ECG Amplifier

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1 Introduction

ECG signals show the bio-potential generated by the activity of the heart. This signal can be very useful in diagnosing and predicting cardio-vascular diseases. However, these signals are quite small and hence amplification and is necessary. In this project we build an ECG amplifier from scratch. We pursue tasks running the gamut from deciding which electrodes to use to finally viewing the signal!

2 Methods

The entire setup was broken into varous stages, and each stage was checked cumulatively along with the previous stages.

- We first researched on various kinds of **electrodes** that take input from our body. We then decided which one would be appropriate and safe for our use.
- The first stage was the **Instrumentation Amplifier**. Also a 1F was connected from the power supply to the ground. After making the circuit one of the end (the inverting end through the resistor, referred to as A) was grounded and the other (the non-inverting end through the resistor, referred to as B) was connected to a 10 mV, 100 Hz sinusoidal signal. Then a common mode input (20 mV, 100 Hz sinusoidal signal) was given to both the input. The output for the common mode input was around 5mV sinusoidal pk-pk.

- The next stage was the **Offset Cancellation Circuit**. Here the input was given a DC Offset but the output obtained had no (i.e. 0) DC Offset, as expected. Thus the offset was "cancelled". This configuration also acts as a High Pass Filter for the ECG signal.

- The next stage was **Driven-Right Leg Circuit**. This stage serves the purpose of reducing the common-mode voltage due to interference, and to provide safety to the patient in case a very high voltage gets applied when the patient is isolated from the ground.

- The next stage is a **Low Pass Filter**, which also provides further amplification. This also limits the bandwidth of the amplifier.

- The next stage is the **Notch Filter**. This is used to eliminate the line frequency and is generally superimposed on the ECG signal. The Last and final step was to provide inputs to the ECG circuit thus constructed. This was done by placing the **Electrodes** chosen in the first step on the right & left hand and the leg.

3 Challenges

- We are using the INA 128 for the instrumentation amplifier. Due to the internal mechanics of this IC we changed the resistances in the feedback and the input port of the opamp, to the same value, of the Right-Leg driven circuit. This was to prevent saturation of the opamp.

- During the project, when we were checking the cumulative progress of our circuit, the output we were getting was a saturated one. Upon debugging we realized that it was due to the fact that the non-inverting terminal of one of the opamps which was supposed to grounded, was not and hence there was no reference point for local circuit elements. Upon grounding the non-inverting terminal of that opamp the output came out as expected.

- While measuring the ECG signal on the oscilloscope we were experiencing noise. We resolved this issue up to some extent by reducing the length of a few wires.

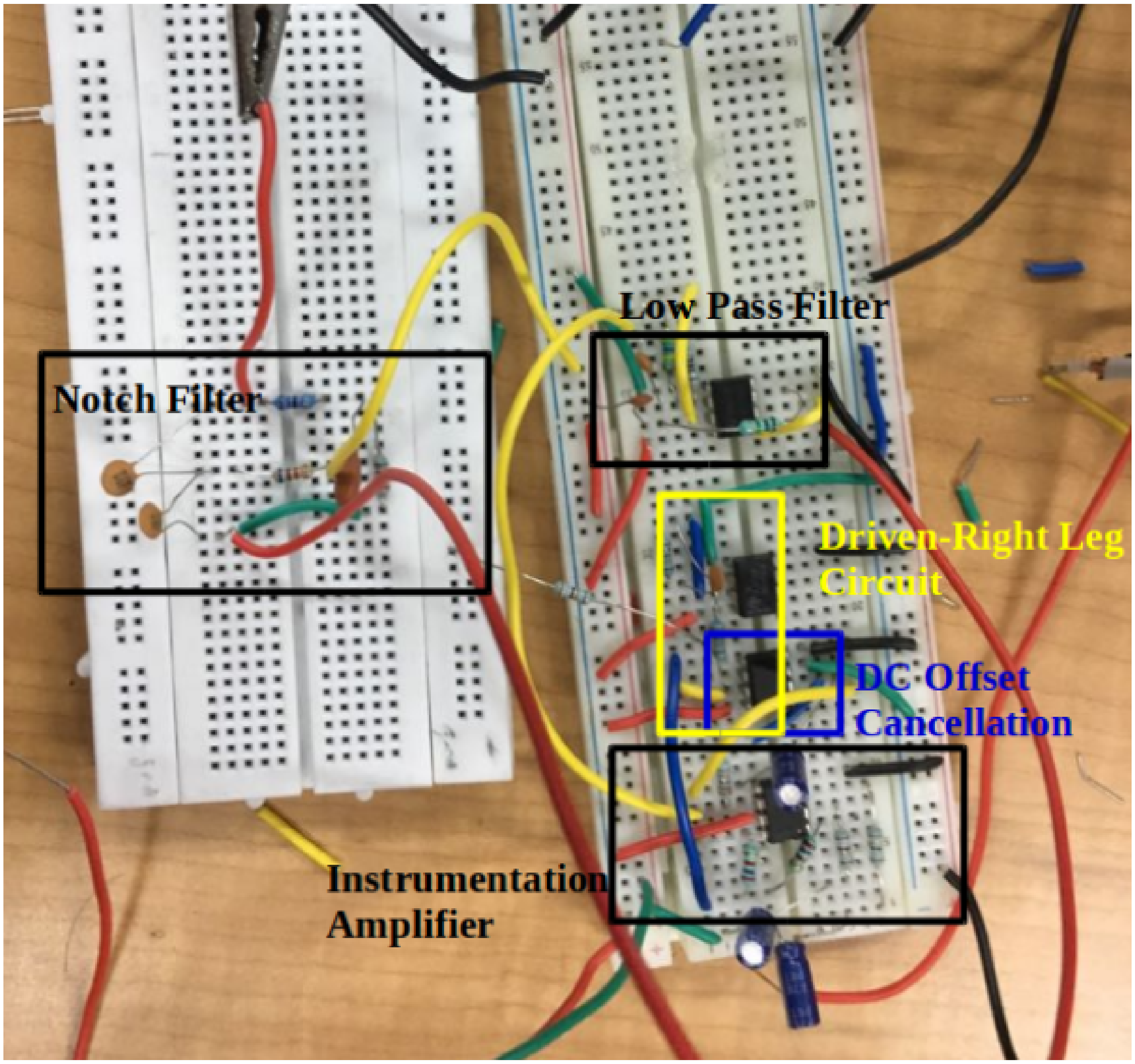

Figure 1: Circuit built for ECG Amplification

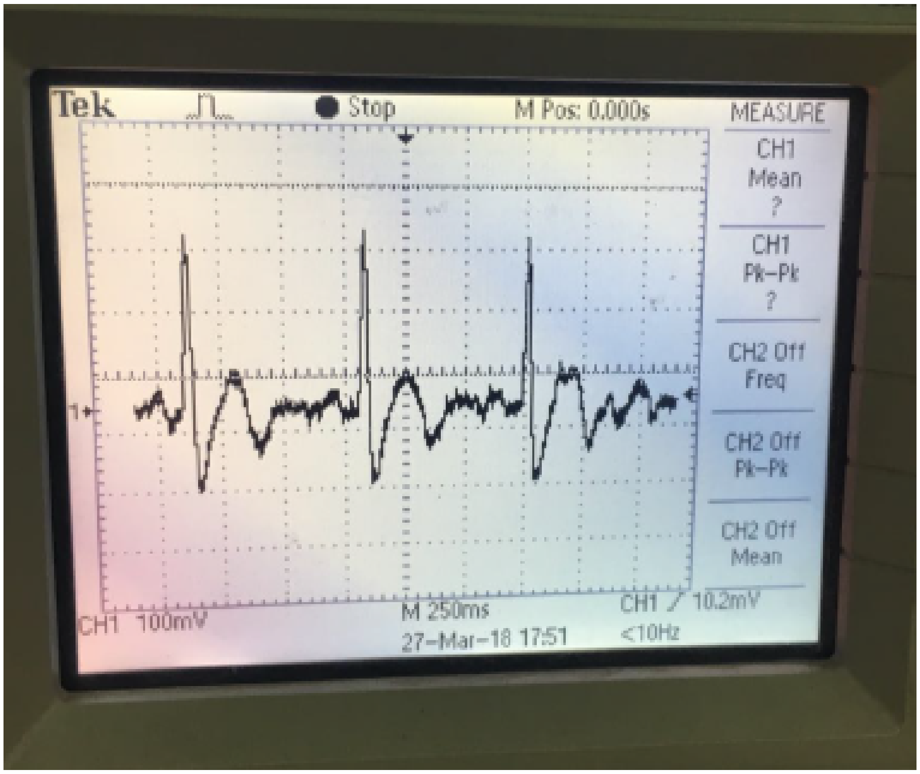

Figure 2: ECG Signal Obtained

4 Improvements

- We can improve the low pass filter by increasing the rate of fall of the bode plot after the cut of frequency. This can be achieved by having square terms in the denominator of the transfer function. Better yet, we can use higher order filters.

- Instead of having two same resistors in the notch filter we can fix one of the resistor and put a rheostat (pot) in place of the other. We can then tune the pot for a better output.