19-3050; Rev 7; 4/10

EVALUATION KIT AVAILABLE

Low-Cost, Mono/Stereo, 1.4W Differential Audio Power Amplifiers

General Description

The MAX9718/MAX9719 differential input audio power amplifiers are ideal for portable audio devices with internal speakers. The differential input structure improves noise rejection and provides common-mode rejection. A bridge-tied load (BTL) architecture minimizes external component count, while providing high-quality, power audio amplification. The MAX9718 is a single-channel amplifier while the MAX9719 is a dual-channel amplifier for stereo systems. Both devices deliver 1.4W continuous average power per channel to a 4Ω load with less than 1% THD+N while operating from a single +5V supply. The devices are available as adjustable gain amplifiers or with internally fixed gains of 0dB, 3dB, and 6dB to reduce component count.

A shutdown input disables the bias generator and amplifiers and reduces quiescent current consumption to less than 100nA. The MAX9718 shutdown input can be set as active high or active low. These devices feature Maxim's comprehensive click-and-pop suppression circuitry that reduces audible clicks and pops during startup and shutdown.

The MAX9718 is pin compatible with the LM4895, and is available in 9-bump UCSP™, 10-pin TDFN, and 10-pin µMAX® packages. The MAX9719 is available in 16-pin TQFN, 16-pin TSSOP, and 16-bump UCSP packages. Both devices operate over the -40°C to +85°C extended temperature range.

Applications

Mobile Phones

PDAs

Portable Devices

Features

- **2.7V to 5.5V Single-Supply Operation**
- **Very High -93dB PSRR at 217Hz**
- **1.4W into 4Ω at 1% THD+N (per Channel)**
- **Differential Input**
- **Internal Fixed Gain to Reduce Component Count**
- **Adjustable Gain Option (MAX9718A/H/MAX9719A)**
- **100nA Low-Power Shutdown Mode**
- **No Audible Clicks or Pops at Power-Up/Down**
- **Improved Performance Pin-Compatible Upgrade to LM4895 (MAX9718D/G)**
- **1.8V Logic Compatible**

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	TOP MARK
MAX9718AEBL+TG45	-40°C to +85°C	3 x 3 UCSP	+ADX
MAX9718AETB+T	-40°C to +85°C	10 TDFN-EP*	+AAV

+Denotes lead(Pb)-free/RoHS-compliant package.

**EP = Exposed pad.*

G45 indicates protective die coating.

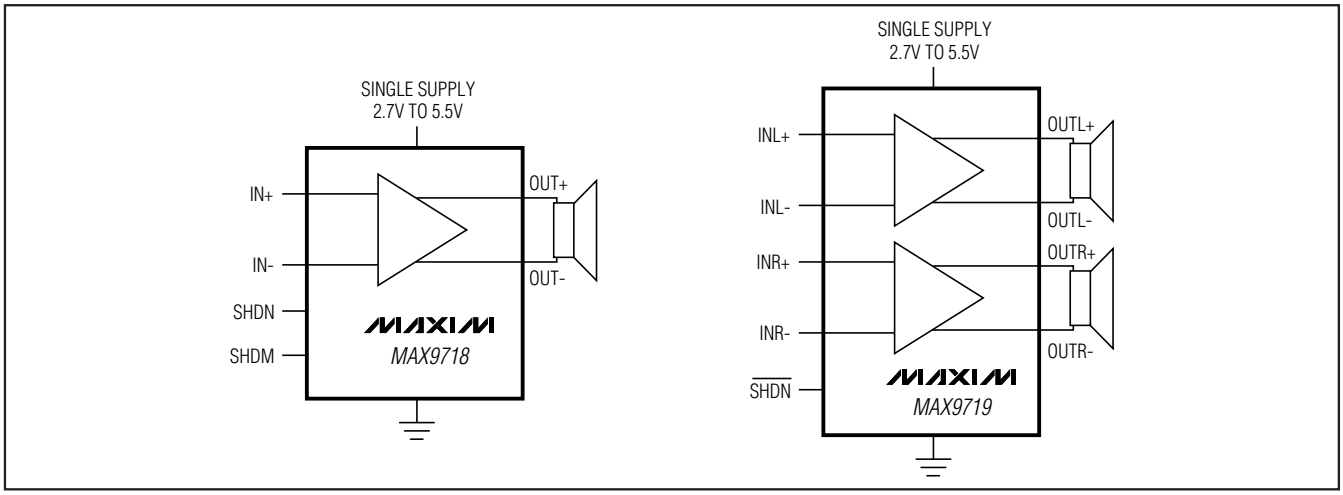
Ordering Information continued at end of data sheet.

Pin Configurations appear at end of data sheet.

UCSP is a trademark of Maxim Integrated Products, Inc.

µMAX is a registered trademark of Maxim Integrated Products, Inc.

Simplified Block Diagrams



For pricing delivery, and ordering information please contact Maxim Direct at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

Low-Cost, Mono/Stereo, 1.4W Differential Audio Power Amplifiers

ABSOLUTE MAXIMUM RATINGS

Supply Voltage (V_{CC} to GND) .....-0.3V to +6V
Any Other Pin to GND .....-0.3V to (V_{CC} + 0.3V)
IN_, BIAS, SHDM, SHDN, $\overline{SHDN}$ Continuous Current 20mA
OUT_ Short-Circuit Duration to GND or V_{CC} .....Continuous
Continuous Power Dissipation (T_A = +70°C)
9-Bump UCSP (derate 5.2mW/°C above +70°C) 1067mW
10-Pin TDFN (derate 24.4mW/°C above +70°C) 1951mW
10-Pin µMAX (derate 10.3mW/°C above +70°C) 825mW
16-Bump UCSP (derate 8.2mW/°C above +70°C) 1633mW
16-Pin TQFN (derate 16.9mW/°C above +70°C) 1349mW
16-Pin TSSOP (derate 21.3mW/°C above +70°C) 1702mW

Operating Temperature Range .....-40°C to +85°C
Junction Temperature .....+150°C
Storage Temperature Range .....-65°C to +150°C
Lead Temperature (soldering, 10s) .....+300°C
Soldering Temperature (reflow) .....+260°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS—5V Supply

(V_{CC} = 5V, GND = 0, SHDN/$\overline{SHDN}$ = V_{CC} (MAX9718/MAX9719), SHDM = GND (MAX9718), R_{IN} = R_F = 10kΩ (MAX971_A/H), T_A = +25°C. C_{BIAS} = 0.1µF, no load. Typical values are at T_A = +25°C, unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Supply Voltage	V_{CC}			2.7		5.5	V
Supply Current	I_{CC}	V_{IN-} = V_{IN+} = V_{BIAS}, T_A = -40°C to +85°C, per amplifier (Note 2)			5.0	7.5	mA
Shutdown Supply Current	I_{SHDN}	SHDN = SHDM = $\overline{SHDN}$ = GND, per amplifier			0.1	1	µA
$\overline{SHDN}$, SHDN, SHDM Threshold	V_{IH}	MAX9718A/B/C/D		0.7 x V_{CC}			V
	V_{IL}					0.3 x V_{CC}	
$\overline{SHDN}$, SHDN, SHDM Threshold	V_{IH}	MAX9718E/F/G/H		1.4			V
	V_{IL}					0.4	
Output Offset Voltage	V_{OS}	V_{IN-} = V_{IN+} = V_{BIAS}	A_V = 0dB, MAX971_A/H, MAX971_B/E		±1	±10	mV
			A_V = 3dB, MAX971_C/F		±1	±15	
			A_V = 6dB, MAX971_D/G		±1	±20	
Common-Mode Input Voltage	V_{IC}	Inferred from CMRR test	A_V = 0dB, MAX971_B/E	0.5		V_{CC} - 0.5	V
			A_V = 3dB, MAX971_C/F	0.5		V_{CC} - 0.6	
			A_V = 6dB, MAX971_D/G	0.5		V_{CC} - 0.8	
		External gain, MAX971_A/H		0.5		V_{CC} - 1.2	
Input Impedance	R_{IN}	MAX971_B/E, MAX971_C/F, MAX971_D/G		10	15	20	kΩ
Common-Mode Rejection Ratio	CMRR			-50	-60		dB
		f_N = 1kHz			-60		
Power-Supply Rejection Ratio	PSRR	V_{IN-} = V_{IN+} = V_{BIAS}, V_{RIPPLE} = 200mV_{P-P}, R_L = 8Ω, C_{BIAS} = 1µF	f = 217Hz		-93		dB
			f = 1kHz		-90		
Output Power	P_{OUT}	THD+N = 1%, f_{IN} = 1kHz (Note 4)	R_L = 8Ω	0.8	1.1		W
			R_L = 4Ω		1.4		
Total Harmonic Distortion Plus Noise	THD+N	R_L = 8Ω, f_{IN} = 1kHz, P_{OUT} = 0.75W, V_{CC} = 5V, A_V = 6dB (Note 5)			0.002		%

ELECTRICAL CHARACTERISTICS—5V Supply (continued)

(V_{CC} = 5V, GND = 0, SHDN/$\overline{SHDN}$ = V_{CC} (MAX9718/MAX9719), SHDM = GND (MAX9718), R_{IN} = R_F = 10kΩ (MAX971_A/H), T_A = +25°C. C_{BIAS} = 0.1µF, no load. Typical values are at T_A = +25°C, unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Gain Accuracy		MAX971_B/E, MAX971_C/F, MAX971_D/G			±1	%
Channel-to-Channel Gain Matching		MAX9719B/E, MAX9719C/F, MAX9719D/G			±1	%
Signal-to-Noise Ratio	SNR	P_{OUT} = 1W, R_L = 8Ω		-104		dB
Thermal-Shutdown Threshold				+160		°C
Thermal-Shutdown Hysteresis				15		°C
Maximum Capacitive Drive	C_{LOAD}	Bridge-tied capacitance		500		pF
Power-Up/Enable from Shutdown Time	t_{PU}			10		ms
Shutdown Time	t_{SHDN}			3.5		µs
Turn-Off Transient	V_{POP}	(Note 6)		50		mV
Crosstalk		MAX9719, f_{IN} = 1kHz		-85		dB

ELECTRICAL CHARACTERISTICS—3V Supply

(V_{CC} = 3V, GND = 0, SHDN/$\overline{SHDN}$ = V_{CC} (MAX9718/MAX9719), SHDM = GND (MAX9718), R_{IN} = R_F = 10kΩ (MAX971_A/H), T_A = +25°C. C_{BIAS} = 0.1µF, no load. Typical values are at T_A = +25°C, unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Supply Current	I_{CC}	V_{IN-} = V_{IN+} = V_{BIAS}, T_A = -40°C to +85°C, per amplifier (Note 2)			3.8	6.0	mA
Shutdown Supply Current	I_{SHDN}	SHDN = SHDM = $\overline{SHDN}$ = GND, per amplifier			0.1	1	µA
$\overline{SHDN}$, SHDN, SHDM Threshold	V_{IH}			0.7 x V_{CC}			V
	V_{IL}					0.3 x V_{CC}	
Common-Mode Bias Voltage	V_{BIAS}	(Note 3)		V_{CC}/2 - 5%	V_{CC}/2	V_{CC}/2 + 5%	V
Output Offset Voltage	V_{OS}	V_{IN-} = V_{IN+} = V_{BIAS}	A_V = 0dB, MAX971_A/H MAX971_B/E		±1	±10	mV
			A_V = 3dB, MAX971_C/F		±1	±15	
			A_V = 6dB, MAX971_D/G		±1	±20	
Common-Mode Input Voltage	V_{IC}	Inferred from CMRR test	A_V = 0dB, MAX971_B/E	0.5		V_{CC} - 0.7	V
			A_V = 3dB, MAX971_C/F	0.5		V_{CC} - 0.8	
			A_V = 6dB, MAX971_D/G	0.5		V_{CC} - 1.0	
		External gain, MAX971_A/H		0.5		V_{CC} - 1.2	
Input Impedance	R_{IN}	MAX971_B/E, MAX971_C/F, MAX971_D/G		10	15	20	kΩ
Common-Mode Rejection Ratio	CMRR			-50	-60		dB
		f_N = 1kHz			-70		
Power-Supply Rejection Ratio	PSRR	V_{IN-} = V_{IN+} = V_{BIAS}, V_{RIPPLE} = 200mV_{P-P}, R_L = 8Ω, C_{BIAS} = 1µF	f = 217Hz		-93		dB
			f = 1kHz		-90		

Low-Cost, Mono/Stereo, 1.4W Differential Audio Power Amplifiers

ELECTRICAL CHARACTERISTICS—3V Supply (continued)

(V_{CC} = 3V, GND = 0, SHDN/$\overline{SHDN}$ = V_{CC} (MAX9718/MAX9719), SHDM = GND (MAX9718), R_{IN} = R_F = 10kΩ (MAX971_A/H), T_A = +25°C. C_{BIAS} = 0.1µF, no load. Typical values are at T_A = +25°C, unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Output Power	P_{OUT}	R_L = 8Ω, THD+N = 1%, f_{IN} = 1kHz (Note 4)		475		mW
Total Harmonic Distortion Plus Noise	THD+N	R_L = 8Ω, f_{IN} = 1kHz, P_{OUT} = 0.25W, A_V = 6dB		0.003		%
Thermal-Shutdown Threshold				+160		°C
Thermal-Shutdown Hysteresis				15		°C
Maximum Capacitive Drive	C_{LOAD}	Bridge-tied capacitance		500		pF
Power-Up/Enable from Shutdown Time	t_{PU}			10		ms
Shutdown Time	t_{SHDN}			3		µs
Turn-Off Transient	V_{POP}	(Note 6)		40		mV
Crosstalk		MAX9719, f_{IN} = 1kHz		-85		dB

Note 1: All specifications are 100% tested at T_A = +25°C. Specifications over temperature (T_A = T_{MIN} to T_{MAX}) are guaranteed by design, not production tested.

Note 2: Quiescent power-supply current is specified and tested with no load. Quiescent power-supply current depends on the offset voltage when a practical load is connected to the amplifier. Guaranteed by design.

Note 3: Common-mode bias voltage is the voltage on BIAS and is nominally V_{CC}/2.

Note 4: Output power is specified by a combination of a functional output current test and characterization analysis.

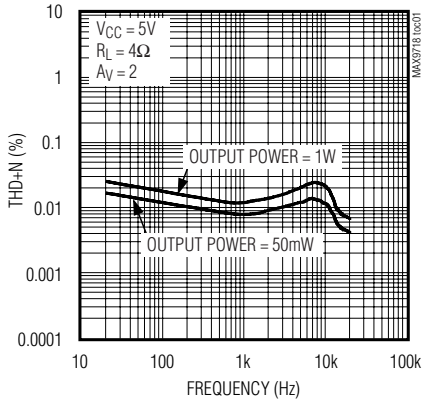
Note 5: Measurement bandwidth for THD+N is 22Hz to 22kHz.

Note 6: Peak voltage measured at power-on, power-off, into or out of SHDN. Bandwidth defined by A-weighted filters, inputs at AC GND. V_{CC} rise and fall times greater than or equal to 1ms.

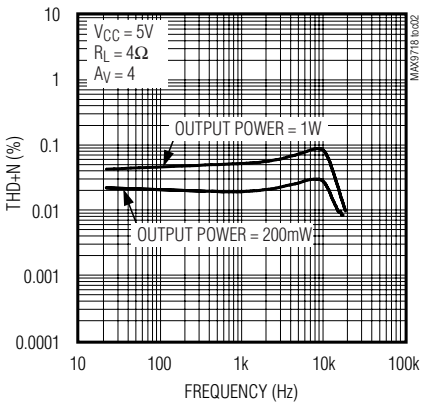
Typical Operating Characteristics

(V_{CC} = 5V, C_{BIAS} = 0.1µF, THD+N measurement bandwidth = 22Hz to 22kHz, T_A = +25°C, unless otherwise noted.)

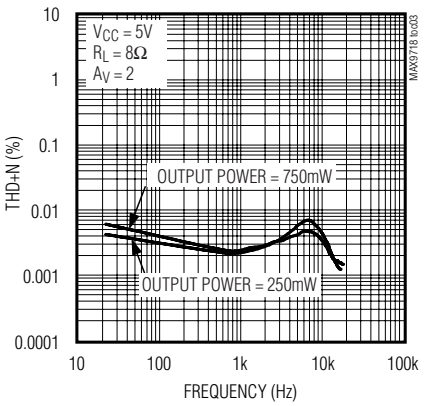
TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY



TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY



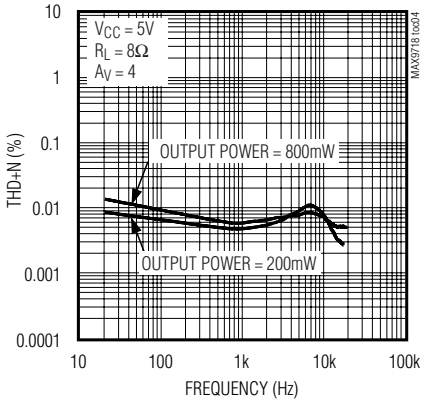
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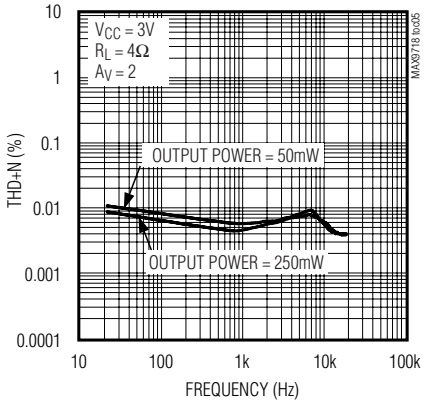
Typical Operating Characteristics (continued)

(V_{CC} = 5V, C_{BIAS} = 0.1µF, THD+N measurement bandwidth = 22Hz to 22kHz, T_A = +25°C, unless otherwise noted.)

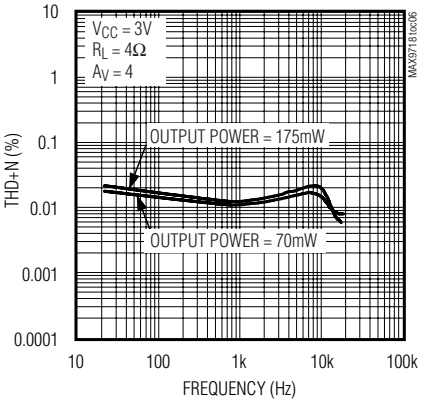
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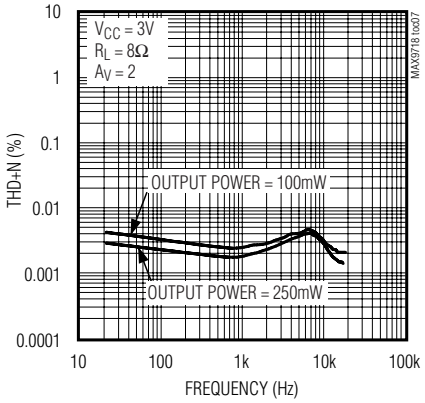
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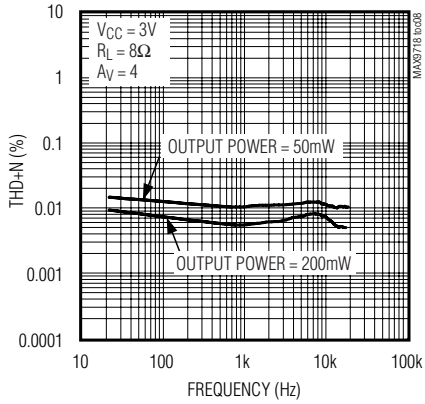
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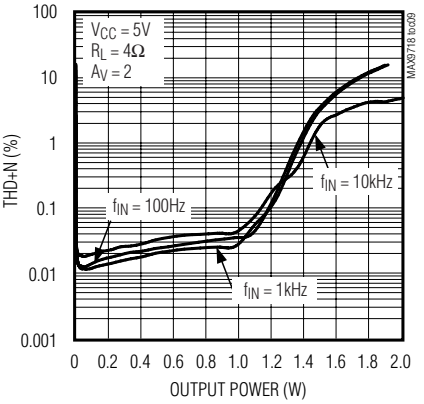
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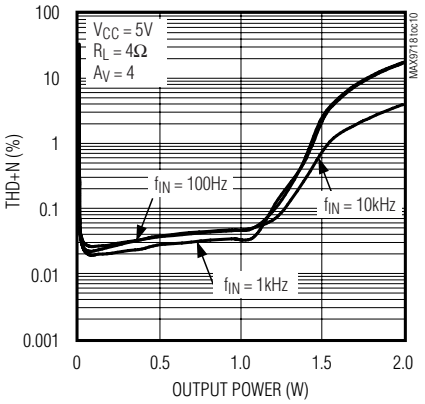
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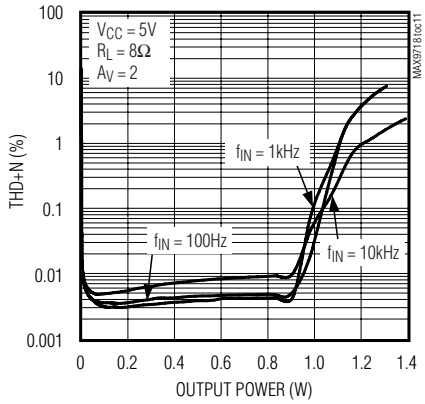
TOTAL HARMONIC DISTORTION PLUS NOISE vs. OUTPUT POWER



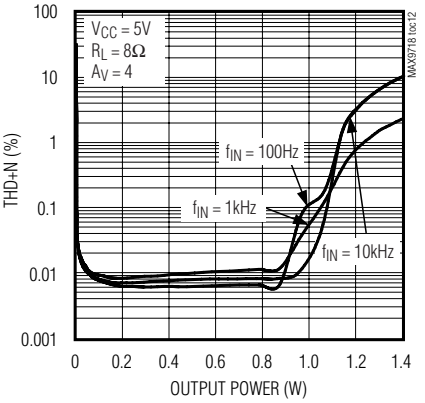
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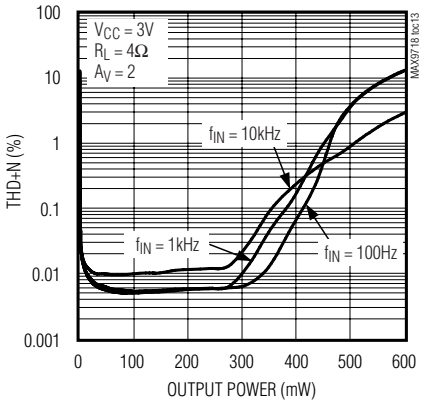


Low-Cost, Mono/Stereo, 1.4W Differential Audio Power Amplifiers

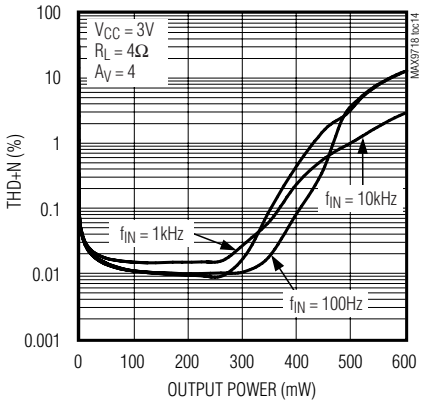
Typical Operating Characteristics (continued)

(V_{CC} = 5V, C_{BIAS} = 0.1µF, THD+N measurement bandwidth = 22Hz to 22kHz, T_A = +25°C, unless otherwise noted.)

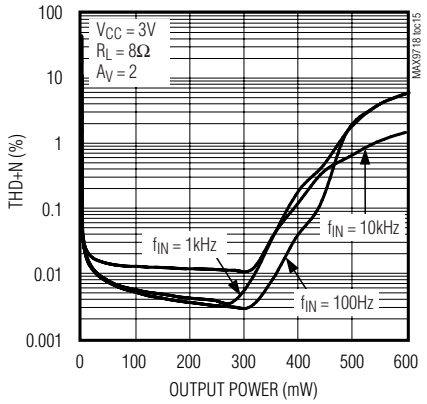
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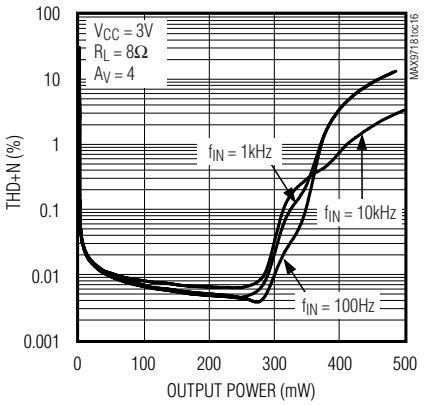
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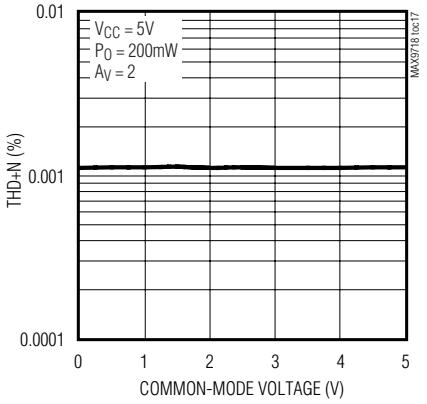
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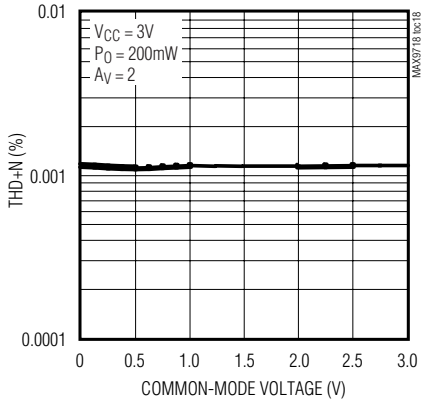
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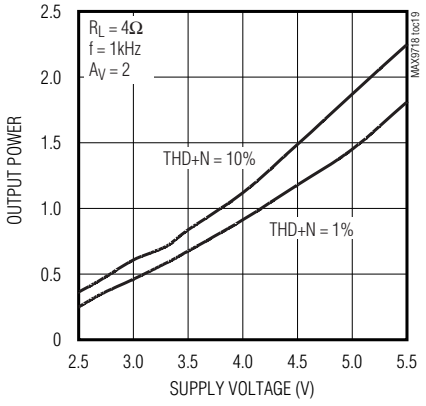
TOTAL HARMONIC DISTORTION PLUS NOISE vs. COMMON-MODE VOLTAGE



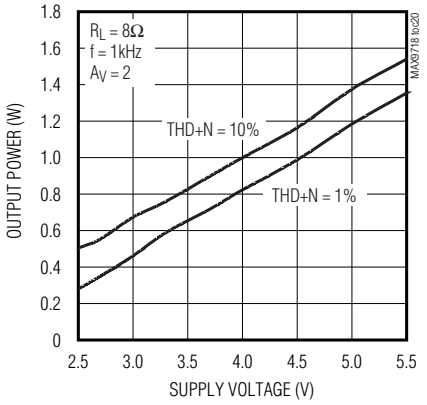
TOTAL HARMONIC DISTORTION PLUS NOISE vs. COMMON-MODE VOLTAGE



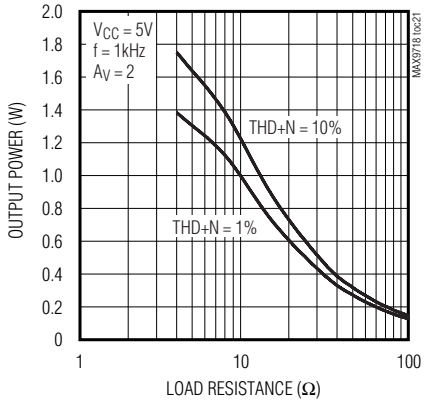
OUTPUT POWER vs. SUPPLY VOLTAGE



OUTPUT POWER vs. SUPPLY VOLTAGE



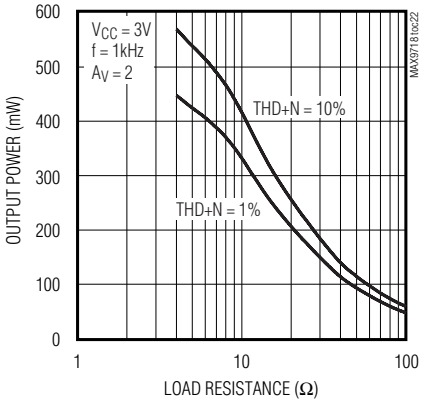
OUTPUT POWER vs. LOAD RESISTANCE



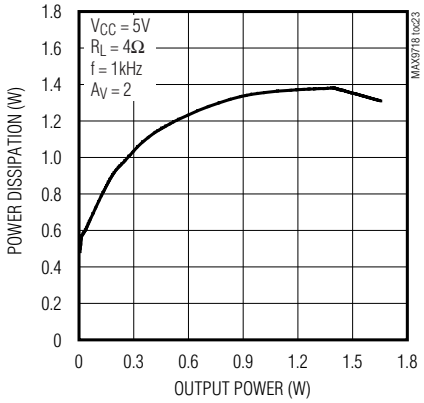
Typical Operating Characteristics (continued)

(V_{CC} = 5V, C_{BIAS} = 0.1µF, THD+N measurement bandwidth = 22Hz to 22kHz, T_A = +25°C, unless otherwise noted.)

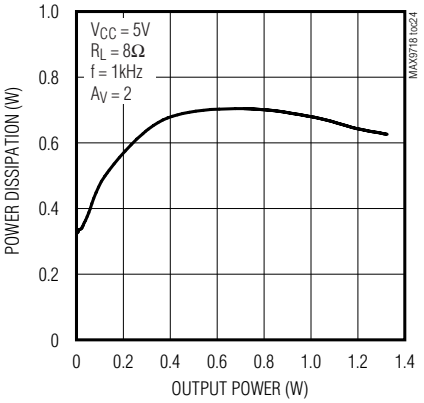
OUTPUT POWER vs. LOAD RESISTANCE



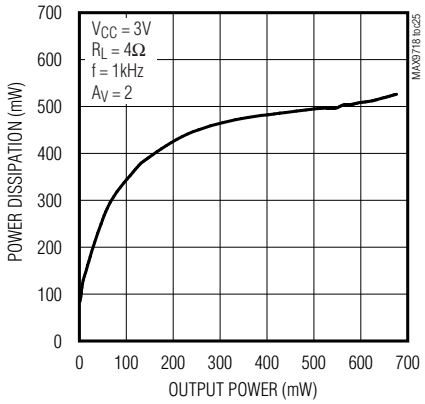
POWER DISSIPATION vs. OUTPUT POWER



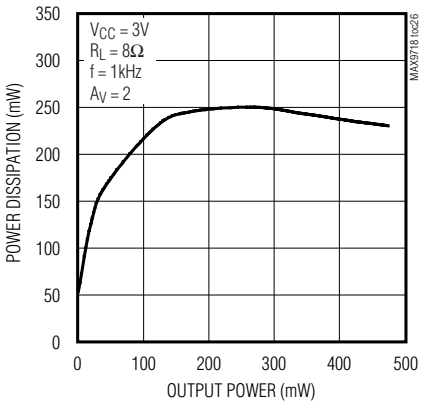
POWER DISSIPATION vs. OUTPUT POWER



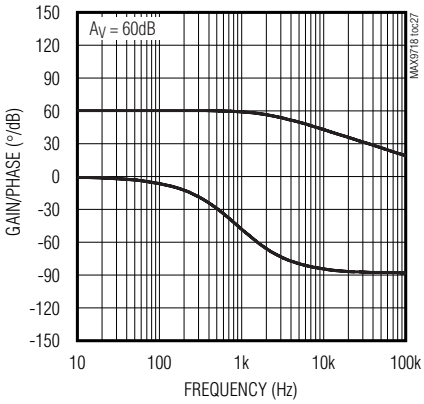
POWER DISSIPATION vs. OUTPUT POWER



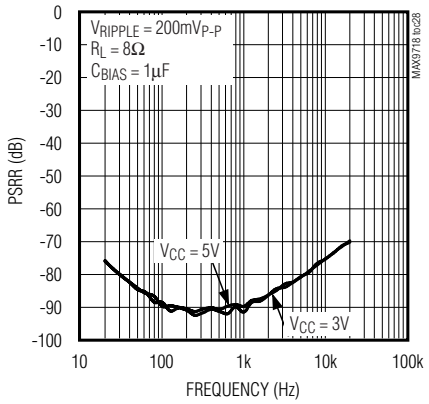
POWER DISSIPATION vs. OUTPUT POWER



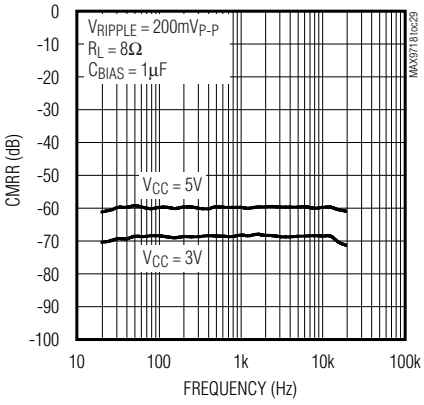
GAIN AND PHASE vs. FREQUENCY



POWER-SUPPLY REJECTION RATIO vs. FREQUENCY



COMMON-MODE REJECTION RATIO vs. FREQUENCY

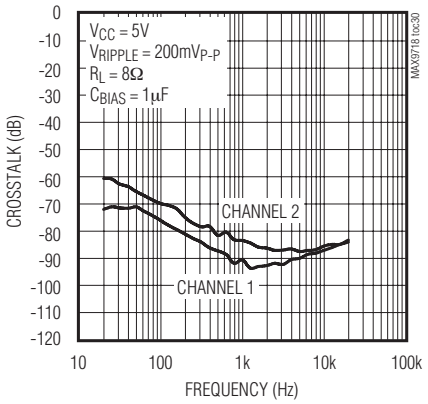


Low-Cost, Mono/Stereo, 1.4W Differential Audio Power Amplifiers

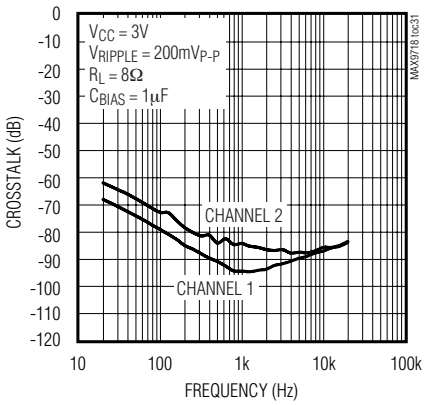
Typical Operating Characteristics (continued)

(V_{CC} = 5V, C_{BIAS} = 0.1µF, THD+N measurement bandwidth = 22Hz to 22kHz, T_A = +25°C, unless otherwise noted.)

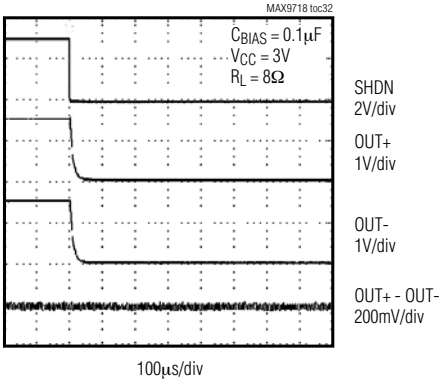
CROSSTALK vs. FREQUENCY



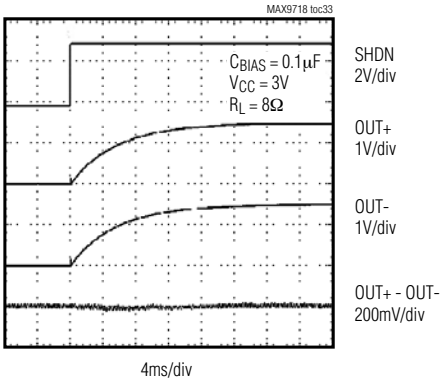
CROSSTALK vs. FREQUENCY



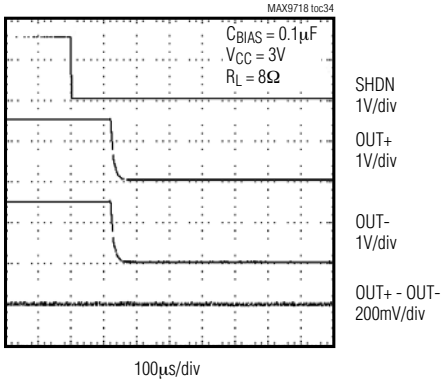
ENTERING SHUTDOWN



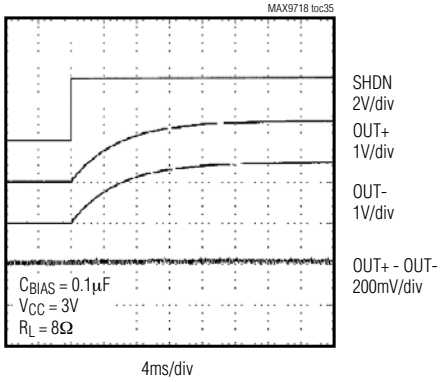
EXITING SHUTDOWN



ENTERING POWER-DOWN



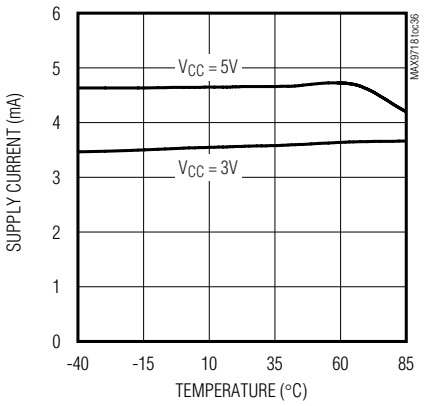
EXITING POWER-DOWN



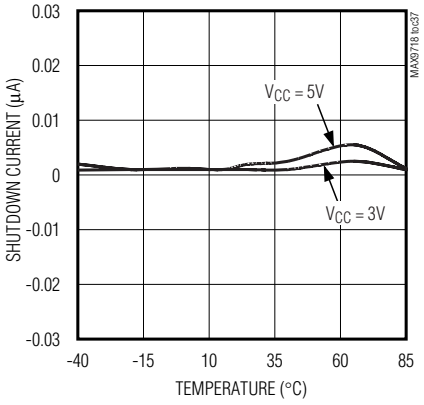
Typical Operating Characteristics (continued)

(V_{CC} = 5V, C_{BIAS} = 0.1µF, THD+N measurement bandwidth = 22Hz to 22kHz, T_A = +25°C, unless otherwise noted.)

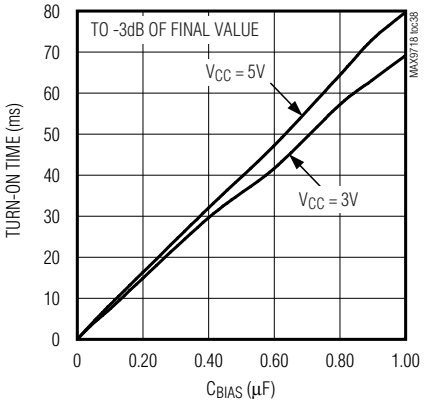
SUPPLY CURRENT vs. TEMPERATURE



SHUTDOWN CURRENT vs. TEMPERATURE



TURN-ON TIME vs. DC BIAS BYPASS CAPACITOR



Pin Description

PIN					NAME	FUNCTION
MAX9718		MAX9719				
TDFN-EP/ µMAX	UCSP	TQFN-EP	UCSP	TSSOP-EP		
1	C2	—	—	—	SHDN	Shutdown Input. The polarity of SHDN is dependent on the state of SHDM.
—	—	9	B3	11	$\overline{SHDN}$	Shutdown Input. Active-low shutdown input.
2	C1	—	—	—	IN-	Inverting Input
3	B2	—	—	—	SHDM	Shutdown-Mode Polarity Input. SHDM controls the polarity of SHDN. Connect SHDM high for an active-high SHDN input. Connect SHDM low for an active-low SHDN input (see Table 1).
4	A1	—	—	—	IN+	Noninverting Input
5	A2	5	B2	7	BIAS	DC Bias Bypass
6	A3	—	—	—	OUT-	Bridge Amplifier Negative Output
7	B3	1, 6, 11	A2, C2, C4	3, 8, 13	GND	Ground
8	—	13	—	15	N.C.	No Connection. Not internally connected.
9	B1	8, 14	A4, D3	16, 10	V_{CC}	Power Supply
10	C3	—	—	—	OUT+	Bridge Amplifier Positive Output
—	—	2	C1	4	INR+	Right-Channel Noninverting Input
—	—	3	B1	5	INL-	Left-Channel Inverting Input
—	—	4	A1	6	INL+	Left-Channel Noninverting Input
—	—	7	A3	9	OUTL+	Left-Channel Bridge Amplifier Positive Output

Low-Cost, Mono/Stereo, 1.4W Differential Audio Power Amplifiers

Pin Description (continued)

PIN					NAME	FUNCTION
TDFN-EP/ µMAX	UCSP	TQFN-EP	UCSP	TSSOP-EP		
—	—	10	B4	12	OUTL-	Left-Channel Bridge Amplifier Negative Output
—	—	12	D4	14	OUTR+	Right-Channel Bridge Amplifier Positive Output
—	—	15	D2	1	OUTR-	Right-Channel Bridge Amplifier Negative Output
—	—	16	D1	2	INR-	Right-Channel Inverting Input
—	—	—	—	—	EP	Exposed Pad. Connect EP to GND.

Detailed Description

The MAX9718/MAX9719 are 1.4W BTL speaker amplifiers. The MAX9718 is a mono speaker amplifier, while the MAX9719 is a stereo speaker amplifier. Both devices feature a low-power shutdown mode and industry-leading click-and-pop suppression. The MAX9718 features a two-input shutdown scheme to configure shutdown for active high or active low. These devices consist of high output-current audio amps configured as BTL amplifiers (see the *Functional Diagrams*). Both adjustable and fixed gain (0dB, 3dB, 6dB) versions are available.

BIAS

These devices operate from a single 2.7V to 5.5V supply and feature an internally generated, common-mode bias voltage of $V_{CC}/2$ referenced to ground. BIAS provides both click-and-pop suppression and sets the DC bias level for the audio outputs. Choose the value of the bypass capacitor as described in the *BIAS Capacitor* section. Do not connect external loads to BIAS as this can affect the overall performance.

Shutdown Mode

The MAX9718/MAX9719 feature a 100nA low-power shutdown mode that reduces quiescent current consumption. Entering shutdown disables the device's bias circuitry, the amplifier outputs go high impedance, and BIAS is driven to GND. The MAX9718 SHDM input controls the polarity of SHDN. Drive SHDM high for an active-high SHDN input. Drive SHDM low for an active-low SHDN input (see Table 1). The MAX9719 features an active-low shutdown input, $\overline{SHDN}$.

Click-and-Pop Suppression

The MAX9718/MAX9719 feature Maxim's industry-leading click-and-pop suppression circuitry. During startup, the amplifier common-mode bias voltage ramps to the DC bias point. When entering shutdown, the amplifier outputs are high impedance to 100kΩ between both outputs. This scheme minimizes the energy present in the audio band.

Table 1. Shutdown Mode Selection (MAX9718 Only)

SHDM	SHDN	OPERATIONAL MODE
0	0	Shutdown
0	1	Normal operation
1	0	Normal operation
1	1	Shutdown

Applications Information

BTL Amplifier

The MAX9718/MAX9719 are designed to drive a load differentially, a configuration referred to as bridge-tied load or BTL. The BTL configuration (Figure 1) offers advantages over the single-ended configuration, where one side of the load is connected to ground. Driving the load differentially doubles the output voltage compared to a single-ended amplifier under similar conditions.

Substituting 2 x $V_{OUT(P-P)}$ for $V_{OUT(P-P)}$ into the following equations yields four times the output power due to doubling of the output voltage:

$$V_{RMS} = \frac{V_{OUT(P-P)}}{2\sqrt{2}}$$

$$P_{OUT} = \frac{V_{RMS}^2}{R_L}$$

Since the differential outputs are biased at midsupply, there is no net DC voltage across the load. This eliminates the need for DC-blocking capacitors required for single-ended amplifiers. These capacitors can be large, expensive, consume board space, and degrade low-frequency performance.

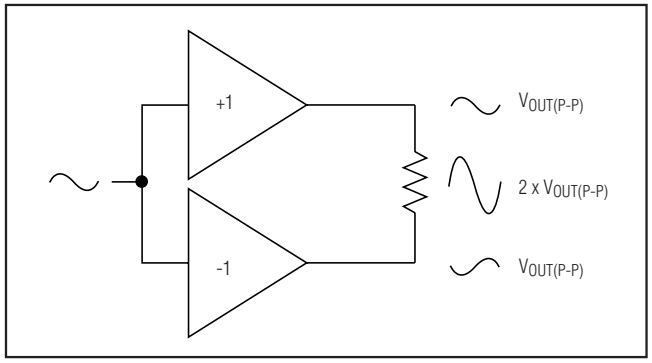


Figure 1. Bridge-Tied Load Configuration

Power Dissipation and Heat Sinking

Under normal operating conditions, the MAX9718/MAX9719 dissipate a significant amount of power. The maximum power dissipation for each package is given in the *Absolute Maximum Ratings* section under Continuous Power Dissipation or can be calculated by the following equation:

$$P_{D(MAX)} = \frac{T_{J(MAX)} - T_A}{\theta_{JA}}$$

where $T_{J(MAX)}$ is +150°C, T_A is the ambient temperature, and θ_{JA} is the reciprocal of the derating factor in °C/W as specified in the *Absolute Maximum Ratings* section. For example, θ_{JA} of the TQFN package is +59.2°C/W.

The increase in power delivered by the BTL configuration directly results in an increase in internal power dissipation over the single-ended configuration. The maximum internal power dissipation for a given V_{CC} and load is given by the following equation:

$$P_{D(MAX)} = \frac{2V_{CC}^2}{\pi^2 R_L}$$

If the internal power dissipation for a given application exceeds the maximum allowed for a given package, reduce power dissipation by increasing the ground plane heat-sinking capability and the size of the traces to the device (see the *Layout and Grounding* section). Other methods for reducing power dissipation are to reduce V_{CC}, increase load impedance, decrease ambient temperature, reduce gain, or reduce input signal.

Thermal-overload protection limits total power dissipation in the MAX9718/MAX9719. When the junction temperature exceeds +160°C, the thermal protection circuitry disables the amplifier output stage. The amplifiers are enabled once the junction temperature cools by 15°C. A pulsing output under continuous thermal overload results as the device heats and cools.

For optimum power dissipation and heat sinking, connect the exposed pad found on the µMAX, TDFN, TQFN, and TSSOP packages to a large ground plane.

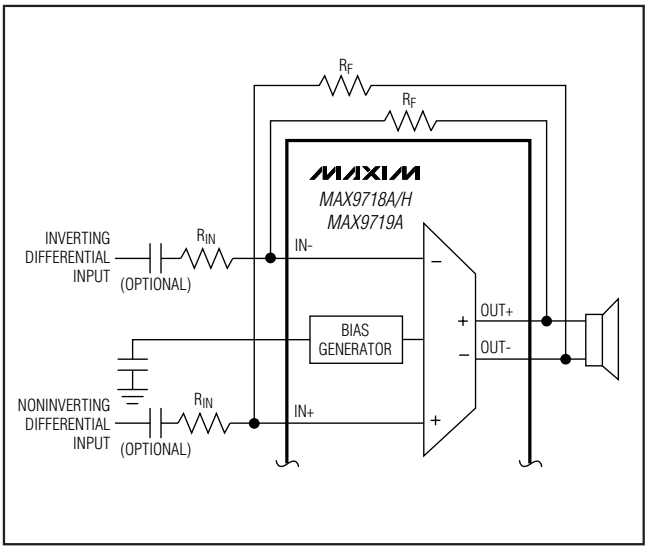


Figure 2. Setting the MAX9718A/H/MAX9719A Gain

Fixed Differential Gain

The MAX9718B/E, MAX9718C/F, MAX9718D/G, MAX9719B, MAX9719C, and MAX9719D feature internally fixed gains (see the *Selector Guide*). This simplifies design, decreases required footprint size, and eliminates external gain-setting resistors. Resistors R_1 and R_2 shown in the *Functional Diagrams* are used to achieve each fixed gain.

Adjustable Differential Gain

Gain-Setting Resistors

External feedback resistors set the gain of the MAX9718A/H and MAX9719A. Resistors R_F and R_{IN} (Figure 2) set the gain of the amplifier as follows:

$$A_V = \frac{R_F}{R_{IN}}$$

where A_V is the desired voltage gain. Hence, an R_{IN} of 10kΩ and an R_F of 20kΩ yields a gain of 2V/V, or 6dB.

R_F can be either fixed or variable, allowing the use of a digitally controlled potentiometer to alter the gain under software control.

Low-Cost, Mono/Stereo, 1.4W Differential Audio Power Amplifiers

Input Filter

The fully differential amplifier inputs can be biased at voltages other than midsupply. The common-mode feedback circuit adjusts for input bias, ensuring the outputs are still biased at midsupply. Input capacitors are not required as long as the common-mode input voltage is within the specified range listed in the *Electrical Characteristics* table.

If input capacitors are used, input capacitor C_{IN}, in conjunction with R_{IN}, forms a highpass filter that removes the DC bias from an incoming signal. The AC-coupling capacitor allows the amplifier to bias the signal to an optimum DC level. Assuming zero-source impedance, the -3dB point of the highpass filter is given by:

$$f_{-3dB} = \frac{1}{2\pi R_{IN} C_{IN}}$$

Setting f_{-3dB} too high affects the low-frequency response of the amplifier. Use capacitors with dielectrics that have low-voltage coefficients, such as tantalum or aluminum electrolytic. Capacitors with high-voltage coefficients, such as ceramics, can increase distortion at low frequencies.

BIAS Capacitor

BIAS is the output of the internally generated $V_{CC}/2$ bias voltage. The BIAS bypass capacitor, C_{BIAS}, improves PSRR and THD+N by reducing power supply and other noise sources at the common-mode bias node, and also generates the clickless/popless startup DC bias waveform for the speaker amplifiers. Bypass BIAS with a 0.1µF capacitor to GND. Larger values of C_{BIAS} (up to 1µF) improve PSRR, but slow down t_{ON}/t_{OFF} times. A 1µF C_{BIAS} capacitor slows turn-on and turn-off times by 10 and improves PSRR by 20dB (at 1kHz). Do not connect external loads to BIAS.

Supply Bypassing

Proper power-supply bypassing ensures low-noise, low-distortion performance. Connect a 1µF ceramic capacitor from V_{CC} to GND. Add additional bulk capacitance as required by the application. Locate the bypass capacitor as close to the device as possible.

Layout and Grounding

Good PC board layout is essential for optimizing performance. Use large traces for the power-supply inputs and amplifier outputs to minimize losses due to parasitic trace resistance and route heat away from the device. Good grounding improves audio performance, minimizes crosstalk between channels, and prevents any digital switching noise from coupling into the audio signal.

The MAX9718/MAX9719 TDFN, TQFN, TSSOP, and µMAX packages feature exposed thermal pads on their undersides. This pad lowers the thermal resistance of the package by providing a direct-heat conduction path from the die to the PC board. Connect the exposed pad to the ground plane using multiple vias, if required.

UCSP Applications Information

For the latest application details on UCSP construction, dimensions, tape carrier information, PC board techniques, bump-pad layout, and recommended reflow temperature profile, as well as the latest information on reliability testing results, refer to the Application Note 1891: *Wafer-Level Packaging (WLP) and Its Applications*.

Selector Guide

PART	MONO	STEREO	GAIN (dB)	SELECTABLE SHUTDOWN POLARITY
MAX9718A/H	√	—	Adjustable	√
MAX9718B/E	√	—	0	√
MAX9718C/F	√	—	3	√
MAX9718D/G	√	—	6	√
MAX9719A	—	√	Adjustable	—
MAX9719B	—	√	0	—
MAX9719C	—	√	3	—
MAX9719D	—	√	6	—

Low-Cost, Mono/Stereo, 1.4W Differential Audio Power Amplifiers

Ordering Information (continued)

PART	TEMP RANGE	PIN-PACKAGE	TOP MARK
MAX9718AEUB+	-40°C to +85°C	10 µMAX-EP*	+AAAA
MAX9718BEBL+TG45	-40°C to +85°C	3 x 3 UCSP	+ADX
MAX9718BETB+T	-40°C to +85°C	10 TDFN-EP*	+AAW
MAX9718BEUB+	-40°C to +85°C	10 µMAX-EP*	+AAAB
MAX9718CEBL+TG45	-40°C to +85°C	3 x 3 UCSP	+ADZ
MAX9718CETB+T	-40°C to +85°C	10 TDFN-EP*	+AAX
MAX9718CEUB+	-40°C to +85°C	10 µMAX-EP*	+AAAC
MAX9718DEBL+TG45	-40°C to +85°C	3 x 3 UCSP	+AEA
MAX9718DETB+T	-40°C to +85°C	10 TDFN-EP*	+AAY
MAX9718DEUB+	-40°C to +85°C	10 µMAX-EP*	+AAAD
MAX9718EEBL+TG45	-40°C to +85°C	3 x 3 UCSP	+AFB
MAX9718EETB+T	-40°C to +85°C	10 TDFN-EP*	+ASY
MAX9718EEUB+	-40°C to +85°C	10 µMAX-EP*	+AAAJ
MAX9718FEBL+TG45	-40°C to +85°C	3 x 3 UCSP	+AFC
MAX9718FETB+T	-40°C to +85°C	10 TDFN-EP*	+ASZ
MAX9718FEUB+	-40°C to +85°C	10 µMAX-EP*	+AAAK
MAX9718GEBL+TG45	-40°C to +85°C	3 x 3 UCSP	+AFD
MAX9718GETB+T	-40°C to +85°C	10 TDFN-EP*	+ATA
MAX9718GEUB+	-40°C to +85°C	10 µMAX-EP*	+AAAL
MAX9718HEBL+TG45	-40°C to +85°C	3 x 3 UCSP	+AFE
MAX9718HETB+T	-40°C to +85°C	10 TDFN-EP*	+ATB
MAX9718HEUB+	-40°C to +85°C	10 µMAX-EP*	+AAAM
MAX9719AEBE+T	-40°C to +85°C	4 x 4 UCSP	—
MAX9719AETE+	-40°C to +85°C	16 TQFN-EP*	—
MAX9719AEUE+	-40°C to +85°C	16 TSSOP-EP*	—
MAX9719BEBE+TG45	-40°C to +85°C	4 x 4 UCSP	—
MAX9719BETE+	-40°C to +85°C	16 TQFN-EP*	—
MAX9719BEUE+	-40°C to +85°C	16 TSSOP-EP*	—
MAX9719CEBE+TG45	-40°C to +85°C	4 x 4 UCSP	—
MAX9719CETE+	-40°C to +85°C	16 TQFN-EP*	—
MAX9719CEUE+	-40°C to +85°C	16 TSSOP-EP*	—
MAX9719DEBE+TG45	-40°C to +85°C	4 x 4 UCSP	—
MAX9719DETE+	-40°C to +85°C	16 TQFN-EP*	—
MAX9719DEUE+	-40°C to +85°C	16 TSSOP-EP*	—

+Denotes lead(Pb)-free/RoHS-compliant package.

**EP = Exposed pad.*

G45 indicates protective die coating.

UCSP Marking Information



■: A1 Bump indicator

AAA: Product code

XXX: Lot code

Chip Information

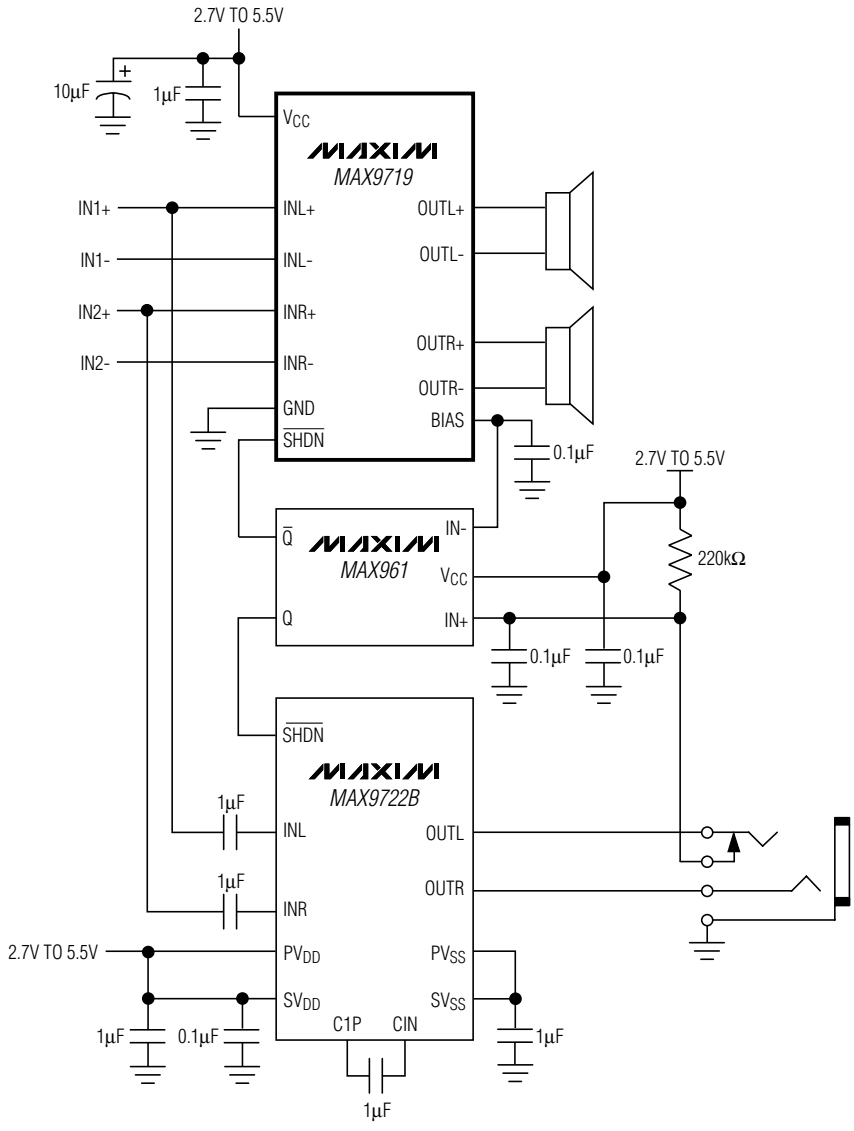
MAX9718 TRANSISTOR COUNT: 2359

MAX9719 TRANSISTOR COUNT: 4447

PROCESS: BiCMOS

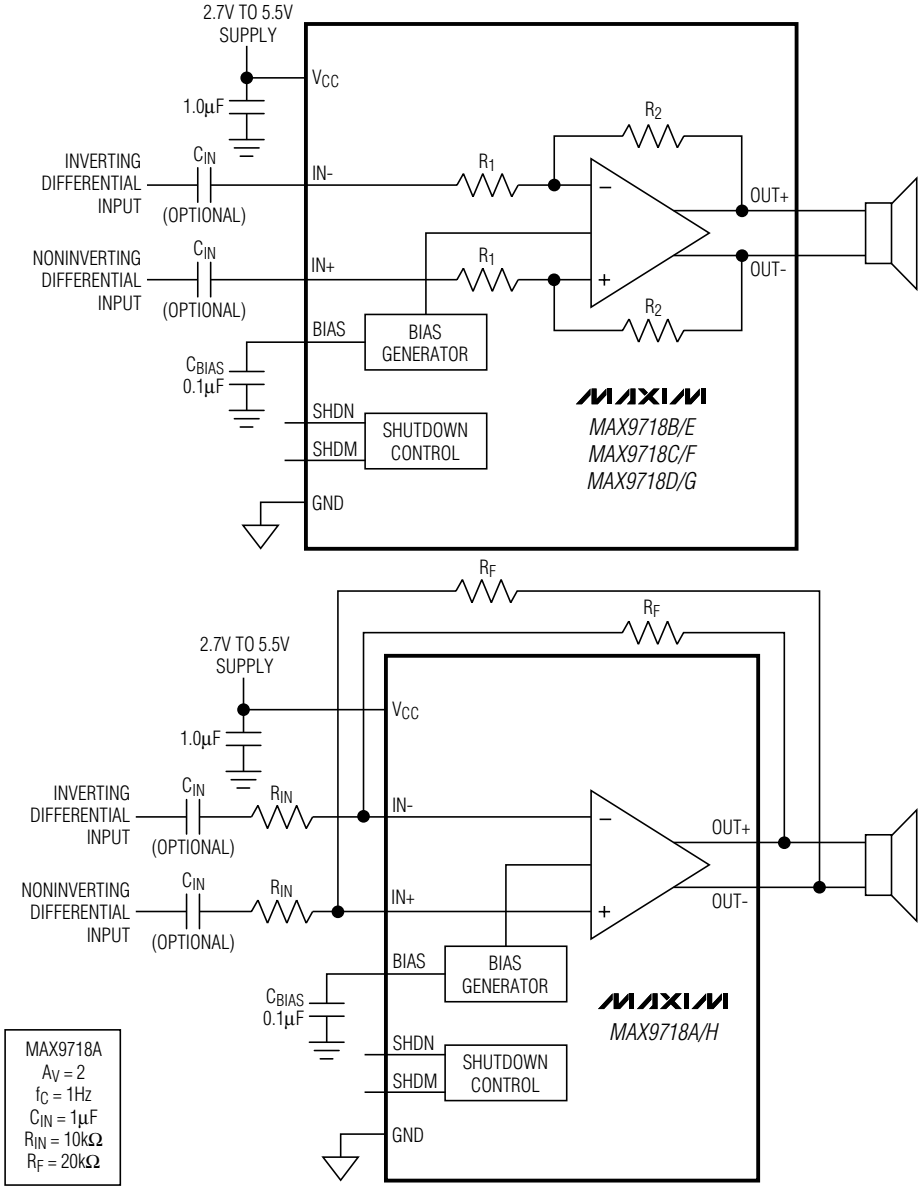
Low-Cost, Mono/Stereo, 1.4W Differential Audio Power Amplifiers

System Diagram



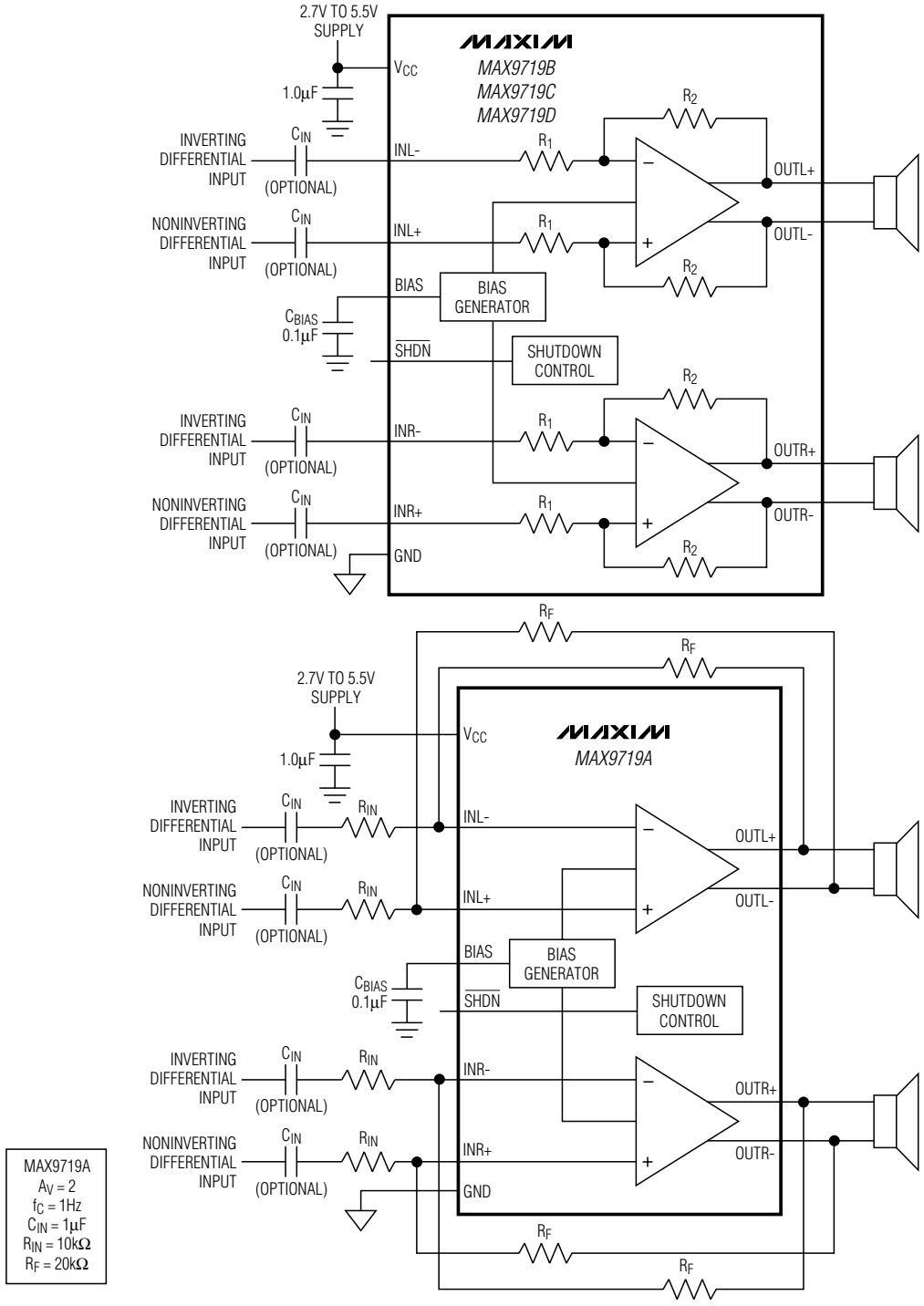
AUTOMATIC HEADPHONE DETECTION AND SPEAKER DISABLE CIRCUIT

Functional Diagrams



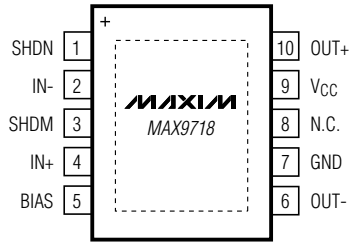
Low-Cost, Mono/Stereo, 1.4W Differential Audio Power Amplifiers

Functional Diagrams (continued)



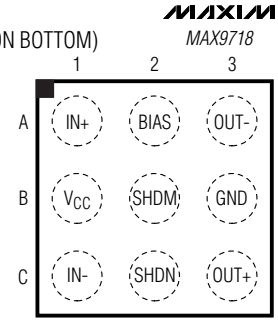
Pin Configurations

TOP VIEW



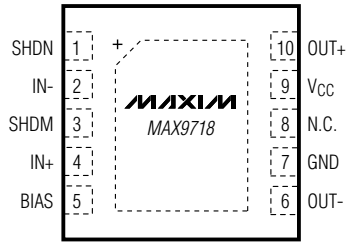
µMAX

TOP VIEW
(BUMPS ON BOTTOM)



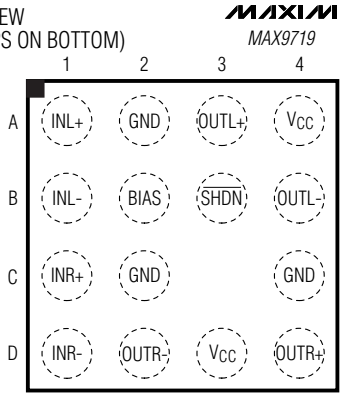
3 × 3 UCSP

TOP VIEW



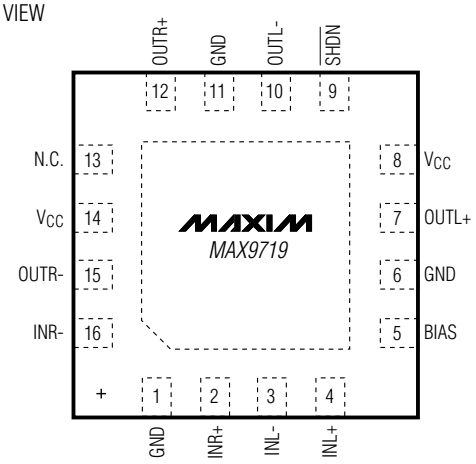
TDFN
(3mm × 3mm × 0.8mm)

TOP VIEW
(BUMPS ON BOTTOM)



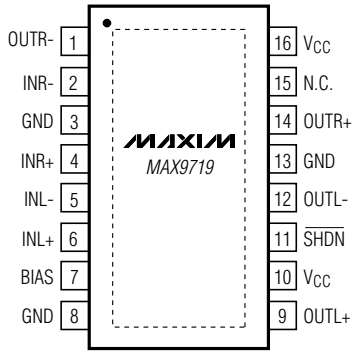
4 × 4 UCSP

TOP VIEW



TQFN
(4mm × 4mm × 0.8mm)

TOP VIEW



TSSOP-EP

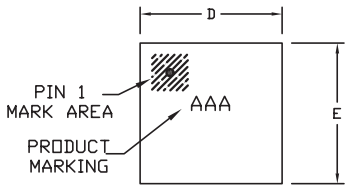
Low-Cost, Mono/Stereo, 1.4W Differential Audio Power Amplifiers

Package Information

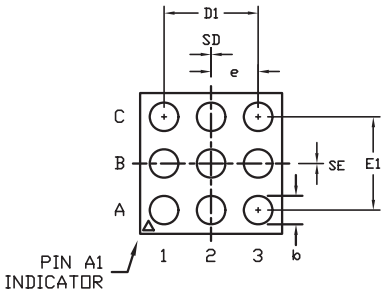
For the latest package outline information and land patterns, go to **www.maxim-ic.com/packages**. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

PACKAGE TYPE	PACKAGE CODE	DOCUMENT NO.
3 x 3 UCSP	B9+1	21-0093
10 TDFN-EP	T1033+1	21-0137
10 µMAX	U10E+3	21-0109
4 x 4 UCSP	B16+6	21-0101
16 TQFN-EP	T1644+4	21-0139
16 TSSOP-EP	U16E+3	21-0108

9LUCSP, 3x3.EPS



TOP VIEW

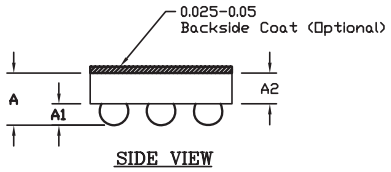


BOTTOM VIEW

COMMON DIMENSIONS	
A	0.62±0.05-0.08
A1	0.29±0.02
A2	0.33 REF.
b	ø0.35±0.03
D1	1.00 BASIC
E1	1.00 BASIC
e	0.50 BASIC
SD	0.00 BASIC
SE	0.00 BASIC

PKG. CODE	VARIABLE DIMENSIONS		DEPOPULATED SOLDER BALLS
	D	E	
B9-1	1.52±0.05	1.52±0.05	NONE
B9-2	1.52±0.05	1.52±0.05	B2
B9-3	1.52±0.05	1.52±0.05	B1, B2, B3
B9-4	1.60±0.05	1.60±0.05	NONE
B9-5	1.60±0.05	1.60±0.05	B2
B9-6	1.60±0.05	1.60±0.05	B1, B2, B3
B9-7	1.52±0.05	1.52±0.05	A2, B1, B2, B3, C2
B9-8	1.98±0.05	1.75±0.05	B1, B2, B3

NOTES:
1. All dimensions in millimeters.
2. Outer dimension (D & E) is defined by center lines between scribe lines.
3. Marking shown is for package orientation reference only. Number of characters and lines vary per product.
4. All dimensions are applicable to Leaded (-), PbFree (+), and MaxFilm parts/pkg codes.



SIDE VIEW

-DRAWING NOT TO SCALE-

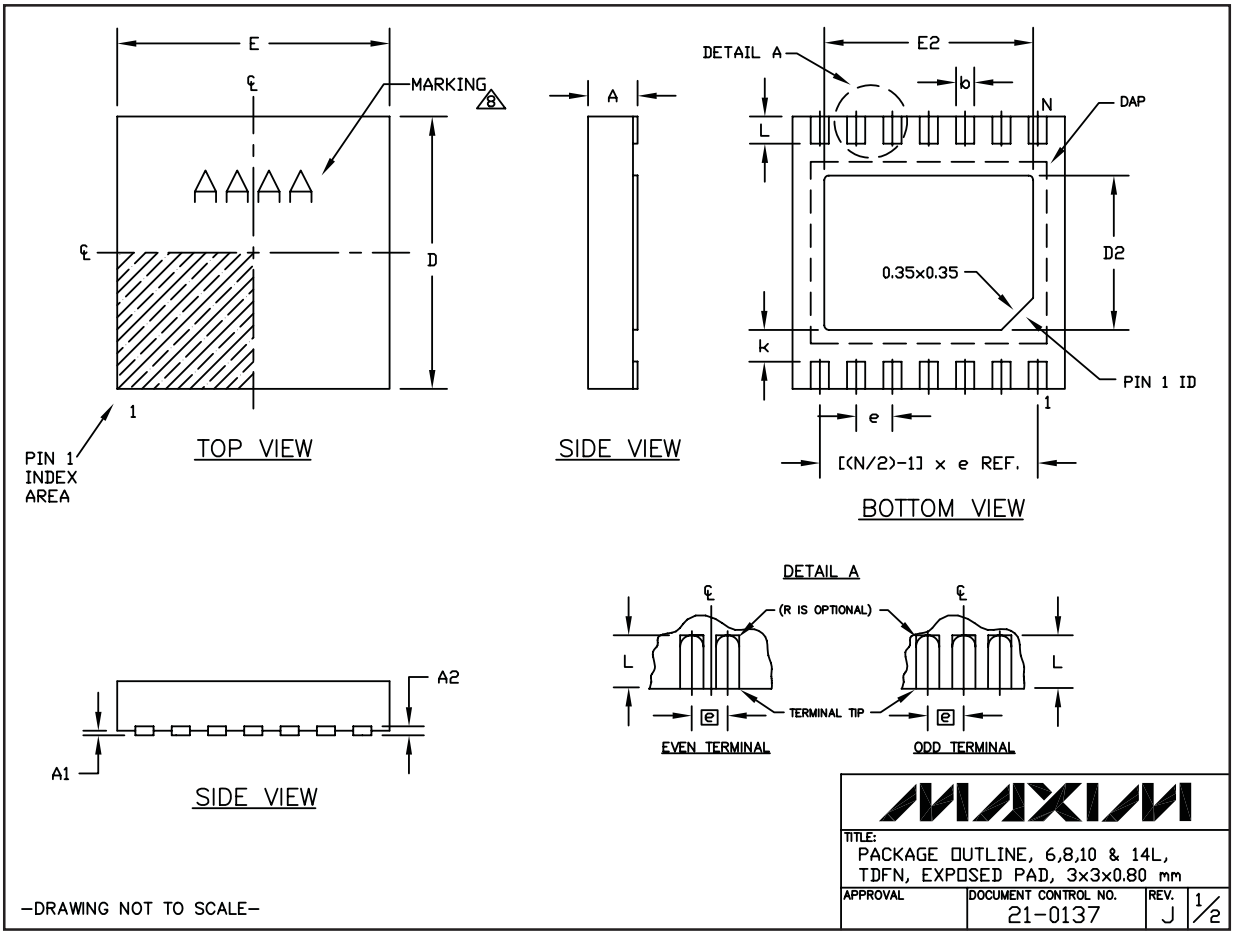
MAXIM

TITLE:
PACKAGE OUTLINE,
9 BUMPS, 3X3 ARRAY, UCSP (B) PKG.

APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0093	M	1/1

Package Information (continued)

For the latest package outline information and land patterns, go to **www.maxim-ic.com/packages**. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.



Low-Cost, Mono/Stereo, 1.4W Differential Audio Power Amplifiers

Package Information (continued)

For the latest package outline information and land patterns, go to **www.maxim-ic.com/packages**. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

COMMON DIMENSIONS		
SYMBOL	MIN.	MAX.
A	0.70	0.80
D	2.90	3.10
E	2.90	3.10
A1	0.00	0.05
L	0.20	0.40
k	0.25 MIN.	
A2	0.20 REF.	

PACKAGE VARIATIONS							
PKG. CODE	N	D2	E2	e	JEDEC SPEC	b	[(N/2)-1] x e
T633-2	6	1.50±0.10	2.30±0.10	0.95 BSC	MO229 / WEEA	0.40±0.05	1.90 REF
T833-2	8	1.50±0.10	2.30±0.10	0.65 BSC	MO229 / WEEC	0.30±0.05	1.95 REF
T833-3	8	1.50±0.10	2.30±0.10	0.65 BSC	MO229 / WEEC	0.30±0.05	1.95 REF
T1033-1	10	1.50±0.10	2.30±0.10	0.50 BSC	MO229 / WEED-3	0.25±0.05	2.00 REF
T1033MK-1	10	1.50±0.10	2.30±0.10	0.50 BSC	MO229 / WEED-3	0.25±0.05	2.00 REF
T1033-2	10	1.50±0.10	2.30±0.10	0.50 BSC	MO229 / WEED-3	0.25±0.05	2.00 REF
T1433-1	14	1.70±0.10	2.30±0.10	0.40 BSC	----	0.20±0.05	2.40 REF
T1433-2	14	1.70±0.10	2.30±0.10	0.40 BSC	----	0.20±0.05	2.40 REF
T1433-3F	14	1.70±0.10	2.30±0.10	0.40 BSC	----	0.20±0.05	2.40 REF

NOTES:
1. ALL DIMENSIONS ARE IN mm. ANGLES IN DEGREES.
2. COPLANARITY SHALL NOT EXCEED 0.08 mm.
3. WARPAGE SHALL NOT EXCEED 0.10 mm.
4. PACKAGE LENGTH/PACKAGE WIDTH ARE CONSIDERED AS SPECIAL CHARACTERISTIC(S).
5. DRAWING CONFORMS TO JEDEC MO229, EXCEPT DIMENSIONS "D2" AND "E2", AND T1433-1 & T1433-2.
6. "N" IS THE TOTAL NUMBER OF LEADS.
7. NUMBER OF LEADS SHOWN ARE FOR REFERENCE ONLY.
8. MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.
9. ALL DIMENSIONS APPLY TO BOTH LEADED (-) AND PbFREE (+) PKG. CODES.

-DRAWING NOT TO SCALE-

MAXIM

TITLE: PACKAGE OUTLINE, 6,8,10 & 14L, TDFN, EXPOSED PAD, 3x3x0.80 mm

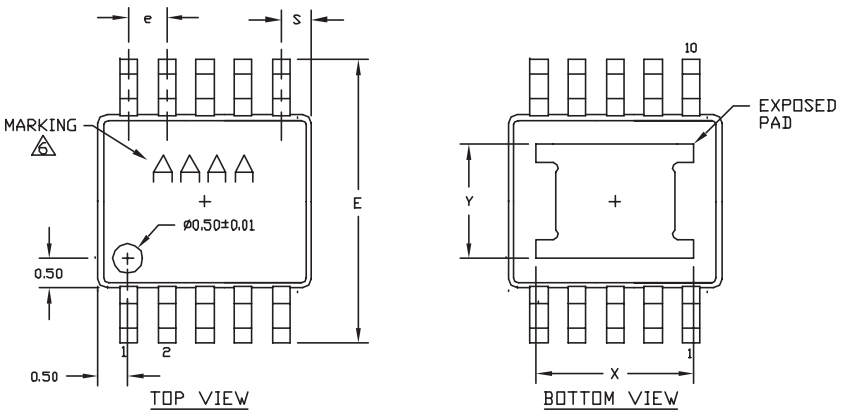
APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0137	J	2/2

Low-Cost, Mono/Stereo, 1.4W Differential Audio Power Amplifiers

Package Information (continued)

For the latest package outline information and land patterns, go to **www.maxim-ic.com/packages**. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

10L UMAX, EXPPADS.EPS



DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.037	0.043	0.94	1.10
A1	0.000	0.006	0.00	0.15
A2	0.030	0.037	0.75	0.95
D1	0.116	0.120	2.95	3.05
D2	0.114	0.118	2.89	3.00
E1	0.116	0.120	2.95	3.05
E2	0.114	0.118	2.89	3.00
E	0.187	0.199	4.75	5.05
L	0.0157	0.0275	0.40	0.70
L1	0.037 REF		0.940 REF	
b	0.007	0.0106	0.177	0.270
e	0.0197 BSC		.500 BSC	
c	0.0035	0.0078	0.090	0.200
S	0.0196 REF		.498 REF	
α	0°	6°	0°	6°
*X	0.087	0.099	2.210	2.515
*Y	0.062	0.074	1.575	1.880

* EXPOSED PAD

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15mm (.006").
3. CONTROLLING DIMENSION: MILLIMETERS.
4. EXPOSED PAD FLUSH WITH BOTTOM OF PACKAGE WITHIN .002".
5. MEETS JEDEC MO187.
6. MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.
7. COPLANARITY SHALL NOT EXCEED 0.10mm.

-DRAWING NOT TO SCALE-

DALLAS SEMICONDUCTOR MAXIM

TITLE: PACKAGE OUTLINE, 10L uMAX/uSOP, EXPOSED PAD

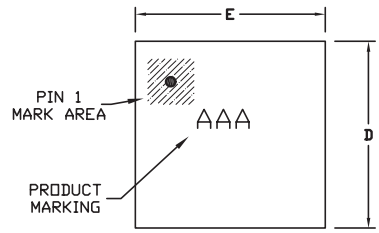
APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0109	D	1/1

Low-Cost, Mono/Stereo, 1.4W Differential Audio Power Amplifiers

Package Information (continued)

For the latest package outline information and land patterns, go to **www.maxim-ic.com/packages**. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

16L,UCSP.EPS

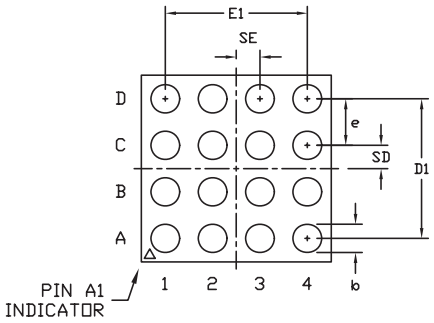


TOP VIEW

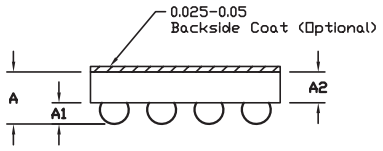
COMMON DIMENSIONS	
A	0.62±0.05-0.08
A1	0.29±0.02
A2	0.33 REF.
b	ø0.35±0.03
D1	1.50 BASIC
E1	1.50 BASIC
e	0.50 BASIC
SD	0.25 BASIC
SE	0.25 BASIC

PKG. CODE	VARIABLE DIMENSIONS		DEPOPULATED SOLDER BALLS
	D	E	
B16-1	2.02±0.05	2.02±0.05	NONE
B16-2	2.02±0.05	2.02±0.05	B3, C3
B16-3	2.02±0.05	2.02±0.05	B3, C2
B16-4	2.02±0.05	2.02±0.05	B2, C3
B16-5	2.02±0.05	2.02±0.05	B2, B3, C2, C3
B16-6	2.02±0.05	2.02±0.05	C3

NOTES:
1. All dimensions in millimeters.
2. Outer dimension (D & E) is defined by center lines between scribe lines.
3. Marking shown is for package orientation reference only. Number of characters and lines vary per product.
4. All dimensions are applicable to Leaded (-), PbFree (+), and MaxFilm parts/pkg codes.



BOTTOM VIEW



SIDE VIEW

-DRAWING NOT TO SCALE-

MAXIM

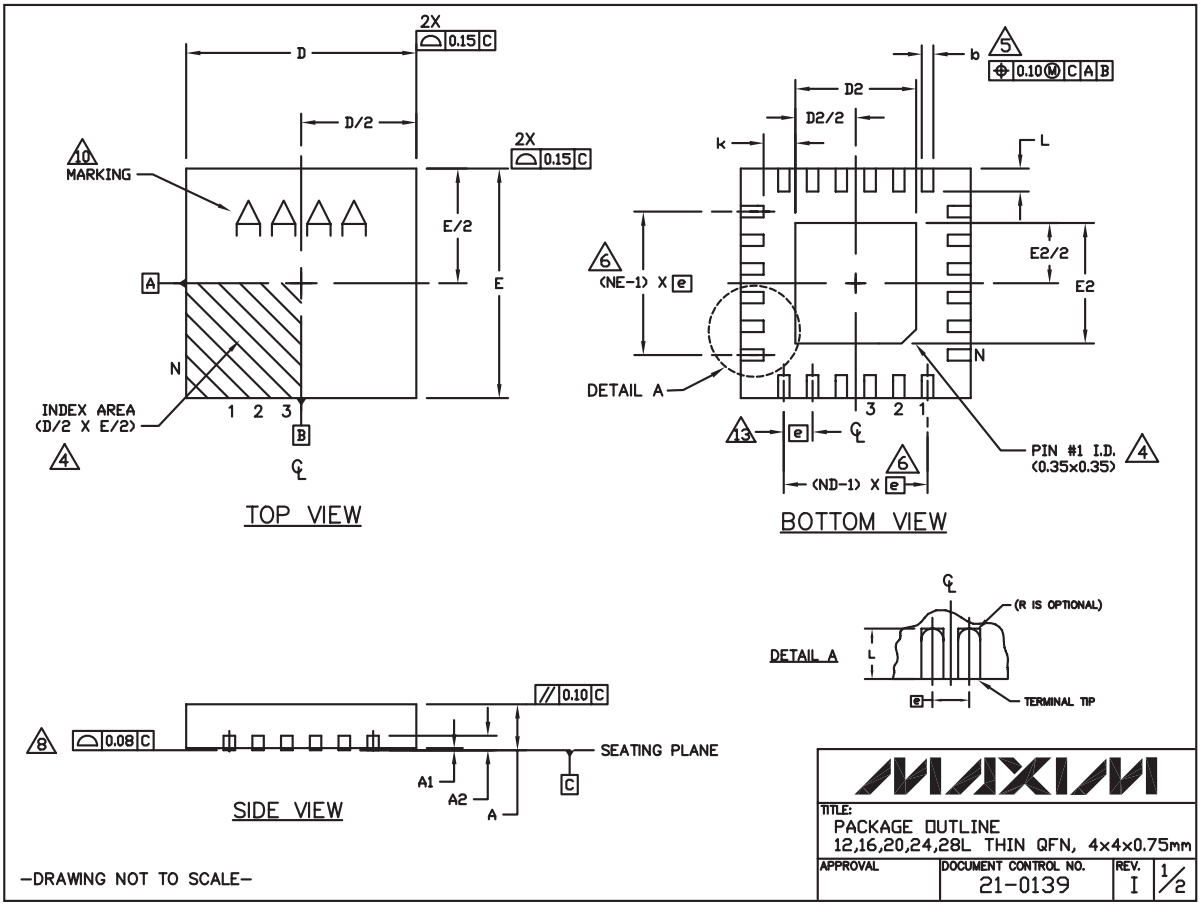
TITLE:
PACKAGE OUTLINE,
16 BUMPS, 4X4 ARRAY, UCSP (B) PKG.

APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0101	I	1/1

Package Information (continued)

For the latest package outline information and land patterns, go to **www.maxim-ic.com/packages**. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

24L QFN THIN.EPS



Low-Cost, Mono/Stereo, 1.4W Differential Audio Power Amplifiers

Package Information (continued)

For the latest package outline information and land patterns, go to **www.maxim-ic.com/packages**. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

COMMON DIMENSIONS

PKG	12L 4x4			16L 4x4			20L 4x4			24L 4x4			28L 4x4		
REF.	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.70	0.75	0.80	0.70	0.75	0.80	0.70	0.75	0.80	0.70	0.75	0.80	0.70	0.75	0.80
A1	0.0	0.02	0.05	0.0	0.02	0.05	0.0	0.02	0.05	0.0	0.02	0.05	0.0	0.02	0.05
A2	0.20 REF			0.20 REF			0.20 REF			0.20 REF			0.20 REF		
b	0.25	0.30	0.35	0.25	0.30	0.35	0.20	0.25	0.30	0.18	0.23	0.30	0.15	0.20	0.25
D	3.90	4.00	4.10	3.90	4.00	4.10	3.90	4.00	4.10	3.90	4.00	4.10	3.90	4.00	4.10
E	3.90	4.00	4.10	3.90	4.00	4.10	3.90	4.00	4.10	3.90	4.00	4.10	3.90	4.00	4.10
e	0.80 BSC.			0.65 BSC.			0.50 BSC.			0.50 BSC.			0.40 BSC.		
k	0.25	-	-	0.25	-	-	0.25	-	-	0.25	-	-	0.25	-	-
L	0.45	0.55	0.65	0.45	0.55	0.65	0.45	0.55	0.65	0.30	0.40	0.50	0.30	0.40	0.50
N	12			16			20			24			28		
ND	3			4			5			6			7		
NE	3			4			5			6			7		
Jedec Var.	WGGB			WGGC			WGGD-1			WGGD-2			WGGE		

EXPOSED PAD VARIATIONS

PKG. CODES	D2			E2		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
T1244-3	1.95	2.10	2.25	1.95	2.10	2.25
T1244-4	1.95	2.10	2.25	1.95	2.10	2.25
T1644-3	1.95	2.10	2.25	1.95	2.10	2.25
T1644-4	1.95	2.10	2.25	1.95	2.10	2.25
T2044-2	1.95	2.10	2.25	1.95	2.10	2.25
T2044-3	1.95	2.10	2.25	1.95	2.10	2.25
T2444-2	1.95	2.10	2.25	1.95	2.10	2.25
T2444-3	2.45	2.60	2.63	2.45	2.60	2.63
T2444-4	2.45	2.60	2.63	2.45	2.60	2.63
T2444N-4	2.45	2.60	2.63	2.45	2.60	2.63
T2444M-1	2.45	2.60	2.63	2.45	2.60	2.63
T2844-1	2.50	2.60	2.70	2.50	2.60	2.70

NOTES:

1. DIMENSIONING & TOLERANCING CONFORM TO ASME Y14.5M-1994.
2. ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES ARE IN DEGREES.
3. N IS THE TOTAL NUMBER OF TERMINALS.
4. THE TERMINAL #1 IDENTIFIER AND TERMINAL NUMBERING CONVENTION SHALL CONFORM TO JESD 95-1 SPP-012. DETAILS OF TERMINAL #1 IDENTIFIER ARE OPTIONAL, BUT MUST BE LOCATED WITHIN THE ZONE INDICATED. THE TERMINAL #1 IDENTIFIER MAY BE EITHER A MOLD OR MARKED FEATURE.
5. DIMENSION b APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.25mm AND 0.30mm FROM TERMINAL TIP.
6. ND AND NE REFER TO THE NUMBER OF TERMINALS ON EACH D AND E SIDE RESPECTIVELY.
7. DEPOPULATION IS POSSIBLE IN A SYMMETRICAL FASHION.
8. COPLANARITY APPLIES TO THE EXPOSED HEAT SINK SLUG AS WELL AS THE TERMINALS.
9. DRAWING CONFORMS TO JEDEC MO220, EXCEPT FOR T2444-3, T2444-4 AND T2844-1.
10. MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.
11. COPLANARITY SHALL NOT EXCEED 0.08mm.
12. WARPAGE SHALL NOT EXCEED 0.10mm.
13. LEAD CENTERLINES TO BE AT TRUE POSITION AS DEFINED BY BASIC DIMENSION 'e', ±0.05.
14. NUMBER OF LEADS SHOWN ARE FOR REFERENCE ONLY.
15. ALL DIMENSIONS ARE THE SAME FOR LEADED (-) & PbFREE (+) PACKAGE CODES.

-DRAWING NOT TO SCALE-

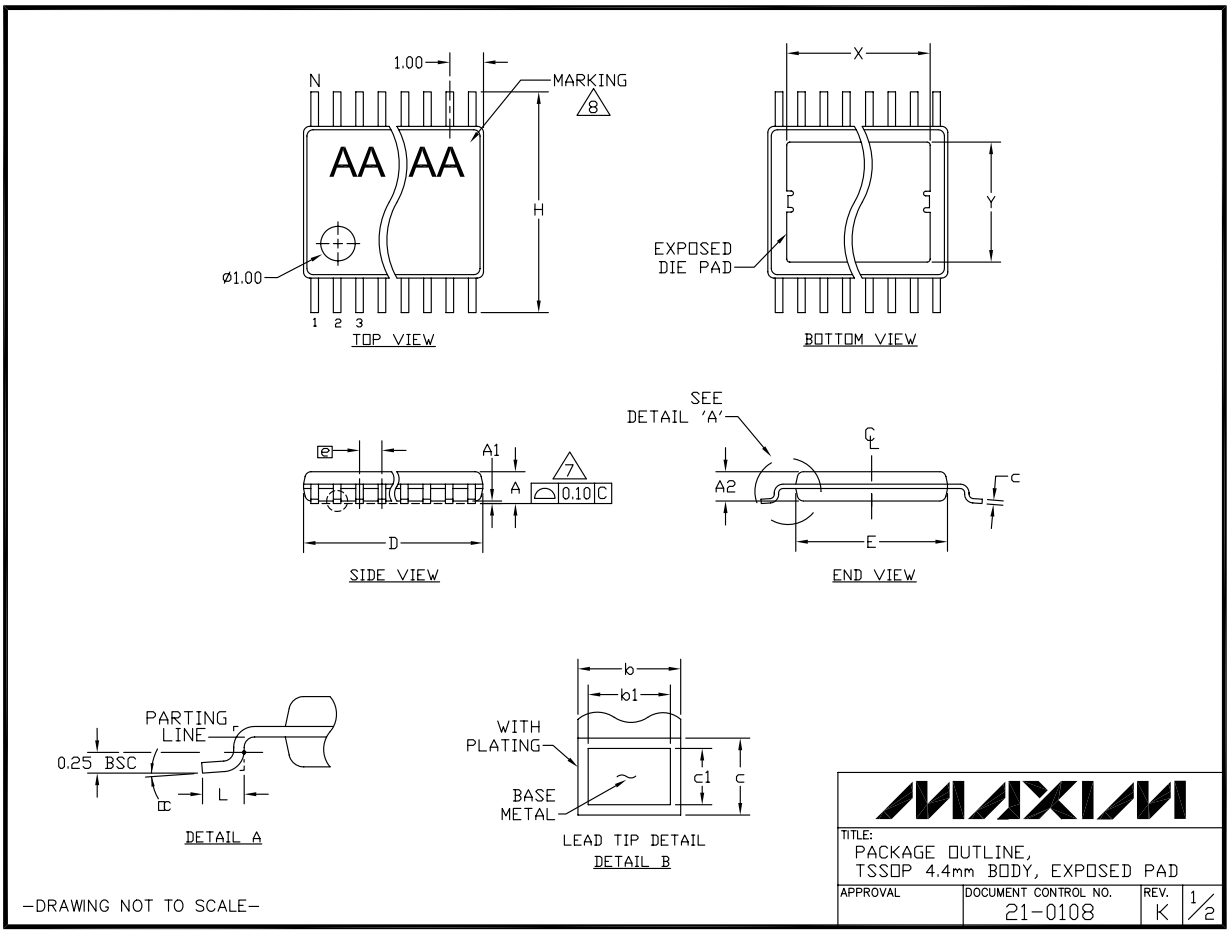
MAXIM

TITLE:
PACKAGE OUTLINE
12,16,20,24,28L THIN QFN, 4x4x0.75mm

APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0139	I	2/2

Package Information (continued)

For the latest package outline information and land patterns, go to **www.maxim-ic.com/packages**. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.



Low-Cost, Mono/Stereo, 1.4W Differential Audio Power Amplifiers

Package Information (continued)

For the latest package outline information and land patterns, go to **www.maxim-ic.com/packages**. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

SYMBOL	COMMON DIMENSIONS			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	--	1.10	--	0.043
A1	0.05	0.15	0.002	0.006
A2	0.85	0.95	0.033	0.037
b	0.19	0.30	0.007	0.012
b1	0.19	0.25	0.007	0.010
c	0.090	0.20	0.004	0.008
c1	0.090	0.135	0.004	0.0053
D	SEE VARIATIONS		SEE VARIATIONS	
E	4.30	4.50	0.169	0.177
e	0.65 BSC		0.026 BSC	
H	6.25	6.50	0.246	0.256
L	0.50	0.70	0.020	0.028
N	SEE VARIATIONS		SEE VARIATIONS	
Y	2.60	3.10	0.102	0.122
α	0°	8°	0°	8°

JEDEC MO-153	N	Pkg.Code		VARIATIONS			
				MILLIMETERS		INCHES	
				MIN.	MAX.	MIN.	MAX.
ABT-1	14	U14E-3	D	4.90	5.10	0.193	0.201
			X	2.80	3.10	0.110	0.122
ABT	16	U16E-3	D	4.90	5.10	0.193	0.201
			X	2.60	3.10	0.102	0.122
ACT	20	U20E-1	D	6.40	6.60	0.252	0.260
			X	3.80	4.20	0.150	0.165
ACT	20	U20E-4	D	6.40	6.60	0.252	0.260
			X	4.50	4.90	0.177	0.193
AET	28	U28E-4	D	9.60	9.80	0.378	0.386
			X	5.20	5.60	0.205	0.221
AET	28	U28E-5	D	9.60	9.80	0.378	0.386
			X	6.50	6.90	0.256	0.272
AET	28	U28ME-1	D	9.60	9.80	0.378	0.386
			X	6.50	6.90	0.256	0.272

JEDEC MO-153	N	Pkg.Code		VARIATIONS			
				MILLIMETERS		INCHES	
				MIN.	MAX.	MIN.	MAX.
ADT	24	U24E-1	D	7.70	7.90	0.303	0.311
			X	4.44	4.64	0.175	0.183
			Y	2.64	2.84	0.104	0.112

NOTES:
1. DIMENSIONS D AND E DO NOT INCLUDE FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15mm PER SIDE.
3. CONTROLLING DIMENSION: MILLIMETERS.
4. MEETS JEDEC OUTLINE MO-153. SEE JEDEC VARIATIONS TABLE.
5. "N" REFERS TO NUMBER OF LEADS.
6. EXPOSED PAD FLUSH WITH BOTTOM OF PACKAGE WITHIN .002".
7. THE LEAD TIPS MUST LIE WITHIN A SPECIFIED ZONE. THIS TOLERANCE ZONE IS DEFINED BY TWO PARALLEL PLANES. ONE PLANE IS THE SEATING PLANE, DATUM [-C-]; THE OTHER PLANE IS AT THE SPECIFIED DISTANCE FROM [-C-] IN THE DIRECTION INDICATED.
8. MARKING SHOWN IS FOR PACKAGE ORIENTATION REFERENCE ONLY.
9. NUMBER OF LEADS SHOWN ARE FOR REFERENCE ONLY.
10. ALL DIMENSIONS APPLY TO BOTH LEADED (-) AND PbFREE (+) PKG. CODES.

-DRAWING NOT TO SCALE-

MAXIM

TITLE:
PACKAGE OUTLINE,
TSSOP 4.4mm BODY, EXPOSED PAD

APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0108	K	2/2

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
5	2/08	Updated *Pin Configurations*.	17
6	3/09	Added lead-free and G45 options to *Ordering Information*	1, 13
7	4/10	Updated continuous power dissipation for 9-bump and 16-bump UCSP packages and corrected error in the *Pin Description* section	2, 9

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