MAX98314

单声道、3.2W D类放大器，集成输入耦合电容

概述

MAX98314单声道、3.2W、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(0dB、3dB、6dB、9dB和12dB)，由一个增益选择输入(GAIN)设置。

限制边沿速率的有源辐射抑制(AEL)、过冲控制电路和无需滤波的扩频调制(SSM)架构大大降低了EMI，省去了传统D类放大器所需的输出滤波器。

IC的低静态电流(3.7V供电时为0.95mA，5.0V供电时为1.2mA)特性，可有效延长便携设备的电池使用寿命。

与使用外部输入电容的标准D类放大器相比，器件较高的线性度和集成输入耦合电容(C_{IN})大大缩小方案尺寸，并提供出色的低频THD+N、PSRR和CMRR性能。

IC提供小尺寸、9焊球、0.3mm间距的WLP (1.0mm x 1.0mm x 0.80mm)封装，工作在-40°C至+85°C扩展级温度范围。

应用

移动电话

便携式音频播放器

笔记本电脑

MP3播放器

上网本

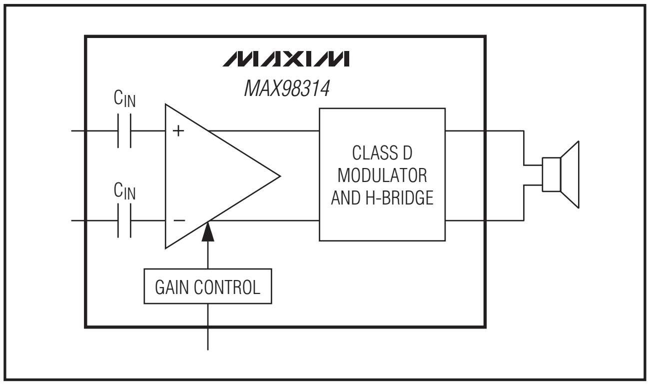
VoIP电话

定购信息在数据资料的最后给出。

特性

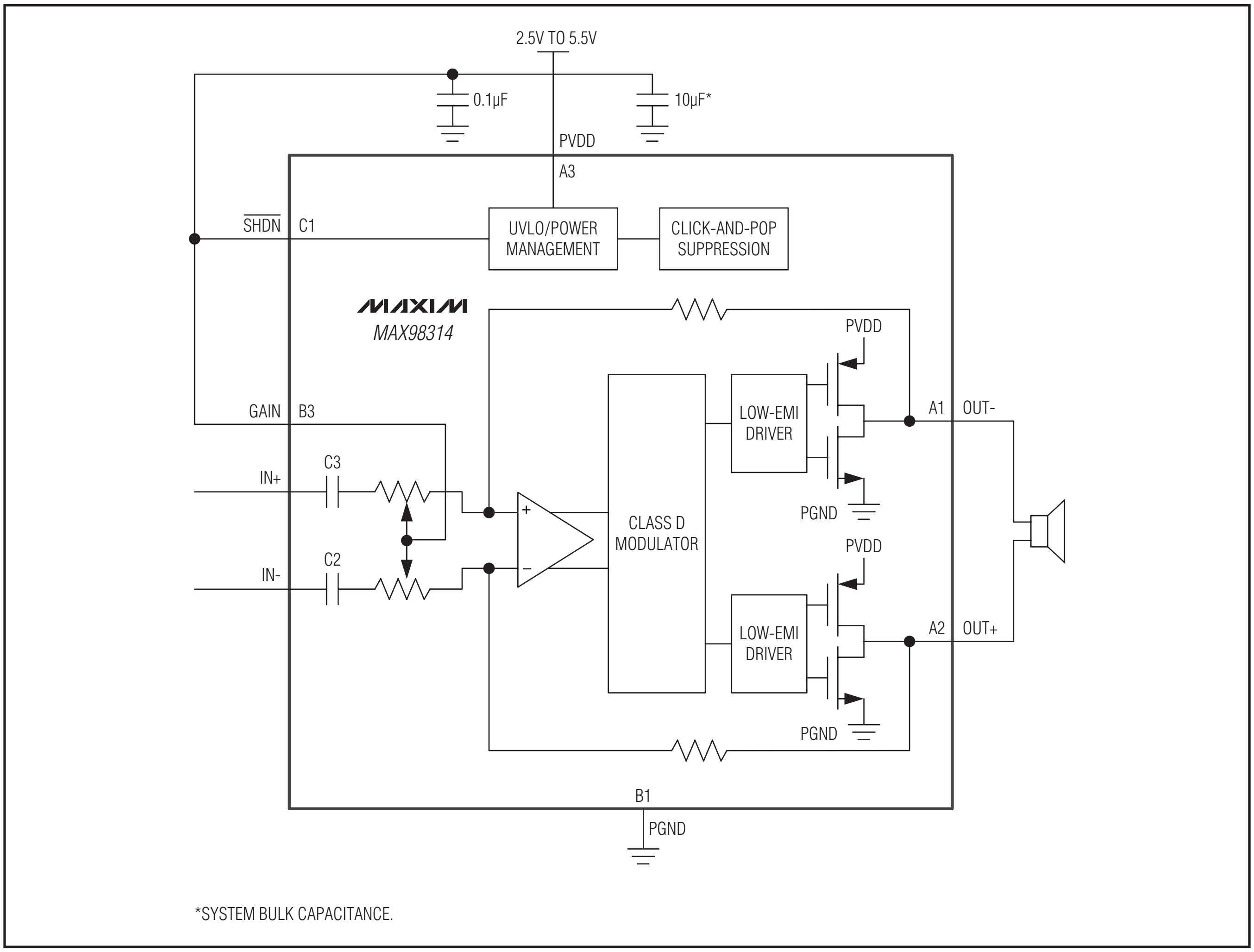
- 集成输入耦合电容，提供优异的线性度
  - f_C = 100Hz (6dB)
  - f_C = 200Hz (12dB)
- 低静态电流
  - 3.7V时为0.95mA
  - 5.0V时为1.2mA
- 以10% THD+N提供大功率输出驱动
  - V_{PVDD} = 5V时，可为4Ω负载提供3.2W功率
  - V_{PVDD} = 3.7V时，可为8Ω负载提供960mW功率
- 超低噪声：19µV
- 无需输出滤波
  - 扩展频谱和有源辐射抑制
- 咔嗒/噼噗声抑制
- 过热和过流保护
- 低电流关断模式
- 小尺寸封装，节省空间

简化框图



相关型号以及配合该器件使用的推荐产品，请参见： **china.maxim-ic.com/MAX98314.related**。

功能框图/典型应用电路


2.5V TO 5.5V
0.1μF
10μF*
PVDD
A3
SHDN
C1
UVLO/POWER
MANAGEMENT
CLICK-AND-POP
SUPPRESSION
MAXIM
MAX98314
PVDD
GAIN
B3
LOW-EMI
DRIVER
A1
OUT-
IN+
C3
CLASS D
MODULATOR
PGND
PVDD
IN-
C2
LOW-EMI
DRIVER
A2
OUT+
PGND
B1
PGND
*SYSTEM BULK CAPACITANCE.

ABSOLUTE MAXIMUM RATINGS

PVDD, IN+, IN-, $\overline{SHDN}$, GAIN to PGND..................0.3V to +6V
OUT+, OUT- to PGND...........................0.3V to (V_{PVDD} + 0.3V)
Continuous Current In/Out of PVDD, PGND, OUT_.........750mA
Continuous Input Current (all other pins)........................ ±20mA
Duration of Short Circuit Between
OUT_ to PVDD, PGND ....Continuous
Between OUT+ and OUT- Pins.............................Continuous

Continuous Power Dissipation (T_A = +70°C) for Multilayer Board
WLP (derate 10.64mW/°C above +70°C).....................851mW
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

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.

PACKAGE THERMAL CHARACTERISTICS (Note 1)

WLP
Junction-to-Ambient Thermal Resistance (θ_{JA}) ....102°C/W
Junction-to-Case Thermal Resistance (θ_{JC})...............47°C/W

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**.

ELECTRICAL CHARACTERISTICS

(V_{PVDD} = $V_{\overline{SHDN}}$ = V_{GAIN} = 5V, V_{PGND} = 0V, A_V = 6dB (GAIN = PVDD), R_L = ∞, R_L connected between OUT+ to OUT-, AC measurement bandwidth 20Hz to 22kHz, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 2, 3)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
AMPLIFIER CHARACTERISTICS							
Supply Voltage Range	V_{PVDD}	Guaranteed by PSRR test		2.5		5.5	V
Undervoltage Lockout	UVLO	PVDD falling			1.8	2.2	V
Quiescent Current	I_{PVDD}	V_{PVDD} = 5V			1.2	1.8	mA
		V_{PVDD} = 3.7V			0.95		
Shutdown Supply Current	$I_{\overline{SHDN}}$	$V_{\overline{SHDN}}$ = 0V, T_A = +25°C			< 0.1	10	µA
Turn-On Time	t_{ON}				3.7	10	ms
Bias Voltage	V_{BIAS}				$V_{PVDD}/2$		V
Voltage Gain	A_V	f = 1kHz	GAIN connected to PGND	11.75	12	12.25	dB
			GAIN connected to PGND through 100kΩ ±5% resistor	8.75	9	9.25	
			GAIN connected to PVDD	5.75	6	6.25	
			GAIN connected to PVDD through 100kΩ ±5% resistor	2.75	3	3.25	
			GAIN unconnected	-0.25	0	+0.25	
Input Capacitance	C_{IN}	All gains			0.011		µF
Highpass Corner Frequency	f_C	-3dB down	A_V = 12dB		199		Hz
			A_V = 9dB		139		
			A_V = 6dB	63	100	189	
			A_V = 3dB		70		
			A_V = 0dB		50		

ELECTRICAL CHARACTERISTICS (continued)

(V_{PVDD} = $V_{\overline{SHDN}}$ = V_{GAIN} = 5V, V_{PGND} = 0V, A_V = 6dB (GAIN = PVDD), R_L = ∞, R_L connected between OUT+ to OUT-, AC measurement bandwidth 20Hz to 22kHz, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 2, 3)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Common-Mode Rejection Ratio	CMRR	f_{IN} = 1kHz, input referred			67		dB
Output Offset Voltage	V_{OS}	T_A = +25°C (Note 4)			±1	±3	mV
Click-and-Pop Level	K_{CP}	R_L = 8Ω + 68µH, peak voltage, T_A = +25°C, A-weighted, 32 samples per second, T_A = +25°C (Notes 4, 5)	Into shutdown		-59		dBV
			Out of shutdown		-82		
Power-Supply Rejection Ratio (Note 4)	PSRR	V_{PVDD} = 2.5V to 5.5V, T_A = +25°C		70	90		dB
		V_{RIPPLE} = 200mV_{P-P}	f = 217Hz		74		
			f = 1kHz		72		
			f = 20kHz		49		
Output Power	P_{OUT}	THD+N = 10% f = 1kHz R_L = 4Ω + 33µH	V_{PVDD} = 5.0V		3.2		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		2.6		
			V_{PVDD} = 4.2V		1.8		
			V_{PVDD} = 3.7V		1.4		
		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		0.96		
		THD+N = 1% f = 1kHz R_L = 8Ω + 68µH	V_{PVDD} = 5.0V		1.4		
			V_{PVDD} = 4.2V		1		
			V_{PVDD} = 3.7V		0.8		
Total Harmonic Distortion Plus Noise	THD+N	f_{IN} = 1kHz	R_L = 4Ω, P_{OUT} = 1W		0.03	0.1	%
			R_L = 8Ω P_{OUT} = 0.725W		0.03		
Output Noise	V_N	A-weighted (Note 4)	A_V = 12dB		31		µV_{RMS}
			A_V = 9dB		26		
			A_V = 6dB		23		
			A_V = 3dB		21		
			A_V = 0dB		19		
Efficiency	η	R_L = 8Ω, P_{OUT} = 1.8W, f = 1kHz			93		%
Oscillator Frequency	f_{OSC}				300		kHz
Spread-Spectrum Bandwidth					20		kHz
Current Limit					2.8		A
Thermal Shutdown Level					155		°C

ELECTRICAL CHARACTERISTICS (continued)

($V_{PVDD} = V_{\overline{SHDN}} = V_{GAIN} = 5V$, $V_{PGND} = 0V$, $A_V = 6dB$ (GAIN = PVDD), $R_L = \infty$, R_L connected between OUT+ to OUT-, AC measurement bandwidth 20Hz to 22kHz, $T_A = T_{MIN}$ to T_{MAX}, unless otherwise noted. Typical values are at $T_A = +25°C$.) (Note 2, 3)

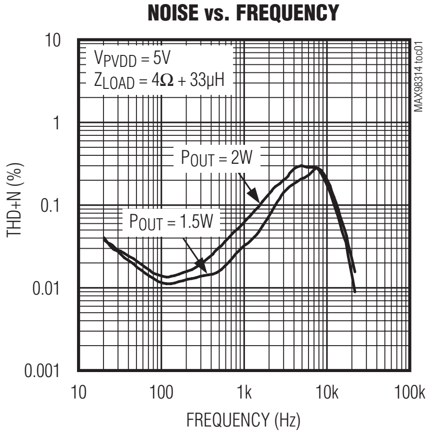
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Thermal Hysteresis				15		°C
DIGITAL INPUT ($\overline{SHDN}$)						
Input Voltage High	V_{INH}	V_{PVDD} = 2.5V to 5.5V	1.4			V
Input Voltage Low	V_{INL}	V_{PVDD} = 2.5V to 5.5V			0.4	V
Input Leakage Current		T_A = +25°C			±1	µA

Note 2: All devices are 100% production tested at T_A = +25°C. Specifications over 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 $\overline{SHDN}$ control pin.

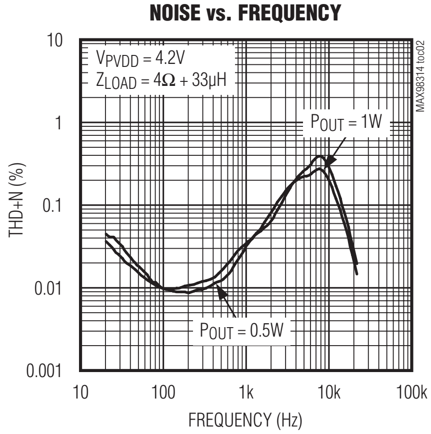
典型工作特性

($V_{PVDD} = V_{\overline{SHDN}} = 5.0V$, $V_{PGND} = 0V$, $A_V = 6dB$, $R_L = \infty$, R_L connected between OUT+ to OUT-, AC measurement bandwidth 20Hz to 22kHz, $T_A = +25°C$, unless otherwise noted.)

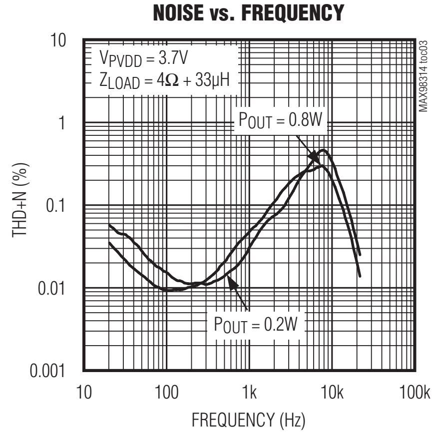
TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY



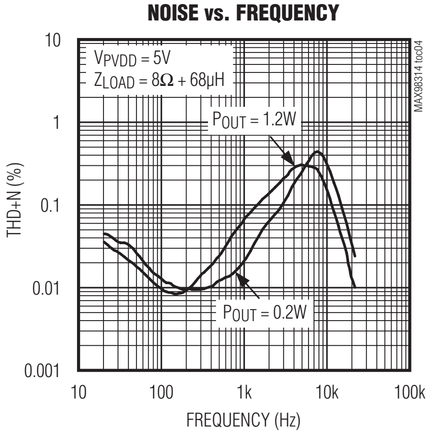
TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY



TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY



TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY



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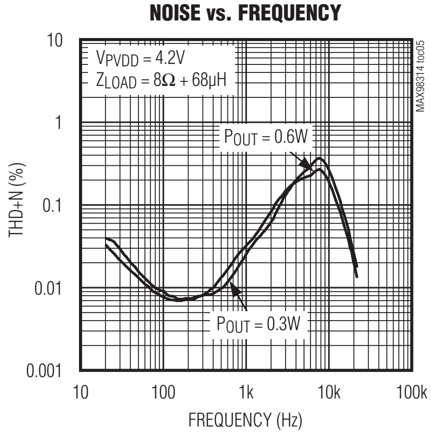
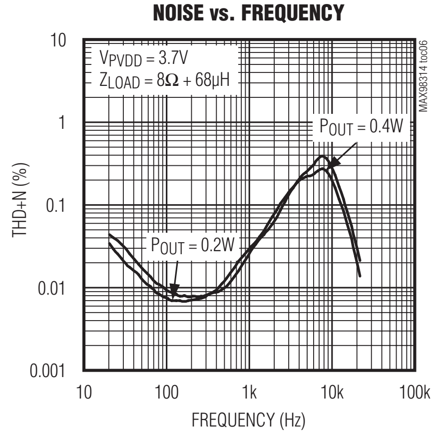


TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY



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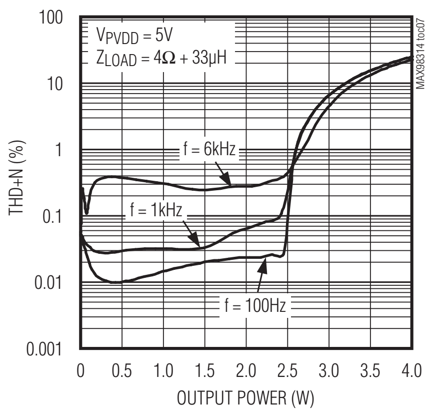
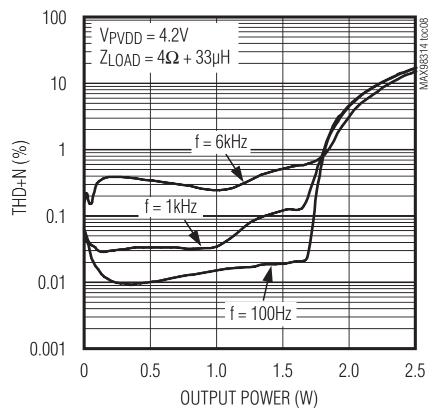
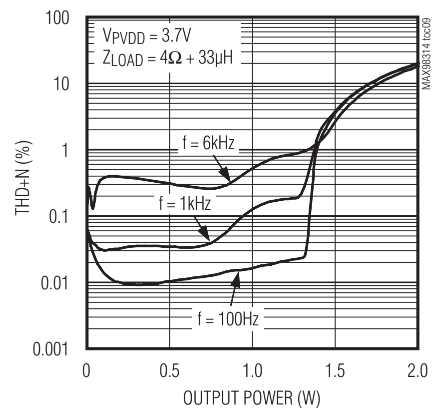
TOTAL HARMONIC DISTORTION PLUS NOISE vs. OUTPUT POWER



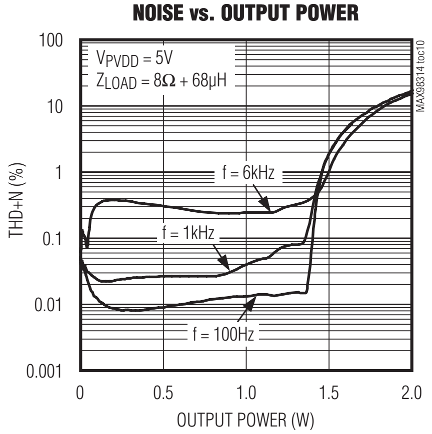
TOTAL HARMONIC DISTORTION PLUS NOISE vs. OUTPUT POWER



TOTAL HARMONIC DISTORTION PLUS NOISE vs. OUTPUT POWER



TOTAL HARMONIC DISTORTION PLUS NOISE vs. OUTPUT POWER



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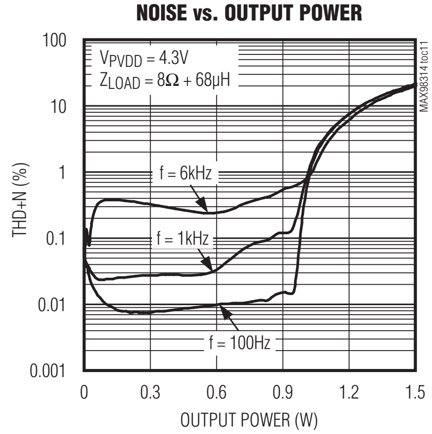
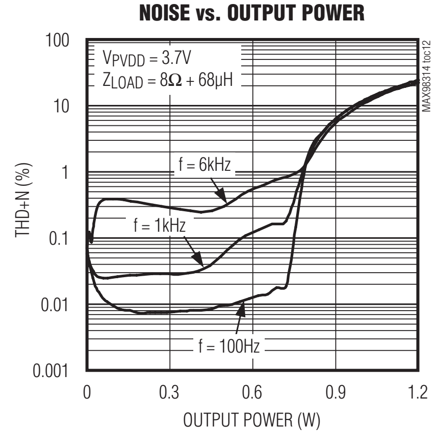
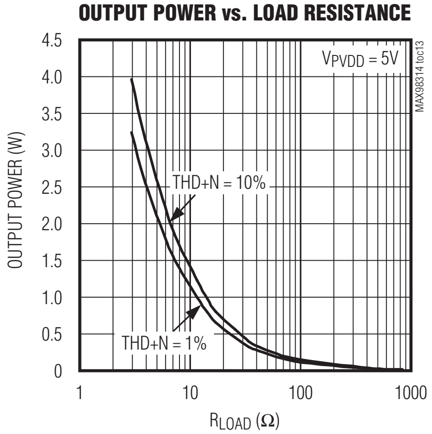


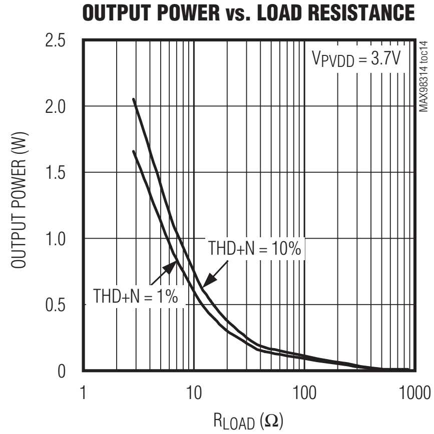
TOTAL HARMONIC DISTORTION PLUS NOISE vs. OUTPUT POWER



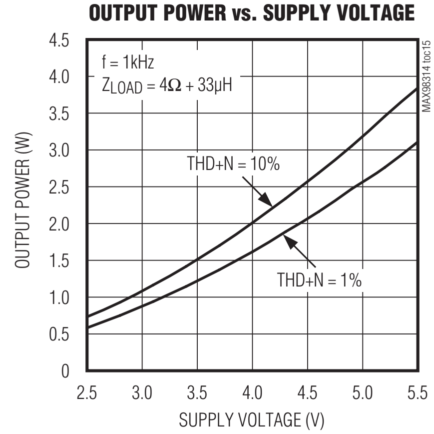
OUTPUT POWER vs. LOAD RESISTANCE



OUTPUT POWER vs. LOAD RESISTANCE



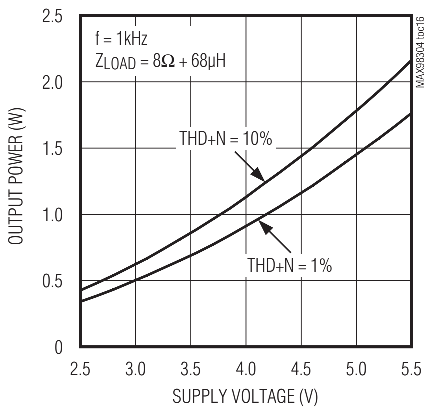
OUTPUT POWER vs. SUPPLY VOLTAGE



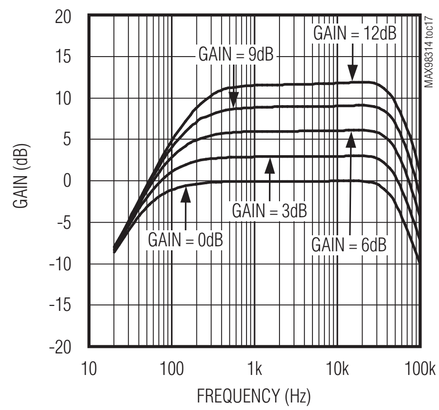
典型工作特性(续)

($V_{PVDD} = V_{\overline{SHDN}} = 5.0V$, $V_{PGND} = 0V$, $A_V = 6dB$, $R_L = \infty$, R_L connected between OUT+ to OUT-, AC measurement bandwidth 20Hz to 22kHz, $T_A = +25°C$, unless otherwise noted.)

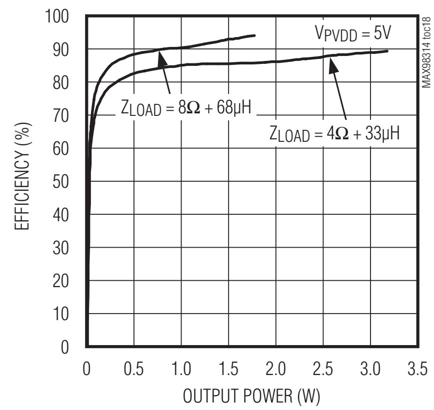
OUTPUT POWER vs. SUPPLY VOLTAGE



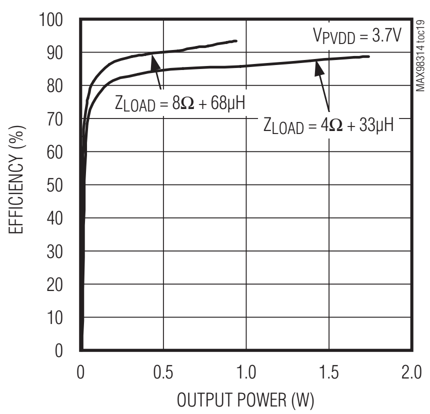
GAIN vs. FREQUENCY



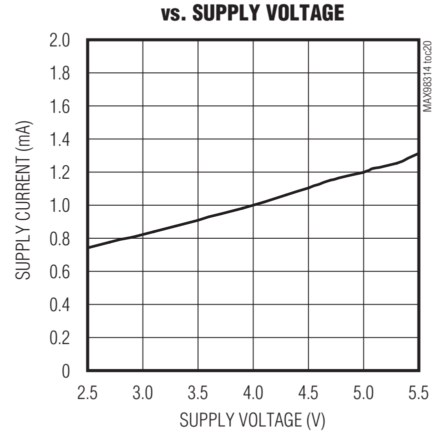
EFFICIENCY vs. OUTPUT POWER



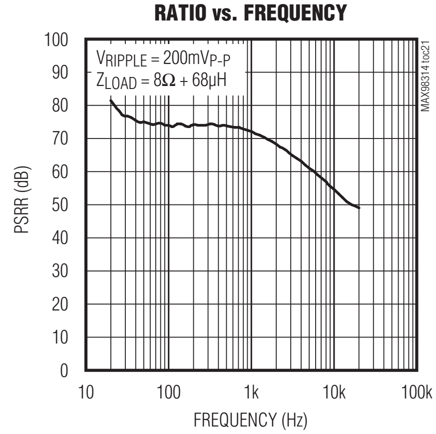
EFFICIENCY vs. OUTPUT POWER



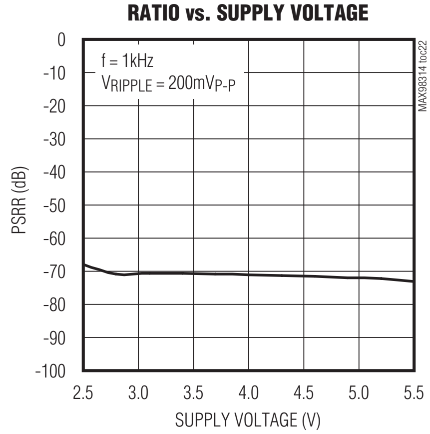
SUPPLY CURRENT vs. SUPPLY VOLTAGE



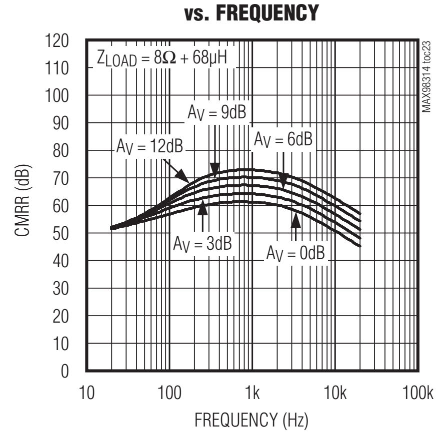
POWER-SUPPLY REJECTION RATIO vs. FREQUENCY



POWER-SUPPLY REJECTION RATIO vs. SUPPLY VOLTAGE



COMMON-MODE REJECTION RATIO vs. FREQUENCY



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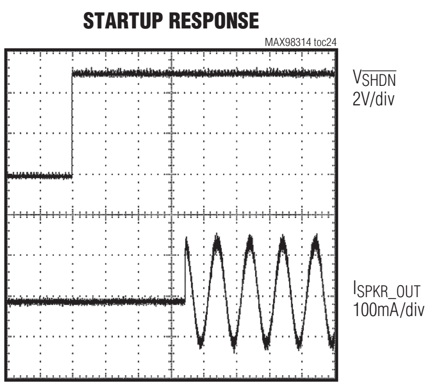
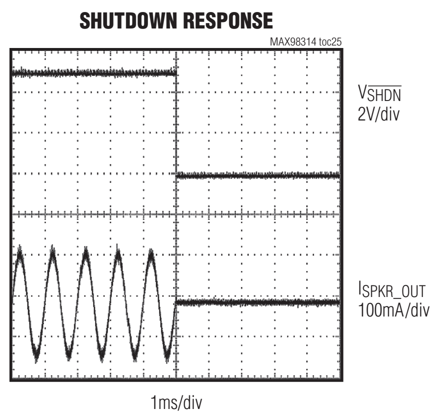
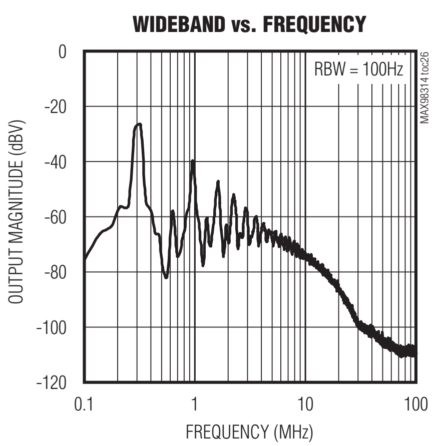
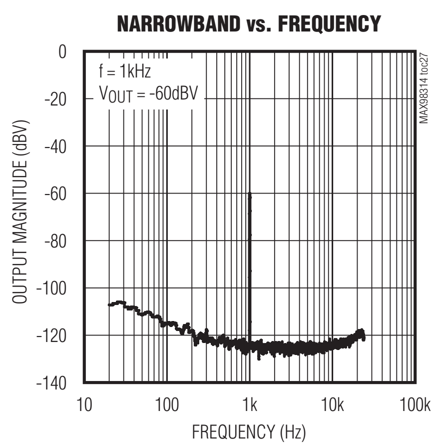
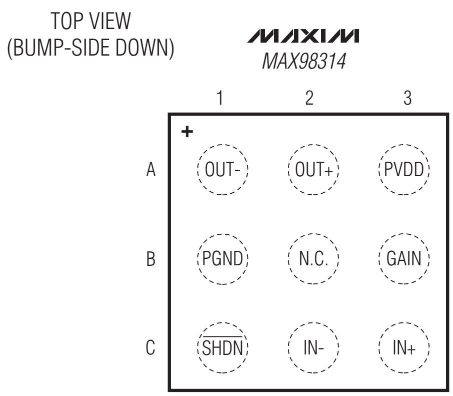








引脚配置



WLP
(0.3mm pitch)

引脚说明

焊球	名称	功能
A1	OUT-	扬声器输出负端。
A2	OUT+	扬声器输出正端。
A3	PVDD	电源，通过0.1μF和10μF并联电容将PVDD旁路至PGND。
B1	PGND	电源地。
B2	N.C.	无连接，可以不连接或连接至PGND。
B3	GAIN	增益选择，GAIN设置请参见表1。
C1	$\overline{SHDN}$	低电平有效关断输入，将$\overline{SHDN}$驱动至低电平时，关断器件。
C2	IN-	反相音频输入。
C3	IN+	同相音频输入。

详细说明

MAX98314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。

与使用外部输入电容的标准D类放大器相比，器件较高的线性度和集成输入耦合电容(C_{IN})大大缩小方案尺寸，并提供出色的低频THD+N、PSRR和CMRR性能。

D类扬声器放大器

IC集成无需滤波的D类放大器，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的导通电阻和静态开关电流造成的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，以满足电磁干扰(EMI)规范的要求。Maxim专有的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。

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±20kHz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)。

放大器限流

如果扬声器放大器的输出电流超过电流门限(2.8A，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。

可选放大器增益

IC提供5种可编程增益选项，通过一个增益输入(GAIN)选择。

表1. GAIN选择

GAIN PIN	MAXIMUM GAIN (dB)
Connect to PGND	12
Connect to PGND through 100kΩ ±5%	9
Connect to PVDD	6
Connect to PVDD through 100kΩ ±5%	3
Unconnected	0

集成输入耦合电容(C_{IN})

IC内部集成了两个0.011μF输入耦合电容C_{IN}。输入耦合电容与放大器的内部输入电阻(R_{IN})构成一阶高通滤波器，从而消除输入信号的直流偏置。这些电容允许放大器对信号进行偏置，优化调整直流电平。

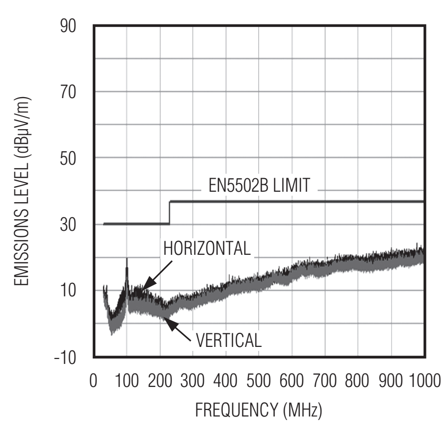


图1. 采用60cm扬声器电缆、无输出滤波器时的EMI特性

假设源阻抗为零，则–3dB角频率f_{-3dB}为：

$$f_{-3dB} = 1/2\pi R_{IN}C_{IN}\ [Hz]$$

集成输入耦合电容具有100ppm/V的电压系数，提供出色的低频THD+N性能。图2给出了集成输入耦合电容的IC与外置0.01µF X7R和X5R 0402输入耦合电容的类似放大器性能比较，从中可以看出IC所具有的优异线性指标。

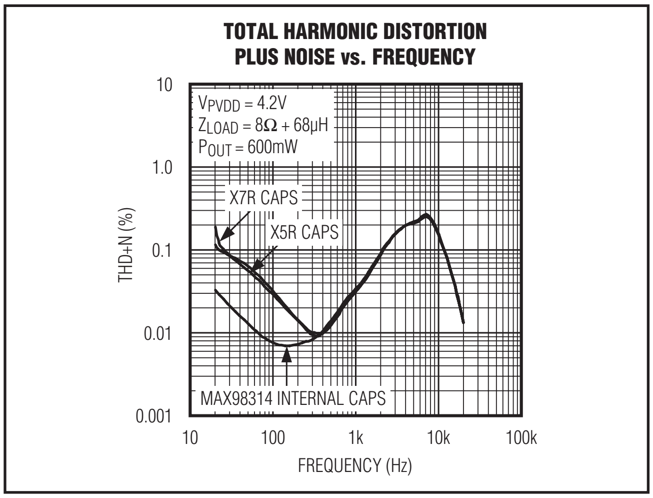


图2. 低频THD+N性能

关断

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

咔嗒/噼噗声抑制

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。

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、降低效率和THD+N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。

扬声器放大器电源输入(PVDD)

PVDD为扬声器放大器供电，电压范围为2.5V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。

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，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3给出了该款IC使用的WLP焊球尺寸。

定购信息

PART	TEMP RANGE	PIN-PACKAGE
MAX98314EWL+	-40°C to +85°C	9 WLP

+表示无铅(Pb)/符合RoHS标准的封装。

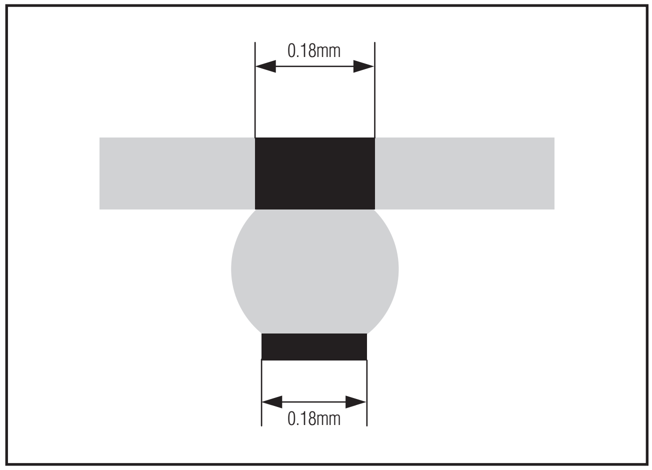
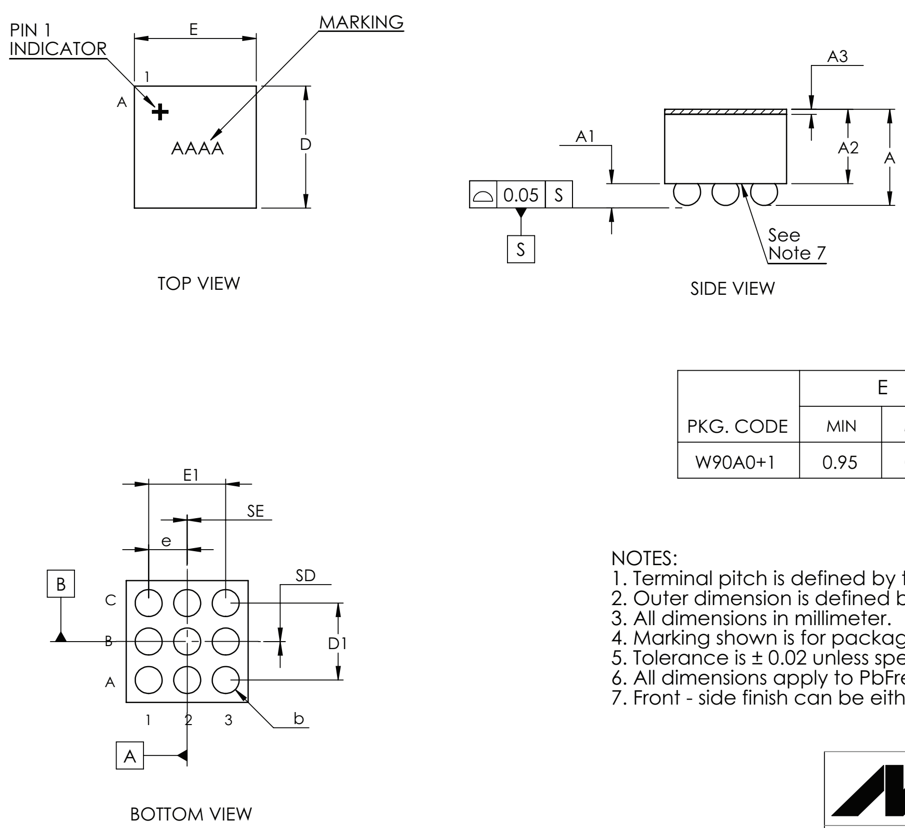


图3. WLP焊球尺寸

封装信息

如需最近的封装外形信息和焊盘布局(占位面积)，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
9 WLP (0.3mm焊球间距)	W90A0+1	**21-0539**	参见 **应用笔记1891**



COMMON DIMENSIONS		
A	0.75	±0.05
A1	0.16	±0.03
A2	0.59	REF
A3	0.040	BASIC
b	∅0.21	±0.03
D1	0.60	BASIC
E1	0.60	BASIC
e	0.30	BASIC
SD	0.00	BASIC
SE	0.00	BASIC

PKG. CODE	E		D		DEPOPULATED BUMPS
	MIN	MAX	MIN	MAX	
W90A0+1	0.95	0.98	0.95	0.98	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 millimeter.
4. Marking shown is for package orientation reference only.
5. Tolerance is ± 0.02 unless specified otherwise.
6. All dimensions apply to PbFree (+) package codes only.
7. Front - side finish can be either Black or Clear.

-DRAWING NOT TO SCALE-

TITLE	Package Outline 9 bumps, WLP Pkg. 0.3MM Pitch	
APPROVAL	DOCUMENT CONTROL NO. 21-0539	REV. B 1/1

MAX98314

单声道、3.2W D类放大器，集成输入耦合电容

修订历史

修订号	修订日期	说明	修改页
0	11/11	最初版本。	—

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