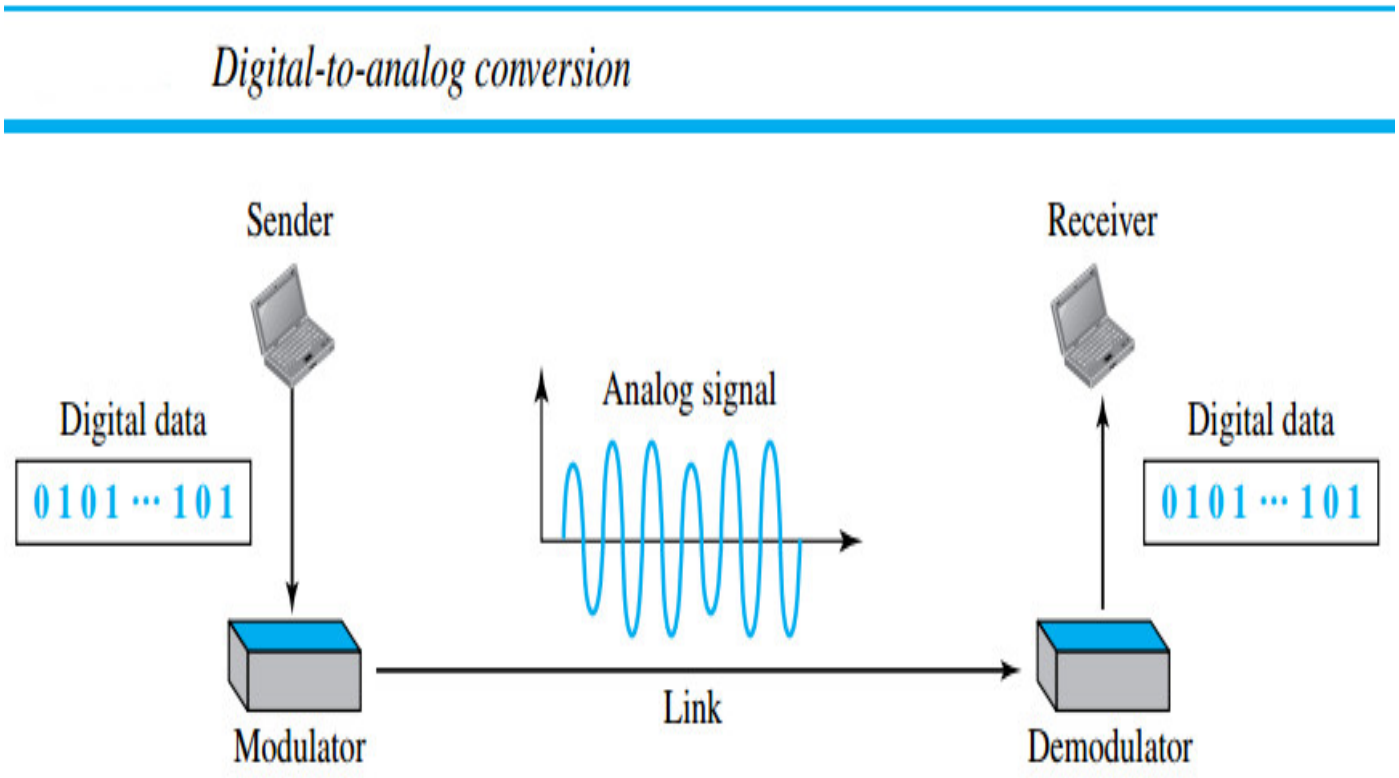
Principles of Data Communications

Reference Book: Data Communications and Networking by Behrouz A. Forouzan

ANALOG TRANSMISSION

- Digital to Analog Conversion: Digital data to Analog Signal
  - Amplitude Shift Keying (ASK)
  - Frequency Shift Keying (FSK)
  - Phase Shift Keying (PSK)
  - Quadrature Amplitude Modulation (QAM)
- Analog-to-Analog conversion: change an analog signal to a new analog signal
  - Amplitude Modulation (AM)
  - Frequency Modulation (FM)
  - Phase Modulation (PM)

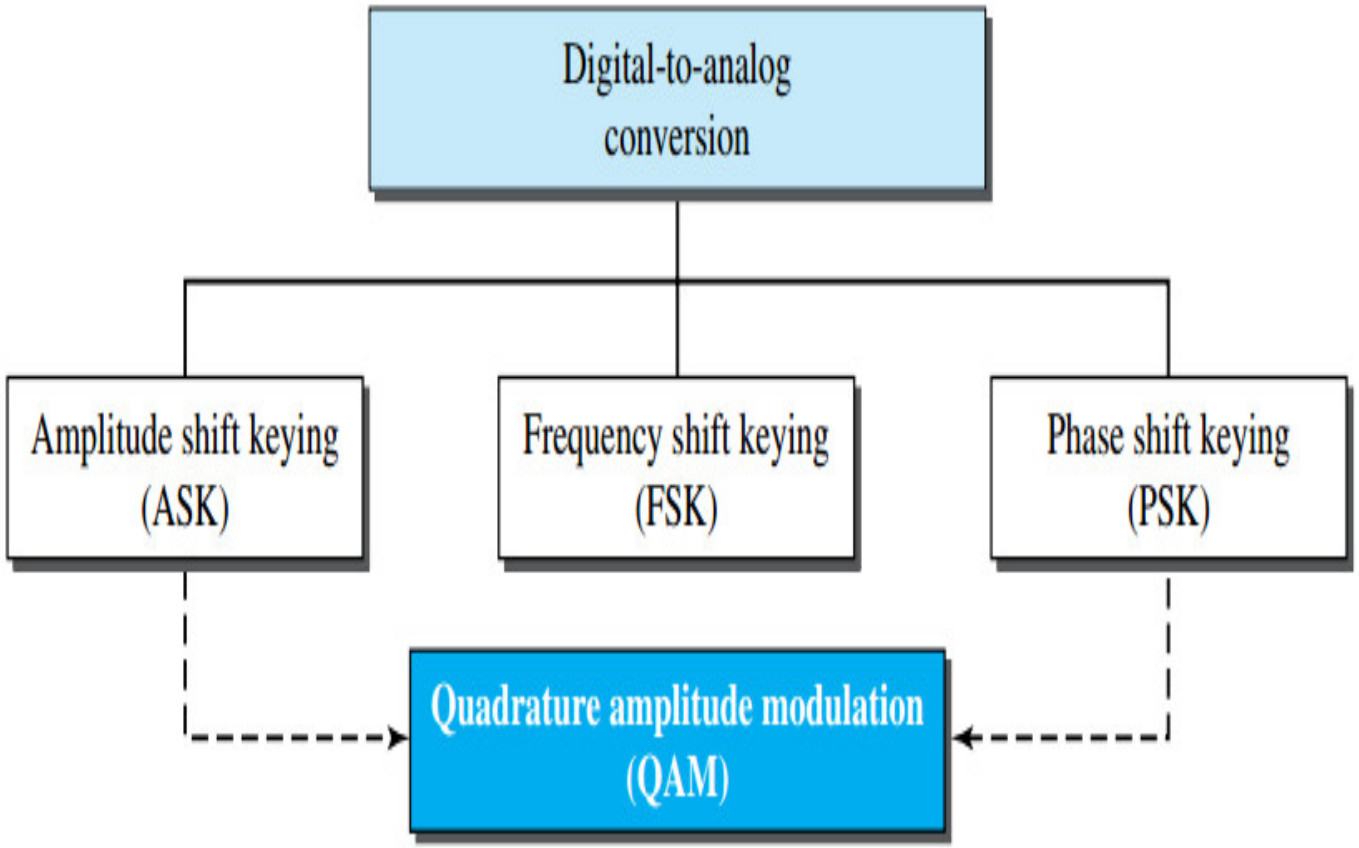
DIGITAL-TO-ANALOG CONVERSION



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

- A sine wave is defined by three characteristics: amplitude, frequency, and phase.
- When we vary any one of these characteristics, we create a different version of that wave.
- So, by changing one characteristic of a simple electric signal, we can use it to represent digital data.
- Any of the three characteristics can be altered in this way, giving us at least three mechanisms for modulating digital data into an analog signal:
  - Amplitude Shift Keying (ASK)
  - Frequency Shift Keying (FSK)
  - Phase Shift Keying (PSK)
  - Quadrature Amplitude Modulation (QAM)

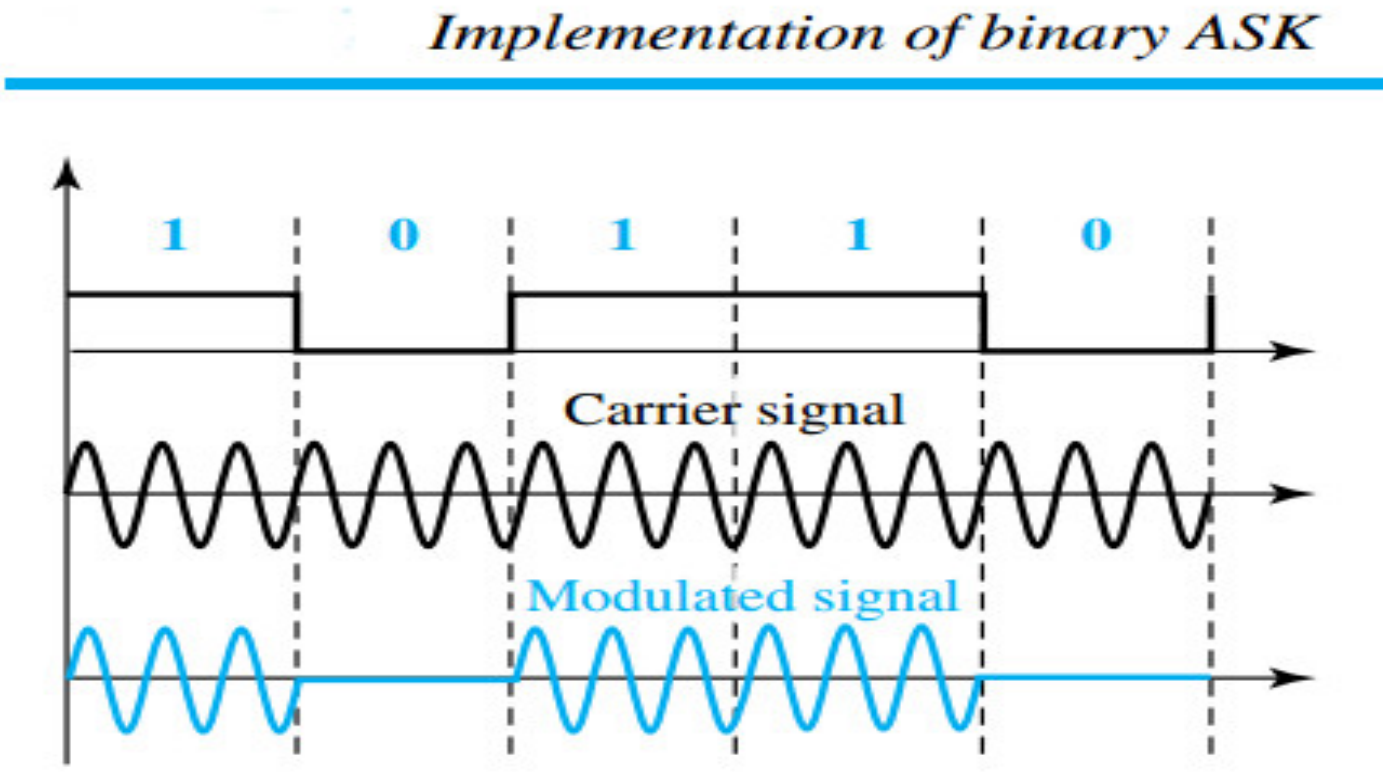
Types of digital-to-analog conversion



Carrier Signal

- In analog transmission, the sending device produces a high-frequency signal that acts as a base for the information signal.
- This base signal is called the carrier signal or carrier frequency.
- The receiving device is tuned to the frequency of the carrier signal that it expects from the sender.
- Digital information then changes the carrier signal by modifying one or more of its characteristics (amplitude, frequency, or phase). This kind of modification is called modulation (shift keying).

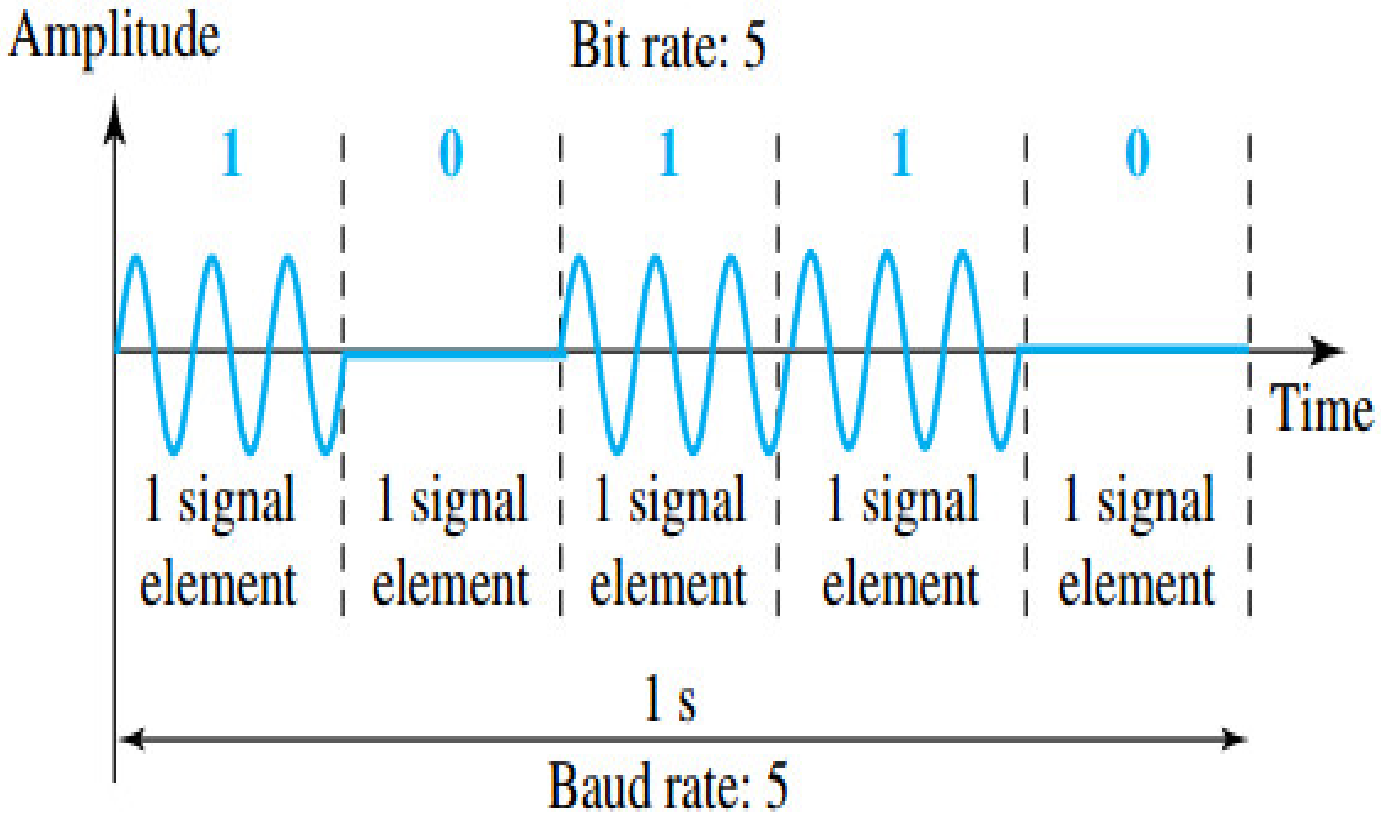
Amplitude Shift Keying



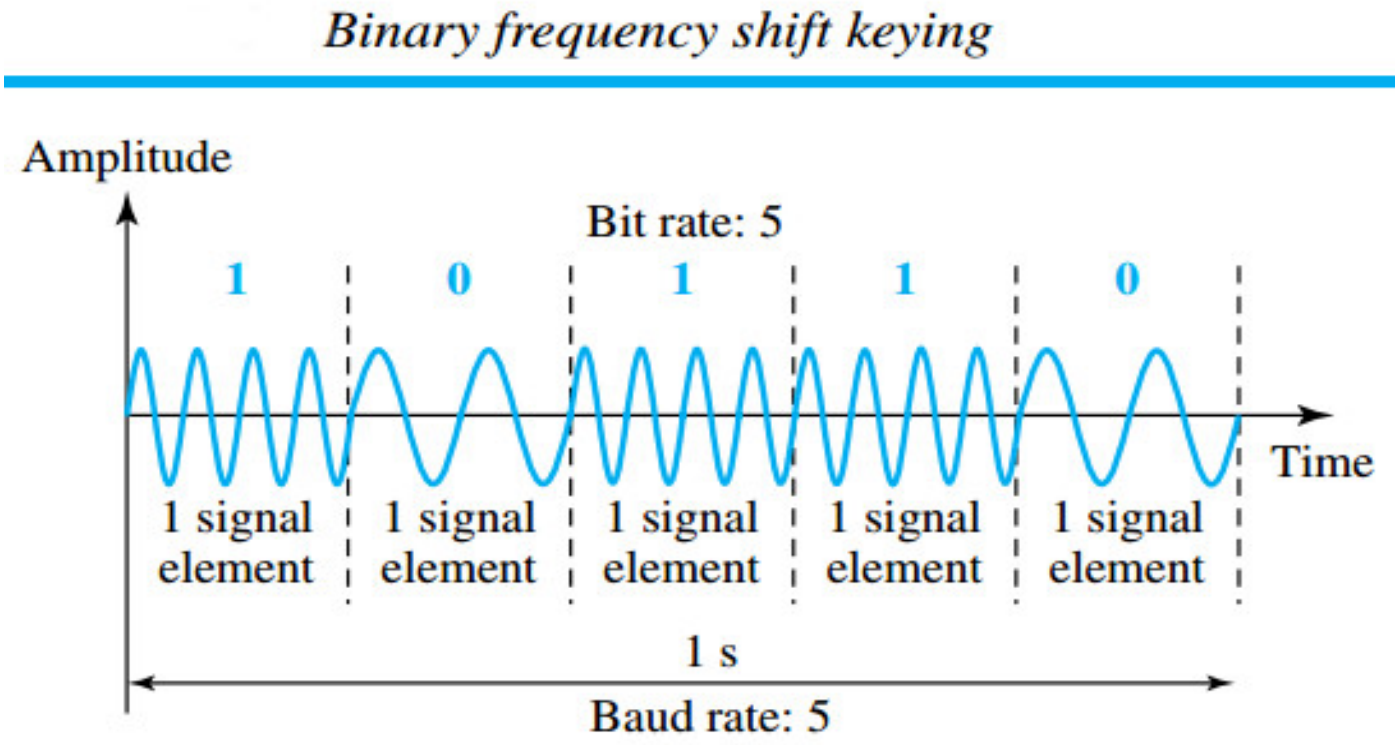
- In amplitude shift keying, the amplitude of the carrier signal is varied to create signal elements.
- Both frequency and phase remain constant while the amplitude changes.

Amplitude Shift Keying

Binary amplitude shift keying

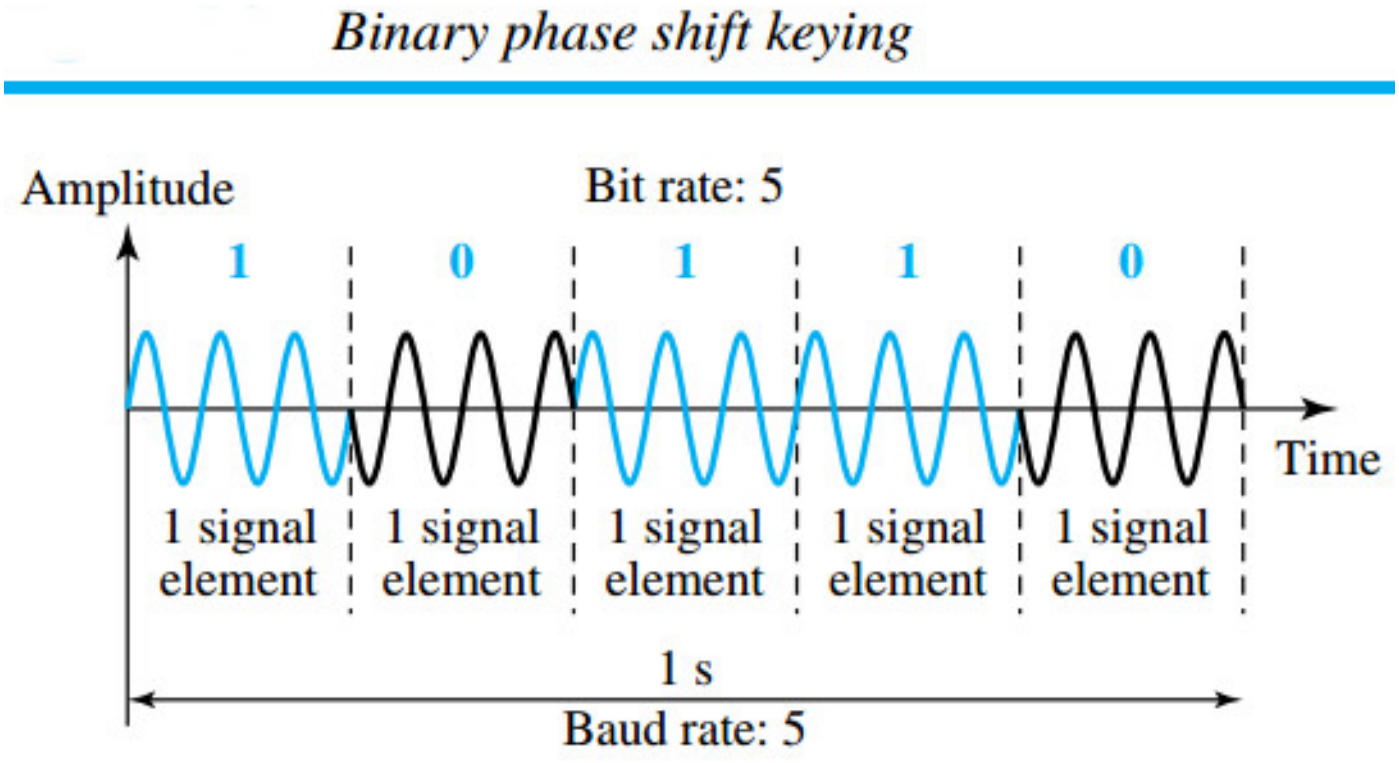


Frequency Shift Keying



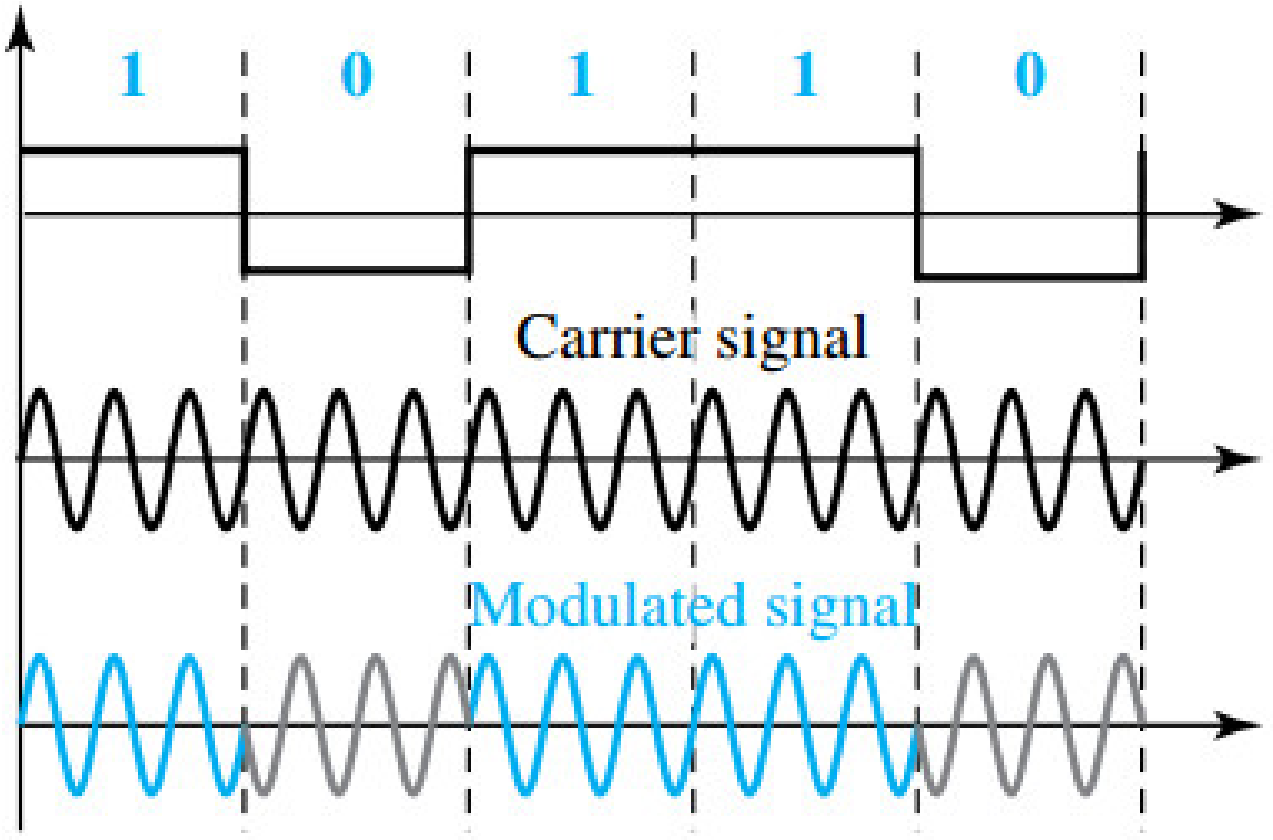
- In frequency shift keying, the frequency of the carrier signal is varied to represent data.
- The frequency of the modulated signal is constant for the duration of one signal element, but changes for the next signal element if the data element changes.
- Both peak amplitude and phase remain constant for all signal elements.

Phase Shift Keying



- In phase shift keying, the phase of the carrier is varied to represent two or more different signal elements.
- Both peak amplitude and frequency remain constant as the phase changes.
- PSK is more common than ASK or FSK.

Implementation of B SK



Quadrature amplitude modulation (QAM)

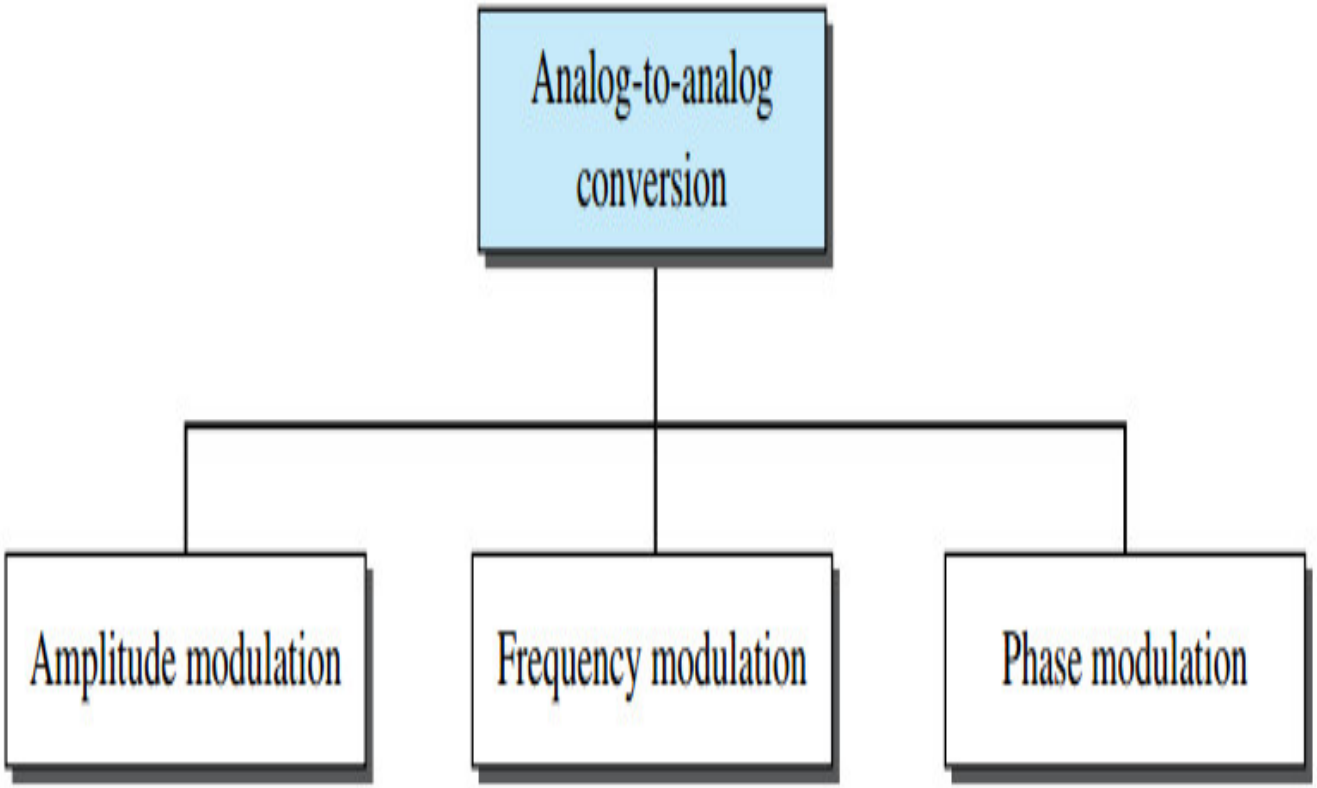
- Quadrature amplitude modulation is a combination of ASK and PSK.

ANALOG-TO-ANALOG CONVERSION

- Analog-to-analog conversion, or analog modulation, is the representation of analog information by an analog signal.

- Analog-to-analog conversion can be accomplished in three ways:
  - Amplitude Modulation (AM)
  - Frequency Modulation (FM)
  - Phase Modulation (PM)

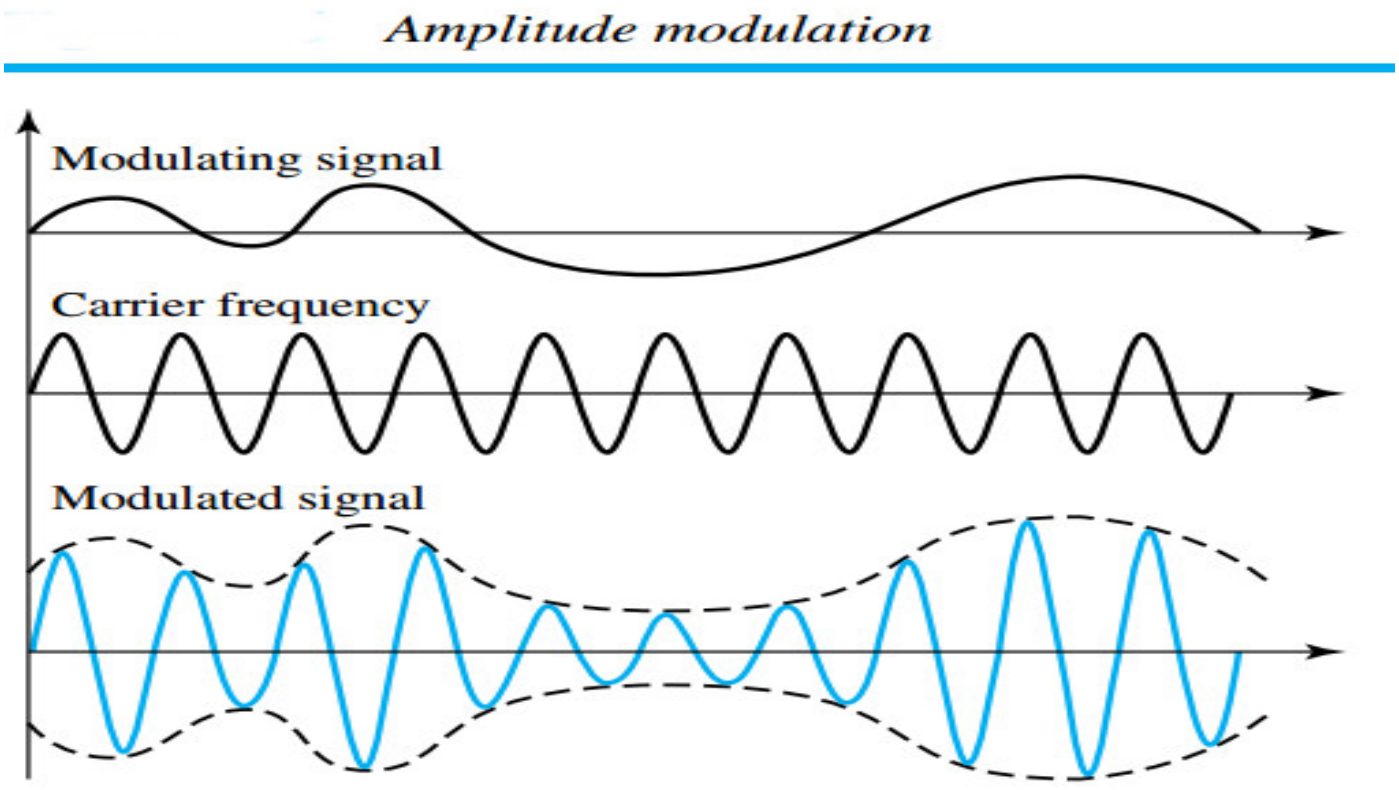
Types of analog-to-analog modulation



Understand modulation through an analogy

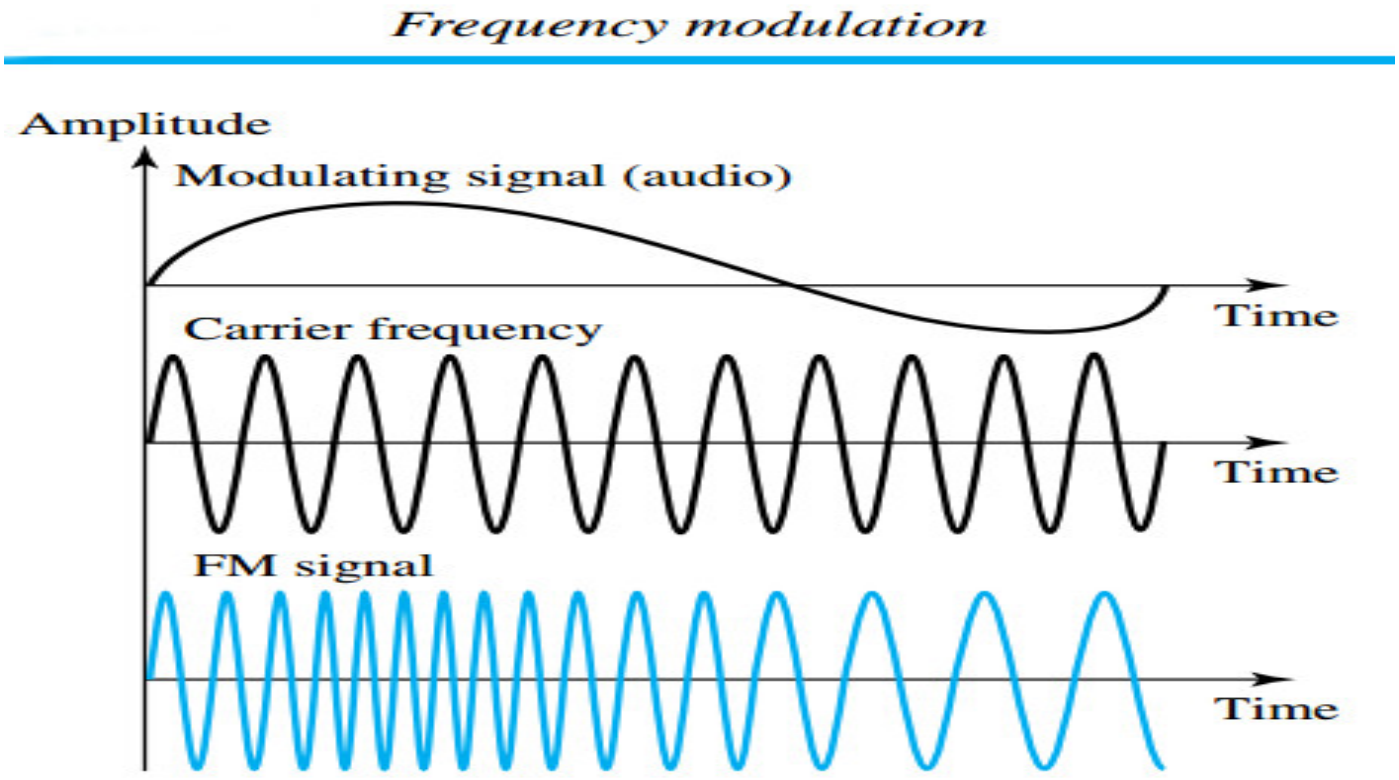
- Try throwing a piece of paper; it won't go far.
- Now, tie it to a stone and throw it again.
- The second method is obviously more efficient than the first one. This is exactly how we do modulation.
- In place of a stone, modulation uses a high frequency signal, known as a carrier signal.
- As we know any signal has three basic properties: amplitude, frequency and phase.
- In the modulation process, one of the properties of the carrier signal is varied in accordance with the message signal.

Amplitude Modulation (AM)



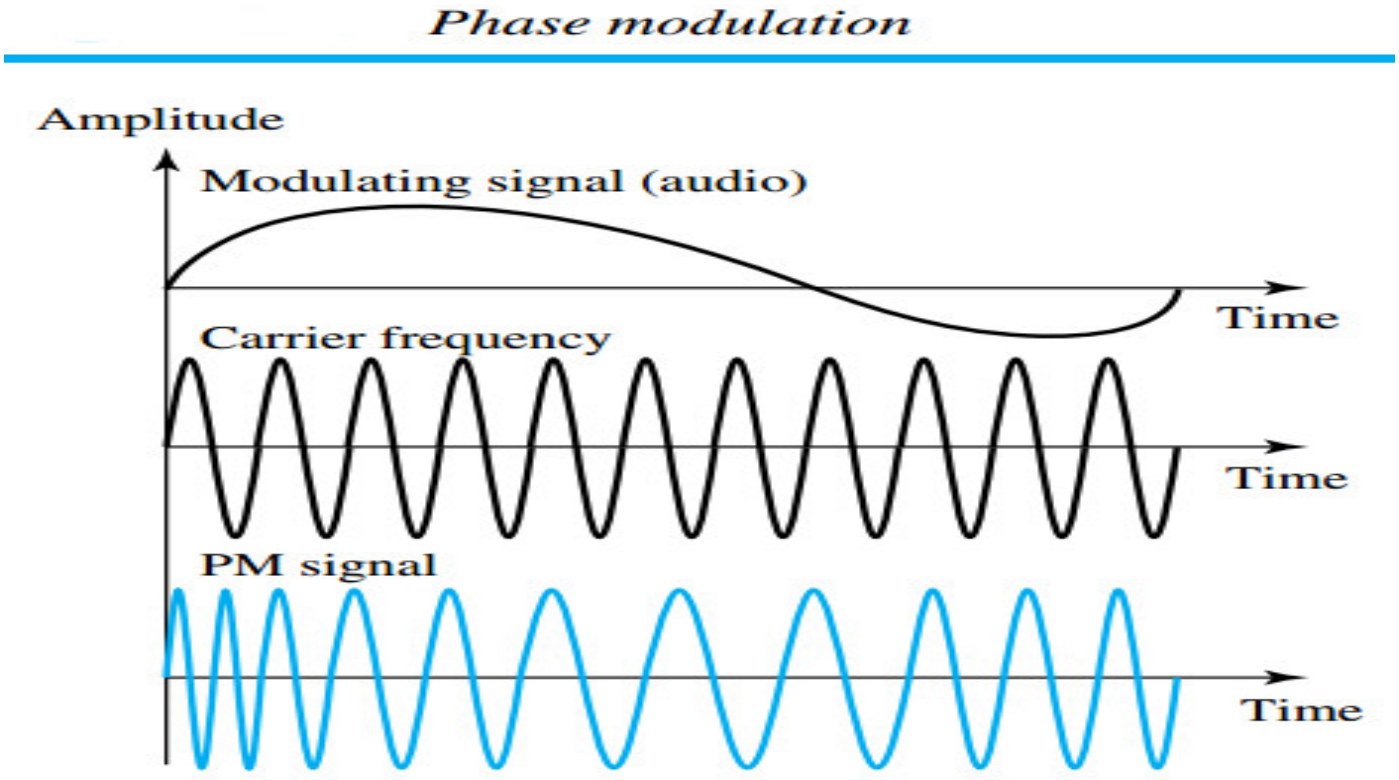
- In AM transmission, the carrier signal is modulated so that its amplitude varies with the changing amplitudes of the modulating signal.
- The frequency and phase of the carrier remain the same; only the amplitude changes to follow variations in the information.

Frequency Modulation (FM)



- In FM transmission, the frequency of the carrier signal is modulated to follow the changing voltage level (amplitude) of the modulating signal.
- The peak amplitude and phase of the carrier signal remain constant, but as the amplitude of the information signal changes, the frequency of the carrier changes correspondingly.

Phase Modulation (PM)



- In PM transmission, the phase of the carrier signal is modulated to follow the changing voltage level (amplitude) of the modulating signal.
- The peak amplitude and frequency of the carrier signal remain constant, but as the amplitude of the information signal changes, the phase of the carrier changes correspondingly.

Summary

- Analog Transmission
  - Digital to Analog Conversion
    - Amplitude Shift Keying (ASK)
    - Frequency Shift Keying (FSK)
    - Phase Shift Keying (PSK)
    - Quadrature Amplitude Modulation (QAM)
  - Analog-to-Analog Conversion
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THANK YOU