

4 PRINCESS

13.11.2008.

1.) $R_b = 1200 \text{ bit/s}$

$f_o = 1300 \text{ Hz}$

$f_d = 2100 \text{ Hz}$

b.) $\Delta f = \frac{f_n - f_o}{2} = 400 \text{ Hz}$

c.) $m_F = \frac{\Delta f}{f_m} = \Delta f \cdot T_m = 2 \Delta f T_c$

$m_F = 0,67$

a.) $d_p = \frac{f_o + f_n}{2} = 1700 \text{ Hz}$

d.)

d.) $B_{FSK} \approx 2(\Delta f + f_m) = 2\Delta f + \frac{1}{T_c} = 2 \cdot 400 + 1200 = 2000 \text{ Hz}$

$f_d = f_p - \frac{B_{FSK}}{2} = 0,7 \text{ kHz}$

$f_g = f_p + \frac{B_{FSK}}{2} = 2,7 \text{ kHz}$

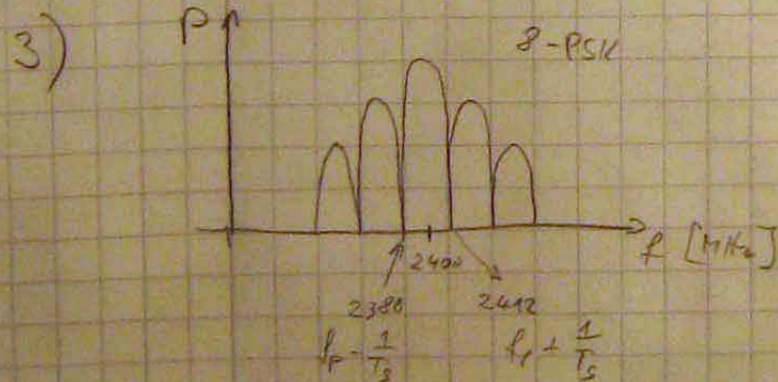
2.) $R_b = 8,448 \text{ Mbit/s}$

$\alpha = 0,3$



a.) $B_N = \frac{1}{T_s} = \frac{1}{2T_c} = \frac{R_b}{2} = 4,224 \text{ MHz}$

b.) $B = B_N (1 + \alpha) = 5,48 \text{ MHz}$



a.) $R_s = \frac{1}{T_s} = 12 \text{ MBaud} = B_N$

$R_b = 3 \cdot R_s = 36 \text{ Mbit/s}$

b.) $\frac{R_b}{B} = \frac{36}{12(1+0,75)} = 2,4 \text{ bit/s/Hz}$

$B_N \leftarrow \text{JEAN, GAZINI, ZIMBOLA}$

$\hookrightarrow \text{IDEAL 3}$

4.) $R_b = 10200 \text{ bit/s}$

$d = 0,5$

$C = 1 \text{ mW}$

$N_0 = 6 \cdot 10^{-15} \text{ W/s}$

a) $N = ?$

$B_N = \frac{1}{T_s} = R_s = \frac{R_b}{2} = 9,6 \text{ kHz}$

$B = B_N (1+d) = 14,4 \text{ kHz}$

$N = N_0 \cdot B = 86,4 \text{ pW}$

$\frac{C}{N} \text{ dB} = 10 \log\left(\frac{C}{N}\right) = 10 \log 11,57 = 10,65 \text{ dB}$

b.) $E_s = C \cdot T_s = C \cdot \frac{2}{R_b} = 1,04 \cdot 10^{-13} \text{ J}$

$\frac{E_s}{N_0} \text{ dB} = 10 \log\left(\frac{E_s}{N_0}\right) = 10 \log \frac{1,04 \cdot 10^{-13}}{6 \cdot 10^{-15}} = 12,4 \text{ dB}$

5.) $P_{\text{rec}} = \frac{1}{2} e^{-\frac{E_b}{N_0}} / \frac{e^{-\frac{E_b}{N_0}}}{P_{\text{rec}}} \rightarrow \frac{1}{2} \text{ erfc}\left(\sqrt{\frac{E_b}{N_0}}\right) \rightarrow \text{fuerst. 1. n. Gauß vert.}$

$R_b = 2048 \text{ bit/s}$

$N_0 = 4 \cdot 10^{-15} \text{ W}$

$P_{\text{rec}} = 10^{-5}$

$A = 90 \text{ dB}$

$e^{-\frac{E_b}{N_0}} = \frac{1}{2 P_{\text{rec}}} \rightarrow E_b = N_0 \ln\left(\frac{1}{2 P_{\text{rec}}}\right) = 4,33 \cdot 10^{-14} \text{ W/s}$

$\frac{E_b}{N_0} = \ln\left(\frac{1}{2 P_{\text{rec}}}\right)$

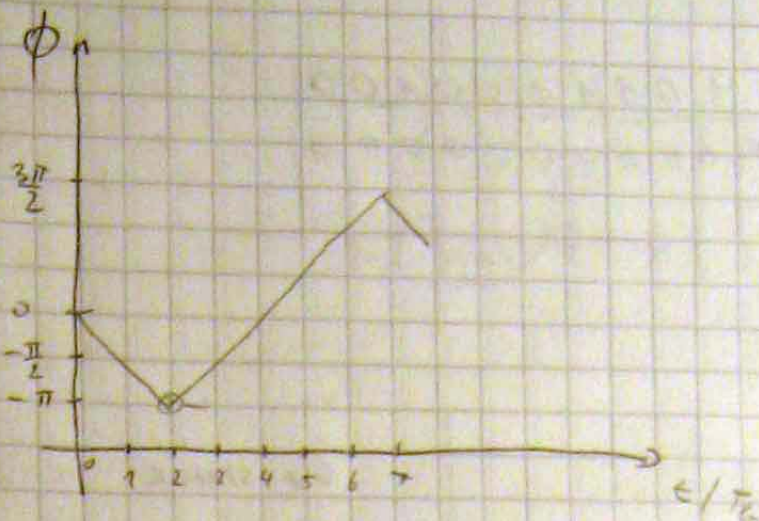
$T_b = \frac{1}{R_b} = \frac{1}{2048} = 0,49 \mu\text{s}$

$C_{\text{rx}} = \frac{E_b}{T_b} = 8,86 \cdot 10^{-8} \text{ W}$

$C_{\text{tx}} = C_{\text{rx}} \cdot 10^9 = 88,6 \text{ W}$

6.) $m_F = 0,5$

0 0 1 1 1 1 0 0 1



7.) $R_G = 140 \text{ bit/s}$

$\alpha = 0,25$

$B = 30 \text{ MHz}$

KOLIKO MOD. POSI?

$B = B_N (1 + \alpha) \rightarrow B_N = \frac{B}{1 + \alpha} = 24 \text{ MHz} = R_s$ → MAJ. BROJ. POS. SIMBOLA

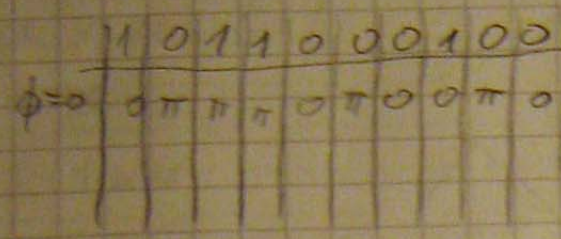
$M = \frac{R_G}{R_s} = \frac{140}{24} = 5,83 \approx 6 \text{ bit/simb}$

MODUL. POSI; 2^6 STANJA = 64 NA KORISNICI 64-QAM

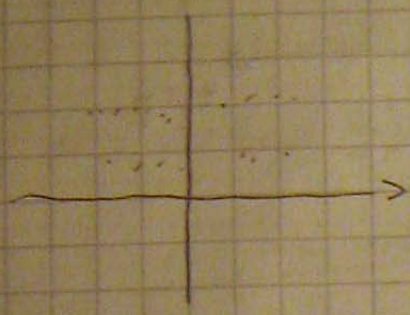
ZATO NE QPSK

IMA VEĆI RAZLIK IZMEĐU STANJA, TIME VEĆU ODPORNOST NA ŠUM

8.)

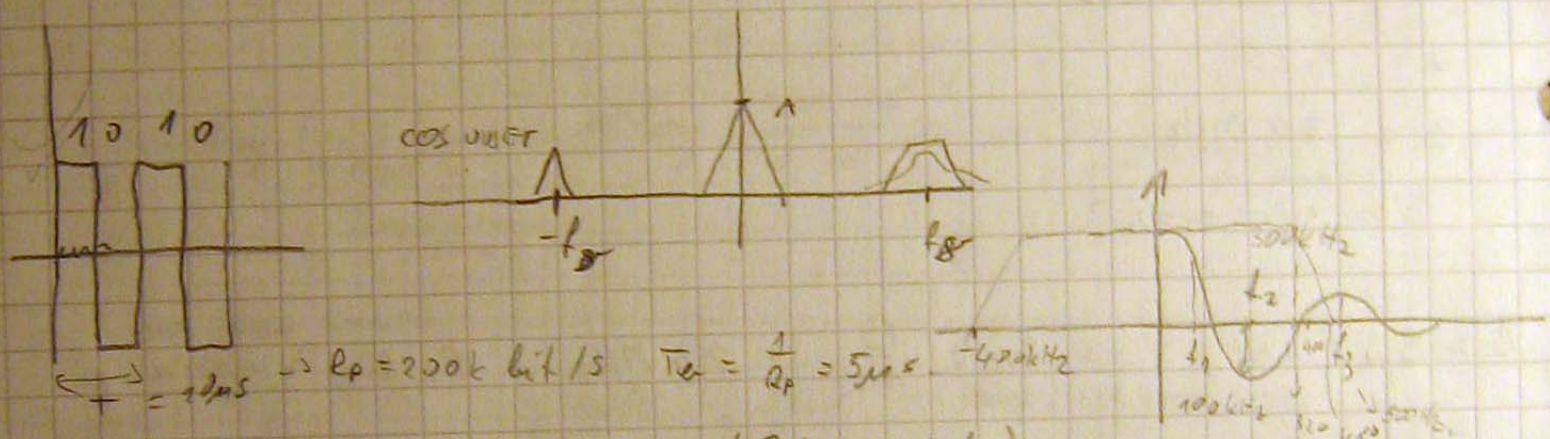


9.)



64-STANJA = 2^6 - 6 BITA PO SIMBOLU

10.)



$$u(t) = \left(\frac{4}{\pi}\right) \sum_{n=1}^{\infty} (-1)^{n+1} \cdot \frac{1}{2n-1} \sin\left(\frac{2(2n-1)\pi t}{T}\right)$$

$\rightarrow f = \frac{1}{T} = 100 \text{ kHz}$

RASTAV
 POTU, SIGMA
 U FOUR. RED

$B = 960 \text{ kHz}$
 $k = 0,2$

$B = B_N(1+k) = 480 \Rightarrow B_N = 400$

$B_N(1-k) = 320$
 $B_N(1+k) = 480$

KOLIKI DLO SNAGE SE PRENOŠI PRVI I DRUGI DIO

$P_{0k} = \left(\frac{4}{\pi}\right)^2 \sum_{n=1}^{\infty} \frac{1}{(2n-1)^2} = 2$ AL LAKŠE JE IZ SLICE 18A.

18 SLICE

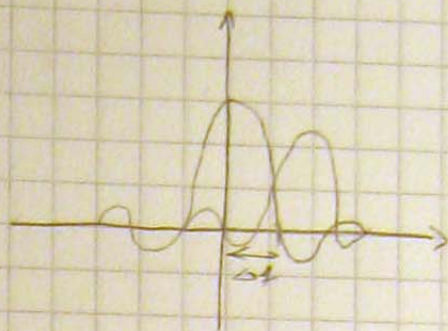
$P_{0k} = \frac{1}{1} \int_0^1 t^2 dt = 1$

$\frac{P_{1,2}}{P_{0k}} = \frac{\left[\left(\frac{4}{\pi}\right)^2 (1) + \left(\frac{4}{\pi}\right)^2 \cdot \frac{1}{9}\right] \cdot \frac{1}{2}}{1} = 0,9 = 90\%$

$$11) T_0 = 806 \mu s$$

$$T_2 = T_0 / 4$$

$$m = 6817 \quad 16-QAM$$



$$a) \bar{T}_{21} = \frac{T_0}{4} = 224 \mu s$$

$$b) \text{bits} / s_{FDM} = 4 \times 6817 = 27268$$

$$c) T_{0FDM} = T_0 + \bar{T}_{21} = 1.12 \text{ ms}$$

$$27268 : 1.12 = x : 1000^{\text{ms}} \rightarrow x = 24,346 \text{ MHz/s}$$

$$d) \Delta f = \frac{1}{T_0} = 1196 \text{ Hz}$$

$$e) B_{0FDM} = N \times \Delta f = 7,61 \text{ MHz}$$