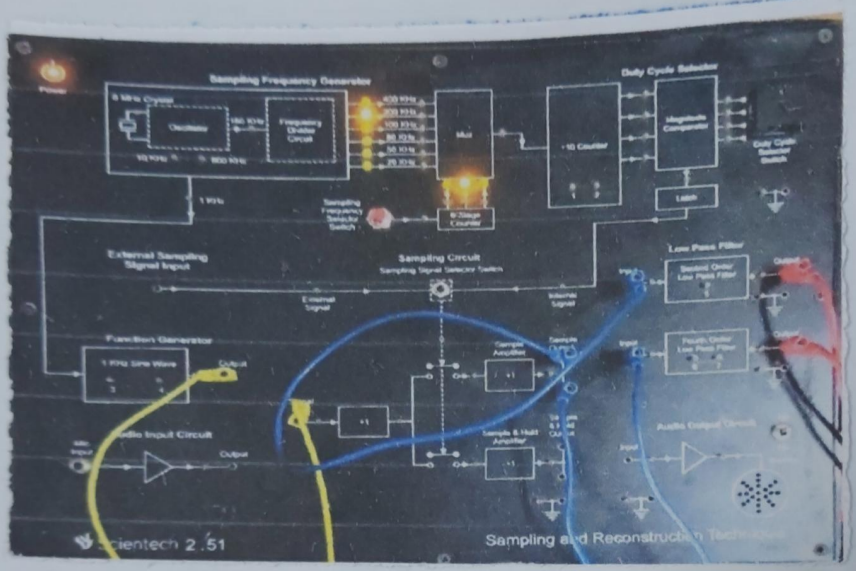
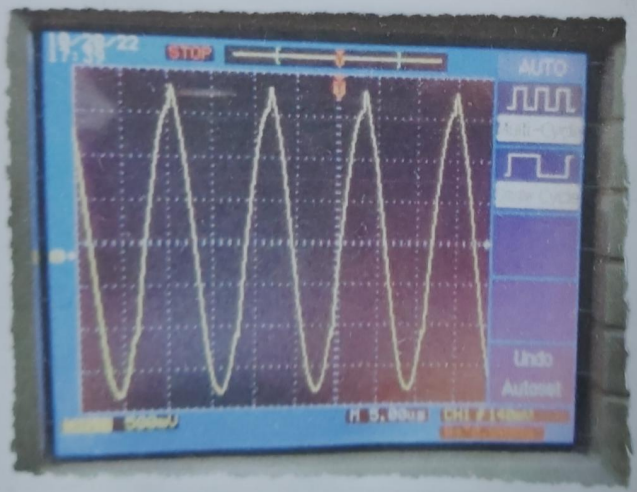


Signal sampling and Reconstruction Trainer



Modulating Signal (Analog)

EXPERIMENT-1

Aim:

- Study of signal sampling & reconstruction techniques.
- Study the effect of sample/ sample & hold o/p on reconstructed form.
- Comparison of freq. of 2nd order & 3rd order LPF.

Equipment Required:

- R101 w/ power supply cord.
- CRO w/ connecting probe
- Connecting cords

Theory:

The signals we use in the real world, such as voice are called analog signals. To process these signals for digital communication, we need to convert these to 'digital form'. While an analog signal is cont. in both time and amplitude, digital signal is discrete. To convert cont. signals to discrete, a process is used called sampling. The value of signal is measured at certain int. in time. Each measurement is refered to as sample.

Principle of sampling:

Let $x(t)$ be a cont. fn of time. We can represent it as a discrete time signal by using values of $x(t)$ at intervals of nT_s to form $x(nT_s)$.

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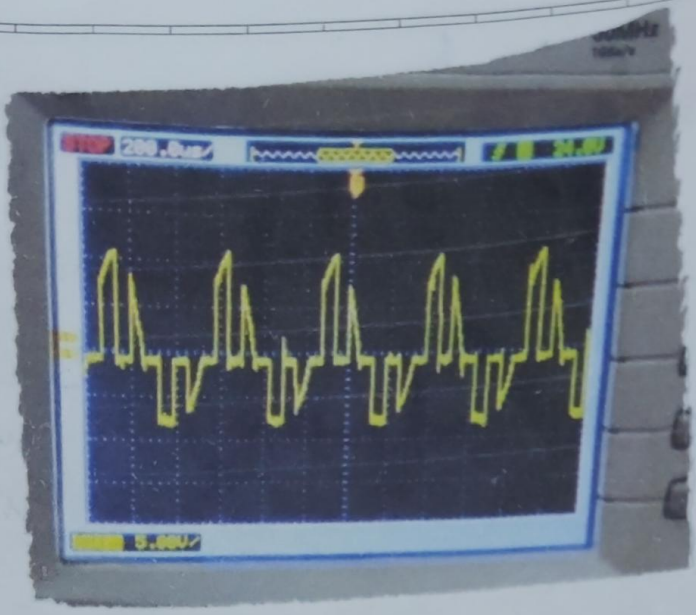
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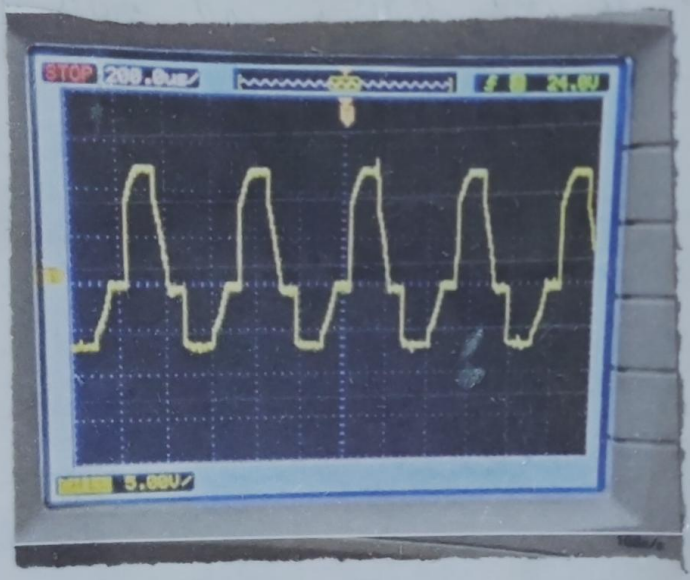
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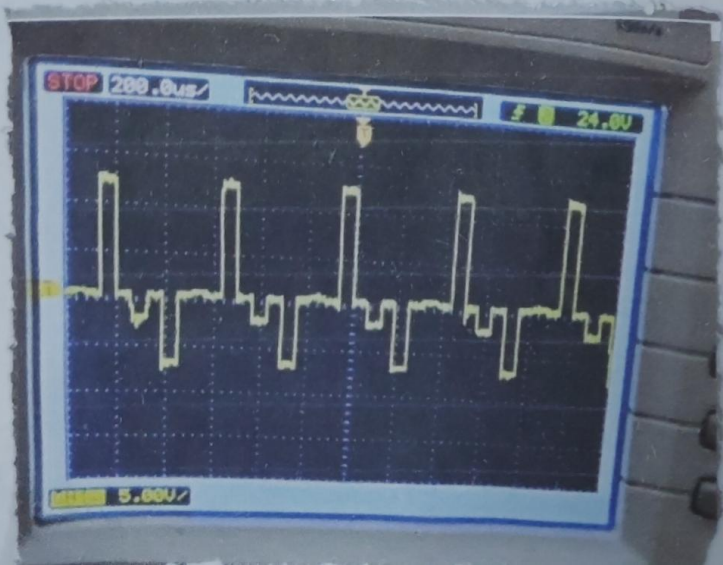
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5.00V

Sampling Theorem:-
Sampling theorem essentially says that a signal needs to be sampled at atleast 2x the max. fr. of the signal for it to be reconstructed back into a cont. time signal w/o any loss of information.

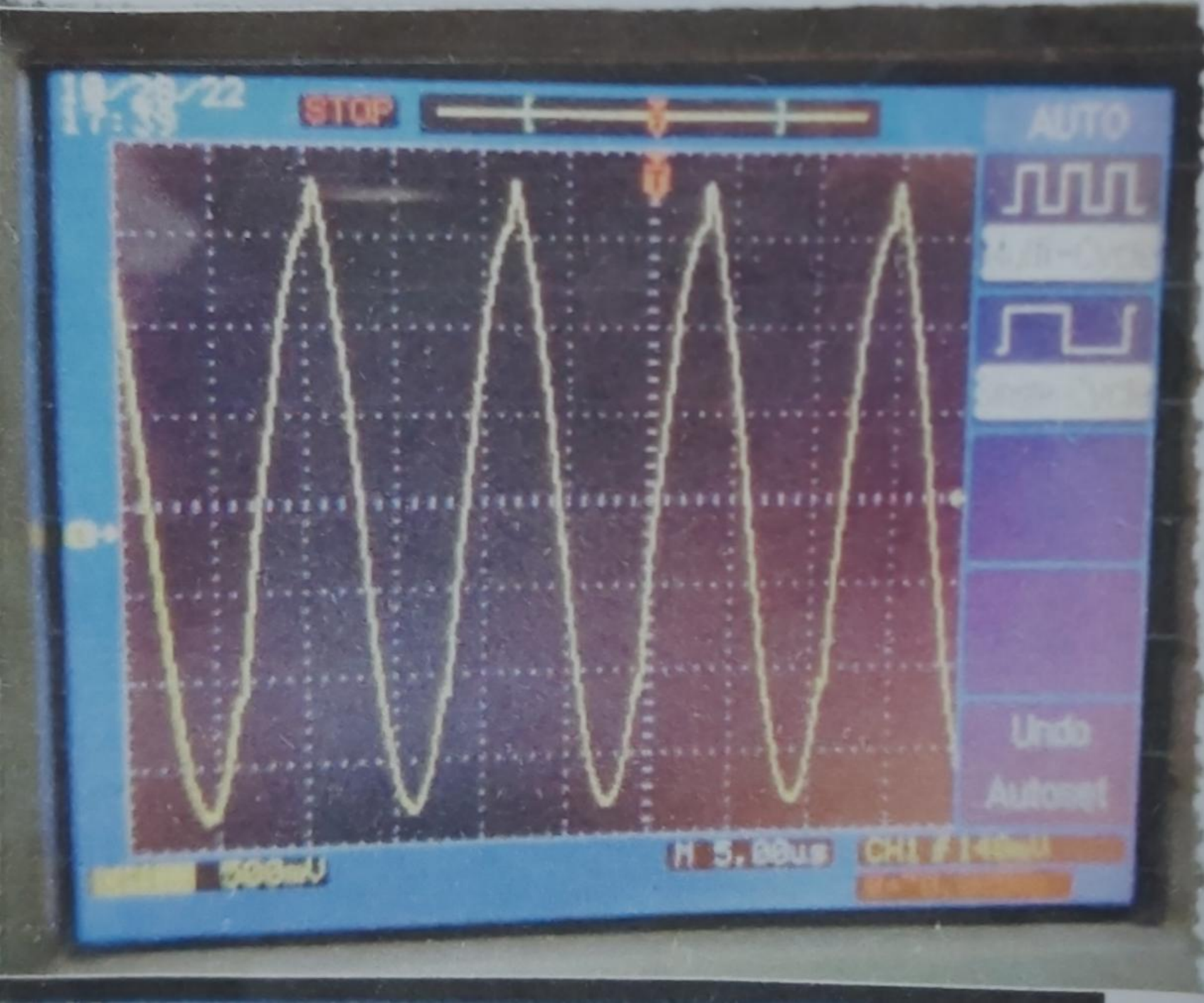
$$f_s \geq 2f_{max}$$

i.e. $f_s = 2f_m$ is also known as Nyquist Rate.
→ The signal should also be band limited.

PROCEDURE:-
1. Setup for sampling & reconstruction of signal:
→ Initially setup the trainer kit & connect the power cord.
→ Connect KHz sine wave to signal i/p.
→ Switch on trainer's power supply & oscilloscope.
→ Connect BNC connector to CRO & to the trainer's o/p.
→ Select 320KHz sampling rate.
→ Connect the sample o/p to i/p of 4th order LPF & observe reconstructed o/p with help of oscilloscope.
→ By successive presses of sampling fr. selector switch, change sampling fr. to 2, 4, 8, 16 KHz and back to 32KHz.
→ We have used sampling fr. > than twice the max. fr. of o/p.

Conclusion:-
As sampling frequencies increases, the o/p sampled wave has more no. of samples.

Teacher's Signature :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2. Setup for sample & hold o/p & reconstructed signal o/p.
→ Repeat the first 5 steps of procedure 1.
→ Connect sample & hold o/p of 4th order low pass filter. Select the cycle selector switch to position 5.
→ Observe the waveform of sample & hold o/p on oscilloscope & vary the frequency.
→ Vary the position of duty cycle selector switch from 0 to 9.

Conclusion
For transmitting the signal, if a sample & hold amp is used just before the transmission channel, the signal will suffer less from distortion as compared to using only sampler amplifier.

3. Comparison of o/p from 2nd and 4th order LPF.
→ Repeat the first five steps of procedure 1.
→ Connect sample o/p to i/p of 2nd & 4th order LPFs respectively. Observe the o/p of 2 filters on oscilloscope.

Conclusion:
As the order of LPF is increased, recovered signal will be reconstructed more like the transmitted signal.

VIVA questions :-

Q) What do you mean by sampling?
→ To convert cont. time signal to discrete time signal, instantaneous values of cont. time signal are measured which is aka. sampling.

Teacher's Signature : .....

Q) What is sampling theorem?

→ Sampling theorem says that a signal can be exactly reproduced if it is sampled at a frequency greater than 2x the max. frequency component of the signal.

$$f_s \geq 2f_{max}$$

Q) What is nyquist frequency?

→ When $f_s = 2f_m$, it is known as nyquist sampling rate. A frequency half of that i.e. $f_s = F_{max}$ is called nyquist frequency.

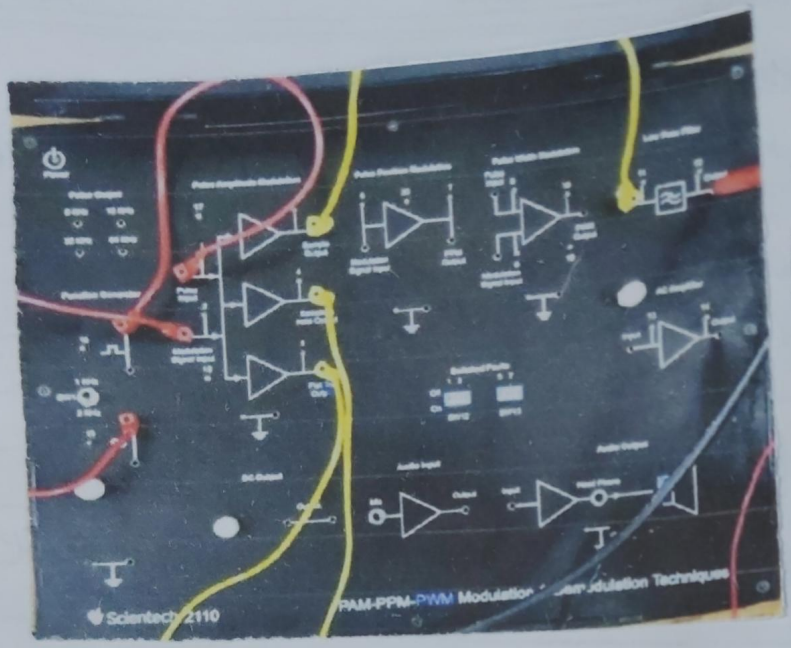
Q) List diff. types of sampling techniques.

→ ① Ideal / Instantaneous / Impulse sampling
② Natural sampling
③ Flat top sampling.

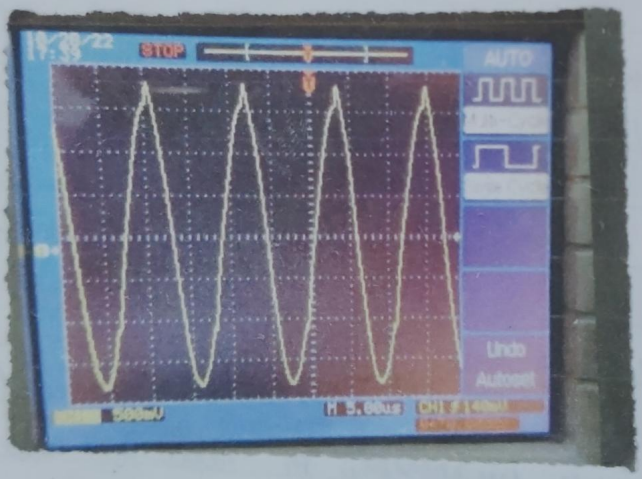
Q) What is under sampling?

→ When sampling rate is lower than nyquist rate ($f_s < 2f_m$), it becomes impossible to rebuild the original signal from sampled signal, acc. to sampling theorem.

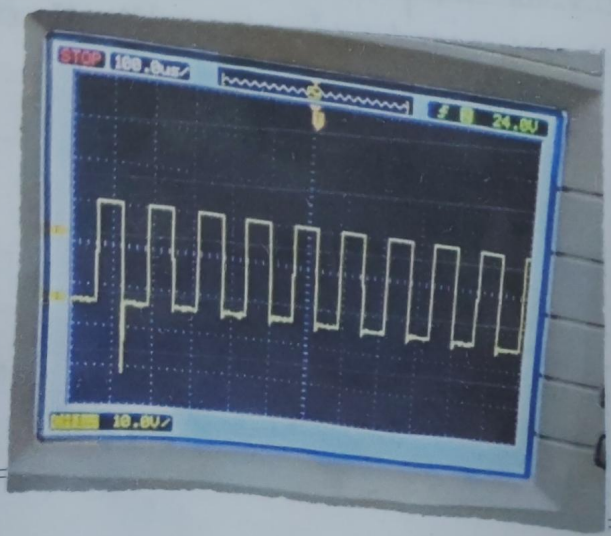
Teacher's Signature :



PAM circuit



Modulating signal
(Analog)



Carrier signal
(Pulse)

Experiment - 2

AIM:

1. Study of PAM using sampling
2. Study of PAM using sample & hold o/p
3. Study of pulse amplitude modulation & demodulation w/ sample, sample and hold & flat top

Equipment required:

with power supply cord.
CRO with connecting probe
connecting wires.

Theory:

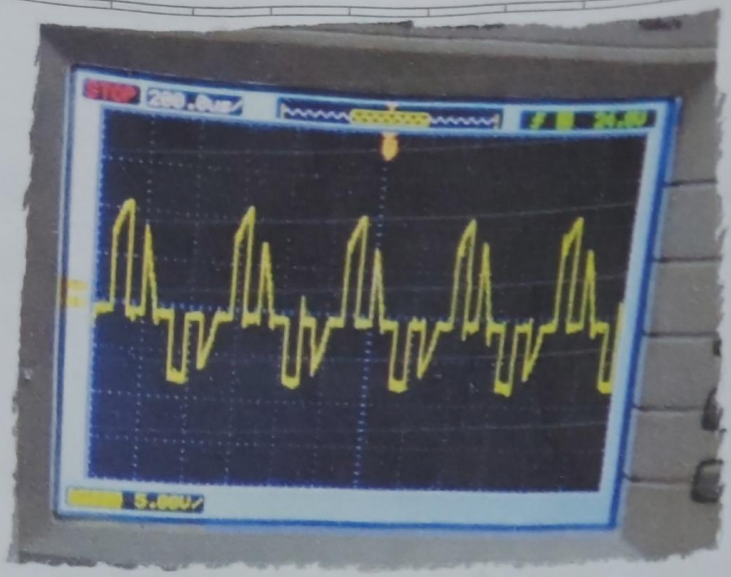
INTRO. TO PULSE MODULATION:

It is a system in which cont. time signals are sampled at regular intervals. Information regarding the signal is transmitted at only the sample times, together w/ any synchronizing pulses that may be required. At the receiver's end the signal may be reconstructed using info regarding the samples.

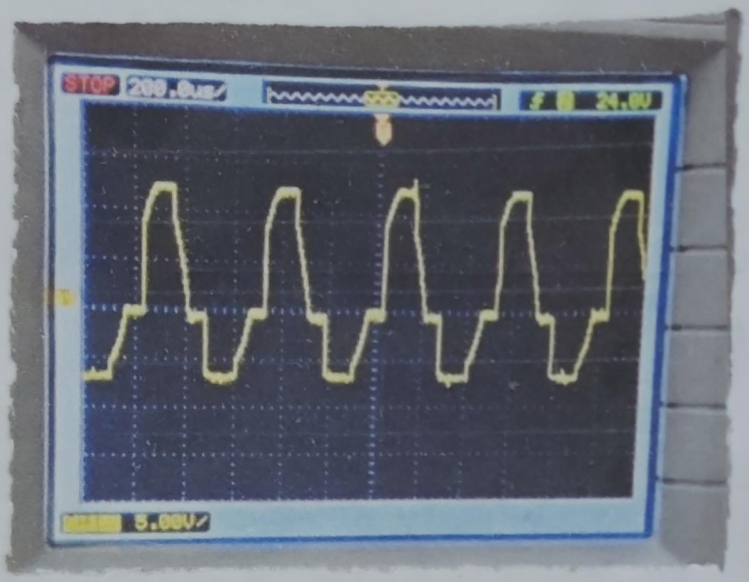
Pulse amplitude modulation (PAM):

This is the simplest form of pulse modulation. Signal is sampled at regular intervals and each sample is made proportional to amp. of signal at interval of sampling.

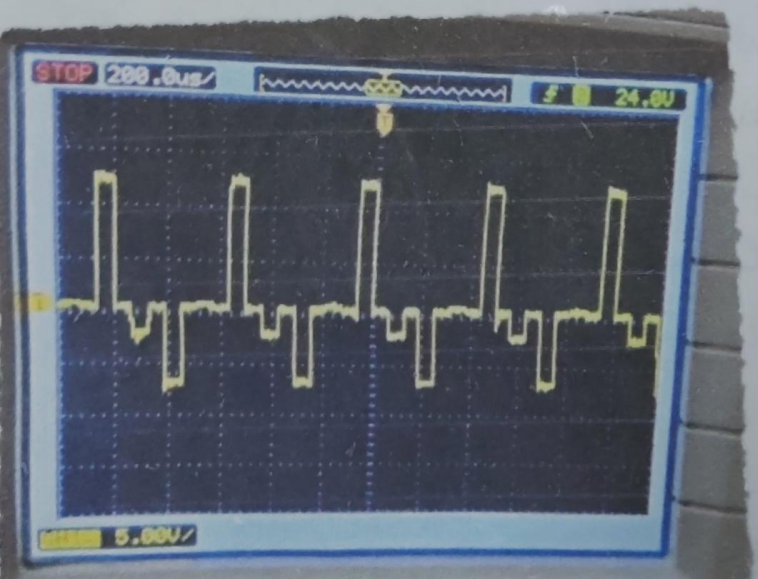
Teacher's Signature : .....



Sampled output



Sample and Hold output



Flat Top Output

It is easy to generate - one the signal to be converted to PAM is fed to one i/p of an AND gate of generator. Pulse at sampling freqency are applied to other ip of AND gate to open it during wanted time intervals.
The o/p of gate then consists of pulse at sampling rate, equal in amplitude to signal voltage at each interval.

Procedure:
A. Study of PAM using sample & hold sampling.
- connect the ckt as described.
a) o/p of sine wave to modulation signal in PAM block.
b) 1KHz pulse o/p to pulse IN of PAM block
c) keep the fr. selector switch in 1KHz position
- switch on the power supply
- Monitor the o/p of sample & hold current at TP4.
- Vary the amp. of i/p sine wave at its freq. by freq. selector switch.
- Vary the i/p pulse fr.
- switch 'on' fault no. 1,2,3 one by one & observe their effect on PAM.
- switch 'off' the power supply.

B. Study of PAM using natural & flat top sampling.
- Follow step 1-2 as above.
- Monitor o/p of TP3 & TP5 and observe diff b/w the 2 outputs.
- Try varying the amp. & fr. of sine wave & observe the change
- Also trying changing the fr. of pulse

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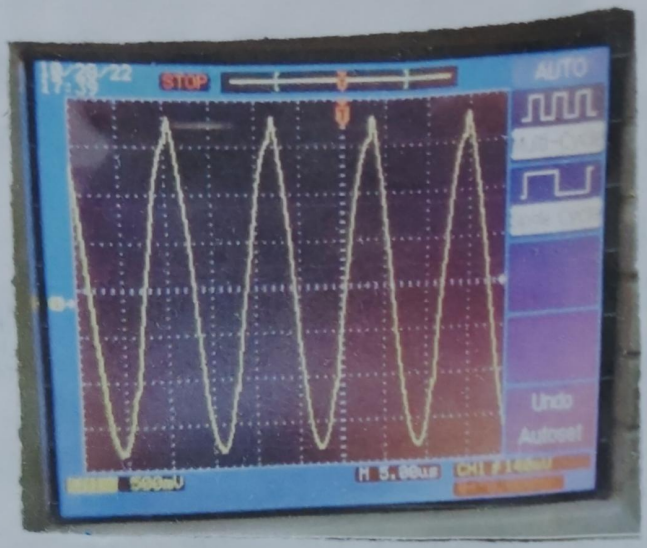


PAM demodulating output

- Switch 'on' fault no. 1, 2, 3, 4 and observe change on PAM o/p
- Switch 'off' the power supply.

C. Study of PAM & demodulation w/ sample & hold and flat top.

- Follow step one of procedure A.
- Connect the sample o/p LPF. i/p.
- O/p of LPF to o/p of AC amp. Keep the gain pot in AC amp. back in max. position.
- Follow the steps of study of PAM using sample & holding.
- Monitor the o/p of AC amp. It should be a pure sine wave similar to i/p.
- Try varying the i/p amplitude, the amp. of o/p will vary.
- Switch 'off' the power supply.

Conclusion
Study of PAM is completed

VIVA - QUESTIONS

Q) What is Pulse amplitude modulation?
→ It is a form of signal modulation where the message is encoded in the amp. of a series of signal pulses.

Q) What is a pulse signal?
→ In signal processing, the term pulse has the following meanings:- a rapid, transient change in amplitude of a signal from a

Teacher's Signature : .....

baseline value to a higher or lower value, followed by a rapid return to baseline value.

Q) What is sample and hold circuit?
→ It is an analog device that samples the voltage of a cont. time varying analog signal and holds its value of a constant level for a specified period of time.

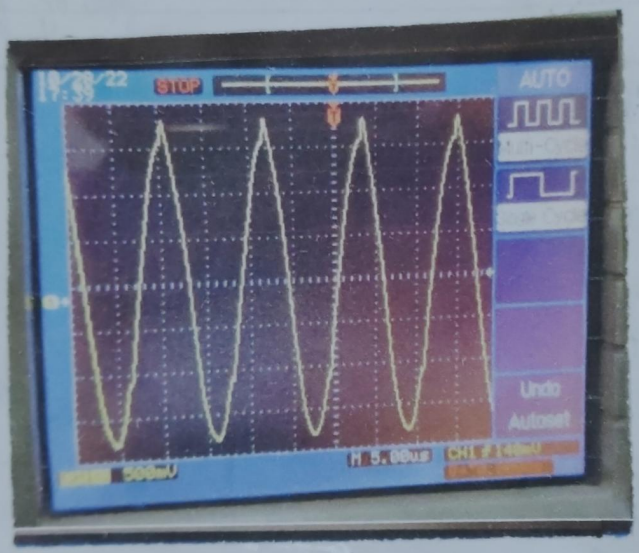
Q) What are the 2 types of PAM based on type of pulse?
→ ① Single polarity PAM → only +ve pulses
② Double polarity PAM → +ve + -ve pulses.

Q) Disadvantages of PAM?
→ Power consumption can be high
→ High bandwidth required
→ Produces additional noise that can cause disruptions.

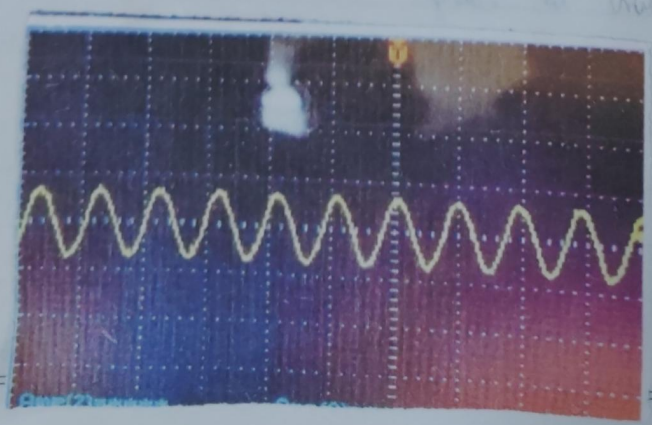
Q) Advantages of PAM?
→ Generation and detection is easy.
→ Transmission and Receiver circuitry are easy to construct.
→ Generation & detection is easy
→ This is the base for all digital modulation techniques.

Teacher's Signature :

DSB-AM Transmitter



Modulating Signal (Analog)



carrier signal

Experiment -3

Aim: 1. Double sideband AM generation.
2. To calculate modulation index of a DSB wave by trapezoidal method.
3. Double sideband AM reception.

Equipment Required:
1. DSB/SSB AM Transmitter & Receiver kits
2. CRO with connection probe
3. Connecting cords.

Theory

Amplitude Modulation:

It is the type of modulation technique in which amp. of high fr. carrier wave is varied in accordance w/ inst. amp. of modulating signal. As the info. signal increases in amp, the carrier wave is made to incr. in amp. & vice versa when info signal decreases, the carrier amplitude decreases.

Depth of modulation:

The ext by which the amp. of the carrier wave incr. or decr. on the amp. of the message signal is called depth of modulation. It can be denoted as a fraction or a percentage.

$$\% \text{ modulation} = \frac{V_{MAX} - V_{MIN}}{V_{MAX} + V_{MIN}} \times 100$$

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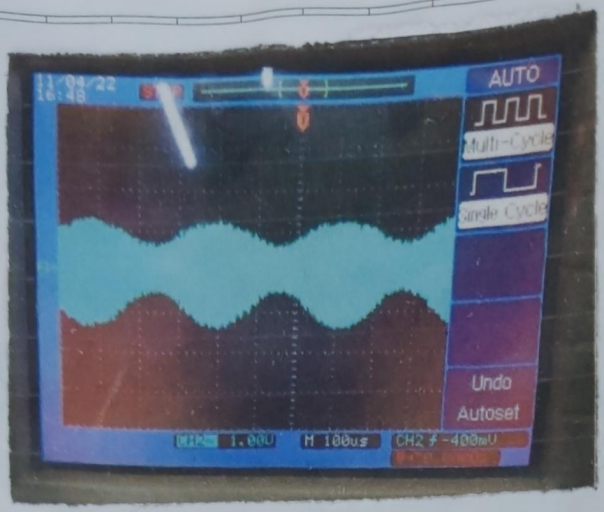
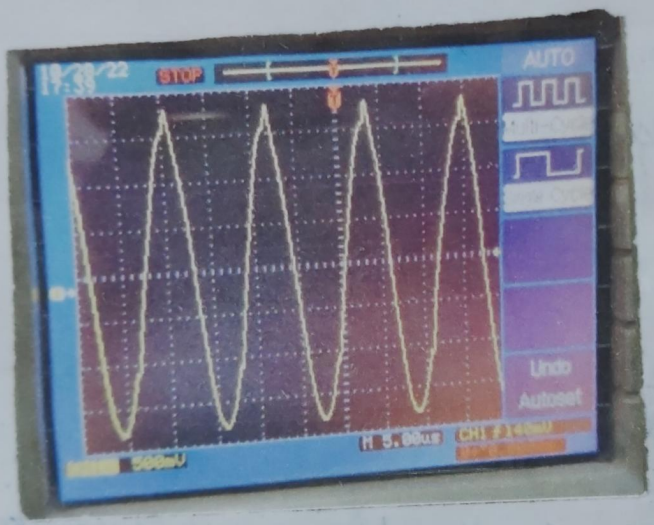
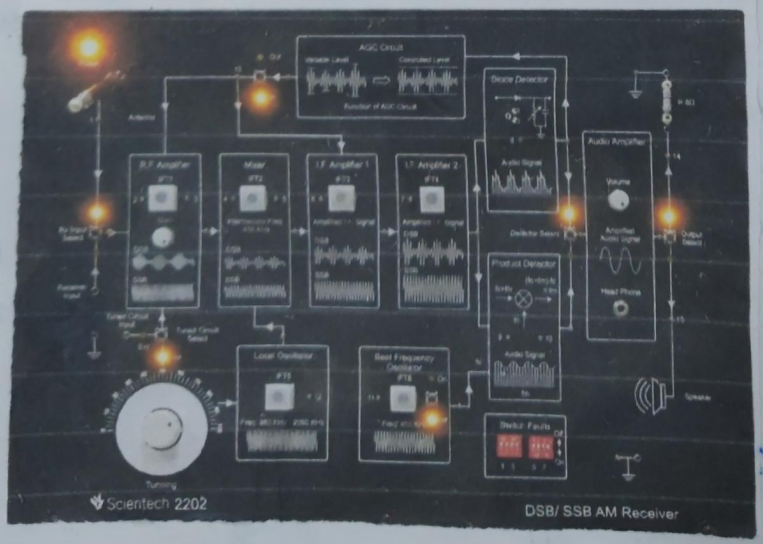


Amplitude Modulation output



Demodulation output



DSB-AM Receiver

Frequency spectrum of AM signal:-
These are the 2 components:-

1. USB (Upper side band): Band of frequencis ranging from carrier frequency to carrier freq. plus message fr. (fc + fm).
2. LSB (Lower side band): (fc - fm)

Procedure:

A. Setup for DSB-AM generation:

- Ensure that audio i/p select switch should be in INT position, mode switch in DSB position, and speaker switch in off position.
- Turn on power to the band ST2201 board.
- Turn the audio oscillator block's amplitude pot to its full clockwise (max) position & examine block's o/p (TP4) on a CRO.
- Turn the balance pot, in the balance modulator's band pass filter to its max position. It is the block that we will use to perform DSB-AM.
- Monitor the 2 i/ps to the balanced modulator & BPF ckt, at where TP1 is audio signal and TP2 is carrier signal.
- Next, examine the o/p of the balanced modulator & BPF at TP3.
- ~~Setup for color~~

B. Setup for calculation of modulation index using trapezoidal method (practical).

- Now apply the modulated waveform to the Y i/p of the CRO & modulating signal to X-input.

Teacher's Signature :

- Press the XY switch, you will observe the waveform similar to trapezoidal pattern.

C. Setup for DSB-AM reception.

- Ensure that DSB-AM is performed and all its conditions satisfy.
- Speaker switch on 'on' position, on board antenna in vertical position and fully extended off ST2201 board.
- Ensure that in ST2102 board, Rx o/p select switch at ANT posn, RF amp's tuned ckt select switch in INT position., RF amp gain in max position, AGC switch in ANT posn, selection switch on diode position, speaker switch in 'ON' position, beat fr. oscillator in off position, on board antenna is fully extended in vertical posn.
- Turn on power to the module.
- Front end of ST2202 antenna receives in the RF amp stage. There is a wide-bandwidth tuned amp stage, once it has been turned into wanted station, the RF amp having light selectivity, will not amplify, but also those fr. that are also close to wanted fr.
- The next stage of the receiver is the mixer stage, which mixes the RF amplifier o/p with the o/p of a local oscillator.
- The operation of the mixer stage is to basically shift the wanted signal down to IF fr., irrespective of the position of the tuning dial.
- Since the mixer band filter is not highly selective, it will not completely remove the local oscillator and sum fr. components from the mixer o/p.

Teacher's Signature : .....

- Tune in to a strong broadcast signal station again & note that the monitored signal show little, if any sign of modulation.
- Examine the o/p of IF amplifier 2 with a.c. coupled oscilloscope channel.
- Extract the audio info. from the amp. variation of the signal at the o/p of the IF amp 2.

Conclusion:

DSB AM generation and reception have been performed with calculation of m.I. using trapezoidal pattern.

VIVA QUESTIONS:

Q) What is amp. modulation?
→ Modulation technique in which amp. of higher fr. carrier wave is varied according to amp of message signal.

Q) What is modulation index?
→ Measure of depth of modulation and varies by 0 & 1.

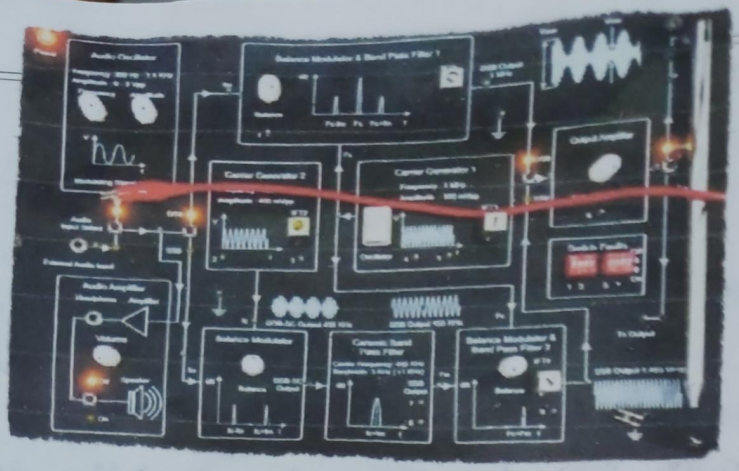
Q) What is the range of commercial AM broadcast bands?
→ Low frequency (Longwave): (45 - 283.5 KHz, Medium frequency: 525 - 1606.5 KHz (Medium Wave / AM Radio)
High frequency: Multiple (Shortwave)

Q) What kind of modulation is used in picture signals in TV broadcasting?
→ VSB (Vestigial Sideband)

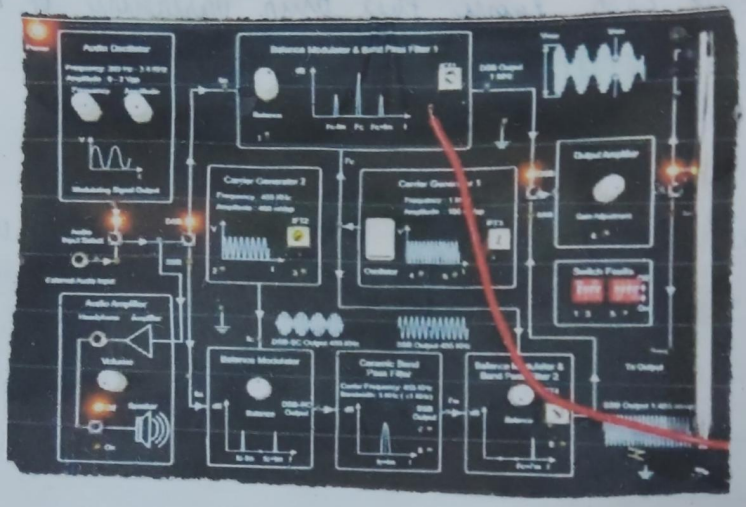
Q) What is another name of AM?
→ Double side band full carrier.

Teacher's Signature : .....

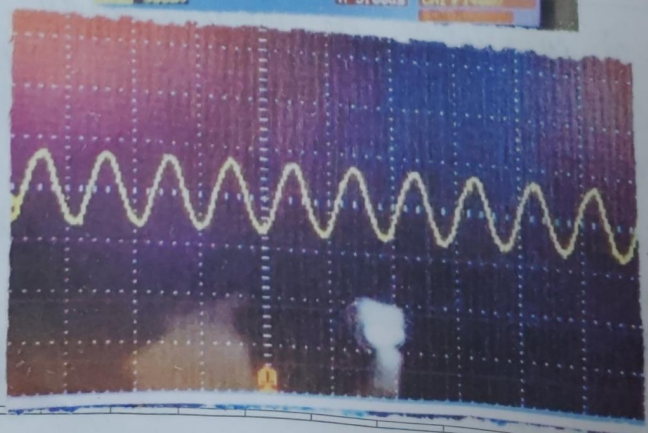
DSB-SC
Transmitter



DSB-SC
Receiver



Modulating signal
(sine)



Carrier signal
(High freq. sine)

EXPERIMENT-6

Aim:
1. Double side band- supressed carrier AM generation.
2. DSB-SC reception.

Equipment Reqd:
1. ST2201 & ST2202 w/ power supply cords
2. CRO w/ connecting probe.
3. connecting cords

Theory:

→ DSB-SC is transmission in which fr. produced by AM are symmetrically spaced above and below the carrier fr. and carrier level is reduced to the lowest practical level, ideally being completely suppressed.

→ DSB-SC is basically amp. modulation wave w/o the carrier, therefore reducing power, giving it a 100% efficiency compared to normal DSB- full carrier which has 33.33% efficiency. Since we basically remove the carrier band, which consumes 2/3 rd of the power, we are able to achieve 100% efficiency.

→ DSB-SC is generated by a mixer. This consists of msg signal ⊗ carrier signal.

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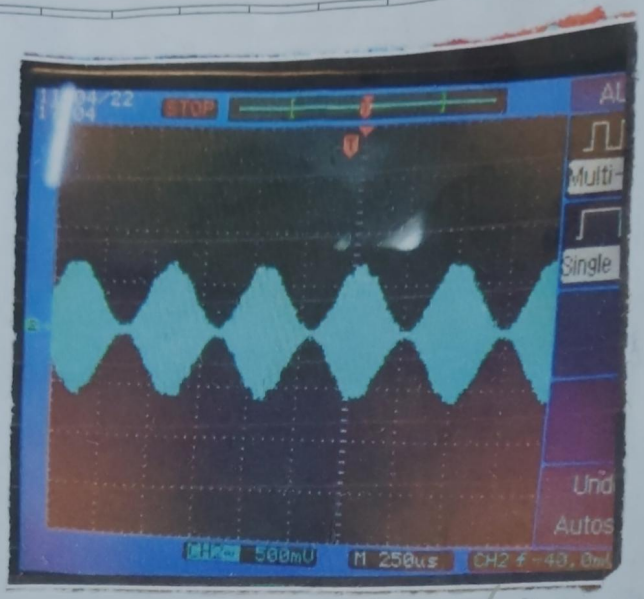
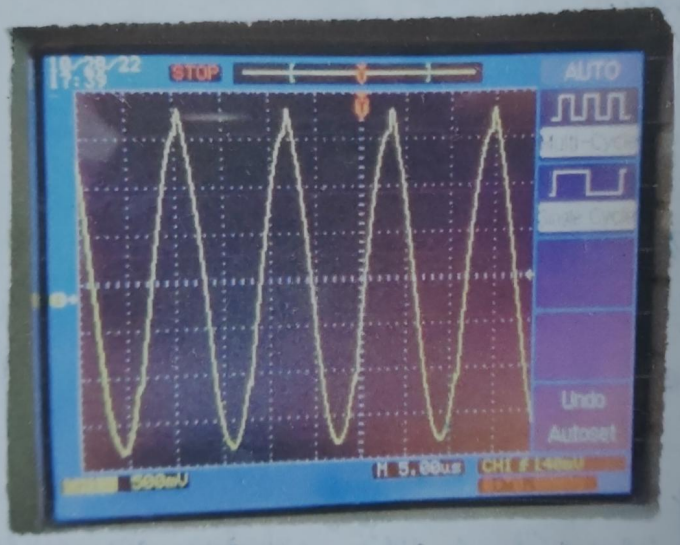


Modulation output



Demodulation

Demodulation output

Procedure:

A- Setup for DSB-SC AM generation.

- Ensure that all regd. connections exist on board.
- Turn on power to the ST2201 board.
- Turn the audio oscillator block's amplitude pot to max position, & examine the blocks o/p on CRO.
- Turn on the balanced pot, in the balanced modulator & band pass filter ckt 1 block, to its max position. It is this block that we will use to perform DSB-SC AM.
- Monitor, in turn, the 2 i/p to the balanced modulator & BPF ckt 1 block, at TP1 and TP9.
- Now vary the amp. and fr. of the audio-fr. frequency, by adjusting the amp. oscillator block.
- Change the amp and fr. of the modulating audio signal and note the effect on DSBSC waveform.
- Examine the o/p from TP13, together w/ audio modulating signal (at TP1) Note the DSBSC waveform appears, amplified slightly at TP13.

B- Setup for DSB AM reception.

- Position the ST2201 & ST2202 modules.
- Ensure the revised conditions exist on both boards.
- Turn on power to the module.
- 1st stage of ST2202 AM receiver is RF amp stage. This is a wide-band width tuned amp. stage, which is tuned into wanted station by means of the tuning dial.
- The next stage of the reciever is mixer stage which mixes RF

Teacher's Signature : .....

amp's o/p w/ o/p of local oscillator.

- The operation of mixer stage is basically to shift the wanted signal down to IF freq. irrespective of the position of tuning dial.
- Note that, since the mixer's band pass is not highly selective, it will not completely remove the oscillator's sum fr. components from the mixer's o/p.
- Tune in to a strong broadcasting station again and note that the monitored signal shows little, if any, sign of modulation.
- Examine the o/p of IF amp. w/ an a.c.-coupled oscilloscope channel, noting that the amp. of the signal has been further amplified by this 2nd IF amplifier stage.
- The next step is to extract this audio info. from the amp. variation of the signal at the o/p of IF amplifier 2.

Result:

DSB-SC AM is successfully generated & receipted.

VIVA-QUESTIONS

Q) Define DSBSC

→ After modulation, the process of transmitting either the LSB or USB alone suppressing the carrier is DSB-SC modulation.

Q) What are the disadv of DSB-FC?

→ Power wastage takes place in DSB-FC.

→ DSB-FC is BW inefficient.

Teacher's Signature :

Q) Define coherent detection.

During demodulation, carrier is exactly coherent or in sync w/ freq and phase of original carrier wave which was used in DSB-SC. This is known as coherent or synchronized detection.

Q) What is the BW of DSBSC wave?

⇒ BW = $f_{max} - f_{min}$

= $(f_c + f_m) - (f_c - f_m)$

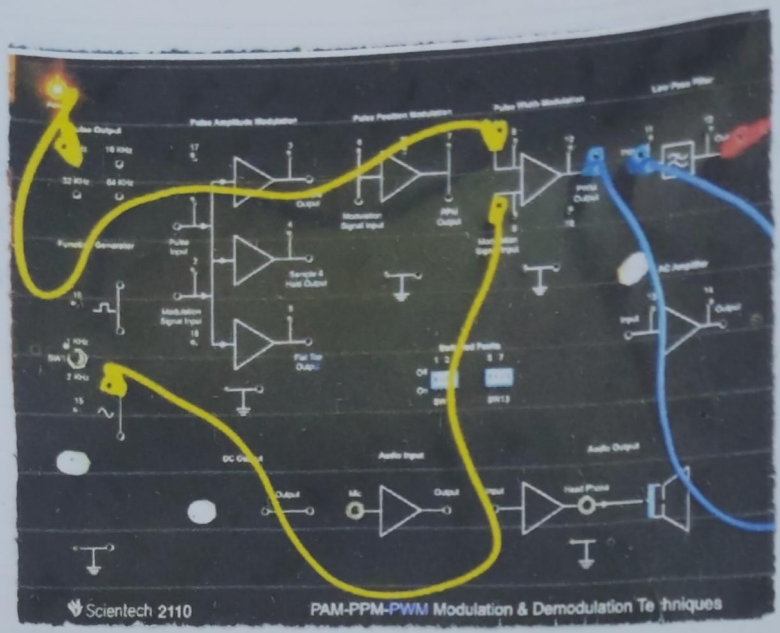
BW = $2f_m$

Q) What are the 2 ways of generating a DSB-SC signal?

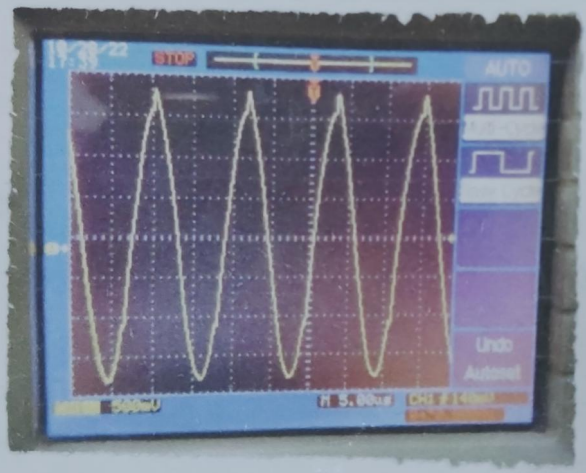
→ ① Balanced Modulator.

② Ring Modulation

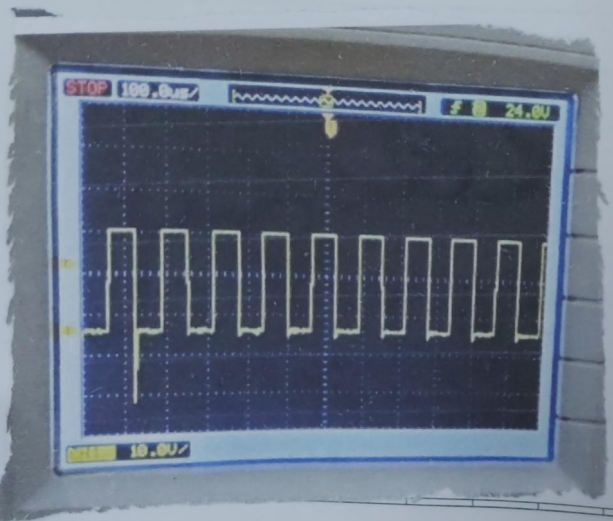
Teacher's Signature :



PWM circuit



Modulating signal
(Sine)



Carrier signal
(Pulse)

Experiment-5

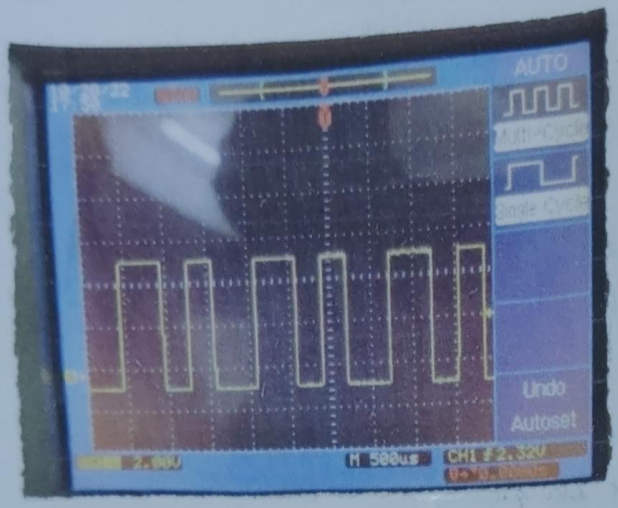
Aim: ① Study of PWM using diff. sampling frequencies
② Study of demodulation of PWM.

Equipment reqd:
1. ST2110 w/ power supply cords.
2. CRO w/ connecting probes
3. Connecting cords

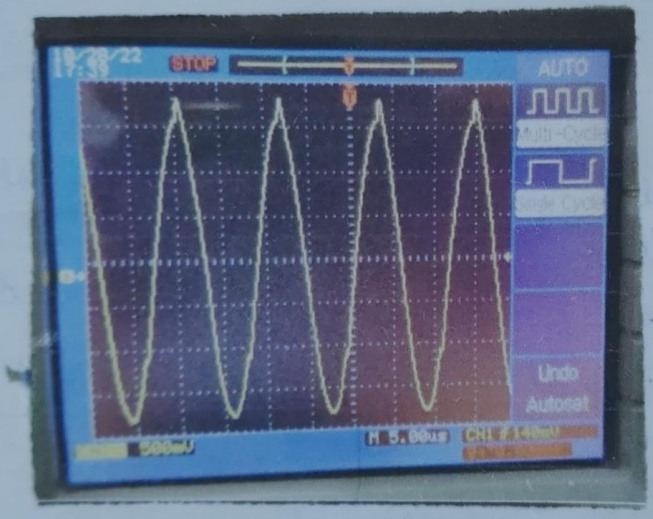
Theory:
In pulse width modulation technique, the width or duration of or time of pulse carrier, which is proportional to inst. amp of the message signal. The width of pulse varies in this method, but amp. of ~~pulse~~ signal remains const.

Procedure:
(A) Study of PWM using diff sampling frequencies :-
- Connect the ckt properly, select 1KHz sine wave & 64KHz sq. wave as i/p in PWM block
- Switch on power supply
- Observe the o/p of PWM block
- Vary the amp. of sine wave & see its effect.
- Vary the sinewave fr. and observe the effect
- Vary the fr & amp of pulse and obs. effects.
- Switch off the power supply.

Teacher's Signature : .....



Modulated PWM output signal



Demodulated output

(b) Study of PWM demodulation:

- o/p of PWM to o/p of LPF
- o/p of LPF to i/p of AC amplifier.
- Observe the o/p.

Result:

→ The pattern of pulse width modulation & demodulation is observed.

VIVA QUESTIONS:

Q) What is PWM?

→ In PWM, the width of carrier varies, which is proportional to inst. amp of message signal.

Q) What is another name of PWM?

→ Pulse time/duration modulation

Q) What type of modulation is PWM?

→ Pulse modulation in which cont.-time signal is transmitted in form of digital signal after modulation.

Q) What remains const in PWM?

→ Amp. of pulse.

Q) What are some adv. and disadv of PWM?

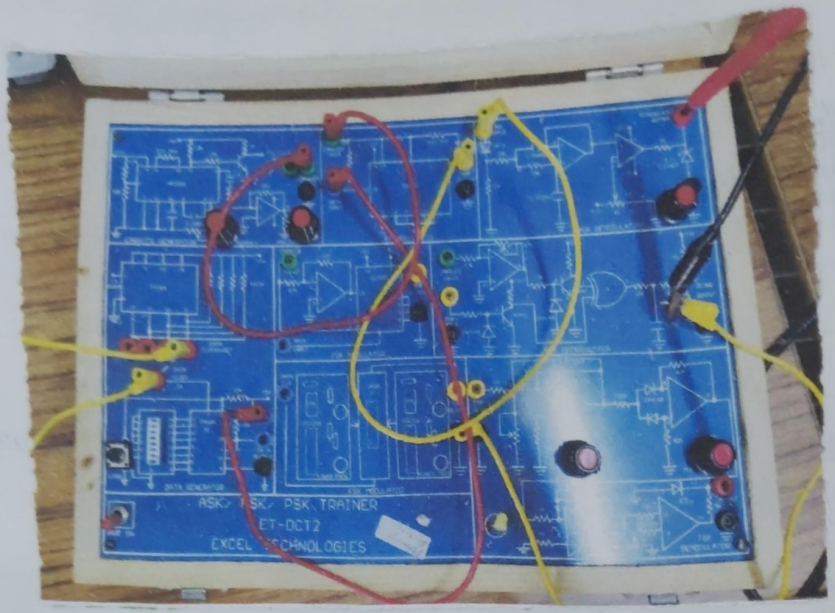
→ ADV:

- prevents overheating of LED
- provides high p/p power factor
- has a high response time

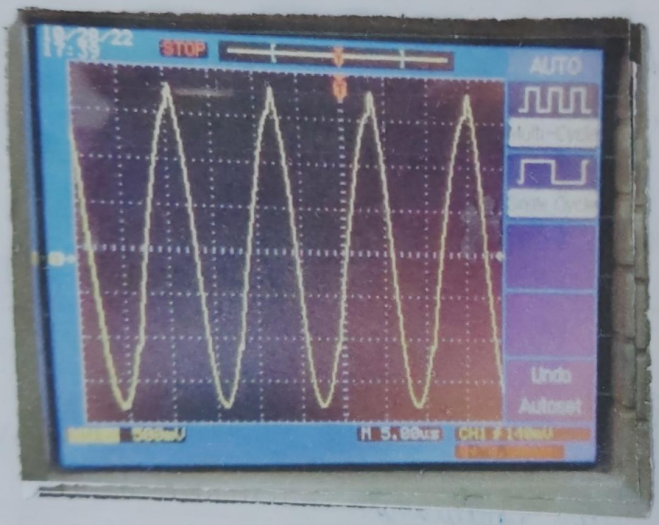
→ DISADV:

- Induces RF interference
- as freq. is high, switching losses considerably high

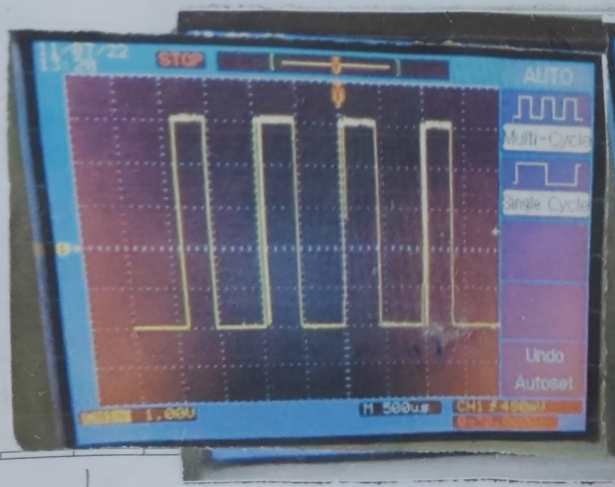
Teacher's Signature: .....

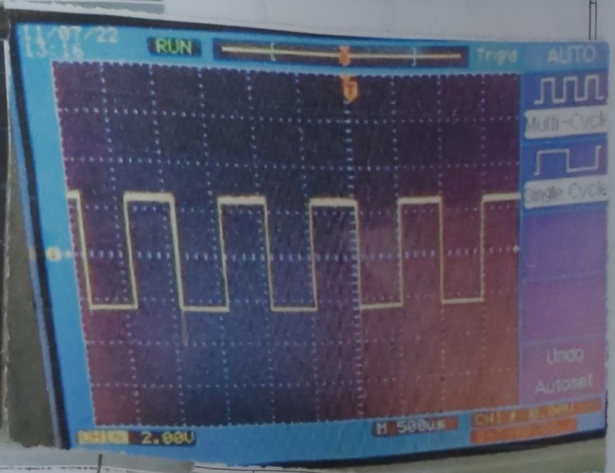


ASK Circuit



Carrier signal
(Sine)





↳ Clock signal

↳ Digital (modulating) signal.

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Experiment 6

AIM: Amplitude shift Keying modulation & demodulation.

Equipment Read:
- ASK Modulator & demodulator kit
- connecting probes
- CRO with connecting probes

Theory:

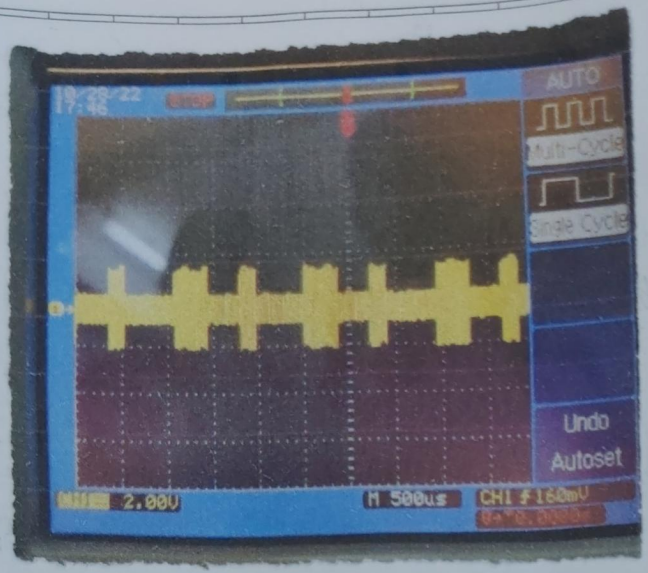
→ In ASK, amplitude is transmitted when modulation data is 1, carrier is refected from transmission when amp = 0. ASK signal maybe generated by simply applying the incoming binary data & sinusoidal carrier at 2 i/p of a modulator.

→ The demodulation of binary ASK can be obtained w/ help of a coherent detector. It consists of a product modulator which is followed by an integrator and a decision making device, which generates demodulated o/p.

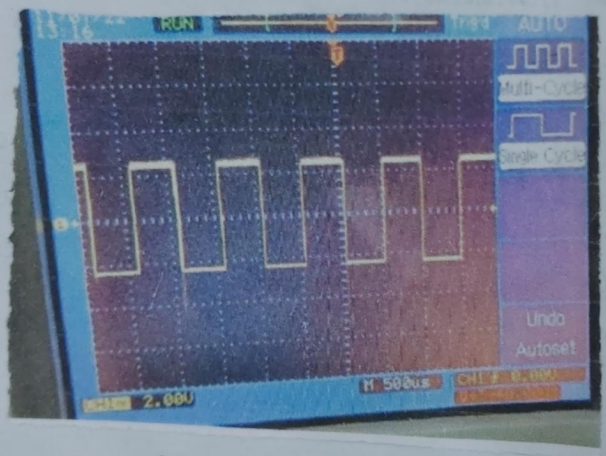
Procedure:

(A) Ask modulation):-
- Switch on the power supply.
- Set the DIP switches and parallel load by pressing load button.
- Adjust the carrier fr., give this input to ASK modulator at point named carrier i/p using patch cord.
- connect 8 bit word generator o/p named DATA OUT to the DATA INPUT terminal of the ASK modulator.

Teacher's Signature : .....



ASK modulated output



ASK demodulated output

- Observe the data o/p on the CRO.

(B) ASK demodulator:-

- Connect the point named ASK OUTPUT to ASK INPUT point in ASK demodulator block.
- Connect one channel of the oscilloscope to the data clock in and other channel to the demodulator o/p.
- Adjust the pot P3 in such a way that you get the original data pattern.

Result:

Pattern of the ASK modulation & demodulation has been observed.

VIVA QUESTIONS:

Q) What is ASK?

→ It a form of amplitude modulation which represents binary data in form of variations in amp. of the signal.

Q) How can we obtain ASK demodulated signal?

→ Using coherent detector

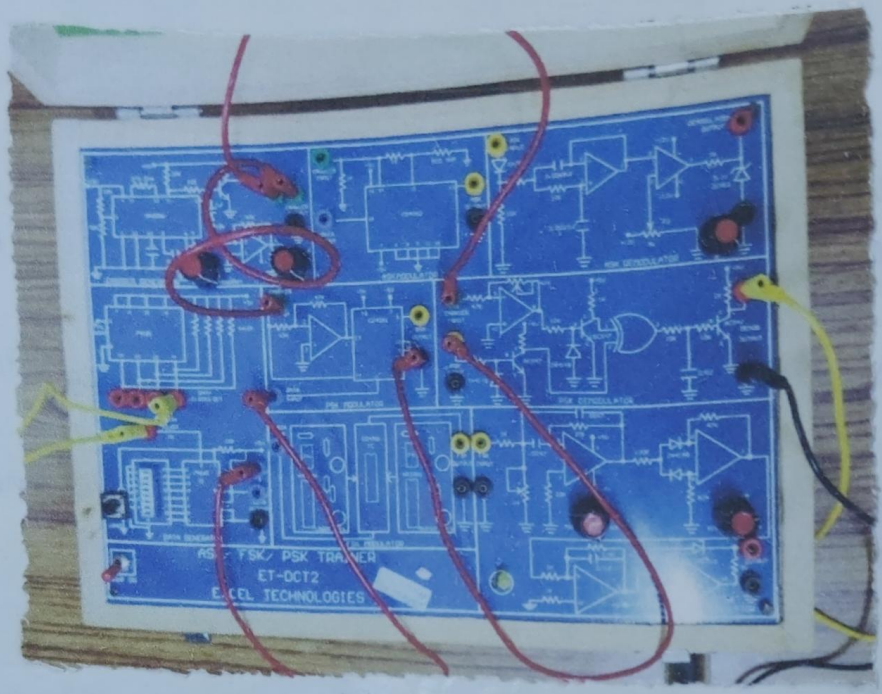
Q) What does coherent detector consist?

→ Product modulator followed by integrator followed by a decision making device.

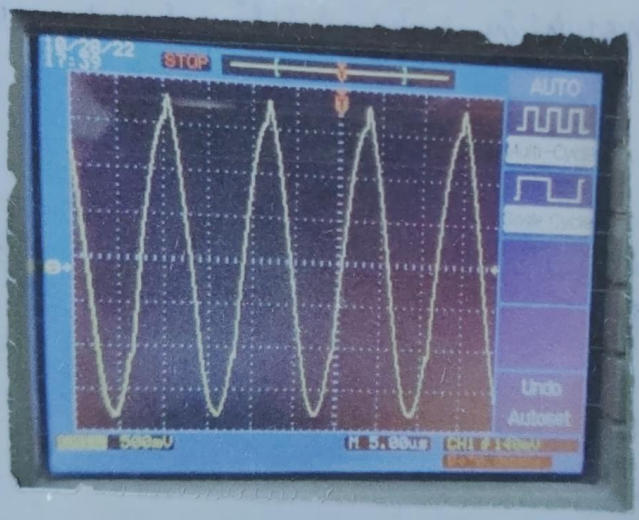
Q) What type of modulation is used in ASK?

→ Digital modulation

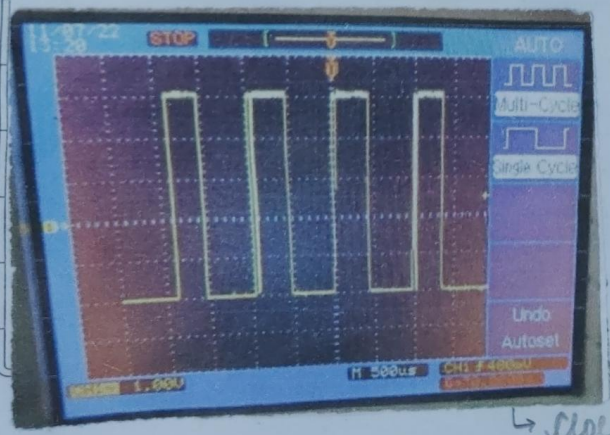
Teacher's Signature : .....



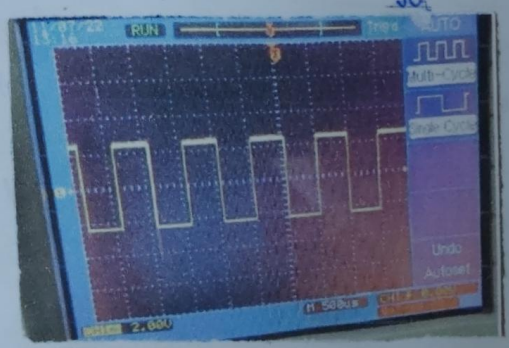
PSK circuit



Carrier signal (sine)



↳ Clock signal



↳ Digital (modulating) signal

Expt. No. 21 Page No. Date

Experiment - 7

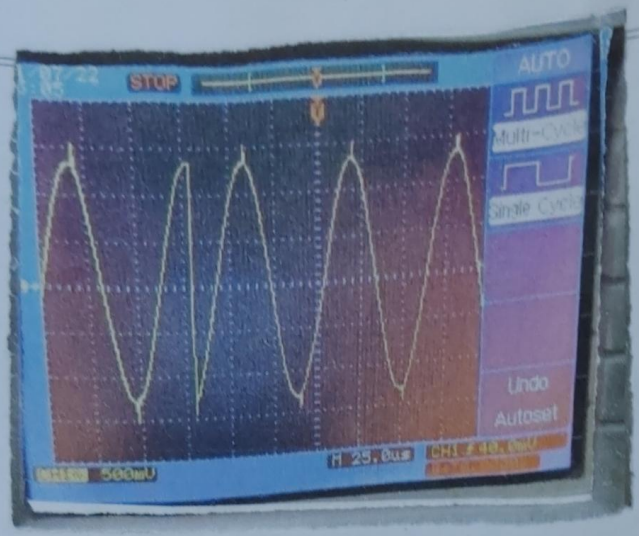
Aim:
Phase shift keying modulation and demodulation.

Equipment Reqd:
- Trainer kit
- Connecting probes
- CRO w/ probes

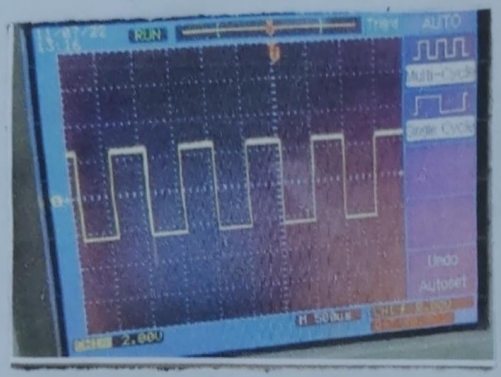
Theory:
PSK is a modulation technique where the phase of carrier is varied in accordance w/ binary value of data. Phase of carrier is shifted by +180° ~~or -180°~~ from the mark by space.

Procedure:
- Switch on the ~~training~~ training kit.
- Apply the data from IC 74165 to data clock i/p, take o/p from data clock o/p.
- The o/p of data clock is the i/p of PSK modulating signal. Give carrier signal from the trainer to carrier input
- Examine the o/p of PSK o/p in CRO
- O/p of PSK is the i/p of PSK demodulator. Here we also give the carrier along with because we are using coherent detection technique here.
- Examine the o/p of PSK demodulator in CRO.

Teacher's Signature : .....



PSK Modulation output



PSK demodulation output

Result:

PSK modulation and demodulation signal has been observed & studied.

VIVA QUESTIONS:

Q) What is Phase shift Keying?

→ It represents digital data as variations in phase shift in carrier wave. When every 0, the phase of carrier wave is shifted by 180°.

Q) What is binary phase shift keying (BPSK)?

→ For each on bit of binary data (0,1), carrier phase will be changed (two shifts 0, 180).

Q) What is quadrature phase shift keying (QPSK)?

→ For each two bits of binary data (00, 01, 10, 11), carrier phase will be changed (four diff - shifts :- 45°, 135°, -45°, -135°)

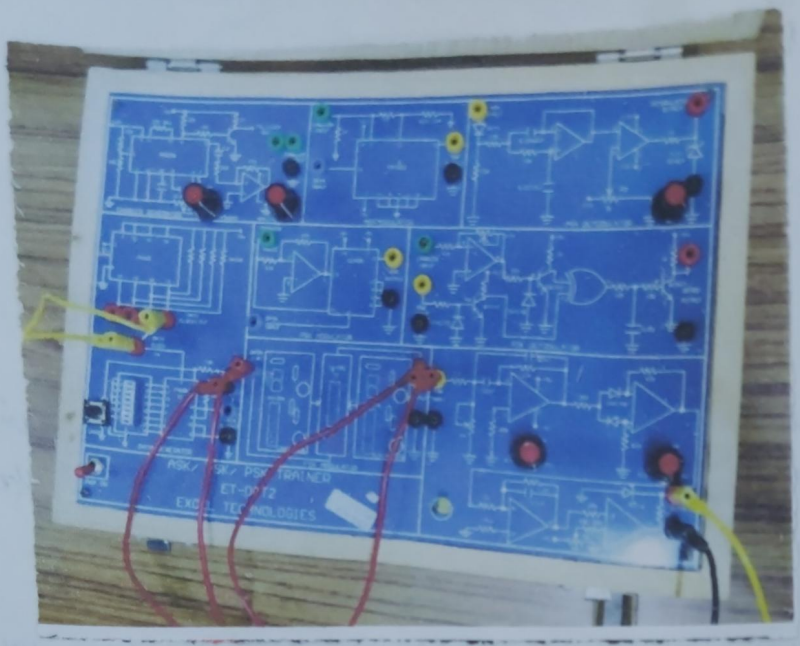
Q) What is BW of PSK signal?

→ 2fe

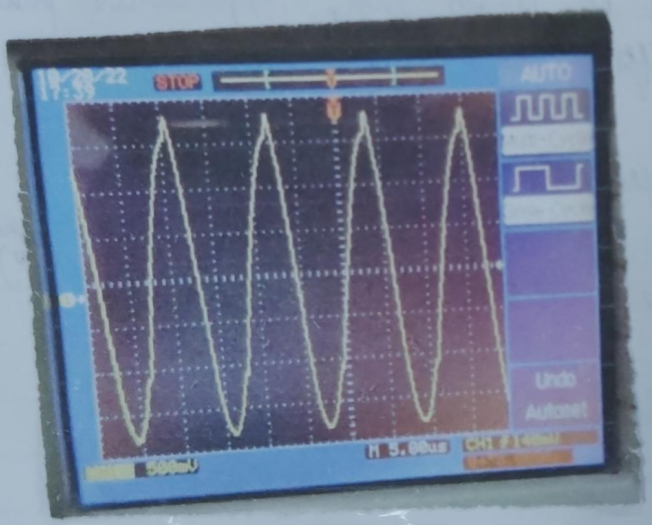
Q) Compare ASK, PSK, FSK.

→ ASK < PSK = FSK

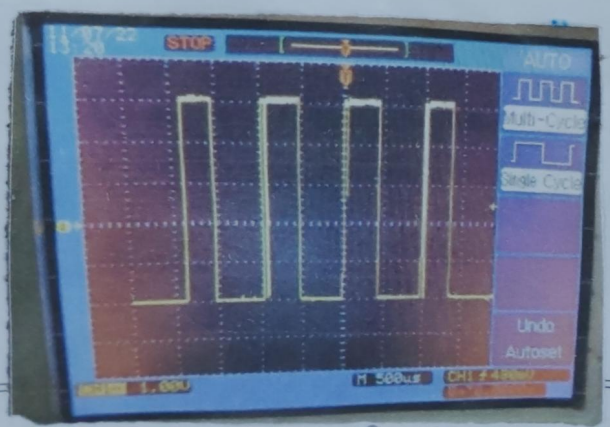
Teacher's Signature : .....



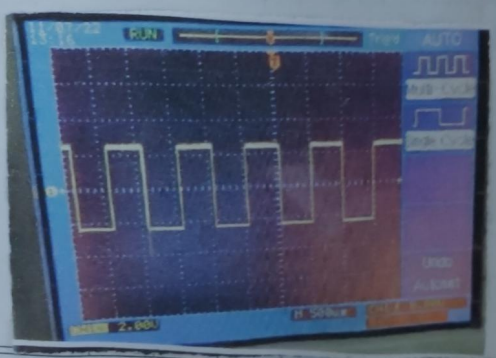
FSK Trainer circuit



Carrier signal (Sine)



→ Clock signal



→ Digital (modulating) signal

Expt. No. Page No.

Experiment-8

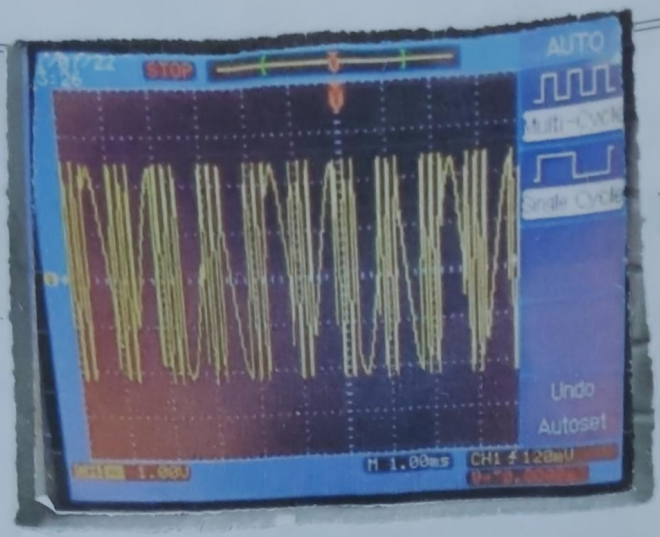
AIM:
Frequency shift keying modulation & demodulation.

Equipment Reqd:
- Training kit
- Connecting wires
- CRO

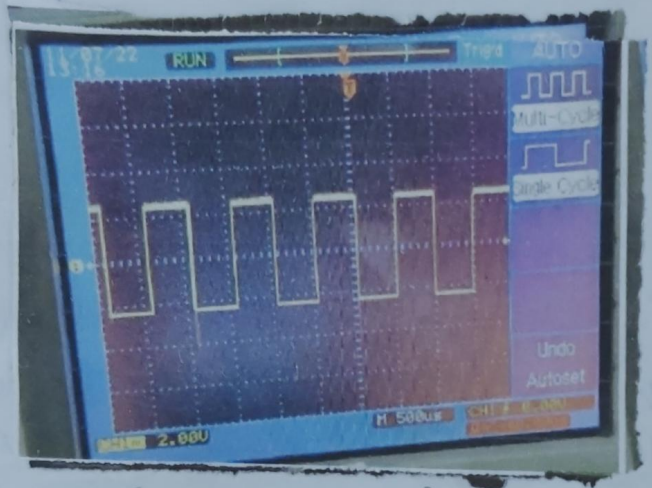
Theory:
FSK is a modulation technique where fr. of carrier is varied in accordance with the binary value of data. Freq is higher when bit value of the data is one and lower when bit value is 0.

Procedure:
- Switch on the training kit.
- Apply the data from IC 74165 to data clock i/p, then take o/p from data clock o/p and give it in as modulating signal in FSK modulator block.
- Give sine wave o/p as carrier i/p of FSK modulator block.
- Examine the o/p of FSK modulation in CRO.
- Now, give the o/p of FSK to i/p of FSK demodulator
- Observe the o/p of FSK demodulator in CRO.

Teacher's Signature : .....



→ FSK modulation output



FSK Demodulation output

Result:
Frequency shift keying (FSK) modulation and demodulation signals have been generated and studied.

VIVA QUESTIONS:

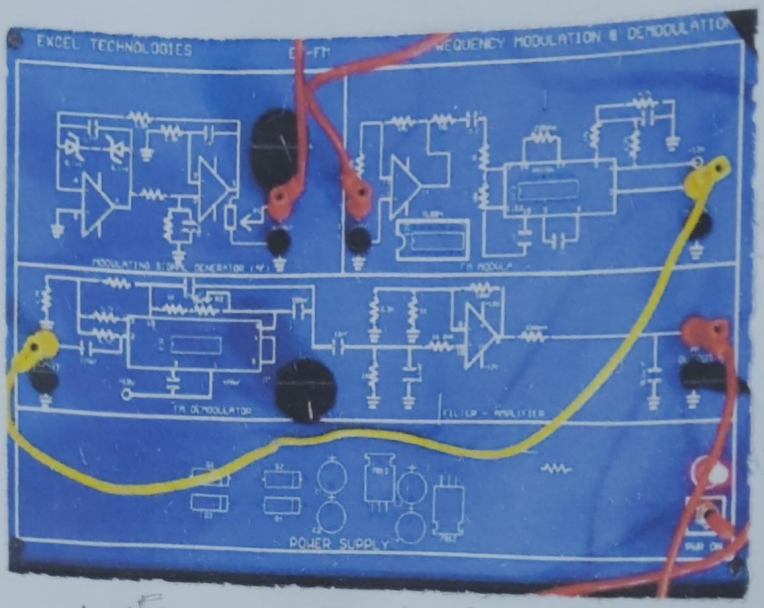
Q) What is frequency shift keying (FSK)?
→ It represents digital data as variations in freq. of carrier wave. For '1', freq. is more than carrier wave and for '0', it's lesser.

Q) What is the diff. b/w bit and baud rate?
→ Bit rate represents no. of bits transmitted per second while baud rate represents no. of symbols per second. ie - the no. of times signal changes its state (change in freq, phase and/or amplitude) per second is known as baud rate.

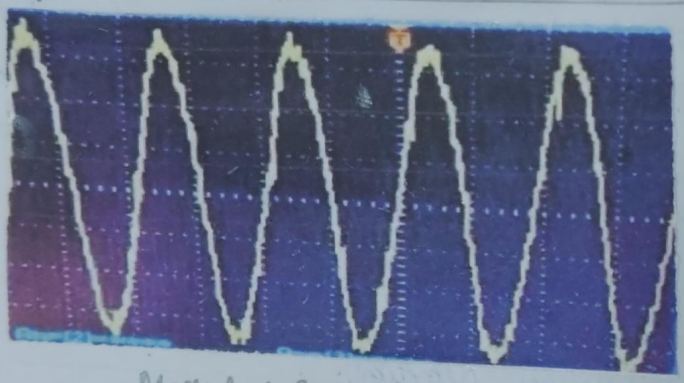
Q) What are the diff methods of FSK detection?
→ Asynchronous and synchronous detection.

Q) What is the bandwidth of FSK?
→ $BW = \min 2(\Delta f + f_b)$
where,
Δf → frequency deviation
f_b → input bit rate

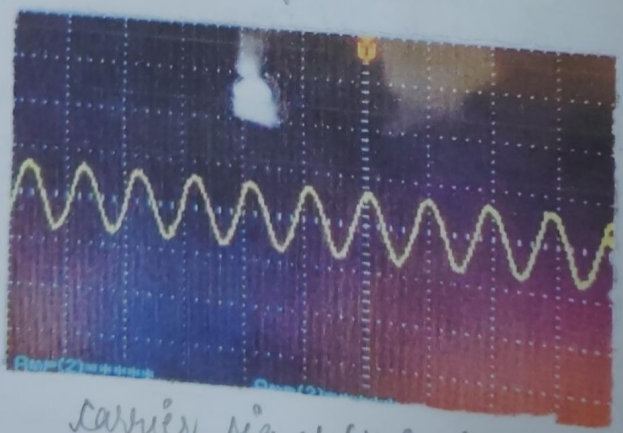
Teacher's Signature : .....



Frequency Modulation and Demodulation circuit



Modulating signal (sine)



Carrier signal (High frequency sine)

Experiment-9

Aim:
Frequency modulation & demodulation.

Equipment Reqd:
- FM trainer kit
- connecting wires
- CRO w/ probes

Theory:
Frequency modulation is a system in which the amplitude of modulated carrier is kept const. while its freq. is varied by modulating signal. FM is used as an alternative to AM, in an effort to make radio transmission more resistant to noise. The amount by which freq. of the carrier is varied from its unmodulated valued is called deviation and is made proportional to the instantaneous value of modulating voltage.

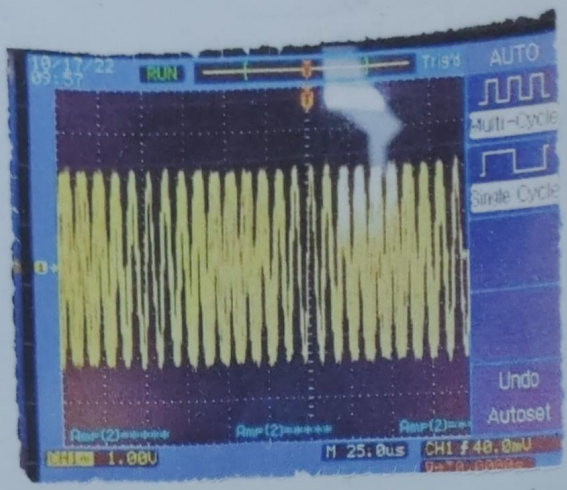
The inst. freq. of the frequency modulation value is given by:-

$$f_{inst} = f_c(1 + K_f V_m \cos\omega_m t)$$

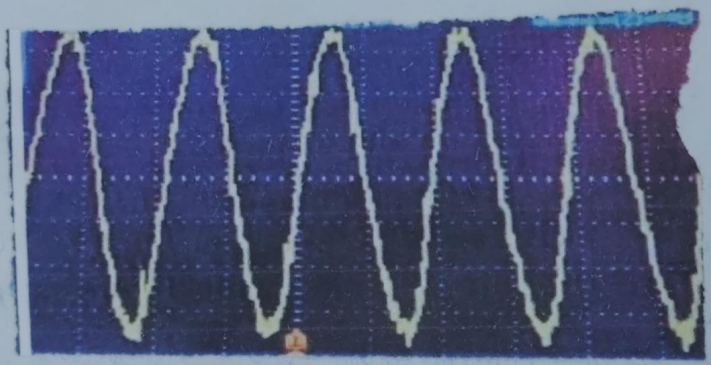
where,

f_c = carrier frequency
K_f = proportionality constant
$V_m \cos\omega_m t$ = instantaneous modulating voltage

Teacher's Signature : .....



Frequency Modulation output



FM Demodulation output

Procedure:

- Switch on the trainer
- connect wire on o/p of modulating signal generator & take its o/p on CRO
- connect o/p of modulating signal as i/p of frequency modulation, take o/p from its o/p section and display it on the CRO, this is the modulated signal.
- For demodulation, connect modulated signal o/p as i/p of FM demodulator, amplify the demodulator o/p & display it on the CRO.

Result:

Frequency modulation and demodulation signals have been generated.

VIVA QUESTIONS:

Q) What is frequency modulation used for?

→ Frequency modulation is the encoding of info in the carrier wave by changing instantaneous frequency of the wave. FM technology is widely used in fields of computing, telecom and signal processing.

Q) What is the formula for FM?

→ $V = A\sin[\omega_c t + \frac{\Delta f}{f_m} \sin\omega_m t]$

$V = A\sin[\omega_c t + m_f \sin\omega_m t]$

where, $m_f = \frac{\Delta f}{f_m}$ = FM modulation index.

Teacher's Signature : .....

Q) what is the principle of FM?

→ The basic principle behind FM is that amplitude of an analog baseband signal can be represented by slightly diff. frequency of the carrier.

Q) which is better - FM or PM?

→ FM has higher BW due to which its less affected by noise interference, hence the signal quality of FM is better than PM.

Q) what is deviation in FM?

→ The diff b/w min and max. freq. components of frequency modulated signal and the carrier frequency.

Q) what is sideband FM?

→ When the value of modulation index (mf) is quite large, then a large no. of FM sidebands are produced & hence BW of FM is very large. This type of FM signal is called wideband FM.

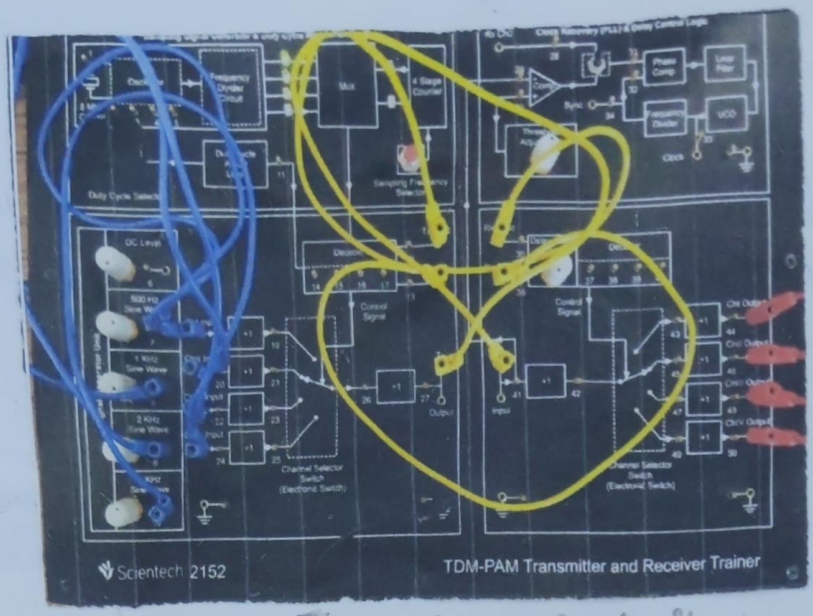
Q) Why is total transmitted power of FM always constant?

→ Transmitted power is given by:

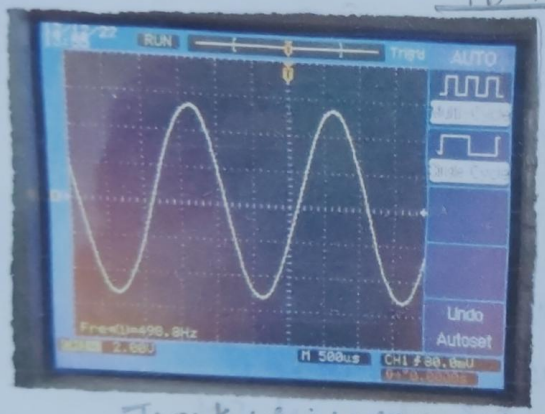
$$P_t = \left(\frac{A}{\sqrt{2}}\right)^2 / R.$$

Since peak amp. of FM is always constant, P_t always remains constant.

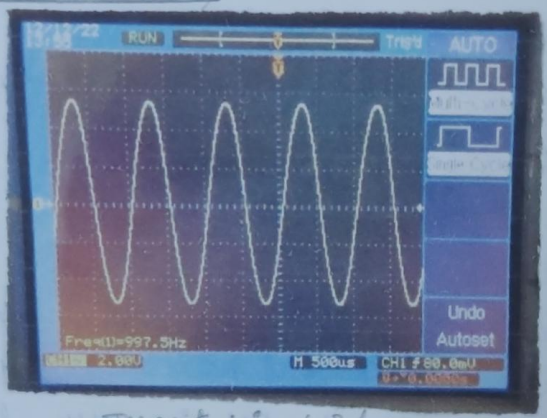
Teacher's Signature : .....



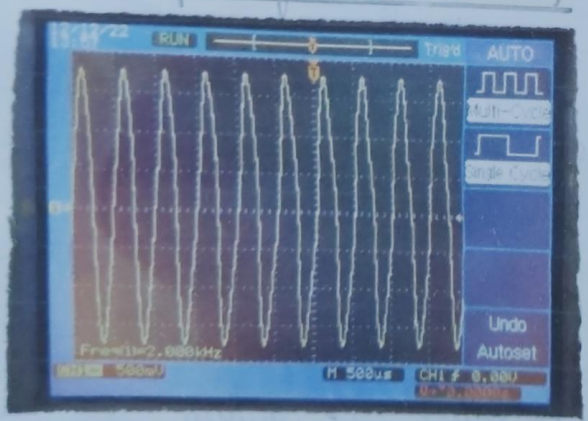
TDM-PAM Tx & Rx circuit



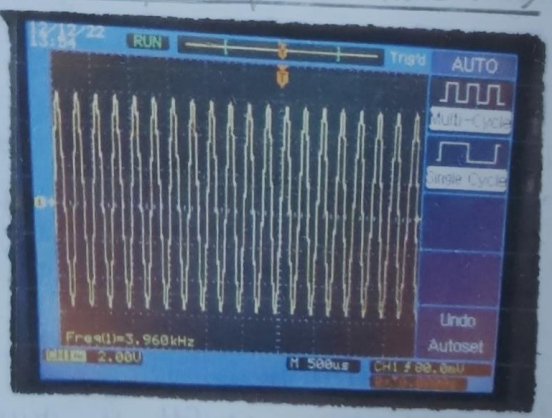
Input signal 1 (500Hz sine)



Input signal 2 (1kHz sine)



Input signal 3 (2kHz sine)



Input signal 4 (4kHz sine)

Experiment-10.

Aim:
To observe the working of a TDM - PAM transmitter & receiver.

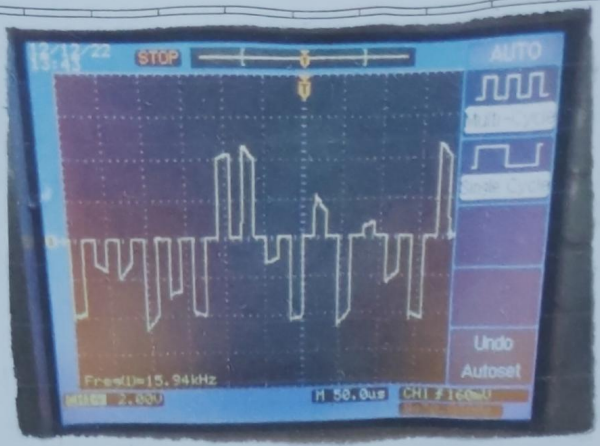
Equipment Read:
- Trainer kit
- DC power supply for digital communication
- 2mm banana cable
- 5 pin
- CRO

Theory:
Time division multiplexing pulse audio modulation is a communication system where message signals are modulated using PAM and multiple access is provided using TDM. The message info is encoded in the amplitude of a series pulse and transmitted using TDM in different time slots.

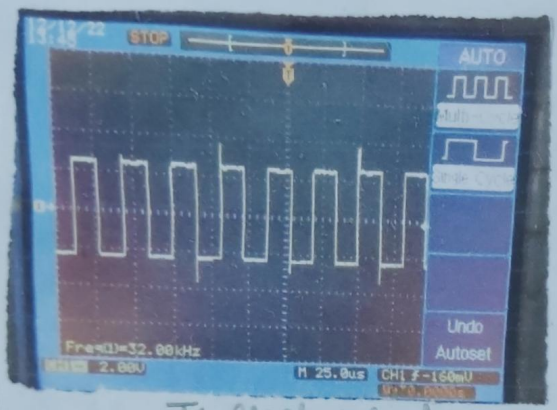
Each time is assigned a time slot and it shows up. Then a device has time to transmits a portion of its data. If a device cannot send or doesn't have data to send, its time slot remains full.

Procedure:
- Switch 'on' the power supply.
- Connect BNC connector to the CRO and to the feedback o/p port.

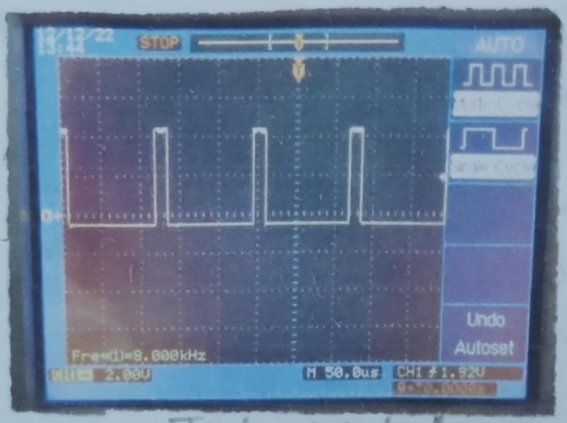
Teacher's Signature : .....



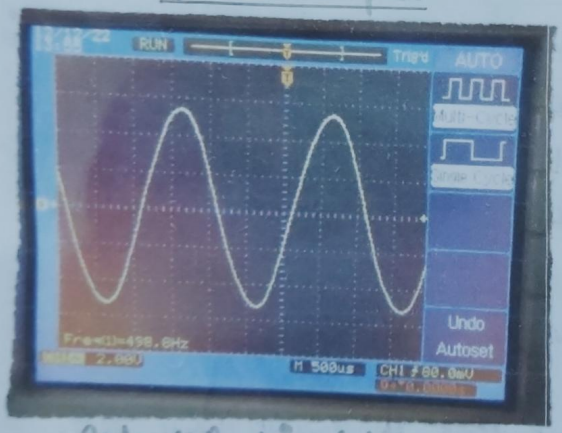
Multiplexer output



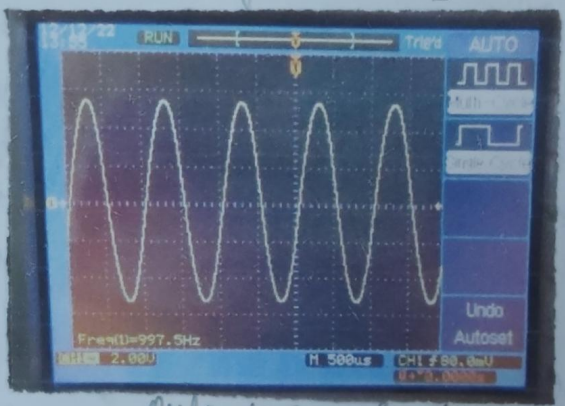
Tx clock output



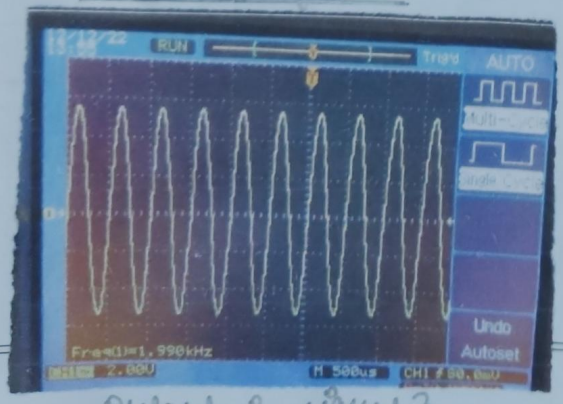
Tx sync output



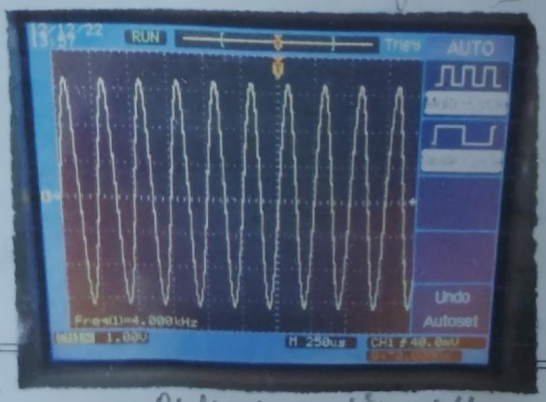
Output Rx signal 1



Output Rx signal 2



Output Rx signal 3



Output Rx signal 4

- Make the following connections:-
  - 500 Hz to CH1 I/P socket
  - 1kHz to CH2 I/P socket
  - 2kHz to CH3 I/P socket
  - 4kHz to CH4 I/P socket
  - Tx O/P (TP27) to Rx I/P (TP41)
  - Tx sync to Rx sync
  - Tx Clock to Rx sync

- Then, check the output from O/P socket of CH1, CH2, CH3, CH4 & take the o/p of sync wave.

Result:
The TDM-PAM waves are obtained

VIVA-QUESTIONS

Q) List the types of multiplexing.
- Frequency Division Multiplexing (FDM)
- Time Division Multiplexing (TDM)

Q) What is FDM?
→ FDM is the process of combining several information channels by shifting their signals to different frequency groups w/in the fr. spectrum so that they can be transmitted over a common transmission channel.

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Q) What is TDM?

→ It is the process of combining the samples from diff. info. signals in time domain so that they can be transmitted over a common channel.

Q) List the types of TDM.

- Asynchronous TDM
- Synchronous TDM.

Q) component used for multiplexing?

- Multiplexer

Q) What is the transmission BW of TDM-PAM channel?

→ BW = $\frac{1}{2}$ (signalling rate).

Therefore,

min. BW : $BW = \left(\frac{1}{2}\right) 2Nf_m$

Hence,

min. $BW = Nf_m$.

Q) Adv and Disadv of TDM?

→ ADV: High transmission speeds, no particular need for carrier, immune to external impedance, efficiency of BW.

→ DISADV: Need for major hardware modifications, need for synchronisati

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