Data Communication

Analog Transmission

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.

- 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.

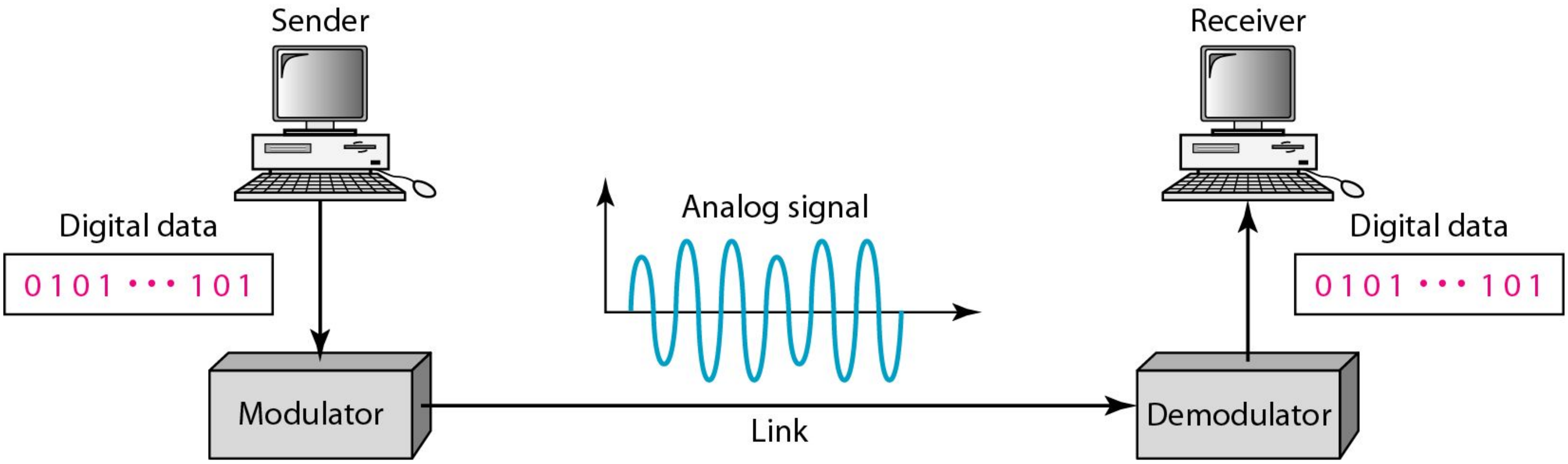


Figure 5.1 ***Digital-to-analog conversion***

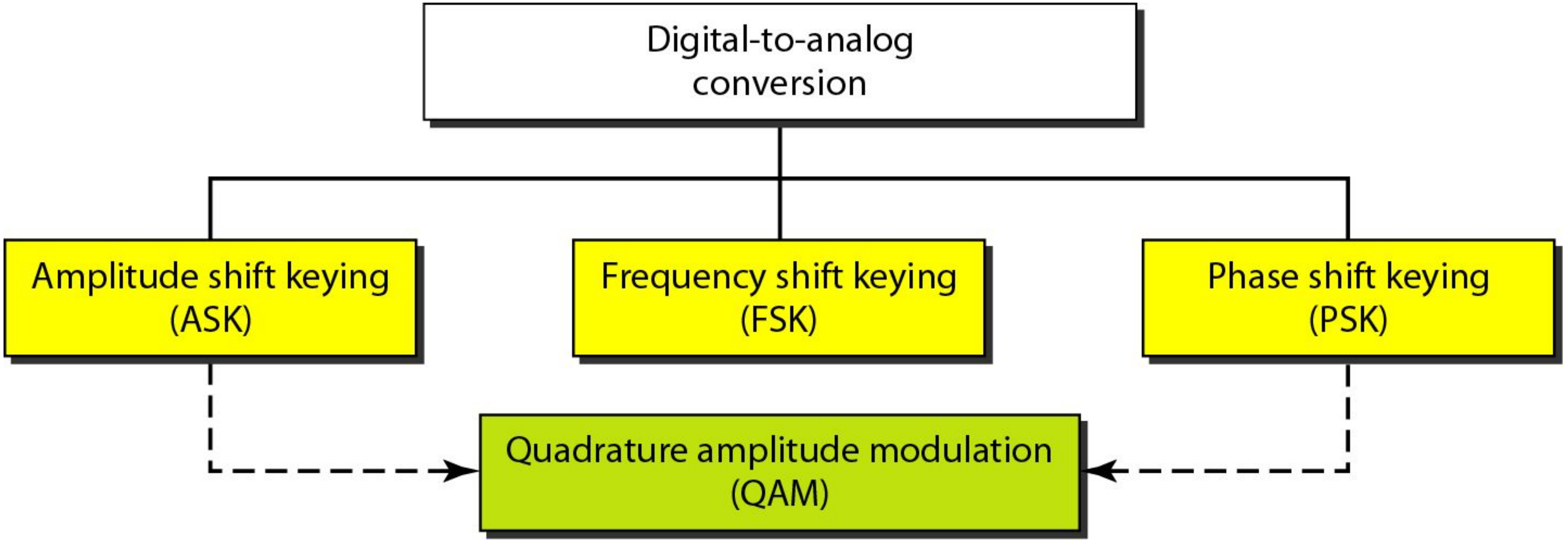


Figure 5.2 ***Types of digital-to-analog conversion***

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. It gives a **zero** value for **Low** input while it gives the **carrier output** for **High** input

- 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*

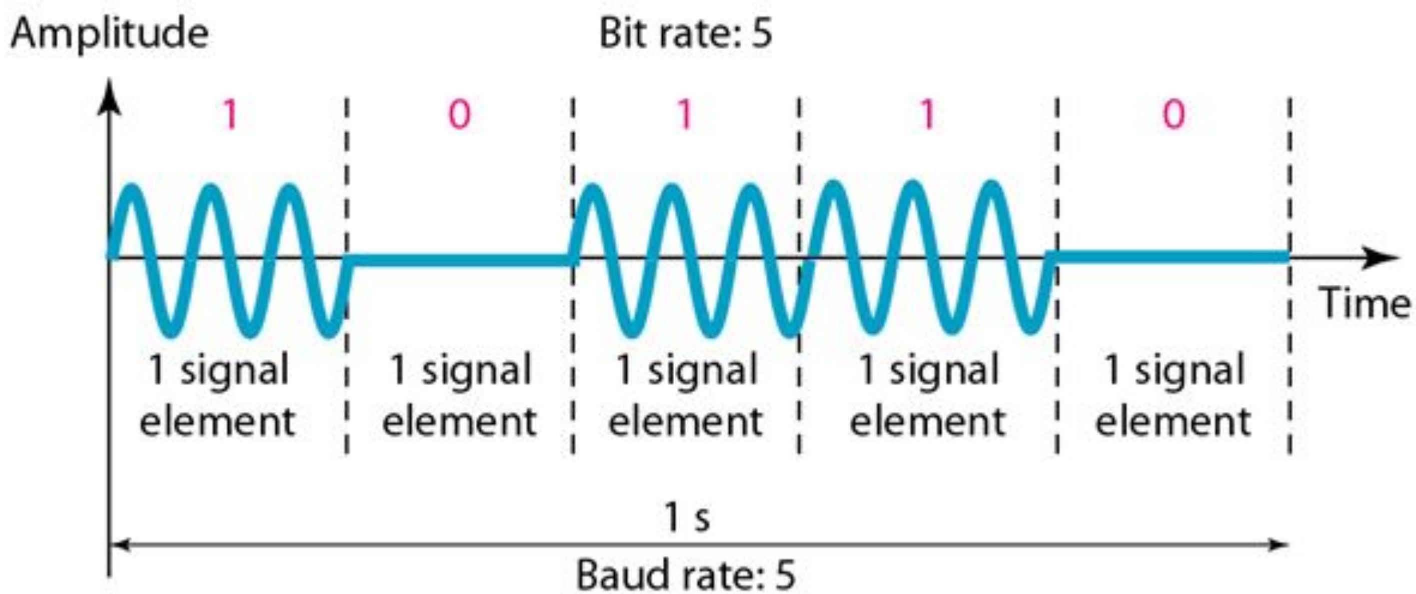
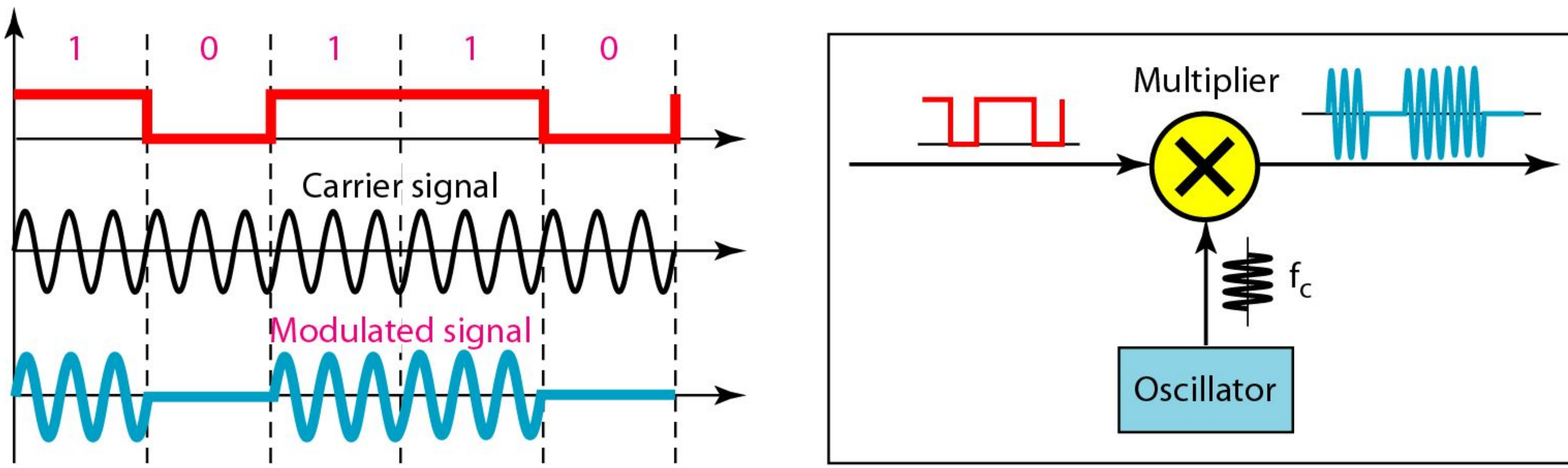


Figure 5.4 *Implementation of binary ASK*

1

ASK
1 = Frequency
0 = No Frequency



Frequency Shift Keying

- FSK is the digital modulation technique in which the frequency of the carrier signal, , f_c varies according to the digital signal changes. FSK is a scheme of frequency modulation.

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

- The output frequency of a FSK modulated wave is high for a binary High input and is low in for a binary Low input. The binary 1s and 0s are called Mark and Space frequencies.

Figure 5.6 ***Binary frequency shift keying***

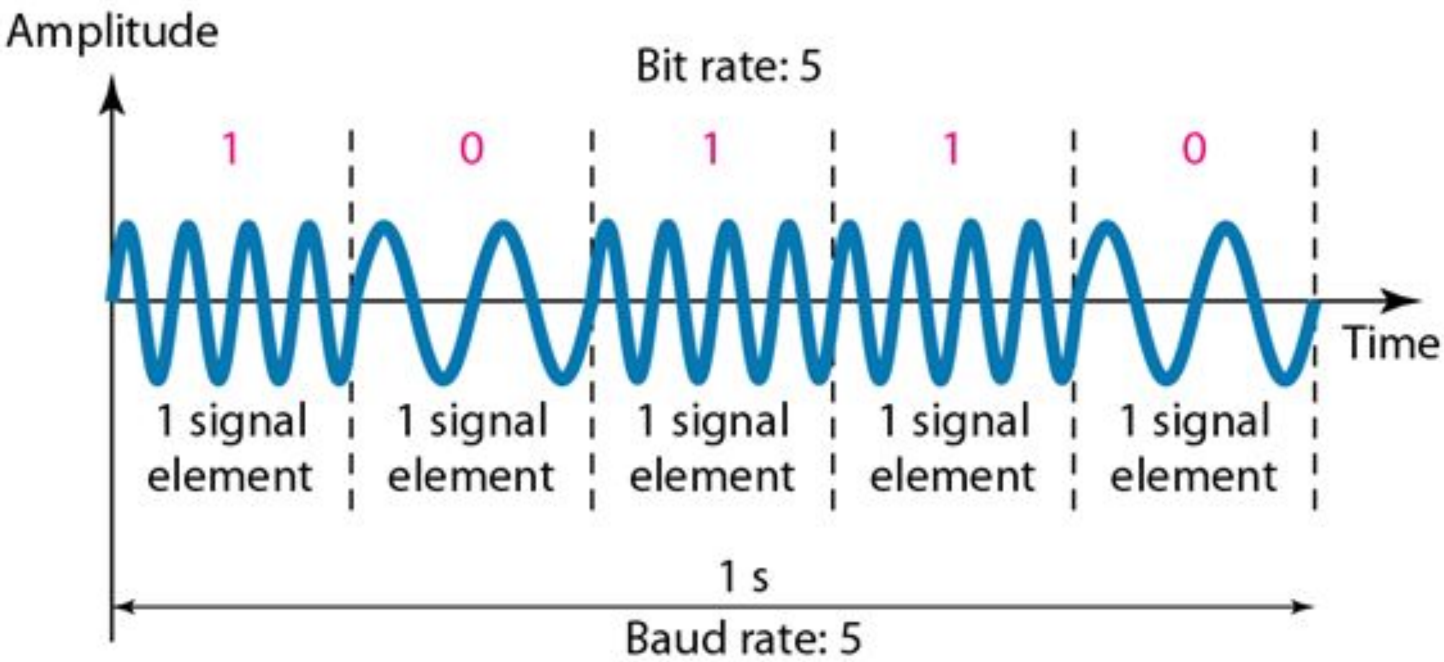
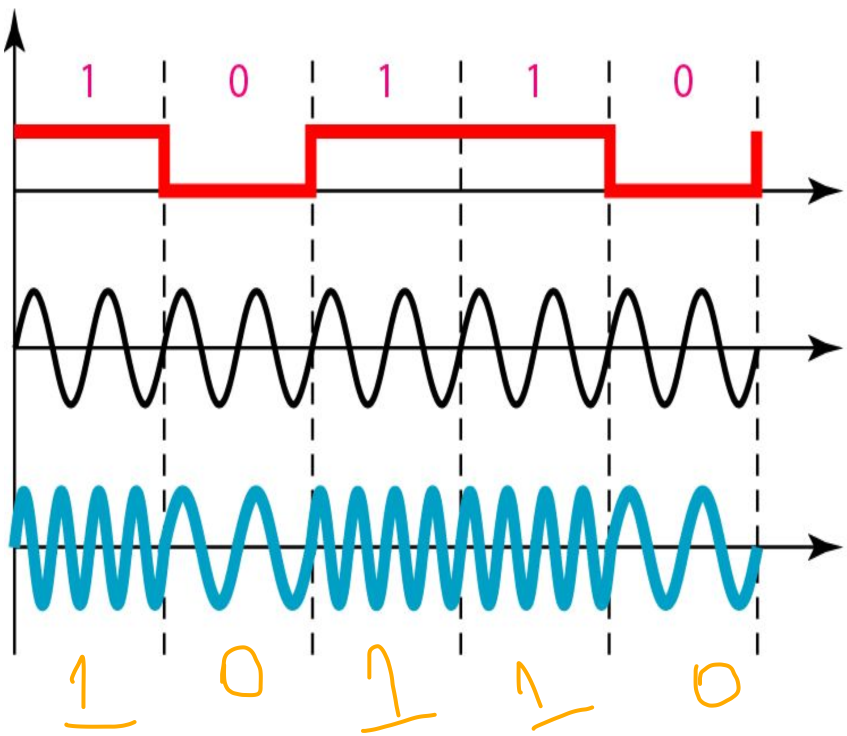
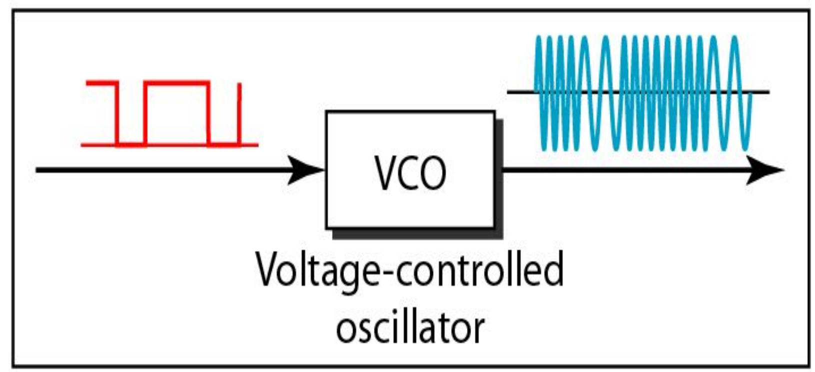


Figure 5.7 *Implementation of BFSK*

2



BFSK
1 = High Frequency
0 = Low Frequency



Phase Shift Keying

- ***PSK*** is the digital modulation technique in which the phase of the carrier signal is changed by varying the sine and cosine inputs at a particular time.

- PSK technique is widely used for wireless LANs, bio-metric, contactless operations, along with RFID and Bluetooth communications. PSK is much more robust than ASK as it is not that vulnerable to noise, which changes amplitude of the signal.

Binary Phase Shift Keying

In this technique, the sine wave carrier takes two phase reversals such as 0° and 180°.

Phase 180 degree means Opposite wave.

Figure 5.9 *Binary phase shift keying*

In this technique, the sine wave carrier takes two phase reversals such as 0° and 180°.

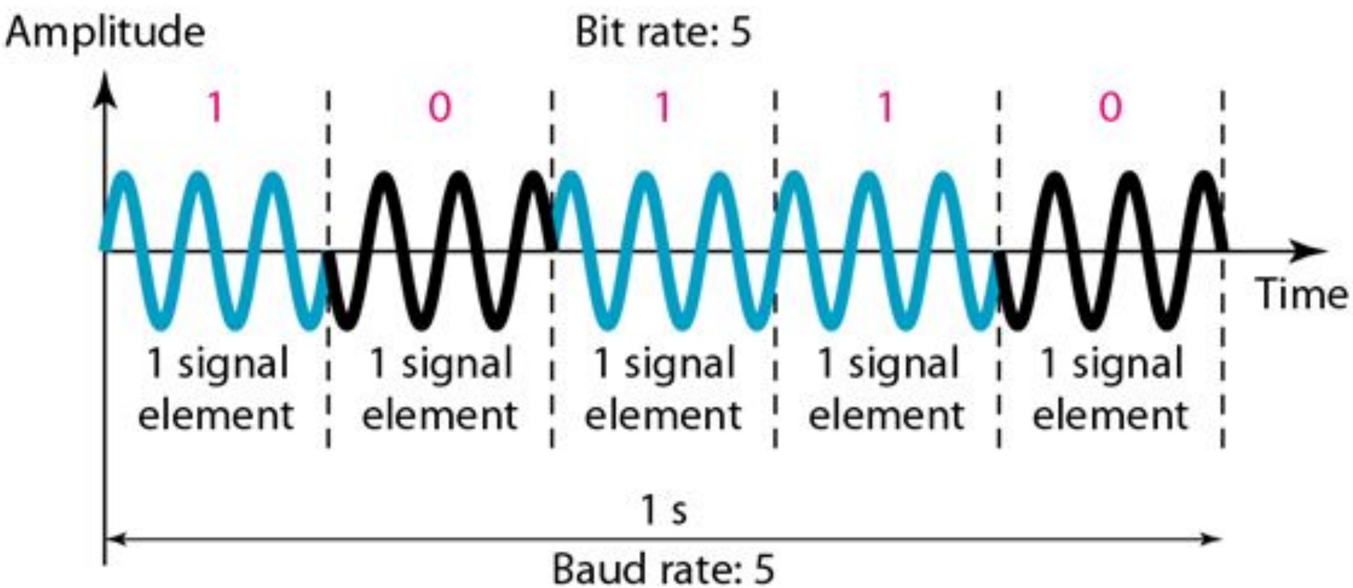
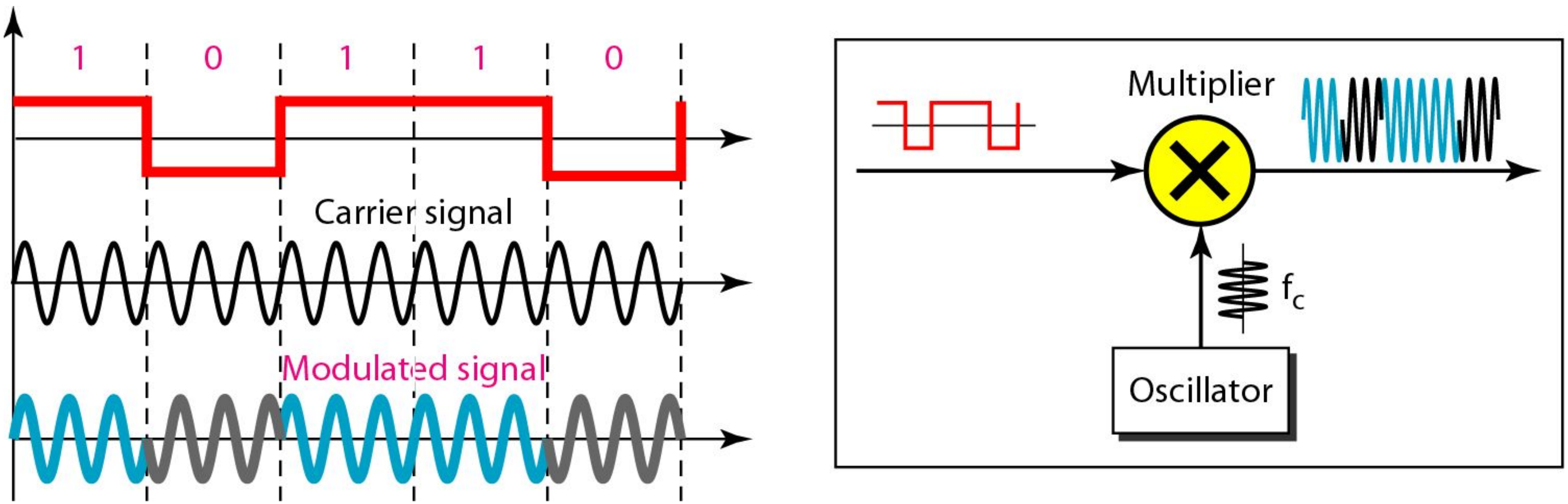


Figure 5.10 *Implementation of BPSK*

3

BPSK
1 = Positive Frequency (0 degree)
0 = Negative Frequency (180 degree)

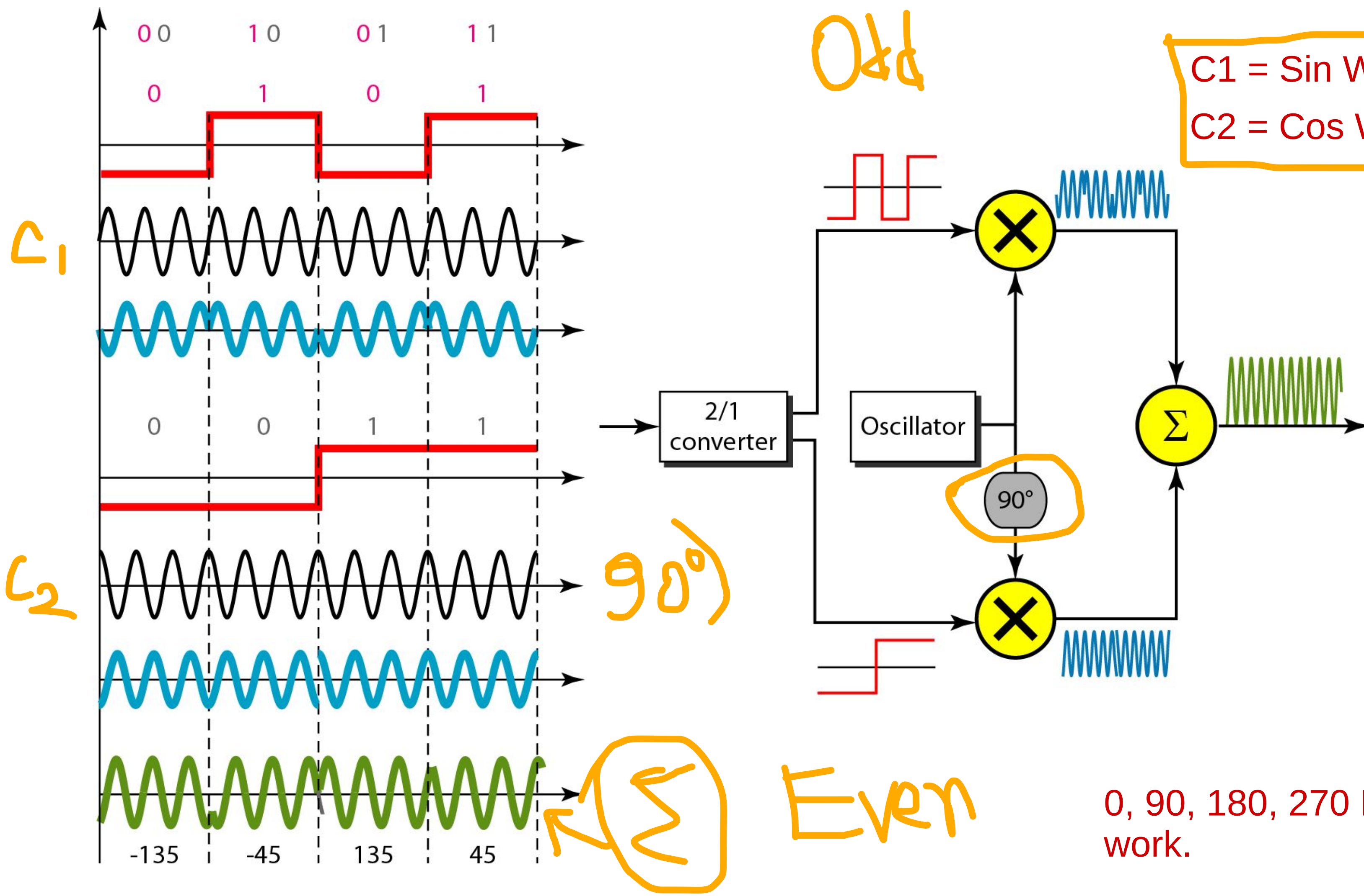


Quadrature PSK

- 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*

9



C1 = Sin Wave

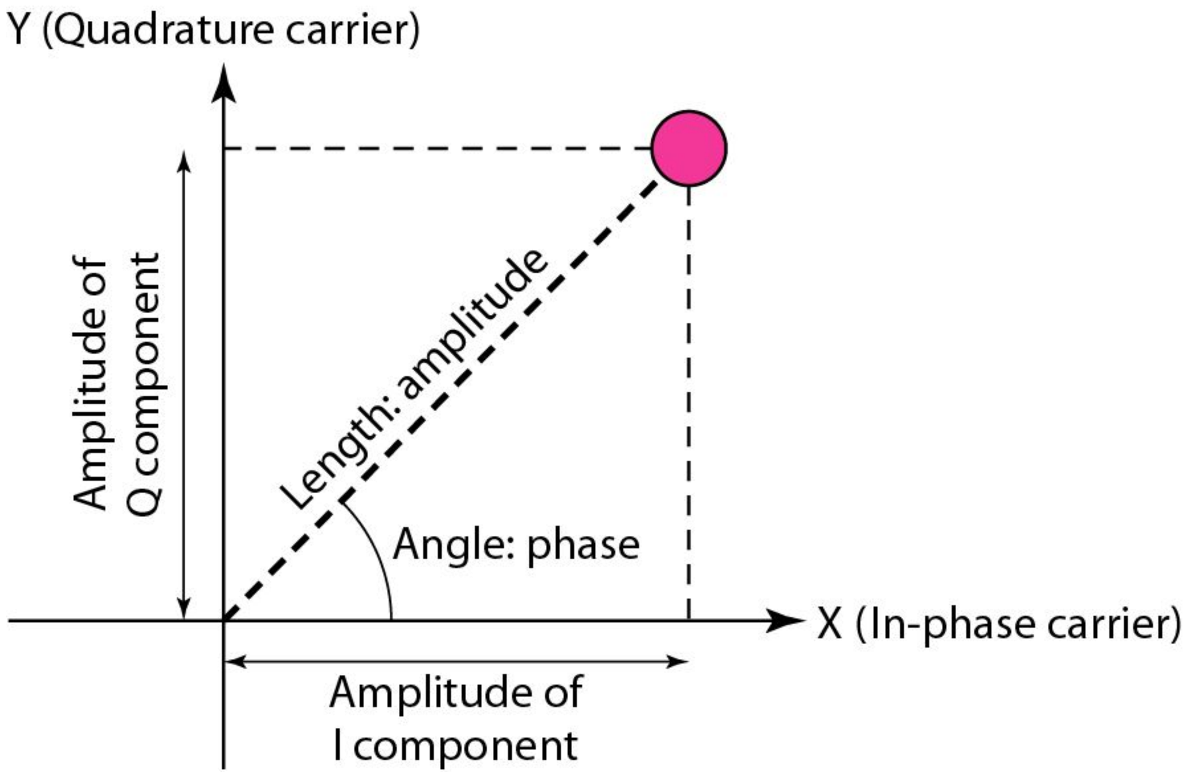
C2 = Cos Wave

0, 90, 180, 270 Degree work.

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.

Figure 5.13 *Three constellation diagrams*