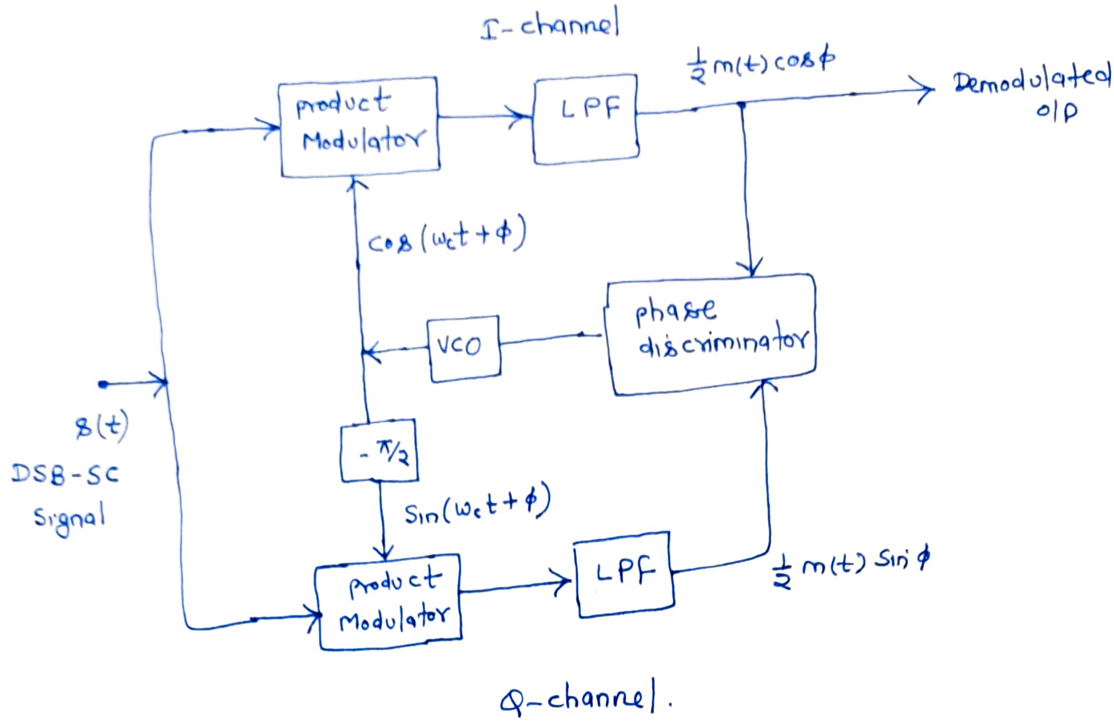
Costas Receiver (DSB-SC)



$s(t) = m(t)\cos\omega_c t$ ...DSB-SC signal

o/p of I-channel $= \frac{1}{2}m(t)\cos\phi$

o/p of Q-channel $= \frac{1}{2}m(t)\sin\phi$

⇒ o/p of I- and Q-channels are coupled together to form -ve feedback system designed in such a way as to maintain the local oscillator synchronous with the carrier wave.

⇒ Let the local oscillator (VCO) signal is of the same phase as the carrier wave $A_c\cos\omega_c t$, i.e. $\phi=0$

∴ o/p of I-channel $= \frac{1}{2}m(t)$ .... desired demodulated signal.

o/p of Q-channel $= 0$

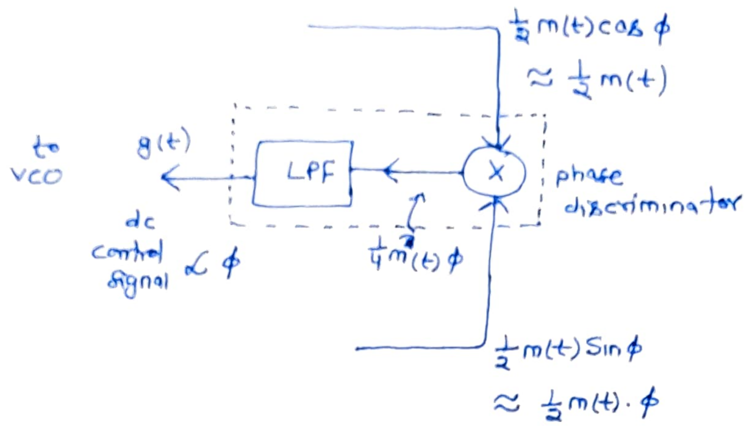
⇒ Now, suppose the local oscillator phase drifts from its proper value by a small angle ϕ radians.

o/p of I-channel $= \frac{1}{2}m(t)\cos\phi \approx \frac{1}{2}m(t)$

o/p of Q-channel $= \frac{1}{2}m(t)\sin\phi \approx \frac{1}{2}m(t).\phi$

as $\cos\phi\approx 1$ and $\sin\phi\approx\phi$ for small ϕ.

⇒ phase discriminator consists of a multiplier followed by a LPF.



o/p of LPF $\propto \phi$

o/p of multiplier $= \frac{1}{4}m^2(t)\,\phi$

$$g(t) = \text{o/p of LPF (time averaging unit)} = \frac{1}{2T}\int_{-T}^{T} \frac{1}{4}\phi\, m^2(t)\,dt$$

$$= \frac{1}{4}\phi \underbrace{\frac{1}{2T}\int_{-T}^{T} m^2(t)\,dt}_{\substack{\text{power of } m(t) \\ \text{(constant)} = k}}$$

$$g(t) = \frac{k}{4}\phi$$

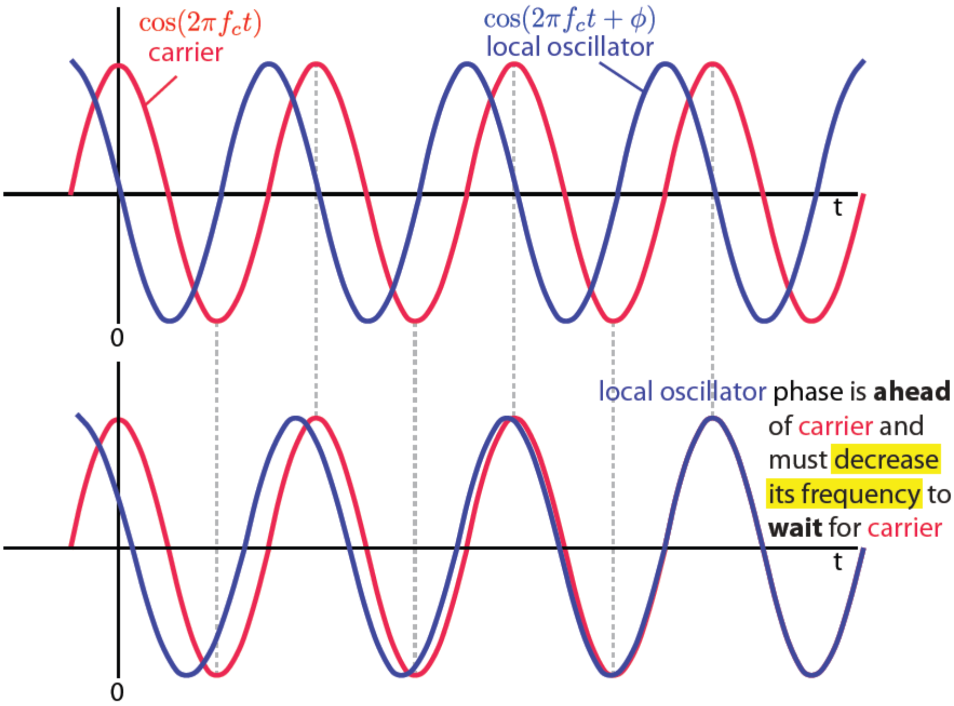
$\therefore$ o/p of LPF $\propto \phi$ or $g(t) \propto \phi$

and is the same sign as the phase error ϕ.

⇒ If $g(t) > 0$ (or $\phi > 0$), then the VCO will decrease from f_c proportional to the value of $g(t)$ (or ϕ).

⇒ If $g(t) < 0$ (or $\phi < 0$), then the VCO will increase from ~~the~~ f_c proportional to the value of $g(t)$. (or ϕ).

$\phi > 0$: Freq of local oscillator needs to temporarily decrease



$\phi < 0$: Freq of local oscillator needs to temporarily increase