MIC2779

Voltage Monitor with Adjustable Hysteresis

General Description

The MIC2779 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 /RST or 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 requiring open-drain output, see MIC2778/MIC833.

The IC's power supply input is separate from the detector inputs, allowing the MIC2779 to be powered from a down-stream 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 MIC2779 is supplied in Micrel's IttyBitty™ 5-pin SOT-23-5 package.
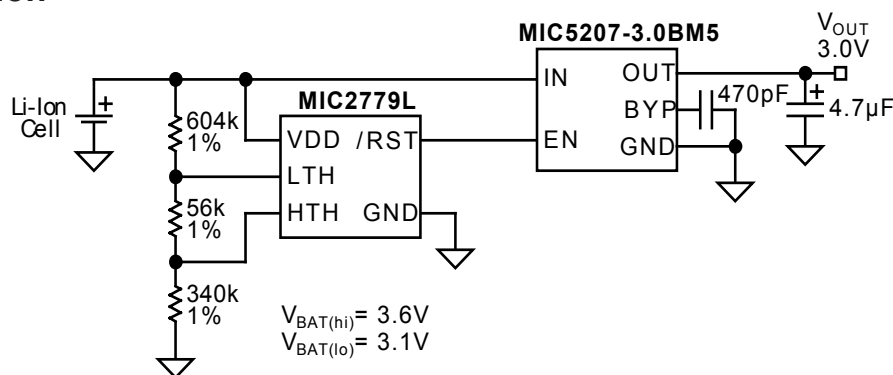
Features

- 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 requiring open-drain output, see MIC2778/MIC833
- Immune to brief power supply transients
- 5-pin SOT-23 package

Applications

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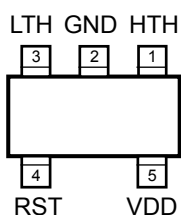- Personal electronics

Typical Application

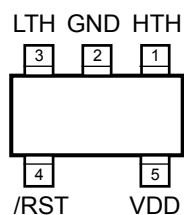**Cellular Telephone Battery Monitor**

Ordering Information

Part Number				Output Polarity	Accuracy	Temperature Range	Package
Standard	Marking	Pb-Free	Marking				
MIC2779H-2BM5	UPA2	MIC2779H-2YM5	UPA2	Active-High RST	2%	–40ºC to +85ºC	SOT-23-5
MIC2779H-1BM5	UPA1	MIC2779H-1YM5	UPA1	Active-High RST	1%	–40ºC to +85ºC	SOT-23-5
MIC2779L-2BM5	UPB2	MIC2779L-2YM5	UPB2	Active-Low /RST	2%	–40ºC to +85ºC	SOT-23-5
MIC2779L-1BM5	UPB1	MIC2779L-1YM5	UPB1	Active-Low /RST	1%	–40ºC to +85ºC	SOT-23-5

Pin Configuration

LTH GND HTH

| 3 | 2 | 1 |

| 4 | | 5 |

RST   VDD

SOT-23-5 (M5)
"H" Version

LTH GND HTH

| 3 | 2 | 1 |

| 4 | | 5 |

/RST   VDD

SOT-23-5 (M5)
"L" Version

Pin Description

Pin Number MIC2779H	Pin Number MIC2779L	Pin Name	Pin Function
1	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 /RST remains low or RST remains high for a minimum of 140ms.
2	2	GND	Ground
3	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}, /RST or RST is asserted and the condition is latched until $V_{HTH} > V_{REF}$.
4		RST	Reset (Output): Push-pull output. This output is asserted and latched when $V_{LTH} < V_{REF}$, indicating a low voltage condition. This state remains latched until $V_{HTH} > V_{REF}$. The polarity of this signal (active-high or low) is deter mined by the part number suffix. See ordering information.
	4	/RST	Reset (Output): Push-pull output. This output is asserted and latched when $V_{LTH} < V_{REF}$, indicating a low voltage condition. This state remains latched until $V_{HTH} > V_{REF}$. The polarity of this signal (active-high or low) is deter mined by the part number suffix. See ordering information.
5	5	VDD	Power Supply (Input): Independent supply input for internal circuitry.

Absolute Maximum Ratings (Note 1)

Supply Voltage (V_{DD})......................................–0.3V to +7V

Input Voltages (V_{LTH}, V_{HTH}, $V_{/RST}$, V_{RST})........–0.3V to +7V

/RST, RST Output Current ($I_{/RST}$), (I_{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_{LTH}, V_{HTH}, $V_{/RST}$, V_{RST}).....–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, RST not asserted		1	**2**	µA
I_{LTH}, I_{HTH}	Input Leakage Current			5		pA
					10	nA
V_{REF}	Reference Voltage			1.240		V
		MIC2779H/L-2	**1.215**		**1.265**	V
		MIC2779H/L-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_{OL}	Reset Output Low Voltage	/RST asserted or RST not asserted, I_{SINK} = 1.6mA, V_{DD} ≥ 1.6V			**0.3**	V
		/RST asserted or RST not asserted, I_{SINK} = 100µA, V_{DD} ≥ 1.2V,			**0.4**	V
V_{OH}	Reset Output High Voltage	/RST not asserted or RST asserted, I_{SOURCE} = 500µA, V_{DD} ≥ 1.6V	**0.8V$_{DD}$**			V
		/RST not asserted or RST asserted, I_{SOURCE} = 50µA, V_{DD} ≥ 1.2V,	**0.8V$_{DD}$**			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.
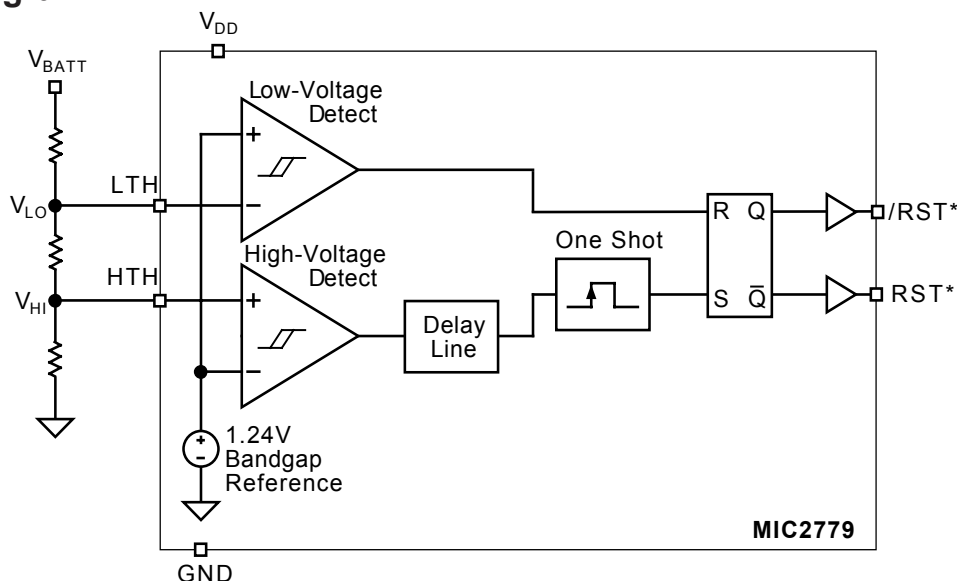
Note 4. V_{DD} operating range is 1.5V to 5.5V. Output is guaranteed to be held low down to V_{DD} = 1.2V.

Timing Diagram

Propagation delays not shown for clarity.

Note A. The MIC2779 ignores very brief transients. See "Applications Information" for details.

Functional Diagram

* Pinout and polarity vary by device type.
See ordering information table.

Functional Description

The MIC2779 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 (MIC2779L) or high (MIC2779H) for a minimum of 140ms and then sends a reset signal to a microprocessor or other downstream component. See "Timing Diagram."

/RST, RST Low Output

The output is a push-pull logic signal which is asserted when the MIC2779 detects a low input voltage. The MIC2779L's /RST output is active-low; the MIC2779H's RST output is active-high.

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 is asserted. 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 is deasserted after a minimum delay of 140ms.

Applications Information

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 measurable 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.
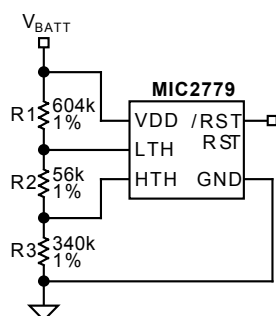

Figure 1. Example Circuit

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 MIC2779 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 MIC2779. The graph represents the typical allowable transient duration for a given amount of threshold overdrive that will not generate a reset.
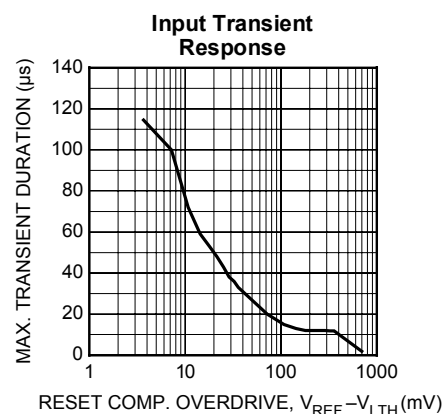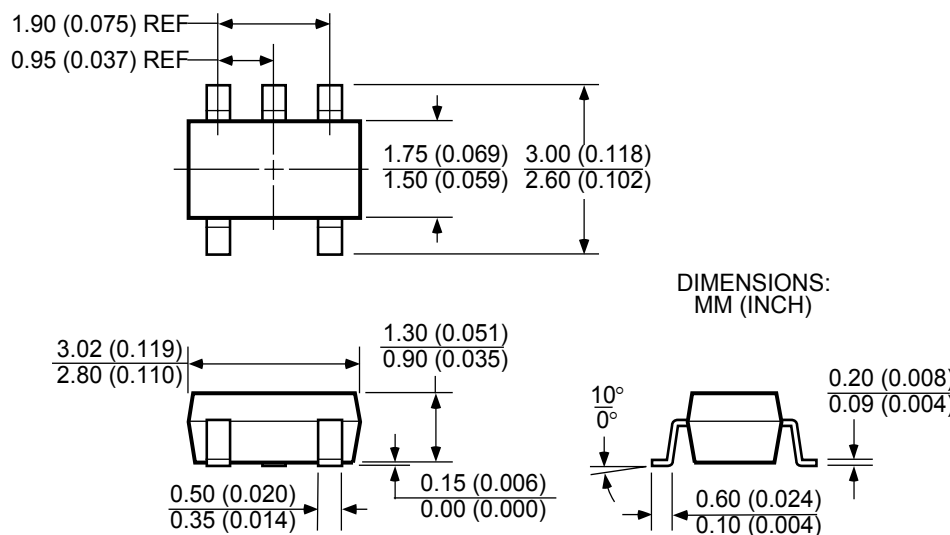

Figure 2. Input Transient Response

Package Information

5-Pin SOT-23 (M5)

DIMENSIONS:
MM (INCH)

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