

Certificate

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Class: 4C7

Roll No: 14114802719

Exam No:

Institution _____

*This is certified to be the bonafide work of the student in the
Laboratory during the academic
year 20 / 20 .*

No of practicals certified _____ out of _____ in the
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Examiner's Signature

.....
Principal

Date:

Institution Rubber Stamp

(N.B: The candidate is expected to retain his/her journal till he/she passes in the subject.)

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Experiment - 1

Aim : To generate Signal Sampling and Reconstruction techniques

Objectives - Study of Sampling and reconstruction of signal.

Study the effect of sample/hold circuitry on reconstructed signal

Comparison of frequency response of 4th order low pass filter

Equipments Required - Scientech 2101 with power cord
 Oscilloscope with connecting probe
 Connecting cords

Theory :

Signals we use in real world, such as our voice are called "analog" signal. To process these signals in digital communication we need to convert analog signals to digital signals.

Analog signals are continuous in time and amplitude while digital signal is discrete time signal and has both time and amplitude discrete. SAMPLING is the process to convert continuous time signal to discrete time signal. The value of signal is measured at certain intervals in time which are called as samples.

Sampling Theorem states that a continuous signal band limited to f_m Hz, can be completely represented by and reconstructed from the samples taken at a rate greater than or equal to $2f_m$ samples per sec. Minimum frequency is called "Nyquist Rate". Thus for faithful reconstruction of information signal from its samples it is necessary that the sampling rate $F_s \geq 2 \cdot f_{\max}$

If the information signal is sampled at a rate lower than that stated by Nyquist criterion, then there is overlap between information signal and side bands of harmonics. Thus the lower and higher frequency components get mixed and cause unwanted signals to appear at the demodulator output. This phenomenon is termed as Aliasing or Fold-over Distortion.

Procedure :

1. Duty cycle selector switch was set to 5 (50% duty cycle) and sampling selector switch was set to internal.
2. 1kHz sine wave was given as input and Oscilloscope was used to observe the wave. Readings were taken at 320KHz and 20kHz sampling rates.
3. For the respective sampling rates sample output waveforms were visualized.
4. Sample input was connected to 4th order low pass filter and waves obtained were visualized for 320kHz and 20kHz sampling rates (sampling frequency was $\frac{1}{10}$ th of frequency indicated by LED illuminated).
5. We observed sample output lower frequencies introduced distortion which was caused as filter did not attenuate unwanted freq. component significantly.
6. As we increased Duty cycle selector, we observed linear relationship with amplitude.
7. The output sample was connected to hold and sample and waveforms were observed. Also some outputs were passed from 4th order low pass filter and waves were visualized.
8. Outputs for different Duty cycles were observed too but there was no change in amplitude in this hold case.
9. Sample output was connected now to 2nd order low pass filter and difference b/w the waveforms of 4th and 2nd order were visualized.
10. The output was observed by varying the duty cycle too. And was done for hold and sample off also.

Result: It was observed from various cases that :

As sample frequency increases, the output of sample port has more number of samples of applied signal.

For transmitting the signal if a sample and hold amplifier is used just before the transmission channel, the signal suffered from less distortion as compared to when only sample amplifier was used.

As the order of LPF is increased at output, no recovered signal will be reconstructed more like transmitted signal.

To further verify when sample amplifier or sample and hold amplifier was connected to II order LPF and this was I/P for IV order LPF.

was obtained was the output for II order LPF.

Signal sampling was generated and various reconstruction techniques are verified and observed.

Viva Voice Questions

Ans. What do you mean by sampling?

To convert continuous time signal to discrete time signal, a process is used and this process is called Sampling.

Ans. What is sampling theorem?

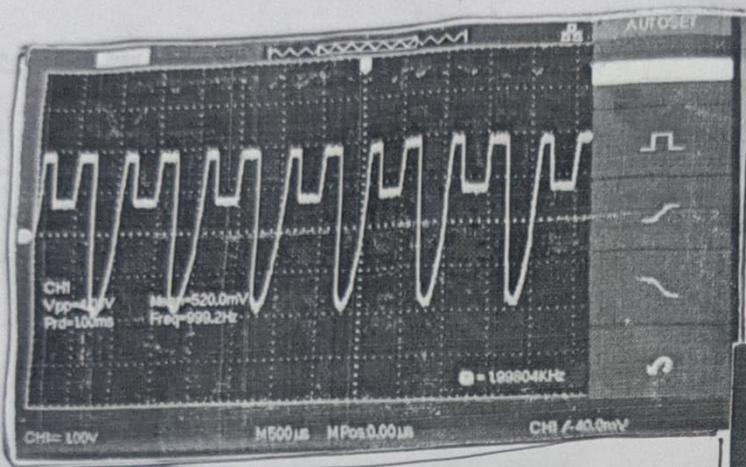
The sampling theorem states that a signal can be exactly reproduced if it is sampled at a frequency F_s

where $F_s > 2 \cdot F_{\text{max}}$: F_{max} - maximum frequency in signal

Ans 3. What is Nyquist frequency?

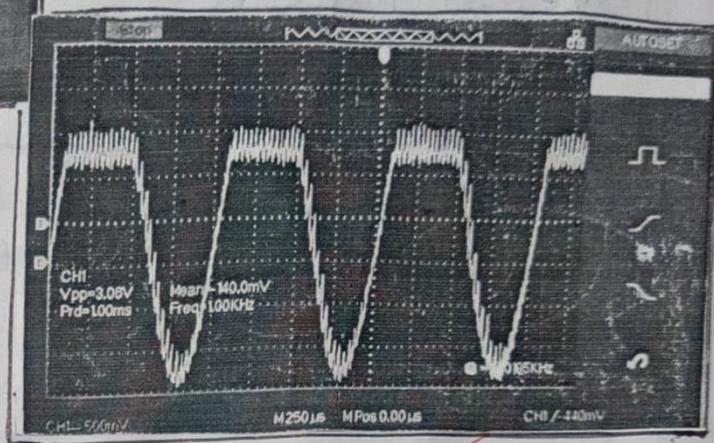
The frequency $2 \cdot F_{\text{max}}$ is called Nyquist sampling rate.

SAMPLE AND HOLD O/P

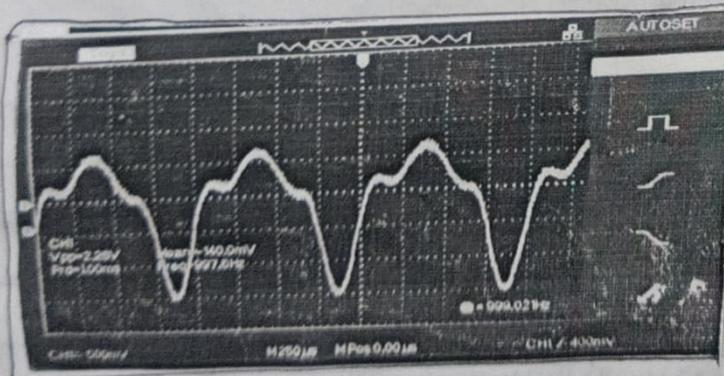


← for Sampling wave of frequency 20kHz

Sample and hold O/P for sampling wave of frequency 320kHz →

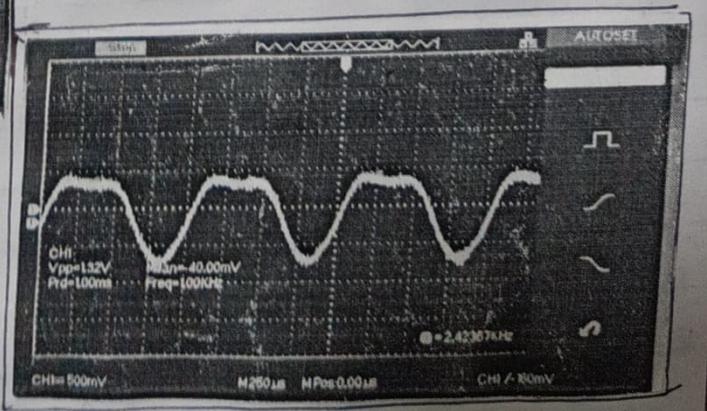


Output WAVE WHEN SAMPLE OUTPUT ORDER PASSED THROUGH 4th LOW-PASS FILTER



← for Sampling wave of frequency 20 kHz

for Sampling wave of frequency 320kHz →



Half of this value f_{max} is sometimes called as Nyquist frequency.

Ques 4. List different sampling techniques ?

Ans 4. There are 3 types of sampling techniques :

- 1) Ideal sampling or Instantaneous sampling or Impulse sampling
- 2) Natural sampling
- 3) Flat top sampling

Ques 5. How aliasing is removed ?

Ans 5. Aliasing is removed by simple filtering out all higher frequencies components before sampling.

Ques 6. What is under sampling ?

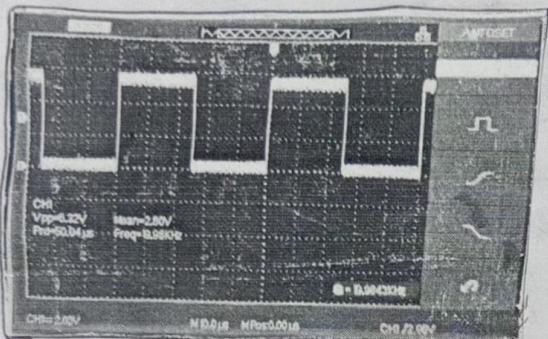
Ans 6. When the sampling rate is lower than or equal to Nyquist rate, a condition defined as under sampling, it is impossible to rebuild the original signal according to Sampling theorem.

✓ ~~8-5~~

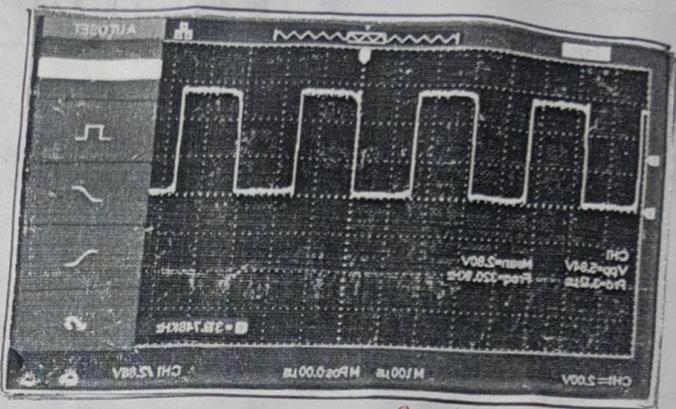
08/04/21

SIGNAL WAVE-FORM VISUALISATION / OUTPUTS

INPUT SIGNAL WAVEFORMS

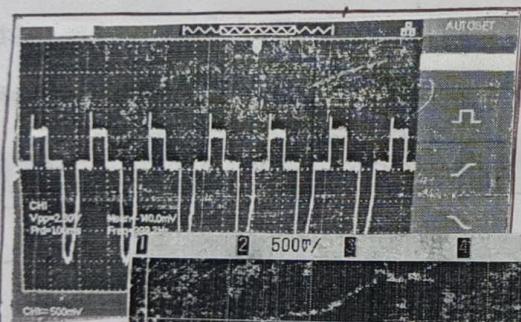


20KHz - Frequency *Somewhat*

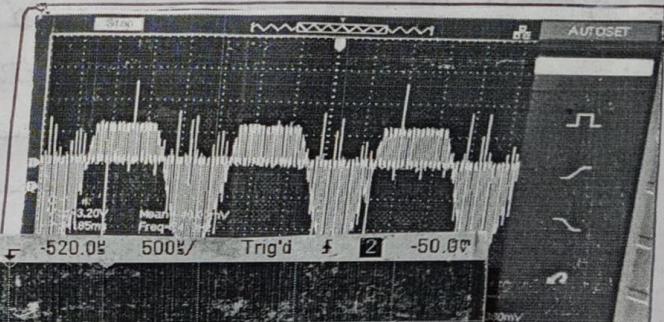


320 KHz - Frequency *Somewhat*

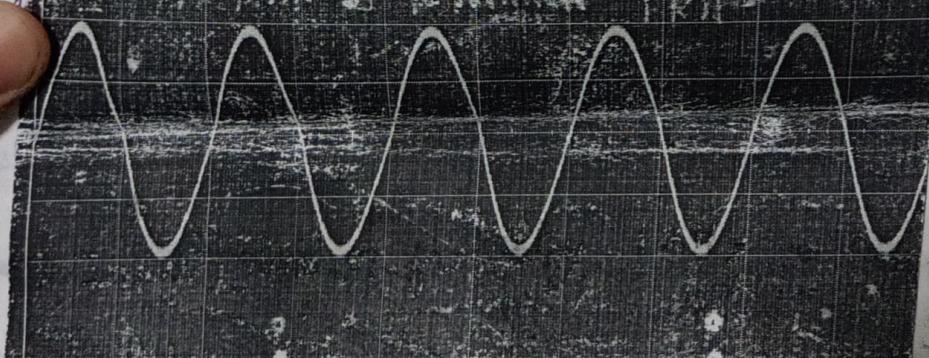
SAMPLE OUTPUT



Sampling wave at 10%



320 KHz



Trigger Mode and Coupling Menu

Mode Normal	Coupling DC	Noise Re	HF Reject	Holdoff 60.000ns
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Experiment - 2

To study generation and detection of DSB-SC
 Aim : 1) Double sideband - suppressed carrier AM Generation
 2) Double sideband - suppressed carrier AM Reception

equipments Required : → ST2201 and ST2202 with power supply cord
 → CRO with connecting probe
 → Connecting cords

Theory :

Double-sideband suppressed-carrier transmission (DSB-SC) is transmission in which frequencies produced by amplitude modulation (AM) are symmetrically spaced above and below the carrier frequency and carrier level is reduced to the lowest practical level, ideally being completely suppressed. In DSB-SC modulation, unlike in AM, the wave carrier is not transmitted; thus much of the power is distributed between the sidebands, which implies an increase of the power in DSB-SC, compared to AM, for the same power used.

DSB-SC is basically an amplitude modulation wave without the carrier, therefore reducing power waste, giving it a 100% efficiency. This is an increase compared to normal AM transmission (DSB), which has a maximum efficiency of 33.333% since 2/3 of the

power is in carrier which carries no intelligence and each sideband carries the same information. Single Side Band (SSB) suppressed carrier is 100% efficient.

GENERATION OF DSB-SC AM

DSB-SC is generated by a mixer. This consists of a message signal multiplied by a carrier signal. The mathematical representation of this process is shown below where product-to-sum trigonometric identity is used.

$$\underbrace{V_m \cos(\omega_m t)}_{\text{message}} \times \underbrace{V_c \cos(\omega_c t)}_{\text{carrier}} = \frac{V_m V_c}{2} [\cos(\omega_m + \omega_c)t) + \cos(\omega_m - \omega_c)t)]$$

modulated signal

Procedure:

- Starting with audio switch in int position, mode switch in DSB position, Output amplifier gain potentiometers in full clockwise position, speaker in off position board S72201 was turned ON.
- Connect the CRO to receiver kit.
- Switch ON both CRO and kit. Select the switch on DSBSC position. All switches found off, Audio pen on.
- Adjust variable capacitor until we get demodulated output.
- Trace variable capacitor until we get demodulated I/P signal.
- Observe the off of SSB-SC modulated wave.
- Watch geromod level transmitter and receiver receiver's kit.
- Insert the modulated signal O/P to receiver.

9. Adjust variable capacitor until you get demodulated O/P on CRO and trace the signal out

Result :

Carrier frequency of selected AM station is shifted down to 455 kHz and sidebands of AM signal are now either side of 455 kHz.

The signal at O/P of IF amplifier 2 (TP28) is composed of entirely of a 455 kHz carrier, and AM sidebands either side of it carrying the wanted audio information.

Viva Questions

Ques 1. Define Amplitude Modulation

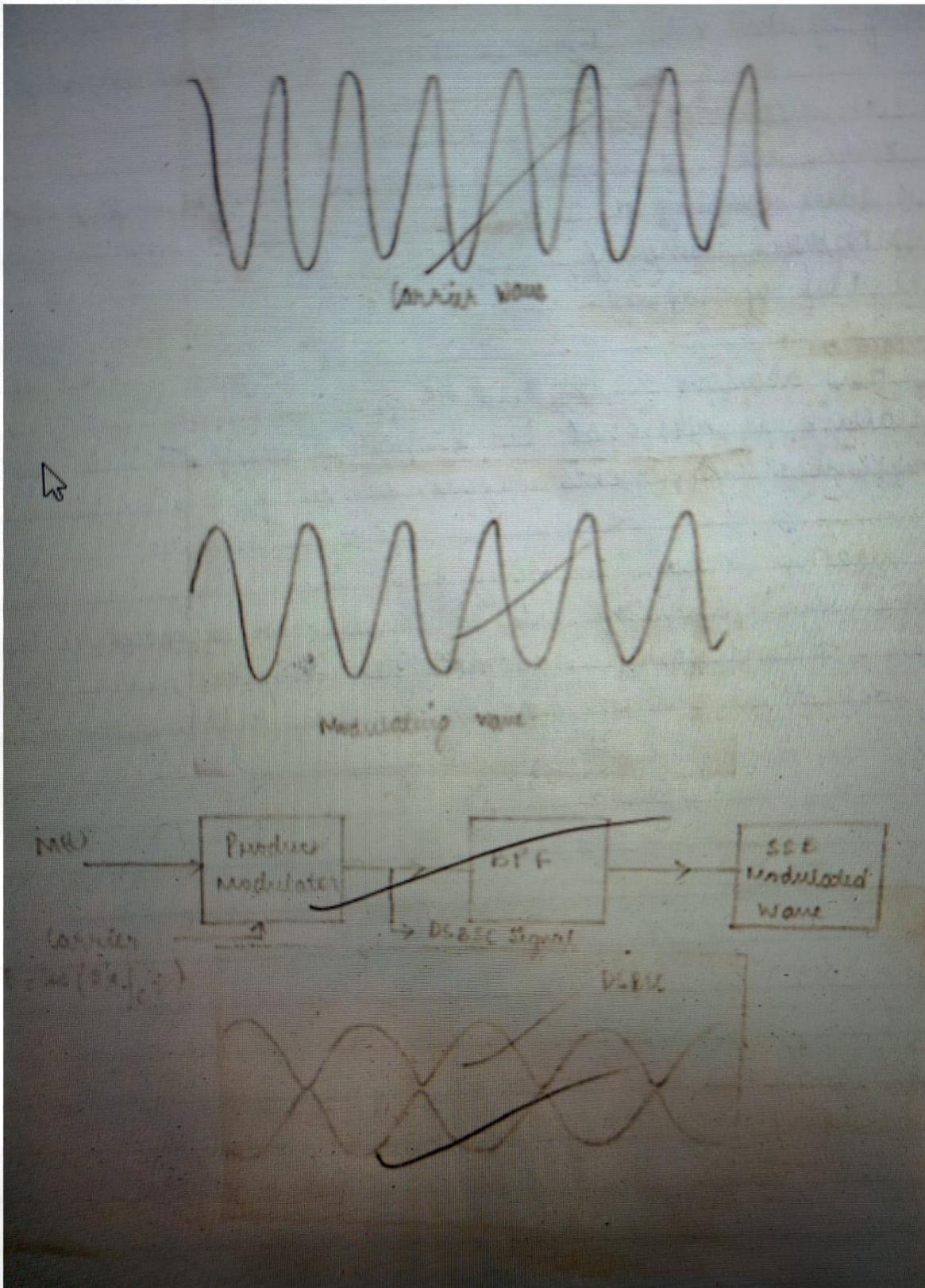
Ans Amplitude modulation is the type of modulation technique in which the amplitude of high frequency carrier wave is varied in accordance with the instantaneous amplitude of modulating signal.

Ques. What is Modulation Index?

Ans Modulation Index is measure of the depth of modulation. It is a numerical value between 0 and 1. Ideally it should be close to 1 or 1.

Ques 3. What is the range of commercial AM broadcast band?

Ans 5.35 kHz - 1605 kHz (Medium Wave) 1.6 - 4.5 MHz (Short Wave), 4.5 - 16 MHz (Short Wave - II) and 16 - 25 MHz (Short Wave - III).



Ques 4. Which kind of modulation is used in picture signals in Television broadcast ?
(Ans) VSB (Vestigial Sideband)

Experiment - 3

Aim: TO study generation and detection of SSBSC

1. Single Sideband AM Generation
2. Single sideband AM Reception

Apparatus Required: Transmitter, receiver, trace paper, connecting wires (connecting cords) ST 2201 and ST 2202 with power supply cords

Theory:

Modulating signal which contains no carrier wave and one side is called band suppressed modulation. In this type of modulation one of two side bands is filtered by a suitable band filter.

Detection:

A modulating signal can be recovered from SSBSC signal by multiplying and receiving RSB-SC signal to the generated carrier.

Procedure:

- 1) Connect the CRO to the scanning kit and I/P frequency counter and trainer key section
- 2) Switch ON both CRO and trainer kit.
- 3) Select mode switch in SSB-SC function
- 4) All switch points are kept off

- 5) Put audio i/p selection on IMT position.
- 6) Observe the B/P of SSBSC modulated wave.
- 7) Match ground level transmission and receiver transistors.
- 8) Turn the modulating signal S/P to receiver.
- 9) Adjust the variable capacitors until we get demodulated O/P.
- 10) Trace out the modulated and demodulated signals.

Result :

SSB SC Wave successfully generated and demodulated.

Precautions :

- i) Connections should be made tight and proper.
- ii) Don't switch 'ON' CRO before connecting wires.

Viva Questions

Ques 1. What is SSB?

Ans 1. Single-Sideband Modulation (SSB) is a refinement of amplitude modulation that more efficiently uses electrical power and bandwidth. It is closely related to vestigial sideband modulation (VSB).

Ques 2. What is Hilbert Transform?

Ans 2. Bandwidth Hilbert transform is an ideal phase shifter which shifts different frequency components present in the signal by $\pi/2$.

Ques 3. What are the advantages of SSB?

~~Ans 3.~~ Band width requirement of SSB is half as compared to DSB system.
SSB is a Power efficient scheme in which only 33% power is being utilized.

~~Ques 4.~~ What are the application of SSB?

~~Ans 4.~~ SSB system is used in telemetry, land and air mobile communications, military communications, navigation and amateur radio. Most of these applications are point to point communication systems.

Experiment - 4

Aim: To Study amplitude modulation and demodulation of AM wave

- 1. Double Sideband Suppressed Carrier AM Generation
- 2. Double sideband Carrier AM Reception

Equipments Required: ST 2201 and ST 2202 with power cords, CRO with connecting points, connecting cords.

Theory:

The simplest form of modulation is Amplitude modulation. In AM, the modulation. In AM, the modulation voltage, whose frequency is variable lower than that of carrier signal. Carrier frequency is high while modulation frequency is low audio frequency.

AM is defined as a system of modulation in which the amplitude of carrier wave is varied in accordance with instantaneous amplitude of modulating signal.

$$\text{Modulating Voltage } V_m(t) = V_m \sin \omega_m t$$

$$\text{Carrier Voltage } V_c(t) = V_c \sin \omega_c t$$

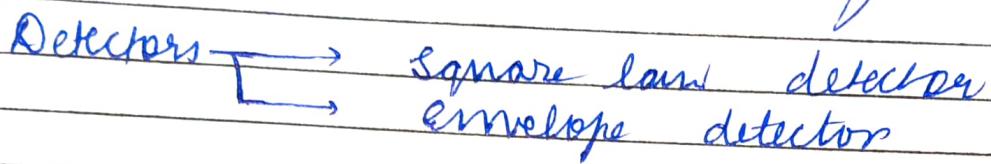
$V_L(t)$: Instantaneous voltage of carrier wave

$$V_L = V_m(t) + V_c$$

$$= V_c(t) + V_m \sin \omega_m t$$

Demodulation : The process of obtaining the baseband signal from the modulating signal with larger carrier frequency are detected by envelope detectors.

Envelope detectors employs rect. that introduces no envelope detector of AM wave in baseband signal



Procedure :

1. Connect CRO with trainer kit.
2. Switch ON both CRO and trainer kit.
3. Select Mode switch ON DSBSC position.
4. All switches faults are kept safe off.
5. Audio I/p switch are turned to ON position.
6. Adjusted variable capacitor until we get the demodulated O/P.
7. View the modulated, demodulated and I/p signal.

Precautions :

- 1) Connections must be proper and tight.
- 2) Do not switch ON CRO before completing the circuit.

Viva Questions

Ques 1. Define DSB-SC.

Ans After modulation, the process of transmitting the sideband (USB, LSB) alone and suppressing the carrier is called as Double side band suppressed carrier.

Ques 2. What are the disadvantages of DSB-FC?

- Ans
- 1) Power wastage takes place
 - 2) DSB FC is bandwidth inefficient system

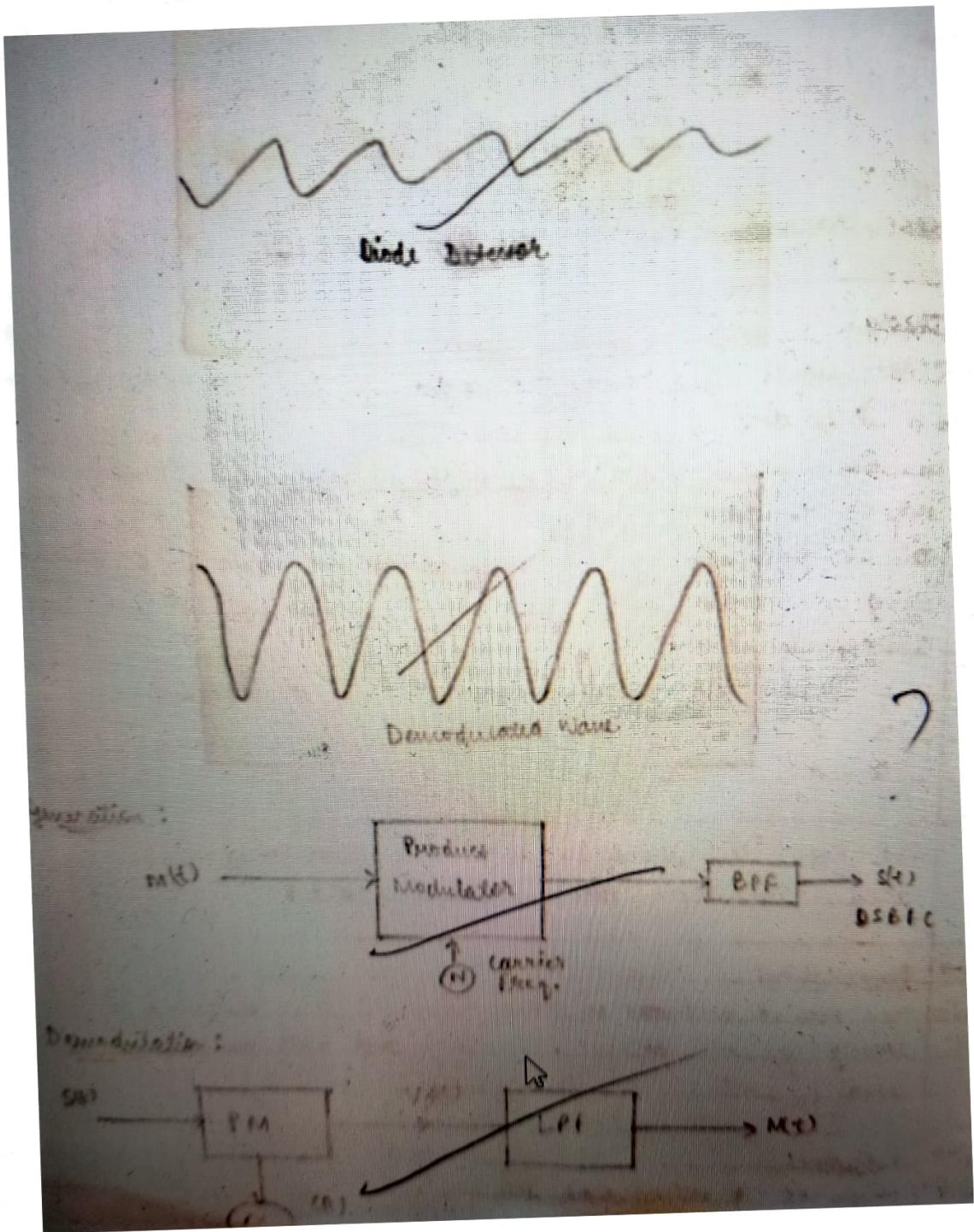
Ques 3 Define coherent detection.

Ans During Demodulation carrier is exactly coherent or synchronized in both the DSB-SC frequency and phase, with original carrier wave used to generate DSB-SC wave. This method of detection is called as Coherent detection or synchronous detection.

Ques 4. How will you generate DSBSC-AM?

Ans There are 2 ways of generating DSBSC

- a) Balanced modulator
- b) Ring modulator



Experiment - 5

Aim :- To study frequency modulation by varactor modulation
 - To study frequency modulation using reactance modulation

Equipments Required : ST 2203 with power cord, CRO with connecting probe, connecting cords

Theory :

A varactor diode is a SC diode where junction capacitance varies similarly with applied bias. The varactor diode must be reverse biased. In oscillator circuit value frequency is calculated by modulating voltage is called Voltage Controlled Oscillation (VCO). The resistance of C is made large enough compared to R so the base band signal may be activated. The oscillation frequency will change with the change in varactor diode capacitance and FM wave is produced.

Reactance Modulation :

We are using phase locked loop detector for the demodulation of FM wave. The oscillator and tuned circuit provide the unmodulate carrier freq-

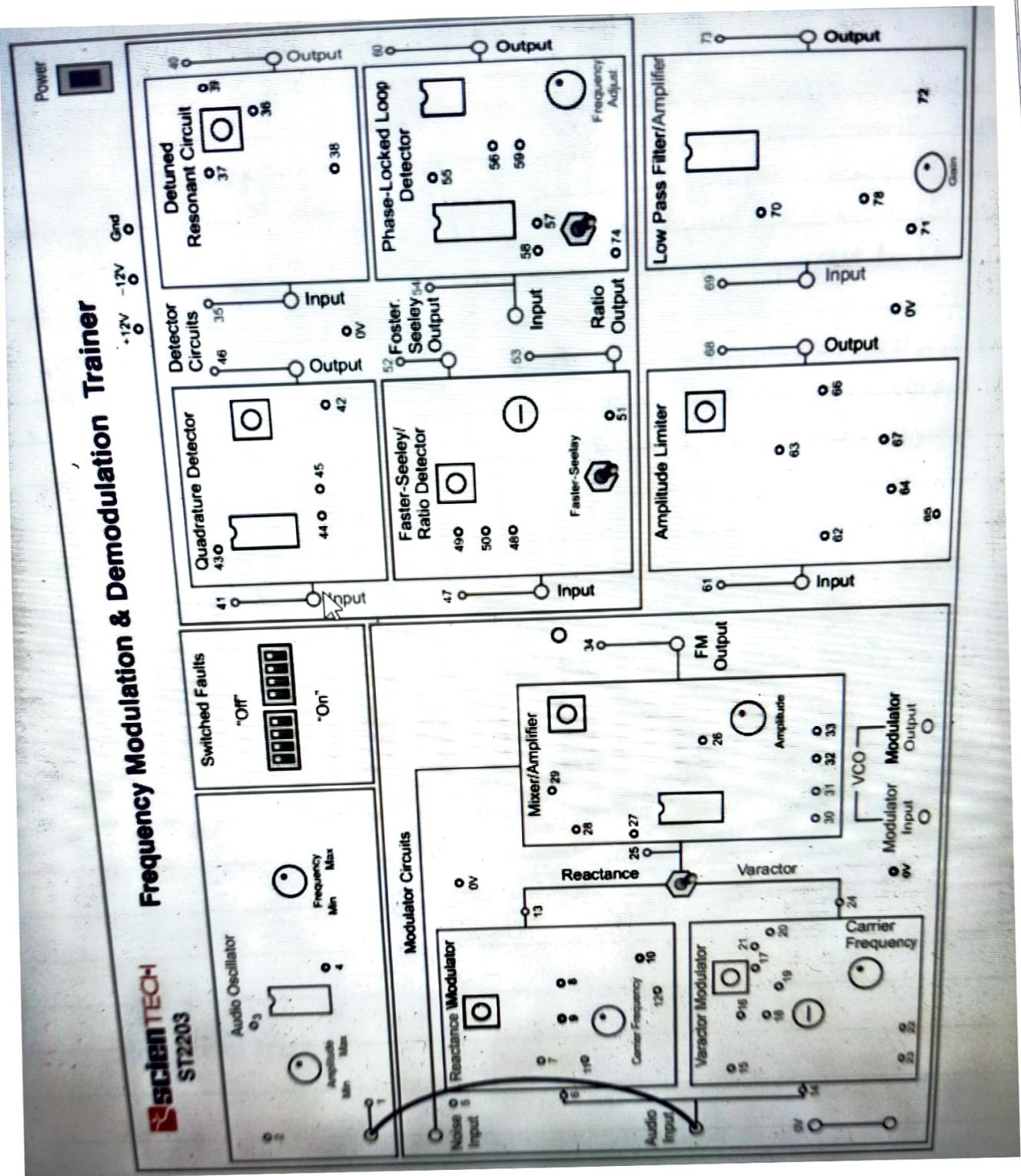
ency and this frequency is present on the collector of the transmitter. The capacitor and resistor provides 90° phase shift between the voltage and collector current. This makes the circuit act as a capacitor. The changing information signal using applied base has the same effect as information signal using applied bias has the same effect as changing the bias voltage applied to the transmitter, and this would have the effect of increase and decrease value of capacitor.

Procedure :

- A) i) Connect the modulated wave to the phase locked loop detector.
- ii) Connect the O/P to PLL to the low pass filter. Trace out the demodulated wave from the O/P of LPF.
- B) i) Convert the modulated wave to the phase locked loop detector. This is done in order to obtain demodulated wave.
- ii) Connect the O/P to PLL to LPF. Trace out the demodulated wave from O/P of LPF.

Result :

The modulation wave signal obtained through varactor diode modulation is known as Baseband signal.



The modulated wave signal obtain through the reactance modulator is same as baseband signal

Precautions :

- i) Connect the circuit properly.
- ii) Do not switch 'on' the supply until circuit is complete.

VIVA QUESTIONS

Ques 1. What is frequency modulation (FM) ?

Ans Frequency modulation is the process of varying frequency of a periodic waveform, called carrier signal with respect to the frequency of modulating signal that typically contains information to be transmitted

Ques 2. What is use of varactor diode ?

Ans Tuning diode / varactor diode / variable capacitance / varicap diode / variable reactance diode is a diode that has a variable capacitance which is a function of voltage that is impressed on its terminals. Tuning / varactor diodes are operated reverse biased, and therefore no current flows.

Experiment - 6

- Aim : → Study of Pulse Amplitude Modulation using Natural and Flat top Sampling
- Study of PAM using Sample and Hold Sampling
- Study of Pulse Amplitude modulation and Demonstration with sample and Hold and Flat top

Equipment Required : ST2110 with power supply cord
CRO with connecting probes, connecting cords

Theory :

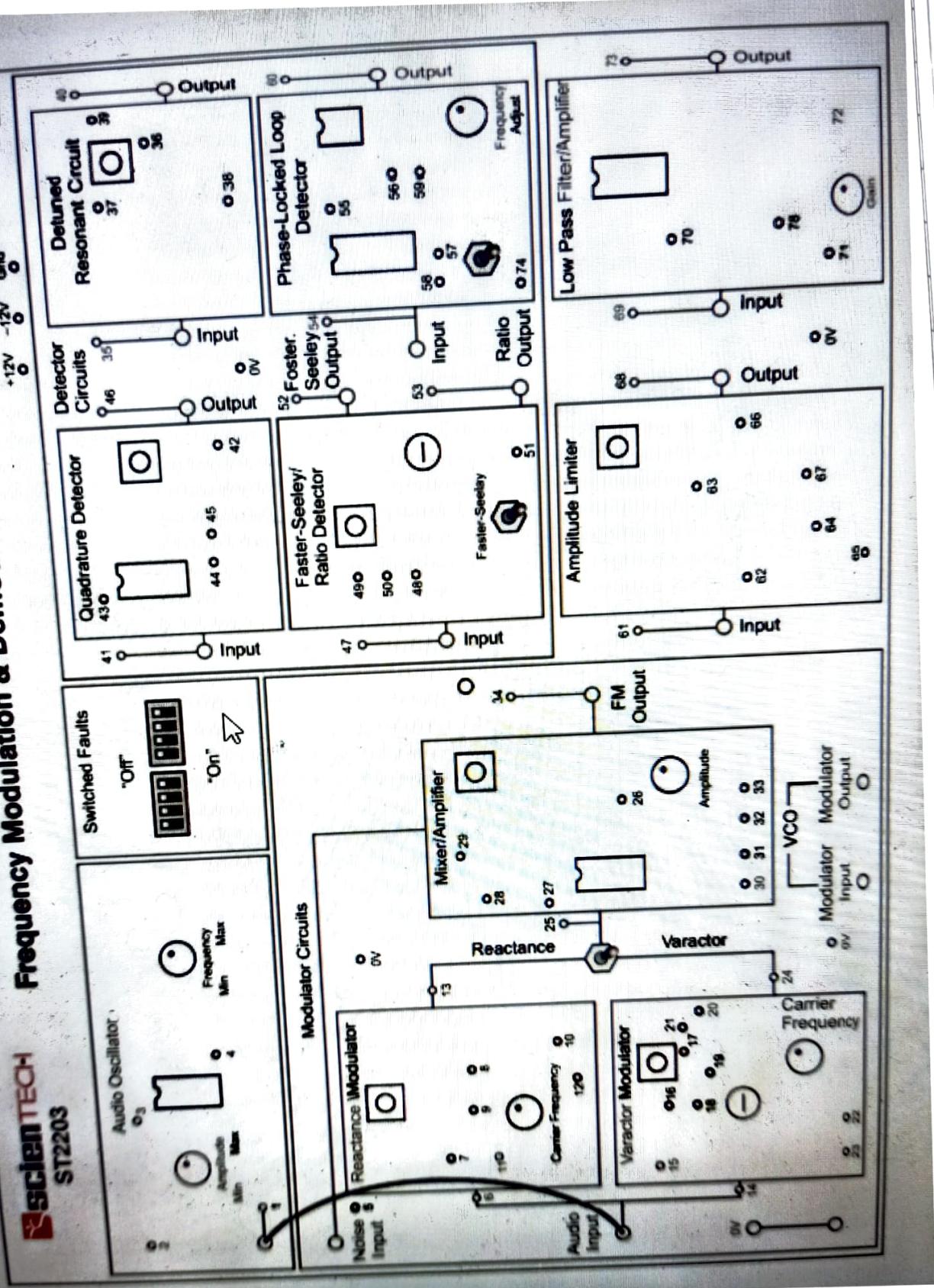
Pulse modulation may be used to transmit information, such as continuous speech or data. It is a system in which continuous waveforms are sampled at regular intervals. Information regarding the signal is transmitted only at the sampling times, together with any synchronizing pulses that may be required. At the receiving end, the original waveforms may be reconstituted from the information regarding the samples, if these are taken frequently enough. Despite the fact that information about the signal is not supplied continuously, as in AM and FM, the resulting receiver output can have negligible distortion.

Pulse modulation may be subdivided broadly as

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Ex

analog and digital. In the former case, the indication of sample amplitude is the nearest variable while later case, a code, which indicates the sample amplitude to the nearest predetermined level, is sent. Pulse amplitude and pulse time modulation, to be treated next, are both analog

Procedure :

1. Connected the kit (as shown in diagram). O/P to PAM block having switch at 1 kHz
2. Monitor O/Ps. T_{P_3} and 5 having natural flat and O/Ps respectively.
3. Observed effect on O/P by varying reasons behind them. Then connected kit acc to diagram 2.
4. Monitored O/P of sample and hold circuit at T_{P_4} .
5. Varyed amplitude I/P wave frequency over 2 kHz.
6. Then at last connected the kit acc to ckt. diagram 3.
7. All the O/P were monitored and traced.
8. Tried to locate fault and switch to different ones and demodulated waveform was obtained.

Precaution :

1. Connect the circuit properly.
2. Do not switch 'on' the ckt. before ensuring the wire connections.

Viva Questions

Ques 1. What is the pulse Amplitude modulation?

Ans Pulse - amplitude modulation, is a form of signal modulation where the message information is encoded in the amplitude of a series of signal pulses. It is an analog pulse modulation scheme in which the amplitudes of a train of carrier pulses are varied according to the sample value of the message signal.

Ques 2. what is pulse signal?

Ans In signal processing, the term pulse has the following meaning:

A rapid, transient change in the amplitude of a signal from a baseline value to a higher or lower value, followed by a rapid return to the baseline value.

Ques 3. What is a sample and hold circuit?

Ans In electronics, a sample and hold (S/H, also "follow-and-hold") circuit is an analog device that samples (captures, grabs) the voltage of a continuously varying analog signal and holds (locks, freezes) its value at a constant level for a specified minimum period of time.

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• PAM-PPM-PWM Modulation & Demodulation Trainer

Power

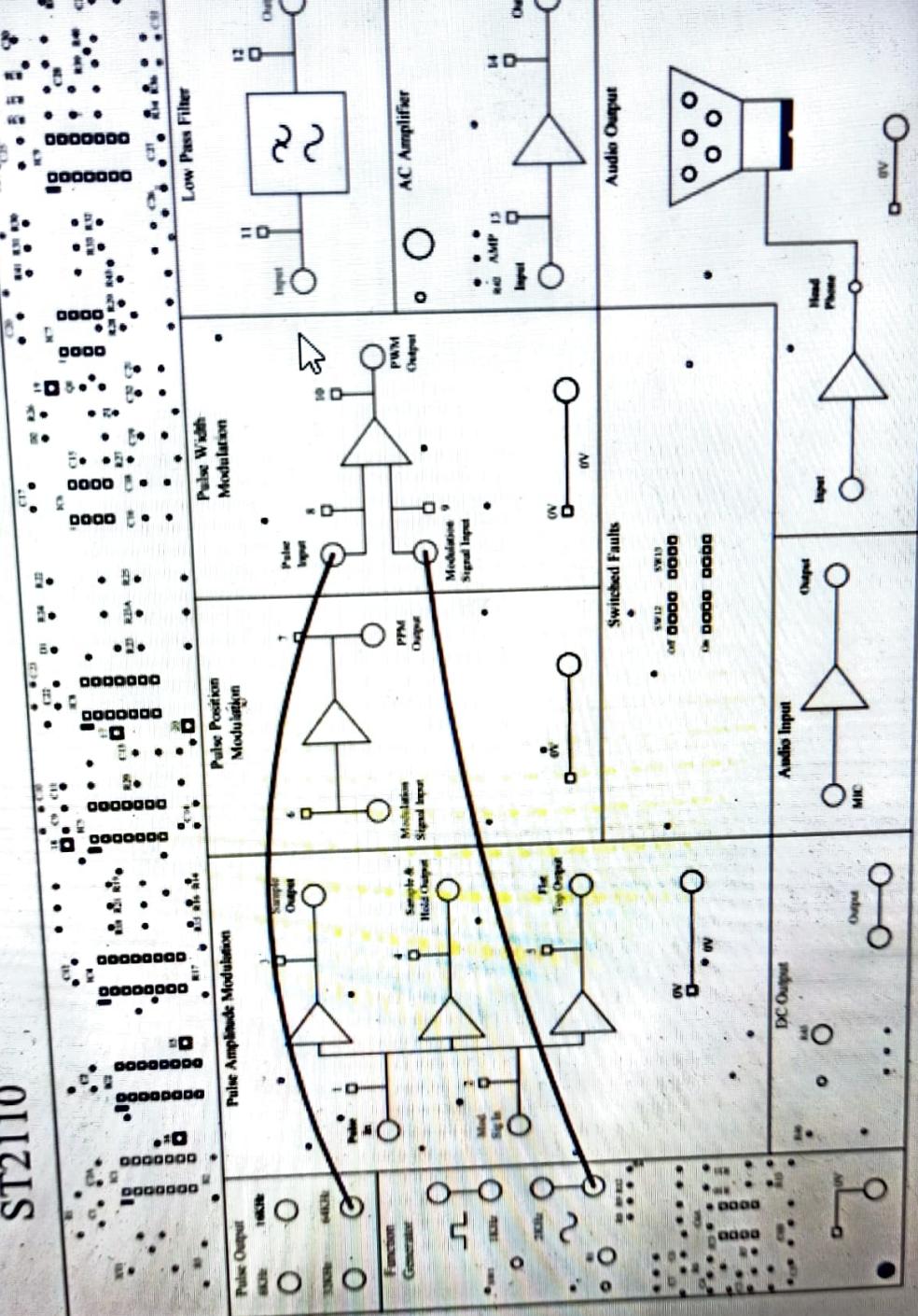


Figure 1

Ques 4. What is a holding circuit?

Ans The holding circuit interlock, is a normally open auxiliary contact on magnetic starters or contactors. Used in three wire control schemes with momentary inputs. It closes when the coil is energized to form a holding circuit for the starter contacts after the "start" button or input has been released.

Ques 5. What is zero order hold?

Ans The zero-order-hold (ZOH) is a mathematical model of the practical signal reconstruction done by a conventional digital-to-analog converter (DAC). That is, it describes the effect of converting a discrete time signal to continuous-time signal to a continuous-time signal by holding each sample value for one sample period.

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• **PAM-PPM-PWM Modulation & Demodulation Trainer**

Power

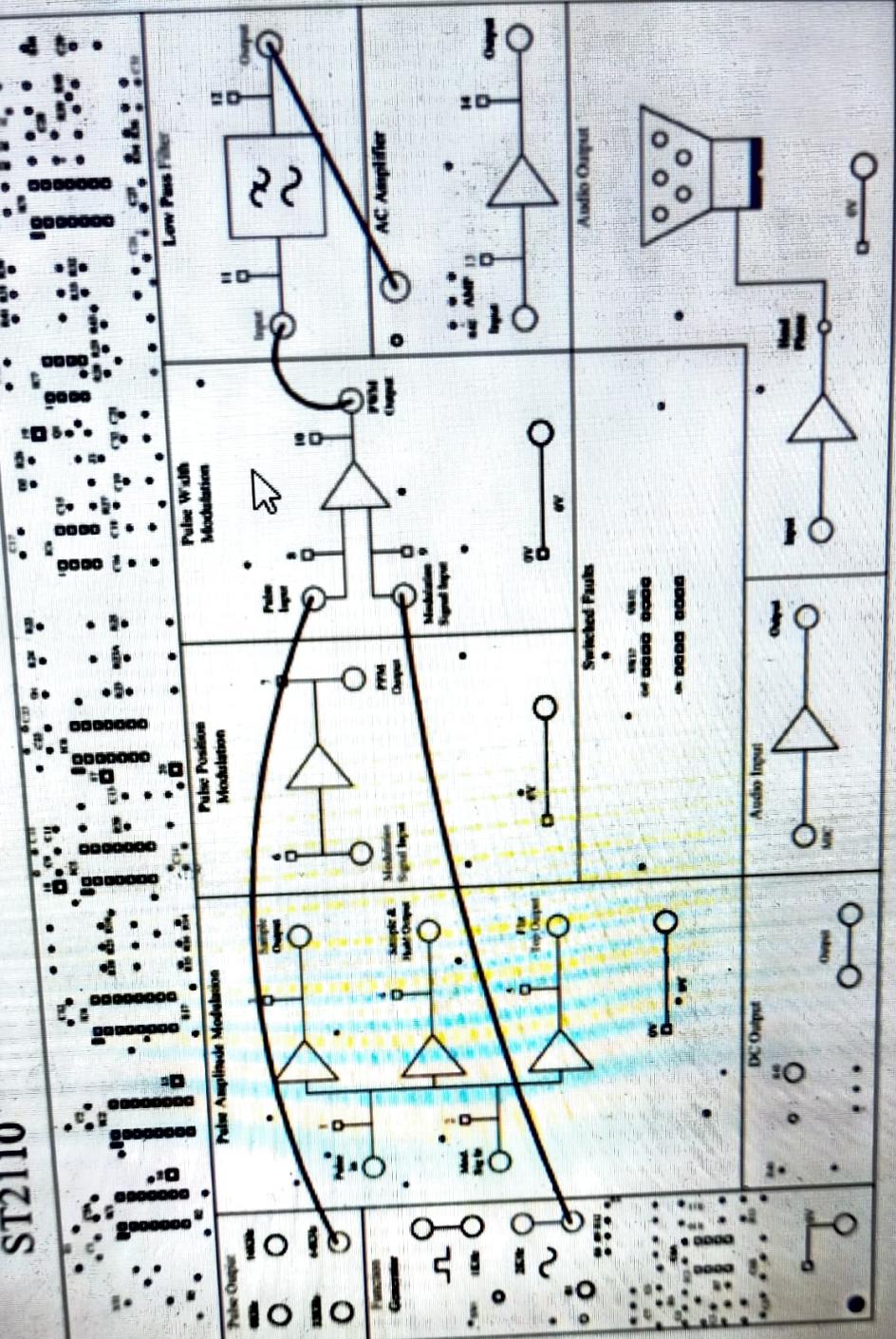


Figure 2

Experiment - 7

- Aim : 1. Study of PWM using different Sampling Frequency
 2. Study of Pulse width Demodulation

Equipments Required : STD110 with power cord ,
 CRO with connecting probes ,
 connecting cords .

Theory :

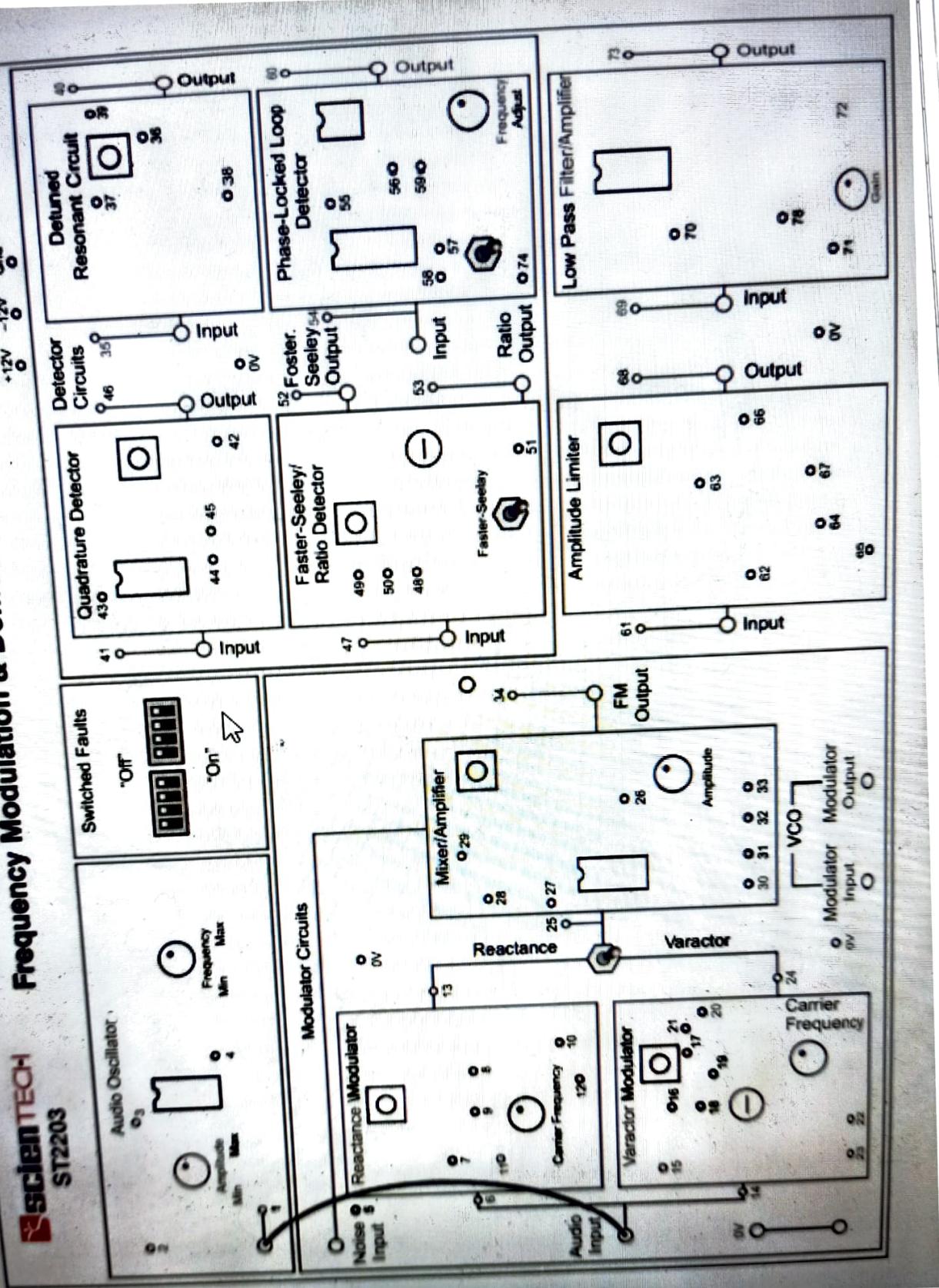
Pulse width modulator (PWM) is a modulation technique that generates variable width pulse to represent the amplitude of an analog input signal . The output switching transistor is on more of the time for a high amplitude signal and off more of the time for a low amplitude signal .

Procedure :

1. Connected the circuit as diagram given Ckt. connections were made.
2. Power supply was switched ON and amplitude was varied in sinewave and effect on pulse was observed.
3. Frequency of pulse was also varied to observe the variation of output PWM.

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4. Circuit was switched off and reconnected as per the second fig and modulations were observed. Output of PWM was passed as input to low pass filter.
5. Circuit was turned on and D/P of low pass filter and AC amplifier respectively to understand the demodulation of pulse width demodulation waveforms.
6. Amplitude and frequency of sine wave was varied to observe the results.

Result :

Learned about PWM and Studied PWM with different sampling frequencies. Successful demodulation of Pulse width was also done.

Precautions :

1. Ensure the circuit connections before turning on the power supply.
2. Do not switch ON CRO before connections are complete.

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• **PAM-PPM-PWM Modulation & Demodulation Trainer**

Power

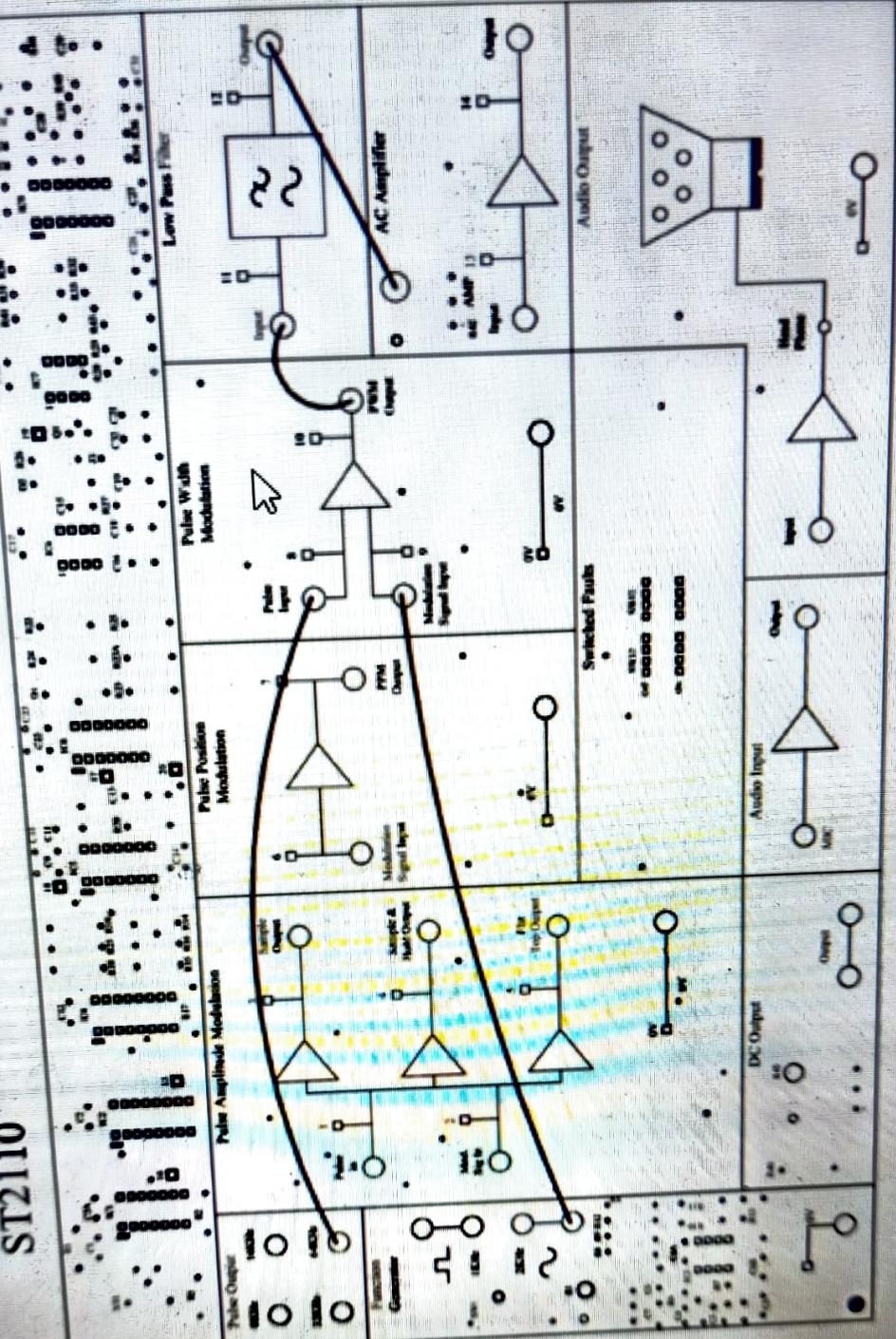


Figure 2

Viva Questions

Ques 1. What is the pulse amplitude modulation?

Ans In Pulse-amplitude modulation where the message information is encoded in the amplitude of a series of signal pulses. It is an analog pulse modulation scheme in which amplitude of a train of carrier pulses are varied according to the value of the message signal.

Ques 2. What is pulse signal?

Ans In signal processing, the term pulse has the following meaning:

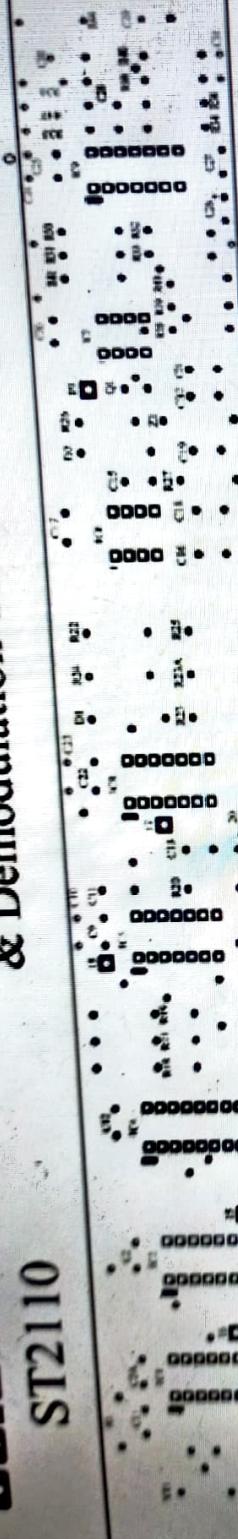
A rapid change in the amplitude of a signal from a baseline value to a higher value, followed by a rapid return to the baseline value.

Ques 3. What is PWM duty cycle?

Ans Electrical motors typically use less than a 100% duty cycle. For example, if a motor runs for one out of 100 seconds, or 1/100 of the time, then its duty cycle is 1/100 or 1 percent. Pulse width modulation (PWM) is used in a variety of electronics situations, such as power delivery and voltage regulation.

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ST2110

POWER



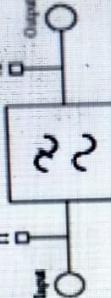
Low Pass Filter

Pulse Width Modulation

Pulse Position Modulation

Pulse Amplitude Modulation

Pulse Output



AC Amplifier

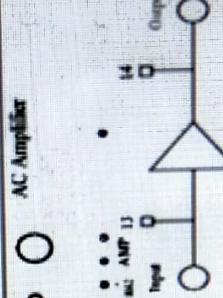
ACM Output

Modulation Signal Input

Modulation & Hold Output

Mod. Signal

Function Generator



Audio Output

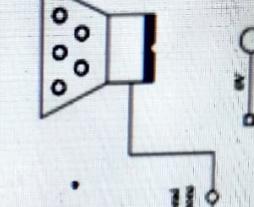
AM Output

Switched Faults

Switched Fault

Switched Fault

D.C. Output



AM Input

AM Input

AM Input

AM Input

AM Input

AM Output

AM Output

AM Output

AM Output

AM Output

AM Output

Ex

Ans. Band-width requirement of SSB is half as compared to DSB system.
SSB is a Power efficient scheme in which only 33% power is being utilized.

Ques 4. What are the application of SSB?

Ans. SSB system is used in telemetry, land and air mobile communications, military communication, navigation and amateur radio. Most of these applications are point to point communication systems.