MIC841/2

Comparator with 1.25% Reference and Adjustable Hysteresis

Features

- 1.5V to 5.5V Operating Range
- 1.5 µA Typical Supply Current
- ±1.25% Voltage Threshold Accuracy
- 10 nA Maximum Input Leakage Current Over Temperature
- 10 µs Propagation Delay
- Externally Adjustable Hysteresis (MIC841)
- Internal 20 mV 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
- 6-Pin 1.6 mm x 1.6 mm TDFN (MIC841)
- 4-Pin 1.2 mm x 1.6 mm TDFN (MIC842)

Applications

- Smartphones
- PDAs
- Precision Battery Monitoring
- Battery Chargers

General Description

The MIC841 and MIC842 are micro-power, 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.
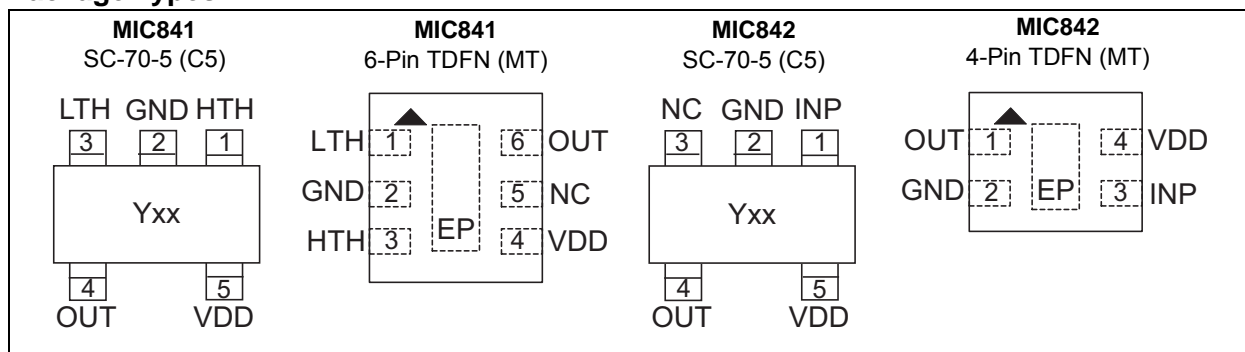
The MIC842 incorporates a voltage reference and comparator with fixed internal hysteresis; two external resistors are used to set the switching threshold voltage. The MIC841 provides a similar function with user adjustable hysteresis; this part requires three external resistors to set the upper and lower 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.

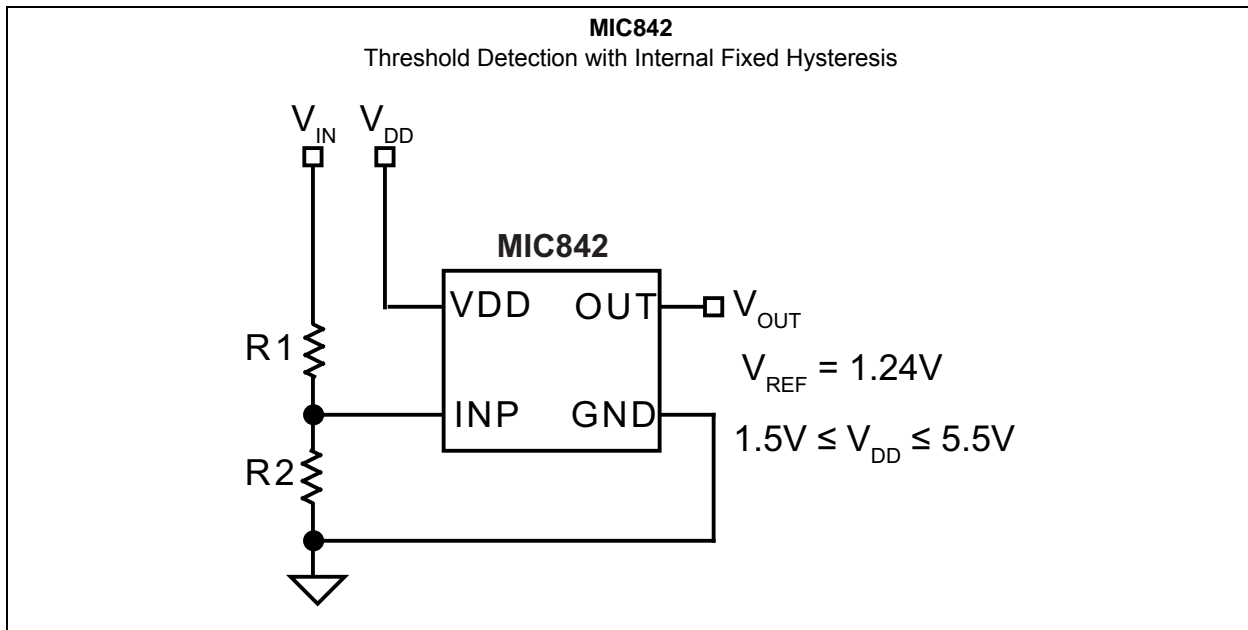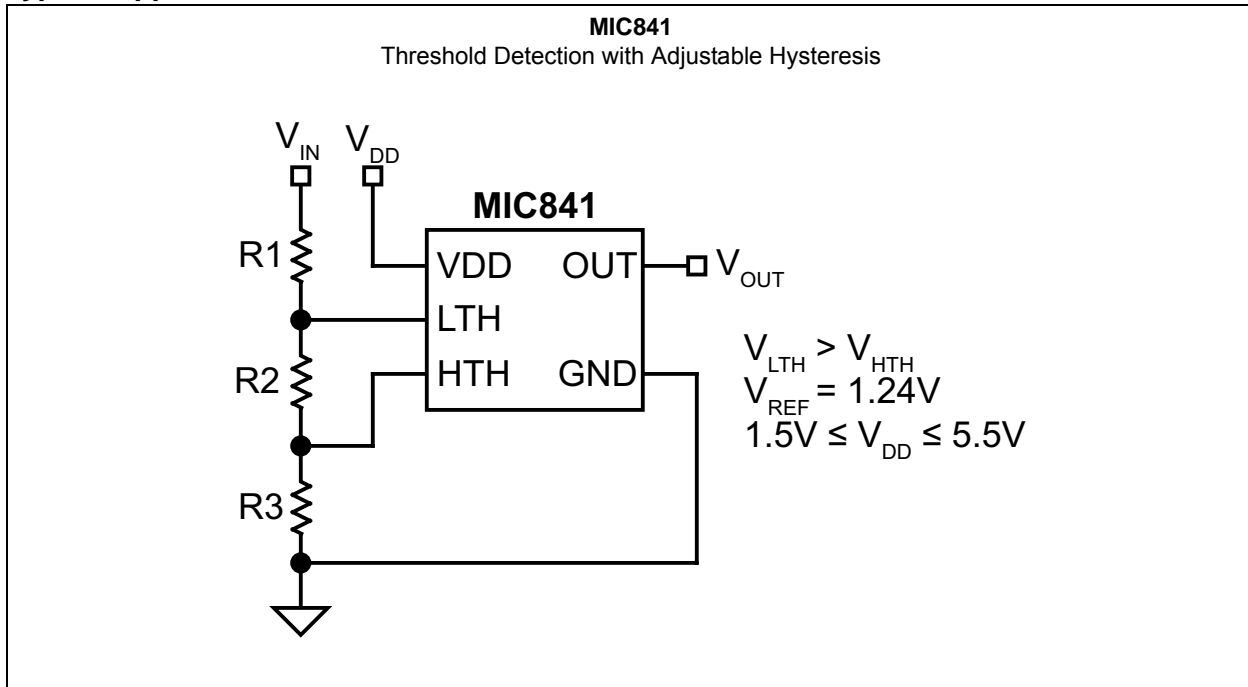Supply current is extremely low (1.5 µA, typical), making it ideal for portable applications.

The MIC841/2 is supplied in the Teeny 5-pin SC-70, 6-pin 1.6 mm × 1.6 mm Thin DFN (MIC841), and 4-pin 1.2 mm × 1.6 mm Thin DFN (MIC842) packages.

Package Types

MIC841/2

Typical Application Circuits

MIC841
Threshold Detection with Adjustable Hysteresis

$V_{LTH} > V_{HTH}$
$V_{REF} = 1.24V$
$1.5V \le V_{DD} \le 5.5V$

MIC842
Threshold Detection with Internal Fixed Hysteresis

$V_{REF} = 1.24V$
$1.5V \le V_{DD} \le 5.5V$

MIC841/2

1.0 FUNCTIONAL BLOCK DIAGRAMS

Note: Block diagrams show SC-70 package pin numbers.

FIGURE 1-1: *MIC841H Block Diagram*

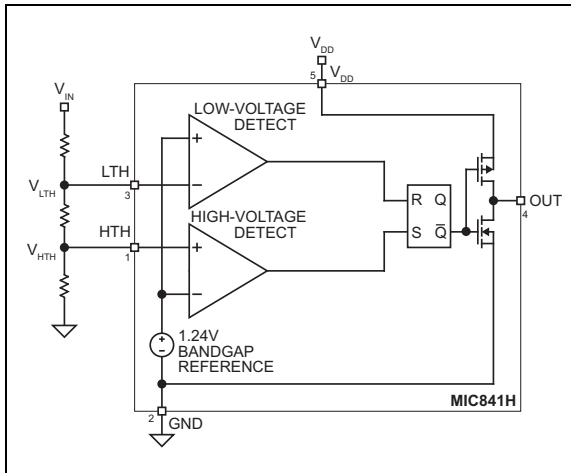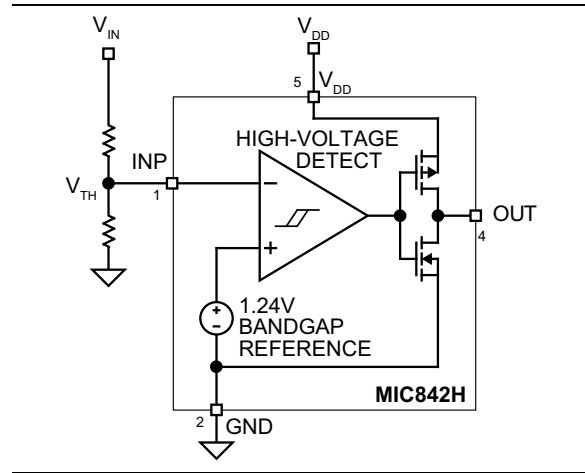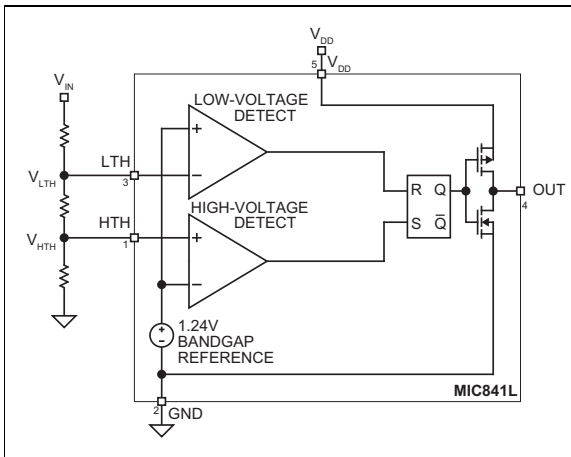
FIGURE 1-2: *MIC841L Block Diagram*
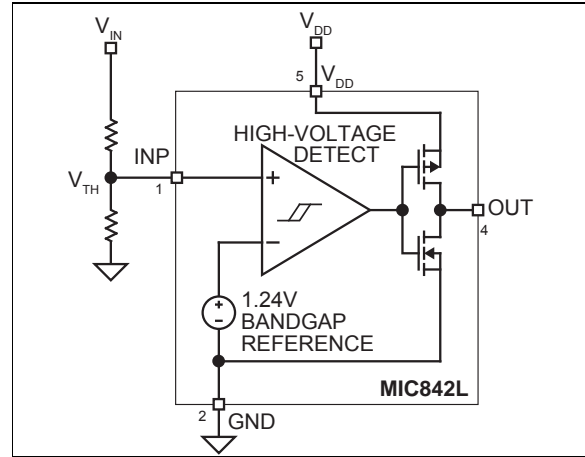

FIGURE 1-3: *MIC841N Block Diagram*
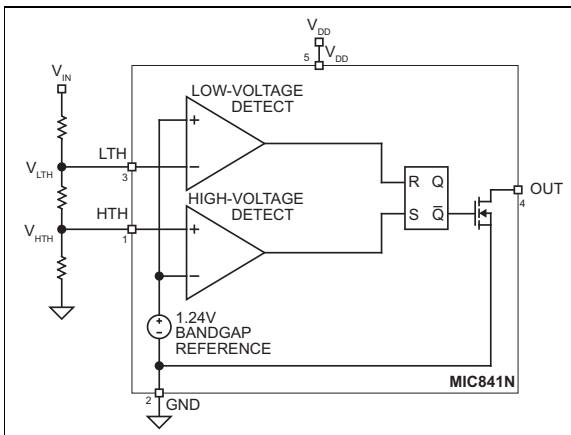

FIGURE 1-4: *MIC842H Block Diagram*

FIGURE 1-5: *MIC842L Block Diagram*
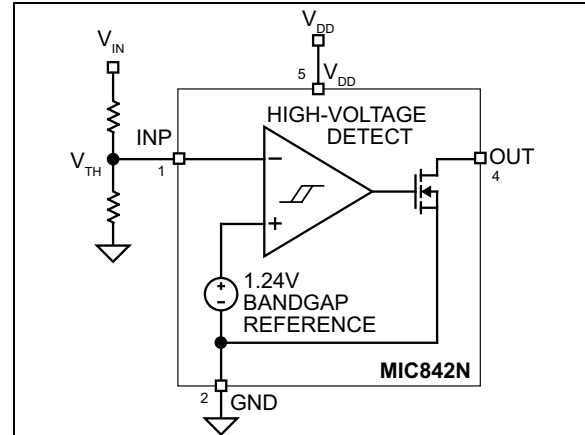
FIGURE 1-6: *MIC842N Block Diagram*

2.0   ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Supply Voltage (V_{DD}) .... –0.3V to +7V
Input Voltage (V_{INP}, V_{LTH}, V_{HTH}) ....+7V
Output Current (I_{OUT}) ....±20 mA
ESD Rating[1] .... 1 kV

Operating Ratings ‡

Supply Voltage (V_{DD}) .... +1.5V to +5.5V
Input Voltage (V_{INP}, V_{LTH}, V_{HTH}) .... 0V to +6V
V_{OUT} ('H' and 'L' versions) .... V_{DD}
V_{OUT} ('N' version)...+6V

† Notice: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational sections of this specification is not intended. Exposure to maximum rating conditions for extended periods may affect device reliability.

‡ Notice: The device is not guaranteed to function outside its operating ratings.

Note 1: Devices are ESD sensitive. Handling precautions are recommended. Human body model, 1.5 kΩ in series with 100 pF.

TABLE 2-1: ELECTRICAL CHARACTERISTICS

Electrical Characteristics: 1.5V ≤ V_{DD} ≤ 5.5V; T_A = 25°C. –40°C ≤ T_A ≤ +85°C, unless noted. **(Note 1)**.					
Parameters	**Min.**	**Typ.**	**Max.**	**Units**	**Conditions**
Supply Current (I_{DD})	—	1.5	3	µA	Output not asserted
Input Leakage Current (I_{INP})	—	0.005	10	nA	—
Reference Voltage (V_{REF})	1.225	1.240	1.256	V	0°C ≤ T_A ≤ 85°C
	1.219	1.240	1.261		–40°C ≤ T_A ≤ 85°C
Hysteresis Voltage (V_{HYST}) **(Note 2)**	8	20	35	mV	MIC842 only
Propagation Delay (t_D)	—	12	50	µs	V_{INP} = 1.352V to 1.128V
	—	8	50		V_{INP} = 1.143V to 1.367V
Output Voltage-Low (V_{OUT}) **(Note 3)**	—	0.05	0.3	V	I_{SINK} = 1.6 mA, V_{DD} ≥ 1.6V
	—	0.005	0.4		I_{SINK} = 100 µA, V_{DD} ≥ 1.2V
Output Voltage-High (V_{OUT}) **(Note 3)**	—	0.99V_{DD}	—		I_{SOURCE} = 500 µA, V_{DD} ≥ 1.6V
	—	0.99V_{DD}	—		I_{SOURCE} = 50 µA, V_{DD} ≥ 1.2V

Note 1: Specification for packaged product only.
2: V_{HTH} = V_{REF} + V_{HYST}.
3: V_{DD} operating range is 1.5V to 5.5V. Output is guaranteed to be de-asserted down to V_{DD} = 1.2V.

MIC841/2

TEMPERATURE SPECIFICATIONS

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Maximum Junction Temperature	T_J	—	—	+150	°C	Note 1
Storage Temperature Range	T_S	–65	—	+150	°C	—
Ambient Temperature Range	T_A	–40	—	+85	°C	—
Lead Temperature	—	—	—	+260	°C	Soldering, 10s
Package Thermal Resistances						
SC-70-5	θ_{JA}	—	256.5	—	°C/W	—
6-Pin 1.6 mm x 1.6 mm TDFN	θ_{JA}	—	92	—	°C/W	—
4-Pin 1.2 mm x 1.6 mm TDFN	θ_{JA}	—	173	—	°C/W	—

Note 1: The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction to air (i.e., T_A, T_J, θ_{JA}). Exceeding the maximum allowable power dissipation will cause the device operating junction temperature to exceed the maximum +150°C rating. Sustained junction temperatures above +150°C can impact the device reliability.

3.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 3-1 and Table 3-2.

TABLE 3-1: MIC841 PIN FUNCTION TABLE

Pin Number SC-70	Pin Number TDFN	Symbol	Description
1	3	HTH	High Threshold Input. HTH and LTH monitor external voltages.
2	2	GND	Ground.
3	1	LTH	Low Threshold Input. LTH and HTH monitor external voltages.
4	6	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	4	VDD	Power Supply Input.
—	5	NC	No Connect. Not internally connected.
—	EP	ePAD	Heatsink Pad. Connect to GND for best thermal performance.

TABLE 3-2: MIC842 PIN FUNCTION TABLE

Pin Number SC-70	Pin Number TDFN	Symbol	Description
1	3	INP	Threshold Input. INP monitors an external voltage.
2	2	GND	Ground.
3	—	NC	No Connect. Not internally connected.
4	1	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	4	VDD	Power Supply Input.
—	EP	ePAD	Heatsink Pad. Connect to GND for best thermal performance.

MIC841/2

4.0 APPLICATION INFORMATION

4.1 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. 470 kΩ is the maximum recommended value. Note that the output of the "N" version may be pulled up as high as 6V regardless of the IC's 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 Table 2-1).

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 3 MΩ. 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's 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 Table 2-1).

4.2 Programming the MIC841 Thresholds

The low-voltage threshold is calculated using Equation 4-1.

EQUATION 4-1:

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

Where:

V_{REF} 1.240V

The high-voltage threshold is calculated using Equation 4-2.

EQUATION 4-2:

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

Where:

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 1 MΩ for R_{TOTAL} is a reasonable value because it draws minimum current but has no significant effect on accuracy.
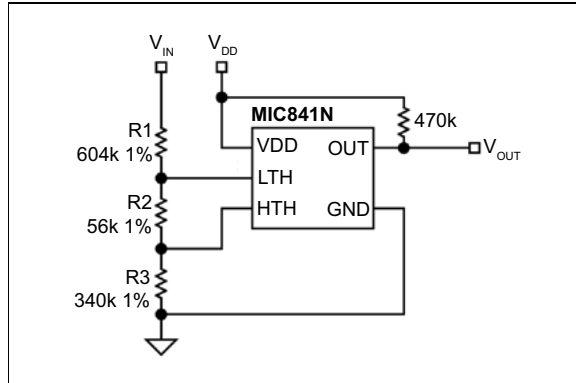

FIGURE 4-1: *MIC841 Example Circuit*

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

For example, use a total of 1 MΩ = 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:

EQUATION 4-3:

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

Solve:

R3   344 kΩ

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 the calculation of the two remaining resistor values.

EQUATION 4-4:

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

Solve:

R2   56 kΩ
R1   1 MΩ - R2 - R3
R1   600 kΩ

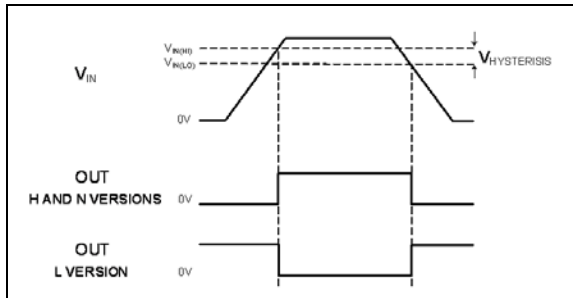The accuracy of the resistors can be chosen based upon the accuracy required by the system.

FIGURE 4-2: *Output Response and Hysteresis*

4.3 Programming the MIC842 Thresholds

The voltage threshold is calculated using Equation 4-5.

EQUATION 4-5:

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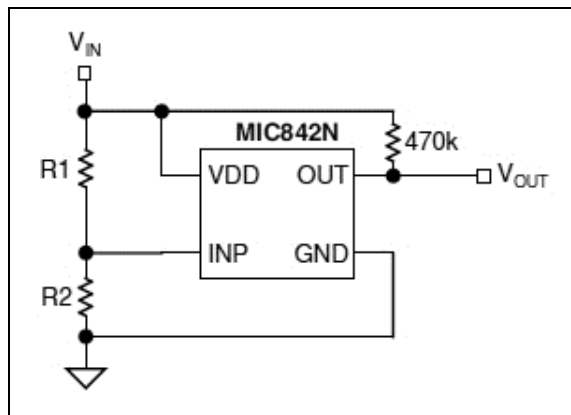
Where:

V_{REF} 1.240V

FIGURE 4-3: *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 1 MΩ for R_{TOTAL} is a reasonable value because it draws minimum current, but has no significant effect on accuracy.

4.4 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 4-4, 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.
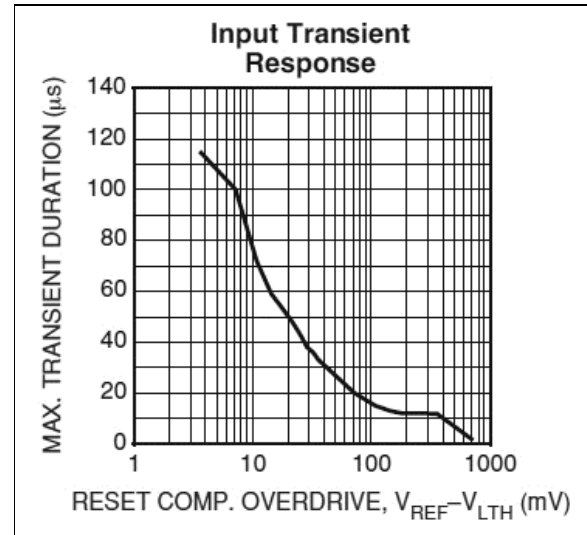
FIGURE 4-4: *Input Transient Response*

MIC841/2

5.0   PACKAGING INFORMATION

5.1   Package Marking Information

5-Pin SC-70*

XXX
NNN
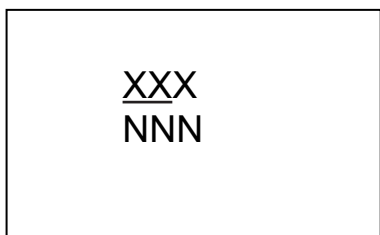
Device	Marking
MIC841H	B̲13
MIC841L	B̲14
MIC841N	B̲15
MIC842H	B̲16
MIC842L	B̲17
MIC842N	B̲18

Example

B̲14
408
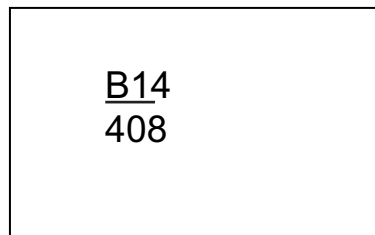
4-Pin TDFN*
6-Pin TDFN*

▲
  XX
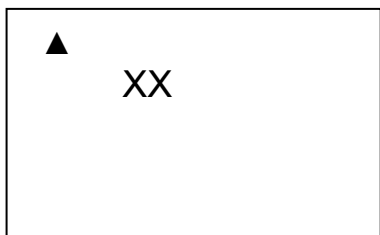
Device	Marking
MIC841H	BH
MIC841L	BL
MIC841N	BN
MIC842H	HB
MIC842L	HL
MIC842N	HN

Example

▲
  BL
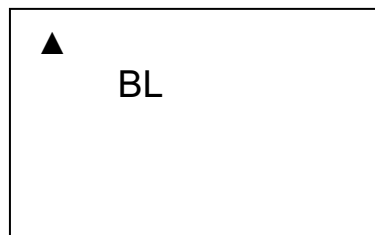
Legend:	XX...X	Product code or customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.

●, ▲, ▼ Pin one index is identified by a dot, delta up, or delta down (triangle mark).

Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo.

Underbar (_) and/or Overbar (¯) symbol may not be to scale.

MIC841/2
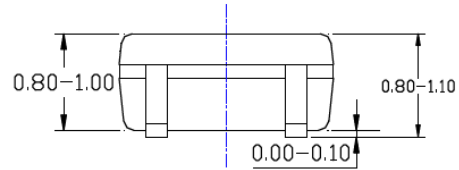
5 Lead SC70 Package Outline and Recommended Land Pattern
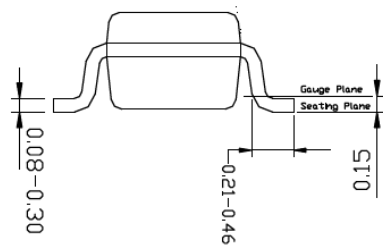
TITLE
5 LEAD SC70 PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

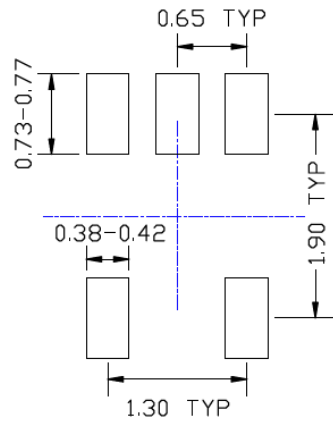| DRAWING #	SC70-5LD-PL-1	UNIT	MM
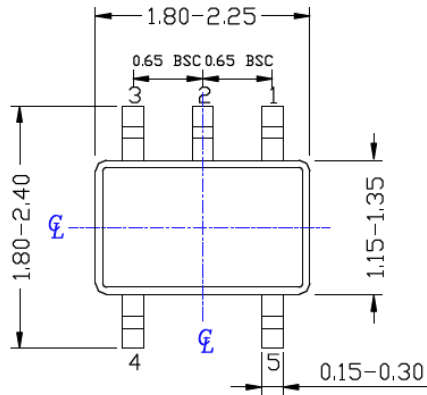
TOP VIEW

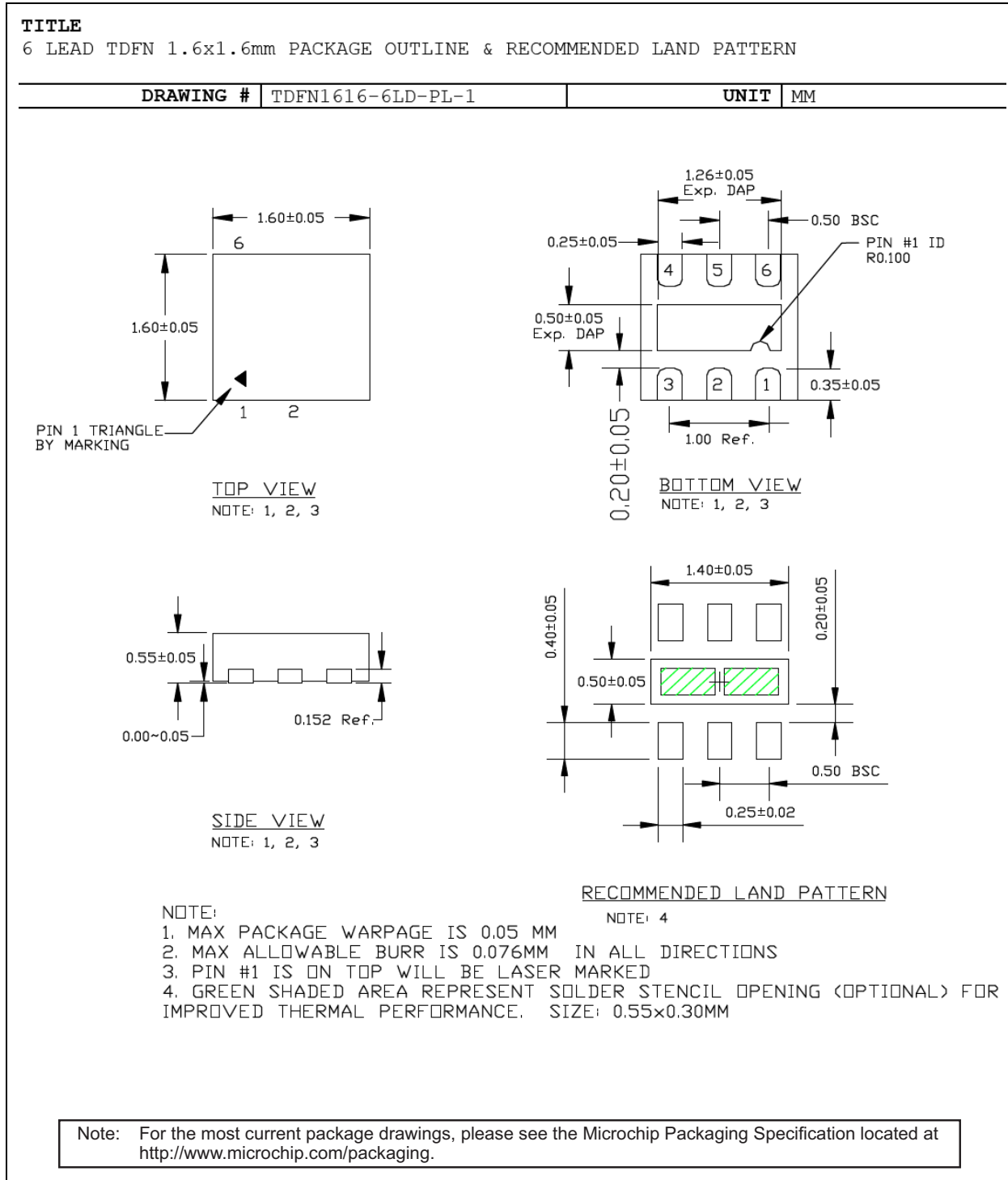SIDE VIEW

END VIEW

RECOMMENDED LAND PATTERN

NOTE:
1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONS ARE INCLUSIVE OF PLATING.
3. DIMENSIONS ARE EXCLUSIVE OF MOLD FLASH & METAL BURR.

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging.
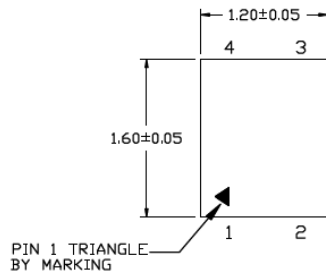
MIC841/2

6-Lead 1.6 mm x 1.6 mm Package Outline and Recommended Land Pattern

TITLE
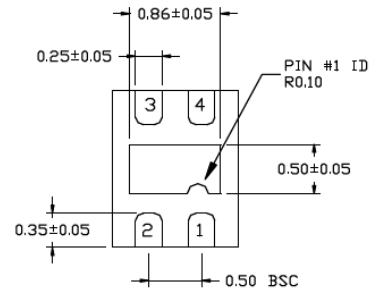6 LEAD TDFN 1.6x1.6mm PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

DRAWING #	TDFN1616-6LD-PL-1	**UNIT**	MM

1.60±0.05

6

1.60±0.05

1   2

PIN 1 TRIANGLE
BY MARKING

TOP VIEW
NOTE: 1, 2, 3

1.26±0.05
Exp. DAP

0.50 BSC

0.25±0.05

PIN #1 ID
R0.100

4 5 6

0.50±0.05
Exp. DAP

3 2 1

0.35±0.05

0.20±0.05

1.00 Ref.

BOTTOM VIEW
NOTE: 1, 2, 3

0.55±0.05

0.00~0.05

0.152 Ref.

SIDE VIEW
NOTE: 1, 2, 3

1.40±0.05

0.40±0.05

0.20±0.05

0.50±0.05

0.50 BSC

0.25±0.02

RECOMMENDED LAND PATTERN
NOTE: 4

NOTE:
1. MAX PACKAGE WARPAGE IS 0.05 MM
2. MAX ALLOWABLE BURR IS 0.076MM IN ALL DIRECTIONS
3. PIN #1 IS ON TOP WILL BE LASER MARKED
4. GREEN SHADED AREA REPRESENT SOLDER STENCIL OPENING (OPTIONAL) FOR
IMPROVED THERMAL PERFORMANCE. SIZE: 0.55x0.30MM

Note: For the most current package drawings, please see the Microchip Packaging Specification located at
http://www.microchip.com/packaging.

4-Lead 1.2 mm x 1.6 mm Package Outline and Recommended Land Pattern

TITLE
4 LEAD TDFN 1.2x1.6mm PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

DRAWING #	TDFN1216-4LD-PL-1	UNIT	MM

1.20±0.05

1.60±0.05

PIN 1 TRIANGLE BY MARKING

TOP VIEW
NOTE: 1, 2, 3

0.86±0.05

0.25±0.05

PIN #1 ID
R0.10

0.50±0.05

0.35±0.05

0.50 BSC

BOTTOM VIEW
NOTE: 1, 2, 3

0.55±0.05

0.00-0.05   0.152 REF   SEATING PLANE

SIDE VIEW
NOTE: 1, 2, 3

0.86±0.05

0.60±0.02
0.25±0.02

R0.15

1.40 BSC   0.30±0.02 0.50±0.02

0.50±0.02

0.50 BSC
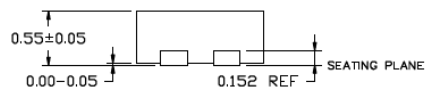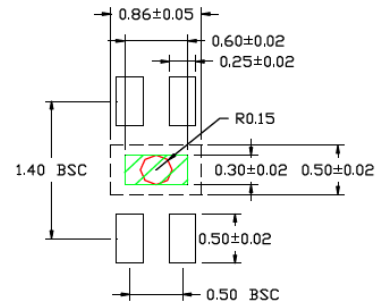
RECOMMENDED LAND PATTERN
NOTE: 4, 5

NOTE:
1. MAX PACKAGE WARPAGE IS 0.05mm.
2. MAX ALLOWABLE BURR IS 0.076mm IN ALL DIRECTIONS.
3. PIN #1 IS ON TOP WILL BE LASER MARKED.
4. GREEN SHADED AREA INDICATES SOLDER STENCIL OPENING (OPTIONAL) FOR IMPROVED THERMAL PERFORMANCE. RECOMMENDED SIZE is 0.60mm x 0.30mm.
5. RED CIRCLE REPRESENTS THERMAL VIA & SHOULD BE CONNECTED TO GND FOR MAX PERFORMANCE. RECOMMENDED DIAMETER is 0.30mm - 0.35mm.

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging.

NOTES:

APPENDIX A: REVISION HISTORY

Revision A (April 2017)

• Converted Micrel data sheet MIC841/2 to Microchip data sheet DS20005758A.

• Minor grammatical corrections throughout.

MIC841/2

NOTES:

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

PART NO.	X	X	XX	-XX
Device	Output Stage	Temp.	Package	Media Type

Device:	MIC841:	Comparator with 1.25% Reference and Adjustable Hysteresis
	MIC842:	Comparator with 1.25% Reference and Internal Fixed Hysteresis
Output Stage:	H =	Push-Pull, Active-Low
	L =	Push-Pull, Active-High
	N =	Open-Drain, Active-Low
Temperature:	Y =	–40°C to +85°C
Package:	C5 =	SC-70-5
	MT =	1.6 mm x 1.6 mm TDFN (MIC841 Only)
	MT =	1.2 mm x 1.6 mm TDFN (MIC842 Only)
Media Type	T5 =	500/Reel
	TR =	5,000/Reel

Examples:

a) MIC841HYC5-T5: Comparator with 1.25% Reference and Adjustable Hysteresis, Push-Pull, Active-Low, –40°C to +85°C Temperature Range, SC-70-5 Package, 500/Reel

b) MIC841LYMT-TR: Comparator with 1.25% Reference and Adjustable Hysteresis, Push-Pull, Active-High, –40°C to +85°C Temperature Range, 1.6 mm x 1.6 mm TDFN Package, 5,000/Reel

c) MIC841NYC5-T5: Comparator with 1.25% Reference and Adjustable Hysteresis, Open-Drain, Active-Low, –40°C to +85°C Temperature Range, SC-70-5 Package, 500/Reel

d) MIC842HYMT-T5: Comparator with 1.25% Reference and Internal Fixed Hysteresis, Push-Pull, Active-Low, –40°C to +85°C Temperature Range, 1.2 mm x 1.6 mm TDFN Package, 500/Reel

e) MIC842LYC5-TR: Comparator with 1.25% Reference and Internal Fixed Hysteresis, Push-Pull, Active-High, –40°C to +85°C Temperature Range, SC-70-5 Package, 5,000/Reel

f) MIC842NYMT-TR: Comparator with 1.25% Reference and Internal Fixed Hysteresis, Open-Drain, Active-Low, –40°C to +85°C Temperature Range, 1.2 mm x 1.6 mm TDFN Package, 5,000/Reel

NOTES:

Note the following details of the code protection feature on Microchip devices:

• Microchip products meet the specification contained in their particular Microchip Data Sheet.

• Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.

• There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.

• Microchip is willing to work with the customer who is concerned about the integrity of their code.

• Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

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