LY8898

3.2 Watt Audio Power Amplifier

FEATURES

- 3.2W Into 3Ω from 5.0V power supply at THD+N = 10% (Typ.).
- 2.7W Into 4Ω from 5.0V power supply at THD+N = 10% (Typ.).
- 1.7W Into 8Ω from 5.0V power supply at THD+N = 10% (Typ.)
- 2.0V~5.5V Power Supply.
- Low shutdown current (TYP.=0.05uA).
- Low quiescent current (TYP.=3.0mA).
- Thermal shutdown protection with auto recovery feature.
- Advanced power ON/OFF pop reduction.
- Lead free and green package available. (RoHS Compliant)
- Space Saving Package
  -- 8-pin ESOP package. (with thermal pad)

APPLICATION

- Boom Box.
- Education, Toy.
- MID,
- Portable electronic devices.
- Mobile Phones.

GENERAL DESCRIPTION

The LY8898 is a 3.2W audio power amplifier. It is capable of driving 3Ω speaker load at a continuous average output of 3.2W with less than 10% distortion (THD+N) from a 5.0V power supply and 4Ω speaker load at a continuous average output of 2.7W with less than 10% distortion (THD+N) from a 5.0V power supply.

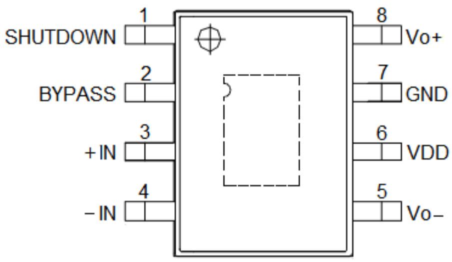
The LY8898 primarily designed for high quality application in other portable communication device. And the LY8898 audio amplifier features low power consumption shutdown mode. It is achieved by driving the shutdown pin with logic high.

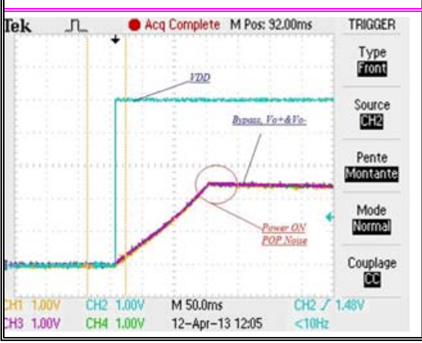
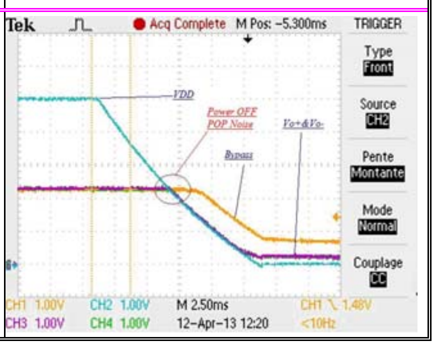
And the LY8898 has an internal thermal shutdown protection feature.

The LY8898 audio amplifier was designed specifically to provide high quality output power with a minimal amount of external components. The LY8898 does not require output capacitors, and the LY8898 is ideally suited for other low voltage applications or portable electronic devices where minimal power consumption is a primary requirement.

PIN CONFIGURATION

LY8898 ESOP8 pin configuration (TOP VIEW)



Power ON POP Noise	Power OFF POP Noise
	

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PIN DESCRIPTION

SYMBOL	Pin No. ESOP8	DESCRIPTION
SHUTDOWN	1	Shutdown the device. (when **HIGH** level is shutdown mode)
BYPASS	2	Bypass pin
+IN	3	Positive Input
-IN	4	Negative Input
Vo1(-)	5	Negative output
V_{DD}	6	Power Supply
GND	7	Ground
Vo2(+)	8	Positive Output

ORDERING INFORMATION

Ordering Code	Speaker Channels	Pin/ Package	Output Power (THD+N=10%)	Input Type	Output Type
LY8898V	Mono	ESOP8 (with thermal pad)	3.2W/3Ω @5.0V_BTL 2.7W/4Ω @5.0V_BTL 1.7W/8Ω @5.0V_BTL	SE/ DF	BTL

APPLICATION CIRCUIT

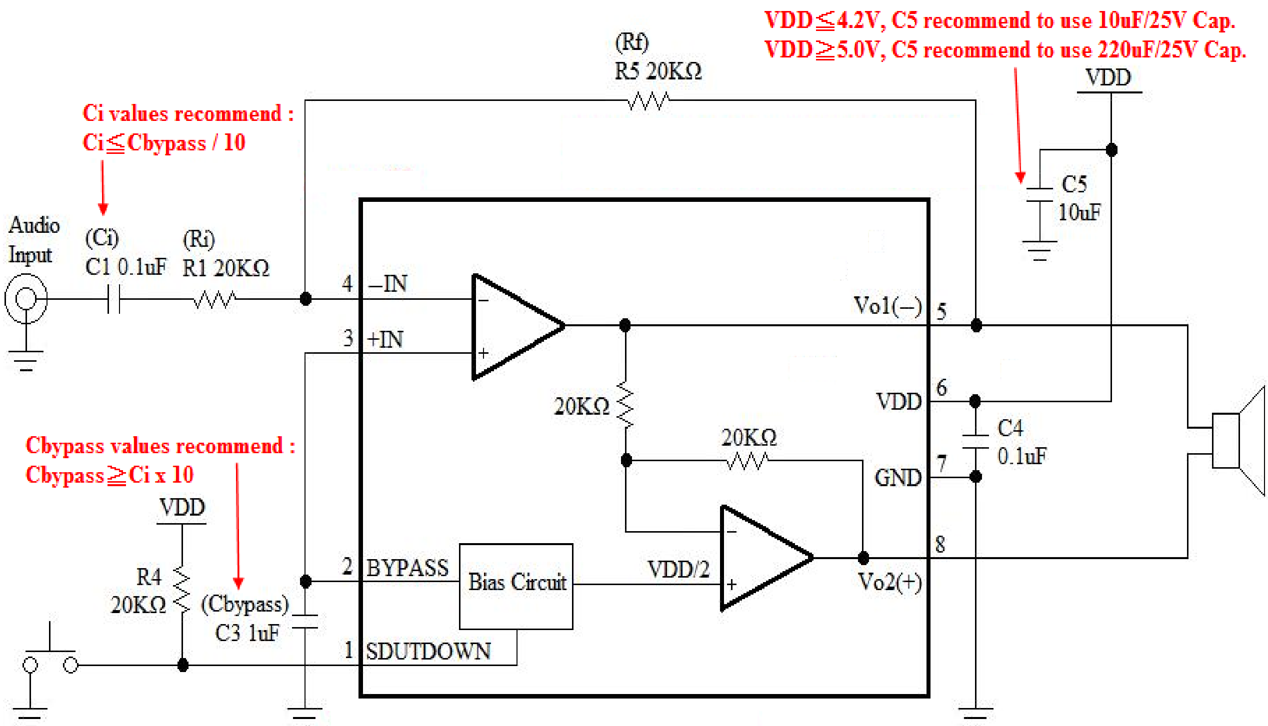

Figure 1. LY8898 application schematic with Single –Ended input

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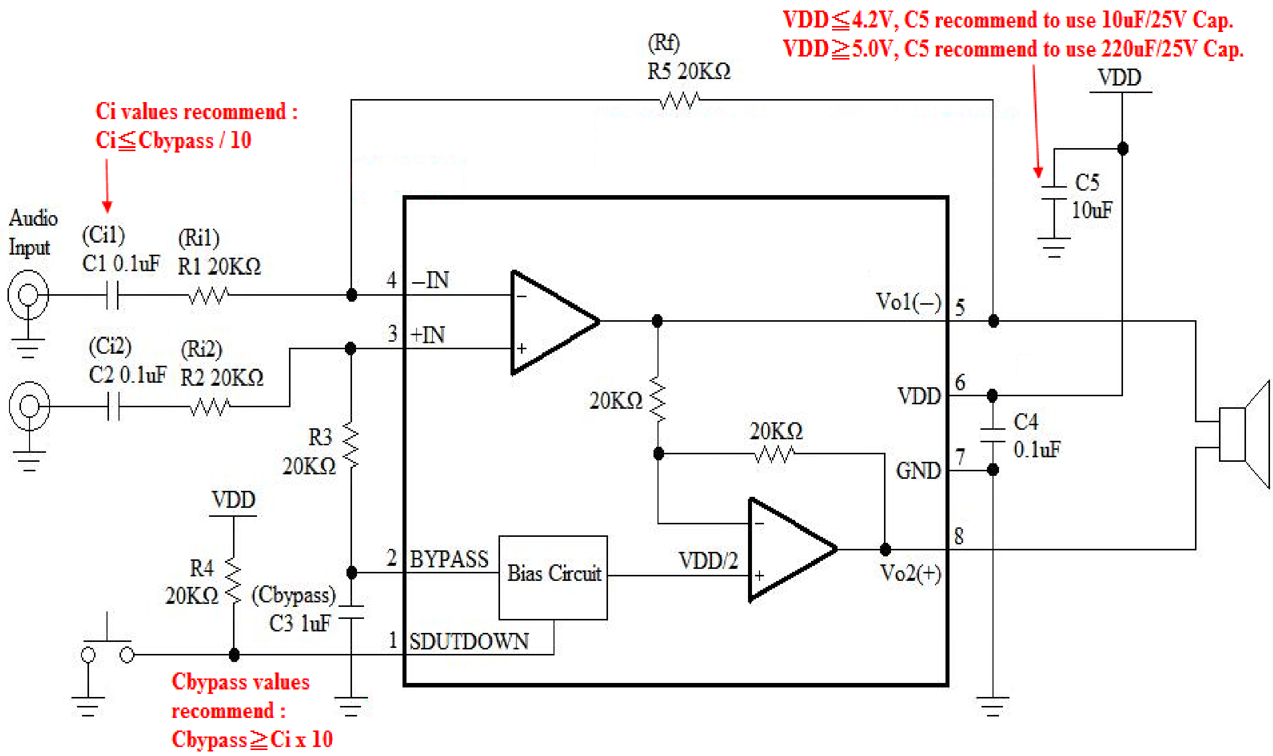

Figure 2. LY8898 application schematic with Differential input

ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	V_{DD}	6.0	V
Operating Temperature	T_A	-40 to 85 (I grade)	℃
Input Voltage	V_I	-0.3V to V_{DD} +0.3V	V
Storage Temperature	T_{STG}	-65 to 150	℃
Power Dissipation	P_D	Internally Limited	W
ESD Susceptibility	V_{ESD}	2000	V
Junction Temperature	T_{JMAX}	150	℃
Soldering Temperature (under 10 sec)	T_{SOLDER}	260	℃

DC ELECTRICAL CHARACTERISTICS (TA=25℃)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP. [*2]	MAX.	UNIT
Power supply voltage	V_{DD}	--	2.0	-	5.5	V
Quiescent Current	I_{Q}	V_{DD}=5.0V, Load=4Ω.	-	3.0	9.0	mA
Shutdown Current	I_{SD}	V_{DD}=5.0V, V_{SD}=V_{DD}	-	0.05	2.0	μA
Shutdown Voltage Input High	V_{SDIH}	V_{DD}=5.0V, $V_{SD\ Mode}$ = V_{DD}	1.2	-	-	V
Shutdown Voltage Input Low	V_{SDIL}	V_{DD}=5.0V, $V_{SD\ Mode}$ = GND	-	-	0.4	
Output Offset Voltage	V_{OS}	V_{DD}=5.0V, Load=4Ω.	-	7.0	50.0	mV

(*2) Typical values are included for reference only and are not guaranteed or tested.
Typical values are measured at VCC = VCC(TYP.) and TA = 25℃

OPERATING CHARACTERISTICS(1) (TA=25℃)

PARAMETER	SYMBOL	TEST CONDITION		MIN.	TYP. [*2]	MAX.	UNIT
Power Supply Rejection Ratio	PSRR	V_{ripple} = 200mV sine p-p, V_{DD}=5.0V, R_L=4Ω, Av=2. Input=GND.	1KHz	-	64.58	-	dB
			217Hz	-	58.80	-	
		V_{ripple} = 200mV sine p-p, V_{DD}=5.0V, R_L=4Ω, Av=2. Input=Floating.	1KHz	-	64.43	-	
			217Hz	-	66.0	-	
Signal-to-noise ratio	SNR	V_{DD}=5.0V,R_L=4Ω, Input=GND, Av=2, 1W=0dB,	A-weighting	-	95.3	-	dB
			None A-weighting	-	92.1	-	
Output voltage noise	Vn	V_{DD}=5.0V,Av=2, f=20Hz~20KHz, Input=GND, R_L=4Ω SPK,	A-weighting	-	34.26	-	uV
			None A-weighting	-	50.13	-	
Thermal shutdown temperature	T_{SD}	Shutdown temp.		-	160	-	℃
		Restore temp.		-	130	-	

(*2) Typical values are included for reference only and are not guaranteed or tested.
Typical values are measured at VCC = VCC(TYP.) and TA = 25℃

OPERATING CHARACTERISTICS(2) (TA=25℃)

PARAMETER	SYMBOL	TEST CONDITION		MIN.	TYP.*2	MAX.	UNIT
Output Power	Po	RL=3Ω*3 THD=10%,f=1 kHz	VDD=5.5V	-	3.8	-	W
			VDD=5.0V	-	3.2	-	
			VDD=3.7V	-	1.7	-	
			VDD=2.5V	-	0.72	-	
			VDD=2.0V	-	0.42	-	
		RL=3Ω*3 THD=1%,f=1 kHz	VDD=5.5V	-	2.8	-	
			VDD=5.0V	-	2.3	-	
			VDD=3.7V	-	1.25	-	
			VDD=2.5V	-	0.5	-	
			VDD=2.0V	-	0.25	-	
		RL=4Ω*3 THD=10%,f=1 kHz	VDD=5.5V	-	3.3	-	
			VDD=5.0V	-	2.7	-	
			VDD=3.7V	-	1.5	-	
			VDD=2.5V	-	0.6	-	
			VDD=2.0V	-	0.37	-	
		RL=4Ω*3 THD=1%,f=1 kHz	VDD=5.5V	-	2.5	-	
			VDD=5.0V	-	2.0	-	
			VDD=3.7V	-	1.1	-	
			VDD=2.5V	-	0.5	-	
			VDD=2.0V	-	0.25	-	
		RL=8Ω THD=10%,f=1 kHz	VDD=5.5V	-	2.0	-	
			VDD=5.0V	-	1.7	-	
			VDD=3.7V	-	1.0	-	
			VDD=2.5V	-	0.4	-	
			VDD=2.0V	-	0.25	-	
		RL=8Ω THD=1%,f=1 kHz	VDD=5.5V	-	1.6	-	
			VDD=5.0V	-	1.3	-	
			VDD=3.7V	-	0.7	-	
			VDD=2.5V	-	0.3	-	
			VDD=2.0V	-	0.2	-	

(*2) Typical values are included for reference only and are not guaranteed or tested.
Typical values are measured at VCC = VCC(TYP.) and TA = 25℃

(*3) When driving 3Ω or 4Ω loads from 4.2V~5V power supply, the device must be mounted to a circuit board.

TYPICAL PERFORMANCE CHARACTERISTICS

Figure 3
THD+N vs. Output Power (@ RL=3Ω, f=1kHz, AV=10)

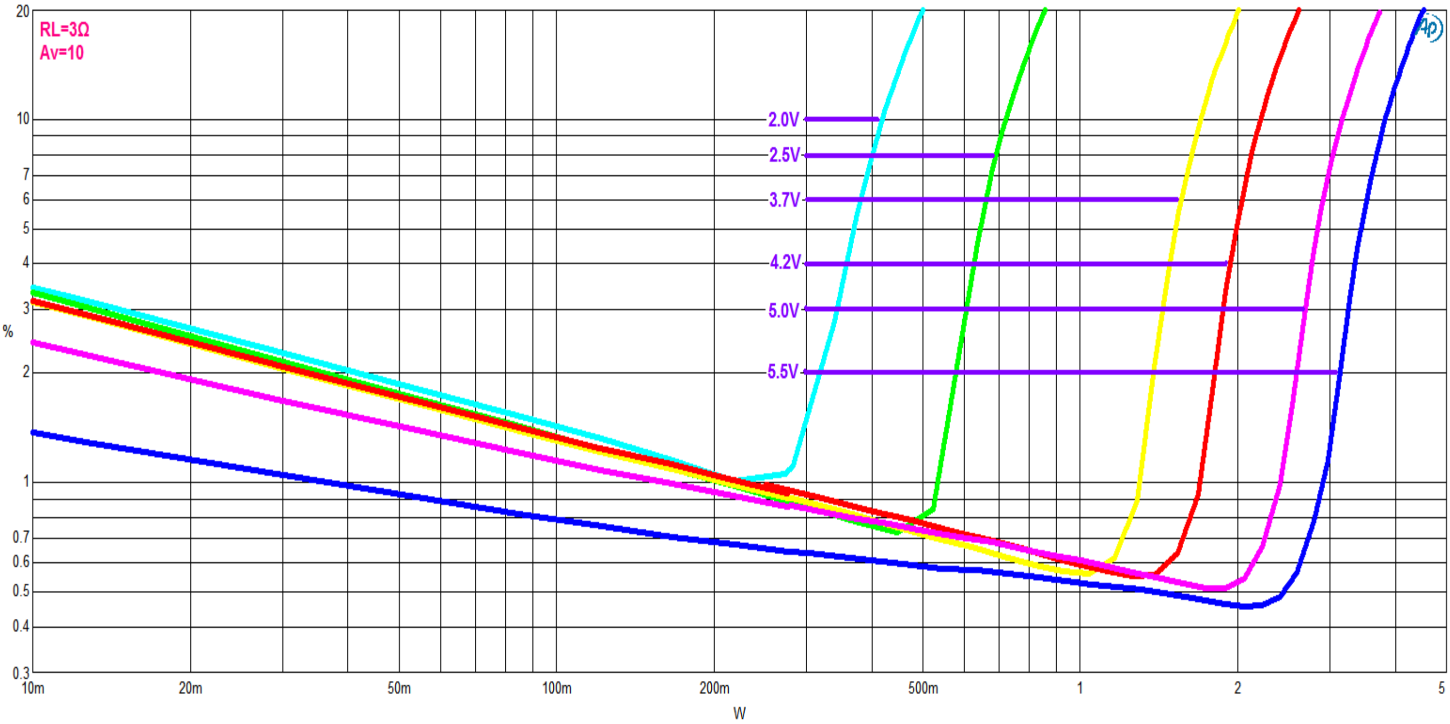

Figure 4
THD+N vs. Output Power (@ RL=4Ω, f=1kHz, AV=10)

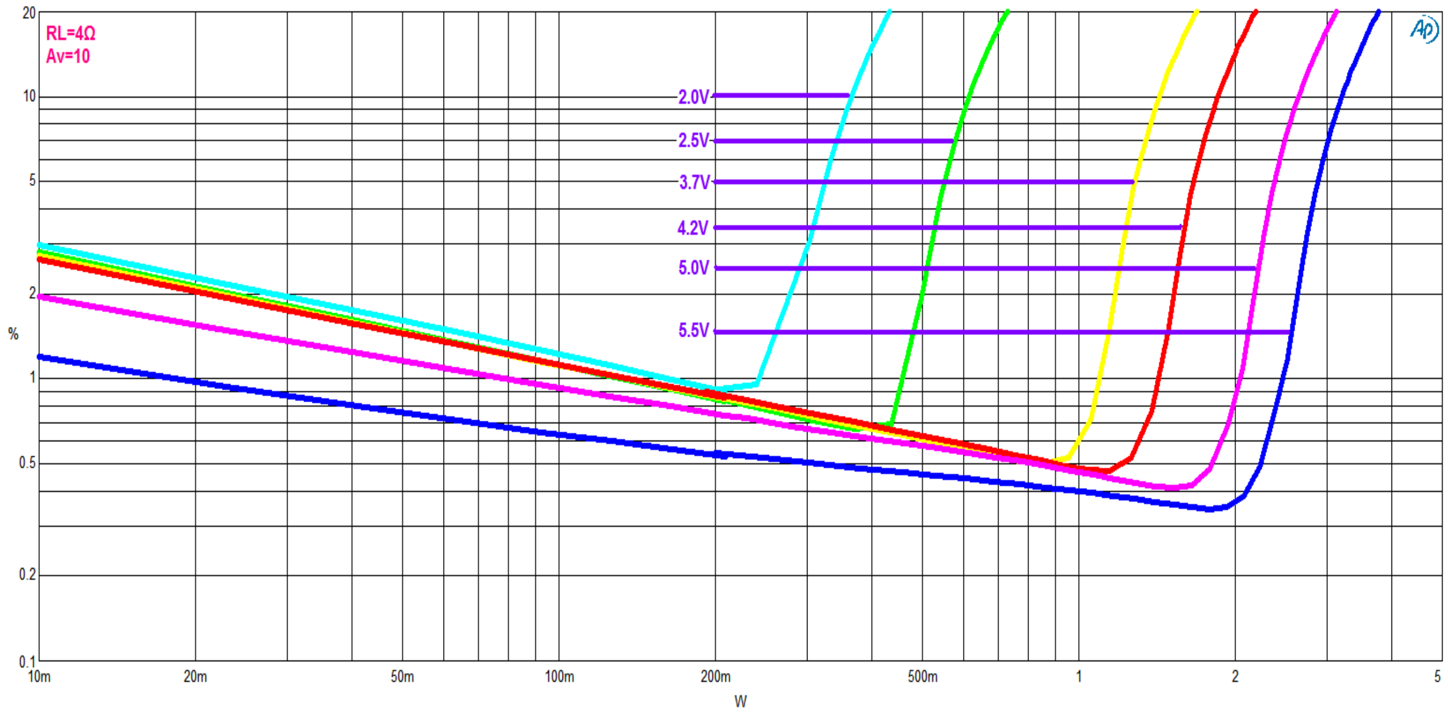

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Figure 5
THD+N vs. Output Power (@ RL=8Ω, f=1kHz, AV=10)

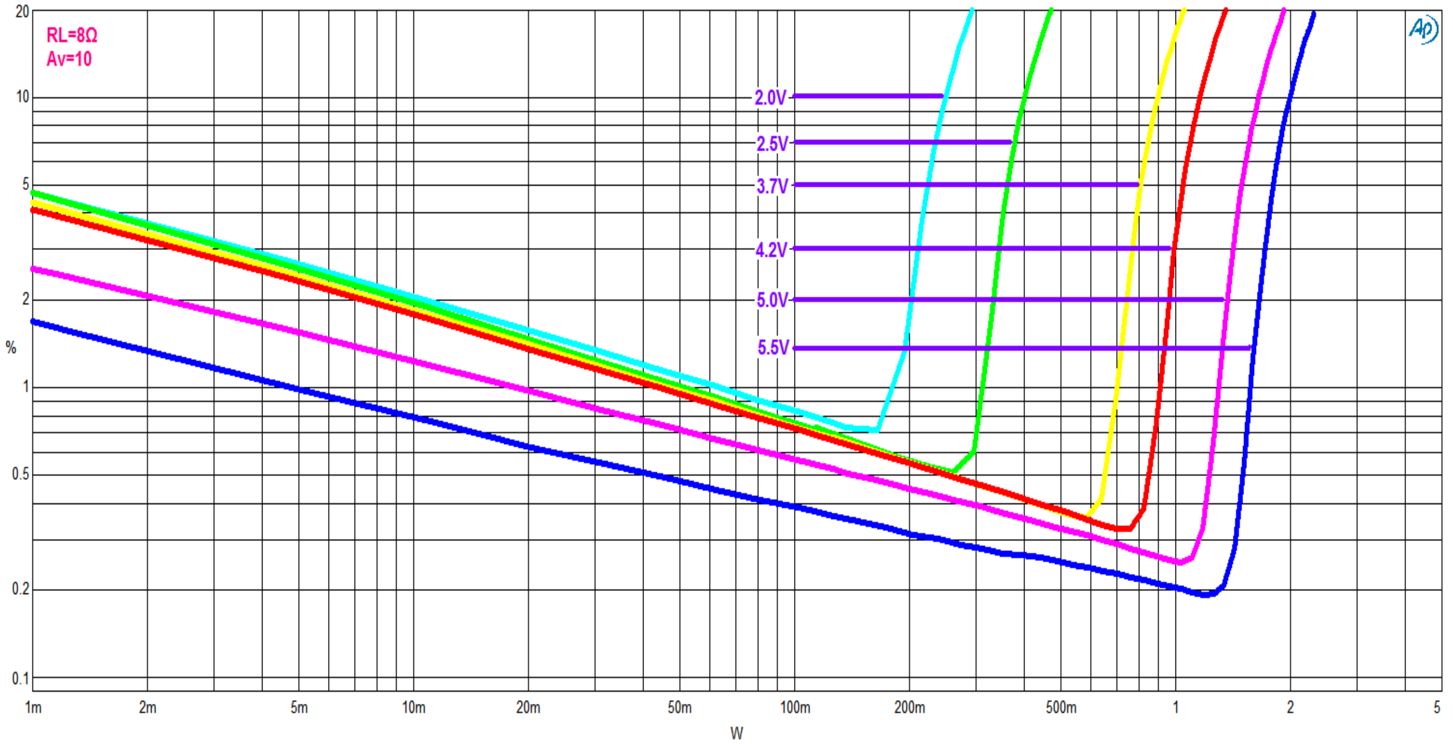


Figure 6
Power Supply Rejection Ratio (PSRR)

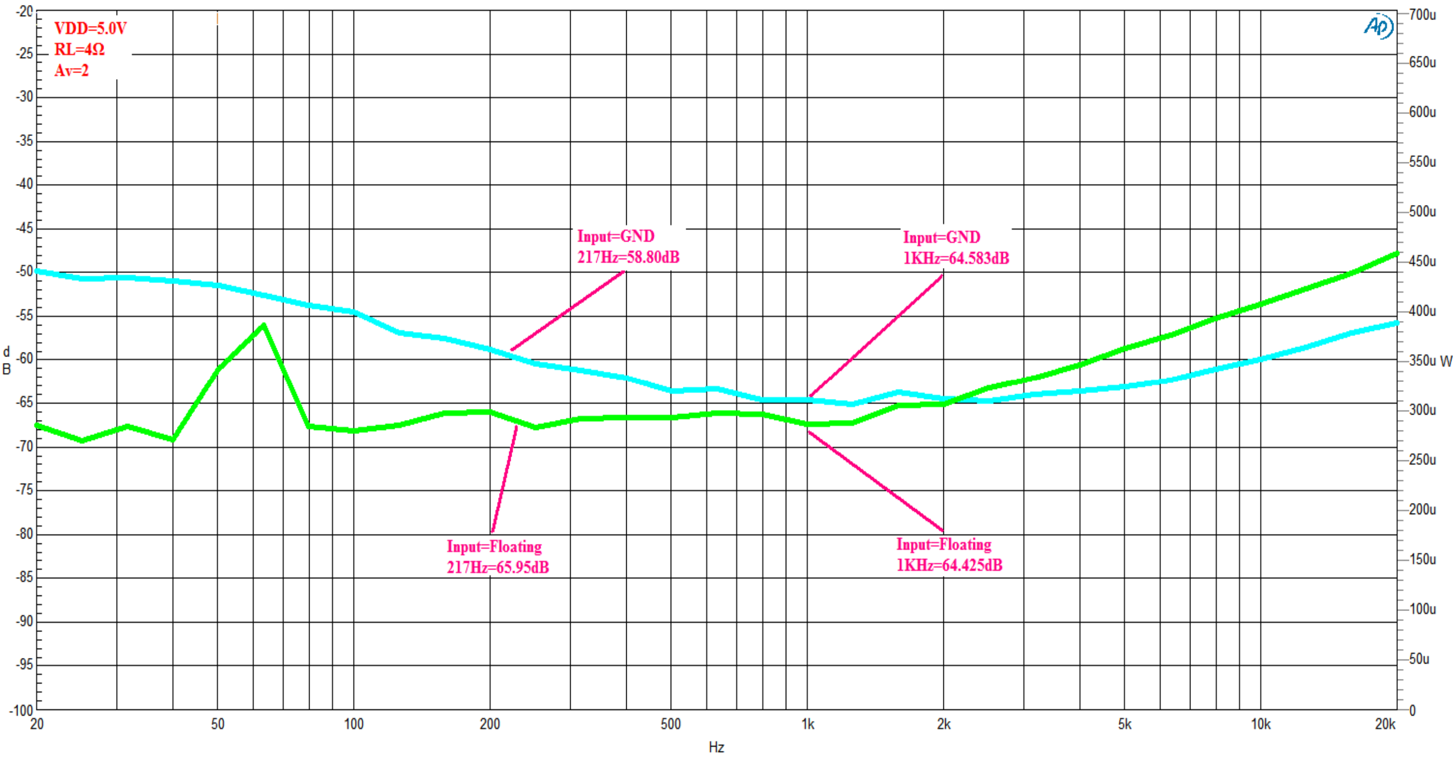


Figure 7
Frequency response vs. input capacitor values

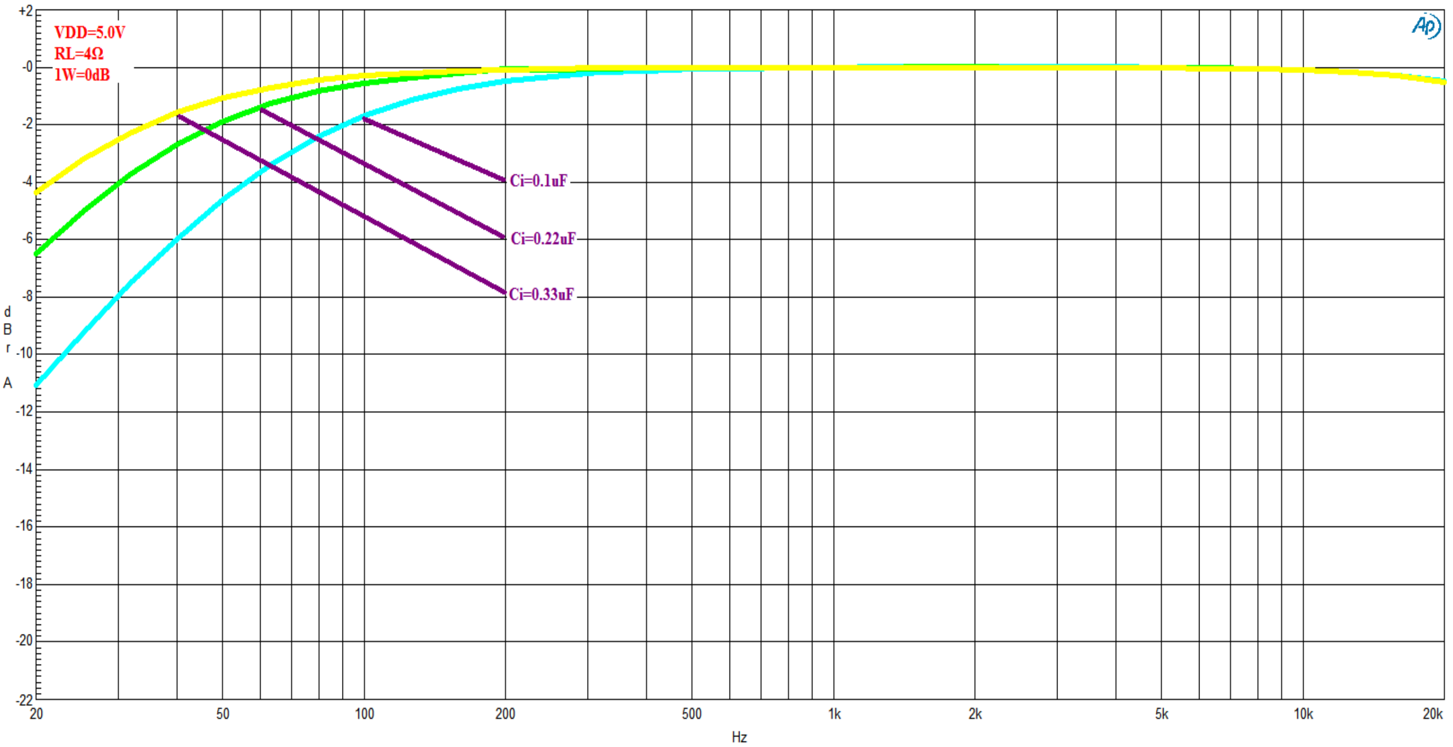
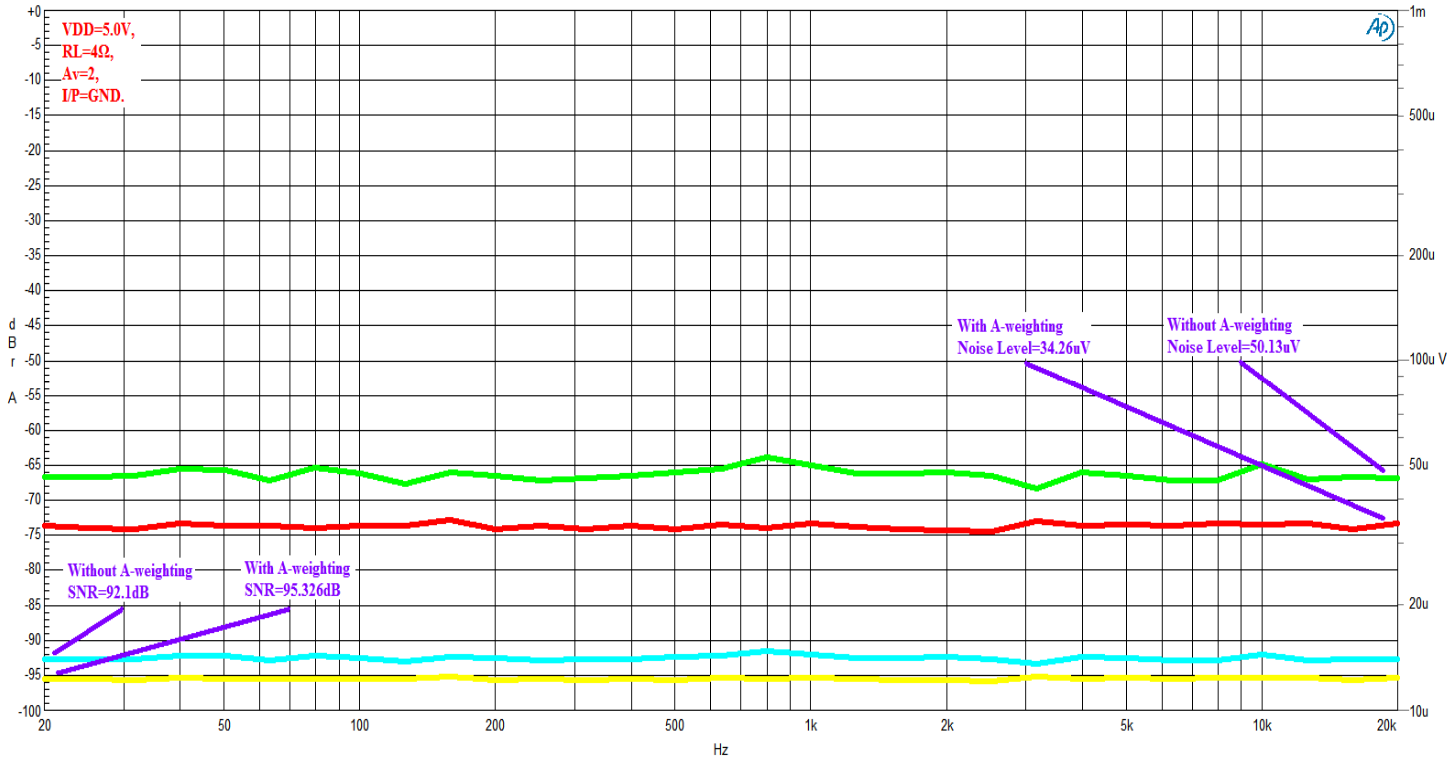


Figure 8
SNR vs. Noise Level



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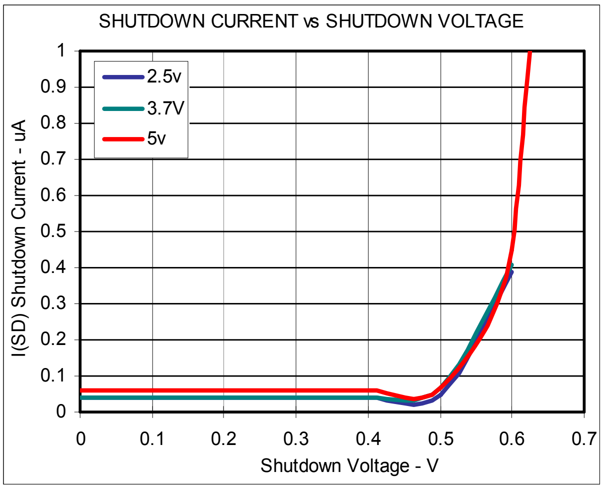
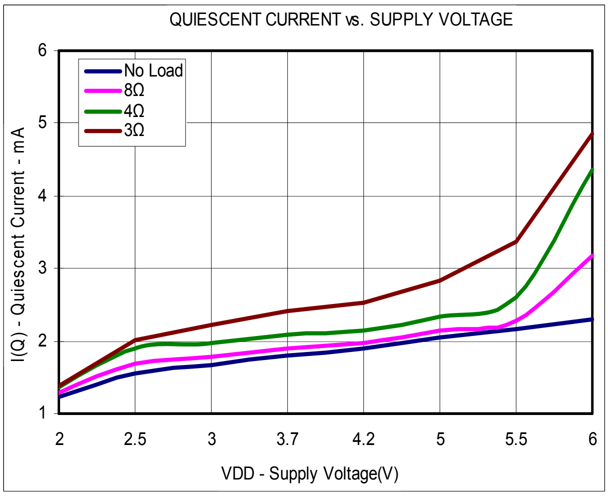
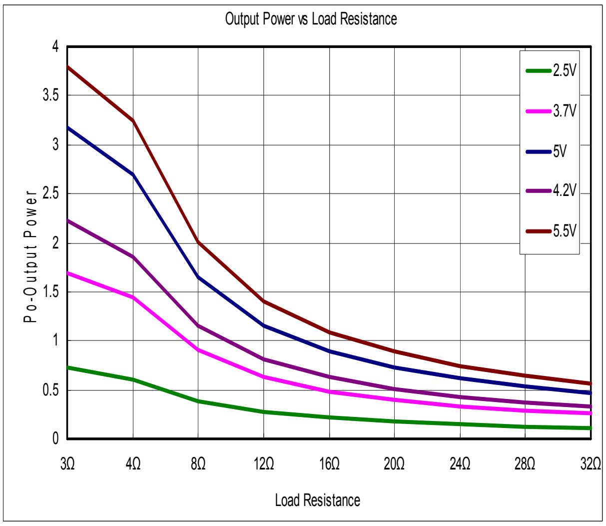
SD Current vs. SD Voltage



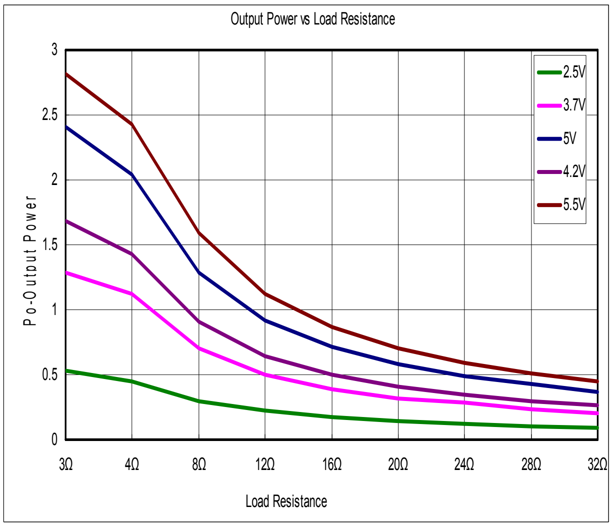
Quiescent Current vs. Supply voltage



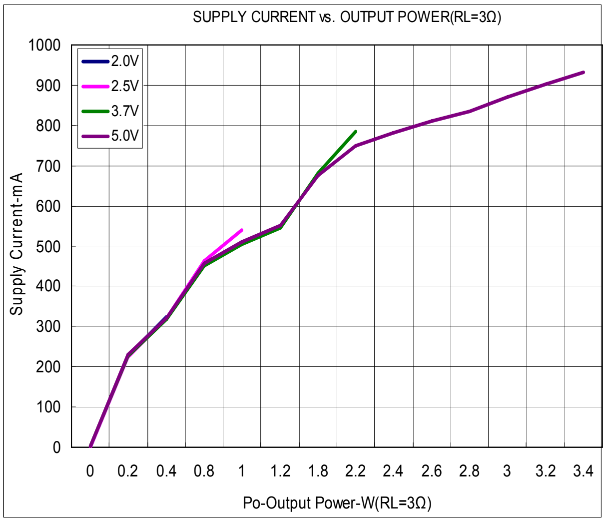
Load Resistance vs. Output Power (THD+N=10%)



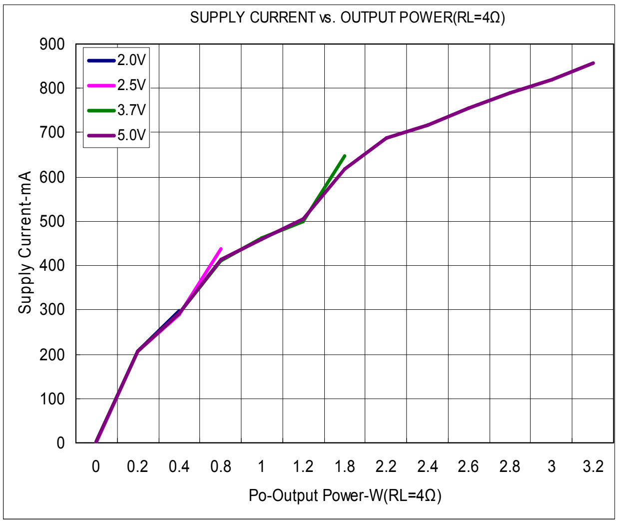
Load Resistance vs. Output Power (THD+N=1%)



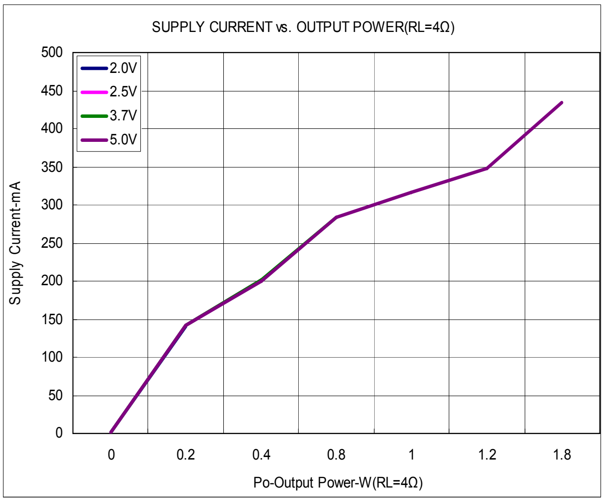
VDD Current vs. Output Power (RL=3Ω)



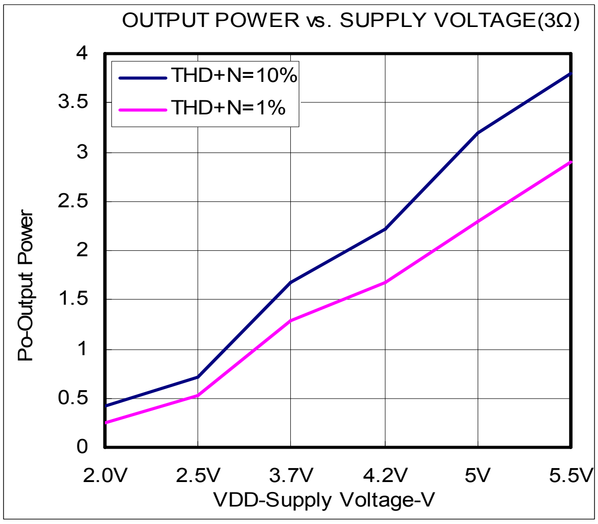
VDD Current vs. Output Power (RL=4Ω)



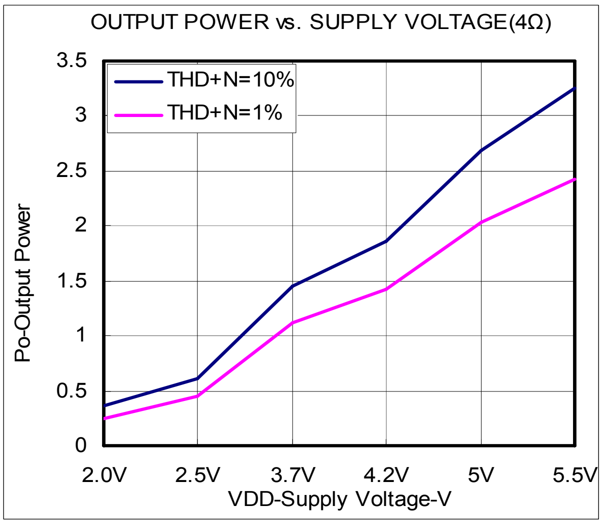
V_{DD} Current vs. Output Power (R_L=8Ω)



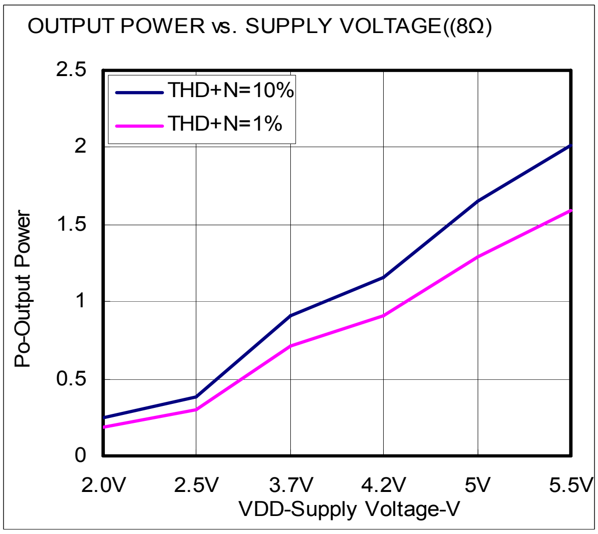
V_{DD} vs. Output Power (R_L=3Ω)



V_{DD} vs. Output Power (R_L=4Ω)



V_{DD} vs. Output Power (R_L=8Ω)



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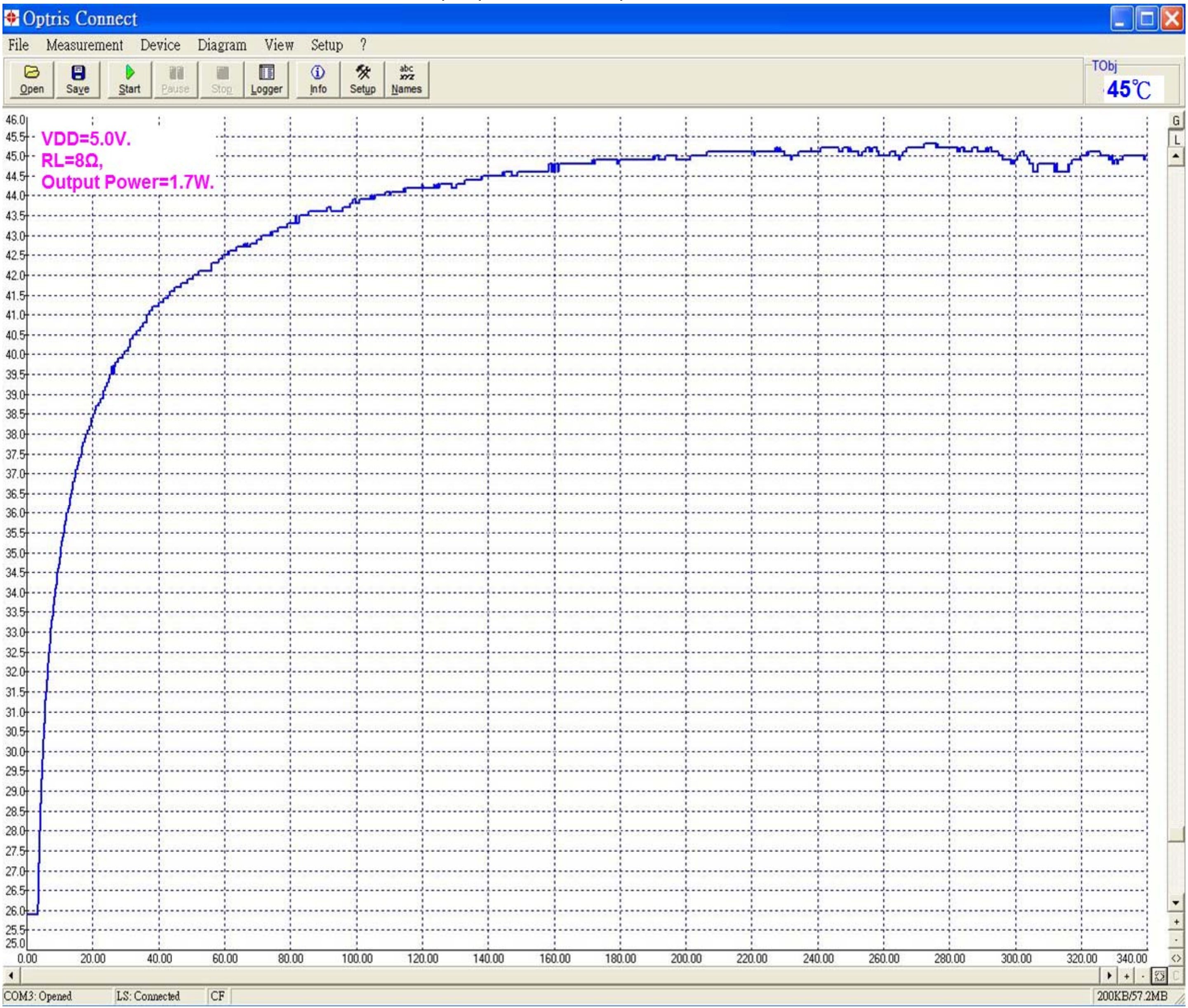
Output power vs. Temperature



APPLICATION INFORMATION

Bridged configuration explanation

As shown in *Figure 1 and 2,* the LY8898 has two operational amplifiers internally, allowing for a few different amplifier configurations. The first amplifier's gain is externally configurable, while the second amplifier is internally fixed in a unity-gain, inverting configuration. The closed-loop gain of the first amplifier is set by selecting the ratio of Rf to RIN while the second amplifier's gain is fixed by the two internal 20kΩ resistors. *Figure 1 and 2* shows that the output of amplifier one serves as the input to amplifier two which results in both amplifiers producing signals identical in magnitude, but out of phase by 180°. Consequently, the differential gain for the IC is

$$A_{VD} = 2 \times (R_f / R_{IN}) \quad \text{......(1)}$$

By driving the load differentially through outputs Vo1(-) and Vo2(+), an amplifier configuration commonly referred to as "bridged mode" is established. Bridged mode operation is different from the classical single-ended amplifier configuration where one side of the load is connected to ground.
A bridge amplifier design has a few distinct advantages over the single-ended configuration, as it provides differential drive to the load, thus doubling output swing for a specified supply voltage. Four times the output power is possible as compared to a single-ended amplifier under the same conditions.
This increase in attainable output power assumes that the amplifier is not current limited or clipped. In order to choose an amplifier's closed-loop gain without causing excessive clipping, please refer to the Audio Power Amplifier Design section.
A bridge configuration, such as the one used in the LY8898, also creates a second advantage over single -ended amplifiers. Since the differential outputs, Vo1(-) and Vo2(+), are biased at half-supply, no net DC voltage exists across the load. This eliminates the need for an output coupling capacitor which is required in a single supply, single-ended amplifier configuration. Without an output coupling capacitor, the half-supply bias across the load would result in both increased internal IC power dissipation and also possible loudspeaker damage.

Input Capacitors (Ci)

The LY8898 input capacitors and input resistors form a high-pass filter with the corner frequency, f_c, determined in equation Equation 2.

$$fc = \frac{1}{2\pi RiCi} \quad \text{......(2)}$$

Equation 3 is reconfigured to solve for the input coupling capacitance.

$$Ci = \frac{1}{2\pi Rifc} \quad \text{......(3)}$$

For example

In the table 1 shows the external components. Rin in connect with Cin to create a high-pass filter.

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Table 1. Typical Component Values

Reference	Description				Note
Ri	20KΩ				1% tolerance resistors
Ci	0.1uF	0.22uF	0.33uF	0.47uF	80%/–20% non polarized
corner frequency	79.57Hz	36.17Hz	20.4Hz	16.93Hz	

Ci = 1 / (2πRifc)

Ci = 1 / (2π x20KΩ x20Hz)=0.1uF，One would likely choose a value of 0.1uF as this value is commonly used.

Note that it is important to C_i must be 10 times smaller than the bypass capacitor to reduce clicking and popping noise from power on/off and entering and leaving shutdown. After sizing C_i for a given cutoff frequency, size the bypass capacitor to 10 times that of the input capacitor.

Ci ≦ Cbypass / 10

Bypass Capacitor Value Selection

Besides minimizing the input capacitor size, careful consideration should be paid to value of Cbypass, the capacitor connected to the BYPASS pin. Since Cbypass determines how fast the LY8898 settles to quiescent operation, its value is critical when minimizing turn-on pops. The slower the LY8898's outputs ramp to their quiescent DC voltage (nominally 1/2 VDD), the smaller the turn-on pop. Choosing Cbypass value equal 1.0 to 10 uF along with a small value of Ci (in the range of 1 nF to 0.39 μF), produces a click-less and pop-less shutdown function. As discussed above, choosing Ci no larger than necessary for the desired bandwith helps minimize clicks and pops. Therefore, increasing the bypass capacitor reduces clicking and popping noise from power on/off and entering and leaving shutdown. To have minimal pop, Cbypass should be 10 times larger than C_i.

Cbypass ≧ Ci x 10

Table 2. CBYPASS Reference Component Values

PARAMETER	SYMBOL	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
Start-up time from shutdown	Z_I	V_{DD}=5.0V, Ci=0.1uF, Ri=20KΩ, Av=10	C_{bypass} = 10μf	-	940	-	ms
			C_{bypass} = 4.7μf	-	550	-	
			C_{bypass} = 2.2μf	-	190	-	
			C_{bypass} = 1.0μf	-	158	-	
		V_{DD}=3.7V, Ci=0.1uF, Ri=20KΩ, Av=10	C_{bypass} = 10μf	-	780	-	
			C_{bypass} = 4.7μf	-	480	-	
			C_{bypass} = 2.2μf	-	180	-	
			C_{bypass} = 1.0μf	-	126	-	

Power Supply Bypassing Capacitor

As with any amplifier, proper supply bypassing is critical for low noise performance and high power supply rejection. The capacitor location on both the bypass and power supply pins should be as close to the device as possible.

The LY8898 is a mono class AB audio amplifier that requires adequate power supply decoupling to ensure the efficiency is high and total harmonic distortion (THD) is low. For higher frequency transients, spikes, or digital hash on the line, a good low equivalent-series-resistance ceramic capacitor or electrolytic capacitors, typically 10~220uF, placed as close as possible to the device VDD lead works best. Placing 0.1uF decoupling capacitor close to the LY8898 is very important for the efficiency of the class AB amplifier, because any resistance or inductance in the trace between the device and the capacitor can cause a loss in efficiency and protect device damage. For filtering lower-frequency noise signals, a 10.0uF or greater capacitor placed near the audio power amplifier would also help, but it is not required in most applications because of the high PSRR of this device.

Shutdown Function

When the LY8898 not in use. The device will be to turn off the amplifier to reduce power consumption. When logic high is applied to the shutdown pin, this shutdown feature will turns the amplifier off. By switching the shutdown pin connected to VDD, the device supply current draw will be minimized in idle mode. The pin cannot be left floating due to the internal did not pull-up.

Over-Heat Protection

The LY8898 has a built-in over-heat protection circuit , it will turn off all power output when the chip temperature over 160℃, the chip will return to normal operation automatically after the temperature cool down to 130℃.

PCB LAYOUT

All the external components must place very close to the LY8898. The input resistors need to be very close to the LY8898 input pins so noise does not couple on the high impedance nodes between the input resistors and the input amplifier of the LY8898. Then place the decoupling capacitor Cs, close to the LY8898 is important for the efficiency of the class AB amplifier. Any resistance or inductance in the trace between the device and the capacitor can cause a loss in efficiency.
Making the high current traces going to VDD, GND, VO+ and VO- pins of the LY8898 should be as wide as possible to minimize trace resistance. If these traces are too thin, the LY8898's performance and output power will decrease. The input traces do not need to be wide, but do need to run side-by-side to enable common-mode noise cancellation.

▪ DEMO BOARD INFORMATION

Demo Board Application Circuit :

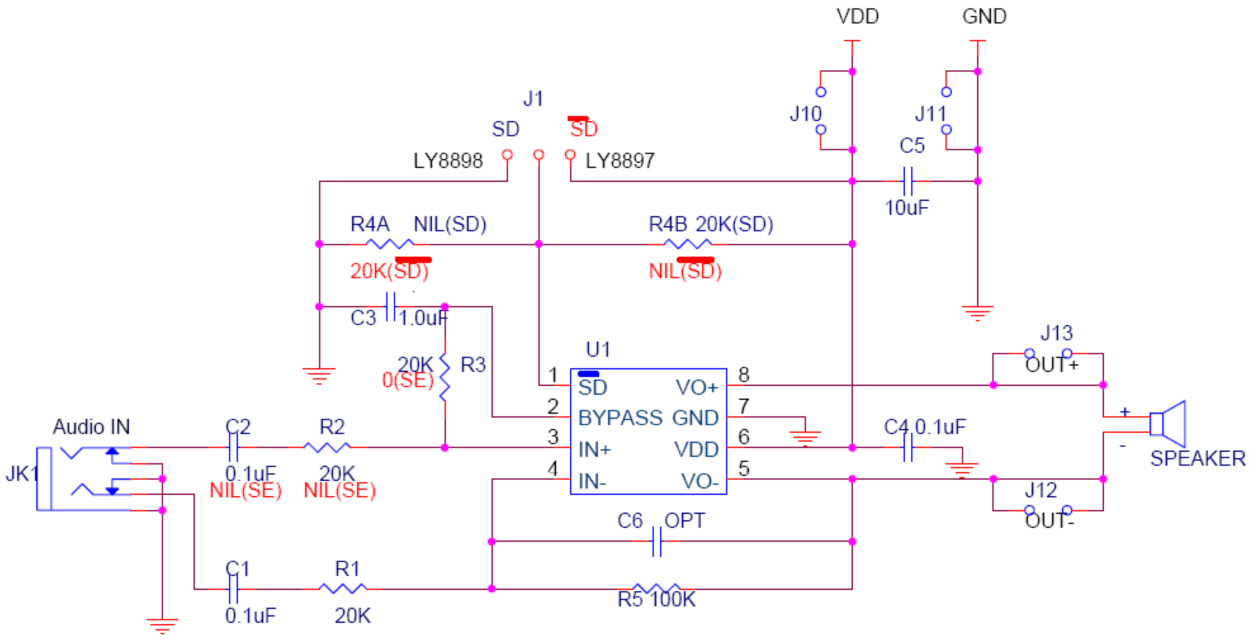


Figure 9. LY8898 Demo Board Application Circuit

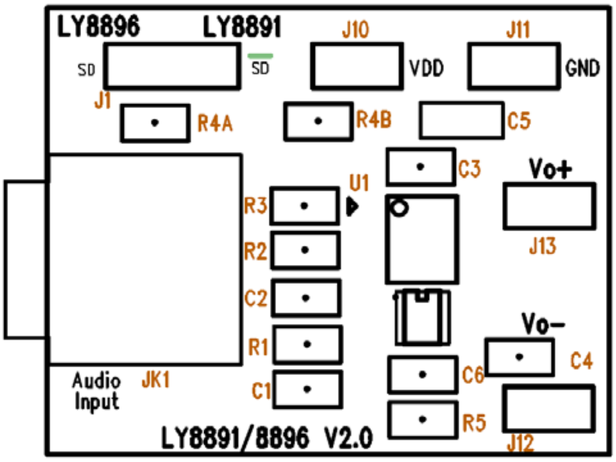
Demo Board BOM List :

LY8898 V2.0 BOM List (Stereo Mode)

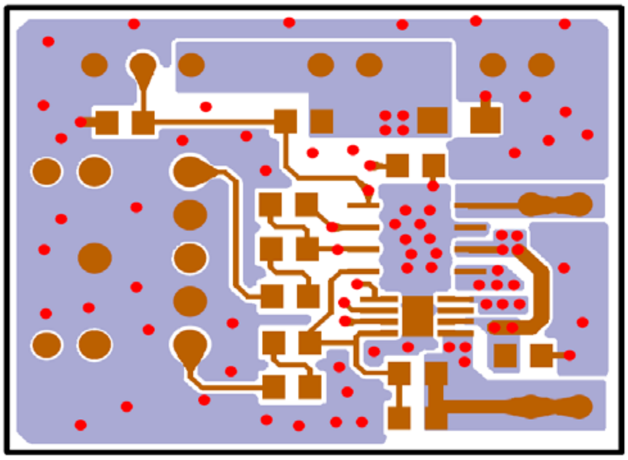
No.	Description	Reference	Note
1	Resistor, 20KΩ	R1, R4B (R2,R3 DF input only)	1/16W,1%
2	Resistor, 100KΩ	R5	1/16W,1%
3	Capacitor, 0.1uF	C1, C4 (C2 DF input only)	80%/−20%, non polarized
4	Capacitor, 1.0uF	C3	80%/−20%, non polarized
5	Capacitor, 10.0uF	C5	25V,105℃,8x11,EC Cap.
6	IC	U1	LY8898 (ESOP8)
7	1*2 Pin Header	J1	Pitch 2.54 mm

Demo Board Artwork :

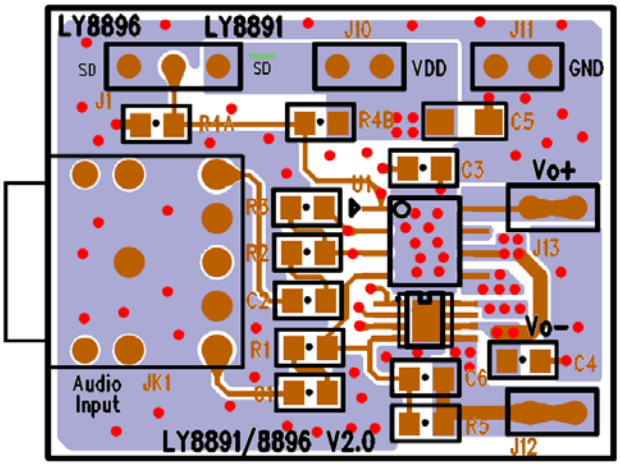
Top Silkscreen



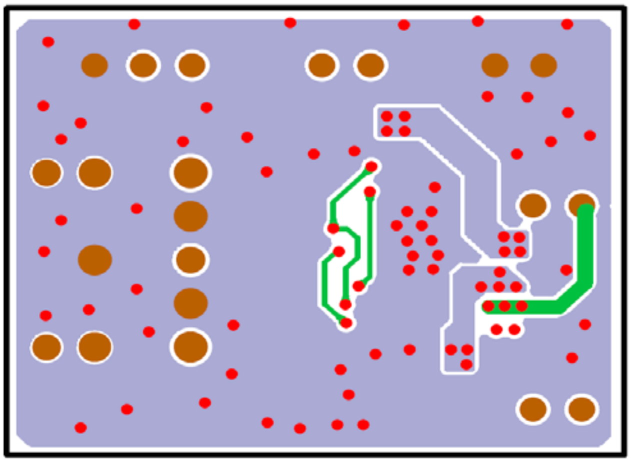
Top Layer



Composite view



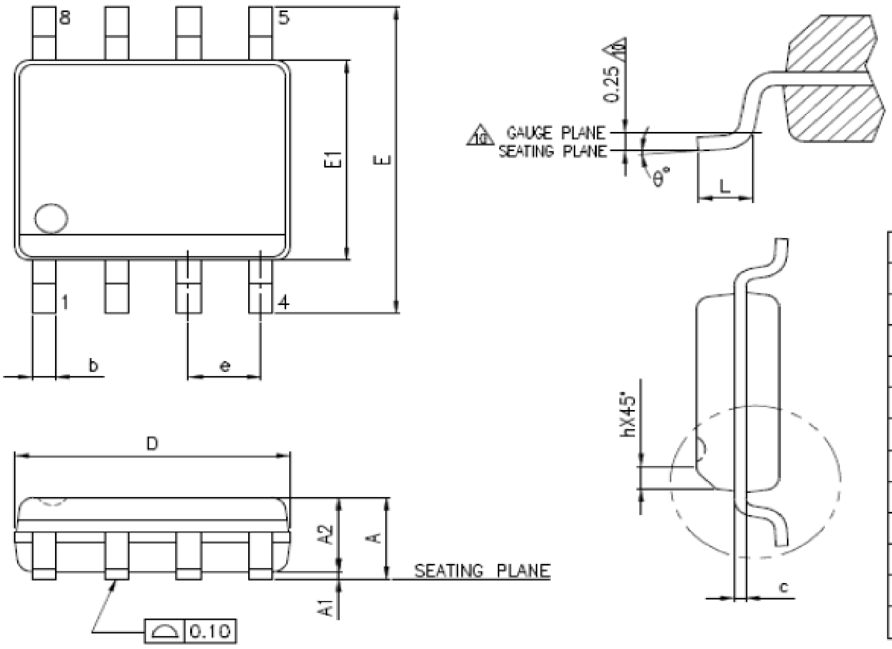
Bottom Layer



(*3) When driving 3Ω or 4Ω loads from 4.2V~5V power supply, the device must be mounted to a circuit board.

PACKAGE OUTLINE DIMENSION

8 Pin ESOP Package Outline Dimension



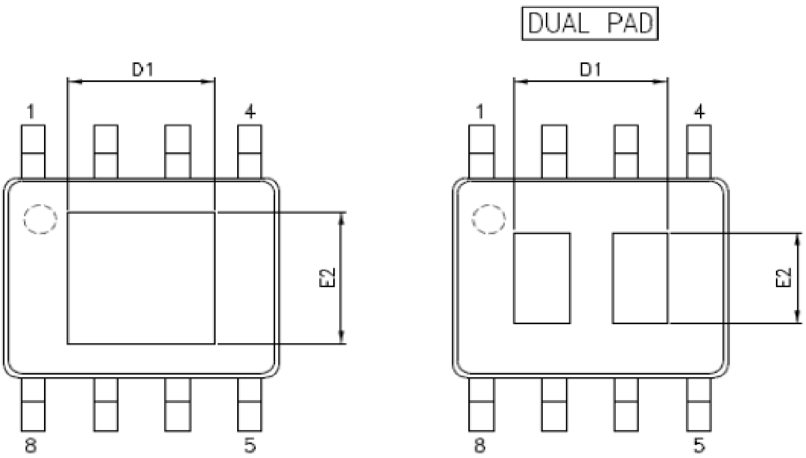
SYMBOLS	STANDARD MIN.	STANDARD MAX.	THERMAL MIN.	THERMAL MAX.
A	—	1.75	—	1.70
A1	0.10	0.25	0.00	0.15
A2	1.25	—	1.25	—
b	0.31	0.51	0.31	0.51
c	0.10	0.25	0.10	0.25
D	4.90 BSC		4.90 BSC	
E	6.00 BSC		6.00 BSC	
E1	3.90 BSC		3.90 BSC	
e	1.27 BSC		1.27 BSC	
L	0.40	1.27	0.40	1.27
h	0.25	0.50	0.25	0.50
θ°	0	8	0	8

UNIT : mm

THERMALLY ENHANCED DIMENSIONS

PAD SIZE	E2 MIN.	E2 MAX.	D1 MIN.	D1 MAX.
90X90E	1.94	2.29	1.94	2.29
95X13E	2.05	2.41	2.81	3.30
96X65E(DUAL PAD)	1.78	2.44	2.90	3.56

UNIT : mm



(THERMAL VARIATIONS ONLY)