3.3W Stereo & FM Enhancement Class D Audio Power Amplifier

FEATURES

- 3.3W/CH Into 4Ω from 5.5V power supply at THD+N = 10%.
- 2.2V~5.5V Power supply.
- Low shutdown Current.
- Low Quiescent Current.
- Minimum external components.
- No output filter required for inductive loads.
- Short-Circuit Protection and automatic recovery.
- Over-Heat Protection and automatic recovery.
- Low noise during turn-on and turn-off transitions.
- FM enhancement function.
- Lead free and green package available. (RoHS Compliant)
- Package : 16pin 150mil SOP, 16pin 4x4 QFN.

APPLICATION

- Portable electronic devices
- Mobile phones, PDAs
- DVD/CD Players, TFT LCD TVs/Monitors
- USB Audio, Audio System
- iPod dock.

GENERAL DESCRIPTION

The LY8212 is a high efficiency, high quality 3.3W stereo class D audio power amplifier which can operate FM enhance function to get good performance in FM mode. It is a low noise, filterless PWM architecture eliminates the output filter, reducing external component count, system cost (BOM cost), and simplify design.

The device was designed to meet of Multimedia application includes mini speaker and other portable electronic devices.

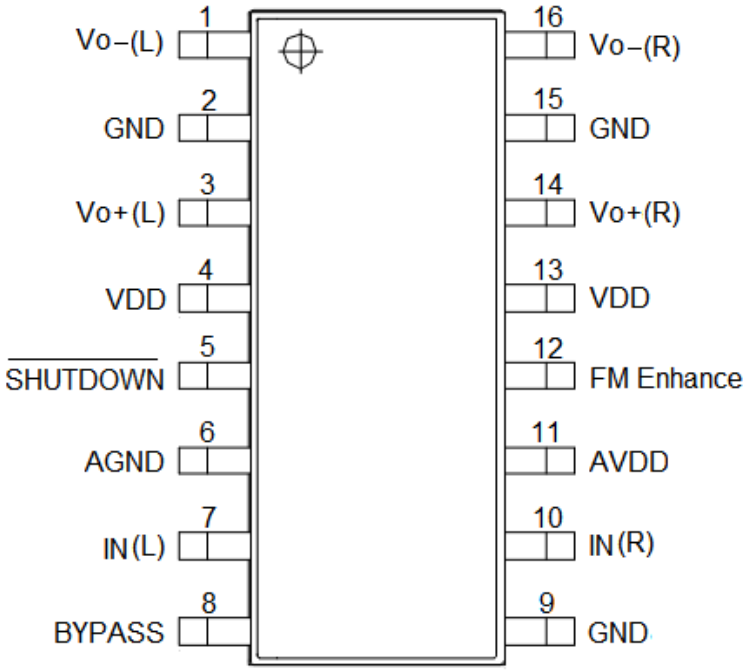
The LY8212 is a single 5.5V power supply, it is capable of driving 4Ω speaker load at a continuous average output of 3.3W/CH with 10% THD+N.

The device also features an internal thermal shutdown protection and output pin short circuit (short to output pin, short to ground and short to VDD) protection prevent the device from damage during fault conditions.

The LY8212 is easily to be used in various portable applications and products. such as FM speaker, MP3, MP4 and MP5 media players.

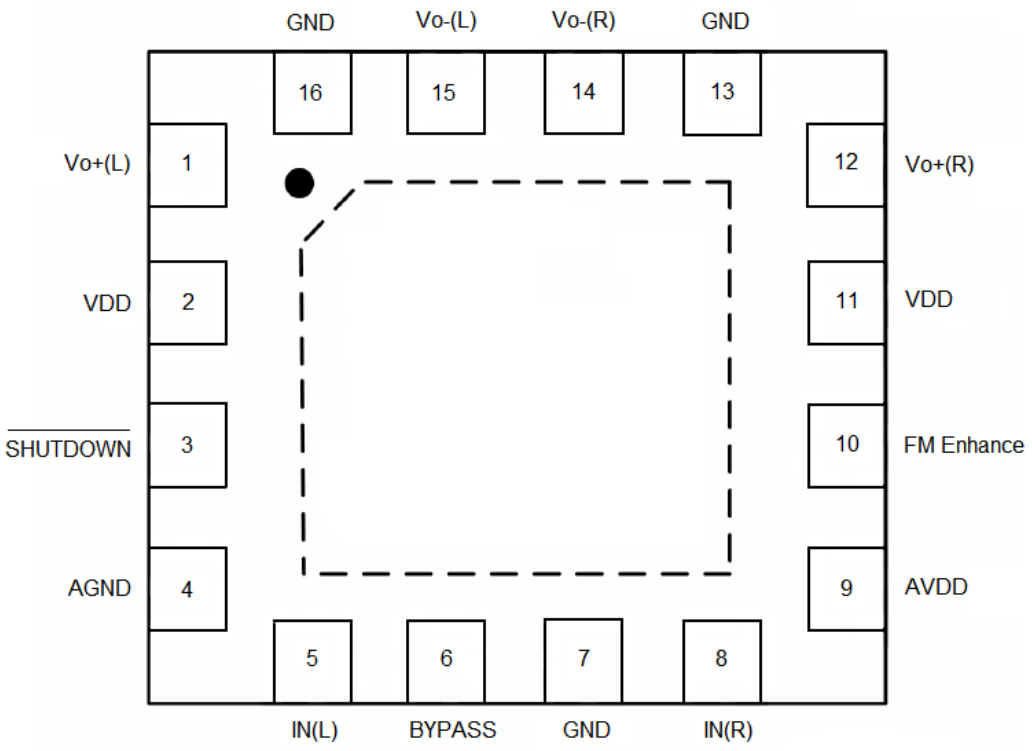
PIN CONFIGURATION

LY8212 SOP16 Pin Configuration (Top View)



5F, No. 2, Industry E . Rd. IX, Science-Based Industrial Park, Hsinchu 300, Taiwan
TEL: 886-3-6668838
FAX: 886-3-6668836

LY8212 QFN16 Pin Configuration (Top View)



▪ PIN DESCRIPTION

SYMBOL	Pin No.		DESCRIPTION
	SOP16	QFN16	
Vo-(L)	1	15	Negative(-) BTL output of left channel.
GND	2/9/15	7/13/16	Ground
Vo+(L)	3	1	Positive(+) BTL output of left channel.
V_{DD}	4/13	2/11	Power supply of left and right channel.
Shutdown	5	3	Shutdown control pin. (when **LOW** level is shutdown mode).
AGND	6	4	Analog GND of left and right channel.
INL	7	5	Input of left channel.
Bypass	8	6	Bypass pin.
INR	10	8	Input of right channel.
AV_{DD}	11	9	Analog Power supply of left and right channel.
FM Enhance	12	10	FM enhance pin. (when **HIGH** level is FM enhance mode).
Vo+(R)	14	12	Positive(+) BTL output of right channel.
Vo-(R)	16	14	Negative(-) BTL output of right channel.

ORDERING INFORMATION

Ordering Code	Speaker Channels	Pin/ Package	Output Power (THD+N=10%)	Input Type	Output Type	Feature
						FM Enhance
LY8212SL	Stereo	SOP16	3.3W/4Ω @5.5V_BTL 2.7W/4Ω @5.0V_BTL 2.0W/8Ω @5.5V_BTL 1.6W/8Ω @5.0V_BTL	SE	BTL	Yes
LY8212EL	Stereo	QFN16	3.3W/4Ω @5.5V_BTL 2.7W/4Ω @5.0V_BTL 2.0W/8Ω @5.5V_BTL 1.6W/8Ω @5.0V_BTL	SE	BTL	Yes

▪ TYPICAL APPLICATION CIRCUIT

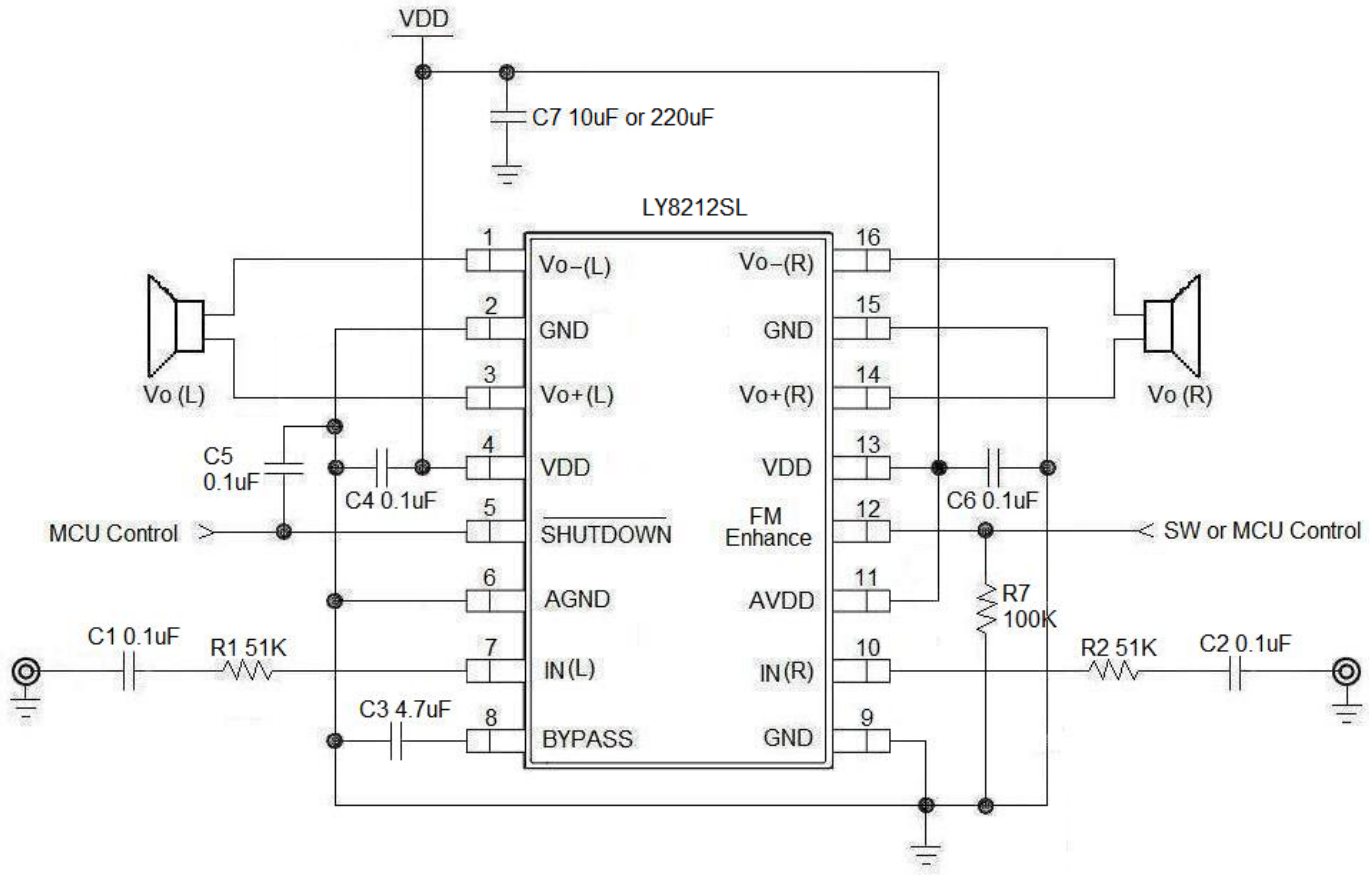


Figure 1. LY8212SL Typical Application Circuit

▪ ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	RATING	UNIT
Power supply voltage range	V_{DD}	6.0	V
Operating temperature	T_A	-40 to 85 (I grade)	℃
Input voltage range	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	℃

▪ ELECTRICAL CHARACTERISTICS (T_A = 25℃)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP. *2	MAX.	UNIT
Power supply voltage	V_{DD}	-	2.2	-	5.5	V
Quiescent current (FM enhance pin=low)	I_Q	V_{DD} = 5.5V, No Load	-	11	-	mA
		V_{DD} = 3.7V, No Load	-	9	-	
		V_{DD} = 2.5V, No Load	-	7	-	
Shutdown current	I_{SD}	$V_{SHUTDOWN} \leqq$ 0.8V, V_{DD} = 2.5V to 5.5V	-	0.1	-	μA
Shutdown voltage input high	V_{SDIH}	-	1.2	-	-	V
Shutdown voltage input low	V_{SDIL}	-	-	-	0.4	
Output offset voltage	V_{OS}	V_I = 0 V, Av = 2 V/V, V_{DD} = 2.5 V to 5.5 V	-	-	25	mV
Thermal shutdown temperature	T_{SD}	Shutdown temp.	-	180	-	℃
		Restore temp.	-	135	-	

▪ OPERATING CHARACTERISTICS (1) (T_A = 25℃)

PARAMETER	SYMBOL	TEST CONDITION			MIN.	TYP. *2	MAX.	UNIT
Output power / channel	P_O	R_L = 4Ω, f = 1kHz,	THD+N=10%	V_{DD}=5.5V	-	3.3	-	W
				V_{DD}=5.0V	-	2.7	-	
				V_{DD}=3.7V	-	1.4	-	
			THD+N=1%	V_{DD}=5.5V		2.6		
				V_{DD}=5.0V	-	1.7	-	
				V_{DD}=3.7V	-	1.2 *1	-	
		R_L = 8Ω, f = 1kHz,	THD+N=10%	V_{DD}=5.5V		2.0		
				V_{DD}=5.0V	-	1.6	-	
				V_{DD}=3.7V	-	0.8	-	
			THD+N=1%	V_{DD}=5.5V		1.6		
				V_{DD}=5.0V	-	1.3	-	
				V_{DD}=3.7V	-	0.6	-	

(*1)R_L = 4Ω,f = 1kHz, VDD=3.7V, Output Power=1.2W@ THD+N=2%

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

▪ OPERATING CHARACTERISTICS (2) (T_A = 25℃)

PARAMETER	SYMBOL	TEST CONDITION		MIN.	TYP. *2	MAX.	UNIT
Power supply rejection ratio	PSRR	Av=10 V/V ,Input=GND Ri=33K, Ci=0.47μF R_L=4Ohm, V_{DD}=5.0V	f=1KHz	-	-62.4	-	dB
			f=217Hz	-	-62	-	
Crosstalk	Cs	R_L = 4Ω,f=1kHz, 0.25W=0dB, V_{DD}=5.0V	L→R	-	85.4	-	dB
			R→L	-	77.6		
Signal-to-noise ratio	SNR	R_L = 8Ω,Av=2 V/V, 1.0W=0dB	V_{DD}=5.0V	-	86.8	-	dB
Output voltage noise	Vn	V_{DD} = 5.0V, R_L = 8Ω, Av=2 V/V, Inputs=GND, f = 20Hz to 20kHz,	No weighting	-	128.7	-	uV
Start-up time from shutdown	Z_I	V_{DD} = 5.0V	C_{bypass} = 4.7μF	-	300	-	ms
			C_{bypass} = 2.2μF	-	156	-	
			C_{bypass} = 1.0μF	-	138	-	
			C_{bypass} =0.47μF	-	72	-	
			C_{bypass} = 0.22μF	-	40	-	
			C_{bypass} =0.1μF	-	32	-	
			C_{bypass} =None	-	22	-	
		V_{DD} = 3.7V	C_{bypass} = 4.7μF	-	236	-	
			C_{bypass} = 2.2μF	-	140	-	
			C_{bypass} = 1.0μF	-	128	-	
			C_{bypass} =0.47μF	-	63	-	
			C_{bypass} = 0.22μF	-	36	-	
			C_{bypass} =0.1μF	-	28	-	
			C_{bypass} =None	-	22	-	
Frequency	Fc	V_{DD}=2.5V~5.5V		-	245	-	kHz
Efficiency	η	f=1kHz, RL=8Ω, Output=1.4W		-	88	-	%
Total Gain *3	Gv	V_{DD}= 2.5V to 5.5V		[150KΩ / (5KΩ+Ri)] x4			V/V

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

(*3)The audio amplifier's gain is determined by：

Pre-Amplifier Gain = [150KΩ / (5KΩ + Ri)] x 2

Total Gain = {[150KΩ / (5KΩ + Ri)] x 2} x 2

where Ri is the external serial resistance at the input pin.

TYPICAL PERFORMANCE CHARACTERISTICS

Figure 2
Total Harmonic Distortion + Noise vs Output Power (4Ω)

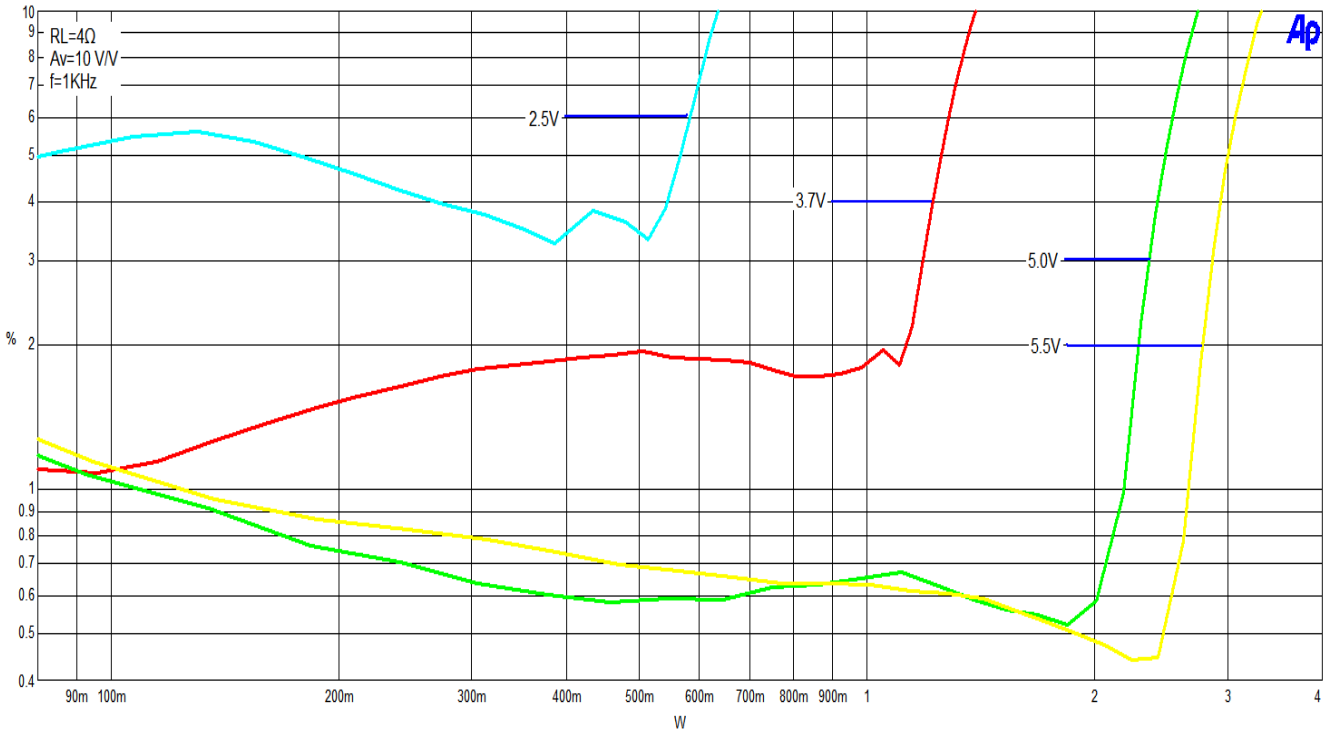


Figure 3
Total Harmonic Distortion + Noise vs Output Power (8Ω)

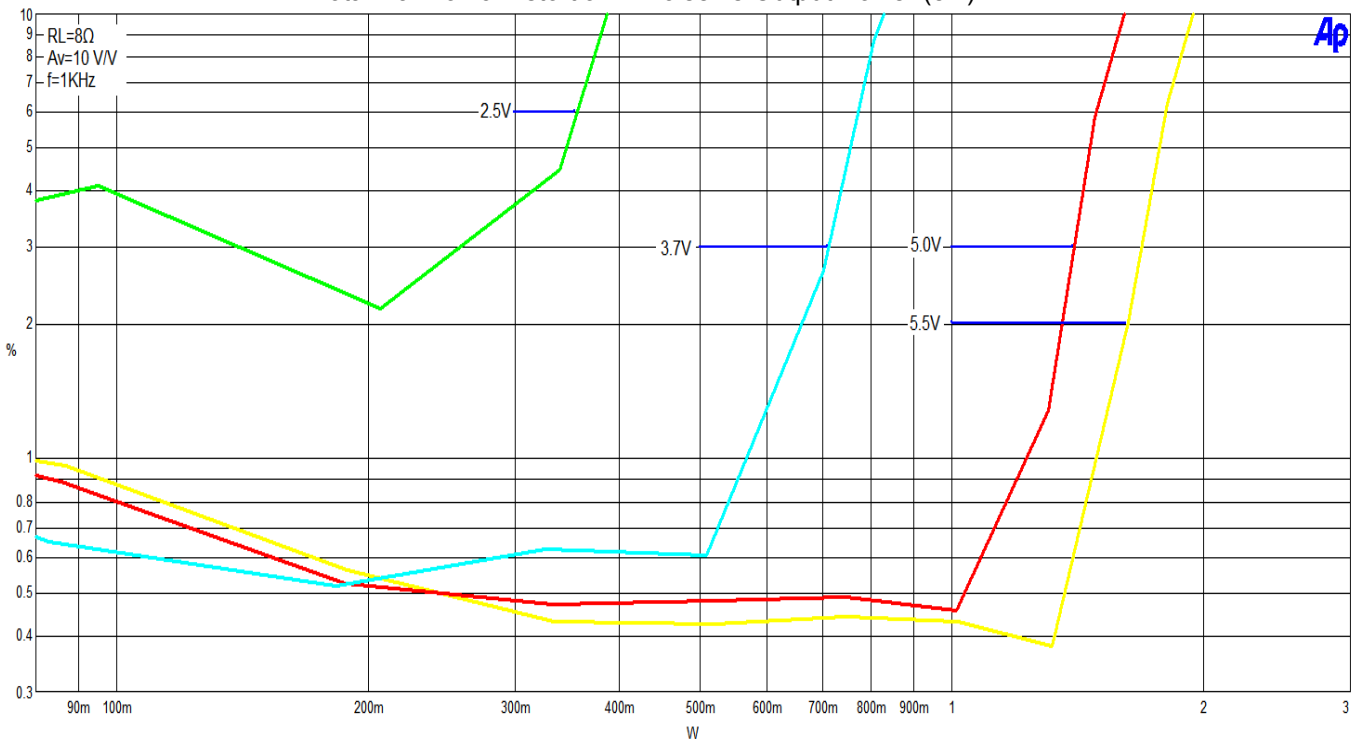


Figure 4
SNR vs. Noise Level

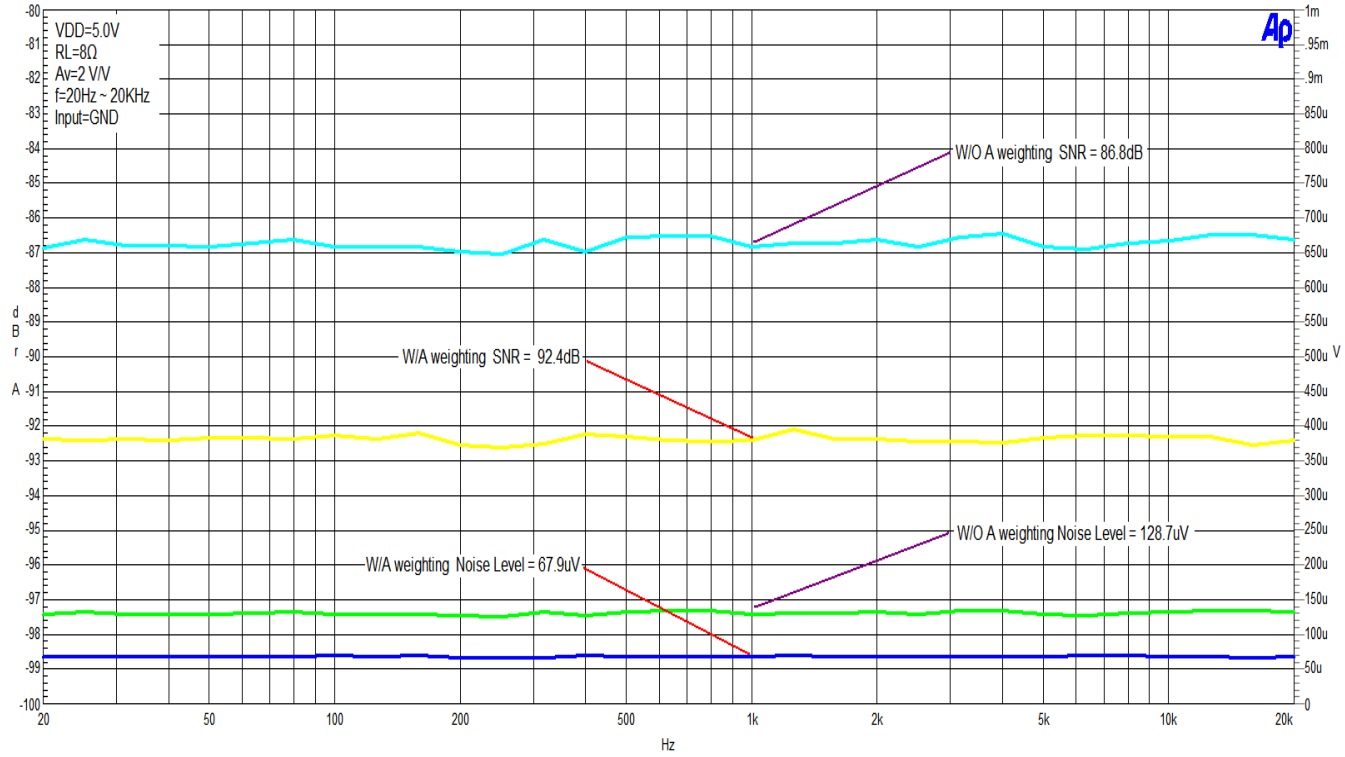
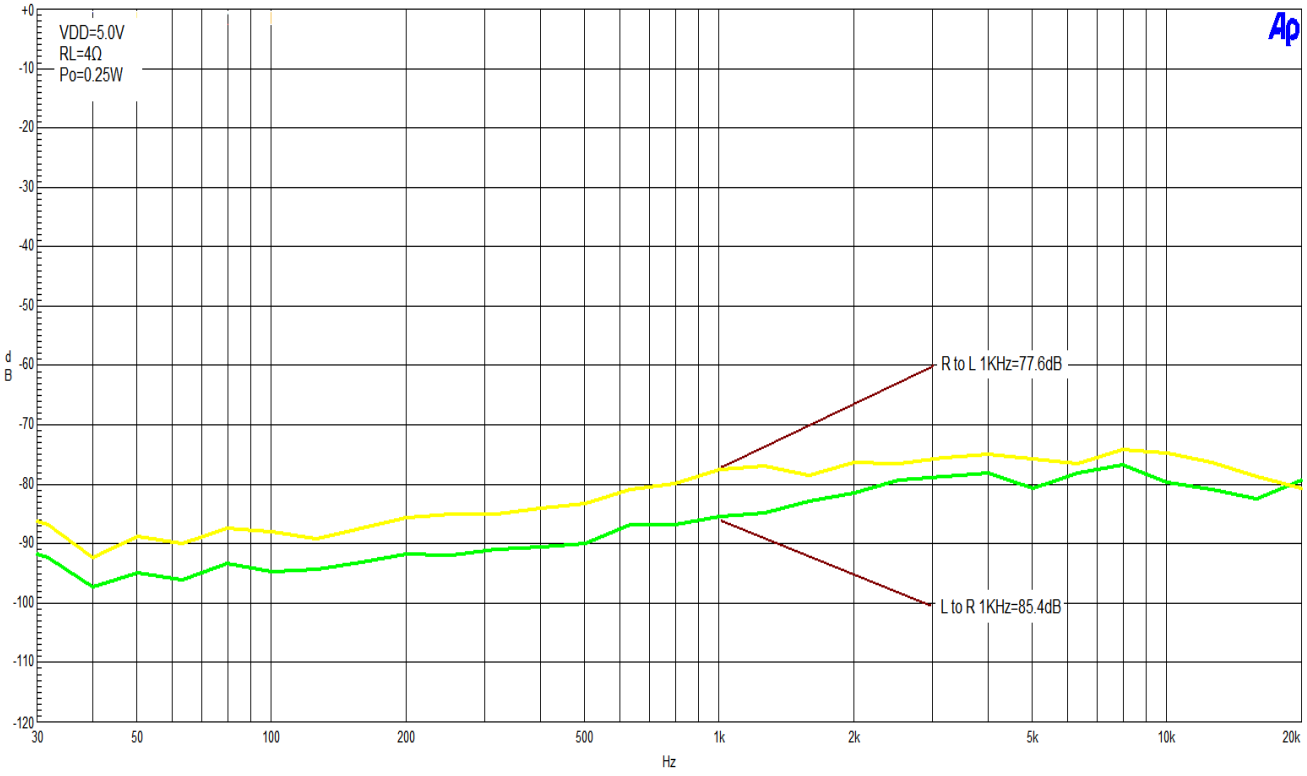
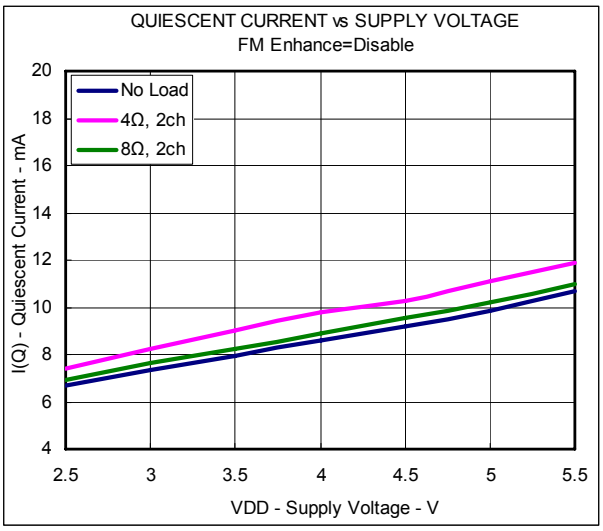
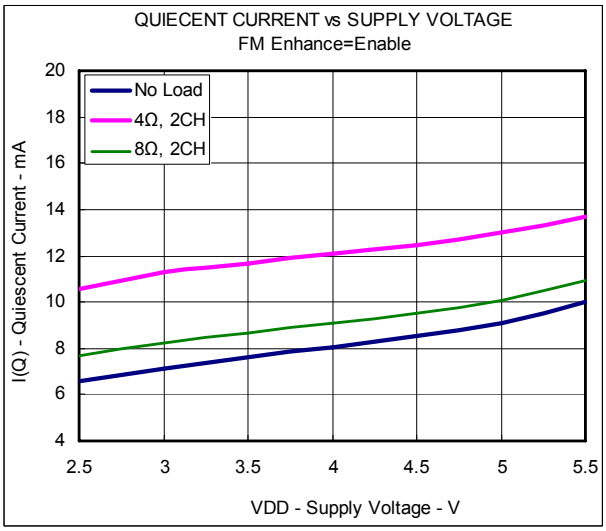


Figure 5
Crosstalk

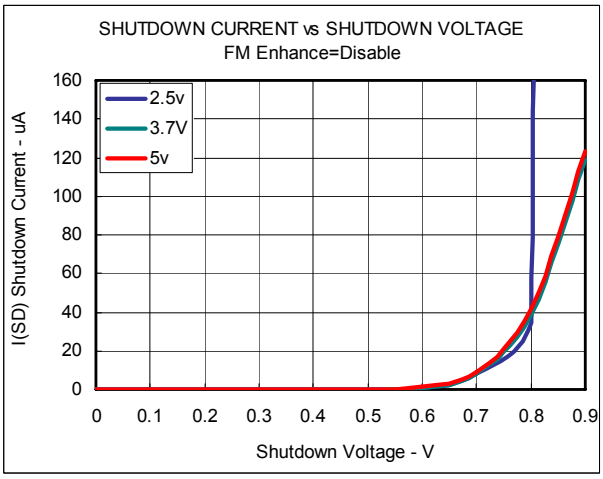


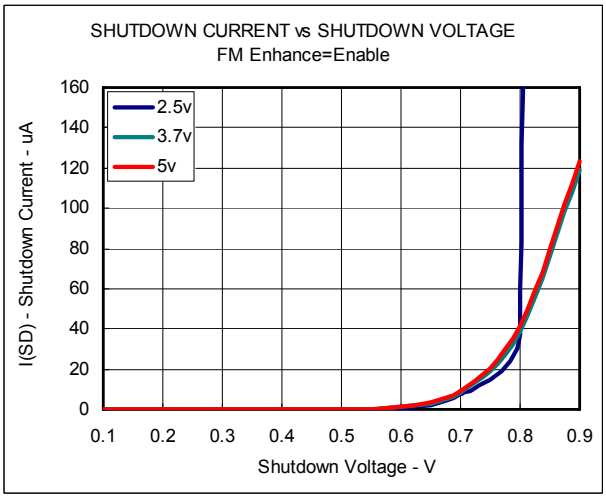
Quiescent Current vs. Supply Voltage



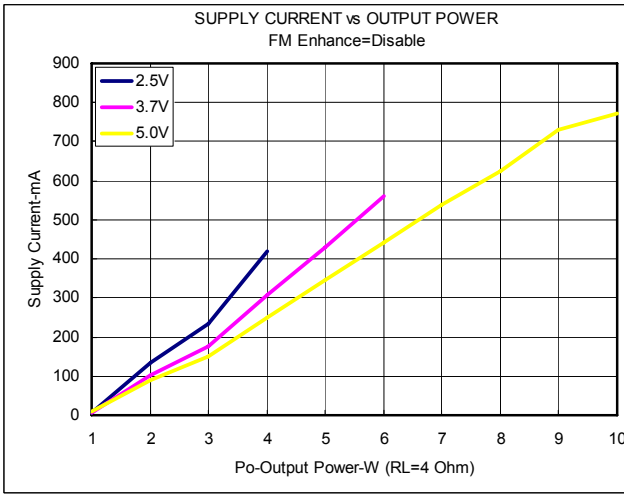


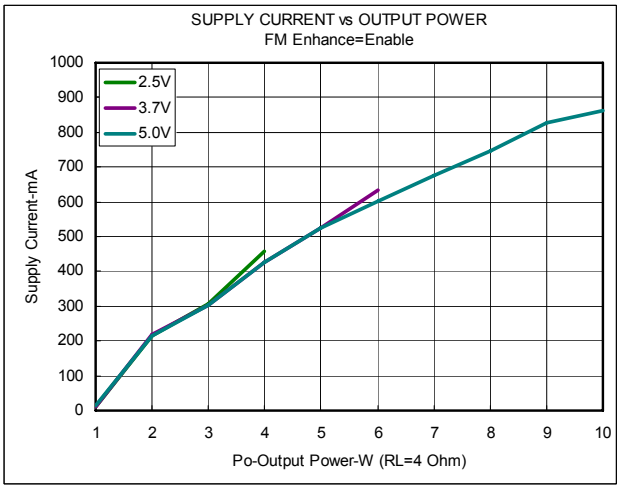
SD Current vs. SD Voltage



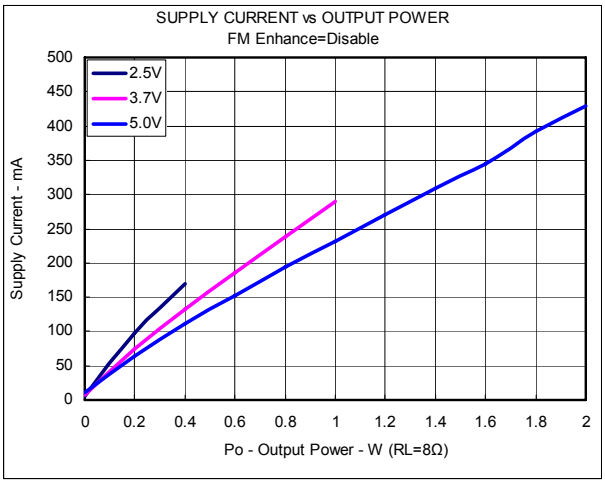


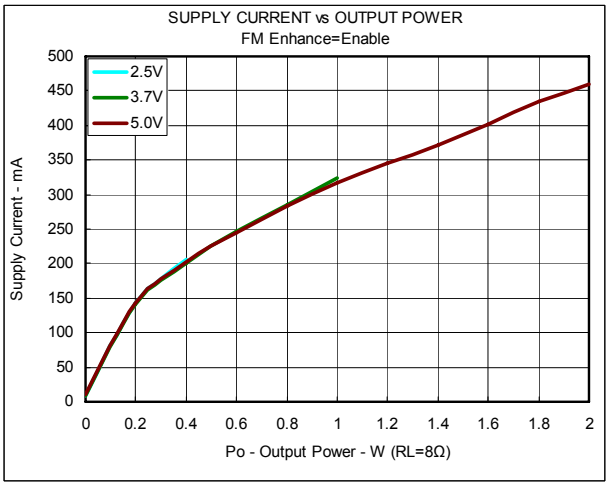
Supply Current vs. Output Power (RL=4Ω)



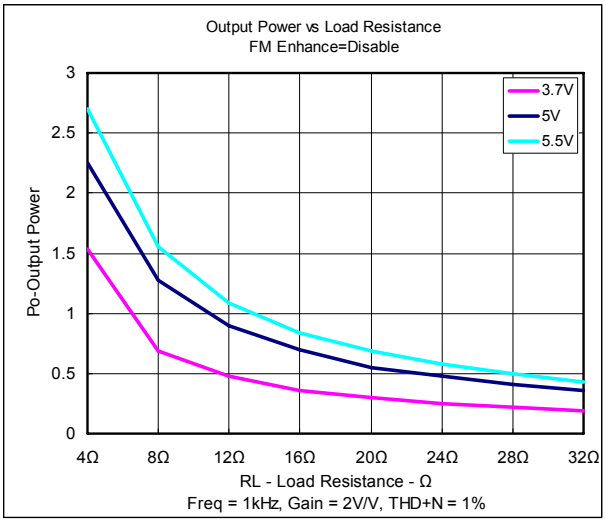


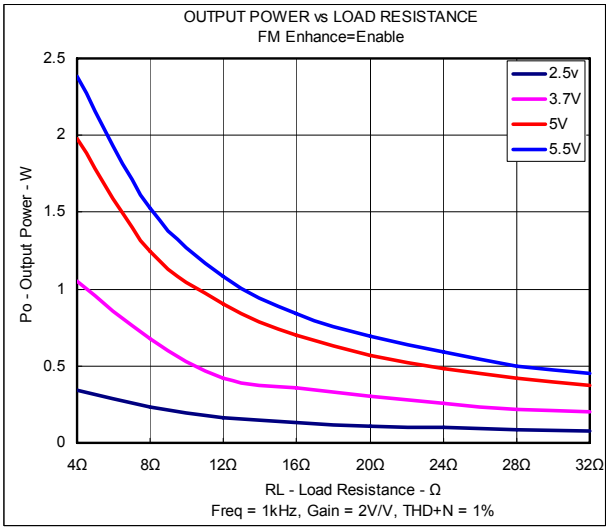
Supply Current vs. Output Power (RL=8Ω)



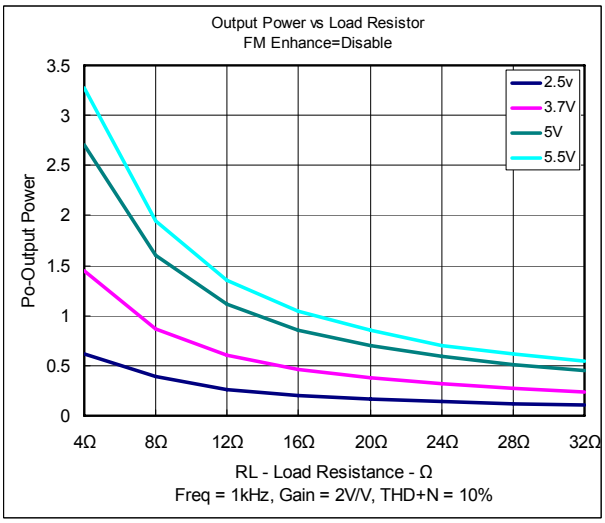


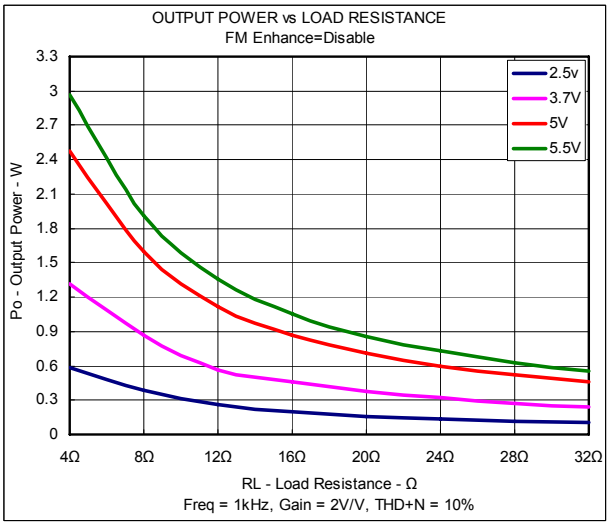
Load Resistance vs. Output Power (THD+N=1%)



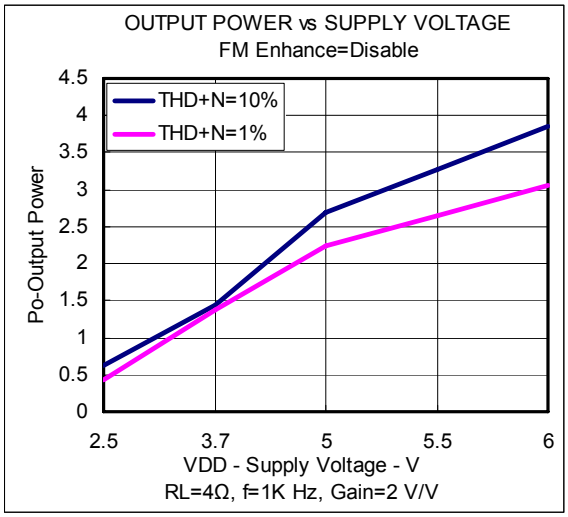


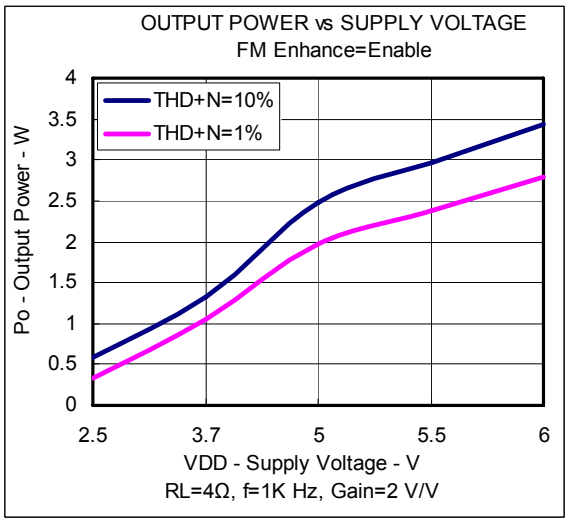
Load Resistance vs. Output Power (THD+N=10%)



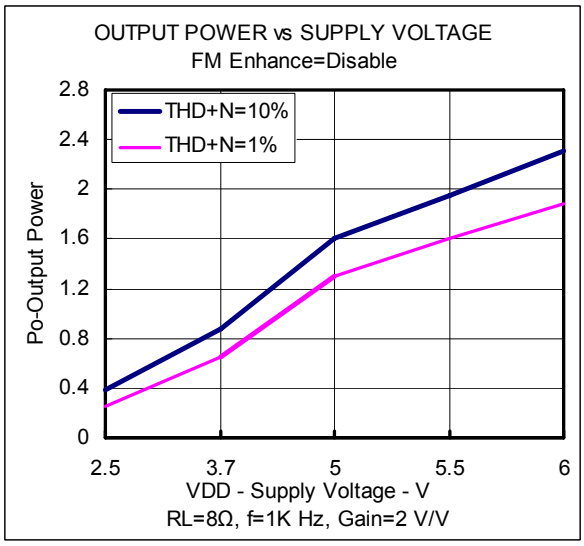


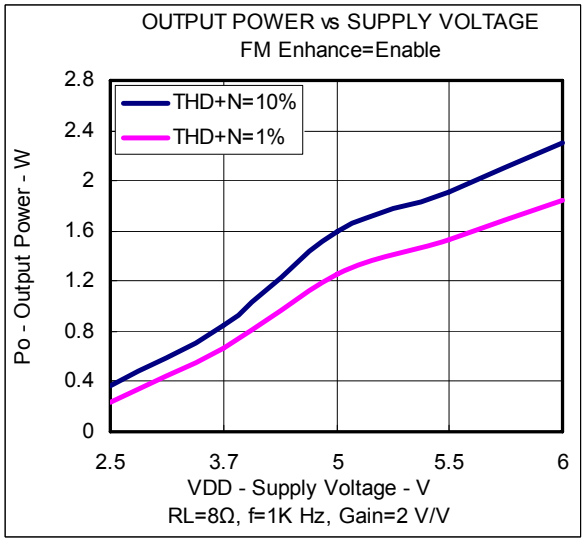
OUTPUT POWER vs. SUPPLY VOLTAGE (RL=4Ω)



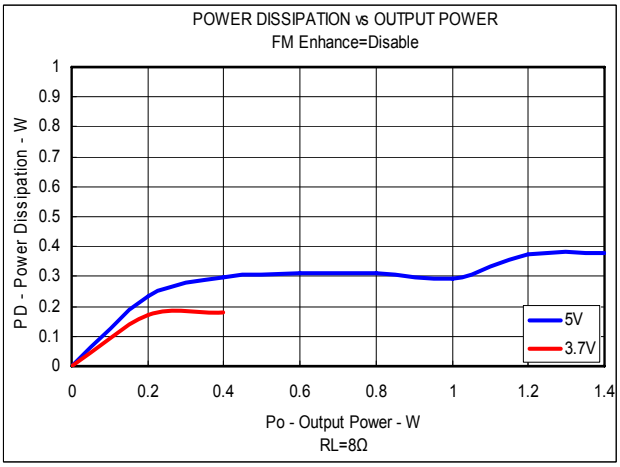


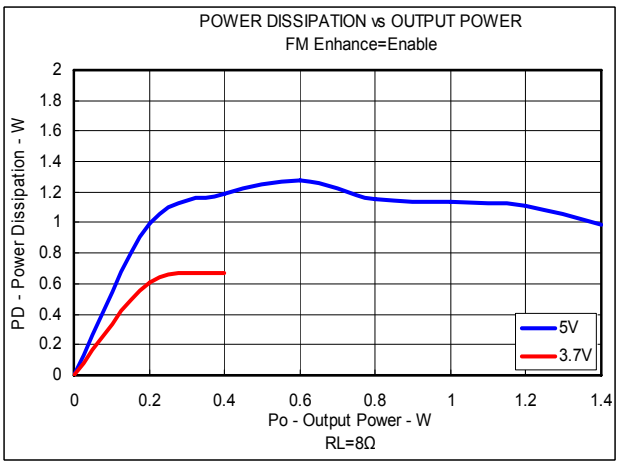
OUTPUT POWER vs. SUPPLY VOLTAGE (RL=8Ω)



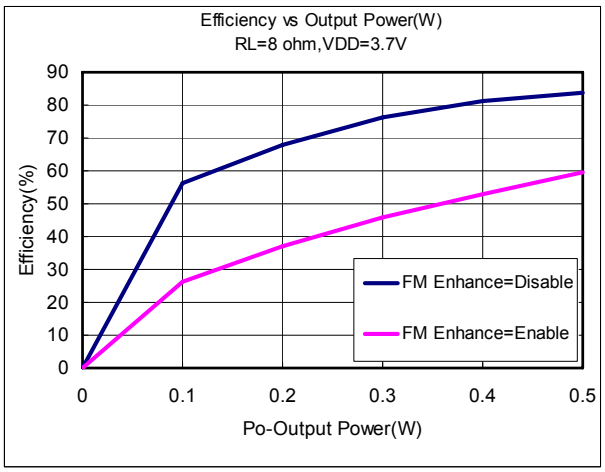


Power Dissipation vs. Output Power (8Ohm)

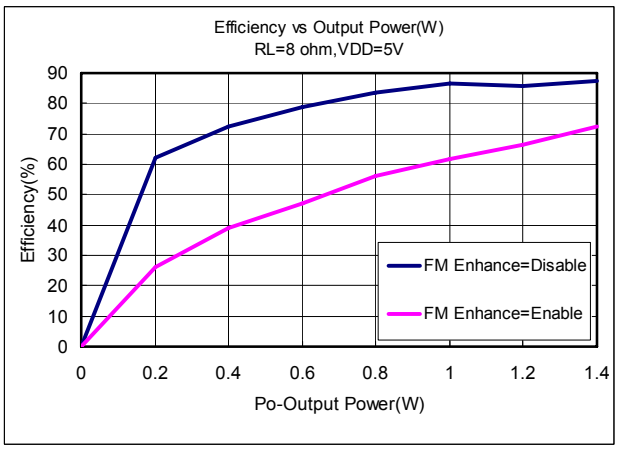




Efficiency vs. Output Power (RL=4Ω,VDD=3.7V)



Efficiency vs. Output Power (RL=4Ohm,VDD=5V)



▪ APPLICATION INFORMATION

Input Resistors (Ri) and Gain

The LY8212 have two internal amplifier stages. The pre-amplifier gain is externally configurable, while the total gain is internally fixed. The closed-loop gain of the pre-amplifier gain is set by selecting the Rf to Ri while the total gain is fixed at 4x. So the input resistors (R_i) set the gain of the amplifier according to the equation.

Pre-Amplifier Gain = (Rf / Ri) x 2

Total Gain = [(Rf / Ri) x 2] x 2

A_{VD} = 20 x log [4 x (Rf /Ri)]

The resistor matching is very important in the amplifiers. Balance of the output on the reference voltage depends on matched ratio of the resistors. CMRR, PSRR, and cancellation of the second harmonic distortion if resistor mismatch occurs. Therefore, it is recommended to use 1% tolerance resistors or better to keep the performance optimized. Matching is more important than overall tolerance.
Resistor arrays with 1% matching can be used with a tolerance greater than 1%.Place the input resistors very close to the LY8212 to limit noise injection on the high-impedance nodes. For optimal performance the gain should be set to 4 V/V or lower. Lower gain allows the LY8212 to operate at its best,

For example

Table 1. Typical Total Gain and A_{VD} Values

Rf (KΩ)	150	150	150	150	150
Ri (KΩ)	150	75	50	25	15
Pre AMP. Gain	2	4	6	12	20
Total Gain	4	8	12	24	40
A_{VD} (db)	12.04	18.06	21.58	27.60	32.04

Input Capacitors (Ci)

The LY8212 using single-end source, So the input coupling capacitors are required. The input capacitors and input resistors form a high-pass filter with the corner frequency(f_c), determined in the equation.

$f_c = 1 / (2\pi R_i C_i)$

The value of the input capacitor is important to consider as it directly affects the bass (low frequency) performance of the circuit. Speakers in wireless phones cannot usually respond well to low frequencies, so the corner frequency can be set to block low frequencies in this application. Equation is reconfigured to solve for the input coupling capacitance.

$C_i = 1 / (2\pi R_i f_c)$

If the corner frequency is within the audio band, the capacitors should have a tolerance of ±10% or better, because any mismatch in capacitance causes an impedance mismatch at the corner frequency and below.

For example

In the table 2 shows the external components. Rin in connect with Cin to create a high-pass filter.

Table 2. Typical Component Values

Reference	Description	Note
Ri	150KΩ	1% tolerance resistors
Ci	0.22uF	80%/–20%

Ci = 1 / (2πRi fc)

Ci = 1 / (2π x 150KΩ x 4.8Hz)=0.221uF，Use 0.22uF

Decoupling Capacitor

The LY8212 is a high-performance class-D 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 (ESR) ceramic capacitor, typically 10.0uF, placed as close as possible to the device V_{DD} lead works best. Placing 0.1uF decoupling capacitor close to the LY8212 is very important for the efficiency of the class-D amplifier, because any resistance or inductance in the trace between the device and the capacitor can cause a loss in efficiency. 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.

Over-Heat Protection

The LY8212 has a built-in over-heat protection circuit at FM enhance pin enable, it will turn off all power output when the chip temperature over 180℃, the chip will return to normal operation automatically after the temperature cool down to 135℃.

FM Enhance

The LY8212 has a built-in FM enhance function. When FM signal is poor. Enable (active to high) the FM enhance pin will improve the signal obviously. But enable the pin will reduce LY8212 efficiency. Therefore recommend if FM function is not to use. Disable (active to low) the FM enhance pin is very important.

▪PCB LAYOUT

All the external components must place very close to the LY8212. The input resistors need to be very close to the LY8212 input pins so noise does not couple on the high impedance nodes between the input resistors and the input amplifier of the LY8212. Then place the decoupling capacitor Cs, close to the LY8212 is important for the efficiency of the class-D 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, V_{O+} and V_{O-} pins of the LY8212 should be as wide as possible to minimize trace resistance. If these traces are too thin, the LY8212'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

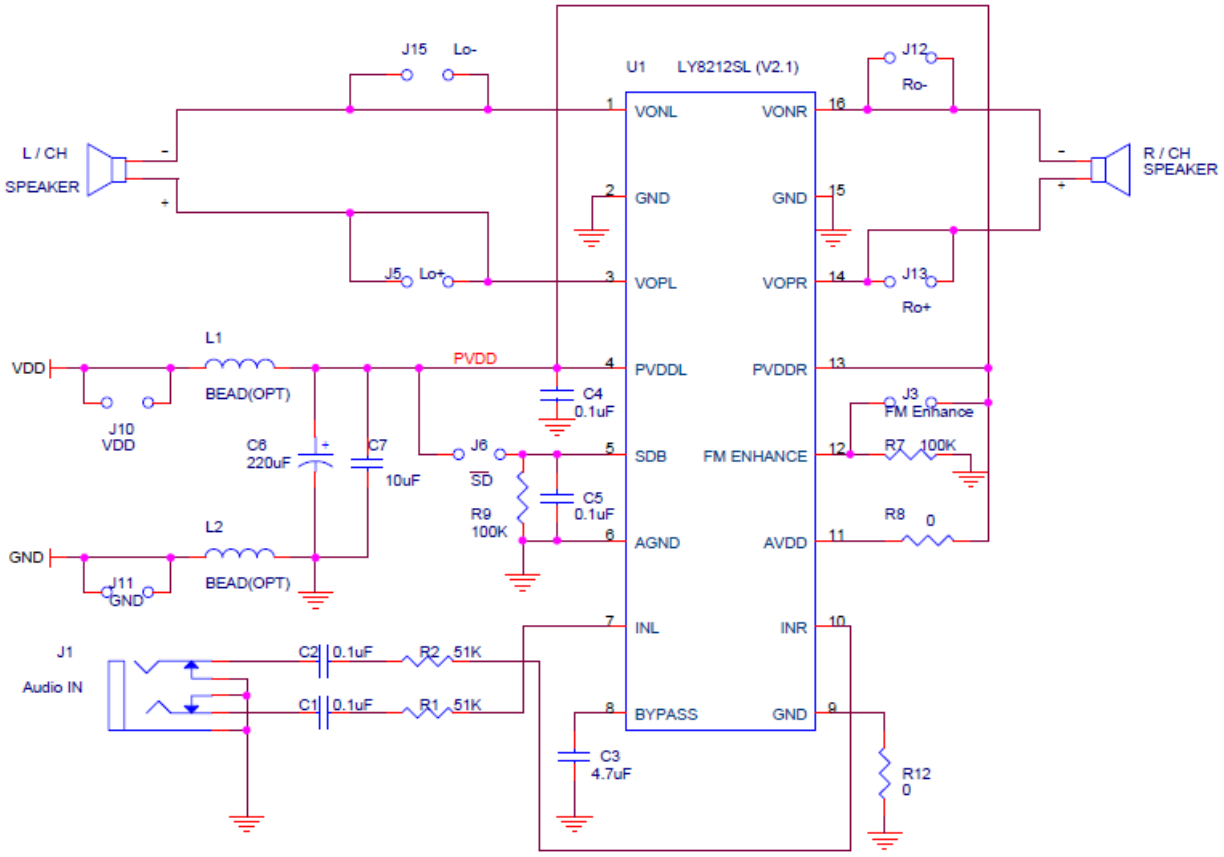


Figure 6. Demo Board Application Circuit

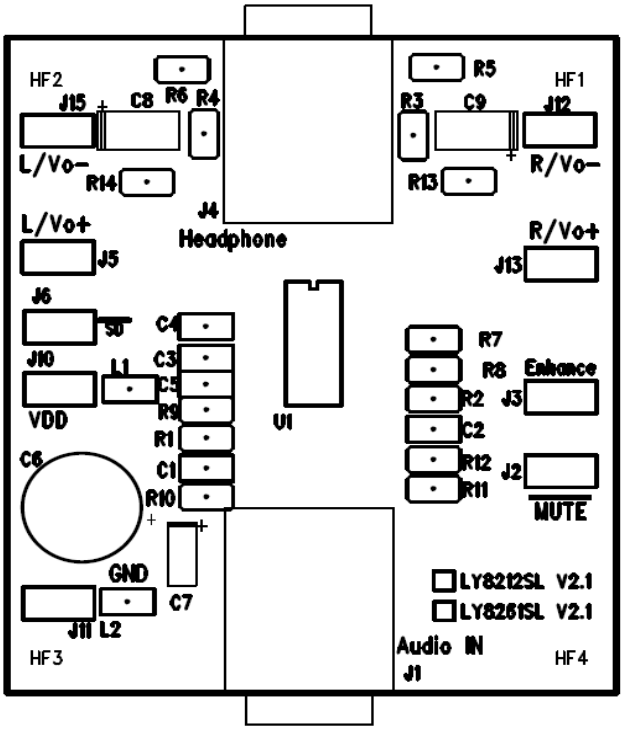
Demo Board BOM List

LY8212 V2.1 BOM List

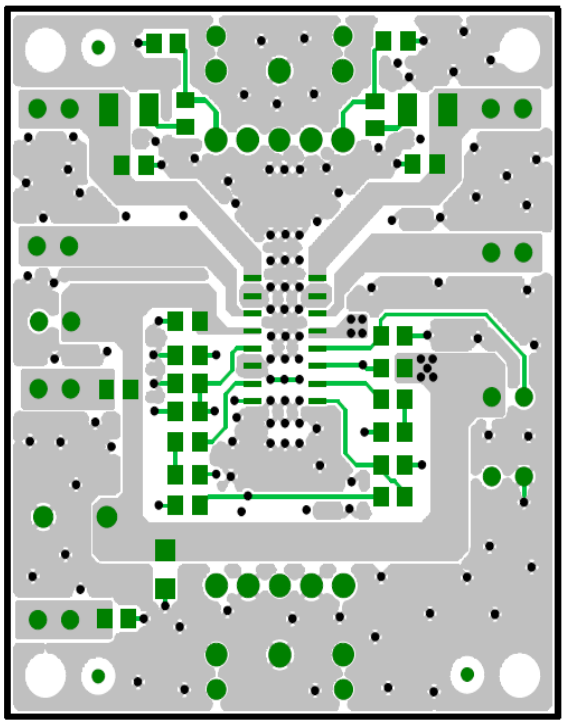
No.	Description	Reference	Note
1	Resistor, 100KΩ	R7,R9	1/16W,1%
2	Resistor, 51KΩ	R1,R2	1/16W,1%
3	Resistor, 0Ω	R8,R12	1/16W,1%
4	Capacitor, 0.1uF	C1,C2,C4,C5	80%/−20%, nonpolarized
5	Capacitor, 4.7uF	C3	80%/−20%, nonpolarized
6	Capacitor, 10.0uF	C7	80%/−20%, 6.3V
7	Capacitor, 220.0uF	C6	25V,105℃,8x11
8	IC	U1	LY8212SL, SOP16
9	1*2 Pin Header	J3,J6	Pitch 2.54 mm

Demo Board Artwork

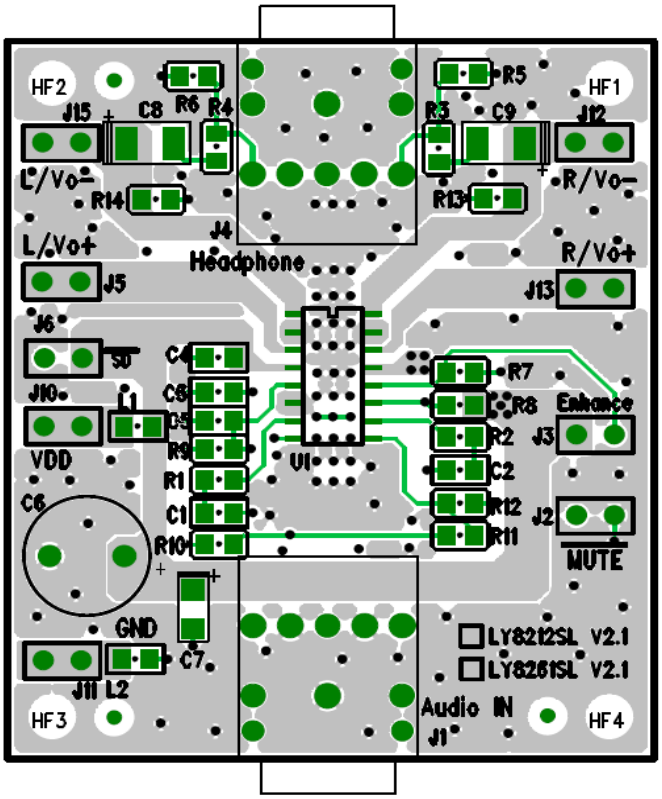
Top Silkscreen



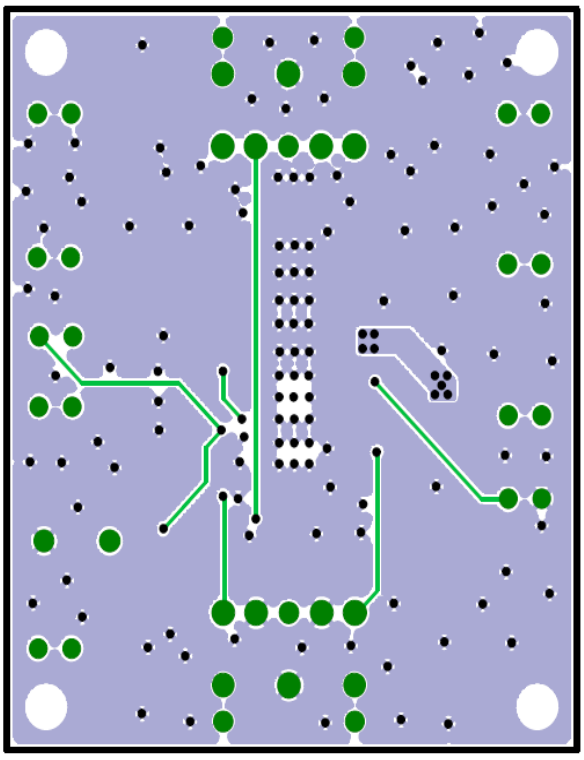
Top Layer



Composite view

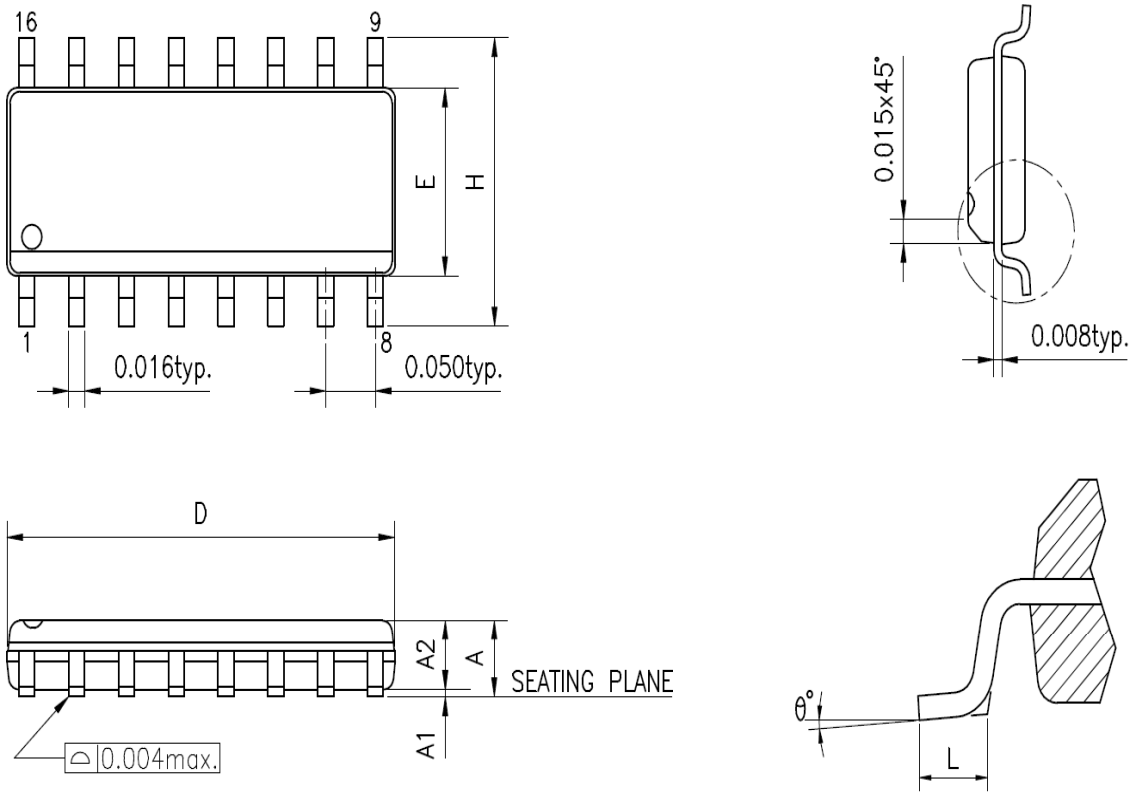


Bottom Layer



▪ PACKAGE OUTLINE DIMENSION

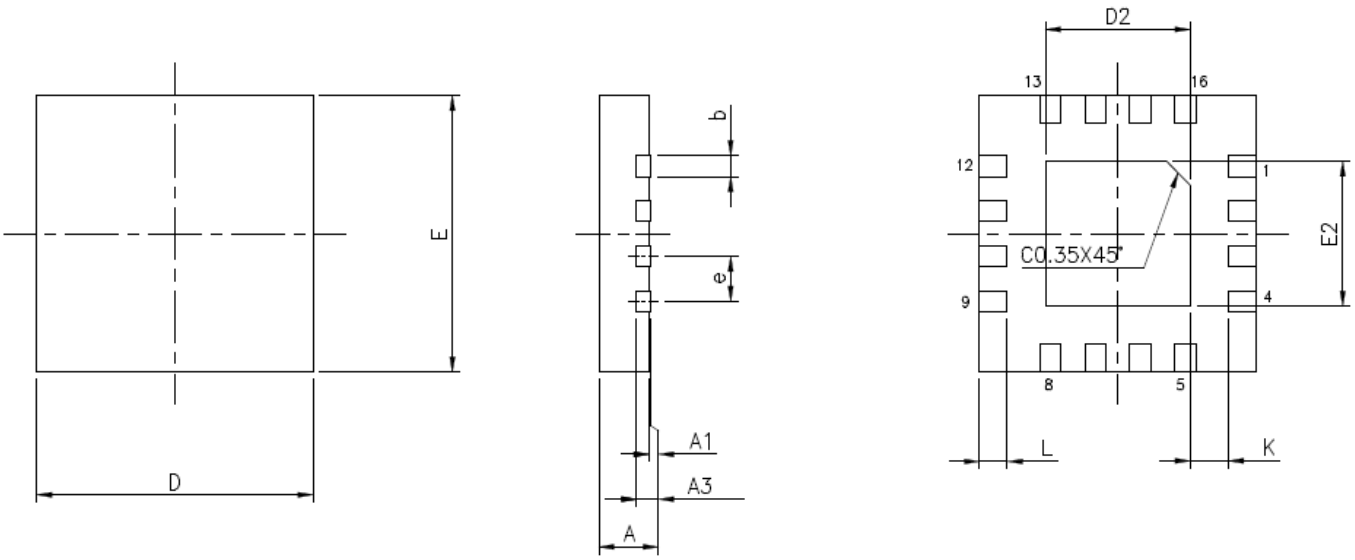
SOP 16 Pin Package Outline Dimension



	STANDARD	
SYMBOLS	MIN.	MAX.
A	0.053	0.069
A1	0.004	0.010
A2	0.049	0.065
D	0.386	0.394
E	0.150	0.157
H	0.228	0.244
L	0.016	0.050
θ°	0	8

UNIT : INCH

QFN4X4 16 Pin Package Outline Dimension



SYMBOLS	MIN.	NOM.	MAX.
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
A3		0.203 REF.	
b	0.25	0.30	0.35
D	3.90	4.00	4.10
E	3.90	4.00	4.10
e		0.65 BSC.	
L	0.35	0.40	0.45
K	0.20	—	—
D2	2.00	2.10	2.20
E2	2.00	2.10	2.20

UNIT : mm