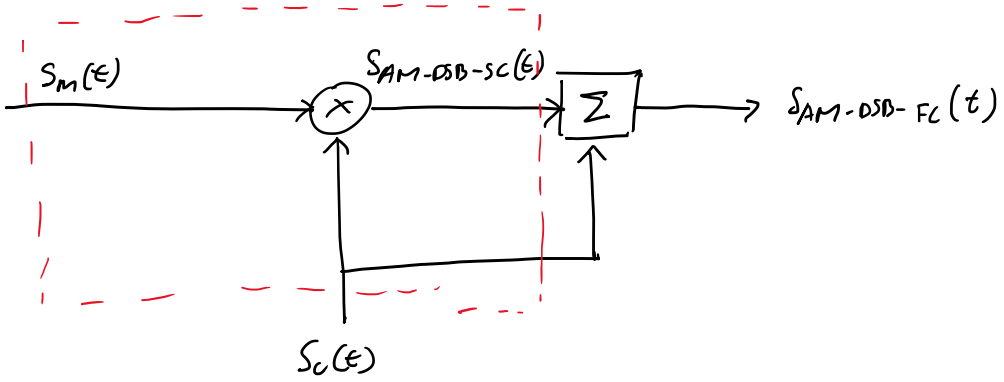
1. Suatu system AM-DSB-SC dengan sinyal pemodulasi :
   $S_m(t) = 2 \cos 10000\,\pi t + 4 \cos 4000\,\pi t$
   Dan sinyal carrier $s_c(t) = 4 \cos 10^5 .2\pi t$ → $f_c = 10^5\ Hz = 100\ kHz$
   a. Gambarkan blok modulator dan tuliskan persamaan sinyal keluaran modulator
   b. Gambarkan spektrum frekuensi sinyal keluaran modulator. Berapa bandwidth sinyal tersebut ?
   c. Hitung daya sinyal

a.



$$S_{AM\text{-}DSB\text{-}FC}(t) = S_m(t).S_c(t) + S_c(t) = (1 + S_m(t))\,S_c(t)$$

$$= (1 + 2\cos 10000\pi t + 4\cos 4000\pi t)\,4\cos 10^5 .2\pi t$$

$$S_{AM\text{-}DSB\text{-}SC}(t) = S_m(t).S_c(t) = (2\cos 10000\pi t + 4\cos 4000\pi t)\,4\cos 10^5 2\pi t$$

$$= 8\cos(10.000\pi t)\cos(10^5 2\pi t) + 16\cos(4000\pi t)\cos(10^5 2\pi t)$$

b. $S_{AM}(t) = 8\left[\cos(10.000\pi t)\cos(10^5 2\pi t)\right] + 16\left[\cos(4000\pi t)\cos(10^5 2\pi t)\right]$

$$= 8\left[\frac{1}{2}\left(\cos(10.000\pi t + 10^5 2\pi t) + \cos(10.000\pi t - 10^5 2\pi t)\right)\right] +$$

$\omega = 2\pi f$

$$16\left[\frac{1}{2}\left(\cos(4000\pi t + 10^5 2\pi t) + \cos(4000\pi t - 10^5 2\pi t)\right)\right]$$

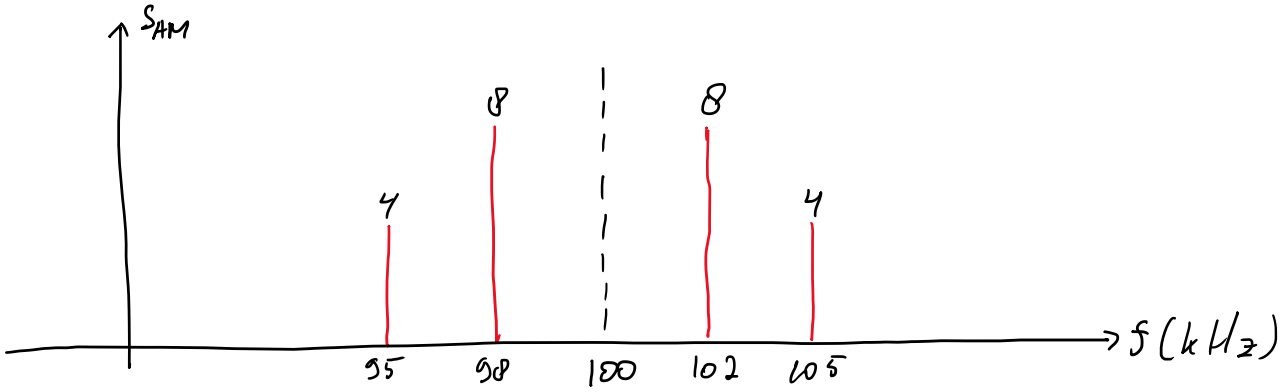
$$= 4\cos 2\pi(5000t + 10^5 t) + 4\cos 2\pi(5000t - 10^5 t)$$

$$+ 8\cos 2\pi(2000t + 10^5 t) + 8\cos 2\pi(2000t - 10^5 t)$$

$\cos(-x) = \cos(x)$

$$= 4\cos 2\pi(105k.t) + 4\cos 2\pi(95k.t)$$

$$+ 8\cos 2\pi(102k.t) + 8\cos 2\pi(98k.t)$$



$$BW = (105 - 95)\ kHz = 10\ kHz$$

c. $$P = \frac{A_m^2}{2R}$$

$$P_{Total} = \frac{4^2}{2} + \frac{8^2}{2} + \frac{8^2}{2} + \frac{4^2}{2}$$

$$= 8 + 32 + 32 + 8$$

$$= 80\ W/\Omega$$

$f_c = 100\ MHz$
$= 100.000\ kHz$

$A_c = 10\ V$

2. Diketahui suatu modulator FM dengan sinyal pembawa Vc(t) = 10 cos ($2\pi.100.10^6 t$). Sinyal FM yang terjadi akan mengalami "Null carrier pertama" jika diberi informasi Vs(t) = 3 cos (10000πt).volt.
   a. Hitung deviasi frekuensi (Δf) dan Bandwidth Carlson (BWc) jika pemodulasi/ informasi diubah menjadi Vs2(t) = 5 cos (30000πt)
   b. Gambarkan spektral Daya pada kondisi di atas dan tentukan besarnya daya pada masing-masing frekuensi.

$A_{m1} = 3\ V$
$f_{m1} = 5000\ Hz$
$= 5\ kHz$

$A_{m2} = 5\ V$
$f_{m2} = 15\ kHz$

$\beta = 2,4 \rightarrow$ Null carrier pertama

a. $k_f = \dfrac{\beta . f_{m1}}{A_{m1}} = \dfrac{2,4 . 5000}{3} = 4\ kHz/volt$

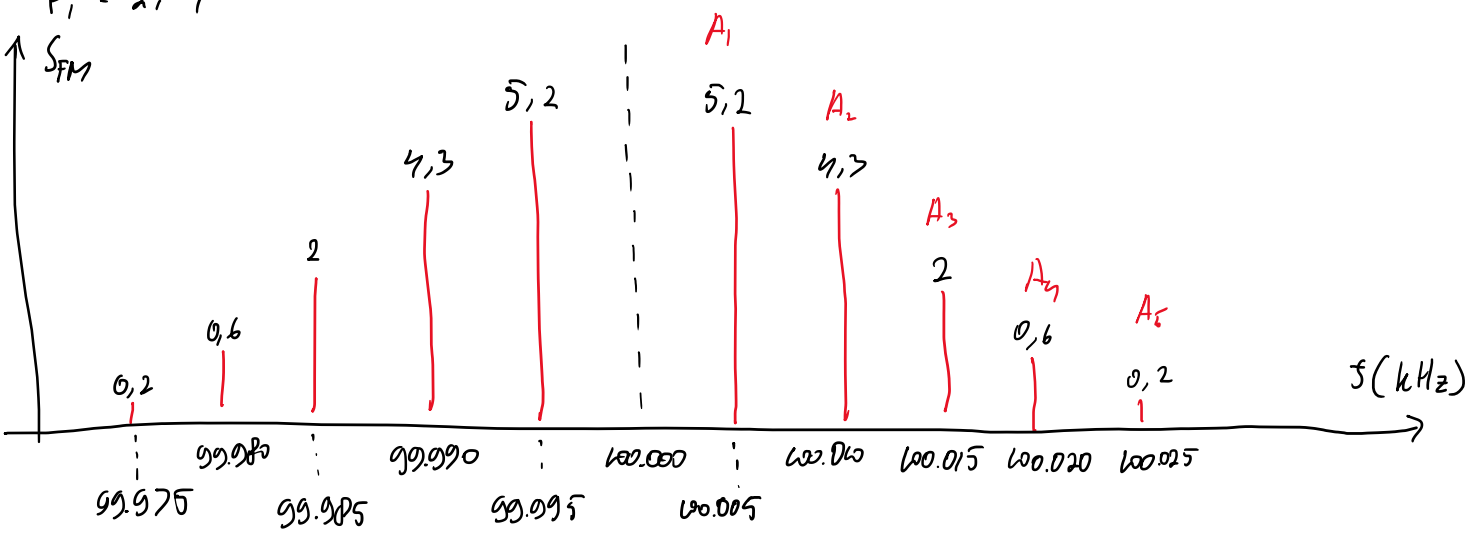
$\Delta f_2 = \beta_2 . f_{m2}$

$= \dfrac{k_f . A_{m2}}{f_{m2}} . f_{m2} = 4\ kHz/volt . 5\ V = 20\ kHz$

$BW_2 = 2\ (\Delta f_2 + f_{m2}) = 2\ (20\ kHz + 15\ kHz)$

$= 70\ kHz$

b. $\beta_1 = 2,4$



$P = \dfrac{A^2}{2R}$

$$P_1 = \frac{A_1^2}{2R} = \frac{5,2^2}{2} = 13,52 \ W/\Omega$$

$$P_2 = \frac{A_2^2}{2R} = \frac{4,3^2}{2} = 9,245 \ W/\Omega$$

$$P_3 = \frac{A_3^2}{2R} = \frac{2^2}{2} = 2 \ W/\Omega$$

$$P_4 = \frac{A_4^2}{2R} = \frac{0,6^2}{2} = 0,18 \ W/\Omega$$

$$P_5 = \frac{A_5^2}{2R} = \frac{0,2^2}{2} = 0,02 \ W/\Omega$$

$$P_T = \frac{A_c^2}{2R} = \frac{10^2}{2} = 50 \ W/\Omega$$ → Pakai Amplitudo carrier

$$P_T = 2(P_1 + P_2 + P_3 + P_4 + P_5) = 2(13,52 + 9,245 + 2 + 0,18 + 0,02)$$

$$= 49,93 \ W/\Omega$$ → Pakai daya sideband

$^{10}\log 10^n = n$

$10\ ^{10}\log\left(\frac{out}{in}\right)$

$3 = {}^{n}\log x$

$x = 10^3$

3. Diagram blok di bawah ini adalah suatu Receiver FM .

a. Tentukan Gain total
b. Tentukan temperature noise ekuivalen (Te) total
c. Tentukan Noise Figure Total
d. Jika Temperatur noise ekuivalen input di titik B = 500° K dan daya sinyal input di titik B adalah 1 micro watt, tentukan S/N di titik E dalam dB

a. $G_{RF} = 33\ dB = 30\ dB + 3\ dB$

$= 1000 \times 2 = 2000$ kali

$G_{mixer} = 23\ dB = 20\ dB + 3\ dB$

$= 100 \times 2 = 200$ kali

$G_{IF} = 13\ dB = 10\ dB + 3\ dB$

$= 10 \times 2 = 20$ kali

$G_{Total} = 2000 \times 200 \times 20 = 8$ juta kali

b $Te_{RF} = 500\ K$

$F_{mixer} = 16\ dB = 10\ dB + 3\ dB + 3\ dB = 10 \times 2 \times 2 = 40$

$Te_{mixer} = (40 - 1) \cdot 290\ K = 11.310\ K$

$F_{IF} = 16\ dB = 40$

$Te_{IF} = (40 - 1) \cdot 290\ K = 11.310\ K$

$$Te_{Total} = Te_{RF} + \frac{Te_{mixer}}{G_{RF}} + \frac{Te_{IF}}{G_{RF} \cdot G_{mixer}}$$

$$Te_{Total} = 500\,k + \frac{11.360}{2000} + \frac{11.360}{2000 \cdot 200}$$

$$Te_{Total} = 500 + 5,655 + 0,028 = 505,683\ K$$

c. $Te_{RF} = (F_{RF} - 1)\,290$

$$\frac{500}{290} = F_{RF} - 1 \rightarrow F_{RF} = 2,72\ kali$$

$$F_{total} = F_{RF} + \frac{F_{mixer} - 1}{G_{RF}} + \frac{F_{IF} - 1}{G_{RF} \cdot G_{mixer}}$$

$$= 2,72 + \frac{40 - 1}{2000} + \frac{40 - 1}{2000 \cdot 200} = 2,74$$

$$NF_T = 10 \cdot \log F = 10 \cdot \log 2,74 = 4,38\ dB$$

d. $\frac{S}{N} = \frac{Si}{k(T_i + Te_T)B_N}$ → B_N tarakhir

$$\frac{S}{N} = \frac{20^{-6}}{1,38 \times 10^{-23}\,(500 + 505,683) \cdot 200 \times 10^3} = 360271418,1$$

$$\frac{S}{N} = 3,6 \times 10^8 \cdot 10 \log (3,6 \times 10^8) = 85,57\ dB$$