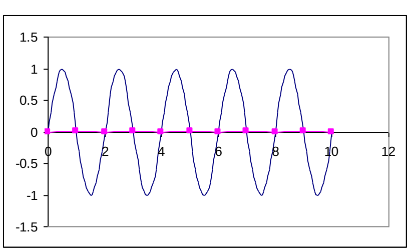
Unit-V

Pulse Communications

Sampling

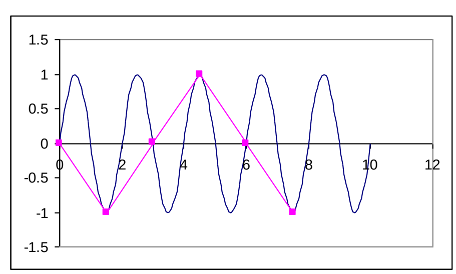
- It is process which converts continuous time continuous valued signal to discrete time continuous valued signal.
- Sampling rate, $f_s \geq 2f_m$
  f_m – frequency of the signal to be sampled

Poor Sampling



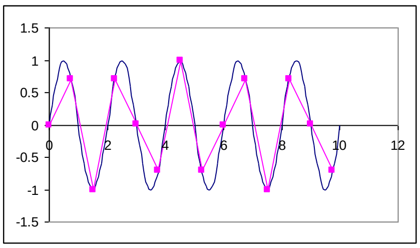
Sampling Frequency = 1/2 X Wave Frequency

Even Worse



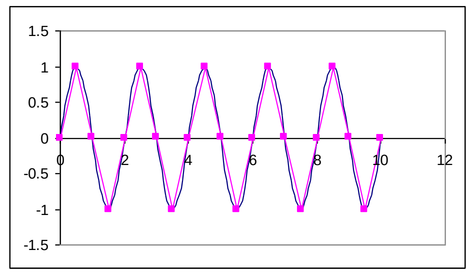
Sampling Frequency = 1/3 X Wave Frequency

Higher Sampling Frequency



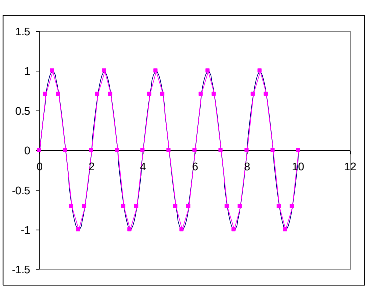
Sampling Frequency = 2/3 Wave Frequency

Getting Better



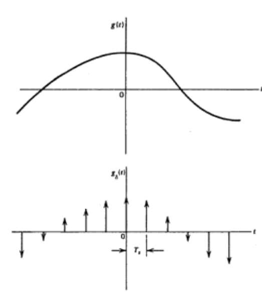
Sampling Frequency = Wave Frequency

Good Sampling



Sampling Frequency = 2 X Wave Frequency

Sampling Process



Contd…

From the definition of a delta function, we have

$$g(nT_s)\,\delta(t - nT_s) = g(t)\,\delta(t - nT_s)$$

$$g_\delta(t) = g(t) \sum_{n=-\infty}^{\infty} \delta(t - nT_s)$$

$$= g(t)\,\delta_{T_s}(t)$$

$\delta_{T_s}(t)$ is the *Dirac comb* or *ideal sampling function*

Contd…

$$F[\delta_{T_s}(t)] = f_s \sum_{m=-\infty}^{\infty} \delta(f - mf_s)$$

$$G_\delta(f) = G(f) \star \left[f_s \sum_{m=-\infty}^{\infty} \delta(f - mf_s) \right]$$

$$G_\delta(f) = f_s \sum_{m=-\infty}^{\infty} G(f) \star \delta(f - mf_s)$$

$$G_\delta(f) = f_s \sum_{m=-\infty}^{\infty} G(f - mf_s)$$

process of uniformly sampling a signal in the time domain results in a periodic spectrum in the frequency domain with a period equal to the sampling rate.

Contd..

$$G_\delta(f) = \sum_{n=-\infty}^{\infty} g(nT_s) \exp(-j2\pi n f T_s)$$

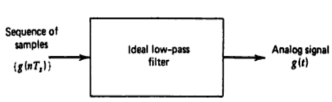
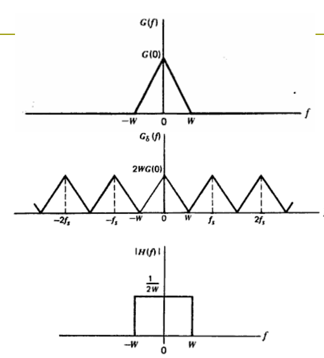


Figure Reconstruction filter.

Contd…



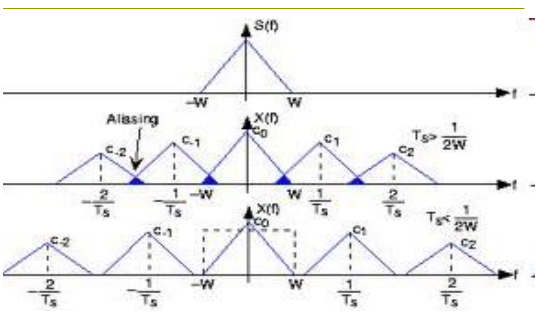
Sampling Theorem

1. *If a finite-energy signal g(t) contains no frequencies higher than W hertz, it is completely determined by specifying its ordinates at a sequence of points spaced 1/2W seconds apart.*
2. *If a finite energy signal g(t) contains no frequencies higher than W hertz, it may be completely recovered from its ordinates at a sequence of points spaced 1/2W seconds apart.*

Aliasing or Foldover

- HF component in the spectrum of signal taking identity of a LF in the spectrum of its sampled version
- Pre-Alias Filter
- fs>2W
- Physically realizable reconstruction filter

Contd…



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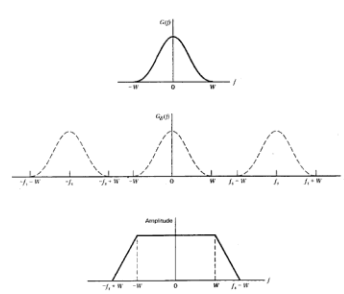
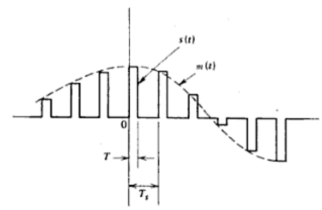


Types of Pulse Modulation

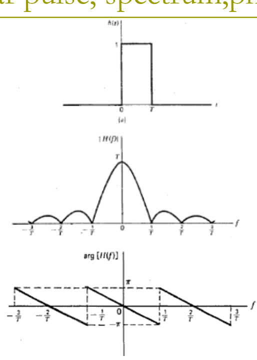
- Pulse Amplitude Modulation
- Pulse Width/Duration/Length Modulation
- Pulse Position Modulation

Pulse Amplitude Modulation

- The amplitude of regularly spaced pulses are varied in proportion to the corresponding sample values of a continuous message signal



Rectangular pulse, spectrum,phase



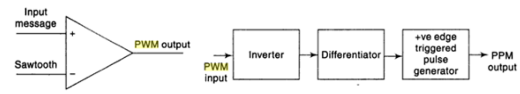
PAM

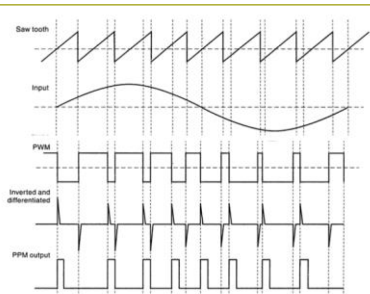
- Derivation- generation
- Aperture Effect

PPM/PWM

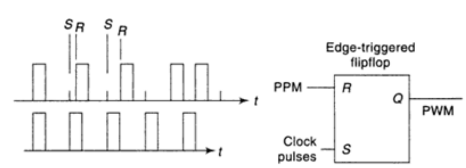
- Definition
- Generation and detection- Refer Principles of Communication by Taub and Schilling or Communication Systems by Simon Haykins

PWM/PPM



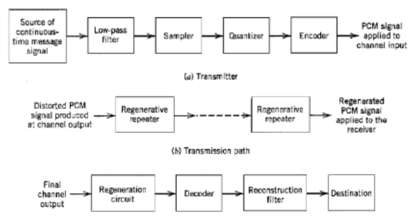


PPM to PWM



Pulse Code Modulation (PCM)

In PCM, a message signal is represented by a sequence of coded pulses, which is accomplished by representing the signal in discrete form in both time and amplitude



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Quantization

- Process in which discrete-time continuous amplitude signal is converted to discrete-time discrete amplitude signal

- Rounding off to the nearest Integer

- Types – Uniform
  Non- Uniform

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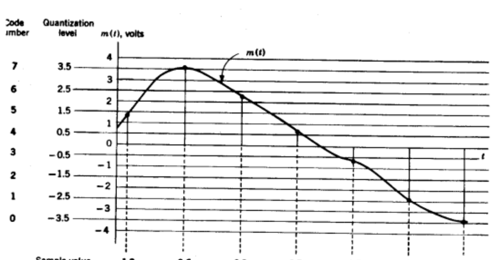
Uniform Quantization



Sample value	1.3	3.6	2.3	0.7	−0.7	−2.4	−3.4
Nearest quantization level	1.5	3.5	2.5	0.5	−0.5	−2.5	−3.5
Code number	5	7	6	4	3	1	0
Binary representation	101	111	110	100	011	001	000

Figure 5.9-1 A message signal is regularly sampled. Quantization levels are indicated. For each sample the quantized value is given and its binary representation is indicated

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Encoding

Electrical representation of binary data

NRZ-Full symbol width

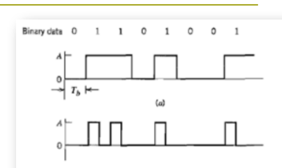
RZ – Half symbol width

NRZ-Non-Return to Zero

RZ- Return to Zero

(a) NRZ – Unipolar
- 1- presence of pulse
- 0-absence of pulse

(b) RZ- Unipolar
- 1- presence of pulse for half symbol period
- 0-absence of pulse



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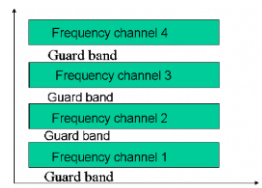
Regenerative Repeaters

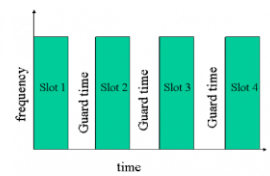
- Helps to control the effects of distortion and channel noise in PCM
- Reconstructing PCM signal from the transmitted signal
- Generates a clean pulse using equalization, timing, and decision making devices

Multiplexing

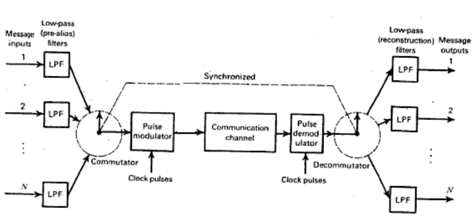
- Definition

  A no. of independent signals are combined into a composite signal suitable for transmission over a common channel
- Types – TDM, FDM





Time Division Multiplexing



Frequency Division Multiplexing

- **Transmitter**
  - The signals from the N sources are shifted to another frequency range by modulation.
  - Usually SSB/SC is preferred
  - BPF filters are used to avoid any spill into the adjacent spectra.
- **Receiver**
  - Demodulation and BPF is done
  - Filtered signals send to respective destinations

Block Diagram