



# Micropower, Latching Voltage Monitors in SOT23-5

MAX834/MAX835

## General Description

The MAX834/MAX835 micropower voltage monitors contain a 1.204V precision bandgap reference, comparator, and latched output in a 5-pin SOT23 package. Using the latched output prevents deep discharge of batteries. The MAX834 has an open-drain, n-channel output driver, while the MAX835 has a push-pull output driver. Two external resistors set the trip-threshold voltage.

The MAX834/MAX835 feature a level-sensitive latch, eliminating the need to add hysteresis to prevent oscillations in battery-load-disconnect applications.

## Applications

Precision Battery Monitors  
Load Switching  
Battery-Powered Systems  
Threshold Detectors

## Features

- ◆ Prevent Deep Discharge of Batteries
- ◆ Precision  $\pm 1.25\%$  Voltage Threshold
- ◆ Latched Output (Once Low, Stays Low Until Cleared)
- ◆ SOT23-5 Package
- ◆ Low Cost
- ◆ +2.5V to +11V Wide Operating Voltage Range
- ◆  $< 2\mu\text{A}$  Typical Supply Current
- ◆ Open-Drain Output (MAX834)/Push-Pull Output (MAX835)

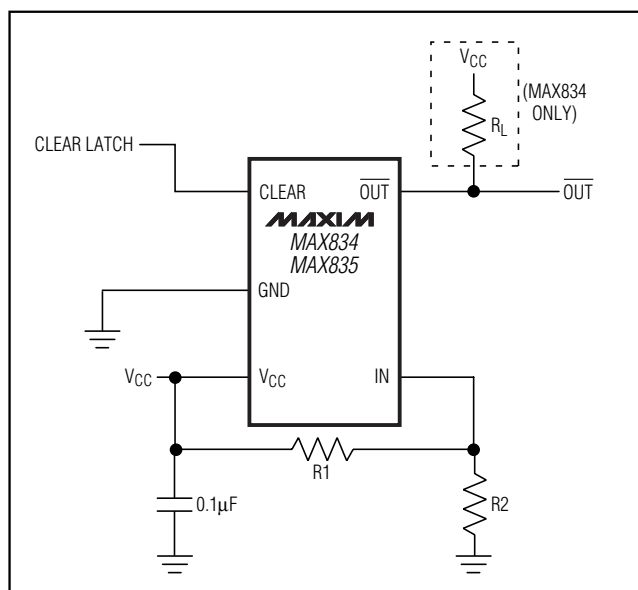
## Ordering Information

PART	PIN-PACKAGE	TOP MARK
MAX834EUK-T	5 SOT23	AAAX
MAX835EUK-T	5 SOT23	AAAY

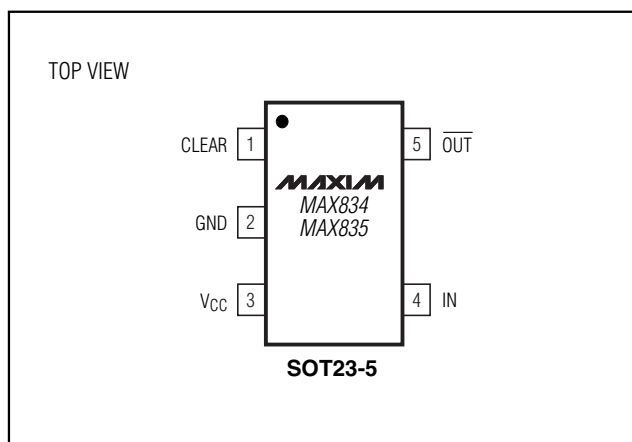
**Note:** All devices are specified over the  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  operating temperature range.

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

## Typical Operating Circuit



## Pin Configuration



# Micropower, Latching Voltage Monitors in SOT23-5

## ABSOLUTE MAXIMUM RATINGS

$V_{CC}$ , $\overline{OUT}$ (MAX834), CLEAR to GND .....	-0.3V to +12V
IN, $\overline{OUT}$ (MAX835) to GND.....	-0.3V to ( $V_{CC} + 0.3V$ )
INPUT Current	
$V_{CC}$ .....	20mA
IN.....	10mA
OUTPUT Current.....	-20mA
$V_{CC}$ Rate of Rise .....	100V/ $\mu$ s

Continuous Power Dissipation ( $T_A = +70^\circ\text{C}$ )	
5-Pin SOT23 (derate 7.1mW/C above $+70^\circ\text{C}$ ) .....	571mW
Operating Temperature Range .....	$-40^\circ\text{C}$ to $+85^\circ\text{C}$
Storage Temperature Range .....	$-65^\circ\text{C}$ to $+150^\circ\text{C}$
Lead Temperature (soldering, 10s) .....	$+300^\circ\text{C}$
Soldering Temperature (reflow) .....	$+240^\circ\text{C}$

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

( $V_{CC} = +2.5V$  to  $+11V$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ\text{C}$ .)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS	
Operating Voltage Range (Note 1)	$V_{CC}$			2.5		11.0	V	
Supply Current (Note 2)	$I_{CC}$	$V_{IN} = 1.6V$ , $\overline{OUT} =$ low, $V_{CLEAR} \geq$ $V_{CC} - 0.25V$ or $V_{CLEAR} \leq 0.25V$	$V_{CC} = 3.6V$	$T_A = +25^\circ\text{C}$	2.4	5	$\mu\text{A}$	
				$T_A = T_{MIN}$ to $T_{MAX}$		10		
		$V_{CC} =$ full operating range						15
		$V_{IN} = 1.25V$ , $\overline{OUT} =$ high, $V_{CLEAR} \geq$ $V_{CC} - 0.25V$ or $V_{CLEAR} \leq 0.25V$	$V_{CC} = 3.6V$	$T_A = +25^\circ\text{C}$	1.1	4		
	$T_A = T_{MIN}$ to $T_{MAX}$			8				
		$V_{CC} =$ full operating range				13		
Threshold Voltage	$V_{TH}$	$V_{IN}$ falling	$T_A = +25^\circ\text{C}$	1.185	1.204	1.215	V	
			$T_A = 0^\circ\text{C}$ to $+70^\circ\text{C}$	1.169	1.204	1.231		
Threshold Voltage Hysteresis	$V_{HYST}$	$V_{CC} = 5V$ , IN = low to high			6		mV	
IN Operating Voltage Range (Note 1)	$V_{IN}$			0		$V_{CC} - 1$	V	
IN Leakage Current (Note 3)	$I_{IN}$	$V_{IN} = V_{TH}$			$\pm 3$	$\pm 12$	nA	
Propagation Delay	$t_{PL}$	$V_{CC} = 5V$ , 50mV overdrive			80		$\mu\text{s}$	
Glitch Immunity		$V_{CC} = 5V$ , 100mV overdrive			35		$\mu\text{s}$	
OUT Rise Time	$t_{RT}$	$V_{CC} = 5V$ , no load (MAX835 only)			200		ns	
OUT Fall Time	$t_{FT}$	$V_{CC} = 5V$ , no load (MAX834 pullup = 10k $\Omega$ )			480		ns	
Output Leakage Current (Note 4)	$I_{LOUT}$	$V_{IN} > V_{TH(MAX)}$ (MAX834 only)				$\pm 1$	$\mu\text{A}$	
Output-Voltage High	$V_{OH}$	$V_{IN} > V_{TH(MAX)}$ , $I_{SOURCE} = 500\mu\text{A}$ (MAX835 only)		$V_{CC} - 0.5$			V	
Output-Voltage Low	$V_{OL}$	$V_{IN} < V_{TH(MIN)}$ , $I_{SINK} = 500\mu\text{A}$				0.4	V	
CLEAR Input High Voltage	$V_{CIH}$			2			V	

# Micropower, Latching Voltage Monitors in SOT23-5

MAX834/MAX835

## ELECTRICAL CHARACTERISTICS (continued)

( $V_{CC} = +2.5V$  to  $+11V$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ C$ .)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
CLEAR Input Low Voltage	$V_{CIL}$				0.4	V
CLEAR Input Leakage Current	$i_{CLEAR}$			$\pm 1$	$\pm 100$	nA
CLEAR Input Pulse Width	$t_{CLR}$		1			$\mu s$

**Note 1:** The voltage-detector output remains in the correct state for  $V_{CC}$  down to 1.2V when  $V_{IN} \leq V_{CC}/2$ .

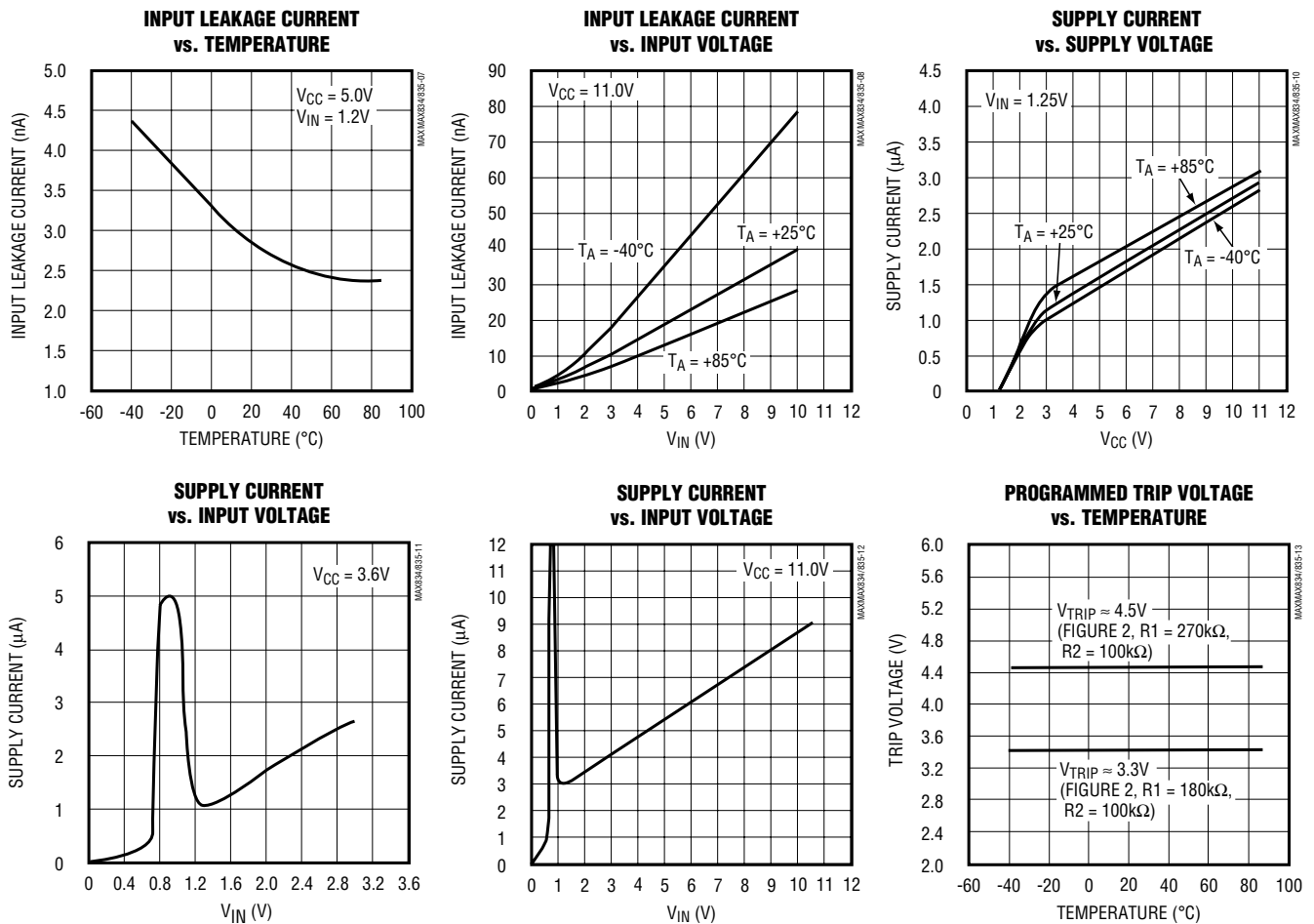
**Note 2:** Supply current has a monotonic dependence on  $V_{CC}$  (see the *Typical Operating Characteristics*).

**Note 3:** IN leakage current has a monotonic dependence on  $V_{CC}$  (see the *Typical Operating Characteristics*).

**Note 4:** The MAX834 open-drain output can be pulled up to a voltage greater than  $V_{CC}$ , but may not exceed 11V.

## Typical Operating Characteristics

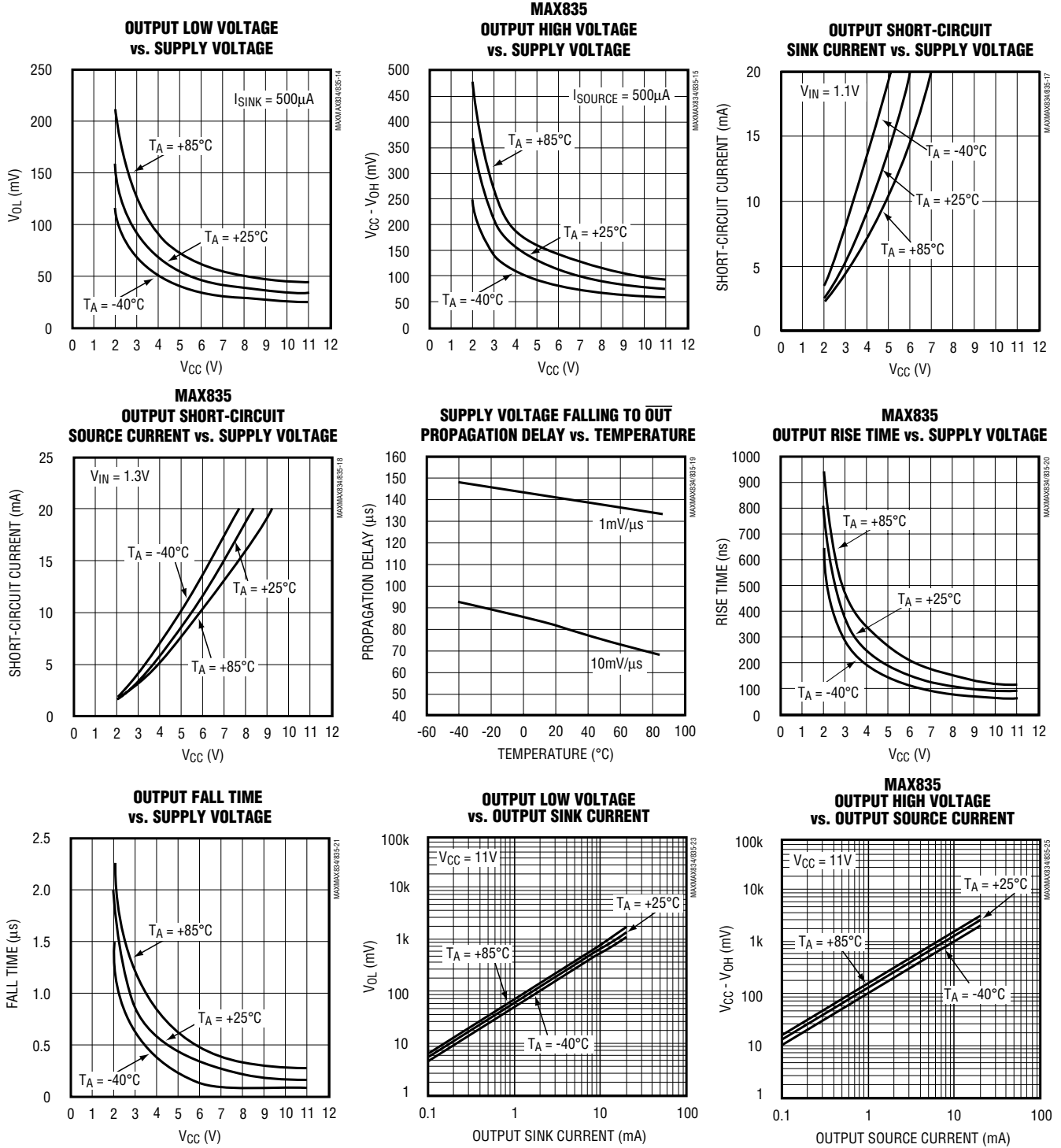
( $V_{CC} = +5V$ , Typical Operating Circuit,  $T_A = +25^\circ C$ , unless otherwise noted.)



# Micropower, Latching Voltage Monitors in SOT23-5

## Typical Operating Characteristics (continued)

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

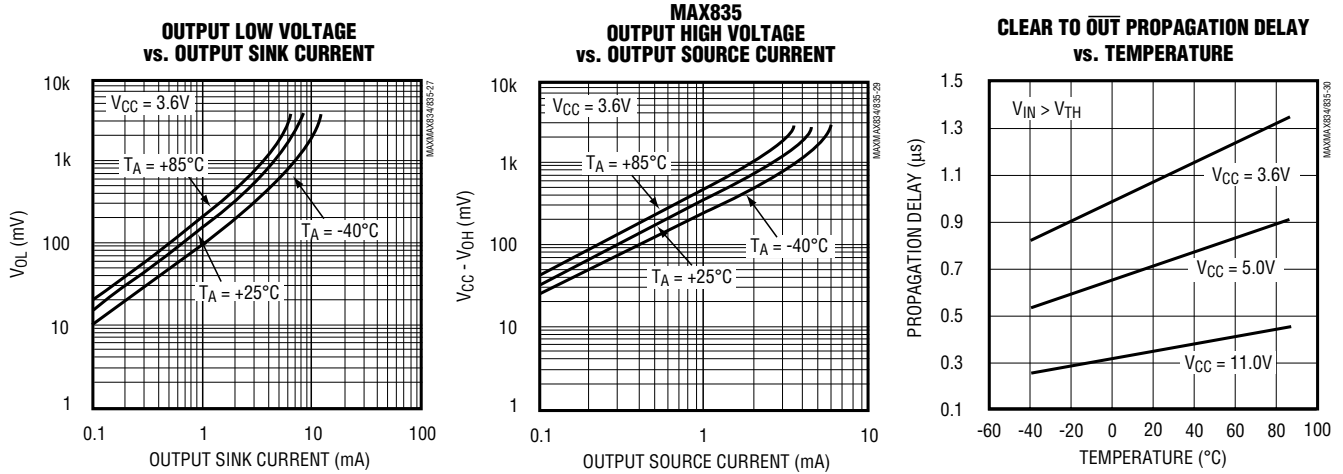


# Micropower, Latching Voltage Monitors in SOT23-5

MAX834/MAX835

## Typical Operating Characteristics (continued)

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



## Pin Description

PIN	NAME	FUNCTION
1	CLEAR	Clear Input Resets the Latched Output. With $V_{IN} > V_{TH}$ , pulse CLEAR high for a minimum of $1\mu s$ to reset the output latch. Connect to $V_{CC}$ to make the latch transparent.
2	GND	System Ground
3	$V_{CC}$	System Supply Input
4	IN	Noninverting Input to the Comparator. The inverting input connects to the internal 1.204V bandgap reference.
5	$\overline{OUT}$	Open-Drain (MAX834) or Push-Pull (MAX835) Latched Output. $\overline{OUT}$ is active-low.

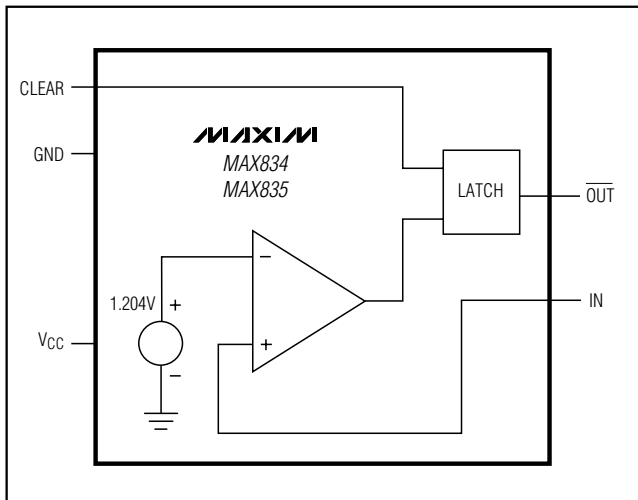


Figure 1. Functional Diagram

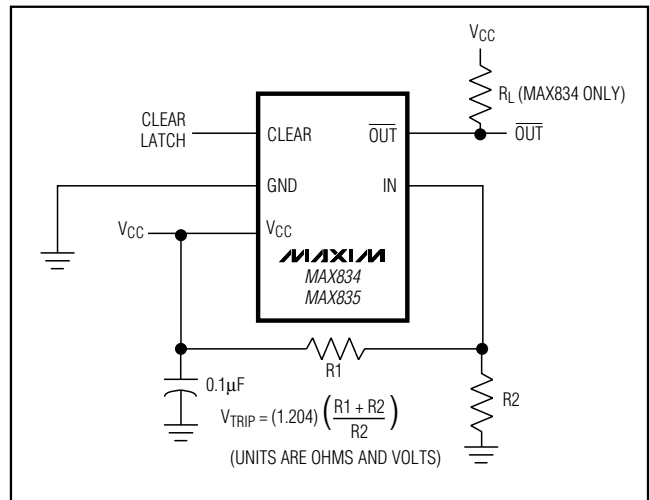


Figure 2. Programming the Trip Voltage ( $V_{TRIP}$ )

# Micropower, Latching Voltage Monitors in SOT23-5

## Detailed Description

The MAX834/MAX835 micropower voltage monitors contain a 1.204V precision bandgap reference and a comparator with an output latch (Figure 1). The difference between the two parts is the structure of the comparator output driver. The MAX834 has an open-drain, n-channel output driver that can be pulled up to a voltage higher than  $V_{CC}$ , but less than 11V. The MAX835's output is push-pull and can both source and sink current.

### Programming the Trip Voltage ( $V_{TRIP}$ )

Two external resistors set the trip voltage,  $V_{TRIP}$  (Figure 2).  $V_{TRIP}$  is the point at which the falling monitored voltage (typically  $V_{CC}$ ) causes  $\overline{OUT}$  to go low. IN's high input impedance allows the use of large-value resistors without compromising trip voltage accuracy. To minimize current consumption, choose a value for  $R_2$  between 500k $\Omega$  and 1M $\Omega$ , then calculate  $R_1$  as follows:

$$R_1 = R_2 [(V_{TRIP} / V_{TH}) - 1]$$

where  $V_{TRIP}$  is the desired trip voltage and  $V_{TH}$  is the threshold voltage (1.204V). The voltage at IN must be at least 1V less than  $V_{CC}$ .

### Latched-Output Operation

The MAX834/MAX835 feature a level-sensitive latch input (CLEAR), designed to eliminate the need for hysteresis in battery undervoltage-detection applications. When the monitored voltage ( $V_{MON}$ ) is above the programmed trip voltage ( $V_{TRIP}$ ) (as when the system battery is recharged or a fresh battery is installed), pulse CLEAR low-high-low for at least 1 $\mu$ s to reset the output latch ( $\overline{OUT}$  goes high). When  $V_{MON}$  falls below  $V_{TRIP}$ ,  $\overline{OUT}$  goes low and remains low (even if  $V_{MON}$  rises above  $V_{TRIP}$ ), until CLEAR is pulsed high again with  $V_{MON} > V_{TRIP}$ . Figure 3a shows the timing relationship between  $V_{MON}$ ,  $\overline{OUT}$ , and CLEAR.

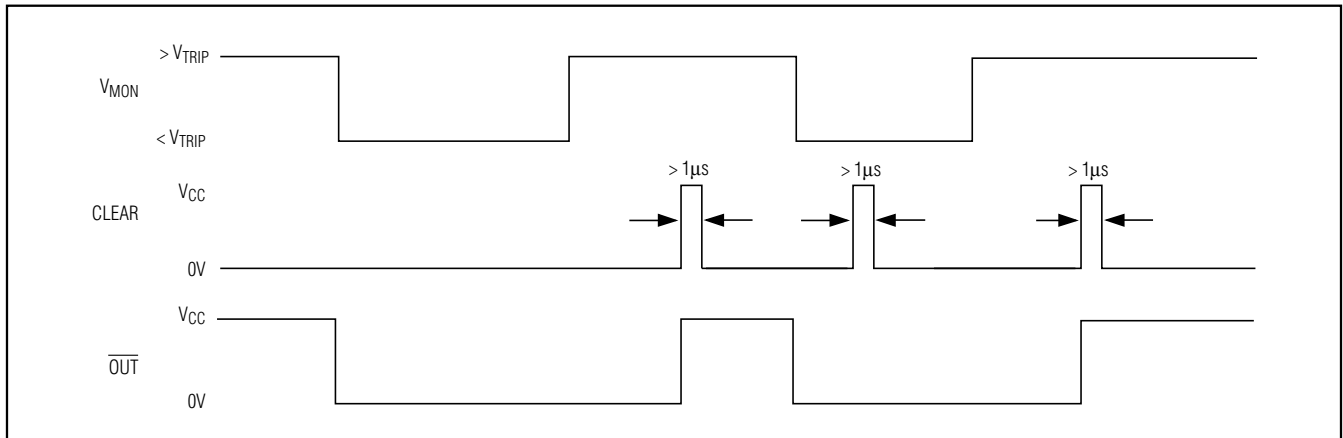


Figure 3a. Timing Diagram

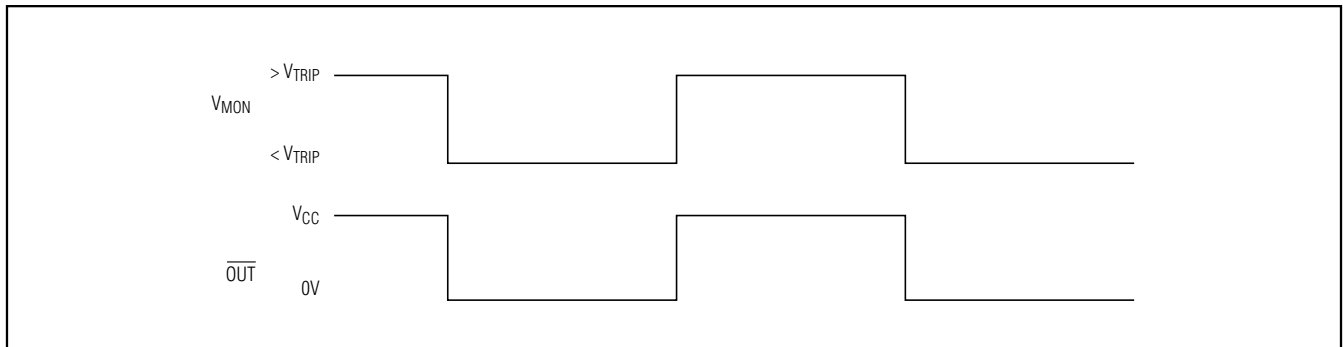


Figure 3b. Timing Diagram, CLEAR =  $V_{CC}$

# Micropower, Latching Voltage Monitors in SOT23-5

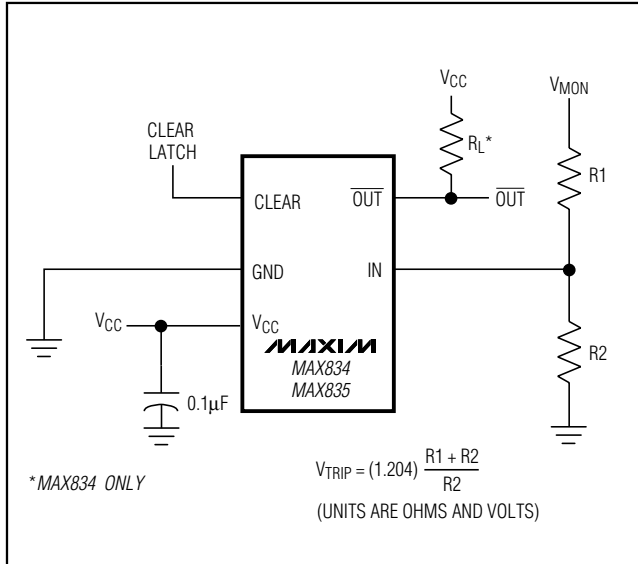


Figure 4. Monitoring Voltages Other than VCC

### Monitoring Voltages Other than VCC

The *Typical Operating Circuit* for the MAX834/MAX835 monitors VCC. Voltages other than VCC can easily be monitored, as shown in Figure 4. Calculate VTRIP as in the *Programming the Trip Voltage (VTRIP)* section. When monitoring voltages other than VCC, ensure that the maximum value for VMON is not exceeded:

$$V_{MON(MAX)} = (V_{CC} - 1) (R1 + R2) / R2$$

### Load-Disconnect Switch

The circuit in Figure 5 is designed to prevent a lead-acid battery or a secondary battery such as an NiCd, from sustaining damage through deep discharge. As the battery reaches critical undervoltage,  $\overline{OUT}$  switches low. Q1 and Q2 turn off, disconnecting the battery from the load. The MAX835's latched output prevents Q1 and Q2 from turning on again as the battery voltage relaxes to its open-circuit voltage when the load disconnects. CLEAR can be connected to a pushbutton switch, an RC network, or a logic gate to reset the latch when the battery is recharged or replaced.

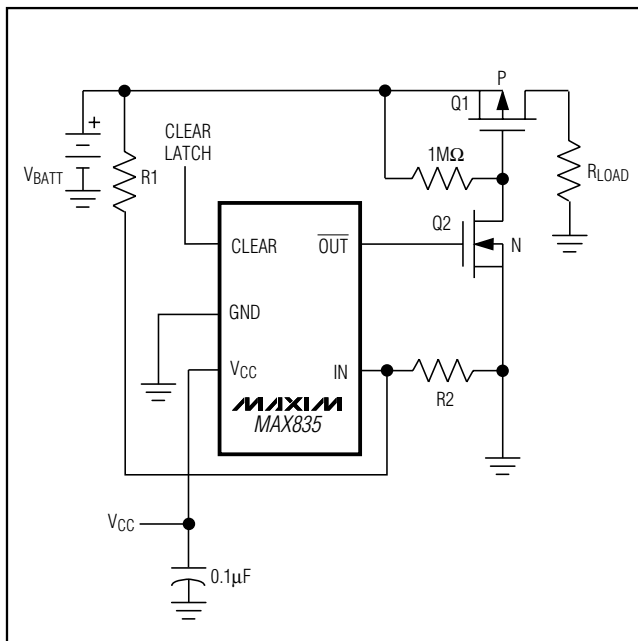


Figure 5. Load-Disconnect Switch

# Micropower, Latching Voltage Monitors in SOT23-5

## Chip Information

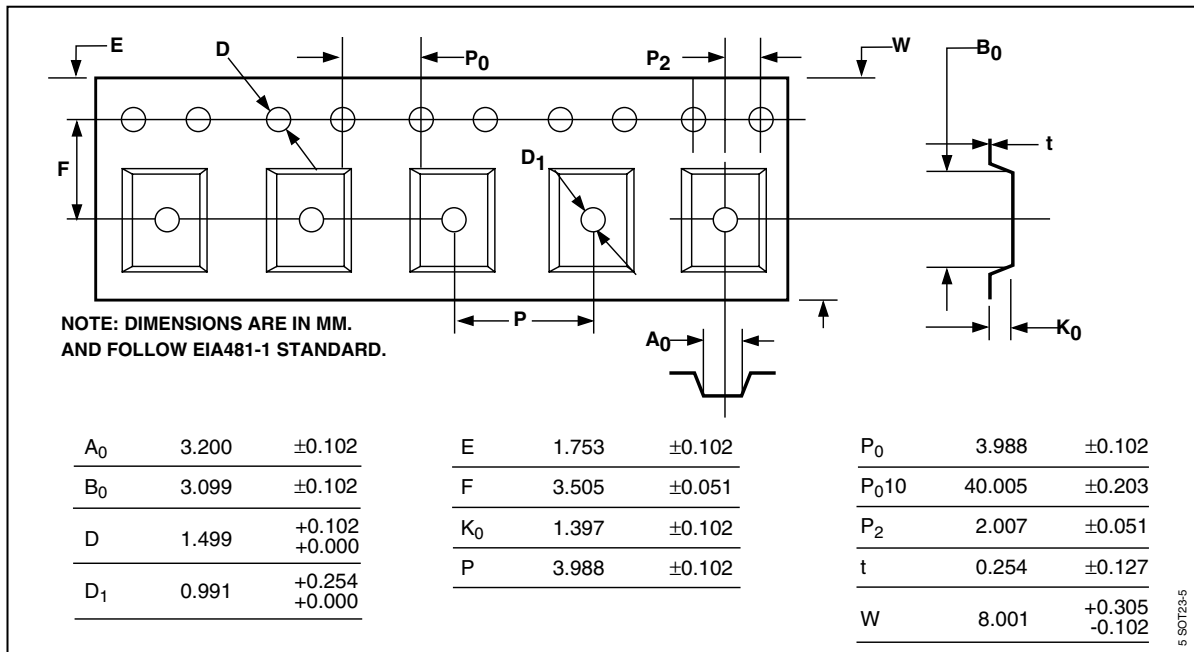
TRANSISTOR COUNT: 74

## 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	DOCUMENT NO.
5 SOT23	U5-1	<a href="#">21-0057</a>

## Tape-and-Reel Information





# Micropower, Latching Voltage Monitors in SOT23-5

## Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	12/96	Initial release	—
1	12/05	Added lead-free option to <i>Ordering Information</i> .	1
2	1/07	Fix limits in <i>Electrical Characteristics</i> and add lead-free part numbers.	1, 2
3	3/10	Updated <i>Electrical Characteristics</i> .	3

MAX834/MAX835

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