



ClearPulse: Stethoscope with noise canceling headphones (and amplification option)

Design Team:

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Advisor:

Prof. Randy Bartels

Client:

Dr. Lenard Markman

Date: 10/2/26



Introduction

Brief client background:

- Dr. Lenard D. Markman, DO
- Family Medicine Physician
- Retired provider with over 35 years experience
- Former president, WI Association of Osteopathic Physicians and Surgeons [1]

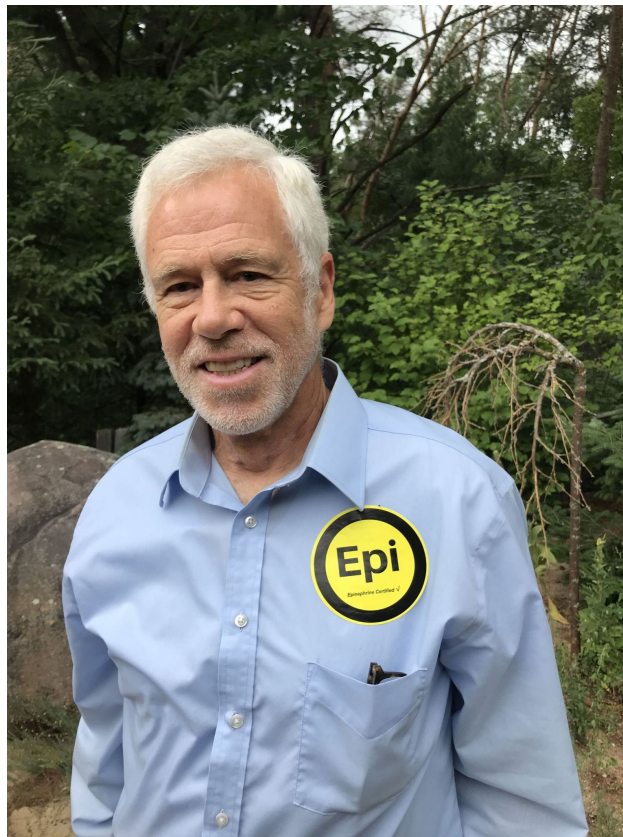


Figure 1: Dr. Lenard Markman
[1]



Problem Statement

Problem: **unreliable auscultation in clinical/field settings**

- Heart/lung sounds often difficult to distinguish from background
- Compounded due to hearing loss or loud environments

Team findings from further research:

- Alternatives exist, although at high price points
- Signal amplification emerges as a promising approach

Background

EMT Workers desire an inexpensive alternative for ambulance readings.

Competing Designs:

Littman CORE

EKO health digital stethoscopes



Figure 2: EKO Digital Stethoscope [2]



Figure 3: Littman Core [3]



Product Design Specification

Client Requested Functions:

1. Transmit clear heartbeat readings in noisy environments
2. Easy transport
3. Turns On/Off
4. Noise cancellation and amplification
5. Long-lasting and reusable
6. Safe for human contact
7. Limit price
8. Encouraged to apply to WARF for a patent.
9. \$101 budget



PDS (continued)

- 100-1000 Hz
- Passive reduction ~15 dB
- Max amplification of 40x peak frequency [3]
- Minimum functionality of 2 years [4]

Design Matrix

Design	Prior Semester		Fully Passive		Fully Detachable	
						
Criteria (weight)	Raw	Weighted	Raw	Weighted	Raw	Weighted
Amplification (25)	2.5/5	12.5	0/5	0	4/5	20
Noise Reduction (25)	2.5/5	12.5	4.5/5	22.5	3.5/5	17.5
Cost (20)	3.5/5	14	4/5	16	1.5/5	6
Ergonomics (15)	1.5/5	4.5	1.5/5	4.5	4/5	12
Durability (10)	2.5/5	5	4/5	8	3.5/5	7
Regulatory Compliance (5)	4/5	3	4/5	4	1.5/5	1.5
Total (100)	51.5		56		64	

Figure 4: Design Matrix

Prior Semester's Model

- Addresses most of client's requests
- Original
- Inconvenient to use



Figure 5: Prototype of headset model



Figure 6: Headset CAD design [5]

Fully Passive Model

- Best passive noise reduction
- Non-electronic
- Has no amplification option



Figure 7: 3M Peltor X5A earmuffs [6]

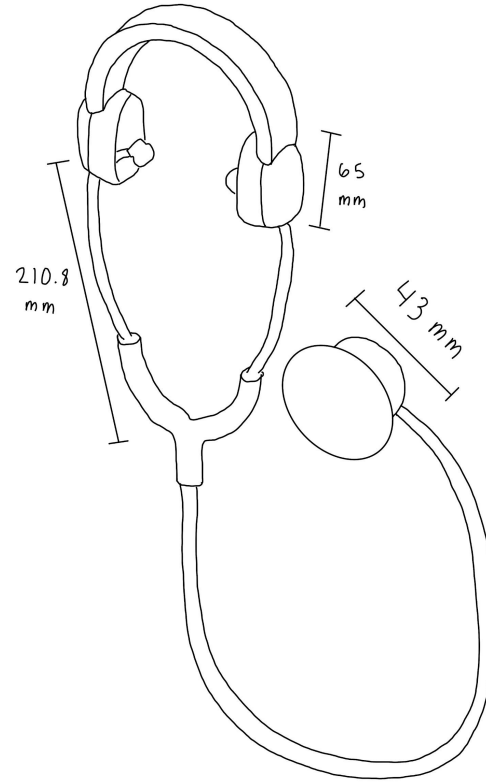


Figure 8: Fully Passive Design Sketch

Fully Detachable Model

- Amplification and noise-cancelling
- User-friendly design
- Regulator Compliance

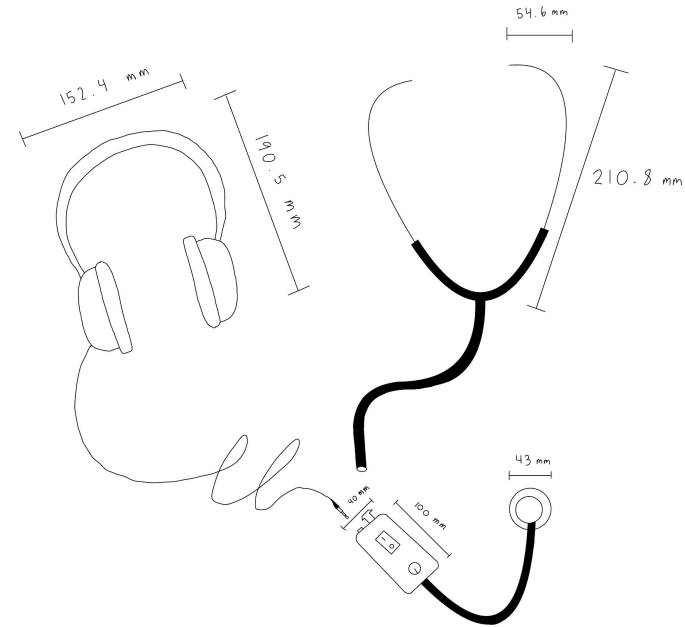


Figure 9: Fully Detachable Design Sketch

Electronic Components

Last Team's Electric Circuit Design

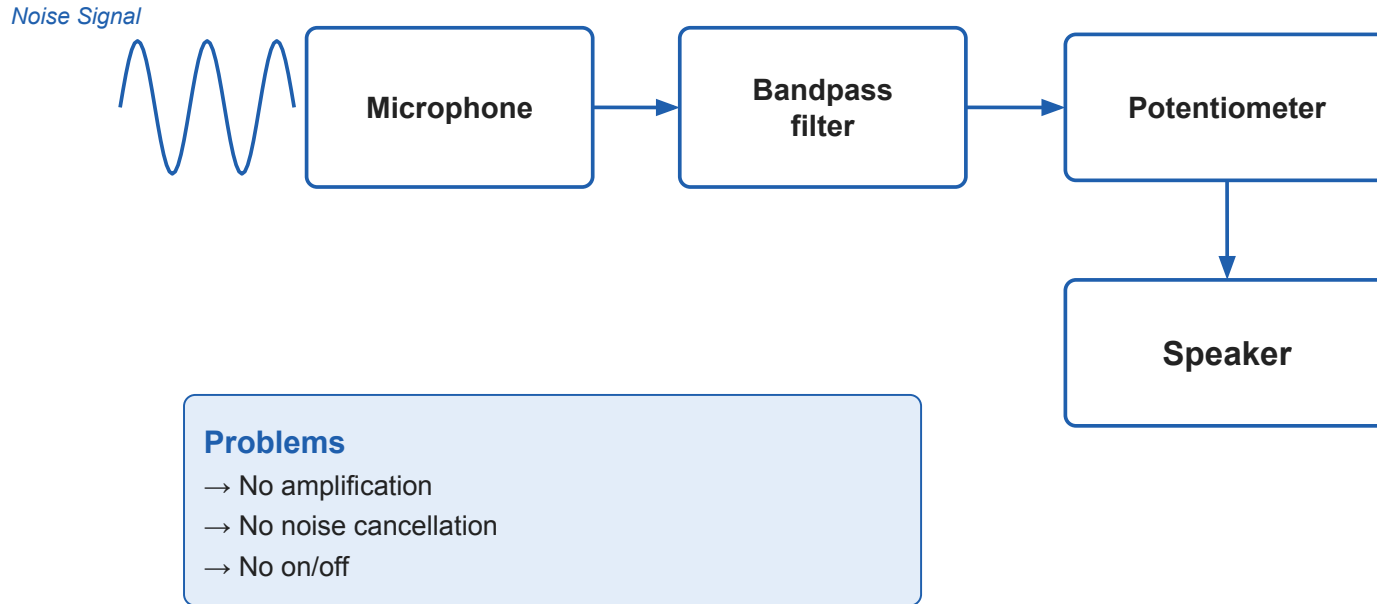


Figure 10: Last Team's Electric Circuit Diagram

Electronic Components Diagram

Our Improved Design

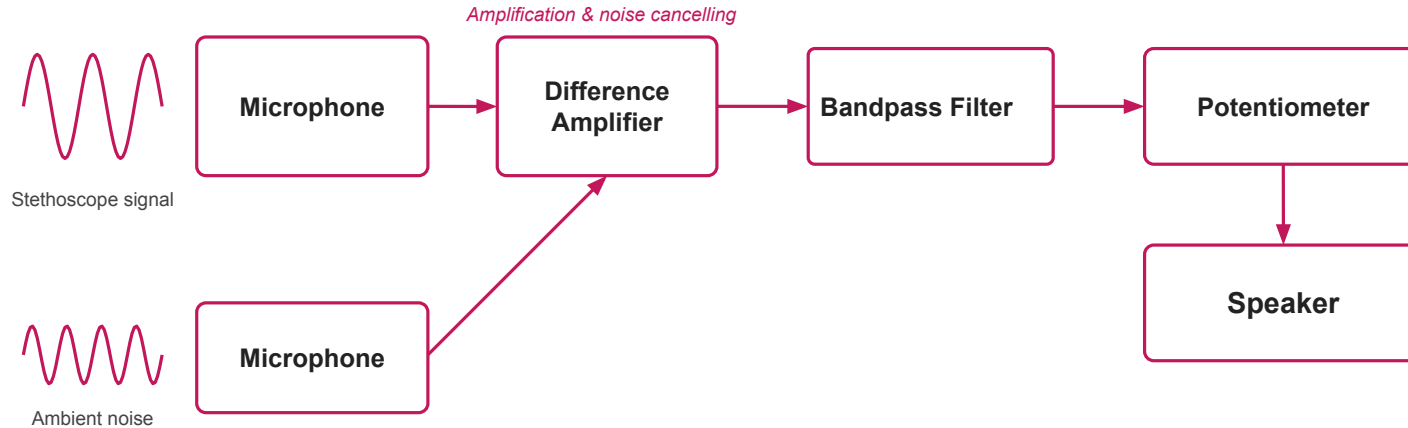
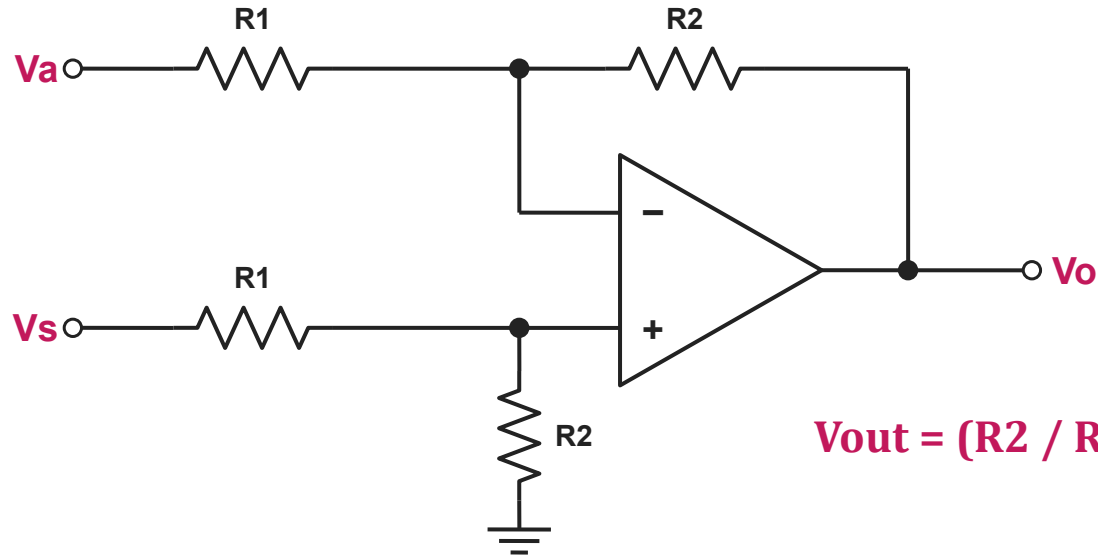


Figure 11: Our Improved Electronic Components Diagram

Difference Amplifier Topology

V_a = ambient signal

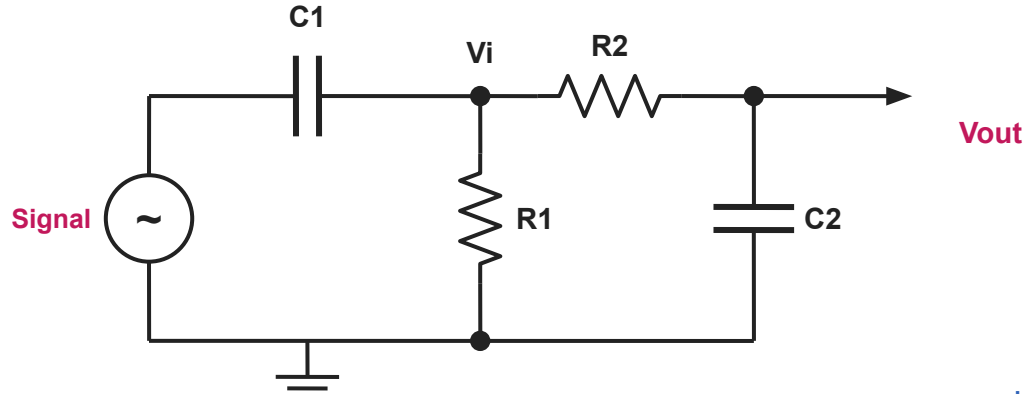
V_s = stethoscope signal



$$V_{out} = (R2 / R1) \cdot (V_s - V_a)$$

Figure 12: Difference Amplifier Topology

Band Pass Filter Topology and Bode Plot



[7]

Figure 13: First Order BandPass Filter

$$f_c = 1 / (2\pi \cdot RC)$$

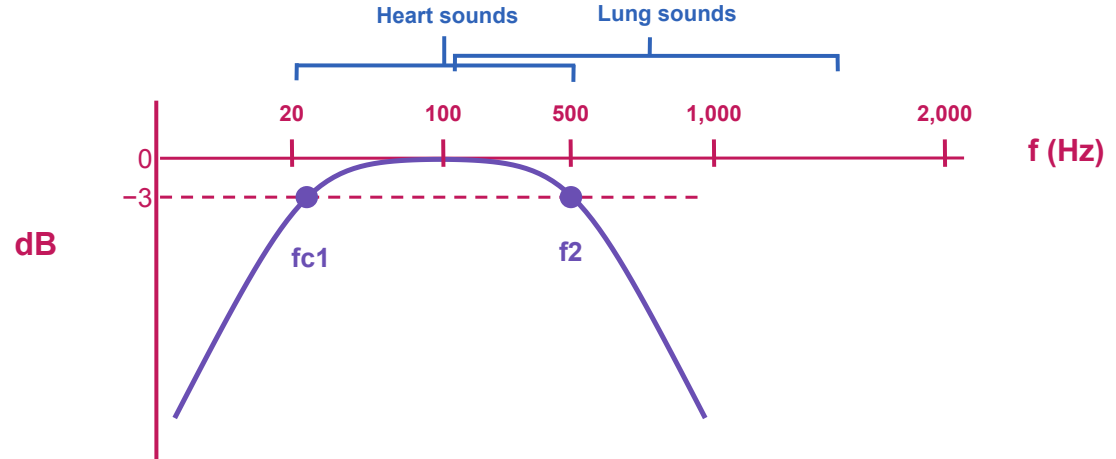


Figure 14: Bandpass Filter Bode Plot



Future Work

- Patent infringement
- ANC Circuitry
- Cost Constraints
- Electronics Housing



Acknowledgements

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References

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Questions?