



# **SNS COLLEGE OF TECHNOLOGY**

## **An Autonomous Institution**

### **Coimbatore-35**



Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade  
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

## **DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING**

### **19ECB301-ANALOG AND DIGITAL COMMUNICATION**

III YEAR/ V SEMESTER

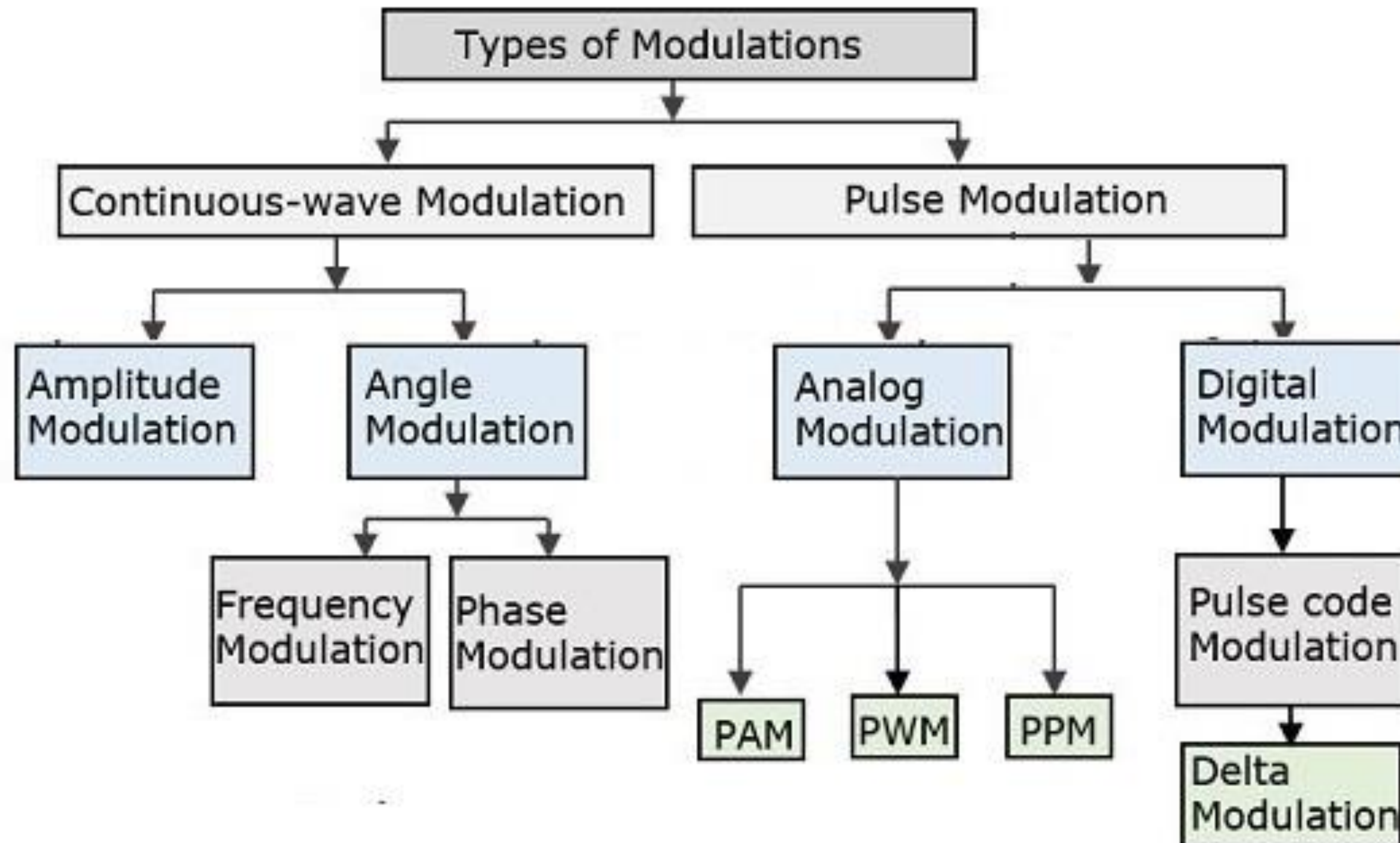
### **UNIT 1 – ANALOG COMMUNICATION**

TOPIC – PULSE COMMUNICATION-PAM-PTM-PPM

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# PULSE MODULATION





# PULSE MODULATION



- A set of techniques where by a sequence of information-carrying quantities occurring at discrete instances of time is encoded into a corresponding regular sequence of electromagnetic carrier pulses
  
- varying the amplitude, polarity, presence or absence, duration, or occurrence in time of the pulses gives rise to the four basic forms of pulse modulation;
  - a. pulse-amplitude modulation (PAM)
  - b. pulse-code modulation (PCM),
  - c. pulse-width modulation (PWM) or pulse-duration modulation, PDM)
  - d. pulse-position modulation (PPM).

Pulse modulation is a technique in which the signal is transmitted with the information by pulses. This is divided into Analog Pulse Modulation and Digital Pulse Modulation.





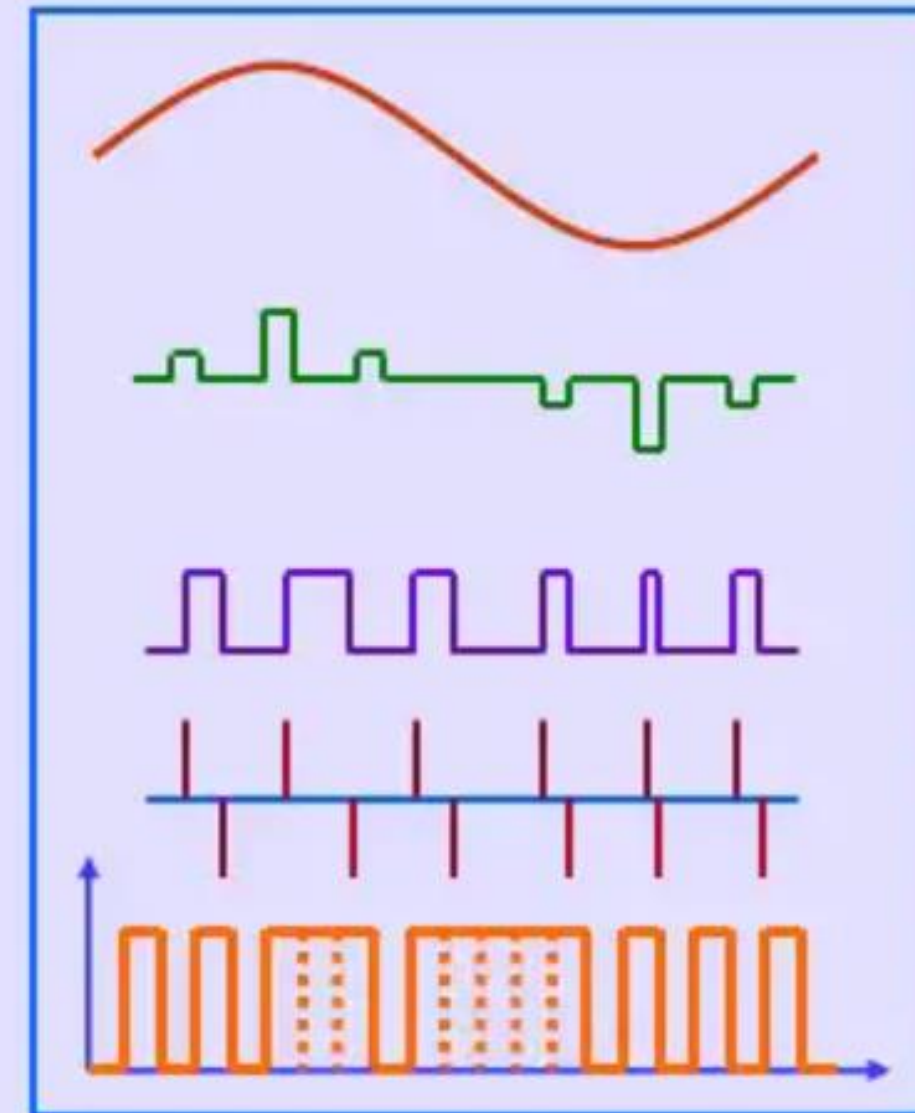
# PULSE MODULATION



The process of transmitting signals in the form of pulses (discontinuous signals) by using special techniques.

The Chapter includes:

- **Pulse Amplitude Modulation**
- **Pulse Width Modulation**
- **Pulse Position Modulation**
- **Pulse Code Modulation**





## ANALOG TO DIGITAL CONVERSION



- an original analog (time- and amplitude-continuous) information signal  $s(t)$  is changed at the transmitter into a series of regularly occurring discrete pulses whose amplitudes are of a fixed and finite number of values.

Conceptually, it involves two steps.

1. First, the range of amplitudes of  $s(t)$  is divided or quantized into a finite number of predetermined levels, and each level is represented by a pulse of fixed amplitude.
2. Second, the amplitude of  $s(t)$  is periodically measured or sampled and replaced by the pulse representing the level that corresponds to the measurement





## PULSE AMPLITUDE MODULATION

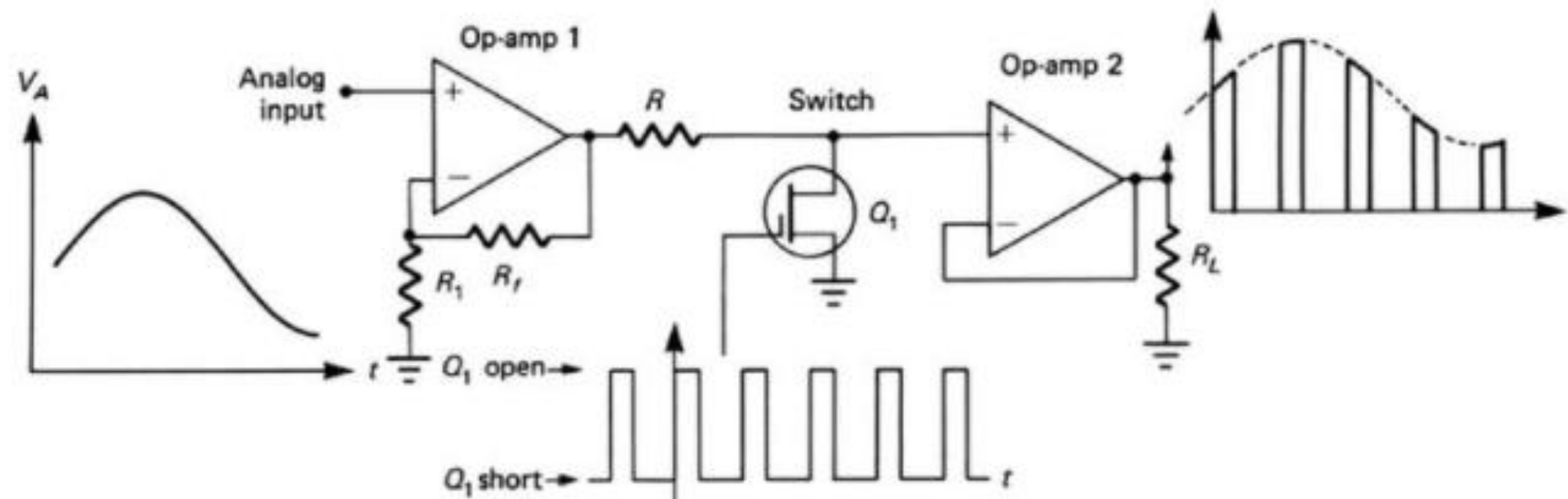


- successive sample values of the analog signal  $s(t)$  are used to effect the amplitudes of a corresponding sequence of pulses of constant duration occurring at the sampling rate
- In principle the pulses may occupy the entire time between samples, but in most practical systems the pulse duration, known as the duty cycle, is limited to a fraction of the sampling interval
- The resulting signal is given by a rectangular pulse train but with amplitudes that are varied in proportion to the corresponding sample values



## PULSE AMPLITUDE MODULATION-NATURAL SAMPLING

- The circuit is used to illustrate pulse amplitude modulation (PAM). The FET is the switch used as a sampling gate.
- When the FET is on, the analog voltage is shorted to ground; when off, the FET is essentially open, so that the analog signal sample appears at the output.
- Op-amp 1 is a noninverting amplifier that isolates the analog input channel from the switching function.
- Op-amp 2 is a high input-impedance voltage follower capable of driving low-impedance loads (high “fanout”).
- The resistor  $R$  is used to limit the output current of op-amp 1 when the FET is “on” and provides a voltage division with  $r_d$  of the FET. ( $r_d$ , the drain-to-source resistance, is low but not zero)



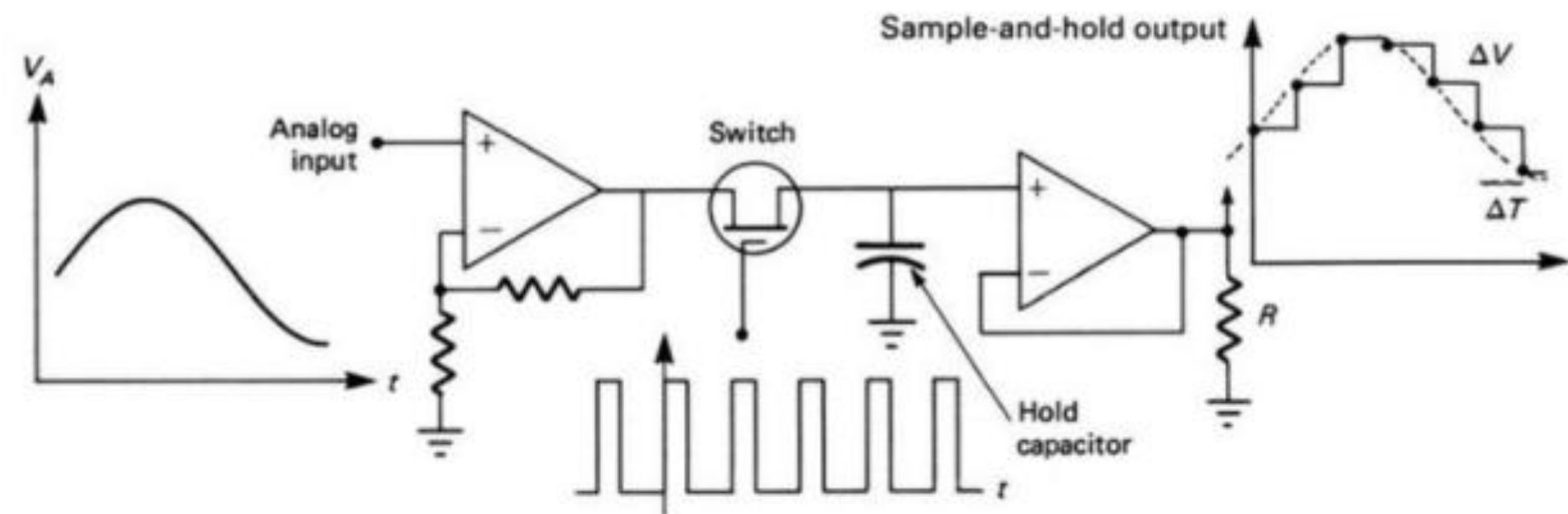




## PULSE AMPLITUDE MODULATION (PAM)-FLAT TOP SAMPLING



- The most common technique for sampling voice in PCM systems is to use a sample-and-hold circuit.
- the instantaneous amplitude of the analog (voice) signal is held as a constant charge on a capacitor for the duration of the sampling period  $T_s$ .
- This technique is useful for holding the sample constant while other processing is taking place, but it alters the frequency spectrum and introduces an error, called aperture error, resulting in an inability to recover exactly the original analog signal.
- The amount of error depends on how much the analog changes during the holding time, called aperture time.



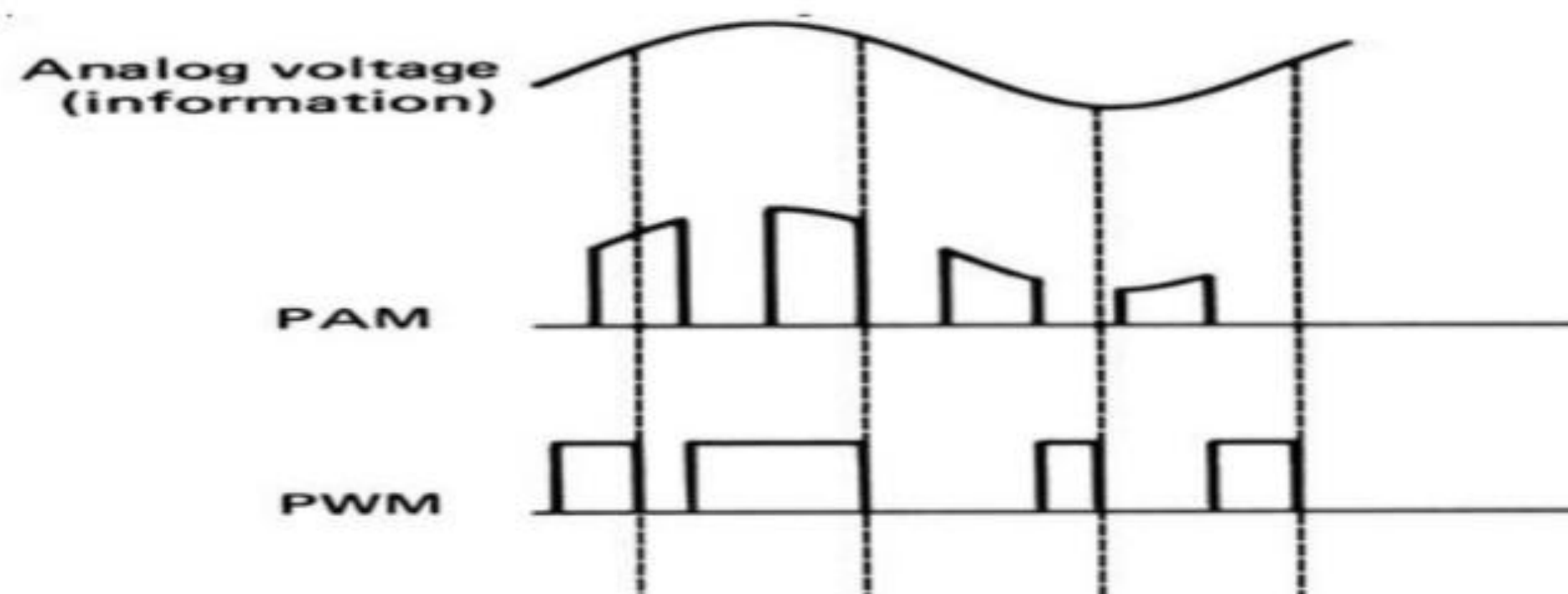




## PULSE WIDTH MODULATION (PWM)

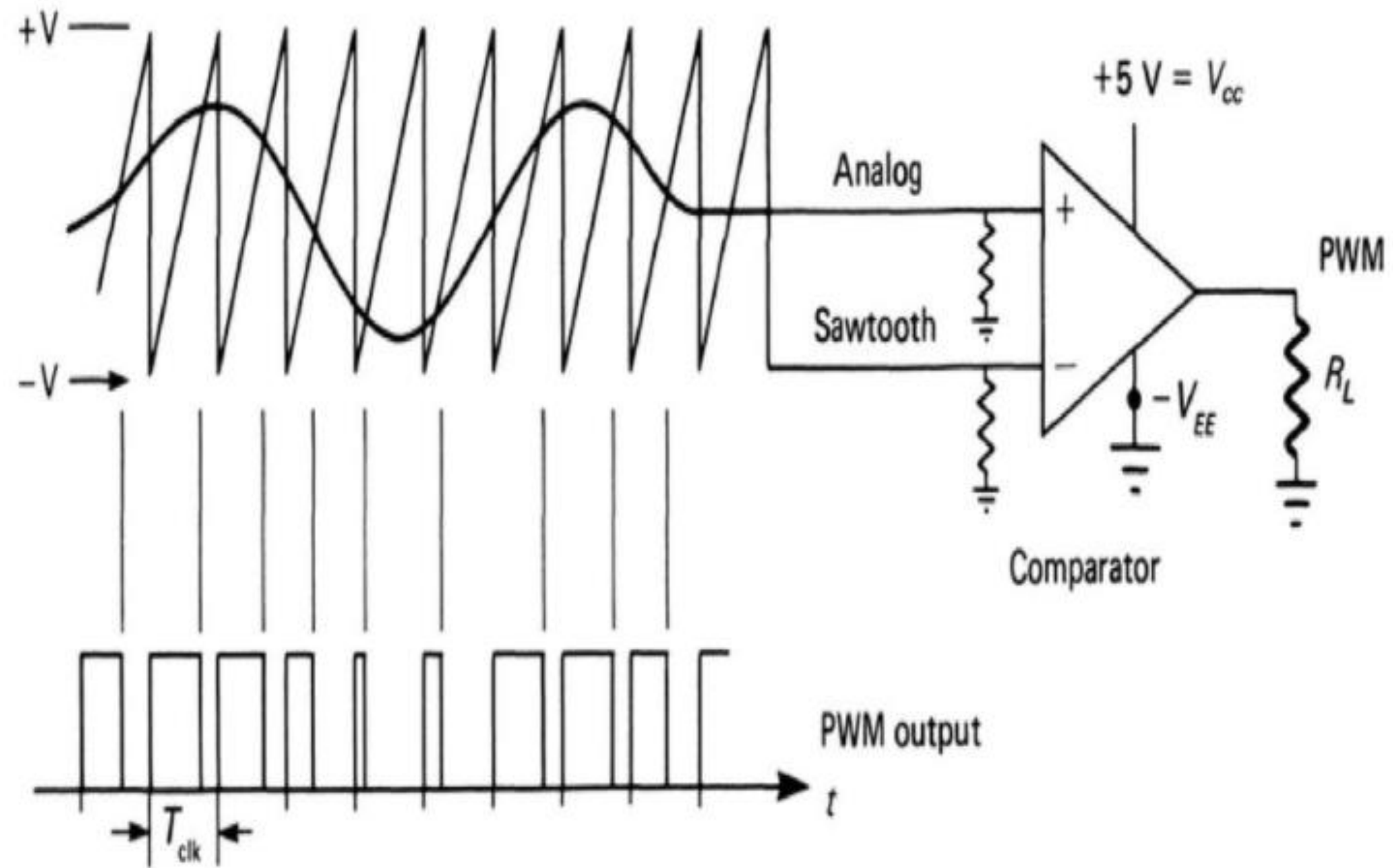


- In pulse width modulation (PWM), the width of each pulse is made directly proportional to the amplitude of the information signal.
- In PWM the pulses representing successive sample values of  $s(t)$  have constant amplitudes but vary in time duration in direct proportion to the sample value. The pulse duration can be changed relative to fixed leading or trailing time edges or a fixed pulse center





# PULSE WIDTH MODULATION (PWM)



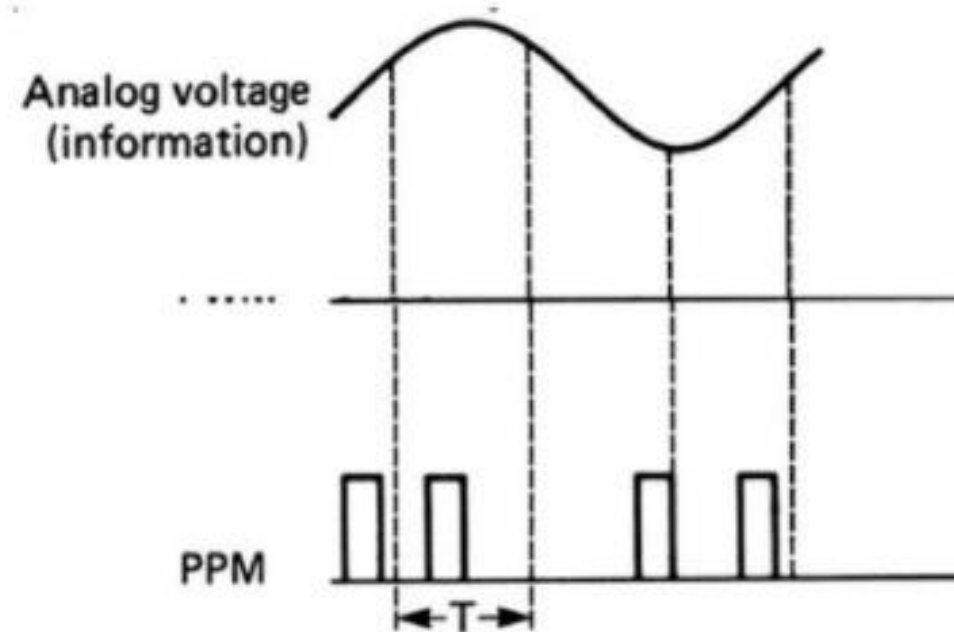




## PULSE POSITION MODULATION (PPM)

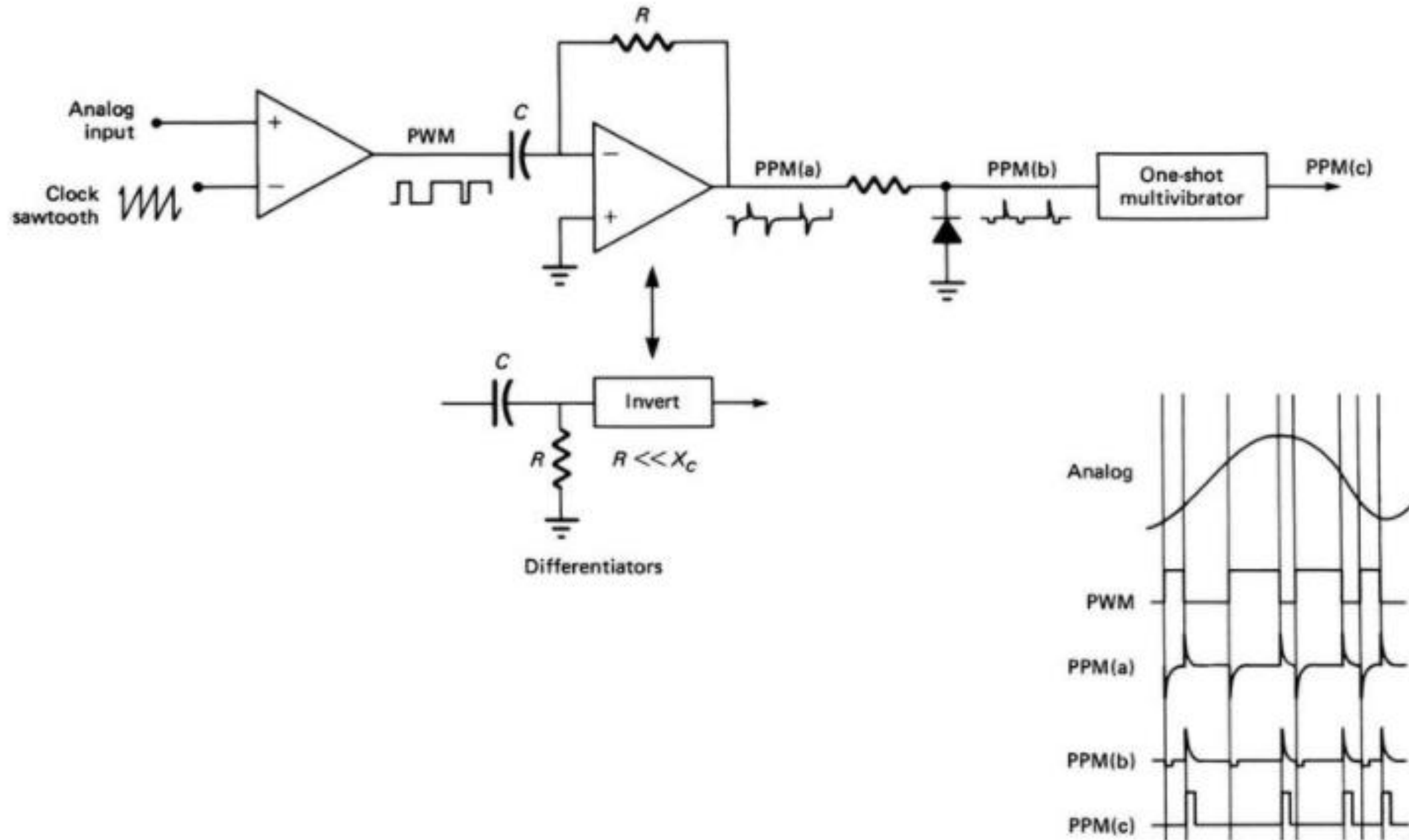


- In pulse position modulation, constant-width pulses are used, and the position or time of occurrence of each pulse from some reference time is made directly proportional to the amplitude of the information signal
- PPM encodes the sample values of  $s(t)$  by varying the position of a pulse of constant duration relative to its nominal time of occurrence. As in PAM and PWM, the duration of the pulses is typically a fraction of the sampling interval.





# PULSE POSITION MODULATION (PPM)







## PULSE MODULATION COMPARISON



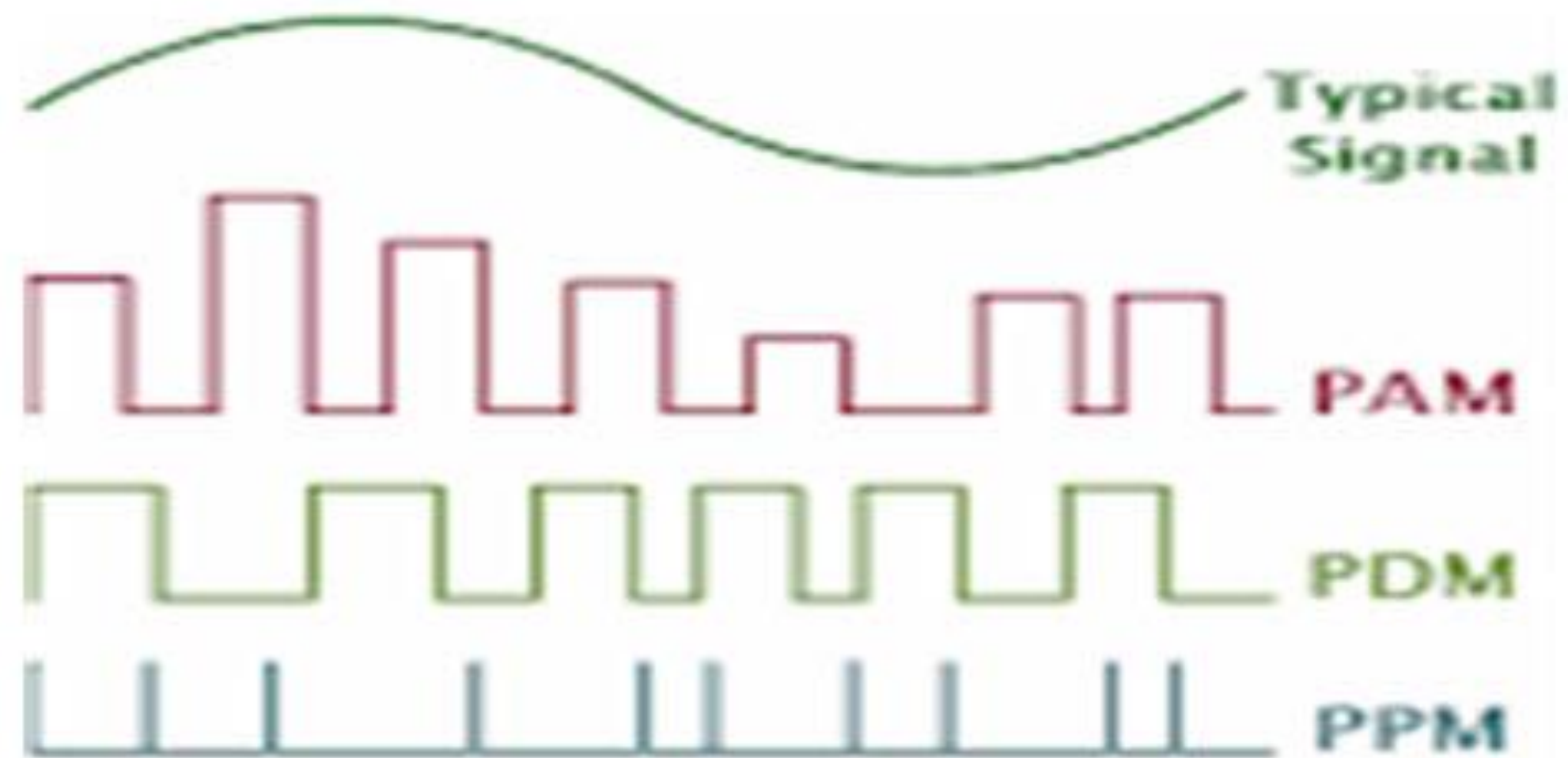
S.No	Pulse Amplitude Modulation (PAM)	Pulse Duration/Width Modulation (PDM/PWM)	Pulse Position Modulation (PPM)
1	Amplitude of the pulse proportional to amplitude of modulating signal	Width of the pulse is proportional to amplitude of modulating signal	The relative position of the pulse is proportional to amplitude of modulating signal
2	Bandwidth of the transmission channel depends on the pulse width	Bandwidth of the transmission channel depends on the rise time of the pulse	Bandwidth of the transmission channel depends on the rising time of the pulse
3	Instantaneous power of the transmitter varies	Instantaneous power of the transmitter varies	Instantaneous power of the transmitter remains constant
4	Noise interference is high	Noise interference is minimum	Noise interference is minimum
5	System is complex to implement	System is simple to implement	System is simple to implement
6	Similar to amplitude modulation	Similar to frequency modulation	Similar to phase modulation



# PULSE MODULATION COMPARISON



Difference Between PAM, PWM, and PPM







## MULTIPLEXING

- Multiplexing is a technique of simultaneous transmission of multiple signal over single data link.
- To combine multiple signals (*analog* or *digital*) for transmission over a single line or media is called Multiplexing.
- A common type of multiplexing combines several low-speed signals for transmission over a single high-speed connection.
- Multiplexing is the set of techniques that allows the simultaneous transmission of multiple signals across a single data link. As data and telecommunications use increases, so traffic also increases. We can either add a new channel for such increasing traffic or we can install higher-bandwidth links and use each to carry multiple signals.



# MULTIPLEXING



- Multiplexing is done by Multiplexer
- Demultiplexing is done by Demultiplexer
- Multiplexer receives large no of different input signals
- Multiplexer has only one link channel
- Multiplexer combines all input signal into one composite signal & then transfers it
- Sometimes this composite signal is modulated as well
- At the receiving end of communication demultiplexer sorts the composite signal into its original forms
- Multiplexing can increase amount of transmitting information





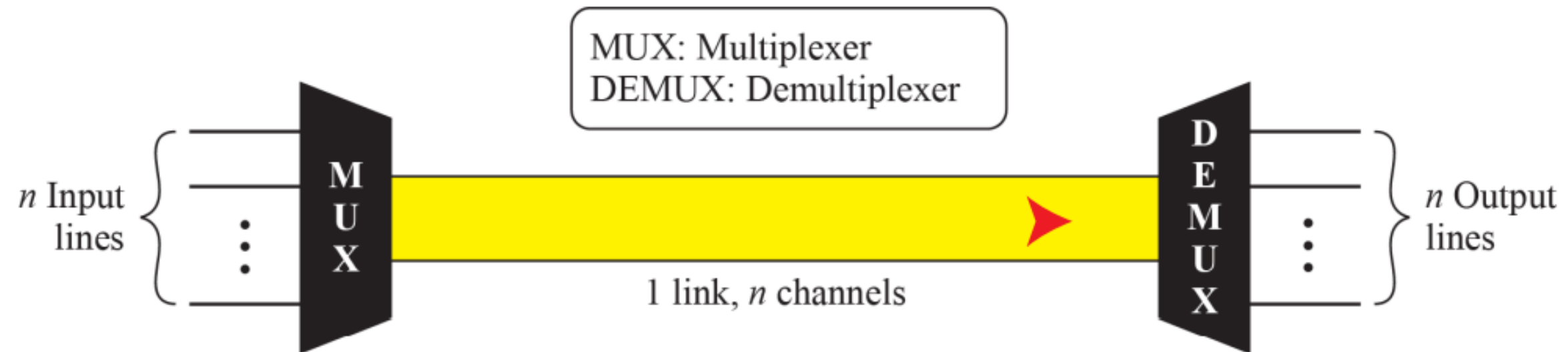
## MULTIPLEXING



- Bandwidth of the medium has to be greater than the linking devices
- Efficiency of utilizing bandwidth can be achieved through multiplexing
- e.g. telephony, telemetry & FM Radio transmission



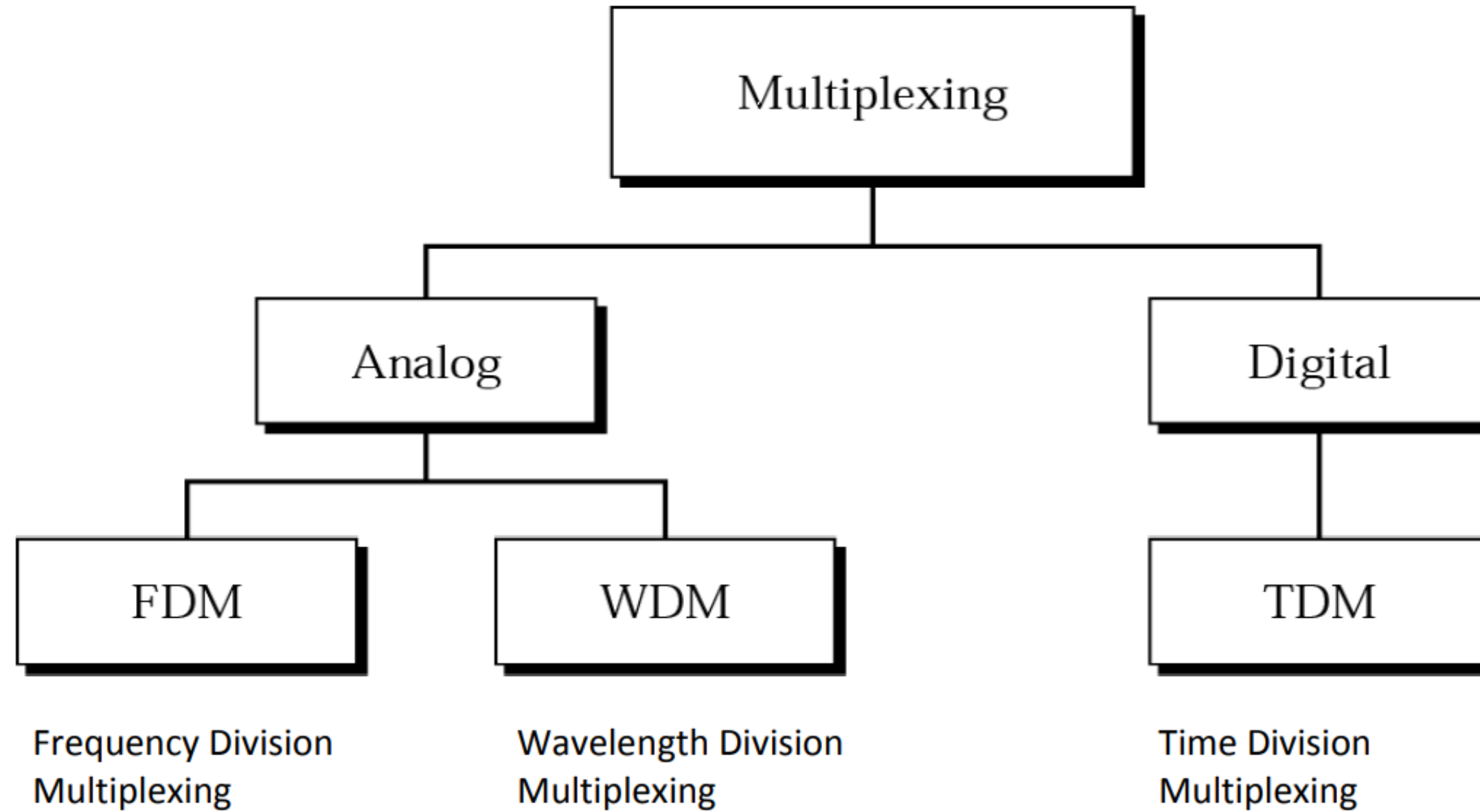
# MULTIPLEXING







# TYPES OF MULTIPLEXING





## FREQUENCY DIVISION MULTIPLEXING(FDM)

- Frequency Division Multiplexing(FDM) is a multiplexing technique that uses different frequencies to combine multiple streams of data for transmission over a communications medium.
- FDM assigns a discrete carrier frequency to each data stream and then combines many modulated carrier frequencies for transmission.
- In FDM, signals generated by each sending device modulate different carrier frequencies.
- These modulated signals are then combined into a single composite signal that can be transported by the link.
- Carrier frequencies are separated by sufficient bandwidth to accommodate the modulated signal. These bandwidth ranges are the channels through which the various signals travel.





## FREQUENCY DIVISION MULTIPLEXING(FDM)

- Channels can be separated by strips of unused bandwidth – **guard bands** – to prevent signals from overlapping. In addition, carrier frequencies must not interfere with the original data frequencies.
- Figure gives a conceptual view of FDM. In this illustration, the transmission path is divided into three parts, each representing a channel that carries one transmission.
- **FDM uses AM, FM or PM Modulations**
- **For example, television transmitters use FDM to broadcast several channels at once.**
- **FM Radio, which combines many frequencies into one channel**



# FREQUENCY DIVISION MULTIPLEXING(FDM)

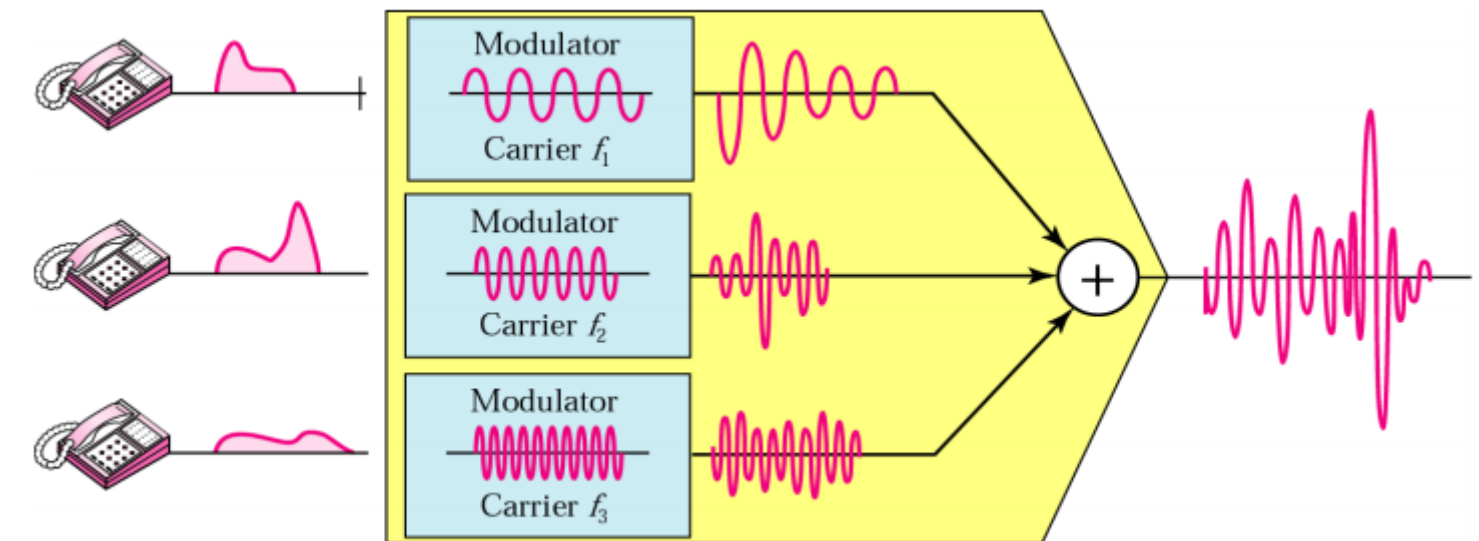




# MULTIPLEXING PROCESS



- The given figure is a conceptual illustration of the multiplexing process.
- Each source generates a signal of a similar frequency range.
- Inside the multiplexer, these similar signals modulate different carrier frequencies ( $f_1$ ,  $f_2$  and  $f_3$ ).
- The resulting modulated signals are then combined into a single composite signal that is sent out over a media link that has enough bandwidth to accommodate it.







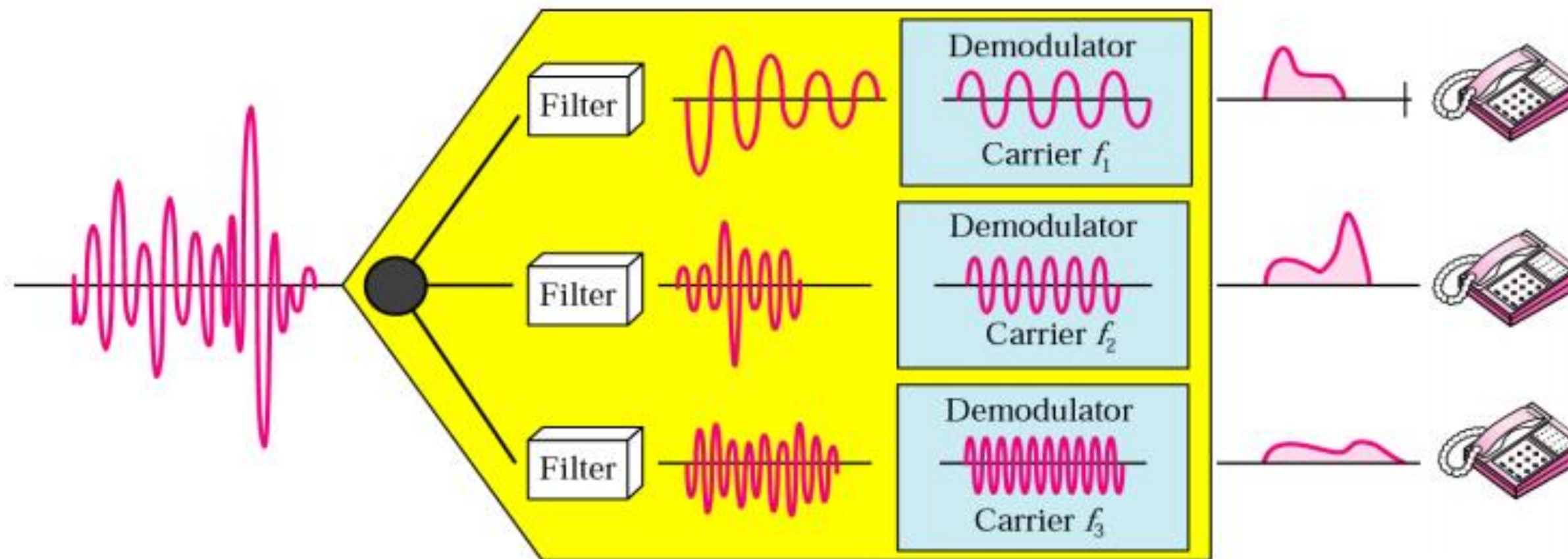
## DEMULTIPLEXING PROCESS



The demultiplexer uses a series of filters to separate the multiplexed signal into its constituent component signals. The individual signals are then passed to a demodulator that separates them from their carriers and passes them to the output lines. Figure is a conceptual illustration of demultiplexing process.

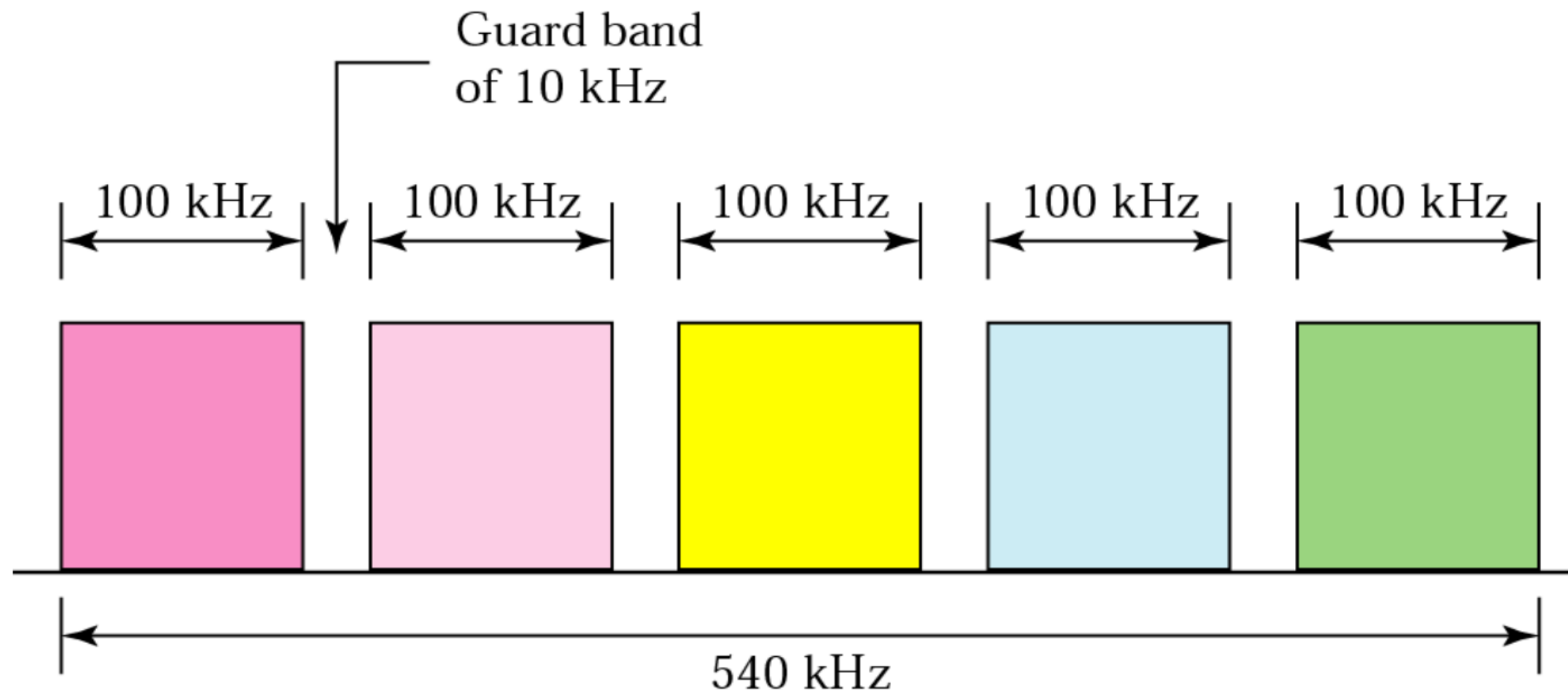


# DEMULTIPLEXING PROCESS





# FDM







**THANK YOU**