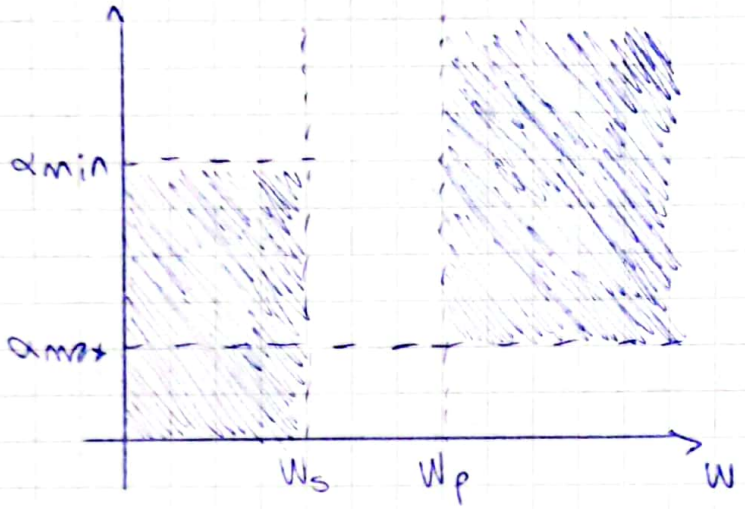
Ejercicio 8 TP2:

Tono: 45 KHz 200 mV $\alpha_{max} = 1$ dB, Pasa-altos

Ruido: 12 KHz 2V → Remanente menor a 4mV

2V → 4mV → 500 veces menos ruido → $\alpha_{min} = 53,979$ dB



$f_s = 12$ KHz

$f_p = 45$ KHz

$\alpha_{max} = 1$ dB

$\alpha_{min} = 53,979$ dB

$\alpha_{min} = 499,976$ (veces)

$\alpha_{min}^2 = 249976,97$

$\varepsilon^2 = 10^{\alpha_{max}/10} - 1 = 0,259$

- Busco orden Cheby:

$$1 + \varepsilon^2 \{\cosh^2[n \cdot \operatorname{arccos}(w_s)]\} \geq \alpha_{min}^2$$

- Normalizo frecuencia:

$w_p = 1 \rightarrow w_s = 0,266 \rightarrow w_{s_{LP}} = \frac{1}{w_s} = 3,75$

$n = 3 \rightarrow 2024,46 < \alpha_{min}^2$

$n = 4 \rightarrow 1090422,94 > \alpha_{min}^2$ ✓ Orden 4

- Polinomio de Cheby:

$C_2 = 2w^2 - 1$ $\qquad C_n = C_{n-1} - C_{n-2}$

$C_3 = 4w^3 - 3w$

$C_4 = 8w^4 - 6w^2 - 2w^2 + 1 = 8w^4 - 8w^2 + 1$

$$|T(jw)|^2 = \frac{1}{1+\varepsilon^2 \cdot (8w^4 - 8w^2 + 1)^2} = \frac{1}{1+\varepsilon^2 (64w^8 - 128w^6 + 80w^4 - 16w^2 + 1)}$$

$$(a+b+c)^2 = a^2 + b^2 + c^2 + 2ab + 2ac + 2bc$$

$$|T(jw)|^2_{w=\frac{s}{j}} = |T(s)|^2 = \frac{1}{1+\varepsilon^2 (64s^8 + 128s^6 + 80s^4 + 16s^2 + 1)} = T(s) \cdot T(-s)$$

$$|T(s)|^2 = \frac{1}{64\varepsilon^2 \cdot s^8 + 128\varepsilon^2 s^6 + 80\varepsilon^2 s^4 + 16\varepsilon^2 s^2 + 1 + \varepsilon^2} = T(s) \cdot T(-s)$$

$$|T(s)|^2 = \frac{1}{16{,}576 \cdot s^8 + 53{,}152 \cdot s^6 + 20{,}72 s^4 + 4{,}144 s^2 + 1{,}259}$$

WolFrom

$$T(s) = \frac{1}{\sqrt{16{,}576}} \cdot \frac{1}{(s^2 + 0{,}277 s + 0{,}986)} \cdot \frac{1}{(s^2 + 0{,}675 s + 0{,}277)}$$

- Reconstruccion de polinomios a partir de polos ζ:

$P_{1-2} = \theta \pm jw \longrightarrow T_1(s) = s^2 + s \cdot (2\theta) + \theta^2 + w^2$

lo hago positivo en semiplano izquierdo

- Convierto a pasa-altos:

$$T_{HP}(\$) = T_{LP}\left(\frac{1}{\$}\right) = \frac{1}{\sqrt{16,576}} \cdot \frac{1}{\frac{1}{\$^2} + 0,279\frac{1}{\$} + 0,986} \cdot \frac{1}{\frac{1}{\$^2} + 0,673\frac{1}{\$} + 0,279}$$

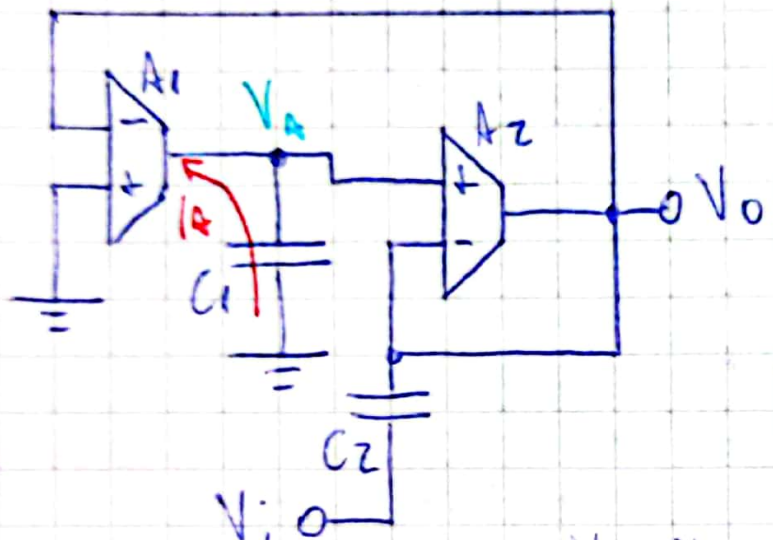
$$T_{HP}(\$) = \frac{1}{\sqrt{16,576}} \cdot \frac{\$^2 \;/0,986}{0,986\$^2 + 0,279\$ + 1} \cdot \frac{\$^2 \;/0,279}{0,279\$^2 + 0,673\$ + 1}$$

$/0,986$ $\qquad$ $/0,279$

$$T_{HP}(\$) = \frac{1}{\sqrt{16,576}} \cdot \frac{\frac{1}{0,986}\$^2}{\$^2 + 0,283\$ + 1,014} \cdot \frac{\frac{1}{0,279}\cdot\$^2}{\$^2 + 2,412\$ + 3,584}$$

$$T_{HP}(\$) = 0,892 \cdot \frac{\$^2}{\$^2 + 0,283\$ + 1,014} \cdot \frac{\$^2}{\$^2 + 2,412\$ + 3,584}$$

- Implementación con OTAs:



$$V_o - V_i = \frac{1}{sC_2} \cdot g_{m2} \cdot (V_A - V_o)$$

$$I_A = g_{m1} \cdot V_o \,, \quad V_A = \frac{-1}{sC_1} g_{m1} V_o$$

$$V_o - V_i = \frac{1}{sC_2} \cdot g_{m2} \cdot \left(\frac{-1}{sC_1} g_{m1} \cdot V_o - V_o \right)$$

$$V_o - V_i = \frac{-g_{m1}g_{m2}}{s^2 C_1 C_2} \cdot V_o - \frac{g_{m2}}{sC_2} \cdot V_o$$

$$V_o \cdot \left(1 + \frac{g_{m1}g_{m2}}{s^2 C_1 C_2} + \frac{g_{m2}}{sC_2} \right) = V_i \Rightarrow \frac{V_o}{V_i} = \frac{1}{\frac{s^2 C_1 C_2 + g_{m1}g_{m2} + s g_{m2} C_1}{s^2 C_1 C_2}}$$

$$\frac{V_o}{V_i} = \frac{s^2 C_1 C_2}{s^2 C_1 C_2 + s C_1 \cdot g_{m2} + g_{m1}g_{m2}}$$

$$\frac{V_o}{V_i} = \frac{s^2}{s^2 + s \frac{g_{m2}}{C_2} + \frac{g_{m1}g_{m2}}{C_1 C_2}}$$

- Fijo $C_1 = C_2 = 1\,\mu F$ y variO g_m: $C_1' = C_2' = 200{,}104\,S$ (Normalizado por W_0)

  $C_1' = C_2' = 0{,}282$

T1: $\frac{W_0}{Q} = 0{,}283$

$W_0^2 = 1{,}014 \rightarrow W_0 = 1{,}007$

$\frac{g_{m2}}{0{,}282} = 0{,}283 \rightarrow g_{m2} = 0{,}0798\,S = 79{,}8\,mS$

$\frac{g_{m1}\,g_{m2}}{0{,}282^2} = 1{,}014 \rightarrow g_{m1} = 1{,}01 = \frac{1{,}014\,C_1 C_2}{g_{m2}}$

~~g_{m1} muy grande, luego $C_1 = 22\,\mu F \rightarrow g_{m1} = 46\,mS$~~ } No

~~$C_1' = 6{,}2$~~

g_{m1} muy grande, luego $C_1 = 10\,nF \rightarrow g_{m1} = 10\,mS$

$C_1' = 0{,}00282$ →

T_2: $\frac{W_0}{Q} = 2{,}412$; $\frac{g_{m2}}{C_2} = 2{,}412$

Propongo $C_2 = 100\,nF \rightarrow g_{m2} = 68\,mS$

$C_2' = 0{,}028\,2$

$\frac{g_{m1}\, g_{m2}}{C_1\, C_2} = 3{,}584 \rightarrow \frac{g_{m1}}{C_1} = 1{,}486$

~~Propongo $C_1 = 10\,\mu F \rightarrow g_{m1}$~~

~~$C_1' = 2{,}327$~~

Propongo $C_1 = 100\,nF \rightarrow g_{m1} = 41{,}9\,mS$

$C_1' = 0{,}028\,2$