19-5494; Rev 0; 9/10

可提供评估板

立体声3.1W D类放大器

MAX98303

概述

MAX98303立体声、3.1W、D类放大器能够以D类放大器的效率提供AB类放大器的音频性能。器件提供5种可选增益设置(6dB、9dB、12dB、15dB和18dB)，由一个增益选择输入(GAIN)设置。

具有有源辐射抑制的边沿速率和过冲控制电路大大降低了EMI。无滤波、扩展频谱调制架构省去了传统D类器件中常见的输出滤波电路。这些功能可减少系统所需的元件数量。

IC的低静态电流特性(3.7V时为2.0mA、5V时为2.7mA)可延长便携设备的电池使用寿命。

IC采用16焊球WLP封装(1.68mm x 1.68mm x 0.64mm)，工作在-40°C至+85°C扩展级温度范围。

应用

笔记本电脑和上网本计算机

平板电脑

蜂窝电话

MP3播放器

便携式音频播放器

VoIP电话

特性

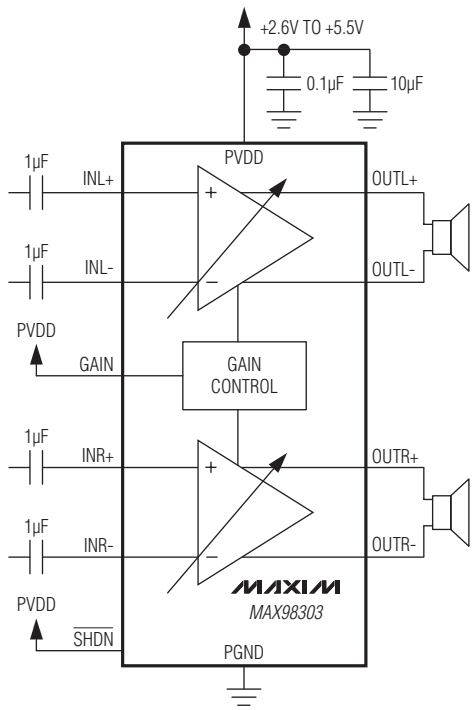
- ♦ 低静态电流：3.7V时为2.0mA、5V时为2.7mA
- ♦ 扩展频谱和有源辐射抑制
- ♦ 通过引脚可选择5种增益设置
- ♦ 咔嗒/噼噗声抑制
- ♦ 过热和过流保护
- ♦ 低电流关断模式
- ♦ 节省空间的1.68mm x 1.68mm x 0.64mm、16焊球WLP封装(焊球间距为0.4mm)

定购信息

PART	TEMP RANGE	PIN-PACKAGE	TOP MARK
MAX98303EWE+	-40°C to +85°C	16 WLP	AAA

+表示无铅(Pb)/符合RoHS标准的封装。

典型应用电路



ABSOLUTE MAXIMUM RATINGS

PVDD to PGND ..... -0.3V to +6V
OUT_+, OUT_- to PGND ..... -0.3V to (V_{PVDD} + 0.3V)
All Other Pins to PGND ..... -0.3V to +6V
Continuous Current for PVDD, PGND, OUTL_, OUTR_ ..... ±1600mA
Continuous Input Current (all other pins) ..... ±20mA
Duration of Short Circuit Between OUTL_, OUTR_ to PVDD or PGND ..... Continuous
OUTL+ to OUTL-, OUTR+ to OUTR- ..... Continuous

Continuous Power Dissipation for Multilayer Board (T_A = +70°C)
16-Bump WLP (derate 17.2mW/°C above +70°C) 1.38W
θ_{JA} (Note 1) ..... 58°C/W
θ_{JC} (Note 1) ..... 15°C/W
Junction Temperature ..... +150°C
Operating Temperature Range ..... -40°C to +85°C
Storage Temperature Range ..... -65°C to +150°C
Soldering Temperature (reflow) ..... +260°C

Note 1: Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to **china.maxim-ic.com/thermal-tutorial**.

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

(V_{PVDD} = $V_{\overline{SHDN}}$ = 3.7V, V_{PGND} = 0V, A_V = 12dB (GAIN = PVDD), R_L = ∞, R_L connected between OUT_+ to OUT_-, 20Hz to 22kHz AC measurement bandwidth, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage Range	V_{PVDD}	Inferred from PSRR test	2.6		5.5	V
Undervoltage Lockout	UVLO				2.3	V
Quiescent Supply Current	I_{DD}			2.0	3.1	mA
		V_{PVDD} = 5.0V		2.7		
Shutdown Supply Current	$I_{\overline{SHDN}}$	$V_{\overline{SHDN}}$ = 0V, T_A = +25°C		≤ 0.1	10	µA
Turn-On Time	t_{ON}			3.4	10	ms
Bias Voltage	V_{BIAS}			1.3		V
Voltage Gain	A_V	Connect GAIN to PGND	17.5	18	18.5	dB
		Connect GAIN to PGND through 100kΩ ±5% resistor	14.5	15	15.5	
		Connect GAIN to PVDD	11.5	12	12.5	
		Connect GAIN to PVDD through 100kΩ ±5% resistor	8.5	9	9.5	
		GAIN unconnected	5.5	6	6.5	
Channel-to-Channel Gain Tracking				±0.1		%
Input Resistance	R_{IN}	A_V = 18dB	15	20	29	kΩ
		A_V = 15dB	15	20	29	
		A_V = 12dB	15	20	29	
		A_V = 9dB	20	28	40	
		A_V = 6dB	30	40	58	
Output Offset Voltage	V_{OS}	T_A = +25°C (Note 4)		±0.3	±3	mV

ELECTRICAL CHARACTERISTICS (continued)

(V_{PVDD} = $V_{\overline{SHDN}}$ = 3.7V, V_{PGND} = 0V, A_V = 12dB (GAIN = PVDD), R_L = ∞, R_L connected between OUT_+ to OUT_-, 20Hz to 22kHz AC measurement bandwidth, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Click and Pop	K_{CP}	Peak voltage, A-weighted, 32 samples per second, R_L = 8Ω + 68µH (Notes 4, 5)	Into shutdown		-74		dBV
			Out of shutdown		-59		
Common-Mode Rejection Ratio	CMRR	f_{IN} = 1kHz, input referred	A_V = 18dB		67		dB
			A_V = 15dB		72		
			A_V = 12dB		67		
			A_V = 9dB		65		
			A_V = 6dB		62		
Crosstalk		P_{OUT} = 300mW, R_L = 8Ω + 68µH	f = 1kHz		100		dB
			f = 10kHz		95		
Power-Supply Rejection Ratio (Note 4)	PSRR	V_{PVDD} = 2.6V to 5.5V, T_A = +25°C		51	78		dB
		V_{RIPPLE} = 200mV_{P-P}, R_L = 8Ω + 68µH	f = 217Hz		66		
			f = 1kHz		66		
			f = 10kHz		63		
Output Power	P_{OUT}	THD+N = 10%, f = 1kHz, R_L = 4Ω + 33µH	V_{PVDD} = 5.0V		3.1		W
			V_{PVDD} = 4.2V		2.2		
			V_{PVDD} = 3.7V		1.7		
		THD+N = 1%, f = 1kHz, R_L = 4Ω + 33µH	V_{PVDD} = 5.0V		2.5		
			V_{PVDD} = 4.2V		1.7		
			V_{PVDD} = 3.7V		1.3		
		THD+N = 10%, f = 1kHz, R_L = 8Ω + 68µH	V_{PVDD} = 5.0V		1.8		
			V_{PVDD} = 4.2V		1.2		
			V_{PVDD} = 3.7V		1.0		
		THD+N = 1%, f = 1kHz, R_L = 8Ω + 68µH	V_{PVDD} = 5.0V		1.4		
			V_{PVDD} = 4.2V		1.0		
			V_{PVDD} = 3.7V		0.7		
Total Harmonic Distortion Plus Noise	THD+N	f_{IN} = 1kHz	R_L = 4Ω + 33µH, P_{OUT} = 1W		0.047		%
			R_L = 8Ω + 68µH, P_{OUT} = 0.5W		0.04		
Oscillator Frequency	f_{OSC}				300		kHz
Spread-Spectrum Bandwidth					±15		kHz
Efficiency	η	THD+N = 10%, f = 1kHz, R_L = 8Ω + 68µH			93		%
Output Noise	V_N	A_V = 6dB, A weighted (Note 4)			37		µV_{RMS}
Signal-to-Noise Ratio	SNR	P_{OUT} = 3.1W, V_{PVDD} = 5.0V, A_V = 6dB			99.6		dB

ELECTRICAL CHARACTERISTICS (continued)

(V_{PVDD} = $V_{\overline{SHDN}}$ = 3.7V, V_{PGND} = 0V, A_V = 12dB (GAIN = PVDD), R_L = ∞, R_L connected between OUT_+ to OUT_-, 20Hz to 22kHz AC measurement bandwidth, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Output Current Limit	I_{LIM}			2		A
Thermal Shutdown Level				145		°C
Thermal Shutdown Hysteresis				15		°C
DIGITAL INPUT ($\overline{SHDN}$)						
Input Voltage High	V_{INH}	V_{PVDD} = 2.5V to 5.5V	1.4			V
Input Voltage Low	V_{INL}	V_{PVDD} = 2.5V to 5.5V			0.4	V
Input Leakage Current		T_A = +25°C			±1	µA

Note 2: This device is 100% production tested at T_A = +25°C. All temperature limits are guaranteed by design.

Note 3: Testing performed with a resistive load in series with an inductor to simulate an actual speaker load. For R_L = 4Ω, L = 33µH. For R_L = 8Ω, L = 68µH.

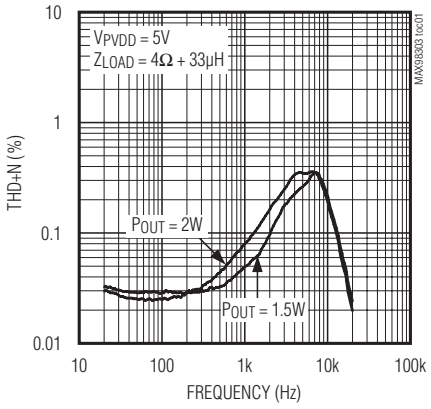
Note 4: Amplifier inputs AC-coupled to ground.

Note 5: Mode transitions controlled by $\overline{SHDN}$.

典型工作特性

(V_{PVDD} = $V_{\overline{SHDN}}$ = 5.0V, V_{PGND} = 0V, A_V = 12dB, R_L = ∞, R_L connected between OUT_+ to OUT_-, 20Hz to 22kHz AC measurement bandwidth, T_A = +25°C, unless otherwise noted.)

TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY



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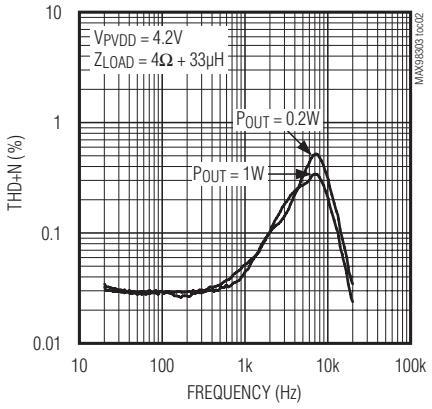

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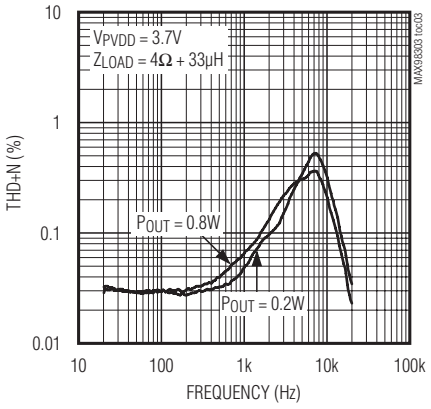
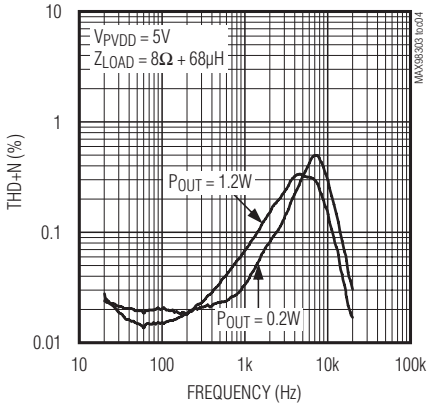


典型工作特性(续)

(V_{PVDD} = $V_{\overline{SHDN}}$ = 5.0V, V_{PGND} = 0V, A_V = 12dB, R_L = ∞, R_L connected between OUT_+ to OUT_-, 20Hz to 22kHz AC measurement bandwidth, T_A = +25°C, unless otherwise noted.)

TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY



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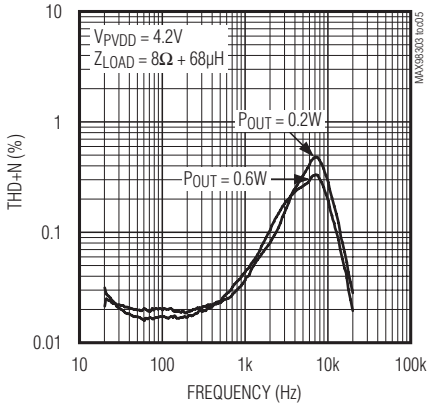

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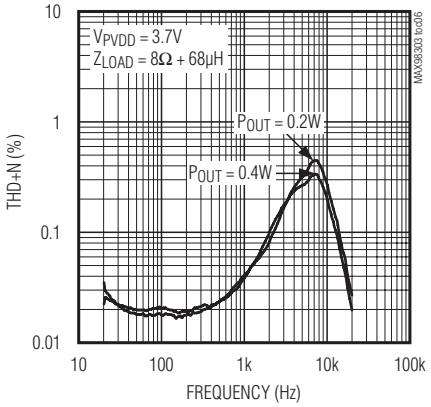
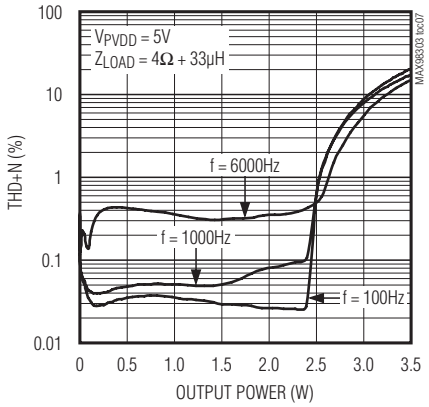


TOTAL HARMONIC DISTORTION PLUS NOISE vs. OUTPUT POWER



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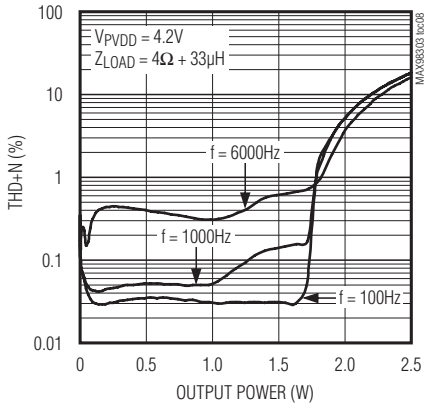

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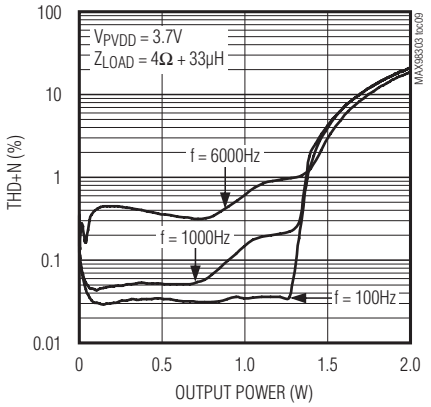

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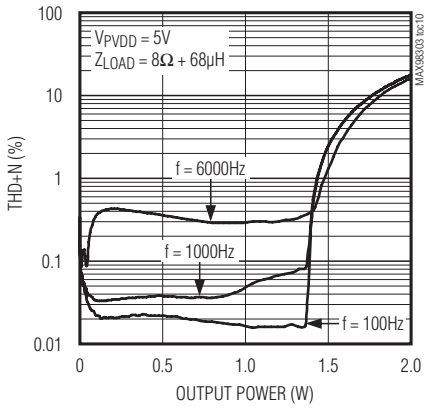

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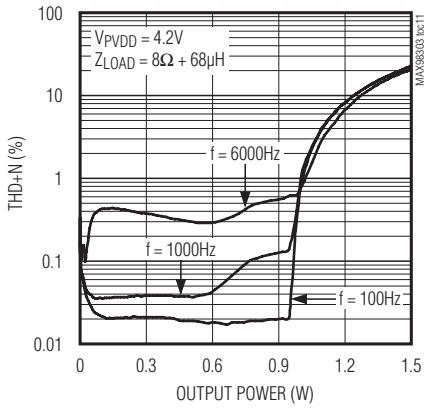

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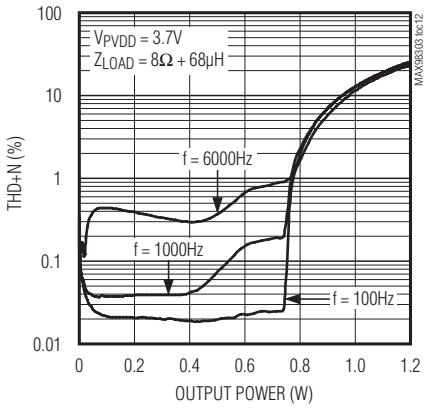
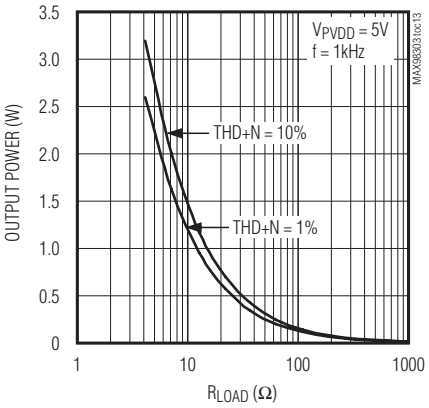


立体声3.1W D类放大器

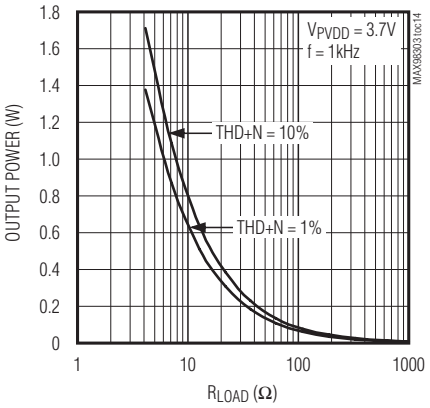
典型工作特性(续)

(V_{PVDD} = $V_{\overline{SHDN}}$ = 5.0V, V_{PGND} = 0V, A_V = 12dB, R_L = ∞, R_L connected between OUT_+ to OUT_-, 20Hz to 22kHz AC measurement bandwidth, T_A = +25°C, unless otherwise noted.)

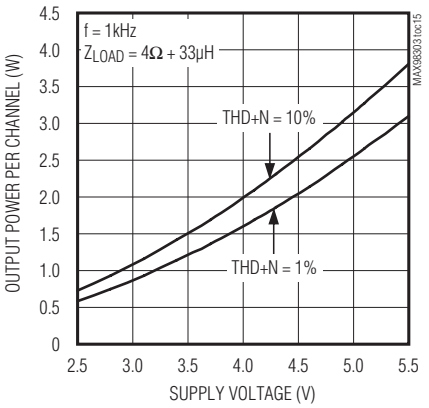
OUTPUT POWER vs. LOAD RESISTANCE



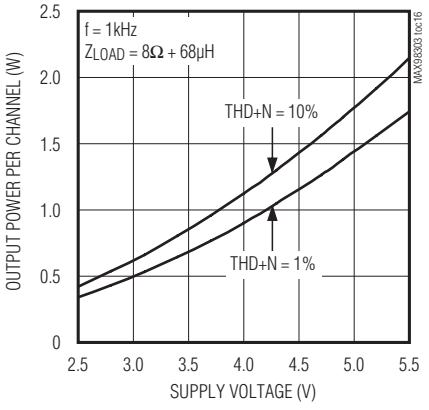
OUTPUT POWER vs. LOAD RESISTANCE



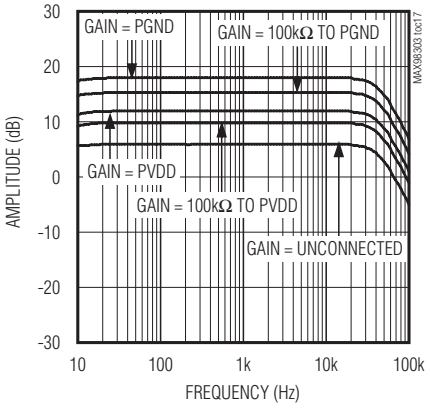
OUTPUT POWER vs. SUPPLY VOLTAGE



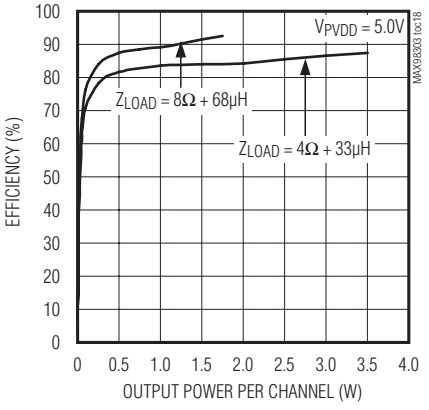
OUTPUT POWER vs. SUPPLY VOLTAGE



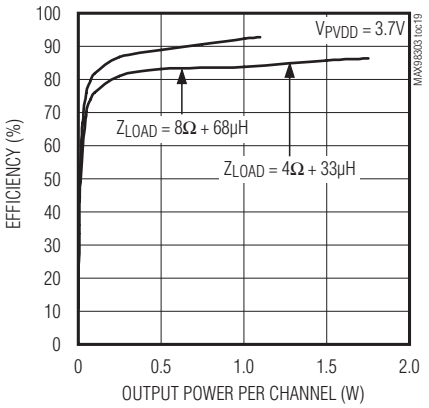
GAIN vs. FREQUENCY



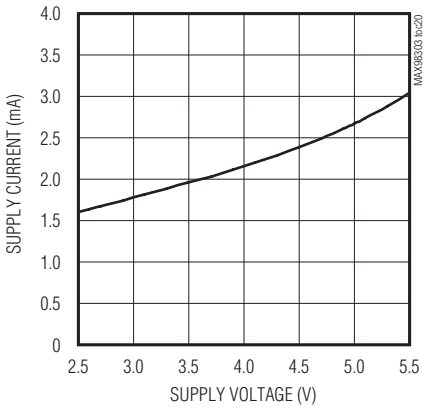
EFFICIENCY vs. OUTPUT POWER



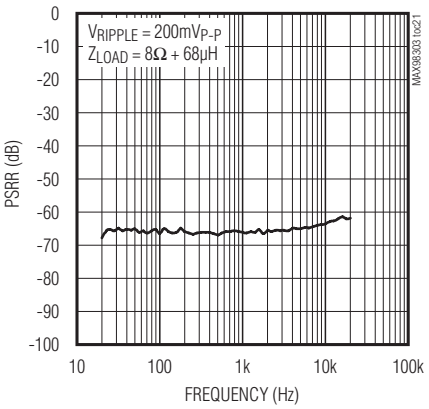
EFFICIENCY vs. OUTPUT POWER



SUPPLY CURRENT vs. SUPPLY VOLTAGE



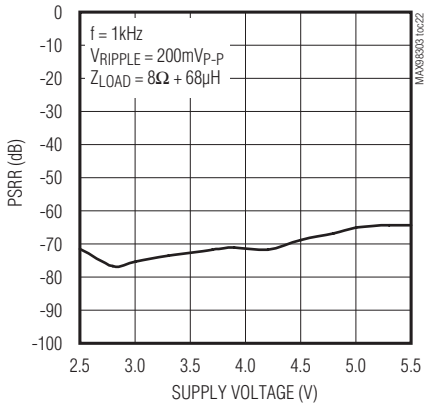
POWER-SUPPLY REJECTION RATIO vs. FREQUENCY



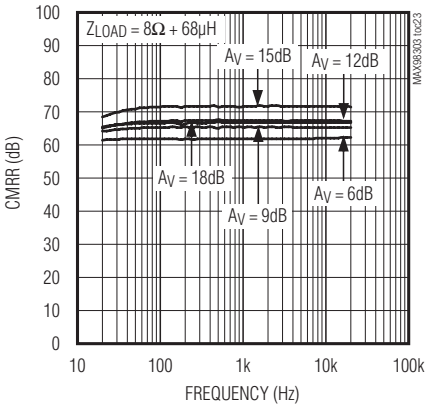
典型工作特性(续)

(V_{PVDD} = $V_{\overline{SHDN}}$ = 5.0V, V_{PGND} = 0V, A_V = 12dB, R_L = ∞, R_L connected between OUT_+ to OUT_-, 20Hz to 22kHz AC measurement bandwidth, T_A = +25°C, unless otherwise noted.)

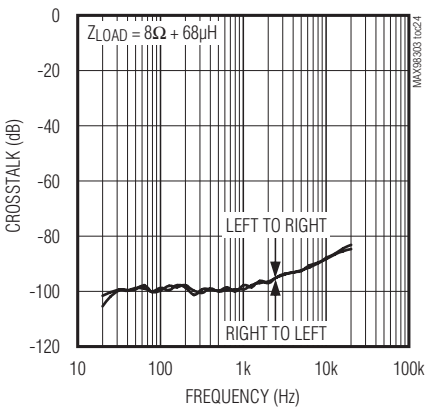
POWER-SUPPLY REJECTION RATIO vs. SUPPLY VOLTAGE



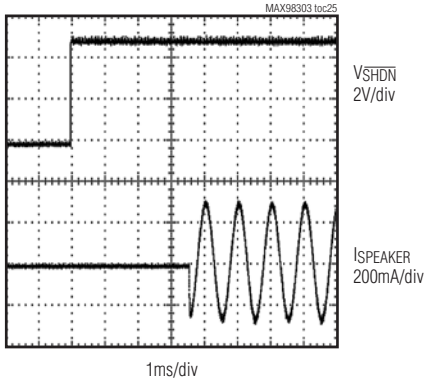
COMMON-MODE REJECTION RATIO vs. FREQUENCY



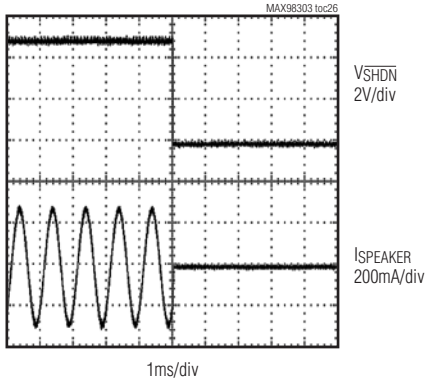
CROSSTALK vs. FREQUENCY



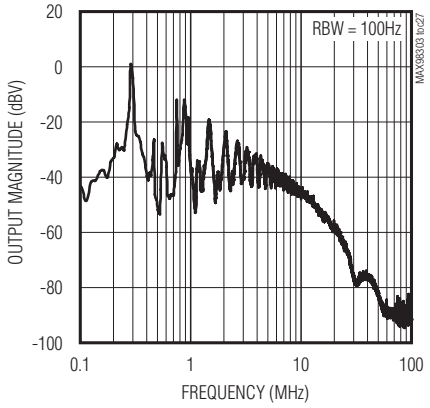
STARTUP RESPONSE



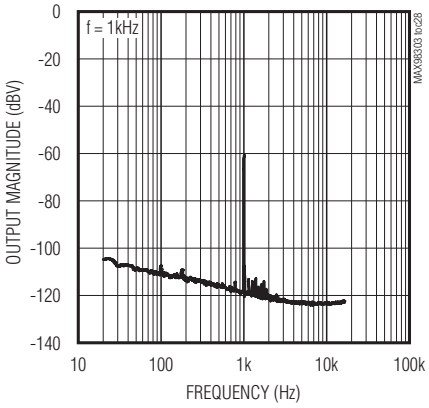
SHUTDOWN RESPONSE



WIDEBAND vs. FREQUENCY

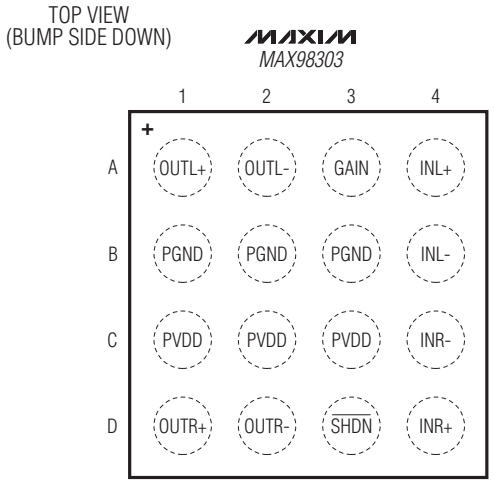


IN-BAND vs. FREQUENCY



立体声3.1W D类放大器

焊球配置



WLP
(1.68mm x 1.68mm x 0.64mm, 0.4mm PITCH)

焊球说明

焊球	名称	功能
A1	OUTL+	左声道扬声器输出正端。
A2	OUTL-	左声道扬声器输出负端。
A3	GAIN	增益选择。增益设置请参见表1。
A4	INL+	左声道同相音频输入。
B1, B2, B3	PGND	地。
B4	INL-	左声道反相音频输入。
C1, C2, C3	PVDD	电源。采用0.1µF和10µF电容将PVDD旁路至PGND。
C4	INR-	右声道反相音频输入。
D1	OUTR+	右声道扬声器输出正端。
D2	OUTR-	右声道扬声器输出负端。
D3	$\overline{\text{SHDN}}$	低电平有效关断输入。驱动$\overline{\text{SHDN}}$为低电平，将器件置于关断模式。
D4	INR+	右声道同相音频输入。

详细说明

MAX98303具有低静态电流、低功耗关断模式，提供完备的咔嗒/噼噗声抑制以及优异的RF抑制性能。

该款IC能够以D类放大器的效率提供AB类放大器的音频性能，占用最小的电路板空间。

该款D类放大器具有扩展频谱调制、边沿速率控制和过冲控制电路，可显著改善开关模式放大器的电磁辐射性能。

放大器具有咔嗒/噼噗声抑制功能，可降低启动和关断过程中的可闻噪声。放大器还具有热过载和短路保护功能。

D类扬声器放大器

无滤波D类放大器的效率远远高于AB类放大器。D类放大器的高效率源于输出级晶体管的开关工作。所有与D类放大器输出级相关的功耗几乎都来自于MOSFET的导通电阻和静态电流造成的I^2R损耗。

超低EMI无需滤波输出级

传统的D类放大器需要使用外部LC滤波器或采用屏蔽，以满足EN55022B电磁干扰(EMI)规范的要求。Maxim带有源辐射抑制的边沿速率控制电路和扩展频谱调制技术可有效降低EMI辐射，同时还可保持高达93%的工作效率。

Maxim的扩展频谱调制模式将频谱分量扩展至较宽频带，同时采用专有技术确保开关周期的逐周期变化不会劣化音频重建或效率。IC的扩展频谱调制器在中心频率(300kHz)附近以±15kHz的幅度随机改变开关频率。高于10MHz时，EMI测试中，宽带频谱类似于噪声频谱(图1)。

扬声器限流

如果扬声器放大器的输出电流超过电流门限(2A，典型值)，IC将禁止输出大约100µs。100µs结束后，重新使能输出。如果仍然存在故障条件，IC则继续禁止和重新使能输出的过程，直到故障条件消除。

可选增益

IC提供5个可编程增益选项，通过GAIN输入选择。

表1. 增益控制配置

GAIN PIN	MAXIMUM GAIN (dB)
Connect to PGND	18
Connect to PGND through 100kΩ ±5% resistor	15
Connect to PVDD	12
Connect to PVDD through 100kΩ ±5% resistor	9
Unconnected	6

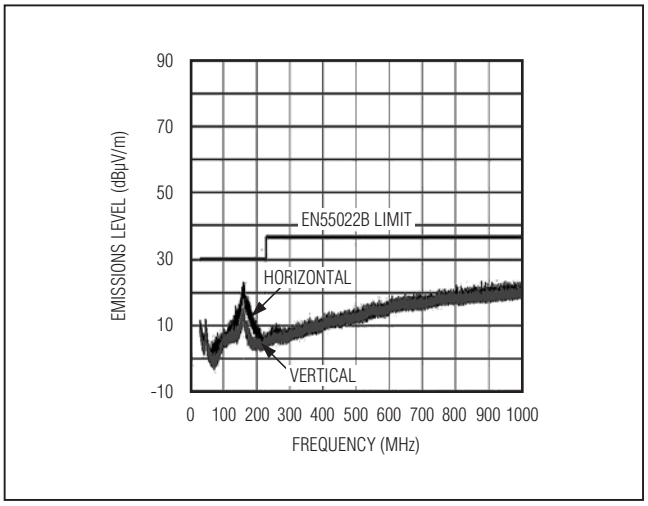


图1. 采用30cm扬声器电缆、无输出滤波器时的EMI特性

关断

IC具有低功耗关断模式，电源电流 ≤ 0.1µA (典型值)。$\overline{SHDN}$为低电平时，MAX98303进入关断模式。

咔嗒/噼噗声抑制

IC的扬声器放大器集成了Maxim完备的咔嗒/噼噗声抑制功能。启动期间，咔嗒/噼噗声抑制电路可以降低器件内部的任何瞬态噪声。进入关断模式时，扬声器的差分输出将同时快速地线性下降到PGND。

立体声3.1W D类放大器

应用信息

无滤波D类放大器工作

传统的D类放大器需要一个输出滤波器。该滤波器会增加成本、增大体积、降低THD性能。IC的无滤波调制方案省去了输出滤波器。

由于IC的开关频率超出了绝大多数扬声器的带宽，在开关频率处的音圈移动非常小。使用串联电感大于10µH的扬声器，典型的8Ω扬声器的串联电感通常在20µH至100µH范围内。

元件选择

电源输入(PVDD)

PVDD为扬声器放大器供电，PVDD的范围为2.6V至5.5V，通过0.1µF和10µF电容将PVDD旁路至PGND。如果在PVDD和电源之间使用了较长的输入引线，则在器件位置采用一个附加的大电容。

输入滤波

输入耦合电容(C_{IN})与放大器内部的输入电阻(R_{IN})一起构成了一个高通滤波器，可以消除输入信号中的直流偏压。这些电容允许放大器将信号偏置在最佳直流电平。

假设源阻抗为零，且采用12dB、15dB或18dB增益设置，则C_{IN}为：

$$C_{IN} = \frac{8}{f_{-3dB}}[\mu F]$$

采用9dB增益设置时，C_{IN}为：

$$C_{IN} = \frac{5.7}{f_{-3dB}}[\mu F]$$

采用6dB增益设置时，C_{IN}为：

$$C_{IN} = \frac{4}{f_{-3dB}}[\mu F]$$

其中，f_{-3dB}为-3dB角频率。使用电压系数足够低的电容，以获得最佳的低频THD性能。

布局和接地

适当的布局和接地对于获得最优性能至关重要。良好的接地可以改善音频性能并防止将开关噪声耦合到音频信号。

使用较宽的低阻输出引线。负载电阻下降时，从器件端吸收的电流增大。电流较大时，输出引线电阻会降低传送到负载的功率。例如，如果通过100mΩ扬声器引线将2W功率从器件的输出传送至4Ω负载，则实际传送到扬声器的功率为1.904W。如果通过10mΩ扬声器引线传输功率，实际传送到扬声器的功率为1.99W。较宽的输出、电源和接地引线还有助于降低器件的功耗。

IC设计具有优异的RF抗干扰能力。为获得最佳性能，可在PCB顶层或底层的所有信号线周围铺设接地区域。

WLP应用信息

关于WLP结构、尺寸、载带信息、PCB技术、焊球-焊盘布局和推荐的回流焊温度特性等最新的应用信息，以及最新的可靠性测试结果，请参考应用笔记1891: *晶片级封装(WLP)及其应用*。图2给出了该款IC使用的WLP焊球尺寸。

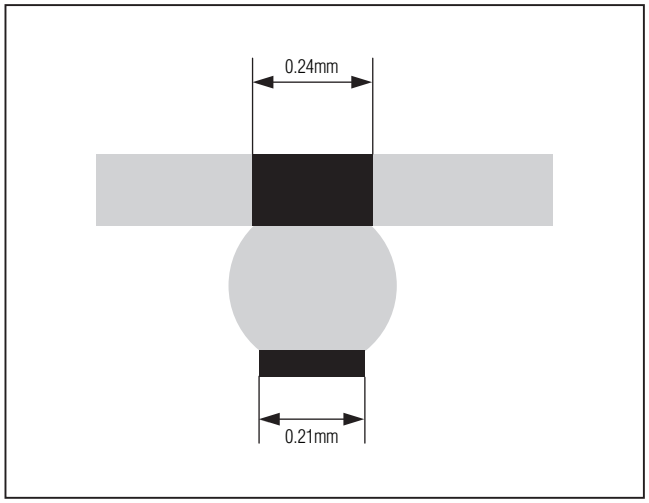
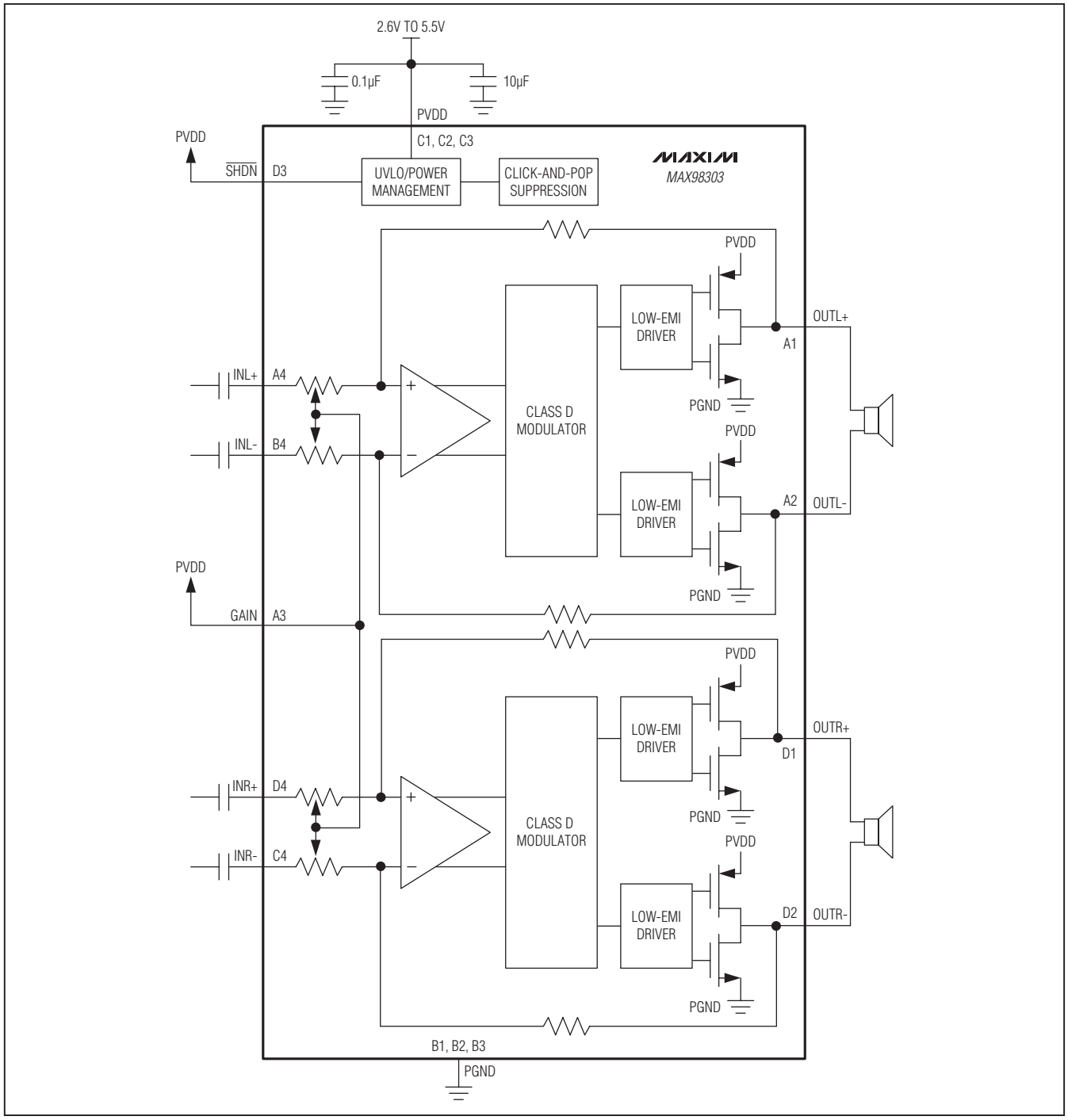


图2. MAX98303的WLP焊球尺寸

方框图



芯片信息

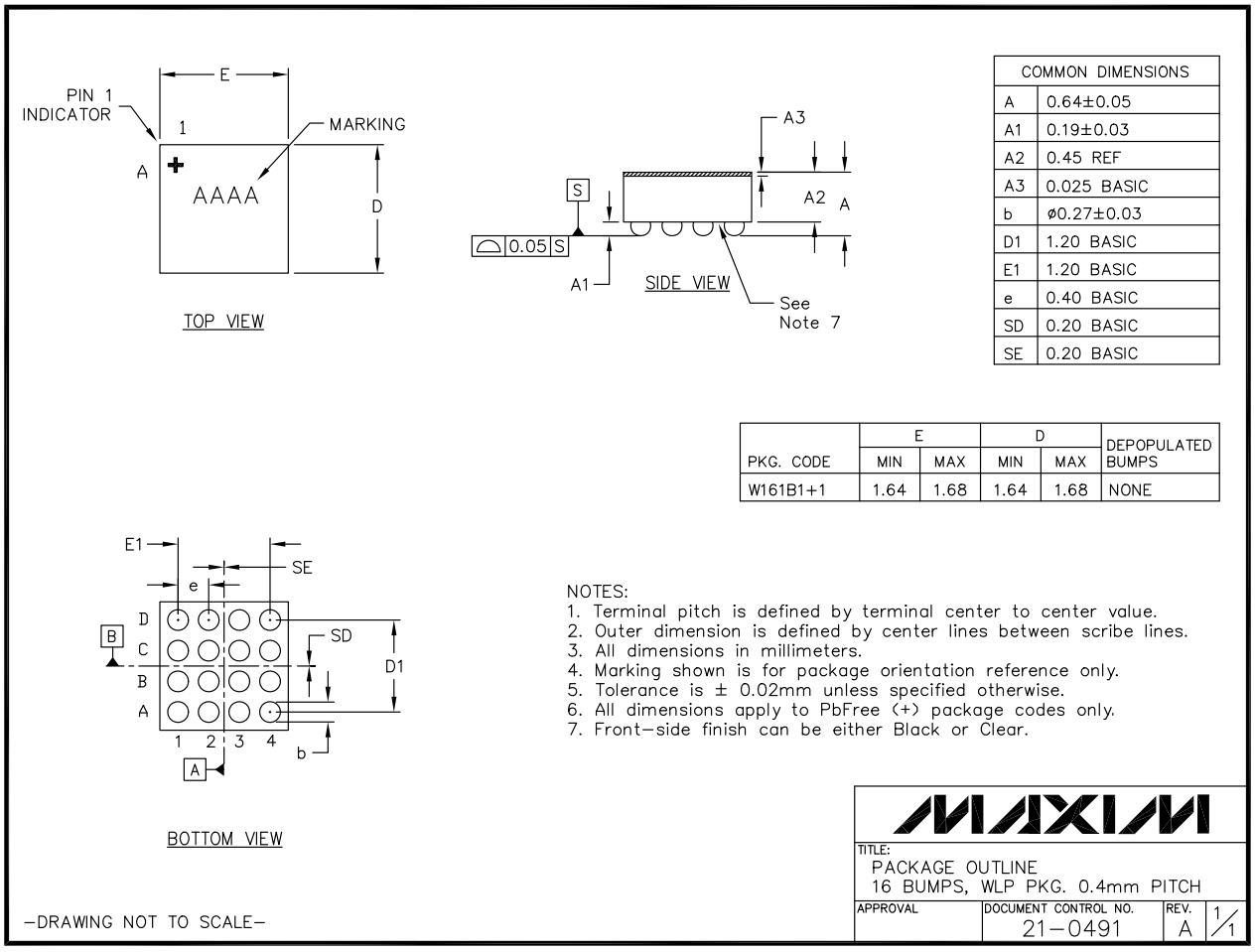
PROCESS: CMOS

立体声3.1W D类放大器

封装信息

如需最近的封装外形信息和焊盘布局，请查询**china.maxim-ic.com/packages**。请注意，封装编码中的“+”、“#”或“-”仅表示RoHS状态。封装图中可能包含不同的尾缀字符，但封装图只与封装有关，与RoHS状态无关。

封装类型	封装编码	外形编号	焊盘布局编号
16 WLP	W161B1+1	21-0491	—



COMMON DIMENSIONS	
A	0.64±0.05
A1	0.19±0.03
A2	0.45 REF
A3	0.025 BASIC
b	ø0.27±0.03
D1	1.20 BASIC
E1	1.20 BASIC
e	0.40 BASIC
SD	0.20 BASIC
SE	0.20 BASIC

PKG. CODE	E		D		DEPOPULATED BUMPS
	MIN	MAX	MIN	MAX	
W161B1+1	1.64	1.68	1.64	1.68	NONE

NOTES:
1. Terminal pitch is defined by terminal center to center value.
2. Outer dimension is defined by center lines between scribe lines.
3. All dimensions in millimeters.
4. Marking shown is for package orientation reference only.
5. Tolerance is ± 0.02mm unless specified otherwise.
6. All dimensions apply to PbFree (+) package codes only.
7. Front-side finish can be either Black or Clear.

MAXIM

TITLE:
PACKAGE OUTLINE
16 BUMPS, WLP PKG. 0.4mm PITCH

APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0491	A	1/1

修订历史

修订号	修订日期	说明	修改页
0	9/10	最初版本。	—

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