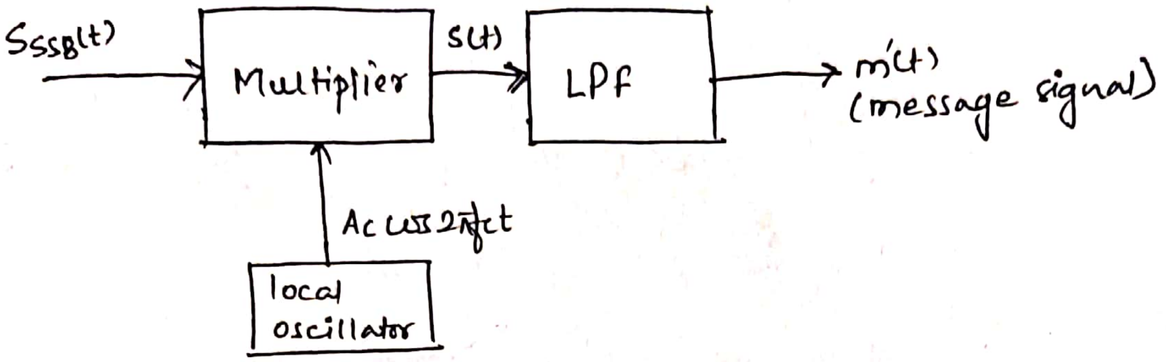
Demodulation of SSB-SC modulated signal :-

→ Synchronous (Coherent) Detector :-

Block diagram:-



→ for theory part of the working of this detector, you have to take a look in the demodulation section of DSB-SC.

Here, I will deal with mathematical evaluations only.

General expression $S_{SSB}(t) = \frac{A_c m(t)}{2} \cos 2\pi f_c t \mp \frac{A_c \hat{m}(t)}{2} \sin 2\pi f_c t$

Case 1:- locally generated carrier is perfectly phase synchronized with carrier wave $c(t)$ in SSB-SC signal.

$$(LO)_{o/p} = A_c \cos 2\pi f_c t$$

Multiplier o/p :-

$$s(t) = S_{SSB}(t) \cdot A_c \cos 2\pi f_c t$$

$$= \frac{A_c^2 m(t)}{2} \cos^2 2\pi f_c t \mp \frac{A_c^2 \hat{m}(t)}{2} \sin 2\pi f_c t \cos 2\pi f_c t$$

$$= \frac{A_c^2 m(t)}{4} (1 + \cos 4\pi f_c t) \mp \frac{A_c^2 \hat{m}(t)}{2} \cdot \frac{\sin 4\pi f_c t}{2}$$

$$\left[\because \cos^2\theta = \frac{1+\cos 2\theta}{2}, \quad \sin\theta \cdot \cos\theta = \frac{\sin 2\theta}{2} \right]$$

$\therefore$

$$s(t) = \frac{A_c^2 m(t)}{4}(1+\cos 4\pi f_c t) \mp \frac{A_c^2 \hat{m}(t)}{4} \sin 4\pi f_c t$$

$$= \frac{A_c^2 m(t)}{4} + \frac{A_c^2 m(t)}{4}\cos 4\pi f_c t \mp \frac{A_c^2 \hat{m}(t)}{4}\sin 4\pi f_c t$$

the low pass filter will allow only the 1st term to pass through and will reject all other terms.

So, $(LPF) o/p = \boxed{m'(t) = \frac{A_c^2 m(t)}{4}}$

<u>Case 2</u> :- If LO generated carrier and carrier wave c(t) in SSB-SC is not perfectly phase synchronised.

then:-

$$(LO) o/p = A_c \cos(2\pi f_c t + \phi)$$

$$(MUL) o/p = s(t) = S_{SSB}(t) \cdot A_c \cos(2\pi f_c t + \phi)$$

$$= \frac{A_c^2 m(t)}{2}\cos 2\pi f_c t \cos(2\pi f_c t + \phi) \mp \frac{A_c^2 \hat{m}(t)}{2} \sin 2\pi f_c t \cdot \cos(2\pi f_c t + \phi)$$

$$= \frac{A_c^2 m(t)}{4}\cos(4\pi f_c t + \phi) + \frac{A_c^2 m(t)}{4}\cos\phi$$

$$\mp \frac{A_c^2 \hat{m}(t)}{4}\sin(4\pi f_c t + \phi) \pm \frac{A_c^2 \hat{m}(t)}{4}\sin\phi$$

Here, LPF will allow 2nd & 4th term to pass and will reject 1st and 3rd term.

$$\therefore (LPF) o/p = m'(t) = \frac{A_c^2 m(t)}{4}\cos\phi \pm \frac{A_c^2 \hat{m}(t)}{4}\sin\phi$$

Now, (i) if $\phi = 0 \Rightarrow \boxed{m'(t) = \frac{A_c^2 m(t)}{4}}$

<ii> if $\phi = 90^\circ$, $m'(t) = \pm \frac{A_c^2 \hat{m}(t)}{4}$

So, unlike DSB-SC demodulation we are getting output for ~~...~~ $\phi = 90^\circ$ ie we don't have null or zero o/p in the detector.

∴ we can say that SSB-SC signal is not affected by Quadrature Null Effect (QNE).

⇒ This is an advantage of SSB-SC over DSB-SC.

Note:-
Here, in case of no phase synchronization, we have

$$\hat{m}'(t) = \frac{A_c^2 m(t)}{4}\cos\phi \pm \frac{A_c^2 \hat{m}(t)}{4}\sin\phi$$

Such a phase distortion does not have serious effects with the voice communication. But in the transmission of music and video it will have untolerable effects.

Advantages of SSB-SC signal :-

1. Bandwidth or spectrum space occupied is lesser than AM and DSB-SC signals.
2. Transmission power is saved as compared to AM & DSB-SC
3. No Affect of QNE.

Disadvantages of SSB-SC :-

1. The Generation and detection (or demodulation) process is complex.
2. Limited only for voice signal transmission.