19-1137; Rev 3; 5/08

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

- ♦ ±1.25% Precision Voltage Threshold
- ♦ SOT143 Package
- ♦ Low Cost
- ♦ < 5µA Typical Supply Current
- ♦ Open-Drain Output (MAX836)
  Push-Pull Output (MAX837)

Applications

Precision Battery Monitor

Load Switching

Battery-Powered Systems

Threshold Detectors

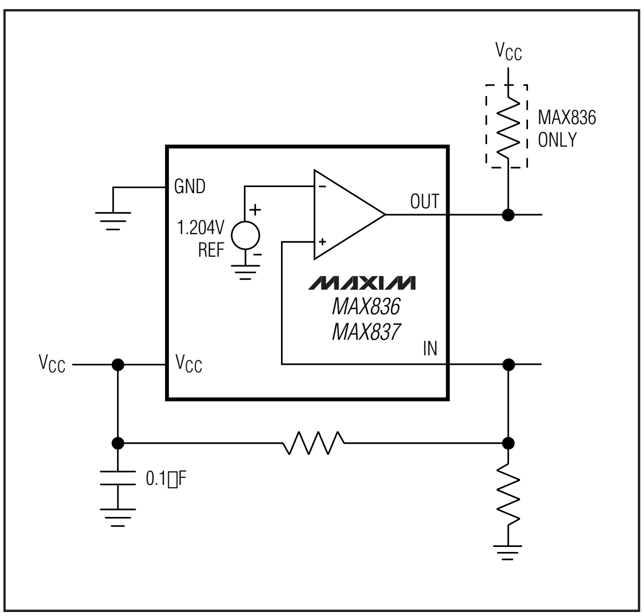
Ordering Information

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

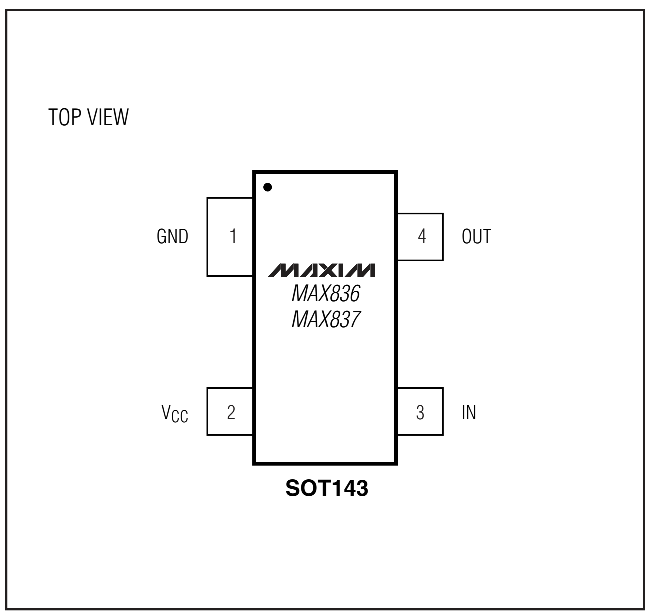
**All devices available in tape-and-reel only. Contact factory for availability.*

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_{CC}, OUT to GND (MAX836) ....-0.3V to 12V
IN, OUT to GND (MAX837).........................-0.3V to (V_{CC} + 0.3V)
Input Current
  V_{CC} 20mA
  IN...10mA
Output Current, OUT..20mA
Rate of Rise, V_{CC} 100V/µs
Continuous Power Dissipation
  4-Pin SOT143 (derate 4mW/°C above +70°C).............320mW
Operating Temperature Range ....-40°C to +85°C
Storage Temperature Range ....-65°C to +150°C
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_{CC} = +2.5V to +11.0V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.)

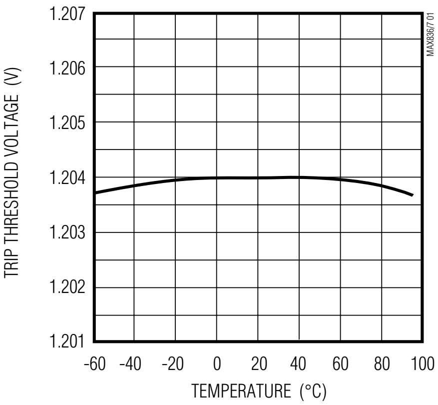
PARAMETER	SYMBOL	CONDITIONS			MIN	TYP	MAX	UNITS
Operating Voltage Range (Note 1)	V_{CC}				2.5		11.0	V
Supply Current (Note 2)	I_{CC}	V_{IN} = 1.16V, OUT = low	V_{CC} = 3.6V	T_A = +25°C		3.5	6.5	µA
				T_A = T_{MIN} to T_{MAX}			10	
			V_{CC} = full operating range				15	
		V_{IN} = 1.25V, OUT = high	V_{CC} = 3.6V	T_A = +25°C		2.0	5.0	
				T_A = T_{MIN} to T_{MAX}			8.0	
			V_{CC} = full operating range				13	
Trip Threshold Voltage	V_{TH}	V_{IN} falling	T_A = +25°C		1.185	1.204	1.215	V
			T_A = -40°C to +85°C		1.169	1.204	1.231	
Trip Threshold Voltage Hysteresis	V_{HYST}	V_{CC} = 5V, IN = low to high				6		mV
IN Operating Voltage Range (Note 1)	V_{IN}						V_{CC} - 1	V
IN Leakage Current (Note 3)	I_{IN}	V_{IN} = V_{TH}				±3	±12	nA
Propagation Delay	t_{PL}	V_{CC} = 5.0V, 50mV overdrive				80		µs
Glitch Immunity		V_{CC} = 5.0V, 100mV overdrive				35		µs
OUT Rise Time	t_{RT}	V_{CC} = 5.0V, no load (MAX837 only)				260		ns
OUT Fall Time	t_{FT}	V_{CC} = 5.0V, no load (MAX836 pull-up = 10kΩ)				680		ns
Output Leakage Current (Note 4)	I_{LOUT}	V_{IN} > V_{THMAX} (MAX836 only)					±1	µA
Output-Voltage High	V_{OH}	V_{IN} > V_{THMAX}, I_{SOURCE} = 500µA (MAX837 only)			V_{CC} - 0.5			V
Output-Voltage Low	V_{OL}	V_{IN} < V_{THMIN}, I_{SINK} = 500µA					0.4	V

Note 1: The voltage-detector output remains in the direct state for V_{CC} down to 1.2V when $V_{IN} \le V_{CC}/2$.
Note 2: Supply current has a monotonic dependence on V_{CC} (see the *Typical Operating Characteristics*).
Note 3: IN leakage current has a monotonic dependence on V_{CC} (see the *Typical Operating Characteristics*).
Note 4: The MAX836 open-drain output can be pulled up to a voltage greater than V_{CC}, but may not exceed 11V.

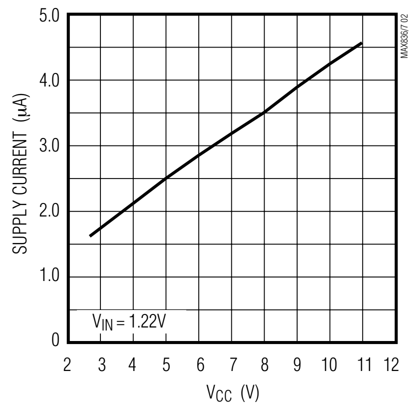
Typical Operating Characteristics

(V_{CC} = +5V, R_{LOAD} = 1MΩ, R_{PULLUP} = 10kΩ (MAX836 only), T_A = +25°C, unless otherwise noted.)

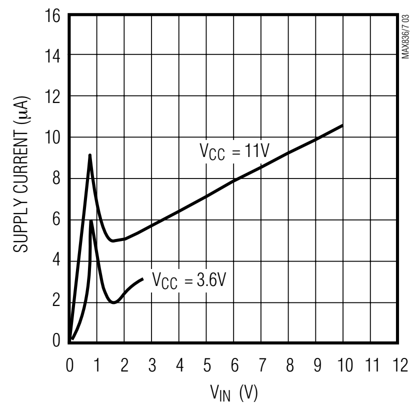
TRIP THRESHOLD VOLTAGE vs. TEMPERATURE



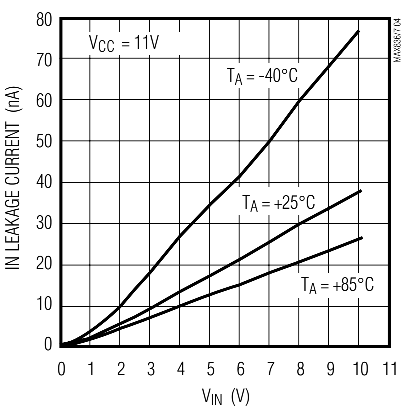
SUPPLY CURRENT vs. SUPPLY VOLTAGE



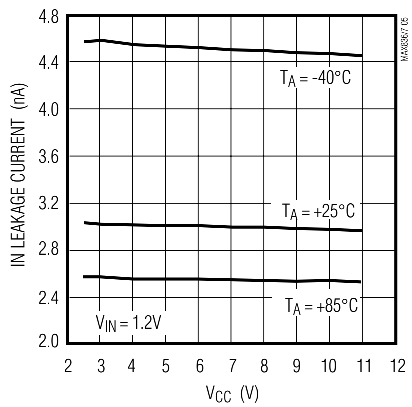
SUPPLY CURRENT vs. IN VOLTAGE



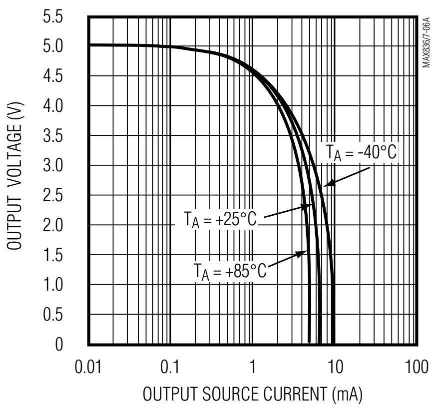
IN LEAKAGE CURRENT vs. IN VOLTAGE



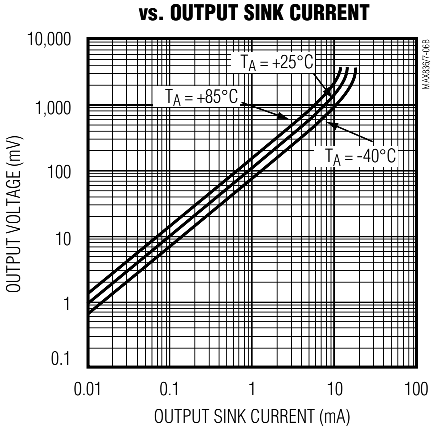
IN LEAKAGE CURRENT vs. SUPPLY VOLTAGE



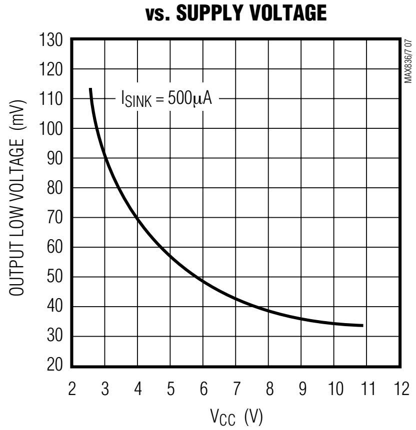
MAX837 OUTPUT VOLTAGE vs. OUTPUT SOURCE CURRENT



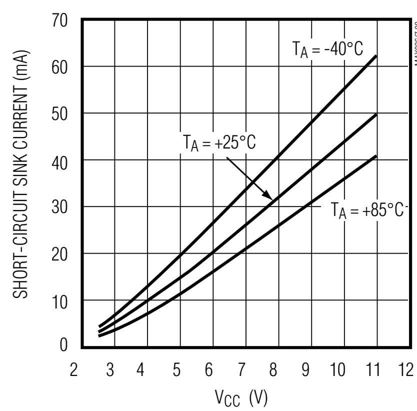
OUTPUT VOLTAGE vs. OUTPUT SINK CURRENT



OUTPUT LOW VOLTAGE vs. SUPPLY VOLTAGE



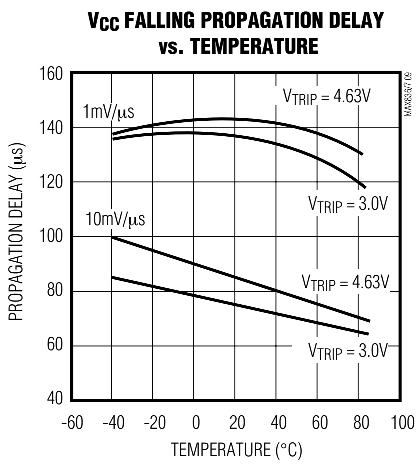
SHORT-CIRCUIT SINK CURRENT vs. SUPPLY VOLTAGE

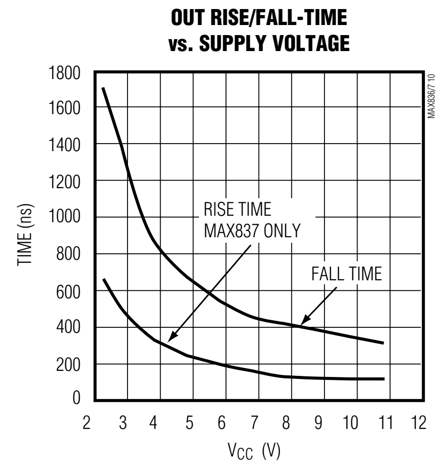


4-Pin Micropower Voltage Monitors

Typical Operating Characteristics (continued)

(V_{CC} = +5V, R_{LOAD} = 1MΩ, R_{PULLUP} = 10kΩ (MAX836 only), T_A = +25°C, unless otherwise noted.)





Pin Description

PIN	NAME	FUNCTION
1	GND	System Ground
2	V_{CC}	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

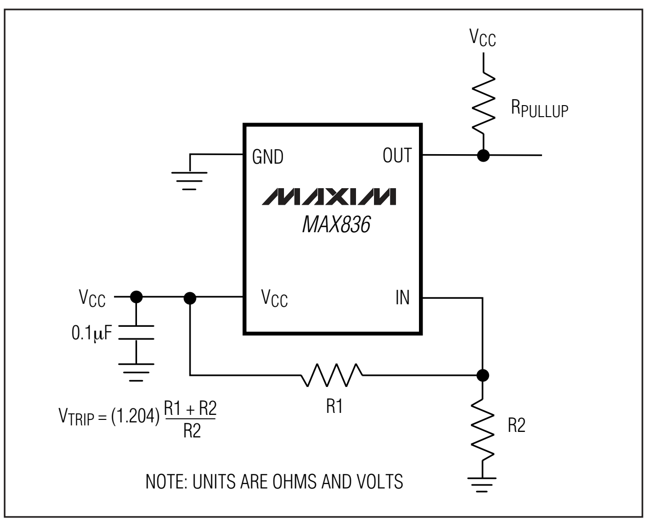


Figure 1. Programming the Trip Voltage, V_{TRIP}

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_{CC}, 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_{TRIP} (Figure 1). V_{TRIP} is the point at which the applied voltage (typically V_{CC}) 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 R2 between 500kΩ and 1MΩ, then calculate R1 as follows:

$$R1 = R2\left(\frac{V_{TRIP}}{V_{TH}} - 1\right)$$

where V_{TRIP} = desired trip voltage (in volts), V_{TH} = threshold trip voltage (1.204V).

Applications Information

Adding Hysteresis

Hysteresis adds noise immunity to the MAX836/MAX837 and prevents repeated triggering when V_{IN} is near the threshold trip voltage. Figure 2 shows how to add hysteresis to the comparator. The technique is similar for 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 (V_{TRIP}). 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 V_{CC}

The MAX836/MAX837 can monitor voltages other than V_{CC} (Figure 3). Calculate V_{TRIP} as shown in the *Programming the Trip Voltage* section. The monitored voltage (V_{MON}) is independent of V_{CC}. V_{IN} must be 1V less than V_{CC}.

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:

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

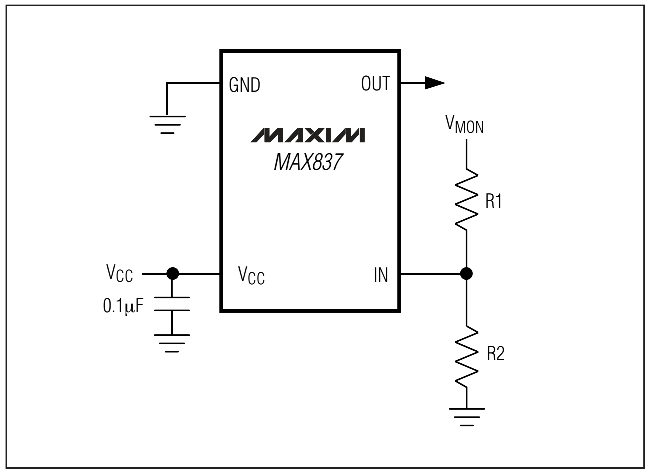


Figure 3. Monitoring Voltages Other than V_{CC}

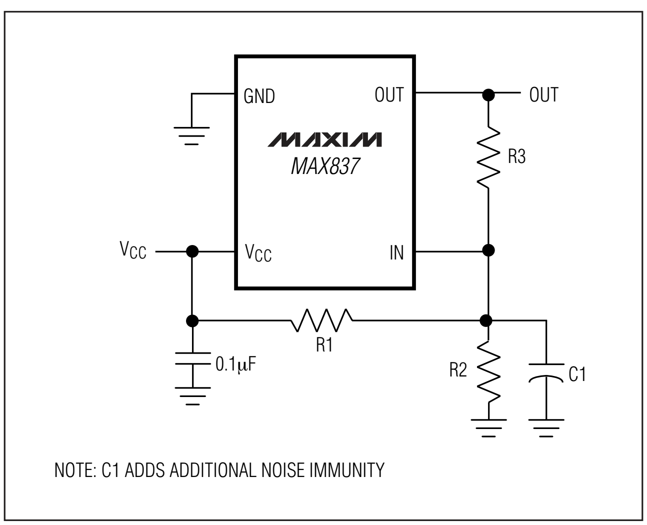


Figure 2. Adding Hysteresis to the Comparator

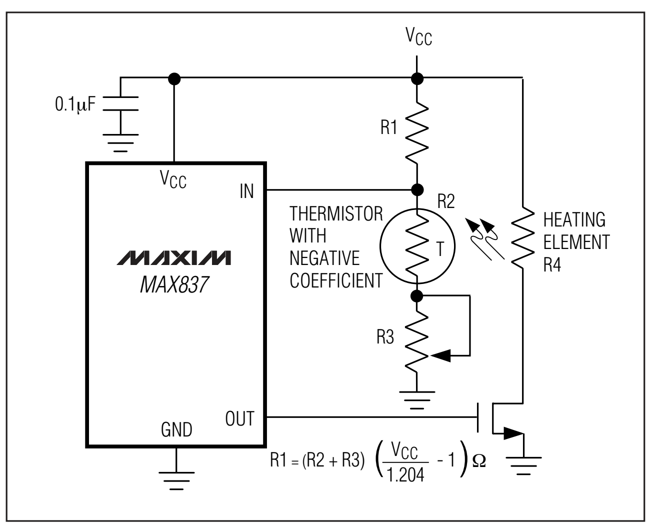


Figure 4. Heater Temperature Control

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**.

PACKAGE TYPE	PACKAGE CODE	DOCUMENT NO.
4 SOT143	U4-1	**21-0052**

Revision History

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