Ultra Small Temperature Switch with Pin-Selectable Hysteresis

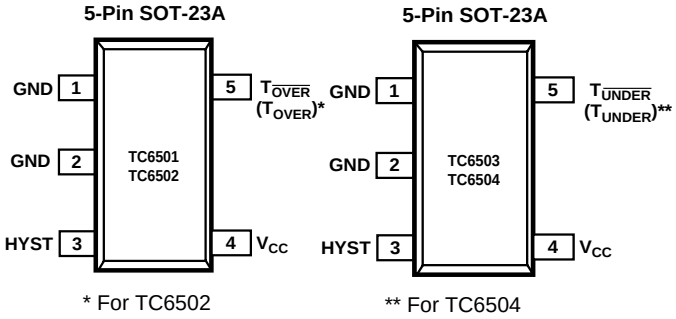
FEATURES

- **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**
- **17µA 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**

PIN CONFIGURATIONS



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

GENERAL DESCRIPTION

The TC6501 through TC6504 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 17µA 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 TC6501 and TC6503 offer an open drain, active low output, meant for microprocessor reset control. The TC6502 and TC6504 have a CMOS, active high output designed to drive a logic level MOSFET to turn on a fan or heater element.

The TC6501/TC6502 are aimed for hot-temperature monitoring (+35°C to +115°C). These devices assert a logic signal when the temperature goes above the threshhold. The TC6503/TC6504 are aimed for cold-temperature monitoring (-45°C to +15°C). These devices assert a logic signal when the temperature goes below the threshhold.

The TC6501 through TC6504 are offered in five 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.

ORDERING INFORMATION

Part No	Package	Standard Temp. Threshhold	Output Stage
TC6501P045VCT	5-Pin SOT-23A	45°C	Open Drain
TC6501P065VCT	5-Pin SOT-23A	65°C	Open Drain
TC6501P095VCT	5-Pin SOT-23A	95°C	Open Drain
TC6502P045VCT	5-Pin SOT-23A	45°C	Push/Pull
TC6502P065VCT	5-Pin SOT-23A	65°C	Push/Pull
TC6502P095VCT	5-Pin SOT-23A	95°C	Push/Pull
TC6503N015VCT	5-Pin SOT-23A	-15°C	Open Drain
TC6503P005VCT	5-Pin SOT-23A	5°C	Open Drain
TC6504N015VCT	5-Pin SOT-23A	-15°C	Push/Pull
TC6504P005VCT	5-Pin SOT-23A	5°C	Push/Pull

Notes: TC6501 and TC6502 are offered in 3 standard temperature settings. Other non-standard versions are available (including 55°C, 75°C, 85°C, 105°C and 115°C), please contact factory for more information. TC6503 and TC6504 are offered in 2 standard temperature settings. Other non-standard versions are available (including -45°C, -35°C, -25°C and -5°C), please contact factory for more information.
A letter “P” in the part number indicates a positive temperature sign or “N” for a negative temperature sign.

ABSOLUTE MAXIMUM RATINGS*

Supply Voltage (V_{CC}) ..... –0.3V to +7V
$\overline{TOVER}$ (TC6501)..... –0.3V to +7V
$\overline{TOVER}$ (TC6502)..... –0.3V to (V_{CC} + 0.3V)
$\overline{TUNDER}$ (TC6503) ..... –0.3V to 7V
TUNDER (TC6504) ..... –0.3V to (V_{CC} + 0.3V)
All Other Pins ..... –0.3V to (V_{CC} + 0.3V)
Input Current (All Pins).....20mA
Output Current (All Pins) 20mA
Operating Temperature Range .....– 55°C to +125°C
Storage Temperature Range .....– 65°C to +165°C
Lead Temperature (Soldering, 10 sec) .....+300°C
Power Dissipation (T_A = +70°C)
(Derate 7.1mW/°C Above +70°C).....571mW

*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} = +2.7V to +5.5V, $R_{PULL-UP}$ = 100KΩ (TC6501/TC6503 only), $C_{COUPLING}$ = 100 pF from V_{CC} to GND, $T_A = T_{MIN}$ to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.

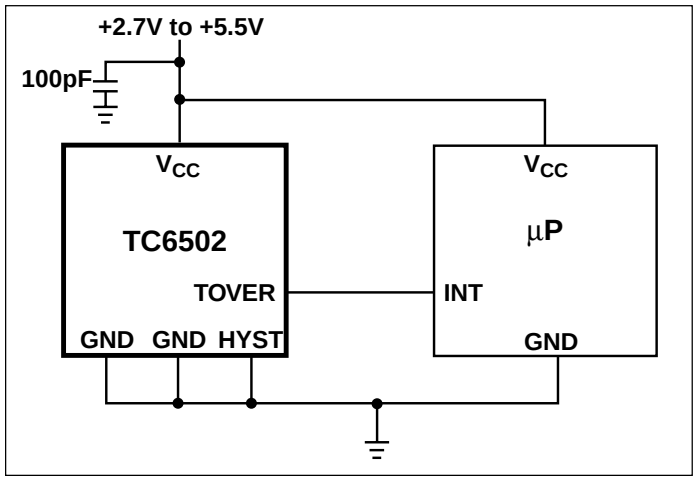
Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{CC}	Supply Voltage Range		2.7	—	5.5	V
I_{CC}	Supply Current		—	17	40	µA
ΔT_{TH}	Temperature Threshold Accuracy (Note 1)	–45°C to –25°C	–6	±0.5	6	°C
		–15°C to +15°C	–4	±0.5	4	
		+35°C to +65°C	–4	±0.5	4	
		+75°C to +115°C	–6	±0.5	6	
T_{HYST}	Temperature Threshold Hysteresis	HYST = GND	—	2	—	°C
		HYST = V_{CC}	—	10	—	
V_{IH}	HYST Input Threshold		0.8 x V_{CC}	—	—	V
V_{IL}	HYST Input Threshold		—	—	0.2 x V_{CC}	V
V_{OH}	Output Voltage High	I_{SOURCE} = 500µA, V_{CC} > 2.7V (TC6502/TC6504 Only)	0.8 x V_{CC}	—	—	V
		I_{SOURCE} = 800µA, V_{CC} > 4.5V (TC6502/TC6504 Only)	V_{CC} – 1.5	—	—	V
V_{OL}	Output Voltage Low	I_{SINK} = 1.2mA, V_{CC} > 2.7V	—	—	0.3	V
		I_{SINK} = 3.2mA, V_{CC} > 4.5V	—	—	0.4	V
	Open-Drain Output Leakage Current	V_{CC} = 2.7V, $V_{\overline{TUNDER}}$ = 5.5V (TC6503); $V_{\overline{TOVER}}$ = 5.5V (TC6501)	—	10	—	nA

NOTES: 1. The TC6501 through TC6504 are available with internal, factory-programmed temperature trip thresholds from –45°C to +115°C in +10°C increments.

PIN DESCRIPTION

TC6501	TC6502	TC6503	TC6504	Name	Description
1,2	1,2	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	3	3	HYST	Hysteresis Input. Connect HYST to GND for +2°C hysteresis, or connect to V_{CC} for +10°C hysteresis.
4	4	4	4	V_{CC}	Supply Input (+2.7V to +5.5V). Recommend 100pF or greater Coupling capacitor fom V_{CC} to GND.
5	—	—	—	$\overline{\text{TOVER}}$	Open-Drain, Active-Low Output. $\overline{\text{TOVER}}$ goes low when the die temperature exceeds the factory-programmed temperature threshold. Connect to a 100 KΩ pull-up resistor. May be pulled up to a voltage higher than V_{CC}.
—	5	—	—	TOVER	Push/Pull Active-High Output. TOVER goes high when the die temperature exceeds the factory-programmed temperature threshold.
—	—	5	—	$\overline{\text{TUNDER}}$	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 KΩ pull-up resistor. May be pulled up to a voltage higher than V_{CC}.
—	—	—	5	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 TC6501 through TC6504 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 TC6501 and TC6502 are intended for a temperature range from 35°C to 115°C in a 10°C increment. The TC6501 has an open drain output and the TC6502 has a push /pull output stage.

The TC6503 and TC6504 are intended for a cold temperature range from –45°C to +15°C in a 10°C increment. The TC6503 has an open drain output and the TC6504 has a push/pull output stage. The TC6501 and TC6503 are intended for applications with a microprocessor reset input. The TC6502 and TC6504 are 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_{DD}) 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_{TH}) Range
TC6501	+35°C < T_{TH} < +115°C
TC6502	+35°C < T_{TH} < +115°C
TC6503	–45°C < T_{TH} < +15°C
TC6504	–45°C < T_{TH} < +15°C

Thermal Considerations

With a very low 17µA supply current, the TC6501 through TC6504 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 for instance the TC6501 had to sink

1mA, and the output voltage is guaranteed to be less than 0.3V, then an additional 0.3mW of power is dissipated within the IC. This corresponds to a 0.042°C rise in die temperature in the 5-Pin SOT-23A.

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 TC6501 through TC6504 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 TC6501 and TC6503 have open drain outputs and are therefore intended to interface as microprocessor reset inputs. 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)

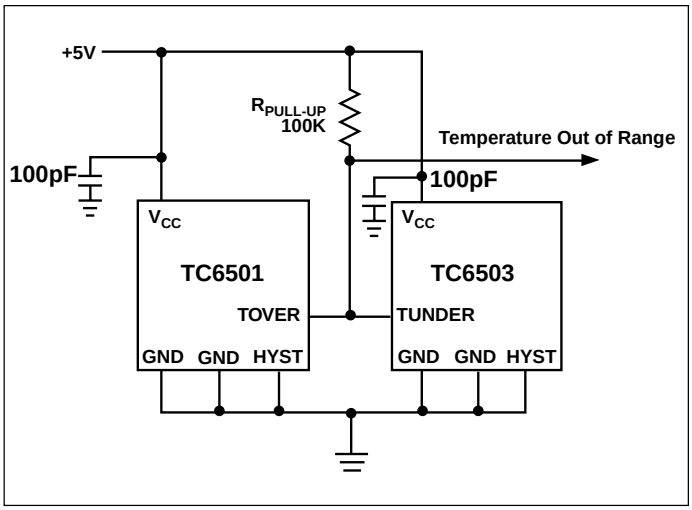


Figure 1. Over and Under Temperature Alarm

The TC6502 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 TC6502 with a higher temperature threshold to alert the user of an impending thermal shutdown, should the temperature continue to rise. (See Figure 2)

The TC6504 with its push/pull output could be used in a similar fashion to turn on a heater element at cold temperatures. (See Figure 3)

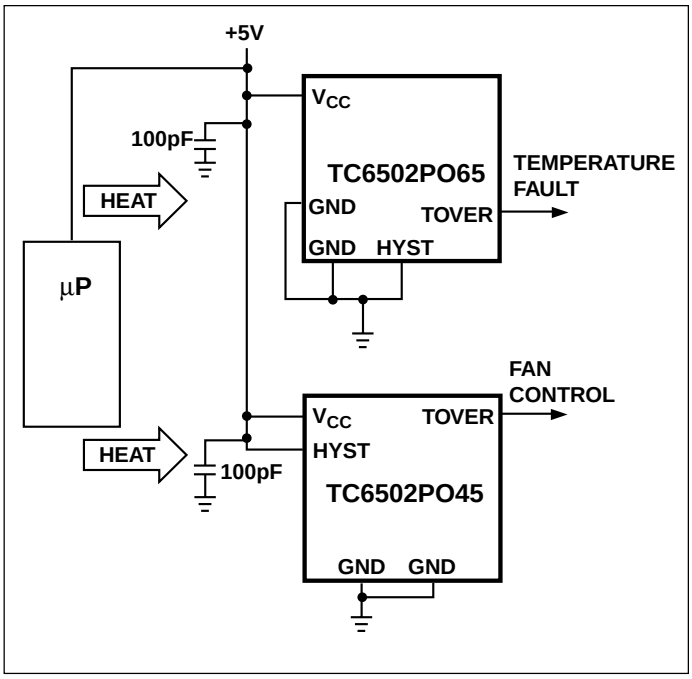


Figure 2. Fan Control Circuit with Over Temperature Alert

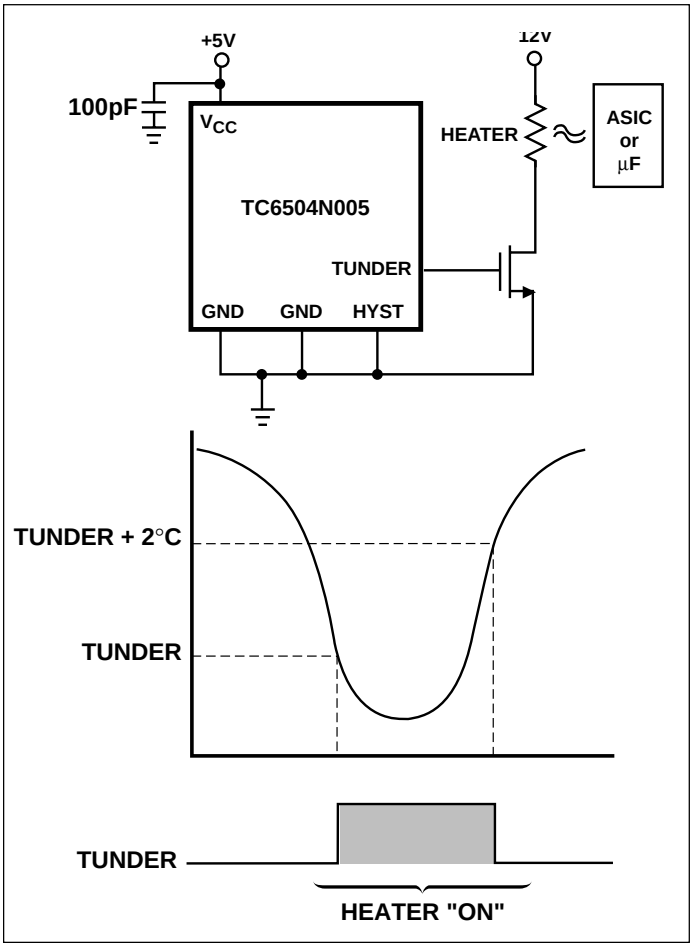


Figure 3. TC6504N005 As Heater Thermostat

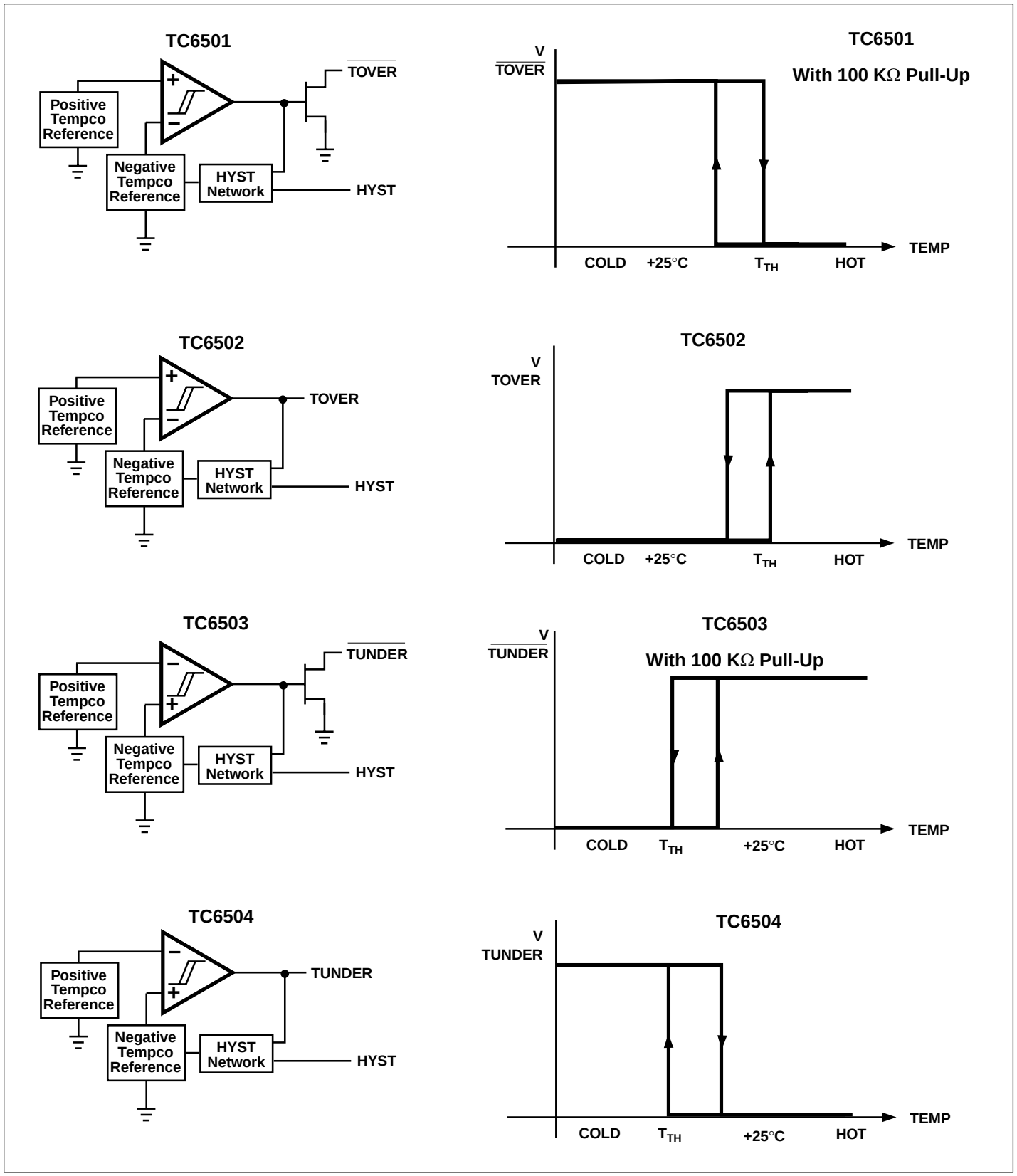
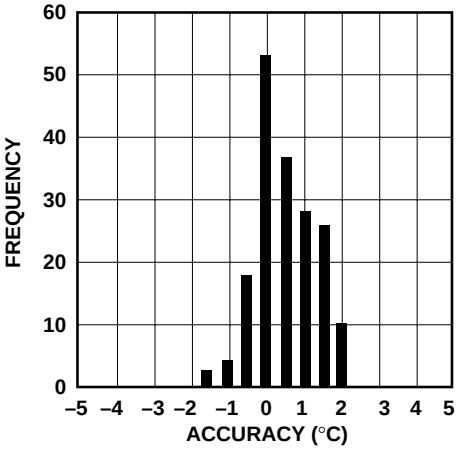
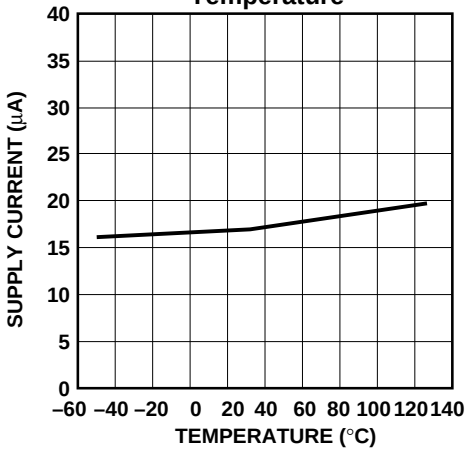
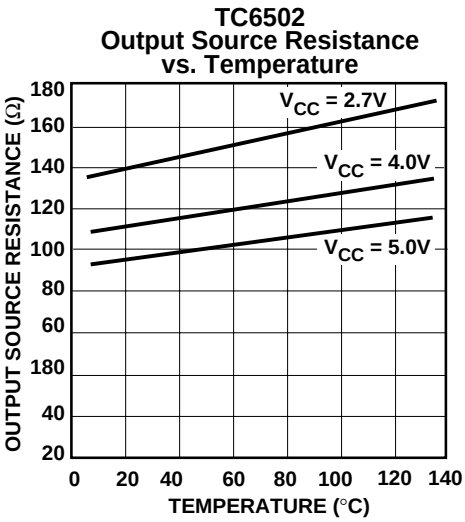


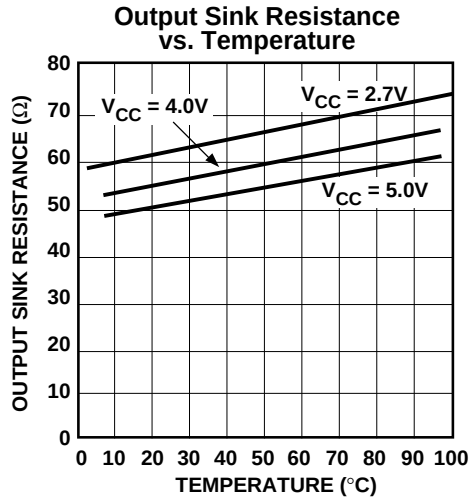
Figure 4. Functional Block Diagrams

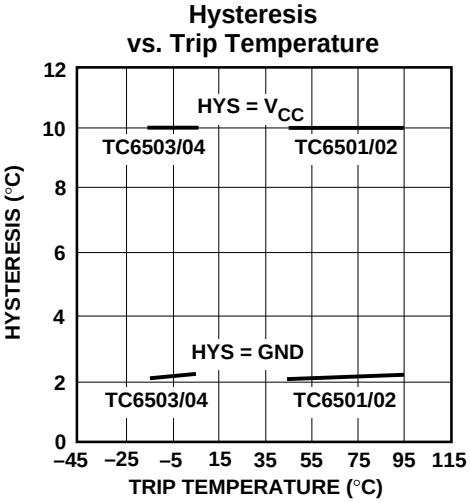
TYPICAL CHARACTERISTICS CURVES

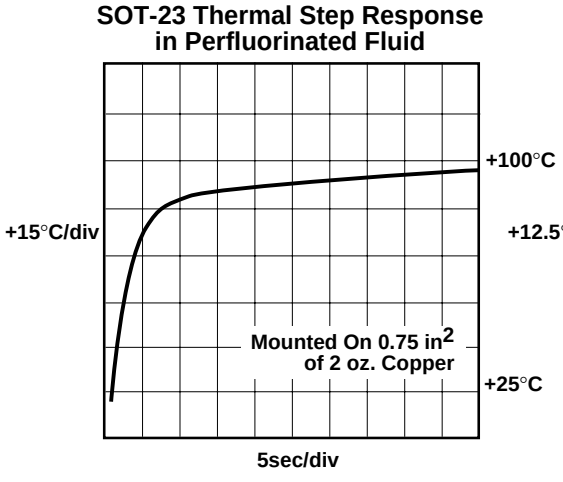


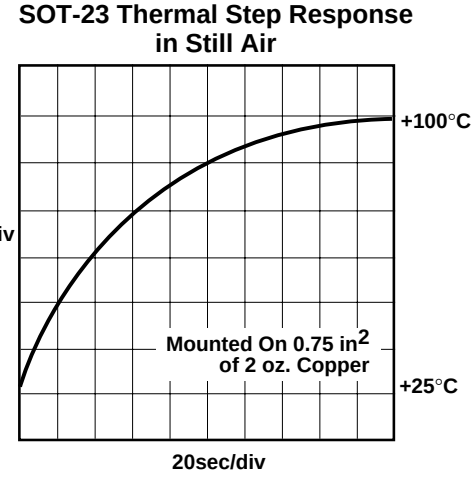






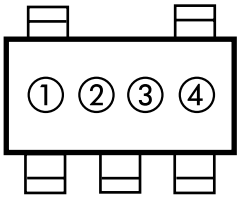






MARKING

5-Pin SOT-23A



Part Numbers and Part Marking

Part Number	Code
TC6501P045VCT	HA
TC6501P065VCT	HC
TC6501P095VCT	HF
TC6502P045VCT	JA
TC6502P065VCT	JC
TC6502P095VCT	JF
TC6503N015VCT	KA
TC6503P005VCT	KB
TC6504N015VCT	LA
TC6504P005VCT	LB

① & ② = two letter part number codes

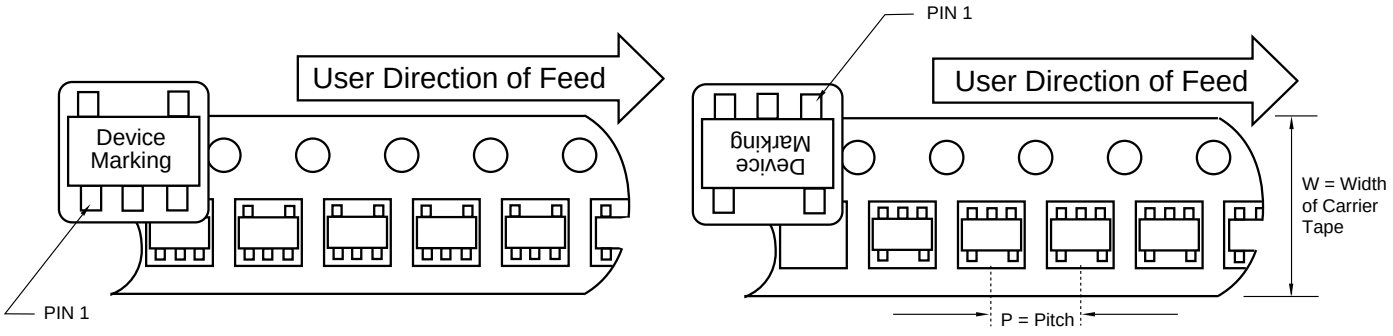
③ represents year and two-month period code

④ represents lot ID number

ex: 6501P045VCT = ⒽⒶ◯◯

TAPING FORM

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



Standard Reel Component Orientation
TR Suffix Device
(Mark Right Side Up)

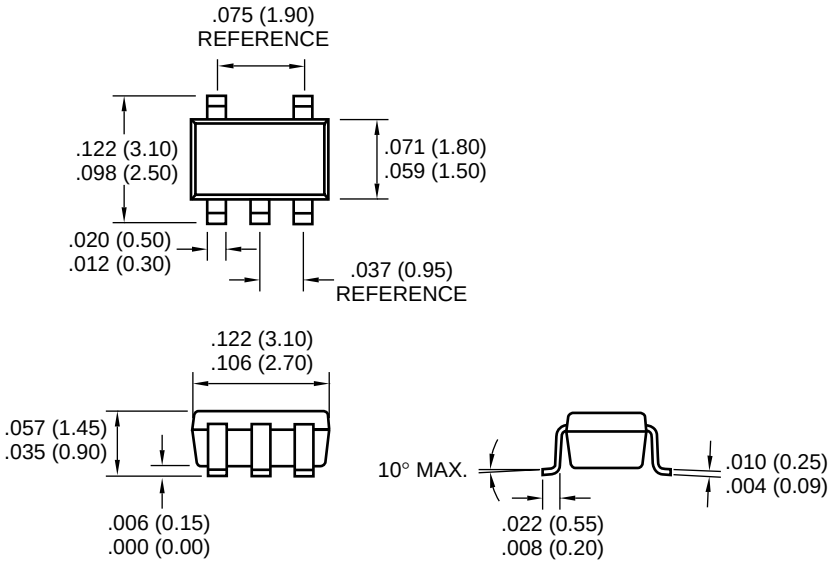
Reverse Reel Component Orientation
RT Suffix Device
(Mark Upside Down)

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

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

PACKAGE DIMENSIONS

5-Pin SOT-23A (EIAJ SC-74A)



Dimensions: inches (mm)

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