UDF®

# ADT6501

## FEATURES

**±0.5°C (typical) threshold accuracy**
**Factory-set trip points from**
**−45°C to +15°C in 10°C increments**
**+35°C to +115°C in 10°C increments**
**No external components required**
**Maximum temperature of 125°C**
**Open-drain output (ADT6501/ADT6503)**
**Push-pull output (ADT6502/ADT6504)**
**Pin-selectable hysteresis of 2°C and 10°C**
**Supply current of 30 µA (typical)**
**Space-saving, 5-lead SOT-23 package**

## APPLICATIONS

**Medical equipment**
**Automotive**
**Cell phones**
**Hard disk drives**
**Personal computers**
**Electronic test equipment**
**Domestic appliances**
**Process control**

## FUNCTIONAL BLOCK DIAGRAM

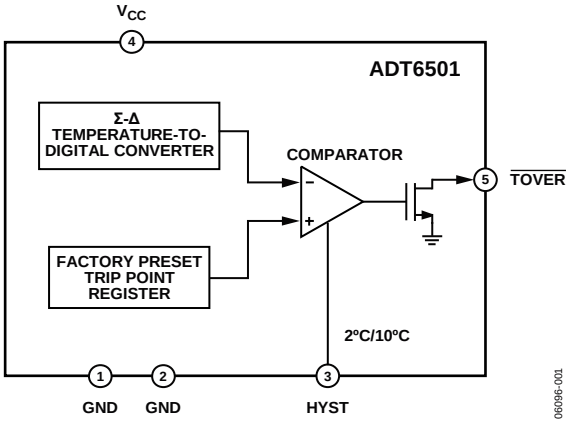


*Figure 1.*

## GENERAL DESCRIPTION

The ADT6501/ADT6502/ADT6503/ADT6504 are trip point temperature switches available in a 5-lead SOT-23 package. Each part contains an internal band gap temperature sensor for local temperature sensing. When the temperature crosses the trip point setting, the logic output is activated. The ADT6501/ADT6503 logic output is active low and open-drain. The ADT6502/ADT6504 logic output is active high and push-pull. The temperature is digitized to a resolution of 0.125°C (11-bit). The factory trip point settings are 10°C apart starting from −45°C to +15°C for the cold threshold models and from +35°C to +115°C for the hot threshold models.

These devices require no external components and typically consume 30 µA supply current. Hysteresis is pin-selectable at 2°C and 10°C. The temperature switch is specified to operate over the supply range of 2.7 V to 5.5 V.

The ADT6501 and ADT6502 are used for monitoring temperatures from +35°C to +115°C only. Therefore, the logic output pin becomes active when the temperature goes higher than the selected trip point temperature.

The ADT6503 and ADT6504 are used for monitoring temperatures from −45°C to +15°C only. Therefore, the logic output pin becomes active when the temperature goes lower than the selected trip point temperature.

## PRODUCT HIGHLIGHTS

1. Σ-Δ based temperature measurement gives high accuracy and noise immunity.
2. Wide operating temperature range from −55°C to +125°C.
3. ±0.5°C typical accuracy from −45°C to +115°C.
4. Factory threshold settings from −45°C to +115°C in 10°C increments.
5. Supply voltage is 2.7 V to 5.5 V.
6. Supply current of 30 µA.
7. Space-saving, 5-lead SOT-23 package.
8. Pin-selectable temperature hysteresis of 2°C or 10°C.
9. Temperature resolution of 0.125°C.

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## REVISION HISTORY

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**1/08—Rev. 0 to Rev. A**

Added ADT6503 and ADT6504 ..... Universal
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**9/07—Revision 0: Initial Version**

# SPECIFICATIONS

$T_A$ = −55°C to +125°C, $V_{CC}$ = 2.7 V to 5.5 V, open-drain $R_{PULL-UP}$ = 10 kΩ, unless otherwise noted.

**Table 1.**

| Parameter | Min | Typ | Max | Unit | Test Conditions/Comments |
|---|---|---|---|---|---|
| TEMPERATURE SENSOR AND ADC | | | | | |
| Threshold Accuracy | | ±0.5 | ±6 | °C | $T_A$ = −45°C to −25°C |
| | | ±0.5 | ±4 | °C | $T_A$ = −15°C to +15°C |
| | | ±0.5 | ±4 | °C | $T_A$ = 35°C to 65°C |
| | | ±0.5 | ±6 | °C | $T_A$ = 75°C to 115°C |
| ADC Resolution | | 11 | | Bits | |
| Temperature Conversion Time | | 30 | | ms | Time necessary to complete a conversion |
| Update Rate | | 600 | | ms | Conversion started every 600 ms |
| Temperature Threshold Hysteresis | | 2 | | °C | HYST pin = 0 V |
| | | 10 | | °C | HYST pin = $V_{CC}$ |
| DIGITAL INPUT (HYST) | | | | | |
| Input Low Voltage, $V_{IL}$ | | | 0.2 × $V_{CC}$ | V | |
| Input High Voltage, $V_{IH}$ | 0.8 × $V_{CC}$ | | | V | |
| DIGITAL OUTPUT (OPEN-DRAIN) | | | | | |
| Output High Current, $I_{OH}$ | | 10 | | nA | Leakage current, $V_{CC}$ = 2.7 V and $V_{OH}$ = 5.5 V |
| Output Low Voltage, $V_{OL}$ | | | 0.3 | V | $I_{OL}$ = 1.2 mA, $V_{CC}$ = 2.7 V |
| | | | 0.4 | V | $I_{OL}$ = 3.2 mA, $V_{CC}$ = 4.5 V |
| Output Capacitance, $C_{OUT}$[1] | | | 10 | pF | $R_{PULL-UP}$ = 10 kΩ |
| DIGITAL OUTPUT (PUSH-PULL) | | | | | |
| Output Low Voltage, $V_{OL}$ | | | 0.3 | V | $I_{OL}$ = 1.2 mA, $V_{CC}$ = 2.7 V |
| | | | 0.4 | V | $I_{OL}$ = 3.2 mA, $V_{CC}$ = 4.5 V |
| Output High Voltage, $V_{OH}$ | 0.8 × $V_{CC}$ | | | V | $I_{SOURCE}$ = 500 µA, $V_{CC}$ = 2.7 V |
| | $V_{CC}$ − 1.5 | | | V | $I_{SOURCE}$ = 800 µA, $V_{CC}$ = 4.5 V |
| Output Capacitance, $C_{OUT}$[1] | | | 10 | pF | |
| POWER REQUIREMENTS | | | | | |
| Supply Voltage | 2.7 | | 5.5 | V | |
| Supply Current | | 30 | 55 | µA | |

## ABSOLUTE MAXIMUM RATINGS

**Table 2.**

| Parameter | Rating |
|---|---|
| $V_{CC}$ to GND | −0.3 V to +7 V |
| HYST Input Voltage to GND | −0.3 V to $V_{CC}$ + 0.3 V |
| Open-Drain Output Voltage to GND | −0.3 V to +7 V |
| Push-Pull Output Voltage to GND | −0.3 V to $V_{CC}$ + 0.3 V |
| Input Current on All Pins | 20 mA |
| Output Current on All Pins | 20 mA |
| Operating Temperature Range | −55°C to +125°C |
| Storage Temperature Range | −65°C to +160°C |
| Maximum Junction Temperature, $T_{JMAX}$ | 150.7°C |
| 5-Lead SOT-23 (RJ-5) | |
| Power Dissipation[1] | $W_{MAX} = (T_{JMAX} - T_A{}^2)/\theta_{JA}$ |
| Thermal Impedance[3] | |
| $\theta_{JA}$, Junction-to-Ambient (Still Air) | 240°C/W |
| IR Reflow Soldering (RoHS Compliant Package) | |
| Peak Temperature | 260°C (+0°C) |
| Time at Peak Temperature | 20 sec to 40 sec |
| Ramp-Up Rate | 3°C/sec maximum |
| Ramp-Down Rate | −6°C/sec maximum |
| Time 25°C to Peak Temperature | 8 minute maximum |

[1] Values relate to package being used on a standard 2-layer PCB. This gives a worst case $\theta_{JA}$. Refer to Figure 2 for a plot of maximum power dissipation vs. ambient temperature ($T_A$).
[2] $T_A$ = ambient temperature.
[3] Junction-to-case resistance is applicable to components featuring a preferential flow direction, for example, components mounted on a heat sink. Junction-to-ambient resistance is more useful for air-cooled, PCB-mounted components.

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

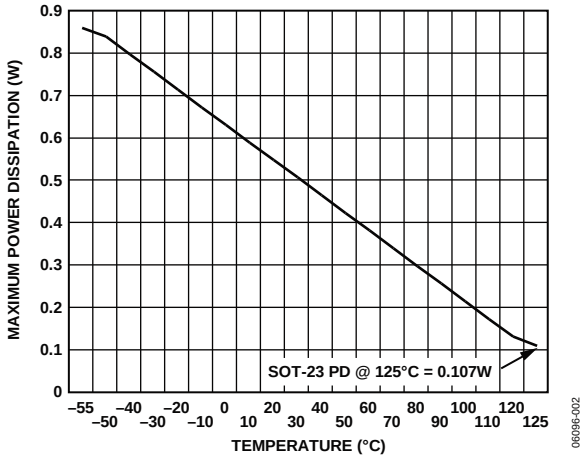


*Figure 2. SOT-23 Maximum Power Dissipation vs. Temperature*

## ESD CAUTION

**ESD (electrostatic discharge) sensitive device.** Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

## PIN CONFIGURATIONS AND FUNCTION DESCRIPTIONS

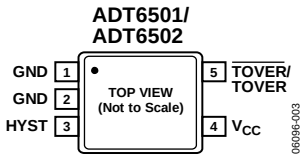


*Figure 3. ADT6501/ADT6502 Pin Configuration*

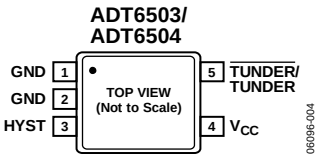


*Figure 4. ADT6503/ADT6504 Pin Configuration*

**Table 3. Pin Function Descriptions**

| Pin Number | | | | | |
|---|---|---|---|---|---|
| **ADT6501** | **ADT6502** | **ADT6503** | **ADT6504** | **Mnemonic** | **Description** |
| 1, 2 | 1, 2 | 1, 2 | 1, 2 | GND | Ground. |
| 3 | 3 | 3 | 3 | HYST | Hysteresis Input. Connects HYST to GND for 2°C hysteresis or connects to $V_{CC}$ for 10°C hysteresis. |
| 4 | 4 | 4 | 4 | $V_{CC}$ | Supply Input (2.7 V to 5.5 V). |
| 5 | — | — | — | $\overline{\text{TOVER}}$ | Open-Drain, Active Low Output. $\overline{\text{TOVER}}$ goes low when the temperature of the part exceeds the factory-programmed threshold; must use a pull-up resistor. |
| — | 5 | — | — | TOVER | Push-Pull, Active High Output. TOVER goes high when the temperature of the part exceeds the factory-programmed threshold. |
| — | — | 5 | — | $\overline{\text{TUNDER}}$ | Open-Drain, Active Low Output. $\overline{\text{TUNDER}}$ goes low when the temperature of the part exceeds the factory-programmed threshold; must use a pull-up resistor. |
| — | — | — | 5 | TUNDER | Push-Pull, Active High Output. TUNDER goes high when the temperature of the part exceeds the factory-programmed threshold. |

## TYPICAL PERFORMANCE CHARACTERISTICS

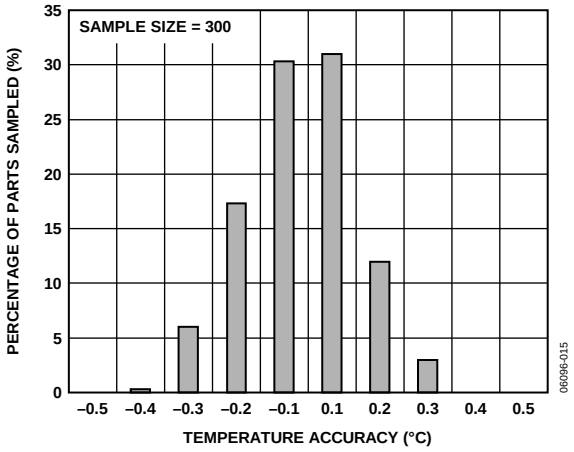


Figure 5. Trip Threshold Accuracy

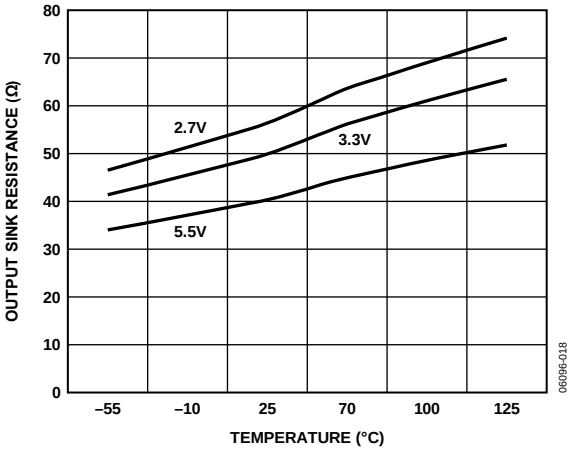


Figure 8. Output Sink Resistance vs. Temperature

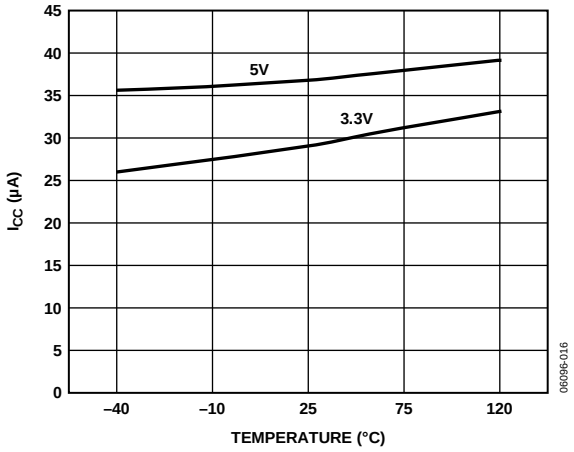


Figure 6. Operating Supply Current vs. Temperature

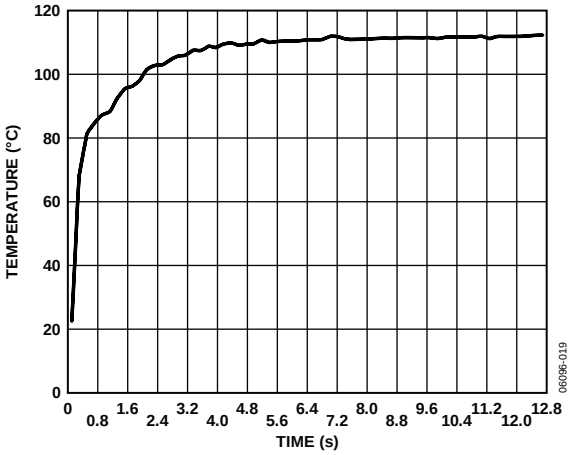


Figure 9. Thermal Step Response in Perfluorinated Fluid

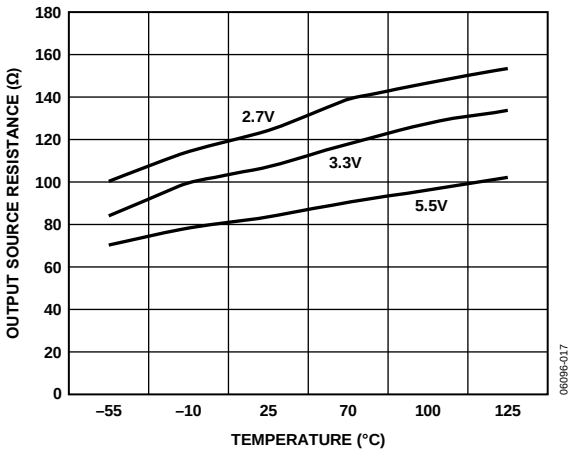


Figure 7. ADT6502/ADT6504 Output Source Resistance vs. Temperature

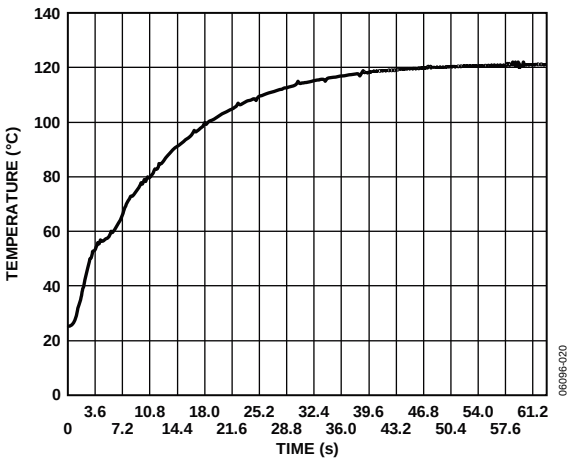


Figure 10. Thermal Step Response in Still Air

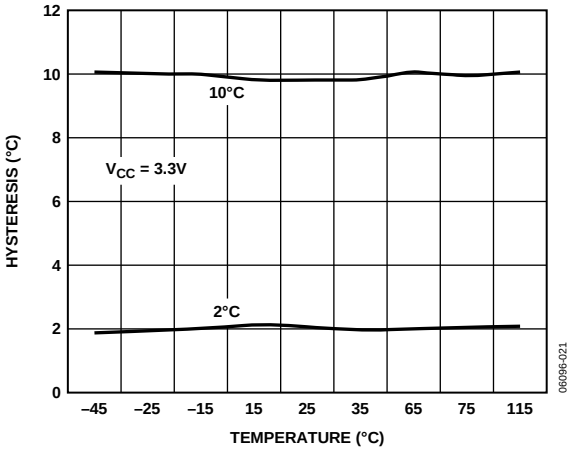


Figure 11. Hysteresis vs. Trip Temperature

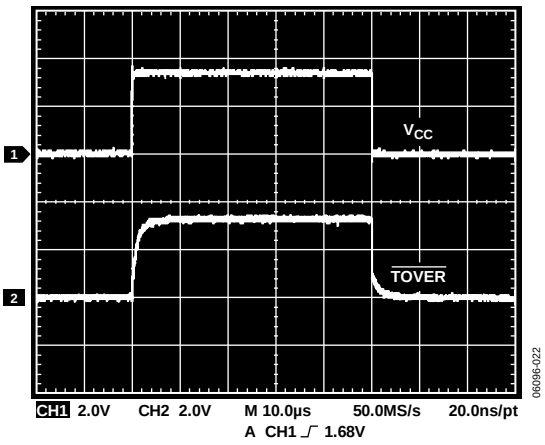


Figure 12. ADT6501 Start-Up and Power-Down

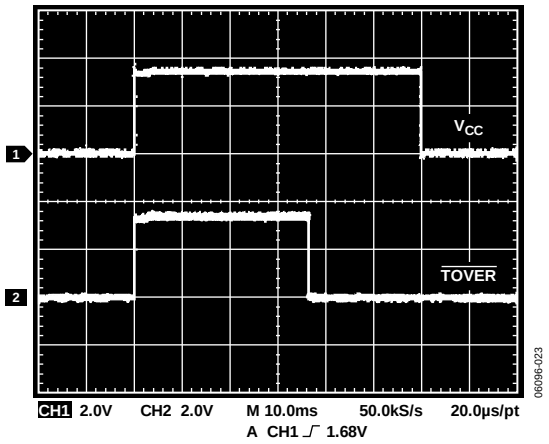


Figure 13. ADT6501 Start-Up Delay

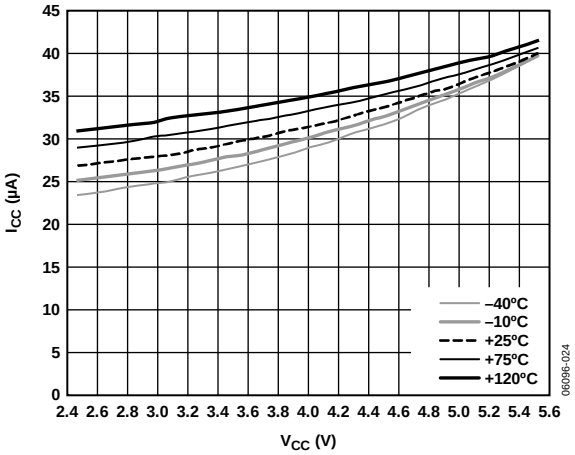


Figure 14. Operating Supply Current vs. Voltage Over Temperature

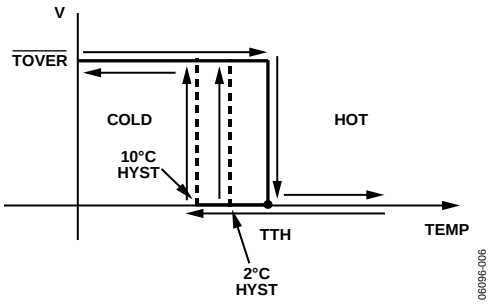


Figure 15. ADT6501 TOVER Transfer Function

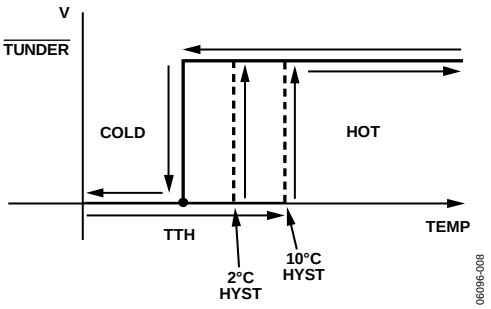


Figure 17. ADT6503 TUNDER Transfer Function

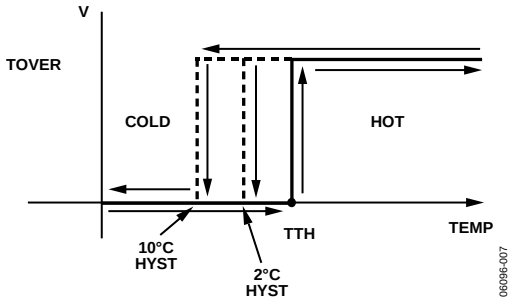


Figure 16. ADT6502 TOVER Transfer Function

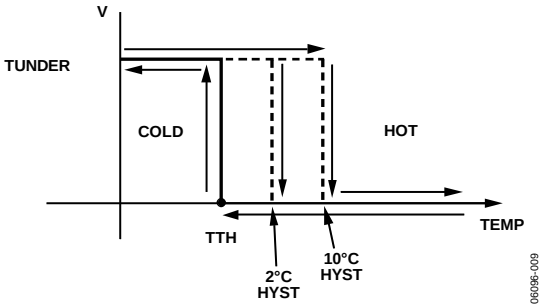


Figure 18. ADT6504 TUNDER Transfer Function

## TYPICAL APPLICATION CIRCUITS

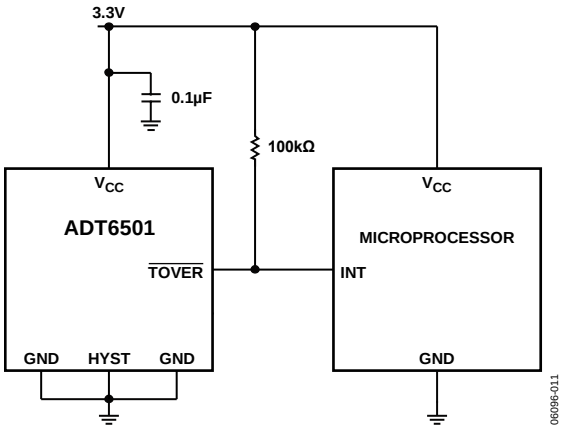


Figure 20. Microprocessor Alarm

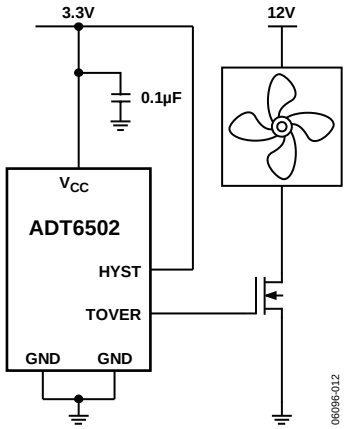


Figure 21. Overtemperature Fan Control

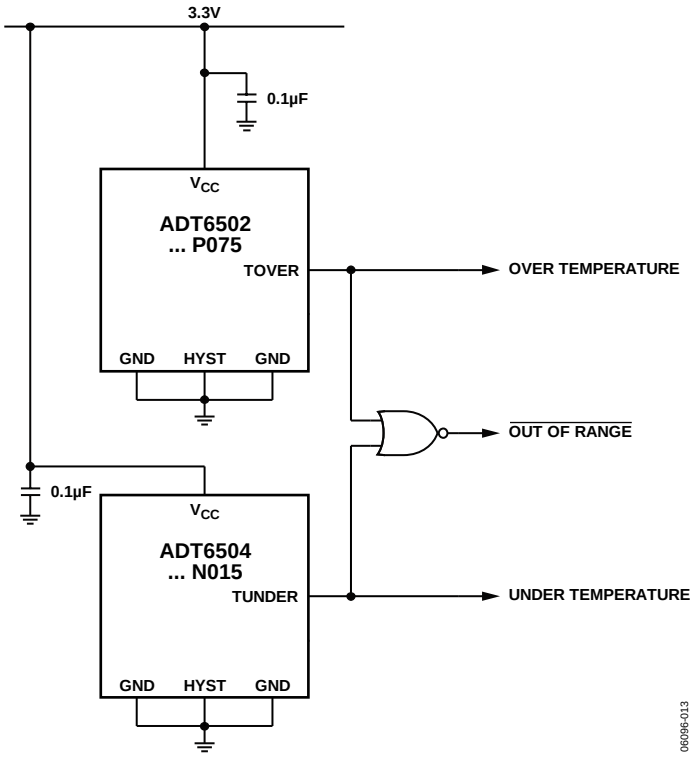


Figure 22. Temperature Window Alarms

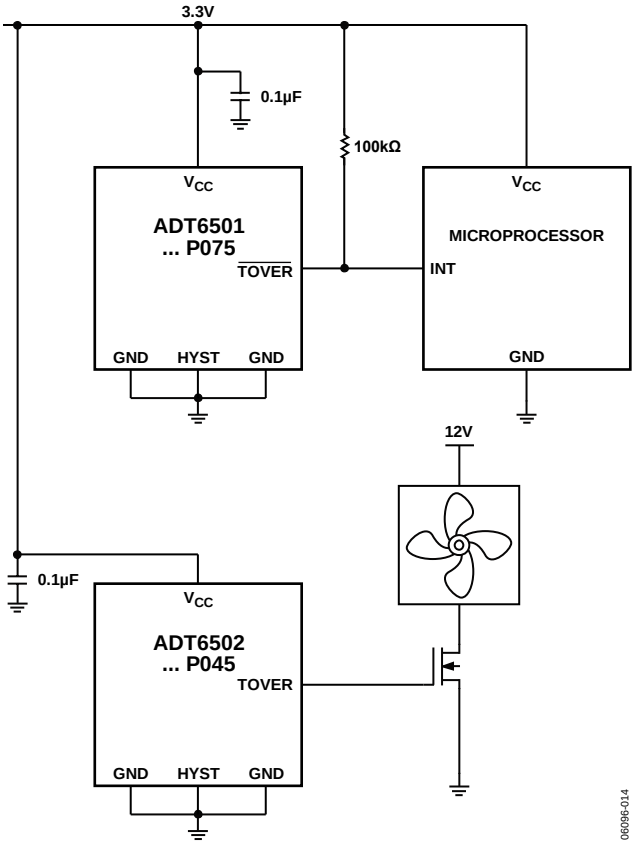


*Figure 23. Fail-Safe Temperature Monitor*

## OUTLINE DIMENSIONS

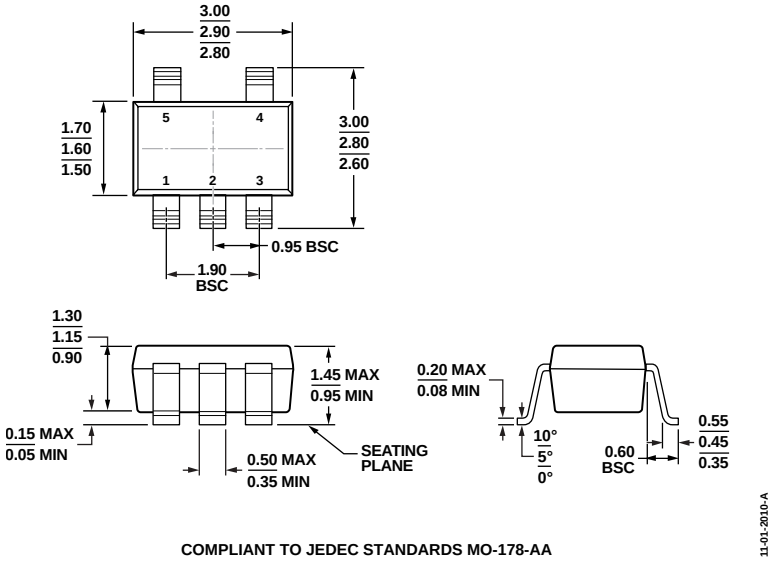


*Figure 24. 5-Lead Small Outline Transistor Package [SOT-23]*
*(RJ-5)*
*Dimensions shown in millimeters*

### ORDERING GUIDE

| Model[1] | Threshold Temperature | Accuracy @ Threshold Temperature | Temperature Range | Package Description | Package Option | Ordering Quantity | Branding |
|---|---|---|---|---|---|---|---|
| ADT6501SRJZP035RL7 | 35°C | ±4°C | −55°C to +125°C | 5-Lead SOT-23 | RJ-5 | 3,000 | T1U |
| ADT6501SRJZP045RL7 | 45°C | ±4°C | −55°C to +125°C | 5-Lead SOT-23 | RJ-5 | 3,000 | T1V |
| ADT6501SRJZP055RL7 | 55°C | ±4°C | −55°C to +125°C | 5-Lead SOT-23 | RJ-5 | 3,000 | T0B |
| ADT6501SRJZP065RL7 | 65°C | ±4°C | −55°C to +125°C | 5-Lead SOT-23 | RJ-5 | 3,000 | T1W |
| ADT6501SRJZP075RL7 | 75°C | ±6°C | −55°C to +125°C | 5-Lead SOT-23 | RJ-5 | 3,000 | T1X |
| ADT6501SRJZP085RL7 | 85°C | ±6°C | −55°C to +125°C | 5-Lead SOT-23 | RJ-5 | 3,000 | T0W |
| ADT6501SRJZP085-RL | 85°C | ±6°C | −55°C to +125°C | 5-Lead SOT-23 | RJ-5 | 10,000 | T0W |
| ADT6501SRJZP095RL7 | 95°C | ±6°C | −55°C to +125°C | 5-Lead SOT-23 | RJ-5 | 3,000 | T1Y |
| ADT6501SRJZP105RL7 | 105°C | ±6°C | −55°C to +125°C | 5-Lead SOT-23 | RJ-5 | 3,000 | T15 |
| ADT6501SRJZP105-RL | 105°C | ±6°C | −55°C to +125°C | 5-Lead SOT-23 | RJ-5 | 10,000 | T15 |
| ADT6501SRJZP115RL7 | 115°C | ±6°C | −55°C to +125°C | 5-Lead SOT-23 | RJ-5 | 3,000 | T1Z |
| ADT6502SRJZP035RL7 | 35°C | ±4°C | −55°C to +125°C | 5-Lead SOT-23 | RJ-5 | 3,000 | T25 |
| ADT6502SRJZP045RL7 | 45°C | ±4°C | −55°C to +125°C | 5-Lead SOT-23 | RJ-5 | 3,000 | T26 |
| ADT6502SRJZP055RL7 | 55°C | ±4°C | −55°C to +125°C | 5-Lead SOT-23 | RJ-5 | 3,000 | T27 |
| ADT6502SRJZP065RL7 | 65°C | ±4°C | −55°C to +125°C | 5-Lead SOT-23 | RJ-5 | 3,000 | T28 |
| ADT6502SRJZP075RL7 | 75°C | ±6°C | −55°C to +125°C | 5-Lead SOT-23 | RJ-5 | 3,000 | T17 |
| ADT6502SRJZP085RL7 | 85°C | ±6°C | −55°C to +125°C | 5-Lead SOT-23 | RJ-5 | 3,000 | T29 |
| ADT6502SRJZP095RL7 | 95°C | ±6°C | −55°C to +125°C | 5-Lead SOT-23 | RJ-5 | 3,000 | T2B |
| ADT6502SRJZP105RL7 | 105°C | ±6°C | −55°C to +125°C | 5-Lead SOT-23 | RJ-5 | 3,000 | T2C |
| ADT6502SRJZP115RL7 | 115°C | ±6°C | −55°C to +125°C | 5-Lead SOT-23 | RJ-5 | 3,000 | T2D |
| ADT6503SRJZN045RL7 | −45°C | ±6°C | −55°C to +125°C | 5-Lead SOT-23 | RJ-5 | 3,000 | T2E |
| ADT6503SRJZN035RL7 | −35°C | ±6°C | −55°C to +125°C | 5-Lead SOT-23 | RJ-5 | 3,000 | T2F |
| ADT6503SRJZN025RL7 | −25°C | ±6°C | −55°C to +125°C | 5-Lead SOT-23 | RJ-5 | 3,000 | T19 |
| ADT6503SRJZN015RL7 | −15°C | ±4°C | −55°C to +125°C | 5-Lead SOT-23 | RJ-5 | 3,000 | T2J |
| ADT6503SRJZN005RL7 | −5°C | ±4°C | −55°C to +125°C | 5-Lead SOT-23 | RJ-5 | 3,000 | T2M |