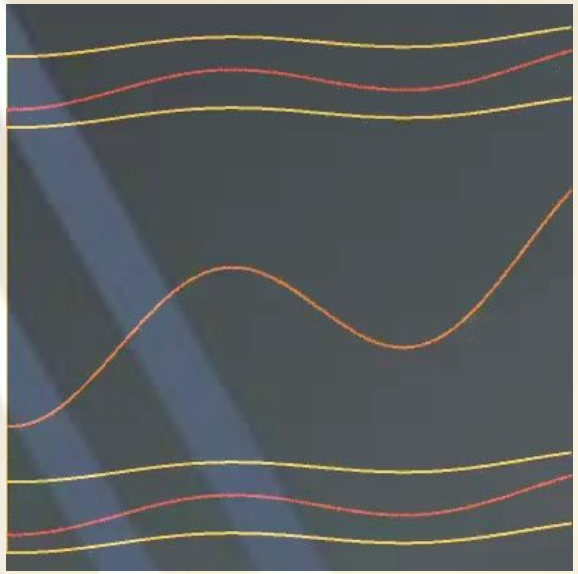
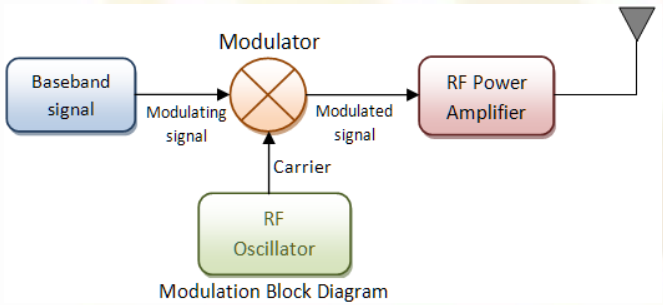


RF Components and Basic Concepts

1.13 - Modulation

Modulation

- **Modulation** is a process of mixing a signal with a sinusoid to produce a new signal. This new signal, will have certain benefits over an un-modulated signal.
- The sinusoidal signal that is used in the modulation is known as the **carrier signal**, or simply "the carrier". The signal that is used in modulating the carrier signal is known as the "data signal" or the "message signal".



Modulation Block Diagram

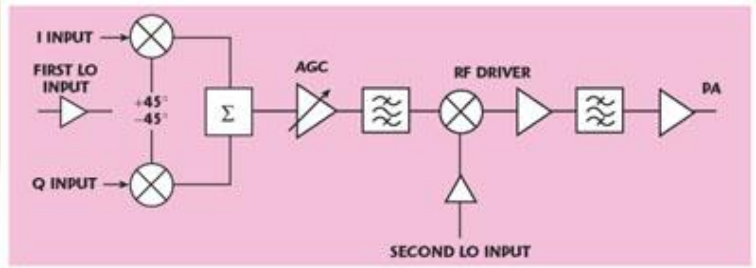


Fig. 1 Dual conversion

Modulation Types

- Analog
  - AM Aplitude Modulation
  - FM Frequency Modulation
  - PM Phase Modulation
- Digital
  - ASK Amplitude Shift Keying
  - FSK Frequency Shift Keying
  - PSK Phase Shift Keying

Amplitude Modulation (AM)

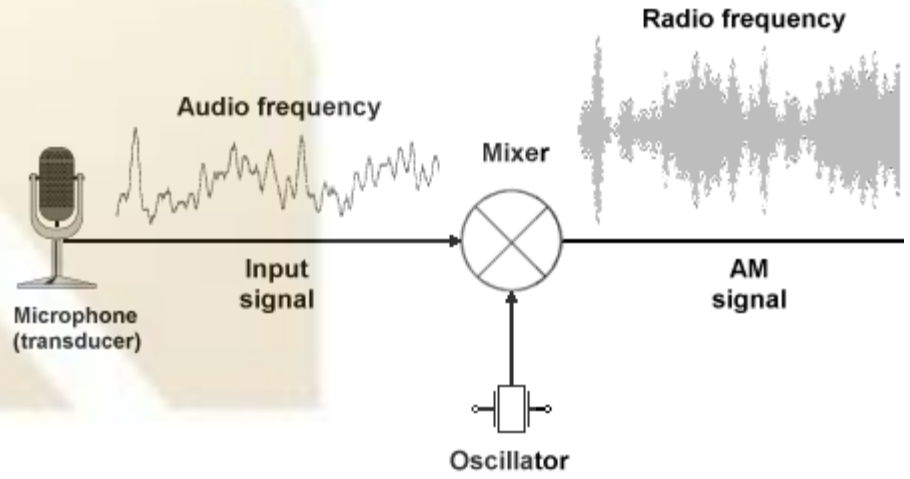
- In Amplitude Modulation or AM, the carrier signal has its amplitude modulated in proportion to the message bearing (lower frequency) or data signal.

Carrier (High Freq)

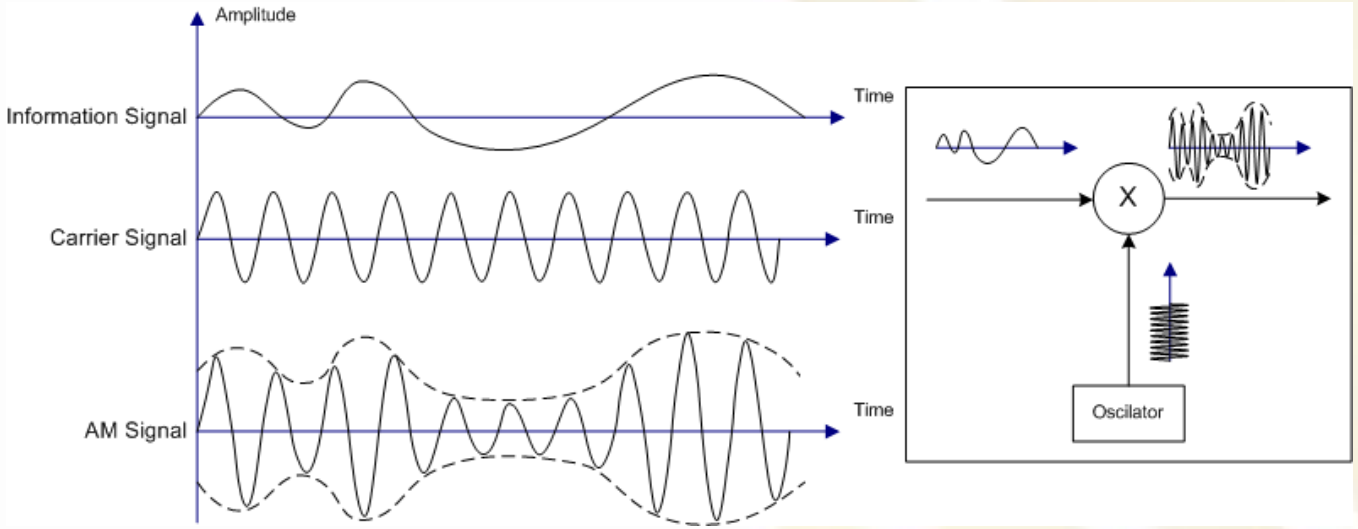
$$x_{am}(t) = [1 + a.x_m(t)] \cdot A_c Sin(w_c t + \emptyset_c)$$

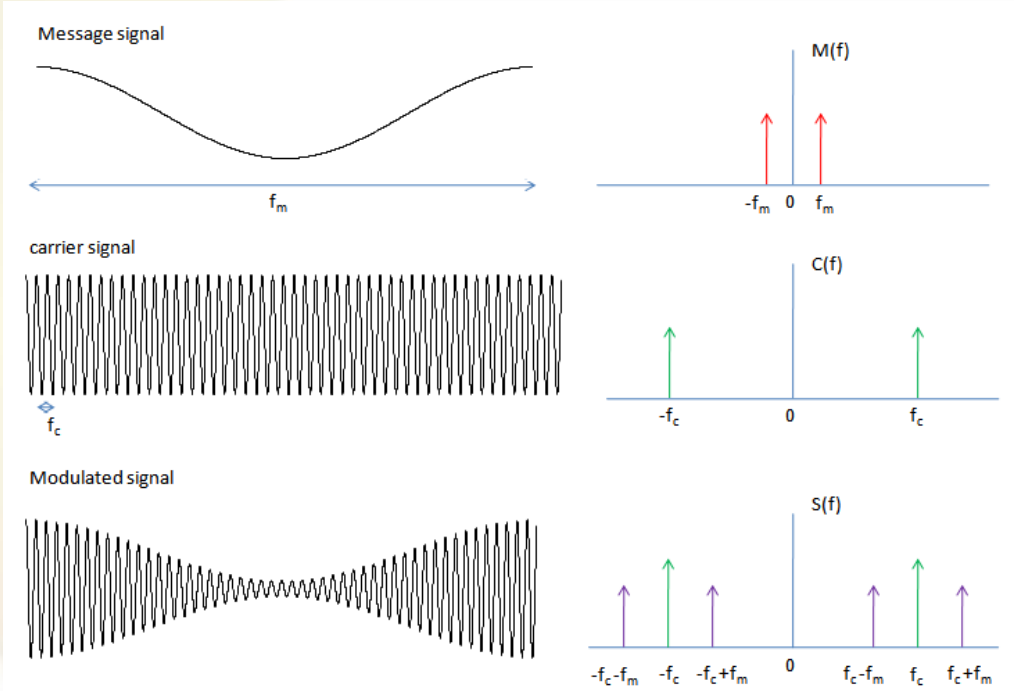
$$x_m(t) = \sin(w_m t + \emptyset_m)$$

Data (Low Freq)



Amplitude Modulation (AM)





Frequency Modulation (FM)

- We can define the FM wave, produced when we modulate a carrier frequency, fc

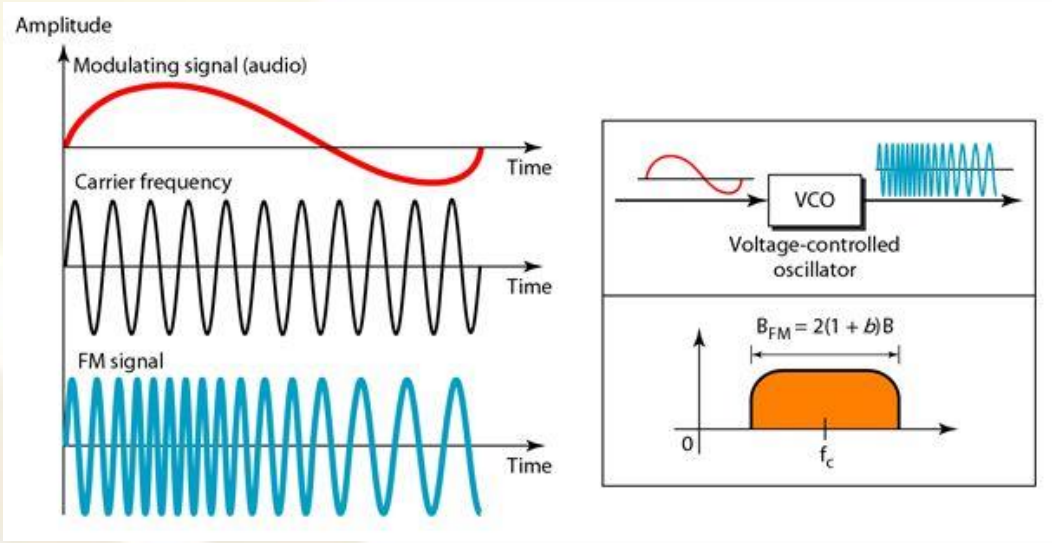
With modulating signal

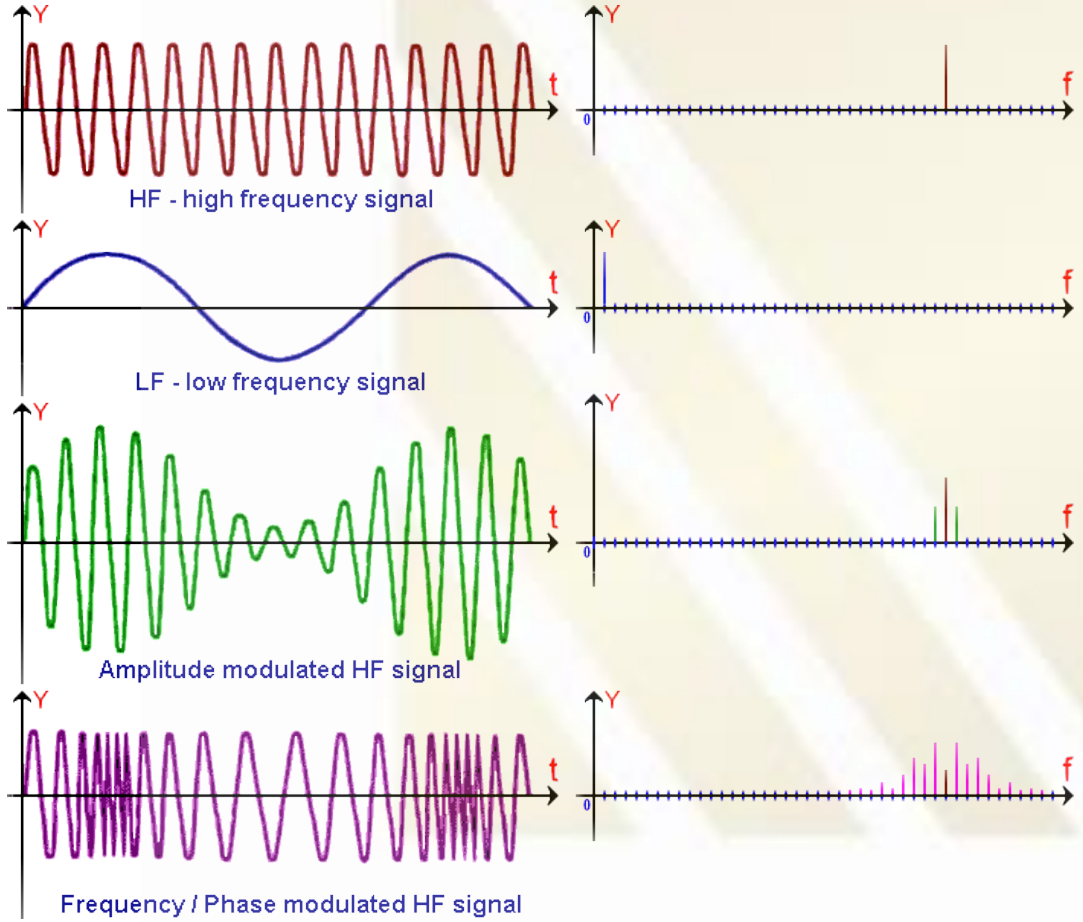
Carrier (High Freq)

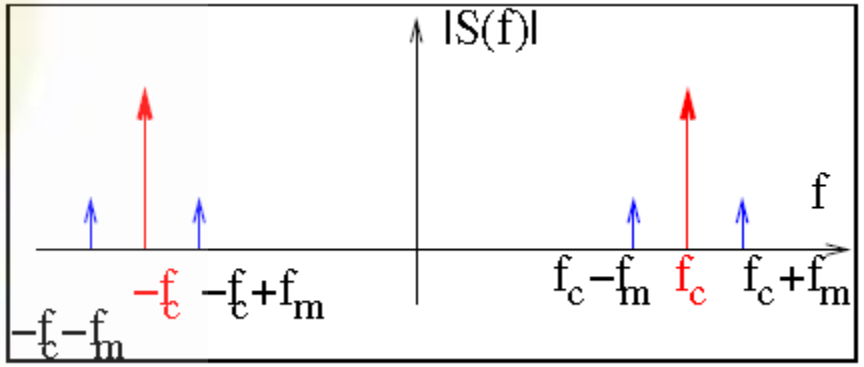
$$x_{fm}(t) = A_c Sin(w_c(t)t + \emptyset_c)$$

$$W_c(t) = \mathrm{w_c} + \mathrm{k_f}.\mathrm{A_m}\sin(w_m t + \emptyset_m)$$

Data (Low Freq)







Narrow band FM

$$W_c(t) = \mathrm{w_c} + \mathrm{k_f}.\mathrm{A_m}\sin(w_m t + \emptyset_m)$$

(Kf.Am) /wm<< 1

Phase Modulation (PM)

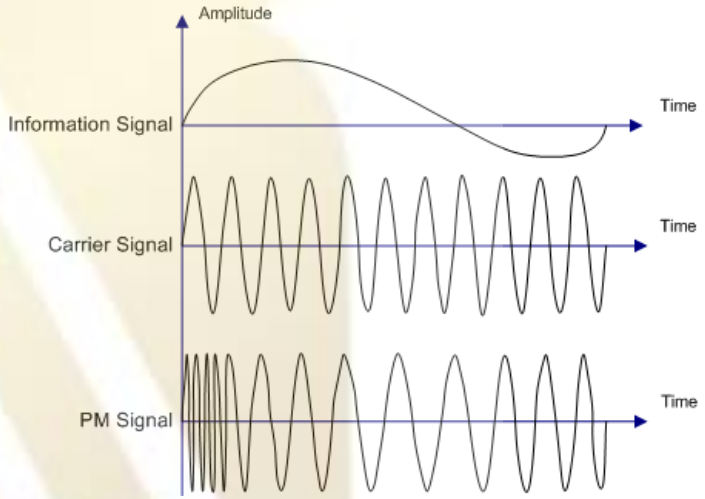
- Phase modulation (PM) is the process of modulating the phase of the carrier.

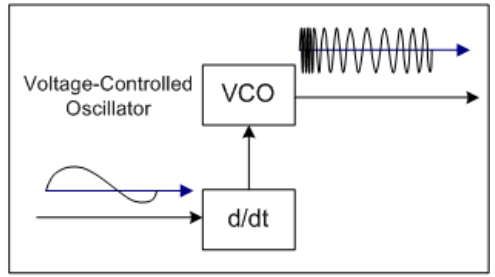
Carrier (High Freq)

$$x_{pm}(t) = A_c Sin(w_c t + m(t))$$

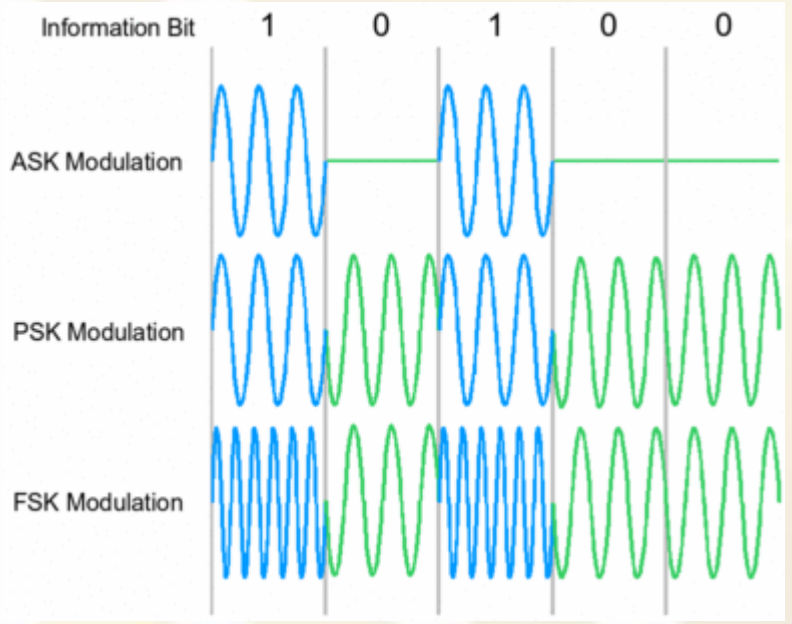
$$m(t) = \mathrm{A}_{\emptyset}\sin(w_m t)$$

Data (Low Freq)





Digital Modulation



Other Modulations