VCLLabs opamp filter blocks

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To realize an ASP crossover filter, VCLLabs has designed a set of opamp filter blocks to transform most of the generic filter blocks that are needed to make an ASP filter.

The blocks are:

LP1	Low Pass first order unity gain
HP1	High Pass first order unity gain
AP1	All Pass first order unity gain
LP2	Low Pass second order unity gain
HP2	High Pass second order unity gain
AP2	All Pass second order unity gain
BP1	First order bandpass filter – A dB gain
BR1 fz > fh	Band reject filter 1st order – fz higher fp
BR1 fz < fh	Band reject filter 1st order – fz lower fp
LEQ boost	Low Frequency Equalization
LEQ cut	Low Frequency Equalization
HEQ boost	High frequency Equalization
HEQ cut	High frequency Equalization
BEQ boost	Parametric Band Equalizer 2nd order
BEQ cut	Parametric Band Equalizer 2nd order

■ LP1 - 1st Order Lowpass Filter

Filter Parameters:

Fp = Frequency of the pole

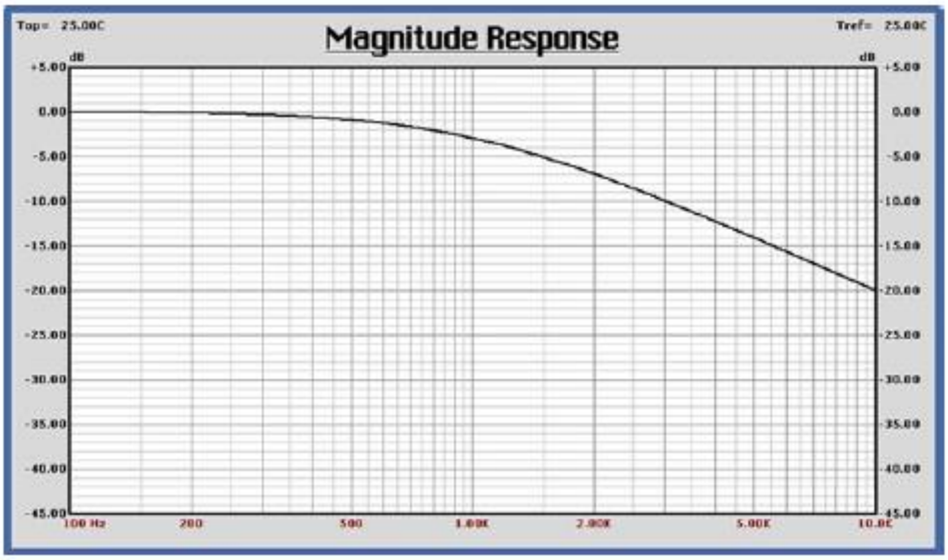
Ao = Gain

$$H(s) = \frac{A_o}{1 + \frac{s}{\omega_p}}$$

$$s = j\omega$$

$$\omega = 2\pi f$$

$$\omega_p = 2\pi f_p$$



■ HP1 - 1st Order Highpass Filter

Filter Parameters:

Fp	=	Frequency of the pole
Ao	=	Gain

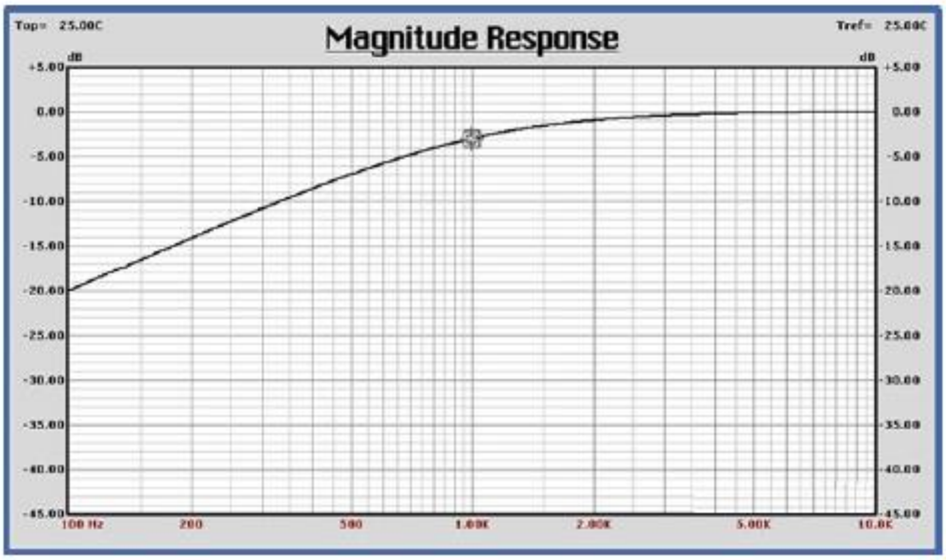
Fz=Fp for this filter.

$$H(s) = \frac{A_o \frac{s}{\omega_p}}{1 + \frac{s}{\omega_p}}$$

$$s = j\omega$$

$$\omega = 2\pi f$$

$$\omega_p = 2\pi f_p$$



■ AP1 - 1st Order Allpass Filter

Filter Parameters:
Fp = Frequency of the pole
Ao = Gain

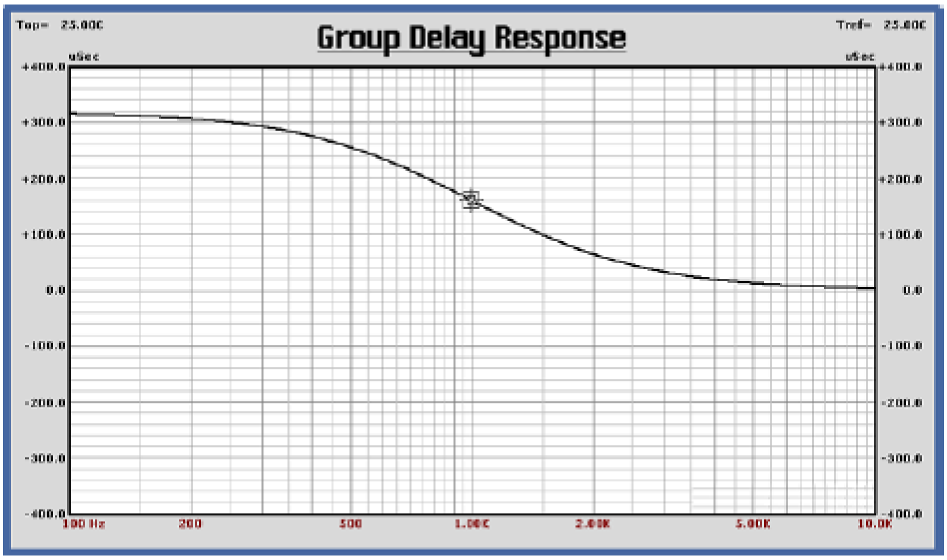
Fz=Fp for this filter.
The magnitude response of this filter is flat.

$$H(s) = \frac{A_o\left(1 - \frac{s}{\omega_p}\right)}{1 + \frac{s}{\omega_p}}$$

$$s = j\omega$$

$$\omega = 2\pi f$$

$$\omega_p = 2\pi f_p$$



■ LP2 - 2nd Order Lowpass Filter

Filter Parameters:

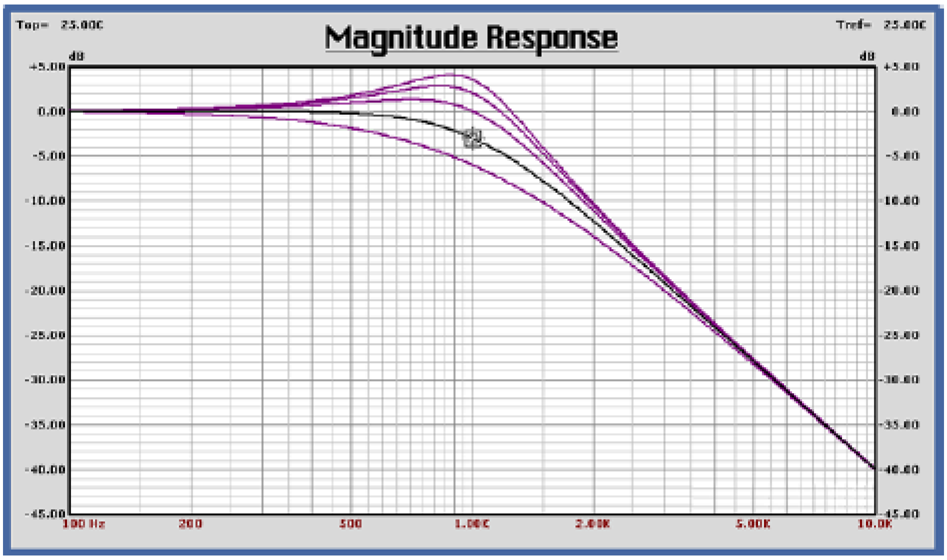
Fp	=	Frequency of the pole conjugate pair
Qp	=	Q of the pole conjugate pair
Ao	=	Gain

$$H(s) = \frac{A_o}{1 + \frac{s}{Q_p \omega_p} + \frac{s^2}{\omega_p^{\,2}}}$$

$$s = j\omega$$

$$\omega = 2\pi f$$

$$\omega_p = 2\pi f_p$$



■ HP2 - 2nd Order Highpass Filter

Filter Parameters:

Fp = Frequency of the pole conjugate pair

Qp = Q of the pole conjugate pair

Ao = Gain

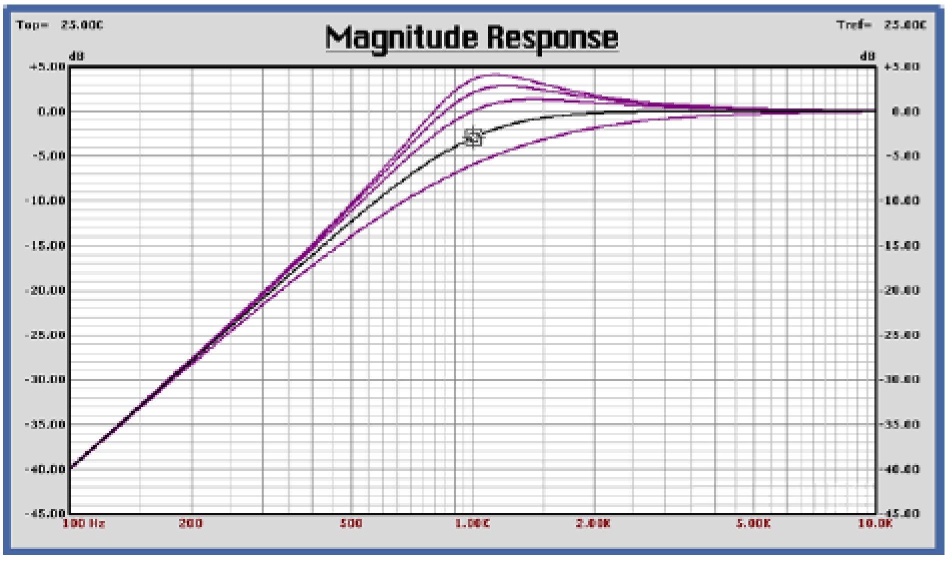
Fz=Fp for this filter.

$$H(s) = \frac{A_o \frac{s^2}{\omega_p{}^2}}{1 + \frac{s}{Q_p \omega_p} + \frac{s^2}{\omega_p{}^2}}$$

$$s = j\omega$$

$$\omega = 2\pi f$$

$$\omega_p = 2\pi f_p$$



■ AP2 - 2nd Order Allpass Filter

Filter Parameters:

Fp = Frequency of the pole conjugate pair

Qp = Q of the pole conjugate pair

Ao = Gain

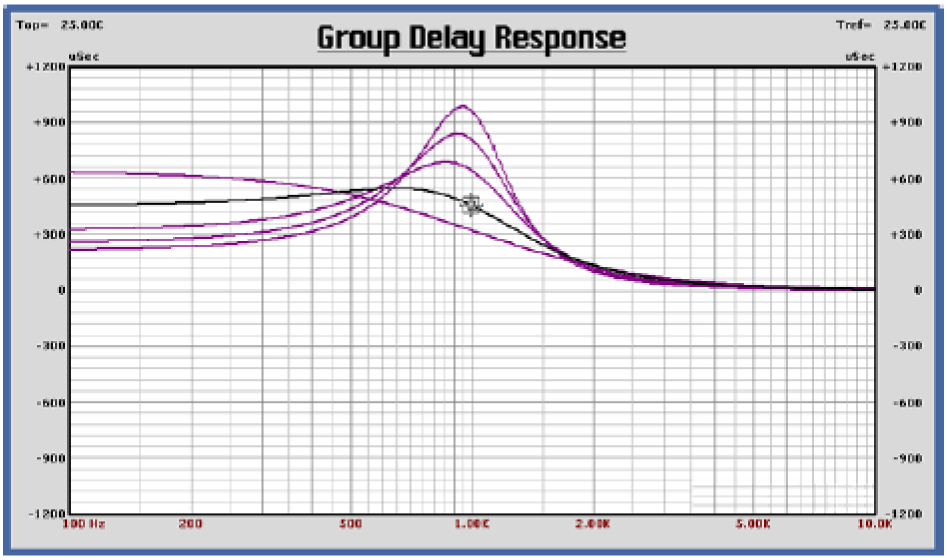
Fz=Fp and Qz=Qp for this filter.
The magnitude response of this filter is flat.

$$H(s) = \frac{A_o\left(1 - \frac{s}{Q_p\omega_p} + \frac{s^2}{\omega_p^2}\right)}{1 + \frac{s}{Q_p\omega_p} + \frac{s^2}{\omega_p^2}}$$

$$s = j\omega$$

$$\omega = 2\pi f$$

$$\omega_p = 2\pi f_p$$



■ BP1 - 1st Order Bandpass Filter

Filter Parameters:

Fp	=	Frequency of the pole conjugate pair
Qp	=	Q of the pole conjugate pair
Ao	=	Gain

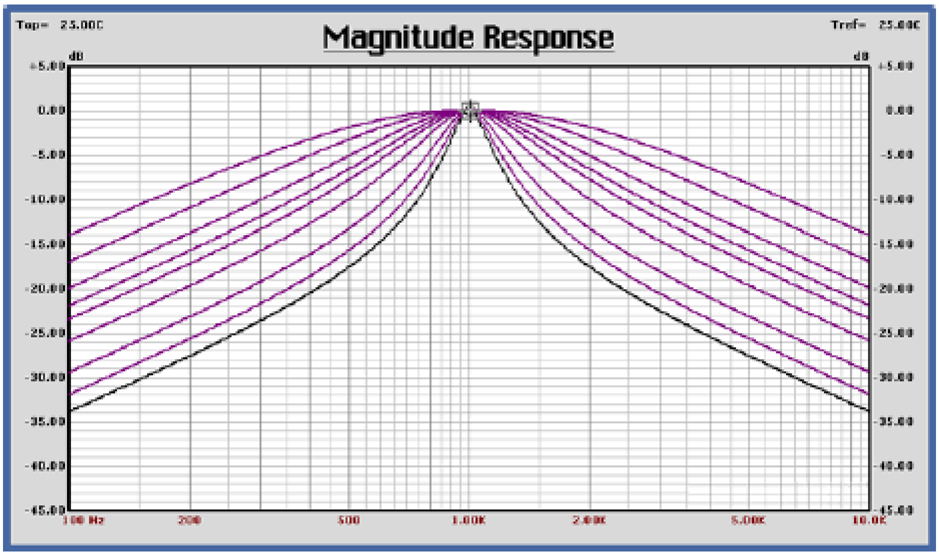
Fz=Fp and Qz=Qp for this filter.
Bandpass and Bandreject filters are defined in terms of their pole pairs.
A 1st order Bandpass is a second order polynomial.

$$H(s) = \frac{A_o\left(\frac{s}{Q_p\omega_p}\right)}{1 + \frac{s}{Q_p\omega_p} + \frac{s^2}{\omega_p^2}}$$

$$s = j\omega$$

$$\omega = 2\pi f$$

$$\omega_p = 2\pi f_p$$



■ BR1 - 1st Order Bandreject Filter

Filter Parameters:

Fz	=	Frequency of the zero conjugate pair
Fp	=	Frequency of the pole conjugate pair
Qp	=	Q of the pole conjugate pair
Ao	=	Gain

Bandpass and Bandreject filters are defined in terms of their pole pairs.
A 1st order Bandreject is a second order polynomial.
This filter supports asymmetrical Bandreject filters (Fz<>Fp).

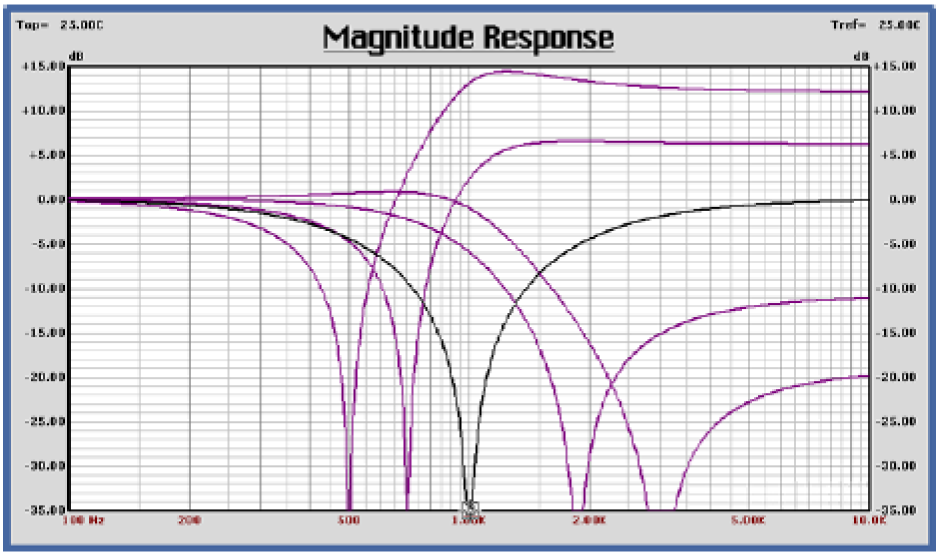
$$H(s) = \frac{A_o\left(1 + \frac{s^2}{\omega_z^2}\right)}{1 + \frac{s}{Q_p\omega_p} + \frac{s^2}{\omega_p^2}}$$

$$s = j\omega$$

$$\omega = 2\pi f$$

$$\omega_p = 2\pi f_p$$

$$\omega_z = 2\pi f_z$$



■ LEQ - Lowpass Equalization Filter

Filter Parameters:

Fp = Frequency of the pole.

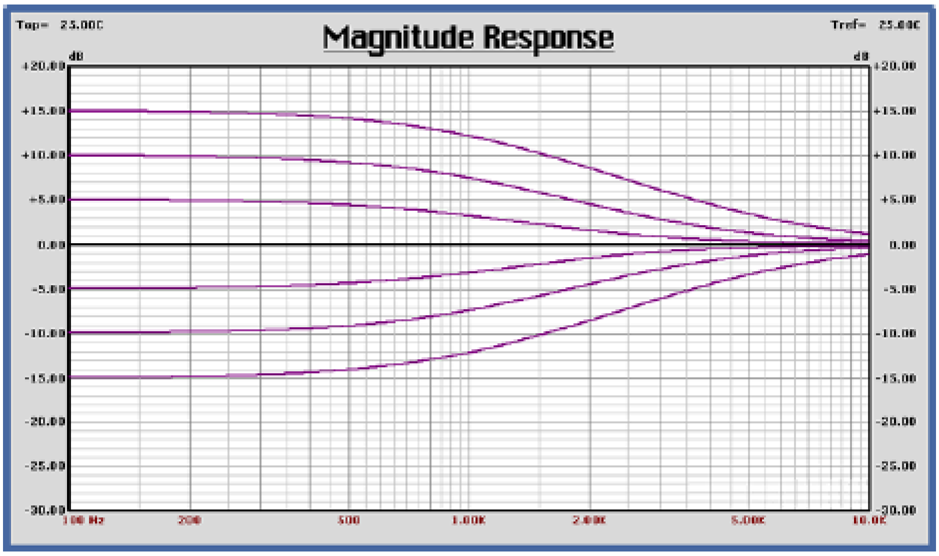
Ao = Boost/Cut Gain at low frequencies

$$H(s) = \begin{cases} \dfrac{A_o + \dfrac{s}{\omega_p}}{1 + \dfrac{s}{\omega_p}} & , \quad A_o \geq 1 \\ \\ \dfrac{1 + \dfrac{s}{\omega_p}}{\dfrac{1}{A_o} + \dfrac{s}{\omega_p}} & , \quad A_o \leq 1 \end{cases}$$

$$s = j\omega$$

$$\omega = 2\pi f$$

$$\omega_p = 2\pi f_p$$



■ HEQ - Highpass Equalization Filter

Filter Parameters:

Fp = Frequency of the pole

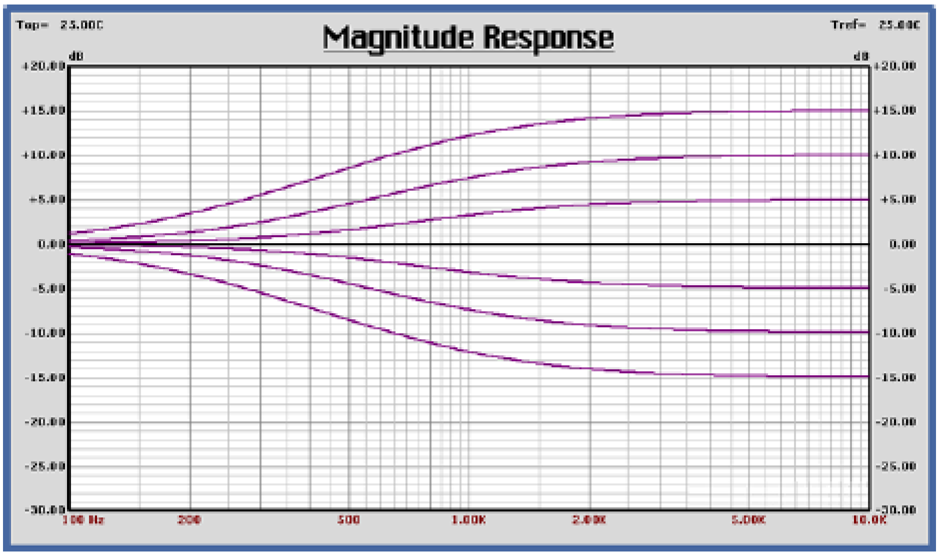
Ao = Boost/Cut Gain at high frequencies

$$H(s) = \begin{cases} \dfrac{1 + A_o \dfrac{s}{\omega_p}}{1 + \dfrac{s}{\omega_p}} \ , & A_o \geq 1 \\ \\ \dfrac{1 + \dfrac{s}{\omega_p}}{1 + \dfrac{s}{A_o \omega_p}} \ , & A_o \leq 1 \end{cases}$$

$$s = j\omega$$

$$\omega = 2\pi f$$

$$\omega_p = 2\pi f_p$$



■ **BEQ - Bandpass Equalization Filter**

Filter Parameters:

Fp = Frequency of the pole conjugate pair

Qp = Q of the pole conjugate pair

Ao = Boost/Cut Gain at Fp frequency

$$H(s)=\begin{cases}\dfrac{1+A_o\dfrac{s}{Q_p\omega_p}+\dfrac{s^2}{\omega_p{}^2}}{1+\dfrac{s}{Q_p\omega_p}+\dfrac{s^2}{\omega_p{}^2}}, & A_o\geq 1\\[2em] \dfrac{1+\dfrac{s}{Q_p\omega_p}+\dfrac{s^2}{\omega_p{}^2}}{1+\dfrac{s}{A_oQ_p\omega_p}+\dfrac{s^2}{\omega_p{}^2}}, & A_o\leq 1\end{cases}$$

$$s=j\omega$$

$$\omega=2\pi f$$

$$\omega_p=2\pi f_p$$