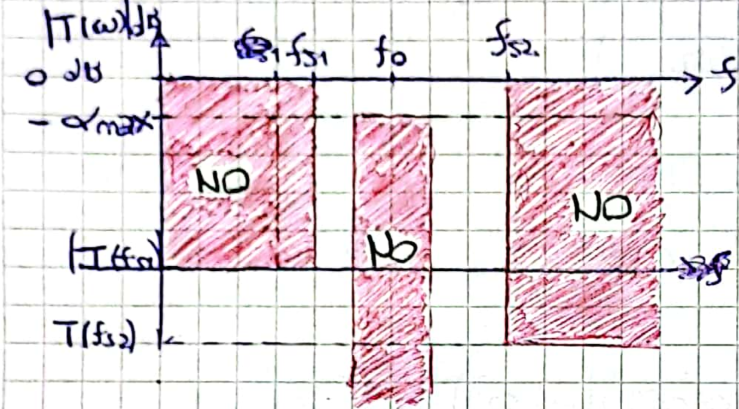
TS4 Bis[2]

Plantilla de diseño



$\omega_0 = 2\pi\, 22kHz$

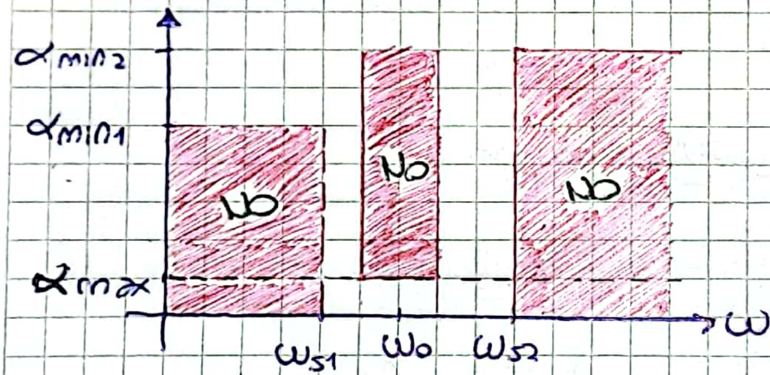
$Q = 5$

$|T(f_{s1})| = -16dB$ para $f_{s1} = 17kHz$

$|T(f_{s2})| = -24dB$ para $f_{s2} = 36kHz$

$\alpha_{max} = 0,5dB$

① Normalizo la plantilla y trabajo con atenuación.



Norma de frecuencia: $2\pi f_0$

$$\omega_0 = \frac{2\pi f_0}{2\pi f_0} = 1$$

$$\omega_{s1} = \frac{2\pi f_{s1}}{2\pi f_0} = \frac{17}{22} \simeq 0,773$$

$$\omega_{s2} = \frac{2\pi f_{s2}}{2\pi f_0} = \frac{18}{11} \simeq 1,\overline{63}$$

$\alpha_{min1} = 16dB$

$\alpha_{min2} = 24dB$

② Prototipo Pasabajos

$\Omega_p = 1$

$$\Omega_{s1} = \left| Q\, \frac{\omega_{s1}^2 - 1}{\omega_{s1}} \right| = 2,6$$

$$\Omega_{s2} = \left| Q\, \frac{\omega_{s2}^2 - 1}{\omega_{s2}} \right| = 5,12$$

Para chequear en la simulación

$BW = \frac{\omega_0}{Q} = \frac{1}{5} = \omega_{p2} - \omega_{p1}$

$\omega_0^2 = \omega_{p1}\omega_{p2} \Rightarrow \omega_{p2} = \frac{1}{\omega_{p1}}$

$BW = \frac{1}{\omega_{p1}} - \omega_{p1}$

$\omega_{p1}^2 + BW\,\omega_{p1} - 1 = 0$

$\omega_{p1} = 0,905 \Rightarrow f_{s1} = 19,9kHz$

$\omega_{p2} = 1,105 \quad f_{s2} = 24,3k$

Notas:

Aproximación de Chebyshev

$$\varepsilon^2 = 10^{\frac{\alpha_{max}\,dB}{10}} - 1 = 0,122 \Rightarrow \varepsilon = 0,349$$

¿Qué Ω_S me impone un mayor requisito?

Ω_{S1} Ω_{S2}

$$\alpha_{min_{1_n}} = 10\log(1+\varepsilon^2\cosh(n\,\mathrm{arccosh}(\Omega_{S1})))$$

Para $n=2$

$$\alpha_{min_{1_2}} = 10,735\,dB$$

Para $n=3$

$$\alpha_{min_{1_3}} = 21,63\,dB$$

$$\alpha_{min_2} = 10\log(1+\varepsilon^2\cosh(n\,\mathrm{arccosh}(\Omega_{S2})))$$

Para $n=2$

$$\alpha_{min_2} = 35,10\,dB$$

Ω_{S1} me impone un requisito mayor

$$\boxed{n=3\,//}$$

Utilizando python, obtengo la transferencia del filtro prototipo.

$$|T_{LP}(\omega)|^2 = \frac{1}{1+\varepsilon^2(4\omega^3-3\omega)^{2,3}}$$

$C_0 = 1$

$C_1 = \omega$

$C_2 = 2\omega^2 - 1$

$C_3 = 2\omega(2\omega^2-1) - \omega = 4\omega^3 - 2\omega - \omega = 4\omega^3 - 3\omega$

La transferencia del filtro prototipo resulta

$$T_{LP}(S) = \frac{0,7157}{S^3 + S^2\,1,253 + S\,1535 + 0,7157}$$

Y en su forma factorizada:

$$\boxed{T_{LP}(S) = \frac{0,6265}{S + 0,6265} \cdot \frac{(1,069)^2}{S^2 + S\left(\frac{1,069}{1,706}\right) + 1,069^2}}$$

③ Transferencia del pasabanda normalizada

Se recurre a Python.

Si se desea llegar a la expresión, se debe aplicar el núcleo de transformación

$$T_{BP}(S) = \frac{(1,069)^2}{\left(Q\,\frac{S^2-1}{S}\right)^2 + Q\,\frac{S^2-1}{S}\left(\frac{1,069}{1,706}\right) + 1,069^2} \cdot \frac{0,6265}{Q\,\frac{S^2-1}{S} + 0,6265}$$

$$\boxed{T_{BP}(S) = \frac{S \cdot 1,207\left(\frac{1}{7,981}\right)}{S^2 + S\left(\frac{1}{7,981}\right) + 1^2} \cdot \frac{S \cdot 2,045\left(\frac{0,903}{16,05}\right)}{S^2 + S\left(\frac{0,903}{16,08}\right) + (0,903)^2} \cdot \frac{S \cdot 1,768\left(\frac{1,107}{16,05}\right)}{S^2 + S\left(\frac{1,107}{16,05}\right) + 1,107^2}}$$

Notas: