19-5165; Rev 0; 3/10

250MHz至4000MHz、双通道、可变电压模拟衰减器

概述

MAX19790为双路、通用模拟电压可变增益衰减器(VVA)，设计用于工作在250MHz至4000MHz频率范围的50Ω系统。每个衰减器包括一个控制电路，可提供22dB衰减范围，具有10dB/V的线性控制斜率。

两路衰减器共用一个共模模拟控制信号，可以级联产生44dB的总动态范围，获得20dB/V的线性控制斜率。

该款IC为单芯片设计，采用Maxim专有SiGe BiCMOS工艺。器件采用+5.0V单电源供电，采用紧凑的36引脚薄型QFN封装(6mm x 6mm x 0.8mm)，带有裸焊盘。在-40°C至+85°C扩展级温度范围内确保电气规格。

应用

宽带应用系统，包括：无线基础架构的数字及扩频通信系统

WCDMA/LTE、TD-SCDMA/TD-LTE、WiMAX™、cdma2000®、GSM/EDGE和MMDS基站

VSAT/卫星调制解调器

地面微波链路

增益调节

温补电路

自动电平控制(ALC)

发送器增益控制

接收器增益控制

通用测试设备

特性

- ♦ 250MHz至4000MHz RF频率范围
- ♦ 单一芯片集成两路模拟衰减器
- ♦ 灵活的衰减范围控制
  - 22dB (每路衰减器)
  - 44dB (两路衰减器级联)
- ♦ 2.4dB 1500MHz插入损耗(每路衰减器)
- ♦ 线性模拟控制响应曲线(dB/V)简化自动电平控制和增益调整算法
- ♦ 在较宽的频率范围和衰减设置下保持优异的衰减平坦度
- ♦ 7.3mA较低的电源电流
- ♦ +5.0V单电源供电

定购信息

PART	TEMP RANGE	PIN-PACKAGE
MAX19790ETX+	-40°C to +85°C	36 Thin QFN-EP*
MAX19790ETX+T	-40°C to +85°C	36 Thin QFN-EP*

+表示无铅(Pb)/符合RoHS标准的封装。

**EP = 裸焊盘。*

T = 卷带包装。

WiMAX是WiMAX论坛的商标。

cdma2000是电信工业协会的注册商标。

250MHz至4000MHz、双通道、可变电压模拟衰减器

ABSOLUTE MAXIMUM RATINGS

V_{CC} to GND.....-0.3V to +5.5V
CTRL to GND (with V_{CC} = +5.0V applied).....0V to +4.75V
All Other Pins to GND ..... -0.3V to (V_{CC} + 0.3V)
RF Input.....+20dBm
Current into CTRL Pin (V_{CC} grounded) 40mA
Maximum Junction Temperature.....+150°C
Operating Temperature Range..... -40°C to +85°C
Storage Temperature Range.....-65°C to +150°C
Continuous Power Dissipation (T_C = +85°C) (Note 1) 2.1W
θ_{JC} (Notes 2, 4)..... +10°C/W
θ_{JA} (Notes 3, 4)..... +35°C/W
Lead Temperature (soldering, 10s) .....+300°C
Soldering Temperature (reflow) .....+260°C

Note 1: T_C is the temperature on the exposed pad of the package. T_A is the ambient temperature of the device and PCB.

Note 2: Based on junction temperature $T_J = T_C + (\theta_{JC} \times V_{CC} \times I_{CC})$. This formula can be used when the temperature of the exposed pad is known while the device is soldered down to a PCB. See the *Applications Information* section for details. The junction temperature must not exceed +150°C.

Note 3: Junction temperature $T_J = T_A + (\theta_{JA} \times V_{CC} \times I_{CC})$. This formula can be used when the ambient temperature of the PCB is known. The junction temperature must not exceed +150°C.

Note 4: Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to **china.maxim-ic.com/thermal-tutorial**.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

CAUTION! ESD SENSITIVE DEVICE

DC ELECTRICAL CHARACTERISTICS

(V_{CC} = +4.75V to +5.25V, V_{CTRL} = +1.0V to +4.0V, no RF signals applied, all input and output ports terminated with 50Ω, T_C = -40°C to +85°C, unless otherwise noted. Typical values are at V_{CC} = +5.0V, V_{CTRL} = +1.0V, T_C = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
SUPPLY						
Supply Voltage	V_{CC}		4.75	5.0	5.25	V
Supply Current	I_{CC}			7.3	9.5	mA
CONTROL INPUT						
Control Voltage Range	V_{CTRL}	(Note 5)	1.0		4.0	V
Control Input Resistance	R_{CTRL}		50			kΩ

RECOMMENDED AC OPERATING CONDITIONS

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
RF Frequency Range	f_{RF}	(Note 6)	250		4000	MHz

AC ELECTRICAL CHARACTERISTICS

(*MAX19790 Evaluation Kit*, line and connector losses included, **two attenuators in cascade**, V_{CC} = 4.75V to 5.25V, RF ports are driven from 50Ω sources, input P_{RF} = -10dBm, f_{RF} = 950MHz to 2150MHz, V_{CTRL} = +1.0V, T_C = -40°C to +85°C. Typical values are for T_C = +25°C, V_{CC} = +5.0V, input P_{RF} = -10dBm, f_{RF} = 1500MHz, V_{CTRL} = +1.0V, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Insertion Loss	IL	T_C = +25°C	950MHz to 1500MHz		4.4	6.3	dB
			950MHz to 2150MHz		4.4	7.0	
Loss Variation Over Temperature		T_C = -40°C to +85°C			0.6		dB
Input P_{1dB}	IP_{1dB}				23.1		dBm
Input Second-Order Intercept Point	IIP2	f_{RF1} + f_{RF2} term, f_{RF1} - f_{RF2} = 1MHz (Note 7)			69.6		dBm
Input Third-Order Intercept Point	IIP3	f_{RF1} - f_{RF2} = 1MHz (Note 7)			36.3		dBm
Second Harmonic	$2f_{IN}$				72		dBc
Third Harmonic	$3f_{IN}$				77		dBc
Attenuation-Control Range	A_R	One attenuator, V_{CTRL} = +1.0V to +4.0V, T_C = +25°C			22		dB
		Two attenuators, V_{CTRL} = +1.0V to +4.0V, T_C = +25°C	950MHz to 1500MHz	36	44.7		
			950MHz to 2150MHz	33	44.7		
Average Attenuation-Control Slope		V_{CTRL} = +1.0V to +3.5V			20.0		dB/V
Maximum Attenuation-Control Slope		V_{CTRL} = +1.0V to +3.5V			30.4		dB/V
Attenuation Flatness Over 125MHz Bandwidth (Note 8)		Peak-to-peak for V_{CTRL} = +1.0V to +3.1V, T_C = +25°C			0.13	0.89	dB
Switching Time		From 15dB to 0dB attenuation (Note 9)			500		ns
Input Return Loss		All gain settings			25		dB
Output Return Loss		All gain settings			21		dB
Group Delay		Input/output 50Ω lines deembedded			190		ps
Group-Delay Flatness Over 125MHz Bandwidth		Peak-to-peak			10		ps
Group-Delay Change vs. Attenuation Control		V_{CTRL} = +1.0V to +4.0V			-175		ps
Insertion Phase Change vs. Attenuation Control		V_{CTRL} = +1.0V to +4.0V			82		Degrees

Note 5: Operating outside this range for extended periods may affect device reliability. Limit pin input current to 40mA when V_{CC} is not present (see Table 1 for R4 value).

Note 6: Operation outside this range is possible, but with degraded performance of some parameters. See the *Typical Operating Characteristics*.

Note 7: f_1 = 1500MHz, f_2 = 1501MHz, -10dBm/tone at attenuator input.

Note 8: Guaranteed by design and characterization.

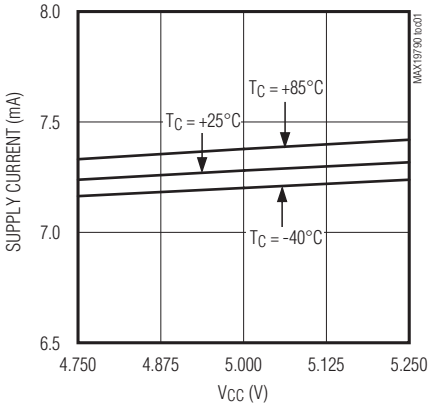
Note 9: Switching time is measured from 50% of the control signal to when the RF output settles to ±1dB.

250MHz至4000MHz、双通道、可变电压模拟衰减器

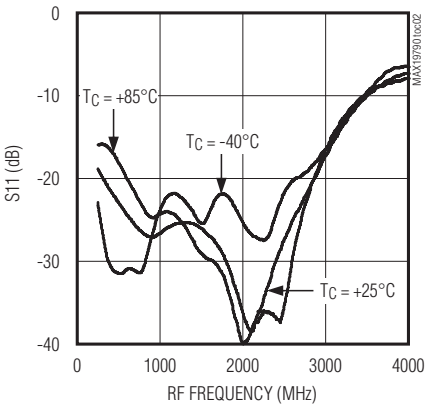
典型工作特性

(*MAX19790 Evaluation Kit*, **two attenuators in cascade**, V_{CC} = +5.0V, P_{RF} = -10dBm, T_C = +25°C, V_{CTRL} = +1.0V, unless otherwise noted.)

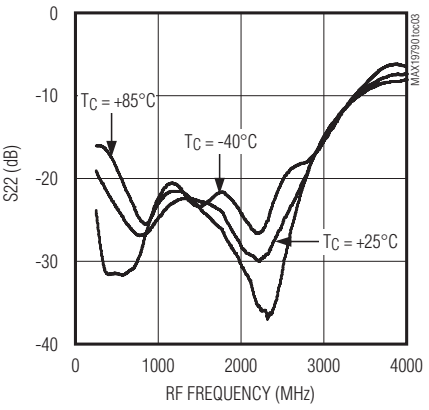
SUPPLY CURRENT vs. V_{CC}



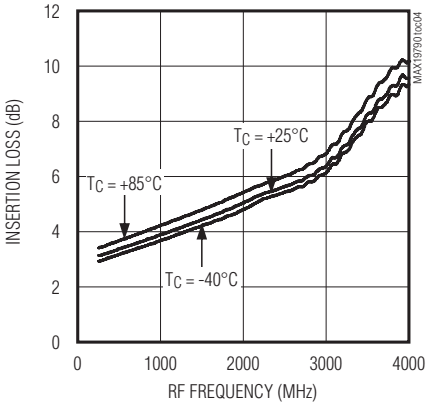
INPUT MATCH vs. RF FREQUENCY



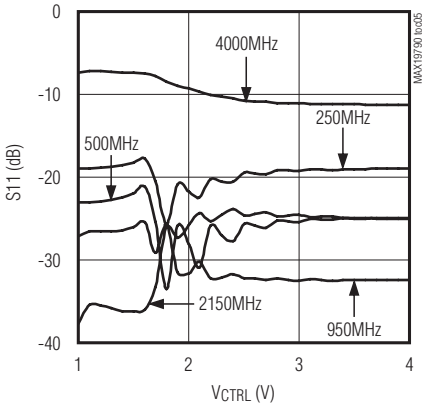
OUTPUT MATCH vs. RF FREQUENCY



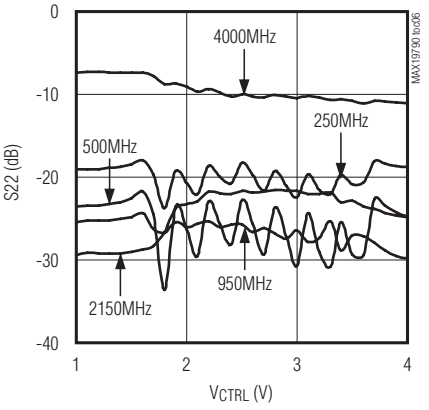
INSERTION LOSS vs. RF FREQUENCY



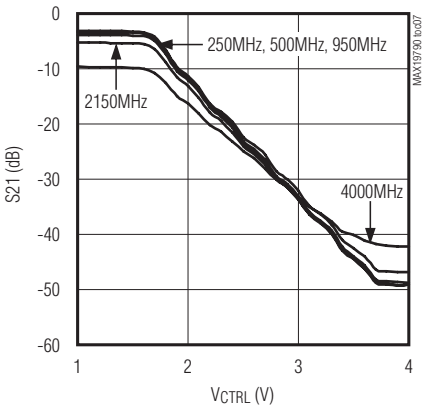
INPUT MATCH vs. V_{CTRL}



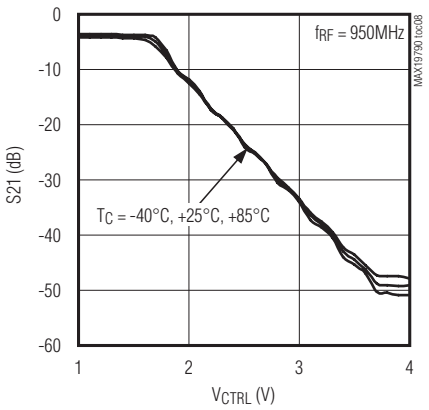
OUTPUT MATCH vs. V_{CTRL}



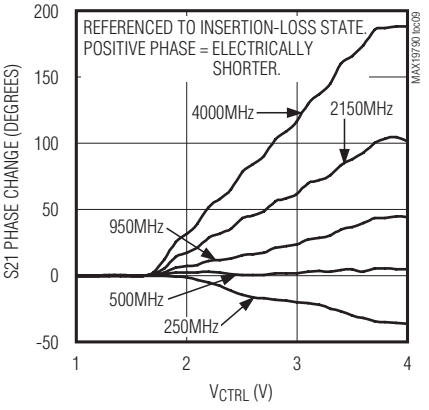
ATTENUATION vs. V_{CTRL}



ATTENUATION vs. V_{CTRL}



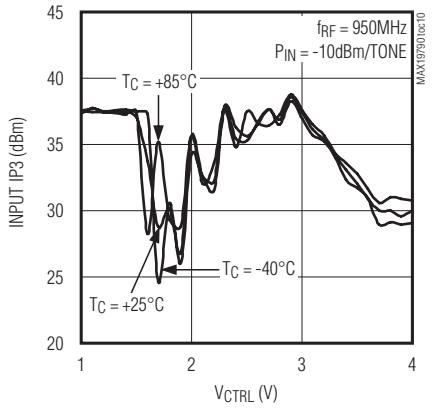
S21 PHASE CHANGE vs. V_{CTRL}



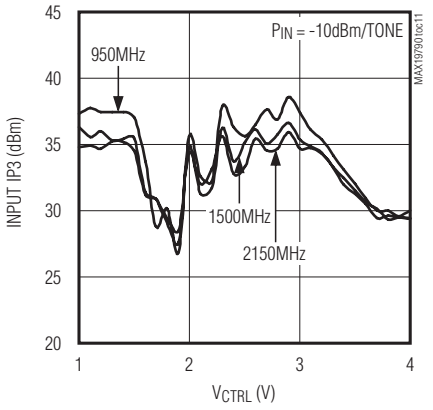
典型工作特性(续)

(*MAX19790 Evaluation Kit*, **two attenuators in cascade**, V_{CC} = +5.0V, P_{RF} = -10dBm, T_C = +25°C, V_{CTRL} = +1.0V, unless otherwise noted.)

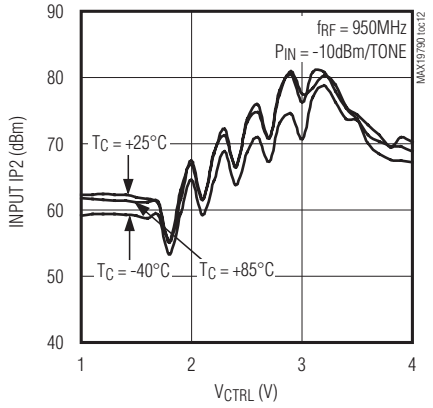
INPUT IP3 vs. V_{CTRL}



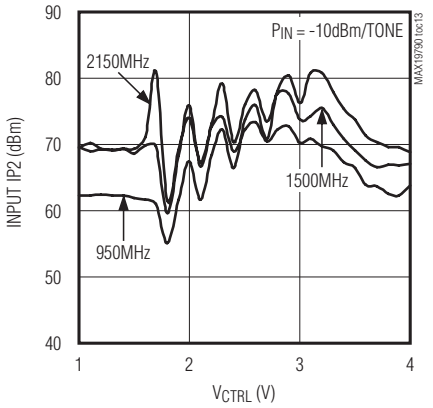
INPUT IP3 vs. V_{CTRL}



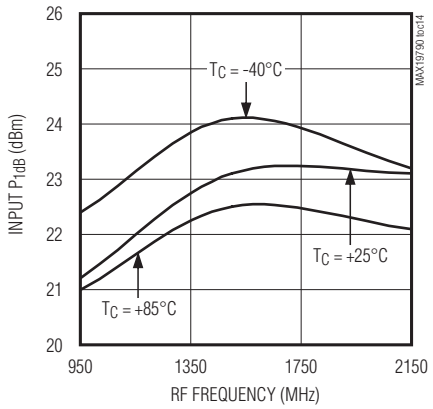
INPUT IP2 vs. V_{CTRL}



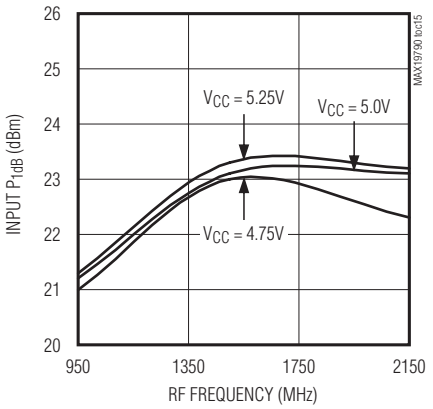
INPUT IP2 vs. V_{CTRL}



INPUT P_{1dB} vs. RF FREQUENCY



INPUT P_{1dB} vs. RF FREQUENCY

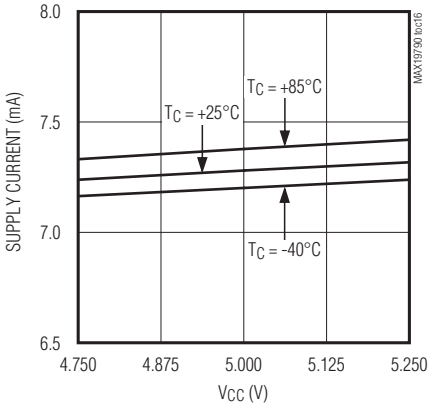


250MHz至4000MHz、双通道、可变电压模拟衰减器

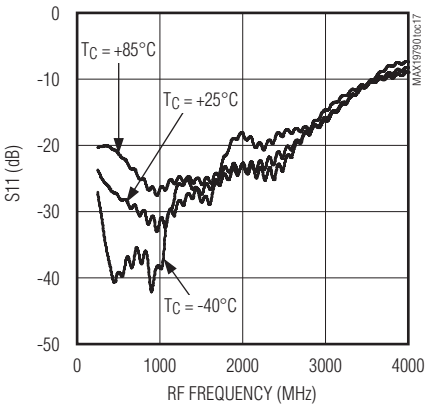
典型工作特性(续)

(*MAX19790 Evaluation Kit*, **one attenuator connected**, V_{CC} = +5.0V, P_{RF} = -10dBm, T_C = +25°C, V_{CTRL} = +1.0V, unless otherwise noted.)

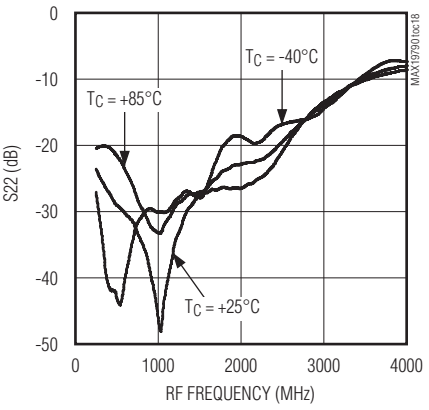
SUPPLY CURRENT vs. V_{CC}



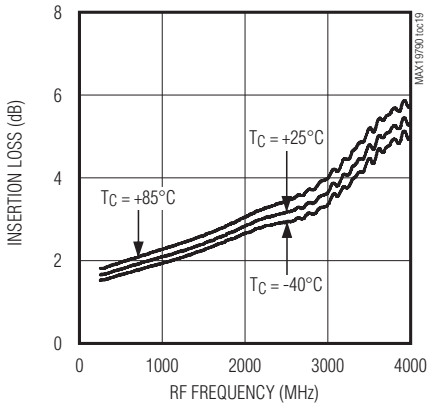
INPUT MATCH vs. RF FREQUENCY



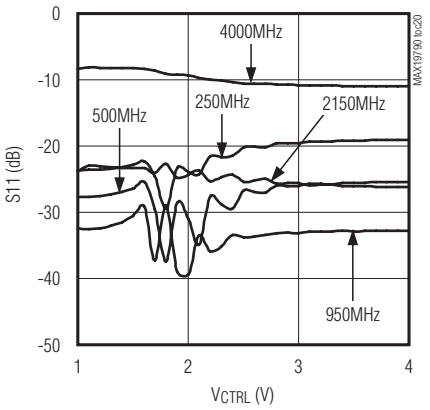
OUTPUT MATCH vs. RF FREQUENCY



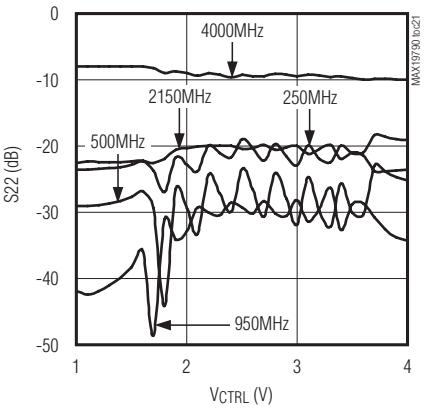
INSERTION LOSS vs. RF FREQUENCY



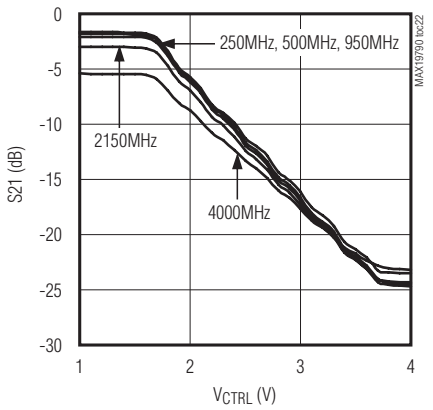
INPUT MATCH vs. V_{CTRL}



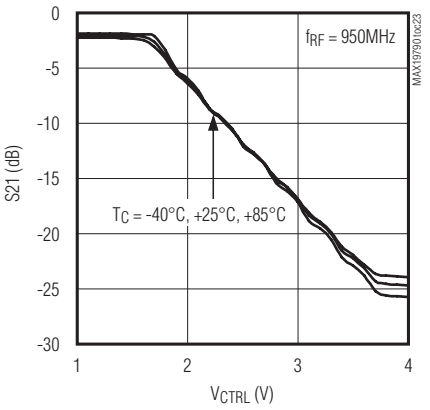
OUTPUT MATCH vs. V_{CTRL}



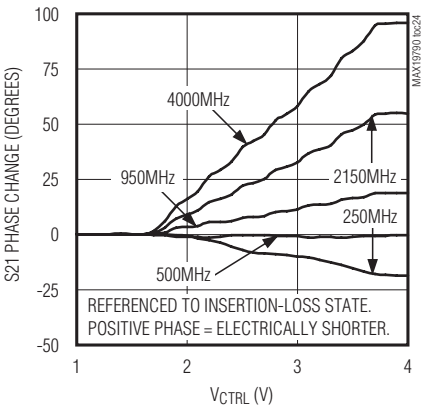
ATTENUATION vs. V_{CTRL}



ATTENUATION vs. V_{CTRL}



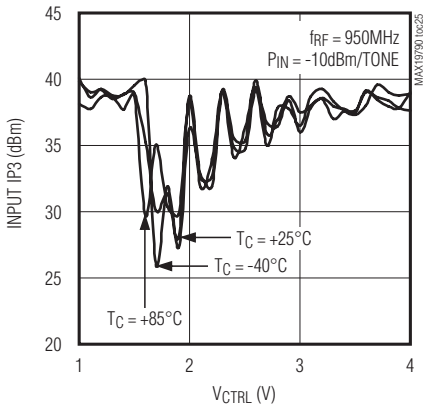
S21 PHASE CHANGE vs. V_{CTRL}



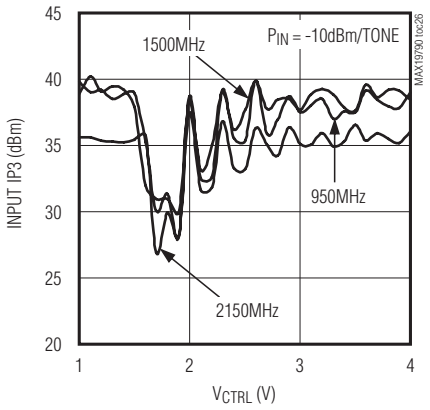
典型工作特性(续)

(*MAX19790 Evaluation Kit*, **one attenuator connected**, V_{CC} = +5.0V, P_{RF} = -10dBm, T_C = +25°C, V_{CTRL} = +1.0V, unless otherwise noted.)

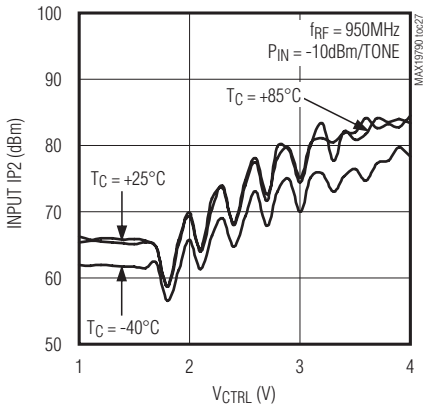
INPUT IP3 vs. V_{CTRL}



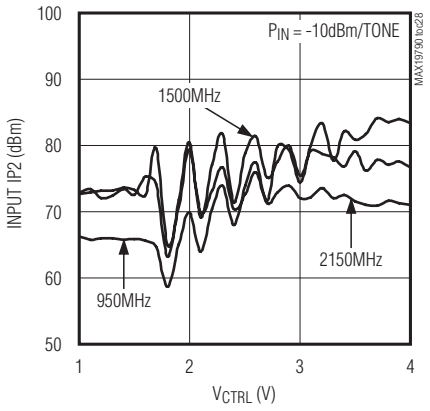
INPUT IP3 vs. V_{CTRL}



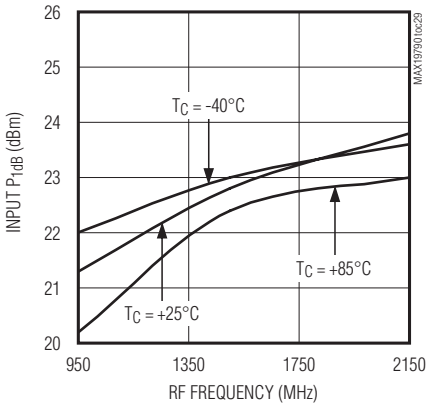
INPUT IP2 vs. V_{CTRL}



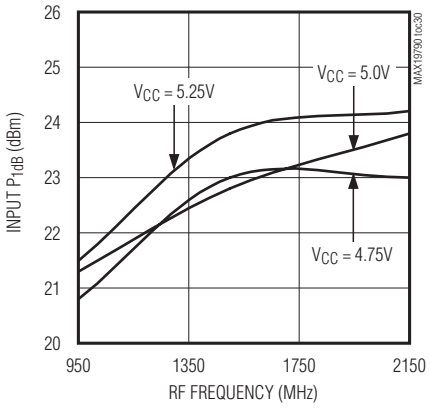
INPUT IP2 vs. V_{CTRL}



INPUT P_{1dB} vs. RF FREQUENCY

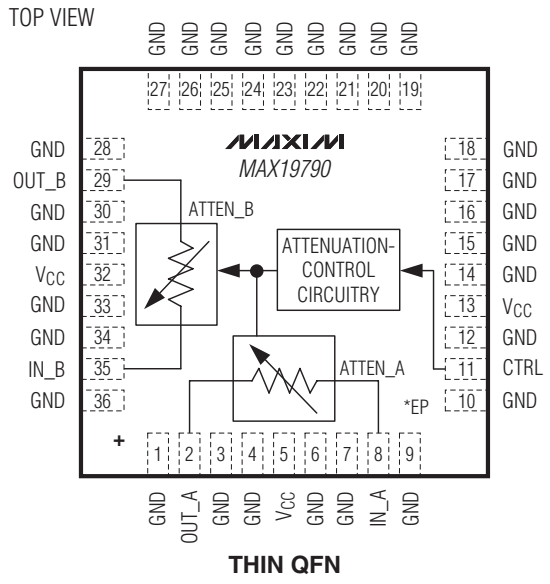


INPUT P_{1dB} vs. RF FREQUENCY



250MHz至4000MHz、双通道、可变电压模拟衰减器

引脚配置/功能框图



引脚说明

引脚	名称	功能
1, 3, 4, 6, 7, 9, 10, 12, 14–28, 30, 31, 33, 34, 36	GND	地，采用低电感布局技术连接至电路板的地平面。
2	OUT_A	衰减器输出A。在工作频率范围内由内部匹配至50Ω。使用该引脚时需要隔直流电容；如果不使用该衰减器，该引脚可以不连接。
5, 13, 32	VCC	电源。通过*典型应用电路*所示的电容和电阻旁路至GND。
8	IN_A	衰减器输入A。在工作频率范围内由内部匹配至50Ω。使用该引脚时需要隔直流电容；如果不使用该衰减器，该引脚可以不连接。
11	CTRL	模拟衰减器控制输入。必须连接V_{CC}，否则应使用限流电阻，如*应用信息*部分所述。接有V_{CC}时，在该引脚施加限制在+1.0V至+4.0V的电压，可确保器件可靠工作。
29	OUT_B	衰减器输出B。在工作频率范围内由内部匹配至50Ω。使用该引脚时需要隔直流电容；如果不使用该衰减器，该引脚可以不连接。
35	IN_B	衰减器输入B。在工作频率范围内由内部匹配至50Ω。使用该引脚时需要隔直流电容；如果不使用该衰减器，该引脚可以不连接。
—	EP	裸焊盘。内部连接至GND，均匀焊接至电路板的地平面以确保正常工作。

详细说明

MAX19790为双路、通用模拟电压可变增益衰减器(VVA)，设计用于工作在250MHz至4000MHz频率范围的50Ω系统。每个衰减器包括一个控制电路，可提供22dB衰减范围，具有10dB/V的线性控制斜率。两路衰减器共用一个共模模拟控制信号，可以级联产生44dB的总动态范围，获得20dB/V的线性控制斜率。

应用信息

模拟衰减控制

CTRL引脚的一路输入电压用于调节器件的衰减，每路衰减器可提供22dB衰减范围。在设置插入损耗时，衰减器的损耗约为2.4dB。

如果需要更大的衰减控制范围，可以串联第二个内部衰减器，提供额外的22dB增益控制范围。

需要注意的是，CTRL引脚同时调节两个片内衰减器。CTRL输入电压驱动高阻负载(> 50kΩ)。未连接V_{CC}的情况下施加控制电压时，建议加一个串联限流电阻，将输入电流限制在40mA以下。大于200Ω的串联电阻能够为+5.0V控制电压范围提供有效保护。**注意：**为确保器件的可靠性，在连接V_{CC}时，应将CTRL输入电压限制在+1.0V至+4.0V范围内。

布局考虑

合理的PCB设计是任何RF/微波电路的一个重要部分。RF信号线应尽可能短，以减小损耗、辐射和电感。为获得最佳性能，接地引脚须直接与封装底部的裸焊盘连接。裸焊盘**必须**通过器件底部的多个过孔连接至电路板的地层，以获得良好的RF和散热路径。将器件封装底部的裸焊盘焊接至PCB。

电源旁路

合理的电源旁路对高频电路的稳定性至关重要。对各V_{CC}引脚使用电容旁路，电容尽可能靠近器件放置，小容值电容距离器件最近。详细信息请参见*典型应用电路*和表1。

表1. 典型应用电路元件值

DESIGNATION	QTY	DESCRIPTION
C1, C3, C5	3	220pF ±5%, 50V C0G ceramic capacitors (0402) Murata GRM1555C1H221J
C2, C4	2	0.01µF ±10%, 25V X7R ceramic capacitors (0402) Murata GRM155R71E103K
C6	1	1000pF ±5%, 50V C0G ceramic capacitor (0402) Murata GRM1555C1H102J
C7	1	0.1µF ±10%, 16V X7R ceramic capacitor (0603) Murata GRM188R71C104K
C8*	0	Not installed, ceramic capacitor (0603)
C9	1	22pF ±5%, 50V C0G ceramic capacitor (0402) Murata GRM1555C1H220J
R1, R2	2	10Ω ±5% resistors (0402) Any
R3, R4	2	0Ω resistors (0402) **Note:** In cases where V_{CTRL} is applied before or removed after V_{CC}, use R4 = 200Ω.
U1	1	Analog attenuator IC Maxim MAX19790ETX+ **Note:** U1 has an exposed pad conductor, which requires it to be solder-attached to a grounded pad on the PCB to ensure a proper electrical/thermal design.

**C8可以提供附加的滤波功能，该电容可以延缓响应时间，具体取决于CTRL引脚处的外部驱动器。*

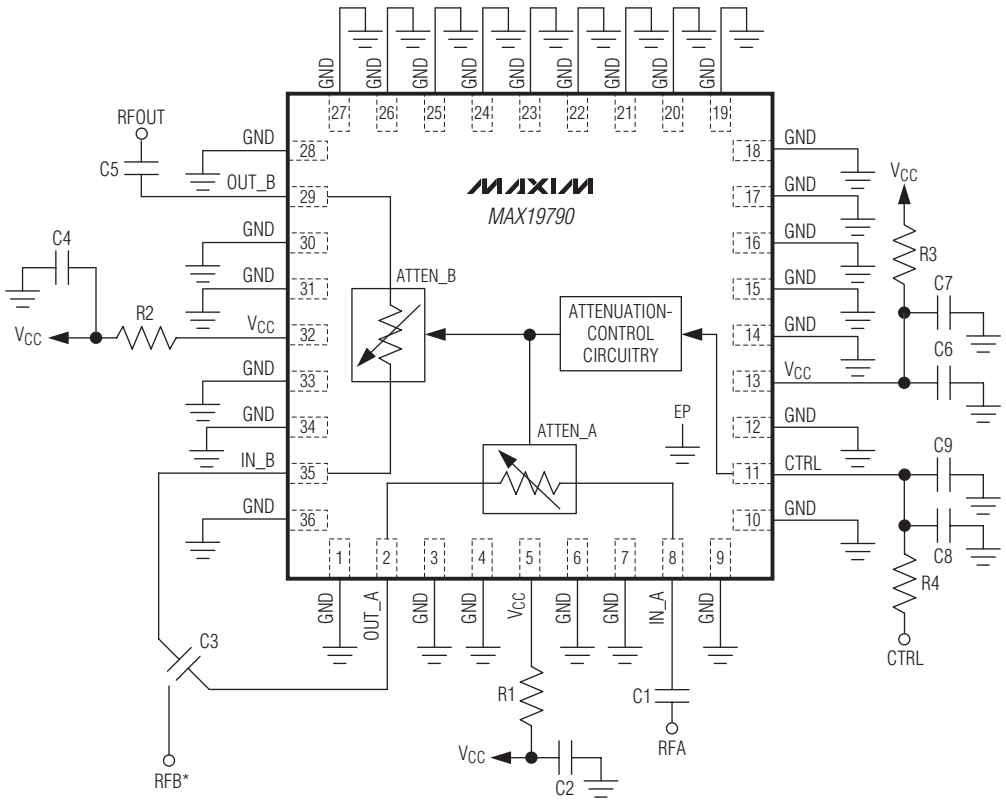
250MHz至4000MHz、双通道、可变电压模拟衰减器

裸焊盘的RF和散热考虑

该器件采用36引脚、薄型QFN封装，其裸焊盘(EP)提供了一个与管芯之间的低热阻通路。在安装IC的PCB与该节点之间保持良好的热传递通道非常重要。此外，EP应通过一个低电感RF路径接地。

EP**必须**直接或通过一系列电镀过孔焊接至PCB的地层。将裸焊盘焊接至地对于有效散热同样重要，尽可能使用连续的地层。

典型应用电路



*SCHEMATIC SHOWS CONFIGURATION FOR TWO CASCADED ATTENUATORS. TO USE ATTENUATOR A ONLY MOVE C3 TO CONNECT OUT_A TO RFB. TO USE ATTENUATOR B ONLY MOVE C3 TO CONNECT RFB TO IN_B.

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，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	文档编号
36引脚薄型QFN-EP	T3666+2	**21-0141**

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