19-1157; Rev 0; 12/96

Micropower, Latching Voltage Monitors in SOT23-5

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.

Features

- **Prevents Deep Discharge of Batteries**
- **Precision ±1.25% Voltage Threshold**
- **Latched Output (once low, stays low until cleared)**
- **SOT23-5 Package**
- **Low Cost**
- **Wide Operating Voltage Range, +2.5V to +11V**
- **<2µA Typical Supply Current**
- **Open-Drain Output (MAX834)**
Push/Pull Output (MAX835)

Applications

Precision Battery Monitor

Load Switching

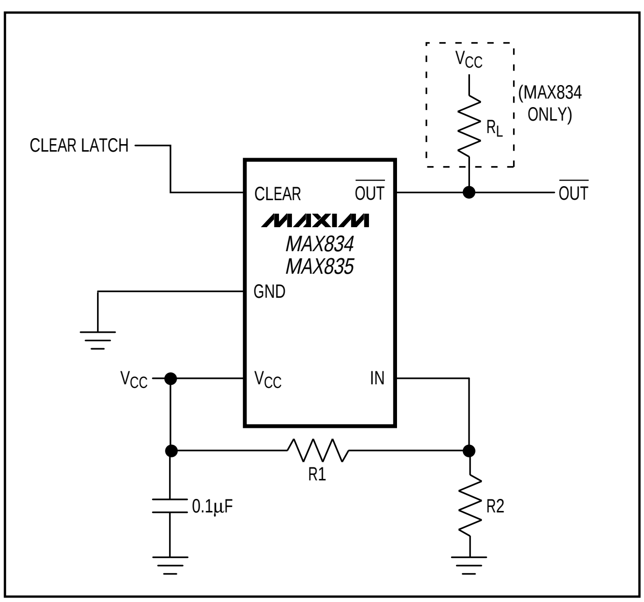
Battery-Powered Systems

Threshold Detectors

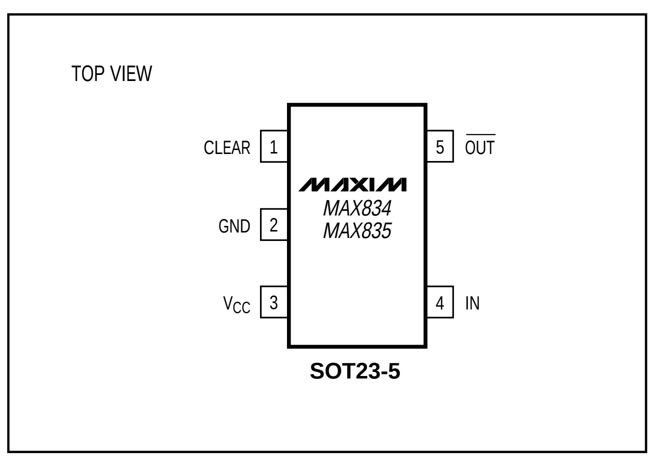
Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE	SOT TOP MARK
MAX834EUK-T	-40°C to +85°C	5 SOT23-5	AAAX
MAX835EUK-T	-40°C to +85°C	5 SOT23-5	AAAY

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
$\overline{OUT}$ Current...-20mA
V_{CC} Rate of Rise 100V/µs
Continuous Power Dissipation
SOT23-5 (derate 7.1mW/°C above +70°C)..................571mW
Operating Temperature Range ....-40°C to +85°C
Storage Temperature Range ....-65°C to +150°C
Lead Temperature (soldering, 10sec) ....+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 +11V, 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	V
Supply Current (Note 2)	I_{CC}	V_{IN} = 1.16V, $\overline{OUT}$ = low, $V_{CLEAR} \geq V_{CC}$ - 0.25V or $V_{CLEAR} \leq$ 0.25V	V_{CC} = 3.6V	T_A = +25°C		2.4	5	µA
				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°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°C		1.185	1.204	1.215	V
			T_A = 0°C to +70°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}				±3	±12	nA
Propagation Delay	t_{PL}	V_{CC} = 5V, 50mV overdrive				80		µs
Glitch Immunity		V_{CC} = 5V, 100mV overdrive				35		µs
OUT Rise Time	t_{RT}	V_{CC} = 5V, no load (MAX835 only)				200		µs
OUT Fall Time	t_{FT}	V_{CC} = 5V, no load (MAX834 pull-up = 10kΩ)				480		µs
Output Leakage Current (Note 4)	$I_{\overline{LOUT}}$	V_{IN} > $V_{TH(MAX)}$ (MAX834 only)					±1	µA
Output Voltage High	V_{OH}	V_{IN} > $V_{TH(MAX)}$, I_{SOURCE} = 500µA (MAX835 only)			V_{CC} - 0.5			V
Output Voltage Low	V_{OL}	V_{IN} < $V_{TH(MIN)}$, I_{SINK} = 500µA					0.4	V

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°C.)

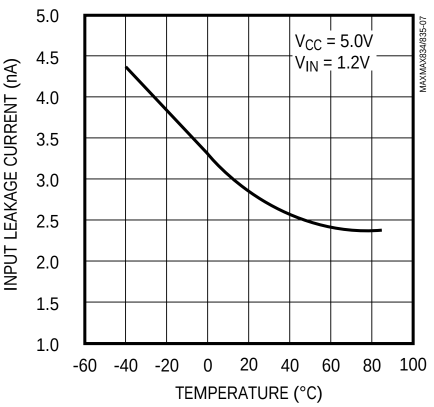
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
CLEAR Input High Voltage	V_{CIH}		2			V
CLEAR Input Low Voltage	V_{CIL}				0.4	V
CLEAR Input Leakage Current	I_{CLEAR}			±1	±100	nA
CLEAR Input Pulse Width	t_{CLR}		1			µs

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

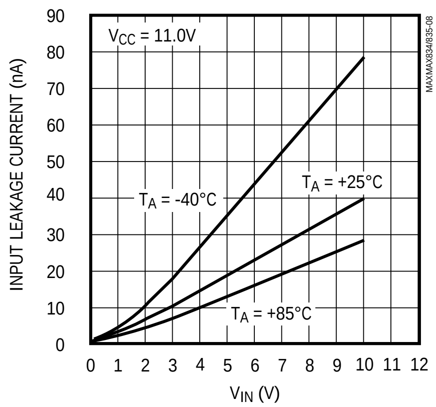
Typical Operating Characteristics

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

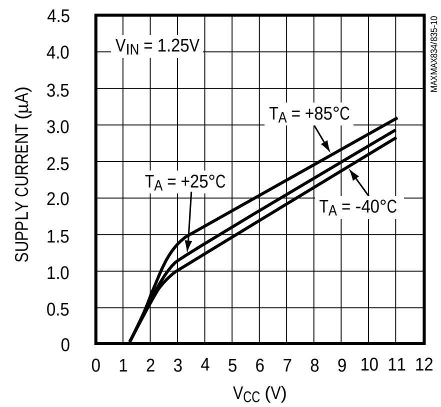
INPUT LEAKAGE CURRENT vs. TEMPERATURE



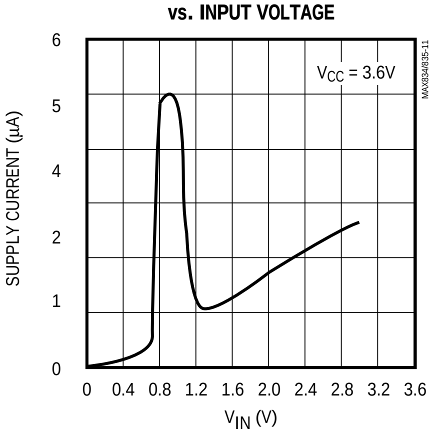
INPUT LEAKAGE CURRENT vs. INPUT VOLTAGE



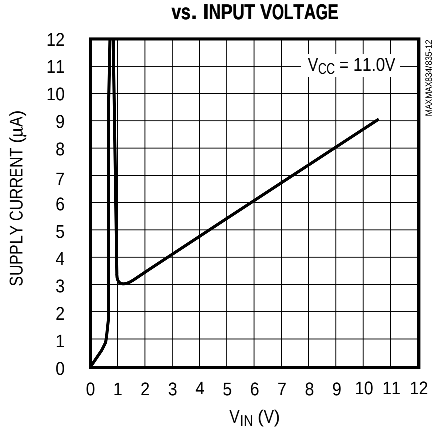
SUPPLY CURRENT vs. SUPPLY VOLTAGE



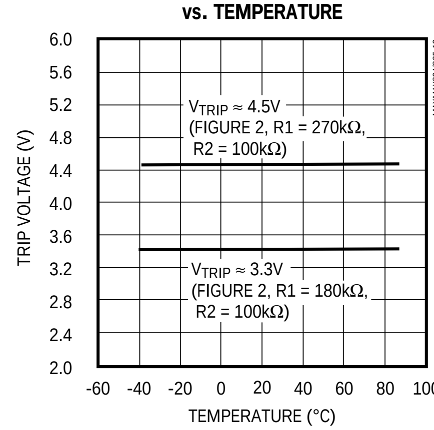
SUPPLY CURRENT vs. INPUT VOLTAGE



SUPPLY CURRENT vs. INPUT VOLTAGE



PROGRAMMED TRIP VOLTAGE vs. TEMPERATURE

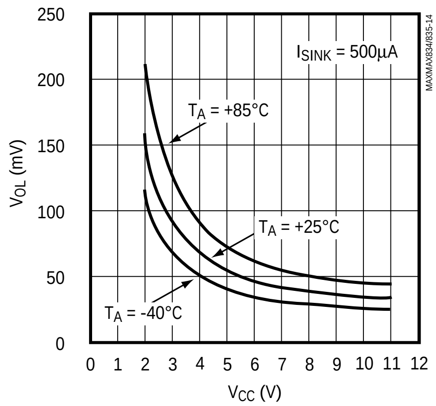


Micropower, Latching Voltage Monitors in SOT23-5

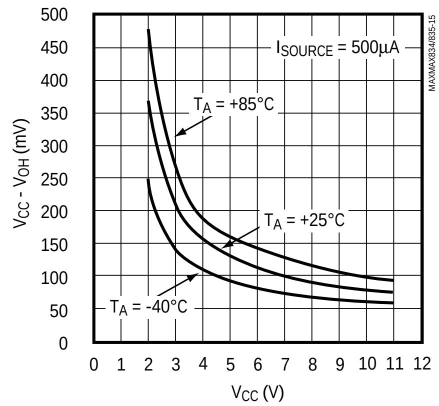
Typical Operating Characteristics (continued)

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

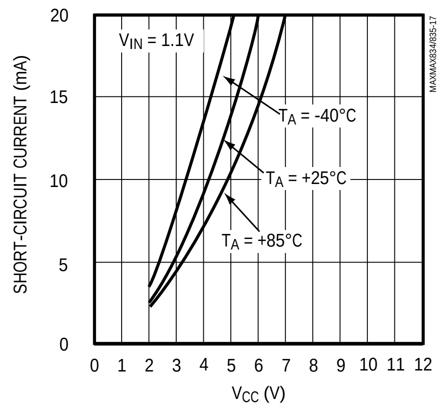
OUTPUT LOW VOLTAGE vs. SUPPLY VOLTAGE



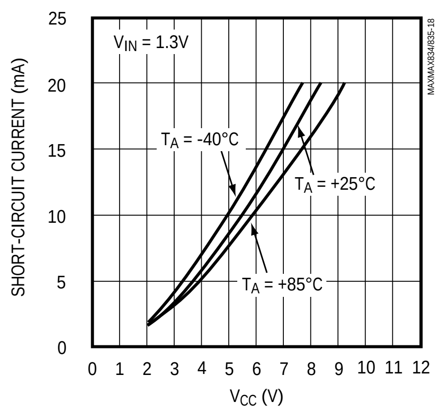
MAX835 OUTPUT HIGH VOLTAGE vs. SUPPLY VOLTAGE



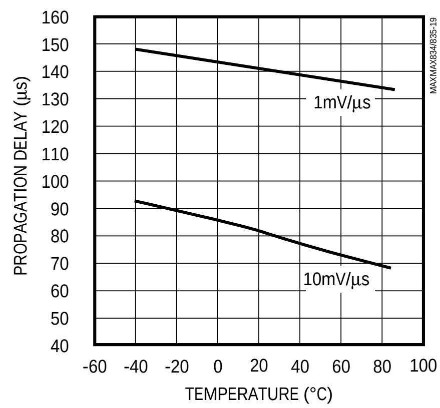
OUTPUT SHORT-CIRCUIT SINK CURRENT vs. SUPPLY VOLTAGE



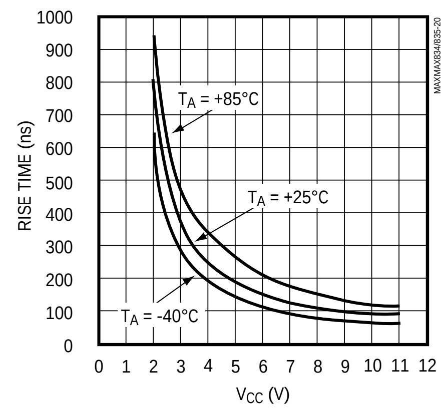
MAX835 OUTPUT SHORT-CIRCUIT SOURCE CURRENT vs. SUPPLY VOLTAGE



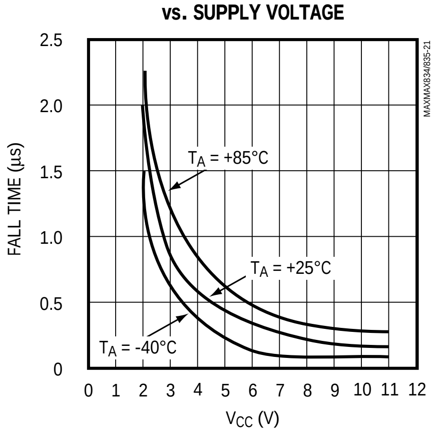
SUPPLY VOLTAGE FALLING TO $\overline{OUT}$ PROPAGATION DELAY vs. TEMPERATURE



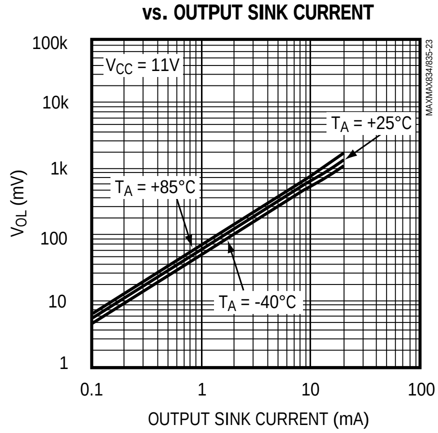
MAX835 OUTPUT RISE TIME vs. SUPPLY VOLTAGE



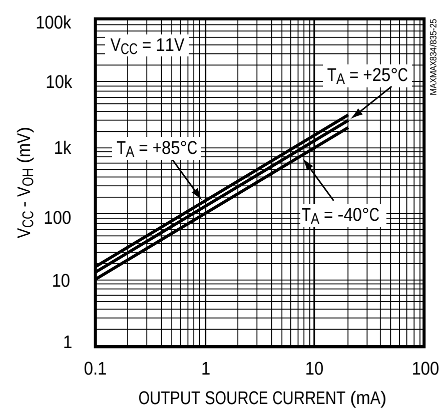
OUTPUT FALL TIME vs. SUPPLY VOLTAGE



OUTPUT LOW VOLTAGE vs. OUTPUT SINK CURRENT

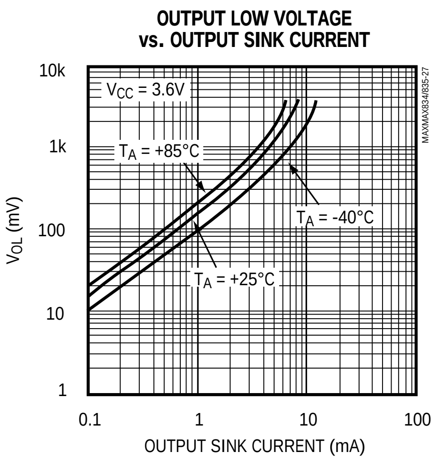


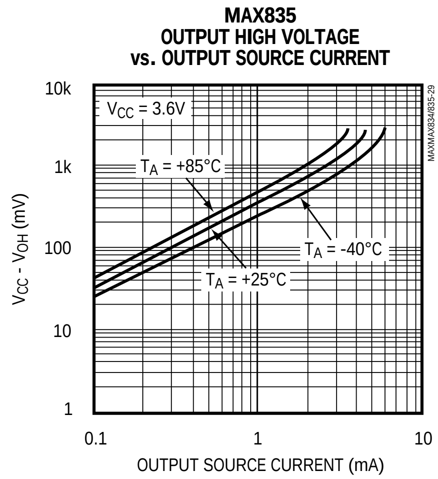
MAX835 OUTPUT HIGH VOLTAGE vs. OUTPUT SOURCE CURRENT

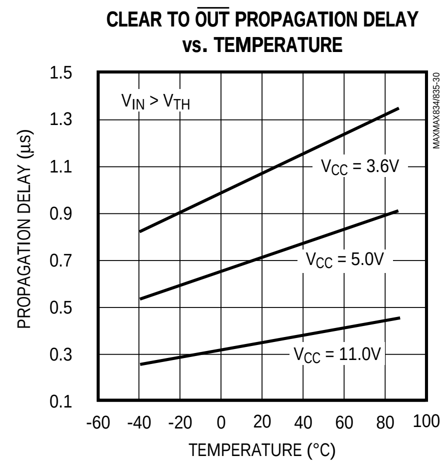


Typical Operating Characteristics (continued)

(V_{CC} = +5V, Typical Operating Circuit, T_A = +25°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 1µs 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.

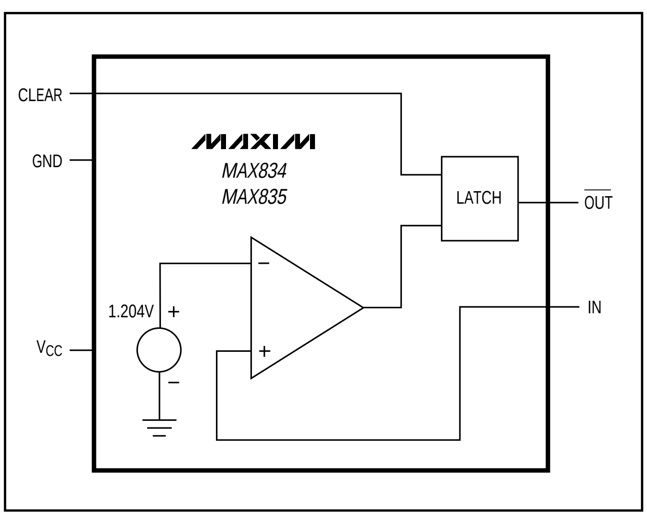


Figure 1. Functional Diagram

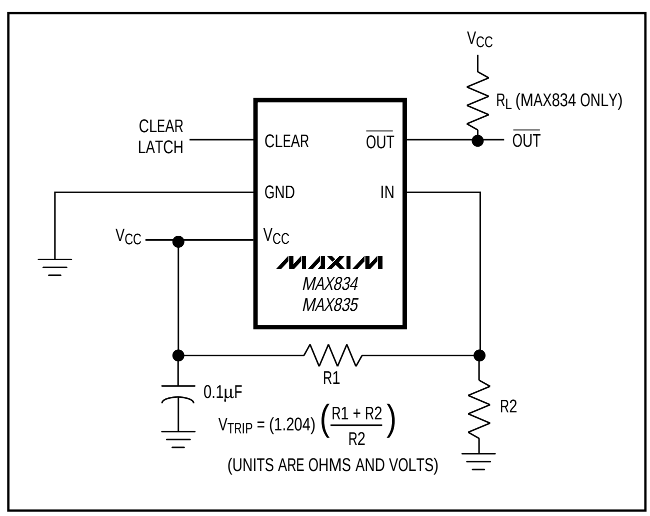


Figure 2. Programming the Trip Voltage (V_{TRIP})

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 R2 between 500kΩ and 1MΩ, then calculate R1 as follows:

$$R1 = R2 [(V_{TRIP} / V_{TH}) - 1]$$

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 1µs 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 3 shows the timing relationship between V_{MON}, $\overline{OUT}$, and CLEAR.

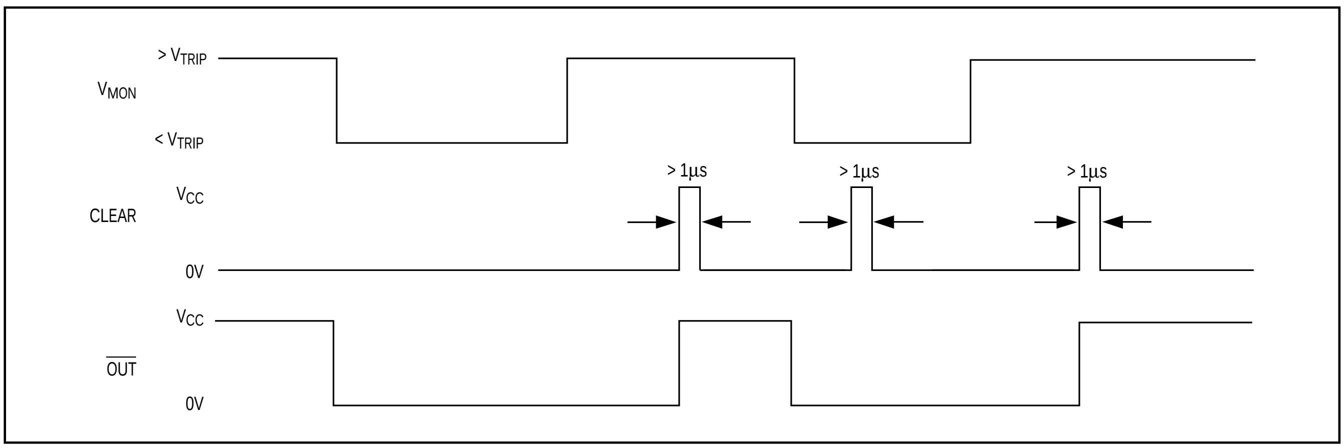


Figure 3a. Timing Diagram

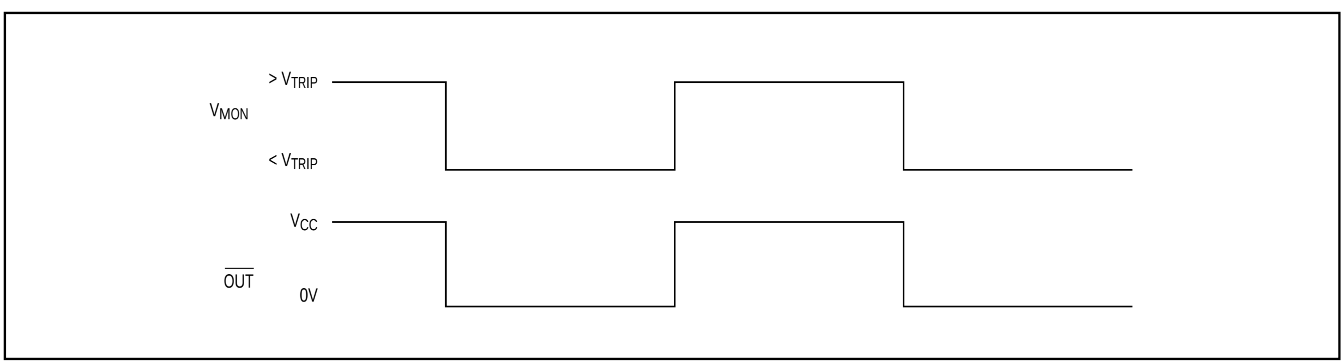


Figure 3b. Timing Diagram, CLEAR = V_{CC}

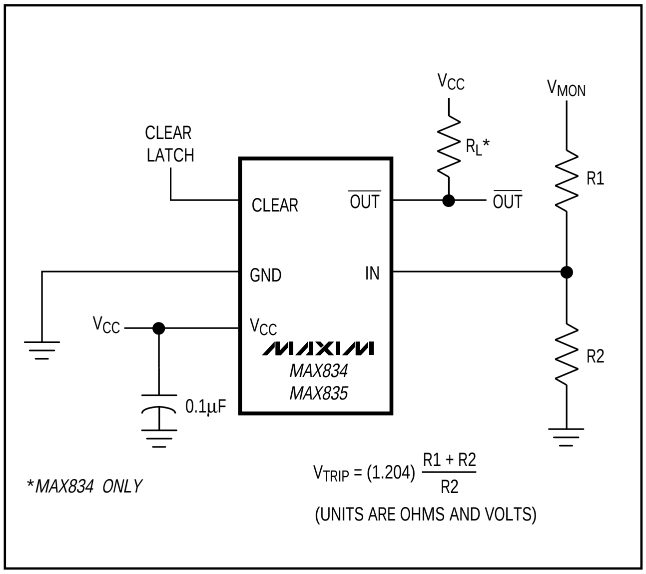


Figure 4. Monitoring Voltages Other than V_{CC}

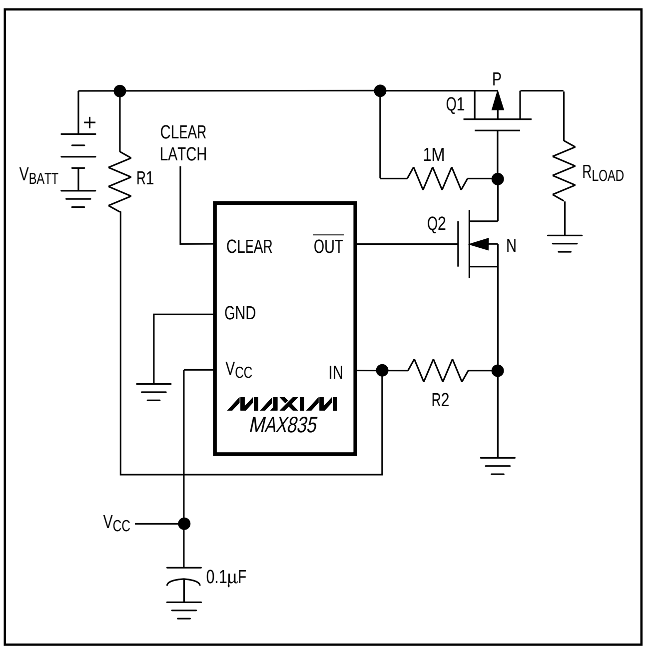


Figure 5. Load-Disconnect Switch

Monitoring Voltages Other than V_{CC}

The typical operating circuit for the MAX834/MAX835 monitors V_{CC}. Voltages other than V_{CC} can easily be monitored, as shown in Figure 4. Calculate V_{TRIP} as in the section *Programming the Trip Voltage.* When monitoring voltages other than V_{CC}, ensure that the maximum value for V_{MON} is not exceeded:

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

Load-Disconnect Switch

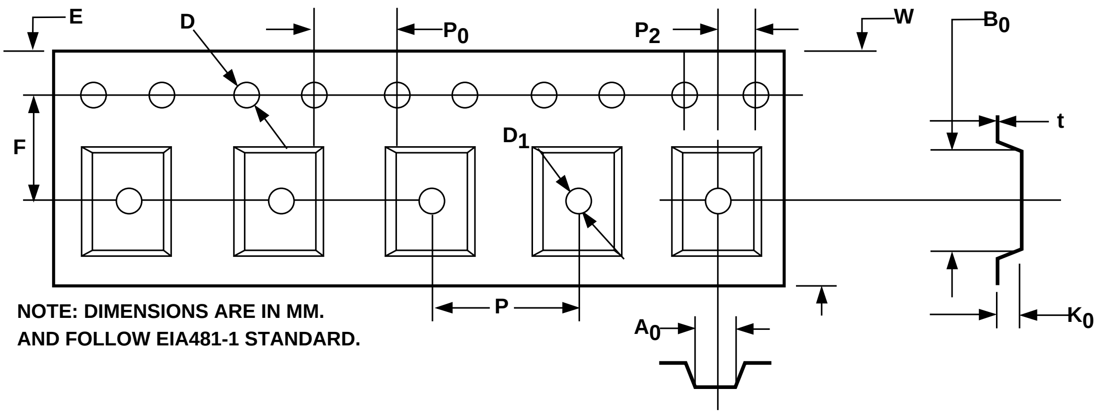
The circuit in Figure 5 is designed to prevent a lead-acid battery or a secondary battery such as an NiCd, from sustaining damage through deep discharge. As the battery reaches critical undervoltage, $\overline{OUT}$ switches low. Q1 and Q2 turn off, disconnecting the battery from the load. The MAX835's 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.

Chip Information

TRANSISTOR COUNT: 74

Micropower, Latching Voltage Monitors in SOT23-5

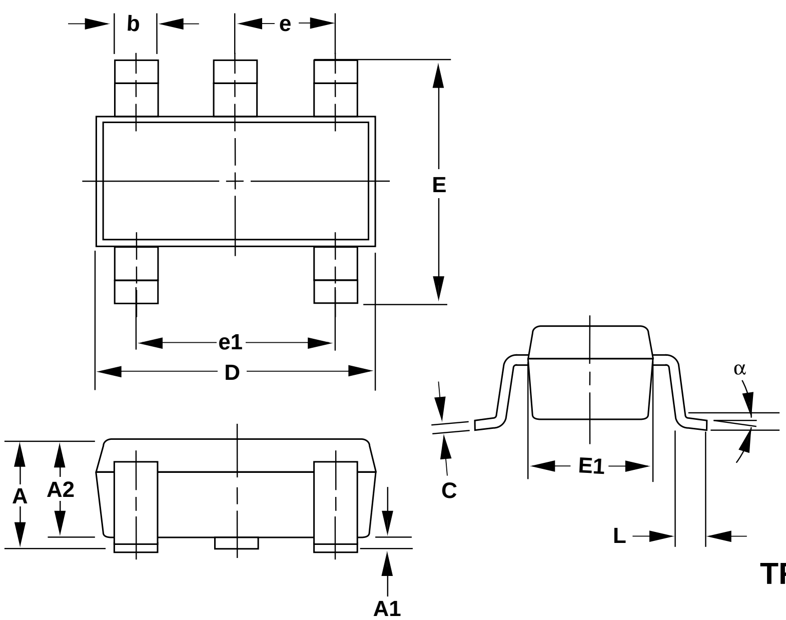
Tape-and-Reel Information



A_0	3.200	±0.102	E	1.753	±0.102	P_0	3.988	±0.102
B_0	3.099	±0.102	F	3.505	±0.051	$P_0$10	40.005	±0.203
D	1.499	+0.102 +0.000	K_0	1.397	±0.102	P_2	2.007	±0.051
D_1	0.991	+0.254 +0.000	P	3.988	±0.102	t	0.254	±0.127
						W	8.001	+0.305 -0.102

5 SOT23-5

Package Information



DIM	MILLIMETERS	
	MIN	MAX
A	0.90	1.45
A1	0.00	0.15
A2	0.90	1.30
b	0.35	0.50
C	0.08	0.20
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.75
L	0.35	0.55
e	0.95ref	
e1	1.90ref	
α	0°	10°

21-0057B

5-PIN SOT23-5 SMALL-OUTLINE TRANSISTOR PACKAGE