Ministry of Higher Education and Scientific Research

Al-Mustaqbal University College

Computer Engineering Techniques Department

Subject: Digital Communications

Class: 3rd

Lecture Three

"Pulse Modulation Techniques"

By

Msc. Musadaq Mahir

2021-2022

Pulse Modulation

In pulse modulation some parameter of a pulse train is varied in accordance with the massage signal.

Two families of pulse modulation may be distinguished: ***analog pulse modulation and digital pulse modulation***. In analog pulse modulation, a periodic pulse train is used as the carrier wave, and some characteristics features of each pulse (e.g. Amplitude, Position, and Width) is varied in a continuous manner in accordance with the corresponding sample value of the message signal. Thus in analog pulse modulation, information is transmitted basically in analog form, but the transmission takes place at discrete times.

In digital pulse modulation, on the other hand, the massage signal is represented in a form that is discrete in both time and amplitude; thereby permitting its transmission in digital form as a sequence of coded pulses.

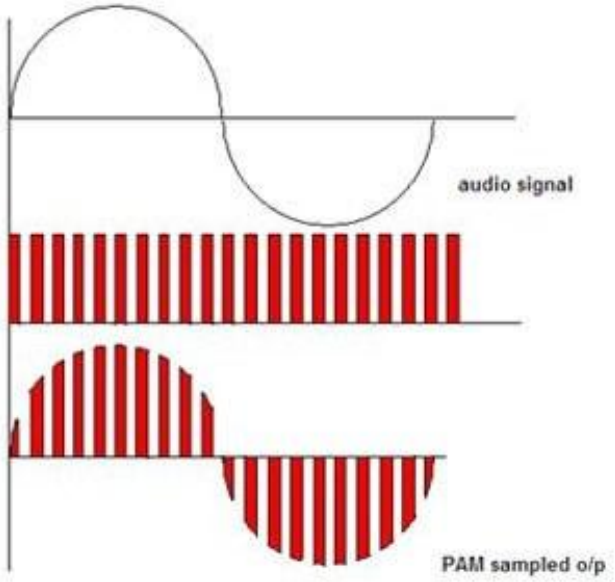
(1) Pulse Amplitude Modulation (PAM)

PAM is the simplest and most basic form of analog pulse modulation. In PAM the amplitude of regularly spaced pulses are varied in proportion to the corresponding sample values of a continuous message signal, the pulses can be of a rectangular form or other appropriate shape.

PAM as defined here is somewhat similar to natural sampling where the message signal is multiplied by a periodic train of rectangular pulses.

However, in natural sampling the top of each modulated rectangular pulse varies with the message signal, whereas in PAM it is maintained flat.

The waveform of PAM signal is shown in figure below.



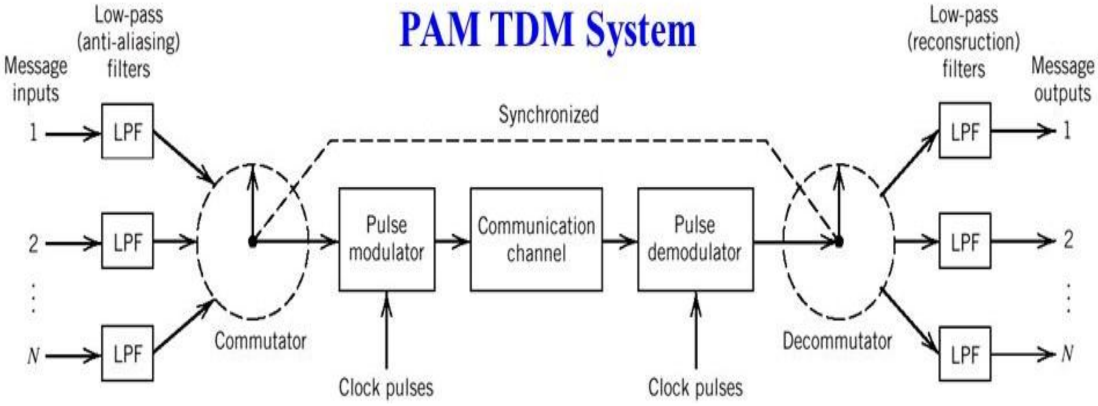
There are two operations involved in the generation of the PAM signal:-

(i) Instantaneous sampling of the message signal every Ts second, where the sampling rate $f_s=1/T_s$ is chosen in accordance with the sampling theorem.

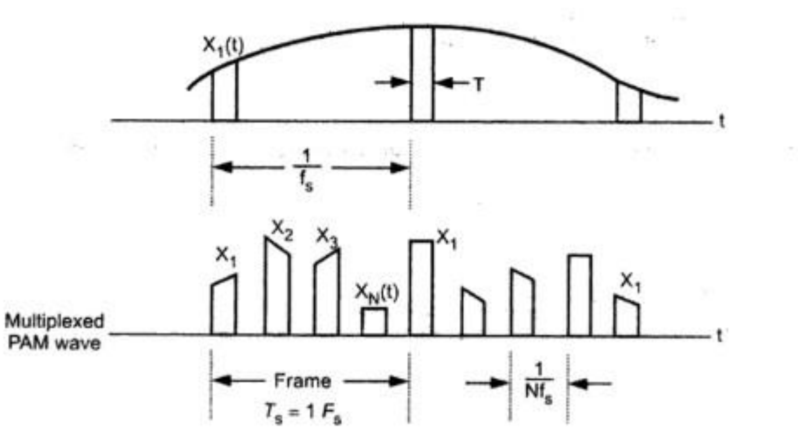
(ii) Lengthening the duration of each sample so obtained to some constant value (τ).

➢ *PAM/TDM System*

Suppose we wish to time multiplexed two signals using PAM. Let us assume that both input signal $f_1(t)$ and $f_2(t)$ are low pass, and band limited to 3KHz. The sampling theorem states that each must be sampled at a rate no less than 6KHz. This requires a 12KHz minimum clock rate for the two channel system. Figure below shows the block diagram of PAM/TDM system.



The time multiplex PAM output might appear something like that shown below.



The time spacing between adjacent samples in the time multiplex signal waveform (T_x), can be defined as

$$T_x = \frac{T_s}{n}$$

where T_s =sampling rate, and n=number of input signals.

To prevent any irretrievable loss of information in the composite waveform then requires that bandwidth B_x of LPF must satisfy the criterion

$$B_x \geq \frac{1}{2T_x}$$

At the receiver the composite time multiplexed and filtered waveform must be resampled and separated into the appropriate channel. One the pulses are separated, the normal sampling considerations applies and the analog reconstruction of signals can be obtained by LPF. The block diagram of PAM/TDM receiver is shown below.