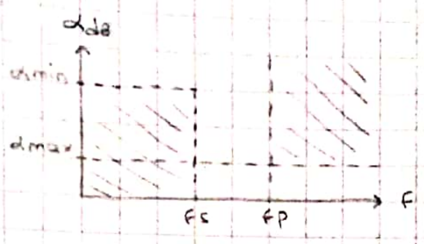
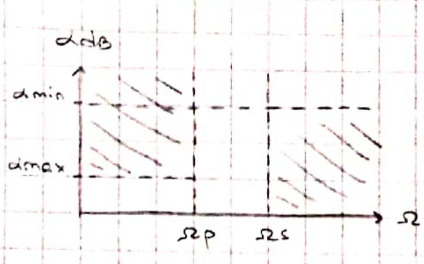
TP Lab



$F_p = 4{,}6$ kHz $\omega_p = 1$ $\alpha_{max} = 1$ dB

$F_s = 1{,}2$ kHz $\omega_s = 0{,}261$ $\alpha_{min} = 20$ dB

Chebyshev pasa alto



$k(\omega) = \dfrac{-1}{\omega} = \Omega$

$\left.\begin{aligned} \Omega_p &= 1 \\ \Omega_s &= \frac{1}{\omega_s} = 3{,}83 \end{aligned}\right\}$ pasabajo

$\varepsilon_1^2 = 10^{\alpha_{max}/10} - 1$

$\varepsilon_1^2 = 10^{1/10} - 1 = 0{,}2589$

$\alpha_{min} = 10 \log \left\{ 1 + \varepsilon_1^2 \cosh^2 \left[n \cdot \cosh^{-1}(\Omega_s) \right] \right\}$

$\underline{\underline{n = 2}}$: $\alpha_{min} = 23{,}2$ dB $\rightarrow$ cumple

Prototipo pasabajo

$$|T_c(j\omega)|^2 = \frac{1}{1+\varepsilon_1^2 C_2^2(\omega)} = \frac{1}{1+\varepsilon_1^2 (2\omega^2 - 1)^2} = \frac{1}{1+\varepsilon_1^2 (4\omega^4 - 4\omega^2 + 1)}$$

$$= \frac{1/4\varepsilon_1^2}{\omega^4 - \omega^2 + 1/4 + 1/4\varepsilon_1^2} = \frac{1/4\varepsilon_1^2}{\omega^4 - \omega^2 + 1{,}215}$$

$$|T(\$)|^2 = |T(j\omega)|^2 \Big|_{\omega = \$/j} = \frac{1/4\varepsilon_1^2}{\$^4 + \$^2 + 1{,}215} = T(\$) \cdot T(-\$)$$

$$T(\$) = \frac{1/2\varepsilon_1}{(\$ + 0{,}549 + j0{,}895)(\$ + 0{,}549 - j0{,}895)}$$

$$T(\$) = \frac{1/2\varepsilon_1}{\$^2 + \$\, 1{,}098 + 1{,}102}$$

Función de transformación $\rightarrow$ $\$ = \dfrac{1}{s}$

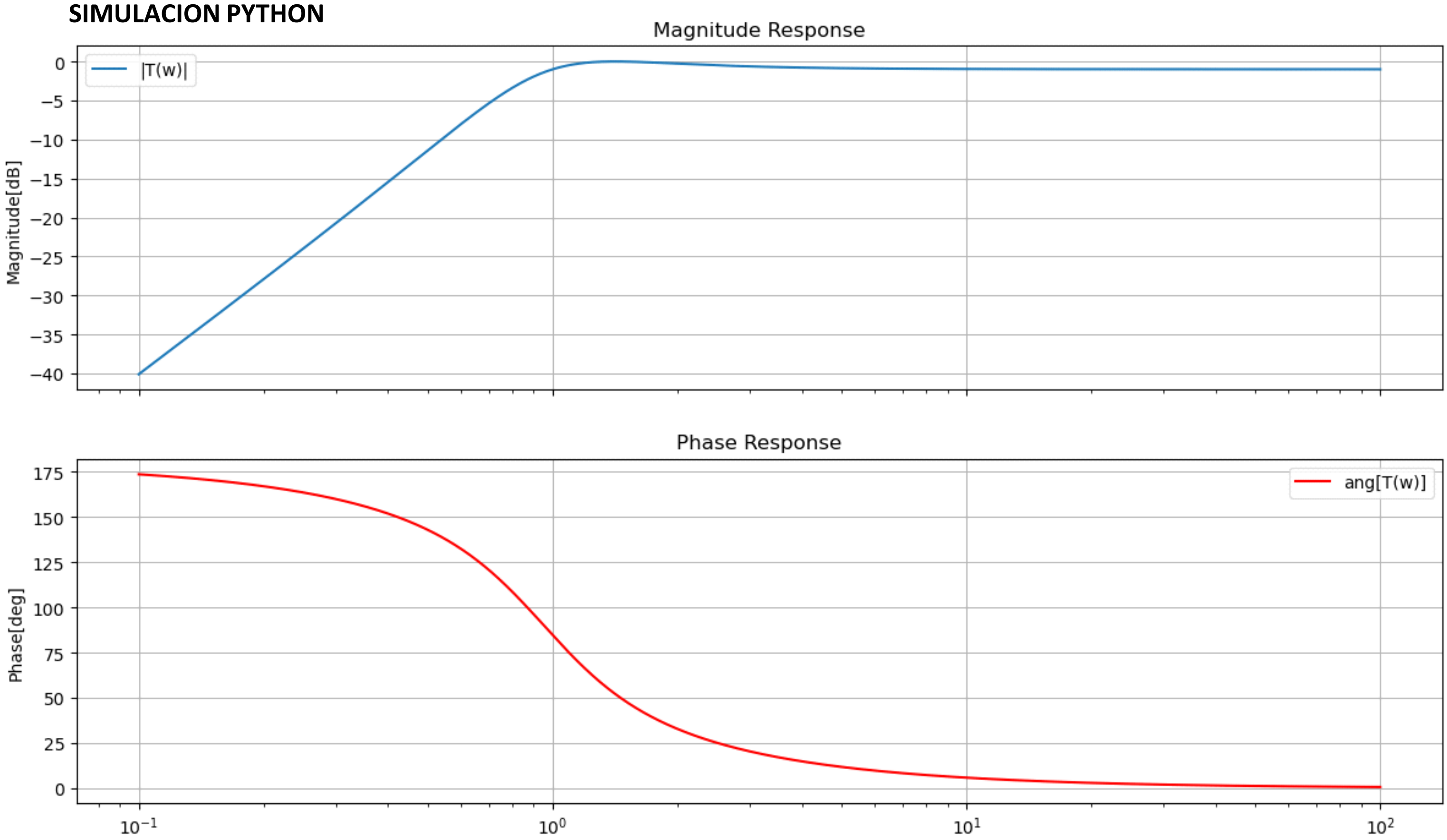
$$T(s) = \frac{1/2\varepsilon_1}{\left(\frac{1}{s}\right)^2 + \left(\frac{1}{s}\right) 1{,}098 + 1{,}102} = \frac{s^2 \cdot 1/2\varepsilon_1}{1 + s \cdot 1{,}098 + s^2 \cdot 1{,}102}$$

$$T(s) = \frac{0{,}983}{1{,}102} \frac{s^2}{s^2 + s \cdot 0{,}996 + 0{,}907} \longrightarrow \boxed{T(\$) = 0{,}89 \frac{s^2}{s^2 + s \cdot 0{,}996 + 0{,}907}}$$

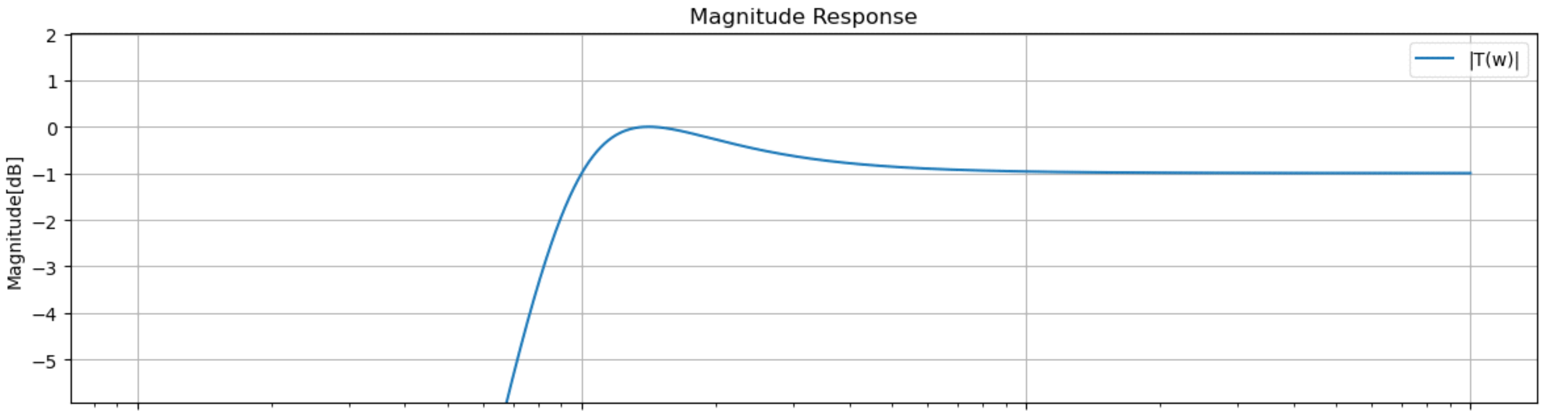
Cero en el origen y polos en $-0{,}498 \pm j\,0{,}812$

NOTA

SIMULACION PYTHON



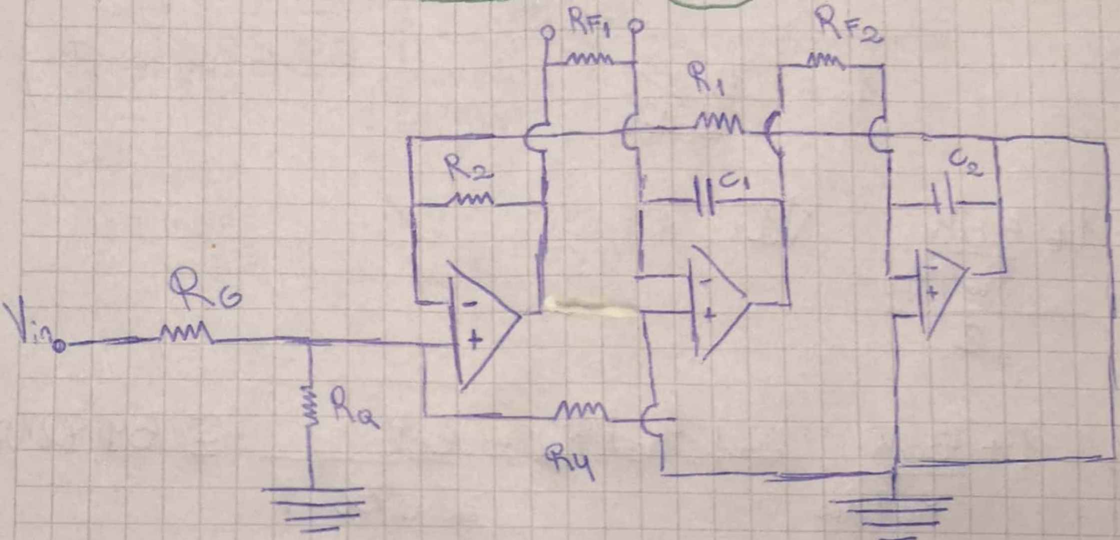
RIPPLE 1dB



HOJA N°

FECHA

TP LAB



$R_1 = R_2 = R_4 = 50k\,\Omega$

$C_1 = C_2 = 1000pF$

$A_{HP} = k = 0{,}89$

$Q = 0{,}956$

$\omega_n = 2\pi \cdot 4{,}6\,kHz \cdot 0{,}952$

De la hoja de datos

$$\omega_n^2 = \frac{R_2}{R_1 R_{F_1} R_{F_2} C_1 C_2}$$

$$A_{HP} = \frac{1 + R_2/R_1}{R_G\left[\frac{1}{R_G} + \frac{1}{R_Q} + \frac{1}{R_4}\right]}$$

$$Q = \frac{1 + R_4\frac{(R_G + R_Q)}{R_G R_Q}}{1 + \frac{R_2}{R_1}} \left[\frac{R_2 R_{F_1} C_1}{R_1 R_{F_2} C_2}\right]^{1/2}$$

NOTA

Adoptamos $R_{F1} = R_{F2}$

$$Q = 0{,}956 = \frac{1 + 50k\Omega \dfrac{(R_G + R_Q)}{R_G \cdot R_Q}}{1 + \cancel{\dfrac{50k\Omega}{50k\Omega}}} \cdot \left[\frac{\cancel{50k\Omega}\, \cancel{R_{F1}}\, \cancel{1000pF}}{\cancel{50k\Omega}\, \cancel{R_{F2}}\, \cancel{1000pF}}\right]^{1/2}$$

$$0{,}956 = \frac{1 + \dfrac{50k}{R_G // R_Q}}{2} \cdot \sqrt{1}$$

$$2 \cdot 0{,}956 = 1 + \frac{50k}{R_G // R_Q} \Rightarrow R_G // R_Q = \frac{50k}{2 \cdot 0{,}956 - 1} \cong 54{,}82k\Omega$$

$$k = \frac{1 + \cancel{\dfrac{50k\Omega}{50k\Omega}}}{R_G\left[\dfrac{1}{R_G} + \dfrac{1}{R_Q} + \dfrac{1}{50k\Omega}\right]}$$

$$k = \frac{2}{R_G\left[\dfrac{1}{R_G // R_Q} + \dfrac{1}{50k\Omega}\right]} \Rightarrow R_G = \frac{2}{0{,}89\left[\dfrac{1}{R_G // R_Q} + \dfrac{1}{50k\Omega}\right]} = \frac{2}{\left[\dfrac{1}{54{,}82k\Omega} + \dfrac{1}{50k\Omega}\right] 0{,}89}$$

$$\boxed{R_G = 58{,}76 k\Omega}$$

$$R_G // R_Q = 54{,}82 k\Omega \Rightarrow$$

$$R_Q = \frac{R_G \cdot 54{,}82k\Omega}{R_G - 54{,}82k\Omega} = \frac{58{,}76k\Omega \cdot 54{,}82k\Omega}{58{,}76k\Omega - 54{,}82k\Omega}$$

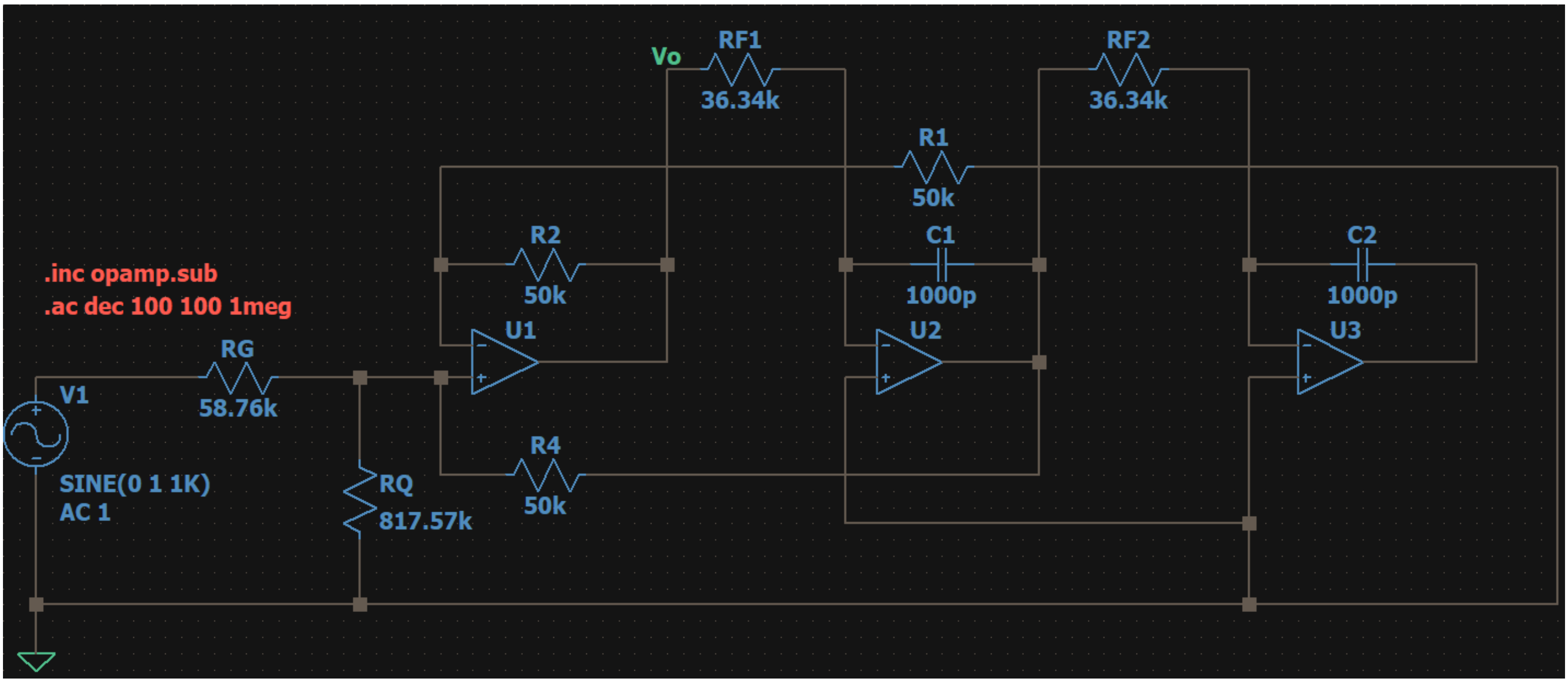
$$\boxed{R_Q = 817{,}57 k\Omega}$$

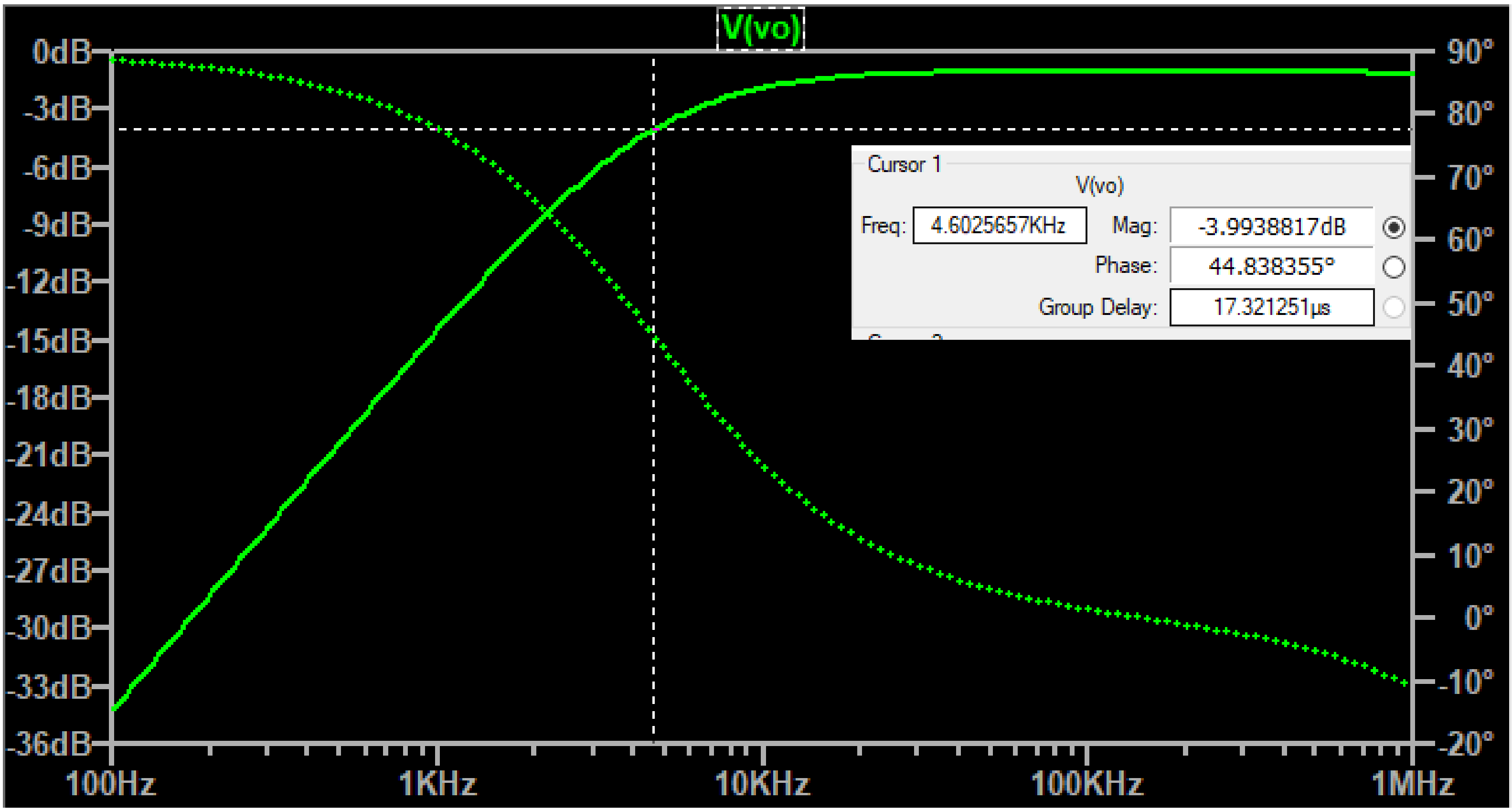
NOTA

$$\omega_n^2 = (2\pi \cdot 4{,}6\,KHz \cdot 0{,}952)^2 = \frac{\cancel{50K\Omega}}{\cancel{50K\Omega}} \cdot \frac{1}{R_{F_1}^2 (1000pF)^2}$$

$$2\pi \cdot 4{,}6\,KHz \cdot 0{,}952 = \frac{1}{\sqrt{R_{F_1}^2 \cdot (1000pF)^2}}$$

$$R_{F_1} = \frac{1}{2\pi \cdot 4{,}6\,KHz \cdot 0{,}952 \cdot 1000pF} = \boxed{36{,}34\,K\Omega = R_{F_1} = R_{F_2}}$$


Vo
RF1
36.34k
RF2
36.34k
R1
50k
R2
50k
C1
1000p
C2
1000p
.inc opamp.sub
.ac dec 100 100 1meg
U1
U2
U3
RG
58.76k
V1
SINE(0 1 1K)
AC 1
RQ
817.57k
R4
50k


V(vo)
0dB
-3dB
-6dB
-9dB
-12dB
-15dB
-18dB
-21dB
-24dB
-27dB
-30dB
-33dB
-36dB
90°
80°
70°
60°
50°
40°
30°
20°
10°
0°
-10°
-20°
100Hz
1KHz
10KHz
100KHz
1MHz
Cursor 1
V(vo)
Freq: 4.6025657KHz
Mag: -3.9938817dB
Phase: 44.838355°
Group Delay: 17.321251µs