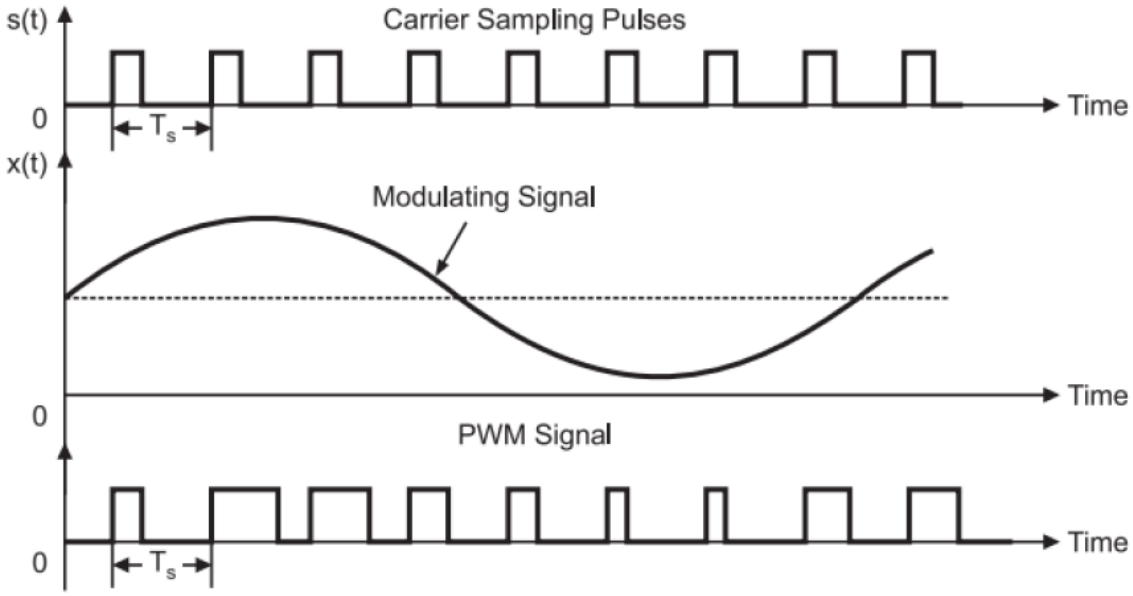
Pulse Width Modulation

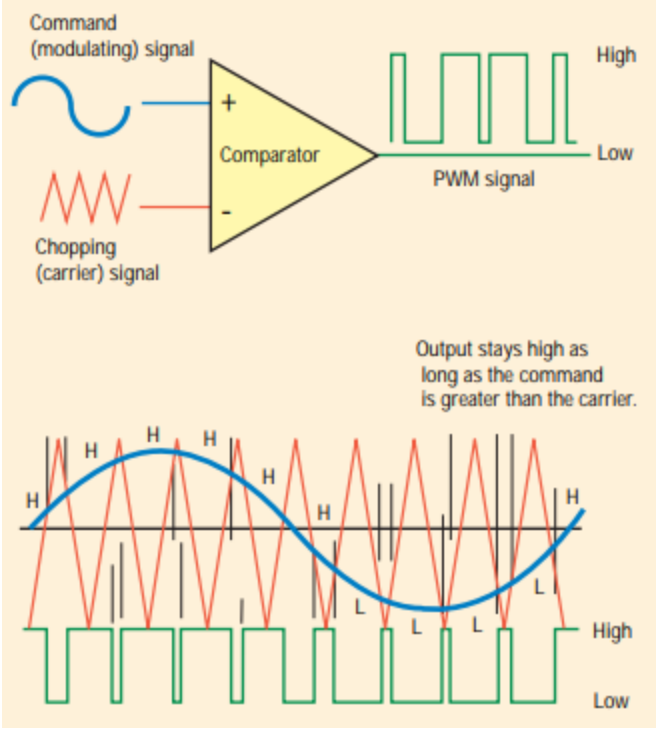
Pulse Width Modulation (PWM) or Pulse Duration Modulation (PDM) or Pulse Time Modulation (PTM) is an analog modulating scheme in which the duration or width or time of the pulse carrier varies proportional to the instantaneous amplitude of the message signal.

The width of the pulse varies in this method, but the amplitude of the signal remains constant. Amplitude limiters are used to make the amplitude of the signal constant. These circuits clip off the amplitude, to a desired level and hence the noise is limited. The following figures explain the types of Pulse Width Modulations.



Wave form Representations of PWM

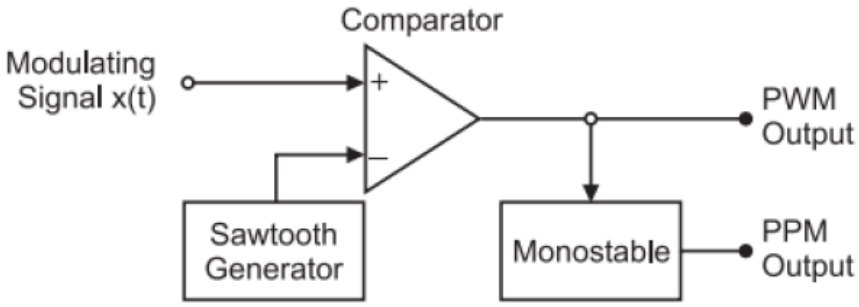
As we can observe, the amplitude and the frequency of the PWM wave remain constant. Only the width changes. That is why the information is contained in the width variation. This is similar to FM. As the noise is normally additive noise, it changes the amplitude of the PWM signal.



At the receiver, it is possible to remove these unwanted amplitude variations very easily by means of a limiter circuits. As the information is contained in the width variation, it is unaffected by the amplitude variations introduced by the noise. Thus, the PWM system is more immune to noise than the PAM signal.

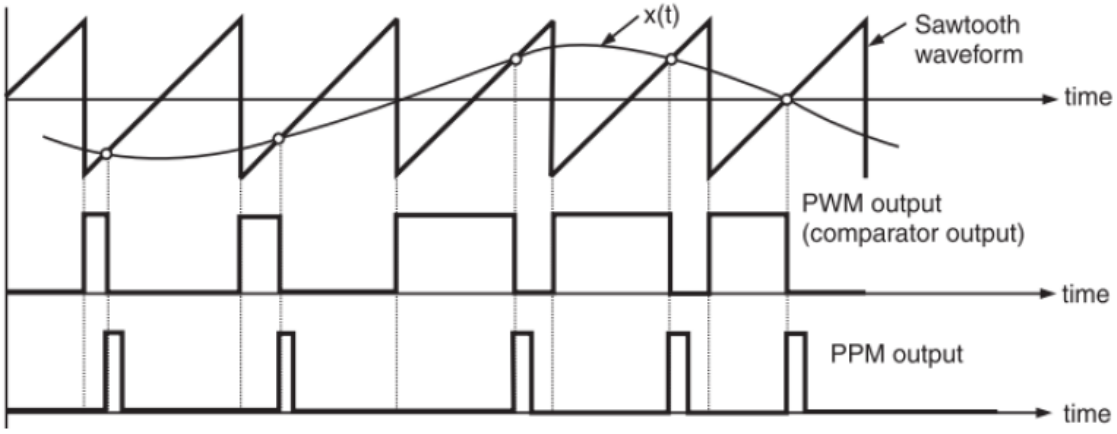
Generation of PWM Signal

The block diagram of a PWM signal generator is shown in fig. below. This circuit can also be used for the generation of PPM signal.



PWM Generator

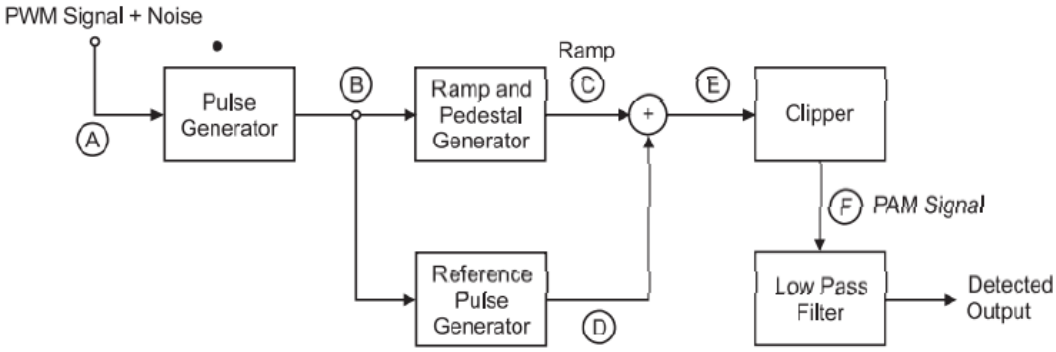
A sawtooth generator generates a sawtooth signal of frequency fs, and this sawtooth signal in this case is used as a sampling signal. It is applied to the inverting terminal of a comparator.The modulating signal x (t) is applied to the non-inverting terminal of the same comparator. The comparator output will remain high as long as the instantaneous amplitude of x (t) is higher than that of the ramp signal. This gives rise to a PWM signal at the comparator output .



Waveforms of PWM and PPM

Detection of PWM Signal

The circuit for the detection of PWM signal is shown in fig.5.4.5 below.



PWM Detection Circuit

Advantages of PWM

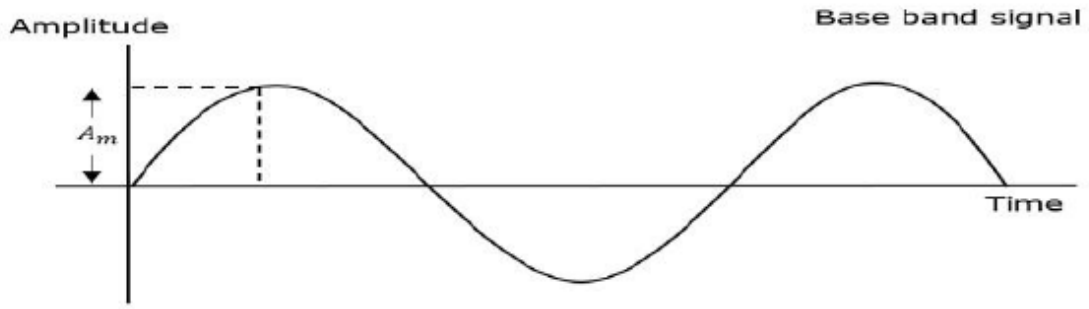
Less effect of noise i.e., very good noise immunity. Synchronization between the transmitter and receiver is not essential (Which is essential in PPM).It is possible to reconstruct the PWM signal from a noise, contaminated PWM, as discussed in the detection circuit. Thus, it is possible to separate out signal from noise (which is not possible in PAM).

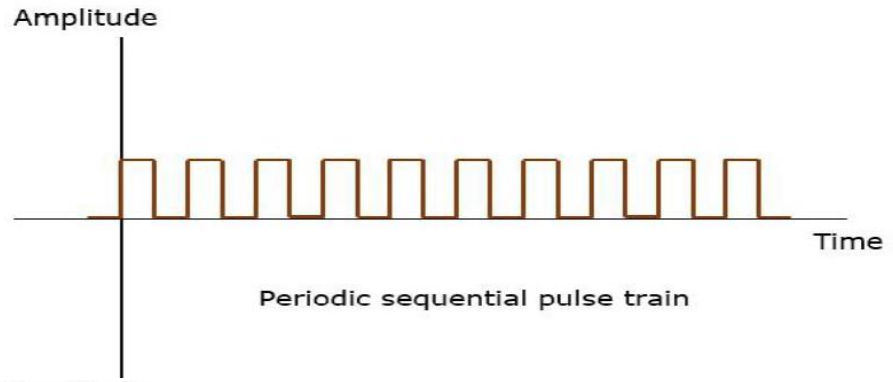
Disadvantages of PWM

Due to the variable pulse width, the pulses have variable power contents. Hence, the transmission must be powerful enough to handle the maximum width, pulse, though the average power transmitted can be as low as 50% of this maximum power. In order to avoid any waveform distortion, the bandwidth required for the PWM communication is large as compared to bandwidth of PAM.

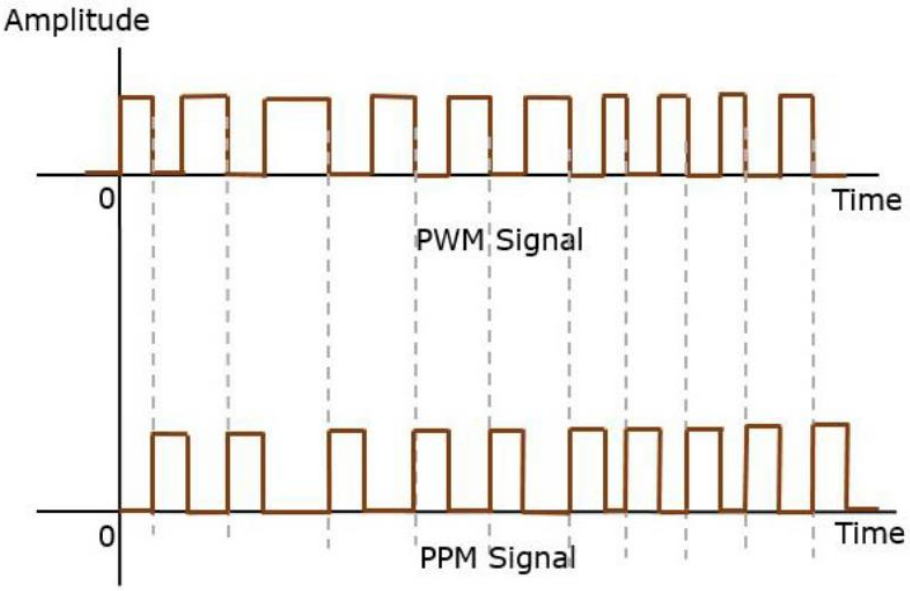
Pulse Position Modulation

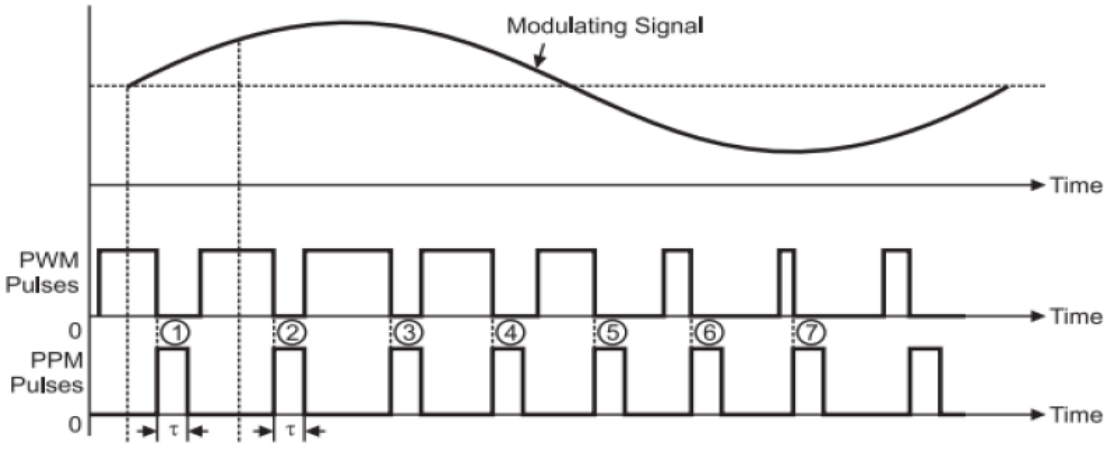
Pulse Position Modulation (PPM) is an analog modulating scheme in which the amplitude and width of the pulses are kept constant, while the position of each pulse, with reference to the position of a reference pulse varies according to the instantaneous sampled value of the message signal. The transmitter has to send synchronizing pulses (or simply sync pulses) to keep the transmitter and receiver in synchronism. These sync pulses help maintain the position of the pulses. The following figures explain the Pulse Position Modulation.





Periodic sequential pulse train

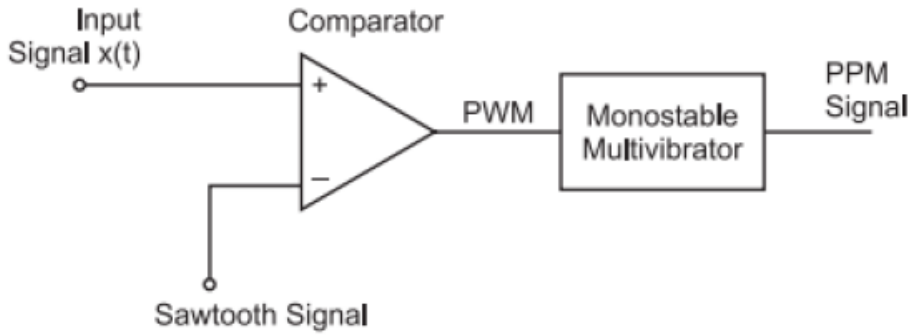


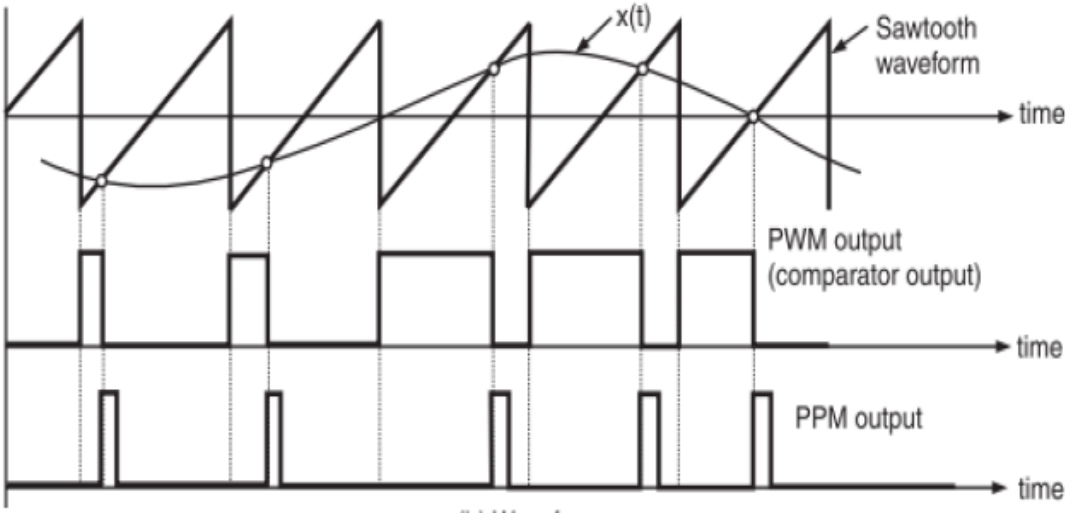


Pulse position modulation is done in accordance with the pulse width modulated signal. Each trailing of the pulse width modulated signal becomes the starting point for pulses in PPM signal. Hence, the position of these pulses is proportional to the width of the PWM pulses. In PPM, the amplitude and width of the pulses is kept constant but the position of each pulse is varied in accordance with the amplitudes of the sampled values of the modulating signal. The position of the pulses is changed with respect to the position of reference pulses. The PPM pulses can be derived from the PWM pulses . Here, it may be noted that with increase in the modulating voltage the PPM pulses shift further with respect to reference.

Generation of PPM Signal

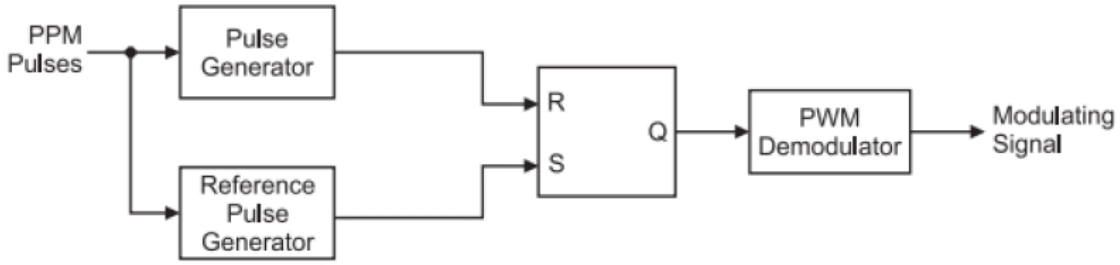
The PPM signal can be generated from PWM signal as shown in fig.





Demodulation of PPM Signal

The PPM demodulator block diagram has been shown in fig.



PPM Demodulator

Advantage

As the amplitude and width are constant, the power handled is also constant.

Disadvantage

The synchronization between transmitter and receiver is a must.

Comparison Chart

Basis for Comparison	PAM	PWM	PPM
Varying parameter	Amplitude	Width	Position
Immunity towards noise	Low	High	High
Signal to noise ratio	Low	Moderate	Comparitively high
Need of synchronization pulse	Not exist	Not exist	Exist
Bandwidth dependency	On pulse width	On rise time of pulse	On rise time of pulse

Basis for Comparison	PAM	PWM	PPM
Transmission power	Variable	Variable	Constant
Bandwidth requirement	Low	High	High
Similarity of implementation	Similar to AM	Similar to FM	Similar to PM
Synchronization between Transmitter and Receiver	Not needed	Not needed	Needed

Definition of PAM

PAM stands for pulse amplitude modulation. It is a modulation technique in which the amplitude of the pulsed carrier signal is changed according to the amplitude of the message signal.