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Physical Layer-Part3

Line coding Schemes-1

DIGITAL-TO-DIGITAL CONVERSION

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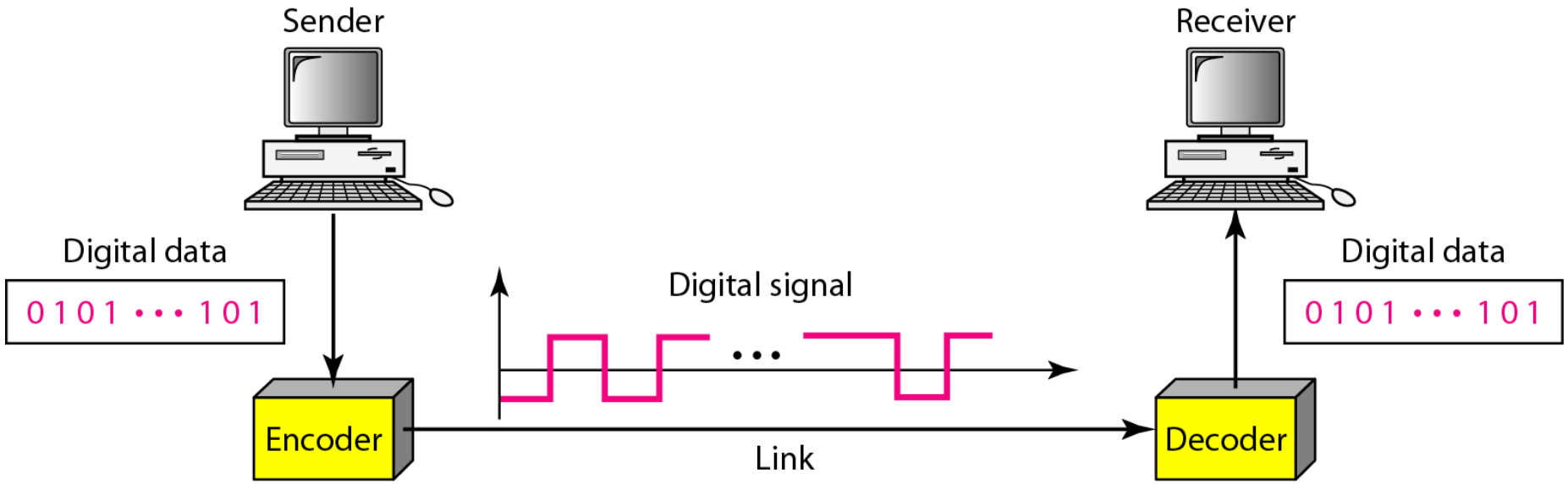
How we can represent digital data by using digital signals?

The conversion involves three techniques:

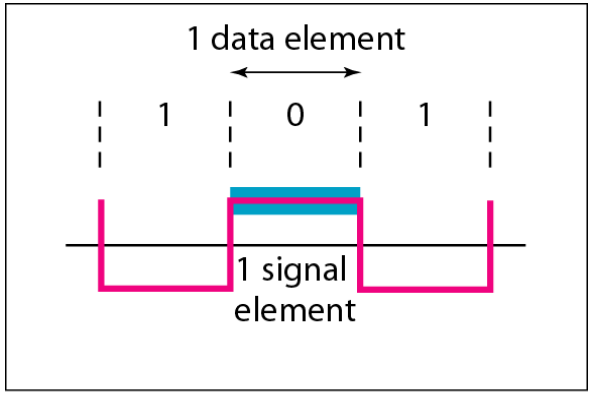
- ***Line coding***
- ***Block coding***
- ***Scrambling***

Line coding is always needed; block coding and scrambling may or may not be needed.

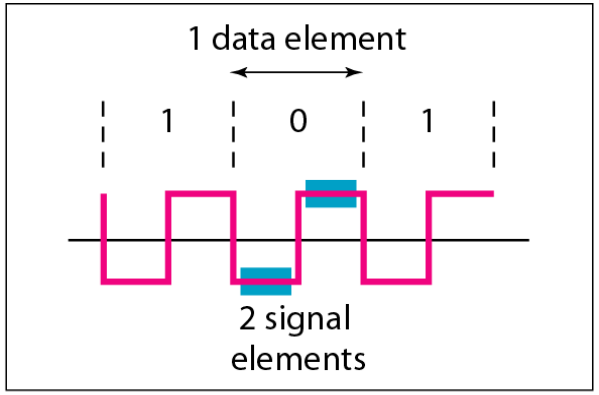
Line coding and Decoding



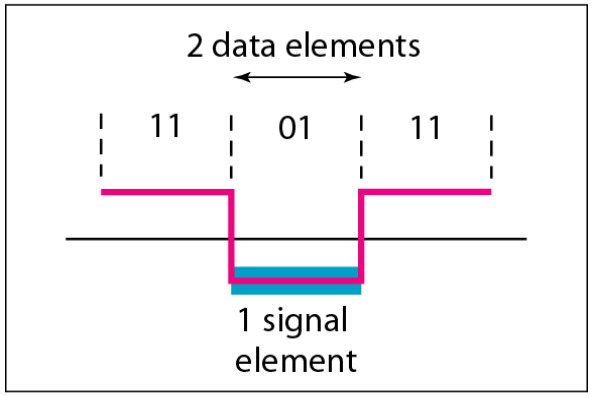
Signal element Vs Data element



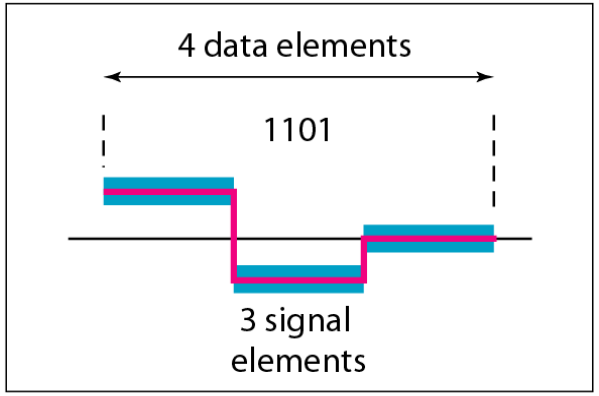
a. One data element per one signal element (r = 1)



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



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



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

Data Element:- It is the

Smallest entity that can represent a piece of information

Signal Element:- ***It refers the Shortest unit of digital signal***

$$r = \frac{\text{No. of data elements}}{\text{No. of signal elements}}$$

Data rate Vs Signal rate

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- ***Data Rate:- It is the number of data elements sent per second.***
- ***Data rate is also called as bit rate and represented in bps.***

- ***Signal Rate:- It refers the number of signal element sent per second.***
- ***Signal rate is also known as pulse rate or baud rate and represented in baud.***

$$\text{Signal Rate (S)} = \frac{\text{Data Rate (N)}}{r}$$

$$\text{Average Signal Rate } (S_{avg}) = c \times \frac{\text{Data Rate (N)}}{r}$$

where c= Case factor

Question

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A signal is carrying data in which one data element is encoded as one signal element (r = 1). If the bit rate is 100 kbps, what is the average value of the baud rate if c is between 0 and 1?

Solution

Assuming that the average value of c is 1/2 . The baud rate is then

$$S = c \times N \times \frac{1}{r} = \frac{1}{2} \times 100{,}000 \times \frac{1}{1} = 50{,}000 = 50 \text{ kbaud}$$

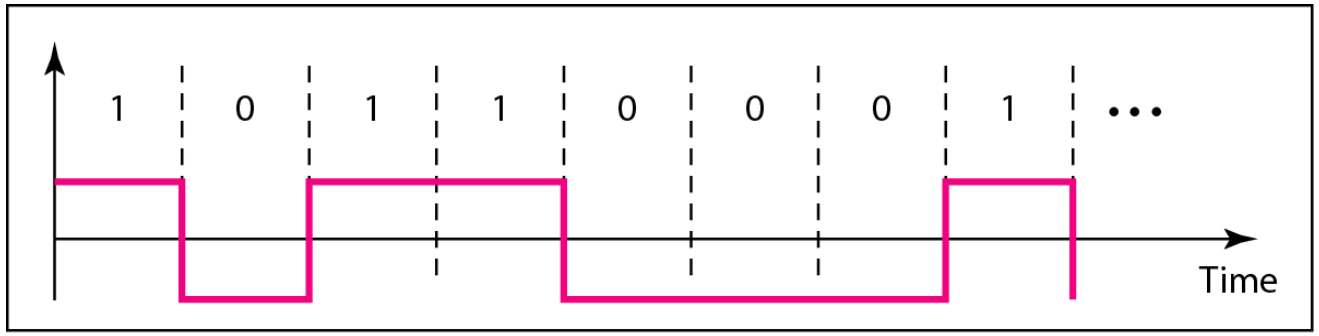
Signal Transmission Issues

DC Components:- When the voltage level in a digital signal is constant for a while, the spectrum creates very low frequencies. These frequencies around zero, called DC (direct-current) components

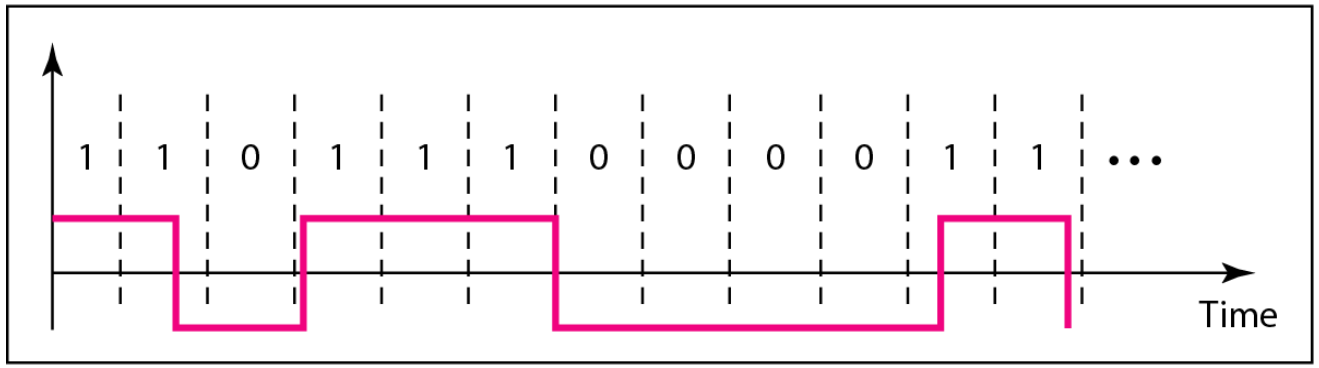
Self-Synchronization-: To correctly interpret the signals received from the sender, the receiver's bit intervals must correspond exactly to the sender's bit intervals.

If the receiver clock is faster or slower, the bit intervals are not matched and the receiver might misinterpret the signals.

Effect of lack of synchronization



a. Sent



b. Received

The sender sends 10110001, while the receiver receives 110111000011

Question

In a digital transmission, the receiver clock is 0.1 percent faster than the sender clock. How many extra bits per second does the receiver receive if the data rate is 1 kbps? How many if the data rate is 1 Mbps?

Solution

At 1 kbps, the receiver receives 1001 bps instead of 1000 bps.

1000 bits sent	1001 bits received	1 extra bps

At 1 Mbps, the receiver receives 1,001,000 bps instead of 1,000,000 bps.

1,000,000 bits sent	1,001,000 bits received	1000 extra bps

Line coding schemes

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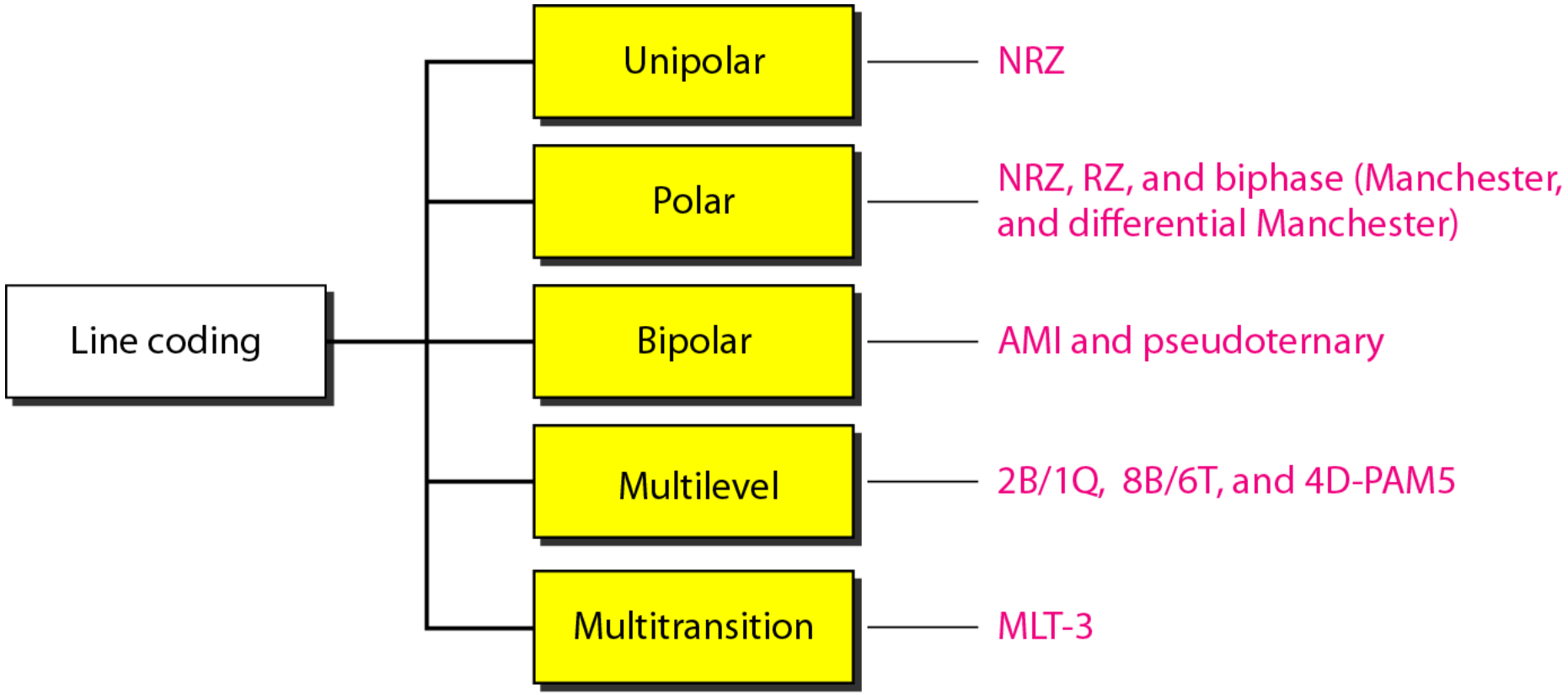
Line coding:- *It is the* process of converting digital data to digital signals



Unipolar NRZ scheme

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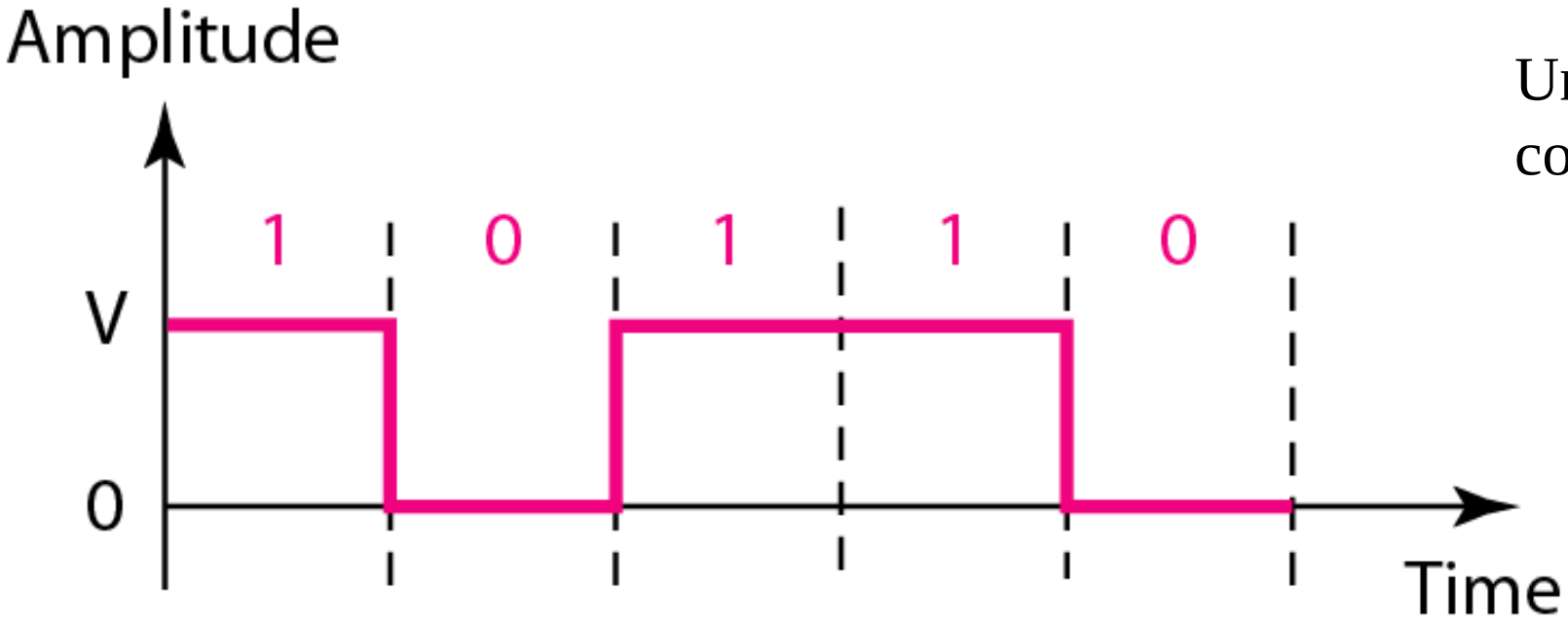
Unipolar :-All signal levels are one side of time axis either below or above.

NRZ – *Non- Return to Zero*



Unipolar NRZ scheme is very costly.

Polar NRZ-L and NRZ-I schemes

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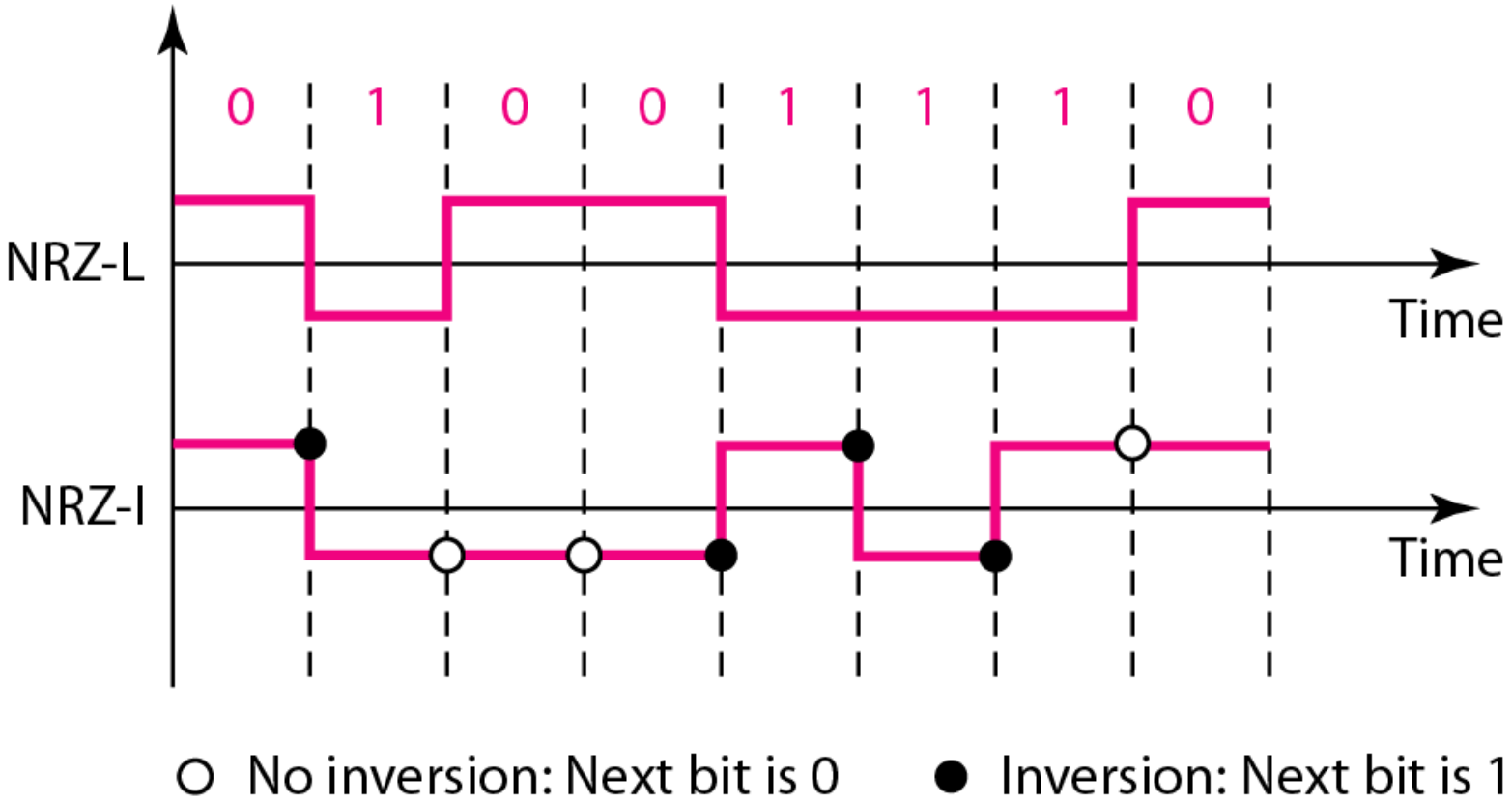
Polar :- Signal levels are on both side of time axis.



- In NRZ-L the level of the voltage determines the value of the bit.
- In NRZ-I the inversion or the lack of inversion determines the value of the bit.
- NRZ-L and NRZ-I both have a DC component problem