Topic of Presentation

Encoding

Encoding:

- Information must be encoded into signals before it can be transported across communication media.
- We must encode data into signals to send them from one place to another.

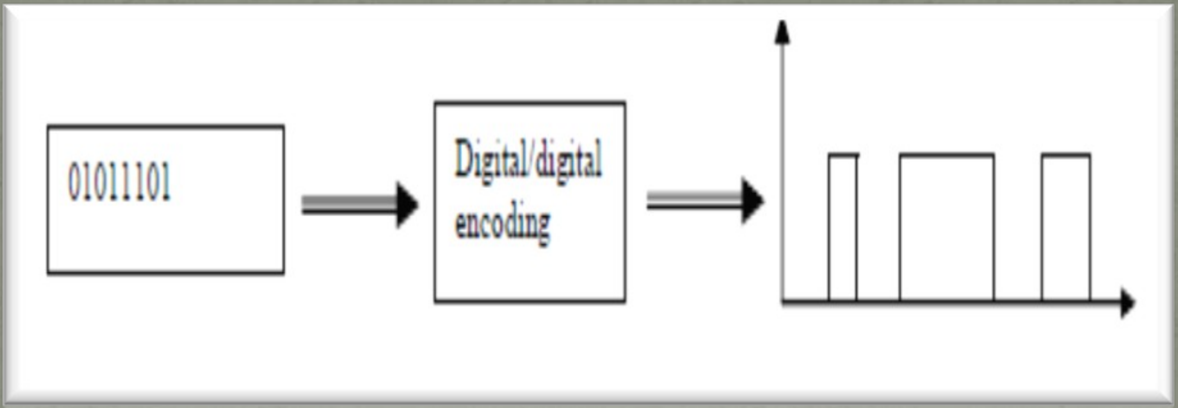
Encoding Techniques

- Digital to digital
- Analog to digital
- Digital to analog
- Analog to analog

Digital to Digital Encoding:

- Digital-to-Digital Encoding is the representation of digital information by a digital signal
- Example is computer to printer

Diagram of digital signal Encoding:



Digital to digital encoding terms

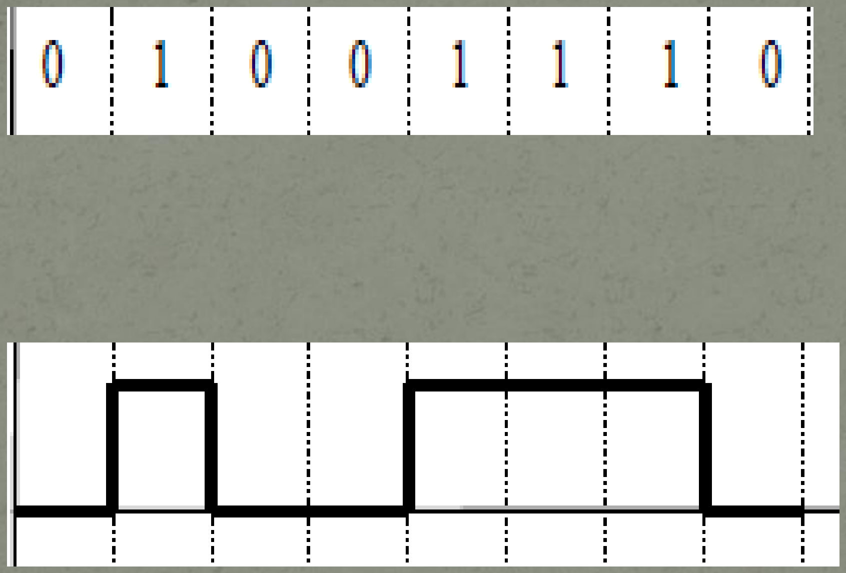
- Digital to digital encoding consist of three types

- Unipolar
- Polar
- Bipolar

Unipolar:

- It uses only one polarity
- One of the two binary states is encoded, usually the 1. The other state, usually 0, is represented by zero voltage
- Unipolar encoding uses only one level of value

Diagram of unipolar encoding:



Problem in unipolar:

- It has two problems that make it unusable:

  - DC component

  - Synchronization.

Problem Description:

- ***DC Component:***

when a signal contains a DC component it cannot travel through media that cannot handle DC components

- ***Synchronization:***

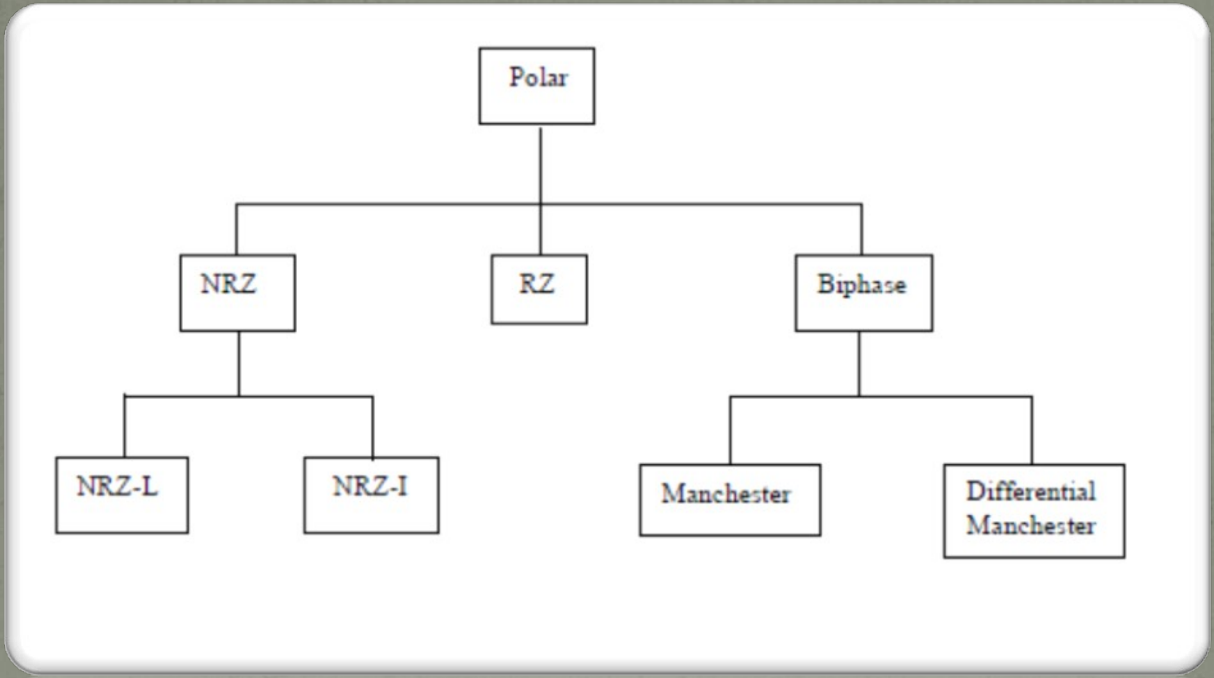
When a signal is unvarying, the receiver cannot determine the beginning and ending of each bit

Synchronization problem in unipolar encoding can occur whenever the data stream includes a long uninterrupted series of 1's or 0's.

Polar Encoding:

- Polar encoding uses two voltage levels
- One positive and one negative
- The average voltage level on the line is reduced and the DC component problem of unipolar encoding is alleviated

Types of polar encoding:



Non-Return-to-Zero (NRZ) Encoding

- In NRZ encoding, the level of the signal is always either positive or negative.
- If the line is idle or zero it means no transmission is occurring at all

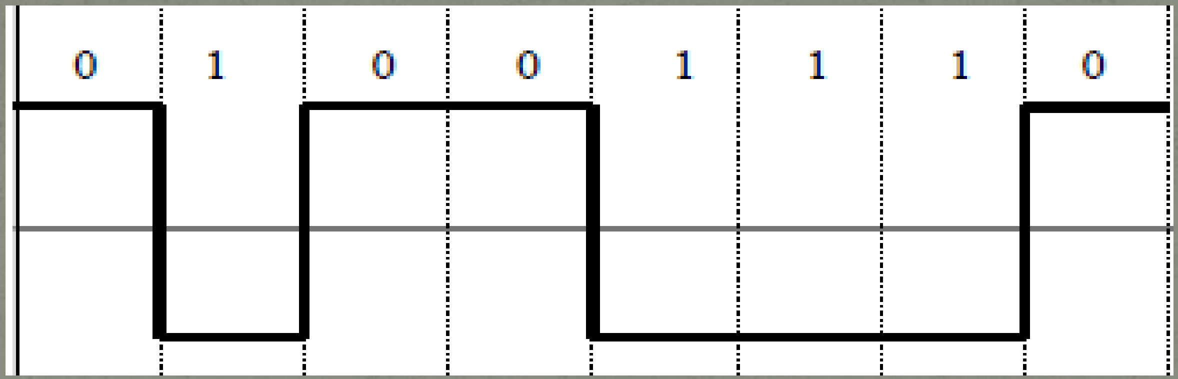
Types of Non-Return-to-Zero (NRZ) Encoding

- NRZ-L (Non-return-to-zero, Level)

- NRZ-I (Non-return-to-zero, Invert)

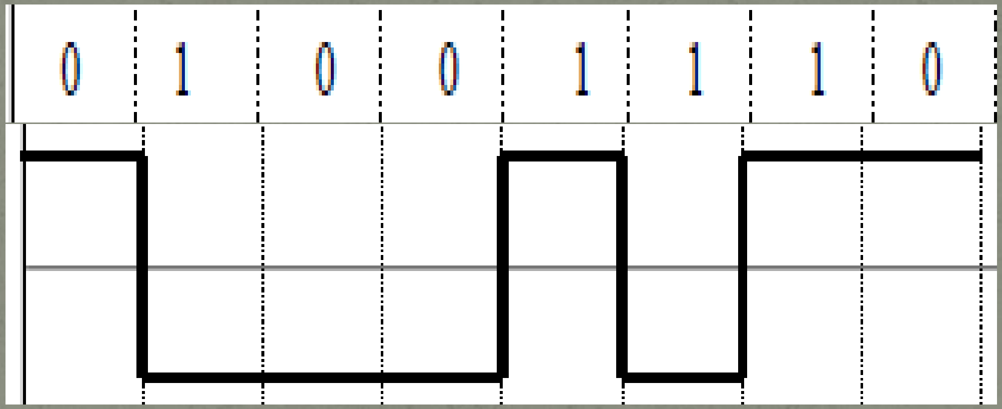
NRZ-L (Non-return-to-zero, Level)

- In NRZ-L the level of the signal is dependant upon the state of the bit.
- A positive voltage usually means the bit is 0, and negative voltage means the bit is a 1



NRZ-I (Non-return-to-zero, Invert)

- In NRZ-I, an inversion of the voltage level represents a 1 bit
- A 0 bit is represented by no change
- It is the transition between a positive and a negative voltage



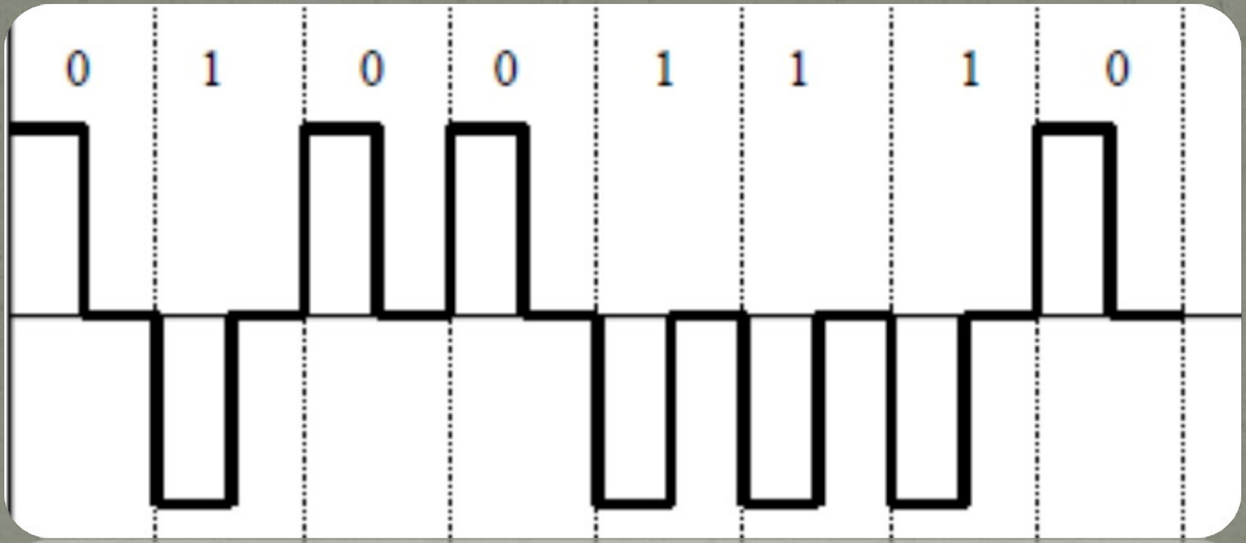
Advantage of NRZ

- The signal changes every time a 1 bit is encountered, it provides some synchronization
- Each inversion allows the receiver to synchronise its timer to the actual arrival of the transmission

RZ (Return-to-zero) Encoding

- Uses three Values: positive, negative, and zero.
- The signal state is determined by the voltage during the first half of each data binary digit
- The signal returns to a resting state (called zero) during the second half of each bit
- The resting state is usually zero volts, although it does not have to be

RZ (Return-to-zero) Encoding



Disadvantage of RZ Encoding:

- The main disadvantage of RZ encoding is that it requires two signal changes to encode one bit and therefore occupies more bandwidth

Biphase Encoding

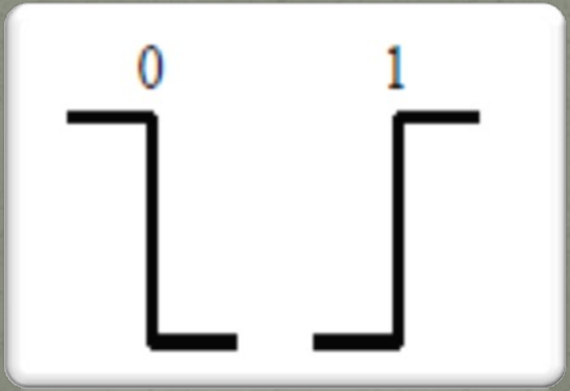
- The signal changes at the middle of the bit interval but does not return to zero
- It continues to the opposite pole

Types of Biphase Encoding

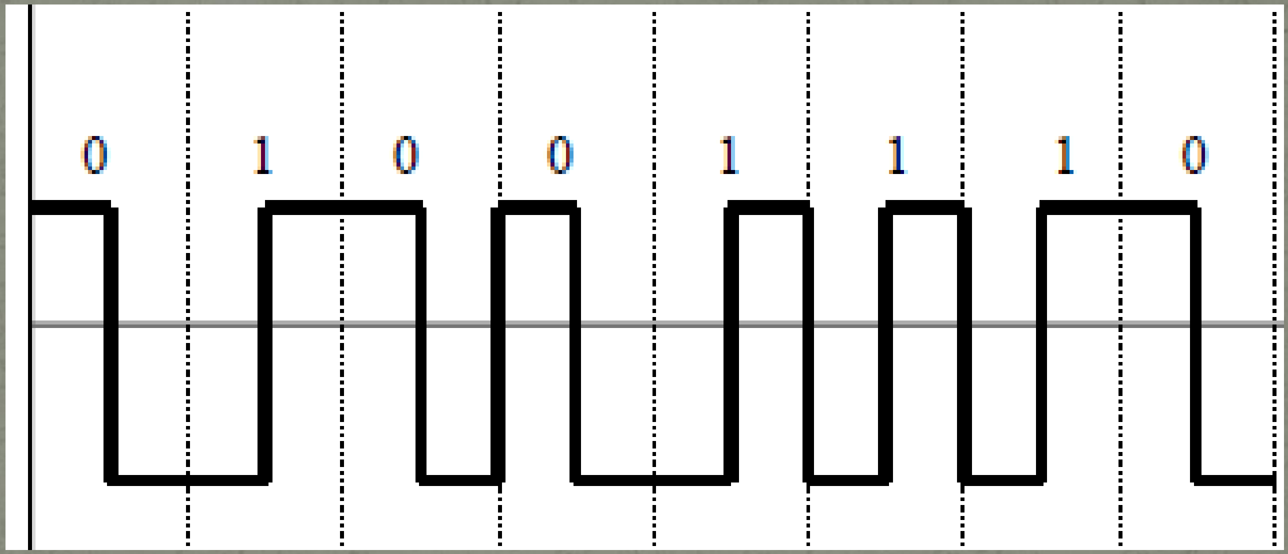
- Biphase encoding is implemented in two different ways
  - Manchester
  - Differential Manchester

Manchester Biphase Encoding

- Uses the inversion at the middle of each bit interval for bit representation
- A negative-to-positive transition represents binary 1 and a positive-to-negative transition represents binary 0.



Manchester Biphase Encoding

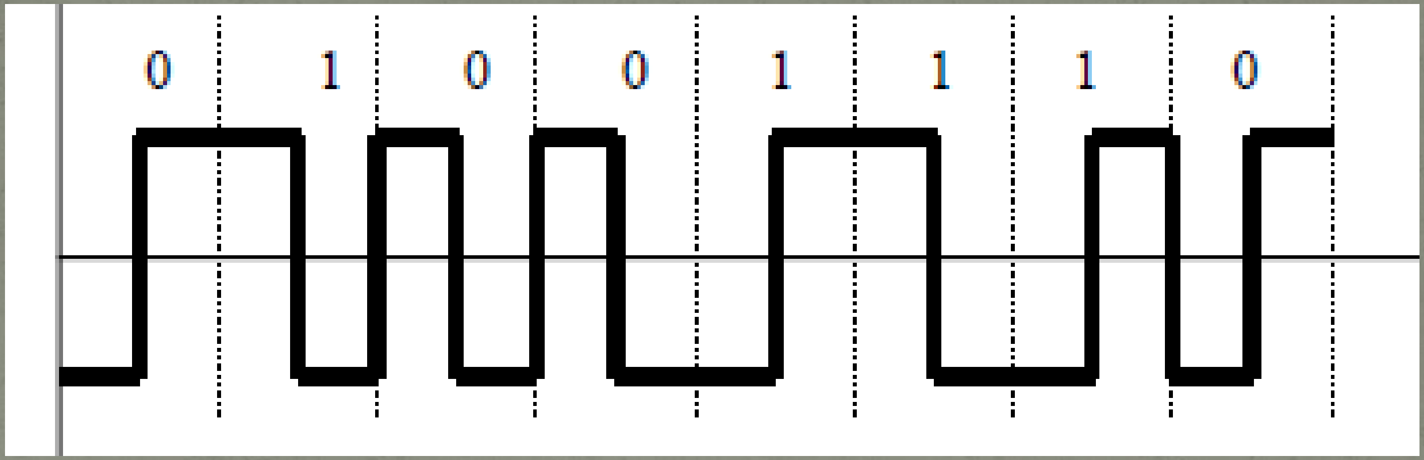


Differential Manchester

- The inversion at the middle of the bit is used
- The presence or absence of an additional transition at the beginning of the interval is used to identify the bit
- A transition means binary 0 and no transition means binary 1

Differential Manchester

- The bit representation is shown by the inversion and non-inversion at the beginning of the bit.



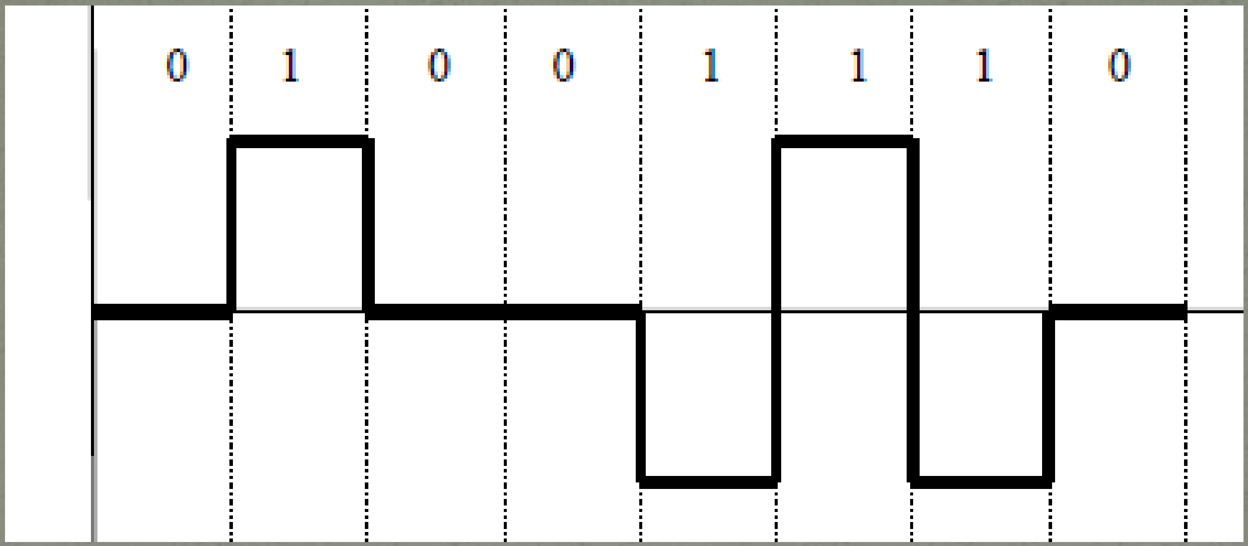
Bipolar Encoding

- Bipolar encoding uses three voltage levels: positive, negative and zero. The zero level is used to represent binary 0 positive and negative voltages represent alternating 1s. (If 1st one +ve, 2nd is -ve).
- * Three types of bipolar encoding are popular use by the data communications industry: AMI, B8ZS, and HDB3

Bipolar Alternate Mark Inversion (AMI)

- AMI means alternate 1 inversion. A neutral, zero voltage represents binary 0.
- Binary 1s are represented by alternating positive and negative voltages

Bipolar Alternate Mark Inversion (AMI)

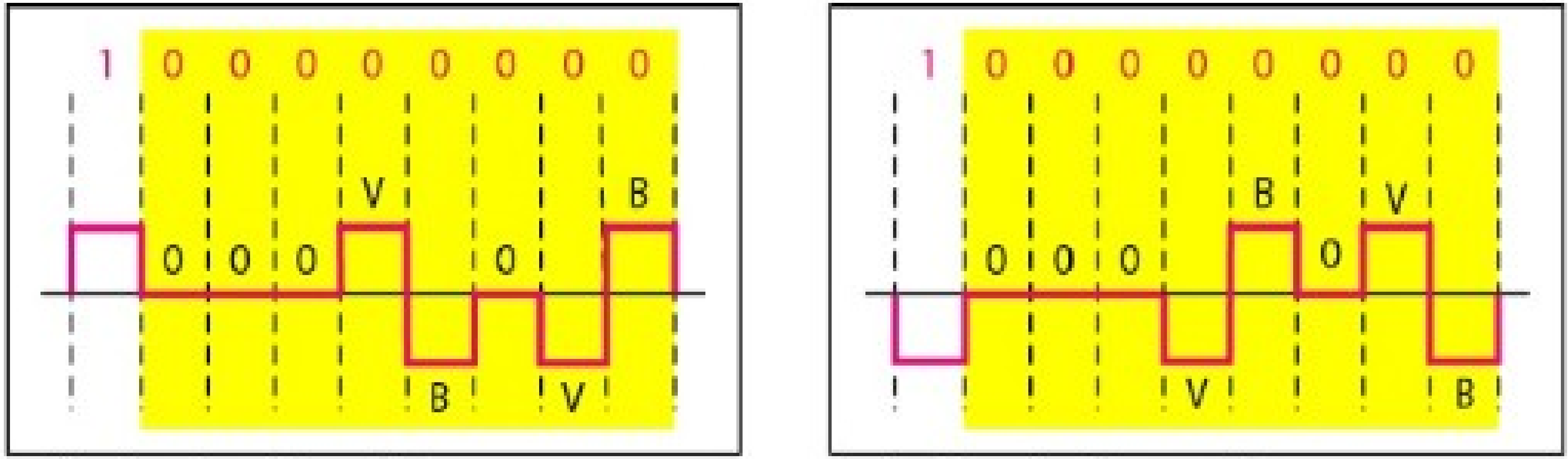


Advantage of AMI

- By inverting on each occurrence of a 1, bipolar AMI accomplishes two things: first, the DC component is zero, and second, a long sequence of 1s stays synchronized.

Bipolar 8-Zero Substitution (B8ZS)

- In B8ZS, if eight 0s come one after another, we change the pattern in one of two ways based on the polarity of previous 1.

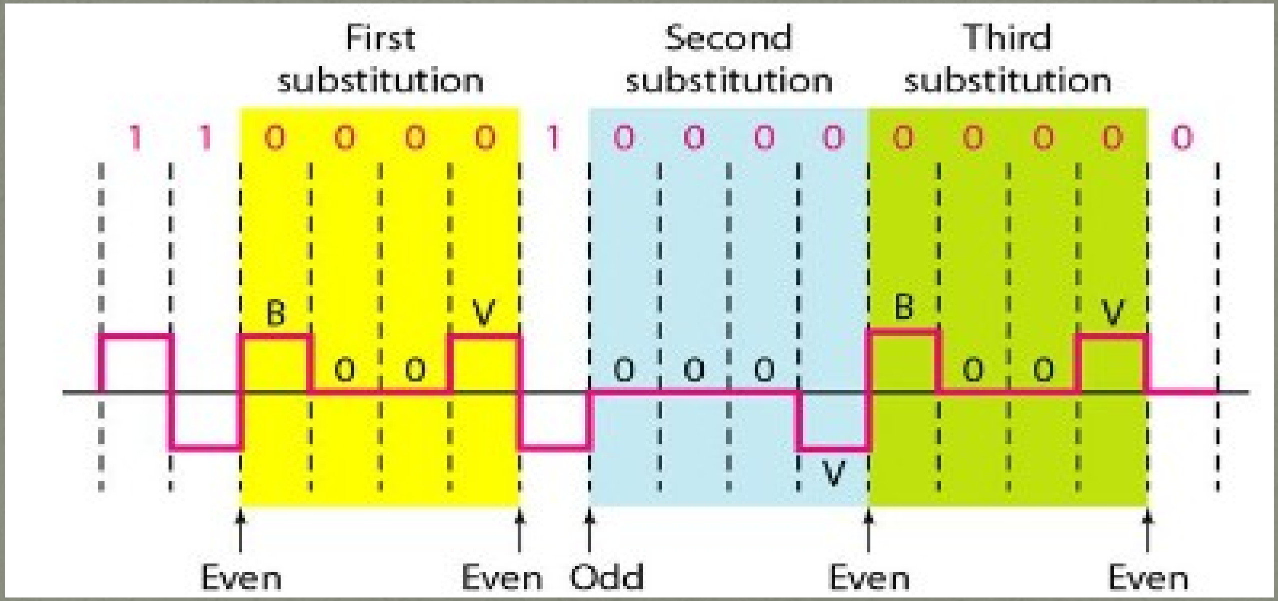


a. Previous level is positive.

b. Previous level is negative.

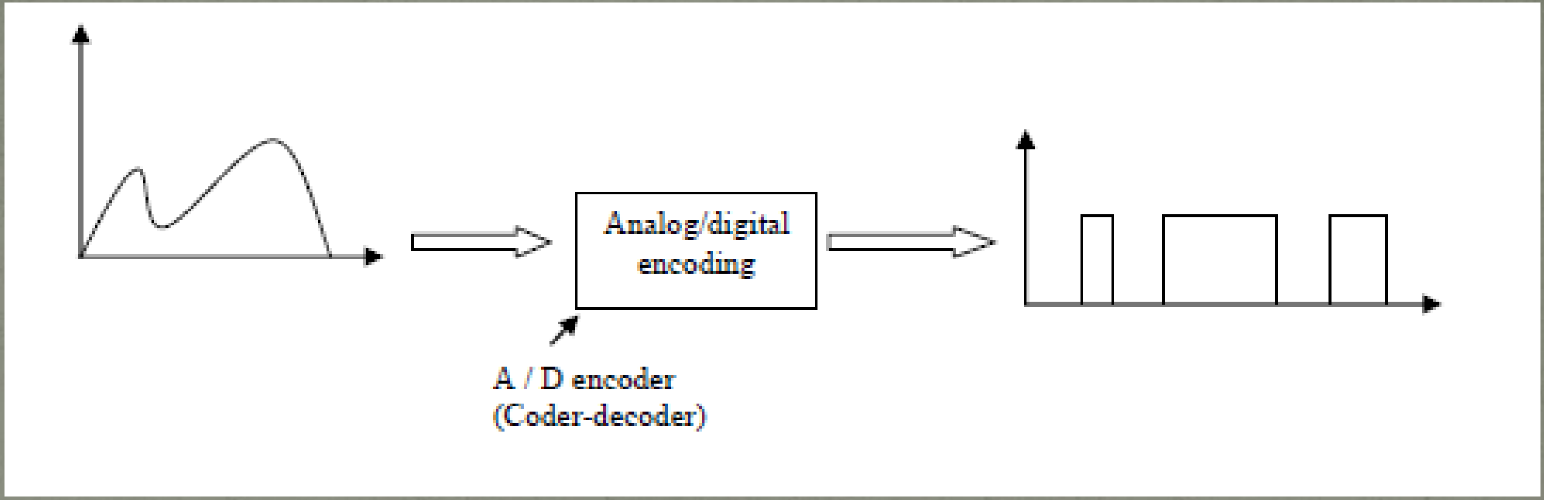
High-Density Bipolar 3 (HDB3)

- In HDB3 if four 0s come one after another, we change the pattern in one of four ways based on the polarity of the previous 1 and the number of 1s since the last substitution



Analog-to- Digital Encoding

- In analog-to-digital encoding, the information contained in a continuous wave form are represented as a series of digital pulses (1s and 0s)



Steps involve in Analogue to digital

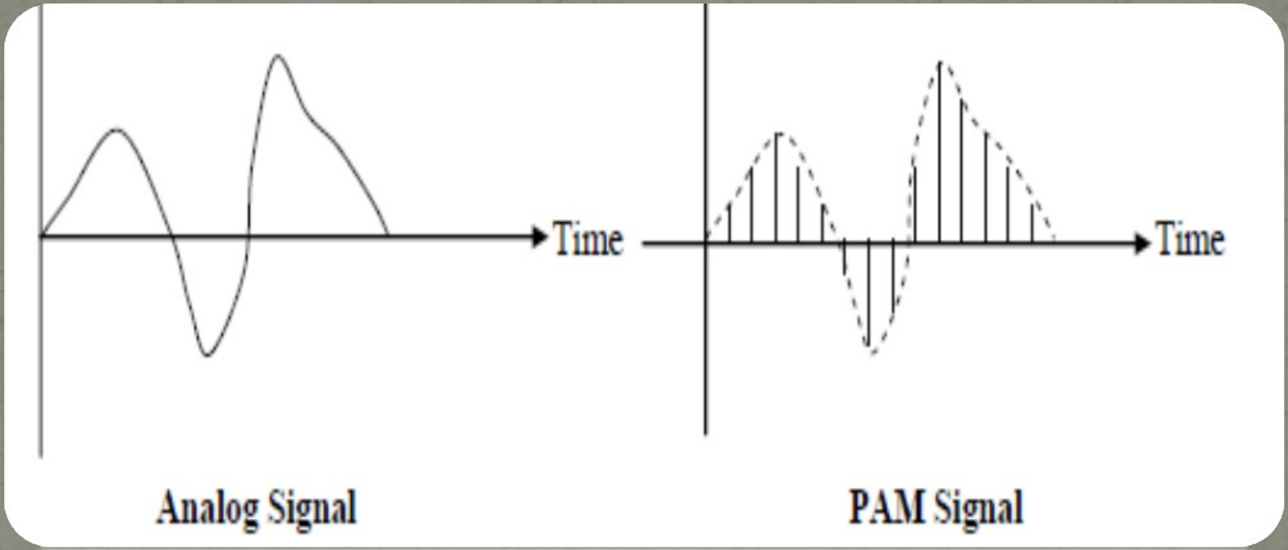
- Pulse Amplitude Modulation (PAM)
- Pulse Code Modulation (PCM)
- Quantisation

Pulse Amplitude Modulation (PAM)

- This technique takes analog information, samples it, and generates a series of pulses based on the results of sampling
- ***Sampling:***

Measuring the amplitude of the signal at equal time intervals.

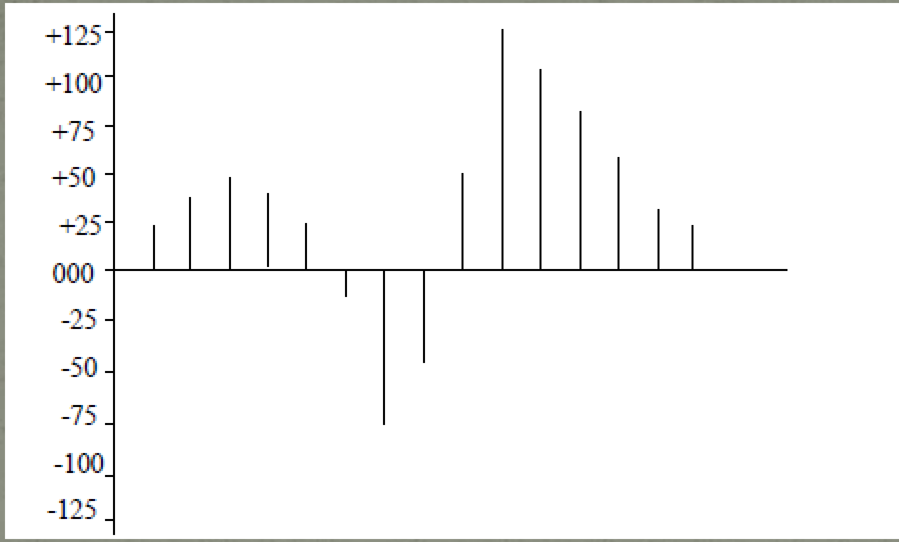
Pulse Amplitude Modulation (PAM)

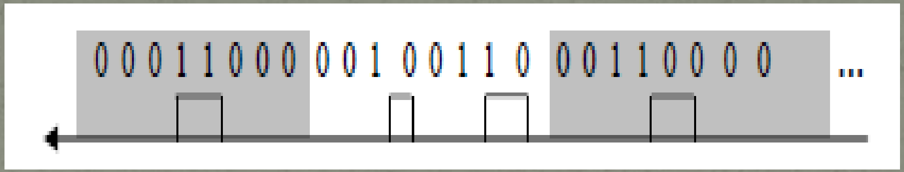


Pulse Code Modulation (PCM)

- PCM modifies the pulses created by PAM to create a complete digital signal
- PCM first quantises the PAM pulses.Quantisation is a method of assigning integral values in a specific range to sampled instances
- Each value is translated into its seven-bit binary equivalent.The eighth bit indicates the sign
- The binary digits are then transformed into a digital signal using one of the digital encoding

Pulse Code Modulation (PCM)





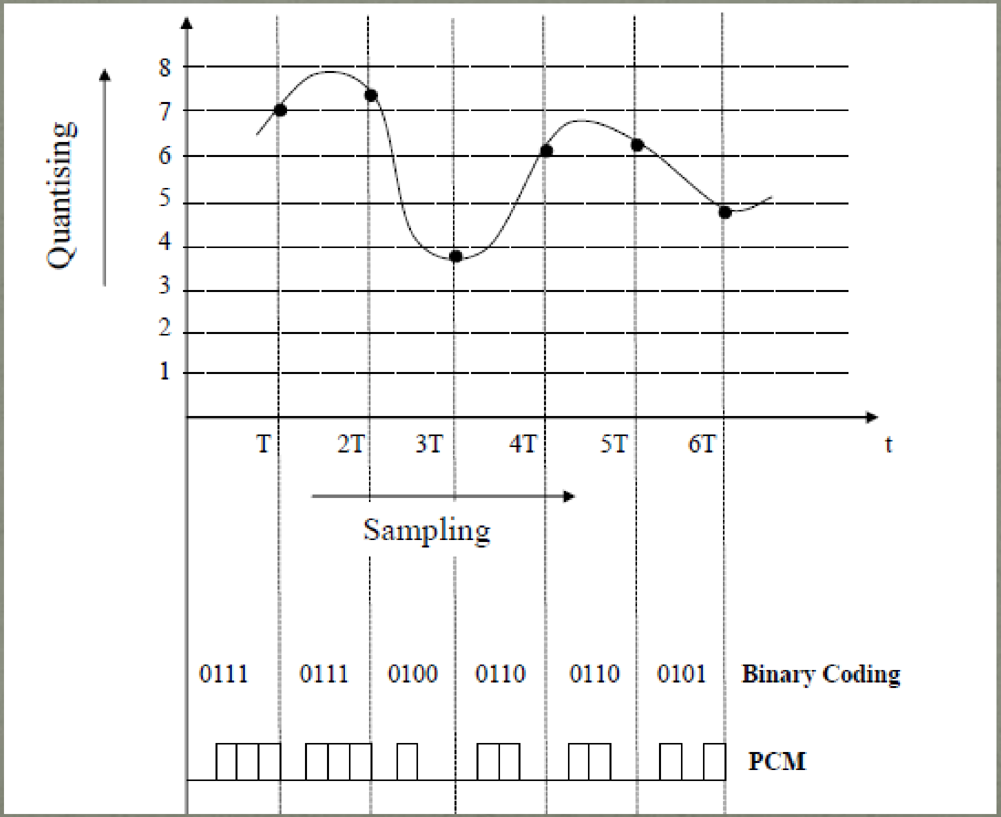
Pulse Code Modulation (PCM)

- The result of the PCM of the original signal encoded finally into a unipolar signal.
- PCM is actually made up of four separate processes:

1. PAM
2. Quantisation
3. binary encoding
4. digital-to-digital encoding

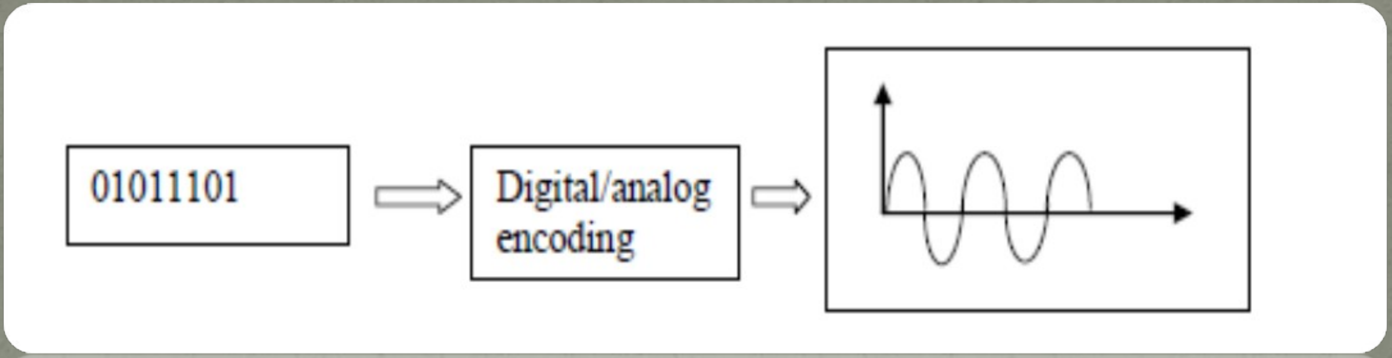
Quantisation:

- Quantising is the process of rounding-off the values of the flat-top samples to certain predetermined levels.

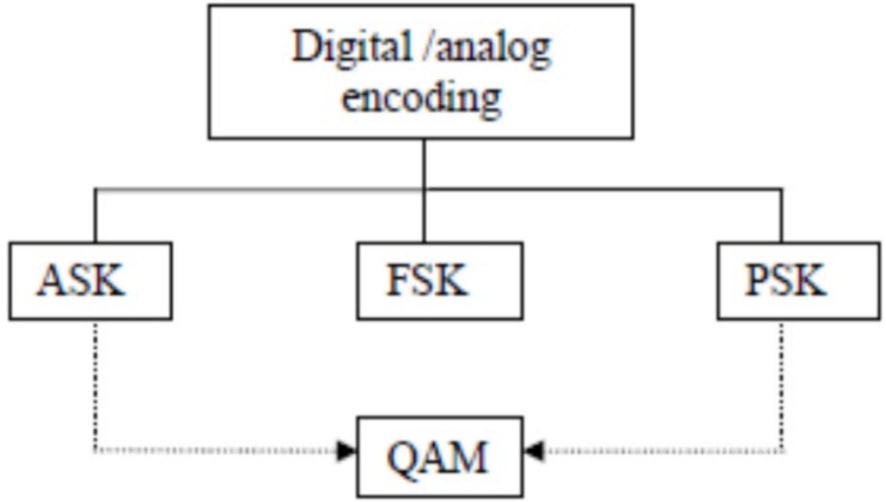


Digital-to-Analog Encoding

- Digital-to-analog encoding is the representation if digital information by an analog signal



Types:



Quadrature Amplitude Modulation

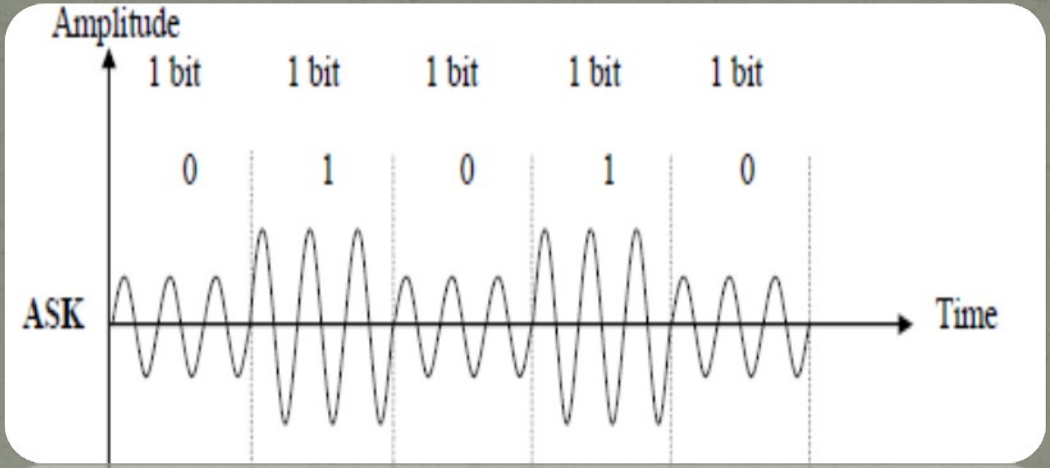
Bit Rate and Baud Rate

- Bit rate is the number of bits transmitted in one second.
- Baud rate refers to the number of signal units per second

  that are required to represent those bits.

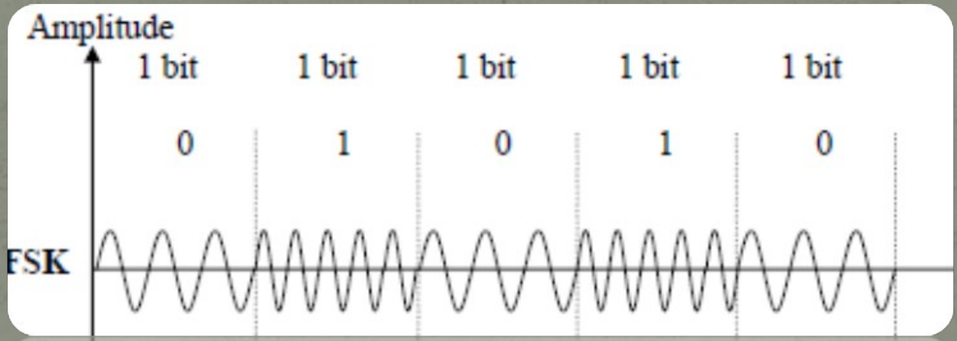
Amplitude Shift Keying (ASK)

- The strength of the signal is varied to represent binary 1 or 0.
- Both frequency and phase remain constant, while the amplitude changes.



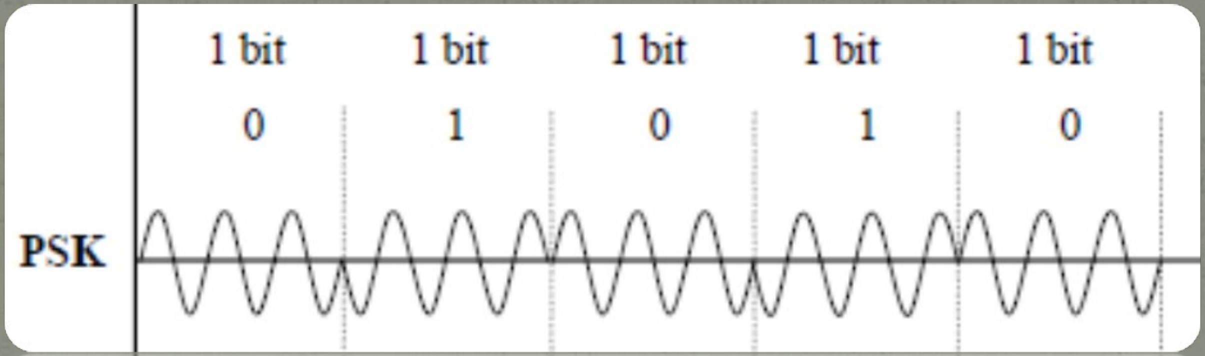
Frequency Shift Keying (FSK)

- The frequency of the signal is varied to represent binary 1 or 0.
- The frequency of the signal during each bit duration is constant and its value depends on the bit (0 or 1): both peak amplitude and phase remain constant.



Phase Shift Keying (PSK)

- the phase is varied to represent binary 1 or 0.
- Both peak amplitude and frequency remain constant as the phase changes.
- The phase of the signal during each bit duration, is constant and its value depends on the bit (0 or 1).



Bandwidth of shifting key

- Bandwidth for ASK

$$BW = (1 + d) * N_{baud}$$

Nbaud is the baud rate and d is a factor related to the condition of the line

- Bandwidth for FSK

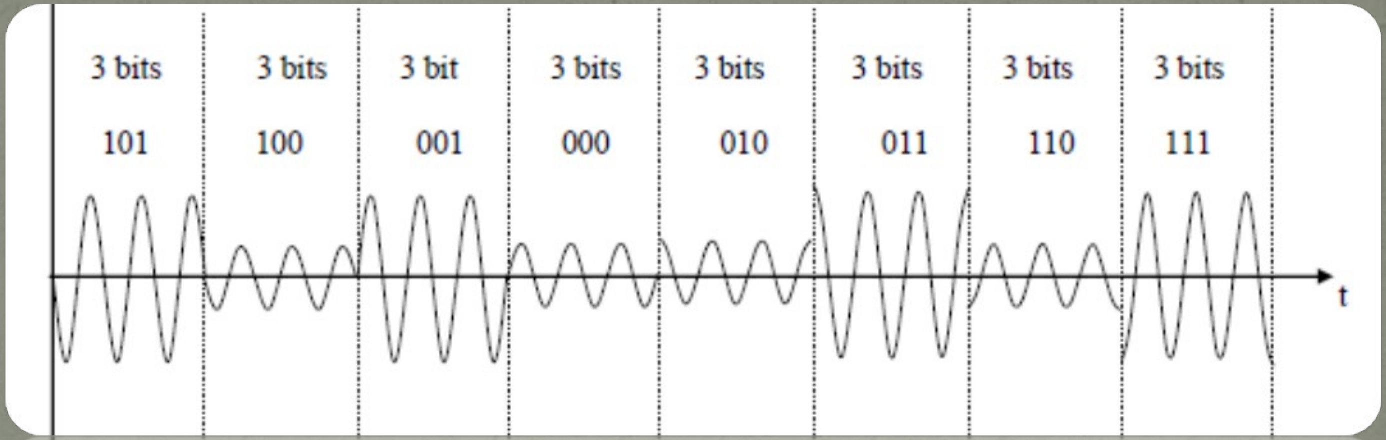
$$BW = N_{baud} + (f_{c1} - f_{c0})$$ difference of two carriers.

- Bandwidth for PSK

$$BW = N_{baud}$$

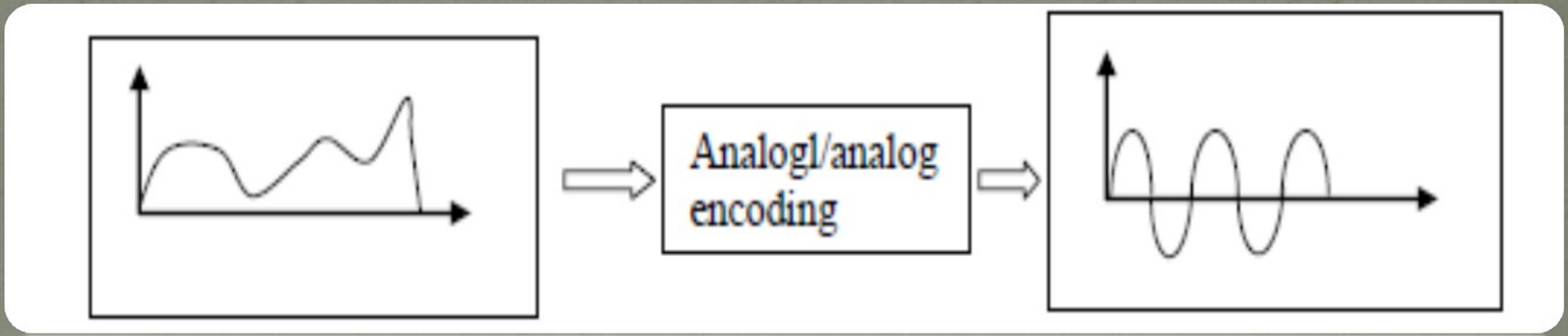
Quadrature Amplitude Modulation (QAM)

- QAM means combining ASK and PSK in such a way that we have maximum contrast between each bit, dibit, tribit, quadbit, and so on.
- Number of amplitude shifts is less than the number of phase shifts



Analog-to-Analog-Encoding

- Analog-to-analog encoding is the representation of analog information by an analog signal.



Types:

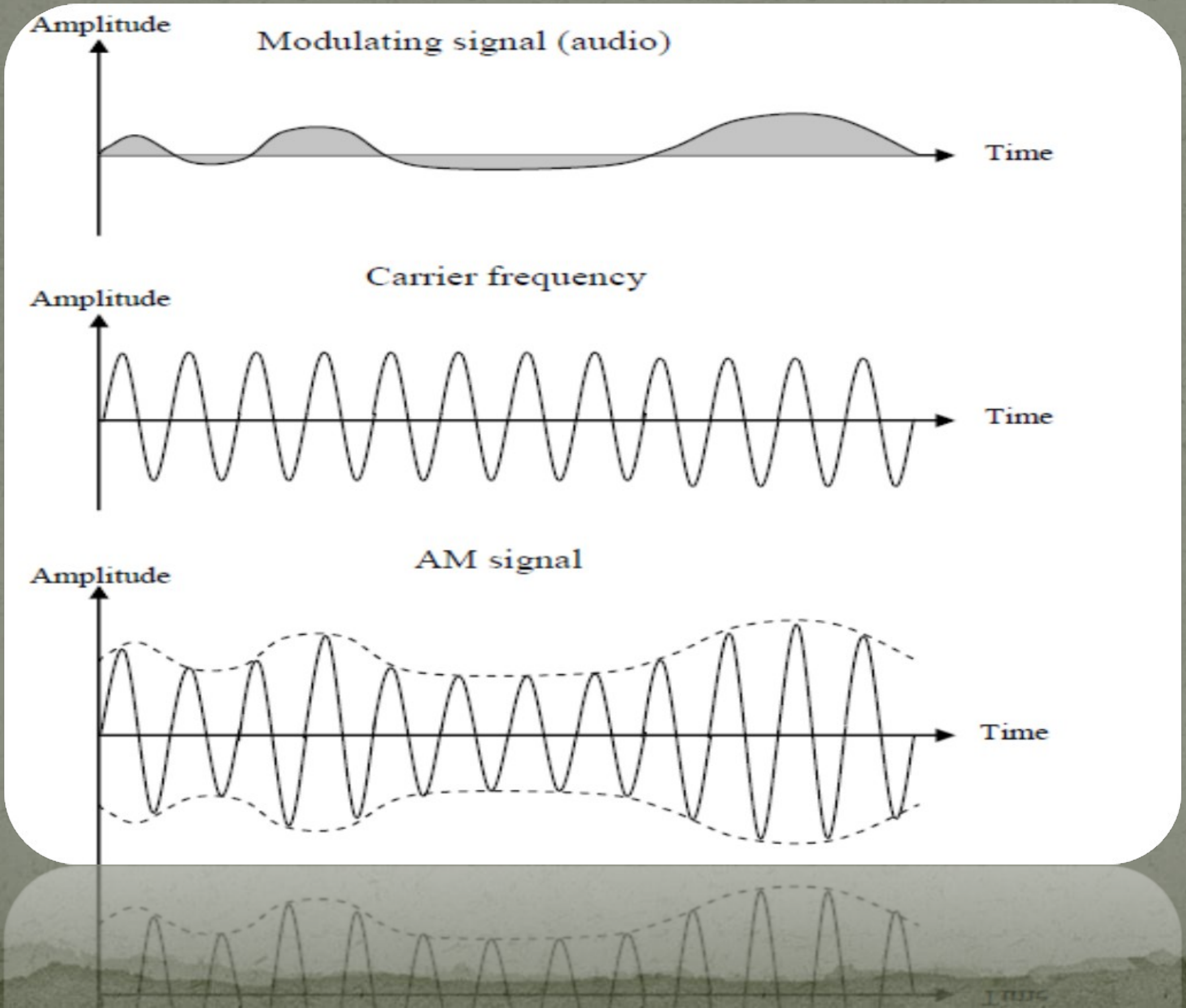
- Analog-to-analog modulation can be accomplished in three ways:

1. Amplitude modulation (AM)
2. Frequency modulation (FM)
3. Phase modulation (PM)

Amplitude Modulation

- The carrier signal is modulated so that its amplitude varies with the changing amplitudes of the modulating signal
- The frequency and phase of the carrier remain the same
- Amplitude changes to follow variations in the information
- The modulating signal becomes the envelope of the carrier.

Amplitude Modulation:



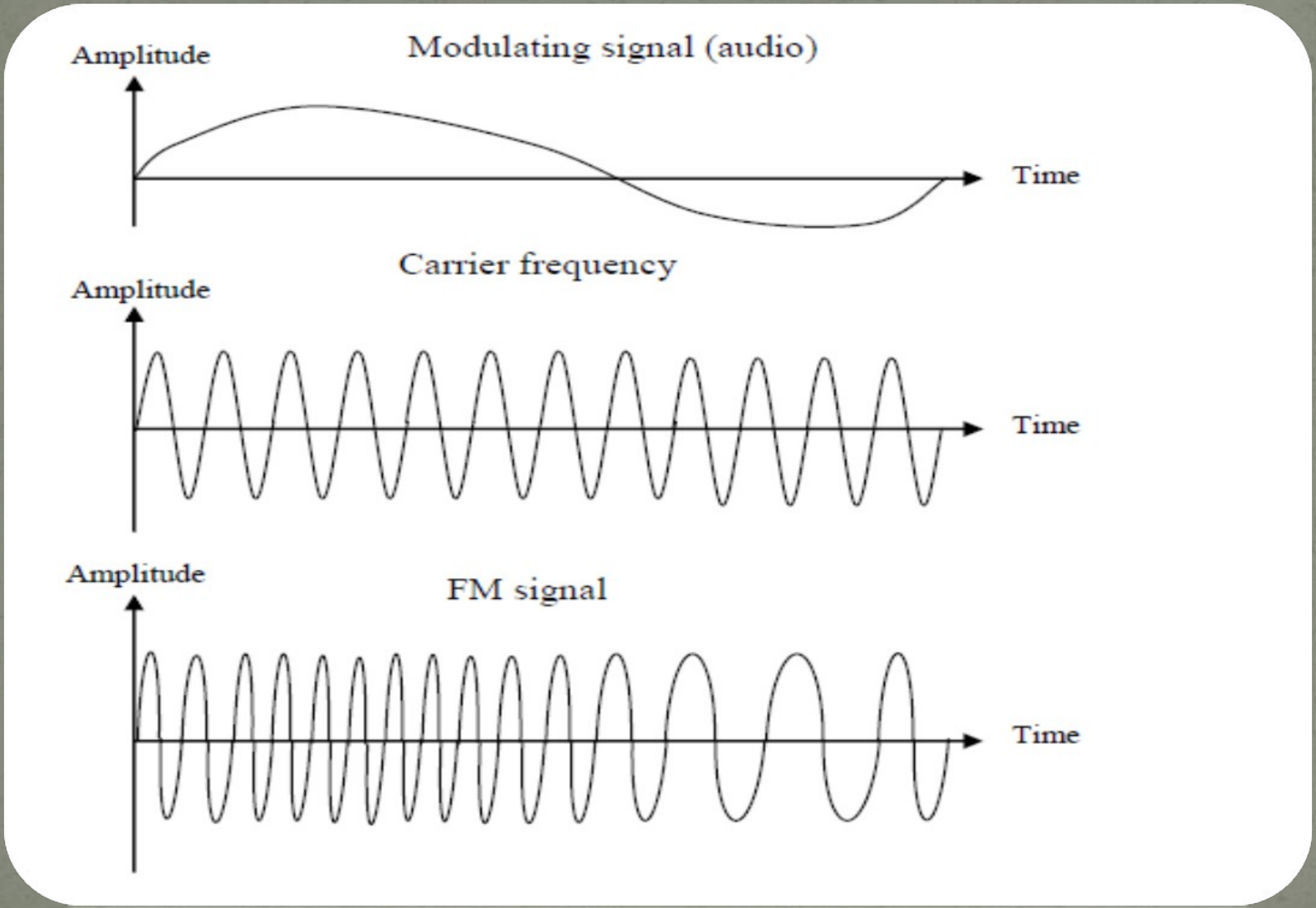
AM Bandwidth

- The bandwidth of an AM signal is equal to twice the bandwidth of the modulating signal and covers a range centered on the carrier frequency
- The total bandwidth required for AM can be determined from the bandwidth of the audio signal
- $$BW_t = 2 \times BW_m$$
- BWm = Bandwidth of the modulating signal

Frequency Modulation (FM)

- The frequency of the carrier signal is modulated to follow the changing voltage level (amplitude) of the modulating signal.
- The peak amplitude and phase of the carrier signal remain constant, but as the amplitude of the information signal changes, the frequency of the carrier changes correspondingly.

Frequency Modulation (FM)



FM Bandwidth

- The bandwidth of an FM signal is equal to 10 times the bandwidth of the modulating signal and, like AM bandwidth, covers a range centered on the carrier frequency
- The total bandwidth required for FM can be determined from the bandwidth of the audio signal:
- BWt = 10 x BWm
- BWm = Bandwidth of the modulating signal
- BWt = Total bandwidth

Phase Modulation (PM)

- The phase of the carrier signal is modulated to follow the changing voltage level of the modulating signal
- The peak amplitude and frequency of the carrier signal remain constant, but as the amplitude of the information signal changes, the phase of carrier changes correspondingly

Thank you