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Guitar Headphone Amplifier

Group Members:

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Abstract

The Guitar Headphone amplifier is designed to enhance the clarity of low guitar output signals when listened to through headphones. The circuit comprises signal and power amplification components, with a 500k-ohm potentiometer facilitating variable gain. Initial simulations were conducted using Multisim, guided by open-source videos and publications. Subsequently, the circuit was implemented on a breadboard for testing, utilizing selected components. The device's PCB and enclosure were meticulously designed using Altium Designer and Solidworks, respectively. Our primary objective is to ensure the device is precise, compact and portable.

Contents

1 Introduction

The guitar headphone amplifier enhances guitarist practice with amplified sound through headphones. Compact and cost-effective, it offers a private playing experience, eliminating the need for a traditional amplifier and external speakers. Perfect for late-night or on-the-go sessions.

This project aims to create a versatile guitar headphone amplifier for modern guitarists, offering silent practice and advanced features like tone shaping and effects processing. With a focus on portability, it empowers musicians to refine their skills in various settings.

2 Functionality

Figure 1: Guitar Headphone Amplifier

The guitar headphone amplifier is designed to process a low-amplitude guitar output signal from a 6.35mm mono jack and deliver the amplified signal through a 3.5mm stereo jack. It features adjustable gain, ranging from x1 to x25, providing flexibility in tailoring the output to individual preferences. The device operates on a 9V DC battery, ensuring portability, with a maximum power consumption of 36mW. This amplifier is crafted to enhance the guitar-playing experience, offering a compact and versatile solution for private practice sessions through headphones.

3 System Model

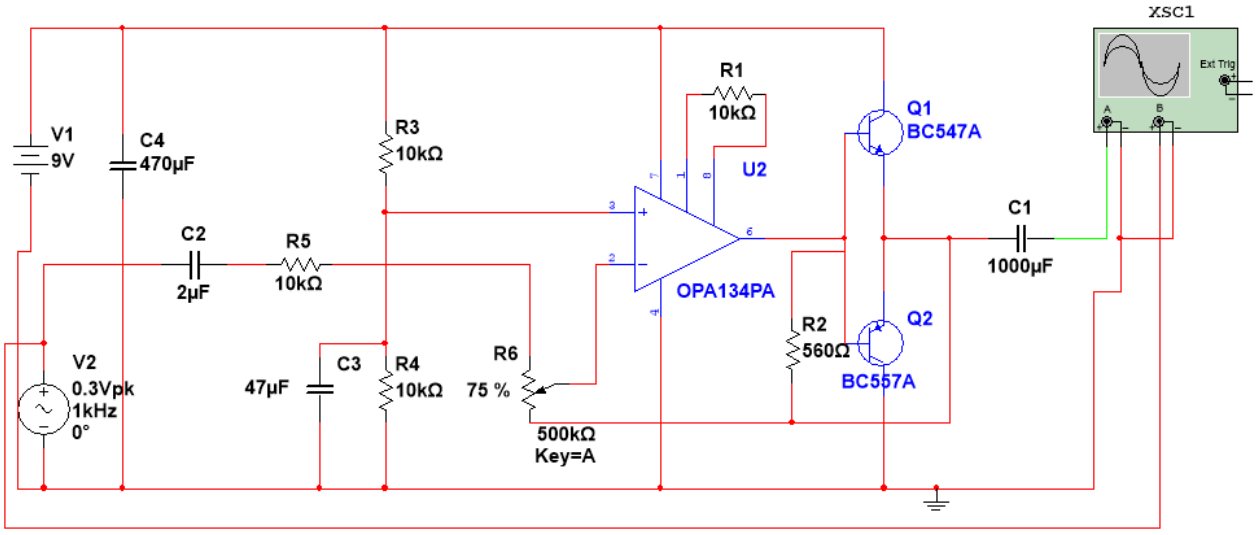


Figure 2: Model

3.1 Input Audio Signal

Purpose of the device is to amplify the the guitar output. Normally guitar produces maximum of 700mV [4] peak to peak voltage in hearing frequrncy range as 20Hz - 20000Hz.

3.2 OPA134PA Op Amp

We are using this operational amplifier because it has a good gain for audio signals.The OPA134 series stands out as ultra-low distortion and low-noise operational amplifiers, meticulously designed and fully specified for application in audio systems. To deliver exceptional audio performance, these amplifiers feature a genuine FET input stage, ensuring superior sound quality and speed. This configuration is crafted to meet the specific requirements of audio applications, emphasizing a commitment to excellence in performance and fidelity [3]

3.3 Class B Push Pull Amplifier

We are using class B push pull amplifier for get more efficiency and output power and also we are able reduce the distortion of the output [1]. In our circuit we used BC547A (npn) and BC557A (pnp) transistors and they have typical current gain as 90.

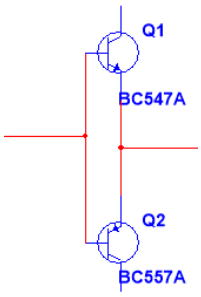


Figure 3: Class B Push Pull Amplifier

4 Schematic

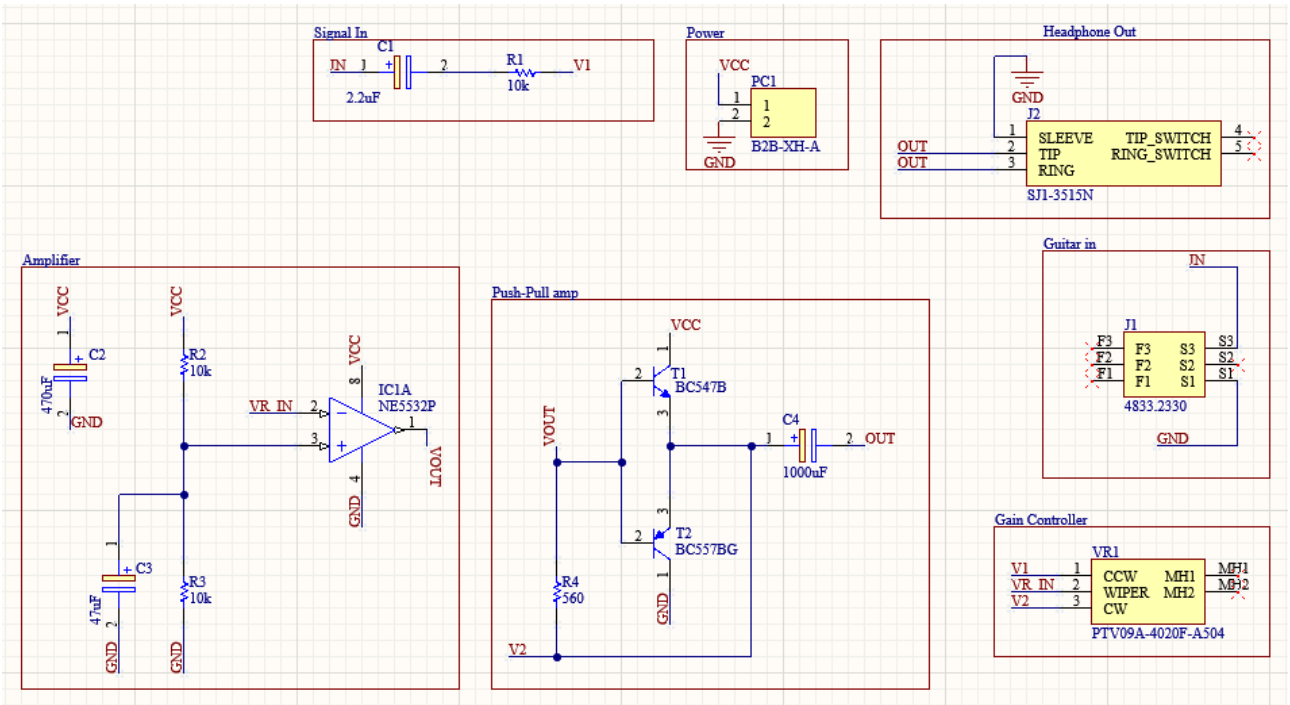
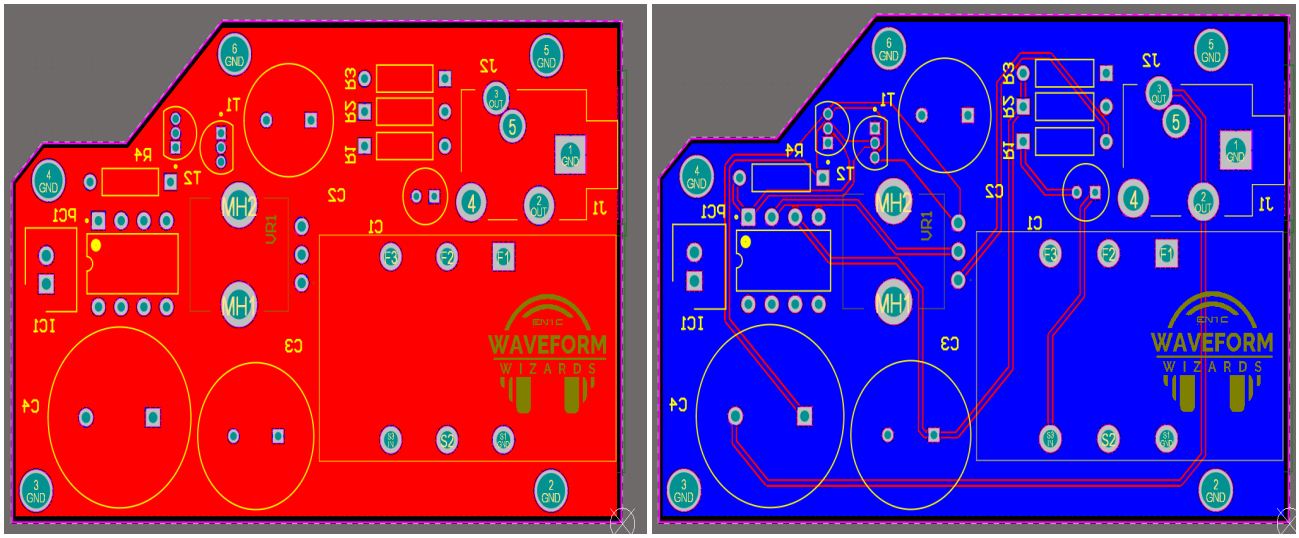


Figure 4: Model

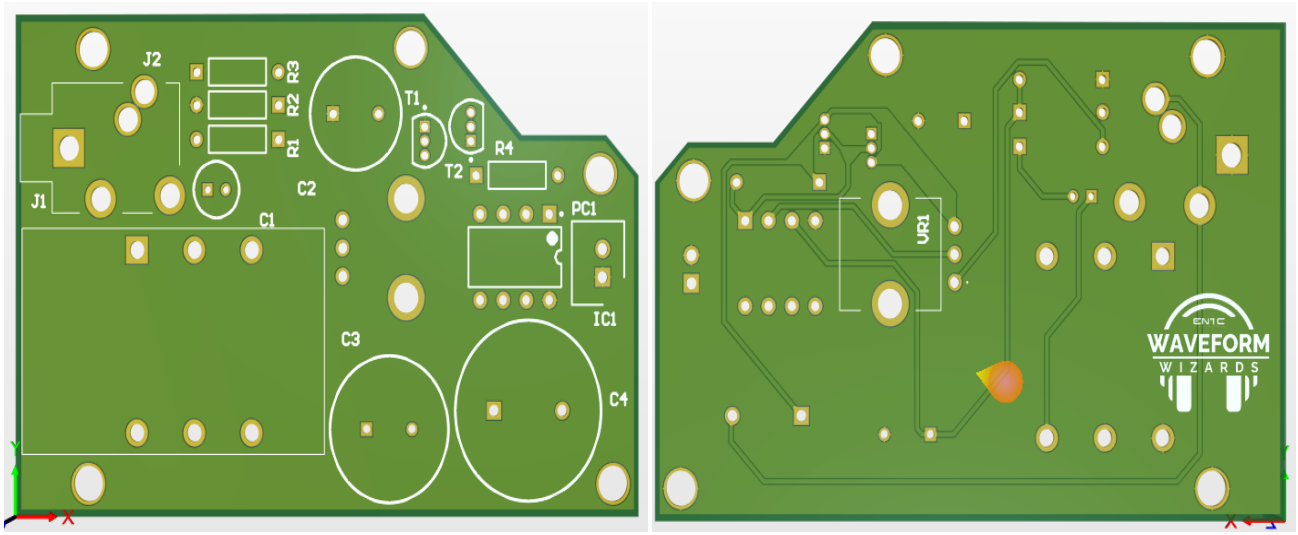
5 PCB Design

After successful breadboard testing, we designed the circuit in Altium Designer, sent it for PCB fabrication, and soldered the components onto the printed PCB. A thorough examination was conducted to verify functionality and integrity.



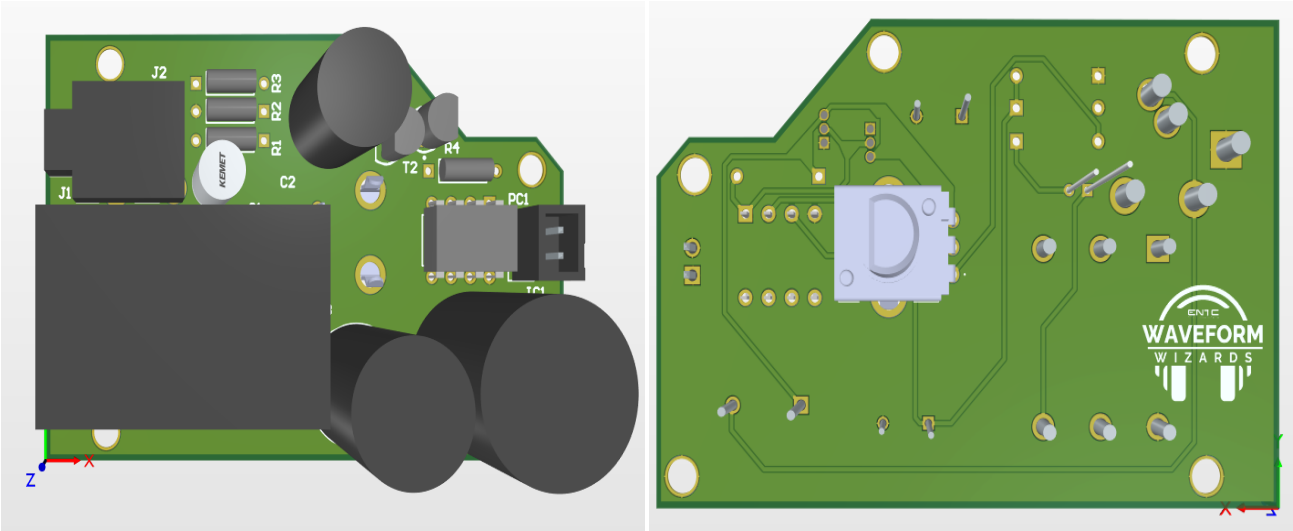
(a) Top Layer (b) Bottom Layer

Figure 5: PCB Layers



(a) Front Side (b) Back Side

Figure 6: 3D view of the PCB

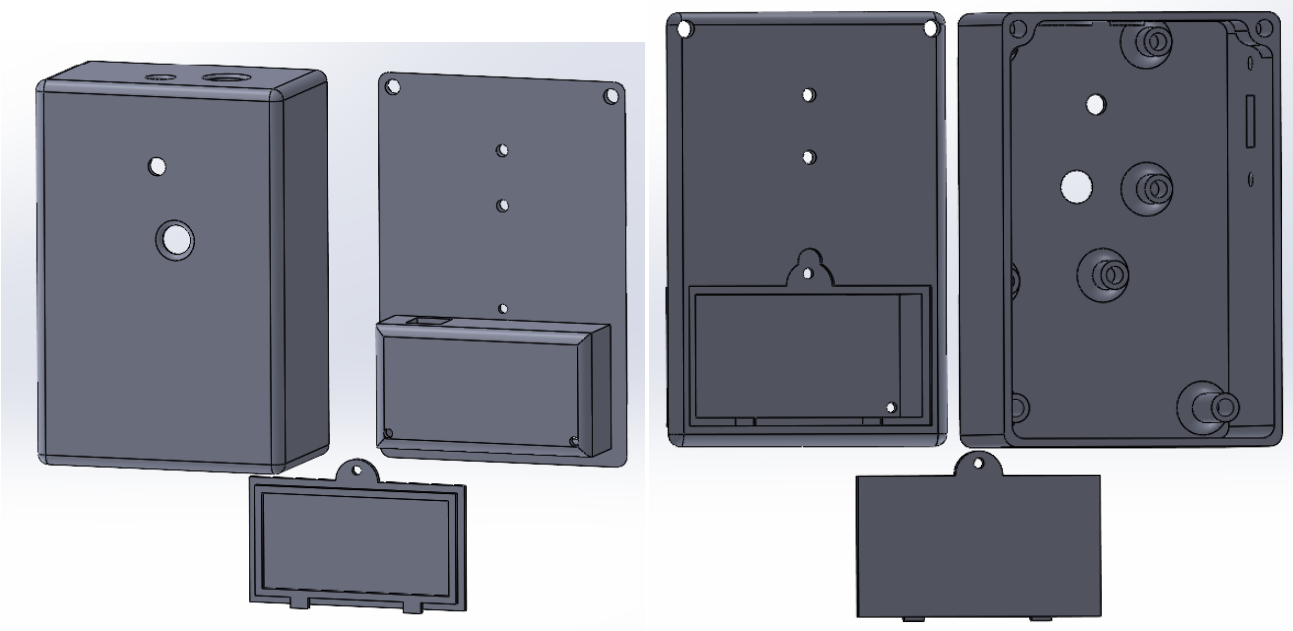


(a) Front Side (b) Back Side

Figure 7: C3D view of the PCB with mounted components

6 Enclosure Design

We used Solidworks to design the enclosure for our project, which was then 3D printed. The printed components were assembled using screws, and the enclosure was divided into two segments—a lid and a base—for easy assembly and disassembly.



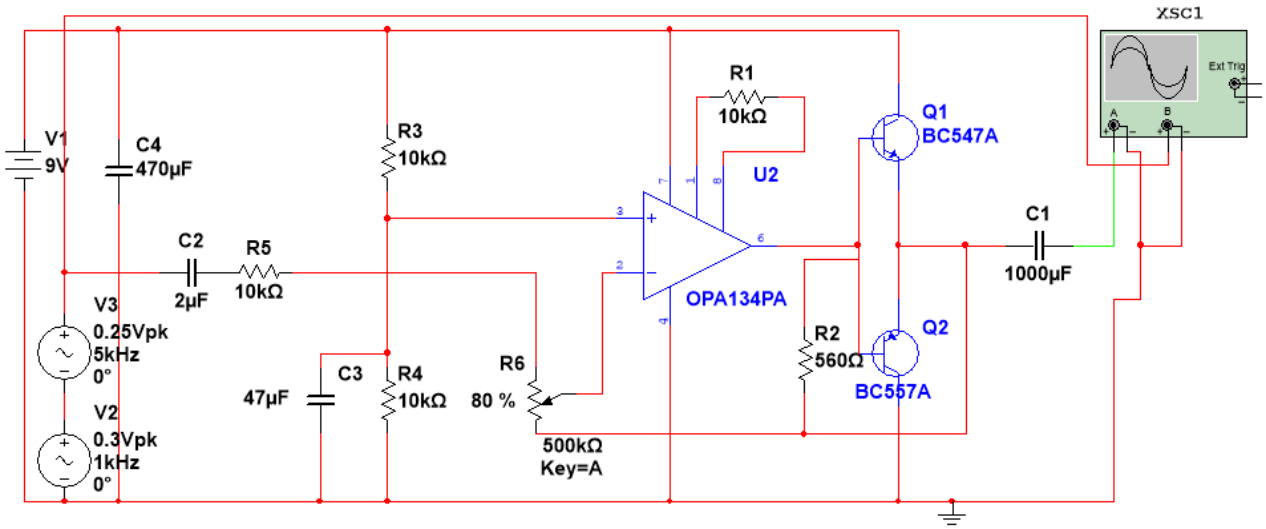
(a) View 1 (b) View 2

Figure 8: Enclosure Design

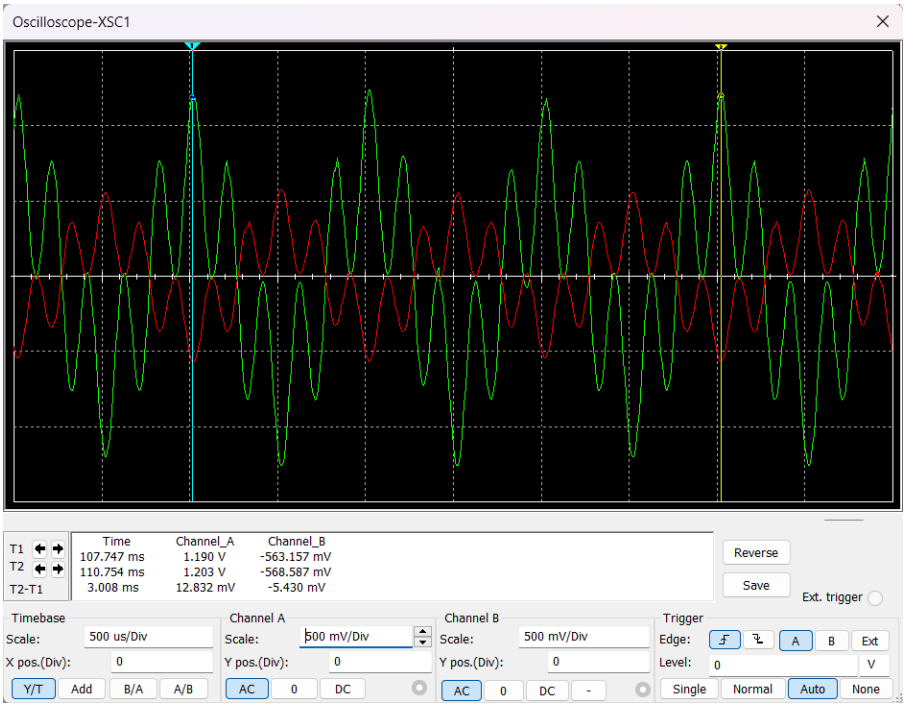
7 Software Simulation and Hardware Testing

7.1 Software Simulation

After finalizing the circuit design, we conducted simulations using NI Multisim, an electronic schematic capture and simulation program. The insights derived from this software played a crucial role in confirming and refining our circuit design.



(a) Circuit

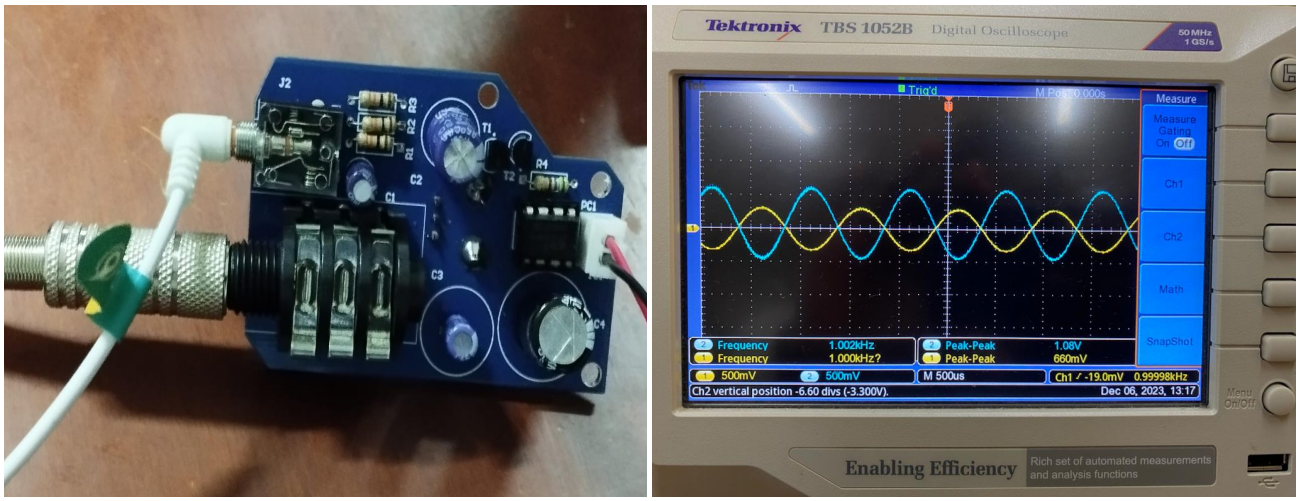


(b) Oscilloscope Output

Figure 9: Multisim Simulation

7.2 Hardware Testing

First, we implemented the circuit on breadboard with locally available components and got more insights. Then we imported some precise components from abroad. After receiving the PCB, we soldered components on the PCB and concluded the circuit with some more testings.



(a) Circuit (b) Input and Output waves

Figure 10: Hardware Testing with x2 gain

8 Conclusion

Building a guitar headphone amplifier with analog components like resistors, op-amps, and capacitors is entirely feasible. This design effectively amplifies low guitar sounds, ensuring a clean waveform without noise. It can drive a 50-ohm load without distortion, meeting project requirements. The amplifier stands as a reliable, versatile, and portable solution for guitarists.

9 Future Works

The project's cost is below Rs.15,000, a fraction of commercial options. Creating our affordable guitar headphone amplifier offers a more economical choice globally. Exporting the product can generate income, addressing economic challenges in Sri Lanka. Options include a dedicated website or platforms like Ebay, AliExpress, or Amazon for global sales.

10 Acknowledgment

We express our sincere gratitude to Dr. Perera M.T.U.S.K. Sampath for his invaluable guidance throughout this project. His initial insights laid the foundation for our work, and his ongoing support helped us navigate challenges effectively. Special thanks are extended to H.M.A.M.Bandara, W.K.Hiruni Ayodya and B.W.J.C. Kumara, our seniors in the final year, who generously dedicated time to mentor us. We are indebted to Eng.Kithsiri Samarasinghe for his elucidation on amplifiers, which proved crucial to our project. The concepts taught during the third semester were instrumental in our successful implementation.

11 Contribution of Group Members

Reg No.	Name	Contribution
210498T	Priyankan V.	Testing & Documentation
210503H	Rajapaksha I.P.D.D.	Enclosure Design
210559H	Samaranayake M.A.S.	PCB Design
210580M	Saumyajith S.A.D.P.	Circuit Design

References

[1] *Class B Amplifiers Push-Pull*. URL: https://ecstudiosystems.com/discover/textbooks/basic-electronics/amplifiers/class-b-and-ab-amplifiers/.

[2] *Headphone Amplifier Biased OPA134*. URL: https://amplifiercircuit.net/headphone-amplifier-based-opa134pa.html.

[3] *OPA134PA Datasheet*. URL: https://www.alldatasheet.com/datasheet-pdf/pdf/170749/BURR-BROWN/OPA134PA.html.

[4] J. Donald Tillman. *Response Effects of Guitar Pickup Position and Width*. URL: https://till.com/articles/PickupResponse/index.html.

Appendix

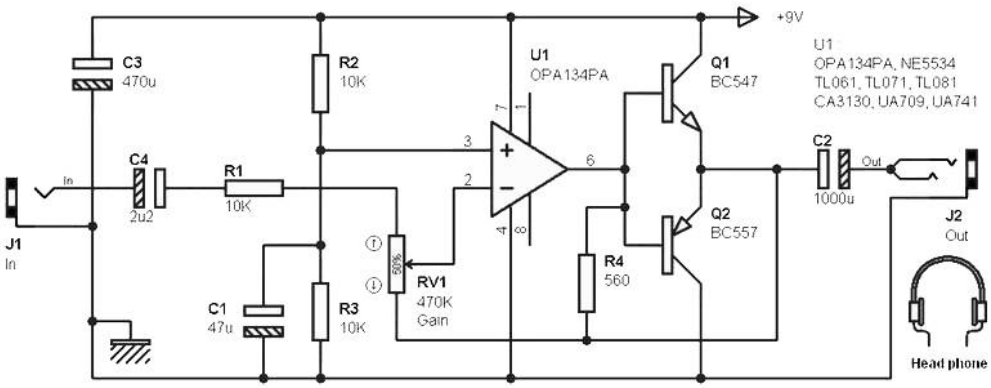


Figure 11: Headphone amplifier biased OPA134[2]