Application Brief

Building Automation Audio Amplifiers and Piezo Souder: Features, Benefits, and Selection Guide



Introduction

Design reliable, high-performance audio for building automation applications with audio amplifiers from Texas Instruments (TI). Building automation systems depend on audio across three primary application areas — building security systems, fire safety systems, and HVAC — spanning video doorbells, IP cameras, electronic locks, security gateways, fire alarm sounders, smoke detectors, and smart thermostats. TI's Class-D and smart audio amplifier portfolio offers the power efficiency, compact integration, and advanced protection required for always-on, space-constrained building automation designs. In this document, you can find key features and device recommendations for different building automation products.

TI's Class-D amplifiers enable designers to:

- Improve system efficiency and reduce power consumption (Y-Bridge, Class-H)
- Minimize board space and thermal footprint (IV sensing, Integrated DSP)
- Achieve higher SPL and better audio performance through advanced speaker protection features (Supply Tracking Limiter, IV sensing)

The following sections cover the key TI amplifier technologies used in building automation designs to save power and improve audio performance: Y-Bridge, Class-H, Supply Tracking Limiter, I/V sensing, and integrated DSP.

Y-Bridge Architecture

For battery-powered building automation devices where runtime directly impacts user experience, TI engineered the Y-Bridge architecture to minimize power losses and extend battery life. In higher-power building automation

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applications, traditional audio amplifier architectures rely on a single high-voltage supply rail (PVDD) for output stage switching and amplification, alongside a low-voltage rail for I/Os and LDOs. However, during idle periods—when no audio signal is present—amplifiers continue to switch, resulting in poor power efficiency. Because the switching occurs exclusively on the high-voltage rail, the excess voltage headroom leads to idle efficiencies falling below 20%. To overcome this limitation, Texas Instruments introduced the Y-Bridge power architecture. Figure 1 shows the intelligent design which allows the amplifier to seamlessly alternate between two supply rails based on the output power demand. By optimizing the supply voltage in real time, the Y-bridge architecture significantly reduces idle power consumption—by up to 90%—and improves efficiency by 15% to 20% at lower output levels, all without compromising audio performance. See also TI's *Y-Bridge in TAS278x Class-D Amplifiers for Improving Efficiency* application note for more detailed information.

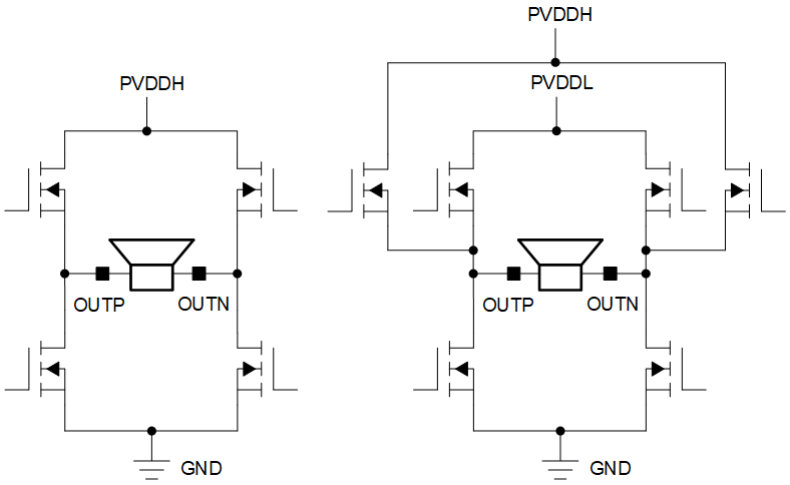


Figure 1. Traditional Class-D Amplifier vs Simplified Y-Bridge Architecture

Class-H Architecture

Class-H significantly reduces switching losses within the output stage by dynamically adjusting the supply voltage (PVDD) to track the audio signal envelope, improving overall efficiency. When the signal is small, PVDD is held low, minimizing power dissipation. When the signal is large, PVDD is raised to provide the necessary headroom to play the audio without distortion. By minimizing the voltage difference between the supply and the instantaneous signal level at all times, Class-H captures efficiency gains that a fixed-rail architecture cannot. Figure 2 and Figure 3 show how Class-H control dynamically adjusts the supply voltage (PVDD) based on the audio signal.

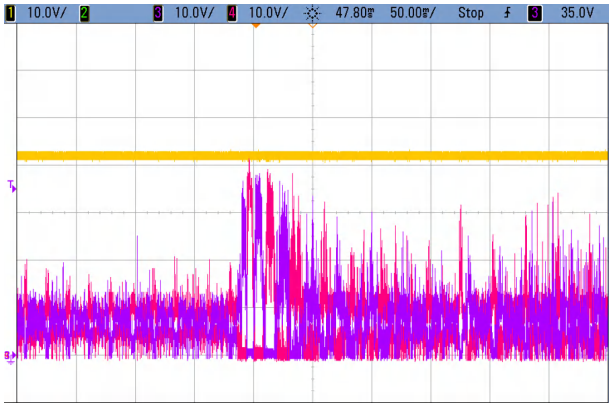


Figure 2. Audio Output and Boost Voltage Without Class-H Operation

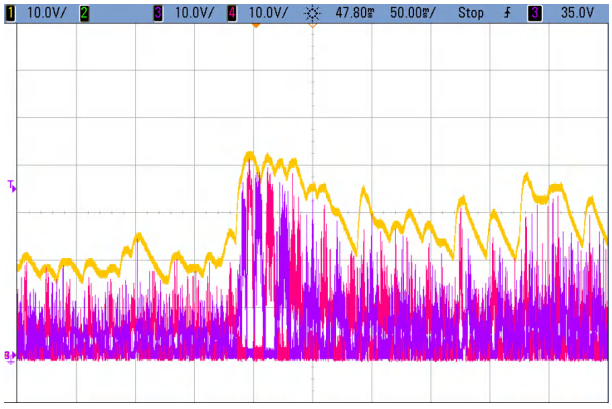


Figure 3. Audio Output and Boost Voltage With Class-H Operation

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Supply Tracking Limiter

In voice-driven building automation applications such as intercoms, audio fidelity is critical - distortion makes speech difficult to understand and degrades the user experience. The Supply Tracking Limiter addresses this by using PVDD supply voltage ADC to track the PVDD and adjust the gain dynamically based on the user input to avoid distortion. This feature is quite useful in the following scenarios:

1. The user sets volume above what the current PVDD supply can support. Without intervention, the amplifier clips the signal peaks, producing audible distortion. Supply Tracking Limiter detects the mismatch and reduces gain automatically to preserve audio quality.
2. PVDD voltage drops due to battery discharging but the input signal amplitude stays the same. Supply Tracking Limiter continuously monitors PVDD via the ADC and adjusts the gain in proportion to the drop, keeping the output within the headroom the supply can support and maintaining clean audio throughout the battery discharge cycle.

See the TAS2573 datasheet for more details on Supply Tracking Limiter.

I/V Sensing

Loudness and audio quality are critical in building automation applications - from intercoms that must be heard clearly in noisy environments to PA systems that deliver intelligible emergency announcements. This is where TI's Smart Amplifier technology changes the equation: it safely drives speakers to their true physical limits, delivering higher output loudness, deeper bass extension, and longer speaker life without the conservative power caps that traditionally define safe audio design. By integrating precision ADCs directly into the amplifier to continuously measure the voltage across the speaker (V) and the current through it (I), the system computes real-time electrical impedance, which changes dynamically with voice coil temperature and cone displacement, enabling closed-loop protection algorithms that keep the speaker operating safely at all times.

Figure 4 shows how a smart amplifier achieves 2.5 times higher SPL in the bass region and 1.5 times higher SPL at high frequencies compared to a conventional amplifier, by driving the speaker closer to its mechanical and thermal limits without damage. Learn more about TI's speaker protection and its benefits.

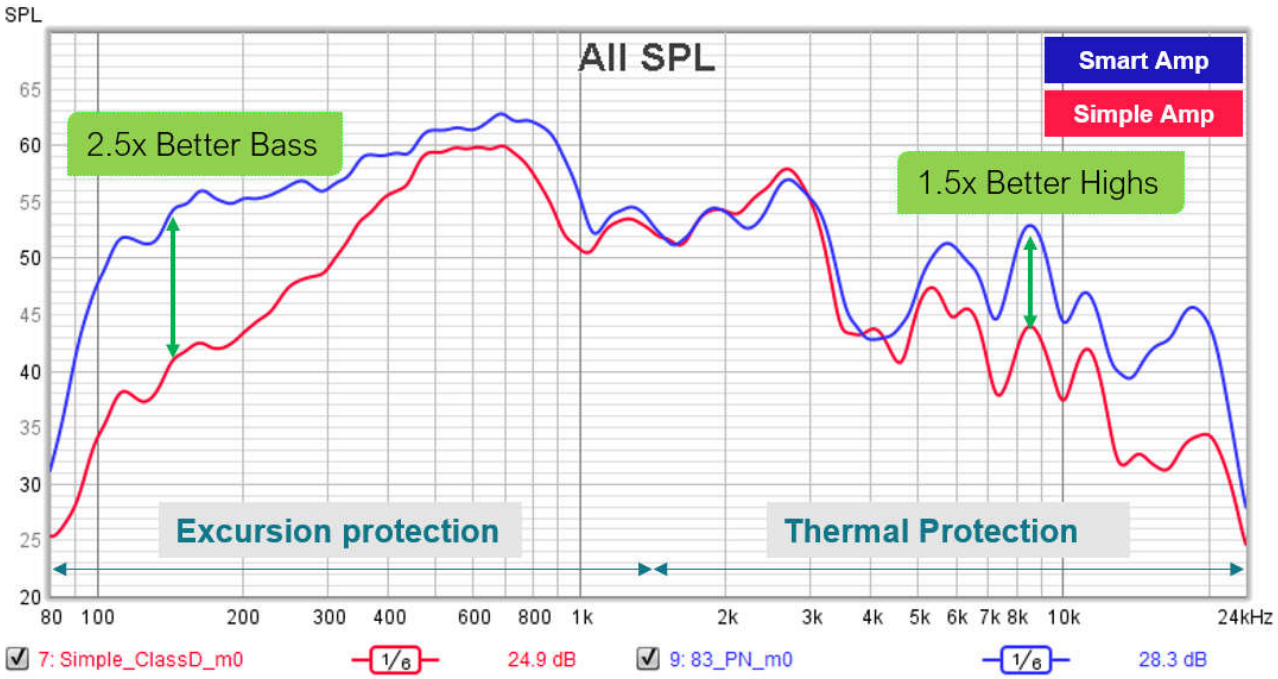


Figure 4. Simple Amp vs Smart Amp

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Integrated DSP

As AI algorithms consume an increasing share of the host SoC's available MIPS (Million Instructions Per Second) and memory, offloading audio processing to the amplifier's integrated DSP frees up critical host resources. In building automation devices, the integrated DSP delivers high audio quality from low-cost speakers. TI does this across three categories: protection and loudness to safely push speakers to their physical limits, audio tuning to optimize frequency response and voice clarity, and power saving to extend battery life.

Table 1. Integrated DSP Features and Benefits

Domain	Protection + Loudness	Audio Enhancement	Power Saving
Features	• IV Sensing • Thermal Protection • Excursion Protection	• Equalizer (EQ) • Dynamic Range Compressor (DRC) • Dynamic Equalizer (DEQ) • Rattle Suppressor	• Advanced Battery Guard (ABG) • Music Efficiency Modes • Noise Gate
Benefits	Safely drives speakers to their physical limits, enabling up to 8dB to 10dB higher perceived loudness without risking thermal damage, mechanical failure, or signal distortion.	Maximizes audio quality from a cost-optimized speaker, delivering clear voice prompts, extended bass, and balanced frequency response from a compact enclosure.	Reduces idle and low-signal power consumption while preventing brownout and clipping events as the battery discharges, directly extending battery life and maintaining audio quality in wire-free building automation devices.

Piezo Sounder

For simple alert tones, a dynamic speaker adds cost and board space without benefit — a fire alarm, security beep, or HVAC error only needs one or two fixed frequencies at high or medium volume. Piezoelectric sounders eliminate the voice coil entirely, using a ceramic element driven by AC voltage: mechanically simpler, more reliable, and louder at a specific frequency.

The TDZ8907 drives a PWM signal differentially across the piezo element using an integrated boost converter that generates 11.5V or 15.5V from a supply as low as 2.0V, delivering up to 31Vpp output and less than 1nA shutdown current with no external boost components required.

Building Security System

Video doorbells, IP cameras, security gateways, and electronic locks operate continuously on battery or PoE power and demand audio that is both reliable and efficient. Two-way communication, high-SPL alert tones, and always-on standby each pull from the same power-constrained supply. TI's amplifier portfolio addresses this with boosted output and ultra-low shutdown current across a range of package sizes suited to space-constrained enclosures.

Key care-abouts:

- Ultra-low standby and shutdown current for battery and PoE-powered devices
- Boosted output from PoE and battery supplies without an external boost converter
- Two-way audio with integrated PDM microphone input and echo reference output
- Compact integration for space-constrained enclosures

Applications: Video doorbell, IP network camera, wireless security camera, building security gateway, intrusion HMI panel, electronic smart lock, building security sounder.

Table 2. Audio Device Recommendation for Building Security Systems

Specifications	TPA2011D1	TAS2020	TAS2563	TAS2573	TAS2320	TAS2780	TDZ8907
PVDD	2.5-5.5V	2.5-5.5V	2.7-5.5V	2.0-5.5V	2.5-5.5V	3-24V	2.1-5.5V
Boost Voltage	N/A	N/A	11.5V	15V	N/A	N/A	12.5V/15.5V
Output Power	3.2W	3.2W	6.1W	8.8W	19W	25W	31Vpp
Input	Analog	Digital	Digital	Digital	Digital	Digital	PWM
Y-Bridge		✓		✓	✓	✓	

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Table 2. Audio Device Recommendation for Building Security Systems (continued)

Specifications	TPA2011D1	TAS2020	TAS2563	TAS2573	TAS2320	TAS2780	TDZ8907
Class-H			✓	✓	✓		
Supply Tracking Limiter		✓	✓	✓	✓	✓	
IV-Sensing			✓	✓		✓	
Integrated DSP			✓	✓			
PDM Mic input			✓				
Package	9 - DSBGA	26 - QFN	42 – DSBGA 32 – QFN	48 - WCSP	26 - QFN	30 – HR QFN	10 – WQFN
Package Size	1.60mm × 1.21mm	4mm × 3.5mm	2.5mm × 3mm 4.5mm × 4mm	3.15mm × 2.26mm	4mm × 3.5mm	4mm × 3.5mm	2mm × 2mm
Applications	Video Doorbell, Wireless Security Camera	Intrusion HMI Panel, Electronic Smart Lock	Video Doorbell, IP Network Camera	Video Doorbell, Wireless Security Camera	IP Network Camera, Building Security Gateway	Building Security Sounder, Building Security Gateway	Electronic Smart Lock, Building Security Sounder

Fire Safety Systems

Smoke detectors, heat detectors, and alarm sounders must deliver high-SPL alerts on demand after years of idle standby, often from a single primary battery. Meeting regulatory SPL thresholds without draining the battery requires an amplifier portfolio that combines boosted output from low supply voltages with sub-microamp shutdown current. TI's Class-D amplifiers and piezo drivers are designed for exactly this tradeoff.

Key care-abouts:

- Ultra-low operating, standby, and shutdown current for primary battery-powered devices
- High SPL output to meet fire safety regulatory requirements
- Boosted output from low battery voltages without an external boost converter
- Minimal external BOM to reduce cost and simplify regulatory certification

Applications: Fire safety sounder, smoke & heat detector, gas detector, digital alarm communicator.

Table 3. Audio Device Recommendation for Fire Safety Systems

Specifications	TPA2006D1	TPA2011D1	TPA2038D1	TAS2120	TAS2563	TAS2573	TDZ8907
PVDD	2.5-5.5V	2.5-5.5V	2.5-5.5V	2.5-5.5V	2.7-5.5V	2.0-5.5V	2.1-5.5V
Boost Voltage	N/A	N/A	N/A	14.75V	11.5V	15V	12.5V/ 15.5V
Output Power	1.45W	3.2W	3.2W	8.2W	6.1W	8.8W	31Vpp
Input	Analog	Analog	Analog	Digital	Digital	Digital	PWM
Y-Bridge				✓		✓	
Class-H				✓	✓	✓	
Supply Tracking Limiter				✓	✓	✓	
IV-Sensing					✓	✓	
Integrated DSP					✓	✓	
Package	8 - VSON	9 - DSBGA	9 - WCSP	26 – QFN	42 – DSBGA 32 – QFN	48 - WCSP	10 – WQFN
Package Size	3mm × 3mm	1.60mm × 1.21mm	1.21mm × 1.16mm	4mm × 3.5mm	2.5mm × 3mm 4.5mm × 4mm	3.15mm × 2.26mm	2mm × 2mm
Applications	Fire safety sounder, Smoke & Heat detector	Gas Detector, Smoke & Heat detector	Fire Safety Sounder, Smoke & Heat detector	Fire Safety Sounder, Smoke & Heat detector	Fire Safety Sounder, Digital Alarm Communicator	Fire Safety Sounder, Digital Alarm Communicator	Fire Safety Sounder, Smoke & Heat detector

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HVAC Systems

Smart thermostats, HVAC valve controllers, and air quality and gas detectors each have distinct audio needs, ranging from spoken audio alerts and UI feedback tones to simple alert beeps. These always-on systems demand idle efficiency as much as peak output. TI's Class-D amplifier portfolio covers the full range from cost-optimized analog-input devices for simple tone alerts to digital smart amplifiers with integrated DSP for clear voice output from compact enclosures.

Key care-abouts:

- Low idle power consumption for always-on mains and battery-powered devices
- Digital input with integrated DSP for clear voice prompts and UI feedback tones
- Wide supply voltage range to support both battery and mains-powered designs
- Compact integration for space-constrained thermostat and controller enclosures

Applications: Smart thermostat, HVAC gateway, air quality and gas detector.

Table 4. Audio Device Recommendation for HVAC Systems

Specifications	TAS2505	TAS2020	TAS2563	TAS2573	TDZ8907
PVDD	2.5-5.5V	2.5-5.5V	2.7-5.5V	2.0-5.5V	2.1-5.5V
Boost Voltage	N/A	N/A	11.5V	15V	12.5V or 15.5V
Output Power	2.6W	3.2W	6.1W	8.8W	31Vpp
Input	Digital	Digital	Digital	Digital	PWM
Y-Bridge		✓		✓	
Class-H			✓	✓	
Supply Tracking Limiter		✓	✓	✓	
IV-Sensing			✓	✓	
Integrated DSP	✓		✓	✓	
Package	24 – QFN	26 - QFN	42 – DSBGA 32 – QFN	48 - WCSP	10 – WQFN
Package Size	4mm × 4mm	4mm × 3.5mm	2.5mm × 3mm 4.5mm × 4mm	3.15mm × 2.26mm	2mm × 2mm
Applications	Thermostat, HVAC Gateway	Thermostat, HVAC Gateway	Thermostat, Air quality & gas detection	Thermostat, Air quality & gas detection	Thermostat, Air quality & gas detection

Conclusion

TI offers a broad portfolio of audio amplifiers and piezo drivers for every building automation application - from ultra-low-power security cameras to high-SPL fire safety sounders. To explore the full product lineup, reference designs, and evaluation modules, visit ti.com/audio.

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