

# LM4871

*LM4871 3W Audio Power Amplifier with Shutdown Mode*



Literature Number: SNAS002E

## LM4871 Boomer® Audio Power Amplifier Series

# 3W Audio Power Amplifier with Shutdown Mode

### General Description

The LM4871 is a mono bridged audio power amplifier capable of delivering 3W of continuous average power into a 3Ω load with less than 10% THD when powered by a 5V power supply (Note 1). To conserve power in portable applications, the LM4871's micropower shutdown mode ( $I_Q = 0.6\mu\text{A}$ , typ) is activated when  $V_{DD}$  is applied to the SHUTDOWN pin.

Boomer audio power amplifiers are designed specifically to provide high power, high fidelity audio output. They require few external components and operate on low supply voltages from 2.0V to 5.5V. Since the LM4871 does not require output coupling capacitors, bootstrap capacitors, or snubber networks, it is ideally suited for low-power portable systems that require minimum volume and weight.

Additional LM4871 features include thermal shutdown protection, unity-gain stability, and external gain set.

**Note 1:** An LM4871LD that has been properly mounted to a circuit board will deliver 3W into 3Ω (at 10% THD). The other package options for the LM4871 will deliver 1.5W into 8Ω (at 10% THD). See the **Application Information** sections for further information concerning the LM4871LD, LM4871MM, LM4871M, and the LM4871N.

### Key Specifications

- PO at 10% THD+N, 1kHz
- LM4871LD: 3Ω, 4Ω loads                      3W (typ), 2.5W (typ)
- All other LM4871 packages: 8Ω load            1.5W (typ)
- Shutdown current                                      0.6μA (typ)
- Supply voltage range                                2.0V to 5.5V
- THD at 1kHz at 1W continuous average output power into 8Ω    0.5% (max)

### Features

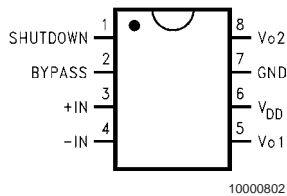
- No output coupling capacitors, bootstrap capacitors, or snubber circuits required
- Unity-gain stable
- LLP, MSOP, SO, or DIP packaging
- External gain configuration capability
- Pin compatible with the LM4861

### Applications

- Portable computers
- Desktop computers
- Low voltage audio systems

### Connection Diagrams

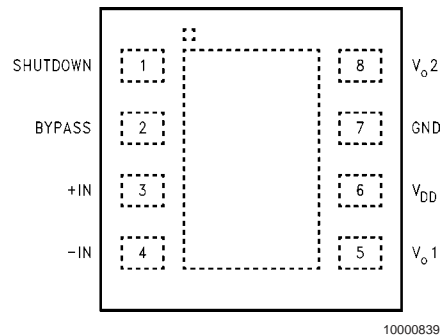
MSOP, Small Outline, and DIP Package



Top View

Order Number LM4871MM, LM4871M, or LM4871N  
See NS Package Number MUA08A, M08A, or N08E

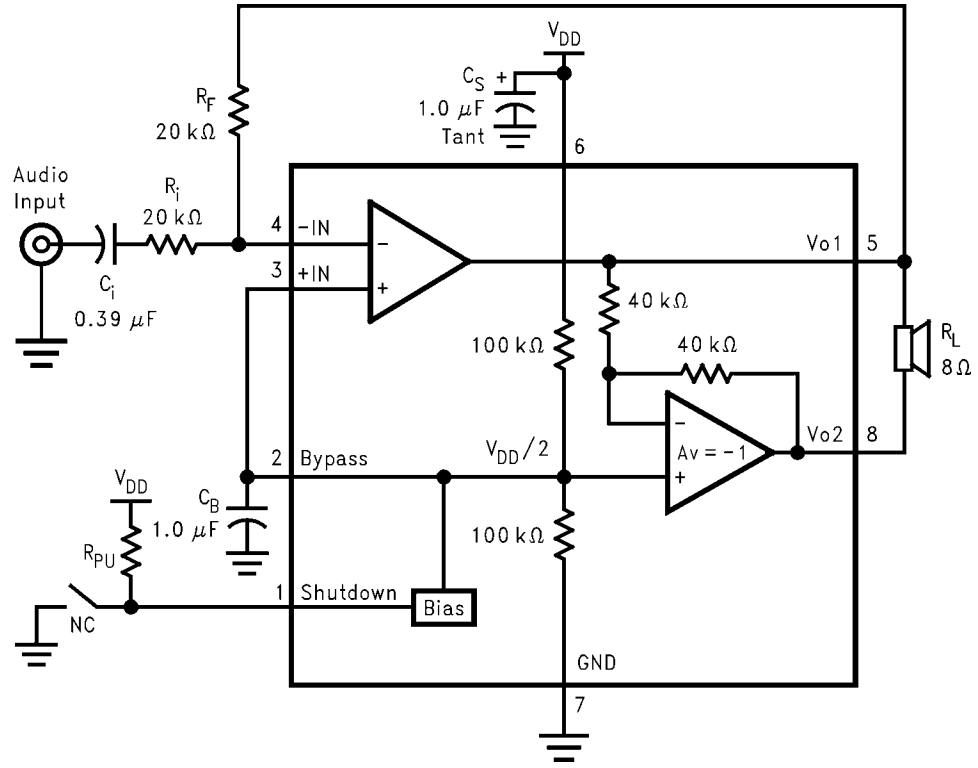
LLP Package



Top View

Order Number LM4871LD  
See NS Package Number LDC08A

# Typical Application



10000801

FIGURE 1. Typical Audio Amplifier Application Circuit

## Absolute Maximum Ratings (Note 2)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage	6.0V
Supply Temperature	-65°C to +150°C
Input Voltage	-0.3V to $V_{DD}$ to +0.3V
Power Dissipation (Note 4)	Internally Limited
ESD Susceptibility (Note 5)	5000V
ESD Susceptibility (Note 6)	250V
Junction Temperature	150°C
Soldering Information	
Small Outline Package	
Vapor Phase (60 sec.)	215°C
Infrared (15 sec.)	220°C

$\theta_{JC}$ (typ)—M08A	35°C/W
$\theta_{JA}$ (typ)—M08A	140°C/W
$\theta_{JC}$ (typ)—N08E	37°C/W
$\theta_{JA}$ (typ)—N08E	107°C/W
$\theta_{JC}$ (typ)—MUA08A	56°C/W
$\theta_{JA}$ (typ)—MUA08A	210°C/W
$\theta_{JC}$ (typ)—LDC08A	4.3°C/W
$\theta_{JA}$ (typ)—LDC08A	56°C/W (Note 9)

## Operating Ratings

Temperature Range	$T_{MIN} \leq T_A \leq T_{MAX}$	-40°C $\leq$ $T_A$ $\leq$ 85°C
Supply Voltage		2.0V $\leq$ $V_{DD}$ $\leq$ 5.5V

## Electrical Characteristics (Notes 2, 3)

The following specifications apply for  $V_{DD} = 5V$  and  $R_L = 8\Omega$  unless otherwise specified. Limits apply for  $T_A = 25^\circ\text{C}$ .

Symbol	Parameter	Conditions	LM4871			Units (Limits)
			Min (Note 7)	Typical (Note 8)	Limit (Note 7)	
$V_{DD}$	Supply Voltage		2.0		5.5	V
$I_{DD}$	Quiescent Power Supply Current	$V_{IN} = 0V, I_O = 0A$		6.5	10.0	mA
$I_{SD}$	Shutdown Current	$V_{PIN1} = V_{DD}$		0.6	2	$\mu\text{A}$
$V_{OS}$	Output Offset Voltage	$V_{IN} = 0V$		5.0	50	mV
$P_O$	Output Power	THD = 1%, $f = 1\text{kHz}$ LM4871LD, $R_L = 3\Omega$ (Note 10) LM4871LD, $R_L = 4\Omega$ (Note 10) LM4871, $R_L = 8\Omega$ (Note 10)		2.38 2 1.2		W
		THD+N = 10%, $f = 1\text{kHz}$ LM4871LD, $R_L = 3\Omega$ (Note 10) LM4871LD, $R_L = 4\Omega$ (Note 10) LM4871, $R_L = 8\Omega$ (Note 10)		3 2.5 1.5		W
THD+N	Total Harmonic Distortion+Noise	20Hz $\leq$ $f \leq$ 20kHz, $A_{VD} = 2$ LM4871LD, $R_L = 4\Omega, P_O = 1.6W$ LM4871, $R_L = 8\Omega, P_O = 1W$		0.13 0.25		%
PSRR	Power Supply Rejection Ratio	$V_{DD} = 4.9V$ to $5.1V$		60		dB

**Note 2:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits. Electrical Characteristics state DC and AC electrical specifications under particular test conditions which guarantee specific performance limits. This assumes that the device is within the Operating Ratings. Specifications are not guaranteed for parameters where no limit is given, however, the typical value is a good indication of device performance.

**Note 3:** All voltages are measured with respect to the ground pin, unless otherwise specified.

**Note 4:** The maximum power dissipation must be derated at elevated temperatures and is dictated by  $T_{JMAX}$ ,  $\theta_{JA}$ , and the ambient temperature  $T_A$ . The maximum allowable power dissipation is  $P_{DMAX} = (T_{JMAX} - T_A) / \theta_{JA}$  or the number given in Absolute Maximum Ratings, whichever is lower. For the LM4871,  $T_{JMAX} = 150^\circ\text{C}$ . For the  $\theta_{JA}$ 's for different packages, please see the Application Information section or the Absolute Maximum Ratings section.

**Note 5:** Human body model, 100pF discharged through a 1.5k $\Omega$  resistor.

**Note 6:** Machine Model, 220pF–240pF discharged through all pins.

**Note 7:** Typicals are specified at 25°C and represent the parametric norm.

**Note 8:** Limits are guaranteed to National's AOQL (Average Outgoing Quality Level).

**Note 9:** The given  $\theta_{JA}$  is for an LM4871 packaged in an LDC08A with the Exposed-DAP soldered to an exposed 1in<sup>2</sup> area of 1oz printed circuit board copper.

**Note 10:** When driving 3 $\Omega$  or 4 $\Omega$  loads from a 5V supply, the LM4871LD must be mounted to a circuit board.

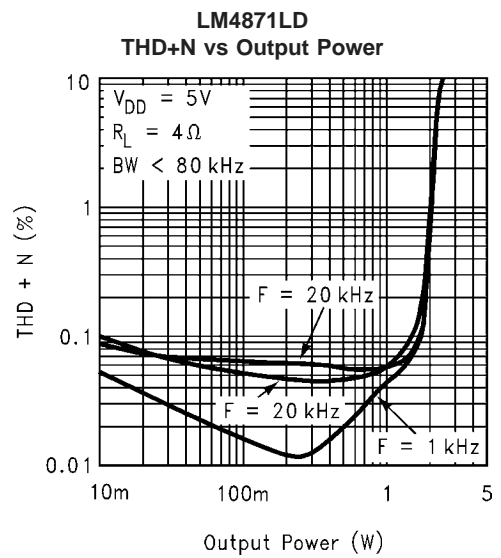
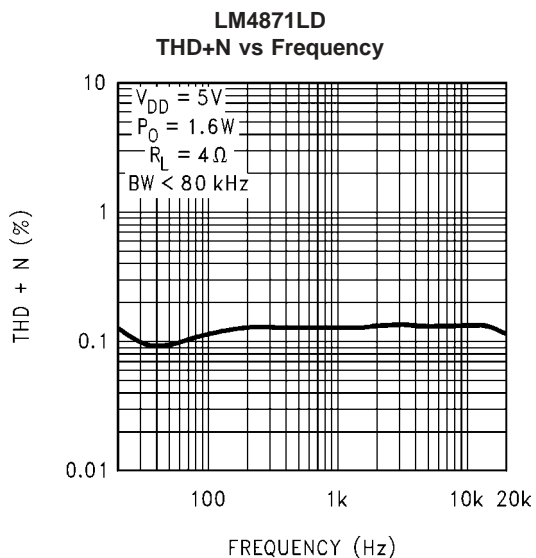
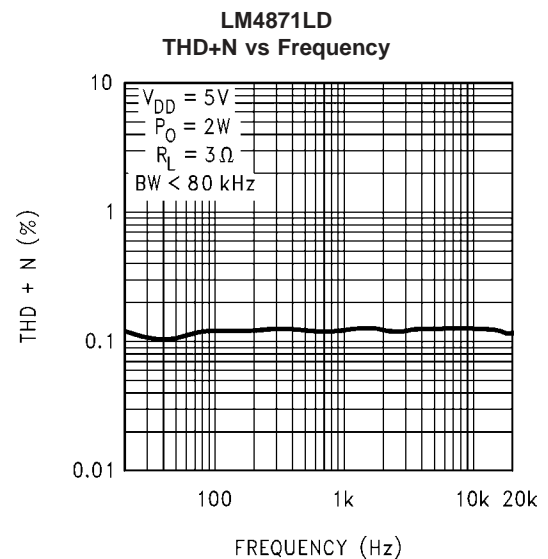
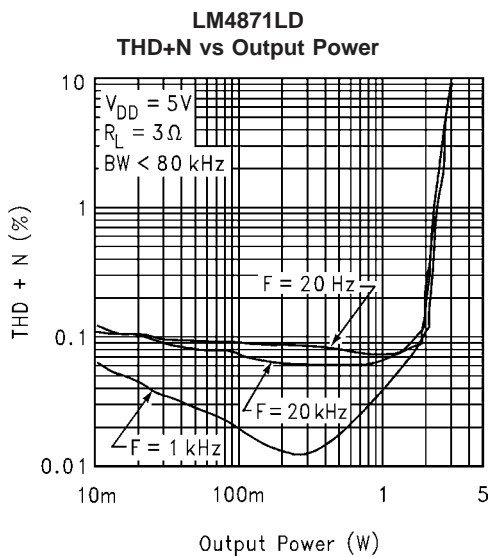
## External Components Description

(Figure 1)

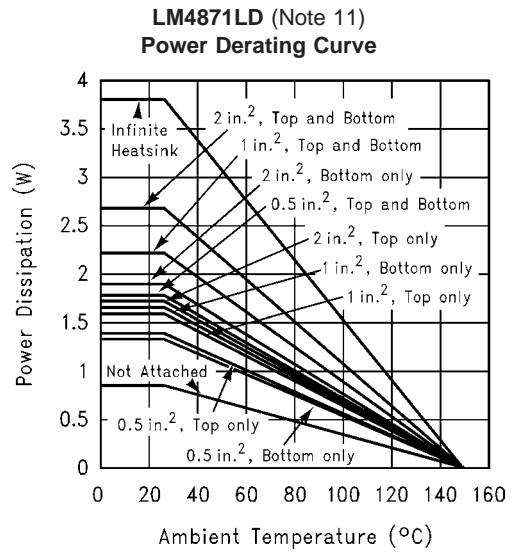
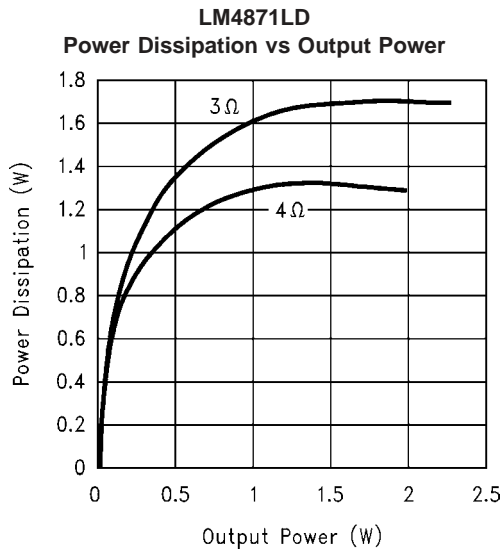
Components		Functional Description
1.	$R_i$	Inverting input resistance that sets the closed-loop gain in conjunction with $R_f$ . This resistor also forms a high pass filter with $C_i$ at $f_c = 1/(2\pi R_i C_i)$ .
2.	$C_i$	Input coupling capacitor that blocks the DC voltage at the amplifiers input terminals. Also creates a highpass filter with $R_i$ at $f_c = 1/(2\pi R_i C_i)$ . Refer to the section, <b>Proper Selection of External Components</b> , for an explanation of how to determine the value of $C_i$ .
3.	$R_f$	Feedback resistance that sets the closed-loop gain in conjunction with $R_i$ .
4.	$C_S$	Supply bypass capacitor that provides power supply filtering. Refer to the <b>Power Supply Bypassing</b> section for information concerning proper placement and selection of the supply bypass capacitor.
5.	$C_B$	Bypass pin capacitor that provides half-supply filtering. Refer to the section, <b>Proper Selection of External Components</b> , for information concerning proper placement and selection of $C_B$ .

## Typical Performance Characteristics

### LD Specific Characteristics

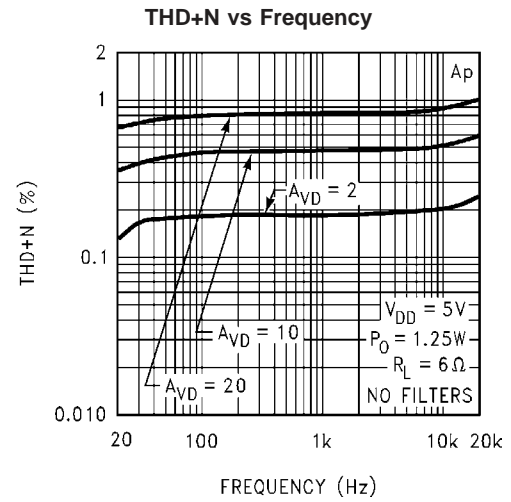
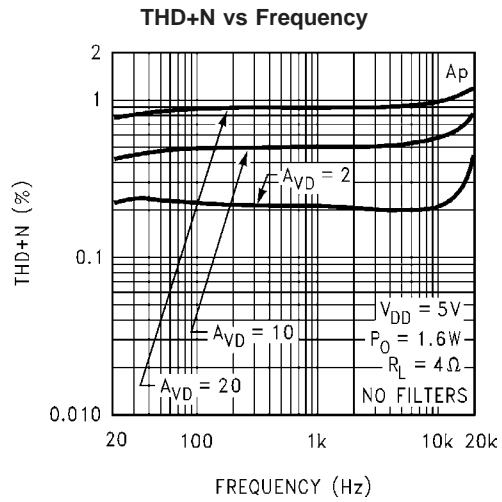


# Typical Performance Characteristics LD Specific Characteristics (Continued)



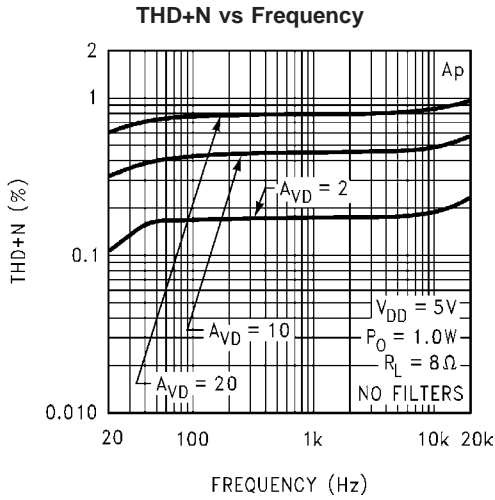
**Note 11:** This curve shows the LM4871LD's thermal dissipation ability at different ambient temperatures given the exposed-DAP of the part is soldered to a plane of 1oz. Cu with an area given in the label of each curve. This label also designates whether the plane exists on the same (top) layer as the chip, on the bottom layer, or on both layers. Infinite heatsink and unattached (no heatsink) conditions are also shown.

# Typical Performance Characteristics Non-LD Specific Characteristics

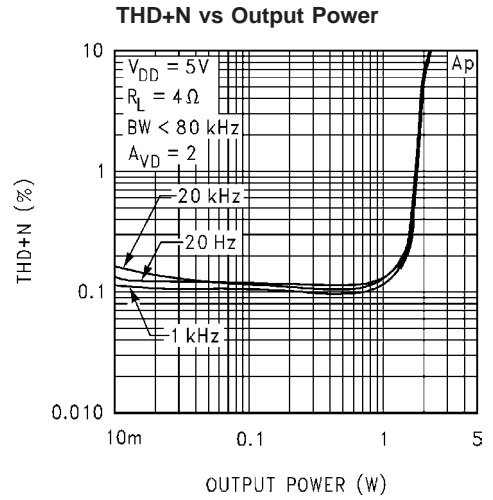


# Typical Performance Characteristics

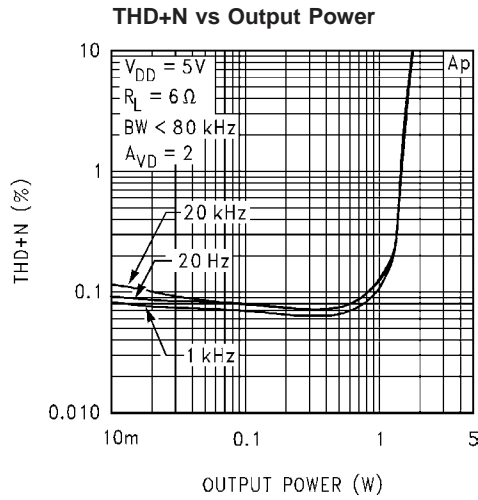
## Non-LD Specific Characteristics (Continued)



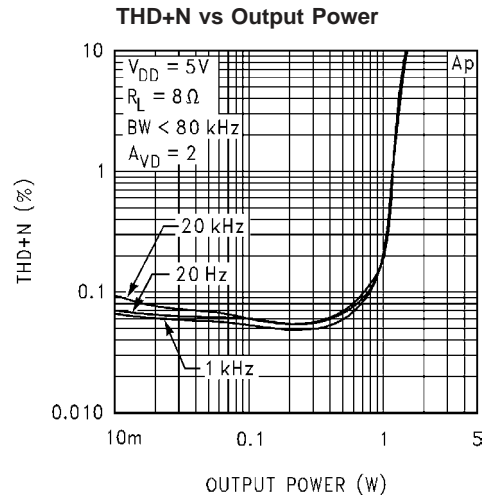
10000805



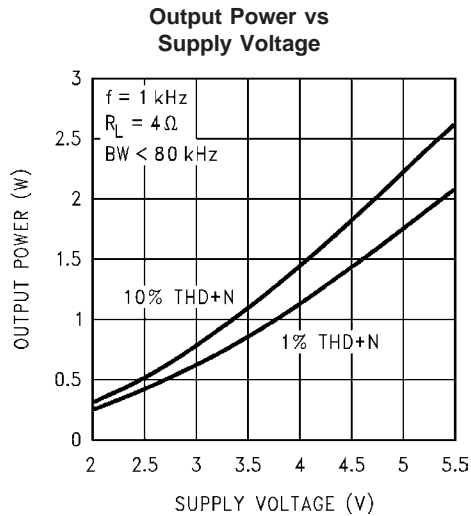
10000806



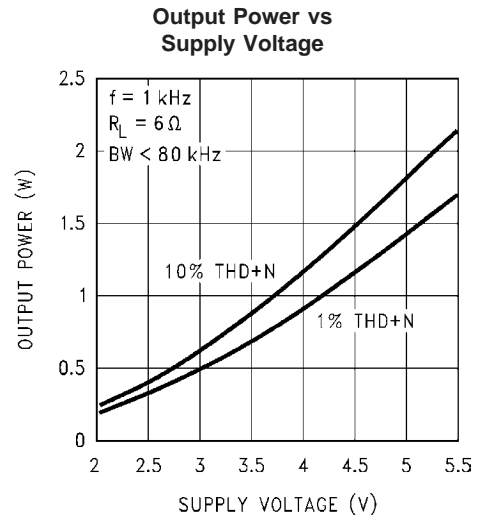
10000807



10000808



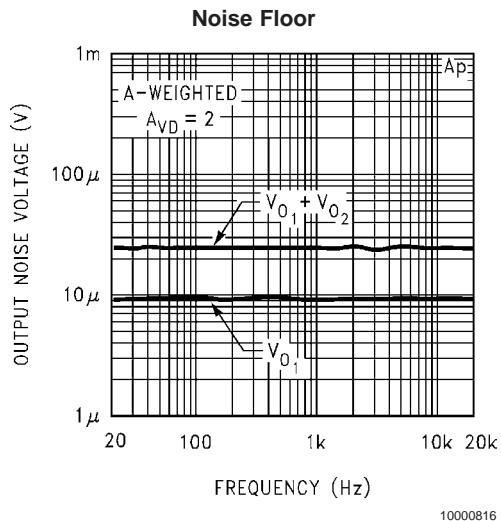
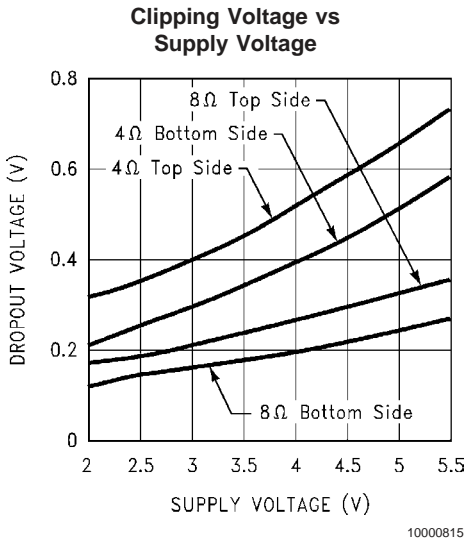
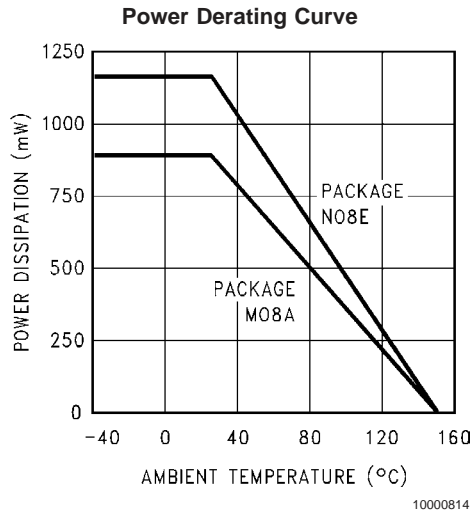
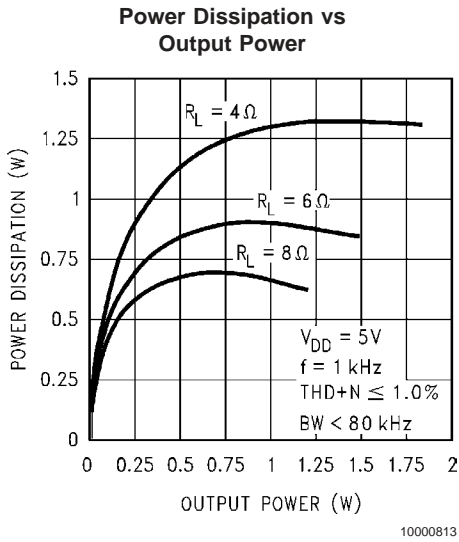
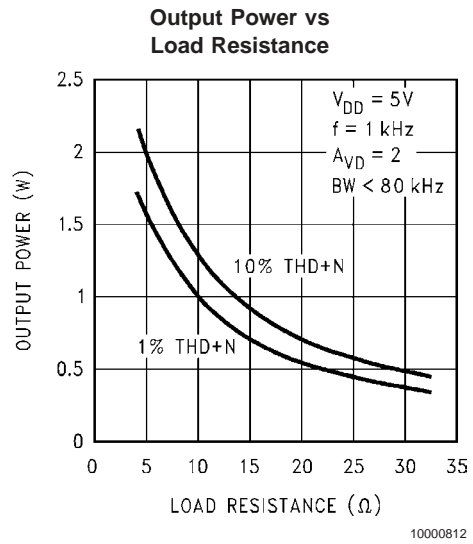
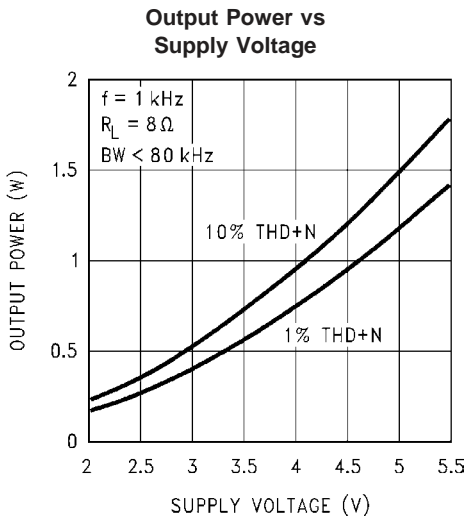
10000809



10000810

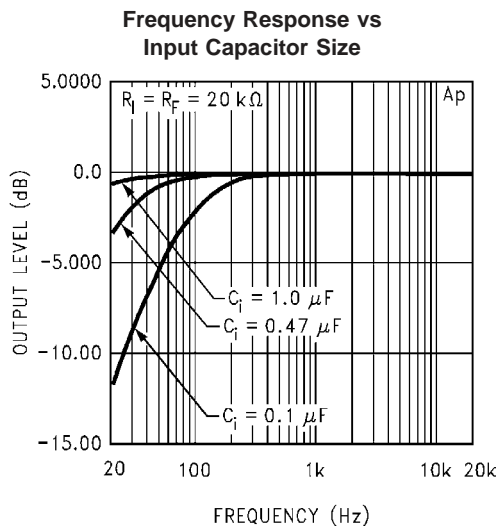
# Typical Performance Characteristics

## Non-LD Specific Characteristics (Continued)

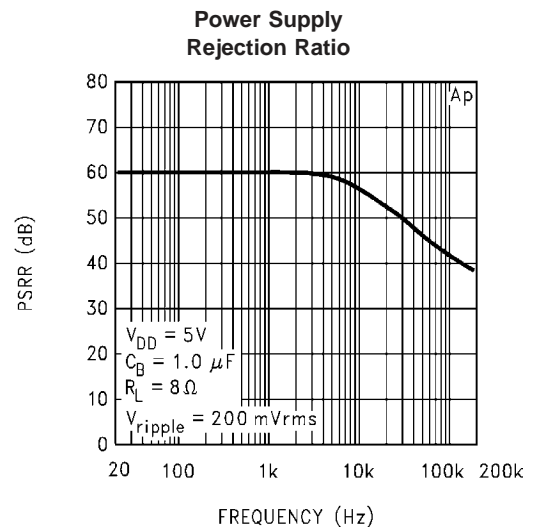




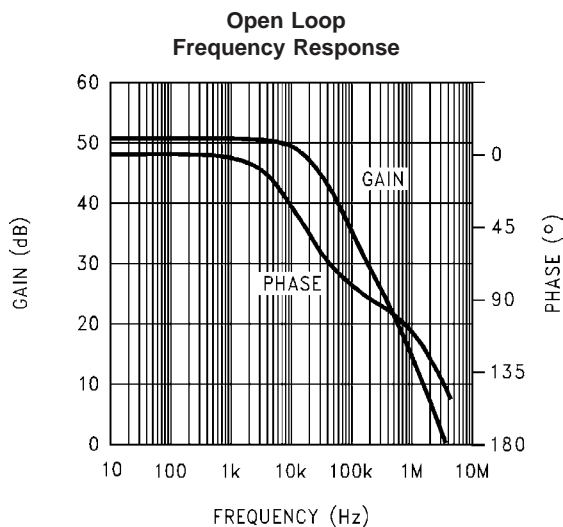
## Typical Performance Characteristics Non-LD Specific Characteristics (Continued)



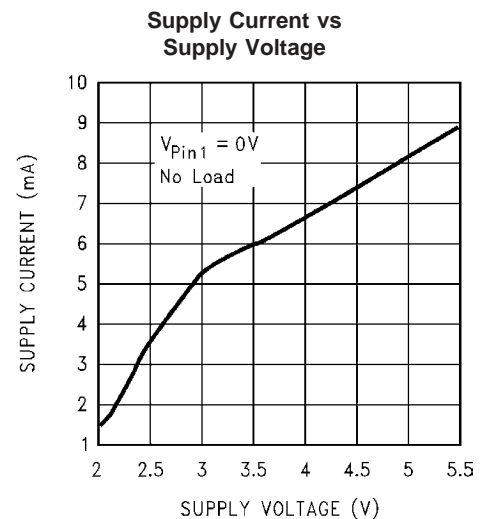
10000817



10000818



10000819



10000820

## Application Information

### EXPOSED-DAP PACKAGE PCB MOUNTING CONSIDERATION

The LM4871's exposed-DAP (die attach paddle) package (LD) provides a low thermal resistance between the die and the PCB to which the part is mounted and soldered. This allows rapid heat transfer from the die to the surrounding PCB copper traces, ground plane, and surrounding air. The result is a low voltage audio power amplifier that produces 2W at  $\leq 1\%$  THD with a 4 $\Omega$  load. This high power is achieved through careful consideration of necessary thermal design. Failing to optimize thermal design may compromise the LM4871's high power performance and activate unwanted, though necessary, thermal shutdown protection.

The LD package must have its DAP soldered to a copper pad on the PCB. The DAP's PCB copper pad is connected to a large plane of continuous unbroken copper. This plane forms a thermal mass, heat sink, and radiation area. Place the heat sink area on either outside plane in the case of a

two-sided PCB, or on an inner layer of a board with more than two layers. Connect the DAP copper pad to the inner layer or backside copper heat sink area with 4(2x2) vias. The via diameter should be 0.012in-0.013in with a 1.27mm pitch. Ensure efficient thermal conductivity by plating through the vias.

Best thermal performance is achieved with the largest practical heat sink area. If the heatsink and amplifier share the same PCB layer, a nominal 2.5in<sup>2</sup> area is necessary for 5V operation with a 4 $\Omega$  load. Heatsink areas not placed on the same PCB layer as the LM4871 should be 5in<sup>2</sup> (min) for the same supply voltage and load resistance. The last two area recommendations apply for 25 $^{\circ}\text{C}$  ambient temperature. Increase the area to compensate for ambient temperatures above 25 $^{\circ}\text{C}$ . The LM4871's power de-rating curve in the **Typical Performance Characteristics** shows the maximum power dissipation versus temperature. An example PCB layout for the LD package is shown in the **Demonstration Board Layout** section. Further detailed and specific information concerning PCB layout, fabrication, and mounting an

## Application Information (Continued)

LD (LLP) package is available from National Semiconductor's Package Engineering Group under application note AN1187.

### PCB LAYOUT AND SUPPLY REGULATION CONSIDERATIONS FOR DRIVING 3Ω AND 4Ω LOADS

Power dissipated by a load is a function of the voltage swing across the load and the load's impedance. As load impedance decreases, load dissipation becomes increasingly dependant on the interconnect (PCB trace and wire) resistance between the amplifier output pins and the load's connections. Residual trace resistance causes a voltage drop, which results in power dissipated in the trace and not in the load as desired. For example, 0.1Ω trace resistance reduces the output power dissipated by a 4Ω load from 2.0W to 1.95W. This problem of decreased load dissipation is exacerbated as load impedance decreases. Therefore, to maintain the highest load dissipation and widest output voltage swing, PCB traces that connect the output pins to a load must be as wide as possible.

Poor power supply regulation adversely affects maximum output power. A poorly regulated supply's output voltage decreases with increasing load current. Reduced supply voltage causes decreased headroom, output signal clipping, and reduced output power. Even with tightly regulated supplies, trace resistance creates the same effects as poor supply regulation. Therefore, making the power supply traces as wide as possible helps maintain full output voltage swing.

### BRIDGE CONFIGURATION EXPLANATION

As shown in *Figure 1*, the LM4871 has two operational amplifiers internally, allowing for a few different amplifier configurations. The first amplifier's gain is externally configurable; 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  $R_f$  to  $R_i$  while the second amplifier's gain is fixed by the two internal 40kΩ resistors. *Figure 1* 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 180° out of phase. Consequently, the differential gain for the IC is

$$A_{VD} = 2 * (R_f/R_i)$$

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 its 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.

Another advantage of the differential bridge output is no net DC voltage across load. This results from biasing  $V_{O1}$  and  $V_{O2}$  at the same DC voltage, in this case  $V_{DD}/2$ . This eliminates the coupling capacitor that single supply, single-ended amplifiers require. Eliminating an output coupling capacitor in a single-ended configuration forces a single supply

amplifier's half-supply bias voltage across the load. The current flow created by the half-supply bias voltage increases internal IC power dissipation and may permanently damage loads such as speakers.

### POWER DISSIPATION

Power dissipation is a major concern when designing a successful amplifier, whether the amplifier is bridged or single-ended. A direct consequence of the increased power delivered to the load by a bridge amplifier is an increase in internal power dissipation. Equation 1 states the maximum power dissipation point for a bridge amplifier operating at a given supply voltage and driving a specified output load.

$$P_{D_{MAX}} = 4 * (V_{DD})^2 / (2\pi^2 R_L) \quad (1)$$

Since the LM4871 has two operational amplifiers in one package, the maximum internal power dissipation is 4 times that of a single-ended amplifier. Even with this substantial increase in power dissipation, the LM4871 does not require heatsinking under most operating conditions and output loading. From Equation 1, assuming a 5V power supply and an 8Ω load, the maximum power dissipation point is 625 mW. The maximum power dissipation point obtained from Equation 1 must not be greater than the power dissipation that results from Equation 2:

$$P_{D_{MAX}} = (T_{J_{MAX}} - T_A) / \theta_{JA} \quad (2)$$

For the SO package,  $\theta_{JA} = 140^\circ\text{C/W}$ , for the DIP package,  $\theta_{JA} = 107^\circ\text{C/W}$ , and for the MSOP package,  $\theta_{JA} = 210^\circ\text{C/W}$  assuming free air operation. For the LD package soldered to a DAP pad that expands to a copper area of 1.0in<sup>2</sup> on a PCB, the LM4871's  $\theta_{JA}$  is 56°C/W.  $T_{J_{MAX}} = 150^\circ\text{C}$  for the LM4871. The  $\theta_{JA}$  can be decreased by using some form of heat sinking. The resultant  $\theta_{JA}$  will be the summation of the  $\theta_{JC}$ ,  $\theta_{CS}$ , and  $\theta_{SA}$ .  $\theta_{JC}$  is the junction to case of the package (or to the exposed DAP, as is the case with the LD package),  $\theta_{CS}$  is the case to heat sink thermal resistance and  $\theta_{SA}$  is the heat sink to ambient thermal resistance. By adding additional copper area around the LM4871, the  $\theta_{JA}$  can be reduced from its free air value for the SO and MSOP packages. Increasing the copper area around the LD package from 1.0in<sup>2</sup> to 2.0in<sup>2</sup> area results in a  $\theta_{JA}$  decrease to 46°C/W. Depending on the ambient temperature,  $T_A$ , and the  $\theta_{JA}$ , Equation 2 can be used to find the maximum internal power dissipation supported by the IC packaging. If the result of Equation 1 is greater than that of Equation 2, then either the supply voltage must be decreased, the load impedance increased, the  $\theta_{JA}$  decreased, or the ambient temperature reduced. For the typical application of a 5V power supply, with an 8Ω load, and no additional heatsinking, the maximum ambient temperature possible without violating the maximum junction temperature is approximately 61°C provided that device operation is around the maximum power dissipation point and assuming surface mount packaging. For the LD package in a typical application of a 5V power supply, with a 4Ω load, and 1.0in<sup>2</sup> copper area soldered to the exposed DAP pad, the maximum ambient temperature is approximately 77°C providing device operation is around the maximum power dissipation point. Internal power dissipation is a function of output power. If typical operation is not around the maximum power dissipation point, the ambient temperature can be increased. Refer to the **Typical Performance Characteristics** curves for power dissipation information for different output powers and output loading.

## Application Information (Continued)

### POWER SUPPLY BYPASSING

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 LM4871 as possible. The capacitor connected between the bypass pin and ground improves the internal bias voltage's stability, producing improved PSRR. The improvements to PSRR increase as the bypass pin capacitor increases. Typical applications employ a 5V regulator with 10 $\mu$ F and a 0.1 $\mu$ F bypass capacitors which aid in supply stability. This does not eliminate the need for bypassing the supply nodes of the LM4871 with a 1 $\mu$ F tantalum capacitor. The selection of bypass capacitors, especially  $C_B$ , is dependent upon PSRR requirements, click and pop performance as explained in the section, **Proper Selection of External Components**, system cost, and size constraints.

### SHUTDOWN FUNCTION

In order to reduce power consumption while not in use, the LM4871 contains a shutdown pin to externally turn off the amplifier's bias circuitry. This shutdown feature turns the amplifier off when a logic high is placed on the shutdown pin. The trigger point between a logic low and logic high level is typically half-supply. It is best to switch between ground and supply to provide maximum device performance. By switching the shutdown pin to  $V_{DD}$ , the LM4871 supply current draw will be minimized in idle mode. While the device will be disabled with shutdown pin voltages less than  $V_{DD}$ , the idle current may be greater than the typical value of 0.6 $\mu$ A. In either case, the shutdown pin should be tied to a definite voltage to avoid unwanted state changes.

In many applications, a microcontroller or microprocessor output is used to control the shutdown circuitry which provides a quick, smooth transition into shutdown. Another solution is to use a single-pole, single-throw switch in conjunction with an external pull-up resistor. When the switch is closed, the shutdown pin is connected to ground and enables the amplifier. If the switch is open, then the external pull-up resistor will disable the LM4871. This scheme guarantees that the shutdown pin will not float thus preventing unwanted state changes.

### PROPER SELECTION OF EXTERNAL COMPONENTS

Proper selection of external components in applications using integrated power amplifiers is critical to optimize device and system performance. While the LM4871 is tolerant of external component combinations, consideration to component values must be used to maximize overall system quality.

The LM4871 is unity-gain stable which gives a designer maximum system flexibility. The LM4871 should be used in low gain configurations to minimize THD+N values, and maximize the signal to noise ratio. Low gain configurations require large input signals to obtain a given output power. Input signals equal to or greater than 1 Vrms are available from sources such as audio codecs. Please refer to the section, **Audio Power Amplifier Design**, for a more complete explanation of proper gain selection.

Besides gain, one of the major considerations is the closed-loop bandwidth of the amplifier. To a large extent, the bandwidth is dictated by the choice of external components shown in *Figure 1*. The input coupling capacitor,  $C_i$ , forms a

first order high pass filter which limits low frequency response. This value should be chosen based on needed frequency response for a few distinct reasons.

### Selection Of Input Capacitor Size

Large input capacitors are both expensive and space hungry for portable designs. Clearly, a certain sized capacitor is needed to couple in low frequencies without severe attenuation. But in many cases the speakers used in portable systems, whether internal or external, have little ability to reproduce signals below 100Hz to 150Hz. Thus, using a large input capacitor may not increase actual system performance.

In addition to system cost and size, click and pop performance is effected by the size of the input coupling capacitor,  $C_i$ . A larger input coupling capacitor requires more charge to reach its quiescent DC voltage (nominally 1/2  $V_{DD}$ ). This charge comes from the output via the feedback and is apt to create pops upon device enable. Thus, by minimizing the capacitor size based on necessary low frequency response, turn-on pops can be minimized.

Besides minimizing the input capacitor size, careful consideration should be paid to the bypass capacitor value. Bypass capacitor,  $C_B$ , is the most critical component to minimize turn-on pops since it determines how fast the LM4871 turns on. The slower the LM4871's outputs ramp to their quiescent DC voltage (nominally 1/2  $V_{DD}$ ), the smaller the turn-on pop. Choosing  $C_B$  equal to 1.0 $\mu$ F along with a small value of  $C_i$  (in the range of 0.1 $\mu$ F to 0.39 $\mu$ F), should produce a virtually clickless and popless shutdown function. While the device will function properly, (no oscillations or motorboating), with  $C_B$  equal to 0.1 $\mu$ F, the device will be much more susceptible to turn-on clicks and pops. Thus, a value of  $C_B$  equal to 1.0 $\mu$ F is recommended in all but the most cost sensitive designs.

## AUDIO POWER AMPLIFIER DESIGN

### Design a 1W/8 $\Omega$ Audio Amplifier

Given:

Power Output	1 Wrms
Load Impedance	8 $\Omega$
Input Level	1 Vrms
Input Impedance	20 k $\Omega$
Bandwidth	100 Hz–20 kHz $\pm$ 0.25 dB

A designer must first determine the minimum supply rail to obtain the specified output power. By extrapolating from the Output Power vs Supply Voltage graphs in the **Typical Performance Characteristics** section, the supply rail can be easily found. A second way to determine the minimum supply rail is to calculate the required  $V_{\text{opeak}}$  using Equation 3 and add the output voltage. Using this method, the minimum supply voltage would be ( $V_{\text{opeak}} + (V_{\text{ODTOP}} + V_{\text{ODBOT}})$ ), where  $V_{\text{ODBOT}}$  and  $V_{\text{ODTOP}}$  are extrapolated from the Dropout Voltage vs Supply Voltage curve in the **Typical Performance Characteristics** section.

$$V_{\text{opeak}} = \sqrt{(2R_L P_O)} \quad (3)$$

Using the Output Power vs Supply Voltage graph for an 8 $\Omega$  load, the minimum supply rail is 4.6V. But since 5V is a standard voltage in most applications, it is chosen for the supply rail. Extra supply voltage creates headroom that al-

## Application Information (Continued)

allows the LM4871 to reproduce peaks in excess of 1W without producing audible distortion. At this time, the designer must make sure that the power supply choice along with the output impedance does not violate the conditions explained in the **Power Dissipation** section.

Once the power dissipation equations have been addressed, the required differential gain can be determined from Equation 4.

$$A_{VD} \geq \sqrt{(P_{O}R_L)/(V_{IN})} = V_{orms}/V_{inrms} \quad (4)$$

$$R_f/R_i = A_{VD}/2 \quad (5)$$

From Equation 4, the minimum  $A_{VD}$  is 2.83; use  $A_{VD} = 3$ . Since the desired input impedance was 20kΩ, and with a  $A_{VD}$  impedance of 2, a ratio of 1.5:1 of  $R_f$  to  $R_i$  results in an allocation of  $R_i = 20k\Omega$  and  $R_f = 30k\Omega$ . The final design step

## Demonstration Board Layout

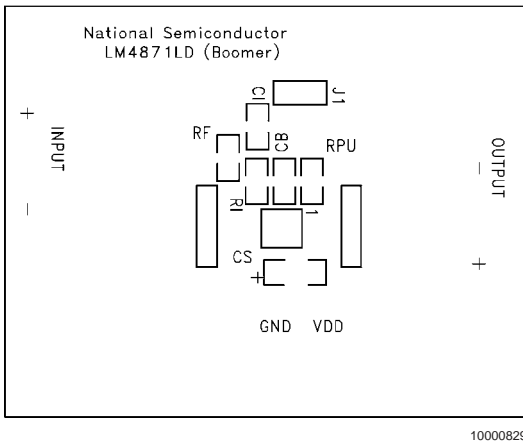


FIGURE 2. Recommended LD PC Board Layout: Component-Side Silkscreen

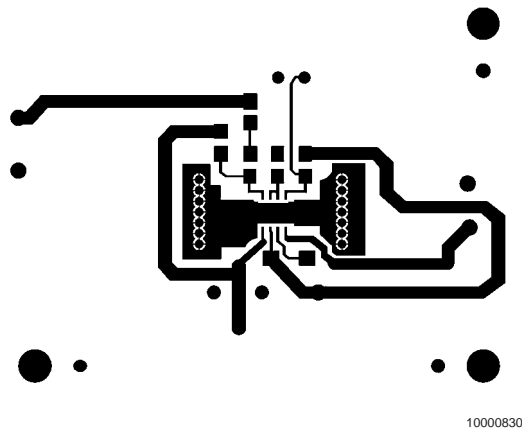


FIGURE 3. Recommended LD PC Board Layout: Component-Side Layout

is to address the bandwidth requirements which must be stated as a pair of -3dB frequency points. Five times away from a -3dB point is 0.17dB down from passband response which is better than the required ±0.25dB specified.

$$f_L = 100\text{Hz}/5 = 20\text{Hz}$$

$$f_H = 20\text{kHz} * 5 = 100\text{kHz}$$

As stated in the **External Components** section,  $R_i$  in conjunction with  $C_i$  create a highpass filter.

$$C_i \geq 1/(2\pi * 20k\Omega * 20\text{Hz}) = 0.397\mu\text{F}; \text{ use } 0.39\mu\text{F}$$

The high frequency pole is determined by the product of the desired frequency pole,  $f_H$ , and the differential gain,  $A_{VD}$ . With a  $A_{VD} = 3$  and  $f_H = 100\text{kHz}$ , the resulting GBWP = 150kHz which is much smaller than the LM4871 GBWP of 4MHz. This figure displays that if a designer has a need to design an amplifier with a higher differential gain, the LM4871 can still be used without running into bandwidth limitations.

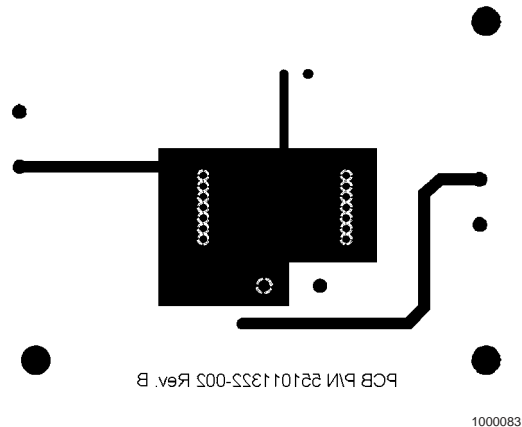
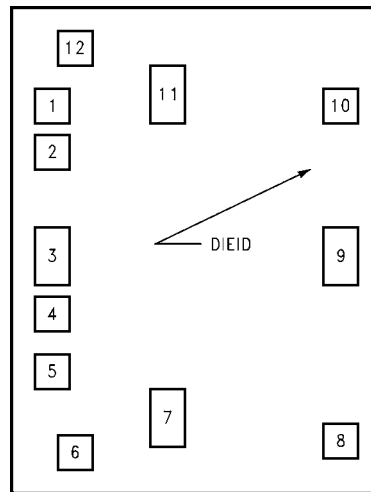


FIGURE 4. Recommended LD PC Board Layout: Bottom-Side Layout

## LM4871 MDA MWA 3W Audio Power Amplifier With Shutdown Mode



Die Layout (C - Step)

### Die/Wafer Characteristics

Fabrication Attributes		General Die Information	
Physical Die Identification	LM4871C	Bond Pad Opening Size (min)	102 $\mu$ m x 102 $\mu$ m
Die Step	C	Bond Pad Metalization	0.5% COPPER_BAL. ALUMINUM
Physical Attributes		Passivation	NITRIDE
Wafer Diameter	150mm	Back Side Metal	BARE BACK
Dise Size (Drawn)	1372 $\mu$ m x 1758 $\mu$ m 54mils x 69mils	Back Side Connection	GND
Thickness	406 $\mu$ m Nominal		
Min Pitch	164 $\mu$ m Nominal		

#### Special Assembly Requirements:

**Note: Actual die size is rounded to the nearest micron.**

#### Die Bond Pad Coordinate Locations (C - Step)

(Referenced to die center, coordinates in  $\mu$ m) NC = No Connection

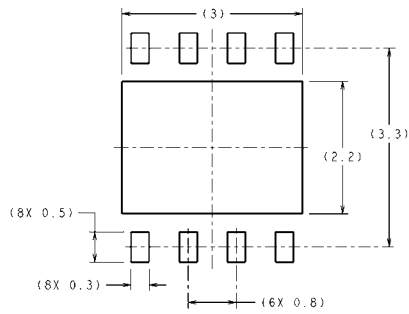
SIGNAL NAME	PAD# NUMBER	X/Y COORDINATES		PAD SIZE		
		X	Y	X	Y	Y
SHUTDOWN	1	-559	541	102	x	102
BYPASS	2	-559	376	102	x	102
NC	3	-559	-45	102	x	210
INPUT +	4	-559	-248	102	x	102
INPUT -	5	-559	-486	102	x	102
GND	6	-476	-725	102	x	102
VOUT 1	7	-135	-598	102	x	210
GND	8	554	-686	102	x	102
VDD	9	554	-4	102	x	210
GND	10	554	568	102	x	102
VOUT 2	11	-135	598	102	x	210
GND	12	-473	752	102	x	102

**LM4871 MDA MWA 3W Audio Power Amplifier With Shutdown Mode**

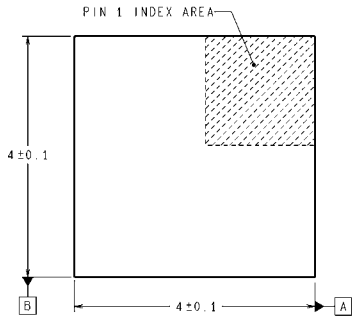
(Continued)

<b>IN U.S.A</b>	
Tel #:	1 877 Dial Die 1 877 342 5343
Fax:	1 207 541 6140
<b>IN EUROPE</b>	
Tel:	49 (0) 8141 351492 / 1495
Fax:	49 (0) 8141 351470
<b>IN ASIA PACIFIC</b>	
Tel:	(852) 27371701
<b>IN JAPAN</b>	
Tel:	81 043 299 2308

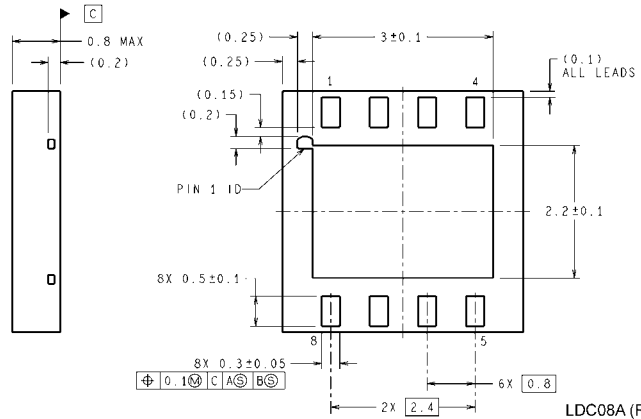
# Physical Dimensions inches (millimeters) unless otherwise noted



**RECOMMENDED LAND PATTERN**  
1:1 RATION WITH PKG SOLDER PADS

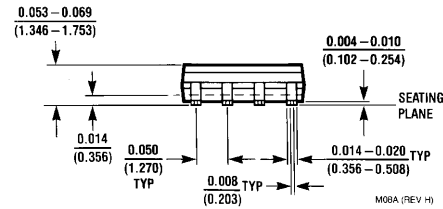
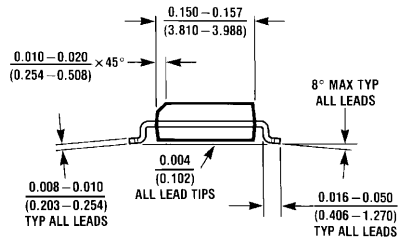
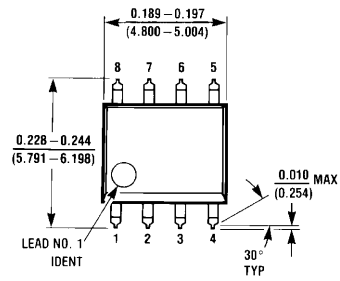


**DIMENSIONS ARE IN MILLIMETERS**  
DIMENSIONS IN ( ) FOR REFERENCE ONLY



LDC08A (Rev B)

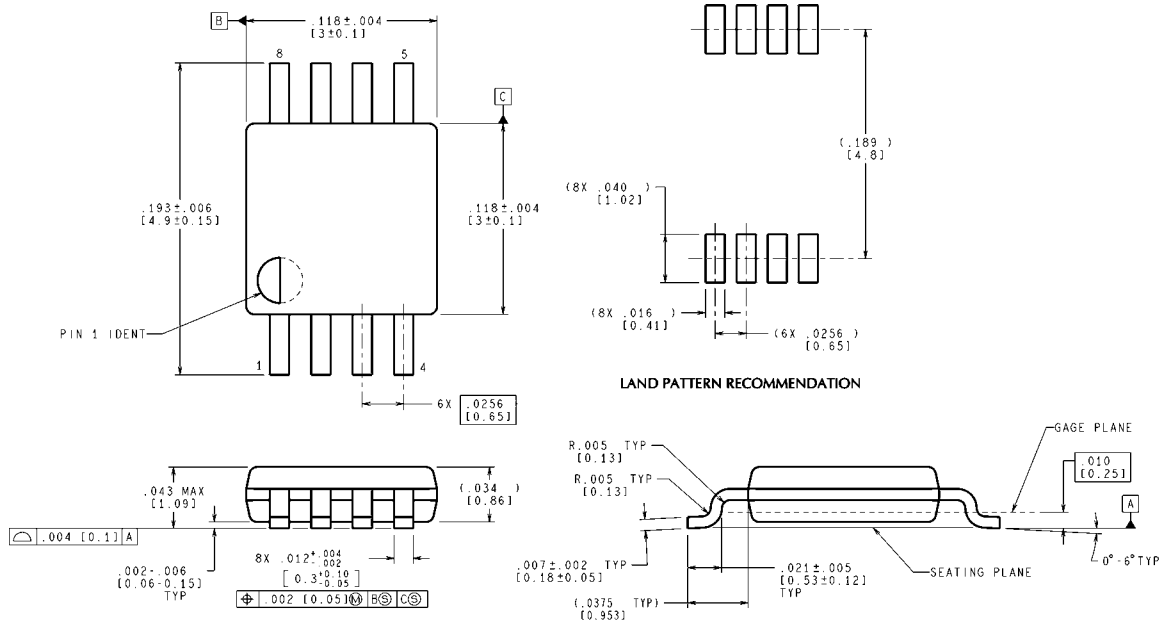
**Order Number LM4871LD**  
**See NS Package Number LDC08A**



M08A (REV H)

**Order Number LM4871M**  
**NS Package Number M08A**

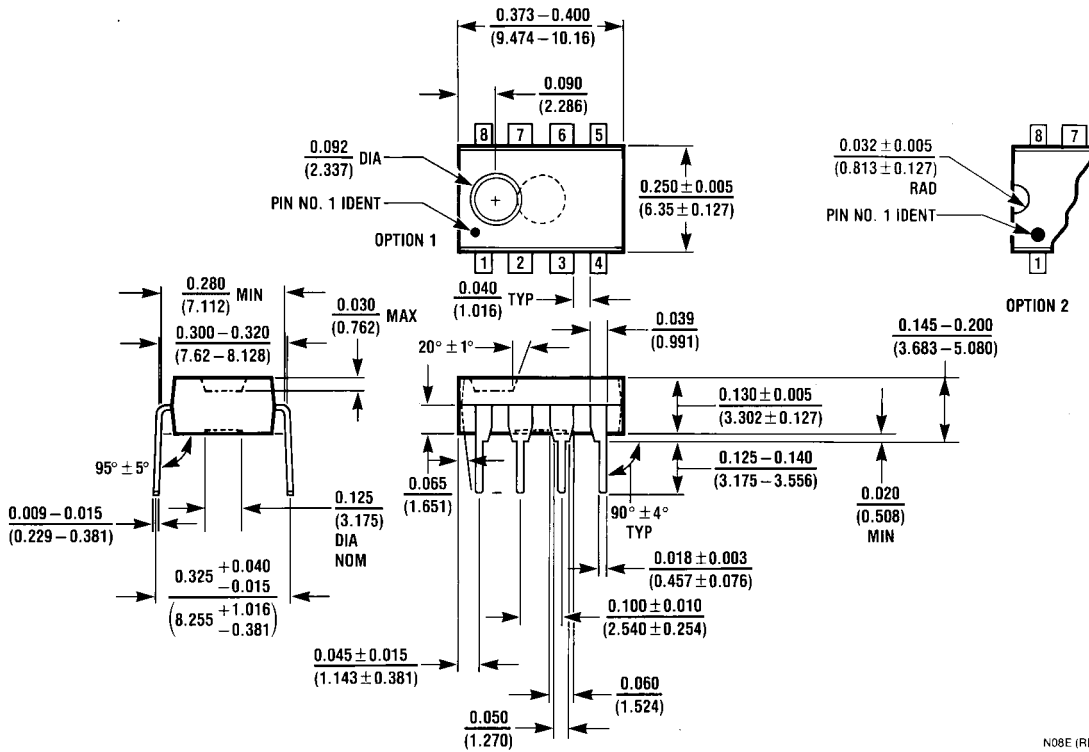
**Physical Dimensions** inches (millimeters) unless otherwise noted (Continued)



CONTROLLING DIMENSION IS INCH  
VALUES IN [ ] ARE MILLIMETERS

MUA08A (Rev E)

**Order Number LM4871MM**  
**NS Package Number MUA08A**



N08E (REV F)

**Order Number LM4871N**  
**NS Package Number N08E**



## Notes

National does not assume any responsibility for use of any circuitry described, no circuit patent licenses are implied and National reserves the right at any time without notice to change said circuitry and specifications.

For the most current product information visit us at [www.national.com](http://www.national.com).

### LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT AND GENERAL COUNSEL OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

### BANNED SUBSTANCE COMPLIANCE

National Semiconductor certifies that the products and packing materials meet the provisions of the Customer Products Stewardship Specification (CSP-9-111C2) and the Banned Substances and Materials of Interest Specification (CSP-9-111S2) and contain no "Banned Substances" as defined in CSP-9-111S2.



**National Semiconductor**  
**Americas Customer**  
**Support Center**  
Email: [new.feedback@nsc.com](mailto:new.feedback@nsc.com)  
Tel: 1-800-272-9959

[www.national.com](http://www.national.com)

**National Semiconductor**  
**Europe Customer Support Center**  
Fax: +49 (0) 180-530 85 86  
Email: [europa.support@nsc.com](mailto:europa.support@nsc.com)  
Deutsch Tel: +49 (0) 69 9508 6208  
English Tel: +44 (0) 870 24 0 2171  
Français Tel: +33 (0) 1 41 91 8790

**National Semiconductor**  
**Asia Pacific Customer**  
**Support Center**  
Email: [ap.support@nsc.com](mailto:ap.support@nsc.com)

**National Semiconductor**  
**Japan Customer Support Center**  
Fax: 81-3-5639-7507  
Email: [jpn.feedback@nsc.com](mailto:jpn.feedback@nsc.com)  
Tel: 81-3-5639-7560

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Mobile Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Transportation and Automotive	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

TI E2E Community Home Page

[e2e.ti.com](http://e2e.ti.com)

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2011, Texas Instruments Incorporated