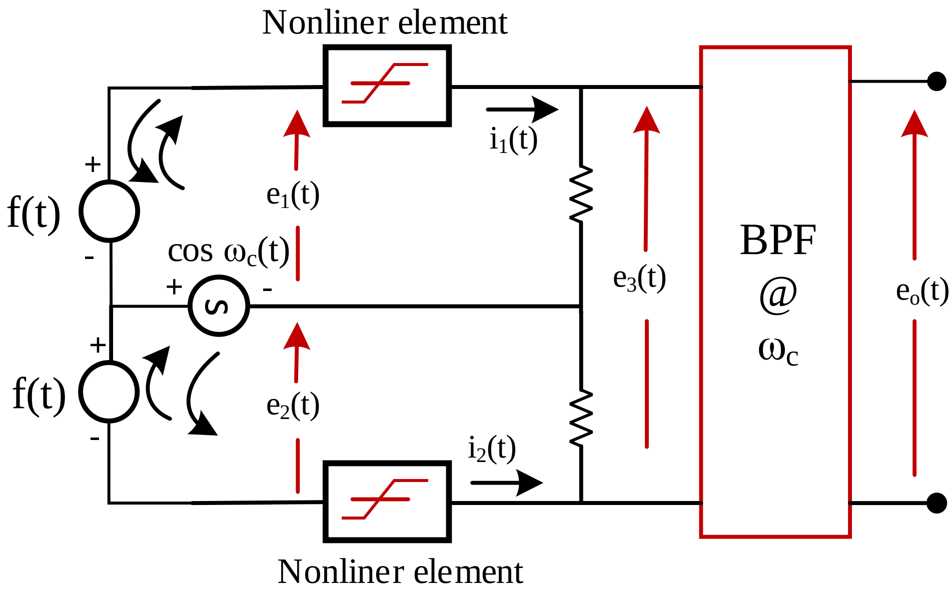


From above figure

$$e_1(t) = cos\omega_c t + f(t)$$

$$e_2(t) = cos\omega_c t - f(t)$$

Taking the first two terms only

$$i_1(t) = a_1[cos\omega_c t + f(t)] + a_2[cos\omega_c t + f(t)]^2$$

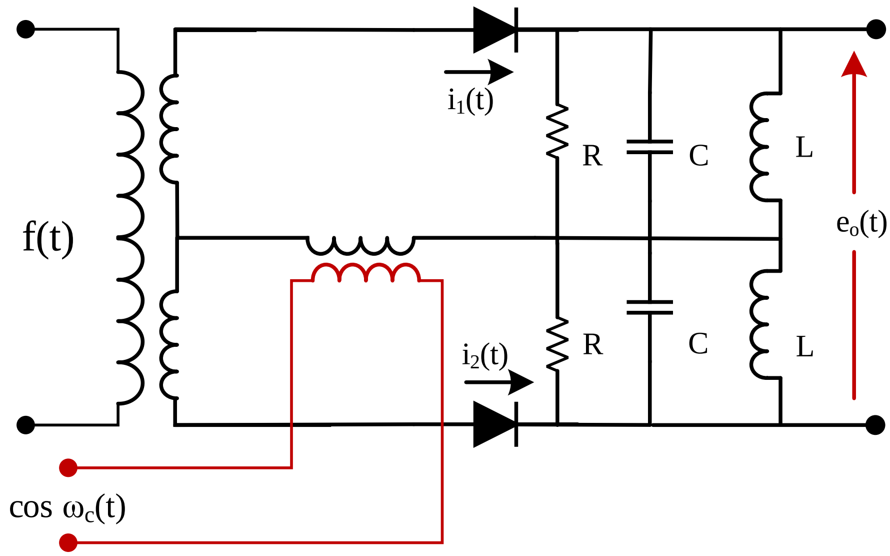
$$i_2(t) = a_1[cos\omega_c t - f(t)] + a_2[cos\omega_c t - f(t)]^2$$

$$e_3(t) = [i_1(t) - i_2(t)].R$$

$$= 4a_2R\left[\underline{f(t)cos\omega_c t} + \frac{a_1}{2a_2}f(t)\right]$$

Filtered by BPF

The schematic diagram of this modulator is shown below:

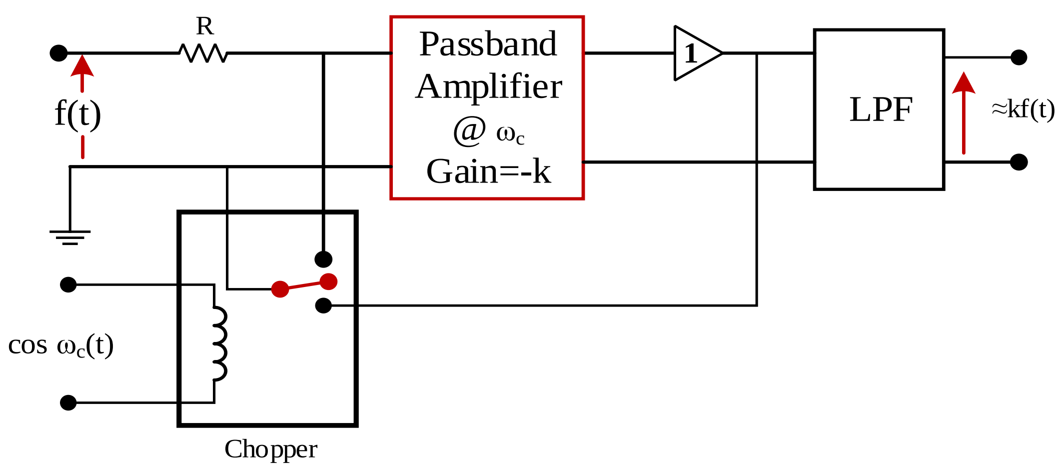


Demodulation (Detection) od DSB-SC Signals:

Since the received and locally generated carrier signals should be synchronized for correct detection, the detection process is accomplished using one of the following schemes:

1- Direct connection (Chopper Amplifier):

It may be used when the modulator and demodulator are near from each other.

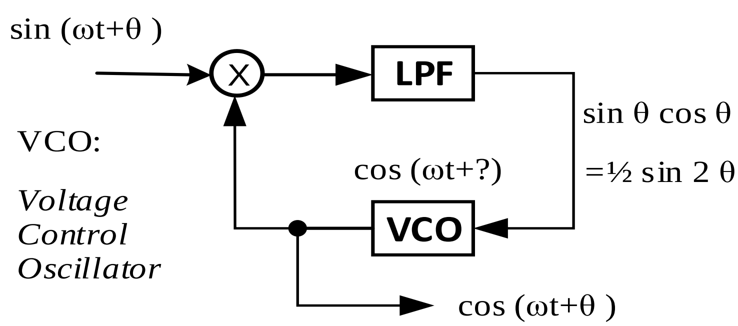


2- Pilot carrier system:

By supplying a sinusoidal signal related to carrier signal in frequency and phase when the demodulator and modulator are far from each other.

- The pilot carrier signal is transmitted outside the baseband of the modulated signal.
- A tuned circuit in the receiver detect this signal and use it to correctly synchronize the carrier signal using a circuit Phase-Locked Loop (PLL).

PLL



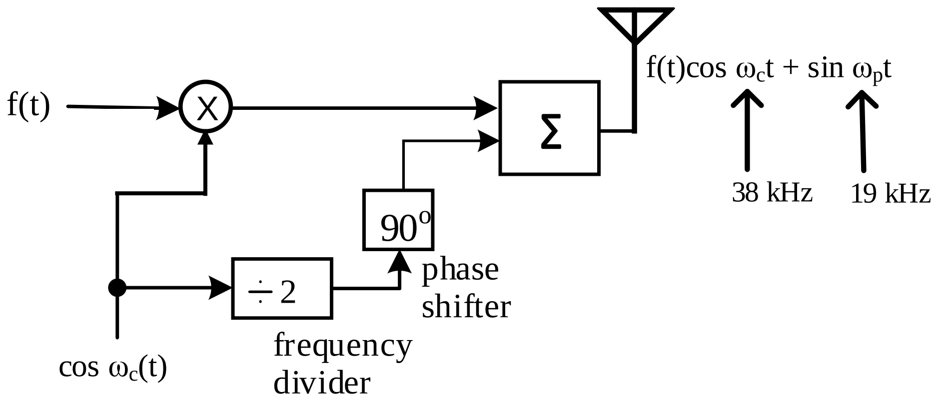
The output of LPF (sign and Magnitude) make VCO increase or decrease the phase of its signal proportional to the magnitude. If the output of LPF is zero, the phase is locked.

Ex 4-1:

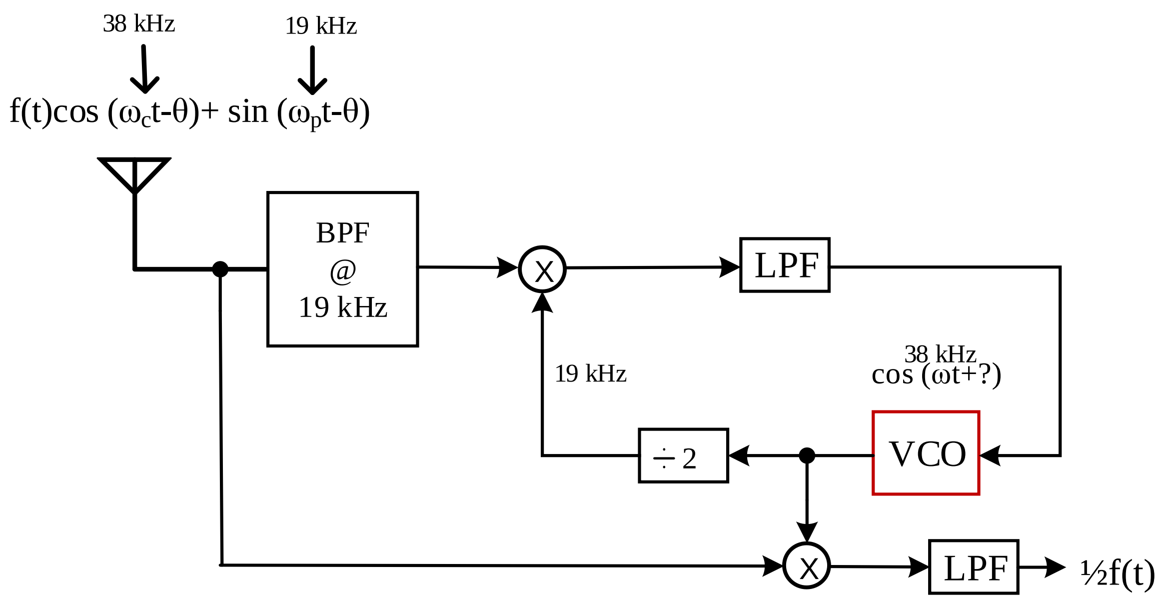
Draw the block diagram for AM/DSB-SC system uses a carrier frequency of 38 kHz and pilot carrier of 19 kHz.

Solution:

Tx:



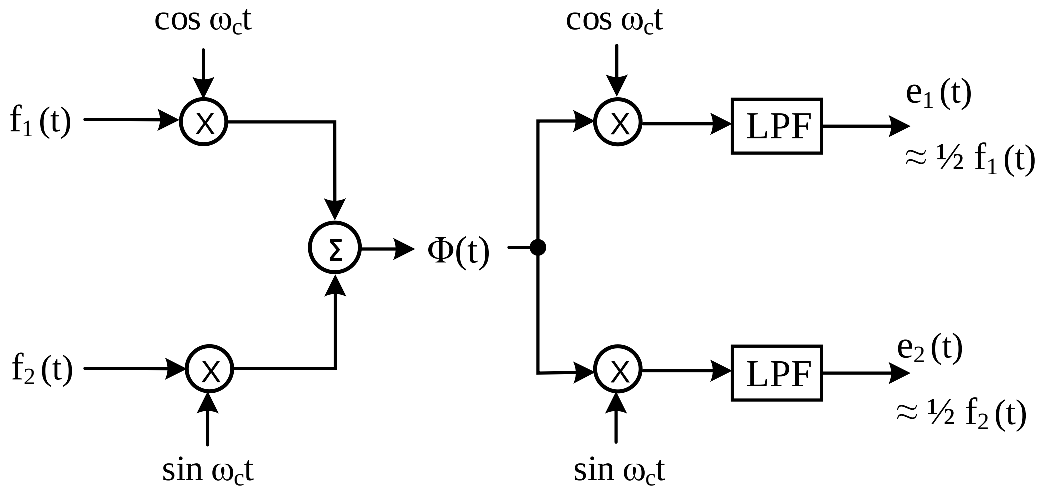
Rx:



- Since the pilot carrier has no actual information, it represents losses in the system.
- AM/DSB-SC is useful to obtain good performance in case of point-to-point communication (one Tx for each Rx).

Quadrature Multiplexing:

Using the orthogonality of sines and cosines make it possible to transmit and receive two different signals simultaneously on the same carrier frequency.



$$\emptyset(t) = f_1(t)cos\omega_c t + f_2(t)sin\omega_c t \qquad \dots (4\text{-}5)$$

$$\emptyset(t)cos\omega_c t = f_1(t)cos^2\omega_c t + f_2(t)sin\omega_c t\ cos\omega_c t$$

$$= \frac{1}{2}f_1(t) + \frac{1}{2}f_1(t)cos2\omega_c t + \frac{1}{2}f_2(t)sin2\omega_c t$$

$$\emptyset(t)sin\omega_c t = f_1(t)cos\omega_c t\ sin\omega_c t\ + f_2(t)sin^2\omega_c t$$

$$= \frac{1}{2}f_1(t)sin2\omega_c t + \frac{1}{2}f_2(t) - \frac{1}{2}f_2(t)cos2\omega_c t$$

In the low pass filter all terms at $2\omega_c$, are attenuated yielding:

$$e_1(t) = \frac{1}{2}f_1(t)$$

$$e_2(t) = \frac{1}{2}f_2(t)$$

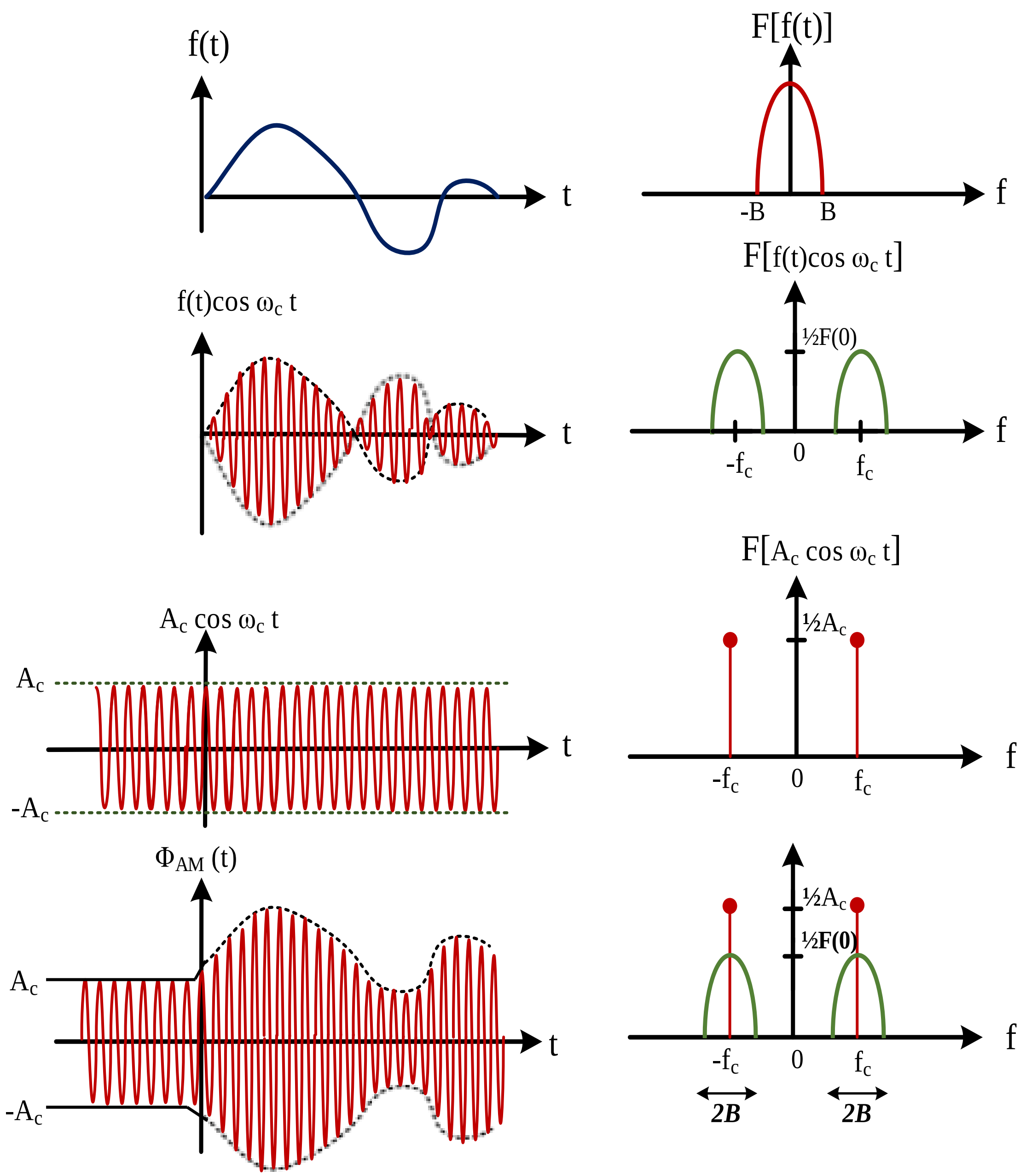
2 - AM/DSB-LC [Standard AM]:

For broadcast system (many Rx for each Tx) it is more economical to obtain less expensive receivers. For such a case, a larger signal is transmitted with the AM/DSB-SC to eliminate the need of local oscillator in Rx.

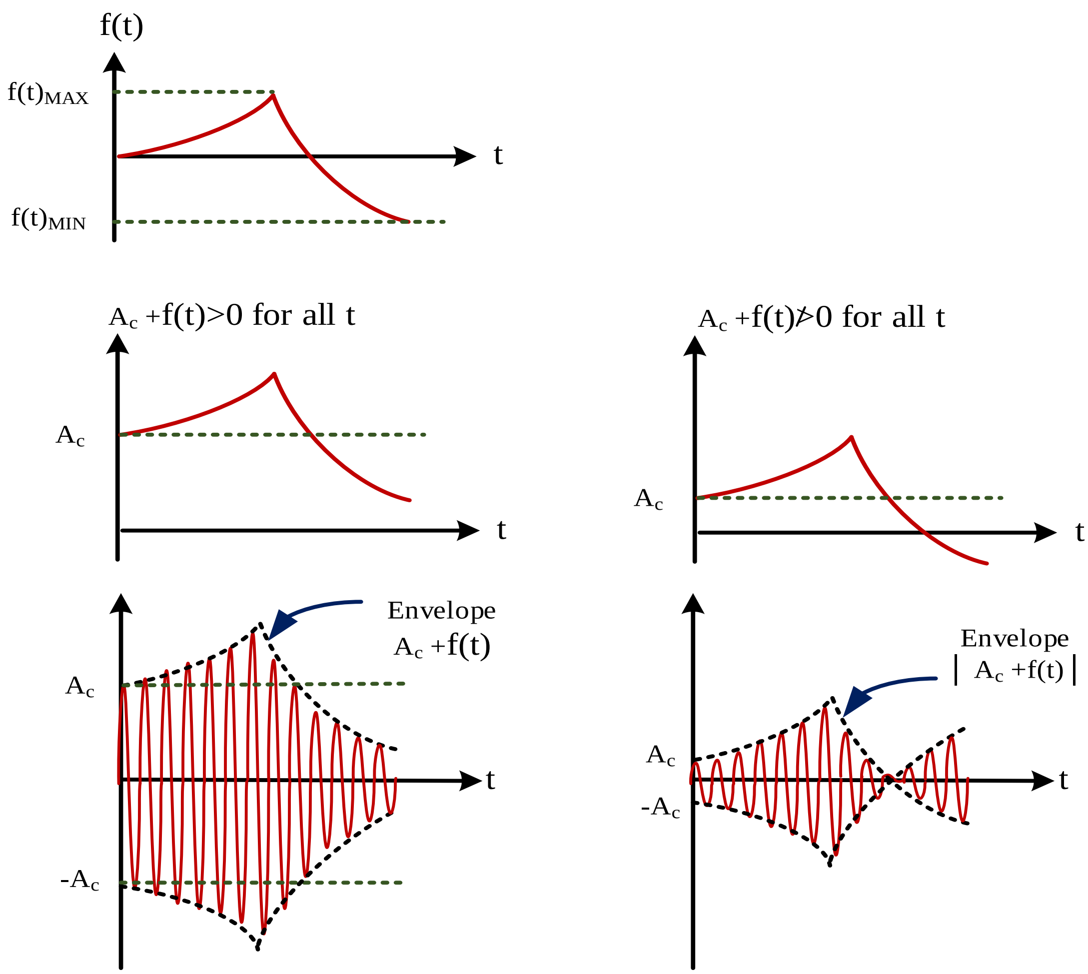
The AM/DSB-LC signal [AM signal] is given by:

$$\boxed{\begin{aligned}\Phi_{AM} &= f(t)cos\omega_c t + A_c cos\omega_c t \\ &= [f(t) + A_c]cos\omega_c t\end{aligned}} \qquad \ldots(4\text{-}6)$$

$$\Phi_{AM}(t) = \pi F(\omega+\omega_c) + \pi F(\omega-\omega_c) + \pi A_c\delta(\omega+\omega_c) + \pi A_c\delta(\omega-\omega_c)$$



The envelope of $\Phi_{AM}(t)$ is $A_c + f(t)$, if A_c is large enough to make $A_c + f(t)$ positive for all t. the recovery of $f(t)$ from $\Phi_{AM}(t)$ simply reduced to envelope detection:



$if\ A_c + f(t) > 0 \quad for\ all\ \ t$ "Envelope detector" (Low cost)

$if\ A_c + f(t)\ \le 0 \quad for\ all\ \ t$ "Synchronous detector" (High cost)

For envelope detection:

$$A_c + f(t) > 0 \quad or\ \ A_c \ge -f(t)_{min}$$