



**THE DATASHEET OF  
MAX836EUS+T**



## 4-Pin Micropower Voltage Monitors

### General Description

The MAX836/MAX837 micropower voltage monitors contain a 1.204V precision bandgap reference and a comparator in a SOT143 package. The MAX836 has an open-drain, n-channel output driver, while the MAX837 has a push-pull output driver. Two external resistors set the trip threshold voltage.

### Features

- ◆  $\pm 1.25\%$  Precision Voltage Threshold
- ◆ SOT143 Package
- ◆ Low Cost
- ◆  $< 5\mu\text{A}$  Typical Supply Current
- ◆ Open-Drain Output (MAX836)  
Push-Pull Output (MAX837)

### Applications

Precision Battery Monitor  
Load Switching  
Battery-Powered Systems  
Threshold Detectors

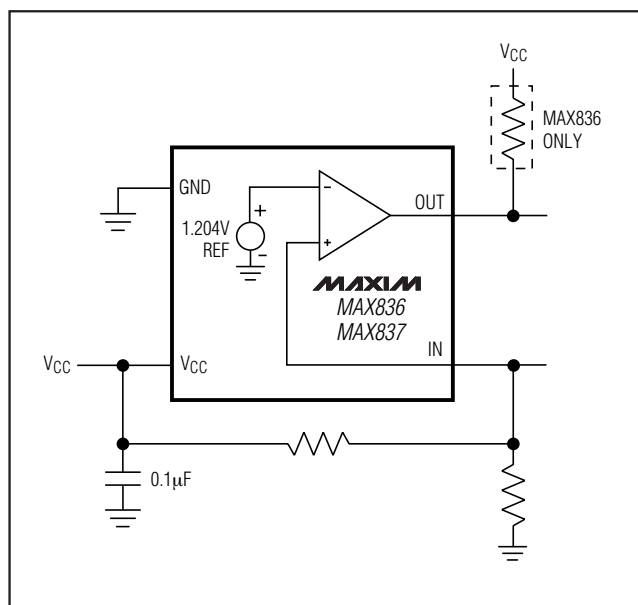
### Ordering Information

| PART*       | TEMP RANGE     | PIN-PACKAGE | TOP MARK |
|-------------|----------------|-------------|----------|
| MAX836EUS-T | -40°C to +85°C | 4 SOT143-4  | EQAA     |
| MAX837EUS-T | -40°C to +85°C | 4 SOT143-4  | ERAA     |

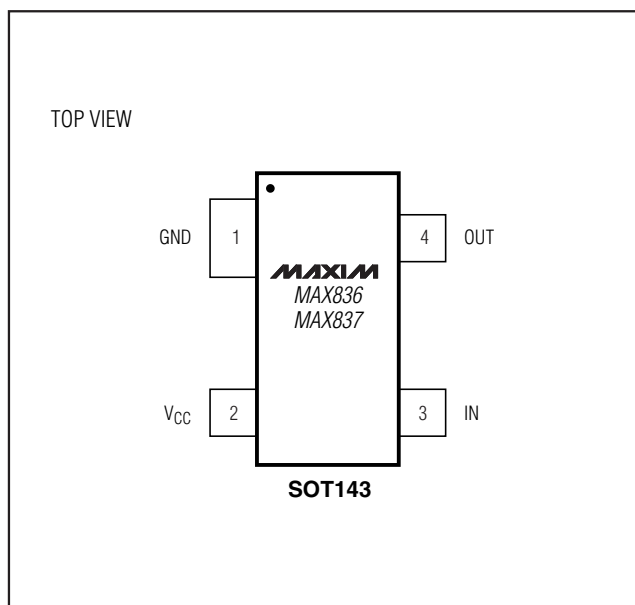
\*All devices available in tape-and-reel only. Contact factory for availability.

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

### Typical Operating Circuit



### Pin Configuration



# 4-Pin Micropower Voltage Monitors

## ABSOLUTE MAXIMUM RATINGS

|   |                                   |  |                 |
|---|-----------------------------------|--|-----------------|
| V <sub>CC</sub> , OUT to GND (MAX836) ..... | -0.3V to 12V                      | Rate of Rise, V <sub>CC</sub> .....            | 100V/μs         |
| IN, OUT to GND (MAX837) .....               | -0.3V to (V <sub>CC</sub> + 0.3V) | Continuous Power Dissipation                   |                 |
| Input Current                               |                                   | 4-Pin SOT143 (derate 4mW/°C above +70°C) ..... | 320mW           |
| V <sub>CC</sub> .....                       | 20mA                              | Operating Temperature Range .....              | -40°C to +85°C  |
| IN .....                                    | 10mA                              | Storage Temperature Range .....                | -65°C to +150°C |
| Output Current, OUT .....                   | 20mA                              | Lead Temperature (soldering, 10s) .....        | +300°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> = +2.5V to +11.0V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at T<sub>A</sub> = +25°C.)

| PARAMETER                           | SYMBOL            | CONDITIONS   |  | MIN                    | TYP                 | MAX   | UNITS |
|-------------------------------------|-------------------|--|--|------------------------|---------------------|-------|-------|
| Operating Voltage Range (Note 1)    | V <sub>CC</sub>   |  |  | 2.5                    |                     | 11.0  | V     |
| Supply Current (Note 2)             | I <sub>CC</sub>   | V <sub>IN</sub> = 1.16V, OUT = low   | V <sub>CC</sub> = 3.6V                 | T <sub>A</sub> = +25°C | 3.5                 | 6.5   | μA    |
|                                     |                   |  | V <sub>CC</sub> = full operating range |                        |                     | 15    |       |
|                                     |                   | V <sub>IN</sub> = 1.25V, OUT = high  | V <sub>CC</sub> = 3.6V                 | T <sub>A</sub> = +25°C | 2.0                 | 5.0   |       |
|                                     |                   |  | V <sub>CC</sub> = full operating range |                        |                     | 13    |       |
| Trip Threshold Voltage              | V <sub>TH</sub>   | V <sub>IN</sub> falling  | T <sub>A</sub> = +25°C                 | 1.185                  | 1.204               | 1.215 | V     |
|                                     |                   |  | T <sub>A</sub> = -40°C to +85°C        | 1.169                  | 1.204               | 1.231 |       |
| Trip Threshold Voltage Hysteresis   | V <sub>HYST</sub> | V <sub>CC</sub> = 5V, IN = low to high   |  |                        | 6                   |       | mV    |
| IN Operating Voltage Range (Note 1) | V <sub>IN</sub>   |  |  |                        | V <sub>CC</sub> - 1 |       | V     |
| IN Leakage Current (Note 3)         | I <sub>IN</sub>   | V <sub>IN</sub> = V <sub>TH</sub>  |  |                        | ±3                  | ±12   | nA    |
| Propagation Delay                   | t <sub>PL</sub>   | V <sub>CC</sub> = 5.0V, 50mV overdrive   |  |                        | 80                  |       | μs    |
| Glitch Immunity                     |                   | V <sub>CC</sub> = 5.0V, 100mV overdrive  |  |                        | 35                  |       | μs    |
| OUT Rise Time                       | t <sub>RT</sub>   | V <sub>CC</sub> = 5.0V, no load (MAX837 only)                                    |  |                        | 260                 |       | ns    |
| OUT Fall Time                       | t <sub>FT</sub>   | V <sub>CC</sub> = 5.0V, no load (MAX836 pull-up = 10kΩ)                          |  |                        | 680                 |       | ns    |
| Output Leakage Current (Note 4)     | I <sub>LOUT</sub> | V <sub>IN</sub> > V <sub>THMAX</sub> (MAX836 only)                               |  |                        |                     | ±1    | μA    |
| Output-Voltage High                 | V <sub>OH</sub>   | V <sub>IN</sub> > V <sub>THMAX</sub> , I <sub>SOURCE</sub> = 500μA (MAX837 only) |  | V <sub>CC</sub> - 0.5  |                     |       | V     |
| Output-Voltage Low                  | V <sub>OL</sub>   | V <sub>IN</sub> < V <sub>THMIN</sub> , I <sub>SINK</sub> = 500μA                 |  |                        |                     | 0.4   | V     |

**Note 1:** The voltage-detector output remains in the direct state for V<sub>CC</sub> down to 1.2V when V<sub>IN</sub> ≤ V<sub>CC</sub>/2.

**Note 2:** Supply current has a monotonic dependence on V<sub>CC</sub> (see the *Typical Operating Characteristics*).

**Note 3:** IN leakage current has a monotonic dependence on V<sub>CC</sub> (see the *Typical Operating Characteristics*).

**Note 4:** The MAX836 open-drain output can be pulled up to a voltage greater than V<sub>CC</sub>, but may not exceed 11V.

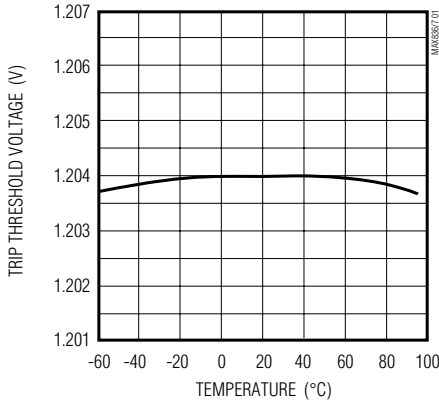
# 4-Pin Micropower Voltage Monitors

## Typical Operating Characteristics

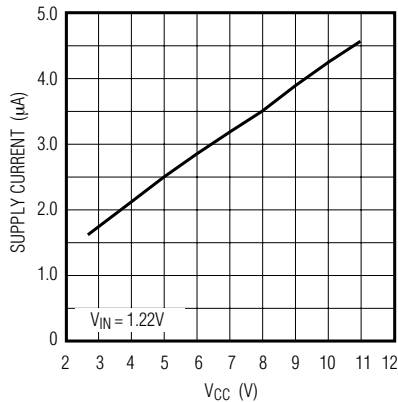
( $V_{CC} = +5V$ ,  $R_{LOAD} = 1M\Omega$ ,  $R_{PULLUP} = 10k\Omega$  (MAX836 only),  $T_A = +25^\circ C$ , unless otherwise noted.)

MAX836/MAX837

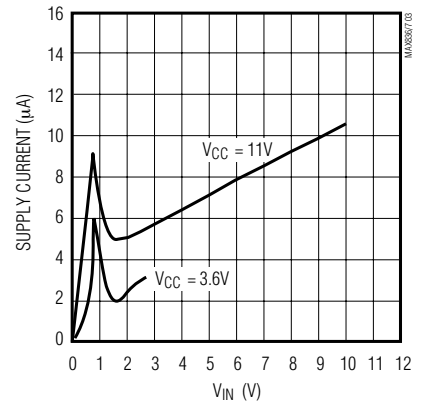
**TRIP THRESHOLD VOLTAGE vs. TEMPERATURE**



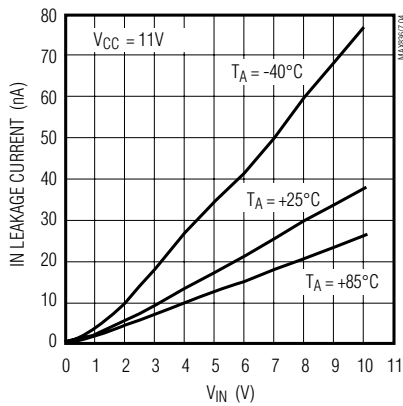
**SUPPLY CURRENT vs. SUPPLY VOLTAGE**



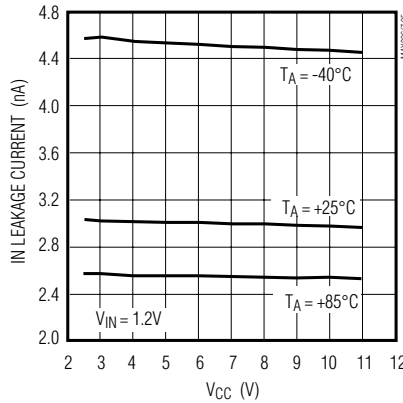
**SUPPLY CURRENT vs. IN VOLTAGE**



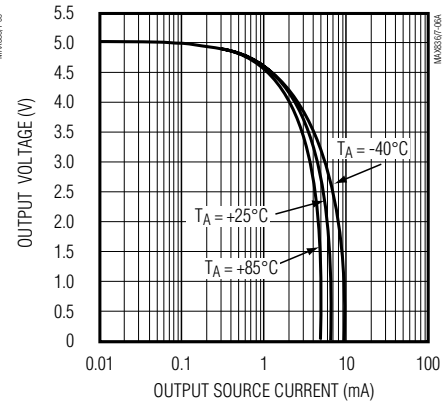
**IN LEAKAGE CURRENT vs. IN VOLTAGE**



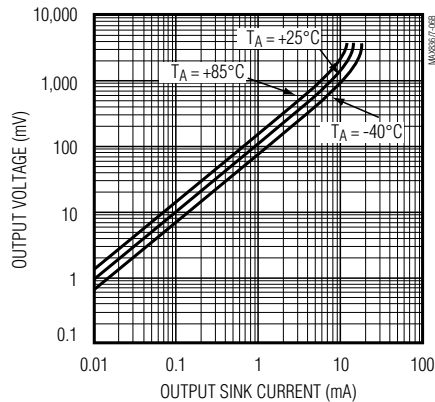
**IN LEAKAGE CURRENT vs. SUPPLY VOLTAGE**



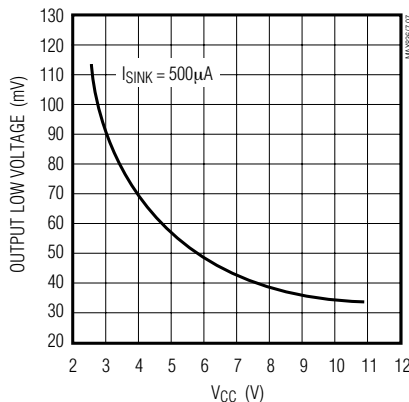
**MAX837 OUTPUT VOLTAGE vs. OUTPUT SOURCE CURRENT**



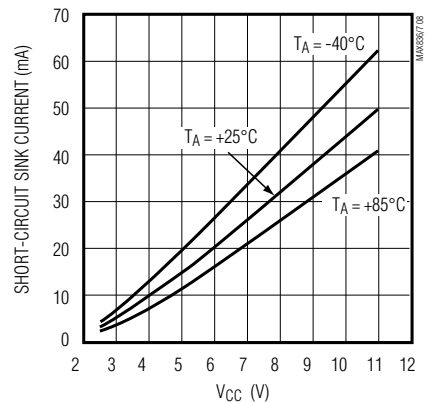
**OUTPUT VOLTAGE vs. OUTPUT SINK CURRENT**



**OUTPUT LOW VOLTAGE vs. SUPPLY VOLTAGE**



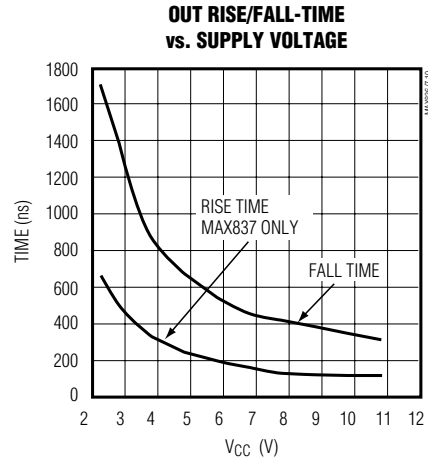
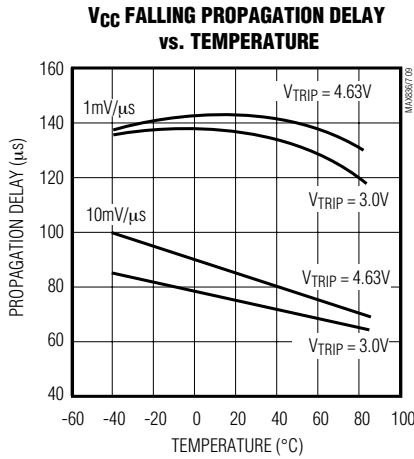
**SHORT-CIRCUIT SINK CURRENT vs. SUPPLY VOLTAGE**



# 4-Pin Micropower Voltage Monitors

## Typical Operating Characteristics (continued)

(V<sub>CC</sub> = +5V, R<sub>LOAD</sub> = 1MΩ, R<sub>PULLUP</sub> = 10kΩ (MAX836 only), T<sub>A</sub> = +25°C, unless otherwise noted.)



### Pin Description

| PIN | NAME | FUNCTION   |
|-----|------|--|
| 1   | GND  | System Ground  |
| 2   | VCC  | System Supply Input  |
| 3   | IN   | Noninverting Input to the Comparator. The inverting input connects to the internal 1.204V bandgap reference. |
| 4   | OUT  | Open-Drain (MAX836) or Push-Pull (MAX837) Output   |

### Detailed Description

The MAX836/MAX837 micropower voltage monitors contain a 1.204V precision bandgap reference and a comparator (see the *Typical Operating Circuit*). The only difference between the two parts is the structure of the comparator output driver. The MAX836 has an open-drain n-channel output driver that can be pulled up to a voltage higher than V<sub>CC</sub>, but under 11V. The MAX837's output is push-pull, and can both source and sink current.

#### Programming the Trip Voltage

Two external resistors set the trip voltage, V<sub>TRIP</sub> (Figure 1). V<sub>TRIP</sub> is the point at which the applied voltage (typically V<sub>CC</sub>) toggles OUT. The MAX836/MAX837's high input impedance allows large-value resistors without compromising trip-voltage accuracy. To minimize current consumption, select a value for R<sub>2</sub> between 500kΩ and 1MΩ, then calculate R<sub>1</sub> as follows:

$$R_1 = R_2 \left( \frac{V_{TRIP}}{V_{TH}} - 1 \right)$$

where V<sub>TRIP</sub> = desired trip voltage (in volts), V<sub>TH</sub> = threshold trip voltage (1.204V).

### Applications Information

#### Adding Hysteresis

Hysteresis adds noise immunity to the MAX836/MAX837 and prevents repeated triggering when V<sub>IN</sub> is near the threshold trip voltage. Figure 2 shows how to add hysteresis to the comparator. The technique is similar for

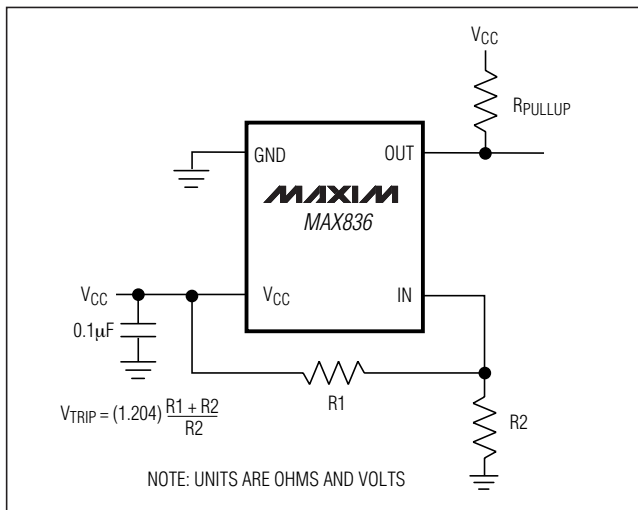


Figure 1. Programming the Trip Voltage, V<sub>TRIP</sub>

## 4-Pin Micropower Voltage Monitors

both parts. For the MAX836, select the ratio of resistors R1 and R2 so that IN sees 1.204V when the monitor voltage falls to or rises above the desired trip point (VTRIP). R3 adds hysteresis and is typically an order of magnitude larger than R1 or R2. The current through R1 and R2 should be at least 500nA to ensure that the 12nA maximum input current does not shift the trip point significantly. Capacitor C1 adds additional noise rejection.

### Monitoring Voltages Other than VCC

The MAX836/MAX837 can monitor voltages other than VCC (Figure 3). Calculate VTRIP as shown in the *Programming the Trip Voltage* section. The monitored voltage (VMON) is independent of VCC. VIN must be 1V less than VCC.

### Heater Temperature Control

Figure 4 shows a basic heater temperature-control circuit. Upon power-up, OUT is high and the n-channel MOSFET turns on. Current flows through the heating element (R4), warming the surrounding area. R2 is a negative-temperature-coefficient thermistor and as temperature increases, its resistance decreases. As the thermistor heats up and its resistance decreases, the MAX837's voltage at IN decreases until it reaches the 1.204V threshold voltage. At this point, OUT goes low, turning off the heating element. The thermistor cools and the voltage at IN rises until it overcomes the MAX837's hysteresis (6mV). OUT returns high when this point is reached, turning on the heating element again. This cycle repeats as long as power is applied.

Determine the thermistor's resistance (R2) at the desired temperature. Then, using R2's resistance and half the resistance of R3, calculate R1's value with the following formula:

$$R1 = (R2 + R3) \left( \frac{V_{CC}}{1.204} - 1 \right)$$

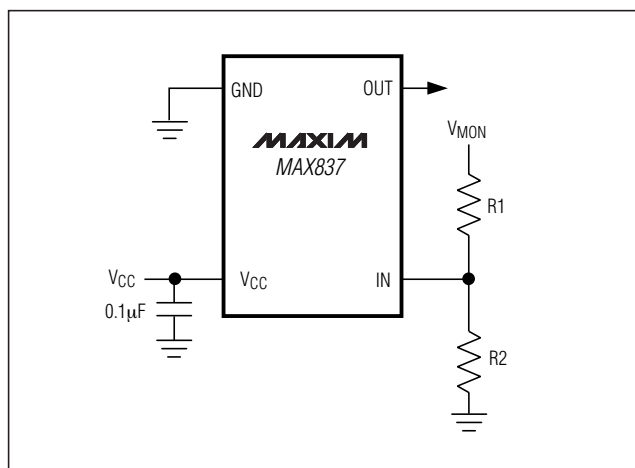


Figure 3. Monitoring Voltages Other than VCC

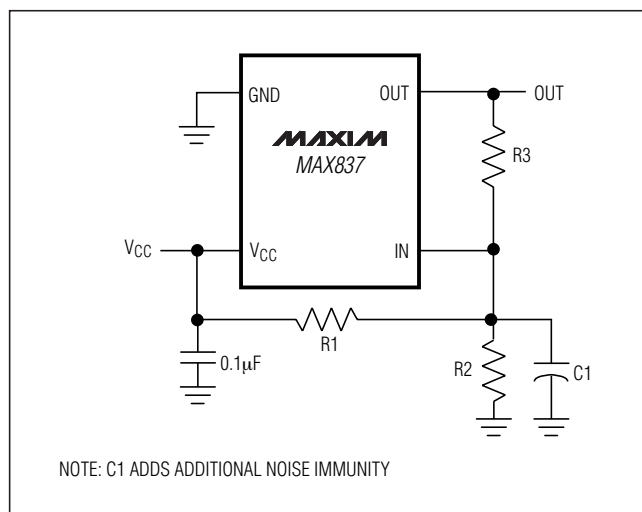


Figure 2. Adding Hysteresis to the Comparator

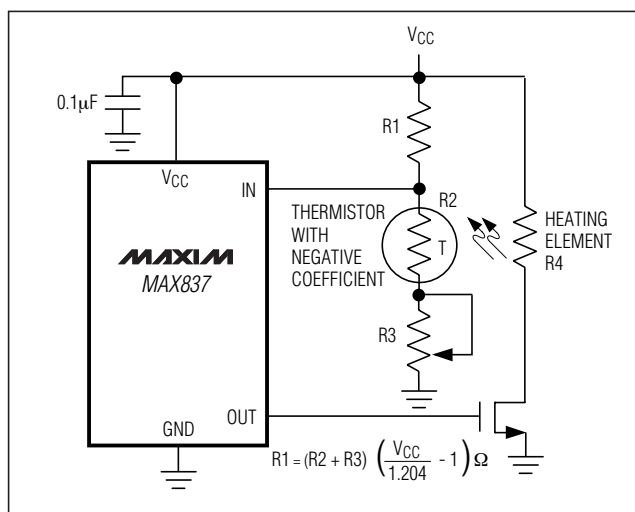


Figure 4. Heater Temperature Control

# 4-Pin Micropower Voltage Monitors

## Chip Information

TRANSISTOR COUNT: 54

## Package Information

For the latest package outline information and land patterns, go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).

| PACKAGE TYPE | PACKAGE CODE | DOCUMENT NO.            |
|--------------|--------------|-------------------------|
| 4 SOT143     | U4-1         | <a href="#">21-0052</a> |

# 4-Pin Micropower Voltage Monitors

## Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION   | PAGES CHANGED |
|-----------------|---------------|---|---------------|
| 0               | 9/96          | Initial release   | —             |
| 1               | 3/04          | Updated top mark information in the <i>Ordering Information</i> . | 1             |
| 2               | 12/05         | Added lead-free notation.   | 1             |
| 3               | 5/08          | Updated top mark information in the <i>Ordering Information</i> . | 1             |

MAX836/MAX837

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