# Pulse Amplitude Modulation

Today communication is the heart of technology. Communication is achieved over a transmitter and a receiver through signals. These signals carry the information through modulation. Pulse Amplitude Modulation is one of the kinds of modulation techniques used in signal transmission. Pulse amplitude modulation is the simplest form of modulation. It is an Analog to digital conversion method where the message information is encoded in the amplitude of the series of signal pulses. This article discusses an overview of pulse amplitude modulation which is known as PAM.

# What is Pulse Amplitude Modulation?

Pulse amplitude modulation is the basic form of pulse modulation. In this modulation, the signal is sampled at regular intervals and each sample is made proportional to the amplitude of the modulating signal. Before we study in detail PAM lets us know the concepts of modulation.

# What is Modulation?

Modulation is a process of changing the characteristics of a carrier signal like amplitude, frequency, and width, etc. It is the process of adding information to the carrier signal. A carrier signal is a steady waveform with constant amplitude and frequency.

**Modulation Signal**

**Carrier Signal**
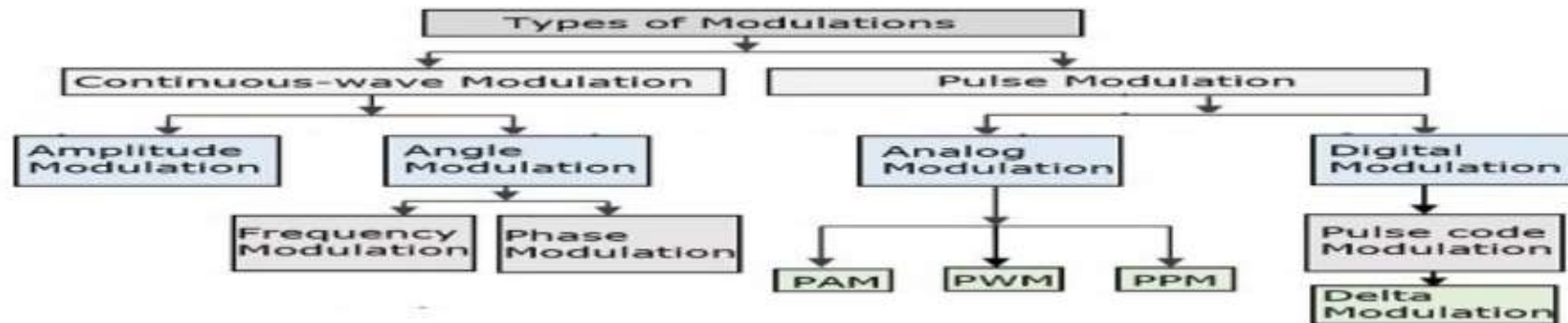
**Modulated Carrier Signal**
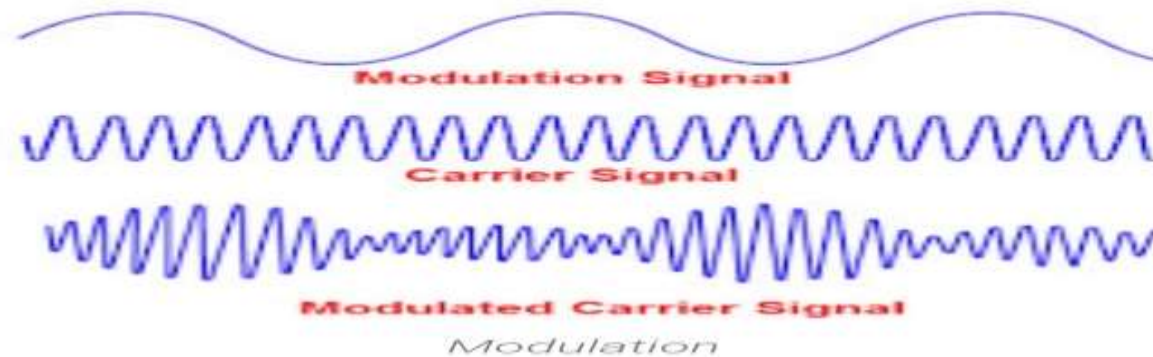
*Modulation*

Modulation is normally applied to electromagnetic signals like radio laser and optical signals. The Audio, video, images, and text data are added to the carrier signal for transmission over telecommunication.

# Types of Modulation

Modulation is categorized into two types depending on the type of signal.

- Continuous–wave Modulation
- Pulse Modulation

Continuous–wave modulation and Pulse modulation are further categorized as shown below.
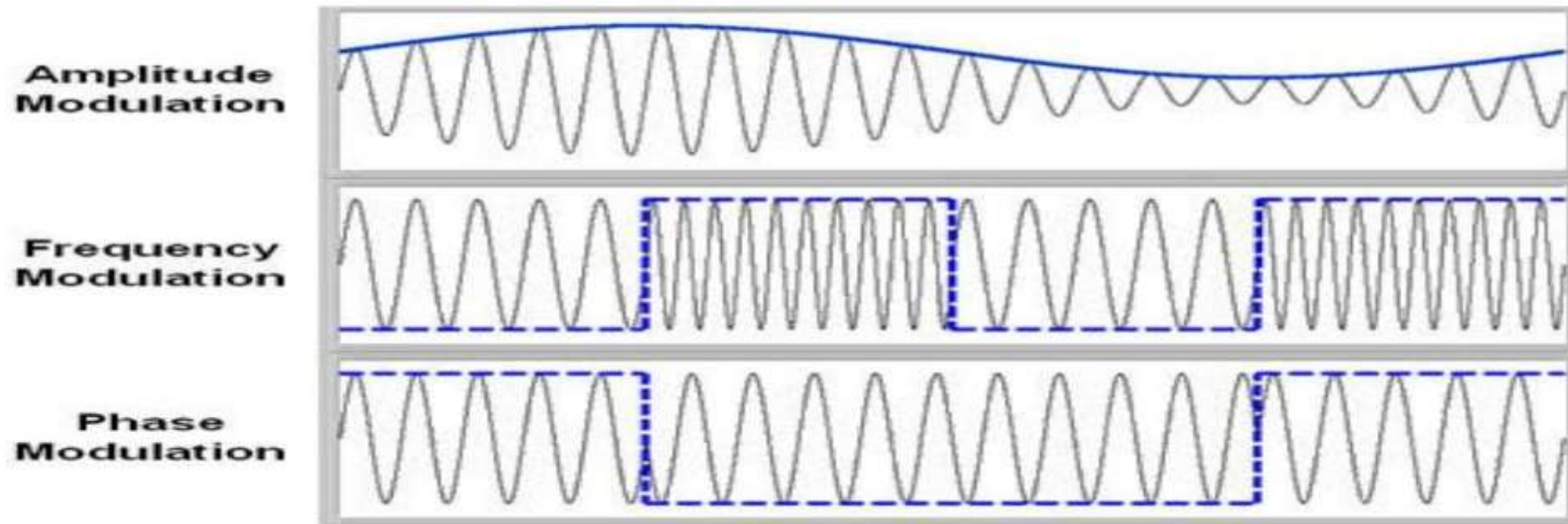


*Types of Modulations*

# Continuous-wave Modulation

In continuous wave modulation signal is used as a carrier signal which modulates the message signal. There are three parameters that can be altered to achieve modulation namely, frequency, amplitude and phase. Thus, there are three types of modulations.

# 1. Amplitude Modulation
# 2. Frequency Modulation
# 3. Phase Modulation



Types of Analog Modulation

# Pulse Modulation

Pulse modulation is a technique in which the signal is transmitted with the information by pulses. This is divided into Analog Pulse Modulation and Digital Pulse Modulation.

Analog pulse modulation is classified as

- Pulse Amplitude Modulation (PAM)
- Pulse Width Modulation (PWM)
- Pulse Position Modulation (PPM)

Digital modulation is classified as

- Pulse Code Modulation
- Delta Modulation

# Pulse Amplitude Modulation

Pulse amplitude modulation is a technique in which the amplitude of each pulse is controlled by the instantaneous amplitude of the modulation signal. It is a modulation system in which the signal is sampled at regular intervals and each sample is made proportional to the amplitude of the signal at the instant of sampling. This technique transmits the data by encoding in the amplitude of a series of signal pulses.
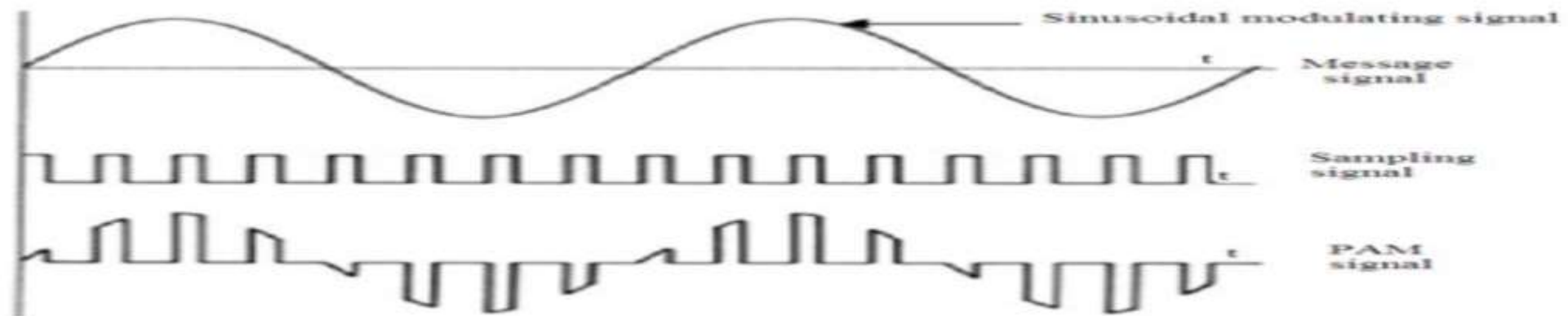
There are two types of sampling techniques

for transmitting a signal using PAM. They are:

1. Flat Top PAM
2. Natural PAM

## Flat Top PAM

The amplitude of each pulse is directly proportional to modulating signal amplitude at the time of pulse occurrence. The amplitude of the signal cannot be changed with respect to the analog signal to be sampled. The tops of the amplitude remain flat.
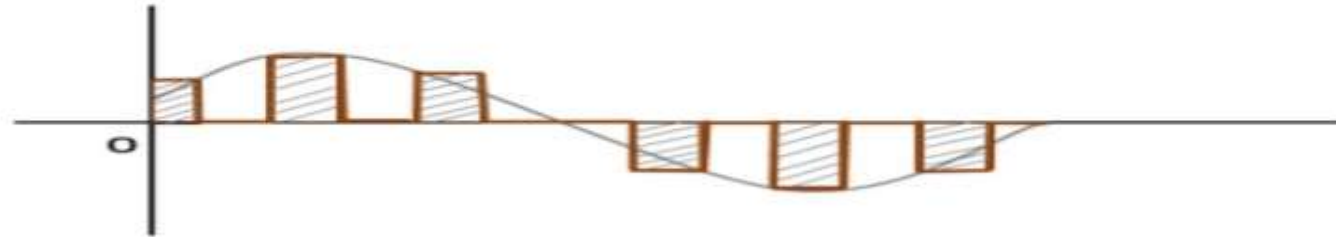
Flat Top Pulse Amplitude Modulation

# Natural PAM

The amplitude of each pulse is directly proportional to modulating signal amplitude at the time of pulse occurrence. Then follows the amplitude of the pulse for the rest of the half-cycle.
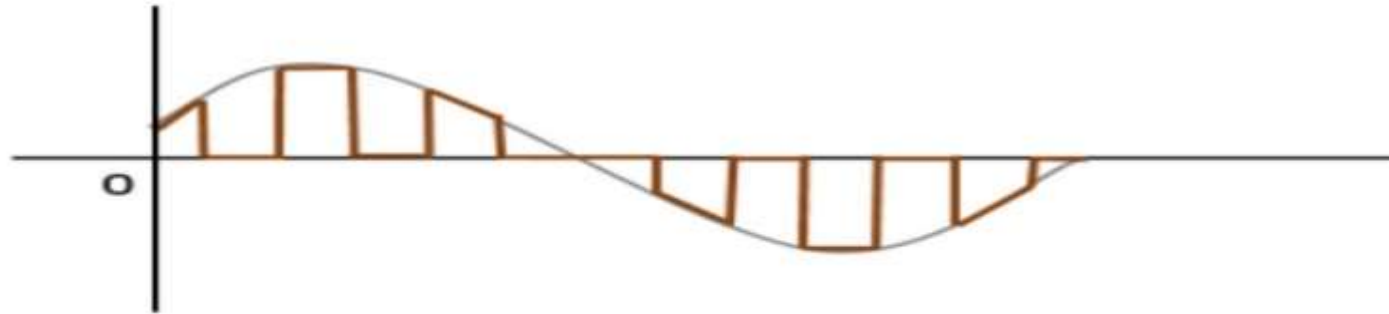
Natural Pulse Amplitude Modulation

# Types of Pulse Amplitude Modulation

Pulse amplitude modulation is categorized into two types

1. Single Polarity PAM
2. Double Polarity PAM

Single polarity PAM is a situation where a suitable fixed DC bias is added to the signal to ensure that all the pulses are positive.

Double polarity PAM is a situation where the pulses are both positive and negative.

In some pulse amplitude modulations, the amplitude of each pulse can be directly proportional to instant modulating amplitude once the pulse takes place. In another type of PAM, each signal's amplitude can be inversely proportional toward instant modulating amplitude once a pulse occurs.

## Advantages

The advantages of pulse amplitude modulation include the following.

- It is a simple process for both modulation and demodulation.
- Transmitter and receiver circuits are simple and easy to construct.
- PAM can generate other pulse modulation signals and can carry the message at the same time.
- The data can be transmitted quickly, efficiently, and effectively through usual copper wires in high volume.
- The FM available is infinite; therefore the development of PAM can be done frequently to permit enhanced data throughput over accessible networks.

## Disadvantages

The disadvantages of pulse amplitude modulation include the following.

- Bandwidth should be large for transmission PAM modulation.
- Noise will be great.
- Pulse amplitude signal varies so the power required for transmission will be more.
- For transmitting PAM signal, BW must be large
- The frequency changes based on the message or modulating signal because of these changes within the frequency of the signal, intrusions will be there.

## Applications of PAM

- It is used in Ethernet communication.
- It is used in many micro-controllers for generating control signals.
- It is used in Photo-biology.
- It is used as an electronic driver for LED lighting.
- PAM is used in the Ethernet network which is used to connect two systems & used to transfer data among these systems. So PAM is used in Ethernet communications.
- The control signals can be generated in various microcontrollers by using PAM
- This modulation technique is mostly used in digital data transmission & applications changed by PCM &PPM. Mostly all phone modems which are faster above 300 bit/s utilize QAM (quadrature amplitude modulation).

# THANK YOU