CH-04

Digital data, digital Signal

Signal Encoding Techniques

(i) Line Coding
- Different line Coding schemes

(ii) Block Coding

(iii) Scrambling

Digital signal

(i) Discrete, discontinuous voltage pulses.

(ii) Each pulse is a signal element

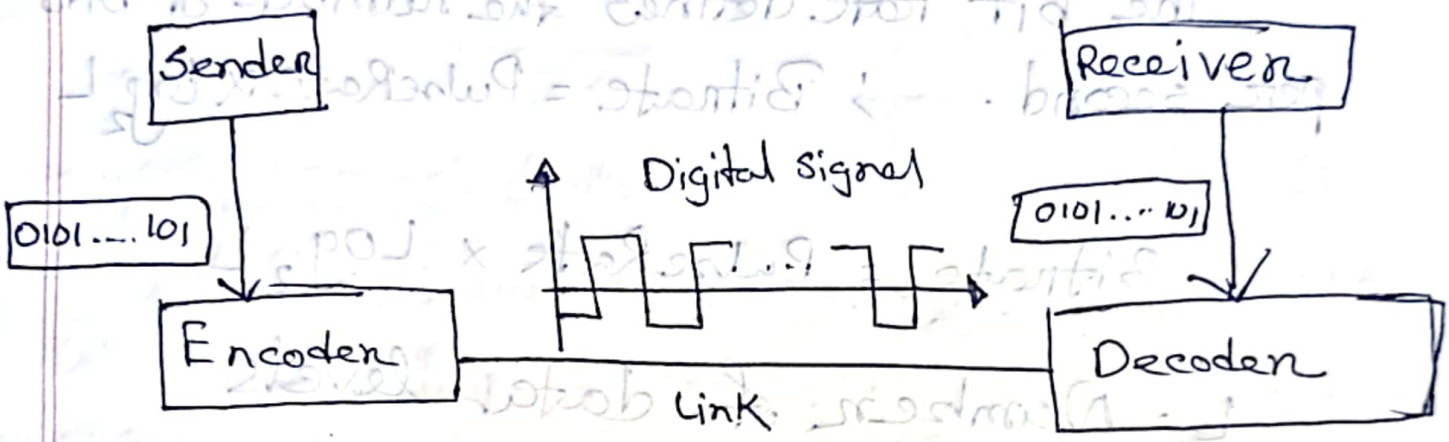
(iii) Binary data encoded into signal elements.

Data Transmitted

0 1 0 1 1 0 0 1 1 0 0 1 0 1 0

Line Coding

Line coding is the process of converting binary data, a sequence of bits, to a digital signal.



Signal Vs Data Element

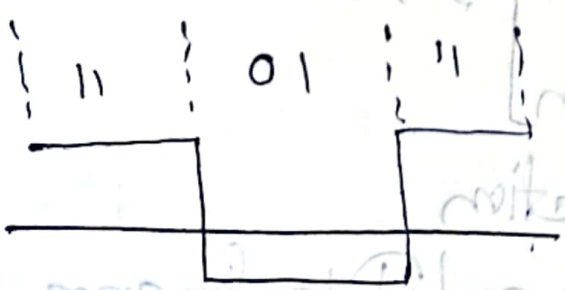
ⓐ One data element per one signal element (r=1)

Bandwith কম লাগে

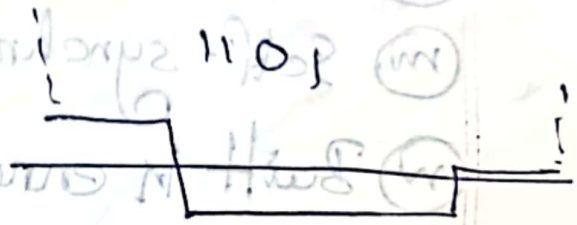
ⓑ One data element per two signal elements ($r = \frac{1}{2}$)

Bandwith বেশি লাগে

ⓒ Two data elements per one signal element (r=2)



ⓓ Four data elements per three signal elements ($r = \frac{4}{3}$)



Baud Rate : The pulse rate defines the number of pulses/signals sent in one second. Also known as known as Baud Rate.

The bit rate defines the number of bits per second. ; Bitrate = PulseRate x $\log_2 L$

Bitrate = PulseRate x $\log_2 L$

L = Number of data levels

Receiver needs to know,

(i) Timing of bits

(ii) Signal levels.

Factors affecting successful interpretation of signals.

(i) Baseline Wandering

(ii) DC Components

(iii) Self-synchronization

(iv) Built in error detection

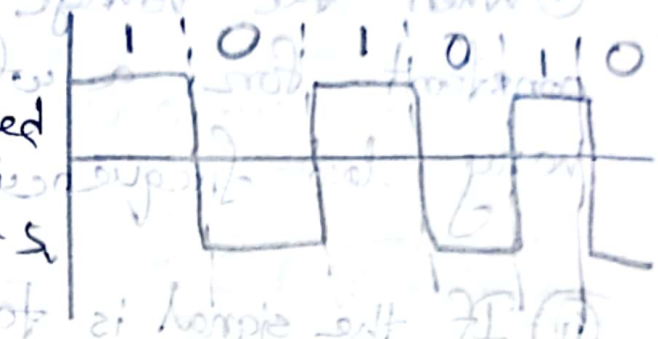
(v) Immunity to Noise and Interference

(vi) Complexity.

V.V.I

Baseline Wandering

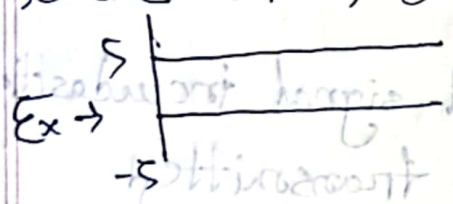
(i) Receiver calculates the running average of received signal power.



(ii) Average = baseline

(iii) A ~~log~~ long strings of 0's and 1's can cause a drift in the baseline making it difficult for the receiver to decode properly.

[Line coding scheme - এ 2টি continuous 1 অথবা 0 থাকে, signal টি continuously এক state এ থাকে অর receiver end এর Baseline যেখানে হওয়ার কথা ছিল সেখানে না হয়ে অন্য একটা set হয়, তার কারণে Line coding scheme খারাপ, তাই এতে Baseline Wandering হওয়ার chance আছে।



DC Components

(i) When the voltage level in a digital signal is constant for a while, the spectrum creates very low frequencies. (Results of Fourier Analysis)

(ii) If the signal is to pass through a system (such as a transformer) that doesn't allow the passage of a dc component, the signal is distorted and may create errors in the output.

(iii) Or continuous ~~current~~ DC component problem

(iv) This component is extra energy residing on the line and is useless.

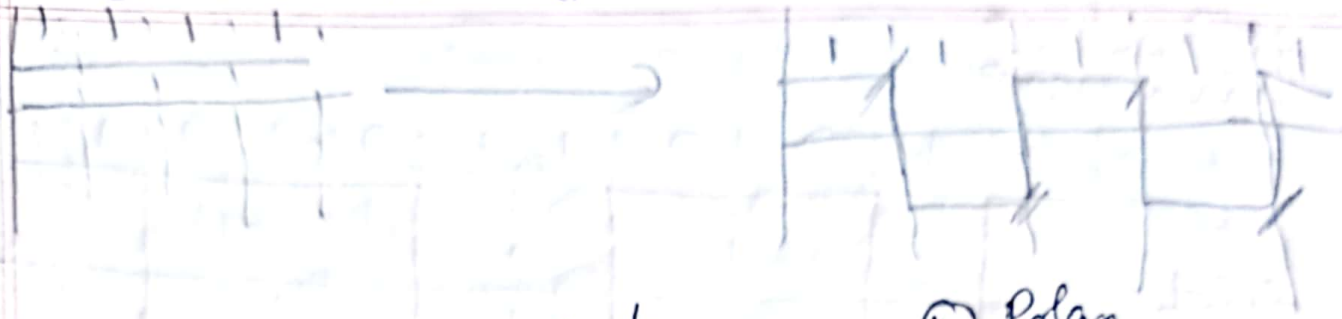
Self Synchronization

(i) A self-synchronizing digital signal includes timing information in the data being transmitted

(ii) This can be achieved if there are transitions in the signal ~~that are~~ alert the receiver to the beginning, middle, or end the pulse.

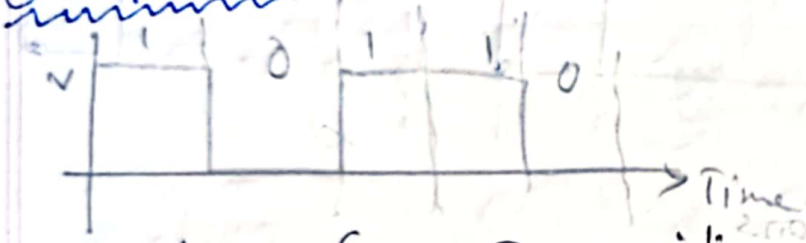
(iii) If the receivers clock is out of synchronization, ~~there~~ ~~the~~ these points can reset the clock

synchronization করে beat transmission করে যে করে Read করে নেয়



Line coding → (i) Unipolar (ii) Polar
(iii) Bipolar (iv) Multilevel
(v) Multitransition

(i) Unipolar (NRZ) → Not return to zero

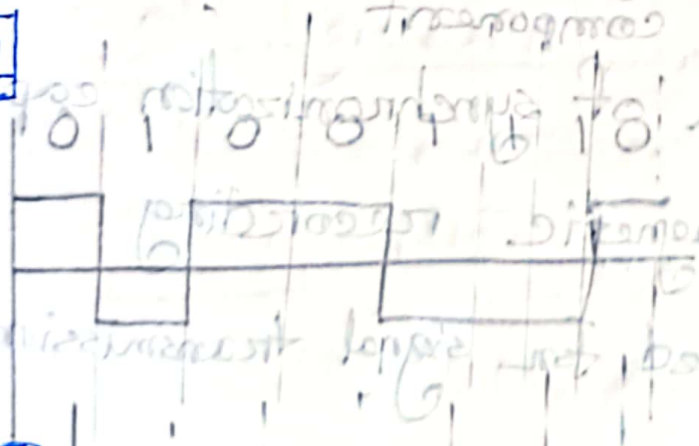


1 = +ve
0 = 0 v

Unipolar এ হয় positive or negative সবগুলো,

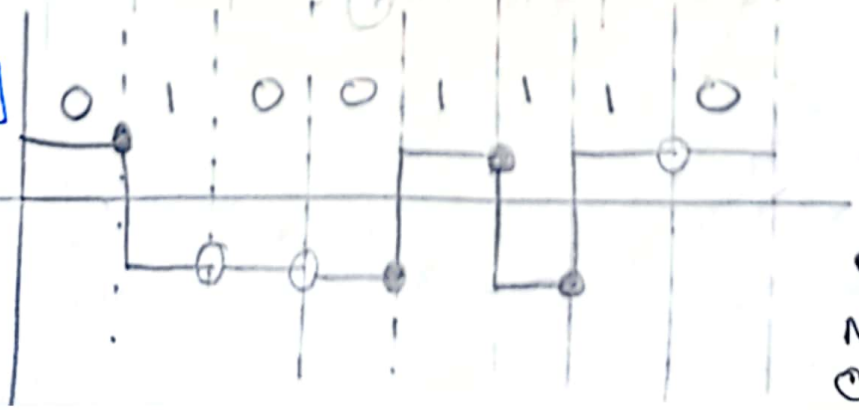
(ii) Bipolar (NRZ-L & NRZ-I)

NRZ-L



if 0 is (+ve) 1 is (-ve)
if 0 is (-ve) 1 is (+ve)

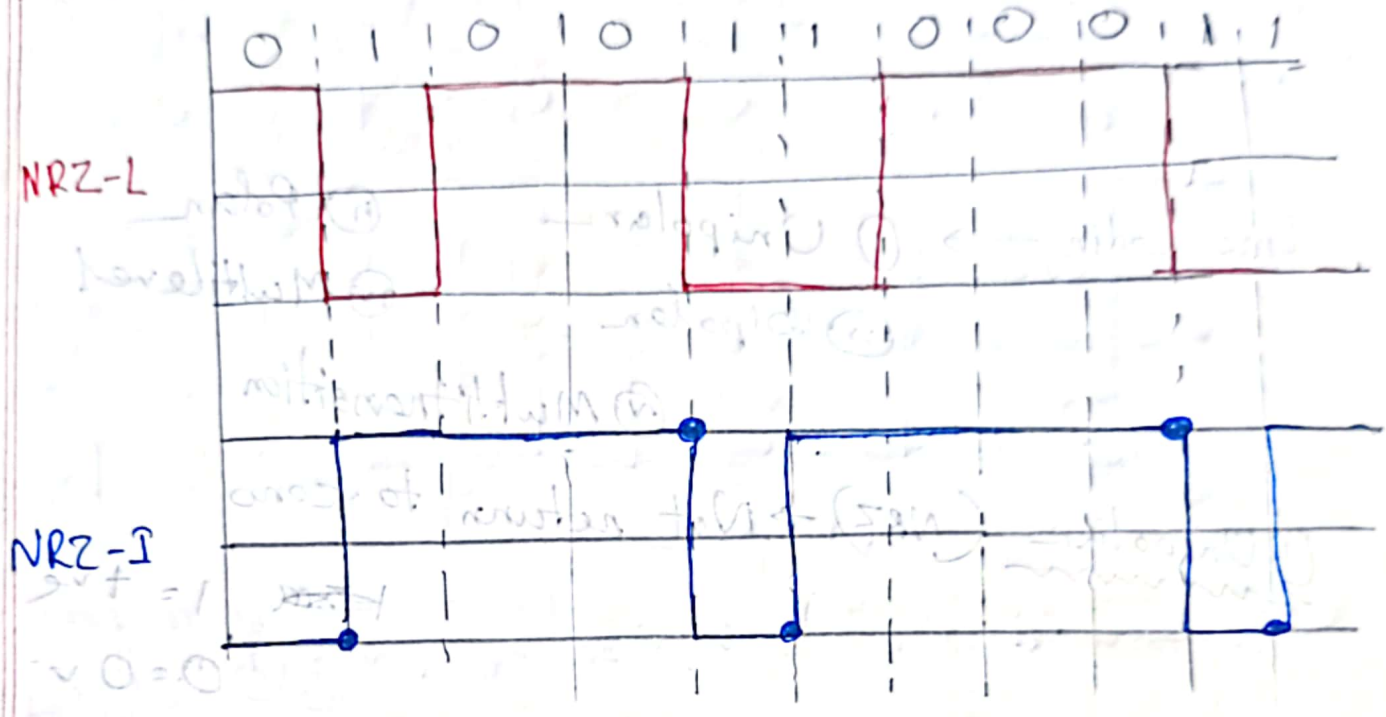
NRZ-I



1 = inverse
0 = keep it as it is

- Inversion:
Next bit is 1
0 No inversion = 0

Practice



NRZ → Pros and Cons

Pros → (i) Easy to engineer
(ii) Make good use of Bandwith

Cons → (i) DC component
(ii) lack of synchronization capability

- Used for magnetic recording
- Not often used for signal transmission.

Differential Encoding

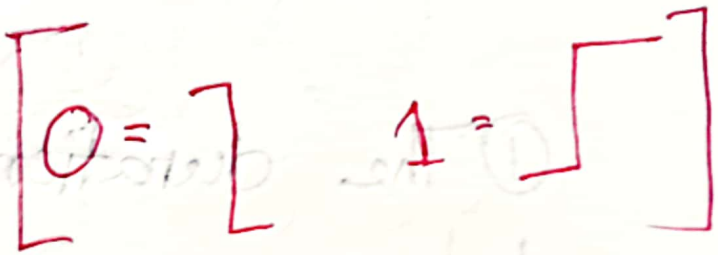
(i) In complex transmission layouts, it is easy to lose sense of polarity.

(ii) Therefore,

→ Data represented by changes (transitions) rather than levels

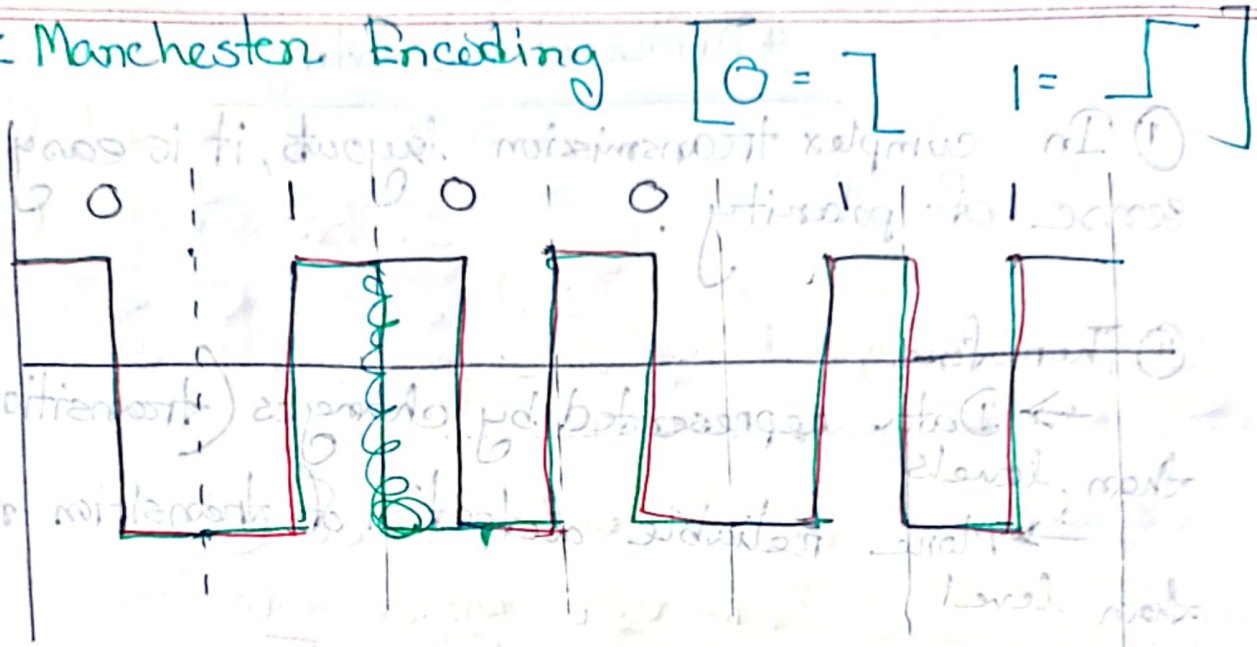
→ More reliable detection of transition rather than level

Manchester Encoding



CamScanner

Manchester Encoding



(i) The duration of a bit is divided into two halves

(ii) Transition always happening in middle

(iii) Ensure synchronization

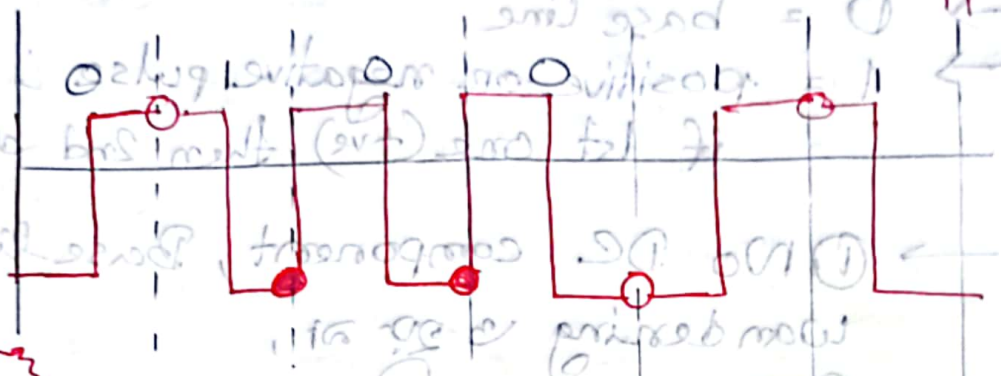
(iv) No Baseline wondering, DC component, self synchronization problem occours

(v) Signal element এর সংখ্যা per bit এ: একই, তবে Bandwith requirement এ বেশি লাগে।

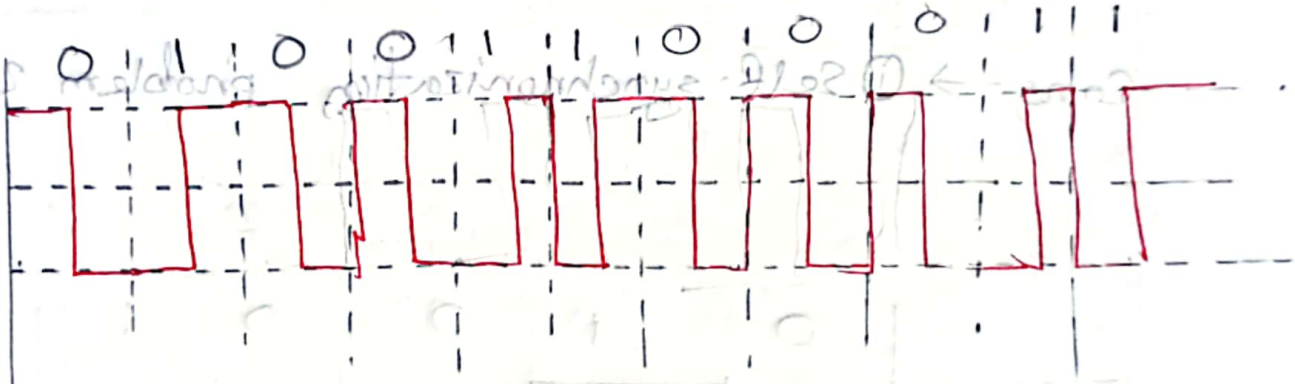
0 = ⌉ 1 = ⌈

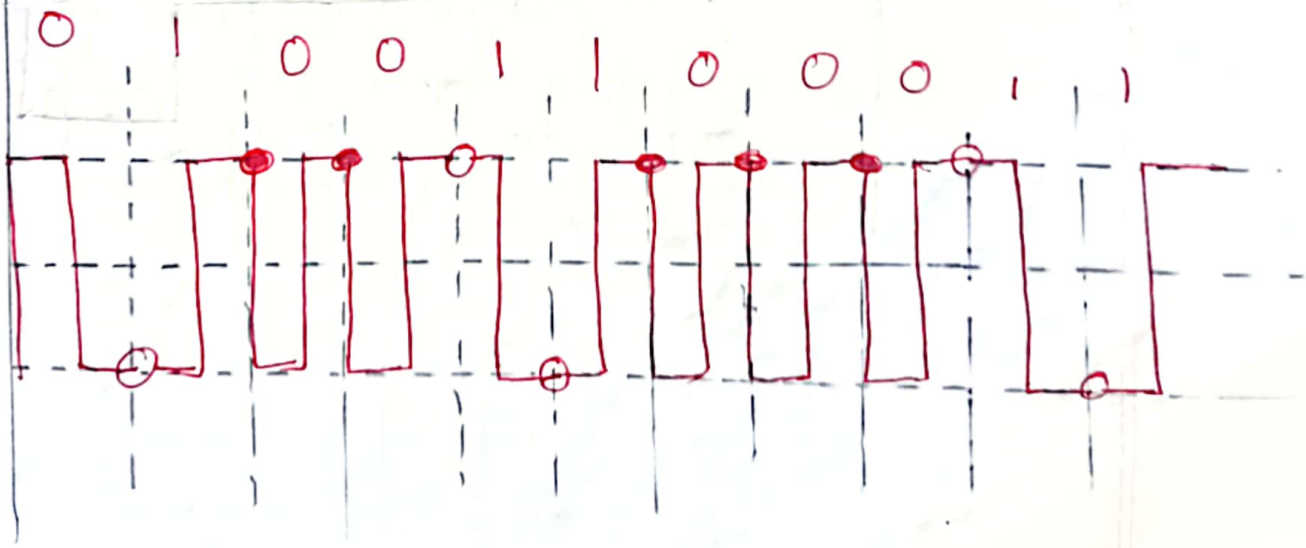
Differential Manchester Encoding

- ○ No inversion ; Next bit is 1 { ○ Different Inversion
- ● Inversion ; Next bit is 0 { ● 1 → keep it as it is



Practice





#Multilevel Binary

(i) Use more the 2 levels

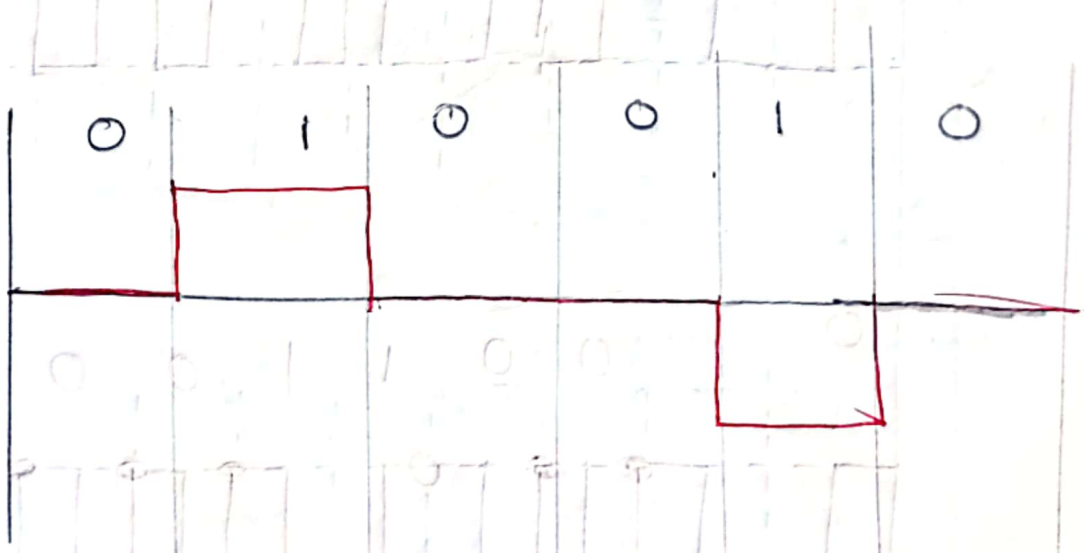
(ii) Bipolar-AMI

→ 0 = base line

→ 1 = positive or negative pulse ;
if 1st one (+ve) then 2nd one (-ve)

Pros → (i) No DC component, Base line wandering ও হয় না,
(ii) Bandwith বেশি লাগে না,

Cons → (i) Self-synchronization problem হয়,



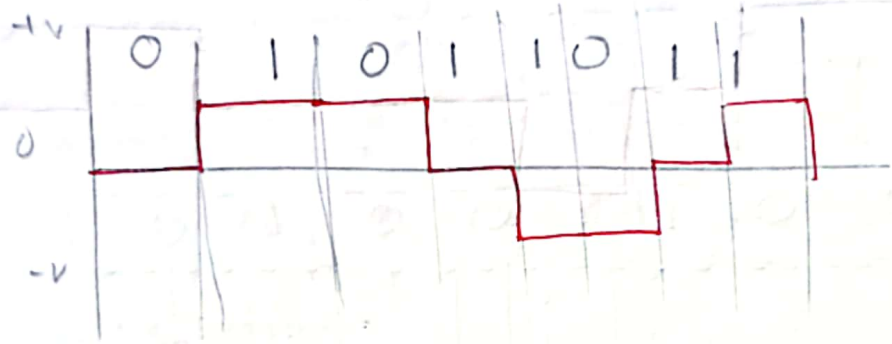
Multilevel Transition, three level - MLT-3.

0 = No transition, keep it as it is

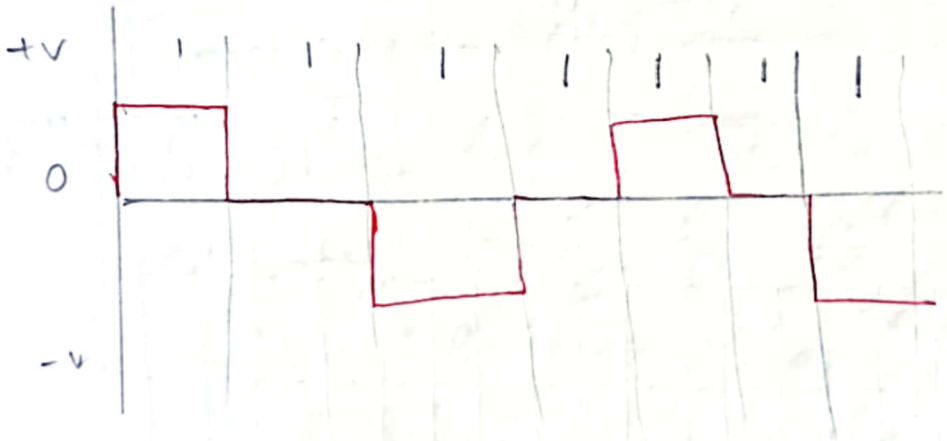
1 = Transition

Transition occours using three levels of signals.

(+1, 0, -1)

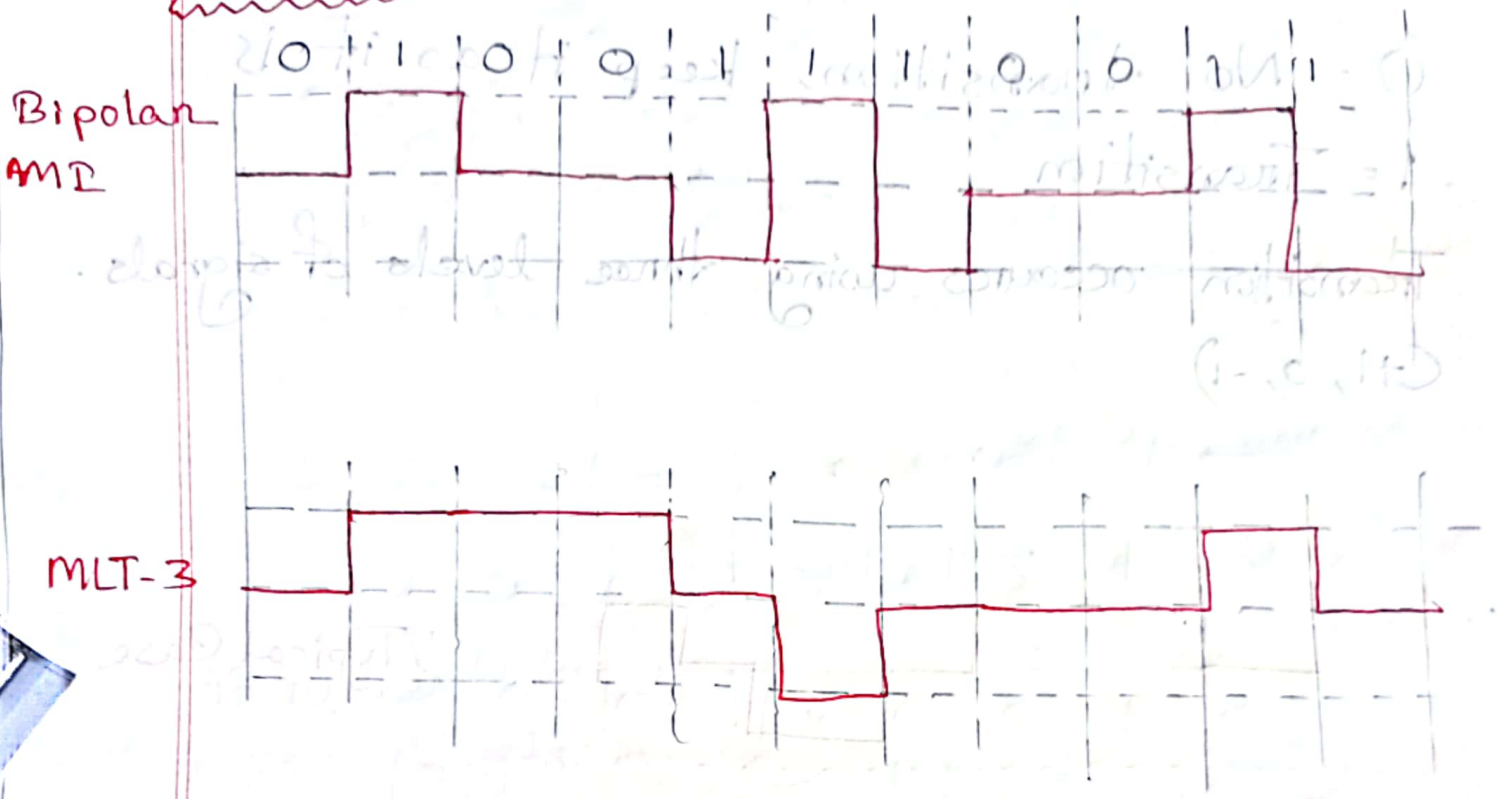


; Typical Case



; Worse case

Practice



Block Coding

- Changes a block of m bits to a block of n bits
- Referred to as mB/nB encoding.

Block Coding is a 3 step process:

(i) Division
(ii) Substitution
(iii) Line Coding / Combination.

Step-1: Division

4 bit এর সামনে ~~5 bit এ~~ এরর বসাব

Step-2: Substitution

5 bit দ্বারা replace করব

(iii) Line-coding

coding scheme follow করব (NRZ-I)

A very simple line coding scheme is choosen, because the block coding procedure provides two desirable features (??) of complex line coding scheme

Pros / and / Cons

* solves Synchronization problem but not the DC component problem

* If DC is unacceptable, use bipolar or biphase encoding

* Increases the baud rate by 20%, still better than Manchester schemes.

Example on the last Page

Scrambling

To replace a long consecutives of 0.

Filling sequence

① must be recognized by receiver and replaced with original

② Same length as original

Design Goals

(i) No DC component

(ii) No long sequences of 0 level line signal

(iii) No reduction in data rate

(iv) Error detection capability

B8Z8 — 1000000000

B8Z5

(i) Based on Bipolar AMI

(ii) 8 টি 0 থাকলে তবে এটা apply হবে।

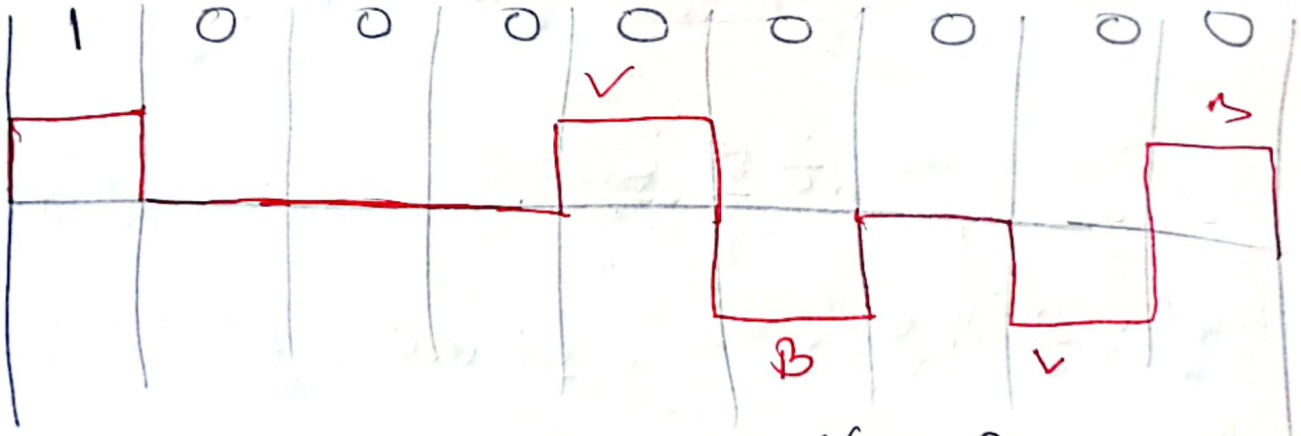
(iii) Causes 2 violation of AMI code.

(iv) Unlikely to occur as a result of noise

~~Formatt~~ {formula}

0 0 0 V B 0 V B ; V = violation of rule

B = by the rule



case-1 (+ve) → 0 0 0 +ve (V) -ve (B) 0 -ve +ve

case-2 (-ve) → 0 0 0 -ve +ve 0 +ve -ve

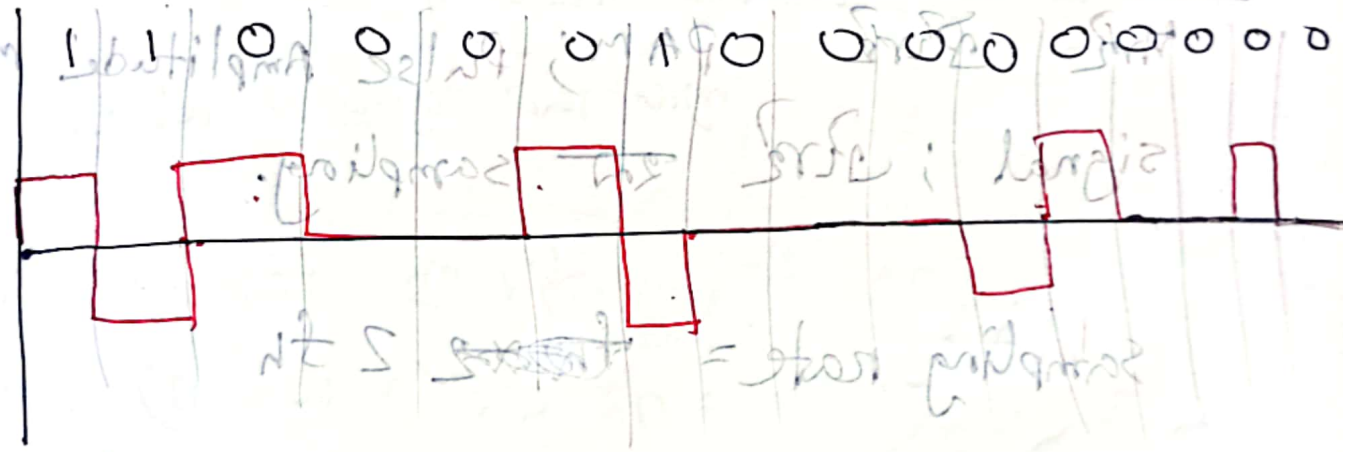
HDB3

4 টা 0 পেলে কাজ করব

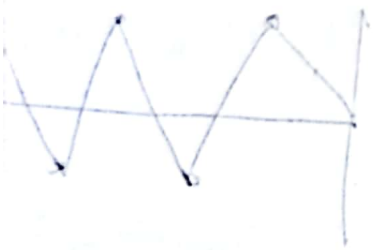
Formula

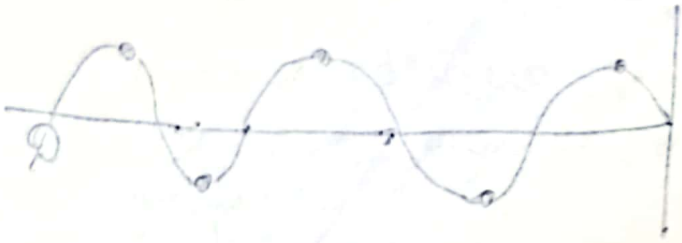
1. odd (+ve) → 0 0 0 +ve } 000V
2. odd (-ve) → 0 0 0 -ve
3. Even (+ve) → -ve 0 0 -ve } B00V
4. Even (-ve) → +ve 0 0 +ve

1 1 0 0 0 0 1 0 0 0 0 0 0 0 0



Odd → 000 V ; Even → B00V





PCM

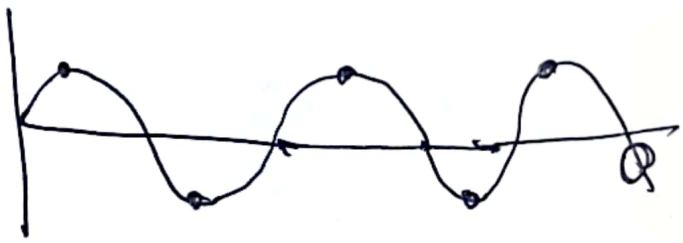
(i) Pulse Code Modulation

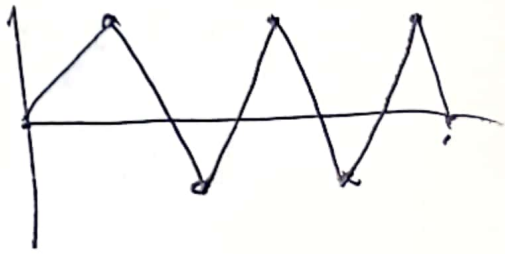
(ii) It has 3 step → 1. Sampling
2. Quantization
3. Binary encoding

Analog signal এর amplitude ~~মাপ measure~~ করি- একটি নির্দিষ্ট সময় পর পর, তারপর সেই signal গুলো একটানে PAM; Pulse Amplitude Modulation signal ; এটাই হল sampling.

Sampling rate = ~~[illegible]~~ $2 f_h$

So, if $f_h = 400$ Hz ; sampling rate will be $2 \times 400 = 800$ ~~Hz~~ sample per second





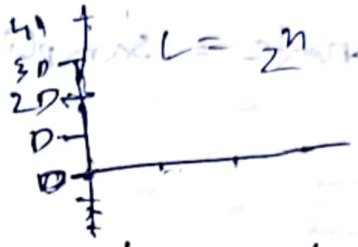
(5)

+20, -2V

0 — 5 khz
1 — 6 khz
2 — 80 3 — 10 khz

Quantization

1. Level selection;



$L = 2^n = 2^3 = 8$

$\frac{40}{8} = 5$

depends on 2 term;

1. Highest and lowest amplitude কত?
2. কত accurately convert করতে চাও?

কত Bit per sample use করতে চাই,

(bps)

যদি 3 bit use করি then level $= 2^n = 2^3 = 8$

Question এ থাকলে বলা যাবে

n Bit এর জন্য 2^n bit

2. Delta (D অথবা Δ); $D = \frac{V_{max} - V_{min}}{L}$

প্রতেক level এর মাঝের Volage এর different কত।

3. Normalized PM values = $\frac{\text{Actual Amplitude}}{\Delta}$

4. Normalized Quantized Values = level এর midpoint

5. Normalized Error = Normalized Quantized Values − Normalize PM values.

6. Quantization Code = level number

7. Encoded words = Binary version of level

CamScanner