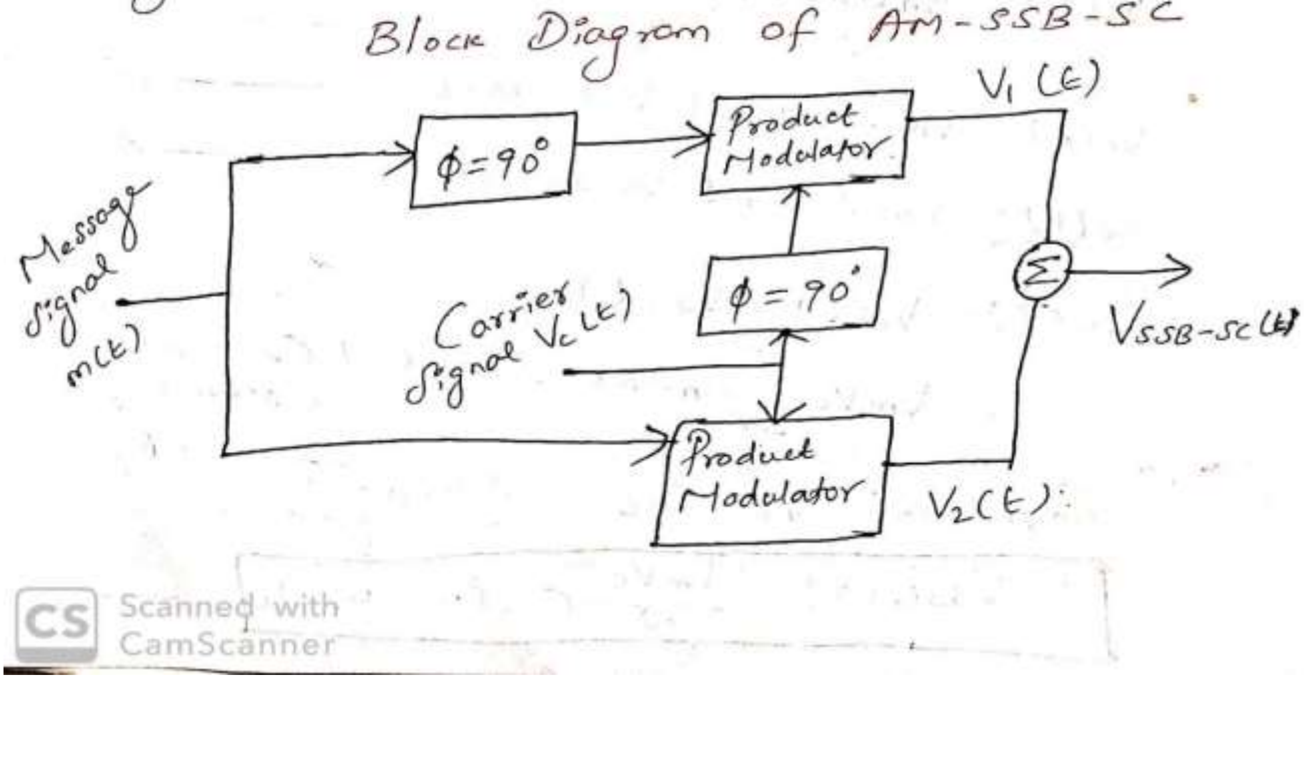
Single Sideband Suppressed Carrier [AM-SSB-SC]

In a DSB Signal, the basic information is transmitted twice, once in each Sideband.

The Sidebands are the sum and difference of the Carrier and modulating Signals, the information must be Contained in both of them. So either one sideband is enough for transmitting as well as recovering the useful message.

One Sideband may be Suppressed. The remaining Sideband is called a Single Sideband Suppressed Carrier (SSBSC or SSB) Signal.

Block Diagram of AM-SSB-SC



Transmission Bandwidth:-

SSB requires half of the bandwidth of the DSB-SC and use less transmitted power.

$$BW = f_m$$

The bandwidth of SSB-SC signal is f_m same as the bandwidth of the baseband signal.

Inorder to suppress one of the sidebands, the i/p signal fed to the modulator 1 is 90° out of phase with that of the signal fed to the modulator 2.

Expression for SSB-SC:-

$$V_1(t) = V_m \sin(\omega_m t + 90) V_c \sin(\omega_c t + 90) \quad \text{——— (1)}$$

$$V_1(t) = V_m \cos \omega_m t \, V_c \cos \omega_c t \quad \text{——— (2)}$$

$$V_2(t) = V_m \sin \omega_m t \, V_c \sin \omega_c t \quad \text{——— (3)}$$

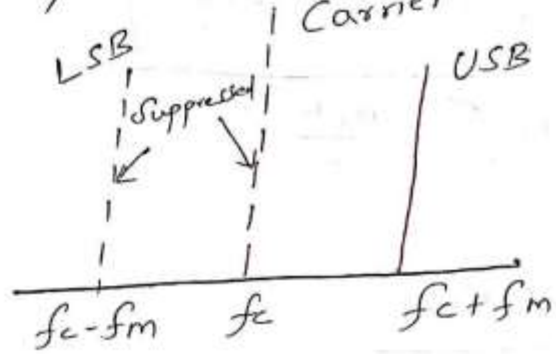
$$V_{SSB}(t) = V_1(t) + V_2(t)$$

$$= V_m V_c \left[\sin \omega_m t \cdot \sin \omega_c t + \cos \omega_m t \cos \omega_c t \right] \quad \text{——— (4)}$$

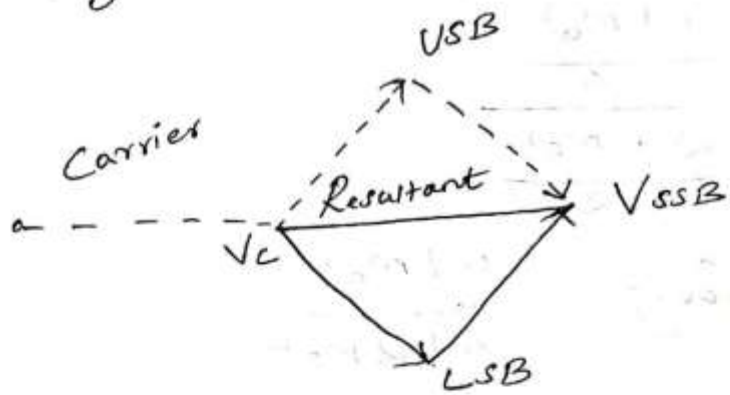
$$\sin A \sin B + \cos A \cos B = \frac{\cos(A-B)}{2}$$

$$\therefore V_{SSB}(t) = \frac{V_m V_c}{2} \cos(\omega_c - \omega_m)t \quad \text{——— (5)}$$

Frequency Spectrum of AM-SSBSC



Phasor Diagram of SSB-SC AM:-



Power Calculation:-

Total Power Saved in SSB-SC-AM

Power in SSB-SC-AM is

$$P_t'' = P_{SB} = \frac{1}{4} m_a^2 P_c \quad \text{—— (6)}$$

$$\text{Power Saving} = \frac{P_t - P_t''}{P_t} \qquad \because P_t = P_c\left[1 + \frac{m_a^2}{2}\right]$$

P_t = Total Power bandwidth

$$= \frac{\left[1 + m_a^2/2\right] P_c - \left[m_a^2/4 \, P_c\right]}{P_c\left[1 + \frac{m_a^2}{2}\right]}$$

$$= \frac{P_c\left[1+\frac{m_a^2}{2}-\frac{m_a^2}{4}\right]}{P_c\left[1+\frac{m_a^2}{2}\right]}$$

$$= \frac{1+m_a^2/4}{1+m_a^2/2}$$

$$= \frac{\frac{4+m_a^2}{4}}{\frac{2+m_a^2}{2}}$$

$$\text{Power Saving} = \frac{4+m_a^2}{4+2m_a^2}$$

If $m_a = 1$ then % power Saving = 5/6 = 83.33%.

In addition to carrier, one of the Sidebands is also Suppressed the power Savings is 83.33% over AM with carrier.

Advantages of SSB:-

(i) Bandwidth is half of that required by DSBFC System

(ii) Transmitter power requirement is reduced

(iii) Noise reduced, so better quality of reception

Disadvantages:-

(i) Transmission and reception of SSB becomes more Complex.

(ii) SSB receivers requires Precise tuning

Applications:-

(i) Point to point radio telephone Communications

(ii) SSB telegraph System

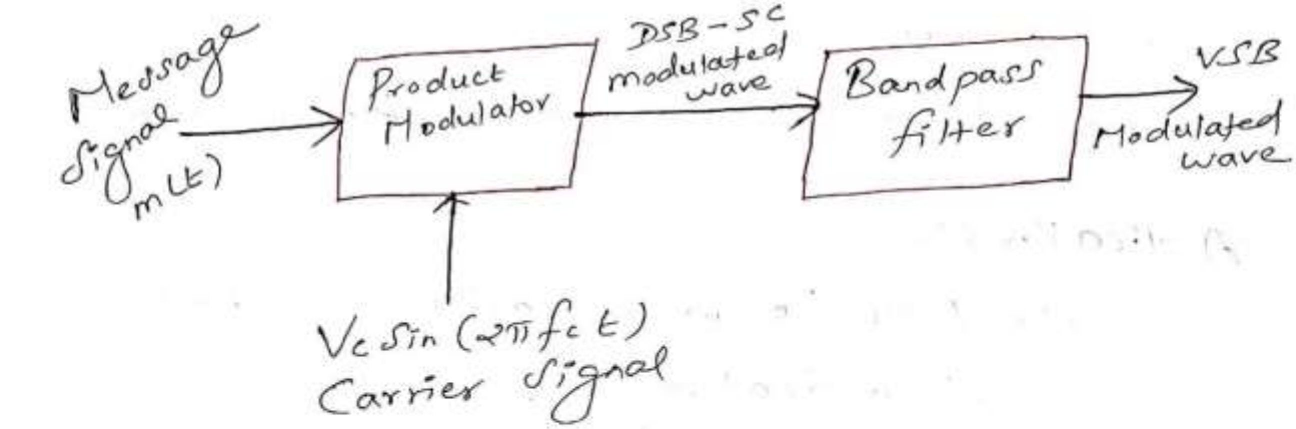
(iii) Police wireless Communication

(iv) VHF and UHF Communication.

Vestigial Sideband (VSB) modulation:-

In VSB Modulation, the desired Sideband is allowed to pass Completely. whereas just a Small portion (called vestige (or) trace) of the Undesired Sideband is allowed. The transmitted Vestige of the Undesired Sideband Components for the loss of the wanted Sidebands.

Generation of VSB [filter method]



The Product modulator generates DSB-SC Signal from the message and Carrier Signal.

Magnitude response of VSB filter :-

Here f_c to $f_c + f_m$ is upper Side band (USB) Its portion from f_c to $f_c + f_v$ is Suppressed partially

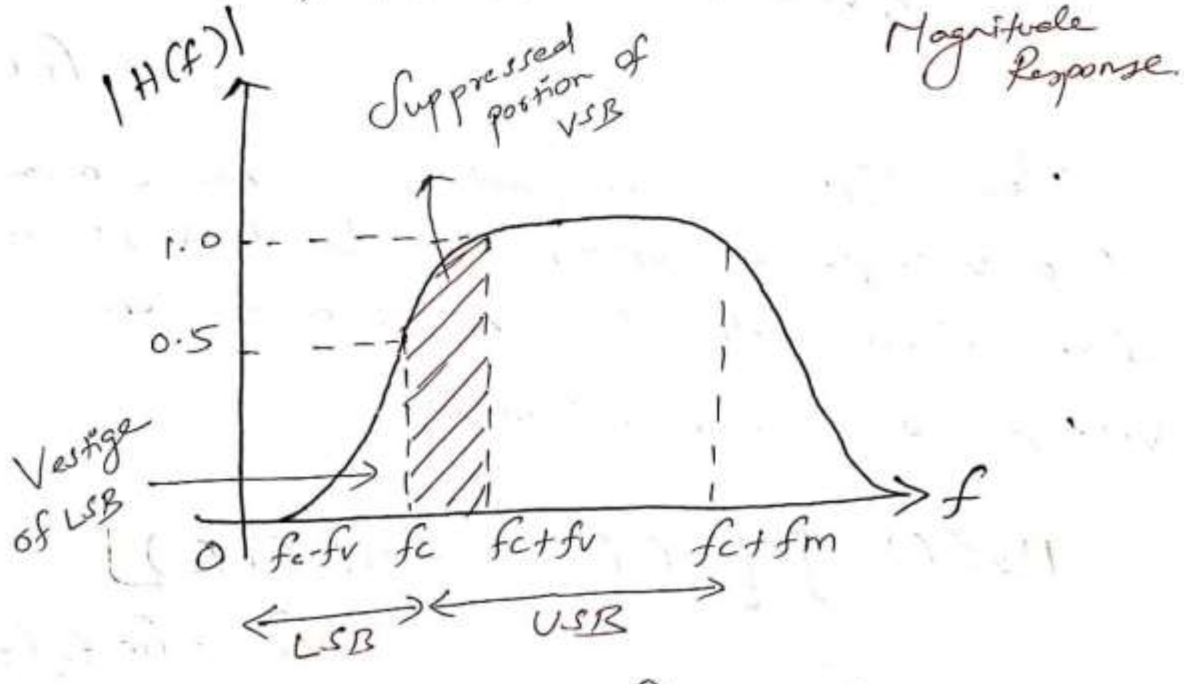
f_c to $f_c - f_m$ is lower Sideband (LSB) Its portion $f_c - f_v$ to f_c is to be transmitted as vestige

The filter response is only for Positive frequencies. This frequency response is normalized, So that at the Carrier frequency $|H(f_c)| = 1/2$

In the transition interval $f_c - f_v \leq |f| \leq f_c + f_v$, the following two conditions are satisfied

1) The sum of the values of magnitude response $|H(f)|$ at any two frequencies equally displaced above & below f_c is unity

2) The phase response arg $|H(f)|$ is linear



H(f) satisfies the condition:-

$$H(f - f_c) + H(f + f_c) = 1 \text{ for } -f_m \leq f \leq f_m$$

Transmission bandwidth:-

$$B_T = f_m + f_v$$

f_m - message bandwidth
f_v - width of the VSB

The VSB modulated wave is described in time domain as

$$s(t) = \frac{1}{2} V_c m(t) \cos(2\pi f_c t) \pm \frac{1}{2} V_c m'(t) \sin(2\pi f_c t)$$

Plus sign Corresponds to the transmission of a vestige of upper side band & minus sign Corresponds to the transmission of a vestige of lower sideband

$$H_2(f) = j\left[H(f-f_c) - H(f+f_c)\right] \quad \text{for } -f_m \le f \le f_m$$

Advantages of VSB:-

(i) Low frequencies, near f_c are transmitted without any attenuation

(ii) Bandwidth is reduced Compared to DSB

(iii) The filter required need not have a Sharp Cut-off

Applications:-

VSB is used in television for transmission of picture signal.