Data Communication

Analog Transmission (Part-2)

ANALOG-to-ANALOG CONVERSION

- 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 band-pass in nature or if only a band-pass channel is available to us.

MODULATION

Modulation is defined as the process by which some **characteristic** of a **carrier wave** is varied in accordance with an **information-bearing signal**.

The **carrier** is needed to facilitate the transportation of the modulated signal across a channel from the transmitter to the receiver.

MODULATION

A commonly used **carrier** is a ***sinusoidal wave***, the source of which is physically independent of the source of the **information-bearing signal**.

When the information-bearing signal is of an analog kind, we speak of ***continuous-wave modulation***, a term that stresses *continuity* of the modulated wave as a function of time.

MODULATION

Primary motivation for modulation:

To facilitate the transmission of the information-bearing signal over a communication channel (e.g., radio channel) with a prescribed pass-band.

The classification of continuous-wave modulation:

1. Amplitude modulation
2. Frequency modulation
3. Phase modulation

Amplitude Modulation

Angle Modulation

Amplitude Modulation

- A carrier signal is modulated only in amplitude value.
- The modulating signal is the envelope of the carrier.
- Since on both sides of the carrier frequency f_c, the spectrum is identical, we can discard one half, thus requiring a smaller bandwidth for transmission.

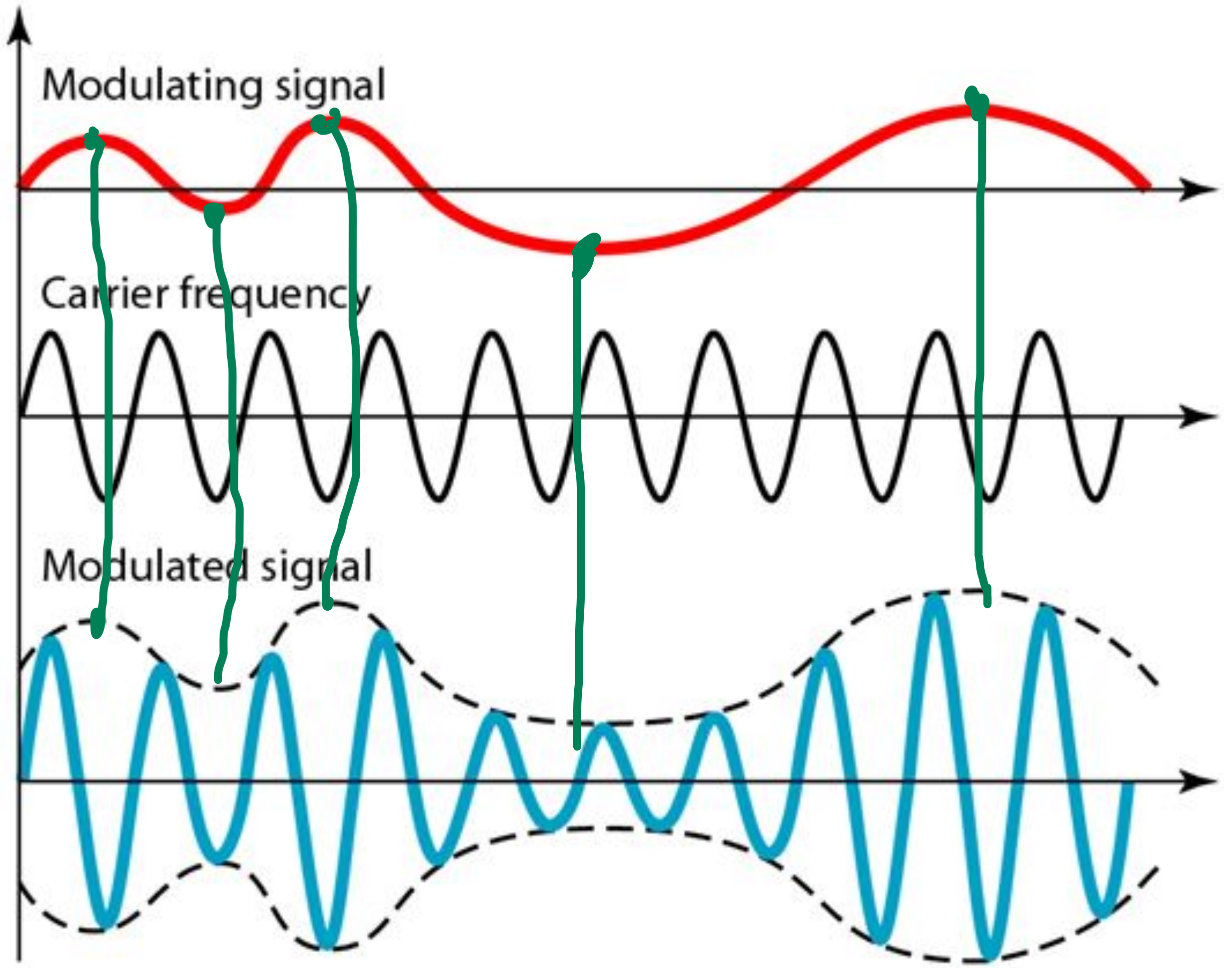


Figure 5.16 *Amplitude modulation*

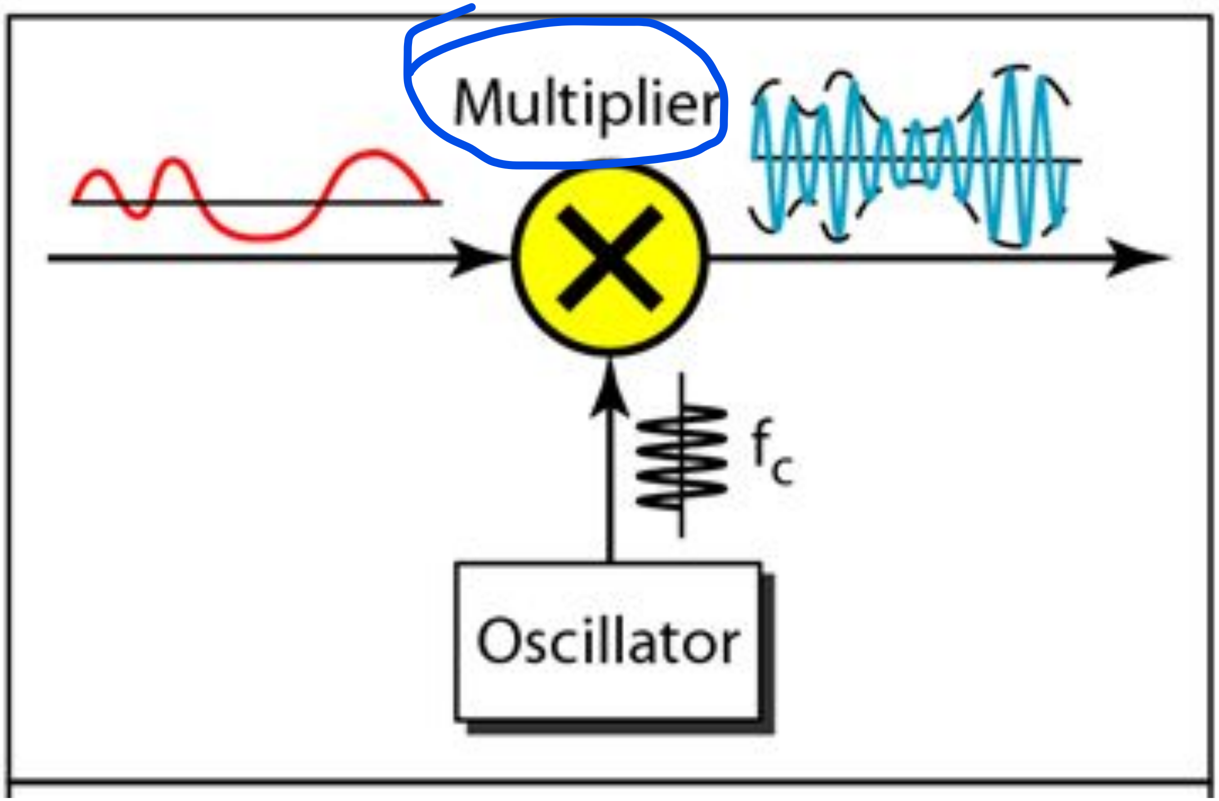


Figure 5.16 *Amplitude modulation*

Amplitude Modulation

$$s(t) = A_c[m(t)]\cos(2\pi f_c t)$$

$$\Rightarrow s(t) = A_c \cos(2\pi f_c t) A_m \cos(2\pi f_m t)$$

$$\Rightarrow s(t) = \frac{A_c A_m}{2} 2\cos(2\pi f_c t)\cos(2\pi f_m t)$$

$$\Rightarrow s(t) = \frac{A_c A_m}{2}[\cos\{2\pi(f_c + f_m)\,t\} + \cos\{2\pi(f_c - f_m)t\}]$$

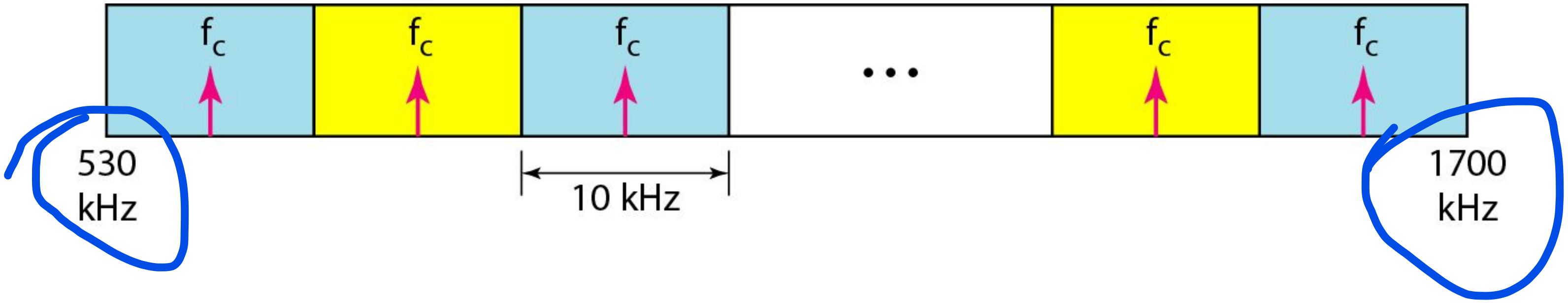
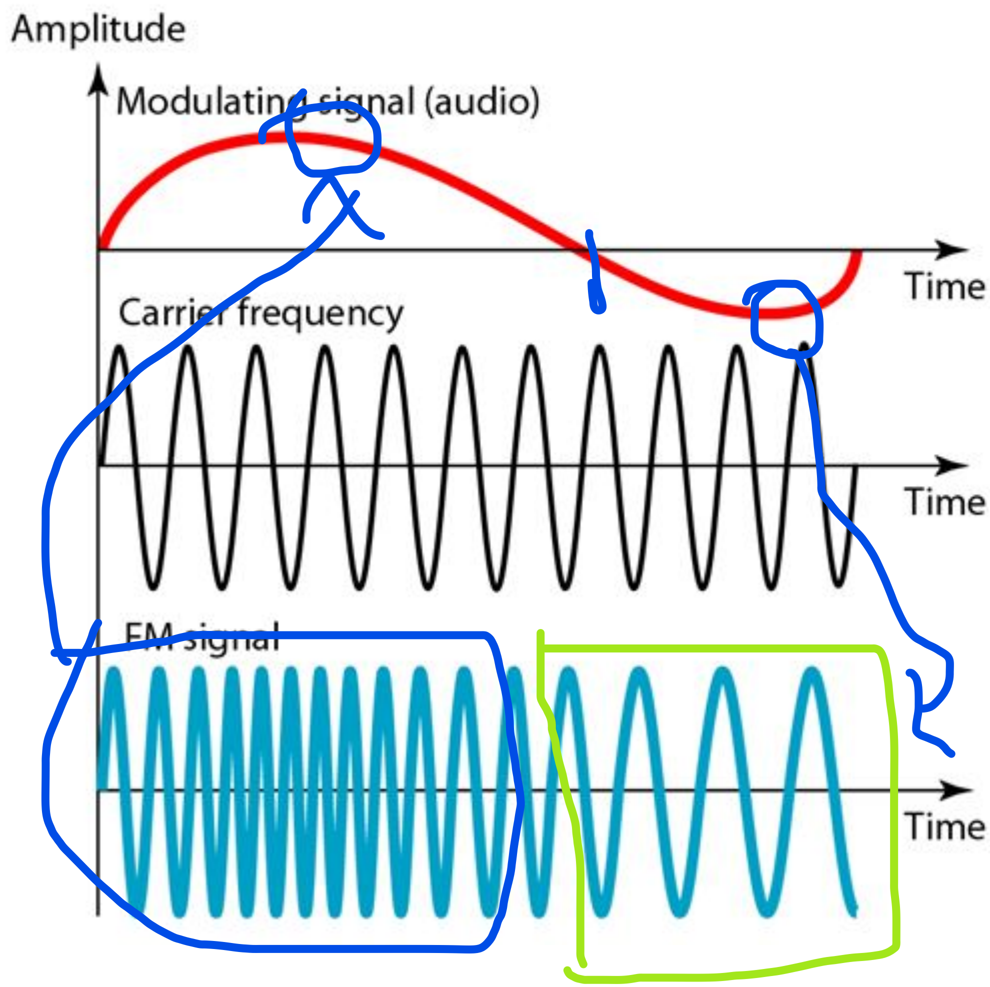


Figure 5.17 *AM band allocation*

Frequency Modulation

- The modulating signal changes the freq. f_c of the carrier signal
- The bandwidth for FM is comparatively higher.



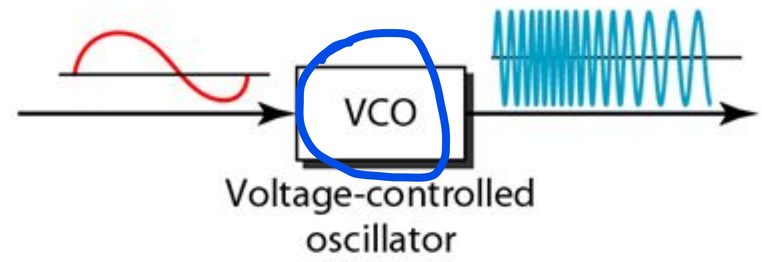
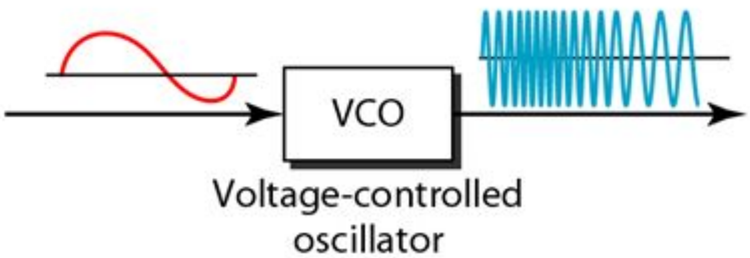
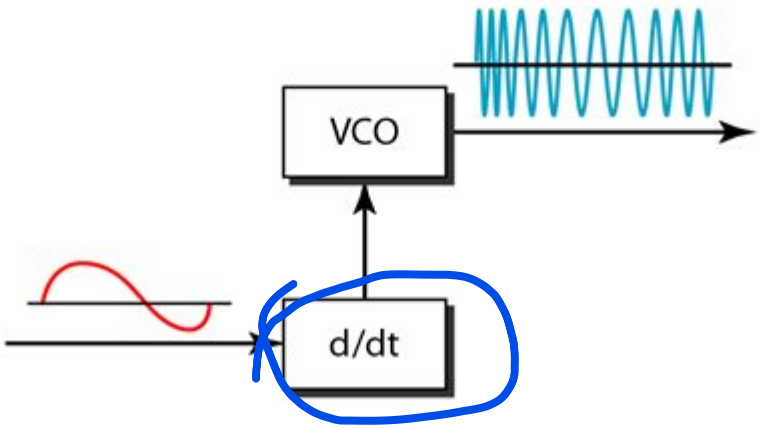


Figure 5.18
Frequency modulation


VCO
Voltage-controlled
oscillator


VCO
d/dt

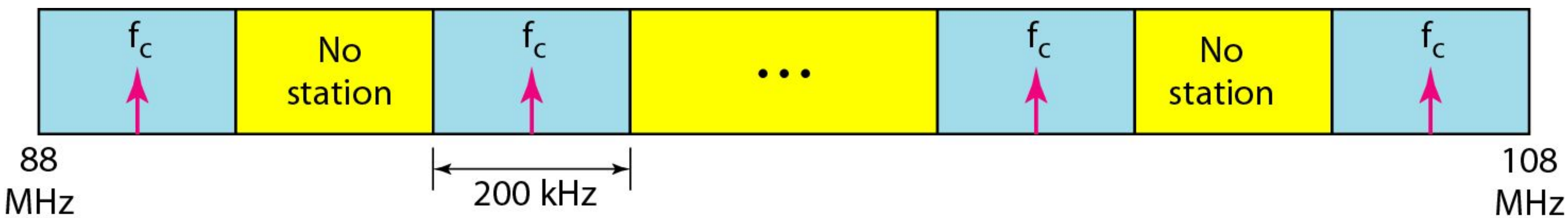
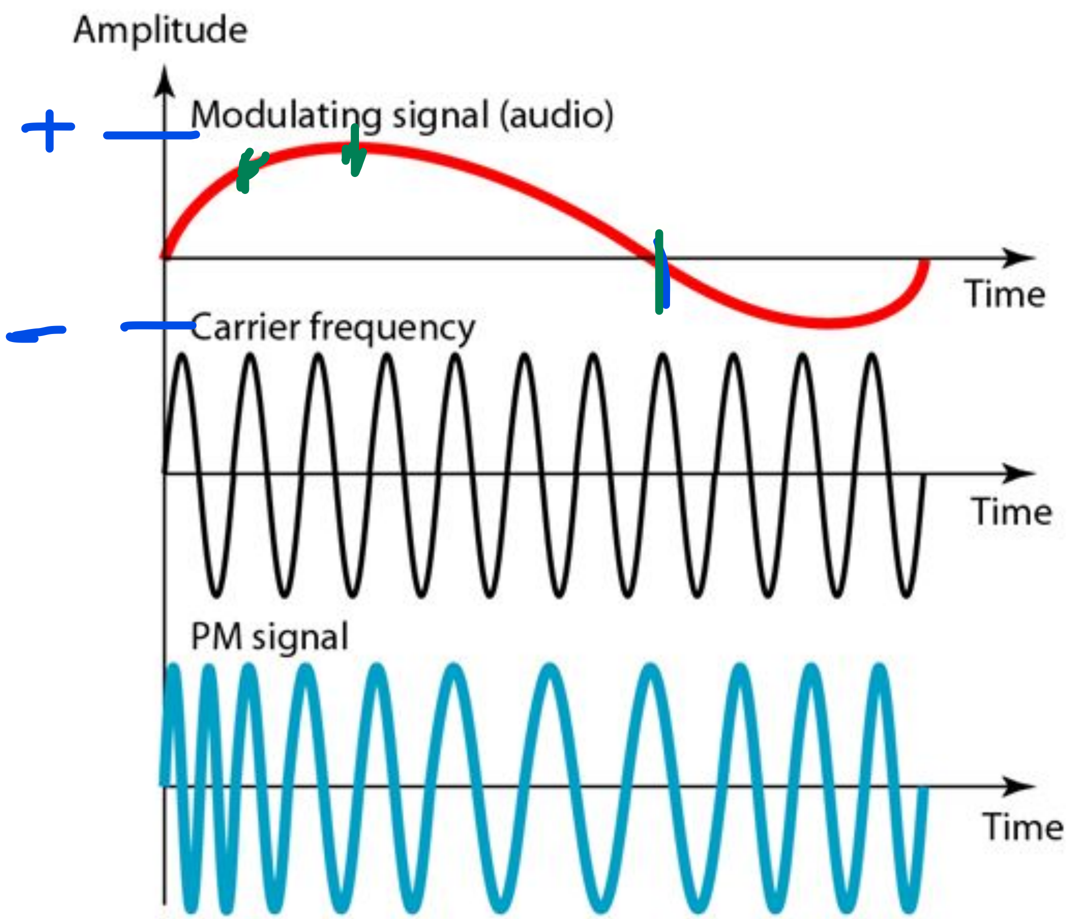


Figure 5.19 *FM band allocation*

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.

Differentiate value of Amplitude.
* The slope high then the PM signal is high.
When it is low then it will be low frequency.



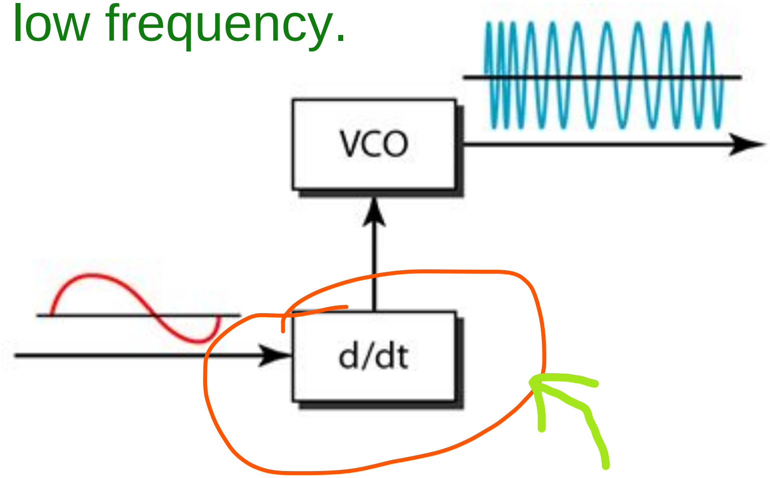


Figure 5.20 *Phase modulation*