



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.
- Support FM enhancement function.
- Support headphone function.
- Support mute function.
- Low shutdown Current.
- Low Quiescent Current.
- Over-Heat Protection and automatic recovery.
- Minimum external components.
- No output filter required for inductive loads.
- Low noise during turn-on and turn-off transitions.
- Lead free and green package available. (RoHS Compliant)
- Package : 16 pin 150 mil SOP.

APPLICATION

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

PIN CONFIGURATION

GENERAL DESCRIPTION

The LY8261 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.

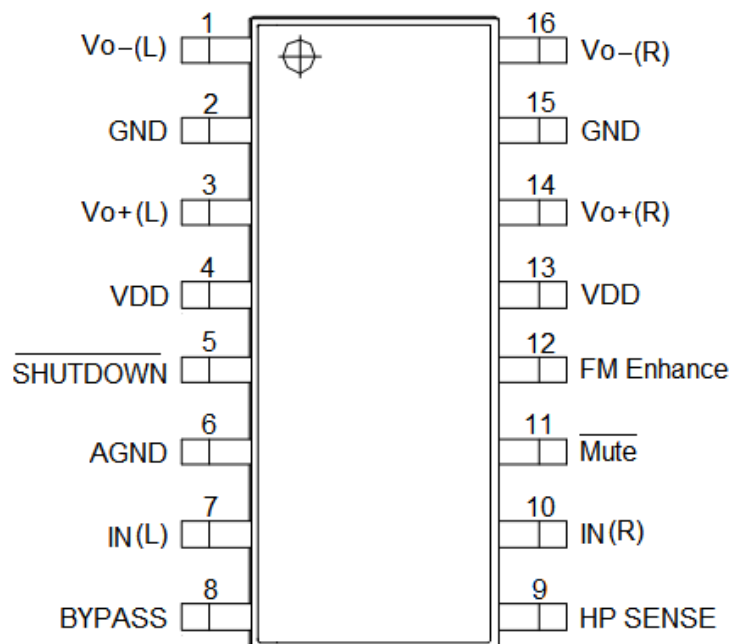
The device was designed to meet of Multimedia application includes mini speaker and other portable electronic devices.

The LY8261 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 LY8261 is easily to be used in various portable applications and products. such as FM speaker, MP3, MP4 and MP5 media players.

LY8261 SOP16 Pin Configuration (Top View)





PIN DESCRIPTION

SYMBOL	Pin No.	DESCRIPTION
	SOP16	
Vo-(L)	1	Negative(-) BTL output of left channel.
GND	2/15	Ground
Vo+(L)	3	Positive(+) BTL output of left channel.
VDD	4/13	Power supply of left and right channel.
Shutdown	5	Shutdown control pin. (when LOW level is shutdown mode).
AGND	6	Analog GND of left and right channel.
INL	7	Input of left channel.
Bypass	8	Bypass pin.
HP Sense	9	Headphone sense pin option. (If none headphone function must connect to GND).
INR	10	Input of right channel.
Mute	11	Mute control pin. (when LOW level is mute mode).
FM Enhance	12	FM enhance pin. (when HIGH level is FM enhance mode).
Vo+(R)	14	Positive(+) BTL output of right channel.
Vo-(R)	16	Negative(-) BTL output of right channel.

ORDERING INFORMATION

Ordering Code	Packing Type	Speaker Channels	Pin/ Package	Output Power (THD+N=10%)	Input Type	Output Type	Feature		
							FM enhance	Mute	Headphone
LY8261SLT	Tape&Reel	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	Yes	Yes

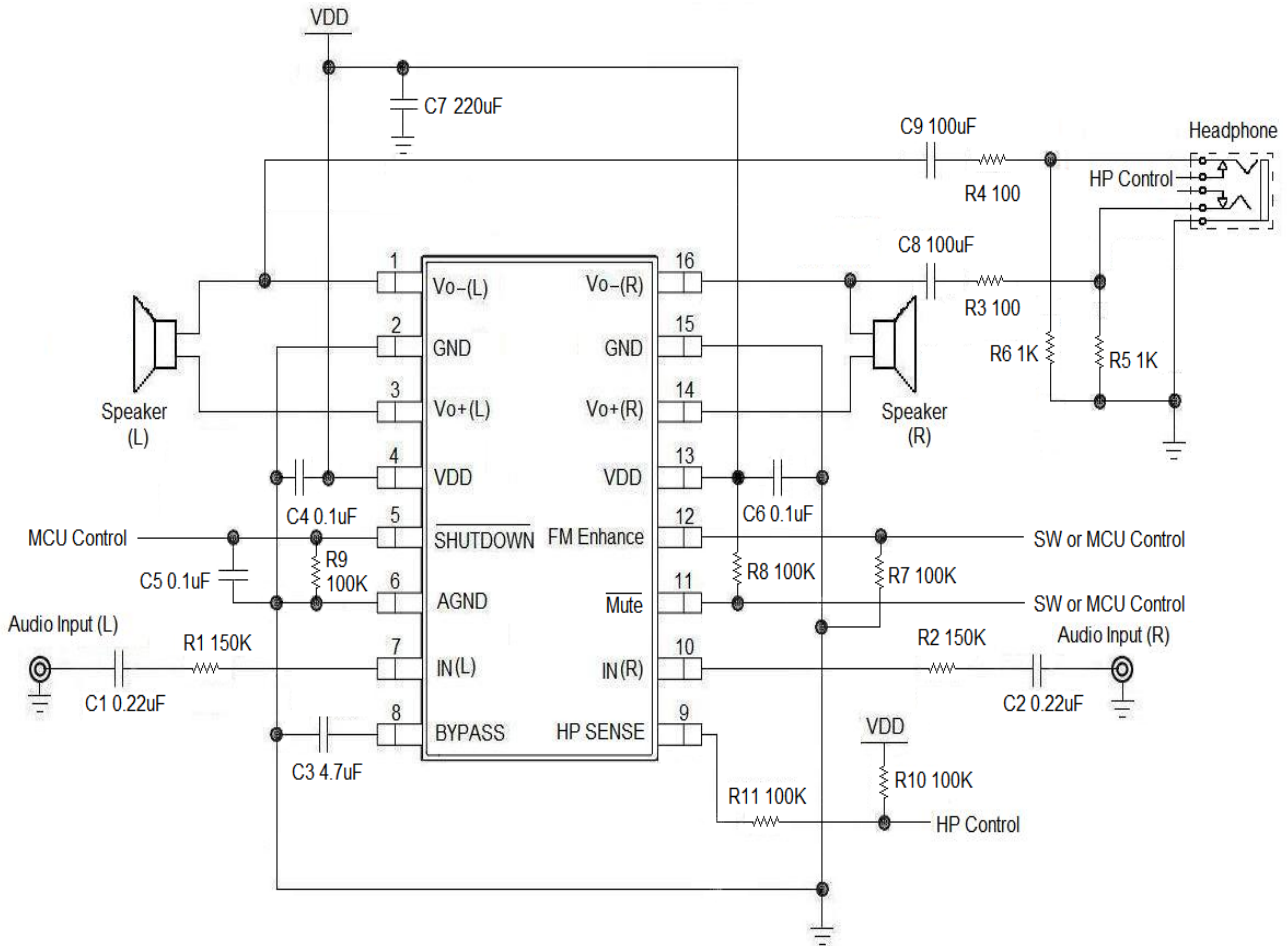
■ TYPICAL APPLICATION CIRCUIT


Figure 1. LY8261SL 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)	°C
Input voltage range	V _I	-0.3V to V _{DD} +0.3V	V
Storage temperature	T _{STG}	-65 to 150	°C
Power dissipation	P _D	Internally Limited	W
ESD susceptibility	V _{ESD}	2000	V
Junction temperature	T _{JMAX}	150	°C
Soldering temperature (under 10 sec)	T _{SOLDER}	260	°C



ELECTRICAL CHARACTERISTICS (T_A = 25°C)

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} ≤ 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, A _v = 2 V/V, V _{DD} = 2.5 V to 5.5 V	-	-	25	mV
Thermal shutdown temperature	T _{SD}	Shutdown temp.	-	180	-	°C
		Restore temp.	-	135	-	

(*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°C

OPERATING CHARACTERISTICS (1) (T_A = 25°C)

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) PS: R_L = 4Ω, f = 1kHz, V_{DD}=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°C



OPERATING CHARACTERISTICS (2) (TA = 25°C)

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 RL=40Ω, VDD=5.0V	f=1kHz	-	-62.4	-	dB
			f=217Hz	-	-62	-	
Crosstalk	Cs	RL = 4Ω, f=1kHz, 0.25W=0dB, VDD=5.0V	L→R	-	85.4	-	dB
			R→L	-	77.6	-	
Signal-to-noise ratio	SNR	RL = 8Ω, Av=2 V/V, 1.0W=0dB	VDD=5.0V	-	86.8	-	dB
Output voltage noise	Vn	VDD = 5.0V, RL = 8Ω, Av=2 V/V, Inputs=GND, f = 20Hz to 20kHz,	No weighting	-	128.7	-	μV
Start-up time from shutdown	Zi	VDD = 5.0V	Cbypass = 4.7μF	-	300	-	ms
			Cbypass = 2.2μF	-	156	-	
			Cbypass = 1.0μF	-	138	-	
			Cbypass = 0.47μF	-	72	-	
			Cbypass = 0.22μF	-	40	-	
			Cbypass = 0.1μF	-	32	-	
			Cbypass = None	-	22	-	
		VDD = 3.7V	Cbypass = 4.7μF	-	236	-	
			Cbypass = 2.2μF	-	140	-	
			Cbypass = 1.0μF	-	128	-	
			Cbypass = 0.47μF	-	63	-	
			Cbypass = 0.22μF	-	36	-	
			Cbypass = 0.1μF	-	28	-	
			Cbypass = None	-	22	-	
Frequency	Fc	VDD=2.5V~5.5V	-	245	-	kHz	
Efficiency	η	f=1kHz, RL=8Ω, Output=1.4W	-	88	-	%	
Total Gain ^{*3}	Gv	VDD= 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 TA = 25°C

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

$$\text{Pre-Amplifier Gain} = [150K\Omega / (5K\Omega + Ri)] \times 2$$

$$\text{Total Gain} = \{ [150K\Omega / (5K\Omega + Ri)] \times 2 \} \times 2$$

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



TYPICAL PERFORMANCE CHARACTERISTICS

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

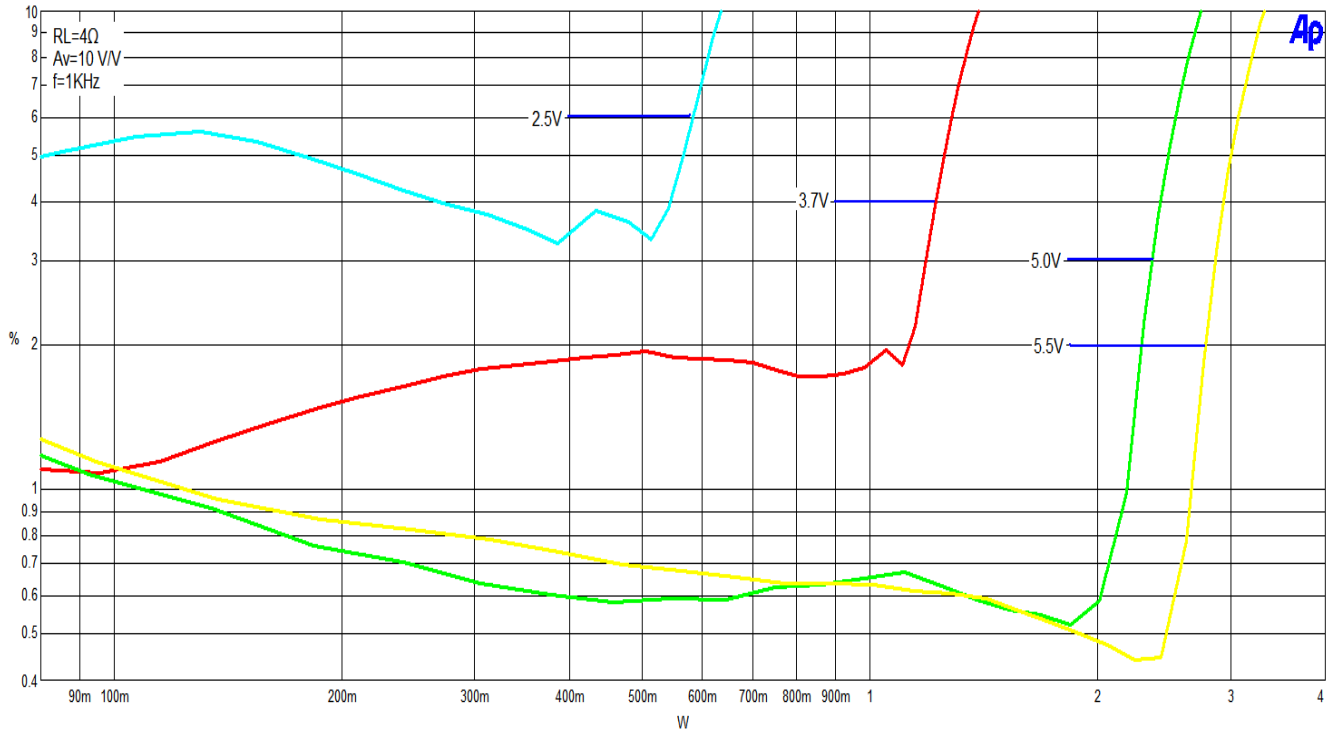


Figure 3
Total Harmonic Distortion + Noise vs Output Power (8Ω)

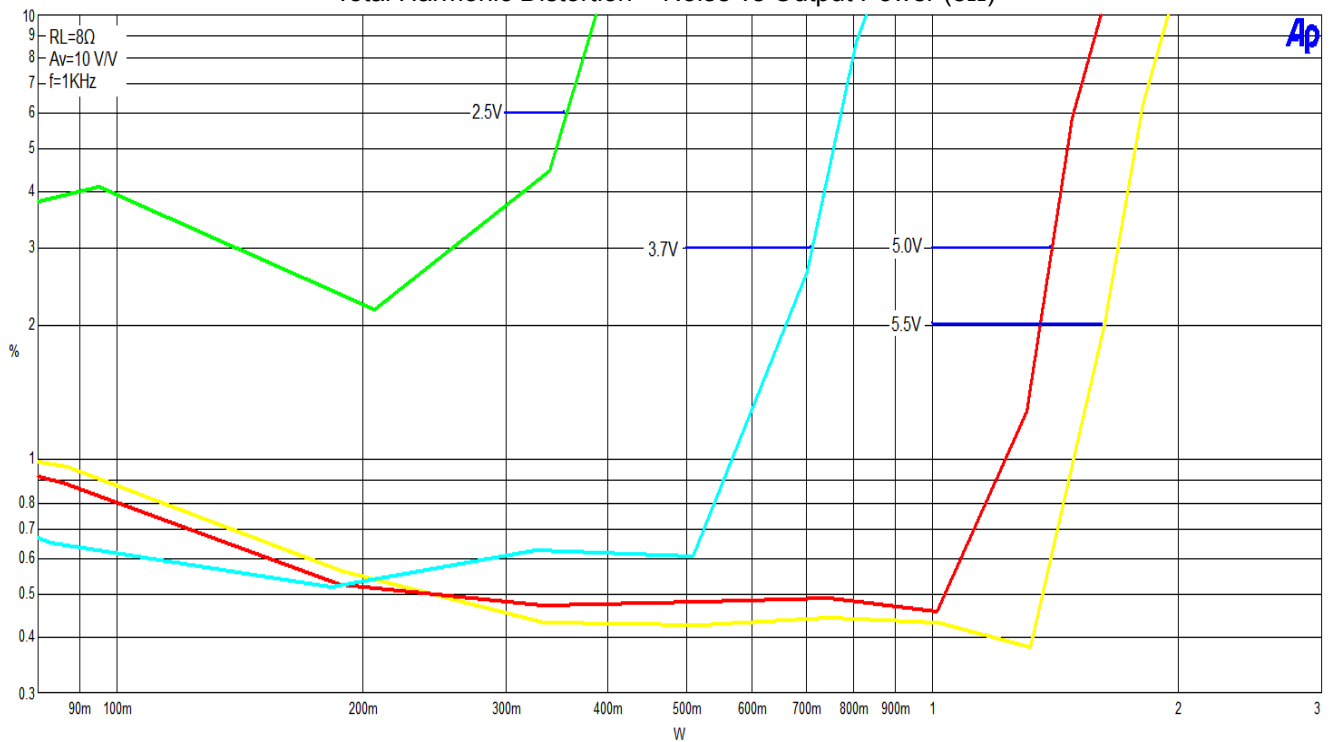




Figure 4
SNR vs. Noise Level

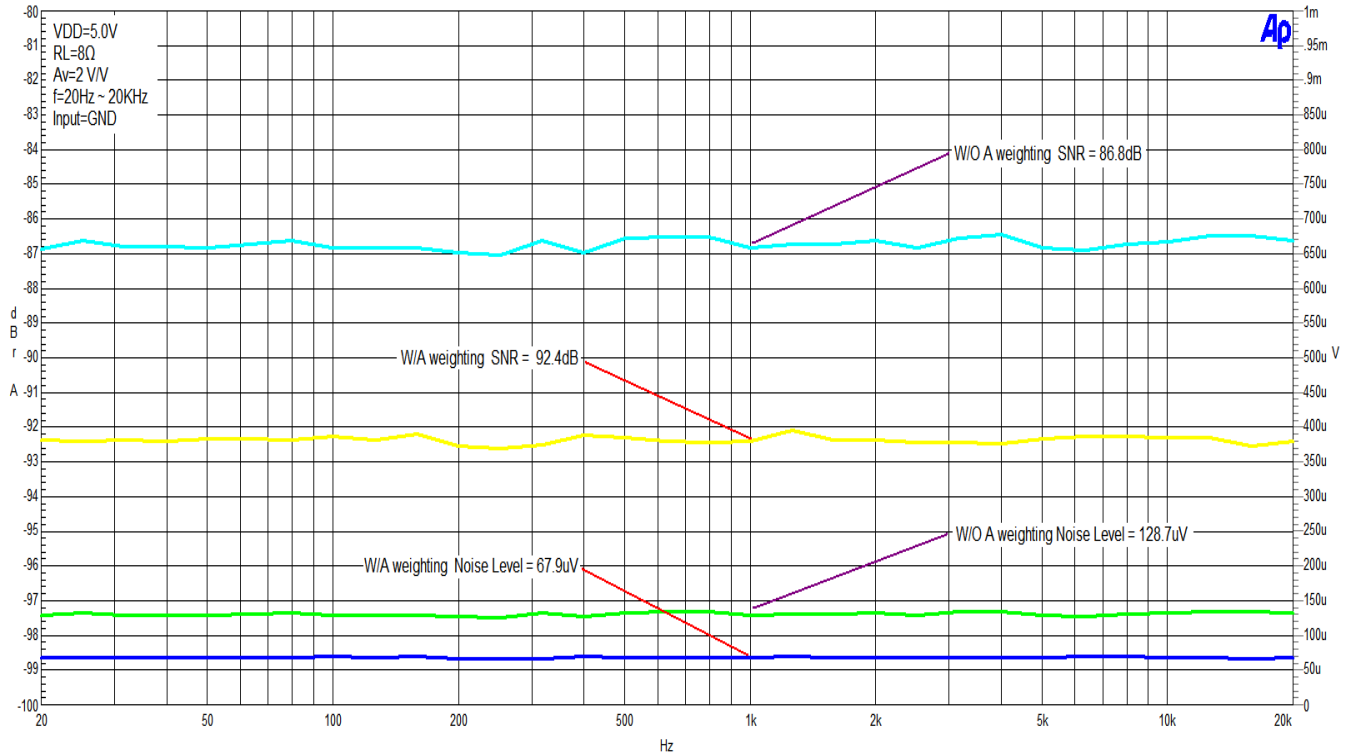
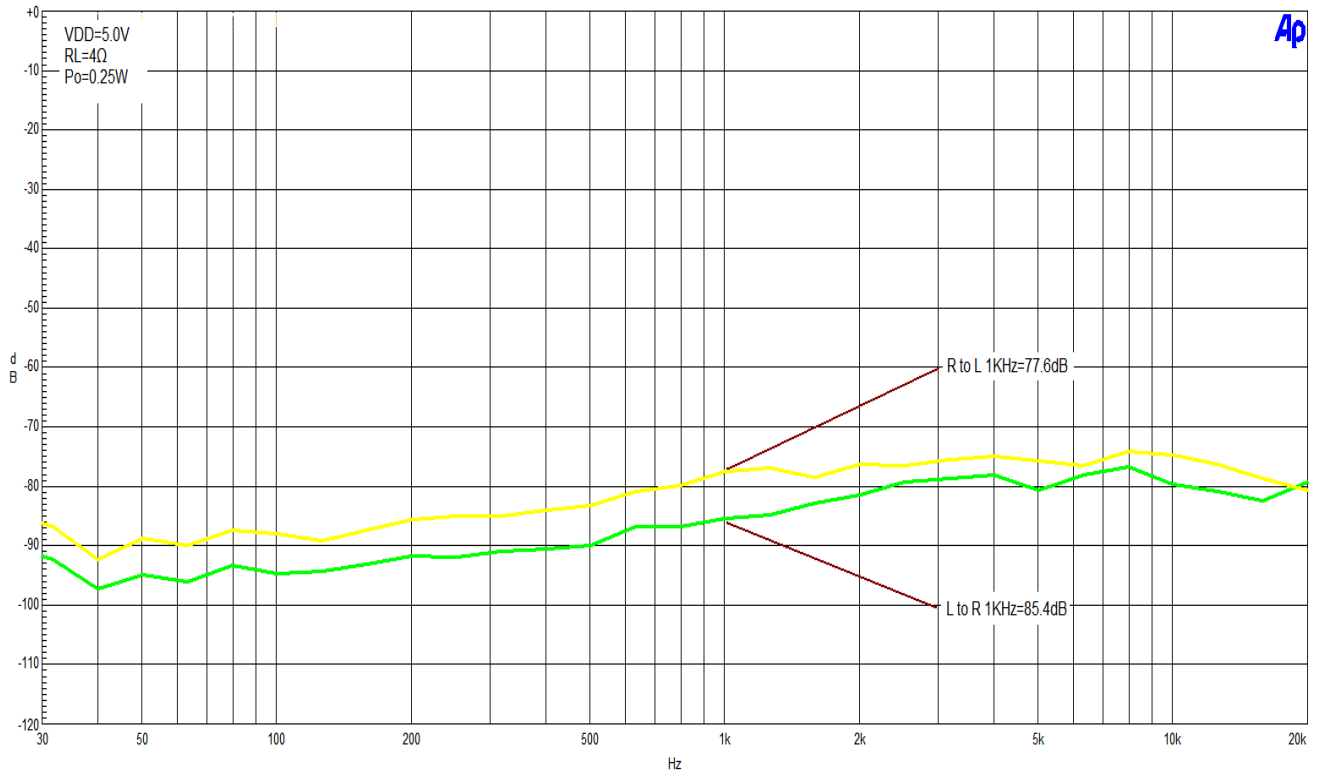
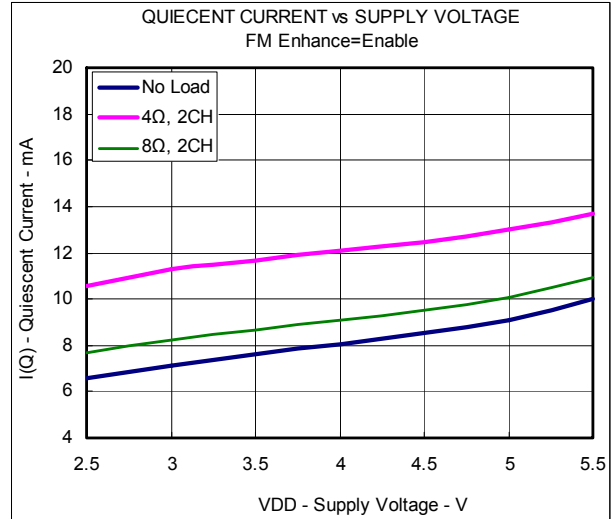
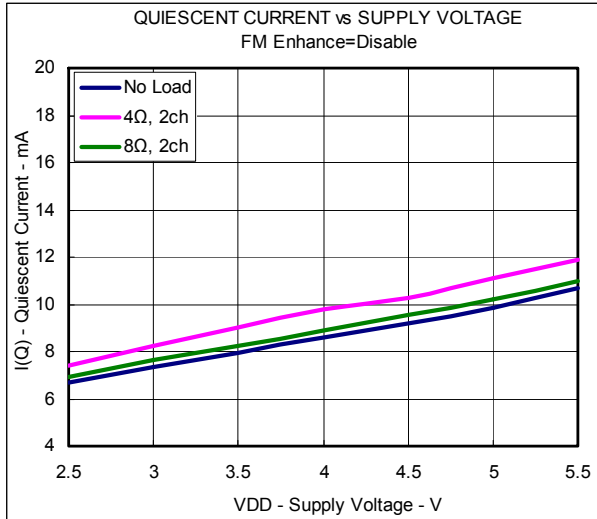


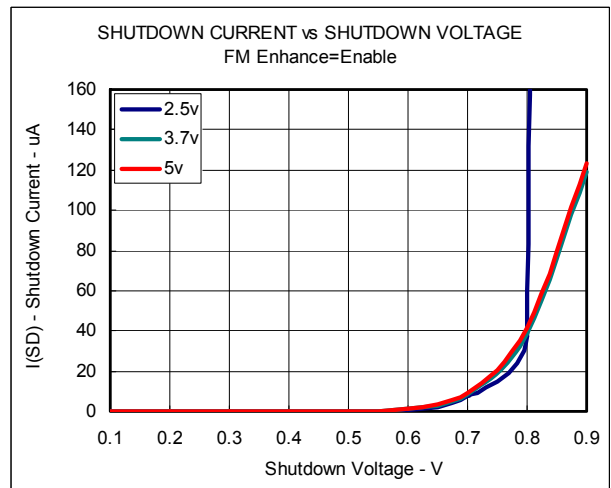
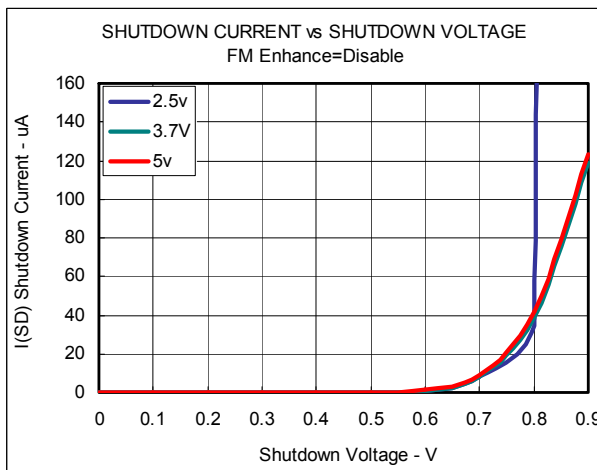
Figure 5
Crosstalk



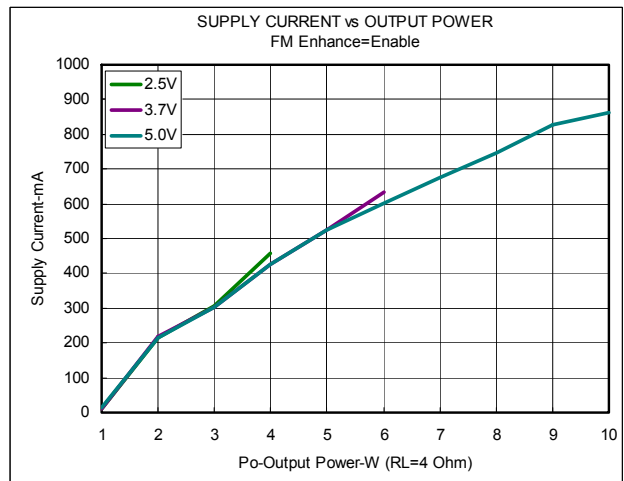
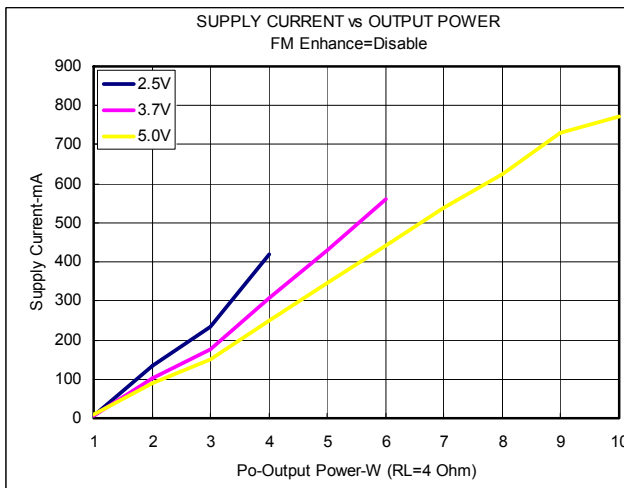
Quiescent Current vs. Supply Voltage



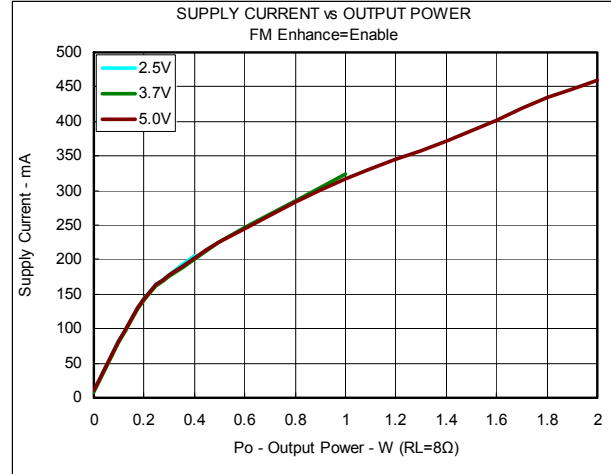
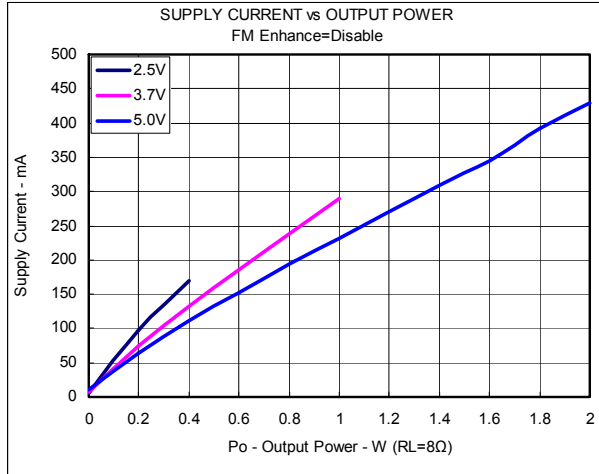
SD Current vs. SD Voltage



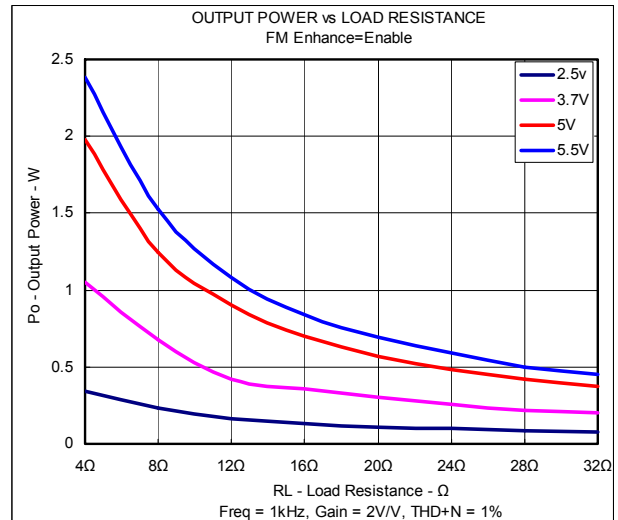
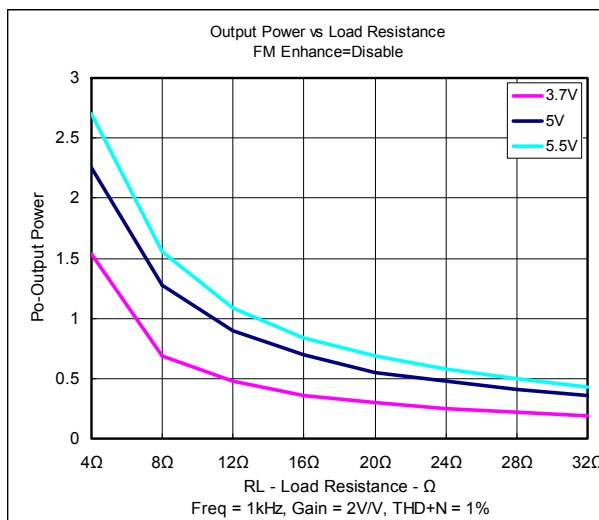
Supply Current vs. Output Power (RL=4Ω)



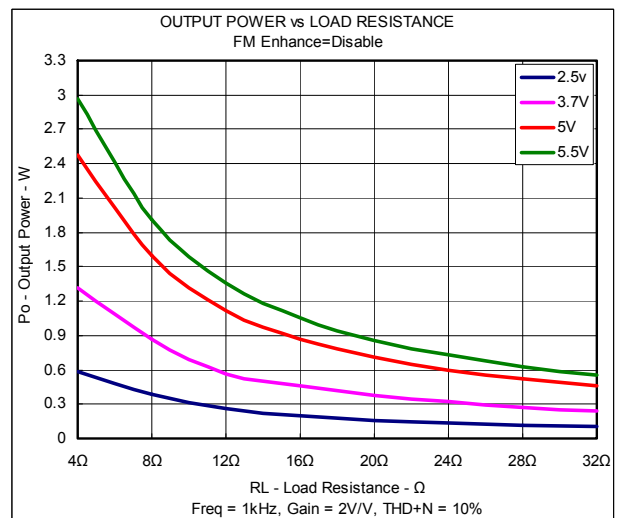
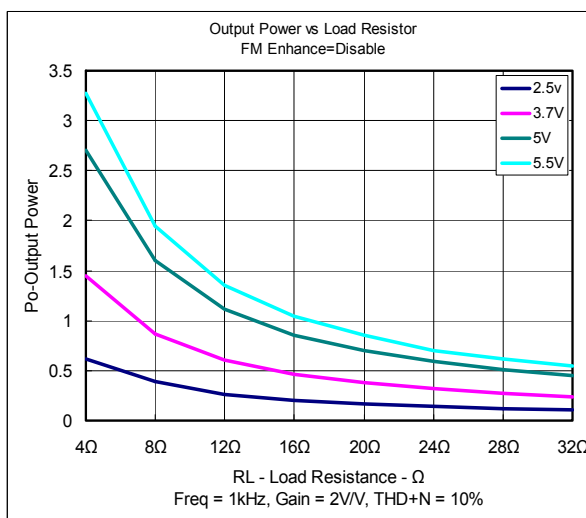
Supply Current vs. Output Power (RL=8Ω)



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

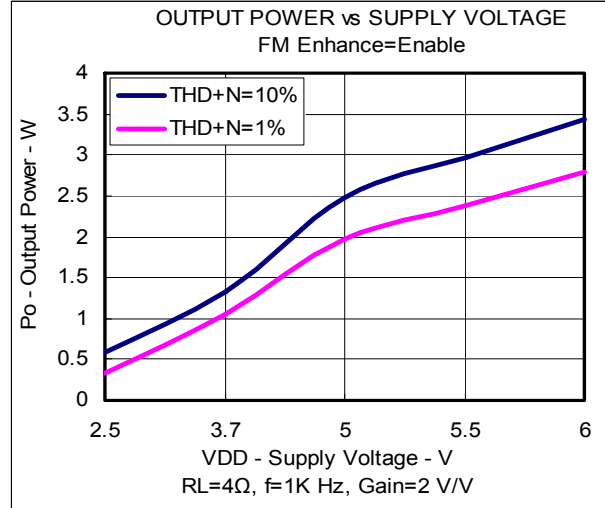
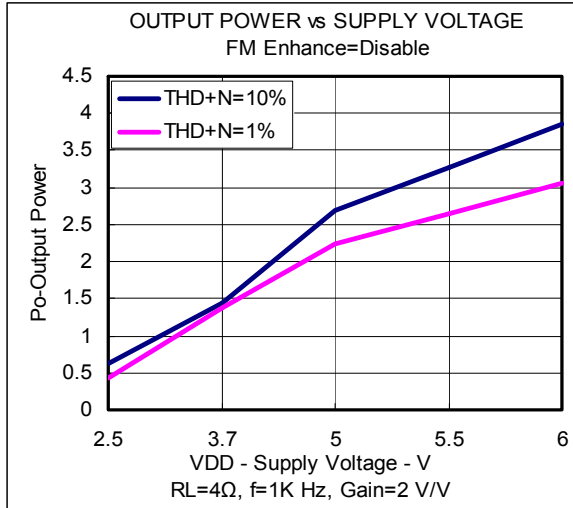


Load Resistance vs. Output Power (THD+N=10%)

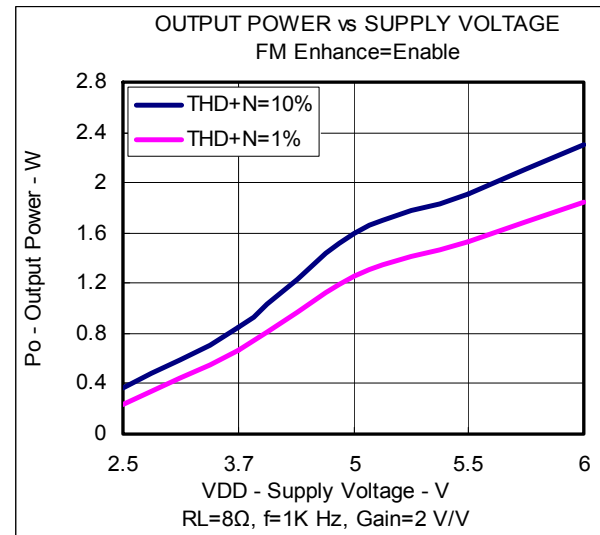
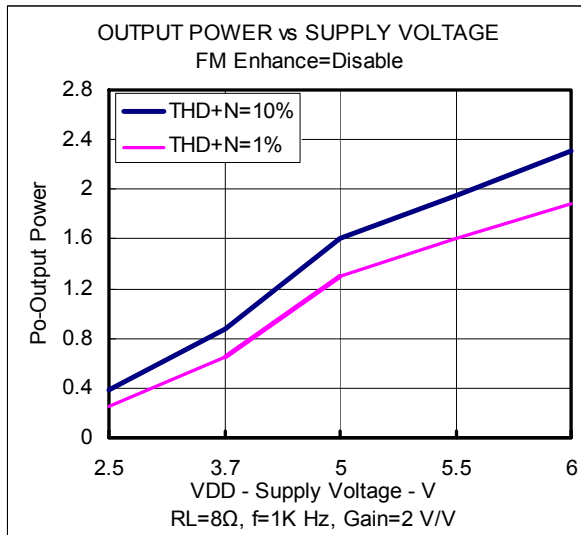




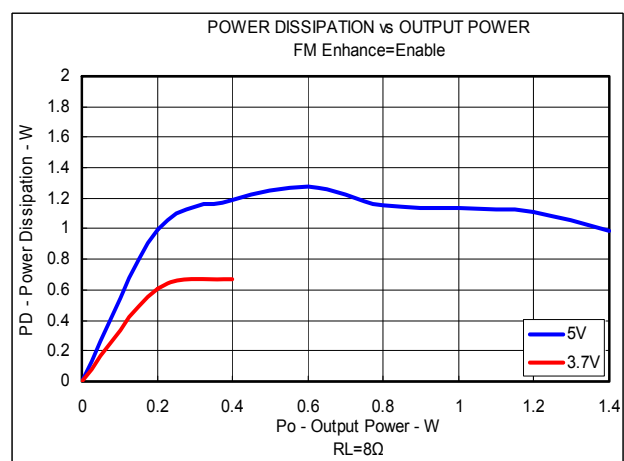
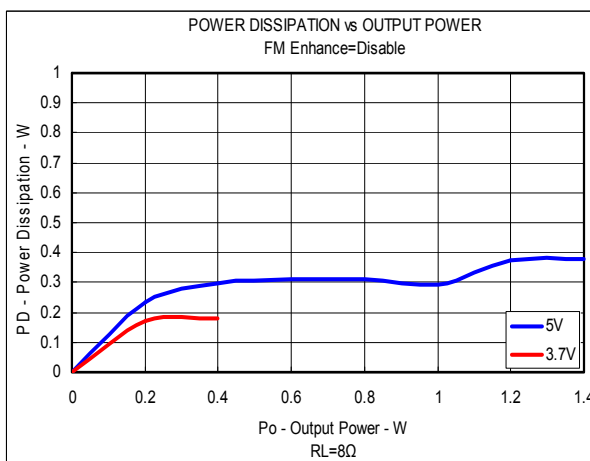
OUTPUT POWER vs. SUPPLY VOLTAGE (RL=4Ω)



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

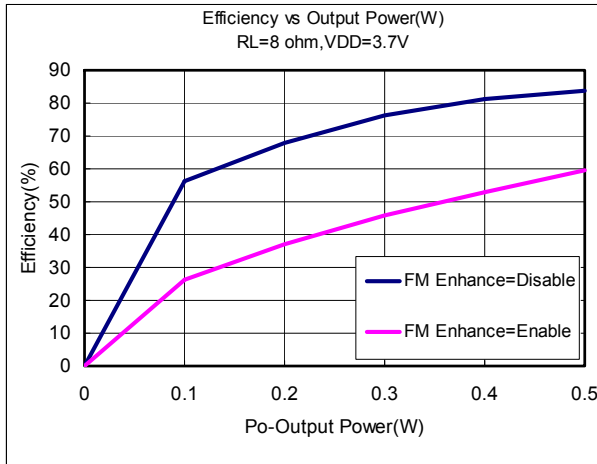


Power Dissipation vs. Output Power (80hm)

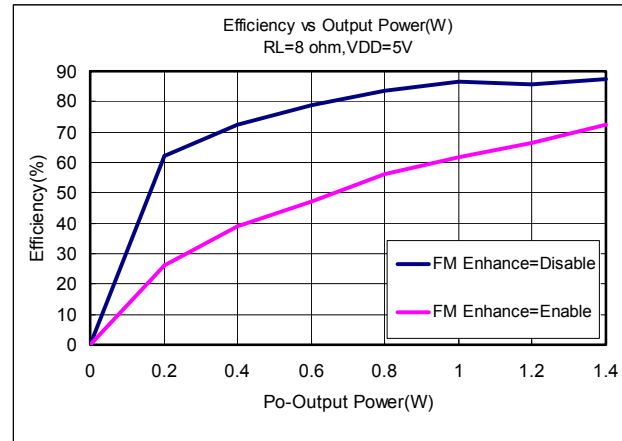




Efficiency vs. Output Power (RL=4Ω, VDD=3.7V)



Efficiency vs. Output Power (RL=40hm, VDD=5V)



APPLICATION INFORMATION

Input Resistors (Ri) and Gain

The LY8261 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 (Ri) set the gain of the amplifier according to the equation.

$$\text{Pre-Amplifier Gain} = (R_f / R_i) \times 2$$

$$\text{Total Gain} = [(R_f / R_i) \times 2] \times 2$$

$$A_{vD} = 20 \times \log [4 \times (R_f / R_i)]$$

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 LY8261 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 LY8261 to operate at its best,

For example

Table 1. Typical Total Gain and AvD 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
AvD (db)	12.04	18.06	21.58	27.60	32.04



Input Capacitors (Ci)

The LY8261 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 $\pm 10\%$ 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%

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

$$C_i = 1 / (2\pi \times 150K\Omega \times 4.8Hz) = 0.221\mu F \cdot \text{Use } 0.22\mu F$$

Decoupling Capacitor

The LY8261 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 220.0uF, placed as close as possible to the device V_{DD} lead works best. Placing 0.1uF decoupling capacitor close to the LY8261 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 220.0uF 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 LY8261 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 $180^\circ C$, the chip will return to normal operation automatically after the temperature cool down to $135^\circ C$.

FM Enhance

The LY8261 has a built-in FM enhance function and the pin should never be left floating. When FM radio signal is poor. Enable (active to high) the FM enhance pin will improve the signal obviously. But enable the pin will reduce LY8261 efficiency. Therefore recommend if FM enhance function is not to use. Disable (active to low) the FM enhance pin is very important.

Mute Function

The mute pin is an input for controlling the output state of the LY8261. A logic high on this pin enables the outputs. A logic low on this pin disables the outputs. This pin may be used as a quick disable/enable of outputs when transitioning between different audio sources.

The mute pin should never be left floating. For power conservation, the Shutdown pin should be used to reduce the quiescent current to the absolute minimum level.

Headphone Sense and headphone logic in functions

Applying a voltage between 4V and VDD to the LY8261's HP-SENCE pin turns off the speaker, muting the a bridged-connected load. Quiescent current consumption is reduced when the device is in this single-ended mode. Figure 6 shows the implementation of the LY8261's headphone control function. With no headphones connected to the headphone jack, the R10 – R6(R5) voltage divider sets the voltage applied to the HP-SENCE pin at approximately 50mV. This 50mV enables the speaker, placing the LY8261 in bridged mode operation.

While the LY8261 operates in bridged mode, the DC potential across the load is essentially 0V. Therefore, even in an ideal situation, the output swing cannot cause a false single-ended trigger. Connecting headphones to the headphone jack disconnects the headphone jack contact pin from -Vout R (-Vout L) and allows R10 to pull the HP-SENCE pin up to VDD.

This enables the headphone function, turns off the speaker, and mutes the bridged speaker. The amplifier then drives the headphones, whose impedance is in parallel with resistors R5 and R6. These resistors have negligible effect on the LY8261's output drive capability since the typical impedance of headphones is 32Ω.

Figure 6 also shows the suggested headphone jack electrical connections. The jack is designed to mate with a four wire (or three wire) plug. The plug's tip and ring should each carry one of the two stereo output signals, whereas the sleeve should carry the ground return. The headphone jack with one control pin contact is sufficient to drive the HP-SENCE pin when connecting headphones.

As outlined above driving the Speaker (BTL) and Headphone (SE) loads simultaneously using LY8261 is simple and easy. However this configuration will only work if the HP Logic pin is used to control the BTL/SE operation and HP sense pin is connected to GND(Figure 7).

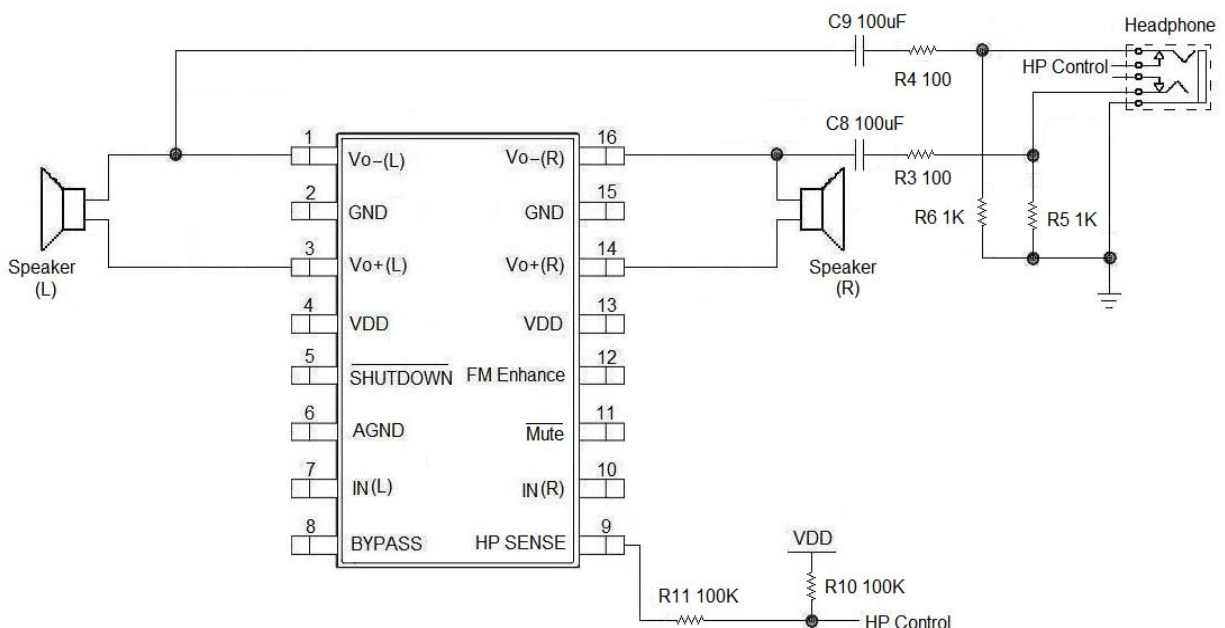


Figure 6. With Headphone Circuit

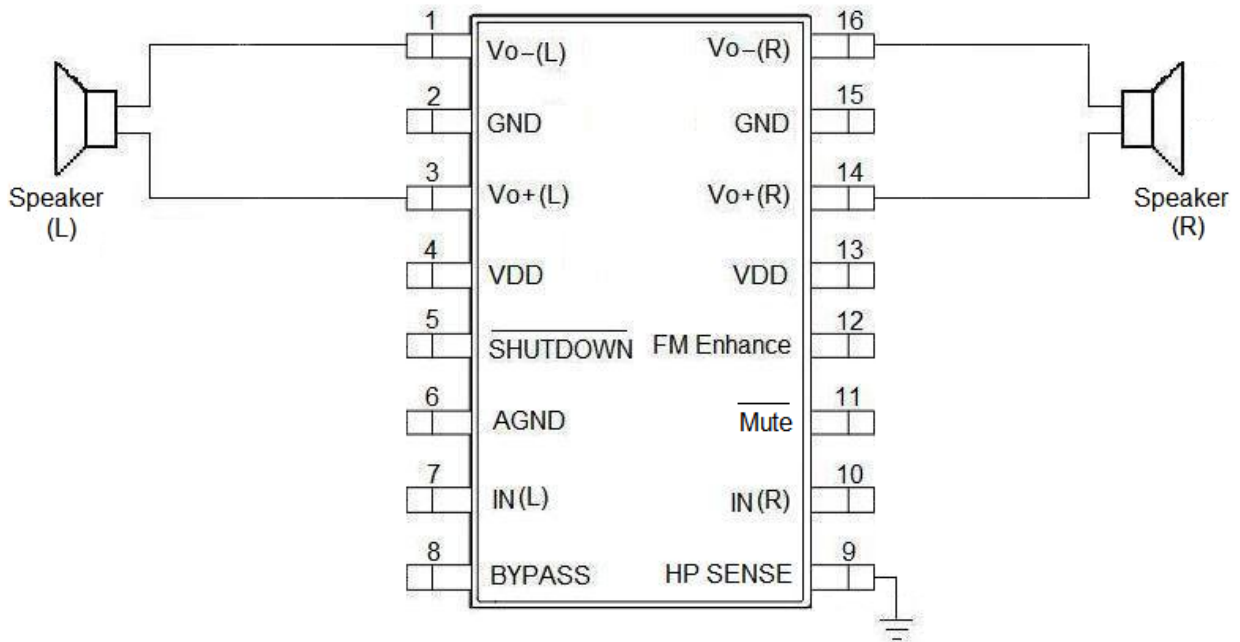


Figure 7. Without Headphone Circuit

■ PCB LAYOUT

All the external components must place very close to the LY8261. The input resistors need to be very close to the LY8261 input pins so noise does not couple on the high impedance nodes between the input resistors and the input amplifier of the LY8261. Then place the decoupling capacitor C_s , close to the LY8261 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 LY8261 should be as wide as possible to minimize trace resistance. If these traces are too thin, the LY8261'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.

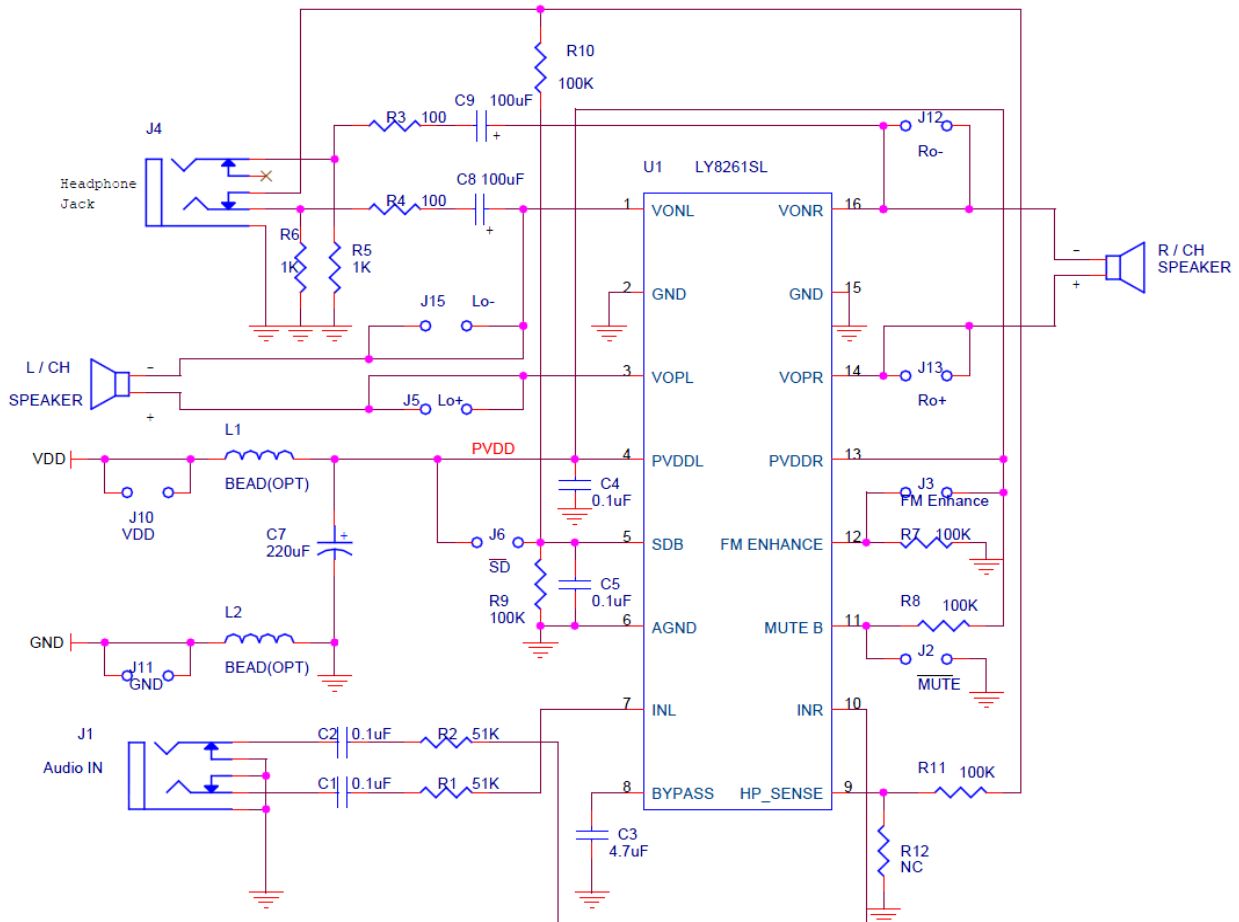
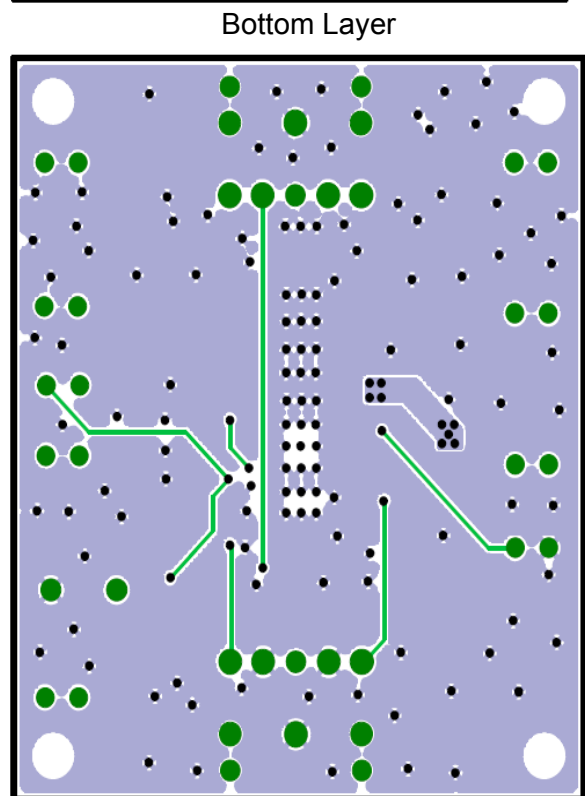
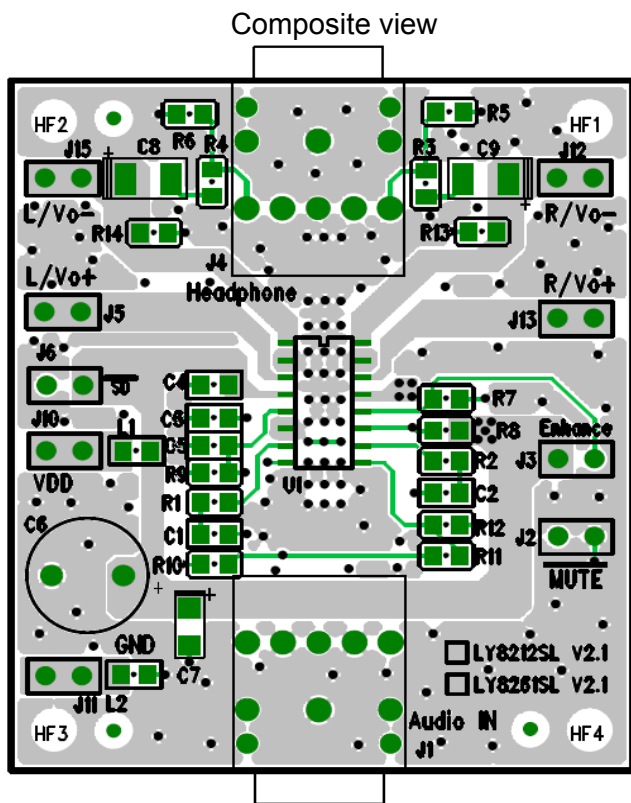
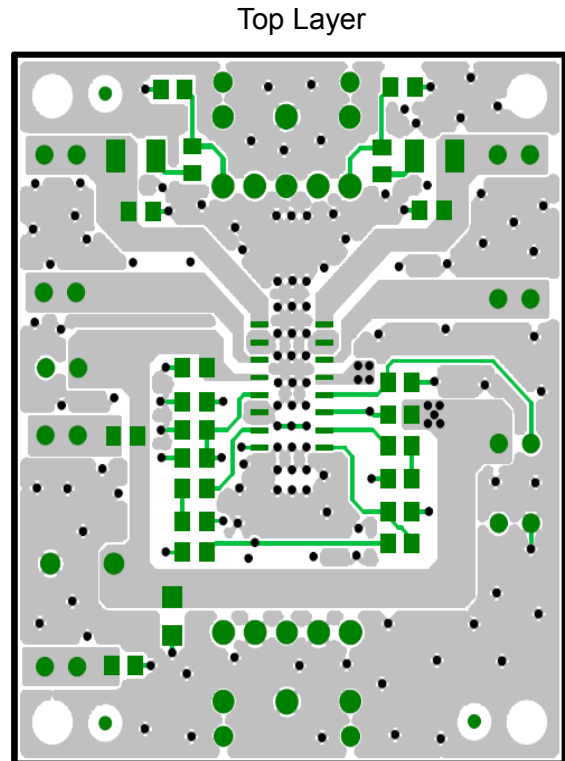
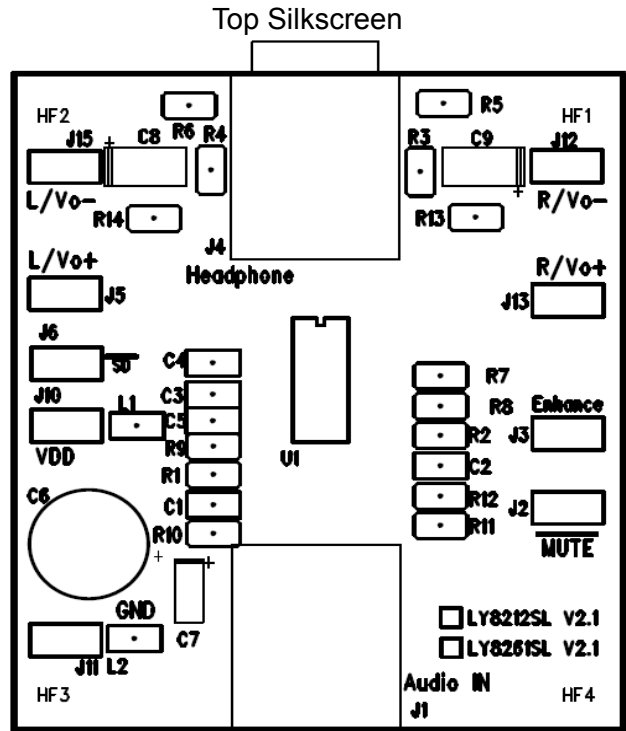
DEMO BOARD INFORMATION
Demo Board Application Circuit


Figure 8. Demo Board Application Circuit

Demo Board BOM List
LY8261 V2.1 BOM List

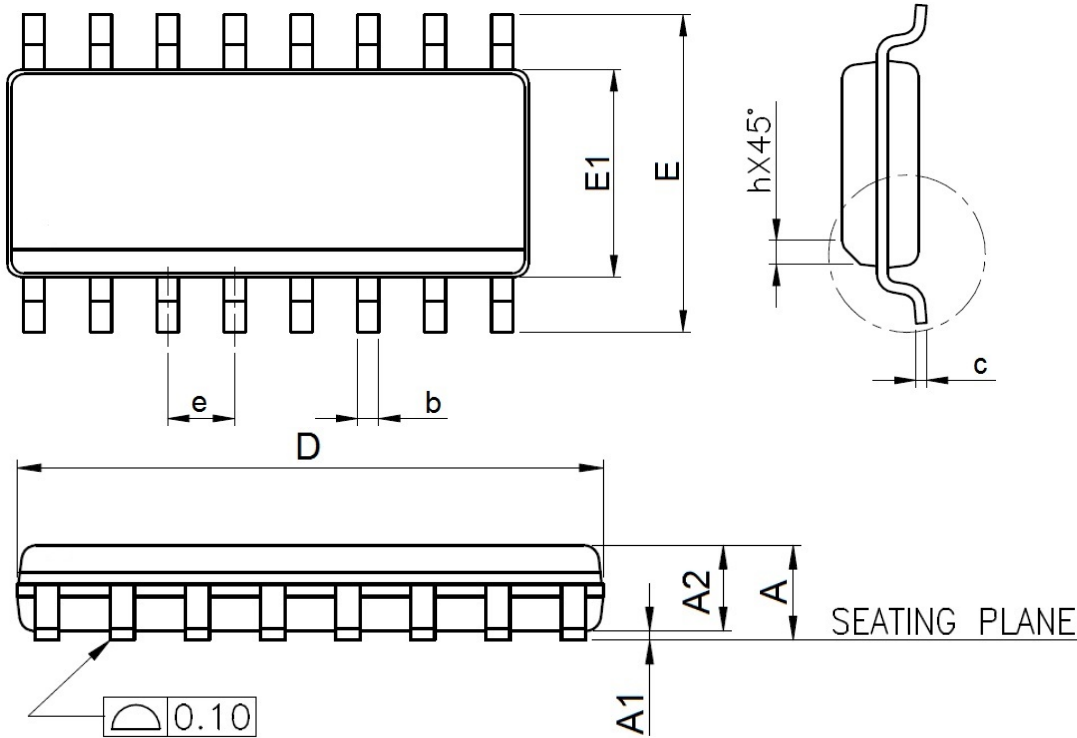
No.	Description	Reference	Note
1	Resistor, 100KΩ	R7,R8,R9,R10,R11	1/16W,1%
2	Resistor, 51KΩ	R1,R2	1/16W,1%
3	Resistor, 1KΩ	R5,R6	1/16W,1%
4	Resistor, 100Ω	R3,R4	1/16W,1%
5	Capacitor, 0.1uF	C1,C2,C4,C5	80%/-20%, nonpolarized
6	Capacitor, 4.7uF	C3	80%/-20%, nonpolarized
7	Capacitor, 220.0uF	C7	25V,105°C,8x11
8	IC	U1	LY8261SL, SOP16
9	1*2 Pin Header	J2,J3,J6	Pitch 2.54 mm

Demo Board Artwork



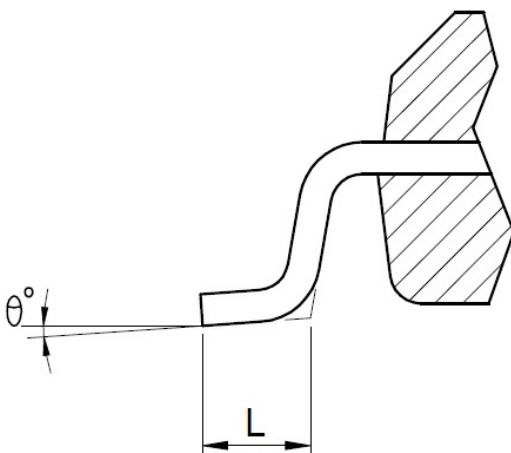
PACKAGE OUTLINE DIMENSION

SOP 16 Pin Package Outline Dimension



Symbol	MIN.	MAX.
A	-	1.75
A1	0.1	0.25
A2	1.24	-
D	9.90 BSC	
E1	3.90 BSC	
E	6.00 BSC	
L	0.4	1.27
b	0.31	0.51
e	1.27 BSC	
c	0.1	0.25
h	0.25	0.5
θ°	0	8

Unit:mm



NOTES:

1. JEDEC OUTLINE : MS-012 AC REV.F (STANDARD)
MS-012 BC REV.F (THERMAL)
2. DIMENSIONS "D" DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS AND GATE BURRS SHALL NOT EXCEED 0.15mm. PER SIDE.
3. DIMENSIONS "E1" DOES NOT INCLUDE INTER-LEAD FLASH, OR PROTRUSIONS. INTER-LEAD FLASH AND PROTRUSIONS SHALL NOT EXCEED 0.25mm PER SIDE.