19-6714; Rev 1; 10/13

MAX14777

四通道、-15V至+35V 超摆幅模拟开关

概述

MAX14777八通道SPST开关支持超摆幅模拟信号切换，采用3.0V至5.5V单电源供电。器件开关可选择-15V/+35V或-15V/+15V模拟信号范围。每路开关具有独立的控制输入，允许独立切换，可替代无需电气隔离的光继电器。

IC的导通电阻为10Ω (最大值)，9mΩ (典型值)R_{ON}平坦度，导通漏电流低至50nA (+85°C时的最大值)。为最大程度地保证信号完整性，器件在整个共模电压范围内维持这一性能。每路开关在各方向均可承载高达60mA (最大值)的连续电流。

MAX14777采用20引脚(4mm x 4mm) TQFN封装，工作在-40°C至+105°C温度范围。

应用

- 工业测量系统
- 仪表系统
- 4–20mA开关
- ATE系统

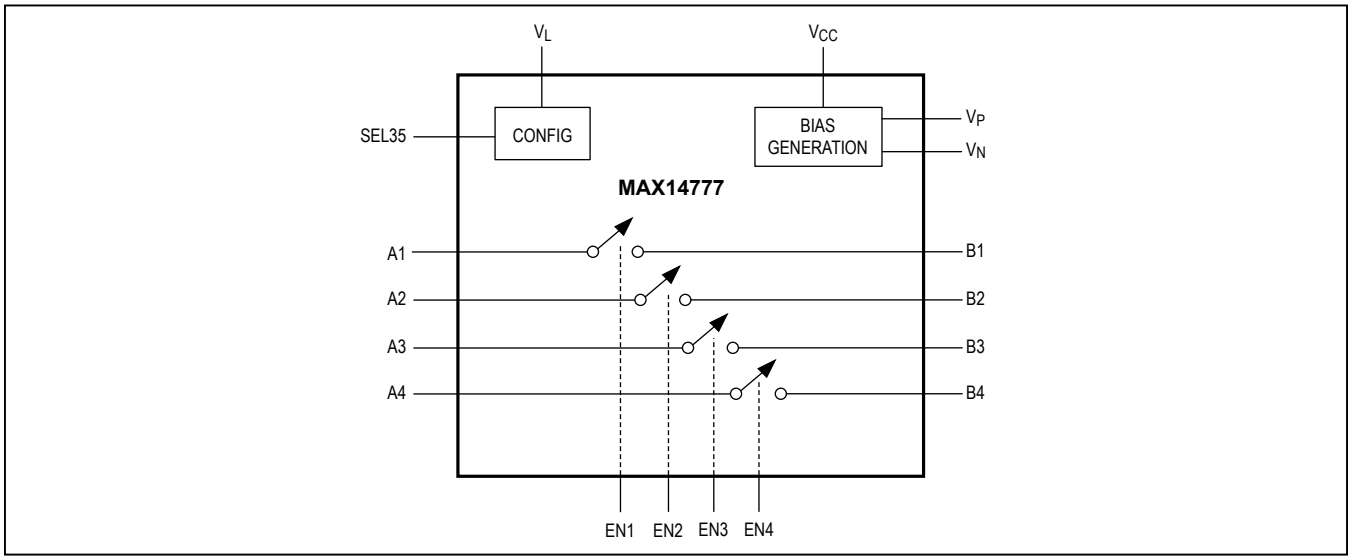
优势和特性

- 简单灵活的电路板设计
  - 采用3.0V至5.5V单电源供电，可处理-15V/+35V超摆幅(Beyond-the-Rails™)信号范围
  - 可选择-15V/+15V信号范围以降低电流损耗
  - 每路开关允许通过最大60mA电流
  - 1.62V至5.5V逻辑接口
- 高性能10Ω R_{ON} (最大值)
- 150mΩ (最大值)R_{ON}平坦度
- T_A = +85°C时，导通漏流为±50nA (最大值)
- 节省电路板面积
  - 小尺寸20引脚TQFN封装(4mm x 4mm)
- -40°C至+105°C工作温度范围

Beyond-the-Rails是Maxim Integrated Products, Inc.的注册商标。

定购信息在数据资料的最后给出。

功能框图



相关型号以及配合该器件使用的推荐产品，请参见：china.maximintegrated.com/MAX14777.related。

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.maximintegrated.com。

Absolute Maximum Ratings

(All voltages referenced to GND, unless otherwise noted.)

V_{CC} ..... -0.3V to +6V
V_L ..... -0.3V to +6V
EN1, EN2, EN3, EN4, SEL35, I.C. ..... -0.3V to +6V
A1, A2, A3, A4, B1, B2, B3, B4 ..... (V_N - 0.3V) to the lesser of (V_P + 0.3V) and (V_N + 70V)
V_P
  SEL35 = High ..... -0.3V to +70V
  SEL35 = Low ..... -0.3V to +48V
V_P to V_N ..... -0.3V to +70V
V_N ..... the greater of -26V and (V_P - 70V) to +0.3V
Absolute Difference Between Switch I/Os (| A_ - B_ |) 70V
Continuous Current ..... ±80mA
Continuous Power Dissipation (T_A = +70°C) .....
  TQFN (derate 25.6mW/°C above +70°C) 2051.3mW
Operating Temperature Range ..... -40ºC to +105ºC
Junction Temperature ..... +150ºC
Storage Temperature Range ..... -65ºC to +150°C
Lead Temperature (soldering, 10s) ..... +300°C
Soldering Temperature (reflow) ..... +260°C

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

Package Thermal Characteristics (Note 1)

Junction-to-Ambient Thermal Resistance (θ_{JA})
  TQFN ..... 39°C/W
Junction-to-Case Thermal Resistance (θ_{JC})
  TQFN ..... 6°C/W

Note 1: Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to **china.maximintegrated.com/thermal-tutorial**.

Electrical Characteristics

(V_{CC} = 3.0V to 5.5V, V_L = 3.3V, T_A = -40°C to +105°C, unless otherwise noted. Typical values are at V_{CC} = 5V and T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
DC CHARACTERISTICS							
Supply Voltage Range	V_{CC}			3.0		5.5	V
V_L Supply Voltage Range	V_L			1.62		5.5	V
V_{CC} Supply Current	I_{CC}	V_{CC} = 3.3V, $V_{EN_}$ = V_L	SEL35 = low		1.8	3.4	mA
			SEL35 = high		2.2	4.3	
		V_{CC} = 5.5V, $V_{EN_}$ = V_L	SEL35 = low		0.6	1.2	
			SEL35 = high		0.8	1.65	
V_L Supply Current	I_L	SEL35, EN_ = low or high		-1		+1	µA
Analog Signal Range	$V_{A_}$,$V_{B_}$	SEL35 = low		-15		+15	V
		SEL35 = high		-15		+35	
Positive High-Voltage Charge-Pump Output (Note 3)	V_P	SEL35 = low		22.5		27.1	V
		SEL35 = high		41.7		49.8	
Negative High-Voltage Charge-Pump Output	V_N	(Note 3)		-18.2		-14.9	V
Continuous Current Through Switch	$I_{A_}$	EN_ = high		-60		+60	mA

Electrical Characteristics (continued)

(V_{CC} = 3.0V to 5.5V, V_L = 3.3V, T_A = -40°C to +105°C, unless otherwise noted. Typical values are at V_{CC} = 5V and T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
On-Resistance, Figure 1	R_{ON}	-15V ≤ $V_{A_}$ ≤ +35V, SEL35 = high, I_{IN} = ±60mA, Figure 1		4.4	10	Ω
		-15V ≤ $V_{A_}$ ≤ +15V, SEL35 = low, I_{IN} = ±60mA, Figure 1		4.4	10	
On-Resistance Flatness	ΔR_{ON}	-15V ≤ $V_{A_}$ ≤ +35V, SEL35 = high, I_{IN} = ±60mA		9	150	mΩ
		-15V ≤ $V_{A_}$ ≤ +15V, SEL35 = low, I_{IN} = ±60mA		8	150	
On-Resistance Matching Between Channels	ΔR_{ON_M}	-15V ≤ $V_{A_}$ ≤ +35V, SEL35 = high, I_{IN} = ±60mA, (Note 4)			200	mΩ
		-15V ≤ $V_{A_}$ ≤ +15V, SEL35 = low, I_{IN} = ±60mA, (Note 4)			200	
A_ Off-Leakage Current	$I_{L_OFF_A}$	-15V ≤ $V_{A_}$ ≤ +35V, SEL35 = high, $V_{B_}$ = 0V, +40°C ≤ T_A ≤ +85°C, Figure 2	-20		+20	nA
		-15V ≤ $V_{A_}$ ≤ +35V, SEL35 = high, $V_{B_}$ = 0V, +40°C ≤ T_A ≤ +105°C, Figure 2	-80		+80	
B_ Off-Leakage Current	$I_{L_OFF_B}$	-15V ≤ $V_{B_}$ ≤ +35V, SEL35 = high, $V_{A_}$ = 0V, +40°C ≤ T_A ≤ +85°C, Figure 2	-20		+20	nA
		-15V ≤ $V_{B_}$ ≤ +35V, SEL35 = high, $V_{A_}$ = 0V, +40°C ≤ T_A ≤ +105°C, Figure 2	-80		+80	
On-Leakage Current	I_{L_ON}	-15V ≤ $V_{A_}$ ≤ +35V, SEL35 = high, B_ unconnected, +40°C ≤ T_A ≤ +85°C, Figure 2	-50		+50	nA
		-15V ≤ $V_{A_}$ ≤ +35V, SEL35 = high, B_ unconnected, +40°C ≤ T_A ≤ +105°C, Figure 2	-200		+200	
A_ Power-Off Leakage Current	$I_{L_PWROFF_A}$	$V_{CC_}$ = 0V or unconnected, $\|V_{A_} - V_{B_}\|$ > 3V, current measured at A; -15V ≤ $V_{A_}$ ≤ +35V	-5		+5	μA
B_ Power-Off Leakage Current	$I_{L_PWROFF_B}$	$V_{CC_}$ = 0V or unconnected, $\|V_{A_} - V_{B_}\|$ > 3V, current measured at B; -15V ≤ $V_{A_}$ ≤ +35V	-5		+5	μA
DIGITAL LOGIC (EN1, EN2, EN3, EN4, SEL35)						
Input Voltage Low	V_{IL}				0.3 x V_L	V
Input Voltage High	V_{IH}		0.7 x V_L			V
Input Leakage Current	I_{DLKG}	$V_{EN_}$ = low or high	-1		+1	μA

Electrical Characteristics (continued)

(V_{CC} = 3.0V to 5.5V, V_L = 3.3V, T_A = -40°C to +105°C, unless otherwise noted. Typical values are at V_{CC} = 5V and T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
AC CHARACTERISTICS							
Power-Up Time	t_{PWRON}	C_{VP} = C_{VN} = 10nF (Note 6)			5		ms
Enable Turn-On Time	t_{ON}	$V_{A_}$ = ±10V, SEL35 = low, R_L = 10kΩ, Figure 3				40	µs
		$V_{A_}$ = ±10V, SEL35 = high, R_L = 10kΩ, Figure 3				40	
Enable Turn-Off Time	t_{OFF}	$V_{A_}$ = ±10V, R_L = 10kΩ, Figure 3 (Note 5)				100	µs
Off-Isolation	V_{ISO}	$V_{A_}$ = 1V_{RMS}, f = 100kHz, R_L = 50Ω, C_L = 15pF, Figure 4	V_{CC} = 3V to 5.5V		-88		dB
			V_{CC} = 0V or unconnected		-66		
Crosstalk	V_{CT}	$V_{A_}$ = 1V_{RMS}, f = 100kHz, R_S = R_L = 50Ω, Figure 5	V_{CC} = 3V to 5.5V		-101		dB
			V_{CC} = 0V or unconnected		-93		
-3dB Bandwidth	BW	$V_{A_}$ = 1V_{P-P}, R_S = R_L = 50Ω, Figure 6			380		MHz
Total Harmonic Distortion	THD+N	R_S = R_L = 1kΩ, f = 20Hz to 20kHz			0.038		%
Charge Injection	Q	$V_{A_}$ = GND, C_L = 1nF, Figure 7			225		pC
Input Capacitance	C_{ON}	A_, B_ pins, f = 1MHz			16		pF
	C_{OFF}	At A_ when B_ = GND, or at B_ when A_ = GND, f = 1MHz			12		pF
THERMAL SHUTDOWN							
Thermal Shutdown Threshold	T_{SHDN}	Temperature rising			160		°C
Thermal Shutdown Hysteresis	T_{HYST}				32		°C
ESD PROTECTION							
All Pins		Human Body Model			±2		kV

Note 2: All units are 100% production tested at +85°C. Specifications over temperature are guaranteed by design.
Note 3: Do not use V_P or V_N to power external circuitry.
Note 4: Tested at -1V, guaranteed by design for -15V ≤ $V_{A_}$ ≤ +35V.
Note 5: This parameter does not depend on the status of SEL35.
Note 6: Power-up time is the time needed of V_P and V_N to reach steady-state values.

测试电路/时序图

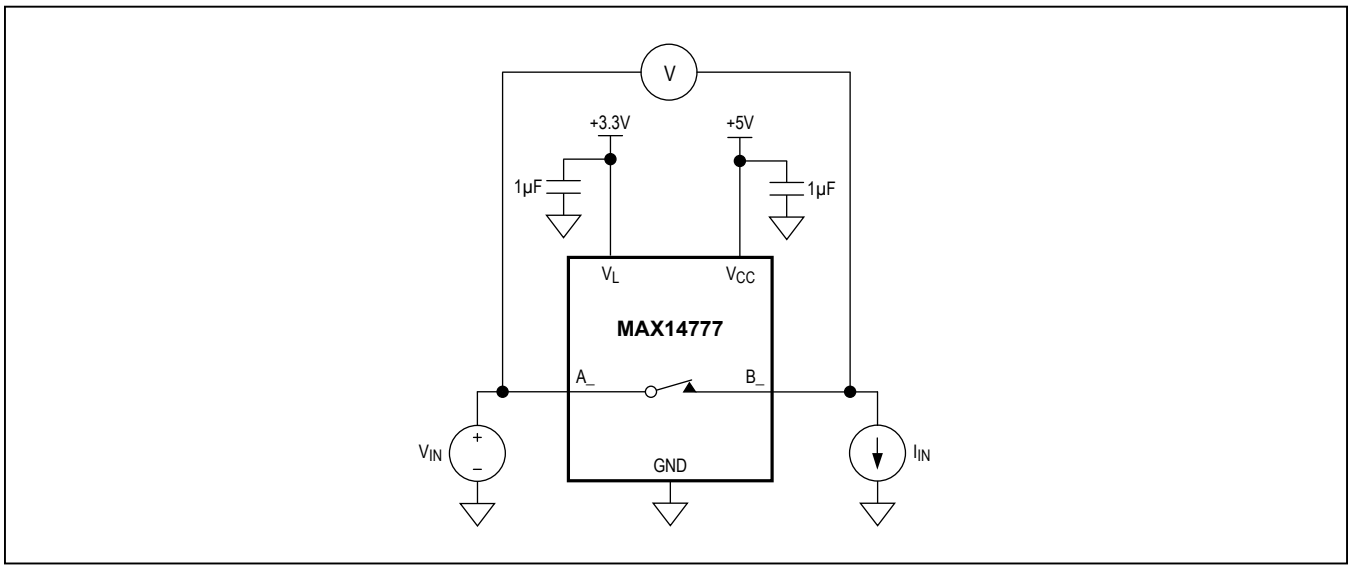


图1. 导通电阻测量

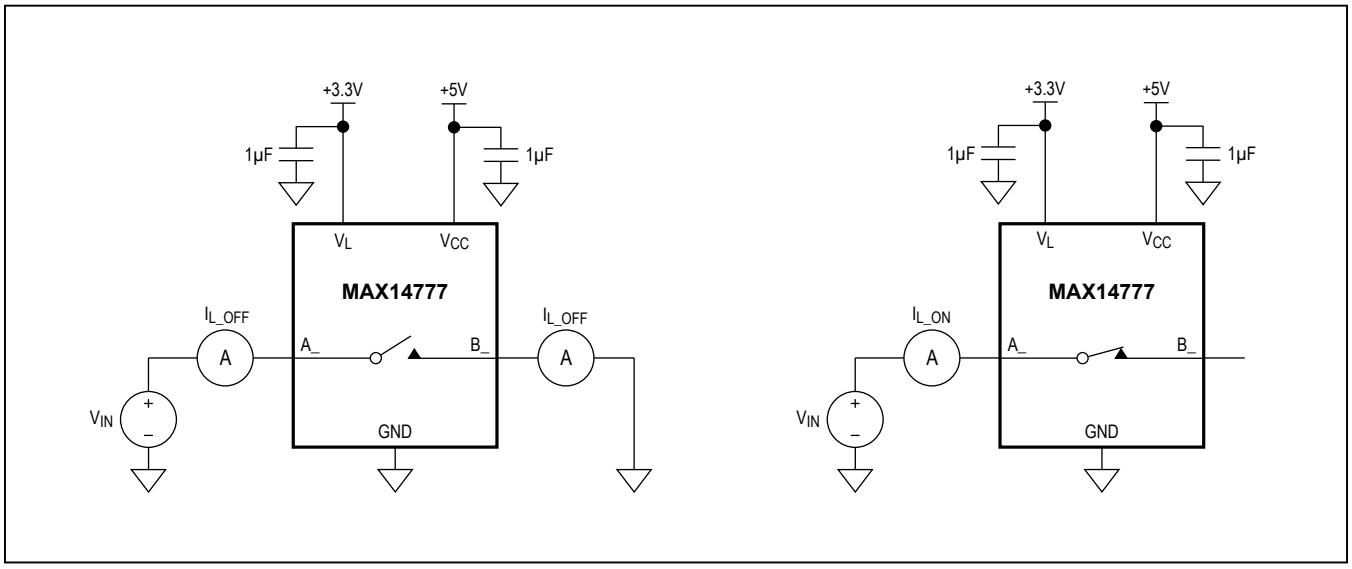


图2. 漏电流测量

测试电路/时序图(续)

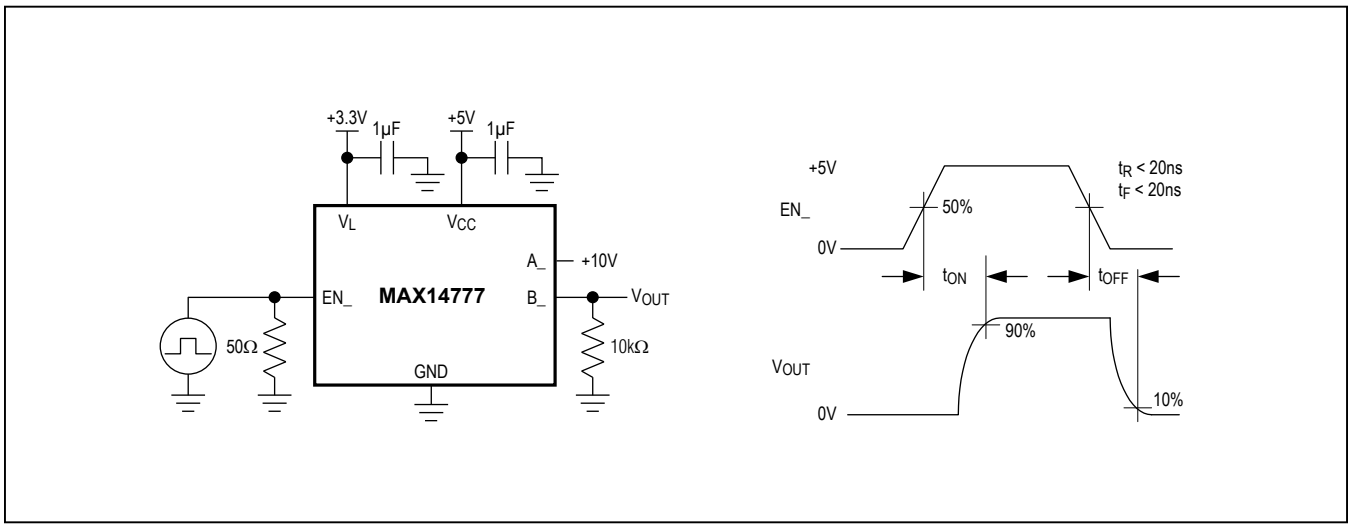


图3. 使能开关时间

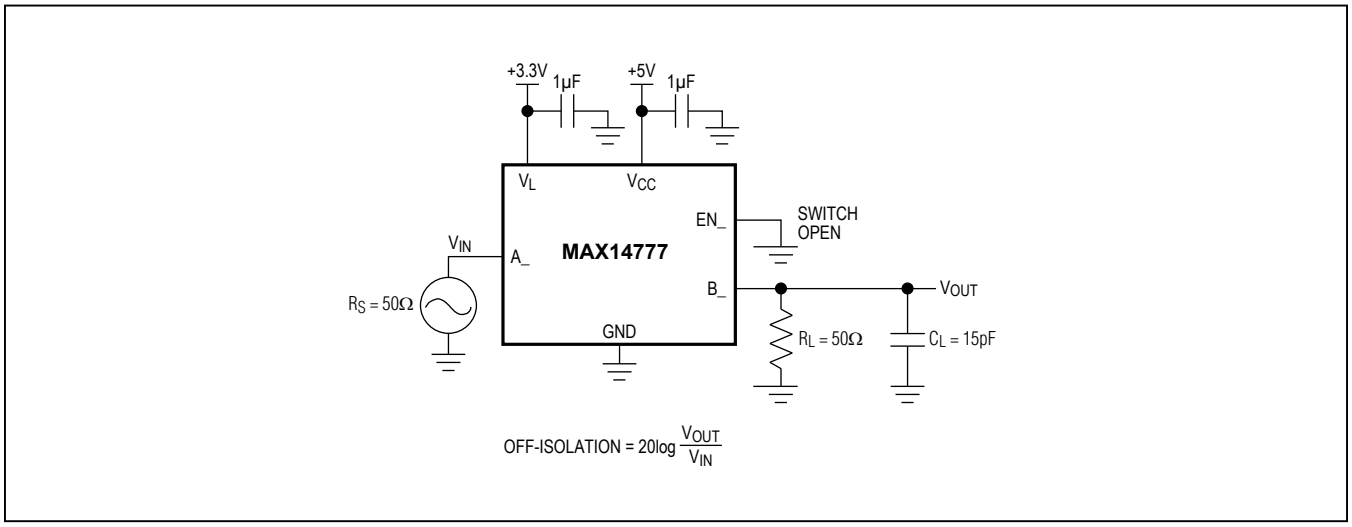


图4. 关断隔离

测试电路/时序图(续)

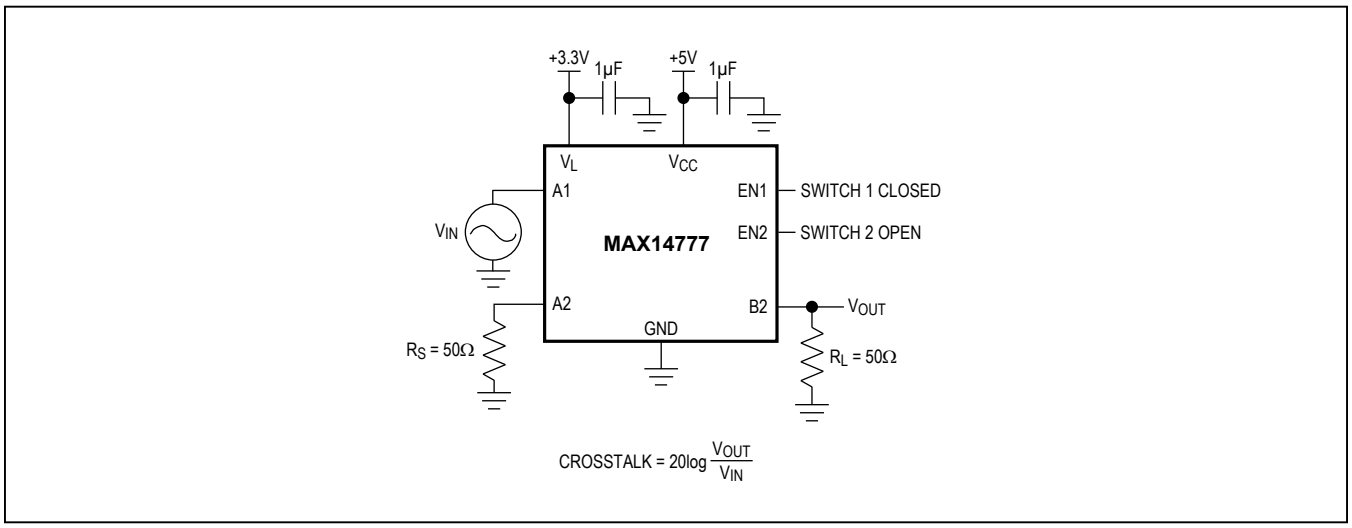


图5. 串扰

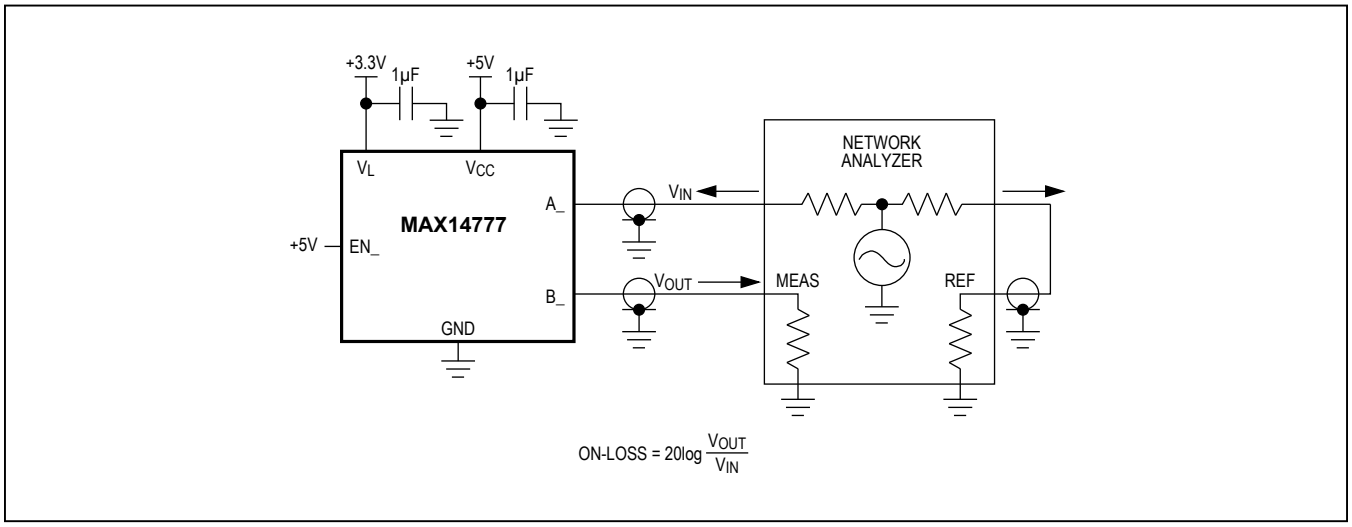


图6. 频率响应

测试电路/时序图(续)

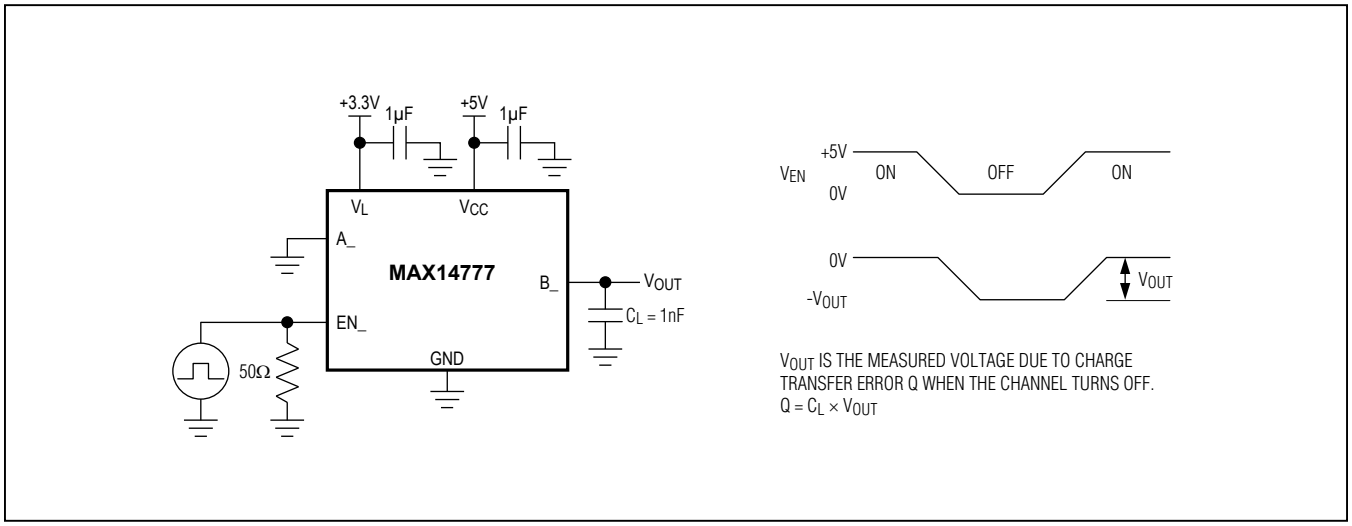
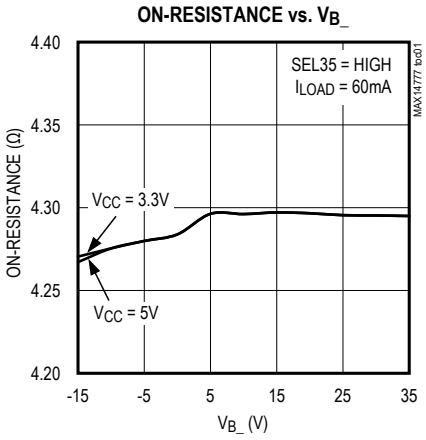
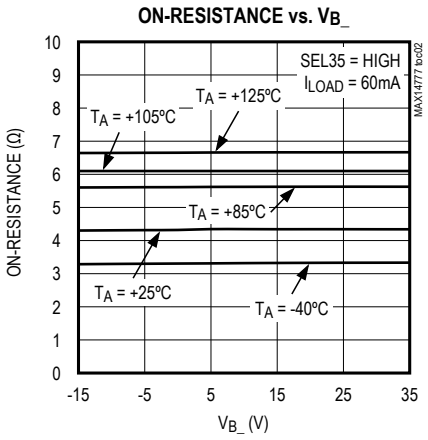


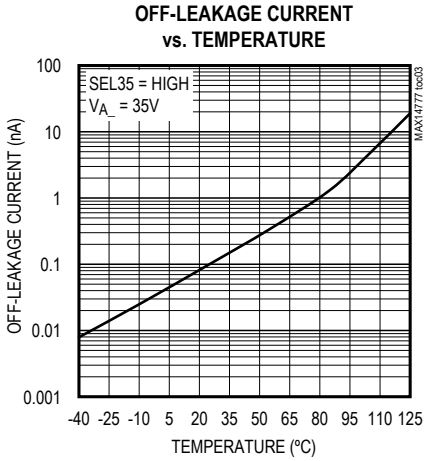
图7. 电荷注入

典型工作特性

(V_{CC} = 5V, V_L = 3.3V, T_A = +25°C, unless otherwise noted.)



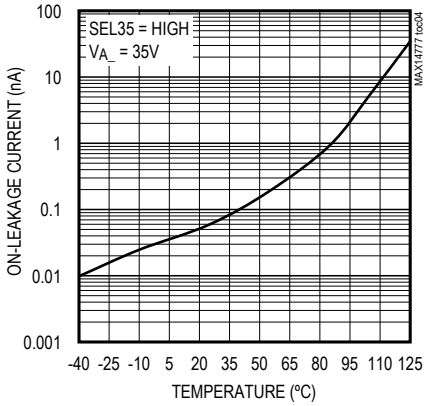




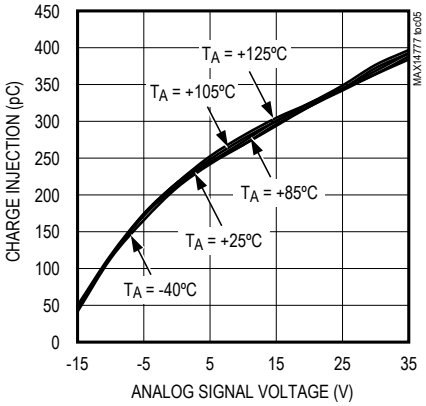
典型工作特性(续)

(V_{CC} = 5V, V_L = 3.3V, T_A = +25°C, unless otherwise noted.)

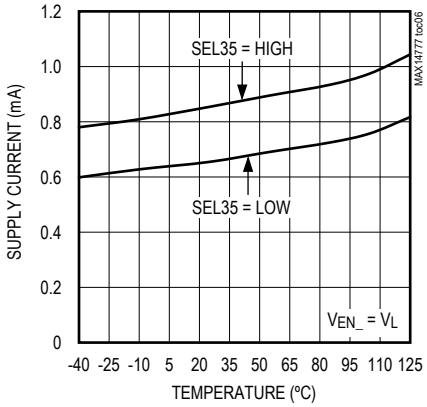
OFF-LEAKAGE CURRENT vs. TEMPERATURE



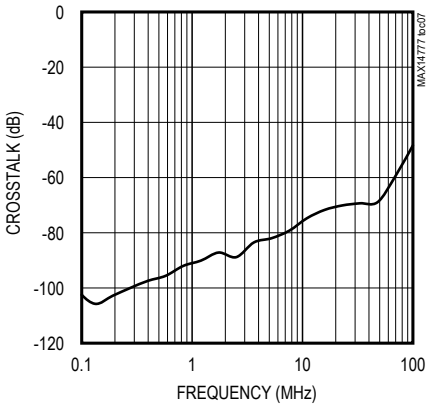
CHARGE INJECTION vs. ANALOG SIGNAL VOLTAGE



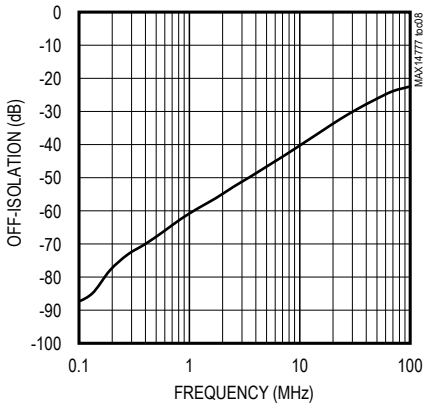
SUPPLY CURRENT vs. TEMPERATURE



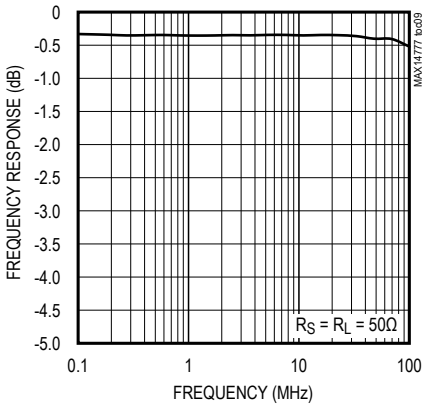
CROSSTALK vs. FREQUENCY



OFF-ISOLATION vs. FREQUENCY

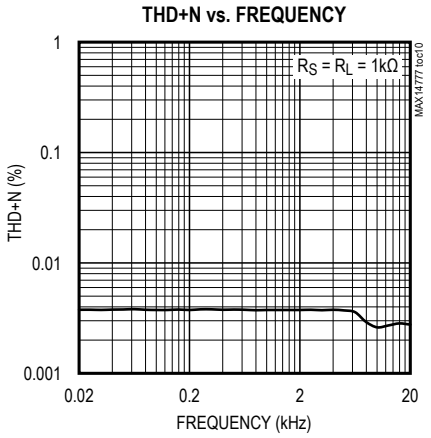


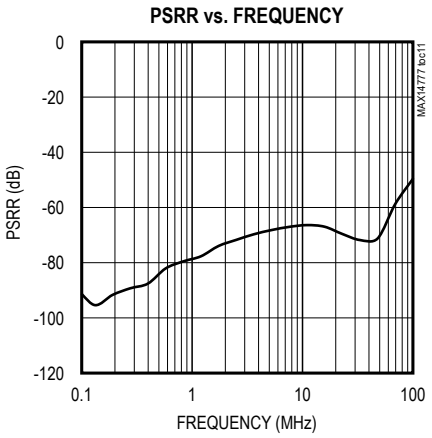
FREQUENCY RESPONSE

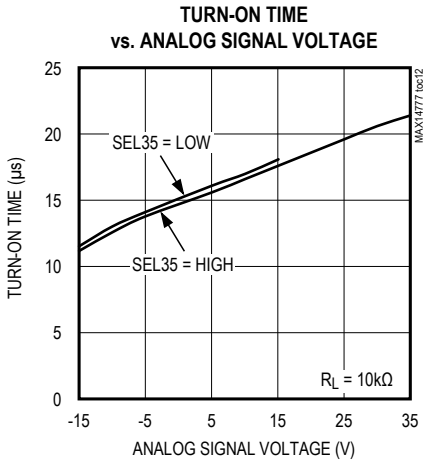


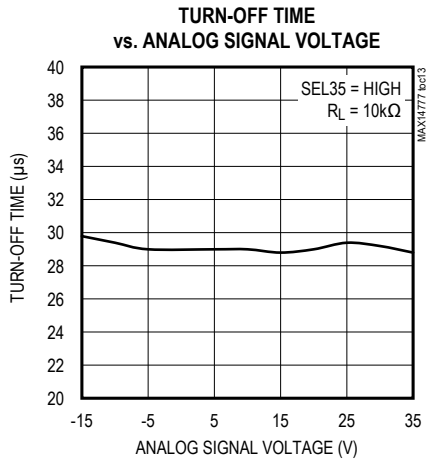
典型工作特性(续)

(V_{CC} = 5V, V_L = 3.3V, T_A = +25°C, unless otherwise noted.)

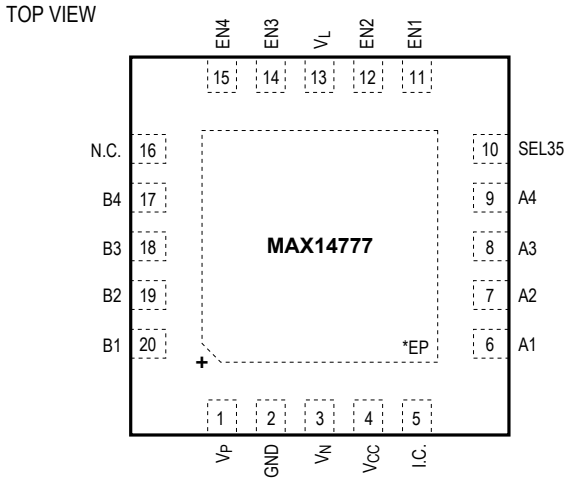








引脚配置



TQFN
4mm x 4mm

*EP = EXPOSED PAD. CONNECT EP TO V_N.

引脚说明

引脚	名称	功能
1	V_P	电荷泵输出正端。对于输入范围为±15V (SEL35 = 低电平)的应用，利用10nF、50V电容将V_P旁路至GND；对于输入范围为-15V/+35V (SEL 35 = 高电平)的应用，使用100V电容旁路，电容尽量靠近器件放置。
2	GND	地。
3	V_N	电荷泵输出负端。利用10nF电容将V_N旁路至GND，电容尽量靠近器件放置。
4	V_{CC}	电源输入。利用1µF陶瓷电容将V_{CC}旁路至GND，电容尽量靠近器件放置。
5	I.C.	内部连接，连接至GND。
6	A1	模拟开关1的A端。EN1为低电平时，开关1为开路。
7	A2	模拟开关2的A端。EN2为低电平时，开关2为开路。
8	A3	模拟开关3的A端。EN3为低电平时，开关3为开路。
9	A4	模拟开关4的A端。EN4为低电平时，开关4为开路。
10	SEL35	模拟信号范围选择输入。SEL35为低电平时，使能-15V/+15V模拟信号范围；SEL35为高电平时，使能-15V/+35V模拟信号范围。
11	EN1	开关1控制输入。EN1为高电平时，开关1闭合；EN1为低电平时，开关1开路。

引脚说明(续)

引脚	名称	功能
12	EN2	开关2控制输入。EN2为高电平时，开关2闭合；EN2为低电平时，开关2开路。
13	V_L	逻辑接口基准电源输入。利用1µF陶瓷电容将V_L旁路至GND。
14	EN3	开关3控制输入。EN3为高电平时，开关3闭合；EN3为低电平时，开关3开路。
15	EN4	开关4控制输入。EN4为高电平时，开关4闭合；EN4为低电平时，开关4开路。
16	N.C.	无连接，无内部连接。
17	B4	模拟开关4的B端。EN4为低电平时，开关4为开路。
18	B3	模拟开关3的B端。EN3为低电平时，开关3为开路。
19	B2	模拟开关2的B端。EN2为低电平时，开关2为开路。
20	B1	模拟开关1的B端。EN1为低电平时，开关1为开路。
—	EP	裸焊盘。将EP连接至V_N，请勿连接至地。EP不作为电气连接点。

详细说明

MAX14777八通道SPST开关支持超摆幅模拟信号切换，采用3.0V至5.5V单电源供电。SEL35引脚为高电平时，器件的所有开关通路可处理的模拟信号范围高达-15V/+35V；SEL35引脚为低电平时，模拟信号范围降至-15V/+15V，这种情况下的V_{CC}电源电流也较低。SEL35引脚需要在高边模拟信号范围与供电电流之间进行折中。每路开关具有独立的控制输入，允许独立切换。

MAX14777的导通电阻为10Ω (最大值)，9mΩ (典型值)R_{ON}平坦度，导通漏电流低至50nA (+85°C时的最大值)。为最大程度地保证信号完整性，IC在整个共模电压范围内维持这一性能。每路开关的各方向可承载高达60mA (最大值)的连续电流。

内部偏压

MAX14777内部共包含三个电荷泵，为内部开关产生偏压：5V稳压电荷泵、正高压电荷泵(V_P)和负高压电荷泵(V_N)。V_{CC}高于4.75V (典型值)时，旁路5V电荷泵，V_{CC}为高压电荷泵提供输入，降低总体的电源电流。

V_N电压始终为-16V (典型值)，但MAX14777具有引脚可选(SEL35)的模拟信号高压范围。SEL35输入为低电平时，V_P电压为+26V (典型值)，模拟信号范围为-15V/+15V；SEL35输入为高电平时，V_P电压为+46V (典型值)，模拟信号范围扩展至-15V/+35V。

V_P/V_N和GND之间，每个高压电荷泵需要一个外部10nF电容。在V_N上使用50V额定值的电容。如果SEL35为低电平，V_P上使用50V电容；如果SEL35为高电平，使用100V电容。不要利用V_P或V_N为外部电路供电。

模拟信号电平

MAX14777内置偏压电路，采用3.0V至5.5V单电源供电支持超摆幅信号切换。模拟信号范围利用SEL35输入引脚进行选择。SEL35为低电平时，信号范围为-15V至+15V；SEL35为高电平时，信号范围为-15V至+35V。

将SEL35设置为低电平时，减小导通延迟和V_{CC}供电电流。

模拟信号为-15V至+35V时，MAX14777的导通电阻为10Ω (最大值)，9mΩ (典型值)R_{ON}平坦度。开关上可双向流通电流。

V_L电源逻辑输入

MAX14777具有独立的逻辑电源输入(V_L)，设置逻辑输入(EN_和SEL35)电平的上限和下限，这一特性使得器件能够灵活连接到逻辑电平不同于V_{CC}的控制器。将V_L连接至1.62V至5.5V的电压，以正常工作。

应用信息

无供电条件

为了理解没有供电(即V_{CC} = 0V)条件下的MAX14777特性，应考虑瞬态及直流信号条件。每个A_和B_引脚具有连接至V_P和V_N的内部二极管，如图8所示。在A_或B_上加正电压时，通过连接至V_P的二极管对V_P电容充电；在A_或B_上加负电压时，通过连接至V_N的二极管对V_N电容充电，器件没有供电电源时，即V_{CC} = 0或V_{CC}浮空时，开关端子A_、B_可承受-15V至+35V高压信号。

电容充电至直流电压时，产生IL_IO_OFF电流。因此，瞬态条件下，向A_或B_引脚加充电电压时，由于V_P和V_N上外部电容的电荷运动，造成电流流入或流出引脚。

直流条件下，向A_或B_引脚施加电压时，如果V_{CC}未加电，当A_和B_引脚之间的电压差大于3V时，开关开路。在这些条件下，直流漏电流流入引脚。当$|V_A - V_B| < 3V$直流时，开关不完全开路，A_和B_引脚之间的电流最高几个mA。

如果SEL35为低电平，V_P电容充电至25V。A_或B_上的正压高于25V时，通过连接至V_P的二极管对V_P电容充电。当V_P电容充电至该电压时，阻断来自A_或B_引脚的电流。所以，即使SEL35为低电平，A_或B_仍可承受高达35V的电压。

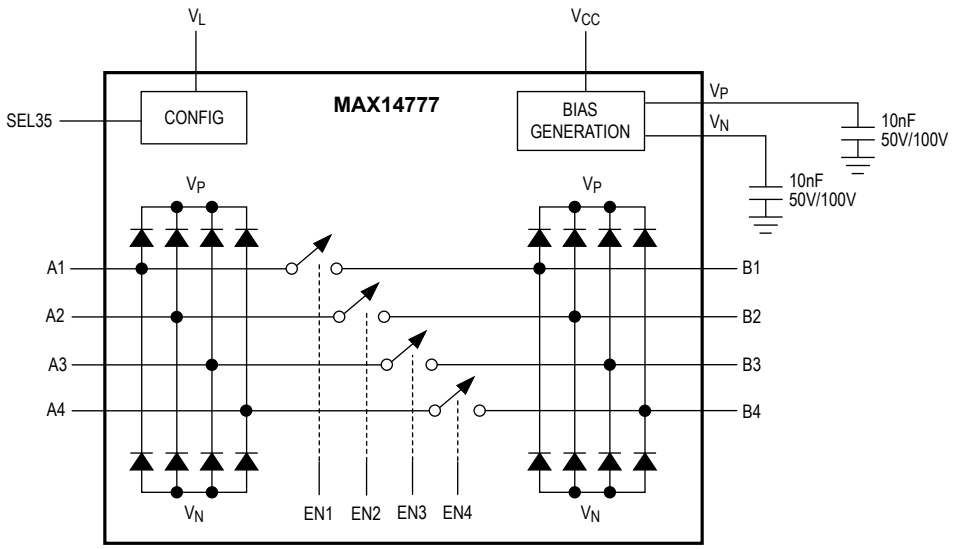


图8. 典型应用电路

应用示例

MAX14777可用于设计单电源供电的工业模拟输入模块，支持±15V电压和4mA–20mA电流测量。这种方案中，MAX14777控制250Ω电阻(通常用于将电流环路电流转换为电压的电阻)的切换，用于模拟测量，如图9所示。利用四个MAX14777开关中的三个，提供高精度电流和电压测量，器件可承受电流环路最常见的36V高压电源。电压测量模式下，开关位置如图9所示，将±15V范围的模拟输入电压连接至放大器输入。改变全部开关位置，即可实现电流环测量。

模拟输入模块未加电时，MAX14777可承受潜在的高压，并保护电阻和PGA不受意外接入AIN端电压的损害。

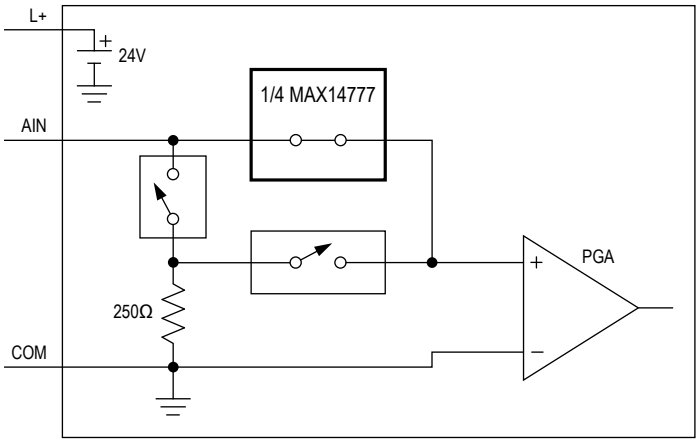


图9. 用于电压和电流环路测量的模拟输入模块

定购信息

器件	温度范围	引脚–封装
MAX14777GTP+	-40°C至+105°C	20 TQFN-EP*

+表示无铅(Pb)/符合RoHS标准的封装。

**EP = 裸焊盘*

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**china.maximintegrated.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
20 TQFN-EP	T2044+4	**21-0139**	**90-0409**

修订历史

修订号	修订日期	说明	修改页
0	6/13	最初版本。	—
1	10/13	去掉了未公开的运放器参考。	14

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

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