

## ±15kV ESD-Protected, Single/Dual/Octal, CMOS Switch Debouncers

### General Description

The MAX6816/MAX6817/MAX6818 are single, dual, and octal switch debouncers that provide clean interfacing of mechanical switches to digital systems. They accept one or more bouncing inputs from a mechanical switch and produce a clean digital output after a short, preset qualification delay. Both the switch opening bounce and the switch closing bounce are removed. Robust switch inputs handle  $\pm 25\text{V}$  levels and are  $\pm 15\text{kV}$  ESD-protected for use in harsh industrial environments. They feature single-supply operation from +2.7V to +5.5V. Undervoltage lockout circuitry ensures the output is in the correct state upon power-up.

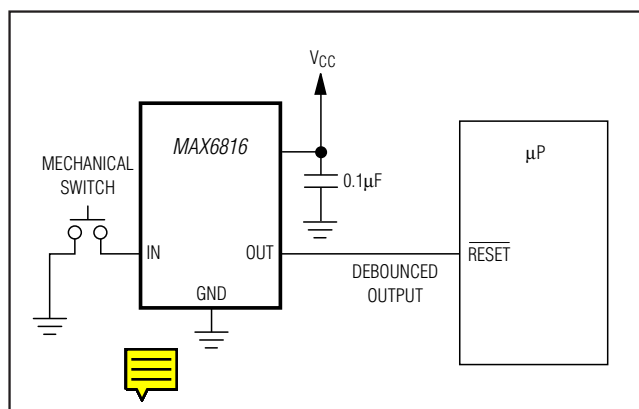
The single MAX6816 and dual MAX6817 are offered in SOT packages and require no external components. Their low supply current makes them ideal for use in portable equipment.

The MAX6818 octal switch debouncer is designed for data-bus interfacing. The MAX6818 monitors switches and provides a switch change-of-state output (CH), simplifying microprocessor ( $\mu\text{P}$ ) polling and interrupts. Additionally, the MAX6818 has three-state outputs controlled by an enable ( $\overline{\text{EN}}$ ) pin, and is pin-compatible with the LS573 octal latch (except for the CH pin), allowing easy interfacing to a digital data bus.

### Applications

- μP Switch Interfacing
- Industrial Instruments
- PC-Based Instruments
- Portable Instruments
- Automotive Applications
- Membrane Key pads

### Typical Operating Circuit



### Features

- ◆ Robust Inputs can Exceed Power Supplies up to  $\pm 25\text{V}$
- ◆ ESD Protection for Input Pins
  - ±15kV—Human Body Model
  - ±8kV—IEC 1000-4-2, Contact Discharge
  - ±15kV—IEC 1000-4-2, Air-Gap Discharge
- ◆ Small SOT Packages (4 and 6 pins)
- ◆ Single-Supply Operation from +2.7V to +5.5V
- ◆ Single (MAX6816), Dual (MAX6817), and Octal (MAX6818) Versions Available
- ◆ No External Components Required
- ◆ 6μA Supply Current
- ◆ Three-State Outputs for Directly Interfacing Switches to μP Data Bus (MAX6818)
- ◆ Switch Change-of-State Output Simplifies Polling and Interrupts (MAX6818)
- ◆ Pin-Compatible with 'LS573 (MAX6818)

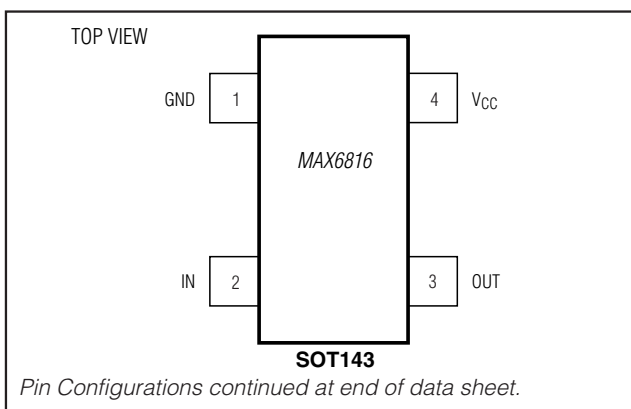
### Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	SOT TOP MARK
MAX6816EUS-T	-40°C to +125°C	4 SOT143	KABA
MAX6817EUT-T	-40°C to +125°C	6 SOT23-6	AAAU
MAX6818EAP	-40°C to +125°C	20 SSOP	—

**Note:** There is a minimum order increment of 2500 pieces for SOT packages.

Devices are available in both leaded and lead-free packaging. Specify lead-free by replacing "-T" with "+T" when ordering.

### Pin Configurations



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### ABSOLUTE MAXIMUM RATINGS

Voltage (with respect to GND)

V<sub>CC</sub> ..... -0.3V to +6V  
 IN<sub>-</sub> (Switch Inputs) ..... -30V to +30V  
 EN<sub>-</sub> ..... -0.3V to +6V  
 OUT<sub>-</sub>, CH<sub>-</sub> ..... -0.3V to (V<sub>CC</sub> + 0.3V)

OUT Short-Circuit Duration

(One or Two Outputs to GND) ..... Continuous

Continuous Power Dissipation (T<sub>A</sub> = +70°C)

4-Pin SOT143 (derate 4.0mW/°C above +70°C) ..... 320mW

6-Pin SOT23 (derate 8.7mW/°C above +70°C) ..... 691mW

20-Pin SSOP (derate 8.0mW/°C above +70°C) ..... 640mW

Operating Temperature Range ..... -40°C to +125°C

Storage Temperature Range ..... -65°C to +160°C

Lead Temperature (soldering, 10s) ..... +300°C

Soldering Temperature (reflow)

Lead(Pb)-free ..... +260°C

Containing lead ..... +240°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.

### ELECTRICAL CHARACTERISTICS

(V<sub>CC</sub> = +2.7V to +5.5V, T<sub>A</sub> = -40°C to +125°C, unless otherwise noted. Typical values are at V<sub>CC</sub> = +5V, T<sub>A</sub> = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Operating Voltage Range	V <sub>CC</sub>		2.7		5.5	V
Supply Current	I <sub>CC</sub>	V <sub>CC</sub> = 5V, I <sub>OUT</sub> = 0A, IN <sub>-</sub> = V <sub>CC</sub>		6	20	μA
Debounce Duration	t <sub>DP</sub>	MAX6818	20	40	60	ms
		MAX6816/MAX6817	20	50	80	
Input Threshold	V <sub>IL</sub>				0.8	V
	V <sub>IH</sub>	V <sub>CC</sub> = 5V	2.4			V
		V <sub>CC</sub> = 2.7V	2.0			
Input Hysteresis				300		mV
Input Pullup Resistance			32	63	100	kΩ
IN Input Current	I <sub>IN</sub>	V <sub>IN</sub> = ±15V			±1	mA
Input Voltage Range	V <sub>IN</sub>		-25		+25	V
Undervoltage-Lockout Threshold				1.9	2.6	V
OUT <sub>-</sub> , CH <sub>-</sub> Output Voltage	V <sub>OL</sub>	I <sub>SINK</sub> = 1.6mA			0.4	V
	V <sub>OH</sub>	I <sub>SOURCE</sub> = 0.4mA	V <sub>CC</sub> - 1.0			
EN Pulse Width	t <sub>EN</sub>		200			ns
EN Threshold		V <sub>CC</sub> = 5V	0.8	1.7	2.4	V
		V <sub>CC</sub> = 2.7V	0.8	1.1	2.0	
EN Input Current	I <sub>IL</sub>				±1	μA
EN Low to Out Active Propagation Delay	t <sub>PE</sub>	R <sub>L</sub> = 10kΩ, C <sub>L</sub> = 100pF			100	ns
EN High to Out Three-State Propagation Delay	t <sub>PD</sub>	R <sub>L</sub> = 1kΩ, C <sub>L</sub> = 15pF			100	ns
EN Low to CH Out High Propagation Delay	t <sub>PC</sub>	R <sub>L</sub> = 10kΩ, C <sub>L</sub> = 50pF			100	ns
OUT <sub>-</sub> Three-State Leakage Current		V <sub>OUT</sub> = 0V or V <sub>CC</sub>			±10	μA
<b>ESD CHARACTERISTICS</b>						
ESD Protection	IN <sub>-</sub>	IEC 1000-4-2 Air Discharge		±15		kV
		IEC 1000-4-2 Contact Discharge		±8		
		Human Body Model		±15		

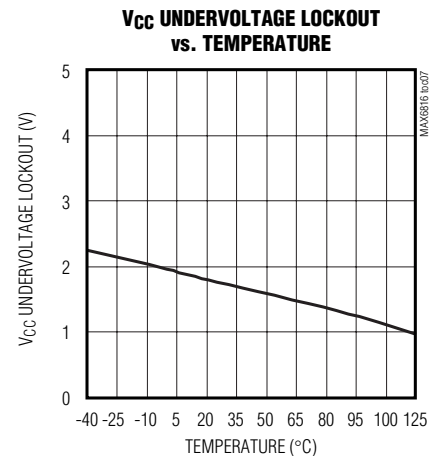
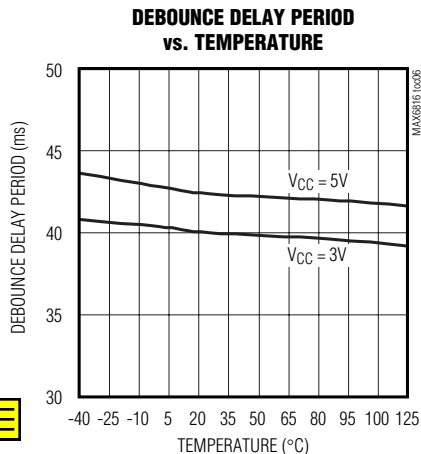
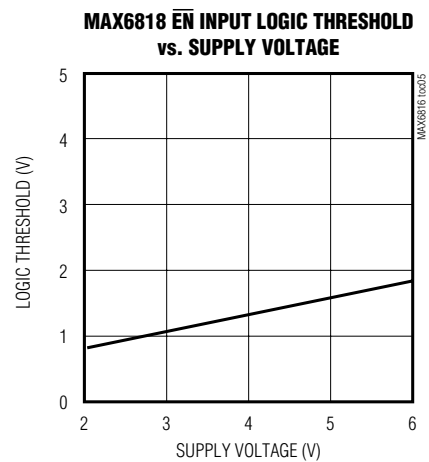
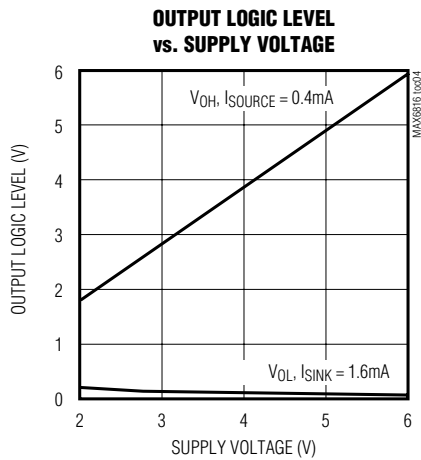
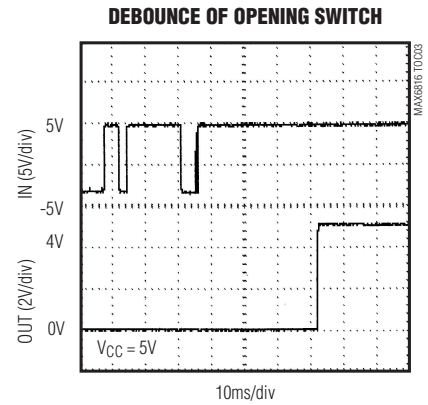
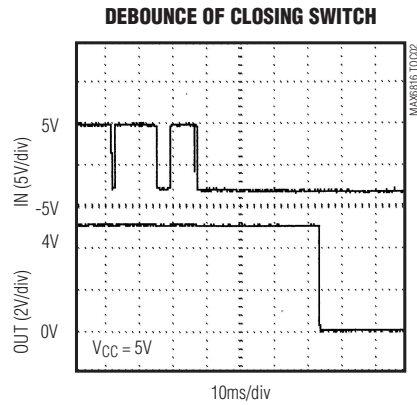
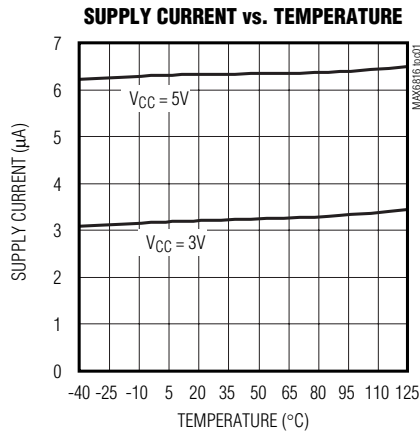
**Note 1:** MAX6816 and MAX6817 production testing is done at T<sub>A</sub> = +25°C; overtemperature limits are guaranteed by design.

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### Typical Operating Characteristics

( $T_A = +25^\circ\text{C}$ , unless otherwise noted.)





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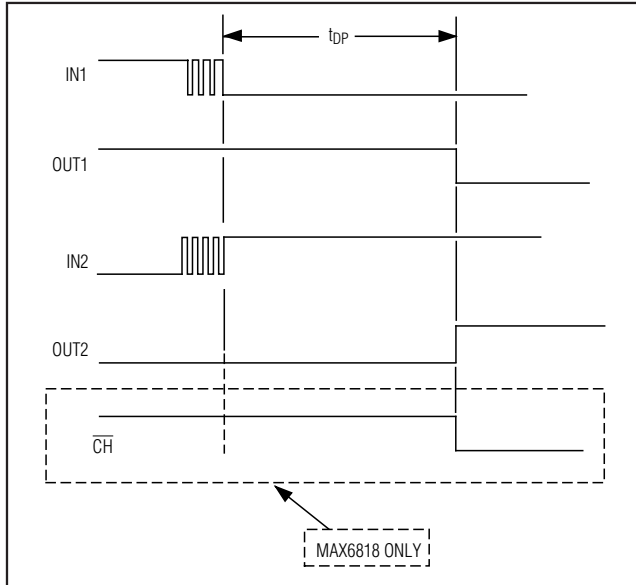


Figure 2. Input Characteristics

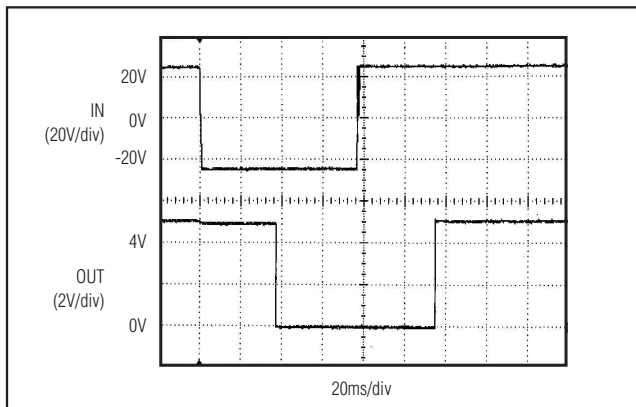


Figure 3. Switch Input  $\pm 25\text{V}$  Fault Tolerance

### Robust Switch Inputs

The switch inputs on the MAX6816/MAX6817/MAX6818 have overvoltage clamping diodes to protect against damaging fault conditions. Switch input voltages can safely swing  $\pm 25\text{V}$  to ground (Figure 3). Proprietary ESD-protection structures protect against high ESD encountered in harsh industrial environments, membrane keypads, and portable applications. They are designed to withstand  $\pm 15\text{kV}$  per the IEC 1000-4-2 Air Gap Discharge Test and  $\pm 8\text{kV}$  per the IEC 1000-4-2 Contact Discharge Test.

Since there are  $63\text{k}\Omega$  (typical) pullup resistors connected to each input, driving an input to  $-25\text{V}$  will draw

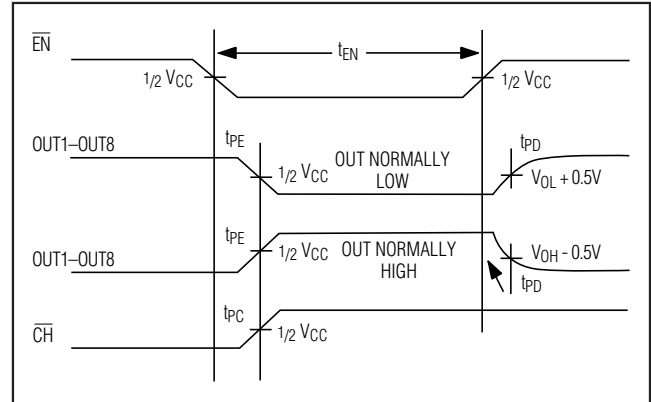


Figure 4. MAX6818  $\mu\text{P}$ -Interface Timing Diagram

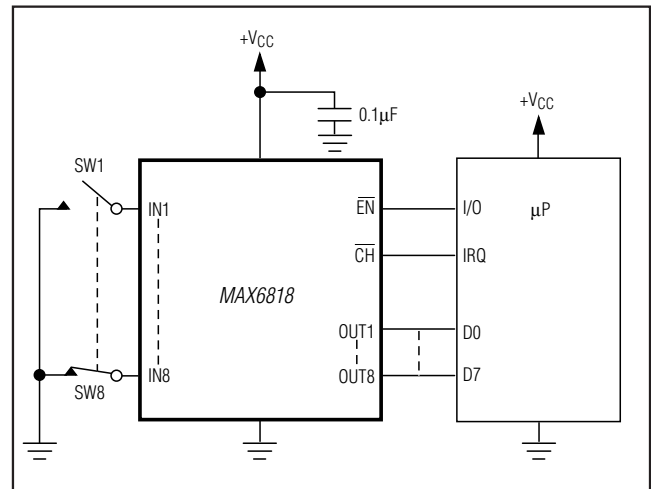


Figure 5. MAX6818 Typical  $\mu\text{P}$  Interfacing Circuit

approximately  $0.5\text{mA}$  (up to  $4\text{mA}$  for eight inputs) from the  $V_{CC}$  supply. Driving an input to  $+25\text{V}$  will cause approximately  $0.32\text{mA}$  of current (up to  $2.6\text{mA}$  for eight inputs) to flow back into the  $V_{CC}$  supply. If the total system  $V_{CC}$  supply current is less than the current flowing back into the  $V_{CC}$  supply,  $V_{CC}$  will rise above normal levels. In some low-current systems, a zener diode on  $V_{CC}$  may be required.

### $\pm 15\text{kV}$ ESD Protection

As with all Maxim devices, ESD-protection structures are incorporated on all pins to protect against electrostatic discharges encountered during handling and assembly. The MAX6816/MAX6817/MAX6818 have extra protection against static electricity. Maxim's engineers have developed state-of-the-art structures to protect against ESD of  $\pm 15\text{kV}$  at the switch inputs without

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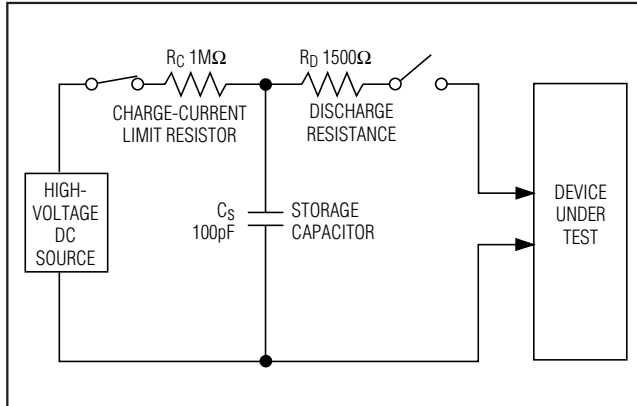


Figure 6a. Human Body ESD Test Model

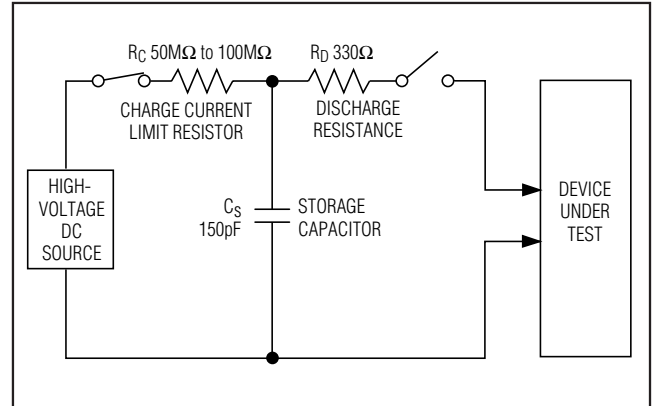


Figure 7a. IEC 1000-4-2 ESD Test Model

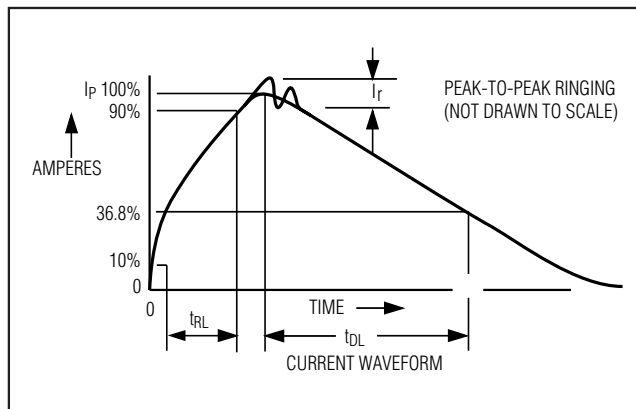


Figure 6b. Human Body Current Waveform

damage. The ESD structures withstand high ESD in all states: normal operation, shutdown, and powered down. After an ESD event, the MAX6816/MAX6817/MAX6818 keep working without latchup, whereas other solutions can latch and must be powered down to remove latchup.

ESD protection can be tested in various ways; these products are characterized for protection to the following limits:

- 1)  $\pm 15\text{kV}$  using the Human Body Model
- 2)  $\pm 8\text{kV}$  using the Contact-Discharge method specified in IEC 1000-4-2
- 3)  $\pm 15\text{kV}$  using IEC 1000-4-2's Air-Gap method.

### ESD Test Conditions

ESD performance depends on a variety of conditions. Contact Method for a reliability report that documents test setup, test methodology, and test results.

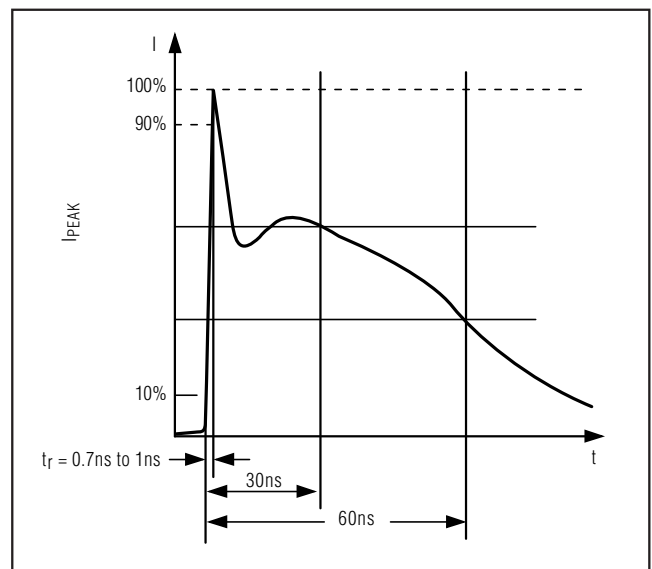


Figure 7b. IEC 1000-4-2 ESD Generator Current Waveform

### Human Body Model

Figure 6a shows the Human Body Model and Figure 6b 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 test device through a 1.5kΩ resistor.

### IEC 1000-4-2

The IEC 1000-4-2 standard covers ESD testing and performance of finished equipment; it does not specifically refer to integrated circuits. The MAX6816/MAX6817/MAX6818 help you design equipment that

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meets Level 4 (the highest level) of IEC 1000-4-2, without the need for additional ESD-protection components.

The major difference between tests done using the Human Body Model and IEC 1000-4-2 is higher peak current in IEC 1000-4-2, because series resistance is lower in the IEC 1000-4-2 model. Hence, the ESD withstand voltage measured to IEC 1000-4-2 is generally lower than that measured using the Human Body Model. Figure 7a shows the IEC 1000-4-2 model and Figure 7b shows the current waveform for the 8kV, IEC 1000-4-2, Level 4, ESD Contact-Discharge test.

The Air-Gap test involves approaching the device with a charged probe. The Contact-Discharge method connects the probe to the device before the probe is energized.

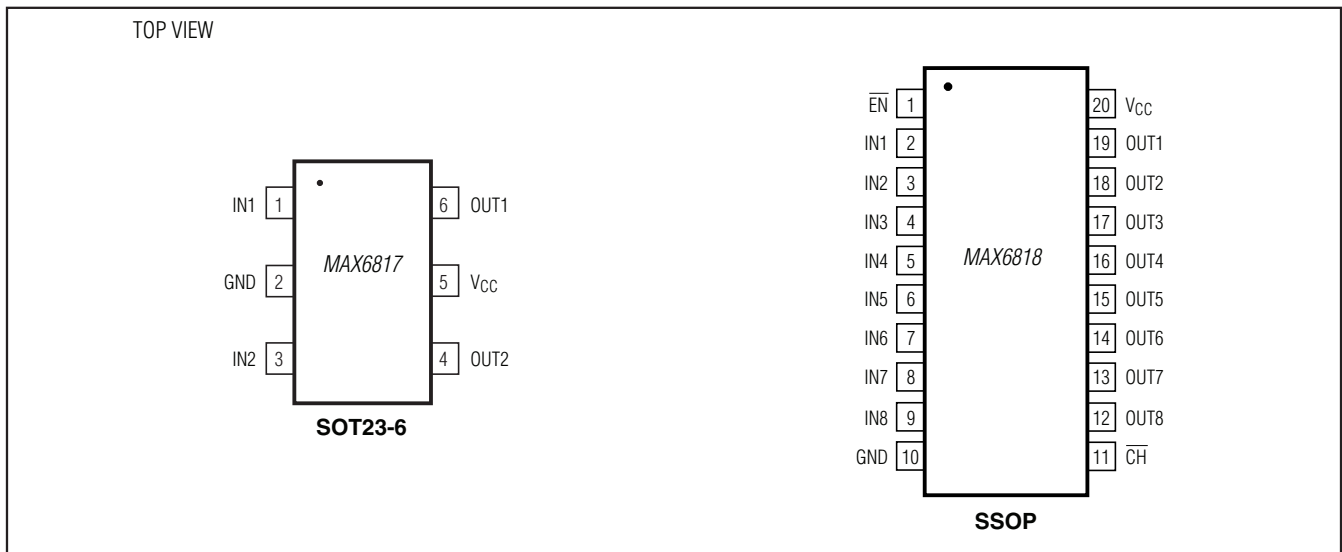
### Machine Model

The Machine Model for ESD tests all pins using a 200pF storage capacitor and zero discharge resistance. Its objective is to emulate the stress caused by contact that occurs with handling and assembly during manufacturing.

### MAX6818 $\mu\text{P}$ Interfacing

The MAX6818 has an output enable ( $\overline{\text{EN}}$ ) input that allows switch outputs to be three-stated on the  $\mu\text{P}$  data bus until polled by the  $\mu\text{P}$ . Also, state changes at the switch inputs are detected, and an output ( $\overline{\text{CH}}$ ) goes low after the debounce period to signal the  $\mu\text{P}$ . Figure 4 shows the timing diagram for enabling outputs and reading data. If the output enable is not used, tie  $\overline{\text{EN}}$  to GND to “always enable” the switch outputs. If  $\overline{\text{EN}}$  is low,  $\overline{\text{CH}}$  is always high. If a change of state is not required, leave  $\overline{\text{CH}}$  unconnected.

## Pin Configurations (continued)



### Chip Information

SUBSTRATE CONNECTED TO GND  
PROCESS: BiCMOS

### Package Information

For the latest package outline information and land patterns, go to [www.maxim-ic.com/packages](http://www.maxim-ic.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.
4 SOT143	U4-1	<a href="#">21-0052</a>	<a href="#">90-0183</a>
6 SOT23	U6-4	<a href="#">21-0058</a>	<a href="#">90-0175</a>
20 SSOP	A20-1	<a href="#">21-0056</a>	<a href="#">90-0094</a>



# MAX6816/MAX6817/MAX6818

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### **Revision History**

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	7/98	Initial release	—
3	8/10	Updated <i>Ordering Information</i> , <i>Electrical Characteristics</i> , <i>Typical Operating Characteristics</i> , and the <i>Undervoltage Lockout</i> section.	1–4, 7



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