Digital Transmission

- *Digital data-to-Digital signal*
- *Analog data-to-Digital signal*

DIGITAL-TO-DIGITAL CONVERSION

Line Coding

Block Coding

Figure 4.1 *Line coding and decoding*

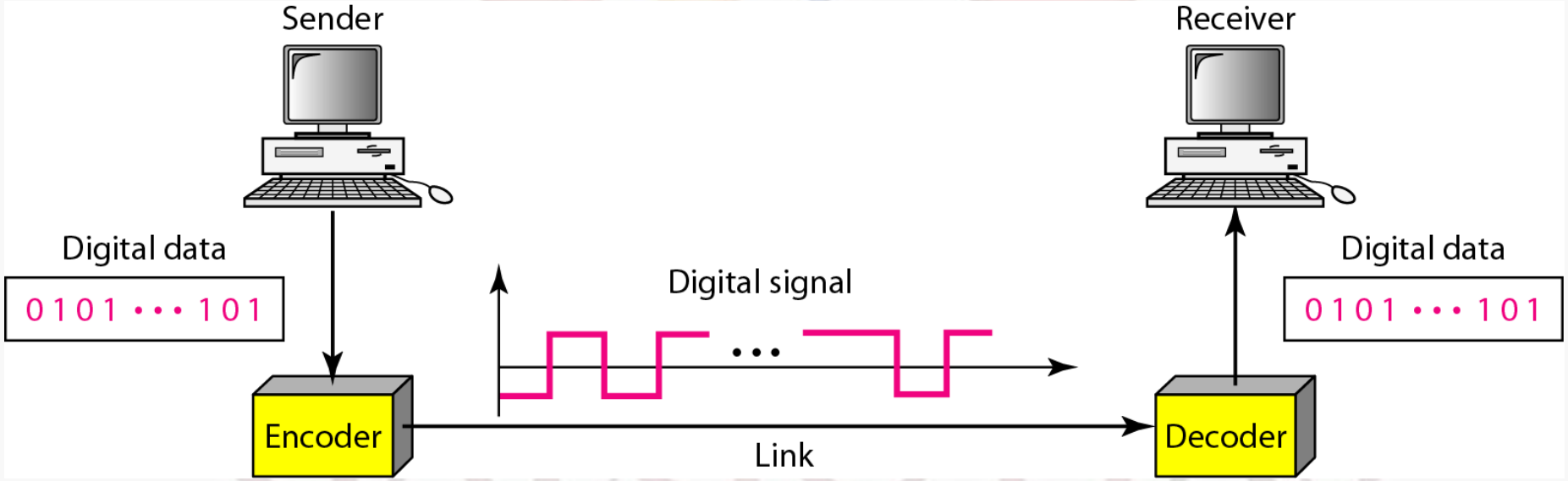
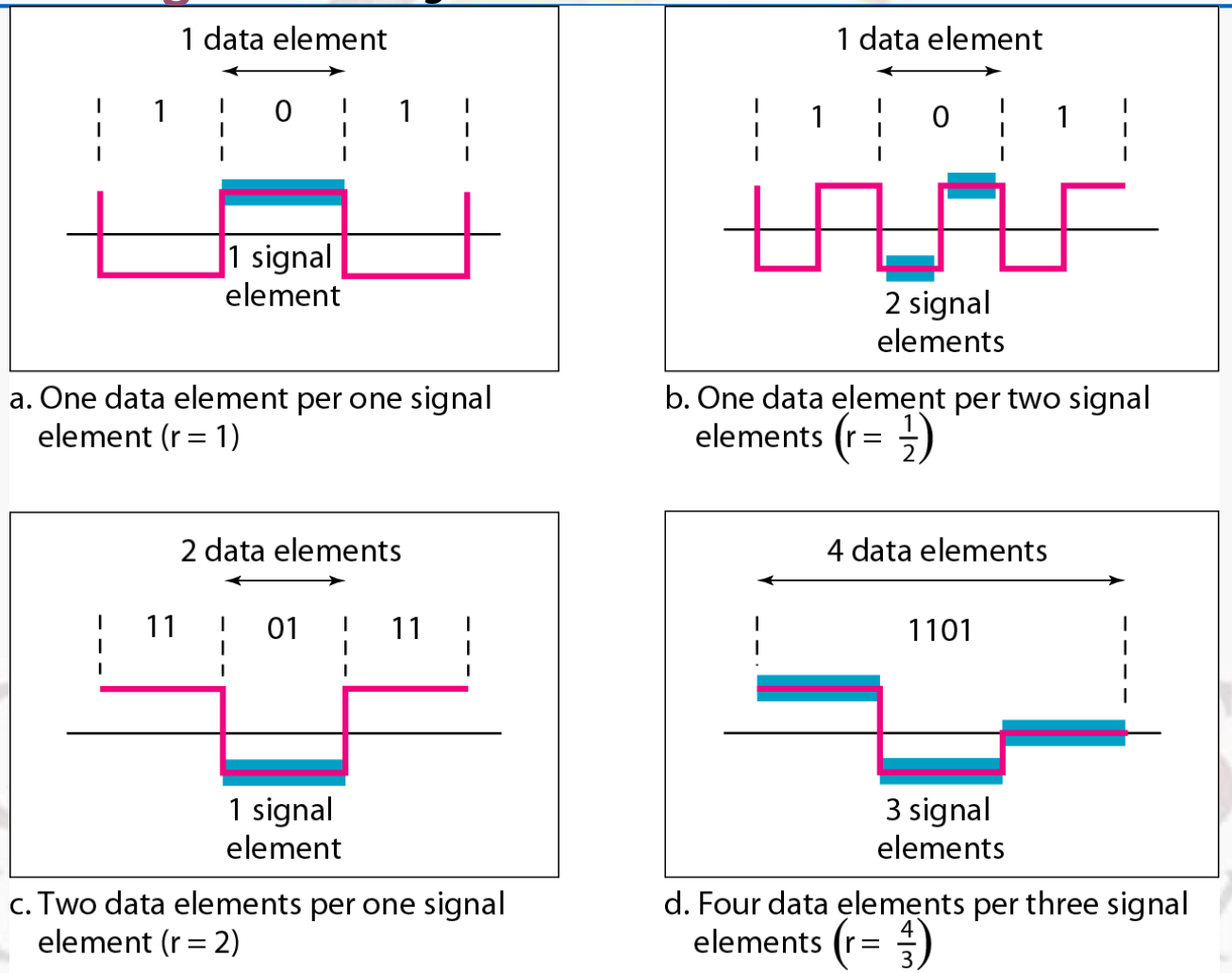


Figure 4.2 *Signal element versus data element*



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

Bit Rate and Baud Rate

Bit rate **is the number of bits transmitted per second.**

Baud rate **is the number of signal units per second.**

Bit rate = baud rate X number of bits per signal

Example 1

A signal is carrying four bits in each signal element. If 1000 signal elements are sent per second, find the bit rate and baud rate.

Solution:

Baud rate = No. of signal elements/sec
= 1000 baud/sec

Bit rate = Baud rate X No. of bits per signal elements
= 1000 X 4= 4000 bps

Example 1

The bit rate of a signal is 3000. If each signal elements carries 6 bits, what is the baud rate?

Solution:

Bit rate = Baud rate X No. of bits per signal elements

Baud rate = No. of bits per signal elements/bit rate

= 3000 /6 = 500 baud/sec

Figure 4.3 *Effect of lack of synchronization*

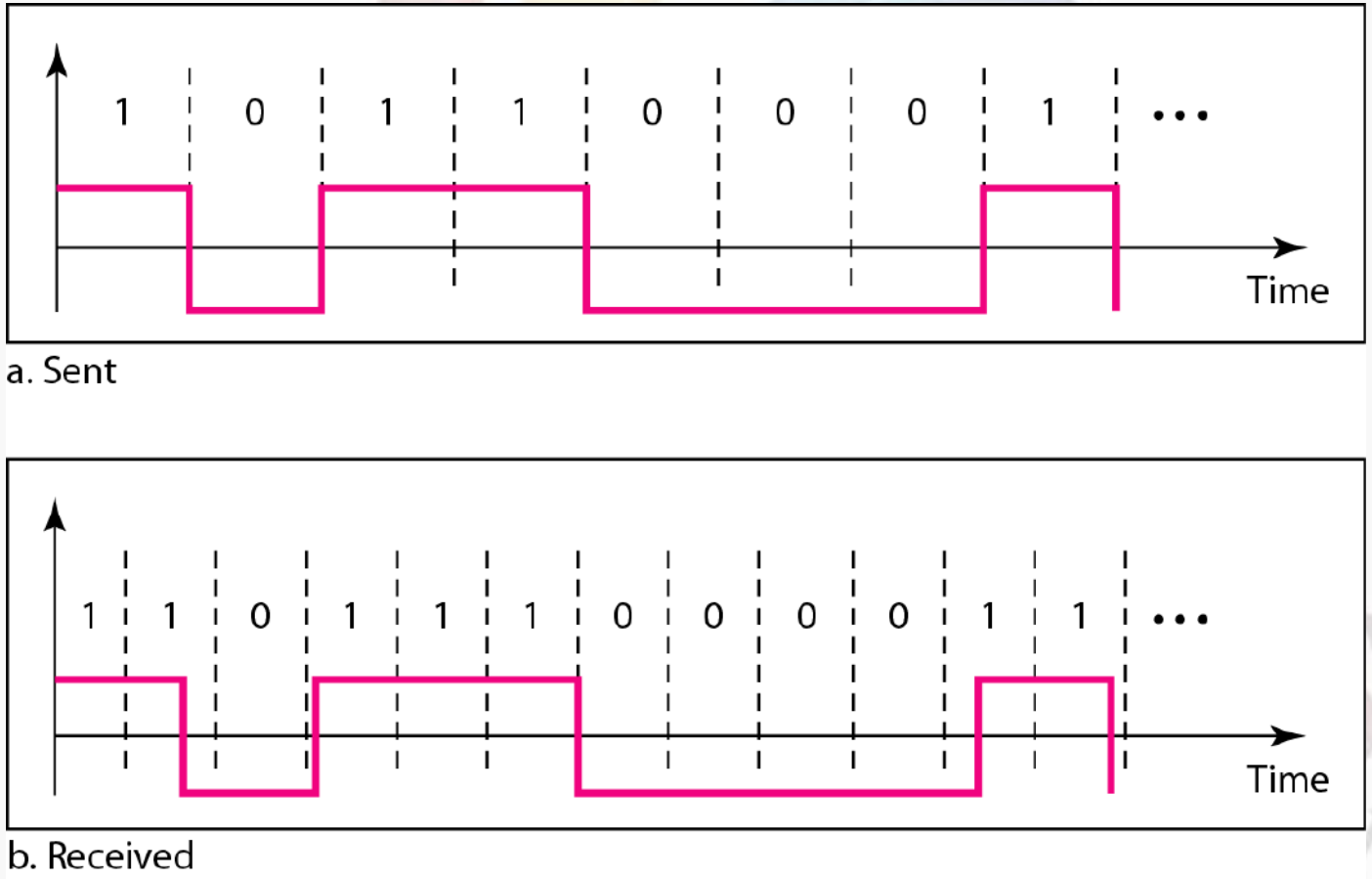


Figure 4.4 *Line coding schemes*

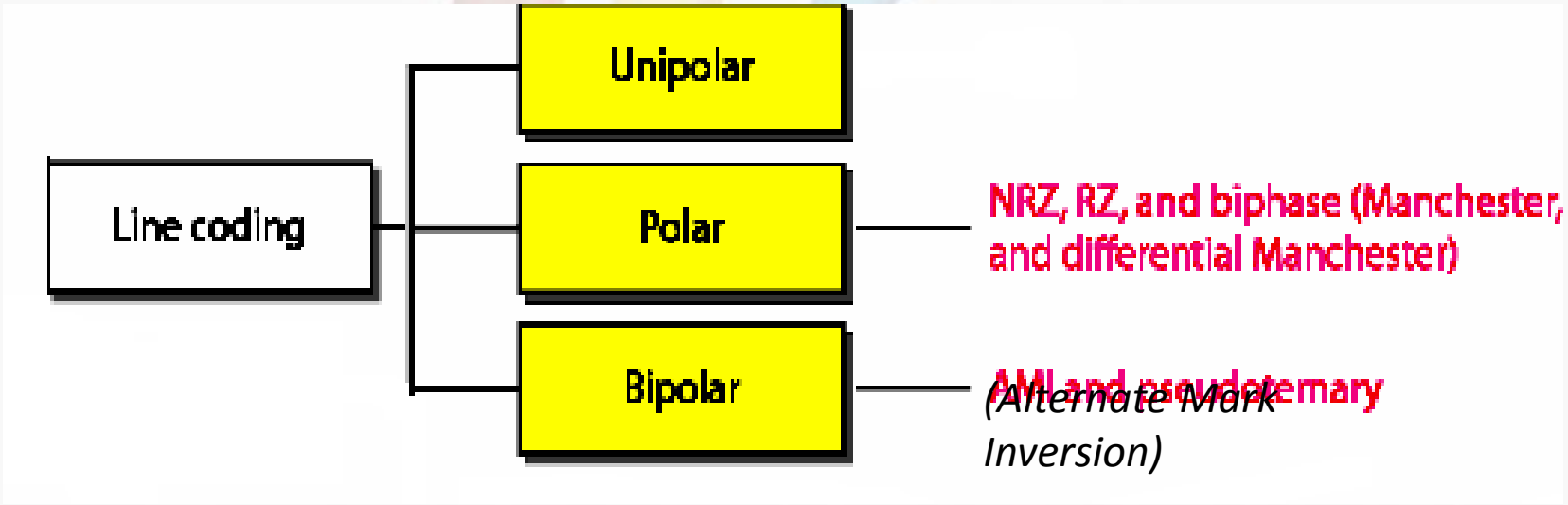
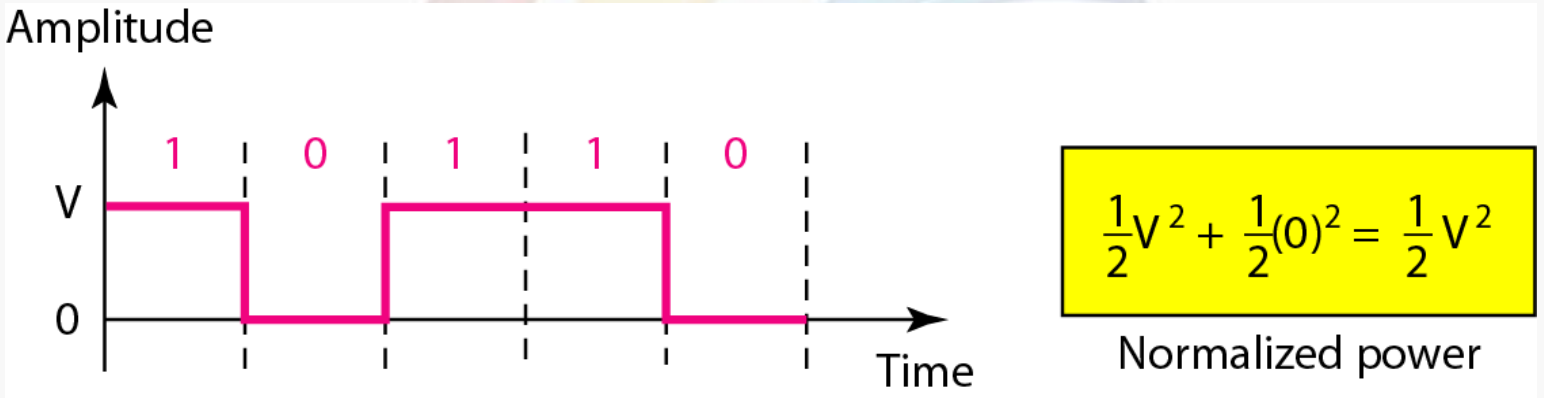


Figure 4.5 *Unipolar scheme*

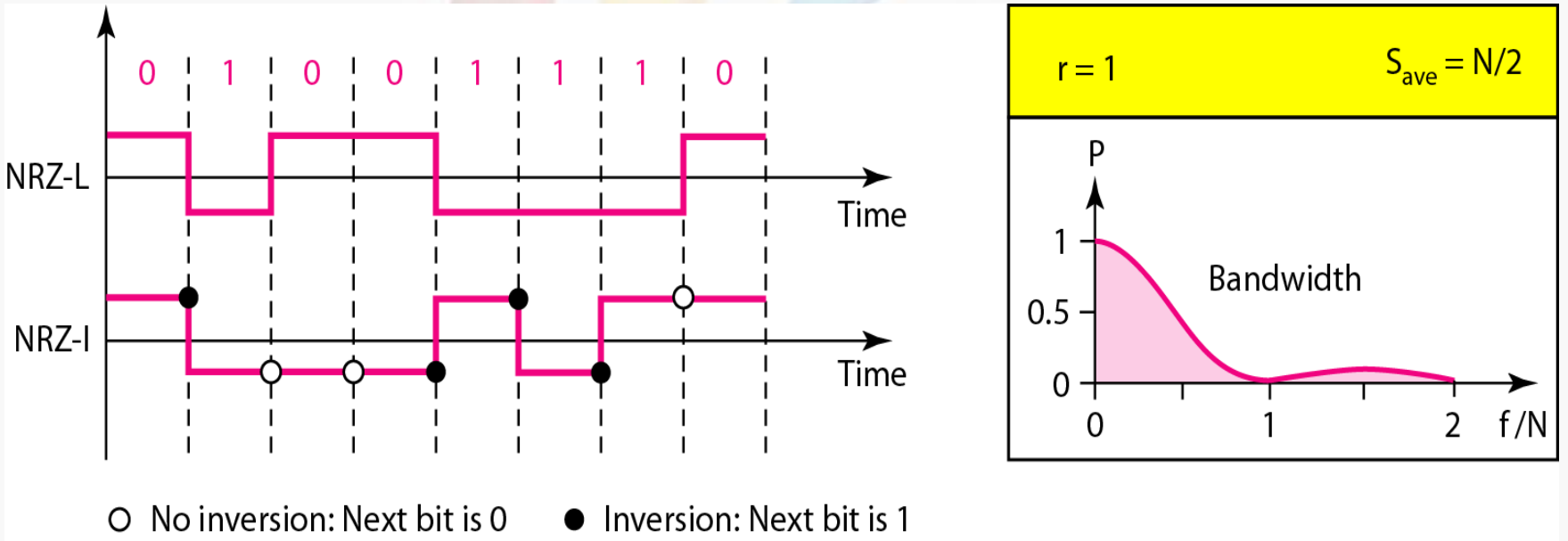


Positive voltage level represents a binary 1

Negative voltage level represents a binary 0

Figure 4.6 ***Polar NRZ-L and NRZ-I schemes***

NRZ-L=>Non Return to Zero-Level



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.

Note: NRZ-L and NRZ-I both have a DC component problem.

Figure 4.7 *Polar RZ scheme*

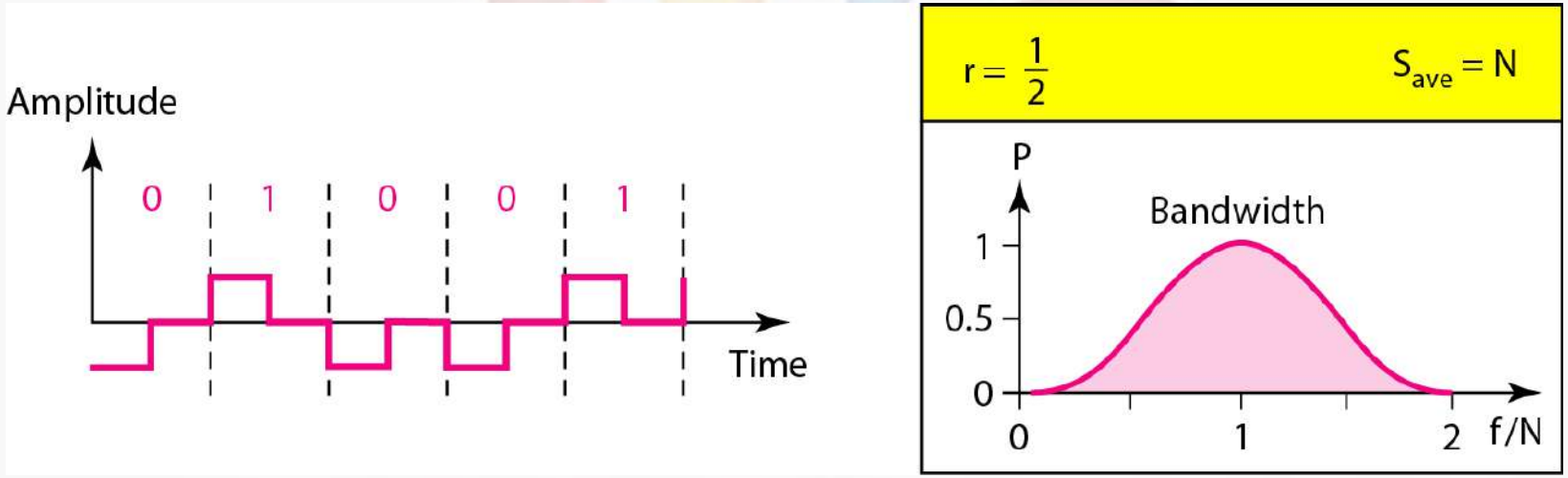
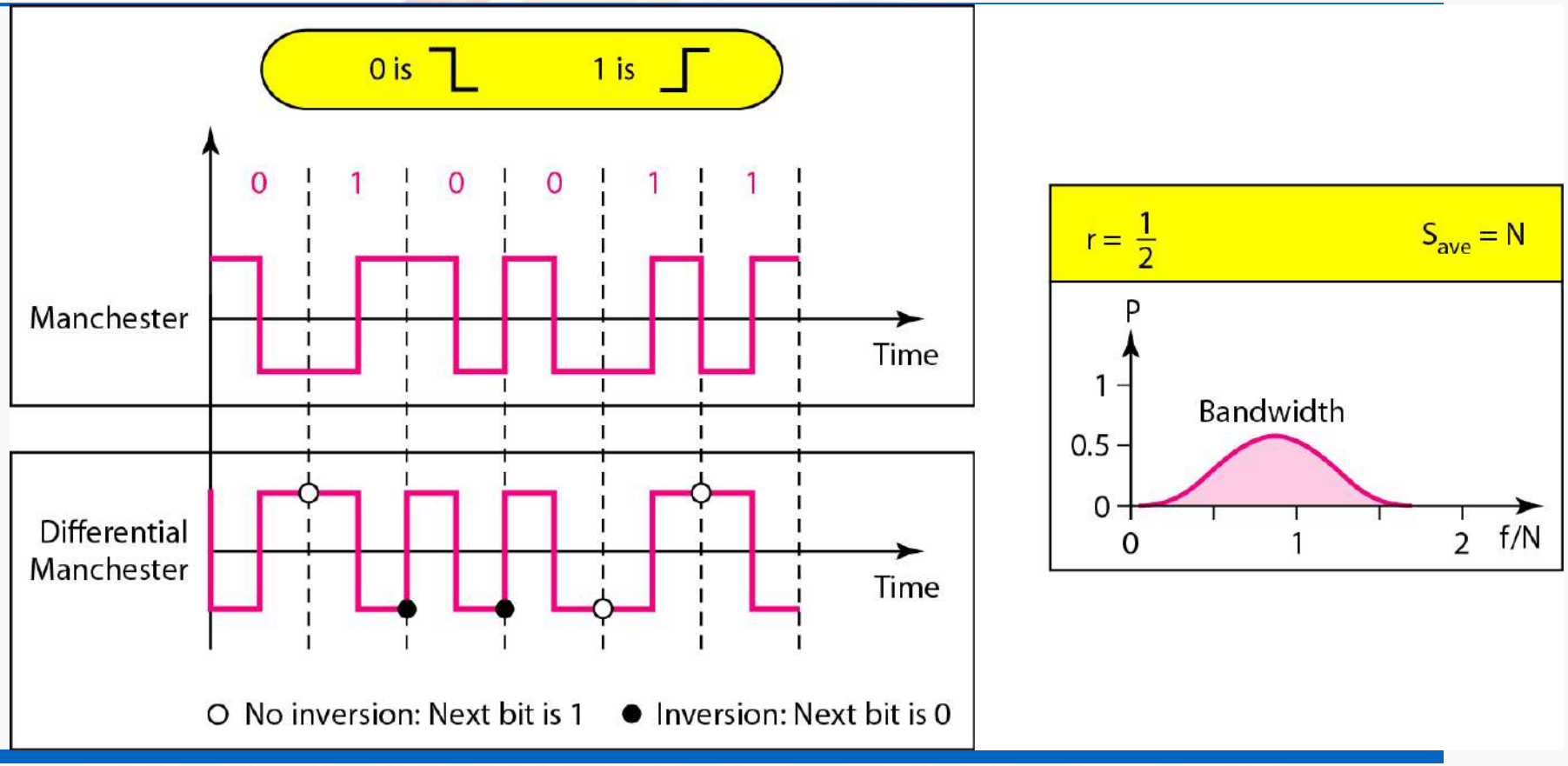
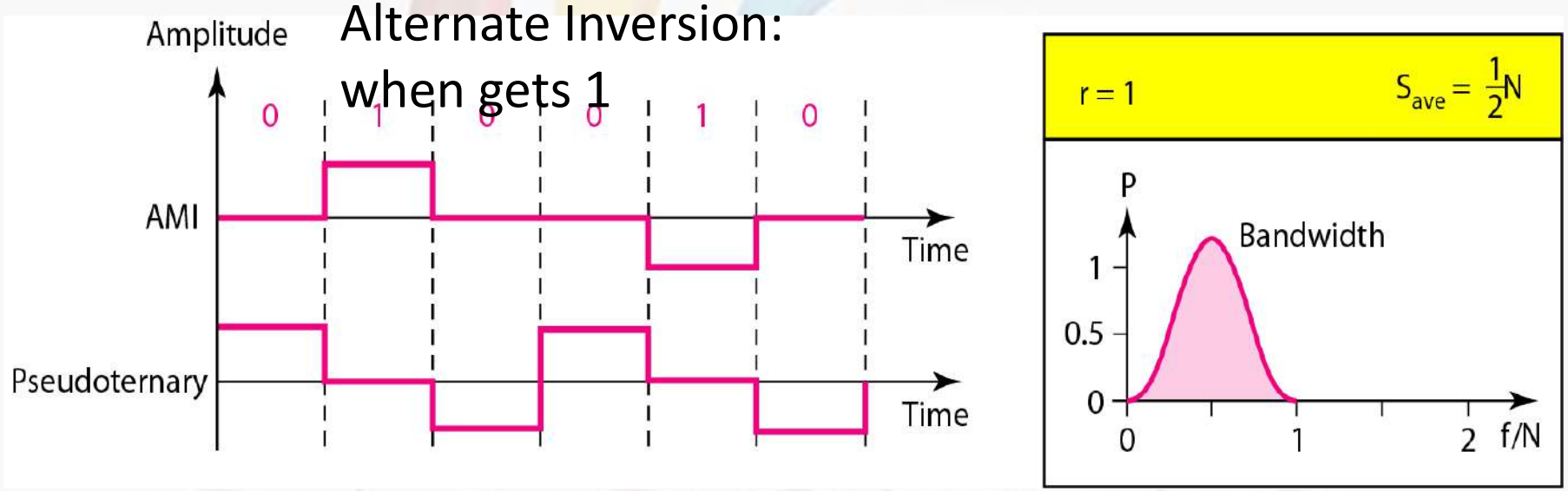


Figure 4.8 *Polar biphase: Manchester and differential Manchester schemes*



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

Figure 4.9 ***Bipolar schemes: AMI (alternate mark inversion) and pseudoternary***



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

Figure 4.14 ***Block coding concept***

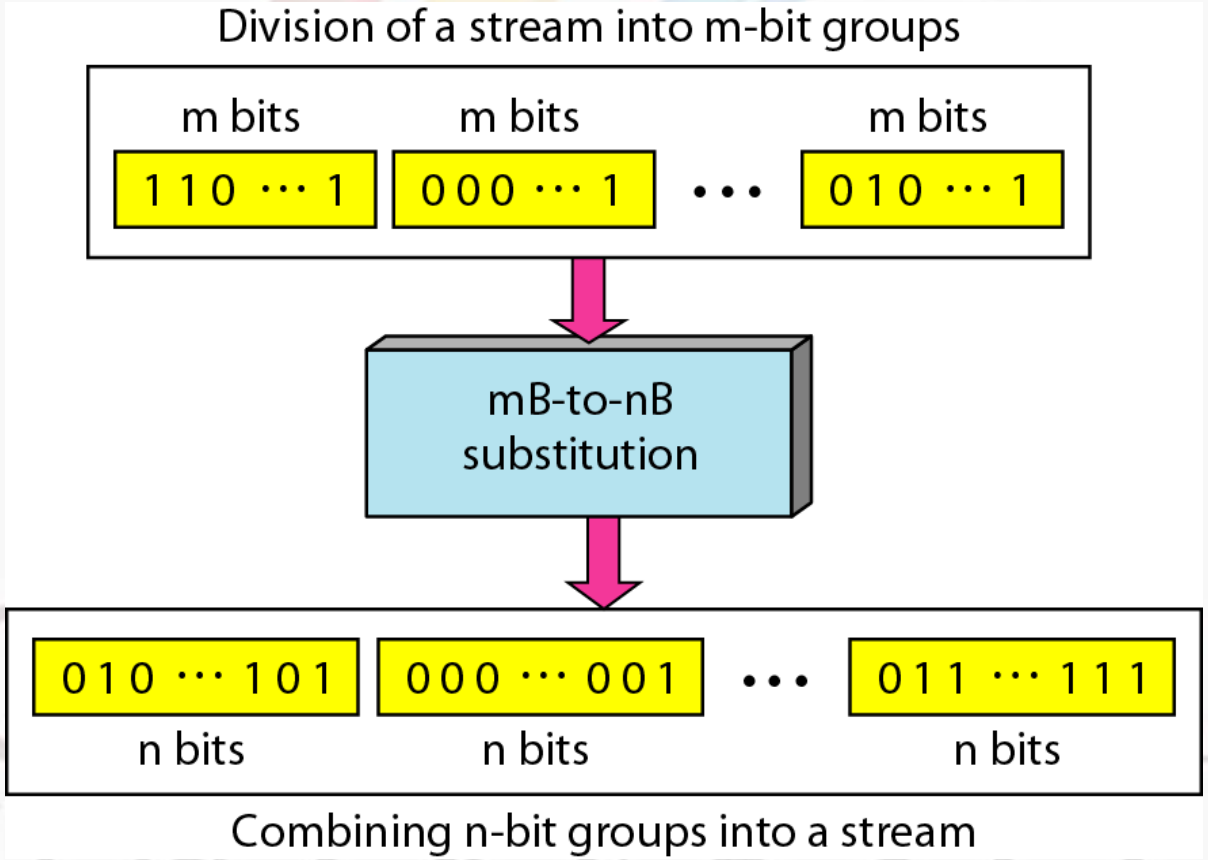


Figure 4.15 *Using block coding 4B/5B with NRZ-I line coding scheme*

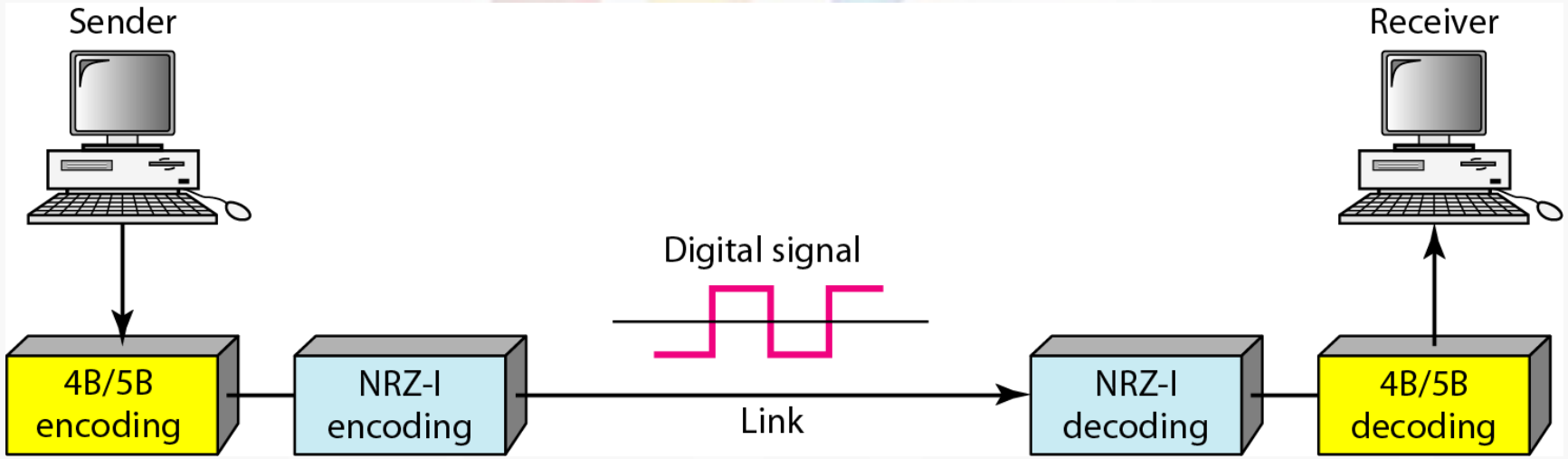
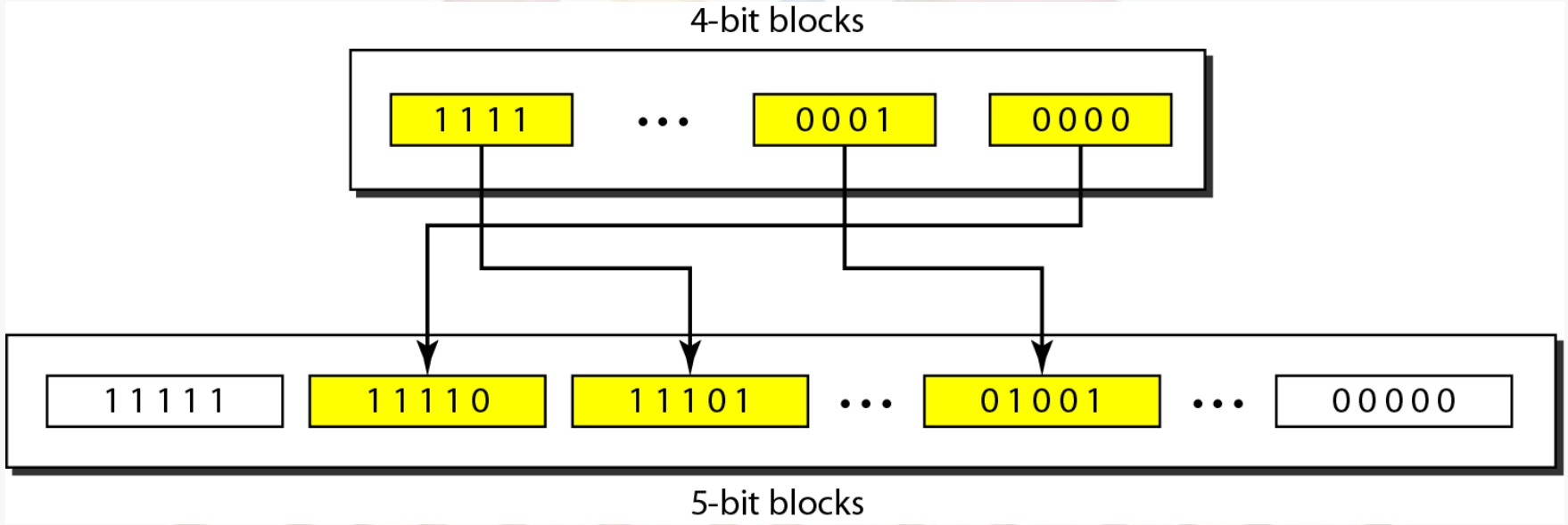


Figure 4.16 *Substitution in 4B/5B block coding*



ANALOG-TO-DIGITAL CONVERSION

Topics discussed in this section:

Pulse Code Modulation (PCM)
Delta Modulation (DM)

Figure 4.21 *Components of PCM encoder*

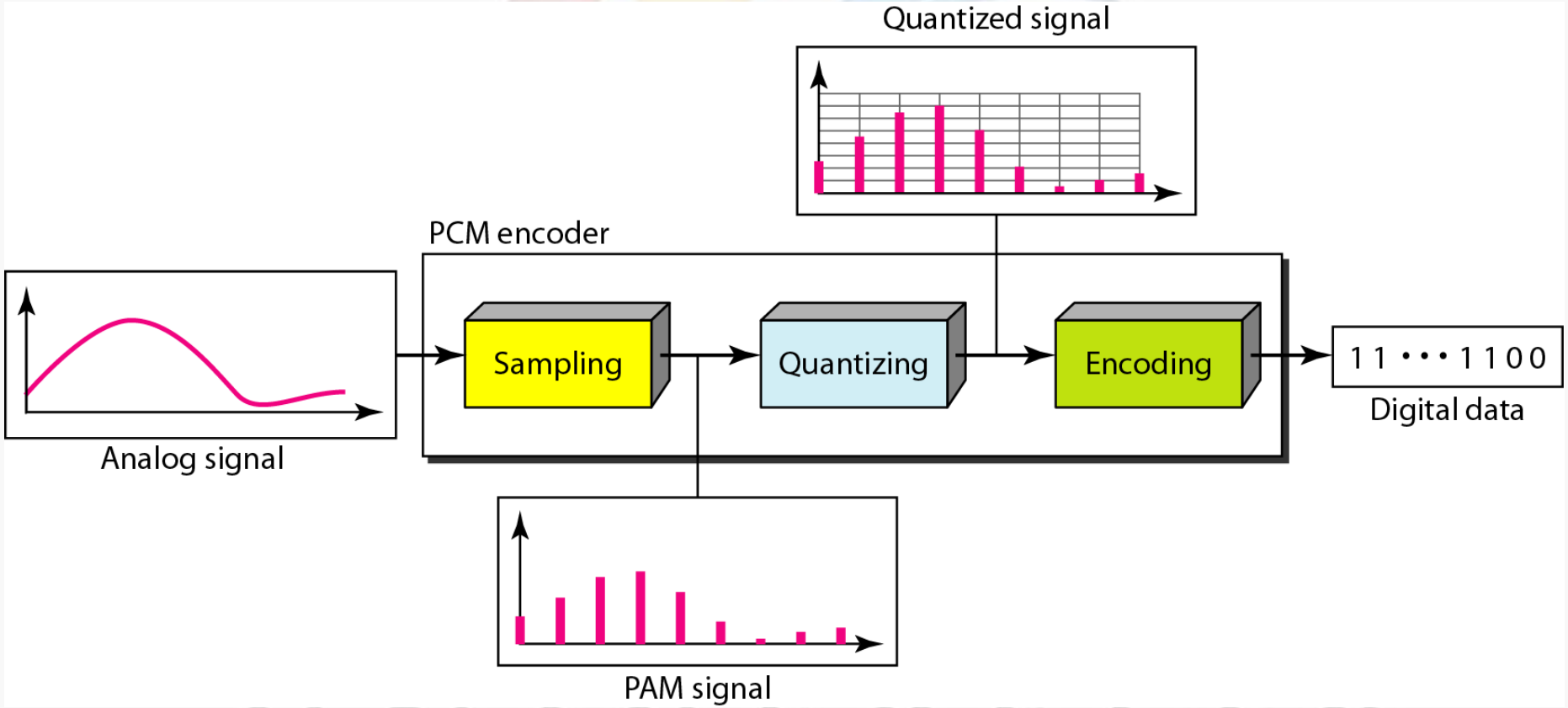
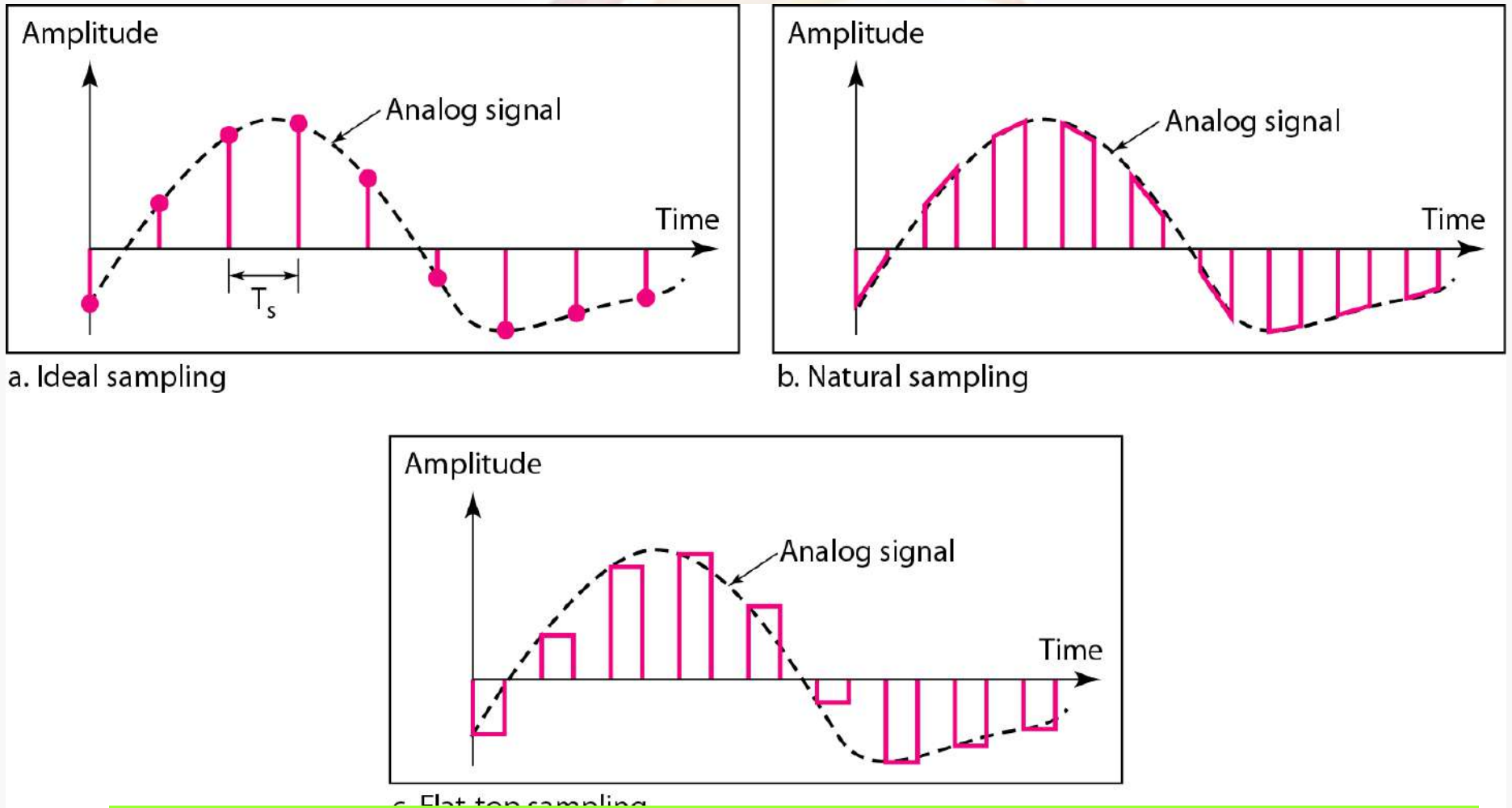


Figure 4.22 *Three different sampling methods for PCM*



According to the Nyquist theorem, the sampling rate must be at least 2 times the highest frequency contained in the signal.

Delta Modulation

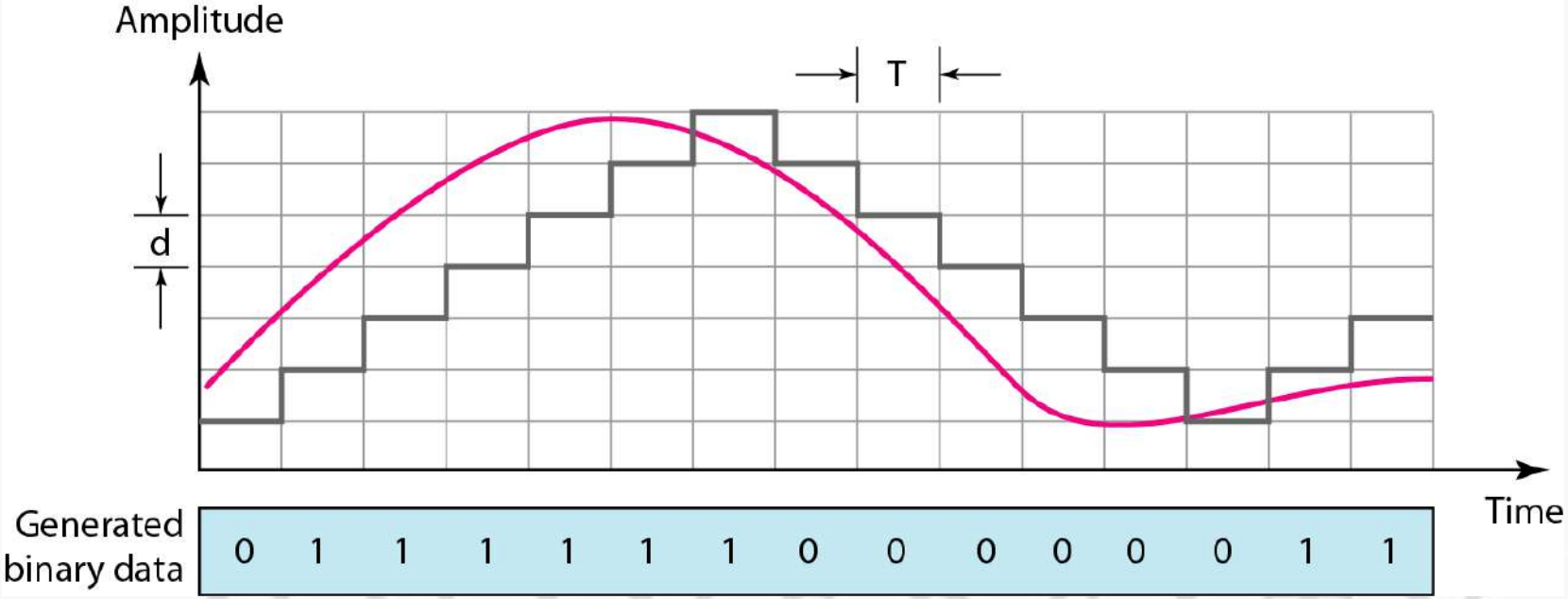
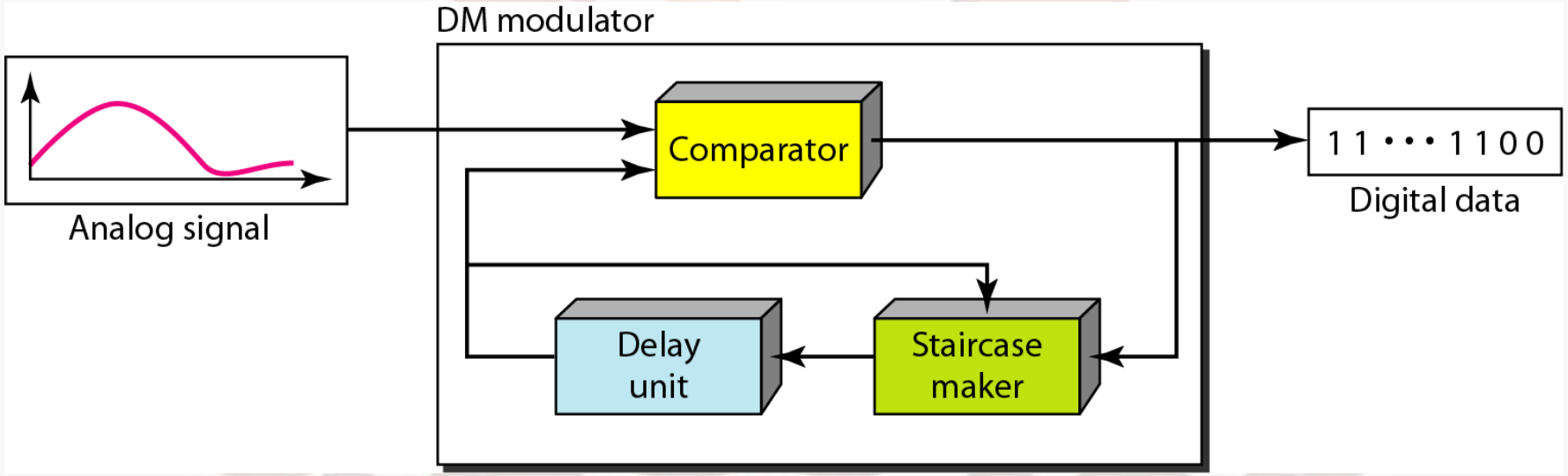


Figure 4.29 ***Delta modulation components***



4-3 TRANSMISSION MODES

The transmission of binary data across a link can be accomplished in either parallel or serial mode. In parallel mode, multiple bits are sent with each clock tick. In serial mode, 1 bit is sent with each clock tick. While there is only one way to send parallel data, there are three subclasses of serial transmission: asynchronous, and synchronous.

Topics discussed in this section:

Parallel Transmission
Serial Transmission

Figure 4.31 *Data transmission and modes*

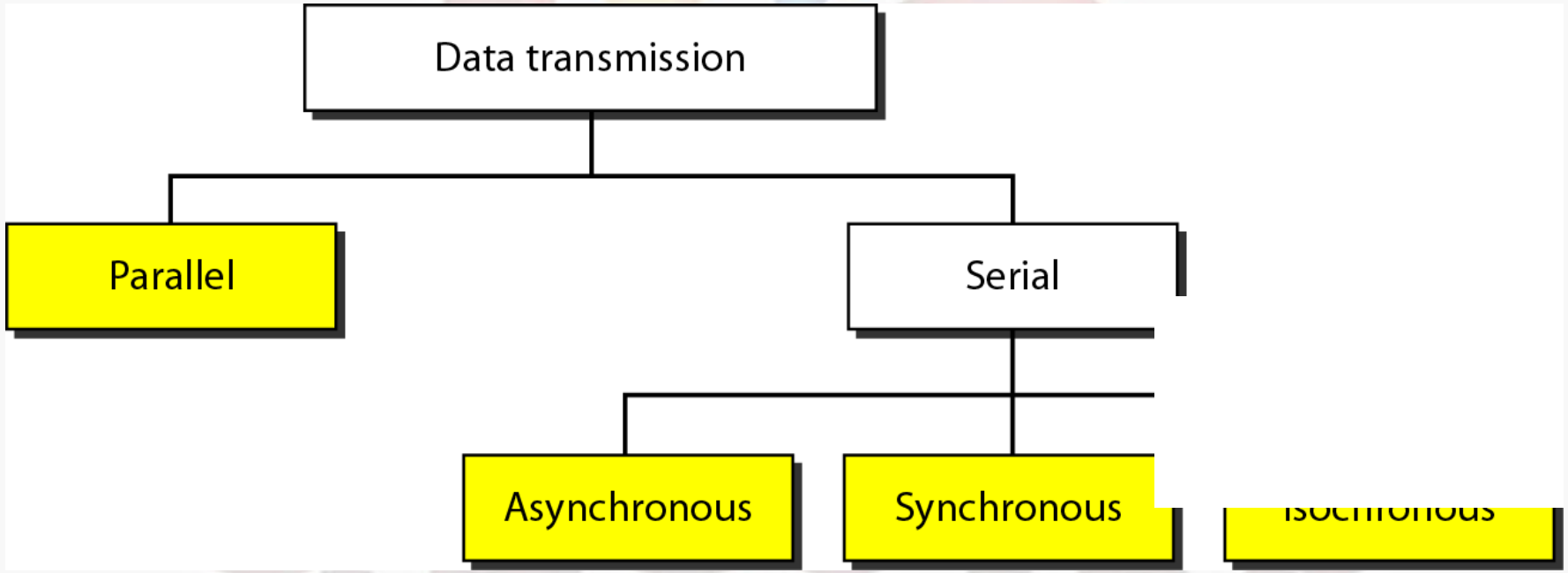


Figure 4.32 ***Parallel transmission***

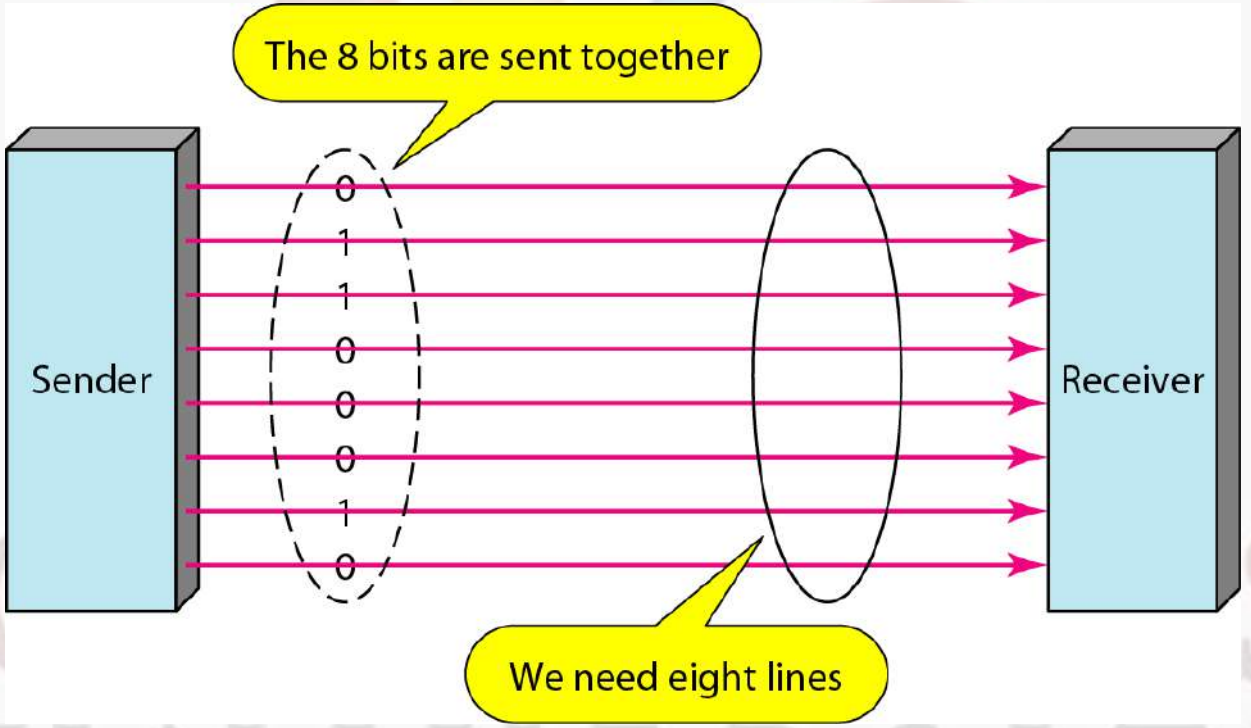


Figure 4.33 *Serial transmission*

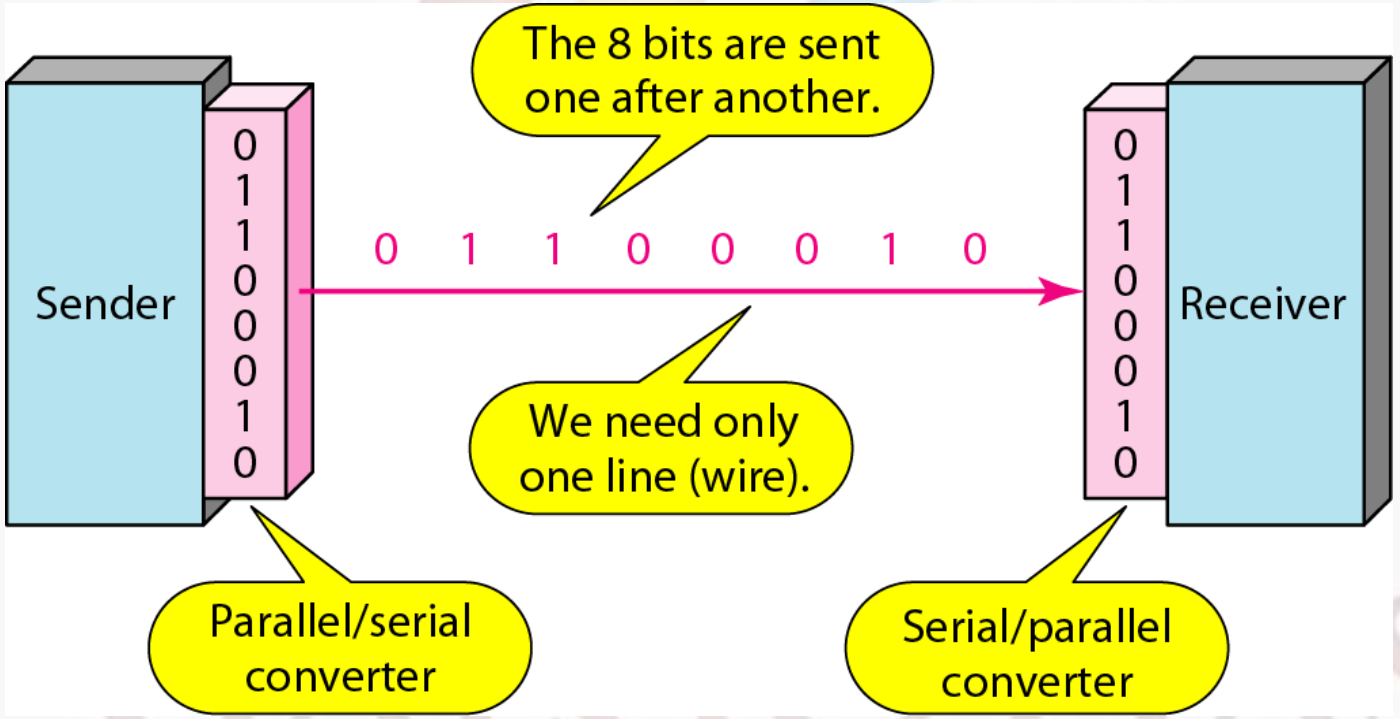
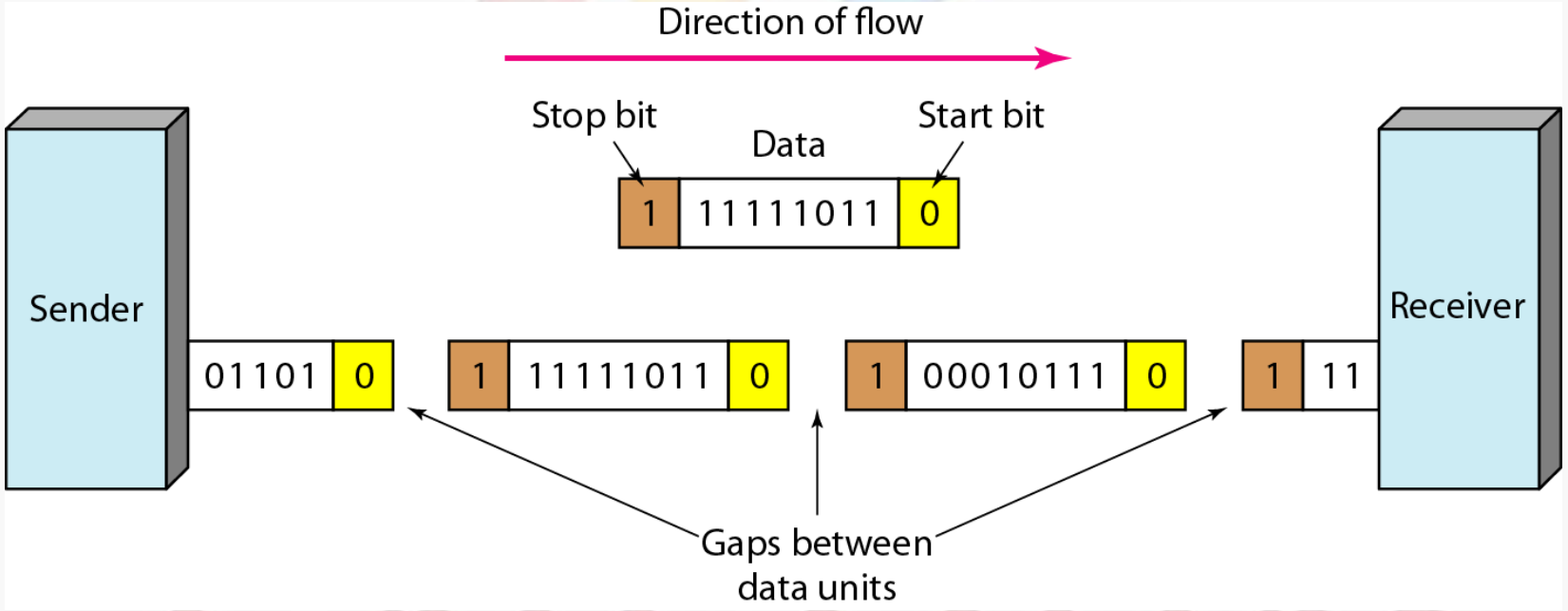


Figure 4.34 *Asynchronous transmission*



In synchronous transmission, we send bits one after another without start or stop bits or gaps. It is the responsibility of the receiver to group the bits.

Figure 4.35 *Synchronous transmission*