# Filter + Amp

toDos :

1. V_out change to 5V
2. Check what V_in actually is
3. Test with noises added (drift and powerline)
4. Determine which R to be adjustable (R1) and how

**Current Design (May 6th)**

- Two bp amplifiers

Single amp gain G = 37.8 = 31.55dB
Total gain G = 1428 = 63.10dB
$R_{IN} = 1k\Omega$
$C_{IN} = 1600uF$
$R_F = 38k\Omega$
$C_F = 168nF$
BP : 0.1 - 24.93Hz

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- Actions

Verify whether I have the capacitors
Build and validate the circuit in real life

**Detail**

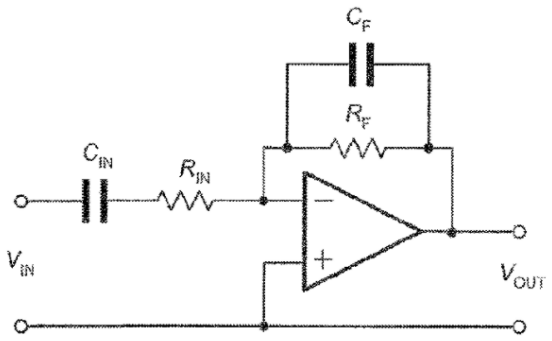



**Figure 8.8** Adding capacitors to modify the frequency response of an inverting operational amplifier

(from perusal week 6 op amp)

Since only the frequency between 0.1 and 20Hz is related to eye movement, we will choose a bandpass between 0.1 to 25 Hz.

From ref[2], the typical signal is 50 to 3500 uV, and we want to amplify it to 0~1.5 V
So we need a gain of 428.6. If we choose $R_{IN} = 100\Omega$, $R_F = 42k\Omega$

Higher cutoff frequency :

$$R_F = 42k\Omega$$

$$F_H = \frac{1}{2\pi R_F C_F} = 25Hz$$

,

$$C_F = \frac{1}{2\pi R_F F_H} = 152nF$$

For simpler circuit, we choose

$$C_F = \frac{1}{2\pi R_F F_H} = 150nF$$

$$F_H = \frac{1}{2\pi R_F C_F} = 25.26Hz$$

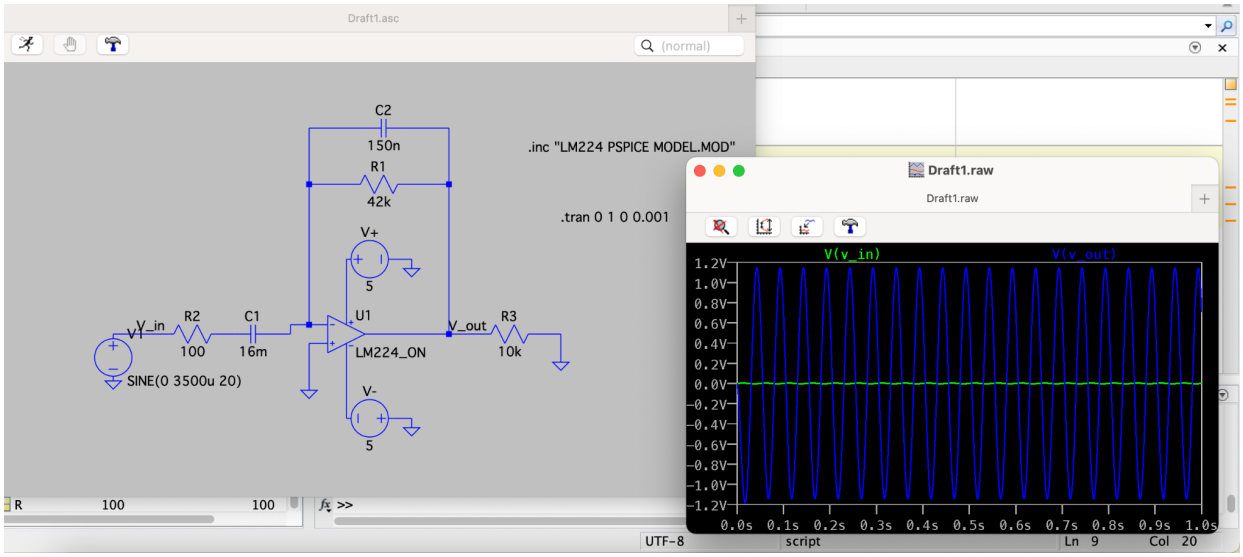
Lower cutoff frequency :

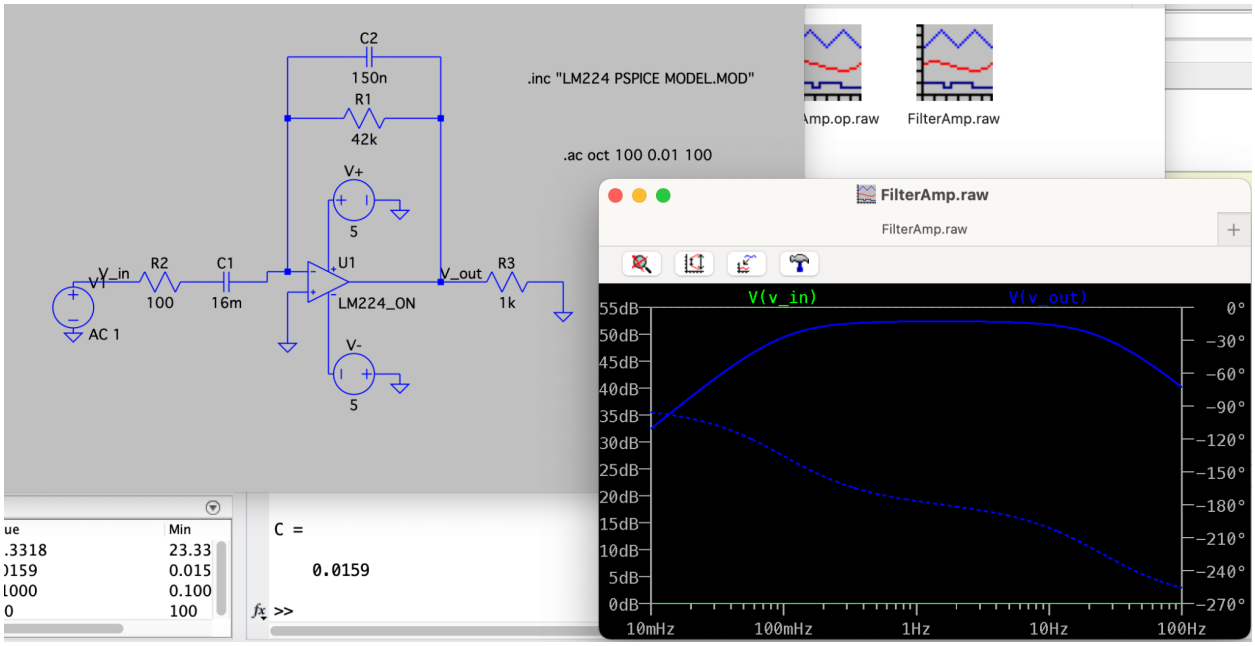
$$R_{IN} = 100\Omega$$

$$F_L = \frac{1}{2\pi R_{IN} C_{IN}} = 0.1Hz$$

$$C_{IN} = \frac{1}{2\pi R_{IN} F_L} = 16mF$$

By simulation, the result is pretty similar to what I expected






Ref

[2] - Deng, L. Y., Hsu, C.-L., Lin, T.-C., Tuan, J.-S., Chang, S.-M. (2010). EOG-based Human–Computer Interface system development. Expert Systems with Applications, 37(4), 3337–3343. doi:10.1016/j.eswa.2009.10.017

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May 6, 2022

Issue 1 : The capacitance come in 1mF maximum

> R_in must be increased

Issue 2 : We need the output signal to be 5V instead of 1.5V

> Either change Rf or add another amplifier

New Gain : 5V/3500uV = 1428

If we use $R_{in} = 1k\Omega$

$$F_L = \frac{1}{2\pi R_{IN} C_{IN}} = 0.1Hz$$

$$C_{IN} = \frac{1}{2\pi R_{IN} F_L} = 1600uF$$

$$R_f = 1428k\Omega$$

$$C_F = \frac{1}{2\pi R_F F_H} = 4.581nF$$ This is a bit too small for our components, and 1.4MOhm may also induce large currents.

New Strategy: use two amplifiers with a same cutoff frequency

New Gain : $\sqrt{1428} = 37.78$

$R_f = 37.78k\Omega$

$$C_F = \frac{1}{2\pi R_F F_H} = 168.5nF$$

For simplicity,

Choose $R_f = 38k\Omega$, $C_F = 168nF$

New cut-off $F_H = 24.93Hz$