Principles of Communication (BEC-28)

Unit-4

Pulse Modulation and Digital Transmission of Analog Signal

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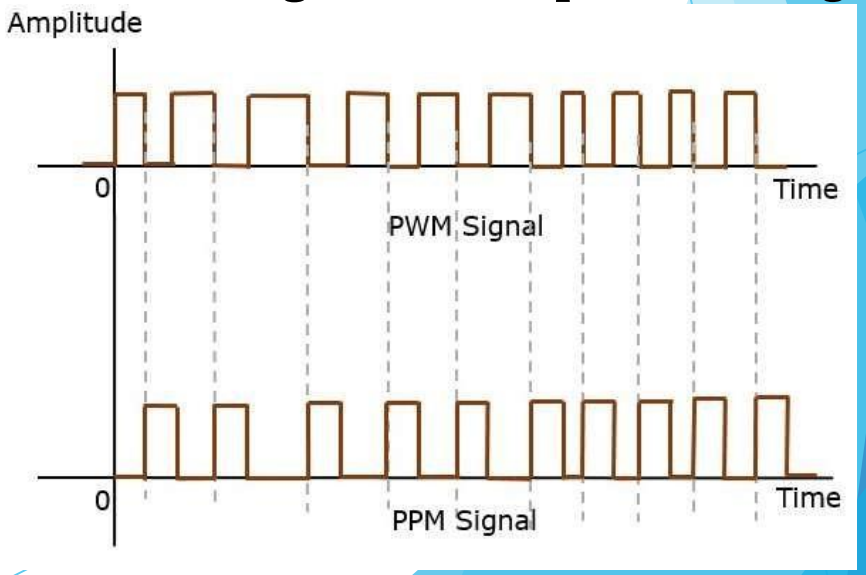
Content of Unit-IV

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 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.
- PPM is done in accordance with the PWM signal.
- PWM signal is used as the trigger input to a monostable multivibrator.
- Its o/p remains zero until it is triggered on the trailing edge of PWM
- O/P of monostable MV switches to positive saturation value A **and remains high for fixed period** then goes low
- Hence, the position of these pulses is proportional to the width of the PWM pulses.



Advantage As the amplitude and width are constant **the power handled is constant**

Disadvantage: Synchronization between Transmitter and receiver is a necessity

- The **PDM is differentiated**, and then **rectified** and **shaped**.
- PPM carries exactly the same information as long as the position of the clock pulses (leading edge) is well defined in the received signal.
- PPM is superior to PDM for message transmission, since the wide pulses of PDM require more energy than PPM when transmitted
- PPM is suited for communication in the presence of noise.
- Very high peak narrow pulses can be transmitted and the pulse position can be determined even when the noise level is high,
- However, transmitting very narrow pulses requires a large band width
- When light is used as the media for transmitting analog signals, **PPM or PCM** are the most suitable types of modulation because **the maximum power output in the modulated light source, such as LED or LASER is achieved when it is pulsed at a very low duty cycle**.
- In PPM, necessary to transmit a series of sync pulses at a much lower repetition rate than the sampling pulses, to avoid interference with original signal and/or minimise the number of pulses transmitted in order to conserve transmission power

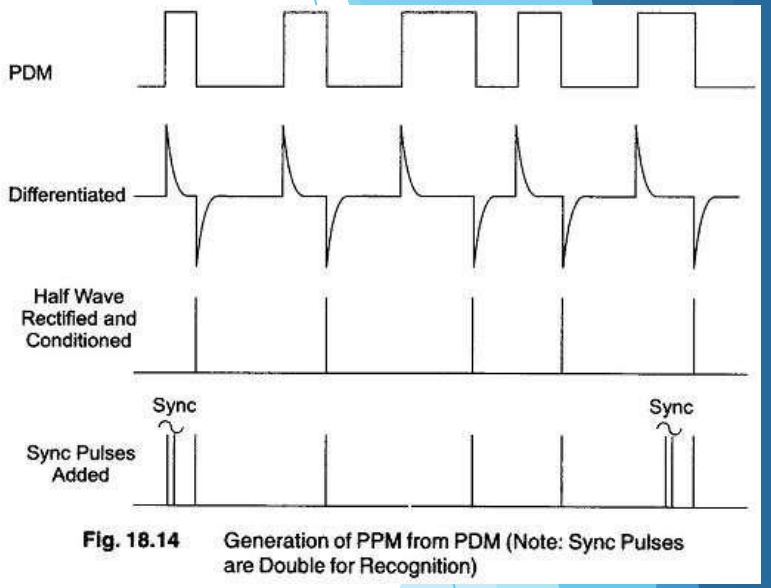


Fig. 18.14 Generation of PPM from PDM (Note: Sync Pulses are Double for Recognition)

Transmission BW of PWM and PPM

- Both PWM and PPM have DC value.
- Both need a shrp rise time and fall time to preserve the message information
- Rise time be very less than Ts i.e. $\mathbf{t_r \ll Ts}$
- **Transmission BW:** $\mathbf{B_T \geq \frac{1}{2tr}}$
- BW higher than PAM

PAM

- The amplitude of the pulse is proportional to the amplitude of modulating the signal.
- **Band width** of transmitting channel depends on the **width of the pulse**
- Instantaneous power of transmitter varies. Noise interference is high
- Complex system. Similar to A.M.

PWM

- Width of pulse is proportional to amplitude of modulating signal.
- The **Bandwidth of transmitting channel** depends on **rise time of the pulse**.
- Instantaneous power of transmitter varies. Noise interference is minimum.
- Simple to implement Similar to F.M.

PPM

- Relative position of pulse is proportional to amplitude of modulating signal.
- The bandwidth of transmitting channel depends on the rise time of the pulse.
- Instantaneous power remains constant. Noise interference is minimum.
- Simple to implement. Similar to P.M.

- Difference Between PAM, PWM, and PPM

Parameter	**PAM**	**PWM**	**PPM**
Type of Carrier:	Train of Pulses	Train of Pulses	Train of Pulses
Variable Characteristic :	Amplitude	Width	Position
Bandwidth Requirement:	Low	High	High
Noise Immunity :	Low	High	High
Information Contained in:	Amplitude Variations	Width Variations	Position Variations
Power efficiency (SNR)	Low	Moderate	High
Transmitted Power	Varies	Varies	Remains Constant
Need to transmit synchronizing pulses	Not needed	Not needed	Necessary
Bandwidth	depends on width of the pulse	rise time of the pulse	rise time of the pulse
Transmitter power	Inst. power varies with amplitude of pulses	Instantaneous power varies with width of the pulses	Constant
Complexity of generation and detection	Complex	Easy	Complex
12 Similarity with other Modulation Systems	Similar to AM	Similar to FM	Similar to PM

Question 1: ***For a PAM transmission of voice signal with f_m=3kHz, calculate the transmission BW. Given that f_s=8kHz and the pulse duration τ=0.1T_s***

Soln: $Ts=\frac{1}{fs}= 125\mu s$

$\tau=0.1Ts=0.1\times125=12.5\mu s$

$\mathbf{BW\geq \frac{1}{2\tau} \geq 40\ kHz}$

Question 2: ***For the above signal if rise time is 1% of pulse width, find minimum Tx BW for PWM and PPM?*** **Soln:** $t_r=\tau\times0,01= 1.25x\ 10^{-7}$

$B_T\geq \frac{1}{2_{\ r}} \geq$ **4MHz**

Thus BW of PWM/PPM much higher than PAM


Thank You