

# NCT51, NCT52

## Ultra Small Temperature Switch with Pin-Selectable Hysteresis

The NCT51 and NCT52 are SOT-23 temperature switches that require no external components and the design is facilitated with factory-programmed temperature thresholds. A choice of factory-trimmed temperature trip points are available. Pin selectable hysteresis of +2°C or +10°C allows flexibility to the design. These parts typically consume only 17 µA of current and operate over the entire -55°C to +125°C temperature range while offering accuracies of ±0.5°C (typ) and ±4°C (max).

The NCT51 has an open drain, active low output, meant for microprocessor reset control. The NCT52 has a CMOS, active high output designed to drive a logic level MOSFET to turn on a fan or heater element.

The NCT51/NCT52 are aimed for hot-temperature monitoring (+45°C to +115°C). These devices assert a logic signal when the temperature goes above the threshold.

The NCT51 and NCT52 are offered in three standard temperature thresholds. Available in 5-Pin SOT-23A packages, these parts are ideal for applications requiring high integration, small size, low power and low installed cost.

### Features

- 5-Pin SOT-23A
- Factory-Programmed Thresholds from +45°C to +115°C in 10°C Increments
- Pin-Selectable +2°C or +10°C Hysteresis
- ±0.5°C (Typ) Threshold Accuracy Over Full Temperature Range
- No External Components Required
- 17 µA Supply Current

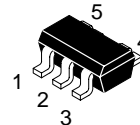
### Typical Applications

- Thermal Management in PCs and Servers
- Over Temperature Fail Safe Circuits
- Simple Fan Controller
- Temperature Alarms
- Projectors/Printers
- Notebook Computers
- Network Boxes



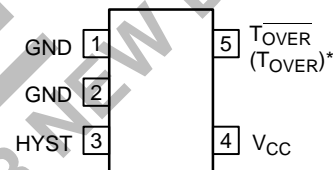
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SOT-23A  
SN SUFFIX  
CASE 1212

### PIN CONNECTIONS



\*For NCT52

Note: 5-Pin SOT-23A is equivalent to EIAJ SC-74A

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 9 of this data sheet.

### DEVICE MARKING INFORMATION

See general marking information in the device marking section on page 9 of this data sheet.

# NCT51, NCT52

## MAXIMUM RATINGS\*

| Rating  | Symbol    | Value                      | Unit |
|---|-----------|----------------------------|------|
| Supply Voltage  | $V_{CC}$  | -0.3 to +7.0               | V    |
| $V_{TOVER}$ (NCT51)   | -         | -0.3 to +7.0               | V    |
| $V_{TOVER}$ (NCT52)   | -         | -0.3 to ( $V_{CC} + 0.3$ ) | V    |
| All Other Pins  | -         | -0.3 to ( $V_{CC} + 0.3$ ) | V    |
| Input Current (All Pins)  | -         | 20                         | mA   |
| Output Current (All Pins)   | -         | 20                         | mA   |
| Operating Temperature Range   | -         | -55 to +125                | °C   |
| Storage Temperature Range   | $T_{stg}$ | -65 to +165                | °C   |
| Lead Temperature (Soldering, 10 seconds)  | -         | +300                       | °C   |
| Power Dissipation ( $T_A = +70^{\circ}\text{C}$ )<br>(Derate 7.1 mW/°C Above +70°C) | -         | 571                        | mW   |

\*Static-sensitive device. Unused devices must be stored in conductive material. Protect devices from static discharge and static fields. Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to Absolute Maximum Rating Conditions for extended periods may affect device reliability.

**ELECTRICAL CHARACTERISTICS**  $V_{CC} = +2.7\text{ V to }+5.5\text{ V}$ ,  $R_{PULL-UP} = 100\text{ k}\Omega$  (NCT51 only),  $C_{COUPLING} = 100\text{ pF}$  from  $V_{CC}$  to GND,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $T_A = +25^{\circ}\text{C}$ .

| Characteristics                         | Test Conditions  | Symbol          | Min                                   | Typ                    | Max                 | Unit          |
|---|--|-----------------|---------------------------------------|------------------------|---------------------|---------------|
| Supply Voltage Range                    | -  | $V_{CC}$        | 2.7                                   | -                      | 5.5                 | V             |
| Supply Current                          | -  | $I_{CC}$        | -                                     | 17                     | 40                  | $\mu\text{A}$ |
| Temperature Threshold Accuracy (Note 1) | +45°C to +65°C<br>+75°C to +115°C  | $\Delta T_{TH}$ | -4.0<br>-6.0                          | $\pm 0.5$<br>$\pm 0.5$ | 4.0<br>6.0          | °C            |
| Temperature Threshold Hysteresis        | HYST = GND<br>HYST = $V_{CC}$  | $T_{HYST}$      | -<br>-                                | 2.0<br>10              | -<br>-              | °C            |
| HYST Input Threshold                    | -  | $V_{IH}$        | $0.8 \times V_{CC}$                   | -                      | -                   | V             |
| HYST Input Threshold                    | -  | $V_{IL}$        | -                                     | -                      | $0.2 \times V_{CC}$ | V             |
| Output Voltage High                     | $I_{SOURCE} = 500\text{ }\mu\text{A}$ , $V_{CC} > 2.7\text{ V}$<br>(NCT52 Only)<br>$I_{SOURCE} = 800\text{ }\mu\text{A}$ , $V_{CC} > 4.5\text{ V}$<br>(NCT52 Only) | $V_{OH}$        | $0.8 \times V_{CC}$<br>$V_{CC} - 1.5$ | -<br>-                 | -<br>-              | V             |
| Output Voltage Low                      | $I_{SINK} = 1.2\text{ mA}$ , $V_{CC} > 2.7\text{ V}$<br>$I_{SINK} = 3.2\text{ mA}$ , $V_{CC} > 4.5\text{ V}$   | $V_{OL}$        | -<br>-                                | -<br>-                 | 0.3<br>0.4          | V             |
| Open-Drain Output Leakage Current       | $V_{CC} = 2.7\text{ V}$ , $V_{TOVER} = 5.5\text{ V}$<br>(NCT51 Only)   | -               | -                                     | 10                     | -                   | nA            |

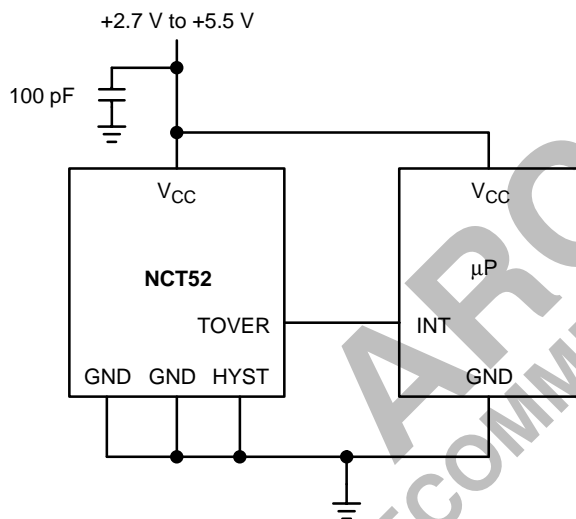
1. The NCT51 and NCT52 are available with internal, factory-programmed temperature trip thresholds from +45°C to +115°C in +10°C increments.

# NCT51, NCT52

## PIN DESCRIPTION

| NCT51 | NCT52 | Name                       | Description  |
|-------|-------|----------------------------|--|
| 1,2   | 1,2   | GND                        | Ground. Ground both pins together close to the chip. Pin 2 provides the lowest thermal resistance to the die.  |
| 3     | 3     | HYST                       | Hysteresis Input. Connect HYST to GND for +2°C hysteresis, or connect to V <sub>CC</sub> for +10°C hysteresis.   |
| 4     | 4     | V <sub>CC</sub>            | Supply Input (+2.7 V to +5.5 V). Recommend 100 pF or greater Coupling capacitor from V <sub>CC</sub> to GND.   |
| 5     | –     | TOVER                      | Open–Drain, Active–Low Output. $\overline{\text{TOVER}}$ goes low when the die temperature exceeds the factory–programmed temperature threshold. Connect to a 100 K $\Omega$ pull–up resistor. May be pulled up to a voltage higher than V <sub>CC</sub> .     |
| –     | 5     | TOVER                      | Push/Pull Active–High Output. TOVER goes high when the die temperature exceeds the factory–programmed temperature threshold.   |
| –     | –     | $\overline{\text{TUNDER}}$ | Open–Drain, Active–Low Output. $\overline{\text{TUNDER}}$ goes low when the die temperature goes below the factory–programmed temperature threshold. Connect to a 100 K $\Omega$ pull–up resistor. May be pulled up to a voltage higher than V <sub>CC</sub> . |
| –     | –     | TUNDER                     | Push/Pull Active–High Output. TUNDER goes high when the die temperature is below the factory–programmed temperature threshold.   |

### Typical Operating Circuit



### DETAILED DESCRIPTION

The NCT51 and NCT52 integrate a temperature sensor with a factory–programmed threshold switch. A logic signal is asserted when the die temperature crosses the factory programmed threshold. An external hysteresis input pin allows the user to select either 2°C or 10°C hysteresis to give further flexibility to the design of the application. The NCT51 and NCT52 are intended for a temperature range from 45°C to 115°C in a 10°C increment. The NCT51 has an open drain output and the NCT52 has a push/pull output stage.

The NCT51 is intended for applications with a microprocessor reset input. The NCT52 is intended for applications of turning on a fan or heater element.

### Hysteresis Input

To prevent the output from “chattering” at or near the trip point temperature, a selectable HYST input pin is provided. Hysteresis can be externally selected at 2°C (HYST = GND) or 10°C (HYST = V<sub>DD</sub>) by means of the CMOS compatible HYST input pin. Do not let the HYST pin float as this could cause increase supply current. The hysteresis does not depend on the part’s programmed trip threshold.

**Table 1. Factory–Programmed Threshold Range**

| Part Number | Threshold (T <sub>TH</sub> ) Range |
|-------------|------------------------------------|
| NCT51       | +45°C < T <sub>TH</sub> < +115°C   |
| NCT52       | +45°C < T <sub>TH</sub> < +115°C   |

### Thermal Considerations

With a very low 17 μA supply current, the NCT51 and NCT52 dissipates very little power. Thus, the die temperature is basically the same as the package temperature. To minimize the error in temperature readings, the load current should be limited to a few milliamps. As an example, the typical thermal resistance of a 5–Pin SOT–23A package is 140°C/W. If the NCT51 had to sink 1.0 mA, and the output voltage is guaranteed to be less than 0.3 V, then an additional 0.3 mW of power is dissipated within the IC. This corresponds to a 0.042°C rise in die temperature in the 5–Pin SOT–23A.

## NCT51, NCT52

Temperature monitoring accuracy depends on the thermal resistance between the device being monitored and the temperature switch die. Heat flows primarily through the leads onto the die. Pin 2 provides the lowest thermal resistance to the die. To achieve the best temperature monitoring results, the NCT51 and NCT52 should be placed closest to the device being monitored. In addition, a short and wide copper trace from Pin 2 to the device should be used. In some cases, the 5-Pin SOT-23A

package can be placed directly under the socketed microprocessor for improved thermal contact.

### APPLICATIONS

The NCT51 has an open drain output and is therefore intended to interface as a microprocessor reset input. Moreover, the combination of these two devices can be used to implement a temperature window alarm by wire-ORing the outputs and using an external pull up resistor. (See Figure 1)

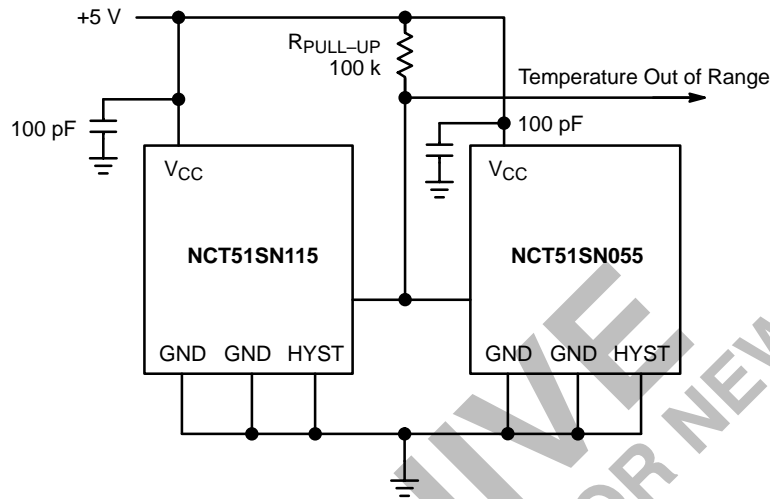


Figure 1. Over and Under Temperature Alarm

The NCT52 can be used to control a DC fan. The fan turns on when the sensed temperature rises above the factory set threshold and remains on until the temperature falls below threshold minus the hysteresis selected. An additional fail

safe measure could be designed by using a second NCT52 with a higher temperature threshold to alert the user of an impending thermal shutdown, should the temperature continue to rise. (See Figure 2)

# NCT51, NCT52

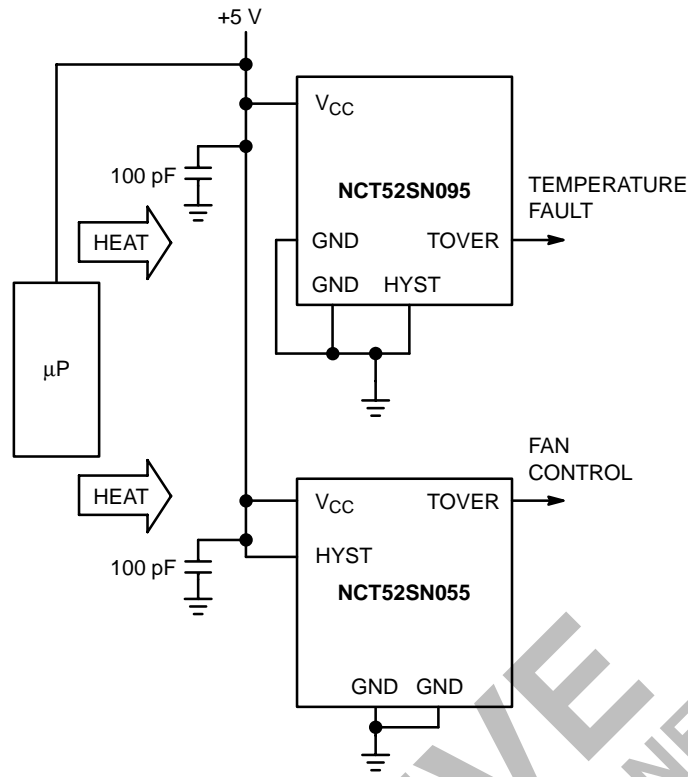


Figure 2. Fan Control Circuit with Over Temperature Alert

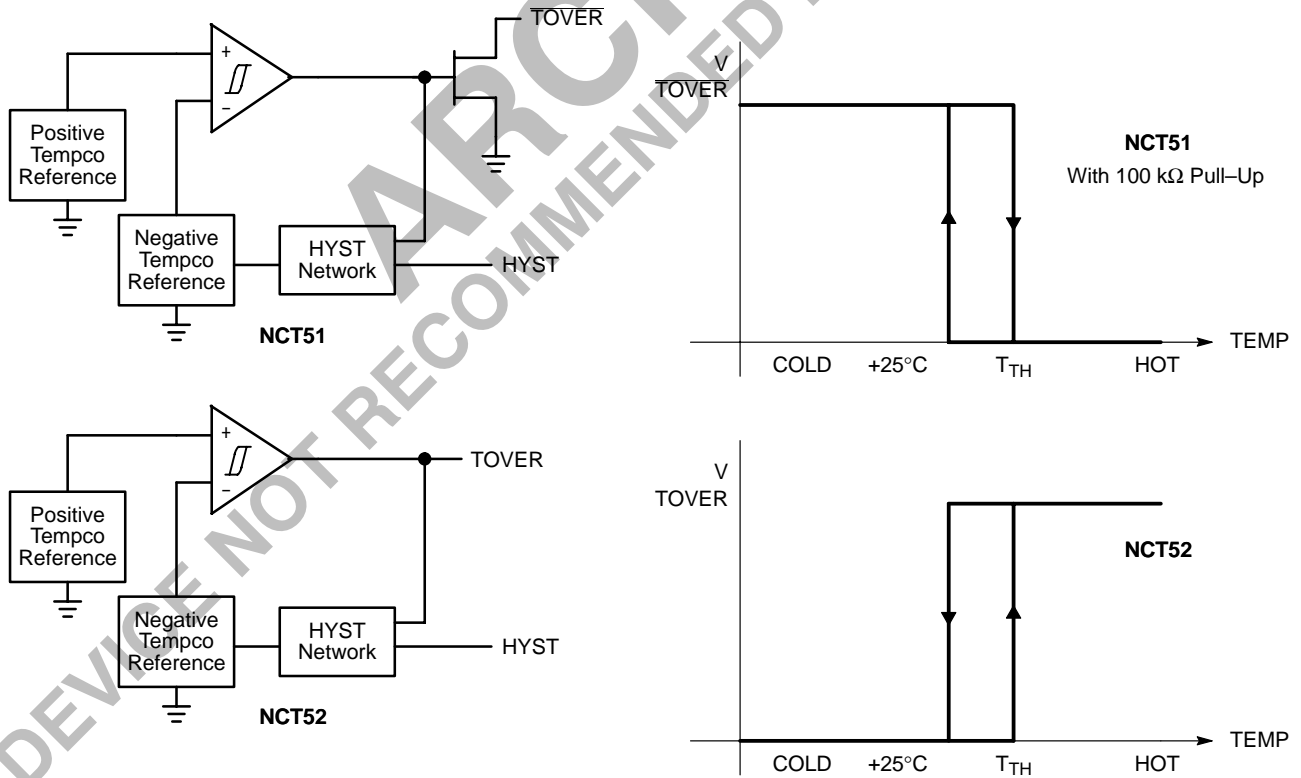


Figure 3. Functional Block Diagrams

# NCT51, NCT52

## TYPICAL CHARACTERISTICS

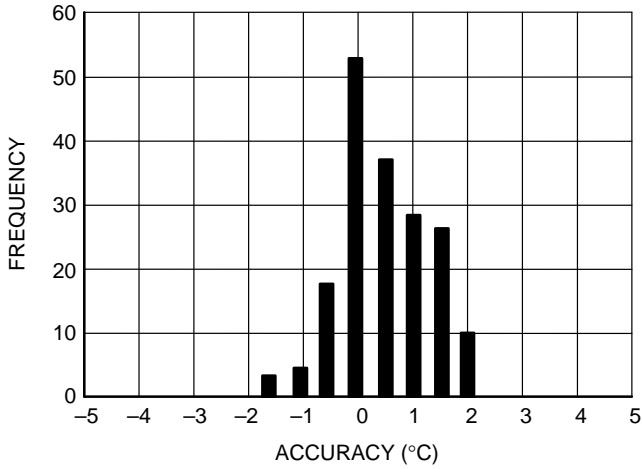


Figure 4. Trip Threshold Accuracy

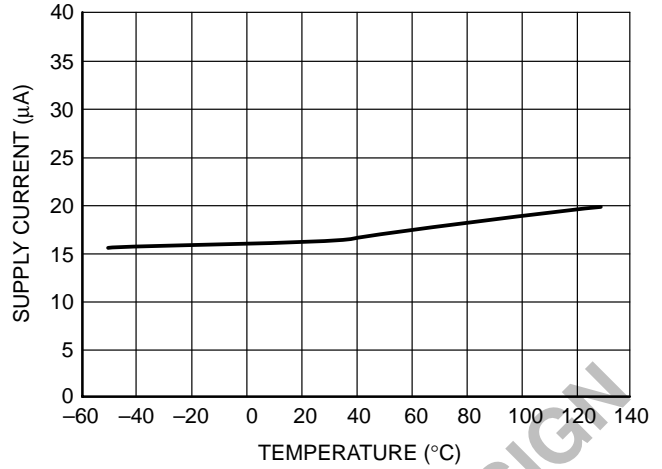


Figure 5. Supply Current vs. Temperature

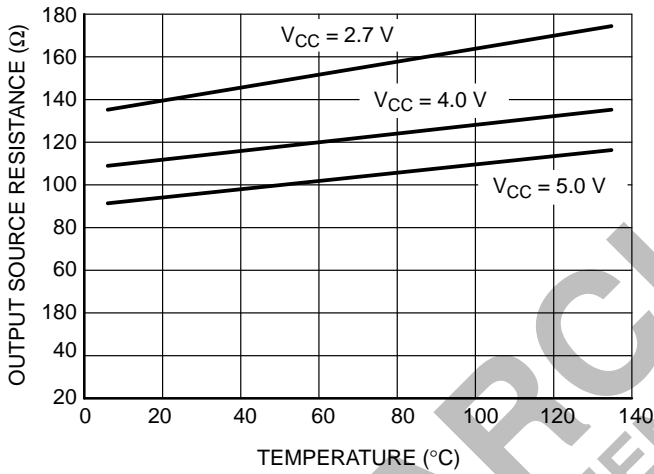


Figure 6. NCT52 Output Source Resistance vs. Temperature

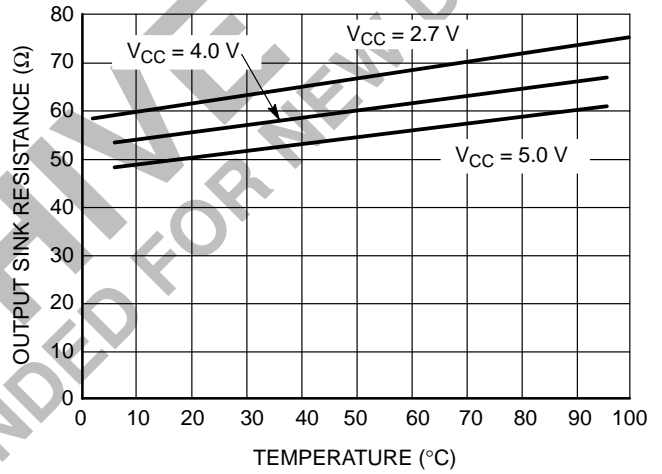


Figure 7. Output Sink Resistance vs. Temperature

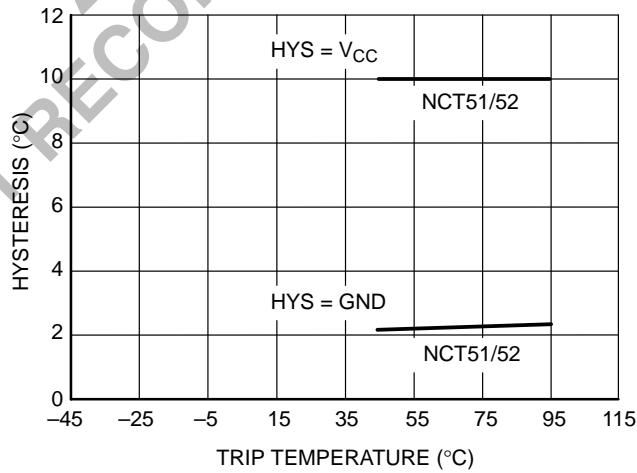
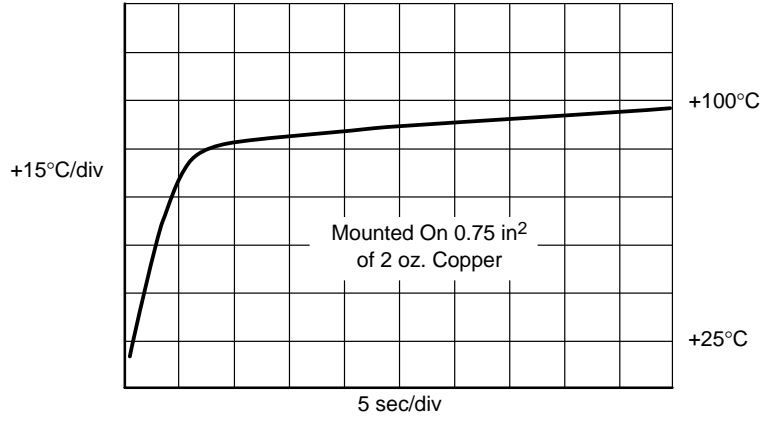


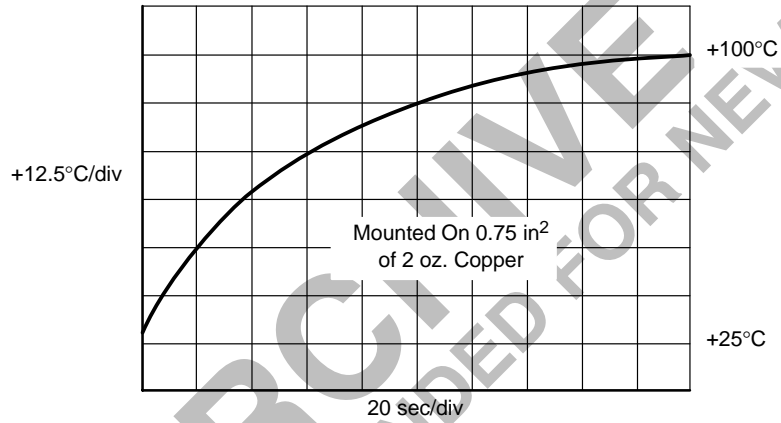
Figure 8. Hysteresis vs. Trip Temperature

# NCT51, NCT52

## TYPICAL CHARACTERISTICS



**Figure 9. SOT-23 Thermal Step Response in Perfluorinated Fluid**

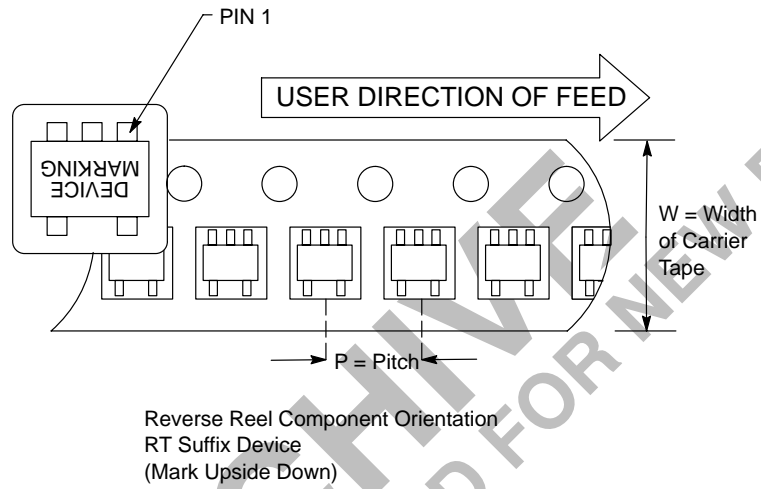
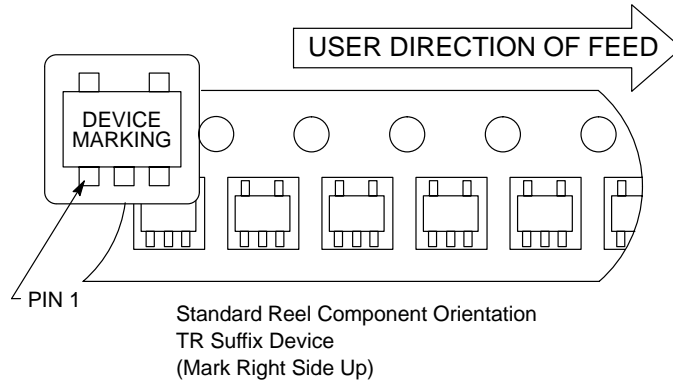


**Figure 10. SOT-23 Thermal Step Response in Still Air**

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DEVICE NOT RECOMMENDED FOR NEW DESIGN

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## Component Taping Orientation for 5-Pin SOT-23A (EIAJ SC-74A) Devices



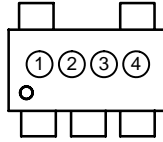
Carrier Tape, Reel Size, and Number of Components Per Reel

| Package | Carrier Width (W) | Pitch (P) | Part Per Full Reel | Reel Size |
|---------|-------------------|-----------|--------------------|-----------|
| SOT-23A | 8 mm              | 4 mm      | 3000               | 7 inches  |



# NCT51, NCT52

## MARKING DIAGRAM



- ① and ② = Two Letter Part Number Codes
- ③ = Year and Two-Month Period Code
- ④ = Lot ID Number

## ORDERING INFORMATION

| Device                                       | Package       | Standard Temperature Threshold | Output Stage | Marking ① and ② | Shipping                 |
|--|---------------|--------------------------------|--------------|-----------------|--------------------------|
| NCT51SN055T1<br>NCT51SN095T1<br>NCT51SN115T1 | 5-Pin SOT-23A | 55°C                           | Open Drain   | HB              | 3000 Units Tape and Reel |
|  |               | 95°C                           | Open Drain   | HF              |                          |
|  |               | 115°C                          | Open Drain   | HH              |                          |
| NCT52SN055T1                                 |               | 55°C                           | Push/Pull    | JB              |                          |
| NCT52SN095T1                                 |               | 95°C                           | Push/Pull    | JF              |                          |
| NCT52SN115T1                                 |               | 115°C                          | Push/Pull    | JH              |                          |

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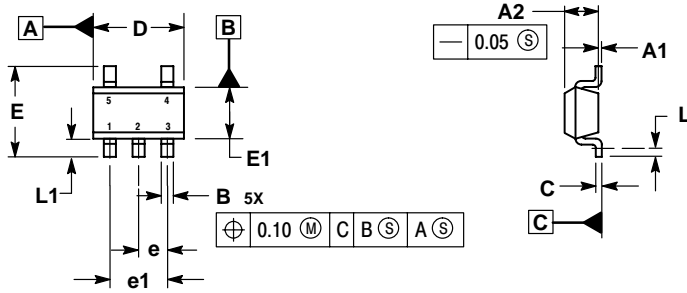
**Notes**

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# NCT51, NCT52

## PACKAGE DIMENSIONS

SOT-23  
 SN SUFFIX  
 CASE 1212-01  
 ISSUE O




NOTES:

1. DIMENSIONS ARE IN MILLIMETERS.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
3. DATUM C IS A SEATING PLANE.

| MILLIMETERS |          |      |
|-------------|----------|------|
| DIM         | MIN      | MAX  |
| A1          | 0.00     | 0.10 |
| A2          | 1.00     | 1.30 |
| B           | 0.30     | 0.50 |
| C           | 0.10     | 0.25 |
| D           | 2.90     | 3.00 |
| E           | 2.50     | 3.10 |
| E1          | 1.50     | 1.80 |
| e           | 0.95 BSC |      |
| e1          | 1.90 BSC |      |
| L           | 0.20     |      |
| L1          | 0.45     | 0.75 |

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