MIC841/842

Comparator with 1.25% Reference and Adjustable Hysteresis

General Description

The MIC841 and MIC842 are micropower, precision voltage comparators with an on-chip voltage reference.

Both devices are intended for voltage monitoring applications. External resistors are used to set the voltage monitor threshold. When the threshold is crossed, the outputs switch polarity.

The MIC842 incorporates a voltage reference and comparator with fixed internal hysteresis; two external resistors are used to set the switching threshold voltage. The MIC841 provides a similar function with user adjustable hysteresis; this part requires three external resistors to set the upper and lower thresholds (the difference between the threshold voltages being the hysteresis voltage).

Both the MIC841 and MIC842 are available with push-pull or open-drain output stage. The push-pull output stage is configured either active high or active low; the open-drain output stage is only configured active low.

Supply current is extremely low (1.5µA, typical), making it ideal for portable applications.

The MIC841/2 is supplied in Micrel's Teeny™ 5-pin SC-70 package.

Data sheets and support documentation are found on the Micrel web site: www.micrel.com.

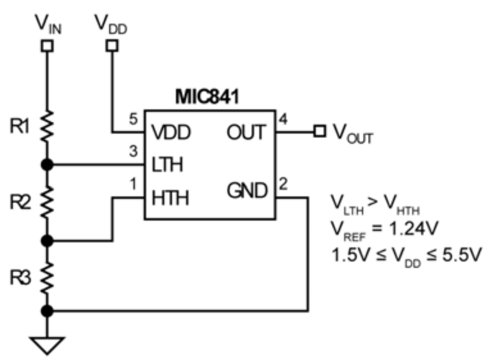
Features

- 1.5V to 5.5V operating range
- 1.5µA typical supply current
- ±1.25% voltage threshold accuracy
- 10nA max input leakage current over temperature
- 10µs propagation delay
- Externally adjustable hysteresis (MIC841)
- Internal 20mV hysteresis (MIC842)
- Output options
  - Push-pull, active high
  - Push-pull, active low
  - Open drain, active low
- Open drain output can be pulled to 6V regardless of V_{DD}
- Immune to brief input transients
- Teeny™ 5-pin SC-70 package

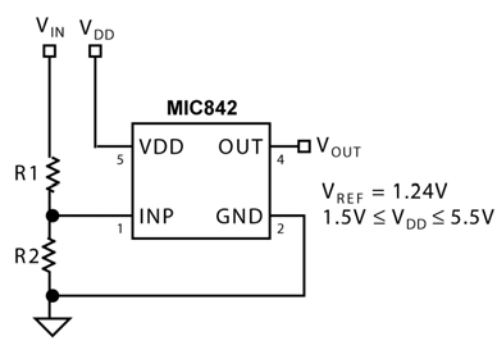
Applications

- Smart phones
- PDAs
- Precision battery monitoring
- Battery chargers

Typical Application



Threshold Detection with Adjustable Hysteresis



Threshold Detector with Internal Fixed Hysteresis

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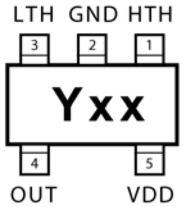
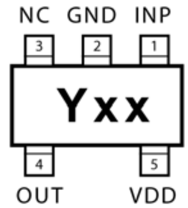
Ordering Information

Part Number	Marking	Hysteresis Adjustment	Output Stage	Output Function	Temperature Range	Pb-Free	Package
MIC841HBC5	B13	External	Push Pull	Active Low	–40° to +85°C		SC-70-5
MIC841LBC5	B14	External	Push Pull	Active High	–40° to +85°C		SC-70-5
MIC841NBC5	B15	External	Open Drain	Active Low	–40° to +85°C		SC-70-5
MIC842HBC5	B16	Internal	Push Pull	Active Low	–40° to +85°C		SC-70-5
MIC842LBC5	B17	Internal	Push Pull	Active High	–40° to +85°C		SC-70-5
MIC842NBC5	B18	Internal	Open Drain	Active Low	–40° to +85°C		SC-70-5
MIC841HYC5	B13	External	Push Pull	Active Low	–40° to +85°C	✓	SC-70-5
MIC841LYC5	B14	External	Push Pull	Active High	–40° to +85°C	✓	SC-70-5
MIC841NYC5	B15	External	Open Drain	Active Low	–40° to +85°C	✓	SC-70-5
MIC842HYC5	B16	Internal	Push Pull	Active Low	–40° to +85°C	✓	SC-70-5
MIC842LYC5	B17	Internal	Push Pull	Active High	–40° to +85°C	✓	SC-70-5
MIC842NYC5	B18	Internal	Open Drain	Active Low	–40° to +85°C	✓	SC-70-5

Pin Configuration



MIC841
SC-70-5 (C5)



MIC842
SC-70-5 (C5)

Pin Description MIC841

Pin Number	Pin Name	Pin Function
1	HTH	High Threshold Input. HTH and LTH monitor external voltages.
2	GND	Ground.
3	LTH	Low Threshold Input. LTH and HTH monitor external voltages.
4	OUT	(“H” Version) Active-Low Push-Pull Output. OUT asserts low when $V_{LTH} < V_{REF}$. OUT remains low until $V_{HTH} > V_{REF}$.
	OUT	(“L” Version) Active-High Push-Pull output. OUT asserts high when $V_{LTH} < V_{REF}$. OUT remains high until $V_{HTH} > V_{REF}$.
	OUT	(“N” Version) Active-Low, Open-Drain Output. OUT asserts low when $V_{LTH} < V_{REF}$. OUT remains low until $V_{HTH} > V_{REF}$.
5	VDD	Power Supply Input

Pin Description MIC842

Pin Number	Pin Name	Pin Function
1	INP	Threshold Input. INP monitors an external voltage.
2	GND	Ground
3	NC	No Connect. Not internally connected.
4	OUT	(“H” Version) Active-Low, Push-Pull Output. OUT asserts low when $V_{INP} < V_{REF}$. OUT remains low until $V_{INP} > (V_{REF} + V_{HYST})$.
	OUT	(“L” Version) Active-High, Push-Pull Output. OUT asserts high when $V_{INP} < V_{REF}$. OUT remains high until $V_{INP} > (V_{REF} + V_{HYST})$.
	OUT	(“N” Version) Active-Low, Open-Drain Output. OUT asserts low when $V_{INP} < V_{REF}$. OUT remains low until $V_{INP} > (V_{REF} + V_{HYST})$.
5	VDD	Power Supply Input

Absolute Maximum Ratings[1]

Supply Voltage (V_{DD}) .... –0.3V to +7V
Input Voltage (V_{INP}, V_{LTH}, V_{LTL}) .... +7V
Output Current (I_{OUT}) .... ±20mA
Storage Temperature (T_S) .... –65°C to +150°C
Junction Temperature (T_J) .... +150°C
ESD Rating[3] 1kV

Operating Ratings[2]

Supply Voltage (V_{DD}) .... +1.5V to +5.5V
Input Voltage (V_{INP} V_{LTH}, V_{LTL}) .... 0V to 6V
V_{OUT} (‘H’ and ‘L’ versions) .... V_{DD}
V_{OUT} (‘N’ version) 6V
Ambient Temperature Range (T_A) .... –40°C to +85°C
Package Thermal Resistance (θ_{JA}) .... 256.5°C/W

Electrical Characteristics[4]

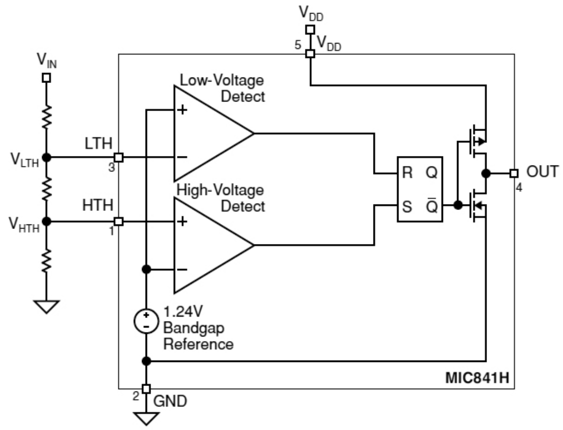
1.5V ≤ V_{DD} ≤ 5.5V; T_A = +25°C, **bold** values indicate –40°C≤ T_A ≤ +85°C, unless noted.

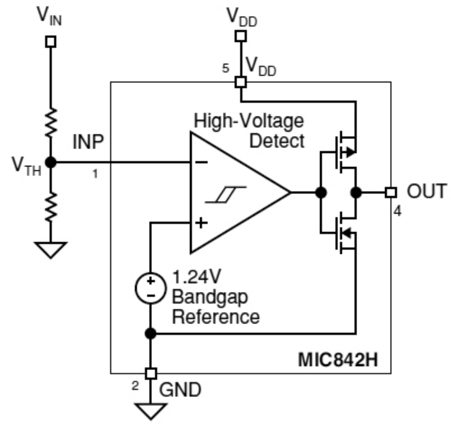
Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
I_{DD}	Supply Current	Output not asserted		1.5	**3**	µA
I_{INP}	Input Leakage Current			0.005	**10**	nA
V_{REF}	Reference Voltage	0°C to 85°C	**1.225**	1.240	**1.256**	V
		–40°C to 85°C	**1.219**	1.240	**1.261**	V
V_{HYST}	Hysteresis Voltage[5]	MIC842 only	**8**	20	**35**	mV
t_D	Propagation Delay	V_{INP} = 1.352V to 1.128V		12		µs
		V_{INP} = 1.143V to 1.367V		8		µs
V_{OUT}[6]	Output Voltage-Low	I_{SINK} = 1.6mA, V_{DD} ≥ 1.6V		0.05	**0.3**	V
		I_{SINK} = 100µA, V_{DD} ≥ 1.2V		0.005	**0.4**	V
	Output Voltage-High	I_{SOURCE} = 500µA, V_{DD} ≥ 1.6V		0.99V_{DD}		V
		I_{SOURCE} = 50µA, V_{DD} ≥ 1.2V		0.99V_{DD}		V

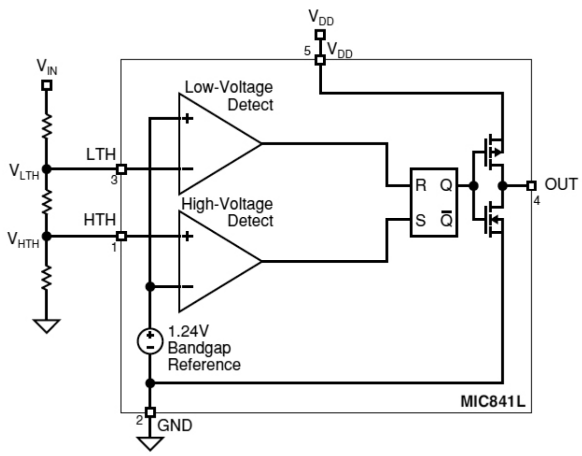
Notes:

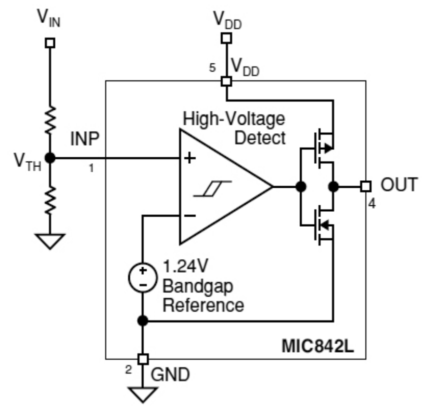
1. Exceeding the absolute maximum rating may damage the device.
2. The device is not guaranteed to function outside its operating rating.
3. Devices are ESD sensitive. Handling precautions recommended. Human body model, 1.5kΩ in series with 100pF.
4. Specification for packaged product only.
5. $V_{HTH} = V_{REF} + V_{HYST}$.
6. V_{DD} operating range is 1.5V to 5.5V. Output is guaranteed to be de-asserted down to V_{DD} = 1.2V.

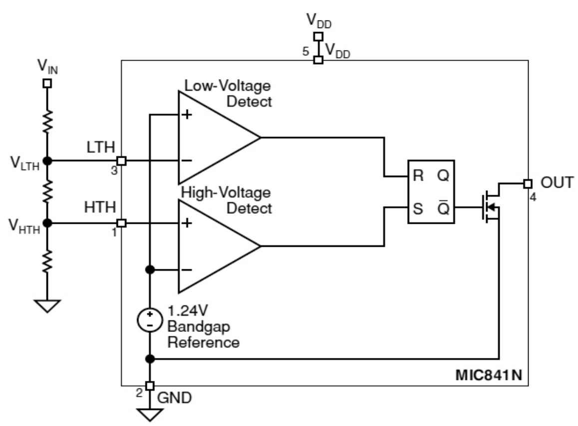
Block Diagrams

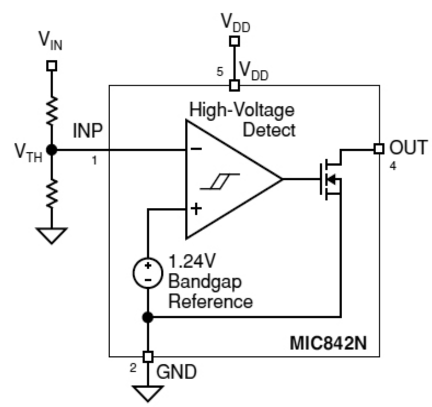












Application Information

Output

The MIC841N and MIC842N outputs are an open-drain MOSFET, so 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 of "N" version may be pulled up as high as 6V regardless of the ICs supply voltage. The "H" and "L" versions of the MIC841 and MIC842 have a push-pull output stage, with a diode clamped to V_{DD}. Thus, the maximum output voltage of the "H" and "L" versions is V_{DD}. See "Electrical Characteristics."

When working with large resistors on the input to the devices, a small amount of leakage current can cause voltage offsets that degrade system accuracy. The maximum recommended total resistance from V_{IN} to ground is 3MΩ. 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 ICs supply voltage. This applies even if the supply voltage is zero. This permits the situation in which the IC's supply is turned off, but voltage is still present on the inputs. See "Electrical Characteristics."

Programming the MIC841 Thresholds

The low-voltage threshold is calculated using:

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

The high-voltage threshold is calculated using:

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

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 current but has no significant effect on accuracy.

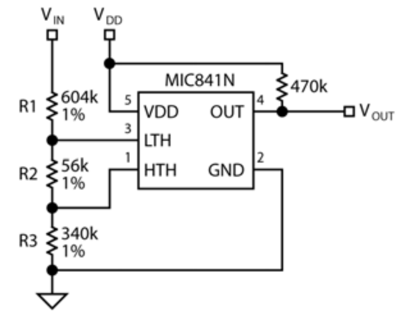


Figure 1. MIC841 Example Circuit

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:

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

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.

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

R2 = 56kΩ

R1 = 1MΩ – R2 – R3

R1 = 600kΩ

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

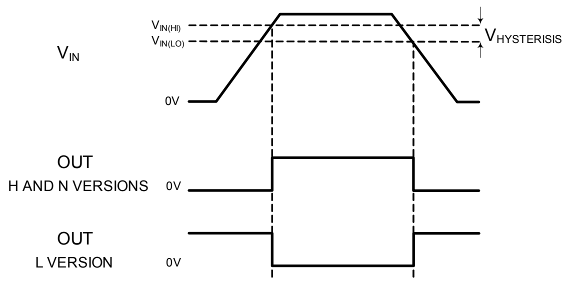


Figure 2. Output Response and Hysteresis

Programming the MIC842 Thresholds

The voltage threshold is calculated using:

$$V_{IN(LO)} = V_{REF}\left(\frac{R1+R2}{R2}\right)$$

where:

V_{REF} = 1.240V

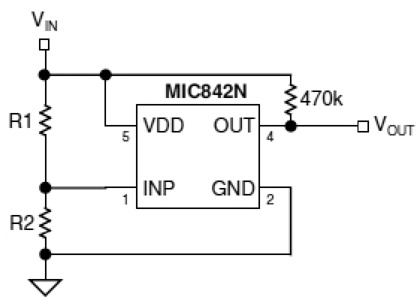


Figure 3. MIC842 Example Circuit

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 = 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.

Input Transients

The MIC841/2 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 4, the narrower the transient, the deeper the threshold overdrive that will be ignored by the MIC841/2. The graph represents the typical allowable transient duration for a given amount of threshold overdrive that will not generate an output.

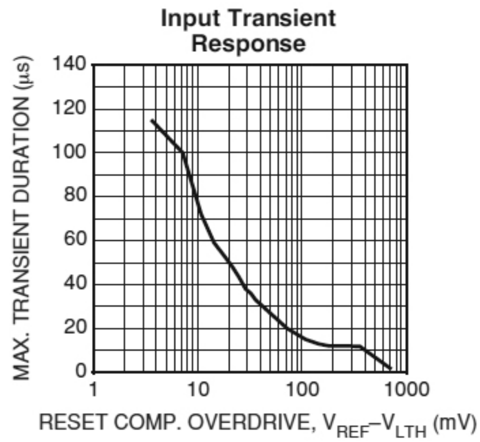
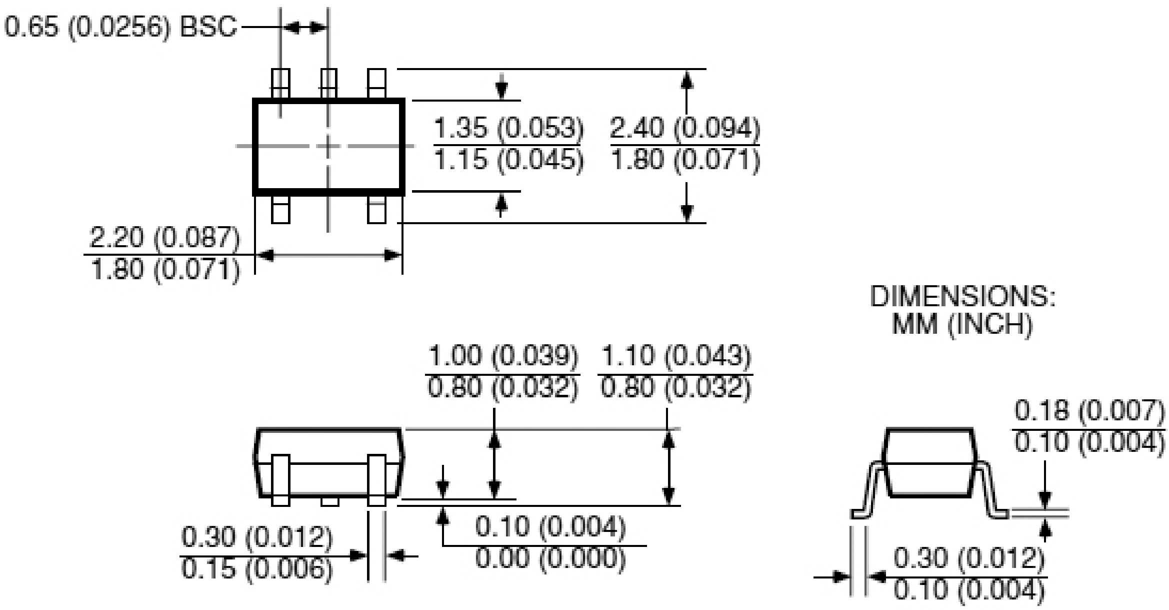


Figure 4. Input Transient Response

Package Information



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