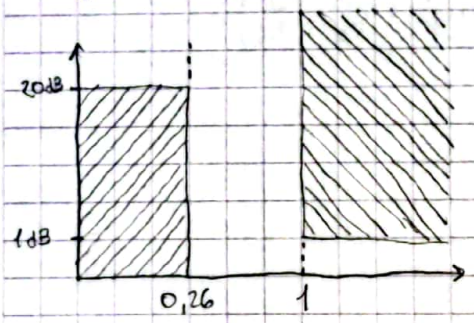
HOJA N°

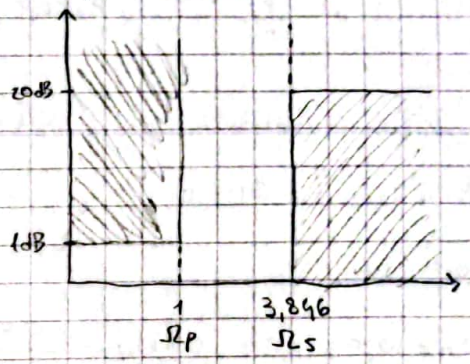
FECHA

TP laboratorio

Filtro Chebyshev $F_s = 1,2\,kHz$ $F_c = 4,6\,kHz$ con atenuación en banda de paso de 1dB como MAX y en banda de stop 20dB como min



$\omega_s = 7,54\,kHz$
$\omega_{s\_n} = 0,26$
$\omega_p = 28,9\,kHz$
$\omega_{p\_n} = 1$



$\varepsilon^2 = 10^{\alpha MAX/10} - 1 \longrightarrow \boxed{\varepsilon = 0,509}$

$\alpha_{min} = 10 \log \left[1 + \varepsilon^2 \cosh^2 (n \cdot \cosh^{-1}(\Omega_s))\right] \longrightarrow \boxed{n=2} \longrightarrow 23,27$ ✓

$C_2(\omega) = 2\omega \cdot C_1(\omega) - C_0(\omega) \qquad C_0(\omega) = 1 \qquad C_1(\omega) = \omega$

$C_2(\omega) = 2\omega^2 - 1$

$$|T(\omega)|^2 = \frac{1}{1 + \varepsilon^2 (2\omega^2 - 1)^2} = \frac{1}{1 + 4\varepsilon^2\omega^4 - 4\varepsilon^2\omega^2 + \varepsilon^2}$$

$$|T(\$)|^2 = \frac{1}{4\varepsilon^2 \left(\frac{\$}{j}\right)^4 - 4\varepsilon^2 \left(\frac{\$}{j}\right)^2 + \varepsilon^2 + 1} = \frac{1}{4\varepsilon^2 \$^4 + 4\varepsilon^2 \$^2 + \varepsilon^2 + 1}$$

$$\frac{1}{4\varepsilon^2 \$^4 + 4\varepsilon^2 \$^2 + \varepsilon^2 + 1} = \frac{1}{A\$^2 + B\$ + C} \quad \frac{1}{A\$^2 - B\$ + C}$$

$C = \sqrt{\varepsilon^2 + 1} = 1,122 \qquad A = 2\varepsilon = 1,018$

$4\varepsilon^2 = 2A \cdot C - B^2 \longrightarrow B = 1,117$

$$T(\$) = \frac{1}{1,018\$^2 + 1,117\$ + 1,122} = \frac{0,98}{\$^2 + 1,097\$ + 1,102}$$

TRANSFORM. PB → PA

$$T(\$) = \frac{\$^2}{1,122\$^2 + 1,117\$ + 1,018}$$

$$\left[T(\$) = \frac{0,9\,\$^2}{\$^2 + 0,995\$ + 0,91}\right] \qquad \omega_0 = 0,953 \quad Q = 0,958 \quad H = 0,9$$

NOTA

IMPLEMENTACIÓN CON UAF42 (EQ DE DISEÑO)

- $\frac{V_{HP}}{V_i} = \frac{A_{HP}\,\$^2}{\$^2 + \$\,\frac{\omega_n}{Q} + \omega_n^2}$
- $\omega_n^2 = \frac{R_2}{R_1 R_{F1} R_{F2} C_1 C_2}$
- $Q = \frac{1 + \frac{R_4(R_G + R_Q)}{R_G R_Q}}{1 + \frac{R_2}{R_1}} \sqrt{\frac{R_2 R_{F1} C_1}{R_1 R_{F2} C_2}}$
- $A_{HP} = \frac{1 + \frac{R_2}{R_1}}{R_G\left(\frac{1}{R_G} + \frac{1}{R_Q} + \frac{1}{R_4}\right)}$

VALORES INTERNOS DEL INTEGRADO:

- $R_1 = R_2 = R_4 = 50k\Omega$
- $C_1 = C_2 = 1nF = C$

OBJETIVO

- $\omega_n = 0{,}953 \cdot 2\pi \cdot 4{,}6kHz = 27544{,}22Hz$
- $Q = 0{,}958$
- $A_{HP} = 0{,}9$

DISEÑO

$[R_{F1} = R_{F2} = R_F]$ $\quad Q = \frac{1 + R_4(R_G /\!/ R_Q)}{2}$ $\quad \omega_n^2 = \frac{1}{R_F^2 C^2}$

$$A_{HP} = \frac{2}{R_G\left(\frac{1}{R_G} + \frac{1}{R_Q} + \frac{1}{R_4}\right)}$$

$$Q = \frac{1 + 50k\,(R_G /\!/ R_Q)^{-1}}{2} \Rightarrow R_G /\!/ R_Q \cong 54{,}22k\Omega \longrightarrow [R_Q = 817{,}5k\Omega]$$

$$A_{HP} = \frac{2}{R_G\left(\frac{R_G + R_Q}{R_G R_Q} + \frac{1}{50k}\right)} = \frac{2}{R_G\left(\frac{1}{54{,}22k} + \frac{1}{50k}\right)} \Rightarrow [R_G = 52{,}76k\Omega]$$

$$\omega_n^2 = \frac{1}{R_F^2 C^2} \longrightarrow [R_F = 36{,}34k\Omega]$$

NORMALIZACIÓN

$R_G = 56k\Omega$

$R_Q = 820k\Omega$

$R_F = 33k\Omega$ ó $39k\Omega$

$\omega_n = 25641Hz$

$Q = 0{,}977$

$A_{HP} = 1{,}023$

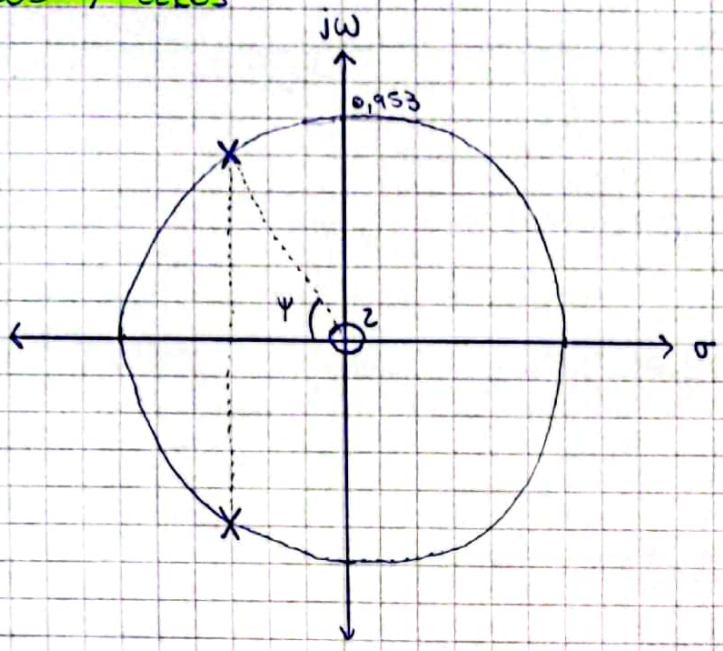
serán ajustados con pruebas

NOTA

HOJA Nº

FECHA

POLOS Y CEROS



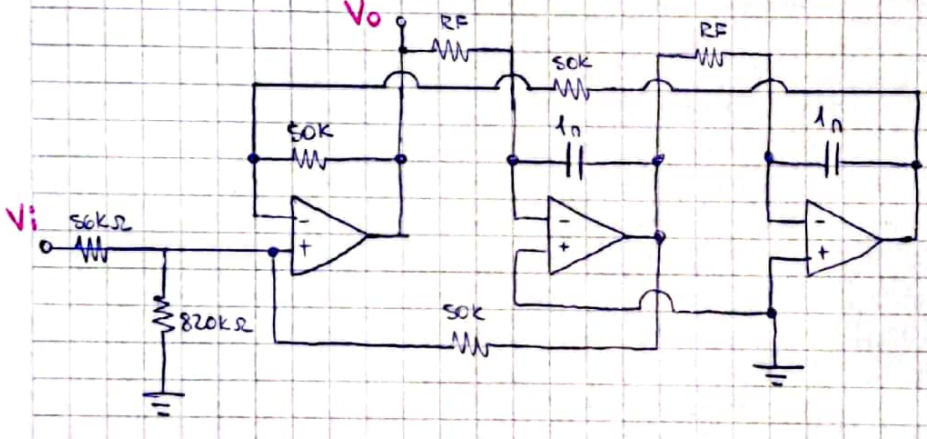
$\omega_0 = 0,953$

$Q = 0,958$

$Q = \frac{\omega_0}{2\cos\Psi}$

$\Psi = 60,16°$

CIRCUITO CON UAF42 Y VALORES COMERCIALES



RF = 33k - 39k

CÁLCULO DE FASE

$\theta(\omega)$

$$T(\omega) = T(s)\Big|_{s=j\omega} = \frac{-\omega^2 0,9}{0,91-\omega^2+j0,995\omega} = |T(\omega)| \cdot e^{j\left(\pi - \arctg\left(\frac{0,995\omega}{0,91-\omega^2}\right)\right)}$$

$\theta(0) = \pi$

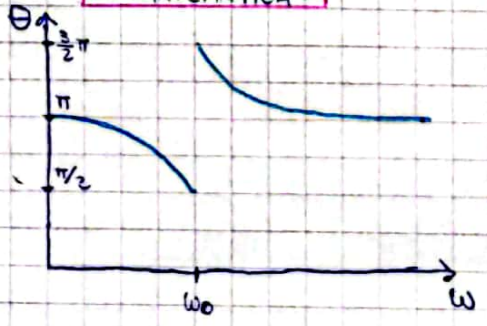
$\lim_{\omega \to \sqrt{0,91}^-} \theta(\omega) = \frac{\pi}{2}$

$\lim_{\omega \to \sqrt{0,91}^+} \theta(\omega) = 3/2\,\pi$

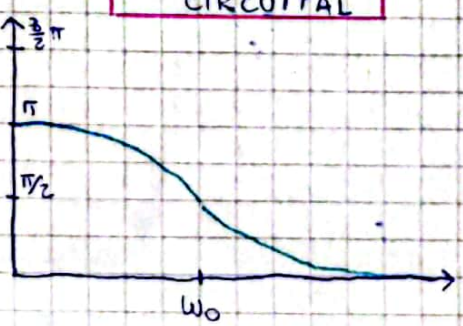
$\lim_{\omega \to \infty} \theta(\omega) = \pi$

$\sqrt{0,91} = \omega_0$

INTERPRETACIÓN MATEMÁTICA



INTERPRETACIÓN CIRCUITAL



NOTA