Softwave PC Commands COMFOCUS PROPRIETARY

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Rev 0

N O T C H F I L T E R

The notch filter function is implemented effectively as a lowpass filter at baseband as shown below in Figure 1. The corner frequency of the lowpass filter (LPF) effectively determines the width of the notch filter (at D.C.) whereas the depth of the notch is governed by the gain parameter a.

The lowpass filter is a second-order filter section. More on this momentarily.

The frequency of the notch filter is easily shifted within the DSP by using simple complex phase rotations on I and Q. This is shown simplistically in Figure 2. By performing the rotation and derotation in this manner, sigificant effort is saved in the filtering process (which is done on I and Q separately rather than also involving complex cross terms.)

Notch Filter for Softwave DSP

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$kk := 0 .. 5$

Damping Factor Used $\zeta := 5.0$

Natural Frequency $\omega_n := 2 \cdot \pi \cdot 0.15$

Sampling Interval $T := 1$

Declare Notch Depths of Interest, dB

$$Ndepth := \begin{pmatrix} 5 \\ 10 \\ 15 \\ 20 \\ 25 \\ 30 \end{pmatrix}$$

$$a_{kk} := 1 - \left(10^{-0.05 \cdot Ndepth_{kk}}\right)$$

Lowpass Filter Portion Alone

$n0 := 1 \qquad n1 := 2 \qquad n2 := 1$

$$d0 := 1 - \frac{4 \cdot \zeta}{\omega_n \cdot T} + \left(\frac{2}{\omega_n \cdot T}\right)^2$$

$$d1 := 2 - 2 \cdot \left(\frac{2}{\omega_n \cdot T}\right)^2$$

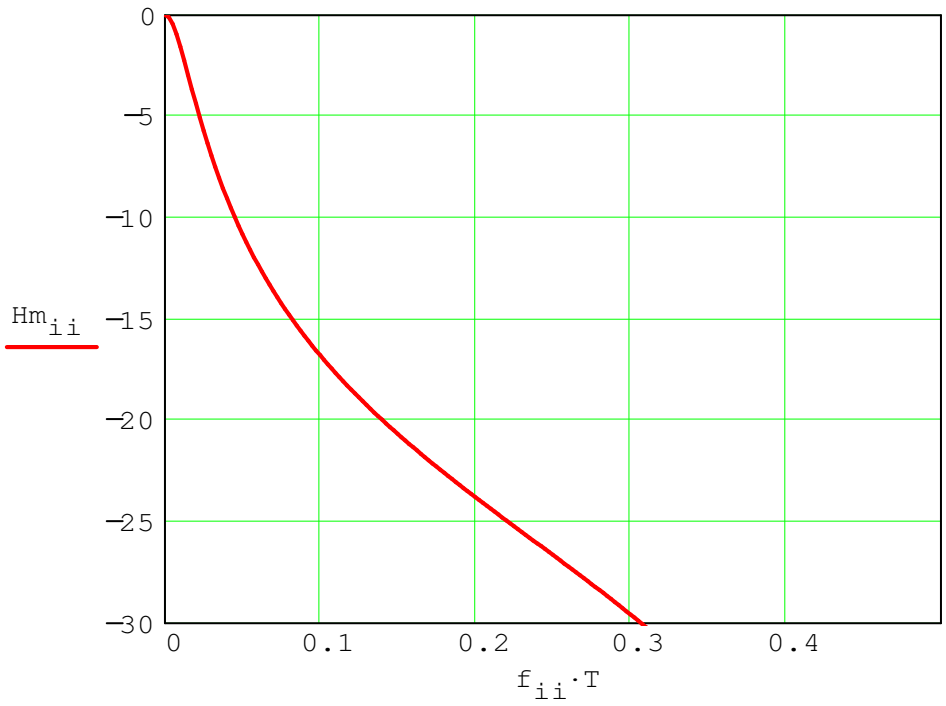
$$d2 := 1 + \frac{4 \cdot \zeta}{\omega_n \cdot T} + \left(\frac{2}{\omega_n \cdot T}\right)^2$$

$ii := 0 .. 199$

$$f_{ii} := ii \cdot \frac{0.50}{200} \qquad z_{ii} := e^{\sqrt{-1} \cdot 2 \cdot \pi \cdot f_{ii}}$$

$$H_{ii} := \frac{n0 + n1 \cdot (z_{ii})^1 + n2 \cdot (z_{ii})^2}{d0 + d1 \cdot (z_{ii})^1 + d2 \cdot (z_{ii})^2}$$

$$Hm_{ii} := 10 \cdot \log\left[\left(\left|H_{ii}\right|\right)^2\right]$$


0
−5
−10
−15
−20
−25
−30
Hm_ii
0
0.1
0.2
0.3
0.4
f_ii·T

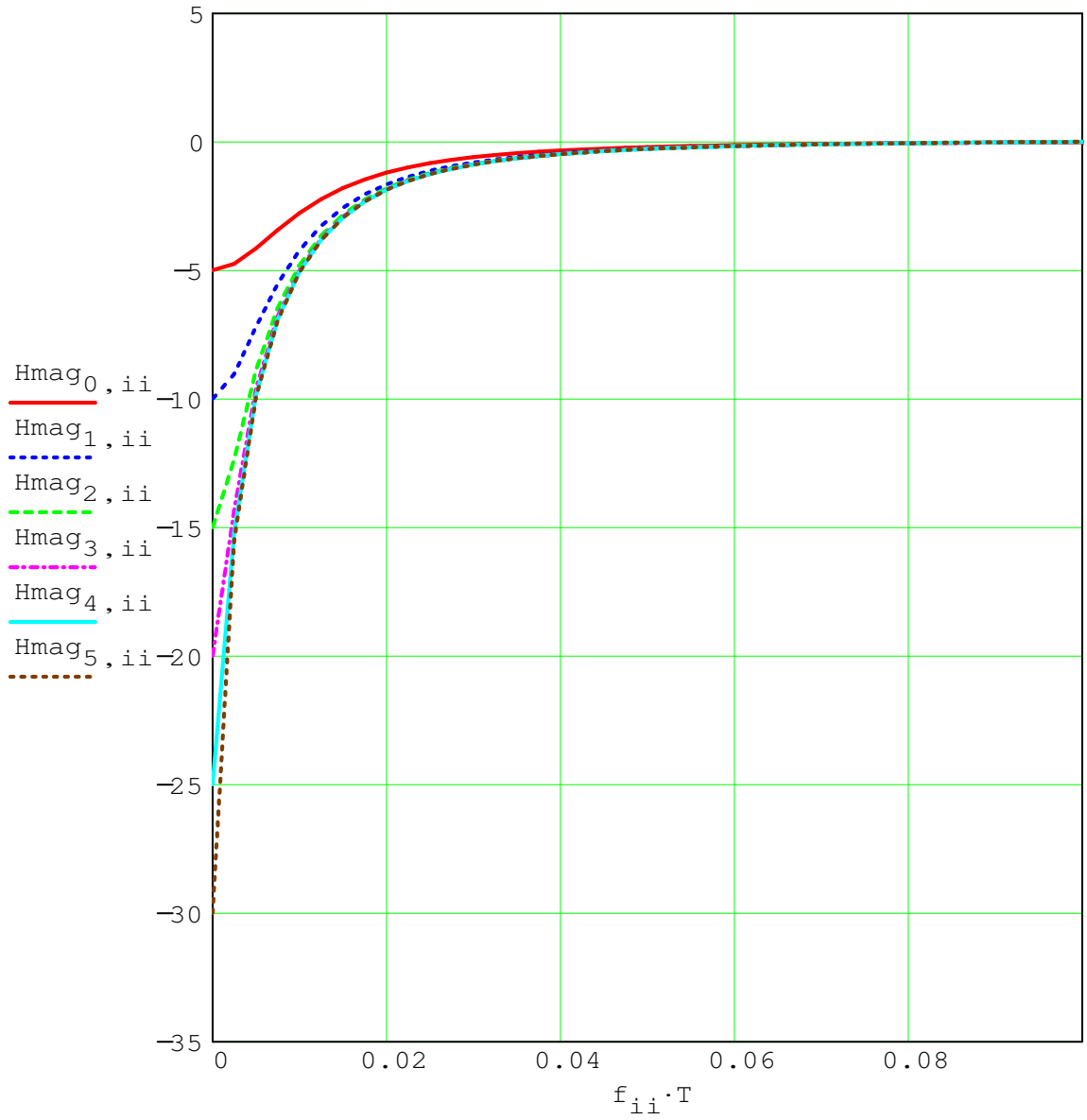
Notch Filter Results

$Hn_{kk,ii} := 1 - a_{kk} \cdot H_{ii}$

$Hmag_{kk,ii} := 20 \cdot \log(|Hn_{kk,ii}|)$

With Damping Factor: $\zeta = 5$

Natural Freq =



Group Delay of Filter

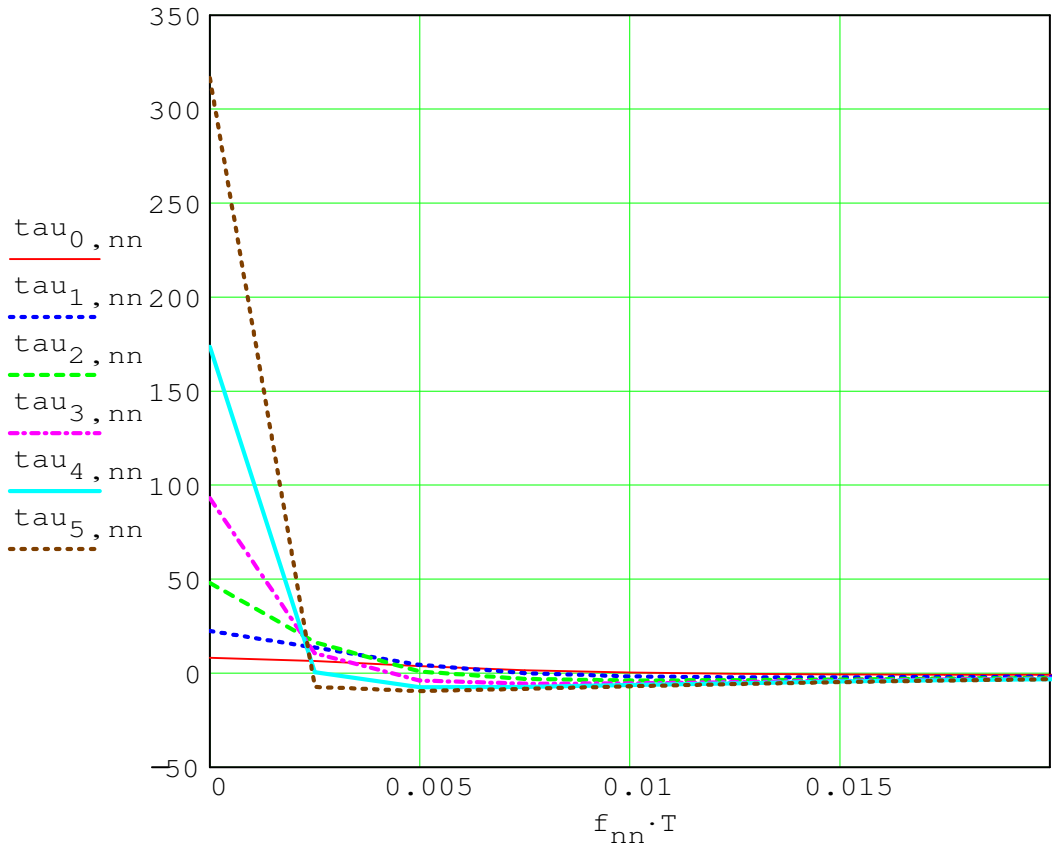
$I_{kk,ii} := \mathrm{Re}(Hn_{kk,ii})$

$Q_{kk,ii} := \mathrm{Im}(Hn_{kk,ii})$

$nn := 0 .. 198$

$$tau_{kk,nn} := \frac{I_{kk,nn} \cdot Q_{kk,nn+1} - Q_{kk,nn} \cdot I_{kk,nn+1}}{\left|(I_{kk,nn})^2 + (Q_{kk,nn})^2\right| \cdot 2 \cdot \pi \cdot \left(\frac{1}{400 \cdot T}\right)}$$

Group Delay Through Notch Filters



$$\frac{\omega_n}{2\cdot\pi} = 0.15$$