ISPIT

(1) $f_1 = 90{,}2\ MHz$ $f_2 = 10\ MHz$

$r = 5km$

$E = 10\mu V/m$

$U = h_{ef} * E$

h_{ef} → efektivna visina antene

$h_{ef} = \frac{\lambda}{4}$ $\lambda = \frac{c}{f}$

$\lambda_1 = \frac{c}{f_1} = \frac{3 \cdot 10^8}{90{,}2 \cdot 10^6} = 3{,}33\ m$ $\lambda_2 = \frac{c}{f_2} = \frac{3 \cdot 10^8}{10 \cdot 10^8} = 30m$

$h_{ef} = \frac{\lambda_1}{4} = 0{,}83\ m$ $h_{ef} = \frac{30m}{4} = 7{,}5m$

$U_{ef} = 0{,}83m \cdot 10\frac{\mu V}{m} = 8{,}3\ \mu V$ $U_{ef} = 7{,}5\ m \cdot \frac{10\mu V}{m} = 7{,}5\mu V$

* Troškovi antena s obzirom na frekvencijsko područje na kojem odašilje

Niža frekvencija - velike antene, jedan odašiljač
Više frekvencije - manje antene ali više odašiljača

(2) $h_{ef_1} = \frac{\lambda_1}{4}$

$h_{ef_1} = \frac{\lambda_2}{4}$

$$\frac{h_{ef1}}{h_{ef2}} = \frac{\frac{\lambda_1}{4}}{\frac{\lambda_2}{4}} = \frac{\lambda_1}{\lambda_2} = \frac{\frac{c}{f_1}}{\frac{c}{f_2}} = \frac{f_2}{f_1}$$

* gušenje na većim frekvencijama je puno veće

③

$f_{VF} = 800 kHz$

$U_{VF} = 3$

$f_m = 2 kHz$ $\boxed{dBV}$

$m = 0,5$

a) amplitudni spektar

b) $U_{AM(MAX)}$, $U_{AM(MIN)}$, D

c) P_{VF}, P_{BP1}, P_{BP2}

d) D kada je $m_a = 1$

a) $u_{AM}(t) = U_{VF}\left[1 + m_a \cos(\omega_m t)\right]\cos(\omega_{VF} t)$

$u_{AM}(t) = \left[U_{VF} + k\cdot U_m(t)\right]\cos(\omega_{VF} t)$

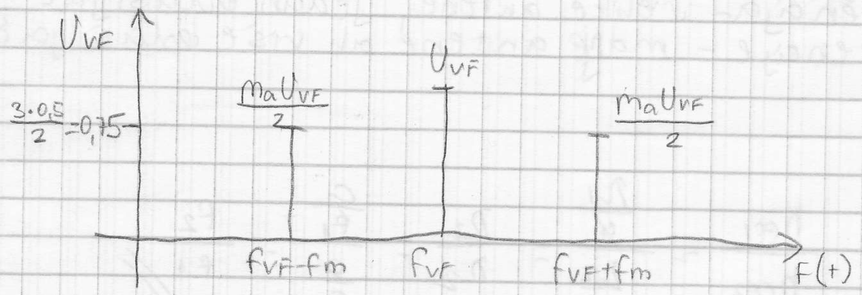
$U_{AM}(t) = U_{VF}\left[1 + \frac{k\cdot U_m(t)}{U_{VF}}\right]\cos(\omega_{VF} t)$

$U_{AM}(t) = U_{VF}\left[1 + k\frac{U_m}{U_{VF}}\cos(\omega_m t)\right]\cos(\omega_{VF} t)$

$U_{AM}(t) = U_{VF}\left[1 + m_a \cos(\omega_m t)\right]\cos(\omega_{VF} t)$

$U_{AM} = U_{VF}\cos(\omega_{VF} t) + U_{VF}\, m_a \cos(\omega_m t)\cos(\omega_{VF} t)$

$U_{AM}(t) = U_{VF}\cos(\omega_{VF} t) + \frac{m_a U_{VF}}{2}\cos\left[(\omega_{VF} + \omega_m)t\right] + \frac{m_a U_{VF}}{2}\cos\left[(\omega_{VF} - \omega_m)t\right]$

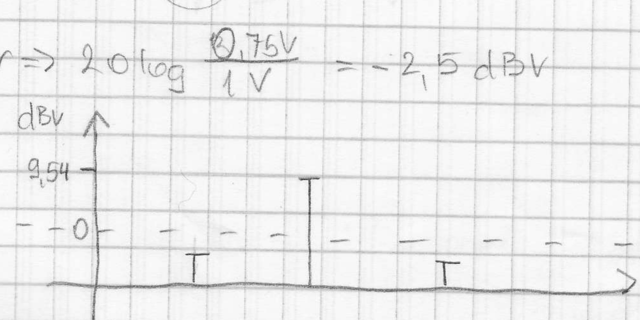


$U \rightarrow dBV$

referentni

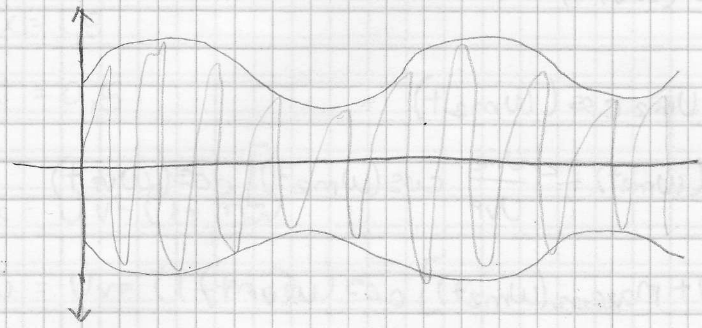
$3V \Rightarrow 20\log\frac{3V}{1V} = 20\log 3 = 9,54\, dBV$ $\quad 3V \rightarrow 20\log\frac{3V}{1mV} = 69,54\, dBmV$

$0,75V \Rightarrow 20\log\frac{0,75V}{1V} = -2,5\, dBV$



b)

$$U_{AM}(t) = U_{VF}\left[1 + m_a \cos(\omega_m t)\right]\cos(\omega_{VF} t)$$



kada je $m = 1$ onda je dinamika beskonačna

$$|A_{MAX}| = U_{VF}(1 + m_a) \qquad D = \left|\frac{A_{MAX}}{A_{MIN}}\right| = \frac{1+m_a}{1-m_a}$$

$$|A_{MIN}| = U_{VF}(1 - m_a)$$

$$D_{[dB]} = 20\log\frac{1+m_a}{1-m_a} = 20\log\frac{1{,}5}{0{,}5} = 9{,}54\,dB$$

c)

$$P = \frac{U_{VFef}^2}{Z} \Rightarrow U_{VF\,ef} = \frac{U_{VF}}{\sqrt{2}} \Rightarrow \boxed{P_{VF} = \frac{U_{VF}^2}{2Z}} \Rightarrow \text{snaga na nosiocu}$$

$$P_{VF[dBmW]} = 10\log\frac{P_{VF}}{1mW}$$

$$P_{BP1} = \frac{U_{efb1}^2}{Z} = \frac{\left(\frac{m_a U_{VF}}{2\sqrt{2}}\right)^2}{Z} = \frac{m_a^2 U_{VF}^2}{8Z}$$

$$U_{b1} = \frac{m_a U_{VF}}{2} \Rightarrow U_{ef\,b1} = \frac{m_a U_{VF}}{2\sqrt{2}}$$

$$P_{BP2} = \frac{m_a^2 U_{VF}^2}{8Z}$$

$$\boxed{P_{b1[dBmW]} = 10\log\frac{P_{b1}}{1mV}}$$

3.

$$U_{AM}(t) = \left[U_{VF} + k\,U_m(t)\right]\cos(\omega_{VF} t)$$

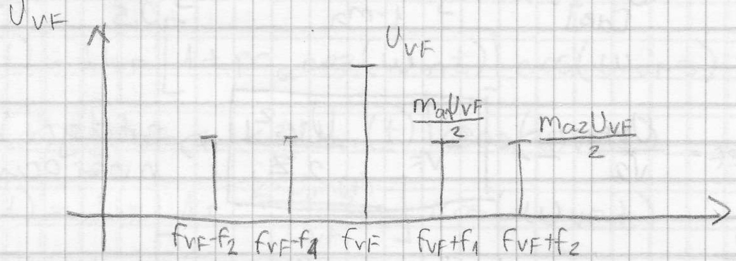
$$U_m(t) = U_{m1}\cos(\omega_{m1} t) + U_{m2}\cos(\omega_{m2} t)$$

$$U_{AM}(t) = U_{VF}\left[1 + k\cdot\frac{U_{m1}}{U_{VF}}\cos(\omega_{m1} t) + \frac{k\cdot U_{m2}}{U_{VF}}\cos(\omega_{m2} t)\right]\cos(\omega_{VF} t)$$

$$U_{AM}(t) = U_{VF}\left[1 + m_{a1}\cos(\omega_{m1} t) + m_{a2}\cos(\omega_{m2} t)\right]\cos(\omega_{VF} t)$$

$$U_{AM}(t) = U_{VF}\cos(\omega_{VF} t) + \frac{m_{a1} U_{VF}}{2}\cos\left[(\omega_{VF} - \omega_{m1})t\right] + \frac{m_{a2} U_{VF}}{2}\cos\left[(\omega_{VF} + \omega_{m2})\right]$$

$$+ \frac{m_{a2} U_{VF}}{2}\cos\left((\omega_{VF} - \omega_{m2})t\right) + \frac{m_{a2} U_{VF}}{2}\cos\left[(\omega_{VF} + \omega_{m2})t\right]$$



$$P_{UK} = \frac{\left(\frac{U_{VF}}{\sqrt{2}}\right)^2}{Z} + 4\cdot\frac{\left(\frac{m_a\cdot U_{VF}}{2\sqrt{2}}\right)^2}{Z}$$

$$U_{AM}(t) = U_{VF}\left[1 + m_a\cos(\omega_{m1} t) + m_{a2}\cos(\omega_{m2} t)\right]\cos(\omega_{VF} t)$$

$$A_{MAX} = U_{VF}\left[1 + 2\,\overset{m_{a1}+m_{a2}}{m_a}\right] \qquad U_{VF}\left[1 + m_{a1} + m_{a2}\right]$$

$$A_{MIN} = U_{VF}\left[1 - 2\,m_a\right]$$

4.

$U_{AM}(t) = U_{VF}\left[1 + m_a \cos(\omega_m t)\right] \cos(\omega_{VF} t)$

$|A_{MAX}| = 1{,}5$

$|A_{MIN}| = 0{,}5$

$A_{MAX} = U_{VF}(1 + m_a)$

$A_{MIN} = U_{VF}(1 - m_a)$

$\left|\frac{A_{MAX}}{A_{MIN}}\right| = \frac{1 + m_a}{1 - m_a} \Rightarrow m_a = ?$

$T_m = 0{,}005\,s$

$f_m = \frac{1}{T_m} = 200\,Hz$

* Premodulacija ⇒ signal se na prijamniku ne može rekonstruirati.

* Vrste AM modulacije

* AM modulacija je u području od 150kHz do 30,55MHz

5.

$$U_{mod} = U_{VF} + k\,U_m(t)$$

$$u_m(t) = U_m \cos(\omega_m t)$$

$$\omega_{mod}(t) = \omega_{VF} + k_F \cdot U_m \cdot \cos(\omega_m t)$$

$$\Delta f_{mod} = k_F \cdot U_m =$$

$$\Delta f = \frac{20\,kHz}{V} \cdot 0{,}2V$$

$$\Delta \omega = 2\pi \cdot \Delta f$$

$$\omega_{mod} = \omega_{VF} + \Delta\omega \cdot \cos(\omega_m t)$$

$$f_{mod} = f_{VF} + \Delta f \cos(\omega_m t)$$

$$\omega = \frac{d\phi}{dt} \Rightarrow \phi(t) = \int_0^t \omega(\tau)\, d\tau$$

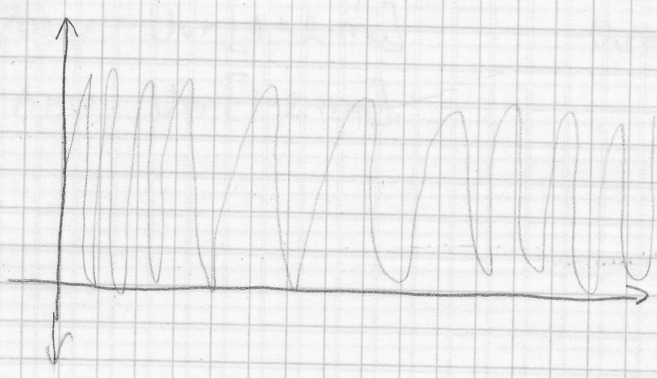
$$\phi(t) = \omega_{VF} \cdot t + \frac{\Delta\omega_{mod}}{\omega_m} \sin(\omega_m t)$$

faza

$$\phi(t) = \omega_{VF} \cdot t + m_F \cdot \sin(\omega_m t)$$

$$U_{FM}(t) = U_{VF} \cdot \cos\left[\omega_{VF} \cdot t + m_F \sin(\omega_m t)\right]$$

$$m_F = \frac{\Delta\omega_{mod}}{\omega_m} = \frac{\Delta f}{f_m} =$$



$$|A_{MAX}| = |A_{MIN}| = U_{VF}$$

$$D = 1$$

$$20 \log 1 = 0 \ dB$$

(6)

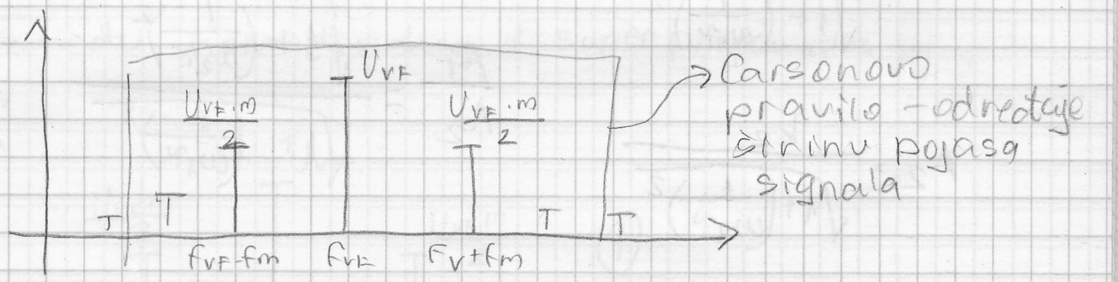
$\cos(\alpha+\beta) = \cos\alpha\cos\beta - \sin\alpha\sin\beta$

$$u_{FM} = U_{VF}\cos[\omega_{VF}t + m_f\sin(\omega_m t)]$$

$$= U_{VF}\cos(\omega_{VF}t)\cos[m_f\cdot\sin(\omega_m t)] - U_{VF}\sin(\omega_{VF}t)\cdot\sin[m_f\sin(\omega_m t)]$$

$$m_f << 1 \Rightarrow \cos x = 1, \quad \sin x = x$$

$$U_{FM} = U_{VF}\cos(\omega_{VF}t) - U_{VF}\sin(\omega_{VF}t)\cdot m_f\cdot\sin(\omega_m t)$$

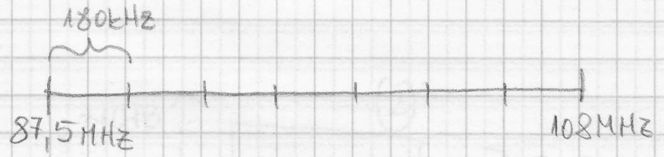


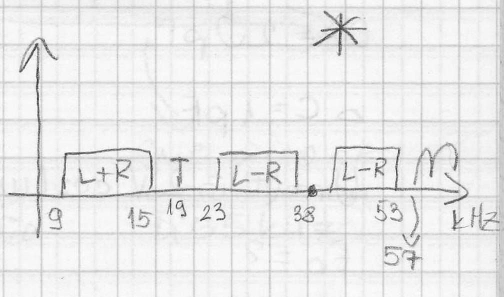
* ako m_f nije <<1 onda ima puno više bočnih komponenti i uzima se carsonovo pravilo

$$B_{FM} = 2\cdot f_m(m_f+1) = 2\cdot f_m\left[\frac{\Delta f_{mod}}{f_{m max}}+1\right] = 2(\Delta f_{mod}+f_{m max})$$

↳ Carsonovo pravilo.

(7.)





$f_{mMAX} = 15\,kHz$

-koliko kanala stane prema Carsonovom pravilu

$$B_{FM} = 2f_{mMAX}[m_f+1] = 2f_{mMAX}\left(\frac{\Delta f}{f_{m max}}+1\right) = 2(\Delta f + f_{m max})$$

$$B_{FM} = 2\cdot(75+15) = 180\,kHz$$

$$\Delta f = 108 - 87{,}5 = 20{,}5\,MHz$$

$$N = \frac{\Delta f}{B_{FM}} = \frac{20{,}5\,MHz}{108\,kHz} = 189$$

8. Akcentuacija

- Šum ima ravnu frekvencijsku karakteristiku - ima konstantnu energiju u ovisnosti o frekvenciji
- kad se šum modulira ispada da $P_{šum} \uparrow \rightarrow f \uparrow$

$P_{signal} \downarrow \rightarrow f \uparrow$

$$A_1 = \frac{k_1}{\sqrt{1+\left(\frac{1}{\omega_1 \tau}\right)^2}}$$

$$A_2 = \frac{k_2}{\sqrt{1+\left(\frac{1}{\omega_2 \tau}\right)^2}}$$

$$\frac{A_1}{A_2} = \frac{\sqrt{1+\left(\frac{1}{\omega_2 \tau}\right)^2}}{\sqrt{1+\left(\frac{1}{\omega_1 \tau}\right)^2}}$$

* Objasniti postupak akcentuacije i deakcentuacije

9.

$L = 1mH$

$C_0 = 20pF$

$\Delta C = 1pF$

$U_m(t) = 2V\cos(\omega_m t)$

$f_0 = ?$

$\Delta f = ?$

$$\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{L\cdot(C_0+\Delta C\cos(\omega_m t))}} = \frac{1}{\sqrt{L\cdot C_0\left[1+\frac{\Delta C}{C_0}\cos(\omega_m t)\right]}}$$

$$\omega = \frac{1}{\sqrt{LC_0}} \cdot \frac{1}{\sqrt{1+\frac{\Delta C}{C_0}\cos(\omega_m t)}} = \omega_0 \cdot \left(1-\frac{\Delta C}{2C_0}\cos(\omega_m t)\right)$$

$\Delta C <<< C_0 \quad \frac{\Delta C}{C_0} << 1$

$$\omega_0 = \frac{1}{\sqrt{LC_0}}$$

$$\frac{1}{\sqrt{1+x}} \approx 1-\frac{x}{2}$$

$$f_0 = \frac{1}{2\pi\sqrt{LC_0}}$$

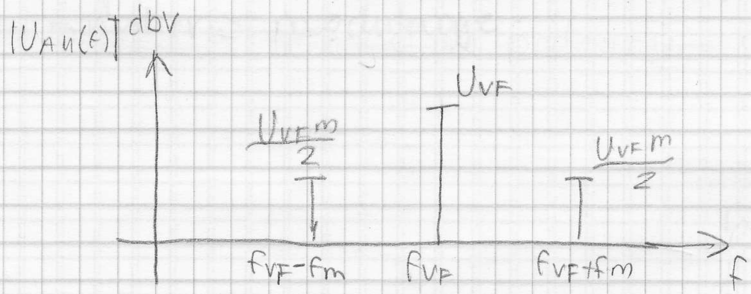
$$\omega(t) = \omega_0 - \omega_0 \cdot \frac{\Delta C}{2C_0} \cos(\omega_m t)$$

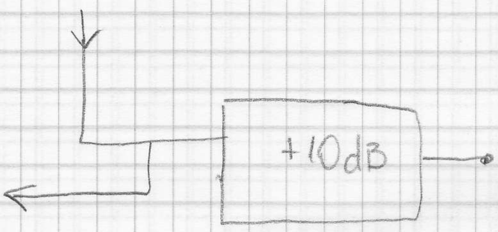
$$\Delta \omega = \omega_0 \cdot \frac{\Delta C}{2C_0}$$

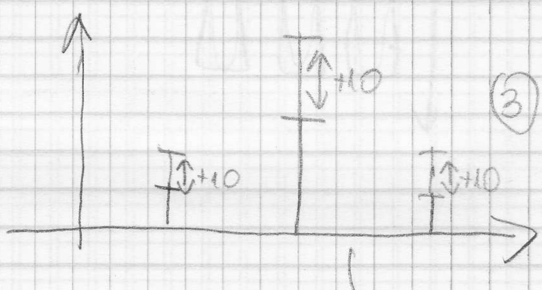
→ promjena

10

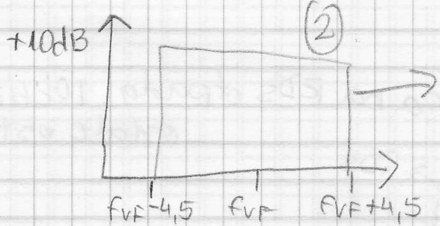
* razlika između homodinskog i superprijamnika



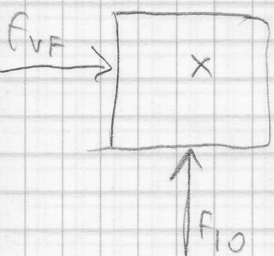




sve ovo se spušta na 455kHz



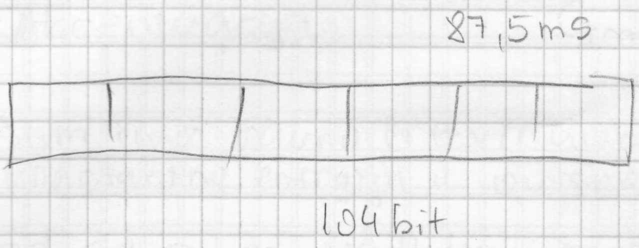
sve unutar ovog pojasa pojačavo za 10dB



$f_{MF} = f_{VF} - f_{LO}$

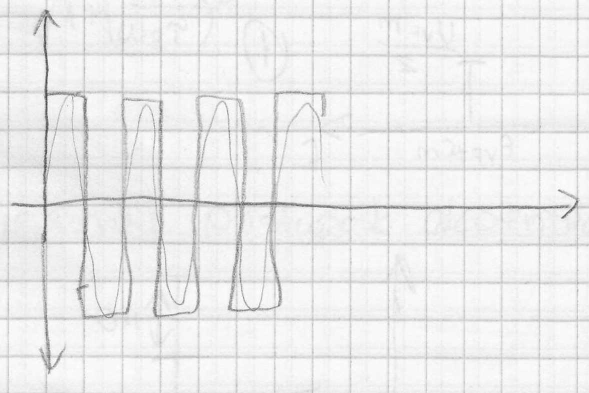
$f_{LO} = f_{VF} - f_{MF} = 950 - 455 = 495\,kHz$

11.



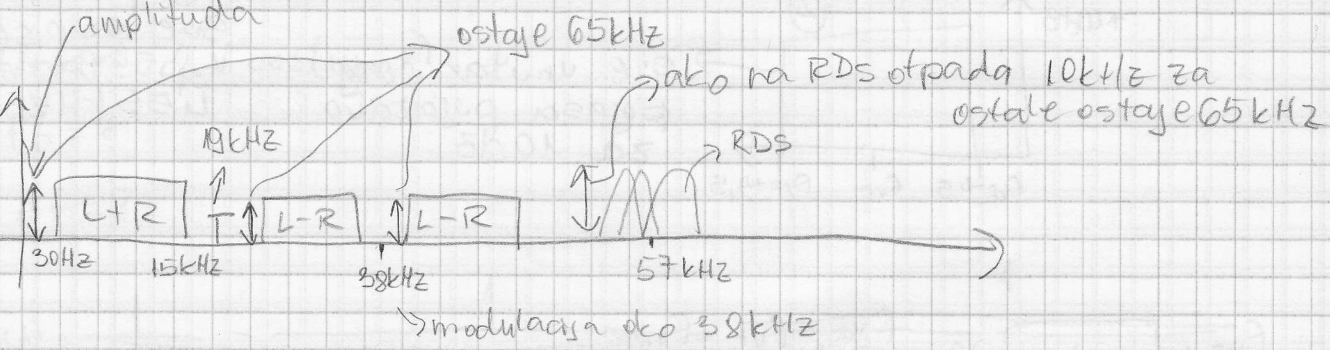
$$R = \frac{104\ bit}{87{,}5ms} = 1189\ bit/s$$

$$R_{kor} = \frac{64\ bit}{87{,}5ms}$$



12.

13.



* objasniti stereo multiplex

$$B_{FM} = 2\left(\Delta f + f_{mMAX}\right)$$

$$\Delta f_{MAX} = 75kHz$$

75 kHz devijacije se raspoređuje na 4 komponente