Description

The PAM8302A is a 2.5W Class-D mono audio amplifier. Its low THD+N feature offers high-quality sound reproduction. The new filterless architecture allows the device to drive speakers directly instead of using low-pass output filters thus saving system cost and PCB area.

With the same number of external components, the efficiency of the PAM8302A is much better than that of Class-AB cousins. It can optimize battery life thus is ideal for portable applications.

The PAM8302A is available in MSOP-8, SO-8, and U-DFN3030-8 (Type E) packages.

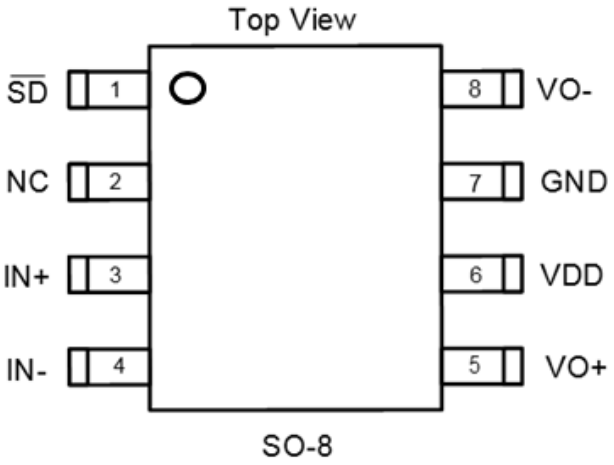
Features

- 2.5W Output at 10% THD with a 4Ω Load and 5V Power Supply
- Filterless, Low Quiescent Current and Low EMI
- High Efficiency up to 88%
- Superior Low Noise
- Short Circuit Protection
- Thermal Shutdown
- Few External Components to Save Space and Cost
- MSOP-8, SO-8 and U-DFN3030-8 (Type E) Packages Available
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **For automotive applications requiring specific change control (i.e. parts qualified to AEC-Q100/101/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please contact us or your local Diodes representative.**
  https://www.diodes.com/quality/product-definitions/

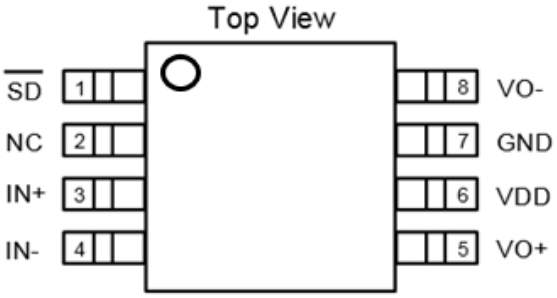
Applications

- PMP/MP4
- GPS
- Portable Speakers
- 2-Way Radios
- Hands-Free Phones/Speaker Phones
- Cellular Phones

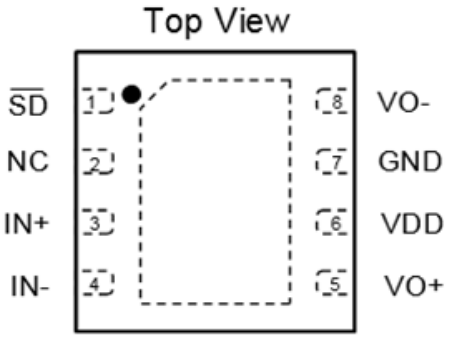
Pin Assignments



SO-8



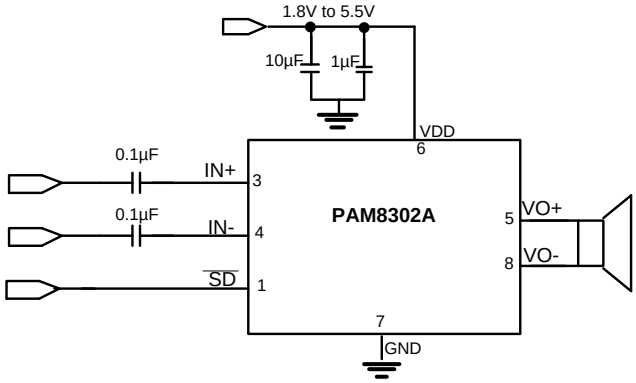
MSOP-8



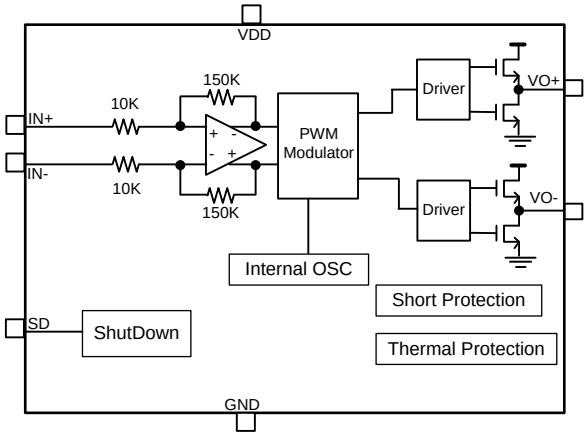
U-DFN3030-8 (Type E)

Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

Typical Applications Circuit



Functional Block Diagram



Absolute Maximum Ratings (@TA = +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 at No Input Signal	6.0	V
Input Voltage	-0.3 to V_{DD} +0.3	
Maximum Junction Temperature	+150	°C
Storage Temperature	-65 to +150	
Soldering Temperature	+300, 5s	

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

Parameter	Rating	Unit
Supply Voltage Range	2.0 to 5.5	V
Operation Temperature Range	-40 to +85	°C
Junction Temperature Range	-40 to +125	°C

Thermal Information

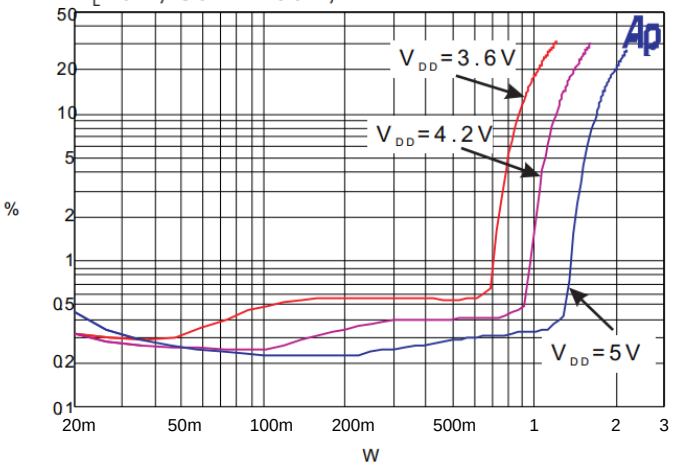
Parameter	Package	Symbol	Max	Unit
Thermal Resistance (Junction to Ambient)	SO-8	θ_{JA}	115	°C/W
	MSOP-8		180	
	U-DFN3030-8 (Type E)		47.9	

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.)

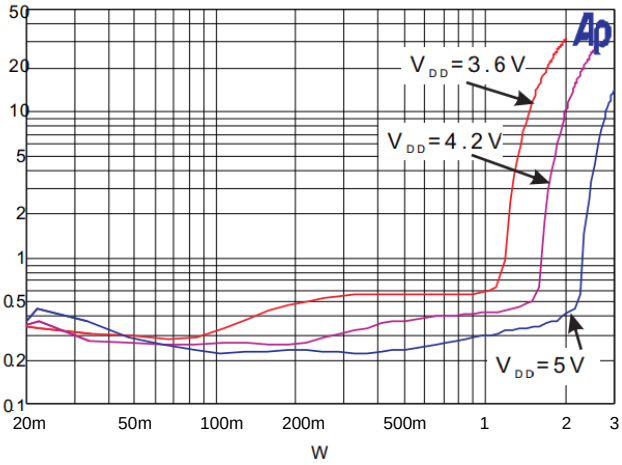
Parameter	Symbol	Test Conditions		Min	Typ	Max	Unit
Supply Voltage Range	V_{DD}	—		2.0	—	5.5	V
Quiescent Current	I_Q	No Load		—	4	8	mA
Shutdown Current	I_{SHDN}	V_{SHDN} = 0V		—	—	1	µA
Output Power	P_O	f = 1kHz, R_L = 4Ω, THD+N = 10%	V_{DD} = 5V	2.25	2.50	—	W
			V_{DD} = 3.6V	1.10	1.25	—	
		f = 1kHz, R_L = 4Ω, THD+N = 1%	V_{DD} = 5V	1.80	2.00	—	
			V_{DD} = 3.6V	0.86	0.95	—	
		f = 1kHz, R_L = 8Ω, THD+N = 10%	V_{DD} = 5V	1.35	1.50	—	
			V_{DD} = 3.6V	0.72	0.80	—	
		f = 1kHz, R_L = 8Ω, THD+N = 1%	V_{DD} = 5V	1.15	1.30	—	
			V_{DD} = 3.6V	0.6	0.65	—	
Peak Efficiency	η	f = 1kHz		—	85	88	%
Total Harmonic Distortion Plus Noise	THD+N	RL = 8Ω, P_O = 0.1W, f = 1kHz		—	0.30	0.35	%
		RL = 8Ω, P_O = 0.5W, f = 1kHz		—	0.45	0.50	
		RL = 4Ω, P_O = 0.1W, f = 1kHz		—	0.35	0.40	
		RL = 4Ω, P_O = 0.5W, f = 1kHz		—	0.40	0.45	
Gain	G_V	—		—	23.5	—	dB
Power Supply Ripple Rejection	PSRR	No Inputs, f = 1kHz, V_{PP} = 200mV		45	50	—	dB
Dynamic Range	DYN	f = 20 to 20kHz		85	90	—	dB
Signal to Noise Ratio	SNR	f = 20 to 20kHz		75	80	—	dB
Noise	V_N	No A-Weighting		—	180	300	µV
		A-Weighting		—	120	200	
Oscillator Frequency	f_{OSC}	—		200	250	300	kHz
Drain-Source On-State Resistance	$R_{DS(ON)}$	I_{DS} = 100mA	P MOSFET	—	0.45	0.50	Ω
			N MOSFET	—	0.20	0.25	
SHD Input High	V_{SH}	—		1.2	—	—	V
SHD Input Low	V_{SL}	—		—	—	0.4	
Over Temperature Protection	OTP	Junction Temperature		+120	+135	—	°C
Over Temperature Hysteresis	OTH	—		—	+30	—	°C

Typical Performance Characteristics (@T_A = +25°C, unless otherwise specified.)

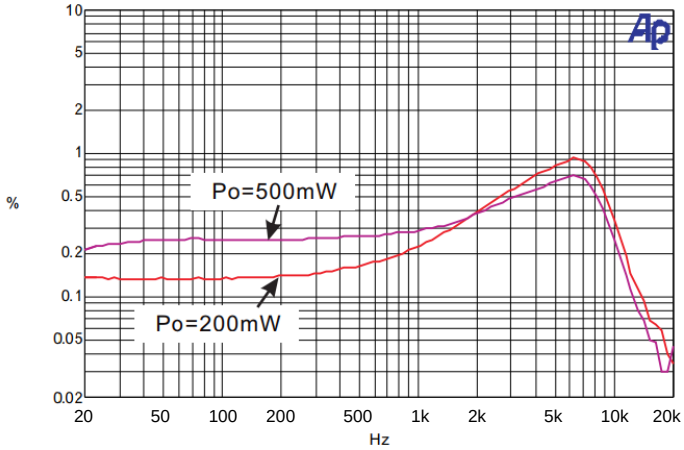
THD+N VS Output Power
R_L=8Ω, Gain=23dB, f=1kHz



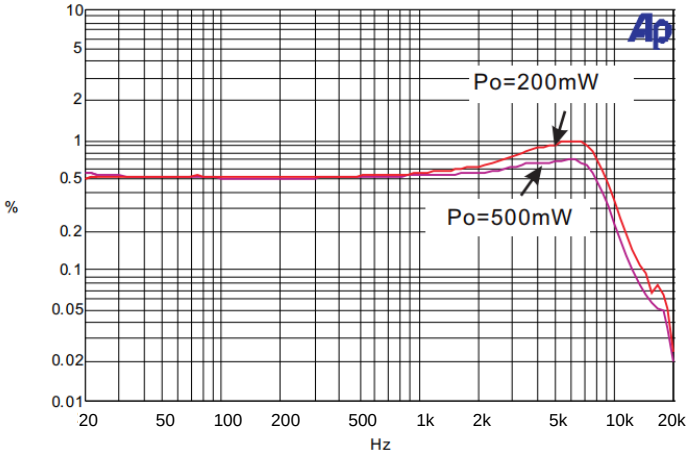
THD+N VS Output Power
R_L=4Ω, Gain=23dB, f=1kHz



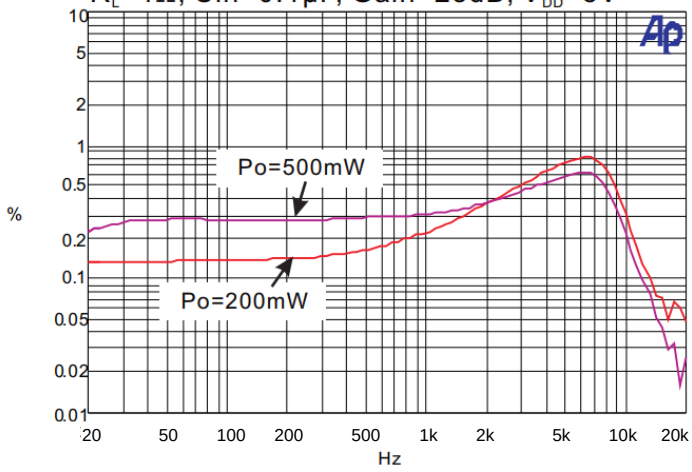
THD+N VS Frequency
R_L=8Ω, Cin=0.1μF, Gain=23dB, V_{DD}=5V



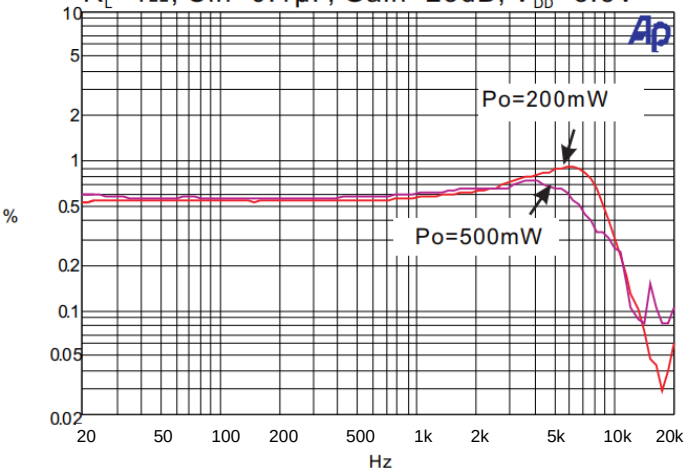
THD+N VS Frequency
R_L=8Ω, Cin=0.1μF, Gain=23dB, V_{DD}=3.6V



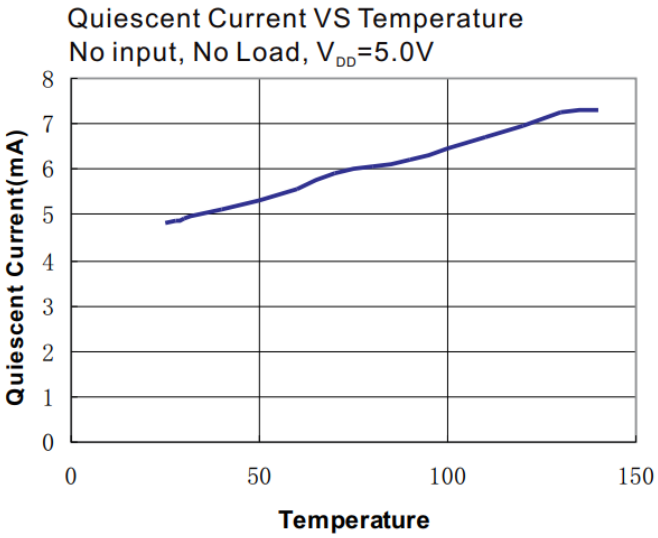
THD+N VS Frequency
R_L=4Ω, Cin=0.1μF, Gain=23dB, V_{DD}=5V

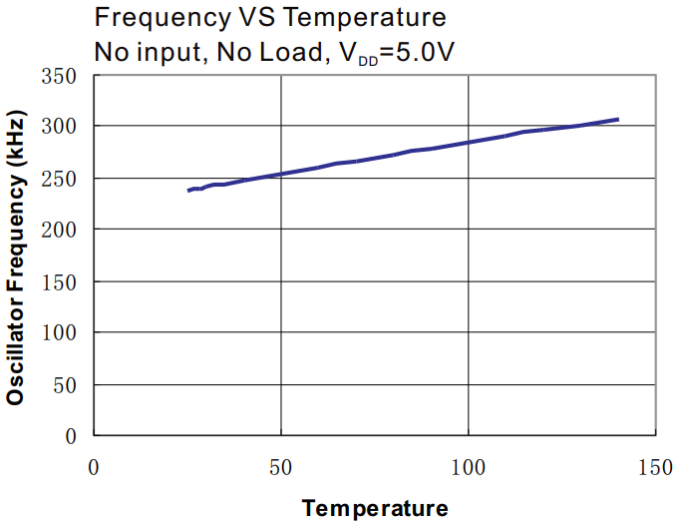


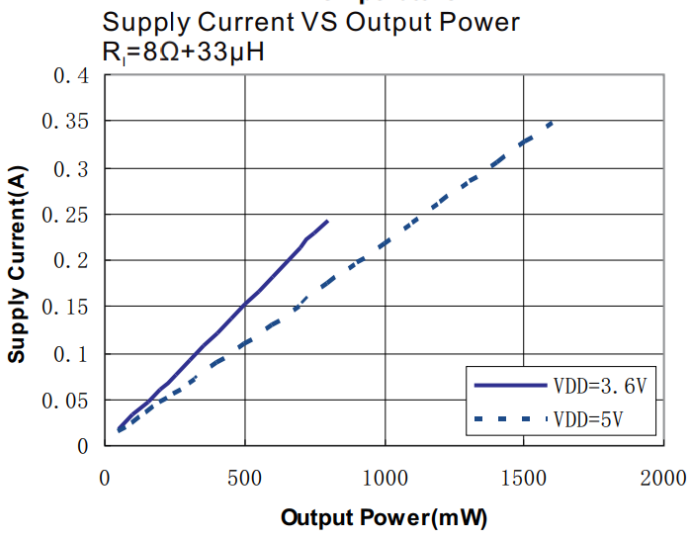
THD+N VS Frequency
R_L=4Ω, Cin=0.1μF, Gain=23dB, V_{DD}=3.6V

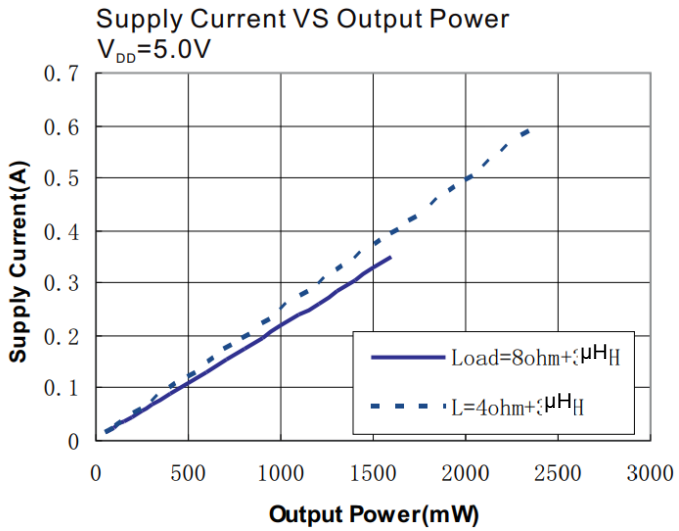


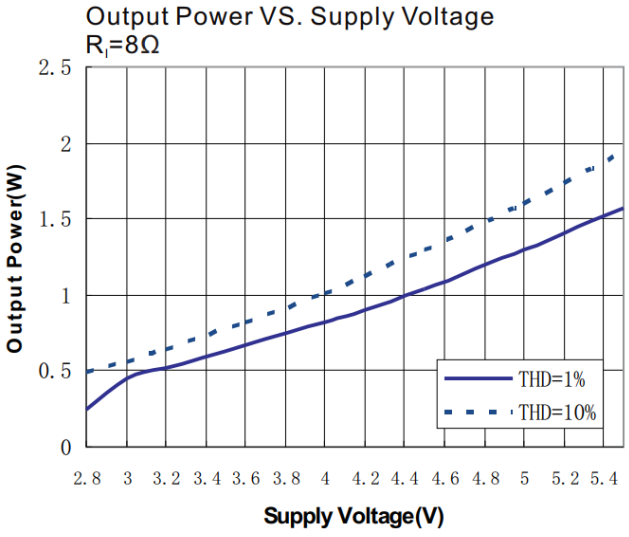
Typical Performance Characteristics (continued) (@T_A = +25°C, unless otherwise specified.)

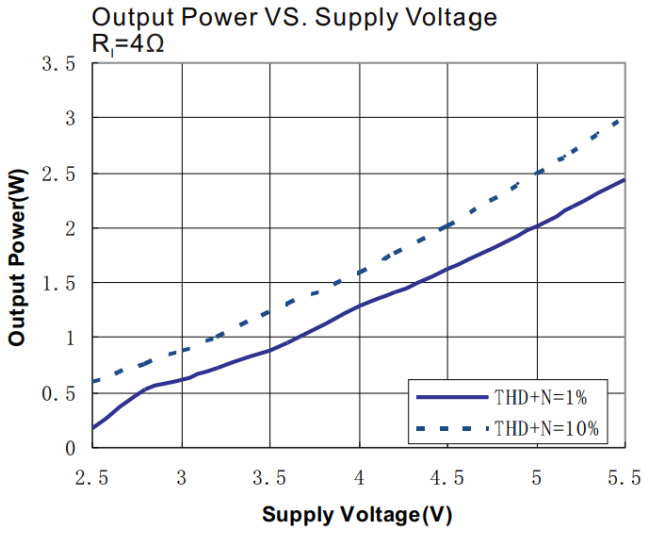






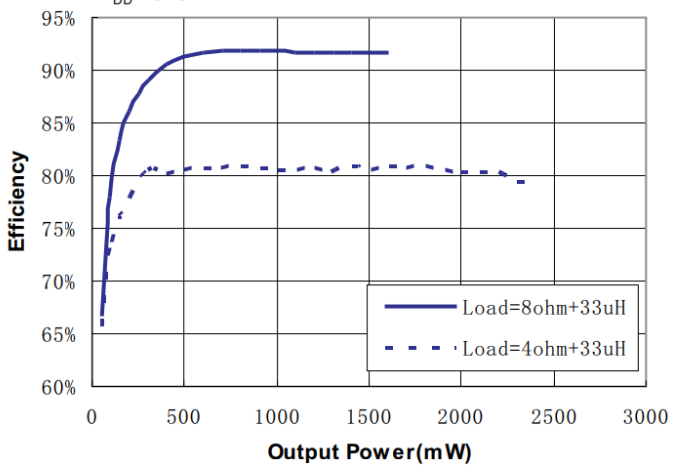




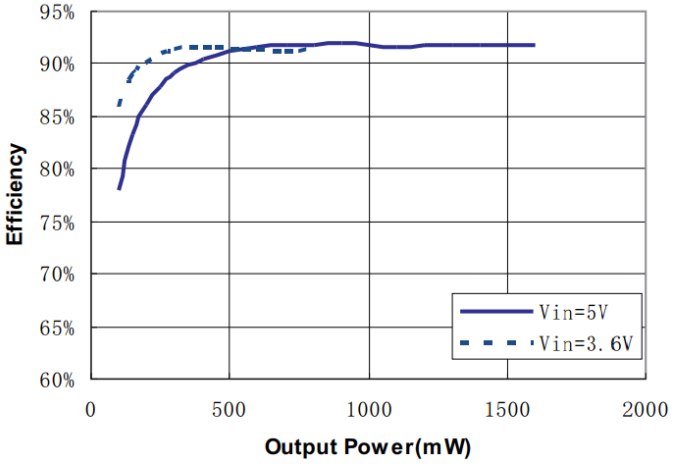


Typical Performance Characteristics (continued) (@T_A = +25°C, unless otherwise specified.)

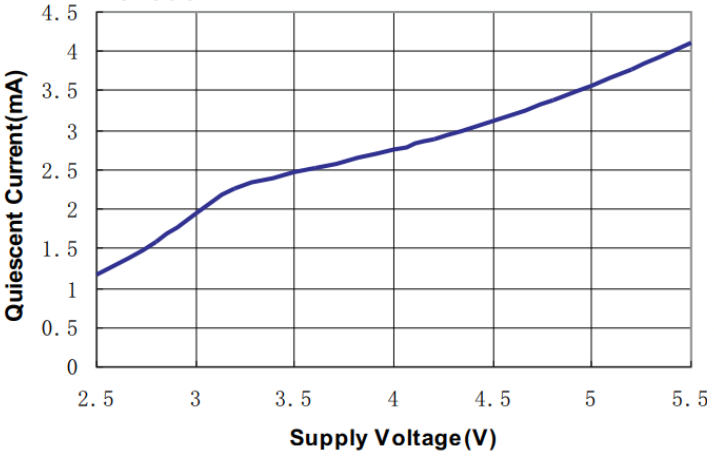
Efficiency VS Output Power
V_{DD}=5.0V



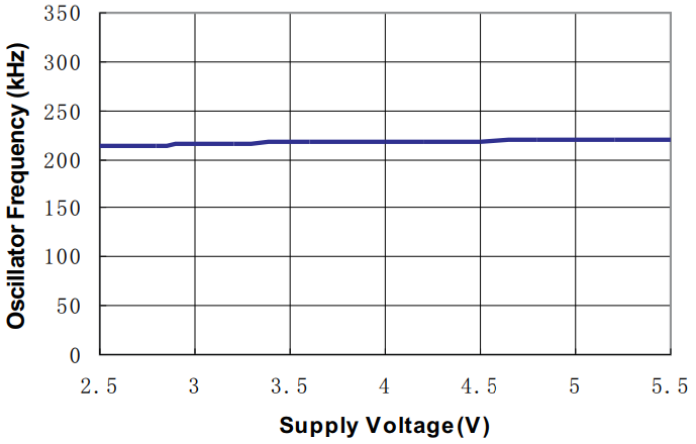
Efficiency VS Output Power
R_l=8Ω+33μH



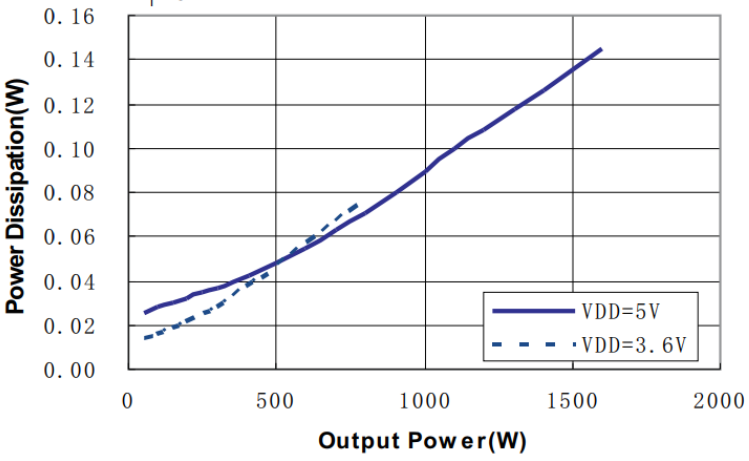
Quiescent Current VS. Supply Voltage
No load



Frequency VS. Supply Voltage

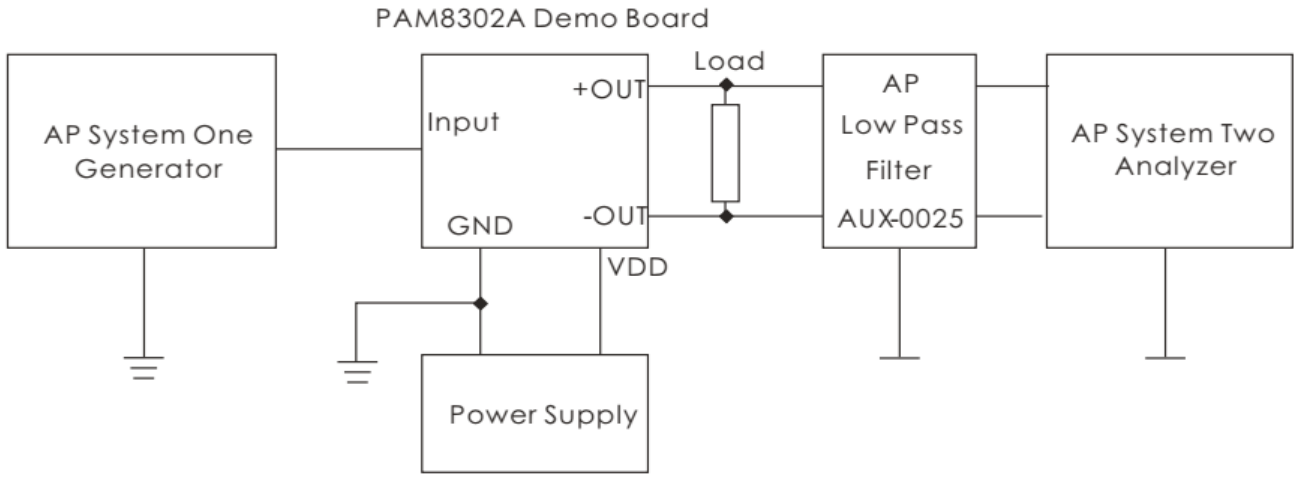


Power Dissipation VS. Output Power
R_l=8Ω



Application Information (Notes 4 & 5)

Test Setup for Performance Testing



Notes: 4. The AP AUX-0025 low pass filter is necessary for every class-D amplifier measurement with AP analyzer.
5. Two 22μH inductors are used in series with load resistor to emulate the small speaker for efficiency measurement.

Maximum Gain

As shown in block diagram (Page 2), the PAM8302A differential gain for the IC is:

$A = 20*\log (R_F/R_I)$

The PAM8302A sets maximum R_F = 150kΩ, minimum R_I = 10kΩ, so the maximum closed-gain around 23.5dB. If need gain adjustment, you can put external R_{IN} at the input pin, and gain calculate as $20*\log (150K/ (10K+R_{IN}))$.

Input Capacitor (CI)

In typical application, an input capacitor, C_I is required to allow the amplifier to bias input signals to a proper DC level for optimum operation. In this case, C_I and the minimum input impedance R_I (10k internal) form a high-pass filter with a corner frequency determined by the following equation:

$$f_C = \frac{1}{2\Pi R_I C_I}$$

It is important to choose the value of C_I as it directly affects low-frequency performance of the circuit, for example, when an application requires a flat bass response as low as 100Hz. Equation is reconfigured as follows:

$$C_I = \frac{1}{2\Pi R_I f_I}$$

As the input resistance is variable for the C_I value of 0.16μF, one should actually choose the C_I within the range of 0.1μF to 0.22μF. A further consideration for this capacitor is the leakage path from the input source through the input network (R_I, R_F, C_I) to the load. This leakage current creates a DC offset voltage at the input to the amplifier that reduces useful headroom—especially in high-gain application. For this reason, a low leakage tantalum or ceramic capacitor is the best choice. When a polarized capacitor is used, the positive side of the capacitor should face the amplifier input in most applications as the DC level is held at $V_{DD}/2$, which is likely higher than the source DC level. Please note that it is important to confirm the capacitor polarity in the application.

Application Information (continued)

Power Supply Decoupling (CS)

The PAM8302A is a high-performance CMOS audio amplifier that requires adequate power supply decoupling to ensure the output THD and PSRR as low as possible. Power supply decoupling affects low frequency response. Optimum decoupling is achieved by using two capacitors of different types that target different types of noise on the power supply leads. For higher-frequency transients, spikes, or digital hash on the line, a good low equivalent-series-resistance (ESR) ceramic capacitor, typical 1.0µF is good, placing it as close as possible to the device V_{DD} terminal. For filtering lower frequency noise signals, capacitor of 10µF or larger, closely located to near the audio power amplifier is recommended.

Shutdown Operation

In order to reduce shutdown power consumption, the PAM8032A contains shutdown circuitry for turn to turn off the amplifier. This shutdown feature turns the amplifier off when a logic low is applied on the $\overline{SD}$ pin. By switching the shutdown pin over to GND, the PAM8302A supply current draw will be minimized in idle mode.

Note: For the best power on/off pop performance, the amplifier should be set in the shutdown mode prior to power on/off operation.

Undervoltage Lockout (UVLO)

The PAM8302A incorporates circuitry to detect low on or off voltage. When the supply voltage drops to 2.1V or below, the PAM8302A goes into a state of shutdown, and the device comes out of its shutdown state to normal operation by reset the power supply or $\overline{SD}$ pin.

How to Reduce EMI (Electro Magnetic Interference)

A simple solution is to put an additional capacitor 1000µF at power supply terminal for power line coupling if the traces from amplifier to speakers are short (< 20CM). Most applications require a ferrite bead filter as shown in Figure 1. The ferrite filter depresses EMI of around 1MHz and higher. When selecting a ferrite bead, choose one with high impedance at high frequencies and low impedance at low frequencies.

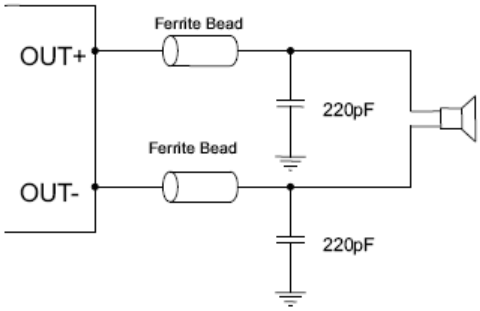
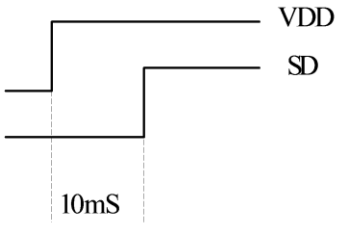


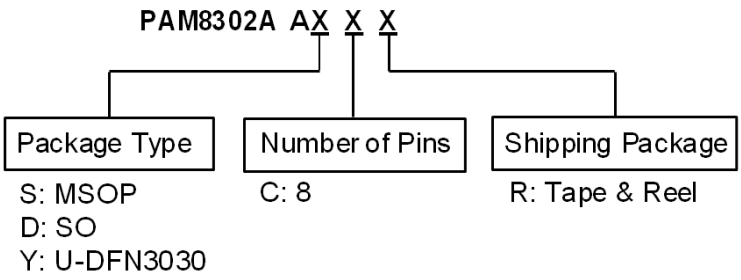
Figure 1 Ferrite Bead Filter to Reduce EMI

System Start-up Timing Recommendation

The start time for SD pin is recommended to delay after rising edge of V_{DD} for 1ms ~100 ms (typically10ms is recommended), depending on customer's application condition.



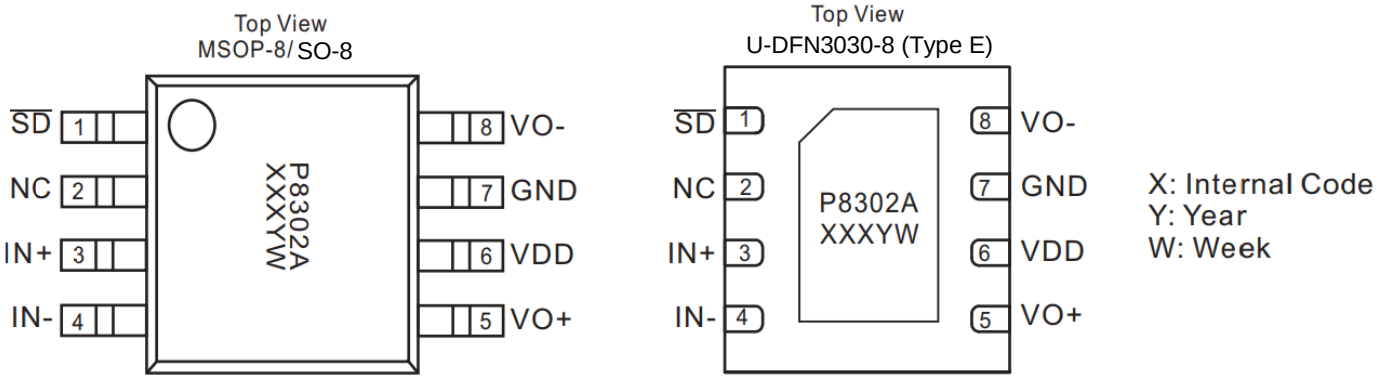
Ordering Information (Note 6)



Part Number	Package Type	Standard Package
PAM8302AASCR	MSOP-8	2500 Units/Tape & Reel
PAM8302AADCR	SO-8	2500 Units/Tape & Reel
PAM8302AAYCR	U-DFN3030-8 (Type E)	3000 Units/Tape & Reel

Note: 6. For packaging details, go to our website at https://www.diodes.com/design/support/packaging/diodes-packaging/.

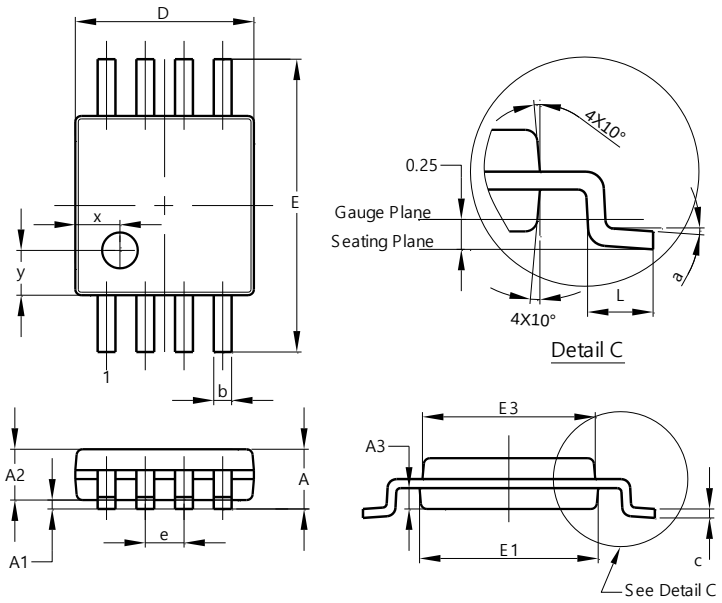
Marking Information



Package Outline Dimensions

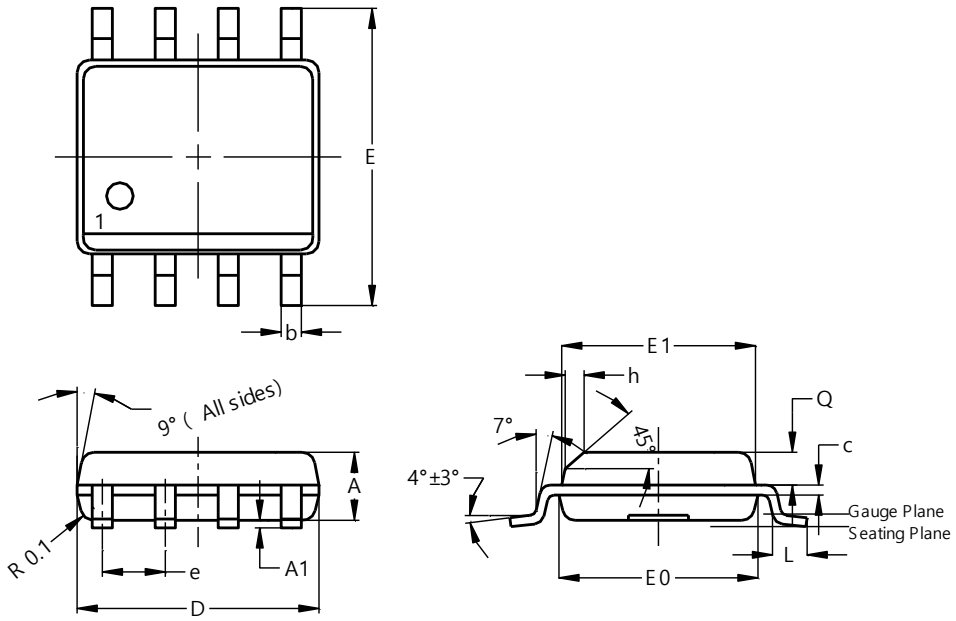
Please see http://www.diodes.com/package-outlines.html for the latest version.

MSOP-8



MSOP-8			
Dim	Min	Max	Typ
A	—	1.10	—
A1	0.05	0.15	0.10
A2	0.75	0.95	0.86
A3	0.29	0.49	0.39
b	0.22	0.38	0.30
c	0.08	0.23	0.15
D	2.90	3.10	3.00
E	4.70	5.10	4.90
E1	2.90	3.10	3.00
E3	2.85	3.05	2.95
e	—	—	0.65
L	0.40	0.80	0.60
a	0°	8°	4°
x	—	—	0.750
y	—	—	0.750
All Dimensions in mm			

SO-8

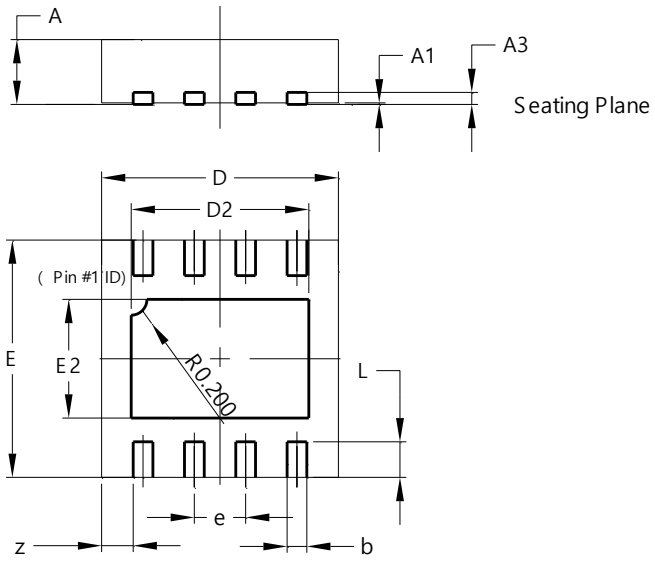


SO-8			
Dim	Min	Max	Typ
A	1.40	1.50	1.45
A1	0.10	0.20	0.15
b	0.30	0.50	0.40
c	0.15	0.25	0.20
D	4.85	4.95	4.90
E	5.90	6.10	6.00
E1	3.80	3.90	3.85
E0	3.85	3.95	3.90
e	—	—	1.27
h	—	—	0.35
L	0.62	0.82	0.72
Q	0.60	0.70	0.65
All Dimensions in mm			

Package Outline Dimensions (continued)

Please see http://www.diodes.com/package-outlines.html for the latest version.

U-DFN3030-8 (Type E)

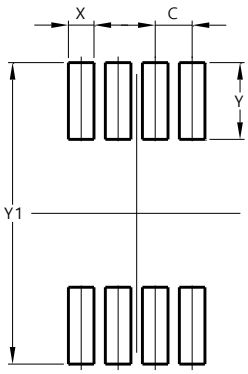


U-DFN3030-8 (Type E)			
Dim	**Min**	**Max**	**Typ**
A	0.57	0.63	0.60
A1	0.00	0.05	0.02
A3	-	-	0.15
b	0.20	0.30	0.25
D	2.95	3.05	3.00
D2	2.15	2.35	2.25
E	2.95	3.05	3.00
E2	1.40	1.60	1.50
e	-	-	0.65
L	0.30	0.60	0.45
z	-	-	0.40
All Dimensions in mm			

Suggested Pad Layout

Please see http://www.diodes.com/package-outlines.html for the latest version.

MSOP-8

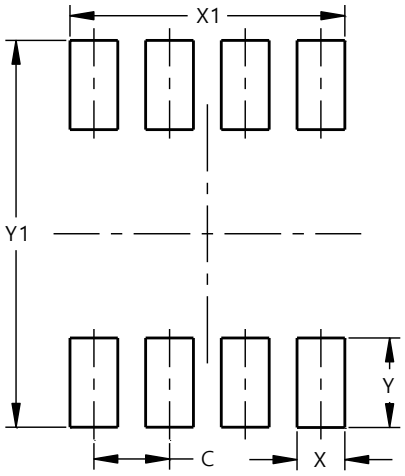


Dimensions	Value (in mm)
C	0.650
X	0.450
Y	1.350
Y1	5.300

Suggested Pad Layout (continued)

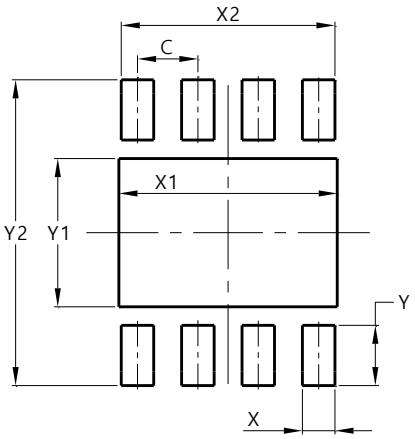
Please see http://www.diodes.com/package-outlines.html for the latest version.

SO-8



Dimensions	Value (in mm)
C	1.27
X	0.802
X1	4.612
Y	1.505
Y1	6.50

U-DFN3030-8 (Type E)



Dimensions	Value (in mm)
C	0.650
X	0.350
X1	2.350
X2	2.300
Y	0.650
Y1	1.600
Y2	3.300

Mechanical Data

MSOP-8

- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Finish – Matte Tin Plated Leads, Solderable per MIL-STD-202, Method 208 e3
- Weight: 0.0246 grams (Approximate)

SO-8

- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Finish – Matte Tin Plated Leads, Solderable per MIL-STD-202, Method 208 e3
- Weight: 0.074 grams (Approximate)

U-DFN3030-8 (Type E)

- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Finish – Matte Tin Plated Leads, Solderable per MIL-STD-202, Method 208 e3
- Weight: 0.018 grams (Approximate)

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