Ordering Information

Part Number	Marking[1]	Accuracy	Junction Temperature Range[1]	Package
MIC833YM5	B11	1.5%	–40° to +85°C	SOT-23-5 Pb-Free

Note:

1. Under bar symbol (_) may not be to scale

Pin Configuration
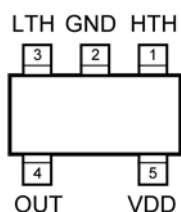
5-Pin SOT-23 (M5)

Pin Description

Pin Number	Pin Name	Pin Function
1	HTH	High-Voltage Threshold (Input): Analog input to a comparator. This is the voltage input assigned to detect a high-voltage condition when the level on this pin exceeds V_{REF}, OUT is asserted and the condition is latched until $V_{LTH} < V_{REF}$.
2	GND	Ground
3	LTH	Low-Voltage Threshold (Input): Analog input to a comparator. This is the voltage input assigned to detect a low voltage condition. When the level on this pin falls below V_{REF}, OUT is de-asserted and the condition is latched until $V_{HTH} > V_{REF}$.
4	OUT	Output: Active-high, open-drain output. This output is de-asserted and latched when $V_{LTH} < V_{REF}$, indicating a low voltage condition. This state remains latched until $V_{HTH} > V_{REF}$.
5	VDD	Power Supply (Input): Independent supply input for internal circuitry.

Absolute Maximum Ratings[1]

Supply Voltage (V_{DD}).. –0.3V to +7V
Input Voltages (V_{LTH}, V_{HTH})..+7V
Output Current (I_{OUT}) 20mA
Output Voltage (V_{OUT}) .... –0.3V to +7V
Lead Temperature (soldering, 10s)...........................260°C
Storage Temperature (Ts).........................–65°C to +150°C
ESD Rating[3]...2kV

Operating Ratings[2]

Supply Voltage (V_{DD})..................................... +1.5V to +5.5V
Input Voltage (V_{LTH}, V_{HTH}) .... 0V to +6V
Output Voltage (V_{OUT}) .... 0V to +6V
Ambient Temperature (T_A) ....–40°C to +85°C
Junction Temperature (T_J) ....Internally Limited
Package Thermal Resistance (θ_{JA})........................260°C/W

Electrical Characteristics[4]

1.5V ≤ V_{DD} ≤ 5.5V; T_A = 25°C, **bold** values indicate –40°C≤ T_A ≤ +85°C, unless noted.

| Symbol	Parameter	Conditions	Min	Typ	Max	Units
I_{DD}	Supply Current	Outputs not asserted		1	**2**	µA
I_{LTH}, I_{HTH}	Input Leakage Current			0.005	**10**	nA
V_{REF}	Reference Voltage		**1.221**	1.240	**1.259**	V
t_D	Propagation Delay	V_{LTH} = 1.352V to 1.128V		5		µs
		V_{HTH} = 1.128V to 1.352V		5		
V_{OUT}	Output Voltage-Low[4]	OUT de-asserted, I_{SINK} = 1.6mA, $V_{DD} \geq$ 1.6V			**0.3**	V
		OUT de-asserted, I_{SINK} = 100µA, $V_{DD} \geq$ 1.2V			**0.4**	

Notes:

1. Exceeding the absolute maximum rating may damage the device.

2. The device is not guaranteed to function outside its operating rating.

3. Devices are ESD sensitive. Handling precautions recommended. Human body model, 1.5kΩ in series with 100pF.

4. V_{DD} operating range is 1.5V to 5.5V. Output is guaranteed to be held low down to V_{DD} = 1.2V.

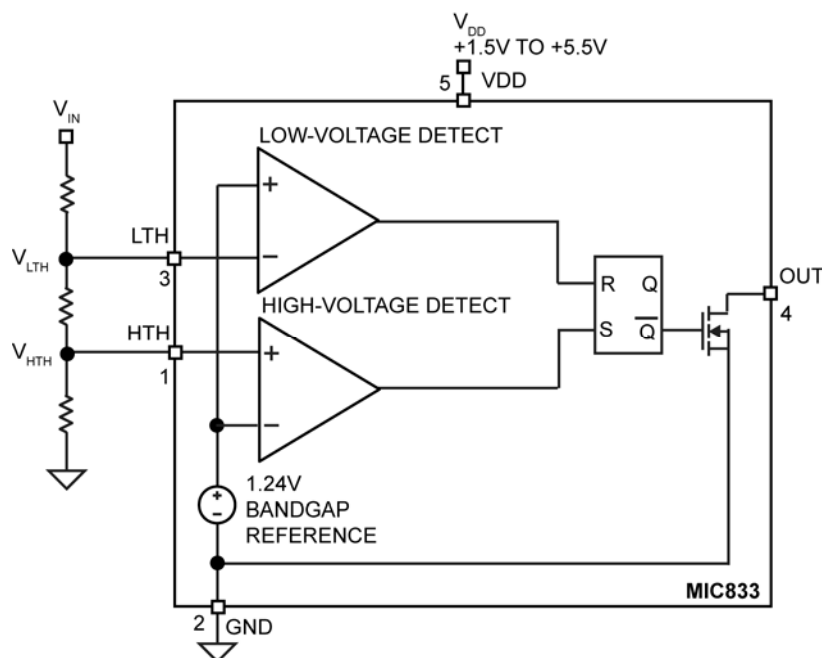## Functional Diagram
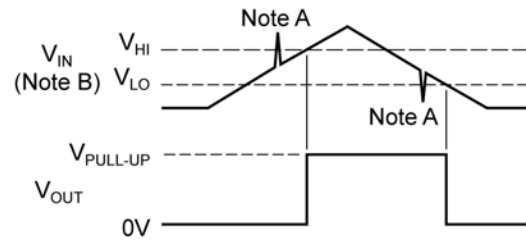
Timing Diagram
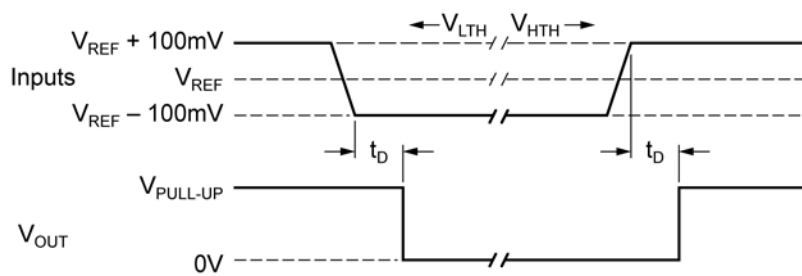
Notes:

Note A.   Brief transients are ignored by the MIC833. See "Application Information".

Note B. $V_{LTH} > V_{LO} > V_{REF}$

Block Diagram

Functional Description

The MIC833 monitors a voltage and detects when it is below or above two independently programmed levels.

Voltage Low Output

The output (OUT) is an active-high, open-drain output which sinks current when the MIC833 detects a low input voltage at its LTH input. This condition is latched until the HTH input is presented with a voltage higher than the internal V_{REF} (+1.24V).

Trip Points

Input voltage is monitored by the comparators via a voltage divider network. The divided voltage is compared to an internal reference voltage. When the voltage at the LTH input pin drops below the internal reference voltage, the output pulls low. Because of the voltage divider, the voltage at HTH is assured to be below the reference voltage.

Applications Information

Output

Since the MIC833 output is an open-drain MOSFET, most applications will require a pull-up resistor. The value of the resistor should not be too large or leakage effects may dominate. 470kΩ is the maximum recommended value. Note that the output may be pulled up as high as 6V regardless of IC supply voltage. See "Electrical Characteristics."

Programming the Thresholds

The low-voltage threshold is calculated using:

$$V_{IN(LO)} = V_{REF}\left(\frac{R1+R2+R3}{R2+R3}\right) \qquad \text{Eq. 1}$$

The high-voltage threshold is calculated using:

$$V_{IN(HI)} = V_{REF}\left(\frac{R1+R2+R3}{R3}\right) \qquad \text{Eq. 2}$$

Where V_{REF} = 1.240V for both equations.

In order to provide the additional criteria needed to solve for the resistor values, the resistors can be selected such that they have a given total value, that is, R1 + R2 + R3 = R_{TOTAL}. A value such as 1MΩ for R_{TOTAL} is a reasonable value because it draws minimum current but has no significant effect on accuracy.

When working with large resistors, a small amount of leakage current can cause voltage offsets that degrade system accuracy. The maximum recommended total resistance from VIN to ground is 3MΩ̃
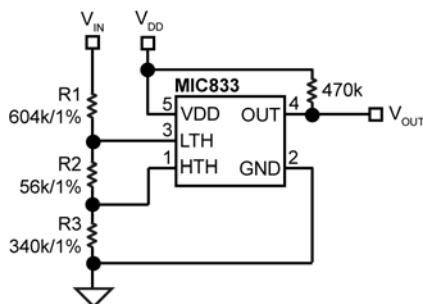

Figure 1. Example Circuit

Once the desired trip points are determined, set the $V_{IN(HI)}$ threshold first.

For example, use a total of 1MΩ = R1 + R2 + R3. For a typical single-cell lithium ion battery, 3.6V is a good "high threshold" because at 3.6V the battery is moderately charged. Solving for R3:

$$V_{IN(HI)} = 3.6V = 1.24\left(\frac{1M\Omega}{R3}\right) \qquad \text{Eq. 3}$$

where:

R3 = 344kΩ

Once R3 is determined, the equation for $V_{IN(LO)}$ can be used to determine R2. A single lithium-ion cell, for example, should not be discharged below 2.5V. Many applications limit the drain to 3.1V. Using 3.1V for the $V_{IN(LO)}$ threshold allows calculation of the two remaining resistor values:

$$V_{IN(LO)} = 3.1V = 1.24V\left(\frac{1M\Omega}{R2+344k}\right) \qquad \text{Eq. 4}$$

where:

R2 = 56kΩ

1MΩ − (R2 − R3) = R1

R1 = 600kΩ

The accuracy of the resistors can be chosen based upon the accuracy required by the system.

The inputs may be subjected to voltages as high as 6V steady state without adverse effects of any kind, regardless of the IC supply voltage. This applies even if the supply voltage is zero. This permits the situation in which the IC supply is turned off, but voltage is still present on the inputs. See "Electrical Characteristics."

Input Transients

The MIC833 is inherently immune to very short negative going "glitches." Very brief transients may exceed the $V_{IN(LO)}$ threshold without tripping the output.

As shown in Figure 2, the narrower the transient, the deeper the threshold overdrive that will be ignored by the MIC833. The graph represents the typical allowable transient duration for a given amount of threshold overdrive that will not toggle the output.
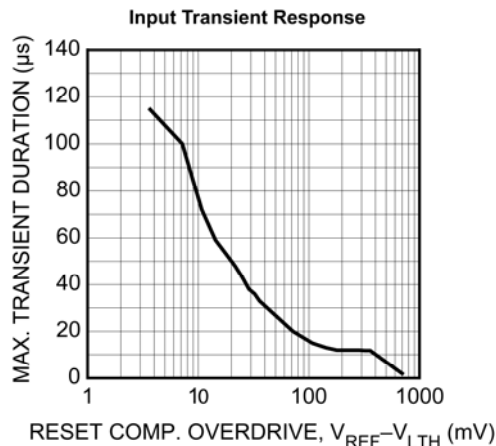
Input Transient Response

Figure 2. Input Transient Response

Initialization Behavior

When the MIC833 is powered up, the comparators and latch become active before the reference voltage reaches its final value. In most applications, this presents no problems. However, the user should be aware of this: when applying power to the part, if the input voltage is between the two thresholds, the output of the part will be high because input HTH will have been higher than the 1.24V reference during initialization.

It is not very likely the part would be powered up in this state; it is more likely the same power supply will power the part and develop its inputs. However, if the above-described condition should occur, the next HTH threshold crossing would not be processed; that is, the latch would have been already set. The next valid input condition would have to be a crossing of the LTH threshold, which resets the latch, after which "normal" operation is restored.

Example Application

The battery charger of Figure 3 uses the MIC833 to detect a low-battery voltage condition (V_{DIS}) and enables a constant-current source (I_{CHG}). Charging current is enabled until a charged-battery voltage condition (V_{CHG}) is detected; at which time the charging-current source is disabled.

Diode D1 was added to Figure 3 to ensure the disabled current source does not draw battery current. Whether or not D1 is required is a function of the output stage of the current source and how it is disabled.

The circuitry of Figure 3 is deliberately generalized to imply flexibility of application. Depending on the application, it may not be possibly to power the MIC833 from the charger supply voltage, see Note 2. It may be necessary to provide a separate voltage regulator, or a resistive voltage divider to reduce the V_{DD} applied to the MIC833. The part can be supplied by the battery voltage (V_{BAT}) if this voltage is never lower than 1.5V, the minimum operating V_{DD} of the part.

Voltage thresholds, V_{DIS} and V_{CHG}, are programmed as described in the appropriate above paragraph.
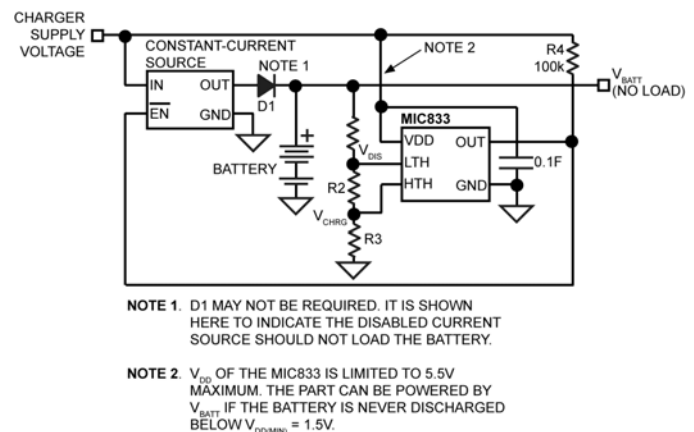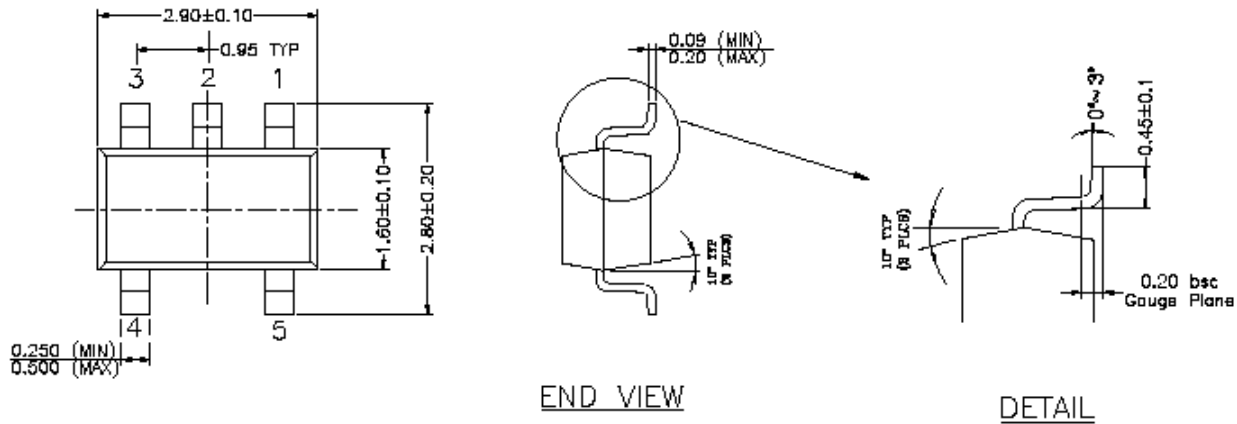

NOTE 1. D1 MAY NOT BE REQUIRED. IT IS SHOWN HERE TO INDICATE THE DISABLED CURRENT SOURCE SHOULD NOT LOAD THE BATTERY.

NOTE 2. V_{DD} OF THE MIC833 IS LIMITED TO 5.5V MAXIMUM. THE PART CAN BE POWERED BY V_{BAT} IF THE BATTERY IS NEVER DISCHARGED BELOW $V_{DD(MIN)}$ = 1.5V.

Figure 3. Battery Charger

Package Information

END VIEW

DETAIL

NOTE:
1. PACKAGE OUTLINE EXCLUSIVE OF MOLD FLASH & BURR.
2. PACKAGE OUTLINE INCLUSIVE OF SOLER PLATING.
3. DIMENSION AND TOLERANCE PER ANSI Y14.5M, 1982.
4. FOOT LENGTH MEASUREMENT BASED ON GAUGE PLANE METHOD.
5. DIE FACES UP FOR MOLD, AND FACES DOWN FOR TRIM/FORM.
6. ALL DIMENSIONS ARE IN MILLIMETERS.

5-Pin SOT-23 (M5)