EXPERIMENT NUMBER 3

Pulse Amplitude Modulation & Demodulation (PAM)

AIM: Conduct an experiment to generate PAM signal by varying the amplitude of the modulating signal and frequency of the sampling signal. Also design a circuit to demodulate the obtained PAM signal and verify sampling theorem. Plot the relevant waveforms.

LEARNING OBJECTIVE: To understand the waveform of PAM and:

- To understand the use of transistor as pulse amplitude modulator.
- To understand the use of operational amplifier and switching device (FET) as pulse amplitude modulator.
- To understand the classification of pulse modulation.

PRIOR CONCEPTS: Modulation and its types, Pulse modulation, Sampling Theorem, Nyquist Rate.

EQUIPMENT REQUIRED

Equipment	Range	Quantity
CRO	(0-20)MHz	1
Function Generator	(0-1)MHz	2
Experiment Kit		1

COMPONENTS REQUIRED

Components	Value	Quantity
Transistor	BC107	1
Capacitor	0.01μF	1
Resistor	10kΩ	2
	2.2kΩ	1

THEORY: Pulse-amplitude modulation is the simplest form of signal modulation and analog to digital conversion method where the message information is encoded in the amplitude of a series of signal pulses. It is a modulation technique in which the amplitude of each pulse is controlled by the instantaneous amplitude of the modulation signal at the time of each pulse. This technique transmits data by varying the voltage or power amplitudes of individual pulses in a timed sequence of electromagnetic pulses. In other words, the data to be transmitted is encoded in the amplitude of a series of signal pulses. Modulating a sine-wave carrier makes it possible to keep the frequency content of the transferred signal as close as possible to the centre frequency (typically the carrier frequency) of the pass band. There are two operations involved in the generation of PAM signal.

i. Instantaneous sampling of modulating signal m(t) every T_s seconds where the sampling rate $f_s = 1/T_s$ is chosen in accordance with the sampling theorem.
ii. Lengthening the duration of each sample so obtained to some constant value T.

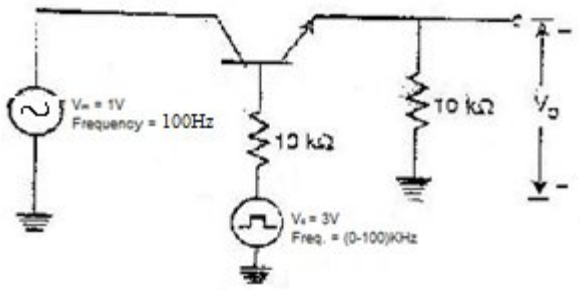
These two operations are jointly referred to as SAMPLE and HOLD.
Demodulation is performed by detecting the amplitude level of the carrier at every symbol period.

PROCEDURE

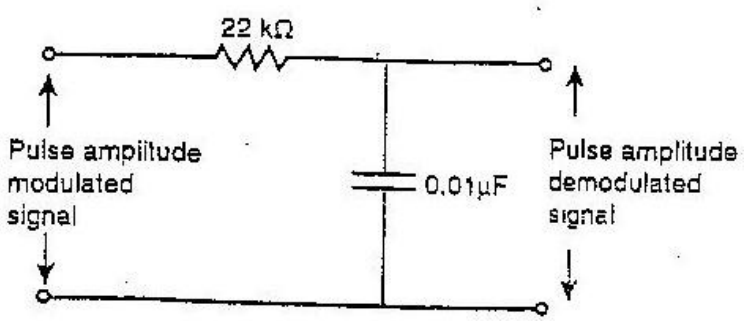
1. Connections are made as shown in the circuit diagram.
2. Apply the square wave carrier signal of around $5V_{(p-p)}$ amplitude with frequency $f_c = 5$ KHz at the base.
3. Apply sine wave modulating signal with frequency $f_m = 100$Hz with $2V_{(p-p)}$ amplitude (use function generator) at the collector of the transistor.
   Note: frequency ranges mentioned above may vary from kit to kit. These values are just for your guidance.
4. Output is taken at the emitter.
5. Observe the PAM output.
6. Modulated signal is fed to the input of demodulation circuit.
7. Observe the demodulated signal at the output.
8. Repeat the steps 2 to 5 for $f_c = 2f_m$ and $f_c < 2f_m$.

CIRCUIT DIAGRAM

Pulse Amplitude Modulation



Pulse Amplitude Demodulation

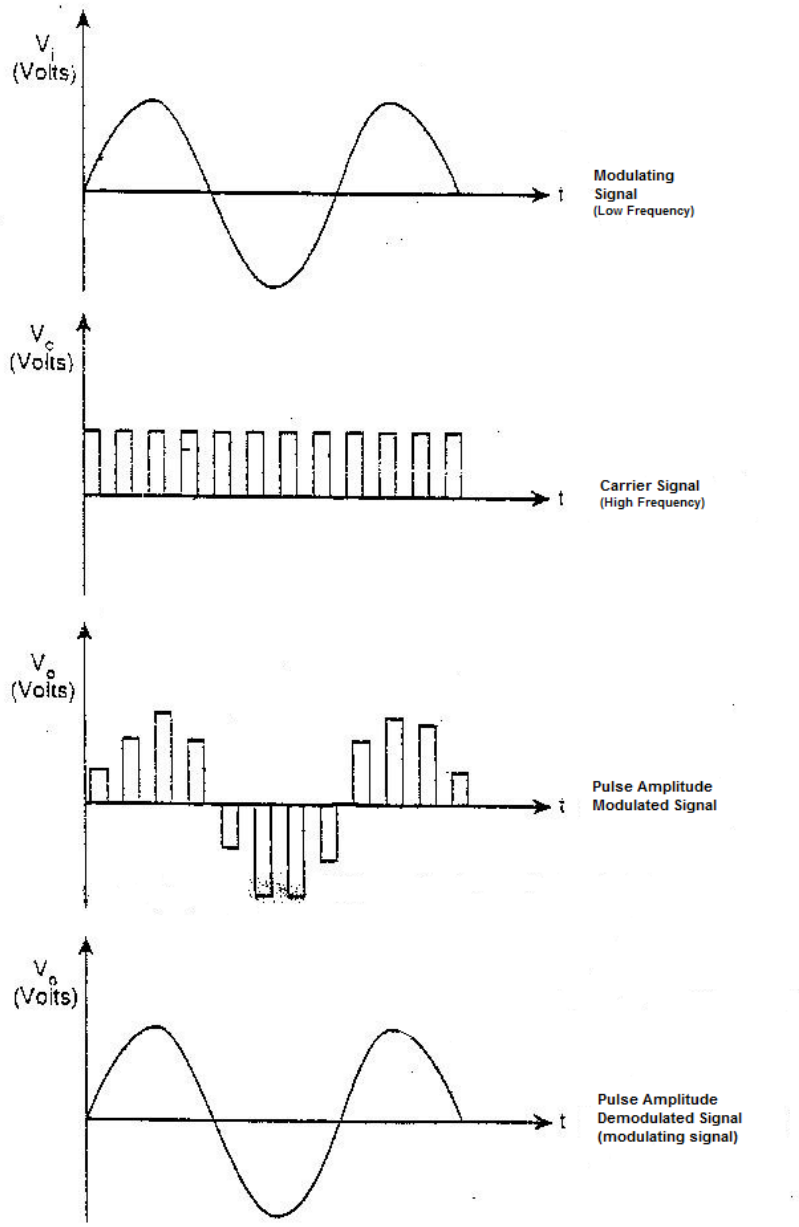


OBSERVATIONS:

- Number of pulses obtained in one cycle of the modulating signal =
- Measure of the amplitude of each pulse =

CONCLUSION: Thus, in PAM, (amplitude/time/position) of carrier changes in accordance to the _____ of the modulating signal. Write the conclusion based on the amplitude (volts) of pulse count.

WAVEFORMS:



Lab Report

Write a paragraph about questions and confusions that you experienced while performing the experiment in this lab.