Department of Electronic & Telecommunication Engineering

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EN2160 - Electronic Design Realization

Final Project Report

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Abstract

The objective of this project was to create an innovative and marketable electronics product to meet the growing demands of consumers seeking an immersive audio experience. To achieve this goal, we designed and developed a cutting-edge electronic stereo amplifier with unique features tailored to existing consumer needs. The amplifier incorporates a versatile tone controller unit with adjustable bass, midrange, and treble settings, providing users with precise control over their audio preferences.

In addition to the stereo amplifier, we integrated a dedicated subwoofer amplifier, enhancing the system's audio performance and delivering powerful bass reproduction. To add a captivating dimension to the audio experience, we implemented a dynamic sound reactive system that synchronizes visually stunning effects with the audio output, further elevating the user's immersion.

Parallel to the design and production phases, we devised a comprehensive marketing plan, centered around a customer-centric marketing survey. The insights gained from the survey enabled us to understand the target audience better and refine the product's features and marketing strategies accordingly. Leveraging these insights, we crafted multiple strategic marketing initiatives, positioning the product as a premium choice in the competitive market.

Furthermore, we established a new company name to launch the product, leveraging the opportunity to build brand recognition from the ground up. Meticulous attention was given to the mass-scale manufacturing process, ensuring efficient sourcing of essential components, optimizing PCB design for reliability and performance, and ensuring precision in enclosure manufacturing and packaging.

The culmination of these efforts is an innovative stereo amplifier that delivers an unparalleled audio experience, setting new standards in the audio electronics market. With its distinctive features, excellent audio performance, and captivating sound-reactive visual effects, the product stands poised to captivate consumers and secure a significant market share. This project exemplifies successful integration of cutting-edge technology, customer-centric marketing, and meticulous manufacturing, resulting in a standout product ready for commercial success.

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1 Introduction

1.1 Background and Motivation

In the realm of audio systems, amplifiers play a pivotal role in elevating the quality and depth of sound reproduction. Recognizing the ever-increasing demand for superior audio experiences, we embarked on a journey to create a comprehensive Amplifier product design that surpasses conventional boundaries. The inspiration behind this endeavor stems from a passion for audio engineering and a desire to enrich people's lives through exceptional sound performance.

The market landscape is replete with various audio amplifiers, each catering to specific needs. However, we identified an opportunity to introduce a revolutionary product that amalgamates advanced features with user-centric customization, delivering an unmatched listening encounter for consumers. Our mission was to conceive an amplifier that embraces cutting-edge technologies while remaining intuitive and accessible to users of all levels of expertise.

1.2 Objectives of the Project

At the heart of our Amplifier product design, our primary objective was to create a marketable electronics product with novel features, catering to existing consumer needs. To achieve this, we established the following key objectives:

- **Innovative Stereo Amplifier**: Develop a stereo amplifier that goes beyond conventional designs by incorporating a versatile tone controller unit. This unit allows users to finely adjust bass, midrange, and treble settings, providing them with complete control over their audio preferences.
- **Enhanced Audio Performance**: Integrate a dedicated subwoofer amplifier to enrich the audio experience with powerful and impactful bass reproduction. By optimizing the subwoofer pre-amplifier, we sought to deliver deep and immersive low-frequency output.
- **Captivating Sound Reactive System**: Create an innovative sound-reactive system that syncs captivating visual effects with the audio output. This dynamic integration aims to create a multisensory experience, captivating users through the seamless fusion of audio and visual elements.
- **Customer-Centric Marketing**: Craft a comprehensive marketing plan alongside the design and production phases. Leveraging customer-centric marketing surveys, we aimed to gather valuable insights, ensuring that the final product is tailored to the preferences and desires of the target audience.
- **Meticulous Manufacturing**: Pay meticulous attention to all aspects of mass-scale manufacturing, including sourcing essential components, optimizing PCB design for reliability and performance, and ensuring precision in enclosure manufacturing and packaging.

1.3 Importance and Applications

The comprehensive Amplifier product design we have created holds paramount importance in the audio electronics market for several reasons.

- **Audio Enthusiasts**: Audio enthusiasts seeking unparalleled sound quality and customization options will find the innovative tone controller, subwoofer amplifier, and sound-reactive system to be transformative additions to their audio setups.

- **Home Entertainment Systems**: Our Amplifier product design caters to home entertainment systems, elevating the audio experience for movies, music, gaming, and other multimedia content.
- **Public Address Systems**: The versatile tone controls and enhanced bass capabilities make our amplifier ideal for professional audio setups, such as public address systems in event venues, auditoriums, and conference rooms.
- **Nightclubs and Bars**: The captivating sound-reactive system brings an immersive and visually engaging element to nightclub and bar environments, enhancing the overall ambiance and entertainment value.

2 Project Overview

2.1 Block Diagram

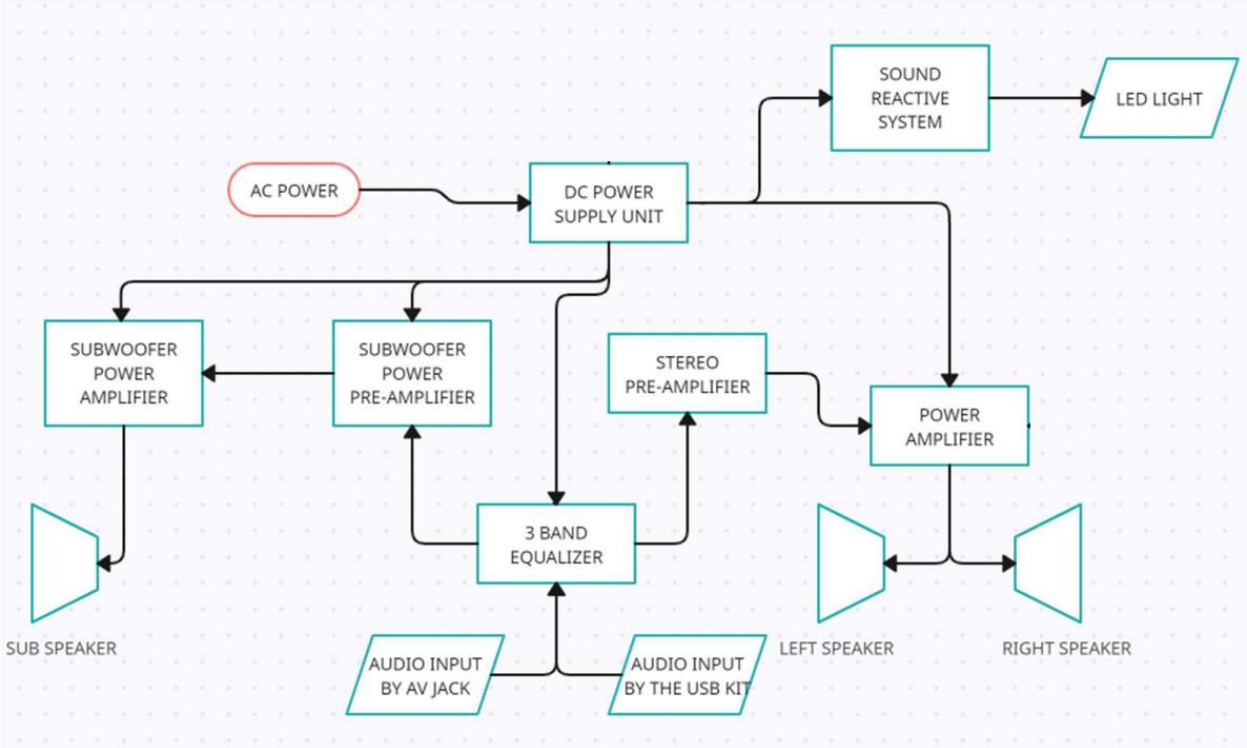


Figure 1: The Block Diagram

2.2 Functionality

2.2.1 Power Supply Unit

The Power Supply Unit (PSU) is a critical component of the amplifier system, responsible for converting incoming AC power from two transformers into stable and regulated DC voltages suitable for powering various subsystems. In this design, the PSU receives power from two transformers: a 12V-0-12V/1A dual supply transformer and a 24V-0-24V/5A dual supply transformer. The PSU generates two main output voltages: 12V-0-12V DC dual supply and 24V-0-24V DC dual supply. These output voltages cater to the different voltage requirements of the amplifier system.

- **Dual Supply Transformers**
  - The Power Supply Unit receives input power from two transformers to accommodate the different voltage needs of the amplifier's components.
  - The 12V-0-12V/1A dual supply transformer provides a lower voltage output suitable for powering the USB kit, preamplifiers, and the sound reactive system.
  - The 24V-0-24V/5A dual supply transformer supplies higher voltage and current capacity to meet the power demands of the power amplifiers.
- **Output Voltages**
  - The Power Supply Unit generates two main output voltages: 12V-0-12V and 24V-0-24V DC dual supplies.
  - The 12V-0-12V dual supply is dedicated to powering the USB kit, preamplifiers, and the sound reactive system. It provides a stable power source for processing audio signals and driving visual effects.
  - The 24V-0-24V dual supply is designed to power the power amplifiers, delivering the necessary power to amplify the audio signals and drive the speakers with ample power.
- **Power Distribution**
  - The PSU efficiently distributes the appropriate DC voltage to each subsystem within the amplifier system.
  - It ensures that the USB kit, preamplifiers, and sound reactive system receive the 12V-0-12V dual supply, providing them with the necessary power for processing audio and visual effects.
  - The power amplifiers are supplied with the required 24V-0-24V dual supply, empowering them to amplify the audio signals and drive the speakers with sufficient power.
- **Regulation and Stability**
  - The Power Supply Unit incorporates voltage regulators and filtering components to maintain stable and regulated output voltages.
  - This regulation helps prevent voltage fluctuations and noise, ensuring consistent and clean power for the sensitive audio and visual components.
- **Overload and Short Circuit Protection**
  - The PSU features built-in overload and short circuit protection mechanisms to safeguard the amplifier system from potential damage caused by excessive current or faults.
  - These protection features enhance the safety and reliability of the amplifier system during operation.
- **Efficient Heat Dissipation**
  - The Power Supply Unit is equipped with heat sinks and efficient ventilation to dissipate excess heat generated during operation.
  - This ensures that the PSU operates efficiently and within safe temperature limits, promoting longevity and reliable performance.

2.2.2 Preamplifiers

The preamplifier is a crucial component in the overall amplifier system, responsible for receiving and processing audio signals before amplification. In this design, the preamplifier is divided into two parts: the Stereo Preamplifier and the Subwoofer Preamplifier. Both preamplifiers receive inputs from various sources, including a USB kit with USB 2.0, Bluetooth, and FM radio options, as well as Left and Right AV ports. The stereo preamplifier processes the stereo audio signals, while the subwoofer preamplifier handles the subwoofer channel output.

i. Stereo Preamplifier

The Stereo Preamplifier has two main functions: processing stereo audio signals and providing tone controls for bass, midrange, and treble.

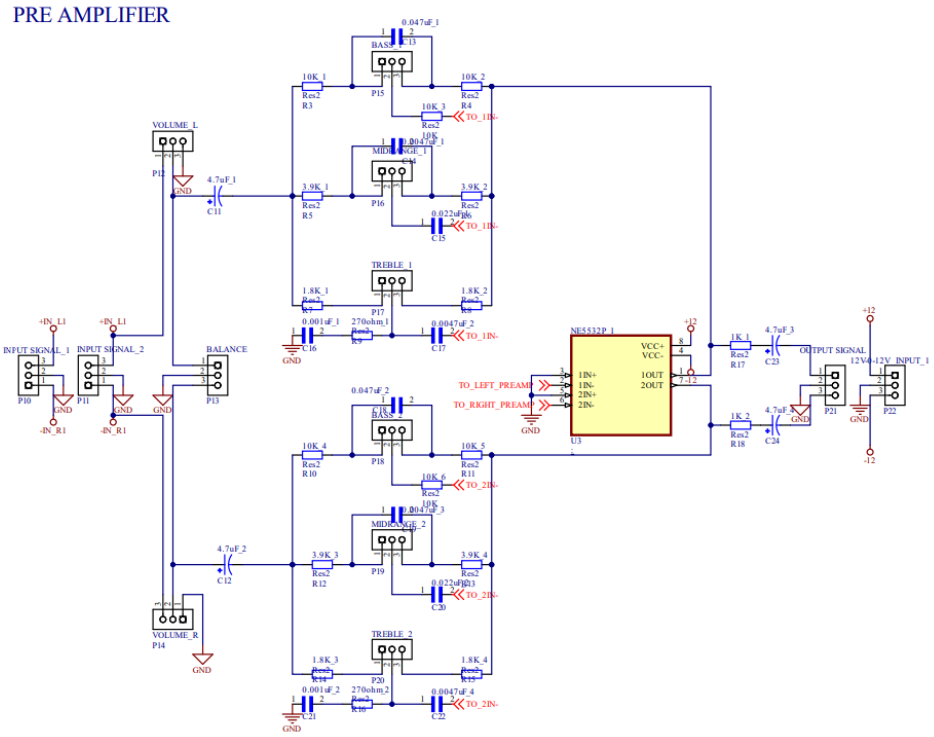


Figure 2: Stereo Pre Amplifier

- **Signal Processing**
  - The stereo preamplifier receives stereo audio signals from the USB kit and AV ports. The USB kit supports USB 2.0, Bluetooth, and FM radio input methods, ensuring versatile connectivity options.
  - Each channel of the stereo preamplifier processes the respective left and right audio signals independently, maintaining stereo separation.
  - The preamplifier operates on a dual supply voltage of 12V-0-12V DC to ensure stable and reliable performance.
- **Tone Controls**
  - The stereo preamplifier features tone controls for bass, midrange, and treble to tailor the audio output according to user preferences.
  - The bass control includes a low-pass filter to emphasize lower frequencies, enhancing the depth and richness of the bass response.
  - The midrange control incorporates a bandpass filter to adjust the prominence of vocals and mid-frequency instruments, achieving a balanced and clear sound.
  - The treble control features a high-pass filter to accentuate higher frequencies, adding brilliance and crispness to the audio output.
- **Volume and Balance Control**
  - The preamplifier includes a volume controller to regulate the overall audio output level, allowing users to adjust the sound to their desired volume.

- The balance controller enables users to control the balance between the left and right stereo inputs, ensuring a centered and balanced audio image.

ii. Subwoofer Preamplifier

The Subwoofer Preamplifier focuses on processing low-frequency audio signals for the subwoofer channel.

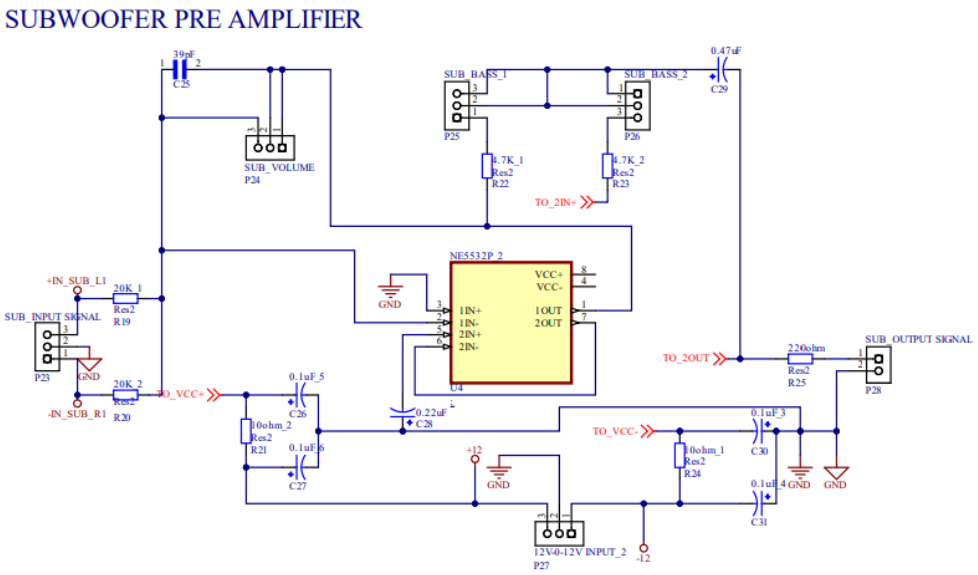


Figure 3: Subwoofer Pre Amplifier

- **Signal Processing**
  - The subwoofer preamplifier receives the subwoofer channel output from the stereo preamplifier, which consists of the low-frequency audio signals.
  - It operates on the same dual supply voltage of 12V-0-12V DC for consistency in the system.
- **Bass Control**
  - The subwoofer preamplifier incorporates a bass control with a low-pass filter to emphasize and enhance the lower frequencies.
  - By adjusting the bass control, users can tailor the intensity and depth of the subwoofer's output, achieving powerful and impactful bass reproduction.
- **Volume Control**
  - The preamplifier includes a volume controller specific to the subwoofer channel, allowing users to adjust the subwoofer's output level to match their preferences and the listening environment.

iii. Active Filters using NE5532 Op-Amps

Both the stereo and subwoofer preamplifiers implement active filters using NE5532 operational amplifiers, resistors, and capacitors. This design choice ensures precise filtering and accurate frequency response, contributing to the overall audio quality.

iv. The Needs of a Preamplifier

- **Amplifying**: The preamplifier's primary function is to amplify weak audio signals to a level suitable for further processing and amplification by power amplifiers.
- **Equalizing**: Tone controls in the preamplifier enable users to adjust the frequency response of the audio, ensuring a balanced and customized audio experience.

2.2.3 Power Amplifier

The Power Amplifier is a crucial component of the amplifier system, responsible for boosting the low-power audio signals received from the preamplifiers to higher power levels suitable for driving speakers and delivering an enhanced audio experience. In this design, the Power Amplifier is powered by a 24V-0-24V DC power supply and receives input signals from the stereo preamplifier and subwoofer preamplifier. The power amplifier consists of three channels, each capable of delivering a maximum power output of 125W. This class AB power amplifier utilizes complementary transistors, BD139 and BD140, for amplification, and further amplification is achieved using the transistors TIP142 and TIP147.1.

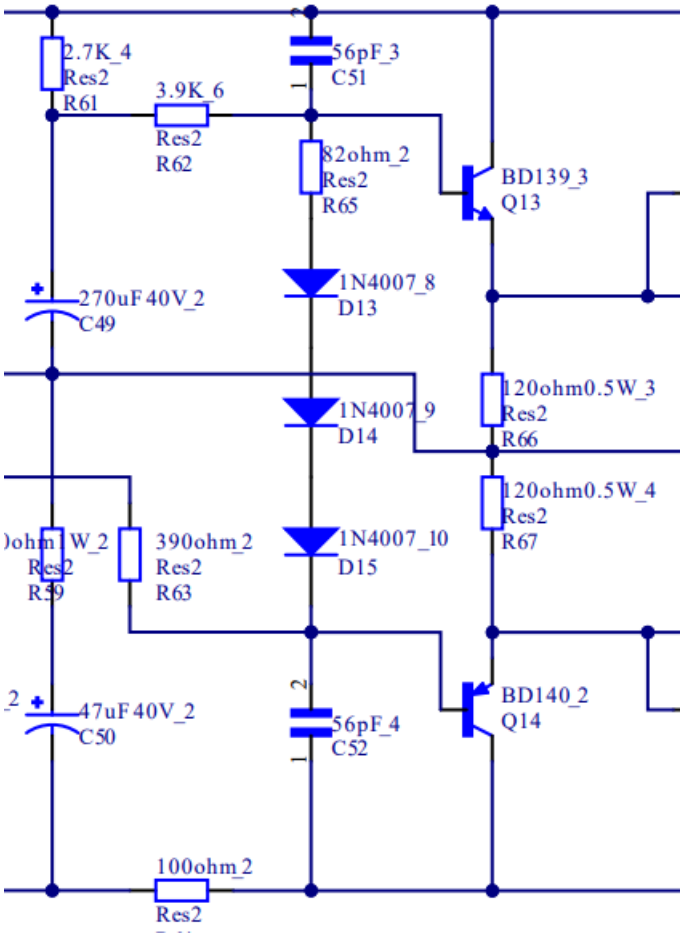


Figure 4: The Class AB Power Amplifier

- Power Amplification
  - The Power Amplifier takes the low-power audio signals received from the preamplifiers and amplifies them to higher power levels sufficient for driving speakers.
  - Each of the three channels in the power amplifier can deliver a maximum power output of 125W, providing ample power for an immersive audio experience.

- Class AB Amplification
  - The power amplifier operates in Class AB mode, which combines the efficiency of Class B amplifiers with the low distortion characteristics of Class A amplifiers.
  - Class AB amplifiers minimize crossover distortion by biasing the output transistors slightly on, ensuring a more linear amplification and reduced distortion.
- Complementary Transistors
  - The power amplifier utilizes complementary transistors BD139 and BD140, which are NPN and PNP types, respectively.
  - Complementary transistors provide a balanced and efficient amplification, ensuring low distortion and high fidelity audio output.
- Further Amplification
  - The amplified signal from the BD139 and BD140 transistors is further amplified using the TIP142 and TIP147 transistors.
  - The TIP142 and TIP147 are high-power NPN and PNP transistors, respectively, capable of handling the higher power demands of the audio signals.
- Importance of Class AB Amplifier

Class AB amplifiers offer several advantages over other amplifier classes (A, B, C, and D) that make them a preferred choice for audio applications.

  - Low Distortion Class AB amplifiers significantly reduce crossover distortion by biasing the output transistors close to their conducting point. This results in less distortion and improved audio fidelity compared to Class B or Class D amplifiers.
  - Higher Efficiency Class AB amplifiers are more power-efficient than Class A amplifiers. While they consume more power than Class D amplifiers at idle, they remain more efficient when operating at moderate power levels.
  - Ample Power Output Class AB amplifiers can deliver higher power output than Class A amplifiers, making them suitable for driving speakers in various audio setups, including home theater systems and sound reinforcement applications.
- Importance of a Power Amplifier
  - The Power Amplifier serves as the backbone of the audio system, responsible for converting low-power audio signals into high-power signals suitable for driving speakers. Its importance lies in the following aspects:
  - Signal Amplification The power amplifier significantly boosts the audio signals from the preamplifiers, ensuring sufficient power to drive the speakers and deliver an immersive audio experience.
  - Audio Fidelity A well-designed power amplifier, such as the class AB amplifier in this design, minimizes distortion and preserves the audio fidelity, ensuring accurate reproduction of the original sound.
  - Sound Reinforcement The power amplifier is vital for sound reinforcement applications, where it amplifies audio signals in large venues, ensuring clear and powerful sound projection.
  - Home Entertainment In home entertainment setups, the power amplifier enhances the audio quality, providing users with an enjoyable and engaging audio experience for movies, music, and gaming.

2.2.4 Sound Reactive System

The Sound Reactive System is an innovative addition to the amplifier design, enhancing the audio-visual experience for users. This system utilizes a condenser microphone to capture the amplitude of the output

sound waves and converts it into voltage, capable of driving a 12V light strip. The IRFZ44N MOSFET is employed for amplification, ensuring effective signal processing and synchronization with the audio output.

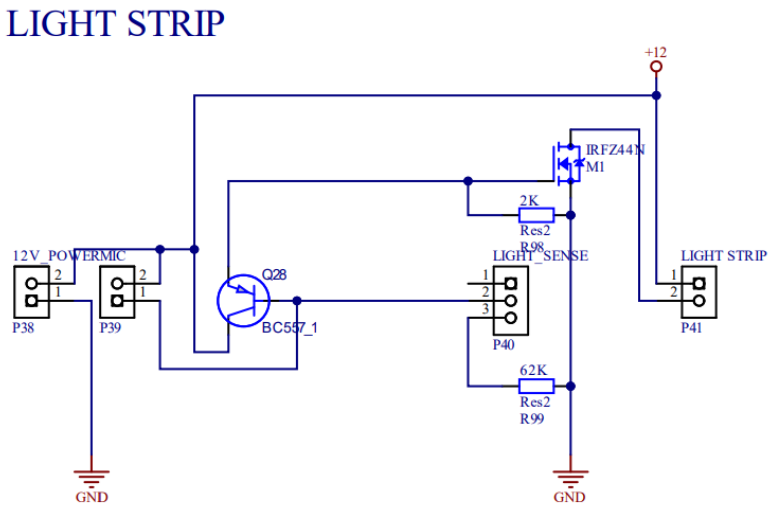


Figure 5: The Sound Reactive Circuit

- Audio Input Capture
  - The Sound Reactive System receives audio input through the condenser microphone. The microphone picks up sound waves from the surrounding environment, capturing the amplitude of the audio signals.
- Amplitude-to-Voltage Conversion
  - The system's circuitry performs amplitude-to-voltage conversion, translating the varying amplitudes of the sound waves into a corresponding voltage signal.
  - As the sound intensity changes, the voltage output also varies accordingly, providing a dynamic response to the audio input.
- Voltage Output
  - The Sound Reactive System generates voltage output up to 12V, suitable for driving external devices like a 12V light strip.
  - The voltage output reflects the real-time audio intensity, resulting in dynamic visual effects that synchronize with the audio output.
- Amplification using IRFZ44N MOSFET
  - The IRFZ44N MOSFET is utilized as an amplifier to ensure efficient signal processing and driving capability.
  - The MOSFET amplifies the voltage signal, enabling it to control the 12V light strip's illumination in response to the audio input.
- Visualizing Audio Output
  - Users can connect a 12V light strip to the Sound Reactive System's output terminals.
  - The light strip visually represents the audio output, illuminating in sync with the sound waves' amplitude, providing an engaging and captivating audio-visual experience.
- Real-time Synchronization
  - The Sound Reactive System's intelligent algorithms analyze the real-time audio input, detecting beats, intensity, and frequency changes.

    - The analysis is used to control the IRFZ44N MOSFET's gate, adjusting the voltage output and effectively synchronizing the light strip's visual effects with the audio's rhythm and dynamics.
- Visual Enhancement
    - The Sound Reactive System adds an artistic dimension to the audio experience by transforming audio signals into visually captivating effects.
    - The dynamic and visually engaging light display enhances the ambiance and immerses users in the audio-visual synergy.

3 Features and Specifications

3.1 Features

- **3 Channel Amplifier:** The 3 Channel Amplifier features two amplifiers for left and right stereo sound input, as well as a dedicated subwoofer amplifier for amplified bass sound input. This configuration qualifies the product as a 2.1 sound amplifier.
- **Subwoofer Amplifier:** The Subwoofer Amplifier allows users to connect a subwoofer speaker, enabling the generation of filtered low-frequency sounds, enhancing the audio experience.
- **Tone controllers:** Tone controllers are included in the amplifier, offering users the flexibility to adjust various aspects of the output sound to suit their preferences. These controls include volume, balance, bass, midrange, and treble adjustments. Additionally, separate volume and bass controllers are provided specifically for the Subwoofer amplifier output.
- **Sound Reactive system:** The Sound Reactive system is a notable feature that enhances the audiovisual experience. Users can connect a 12V light trip to the amplifier, and the lights will change in response to the amplitude of the sound. The sensitivity of this reaction can be customized using a controller.
- **USB kit:** The USB kit is a convenient module that enables users to connect various input sources to the amplifier. This includes USB inputs, Bluetooth inputs, and FM radio signals, providing multiple options for audio input.
- **Input Signal:** Users have the flexibility to provide input signals to the amplifier either through the USB kit or AV ports, allowing for versatile connectivity with different devices.
- **Output Signal:** The amplifier is designed with TIP142/147 power amplifiers, enabling each power amplifier unit to deliver a maximum power output of 125W. As a result, there are three channel outputs for left and right signals and the subwoofer, ensuring a powerful audio performance.
- **Safety from overheating:** the amplifier is equipped with safety measures to prevent overheating. The inclusion of heatsinks and strategically placed vents on the enclosure enables users to achieve maximum power output through speakers without the risk of overheating.
- **Safety from higher current:** Using a 5A fuse in an amplifier circuit is a common safety measure to protect the circuits from overcurrent. The purpose of the fuse is to act as a sacrificial component that will break the circuit and interrupt the flow of current if it exceeds the rated value. This helps prevent damage to the amplifier and the connected components in the event of a fault or malfunction.

3.2 Specifications

3.2.1 Stereo Amplifier

- Power Output Requirements
    - Minimum 125W per channel into 8 ohms load for a total of 250W RMS stereo power output.
    - Adequate power reserves to handle dynamic peaks without distortion.

- Frequency Response Specifications
  - Full-range frequency response from 20Hz to 20kHz, ensuring accurate reproduction of audio across the entire audible spectrum.
- Signal-to-Noise Ratio (SNR) Targets
  - SNR of at least 100dB, providing a high signal-to-noise ratio to minimize background noise and ensure clean audio reproduction.
- Total Harmonic Distortion (THD) Limits
  - THD should be less than 0.05% at rated power, ensuring low distortion and high fidelity audio output.
- Input/Output Interface Requirements
  - Inputs: Left and right RCA line inputs for connecting various audio sources like CD players, turntables, and digital devices.
  - Outputs: Speaker binding posts or banana plug terminals for connecting speakers.

3.2.2 Subwoofer Amplifier

- Power Output Requirements for the Subwoofer
  - Minimum 250W RMS power output into the subwoofer's load impedance.
- Frequency Response Specifications for the Subwoofer
  - Low-frequency response from 20Hz to 200Hz to handle deep and impactful bass reproduction.
- THD Limits for the Subwoofer
  - THD should be less than 0.1% at rated power, ensuring minimal distortion in the subwoofer output.
- Input/Output Interface Requirements for the Subwoofer
  - Low-level input (RCA or XLR) for connecting to the preamplifier's subwoofer output.
  - Speaker-level input/output for integrating with the main stereo amplifier and driving the subwoofer.

3.2.3 Sound-Reactive System

- Description of the Sound-Reactive System's Functionality
  - The sound-reactive system analyzes real-time audio input captured from the condenser microphone.
  - It converts the audio amplitude into a voltage output, ranging up to 12V.
  - The voltage output drives a 12V light strip to provide visual effects synchronized with the audio.
- Input Sensitivity and Response Characteristics
  - The system's condenser microphone has a high sensitivity, capable of capturing audio signals across a wide dynamic range.
  - The response characteristics are optimized to detect audio changes, beats, and intensity variations in real-time, enabling dynamic visual effects.

3.2.4 Other Specifications

- Input Voltage
  - Input voltage: 230V AC
  - Frequency: 50Hz
- Preamps Supply Voltage
  - Stereo Preamp: Dual supply of +12V and -12V DC
  - Subwoofer Preamp: Dual supply of +12V and -12V DC
- Power Amplifiers Supply Voltage
  - Power Amplifiers: Dual supply of +24V and -24V DC

- Maximum Output Power
  - Total Maximum Output Power: 375W
- Input Selection
  - DPDT Toggle Switch: For selecting input method from USB kit or AV ports
- Power Amplifier On/Off
  - SPST Switch: For turning on/off the power amplifier of the Subwoofer amplifier part
- Power Indicator
  - Red LED: For indicating power on/off status
- Tone Controller - Frequency Bands
  - Stereo Pre-Amplifier:
    - Bass Control: 20Hz to 250Hz
    - Midrange Control: 250Hz to 4kHz
    - Treble Control: 4kHz to 20kHz
  - Subwoofer Pre-Amplifier:
    - Bass Filter: 20Hz to 200Hz
- Enclosure Material
  - Made from PLA (polylactic acid), a biodegradable and eco-friendly material.
- Product Dimensions
  - Overall Dimensions: 300mm x 210mm x 70mm

4 Components Used

4.1 Components List

Type of the component	Component	Quantity
Transistors	Tip142	6
	Tip147	6
	BD139	6
	BD140	3
	BC556C	6
	BC557C	1
	IRFZ44N	1
IC	NE5532 Opamp	2
	LM7812	1
	LM7912	1
Diode	1N4007	13
	1N4001	3
	1N5408	4
	Red LED	2
Resistors	0.5 5W	12
	10 5W	6
	270 1W	3
	120 0.5W	6

	1K	6
	12K	3
	47K	3
	270	8
	680	6
	2.2K	3
	33K	3
	47	3
	2.7K	7
	3.9K	7
	82	3
	390	3
	100	3
	10K	6
	1.8K	4
	20K	3
	4.7K	2
	10	2
	220	1
	62K	1
	2K	1
Volume Controller	100K – 6 pin	4
	100K – 3 pin	1
	22K – 6 pin	1
	47K – 3 pin	1
	10K – 3 pin	1
Capacitors	100uF 50V	5
	47uF 25V	3
	47uF 50V	3
	270uf 50V	3
	2200uF 50V	2
	6800uF 50V	2
	220nF	7
	100pF	6
	47nF	5
	56pF	6
	100nF	11
	0.001uF	2
	0.0047uF	4
	0.022uF	2
	39pF	1
	4.7uF	4
	0.47uF	1

Other	Electret condenser microphone	1
	USB Kit	1
	24V-0-24V Dual Supply Transformer	1
	12V-0-12V Dual Supply Transformer	1
	AC Power Socket	1
	4-Way Speaker Connector	1
	Banana Socket	2
	RCA Port	1
	DC Base Barrel Female Socket	1
	SPST Switch	2
	DPDT Toggle Switch	1
	5A Fuse	1
	3-Way PCB Mount Wire Clip with Socket	30
	3-Way PCB Mount Wire Clip with Socket	12

Table 1: The Components List

4.2 Component Selection

4.2.1 Transformers

Using transformers in high-power audio amplifiers offers several important advantages that make them valuable components in such systems. Here are some key reasons why transformers are commonly employed in high-power audio amplifiers.

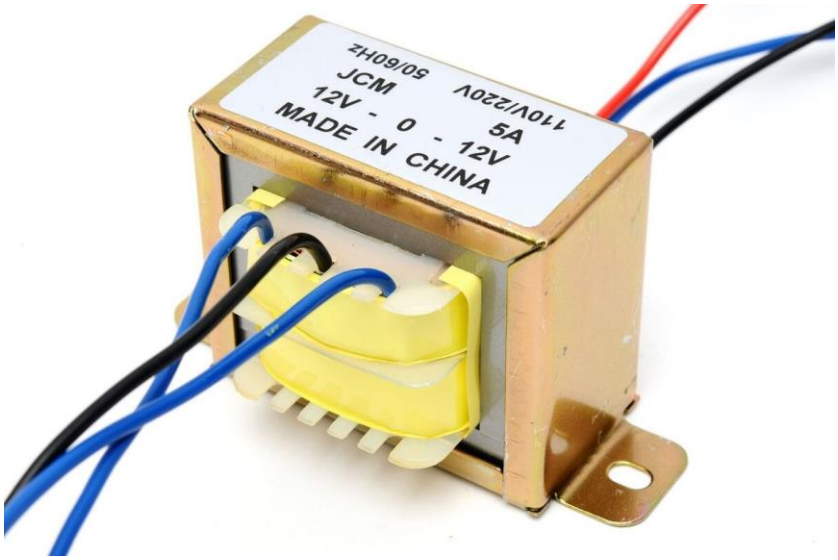


Figure 6: 12V-0-12V Dual Supply Transformer

- **Voltage Transformation:** High-power audio amplifiers often require significant voltage levels to drive loudspeakers efficiently. Transformers can step up or step down the voltage levels, allowing the amplifier to work with different speaker configurations while maintaining impedance matching. This ensures maximum power transfer from the amplifier to the speakers.
- **Isolation and Grounding:** Transformers provide electrical isolation between input and output circuits. This isolation helps prevent ground loop issues and reduces the risk of electrical shocks. It also

minimizes interference and noise between different parts of the amplifier, resulting in improved audio quality.

- **Safety:** Transformers offer a safety barrier between the power supply and the output stage of the amplifier. In the event of a catastrophic failure, such as a short circuit or component malfunction, the transformer can act as a protective barrier, preventing dangerous voltage levels from reaching the speakers or users.
- **Impedance Matching:** Transformers are crucial for impedance matching between the amplifier and the connected speakers. This ensures that the amplifier delivers power efficiently to the speakers without reflections or excessive power loss due to impedance mismatches.

4.2.2 LM7812/LM7912 Voltage Regulators

Using voltage regulators in power supply circuits offers several important benefits that make them essential components for reliable and stable power delivery. Here are some key reasons why voltage regulators are important in power supplies.

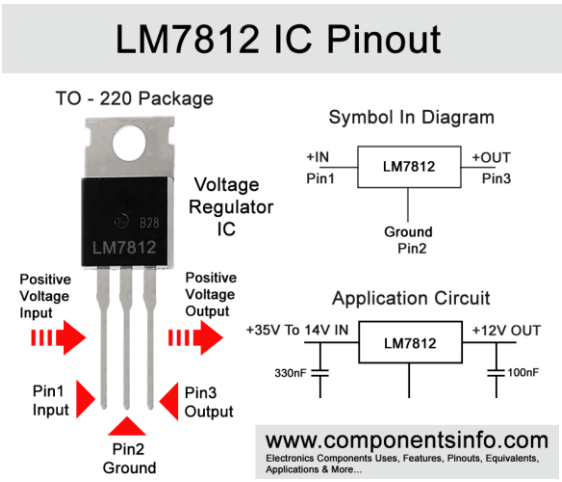


Figure 7: LM7812 Voltage Regulator

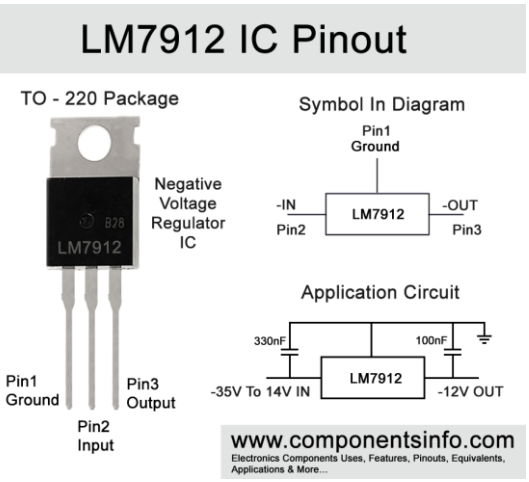


Figure 8: LM7912 Voltage Regulator

- **Voltage Stability:** Voltage regulators provide a constant and stable output voltage regardless of changes in input voltage or load conditions. This stability is crucial for sensitive electronic devices that require a steady and reliable power source to operate correctly and prevent potential damage from voltage fluctuations.
- **Noise Reduction:** Voltage regulators can filter out high-frequency noise and ripple from the input power source, resulting in cleaner and more stable output voltages. This is particularly important for electronic circuits that are sensitive to electrical noise, as it helps ensure optimal performance and minimizes interference.
- **Protection:** Voltage regulators often include built-in protection features such as overcurrent protection, overvoltage protection, and thermal shutdown. These protection mechanisms help safeguard the connected devices and the regulator itself from damage due to faults or abnormal operating conditions.
- **Efficiency:** Voltage regulators can improve the overall efficiency of the power supply by reducing unnecessary power dissipation. Linear voltage regulators, for example, regulate the output voltage by dissipating excess voltage as heat. On the other hand, switching voltage regulators can achieve higher efficiency by controlling the output voltage through switching operations, resulting in less power loss.
- **Voltage Conversion:** In some cases, voltage regulators can be used to convert one voltage level to another. For instance, a step-down voltage regulator (buck regulator) can convert a higher input voltage

to a lower output voltage, while a step-up voltage regulator (boost regulator) can increase the output voltage above the input voltage.

- **Current Limiting:** Many voltage regulators include current limiting capabilities, which restrict the maximum current that can flow through the circuit. This protects both the regulator and the connected devices from excessive currents, reducing the risk of damage and improving the overall system reliability.
- **Easy Integration:** Voltage regulators are available in various packages, including through-hole and surface-mount types, making them easy to integrate into different circuit designs and power supply modules.
- **Longer Lifespan:** By providing stable and regulated voltage levels, voltage regulators help reduce stress on electronic components and circuits, potentially extending their lifespan and improving overall system reliability.

4.2.3 NE5532 Opamps

Using the NE5532 operational amplifier (op-amp) over the TL072 and 4558 ICs for making a preamp offers several advantages due to its superior performance characteristics. Here are some of the key reasons why the NE5532 is often preferred in preamp circuits.

Figure 9: NE5532 Opamp IC

- **Low Noise:** The NE5532 has lower noise characteristics compared to the TL072 and 4558. Lower noise is crucial in preamp circuits, especially when amplifying low-level signals from sources like microphones or instruments. It helps preserve the signal fidelity and reduces the chances of introducing unwanted noise into the audio signal.
- **Wide Bandwidth:** The NE5532 has a wider bandwidth compared to the TL072 and 4558. This means it can handle a broader range of frequencies without significant distortion, making it well-suited for audio applications where accurate signal reproduction across the entire audible spectrum is important.
- **Higher Slew Rate:** The NE5532 has a higher slew rate, which indicates how fast the op-amp can respond to rapid changes in the input signal. A higher slew rate allows the NE5532 to handle transients

and fast audio signals more effectively, resulting in better transient response and improved audio quality.

- **Better Distortion Performance:** The NE5532 generally exhibits lower harmonic distortion compared to the TL072 and 4558 ICs. Lower distortion ensures cleaner and more faithful audio reproduction.
- **Lower Total Harmonic Distortion + Noise (THD+N):** The combination of low harmonic distortion and low noise results in a lower THD+N figure for the NE5532 compared to the TL072 and 4558. A lower THD+N means the audio output is closer to the original input signal, which is highly desirable in audio preamplifiers.
- **Higher Open-Loop Gain:** The NE5532 typically has a higher open-loop gain than the TL072 and 4558, which is advantageous when used in audio applications where feedback loops are employed to achieve precise gain control and stability.
- **Availability:** The NE5532 is a widely available and popular op-amp with a long history of successful use in audio applications. This availability makes it easy to source and use in various projects.

4.2.4 Active filters

Using active filters over passive filters in a preamplifier offers several advantages that make them a preferred choice in many audio applications. Here are some of the key reasons why active filters are often favored. Flexibility and Adjustability Active filters can be easily designed with adjustable parameters such as cutoff frequency, gain, and Q-factor. This flexibility allows for precise tuning and customization of the filter response to suit specific audio requirements and match different audio sources. Higher Order Filtering Active filters can achieve higher-order filtering (e.g., second-order, fourth-order, etc.) more easily than passive filters. Higher-order filters provide steeper roll-off slopes and better attenuation of unwanted frequencies, resulting in improved noise rejection and better overall filtering performance.

- **Buffering and Isolation:** Active filters often incorporate op-amps as buffer stages, providing isolation between the input and output stages. This buffering helps prevent loading effects and ensures that the filter performance is not influenced by the impedance of the following circuitry or the load.
- **Low Output Impedance:** Active filters typically have a low output impedance, which means they can drive loads (e.g., power amplifiers) with minimal signal loss. Passive filters, on the other hand, may introduce higher output impedance, leading to potential signal degradation and reduced power transfer.
- **Less Sensitivity to Load Impedance:** Passive filters can be more sensitive to changes in the load impedance, affecting their frequency response and performance. Active filters, with their low output impedance, are generally less affected by load variations.
- **Gain Control:** Active filters can provide both gain and filtering in a single circuit. This capability is useful in preamplifiers, as it allows for simultaneous signal amplification and filtering, simplifying the overall design.
- **Noise Performance:** Active filters can offer better noise performance compared to passive filters, particularly at higher frequencies. This is especially important in audio applications, where maintaining a low noise floor is crucial for preserving audio fidelity.
- **Signal Level Shifting:** Active filters can easily shift the signal levels, which can be advantageous in certain applications where signal levels need to be adjusted or matched between different stages of the audio system.
- **Electronic Control:** Active filters can be easily integrated into electronic systems and controlled digitally or via software, enabling more advanced filter designs and adaptability.

4.2.5 BD139 and BD140 Complementary Pair

Using BD139 and BD140 as a complementary pair in a Class AB power amplifier has several advantages that make them a popular choice for such applications.

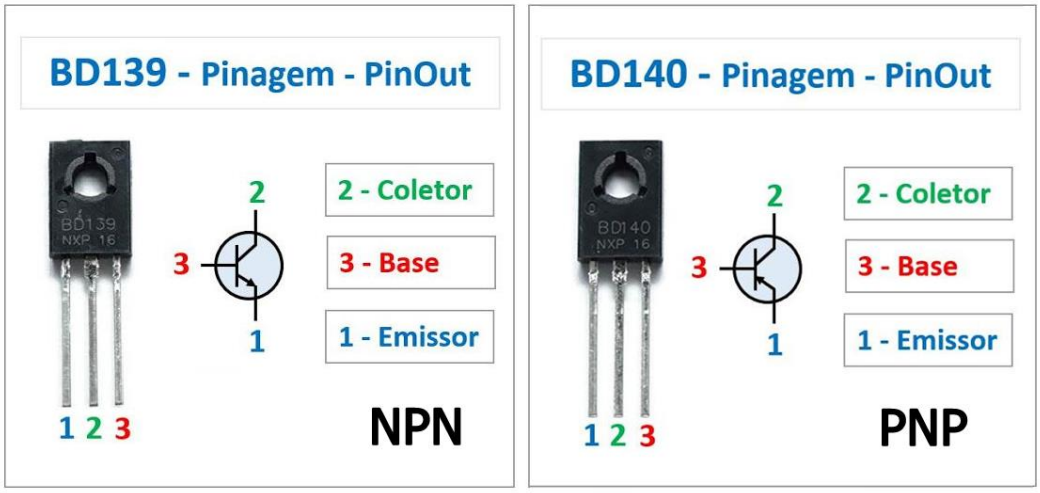


Figure 10: BD139 and BD140 Transistors

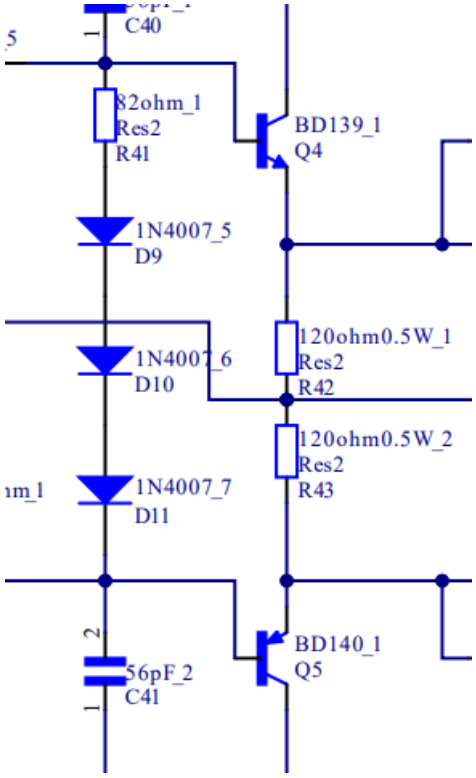


Figure 11: BD139 and BD140 Complementary Pair

- **Complementary Pair:** BD139 and BD140 are complementary NPN and PNP transistors, respectively. When used in a push-pull configuration, they provide a well-balanced and symmetrical amplification of the positive and negative halves of the input signal. This results in reduced distortion and improved linearity in the output signal.

- **High Current and Power Handling:** Both BD139 and BD140 are capable of handling relatively high currents and power levels. This makes them suitable for use in power amplifiers where they can deliver significant output power to drive speakers or loads efficiently.
- **Medium Power Application:** BD139 and BD140 are typically considered medium power transistors. They are well-suited for applications where moderate power amplification is required, such as audio amplifiers used in home stereo systems and small PA systems.
- **Cost-Effectiveness:** BD139 and BD140 are widely available and relatively inexpensive, making them cost-effective choices for power amplifier designs, especially in hobbyist projects or low-cost audio equipment.
- **Reliability:** These transistors have proven to be reliable over time and have a long track record of successful use in audio amplifier designs. Their robustness and durability contribute to the overall reliability of the power amplifier.
- **Thermal Stability:** BD139 and BD140 have good thermal characteristics, which is important in power amplifiers that can generate considerable heat during operation. Adequate thermal stability helps prevent thermal runaway and ensures safe and reliable amplifier performance.
- **Ease of Circuit Design:** The complementary nature of BD139 and BD140 simplifies the circuit design for Class AB amplifiers, as it eliminates the need for complex biasing networks and facilitates push-pull operation.
- **Amplifier Efficiency:** Class AB amplifiers strike a balance between Class A and Class B amplifiers, offering relatively good efficiency while still reducing power dissipation and crossover distortion compared to Class B designs.

4.2.6 TIP142/TIP147 Power Transistors

Using the TIP142 and TIP147 complementary pair as output transistors for further amplification in a power amplifier offers several advantages that make them suitable for high-power audio applications.

Figure 12: TIP142/TIP147 Power Transistors

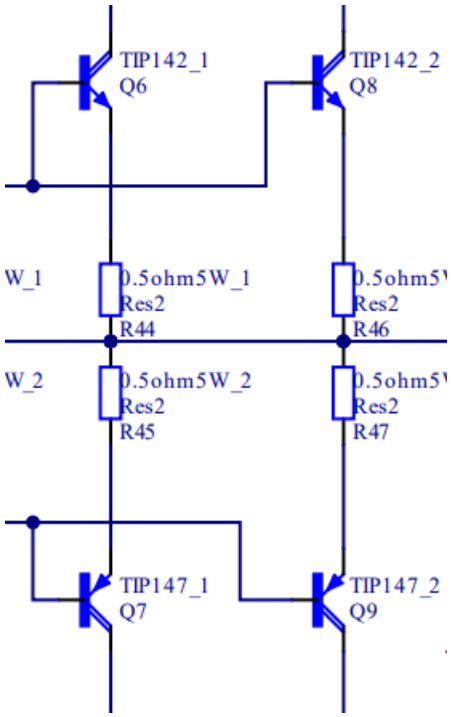


Figure 13: TIP142/TIP147 Complementary Pair

- **High Power Handling:** The TIP142 (NPN) and TIP147 (PNP) transistors are specifically designed for high-power applications. They can handle relatively large currents and power levels, making them well-suited for driving speakers and other high-power loads in power amplifiers.
- **Complementary Pair:** Similar to BD139 and BD140, the TIP142 and TIP147 form a complementary pair, allowing for balanced amplification of both positive and negative halves of the input signal. This balanced operation reduces distortion and improves overall linearity in the output signal.
- **Robustness and Reliability:** These transistors are designed for industrial and high-power applications, which means they are robust and can handle the demands of continuous and high-power operation. Their reliability is important for ensuring stable and trouble-free amplifier performance.
- **Efficient Push-Pull Operation:** By using the TIP142 and TIP147 in a push-pull configuration, Class AB operation can be achieved. This offers a good compromise between the efficiency of Class B and the low distortion of Class A amplifiers. It helps reduce crossover distortion and improves overall efficiency compared to Class A designs.
- **Thermal Stability:** The TIP142 and TIP147 have good thermal characteristics and can handle higher operating temperatures. This is important in power amplifiers, where the transistors can generate considerable heat during high-power operation. Proper heat sinking and thermal management are still necessary to ensure stable and reliable performance.
- **Wide Voltage Range:** The TIP142 and TIP147 can handle a wide range of supply voltages, making them versatile in different amplifier designs and power supply configurations.
- **Availability and Cost-Effectiveness:** These transistors are widely available and are often cost-effective options for high-power amplifier designs, especially in DIY or hobbyist projects.
- **Audio Fidelity:** When properly biased and implemented, the TIP142 and TIP147 can provide good audio fidelity, ensuring accurate signal reproduction and minimal distortion.

5 Instructions for Assembly

i. **Prepare Components:** Ensure that you have all the required components, PCBs, transformers, volume controllers, switches, and ports ready for assembly.

ii. **Soldering the PCBs:** Follow the schematic diagrams and texts on the PCBs to solder the components onto their designated places on the PCBs. Use a soldering iron and solder wire to make secure connections. Double-check for any solder bridges or cold solder joints.

iii. **Wiring the USB Kit, Volume Controllers, Switches, and Ports:** Attach 3-way or 2-way PCB mount wire clips to the USB kit, volume controllers, switches, and ports. These clips will make it easier to connect them to the PCBs later. Ensure that the connectors on these components match the connectors placed on the PCBs.

iv. **Mounting the Transformers:** Position the 24V-0-24V transformer at the center of the main part of the enclosure. Place the 12V-0-12V transformer on the dedicated side of the main part of the enclosure.

v. **Mounting the PCBs:** Position the Power Supply PCB at the center of the main part of the enclosure. Place the Pre-Amplifier PCB in a dedicated corner of the enclosure. Position the 3 Power Amplifier PCBs at the other three corners of the enclosure. Mount the USB kit on the front wall of the enclosure.

vi. **Connecting the Volume Controllers, Switches, and Ports to the Enclosure:** Carefully connect the volume controllers, switches, and ports to their designated positions on the enclosure. Ensure that they are securely attached.

vii. **Proper Wiring:** Follow these steps to ensure proper wiring:

   a. First, connect the transformers to the Power Supply unit using the appropriate wires.
   b. Connect the power supply sockets with the other PCBs using 5-wire connections for each PCB.
   c. Use PCB mount wire clips to connect relevant ports between each PCB to establish their connections.
   d. Connect the volume controllers, switches, and ports to their corresponding PCBs using the prepared wire clips.
   e. Double-check all the connections to ensure they are correct and secure.

viii. **Testing:** Before closing the enclosure, conduct a thorough inspection of the assembled components and wiring. Perform initial testing of the amplifier to check if it powers up correctly and if the audio output is functioning as expected.

ix. **Enclosure Assembly:** Once all the components are properly wired and tested, securely close the enclosure using the appropriate screws or fasteners.

x. **Final Testing:** After assembling the enclosure, perform a final test of the complete stereo amplifier, subwoofer amplifier, and sound-reactive system. Test various input sources, adjust the volume levels, and check if the system responds to audio inputs as intended.

xi. **Troubleshooting:** If any issues are encountered during testing, troubleshoot the circuitry, connections, and components to identify and rectify the problems.

xii. **Final Check and Safety Measures:** After successful testing, ensure that all electrical connections are properly insulated and secure. Apply any necessary safety measures, such as adding fuses or overload protection, to safeguard the amplifier and connected devices.

Please prefer Appendix A for the physical view of the enclosure.

6 Testing the Product Functionality

The testing process involves evaluating the functionality and performance of the 300W electronic stereo amplifier, comprising the power supply unit, preamplifier, power amplifiers, and sound-reactive system. The test setup includes audio signal sources, oscilloscopes, multimeters, load resistors, speakers, and audio measurement equipment.

i. Visual Inspection

- Start with a thorough visual inspection of all PCBs, components, switches, volume controllers, and ports.
- Check for any physical damages, loose connections, or soldering issues.
- Ensure all components are securely mounted.

ii. Power Supply Unit (PSU) Testing

- Measure the output voltage using a multimeter and verify that the PSU provides the correct DC voltage as specified for the amplifier.
- Ensure there are no abnormal voltage fluctuations or noise on the output to guarantee stable power delivery to the amplifier circuitry.

iii. Pre-Amplifier Testing

- Connect an audio source (e.g., phone or music player) to the input of the pre-amplifier.
- Connect the pre-amplifier output to an oscilloscope or a speaker.
- Gradually increase the volume and test each controller (volume, balance, bass, midrange, and treble) to verify they have the desired effect on the audio signal without introducing distortion or noise.

iv. Power Amplifier Testing

- Connect the output of the pre-amplifier to the input of the power amplifier.
- Use appropriate load resistors or speakers rated for the amplifier's power output.
- Play various audio sources through the amplifier and gradually increase the volume to verify that the power amplifier delivers the expected power output and faithfully amplifies the input signal without distortion.

v. Volume Controllers and Switches Testing

- Test all volume controllers and switches by adjusting them and observing their impact on the amplifier's output.
- Check that each control works smoothly and accurately, without any crackling or irregular behavior.

vi. Port Testing

- Test all input and output ports (e.g., USB, audio input/output) to ensure proper connectivity and functionality.
- Connect different devices to the ports and verify that the signals are routed correctly through the amplifier.

vii. Balance Testing

- Test the balance controller to ensure that it properly adjusts the volume levels between the left and right audio channels, creating an accurate stereo effect.

viii. Tone Controls Testing

- For the pre-amplifier's tone controls (bass, midrange, treble), verify that each control accurately modifies the corresponding frequency range without introducing distortion or affecting other frequency bands.

ix. Thermal Testing

- Operate the amplifier at maximum power output for an extended period while monitoring the temperature.
- Ensure that the heatsinks and cooling mechanisms effectively dissipate heat, preventing overheating.

x. Load Testing

- Conduct load testing with different speaker loads (e.g., 4 ohms, 8 ohms) to ensure the power amplifiers can handle the specified loads without issues.

xi. Safety Testing

- Verify the effectiveness of safety features like short-circuit protection and overcurrent protection.
- Ensure the amplifier is protected from potential hazards.

xii. Audio Performance Testing

- Conduct audio performance tests such as Total Harmonic Distortion (THD), Signal-to-Noise Ratio (SNR), Frequency Response, and Crosstalk to ensure the amplifier meets the desired audio quality standards.

xiii. EMI/EMC Testing

- If required, perform electromagnetic interference (EMI) and electromagnetic compatibility (EMC) testing to ensure the amplifier complies with relevant regulations and standards.

xiv. Sound-Reactive System Performance Test Results

- Evaluate the sound-reactive system's performance using an audio source with varying amplitudes.
- Observe the response of the system and check if the voltage output corresponds to the input audio level accurately.
- Connect a 12V light strip to the system and observe its responsiveness to sound.

xv. Final Functional Test

- Run a comprehensive test with various audio sources, load conditions, and control settings to ensure the amplifier operates flawlessly under different scenarios.

By following this testing process, you can verify the functionality, performance, and safety of the 300W electronic stereo amplifier, ensuring it meets the specified requirements and is ready for use or production. Any discrepancies or issues should be addressed and resolved during the testing phase to achieve a high-quality and reliable final product.

7 Simulation Results

All the Simulation Results were captured using Proteus 8 Professional software.

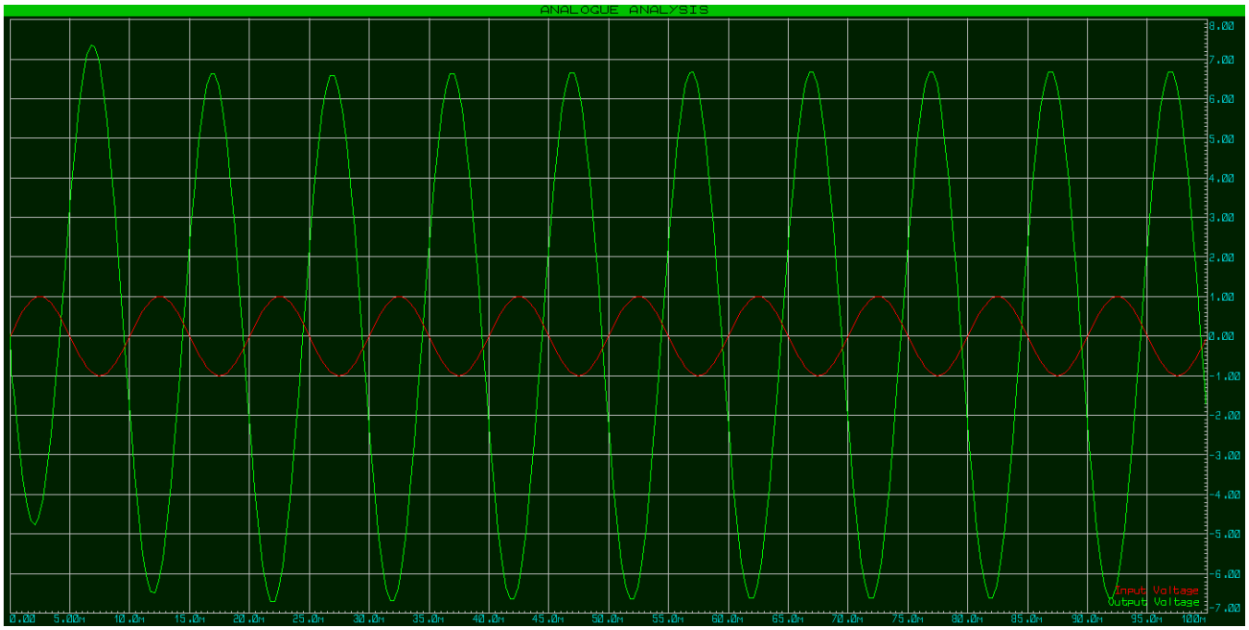


Figure 14: Input voltage(2v peak-peak/100Hz) and output voltage(open loop) of main amplifier when bass, midrange and treble are fully used

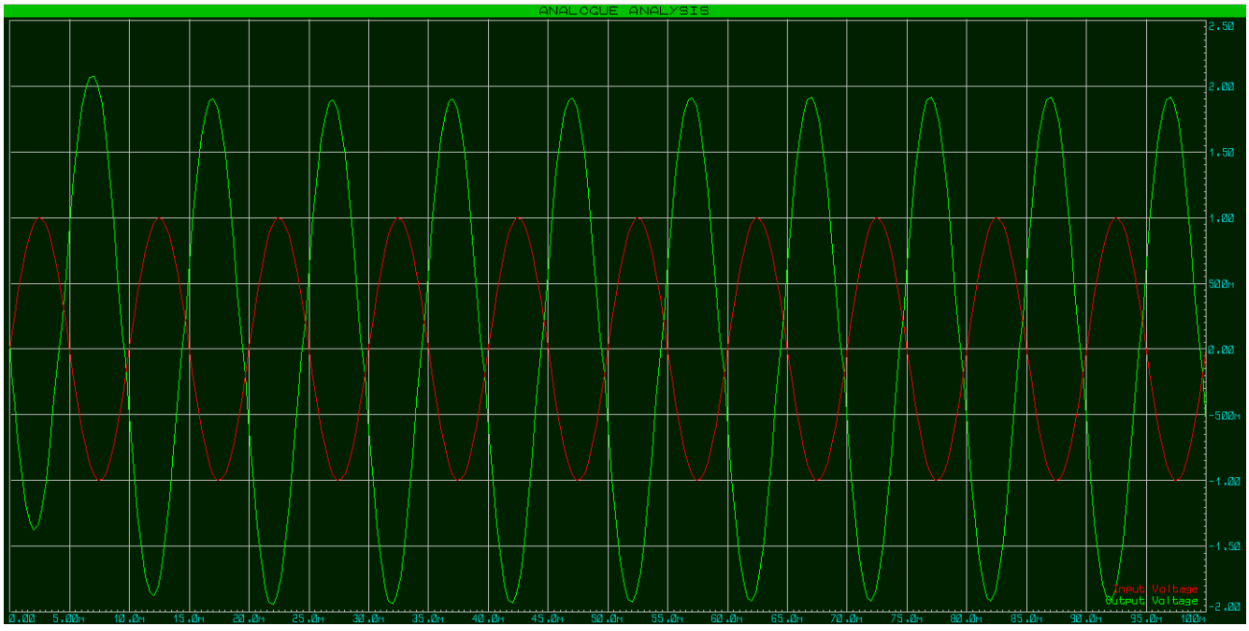


Figure 15: Input voltage(2v peak-peak/100Hz) and output voltage(closed loop/8ohm speaker) of main amplifier when bass, midrange and treble are fully used

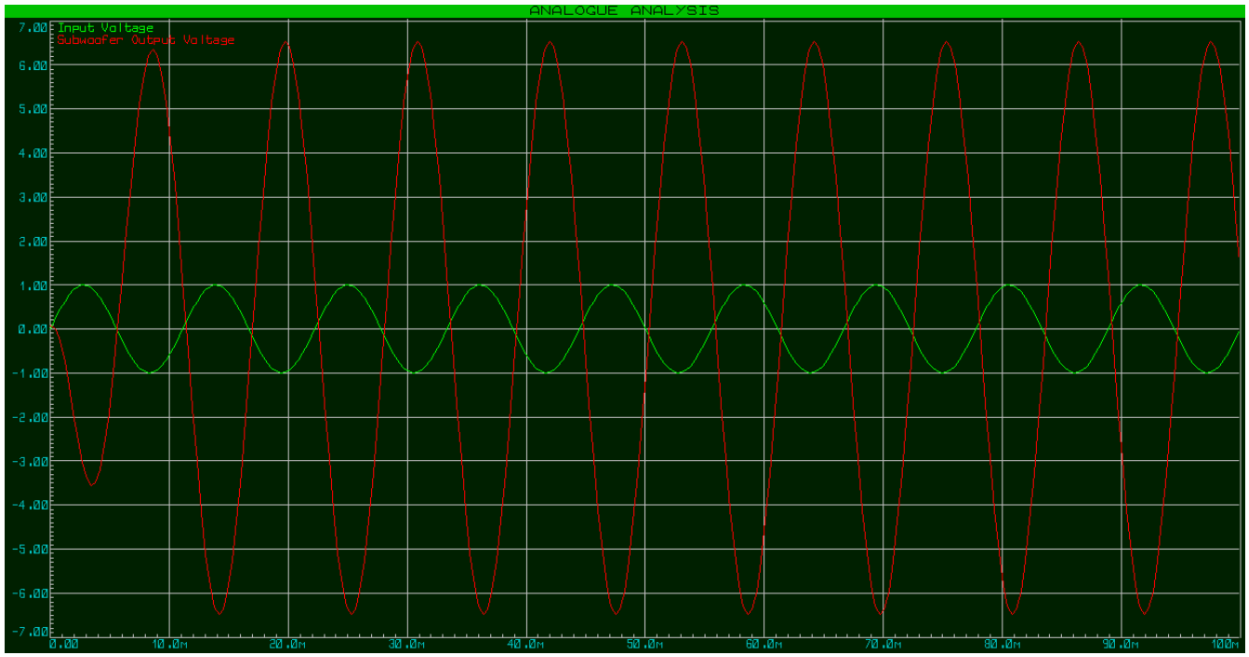


Figure 16: Input voltage(2v peak-peak/90Hz) and output voltage(open loop) of subwoofer amplifier when bass is fully used

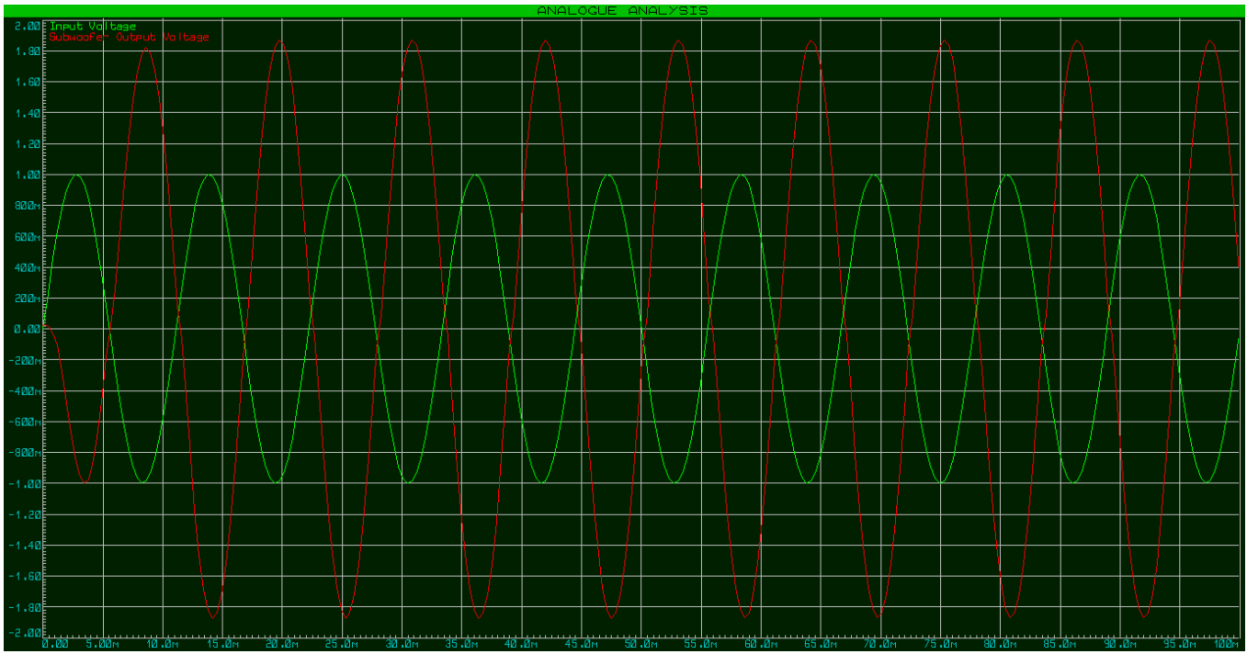


Figure 17: Input voltage(2v peak-peak/90Hz) and output voltage(closed loop/8 ohm speaker) of subwoofer amplifier when bass is fully used

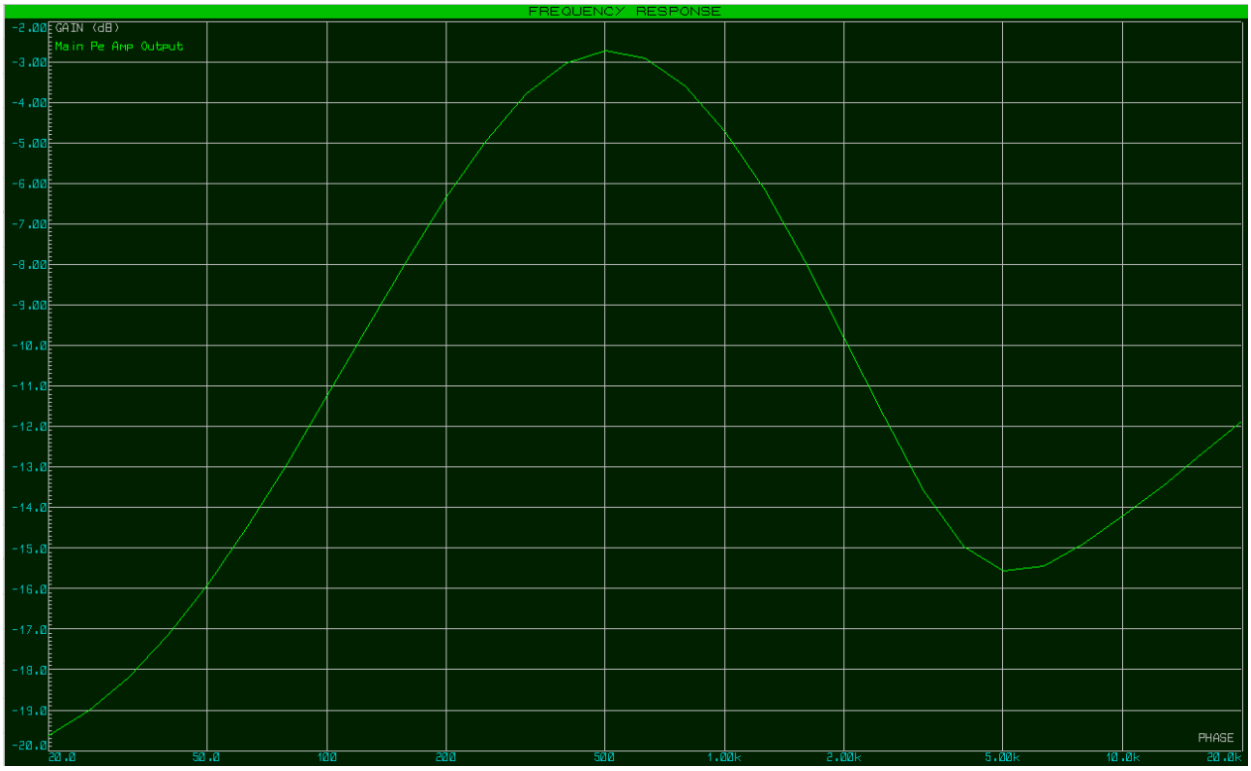


Figure 18: Frequency vs Magnitude of main pre amplifier when bass, midrange and treble are not used

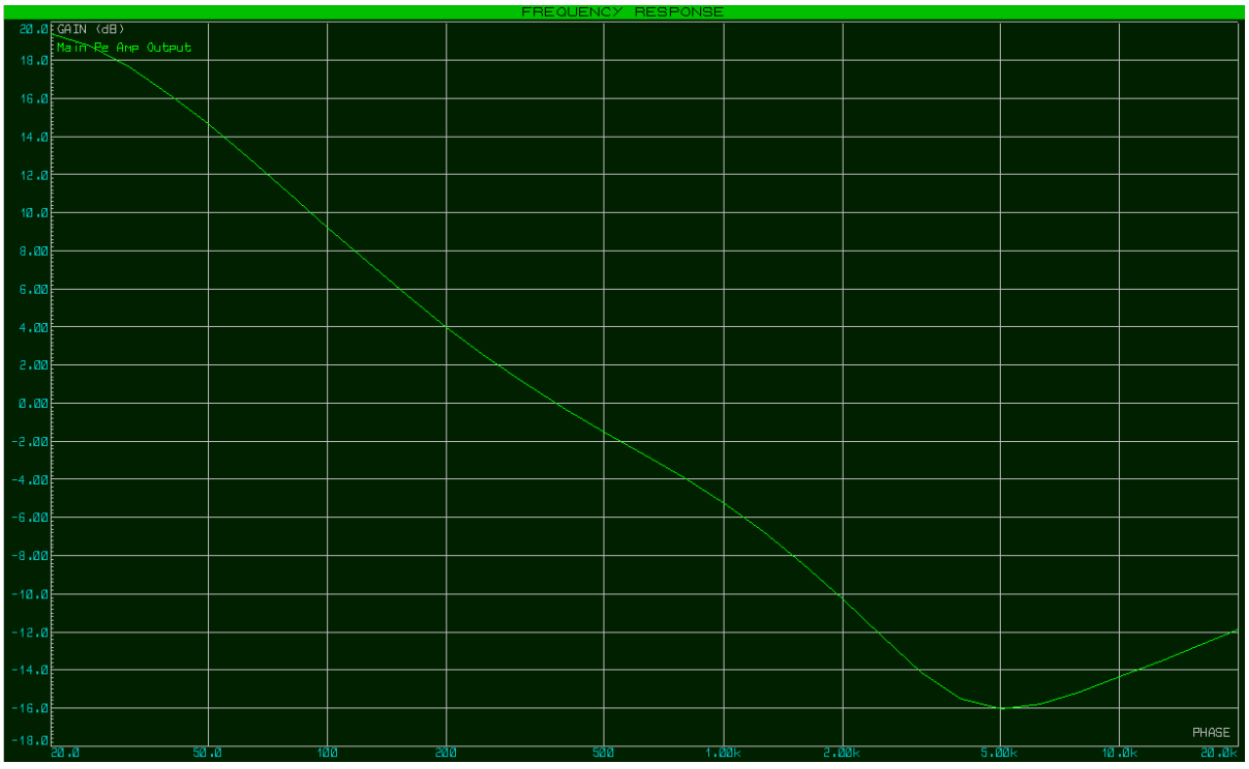


Figure 19: Frequency vs Magnitude of main pre amplifier when only bass is fully used

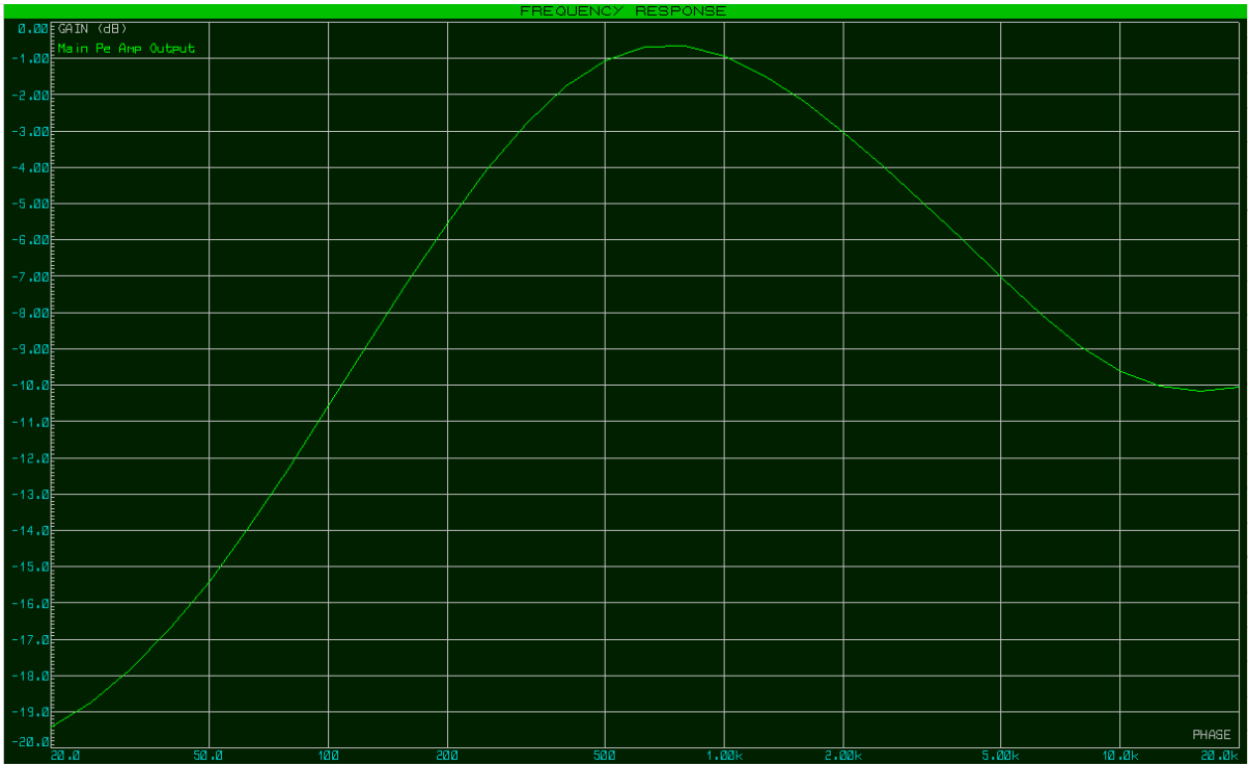


Figure 20: Frequency vs Magnitude of main pre amplifier when only midrange is fully used

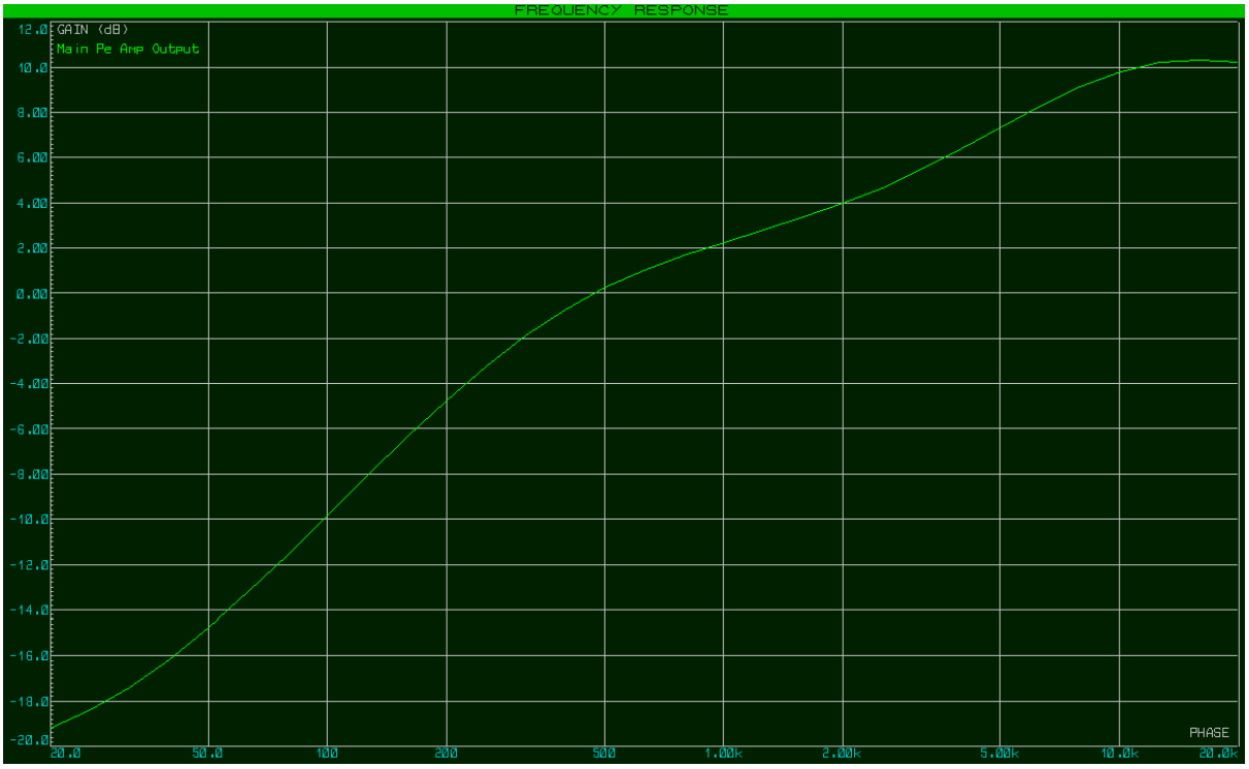


Figure 21: Frequency vs Magnitude of main pre amplifier when only treble is fully used

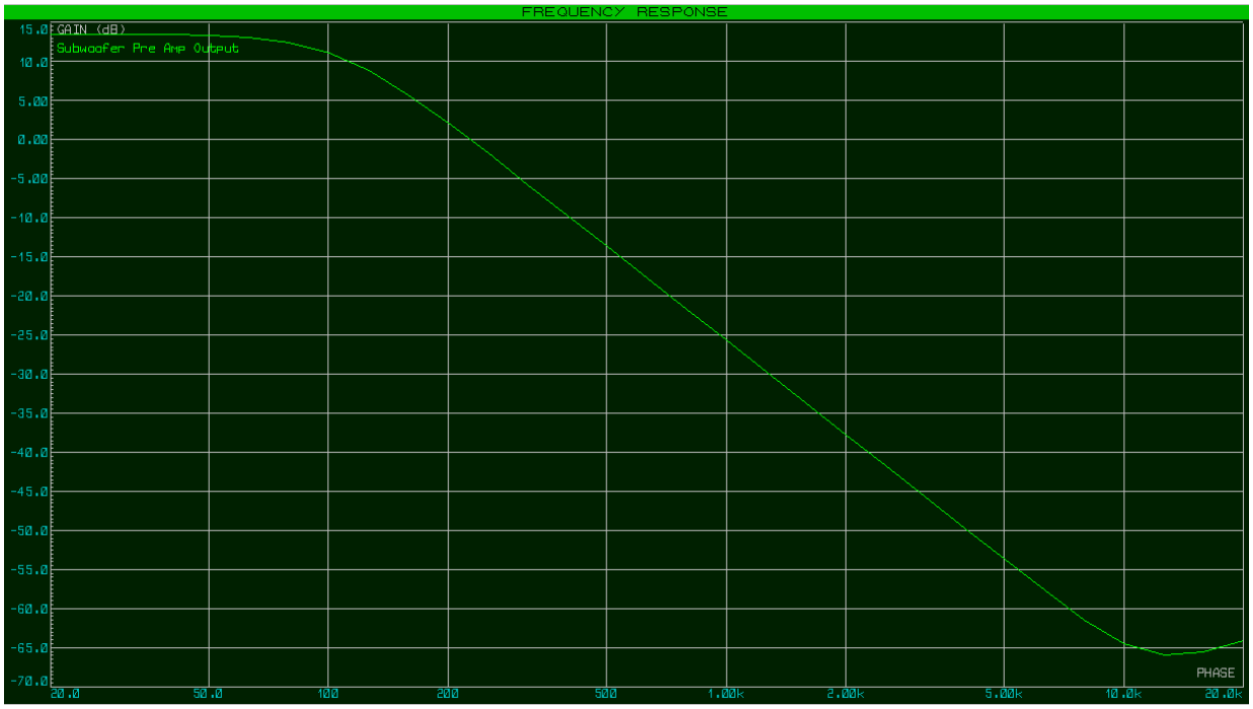


Figure 22: Frequency vs Magnitude of subwoofer pre amplifier when only bass is fully used

8 Product Goals

8.1 Functionality Goals

Once the amplifier is connected to a 230V power source, it becomes operational, offering versatile input options through the 2.0 USB port, Bluetooth, or AV ports. Users can switch between AV and USB inputs using an SPDT switch, allowing them to use one input at a time. As a 2.1 amplifier, it provides outputs in both stereo and subwoofer modes. Users have the convenience of an on/off switch for the subwoofer amplifier. The amplifier's tone controller unit empowers users to adjust volume, bass, treble, and midrange frequencies according to their preferences. Additionally, users can independently control the subwoofer volume and bass for a customized bass experience. The inclusion of a 12V LED strip port enables users to connect an LED strip for an immersive sound reactive system, and its sensitivity can be easily adjusted using a controller. This comprehensive set of features ensures users can enjoy a personalized and captivating audio experience with the utmost convenience.

8.2 Marketing Goals

Initial plan is to produce 10 units and assess market demand before proceeding with mass manufacturing. Utilizing the design-driven innovation approach, the primary objective within the market scope is to maximize profits while satisfying user needs. The approximate cost per unit is Rs. 47,555.36, and the target market price is set at Rs. 52,990.00. The pricing strategy aims to strike a balance between affordability for customers and ensuring a reasonable profit margin for the company. By closely monitoring customer feedback and market response, the goal is to optimize production, distribution, and marketing strategies to achieve both financial success and customer satisfaction.

9 Conclusion

9.1 Summary of Project Outcomes

The project's primary objective was to design and develop a cutting-edge 300W audio amplifier that would deliver exceptional performance and meet the highest audio quality standards. Through meticulous planning and careful selection of components, the team successfully achieved this goal. The resulting amplifier exhibited superior audio fidelity, powerful and efficient power delivery, and versatile controls. The incorporation of a sound-reactive system further enhanced the user experience, creating a captivating and immersive audio environment. Rigorous testing procedures, including power output measurement, frequency response analysis, THD and SNR evaluation, and thermal testing, were conducted to ensure the amplifier's functionality and adherence to safety standards. The project culminated in the creation of a high-quality, feature-rich audio amplifier that met and exceeded the expectations of both audiophiles and professional users alike.

9.2 Achievement of Objectives

The project's objectives encompassed various stages, each aimed at realizing a specific aspect of the 300W audio amplifier's development. The team achieved the first objective by successfully designing and developing the amplifier, integrating the power supply unit, pre-amplifier, power amplifier PCBs, and sound-reactive system into a cohesive and well-functioning unit. Comprehensive functionality testing allowed the team to verify the seamless operation of the amplifier's controls, switches, and ports, ensuring an intuitive user experience. Additionally, audio performance validation through THD, SNR, and frequency response tests demonstrated that the amplifier met stringent audio quality standards, providing users with clear and distortion-free sound. Safety features, such as short-circuit protection and overcurrent protection, were rigorously tested and proven effective, addressing the project's objective of ensuring user safety during amplifier operation. In conclusion, the project's successful achievement of its objectives culminated in the creation of a high-quality audio amplifier with outstanding performance, versatility, and safety, setting the stage for future advancements in audio amplification technology.

10 Future Improvements for the Audio Amplifier

i. **Class D Amplification Technology:** Consider implementing Class D amplification technology, which offers higher efficiency and lower heat generation compared to traditional Class AB amplifiers. This would result in reduced power consumption and improved thermal management.

ii. **Digital Signal Processing (DSP) Integration:** Integrate DSP technology into the amplifier to enable advanced audio processing capabilities. This would allow for customizable equalization, digital crossovers, room correction, and other digital audio enhancements to cater to individual preferences and room acoustics.

iii. **High-Resolution Audio Support:** Upgrade the amplifier to support high-resolution audio formats, such as 24-bit/192kHz, to provide audiophiles with superior sound quality and a more immersive listening experience.

iv. **Wireless Audio Streaming:** Incorporate wireless audio streaming capabilities, such as Bluetooth or Wi-Fi, to enable seamless connectivity with smartphones, tablets, and other smart devices. This would enhance user convenience and accessibility to various audio sources.

v. **Voice Assistant Integration:** Integrate popular voice assistants like Amazon Alexa or Google Assistant into the amplifier to offer hands-free control and voice commands for audio playback and settings adjustments.

vi. **Multi-Room Audio Support:** Enable multi-room audio functionality, allowing users to sync and distribute audio across different rooms or zones within a home entertainment system.

vii. **Expandable Input Options:** Provide expansion slots or ports that allow users to add new input options, such as USB Type-C, HDMI, or optical inputs, to accommodate the increasing variety of audio sources.

viii. **Smartphone App Control:** Develop a dedicated smartphone app that enables users to control and adjust amplifier settings remotely. This app could also offer additional features like preset management and access to online music services.

ix. **Energy-Efficient Standby Mode:** Optimize the standby mode to consume minimal power while ensuring quick startup and responsiveness when the amplifier is reactivated.

x. **User-Friendly Interface Design:** Enhance the user interface with a user-friendly display or touchscreen panel, intuitive controls, and easily accessible audio settings for a more pleasant user experience.

xi. **Smart Connectivity with Smart TVs:** Improve compatibility with smart TVs and entertainment systems, allowing the amplifier to synchronize with the TV's audio output and function seamlessly as part of a home theater setup.

xii. **Dynamic Power Management:** Implement dynamic power management to allocate power efficiently based on the connected load and audio demands, optimizing performance while minimizing energy consumption.

xiii. **Enhanced Audio Calibration:** Provide automated audio calibration features, using built-in microphones and advanced algorithms to analyze room acoustics and adjust audio settings accordingly.

xiv. **Enhanced Cooling System:** Develop an advanced cooling system that efficiently dissipates heat without producing excessive fan noise, ensuring stable performance during prolonged use.

xv. **Modular Design for Upgradability:** Design the amplifier with a modular approach, allowing users to upgrade specific components or add expansion modules to future-proof the device and adapt to evolving audio technologies.

These real-world improvements would elevate the audio amplifier's capabilities, making it more versatile, user-friendly, and future-proof, while delivering an exceptional audio experience for a wide range of users and applications.

11 Appendices

11.1 Appendix A - The Audio Amplifier production

Figure 23: Controllers and USB kit - Front View

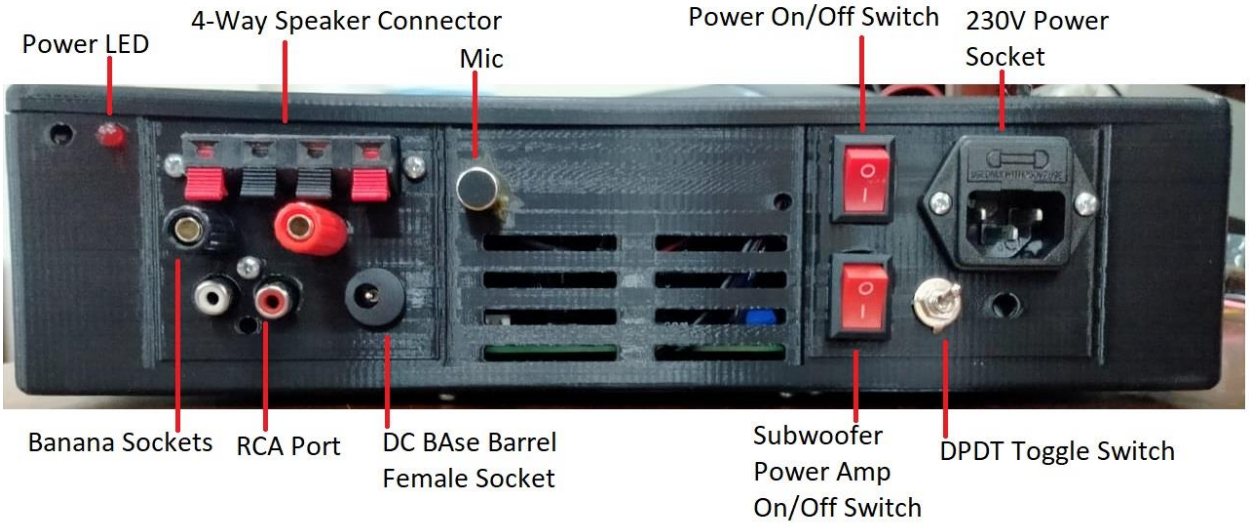


Figure 24: Swtiches and I/O Ports – Rear View

Figure 25: The Amplifier Product

Figure 26: The Amplifier Product at EXMO 23 UOM

11.2 Appendix B - Enclosure Design

Enclosure design was made by using SOLIDWORKS 2020. It consisted with 2 parts Lid and the main body. It is a 3D printed enclosure and made by plastics. All the PCBs, transformers, the lid and the input output ports can mounted and connected on the main part properly by 3mm x 5mm screws.

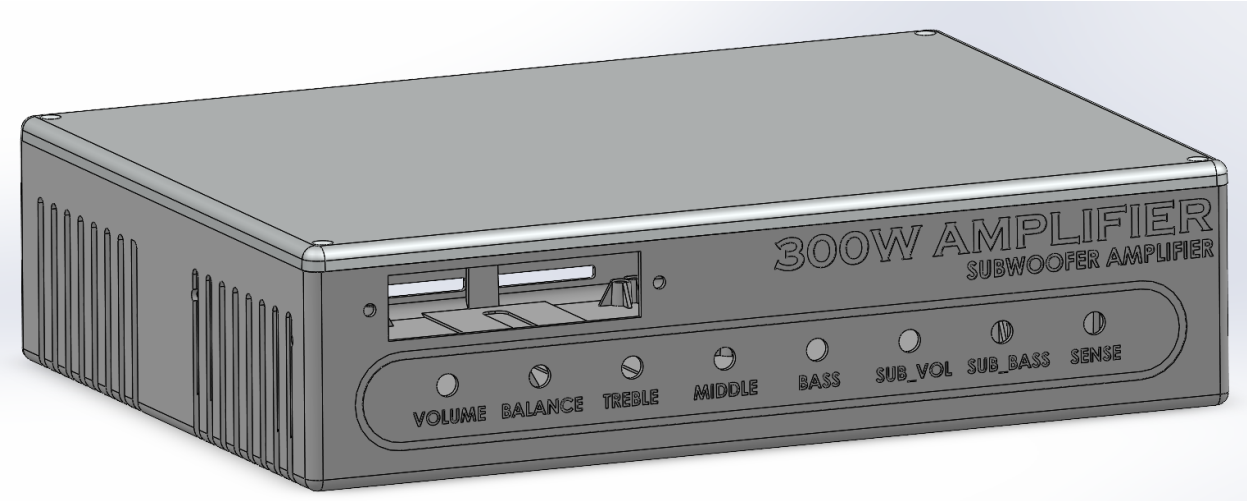


Figure 27: Front View

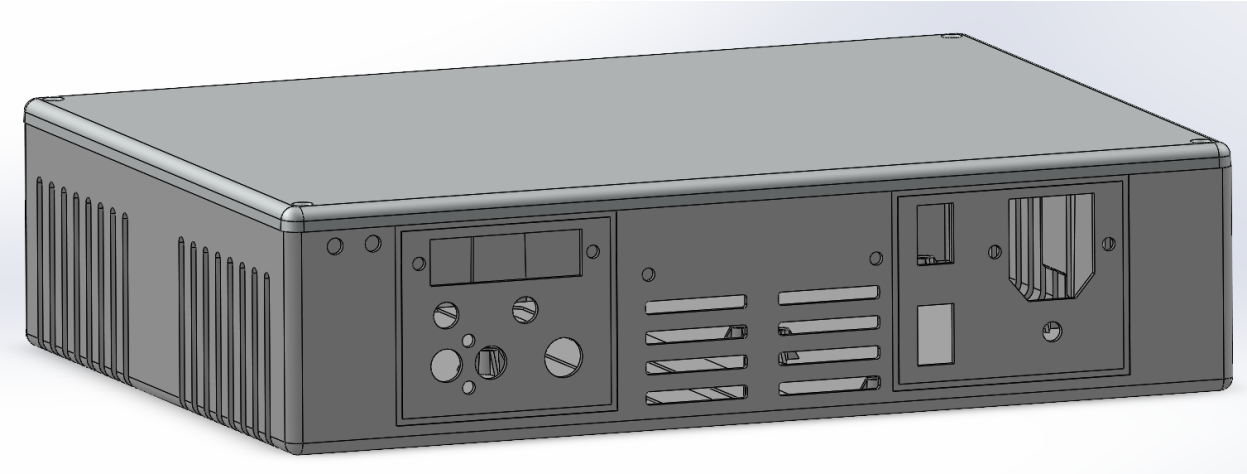


Figure 28: Rear View

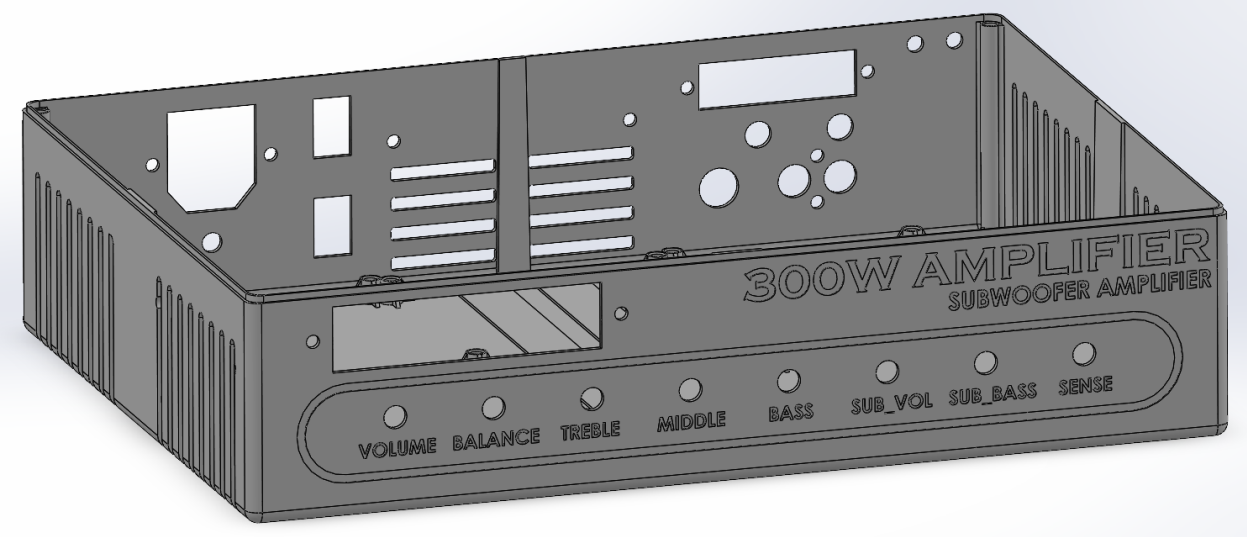


Figure 29: The Base Part of the Enclosure

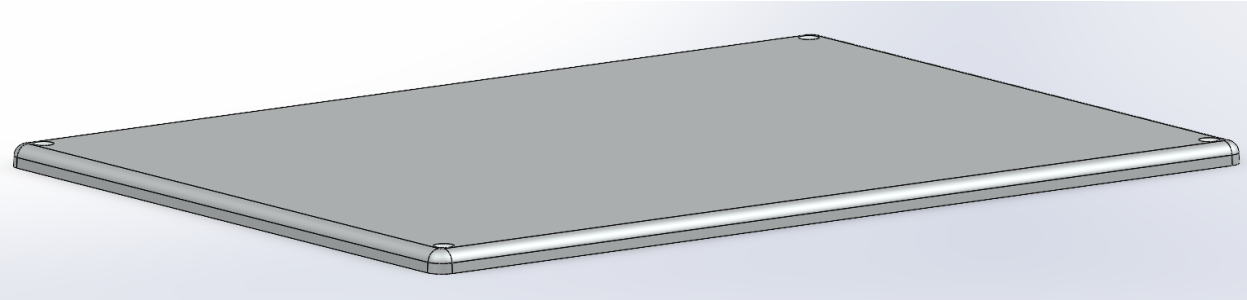


Figure 30: The Lid Part of the Enclosure

11.3 Appendix C - PCB Design

All PCBS are designed using Altium 23.5.1. Also they are 4 layer PCBs for reducing the physical size of the circuit board and the cost. They have been manufactured at JLCPCB in China by following the rules given in the online JLCPCB site.

11.3.1 PCB Schematics

i. Power Supply Unit

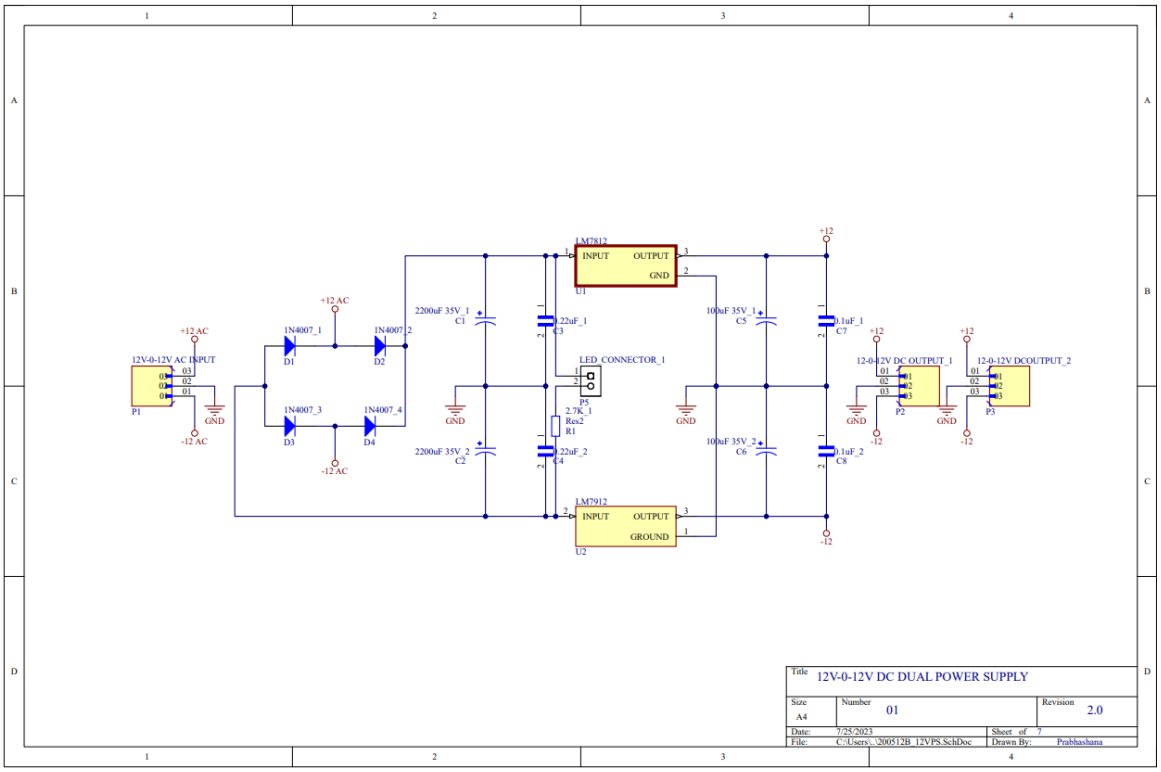


Figure 31: 12V-0-12V DC Dual Power Supply Schematic

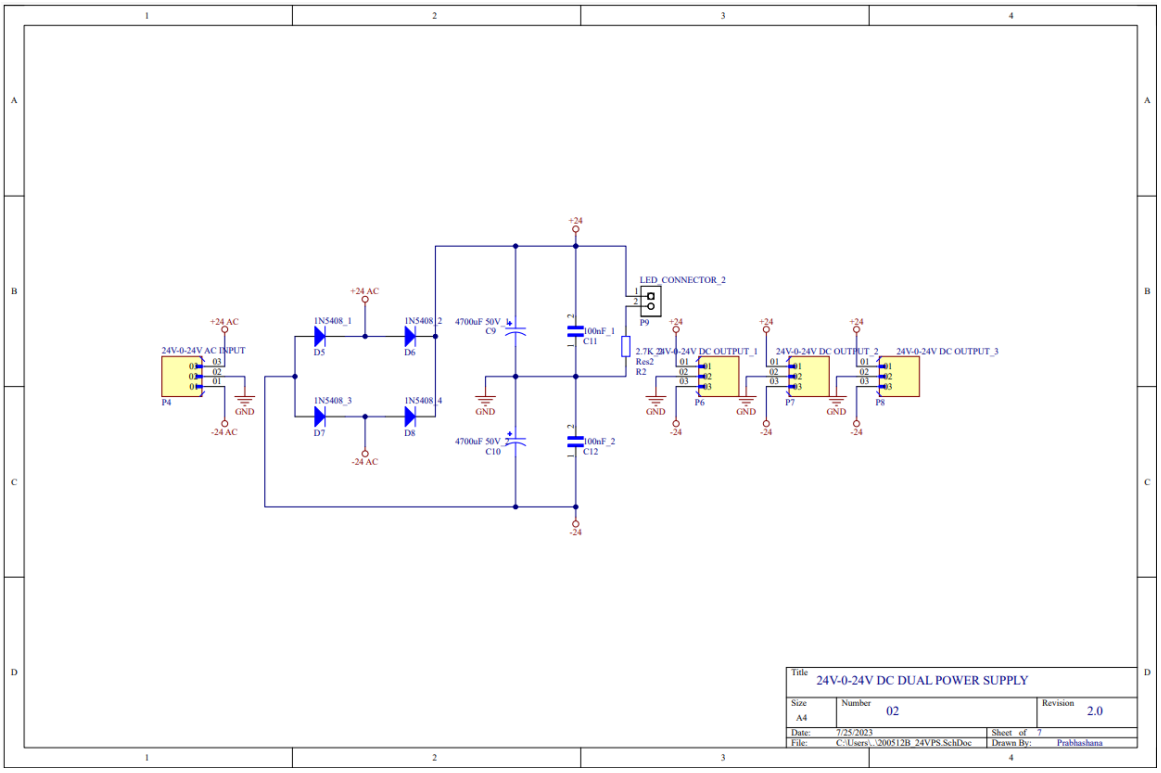


Figure 32: 24V-0-24V DC Dual Power Supply Schematic

ii. Pre Amplifier

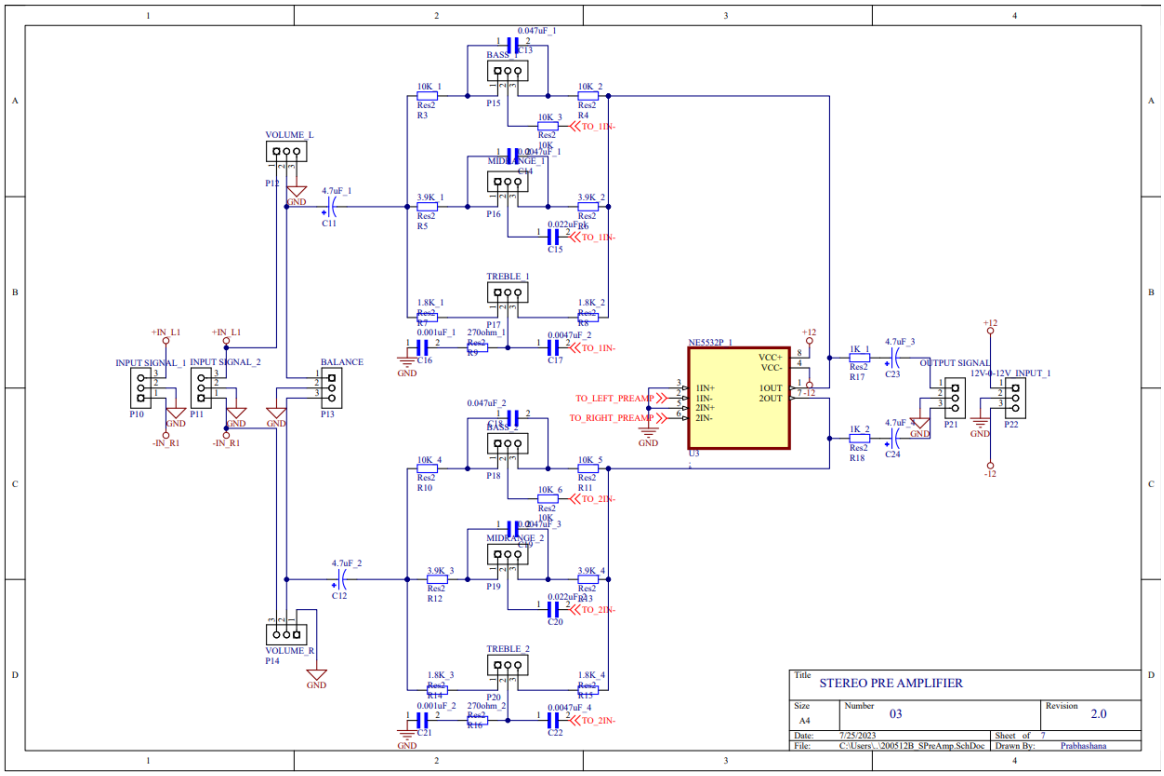


Figure 33: Stereo Pre Amplifier Schematic

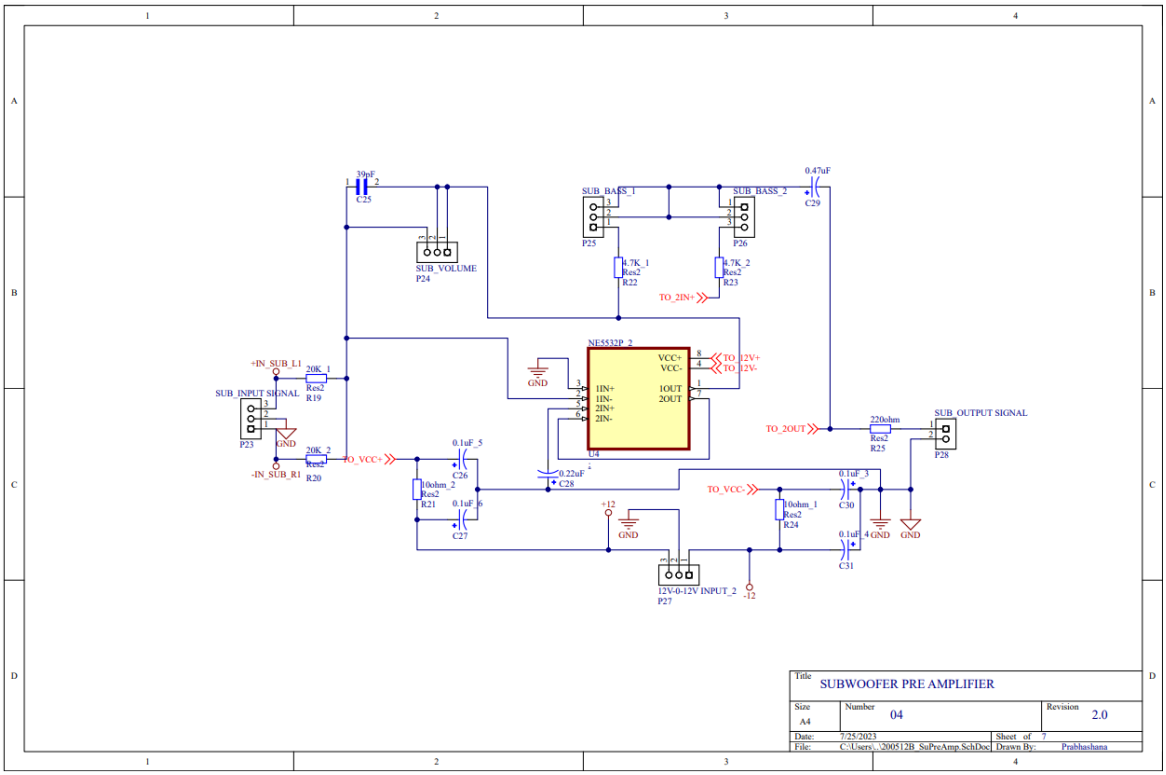


Figure 34: Subwoofer Pre Amplifier Schematic

iii. Power Amplifier

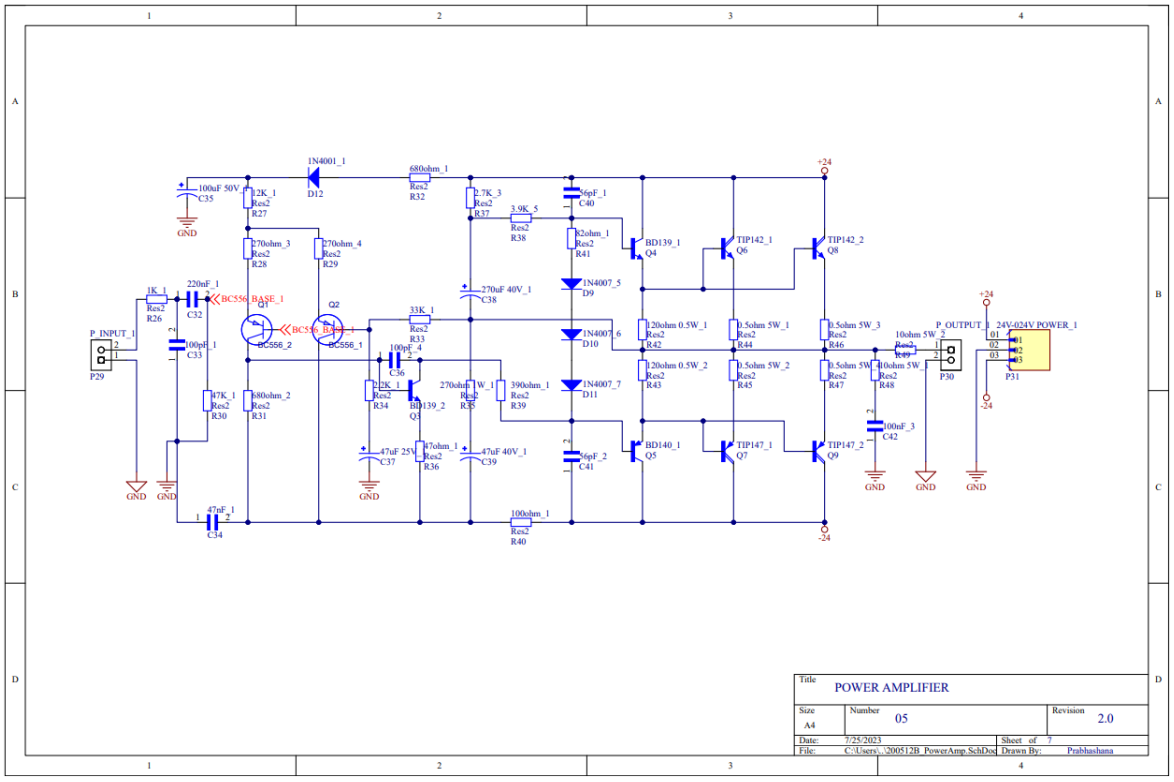


Figure 35: Power Amplifier Schematic

iv. Sound Reactive System

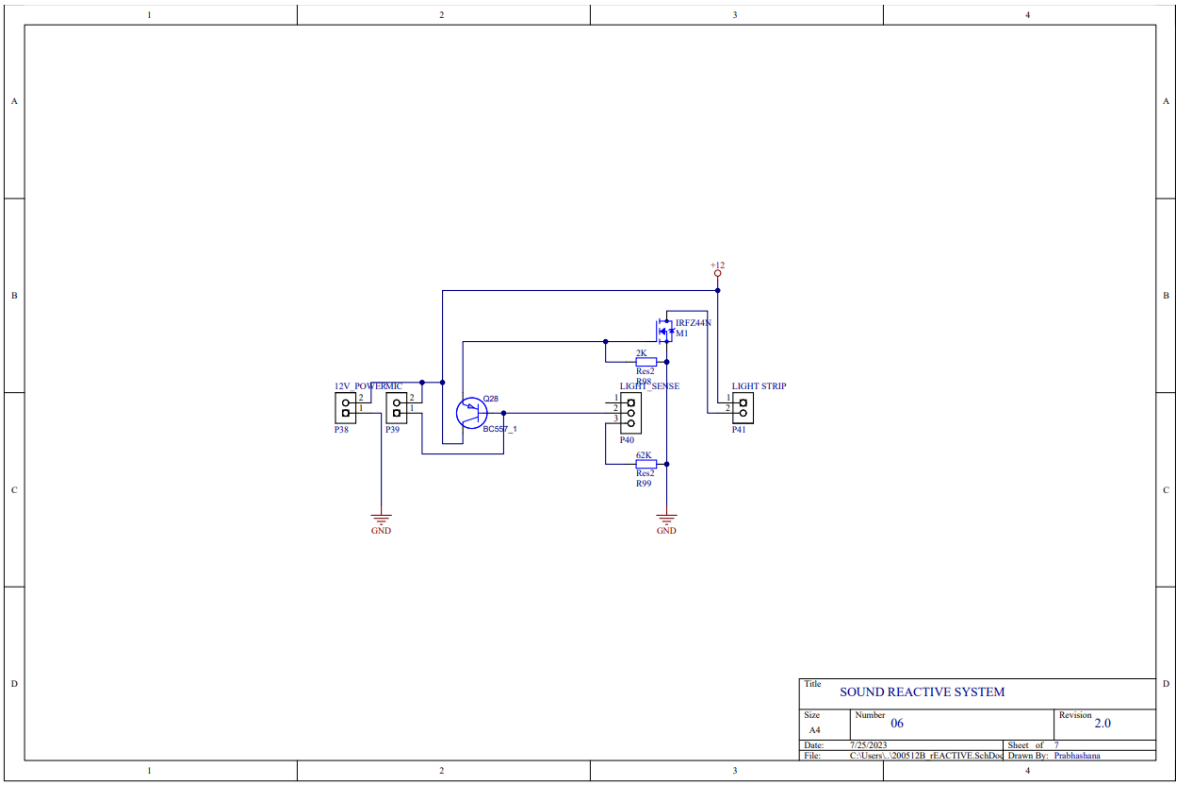


Figure 36: Sound Reactive System Schematic

11.3.2 PCB Layout

i. Power Supply Unit

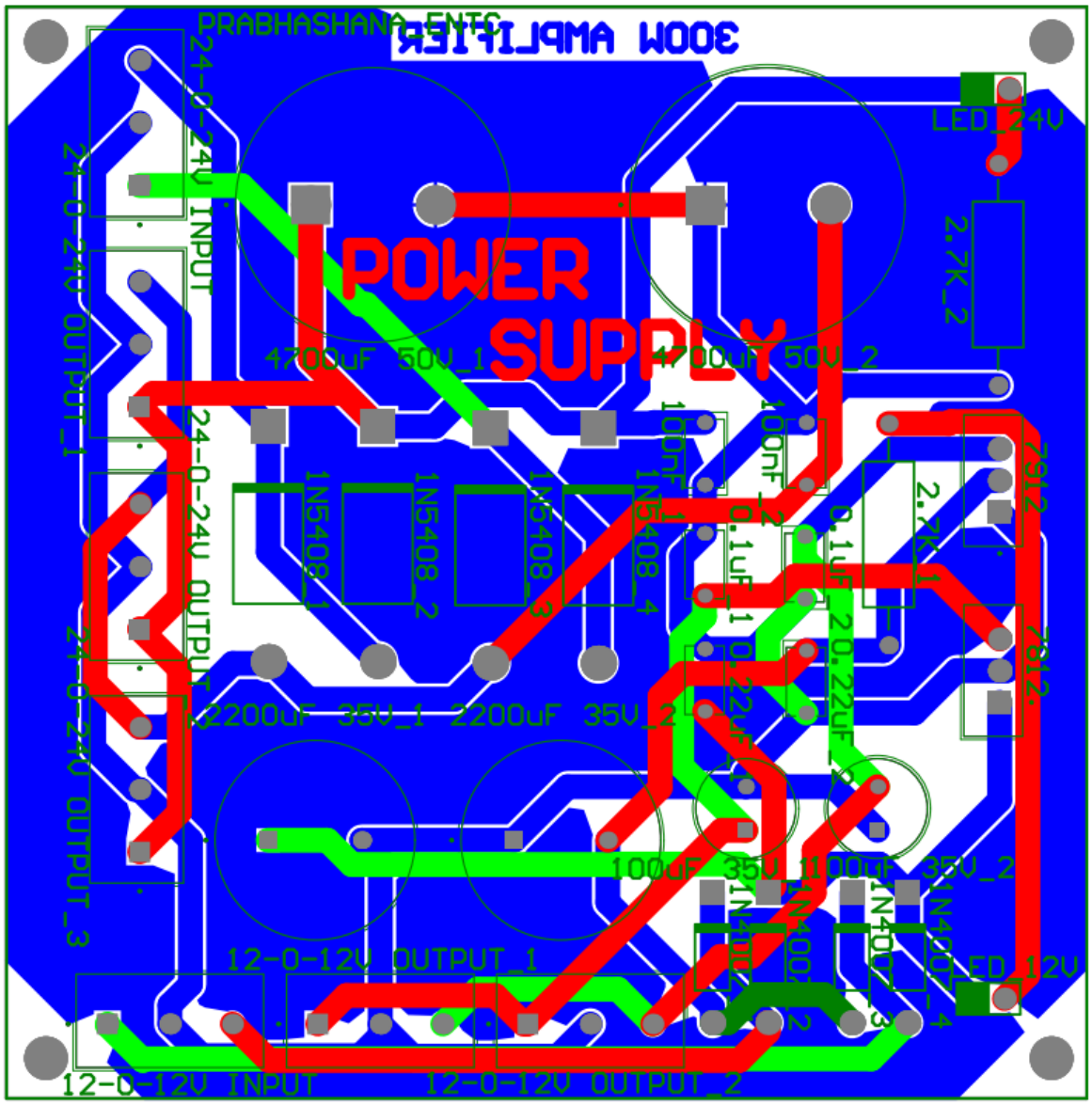


Figure 37: Power Supply Unit PCB

ii. Pre Amplifier

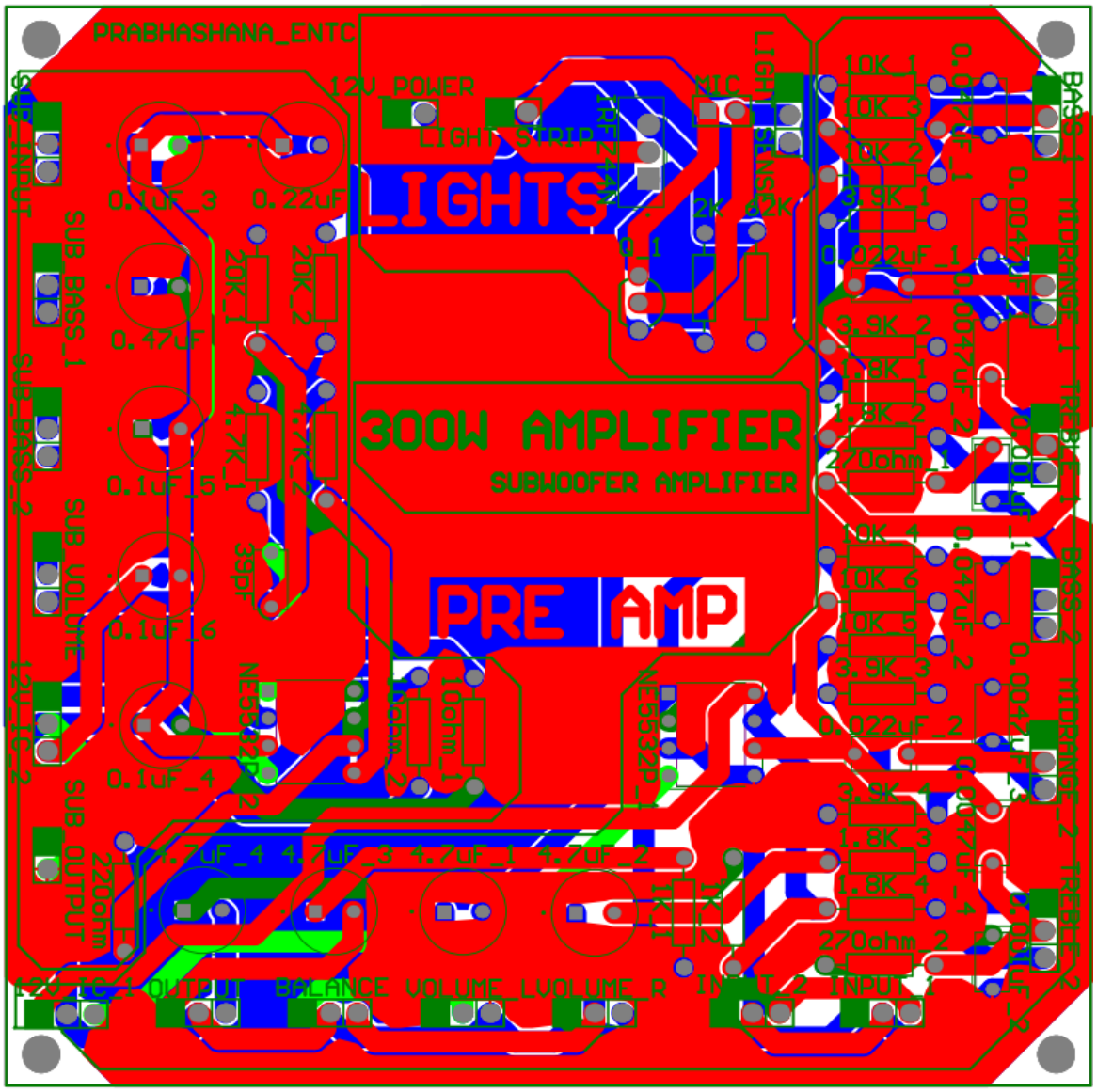


Figure 38: Pre Amplifier PCB

iii. Power Amplifier

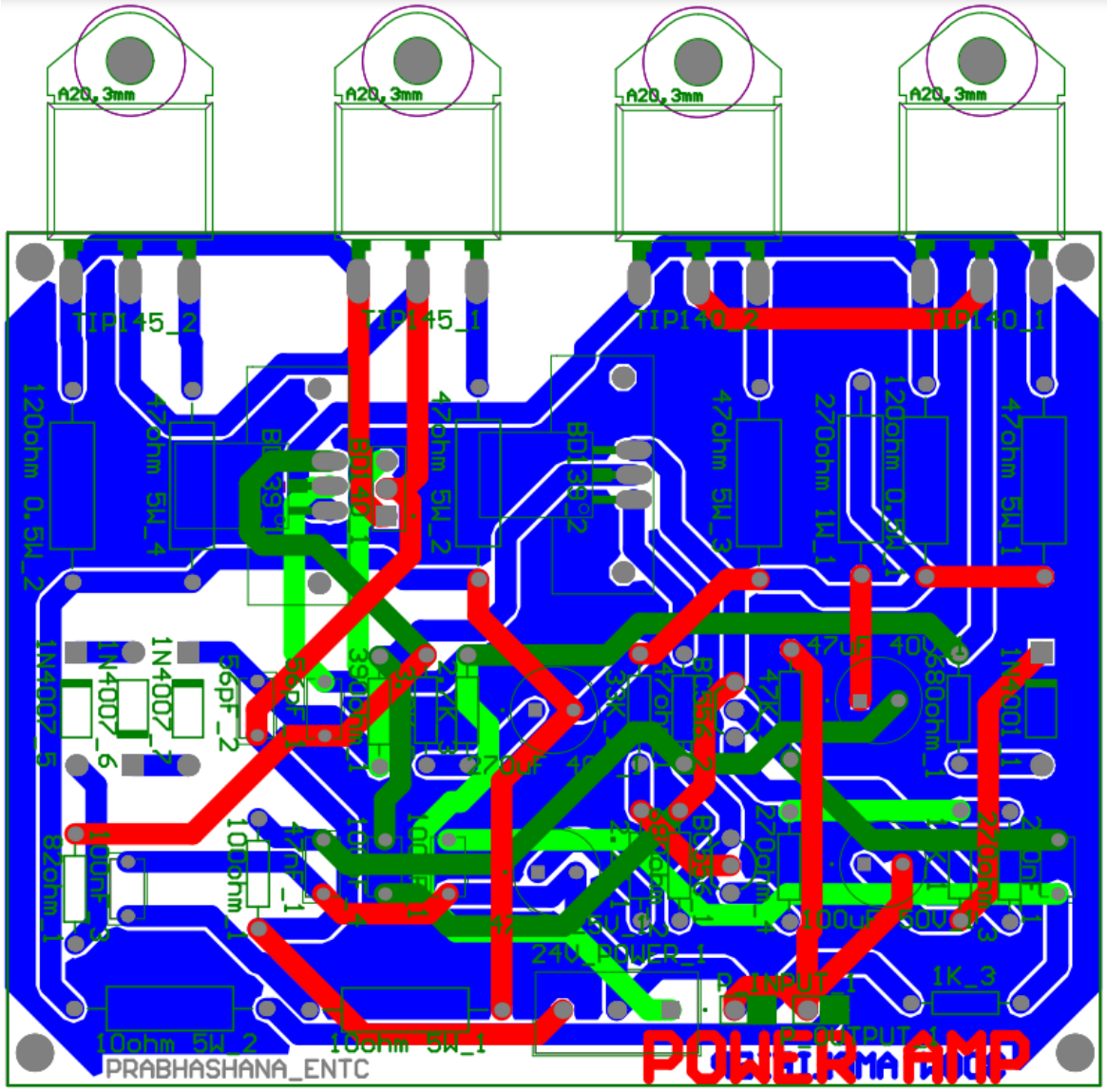
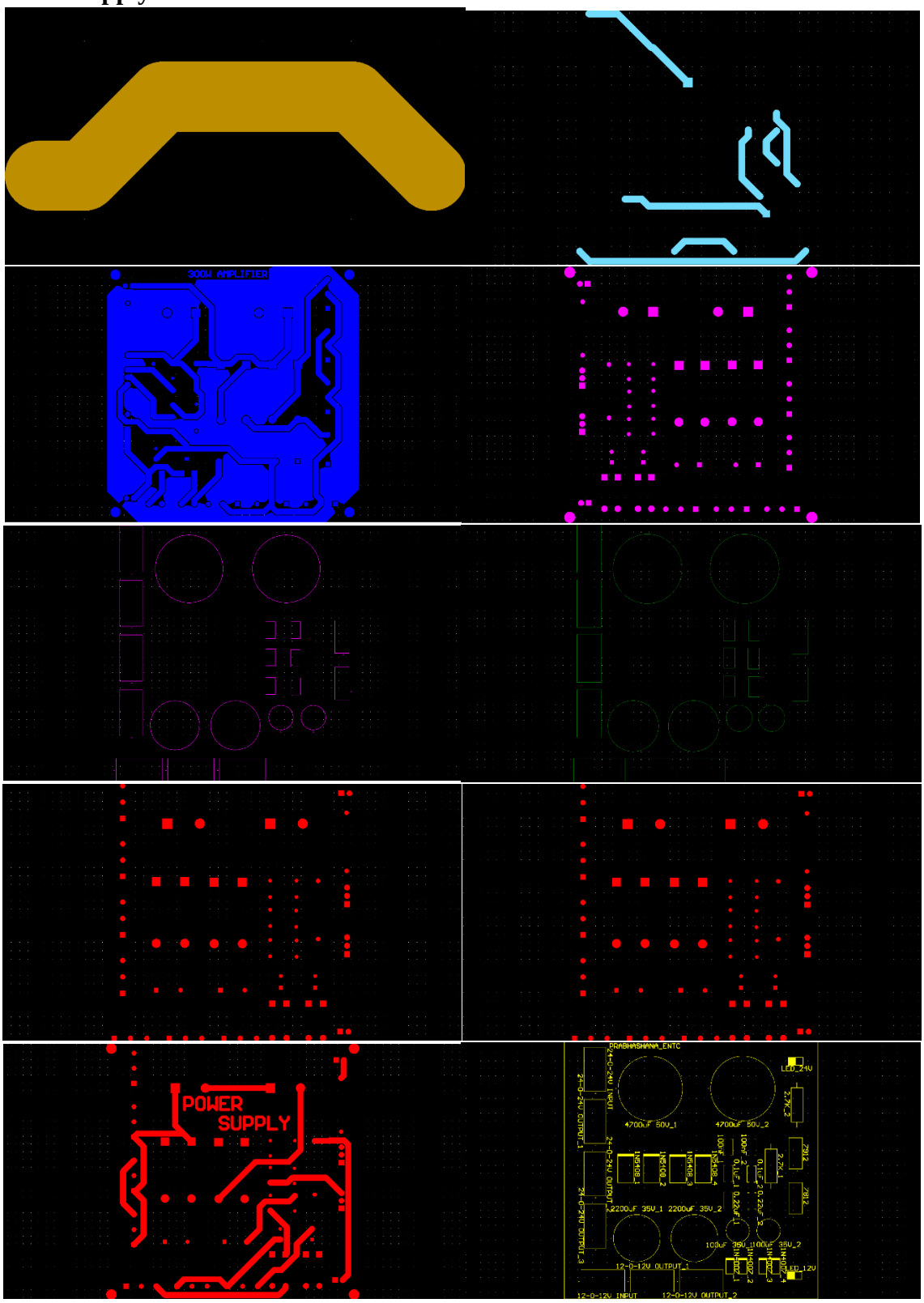


Figure 39: Power Amplifier PCB

11.3.3 Gerber Views

i. Power Supply Unit



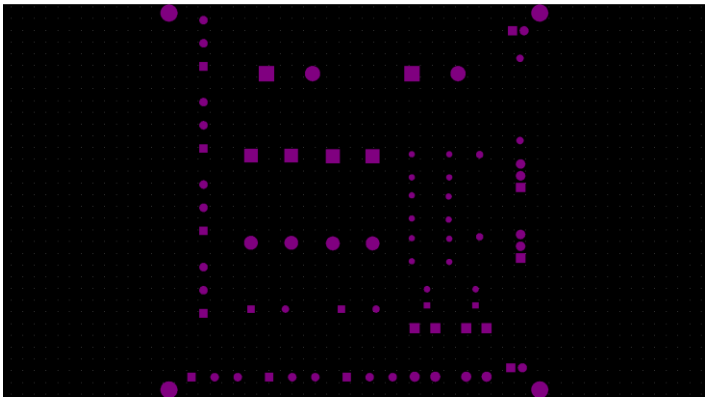
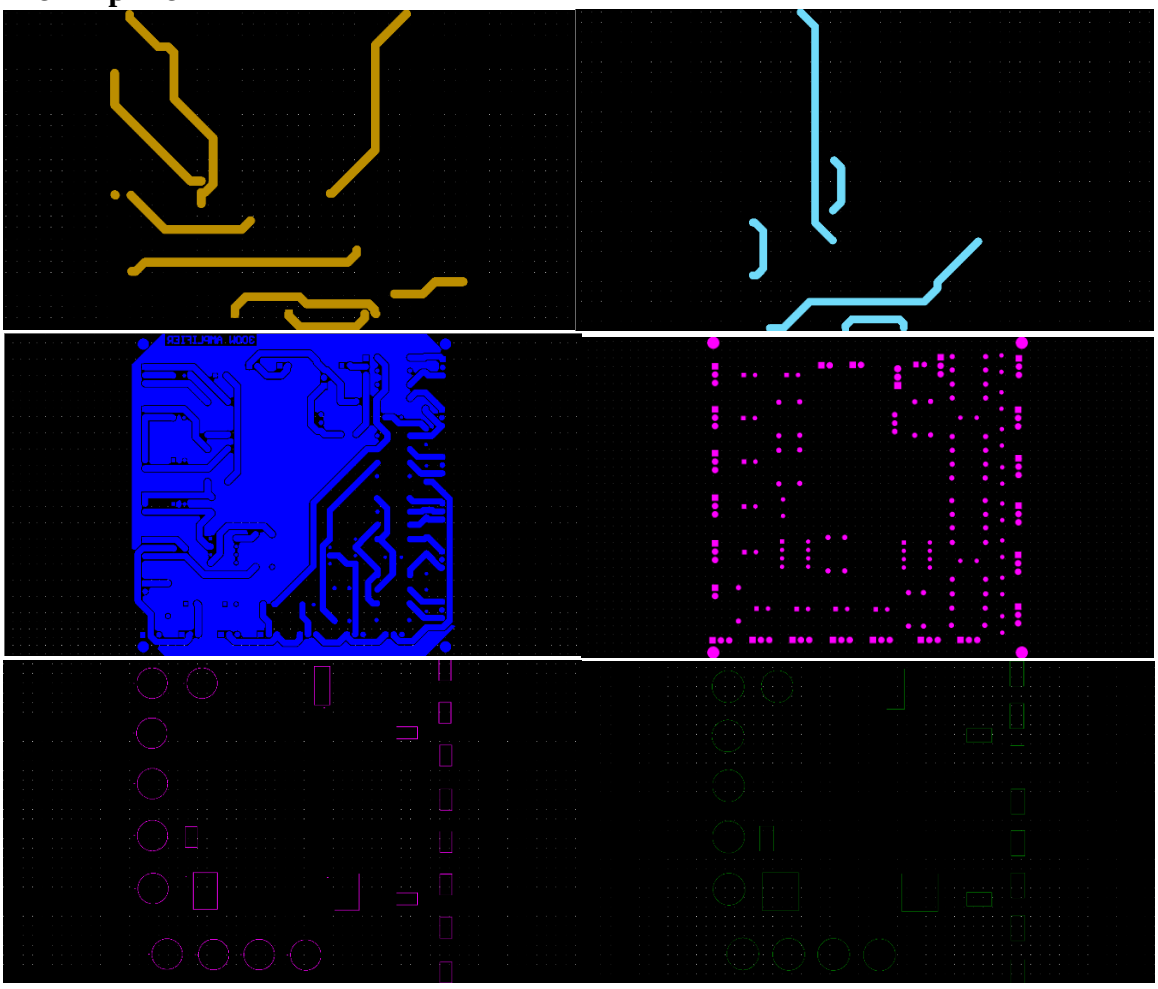


Figure 40: Gerber Views of Power Supply Unit PCB

ii. Pre Amplifier



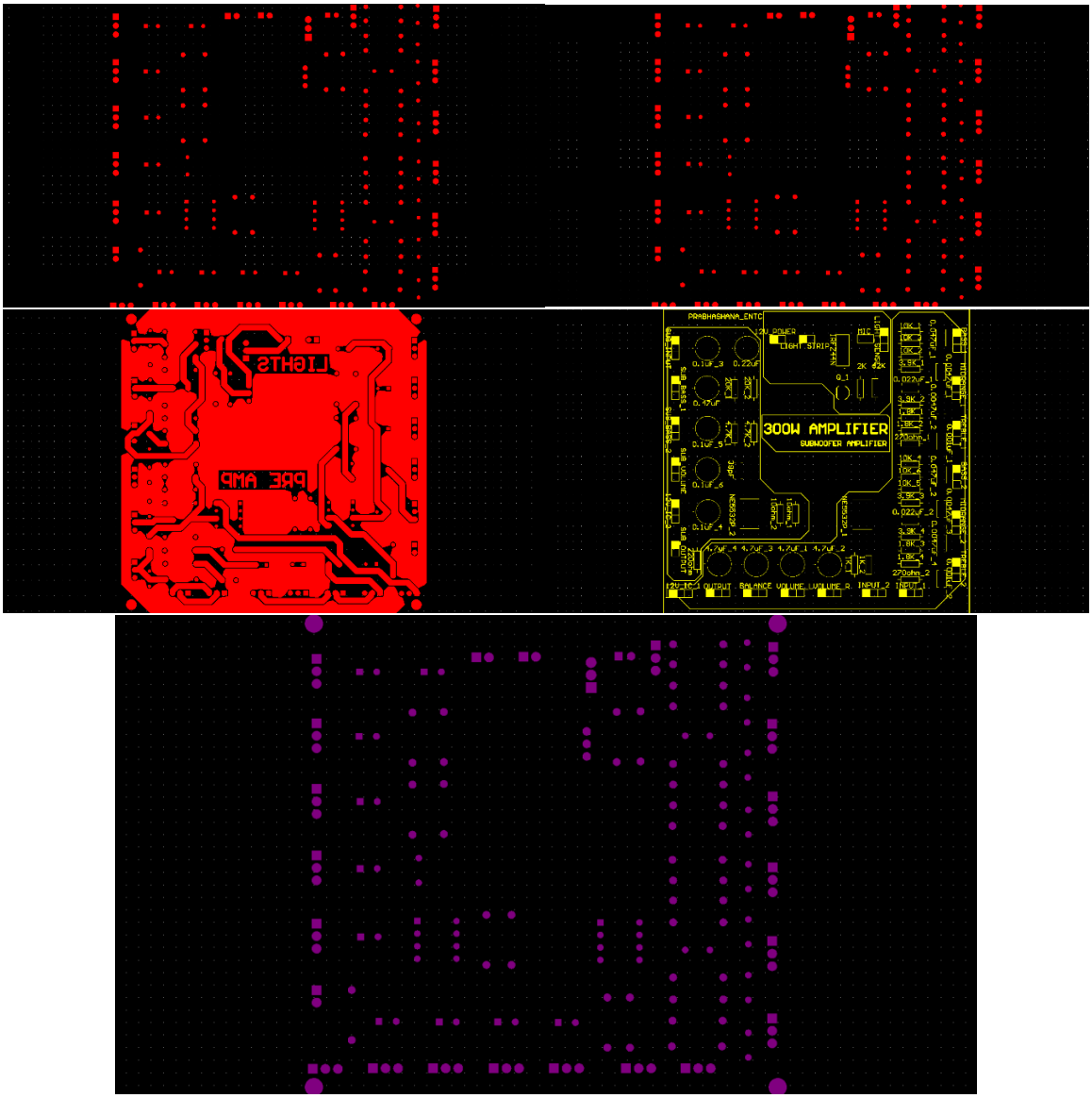


Figure 41: Gerber Views of Pre Amplifier PCB

iii. Power Amplifier

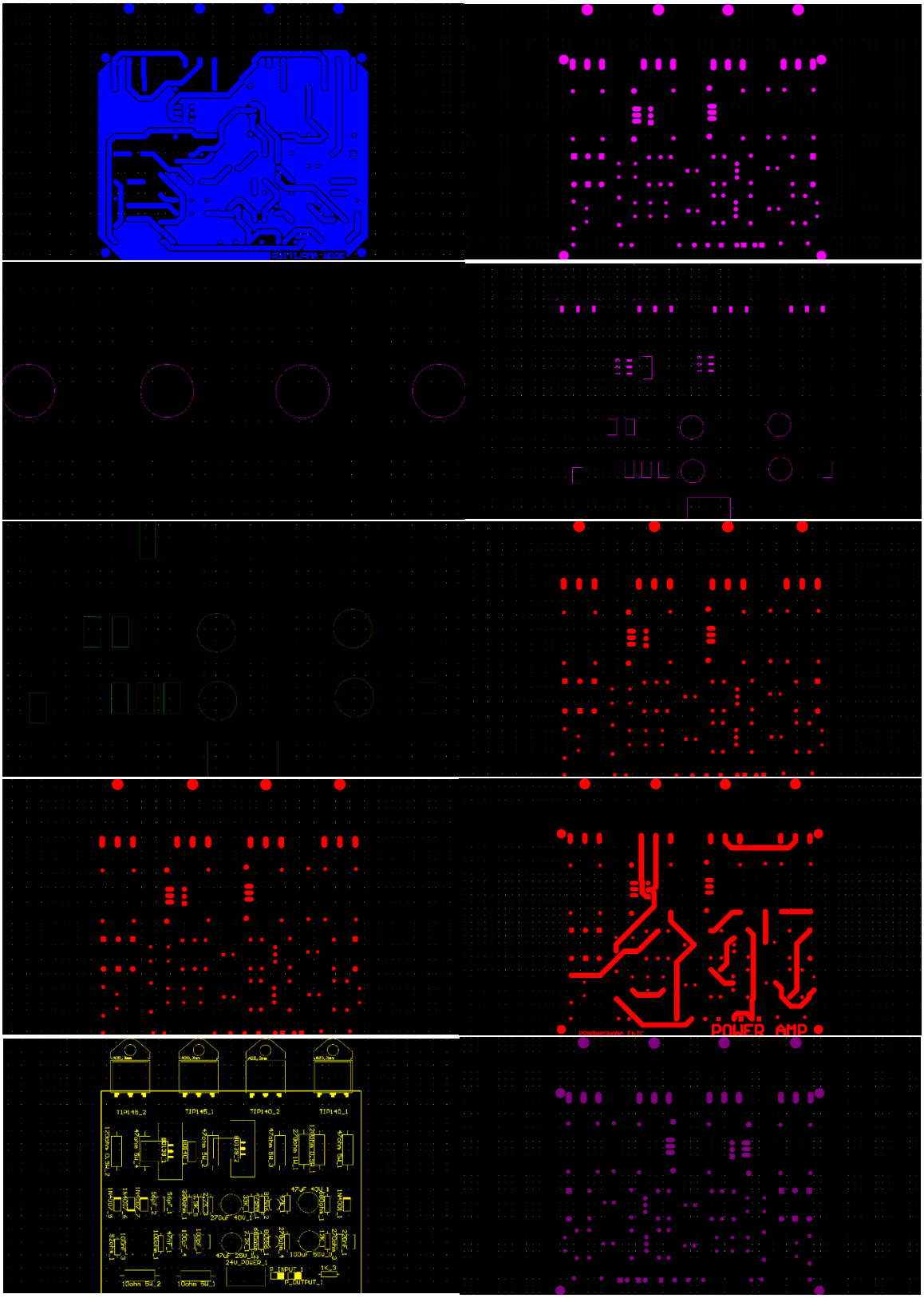


Figure 42: Gerber Views of Power Amplifier PCB

11.4 Appendix D – The Bill of Materials (BOM)

Item	Supplier	Cost (Rs.)
Components	Mouser	7726.28
	MICRO ELECTRONICS LTD.	380.00
	TRONIC.LK	7745.00
	ASIA ELECTRONICS	350.00
	DIGITAL ELECTRONICS (PVT) LTD.	320.00
	UNITECH TRADING (PVT) LTD.	2277.00
	Ranaweera Trade Center (PVT) LTD.	2000.00
PCB	JLC PCB	10207.08
Enclosure	Xydder 3D Labs	15050.00
Others		1500.00
Total Cost		47555.36

Table 2: The Bill of Materials

12 References

12.1 Datasheets

[1]. https://pdf1.alldatasheet.com/datasheet-pdf/view/2893/MOTOROLA/BC556.html
[2]. https://pdf1.alldatasheet.com/datasheet-pdf/view/2920/MOTOROLA/BD139.html
[3]. https://pdf1.alldatasheet.com/datasheet-pdf/view/2921/MOTOROLA/BD140.html
[4]. https://pdf1.alldatasheet.com/datasheet-pdf/view/27244/TI/NE5532.html
[5]. https://pdf1.alldatasheet.com/datasheet-pdf/view/2772/MOSPEC/TIP142.html
[6]. https://pdf1.alldatasheet.com/datasheet-pdf/view/2775/MOSPEC/TIP147.html
[7]. https://pdf1.alldatasheet.com/datasheet-pdf/view/17807/PHILIPS/IRFZ44N.html

12.2 Books

[1]. Electronic Devices and Circuits 4th Edition Millman, Halkias and Jit, 2015 ISBN 13: 9789339219543 2.
[2]. Active Filters: Theory & Design, S. A. Pactitis, CRC Press ISBN-13: 978-1- 4200-5477-4 (eBook - PDF)