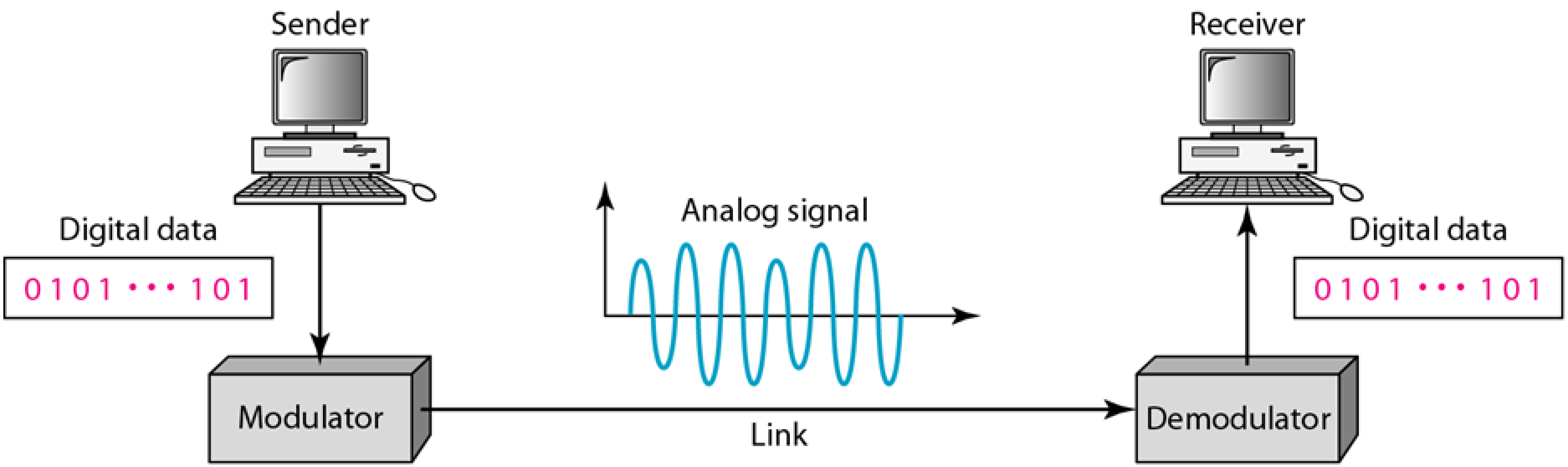
CSE320: Data Communication

Chapter 5

Analog Transmission

Figure 5.1 *Digital-to-analog conversion*



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.

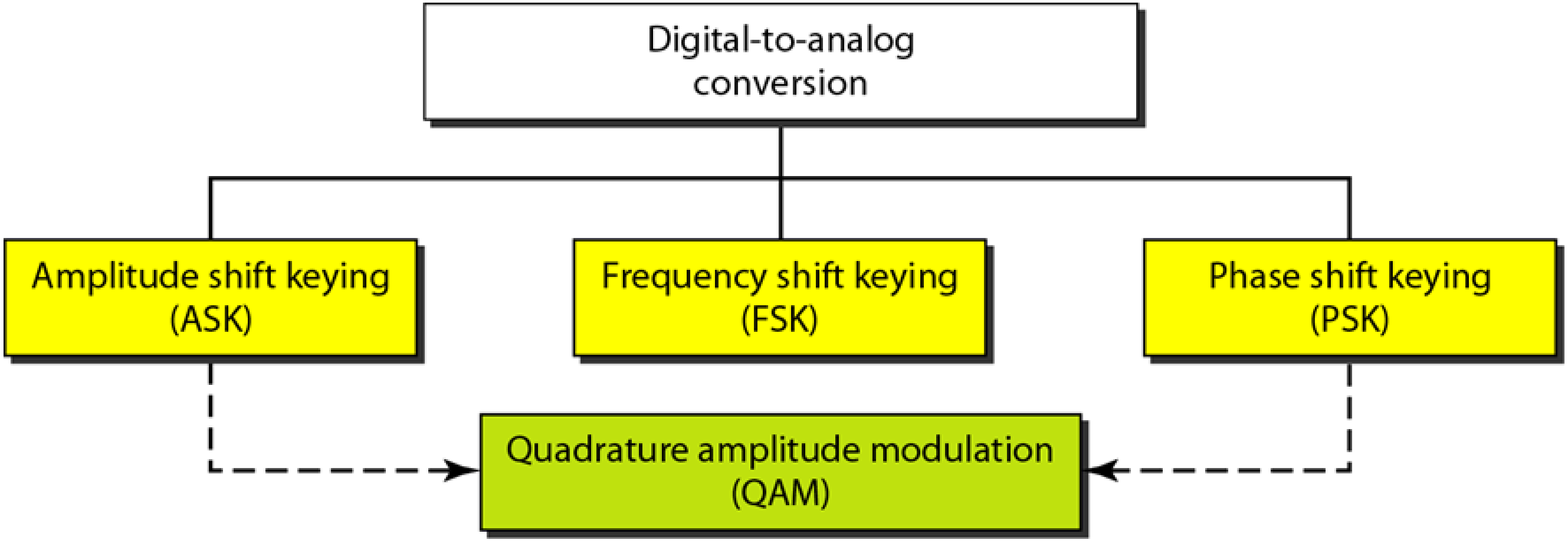
Topics discussed in this section:

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

Digital to Analog Conversion

- Digital data needs to be carried on an analog signal.
- A carrier signal (frequency f_c) performs the function of transporting the digital data in an analog waveform.
- The analog carrier signal is manipulated to uniquely identify the digital data being carried.

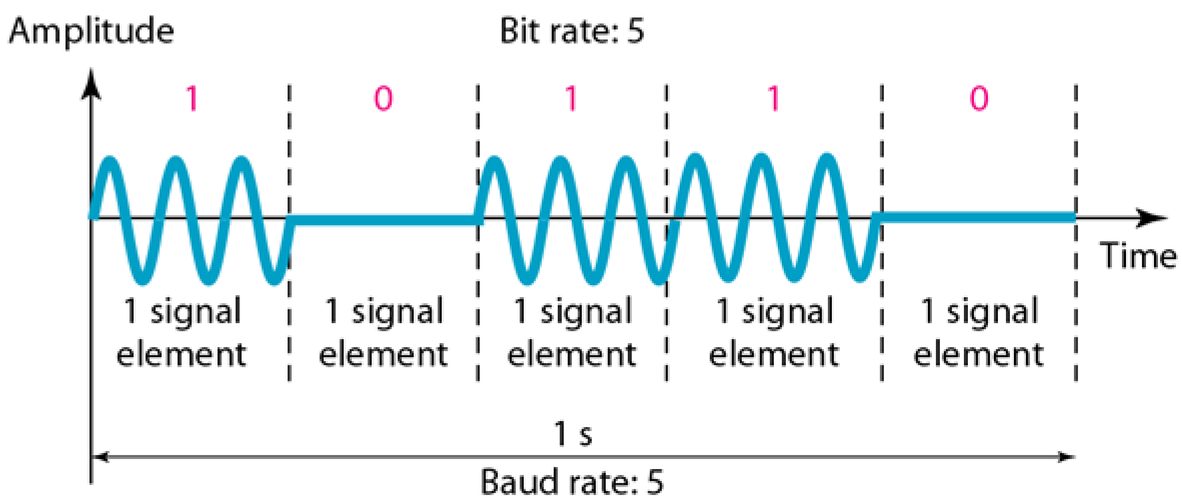
Figure 5.2 *Types of digital-to-analog conversion*



Amplitude Shift Keying (ASK)

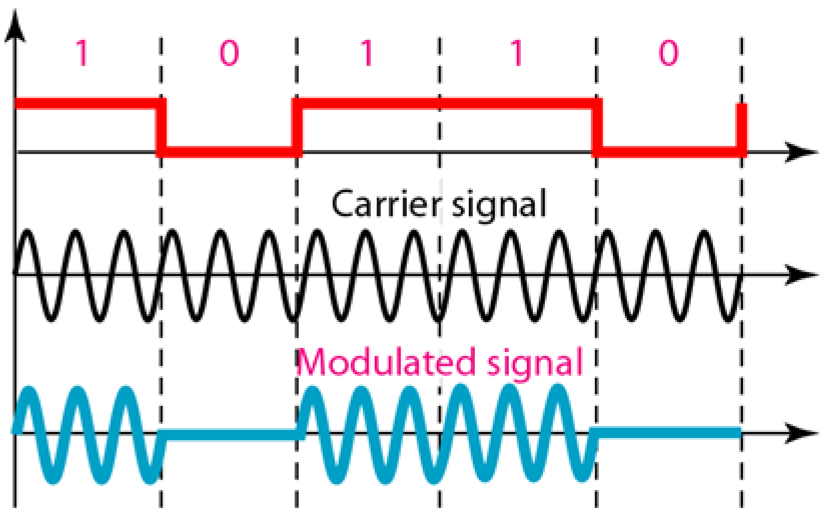
- ASK is implemented by changing the amplitude of a carrier signal to reflect amplitude levels in the digital signal.
- For example: a digital “1” could not affect the signal, whereas a digital “0” would, by making it zero.
- The line encoding will determine the values of the analog waveform to reflect the digital data being carried.

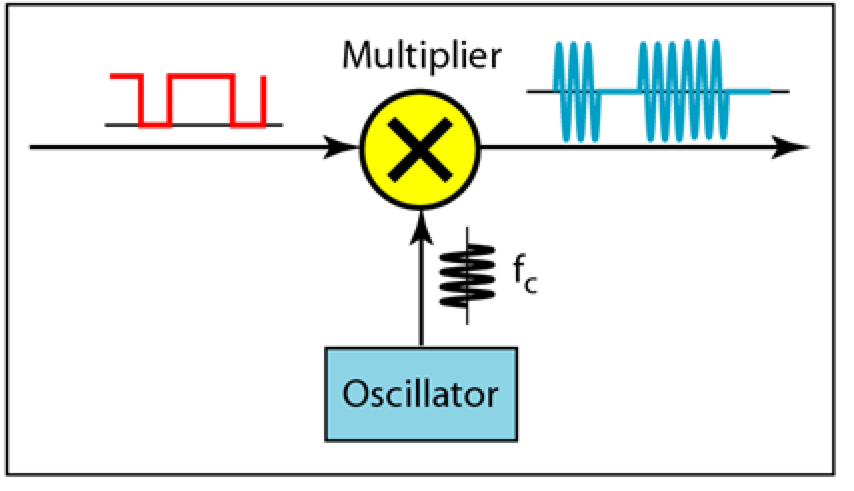
Figure 5.3 *Binary amplitude shift keying*



Also known as On Off Keying (OOK)

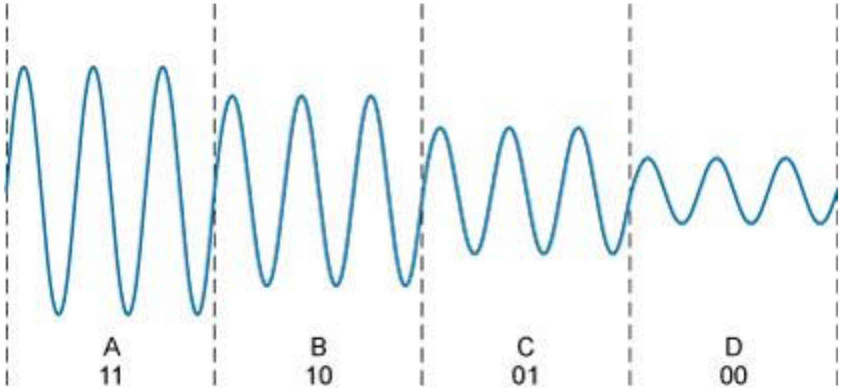
Figure 5.4 *Implementation of binary ASK*





Multi level ASK

- ASK can use multiple bits per signal element.

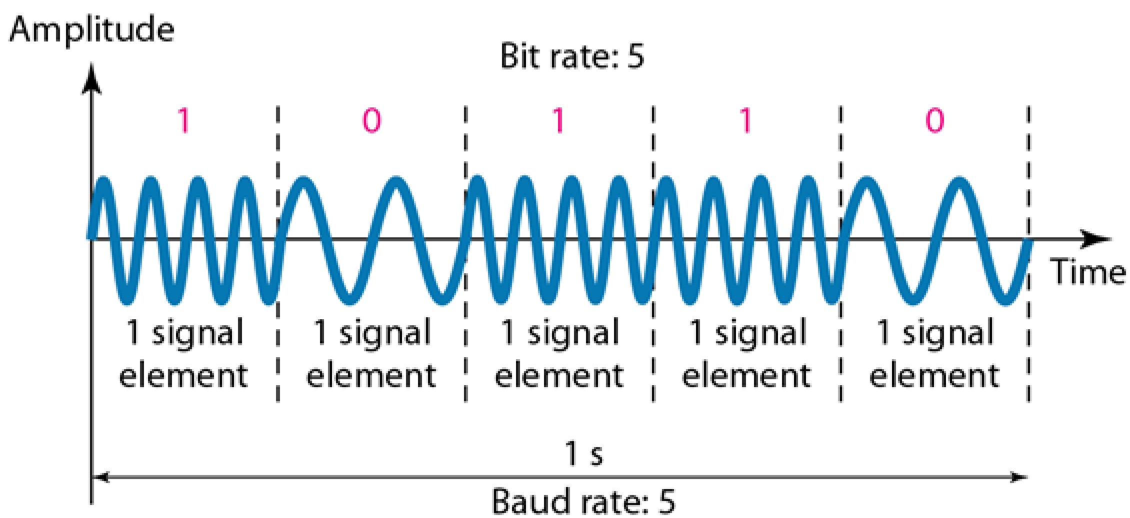


Frequency Shift Keying

- The digital data stream changes the frequency of the carrier signal, f_c.

- For example, a "1" could be represented by $f_1=f_c+\Delta f$, and a "0" could be represented by $f_2=f_c-\Delta f$.

Figure 5.6 *Binary frequency shift keying*

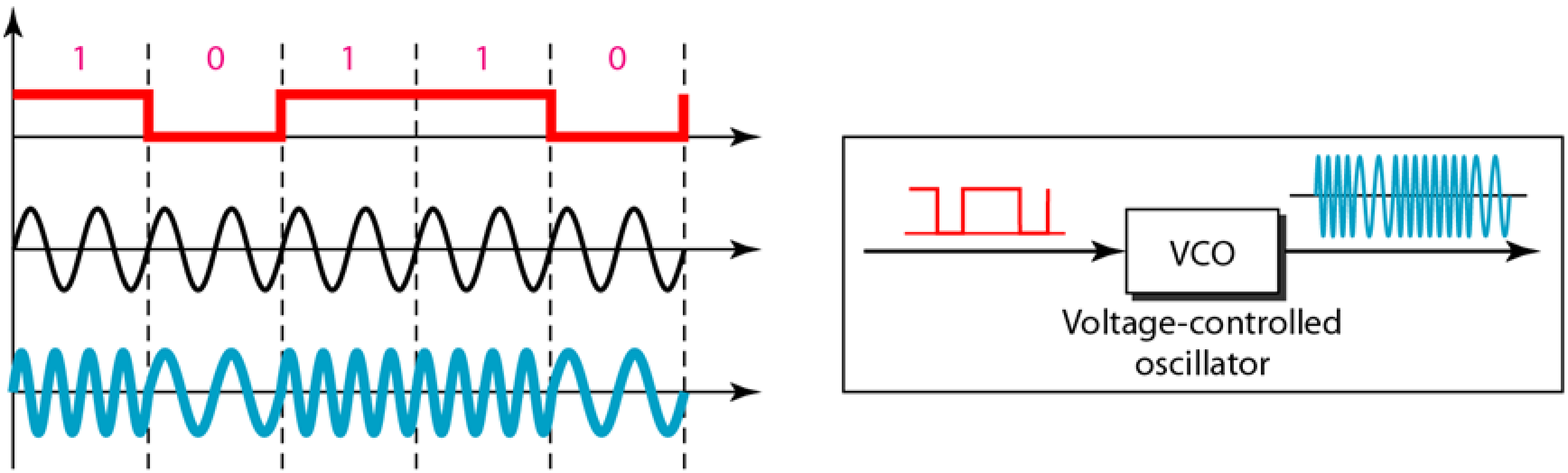


Coherent and Non Coherent

- In a non-coherent FSK scheme, when we change from one frequency to the other, we do not adhere to the current phase of the signal.

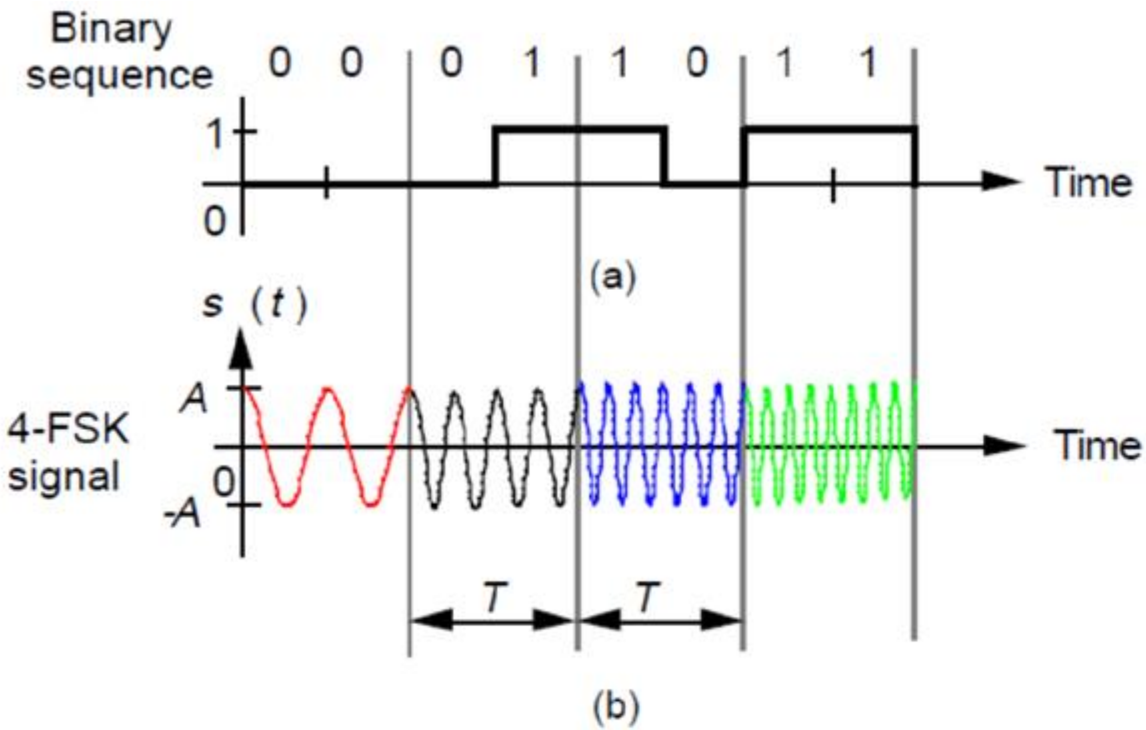
- In coherent FSK, the switch from one frequency signal to the other only occurs at the same phase in the signal.

Figure 5.7 *Bandwidth of MFSK used in Example 5.6*



Multi level FSK

- Like ASK, FSK can use multiple bits per signal element.



Phase Shift Keying

- We vary the phase shift of the carrier signal to represent digital data.
- PSK is much more robust than ASK as it is not that vulnerable to noise, which changes amplitude of the signal.

Figure 5.9 *Phase shift keying*

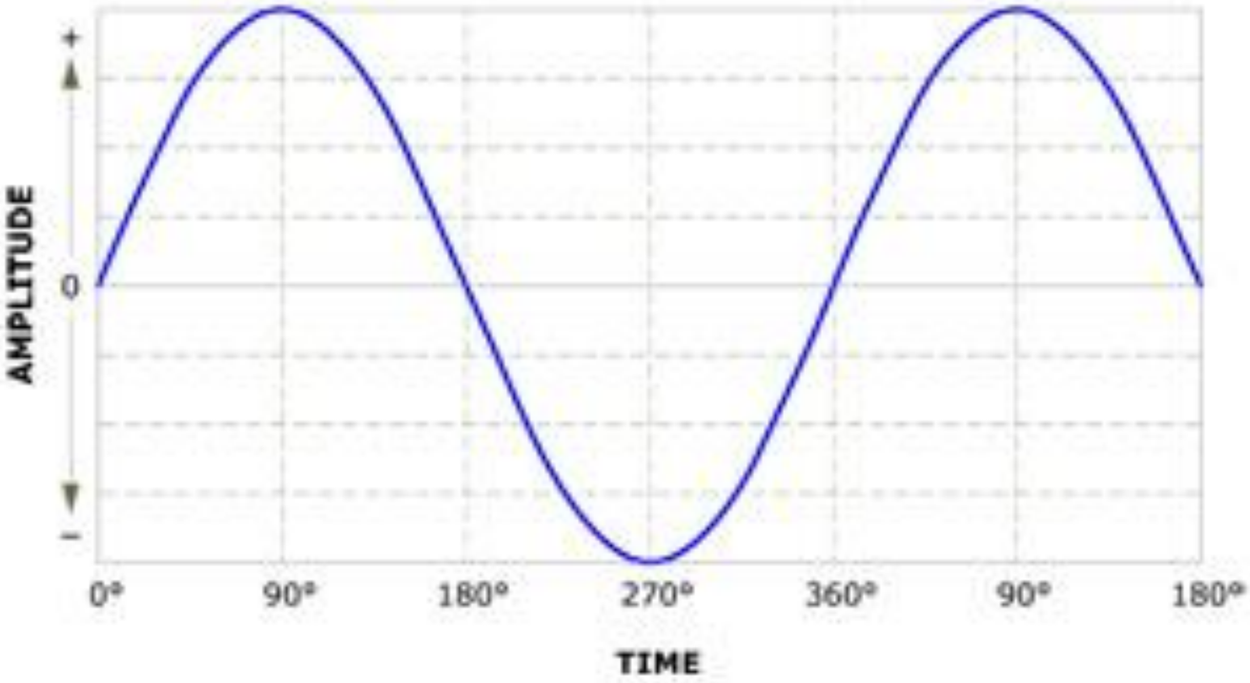


Figure 5.9 *Binary phase shift keying*

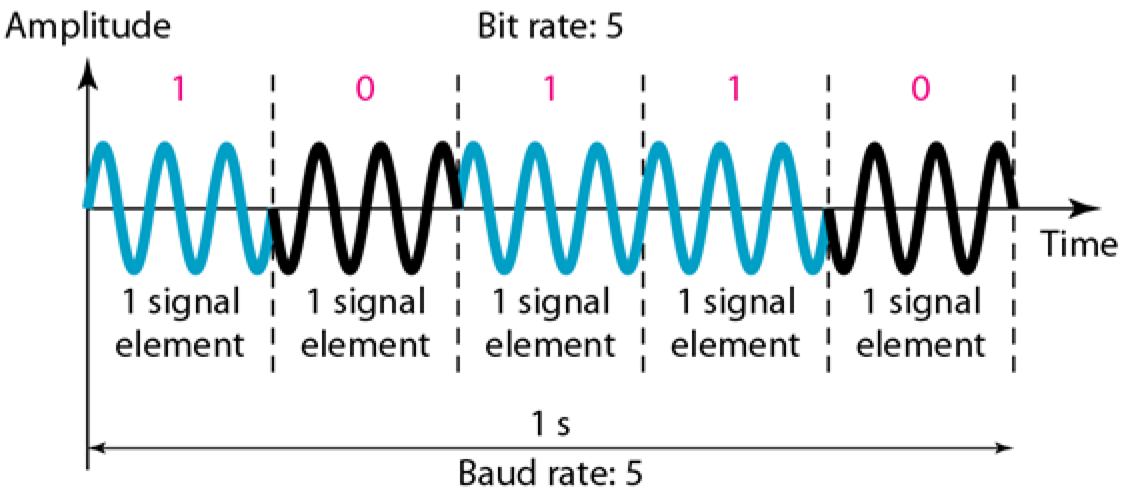
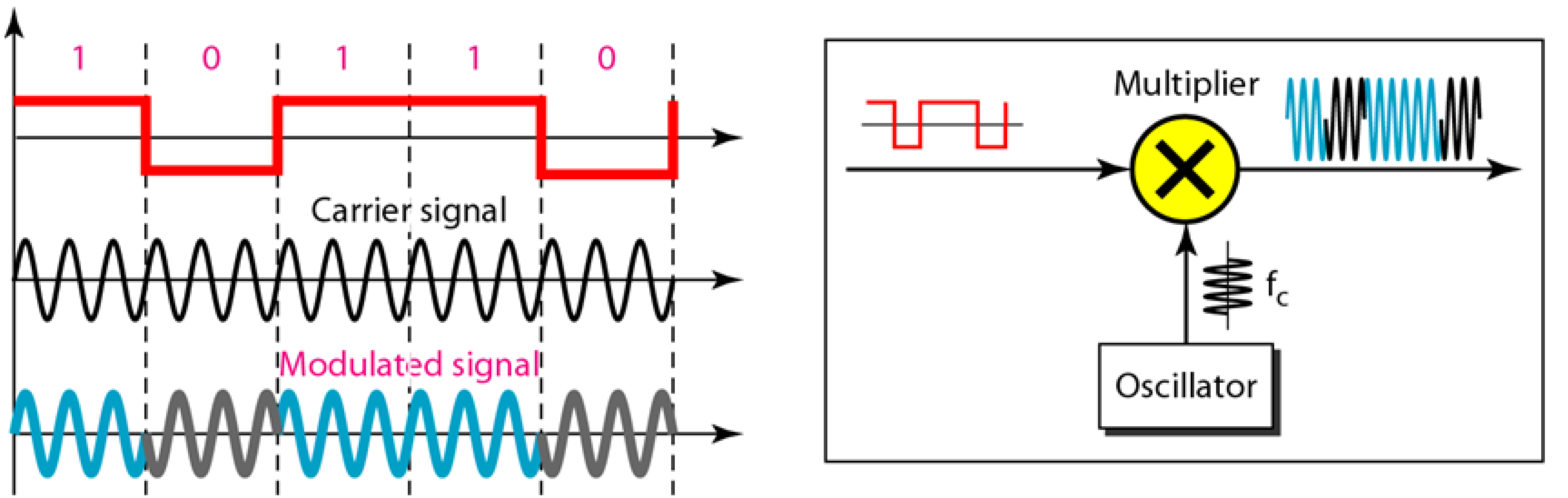


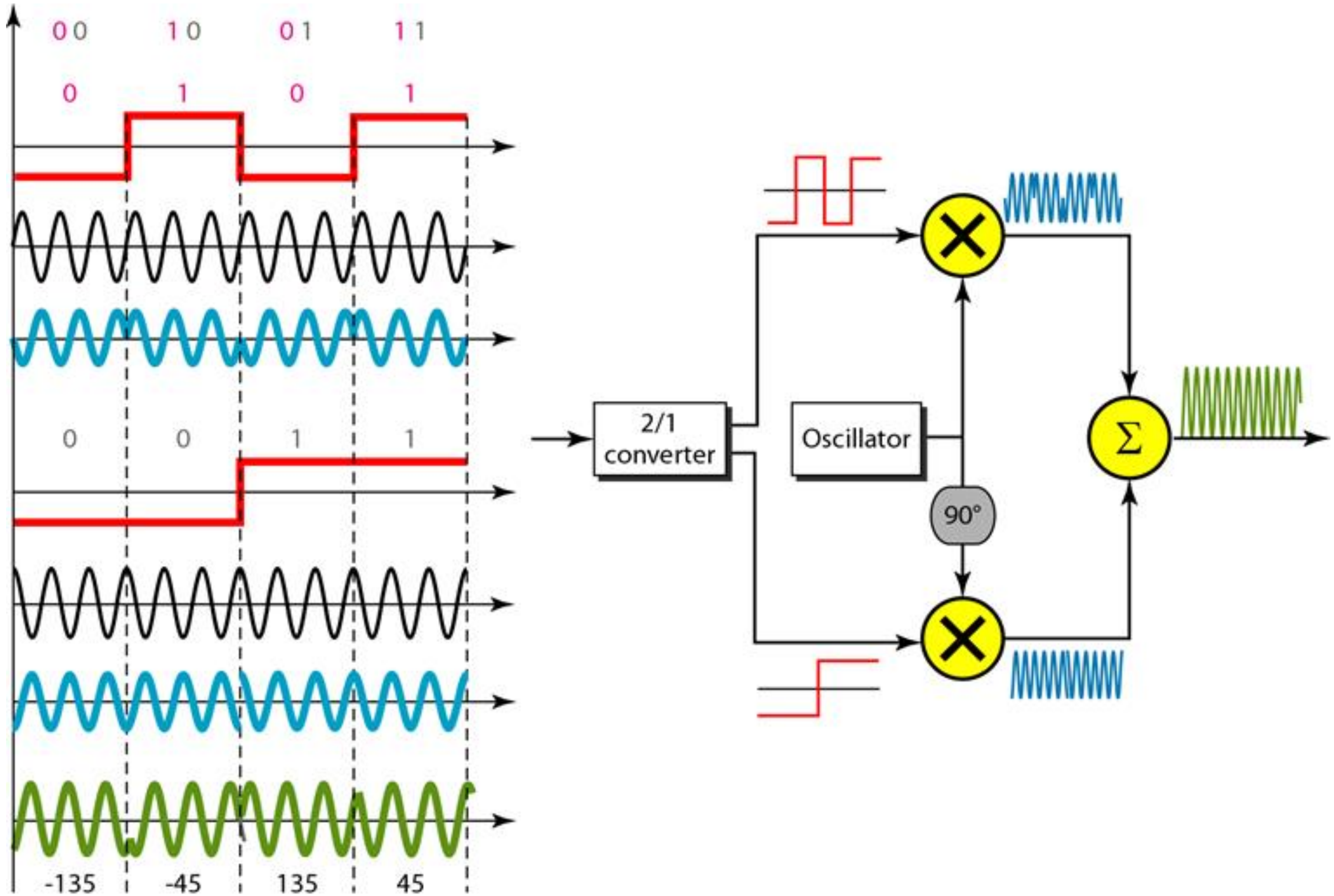
Figure 5.10 *Implementation of BPSK*



Quadrature PSK

- To increase the bit rate, we can code 2 or more bits onto one signal element.
- In QPSK, we parallelize the bit stream so that every two incoming bits are split up and PSK a carrier frequency. One carrier frequency is phase shifted 90^o from the other - in quadrature.
- The two PSKed signals are then added to produce one of 4 signal elements. L = 4 here.

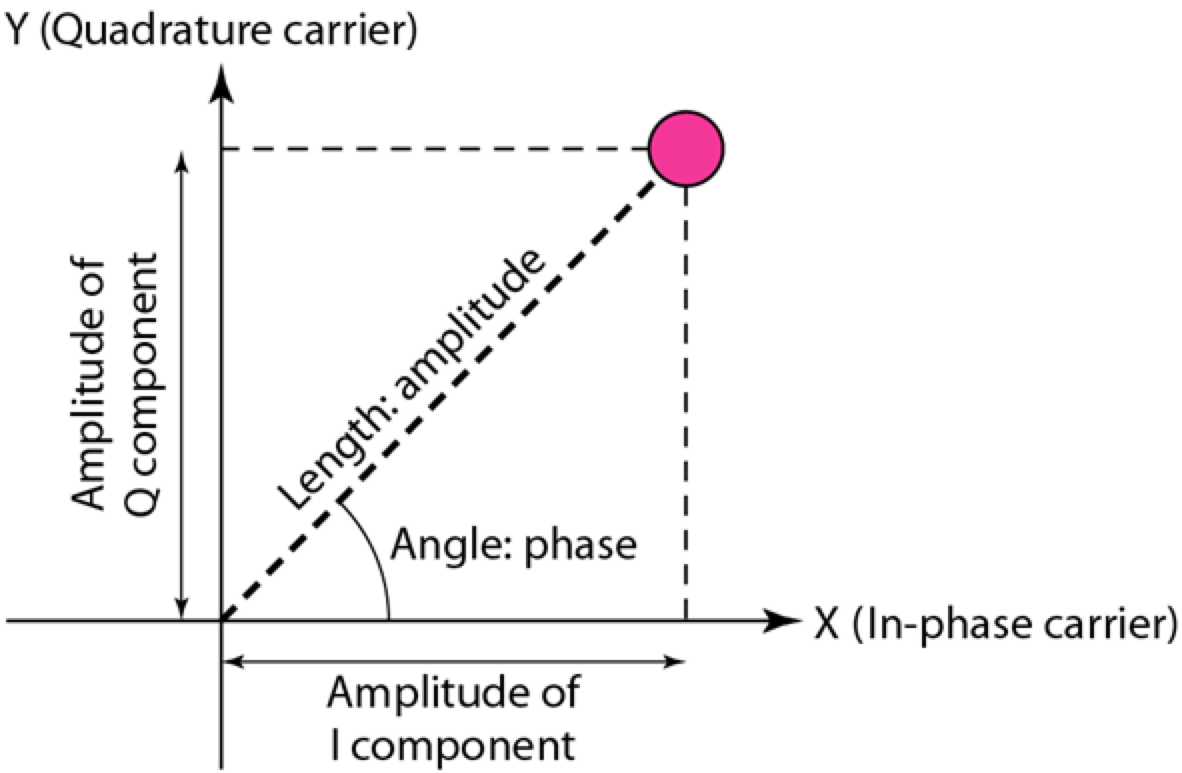
Figure 5.11 *QPSK and its implementation*



Constellation Diagrams

- A constellation diagram helps us to define the amplitude and phase of a signal when we are using two carriers, one in quadrature of the other.
- The X-axis represents the in-phase carrier and the Y-axis represents quadrature carrier.

Figure 5.12 *Concept of a constellation diagram*

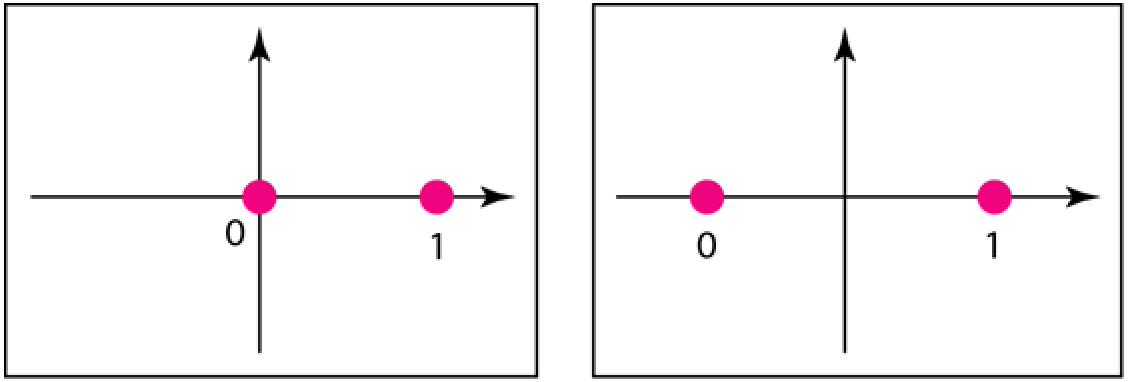


Example 5.8

Show the constellation diagrams for an ASK (OOK), BPSK, and QPSK signals.

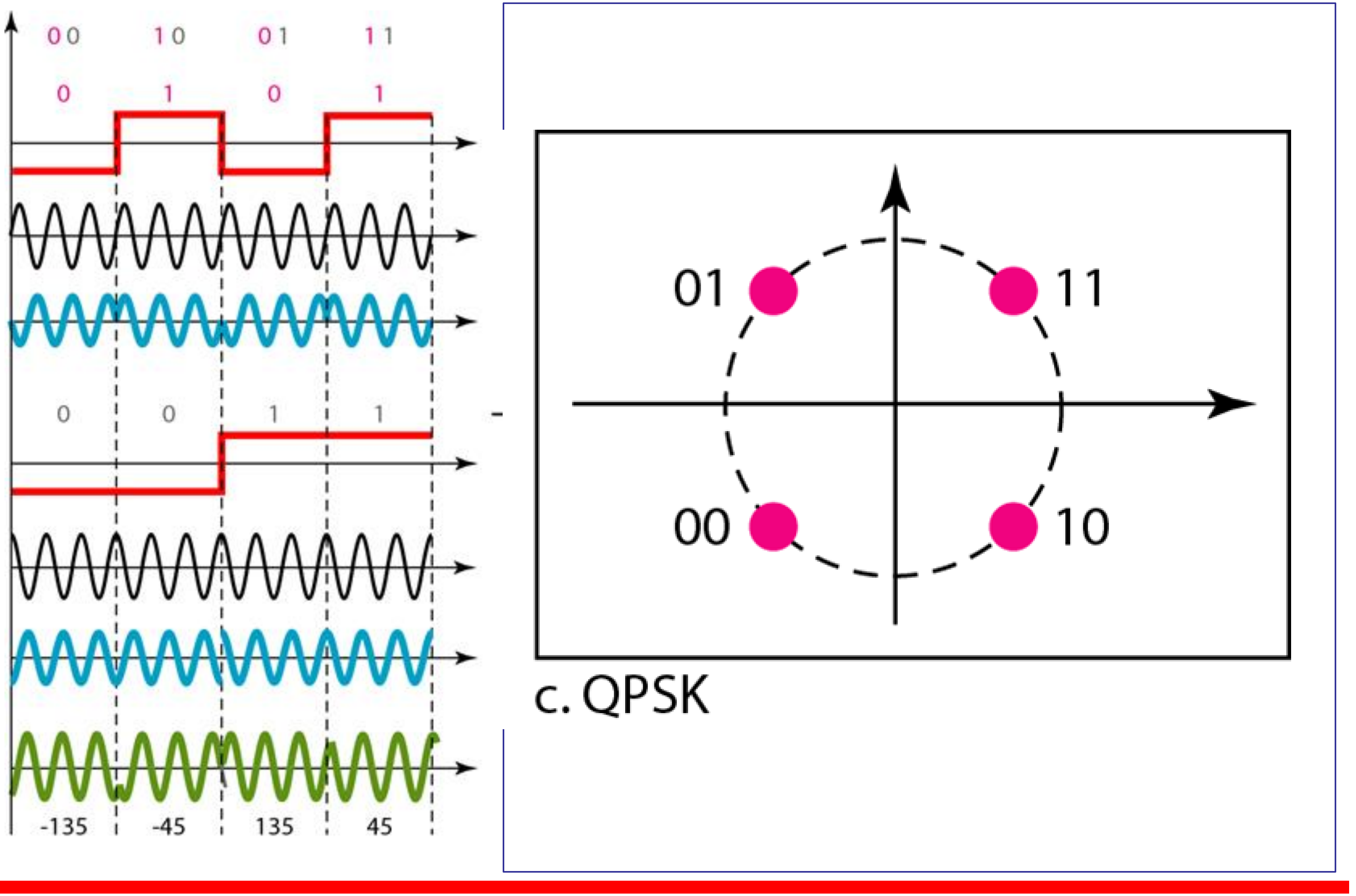
Solution

Figure 5.13 shows the three constellation diagrams.



a. ASK (OOK)   b. BPSK

Figure 5.11 ***QPSK and its implementation***



Note

Quadrature amplitude modulation is a combination of ASK and PSK.

Figure 5.14 *Constellation diagrams for some QAMs*