

# Ch-3 Digital Transmission

21/9/22

convert info into analog or digital

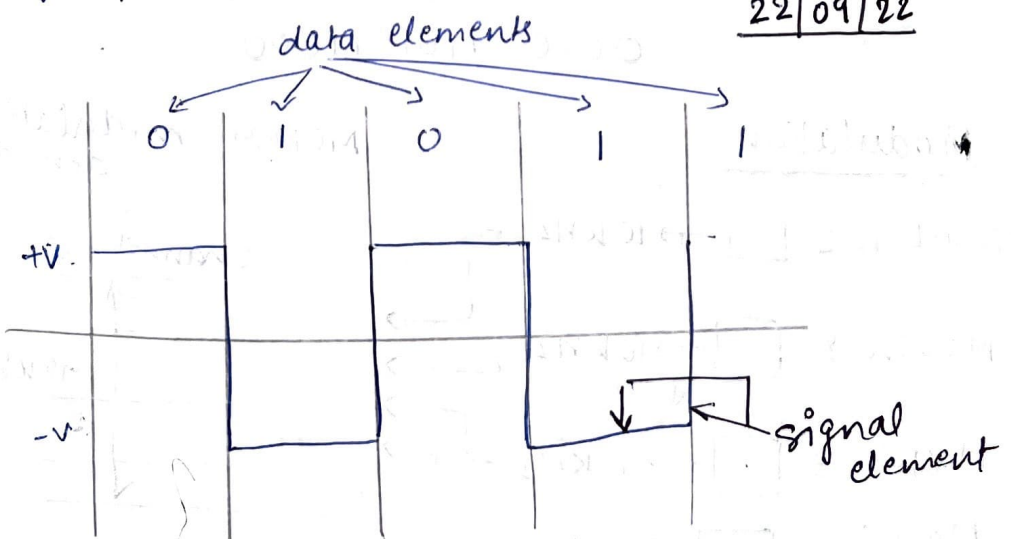


- \* The user data can be in one of two formats. One is analog which are continuous signal & the second one is digital or discrete signals. The transmitted signals can also be in one of the two forms i.e. analog or digital.
- \* Data that has to be converted into signal using some technique.

Data	Signal
Digital	Digital or Analog
Analog	Digital or Analog

Data	Signal	Technique
Digital	Digital	Encoding
Digital	Analog	Modulation
Analog	Digital	Encoding
Analog	Analog	Modulation

22/09/22

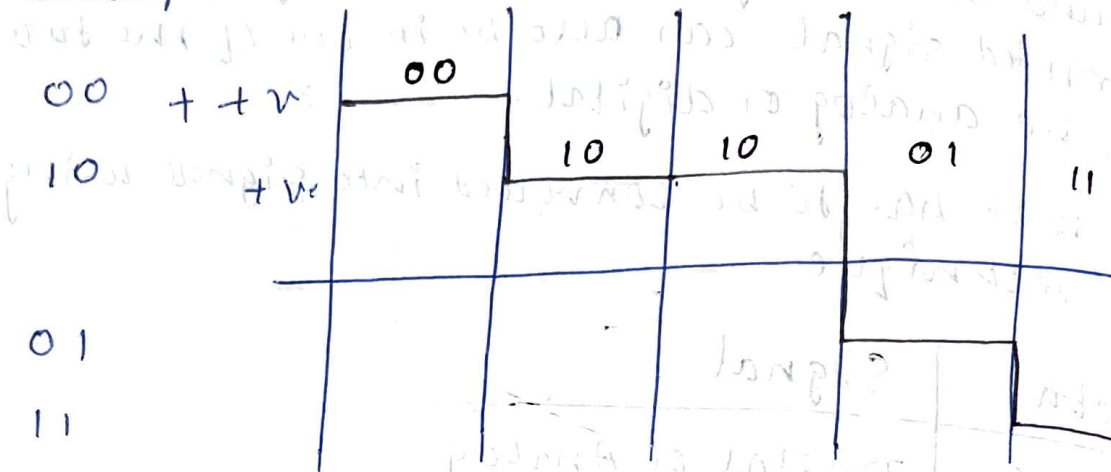


In 2 bits, combination

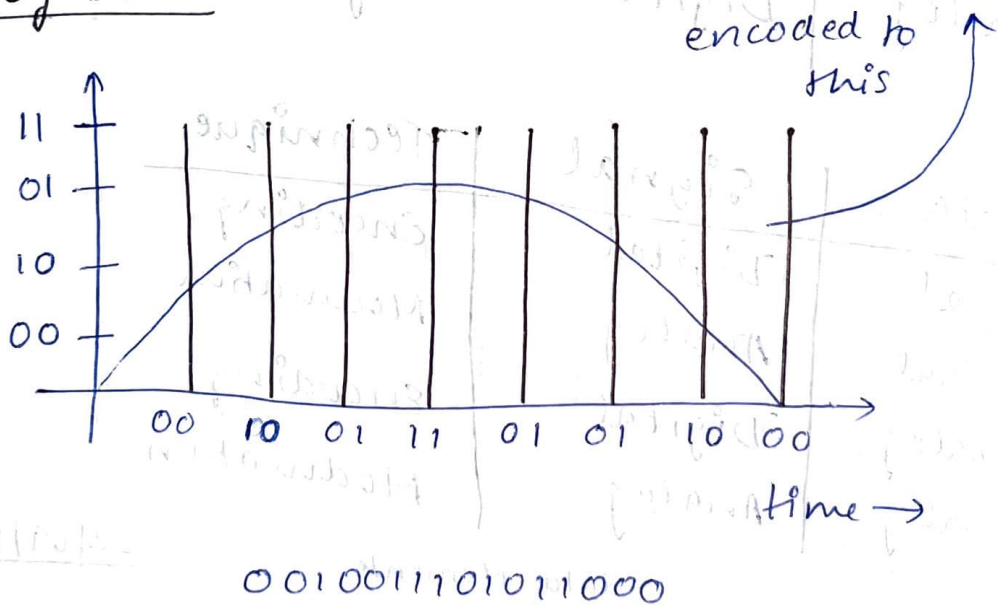
= 00  
01  
10  
11

### Digital Data

Example: 0010100111



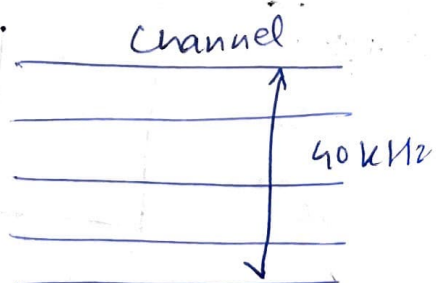
### Analog Data



### Modulation

Machine 1 ☐ → 10 kHz  
Machine 2 ☐ → 10 kHz  
Machine 3 ☐ → 10 kHz  
Machine 4 ☐ → 10 kHz

MODEM - modulator & demodulator



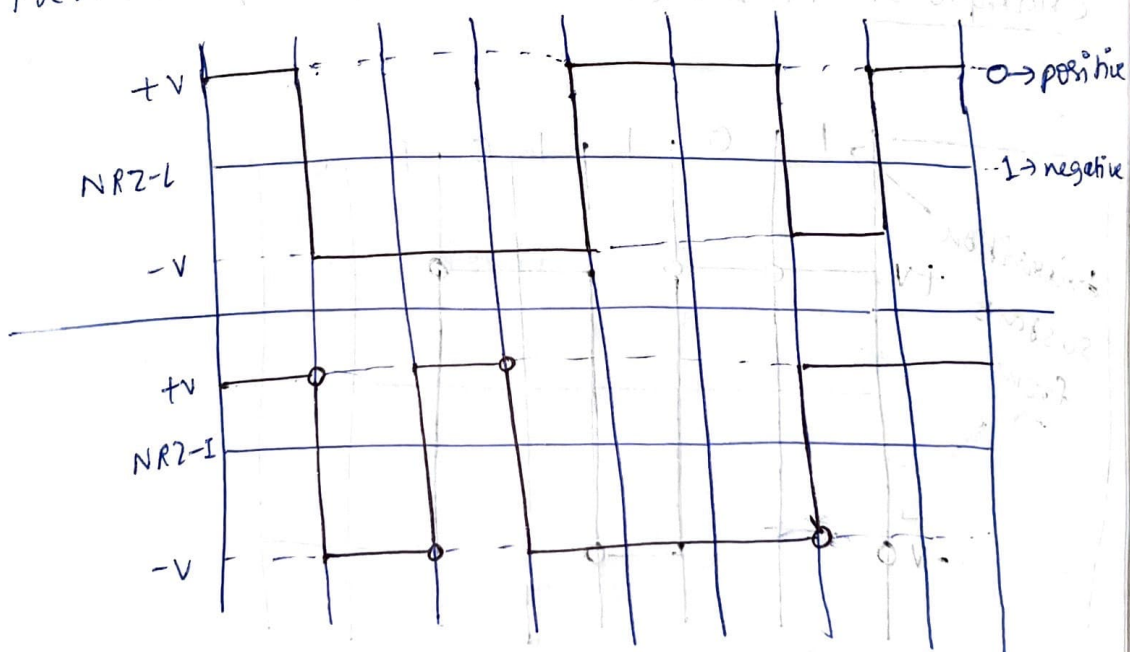
Machine 1 can give to the channel as 1 to 10 in layer 1  
 but Machine 2 cannot because of layers, (11-20) it will  
 be difficult so  
 Machine 2, 3, 4 should use modulator.

0 - middle of the bit.

Positive voltage encodes -0  
 negative voltage encodes -1

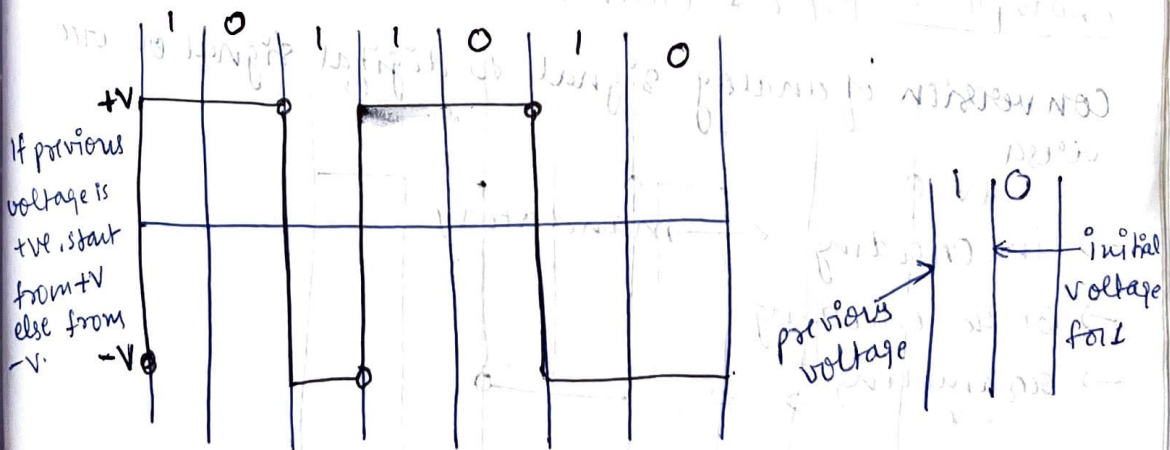
Balance of negative & positive voltage should be there  
 Initial voltage  $\rightarrow$  voltage after zero (first voltage)

Previous voltage  $\rightarrow$  voltage before zero



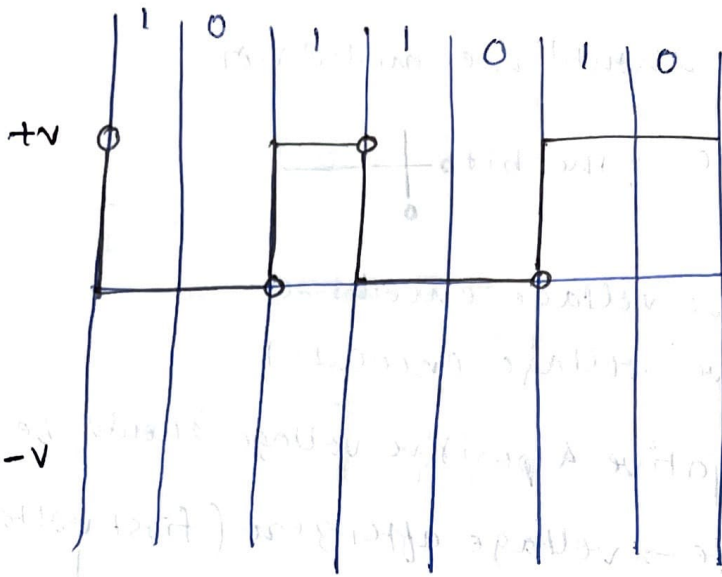
Example - 1 NRZ-I (Previous voltage is negative)

0 - no transition  
 1 - transition

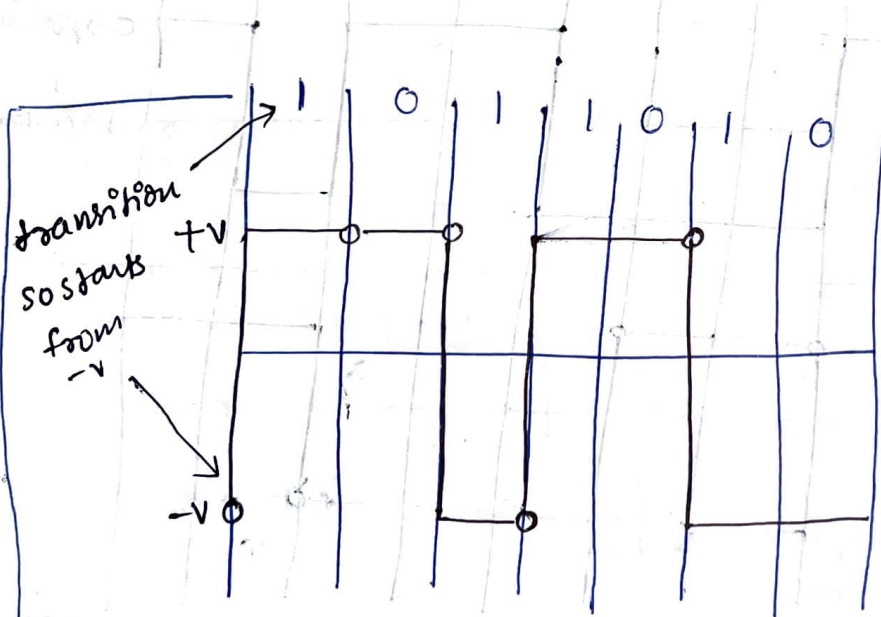




Example 2: NRZ-I (Previous voltage is positive)

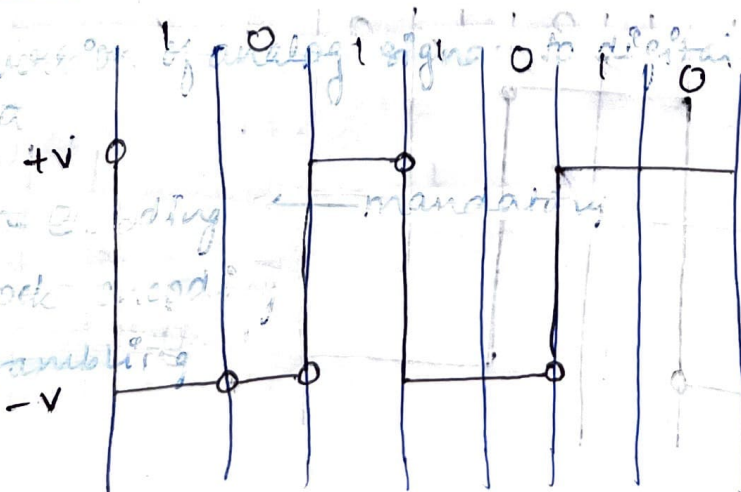


Example 3: NRZ-I (Initial voltage is positive)



→ If this was 0, it would start from  $+V$

Example 4: NRZ-I (Initial voltage is negative)



# Conversion of analog signal to digital signal 24/09/22 or vice versa

\* Line encoding ← mandatory for signal transmission & conversion

\* Block encoding

\* Scrambling

Transfer of digital data requires conversion into digital signal or analog signal.

## line encoding

\* Unipolar → NRZ

\* Polar → NRZ

→ RZ

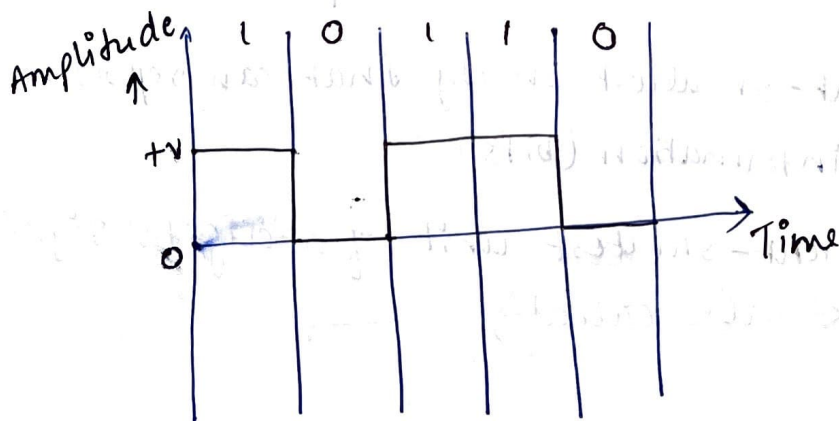
→ Manchester } Biphasic

\* Bipolar → AMI & pseudoternary

\* Multilevel

\* Multitransition.

Unipolar → not used because voltage required is more.

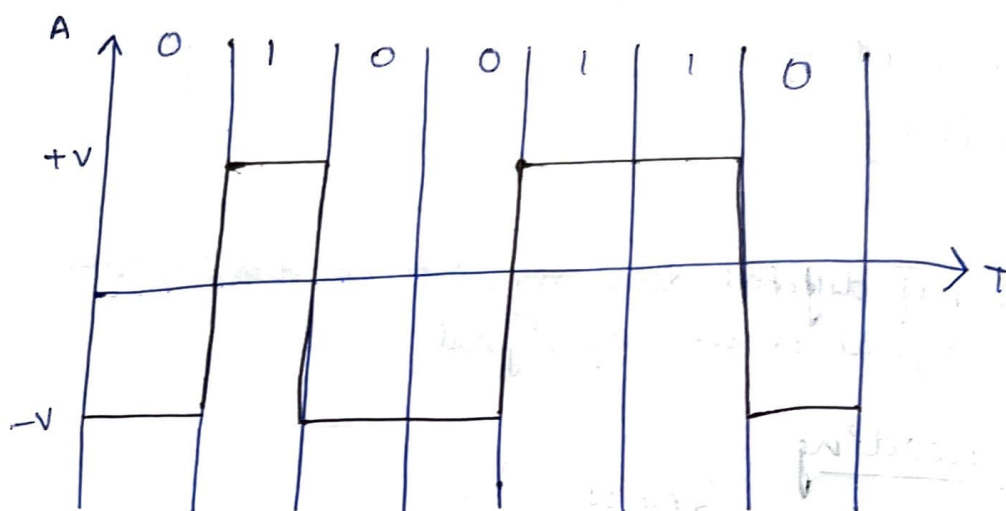


## Polar

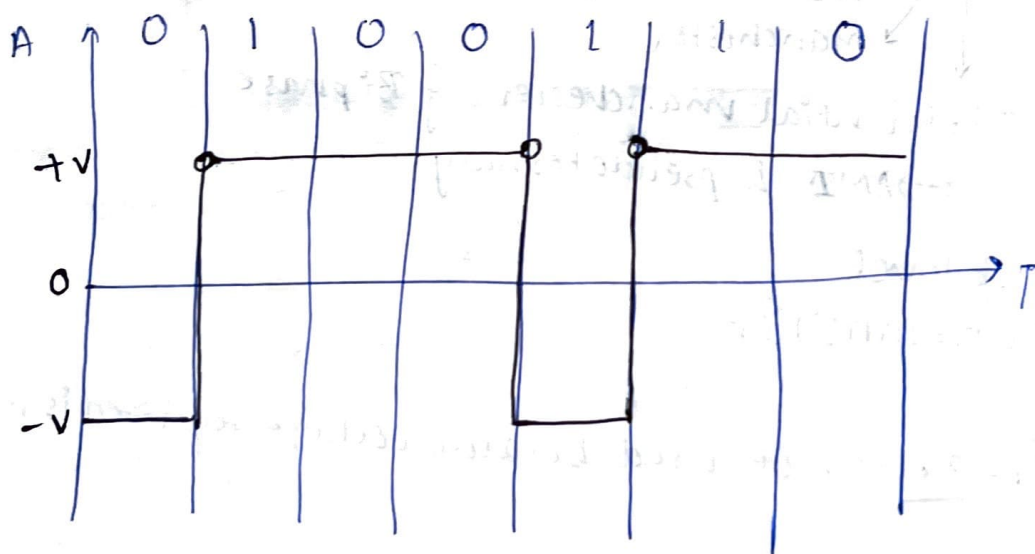
\* Two signal level +ve & -ve polarities

NRZ-2

Here +v - 1  
-v - 0

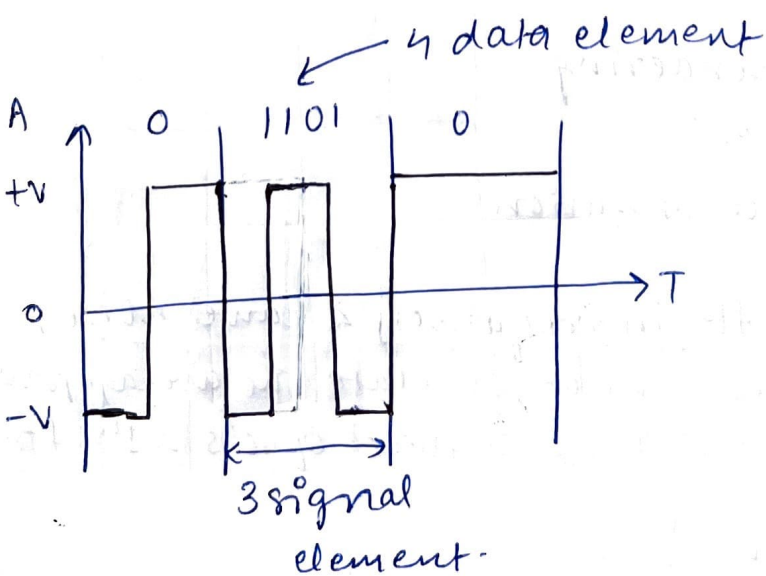
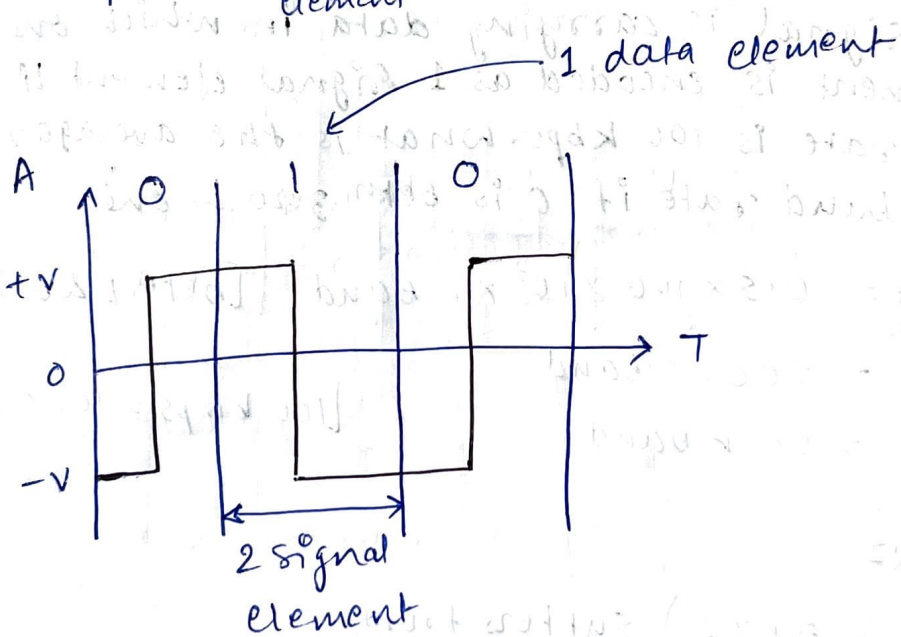
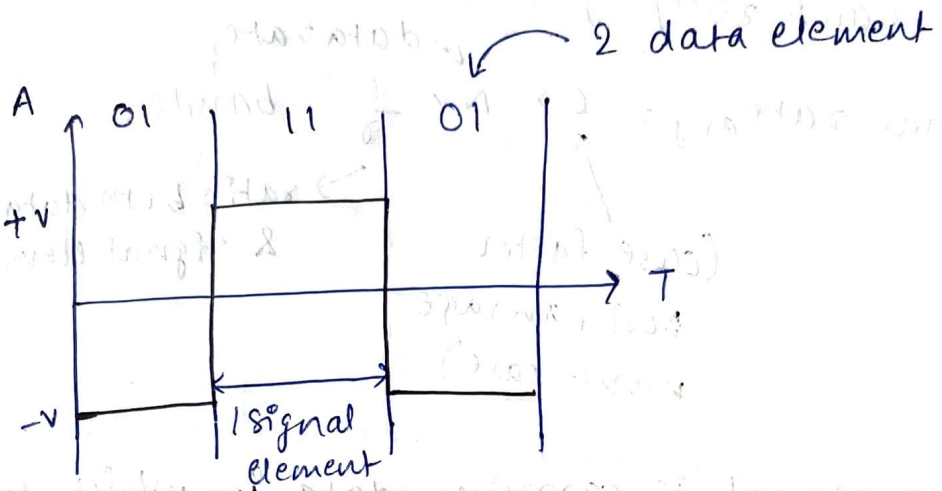
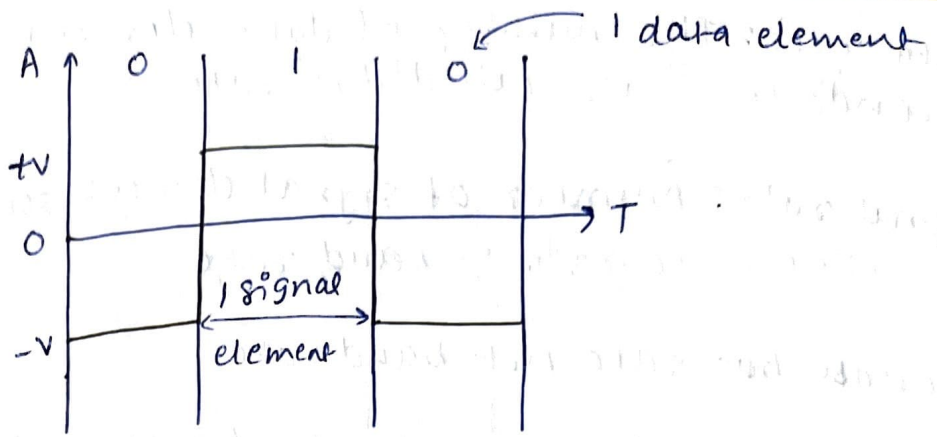


NRZ I



Data element - smallest entity that can represent a piece of information (bits)

Signal element - shortest unit of a digital signal (data rate ← also called)





**Data rate:** The number of data elements sent second. It is also called bit rate.

**Signal rate:** Number of signal element sent per second.  
Also called pulse rate or baud-rate

Increase bit rate not baud rate

The baud rate/signal rate can be calculated

$$\text{Signal rate}_{\text{avg}} = C \times N \times \frac{1}{8} \text{ baud}$$

← data rate

(case factor  
best, average  
worst case)

→ ratio betn data element  
& signal element

Q1 A signal is carrying data in which one data element is encoded as 1 signal element. If the bit rate is 100 kbps. What is the average value of baud rate if C is betn zero & one.

$$\begin{aligned} \rightarrow S_{\text{avg}} &= 0.5 \times 100 \times 10^3 \times 1 \text{ baud} \quad [\text{betn } 1 \text{ \& } 0 \text{ is half}] \\ &= 50000 \text{ baud} \\ &= 50 \text{ kbaud} \end{aligned}$$

[100 kbps =  $100 \times 10^3$  bps]

NRZ

(NRZI & NRZ2) suffers from:

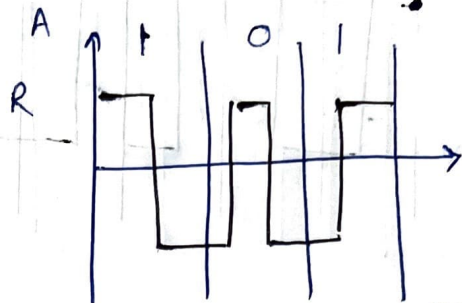
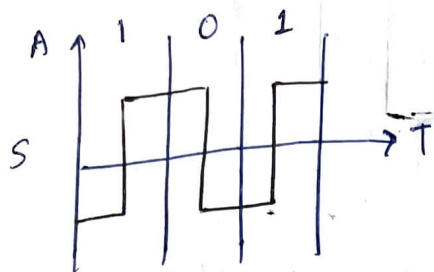
- 1) Baseline wandering
- 2) DC Component
- 3) Clock Synchronization.

1) causes drift in frequency & causes noise, the receiver cannot calculate the average power when constant long sequence of 0's & 1's from senders.



2) A very low frequency needs to be amplified  
increase in low signals due to long sequence of 0's & 1's & channel cannot handle low frequency signals  
so remove those frequencies

3) Synchronization betw sender & receiver



can be removed

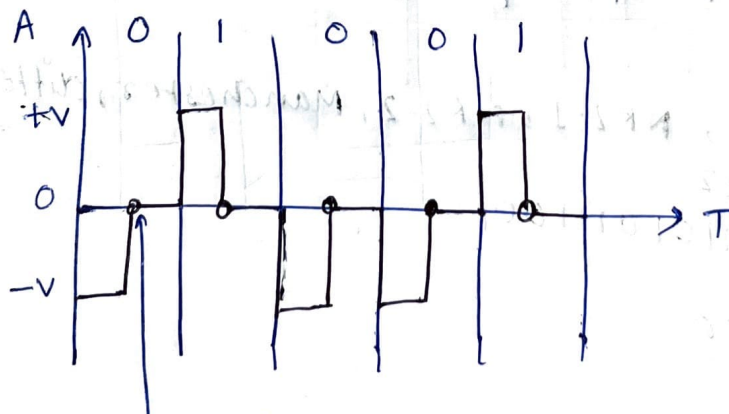
not synchronized to different at different ends

RZ  $\rightarrow$  return to zero

Both NRZ I & NRZ 2 suffers from the above problems.

RZ

Three signal voltage is required in RZ  $+V, 0, -V$



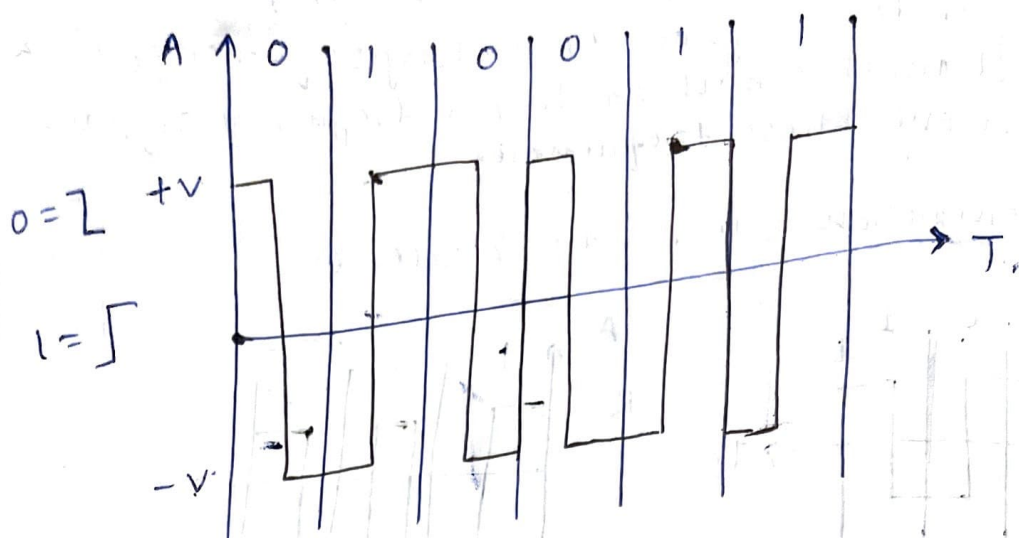
Each signal returns to zero

Polar-Biphase.

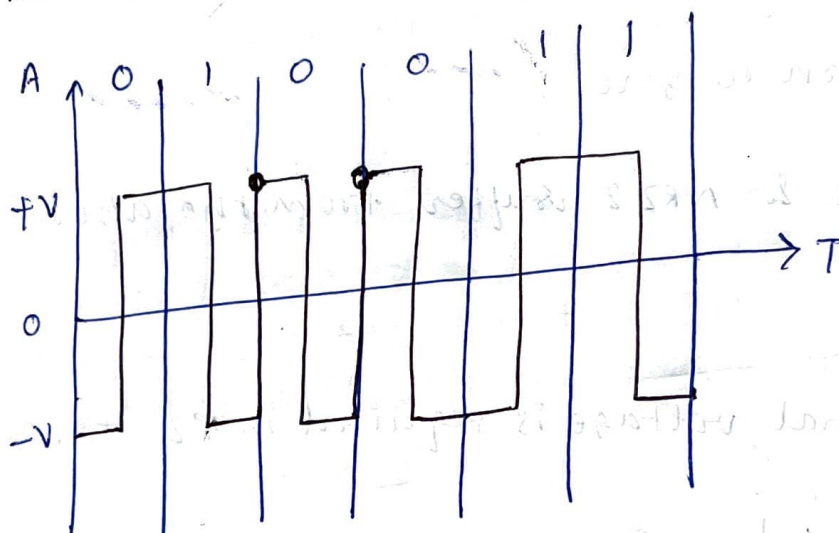
Manchester:

It is the combination of NRZ 2 & RZ scheme.

Uses 2 voltage levels.

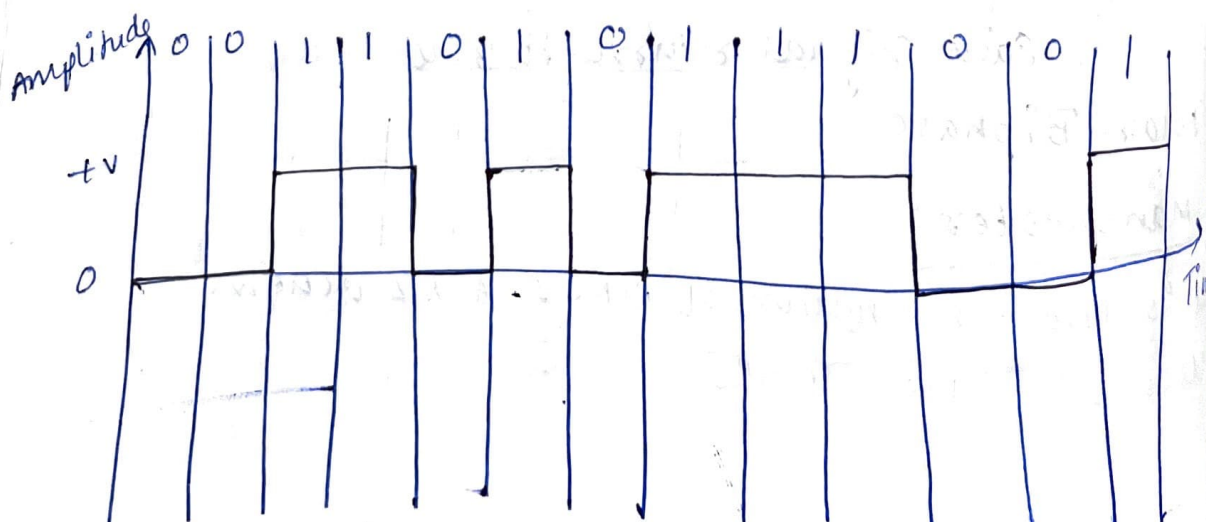


Differential Manchester - encounter zero, change, consider from 2nd bit

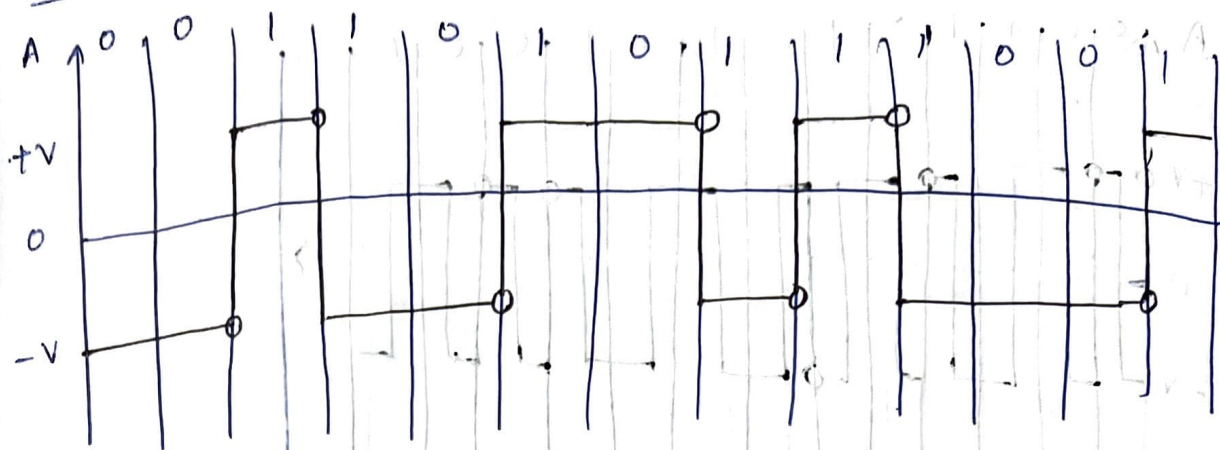


Q1: NRZ unipolar, NRZ-I, NRZ-2, Manchester, differential manchester, RZ  
 0011010111001

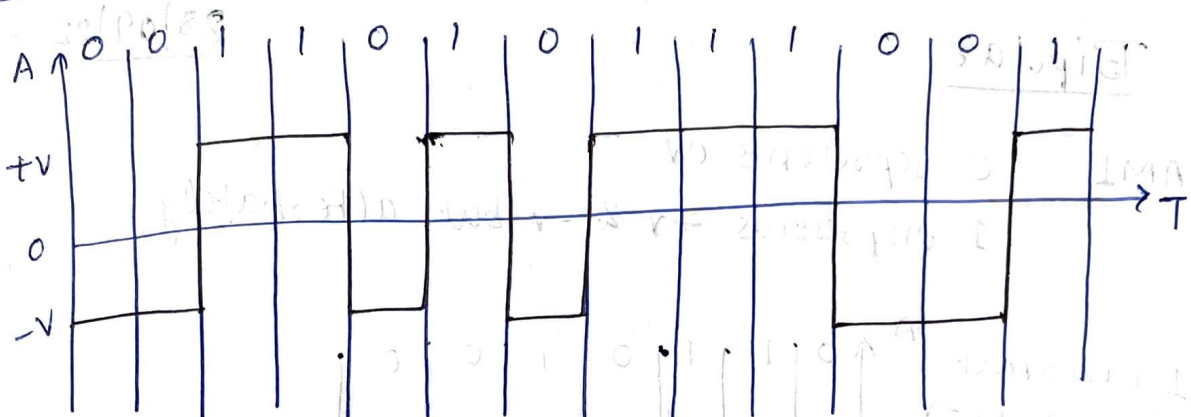
→ NRZ unipolar



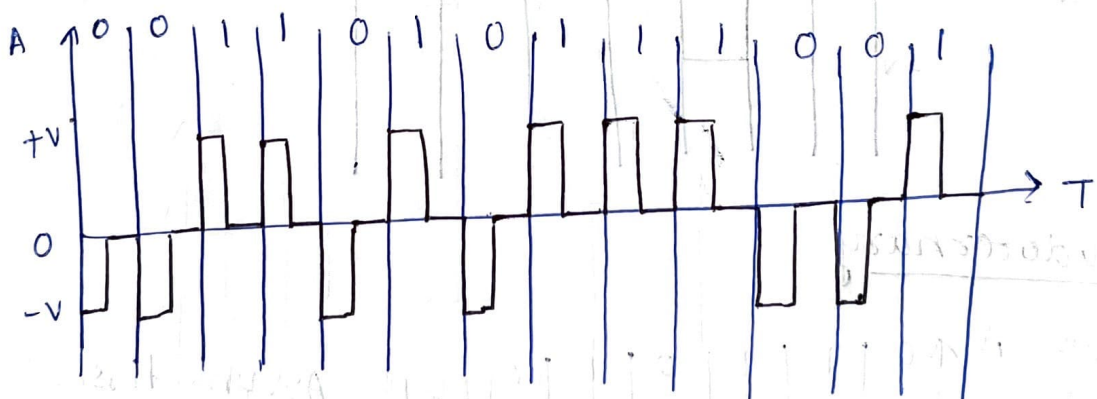
NRZ-1



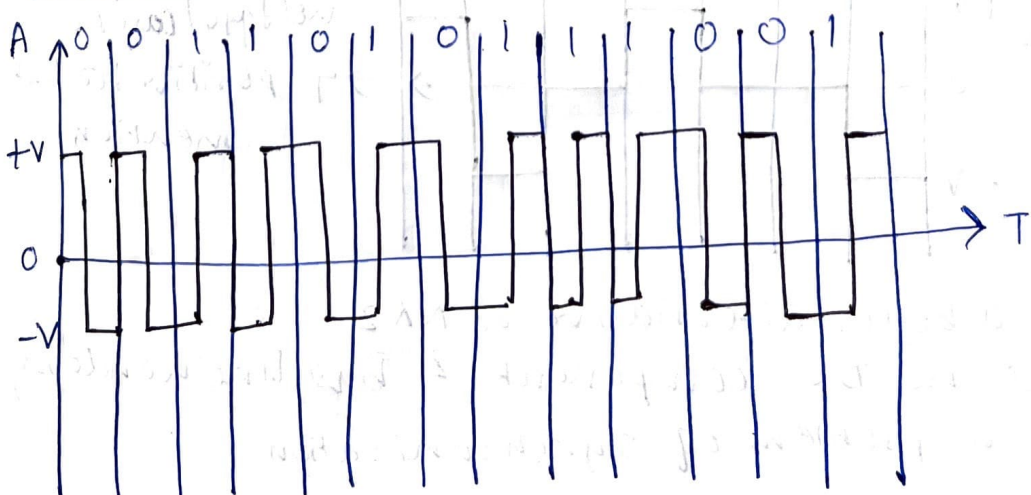
NRZ-2



RZ

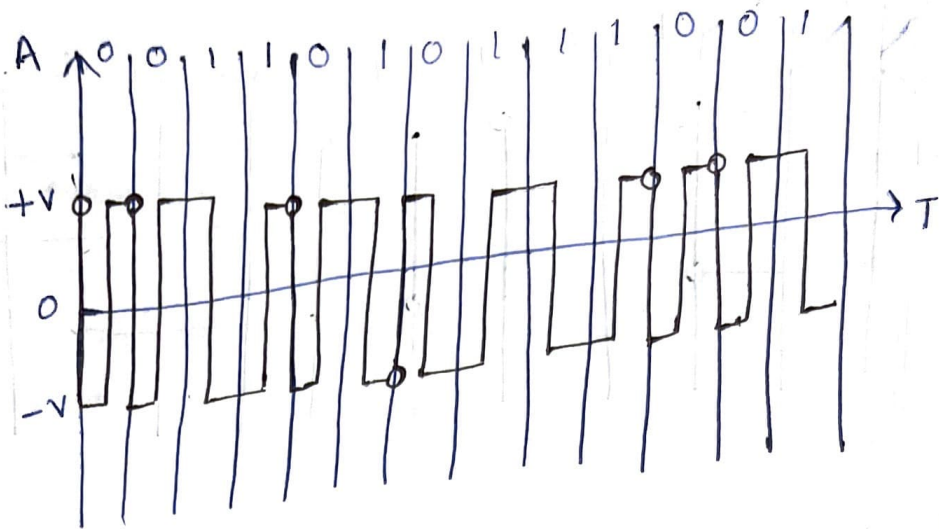


Manchester





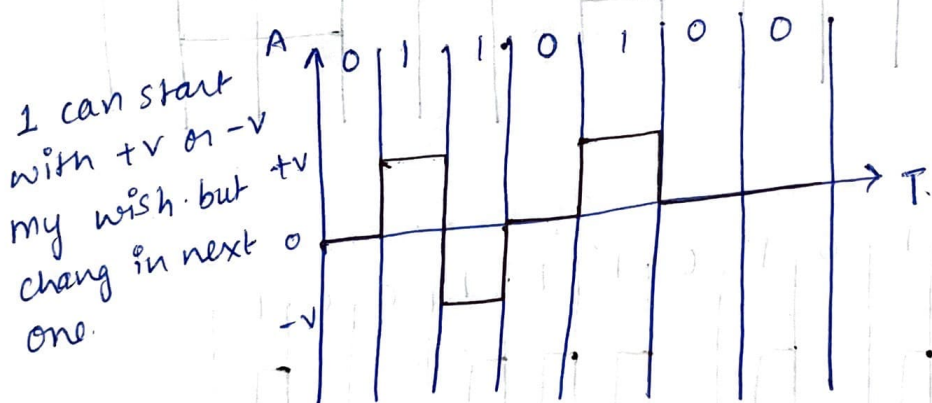
# Differential Manchester



28/09/22

## Bipolar

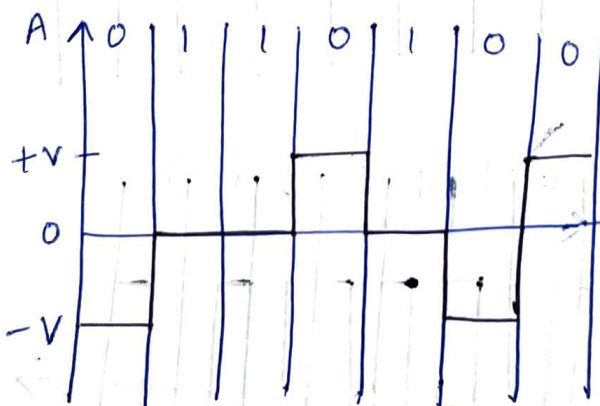
AM1  
0 represents 0V  
1 represents +v & -v but alternately



1 can start with +v or -v my wish but change in next one.

## Pseudoternary

0 represents +ve -v but alternate  
1 represents 0



Assume first lower or negative voltage / can be positive too (mention)

It is a better alternative to NR2.  
It has no DC component & baseline wander.  
It has a problem of synchronization.