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Audio Voice Over Circuit

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EN 2091 Laboratory Practice and Projects

14-12-2025

0.1 Abstract

This report provides a comprehensive overview of the methodology adopted in the development of the audio voiceover circuit, which enables users to seamlessly switch between an audio source and a microphone input based on their preference. When either input mode is selected, the voice or audio signal is clearly audible while background music continues to play at a reduced level. In the absence of any input signal, the background music is played at full volume.

The project incorporates essential components such as amplifiers, automatic switching systems, and various operational amplifier configurations to ensure stable, efficient, and reliable operation. Initial design and simulation were carried out using Multisim Professional software, allowing precise evaluation and validation of the circuit's performance prior to implementation.

The mechanical enclosure for the circuit was designed using SolidWorks, ensuring a structurally sound, functional, and aesthetically pleasing design. Furthermore, Altium Designer was utilized for printed circuit board (PCB) development, enabling an accurate and well-organized component layout that adheres to industry standards.

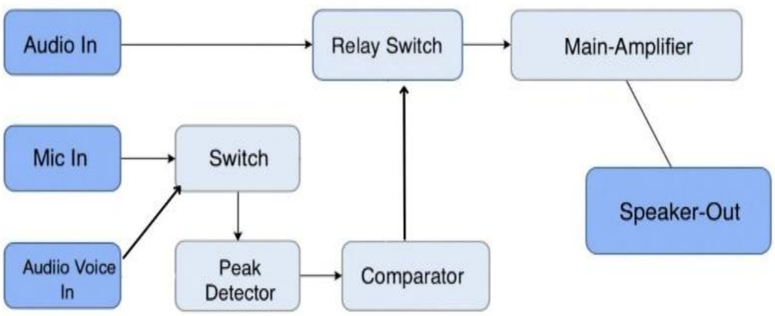
Overall, this report offers a detailed explanation of each stage of the design process, highlighting the techniques and software tools used in the successful realization of the audio voiceover circuit.

Contents

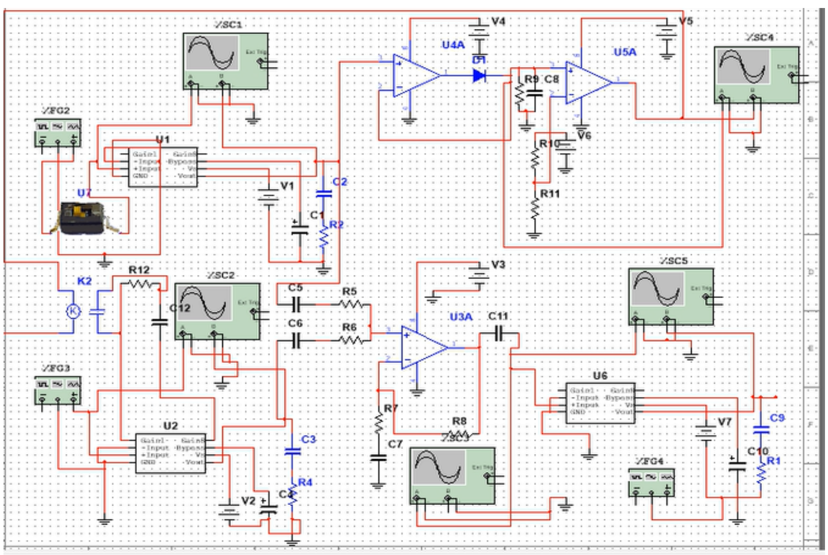
1 Introduction

The objective of this project is to design and implement an audio voiceover circuit that allows users to seamlessly switch between a microphone input and an audio source while maintaining clear and balanced sound output. The system is designed to ensure that the selected input is clearly audible over background music, which continues to play softly when an input is active and at full volume when no input is present. To achieve reliable and efficient operation, the project integrates key components such as amplifiers, automatic switching mechanisms, and operational amplifier circuits. The design and simulation were performed using Multisim Professional to validate circuit functionality, while SolidWorks and Altium Designer were employed for mechanical enclosure design and PCB layout, respectively, ensuring structural integrity, precise component placement, and adherence to industry standards. This project highlights a systematic approach to circuit development, combining hardware design, simulation, and practical implementation for a functional and user-friendly audio voiceover system.

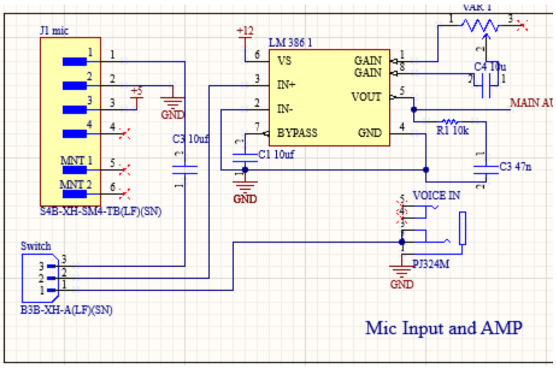
2 Functional Block Diagram and Functionality



The integrated circuit consists of six primary functional blocks that are interconnected to ensure stable and high-quality audio output.

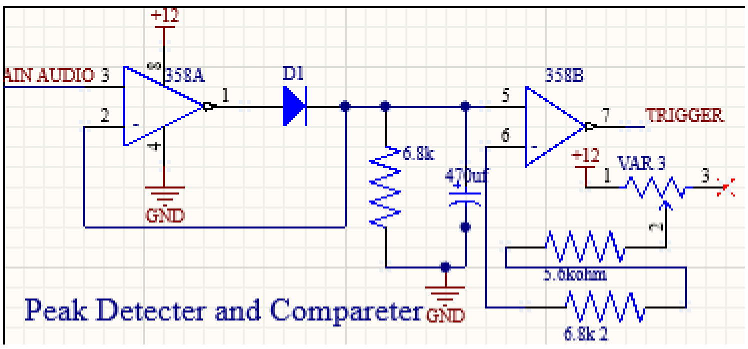


2.1 Mic/Audio Pre-Amplifier



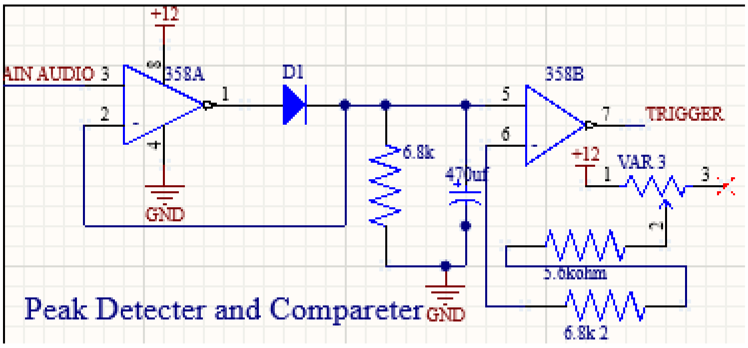
The preamplifier circuit is designed to amplify the audio signal from the microphone or audio input to a level suitable for detection by the peak detector circuit. An LM386N audio amplifier is used due to its reliability and suitability for low-power audio applications. The LM386 operates from a +12 V supply, with a bypass capacitor connected to the supply pin to reduce noise and improve stability. A capacitor is connected between pins 1 and 8 of the LM386 to increase the amplifier gain. Additional capacitors and resistors are used to control the bandwidth and ensure stable operation of the amplifier. An output capacitor is included to stabilize the output signal and block DC components, while a series resistor limits current flow and defines the load impedance. Together, these components ensure clean, stable, and sufficient amplification of the input audio signal for subsequent processing stages.

2.2 Peak Detector



The peak detector circuit was implemented using an LM358 single-supply operational amplifier together with a diode, resistor, and capacitor to detect the peak amplitude of the input audio signal and convert it into a DC voltage. The input audio signal is applied to the LM358, and the output is rectified using a diode, which charges the capacitor to the peak value of the signal. The capacitor holds this peak voltage, while the diode prevents the stored charge from flowing back into the operational amplifier. A resistor connected across the capacitor provides a discharge path, allowing the capacitor voltage to decrease gradually when the input signal level drops. The voltage across the capacitor therefore represents the peak level of the input audio signal and is used for further control and processing within the circuit.

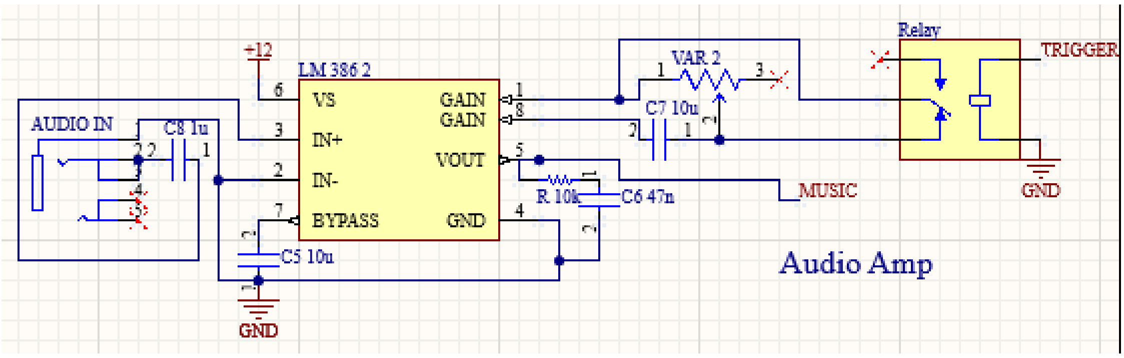
2.3 Comparator



A comparator circuit was implemented using the LM358 opamp to determine the presence of an input signal by comparing the output of the peak detector with a reference voltage. The comparator reference level was set around 6 V using a voltage divider formed by two 6.8 kΩ resistors and a 1 kΩ variable resistor. Under normal conditions with no input signal, the peak detector output remains at approximately 6 V. When an input signal is present, the peak detector output rises above this level, allowing the comparator to distinguish between the two states. The inclusion of the variable resistor allows fine adjustment of the reference voltage to

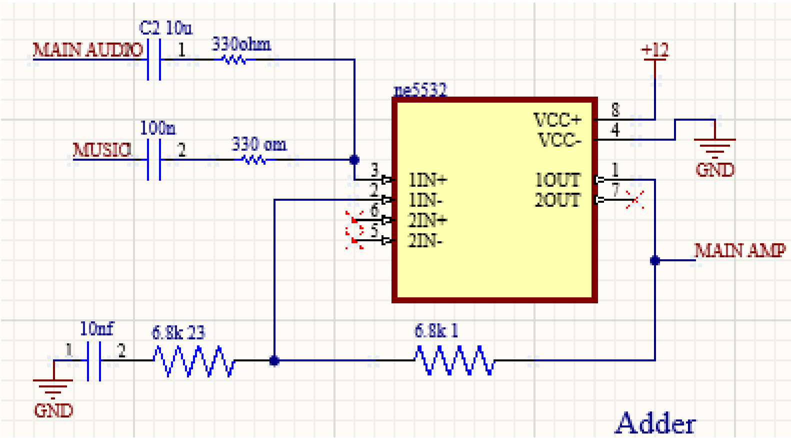
account for non-ideal components and practical variations, ensuring reliable operation. Based on the comparison, the comparator output switches to 12 V when an input is detected and drops to 0 V when no input signal is present. This output voltage is used to operate the 12V relay.

2.4 Music Amplifier



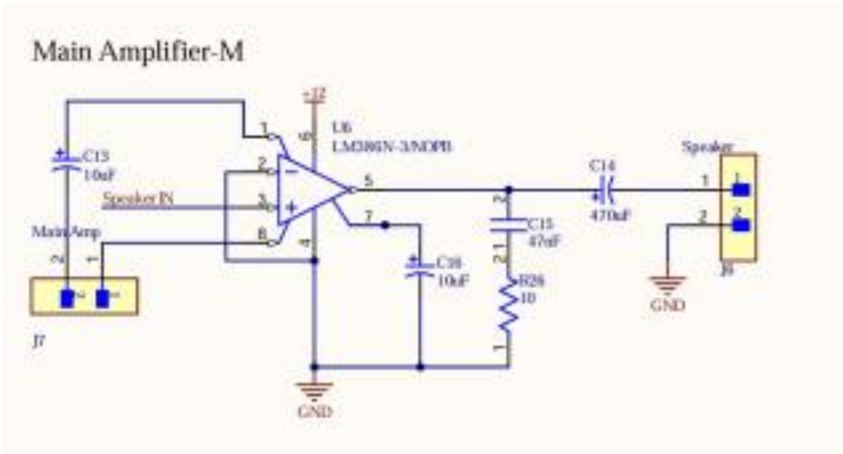
The background music amplifier was implemented using an LM386 audio operational amplifier, with its gain controlled through a mechanical relay. The gain of the LM386 is set by a capacitor and a resistor connected between pins 1 and 8. Under normal conditions, when no input signal is detected, the resistor remains connected between these pins, resulting in maximum amplifier gain and allowing the background music to play at a higher volume. When an input signal is present, the relay is activated, causing the resistor to be short-circuited. This reduces the effective resistance between pins 1 and 8, thereby lowering the gain of the LM386 and reducing the background music level. This arrangement enables automatic attenuation of the background music whenever an input signal is detected.

2.5 Adder Circuit



The adder circuit is used to combine the pre-amped microphone or audio signal with the preamped background music signal into a single output. DC coupling capacitors are placed at the inputs to remove any DC offset present in the audio signals, ensuring that only the AC audio components are summed. The signals are then added using a NE5532 single-supply operational amplifier configured for unity gain, so the combined output maintains the original signal levels without additional amplification. This circuit allows the microphone or audio input and the background music to be mixed cleanly and efficiently before being passed to the next stage.

2.6 Main Amplifier



The output of the adder circuit is fed into an LM386 audio amplifier to further increase the signal level and drive the speaker effectively. In this stage, the LM386 is configured with its default gain of 20 by leaving the gain control pins (pins 1 and 8) unconnected. This configuration provides sufficient amplification to produce clear, smooth, and pleasant audio at the speaker output without introducing unnecessary complexity. The amplifier ensures that the combined audio signal from the adder circuit is delivered at an appropriate power level for audible playback.

3 Component Selection and Justification

3.1 LM386N Audio Amplifier IC

• Low Power Consumption
The LM386N functions effectively with minimal power consumption, making it suitable for battery operated or portable applications. It operates within a power supply range of 4V to 12V, providing flexi ability in low-voltage configurations.

• Easy gain control
The LM386N allows easy gain modification, typically ranging from 20 to 200, without the requirement for external feedback networks. Introducing just one capacitor/resistor, between pins 1 and 8 enhances the gain, allowing for significant customization to meet various audio amplification requirements.

• High Output Power
Despite its small dimensions, the LM386N is capable of delivering an output power of up to 0.7W,adequate for small to medium-sized audio devices such as headphones, compact speakers, or intercomsystems.

• Low Quiescent current
The IC has a low quiescent current of 4mA (typical),meaning it consumes very little power when there is no input signal. This is essential for devices that need to conserve power during idle times.

• Built in protection
The LM386N includes features like internal thermal shutdown and short-circuit protection. Thismakes it robust and durable in consumer electronics,preventing damage from overcurrent or overheating conditions.

3.2 NE5532P Dual Op-Amp IC

• Low Noise Performance
The NE5532P offers exceptionally low noise performance, making it suitable for high-fidelity audio applications. It preserves clarity in the enhanced signal by reducing background noise and hum, which is essential for audio systems such as preamplifiers, mixers, and audio processing devices.

• Low Staturation Voltage
The saturation voltage of the 2N3904 is rather low,approximately 0.2V. This indicates that while the transistor is ”on” (in saturation), it has a minimal voltage drop across the collector-emitter junction,hence reducing power loss and facilitating efficient switching.

• Low power consumption
The 2N3904, with a collector current capacity of up to 200 mA and a maximum power dissipation of 625 mW, is well suited for low-power switching applications such as controlling small relays, LEDs, buzzers, and other low-current loads, while maintaining efficient operation and minimal power loss.

3.3 LM358 Dual Op-Amp IC

• **Dual Operational Amplifier in a Single Package**
The LM358 contains two independent, high-gain operational amplifiers in a single IC, making it suitable for compact circuit designs such as peak detectors and comparator circuits. Its versatility allows simultaneous processing of multiple signals with minimal component count.

• **Single-Supply Operation**
The LM358 can operate from a single supply voltage (typically 3V to 32V), which simplifies circuit design by eliminating the need for dual power rails. This feature is particularly useful in low-power audio applications and portable electronics.

• **Low Input Bias and Offset Voltage**
The IC has a low input bias current and offset voltage, enabling accurate signal detection and comparison in sensitive applications like peak detection, ensuring the output voltage closely follows the intended input signal characteristics.

• **Low Power Consumption**
With minimal quiescent current, the LM358 is efficient for continuous operation in battery-powered and low-power circuits. Its low power dissipation ensures stable operation in both audio amplification and signal-processing applications.

• **Wide Input Voltage Range**
The input voltage can include the negative rail (ground in single-supply mode), allowing it to detect signals close to 0V, which is ideal for audio signals and peak detection in single-supply configurations.

3.4 12V mechanical Relay

• High current and voltage handling

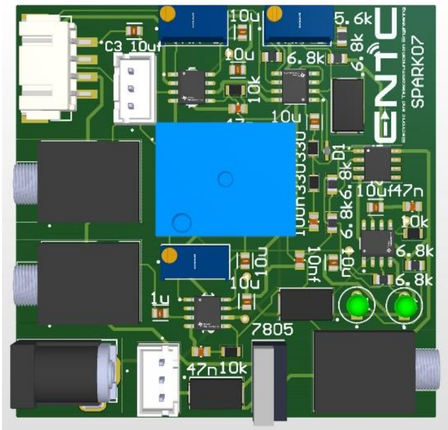
Relays are capable of switching larger currents and voltages compared to solid-state devices such as transistors or MOSFETs. In an audio circuit, this is crucial for controlling greater loads, such as speakers, amplifiers, or various audio sources, without jeopardizing the functionality of the switching components.

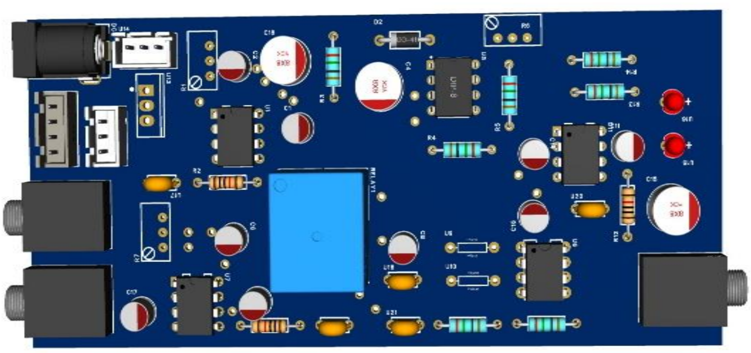
• Minimal signal distortion
Mechanical relays, in contrast to certain semiconductor-based switches, do not induce distortion or interference in the signal pathway. This is vital in audio applications where preserving flawless high-quality sound is crucial. The relay’s contacts either fully engage or disengage the audio signal without alteration.

3.5 other components

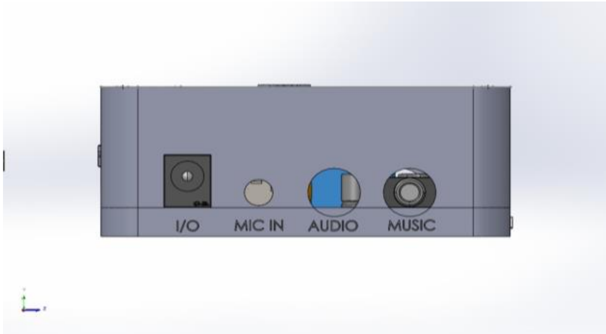
1N4148 | 7805 Voltage Regulator | speaker

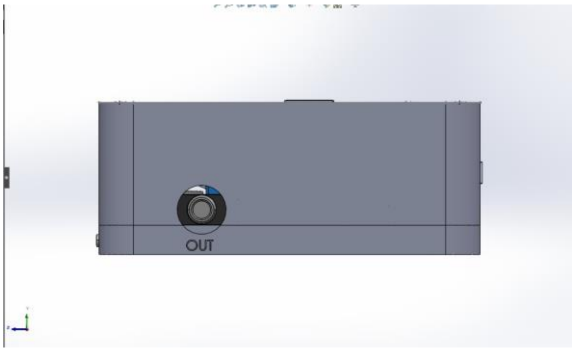
4 PCB Design





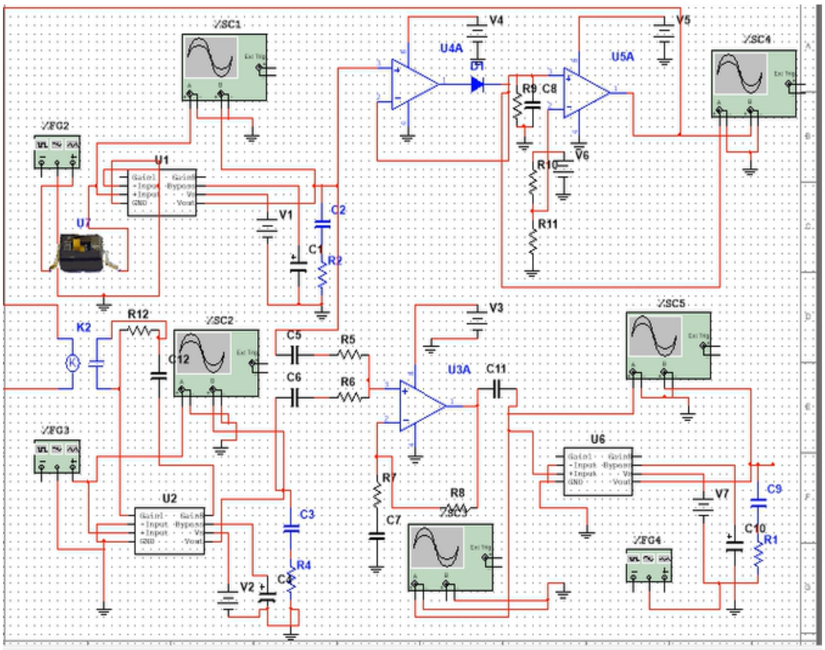
5 Enclosure Design



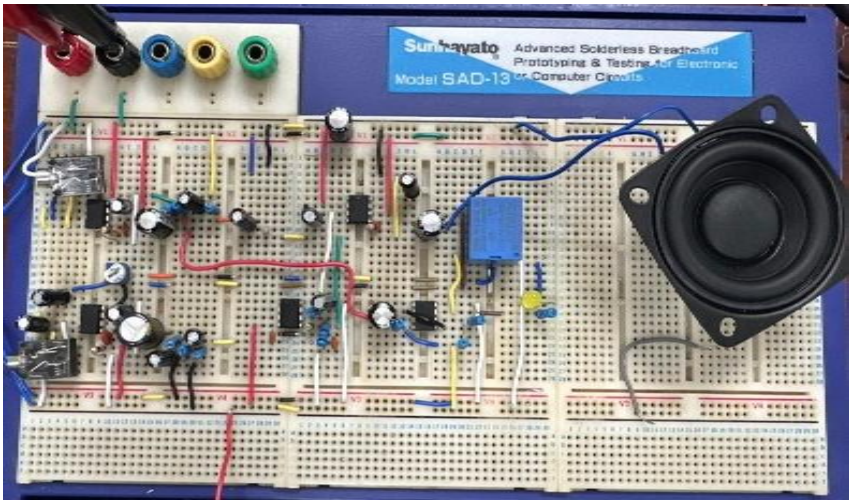


6 Software Simulation and Hardware Testing

6.1Multisim Simulation



6.2 Hardware Testing



7 Bill of Materials

Components for Breadboard Implementation	LKR 3200.00
SMD	LKR 4650.00
PCB	LKR 5650.00
Enclosure	LKR 2970.00
TOTAL	**LKR 16470.00**

8 Conclusion and Future Works

The analog voice-over circuit was constructed using discrete analog components and operates reliably, effectively detecting the input signals and switching channels as intended. Future enhancements to the system will include:

• **Volume control for inputs** – Adding volume control knobs for both the background music and microphone/audio inputs to allow users to adjust audio levels for an improved listening experience.
• **More channels with priority system** – Expanding the system to include additional channels and implementing a priority mechanism to efficiently manage and route multiple signals.
• **Battery integration –** Incorporating batteries into the power circuit to enhance portability and ensure reliable operation in situations without direct mains power.

These improvements will enhance the overall performance, adaptability, and user experience of the voice-over system

9 Contribution of Group Members

Member	Contribution
Balasooriya B.R.B.D 230070T	• Main circuit design, approach, and testing • PCB design(Altium) • PCB soldering
Gunasekara K.S 230211E	• PCB design(Altium) • Multisim simulation • Documentation
Munasinghe A.I 230417P	• Main circuit design, approach, and testing • Documentation
Ubeysekara V.T.T 230650X	• Enclosure design(Solidworks) • Presentation
Testing and validation shared by all members	

Table 1: Individual Contributions

References

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