高精度可调过压保护器 MAX14527/8

李强 范孝军 杨立清

MAX14527/8 是 MAXIM 公司推出的新器件，是一种高精度可调过压保护器。该过压保护器主要特点：输入电压可达 28V；过压保护的阈值电压可由器件内预设定，但用户也可根据电路的需求设定过压保护阈值电压，其范围为 4~8V 内的任意值；MAX14527 的预设定阈值电压是 5.27V，MAX14528 的预设定阈值电压为 6.76V，这两个阈值电压精度为 ±2.5%；在输入电压超过保护的阈值电压后，输出电压瞬间变为地电平（输出 0V），使电路得以保护；在输入电压回落到低于阈值电压后，经过 15ms 的去抖动时间，输出正常电压（由于内部开关的导通电阻甚小，仅 100mΩ，输出电压接近于输入电压）；内部有软启动电路，尽量减小冲击电流；工作电流低，典型值为 80μA；内部有过热保护电路（结温超过 150℃）；8 引脚 TDFN（2×2mm）小尺寸贴片式封装；工作温度范围为 −40℃~+85℃。

该过压保护器主要应用于便携式电子产品，如手机、多媒体播放器、PDA 等。各种便携式电子产品都由电池供电，但往往配有市电供电的适配器（插头式电源），各种便携式电子产品的工作电压不同，因此有可能用错了适配器（如 5V 的供电便携式设备插上了 12V 输出的适配器），有可能把便携式设备损坏。采用过压保护器

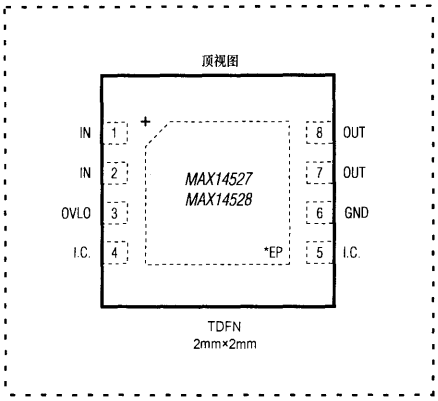


图 1

表 1

引脚	符号	功能
1、2	IN	电压输入端，此端接一个 1μF 的陶瓷电容到地（尽可能接近 IN 端）可防止人体静电放电（15kV）的损害。若无 1μF 电容，则 ESD 保护仅为 2kV。两个 IN 端应焊在一起
3	OVLO	若使用内部预设定的阈值电压，此端接地。若用户自行设定阈值电压，此端接一个电阻分压器（具体见图）
4、5	I.C	内部链接的，此端应悬空
6	GND	地
7、8	OUT	电压输出端，两个 OUT 端应连接在一起，输出电压正常不过压时，VOUT≈VIN
—	EP	加强散热垫，此垫与地相连加强散热

的 r_{COLD}=3.266，r_{HOT}=0.4368。R_{NOM} 电阻值为：R_{NOM}= (rCOLD−rHOT)/2.714 ×R25= (3.266−0.4368)/2.714 ×100kΩ=104.2kΩ，误差最接近 1% 的电阻值是 105kΩ。

R_B 值为：R_B=0.536×−rHOT×R25=0.536105kΩ−0.4368100kΩ=12.6kΩ。误差最接近 1% 的电阻值是 12.7kΩ。也就是说，当选取 R_{NOM}=105kΩ 和 R_B=12.7kΩ 时，只要温度达到 45℃或降为 0℃，充电器都会自动暂停充电。连接在 IC 引脚 FB2 与 Vc2 之间的 R6 和 C2，提供环路补偿。

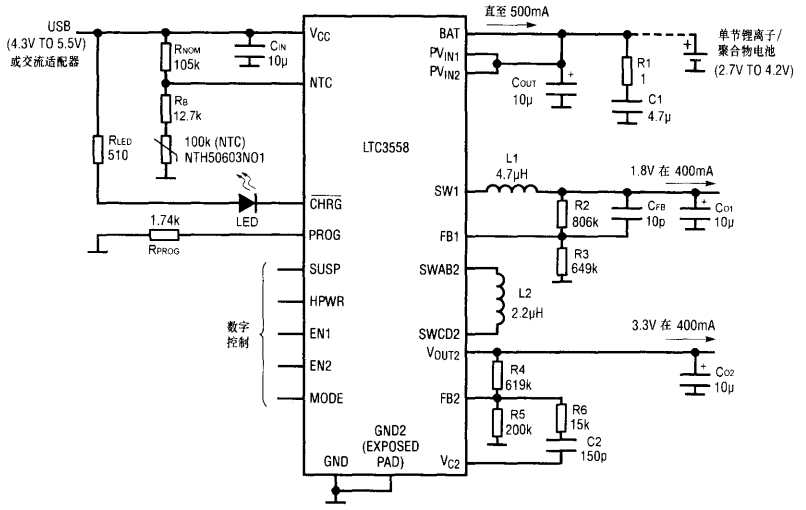


图 5

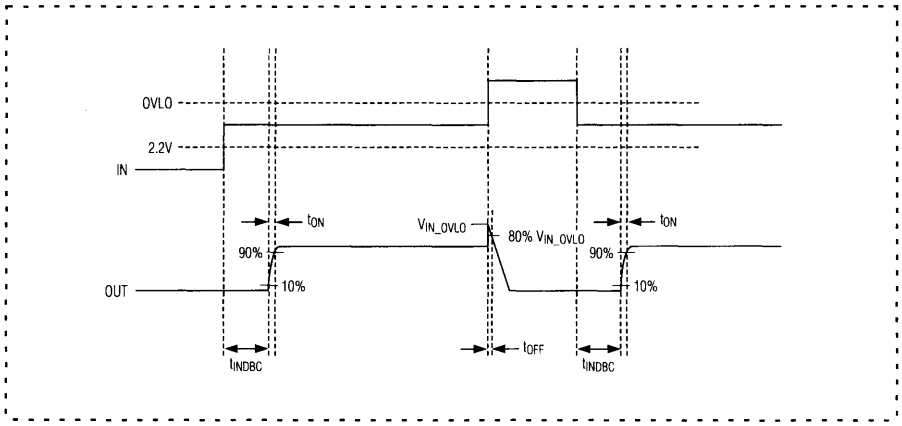


图 2

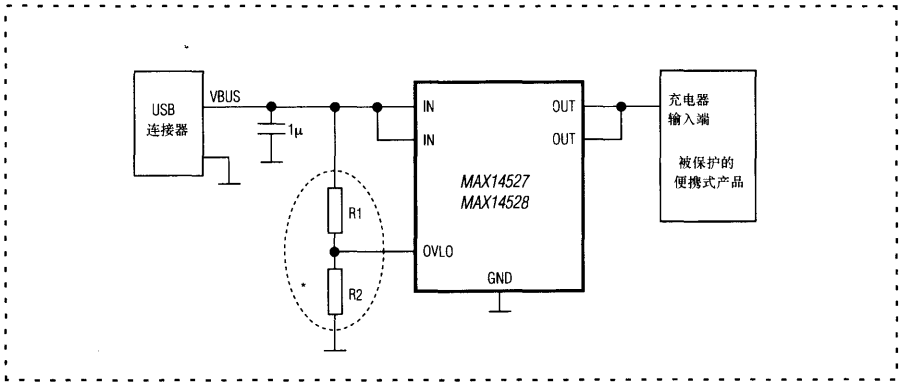


图 3

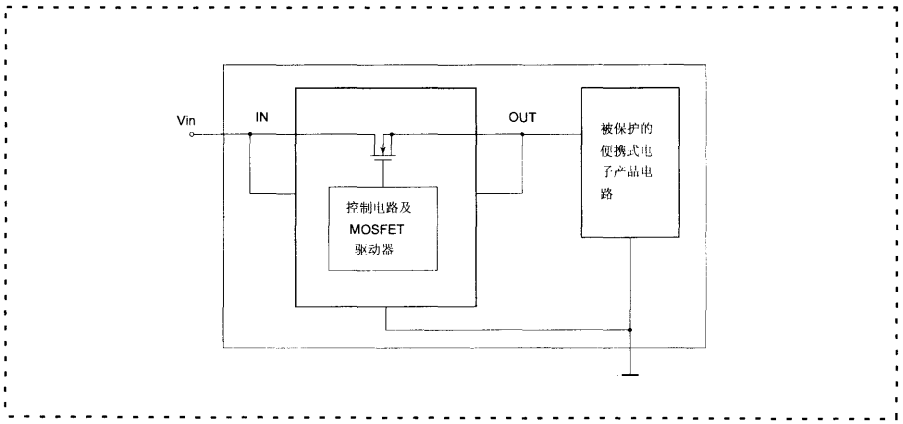


图 3

则可避免这种损失。

引脚排列及功能

MAX14527/8 的引脚排列如图 1 所示，各引脚功能如表 1 所示。

主要参数

MAX14527/8 的主要参数：输入电压的范围 2.2~28V；工作电流典型值（V_{IN}< 过压阈值电压）为 80μA；MAX14527 的预设定阈值电压是 5.27V ±2.5%，MAX14528 的预设定阈值电压为 6.76V ±2.5%；内部基准电压（V_{OVLO_THRESH}）为 1.245V；过压保护的阈值电压设定范围为 4~8V；内部开关管导通电阻 $R_{DS\ (ON)}$为 100mΩ（典型值）。

输入、输出特性

MAX14527/8 的时序图（输入、输出特性）如图 2 所示。图 2 中，ton 是开关导通时间 0.7ms~1.4ms、t_{off} 是开关关断时间 1.3ms~3.5ms、t_{INDBC} 是消除抖动时间 15ms。OVLO 是输入电压过压、输出锁存。

从图 2 可以看出，无论过压是瞬间脉冲或长时间过压，只要其输入电压小于 28V，输出电压都降为 0V，因此即使 5V 的适配器错用了 12V~15V 的输出的适配器，对产品是无输入电压，有效地保护了产品的安全。

典型应用电路

MAX14527/8 的典型应用电路如图 3 所示。保护的是便携式产品，MAX14527/8 应装在它的内部，MAX14527/8 的输入 IN 与电源相接（图 3 为 USB 端口供电），其输出端与便携式充电器连接。图中 R1、R2 分压器为用户设定过压阈值电压用，若设定的过压阈值电压为 V_{IN_OVLO}，则与 R1、R2 的关系为 $V_{IN\_OVLO}=V_{OVLO\_THRESH}\times(1+R1/R2)$；式中 V_{OVLO_THRESH} 为内部基准电压，V_{OVLO_THRESH}=1.245V。

建议 R1 取 1MΩ，则在设定好 V_{IN_OVLO} 后可用上式计算出 R2。例如 V_{IN_OVLO}=7V，R1=1MΩ，则可计算出 R2=210kΩ。

如果用户选用 MAX14527/8 内部设定的过压阈值电压，此时电路更简单，无需 R1、R2，只要在 OVLO 端连接 GND 即可。

此过压保护器件并未给出允许流过保护器的电流值，但在主要参数中已经给出内部开关管导通电阻 R_{DSION}为 100~200mΩ。如果通过过压保护器的电流为 1A，则在开关管上的最大压降 V_{DS}=1A×200mΩ=200mV；开关管的功耗 P_D=1A×200mV=200mW。

从上面计算可知，在输出 1A 时，输入电压与输出电压最大压差 0.2V，开关管的功耗仅为 0.2W。这个过压保护器件的特性是不错的。如图 4 所示。

19-4357; Rev 0; 10/08

Adjustable Overvoltage Protector with High Accuracy

General Description

The MAX14527/MAX14528 overvoltage protection devices feature a low 100mΩ (typ) R_{ON} internal FET and protect low-voltage systems against voltage faults up to +28V. When the input voltage exceeds the overvoltage threshold, the internal FET is turned off to prevent damage to the protected components.

The overvoltage protection threshold can be adjusted with optional external resistors to any voltage between 4V and 8V. With the OVLO input set below the external OVLO select voltage, the MAX14527/MAX14528 automatically choose the internal ±2.5% accurate trip thresholds. The internal overvoltage thresholds (OVLO) are preset to 5.75V typical (MAX14527) or 6.76V typical (MAX14528). The MAX14527/MAX14528 are also protected against overcurrent events with an internal thermal shutdown.

The MAX14527/MAX14528 are offered in a small, 8-pin TDFN-EP package and operate over the -40°C to +85°C extended temperature range.

Features

- **Input Voltage Protection Up to +28V**
- **Preset Internal ±2.5% Accurate OVLO Thresholds**
  5.75V (MAX14527)
  6.76V (MAX14528)
- **Adjustable Overvoltage Protection Trip Level**
- **Integrated 100mΩ (typ) n-Channel MOSFET Switch**
- **Soft-Start to Minimize In-Rush Current**
- **Automatic Overvoltage Protection Trip-Level Selection**
- **Internal 15ms Startup Delay**
- **Thermal Shutdown Protection**
- **8-Pin TDFN (2mm x 2mm) Package**
- **-40°C to +85°C Operating Temperature Range**

Applications

Cell Phones

Media Players

PDAs and Palmtop Devices

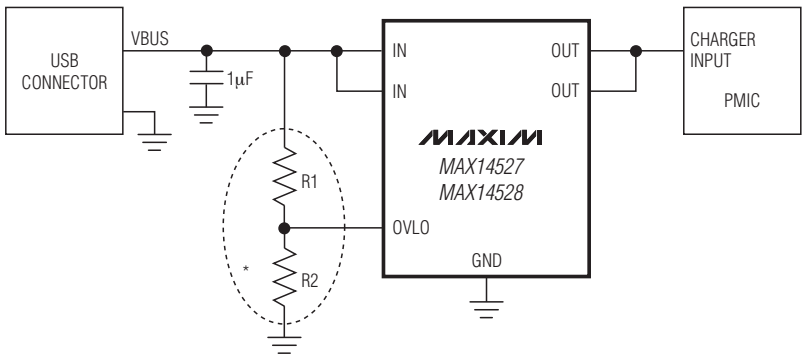
Pin Configuration appears at end of data sheet.

Ordering Information

PART	PIN-PACKAGE	TOP MARK	OVLO (V)
MAX14527ETA+T	8 TDFN-EP*	ACR	5.75
MAX14528ETA+T	8 TDFN-EP*	ACS	6.76

Note: *Devices are specified over the -40°C to +85°C temperature range.*
+Denotes a lead-free/RoHS-compliant package.
T = Tape and reel.
**EP = Exposed pad.*

Typical Application Circuit



*R1 AND R2 ARE REQUIRED ONLY FOR ADJUSTABLE OVLO; OTHERWISE, CONNECT OVLO TO GND.

Adjustable Overvoltage Protector with High Accuracy

ABSOLUTE MAXIMUM RATINGS

(All voltages referenced to GND.)
IN .....-0.3V to +30V
OUT .....-0.3V to (V_{IN} + 0.3V)
OVLO .....-0.3V to +6V
Continuous IN Current 1A
Peak IN Current (Note 1).....5A
Continuous OVLO Current 50µA
Continuous Power Dissipation (T_A = +70°C)
8-Pin TDFN (derate 11.9mW/°C above +70°C) 954mW
Package Junction-to-Ambient Thermal Resistance (θ_{JA})
(Note 2) .....83.9°C/W
Package Junction-to-Case Thermal Resistance (θ_{JC})
(Note 2) .....37°C/W
Operating Temperature Range .....-40°C to +85°C
Junction Temperature .....+150°C
Storage Temperature Range .....-65°C to +150°C
Lead Temperature (soldering) .....+300°C

Note 1: Limited by thermal shutdown.

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.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.

ELECTRICAL CHARACTERISTICS

(V_{IN} = +2.2V to +28V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V_{IN} = +5.0V and T_A = +25°C.) (Note 3)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Input Voltage Range	V_{IN}			2.2		28	V
Input Supply Current	I_{IN}	V_{IN} < OVLO			80	160	µA
IN Overvoltage Trip Level	V_{IN_OVLO}	V_{IN} rising	MAX14527	5.6	5.75	5.9	V
			MAX14528	6.55	6.765	7	
		V_{IN} falling	MAX14527	5.54		5.84	
			MAX14528	6.5		6.95	
IN Overvoltage Lockout Hysteresis	$V_{IN\_OVLO\_HYS}$				1		%
OVLO Set Threshold	V_{OVLO_THRESH}			1.2	1.245	1.29	V
Adjustable OVLO Threshold Range				4		8	V
External OVLO Select Threshold	V_{OVLO_SELECT}			0.15	0.33	0.5	V
Switch On-Resistance	R_{ON}				100	200	mΩ
OVLO Clamp		I_{CLAMP} = 10µA		3	4.56	5.5	V
OUT Capacitor	C_{OUT}					1000	µF
OVLO Input Leakage Current	I_{OVLO}	V_{OVLO_THRESH} = 1.245V		-100		+100	nA
Thermal Shutdown					150		°C
Thermal Shutdown Hysteresis					20		°C
TIMING CHARACTERISTICS (Figure 1)							
Debounce Time	t_{INDBC}	Time from 2.2V < V_{IN} < V_{IN_OVLO} to V_{OUT} = 10% of V_{IN}			15		ms
Switch Turn-On Time	t_{ON}	2.2V < V_{IN} < V_{IN_OVLO}, R_{LOAD} = 100Ω, C_{LOAD} = 100µF; V_{OUT} from 10% to 90% of V_{IN}			0.7		ms
		2.2V < V_{IN} < V_{IN_OVLO}, R_{LOAD} = 100Ω, C_{LOAD} = 1mF; V_{OUT} from 10% to 90% of V_{IN}			1.4		
Switch Turn-Off Time	t_{OFF}	V_{IN} > V_{OVLO_THRESH} to V_{OUT} = 80% of V_{IN_OVLO}; R_{LOAD} = 1kΩ, V_{IN} rising at 2V/100ns			1.3	3.5	µs

Note 3: All specifications are 100% production tested at T_A = +25°C, unless otherwise noted. Specifications are over -40°C to +85°C and are guaranteed by design.

Timing Diagram

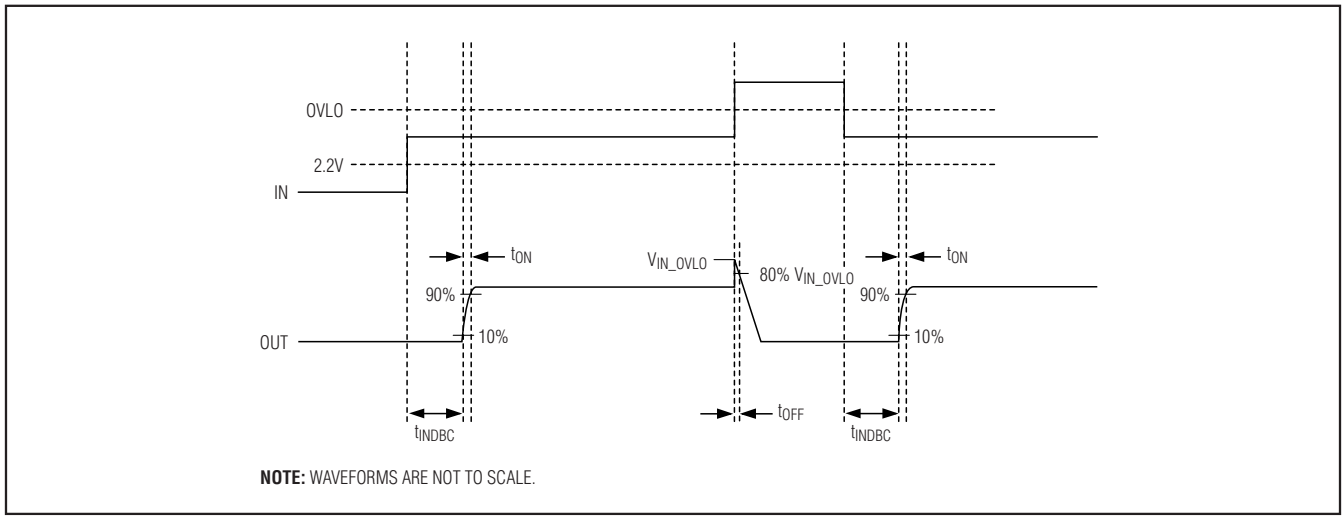


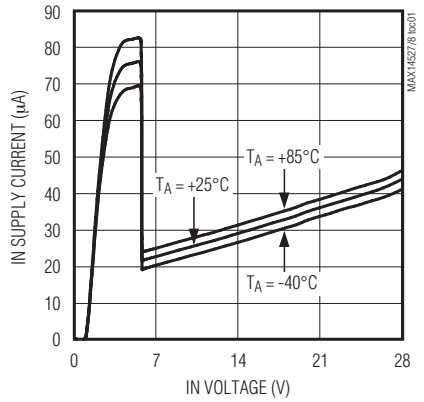
Figure 1. Timing Characteristics

Adjustable Overvoltage Protector with High Accuracy

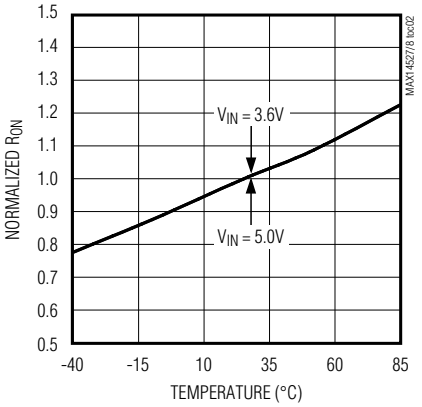
Typical Operating Characteristics

(T_A = +25°C, unless otherwise noted.)

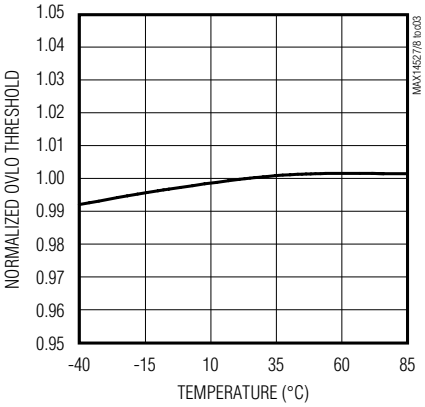
IN SUPPLY CURRENT vs. IN VOLTAGE



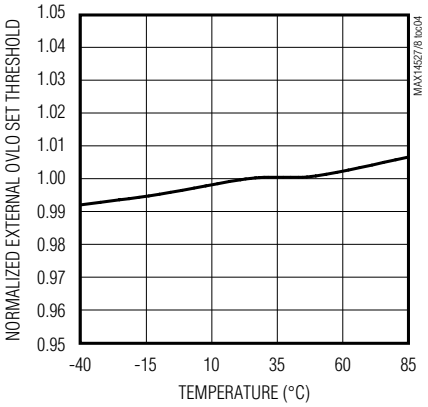
NORMALIZED R_{ON} vs. TEMPERATURE



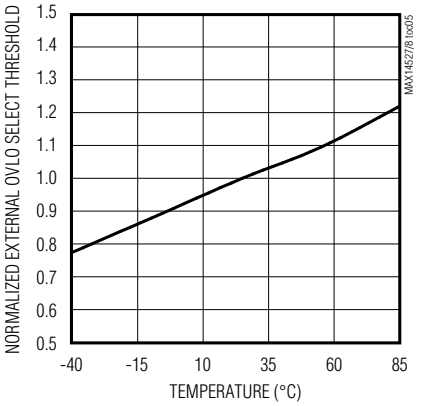
NORMALIZED OVLO THRESHOLD vs. TEMPERATURE



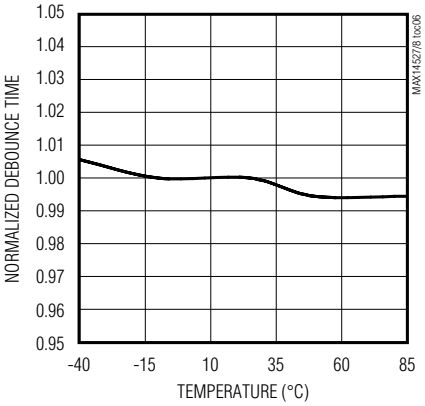
NORMALIZED EXTERNAL OVLO SET THRESHOLD vs. TEMPERATURE



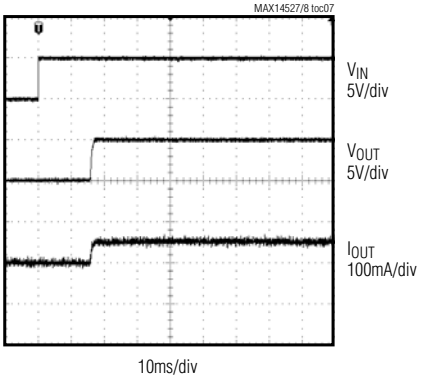
NORMALIZED EXTERNAL OVLO SELECT THRESHOLD vs. TEMPERATURE



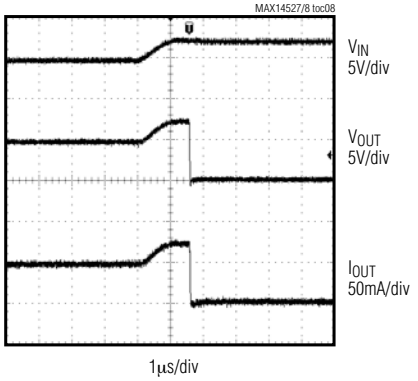
NORMALIZED DEBOUNCE TIME vs. TEMPERATURE



POWER-UP RESPONSE



OVERVOLTAGE FAULT RESPONSE

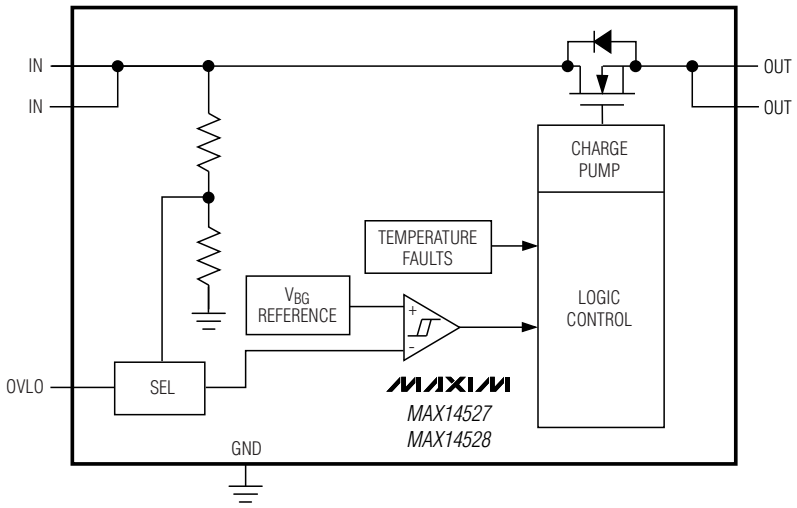


Adjustable Overvoltage Protector with High Accuracy

Pin Description

PIN	NAME	FUNCTION
1, 2	IN	Voltage Input. Bypass IN with a 1µF ceramic capacitor as close as possible to the device to obtain ±15kV Human Body Model (HBM) ESD protection. Connect all the IN pins together for proper operation. IN is protected to ±2kV HBM when IN is not bypassed with a capacitor to GND.
3	OVLO	External OVLO Adjustment. Connect OVLO to GND when using the internal threshold. Connect a resistor-divider to OVLO to set a different OVLO threshold; this external resistor-divider is completely independent from the internal threshold.
4, 5	I.C.	Internally Connected. Do not connect. Leave I.C. unconnected.
6	GND	Ground
7, 8	OUT	Output Voltage. Output of internal switch. Connect all the OUT outputs together for proper operation.
—	EP	Exposed Pad. Connect exposed pad to ground. For enhanced thermal dissipation, connect EP to a copper area as large as possible. Do not use EP as a sole ground connection.

Functional Diagram



Detailed Description

The MAX14527/MAX14528 overvoltage protection devices feature a low R_{ON} internal FET and protect low-voltage systems against voltage faults up to +28V. If the input voltage exceeds the overvoltage threshold, the internal FET is turned off to prevent damage to the protected components. The 15ms debounce time prevents false turn-on of the internal FET during startup.

Device Operation

The MAX14527/MAX14528 have timing logic that controls the turn-on of the internal FET. If $V_{IN} < V_{OVLO\_THRESH}$, the internal charge pump is enabled. The charge-pump startup, after a 15ms debounce delay, turns on the internal FET (see the *Functional Diagram*). At any time, if V_{IN} rises above V_{OVLO_THRESH}, OUT is disconnected from IN.

Adjustable Overvoltage Protector with High Accuracy

Internal Switch

The MAX14527/MAX14528 incorporate an internal FET with a 100mΩ (typ) R_{ON}. The FET is internally driven by a charge pump that generates a necessary gate voltage above IN. The internal FET is capable of passing more than 5A inrush current.

Overvoltage Lockout (OVLO)

The MAX14527 has a 5.75V (typ) overvoltage threshold (OVLO).The MAX14528 has a 6.76V (typ) OVLO threshold.

Thermal-Shutdown Protection

The MAX14527/MAX14528 feature thermal shutdown circuitry. The internal FET turns off when the junction temperature exceeds +150°C (typ). The device exits thermal shutdown after the junction temperature cools by 20°C (typ).

Applications Information

IN Bypass Capacitor

For most applications, bypass IN to GND with a 1µF ceramic capacitor as close as possible to the device to enable ±15kV (HBM) ESD protection on IN. If ±15kV (HBM) ESD is not required, there is no capacitor required at IN. If the power source has significant inductance due to long lead length, take care to prevent overshoots due to the LC tank circuit and provide protection if necessary to prevent exceeding the +30V absolute maximum rating on IN.

OUT Output Capacitor

The slow turn-on time provides a soft-start function that allows the MAX14527/MAX14528 to charge an output capacitor up to 1000µF.

External OVLO Adjustment Functionality

If OVLO is connected to ground, the internal OVLO comparator uses the internally set OVLO value.

If an external resistor-divider is connected to OVLO and V_{OVLO} exceeds the OVLO select voltage, V_{OVLO_SELECT}, the internal OVLO comparator reads the IN fraction fixed by the external resistor divider. R_1 = 1MΩ is a good starting value for minimum current consumption. Since V_{IN_OVLO}, V_{OVLO_THRESH}, and R_1 are known, R_2 can be calculated from the following formula:

$$V_{IN\_OVLO} = V_{OVLO\_THRESH} \times \left[1 + \frac{R_1}{R_2}\right]$$

This external resistor-divider is completely independent from the internal resistor-divider.

ESD Test Conditions

ESD performance depends on a number of conditions.

The MAX14527/MAX14528 are specified for ±15kV (HBM) typical ESD resistance on IN when IN is bypassed to ground with a 1µF ceramic capacitor.

HBM ESD Protection

Figure 2a shows the Human Body Model, and Figure 2b shows the current waveform it generates when discharged into a low impedance. This model consists of a 100pF capacitor charged to the ESD voltage of interest, which is then discharged into the device through a 1.5kΩ resistor.

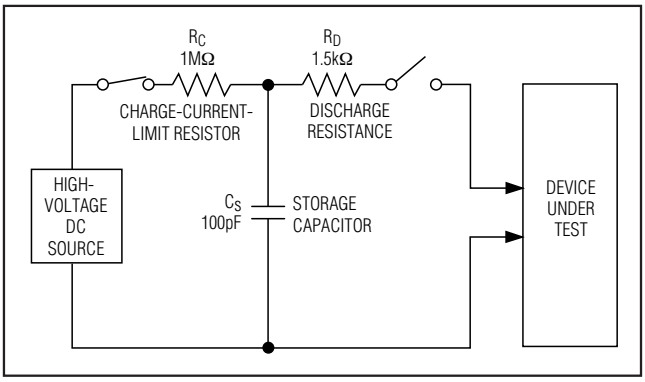


Figure 2a. Human Body ESD Test Model

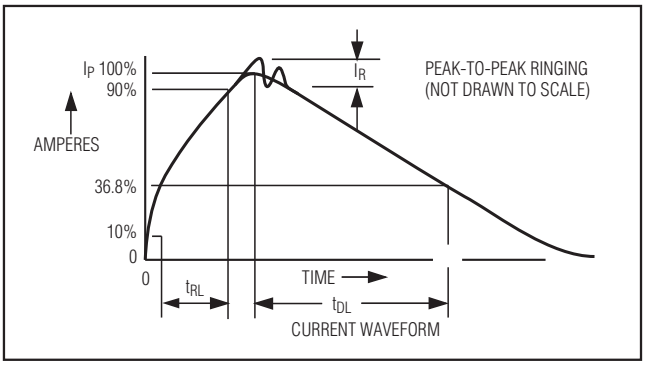
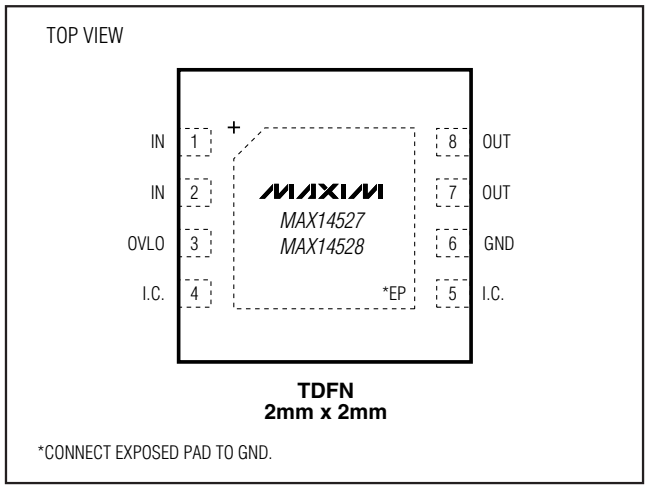


Figure 2b. Human Body Current Waveform

Adjustable Overvoltage Protector with High Accuracy

Pin Configuration



Chip Information

PROCESS: BiCMOS

Package Information

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

PACKAGE TYPE	PACKAGE CODE	DOCUMENT NO.
8 TDFN-EP	T822+2	**21-0168**