Chebyshev Bandpass Filter Design

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Unloaded Element Q $Qu := 100$

Filter Order: $N := 5$

Passband Ripple, dB: $\rho := 0.1$ $k := 1 .. N$

Filter Lower Corner Frequency, MHz: $F1 := 147$

Filter Upper Corner Frequency, MHa: $F2 := 180$

Tuning Range, Fmin, MHz $Ft1 := 152$

Fmax, MHz $Ft2 := 174$

Geometric Center Frequency, MHz: $Fo := \sqrt{F1 \cdot F2}$

$$\varepsilon := \sqrt{10^{0.1 \cdot \rho} - 1}$$

$$\beta := \ln\left(\coth\left(\frac{\rho}{17.37}\right)\right) \qquad \gamma := \sinh\left(\frac{\beta}{2 \cdot N}\right)$$

$$a_k := \sin\left[\frac{(2 \cdot k - 1) \cdot \pi}{2 \cdot N}\right] \qquad b_k := \gamma^2 + \sin\left(\frac{k \cdot \pi}{N}\right)$$

$g_0 := 1.0$ $m := 2 .. N$

$$g_1 := \frac{2 \cdot a_1}{\gamma} \qquad g_{N+1} := \text{if}\left(\text{mod}(N, 2) = 1, 1.0, \frac{1}{\tanh\left(\frac{\beta}{4}\right)^2}\right)$$

$$g_m := \frac{4 \cdot a_{m-1} \cdot a_m}{b_{m-1} \cdot g_{m-1}}$$

$$Tm := \frac{4 \cdot g_0 \cdot g_{N+1}}{(g_0 + g_{N+1})^2}$$

$$sumg := \sum_m g_m + g_0 + g_1 + g_{N+1} \qquad sumg = 8.905$$

$$Aloss := \frac{4.343 \cdot Tm \cdot sumg}{\left(\frac{F2 - F1}{Fo}\right) \cdot Qu} \qquad Aloss = 1.906$$

Start Frequency for Sweep, MHz: $Fstart := F1 - 2.5 \cdot (F2 - F1)$

Stop Frequency for Sweep, MHz: $Fstop := F2 + 4 \cdot (F2 - F1)$

$Nsteps := 511$

$i := 0 .. Nsteps$

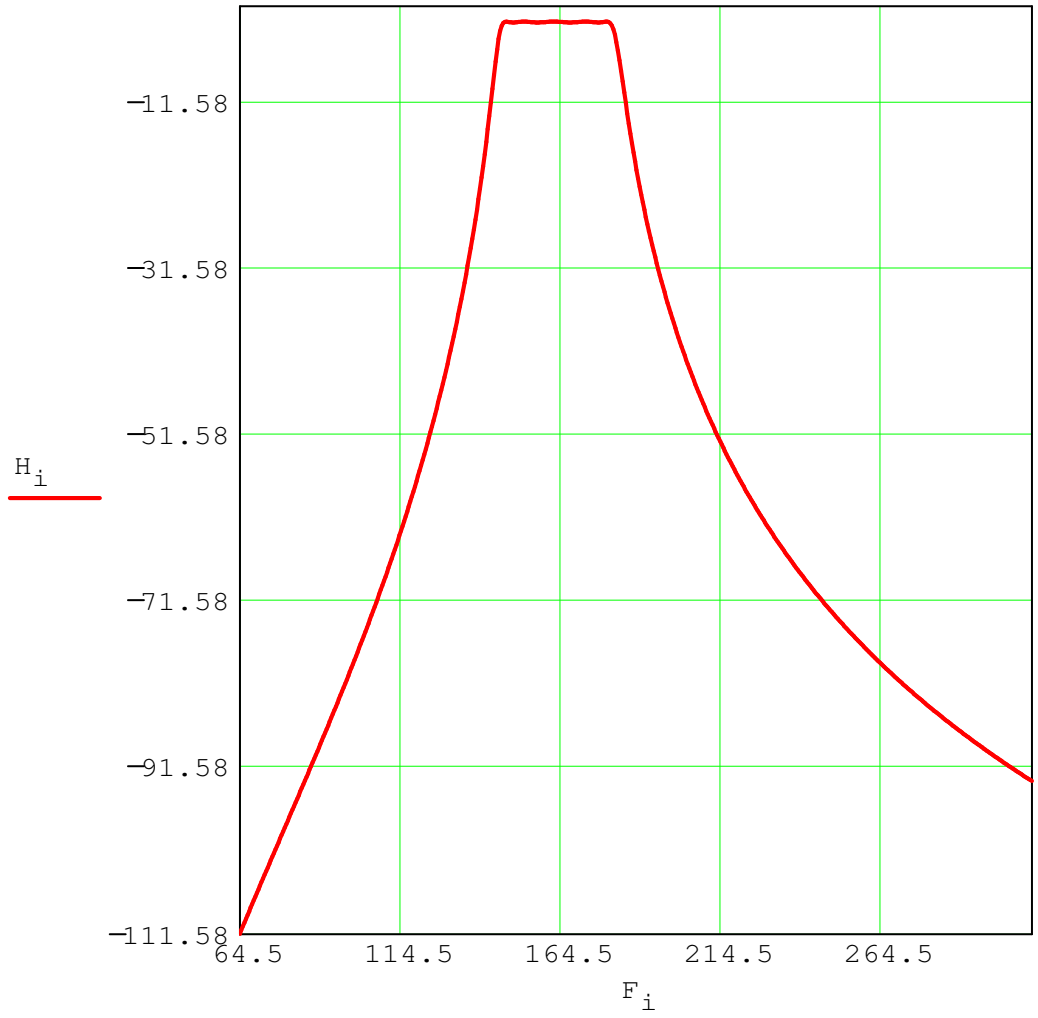
$$Fstep := \frac{Fstop - Fstart}{Nsteps}$$

$$F_i := Fstart + Fstep \cdot i$$

$$\chi_i := \frac{Fo}{F2 - F1} \cdot \left(\frac{F_i}{Fo} - \frac{Fo}{F_i} \right)$$

$$C_i := if\left(\chi_i \le 1.0, \cos\left(N \cdot acos\left(\chi_i\right)\right), \cosh\left(N \cdot acosh\left(\chi_i\right)\right)\right)$$

$$H_i := -20 \cdot \log\left[\sqrt{1 + \varepsilon^2 \cdot (C_i)^2}\right] - Aloss$$

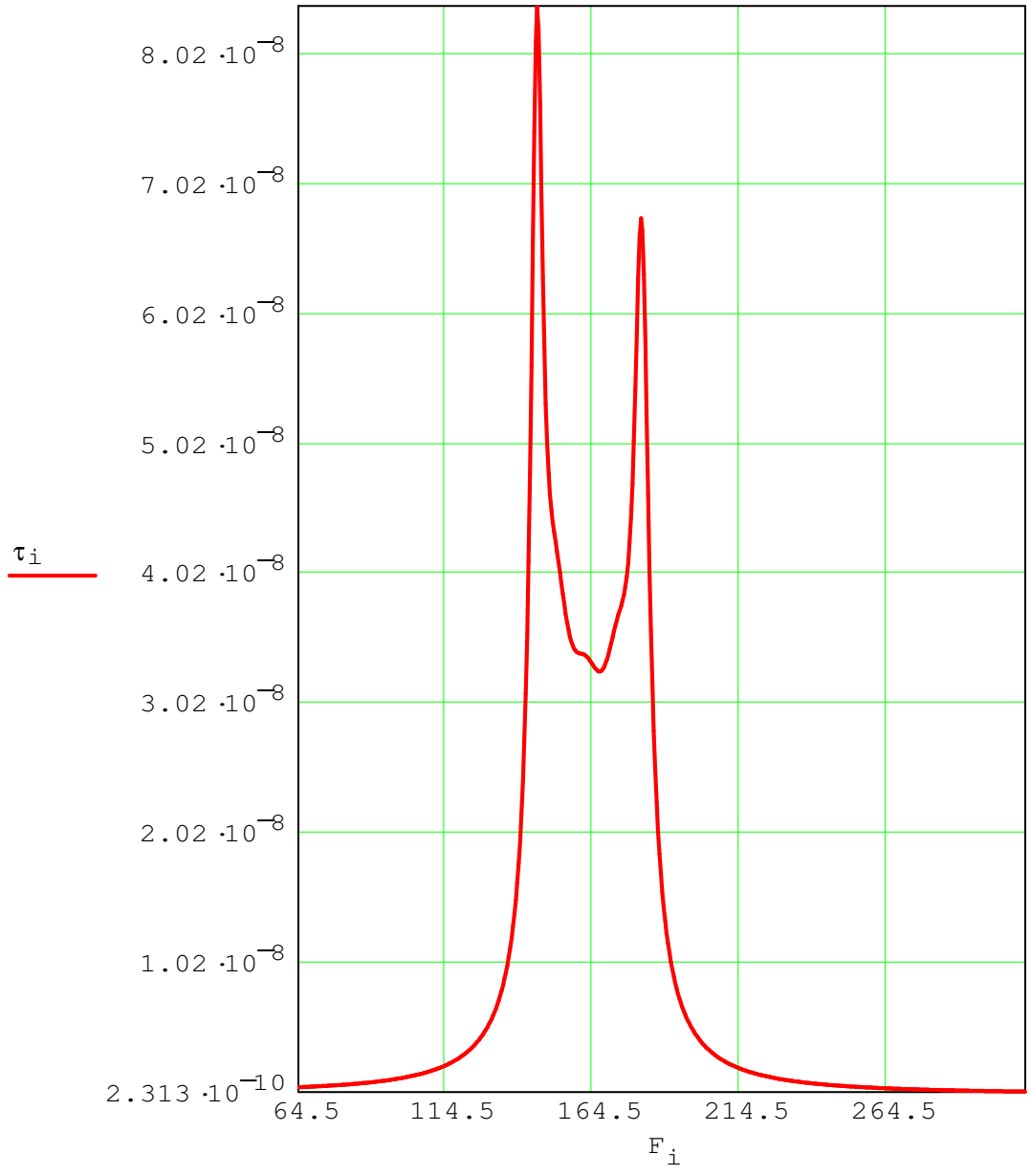


$$\sigma_k := \sinh\left(\frac{1}{N}\cdot\operatorname{asinh}\left(\frac{1}{\varepsilon}\right)\right)\cdot\sin\left(\frac{2\cdot k-1}{N}\cdot\frac{\pi}{2}\right)$$

$$\omega_k := \cosh\left(\frac{1}{N}\cdot\operatorname{asinh}\left(\frac{1}{\varepsilon}\right)\right)\cdot\cos\left(\frac{2\cdot k-1}{N}\cdot\frac{\pi}{2}\right)$$

$$\Omega_i := \left|\frac{1}{F2-F1}\cdot\left(F_i-\frac{F2\cdot F1}{F_i}\right)\right|$$

$$\tau_i := \frac{1}{2\cdot\pi\cdot(F2-F1)\cdot 10^6}\cdot\left[1+\frac{F2\cdot F1}{(F_i)^2}\right]\cdot\sum_k\frac{|\sigma_k|}{(\sigma_k)^2+(\Omega_i-\omega_k)^2}$$



Attenuation at Specific Frequencies of Interest:

$$Fx(f) := \frac{Fo}{F2 - F1} \cdot \left(\frac{f}{Fo} - \frac{Fo}{f} \right)$$

$$Cf(x) := if(x \le 1.0, \cos(N \cdot \acos(x)), \cosh(N \cdot \acosh(x)))$$

$kk := 0 .. 4$ Number of critical frequencies

$$Fc := \begin{pmatrix} 45 \\ Ft1 + 45 \\ Ft1 + 90 \\ 132 \\ 182 \end{pmatrix}$$

First IF Frequency
Frequency of LO @ Low Edge of Band
Frequency of Image Band
Prominent Spur Frequency 1
Prominent Spur Frequency 2

$$Ax_{kk} := -20 \cdot \log\left(\sqrt{1 + \varepsilon^2 \cdot Cf(Fx(Fc_{kk}))^2} \right) - Aloss$$

Critical Freqs Attenuation, dB

$$Fc = \begin{pmatrix} 45 \\ 197 \\ 242 \\ 132 \\ 182 \end{pmatrix} \qquad Ax = \begin{pmatrix} -131.249 \\ -34.148 \\ -69.396 \\ -38.574 \\ -3.986 \end{pmatrix}$$

First IF Frequency
Frequency of LO @ Low Edge of Band
Frequency of Image Band
Prominent Spur Frequency 1
Prominent Spur Frequency 2