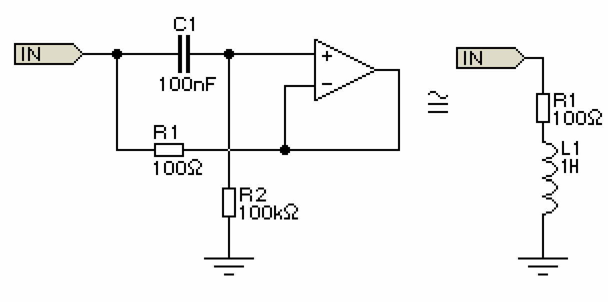
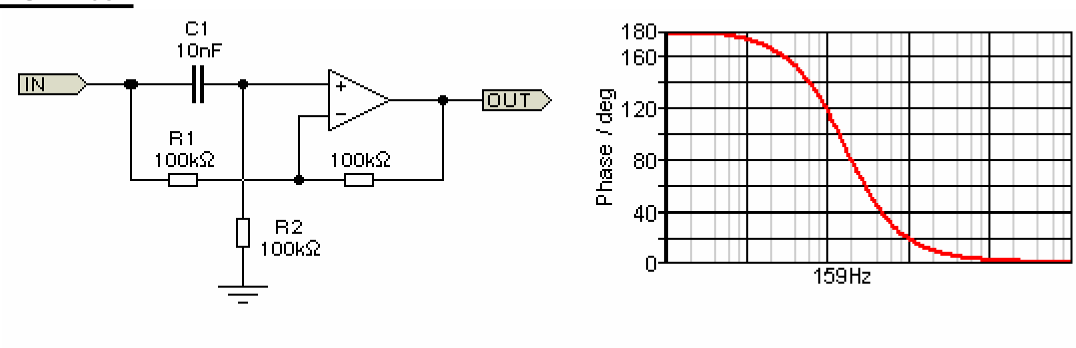
These are some of the basic concepts of active filters taken from Rod Elliot's website. For full articles and explanations, see the "Elliot Sound Products" link from the home page. This is just an overview for quick reference.

## Simulated Inductor



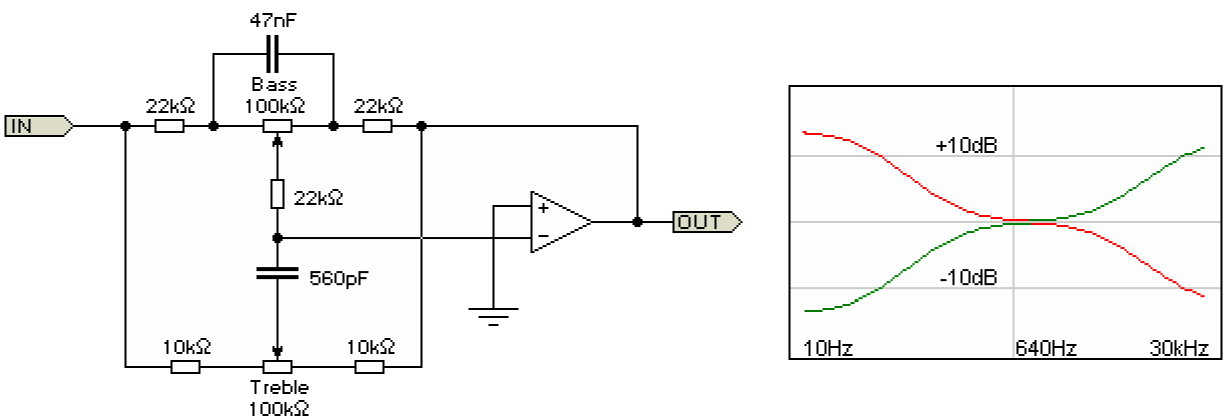

$$L = C1 * R1 * (R2 - R1)$$

## Phase Shifter



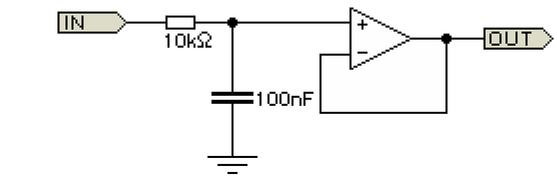

$$F_{Phase\ Shift} = 1 / (2 * \pi * R2 * C1)$$

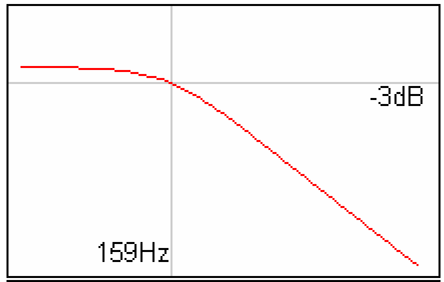
## Simple Tone Control

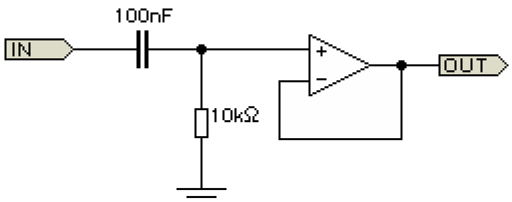


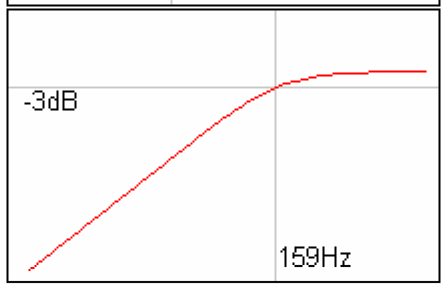

$F_{Bass_0} = 1 / (2 * \pi * C * Rv)$ ... where C is the cap across the pot, and Rv is the pot value
$F_{Bass_{+/-3dB}} = 1 / (2 * \pi * C * Rs)$ ... where C is the cap, and Rs is the series resistance to the pot
$F_{Treble} = 1 / ( 2 * \pi * C * Rb)$ ... where C is the treble cap (560pF above) and Rb is the bass feed resistor from the pot wiper. (Not accurate for treble due to bass interaction)

## First Order Filter



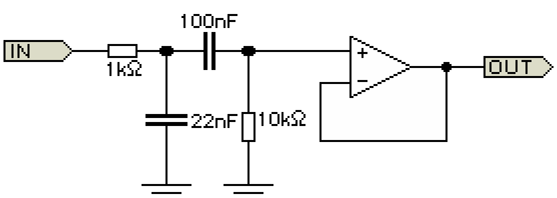



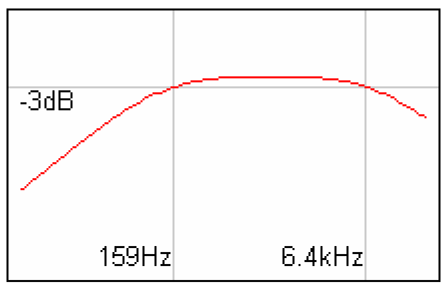




$Rc = 1 / (2 * \pi * F * C)$ ... where Rc is capacitive reactance

$F_{+/-3dB} = 1 / (2 \pi R C)$

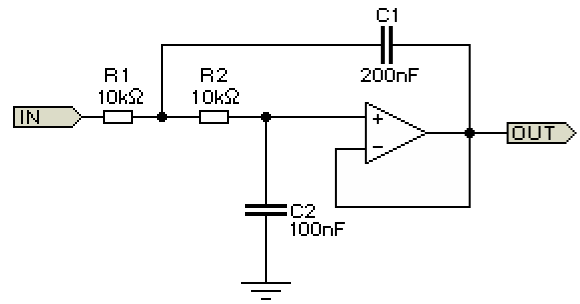
$F_{+/-3dB} = 1 / (2 \pi * 10k * 100nF) = 159$ Hz

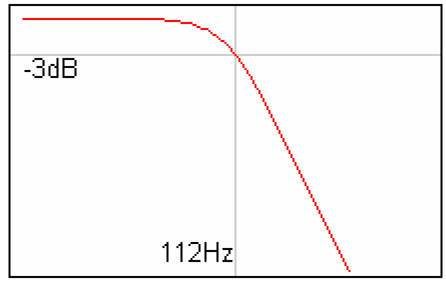



Cascaded (Second filter loads the first so separate filters would be more accurate)

## Second Order Filter

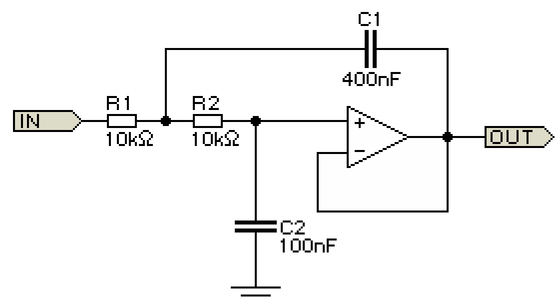


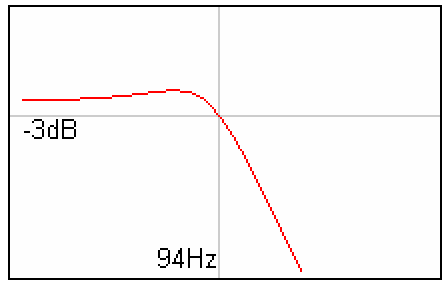




Butterworth (Q=.707)

$C1 = 4 / d^2 * C2 = 2 * C2$ ... where $d = 1 / Q$

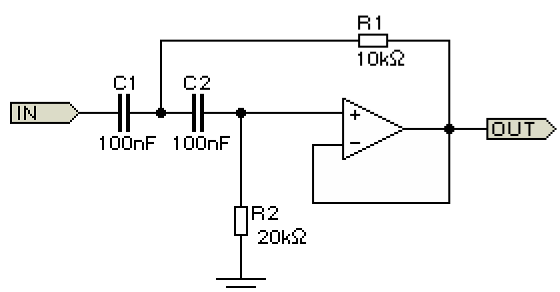
$C2 = 0.707 / (2 * \pi * F * R)$

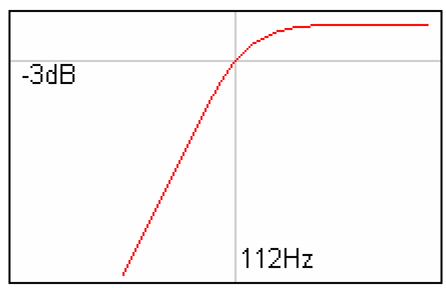



Chebychev (Q=1)

Formulae do not apply to Chebychev!



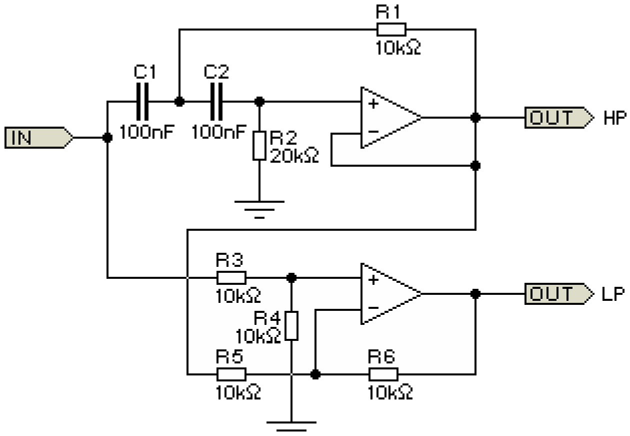

Butterworth (Q=.707)

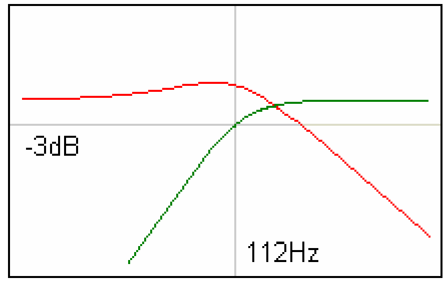
Reversed Butterworth for High-Pass: Frequency determined by R1 and C1

$R1 = 4 / d^2 * R2 = 2 * R2$ ... where $d = 1 / Q$

$C = 0.707 / (2 * \pi * F * R)$

## Subtracting Technique



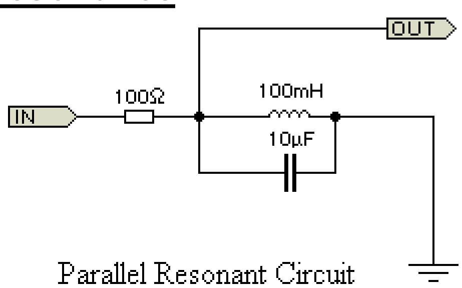




Subtracting Electronic Crossover

12dB/octave High-Pass subtracted from the full input by a differencing op-amp.

- -6dB Hi rolloff
- -12dB Lo rolloff
- Flat Response
- Phase Coherent

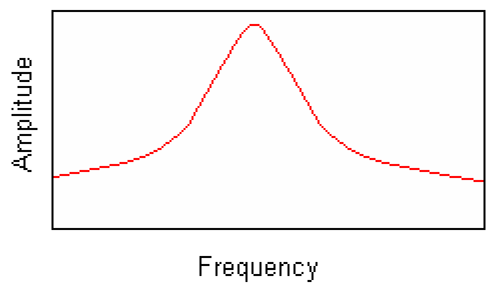
## Resonance

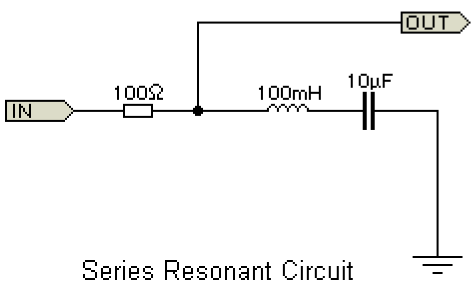



Parallel Resonant Circuit

$f_o = 1 / (2 * \pi * \sqrt{LC})$

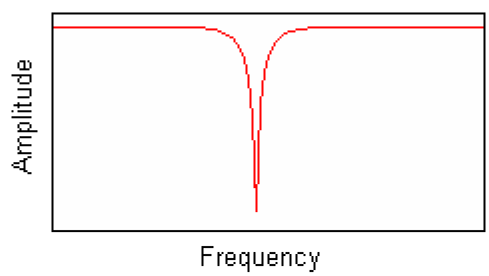
Increase Q by increasing $R_{in}$



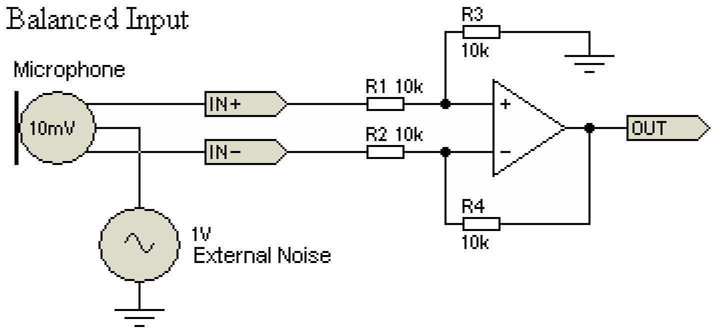




Series Resonant Circuit

Reduce Q by increasing $R_{in}$

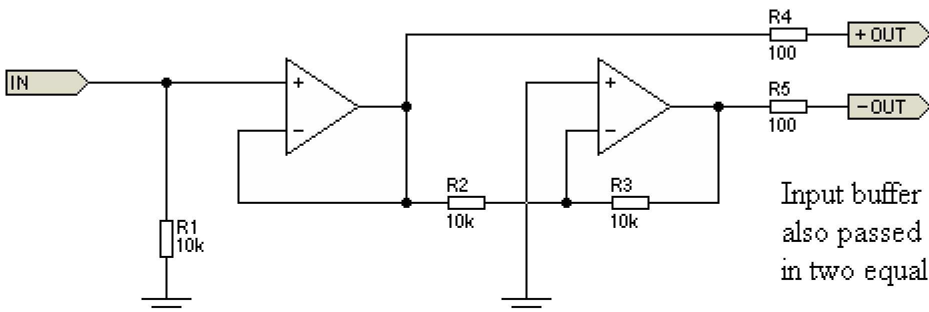



## Common-Mode Rejection (Balanced Audio)



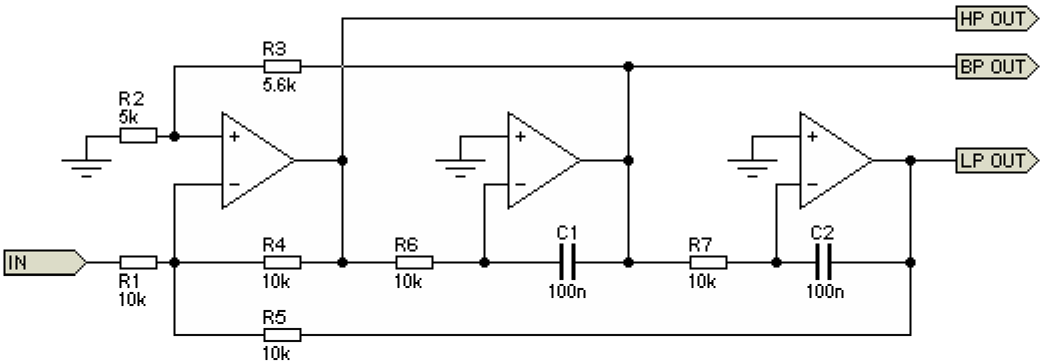

Common-Mode Rejection
Opposite voltages are differenced, adding the absolute voltages together and cancelling what is common (noise).

Balanced Output




Input buffer is passed to the + Output and also passed to an inverting buffer, resulting in two equal but opposite signals.

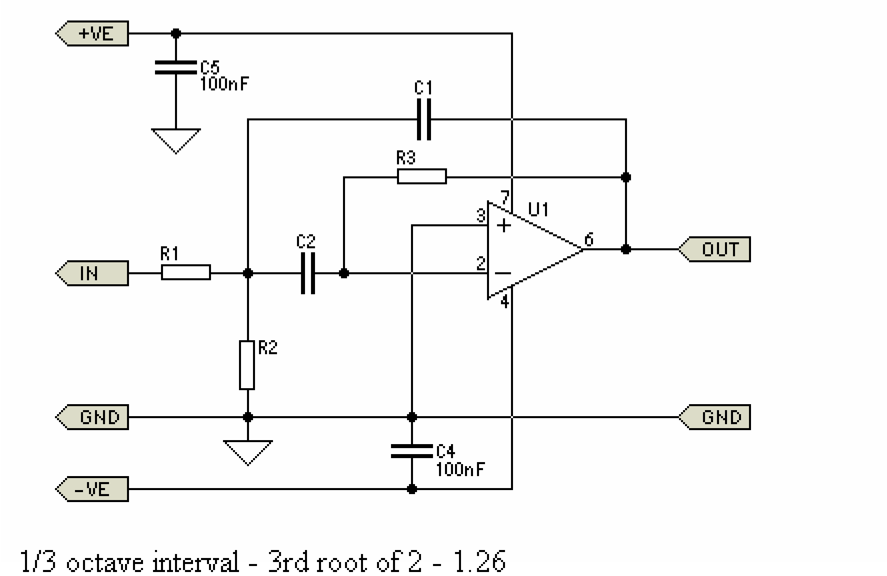
## Advanced EQ




State Variable Filter

R3 sets filter Q: R3 = ( 3 - d / d ) * R2  Where d = damping ( 1 / Q )
Frequency is changed by varying R6 and R7, or C1 and C2.
Bandpass output is in phase with input. Lowpass is +90°out of phase. Highpass is -90°out of phase.

## Multiple Feedback Bandpass Filter (Graphic EQ)




1/3 octave interval - 3rd root of 2 - 1.26
For the 100 to 200 Hz octave, freq's are:
100*1.26, 100*1.26*1.26, 100*1.26*1.26...
= 100Hz, 126Hz, 158.7Hz and 200Hz.

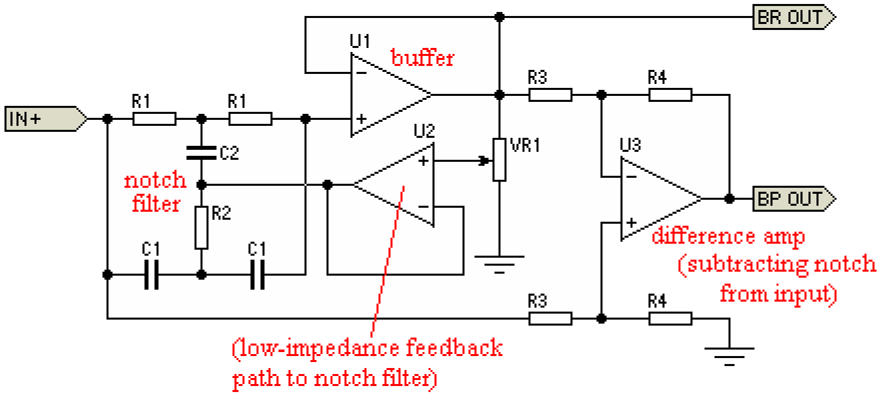
bandwidth = 1/Q

Select capacticance first.

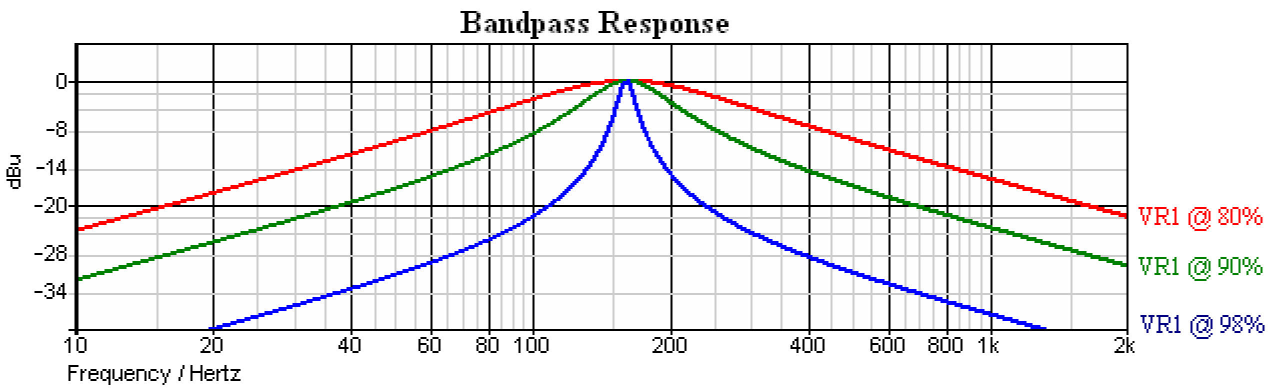
| f (min) (Hz) | f(max) (Hz) | Capacitance (nF) |
|---|---|---|
| 20 | 80 | 330 |
| 80 | 300 | 82 |
| 300 | 1,200 | 22 |
| 1200 | 4,800 | 5.6 |
| 4,800 | 20k | 1.5 |

Input resistance R1 = Q / (G * 2 * π * f *C)
Attenuator resistance R2 = Q / ((2 * Q² - G) * 2 * π * f * C)
Feedback resistance R3 = Q / (π * f * C)
Passband Gain G = 1 / ((R1 / R3) * 2)
Centre Frequency f = (1 / (2 * π * C)) * √((R1 + R2) / (R1 * R2 * R3))

Constant Gain, Variable Q

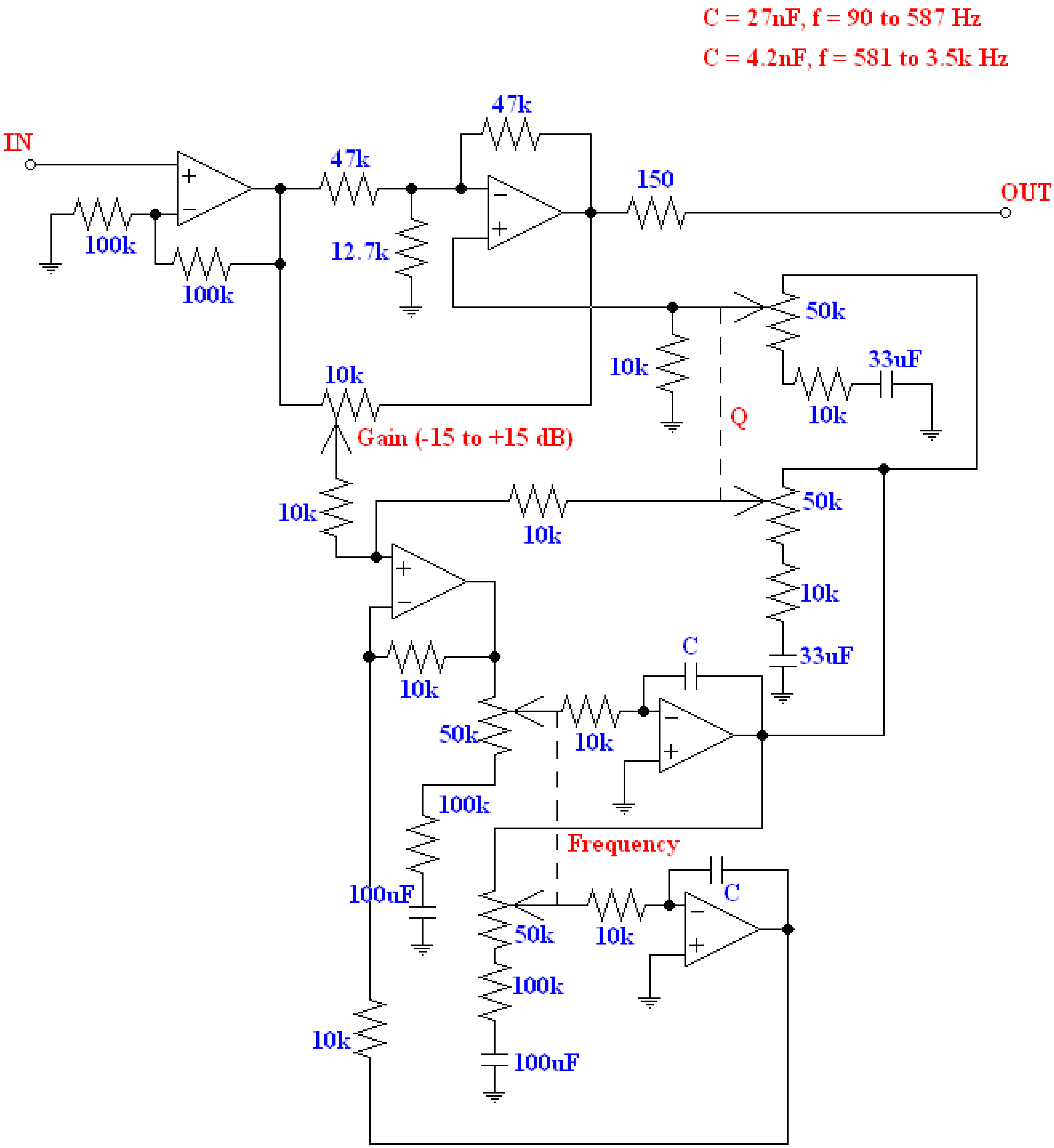



R2 = R1 / 2 and C2 = C1 * 2




## Fully Parametric EQ

This schematic is not part of the Elliot Sound Products website, but I think it is the most important filter network ever invented. This is a fully parametric EQ with characteristics similar to those found on a high-end mixing desk. All three parameters can be adjusted virtually independently of eachother. At the extremes of the frequency sweep, Q adjustment has a slight effect on gain. Besides that, it is a very good parametric EQ.


C = 27nF, f = 90 to 587 Hz
C = 4.2nF, f = 581 to 3.5k Hz
IN
OUT
47k
47k
150
100k
100k
12.7k
50k
33uF
10k
10k
10k
Q
Gain (-15 to +15 dB)
10k
10k
50k
10k
33uF
C
10k
50k
10k
100k
Frequency
C
100uF
50k
10k
100k
10k
100uF

[Back Home](#)