Lab 14

ECG Circuit 1 – Instrumentation Amplifier

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1. Introduction

The purpose of this lab has 2 parts: One is to connect and test AD627 Amplifier, and the other part is to measure ECG signal. Instrumentation amplifiers are often used to reject commonmode signals and provide a stable gain with a high-impedance input over a modest range of frequencies. This is required for amplifying bio-potentials associated with electrocardiogram (ECG) signals.

2. Results

Part I:

Connect the AD627 instrumentation amplifier as shown in Fig. 1, and the photo of protoboard was displayed in Fig. 2

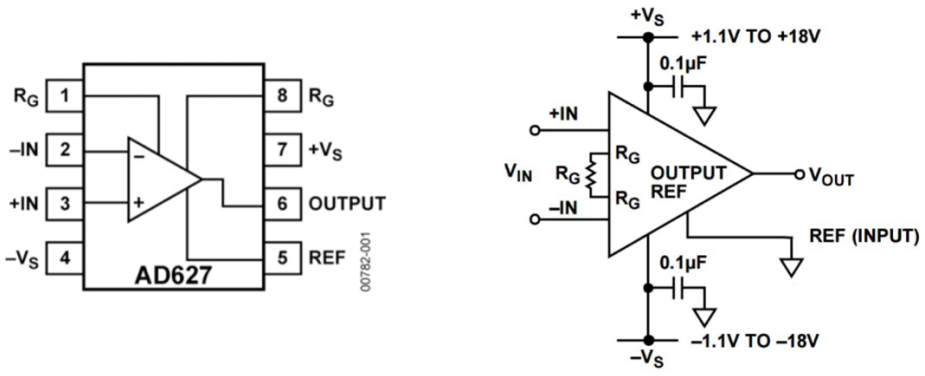

Fig. 1 Connection diagram of AD627 instrumentation amplifier

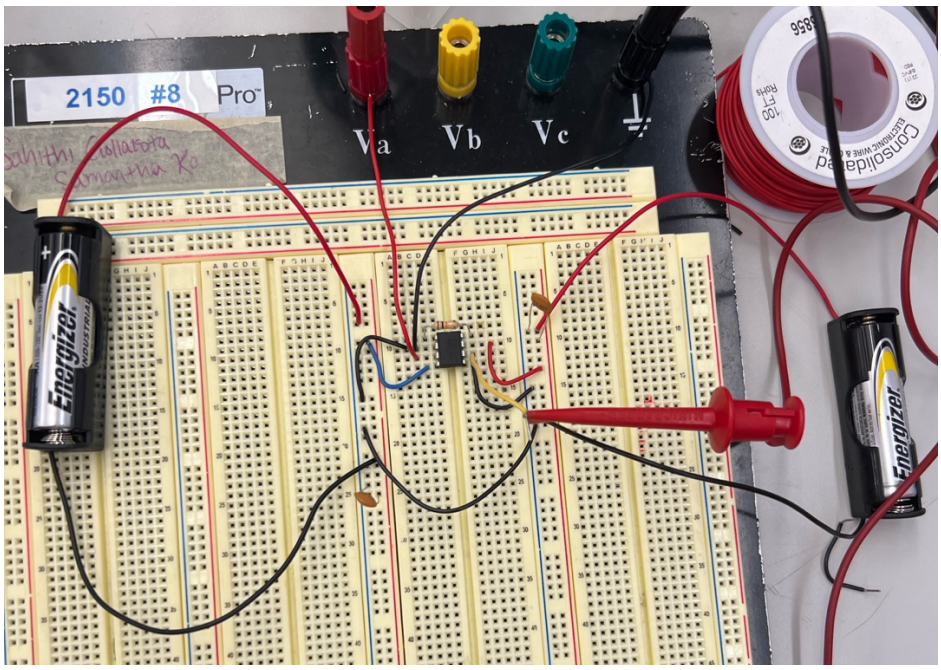

Fig. 2 Protoboard of AD627 instrumentation amplifier

Use the provided 1.5 V battery connectors, being sure to provide a positive and negative 1.5 V supply. The reason for use of capacitor is to stabilize and improve the performance of the AD627 instrumentation amplifier, including helping filter out high-frequency noise.

According to the formula of gain:

$$Gain = 5 + \frac{200K}{R_G} = 25$$

The value of R_G was calculated as $10k\ \Omega$.

Part II:

Use function generator to generate a sine wave with peak-to-peak of 30mV. We set the frequency of the wave as 50Hz. The output V_{out} was measured by oscilloscope, and the value was 800mV. The gain, also called differential mode gain, is given by $\frac{V_{out}}{V_{in}} = \frac{800}{30} = 26.7$, which agreed with expectation (gain = 25).

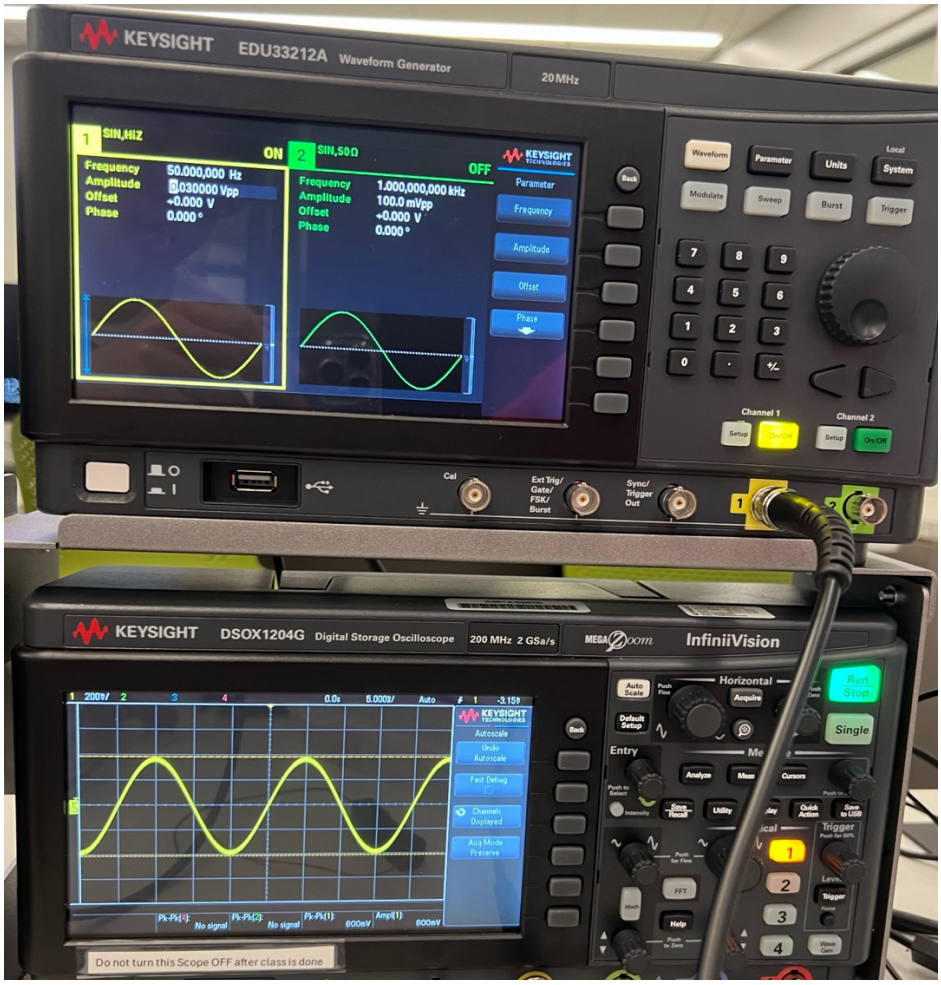

Fig. 3 Output measured by oscilloscope

The cutoff frequency was measured around 15kHz, when the frequency corresponds to 0.707 of maximum gain. Measure the common mode gain with an input signal with 500 mV amplitude at 150 Hz, the output was measured as 400 mV. As a result, the common mode gain was calculated by $\frac{V_{out}}{V_a} = \frac{400}{500} = 0.8$.

As we know, the common mode rejection ration CMRR is given by:

$$CMRR = 20log_{10}\left(\frac{A_{dm}}{A_{cm}}\right) = 20log_{10}\left(\frac{26.7}{0.8}\right) = 30.46$$

We can also compute the CMRR by:

$$CMRR = \frac{A_{dm}}{A_{cm}} = \frac{26.7}{0.8} = 33.75$$

The result satisfied the expectation.

Part III:

This part was first time for us to measure the ECG signal. Place the electrode on the forearm and keep the muscle still to keep the experiment stable and reduce the impact of electrical potentials produced by muscle motion. The signal displayed in the oscilloscope was shown in the Fig. 4.

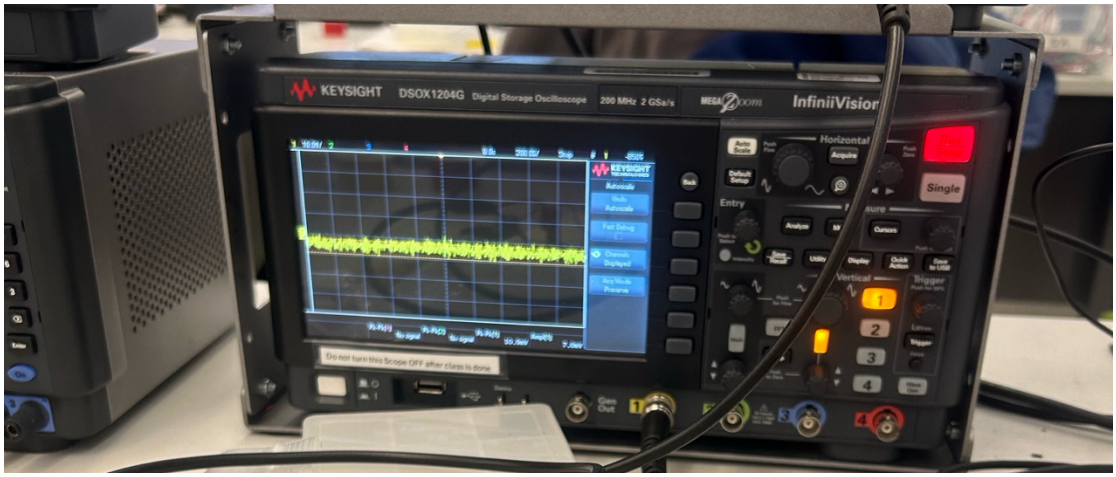

Fig. 4 ECG signal diagram

However, it didn't look like a typical ECG signal, and the reasons for the error could be caused by external noise, motion of muscle, or incorrect connection of electrode.

3. Discussions and Conclusions

This lab consists of 2 parts: One is to connect and test AD627 Amplifier, and the other part is to measure ECG signal.

In the first experiment, we assembled correctly the AD627, a high quality and instrumentation amplifier. Moreover, we tested the circuit with a sine wave and measured the differential mode gain and common mode gain correctly. Then we calculated the value for the common mode rejection ratio CMRR, and prove the

relationship among CMRR, differential mode gain and common node gain in this circuit. In the second experiment, we firstly tried to measure the ECG signal. However, the result seemed to be wrong, and the problem could be caused by external noise, motion of muscle, or incorrect connection of electrode. We will fix the problem in the future lab.

Reference:

[1] Dr. Iman Salama. “Lab 14 – ECG Signal 1 – The Instrumentation Amplifier” Northeastern University. 8/25/2021.