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MIC2778

Voltage Monitor with Adjustable Hysteresis

General Description

The MIC2778 is a voltage monitor—uniquely designed to detect two separate voltage thresholds—combined with a delay generator and logic. It is designed for monitoring the battery supply of portable digital systems, particularly PDAs, pagers, and cellular telephones.

High- and low-voltage thresholds can be adjusted independently, allowing for wide hysteresis. Voltage detection thresholds are accurate to 2%.

If the battery voltage falls below the low-voltage threshold, the output ($\overline{RST}$) is asserted and latched, preventing system operation until the battery is replaced or recharged. Internal logic prevents the output from chattering due to battery recovery or load removal. The output is asserted for 140ms (minimum) when a fresh battery is inserted. For applications not requiring built-in delay, see MIC841.

The IC's power supply input is separate from the detector inputs, allowing the MIC2778 to be powered from a downstream supply, such a boost converter. Supply current is extremely low (1µA, typical), making it ideal for portable applications.

A high-precision 1% grade is available. The MIC2778 is supplied in Micrel's IttyBitty™ 5-lead SOT-23-5 package.

Features

- Optimized for PDAs, cellular telephones, pagers, and other battery-powered devices
- Independently adjustable high- and low-voltage thresholds
- Internal logic prevents battery-voltage-fluctuation chatter
- High ±2% voltage threshold accuracy; 1% available
- Built in 140ms (minimum) delay deglitches output
- Extremely low 1µA typical supply current
- For applications not requiring built-in delay, see MIC841
- Immune to brief power supply transients
- 5-lead SOT-23 package

Applications

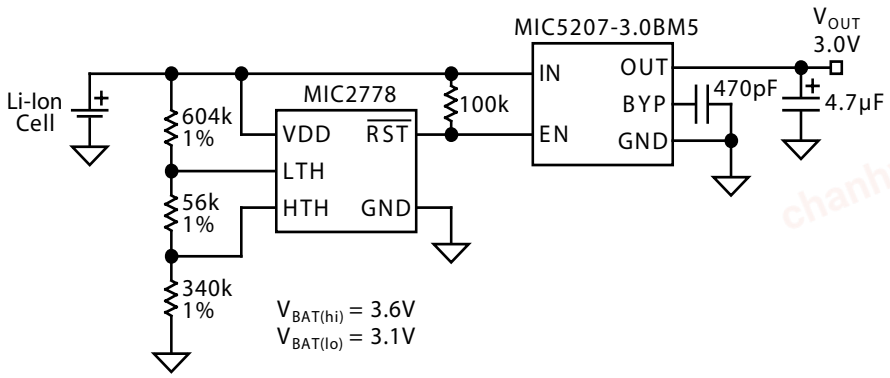
- PDAs
- Pagers
- Cordless phones
- Consumer electronics
- Embedded controllers
- Personal electronics

Ordering Information

Part Number				Accurary	Temperature Range	Package
Standard	Marking	Pb-Free	Marking			
MIC2778-2BM5	UFB	MIC2778-2YM5	UFB*	2%	-40°C to +85°C	SOT-23-5
MIC2778-1BM5	UFA	MIC2778-1YM5	UFA*	1%	-40°C to +85°C	SOT-23-5

* Underscore indicates a Pb-Free part.

Typical Application

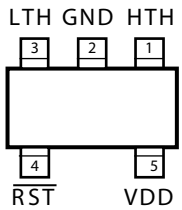


Cellular Telephone Battery Monitor

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Pin Configuration



SOT-23-5 (M5)

Pin Description

Pin Number	Pin Name	Pin Function
1	HTH	High-Voltage Theshold (Input): Analog input to a comparator. When the level on this pin initially rises above V_{REF}, the delay generator cycles and the $\overline{RST}$ remains low for a minimum of 140ms.
2	GND	Ground
3	LTH	Low-Voltage Threshold (Input): Analog input to a comparator. This is the voltage monitor input assigned to detect a low voltage condition. When the level on this pin falls below V_{REF}, $\overline{RST}$ is asserted and the condition is latched until $V_{HTH} > V_{REF}$.
4	$\overline{RST}$	Reset (Output): Active-low, open-drain output. This output is 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.

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Absolute Maximum Ratings (Note 1)

Supply Voltage (V_{DD}).....–0.3V to +7V
Input Voltages (V_{HI}, V_{LO}).....–0.3V to +7V
RST Output Current ($I_{\overline{RST}}$) 20mA
Storage Temperature (T_S) ..... –65°C to +150°C
ESD Rating, **Note 3**..... 2kV

Operating Ratings (Note 2)

Supply Voltage (V_{DD}) ..... +1.5V to +5.5V
Input Voltages ($V_{\overline{RST}}$, V_{LTH}, V_{HTH}).....–0.3V to +6.0V
Ambient Temperature Range (T_A) ..... –40°C to +85°C
Package Thermal Resistance..... 256°C/W

Electrical Characteristics

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

Symbol	Parameter	Condition	Min	Typ	Max	Units
I_{DD}	Supply Current	RST not asserted		1	**2**	µA
I_{LTH}, I_{HTH}	Input Leakage Current			5		pA
					10	nA
V_{REF}	Reference Voltage			1.240		V
		MIC2778-2	**1.215**		**1.265**	V
		MIC2778-1	**1.228**		**1.252**	V
t_D	Propagation Delay	V_{LTH} = $V_{REF(max)}$ +100mV to $V_{REF(min)}$ – 100mV		5		µs
t_{RESET}	Reset Pulse Width		**140**		**420**	ms
$V_{\overline{RST}}$	Voltage-Low Reset	$\overline{RST}$ asserted, I_{SINK} = 1.6mA, V_{DD} ≥ 1.6V			**0.3**	V
		$\overline{RST}$ asserted, I_{SINK} = 100µA, V_{DD} ≥ 1.2V,			**0.4**	V

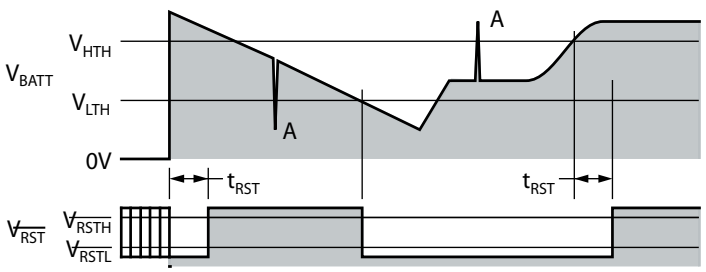
Note 1. Exceeding the absolute maximum rating may damage the device.

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

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

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

Timing Diagram

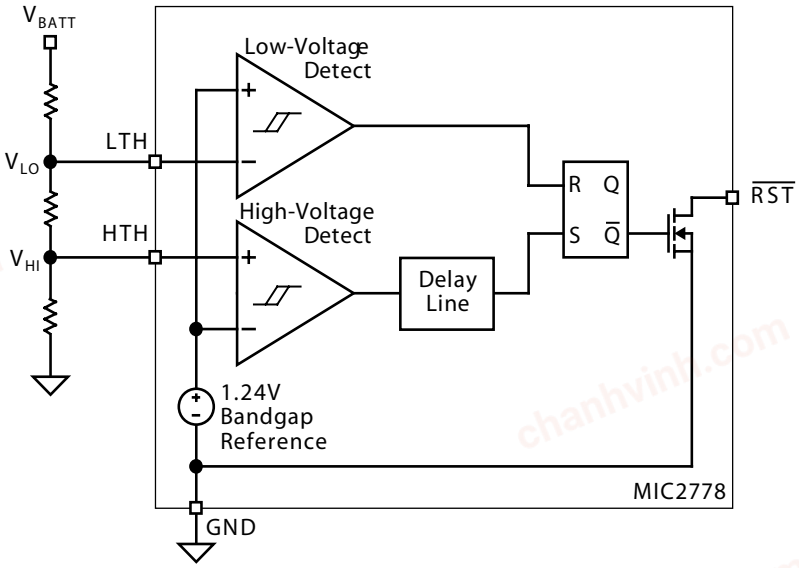


Propagation delays not shown for clarity.

Note A. The MIC2778 ignores very brief transients. See “Applications Information” for details.

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Functional Diagram



Functional Description

The MIC2778 monitors the voltage of a battery and detects when it is discharged below a programmed level. Upon being replaced, or being recharged above a second higher programmed trip point, the output remains low for a minimum of 140ms and then sends a reset signal to a microprocessor or other downstream component.

Voltage Low Output

The voltage-low output ($\overline{RST}$) is an active-low, open-drain output which sinks current when the MIC2778 detects a low input voltage.

Trip Points

Battery voltage is monitored by a comparator 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. At this point, the voltage at HTH is assumed to be below the reference voltage.

Delay

At power-on or when the battery is replaced or recharged, and the voltage at HTH exceeds the reference voltage, the output goes high after a minimum delay of 140ms.

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Applications Information

Output

Since the MIC2778 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.

Programming the Thresholds

The low-voltage threshold is calculated using:

$$V_{BAT(lo)} = V_{REF}\left(\frac{R1 + R2 + R3}{R2 + R3}\right)$$

The high-voltage threshold is calculated using:

$$V_{BAT(hi)} = V_{REF}\left(\frac{R1 + R2 + R3}{R3}\right)$$

where, for both equations:

$$V_{REF} = 1.240V$$

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 battery 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 V_{BAT} to ground is 3MΩ.

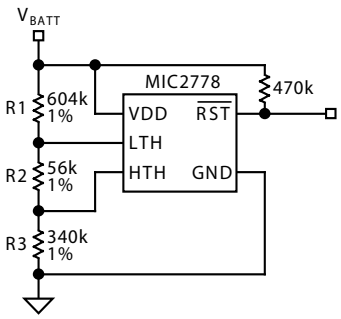


Figure 1. Example Circuit

Once the desired trip points are determined, set the $V_{BAT(hi)}$ 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:

$$V_{BAT(hi)} = 1.24\left(\frac{1M\Omega}{R3}\right)$$

$$R3 = 344k\Omega$$

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

$$V_{BAT(lo)} = 3.1V = 1.24\left(\frac{1M\Omega}{R2 + 344k}\right)$$

$$R2 = 56k\Omega$$

$$R1 = 1M\Omega - R2 - R3$$

$$R1 = 600k\Omega$$

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

Input Transients

The MIC2778 is inherently immune to very short negative-going "glitches." Very brief transients may exceed the $V_{BAT(lo)}$ 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 MIC2778. The graph represents the typical allowable transient duration for a given amount of threshold overdrive that will not generate a reset.

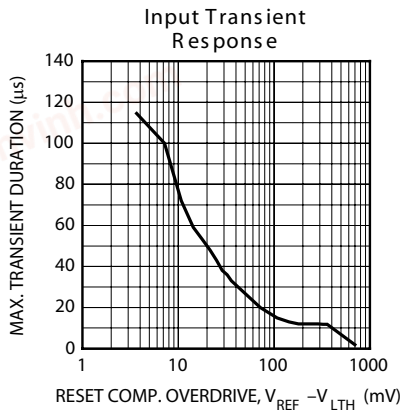


Figure 2. Input Transient Response

Interfacing to Processors With Bidirectional Reset Pins

Some microprocessors have reset signal pins that are bidirectional, rather than input only. The Motorola 68HC11 family is one example. Because the MIC2778's output is open drain, it can be connected directly to the processor's reset pin using only the pull-up resistor normally required. See Figure 3.

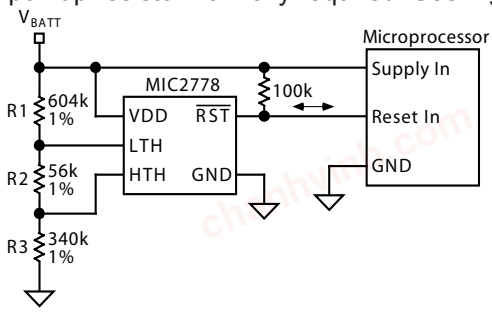
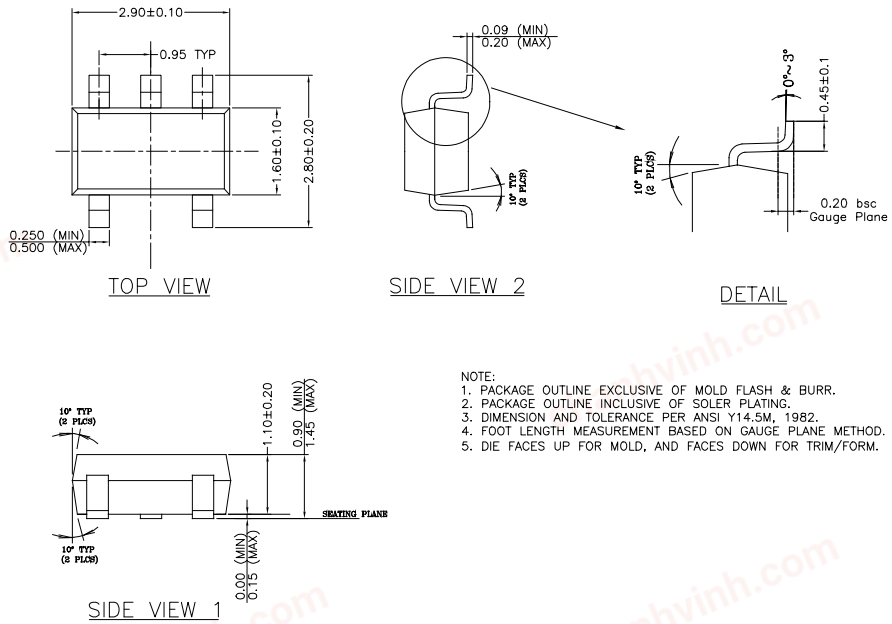


Figure 3. Interfacing to Bidirectional Reset Pin

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Package Information



SOT-23-5 (M5)

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