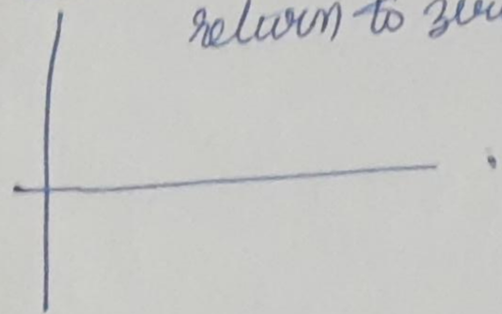
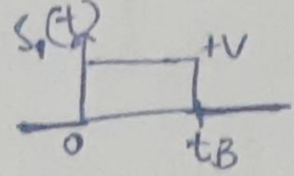
LINE CODING.

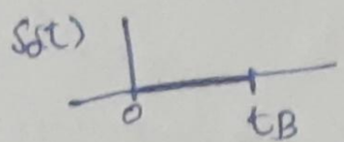
NRZ :- Single Bit Period doesn't return to zero.



Unipolar:

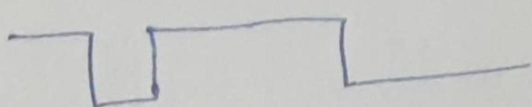
$b(t) = \begin{cases} s_1(t) :- \\ s_2(t) :- \end{cases}$





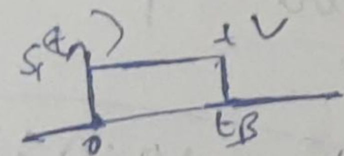
1 0 1 1 0 0

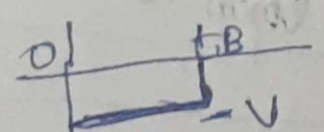
s_1 s_0 s_1 s_1 s_0 s_0



Polar

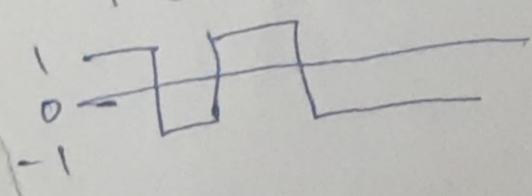
$b(t) = \begin{cases} s_1(t) :- \\ s_2(t) :- \end{cases}$





Eg

1 0 1 1 0 0



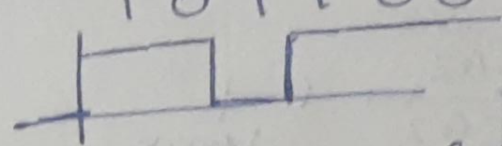
Further level of Reps of Line Coding

L	M	S
Level	Mark	Space

↓

Differential Encoding (Mark)

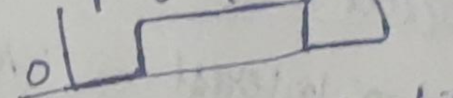
1 0 1 1 0 0



XOR (previous bit & current bit)

Space Encodings

1 0 1 1 0 0



XNOR (previous bit & curr bit).

NRZ-L NRZ-M NRZ-S. | Unipolar

NRZ-L NRZ-M NRZ-S | Polar.

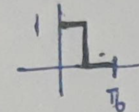
LINE CODING's

* RZ : Return to Zero.

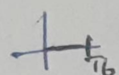
- Unipolar
- Bipolar.

RZ-Unipolar

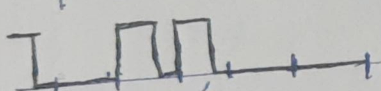
$$S_1(t) = \begin{cases} 1 & 0 \rightarrow T_b/2 \\ 0 & \frac{T_b}{2} \rightarrow T_b \end{cases}$$



$S_0(t) = 0$



1 0 1 1 0 0



switching form.

* DC wandering.

Synchro of bit timing is important. Bit period identification for clock.

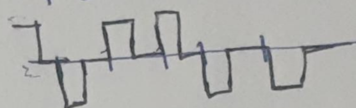
RZ could do itself.

RZ-bipolar.

$$S_1(t) = \begin{cases} 1 & 0 \rightarrow T_b/2 \\ 0 & T_b/2 \rightarrow T_b. \end{cases}$$

$$S_0(t) = \begin{cases} -1 & 0 \rightarrow T_b/2 \\ 0 & T_b/2 \rightarrow T_b. \end{cases}$$

1 0 1 1 0 0



2 different voltage & 1 stable voltage.

Self clocking

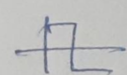
larger bandwidth ⇐ Higher frequency.

Phase Codes.

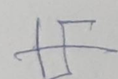
Miller Code/ Delay Modu

Bi-Φ-L
Bi-Φ-M
Bi-Φ-S

Bi-Φ-L : Manchester Code.



$$S_1(t) = \begin{cases} 1 & 0 \rightarrow T_b/2 \\ -1 & T_b/2 \rightarrow T_b \end{cases}$$

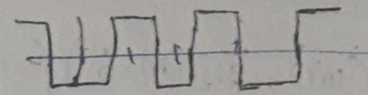


$$S_0(t) = \begin{cases} -1 & 0 \rightarrow T_b/2 \\ 1 & T_b/2 \rightarrow T_b \end{cases}$$

Self clocking, constant voltage slewing, good performance.

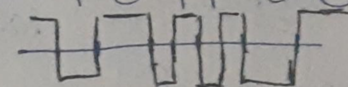
Bi-Φ-L

1 0 1 1 0 0



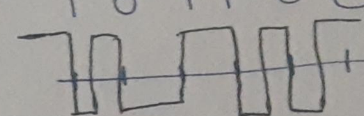
Bi-Φ-M – when new bit, opposite voltage level. – If 1 mid point switch – If 0 no switching

1 0 1 1 0 0



Bi-Φ-S

1 0 1 1 0 0 – use for this case

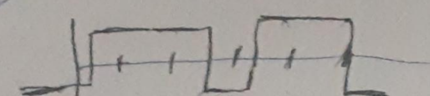


* Differential manch. Code

Delay line Code Narrowest BW

1. For Every 1, there is a mid pt transition
2. For a single zero, no transition
3. For consecutive zeroes, alternate polarity.

1 0 1 1 0 0



A Multilevel Binary Sequences.
There are more than 2 vol levels
for 0&1 representations.
Bipolar Schemes: Base level & +v/-v

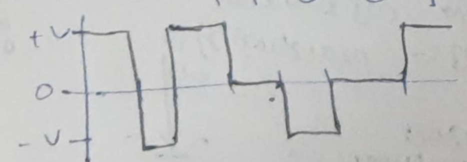
1. DICODE SCEME : RZ & NRZ.
2. AMI : Alternate mark inversion.
- Std
- HDB3
- B8ZS.

*3. Duobinary : method of recovery Unit3

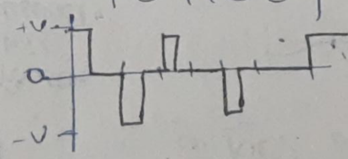
I. DICODE SCHEME. - mapping change of Bit b/w +V & -V.
encode with level change.
0->1 or 1->0

- 0->0 or 1->1
then transmit zero.

a. NRZ
10 11 0 0 1.



b RZ.
1011001



II. AMI : Alter transition of '1' will be reversed.

101100
+0-+00

RZ scheme.
1011 00

Problem : A large sequence of '0' causes DC wandering.

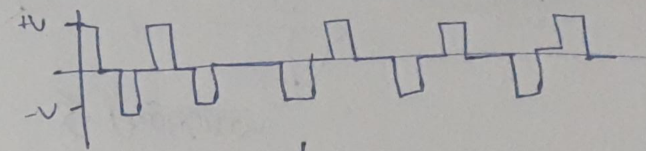
Modified AMI :
HDB3 : High Density Bipolar '3'
HDBn : n is the no. of Tolerable zero.

1011000000010
some sort of change is reqd.

Rule 1: 0000-> B00V even
000V odd
B => Bias By Rule. V -> Violation of AMI.

1011000000010
+0-+000+000-0
000V

11110000101101000001
+-+-000-+0-+0-+00+-
000V B00V



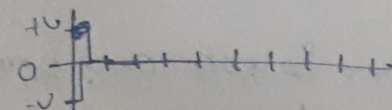
1000|0000 1

lots of Decoding Possibilities...

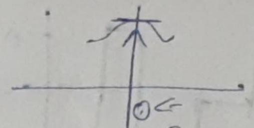
B00V
zero violation b/w parity.

B8ZS : Bipolar 8 Zero Substitution
Looks for 8 consec. Zeroes.
1000000001
1000VB0VB 1
+000+-0-+-
-000-+0+-+

"000VB0VB"
1000000001



Parameters for Choosing Line Code:



=> Power spectral Density

1. ↑ Dc Component nonzero at f0) => Dc Power which is not desired.

2. Self Clocking

DC wandering: losing track of bit information

3. Error Detection: Advanced Feature

multilevel Binary Signalling & Duobinary

4. Bandwidth compression/Utilization:

Efficient utilization → multilevel line code.

5. Differential Line Code: Extra feature to choose for particular data like where waveforms experience inver.

6. Noise Immunity/Bit Error:

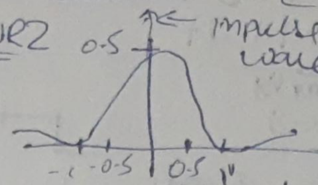
Bit Errosion Detection

NRZ > RZ unipolar.

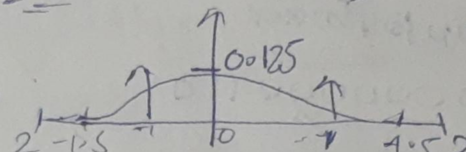
Power Spectral Density of Line Code

1. Unipolar Signalling [-1, 1] => (-Rb, Rb) Bit rates

a. NRZ



b. RZ.



2. Polar Signalling

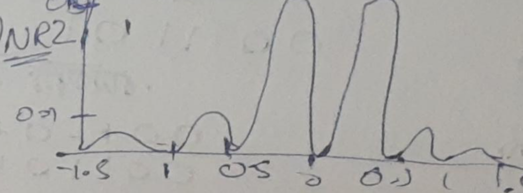
Absence of impulse signal. only sinc wave.

Extra DC power is removed.

a) NRZ > b RZ DC

3. AMI Signalling

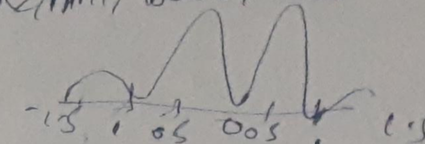
*a) NRZ



Narrow Bandwidth, no DC component

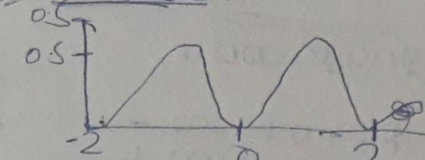
Non negligible side bands, higher error

b. RZ/AMI, B8ZS, HDB3



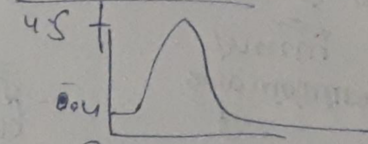
Double Bandwidth of NRZ

c. Manchester:



Bandwidth wasting else high performance.

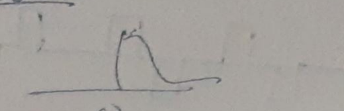
4. Delay modulation



High power, low bandwidth

low DC component

5. Duobinary



Lower power than

DM but significan