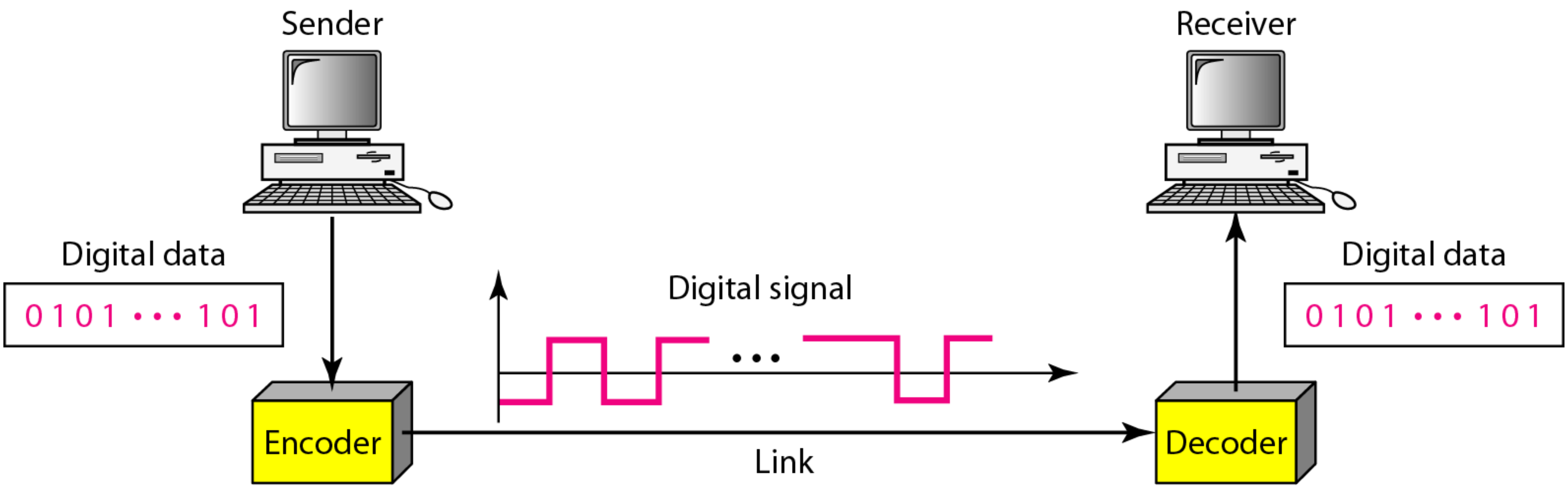
DIGITAL-TO-DIGITAL CONVERSION

In this section, we see how we can represent digital data by using digital signals. The conversion involves technique: line coding

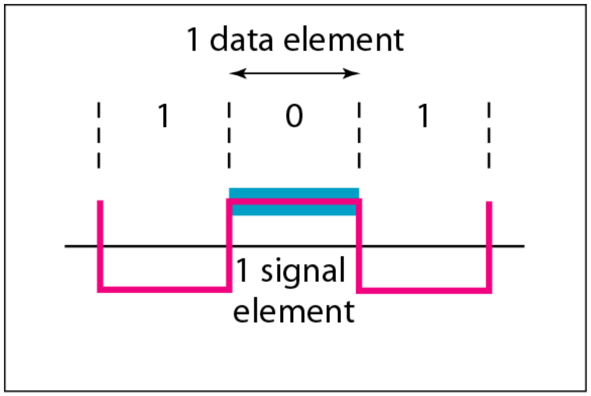
Topics discussed in this section:

Line Coding
Line Coding Schemes

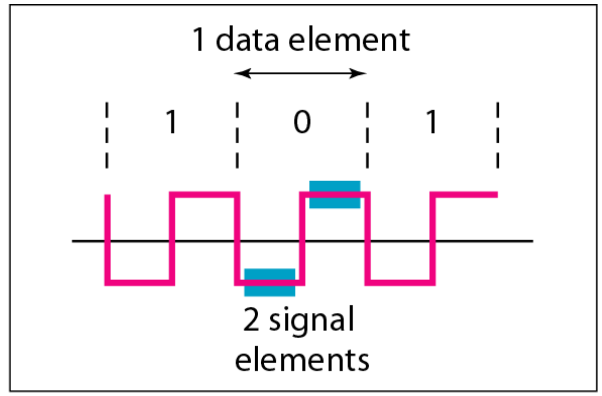
Line coding and decoding



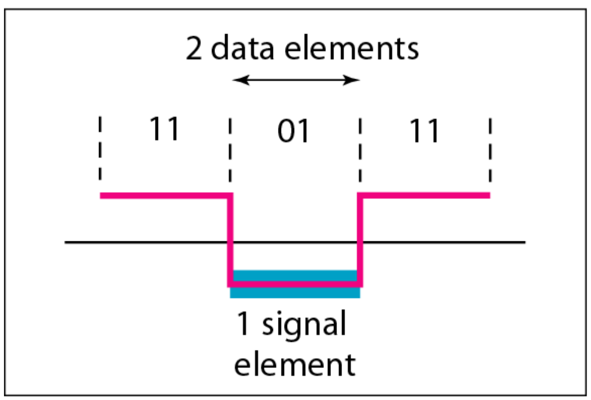
Signal element versus data element



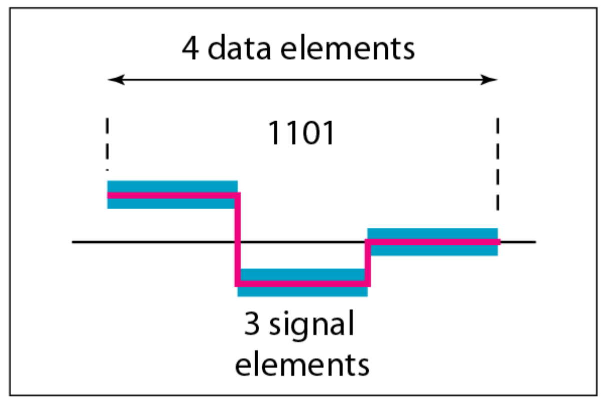
a. One data element per one signal element (r = 1)



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 $\left(r = \frac{4}{3}\right)$

Example

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

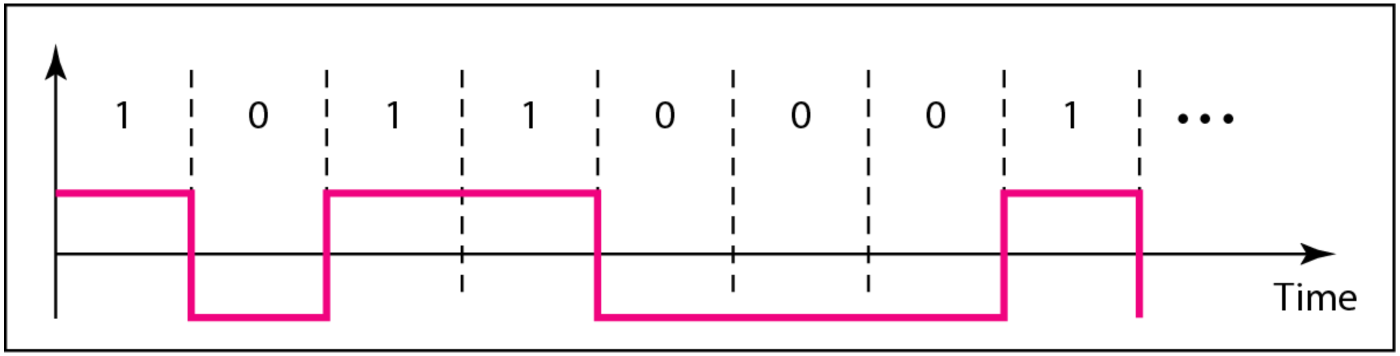
We assume that the average value of c is 1/2 . The baud rate is then

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

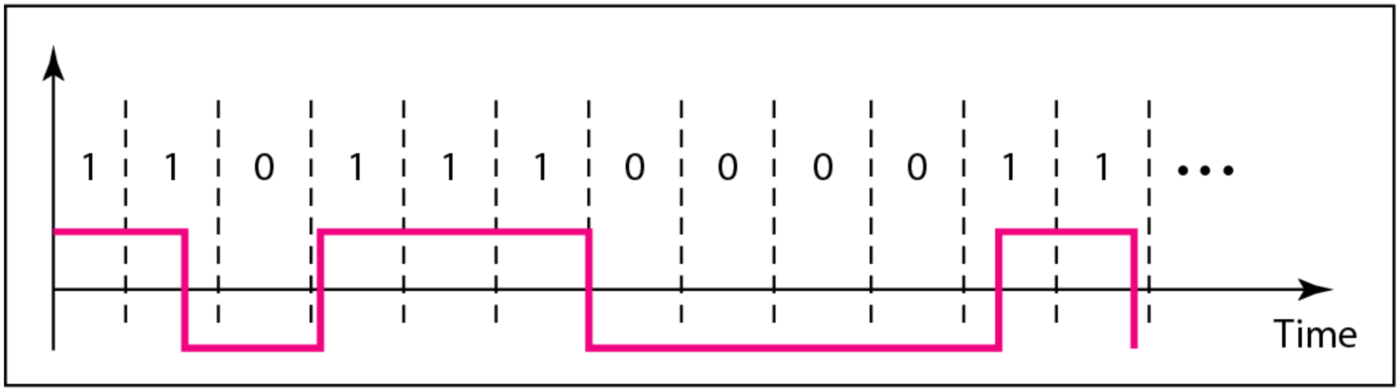
Note

Although the actual bandwidth of a digital signal is infinite, the effective bandwidth is finite.

Effect of lack of synchronization



a. Sent



b. Received

Line coding schemes

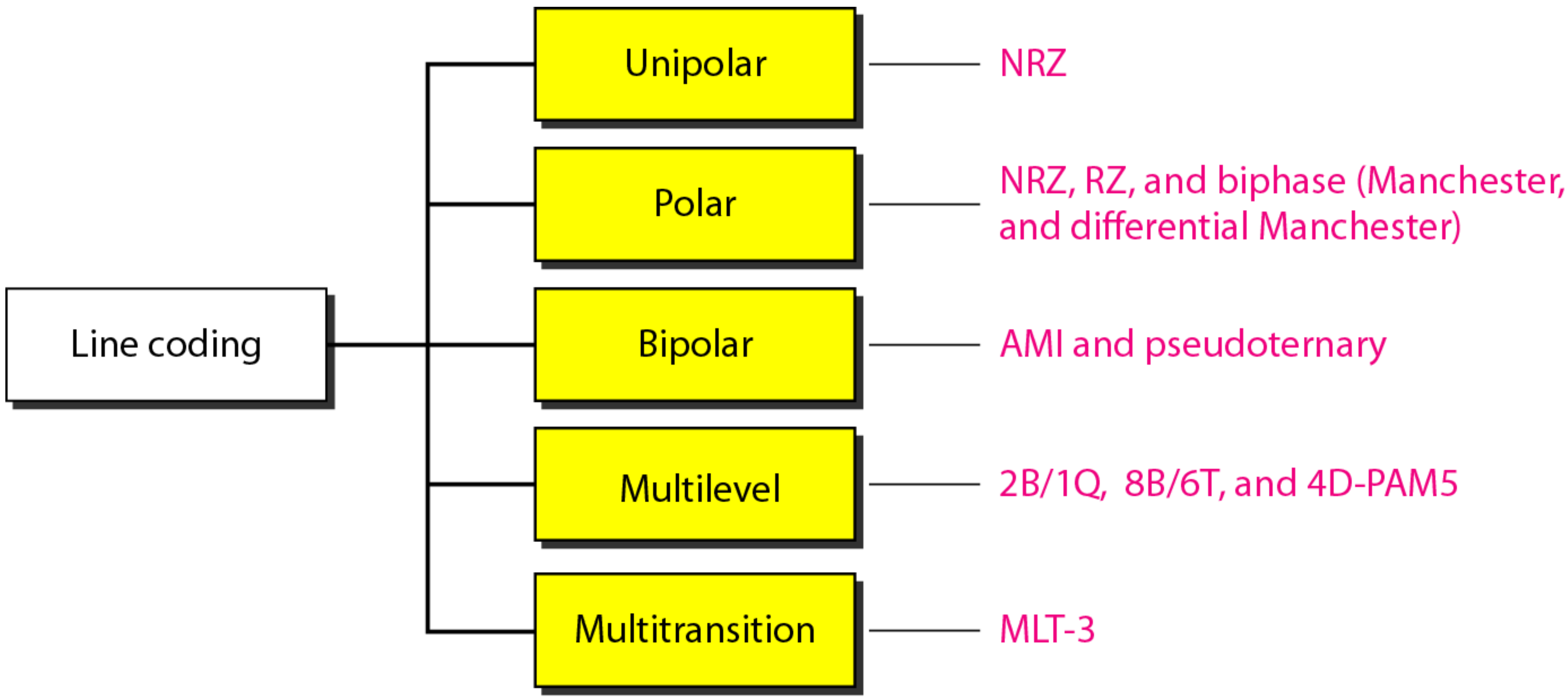
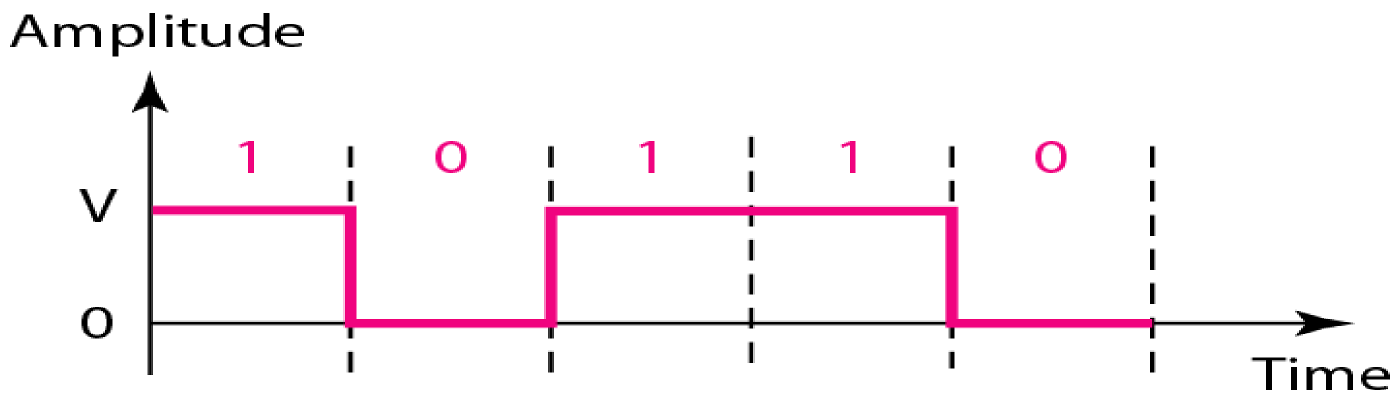
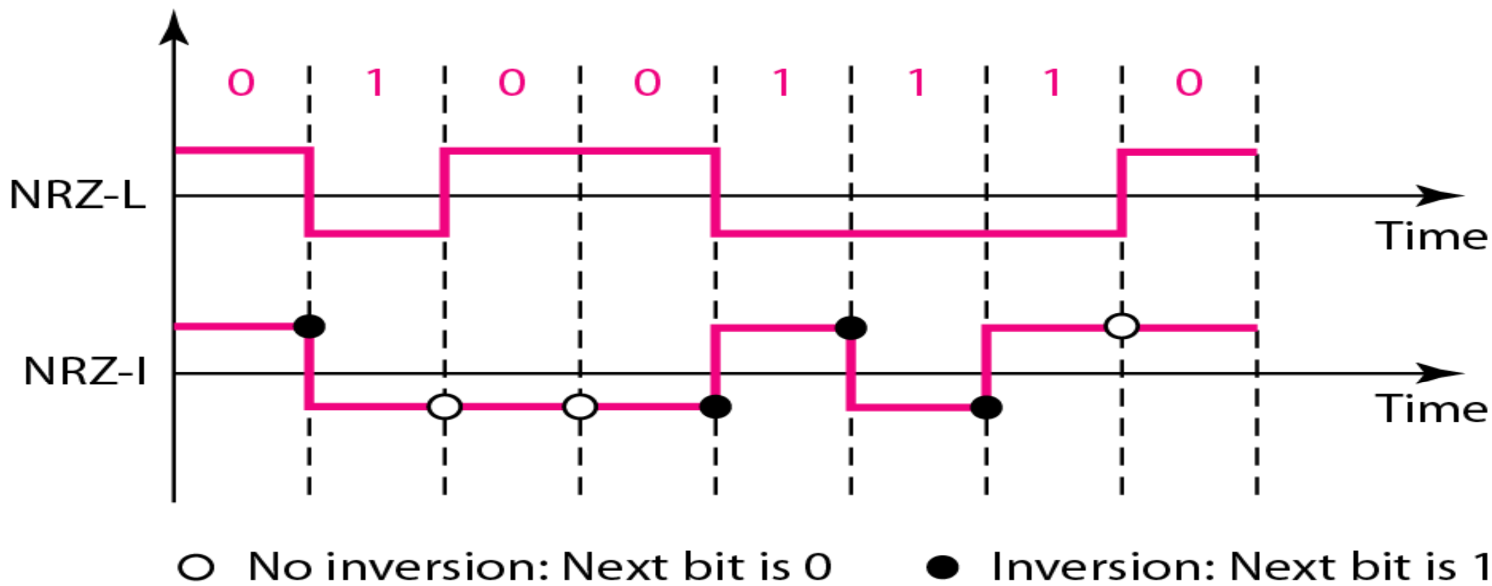


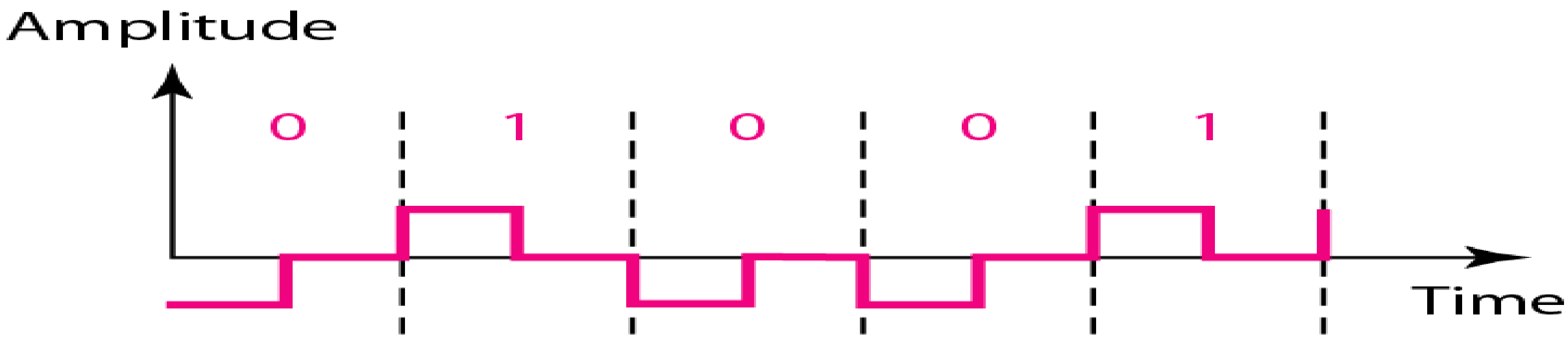
Figure ***Unipolar NRZ scheme***



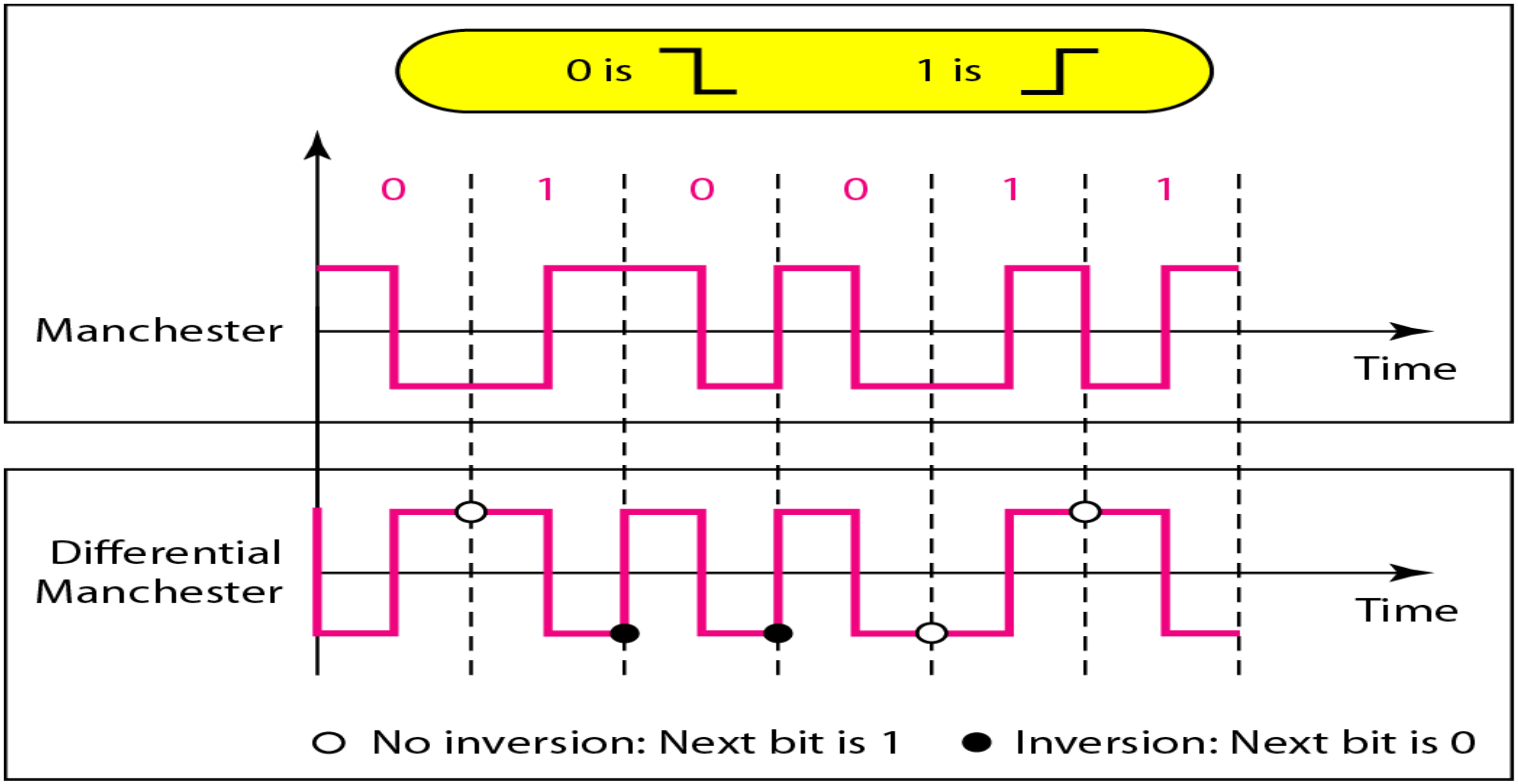
Polar NRZ-L and NRZ-I schemes



Polar RZ scheme



Polar biphase: Manchester and differential Manchester schemes



Note

In Manchester and differential Manchester encoding, the transition at the middle of the bit is used for synchronization.

Note

In bipolar encoding, we use three levels: positive, zero, and negative.

Figure ***Bipolar schemes: AMI and pseudoternary***

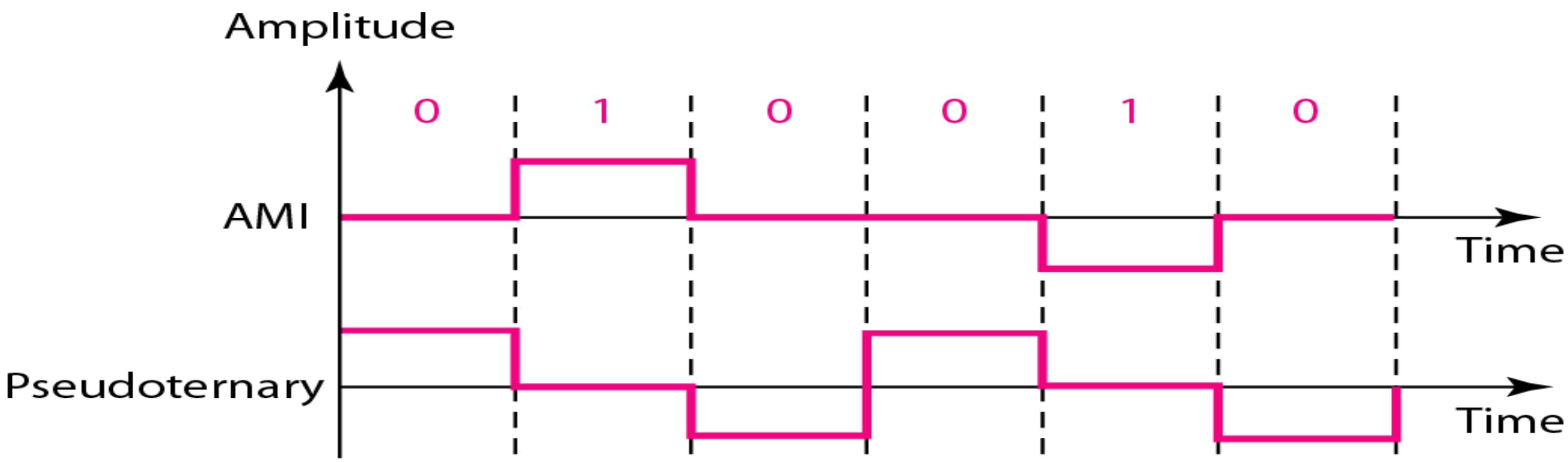


Table ***Summary of line coding schemes***

Category	*Scheme*	*Bandwidth (average)*	*Characteristics*
Unipolar	NRZ	$B = N/2$	Costly, no self-synchronization if long 0s or 1s, DC
Unipolar	NRZ-L	$B = N/2$	No self-synchronization if long 0s or 1s, DC
	NRZ-I	$B = N/2$	No self-synchronization for long 0s, DC
	Biphase	$B = N$	Self-synchronization, no DC, high bandwidth
Bipolar	AMI	$B = N/2$	No self-synchronization for long 0s, DC
Multilevel	2B1Q	$B = N/4$	No self-synchronization for long same double bits
	8B6T	$B = 3N/4$	Self-synchronization, no DC
	4D-PAM5	$B = N/8$	Self-synchronization, no DC
Multiline	MLT-3	$B = N/3$	No self-synchronization for long 0s