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The Mini Project

Report on

Audio Amplifier Using PAM 8403 IC

Bachelor of Engineering
in

ELECTRONICS AND COMMUNICATION ENGINEERING

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Mini Project Guide

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SAPTHAGIRI COLLEGE OF ENGINEERING

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CERTIFICATE

This is to certify that the Mini Project Report entitled “Audio Amplifier Using PAM 8403 IC” is a bonafide work of Ravikiran T[1SG22EC089], Shashank M S [1SG22EC100], Shashank N [1SG22EC101], Thilak T [1SG22EC114] student of V semester B.E, at Sapthagiri College of Engineering, Bangalore in partial fulfillment of the requirement of Mini Project work of Visvesvaraya Technological University, Belagavi, during year 2024-2025. It is certified that all the corrections/suggestions indicated for Internal Assessment have been incorporated in the report submitted to the department. The report has been approved as it satisfies the academic requirements as prescribed by the university.

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ABSTRACT

The audio amplifier using PAM8403 is a compact and efficient solution for enhancing audio playback in various electronic devices. The PAM8403 is a class-D amplifier integrated circuit capable of delivering high-quality stereo audio output with low power consumption. This amplifier module is particularly popular for its small size and ease of integration into portable devices such as speakers, headphones, and other audio systems.

The PAM8403 operates with a wide voltage range, making it versatile for different power supply configurations. Its digital class-D architecture ensures efficient power usage, minimizing heat generation and extending battery life in portable applications. The amplifier supports a broad range of audio input sources, making it suitable for various audio playback devices.

The module's simplicity in design, featuring minimal external components, facilitates easy implementation, even for electronics enthusiasts and hobbyists. Despite its compact size, the PAM8403 is capable of delivering clear and powerful audio output, making it an ideal choice for applications where space constraints and power efficiency are crucial considerations. Overall, the audio amplifier using PAM8403 stands out as a cost-effective, compact, and energy-efficient solution for enhancing audio performance in a wide range of electronic devices.

The PAM8403 is a compact, low-power, Class D audio amplifier IC designed for applications requiring high efficiency and minimal distortion. Operating on a supply voltage range of 2.5V to 5.5V, it delivers up to 5W per channel into 4Ω speakers in stereo mode.

CHAPTER 1:

1.1 INTRODUCTION

An audio amplifier serves as a crucial component in enhancing the sound quality and volume of audio signals, making it an integral part of various electronic devices such as portable speakers, headphones, and audio systems. The PAM8403, a highly efficient and compact audio amplifier integrated circuit, has gained significant popularity for its ability to deliver robust performance in a small form factor. In this introduction, we delve into the fundamentals of the audio amplifier using the PAM8403, exploring its key features, working principles, and applications.

The PAM8403 is a class-D amplifier, characterized by its efficiency in converting digital audio signals into amplified analog audio output. Its compact size and low power consumption make it an ideal choice for battery-powered devices and applications where space is a constraint. Operating on a dual-channel configuration, the PAM8403 is capable of delivering stereo audio output, catering to the demands of modern audio systems that require immersive and high-quality sound reproduction.

One of the standout features of the PAM8403 is its impressive power efficiency, achieved through its class-D design. Unlike traditional linear amplifiers, class-D amplifiers minimize power dissipation, resulting in a more energy-efficient operation. This makes the PAM8403 particularly suitable for portable electronics, where battery life is a critical factor.

The PAM 8403 IC produces low distortion and noise, ensuring clear and crisp audio output. Its compact size and affordability make it popular among hobbyists and professionals alike. Whether for small audio systems or DIY speaker projects, the PAM8403 is a versatile and efficient choice for amplifying sound in compact setups.

1.2 CIRCUIT DIAGRAM AND BLOCK DIAGRAM OF Audio Amplifier Using PAM8403

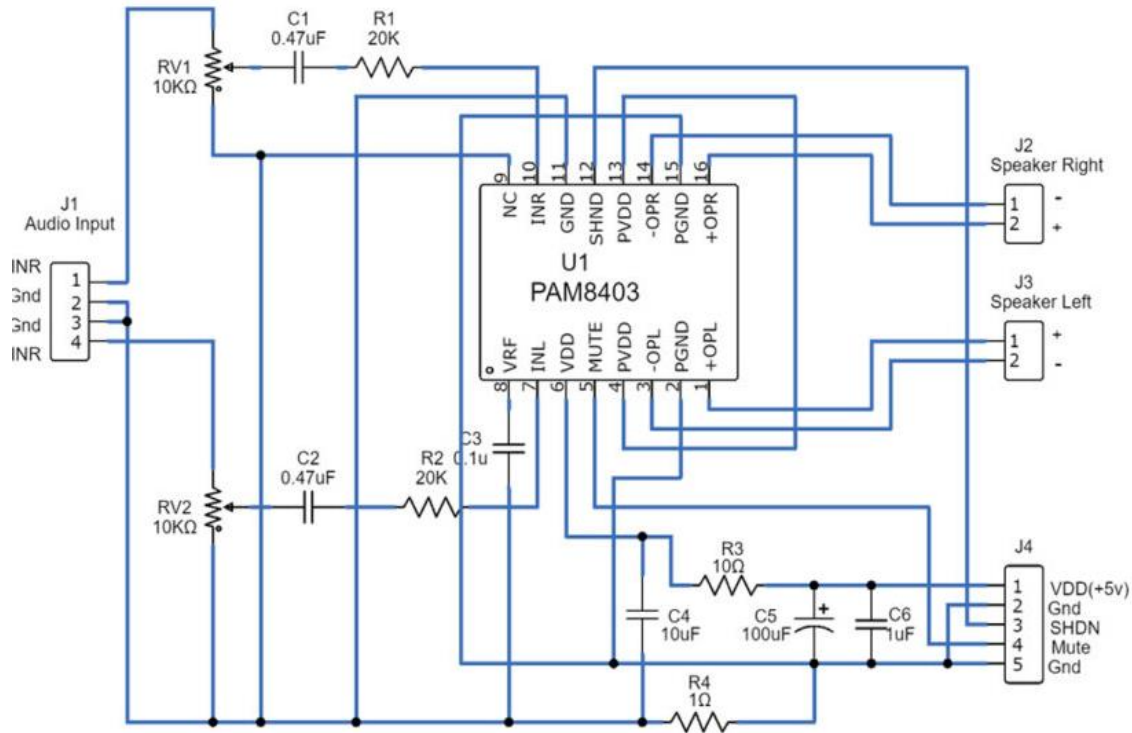


FIG 1.0: Circuit Diagram of Audio Amplifier Using PAM8403.

The PAM8403 is a compact audio amplifier IC suitable for various applications. To create a simple audio amplifier using the PAM8403, connect the input audio signal to the IN+ and IN- pins, and provide a power supply within the recommended voltage range of 2.5V to 5.5V. Connect the speakers to the OUTL and OUTR pins. Add decoupling capacitors at the power supply inputs for stability, as shown in fig 1.0. The PAM8403 is a Class-D amplifier, so it efficiently amplifies audio signals with low power consumption. Ensure proper grounding and follow the datasheet guidelines for optimal performance. This compact module is ideal for portable audio projects.

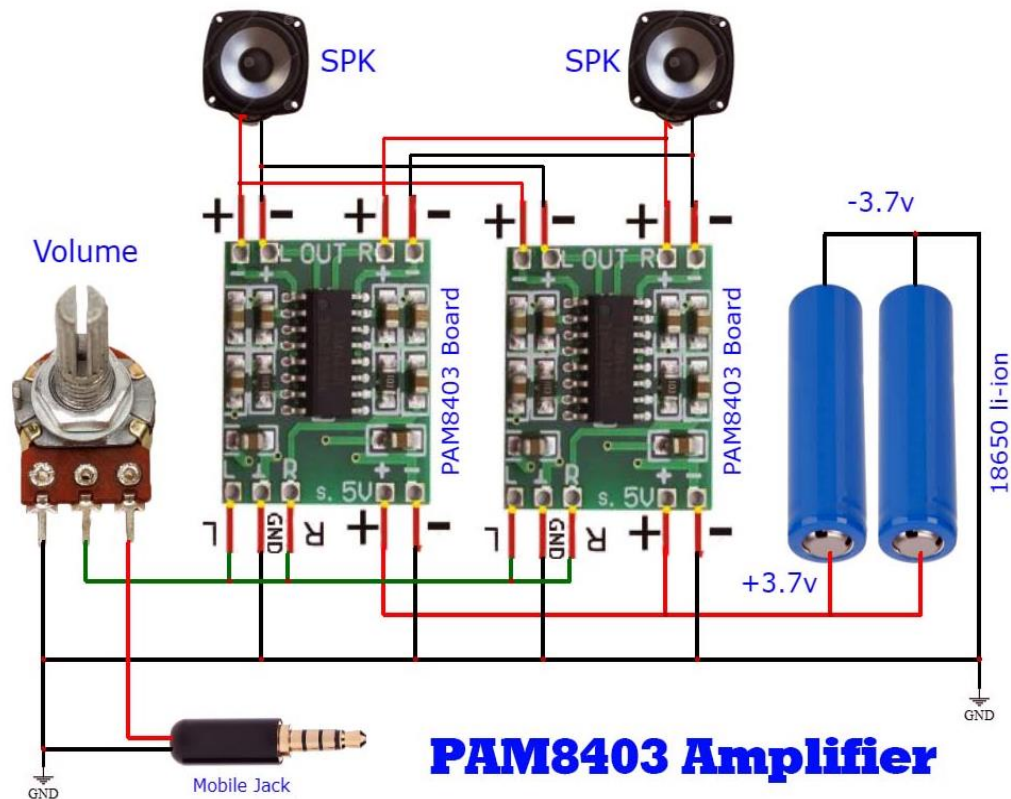


FIG 1.1: Block Diagram of Audio Amplifier Using PAM8403.

The block diagram of an audio amplifier using PAM8403 typically consists of four main sections: an audio input stage, a pre-amplification stage, a power amplification stage utilizing the PAM8403 chip, and an output stage. The audio input receives the signal, which is then pre-amplified to an appropriate level. The fig 1.1 shows the block diagram of PAM8403, an audio amplifier IC, handles power amplification, boosting the signal to drive speakers. Finally, an output stage filters and conditions the amplified audio before transmitting it to the connected speakers. This compact and efficient design makes PAM8403 a popular choice for portable audio applications due to its small size and low power.

CHAPTER 2:

2.1 SPECIFICATION

- The PAM8403 is a compact and efficient audio amplifier widely used for low-power applications
- **Output Power:** The PAM8403 can deliver up to 3W per channel (2 channels) into a 4-ohm load, making it suitable for small audio devices such as portable speakers.
- **Power Supply:** Operating on a low voltage, it typically requires a power supply between 2.5V to 5V DC, making it energy-efficient and versatile.
- **Input Impedance:** With a low input impedance of around 15k ohms, it accommodates various audio sources like smartphones, tablets, or other devices.
- **Signal-to-Noise Ratio (SNR):** The amplifier offers a good SNR, ensuring clear audio reproduction with minimal interference or noise, typically greater than 90 db.
- **Efficiency:** Known for its high efficiency, the PAM8403 minimizes power wastage, making it suitable for battery-powered applications.
- **Size and Form Factor:** Its compact size and surface-mount design make it ideal for space-constrained projects, providing flexibility in design.
- **Built-in Volume Control:** The PAM8403 often includes a built-in digital volume control, allowing easy adjustment of audio levels in the system.
- **Low Distortion:** The amplifier produces low harmonic distortion, maintaining audio quality even at higher volumes.
- **Thermal Protection:** Integrated thermal protection mechanisms prevent the IC from overheating, enhancing the overall reliability of the amplifier.

2.2 WORKING PRINCIPLE AND OPERATION

The **PAM8403** is a highly efficient stereo audio amplifier IC that works on the principle of **Class-D amplification**. Unlike traditional amplifiers such as Class-A or Class-AB, which directly amplify the analog audio signal and waste a significant amount of energy as heat, the PAM8403 first converts the input audio signal into a **high-frequency pulse-width modulated (PWM) signal**. This PWM technique allows the internal MOSFET transistors to operate only in two states – fully ON or fully OFF. Since the transistors spend almost no time in the partially conducting region, the power loss is greatly minimized. This makes the IC extremely efficient, achieving up to **90% efficiency**, which allows it to deliver high output power while producing very little heat. For this reason, the PAM8403 does not require a heatsink, even during extended operation.

The IC is a **stereo amplifier**, meaning it provides two separate channels, left and right, for audio output. Each channel uses a **bridge-tied load (BTL) configuration**. In a BTL system, the output is connected in such a way that the speaker receives a voltage difference from two active outputs instead of one output and ground. This doubles the effective voltage swing across the speaker and increases the output power. Additionally, this arrangement eliminates the need for bulky output coupling capacitors, making the circuit more compact and cost-effective. The high-frequency PWM signal at the output is naturally filtered by the **inductance and capacitance of the speaker**, so the listener hears a clean and amplified audio signal.

The PAM8403 is designed to operate from a **2.5V to 5.5V power supply**, with 5V being the most common when powered from a USB source or battery. Under these conditions, it can deliver up to **3 watts per channel into a 4Ω speaker**, which is sufficient for small speaker systems, desktop audio, and portable devices. The IC also integrates several important **protection features**, including short-circuit protection, thermal shutdown, and over-voltage protection, which make it safe and reliable in practical use.

Because of its small size, low power consumption, high efficiency, and good sound quality, the PAM8403 has become a popular choice in **portable audio systems, Bluetooth speakers, MP3 players, USB-powered amplifiers, and DIY electronic projects**. Its simple design requirements, combined with its ability to deliver clear and loud audio, make it one of the most widely used low-power amplifier ICs in modern consumer electronics.

CHAPTER 3:

3.1 ADVANTAGES

- **Compact Size:** PAM8403 is a small-sized chip, enabling compact audio amplifier designs.
- **Low Power Consumption:** It operates efficiently, consuming minimal power for extended battery life in portable devices.
- **Dual-Channel Output:** Supports stereo audio output for a rich and immersive sound experience.
- **Wide Voltage Range:** Operates within a broad voltage range, making it versatile for various applications.
- **Simple Circuit Design:** Requires minimal external components, simplifying the overall amplifier circuit design.
- **Cost-Effective:** PAM8403 offers a cost-efficient solution for audio amplification needs.
- **Low Noise and Distortion:** Provides clear audio output with minimal interference.
- **Easy Integration:** Compatible with diverse audio sources and easily integrated into electronic projects.
- **Ideal for DIY Projects:** Popular choice for hobbyists due to its ease of use and reliability.
- **Ample Output Power:** Despite its small size, it delivers sufficient power for many audio applications.
- **High Efficiency:** Minimal heat generation.
- **No External Heatsink Needed:** Reduces design complexity.
- **Low EMI:** Minimizes electromagnetic interference in circuits.

3.2 APPLICATION

- **Portable Speakers:** Construct compact and powerful portable speakers for mobile devices, providing enhanced audio quality on the go.
- **DIY Audio Projects:** Ideal for hobbyists and enthusiasts to build custom audio systems, amplifying the sound output with the PAM8403 module.
- **Educational Purposes:** Great for educational settings, demonstrating basic principles of audio amplification and electronic circuit design.
- **Computer Audio Upgrade:** Enhance the audio output of computers or laptops by integrating the PAM8403 into external speakers for a richer listening experience.
- **Home Automation:** Incorporate the amplifier into smart home setups for improved sound quality in voice-controlled devices or home entertainment systems.
- **Gaming Accessories:** Design gaming accessories such as DIY gaming headsets or speakers for immersive audio experiences.
- **Low-Power Applications:** Efficient power consumption makes it suitable for battery-powered devices, extending the life of portable audio gadgets.
- **Audio for Microcontrollers:** Integrate the PAM8403 into microcontroller-based projects, adding amplified sound output to various applications.
- **Audio Learning Kits:** Feature in audio electronics learning kits, fostering hands-on experience in circuit design and amplification principles.
- **Budget-Friendly Solutions:** Create cost-effective audio solutions without compromising on sound quality for a wide range of applications.

CHAPTER 4:

4.1 APPENDIX:

- VDD (Pin 1): Function: Power supply input. Connect this pin to a 5V DC source. Proper decoupling with a capacitor (e.g., 0.1 μ F and 10 μ F) is recommended to ensure stable operation.
- OUTR+ (Pin 2): Function: Positive output for the right audio channel. Connect this pin to the positive terminal of the right speaker.
- OUTR- (Pin 3): Function: Negative output for the right audio channel. Connect this pin to the negative terminal of the right speaker.
- GND (Pin 4): Function: Ground connection. Connect this pin to the circuit ground.
- OUTL- (Pin 5): Function: Negative output for the left audio channel. Connect this pin to the negative terminal of the left speaker.
- OUTL+ (Pin 6): Function: Positive output for the left audio channel. Connect this pin to the positive terminal of the left speaker.
- INL (Pin 7): Function: Audio input for the left channel. Connect to the left channel audio source, typically via a coupling capacitor.
- INR (Pin 8): Function: Audio input for the right channel. Connect to the right channel audio source, typically via a coupling capacitor.

4.2 COST ESTIMATION

SL.NO	NAME	QUANTITY	COST
1	PAM8403 IC	1	100
2	Speakers	2	400
3	47 μ F capacitor	3	30
4	Audio jack cable	1	50
5	Connecting wire	4	20

TOTAL COST-RS: 600

4.3 CONCLUSION

The PAM8403 is a highly efficient, compact, and versatile Class-D audio amplifier IC that has gained significant popularity in low-power audio applications. Known for its ability to deliver clear and high-quality sound, it is ideal for portable devices, battery-powered systems, and cost-effective audio solutions. With an output power of 3W per channel at 4Ω and a 5V power supply, the PAM8403 is capable of driving small speakers while maintaining a high signal-to-noise ratio (SNR) and minimal total harmonic distortion (THD). These features ensure superior audio performance without significant loss of quality or introduction of noise.

One of the standout features of the PAM8403 is its energy efficiency, attributed to its Class-D architecture. This design not only minimizes power consumption but also reduces heat dissipation, making the IC suitable for compact, heat-sensitive applications. The device operates over a wide voltage range and consumes very low standby current, further enhancing its adaptability to various power sources and usage scenarios.

Another advantage of the PAM8403 is its simplicity. The IC requires minimal external components, making it easy to design and implement in projects. Its built-in features, such as low electromagnetic interference (EMI) and short-circuit protection, add to its robustness and reliability, ensuring stable performance over time.

Applications of the PAM8403 range from portable speakers and soundbars to multimedia systems and educational DIY kits. Its affordability, compact size, and excellent sound quality have made it a preferred choice among hobbyists and professionals alike.

4.4 REFERENCES

[1] How to make a PAM8403 audio amplifier.

<https://www.circuits-diy.com/simple-pam8403-audio-amplifier-circuit/>

[2] How to make an audio amplifier using PAM 8403 IC.

https://youtu.be/IppZkh-zU8Y?si=SQ3_A7YyAb3CLx36