Pulse Modulation Systems

Sampling theorem - Types of Sampling. Pulse modulation schemes – generation and detection PAM, PPM and PWM, Conversion of PWM to PPM. Multiplexing Techniques – FDM and TDM

Merits of Digital Communication:

Digital signals are very easy to receive. The receiver has to just detect whether the pulse is low or high.

AM & FM signals become corrupted over much short distances as compared to digital signals. In digital signals, the original signal can be reproduced accurately.

The signals lose power as they travel, which is called attenuation. When AM and FM signals are amplified, the noise also get amplified. But the digital signals can be cleaned up to restore the quality and amplified by the regenerators.

Merits of Digital Communication:

AM and FM signals can be received by any one by suitable receiver. But digital signals can be coded so that only the person, who is intended for, can receive them.

AM and FM transmitters are ‘real time systems’. i.e. they can be received only at the time of transmission. But digital signals can be stored at the receiving end.

The digital signals can be stored, or used to produce a display on a computer monitor or converted back into analog signal to drive a loud speaker.

Analog to Digital Conversion

- A digital signal is superior to an analog signal.
- Digital is less prone to noise and distortion.
- We can ’ t use analog signals for long distance (lose their strength, which means amplifiers are needed to amplify signal. However the amplifier creates distortion in the signal and adds some noise).
- The tendency today is to change an analog signal (such as audio ,voice and music) to digital data.

Analog to Digital Conversion Steps

Analog to Digital Conversion Steps

1- Sampling (PAM).

2- Quantization.

3- Binary encoding.

4- Line or block coding.

1. Sampling (PAM)

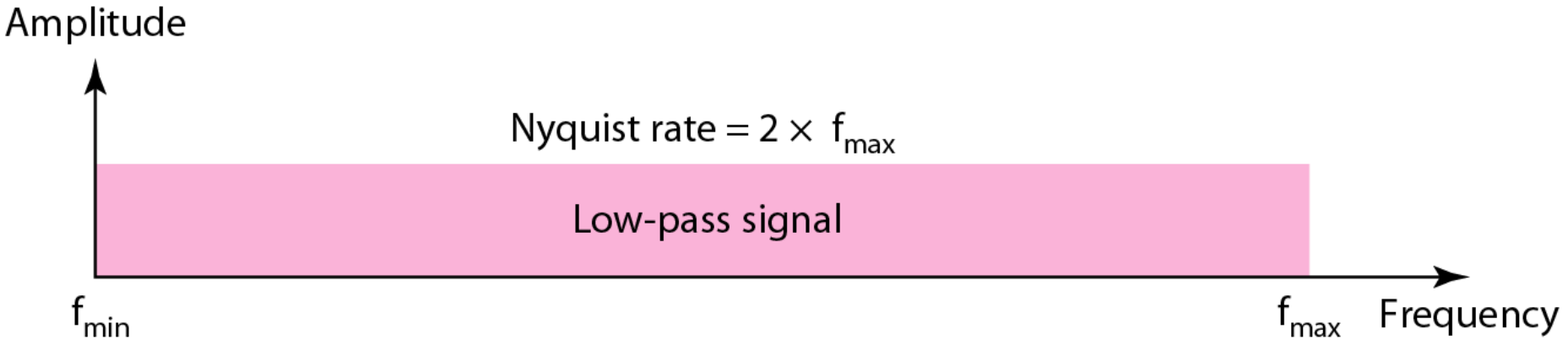
- The first step is sampling.
- The analog signal is sampled at equal interval, every T_s s (sample interval)
- The inverse of sampling interval is sampling rate or sampling frequency.

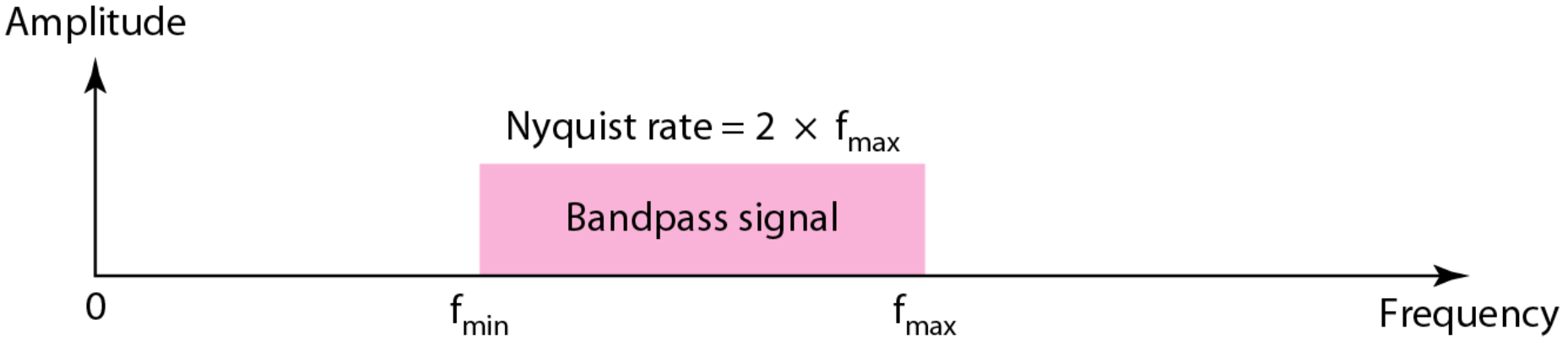
$$f_s = 1/T_s$$

- Sampling rate: number of samples per second.

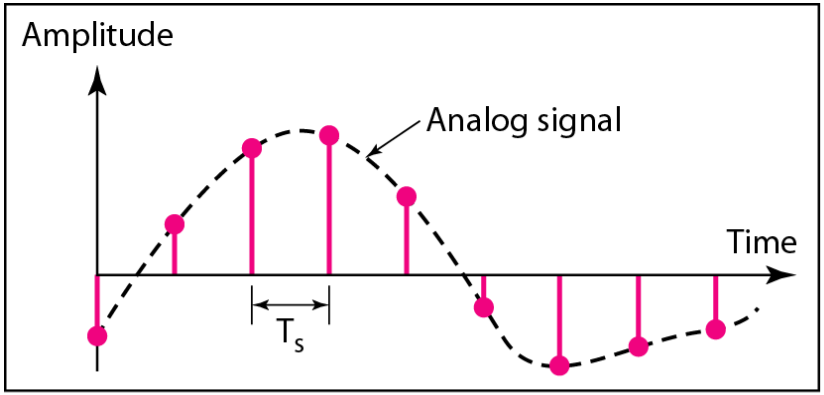
According to the Nyquist theorem, the sampling rate must be at least 2 times the highest frequency contained in the signal.

Nyquist sampling rate

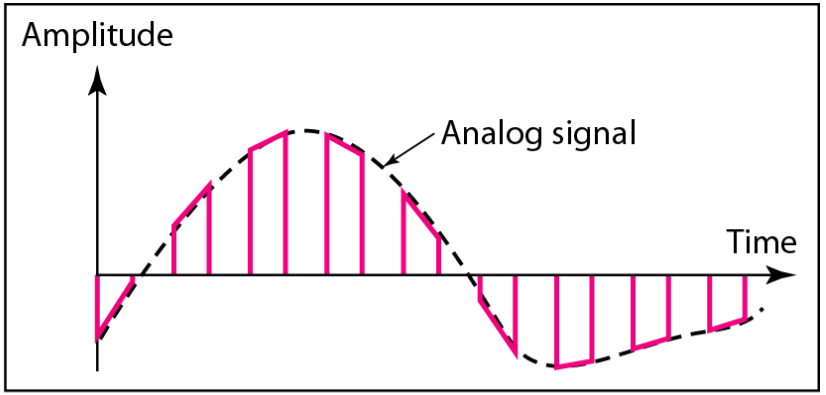




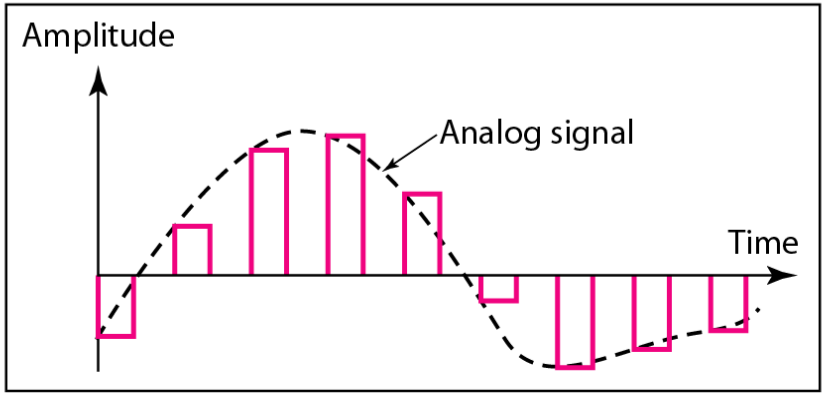
Types of sampling methods



a. Ideal sampling



b. Natural sampling



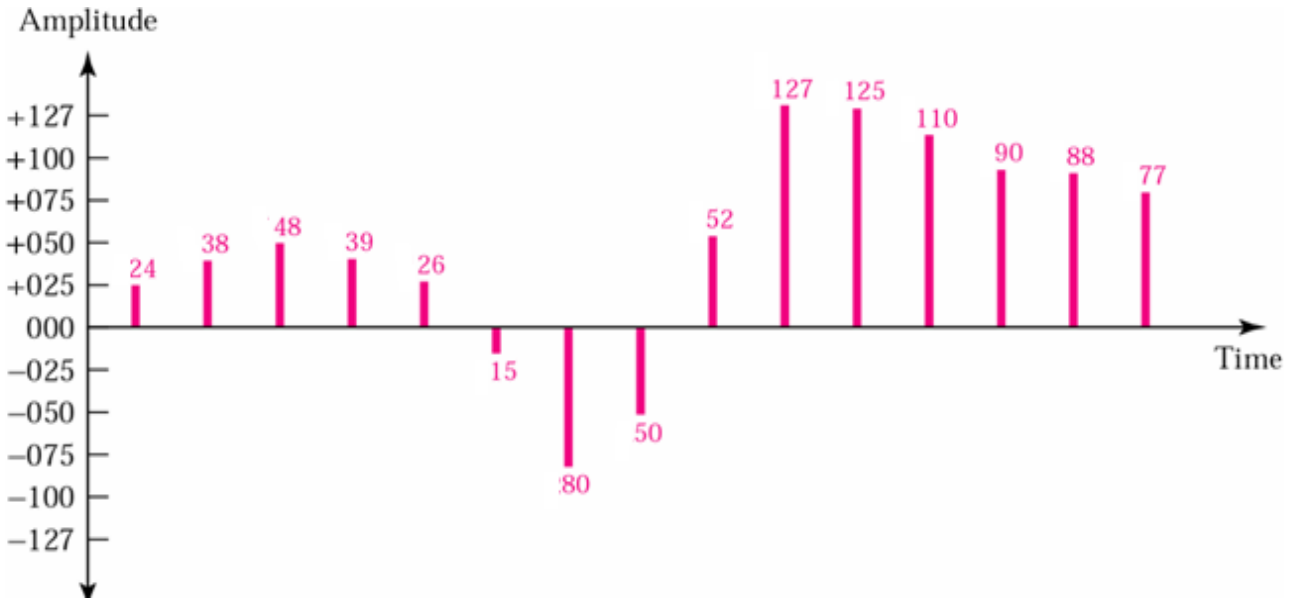
c. Flat-top sampling

Sampling

- There are 3 sampling methods:
  - Ideal - an impulse at each sampling instant
  - Natural - a pulse of short width with varying amplitude
  - Flattop - sample and hold, like natural but with single amplitude value

2. Quantized PAM Signal

- The result of sampling is a series of pulses with amplitude values between the maximum and minimum amplitudes of the signal with real values.
- **Quantization:** is a method of assigning integer values in a specific range to sampled instances.



3. Binary Encoding

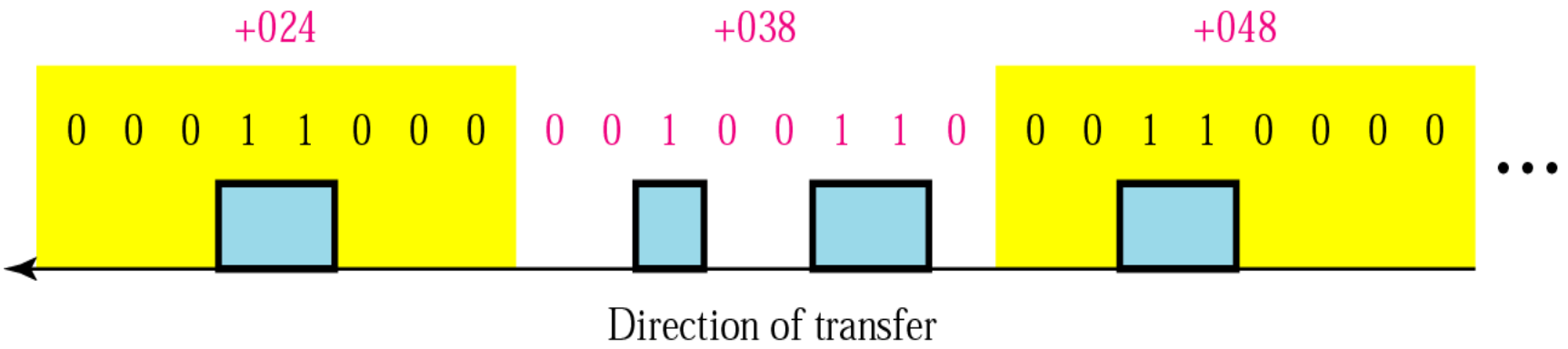
Each quantized samples is translated into equivalent binary codes .

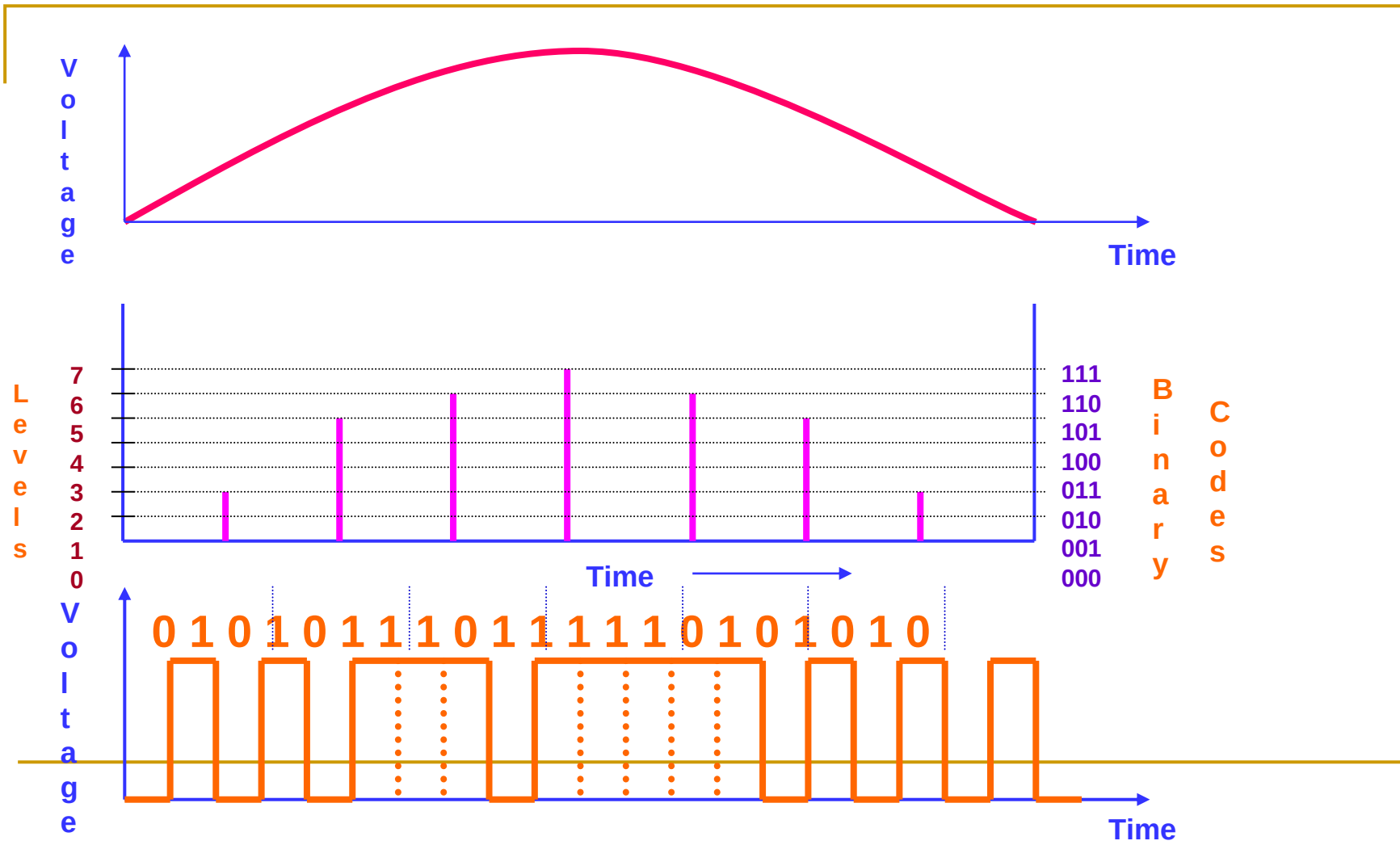
+024	00011000	–015	10001111	+125	01111101
+038	00100110	–080	11010000	+110	01101110
+048	00110000	–050	10110010	+090	01011010
+039	00100111	+052	00110110	+088	01011000
+026	00011010	+127	01111111	+077	01001101

Sign bit
+ is 0 – is 1

4. Line Encoding

- The binary digits are then transformed to a digital signal using one of the line encoding.




Voltage
Time
Levels
7
6
5
4
3
2
1
0
111
110
101
100
011
010
001
000
Binary
Codes
Time
0 1 0 1 0 1 1 1 0 1 1 1 1 0 1 0 1 0 1 0
Voltage
Time

PULSE MODULATION

The process of transmitting signals in the form of pulses (discontinuous signals) by using special techniques.

- **Pulse Amplitude Modulation**
- **Pulse Width Modulation**
- **Pulse Position Modulation**

Pulse Modulation

Analog Pulse Modulation

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

Digital Pulse Modulation

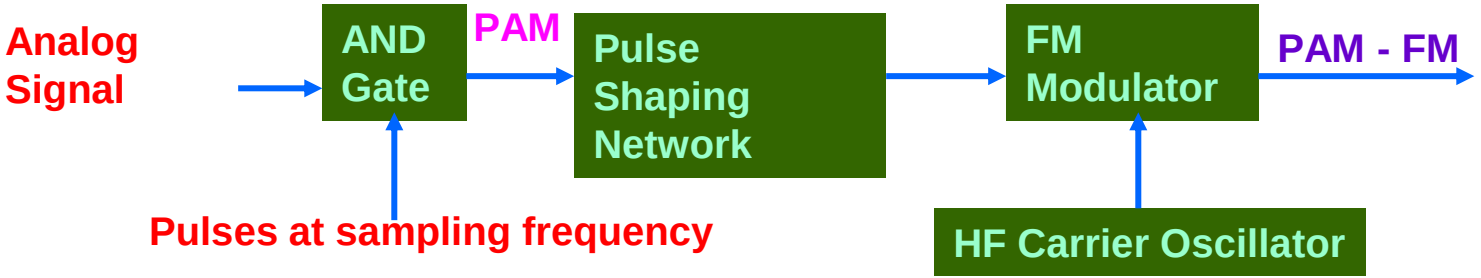
- Pulse Code (PCM)
- Delta (DM)

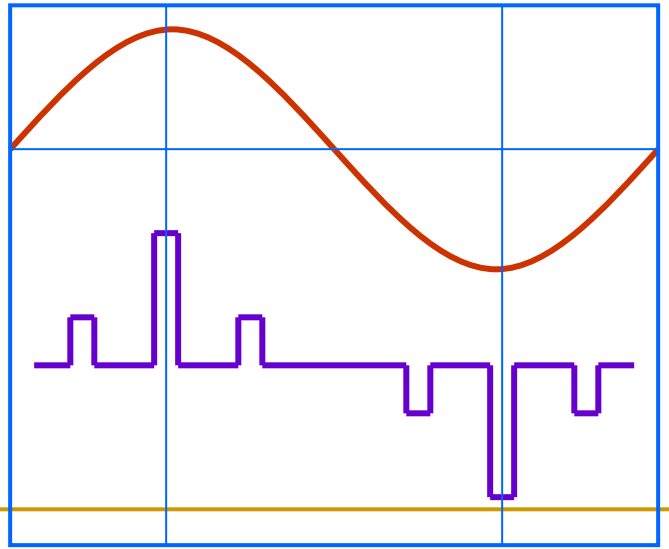
Pulse Amplitude Modulation (PAM):

*** The signal is sampled at regular intervals such that each sample is proportional to the amplitude of the signal at that sampling instant. This technique is called "sampling".**

**** For minimum distortion, the sampling rate should be more than twice the signal frequency.***

Pulse Amplitude Modulator





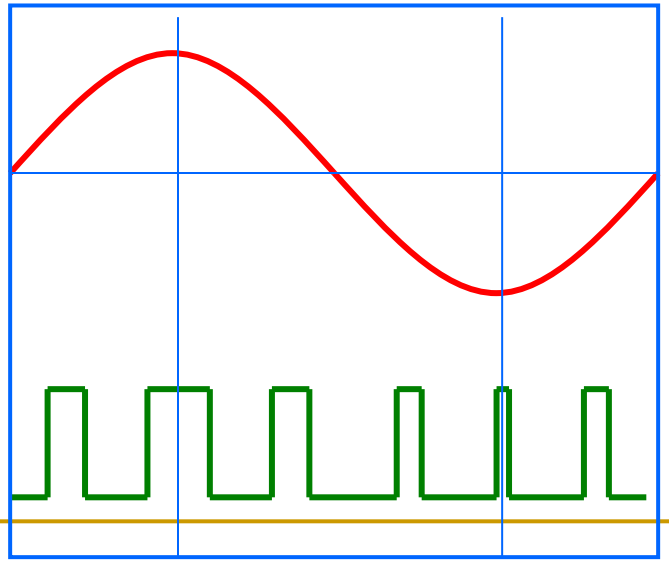
Analog Signal

Amplitude Modulated Pulses

Pulse Width Modulation (PWM):

* In this type, the amplitude is maintained constant but the duration or length or width of each pulse is varied in accordance with instantaneous value of the analog signal.

* The negative side of the signal is brought to the positive side by adding a fixed d.c. voltage.



Analog Signal

Width Modulated Pulses

Pulse Position Modulation (PPM):

* In this type, the sampled waveform has fixed amplitude and width whereas the position of each pulse is varied as per instantaneous value of the analog signal.

* PPM signal is further modification of a PWM signal. It has positive thin pulses (zero time or width) corresponding to the starting edge of a PWM pulse and negative thin pulses corresponding to the ending edge of a pulse.