25mW TRUE CAP FREE STEREO HEADPHONE AMPLIFIER

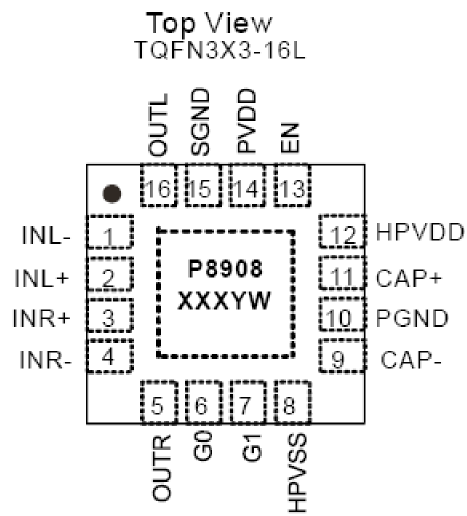
Description

The PAM8908 stereo headphone driver is designed for portable equipment where board space is at a premium. The PAM8908 uses a unique, patent pending architecture to produce a ground-referenced output from a single supply, eliminating the need for large DC-blocking capacitors, saving cost , board space, and component height.

The PAM8908 delivers up to 25mW per channel into a 16Ω load and has low 0.03% THD+N. A high power-supply rejection ratio allows this device to operate from noisy digital supplies without an additional linear regulator.

The PAM8908 operates from a single supply from 2.5V t o 5.5V, has short-circuit and over temperature protection. Shutdown mode reduces supply current to less than 1μA.

Pin Assignments



Features

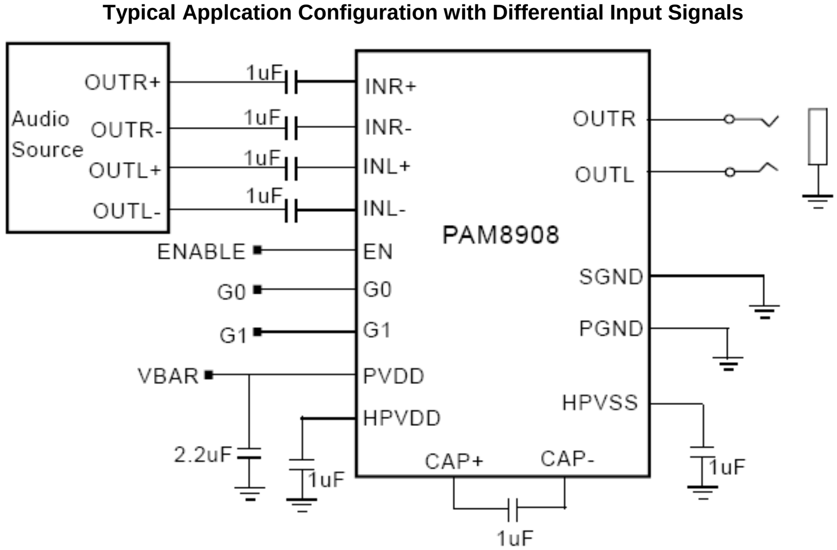
- Patent Pending 3 Phase Power Line Shift Charge Pump Eliminates Need for DC-BlockingCapacitors
- TrueCapFree Architecture, Output Biased at 0V (System Ground)
- Excellent Low Frequency Fidelity
- High PSRR
- Less Than 1μA Shutdown Current
- Support Both Fully Differential and Single Ended Inputs
- Short Circuit and Over Temperature Protection
- Selectable Gain Settings: -6dB, 0dB, 3dB and 6dB
- Available in Space Saving Packages: TQFN3x3-16L

Applications

- Smart Phones/Cellular Phones
- Notebook Computers
- Portable DVD Player
- Personal Digital Assistants (PDAs)
- Electronic Dictionaries
- Digital Still Cameras
- Portable Gaming

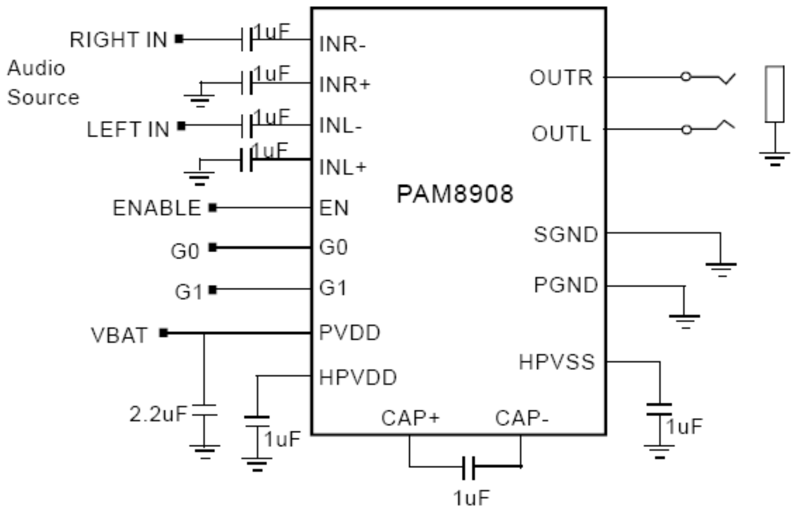
Typical Applications Circuit

Typical Applcation Configuration with Differential Input Signals



Typical Applications Circuit (cont.)

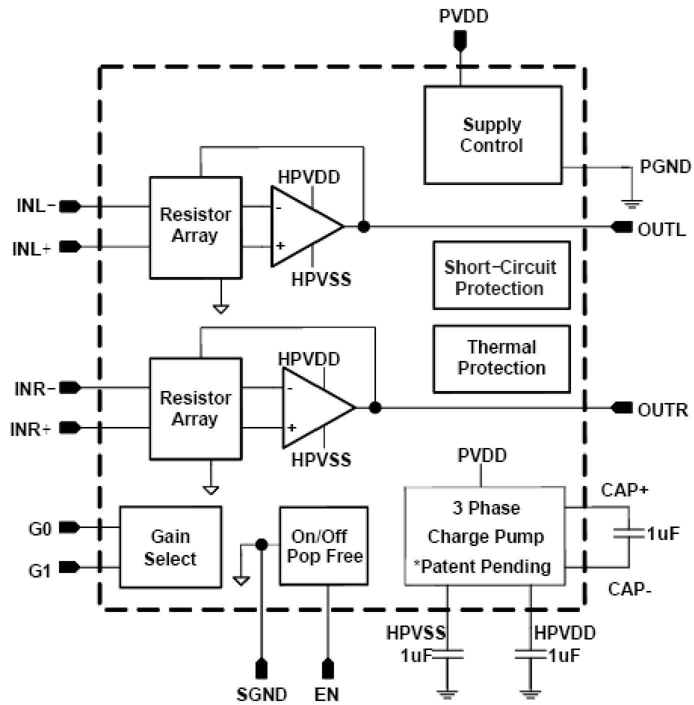
Typical Applcation Configuration with Single-Ended Input Signal



Pin Descriptions

Pin Number	T-QFN3x3-16L Pin Name	I/O/P	Function
1	INL-	I	Inverting left input for differential signals.
2	INL+	I	Non-inverting left input for differential signals.
3	INR+	I	Inverting right input for differential signals.
4	INR-	I	Non-inverting right input for differential signals.
5	OUTR	O	Right headphone amplifier output. Connect to right terminal of headphone jack.
6	G0	I	Gain select bit 0
7	G1	I	Gain select bit 1
8	HPVSS	P	Charge pump output and negative power supply for output amplifiers; connect 1µF capacitor to GND
9	CAP-	O	Charge pump negative flying cap.
10	PGND	P	Power Ground
11	CAP+	O	Charge pump positive flying cap.
12	HPVDD	O	Positive power supply for headphone amplifiers. Charge pump positive half V_{DD} output.
13	EN	I	Amplifier enabled. Connect to logic low to shutdown; connect to logic high to activate
14	PVDD	P	Power V_{DD}.
15	SGND	I	Amplifier reference voltage.
16	OUTL	O	Left headphone ampli fier output. Connect to left terminal of headphone jack.

Functional Block Diagram



Absolute Maximum Ratings (@T_A = +25°C, unless otherwise specified.)

These are stress ratings only and functional operation is not implied. Exposure to absolute maximum ratings for prolonged time periods may affect device reliability. All voltages are with respect to ground.

Parameter	Rating	Unit
Supply Voltage (PV_{DD})	6.0	V
Input Voltage (INR+, INR-, INL+, INL-)	HPV_{SS} -0.3 to HPV_{DD} +0.3	V
Control Interface Voltage (G0, G1, EN)	-0.3 to PV_{DD} +0.3	V
Storage Temperature	-65 to +150	°C
Maximum Junction Temperature	150	
Soldering Temperature	250, 10sec	

Recommended Operating Conditions (@T_A = +25°C, unless otherwise specified.)

Parameter	Rating	Unit
Supply Voltage Range	2.5 to 5.5	V
Ambient Temperature Range	-40 to +85	°C
Junction Temperature Range	-40 to +125	

Thermal Information

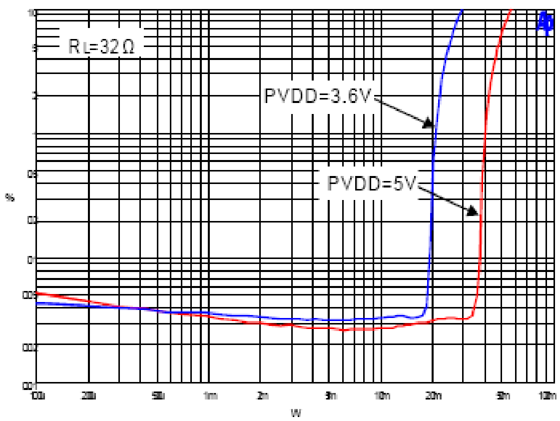
Parameter	Symbol	Package	Max	Unit
Thermal Resistance (Junction to Ambient)	θ_{JA}	TQFN3x3-16	35	°C/W
Thermal Resisitance (Junction to Case)	θ_{JC}	TQFN3x3-16	14	°C/W

Electrical Characteristics (@T_A = +25°C, V_{IN} = 3.6V, V_O = 1.8V, C_{IN} = 10μF, C_{OUT} = 10μF, L = 4.7μH, unless otherwise specified.)

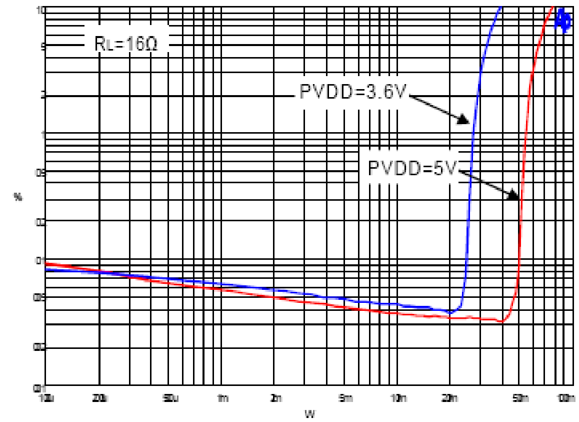
Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Supply Voltage	PV_{DD}		2.5		5.5	V
Quiescent Current	I_Q	EN = PVDD, No Load		4		mA
Output Power per Channel	P_O	THD = 1%, f = 1kHz, RL = 16Ω		35		
		THD = 1%, f = 1kHz, RL = 16Ω		25		mW
Shutdown Current	I_{SD}	EN = 0V, PVDD = 2.5V to 5.5V		0.1	1	μA
EN High Level Input Voltage	VIH		1.4			V
EN Low Level Voltage	VIL				0.6	V
G0, G1 High Level Input Voltage	VGH		1.4			V
G0, G1Low Level Voltage	VGL				0.6	V
Output Offset Voltage	V_{OS}			1	3	mV
Closed-Loop Voltage Gain	AV	G0 =0V, G1 = 0V		-6		dB
		G0 =PVDD, G1 = 0V		0		dB
		G0 =0V, G1 = PVDD		3		dB
		G0 =PVDD, G1 = PVDD		6		dB
Power Supply Rejection Ratio	PSRR	Input A C-GND, f + 1KHz, VPP = 200mV		75		dB
Total Harmonic Distortion Plus Noise	THD+N	PO = 20mW, f = 1kHz		0.03		%
Signal to Noise Ratio	SNR	PO = 20mW, into 16Ω		100		dB
Noise Output Voltage	EN	A-Weighted		10		μV_{RMS}
Crosstalk	CS	PO = 15mW, f = 1kHz		80		dB
Chargepump Switching Frequency	f_{OSC}		1.2	1.5	1.8	MHz
Start-Up Time	t_{ON}	EN from low to high		0.4		Ms
Thermal Shutdown	OTP	Threshold		150		°C
Thermal Shutdown Hysteresis	OTPH	Hysteresis		20		°C

Typical Performance Characteristics (@T_A = +25°C, PVDD=3.6V, f =1kHz, Gain = 6dB, unless otherwise specified.)

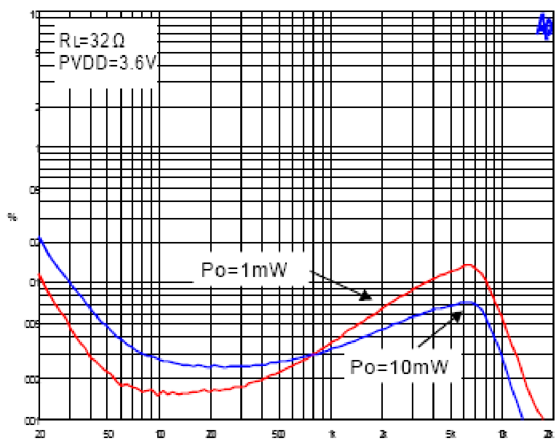
1. THD+N vs Output Power



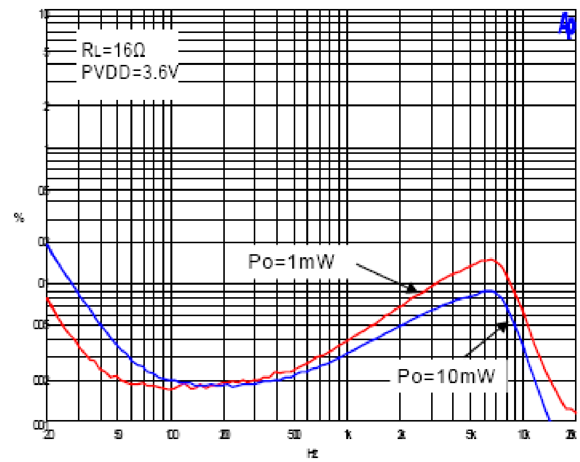
2. THD+N vs Output Power



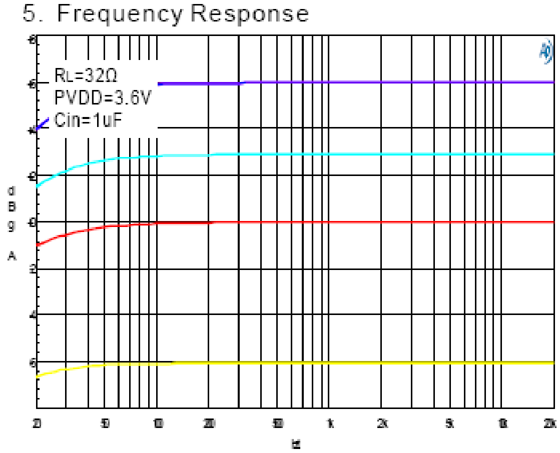
3. THD+N vs Frequency



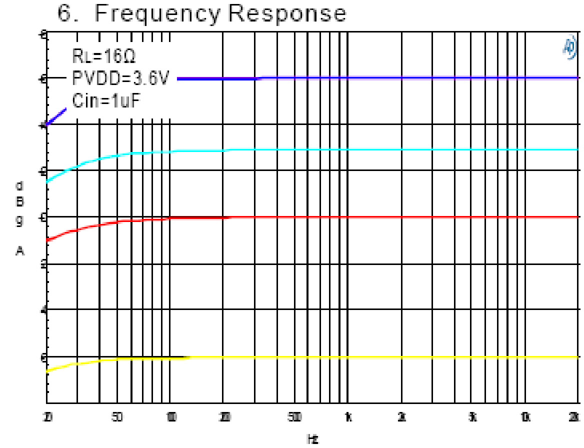
4. THD+N vs Frequency



5. Frequency Response

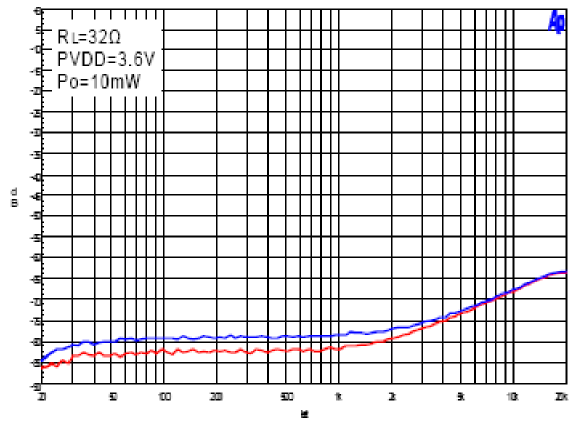


6. Frequency Response

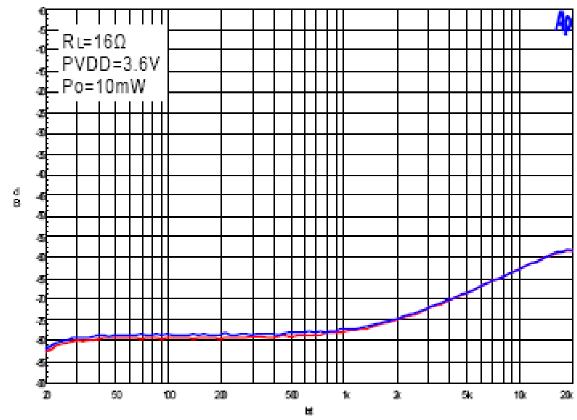


Typical Performance Characteristics (cont.) (@T_A=+25°C, PVDD=3.6V, f =1kHz, Gain=6dB, unless otherwise specified.)

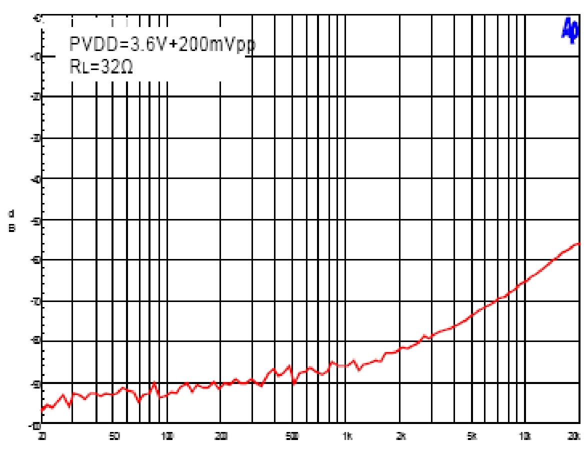
7. Crosstalk



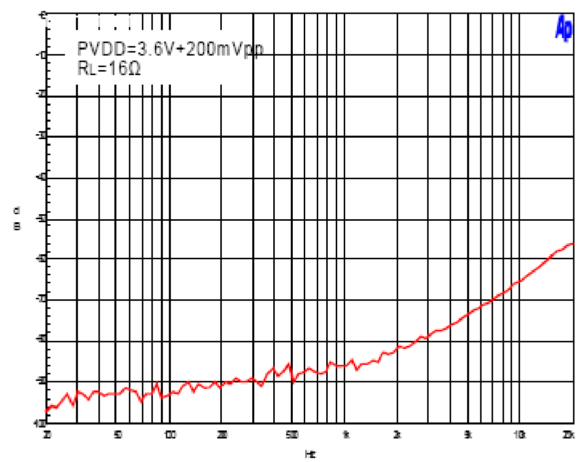
8. Crosstalk



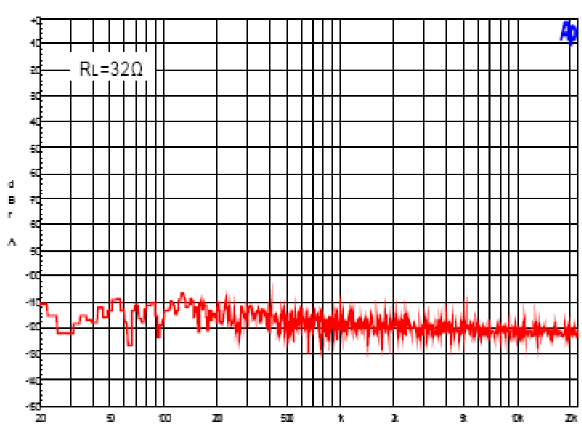
9. PSRR



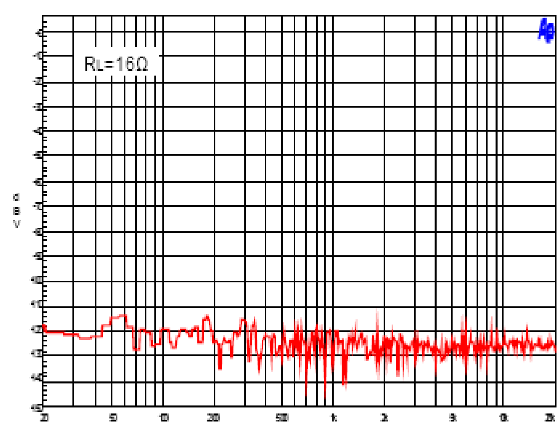
10. PSRR



11. FFT Noise

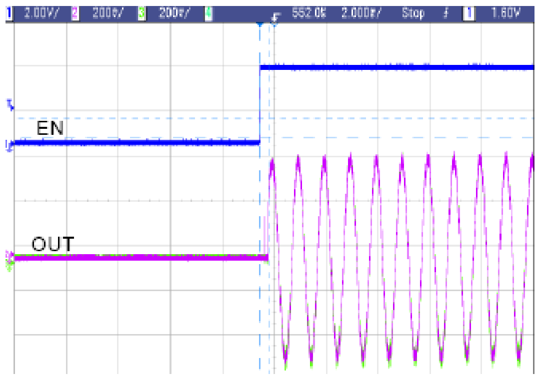


12. FFT Noise

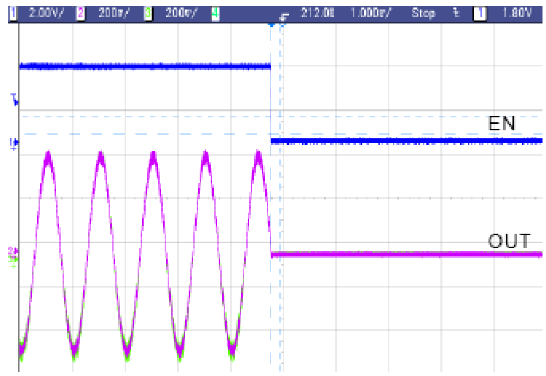


Typical Performance Characteristics (cont.) (@T_A = +25°C, C_{IN}=10μF, C_O=10μF, L=4.7μH, unless otherwise specified.)

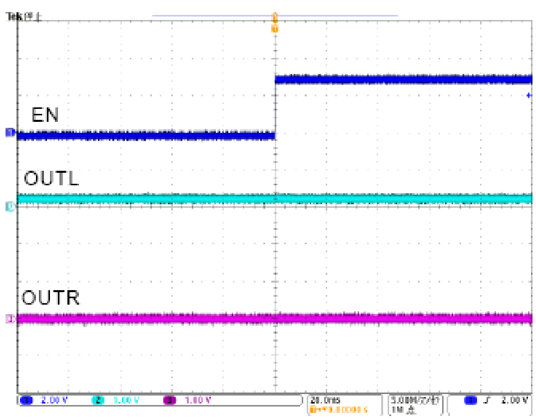
13. Start up with signal



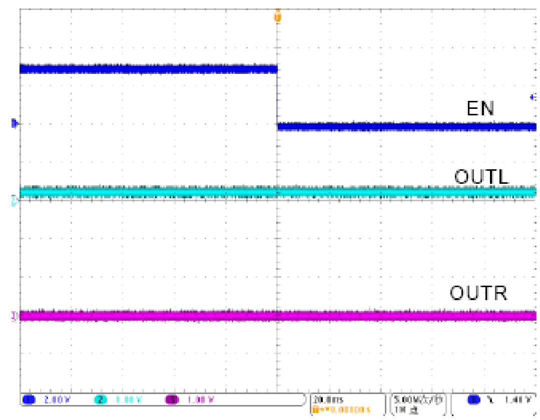
14. Shutdown with signal



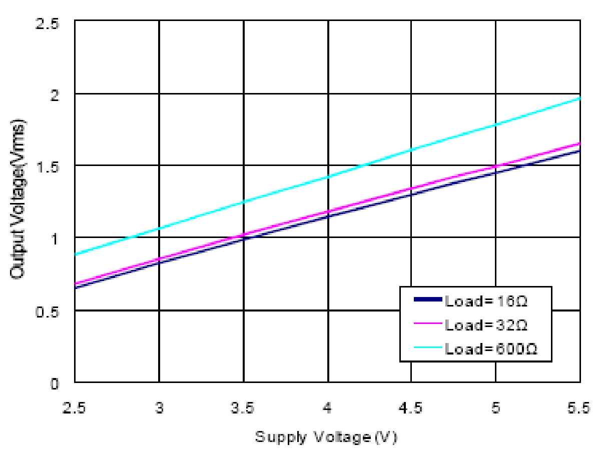
15. Start up without signal



16. Shutdown without signal



17. Output Voltage vs Supply Voltage



Application Information

The basic PAM8908 application circuit is shown in page 1 and page 2.

Gain Control

The PAM8908 has four gain settings which are controlled with pins G0 and G1. The following table gives an overview of the gain function. Input coupling capacitors block any DC bias from the audio source and ensure maximum dynamic range. Input coupling capacitors also minimize PAM8908 turn-on pop to an inaudible level.

G0 Voltage	G1 Voltage	Amplifier Gain
≤0.6V	≤0.6V	-6dB
≥1.4V	≤0.6V	0dB
≤0.6V	≥1.4V	3dB
≥1.4V	≥1.4V	6dB

Input Coupling Capacitors

The input capacitors are in series with PAM8908 internal input resistors, creating a high-pass filter. The following Equation calculates the highpass filter corner frequency.

$$f_C = \frac{1}{2\pi R_{IN} C_{IN}}$$

The input impedance, RIN, is dependent on device gain. Larger input capacitors decrease the corner frequency. See the following table for input impedance values.

G0 Voltage	G1 Voltage	R_{IN}
≤0.6V	≤0.6V	26.4kΩ
≥1.4V	≤0.6V	19.8kΩ
≤0.6V	≥1.4V	16.5kΩ
≥1.4V	≥1.4V	13.2kΩ

For a given high-pass cutoff frequency, the minimum input coupling capacitor is found as:

$$C_{IN} = \frac{1}{2\pi f_C R_{IN}}$$

Example: Design for a 20Hz corner frequency with a PAM8908 gain of +6dB. The input impedance table gives RIN as 13.2kΩ. The C_{IN} Equation shows the input coupling capacitors must be at least 0.6μF to achieve a 20Hz highpass corner frequency. Choose a 0.68μF standard value capacitor for each PAM8908 input (X5R material or better is required for best performance).

Charge Pump Flying Capacitor, HPVDD Capacitor and HPVSS Capacitor

The PAM8908 uses a built-in charge pump to generate a positive and negative voltage supply for the headphone amplifiers. The charge pump flying capacitor connects between CAP+ and CAP-. It transfers charge to generate the positive and negative supply voltage. The HPVDD capacitor or HPVSS capacitor must be at least equal in or larger than value to the flying capacitor to allow maximum charge transfer. Use low equivalent-series-resistance (ESR) ceramic capacitors (X5R material or better is required for best performance) to maximize charge pump efficiency. Typical values are 1μF for the HPVDD, HPVSS and flying capacitors.

Power Supply Decoupling Capacitors

The PAM8908 TrueCapFree headphone ampl ifier requi res adequate power supply decoupling to ensure that output noise and total harmonic distortion (THD) remain low. Use good low equivalent-series-resistance (ESR) ceramic capacitors (X5R material or better is required for best performance). Place a 2.2μF capacitor within 5mm of the PVDD pin. Reducing the distance between the decoupling capacitor and PVDD minimizes parasitic inductance and resistance, improving PAM8908 supply rejection performance. Use 0402 or smaller size capacitors if possible.

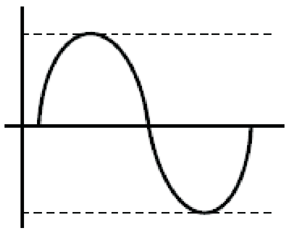
Power Supply Sequencing

Use input coupling capacitors to ensure inaudible turn-on pop. Activate the PAM8908 after all audio sources have been activated and their output voltages have settled. On powerdown, deactivate the PAM8908 before deactivating the audio input source. The EN pin controls device shutdown: Set to 0.6V or lower to deactivate the PAM8908; set to 1.4V or higher to activate.

Application Information (cont.)

TrueCapFree Headphone Amplifiers

The TrueCapFree amplifier architecture operates from a single supply voltage and uses two internal charge pumps to generate a positive supply and a rail for the headphone amplifier. The output voltages are centered around 0V and are capable of positive and negative voltage swings as shown in the following drawing.



The TrueCapFree amplifiers require no output DC-blocking capacitors. The headphone connector shield pin connects to ground and will interface with headphones and non-headphone accessories. The PAM8908 is an amplifier.

LAYOUT RECOMMENDATIONS

Exposed Pad on PAM8908JR

Solder the exposed metal pad on the PAM8908 TQFN package to the landing pad on the PCB. Connect the landing pad to ground or leave it electrically unconnected (floating). Do not connect the landing pad to PVDD or to any other power supply voltage.If the pad is grounded, it must be connected to the same ground as the PGND pin 9. Soldering the thermal pad is required for mechanical reliability and enhances thermal conductivity of the package.

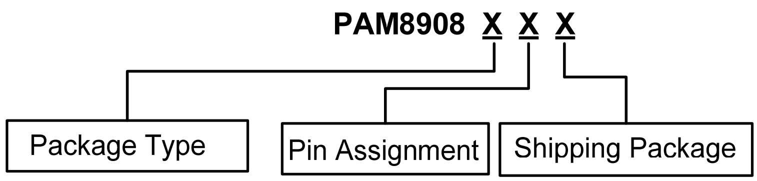
GND Connections

The SGND pin is an input reference and must be connected to the headphone ground connector pin. This ensures no turn-on pop and minimizes output offset voltage. Do not connect more than ±0.3V to SGND.
PGND is a power ground. Connect supply decoupling capacitors for PVDD, HPVDD, and HPVSS to PGND.

Power Supply Connections

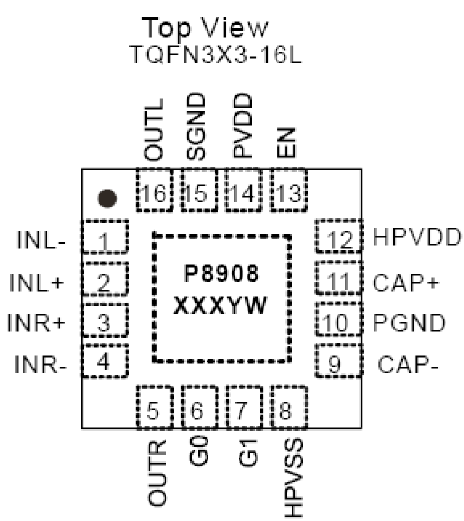
Connect the supply voltage to the PVDD pin and decouple it with an X5R or better capacitor. Place both PVDD capacitor within 5 mm of PVDD pin on the PAM8908. Ensure that the ground connection of PVDD capacitor has a minimum length return path to the device. Failure to properly decouple the PAM8908 may degrade audio or EMC performance.

Ordering Information



Part Number	Package Type	Standard Package
PAM8908JER	TQFN3x3-16L	3000 Units/ Tape & Reel

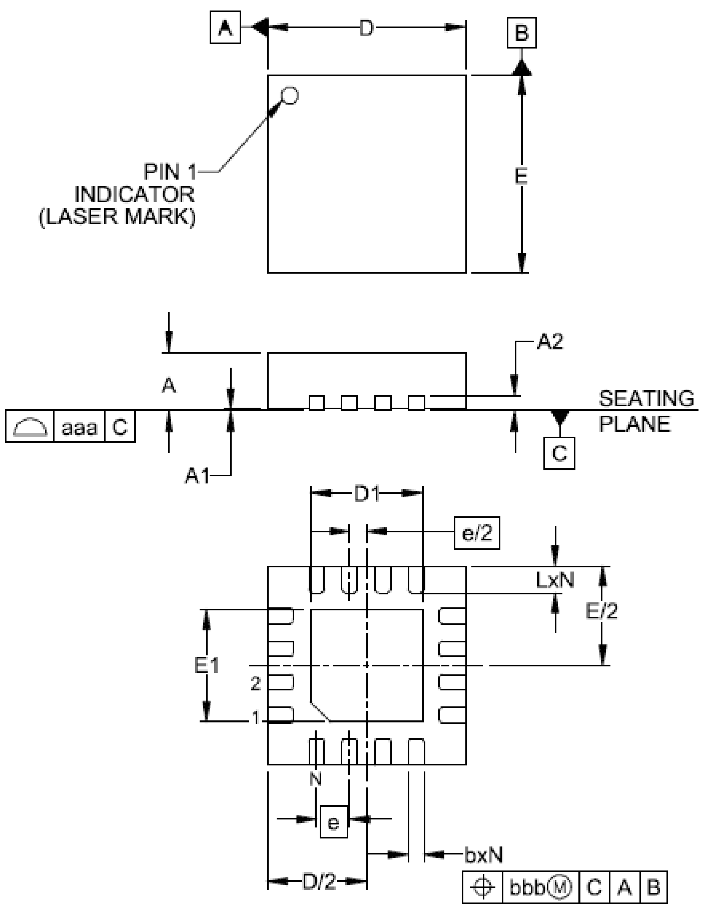
Marking Information



X: Internal Code
Y: Year
W: Week

Package Outline Dimensions (All dimensions in mm.)

TQFN3x3mm-16



DIMENSIONS (Millieters)			
	MIN	TYP	MAX
A	0.40	0.50	0.60
A1	0.00	0.02	0.05
A2		0.20	
b	0.18	0.25	0.30
D	2.90	3.00	3.10
D1	1.55	1.70	1.80
E	2.90	3.00	3.10
E1	1.55	1.70	1.80
e		0.50BSC	
L	0.30	0.40	0.50
N		16	
aaa		0.08	
bbb		0.10	

Notes:
1. Controlling dimensions are in millimeters (angles in degrees).
2. Coplanarity applies to the exposed pad as well as the terminals.
3. DAP is 1.90 x 1.90mm.

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