

# MAX14606/MAX14607

## Overvoltage Protectors with Reverse Bias Blocking

### General Description

The MAX14606/MAX14607 overvoltage protection devices feature low 54mΩ (typ) on-resistance (R<sub>ON</sub>) internal FETs and protect low-voltage systems against voltage faults up to +36V. When the input voltage exceeds the overvoltage threshold, the internal FET is turned off to prevent damage to the protected components.

The devices automatically choose the accurate internal trip thresholds. The internal OVLO are preset to typical 5.87V (MAX14606) or 6.8V (MAX14607).

The MAX14606/MAX14607 feature reverse bias blocking capability. Unlike other overvoltage protectors, when the MAX14606/MAX14607 are disabled, the voltage applied to OUT does not feed back into IN. These devices also feature thermal shutdown to protect against overcurrent events.

The MAX14606/MAX14607 are specified over the extended -40°C to +85°C temperature range, and are available in 9-bump WLP packages.

### Applications

Tablets  
Smart Phones  
Portable Media Players

**Ordering Information/Selector Guide** appears at end of data sheet.

**Typical Operating Circuit** appears at end of data sheet.

Visit [www.maximintegrated.com/products/patents](http://www.maximintegrated.com/products/patents) for product patent marking information.

### Benefits and Features

- ◆ **Protect High-Power Portable Devices**
  - ◇ Wide Operating Input Voltage Protection from +2.3V to +36V
  - ◇ 3A Continuous Current Capability
  - ◇ Integrated 54mΩ (typ) nMOSFET Switch
- ◆ **Flexible Overvoltage Protection Design**
  - ◇ Easy Paralleling
  - ◇ ACOK Indicates Input Is in Range
  - ◇ Preset Accurate Internal OVLO Thresholds
    - 5.87V ±3% (MAX14606)
    - 6.8V ±3% (MAX14607)
- ◆ **Additional Protection Features Increase System Reliability**
  - ◇ Reverse Bias Blocking Capability
  - ◇ Soft-Start to Minimize Inrush Current
  - ◇ Internal 15ms Startup Debounce
  - ◇ Thermal Shutdown Protection
- ◆ **Save Space**
  - ◇ 9-Bump, 1.3mm x 1.3mm, WLP Package

For related parts and recommended products to use with this part, refer to: [www.maximintegrated.com/MAX14606.related](http://www.maximintegrated.com/MAX14606.related).

For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim Integrated's website at [www.maximintegrated.com](http://www.maximintegrated.com).

# MAX14606/MAX14607

## Overvoltage Protectors with Reverse Bias Blocking

### ABSOLUTE MAXIMUM RATINGS

(All voltages referenced to GND.)

IN	-0.3V to +40V	Continuous Current into IN, OUT	±3A
OUT	-0.3V to +40V	Continuous Power Dissipation (T <sub>A</sub> = +70°C)	
IN - OUT	-6V to +40V	WLP (derate 11.9mW/°C above +70°C)	952mW
EN, ACOK	-0.3V to +6V	Operating Temperature Range	-40°C to +85°C
OVLO	-0.3V to +10V	Storage Temperature Range	-65°C to +150°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)

WLP

Junction-to-Ambient Thermal Resistance (θ<sub>JA</sub>).....+84°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 [www.maximintegrated.com/thermal-tutorial](http://www.maximintegrated.com/thermal-tutorial).

### ELECTRICAL CHARACTERISTICS

(V<sub>IN</sub> = +2.3V to +36V, T<sub>A</sub> = -40°C to +85°C, unless otherwise noted. Typical values are at V<sub>IN</sub> = +5V, T<sub>A</sub> = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	
Input Voltage	V <sub>IN</sub>	V <sub>IN</sub> goes from low to high, $\overline{\text{ACOK}}$ goes from high to low	2.3		36	V	
Input Supply Current	I <sub>IN</sub>	$\overline{\text{EN}}$ low, V <sub>IN</sub> = 5V, I <sub>OUT</sub> = 0mA		70	120	μA	
Input Disable Current	I <sub>IN_DIS</sub>	$\overline{\text{EN}}$ low, V <sub>IN</sub> = 5V, V <sub>OVLO</sub> < V <sub>OVLO_TH</sub>		60	120	μA	
Input Shutdown Current	I <sub>IN_Q</sub>	$\overline{\text{EN}}$ high, V <sub>IN</sub> = 5V, V <sub>OUT</sub> = 0V		6	12	μA	
Output Disable Current	I <sub>OUT_DIS</sub>	$\overline{\text{EN}}$ low, V <sub>OUT</sub> = 5V, V <sub>IN</sub> = 5V, V <sub>OVLO</sub> < V <sub>OVLO_TH</sub> or $\overline{\text{EN}}$ low, V <sub>OUT</sub> = 5V, V <sub>IN</sub> > V <sub>IN_OVLO</sub>			3	μA	
Output Shutdown Current	I <sub>OUT_SD</sub>	$\overline{\text{EN}}$ high, V <sub>OUT</sub> = 5V, V <sub>IN</sub> = 5V			5.5	μA	
<b>OVP (IN TO OUT)</b>							
On-Resistance (IN to OUT)	R <sub>ON</sub>	V <sub>IN</sub> = 5V, I <sub>OUT</sub> = 100mA		54	100	mΩ	
Internal Overvoltage Lockout Threshold	V <sub>IN_OVLO</sub>	IN rising	MAX14606	5.75	5.87	6.00	V
			MAX14607	6.6	6.8	7.0	
		IN falling	MAX14606	5.5			
			MAX14607	6.4			
OUT Load Capacitance	C <sub>OUT</sub>				1000	μF	
<b>OVLO</b>							
OVLO Clamp Current		V <sub>OVLO</sub> = 5.5V, V <sub>IN</sub> = 5V		9.7	25	μA	
OVLO Open Voltage	V <sub>OVLO_OP</sub>	$\overline{\text{VEN}}$ = 0V		2.95	3.6	V	
OVLO Pullup Resistance	R <sub>OVLO_PU</sub>			500		kΩ	
OVLO Force Off Voltage	V <sub>OVLO_TH</sub>		0.6	1.221	1.4	V	

# MAX14606/MAX14607

## Overvoltage Protectors with Reverse Bias Blocking

### ELECTRICAL CHARACTERISTICS (continued)

( $V_{IN} = +2.3V$  to  $+36V$ ,  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ , unless otherwise noted. Typical values are at  $V_{IN} = +5V$ ,  $T_A = +25^{\circ}C$ .) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>DIGITAL SIGNALS (<math>\overline{EN}</math>, <math>\overline{ACOK}</math>)</b>						
$\overline{EN}$ Input High Voltage	$V_{IH}$		1.4			V
$\overline{EN}$ Input Low Voltage	$V_{IL}$				0.4	V
$\overline{EN}$ Input Leakage Current	$I_{EN\_LEAK}$	$V_{IN\_OVLO}$ or 5.5V	-1		+1	$\mu A$
$\overline{ACOK}$ Output Low Voltage	$V_{OL}$	$V_{IO} = 3.3V$ , $I_{SINK} = 1mA$ (see the <i>Typical Operating Circuit</i> )			0.4	V
$\overline{ACOK}$ Leakage Current	$V_{ACOK\_LEAK}$	$V_{IO} = 3.3V$ , $\overline{ACOK}$ deasserted (see the <i>Typical Operating Circuit</i> )	-1		+1	$\mu A$
<b>TIMING CHARACTERISTICS</b>						
IN Debounce Time	$t_{DEB}$	$2.3V < V_{IN} < V_{OVLO}$ to charge-pump on, Figure 1	10	15	35	ms
IN/OUT OVP Soft-Start Time	$t_{SS}$	$2.3V < V_{IN} < V_{OVLO}$ to 90% of $V_{OUT}$		30		ms
OVP Turn-On Time During Soft-Start	$t_{ON}$	$V_{IN} = 5V$ , $R_L = 50\Omega$ , $C_L = 10\mu F$ , $V_{OUT} = 20\%$ of $V_{IN}$ to 80% of $V_{IN}$ , Figure 1		2		ms
Turn-Off Time	$t_{OFF}$	$V_{IN} > V_{OVLO}$ 2V/ $\mu s$ to $V_{OUT} = 80\%$ of $V_{IN}$ , $R_L = 50\Omega$ , Figure 1		1.5		$\mu s$
		$\overline{EN}$ low to high to $V_{OUT} = 80\%$ of $V_{IN}$ , $R_L = 50\Omega$ , Figure 1		84		
<b>THERMAL PROTECTION</b>						
Thermal Shutdown	$T_{SHDN}$			+150		$^{\circ}C$
Thermal Hysteresis	$T_{HYST}$			20		$^{\circ}C$

**Note 2:** All devices are 100% production tested at  $T_A = +25^{\circ}C$ . Limits over the operating temperature range are guaranteed by design and not production tested.

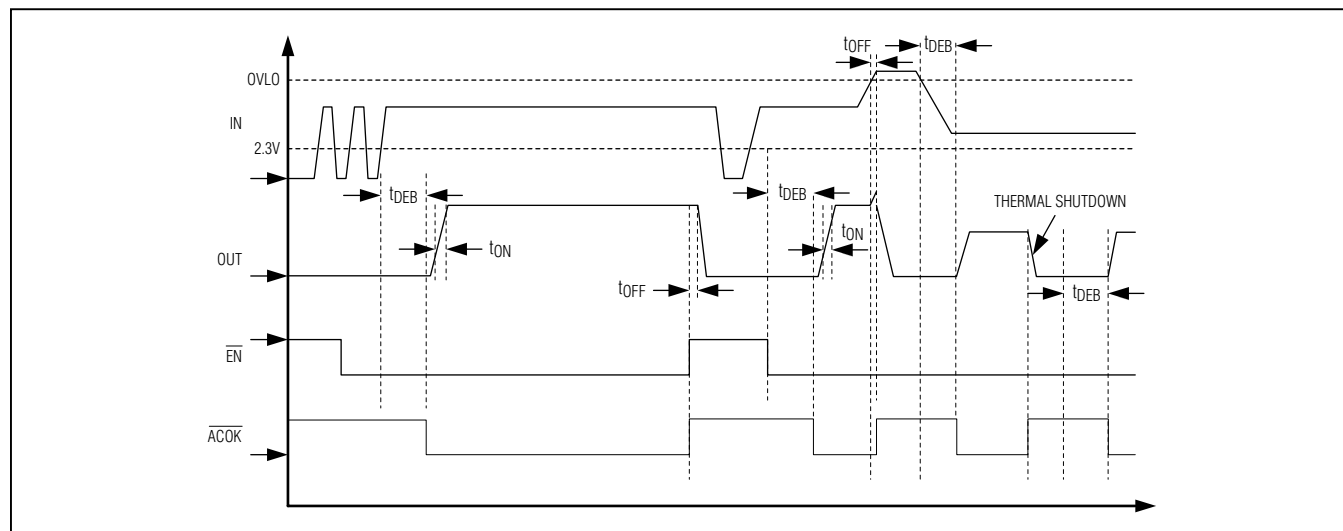


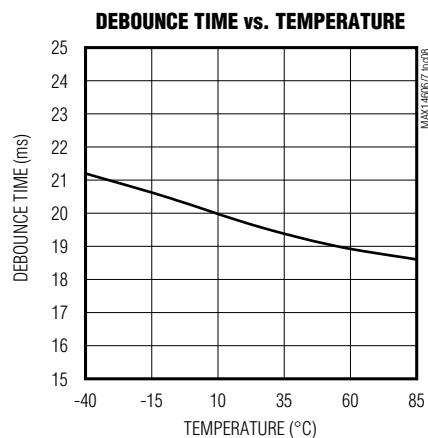
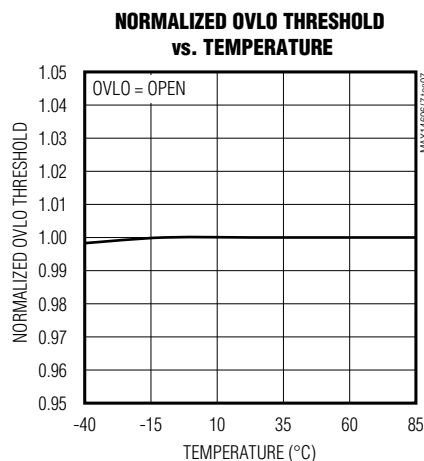
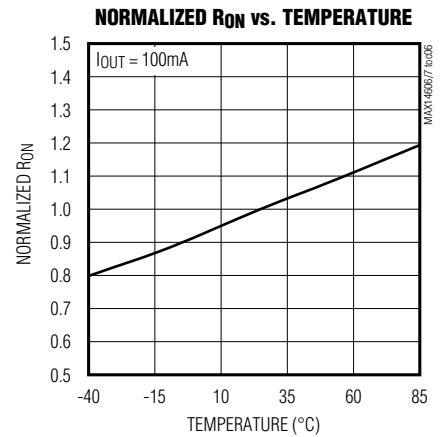
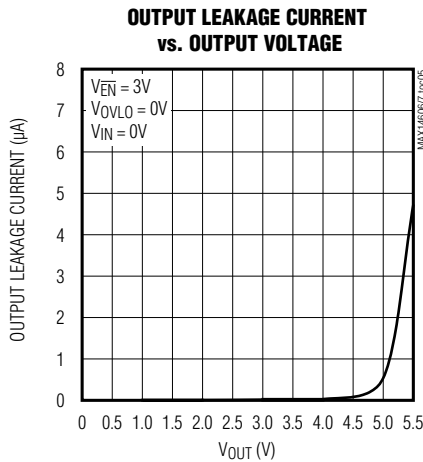
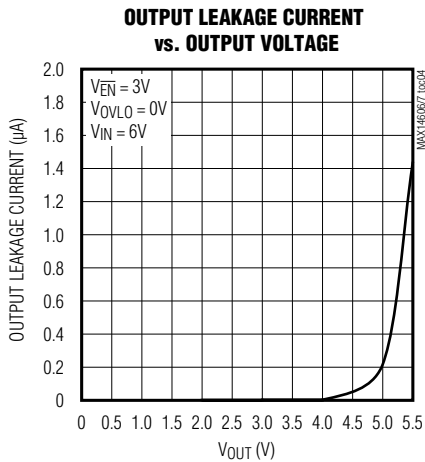
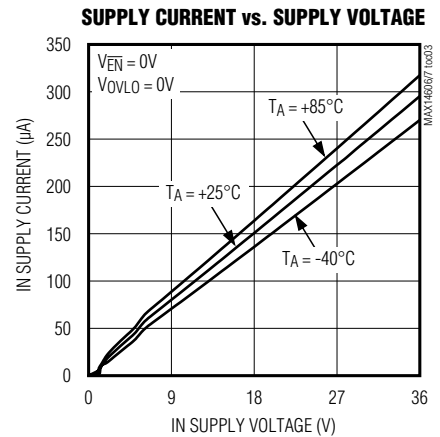
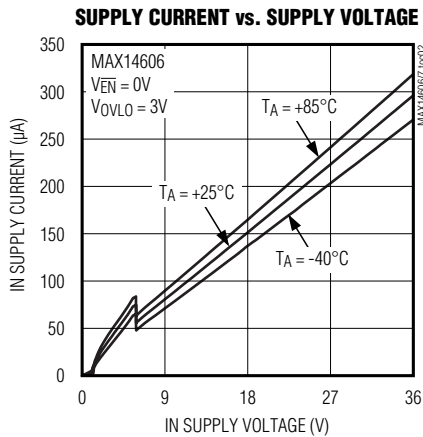
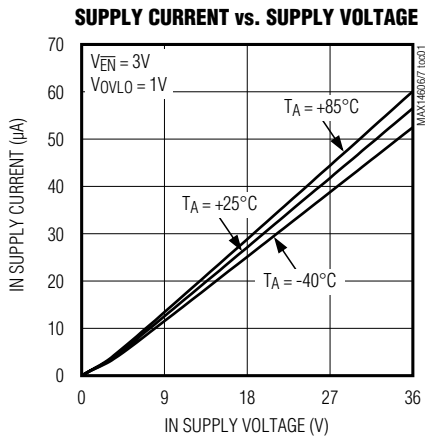
Figure 1. Timing Diagram

# MAX14606/MAX14607

## Overvoltage Protectors with Reverse Bias Blocking

### Typical Operating Characteristics

( $V_{IN} = +5V$ ,  $C_{IN} = 1\mu F$ ,  $C_{OUT} = 1\mu F$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)

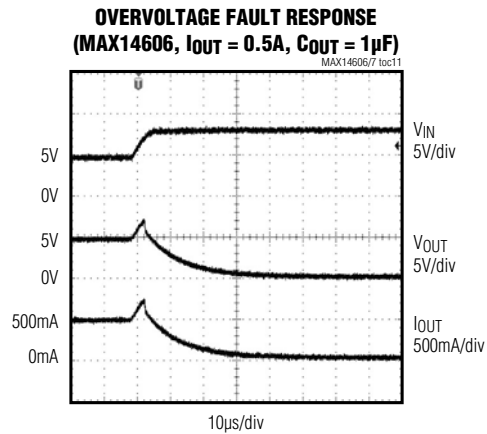
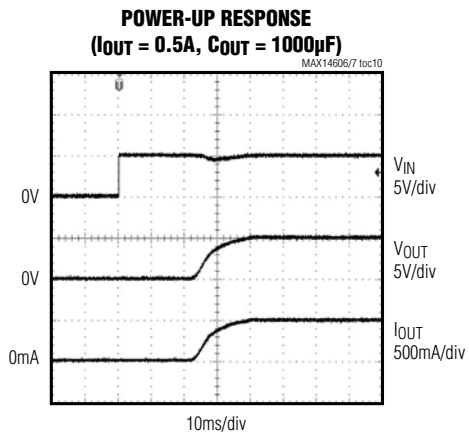
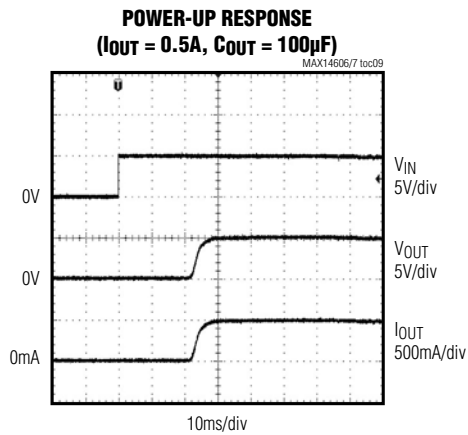


# MAX14606/MAX14607

## Overvoltage Protectors with Reverse Bias Blocking

### Typical Operating Characteristics (continued)

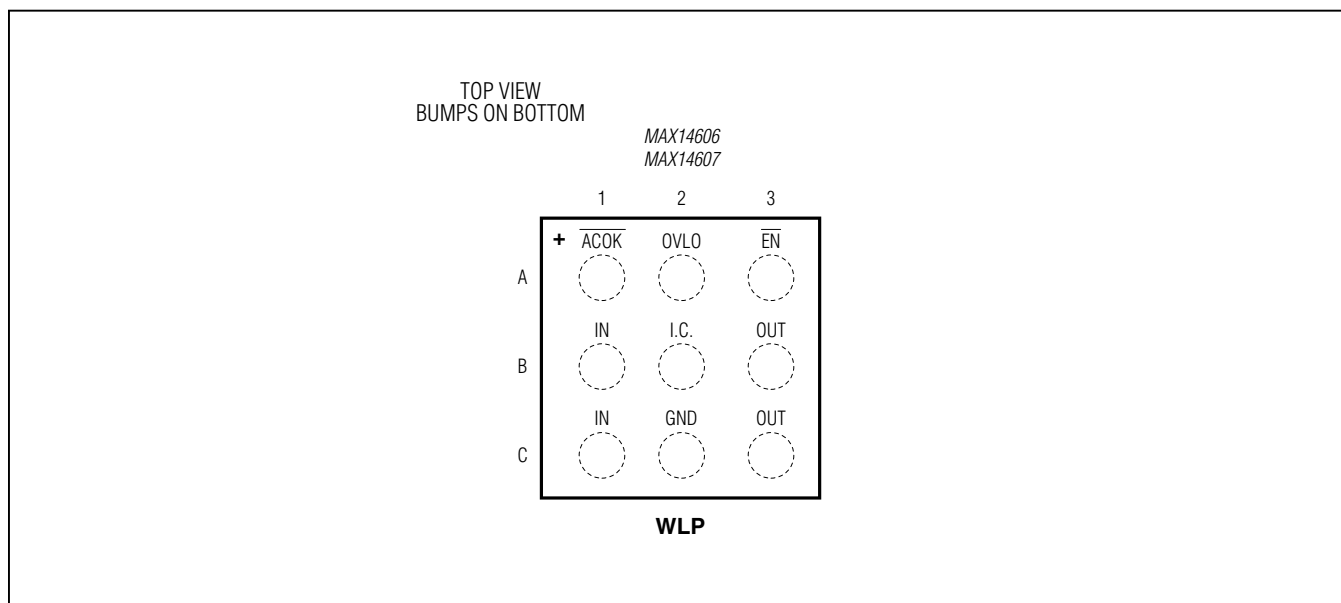
( $V_{IN} = +5V$ ,  $C_{IN} = 1\mu F$ ,  $C_{OUT} = 1\mu F$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)



# MAX14606/MAX14607

## Overvoltage Protectors with Reverse Bias Blocking

### Bump Configuration



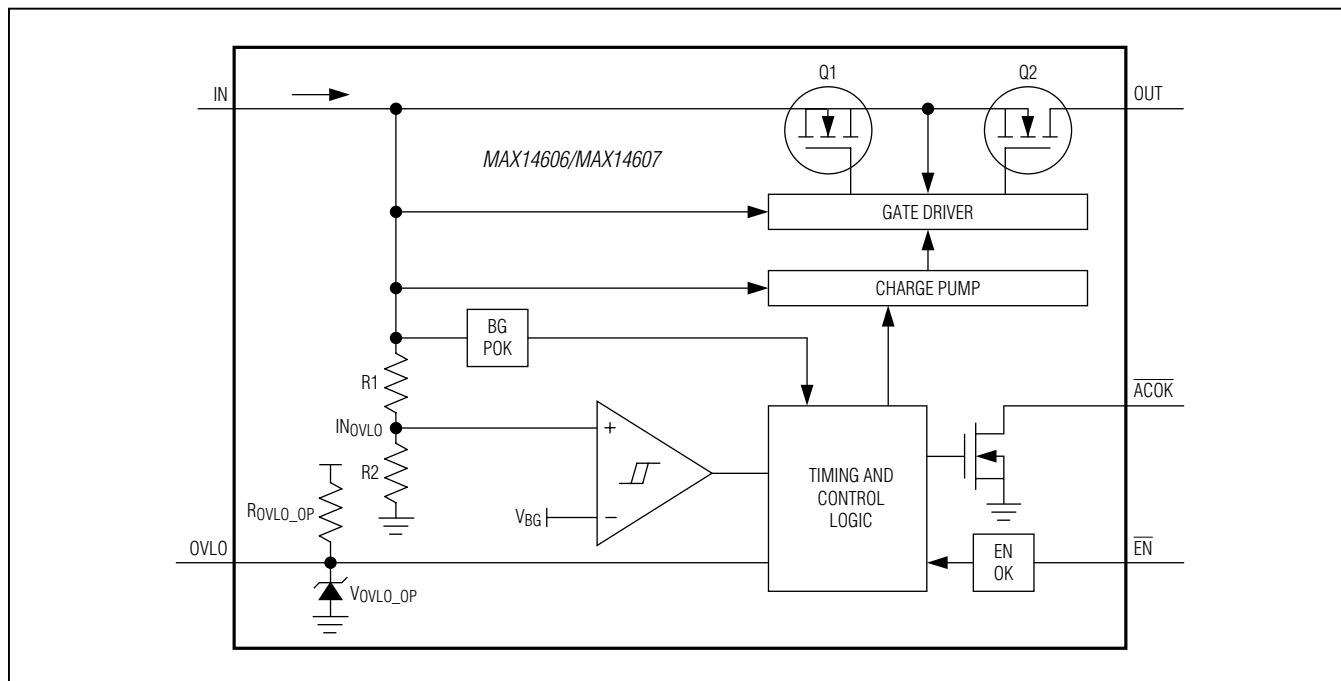
### Bump Description

PIN	NAME	FUNCTION
A1	$\overline{\text{ACOK}}$	Open-Drain Flag Output. $\overline{\text{ACOK}}$ is driven low after input voltage is stable between minimum $V_{\text{IN}}$ and $V_{\text{OVLO}}$ after debounce. Connect a pullup resistor from $\overline{\text{ACOK}}$ to the logic I/O voltage of the host system. $\overline{\text{ACOK}}$ is high impedance after thermal shutdown.
A2	OVLO	Overvoltage Lockout Input. When forced low, it forces the pass element to be switched off. When left unconnected, the part operates normally using its internal OVLO threshold.
A3	$\overline{\text{EN}}$	Active-Low Enable Input. Drive $\overline{\text{EN}}$ low to turn on the device. Drive $\overline{\text{EN}}$ high to turn off the device.
B1, C1	IN	Overvoltage Protection Input. Bypass IN with a 1 $\mu\text{F}$ ceramic capacitor for high $\pm 15\text{kV}$ HBM ESD protection. No capacitor is required for $\pm 2\text{kV}$ HBM ESD protection. Externally connect both IN together.
B2	I.C.	Internally Connected. I.C. is internally connected to ground. Leave I.C. unconnected or connect to GND.
B3, C3	OUT	Overvoltage Protection Output. Bypass OUT with a 1 $\mu\text{F}$ ceramic capacitor. Externally connect both OUT together.
C2	GND	Ground

# MAX14606/MAX14607

## Overvoltage Protectors with Reverse Bias Blocking

### Functional Diagram



### Detailed Description

The MAX14606/MAX14607 overvoltage protection (OVP) devices feature low on-resistance ( $R_{ON}$ ) internal FETs (Q1+Q2) and protect low-voltage systems against voltage faults up to +36V. If the input voltage exceeds the overvoltage threshold, the output is disconnected from the input to prevent damage to the protected components. The 15ms debounce time prevents false turn-on of the internal FETs during startup.

#### Soft-Start

To minimize inrush current, the MAX14606/MAX14607 feature a soft-start capability to slowly turn on Q1 and Q2. Soft-start begins when  $\overline{ACOK}$  is asserted and ends after 15ms (typ).

#### Overvoltage Lockout (OVLO)

The MAX14606/MAX14607 use the internal OVLO comparator with the internally set OVLO value. When IN goes above the overvoltage lockout threshold ( $V_{IN\_OVLO}$ ), OUT is disconnected from IN and  $\overline{ACOK}$  is deasserted. When IN drops below  $V_{IN\_OVLO}$ , the debounce time

starts counting. After the debounce time, OUT follows IN again and  $\overline{ACOK}$  is asserted.

There are a few options of  $\overline{ACOK}$  and shutdown conditions to choose from with different OVLO and  $\overline{EN}$  input combinations (Table 1). For applications that need  $\overline{ACOK}$  present and OVP open, drive EN low and use OVLO as a digital input to enable and disable the OVP switch.

**Table 1. Logic Input Table**

	$\overline{EN}$	LOW	HIGH
OVLO			
Low		OVP Disabled (Reverse Blocking Present) $\overline{ACOK}$ Present; $I_{IN} = 70\mu A$ (typ)	OVP Shutdown (Reverse Blocking Present) $\overline{ACOK}$ Not Present; $I_{IN} = 5\mu A$ (typ)
High		OVP Enabled $\overline{ACOK}$ Present; $I_{IN} = 70\mu A$ (typ)	OVP Shutdown (Reverse Blocking Present) $\overline{ACOK}$ Not Present; $I_{IN} = 5\mu A$ (typ)

# MAX14606/MAX14607

## Overvoltage Protectors with Reverse Bias Blocking

### Reverse Bias Blocking

When the MAX14606/MAX14607 are in overvoltage condition,  $\overline{EN}$  is high, OVLO is low, or thermal shutdown is on, then the switch between IN and OUT is open and the two back-to-back diodes of the two series switches block reverse bias. Therefore, when the voltage is applied at the output, current does not travel back to the input.

### Thermal Shutdown Protection

The MAX14606/MAX14607 feature thermal shutdown protection to protect the device from overheating. The device enters thermal shutdown when the junction temperature exceeds  $+150^{\circ}\text{C}$  (typ), and the device is back to normal operation again after the temperature drops by approximately  $20^{\circ}\text{C}$  (typ). In thermal shutdown, the overvoltage protector is disabled and  $\overline{ACOK}$  is high.

## Applications Information

### IN Bypass Capacitor

For most applications, it is recommended to bypass IN to GND with a  $1\mu\text{F}$ , 30V ceramic capacitor as close to the device as possible to enable  $\pm 15\text{kV}$  HBM ESD protection on IN. In addition, observe good layout practices such as

placing the bypass capacitor next to the connector. IC power and ground must also be routed from the connector to the bypass capacitor and then to the MAX14606/MAX14607. In this way, the capacitor will absorb the ESD energy and thereby protect the device from a high-voltage ESD event.

### OUT Output Capacitor

The slow turn-on time provides a soft-start function that allows the devices to charge an output capacitor up to  $1000\mu\text{F}$  without turning off due to an overcurrent condition.

### ESD Test Conditions

ESD performance depends on a number of conditions. Contact Maxim for a reliability report that documents test methodology and results.

### Human Body Model ESD Protection

Figure 2 shows the HBM, and Figure 3 shows the current waveform it generates when discharged into a low-impedance state. This model consists of a  $100\text{pF}$  capacitor charged to the ESD voltage of interest, which is then discharged into the device through a  $1.5\text{k}\Omega$  resistor.

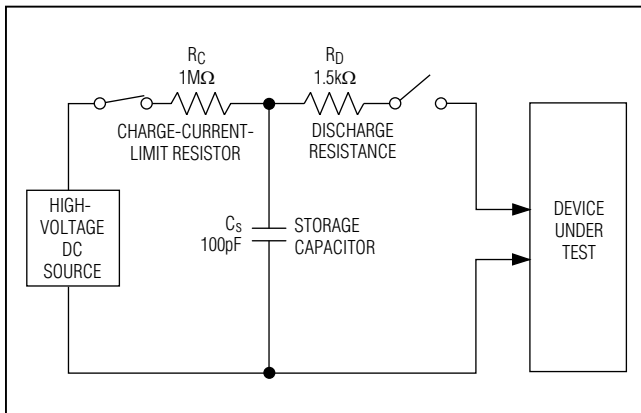


Figure 2. Human Body ESD Test Model

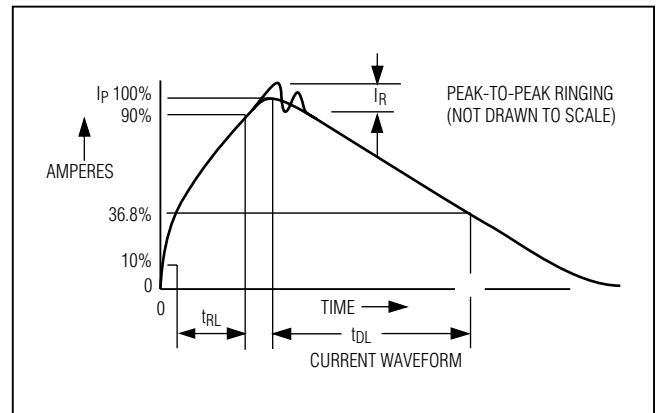


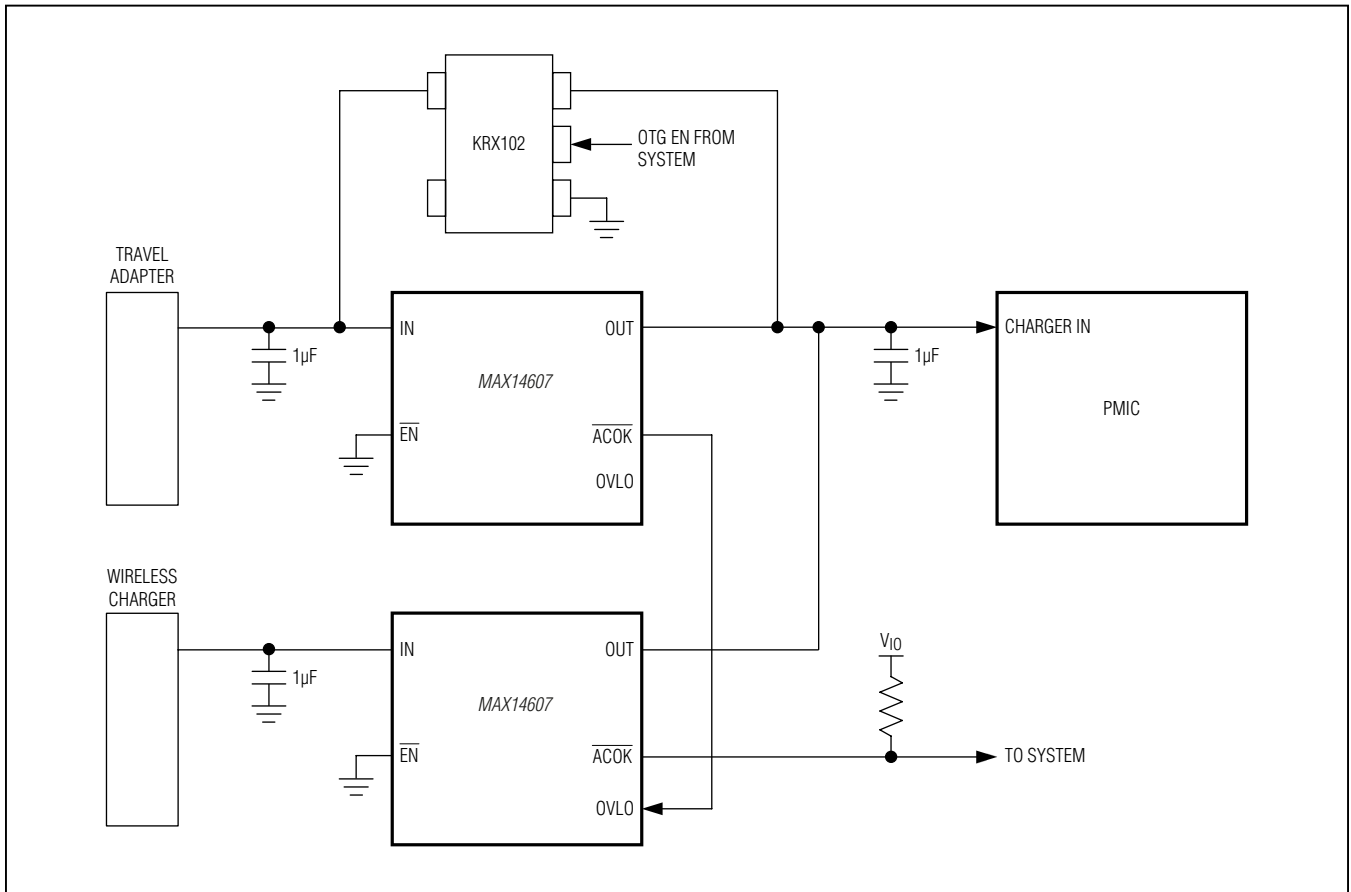
Figure 3. Human Body Current Waveform



# MAX14606/MAX14607

## Overvoltage Protectors with Reverse Bias Blocking

### Typical Operating Circuit



# MAX14606/MAX14607

## Overvoltage Protectors with Reverse Bias Blocking

### Ordering Information/Selector Guide

PART	OVLO (V)	TOP MARK	PIN-PACKAGE
MAX14606EWL+T	5.87	AJR	9 WLP
MAX14607EWL+T	6.80	AJS	9 WLP

**Note:** All devices are specified over the -40°C to +85°C operating temperature range.

+Denotes a lead(Pb)-free package/RoHS-compliant package.

T = Tape and reel.

### Chip Information

PROCESS: BiCMOS

### Package Information

For the latest package outline information and land patterns (footprints), go to [www.maximintegrated.com/packages](http://www.maximintegrated.com/packages). Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

PACKAGE TYPE	PACKAGE CODE	OUTLINE NO.	LAND PATTERN NO.
9 WLP	W91B1+6	<a href="#">21-0430</a>	Refer to <a href="#">Application Note 1891</a>

# MAX14606/MAX14607

## Overvoltage Protectors with Reverse Bias Blocking

### *Revision History*

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	12/11	Initial release	—



*Maxim Integrated cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim Integrated product. No circuit patent licenses are implied. Maxim Integrated reserves the right to change the circuitry and specifications without notice at any time. The parametric values (min and max limits) shown in the Electrical Characteristics table are guaranteed. Other parametric values quoted in this data sheet are provided for guidance.*

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