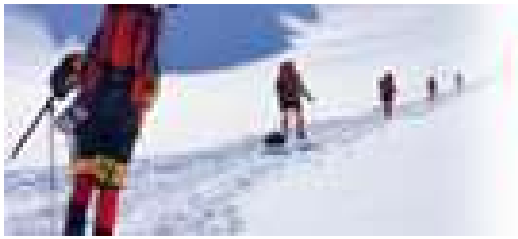


Data Communications and Networking Fourth Edition

Forouzan

Chapter 5

Analog Transmission

5-1 DIGITAL-TO-ANALOG CONVERSION

Digital-to-analog ***conversion is the process of changing one of the characteristics of an analog signal based on the information in digital data.***

Topics discussed in this section:

Aspects of Digital-to-Analog Conversion
Amplitude Shift Keying
Frequency Shift Keying
Phase Shift Keying
Quadrature Amplitude Modulation

Figure 5.1 *Digital-to-analog conversion*

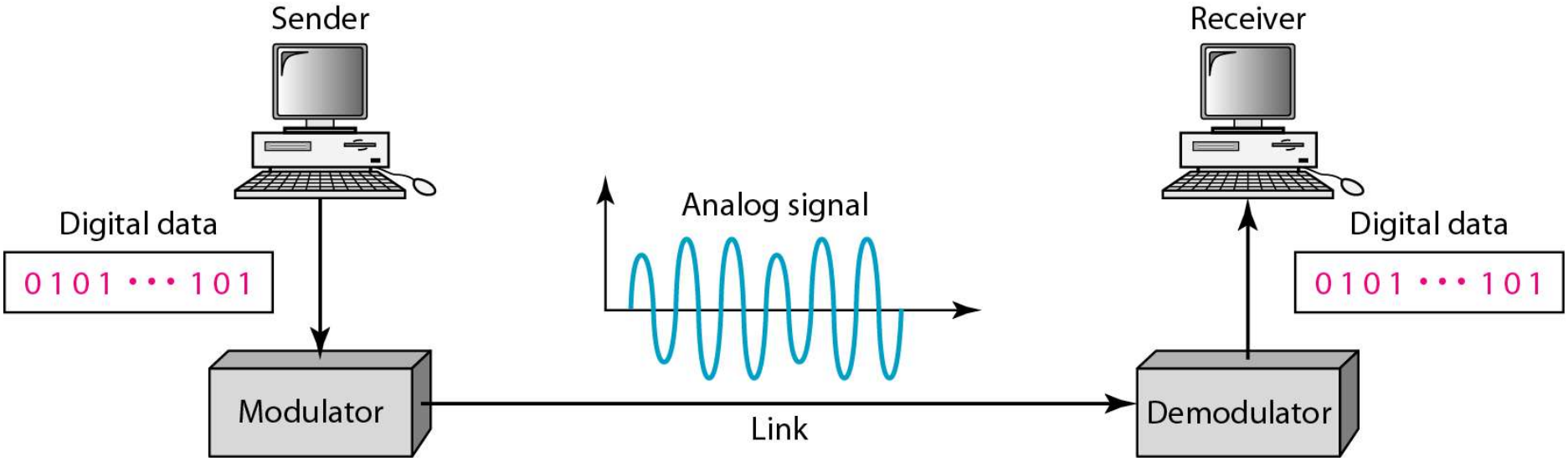
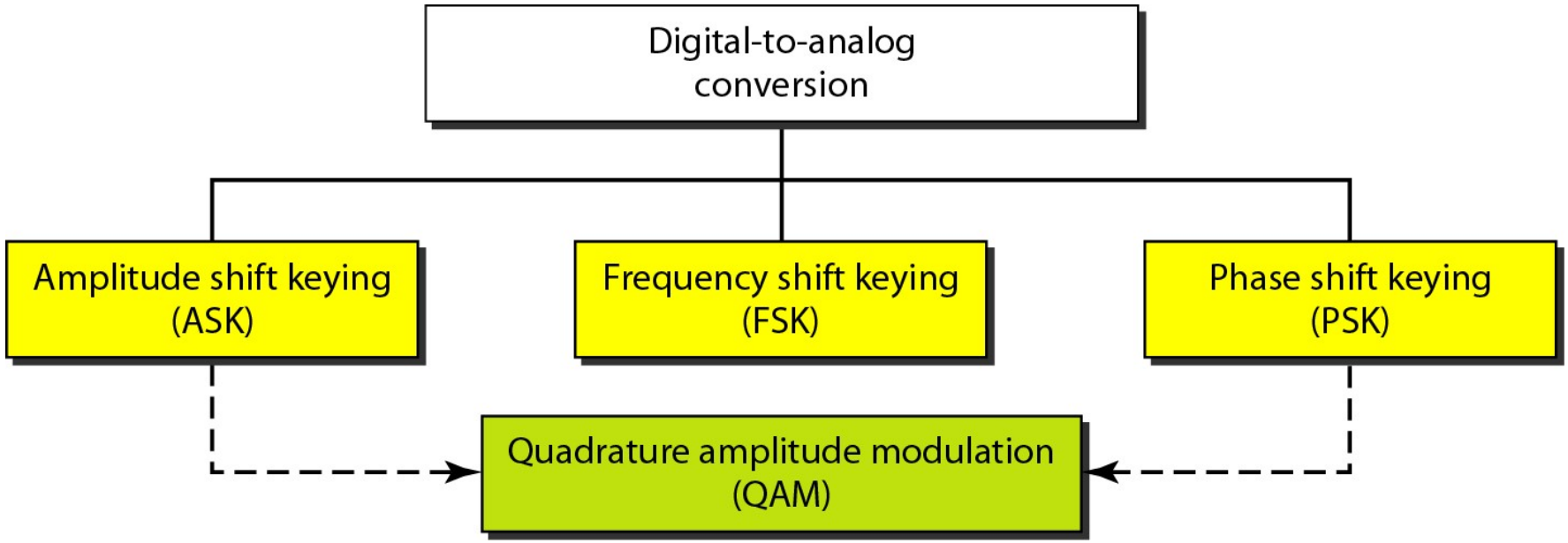


Figure 5.2 *Types of digital-to-analog conversion*



Note

Bit rate is the number of bits per second. Baud rate is the number of signal elements per second.

In the analog transmission of digital data, the baud rate is less than or equal to the bit rate.

S=N/r baud,
where N is the data rate (bps) and r is the number of data elements carried in one signal element. The value of r in analog transmission is r = log2 L, where L is the number of different signal elements.

Example 5.2

An analog signal has a bit rate of 8000 bps and a baud rate of 1000 baud. How many data elements are carried by each signal element? How many signal elements do we need?

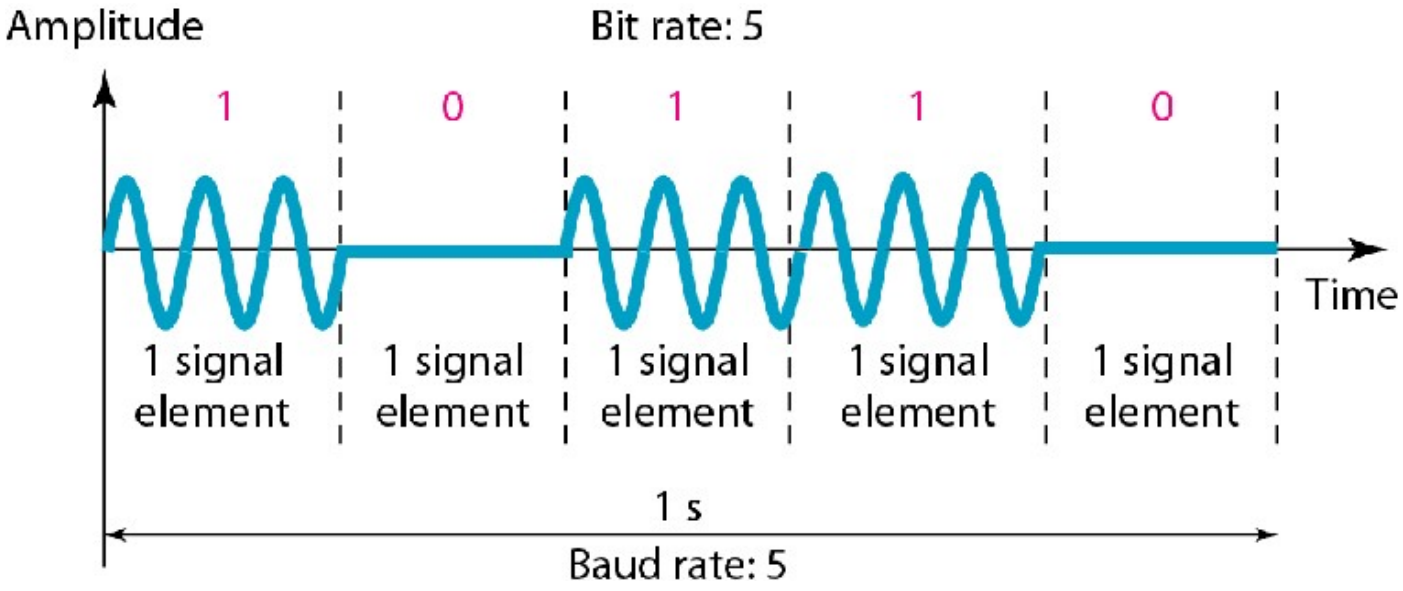
Solution

In this example, S = 1000, N = 8000, and r and L are unknown. We find first the value of r and then the value of L.

$$S = N \times \frac{1}{r} \quad \rightarrow \quad r = \frac{N}{S} = \frac{8000}{1000} = 8 \text{ bits/baud}$$

$$r = \log_2 L \quad \rightarrow \quad L = 2^r = 2^8 = 256$$

Figure 5.3 *Binary amplitude shift keying*



The peak amplitude of one signal level is 0; the other is the same as the amplitude of the carrier frequency.

Figure 5.6 *Binary frequency shift keying*

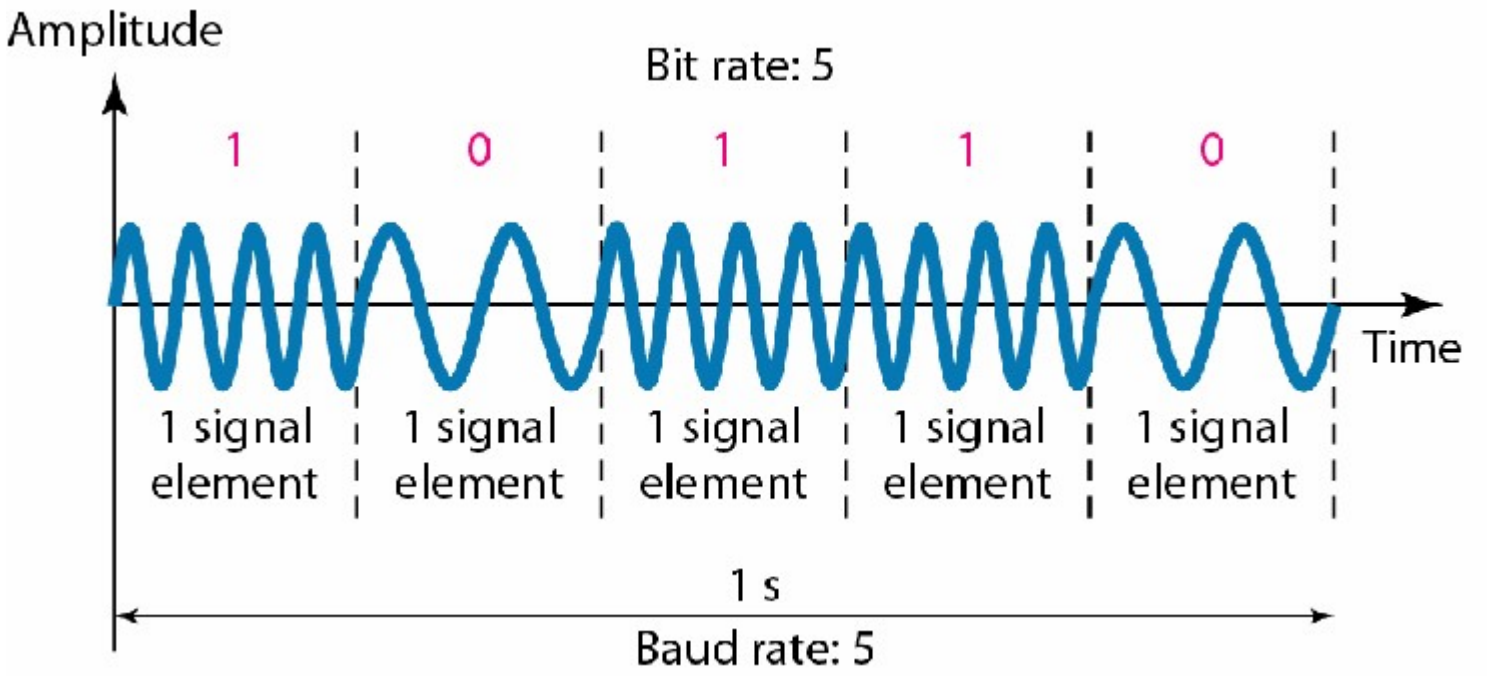
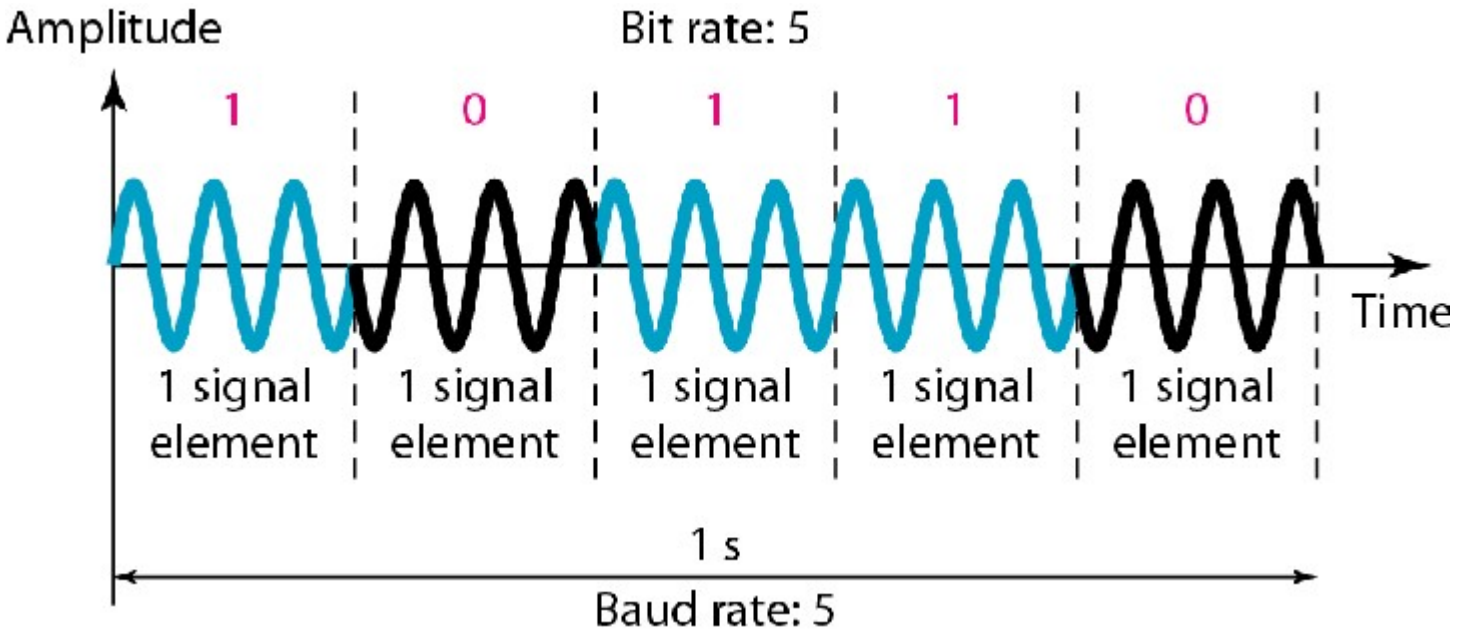


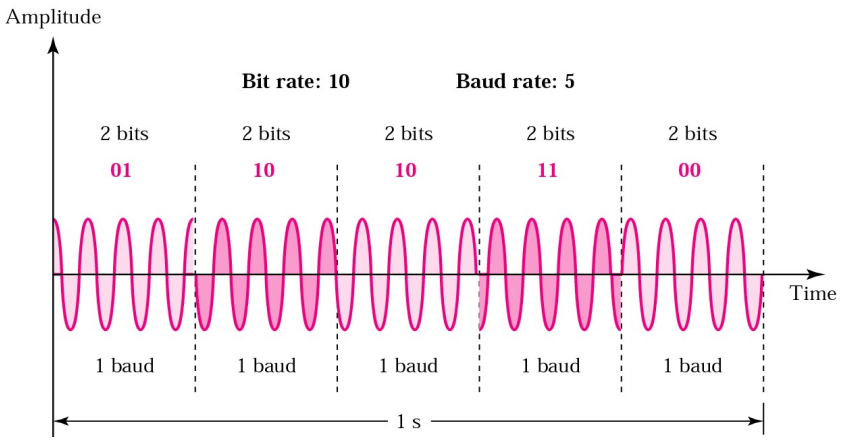
Figure 5.9 *Binary phase shift keying*



1 with a phase of 0°, and the other with a phase of 180°

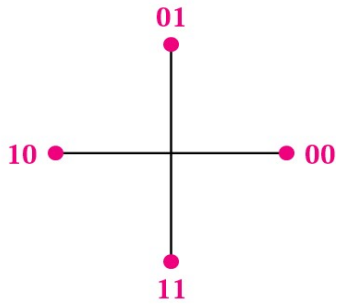
The 4-PSK and 8-PSK methods

4-PSK



Dibit	Phase
00	0
01	90
10	180
11	270

Dibit
(2 bits)

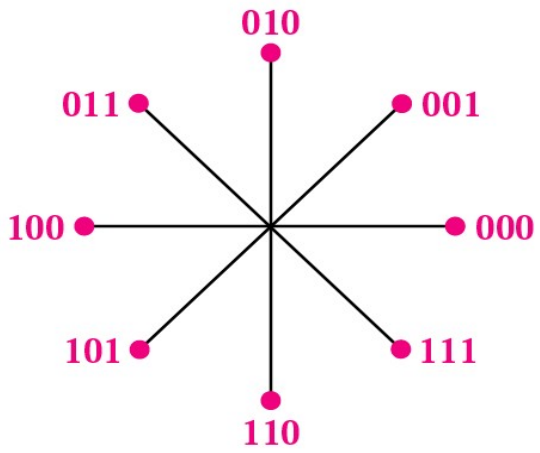


Constellation diagram

8-PSK

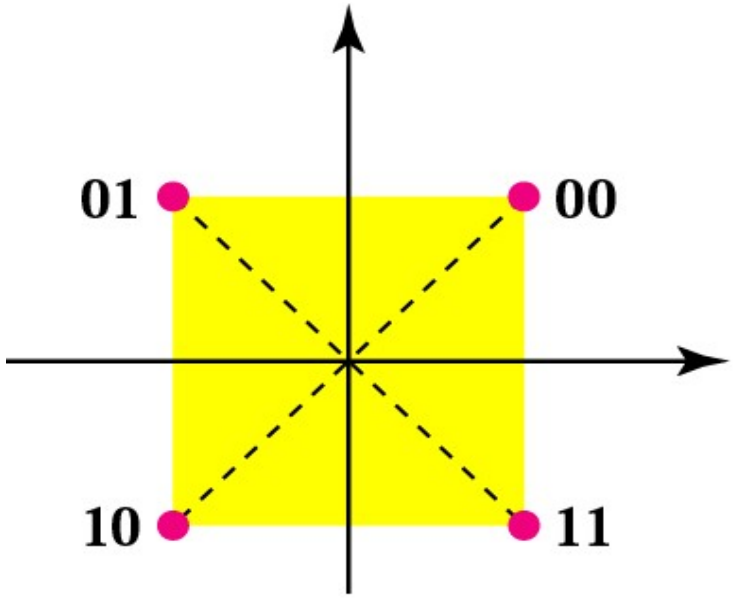
Tribit	Phase
000	0
001	45
010	90
011	135
100	180
101	225
110	270
111	315

Tribits
(3 bits)

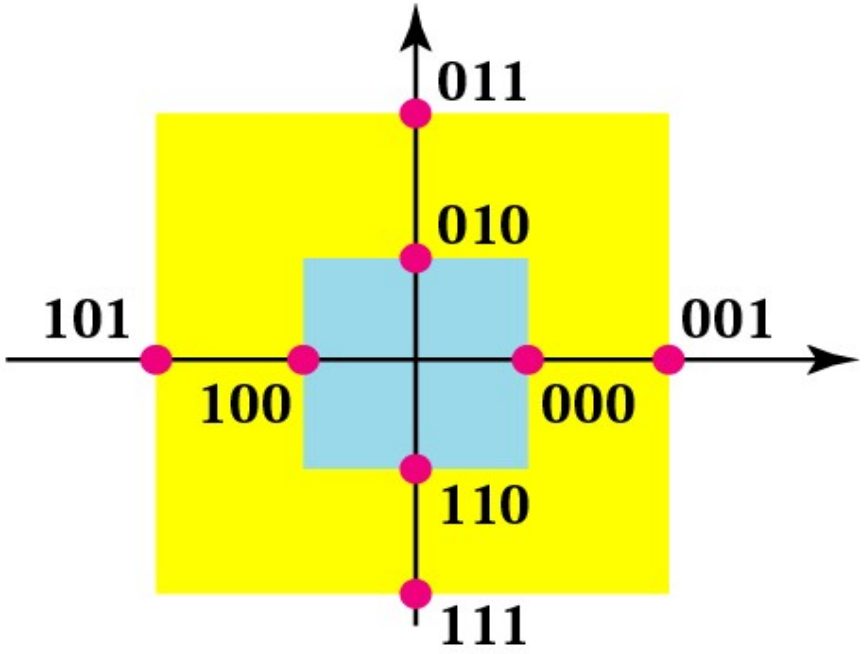


Constellation diagram

Quadrature amplitude modulation is a combination of ASK and PSK.

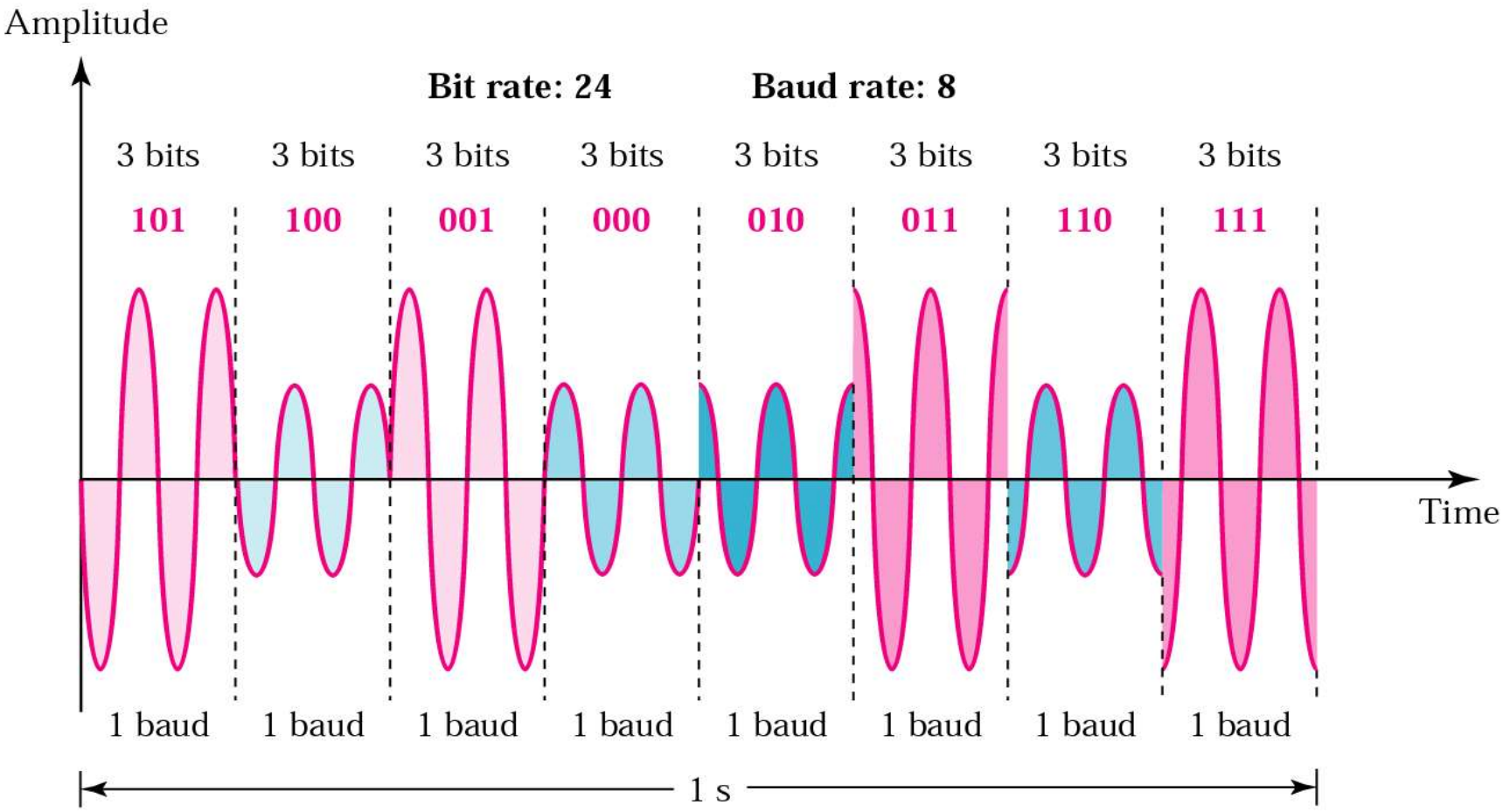


4-QAM
1 amplitude, 4 phases



8-QAM
2 amplitudes, 4 phases

Time domain for an 8-QAM signal



5-2 ANALOG-TO-ANALOG CONVERSION

Analog-to-analog conversion is the representation of analog information by an analog signal. One may ask why we need to modulate an analog signal; it is already analog. Modulation is needed if the medium is bandpass in nature or if only a bandpass channel is available to us.

Topics discussed in this section:

Amplitude Modulation
Frequency Modulation
Phase Modulation

Analog-to-analog modulation

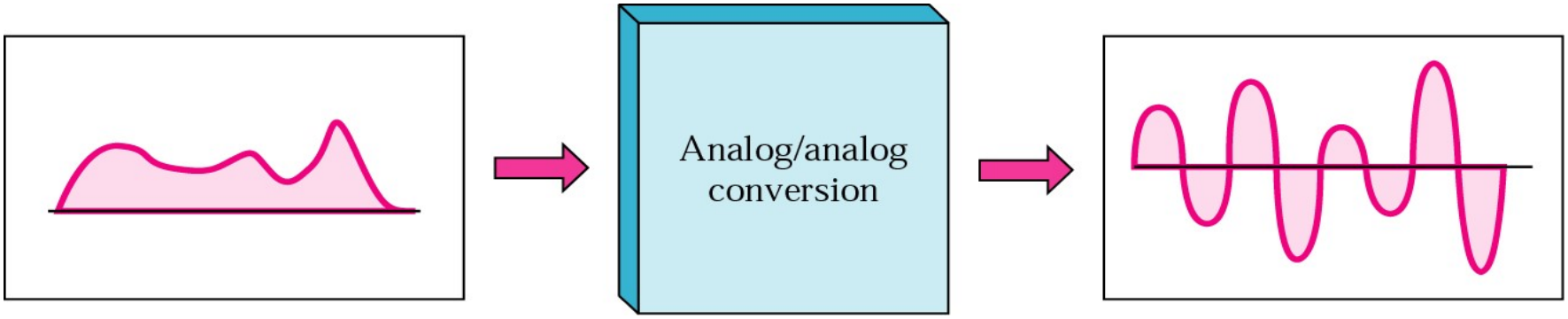


Figure 5.15 *Types of analog-to-analog modulation*

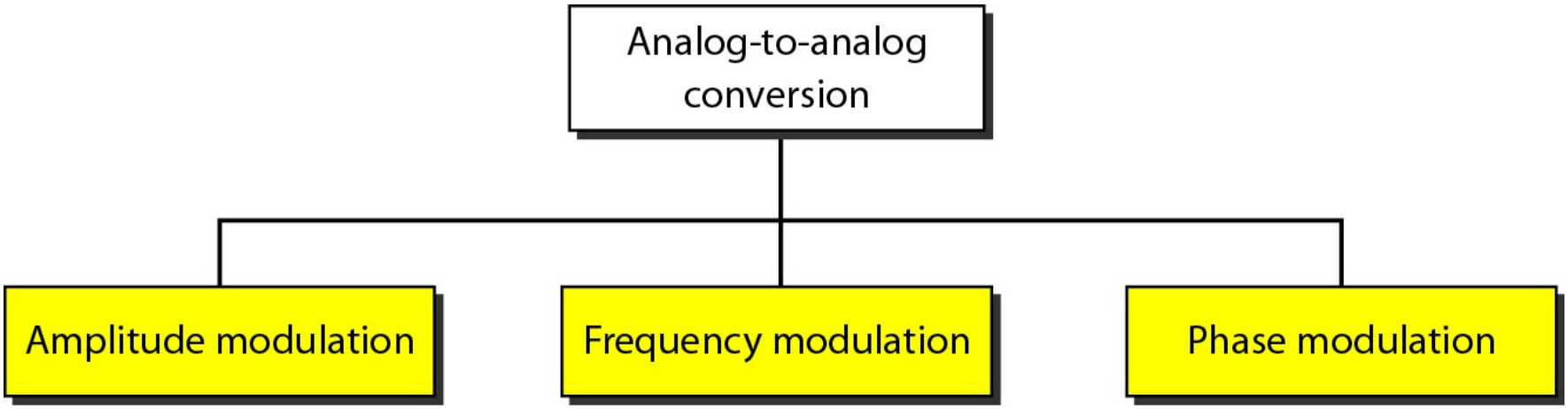


Figure 5.16 *Amplitude modulation*

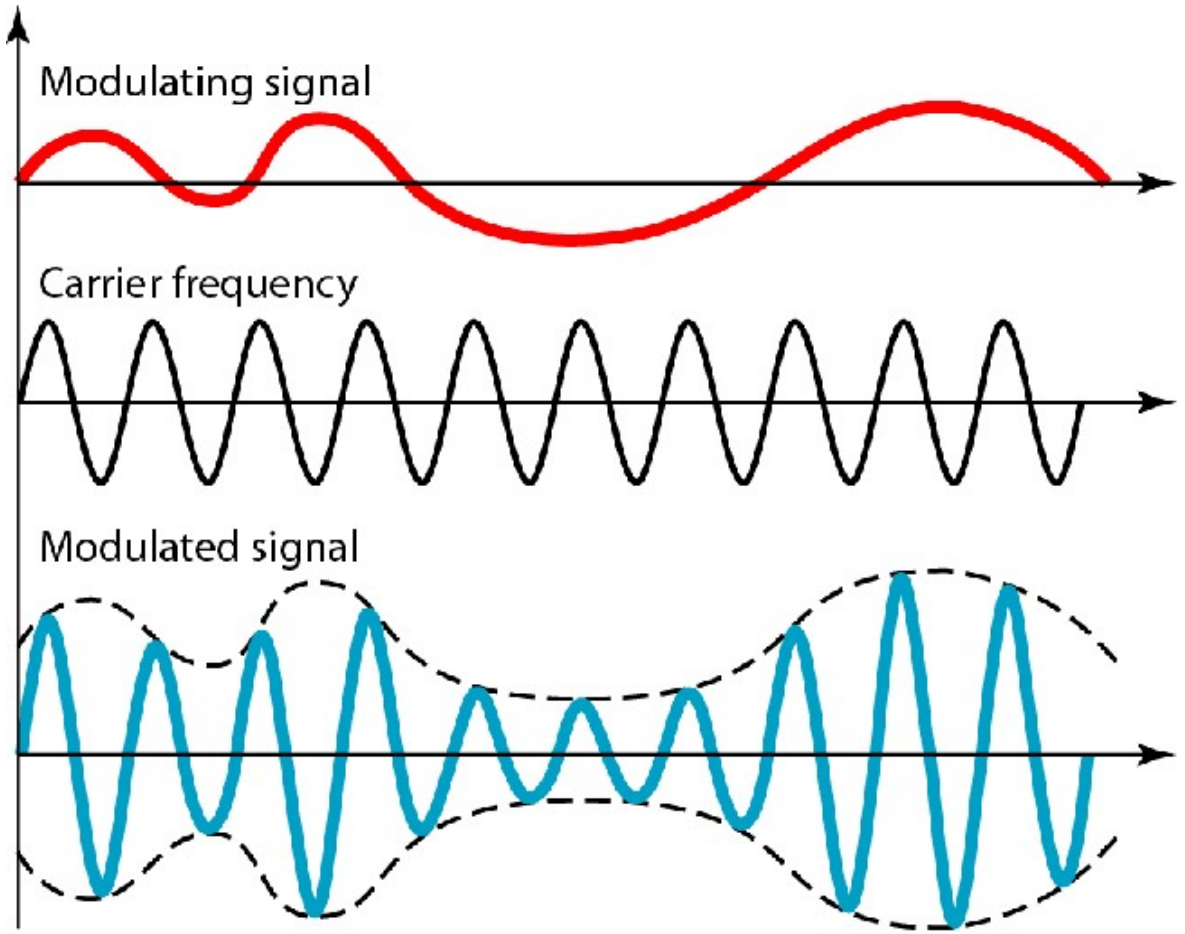


Figure 5.18 *Frequency modulation*

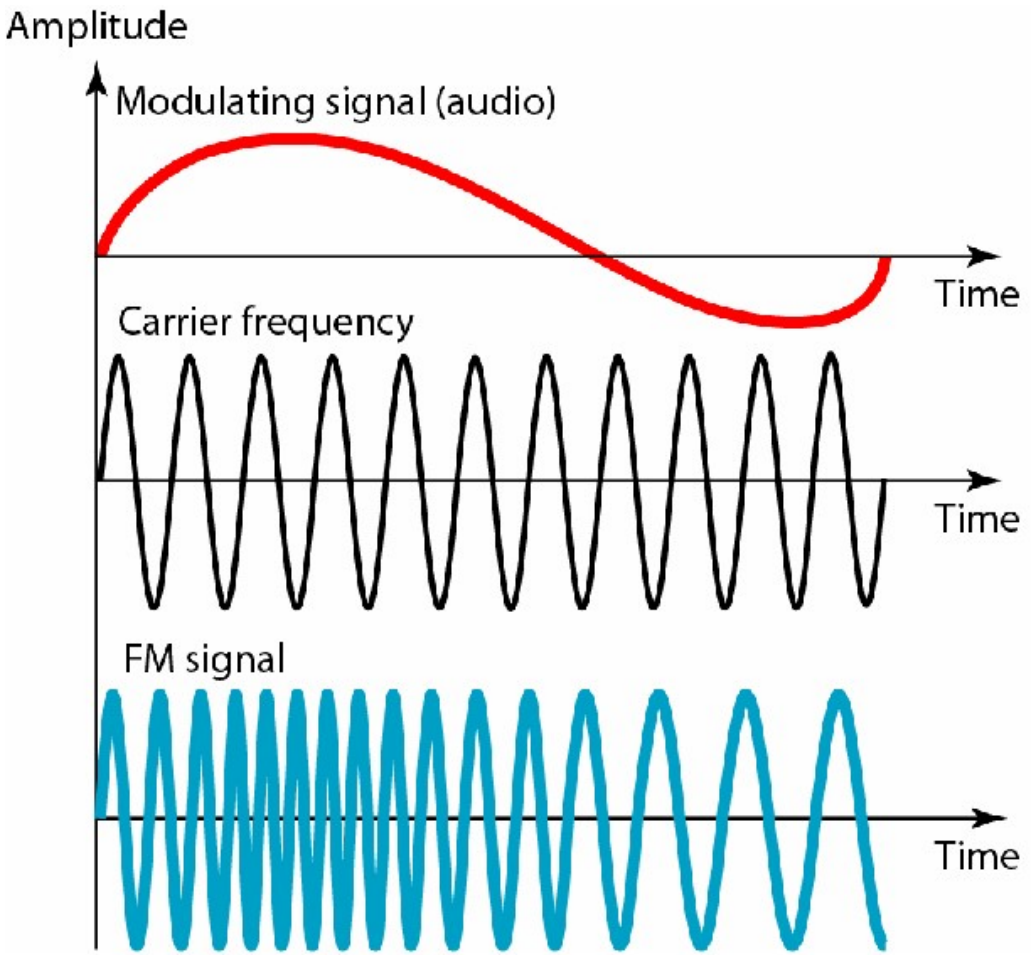


Figure 5.20 *Phase modulation*