

# MAXIM

## 3-Pin, Ultra-Low-Power SC70 Voltage Detectors

MAX6375-MAX6380

### General Description

The MAX6375–MAX6380 are ultra-low-power circuits used for monitoring battery, power-supply, and regulated system voltages. Each detector contains a precision bandgap reference, comparator, and internally trimmed resistors that set specified trip threshold voltages. These devices provide excellent circuit reliability and low cost by eliminating external components and adjustments when monitoring nominal system voltages from 2.5V to 5V.

These circuits perform a single function: they assert an output signal whenever the  $V_{CC}$  supply voltage falls below a preset threshold. The devices are differentiated by their output logic configurations and preset threshold voltages. The MAX6375/MAX6378 (push-pull) and MAX6377/MAX6380 (open-drain) have an active-low output ( $\overline{OUT}$  is logic low when  $V_{CC}$  is below  $V_{TH}$ ). The MAX6376/MAX6379 have an active-high push-pull output (OUT is logic high when  $V_{CC}$  is below  $V_{TH}$ ). All parts are guaranteed to be in the correct output logic state for  $V_{CC}$  down to 1V. The detector is designed to ignore fast transients on  $V_{CC}$ . The MAX6375/MAX6376/MAX6377 have voltage thresholds between 2.20V and 3.08V in approximately 100mV increments. The MAX6378/MAX6379/MAX6380 have voltage thresholds between 3.30V and 4.63V in approximately 100mV increments.

Ultra-low supply current of 500nA (MAX6375/MAX6376/MAX6377) makes these parts ideal for use in portable equipment. All six devices are available in space-saving SC70 packages.

### Applications

Precision Battery Monitoring  
Load Switching/Power Sequencing  
Power-Supply Monitoring in Digital/Analog Systems  
Portable/Battery-Powered Equipment

**Selector Guide appears at end of data sheet.**

### Features

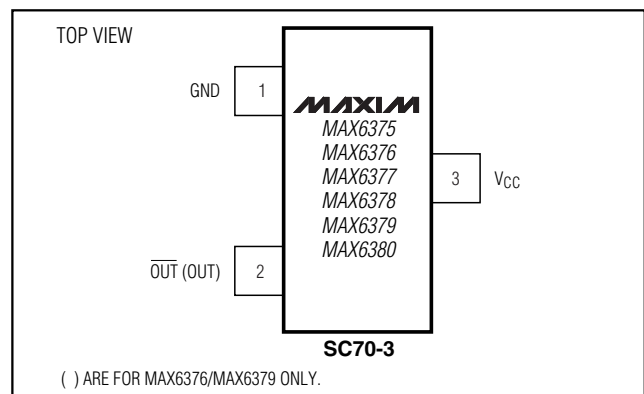
- ◆ Ultra-Low 500nA Supply Current (MAX6375/MAX6376/MAX6377)
- ◆ Thresholds Available from 2.20V to 4.63V in Approximately 100mV Increments
- ◆  $\pm 2.5\%$  Threshold Accuracy Over Temperature
- ◆ Low Cost
- ◆ Available in Three Versions: Push-Pull  $\overline{OUT}$ , Push-Pull OUT, and Open-Drain  $\overline{OUT}$
- ◆ Power-Supply Transient Immunity
- ◆ No External Components
- ◆ 3-Pin SC70 Package

### Ordering Information

PART <sup>†</sup>	TEMP. RANGE	PIN-PACKAGE
MAX6375XR__-T	-40°C to +85°C	3 SC70-3
MAX6376XR__-T	-40°C to +85°C	3 SC70-3
MAX6377XR__-T	-40°C to +85°C	3 SC70-3
MAX6378XR__-T	-40°C to +85°C	3 SC70-3
MAX6379XR__-T*	-40°C to +85°C	3 SC70-3
MAX6380XR__-T	-40°C to +85°C	3 SC70-3

<sup>†</sup>The MAX6375/MAX6376/MAX6377 are available in factory-preset thresholds from 2.20V to 3.08V, in approximately 0.1V increments. The MAX6378/MAX6379/MAX6380 are available in factory-preset thresholds from 3.30V to 4.63V, in approximately 0.1V increments. Choose the desired threshold suffix from Table 1 and insert it in the blank spaces following R. There are 21 standard versions, with a required order increment of 2500 pieces. Sample stock is generally held on the standard versions only (see the Selector Guide). The required order increment is 10,000 pieces for nonstandard versions (Table 2). Contact factory for availability. All devices available in tape-and-reel only.  
\*Future product—contact factory for availability.

### Pin Configuration



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# 3-Pin, Ultra-Low-Power SC70 Voltage Detectors

## ABSOLUTE MAXIMUM RATINGS

Terminal Voltage (with respect to GND)		Continuous Power Dissipation ( $T_A = +70^\circ\text{C}$ )
$V_{CC}$ .....	-0.3V to +6V	3-Pin SC70 (derate 2.17mW/ $^\circ\text{C}$ above +70 $^\circ\text{C}$ ).....
$\overline{\text{OUT}}$ , $\overline{\text{OUT}}$ (push-pull) .....	-0.3V to ( $V_{CC} + 0.3\text{V}$ )	174mW
$\overline{\text{OUT}}$ (open-drain) .....	-0.3V to +6V	Operating Temperature Range .....
Input Current ( $V_{CC}$ ).....	20mA	-40 $^\circ\text{C}$ to +85 $^\circ\text{C}$
Output Current ( $\overline{\text{OUT}}$ , $\overline{\text{OUT}}$ ).....	20mA	Storage Temperature Range .....
		-65 $^\circ\text{C}$ to +150 $^\circ\text{C}$
		Junction Temperature .....
		+150 $^\circ\text{C}$
		Lead Temperature (soldering, 10s) .....
		+300 $^\circ\text{C}$

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

( $V_{CC}$  = full range,  $T_A = -40^\circ\text{C}$  to +85 $^\circ\text{C}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ\text{C}$  and  $V_{CC} = 3\text{V}$ .) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	
V <sub>CC</sub> Operating Range		T <sub>A</sub> = 0 $^\circ\text{C}$ to +70 $^\circ\text{C}$	1.0		5.5	V	
		T <sub>A</sub> = -40 $^\circ\text{C}$ to +85 $^\circ\text{C}$	1.2		5.5		
Supply Current	I <sub>CC</sub>	MAX6375/76/77 only, V <sub>CC</sub> = 3.0V for V <sub>TH</sub> ≤ 2.93V, V <sub>CC</sub> = 3.2V for V <sub>TH</sub> > 2.93V, no load		0.5	1.0	μA	
		V <sub>CC</sub> = 5.5V, no load		1.0	1.75		
Voltage Threshold	V <sub>TH</sub>	Table 1	T <sub>A</sub> = +25 $^\circ\text{C}$	V <sub>TH</sub> - 1.5%	V <sub>TH</sub>	V <sub>TH</sub> + 1.5%	V
			T <sub>A</sub> = -40 $^\circ\text{C}$ to +85 $^\circ\text{C}$	V <sub>TH</sub> - 2.5%	V <sub>TH</sub>	V <sub>TH</sub> + 2.5%	
Voltage Threshold Tempco	ΔV <sub>TH</sub> / $^\circ\text{C}$			40		ppm/ $^\circ\text{C}$	
Propagation Delay		V <sub>CC</sub> = (V <sub>TH</sub> + 100mV) to (V <sub>TH</sub> - 100mV)		20		μs	
		V <sub>CC</sub> = (V <sub>TH</sub> - 100mV) to (V <sub>TH</sub> + 100mV)		42			
$\overline{\text{OUT}}$ Output Voltage (MAX6375/MAX6377/MAX6378/MAX6380)	V <sub>OL</sub>	I <sub>SINK</sub> = 1.6mA, V <sub>CC</sub> > 2.1V, $\overline{\text{OUT}}$ asserted			0.3	V	
		I <sub>SINK</sub> = 100μA, V <sub>CC</sub> ≥ 1.2V, $\overline{\text{OUT}}$ asserted			0.4		
$\overline{\text{OUT}}$ Output Voltage (MAX6375/MAX6377)	V <sub>OH</sub>	I <sub>SOURCE</sub> = 500μA, V <sub>CC</sub> = 3.2V, MAX6375 only		0.8 × V <sub>CC</sub>		V	
		I <sub>SOURCE</sub> = 800μA, V <sub>CC</sub> = 4.5V, V <sub>TH</sub> ≤ 4.38V		0.8 × V <sub>CC</sub>			
		I <sub>SOURCE</sub> = 800μA, V <sub>CC</sub> = V <sub>TH</sub> (MAX), V <sub>TH</sub> ≥ 4.5V		0.8 × V <sub>CC</sub>			
OUT Output Voltage (MAX6376/MAX6379)	V <sub>OH</sub>	I <sub>SOURCE</sub> = 500μA, V <sub>CC</sub> ≥ 2.1V, OUT asserted		0.8 × V <sub>CC</sub>		V	
		I <sub>SOURCE</sub> = 50μA, V <sub>CC</sub> ≥ 1.2V, OUT asserted		0.8 × V <sub>CC</sub>			
	V <sub>OL</sub>	I <sub>SINK</sub> = 1.2mA, V <sub>CC</sub> ≥ 3.2V, OUT not asserted, MAX6376 only			0.3		
		I <sub>SINK</sub> = 3.2mA, V <sub>CC</sub> ≥ 4.5V, OUT not asserted, V <sub>TH</sub> ≤ 4.38V			0.4		
		I <sub>SINK</sub> = 3.2mA, V <sub>CC</sub> = V <sub>TH</sub> (MAX), V <sub>TH</sub> ≥ 4.5V			0.4		
Voltage Threshold Hysteresis		MAX6375/MAX6376/MAX6377		6.3		mV	
		MAX6378/MAX6379/MAX6380		9.5			
Open-Drain $\overline{\text{OUT}}$ Output Leakage Current					0.1	μA	

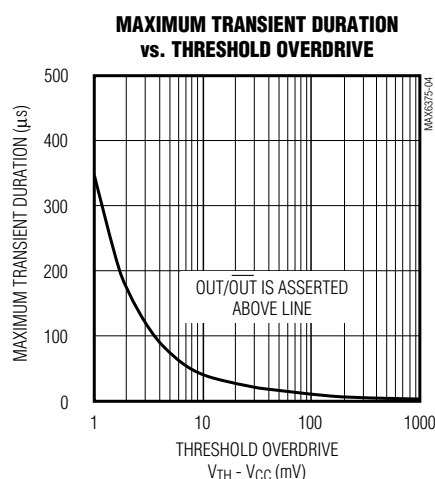
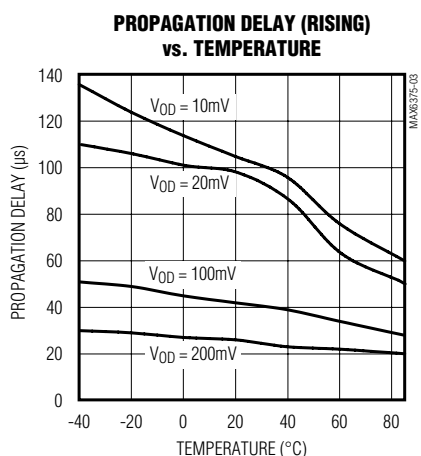
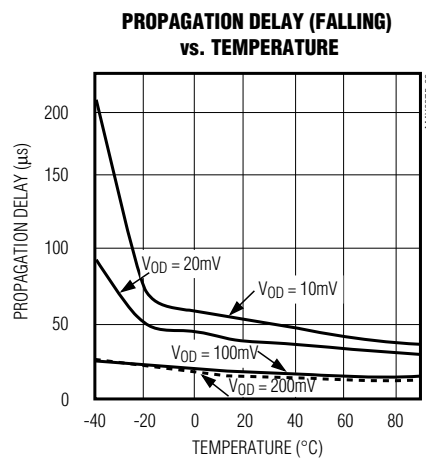
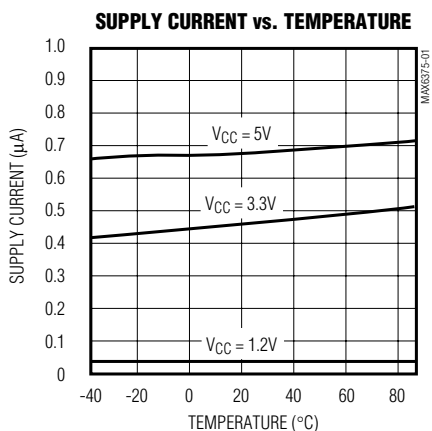
**Note 1:** Production tested at +25 $^\circ\text{C}$  only. Overtemperature limits are guaranteed by design, not production tested.

# 3-Pin, Ultra-Low-Power SC70 Voltage Detectors

## Typical Operating Characteristics

( $V_{CC} = 5$ ,  $T_A = +25^\circ\text{C}$ , unless otherwise noted.)

MAX6375-MAX6380



## Pin Description

PIN		NAME	FUNCTION
MAX6375/MAX6378 MAX6377/MAX6380	MAX6376 MAX6379		
1	1	GND	Ground
2	—	$\overline{\text{OUT}}$	Active-Low Output. $\overline{\text{OUT}}$ remains low while $V_{CC}$ is below the threshold. $\overline{\text{OUT}}$ is open-drain on the MAX6377/MAX6380 and push-pull on the MAX6375/MAX6378.
—	2	OUT	Active-High Output. OUT remains high while $V_{CC}$ is below the threshold.
3	3	$V_{CC}$	Supply Voltage

# 3-Pin, Ultra-Low-Power SC70 Voltage Detectors

## Applications Information

### Interfacing to Different Logic Voltage Components

The MAX6377/MAX6380 have an active-low, open-drain output. This output structure will sink current when  $\overline{\text{OUT}}$  is asserted. Connect a pull-up resistor from  $\overline{\text{OUT}}$  to any supply voltage up to 5.50V (Figure 1). Select a resistor value large enough to allow a valid logic low (see *Electrical Characteristics*), and small enough to register a logic high while supplying all input current and leakage paths connected to the  $\overline{\text{OUT}}$  line.

### Negative-Going Vcc Transients

These devices are relatively immune to short-duration, negative-going VCC transients (glitches). The *Typical Operating Characteristics* show the Maximum Transient Duration vs. Threshold Overdrive graph, for which output pulses are not generated. The graph shows the maximum pulse width that a negative-going VCC transient may typically have before the devices issue output signals. As the amplitude of the transient increases, the maximum-allowable pulse width decreases.

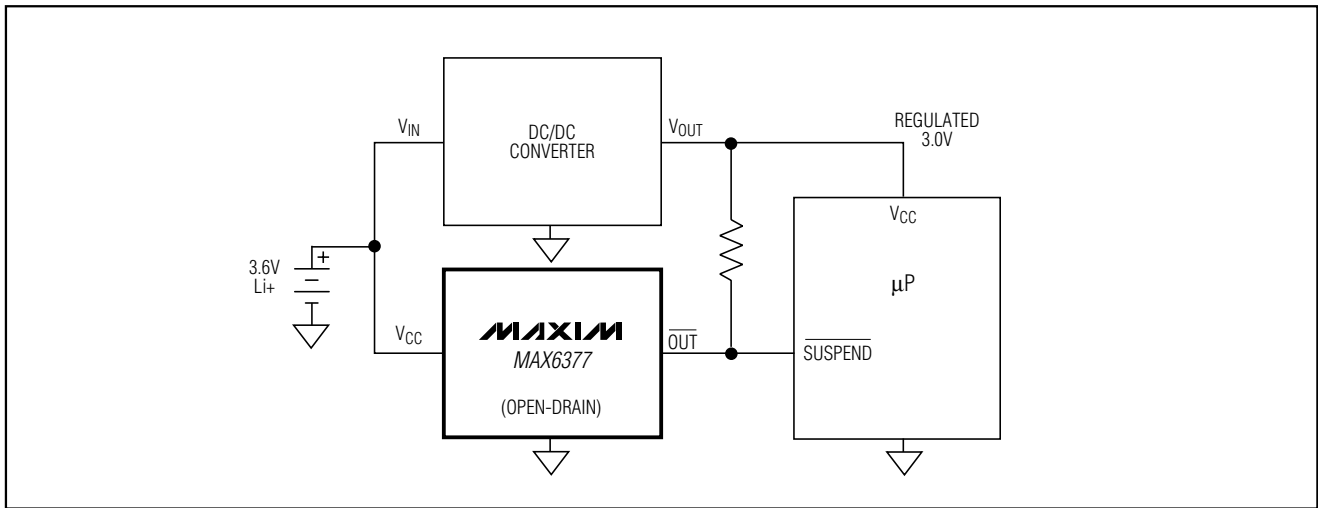


Figure 1. Interfacing to Different Logic Voltage Components

Table 1. Factory-Trimmed Voltage Thresholds‡

PART	SUFFIX	THRESHOLD VOLTAGE, $V_{\text{TH}}$ (V)				
		$T_A = +25^\circ\text{C}$			$T_A = -40^\circ\text{C TO } +85^\circ\text{C}$	
		MIN	TYP	MAX	MIN	MAX
MAX6375XR MAX6376XR MAX6377XR	22	2.167	2.200	2.233	2.145	2.250
	23	2.285	2.320	2.355	2.262	2.375
	24	2.364	2.400	2.436	2.340	2.460
	25	2.462	2.500	2.537	2.437	2.562
	26	2.591	2.630	2.669	2.564	2.696
	27	2.660	2.700	2.741	2.633	2.768
	28	2.758	2.800	2.842	2.730	2.870
	29	2.886	2.930	2.974	2.857	3.000
	30	2.955	3.000	3.045	2.925	3.075
31	3.034	3.080	3.126	3.003	3.150	

‡Factory-trimmed voltage thresholds are available in approximately 100mV increments with a 1.5% room-temperature variance.

# 3-Pin, Ultra-Low-Power SC70 Voltage Detectors

**MAX6375-MAX6380**

**Table 1. Factory-Trimmed Voltage Thresholds‡ (continued)**

PART	SUFFIX	THRESHOLD VOLTAGE, $V_{TH}$ (V)				
		$T_A = +25^\circ\text{C}$			$T_A = -40^\circ\text{C TO } +85^\circ\text{C}$	
		MIN	TYP	MAX	MIN	MAX
MAX6378XR MAX6379XR MAX6380XR	33	3.250	3.300	3.350	3.217	3.383
	34	3.349	3.400	3.451	3.315	3.485
	35	3.447	3.500	3.552	3.412	3.587
	36	3.546	3.600	3.654	3.510	3.690
	37	3.644	3.700	3.755	3.607	3.792
	38	3.743	3.800	3.857	3.705	3.895
	39	3.841	3.900	3.958	3.802	3.997
	40	3.940	4.000	4.060	3.900	4.100
	41	4.038	4.100	4.161	3.997	4.202
	42	4.137	4.200	4.263	4.095	4.305
	43	4.235	4.300	4.364	4.192	4.407
	44	4.314	4.380	4.446	4.270	4.489
	45	4.432	4.500	4.567	4.387	4.612
	46	4.560	4.630	4.699	4.514	4.746

‡Factory-trimmed voltage thresholds are available in approximately 100mV increments with a 1.5% room-temperature variance.

**Table 2. Device Marking Codes and Minimum Order Increments**

PART	TOP MARK (SC70)	ORDER INCREMENT (k)	PART	TOP MARK (SC70)	ORDER INCREMENT (k)
<b>MAX6375XR22-T</b>	ADH	2.5	MAX6376XR28-T	—	10
MAX6375XR23-T	ADI	2.5	MAX6376XR29-T	ADA	2.5
MAX6375XR24-T	—	10	MAX6376XR30-T	—	10
MAX6375XR25-T	—	10	MAX6376XR31-T	ADO	2.5
MAX6375XR26-T	ACZ	2.5	<b>MAX6377XR22-T</b>	ADP	2.5
MAX6375XR27-T	—	10	MAX6377XR23-T	ADB	2.5
MAX6375XR28-T	—	10	MAX6377XR24-T	—	10
MAX6375XR29-T	ADJ	2.5	MAX6377XR25-T	—	10
MAX6375XR30-T	—	10	MAX6377XR26-T	ADQ	2.5
MAX6375XR31-T	ADK	2.5	MAX6377XR27-T	—	10
<b>MAX6376XR22-T</b>	ADL	2.5	MAX6377XR28-T	—	10
MAX6376XR23-T	ADM	2.5	MAX6377XR29-T	ADC	2.5
MAX6376XR24-T	—	10	MAX6377XR30-T	—	10
MAX6376XR25-T	—	10	MAX6377XR31-T	ADR	2.5
MAX6376XR26-T	ADN	2.5	<b>MAX6378XR33-T</b>	—	10
MAX6376XR27-T	—	10	MAX6378XR34-T	—	10

## 3-Pin, Ultra-Low-Power SC70 Voltage Detectors

Table 2. Device Marking Codes and Minimum Order Increments (continued)

PART	TOP MARK (SC70)	ORDER INCREMENT (k)
MAX6378XR35-T	—	10
MAX6378XR36-T	—	10
MAX6378XR37-T	—	10
MAX6378XR38-T	—	10
MAX6378XR39-T	—	10
MAX6378XR40-T	—	10
MAX6378XR41-T	—	10
MAX6378XR42-T	—	10
MAX6378XR43-T	—	10
MAX6378XR44-T	ADS	2.5
MAX6378XR45-T	—	10
MAX6378XR46-T	ADD	2.5
<b>MAX6379XR33-T</b>	—	10
MAX6379XR34-T	—	10
MAX6379XR35-T	—	10
MAX6379XR36-T	—	10
MAX6379XR37-T	—	10
MAX6379XR38-T	—	10
MAX6379XR39-T	—	10
MAX6379XR40-T	—	10

PART	TOP MARK (SC70)	ORDER INCREMENT (k)
MAX6379XR41-T	—	10
MAX6379XR42-T	—	10
MAX6379XR43-T	—	10
MAX6379XR44-T	ADE	2.5
MAX6379XR45-T	—	10
MAX6379XR46-T	ADT	2.5
<b>MAX6380XR33-T</b>	—	10
MAX6380XR34-T	—	10
MAX6380XR35-T	—	10
MAX6380XR36-T	—	10
MAX6380XR37-T	—	10
MAX6380XR38-T	—	10
MAX6380XR39-T	—	10
MAX6380XR40-T	—	10
MAX6380XR41-T	—	10
MAX6380XR42-T	—	10
MAX6380XR43-T	—	10
MAX6380XR44-T	ADU	2.5
MAX6380XR45-T	—	10
MAX6380XR46-T	ADF	2.5

### Selector Guide (Standard Versions\*)

PART	NOMINAL V <sub>TH</sub> (V)
MAX63_XR46-T	4.63
MAX63_XR44-T	4.38
MAX63_XR31-T	3.08
MAX63_XR29-T	2.93
MAX63_XR26-T	2.63
MAX63_XR23-T	2.32
MAX63_XR22-T	2.20

\*Sample stock is generally held on all standard versions. Contact factory for availability of nonstandard versions.

### Chip Information

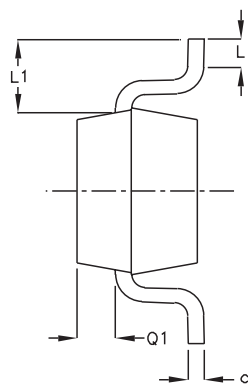
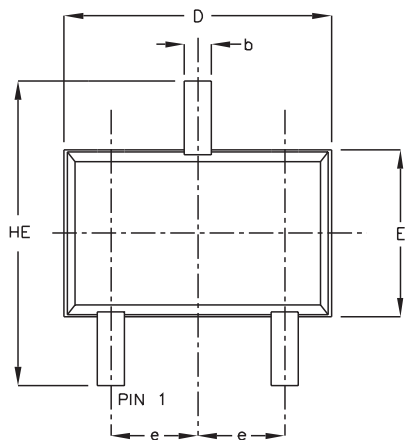
TRANSISTOR COUNT: 419

# 3-Pin, Ultra-Low-Power SC70 Voltage Detectors

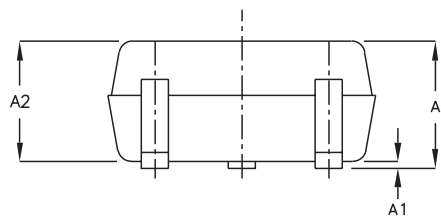
## Package Information

**MAX6375-MAX6380**

SC70, 3L EPS



SYMBOL	MIN	MAX
e	0.65	BSC
D	1.80	2.20
b	0.25	0.40
E	1.15	1.35
HE	1.80	2.40
Q1	0.10	0.40
A2	0.80	1.00
A1	0.00	0.10
A	0.80	1.10
c	0.10	0.18
L	0.10	0.30
L1	0.425	TYP.



**NOTE:**

1. ALL DIMENSIONS ARE IN MILLIMETERS
2. DIMENSIONS ARE INCLUSIVE OF PLATING
3. DIMENSIONS ARE EXCLUSIVE OF MOLD FLASH & METAL BURR
4. ALL SPECIFICATIONS COMPLY TO EIAJ SC70
5. COPLANARITY 4 MILS. MAX.

<b>MAXIM</b>			
<small>PROPRIETARY INFORMATION</small>			
<small>TITLE:</small>			
PACKAGE OUTLINE, SC70, 3L			
<small>APPROVAL</small>	<small>DOCUMENT CONTROL NO.</small>	<small>REV</small>	<small>REV</small>
	21-0075	B	1/1

# **3-Pin, Ultra-Low-Power SC70 Voltage Detectors**

## **NOTES**

*Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.*

**8** \_\_\_\_\_ **Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086 408-737-7600**