PAM8302L

2.5W Filterless Class-D Mono Audio Amplifier

Key Features

- Support 2.0V to 5.5V Supply Voltage Range
- 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 and DFN3x3 Packages Available
- Pb-Free Package

Applications

- PMP/MP4
- GPS
- Portable Speakers
- Walkie Talkie
- Handsfree Phones/Speaker Phones
- Cellular Phones

General Description

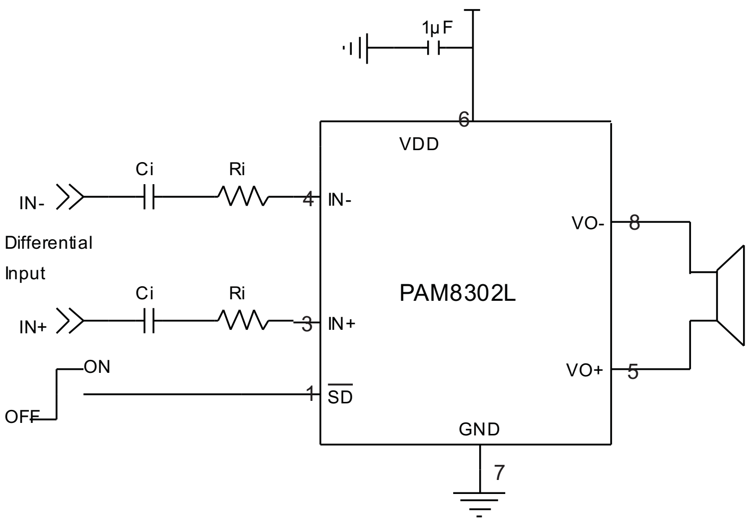
The PAM8302L is a 2.5W class-D mono audio amplifier. Its low total harmonic distortion (THD+N) offers high-quality sound reproduction.

The PAM8302L uses a filterless design that avoids the use of low-pass filters. This new design allows the amplifier to directly drive a speaker, making it cheap and compact. The new design allows the amplifier to be more affordable and take less PCB area.

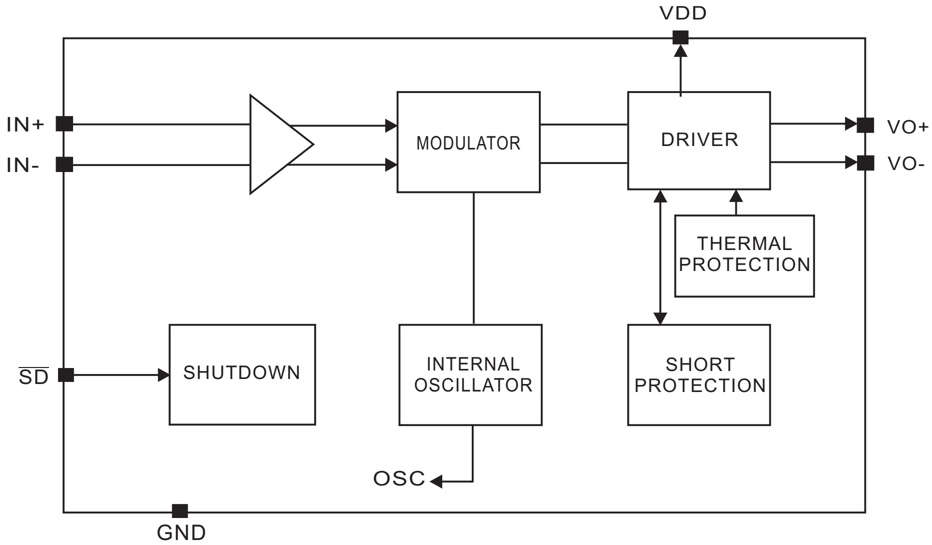
The PAM8302L uses less power than Class-AB amplifiers. The use of this product can help optimize battery life; it is ideal for portable applications.

The PAM8302L is available in MSOP-8 and DFN3x3-8 packages.

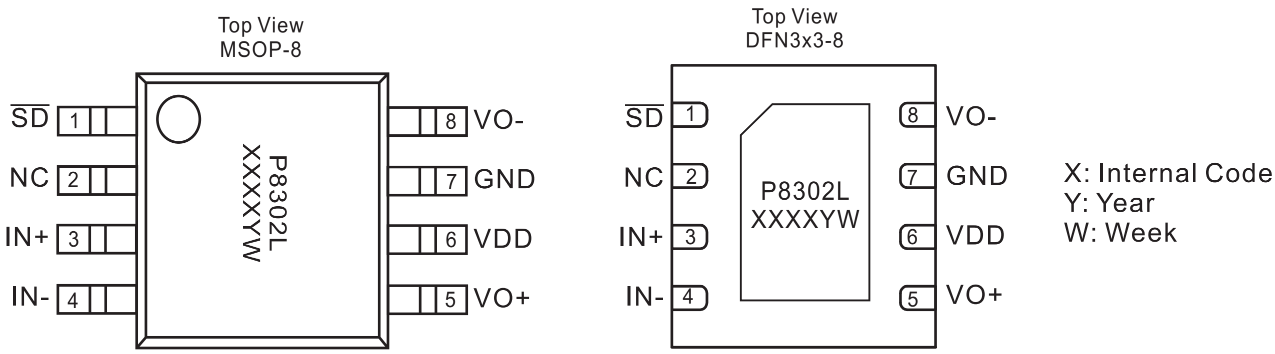
Typical Application



Block Diagram



Pin Configuration & Marking Information



Pin Number	Pin name	Description
1	SD	Shutdown terminal,active low
2	NC	No connection
3	IN+	Positive differential input
4	IN-	Negative differential input
5	VO+	Positive BTL output
6	VDD	Analog power supply
7	GND	Ground
8	VO-	Negative BTL output

Absolute Maximum Ratings

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.

Supply Voltage at no Input Signal...................6.0V
Input Voltage.............................-0.3V to V_{DD}+0.3V

Maximum Junction Temperature..................150°C
Storage Temperature.....................-65°C to 150°C
Soldering Temperature.......................300°C,5sec

Recommended Operating Conditions

Supply voltage Range........................2.0V to 5.5V

Operation Temperature Range........ -40°Cto 85°C
Junction Temperature Range.........-40°C to 125°C

Thermal Information

Parameter	Package	Symbol	Maximum	Unit
Thermal Resistance (Junction to Case)	MSOP-8	θ_{JC}	75	°C/W
	DFN3x3-8	θ_{JC}	20	
Thermal Resistance (Junction to Ambient)	MSOP-8	θ_{JA}	180	
	DFN3x3-8	θ_{JA}	50	
Internal Power Dissipation @ TA=25°C	MSOP-8	P_D	550	mW
	DFN3x3-8	P_D	2000	

Electrical Characteristics

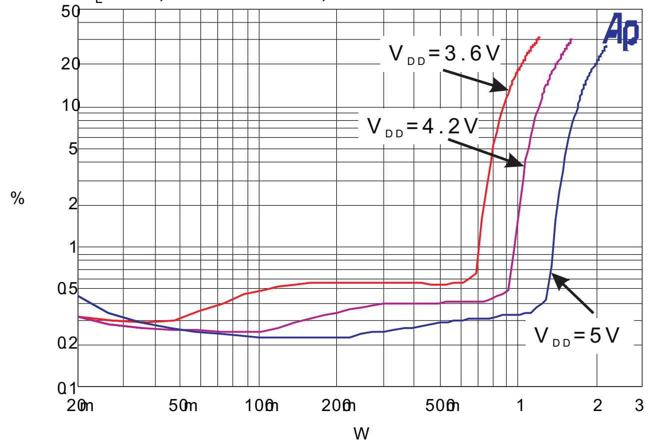
V_{DD}=5V, Gain = 24dB, R_L=4Ω, T_A=25°C, unless otherwise noted.

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
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	R_L = 8Ω, P_O=0.1W, f=1kHz			0.30	0.35	%
		R_L = 8Ω, P_O=0.5W, f=1kHz			0.45	0.50	
		R_L = 4Ω, P_O=0.1W, f=1kHz			0.35	0.40	
		R_L = 4Ω, P_O=0.5W, f=1kHz			0.40	0.45	
Gain	Gv			22.5	24	25.5	dB
Power Supply Ripple Rejection	PSRR	No input, f=1kHz, Vpp=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	Vn	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	
$\overline{SHDN}$ Input High	V_{SH}			1.2			V
$\overline{SHDN}$ Input Low	V_{SL}					0.4	V
Over Temperature Protection	OTP	junction temperature		120	135		°C
Over Temperature Hysteresis	OTH				30		°C

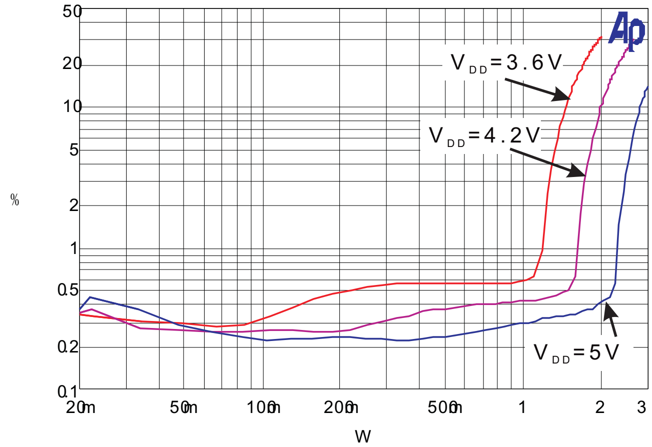
Typical Performance Characteristics

T_A=25°C, unless otherwise noted.

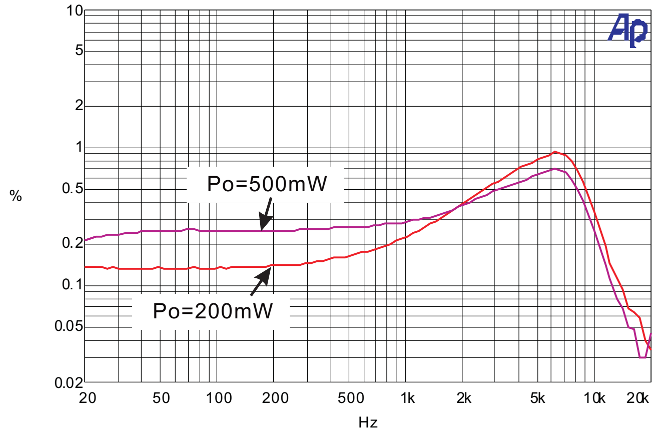
THD+N VS Output Power
R_L=8Ω, Gain=23dB, f=1kHz



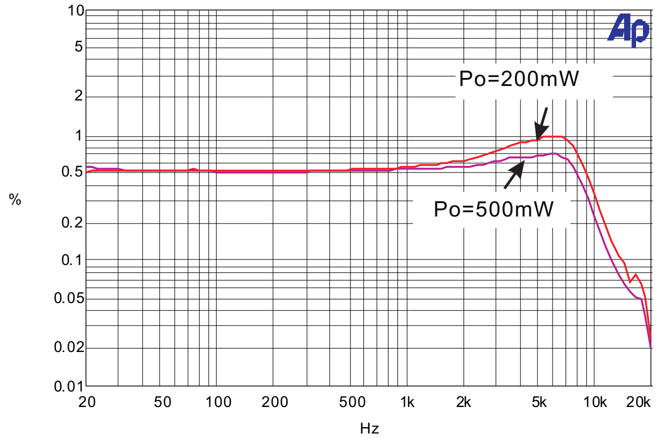
THD+N VS Output Power
R_L=4Ω, Gain=23dB, f=1kHz



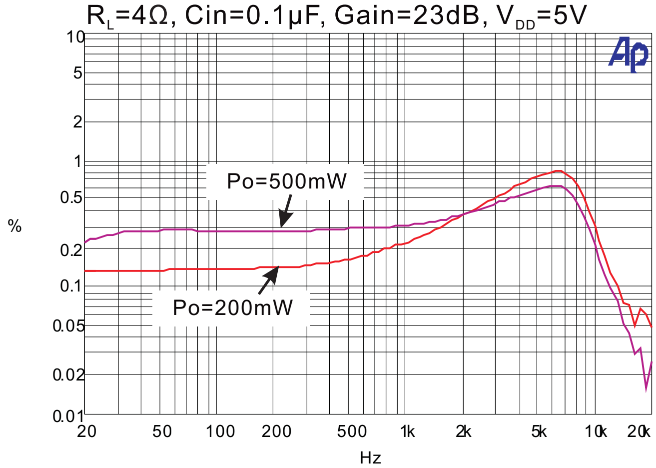
THD+N VS Frequency
R_L=8Ω, Cin=0.1μF, Gain=23dB, V_{DD}=5V



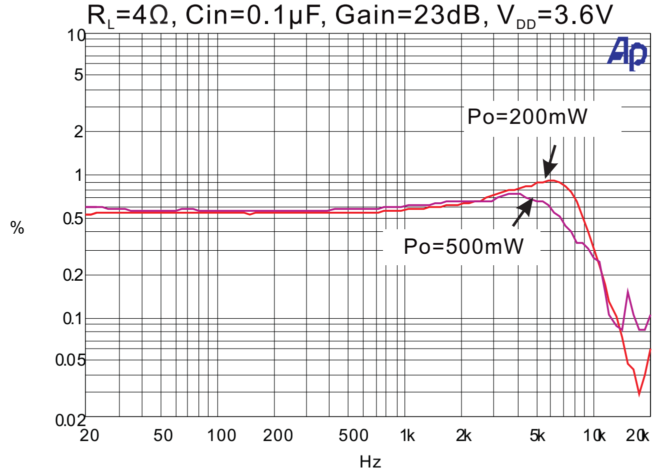
THD+N VS Frequency
R_L=8Ω, Cin=0.1μF, Gain=23dB, V_{DD}=3.6V



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



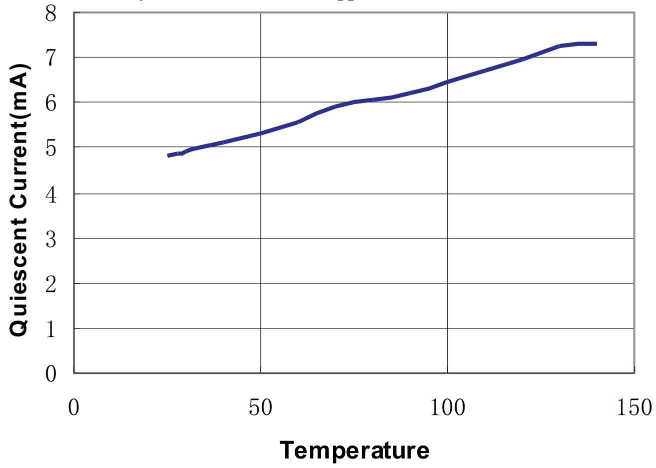
THD+N VS Frequency
R_L=4Ω, Cin=0.1μF, Gain=23dB, V_{DD}=3.6V



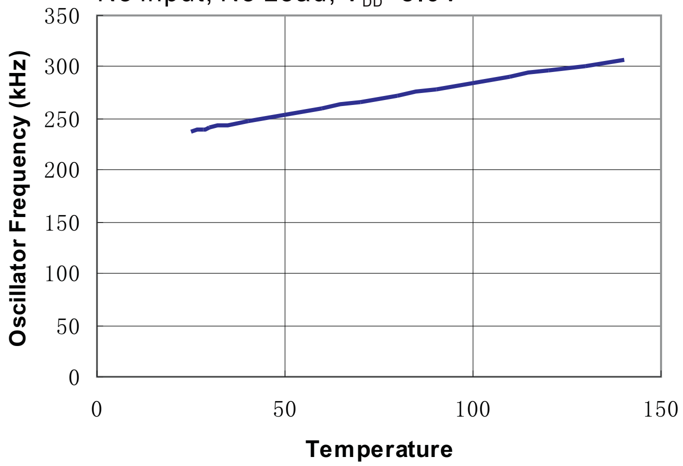
Typical Performance Characteristics

T_A=25°C, unless otherwise noted.

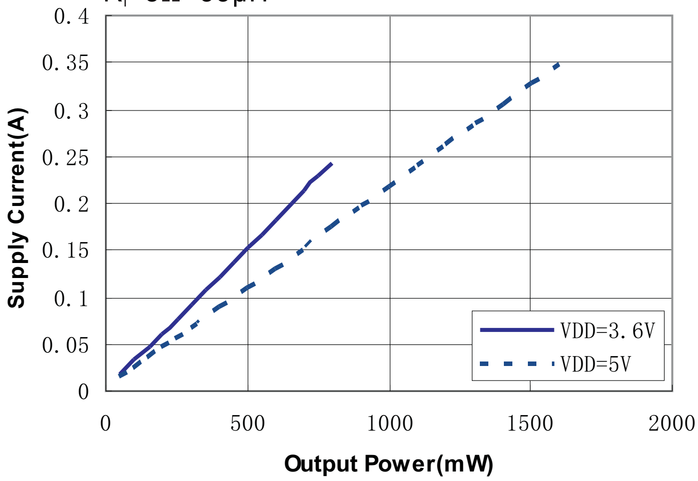
Quiescent Current VS Temperature
No input, No Load, V_{DD}=5.0V



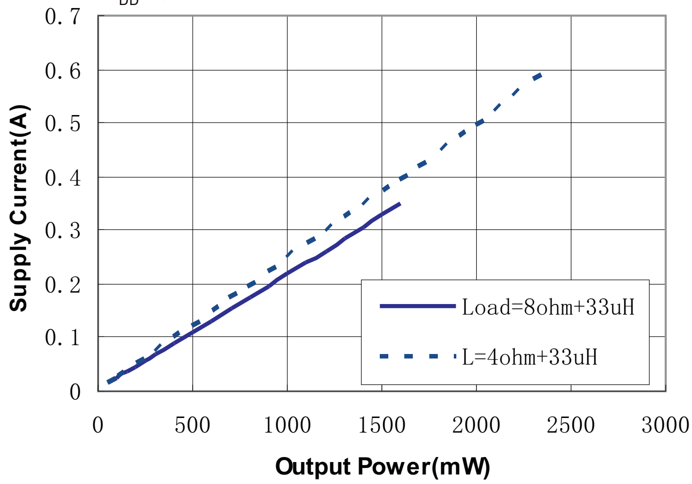
Frequency VS Temperature
No input, No Load, V_{DD}=5.0V



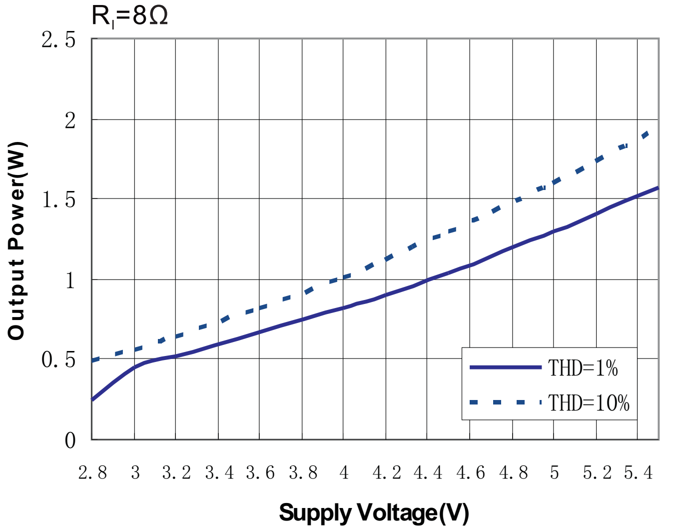
Supply Current VS Output Power
R_l=8Ω+33μH



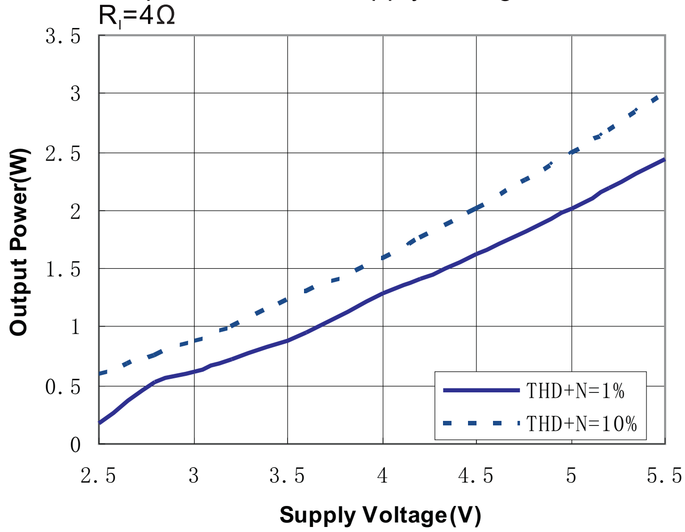
Supply Current VS Output Power
V_{DD}=5.0V



Output Power VS. Supply Voltage
R_l=8Ω



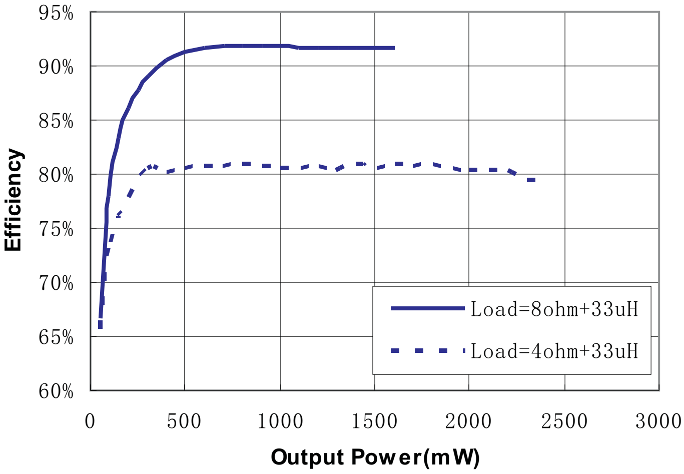
Output Power VS. Supply Voltage
R_l=4Ω



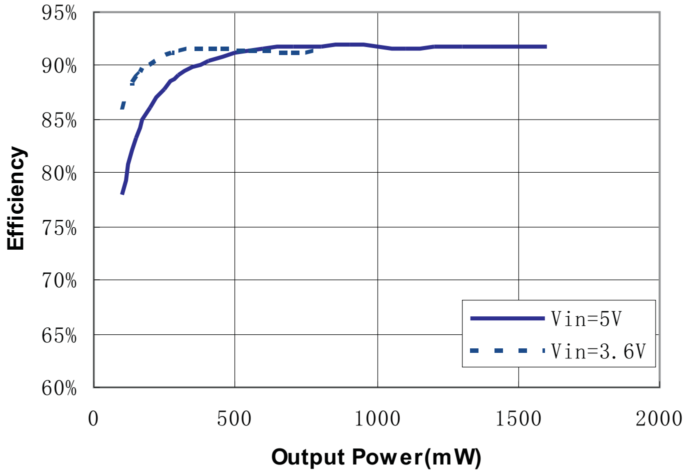
Typical Performance Characteristics

T_A=25°C, unless otherwise noted.

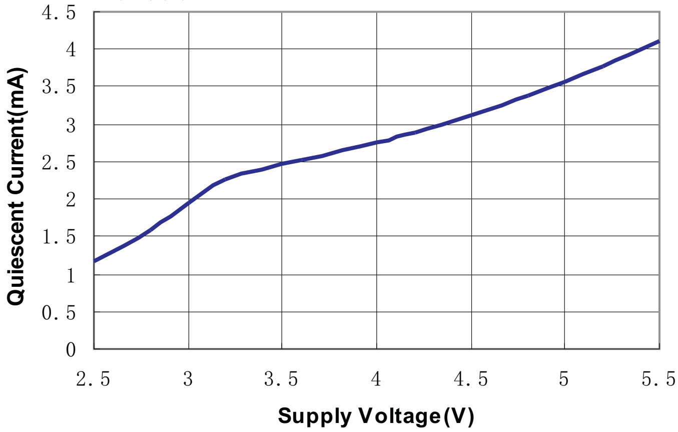
Efficiency VS Output Power
V_{DD}=5.0V



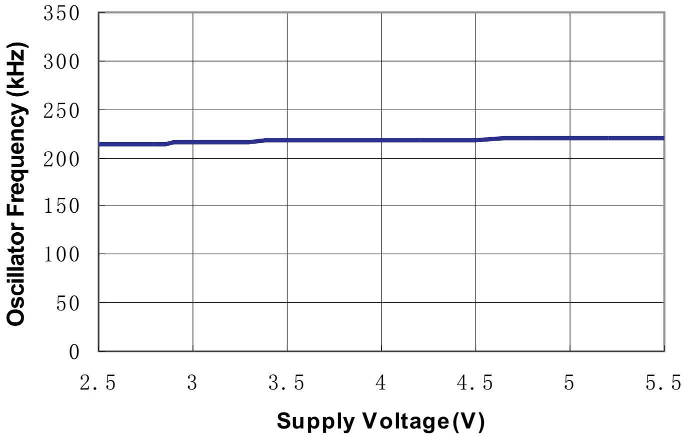
Efficiency VS Output Power
R_l=8Ω+33μH



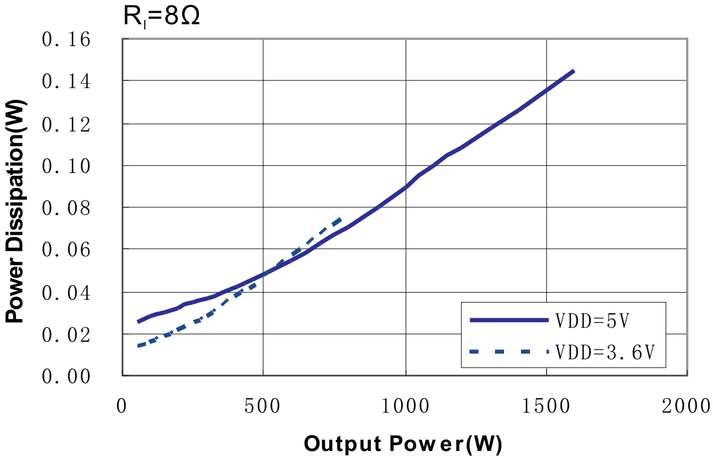
Quiescent Current VS. Supply Voltage
No load



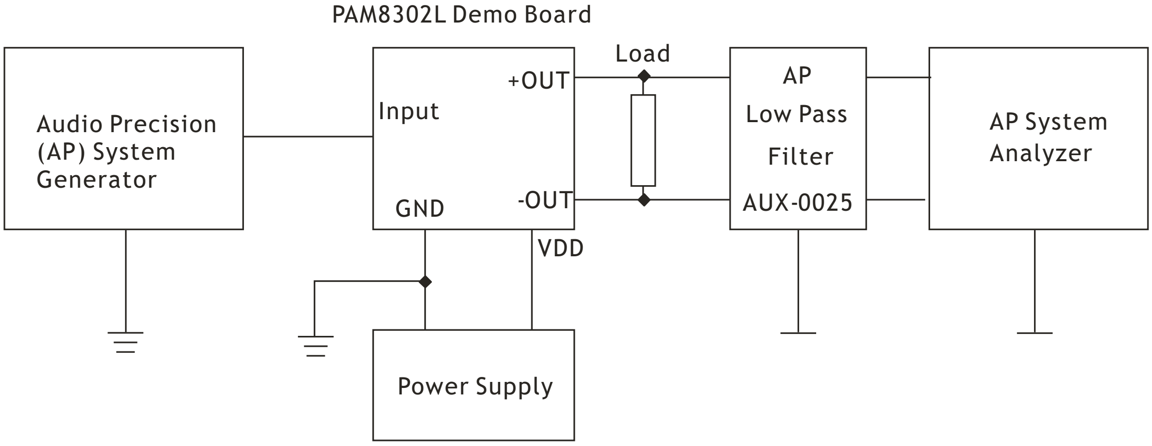
Frequency VS. Supply Voltage



Power Dissipation VS. Output Power
R_l=8Ω



Test Setup for Performance Testing



Notes

1. The Audio Precision(AP) AUX-0025 low pass filter is necessary for every class-D amplifier measurement with AP analyzer.
2. Two 22μH inductors are used in series with load resistor to emulate the small speaker for efficiency measurement.

Application Information

Maximum Gain

As shown in block diagram (page 2), the PAM8302L has two internal amplifier stages. The first stage's gain is externally configurable, while the second stage's is internally fixed. The closed-loop gain of the first stage is set by selecting the ratio of R_f to R_i while the second stage's gain is fixed at 2x.The output of amplifier 1 serves as the input to amplifier 2, thus the two amplifiers produce signals identical in magnitude, but different in phase by 180°. Consequently, the differential gain for the IC is

$$A_{VD}=20*\log[2*(R_f/R_i)]$$

The PAM8302L sets maximum R_f=80kΩ, minimum R_i=10kΩ, so the maximum closed-gain is 24dB.

Input Capacitors (Ci)

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

$$f_C = \frac{1}{(2\pi RiCi)}$$

It is important to choose the value of Ci 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:

$$Ci = \frac{1}{(2\pi R_i f_C)}$$

As the input resistance is variable, for the Ci value of 0.16μF, one should actually choose the Ci 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 (Ri, RF,Ci) 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 VDD/2, which is likely higher than the source DC level. Please note that it is important to confirm the capacitor polarity in the application.

Power Supply Decoupling (Cs)

The PAM8302L 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, typically 1.0μF is good, placing it as close as possible to the device VDD terminal. For filtering lower-frequency noise signals, a 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 PAM8302L contains shutdown circuitry for 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 PAM8302L supply current draw will be minimized in idle mode.

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

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 at 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.

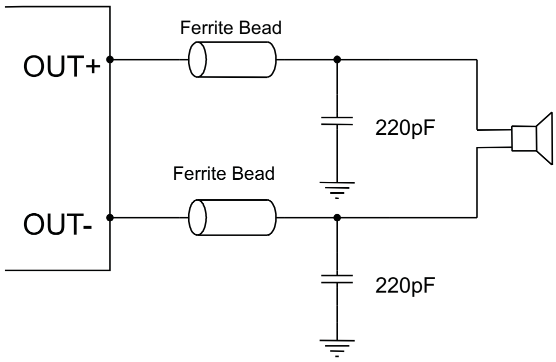


Figure 1: Ferrite Bead Filter to reduce EMI

Ordering Information

PAM8302L X X X X

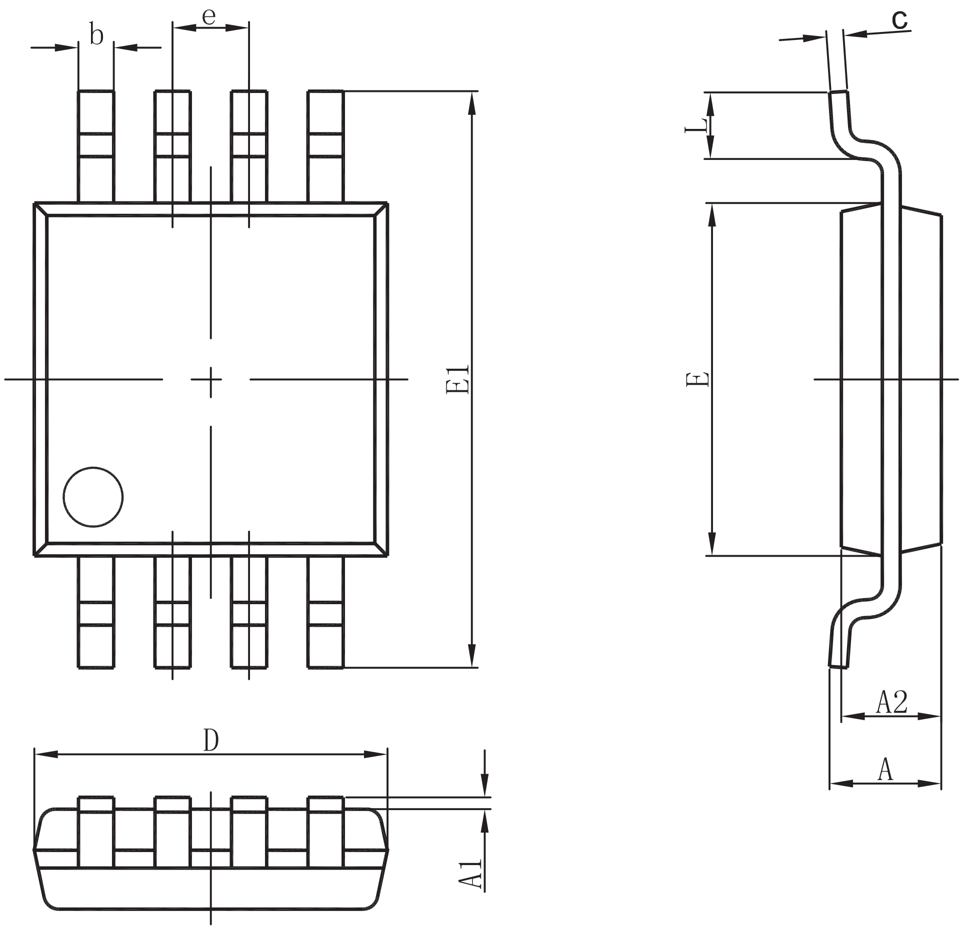
- Shipping Package
- Number of pins
- Package Type
- Pin Configuration

Pin Configuration	Package Type	Number of pins
A: 1: $\overline{SD}$ 2: NC 3: IN+ 4: IN- 5: VO+ 6: VDD 7: GND 8: VO-	S: MSOP Y: DFN3x3	C: 8

Part Number	Package Type	MOQ/Shipping Package
PAM8302LASCR	MSOP-8	2,500 Units/Tape & Reel
PAM8302LAYCR	DFN3x3-8	3,000 Units/Tape & Reel

Outline Dimensions

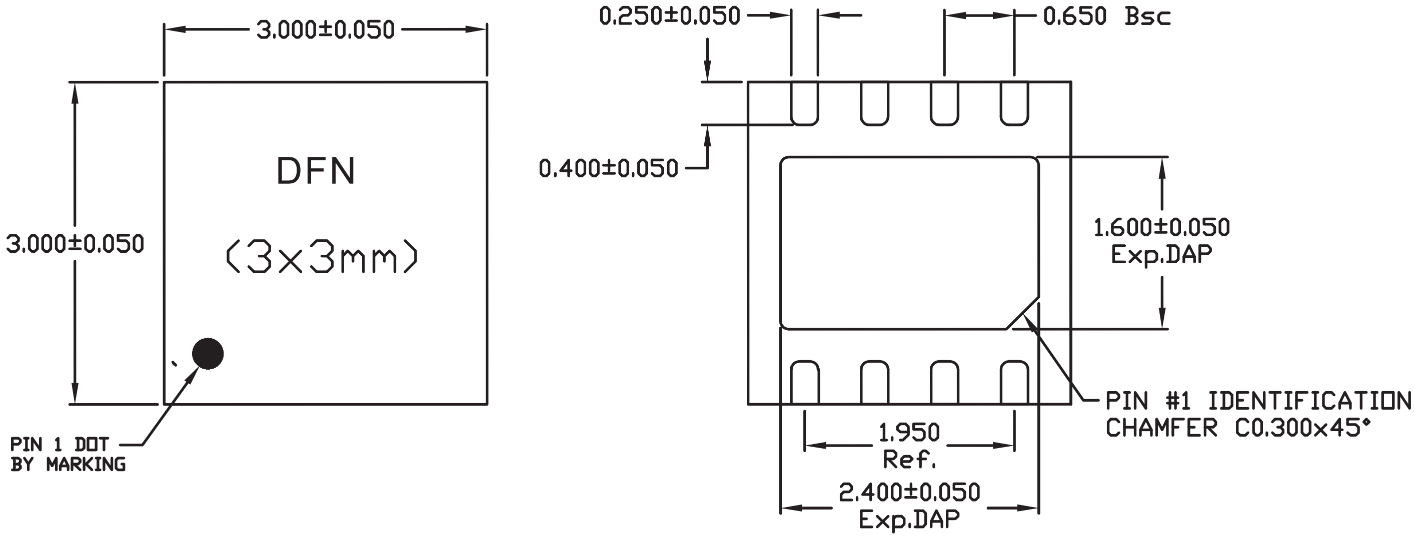
MSOP-8



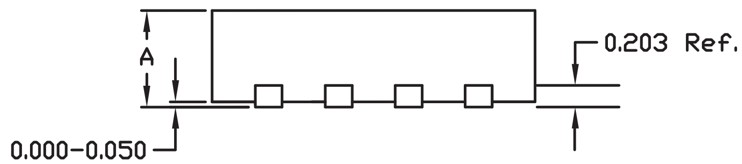
REF	Millimeter	
	Min	Max
A	--	1.10
A1	0.05	0.15
A2	0.78	0.94
b	0.22	0.38
c	0.08	0.23
D	2.90	3.10
E	2.90	3.10
E1	4.75	5.05
e	0.65BSC	
L	0.40	0.70

Outline Dimensions

DFN 3x3-8



A	MAX.	0.800
	NOM.	0.750
	MIN.	0.700



Note: All dimensions are in Millimeters.