LM48820 Boomer® Audio Power Amplifier Series Ground-Referenced, Ultra Low Noise, Fixed Gain, 95mW Stereo Headphone Amplifier

Check for Samples: LM48820

FEATURES

- **Available in Space Saving 0.4mm Pitch DSBGA Package**
- **Fixed Logic Levels**
- **Ground Referenced Outputs**
- **High PSRR**
- **Ultra Low Current Shutdown Mode**
- **Improved Pop and Click Circuitry Eliminates Noises During Turn-On and Turn-Off Transitions**
- **No Output Coupling Capacitors, Snubber Networks, Bootstrap Capacitors, or Gain-Setting Resistors Required**
- **Shutdown Either Channel Independently**
- **Soft Start Feature Reduces Start up Transient Current**

APPLICATIONS

- **Mobile Phones**
- **MP3 Players**
- **PDAs**
- **Portable electronic devices**
- **Notebook PCs**

KEY SPECIFICATIONS

- **Improved PSRR at 217Hz: 80dB (typ)**
- **Power Output at VDD = 3V, RL = 16Ω, THD+N = 1%: 95mW (typ)**
- **Shutdown Current: 0.05μA (typ)**
- **Internal Fixed Gain: 1.5V/V (typ)**
- **Wide Operating Voltage Range: 1.6V to 4.5V**

DESCRIPTION

The LM48820 is a ground referenced, fixed-gain audio power amplifier capable of delivering 95mW of continuous average power into a 16Ω single-ended load, with less than 1% THD+N from a 3V power supply.

The LM48820 features a new circuit technology that utilizes a charge pump to generate a negative reference voltage. This allows the outputs to be biased about ground, thereby eliminating output-coupling capacitors typically used with normal single-ended loads.

Boomer audio power amplifiers were designed specifically to provide high quality output power with a minimal number of external components. The LM48820 does not require output coupling capacitors or bootstrap capacitors, and therefore is ideally suited for mobile phone and other portable applications.

The LM48820 features a low-power consumption shutdown mode selectable for each channel and a soft start function that reduces start-up current transients. Additionally, the LM48820 features an internal thermal shutdown protection mechanism.

The LM48820 contains advanced pop and click circuitry that eliminates noises which would otherwise occur during turn-on and turn-off transitions.

The LM48820 has an internal fixed gain of 1.5V/V.

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Typical Application

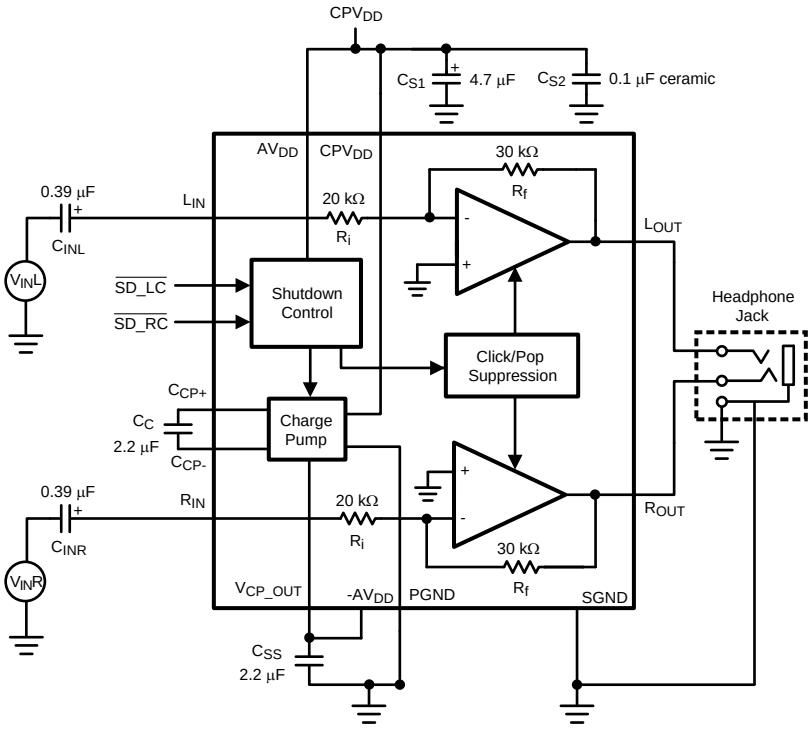

Figure 1. Typical Audio Amplifier Application Circuit

Connection Diagrams

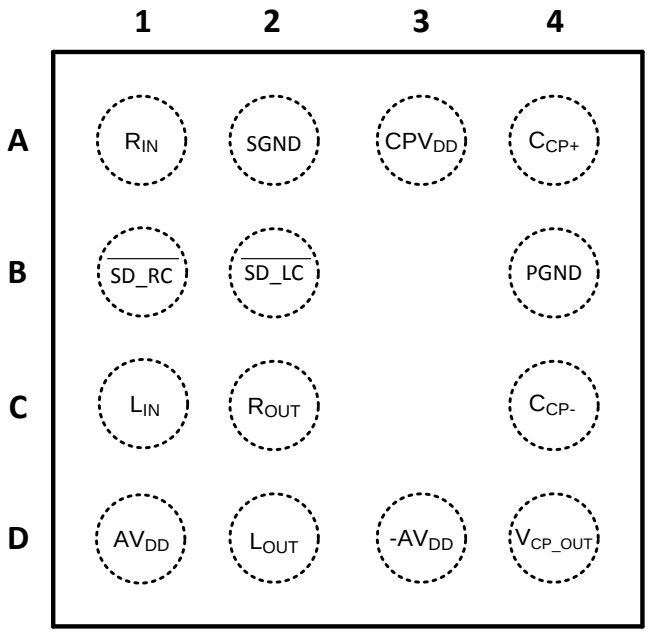

Figure 2. DSBGA Package
Top View
Package Number YFR0014AAA

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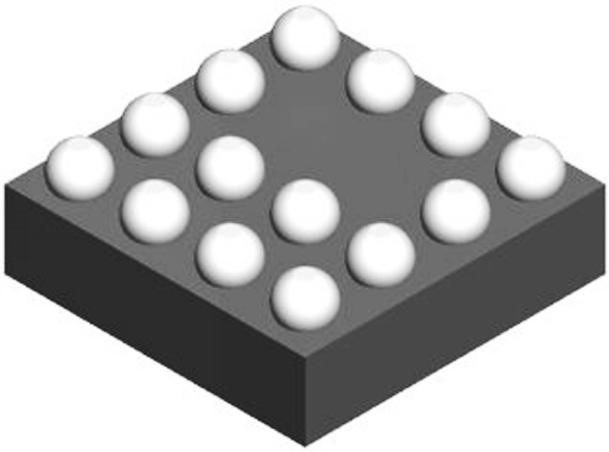

Figure 3. YFR0014 Package View

PIN DESCRIPTIONS

Pin	Name	Function
A1	R_{IN}	Right Channel Input
A2	SGND	Signal Ground
A3	CPV_{DD}	Charge Pump Power Supply
A4	C_{CP+}	Positive Terminal - Charge Pump Flying Capacitor
B1	$\overline{SD_RC}$	Active-Low Shutdown, Right Channel
B2	$\overline{SD_LC}$	Active-Low Shutdown, Left Channel
B4	PGND	Power Ground
C1	L_{IN}	Left Channel Input
C2	R_{OUT}	Right Channel Output
C4	C_{CP-}	Negative Terminal - Charge Pump Flying Capacitor
D1	AV_{DD}	Positive Power Supply - Amplifier
D2	L_{OUT}	Left Channel Output
D3	$-AV_{DD}$	Negative Power Supply - Amplifier
D4	V_{CP_OUT}	Charge Pump Power Output

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These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

Absolute Maximum Ratings (1)(2)(3)

Supply Voltage	4.75V
Storage Temperature	−65°C to +150°C
Input Voltage	-0.3V to V_{DD} + 0.3V
Power Dissipation (4)	Internally Limited
ESD Susceptibility (5)	2000V
ESD Susceptibility (6)	200V
Junction Temperature	150°C
Thermal Resistance	
θ_{JA} (7)	86°C/W (typ)

(1) All voltages are measured with respect to the GND pin unless otherwise specified.
(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 ensure specific performance limits. Electrical Characteristics state DC and AC electrical specifications under particular test conditions that specify performance limits. This assumes that the device is within the Operating Ratings. Specifications are not ensured for parameters where no limit is given; however, the typical value is a good indication of device performance.
(3) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/ Distributors for availability and specifications.
(4) The maximum power dissipation must be derated at elevated temperatures and is dictated by T_{JMAX}, θ_{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. See Typical Performance Characteristics for more information
(5) Human body model, 100pF discharged through a 1.5kΩ resistor.
(6) Machine Model, 220pF - 240pF discharged through all pins.
(7) θ_{JA} value is measured with the device mounted on a PCB with a 3" x 1.5", 1oz copper heatsink.

Operating Ratings

Temperature Range	
$T_{MIN} \le T_A \le T_{MAX}$	$-40°C \le T_A \le 85°C$
Supply Voltage (V_{DD})	$1.6V \le V_{DD} \le 4.5V$

Electrical Characteristics V_{DD} = 3V (1)(2)

The following specifications apply for V_{DD} = 3V, 16Ω load, and the conditions shown in "*Typical Audio Amplifier Application Circuit*" (see Figure 1) unless otherwise specified. Limits apply to T_A = 25°C.

Symbol	Parameter	Conditions	LM48820		Units (Limits)
			Typical (3)	Limit (4) (5)	
I_{DD}	Quiescent Power Supply Current Full Power Mode	V_{IN} = 0V, inputs terminated both channels enabled	4.7	5.5	mA (max)
		V_{IN} = 0V, inputs terminated one channel enabled	3		mA (max)
I_{SD}	Shutdown Current	$\overline{SD_LC}$ = $\overline{SD_RC}$ = GND	0.05	2	µA (max)
V_{OS}	Output Offset Voltage	R_L = 32Ω, V_{IN} = 0V	1	5	mV (max)
A_V	Voltage Gain		–1.5		V/V
ΔA_V	Gain Match		1		%

(1) All voltages are measured with respect to the GND pin unless otherwise specified.
(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 ensure specific performance limits. Electrical Characteristics state DC and AC electrical specifications under particular test conditions that specify performance limits. This assumes that the device is within the Operating Ratings. Specifications are not ensured for parameters where no limit is given; however, the typical value is a good indication of device performance.
(3) Typicals are measured at 25°C and represent the parametric norm.
(4) Limits are specified to AOQL (Average Outgoing Quality Level).
(5) Data sheet min and max specification limits are specified by design, test, or statistical analysis.

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Electrical Characteristics V_{DD} = 3V (1)(2) (continued)

The following specifications apply for V_{DD} = 3V, 16Ω load, and the conditions shown in "*Typical Audio Amplifier Application Circuit*" (see Figure 1) unless otherwise specified. Limits apply to T_A = 25°C.

Symbol	Parameter	Conditions	LM48820		Units (Limits)
			Typical (3)	Limit (4) (5)	
R_{IN}	Input Resistance		20	15 25	kΩ (min) kΩ (max)
P_O	Output Power	THD+N = 1% (max); f = 1kHz, one channel	95		mW
		THD+N = 1% (max); f = 1kHz, R_L = 32Ω, one channel	80		mW
		THD+N = 1% (max); f = 1kHz, two channels in phase	50	40	mW (min)
		THD+N = 1% (max); f = 1kHz, R_L = 32Ω, two channels in phase	55	45	mW (min)
THD+N	Total Harmonic Distortion + Noise	P_O = 60mW, f = 1kHz, single channel	0.01		%
		P_O = 50mW, f = 1kHz, R_L = 32Ω single channel	0.007		%
PSRR	Power Supply Rejection Ratio Full Power Mode	V_{RIPPLE} = 200mV_{P-P}, Input Referred f = 217Hz f = 1kHz f = 20kHz	 80 75 58		 dB dB dB
SNR	Signal-to-Noise Ratio	R_L = 32Ω, P_O = 20mW, (A-weighted) f = 1kHz, BW = 20Hz to 22kHz	100		dB
V_{IH}	Shutdown Input Voltage High	V_{DD} = 1.8V to 4.2V		1.2	V (min)
V_{IL}	Shutdown Input Voltage Low	V_{DD} = 1.8V to 4.2V		0.45	V (max)
X_{TALK}	Crosstalk	P_O = 1.6mW, f = 1kHz	70		dB
Z_{OUT}	Output Impedance	$\overline{SD_LC}$ = $\overline{SD_RC}$ = GND Input Terminated Input not terminated	 30 30	25	kΩ (min)
Z_{OUT}	Output Impedance	$\overline{SD_LC}$ = $\overline{SD_RC}$ = GND –500mV ≤ V_{OUT} ≤ V_{DD} +500mV (6)	8	2	kΩ (min)
I_L	Input Leakage		±0.1		nA

(6) V_{OUT} refers to signal applied to the LM48820 outputs.

External Components Description

(Figure 1)

Components		Functional Description
1.	$C_{INR/INL}$	Input coupling capacitor which blocks the DC voltage at the amplifier's input terminals. Also creates a high-pass filter with R_i at $f_C = 1/(2\pi R_i C_{IN})$. Refer to the section SELECTING PROPER EXTERNAL COMPONENTS, for an explanation of how to determine the value of C_i.
2	C_C	Flying capacitor. Low ESR ceramic capacitor (≤100mΩ)
3.	C_{SS}	Output capacitor. Low ESR ceramic capacitor (≤100mΩ)
4.	C_{S1}	Tantalum capacitor. Supply bypass capacitor which provides power supply filtering. Refer to the POWER SUPPLY BYPASSING section for information concerning proper placement and selection of the supply bypass capacitor.
5.	C_{S2}	Ceramic capacitor. Supply bypass capacitor which provides power supply filtering. Refer to the POWER SUPPLY BYPASSING section for information concerning proper placement and selection of the supply bypass capacitor.

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Typical Performance Characteristics

THD+N vs Frequency
V_{DD} = 1.6V, R_L = 16Ω, Stereo, P_O = 3mW

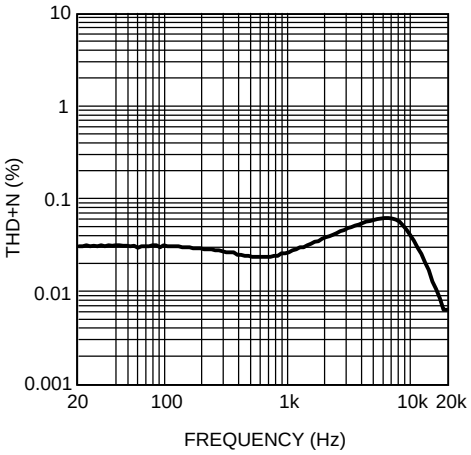

Figure 4.

THD+N vs Frequency
V_{DD} = 1.6V, R_L = 32Ω, Stereo, P_O = 3mW

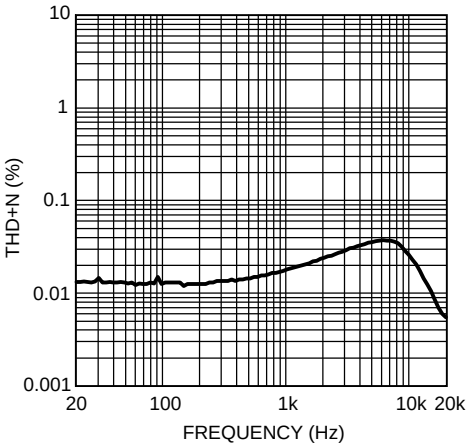

Figure 5.

THD+N vs Frequency
V_{DD} = 3V, R_L = 16Ω, Stereo, P_O = 25mW

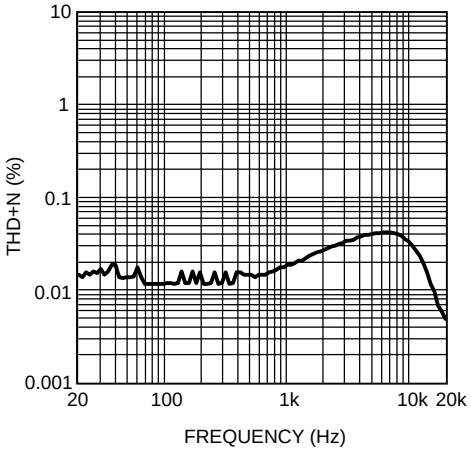

Figure 6.

THD+N vs Frequency
V_{DD} = 3V, R_L = 32Ω, Stereo, P_O = 25mW

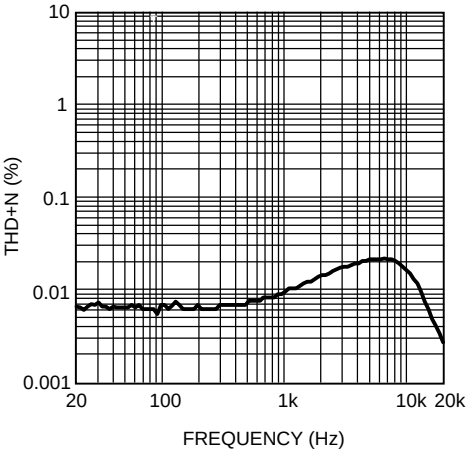

Figure 7.

THD+N vs Frequency
V_{DD} = 3V, R_L = 16Ω, One channel, P_O = 60mW

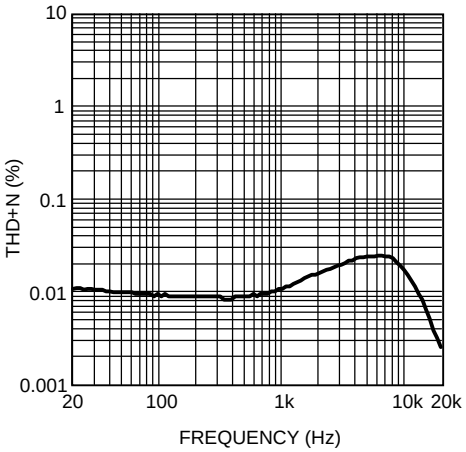

Figure 8.

THD+N vs Frequency
V_{DD} = 3V, R_L = 32Ω, One channel, P_O = 50mW

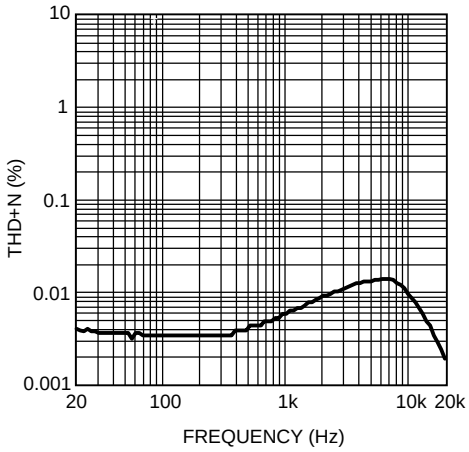

Figure 9.

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Typical Performance Characteristics (continued)

THD+N vs Output Power
V_{DD} = 1.6V, R_L = 16Ω, One channel

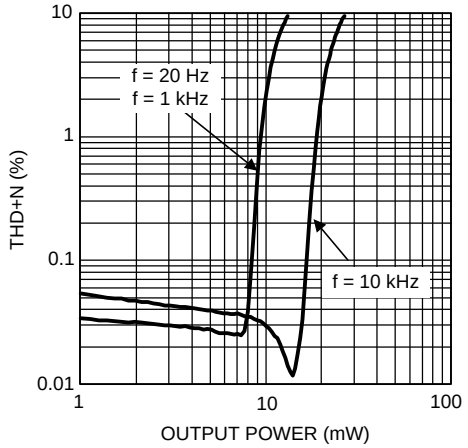

Figure 10.

THD+N vs Output Power
V_{DD} = 1.6V, R_L = 32Ω, One channel

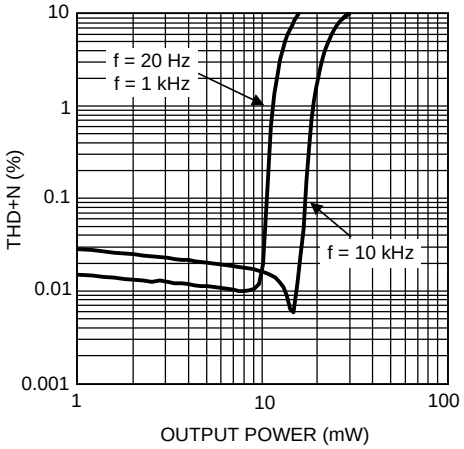

Figure 11.

THD+N vs Output Power
V_{DD} = 1.6V, R_L = 16Ω, Stereo

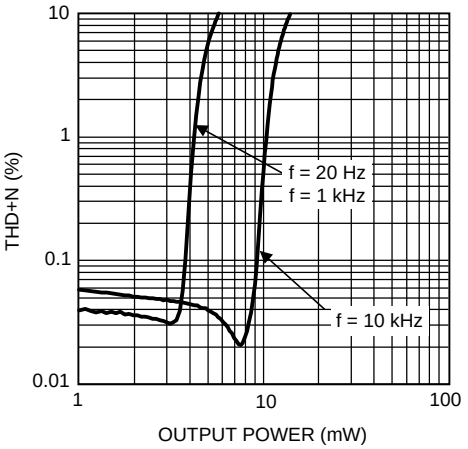

Figure 12.

THD+N vs Output Power
V_{DD} = 1.6V, R_L = 32Ω, Stereo

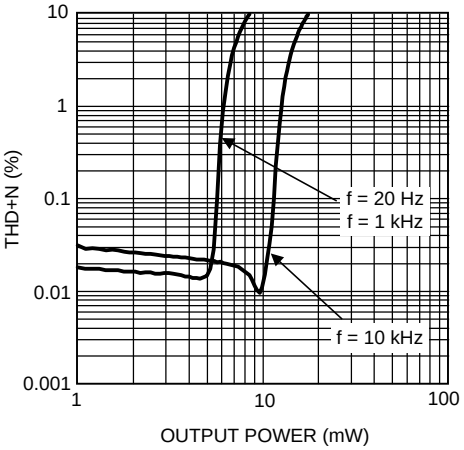

Figure 13.

THD+N vs Output Power
V_{DD} = 3V, R_L = 16Ω, One channel

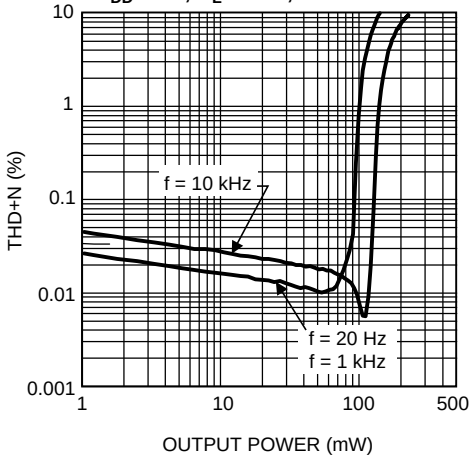

Figure 14.

THD+N vs Output Power
V_{DD} = 3V, R_L = 32Ω, One channel

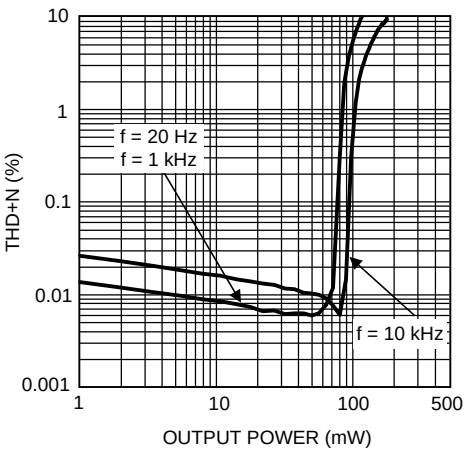

Figure 15.

Typical Performance Characteristics (continued)

THD+N vs Output Power
V_{DD} = 3V, R_L = 16Ω, Stereo

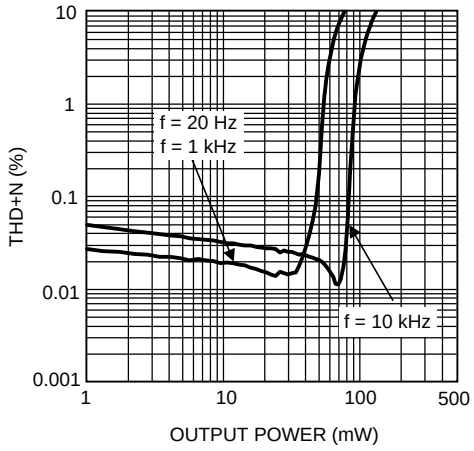

Figure 16.

THD+N vs Output Power
V_{DD} = 3V, R_L = 32Ω, Stereo

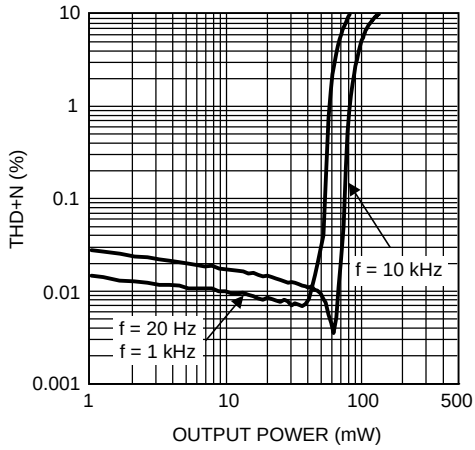

Figure 17.

Output Power vs Power Supply Voltage
R_L = 16Ω, f = 1kHz, Mono

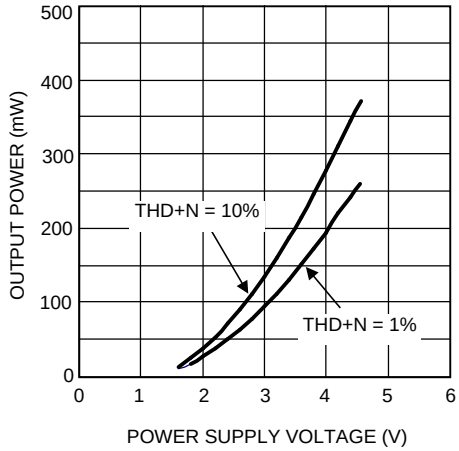

Figure 18.

Output Power vs Power Supply Voltage
R_L = 16Ω, f = 1kHz, Stereo

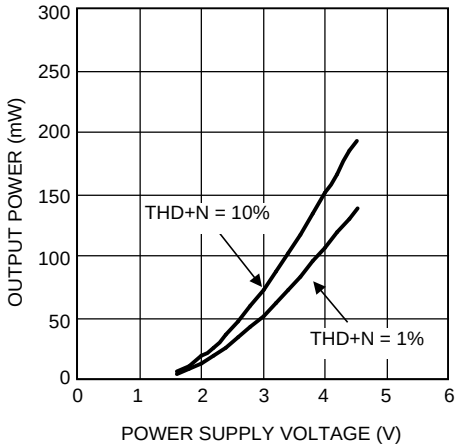

Figure 19.

Output Power vs Power Supply Voltage
R_L = 32Ω, f = 1kHz, Mono

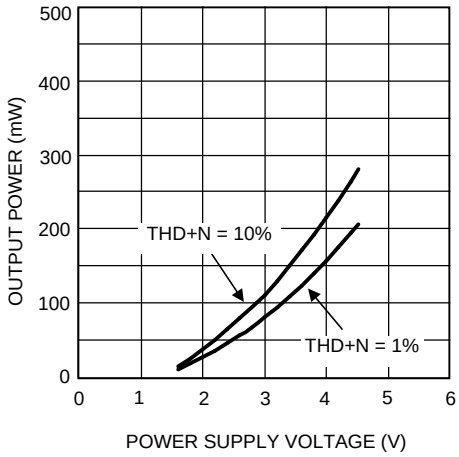

Figure 20.

Output Power vs Power Supply Voltage
R_L = 32Ω, f = 1kHz, Stereo

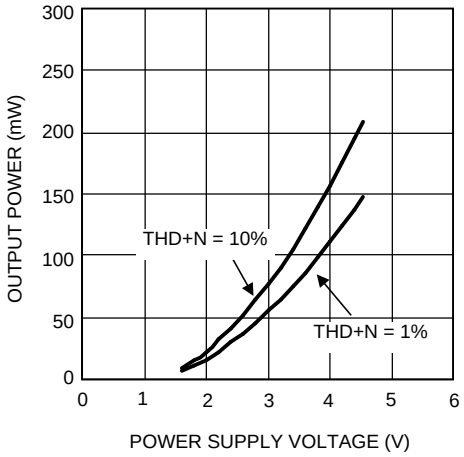

Figure 21.

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Typical Performance Characteristics (continued)

Power Dissipation vs Output Power
V_{DD} = 1.6V, R_L = 16Ω, f = 1kHz

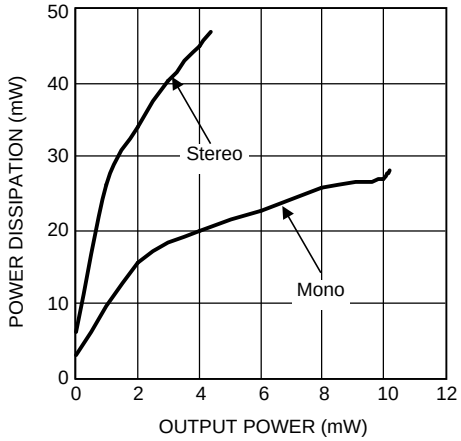

Figure 22.

Power Dissipation vs Output Power
V_{DD} = 1.6V, R_L = 32Ω, f = 1kHz

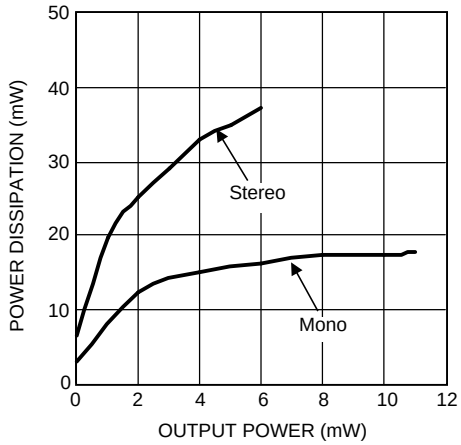

Figure 23.

Power Dissipation vs Output Power
V_{DD} = 3V, R_L = 16Ω, f = 1kHz

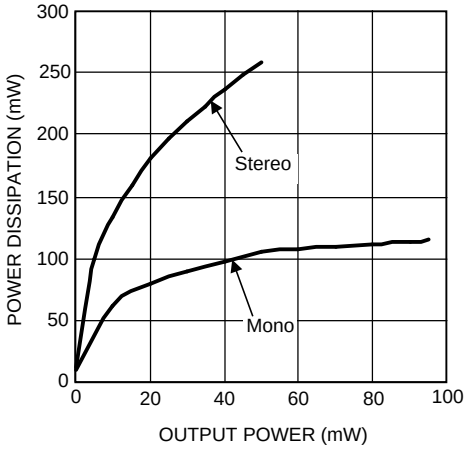

Figure 24.

Power Dissipation vs Output Power
V_{DD} = 3V, R_L = 32Ω, f = 1kHz

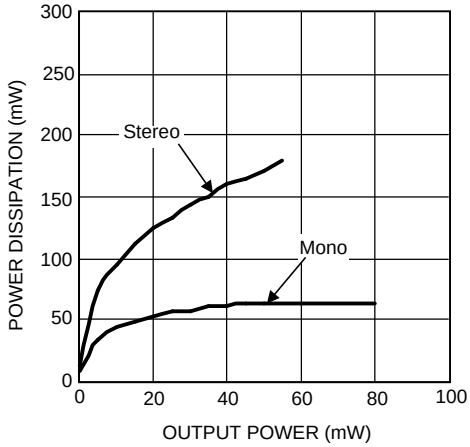

Figure 25.

PSRR vs Frequency
V_{DD} = 1.6V, R_L = 16Ω

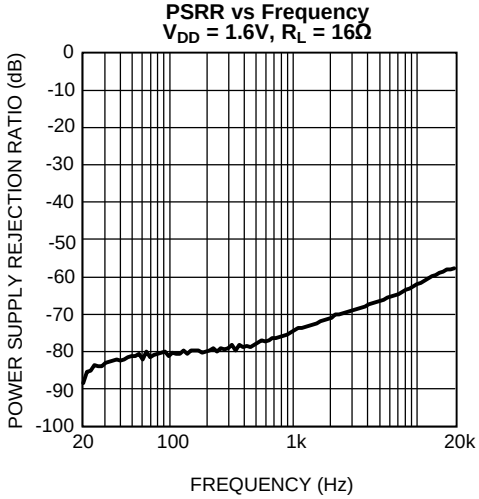

Figure 26.

PSRR vs Frequency
V_{DD} = 1.6V, R_L = 32Ω

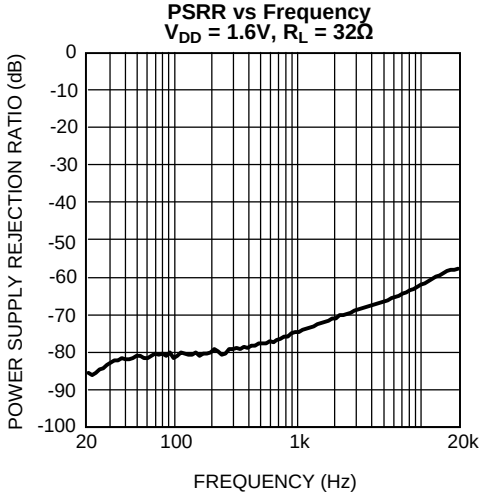

Figure 27.

Typical Performance Characteristics (continued)

PSRR vs Frequency
V_{DD} = 3V, R_L = 16Ω

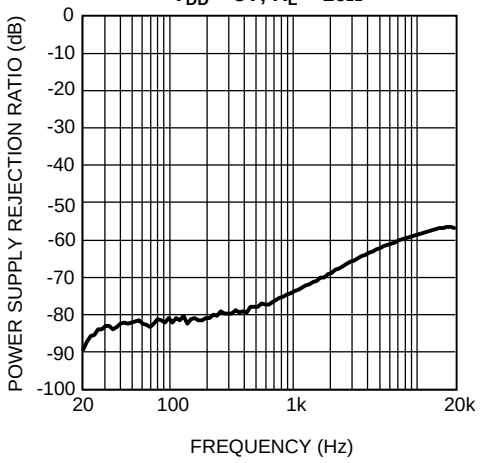

Figure 28.

PSRR vs Frequency
V_{DD} = 3V, R_L = 32Ω

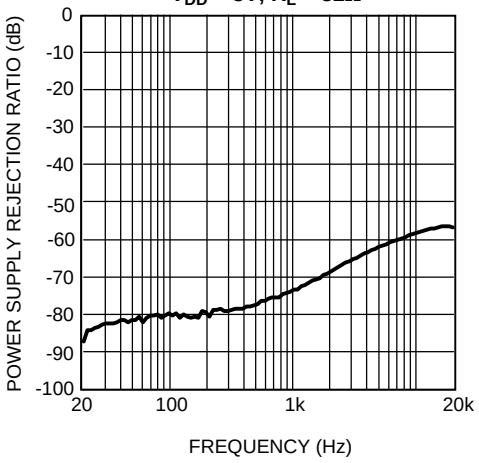

Figure 29.

Power Supply Current vs Power Supply Voltage
V_{IN} = 0V, Mono

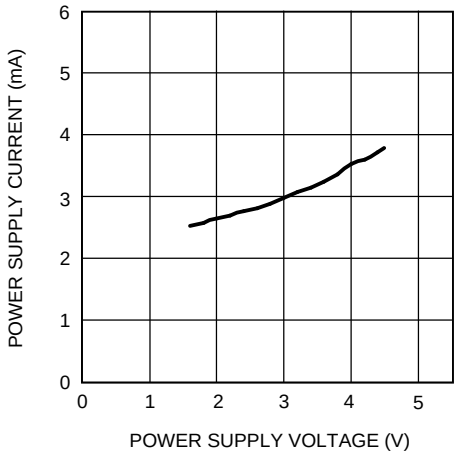

Figure 30.

Power Supply Current vs Power Supply Voltage
V_{IN} = 0V, Stereo

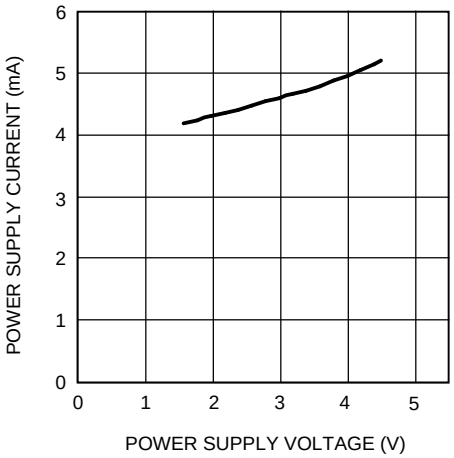

Figure 31.

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APPLICATION INFORMATION

SUPPLY VOLTAGE SEQUENCING

Before applying any signal to the inputs or shutdown pins of the LM48820, it is important to apply a supply voltage to the V_{DD} pins. After the device has been powered, signals may be applied to the shutdown pins (see MICRO POWER SHUTDOWN) and input pins.

ELIMINATING THE OUTPUT COUPLING CAPACITOR

The LM48820 features a low noise inverting charge pump that generates an internal negative supply voltage. This allows the outputs of the LM48820 to be biased about GND instead of a nominal DC voltage, like traditional headphone amplifiers. Because there is no DC component, the large DC blocking capacitors (typically 220µF) are not necessary. The coupling capacitors are replaced by two, small ceramic charge pump capacitors, saving board space and cost.

Eliminating the output coupling capacitors also improves low frequency response. In traditional headphone amplifiers, the headphone impedance and the output capacitor form a high pass filter that not only blocks the DC component of the output, but also attenuates low frequencies, impacting the bass response. Because the LM48820 does not require the output coupling capacitors, the low frequency response of the device is not degraded by external components.

In addition to eliminating the output coupling capacitors, the ground referenced output nearly doubles the available dynamic range of the LM48820 when compared to a traditional headphone amplifier operating from the same supply voltage.

OUTPUT TRANSIENT ('CLICK AND POPS') ELIMINATED

The LM48820 contains advanced circuitry that virtually eliminates output transients ('clicks and pops'). This circuitry prevents all traces of transients when the supply voltage is first applied or when the part resumes operation after coming out of shutdown mode.

AMPLIFIER CONFIGURATION EXPLANATION

As shown in Figure 1, the LM48820 has two internal operational amplifiers. The two amplifiers have internally configured gain, the closed loop gain is set by selecting the ratio of R_f to R_i. Consequently, the gain for each channel of the IC is

$$A_V = -(R_f / R_i) = 1.5 \text{ (V/V)}$$

where

- $R_F = 30k\Omega$
- $R_i = 20k\Omega$ (1)

POWER DISSIPATION

Power dissipation is a major concern when using any power amplifier and must be thoroughly understood to ensure a successful design. Equation 2 states the maximum power dissipation point for a single-ended amplifier operating at a given supply voltage and driving a specified output load.

$$P_{DMAX} = (V_{DD})^2 / (2\pi^2 R_L) \text{ (W)} \quad (2)$$

Since the LM48820 has two operational amplifiers in one package, the maximum internal power dissipation point is twice that of the number which results from Equation 2. Even with large internal power dissipation, the LM48820 does not require heat sinking over a large range of ambient temperatures. From Equation 2 , assuming a 3V power supply and a 16Ω load, the maximum power dissipation point is 28mW per amplifier. Thus the maximum package dissipation point is 56mW. The maximum power dissipation point obtained must not be greater than the power dissipation that results from Equation 3:

$$P_{DMAX} = (T_{JMAX} - T_A) / (\theta_{JA}) \text{ (W)} \quad (3)$$

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For this DSBGA package, θ_{JA} = 86°C/W and T_{JMAX} = 150°C. Depending on the ambient temperature, T_A, of the system surroundings, Equation 3 can be used to find the maximum internal power dissipation supported by the IC packaging. If the result of Equation 2 is greater than that of Equation 3, then either the supply voltage must be decreased, the load impedance increased or T_A reduced. For the typical application of a 3V power supply, with a 16Ω load, the maximum ambient temperature possible without violating the maximum junction temperature is approximately 127°C provided that device operation is around the maximum power dissipation point. Power dissipation is a function of output power and thus, if typical operation is not around the maximum power dissipation point, the ambient temperature may be increased accordingly.

POWER SUPPLY BYPASSING

As with any power amplifier, proper supply bypassing is critical for low noise performance and high power supply rejection. Applications that employ a 3V power supply typically use a 4.7µF capacitor in parallel with a 0.1µF ceramic filter capacitor to stabilize the power supply output, reduce noise on the supply line, and improve the supply's transient response. Keep the length of leads and traces that connect capacitors between the LM48820's power supply pin and ground as short as possible.

MICRO POWER SHUTDOWN

The voltage applied to the $\overline{\text{SD_LC}}$ (shutdown left channel) pin and the $\overline{\text{SD_RC}}$ (shutdown right channel) pin controls the LM48820's shutdown function. When active, the LM48820's micropower shutdown feature turns off the amplifiers' bias circuitry, reducing the supply current. The trigger point is 0.45V (max) for a logic-low level, and 1.2V (min) for logic-high level. The low 0.05µA (typ) shutdown current is achieved by applying a voltage that is as near as ground a possible to the $\overline{\text{SD_LC}}$/$\overline{\text{SD_RC}}$ pins. A voltage that is higher than ground may increase the shutdown current.

There are a few ways to control the micro-power shutdown. These include using a single-pole, single-throw switch, a microprocessor, or a microcontroller. When using a switch, connect an external 100kΩ pull-up resistor between the $\overline{\text{SD_LC}}$/$\overline{\text{SD_RC}}$ pins and V_{DD}. Connect the switch between the $\overline{\text{SD_LC}}$/$\overline{\text{SD_RC}}$ pins and ground. Select normal amplifier operation by opening the switch. Closing the switch connects the $\overline{\text{SD_LC}}$/$\overline{\text{SD_RC}}$ pins to ground, activating micro-power shutdown. The switch and resistor ensure that the $\overline{\text{SD_LC}}$/$\overline{\text{SD_RC}}$ pins will not float. This prevents unwanted state changes. In a system with a microprocessor or microcontroller, use a digital output to apply the control voltage to the $\overline{\text{SD_LC}}$/$\overline{\text{SD_RC}}$ pins. Driving the $\overline{\text{SD_LC}}$/$\overline{\text{SD_RC}}$ pins with active circuitry eliminates the pull-up resistor.

SELECTING PROPER EXTERNAL COMPONENTS

Optimizing the LM48820's performance requires properly selecting external components. Though the LM48820 operates well when using external components with wide tolerances, best performance is achieved by optimizing component values.

Charge Pump Capacitor Selection

Use low (<100mΩ) ESR (equivalent series resistance) ceramic capacitors with an X7R dielectric for best performance. Low ESR capacitors keep the charge pump output impedance to a minimum, extending the headroom on the negative supply. Higher ESR capacitors result in reduced output power from the audio amplifiers.

Charge pump load regulation and output impedance are affected by the value of the flying capacitor (C_C). A larger valued C_C (up to 3.3µF) improves load regulation and minimizes charge pump output resistance. The switch-on resistance dominates the output impedance for capacitor values above 2.2µF.

The output ripple is affected by the value and ESR of the output capacitor (C_{SS}). Larger capacitors reduce output ripple on the negative power supply. Lower ESR capacitors minimize the output ripple and reduce the output impedance of the charge pump.

The LM48820 charge pump design is optimized for 2.2µF, low ESR, ceramic, flying, and output capacitors.

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Input Capacitor Value Selection

Amplifying the lowest audio frequencies requires high value input coupling capacitors (C_{INL} and C_{INR} in Figure 1). A high value capacitor can be expensive and may compromise space efficiency in portable designs. In many cases, however, the speakers used in portable systems, whether internal or external, have little ability to reproduce signals below 150Hz. Applications using speakers with this limited frequency response reap little improvement by using high value input and output capacitors.

Besides affecting system cost and size, the input coupling capacitor has an effect on the LM48820's click and pop performance. The magnitude of the pop is directly proportional to the input capacitor's size. Thus, pops can be minimized by selecting an input capacitor value that is no higher than necessary to meet the desired −3dB frequency.

As shown in Figure 1, the internal input resistor, R_i and the input capacitor, C_{INL} and C_{INR}, produce a -3dB high pass filter cutoff frequency that is found using Equation 4.

$$f_{-3dB} = 1 / 2\pi R_i C_{IN} \text{ (Hz)} \quad (4)$$

Also, careful consideration must be taken in selecting a certain type of capacitor to be used in the system. Different types of capacitors (tantalum, electrolytic, ceramic) have unique performance characteristics and may affect overall system performance.

REVISION HISTORY

Rev	Date	Description
1.0	05/09/07	Initial release.
1.1	05/15/07	Added the BOM table.
1.2	06/25/07	Deleted and replaced some curves. Input text edits also.
B	05/02/2013	Changed layout of National Data Sheet to TI format

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PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
LM48820TM/NOPB	ACTIVE	DSBGA	YFR	14	250	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	-40 to 85	GI7	Samples
LM48820TMX/NOPB	ACTIVE	DSBGA	YFR	14	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	-40 to 85	GI7	Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
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Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Top-Side Marking for that device.

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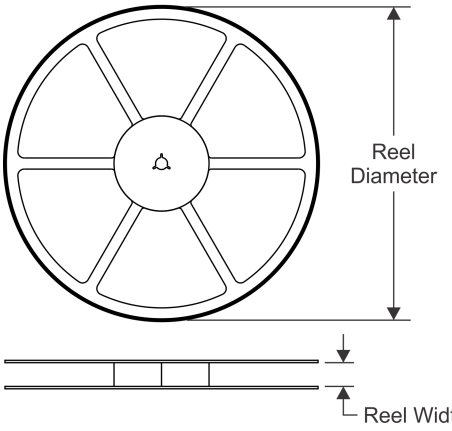
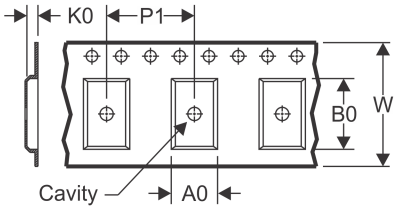
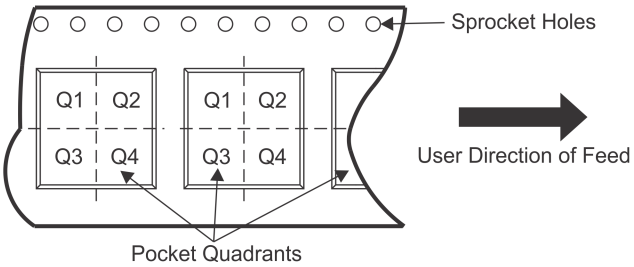


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

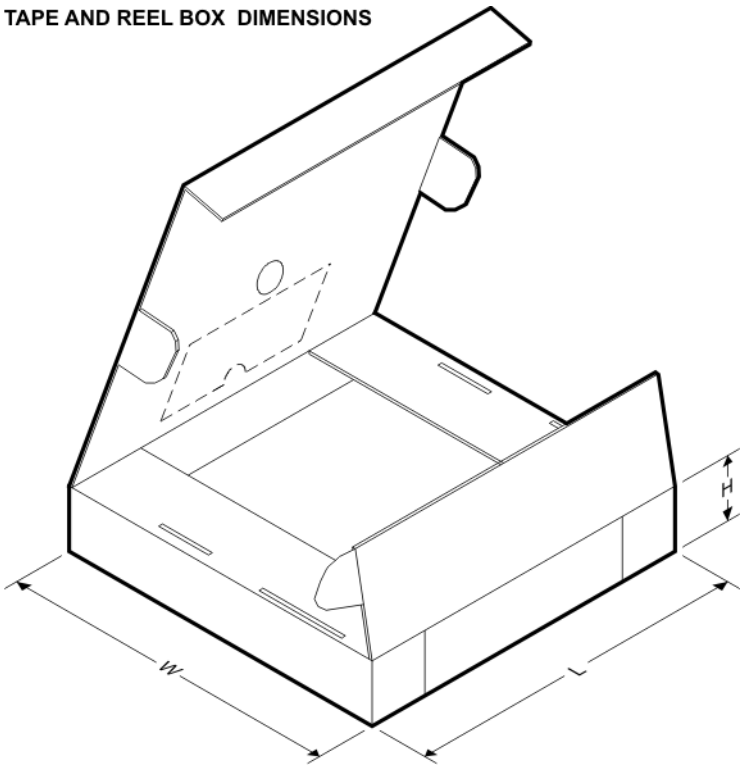
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM48820TM/NOPB	DSBGA	YFR	14	250	178.0	8.4	1.7	1.7	0.76	4.0	8.0	Q1
LM48820TMX/NOPB	DSBGA	YFR	14	3000	178.0	8.4	1.7	1.7	0.76	4.0	8.0	Q1

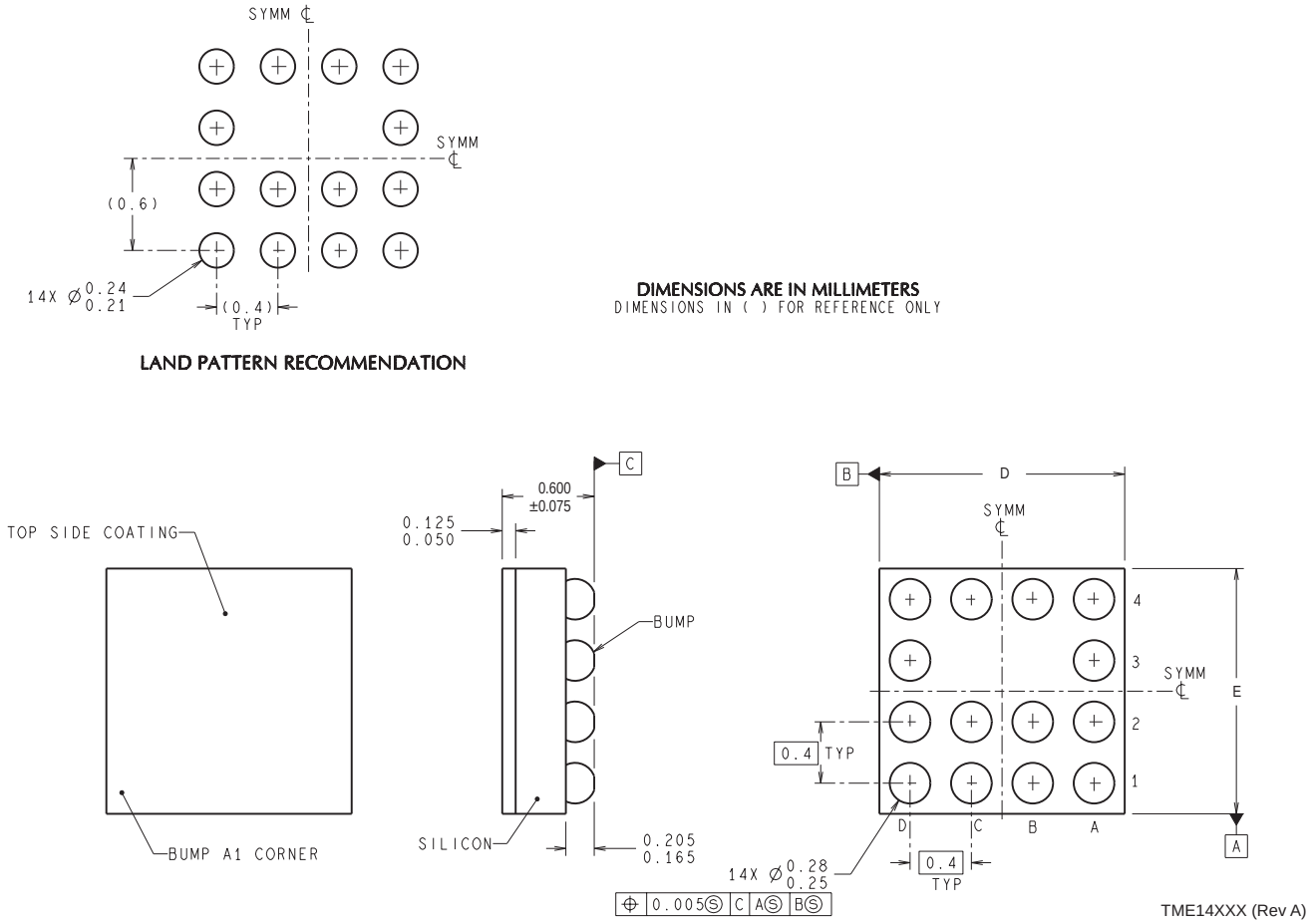
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM48820TM/NOPB	DSBGA	YFR	14	250	210.0	185.0	35.0
LM48820TMX/NOPB	DSBGA	YFR	14	3000	210.0	185.0	35.0

YFR0014



D: Max = 1.64 mm, Min = 1.58 mm

E: Max = 1.64 mm, Min = 1.58 mm

4215090/A 12/12

NOTES: A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
B. This drawing is subject to change without notice.

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