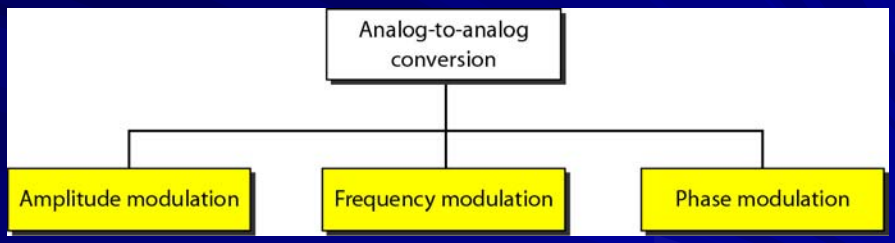
5-2 ANALOG MODULATION

Topics discussed in this section:

- **Amplitude Modulation**
- **Frequency Modulation**
- **Phase Modulation**

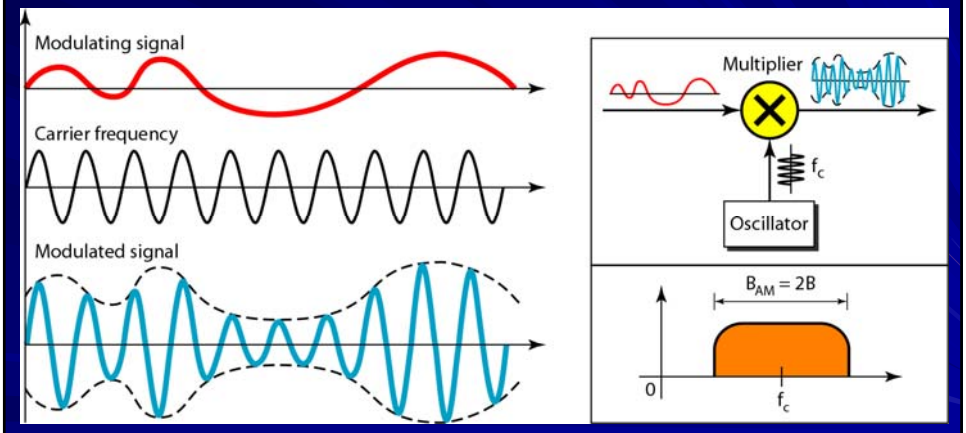
Types of analog-to-analog modulation



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_c, the spectrum is identical, we can discard one half, thus requiring a smaller bandwidth for transmission.

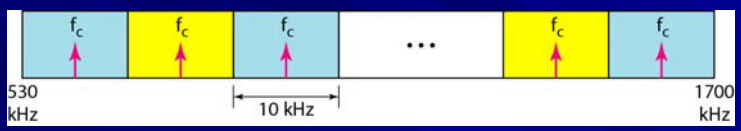
Amplitude modulation



Note

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

AM band allocation



Amplitude Modulation

- Amplitude Modulation is a process where the amplitude of a carrier signal is altered according to information in a message signal.
- The frequency of the carrier signal is usually much greater than the highest frequency of the input message signal.

AM – Basic Definitions

The AM signal

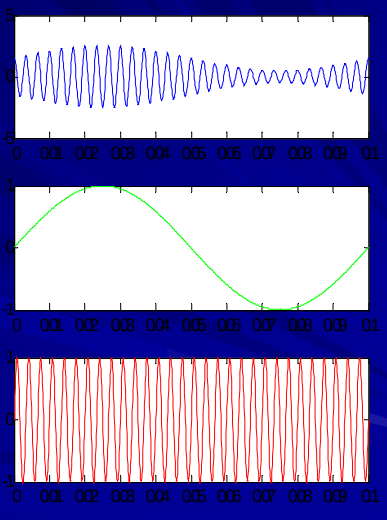
$$s(t) = A_c\left[1 + k \bullet m(t)\right]\cos \omega_c t$$

The modulating signal:

$$m(t)$$

The Carrier Signal:

$$c(t) = A_c \cos \omega_c t$$



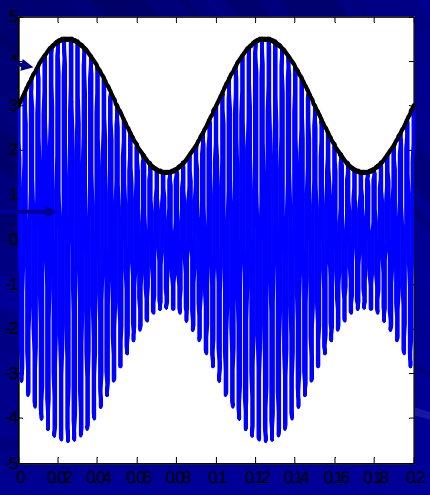
AM – Basic Definitions (cont.)

The Envelope:

$$s(t) = A_c\left[1 + k \bullet m(t)\right]$$

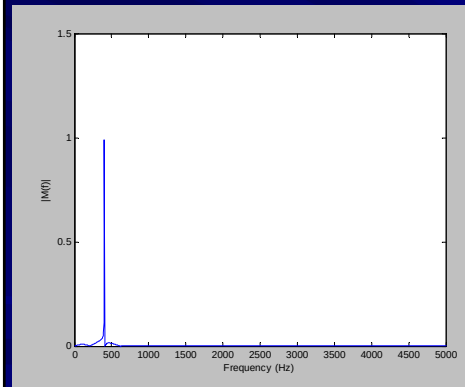
The AM Signal

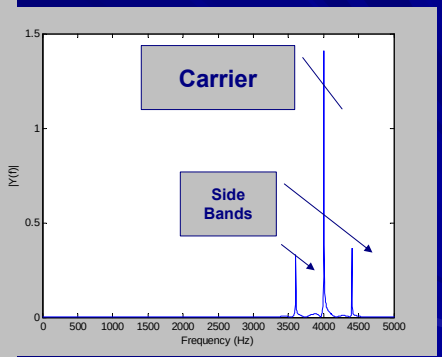
$$s(t) = A_c\left[1 + k \bullet m(t)\right]\cos \omega_c t$$



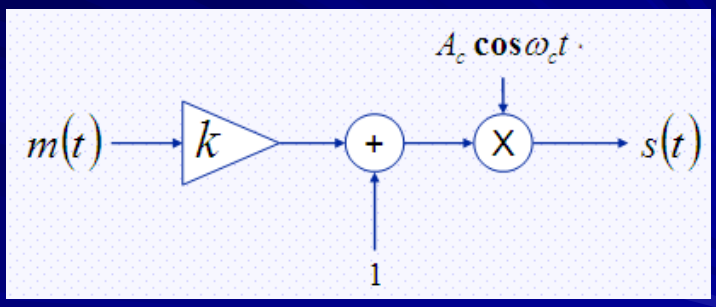
The AM Spectrum

$m(t)$ $s(t)$

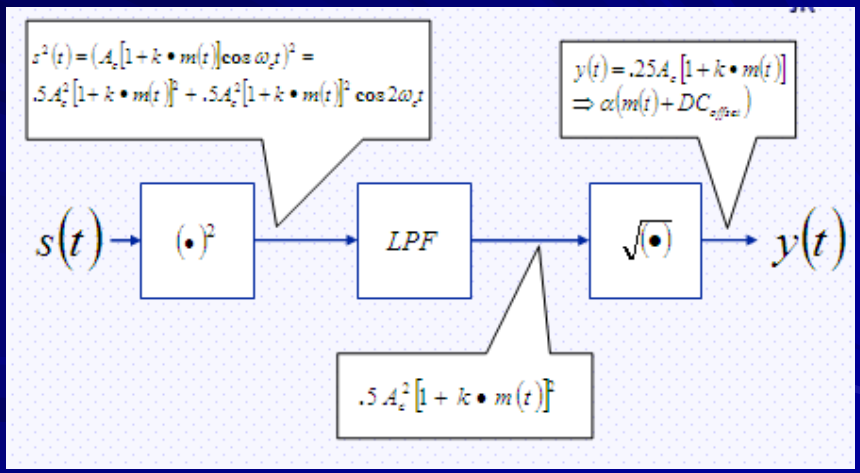




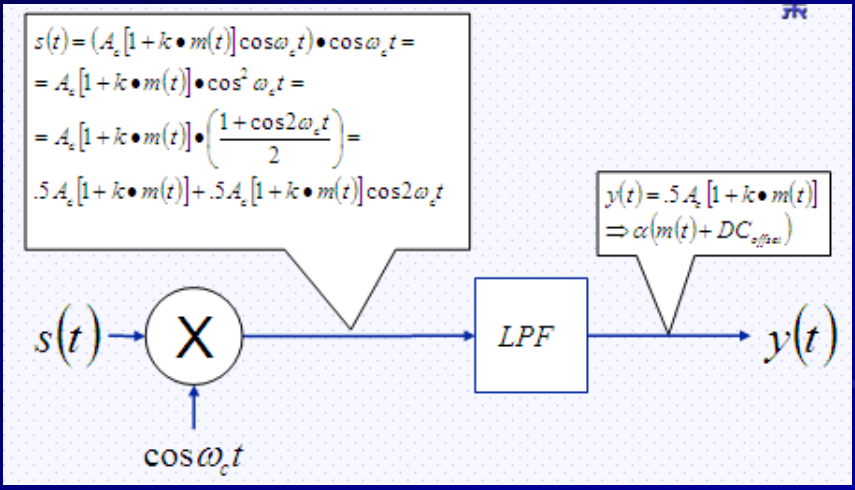
AM Modulation Scheme



Square-Law Demodulation



Coeherent Demodulation



Frequency Modulation

- The modulating signal changes the freq. f_c 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 β is usually 4.

Figure 5.18 *Frequency modulation*

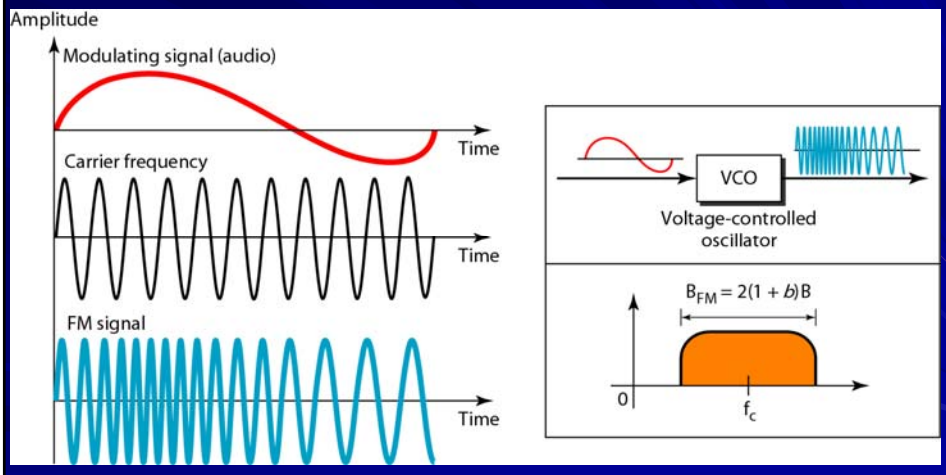
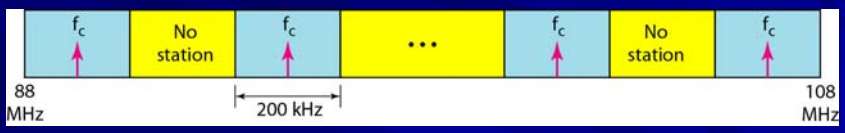


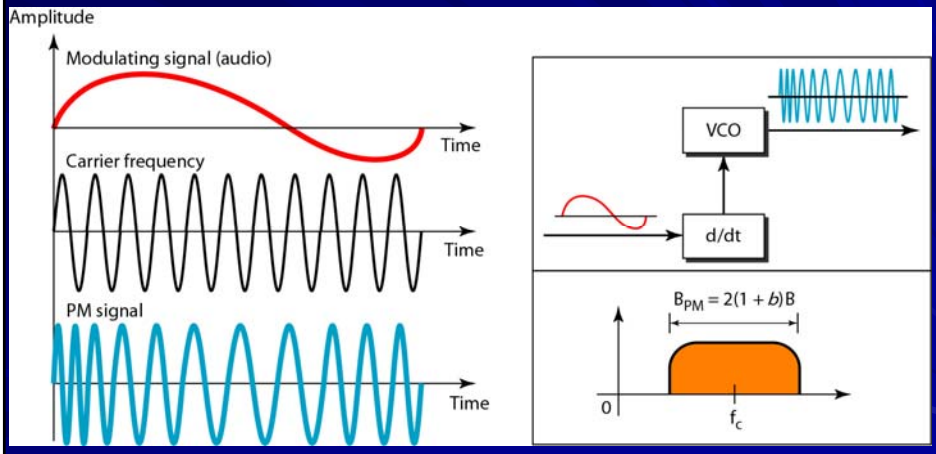
Figure 5.19 *FM band allocation*



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.