Gegebene Werte:

$A_{0\_1} := 1$ $A_{0\_2} := 1$ $a_D := 1$ dB $a_s := 40$ dB

$f_{pb} := 10000$ $n := 4$ $R := 10000$ $C := 1 \cdot 10^{-9}$

Berechnung Polfrequenzen, Nullfrequenzen und Polgüte:

$$\varepsilon := \frac{1}{\sqrt{10^{0.1 \cdot a_s} - 1}} = 0.0100005$$ ... Welligkeit im Sperrbereich

$$s_P(k) := \frac{1}{-\sin\left(\frac{1+2\cdot k}{2\cdot n}\cdot\pi\right)\cdot\sinh\left(\frac{1}{n}\cdot\operatorname{asinh}\left(\frac{1}{\varepsilon}\right)\right) + 1\mathrm{i}\cdot\cos\left(\frac{1+2\cdot k}{2\cdot n}\cdot\pi\right)\cdot\cosh\left(\frac{1}{n}\cdot\operatorname{asinh}\left(\frac{1}{\varepsilon}\right)\right)}$$

$$s_Z(k) := \frac{1\mathrm{i}}{\cos\left(\frac{1+2\cdot k}{2\cdot n}\cdot\pi\right)}$$ ... Nullfrequenzen

$$Q_P(k) := \frac{-\left|s_P(k)\right|}{2\cdot\mathrm{Re}\left(s_P(k)\right)}$$ ... Polgüten

$s_P(0) = -0.171 - 0.476\mathrm{i}$ $s_P(1) = -0.505 - 0.241\mathrm{i}$

$s_P(2) = -0.505 + 0.241\mathrm{i}$ $s_P(3) = -0.171 + 0.476\mathrm{i}$

$s_Z(0) = 1.082\mathrm{i}$ $s_Z(1) = 2.613\mathrm{i}$

$s_Z(2) = -2.613\mathrm{i}$ $s_Z(3) = -1.082\mathrm{i}$

$Q_P(0) = 1.478$ $Q_P(1) = 0.554$

$Q_P(2) = 0.554$ $Q_P(3) = 1.478$

$\Omega_{P1} := \left|s_P(0)\right| = 0.506$ $\Omega_{P2} := \left|s_P(1)\right| = 0.559$

$\Omega_{Z1} := \left|s_Z(0)\right| = 1.082$ $\Omega_{Z2} := \left|s_Z(1)\right| = 2.613$

$Q_{P1} := Q_P(0) = 1.478$ $Q_{P2} := Q_P(1) = 0.554$

Wählbare Werte zuordnen:

$C_{5\_1} := C = 1 \cdot 10^{-9}$ $C_{5\_2} := C = 1 \cdot 10^{-9}$

$R_{B\_1} := R = 1 \cdot 10^{4}$ $R_{B\_2} := R = 1 \cdot 10^{4}$

$$k := \cosh\left(\frac{\operatorname{acosh}\left(\frac{\sqrt{\frac{10^{-0.1 \cdot a_D}}{1-10^{-0.1 \cdot a_D}}}}{\varepsilon}\right)}{n}\right) = 2.339$$

Entnormierte Pol-/ Nullstellenkreisfrequenzen bestimmen:

$\omega_{P1} := 2 \cdot \pi \cdot f_{pb} \cdot \Omega_{P1} \cdot k = 74339.6$ $\omega_{P2} := 2 \cdot \pi \cdot f_{pb} \cdot \Omega_{P2} \cdot k = 82144.333$

$\omega_{Z1} := 2 \cdot \pi \cdot f_{pb} \cdot \Omega_{Z1} \cdot k = 159041.723$ $\omega_{Z2} := 2 \cdot \pi \cdot f_{pb} \cdot \Omega_{Z2} \cdot k = 383960.684$

C_1 berechnen:

$$C_{1\_1min} := \frac{C_{5\_1} \cdot {A_{0\_1}}^2 \cdot \left({Q_{P1}}^2 \cdot \left({\omega_{Z1}}^2 - {\omega_{P1}}^2\right) + {\omega_{P1}}^2\right)^2}{{\omega_{Z1}}^4 \cdot {Q_{P1}}^2 \cdot \left(A_{0\_1} - 1\right) + {\omega_{Z1}}^2 \cdot {\omega_{P1}}^2 \cdot {Q_{P1}}^2 \cdot A_{0\_1} \cdot \left(A_{0\_1} - 1\right) + {\omega_{P1}}^2 \cdot A_{0\_1} \cdot \left({\omega_{Z1}}^2 - A_{0\_1} \cdot {\omega_{P1}}^2\right)} = 2.172 \cdot 10^{-8}$$

$$C_{1\_2min} := \frac{C_{5\_2} \cdot {A_{0\_2}}^2 \cdot \left({Q_{P2}}^2 \cdot \left({\omega_{Z2}}^2 - {\omega_{P2}}^2\right) + {\omega_{P2}}^2\right)^2}{{\omega_{Z2}}^4 \cdot {Q_{P2}}^2 \cdot \left(A_{0\_2} - 1\right) + {\omega_{Z2}}^2 \cdot {\omega_{P2}}^2 \cdot {Q_{P2}}^2 \cdot A_{0\_2} \cdot \left(A_{0\_2} - 1\right) + {\omega_{P2}}^2 \cdot A_{0\_2} \cdot \left({\omega_{Z2}}^2 - A_{0\_2} \cdot {\omega_{P2}}^2\right)} = 2.626 \cdot 10^{-9}$$

$C_{1\_1} := 22 \cdot 10^{-9}$ $C_{1\_2} := 2.7 \cdot 10^{-9}$

R_A berechnen:

$$R_{A\_1} := \frac{R_{B\_1} \cdot \left({\omega_{Z1}}^2 - A_{0\_1} \cdot {\omega_{P1}}^2\right)}{{\omega_{P1}}^2 \cdot A_{0\_1}} = 35770.083$$

$R_{A\_1} := 36 \cdot 10^{3}$

$$R_{A\_2} := \frac{R_{B\_2} \cdot \left({\omega_{Z2}}^2 - A_{0\_1} \cdot {\omega_{P2}}^2\right)}{{\omega_{P2}}^2 \cdot A_{0\_1}} = 208483.325$$

$R_{A\_2} := 200 \cdot 10^{3}$

R_3 berechnen:

$$R_{3\_1} := \frac{C_{1\_1}\cdot\omega_{Z1}{}^2 - \sqrt{C_{1\_1}{}^2\cdot\omega_{Z1}{}^4 - 4\cdot C_{1\_1}\cdot C_{5\_1}\cdot A_{0\_1}{}^2\cdot\omega_{P1}{}^2\cdot\left(\omega_{P1}{}^2 + Q_{P1}{}^2\cdot\omega_{Z1}{}^2\right)}}{2\cdot C_{1\_1}\cdot C_{5\_1}\cdot A_{0\_1}\cdot Q_{P1}\cdot\omega_{P1}{}^3} = 1019.002$$

$$R_{3\_2} := \frac{C_{1\_2}\cdot\omega_{Z2}{}^2 - \sqrt{C_{1\_2}{}^2\cdot\omega_{Z2}{}^4 - 4\cdot C_{1\_2}\cdot C_{5\_2}\cdot A_{0\_2}{}^2\cdot\omega_{P2}{}^2\cdot\left(\omega_{P2}{}^2 + Q_{P2}{}^2\cdot\omega_{Z2}{}^2\right)}}{2\cdot C_{1\_2}\cdot C_{5\_2}\cdot A_{0\_2}\cdot Q_{P2}\cdot\omega_{P2}{}^3} = 2887.827$$

$R_{3\_1} = 1\cdot 10^3$ $R_{3\_2} = 2.7\cdot 10^3$

R_4 berechnen:

$$R_{4\_1} := \frac{1}{C_{1\_1}\cdot C_{5\_1}\cdot R_{3\_1}\cdot\omega_{P1}{}^2} = 8071.64$$ $R_{4\_1} := 8.2\cdot 10^3$

$$R_{4\_2} := \frac{1}{C_{1\_2}\cdot C_{5\_2}\cdot R_{3\_2}\cdot\omega_{P2}{}^2} = 19006.84$$ $R_{4\_2} := 18\cdot 10^3$

R_2 berechnen:

$$R_{2\_1} := \frac{-Q_{P1}\cdot R_{3\_1}}{Q_{P1} + R_{3\_1}{}^2\cdot C_{1\_1}\cdot C_{5\_1}\cdot Q_{P1}\cdot\omega_{P1}{}^2 - R_{3\_1}\cdot C_{1\_1}\cdot\omega_{P1}} = 749432.005$$

$$R_{2\_2} := \frac{-Q_{P2}\cdot R_{3\_2}}{Q_{P2} + R_{3\_2}{}^2\cdot C_{1\_2}\cdot C_{5\_2}\cdot Q_{P2}\cdot\omega_{P2}{}^2 - R_{3\_2}\cdot C_{1\_2}\cdot\omega_{P2}} = 698494.457$$

$R_{2\_1} := 750\cdot 10^3$ $R_{2\_2} := 680\cdot 10^3$

R_6 berechnen:

$$R_{6\_1} := \frac{R_{B\_1}\cdot Q_{P1}}{C_{5\_1}\cdot\omega_{P1}\cdot\left(R_{3\_1}\cdot R_{A\_1}\cdot C_{1\_1}\cdot Q_{P1}\cdot\omega_{P1} - R_{B\_1}\right)} = 2527.122$$

$$R_{6\_2} := \frac{R_{B\_2}\cdot Q_{P2}}{C_{5\_2}\cdot\omega_{P2}\cdot\left(R_{3\_2}\cdot R_{A\_2}\cdot C_{1\_2}\cdot Q_{P2}\cdot\omega_{P2} - R_{B\_2}\right)} = 1106.214$$

$R_{6\_1} := 2588\cdot 10^3$ $R_{6\_2} := 1\cdot 10^3$