

MAX44259/MAX44260/MAX44261/MAX44263

1.8V、15MHz、低失调、低功耗、 轨到轨I/O运算放大器

概述

MAX44241/MAX44243/MAX44246为36V、超高精度、低噪声、低漂移、单/双/四通道运算放大器，采用专有的斩波稳定和自调零技术，可基本上消除直流失调和漂移。通过对输入失调的连续测量和补偿，在整个工作时间和温度范围内消除漂移及1/f噪声的影响。这些单/双/四通道器件具有轨到轨满摆幅输出，采用2.7V至36V单电源或±1.35V至±18V双电源供电，每通道仅消耗0.42mA电流，输入参考噪声电压只有 $9\text{nV}/\sqrt{\text{Hz}}$ 。

IC采用8引脚 $\mu\text{MAX}^{\circledR}$ 或SO封装，可工作在 -40°C 至 $+125^{\circ}\text{C}$ 温度范围。

应用

传感器放大器
 负载单元放大器
 精密仪表

电池供电设备
 PLC模拟I/O模块

优势和特性

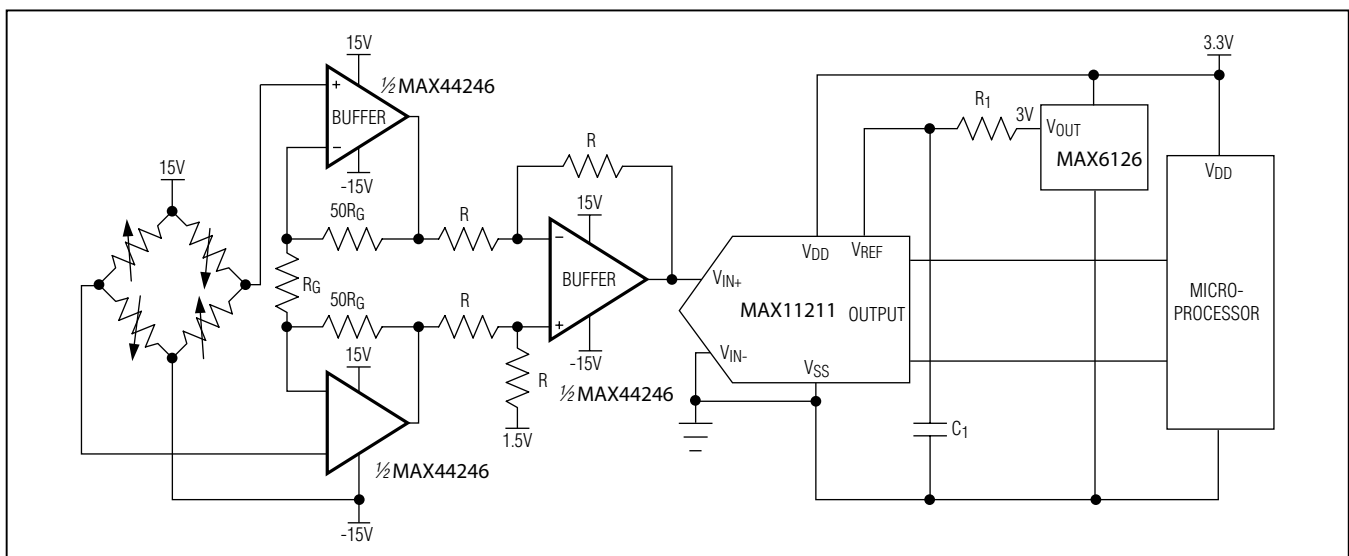
- ◆ 减少噪声灵敏高精度应用
 - 低噪声： $9\text{nV}/\sqrt{\text{Hz}}$ @ 1kHz
 - 集成EMI滤波器
- ◆ 采用增强精度和专有自调零电路，免除了校准的开销
 - 超低输入失调 V_{OS} ： $5\mu\text{V}$ (最大值)
 - 低失调偏移： $20\text{nV}/^{\circ}\text{C}$ (最大值)
- ◆ 适合高带宽应用
 - $1\mu\text{s}$ 快速建立时间
 - 5MHz增益带宽积
- ◆ 低静态电流：每通道0.55mA (最大值)
- ◆ 宽电源电压范围，用于高压前端
 - 2.7V至36V供电范围
- ◆ 满摆幅输出

订购信息在数据资料的最后给出。

相关型号以及配合该器件使用的推荐产品，请参见：www.maximintegrated.com/MAX44241.related。

μMAX 是Maxim Integrated Products, Inc.的注册商标。

典型工作电路



本文是英文数据资料的译文，文中可能存在翻译上的不准确或错误。如需进一步确认，请在您的设计中参考英文资料。
 有关价格、供货及订购信息，请联络Maxim亚洲销售中心：10800 852 1249 (北中国区)，10800 152 1249 (南中国区)，
 或访问Maxim的中文网站：www.maximintegrated.com/cn。

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ABSOLUTE MAXIMUM RATINGS

Supply Voltage (V_{DD} to GND)	-0.3V to +40V	8-Pin SO (derate 7.60mW/°C above +70°C).....	606.1mW
All Other Pins.....	(GND - 0.3V) to (V_{DD} + 0.3V)	14-Pin SO (derate 12.30mW/°C above +70°C).....	987.7mW
Short-Circuit Duration, OUTA, OUTB to Either Supply Rail.....	1s	14-Pin TSSOP (derate 10mW/°C above +70°C).....	796.8mW
Continuous Input Current (Any Pin)	±20mA	Operating Temperature Range	-40°C to +125°C
Differential Input Current.....	±20mA	Junction Temperature	+150°C
Differential Input Voltage (Note 1).....	±6V	Storage Temperature Range.....	-65°C to +150°C
Continuous Power Dissipation ($T_A = +70^\circ\text{C}$)		Lead Temperature (soldering, 10s)	+300°C
5-Pin SOT23 (derate 3.9mW/°C above +70°C).....	312.6mW	Soldering Temperature (reflow)	+260°C
8-Pin μ MAX (derate 4.8mW/°C above +70°C).....	387.8mW		

Note 1: The amplifier inputs are connected by internal back-to-back clamp diodes. In order to minimize noise in the input stage, current-limiting resistors are not used. If differential input voltages exceeding $\pm 1\text{V}$ are applied, limit input current to 20mA.

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 2)

μ MAX	Junction-to-Ambient Thermal Resistance (θ_{JA})	206.3°C/W	Junction-to-Ambient Thermal Resistance (θ_{JA})	255.9°C/W
	Junction-to-Case Thermal Resistance (θ_{JC})	42°C/W	Junction-to-Case Thermal Resistance (θ_{JC})	81°C/W
SO-8	Junction-to-Ambient Thermal Resistance (θ_{JA})	132°C/W	Junction-to-Ambient Thermal Resistance (θ_{JA})	100.4°C/W
	Junction-to-Case Thermal Resistance (θ_{JC})	38°C/W	Junction-to-Case Thermal Resistance (θ_{JC})	30°C/W
SO-14	Junction-to-Ambient Thermal Resistance (θ_{JA})	81°C/W		
	Junction-to-Case Thermal Resistance (θ_{JC})	32°C/W		

Note 2: 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 www.maximintegrated.com/thermal-tutorial.

ELECTRICAL CHARACTERISTICS

($V_{DD} = 30\text{V}$, $V_{GND} = 0\text{V}$, $V_{IN+} = V_{IN-} = V_{DD}/2$, $R_L = 5\text{k}\Omega$ to $V_{DD}/2$, $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$, unless otherwise noted. Typical values at $T_A = +25^\circ\text{C}$.) (Note 3)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	
Supply Voltage Range	V_{DD}	Guaranteed by PSRR	2.7		36	V	
Power-Supply Rejection Ratio (Note 4)	PSRR	$V_{DD} = 2.7\text{V}$ to 36V , $T_A = +25^\circ\text{C}$	148	166		dB	
		$V_{DD} = 2.7\text{V}$ to 36V , $-40^\circ\text{C} < T_A < +125^\circ\text{C}$	146				
Quiescent Current per Amplifier	I_{DD}	$R_L = \infty$	$T_A = +25^\circ\text{C}$		0.42	0.55	mA
			$-40^\circ\text{C} < T_A < +125^\circ\text{C}$			0.60	
Power-Up Time	t_{ON}			20		μs	
DC SPECIFICATIONS							
Input Common-Mode Range	V_{CM}	Guaranteed by CMRR test	($V_{GND} - 0.05$)		($V_{DD} - 1.5$)	V	
Common-Mode Rejection Ratio (Note 4)	CMRR	$V_{CM} = (V_{GND} - 0.05\text{V})$ to $(V_{DD} - 1.5\text{V})$	146	166		dB	
Input Offset Voltage (Note 4)	V_{OS}			1	5	μV	

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ELECTRICAL CHARACTERISTICS (continued)

($V_{DD} = 30V$, $V_{GND} = 0V$, $V_{IN+} = V_{IN-} = V_{DD}/2$, $R_L = 5k\Omega$ to $V_{DD}/2$, $T_A = -40^\circ C$ to $+125^\circ C$, unless otherwise noted. Typical values at $T_A = +25^\circ C$.) (Note 3)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage Drift (Note 4)	TC V_{OS}			1	20	nV/ $^\circ C$
Input Bias Current (Note 4)	I_B	$T_A = +25^\circ C$		300	600	pA
		$-40^\circ C < T_A < +125^\circ C$			1250	
Input Offset Current (Note 4)	I_{OS}	$T_A = +25^\circ C$		600	1200	pA
		$-40^\circ C < T_A < +125^\circ C$			2500	
Open-Loop Gain (Note 4)	A_{VOL}	$(V_{GND} + 0.5V) \leq V_{OUT} \leq (V_{DD} - 0.5V)$	154	168		dB
Output Short-Circuit Current		Noncontinuous	Sinking	40		mA
			Sourcing	30		
Output Voltage Low	V_{OL}	$T_A = +25^\circ C$		90	115	mV
		$-40^\circ C < T_A < +125^\circ C$			180	
Output Voltage High	V_{OH}	$T_A = +25^\circ C$	$(V_{DD} - 0.17)$	$(V_{DD} - 0.13)$		V
		$-40^\circ C < T_A < +125^\circ C$	$(V_{DD} - 0.25)$			

AC SPECIFICATIONS

Input Voltage-Noise Density	e_N	$f = 1kHz$		9		nV/ \sqrt{Hz}
Input Voltage Noise		$0.1Hz < f < 10Hz$		117		nV _{P-P}
Input Capacitance	C_{IN}			2		pF
Gain-Bandwidth Product	GBW			5		MHz
Phase Margin	PM	$C_L = 20pF$		60		Degrees
Slew Rate	SR	$A_V = 1V/V$, $V_{OUT} = 4V_{P-P}$		3.8		V/ μs
Capacitive Loading	C_L	No sustained oscillation, $A_V = 1V/V$		300		pF
Total Harmonic Distortion	THD	$V_{OUT} = 4V_{P-P}$, $A_V = +1V/V$	$f = 1kHz$	-96		dB
			$f = 20kHz$	-77		
		$V_{OUT} = 2V_{P-P}$, $A_V = +1V/V$	$f = 1kHz$	-91		dB
			$f = 20kHz$	-76		

ELECTRICAL CHARACTERISTICS

($V_{DD} = 10V$, $V_{GND} = 0V$, $V_{IN+} = V_{IN-} = V_{DD}/2$, $R_L = 5k\Omega$ to $V_{DD}/2$, $T_A = -40^\circ C$ to $+125^\circ C$, unless otherwise noted. Typical values at $T_A = +25^\circ C$.) (Note 3)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
POWER SUPPLY						
Quiescent Current per Amplifier	I_{DD}	$R_L = \infty$	$T_A = +25^\circ C$	0.42	0.55	mA
			$-40^\circ C < T_A < +125^\circ C$		0.60	
Power-Up Time	t_{ON}			20		μs

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ELECTRICAL CHARACTERISTICS (continued)

($V_{DD} = 10V$, $V_{GND} = 0V$, $V_{IN+} = V_{IN-} = V_{DD}/2$, $R_L = 5k\Omega$ to $V_{DD}/2$, $T_A = -40^\circ C$ to $+125^\circ C$, unless otherwise noted. Typical values at $T_A = +25^\circ C$.) (Note 3)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
DC SPECIFICATIONS						
Input Common-Mode Range	V_{CM}	Guaranteed by CMRR test	$(V_{GND} - 0.05V)$		$(V_{DD} - 1.5V)$	V
Common-Mode Rejection Ratio (Note 4)	CMRR	$V_{CM} = (V_{GND} - 0.05V)$ to $(V_{DD} - 1.5V)$	140	158		dB
Input Offset Voltage (Note 4)	V_{OS}			1	5	μV
Input Offset Voltage Drift (Note 4)	TC V_{OS}			2.4	20	nV/ $^\circ C$
Input Bias Current (Note 4)	I_B	$T_A = +25^\circ C$		300	600	μA
		$-40^\circ C < T_A < +125^\circ C$			1100	
Input Offset Current (Note 4)	I_{OS}	$T_A = +25^\circ C$		600	1200	μA
		$-40^\circ C < T_A < +125^\circ C$			2200	
Open-Loop Gain (Note 4)	A_{VOL}	$(V_{GND} + 0.5V) \leq V_{OUT} \leq (V_{DD} - 0.5V)$	144	164		dB
Output Short-Circuit Current		Noncontinuous	Sinking	40		mA
			Sourcing	30		
Output Voltage Low	V_{OL}	$T_A = +25^\circ C$		30	40	mV
		$-40^\circ C < T_A < +125^\circ C$			60	
Output Voltage High	V_{OH}	$T_A = +25^\circ C$	$(V_{DD} - 0.06V)$	$(V_{DD} - 0.05V)$		V
		$-40^\circ C < T_A < +125^\circ C$	$(V_{DD} - 0.09V)$			
AC SPECIFICATIONS						
Input Voltage-Noise Density	e_N	$f = 1kHz$		9		nV/ \sqrt{Hz}
Input Voltage Noise		$0.1Hz < f < 10Hz$		117		nV _{P-P}
Input Capacitance	C_{IN}			2		pF
Gain-Bandwidth Product	GBW			5		MHz
Phase Margin	PM	$C_L = 20pF$		60		Degrees
Slew Rate	SR	$A_V = +1V/V$, $V_{OUT} = 2V_{P-P}$, 10% to 90%		3.8		V/ μs
Capacitive Loading	C_L	No sustained oscillation, $A_V = 1V/V$		300		pF
Total Harmonic Distortion	THD	$V_{OUT} = 2V_{P-P}$, $A_V = 1V/V$	$f = 1kHz$	-92		dB
			$f = 20kHz$	-76		
Settling Time		To 0.01%, $V_{OUT} = 2V$ step, $A_V = 1V/V$		1		μs

Note 3: All devices are 100% production tested at $T_A = +25^\circ C$. Temperature limits are guaranteed by design.

Note 4: Guaranteed by design.

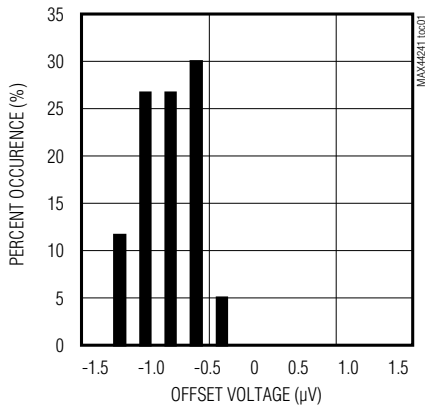
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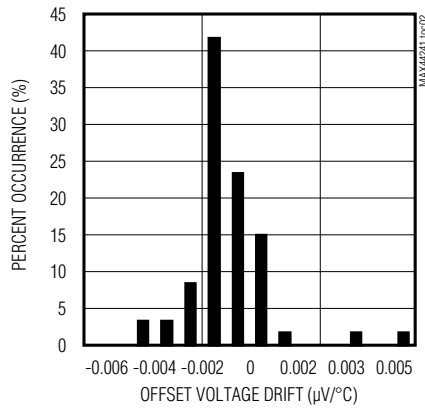
典型工作特性

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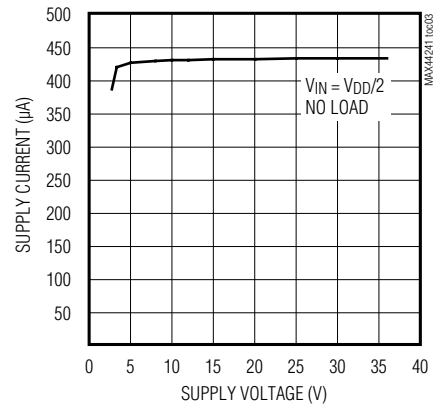
INPUT OFFSET VOLTAGE HISTOGRAM



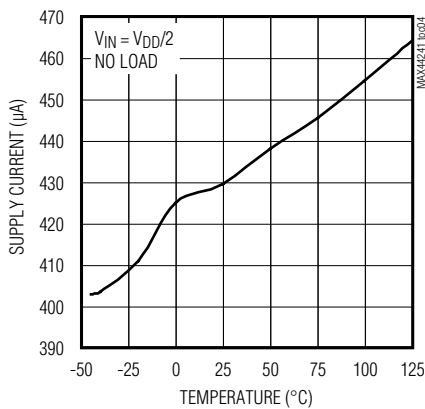
INPUT OFFSET VOLTAGE DRIFT HISTOGRAM



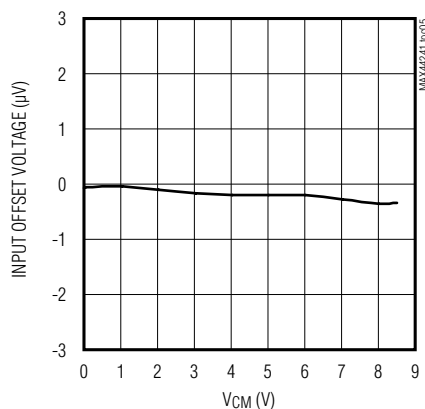
SUPPLY CURRENT PER AMPLIFIER vs. SUPPLY VOLTAGE



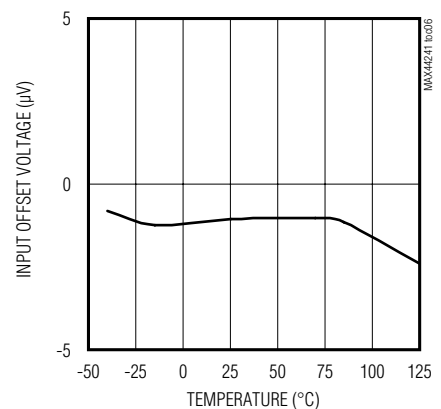
SUPPLY CURRENT PER AMPLIFIER vs. TEMPERATURE



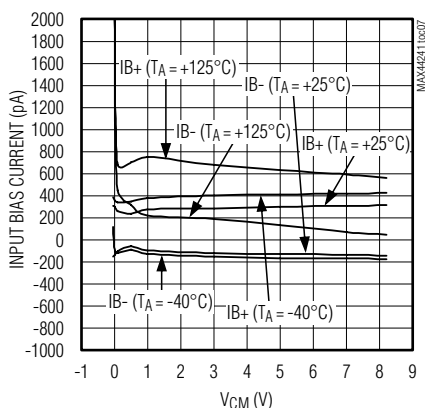
INPUT OFFSET VOLTAGE vs. INPUT COMMON-MODE VOLTAGE



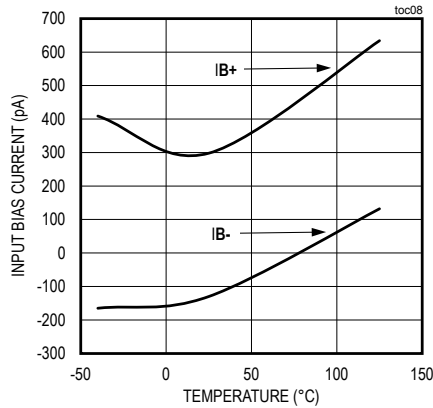
INPUT OFFSET VOLTAGE vs. TEMPERATURE



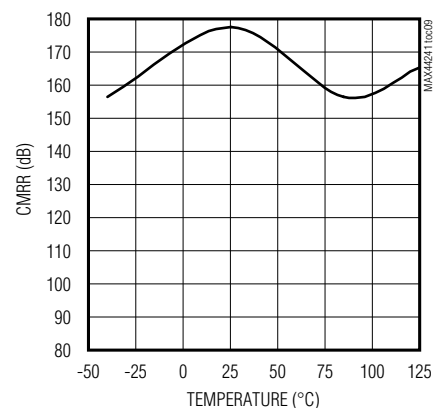
INPUT BIAS CURRENT vs. V_{CM} vs. TEMPERATURE



INPUT BIAS CURRENT vs. TEMPERATURE



COMMON-MODE REJECTION RATIO vs. TEMPERATURE



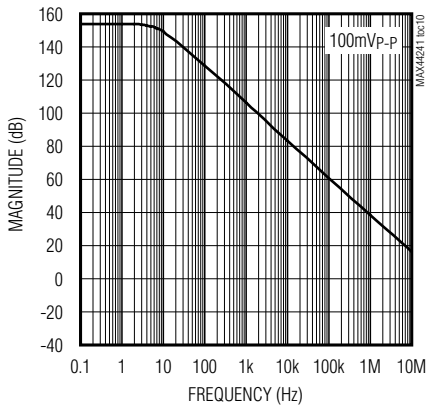
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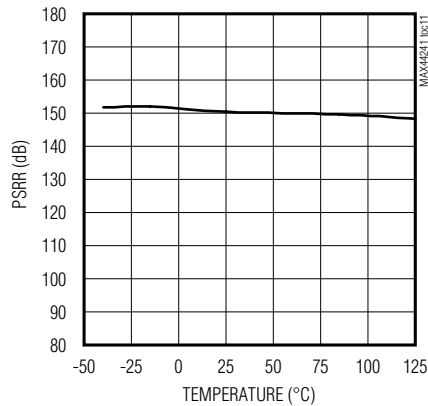
典型工作特性(续)

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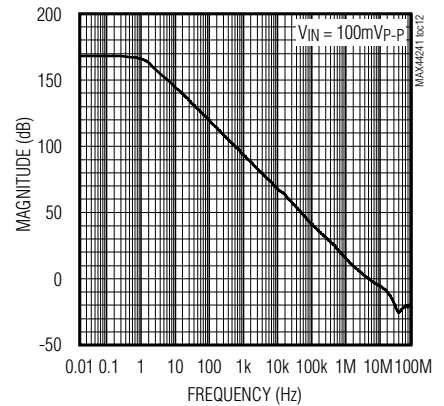
COMMON-MODE REJECTION RATIO vs. FREQUENCY



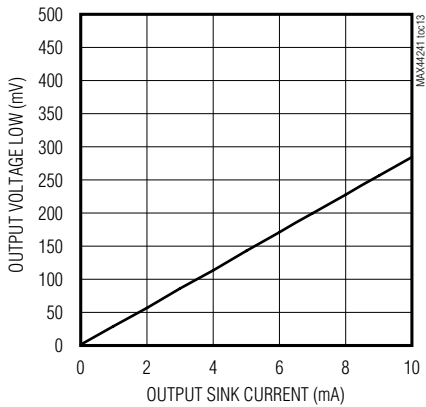
POWER-SUPPLY REJECTION RATIO vs. TEMPERATURE



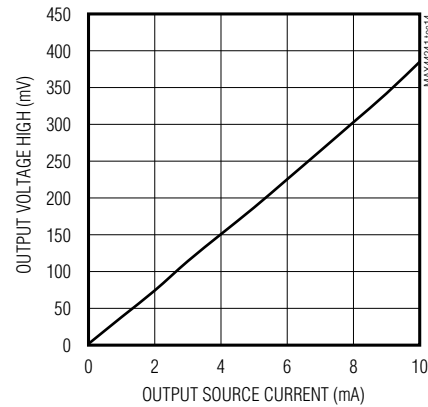
OPEN-LOOP GAIN vs. FREQUENCY



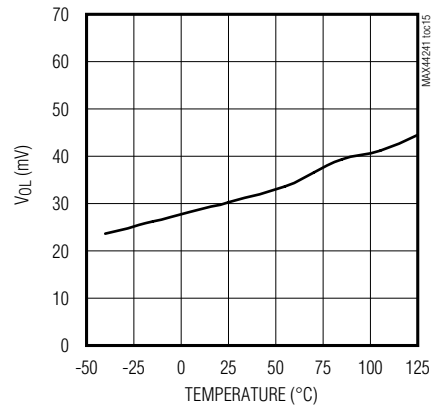
OUTPUT VOLTAGE LOW vs. OUTPUT SINK CURRENT



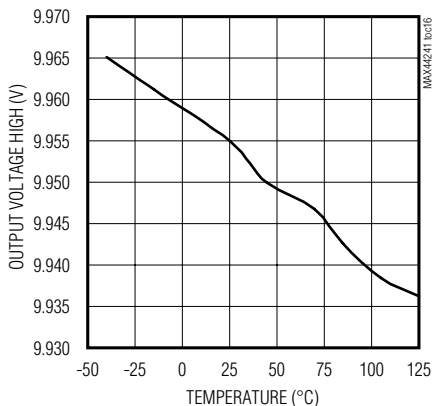
OUTPUT VOLTAGE HIGH vs. OUTPUT SOURCE CURRENT



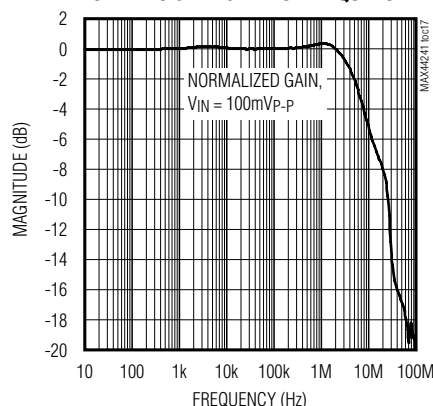
OUTPUT VOLTAGE LOW vs. TEMPERATURE



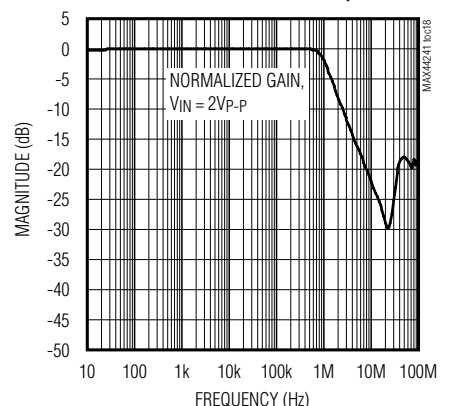
OUTPUT VOLTAGE HIGH vs. TEMPERATURE



SMALL-SIGNAL GAIN vs. FREQUENCY



LARGE-SIGNAL GAIN vs. FREQUENCY

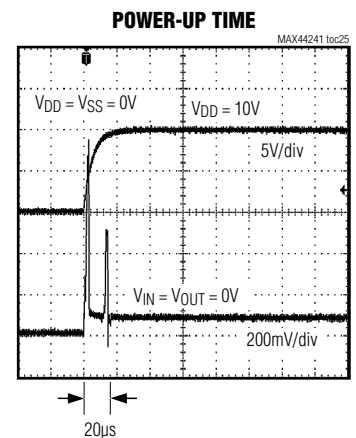
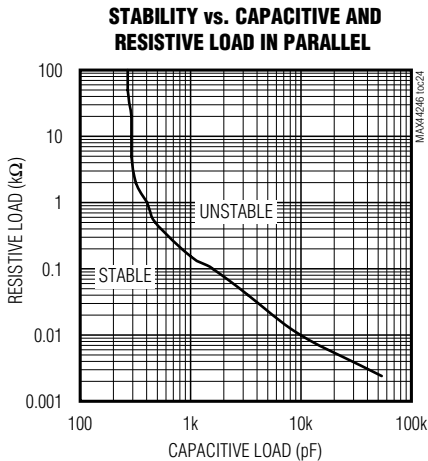
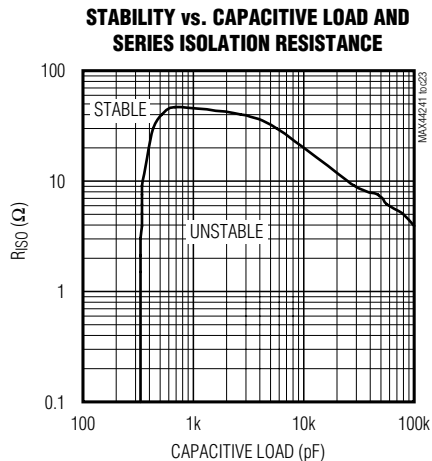
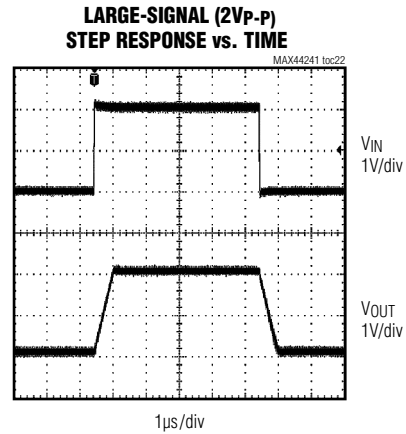
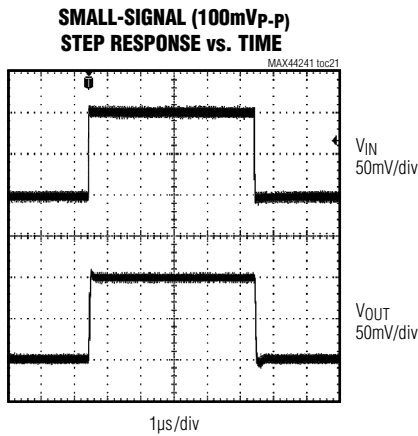
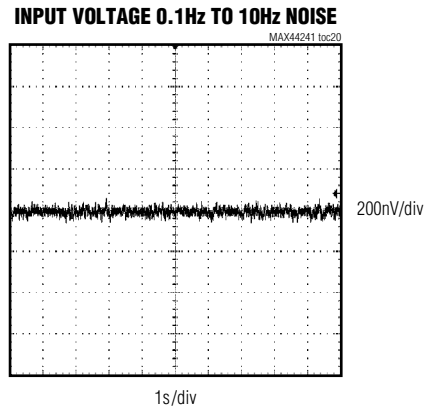
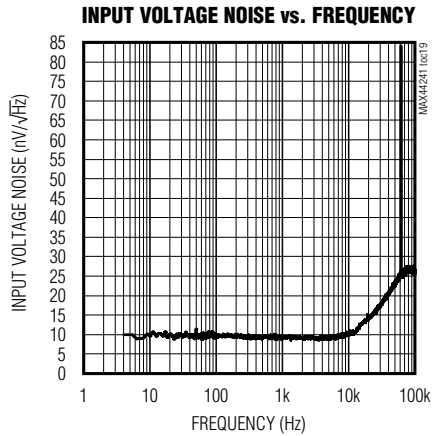


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典型工作特性(续)

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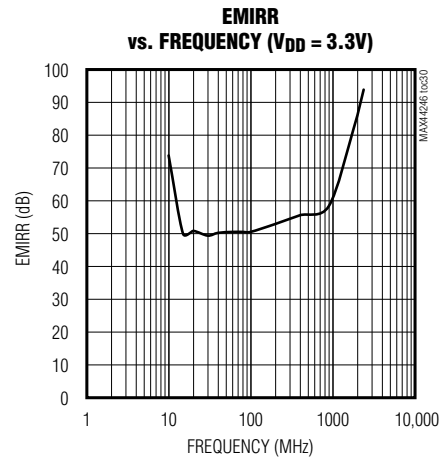
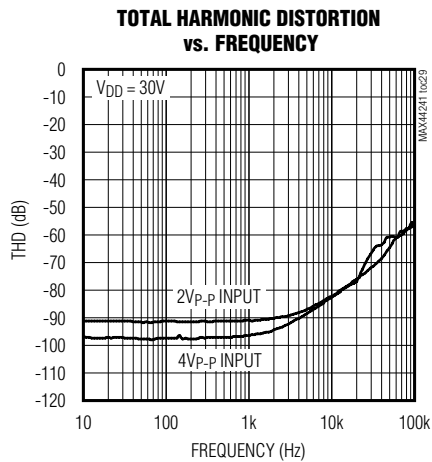
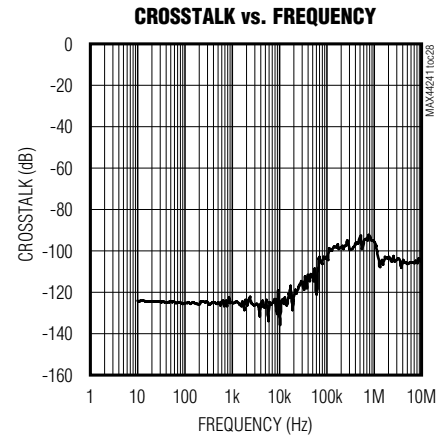
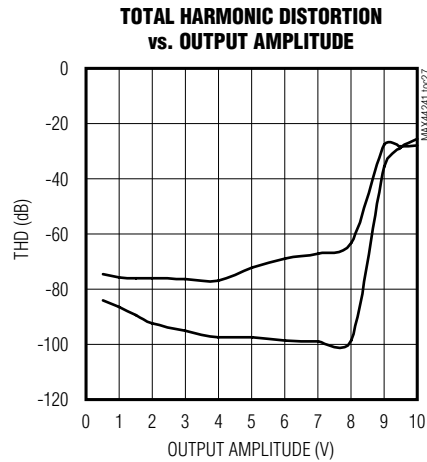
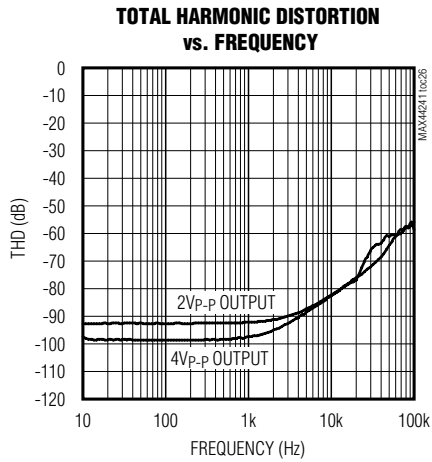


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典型工作特性(续)

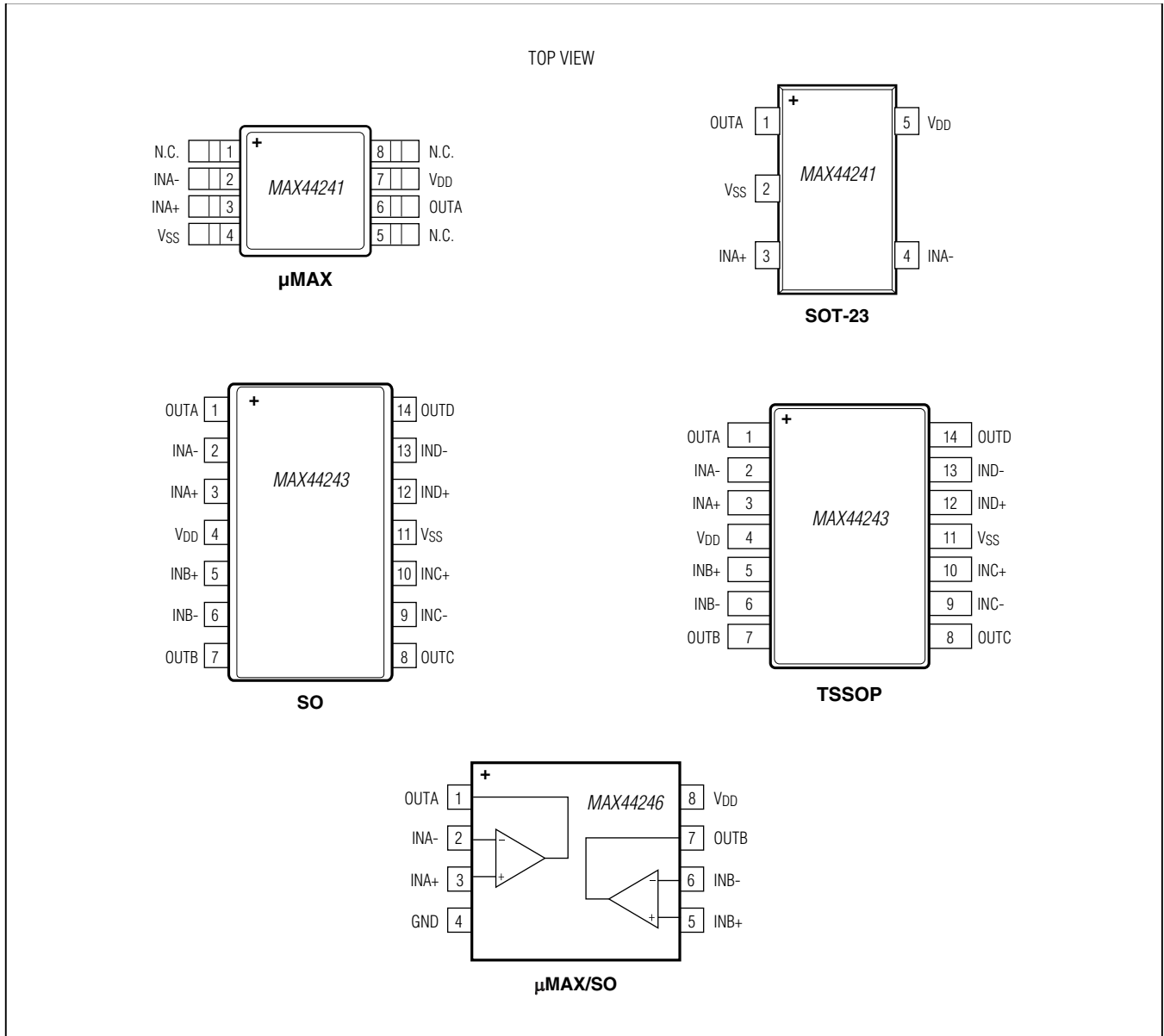
($V_{DD} = 10V$, $V_{GND} = 0V$, $V_{IN+} = V_{IN-} = V_{DD}/2$, $R_L = 5k\Omega$ to $V_{DD}/2$, $T_A = -40^\circ C$ to $+125^\circ C$, unless otherwise noted. Typical values are at $T_A = +25^\circ C$.) (Note 3)



MAX44259/MAX44260/MAX44261/MAX44263

1.8V、15MHz、低失调、低功耗、
轨到轨I/O运算放大器

引脚配置



MAX44259/MAX44260/MAX44261/MAX44263

1.8V、15MHz、低失调、低功耗、
轨到轨I/O运算放大器

引脚说明

引脚						名称	功能
MAX44241		MAX44243		MAX44246			
SOT23-5	μMAX-8	SO-14	TSSOP-14	SO-8	μMAX-8		
16		11		11		OUTA	通道A输出。
24		11	11	44		V _{SS}	负电源电压。
33		33		33		INA+	通道A输入正端。
42		22		22		INA-	通道A输入负端。
57		44		88		V _{DD}	正电源电压。
—	—	55		55		INB+	通道B输入正端。
—	—	66		66		INB-	通道B输入负端。
—	—	77		77		OUTB	通道B输出。
—	—	88		—		OUTC	通道C输出。
—	—	99		—		INC-	通道C输入负端。
—		10	10	—		INC+	通道C输入正端。
—		12	12	—		IND+	通道D输入正端。
—		13	13	—		IND-	通道D输入负端。
—		14	14	—		OUTD	通道D输出。
—	1, 5, 8—		—	—		N.C.	不连接。无内部连接。

MAX44259/MAX44260/MAX44261/MAX44263

1.8V、15MHz、低失调、低功耗、轨到轨I/O运算放大器

详细说明

MAX44241/MAX44243/MAX44246为高精度放大器，最大输入失调低至 $5\mu\text{V}$ 以下，并具有超低闪烁噪声。器件采用专有的自调零和斩波技术，获得优异的特性指标。自调零与斩波技术相结合，确保这些放大器在保持零漂放大器优势的同时，具有低噪声、最小斩波毛刺以及宽频带等特性。电源纹波/毛刺以及共模电压变化引起的失调电压被修正掉，得到优异的PSRR和CMRR指标。

噪声抑制

任何有源器件都存在固有的闪烁噪声，闪烁噪声与频率成反比。MOSFET氧化物在氧化硅表面低频吸收、释放电荷，产生闪烁噪声，也称为 $1/f$ 噪声。MAX44241/MAX44243/MAX44246从内部消除了 $1/f$ 噪声，非常适合对直流或亚Hz噪声要求苛刻的场所。 $1/f$ 噪声表现为慢变化的失调电压，可以利用斩波技术消除掉。

电磁干扰(EMI)噪声具有较高频率，通常会造成电气设备故障或降低性能。IC输入端提供EMI滤波器，以避免输出信号受射频干扰的影响。EMI滤波器由无源器件组成，对高频噪声呈现较高阻抗。

应用信息

ADC 缓冲放大器

MAX44241/MAX44243/MAX44246具有低的输入失调电压和噪声，快速建立时间，很适合用于做ADC的缓冲器。电子秤等设备通常在ADC之前需要一级低噪声、高电压放大器。典型工作电路所示为负载单元和放大器驱动电路，它们采用同一 $\pm 10\text{V}$ 电源供电，配合MAX11211 18位 Σ - Δ ADC

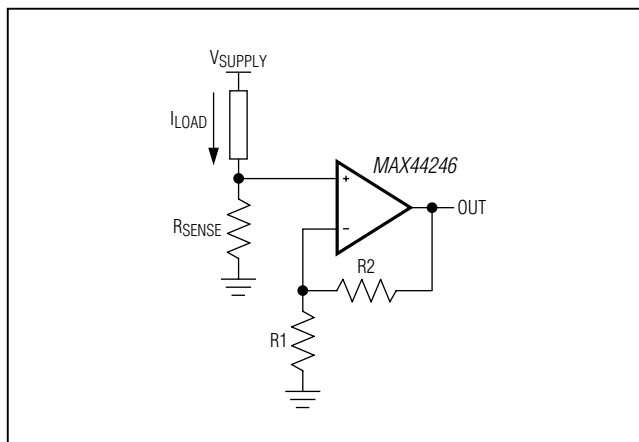


图1. 低边电流检测

工作。负载单元输出电压变化非常小，利用高压驱动激励源可以为ADC输入测量产生较宽的动态范围。

MAX11211 ADC采用2.7V至3.6V单路模拟电源供电，提供18位无噪声分辨率，功耗只有0.86mW。MAX11211具有大于100dB的50Hz、60Hz抑制，是Maxim 16位、18位、20位和24位 Σ - Δ ADC系列产品的其中一员，在提供超高精度的同时，保持极低功耗(小于1mW)。

MAX44241/MAX44243/MAX44246的低输入失调电压和低噪声特性，作为MAX11211的前级放大电路，不会损失ADC的任何动态范围。参见典型工作电路。

高精度低边电流检测

IC提供超低失调电压和温漂，理想用于高精度电流检测。图1所示电路中，IC配置为低边电流检测。该电路产生高精度输出电压： $V_{\text{OUT}} = I_{\text{LOAD}} \times R_{\text{SENSE}} \times (1 + R_2/R_1)$ 。

MAX44259/MAX44260/MAX44261/MAX44263

1.8V、15MHz、低失调、低功耗、 轨到轨I/O运算放大器

布板指南

MAX44241/MAX44243/MAX44246具有超低失调电压和噪声，需遵循以下电路板布局原则，以优化系统性能。

须避免两种不同金属形成的结产生温度梯度，PCB上最常见的金属结是引脚与电路板引线的焊接点。不同的金属形成本地热电偶，由于焊接点的热电系数(Seebeck系数)，温度变化时将在电路板上形成额外的失调。为了使热电系数降至最小，放大器应该尽可能远离热源。调整热阻使得接点两侧的温度相同，最好在输入信号通路保持匹配，使热电偶结的类型和数量相同。例如，考虑使用0Ω哑电阻，使其与热电偶同向，从而与信号通道的实际电阻相抵消。建议铺设大面积的PCB地层，确保板子均匀散热，降低潜在的热点效应的影响。

订购信息

器件	温度范围	引脚-封装	顶标
MAX44241 AUA+	-40°C至+125°C	8 μMAX	—
MAX44241AUK+	-40°C至+125°C	5 SOT23	AFMQ
MAX44243 ASD+	-40°C至+125°C	14 SO	—
MAX44243AUD+	-40°C至+125°C	14 TSSOP	—
MAX44246 ASA+	-40°C至+125°C	8 SO	—
MAX44246AUA+	-40°C至+125°C	8 μMAX	—

+表示无铅(Pb)/符合RoHS标准的封装。

芯片信息

PROCESS: BiCMOS

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www.maximintegrated.com/cn/design/packaging。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
5 SOT23	U5+1	21-0057	90-0174
8 SO	S8+4	21-0041	90-0096
8 μMAX	U8+1	21-0036	90-0092
14 SO	S14M+4	21-0041	90-0112
14 TSSOP	U14M+1	21-0066	90-0113

MAX44259/MAX44260/MAX44261/MAX44263

1.8V、15MHz、低失调、低功耗、 轨到轨I/O运算放大器

修订历史

修订号	修订日期	说明	修改页
0	7/12	最初版本。	—
1	9/12	修改了电气特性和典型工作特性。	1, 2, 3, 5
2	2/13	修订典型工作特性。	8
3	5/13	更新概述、典型应用电路和引脚说明。	1, 9
4	9/13	数据资料中增加MAX44241/MAX44243。修订典型工作电路。	1-13
5	1/14	修订 <i>Electrical Characteristics</i> 和典型工作特性。	2, 5
6	12/14	修订优势和特性部分。	1
7	4/15	修订订购信息。	13



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Maxim Integrated 160 Rio Robles, San Jose, CA 95134 USA 1-408-601-10 00

13