Principles of Communication (BEC-28)

Unit-4

Pulse Modulation and Digital Transmission of Analog Signal

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Content of Unit-IV

Pulse Modulation and Digital Transmission of Analog Signal: Sampling Theorem and its applications, Concept of Pulse Amplitude Modulation, Pulse width modulation and pulse position modulation, PCM, Pulse Time Modulation, TDM and FDM. Line Coding, Quantizer, Quantization Noise, Compounding multiplexer.

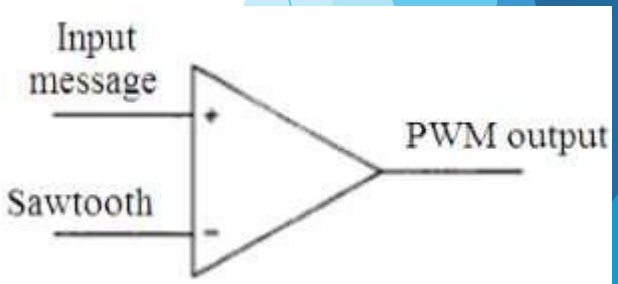
Pulse Time modulation

- In **PTM**, **amplitude of pulse is constant** while **position or width of pulse** is made proportional to the **amplitude of the signal** at the **sampling instant**.
- It can be PWM and PPM
- In both the cases amplitude constant and does not carry information so amplitude limiters can be used (like in FM) providing good noise immunity

Generation of PTM signals can be either by:

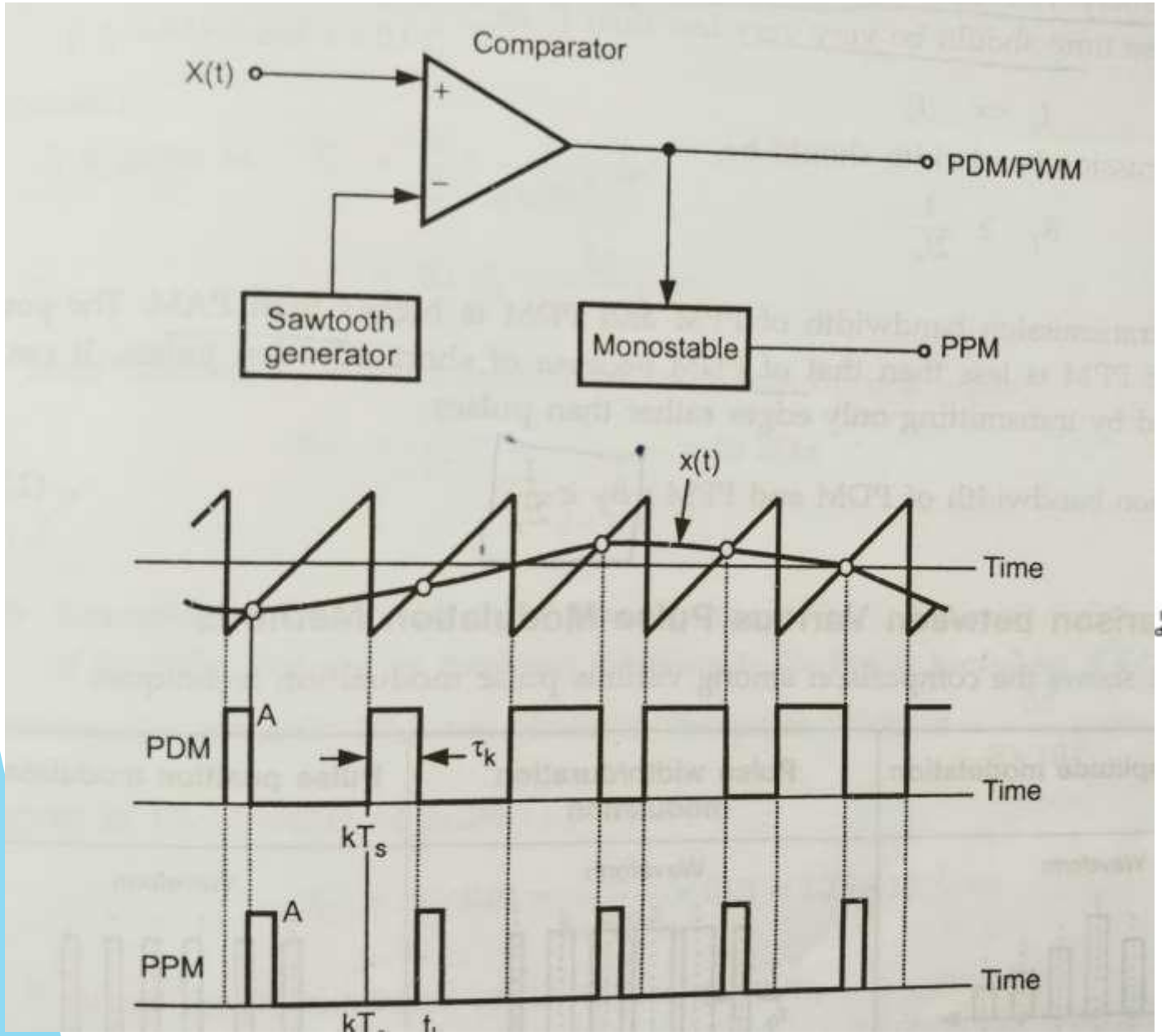
(i) **Indirect Method**: Firstly PAM signals are generated, Synchronized is generated during each pulse interval. These two signals are added and the sum is applied to a comparator whose reference level is suitably chosen. The second crossing of comparator level used for PPM

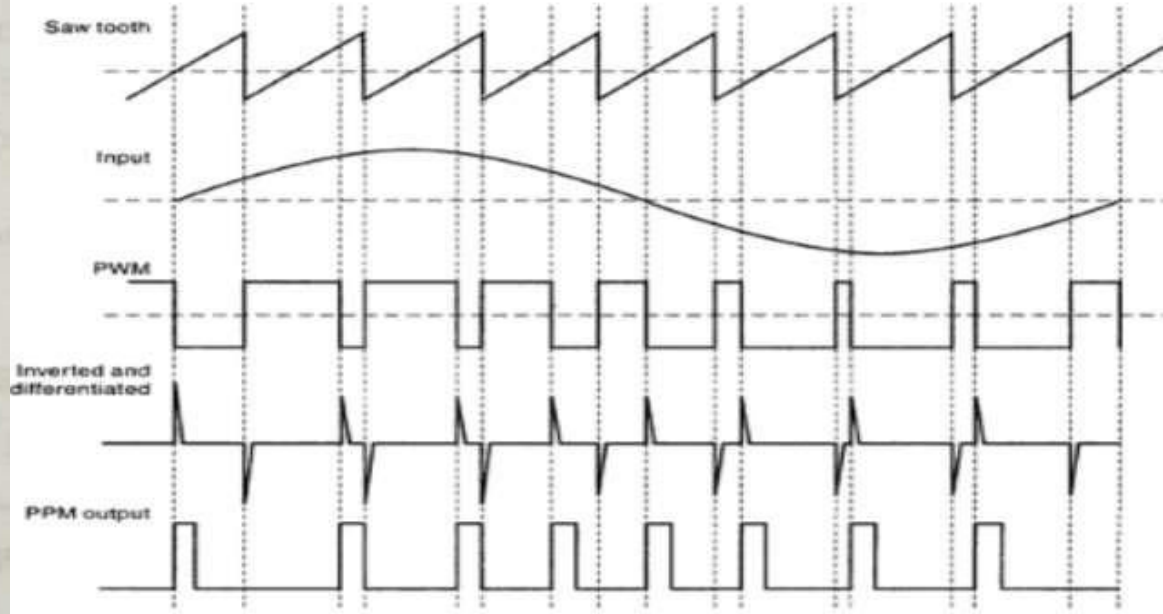
(ii) Direct method: PTM waveforms generated without using PAM waveforms



Pulse Width modulation

The pulse width modulation is the modulation of signals by varying the width of pulses. The amplitude and positions of the pulses are constant in this modulation



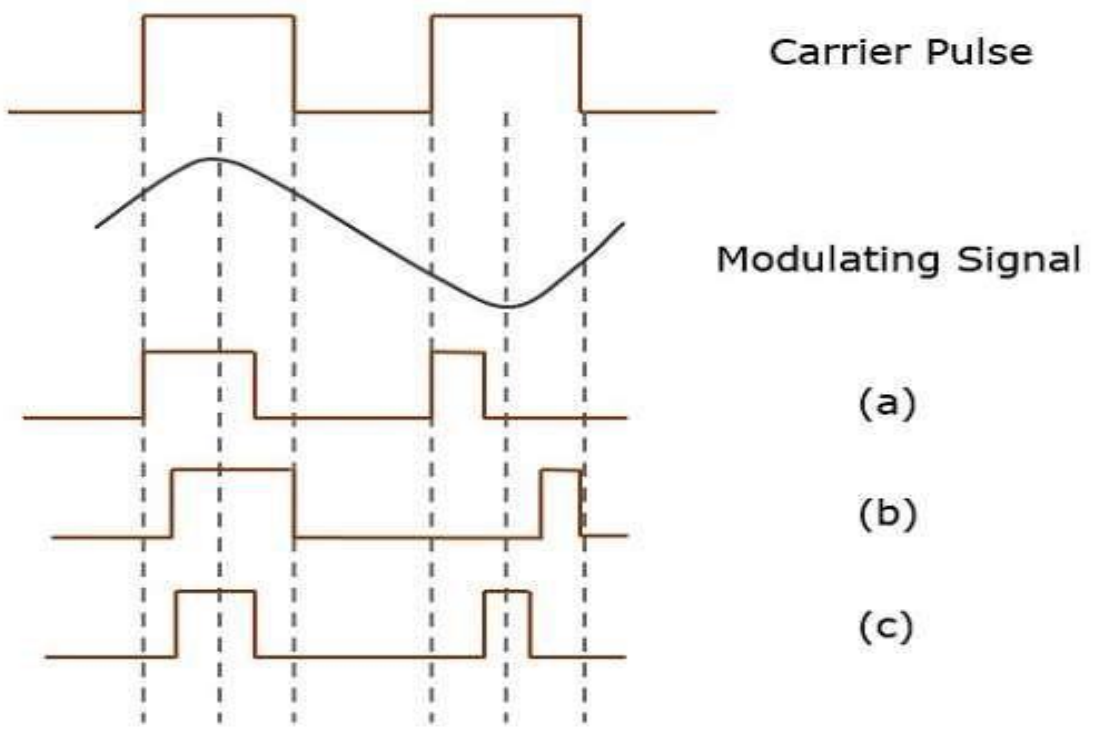


Generation of PWM and PPM by Direct Method

- **The non inverting input** of the **comparato**r is fed by the **input message or modulating signal x(t)** and the other input by a **saw-tooth signal** which operates at carrier frequency.
- The comparator compares the two signals together to generate the PWM signal at its output. Its o/p is high only when the instantaneous value of x(t) is higher than sawtooth waveform.
- The rising edges of the PWM signal occurs at the fixed time period (kT_s) while trailing edge depends on amplitude of message signal x(t).
- When saw-tooth voltage waveform greater than x(t), o/p of comparator is zero, **trailing edge is modulated**
- If **saw-tooth. waveform is reversed**, trailing edge is fixed while **leading edge is modulated**.
- Replacing saw-tooth waveform by **triangular**, both leading and trailing edge modulated. (**symmetrical PWM**)
- The amplitude of PDM/PWM will be positive saturation of the comparator shown as ‘A’, being same for all pulses,

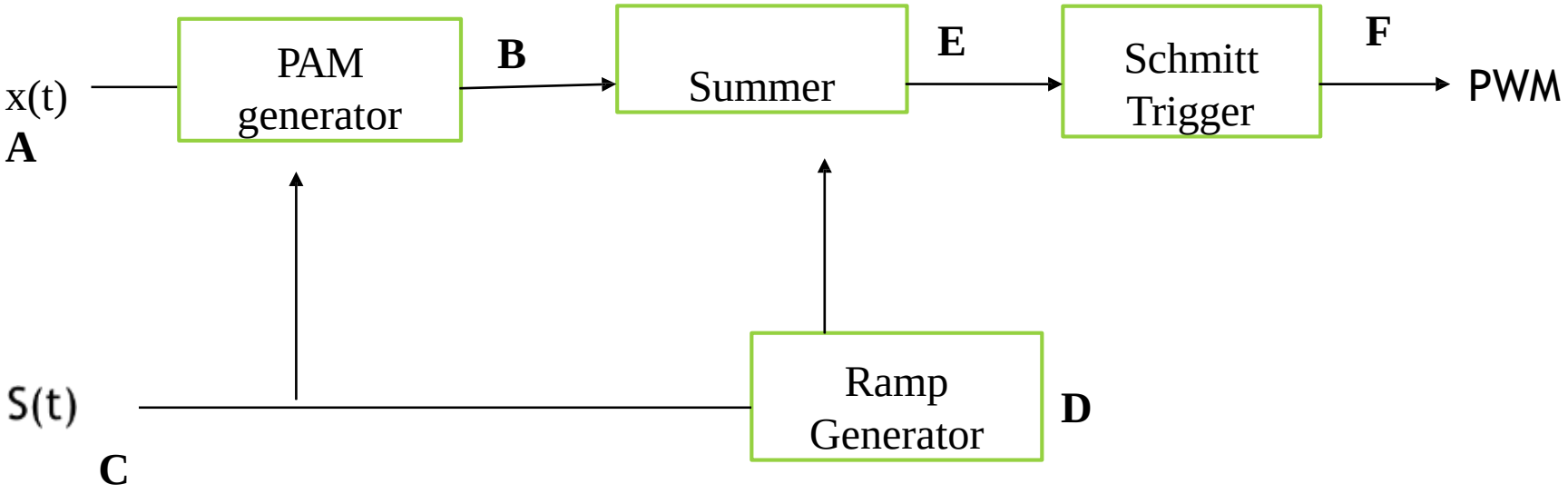
Three types of pulse-width modulation (PWM) are possible:

- The leading edge of the pulse being constant, the trailing edge varies according to the message signal.
- The trailing edge of the pulse being constant, the leading edge varies according to the message signal
- The center of the pulse being constant, the leading edge and the trailing edge varies according to the message signal (Symmetrical PWM)

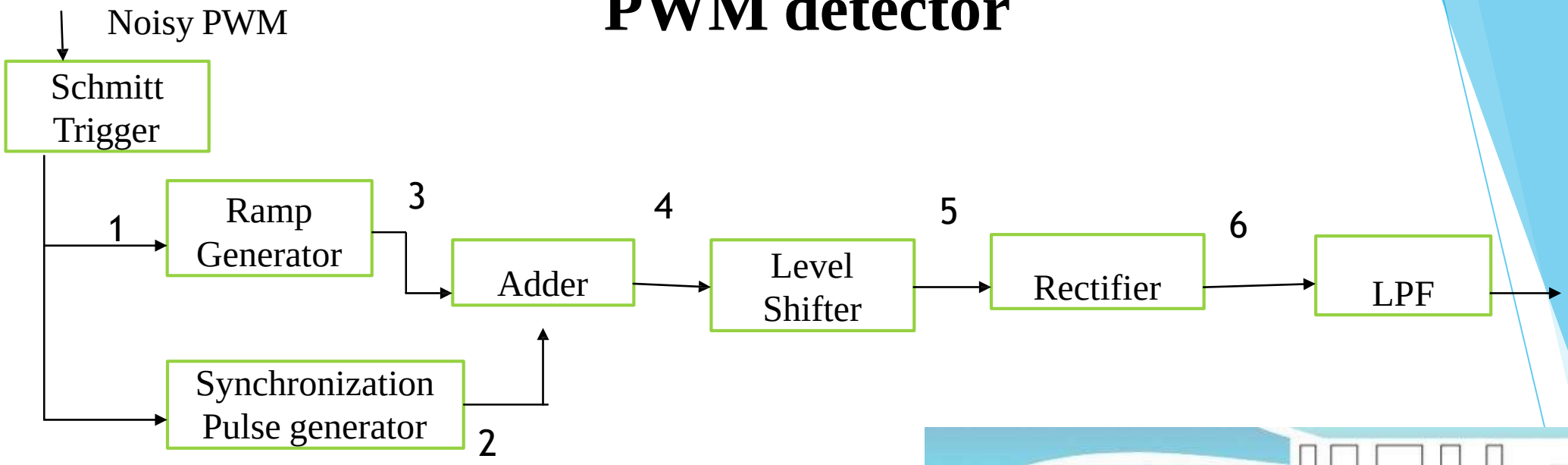


Indirect Method:

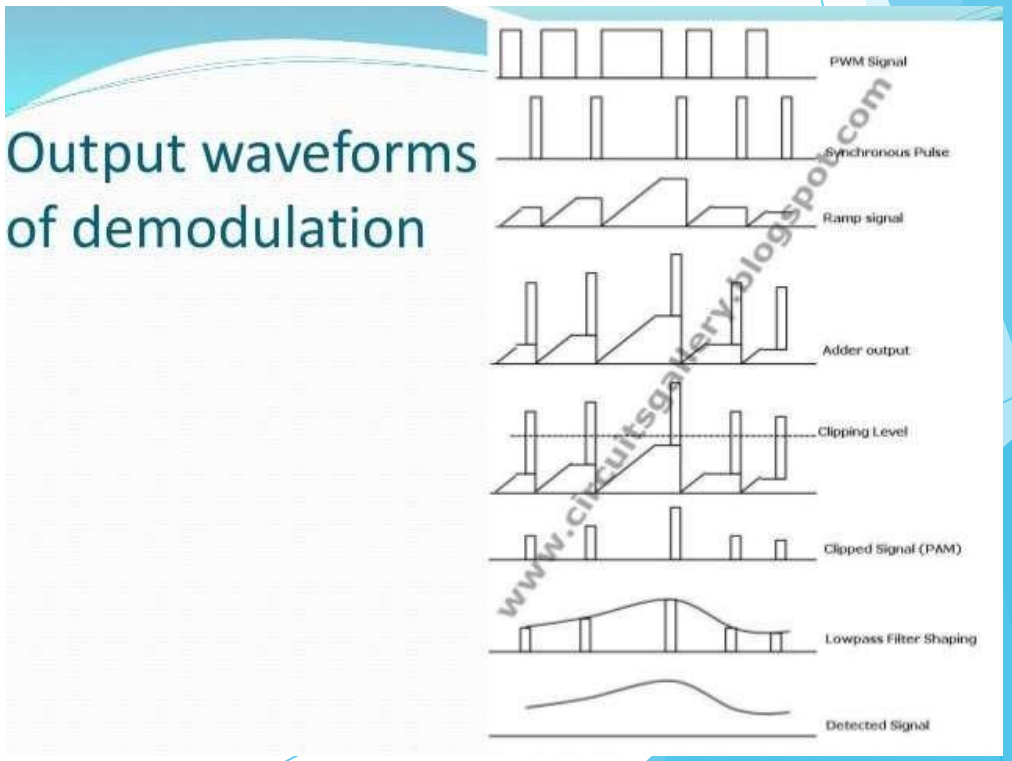
Modulating signal (A) applied to i/p of PAM circuit [s(t) pulse train] and PAM signal generated(B). S(t) also is i/p to Ramp generator(Integrator circuit), all having equal slopes, amplitude and generation(D). These ramp pulses added to PAM pulses to produce varying height samples. These varying height ramp gates a S.T ckt to generate varying width rectangular pulses of PWM.



PWM detector



- Received PWM signal applied to ST circuit to remove noise
- Regenerated PWM applied to Ramp generator and synchronization pulse.
- Heights of Ramp proportional to width of pulses.
- Pulse generator produces reference pulses with constant amplitude and width but delayed by specific amount.
- Delayed reference pulses added to o/p of ramp generator
- The o/p given to level shifter, negative offset shifts waveform. Then clipped by rectifier followed by LPF to give message signal.




Thank You