values of modulating signal voltage.

WAVEFORM:



PCM WAVE FORM/TIMING

DIAGRAM OF INPUT:



SAMPLE WORK SHEET:

1. Modulating signal : 1 V
2. A/D output(theoretical) : 00 11 0011(2)
3. A/D output(practical) :0110011(2)4.
4. P output : 00110011(2)
5. D/A Converter output : 1 V (Demodulation output)

PCM OPERTION (WITH AC INPUT):
MODULATION:

1. ConnectACsignalof2V_{P-P} amplitude to Sample & Hold circuit.
2. Keep the CRO in dual mode. Connect one channel to the AF signal and another channel tothe sample hold output. Observe and sketch the sample &hold output.
3. Connect the sample and hold output to the A/D converter and observe the PCM output using storage oscilloscope/DTO.
4. Observe PCM output by varying AF signal voltage.

DEMODULATION:

1. Connect clock signal (64 kHz) from the transmitter other receiver usingcoaxial cable.
2. Connect transmitter clock to the timing circuit.
3. Keep CRO in dual mode. Connect CH 1 input to the sample and hold output and CH 2input of the D/A converter output.
4. Observe and sketch the D/A output.
5. Connect D/A output to the LPF input.
6. Observe output of the LPF/Amplifier and compare it with the original modulating signal.
7. From above observation you can verify that there is no loss in information (modulating signal) in conversion and transmission process.
8. Disconnect clock from transmitter and connect to local oscillator (i.e., clock generator output from Demodulator) with remaining setup as it is. Observe D/A output and compare it with the previous result. This signal is little bit distorted in shape. This is because lack of synchronization between clock at transmitter and clock at receiver.

Note: You can take modulating signals from external sources. Maximum amplitude should notexceed 4 V in case of DC and 3 V_{P-P}in case of AC (AF)signals.

RESULT:

QUESTIONS:

1. Define modulation.
2. What are three different processing steps in PCM?
3. Define signal – to – noise ratio.
4. Define quantization error.
5. Define overload level.
6. What is ternary code?
7. What are advantages of PCM?
8. Define White Gaussian noise.
9. Define channel and Quantization noise.
10. What are three basic functions of Regenerative repeaters?

EXPERIMENT NO-10

DELTA MODULATION

AIM: To study the characteristics of Delta Modulation and Demodulation.

APPARATUS:

1. DM Modulator &Demodulator trainer
2. Storage Oscilloscope
3. Digital multimeter.
4. 2 No's co-axial cables (standard accessories with trainer)

THEORY:

Delta modulation is almost similar to differential PCM. In this, only one bit is transmitted per sample just to indicate whether the present sample is larger or smaller than the previous one. The encoding, decoding and quantizing process become extremely simple, but this system cannot handle rapidly varying samples. This increases quantizing noise. It has also not found wide acceptance.

PROCEDURE:

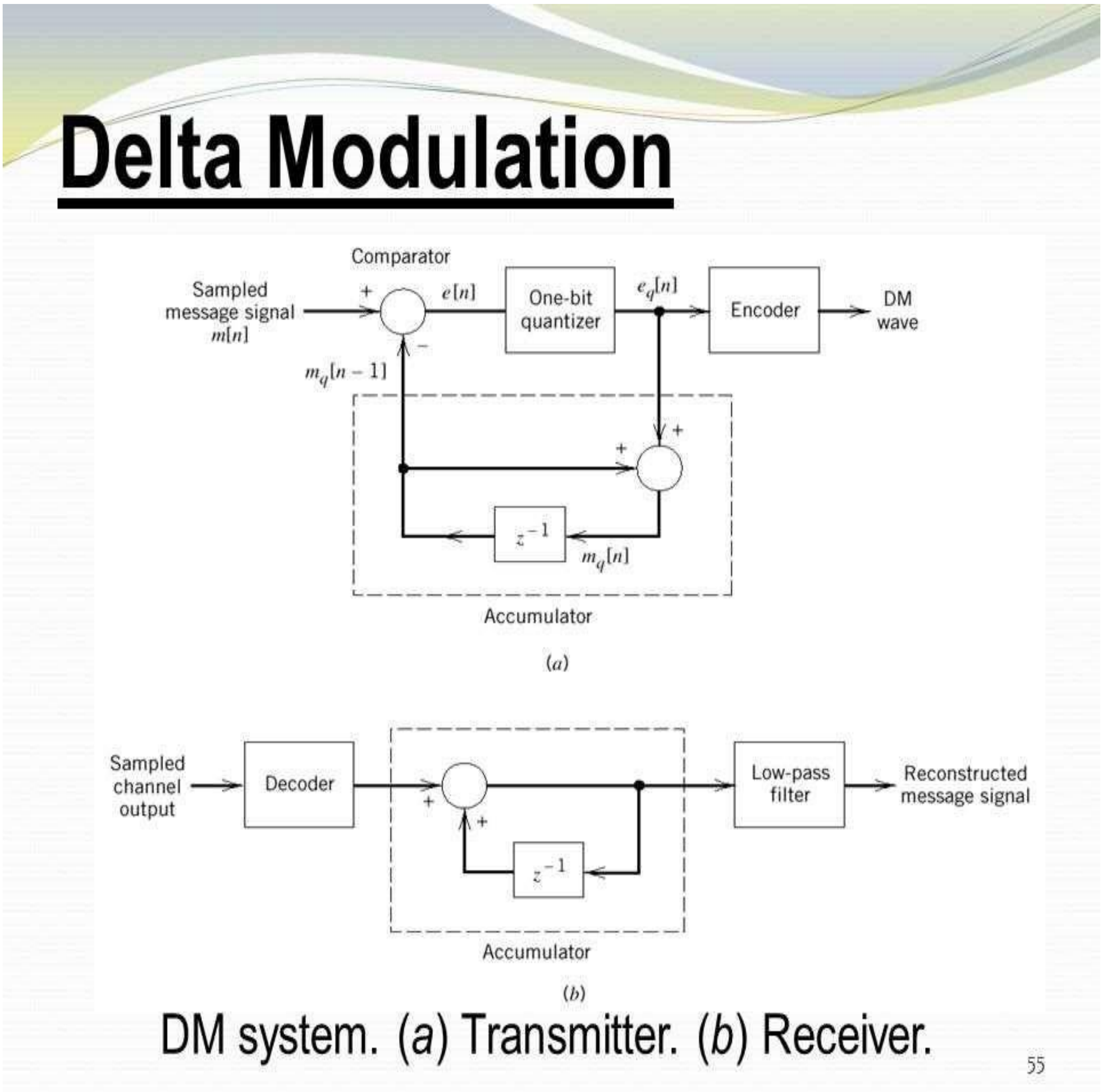
DM MODULATOR:

1. Study the theory of operation.
2. Connect the trainer (DM Modulator) to the mains and switch on the power supply.
3. Observe the output of the AF generator using CRO; it should be a Sine waveof100Hzfrequencywith3Vp–$p$amplitude.
4. Verify the output of the DC source with multimeter/scope; output should vary 0 to +4V.
5. Observe the output of the Clock generator using CRO, they should be 4 kHz frequencyofsquarewavewith5Vp–p amplitude.

Note: This clock signal is ***internally connected to the up/down counter*** so no external coionis required

DM WITH DC VOLTAGE AS MODULATING SIGNAL:

1. Connect dc signal from the DC source to the inverting input of the comparator and setsome voltage say 3 V.
2. Observe and plot the signals at D/A converter output(i.e., non-inverting input of the comparator), DM signal using CRO and compare them with the wave forms



CIRCUIT DIAGRAM:

1. Connect DM signal (from Modulator) to the DM input of the demodulator.
2. Connect clock (4 kHz) from modulator to the clock input of the demodulator. Connect clock input of the UP/DOWN counter to the clock from transmitter with the help of springs provided.
3. Observe digital output (LED Indication) of the UP/DOWN counter and compare it with the output of the UP/DOWN. By this you can notice that the both the outputs are same.
4. Observe and plot the output of the D/A converter and compare it with the wave formsgiven in Figure.

5. Measure the demodulated signal (i.e., output of the D/A converter with the help of multimeter and compare it with the original signal.
6. From above observation you can notice that the both the voltages are equal and there is no loss in process of modulation, transmission and demodulation.

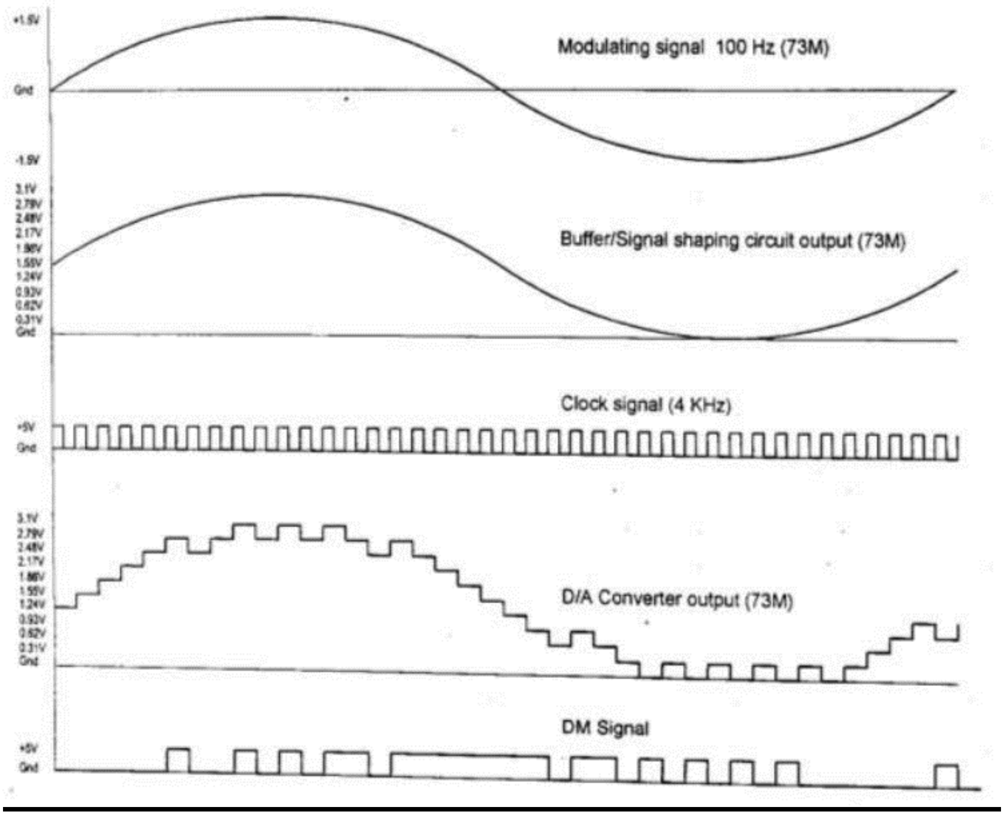
Similarly, you can verify the DM operation for different values of modulating signal

DM WITH AF SIGNALS AS MODULATING SIGNAL:

1. Connect AF signal from AF generator to the inverting input of the comparatorandsetoutputamplitudeat3$Vp\text{–}p$.
2. Observe and plot the signals at D/A converter output (i.e., non-inverting input of the comparator), DM signal using CRO and compare them with the waveforms given in figure.
3. Connect DM signal to the DM input of the demodulator.
4. Connect clock (4 kHz) from modulator to the clock input of the demodulator. Connect clock input of the UP/DOWN counter to the clock from transmitter with the help of springs provided.
5. Observe and plot the output of the D/A converter and compare itwith the wave formsgiven in Figure.
6. Observe and sketch the D/A output.
7. Connect D/A output to the LPF input.

Observe the output of the LPF/Amplifier and compare it with the original modulating signal.

WAVEFORM:



RESULT:

EXPERIMENT NO-11

FREQUENCY SHIFT KEYING

AIM:

To study the characteristics of Frequency Shift keying.

APPARATUS:

Frequency Shift Keying (FSK) is a modulation/ Data transmitting technique in which carrier frequency is shifted between two distinct fixed frequencies to represent logic 1 and logic 0. The low carrier frequency represents a digital 0 (space) and higher carrier frequency is a 1 (mark). FSK system has a wide range of applications in low-speed digital data transmission systems. Wave forms are shown in Figure. FSK Modulating &Demodulating circuitry can be developed in number of ways, familiar VCO and PLL circuits are used in this trainer.

PROCEDURE:

1. Connect the trainer to mains and switch on the power supply.
2. Measure the output voltage of the regulated power supply i.e. +12 V with the help ofdigital multimeter.
3. Verify the operation of the logic source using digital multimeter. Output should be zero voltsin Logic 0 position and 12 V in logic 1 position.
4. Observe the output of the data signal using Oscilloscope. It should be a square wave of 20 Hz to 180 Hz @ 10 $Vp{-}p$. (For frequency variation potentiometer is provided)

FSK MODULATION:

1. Connect output of the logic source to data input of the FSK Modulator.
2. Set logic source switch in 0 positions.
3. Connect FSK modulator output to Oscilloscope as well as frequency counter.
4. Set the output frequency of the FSK modulator as per your desire (say 1.2 kHz) with thehelp of control F0 which represents logic 0.
5. Set logic source switch in 1 position.

6. Set the output frequency of the FSK modulator as per your desire (say 2.4 kHz) with the helpof control F1 which represents logic 1.

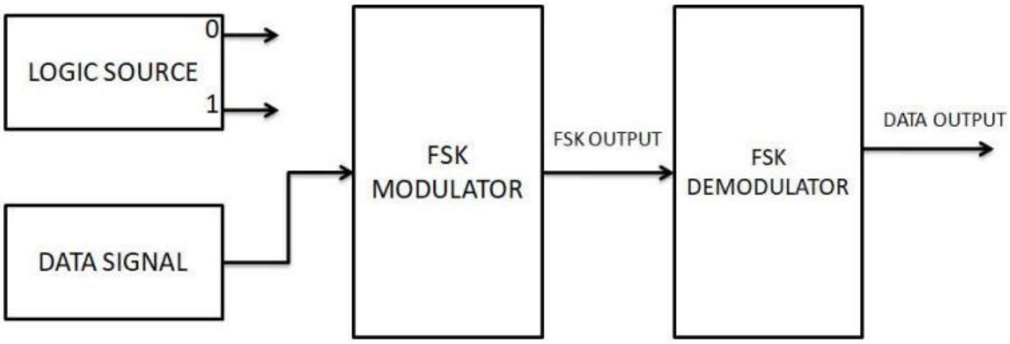
Note: We F0 as 1.2 kHz and F1 as 2.4 kHz for ease of operation; in fact you mayset any value.

7. Now connect data input of the FSK modulator to the output of the data signal generator.
8. Keep CRO in dual mode connect CH1 input of the oscilloscope to the input of the FSK modulator and CH2 input to the output of the FSK modulator.
9. Observe the FSK signal for different data signal frequencies and plot them. By this we can observe that the carrier frequency is shifting between two predetermined frequencies as per the data signal i.e., 1.2 kHz when data signal is 0 and 2.4 kHz when data input is 1 in thiscase.
10. Compare these plotted wave forms with the theoretically drawn in figure.

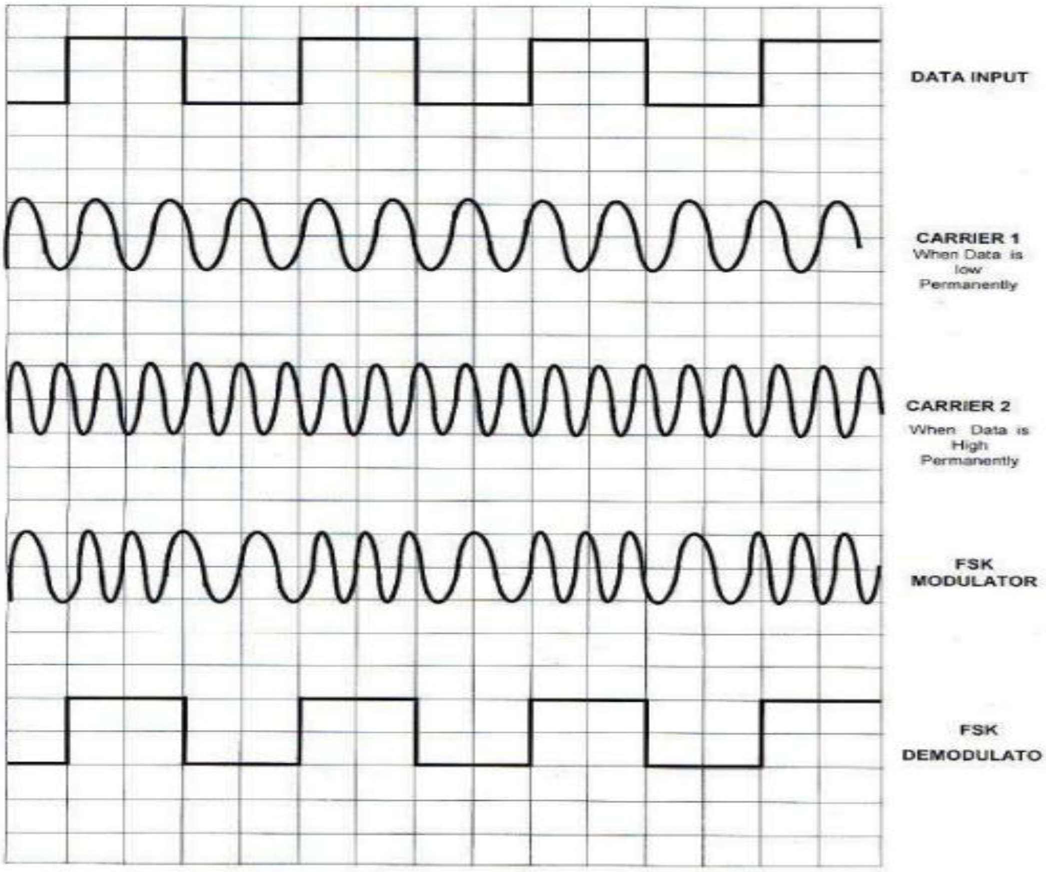
FSK DEMODULATION:

1. Again, connect input of the FSK modulator to the logic source and put data source switch in 0positions.
2. Connect the frequency counter to the output of the FSK modulator output.
3. Set FSK output frequency to 2025 Hz with the help of FO control.
4. Now put data source switch in 1 position and set the FSK output frequency to 2225 Hz withthe help of F1 control without disturbing the F0.
5. **Note:** As per one of the standards, for proper demodulation of FSK signal the F0 should be 2025 Hzand F1 should be 2225Hz.
6. Disconnect the FSK input of the modulator from logic source and connect to the data signalgenerator.
7. Observe the output of the modulator using CRO and compare them with given waveformsin figure.
8. Now connect the FSK modulator output to the FSK input of the demodulator.
9. Connect CH1 input of the Oscilloscope to the data signal at modulator and CH2 input to theoutput of the FSK demodulator (keep CRO in dual mode).
10. Observe and plot the output of the FSK demodulator for different frequencies of data signal. Compare the original data signal and demodulated signal; by this we can observe that there is no loss in process of FSK modulation and de-modulation

CIRCUIT DIAGRAMS:



WAVEFORM:



RESULT:

EXPERIMENT NO- 12

BINARY PHASE SHIFT KEYING

AIM:

To study the operation of PSK (Binary) Modulation & Demodulation and to plot the PSK wave forms for Binary data at different frequencies.

APPARATUS:

Phase Shift keying trainer

1. Dual trace Oscilloscope
2. Digital multimeter
3. Patch chords

THEORY:

Phase Shifting Keying (PSK) is a modulating / Data transmitting technique in which phase of the carrier signal is shifted between two distinct levels. In a simple PSK (i.e., Binary PSK) un-shifted carrier $V\cos m_0 t$ is transmitted to indicate. Condition, and the carrier shifted by 180^o i.e., $-V\cos m_0 t$ is transmitted to indicate a 0 condition. Wave forms are shown in Figure PSK Modulating & Demodulating circuitry can be developed in number of ways; one of the simple circuits is used in this trainer.

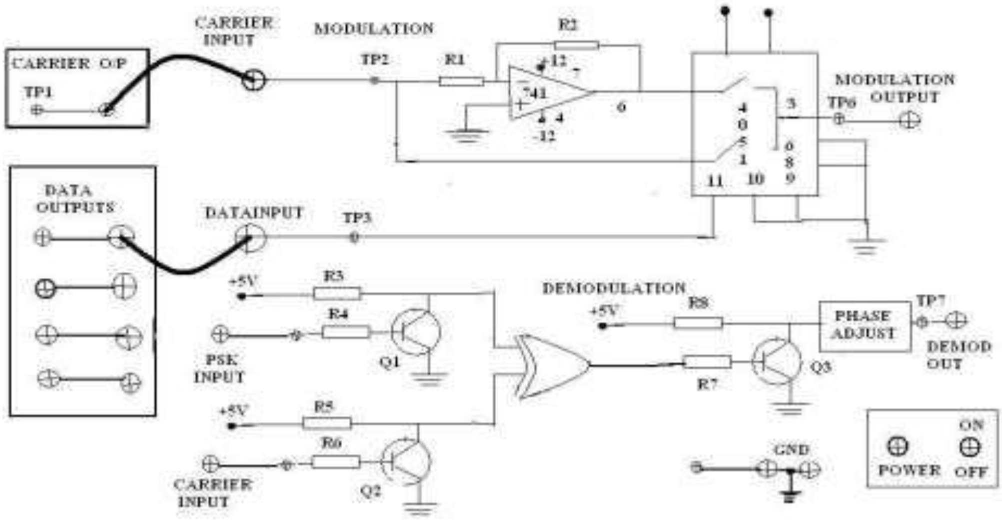
PROCEDURE:

1. Study the theory of operation.
2. Connect the trainer to the mains and switch on the power supply.
3. Measure the output of the regulated power supply i.e. +5 V and -5 V with the help of digital multimeter.
4. Observe the output of the carrier generator using CRO, it should be an 8 kHz Sine with $5Vp-p$ amplitude.
5. Observe the various data signals (1 kHz, 2 kHz and 4 kHz) using CRO.
6. Compare the plotted waveforms with given wave forms.

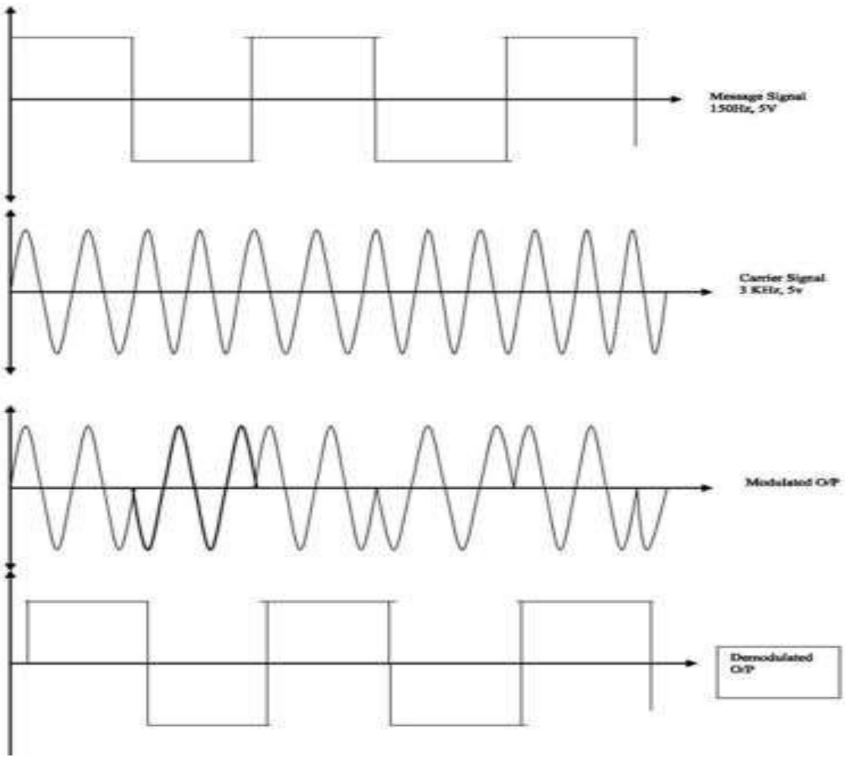
DEMODULATION:

1. Connect the PSK output to the PSK input of the demodulator.
2. Connect carrier to the carrier input of the PSK demodulator

CIRCUIT DIAGRAM:



WAVEFORM:



RESULT:

EXPERIMENT NO- 13

DIFFERENTIAL PHASE SHIFTKEYING

AIM: To study the characteristics of differential phase shift keying.

APPARATUS:

1. Differential Phase Shift Keying Kits
2. C.R.O
3. Digital multimeter.
4. No's of coaxial cables (standard accessories with trainer)

THEORY:

DPSK: Phase Shift Keying requires a local oscillator at the receiver which is accurately synchronized in phase with the un-modulated transmitted carrier, and in practice this can be difficult to achieve. **Differential Phase Shift Keying (DPSK)** overcomes the difficult by combining two basic operations at the transmitter (1) differential encoding of the input binary wave and (2) phase shift keying – hence the name differential phase shift keying. In other words DPSK is a non - coherent version of the PSK.

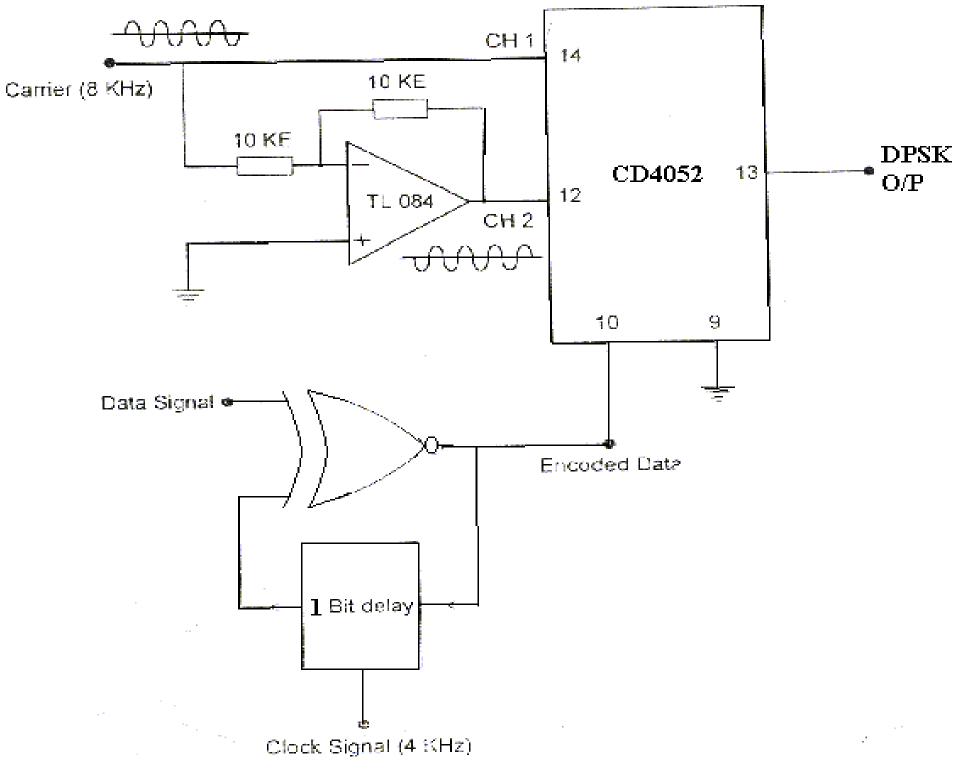
DPSK DEMODULATOR: Fig shows the DPSK modulator. This consists of PSK modulator and differential encoder. PSK Modulator: IC CD 4052 is a 4-channel analog multiplexer and is used as an active component in this circuit. One of the control signals of 4052 is grounded so that 4052 will act as a two-channel multiplexer and other control is being connected to the binary signal i.e., encoded data. Un shifted carrier signal is connected directly to CH1 and carrier shifted by $180^0$is connected to CH2. Phase shift network is a unity gain inverting amplifier using Op-Amp (TL084). When control signal is at high voltage, output of the 4052 is connected to CH1 and un-.

shifted (or 0 phase) carrier is passed on to output. Similarly, when control signal is at zero voltage output of 4052 is connected to CH2 and carrier shifted by 180^0 is passed on to output.

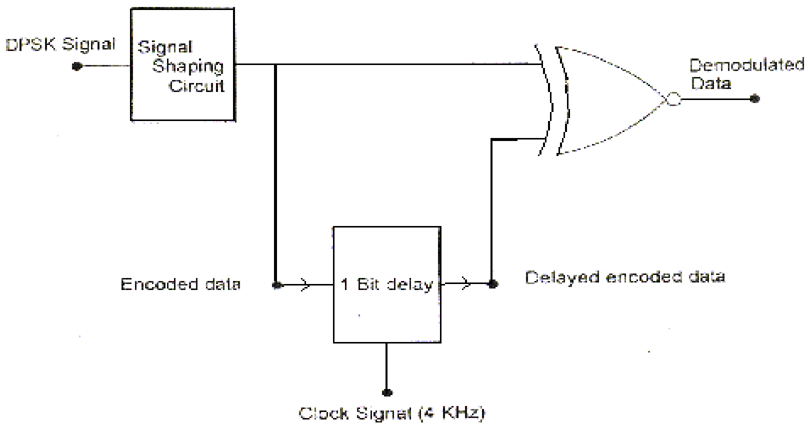
Differential encoder: This consists of 1 bit delay circuit and an X-NOR Gate. 1 bit delay circuit is formed by a D-Latch. Data signal i.e., signal to be transmitted is connected to one of the inputs of the X-NOR gate and other one being connected to out of the delay circuit. Output of the X- NOR gate and is connected to control input of the multiplexer (IC 4052) and as well as to input of the D-Latch. Output of the X-NOR gate is 1 when both the inputs are same, and it is 0 when both the inputs are different.

CRICUIT DIAGRAM:

DPSK Modulator



DPSK Demodulator



DPSK DEMODULATOR: Second fig shows the DPSK Demodulator. This consists of1 bit delay circuit, X-NOR Gate, and a signal shaping circuit. Signal shaping circuit consists of an Op- amp based zero crossing detector followed by a D-latch. Receiver DPSK signal is converted to square wave with the help of zero crossing and this square wave will pass through the D-Latch. So, output of the D-latch is an encoded data. This encoded data is applied to 1 bit delay circuit as well as to one of the inputs of X-NOR gate. And output of the delay circuit is connected to another input of the X-NOR gate. Output of the X-NOR gate is 1 when both the inputs are same, and it is 0 when both the inputs are different.

PROCEDURE:

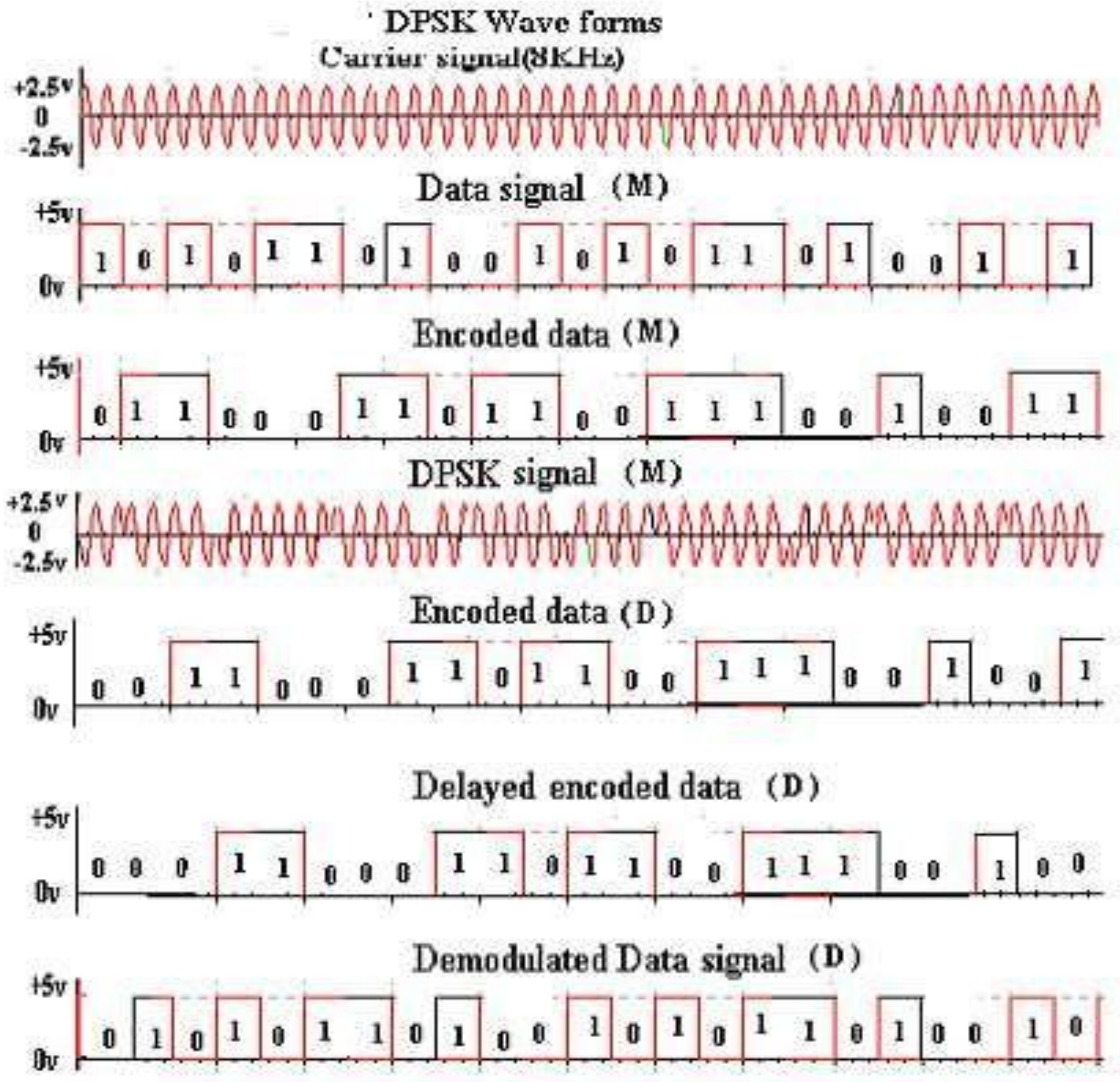
MODULATION:

1. Connect carrier signal to carrier input of the PS Modulator.
2. Connect data signal from data input of the X-NOR gate.
3. Keep CRO in dual mode.
4. Connect CH1 input of the CRO to data signal and CH2 input to the encoded data (which is nothing but the output of the X-NOR gate)
5. Observe the encoded data with respect to data input. The encoded data will be in a given sequence.
   Actual data signal : 10101101001010110100
   Encoded data signal : 01100011011001110010
6. Now connect CH2 input of the CRO to the DPSK output andCH1 input to the encoded data. Observe the input and output waveforms and plot the same.
7. Compare the plotted waveforms with the given waveforms in fig.

   Note: Observe and plot the waveforms after perfect triggering. Better to keep theencoded data more than 4 cycles for perfect triggering.

DEMODULATION:

1. Connect DPSK signal to the input of the signal shaping circuit from DPSK transmitter with the help of coaxial cable (supplied with trainer).
2. Connect clock from the transmitter (i.e. DPSK Modulator) to clock input of the 1 bitdelay circuit using coaxial cable.
3. Keep CRO in dual mode. Connect CH1 input to the encoded data (at modulator) andCH2 input to the encoded data (at demodulator).



1. Observe and plot both the waveforms and compare it with the given waveforms. You willnotice that both the signals are same with one bit delay.
2. Keep CRO in dual mode. Connect CH1 input to the data signal(at modulator) and CH2input to the output of the demodulator
3. Observe and plot both the waveforms and compare it with the given waveforms. You will notice that both the signals are same with one bit delay.
4. Disconnect clock from transmitter and connect to local oscillator clock
5. Generator output from De Modulator) with remaining setup as it is. Observe demodulator output and compare it with the previous output. This signal is little bit distorted. This is because lack of synchronization between clock at modulator and clock at demodulator. You can get further perfection in output waveform by adjusting the locally generated varying potentiometer.

RESULT:

EXPERIMENT NO- 14

TITLE: QUADRATURE AMPLITUDE MODULATION

AIM: To study the Digital Signal transmission using Quadrature Amplitude Modulation (QAM)

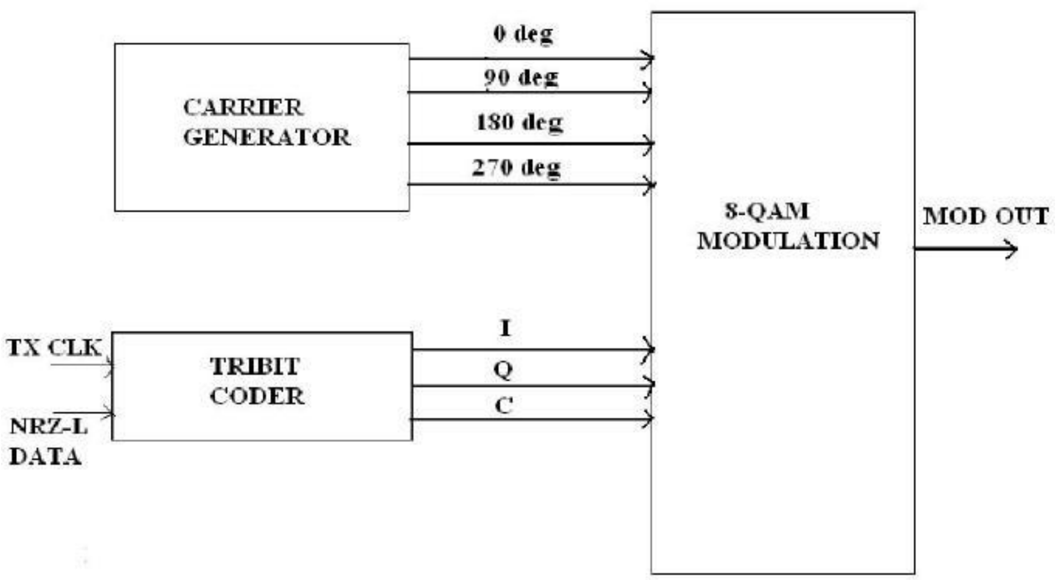
EQUIPMENT REQUIRED:

1.Quadrature Amplitude Modulation trainer
2.Digital Storage Oscilloscope
3.Co-axial cables (standard accessories with trainer)

THEORY:

Quadrature amplitude modulation (**QAM**) Quadrature Amplitude Modulation (QAM) is a modulation method which is used to encode a variable number of bits into both a phase and amplitude modulated signal. In 8-QAM the main data source is divided into the group of 3 bits (tribit), one of which will vary the amplitude of the carrier and the last two will vary the phase. The modulated signal can take four different phases and two different amplitudes, for a total of eight different states. Similarly in the 16-QAM the data are divided into group of four bits (quad bit).

A generator of 8-QAM signals for 3-bit symbols is shown below. Here the main data source is divided into 3 bits called I bit, Q bit, C bit. These 3 bits are called TRIBIT. These tribit together generates a symbol. Among the three bits, I and Q are responsible for the phase modulation and the last bit C performs the amplitude modulation. The effect of each symbol on the finalQAM signal is shown below.



The modulator uses four 500KHz sine carriers, shifted between them of 90 deg, are applied to modulator. The data reach the modulator from the tribit coder. The instantaneous value of I, Q, C data bit generates a symbol. Since these data can take either 0 or 1 value, maximum 8 possible symbols can be generated as shown in the above table. According to the symbol generated one of the four sine carriers will be selected.

The receiver of the QAM signal requires synchronous detection and hence it is necessary to locally regenerate the carrier. The scheme for the carrier regeneration is similar to BPSK. In the earlier case we squared the incoming signal, extracted the waveform at twice the carrier frequency dividing by two. In the present case, it is required that the incoming signal be raised to the fourth power after which filtering recovers a waveform at four times the carrier.

The incoming signal also applied to the sampler followed by an adder and an envelope detector. Two adders add the sampled QAM signal, sampled by the clock having different phases. At the output of adder the signal consisting the envelope frequency components and recovers I and Q bits. These recovered bits having exactly same phase and frequency as the transmitted bit pattern. The C bit is recovered simply by passing the QAM modulated data through envelope detector. These recovered bits are then applied to data decoder logic to recover the original NRZ-L data.

QAM constellation diagram

The constellation diagram of geometrical representation is shown below. The points in signal space corresponding to each of the eight possible transmitted signals are indicated by dots. For each such signal we can recover three bits rather than one.

The distance of a signal from the origin is $\sqrt{(E_s)}$ Which is the square root of the signal energy associated with the symbol, Distance $d=2\sqrt{P_s T_b}=2\sqrt{E_b}$ Where E_b is the energy contained in a bit transmitted for a time T_b.

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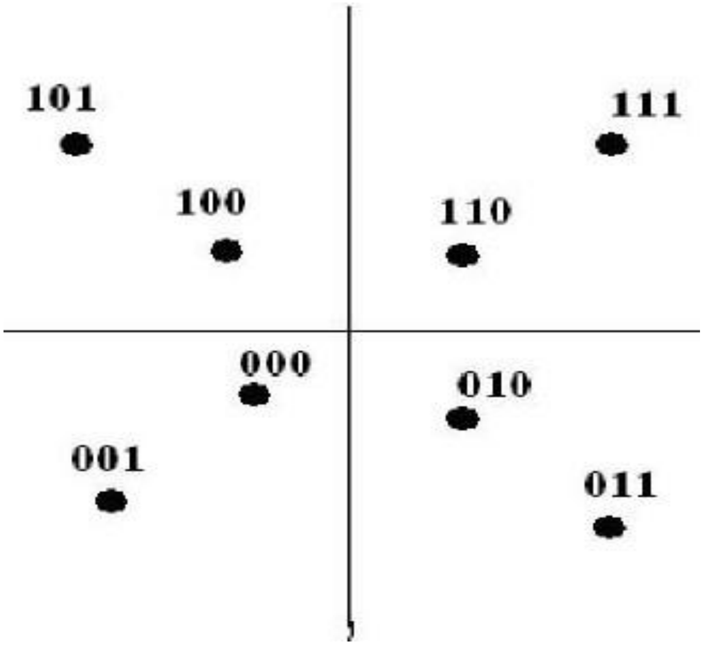


The number of dot points appearing in the cancellation diagram depends on the number of symbols generated due to I, Q, C bits. The position of dot points in the quadrant of the cancellation diagram also depends on symbol generated due to I, Q, C bits as shown above.

The bandwidth efficiency of QAM is defined by the ratio of bit transmission speed in QAM to bandwidth of QAM signal. It is given by Bandwidth efficiency = Fb / Bw Where Fb is bit transmission speed and Bw is the bandwidth of signal transmitted.

The more the bandwidth efficiency more is the data transfer within the same bandwidth of signal transmission.

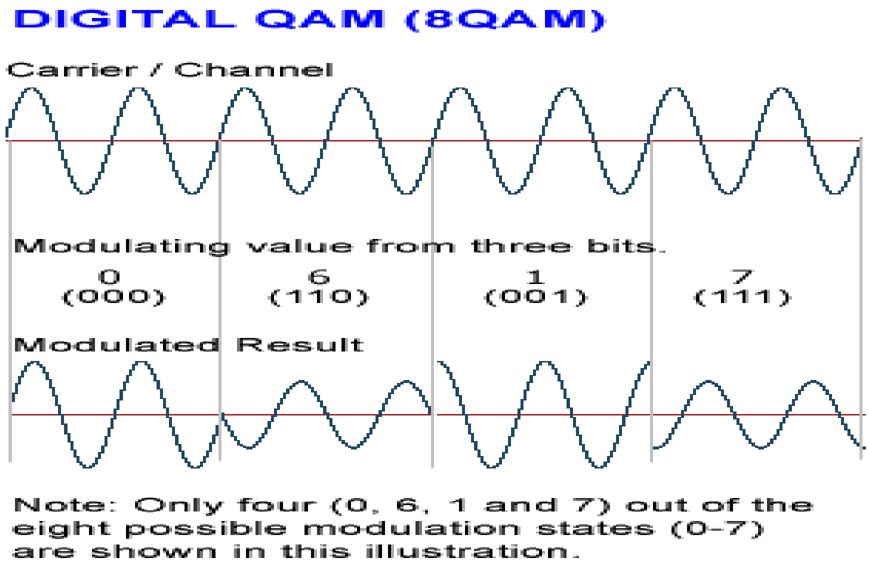
PROCEDURE:

1. Connect the AC supply to the kit.
2. Make the connections as shown in the connection diagram.
3. Select data pattern of simulated data using switch SW1, SW2, SW3.
4. Connect S-DATA generated to IN of NRZ-L CODER.
5. Connect the tri bit data I-BIT, Q-BIT, C-BIT to control input CI/P-1, CI/P-2, and CI/P-3of CARRIER MODULATOR respectively.
6. Connect sine carrier to input of CARRIER GENERATOR as follows.

- SIN 1 to IN/P-1
- SIN 2 to IN/P-2
- SIN 3 to IN/P-3
- SIN 4 to IN/P-4
-

7. Connect QAM modulated signal MOD OUTPUT to the IN of QAMDEMODULATOR.
8. Connect I-BIT, Q-BIT, C-BIT outputs of QAM demodulator to I BITINPUT, Q BIT INPUT, C BIT INPUT posts of data decoder.
9. thedecoded data with S-DATA on modulation kit. Observe the decoded data at OUT post of data decoder. Compare
10. The wave forms of above experiments are given below.

Expected Graphs:



RESULTS AND OBSERVATION: Observe the generated binary data stream and compare this with its equivalent integers signal.