# **Analog Transmission**

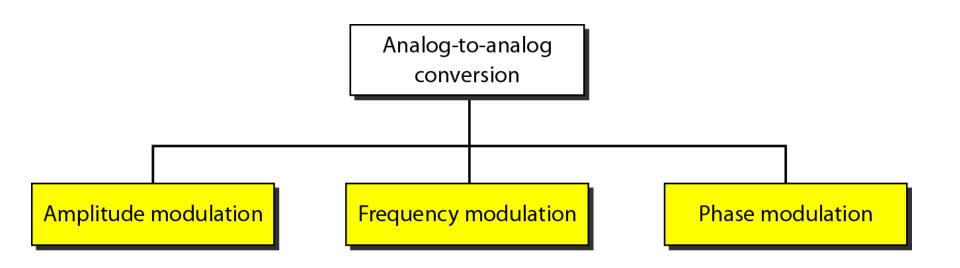
## 5-2 ANALOG AND DIGITAL

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

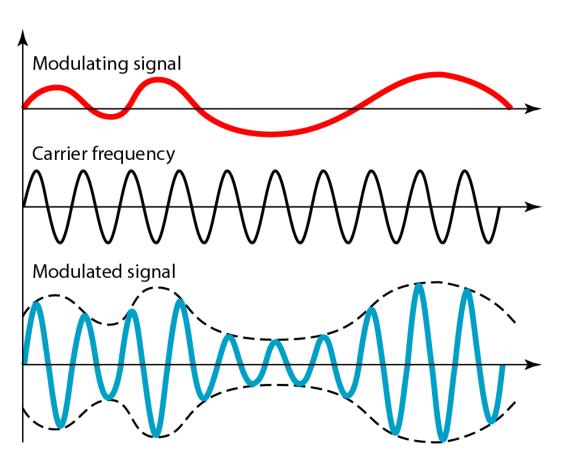
#### Figure 5.15 Types of analog-to-analog modulation

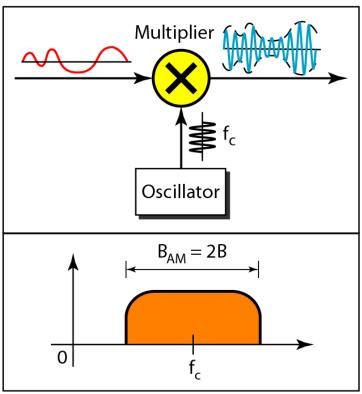


# **Amplitude Modulation**

- A carrier signal is modulated only in amplitude value
- The modulating signal is the envelope of the carrier
- The required bandwidth is 2B, where B is the bandwidth of the modulating signal
- Since on both sides of the carrier freq. f<sub>c</sub>, the spectrum is identical, we can discard one half, thus requiring a smaller bandwidth for transmission.

#### Figure 5.16 Amplitude modulation

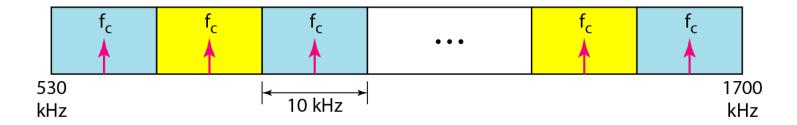




Note

# The total bandwidth required for AM can be determined from the bandwidth of the audio signal: $B_{AM} = 2B$ .

# Figure 5.17 AM band allocation



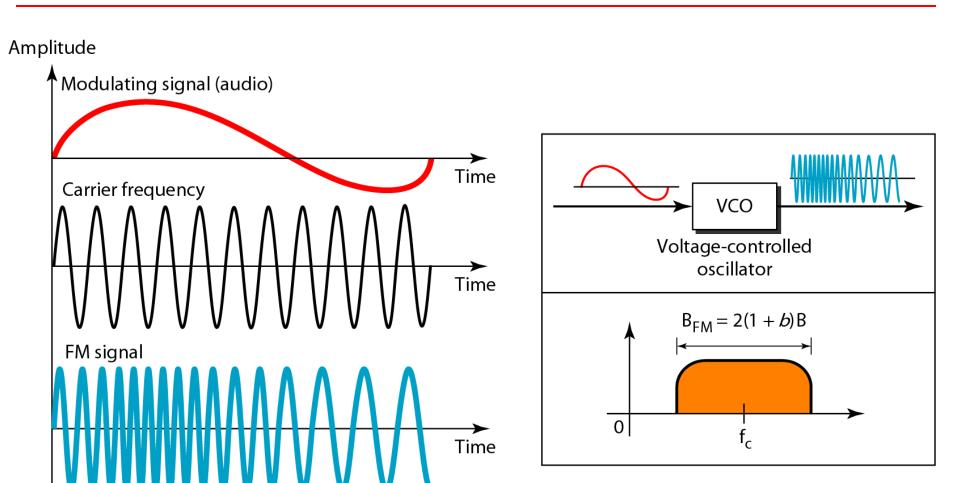
# Frequency Modulation

- The modulating signal changes the freq. f<sub>c</sub> of the carrier signal
- The bandwidth for FM is high
- It is approx. 10x the signal frequency

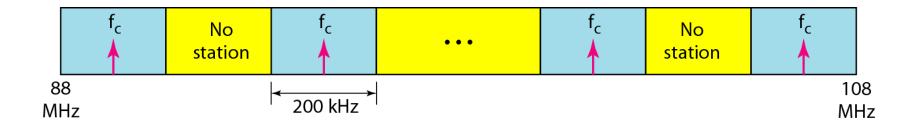
#### Note

The total bandwidth required for FM can be determined from the bandwidth of the audio signal:  $B_{FM} = 2(1 + \beta)B$ . Where  $\beta$  is usually 4.

#### Figure 5.18 Frequency modulation



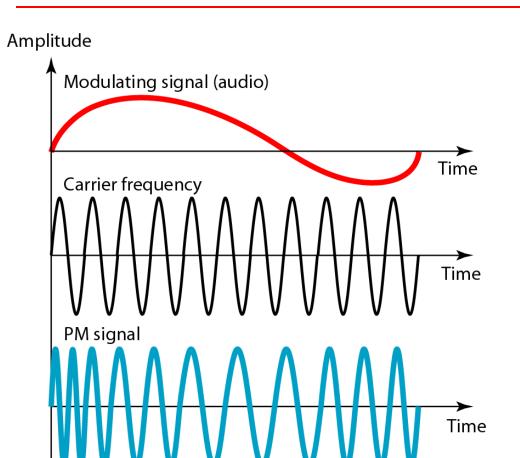
## Figure 5.19 FM band allocation

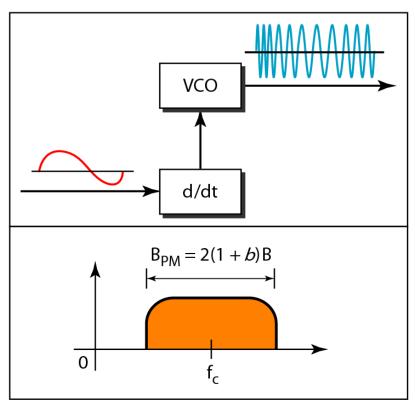


# Phase Modulation (PM)

- The modulating signal only changes the phase of the carrier signal.
- The phase change manifests itself as a frequency change but the instantaneous frequency change is proportional to the derivative of the amplitude.
- The bandwidth is higher than for AM.

## Figure 5.20 Phase modulation





## **Note**

The total bandwidth required for PM can be determined from the bandwidth and maximum amplitude of the modulating signal:  $B_{PM} = 2(1 + \beta)B.$ Where  $\beta = 2$  most often.