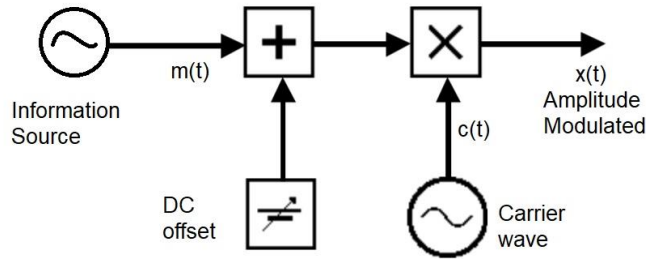


Amplitude Modulation

Time Domain Representation



$$x_{AM}(t) = (A_c + m(t))c(t)$$

$$x_{AM}(t) = (A_c + m(t))A_c \cos(2\pi f_c t)$$

$$x_{AM}(t) = A_c^2 \left(1 + \frac{m(t)}{A_c} \right) \cos(2\pi f_c t)$$

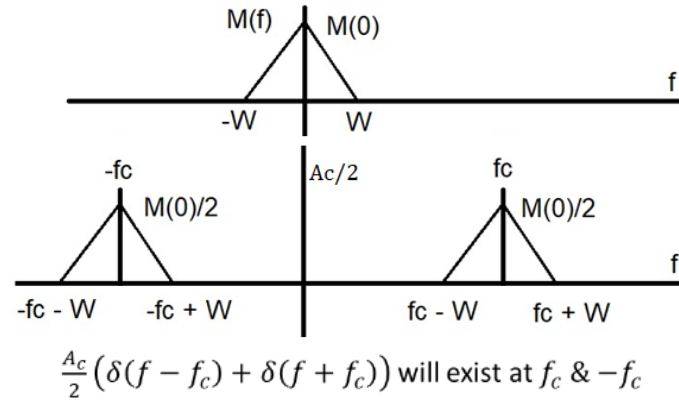
$$x_{AM}(t) = A'_c \left(1 + \frac{A_m m(t)}{A_m A_c} \right) \cos(2\pi f_c t)$$

$$x_{AM}(t) = A'_c \left(1 + \frac{A_m m(t)}{A_c A_m} \right) \cos(2\pi f_c t)$$

$$x_{AM}(t) = A'_c (1 + a m_n(t)) \cos(2\pi f_c t)$$

Modulation index $a = \frac{A_m}{A_c}$ Normalized message $m_n(t) = \frac{m(t)}{A_m}$

Frequency Domain Representation



$$m(t) \leftrightarrow M(f)$$

$$x_{AM}(t) = (A_c + m(t)) \cos(2\pi f_c t)$$

$$x_{AM}(t) = A_c \cos(2\pi f_c t) + m(t) \cos(2\pi f_c t)$$

$$\cos(2\pi f_0 t + \theta) \leftrightarrow \frac{1}{2} (e^{j\theta} \delta(f - f_0) + e^{-j\theta} \delta(f + f_0))$$

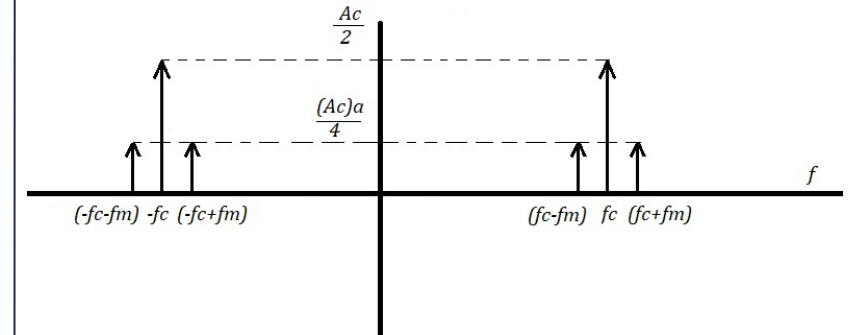
$$A_c \cos(2\pi f_c t) \leftrightarrow \frac{A_c}{2} (\delta(f - f_c) + \delta(f + f_c))$$

$$x(t) \cos(2\pi f_0 t) \leftrightarrow \frac{1}{2} (X(f - f_0) + X(f + f_0))$$

$$m(t) \cos(2\pi f_c t) \leftrightarrow \frac{1}{2} (M(f - f_c) + M(f + f_c))$$

$$X_{AM}(f) = \frac{A_c}{2} (\delta(f - f_c) + \delta(f + f_c)) + \frac{1}{2} (M(f - f_c) + M(f + f_c))$$

Single-tone AM



$$m(t) = \cos(2\pi f_m t) \leftrightarrow \frac{1}{2} (\delta(f - f_m) + \delta(f + f_m))$$

$$c(t) = A_c \cos(2\pi f_c t) \leftrightarrow \frac{A_c}{2} (\delta(f - f_c) + \delta(f + f_c))$$

$$x_{AM}(t) = A_c [1 + a \cos(2\pi f_m t)] \cos(2\pi f_c t)$$

$$= A_c \cos(2\pi f_c t) + A_c a \cos(2\pi f_m t) \cos(2\pi f_c t)$$

$$\cos(\alpha + \beta) = \cos \alpha \cos \beta - \sin \alpha \sin \beta$$

$$\cos(\alpha - \beta) = \cos \alpha \cos \beta + \sin \alpha \sin \beta$$

$$\cos(\alpha + \beta) + \cos(\alpha - \beta) = 2 \cos \alpha \cos \beta$$

$$\cos \alpha \cos \beta = \frac{\cos(\alpha + \beta) + \cos(\alpha - \beta)}{2}$$

$$= A_c \cos(2\pi f_c t) + \frac{A_c a}{2} [\cos(2\pi(f_c - f_m)t) + \cos(2\pi(f_c + f_m)t)]$$

$$x_{AM}(t) = A_c \cos(2\pi f_c t) + \frac{A_c a}{2} \cos(2\pi(f_c - f_m)t) + \frac{A_c a}{2} \cos(2\pi(f_c + f_m)t)$$

$$X_{AM}(f) = \frac{A_c}{2} (\delta(f - f_c) + \delta(f + f_c)) + \frac{A_c a}{2} \left[\frac{(\delta(f - (f_c - f_m)) + \delta(f + (f_c - f_m)))}{2} \right] + \frac{A_c a}{2} \left[\frac{(\delta(f - (f_c + f_m)) + \delta(f + (f_c + f_m)))}{2} \right]$$