Agenda

- TI Audio Overview: Products, Support Tools and Resources
- New Product Technologies:
- Digital Input Class-D
- Inductor Free Class-D

Mid Power Audio Amps | Value Proposition

Breadth of Portfolio

Offering both analog and digital input audio solutions ranging in all power levels and sophistication, our portfolio address everything from value to performance-line products

HR

Premium Sound

New and improved portfolio with **closed-loop architecture** to provide superior sound quality with **high-res audio support** up to 192 kHz sampling rate

Analog Input

<15W

Product families
- TPA3111/2
- TPA3113
- TPA3140/4
- TPA3110/36/37

New Development
- TPA3138 (released)

Sectors/EEs
- TV
- Battery-Powered Speakers
- Bluetooth/Wireless Speakers
- IoT / Smart Home Appliance
- Notebook

15W-100W

Product families
- TPA3131/2
- TPA3130, TPA3116/8
- Low-idle-loss family: TPA3128/9/6, TPA3156

New Development
- TPA3126 (released)

Sectors/EEs
- Smart Speakers
- Wireless Speakers
- IoT / Smart Home Appliance
- TEC / Base Station

>100W

Product families
- TPA325x
- TPA324x
- TPA3221

New Development
- TPA3220 (released)

Sectors/EEs
- Soundbar
- Premium AV
- Home Theatre
- Active Speakers
- Pro Audio Equipment

Digital Input

<20W

Up to 96kHz
No / Basic DSP

Product families
- TAS5733L
- TAS5760
- TAS5720L

New Development
- TAS5805 (released)

Sectors/EEs
- Smart Speaker
- IoT / Smart Home Appliance
- Notebook / Chromebook
- TV / STB

20-30W

Up to 96kHz
Fixed flows

Product families
- TAS5707/11
- TAS5751/31
- TAS5721

New Development
- TAS5805 (released)

Sectors/EEs
- Smart Speaker
- Wireless/Bluetooth Speaker
- TV

>30W

Up to 192kHz
Flexible flows

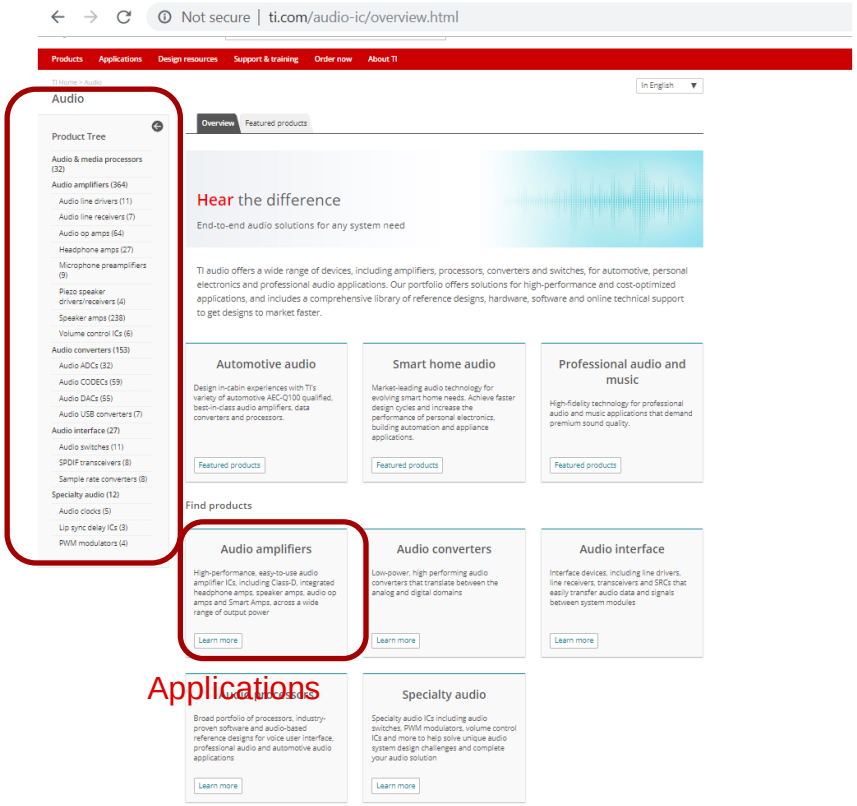
Product families
- TAS575x
- TAS5766/8
- TAS5780/2

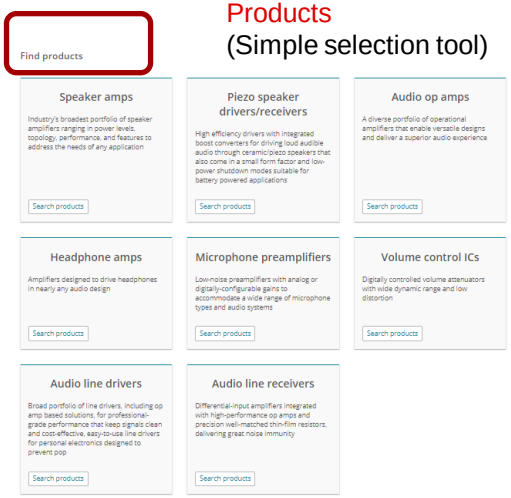
New Development
- TAS3251 (released)
- TAS5825 (released)

Sectors/EEs
- Smart Speaker
- Wireless Speakers
- Soundbar
- Pro Audio Equipment
- Home Theatre / AVR

Visit ti.com/audio for all your audio needs!

Products
(by parameter)



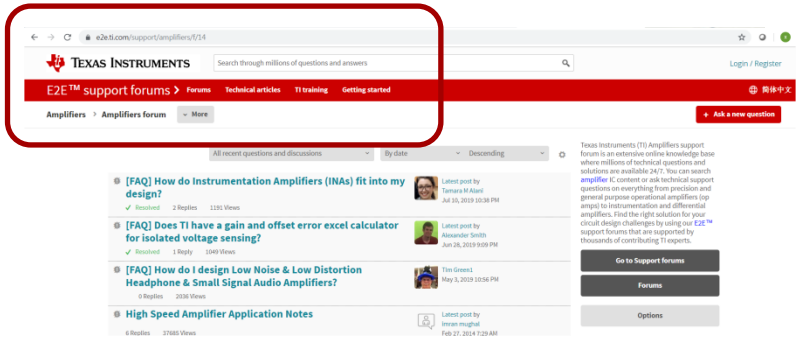


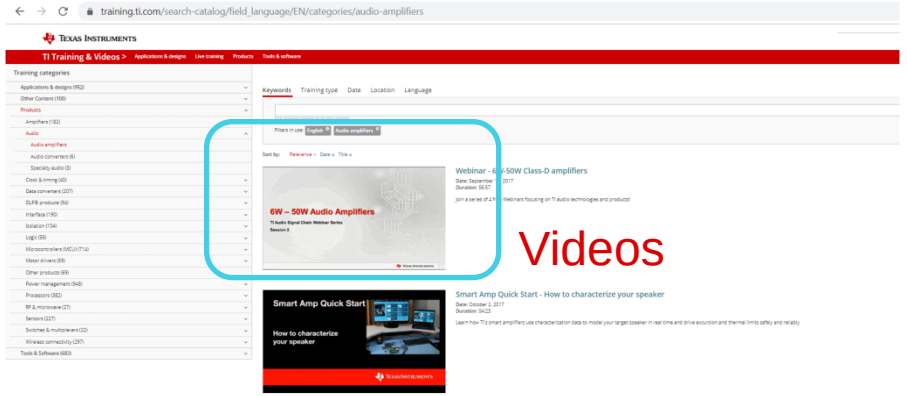
Texas Instruments

Audio Support & Training at ti.com/audio

Blogs

e2e daily support



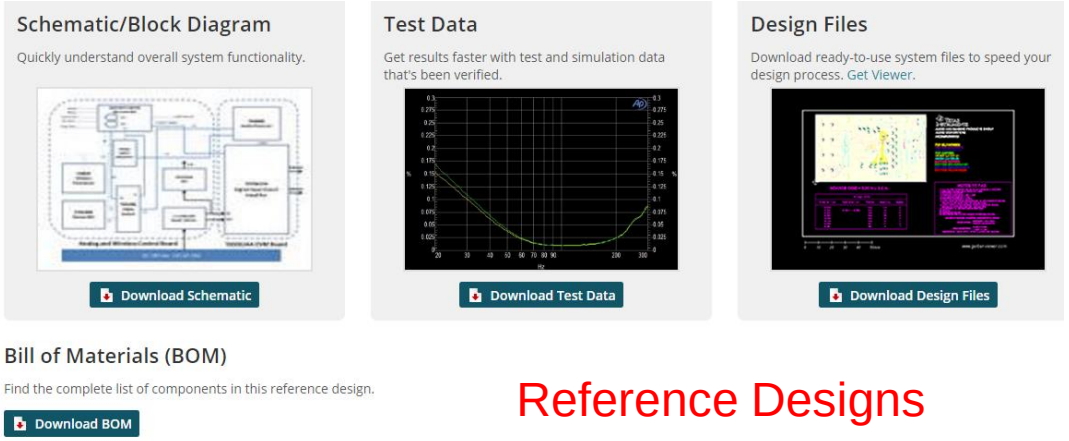


Videos

- Training videos at: https://training.ti.com/search-catalog/field_language/EN/categories/audio-amplifiers

Tool Overview

- TI provides development resource including EVM's, Reference Designs, GUI software and calculation tools.



Reference Designs

Pure Path Console 3 (PPC3)

- Single, easy to use tool for Smart Amp integration
- Always up to date with notifications for platform / application updates
- Step by step wizard for speaker characterization
- Smart-EQ for quick tuning evaluation
- 10 Bi-quads & 3 band prioritization for manual tuning adjustments
- Track temperature and excursion performance during verification
- Built-in audio player and tuning snapshots
- In-system tuning capable

[For more information about TI audio click here]

Texas Instruments

Audio Trends in STB application

Market Trends

Higher-Quality and Higher-Power Audio

Trends show that the market is demanding better quality and high-power audio. Our **Smart Amp** solutions maximize performance from any system, and Integrated DSPs support enhanced processing **eliminating the need for an external DSP**

Industrial Design

Advanced system protection including **Thermal Foldback** and **Cycle-by-Cycle current limit** as well as High efficiency modulation schemes like Hybrid Modulation and a new and improved 1SPW **reduce thermal concerns for industrial applications**

Voice Control & Echo Cancellation

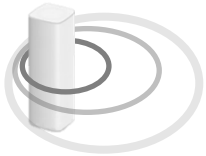
SDOUT is an audio data stream identical to the one coming out of the internal DSP. It provides the speaker audio content, so it can be easily removed from the mic input for **enhancing accurate voice recognition**

Cost-Sensitivity

Our **advanced EMI suppression technology** enables true inductor-free operation with the use of inexpensive ferrite beads for power levels < 10W, providing savings on PCB and BOM costs while maintaining high audio quality

Integration and Component Reduction

With features like pin-to-pin short protection, cycle-by-cycle current limit, Thermal Foldback, PVDD Sensing, and more, our amplifiers **eliminate the need for external protection circuitry**

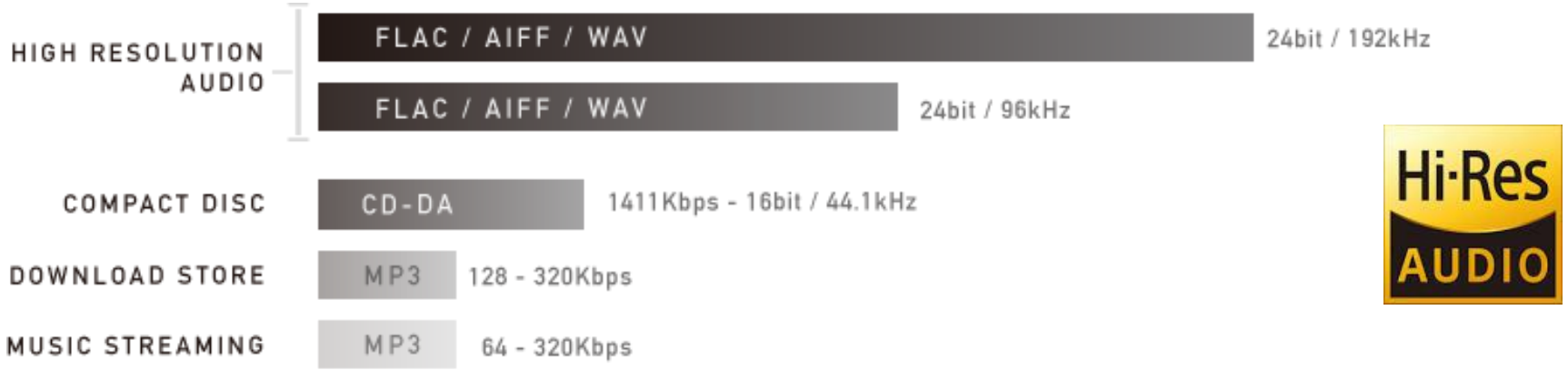


Ultrasound Support

Support for up to 192kHz sampling allows **for ultrasonic tones** of up to 92kHz, enabling new features such as **presence detection** or ultrasonic communication between devices.

Audio Format Trends

Audio download and streaming services are moving towards Hi-Res audio formats like FLAC



STB new trend

Next generation STB could be expected control center of smart home infotainment system. It will integrate set top box, speaker & intelligent voice control. By connecting AI assistant, when screen is turned off, it could be acting as one smart speaker and support music playing, info & news broadcast and home IOT control etc.

New Product Highlights for STB application

Higher Efficiency and Optimized Thermal

1SPW Modulation

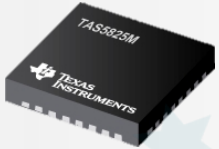
We've **improved 1SPW** to have better audio performance while **still providing superior efficiency** and low idle losses. Higher efficiency reduces thermal demands tremendously

New Hybrid Modulation

Hybrid brings the best of 1SPW and BD to offer **excellent audio performance and low idle losses** by dynamically adjusting the duty cycle to maintain differential output while still providing higher efficiency

Longer Battery Life

Market trends show large growth for battery powered speakers. Customers can use **smaller batteries and get more lifetime** with our efficient modulation schemes , low RDS(ON), and low idle losses



TAS5825M
Digital-Input Smart Amp
2 x 38W , 1 x 65W

TAS5805M
Digital-Input Inductor-Free
2 x 23W , 1 x 45W

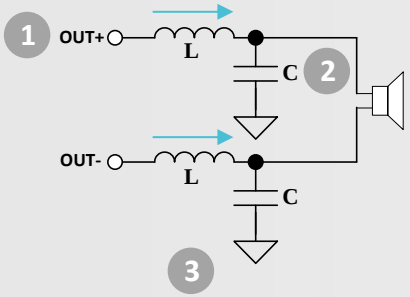
TPA3138D2
Analog-Input
2 x 10W , 1 x 18.5W

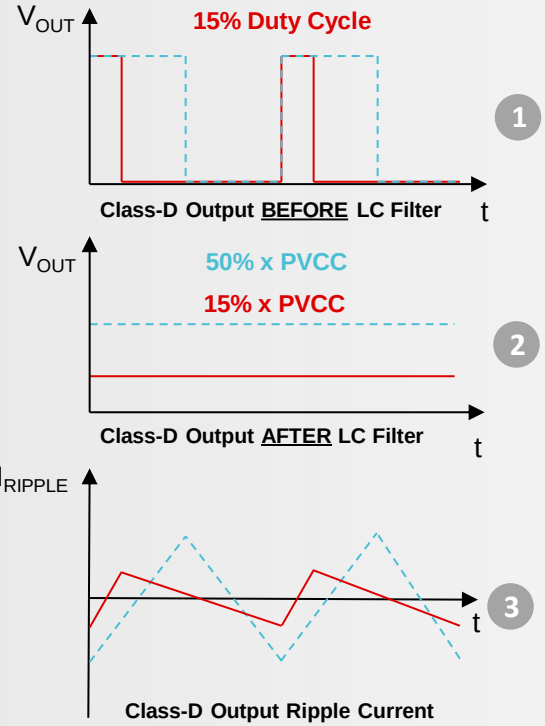
TPA3129D2
Analog-Input, Hybrid Modulation
2 x 15W , 1 x 30W

Hybrid Modulation | TAS5825/05, TPA3156/26/28/29

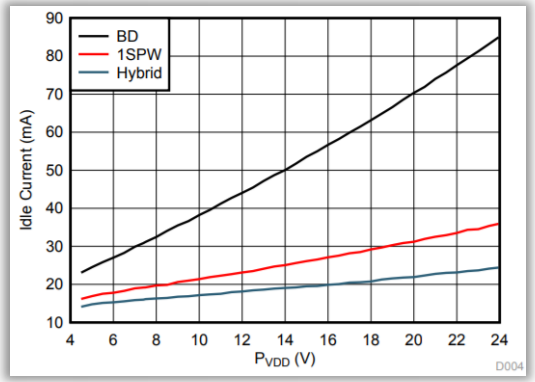
The main causes of idle losses are ripple current and PVDD loss

Ripple Current Loss Reduction

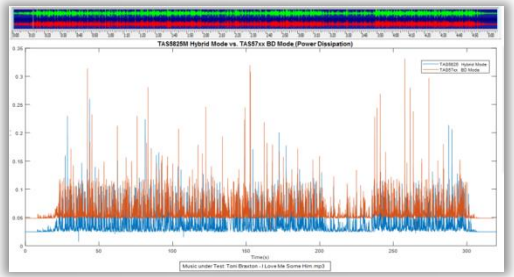




Hybrid Modulation dynamically adjusts the duty cycle to reduce ripple current and DC offset, resulting in less losses in the inductor and power FETs.



TAS5805M Idle Current vs PVDD
(FSW = 384 kHz, 10 µH + 0.68 µF)



Hybrid modulation with music

	PVDD	DVDD
TAS5825 (Hybrid)	11.51As	8.16As
TAS57xx (BD)	18.83As	17.76As
Power Saving	**38.86%**	**54.05%**

1.72x longer battery life!

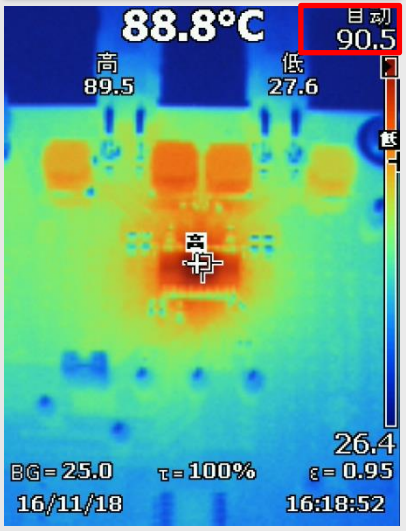
Modulation Scheme and PVDD Impact On Power Loss

Product data: TAS5805M

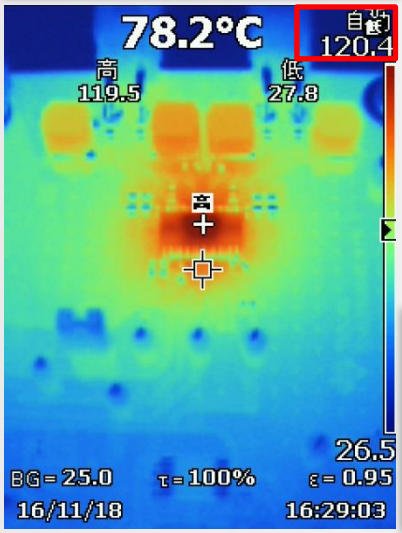
1SPW Modulation

- Optimizes thermal performance
- Best efficiency
- Slight penalty on THD

1SPW



BD



Experiment on TAS5805M

Test Condition

- TAS5805 EVM (4-layer)
- Fsw=384kHz
- 10uH+0.68uF
- Measured with IR gun

1SPW vs. BD		
Condition	2*10W_24V_384kHz_6Ω	
Modulation Schemes	1SPW	BD
Top case temperature	90.5C	120.4C

Modulation scheme impact

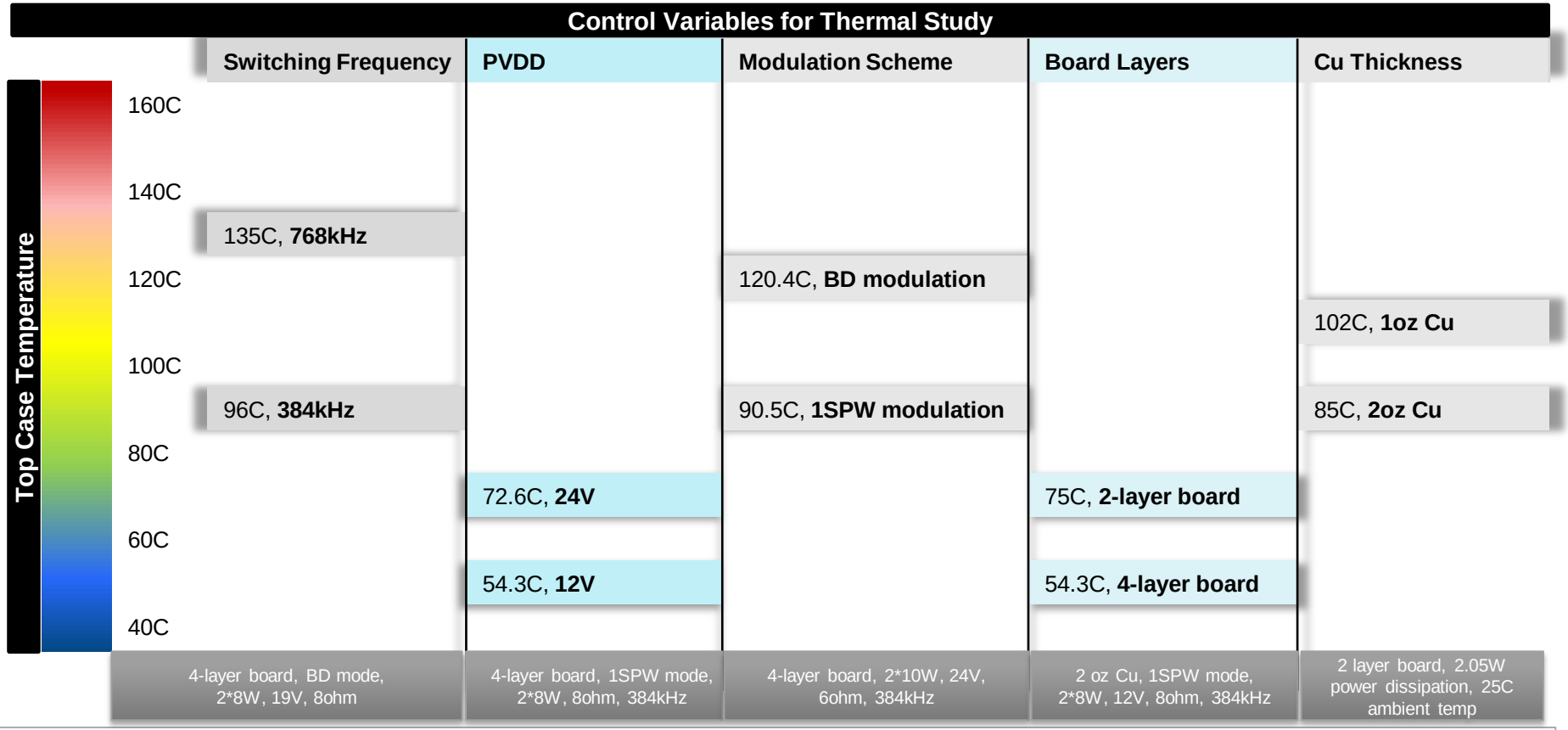
1SPW (idle vs. play power)						
PVDD	12V			24V		
Condition	Idle	2*10W_6Ω	2*8W_8Ω	Idle	2*10W_6Ω	2*8W_8Ω
Top case temperature	38.1C	69.9C	54.3C	50.5C	90.5C	72.6C

PVDD impact

Texas Instruments

Thermal Optimizations

Product Data From: TAS5805M



Achieve lowest system BOM

New Silicon Process Technology
Our latest technology **shrinks the size of the die** and reduces the cost of our amplifiers, providing solutions that are competitive in cost

Inductor-Free Solution
Our **advanced EMI suppression technology** enables true inductor-free operation with the use of inexpensive ferrite beads for power levels < 10W, providing savings on PCB and BOM costs

Integration for Component Reduction
With features like pin-to-pin short protection, over-current error, a multi-tiered thermal protection system, and under/over-voltage protection to name a few, these devices **eliminate the need for external protection circuitry**

$0.08-$0.16 Savings Just from Inductors

Component	Conventional Class-D			TPA3138/TAS5805		
	Qty	Cost	Total	Qty	Cost	Total
Inductors	4	$0.03 ($0.03-$0.05)	$0.12-$0.20	0	-	0
Ferrite Beads	0	-	0	4	$0.01	$0.04
Total Cost			$0.12-$0.20			$0.04

TPA3138/*9D2
Analog-Input
2 x 10W , 1 x 18.5W

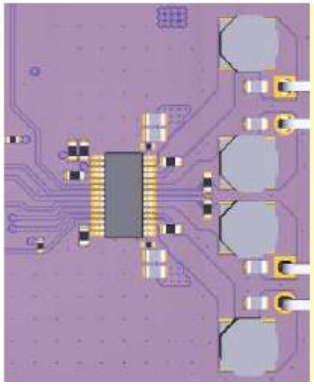
TAS5805M
Digital-Input
2 x 23W , 1 x 45W

*TPA3139: roadmap, QFN-24, 4x4mm^2

Robust EMI Performance

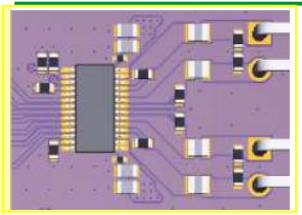
Saves BOM Cost and PCB Area | Product Data From: TAS5805M

Inductor+ Capacitor



Reduced PCB area

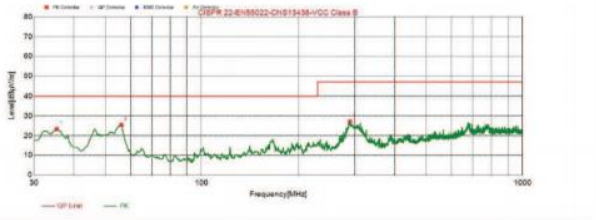
Ferrite bead + Capacitor (Generally for ≤2*10W)



Cost Saving Examples with inductor less			
Stereo BTL	4 x inductors	4 x ferrite beads	Total savings: $0.08 - $0.16
	4 x ($0.03- $0.05)	4 x $0.01	

>7dB Margin with 1meter speaker wire for each channel ←

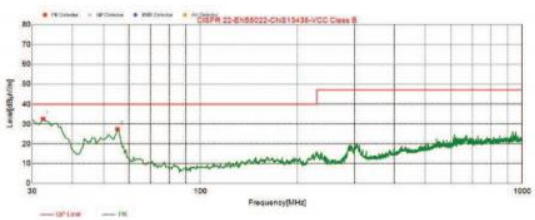
PVDD=12V, 2*8W into 8ohm



Suspected List

NO.	Freq. [MHz]	Reading [dBµV/m]	Factor [dB]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	35.33	40.78	-17.45	23.33	40.00	16.67	200	319	Horizontal
2	56.19	43.07	-17.58	25.49	40.00	14.51	200	280	Horizontal
3	289.9	43.36	-16.21	27.15	47.00	19.85	100	124	Horizontal

Figure 117. Radiated Emission with Ferrite Bead Filter - Horizontal

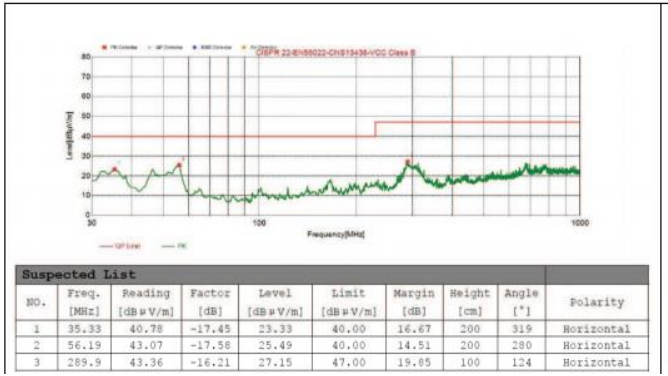


Suspected List

NO.	Freq. [MHz]	Reading [dBµV/m]	Factor [dB]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	32.42	50.05	-17.45	32.6	40.00	7.40	100	28	Vertical
2	55.22	44.81	-17.46	27.35	40.00	12.65	100	325	Vertical

Figure 118. Radiated Emission with Ferrite Bead Filter - Vertical

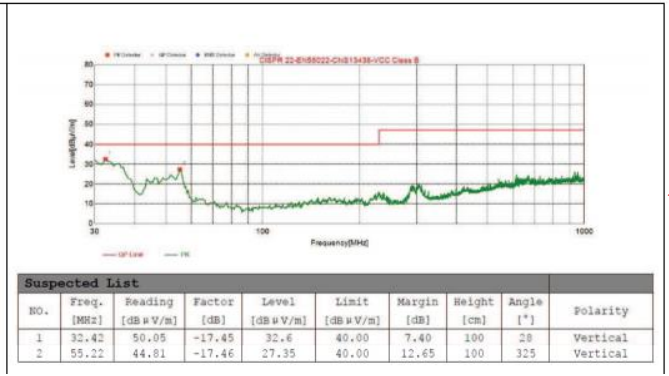
EMC Performance - LC Filters vs. Inductor Free



Suspected List

NO.	Freq. [MHz]	Reading [dBμV/m]	Factor [dB]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	35.33	40.78	-17.45	23.33	40.00	16.67	200	319	Horizontal
2	56.19	43.07	-17.58	25.49	40.00	14.51	200	280	Horizontal
3	289.9	43.36	-16.21	27.15	47.00	19.85	100	124	Horizontal

RE with ferrite beads (H)



Suspected List

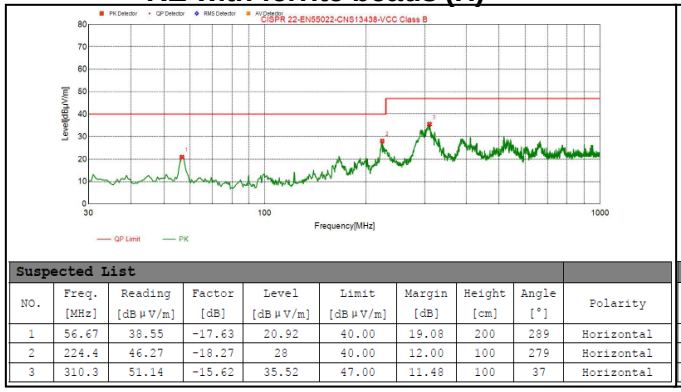
NO.	Freq. [MHz]	Reading [dBμV/m]	Factor [dB]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	32.42	50.05	-17.45	32.6	40.00	7.40	100	28	Vertical
2	55.22	44.81	-17.46	27.35	40.00	12.65	100	325	Vertical

RE with ferrite beads (V)

Ferrite Beads

>7dB Margin with 1meter speaker wire for each channel

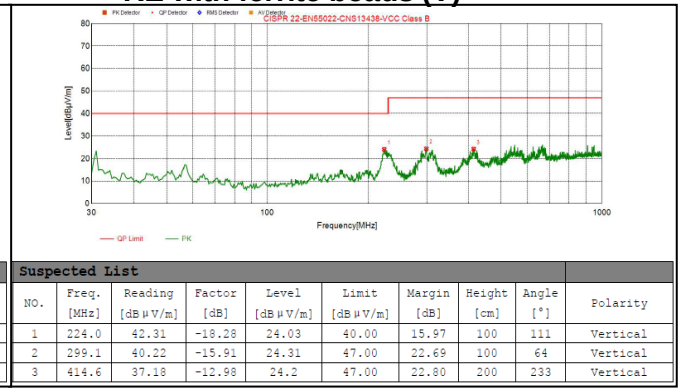
PVDD=12V, 2*8W into 8ohm



Suspected List

NO.	Freq. [MHz]	Reading [dBμV/m]	Factor [dB]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	56.67	38.55	-17.63	20.92	40.00	19.08	200	289	Horizontal
2	224.4	46.27	-18.27	28	40.00	12.00	100	279	Horizontal
3	310.3	51.14	-15.62	35.52	47.00	11.48	100	37	Horizontal

RE with LC filters (H)



Suspected List

NO.	Freq. [MHz]	Reading [dBμV/m]	Factor [dB]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	224.0	42.31	-18.28	24.03	40.00	15.97	100	111	Vertical
2	299.1	40.22	-15.91	24.31	47.00	22.69	100	64	Vertical
3	414.6	37.18	-12.98	24.2	47.00	22.80	200	233	Vertical

RE with LC filters (V)

LC Filter

>15dB Margin with 1meter speaker wire for each channel

PVDD=12V, 2*8W into 8ohm

Texas Instruments

Tight on Space

Small Solution Size

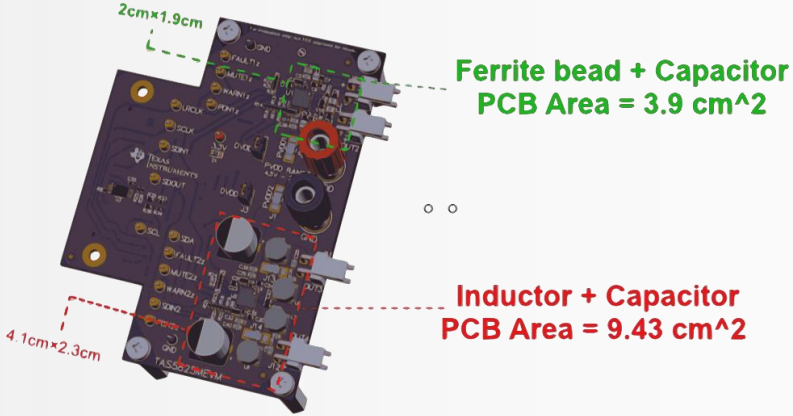
Reduce component count with true inductor-free functionality to save on total solution size with EMI reduction techniques like spread spectrum and channel-to-channel dephasing

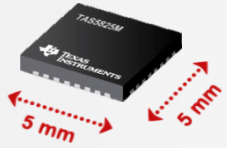
Integrated System Protection

Advanced system protection including **thermal foldback** and dynamic headroom **(PVDD) tracking** to maintain thermal balance without clipping, as well as fundamental features such as over-current (OCP) and over-voltage protection (OVP)

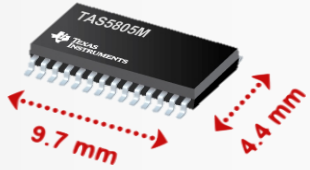
Integrated Processing

Integrated DSPs with flexible process flows support enhanced processing with 3-band DRC and 15 biquads per channel, **eliminating the need for an external DSP**





TAS5825M
Digital-Input Smart Amp
2 x 38W , 1 x 65W

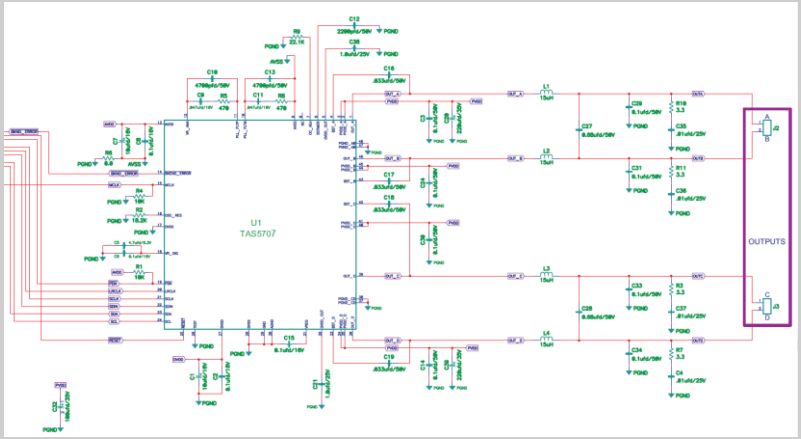


TAS5805M
Digital-Input Inductor-Free
2 x 23W , 1 x 45W

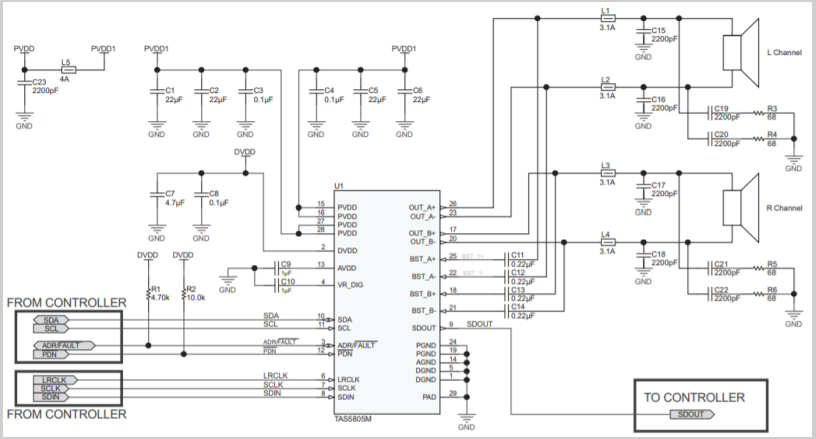
Closed-Loop Architecture

Much Fewer External Components | Product data: TAS5805M

TAS5707 (open loop)



TAS5805M (closed loop)



Device	External Components				Total
	Capacitors	Resistors	Inductor (expensive)	Ferrite Beads (Cheap)	
TAS5805	23	6	0	5	34
TAS5707	35	11	4	0	50

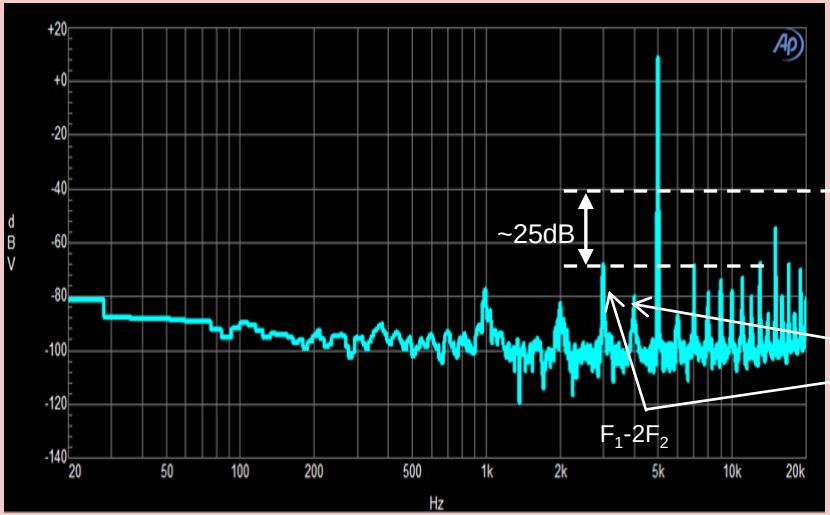
16 fewer **passive components**

Closed-Loop Architecture

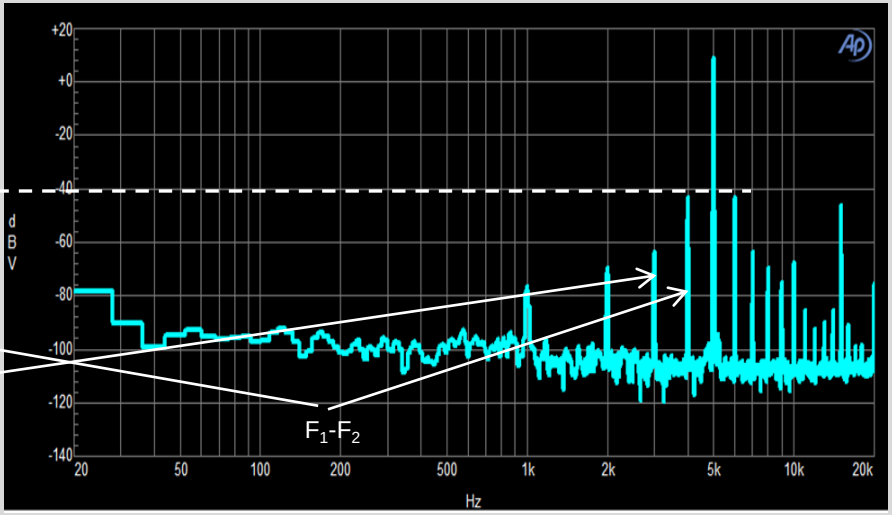
More Robustness to Power Supply Noise | Product data: TAS5805, TAS5825

Test Condition: PVDD=12V + 200mVp-p 1kHz ripple (F_2), I2S=5kHz input (F_1), Output Power=1W, Load=8Ω

Output FFT (Harmonics & IMD)
SN001128 with Closed-Loop Structure



Output FFT (Harmonics & IMD)
TAS5733L with Open-Loop Structure



IMD (Intermodulation Distortion) will deteriorate the audio sound quality if there is some noise in the power supply.

***25dB Less** power supply IMD with SN001128 Closed-Loop architecture*

PVDD Sensing

Avoids Clipping When Battery Discharges | Featured Product: TAS5825

Why is PVDD Sensing needed?

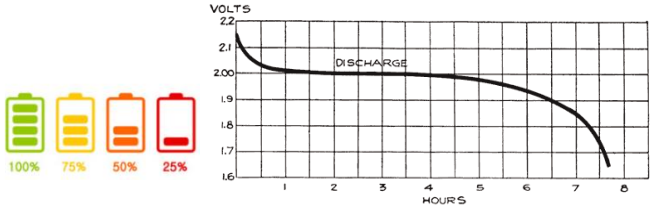


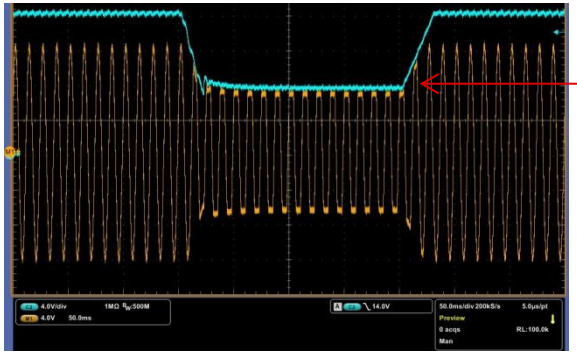
Fig. 22. Voltage Changes During Discharge

Output clips when battery discharges while the input signal is kept the same.

How does PVDD Sensing work?

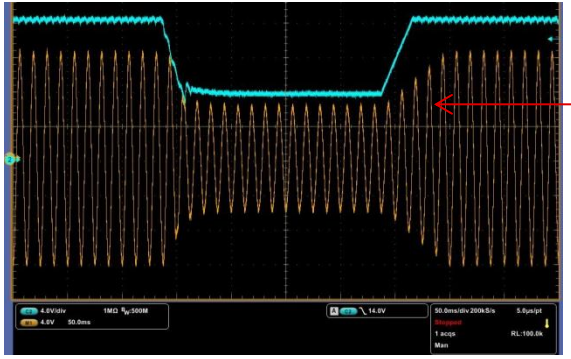
- Changes amplifier gain gradually based on amplifier's power supply (PVDD)

PVDD sensing disabled



Output clipping

PVDD sensing enabled



No output clipping

Texas Instruments

Short Design Cycle

SDOUT for Echo Cancelation

Our amplifiers SDOUT provides the speaker audio content so it can be easily removed from the mic input leaving only the voice command signal and spurious ambient noise **enhancing accurate voice recognition**

Closed-Loop Architecture

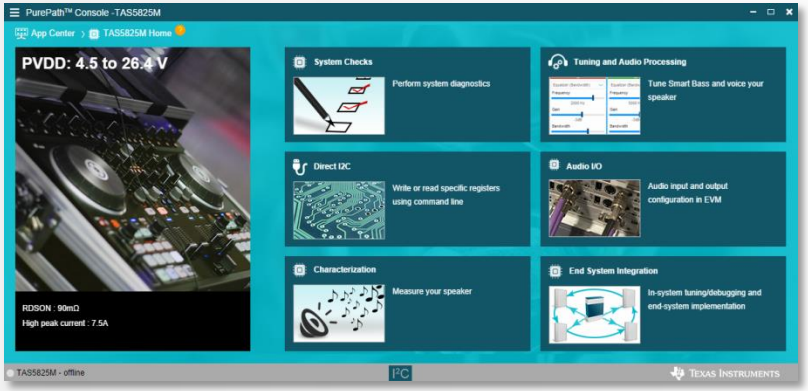
Our internal closed-loop architecture is more robust to power supply noise, making them quicker and easier to design with, requiring less external components

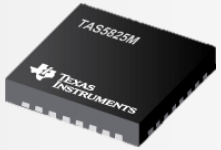
EVMs

Our TAS5805M evaluation module implements an inductor-free solution and an inductor solution side-by-side for convenient testing and comparisons

Pure Path Console 3

Our powerful PPC3 software is **easy to use** with lots of help features, supporting documents, and **video tutorials**– enabling a simple method for speaker and device characterization to optimize sound quality and system protection with end-system integration





TAS5825M
Digital-Input Smart Amp
2 x 38W , 1 x 65W

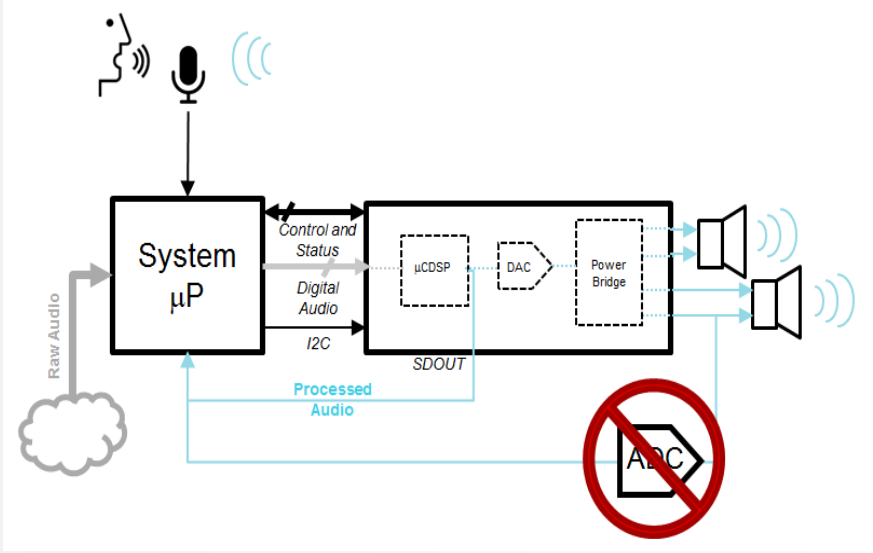
TAS5805M
Digital-Input Inductor-Free
2 x 23W , 1 x 45W

SDOUT for Echo Cancelation

Eliminating external ADC | Simple, Accurate | Featured Product: TAS5805/TAS5825

SDOUT is an audio data stream identical to the one coming out of the internal DSP. It provides the speaker audio content, so it can be easily removed from the mic input. This leaves behind only the voice command signal and spurious ambient noise, **enhancing accurate voice recognition.**

As smart speakers contribute to ambient sound, they themselves make it more difficult to capture a clean voice command. Echo cancellation increases accuracy as the system knows exactly what is playing and can adequately compensate to increase voice recognition accuracy.



TAS5825M
Digital-Input Smart Amp
2 x 38W , 1 x 65W

TAS5805M
Digital-Input Inductor-Free
2 x 23W , 1 x 45W

Tight on Space?

Small Solution Size

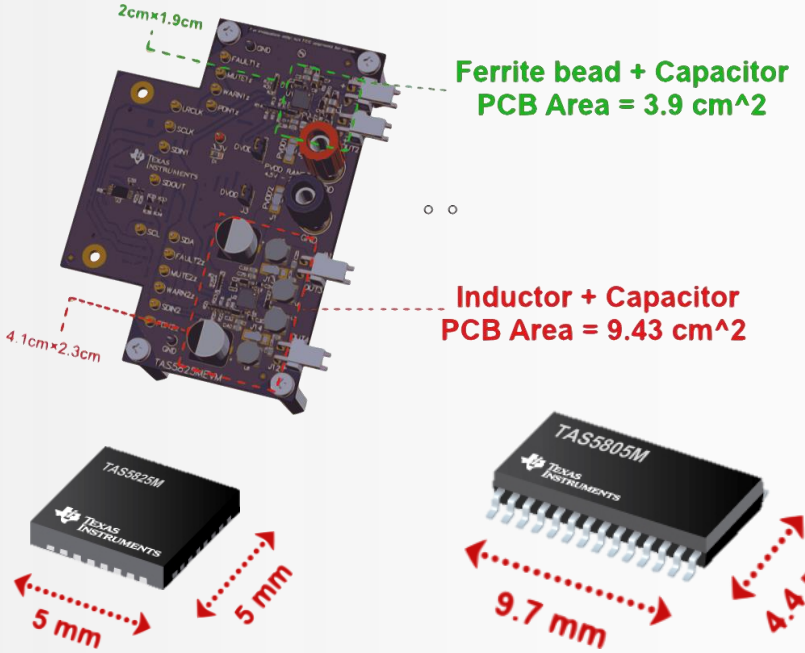
Reduce component count with true inductor-free functionality to save on total solution size with EMI reduction techniques like spread spectrum and channel-to-channel dephasing

Integrated System Protection

Advanced system protection including **thermal foldback** and dynamic headroom **(PVDD) tracking** to maintain thermal balance without clipping, as well as fundamental features such as over-current (OCP) and over-voltage protection (OVP)

Integrated Processing

Integrated DSPs with flexible process flows support enhanced processing with 3-band DRC and 15 biquads per channel, **eliminating the need for an external DSP**



TAS5825M
Digital-Input Smart Amp
2 x 38W , 1 x 65W

TAS5805M
Digital-Input Inductor-Free
2 x 23W , 1 x 45W

Need Higher Efficiency?

New and Improved 1SPW

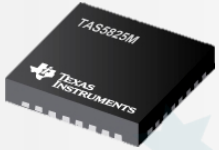
We've **improved 1SPW** to have better audio performance while **still providing superior efficiency** and low idle losses. Higher efficiency reduces thermal demands tremendously

New Hybrid Modulation

Hybrid brings the best of 1SPW and BD to offer **excellent audio performance and low idle losses** by dynamically adjusting the duty cycle to maintain differential output while still providing higher efficiency

Longer Battery Life

Market trends show large growth for battery powered speakers. Customers can use **smaller batteries and get more lifetime** with our efficient modulation schemes , low RDS(ON), and low idle losses



TAS5825M
Digital-Input Smart Amp
2 x 38W , 1 x 65W

TAS5805M
Digital-Input Inductor-Free
2 x 23W , 1 x 45W

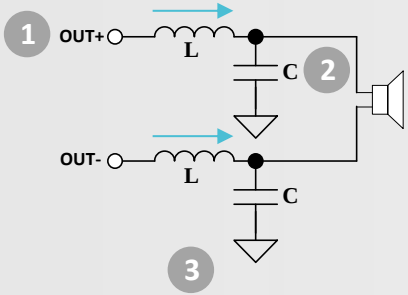
TPA3138D2
Analog-Input
2 x 10W , 1 x 18.5W

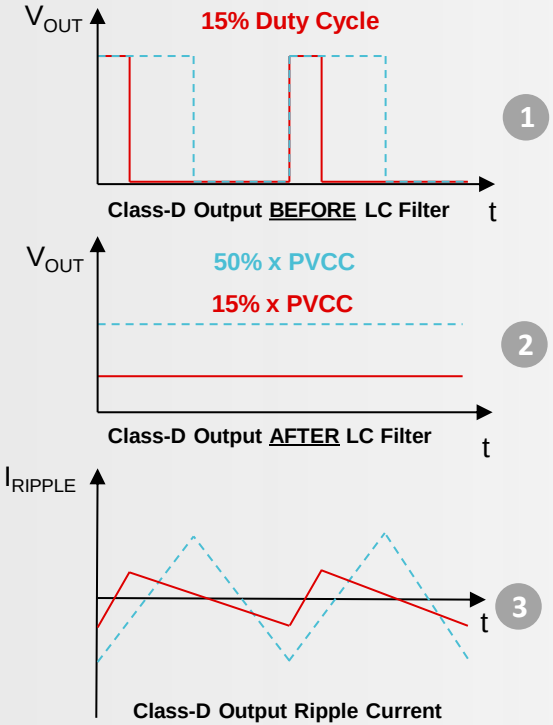
TPA3129D2
Analog-Input, Hybrid Modulation
2 x 15W , 1 x 30W

Hybrid Modulation | TAS5825/05, TPA3156/26/28/29

The main causes of idle losses are ripple current and PVDD loss

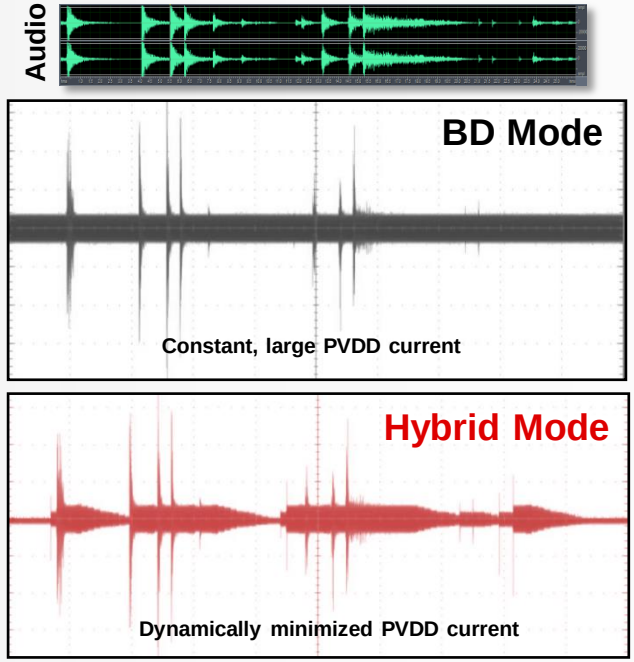
Ripple Current Loss Reduction





Hybrid Modulation dynamically adjusts the duty cycle to reduce ripple current and DC offset, resulting in less losses in the inductor and power FETs.

PVDD Current Loss Reduction



(TPA3128)

Texas Instruments

Modulation Scheme Impact On Thermal

Product data: TAS5805M & TAS5825M

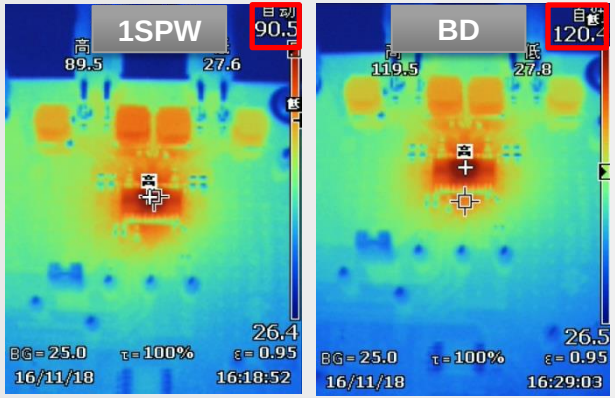
1SPW Modulation

- Optimizes thermal performance
- Best efficiency

Test Condition

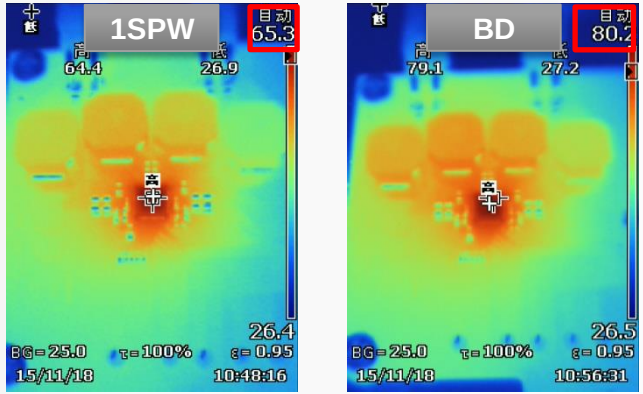
- TAS5805 and TAS5825 EVMs (4-layer), measured with IR gun
- Fsw=384kHz, 10uH+0.68uF

TAS5805M



TAS5805M 1SPW vs. BD		
Condition	2*10W_24V_384kHz_6Ω	
Modulation Schemes	1SPW	BD
Top case temperature	90.5C	120.4C

TAS5825M



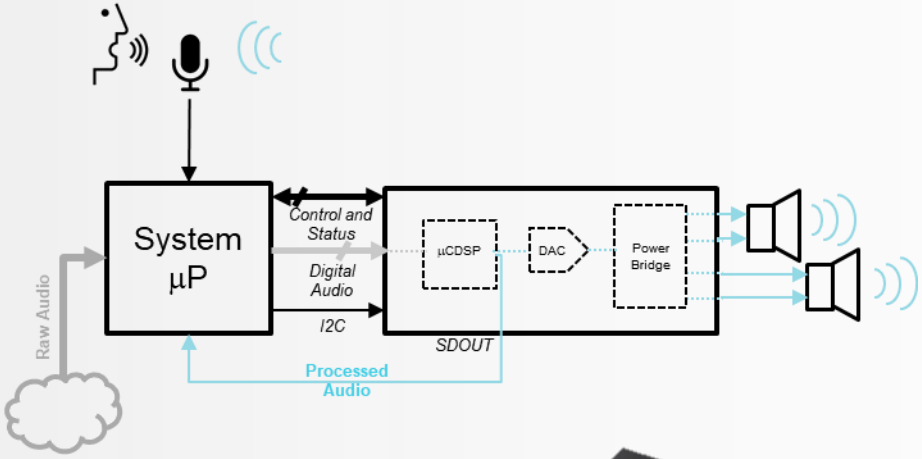
TAS5825M 1SPW vs. BD		
Condition	2*10W_24V_384kHz_6Ω	
Modulation Schemes	1SPW	BD
Top case temperature	65.3C	80.2C

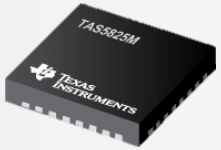
Texas Instruments

SDOUT for Echo Cancelation

SDOUT is an audio data stream identical to the one coming out of the internal DSP. It provides the speaker audio content, so it can be easily removed from the mic input. This leaves behind only the voice command signal and spurious ambient noise, **enhancing accurate voice recognition.**

As smart speakers contribute to ambient sound, they themselves make it more difficult to capture a clean voice command. Echo cancellation increases accuracy as the system knows exactly what is playing and can adequately compensate to increase voice recognition accuracy.





TAS5825M
Digital-Input Smart Amp
2 x 38W , 1 x 65W

TAS5805M
Digital-Input Inductor-Free
2 x 23W , 1 x 45W

Ultrasound

People Detection, Directivity | Featured Products: TAS58xx

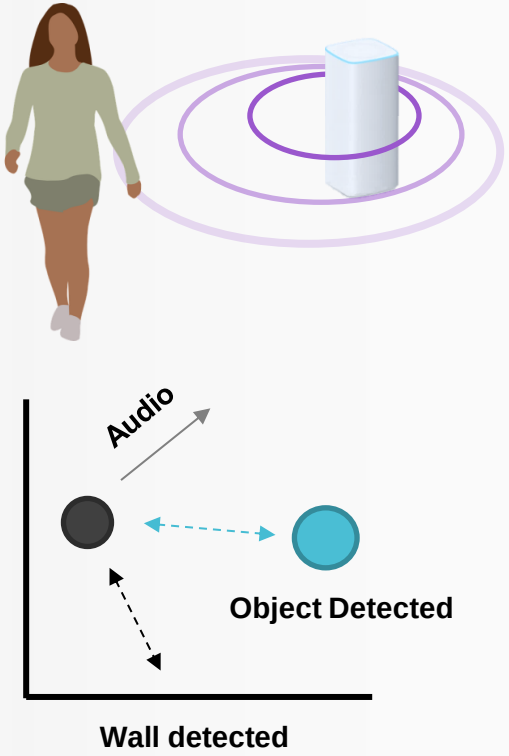
TAS58xx family supports 96kHz+ sampling with a good frequency response to support ultrasonic tones

People Detection

Make smart speakers even smarter. By detecting motion a smart speaker can double as a security system, pause a podcast when you leave the room, or change its volume based on your distance.

Directivity

Detect barriers or walls and use multiple speakers to beam-form audio to create the best audio experience based on the surrounding.



TAS5825: The details

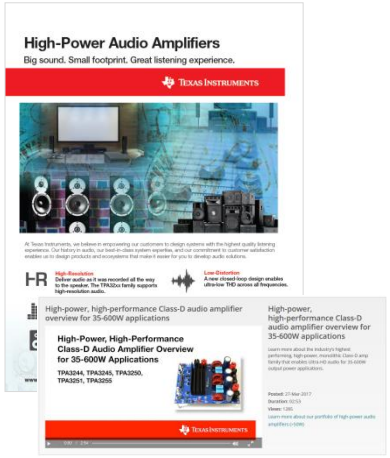
Learn more about TI's proven audio innovation:

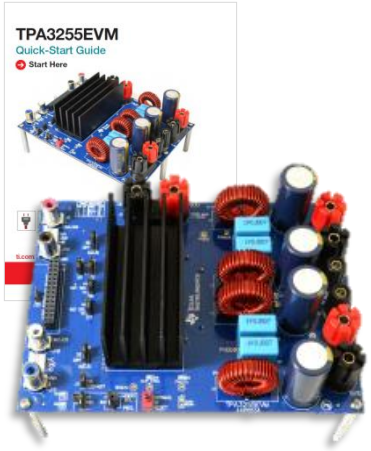
- Download theTAS58xx datasheet
- Watch a short video that outlines theTAS58xx video
- Easy for use software PPC3

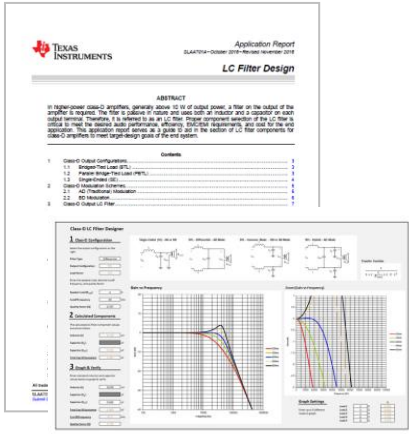
Give us a listen

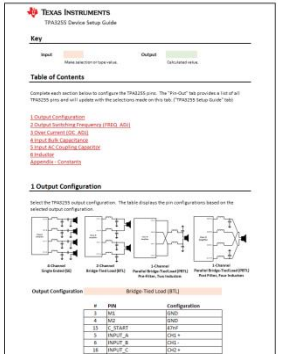
Give us a listen

Tools for listening, designing and building with TI Class-D Amplifiers









Selection Guides

Guides, Brochures, and Videos

- Learn about our new Class-D family with the High-Power Audio Amplifier Overview
- Watch an overview video in English or Chinese
- Visit TI.com/highpoweraudio

Evaluation Modules

Designed for each Class-D amplifier

- Easily setup and listen right out of the box in < 1 minute
- Designed with optimal layout and components
- Design files available on TI.com

Application Design

Guides and calculators

- Guides and calculators for selecting the best components for your application
- **Popular:** LC Filter Calculator & App Note (15,000+ downloads)
- Post-filter feedback, Class-G Power Supply, Noise Reduction

Board Design

Schematic and Layout Review

- Step-by-step Guide and Configuration Tool to setup and configure the Class-D amplifier, see device product webpage
- Expert apps support for schematic and layout questions

Texas Instruments

TI is your partner for all audio applications!

From most cost-effective to highest performance

Q & A

Texas Instruments

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale (www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2019, Texas Instruments Incorporated