19-0764; Rev 1; 2/09

可提供评估板

具有AGC和低噪声麦克风偏置电路的麦克风放大器

概述

MAX9814是一款低成本、高品质麦克风放大器，内置自动增益控制(AGC)以及低噪声麦克风偏置。该器件集成低噪声前置放大器、可变增益放大器(VGA)、输出放大器、麦克风偏压发生器以及AGC控制电路。

低噪声前置放大器的增益固定为12dB，而VGA增益可以根据输出电压和AGC门限在20dB和0dB之间自动调节。输出放大器具有8dB、18dB和28dB三种可选增益。在没有压缩的条件下，放大器级联可使总增益达到40dB、50dB或60dB。三态数字输入编程设置输出放大器的增益。外部电阻分压器控制AGC门限，单个电容可设置启动/释放时间。三态数字输入还可编程设置启动与释放时间的比，AGC的保持时间固定值为30ms。低噪声麦克风偏置发生器能为大多数驻极体麦克风提供偏压。

MAX9814采用节省空间的、12焊球、UCSP™ (1.5mm x 2mm)封装以及14引脚TDFN封装。该器件规定工作在-40°C至+85°C扩展级温度范围。

特性

- ♦ 自动增益控制(AGC)
- ♦ 三种增益设置(40dB、50dB、60dB)
- ♦ 可编程启动时间
- ♦ 可编程启动与释放比
- ♦ 2.7V至5.5V电源电压范围
- ♦ 低达30nV/√Hz的输入参考噪声密度
- ♦ 低达0.04% (典型值)的THD
- ♦ 低功耗关断模式
- ♦ 内部提供低噪声麦克风偏置，2V
- ♦ 采用节省空间的12焊球UCSP (1.5mm x 2mm)封装和14引脚TDFN (3mm x 3mm)封装
- ♦ -40°C至+85°C扩展级温度范围

应用

数码相机
数字摄像机
PDA
蓝牙耳机
娱乐系统(例如，卡拉OK)
双向通信装置
高品质便携式录像机
IP电话/电话会议

定购信息

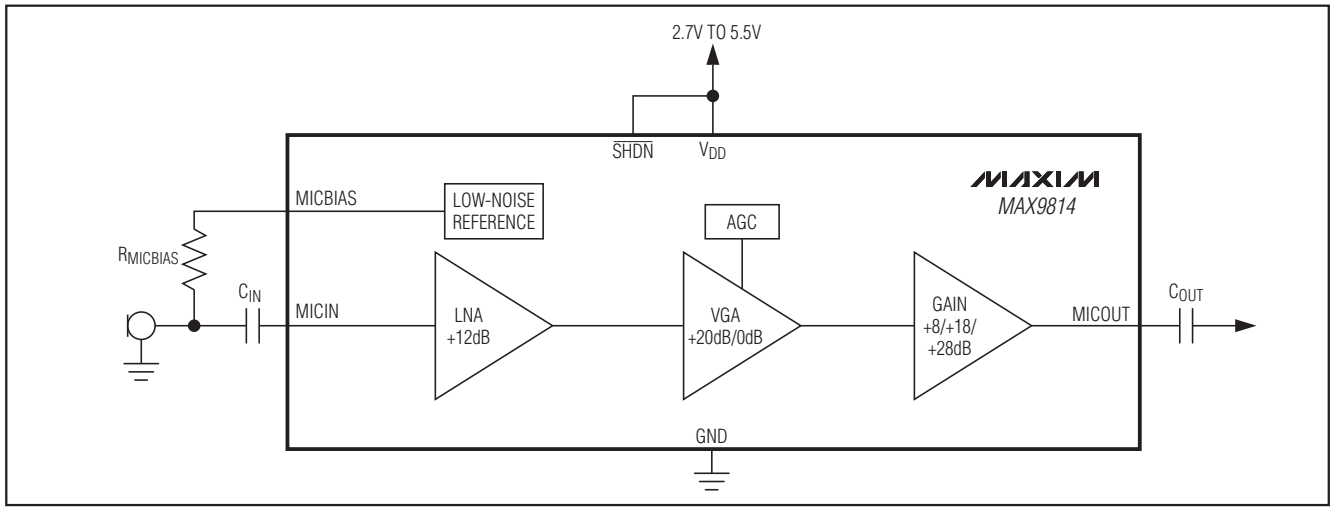
PART	TEMP RANGE	PIN-PACKAGE
MAX9814EBC+T	-40°C to +85°C	12 UCSP
MAX9814ETD+T	-40°C to +85°C	14 TDFN-EP*

+表示无铅(Pb)/符合RoHS标准的封装。
**EP = 裸焊盘。*

引脚配置在数据资料的最后给出。

UCSP是Maxim Integrated Products, Inc.的商标。

简化框图



ABSOLUTE MAXIMUM RATINGS

V_{DD} to GND .....-0.3V to +6V
All Other Pins to GND.....-0.3V to (V_{DD} + 0.3V)
Output Short-Circuit Duration.....Continuous
Continuous Current (MICOUT, MICBIAS).....±100mA
All Other Pins .....±20mA

Continuous Power Dissipation (T_A = +70°C)
12-Bump UCSP (derate 6.5mW/°C above +70°C).....518mW
14-Pin TDFN-EP
(derate 16.7mW/°C above +70°C).....1481.5mW
Operating Temperature Range .....-40°C to +85°C
Junction Temperature.....+150°C
Lead Temperature (soldering, 10s) .....+300°C
Bump Temperature (soldering) Reflow.....+235°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

(V_{DD} = 3.3V, $\overline{SHDN}$ = V_{DD}, C_{CT} = 470nF, C_{CG} = 2µF, GAIN = V_{DD}, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
GENERAL						
Operating Voltage	V_{DD}	Guaranteed by PSRR test	2.7		5.5	V
Supply Current	I_{DD}			3.1	6	mA
Shutdown Supply Current	$I_{\overline{SHDN}}$			0.01	1	µA
Input-Referred Noise Density	e_n	BW = 20kHz, all gain settings		30		nV/√Hz
Output Noise		BW = 20kHz		430		μV_{RMS}
Signal-to-Noise Ratio	SNR	BW = 22Hz to 22kHz ($500mV_{RMS}$ output signal)		61		dB
		A-weighted		64		
Dynamic Range	DR	(Note 2)		60		dB
Total Harmonic Distortion Plus Noise	THD+N	f_{IN} = 1kHz, BW = 20Hz to 20kHz, R_L = 10kΩ, V_{TH} = 1V (threshold = $2V_{P-P}$), V_{IN} = $0.5mV_{RMS}$, V_{CT} = 0V		0.04		%
		f_{IN} = 1kHz, BW = 20Hz to 20kHz, R_L = 10kΩ, V_{TH} = 0.1V (threshold = $200mV_{P-P}$), V_{IN} = $30mV_{RMS}$, V_{CT} = 2V		0.2		
Amplifier Input BIAS	V_{IN}		1.14	1.23	1.32	V
Maximum Input Voltage	V_{IN_MAX}	1% THD		100		mV_{P-P}
Input Impedance	Z_{IN}			100		kΩ
Maximum Gain	A	GAIN = V_{DD}	39.5	40	40.5	dB
		GAIN = GND	49.5	50	50.6	
		GAIN = unconnected	59.5	60	60.5	
Minimum Gain		GAIN = V_{DD}	18.7	20	20.5	dB
		GAIN = GND	29.0	30	30.8	
		GAIN = unconnected	38.7	40	40.5	
Maximum Output Level	V_{OUT_RMS}	1% THD+N, V_{TH} = MICBIAS		0.707		V_{RMS}
Regulated Output Level		AGC enabled, V_{TH} = 0.7V	1.26	1.40	1.54	V_{P-P}
AGC Attack Time	t_{ATTACK}	C_{CT} = 470nF (Note 3)		1.1		ms
Attack/Release Ratio	A/R	A/R = GND		1:500		ms/ms
		A/R = V_{DD}		1:2000		
		A/R = unconnected		1:4000		

ELECTRICAL CHARACTERISTICS (continued)

(V_{DD} = 3.3V, $\overline{SHDN}$ = V_{DD}, C_{CT} = 470nF, C_{CG} = 2µF, GAIN = V_{DD}, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
MICOUT High Output Voltage	V_{OH}	I_{OUT} sourcing 1mA		2.45		V
MICOUT Low Output Voltage	V_{OL}	I_{OUT} sinking 1mA		3		mV
MICOUT Bias		MICOUT unconnected	1.14	1.23	1.32	V
Output Impedance	Z_{OUT}			50		Ω
Minimum Resistive Load	R_{LOAD_MIN}			5		kΩ
Maximum Capacitive Drive	C_{LOAD_MAX}			200		pF
Maximum Output Current	I_{OUT_MAX}	1% THD, R_L = 500Ω		1	2	mA
Output Short-Circuit Current	I_{SC}		3	8		mA
Power-Supply Rejection Ratio	PSRR	AGC mode; V_{DD} = 2.7V to 5.5V (Note 4)	35	50		dB
		f = 217Hz, V_{RIPPLE} = 100mV_{P-P} (Note 5)		55		
		f = 1kHz, V_{RIPPLE} = 100mV_{P-P} (Note 5)		52.5		
		f = 10kHz, V_{RIPPLE} = 100mV_{P-P} (Note 5)		43		
MICROPHONE BIAS						
Microphone Bias Voltage	$V_{MICBIAS}$	$I_{MICBIAS}$ = 0.5mA	1.84	2.0	2.18	V
Output Resistance	$R_{MICBIAS}$	$I_{MICBIAS}$ = 1mA		1		Ω
Output Noise Voltage	$V_{MICBIAS\_NOISE}$	$I_{MICBIAS}$ = 0.5mA, BW = 22Hz to 22kHz		5.5		$µV_{RMS}$
Power-Supply Rejection Ratio	PSRR	DC, V_{DD} = 2.7V to 5.5V	70	80		dB
		$I_{MICBIAS}$ = 0.5mA, V_{RIPPLE} = 100mV_{P-P}, f_{IN} = 1kHz		71		
TRILEVEL INPUTS (A/R, GAIN)						
Tri-Level Input Leakage Current		A/R or GAIN = V_{DD}	$0.5V_{DD}$ / 180kΩ	$0.5V_{DD}$ / 100kΩ	$0.5V_{DD}$ / 50kΩ	mA
		A/R or GAIN = GND	$0.5V_{DD}$ / 180kΩ	$0.5V_{DD}$ / 100kΩ	$0.5V_{DD}$ / 50kΩ	
Input High Voltage	V_{IH}		V_{DD} x 0.7			V
Input Low Voltage	V_{IL}				V_{DD} x 0.3	V
Shutdown Enable Time	t_{ON}			60		ms
Shutdown Disable Time	t_{OFF}			40		ms
DIGITAL INPUT ($\overline{SHDN}$)						
$\overline{SHDN}$ Input Leakage Current			-1		+1	µA
Input High Voltage	V_{IH}		1.3			V
Input Low Voltage	V_{IL}				0.5	V
AGC THRESHOLD INPUT (TH)						
TH Input Leakage Current			-1		+1	µA

Note 1: Devices are production tested at T_A = +25°C. Limits over temperature are guaranteed by design.
Note 2: Dynamic range is calculated using the EIAJ method. The input is applied at -60dBFS (0.707$µV_{RMS}$), f_{IN} = 1kHz.
Note 3: Attack time measured as time from AGC trigger to gain reaching 90% of its final value.
Note 4: CG is connected to an external DC voltage source, and adjusted until V_{MICOUT} = 1.23V.
Note 5: CG connected to GND with 2.2µF.

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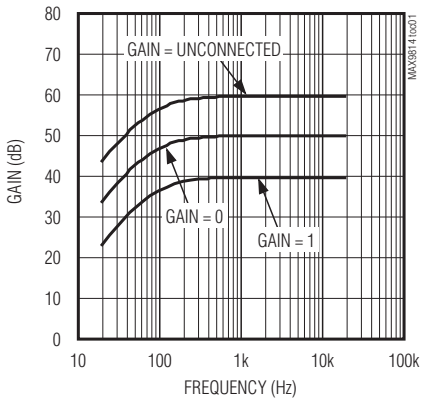
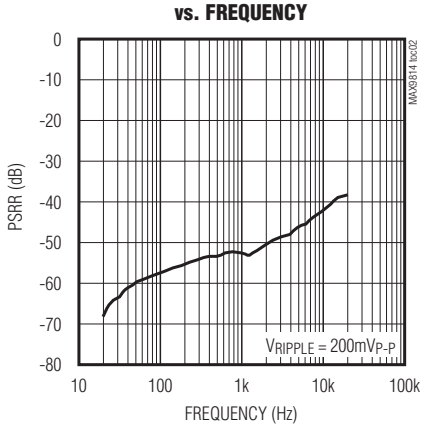
典型工作特性

(V_{DD} = 5V, C_{CT} = 470nF, C_{CG} = 2.2µF, V_{TH} = $V_{MICBIAS}$ x 0.4, GAIN = V_{DD} (40dB), AGC disabled, no load, R_L = 10kΩ, C_{OUT} = 1µF, T_A = +25°C, unless otherwise noted.)

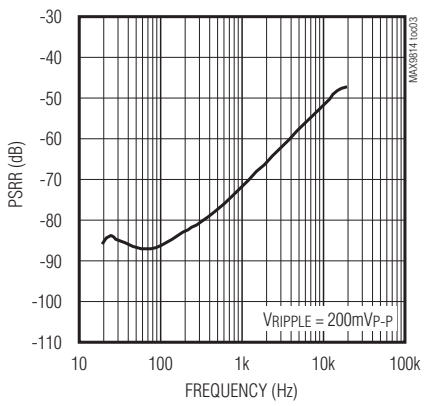
GAIN vs. FREQUENCY



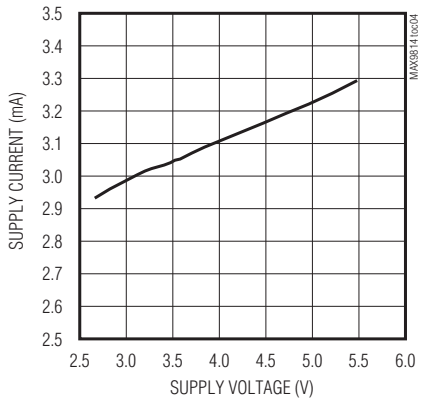
POWER-SUPPLY REJECTION RATIO vs. FREQUENCY



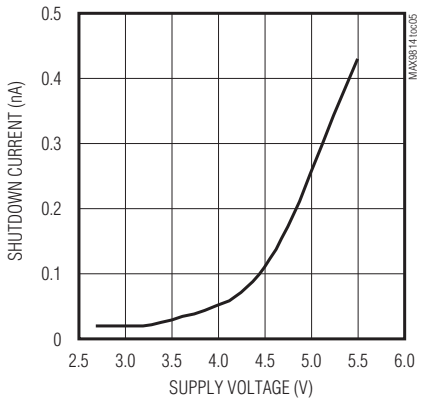
MICBIAS POWER-SUPPLY REJECTION RATIO vs. FREQUENCY



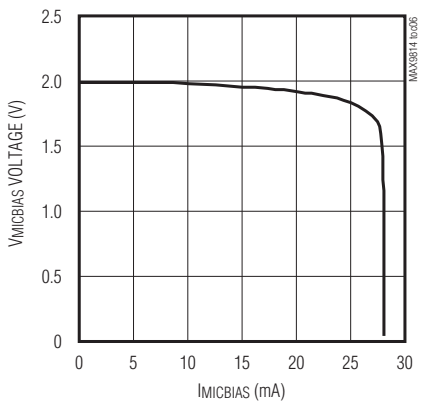
SUPPLY CURRENT vs. SUPPLY VOLTAGE



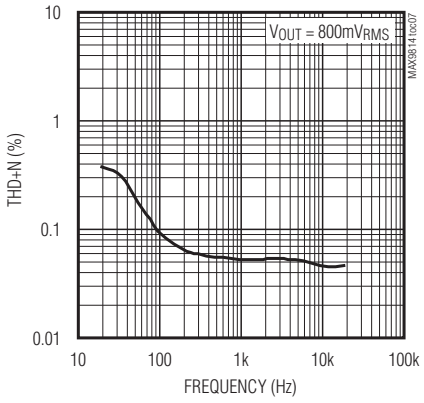
SHUTDOWN CURRENT vs. SUPPLY VOLTAGE



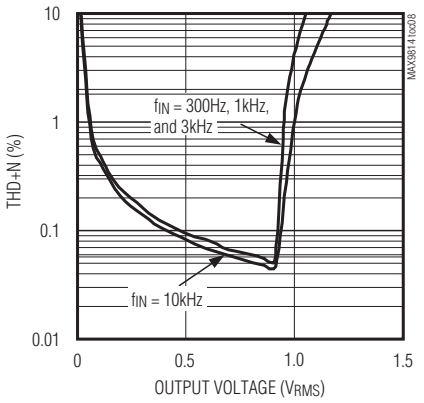
MICROPHONE BIAS VOLTAGE vs. MICROPHONE BIAS SOURCE CURRENT



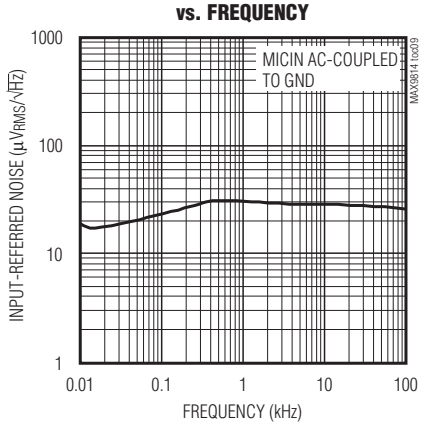
TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY



TOTAL HARMONIC DISTORTION PLUS NOISE vs. OUTPUT VOLTAGE



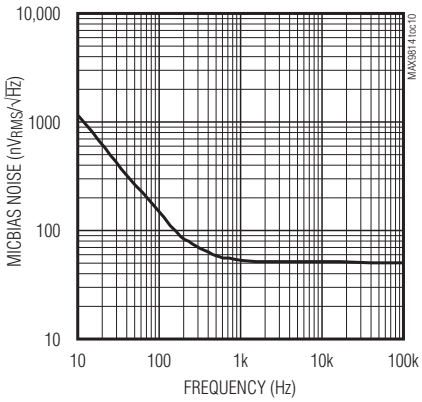
INPUT-REFERRED NOISE vs. FREQUENCY



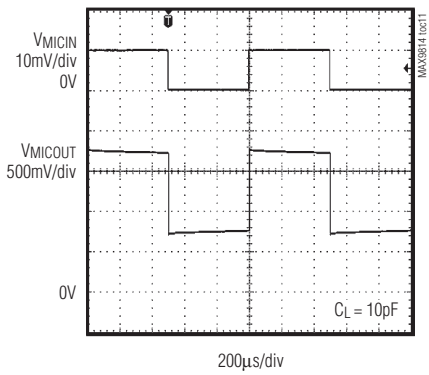
典型工作特性(续)

(V_{DD} = 5V, C_{CT} = 470nF, C_{CG} = 2.2µF, V_{TH} = $V_{MICBIAS}$ x 0.4, GAIN = V_{DD} (40dB), AGC disabled, no load, R_L = 10kΩ, C_{OUT} = 1µF, T_A = +25°C, unless otherwise noted.)

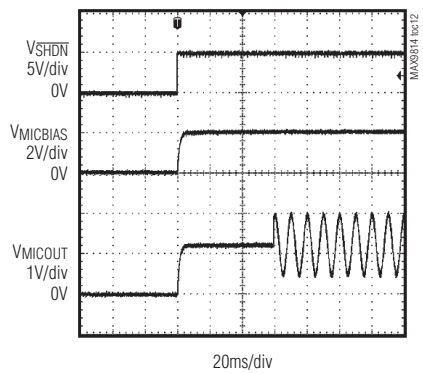
MICBIAS NOISE vs. FREQUENCY



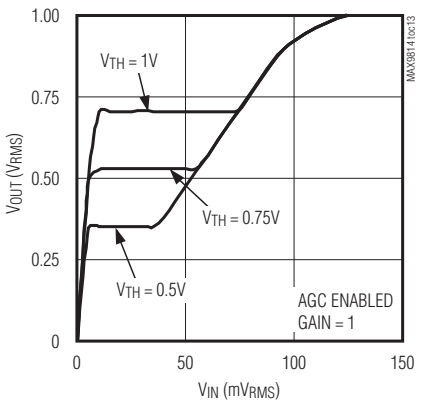
SMALL-SIGNAL PULSE RESPONSE



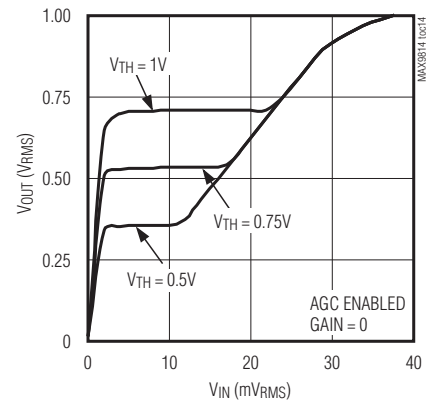
TURN-ON RESPONSE



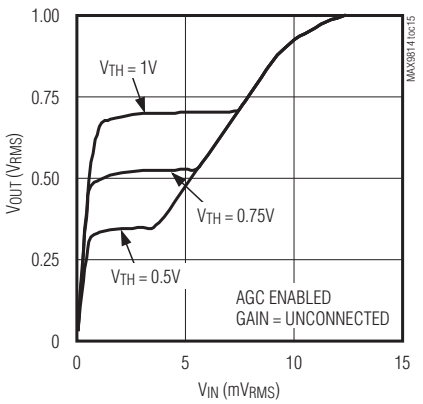
VOUT vs. VIN



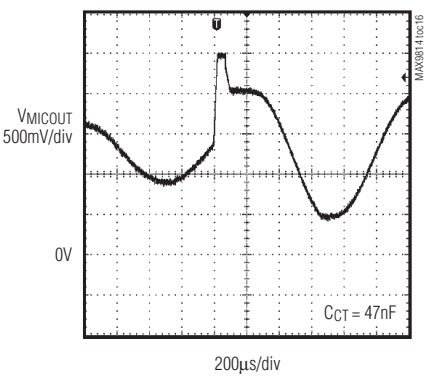
VOUT vs. VIN



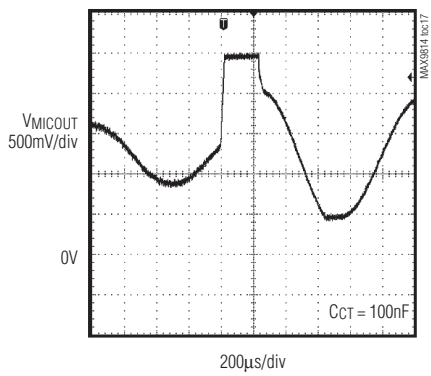
VOUT vs. VIN



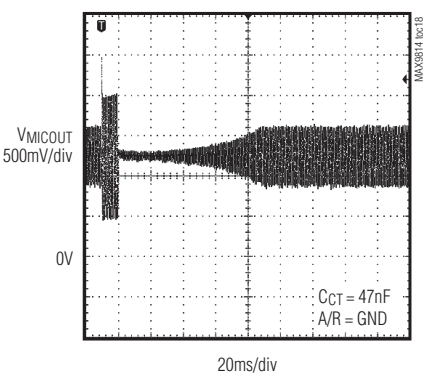
ATTACK TIME



ATTACK TIME



HOLD AND RELEASE TIME



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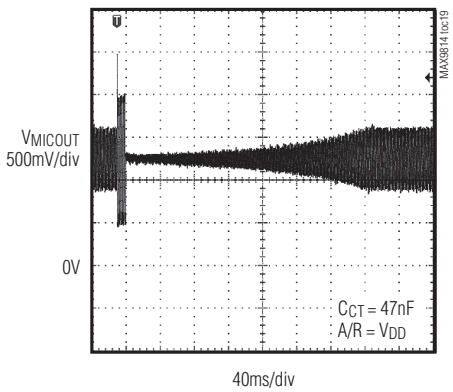
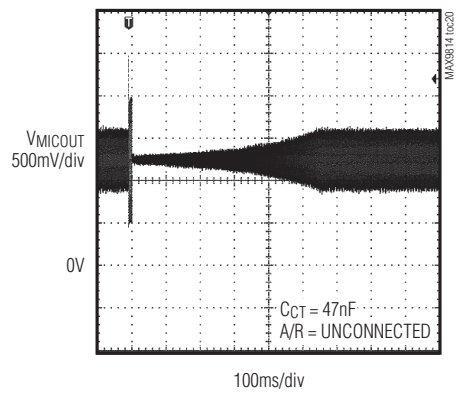
典型工作特性(续)

(V_{DD} = 5V, C_{CT} = 470nF, C_{CG} = 2.2µF, V_{TH} = $V_{MICBIAS}$ x 0.4, GAIN = V_{DD} (40dB), AGC disabled, no load, R_L = 10kΩ, C_{OUT} = 1µF, T_A = +25°C, unless otherwise noted.)

HOLD AND RELEASE TIME



HOLD AND RELEASE TIME



引脚说明

引脚		名称	功能
TDFN-EP	UCSP		
1	A1	CT	定时电容连接，将电容连接至CT控制AGC的启动时间和释放时间。
2	B2	$\overline{SHDN}$	低电平有效关断控制。
3	A2	CG	放大器直流失调调节，连接一只2.2µF的电容至GND，确保输出端零失调。
4, 11	—	N.C.	无连接，接GND。
5	A3	V_{DD}	电源，采用一只1µF电容旁路至GND。
6	A4	MICOUT	放大器输出。
7	B4	GND	地。
8	C4	MICIN	麦克风放大器同相输入。
9	B3	A/R	三态启动与释放比选择，控制AGC电路的启动时间与释放时间比： A/R = GND：启动/释放比为1:500 A/R = V_{DD}：启动/释放比为1:2000 A/R = 悬空：启动/释放比为1:4000
10	C3	GAIN	三态放大器增益控制： GAIN = V_{DD}，增益设置为40dB。 GAIN = GND，增益设置为50dB。 GAIN = 悬空，无压缩增益设置为60dB。
12	C2	BIAS	放大器偏置，采用一只0.47µF的电容旁路至GND。
13	C1	MICBIAS	麦克风偏置输出。
14	B1	TH	AGC门限控制，TH电压设置增益控制门限。将TH连接至MICBIAS，禁止AGC。
—	—	EP	裸焊盘，将TDFN封装的EP连接至GND。

具有AGC和低噪声麦克风偏置电路的麦克风放大器

详细说明

MAX9814是一款低成本、高品质麦克风放大器，内置自动增益控制(AGC)以及低噪声麦克风偏置。MAX9814是由低噪声前置放大器、可变增益放大器(VGA)、输出放大器、麦克风偏置发生器以及AGC控制电路等多个不同电路组成。

内部麦克风偏置发生器提供2V的偏压，适用于大多数驻极体电容式麦克风。MAX9814分为三级，对输入进行放大。在第一级，输入通过增益为12dB的低噪声前置放大器进行缓冲和放大；第二级则由AGC控制的VGA组成，VGA/AGC组合能够使增益在20dB与0dB之间变化；输出放大器是最后一级，具有8dB、18dB、20dB三个不同的固定增益，可通过一个三态逻辑输入编程设置。AGC无压缩时，MAX9814能够提供40dB、50dB或60dB的增益。

自动增益控制(AGC)

不具备AGC的器件在输入增益过大时，输出将会出现削波；而在输入增益过大时，AGC能够避免输出削波。图1所示为增益过大的麦克风输入在具有AGC和不带AGC的情况下的比较。

MAX9814的AGC对增益进行控制，首先检测输出电压是否超过预设门限。随后，通过可选的时间常数降低麦克风放大器增益，以修正过大的输出电压幅值。这一过程称为启动时间。当输出信号幅值降低后，增益在很短时间内保持衰减状态，随后输出信号缓慢增加到正常值。该过程称为保持和释放时间。放大器调节输入信号的速度由外部定时电容C_{CT}和A/R端电压设置。AGC门限可通过V_{TH}调节。增益衰减量为输入信号幅值的函数，最大AGC衰减为20dB。图2给出了输入突然超出预设门限时，对输出启动时间、保持时间和释放时间的影响。

如果配置的启动时间和释放时间响应太快，增益随信号动态变化而快速调节，常常会产生类似“砰然”声(pumping)或“喘息”声(breathing)的音频噪声。调节AGC的时间常数使其与声源匹配，从而达到最佳效果。对于那些以CD音乐为主要音源的应用来说，推荐启动时间为160µs，释放时间为80ms。通常情况下，音乐播放设备要比语音或电影等设备需要更短的释放时间。

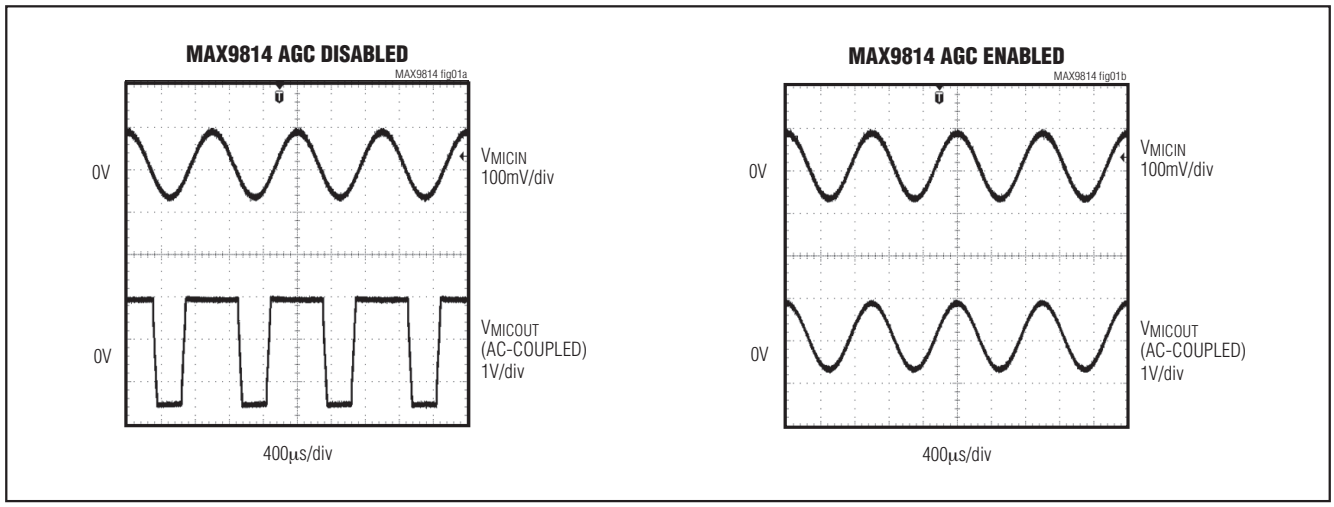


图1. 带有AGC和没有AGC的麦克风输入

具有AGC和低噪声麦克风偏置电路的麦克风放大器

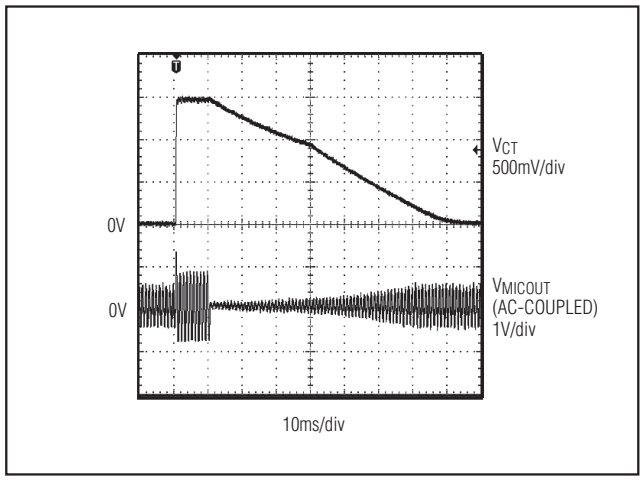


图2. 输入突然超过AGC门限

启动时间

启动时间是指当输入信号超过门限电平后，AGC降低增益所需的时间。增益在启动时间内以指数形式衰减，定义为一个时间常数。该时间常数为2400 x C_{CT}秒(其中C_{CT}是外部定时电容)：

- 选取较短的启动时间，以保证AGC快速响应瞬态信号，例如击鼓声(音乐)或枪击声(DVD)。
- 选用较长的启动时间，AGC将忽略瞬时峰值，只有当声响明显增加时才降低增益。瞬时峰值并不被衰减，但较响的声音将被衰减。这样可从音量上降低响声，使动态范围最大化。

保持时间

保持时间是指信号降到门限以下、释放过程开始以前的延迟。保持时间内部设置为30ms，并且不可调。当信号超过门限，重新进入启动阶段时，保持时间终止。

释放时间

释放时间是指信号跌落至门限以下，并且经过30ms的保持时间之后，增益回到其正常水平所需的时间。释放时间定义为当输入信号跌落至TH门限以下，并且经过30ms的保持时间之后，增益从20dB压缩释放到正常增益的10%的时间。释放时间可调，其最小值为25ms。释放时间由C_{CT}设置的启动时间以及利用A/R(如表1所示)设置的启动/释放时间比确定：

- 采用小比值，使AGC的速度达到最大。
- 采用大比值，使音质达到最佳，防止AGC重复调节短时间内超出门限的信号。

AGC输出门限

激活AGC工作的输出门限可通过外部电阻分压器调节。完成对分压器的设置后，AGC将降低增益，使输出电压与TH输入端设置的电压相匹配。

麦克风偏置

MAX9814由内部提供低噪声麦克风偏置电压，可驱动大多数驻极体电容式麦克风。调节麦克风偏置至2V，以保证进入低噪声前置放大器的输入信号不被箝位到地。

应用信息

设置启动时间和释放时间

启动时间和释放时间分别由CT和GND之间的电容以及A/R的逻辑状态(表1)决定。A/R为三态逻辑输入，可设置启动与释放时间比。

表1. 启动与释放比

A/R	ATTACK/RELEASE RATIO
GND	1:500
V_{DD}	1:2000
Unconnected	1:4000

根据表2所列的相应电容，可以选择启动时间和释放时间。

表2. 启动-释放时间

C_{CT}	t_{ATTACK} (ms)	$t_{RELEASE}$ (ms)		
		A/R = GND	A/R = V_{DD}	A/R = UNCONNECTED
22nF	0.05	25	100	200
47nF	0.11	55	220	440
68nF	0.16	80	320	640
100nF	0.24	120	480	960
220nF	0.53	265	1060	2120
470nF	1.1	550	2200	4400
680nF	1.63	815	3260	6520
1µF	2.4	1200	4800	9600

具有AGC和低噪声麦克风偏置电路的麦克风放大器

设置AGC门限

若要设置麦克风输出箝位时的输出电压门限，应在MICBIAS和地之间连接外部电阻分压器，电阻分压器输出连接到TH。电压V_{TH}可确定输出箝位时的峰值电压门限。此时，输出端的最大信号摆幅为V_{TH}的2倍，并保持不变，直到输入信号幅值衰减为止。若要禁止AGC，可将TH连接至MICBIAS。

麦克风偏置电阻

MICBIAS可源出20mA的电流。选择适当的$R_{MICBIAS}$，从而为驻极体麦克风提供所需要的偏置电流。一般来说，2.2kΩ的阻值对于典型灵敏度的麦克风已经足够了。关于偏置电阻的选择，请参考麦克风数据资料。

偏置电容

MAX9814的BIAS输出在内部经过缓冲，提供低噪声偏压。采用一只470nF的电容将BIAS旁路至地。

输入电容

麦克风放大器的输入交流耦合电容(C_{IN})和输入阻抗(R_{IN})组成了一个高通滤波器，可滤除输入信号中的所有直流偏置(参见*典型应用电路/功能框图*)。C_{IN}可防止输入信号源的直流成分出现在放大器的输出。假设输入信号源阻抗为零，则高通滤波器的-3dB点为：

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

选择适当的C_{IN}使f_{-3dB_IN}远低于敏感频率。f_{-3dB_IN}设置过高，会影响放大器的低频响应，选择低电压系数的电介质电容。对于交流耦合电容来说，铝电解电容、钽电容或薄膜电介质电容都是很好的选择。高电压系数的电容，诸如陶瓷电容(非C0G电介质)，会加剧低频失真。

输出电容

MAX9814的输出偏置在1.23V，若要消除直流失调，应采用交流耦合电容(C_{OUT})。考虑到下一级的输入阻抗(R_L)，C_{OUT}和R_L组成高通滤波器。假设输出阻抗为零，高通滤波器的-3dB点为：

$$f_{-3dB\_OUT} = \frac{1}{2\pi \times R_L \times C_{OUT}}$$

关断

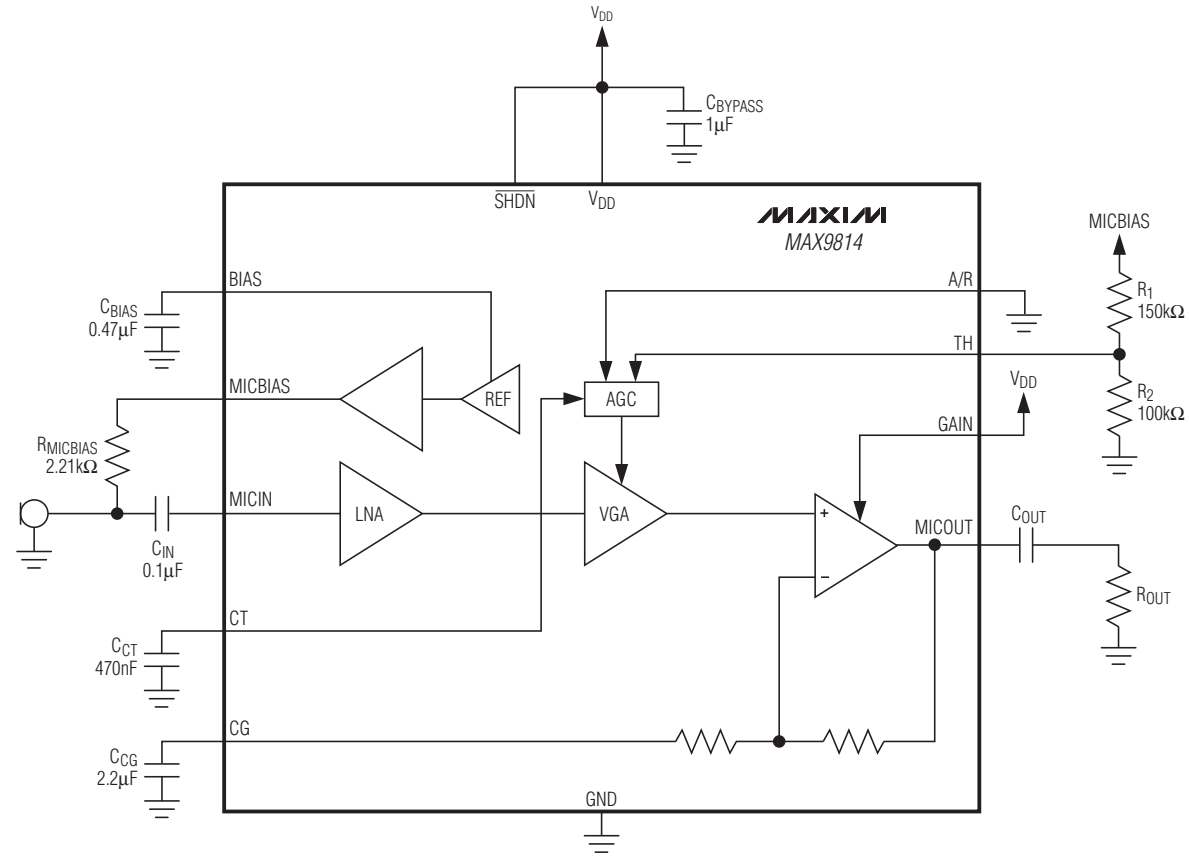
MAX9814具有低功耗关断模式。当$\overline{SHDN}$为低电平时，电源电流跌落至0.01μA，输出进入高阻状态，麦克风的偏置电流关断。驱动$\overline{SHDN}$为高电平，使能放大器。请勿将$\overline{SHDN}$悬空。

电源旁路与PCB布局

采用一只0.1μF的电容将电源旁路至地。缩短引线长度可降低寄生电容，外部元件应尽可能靠近器件放置，推荐选用表贴元件。在同时具有模拟地和数字地的系统中，MAX9814的地与模拟地相连。

具有AGC和低噪声麦克风偏置电路的麦克风放大器

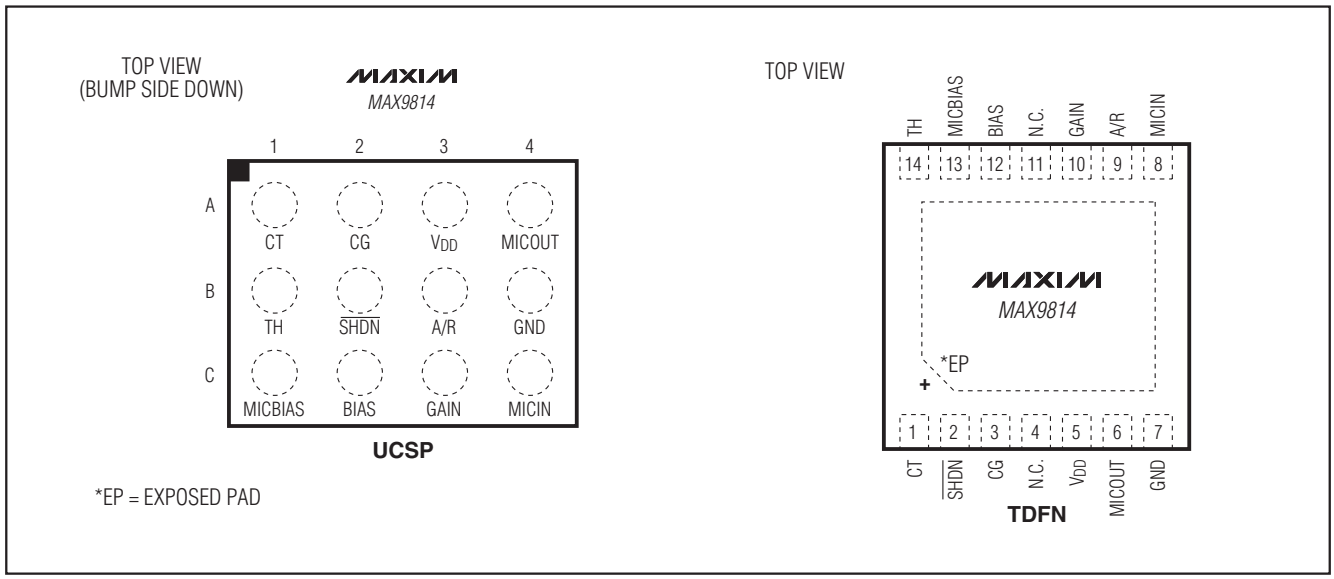
典型应用电路/功能框图



*THE DEVICE HAS BEEN CONFIGURED WITH AN ATTACK TIME OF 1.1ms, 40dB GAIN, AND AN ATTACK-AND-RELEASE RATIO OF 1:500.

具有AGC和低噪声麦克风偏置电路的麦克风放大器

引脚配置



芯片信息

PROCESS: BiCMOS

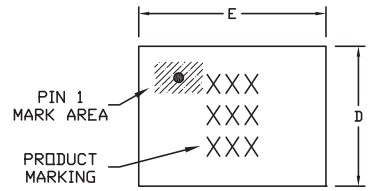
具有AGC和低噪声麦克风偏置电路的麦克风放大器

封装信息

如需最近的封装外形信息和焊盘布局，请查询 **www.maxim-ic.com.cn/packages**。

封装类型	封装编码	文档编号
12 UCSP	B12-3	**21-0104**
14 TDFN-EP	T1433-2	**21-0137**

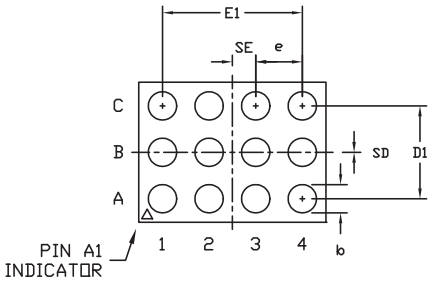
12L, UCSP 4x3.EPS



TOP VIEW

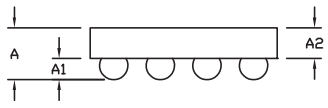
COMMON DIMENSIONS	
A	0.62±0.05-0.08
A1	0.29±0.02
A2	0.33 REF.
b	ø0.35±0.03
D1	1.00 BASIC
E1	1.50 BASIC
e	0.50 BASIC
SD	0.00 BASIC
SE	0.25 BASIC

PKG. CODE	VARIABLE DIMENSIONS		DEPOPULATED SOLDER BALLS
	D	E	
B12-1	1.54±0.05	2.02±0.05	NONE
B12-2	1.54±0.05	2.02±0.05	B3
B12-3	1.54±0.05	2.12±0.05	NONE
B12-4	1.54±0.05	2.02±0.05	B2, B3
B12-5	1.64±0.05	2.12±0.05	B2
B12-6	1.64±0.05	2.12±0.05	B3
B12-7	1.54±0.05	2.02±0.05	B1, B3
B12-8	1.54±0.05	2.02±0.05	B2
B12-9	1.54±0.05	2.12±0.05	B2, B3
B12-10	1.54±0.05	2.02±0.05	B1, B2, B3, B4
B12-11	1.54±0.05	2.02±0.05	A2, C3



BOTTOM VIEW

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. PRODUCT MARKING: NUMBER OF CHARACTERS AND LINES VARY PER PRODUCT.



SIDE VIEW

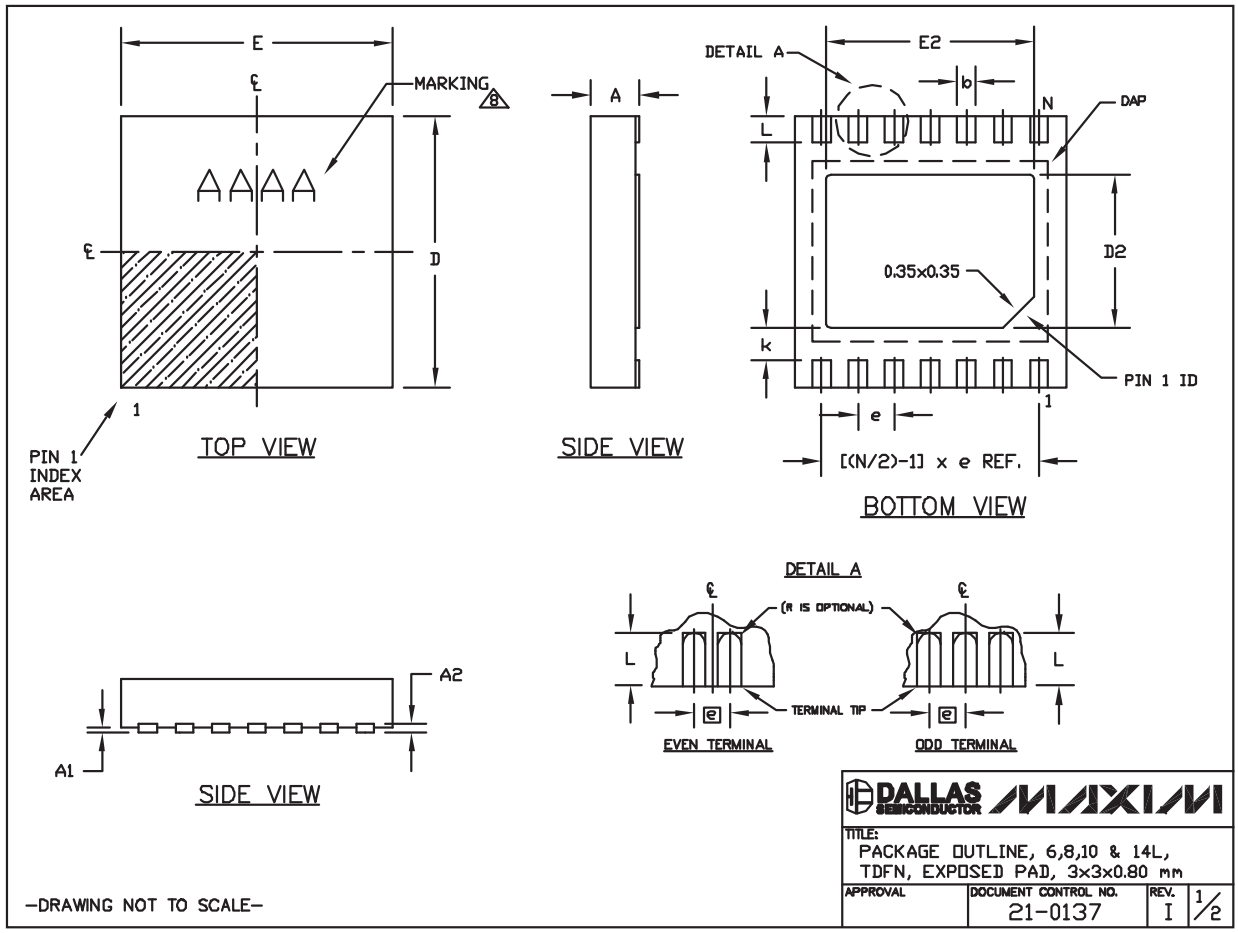
DALLAS SEMICONDUCTOR MAXIM
PROPRIETARY INFORMATION

TITLE: PACKAGE OUTLINE, 4x3 UCSP

APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0104	F	1/1

封装信息(续)

如需最近的封装外形信息和焊盘布局，请查询 **www.maxim-ic.com.cn/packages**。



具有AGC和低噪声麦克风偏置电路的麦克风放大器

封装信息(续)

如需最近的封装外形信息和焊盘布局，请查询 **www.maxim-ic.com.cn/packages**。

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
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

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.

DALLAS SEMICONDUCTOR MAXIM

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

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

-DRAWING NOT TO SCALE-

修订历史

修订次数	修订日期	说明	修改页
0	3/07	最初版本。	—
1	2/09	更新了*定购信息*、*Absolute Maximum Ratings*、*引脚说明*和*引脚配置*部分，为TDFN封装添加了EP相关内容。	1, 2, 6, 11

Maxim北京办事处

北京 8328信箱 邮政编码 100083

免费电话：800 810 0310

电话：010-6211 5199

传真：010-6211 5299

19-0760; Rev 0; 4/07

MAX9814评估板

概述

MAX9814评估板(EV kit)是完全安装并经过测试的PCB，用于评估单电源供电的MAX9814低噪声麦克风放大器IC。MAX9814 IC内置低噪声放大器、输出放大器、麦克风偏压发生器以及自动增益控制(AGC)电路。在无压缩的条件下，麦克风放大器的总增益可以设定为40dB、50dB或者60dB。MAX9814还带有压缩/限幅电路，可以将麦克风输出限制到一个设定的电压。

MAX9814评估板工作在2.7V至5.5V电压范围。评估板还具有低静态电流以及关断控制特性，将功耗降至最低。MAX9814 IC采用带裸焊盘的14引脚TDFN (3mm x 3mm x 0.8mm)封装。

特性

- ♦ 2.7V至5.5V单电源工作
- ♦ 20dB动态增益压缩
- ♦ 可选增益控制
- ♦ 可编程启动时间
- ♦ 可选择启动/释放比
- ♦ 低功耗关断模式
- ♦ 完全安装和测试

定购信息

PART	TEMP RANGE	IC PACKAGE
MAX9814EVKIT+	0°C to +70°C*	14 TDFN-EP**

+表示评估板无铅并符合RoHS标准的要求。
**仅表示评估板PCB的温度范围。*
***EP = 裸焊盘。*

元件列表

DESIGNATION	QTY	DESCRIPTION
C1	1	0.22µF ±10%, 6.3V X5R ceramic capacitor (0402) TDK C1005X5R0J224K
C2, C7, C9	3	0.1µF ±10%, 10V X5R ceramic capacitors (0402) TDK C1005X5R1A104K
C3	1	0.047µF ±10%, 25V X7R ceramic capacitor (0402) TDK C1005X7R1E223K
C4	1	0.022µF ±10%, 25V X7R ceramic capacitor (0402) TDK C1005X7R1E223K
C5	1	2.2µF ±10%, 6.3V X5R ceramic capacitor (0603) TDK C1608X5R0J225K
C6	1	1µF ±10%, 6.3V X5R ceramic capacitor (0603) TDK C1608X5R1A105KB
C8	1	0.47µF ±10%, 6.3V X5R ceramic capacitor (0402) TDK C1005X5R0J474K

DESIGNATION	QTY	DESCRIPTION
J1	1	Nonswitched PC-mount RCA jack, black
J2	1	Nonswitched PC-mount RCA jack, red
JU1, JU2, JU3	3	3-pin headers
JU4, JU5, JU6	3	2-pin headers
R1	1	150kΩ ±1% resistor (0402)
R2	1	100kΩ ±1% resistor (0402)
R3	1	2.21kΩ ±1% resistor (0402)
U1	1	MAX9814ETD+ (14-pin TDFN)
—	6	Shunts (JU1–JU6)
—	1	PCB: MAX9814 Evaluation Kit

元件供应商

SUPPLIER	PHONE	WEBSITE
TDK Corp.	847-803-6100	www.component.tdk.com

注：与元件供应商联系时，请说明您正在使用的是MAX9814。

MAX9814评估板

快速入门

推荐设备

- 5V 200mA电源
- 函数发生器
- 数字万用表(DMM)
- 示波器

步骤

MAX9814评估板完全安装并经过测试。按照下列步骤检验电路板的工作。**注意：在完成所有连接以前，请勿打开电源：**

1) 确认跳线JU1的引脚1-2 (MAX9814使能)、JU2的引脚1-2 (增益 = 40dB)以及JU3的的引脚1-2 (启动/释放比 = 1:2000)之间安装了短路器。
2) 确认跳线JU4、JU5、JU6没有安装短路器(启动时间 ≈ 53μs)。
3) 设置电源至5V。
4) 设置函数发生器的输出为正弦波，具有10mV_{P-P}、1kHz频率以及0V偏置。
5) 关断电源和函数发生器。
6) 连接示波器通道1至MIC_IN焊盘以及示波器通道2至MIC_OUT焊盘。连接示波器的地引线至相应的SGND_焊盘。
7) 连接电源的5V端至VCC焊盘，而电源的地至GND焊盘。
8) 连接函数发生器的正端输出至评估板的MIC_IN焊盘，而函数发生器的地线连接至SGND_IN焊盘。
9) 连接数字万用表的正端至TH焊盘，而地端则连接至GND焊盘。
10) 打开电源。
11) 确认TH的电压大约为800mV。
12) 打开函数发生器。
13) 用示波器检查MIC_OUT焊盘上的信号为1V_{P-P}。
14) 将函数发生器的输出提高到50mV_{P-P}。
15) 确认MIC_OUT的幅值为1.6V_{P-P}。

详细说明

MAX9814评估板用于评估专为单电源应用设计的MAX9814低噪声麦克风放大器IC。MAX9814评估板工作在2.7V至5.5V，评估板电源须最低可提供200mA的电流。

MAX9814 IC内置低噪声放大器、带有自动增益控制的可变增益放大器(VGA)、输出放大器以及麦克风偏压发生器。低噪声前置放大器的增益固定在12dB，同时VGA具有0dB至20dB的动态增益，而输出放大器的增益为8dB、18dB和28dB。在无压缩状态下，所有增益模块的总增益为40dB、50dB或60dB。MAX9814 IC还包括启动/保持以及释放时间控制电路，可将MICOUT引脚限制到设定的电压上。

MAX9814压缩电路监视MICOUT并限制TH的峰值电压。增益压缩通过VGA实现，VGA自动调整自身增益，从而将输出电压峰值保持在设定的门限以内。VGA具有20dB的动态增益。因此最大增益压缩为20dB。AGC禁止时，放大器的总增益可通过跳线JU2设定至40dB、50dB或60dB。AGC使能，输出电压被完全压缩时，总题增益为20dB、30dB或40dB。

当MICOUT峰值电压幅度超过TH的设定电压时，放大器的输出将被衰减。MAX9814评估板衰减门限被预设至800mV。可以通过电阻R1和R2，以及2V麦克风偏压输出MICBIAS编程设置门限电压。去掉R1并将TH焊盘连接到一个电压上，可以从外部控制MICOUT门限。

输入信号可以连接到RCA插座J2，也可以将麦克风连接到MIC_IN和SGND_IN焊盘之间。2V麦克风偏置MICBIAS通过R3连接到MIC_IN节点。

MAX9814的启动时间和启动/释放比可以通过跳线JU3–JU6设置。

跳线选择

关断

跳线JU1控制MAX9814评估板的关断模式。在引脚2-3之间安装短路器可激活评估板的关断模式。还可以将跳线的短路器移除，然后连接外部控制器至$\overline{SHDN}$焊盘，实现关断功能的控制。参见表1跳线JU1关断配置。

表1. 关断配置(JU1)

SHUNT POSITION	$\overline{SHDN}$ PIN	EV KIT FUNCTION
1-2	Connected to VCC	MAX9814 enabled
2-3	Connected to GND	MAX9814 disabled
—	Not connected	$\overline{SHDN}$ driven by external controller

增益控制

MAX9814最大信号增益可以配置为40dB、50dB或60dB。跳线JU2选择MAX9814评估板的总增益。参见表2跳线JU2增益配置。

表2. 增益控制配置(JU2)

SHUNT POSITION	GAIN PIN	MAXIMUM GAIN (dB)
1-2	Connected to VCC	40
2-3	Connected to GND	50
—	Not connected	60

启动/释放比设置

跳线JU3设置MAX9814 AGC电路的启动时间/释放时间比为1:500、1:2000以及1:4000。参见表3，利用跳线JU3配置所期望的启动/释放比。

表3. 启动/释放比配置(JU3)

SHUNT POSITION	ATTACK/RELEASE PIN	ATTACK/RELEASE RATIO
2-3	Connected to GND	1:500
1-2	Connected to VCC	1:2000
—	Not connected	1:4000

跳线JU4、JU5和JU6配置启动时间。电容C4可将启动时间设置到53µs。要延长启动时间，可以通过配置JU4、JU5和/或JU6的短路器，从而改变连接到MAX9814 CT引脚的电容。参见表4关于跳线JU4、JU5和JU6的配置；表5给出了启动/释放时间。启动时间可由下列公式确定：

$$t_{Attack} \approx 2400 * C_{CT}$$

其中C_{CT}为总电容，单位为法拉。

表4. 启动时间配置(JU4、JU5和JU6)

JU4 SHUNT POSITION	JU5 SHUNT POSITION	JU6 SHUNT POSITION	CT PIN CAPACITANCE (µF)	ATTACK TIME (µs)
Not installed	Not installed	Not installed	0.022	53
Installed	Not installed	Not installed	0.069	166
Installed	Installed	Not installed	0.169	406
Installed	Installed	Installed	0.389	937

表5. 启动/释放时间

ATTACK TIME (µs)	RELEASE TIMES (ms)		
	1:500	1:2000	1:4000
53	26.4	105.6	211.2
166	83	332	664
406	203	812	1624
937	468	1874	3748

MAX9814评估板

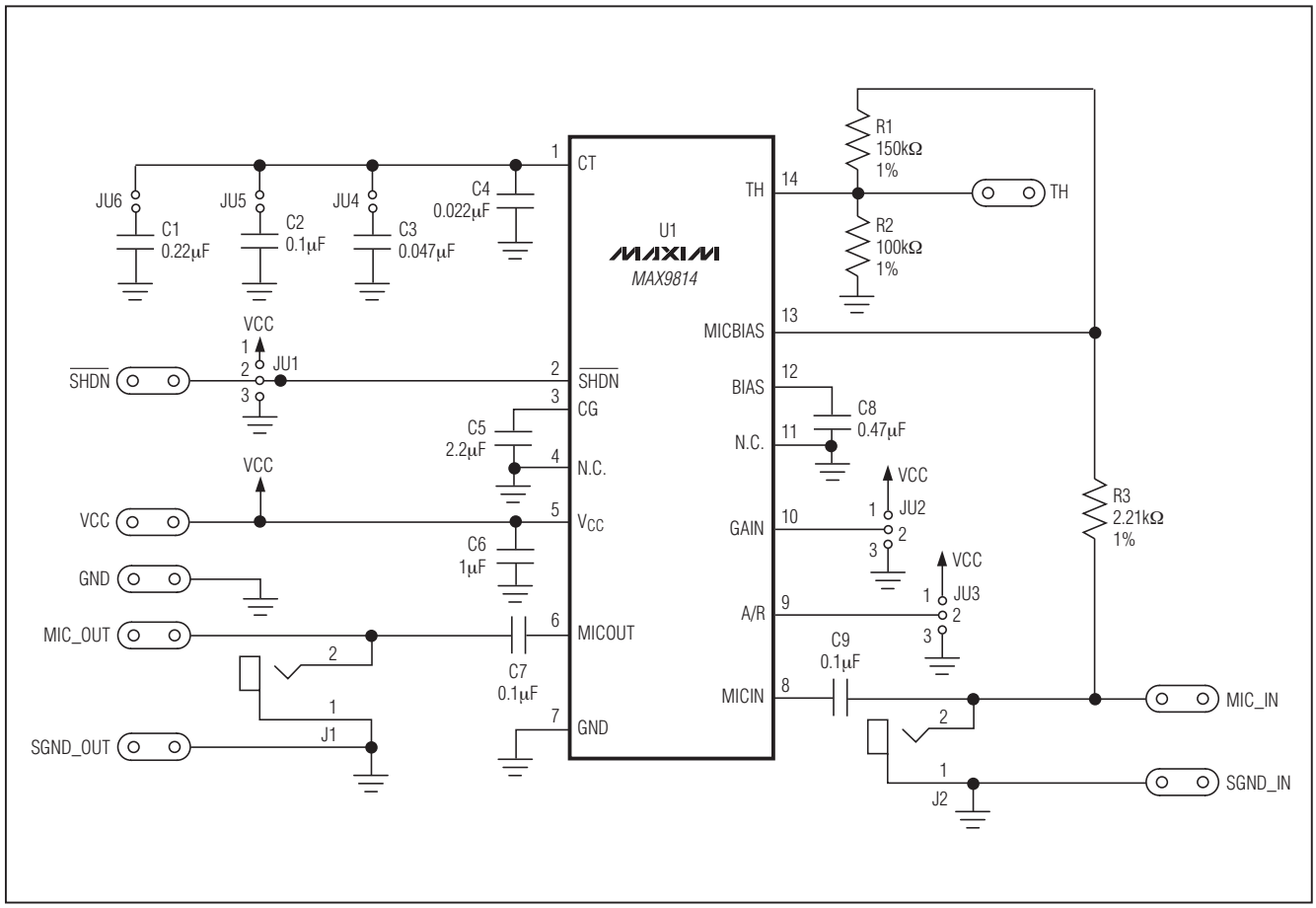


图1. MAX9814评估板原理图

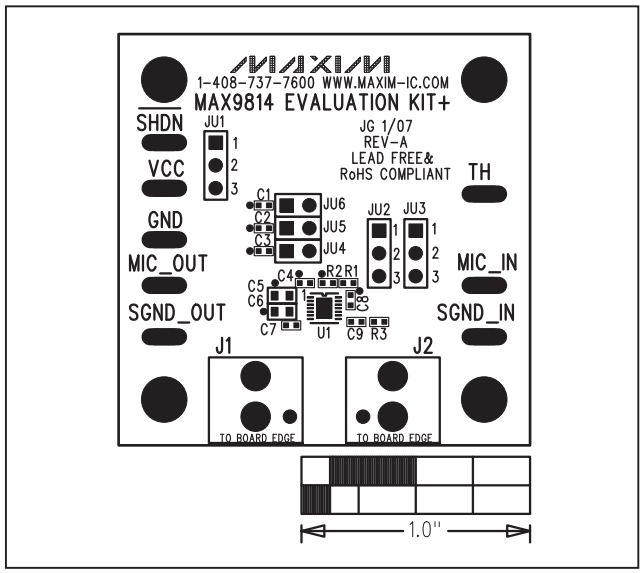


图2. MAX9814评估板元件布局—元件层

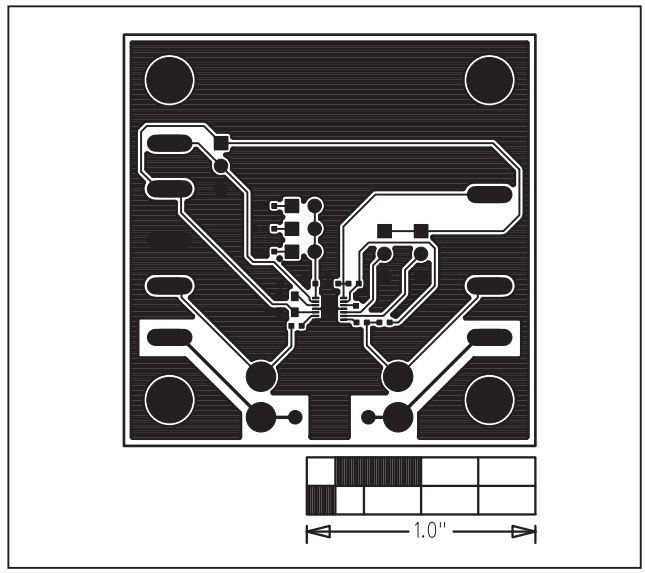


图3. MAX9814评估板PCB布局—元件层

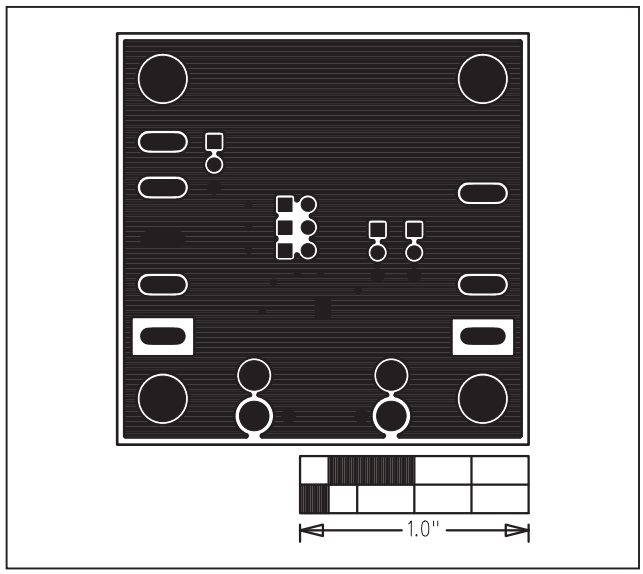


图4. MAX9814评估板PCB布局—焊接层

19-0764; Rev 2; 6/09

EVALUATION KIT AVAILABLE

Microphone Amplifier with AGC and Low-Noise Microphone Bias

General Description

The MAX9814 is a low-cost, high-quality microphone amplifier with automatic gain control (AGC) and low-noise microphone bias. The device features a low-noise preamplifier, variable gain amplifier (VGA), output amplifier, microphone-bias-voltage generator and AGC control circuitry.

The low-noise preamplifier has a fixed 12dB gain, while the VGA gain automatically adjusts from 20dB to 0dB, depending on the output voltage and the AGC threshold. The output amplifier offers selectable gains of 8dB, 18dB, and 28dB. With no compression, the cascade of the amplifiers results in an overall gain of 40dB, 50dB, or 60dB. A trilevel digital input programs the output amplifier gain. An external resistive divider controls the AGC threshold and a single capacitor programs the attack/release times. A trilevel digital input programs the ratio of attack-to-release time. The hold time of the AGC is fixed at 30ms. The low-noise microphone-bias-voltage generator can bias most electret microphones.

The MAX9814 is available in the space-saving, 14-pin TDFN package. This device is specified over the -40°C to +85°C extended temperature range.

Applications

Digital Still Cameras

Digital Video Cameras

PDAs

Bluetooth Headsets

Entertainment Systems (e.g., Karaoke)

Two-Way Communicators

High-Quality Portable Recorders

IP Phones/Telephone Conferencing

Features

- **Automatic Gain Control (AGC)**
- **Three Gain Settings (40dB, 50dB, 60dB)**
- **Programmable Attack Time**
- **Programmable Attack and Release Ratio**
- **2.7V to 5.5V Supply Voltage Range**
- **Low Input-Referred Noise Density of 30nV/√Hz**
- **Low THD: 0.04% (typ)**
- **Low-Power Shutdown Mode**
- **Internal Low-Noise Microphone Bias, 2V**
- **Available in the Space-Saving, 14-Pin TDFN (3mm x 3mm) Package**
- **-40°C to +85°C Extended Temperature Range**

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX9814ETD+T	-40°C to +85°C	14 TDFN-EP*

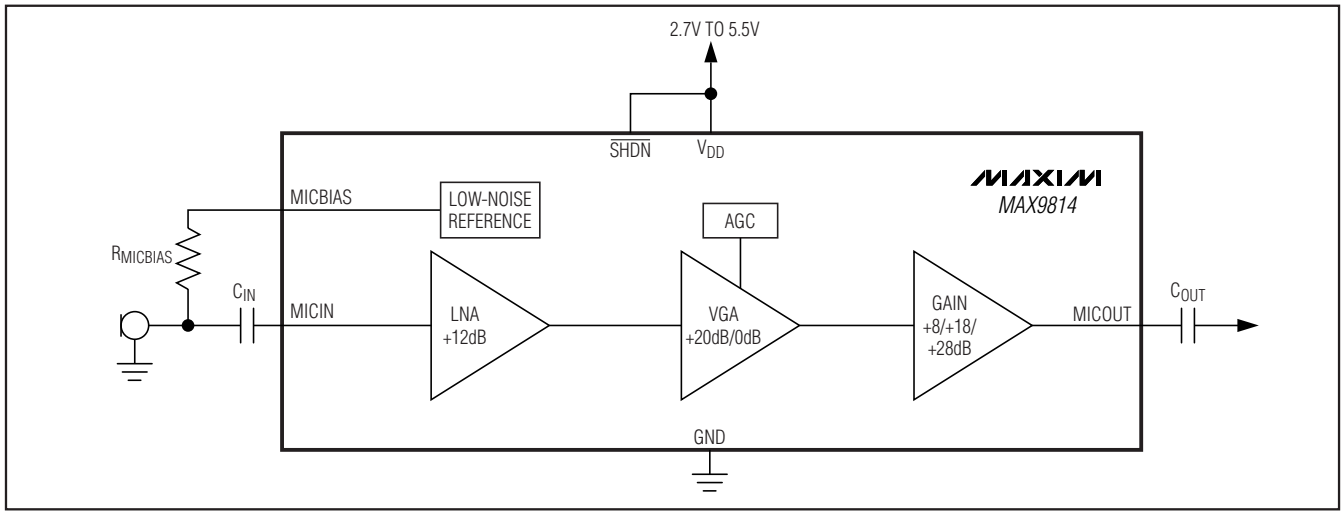
+Denotes a lead(Pb)-free/RoHS-compliant package.

**EP = Exposed pad.*

Pin Configurations appear at end of data sheet.

UCSP is a trademark of Maxim Integrated Products, Inc.

Simplified Block Diagram



Microphone Amplifier with AGC and Low-Noise Microphone Bias

ABSOLUTE MAXIMUM RATINGS

V_{DD} to GND .....-0.3V to +6V
All Other Pins to GND.....-0.3V to (V_{DD} + 0.3V)
Output Short-Circuit Duration.....Continuous
Continuous Current (MICOUT, MICBIAS).....±100mA
All Other Pins .....±20mA

Continuous Power Dissipation (T_A = +70°C)
14-Pin TDFN-EP
(derate 16.7mW/°C above +70°C).....1481.5mW
Operating Temperature Range .....-40°C to +85°C
Junction Temperature.....+150°C
Lead Temperature (soldering, 10s) .....+300°C
Bump Temperature (soldering) Reflow.....+235°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

(V_{DD} = 3.3V, $\overline{SHDN}$ = V_{DD}, C_{CT} = 470nF, C_{CG} = 2µF, GAIN = V_{DD}, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
GENERAL						
Operating Voltage	V_{DD}	Guaranteed by PSRR test	2.7		5.5	V
Supply Current	I_{DD}			3.1	6	mA
Shutdown Supply Current	$I_{\overline{SHDN}}$			0.01	1	µA
Input-Referred Noise Density	e_n	BW = 20kHz, all gain settings		30		nV/√Hz
Output Noise		BW = 20kHz		430		μV_{RMS}
Signal-to-Noise Ratio	SNR	BW = 22Hz to 22kHz ($500mV_{RMS}$ output signal)		61		dB
		A-weighted		64		
Dynamic Range	DR	(Note 2)		60		dB
Total Harmonic Distortion Plus Noise	THD+N	f_{IN} = 1kHz, BW = 20Hz to 20kHz, R_L = 10kΩ, V_{TH} = 1V (threshold = $2V_{P-P}$), V_{IN} = $0.5mV_{RMS}$, V_{CT} = 0V		0.04		%
		f_{IN} = 1kHz, BW = 20Hz to 20kHz, R_L = 10kΩ, V_{TH} = 0.1V (threshold = $200mV_{P-P}$), V_{IN} = $30mV_{RMS}$, V_{CT} = 2V		0.2		
Amplifier Input BIAS	V_{IN}		1.14	1.23	1.32	V
Maximum Input Voltage	V_{IN_MAX}	1% THD		100		mV_{P-P}
Input Impedance	Z_{IN}			100		kΩ
Maximum Gain	A	GAIN = V_{DD}	39.5	40	40.5	dB
		GAIN = GND	49.5	50	50.6	
		GAIN = unconnected	59.5	60	60.5	
Minimum Gain		GAIN = V_{DD}	18.7	20	20.5	dB
		GAIN = GND	29.0	30	30.8	
		GAIN = unconnected	38.7	40	40.5	
Maximum Output Level	V_{OUT_RMS}	1% THD+N, V_{TH} = MICBIAS		0.707		V_{RMS}
Regulated Output Level		AGC enabled, V_{TH} = 0.7V	1.26	1.40	1.54	V_{P-P}
AGC Attack Time	t_{ATTACK}	C_{CT} = 470nF (Note 3)		1.1		ms
Attack/Release Ratio	A/R	A/R = GND		1:500		ms/ms
		A/R = V_{DD}		1:2000		
		A/R = unconnected		1:4000		

ELECTRICAL CHARACTERISTICS (continued)

(V_{DD} = 3.3V, $\overline{SHDN}$ = V_{DD}, C_{CT} = 470nF, C_{CG} = 2µF, GAIN = V_{DD}, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
MICOUT High Output Voltage	V_{OH}	I_{OUT} sourcing 1mA		2.45		V
MICOUT Low Output Voltage	V_{OL}	I_{OUT} sinking 1mA		3		mV
MICOUT Bias		MICOUT unconnected	1.14	1.23	1.32	V
Output Impedance	Z_{OUT}			50		Ω
Minimum Resistive Load	R_{LOAD_MIN}			5		kΩ
Maximum Capacitive Drive	C_{LOAD_MAX}			200		pF
Maximum Output Current	I_{OUT_MAX}	1% THD, R_L = 500Ω		1	2	mA
Output Short-Circuit Current	I_{SC}		3	8		mA
Power-Supply Rejection Ratio	PSRR	AGC mode; V_{DD} = 2.7V to 5.5V (Note 4)	35	50		dB
		f = 217Hz, V_{RIPPLE} = 100mV_{P-P} (Note 5)		55		
		f = 1kHz, V_{RIPPLE} = 100mV_{P-P} (Note 5)		52.5		
		f = 10kHz, V_{RIPPLE} = 100mV_{P-P} (Note 5)		43		
MICROPHONE BIAS						
Microphone Bias Voltage	$V_{MICBIAS}$	$I_{MICBIAS}$ = 0.5mA	1.84	2.0	2.18	V
Output Resistance	$R_{MICBIAS}$	$I_{MICBIAS}$ = 1mA		1		Ω
Output Noise Voltage	$V_{MICBIAS\_NOISE}$	$I_{MICBIAS}$ = 0.5mA, BW = 22Hz to 22kHz		5.5		$µV_{RMS}$
Power-Supply Rejection Ratio	PSRR	DC, V_{DD} = 2.7V to 5.5V	70	80		dB
		$I_{MICBIAS}$ = 0.5mA, V_{RIPPLE} = 100mV_{P-P}, f_{IN} = 1kHz		71		
TRILEVEL INPUTS (A/R, GAIN)						
Tri-Level Input Leakage Current		A/R or GAIN = V_{DD}	0.5V_{DD} / 180kΩ	0.5V_{DD} / 100kΩ	0.5V_{DD} / 50kΩ	mA
		A/R or GAIN = GND	0.5V_{DD} / 180kΩ	0.5V_{DD} / 100kΩ	0.5V_{DD} / 50kΩ	
Input High Voltage	V_{IH}		V_{DD} x 0.7			V
Input Low Voltage	V_{IL}				V_{DD} x 0.3	V
Shutdown Enable Time	t_{ON}			60		ms
Shutdown Disable Time	t_{OFF}			40		ms
DIGITAL INPUT ($\overline{SHDN}$)						
$\overline{SHDN}$ Input Leakage Current			-1		+1	µA
Input High Voltage	V_{IH}		1.3			V
Input Low Voltage	V_{IL}				0.5	V
AGC THRESHOLD INPUT (TH)						
TH Input Leakage Current			-1		+1	µA

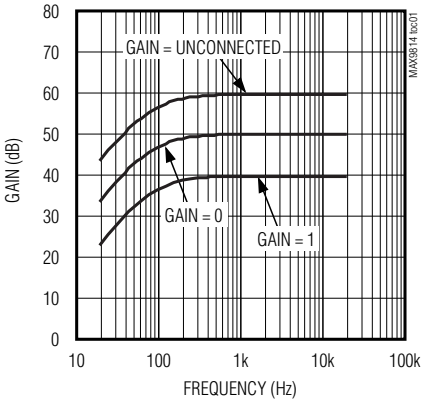
Note 1: Devices are production tested at T_A = +25°C. Limits over temperature are guaranteed by design.
Note 2: Dynamic range is calculated using the EIAJ method. The input is applied at -60dBFS (0.707$µV_{RMS}$), f_{IN} = 1kHz.
Note 3: Attack time measured as time from AGC trigger to gain reaching 90% of its final value.
Note 4: CG is connected to an external DC voltage source, and adjusted until V_{MICOUT} = 1.23V.
Note 5: CG connected to GND with 2.2µF.

Microphone Amplifier with AGC and Low-Noise Microphone Bias

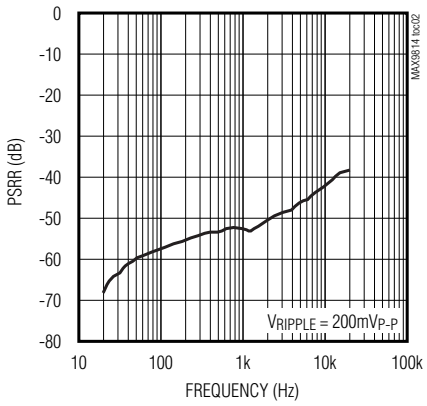
Typical Operating Characteristics

(V_{DD} = 5V, C_{CT} = 470nF, C_{CG} = 2.2µF, V_{TH} = $V_{MICBIAS}$ x 0.4, GAIN = V_{DD} (40dB), AGC disabled, no load, R_L = 10kΩ, C_{OUT} = 1µF, T_A = +25°C, unless otherwise noted.)

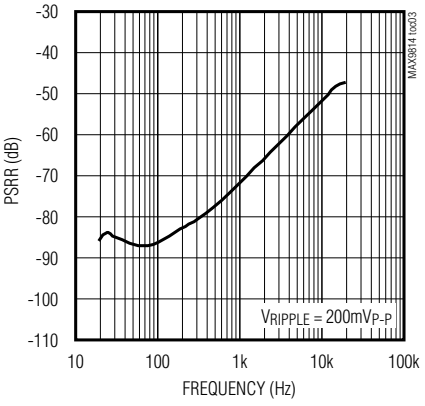
GAIN vs. FREQUENCY



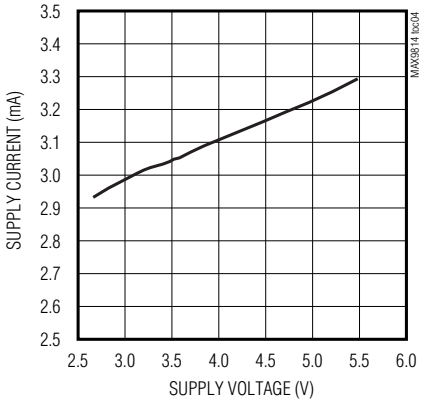
POWER-SUPPLY REJECTION RATIO vs. FREQUENCY



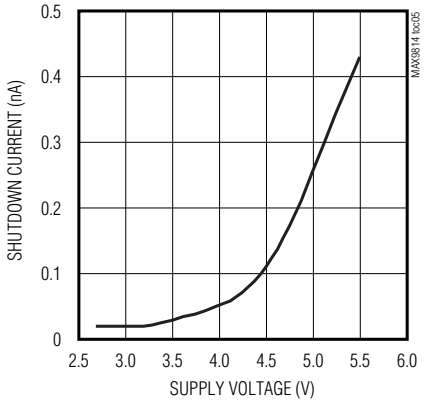
MICBIAS POWER-SUPPLY REJECTION RATIO vs. FREQUENCY



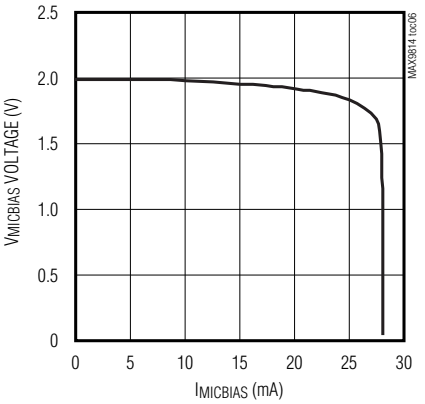
SUPPLY CURRENT vs. SUPPLY VOLTAGE



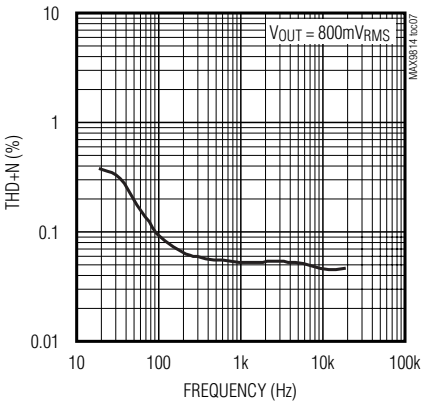
SHUTDOWN CURRENT vs. SUPPLY VOLTAGE



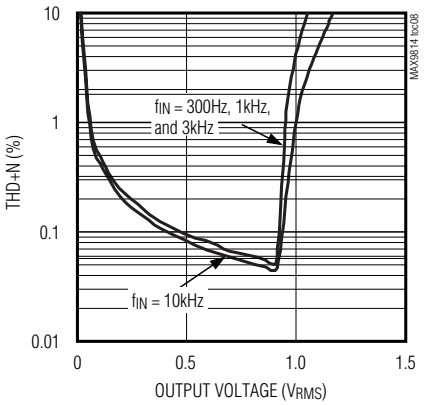
MICROPHONE BIAS VOLTAGE vs. MICROPHONE BIAS SOURCE CURRENT



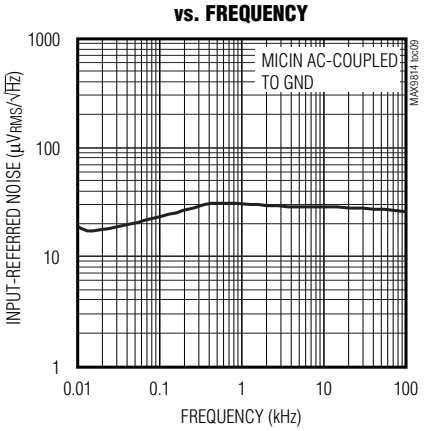
TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY



TOTAL HARMONIC DISTORTION PLUS NOISE vs. OUTPUT VOLTAGE



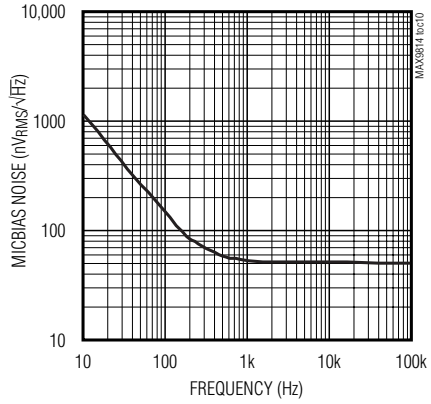
INPUT-REFERRED NOISE vs. FREQUENCY



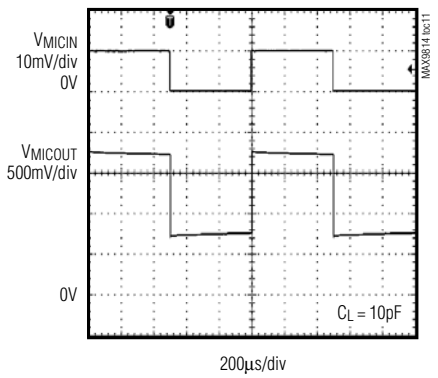
Typical Operating Characteristics (continued)

(V_{DD} = 5V, C_{CT} = 470nF, C_{CG} = 2.2µF, V_{TH} = $V_{MICBIAS}$ x 0.4, GAIN = V_{DD} (40dB), AGC disabled, no load, R_L = 10kΩ, C_{OUT} = 1µF, T_A = +25°C, unless otherwise noted.)

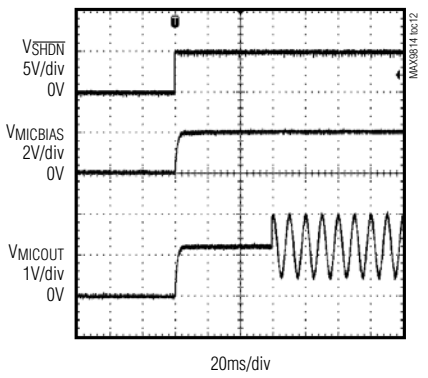
MICBIAS NOISE vs. FREQUENCY



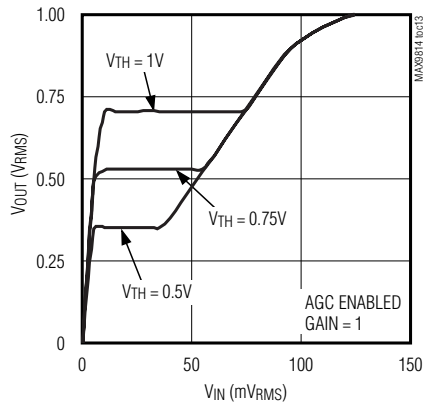
SMALL-SIGNAL PULSE RESPONSE



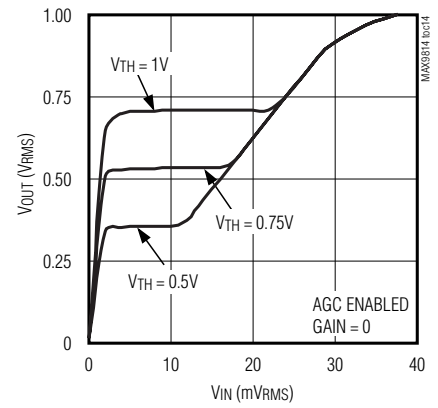
TURN-ON RESPONSE



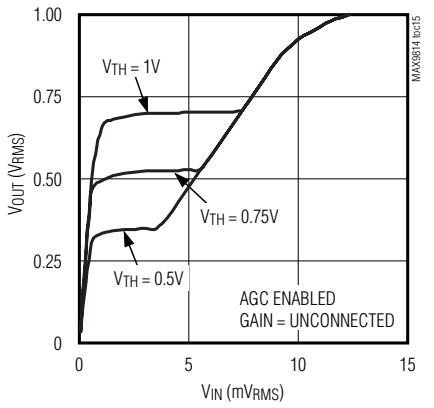
VOUT vs. VIN



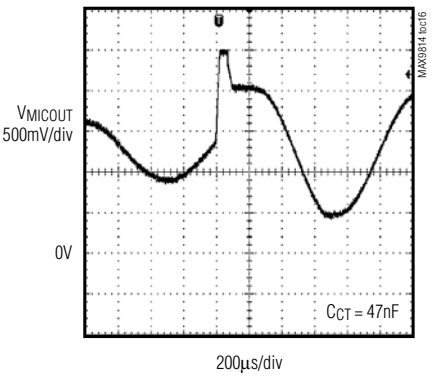
VOUT vs. VIN



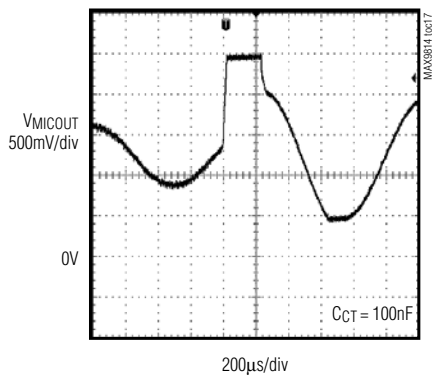
VOUT vs. VIN



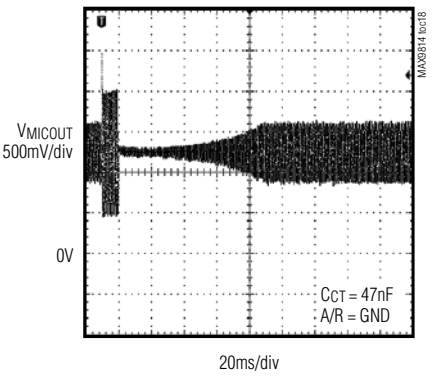
ATTACK TIME



ATTACK TIME



HOLD AND RELEASE TIME

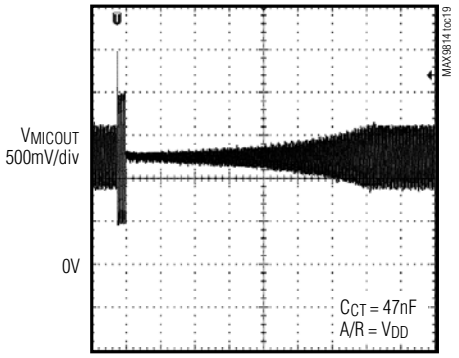


Microphone Amplifier with AGC and Low-Noise Microphone Bias

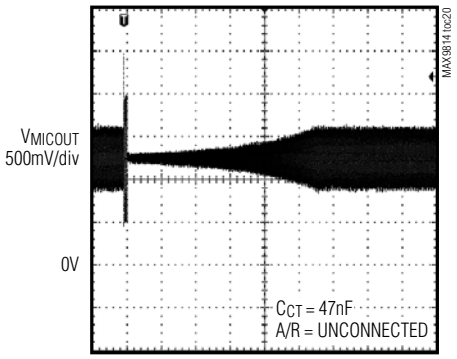
Typical Operating Characteristics (continued)

(V_{DD} = 5V, C_{CT} = 470nF, C_{CG} = 2.2µF, V_{TH} = $V_{MICBIAS}$ x 0.4, GAIN = V_{DD} (40dB), AGC disabled, no load, R_L = 10kΩ, C_{OUT} = 1µF, T_A = +25°C, unless otherwise noted.)

HOLD AND RELEASE TIME



HOLD AND RELEASE TIME



Pin Description

PIN TDFN	NAME	FUNCTION
1	CT	Timing Capacitor Connection. Connect a capacitor to CT to control the Attack and Release times of the AGC.
2	$\overline{SHDN}$	Active-Low Shutdown Control
3	CG	Amplifier DC Offset Adjust. Connect a 2.2µF capacitor to GND to ensure zero offset at the output.
4, 11	N.C.	No Connection. Connect to GND.
5	V_{DD}	Power Supply. Bypass to GND with a 1µF capacitor.
6	MICOUT	Amplifier Output
7	GND	Ground
8	MICIN	Microphone Noninverting Input
9	A/R	Tri-Level Attack and Release Ratio Select. Controls the ratio of attack time to release time for the AGC circuit. A/R = GND: Attack/Release Ratio is 1:500 A/R = V_{DD}: Attack/Release Ratio is 1:2000 A/R = Unconnected: Attack/Release Ratio is 1:4000
10	GAIN	Tri-Level Amplifier Gain Control. GAIN = V_{DD}, gain set to 40dB. GAIN = GND, gain set to 50dB. GAIN = Unconnected, uncompressed gain set to 60dB.
12	BIAS	Amplifier Bias. Bypass to GND with a 0.47µF capacitor.
13	MICBIAS	Microphone Bias Output
14	TH	AGC Threshold Control. TH voltage sets gain control threshold. Connect TH to MICBIAS to disable the AGC.
—	EP	Exposed Pad. Connect the TDFN EP to GND.

Microphone Amplifier with AGC and Low-Noise Microphone Bias

Detailed Description

The MAX9814 is a low-cost, high-quality microphone amplifier with automatic gain control (AGC) and a low-noise microphone bias. The MAX9814 consists of several distinct circuits: a low-noise preamplifier, a variable gain amplifier (VGA), an output amplifier, a microphone-bias-voltage generator, and AGC control circuitry.

An internal microphone bias voltage generator provides a 2V bias that is suitable for most electret condenser microphones. The MAX9814 amplifies the input in three distinct stages. In the first stage, the input is buffered and amplified through the low-noise preamplifier with a gain of 12dB. The second stage consists of the VGA controlled by the AGC. The VGA/AGC combination is capable of varying the gain from 20dB to 0dB. The output amplifier is the final stage in which a fixed gain of 8dB, 18dB, 20dB is programmed through a single tri-level logic input. With no compression from the AGC, the MAX9814 is capable of providing 40dB, 50dB, or 60dB gain.

Automatic Gain Control (AGC)

A device without AGC experiences clipping at the output when too much gain is applied to the input. AGC prevents clipping at the output when too much gain is applied to the input, eliminating output clipping. Figure 1 shows a comparison of an over-gained microphone input with and without AGC.

The MAX9814's AGC controls the gain by first detecting that the output voltage has exceeded a preset limit. The microphone amplifier gain is then reduced with a selectable time constant to correct for the excessive output-voltage amplitude. This process is known as the attack time. When the output signal subsequently lowers in amplitude, the gain is held at the reduced state for a short period before slowly increasing to the normal value. This process is known as the hold and release time. The speed at which the amplifiers adjust to changing input signals is set by the external timing capacitor C_{CT} and the voltage applied to A/R. The AGC threshold can be set by adjusting V_{TH}. Gain reduction is a function of input signal amplitude with a maximum AGC attenuation of 20dB. Figure 2 shows the effect of an input burst exceeding the preset limit, output attack, hold and release times.

If the attack and release times are configured to respond too fast, audible artifacts often described as "pumping" or "breathing" can occur as the gain is rapidly adjusted to follow the dynamics of the signal. For best results, adjust the time constant of the AGC to accommodate the source material. For applications in which music CDs are the main audio source, a 160µs attack time with an 80ms release time is recommended. Music applications typically require a shorter release time than voice or movie content.

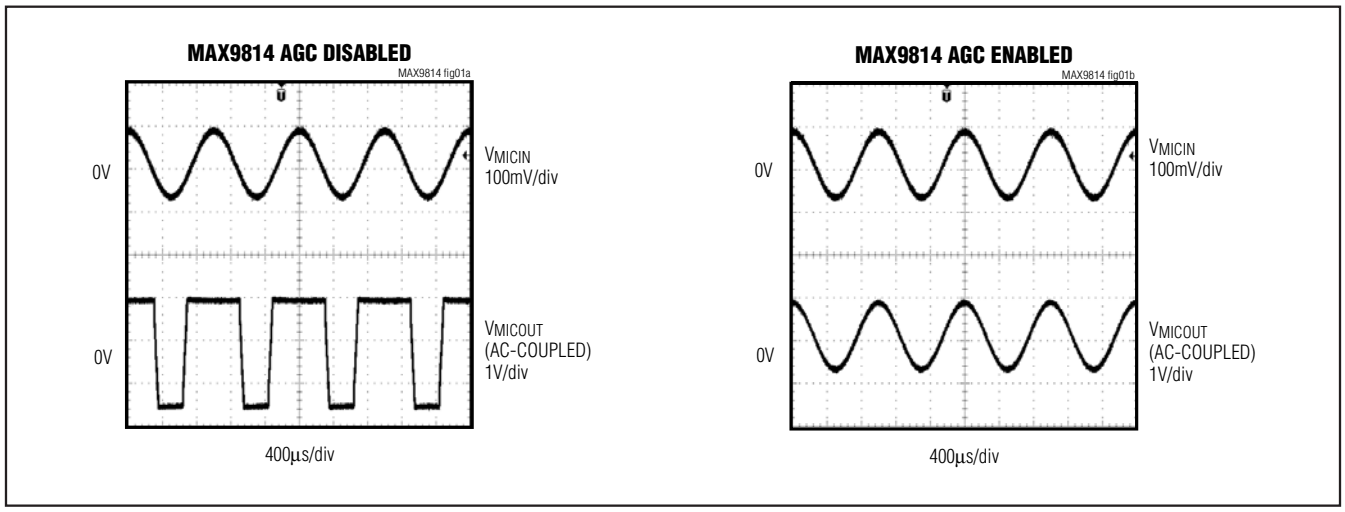


Figure 1. Microphone Input with and Without AGC

Microphone Amplifier with AGC and Low-Noise Microphone Bias

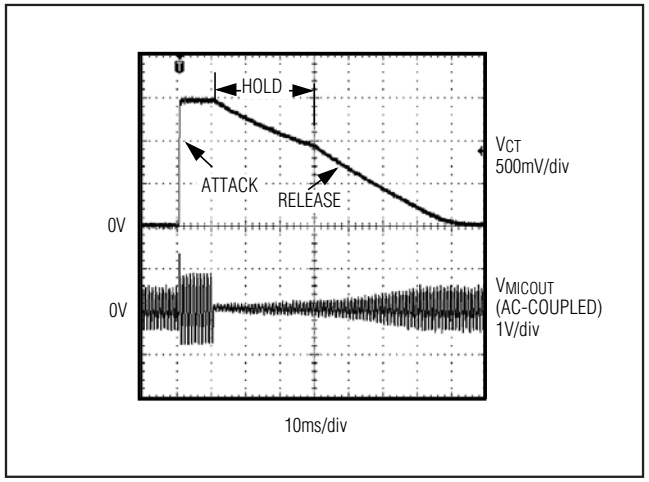


Figure 2. Input Burst Exceeding AGC Limit

Attack Time

The attack time is the time it takes for the AGC to reduce the gain after the input signal has exceeded the threshold level. The gain attenuation during the attack time is exponential, and defined as one-time constant. The time constant of the attack is given by 2400 x C_{CT} seconds (where C_{CT} is the external timing capacitor):

- Use a short attack time for the AGC to react quickly to transient signals, such as snare drum beats (music) or gun shots (DVD).
- Use a longer attack time to allow the AGC to ignore short-duration peaks and only reduce the gain when a noticeable increase in loudness occurs. Short-duration peaks are not reduced, but louder passages are. This allows the louder passages to be reduced in volume, thereby maximizing output dynamic range.

Hold Time

Hold time is the delay after the signal falls below the threshold level before the release phase is initiated. Hold time is internally set to 30ms and nonadjustable. The hold time is cancelled by any signal exceeding the set threshold level, and the attack time is reinitiated.

Release Time

The release time is how long it takes for the gain to return to its normal level after the output signal has fallen below the threshold level and 30ms hold time has expired. Release time is defined as release from a 20dB gain compression to 10% of the nominal gain setting after the input signal has fallen below the TH threshold and the 30ms hold time has expired. Release time is adjustable and has a minimum of 25ms. The release time is set by picking an attack time using C_{CT} and setting the attack-to-release time ratio by configuring A/R as shown in Table 1:

- Use a small ratio to maximize the speed of the AGC.
- Use a large ratio to maximize the sound quality and prevent repeated excursions above the threshold from being independently adjusted by the AGC.

AGC Output Threshold

The output threshold that activates AGC is adjustable through the use of an external resistive divider. Once the divider is set, AGC reduces the gain to match the output voltage to the voltage set at the TH input.

Microphone Bias

The MAX9814 features an internal low-noise microphone bias voltage capable of driving most electret condenser microphones. The microphone bias is regulated at 2V to provide that the input signal to the low-noise preamplifier does not clip to ground.

Applications Information

Programming Attack and Release Times

Attack and release times are set by selecting the capacitance value between CT and GND, and by setting the logic state of A/R (Table 1). A/R is a tri-level logic input that sets the attack-to-release time ratio.

Table 1. Attack-and-Release Ratios

A/R	ATTACK/RELEASE RATIO
GND	1:500
V_{DD}	1:2000
Unconnected	1:4000

The attack and release times can be selected by utilizing the corresponding capacitances listed in Table 2.

Table 2. Attack-and-Release Time

C_{CT}	t_{ATTACK} (ms)	$t_{RELEASE}$ (ms)		
		A/R = GND	A/R = V_{DD}	A/R = UNCONNECTED
22nF	0.05	25	100	200
47nF	0.11	55	220	440
68nF	0.16	80	320	640
100nF	0.24	120	480	960
220nF	0.53	265	1060	2120
470nF	1.1	550	2200	4400
680nF	1.63	815	3260	6520
1µF	2.4	1200	4800	9600

Microphone Amplifier with AGC and Low-Noise Microphone Bias

Setting the AGC Threshold

To set the output-voltage threshold at which the microphone output is clamped, an external resistor-divider must be connected from MICBIAS to ground with the output of the resistor-divider applied to TH. The voltage V_{TH} determines the peak output-voltage threshold at which the output becomes clamped. The maximum signal swing at the output is then limited to two times V_{TH} and remains at that level until the amplitude of the input signal is reduced. To disable AGC, connect TH to MICBIAS.

Microphone Bias Resistor

MICBIAS is capable of sourcing 20mA. Select a value for $R_{MICBIAS}$ that provides the desired bias current for the electret microphone. A value of 2.2kΩ is usually sufficient for a microphone of typical sensitivity. Consult the microphone data sheet for the recommended bias resistor.

Bias Capacitor

The BIAS output of the MAX9814 is internally buffered and provides a low-noise bias. Bypass BIAS with a 470nF capacitor to ground.

Input Capacitor

The input AC-coupling capacitor (C_{IN}) and the input resistance (R_{IN}) to the microphone amplifier form a highpass filter that removes any DC bias from an input signal (see the *Typical Application Circuit/Functional Diagram*). C_{IN} prevents any DC components from the input-signal source from appearing at the amplifier outputs. The -3dB point of the highpass filter, assuming zero source impedance due to the input signal source, is given by:

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

Choose C_{IN} such that f_{-3dB_IN} is well below the lowest frequency of interest. Setting f_{-3dB_IN} too high affects the amplifier's low-frequency response. Use capacitors with low-voltage coefficient dielectrics. Aluminum electrolytic, tantalum, or film dielectric capacitors are good choices for AC-coupling capacitors. Capacitors with high-voltage coefficients, such as ceramics (non-C0G dielectrics), can result in increased distortion at low frequencies.

Output Capacitor

The output of the MAX9814 is biased at 1.23V. To eliminate the DC offset, an AC-coupling capacitor (C_{OUT}) must be used. Depending on the input resistance (R_L) of the following stage, C_{OUT} and R_L effectively form a highpass filter. The -3dB point of the highpass filter, assuming zero output impedance, is given by:

$$f_{-3dB\_OUT} = \frac{1}{2\pi \times R_L \times C_{OUT}}$$

Shutdown

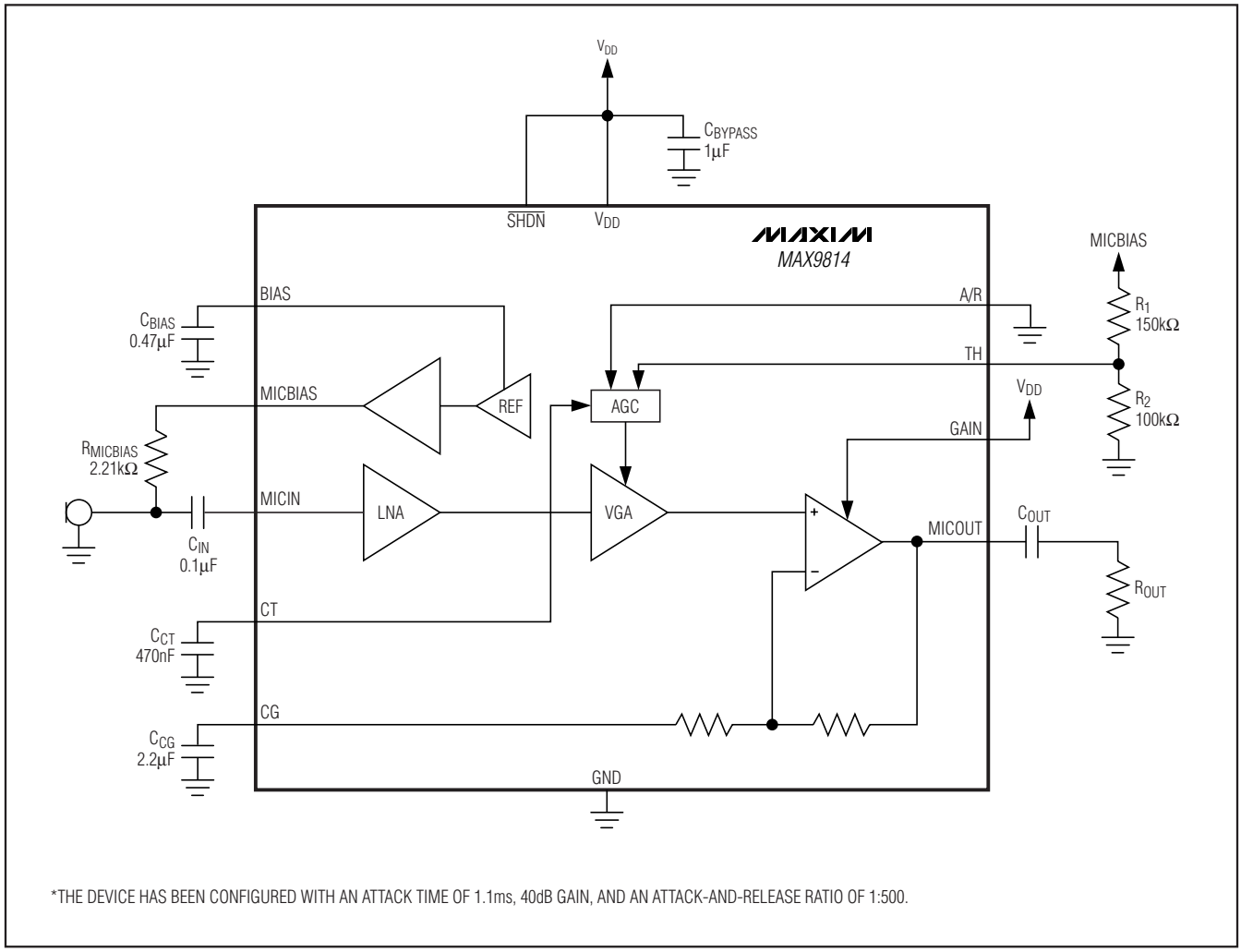
The MAX9814 features a low-power shutdown mode. When $\overline{SHDN}$ goes low, the supply current drops to 0.01µA, the output enters a high-impedance state, and the bias current to the microphone is switched off. Driving $\overline{SHDN}$ high enables the amplifier. Do not leave $\overline{SHDN}$ unconnected.

Power-Supply Bypassing and PCB Layout

Bypass the power supply with a 0.1µF capacitor to ground. Reduce stray capacitance by minimizing trace lengths and place external components as close to the device as possible. Surface-mount components are recommended. In systems where analog and digital grounds are available, connect the MAX9814 to analog ground.

Microphone Amplifier with AGC and Low-Noise Microphone Bias

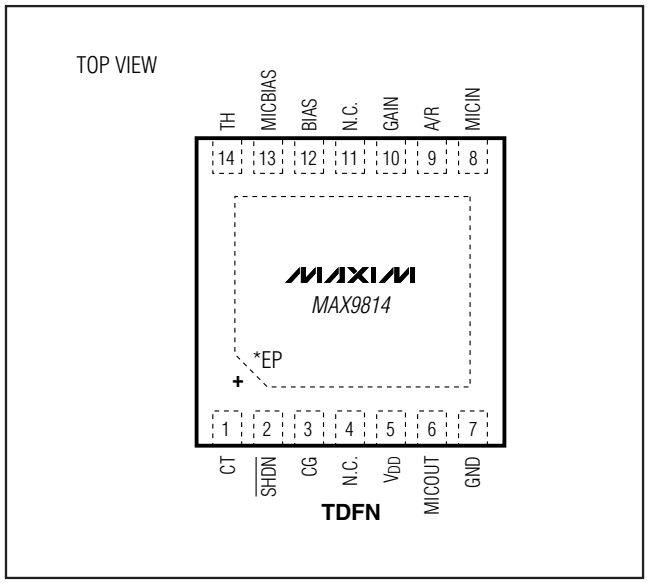
Typical Application Circuit/Functional Diagram



*THE DEVICE HAS BEEN CONFIGURED WITH AN ATTACK TIME OF 1.1ms, 40dB GAIN, AND AN ATTACK-AND-RELEASE RATIO OF 1:500.

Microphone Amplifier with AGC and Low-Noise Microphone Bias

Pin Configuration



Chip Information

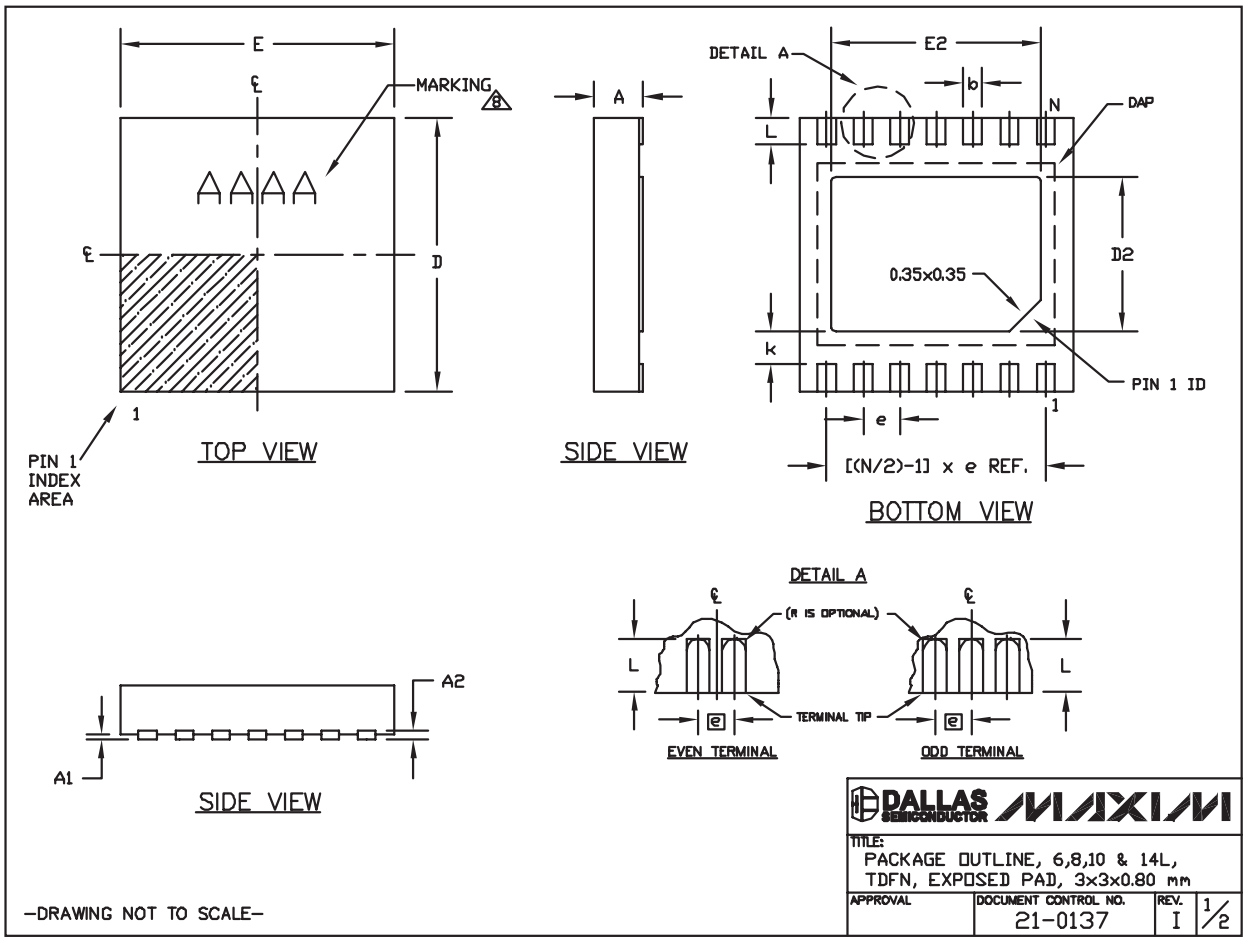
PROCESS: BiCMOS

Microphone Amplifier with AGC and Low-Noise Microphone Bias

Package Information

For the latest package outline information and land patterns, go to **www.maxim-ic.com/packages**.

PACKAGE TYPE	PACKAGE CODE	DOCUMENT NO.
14 TDFN-EP	T1433-2	21-0137



Package Information (continued)

For the latest package outline information and land patterns, go to **www.maxim-ic.com/packages**.

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
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

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.

-DRAWING NOT TO SCALE-

DALLAS SEMICONDUCTOR MAXIM

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

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

Microphone Amplifier with AGC and Low-Noise Microphone Bias

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	3/07	Initial release	—
1	2/09	Updated *Ordering Information*, *Absolute Maximum Ratings*, *Pin Description*, and *Pin Configuration* sections to include EP for TDFN package	1, 2, 6, 11
2	6/09	Removed UCSP package	1, 2, 6, 11, 12