19-6040; Rev 0; 9/11

备有评估板

GPS/GNSS低噪声放大器

概述

MAX2687/MAX2694低噪声放大器(LNA)设计用于GPS L1、Galileo和GLONASS应用。器件采用Maxim先进的SiGe工艺，在提供高增益和低噪声系数的同时，保持最高输入参考1dB压缩点和三阶截点。MAX2687具有高达17.8dB的增益；MAX2694在提供11.6dB增益的前提下保持最佳线性指标。

器件采用+1.6V至+3.6V单电源供电，可选择的关断模式使器件电源电流降至10µA以下。器件采用超小尺寸、无铅并符合RoHS标准的0.86mm x 0.86mm x 0.65mm晶片级封装(WLP)。

特性

- ♦ 高功率增益：17.8dB (MAX2687)
- ♦ 低噪声系数：0.85dB (MAX2687)
- ♦ 集成50Ω输出匹配电路
- ♦ 低电源电流：4.5mA
- ♦ 较宽的电源电压范围：1.6V至3.6V
- ♦ 较少的材料清单：1个电感、2个电容
- ♦ 小尺寸封装：0.86mm x 0.86mm
- ♦ 0.4mm焊球间距的晶片级封装(WLP)

应用

汽车导航

远程信息处理(物品跟踪和库存管理)

个人导航设备(PND)

带有GPS的蜂窝电话

笔记本PC/超便携移动PC

娱乐终端，航海导航

航空电子

手表

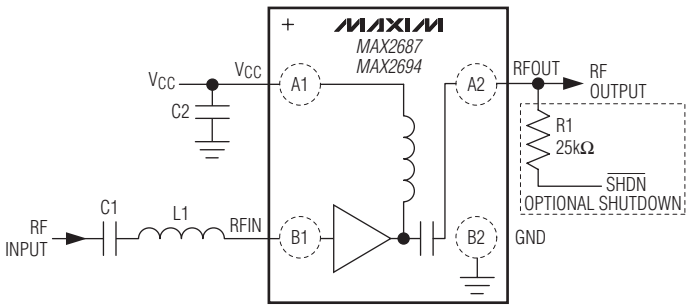
数码相机

定购信息

PART	TEMP RANGE	PIN-PACKAGE
MAX2687EWS+T	-40°C to +85°C	4 WLP
MAX2694EWS+T	-40°C to +85°C	4 WLP

+表示无铅(Pb)/符合RoHS标准的封装。
T = 卷带包装。

典型应用电路



MAX2687	MAX2694
L1 = 4.7nH	L1 = 4.7nH
C1 = 100nF	C1 = 100nF
C2 = 10pF	C2 = 10pF

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：china.maxim-ic.com。

ABSOLUTE MAXIMUM RATINGS

V_{CC} to GND.....-0.3V to +3.6V
Other Pins to GND .....-0.3V to (+ Operating V_{CC} + 0.3V)
Maximum RF Input Power ..... +5dBm
Continuous Power Dissipation (T_A = +70°C)
4-Bump WLP (derates 9.7mW/°C above +70°C) 776mW
Maximum Current into RF Input 10mA
Operating Temperature Range ..... -40°C to +85°C
Junction Temperature .....+150°C
Storage Temperature Range..... -65°C to +160°C
Lead Temperature (soldering, 10s) .....Reflow Profile (Note 1)
Soldering Temperature (reflow) .....+260°C

Note 1: Refer to Application Note 1891: *Wafer-Level Packaging (WLP) and Its Applications*.

CAUTION! ESD SENSITIVE DEVICE

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.

DC ELECTRICAL CHARACTERISTICS

(MAX2687/MAX2694 EV kit, V_{CC} = 1.6V to 3.6V, T_A = -40°C to +85°C, no RF signals are applied. Typical values are at V_{CC} = 2.85V and T_A = +25°C, unless otherwise noted.) (Note 2)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Supply Voltage			1.6	2.85	3.6	V
Supply Current	$\overline{SHDN}$ = high	MAX2687		7.63		mA
		MAX2694		4.5		
	Shutdown mode, $\overline{SHDN}$ = 0V				10	µA
Digital Input Logic-High	(Note 3)		1.2			V
Digital Input Logic-Low	(Note 3)				0.45	V

AC ELECTRICAL CHARACTERISTICS

(MAX2687/MAX2694 EV kit, V_{CC} = 1.6V to 3.6V, T_A = -40°C to +85°C, f_{RFIN} = 1575.42MHz. Typical values are at V_{CC} = 2.85V and T_A = +25°C, unless otherwise noted.) (Note 2)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
RF Frequency	L1 band			1575.42		MHz
Power Gain	V_{CC} = 2.85V (Note 4)	MAX2687	14.7	17.8		dB
		MAX2694	11.9	11.6		
	V_{CC} = 1.6V	MAX2687	14.0	17.7		
		MAX2694	8.7	11.5		
Noise Figure	V_{CC} = 1.6V to 3.3V	MAX2687		0.85		dB
		MAX2694		0.97		
In-Band 3rd-Order Input Intercept Point	(Note 5)	MAX2687		5.5		dBm
		MAX2694		6.85		
Out-of-Band 3rd-Order Input Intercept Point	(Note 6)	MAX2687		9.146		dBm
		MAX2694		8.644		
Input 1dB Compression Point	(Note 7)	MAX2687		-9.3		dBm
		MAX2694		-2.25		
Input Return Loss	MAX2687			7.8		dBm
	MAX2694			16.8		

AC ELECTRICAL CHARACTERISTICS (continued)

(MAX2687/MAX2694 EV kit, V_{CC} = 1.6V to 3.6V, T_A = -40°C to +85°C, f_{RFIN} = 1575.42MHz. Typical values are at V_{CC} = 2.85V and T_A = +25°C, unless otherwise noted.) (Note 2)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Output Return Loss	MAX2687		20.7		dB
	MAX2694		11.6		
Reverse Isolation	MAX2687		43.9		dB
	MAX2694		21.5		

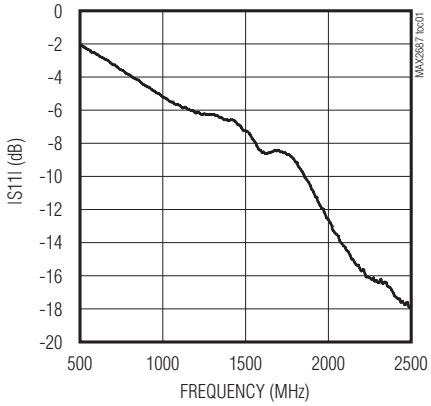
Note 2: Min and max limits guaranteed by test at T_A = +25°C and guaranteed by design and characterization at T_A = -40°C and T_A = +85°C, unless otherwise noted.
Note 3: Min and max limits guaranteed by test at T_A = +25°C.
Note 4: Min limit guaranteed by design and characterization.
Note 5: Measured with the two tones located at 1MHz and 2MHz offset from the center of the GPS band with -27dBm/tone for the MAX2687 and -24dBm/tone for the MAX2694.
Note 6: Measured with input tones at 1713MHz (-27dBm) and 1851MHz (-39dBm).
Note 7: Measured with a tone located at the center of the GPS band.

典型工作特性

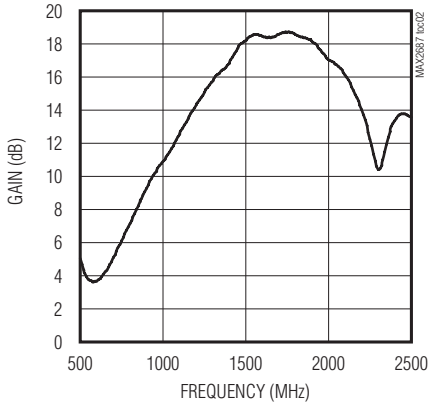
(MAX2687/MAX2694 EV kit. Typical values are at V_{CC} = 2.85V, T_A = +25°C, and f_{RFIN} = 1575.42MHz, unless otherwise noted.)

MAX2687

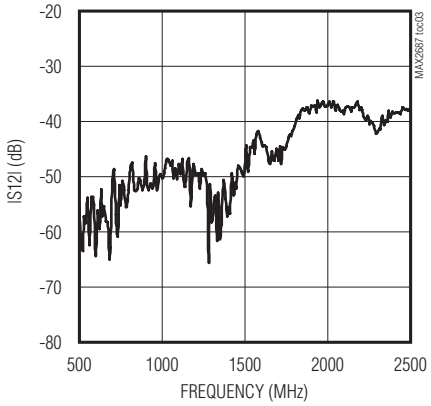
INPUT RETURN LOSS vs. FREQUENCY



GAIN vs. FREQUENCY



REVERSE ISOLATION vs. FREQUENCY



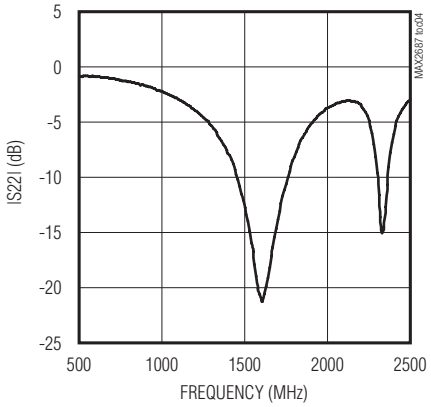
GPS/GNSS低噪声放大器

典型工作特性(续)

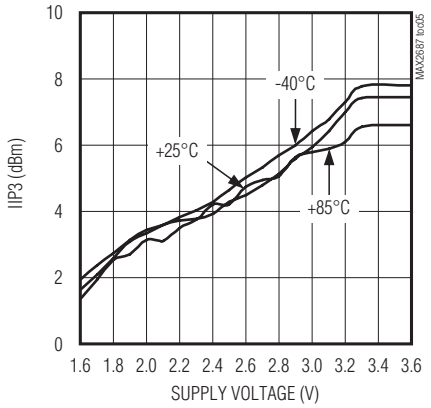
(MAX2687/MAX2694 EV kit. Typical values are at V_{CC} = 2.85V, T_A = +25°C, and f_{RFIN} = 1575.42MHz, unless otherwise noted.)

MAX2687

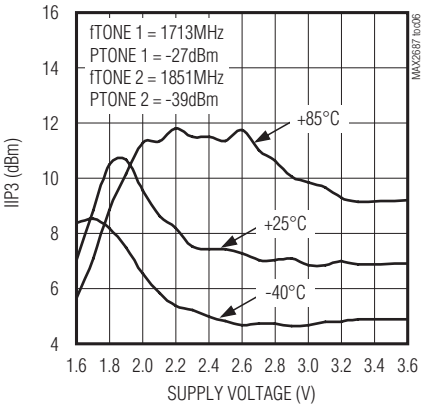
OUTPUT RETURN LOSS vs. FREQUENCY



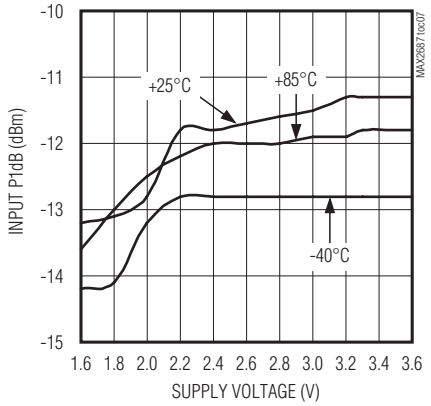
IN-BAND IIP3 vs. SUPPLY VOLTAGE AND TEMPERATURE



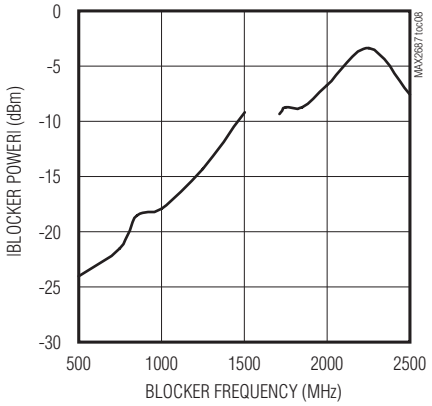
OUT-OF-BAND IIP3 vs. SUPPLY VOLTAGE AND TEMPERATURE



INPUT P1dB vs. SUPPLY VOLTAGE AND TEMPERATURE



1dB GAIN DESENSE vs. BLOCKER FREQUENCY

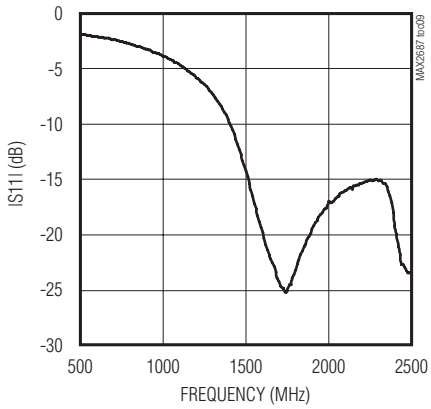


典型工作特性(续)

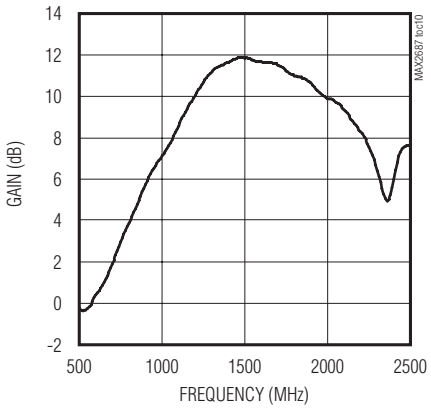
(MAX2687/MAX2694 EV kit. Typical values are at V_{CC} = 2.85V, T_A = +25°C, and f_{RFIN} = 1575.42MHz, unless otherwise noted.)

MAX2694

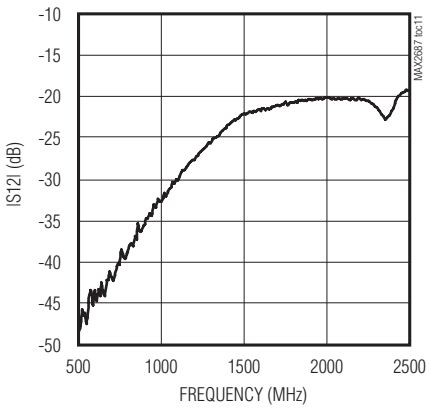
INPUT RETURN LOSS vs. FREQUENCY



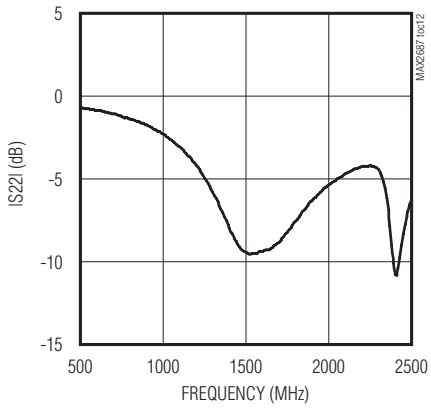
GAIN vs. FREQUENCY



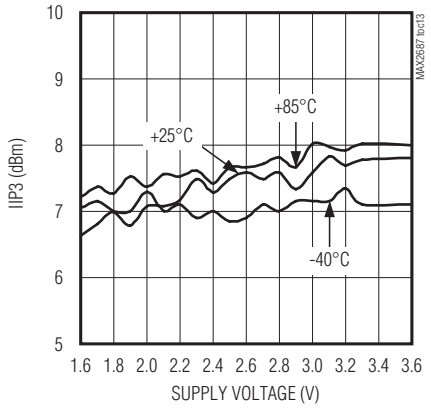
REVERSE ISOLATION vs. FREQUENCY



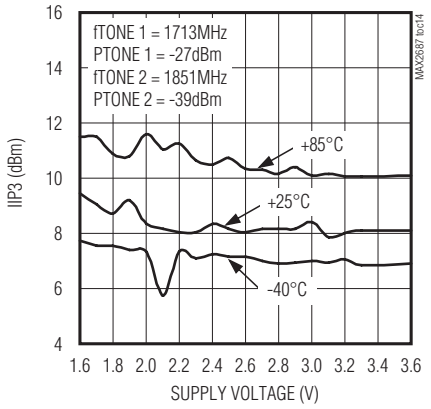
OUTPUT RETURN LOSS vs. FREQUENCY



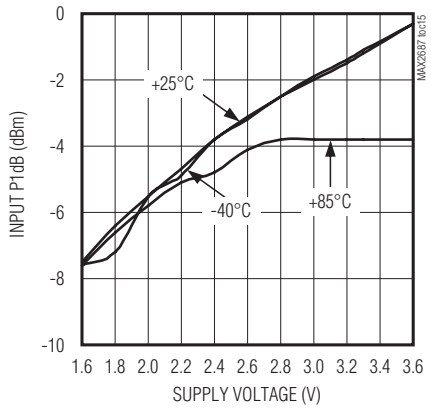
IN-BAND IIP3 vs. SUPPLY VOLTAGE AND TEMPERATURE



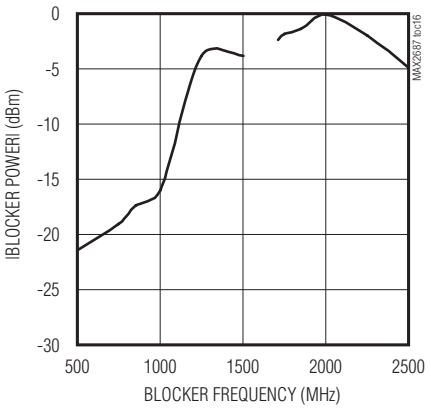
OUT-OF-BAND IIP3 vs. SUPPLY VOLTAGE AND TEMPERATURE



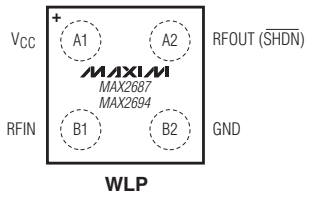
INPUT P1dB vs. SUPPLY VOLTAGE AND TEMPERATURE



1dB GAIN DESENSE vs. BLOCKER FREQUENCY



焊球配置



WLP

焊球说明

焊球	名称	功能
A1	V_{CC}	电源电压，通过10pF电容旁路至地，电容应尽量靠近IC放置。
A2	RFOUT ($\overline{SHDN}$)	RF输出/$\overline{SHDN}$输入。RFOUT在内部匹配至50Ω并通过1MΩ电阻上拉到V_{CC}。$\overline{SHDN}$与RFOUT共用一个焊球，默认状态下，一旦V_{CC}施加电源将立即进入有效工作模式；可从外部通过一个25kΩ电阻将RFOUT ($\overline{SHDN}$)拉至直流低电平，关断IC。
B1	RFIN	RF输入，需要外部连接隔直流电容和匹配元件。
B2	GND	地，连接到PCB地层。

详细说明

MAX2687/MAX2694是针对GPS L1、Galileo和GLONASS应用设计的LNA。器件具有可选择的电源关断控制模式，无需外部电源开关。器件具有高增益、低噪声系数和优异的线性指标。

输入和输出匹配

器件需要外部输入匹配电路，只需一个电感与隔直流电容串联，即可构建输入匹配电路。*典型应用电路*给出了所推荐的输入匹配网络。这些数值同时优化于最佳的增益、噪声系数、回波损耗等性能指标。输入耦合电容会影响IIP3，选择较小的耦合电容时将产生较低的IIP3。器件内部集成了50Ω输出匹配电路，无需外部匹配元件。表1和表2列出了器件的典型S参数和K_f系数，典型噪声参数如表3和表4所示。

关断

器件包含关断功能，用于关断整个芯片的工作。由于器件内部，RFOUT (与$\overline{SHDN}$输入共用同一焊球)通过上拉电阻拉至V_{CC}，默认条件下，一旦V_{CC}施加电源，器件将立即进入有效工作模式；通过一个适当的外部电阻(例如：25kΩ)，在RFOUT端作用一个低电平关断器件，避免器件在有效工作期间给RF输出信号增加负载。

表1. MAX2687的典型S参数和K系数

FREQ (MHz)	S11 MAG (dB)	S11 PHASE (DEGREES)	S21 MAG (dB)	S21 PHASE (DEGREES)	S12 MAG (dB)	S12 PHASE (DEGREES)	S22 MAG (dB)	S22 PHASE (DEGREES)	K_f
1000	-3.9	-91.5	10.1	164.7	-48.4	96.6	-2.2	-154.8	10.0
1100	-4.1	-97.6	11.7	152.8	-51.2	47.8	-2.9	-175.2	14.0
1200	-4.4	-103.6	13.3	136.5	-47.3	42.2	-3.9	164.0	9.6
1300	-4.3	-109.6	14.6	118.8	-53.1	80.2	-5.4	140.3	19.1
1400	-4.0	-116.9	15.6	102.3	-55.0	152.6	-7.5	112.1	23.4
1500	-3.9	-127.1	17.0	82.1	-45.7	119.1	-11.7	70.7	7.6
1575	-4.5	-133.3	17.3	63.7	-44.5	72.7	-18.1	15.0	7.3
1600	-4.7	-133.6	17.1	56.9	-46.9	36.4	-20.9	-18.1	10.1
1700	-4.2	-140.0	17.1	39.7	-48.8	77.8	-14.7	-100.3	11.4
1800	-4.2	-150.0	17.0	18.6	-41.6	76.6	-8.8	-137.7	4.3
1900	-4.5	-159.2	16.6	-1.5	-39.2	39.1	-5.6	-168.2	2.9
2000	-4.8	-166.3	15.5	-20.2	-37.6	17.5	-4.0	163.7	2.3

表2. MAX2694的典型S参数和K系数

FREQ (MHz)	S11 MAG (dB)	S11 PHASE (DEGREES)	S21 MAG (dB)	S21 PHASE (DEGREES)	S12 MAG (dB)	S12 PHASE (DEGREES)	S22 MAG (dB)	S22 PHASE (DEGREES)	K_f
1000	-2.7	-106.3	5.8	145.8	-33.4	103.0	-2.2	-160.9	2.7
1100	-3.0	-117.0	7.1	133.6	-31.1	95.5	-2.8	-179.0	2.4
1200	-3.4	-127.6	8.5	117.1	-29.0	81.3	-3.8	163.5	2.1
1300	-4.0	-138.6	9.7	98.3	-26.8	67.7	-5.3	145.9	1.9
1400	-4.9	-149.8	10.3	79.8	-24.9	55.3	-7.6	130.7	1.8
1500	-6.2	-158.2	10.8	59.9	-22.9	36.8	-10.8	126.6	1.6
1575	-7.0	-159.5	10.7	46.2	-22.4	21.7	-12.3	132.7	1.6
1600	-7.2	-160.0	10.6	41.3	-22.5	17.5	-12.7	134.9	1.6
1700	-7.7	-163.0	10.6	23.5	-22.0	4.0	-12.9	150.7	1.5
1800	-8.2	-164.6	10.2	6.2	-21.3	-11.5	-10.3	158.0	1.4
1900	-8.1	-165.5	9.9	-11.7	-21.2	-26.8	-7.7	150.4	1.3
2000	-7.7	-167.3	9.0	-27.0	-20.9	-42.3	-5.9	137.5	1.2

表3. MAX2687的典型噪声参数(V_{CC} = 2.85V，T_A = +25℃)

FREQUENCY (MHz)	FMIN (dB)	$\lvert\Gamma_{OPT}\rvert$	$\lvert\Gamma_{OPT}\rvert$ ANGLE	R_N (Ω)
1550	0.69	0.26	66	5.28
1560	0.69	0.26	66	5.27
1570	0.69	0.26	67	5.27
1575	0.69	0.25	67	5.26
1580	0.69	0.25	67	5.26
1590	0.70	0.25	68	5.26
1600	0.70	0.25	68	5.25

表4. MAX2694的典型噪声参数(V_{CC} = 2.85V，T_A = +25°C)

FREQUENCY (MHz)	FMIN (dB)	$\|\Gamma_{OPT}\|$	$\|\Gamma_{OPT}\|$ ANGLE	R_N (Ω)
1550	0.75	0.44	48	9.06
1560	0.75	0.44	48	9.04
1570	0.75	0.44	48	9.02
1575	0.75	0.43	49	9.01
1580	0.75	0.43	49	9.00
1590	0.75	0.43	49	8.98
1600	0.75	0.43	49	8.96

应用信息

合理设计PCB是任何RF微波电路设计的基础，在所有高频输入和输出采用阻抗受控引线。利用去耦电容旁路V_{CC}，电容应尽可能靠近器件放置。V_{CC}引线较长时，可能需要增加去耦电容，这些增添的电容应远离器件放置。GND焊球采用适当的接地也非常重要，如果PCB的顶层为RF地，可以将GND焊球直接连接到该接地层。如果电路板的地不在元件层，则将GND焊球通过多个过孔连接到电路板地，过孔须尽量靠近器件。

MAX2687/MAX2694的评估板原理图、Gerber文件、PADS布局文件以及BOM信息，请参考**china.maxim-ic.com/data-sheet/index.mvp/id/6932/t/do**。

芯片信息

PROCESS: SiGe 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**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
4 WLP	W40A0+1	**21-0480**	参见 **应用笔记1891**

修订历史

修订号	修订日期	说明	修改页
0	9/11	最初版本。	—

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