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Introduction to Sensors, Instrumentation, and Measurement

03/04/2024

Lab Three: EKG Machine

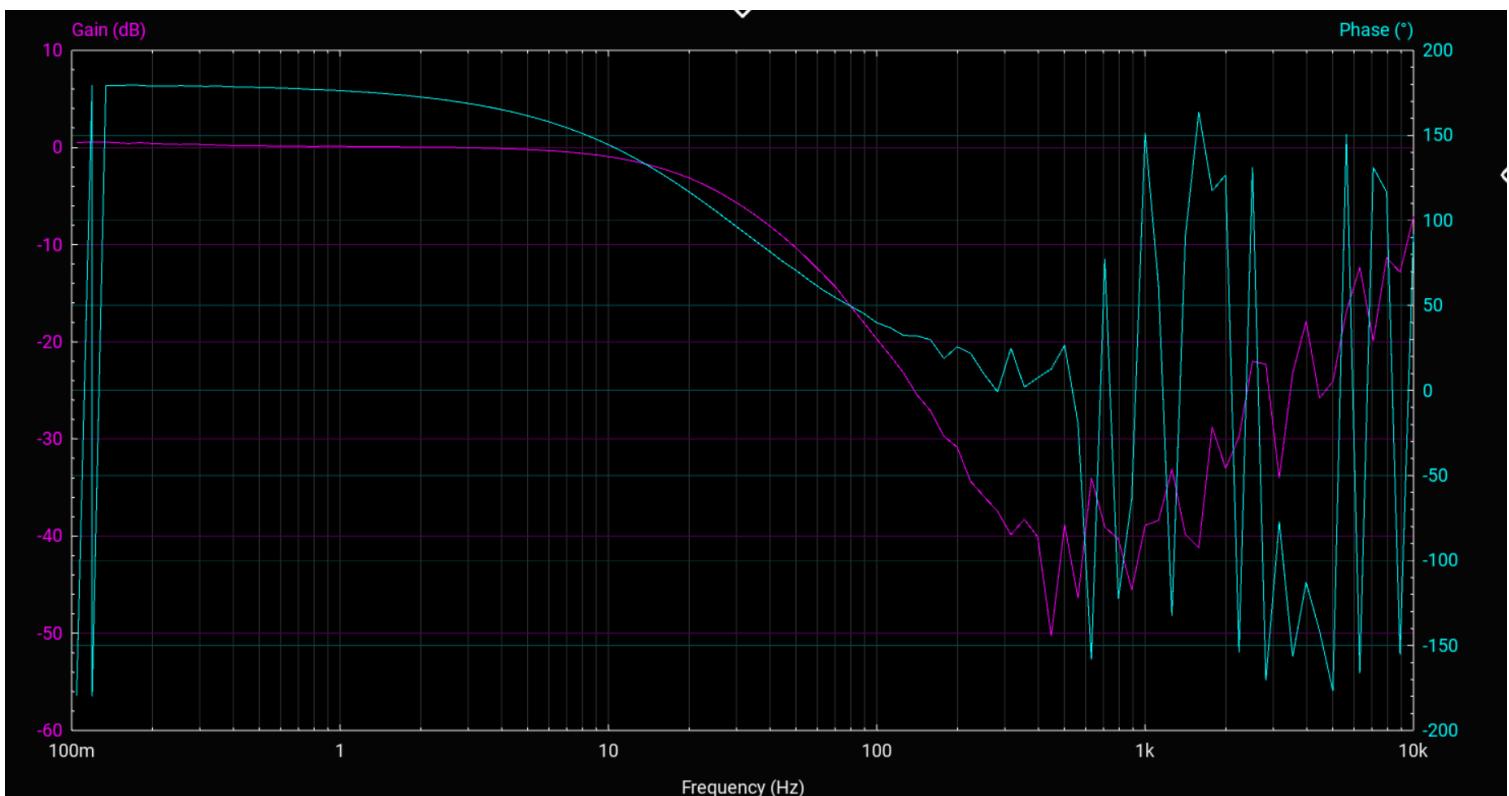
Purpose:

Use filters and amplifiers to build a circuit that will sense and measure a heartbeat.

Results:

- 1.) A Bode plot (Amplitude only) of the final circuit (stages 1 and 2 together) with labeled axes, units and caption. [Screenshot is fine. There is no need to re-plot it.]

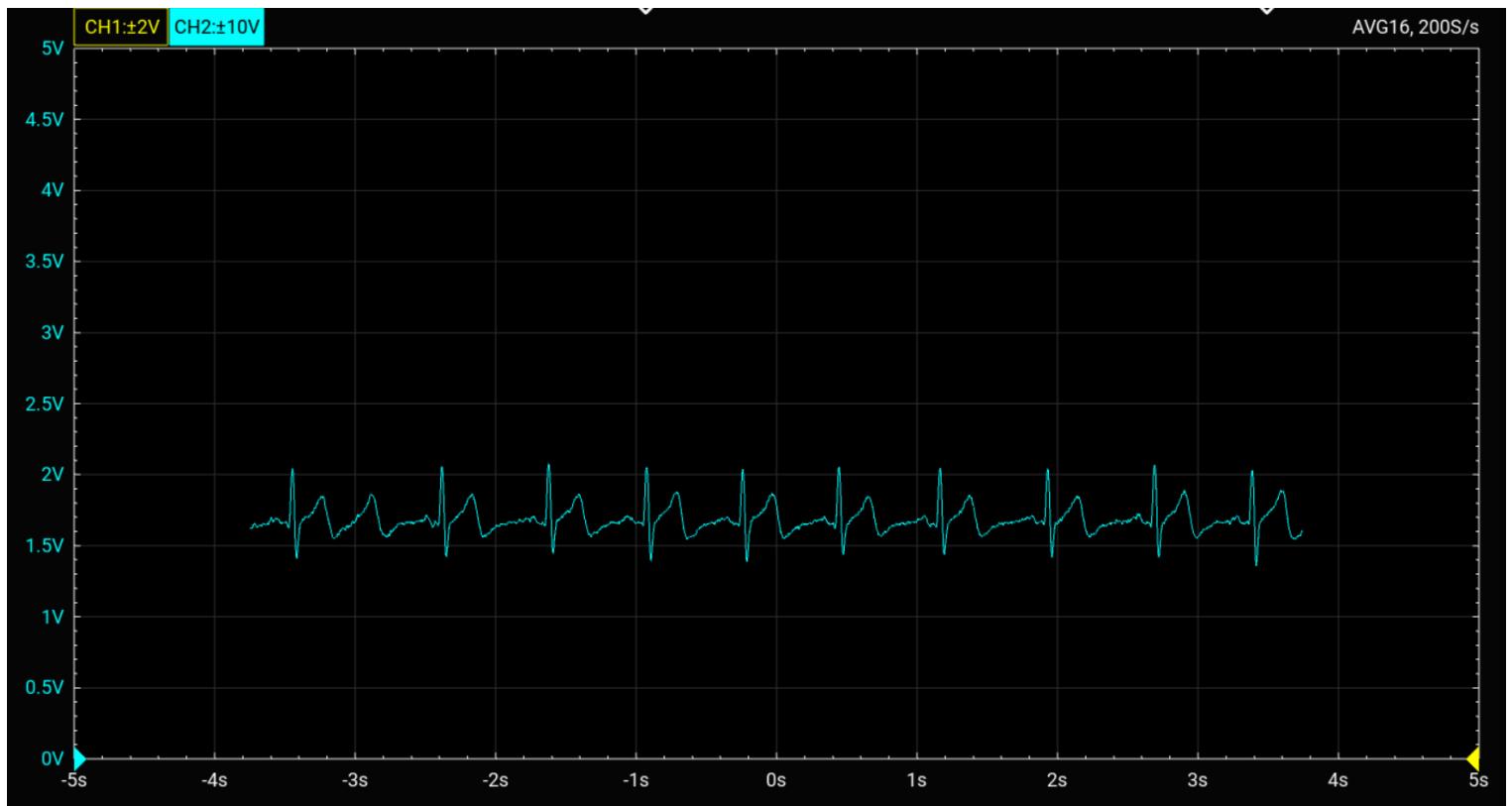
Bode Plot of an EKG Circuit



Bode Plot of a EKG Circuit. The input is from the WG using a sine wave with an amplitude of 10 mV. The signal is amplified through two AD623 chips with both RGs removed (providing an amplification of 1). There are 3 low pass filters and 1 high pass filters in the circuit. The plot is tested from 100 mHz to 10 kHz.

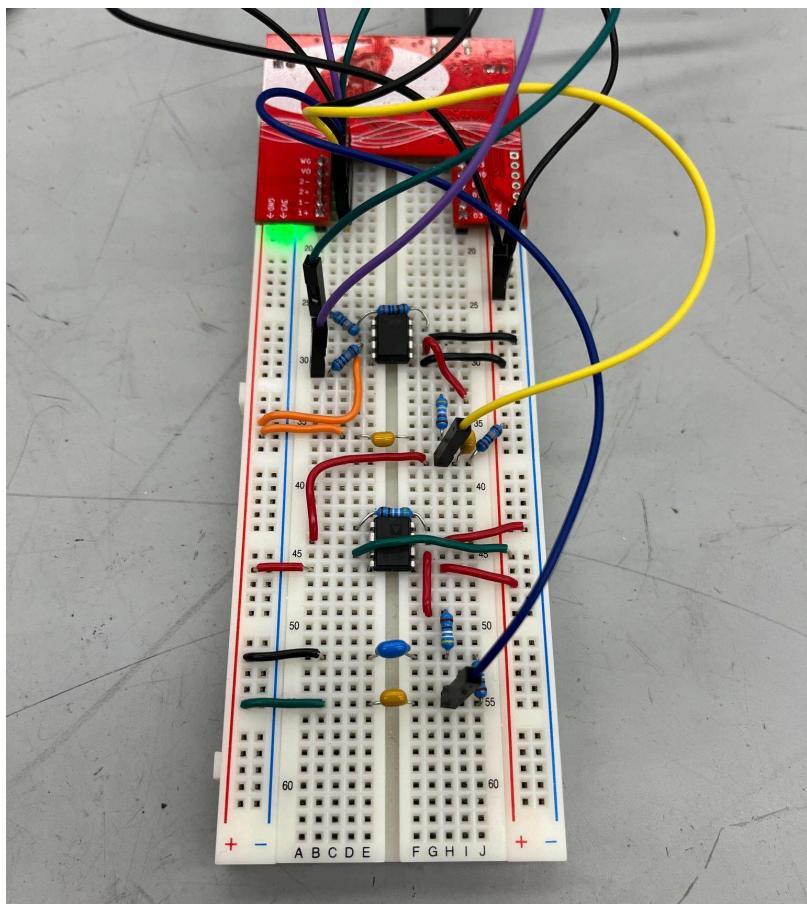
2.) A screenshot of an EKG trace and caption.

EKG reading of my heartbeat



EKG reading of my heartbeat. The inputs (slots 2 and 3 of the first AD623) are from two electrodes placed on my left and right shoulders. Additionally, the back of my left hand was grounded. The signal was then filtered through 3 low pass filters and 1 high pass filter, as well as amplified across two AD623's for a final amplification of 1000x.

3.) A picture of your built circuit using best breadboarding practices (no long loopy wires).



4.) Description of how the circuit functions.

a.) How many filters are used?

There were a total of four filters used. There were three low pass filters and one high pass filter. In order from input to output, they are:

- Low pass, $4.9\text{k}\Omega$ resistor with $1\mu\text{F}$ capacitor
- High pass, $1\mu\text{F}$ capacitor with $100\text{k}\Omega$ resistor
- Low pass, 499Ω resistor with $10\mu\text{F}$ capacitor
- Low pass, $4.9\text{k}\Omega$ resistor with $1\mu\text{F}$ capacitor

b.) What types of filters are these and what do they do?

As mentioned, there are three low pass filters and one high pass filter. The low pass filters allow signals lower than the cutoff frequency to pass through while high pass filters allow signals higher than the cutoff frequency to pass through. This is shown on the bode plot, where the signal is maintained at low frequencies, begins to fall at $>10\text{Hz}$, but then begins to regain stability after 1kHz .

c.) What are the characteristic frequencies?

The characteristic frequencies are 10Hz , when the amplitude begins to drop significantly, and 1kHz , when the amplitude begins to rise back towards 0.

d.) What is the overall amplification of the final circuit?

The overall amplification of the final circuit is $1000\times$. The first AD623 amplifies the signal by 50 times ($2\text{k}\Omega$ resistor), while the second amplifies the signal by 20 times (4.9k resistor).