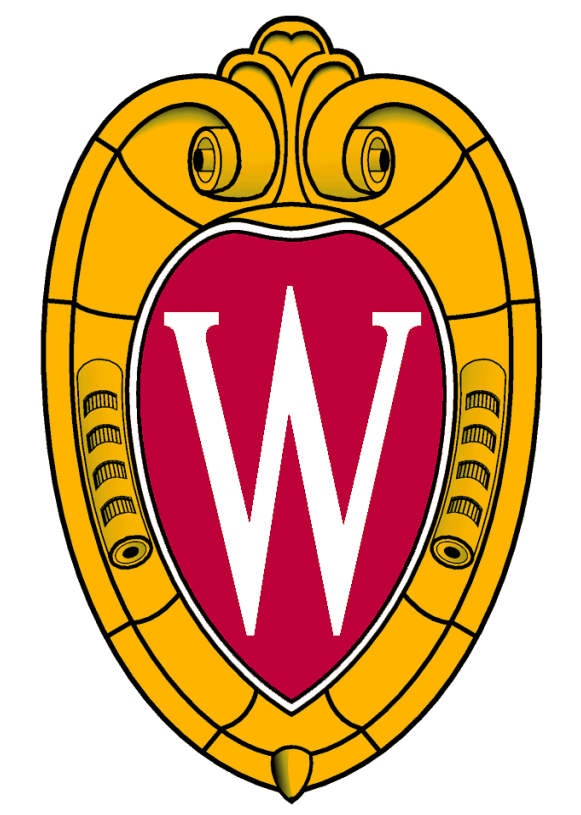




Electronic Stethoscope



Kyle Jamar Michael Scherer Taylor Weis Meghan Anderson

Client: Dr. Scott Springman¹ Advisor: John Webster²

¹Department of Anesthesiology – UWSPH

²Department of Biomedical Engineering – University of Wisconsin-Madison

Abstract

The traditional acoustic stethoscope has been in use for nearly 200 years. As one of the most important diagnostic tools in a doctor's repertoire, and comparatively low-tech by today's standards, many recent attempts have been made to upgrade the design of the stethoscope. However these new designs, being twice the cost of the original and producing an unfamiliar sound, have been slow to catch on. Since the current methods are inadequate, an accurate electronic stethoscope was designed.

The final prototype utilizes two microphones whose signals are sent through a quad amp which implements an initial gain of three and filters the input via a five pole Sallen-Key low pass filter. The two filtered signals are then sent to a mixer, which allows the user to select which input microphone they would like to use and adjust the bass and treble characteristics of the signal. Following the mixer, the signal is sent to another switch, which allows the user to choose between headphone or speaker output.

Future work includes continued work to refine our circuit, and implementing wireless technology for transmission of the microphone signal. After implementing these two improvements, the circuitry would be wire wrapped in order to fit it into the existing speaker case.

Background

Stethoscope

- Invented by French physician Rene Laennec in 1816 to hear heart and lung sounds of obese patient [1]
- Dr. David Littman patented improved, lighter version, in 1961 and few changes made since [1]
- Consists of four key parts: bell, diaphragm, rubber tube, and ear pieces (Figure 1)

Standard Littman Stethoscope



Figure 1: A standard Littman Stethoscope used today with four key elements labeled

<http://www.craicventures.com/product.php?productId=17519>

References

- [1] "History". 3M Littmann Stethoscopes. 2011. 6 December 2011. <http://solutions.3m.com/wps/portal/3M/en_US/3M-Littmann/stethoscope/littmann-learning-institute/about-stethoscopes/stethoscope-history/>
- [2] "3M Littmann". Electronic Stethoscope Model 3200. 2011. 6 December 2011. <http://solutions.3m.com/wps/portal/3M/en_US/Littmann_3100_3200/stethoscope/>
- [3] "Heart and Breath Sounds Amplifier". Department of Biomedical Engineering: University of Wisconsin-Madison. 2011. 6 December 2011. <<http://bmedesign.engr.wisc.edu/websites/project.php?id=383>>

Final Design

Design Concept (Figures 2, 3, and 4)

- Two quadruple amplifiers, LM324, used to provide an initial gain of 3 and two 5th order Sallen-Key low pass filters, with a corner frequency of 1000Hz, for each microphone
- Mixer to adjust bass and treble characteristics as well as the balance of the microphone input signals
- Separate amplification stages for the headphone and speaker outputs
 - LM386N for headphones
 - TDA2003 for speakers
- One 4" 200-Watt speaker for audio output in addition to headphone jack

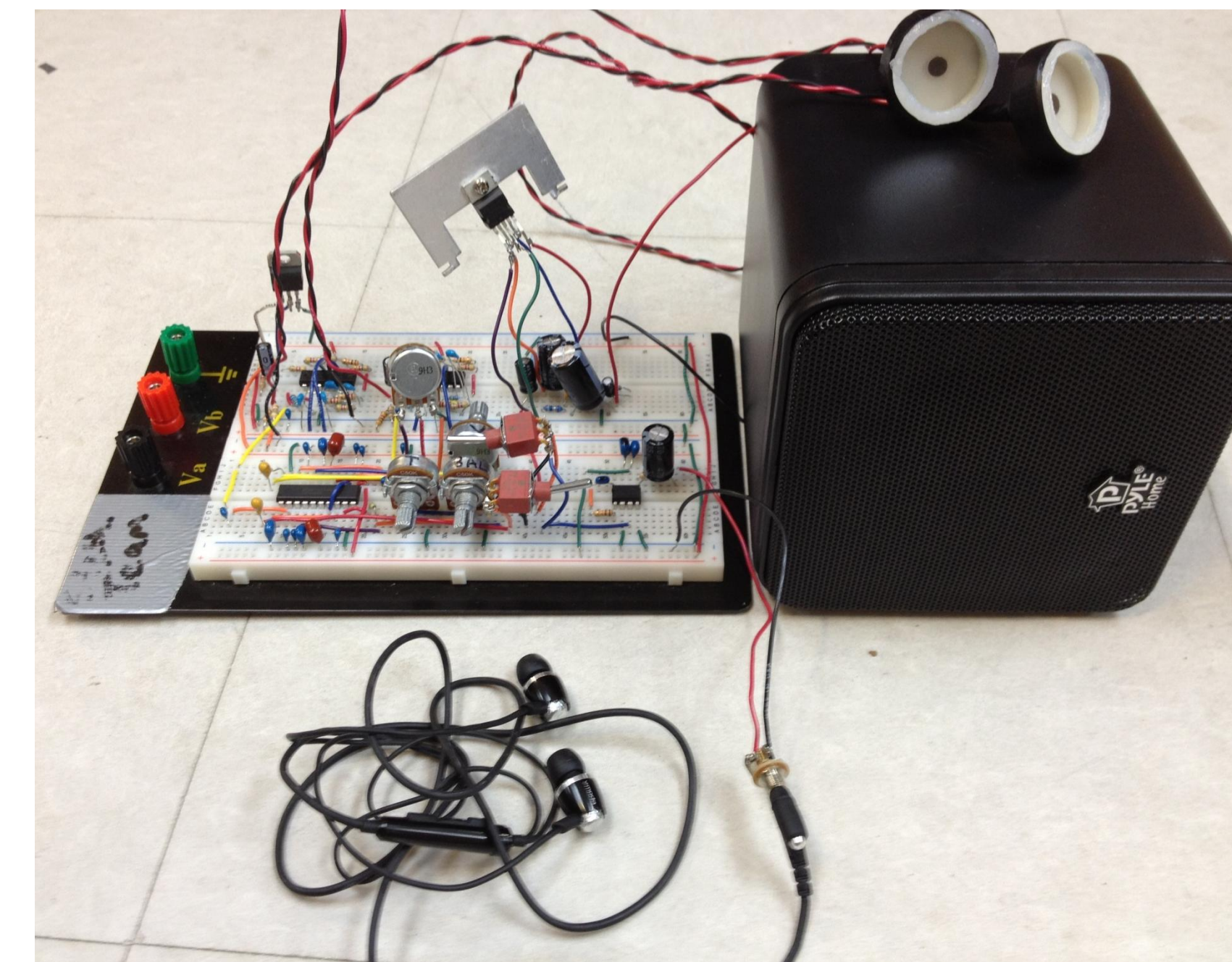


Figure 2: The finished prototype

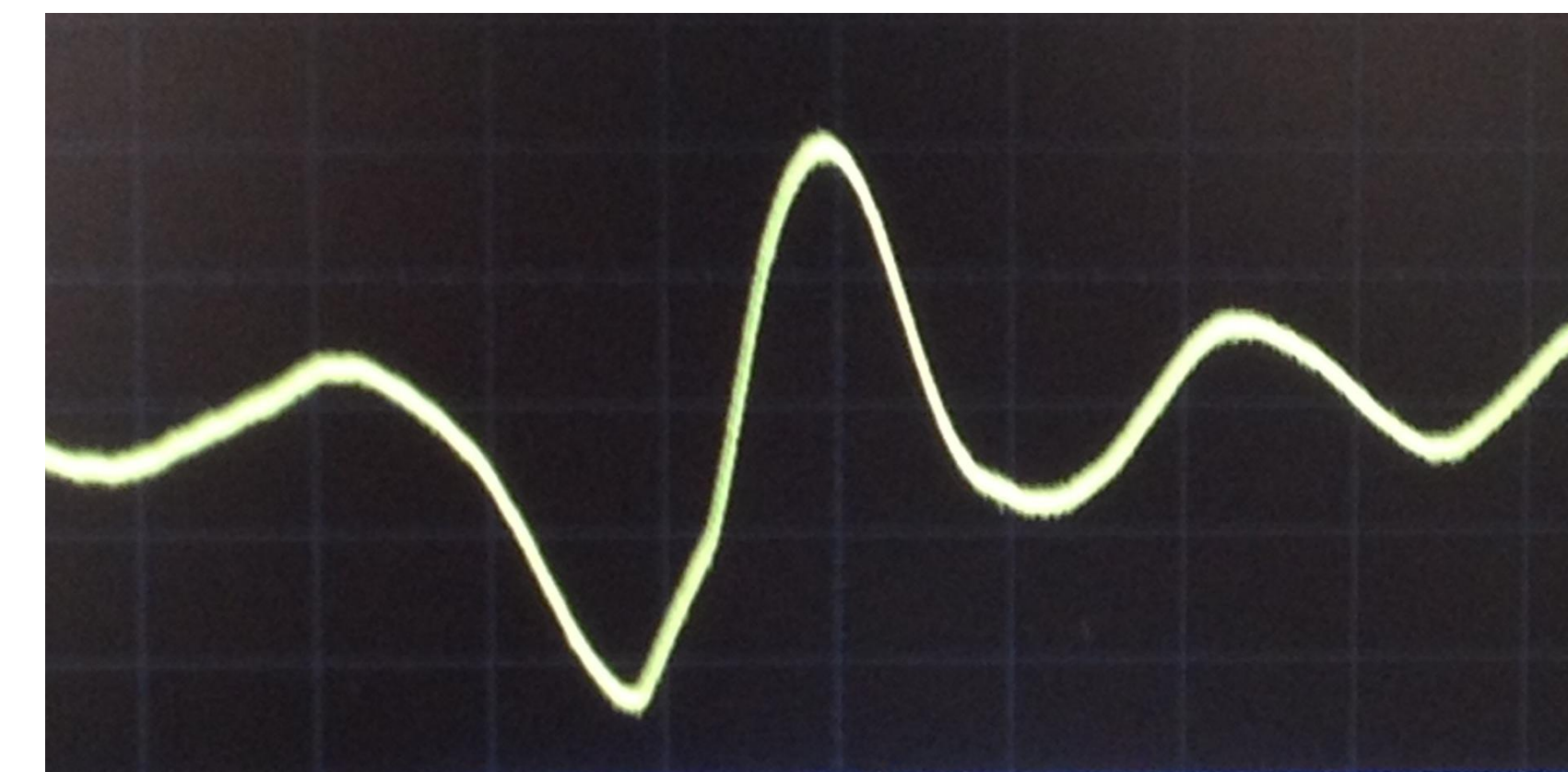


Figure 3: An oscilloscope screenshot of Mike's heartbeat as recorded by the prototype

Stethoscope Head (Figure 5)

- Manufactured using FDM Dimension Elite printer
- Modeled after stethoscope head provided by client
- Silicon gel and shrink wrap used to create diaphragm and rim

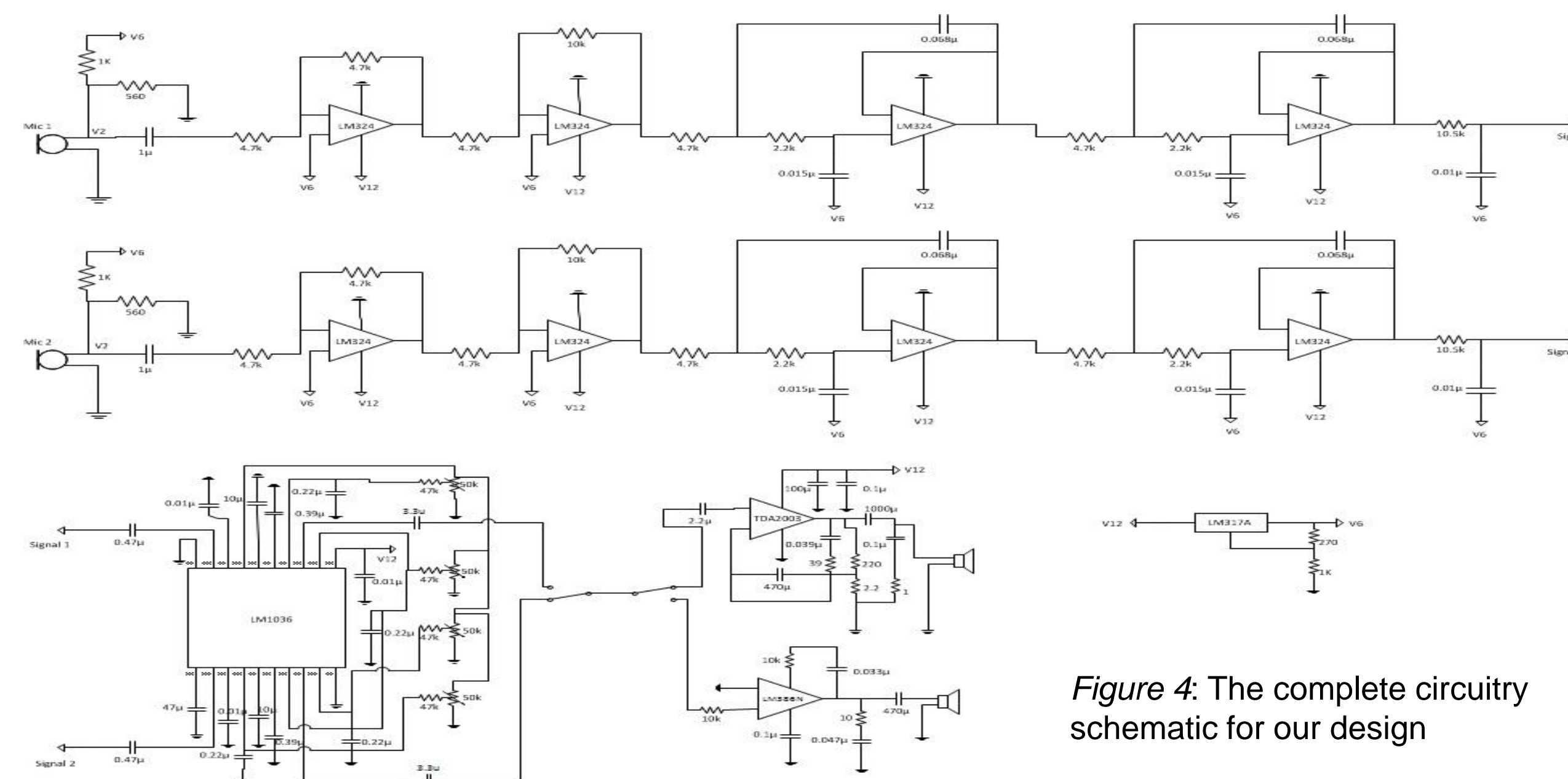


Figure 4: The complete circuitry schematic for our design

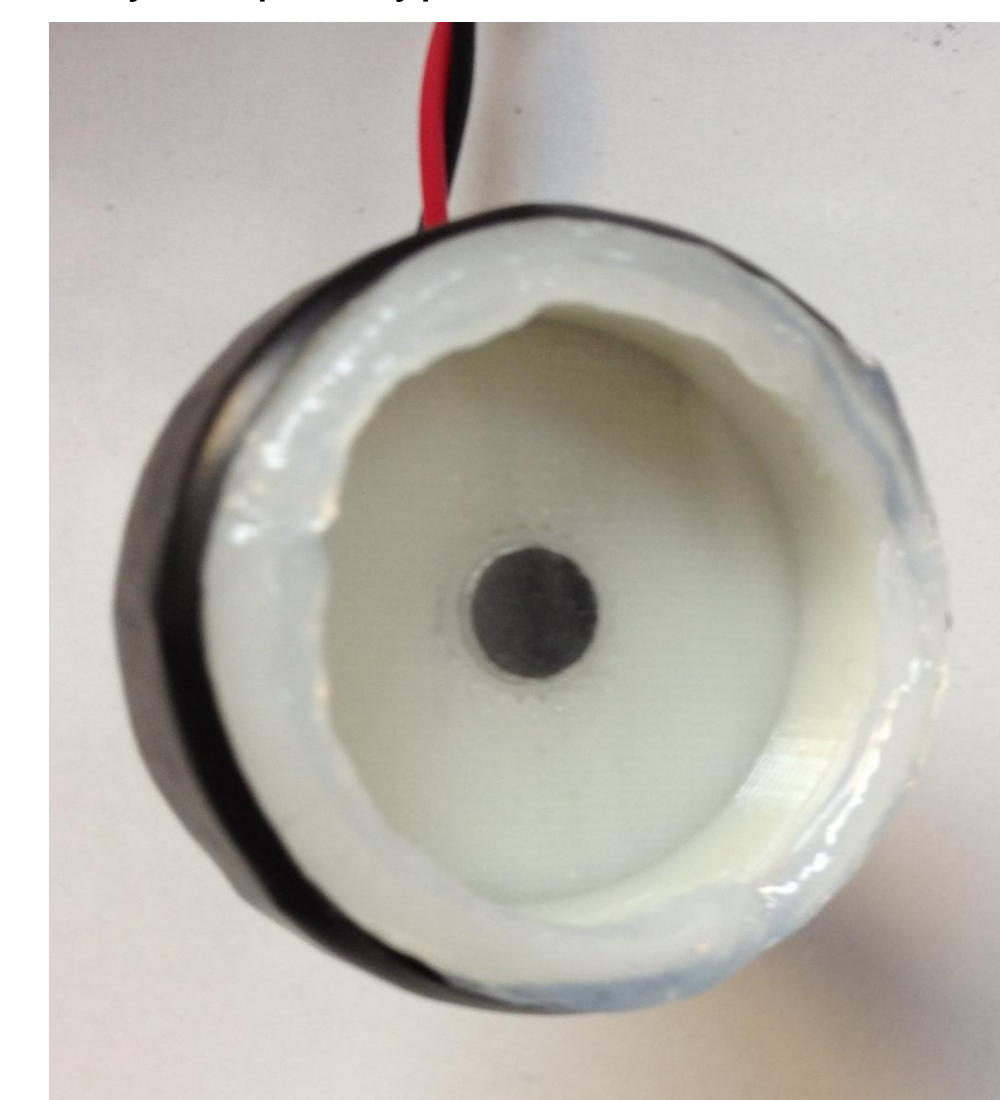


Figure 5: One of the two stethoscope heads as designed in SolidWorks and modified with silicon gel and shrink wrap

Future Work

Size Reduction

- Wire wrap the finished circuit
- Fit all components into speaker housing with dials on the top to adjust sound, etc.

Functionality

- Integrate wireless system to transmit microphone sounds to main receiver box
- Better amplify the heart sounds to make them audible in an operating room setting
- Clean up background interference in the signal
- Implement class D amplifiers to improve efficiency

Motivation

- Current devices on the market are too expensive
- Current devices do not allow for multiple listeners via a speaker
- Current devices limit freedom of movement due to short length of rubber tubing between ear pieces and stethoscope head

Goal: To create an electronic stethoscope that allows for listening by multiple people, as well as utilizes two microphones for signal input.

Design Criteria

Client Requirements

- One high-quality microphone; ideally two wireless microphones
- Option for headphone or speaker listening
- Can be attached to medical instrument cart
- Volume level sufficient to be heard in an operating room

Functionality

- Frequency response sufficient to detect heart and lung sounds (100-1000 Hz)
- Used to monitor patients heartbeat and respiratory sounds during surgery, not for diagnostic purposes

Competition

3M Littmann Model 3200^[2] (Figure 6)

- Similar appearance to regular stethoscope
- No option for speaker listening
- MSRP ~ \$400.00

Figure 6: The Talking Watch announces the time to the user when prompted

Image courtesy of: <http://www.medshop.com.au/littmann-stethoscope-digital-electronic-3100nb.html>



2011 Spring Prototype^[3] (Figure 7)

- Allowed for listening via headphones or speakers
- Bulky main housing with circuit on breadboard
- Heartbeat sound is difficult to hear due to quiet volume



Figure 7: The Spring 2011 prototype

Image courtesy of: Spring 2011 Electronic Stethoscope Design Team

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