

# Pulse Amplitude Modulation

- The PAM signal can be detected by passing it through a low pass filter.

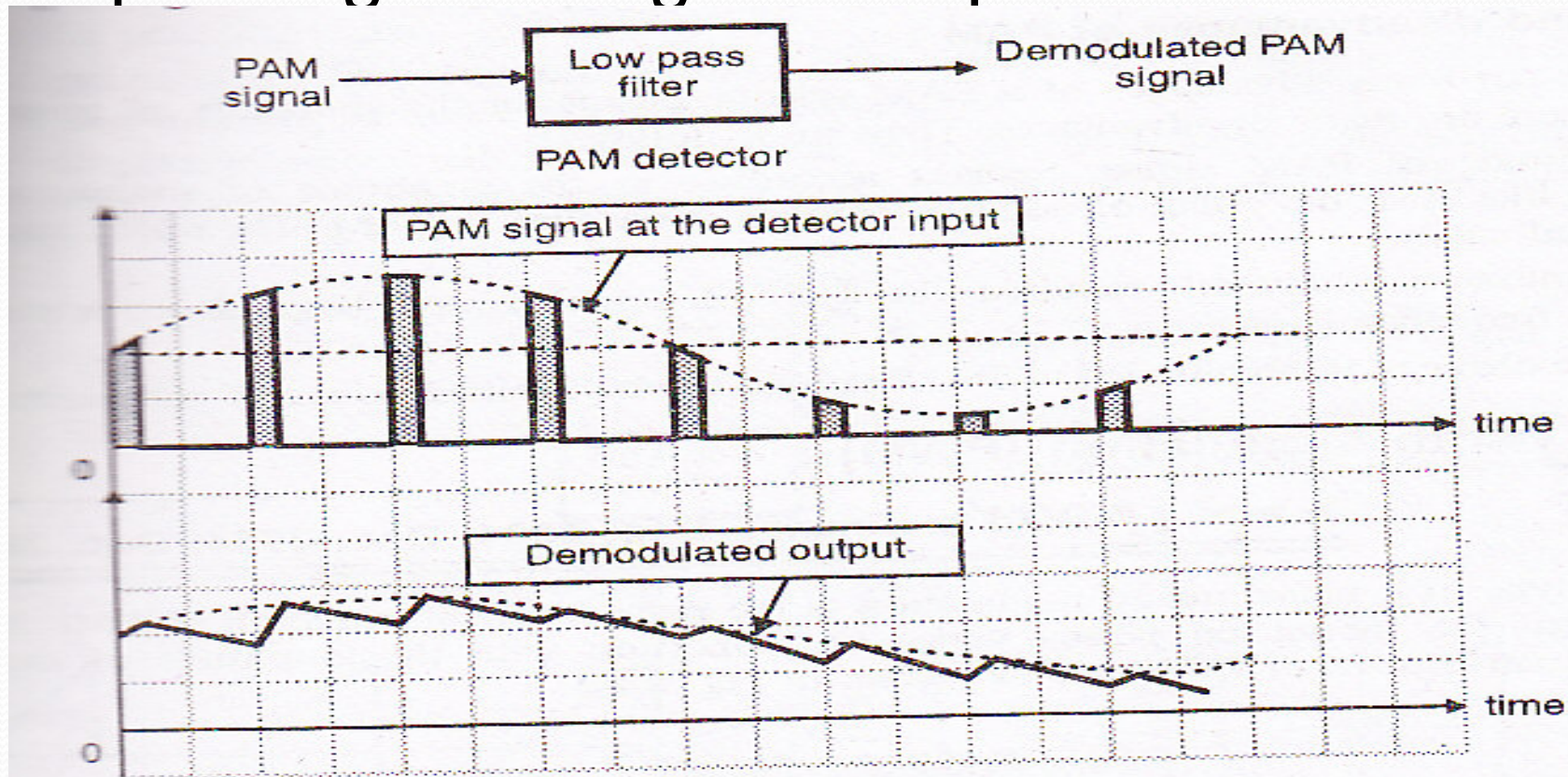
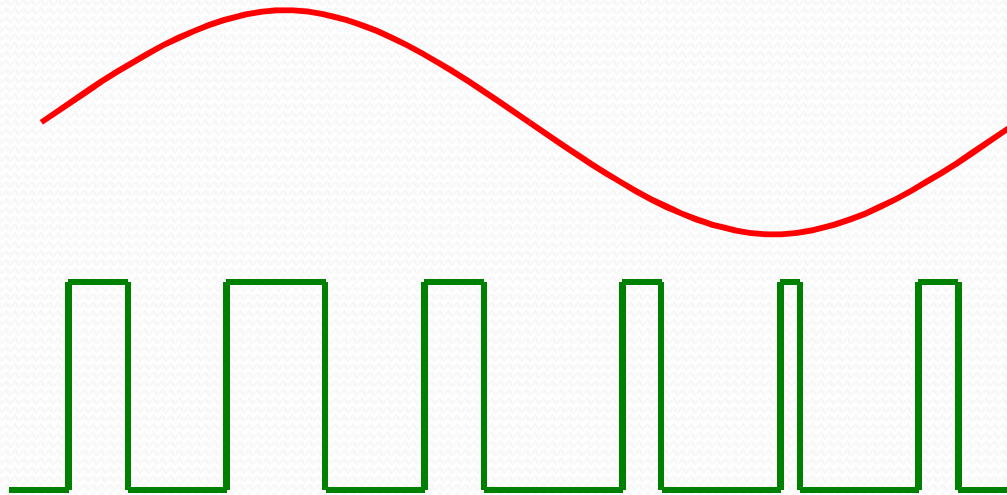


Fig : Detection of PAM and waveforms

# Pulse Width Modulation

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



# Pulse Width Modulation

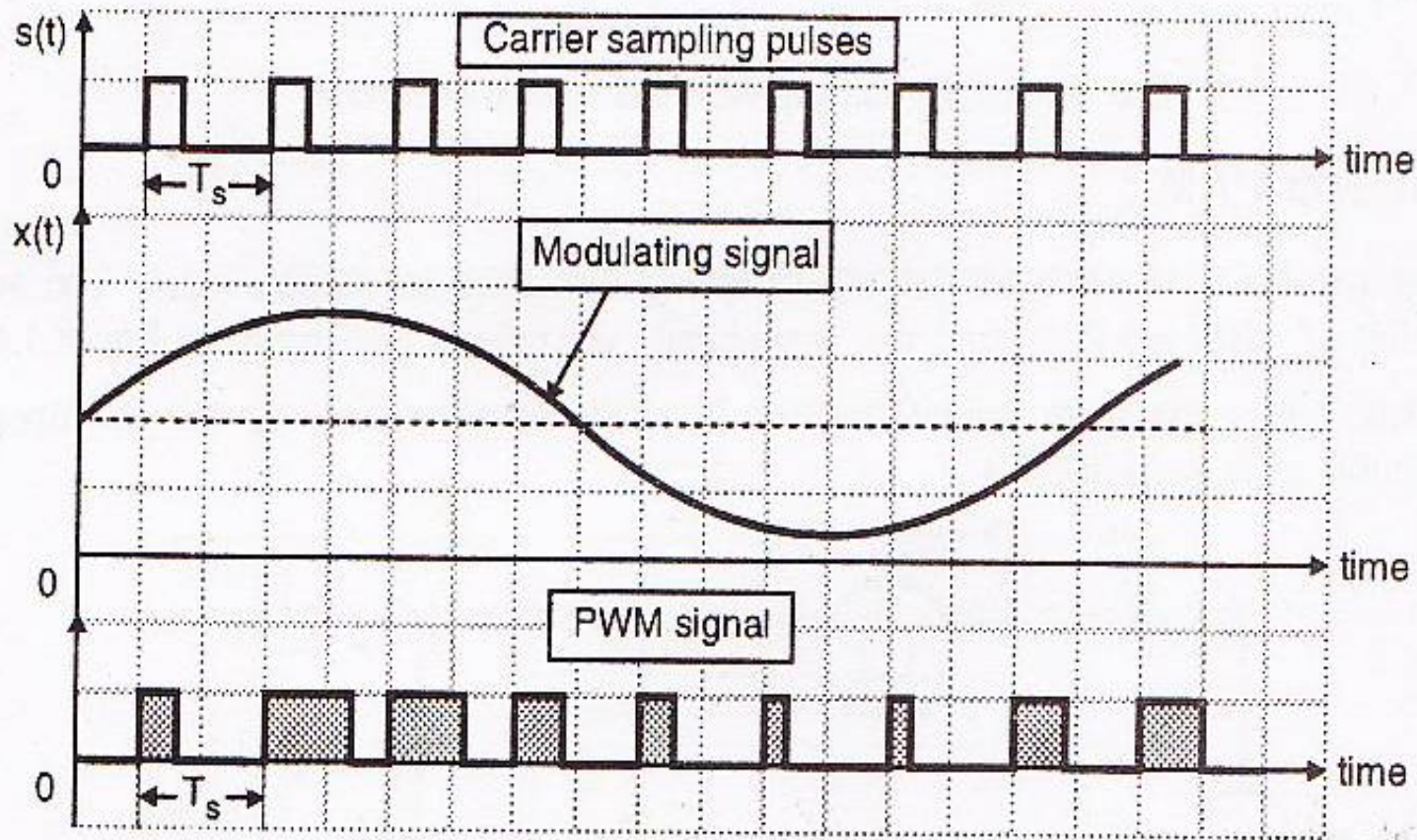


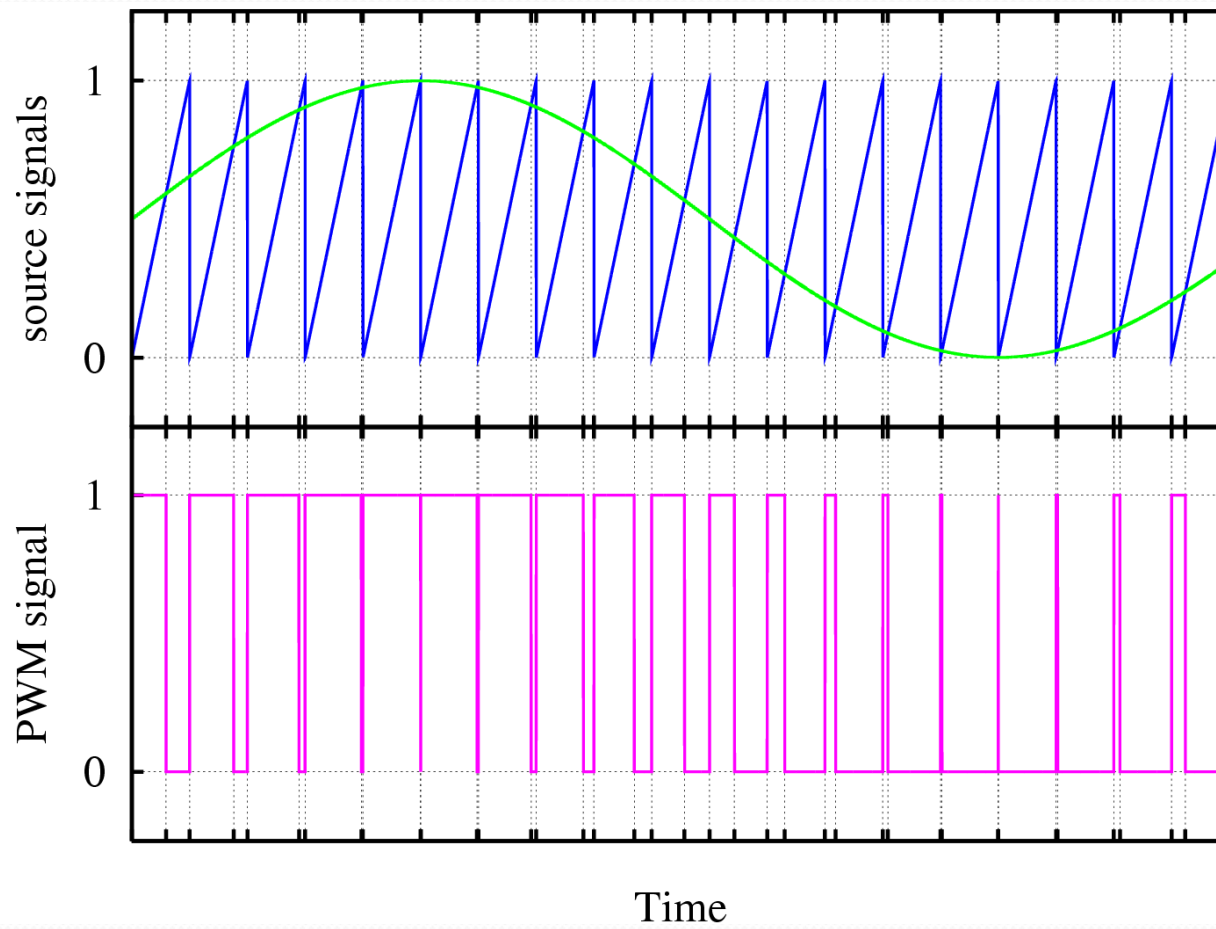
Fig: PWM signal [ Trail edge modulated signal ]



# **Pulse Width Modulation**

- That is why the information is contained in width variation. This is similar to FM.
- In pulse width modulation (PWM), the width of each pulse is made directly proportional to the amplitude of the information signal.

# Pulse Width Modulation





# Pulse Width Modulation

- A simple method to generate the PWM pulse train corresponding to a given signal is the intersective PWM: the signal (here the green sinewave) is compared with a sawtooth waveform (blue). When the latter is less than the former, the PWM signal (magenta) is in high state (1). Otherwise it is in the low state (0).



# Pulse Width Modulation

- The block diagram of next slide can be used for generation of PWM as well as PPM. In this case a sawtooth signal of frequency  $f_s$  is a sampling signal.
- It is applied to inverting terminal of a comparator with modulating signal at non inverting terminal.
- O/P remains high as long as modulating signal is higher than that of ramp signal.

# Pulse Width Modulation

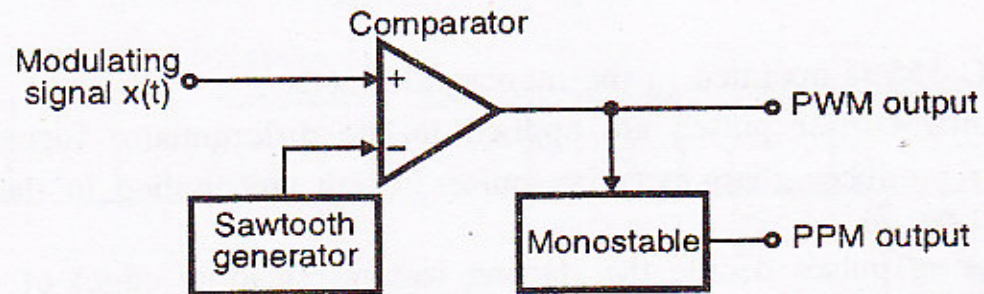


Fig. 8.4.2(a) : PWM and PPM generator

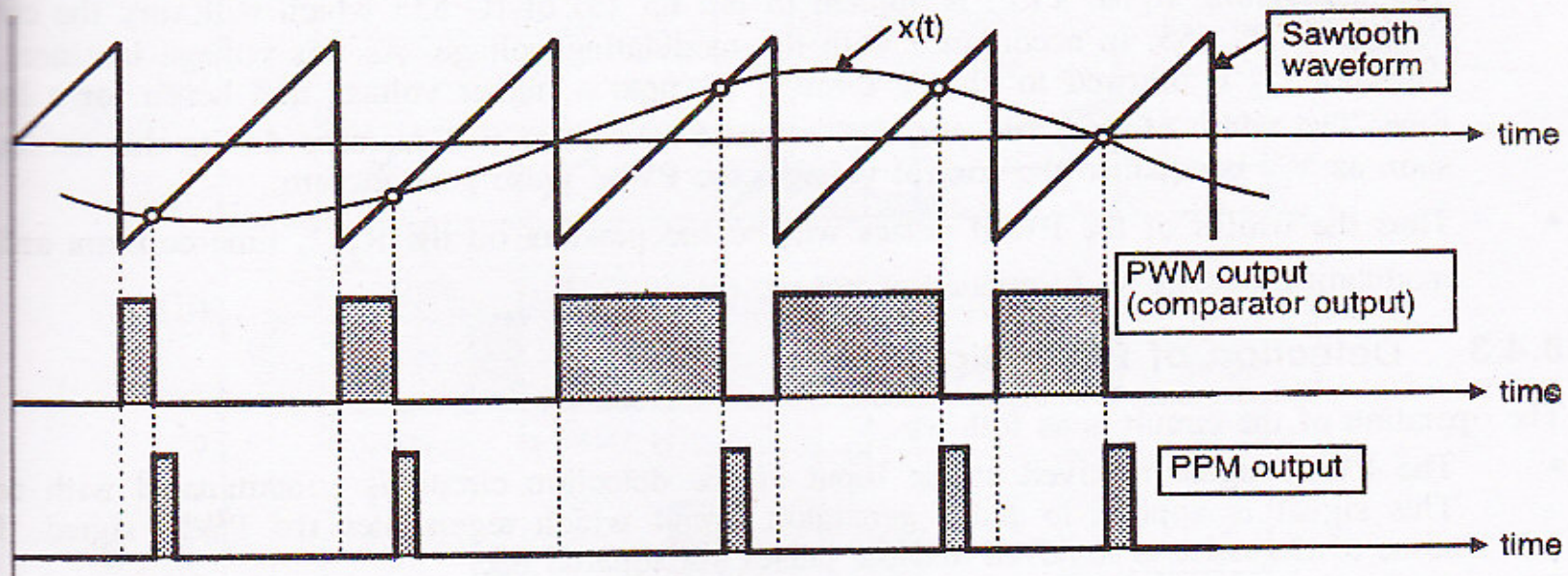


Fig. : Waveforms





# **Pulse Position Modulation**

- 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.

# Pulse Position Modulation

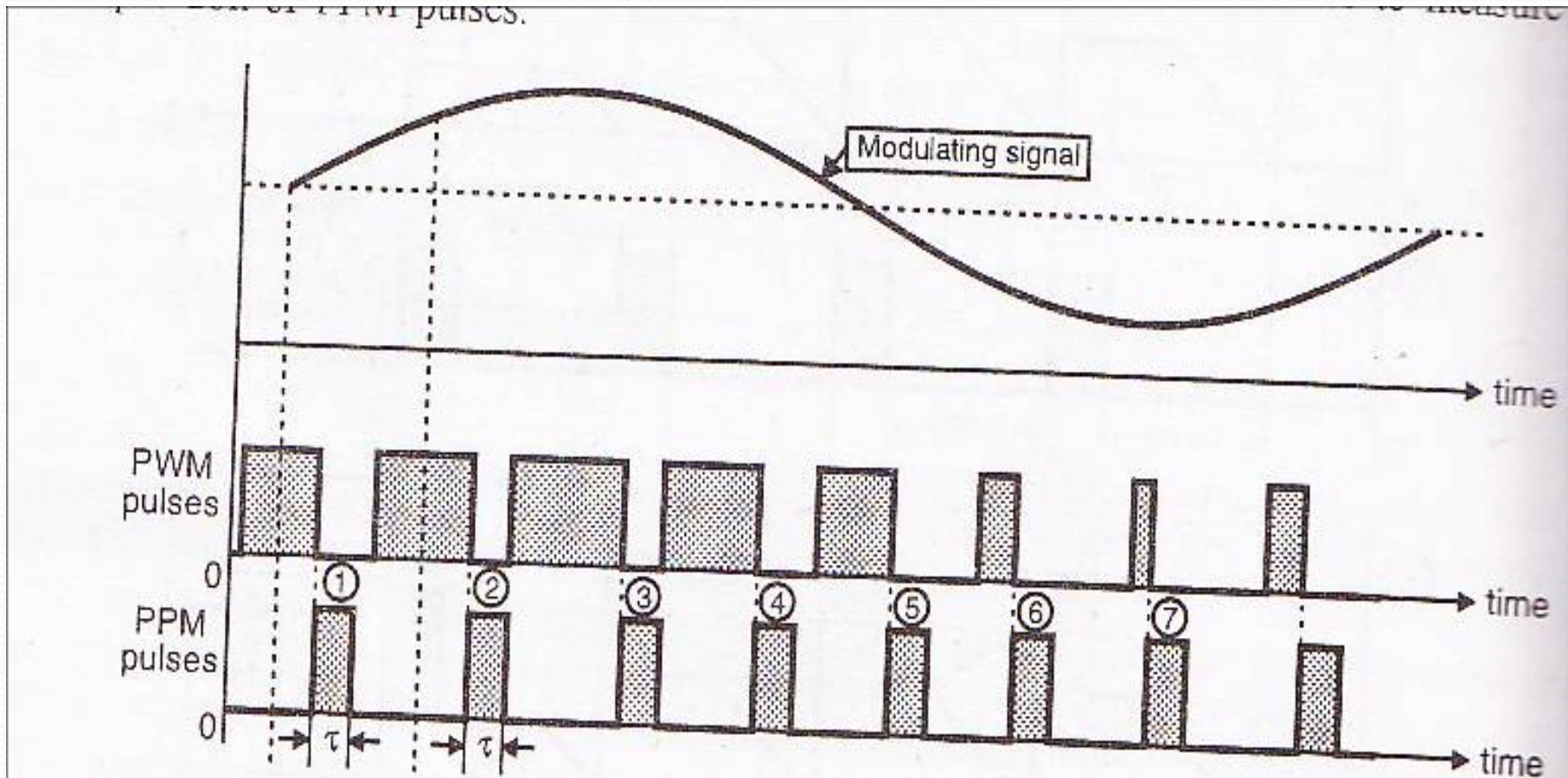


Fig. : PPM pulses generated from PWM signal



# **Pulse Position Modulation**

- The vertical dotted lines shown in last slide treated as reference lines.
- The PPM pulses marked 1,2 and 3 go away from their respective reference lines. This corresponds to increase in modulating signal amplitude.
- Then as modulating signal decreases the PPM pulses 4,5,6,7 come closer to their respective reference lines.



# Pulse Position Modulation

- The PPM signal can be generated from PWM signal.
- The PWM pulses obtained at the comparator output are applied to a monostable multivibrator which is –ve edge triggered.
- Hence for each trailing edge of PWM signal, the monostable output goes high. It remains high for a fixed time decided by its own RC components.



# **Pulse Position Modulation**

- Thus as the trailing edges of the PWM signal keeps shifting in proportion with the modulating signal, the PPM pulses also keep shifting.
- Therefore all the PPM pulses have the same amplitude and width. The information is conveyed via changing position of pulses.

# Digital Pulse Modulation

- **Merits of Digital Communication:**

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

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

# Digital Pulse Modulation

- **Merits of Digital Communication**

3. 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.

4. The noise may change the shape of the pulses but not the pattern of the pulses.

# Digital Pulse Modulation

- Merits of Digital Communication:

5. 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.

6. 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.

7. The digital signals can be stored.