Application Brief

TAS6584-Q1 in Personal Electronics

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Introduction

A four-channel, high-power audio amplifier is now available for the personal electronics industry. The TAS6584-Q1 is a digital input, Class-D audio amplifier with high-quality audio performance, integrated protection, and advanced diagnostics. The TAS6584-Q1 device was originally designed for use in automotive external amplifiers and head units. However, the TAS6584-Q1 features can be used in high-end soundbars, professional audio, and multiroom audio distribution systems to improve the current designs of these applications.

Soundbar

Soundbar systems work by producing high-quality audio similar to a surround sound system using a mix of speaker types such as tweeters, mid-range drivers, woofers, and subwoofers. The speakers are angled towards different points in the room, and designing the system to direct sound at the ceiling to *bounce* the audio back down onto the listener creates a more immersive home theater experience similar to Figure 1.

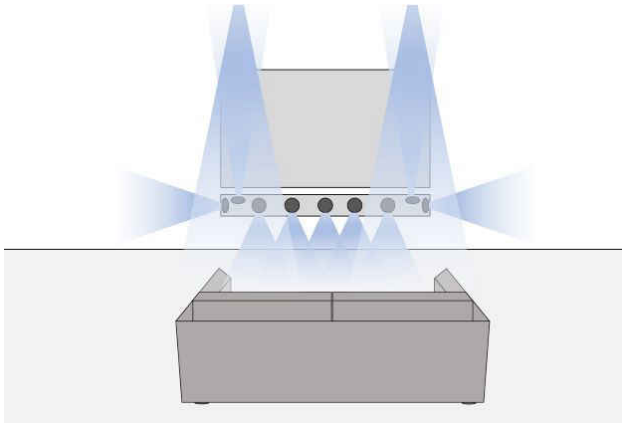

Figure 1. Surround Sound System

Audio output generation in a soundbar typically consists of a digital-to-analog converter (DAC) to convert the digital signals back to the original audio signal. The original audio signal then travels into the chosen Class-D amplifiers to generate the virtual surround sound presentation of the soundbar system. Using a digital-input audio amplifier; however, removes the need for the DAC, offering a simpler design compared to a discrete design such as modulator and power stage design. In early generations of soundbars, the speaker amplifiers supported one to three channels accounting for sound coming from the left, right, and center of the soundbar, and traditional audio amplifiers used in the industry are typically stereo-channeled devices. Recent systems are trending towards increasing the number of speaker channels, and advanced surround sound audio technology is driving directional audio towards higher power. Following this trend, the four-channel TAS6584-Q1 is designed for applications using multiple stereo-channel devices, allowing the customer to achieve high-fidelity audio in a smaller package. Additionally, the device achieves excellent audio performance with a signal-to-noise ratio (SNR) greater than 110 dB, making the TAS6584-Q1 a key differentiator in the soundbar market and helping phase-current designs to improve their design specifications. Overall, the TAS6584-Q1 is an excellent fit for high-end soundbar systems that require more than two channels with high voltage, current, and output power.

Professional and Public Address Speakers

Professional and public address (PA) speakers are another personal electronic application that the TAS6584-Q1 can improve. Typical PA speakers work by accepting audio from a microphone, instrument, or Bluetooth® stream and sending the audio through the amplifier and loudspeaker to serve as either personal or full-scale PA systems. Similar to the soundbar, the audio amplifiers in this application are trending towards higher output power and higher channel count to send loud, high-quality sound to a large amount of people. While the TAS6584-Q1 is more than capable of supporting this trend, the device also has a high maximum operating voltage of 45 V that enables the use of higher impedance loudspeakers, such as 16 Ω. Additionally, this device offers DC offset protection that detects any unbalance of the output and input current and allows for lower pop noise. Another important feature of portable PA systems is

longer battery life, which can be achieved using the Class-H control of the TAS6584-Q1.

Class-H works by monitoring the audio-input signal up to 5 ms ahead and sending a pulse-width modulated (PWM) control signal to the boost converter that then outputs the supply voltage in time for the audio to play without clipping. This design prevents the audio amplifier and speaker from being damaged from clipping and optimizes efficiency by varying the PVDD voltage the minimum level needed to produce the intended audio signal as seen in Figure 2.

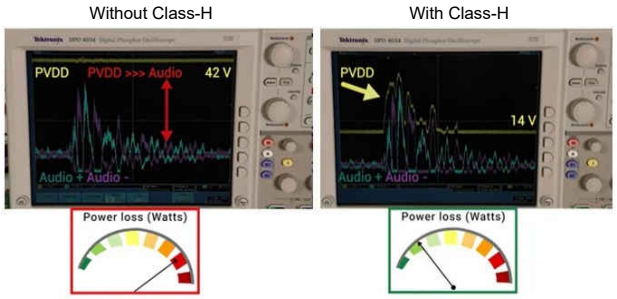

Figure 2. Class-H Efficiency

Compare Figure 3 with Figure 4 to see that Class-H improves system efficiency leading to better thermal performance that can contribute to a smaller heat sink. By dynamically tracking the envelope of the audio waveform with Class-H control, the audio design demonstrates improved efficiency and power savings that otherwise are dissipated if the PVDD voltage is fixed. Increasing output power, number of channels, and efficiency for PA speakers can be accomplished using the TAS6584-Q1.

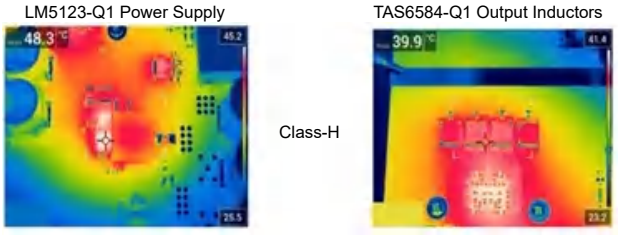

Figure 3. Thermal Images With Class-H Control

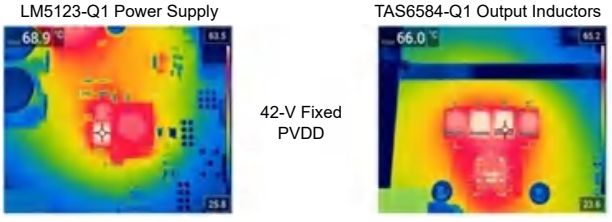

Figure 4. Thermal Images Without Class-H Control

For more information on Class-H control, see the CES2022 Virtual Demonstration, technical article, and Class-H Control Reference Design.

Rackmount Amplifiers

The TAS6584-Q1 can also be used in rackmount amplifiers that contribute to a multiroom audio distribution system. This application functions like a wired amplifier with a network interface that receives audio and sends the audio signal to multiple speaker channels to produce the same sound in different rooms or wide-spread areas. The constant voltage audio application is a popular method among rackmount amplifiers to produce the multiroom audio distribution. Instead of an individual amplifier driving each channel, a single amplifier is boosted to the desired voltage and outputs to a series of speakers in parallel with each other to achieve the desired impedance load.

Figure 5 shows this is often transformer-coupled in which the amplifier is isolated through a transformer that can step up a lower voltage to the required bust voltage. While this type of system can get rather large, a common design includes power taps at each speaker to adjust the load to a specific impedance value, allowing varying sound levels in different coverage zones. Furthermore, this type of non-integrated system with different load impedances can benefit from the real time, AC, and DC load diagnostic features of the TAS6584-Q1, detecting when the speaker system falls into open load, shorted load, short-to-power, and short-to-ground fault conditions.

The AC and DC diagnostics prevent starting in a fault condition, while the real-time load diagnostics reports real-time impedance based on voltage prediction and current sense values to notify of fault conditions while audio is playing. An alternative approach is the series-parallel method, seen in Figure 6, in which the loudspeakers are wired so that the amplifier sees a net impedance of 8 Ω. In this case, the current sense capabilities of the TAS6584-Q1 can be used to monitor the current at each channel of the amplifier to verify the impedance of the series-parallel speakers are balanced with the correct amount of current.

The device supports other amplifier protection and monitoring features, such as overcurrent protection, over- and undervoltage protection, and thermal foldback (automatically adjusting audio output levels to keep the audio playing before reaching thermal shutdown), reported via I^2C. Generally, this type of multiroom audio distribution system can benefit from the current sense, diagnostics, and protection features of the TAS6584.

Table 1. LM5123 MOSFET vs TAS6584 Inductor Configuration Comparison

Waveform	Configuration	LM5123 MOSFET	TAS6584 Inductor
1-kHz, 900 ms, 1/8th power, 100-ms full power	With Class-H	56.6°C	56.4°C
	Without Class-H	76.6°C	76.2°C
Difference		20.1°C	19.8°C

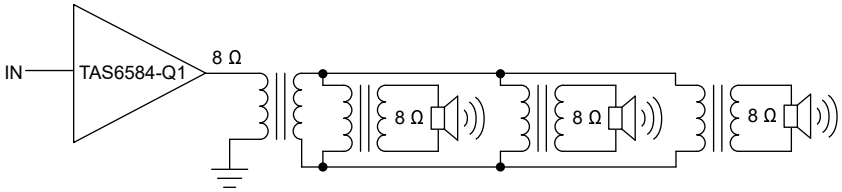

Figure 5. Transformer-Coupled Method With Isolated Amplifier

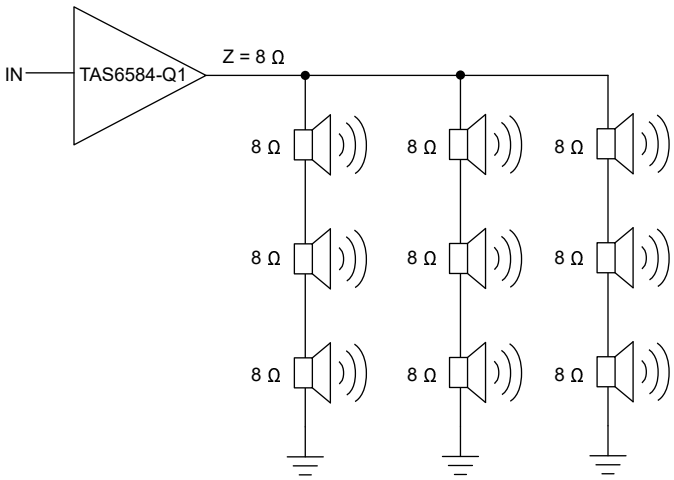

Figure 6. Series-Parallel Method

Conclusion

The TAS6584-Q1 offers a comprehensive design for soundbars, PA speakers, and rackmount amplifier designs. The simplification of the discrete design and four-channels cater to decreasing the size of the design by eliminating the need of a DAC and multiple two-channel audio amplifiers, while sill providing high-output power and high-fidelity sound. Professional audio applications can benefit from the high maximum operating voltage and low pop noise characteristics of the device to support high-impedance loudspeakers, and the Class-H algorithms can improve the battery life of battery-powered speakers by boosting efficiency and enhancing thermal performance. Furthermore, the current-sense capabilities and diagnostics features of the TAS6584 can help better monitor the status and promote functionality of multiroom audio distribution systems such as rackmount amplifiers. In conclusion, the high voltage, high power, and overall audio performance characteristics are great reasons to design using the TAS6584-Q1 and meet the upcoming demands of the personal electronics market.

Texas Instruments References

- TAS6584-Q1 product page
- *TAS6584-Q1 - 45-V, 10-A Digital Input 4-Channel Automotive Class-D Audio Amplifier with Current Sense and Real-time Load Diagnostics* data sheet
- *Optimize system efficiency and power consumption with Class-H power control* video training
- Creating an immersive automotive audio experience with higher output power and Class-H control E2E™ blog
- *Automotive Class-H audio and tracking power supply reference design*

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