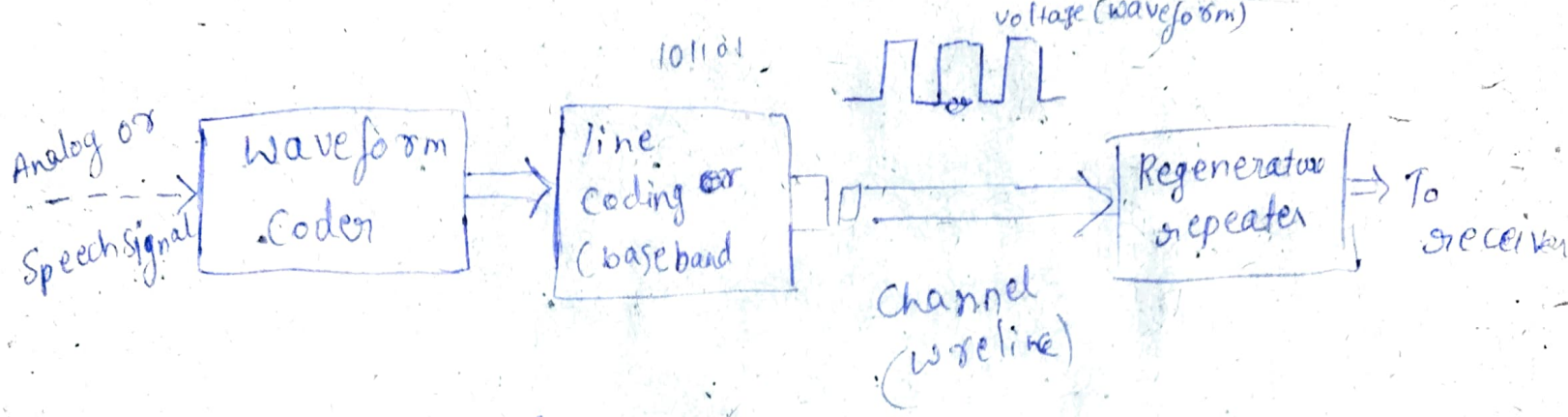
5) 16 or 32 level QAM
6) 64 level QAM
7) MSK & GMSK

- Microwave digital radio links, Digital radio broadcasting
- Digital video broadcasting, set up box, Modem etc.
- Cellar telephone system (GSM)

8) [redacted]

Baseband transmission (Line coding techniques)



Baseband digital transmission

~~Desirable properties of LC~~

Wkt how to convert an analog signal to a digital data in sequence of binary symbol '1' & '0' either by using waveform encoders such as PCM, Δ-modulation. The digital o/p comprising of a long sequences of binary symbols 1's & 0's. It is neither uniform nor suitable for direct transmission over the communication channel. These binary symbols are required to be converted into electrical pulses or waveforms having finite voltage levels so as to make it compatible for transmission over the communication channel.

Line coding is a process by which digital symbol are transformed into waveforms that are compatible

with the characteristics of the baseband channel.

2) Desirable properties of Line codes (LC)..

Types of Line coding technique

→ Unipolar: represented by only one level +V or -V and unipolar can be (UP-RZ) & (UP-NRZ)
(Unipolar - return to zero)

→ polar: represented by 2 distinct non zero symmetrical but opposite voltage levels +V and -V

→ bipolar: It is also known as pseudoternary +V, -V and 0V or alternate mark inversion.

• Transmission power efficiency: It is equal to ratio of P average polar and P average unipolar

$$\eta = \frac{P \text{ average polar}}{P \text{ average unipolar}}$$

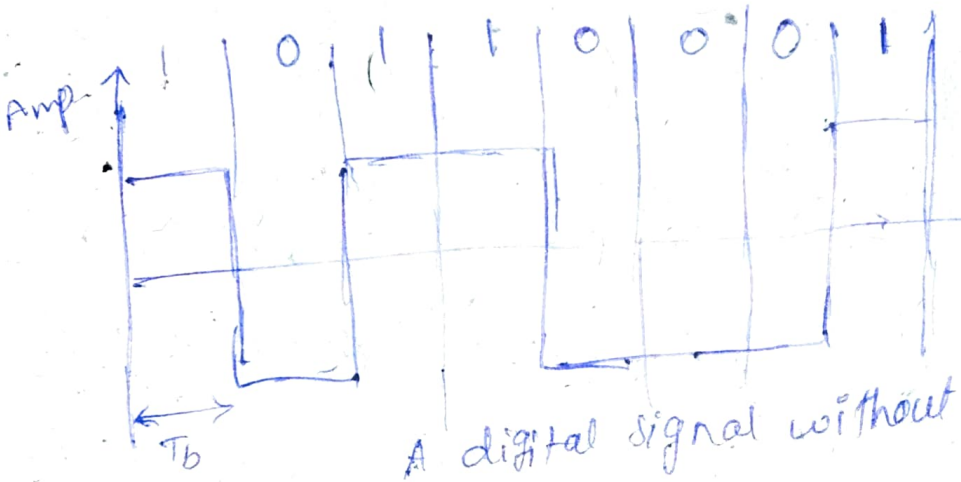
Transmiss efficiency / Transfer Power can be categorised either unipolar or polar. The transmission power efficiency can be by using polar voltage levels.

• Duty cycle: It is defined as the ratio of bit duration in which binary pulsed define transmission voltage to the entire bit duration.. In NRZ the duty cycle is 100%, because the binary pulse is maintained high for entire bit duration or binary pulse is maintained low for binary data '0' for entire bit duration

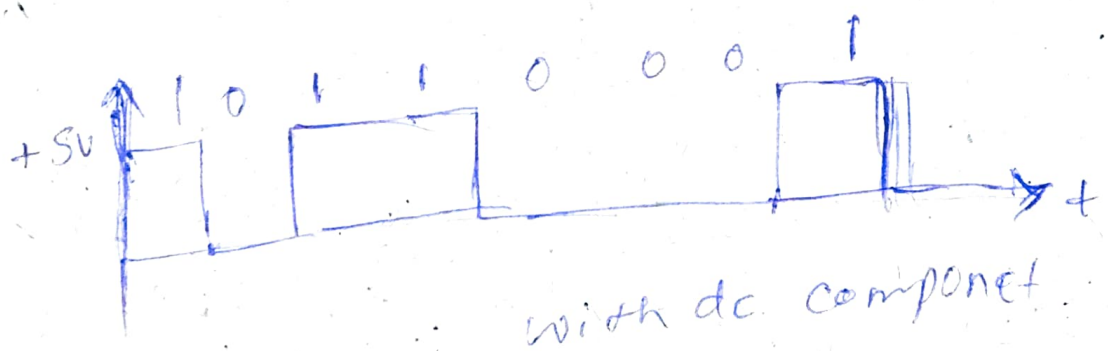
• In NRZ line coding format the binary pulse is maintained high for binary data '1' for 50% for entire bit duration. if the binary pulse is maintained low for binary dat '0' for the entire bit duration average duty cycle is less than 100% of specified bit duration.

- DC components: Some communication systems like a telephone system. A telephone line cannot pass frequency below 200 Hz and a long distance link using transformers do not allow transmission of frequency around 0 Hz. This is called direct current. This situation occurs in the voltage level in digital signal constant for a while the frequency spectrum shown

∴ we need a line coding technique



A digital signal without dc current



with dc componet

- Immunity to noise and Interference. Line coding format should be capable to minimize the effect of noise & interference. This will enable to have minimum errors induced in transmitted data due to external noise & interference
- Error detection capability: It is desirable that LC could have built in error detection capability. It should enable to detect errors & correct errors that occured during transmis.

~~Types of~~ types of line coding

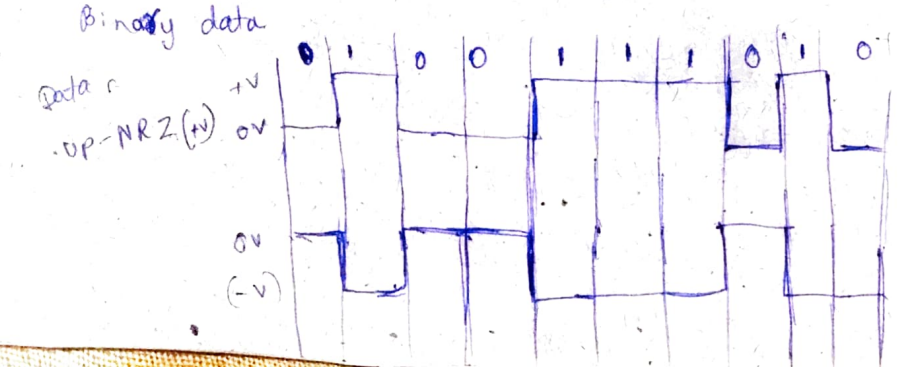
1) Unipolar NRZ line code
2) Unipolar RZ —11—
3) polar NRZ —11—
4) manchester polar —11—
5) Differential manchester polar —11—
6) Bipolar NRZ Alternate mask Inverting (BP-NRZ-AMI) —11—
7) Bipolar RZ —11—
8) Bipolar RZ-AMI —11—
9) High density Bipolar (HDB) NRZ-AMI —11—
10) Binar eight zeros substitution (B8zS) RZ-AMI —11—

---

1) Unipolar NRZ - line code

for Symbol '0' $v(t) = 0 \quad 0 \le t \le T_b$

for Symbol '1' $v(t) = +V$ or $-V \quad 0 \le t < T_b$



Unipolar RZ - line code

for symbol '0'

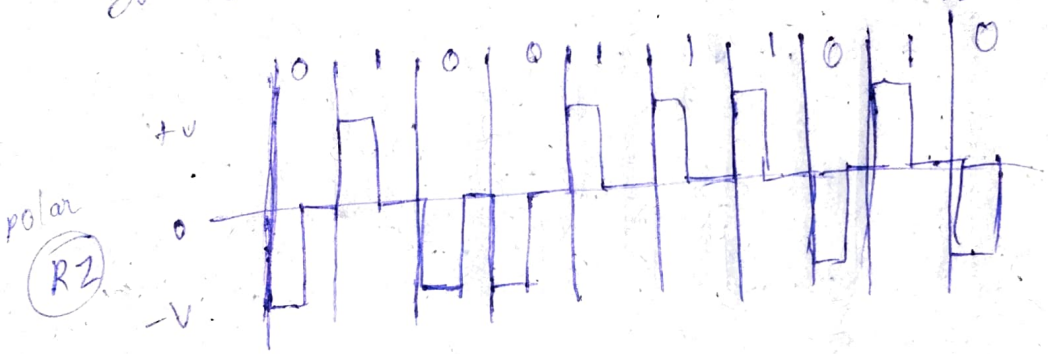
for symbol '1'

$$v(t) = \begin{cases} +V & \longrightarrow 0 \le t \le T_b/2 \\ 0 & \longrightarrow T_b/2 \le t \le T_b \end{cases}$$

Polar - RZ

for symbol '0' $v(t) = \begin{cases} -V \\ 0 \end{cases}$ for $\begin{cases} 0 \le t \le T_b/2 \\ T_b/2 \le t < T_b \end{cases}$

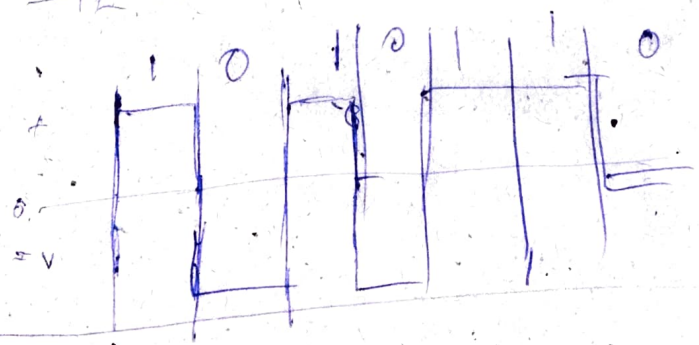
for symbol '1' $v(t) = \begin{cases} +V \\ 0 \end{cases}$ for $\begin{cases} 0 < t \le T_b \\ T_b/2 \le t < T_b \end{cases}$



Polar NRZ

for symbol '0' $v(t) = \{0$ for $\{0 \le t \le T_b$

for symbol '1' $v(t) = \{+V$ or $-V$ for $\{0 < t \le T_b$

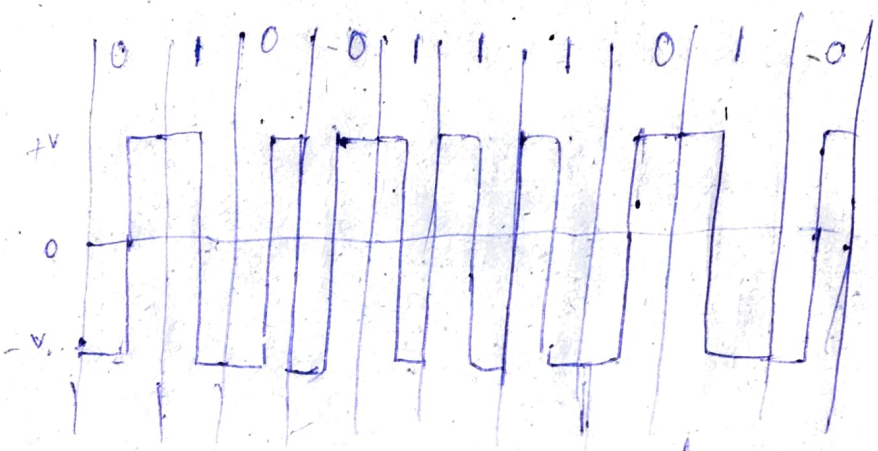


manchester polar line code: Binary '1' is reg.

Binary symbol '1' is represented by +ve pulse during first half of the bit period followed by -ve pulse during 2nd half of the bit period. Due to this

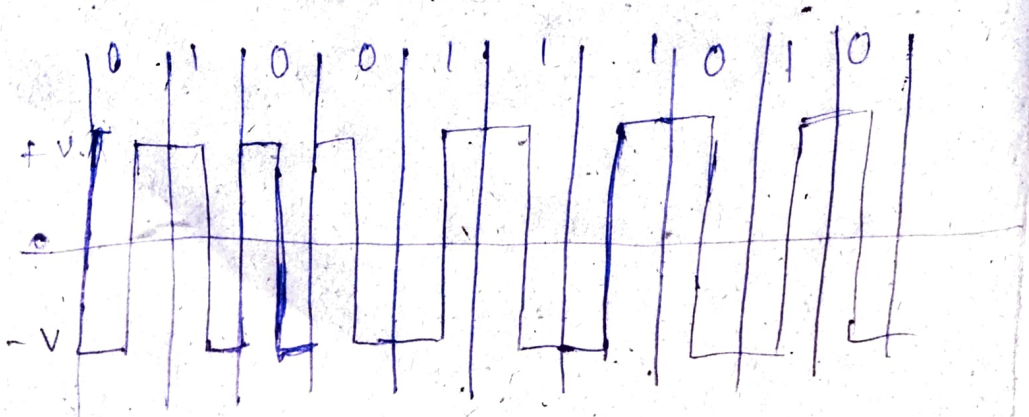
for symbol '0' $v(t) = \begin{cases} -V \\ +V \end{cases}$ or $\begin{cases} 0 \le t < T_b/2 \\ T_b/2 \le t < T_b \end{cases}$

for symbol '1' $v(t) = \begin{cases} +V \\ -V \end{cases}$ for $\begin{cases} 0 \le t < T_b/2 \\ T_b/2 \le t < T_b \end{cases}$



Differential manchesterpolar line code

w.k.t indifferential manchester polar line code. The binary Symbol zero is represented by the transition of begining of the bit followed by transition at the middle of the bit interval & binary symbol '1' is represented by no transition at the begining of the bit followed by transition at the middle of the bit interval.

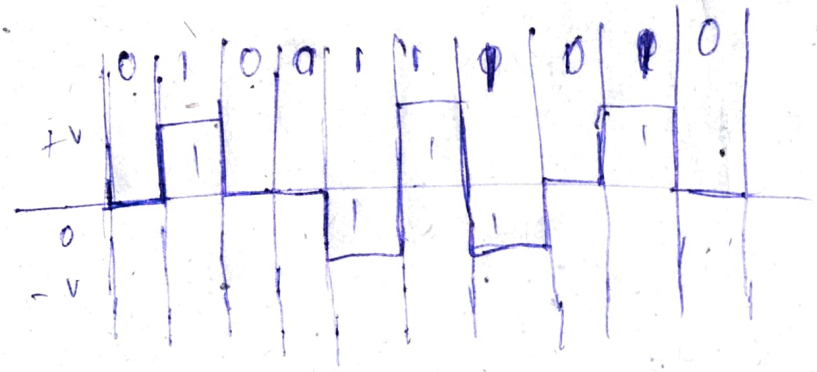


It may be noted here that diff. manchester line code requires only one transition to represent binary '1' but 2 transition to represent binary '0'. In order to achieve better synchronization it is more complex to design & implement.

Manchester line code is specified in IEEE 8023 standard local area ethernet. It is mostly used satellite communication links & optical communication.

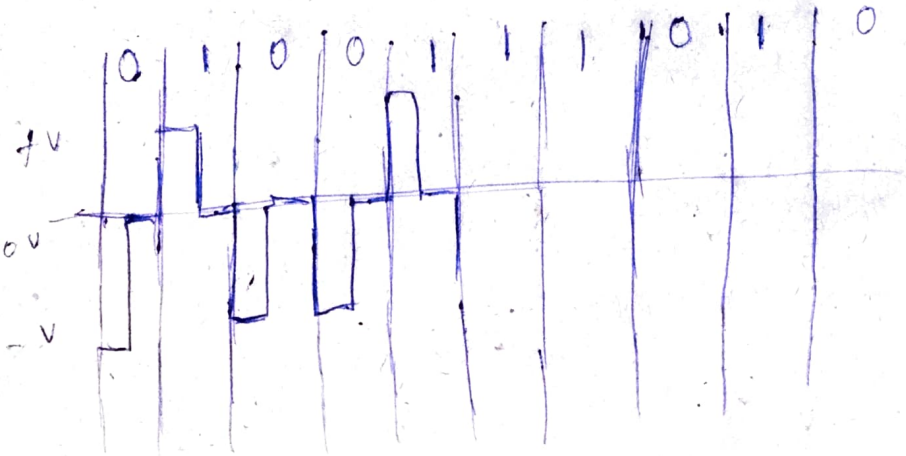
- Bipolar NRZ

  binary '1' is represent alternative +V & -V. binary symbol '0' is represented by 0V



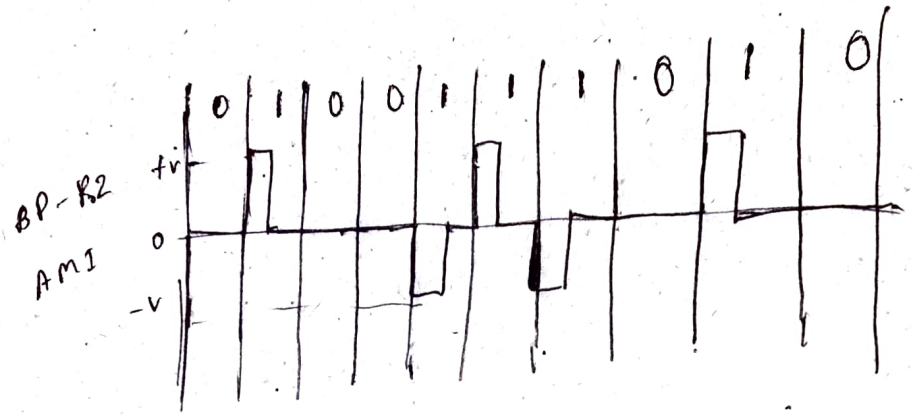
- Bipolar RZ line code

  Binary symbol 0 & 1 are represented by opposite level pulse. -V & +V for 1st half of period & 0V during 2nd half of the period



Bipolar RZ AMI ~~HDB (High density bipolar)~~

Bipolar RZ AMI line coding technique is used in telep systems as signaling schemes and T-carrier lines with + 0V and -3V voltage levels to represent the binary da



HDB (High density bipolar) NRZ AMI line coding.

HDB is a scrambling type technique of line code which pr -es synchronization without increasing the no. of bit. In HD

NRZ line coding:

- Some predefined no. of pulses are added then the no. of consecutive binary symbols zero exceeds an integer value n it is denoted as (HDBn) where

In HDB encoding the i/p data sequence content the consecutive these group of zeros replaced by Special n+1 binary digit sequence. These special data sequence consist of some binary 1 so that they may be detected at receiver

when n = 3 →

(HDB) → n+1 = 4 = 000V

B 00V

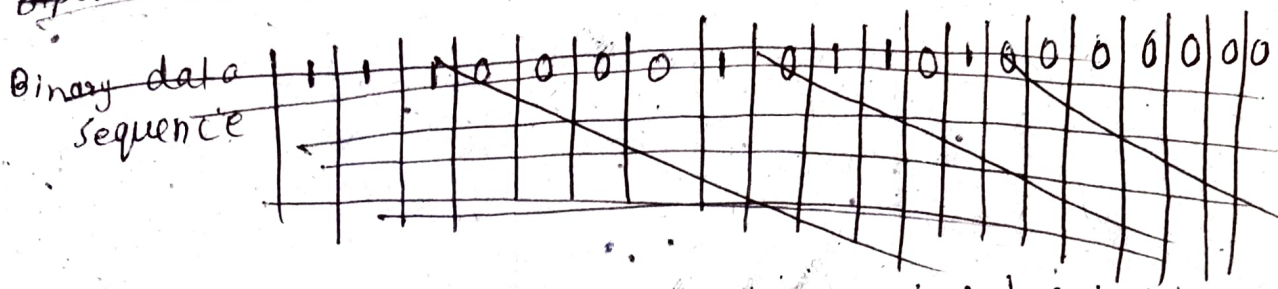
↑ ↓

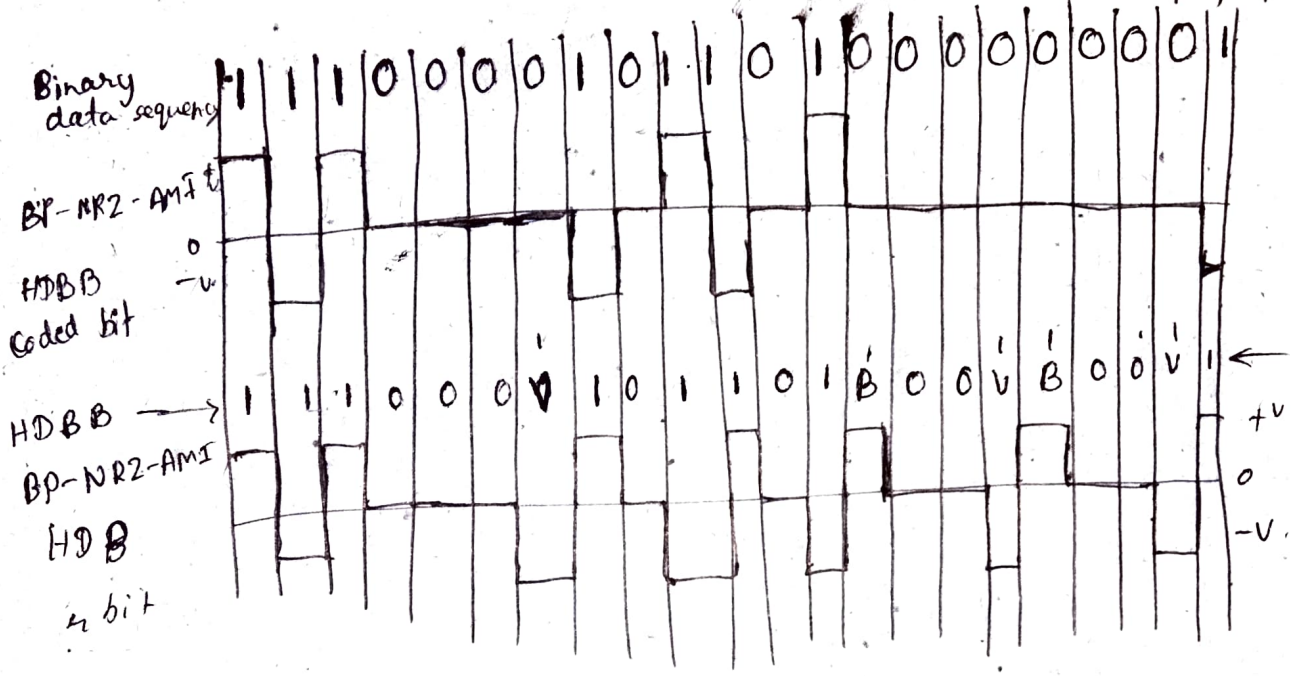
Bipolar violation to AMI rule of Encodi

Where b and V are consider ones this means are 4 consecutive zeros are replaced with a Sequ of either 00V or B0V

Illustrate the bipolar ... for the given binary data 1 1 1 0 0 0 0 1 0 1 1 0 1 0 0 0 0 0 0 0 1

~~Bipolar-NRZ-AMI~~





- B8ZS (Binary eight zeros substitution) RZ-AMI line cond.
  Just like the HDBP, B8ZS is another scrambling like technique, which provides synchronization without increasing in the B8ZS
  In this whenever 8 consecutive binary data appears gi... in binary.

1 1 1 0 1 1 0 0 0

+ - 0 - + 0 0 0 or

- + 0 + - 0 0 0

Illustrate waveform B8ZS - RZ - AMI line code using speci bit sequence

+ - 0 + 00'0

for the given binary data 0000000001101000