Noise in DSB-SC Receiver:

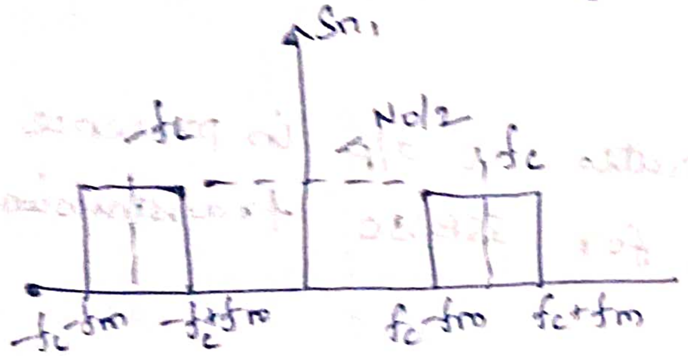
→ The range of transmitted frequency will be $f_c - f_m$ to $f_c + f_m$.

→ Bandwidth is increased to $2f_m$

→ The bandwidth of carrier filter is $2f_m$ to pass both the side bands.

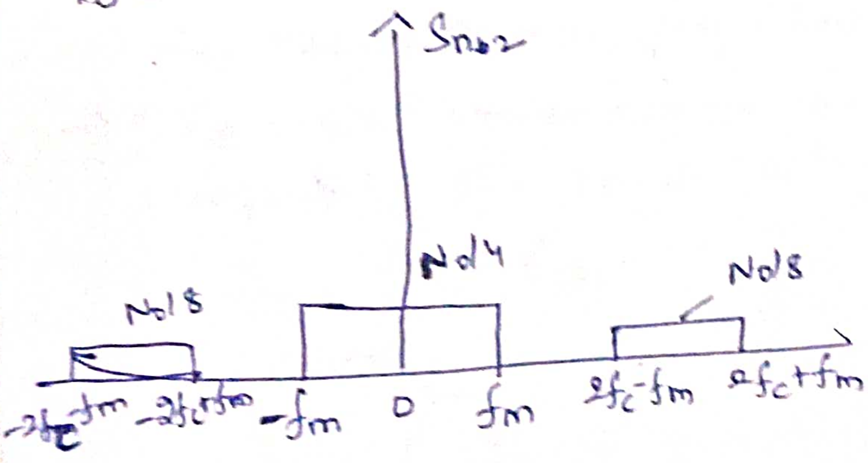
Calculation of Noise power

→ White noise of power spectral density $S_n = N_0/2$ is passed through the carrier filter.

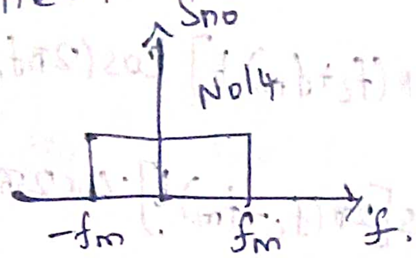


SD of carrier filter.

→ After multiplication with carrier,



→ SD of ~~of~~ noise at O/p of Baseband filter.



→ The noise power is,

$$P_{no} = \int_{-\infty}^{\infty} S_n(f)\, df$$

$$= \int_{-f_m}^{f_m} N_0/4 \; df$$

$$P_{no} = \frac{N_0}{4}\left[f_m + f_m\right] = \frac{N_0 f_m}{2}$$

Calculation of Signal Power:

→ The normalized Power of received signal will be

$$P_i = \left(\frac{A/\sqrt{2}}{\sqrt{2}}\right)^2 + \left(\frac{A/\sqrt{2}}{\sqrt{2}}\right)^2$$

$$= \frac{A^2}{2}.$$

→ $x_1(t)$ ~~is~~ at the carrier filter will be same as $x_i(t)$.

→ $x_1(t)$ is multiplied with $x_c(t)$ in demodulator.

→ O/p of Demodulator will be,

$x_2(t) = x_1(t) \cdot \cos(2\pi f_c t)$

$= \frac{A}{\sqrt{2}} \cos(2\pi(f_c+f_m)t] \cos(2\pi f_c t) +$

$\frac{A}{\sqrt{2}} \cos[2\pi(f_c-f_m)t] \cdot \cos 2\pi f_c t$

[By using $\cos A \cos B$ formula]

$x_2(t) = \frac{A}{2\sqrt{2}} \cos(2\pi(2f_c+f_m)t] + \frac{A}{2\sqrt{2}} \cos 2\pi f_m t$

$+ \frac{A}{2\sqrt{2}} \cos(2\pi(2f_c-f_m)t] + \frac{A}{2\sqrt{2}} \cos 2\pi f_m t$

→ Here $2f_c+f_m$ & $2f_c-f_m$ are not passed through BPF.

$\therefore x_2(t) = \frac{A}{2\sqrt{2}} \cos 2\pi f_m t + \frac{A}{2\sqrt{2}} \cos(2\pi f_m t)$

$x_2(t) = \frac{A}{\sqrt{2}} \cos 2\pi f_m t$

→ The normalized o/p signal will be,

$P_0 = \left(\frac{A/\sqrt{2}}{\sqrt{2}}\right)^2 = \frac{A^2}{4}$

Signal to Noise Ratio:

$$\left(\frac{S}{N}\right)_{O/P} = \frac{P_o}{P_{no}}.$$

$$= \frac{A^2/4}{N_o f_m/2} = \frac{A^2}{2N_o f_m}$$

$$P_i = A^2/2.$$

$$(S/N)_{O/P} = \frac{P_i}{N_o f_m}.$$

Figure of Merit (FOM) (γ)

$$\gamma = \frac{(SNR)_o}{(SNR)_i}$$

$$SNR_o = \cancel{P_i/N_o f_m} \quad A^2/2N_o f_m$$

$$SNR_i = A^2/2N_o f_m.$$

$$\gamma = \frac{A^2/2N_o f_m}{A^2/2N_o f_m} = 1.$$

NOISE in Envelope detector:

→ Consider the AM transmission that has both the side bands & carrier.

Modulated signal is mathematically represented is,

$$s(t) = A_c[1+K_a m(t)] \cos 2\pi f_c t.$$

K_a – modulation index.

→ Total power of modulated signal.

$$P_{tot} = P_c\left(1+\frac{m^2}{2}\right).$$

Carrier power $P_{c} = A_c^2/2$ $(K_a = m)$

$$\text{Modulated power} = \frac{A_c^2}{2}\left(1+\frac{K_a^2}{2}\right).$$

→ normalized power of message signal is $K_a^2/2$,

take, $P = K_a^2/2$.

∴ Modulated signal power $= \frac{A_c^2}{2}(1+K_a^2 P)$.

→ average NOISE power $= N_0 B$.

→ channel signal to NOISE ratio is,

$$(SNR)_c = \frac{\text{Modulated signal power}}{\text{average NOISE power.}}$$

$$= \frac{\frac{A_c^2}{2}(1+K_a^2 P)}{N_0 B} = \frac{A_c^2 (1+K_a^2 P)}{2N_0 B}$$

O/P SNR for envelope detection:

The envelope detector consists of modulated signal $s(t)$ plus noise $n(t)$

$$x(t) = s(t) + n(t).$$

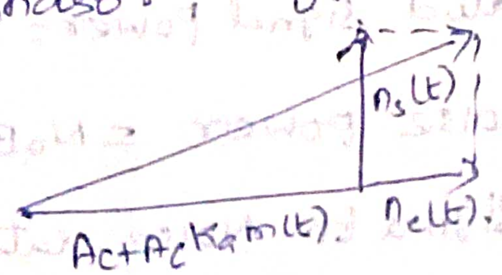
$n(t)$ represents inphase & Quadrature components:

$$x(t) = s(t) + n_c(t)\cos 2\pi f_c t - n_s(t)\sin 2\pi f_c t$$

$$= A_c[1+K_a m(t)]\cos 2\pi f_c t + n_c(t)\cos 2\pi f_c t - n_s(t)\sin 2\pi f_c t$$

$$= [A_c + A_c K_a m(t) + n_c(t)]\cos 2\pi f_c t - n_s(t)\sin 2\pi f_c t.$$

→ Phasor Diagram



$$y(t) = \sqrt{\left(A_c + A_c k_a m(t) + n_c(t)\right)^2 + \left(n_s(t)\right)^2}$$

Compare to noise power, $n_c(t)$ & $n_s(t)$ is Very small.

$$y(t) = A_c + A_c k_a m(t).$$

→ with help of blocking capacitor A_c is removed.

$$\therefore y(t) = A_c k_a m(t).$$

→ Power this equ^n is, $\dfrac{A_c^2 k_a^2 P}{2}.$

(~~noise~~ power at Rx)

→ Noise power at Rx. $= N_0 B.$

$$(SNR)_0 = \frac{\text{Power of Rx O/P}}{\text{Noise Power Of Rx O/P}}.$$

$$= \frac{A_c^2 k_a^2 P / 2}{N_0 B}.$$

Figure of Merit (FOM).

$$\eta = \frac{(SNR)_0}{(SNR)_c}$$

$$\eta = \frac{A_c^2 k_a^2 P / 2N_0 B}{\dfrac{A_c^2 (1 + k_a^2 P)}{2 N_0 B}} = \frac{k_a^2 P}{1 + k_a^2 P}.$$

This above equ^n is always less than unity.