# Vestigial Side Band Suppressed Carrier Modulation :⇒

## VSB-SC Modulation :⇒

* A VSB-SC modulation system is actually a compromise between DSB-SC and SSB-SC modulation system. The generation of VSB modulation signals is easier than the conventional AM, DSB-SC and SSB-SC modulation signals.

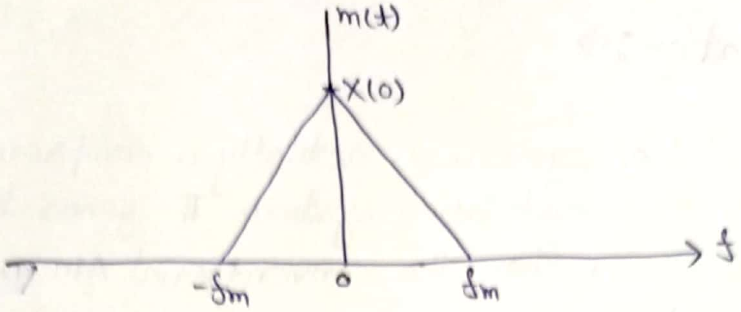
* Its band width is only slightly higher (≃25%) than SSB signals but considerable less than DSB-SC signals.

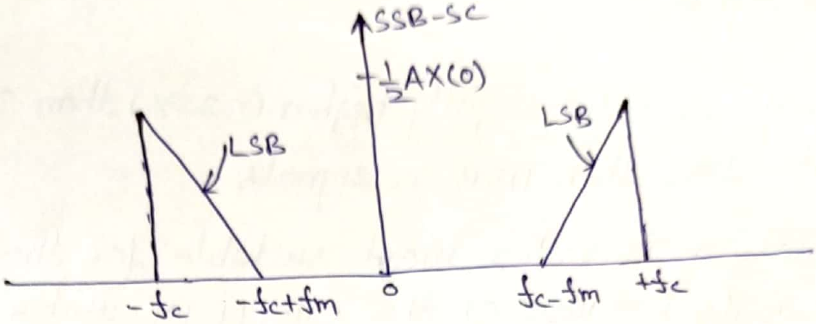
* SSB modulation is rather most suitable for the transmission of voice signals because of the energy gap that exists in the frequency spectrum of the voice signals between (0 to 100Hz)

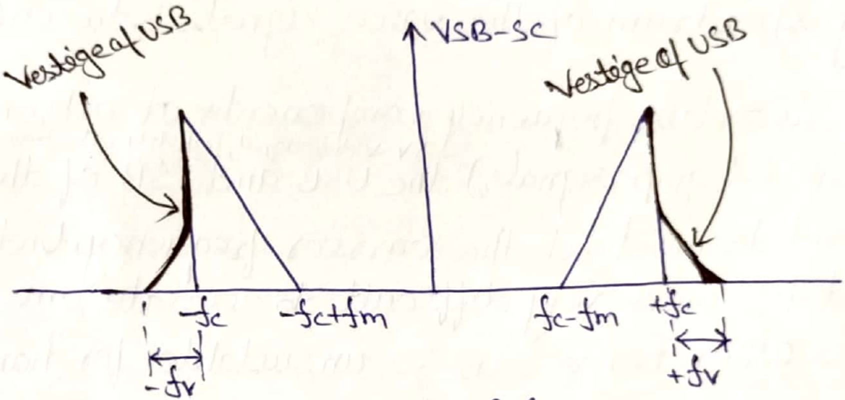
* When signals contain frequency components at extremely low frequencies (as in telegrap signals, TV video signal, high data rate transmission) the USB and LSB of the translated signal tend to meet at the carrier frequency, Under such circumstances, it becomes very difficult to isolate one side band from the other. hence SSB-SC unsuitable for handling such types of signals.

* This difficulty has been overcome in a scheme known as VSB-SC modulation. In VSB-SC modulation, one side band passed completely as in SSB-SC modulation but a gradual cut-off of other side band is allowed, which comes due to the use of practical filter. this gradual cut is compensated by a vestige or portion of the other side band.

## Spectrum :⇒




$BW = (f_c + f_v) - (f_c - f_m)$

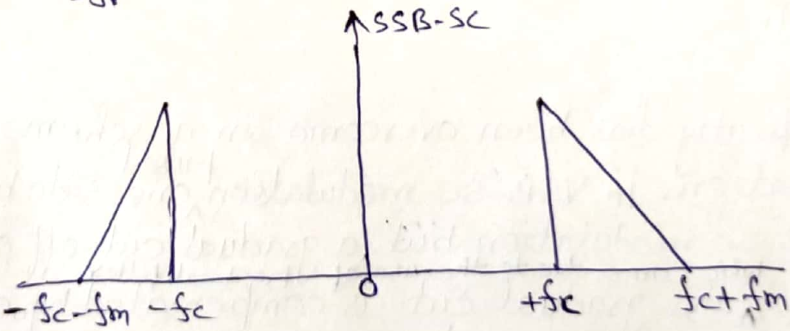
$= f_c + f_v - f_c + f_m$

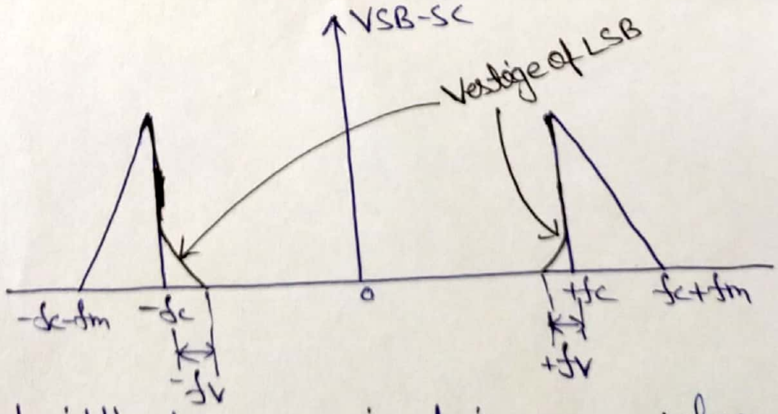
$= f_m + f_v$

where,

$f_m \rightarrow$ Bandwidth of bandlimited message signal

$f_v \rightarrow$ Bandwidth of the vestige in frequency.




The bandwidth of VSB-sc signal is

$BW = (f_c + f_m) - (f_c + f_v)$

$= f_m + f_v$

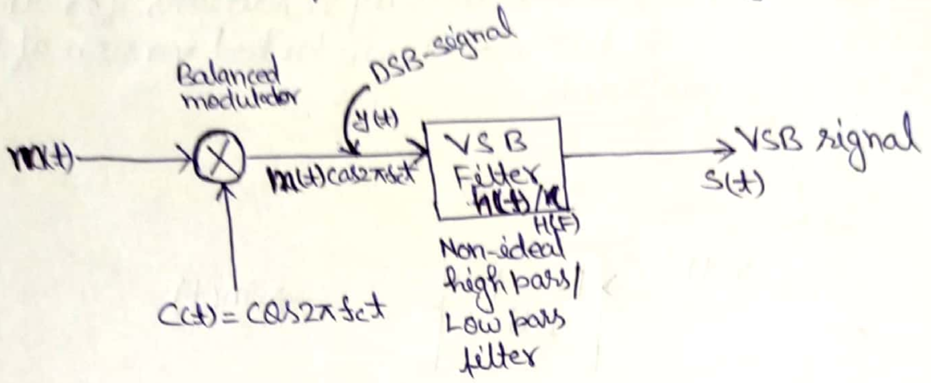
where,

$f_m$ = Band width of m(t)

$f_v$ = Band width of VSB signal

## Generation of VSB-SC signals :⇒

VSB signal can be generated by passing a DSB-SC signal through an appropriate filter (VSB-Filter) having transfer function $H(f)$.




The output of the balanced modulator is given by

$$y(t) = m(t)\cos 2\pi f_c t$$

and the output of VSB signal is

$$S(t) = [m(t).\cos 2\pi f_c t] * h(t)$$

(* ← convalution)

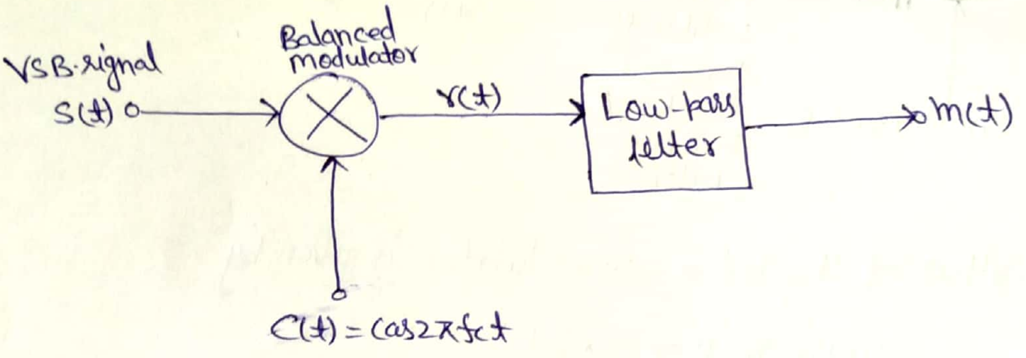
The frequency spectrum of VSB signal is

$$S(F) = \frac{1}{2}[M(F-F_c)+M(F+F_c)] \cdot H(F)$$

(· ← Product)

## Demodulation of VSB-SC signals:⇒

VSB signal $s(t)$ can be demodulated by passing through a coherent detector without distortion. now derive the expression for transfer function $H(F)$ by determining the necessary conditions for the coherent detection output to provide undistorted version of the original modulating signal $m(t)$.




the output of product modulator is

$$r(t) = s(t)\cos 2\pi f_c t$$

Taking the F.T.

$$R(F) = \frac{1}{2}\left[S(F-F_c) + S(F+F_c)\right]$$

we know that

$$S(F) = \frac{1}{2}\left[M(F-F_c) + M(F+F_c)\right] \cdot H(F)$$

Therefore,

$$R(F) = \frac{1}{2}\left\{\frac{1}{2}\left[M(F-F_c-F_c) + M(F-F_c+F_c)\right] H(F-F_c)\right\}$$

$$+ \frac{1}{2}\left\{\frac{1}{2}\left[M(F+F_c-F_c) + M(F+F_c+F_c)\right] H(F+F_c)\right\}$$

$$= \underline{\frac{1}{4}M(F-2F_c)H(F-F_c)} + \frac{1}{4}M(F)H(F-F_c) + \frac{1}{4}M(F)H(F+F_c)$$

$$+ \underline{\frac{1}{4}M(F+2F_c)H(F+F_c)}$$

$$= \underline{\frac{1}{4}\left[M(F-F_c)\cdot H(F-F_c) + M(F+2F_c)\cdot H(F+F_c)\right]}$$ ↳ These can be eliminated by LPF (Low pass filtering)

$$+ \frac{1}{4}M(F)\left[H(F-F_c) + H(F+F_c)\right]$$

hence the output of LPF

$$\breve{R}(F) = \frac{1}{4}M(F)\underbrace{\left[H(F-F_c) + H(F+F_c)\right]}_{\text{constant}}$$

OR $\breve{R}(F) = \frac{1}{4}M(F) \longleftrightarrow \frac{1}{4}[m(t)]$ we have recovered our original message signal $m(t)$

because non-ideal VSB filter must satisfy

$$H(F-F_c)+H(F+F_c)=1$$