ANALOG & DIGITAL COMMUNICATIONS LAB

(II Year, ECE, II Semester)

Department of Electronics and Communication Engineering

MAHATMA GANDHI INSTITUTE OF TECHNOLOGY

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ANALOG AND DIGITAL COMMUNICATIONS LAB

B.Tech , II Year II Sem.

Note: • Minimum 12 experiments should be conducted:

• All these experiments are to be simulated first either using MATLAB, COMSIM or any other simulation package and then to be realized in hardware

1. Amplitude modulation and demodulation (ii) Spectrum analysis of AM
2. Frequency modulation and demodulation (ii) Spectrum analysis of FM
3. DSB-SC Modulator & Detector
4. SSB-SC Modulator & Detector (Phase Shift Method)
5. Frequency Division Multiplexing & De multiplexing
6. Pulse Amplitude Modulation & Demodulation
7. Pulse Width Modulation & Demodulation
8. Pulse Position Modulation & Demodulation
9. PCM Generation and Detection
10. Delta Modulation
11. Frequency Shift Keying: Generation and Detection
12. Binary Phase Shift Keying: Generation and Detection
13. Generation and Detection (i) DPSK (ii) QPSK
14. Time Division multiplexing& De multiplexing (Beyond Syllabus)

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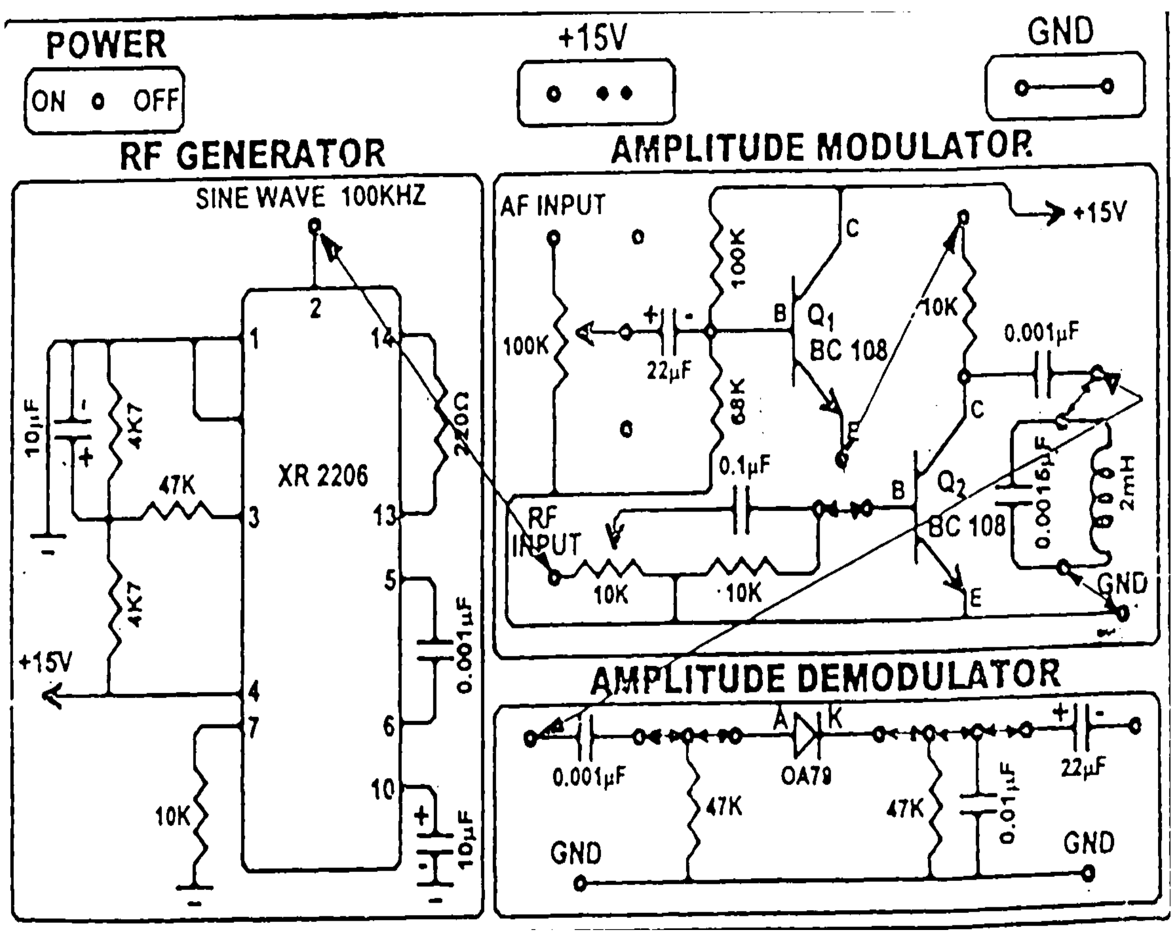
1. AMPLITUDE MODULATION AND DEMODULATION

AIM: To observe the modulated and demodulated wave at different levels and calculate their modulation indices.

EQUIPMENT:

1. Amplitude modulation kit
2. Function generator
3. CRO and probes
4. Connecting wires

CIRCUIT DIAGRAM:

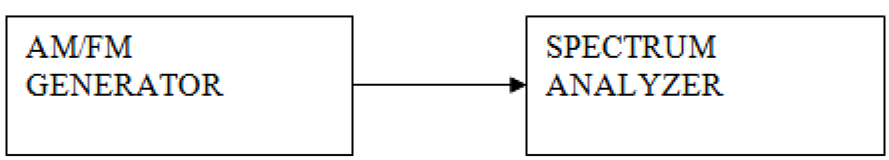


PROCEDURE:

1. Swich on AM trainer and measure the +ve +15V dc with the help of multimeter. If it is ok then make the connections as per the circuit diagram, when power is off.
2. Switch on and measure the amplitude, frequency of sinusoidal signal from RF generator block.
3. Externally apply the AF signal of 200Hz to AF i/p of AF modulator.
4. Observe the modulated o/p at tank circuit or 0.01uf capacitor.
5. Find out the modulation index from the modulated wave at different frequency. Formula for this is

$$m= (E_{max}-E_{min})/(E_{max}+E_{min})$$

6. The modulated wave is given to the input of amplitude demodulator circuit, input stage (0.01µFcapacitor) and connect the connections as per circuit diagram.
7. Finally observe the demodulated signal at 22uf capacitor and note down the corresponding amplitude and frequency. Compare with modulating signal amplitude and frequency.
8. Vary R_1, R_2 potentiometer at modulated stage take 5 or 6 readings for modulated and demodulated waves.
9. The amplitude modulated signals or Frequency modulated signal is connected to the spectrum analyzer through probe.
10. Initially the spectrum analyzer should be set to the required frequency range by selecting the frequency menu.
11. The frequency range of the analyzer can also be adjusted to the input signal(Unknown frequency) by the frequency knob provided .
12. The frequency spectrum appears on the screen from which the amplitude and frequencies of the peaks can be noted down.

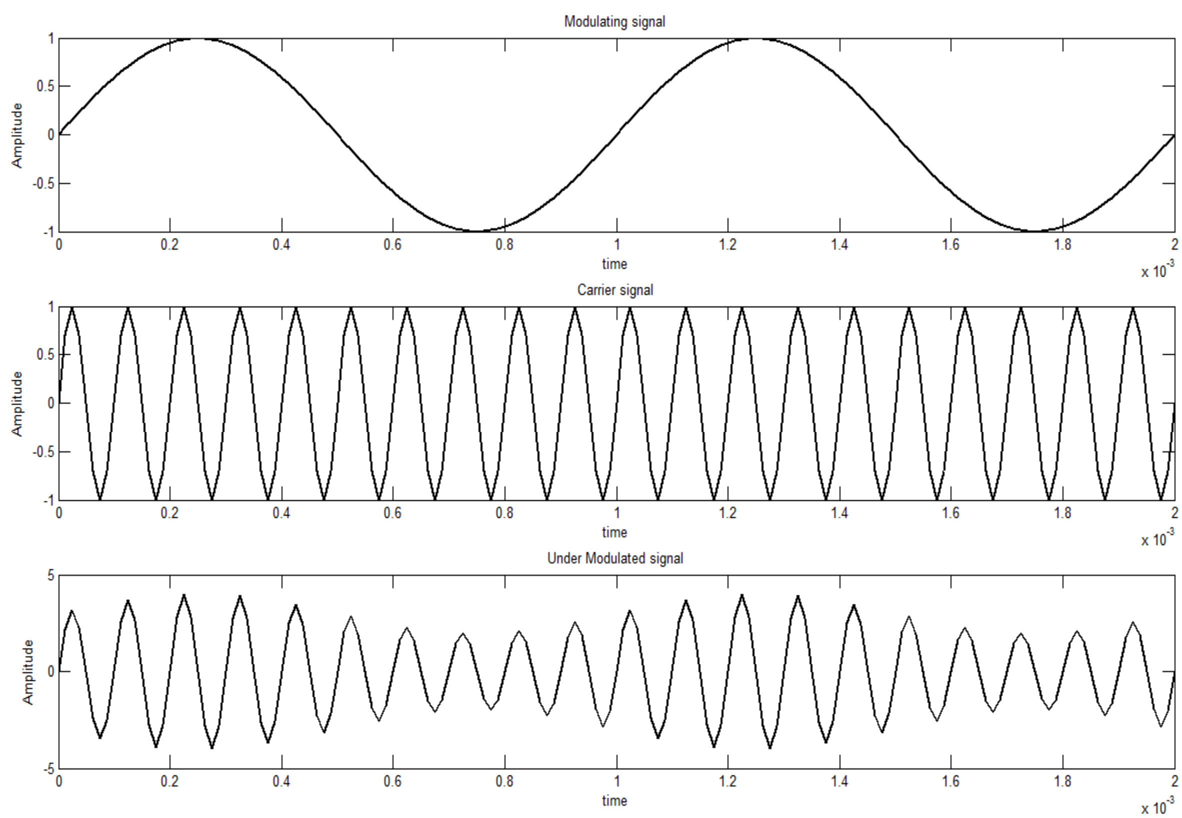


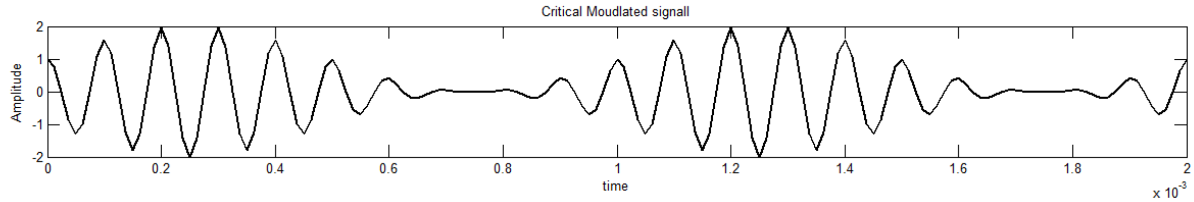
OBSERVATIONS:

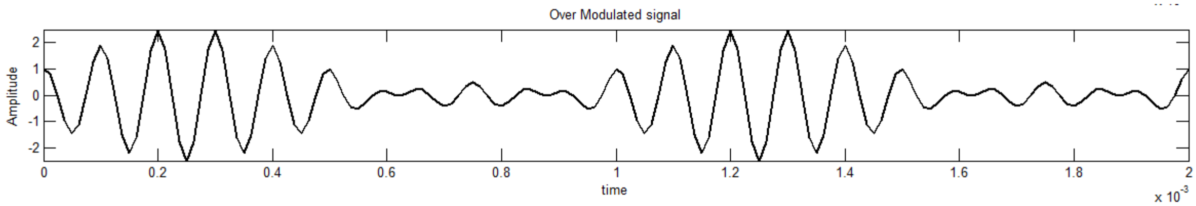
By varying R_1 and R_2 note down E_{max} , E_{min} and calculate modulation index.

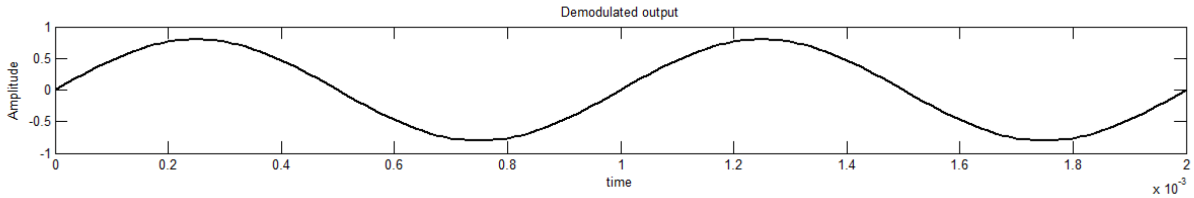
S.No	Type of modulation	E_{max}(V)	E_{min}(V)	m%

Waveforms:









<u>RESULT:</u>

<u>VIVA QUESTIONS :</u>

1. Define amplitude modulation? Give the application of AM?
2. Draw the frequency spectrum of modulated signal for a modulating signal with a) signal tone frequency fm b) Band limited signal - w<=f<=+w.
3. What is Envelope Distortion?
4. What is the Bandwidth of AM wave?
5. For multi tone modulation, what is the total modulation index?
6. What are the components of a square- law modulator?
7. Give the specifications for Band- pass filter used in Square- law modulator?
8. Explain the principle of switching modulator?
9. What is a De modulator? What are the types of AM De- modulators?
10. What are the conditions necessary for Envelope Detection?

2. FREQUENCY MODULATION AND DEMODULATION

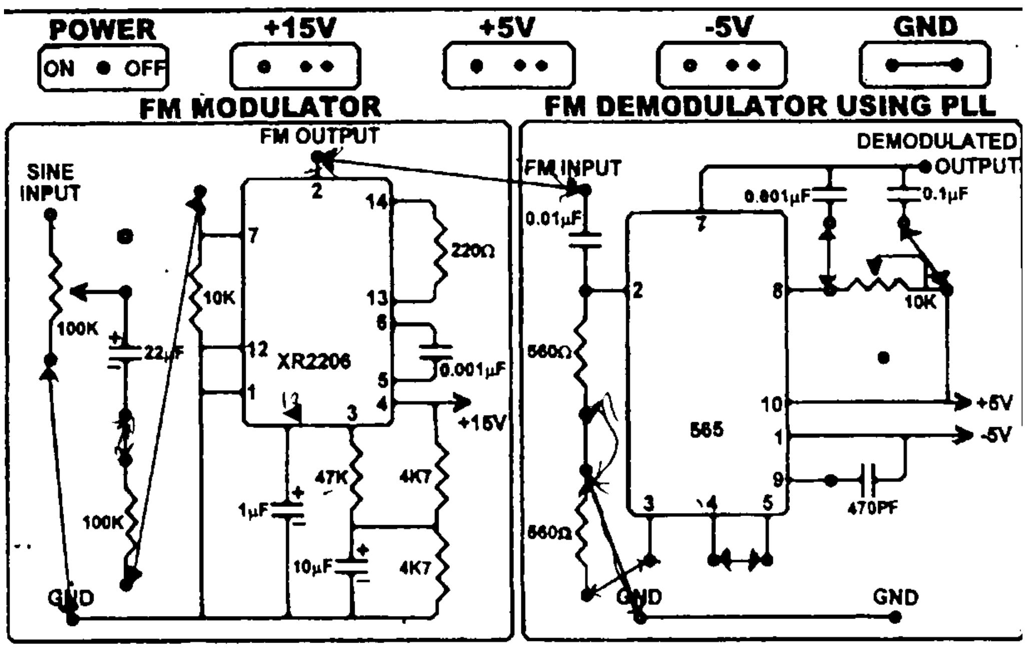
AIM:

To generate the modulated output and detect the modulated o/p using PLL different audio frequencies.

EQUIPMENT:

1. Frequency modulation kit.
2. CRO and probes.
3. Function generator.
4. Connecting wires.

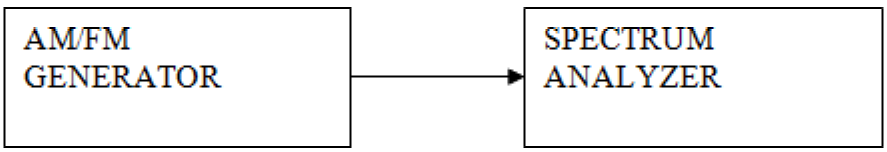
CIRCUIT DIAGRAM:



PROCEDURE:

1. Switch on the trainer and measure the power supply to be +5V, +15V, -5V with the help of multimeter.
2. Connect the circuit diagram and apply 10V, (P-P) from function generator and set the frequency 1KHz.
3. Observe the FM o/p at pin 2 in FM modulator block
4. Vary the function generator amplitude to be 2v to 20v and observe the FM o/p and note down FM o/p amplitude for different frequencies.

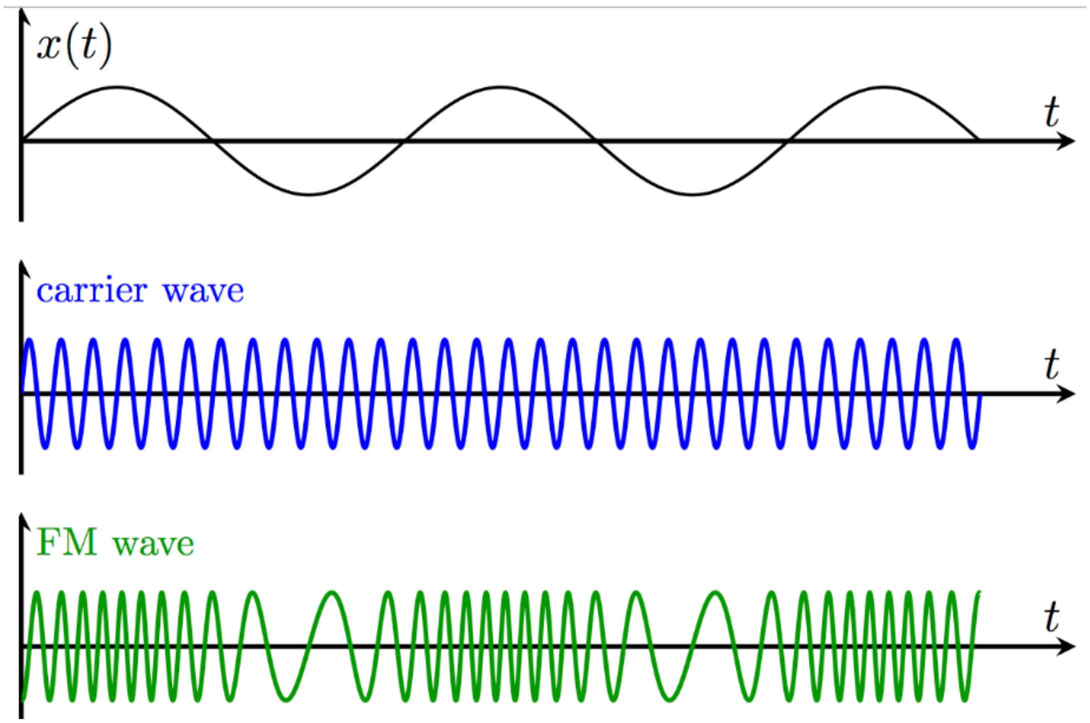
5. Connect the FM o/p to the i/p of the demodulator
6. Set the frequency control to 500Hz and varying the R_i fully clockwise.
7. Observe the FM demodulated o/p at pin 7 of PLL.
8. The amplitude modulated signals or Frequency modulated signal is connected to the spectrum analyzer through probe.
9. Initially the spectrum analyzer should be set to the required frequency range by selecting the frequency menu.
10. The frequency range of the analyzer can also be adjusted to the input signal(Unknown freq uency) by the frequency knob provided .
11. The frequency spectrum appears on the screen from which the amplitude and frequencies of the peaks can be noted down.

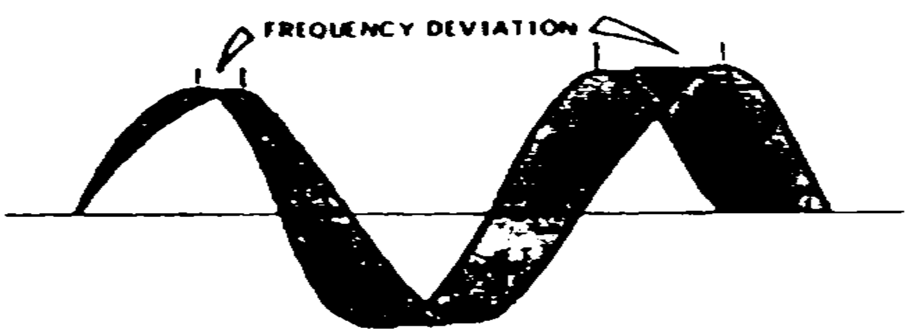


OBSERVATIONS:

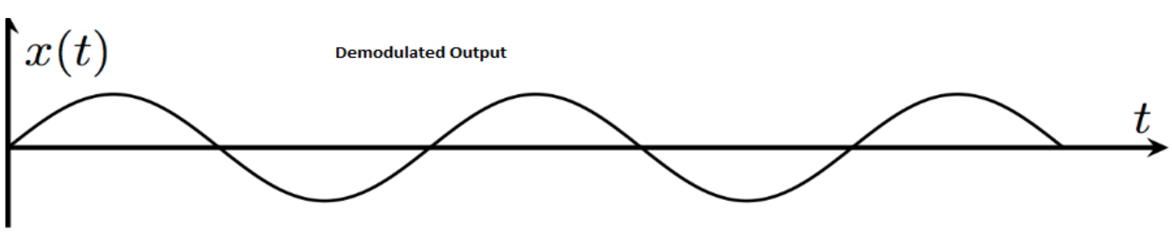
S.No	Amplitude (V)	f_1(Hz)	f_2(Hz)	f_d(Hz)	m(%)

Waveforms:





Demodulated output waveform:



RESULT:

VIVA QUESTION:

1. What is Angle Modulation?
2. How are frequency modulation and phase modulation related?
3. What is Narrow band FM?
4. What is frequency deviation? On what factor does it depend?
5. Draw the frequency spectrum of wideband FM and give the expression for wideband FM wave?
6. What is the transmission bandwidth of FM wave
7. What is the principle used in Direct method of FM generation?
8. Give the Advantages and Disadvantages of FM?
9. Give the Application of FM?
10. What is the difference between AM and FM?

3. DSB-SC MODULATOR & DETECTOR

AIM: To observe that the output is a double side band with a suppressed carrier signal.

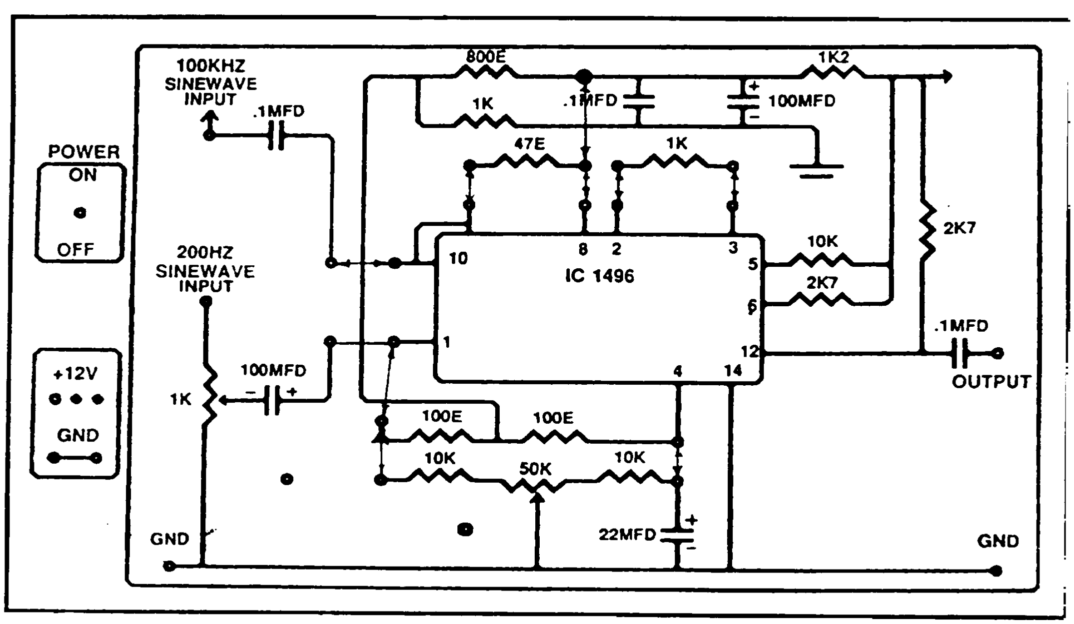
EQUIPMENT:

1. Balanced Modulator kit
2. CRO and probes
3. Signal Generator
4. Connecting wires

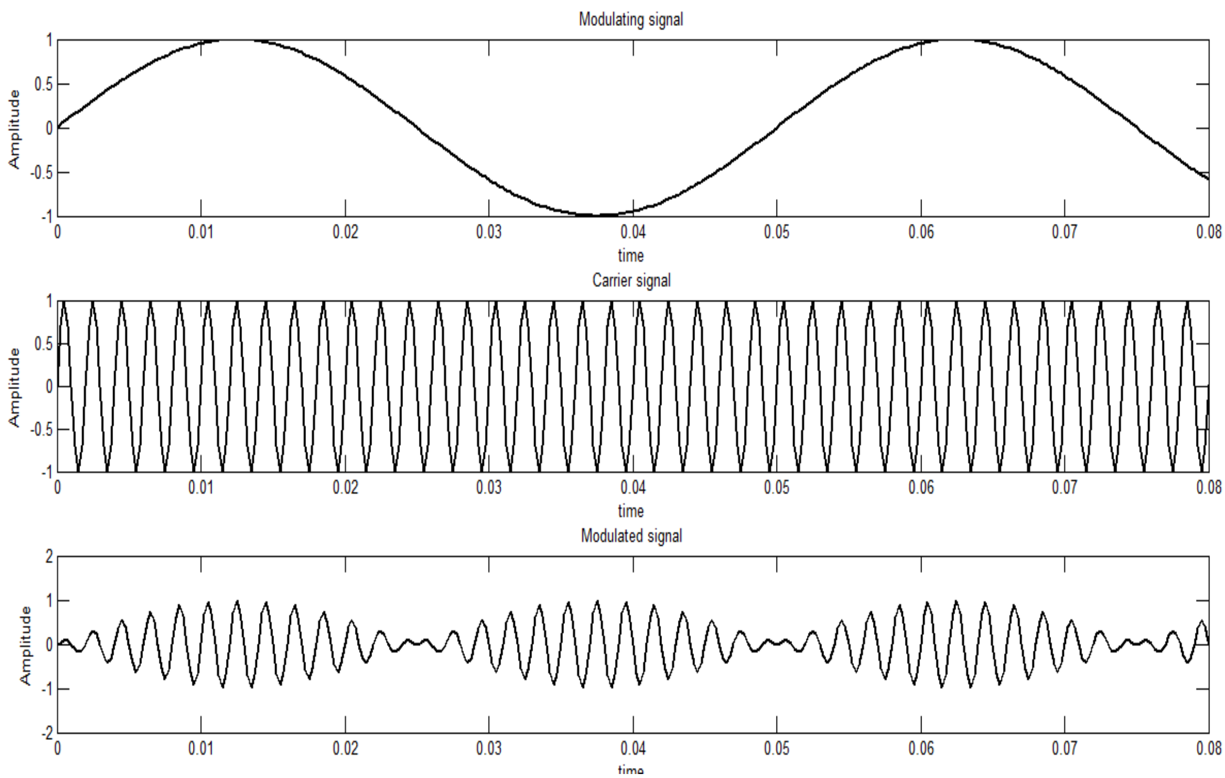
PROCEDURE:

1. Switch ON the trainer and check the power supply to be +12V, then connect the connections as per the circuit diagram.
2. Externally apply 200 HZ, 5V sine wave from function generator and 100KHZ sine wave from RF generator.
3. Adjust R1 and R2 potentiometer and observe the modulated waveforms.
4. Vary the modulating voltage and note down the maximum output without producing clipping.

CIRCUIT DIAGRAM:



WAVEFORMS:



RESULT:

VIVA QUESTIONS:

1. What is DSB-SC Signal?
2. What is the expression for DSB-SC wave?
3. What is the advantage of DSB-SC over AM?
4. Draw the frequency spectrum of DSB-SC signal for a modulating signal with a) Single tone frequency and b) Band limited signal
5. What is the bandwidth of DSB-SC wave?
6. What is the amount of power saving in DSB-SC for a modulation index=1?
7. What are the types of DSB-SC modulator?
8. Draw the block diagram of the balanced modulator?
9. What is ring modulator?
10. Give the applications of DSB-SC?

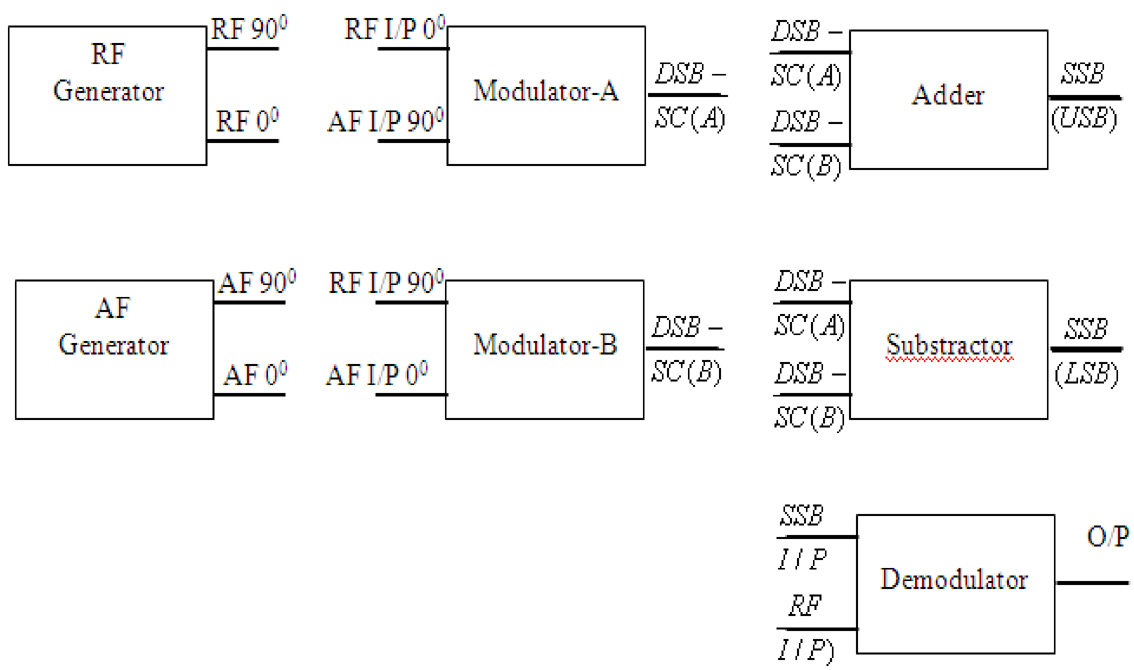
4. SSB-SC MODULATOR & DETECTOR

AIM: To observe the modulated and demodulated waveforms of SSB modulation.

APPARATUS:

1. Modulator Kit,
2. Demodulator kit,
3. CRO ,
4. Probes and
5. Connecting wires.

CIRCUIT DIAGRAM :



PROCEDURE:

Modulation:

1. Study the circuit operation of SSB system thoroughly.
2. Observe the output of RF generator using CRO. There are two outputs from the RF generator, one is direct output and another is 90° phase shift with the direct output. The output frequency is 100 KHz and the amplitude is ≥0.2 Vpp (potentiometers are to vary the output amplitude).
3. Observe the output of the AF generator using CRO. There are two outputs from the AF generator, one is direct output and another is 90° phase shift with the direct output. AGC

potentiometers are provided to adjust the gain of the oscillator (or to set the output to good shape). Potentiometers are provided to vary the output amplitude.

4. Measure and record the RF signal frequency using CRO.
5. Connect the 0° phase shift RF signal to one balance modulator and 90° phase shift to another balanced modulator as shown in figure.
6. Select the required frequency (2K, 4K or 6KHz) of the AF generator and adjust the AGC potentiometer until the output amplitude is ≡ 10Vpp (when amplitude controls are in maximum condition).
7. Measure and record the AF signal frequency CRO.
8. Set the AF signal amplitude to 8 Vpp using amplitude control and connect to the balanced modulators as shown in the figure.
9. Observe the outputs of both the balanced modulators simultaneously using dual trace oscilloscope, and adjust the balance control until you get the output waveforms (DSB-SC) as shown in figure.
10. To get SSB lower side band signal, connect balanced modulator outputs (DSB-SC signals) to subtractor.
11. Measure and record the SSB signal frequency using CRO.
12. Calculate theoretical frequency of SSB (LSB) and compare it with the practical value.

LSB = RF frequency – AF frequency

Ex: If RF frequency is 100 KHz and AF frequency is 2 KHz

The LSB=100 KHz−2KHz = 98 KHz.

13. To get SSB upper side band signal, connect the output of the balanced modulator to the summer circuit.
14. Measure and record the SSB upper side band signal frequency using CRO.
15. Calculate theoretical value of the SSB (USB) frequency and compare it with practical value.

USB=RF frequency + AF frequency

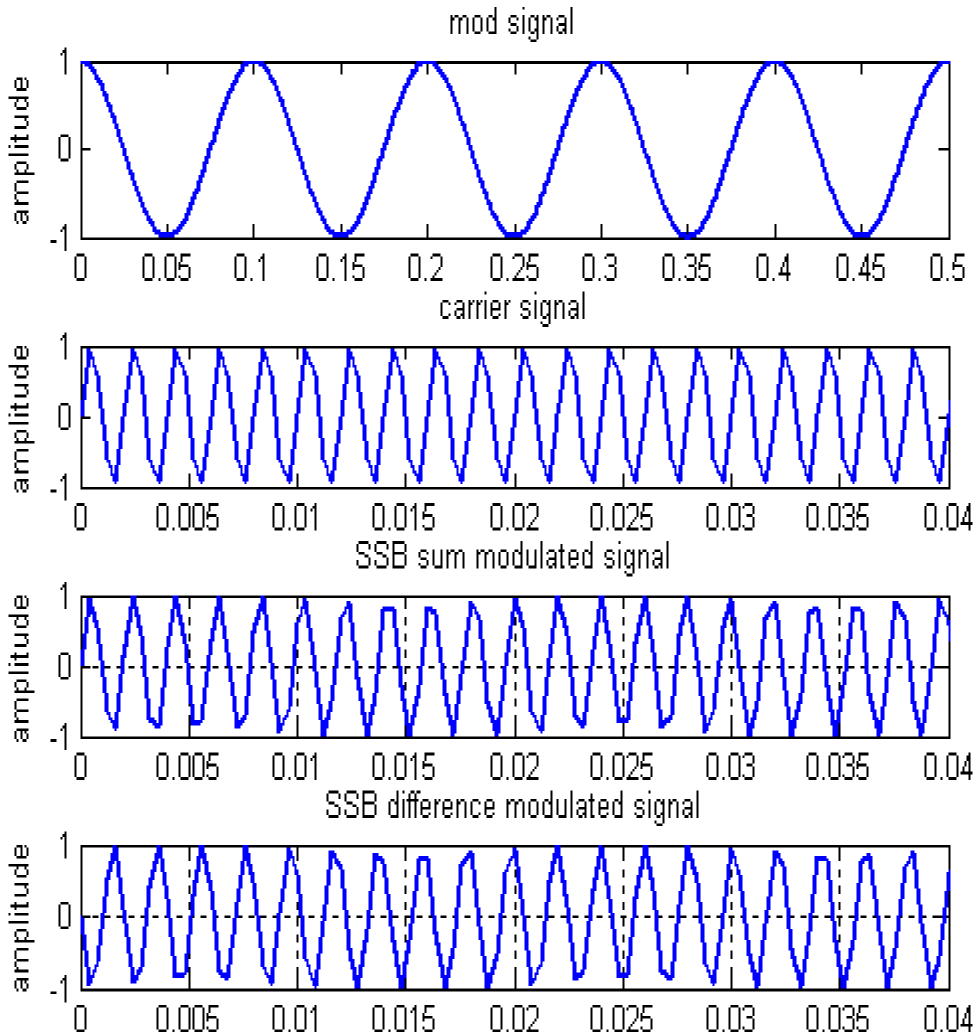
Ex: If RF frequency is 100 KHz and AF frequency is 2 KHz

Then USB = 100KHz + 2 KHz = 102 KHz

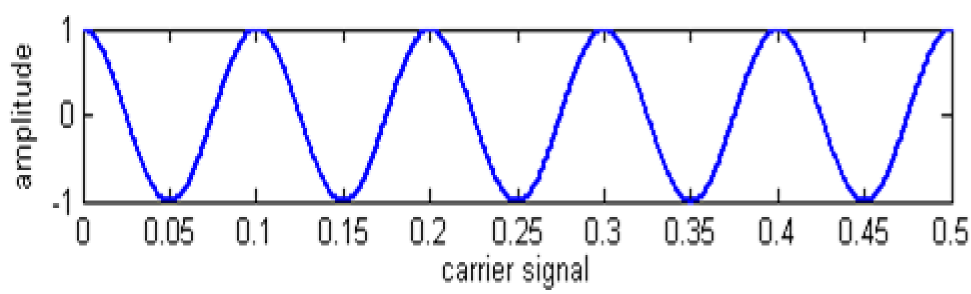
Demodulation of SSB signal:

16. Connect SSB signal from the summer (or) subtractor to the SSB signal input of the synchronous detector and RF signal (0°) to the RF input of the synchronous detector.
17. Observe the detector output using CRO and compare it with the modulating signal (AF signal).
18. Observe the SSB signal for the different voltages of the modulating (AF) signal.

Expected waveforms



Demodulated waveform



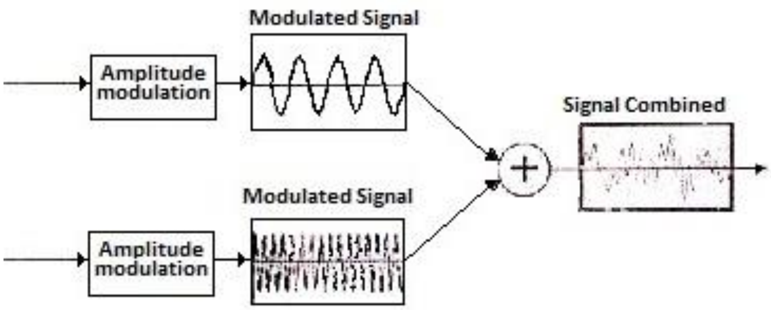
RESULT:

VIVA QUESTION:

1. How much power can be saved using SSB?
2. How many number of balanced modulator are required to generate SSB?
3. What is the bandwidth of in SSB?
4. Write the difference between DSB and SSB?
5. What is meant by in phase and quadrature phase component?
6. What is the method to generate SSB?
7. Hilbert transform of sinω t?
8. Give the application of SSB signal?
9. What is the advantages of SSB over AM and DSB-SC?
10. What is the expression for SSB in times of Domain?

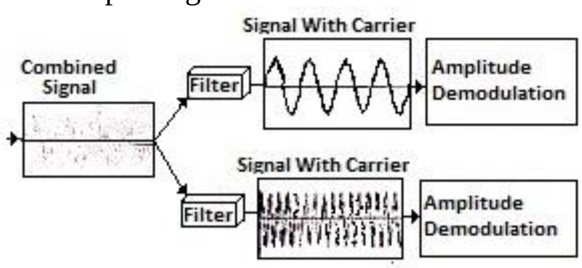
5. FREQUENCY DIVISION MULTIPLEXING AND DEMULTIPLEXING

AIM: To verify frequency division multiplexing and demultiplexing
Apparatus: AM Kits, Op-amp adder, resistors and Capacitors
Circuit diagram:
FDM:



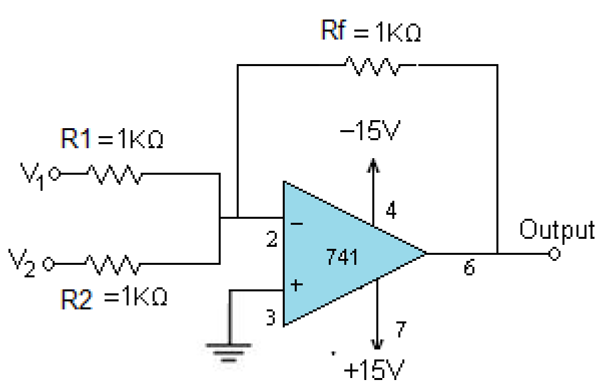
1. Generate the two amplitude modulated signal s using two AM Kits
2. Add the two signals by using op-amp adder
3. Observe the combined output on the CRO

Demultiplexing:

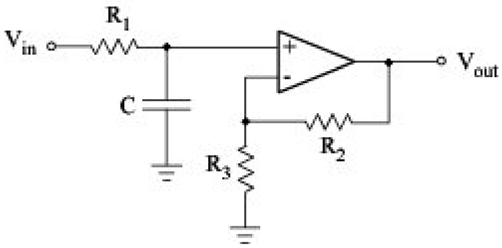


1. Use the two low pass filters to filter the two AM signals.
2. Use the two AM demodulation kits to to demodulate the original message signals

Op-amp adder:



Op-amp low pass filters:



F1=$\frac{1}{2\pi R1C}$ C= R=

F2= $\frac{1}{2\pi R1C}$ C= R=

RESULT:

Viva Questions:

1. What is meant by multiplexing technique and what are the different types of Multiplexers?
2. What are the advantages of Multiplexing?
3. Differentiate the FDM and TDM?
4. Write the applications of FDM.
5. What type of multiplexing is widely used in cell phones**?**
6. Which modulation technique is used in FDM?
7. Why Guard bands are used in FDM?
8. What is OFDM?
9. Five channels, each with a 100-kHz bandwidth are to be multiplexed together. What is the minimum bandwidth of the link if there is a need for a guard band of 10 kHz between the channels to prevent interference?
10. Which filter is used to de multiplex the received signals?

6. PULSE AMPLITUDE MODULATION ANDDEMODULATION

AIM:

To study the operation of pulse amplitude modulation and Demodulation and to plot waveforms of PAM at different pulse frequencies.

EQUIPMENT REQUIRED:

1. Pulse Amplitude modulation trainer kit
2. Dual trace oscilloscope
3. Digital multi meter
4. Patch cords

EXPERIMENTAL PROCEDURE:

1. As the circuitry is already wired you just have to trace the circuit according to the circuit diagram given above.
2. Connect trainer to mains and switch on the power.
3. Measure the output voltages of regulated power supply circuit i.e. $\pm$12V.
4. Observe the output of AF generator and pulse generator using CRO and note that AF signal is approximately 3V P-P of 400Hz frequency and pulse generator output is pulse train of 10V P-P with frequency between 1 KHz and 6 KHz.

MODULATOR:

5. Connect pulse output and AF output to the respective inputs of modulator circuit.
6. Connect one of the input of oscilloscope to the modulator output and another to AF signal.
7. Initially set the amplitude of the AF generator to minimum level and sampling frequency to 1 KHz (by adjusting the preset provided in pulse generator block). Note down the output of modulator, by varying amplitude of modulating signal observe the modulator output so that you can notice the amplitude of the sampling pulses is varying in accordance with the modulating signal.

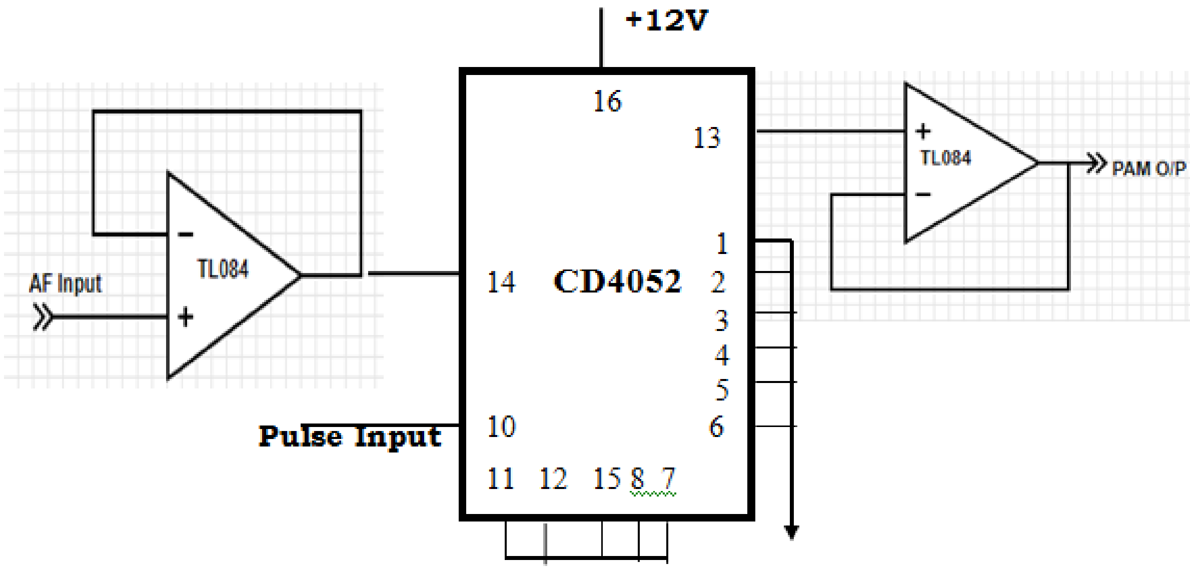
DEMODULATOR:

8. Connect PAM wave input to demodulator input and set sampling pulse frequency to maximum (6 KHz).
9. Observe demodulated signals at output of demodulator; compare it with the original AF signal.

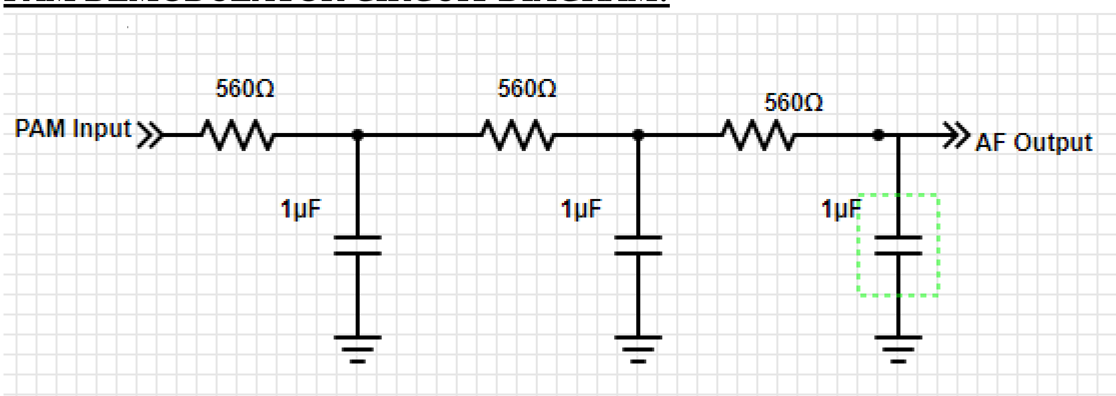
(Note: Only shape, amplitude will be attenuated).

10. You can observe the amplified signal by applying demodulated signal to amplifier.
11. Find the detected signal is same as the AF signal applied. Thus no information is lost in the process of modulation.

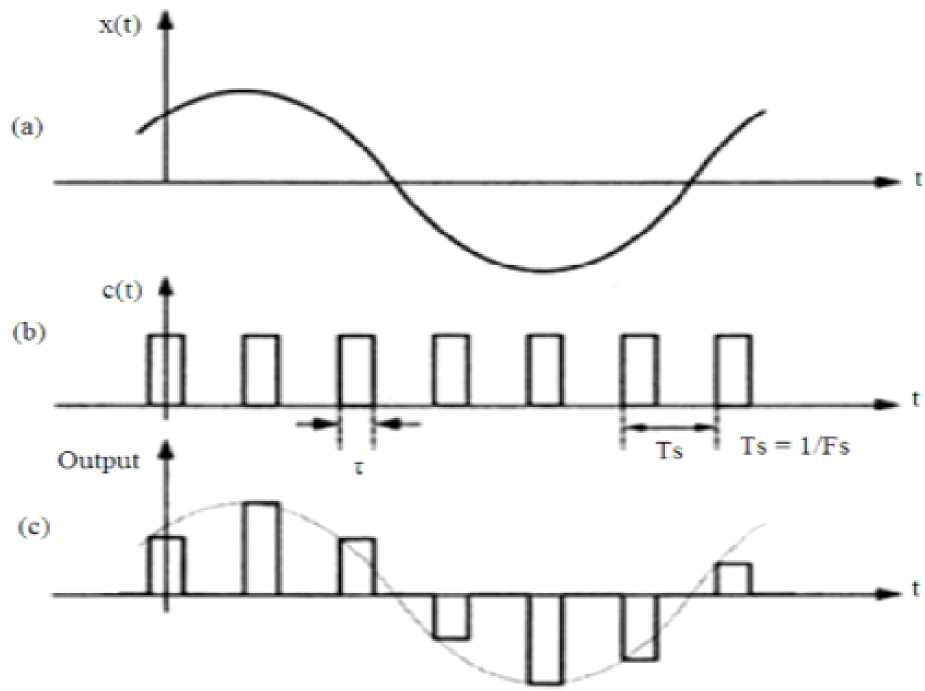
PAM MODULATOR CIRCUIT DIAGRAM:



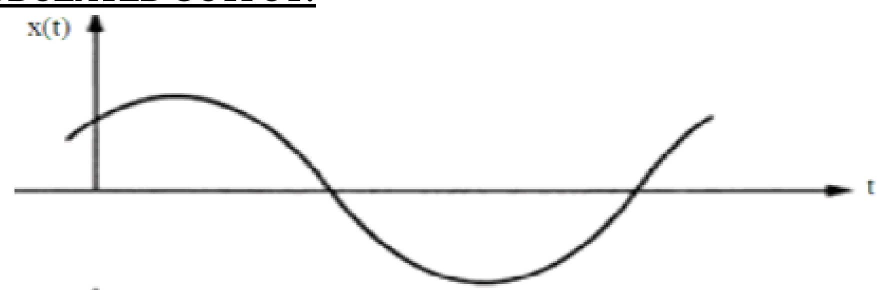
PAM DEMODULATOR CIRCUIT DIAGRAM:



INPUT & OUTPUT WAVE FORMS:



DEMODULATED OUTPUT:



RESULT:

VIVA QUESTIONS:

1. Define pulse position modulation?
2. What is the circuit used to generate PPM signal?
3. Mention the advantages of PPM?
4. Mention the disadvantages of PPM?
5. Mention the applications of PPM?
6. Define synchronization with respect to PPM?
7. Mention the principle of Monostable multi vibrator?
8. Compare PPM with PWM and PAM?
9. Is it possible to generate a PPM signal from PWM?
10. What is the circuit used to demodulate a PPM signal?

7. PULSE WIDTH MODULATION AND DEMODULATION

AIM: To study the operation of pulse width modulation and demodulation and to plot the waveforms of PMW at different amplitudes of AF signal.

EQUIPMENT:

1. PWM demonstrator trainer.
2. Dual trace oscilloscope (Storage oscilloscope is desirable).
3. Digital multimeter.
4. Patch cords.

PROCEDURE:

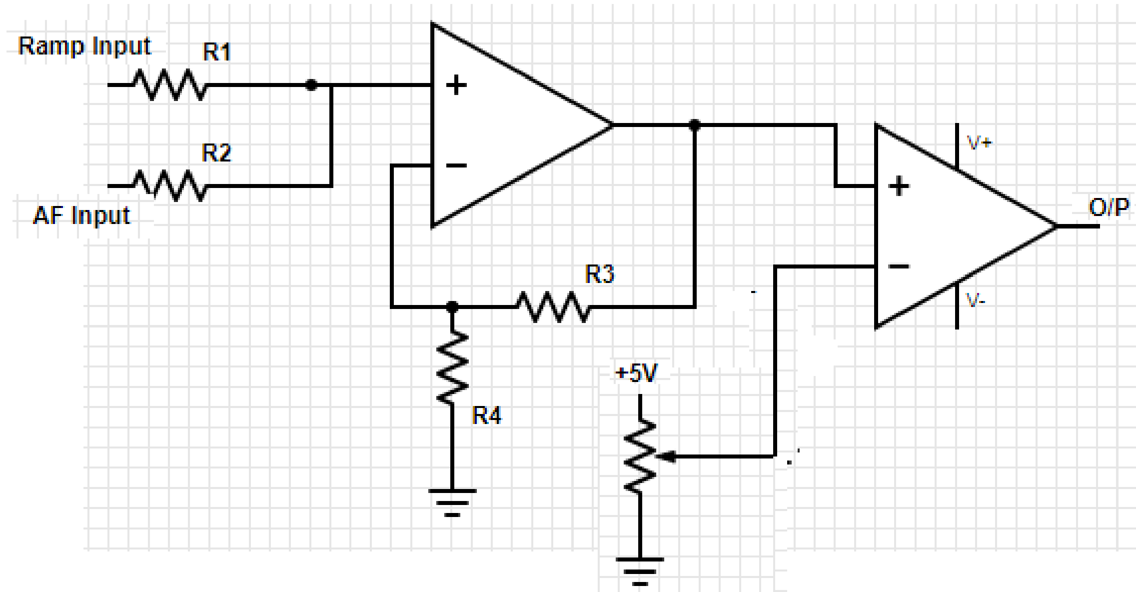
Observation of PWM with AC input signal:

1. Study the circuit operation thoroughly.
2. Switch on the trainer and measure the output voltages of the regulated power supply i.e. +5V and -5V.
3. Observe the output of the AF generator using CRO, note that the output is 5V p-p @ 400 Hz frequency.
4. Observe the output of the control signal generator i.e. ramp and reference pulse using CRO.
5. Now connect AF signal to the modulator and observe output waveform (condition: scope is in dual mode, CH 1 is connected to AF signal and CH 2 is connected to PWM output, trigger source in CH 1, if you are using storage oscilloscope after setting AF input voltage observe output in stop mode).

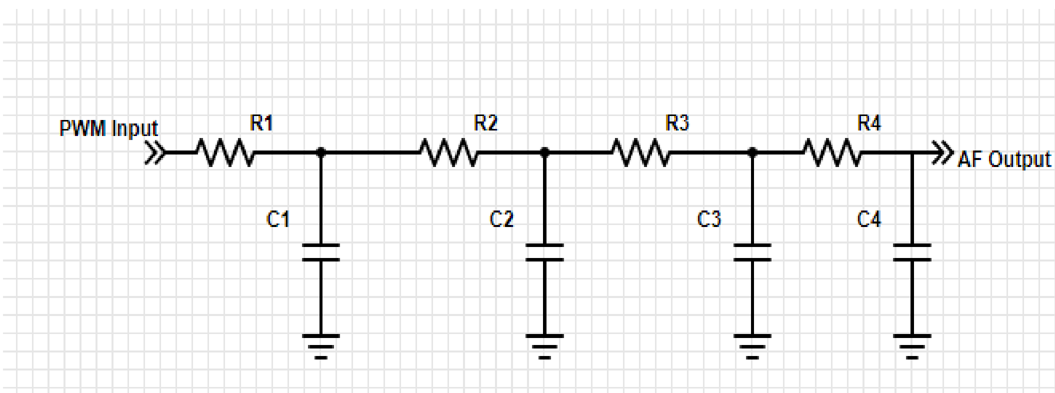
PWM DEMODULATION:

6. Connect PWM input to demodulator input.
7. Connect CH 1 to input AF signal and CH 2 to demodulator output and observe the output, compare it with original AF signal.

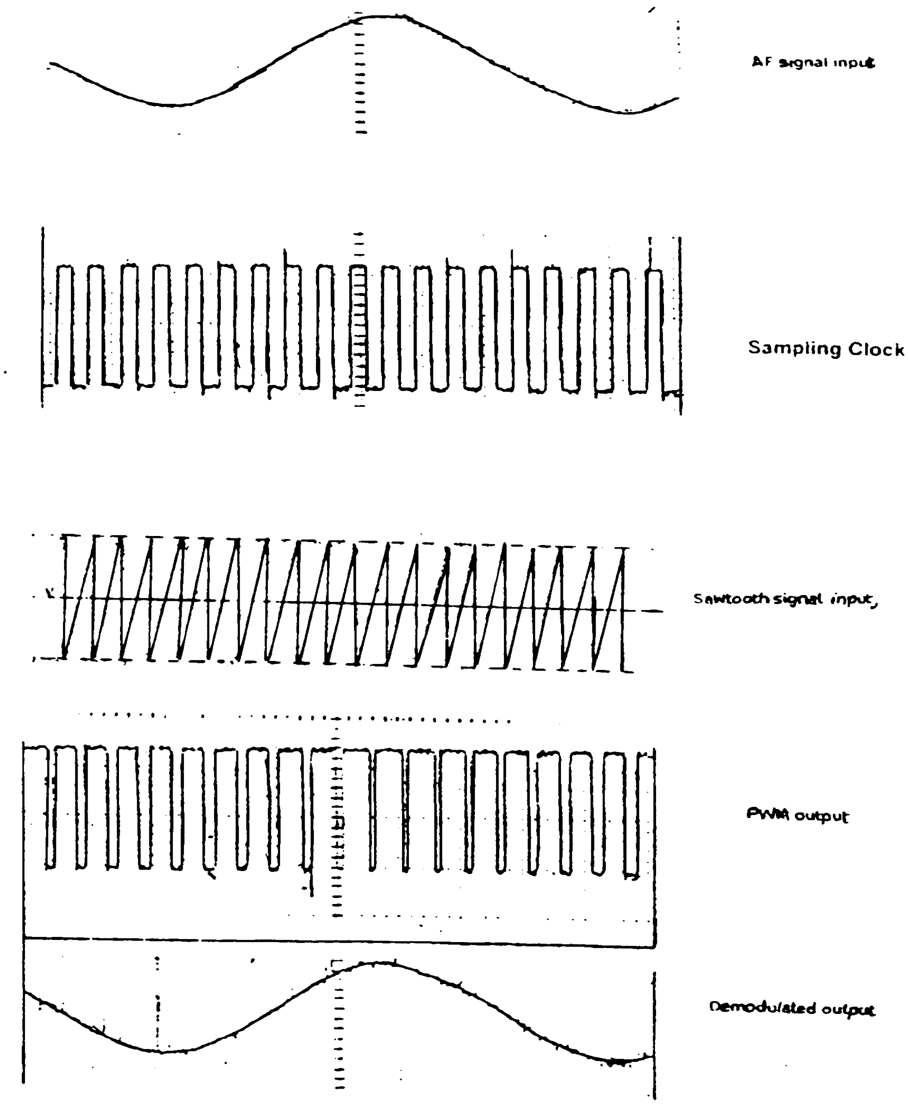
PWM MODULATOR CIRCUIT DIAGRAM:



PWM DEMODULATOR CIRCUIT DIAGRAM:



WAVEFORMS:



MODEL WAVEFORMS

RESULT:

VIVA QUESTIONS:

1. Define pulse width modulation.
2. What is the circuit used to generate a PWM signal.
3. Mention the advantages of PWM.
4. Mention the disadvantages of PWM.
5. What is the IC used as function generator.
6. Mention the bandwidth requirements of PWM.
7. Mention the applications of PWM.
8. What is the circuit used to demonstrate a PWM signal.
9. Compare PWM with PAM.
10. Mention the IC used to generate PWM.

8. PULSE POSITION MODULATION & DEMODULATION

AIM: To study the operation of pulse position modulation and to plot the waveforms of PPM at different amplitudes of AF signal.

EQUIPMENT:

1. Pulse position modulation & de modulation trainer
2. Dual trace oscilloscope (Storage oscilloscope is desirable)
3. Digital multimeter

PROCEDURE:

Observation of PWM and PPM with AC input signal:

1. Study circuit operation thoroughly.
2. Switch on the trainer and measure the output voltages of the regulated power supply i.e. +5V and -5V.
3. Observe the output of the AF generator using CRO, note that the output is 5V pp @ 400Hz frequency.
4. Observe the output of the control signal generator i.e. ramp and reference pulse using CRO.
5. Connect ramp signal to the ramp input of the PWM modulator.

Observation of PWM and PPM with AC input signal:

6. Now connect AF signal to the modulator and observe PWM output waveform(condition: scope is in dual mode, CH 1 is connected to AF signal and CH 2 is connected to PWM output, trigger source in CH 1,if you are using storage oscilloscope after setting AF input voltage observe output in stop mode).
7. Now connect output of the PWM modulator to monostable multivibrator input and CH 2 input of the oscilloscope to the monostable output i.e. PPM output (Set scope in dual mode and trigger source in CH 1).
8. Observe PWM and PPM waveforms.

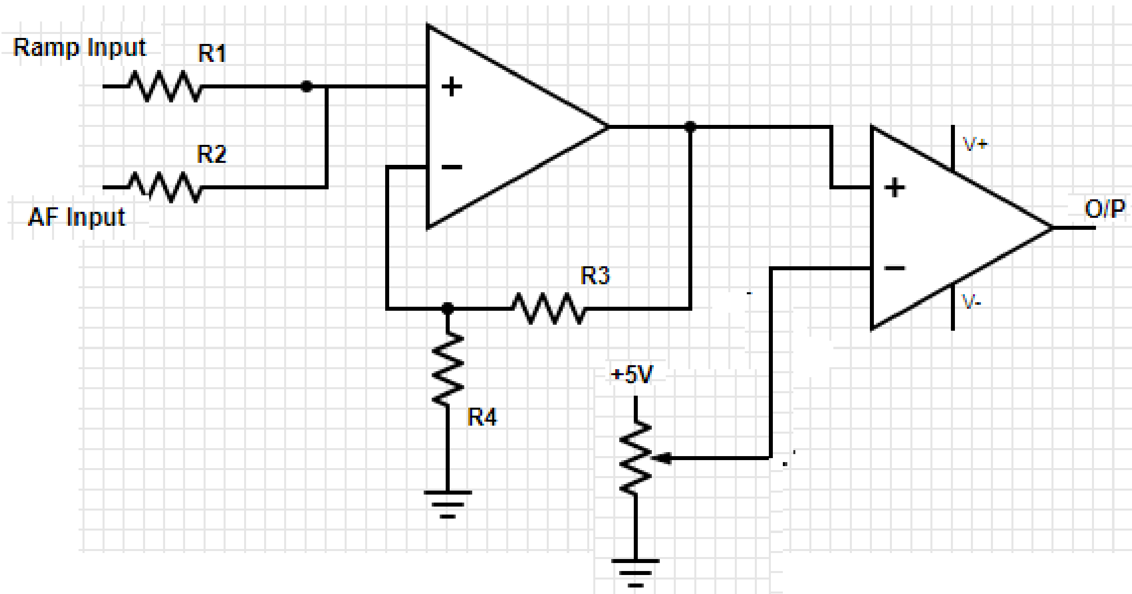
PPM DEMODULATION:

9. Connect PPM and reference pulse signals to respective inputs PPM-PWM converter circuit and output of the same circuit to PWM demodulator.(Scope should be set in dual mode, CH 1 is connected to input AF signal ,CH 2 to demodulator output and trigger source to CH 1).Observe the output signal and compare it with input AF signal.

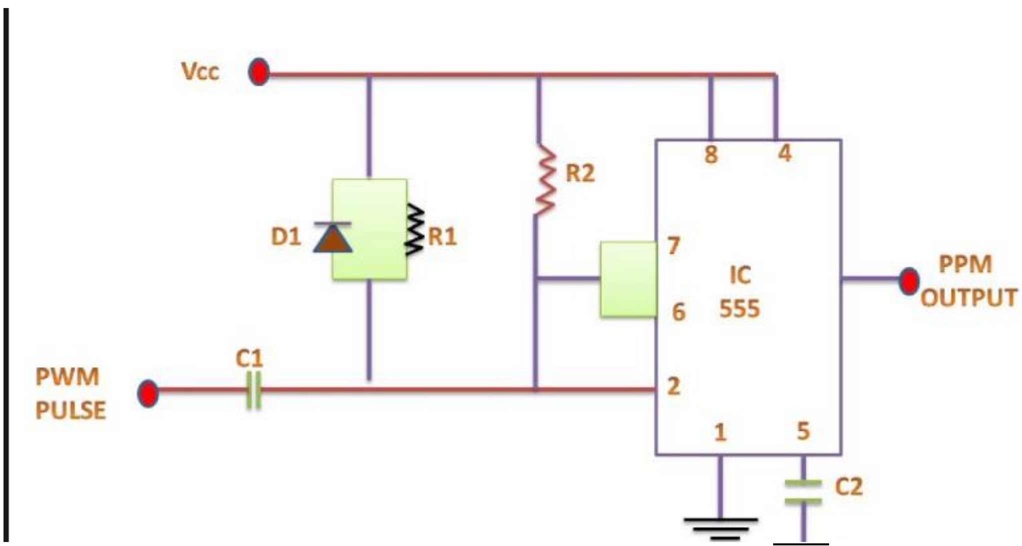
NOTE: The main problem in this experiment will be in triggering the oscilloscope to observe the waveforms, especially PPM.

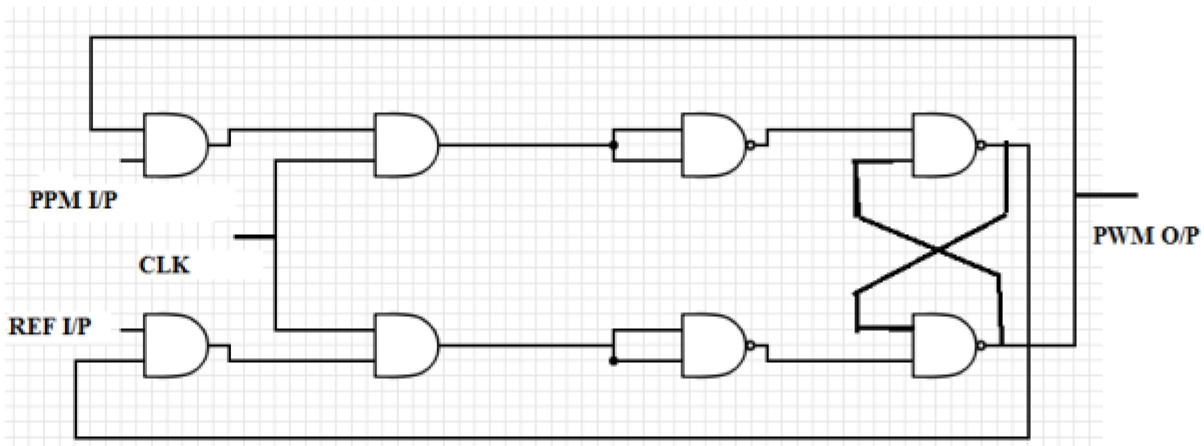
CIRCUIT DIAGRAM:

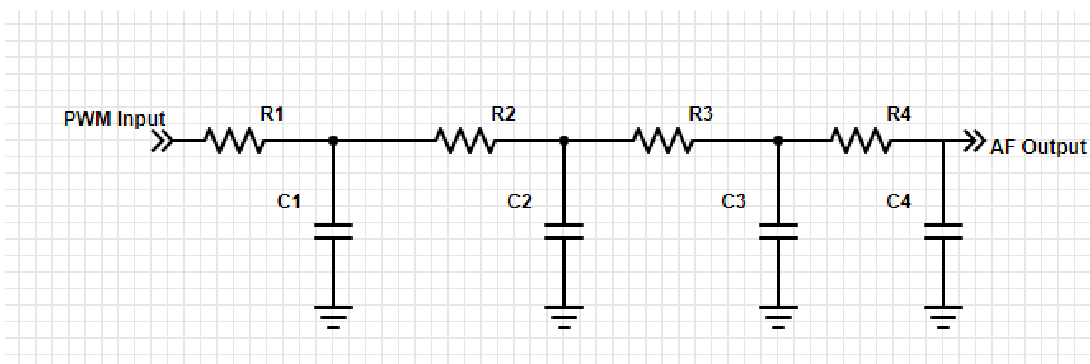
PWM Modulator



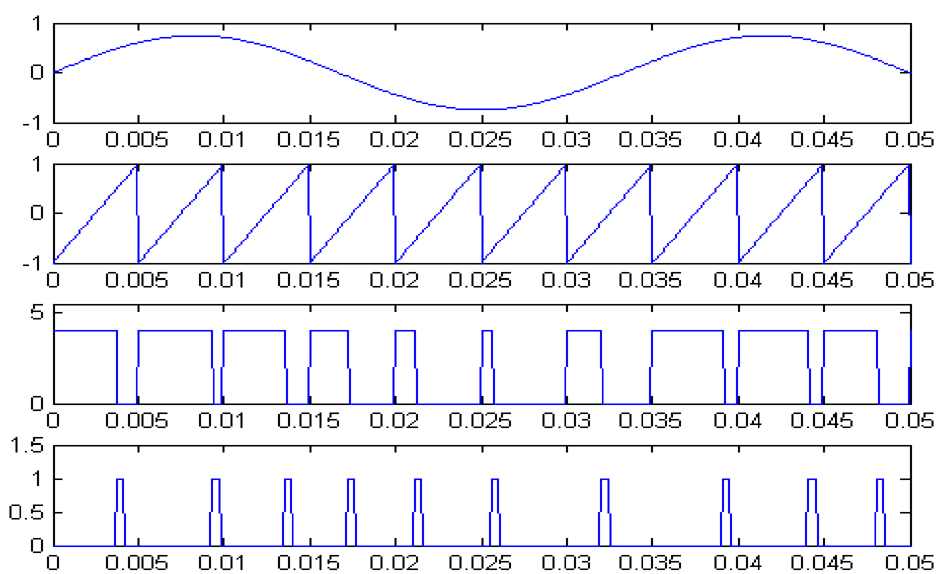
PWM-PPM Conversion



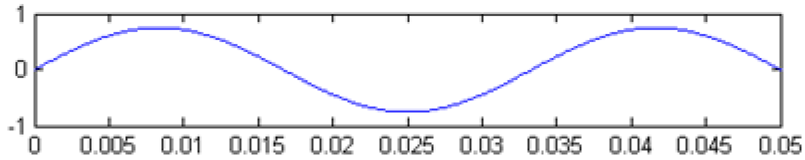

PPM I/P
CLK
REF I/P
PWM O/P


PWM Input
R1
R2
R3
R4
AF Output
C1
C2
C3
C4

WAVEFORMS:



Demodulated output:



RESULT:

VIVA QUESTIONS:

1. Define Pulse Position Modulation.
2. What is the circuit used to generate a PPM siganl.
3. Mention the Advantages of PPM.
4. Mention the Disadvantages of PPM.
5. Define Synchronization with respect to PPM.
6. Mention the Applications of PPM.
7. Mention the principle of Monostable Multivibrator.
8. Compare PPM with PWM and PAM.
9. Is it possible to generate a PPM signal from PWM.
10. What is the circuit used to demodulate a PPM?

9.PCM GENERATION AND DETECTION

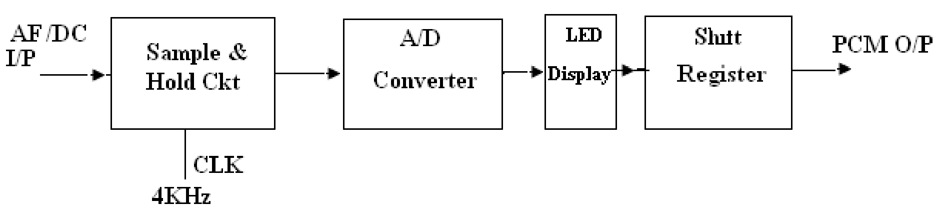
AIM: To Study & understand the operation of the Pulse code modulation & Demodulation.

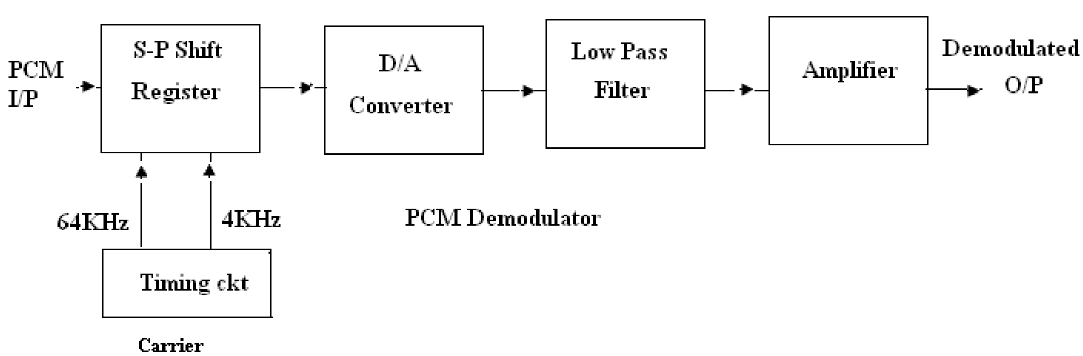
APPARATUS:

1. PCM Modulator trainer
2. PCM Demodulator trainer
3. Storage Oscilloscope/ Dual Trace Oscilloscope
4. Digital multi-meter.
5. Co-axial cables (standard accessories with trainer)
6. Patch chords

CIRCUIT DIAGRAM:

PCM Modulator





PCM Demodulator

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.

PROCEDURE:

1. Study the theory of operation thoroughly.
2. Connect the trainer (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 wave of 200Hz frequency with 3Vpp amplitude.
4. Verify the output of the DC source with multi-meter/ scope, output should vary 0 to +5v.
5. Observe the output of the Clock generator using CRO, they should be 64 KHz and 8KHz frequency of square wave with 5Vpp amplitude.
6. Note: These clock signals are internally connected the circuit so no external connections are required.
7. Connect the trainer (De Modulator) to the mains and switch on the power supply.
8. Observe the output of the clock generator using CRO; it should be 64 KHz square wave with 5Vpp amplitude.

PCM Operation (with DC input)

Modulation:

8. Set DC source to some value say 1 V with the help of multi-meter and connect it to the A/D converter input and observe the output LED's.

9. Note down the digital code i.e. output of the A/D converter and compare with the theoretical value

Theoretical value can be obtained by:

$$\frac{\text{A/D input voltage}}{\text{1 LSB value}} = X_{(10)} = Y_{(2)}$$

Where , 1 LSB value = $V_{ref} / 2^n$, Since V_{ref} = 5V and n= 8

1 LSB Value = 0.01953

Example:

A/D input voltage = 1 V = $51.2_{(10)}$ = $00110011_{(2)}$

So digital output is 00110011

10. Keep CRO in dual mode. Connect one channel to 8KHz signal (which is connected to the shift register) and another channel to the PCM out put
11. Observe the PCM output with respect to the 8 KHz signal and sketch the waveforms. Compare them with the given waveforms

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

Demodulation:

Connect PCM signal to the demodulators (S-P Shift register) from the PCM modulator (AET-68M) with help of coaxial cable (supplied with the trainer)

12. Connect clock signal (64 KHz) from the transmitter to the receiver using coaxial cable.
13. Connect transmitter clock to the timing circuit
14. 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). It will be noticed that the output of the S-P shift register is following the A/D converter output in the modulator. Observe D/A converter output (demodulated output) using multi-meter /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.
15. Similarly you can try for different values of modulating signal voltage.

Sample work sheet:

1. Modulating signal : 1V
2. A/D output (theoretical) : 00 11 00 $11_{(2)}$
3. A/D output (practical) : 00 11 00 $11_{(2)}$
4. S-P output : 00 11 00 $11_{(2)}$
5. D/A Converter output : 1V

PCM Operation (with AC input)

Modulation:

16. Connect AC signal of $2V_{PP}$ amplitude to Sample & Hold circuit.
17. Keep the CRO in dual mode. Connect one channel to the AF signal and another channel to the sample & hold output. Observe and sketch the sample & hold output.
18. Connect the sample and hold output to the A/D converter and observe the PCM output using storage oscilloscope/ DTO
19. Observe PCM output by varying AF signal voltage.

Demodulation:

20. Connect PCM signal to the demodulator input (S-P shift register) from the PCM modulator with the help of coaxial cable (supplied with the trainer)
21. Connect clock signal (64KHz) from the transmitter to the receiver using coaxial cable

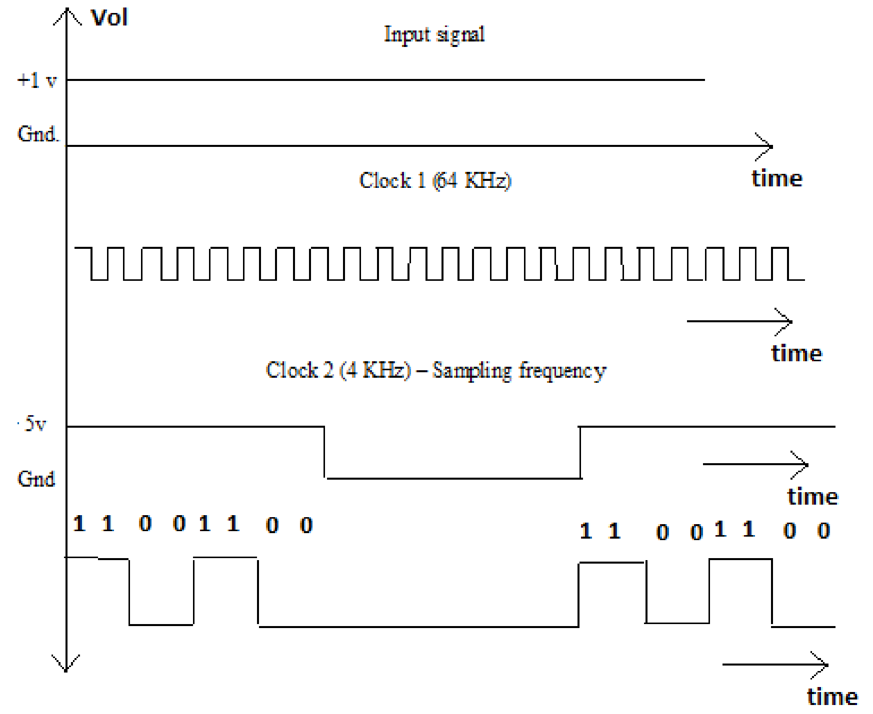
22. Connect transmitter clock to the timing circuit.
23. Keep CRO in dual mode. Connect CH 1 input to the sample and hold output and CH 2 input ot the D/A converter output.
24. Observe and sketch the D/A output.
25. Connect D/A output to the LPF input.
26. Observe output of the LPF/Amplifier and compare it with the original modulating signal.
27. From above observation you can verify that there is no loss in information (modulating signal) in conversion and transmission process.
28. Disconnect clock from transmitter and connect to local oscillator (i.e. clock generator output from De-Modulator) 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: We can take modulating signals from external sources. Maximum amplitude should not exceed 4V in case of DC and $3V_{PP}$ in case of AC (AF) signals.

S.No	**DC Input (Vol)**	**A/D converter output**	**Theoretical value**

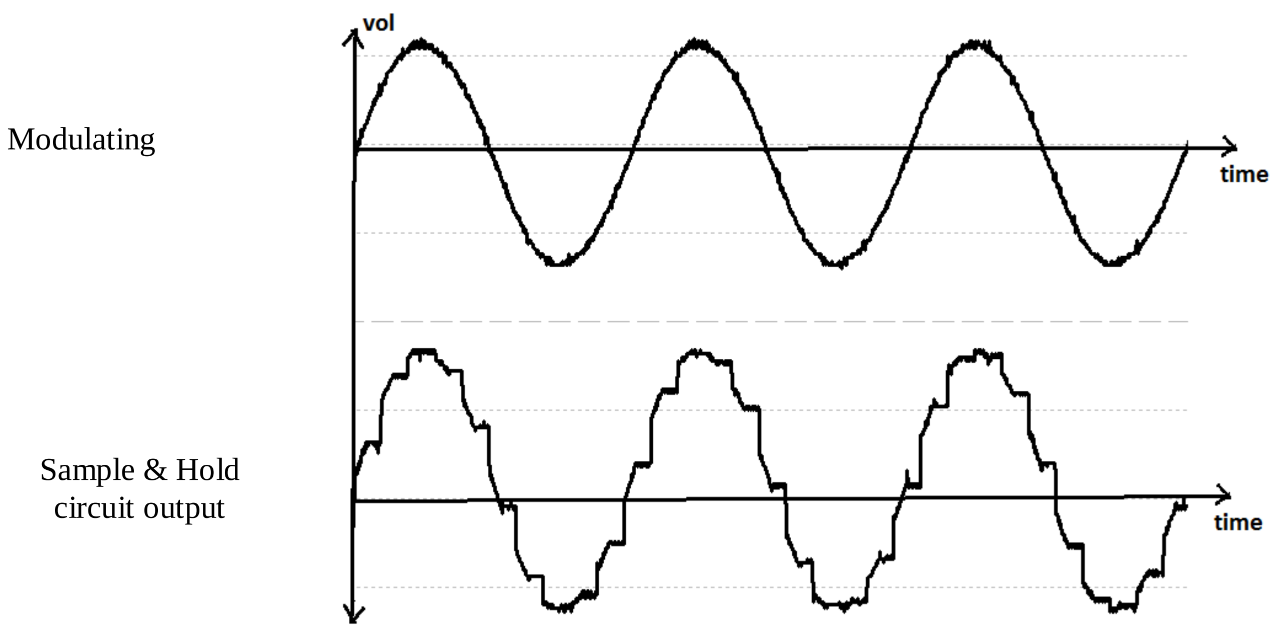
EXPECTED WAVEFORMS:

PCM wave forms / timing diagram for DC input

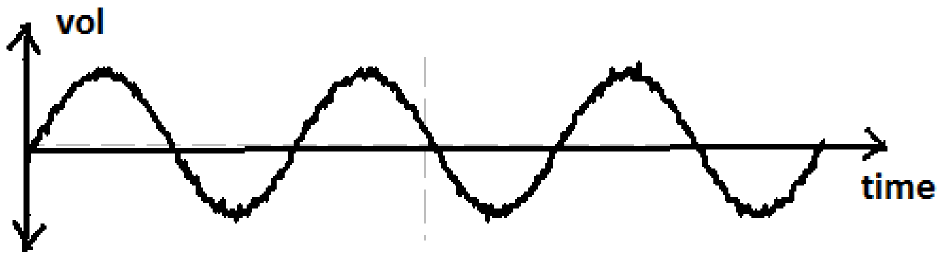


S – P Converter output 00110011 (LSB to MSB) LED Indication 11001100 (MSB to LSB)

PCM wave forms for AC input



Demodulated output



RESULT:

VIVA QUESTIONS

1. Mention the major stages to generate a PCM signal?
2. Define sampling?
3. Define Quantization?
4. Define Quantization error?
5. Define Encoding with respect to PCM?
6. Define Synchronization?
7. Mention the applications of PCM?
8. What are the Band width requirements of PCM?
9. What is the role of A/D converter in PCM?
10. Define S/N ration for Uniform Quantization?

10.DELTA MODULATION

AIM: To study the Delta modulation process by comparing the present signal with the previous signal of the given Modulating signal.

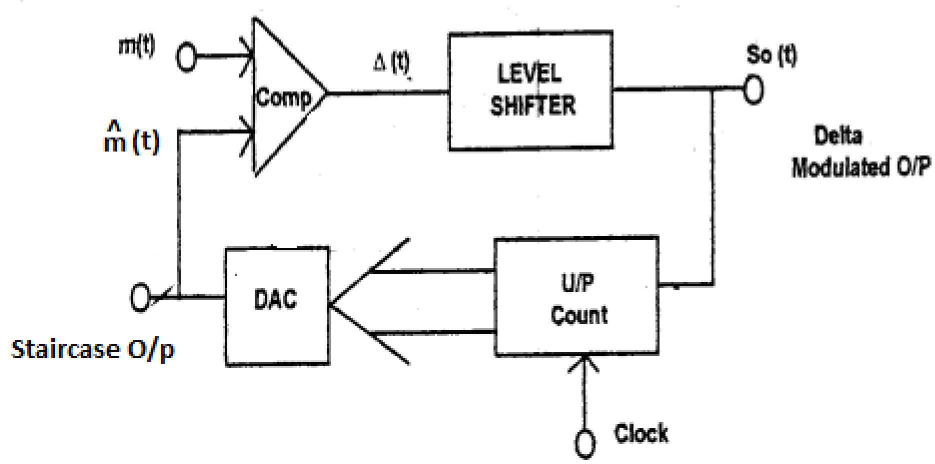
APPARATUS:

1. Trainer Kit of Delta Modulation & Demodulation.
2. CRO
3. Function Generator
4. Patch cords, Probes.

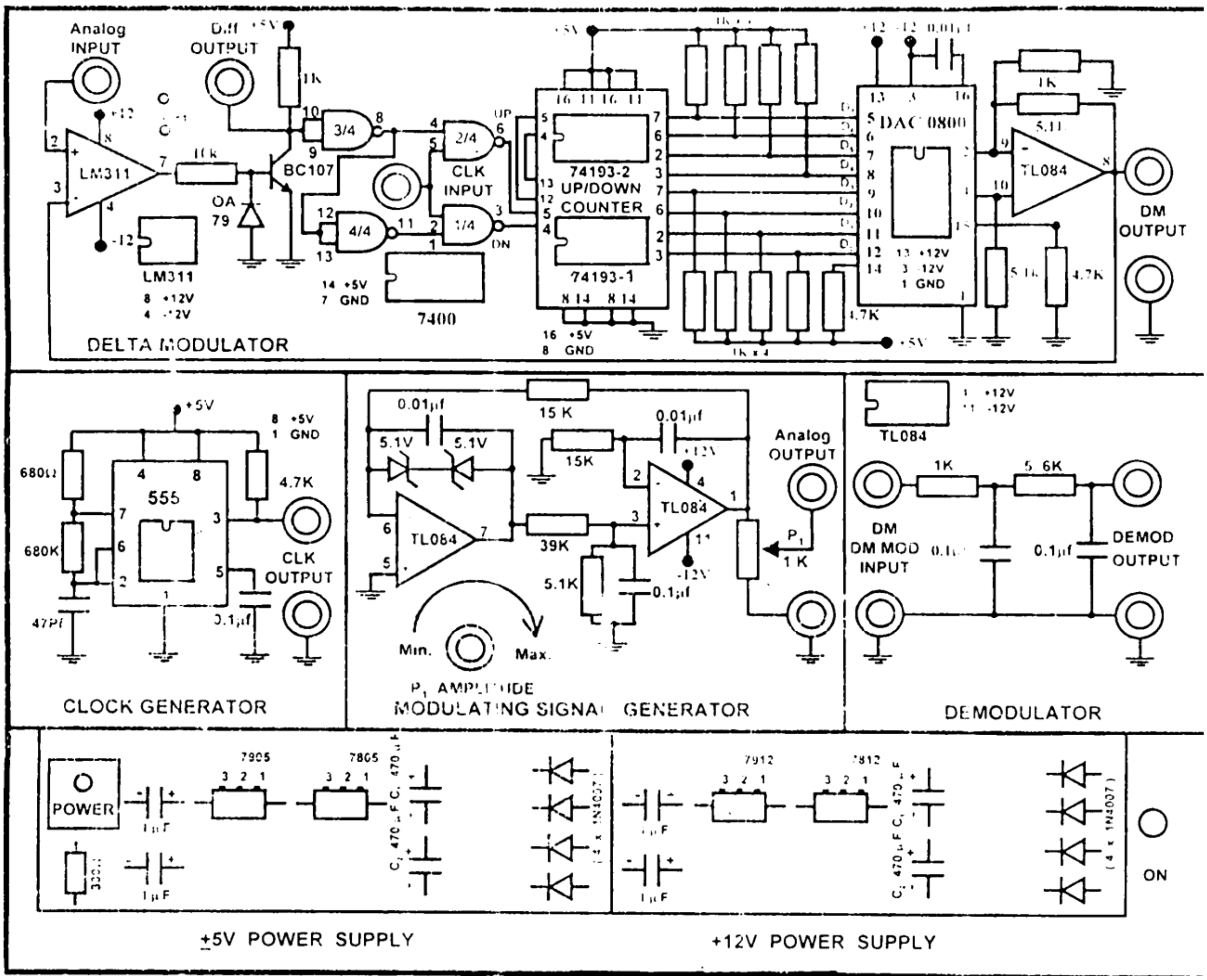
PROCEDURE:

1. Switch ON the experimental board
2. Connect Clock Signal to the Delta Modulator circuit.
3. Connect Modulating Signal to the Modulating signal input of the Delta Modulator and observe the same on channel 1 of a Dual Trace Oscilloscope.
4. Observe the Delta Modulator output on channel II.
5. Observe Slope Over Load noise by increasing the amplitude of Modulating signal and also observe granular noise.
6. Connect this Delta Modulator output to the Demodulator
7. Also connect the clock signal to the demodulator.
8. Observe the demodulator output with and without RF filter on CRO

BLOCK DIAGRAM

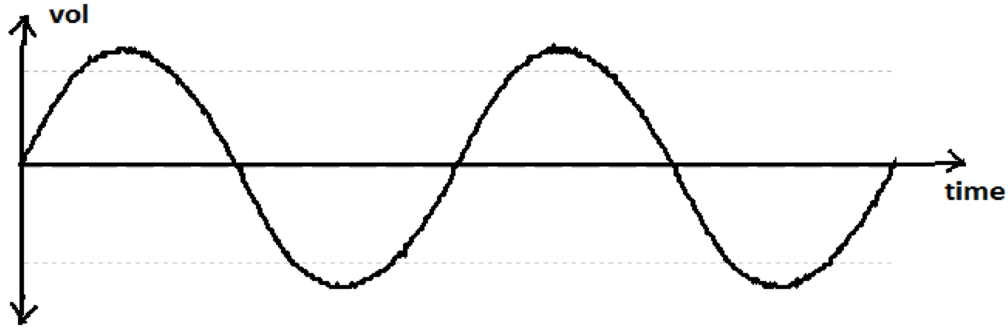


CIRCUIT DIAGRAM

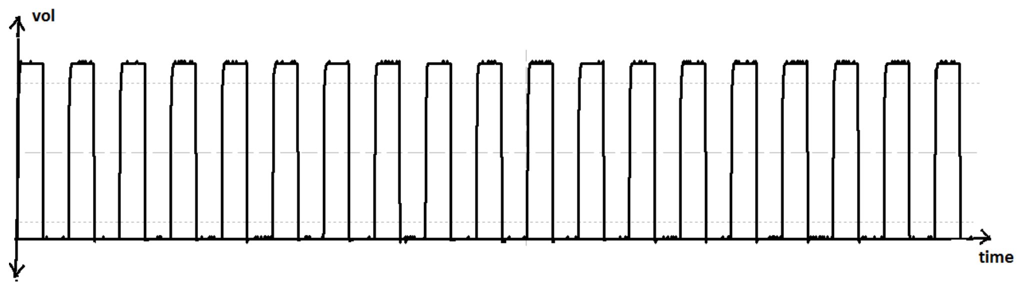


EXPECTED WAVE FORMS:

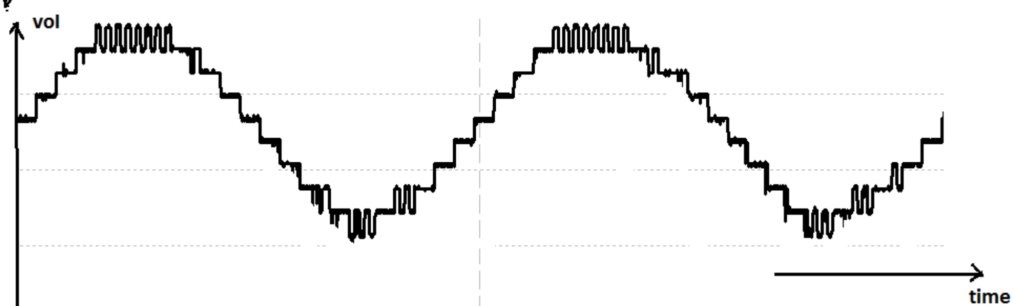
Modulating



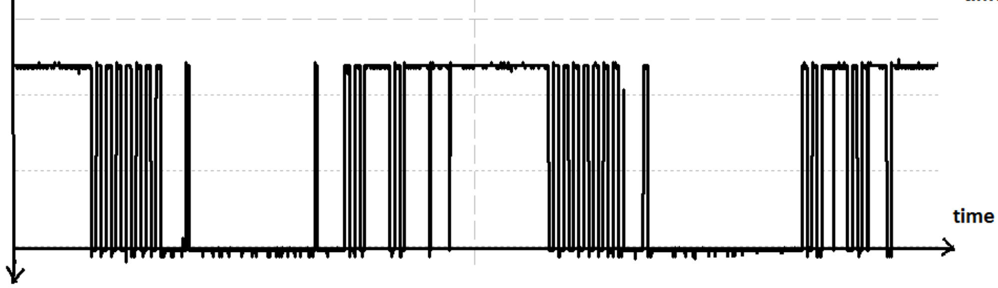
Clock input



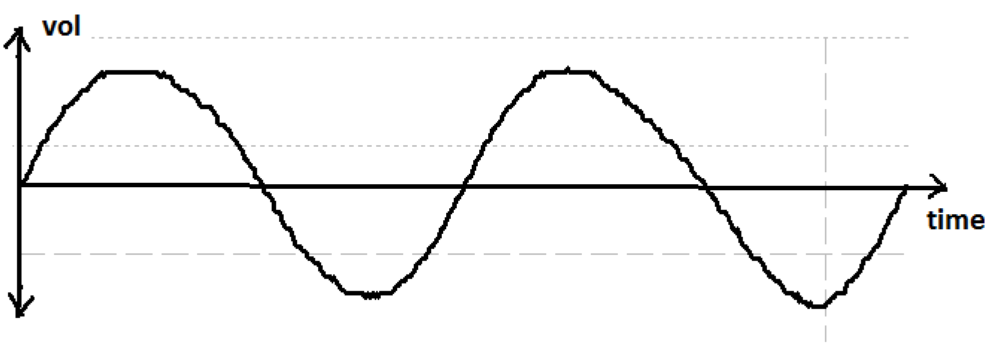
Staircase approximation



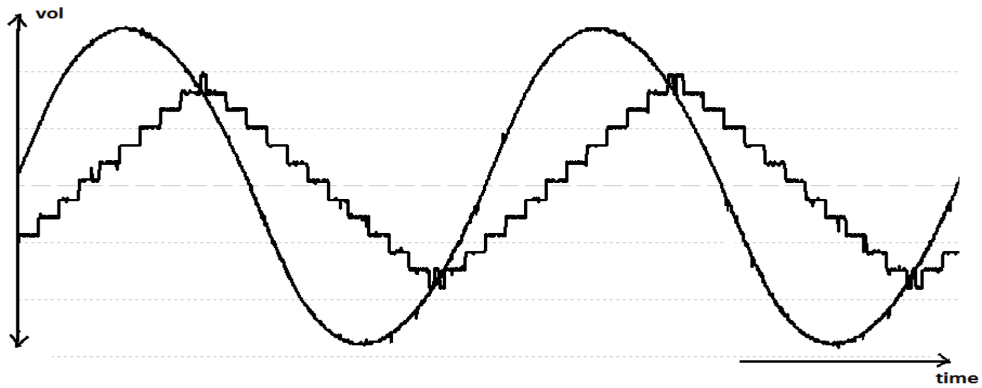
Delta Modulator output



Demodulator output



Slope over load noise condition



RESULT:

VIVA QUESTIONS

1. What are the advantages of Delta modulator?
2. What are the disadvantages of delta modulator?
3. How to overcome slope overload distortion?
4. How to overcome Granular or ideal noise?
5. What are the differences between PCM & DM?
6. Define about slope over load distortion?
7. What is the other name of Granular noise?
8. What is meant by staircase approximation?
9. What are the disadvantages of Delta modulator?
10. Write the equation for error at present sample?

11. FREQUENCY SHIFT KEYING GENERATION AND DETECTION

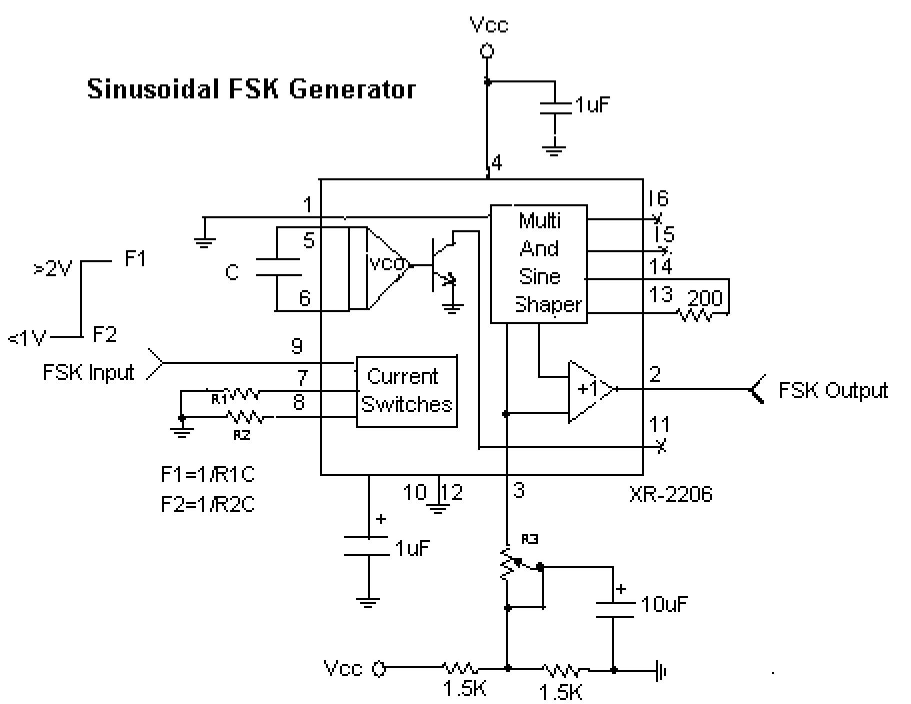
AIM: Study the operation of FSK modulation & Demodulation and to plot the Frequency Shift Keying waveforms for binary data at different frequencies.

APPARATUS: 1. Frequency Shift Keying kit

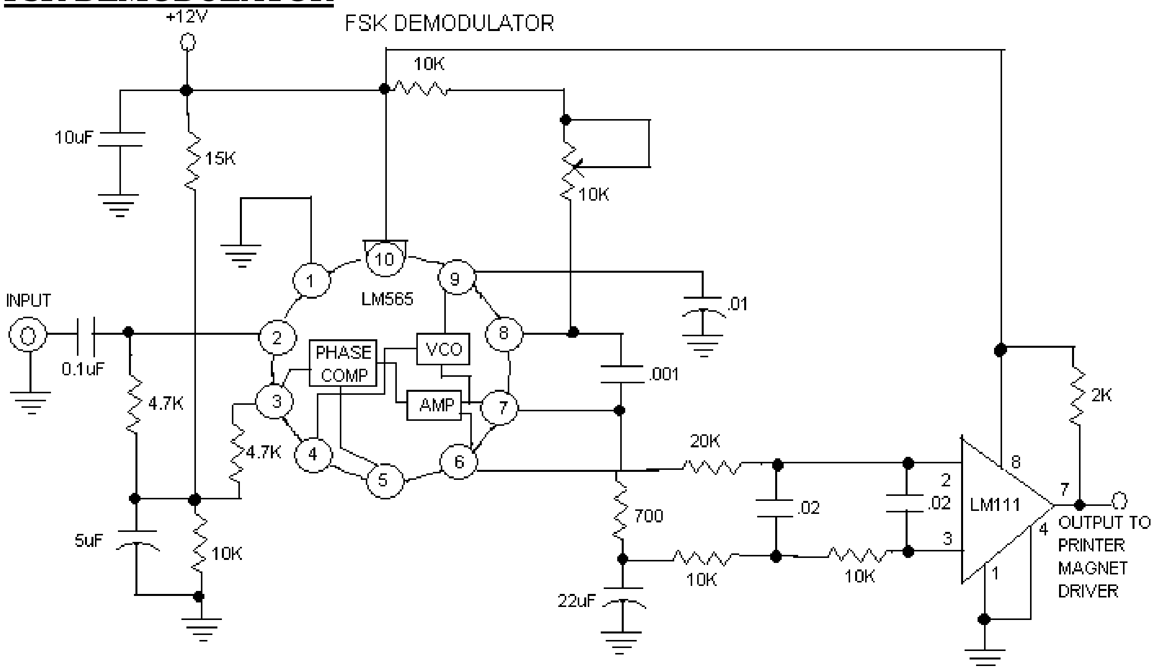
2. Dual trace C.R.O (30MHz)

3. Digital frequency counter & DMM

CIRCUIT DIAGRAM:



FSK DEMODULATOR



THEORY:

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. Waveforms 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.

FSK Modulator:

Figure 1 shows the FSK modulator using IC XR 2206, IC XR 2206 is a VCO based monolithic function generator capable of producing Sine, Square, Triangle signals with AM and FM facility. In this trainer XR2206 is used generate FSK signal. Mark (Logic 1) and space (Logic 0) frequencies can be independently adjusted by the choice of timing potentiometers F) & F!. The output is phase continuous during transitions. The keying signal i.e. data signal is applied to pin 9.

FSK Demodulator:

Figure 2 shows FSK Demodulator is a combination of PLL (LM565) and comparator (Op-amp). The frequency changing signal at the input to the PLL drives the phase detector to result in rapid change in the error voltage, which is applied to the input of the comparator. At the space frequency, the error voltage out of the phase detector is below the comparison voltage of the comparator. The comparator is a non inverting circuit, so its output level is also low. As the phase detector input frequency shifts low (to the mark frequency), the error voltage steps to a high level, passing through the comparison level, causing the comparator output voltage between its two output levels in manner that duplicates the data signal input to the XR2206 modulator.

The free running frequency of the PLL (no input signal) is set midway between the mark and space frequencies. A space at 2025 HZ and mark at 2225 Hz will have a free running VCO frequency of 21125Hz.

PROCEDURE:

1. Study the theory of operation.
2. Connect the trainer to mains and switch on the power supply.
3. Measure the output voltage of the regulated power supply i.e +12V with the help of digital multi-meter.
4. Verify the operation of the logic source using digital multi-meter. Output should be zero volts in logic 0 position and 12V in logic 1 position.
5. Observe the output of the data signal using oscilloscope. It should be a square wave of 20Hz to 180Hz @ 10Vpp. Select 125Hz for getting proper demodulated output. (For frequency variation potentiometer is provided).

FSK Modulation:

6. Connect output of the logic source to data input of the FSK modulator.
7. Set logic source switch in 0 positions.
8. Connect FSK modulator output to oscilloscope as well as frequency counter.
9. Set the output frequency of the FSK modulator as per your desire(say 2KHz) with the help of control F0 which represents logic 0
10. Set logic source switch in 1 position.
11. Set the output frequency of the FSK modulator as per your desire (say 2.5 KHz) with the help of control F1 which represents logic 1.

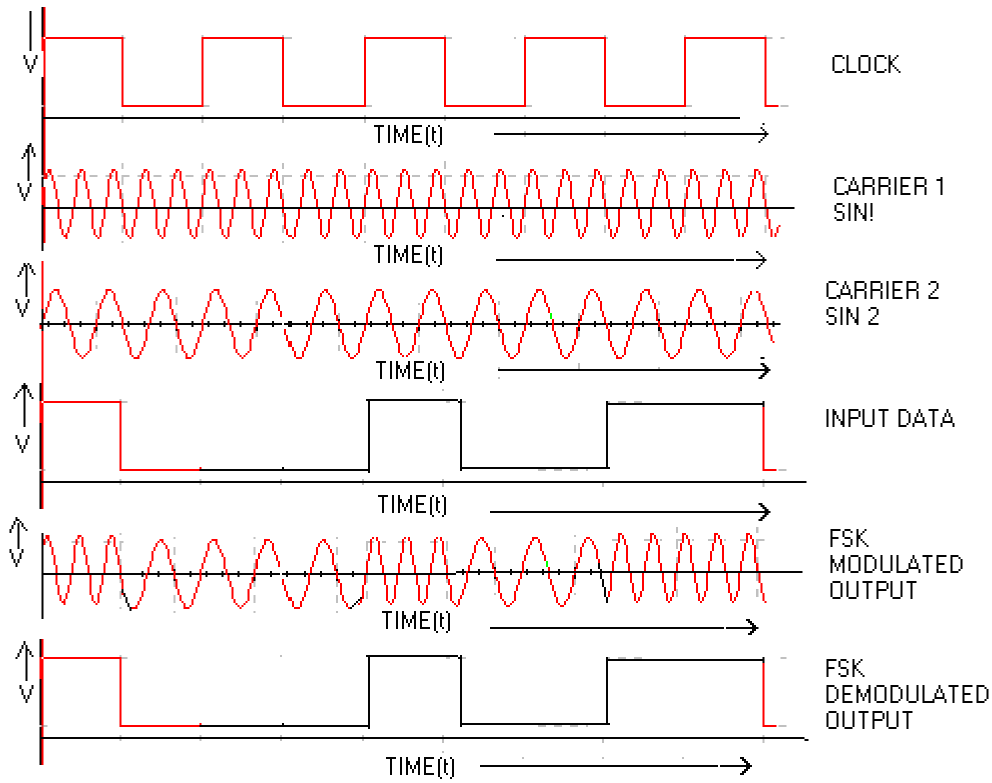
Note: we have chosen F0 as 2 KHz and F1 as 2.5 KHz for ease of operation in fact you may set any value.

12. Now connect data input of the FSK modulator to the output of the data signal generator.
13. 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.
14. Observe the FSK signal for different data signal frequencies and plot them. By this we can observe that the carrier frequency shifting between two predetermined frequencies as per the data signal i.e. 2 KHz when data signal is 0 and 2.5KHz when data input is 1 in this case.
15. Compare these plotted wave forms with the theoretically drawn in figure.

FSK Demodulation:

16. Now connect the FSK modulator output to the FSK input of the demodulator.
17. Connect CH1 input of the Oscilloscope to the data signal at modulator and CH2 input to the output of the FSK demodulator (keep CRO in dual mode)
18. 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 demodulation.

EXPECTED WAVEFORMS:



RESULT:

VIVA QUESTIONS

1. Define frequency shift keying.
2. What is meant by carrier swing?
3. Define Frequency deviation of FSK?
4. What are the advantages of FSK?
5. What is the probability of error for FSK?
6. Give the differences between FSK & FM.
7. What are the disadvantages of FSK?
8. What is the bandwidth required for coherent FSK?
9. Compare FSK with ASK signaling schemes.
10. Draw a FSK signal for an input bit sequence of 10011001.

12.PHASE SHIFT KEYING GENERATION AND DETECTION

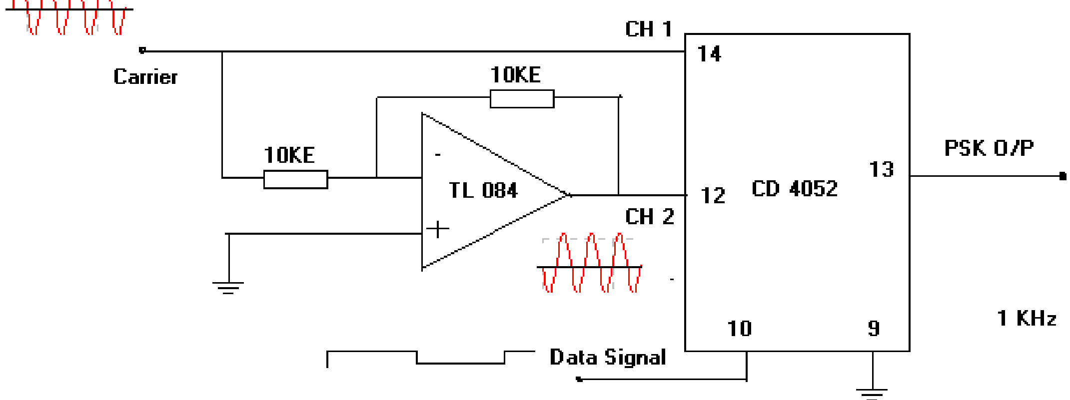
AIM: Study the operation of PSK (Binary) Modulation & Demodulation and to plot the PSK wave forms for Binary data at different frequencies.

APPARATUS:

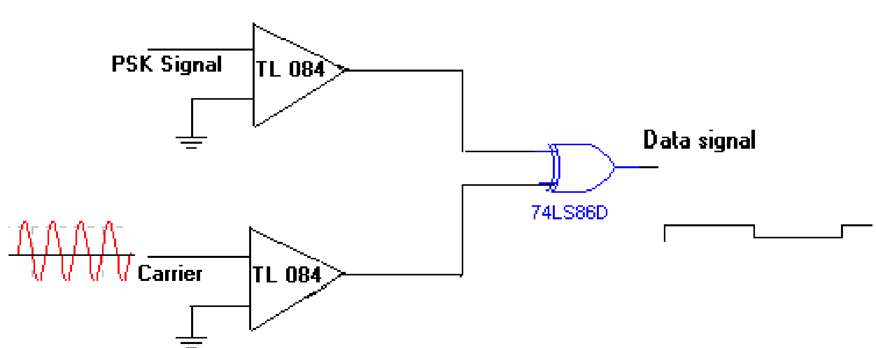
1. Phase Shift keying trainer-kit
2. Dual trace Oscilloscope
3. Digital multi-meter
4. Patch chords

BLOCK DIAGRAM:

PSK Modulator



PSK Demodulator



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 Vcos W_o t is transmitted to indicate a 1 condition , and the carrier shifted by 180 ^{o} i.e -V cos W_o 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 circuit is used in this trainer.

PROCEDURE:

1. Study the theory of operation.
2. Connect the trainer to mains and switch on the power supply.
3. Measure the output of the regulated power supply i.e +5V and -5V with the help of digital multi-meter.
4. Observe the output of the carrier generator using CRO, it should be an 8 KHz Sine with 5 Vpp amplitude.
5. Observe the various data signals (1 KHz, 2 KHz and 4 KHz) using CRO.

Modulation

6. Connect carrier signal to carrier input of the PSK Modulator.
7. Connect data signal say 4 KHz from data source to data input of the modulator.
8. Keep CRO in dual mode.
9. Connect CH1 input of the CRO to data signal and CH2 to the output of the PSK modulator
10. Observe the PSK o/p Signal with respect to data signal and plot the wave forms
    Compare the plotted waveforms with given wave forms.

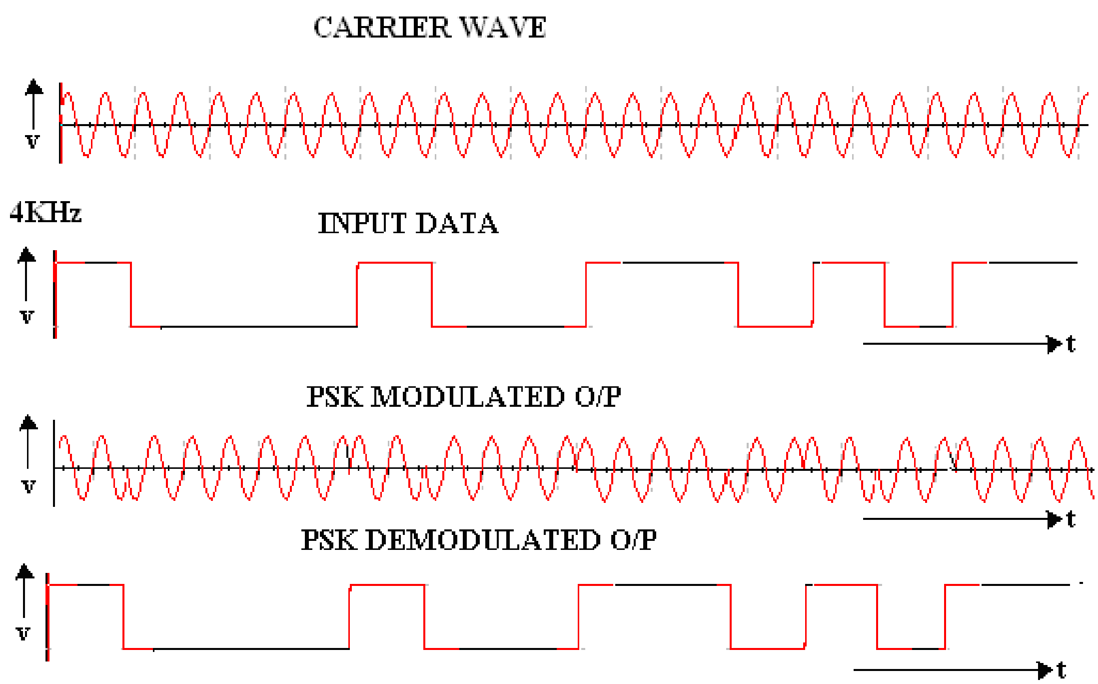
Demodulation:

11. Connect the PSK output to the PSK input of the demodulator.
12. Connect carrier to the carrier input of the PSK demodulator
    Note: In actual communication system reference carrier is generated at receiver.
13. Keep CRO in dual mode.
14. Connect CH1 to the data signal (at Modulator) and CH2 to the output of the demodulator.

15. Compare the demodulated signal with original data signal; by this we can notice that there is no loss in modulation and demodulation process.

16. Repeat the steps 7 to 15 with different data signals i.e. 2 KHz and 1 KHz.

EXPECTEDWAVEFORMS:



RESULT:

VIVA QUESTIONS

1. Explain concept of PSK?
2. What is the band width requirement of a DPSK?
3. Explain the operation of DPSK detection?
4. What are the advantages of PSK?
5. What is meant by differential encoding?
6. In Differential encoding technique which type of logic gates are used?
7. Draw the waveforms of PSK?
8. What is the difference between PSK&DPSK?
9. What is the minimum bandwidth required in PSK?
10. Explain the Demodulation scheme of PSK?

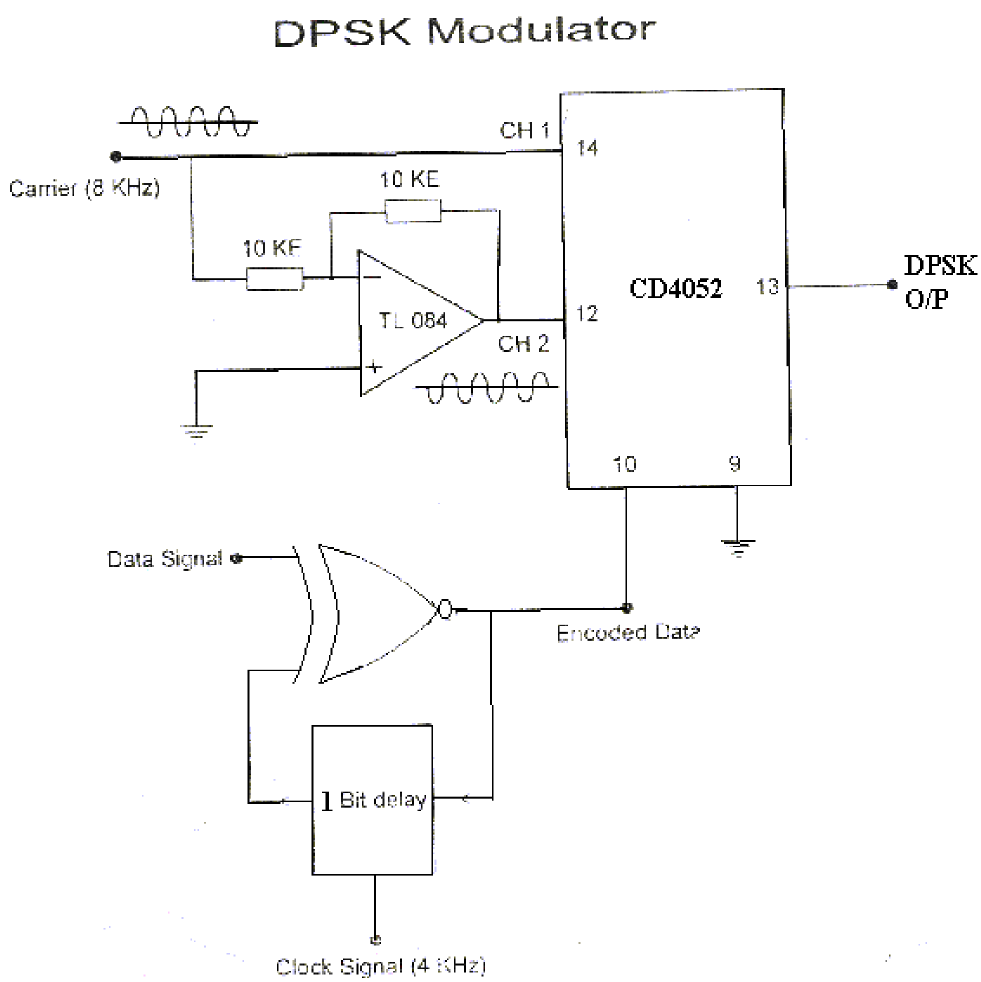
13.(i) DIFFERENTIAL PHASE SHIFT KEYING GENERATION AND DETECTION

AIM: Study the characteristics of differential phase shift keying.

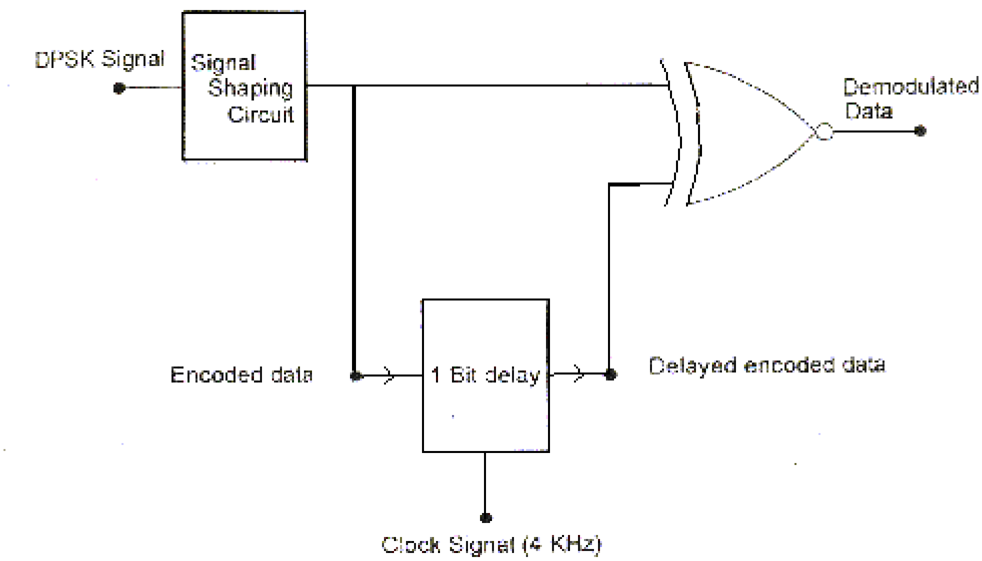
APPARATUS:

1. Differential Phase Shift Keying Kits
2. C.R.O (20MHz)
3. Digital multi-meter.
4. No's of coaxial cables (standard accessories with trainer)

BLOCK DIAGRAM:



DPSK Demodulator



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)** over comes 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.

The differential encoding operation performed by the modulator is explained below Let b (t) be the binary message to be transmitted. An encoded message stream b(t) is generated from b'(t) by using a logic circuit The first bit in b(t) is arbitrary which may be chosen as 1 or 0 . The subsequent bits in b(t) are determined on the basis of the rule that when b'(t) is 1 b(t)does not change its value. In the first bit stream, the initial bit (arbitrary) is 1 and in the second bit stream, the initial bit is 0 EX-NOR gate can be used to perform this operation as its output is a 1 when both the input are same, and a 0 when the inputs are different.

b'(t)		0	1	1	0	0
b(t)	1	0	0	0	1	0
Phase	0^0	180^0	180^0	180^0	0^0	180^0
B(t)		0	1	1	0	0

<u>Example for Complete DPSK operation (with arbitrary bit as 0):</u>

Message signal (to be transmitted) 0 0 1 1 0 0

Encoded data (differential data)	0	1	1	1	0	1	
Transmitted signal phase:		180^0	0^0	0^0	0^0	180^0	0^0
Received signal phase:	180^0	0^0	0^0	0^0	180^0	0^0	
Encoded data (differential data)		0	1	1	1	0	
Message signal (Demodulation)			0	1	1	0	0

DPSK Demodulator:

DPSK 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 input 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.

DPSK Demodulator: This consists of 1 bit delay circuit, X-NOR Gate and a signal shaping circuit. Signal shaping circuit consists of 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 PSK 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.
6. Actual data signal : 10101101001010110100
7. Encoded data signal : 0110001101100111 0010
8. Now connect CH2 input of the CRO to the DPSK output and CH1 input to the encoded data. Observe the input and output waveforms and plot the same.
9. Compare the plotted waveforms with the given waveforms in fig: 1.3
10. Note: Observe and plot the waveforms after perfect triggering. Better to keep the encoded data more than 4 cycles for perfect triggering.

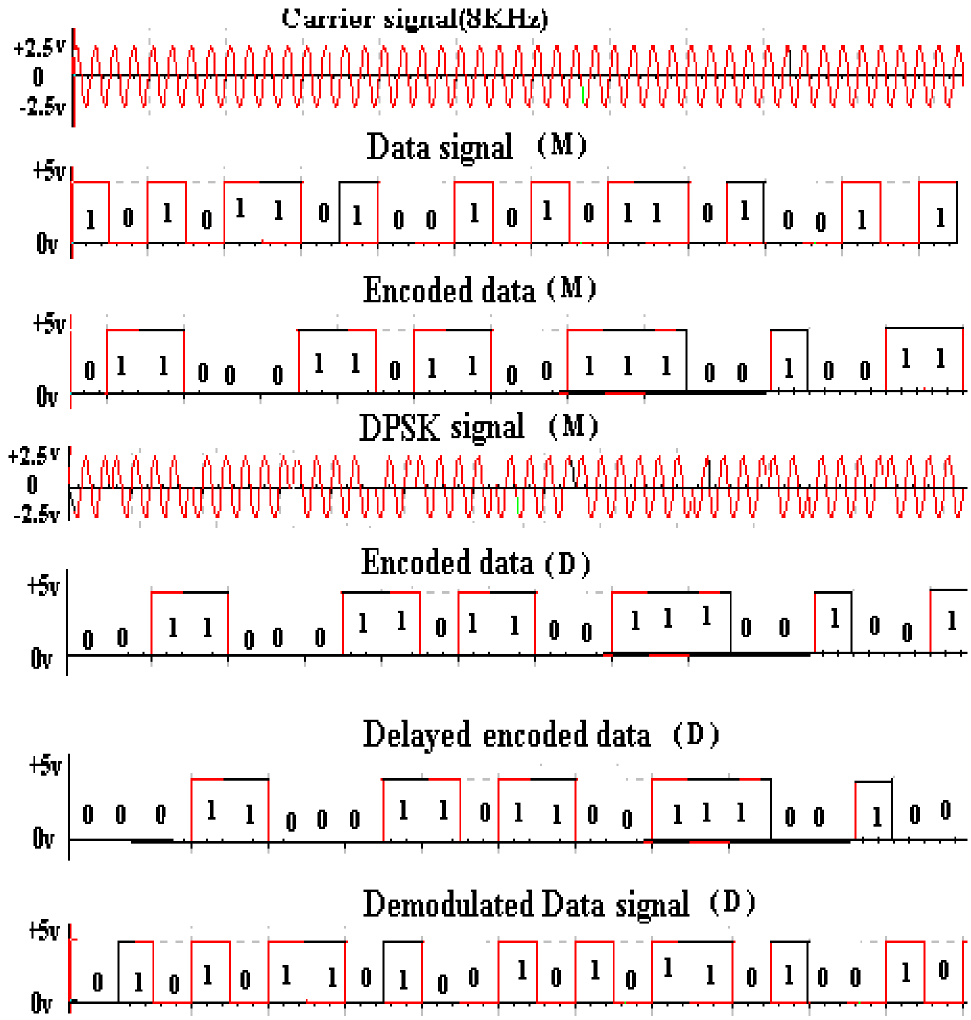
Demodulation:

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 bit delay circuit using coaxial cable.
3. Keep CRO in dual mode. Connect CH1 input to the encoded data (at modulator) and CH2 input to the encoded data (at demodulator).
4. 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.
5. Keep CRO in dual mode. Connect CH1 input to the data signal (at modulator) and CH2 input to the output of the demodulator.
6. 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.

7. Disconnect clock from transmitter and connect to local oscillator clock (i.e., clock 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 clock frequency by varying potentiometer.

EXPECTED WAVEFORMS

Fig 1:3 DPSK Wave forms



RESULT:

VIVA QUESTIONS

1. Define DPSK?
2. Mention the Advantages of DPSK?
3. Mention the Disadvantages of DPSK?
4. Draw the waveforms of DPSK?
5. Compare ASK, PSK, FSK& DPSK?
6. What are the Applications of DPSK?
7. What is the expression for DPSK Error?
8. Why do we need 1-Bit delay in DPSK Modulator & Demodulator?
9. How does DPSK differ from PSK?
10. Is the error rate of DPSK is greater than PSK?

13 (ii). QPSK Generation and Detection

AIM: To study modulation and demodulation of QPSK and sketch the relevant waveforms.

APPARATUS:
1. QPSK modulation and demodulation trainer.
2. CRO
3. Connecting probes and cords
4. Power supply.

PROCEDURE:
1. Connect and switch on the power supply.
2. QPSK is selected by default and LEDs of corresponding technique will glow.
3. Select the bit pattern using push button i.e. 8 bit or 16 bit or 32 bit or 64 bit. Observe bit pattern on TP-2.
4. Select data rate using push button i.e. 2 KHz or 4 KHz or 8 KHz 16 KHz.

Modulation:

5. Observe the input bit pattern at TP-2 by varying bit pattern using respective push button.
6. Observe the data rate at TP-1 by varying data rate using respective push button.
7. Observe the Two- bit encoding i.e. I-Channel (TP-3) and Q-Channel (TP-4).
8. Observe carrier signal i.e. cosine wave (TP-5) and sine wave (TP-6). Frequency of carrier signal will change with respect to data rate.
9. Observe I-Channel (TP-7) and Q-Channel (TP-8) modulated signal.
10. Observe QPSK modulated signal at TP-9.

Demodulation:

11. Apply the QPSK modulated output to the demodulator input.
12. Observe the multiplied signal of QPSK and carrier signal, cosine at TP-12 and also observe the multiplied signal of QPSK and carrier signal, sine at TP-13.
13. Observe the integrated output at I-channel (TP-14) and Q-channel (TP-15).
14. Observe the comparator output at I-channel (TP-16) and Q-channel (TP-17) i.e. same as at input with delay.
15. Observe the QPSK demodulated output at TP-18.

BLOCK DIAGRAM:

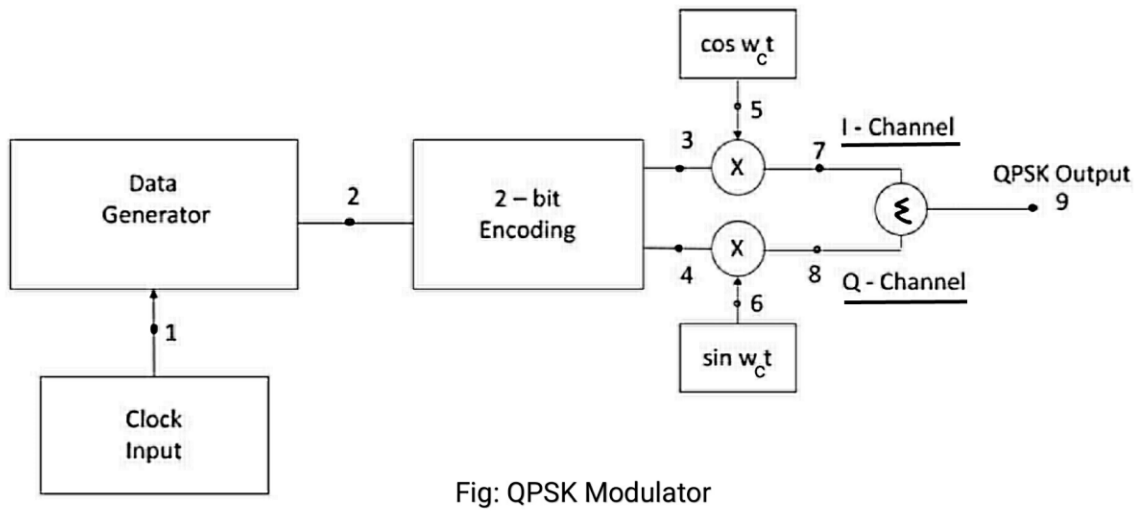


Fig: QPSK Modulator

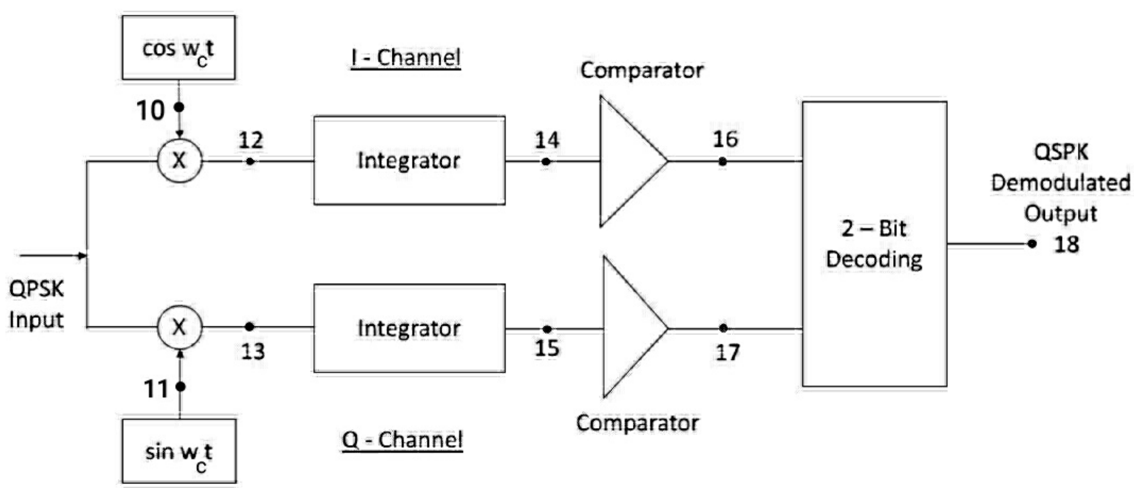
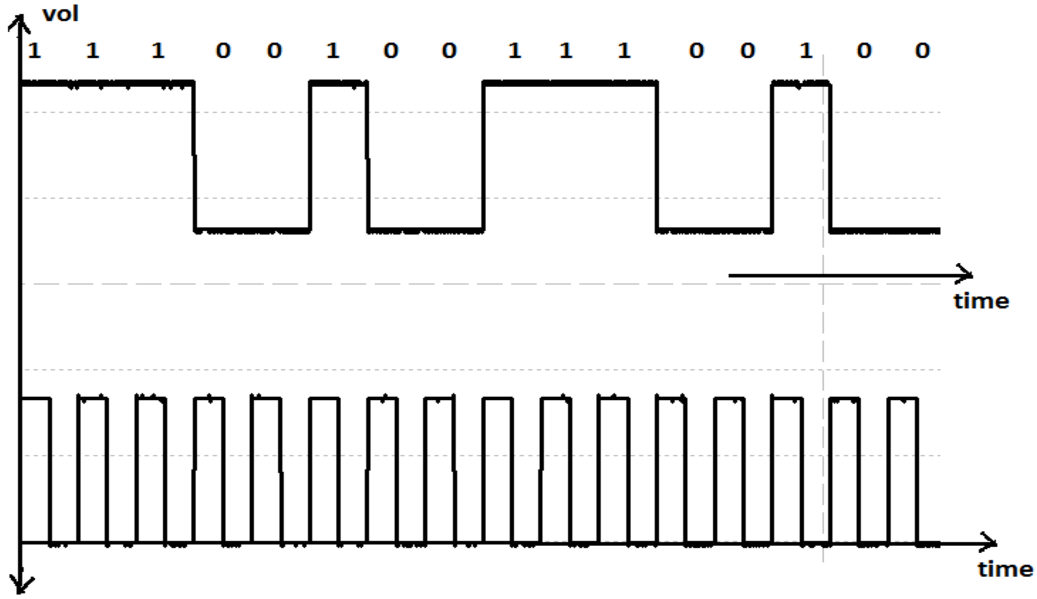


Fig: QPSK Demodulator

EXPECTED WAVEFORMS:

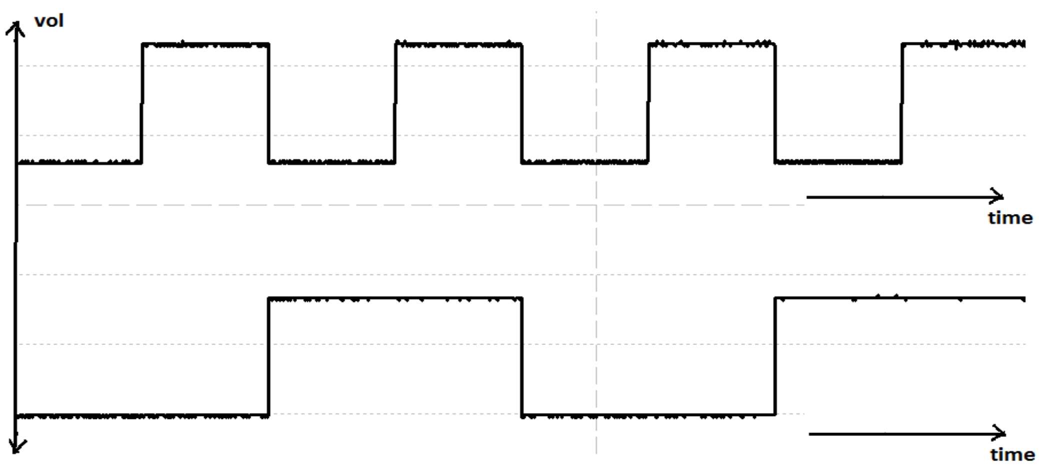
Data input

Clock input



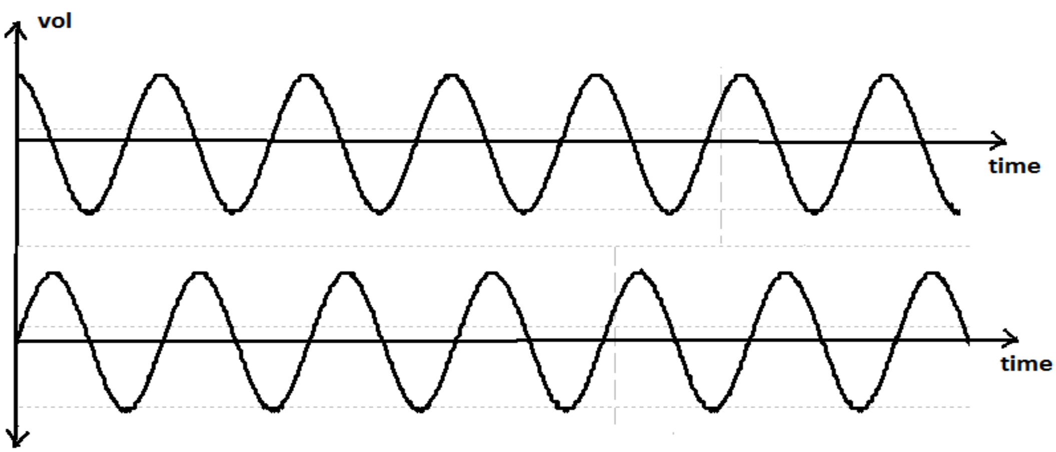
Odd bit stream (I-Ch. i/p)

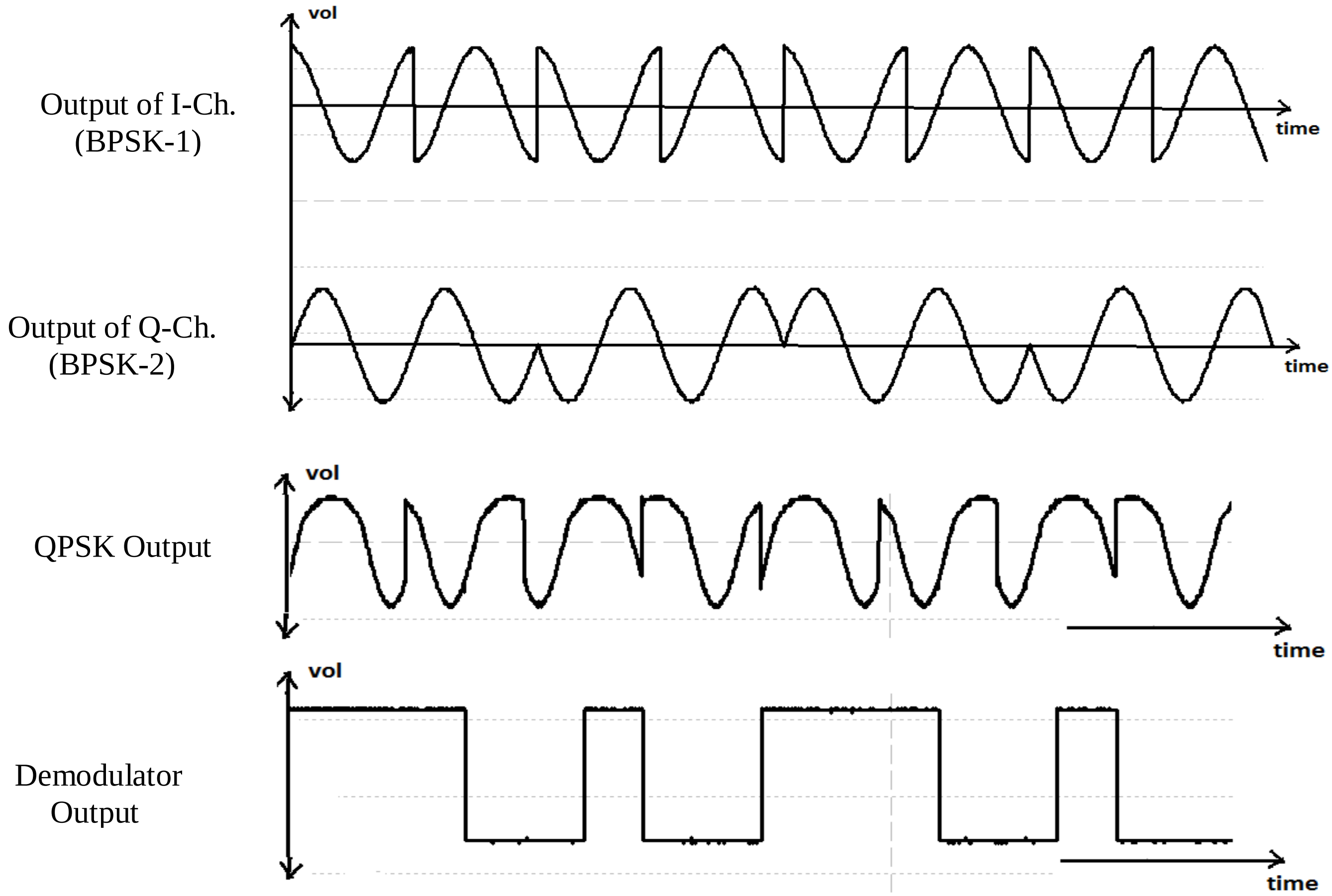
Even bit stream (Q-Ch. i/p)



Carrier I/P to I-Ch. (Cos $\omega_c t$)

Carrier I/P to Q-Ch. (Sin $\omega_c t$)





RESULT: QPSK modulation and demodulation is verified

14. TIME DIVISION MULTIPLEXER AND DE-MULTIPLEXER

AIM: To study time division multiplexing and de-multiplexing.

APPARATUS:

1. Time division multiplexer and de-multiplexer trainer kits.
2. Coaxial cable.
3. Patch cords.

PROCEDURE:

MULTIPLEXER:

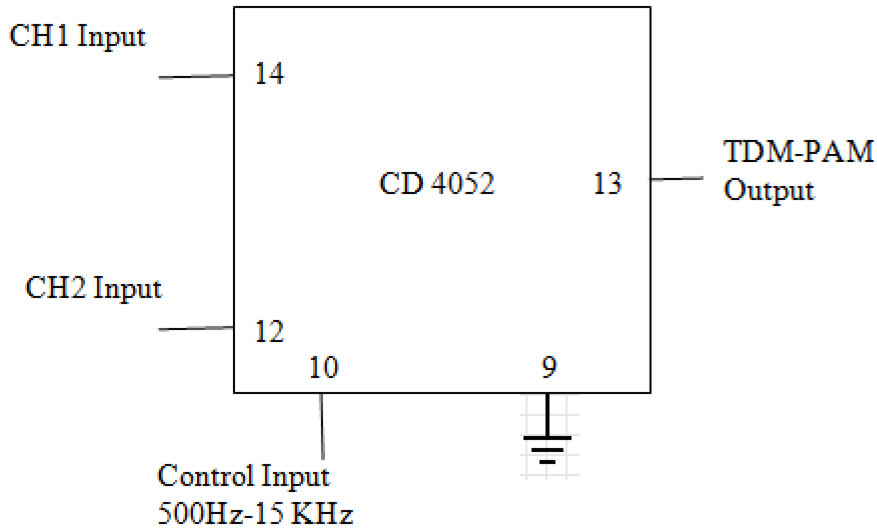
1. Observe the AF generator-1 output and note down the amplifier and frequency.
2. Observe the AF generator-2 output and note down the amplitude and frequency.
3. Connect the AF generator and 2 outputs to CH1 and CH2 of TDM multiplexer.
4. Observe and connect the clock generator output to the control input of the TDM multiplexer (it acts like selection line for MUX).
5. Observe the TDM output in storage oscilloscope.

DEMULTIPLEXER:

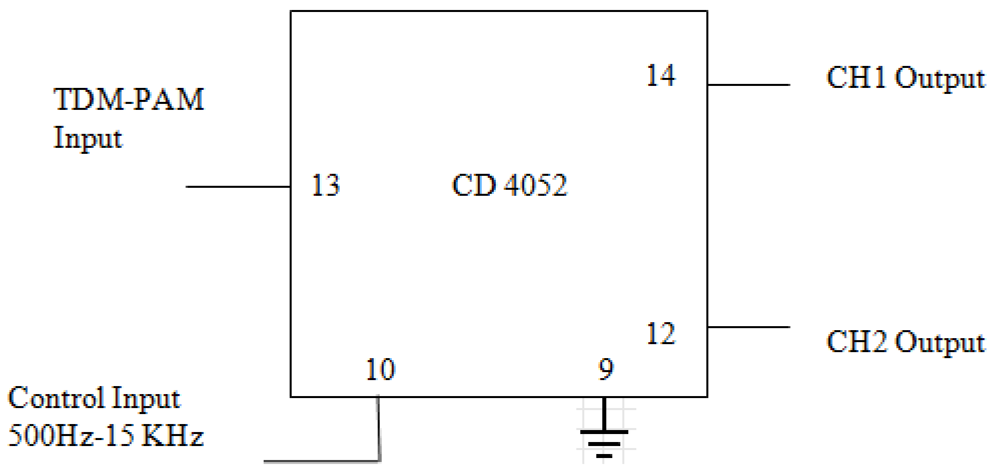
6. Using coaxial cable connect the TDM de-multiplexer.
7. Connect the clock generator output in de-multiplexer trainer to the control input of the TDM de-multiplexer.
8. Observe the de-multiplexed signals at CH1 and CH2.
9. Connected the CH1 and CH2 outputs to low pass filter and amplifier and note down the outputs.

CIRCUIT DIAGRAM:

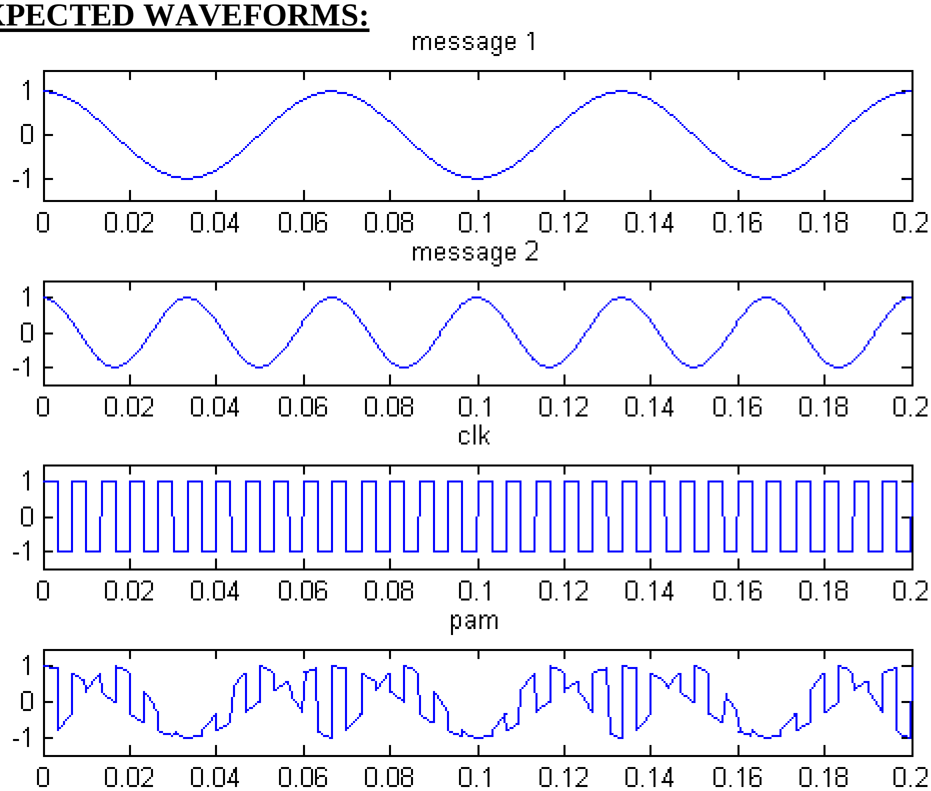
MULTIPLEXER:



DEMULTIPLEXER:



EXPECTED WAVEFORMS:



RESULT:

VIVA QUESTIONS

1. What is meant by multiplexing technique and what are the different types of Multiplexers?
2. Briefly explain about TDM&FDM?
3. What is the transmission band width of a PAM/TDM signal?
4. Define crosstalk effect in PAM/TDM system?
5. What are the advantages of TDM system?
6. What are major differences between TDM&FDM?
7. Give the value of Ts in TDM system?
8. What are the applications of TDM system and give some example?
9. What is meant by signal overlapping?
10. Which type of modulation technique will be used in TDM?