

Laboratory 4
Design of a bio-instrumentation amplifier for
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Scope of the lab

1. Design a multistage bioinstrumentation amplifier for EEG.
2. Acquire EEG data.
3. Perform simple analysis of EEG data.

Before the lab

1. (5pts) Design a multistage bioinstrumentation amplifier for EEG signals. The amplifier should have the following stages

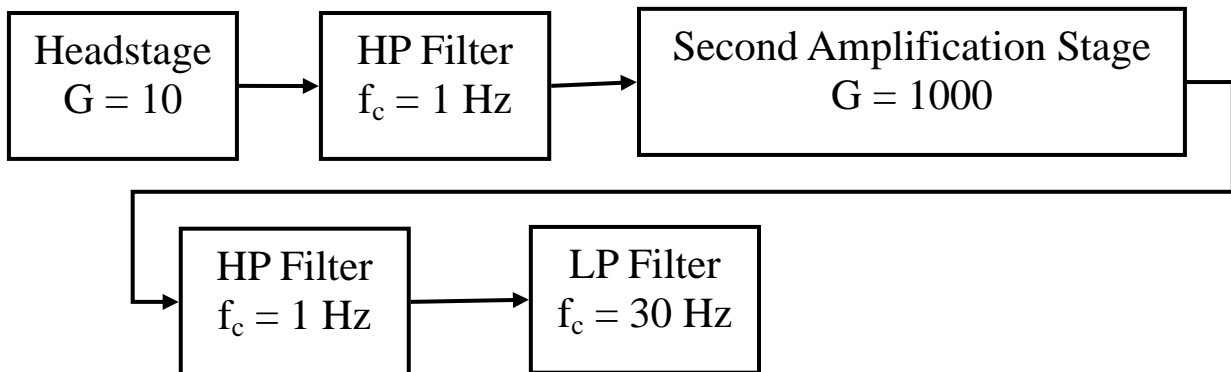


Illustration 1: Block diagram of a bioinstrumentation amplifier suitable for EEG measurements

Specifications

You are required to use 1% resistors with **standard values**.

Headstage - Use a differential amplifier LT1920, Gain of 10.

First HP Filter & Second Amplification Stage – Passive with a cutoff frequency of 1 Hz; Capacitor value 2.2 μ F; Use $\frac{1}{4}$ TI C2274 in a non-inverting configuration.

Second high pass filter – use a Sallen Key topology to implement a **second order** Tchebyscheff filter with 1dB pass band ripple. Set the cut-off frequency at 1 Hz. Use capacitors $C1 = C2 = 2.2\mu\text{F}$.

Low pass filter – use a Sallen Key topology to implement a **fourth order** Tchebyscheff filter with 1dB pass band ripple. Set the cut-off frequency at 30 Hz. Use capacitors $C1 = 33\text{nF}$; $C2 = 330\text{nF}$; $C3=330\text{nF}$; $C4=4.7\text{nF}$; verify the order of use for $C1$ and $C2$, as well as $C3$ and $C4$; compute the resistors values.

Write a short report describing the design. Include schematics. The report should be delivered to the TA before starting the lab.

During the lab

A. Test and adjust the performance of the circuit

1. Build the circuit that you designed. You will find most of the circuit already assembled, you will have to build the last two active filters.
2. Replace the gain resistor of the second stage such that instead of a gain of 1000 you have a gain of 10.
3. Connect your circuit to the signal generator and to the oscilloscope as in Illustration 2.
4. Check the gain of your circuit for frequencies between DC to 100Hz.
5. Plot gain vs. frequency for signals between DC and 100Hz. (See **After the lab.**)

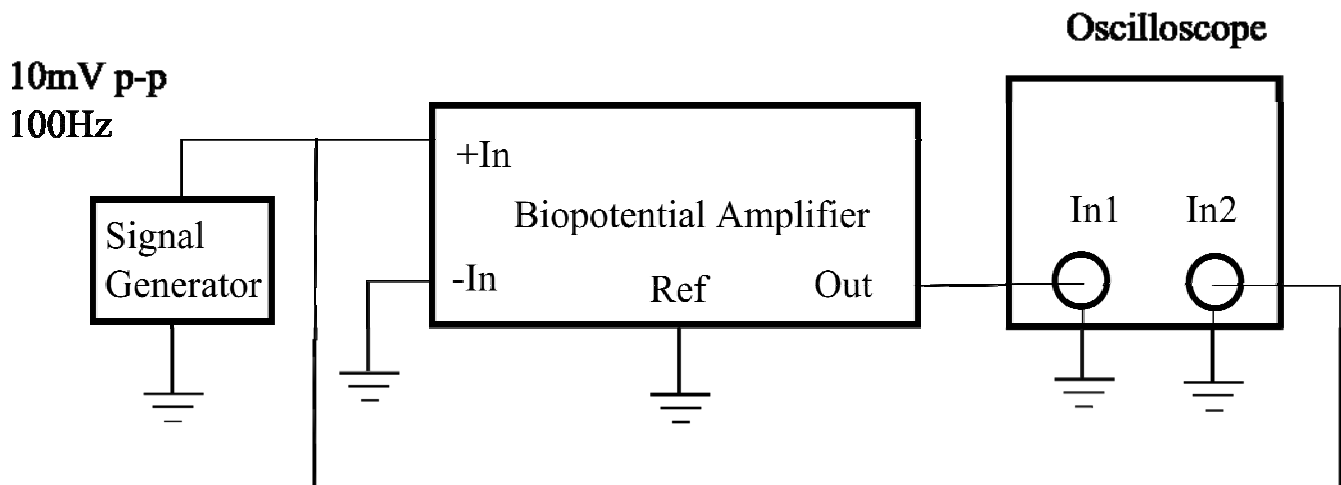


Illustration 2: Connections for performance evaluation and tuning

B. Acquire EEG signal

1. Add the isolation amplifier at the output of the bioinstrumentation amplifier.
2. Readjust the gain of the first and second amplification stages to 30 and 1000.
3. The amplifier and filters are on isolated power and the output half of the isolated amplifier is powered by line power (The BNC grnd is system grnd)
4. Attach the non-disposable electrodes with adhesive paste on P3, forehead, behind the ear lobe.
5. Connect the electrodes to your amplifier (P3 to +, Ear lobe to -, forehead to ground).
6. Connect the output of your circuit to the NI Analog to digital board.
7. Start the Labview program used for data acquisition.
8. Turn on the power.
9. Check the main frequency of the signal on the oscilloscope. Verify if this is a beta wave. Save the data .
10. Close your eyes and relax. Your partner should be able to see and save your alpha rhythm.

11. Perform spectral analysis on the data that you acquired using software of your choice, ie MATLAB. (See **After the lab.**)

After the lab

1. (5pts) Prepare a report that includes

- A6: Plot of gain vs frequency
- B9: spectral analysis. Plot the frequency spectrum from 0 to 70 Hz. Bandpass filter the signal from 1 to 30 Hz using a 30th order filter (any choice). Again plot the spectrum of the filtered signal from 0 to 70 Hz and compare to the first plot.
- B10: Repeat spectral analysis. Compare to B9