

The background features a dark gray field with intricate white circuit traces on the left side, extending towards the center. A large, light gray sphere is positioned in the upper left quadrant, partially obscured by the circuit lines. The overall aesthetic is technical and futuristic.

Analog Voice Over Circuit

Dynamic Audio Ducking for Clear
Speech Transmission

Team: Spark 07

Group: 230650X, 230417P, 230070T, 230211E

Project Motivation & Core Objectives



Automatic Attenuation

Instantaneous music gain reduction upon voice detection.



Clarity and Fidelity

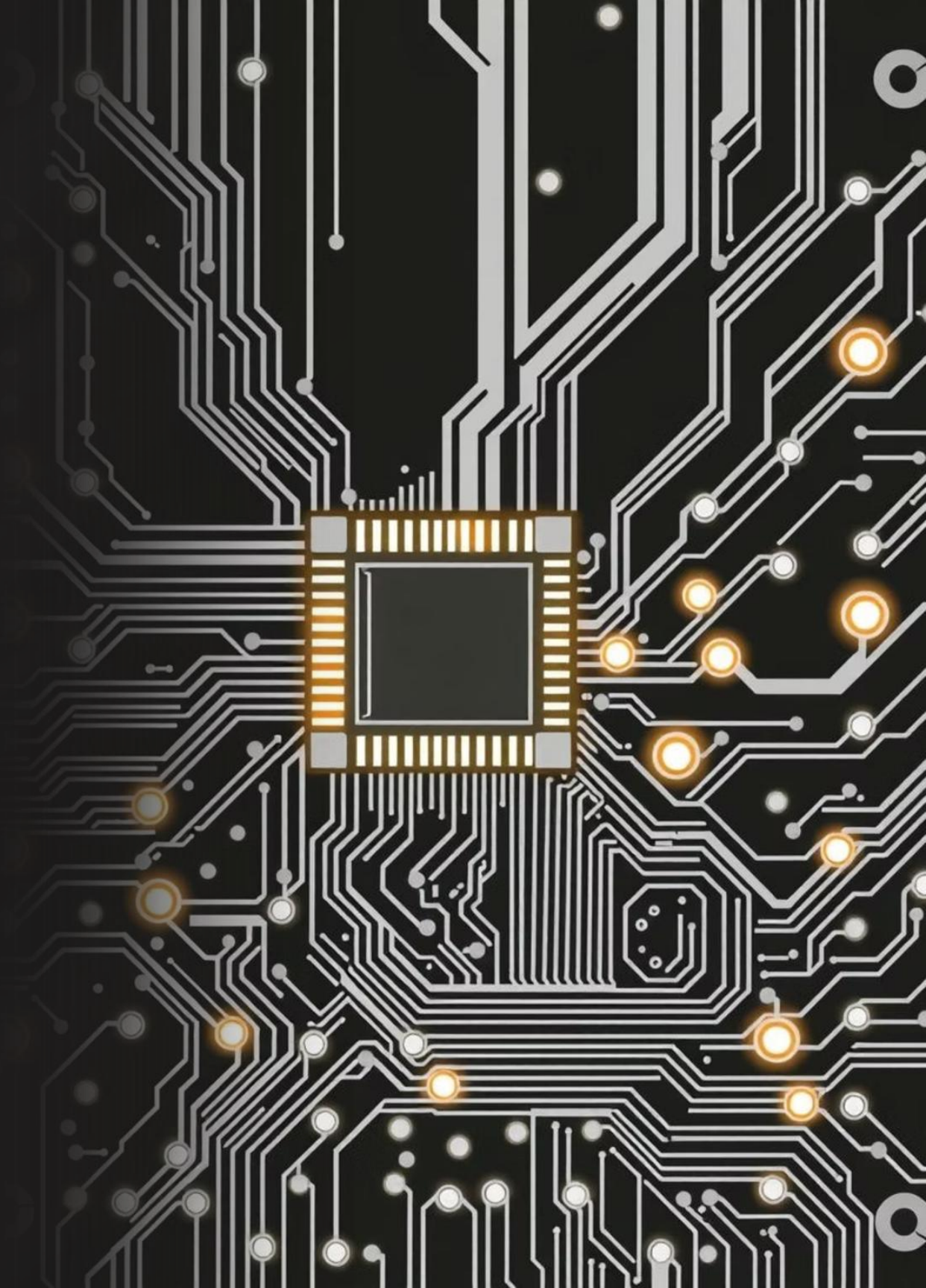
Maintain high audio quality for both voice and music signals.



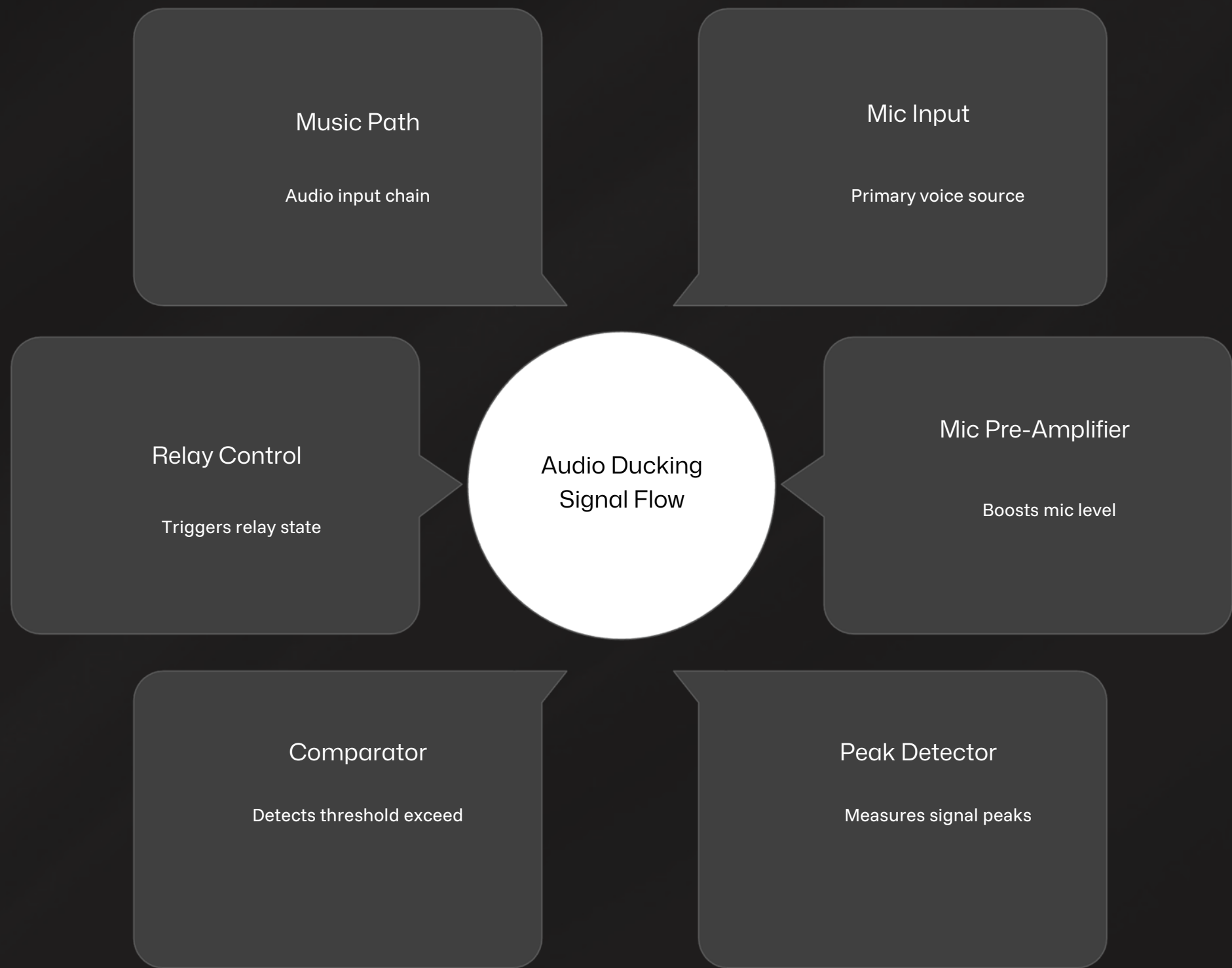
Single-Supply Efficiency

Operate reliably using only 12V and ground for simplified integration.

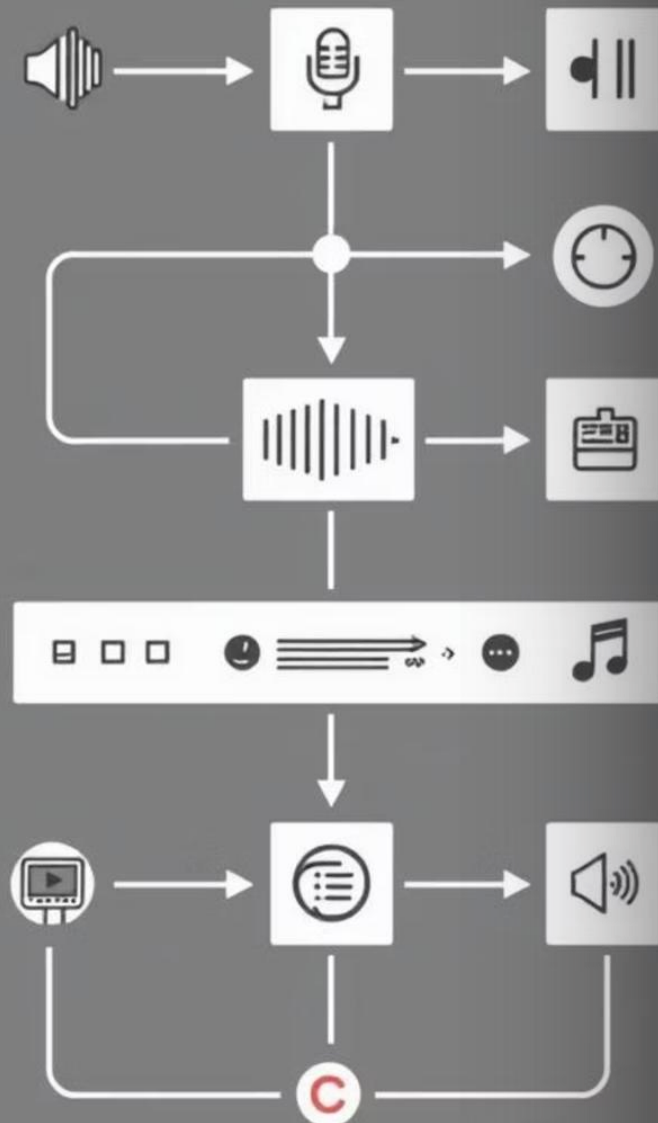
Analog ducking provides a low-latency, power-efficient alternative to complex digital processors, ensuring **clear speech transmission** with **real-time gain control**.



System Architecture: Block Diagram



Functional System Overview and Signal Flow



Voice Path

Mic In → Pre-Amplifier → Peak Detector → Comparator



Music Path

Audio In → Pre-Amplifier → Relay Circuit



Combined Output

Adder → Main Amplifier → Output

The **peak detector** converts the voice signal to a DC peak. If this crosses the threshold, the **comparator** activates the **relay**, which attenuates the music signal by switching a parallel resistor into the music channel's feedback loop.

Op-Amp Selection for Performance

Choosing the right operational amplifiers was crucial for balancing single-supply compatibility with low noise and distortion requirements.



LM358 Dual Op-Amp

Used in the **peak detector** and **comparator** stages. Reliable single-supply (12V) operation for control circuits.



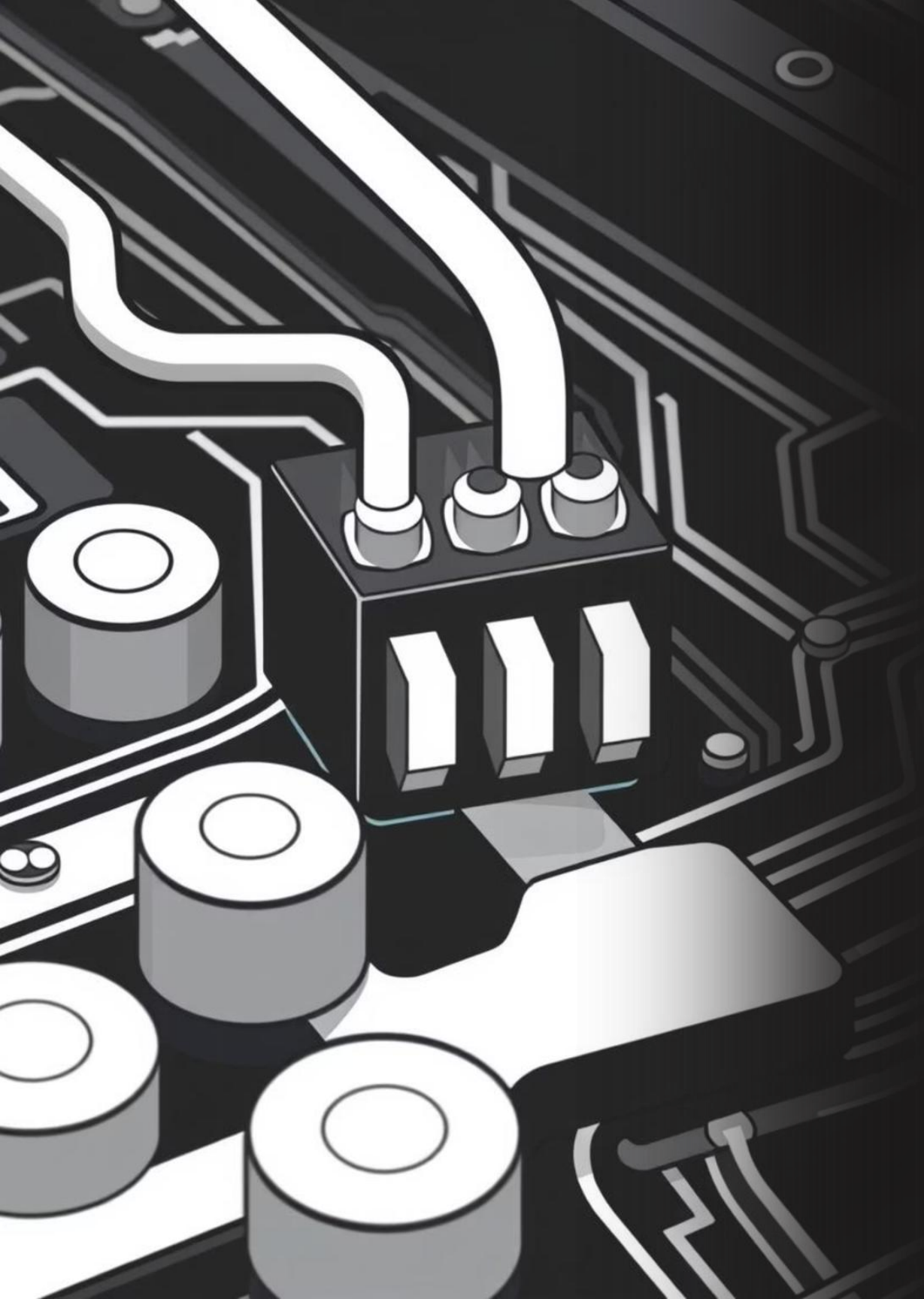
LM386 Low Noise Op-Amp

Dedicated to **microphone signal amplification**. Provides excellent low-noise performance and stable gain.



NE5532 Audio Op-Amp

Used in the **output adder (mixer)** stage. Offers low THD and wide bandwidth for clean, high-fidelity mixing.



Key Circuit Stages & Principle of Operation

Peak Detection & Threshold

LM358 converts the mic AC signal to DC. Comparator triggers when this DC level exceeds a reference threshold, indicating speech presence.

Relay-Based Attenuation

Comparator output drives a transistor-based relay driver. The relay switches a parallel resistor, reducing music gain by ~20 dB upon voice detection.

High-Fidelity Mixing

The NE5532 adder sums the attenuated music and amplified voice signals, producing a balanced output that prioritizes voice clarity.

Prototype Validation and Future Scope

Achievements

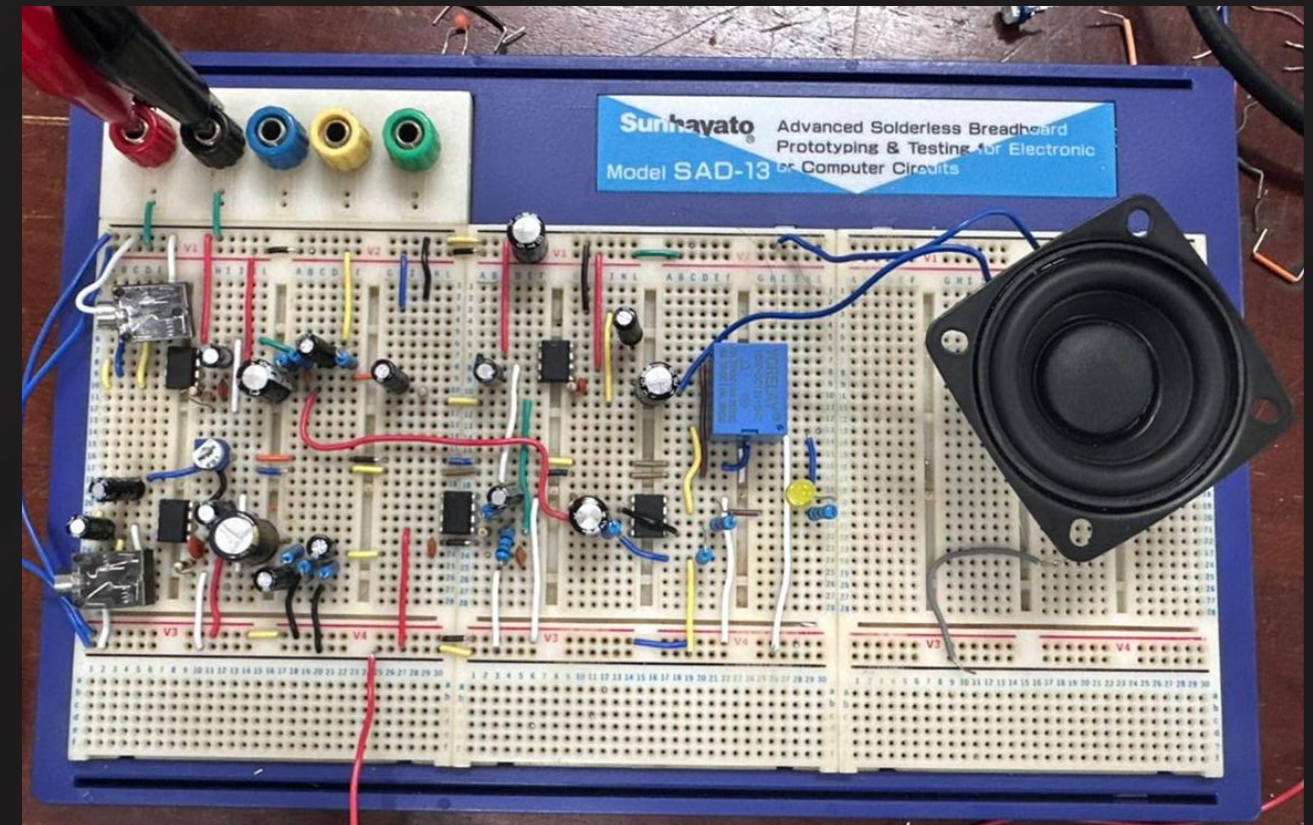
- Prototype validated the analog ducking concept.
- Achieved real-time music attenuation using single-supply 12V.
- Demonstrated clear voice prioritization over background audio.

Refinements (Future Work)

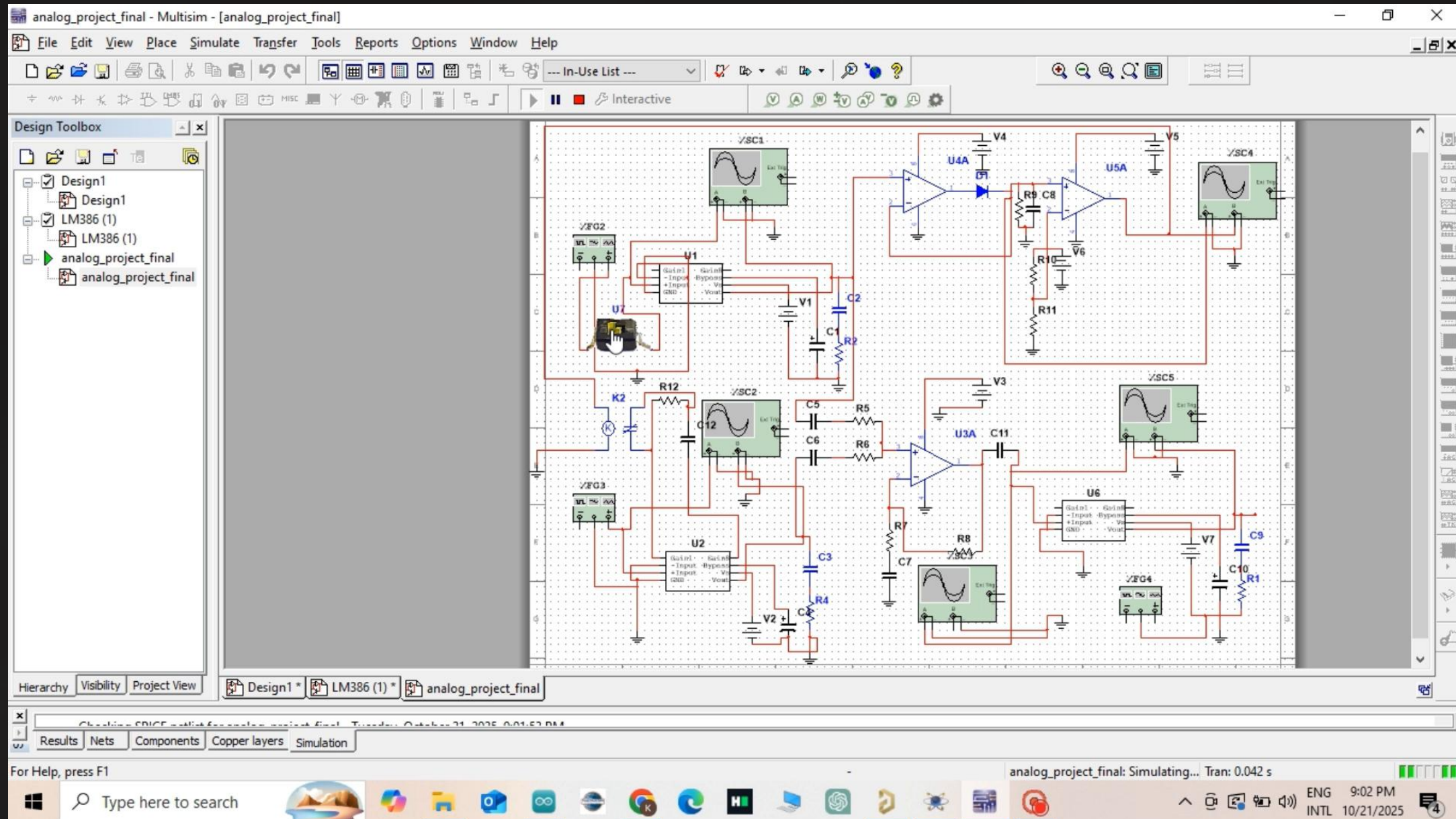
Solid-State Gain Control: Replace relay with VCA/FET for silent switching.

Advanced Thresholding: Add microcontroller for ambient noise monitoring and auto-adjustment.

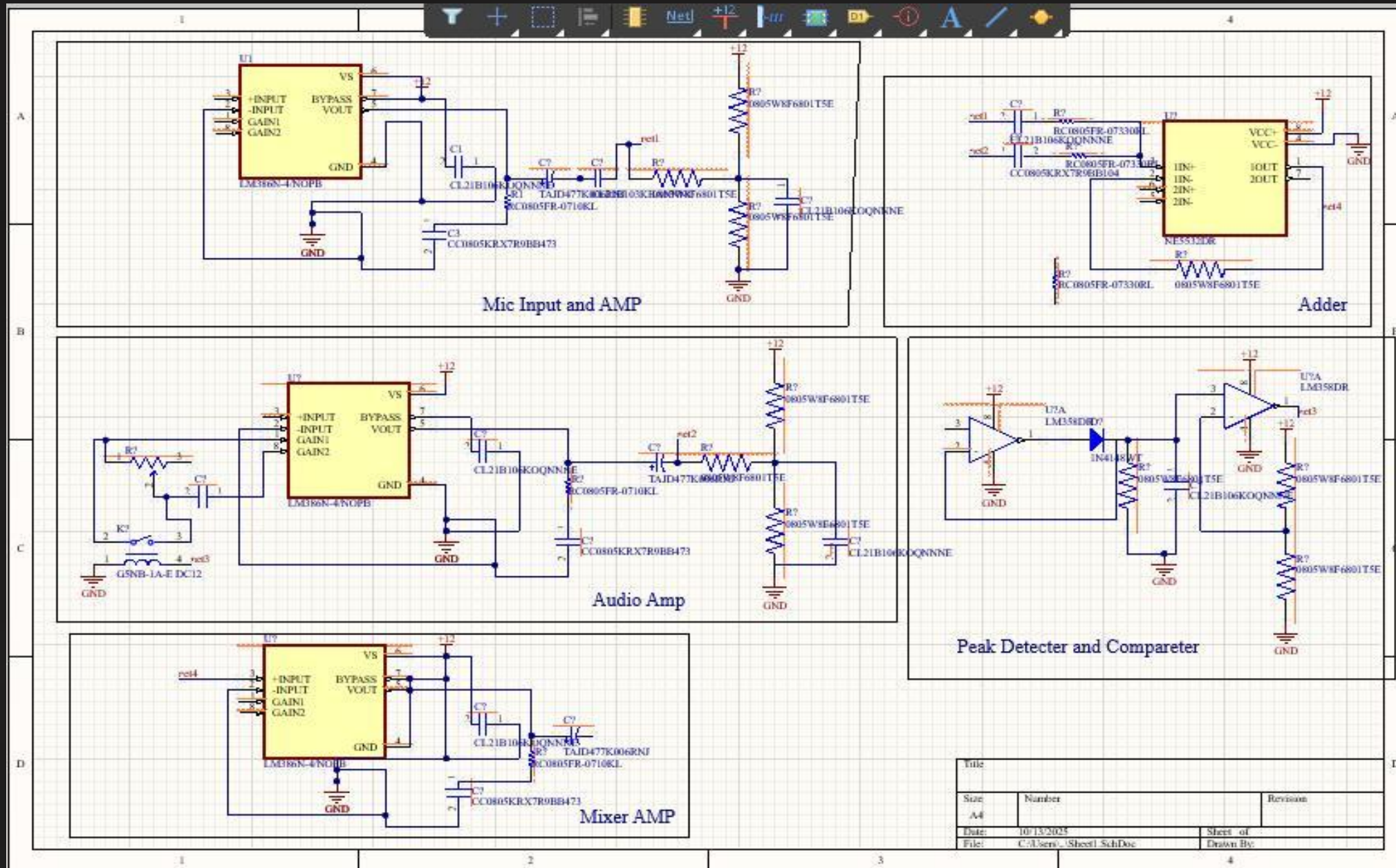
Professional Integration: Design a compact PCB with buffered I/O for PA systems.



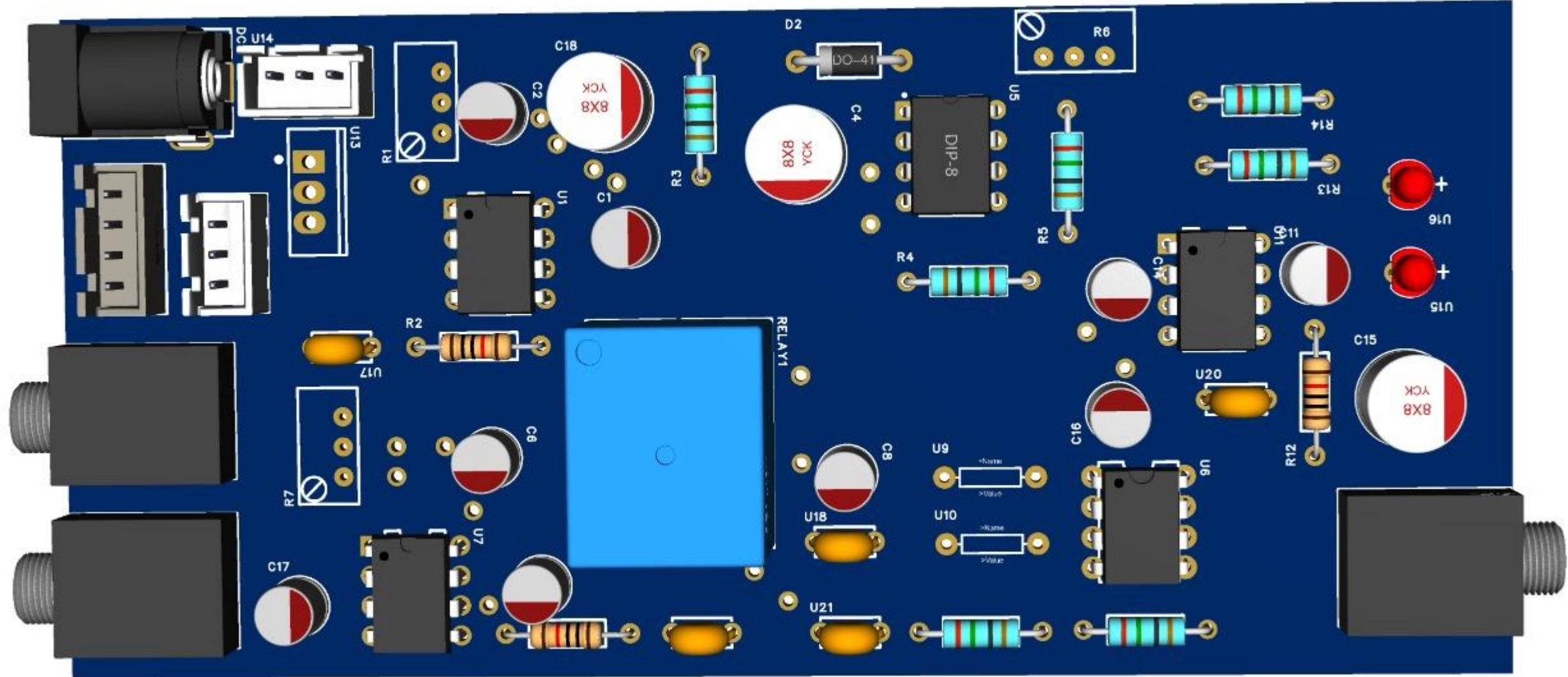
Simulation



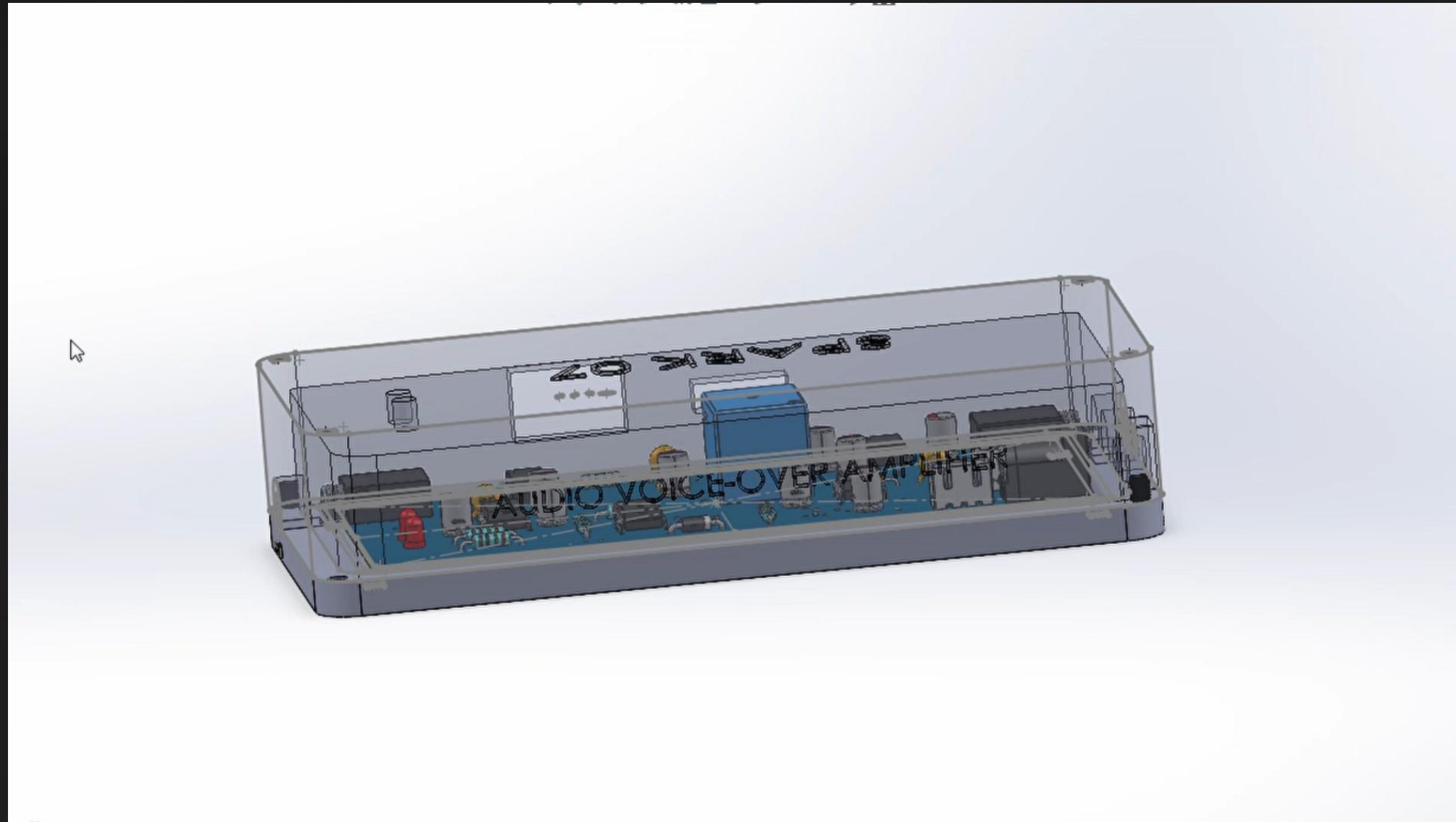
PCB Schematic



PCB



Product Design



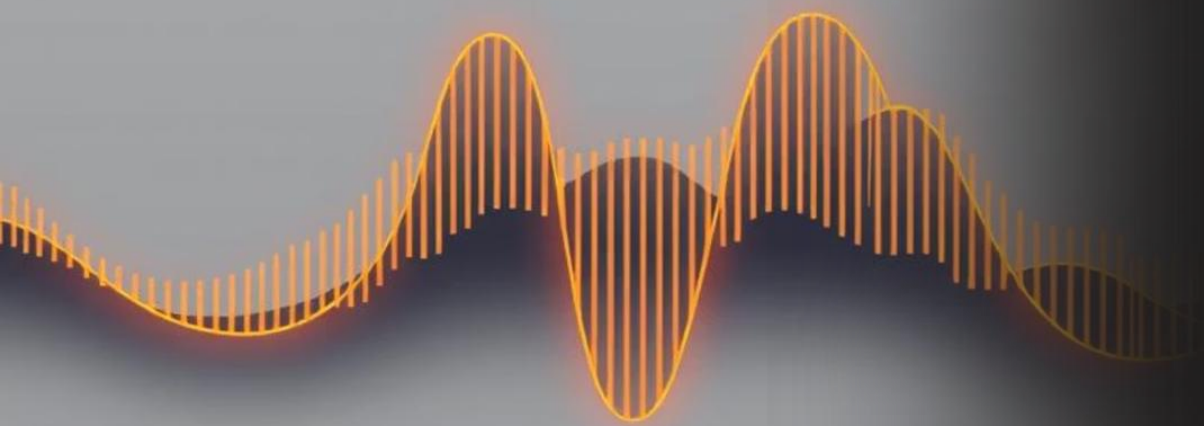
Task Allocation

Banula Balasooriya - PCB design , soldering, Amplifier circuit

Kavin Gunasekara - PCB design , Simulation

Thamindu Ubeysekara - Enclosure Design

Amiru Munasinghe - Circuit Design



Thank

You

Developed by Spark 07

Questions & Feedback Welcome