Introduction:

Communication systems: used to transmit information bearing signals through a communication channel.

The proper utilization of the communication channel requires a shift (called modulation) of the range of the baseband frequencies into other frequency ranges suitable for transmission (reverse of the receiver).

Modulating wave ≜ baseband (original) signal.

Modulated wave ≜ result of carrier modulating.

Amplitude modulation

Consider:

$$C(t) = Ac\ \cos(2 * \pi * fc * t)$$

Sinusoidal carrier wave Ac & fc are the carrier Amplitude & carrier frequency.

Let:

m(t)= Original signal (baseband message)

Define:

Amplitude modulation (AM): It is a process in which the amplitude of the carrier wave C(t) is varied about a mean value, linearly with the baseband signal m(t).

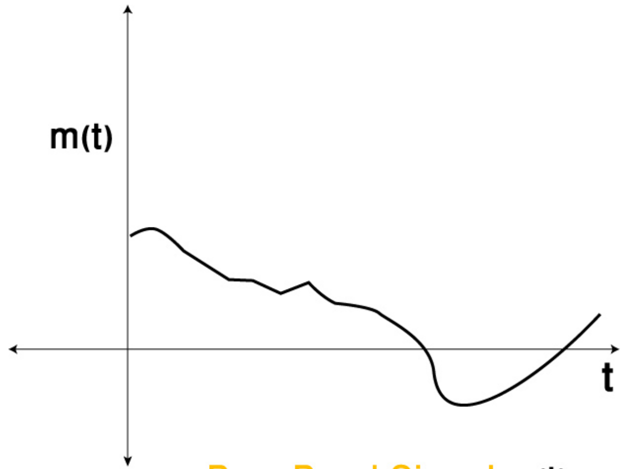
$$S(t) = Ac\ [1 + Ka\, m(t)]\ \cos(2\pi * fc * t)$$

S(t): Amplitude modulated wave.

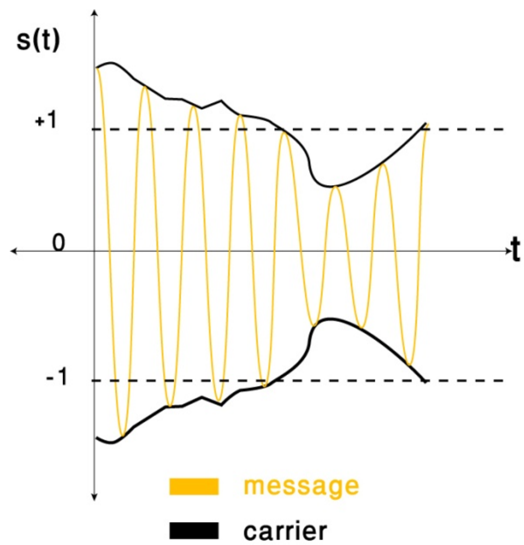
Ka: Amplitude sensitivity.

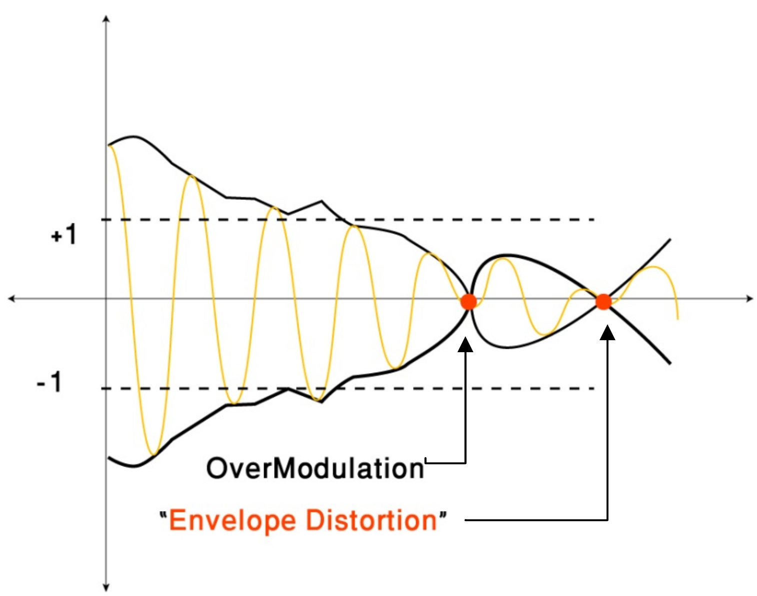
m(t): can be normalized.

Ac & m(t) are measured in volts ⟶ Ka is measured in volts^{-1}.



BaseBand Signal m(t)





Figures show the baseband signal m(t) & the corresponding AM wave S(t) for two values of amplitude sensitivity Ka & a carrier amplitude A_c=1 volt.

- ❖ The envelop of S(t) has (essentially) the same shape as the baseband signal m(t), provided that
    1. The amplitude of (Ka m(t)) is always less than unity

$$|K_a m(t)| < 1 \quad for\ all\ t$$

Figure 3.1b:

$|Ka\, m(t)| < 1 \quad for\ all\ t \longrightarrow 1 + Ka\, m(t) > 1 \longrightarrow$ the envelop is a positive function.

- ❖ When the amplitude sensitivity Ka of the modulator is large enough to make $|K_a m(t)| > 1$ for any time, the carrier wave becomes "Overmodulated".

- Overmodulated: resulting in carrier phase reversals whenever the factor $1 + K_a m(t)$ crosses zero.
- The modulated wave exhibits "envelop distortion" Fig. 3.1c

By avoiding overmodulation (restricting $|K_a m(t)| < 1$), a one-to-one relation is maintained between the envelope of the AM wave & the modulating wave (original baseband) for all time.

- ❖ The percentage modulation: is the absolute maximum value of (K_a m(t) * 100)

(100 K_a m(t) ← % modulation)

second requirement for the envelop s(t) to have the same shape as the baseband m(t) signal- is:

The carrier frequency fc is much greater than the highest frequency component W of the message signal m(t),

fc ≫ W, where W: message bandwidth
fc: carrier frequency

If ($f_c \gg W$) is NOT satisfied, an envelope cannot be visualized (hence cannot be detected) satisfactorily.