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#### Description

CAT34TS00 is a low-voltage digital temperature sensor, which implements the JEDEC JC42.4 specification. CAT34TS00 measures temperature every 100 ms over a range of  $-20^{\circ}$ C to  $+125^{\circ}$ C, with a resolution of 12 bits.

The host communicates with the device via the serial  $I^2C$  / SMBus Interface, at either 100 kHz or 400 kHz. Temperature readings can be retrieved via serial interface. Internally, they are compared to high, low and critical trigger limits stored in device registers. Over or under limit conditions can be signaled on the open–drain EVENT pin. These limits, as well as other settings, can be configured via serial interface.

#### Features

- JEDEC JC42.4 Compliant Temperature Sensor
- Supply Range: 1.7 V to 1.9 V
- Temperature Range: -20°C to +125°C
- I<sup>2</sup>C / SMBus Interface
- Temperature Sampling Rate: 100 ms max
- Temperature Reading Accuracy: ±0.5°C typ for Active Range (+75°C to +95°C)
- Schmitt Triggers and Noise Suppression Filters on SCL and SDA Inputs
- 2 x 3 x 0.75 mm TDFN Package
- These Devices are Pb-Free and are RoHS Compliant

## **Typical Applications**

- Solid State Drives
- Graphics Cards
- Portable Devices
- Process Control Equipment



Figure 1. Functional Symbol

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#### Table 1. ABSOLUTE MAXIMUM RATINGS (Notes 1 and 2)

Parameter	Rating	Unit
Voltage on any pin (except $A_0$ ) with respect to Ground (Note 3)	–0.5 to +6.5	V
Voltage on pin A <sub>0</sub> with respect to Ground	–0.5 to +10.5	V
Operating Temperature	-45 to +130	°C
Storage Temperature Range	-65 to +150	°C

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Refer to ELECTRICAL CHARACTERISTICS, RECOMMENDED OPERATING RANGES and/or APPLICATION INFORMATION for Safe Operating parameters.

2. For information, please refer to our Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

The DC input voltage on any pin should not be lower than -0.5 V or higher than V<sub>CC</sub> + 0.5 V. SCL and SDA inputs can be raised to the maximum limit, irrespective of V<sub>CC</sub>. During transitions, the voltage on any pin may undershoot to no less than -1.5 V or overshoot to no more than V<sub>CC</sub> + 1.5 V, for periods of less than 20 ns.

#### Table 2. TEMPERATURE CHARACTERISTICS

Parameter	Conditions	Тур	Max	Unit
Temperature Reading Error	+75°C $\leq$ T <sub>A</sub> $\leq$ +95°C, active range	±0.5	±1.0	°C
	+40°C $\leq$ T <sub>A</sub> $\leq$ +125°C, monitor range	±1.0	±2.0	°C
	$-20^{\circ}C \le T_A \le +125^{\circ}C$ , sensing range	±1.5	±3.0	°C
ADC Resolution			12	Bits
Temperature Resolution			0.0625	°C
Conversion Time			100	ms
Thermal Resistance (Note 4) $\theta_{JA}$	Junction-to-Ambient (Still Air)		92	°C/W

4. Power Dissipation is defined as  $P_J = (T_J - T_A)/\theta_{JA}$ , where  $T_J$  is the junction temperature and  $T_A$  is the ambient temperature. The thermal resistance value refers to the case of a package being used on a standard 2–layer PCB.

#### Table 3. D.C. OPERATING CHARACTERISTICS ( $V_{CC}$ = 1.7 V to 1.9 V, $T_A$ = -20°C to +125°C, unless otherwise specified)

Symbol	Parameter	Test Conditions/Comments	Min	Max	Unit
I <sub>CC</sub>	Supply Current	TS active, Bus idle		500	μΑ
I <sub>SHDN</sub>	Standby Current	TS shut-down; Bus idle		5	μΑ
I <sub>LKG</sub>	I/O Pin Leakage Current	Pin at GND or $V_{CC}$		2	μΑ
V <sub>IL</sub>	Input Low Voltage		-0.5	0.3 x V <sub>CC</sub>	V
V <sub>IH</sub>	Input High Voltage			-	-

		100 kHz		400 kHz		
Symbol	Parameter	Min	Max	Min	Max	Units
F <sub>SCL</sub> (Note 5)	Clock Frequency	10	100	10	400	kHz
t <sub>HIGH</sub>	High Period of SCL Clock	4		0.6		μs
t <sub>LOW</sub>	Low Period of SCL Clock	4.7		1.3		μs
t <sub>TIMEOUT</sub> (Note 6)	SMBus SCL Clock Low Timeout	25	35	25	35	ms
t <sub>R</sub> (Note 7)	SDA and SCL Rise Time		1000			

Table 4. A.C. CHARACTERISTICS (V<sub>CC</sub> = 1.7 V to 1.9 V, T<sub>A</sub> =  $-20^{\circ}$ C to  $+125^{\circ}$ C)



Figure 2. Pull-up Resistance vs. Load Capacitance

## **Pin Description**

**SCL:** The Serial Clock input pin accepts the Serial Clock generated by the Master (Host).

**SDA:** The Serial Data I/O pin receives input data and transmits data stored in the TS registers. In transmit mode, this pin is open drain. Data is acquired on the positive edge, and is delivered on the negative edge of SCL.

**A0, A1 and A2:** The Address pins accept the device address. These pins have on-chip pull-down resistors.

**EVENT:** The open-drain **EVENT** pin can be programmed to signal over/under temperature limit conditions.

## Power-On Reset (POR)

The CAT34TS00 incorporates Power–On Reset (POR) circuitry which protects the device against powering up to an undetermined logic state. As  $V_{CC}$  exceeds the POR trigger level, the device will power up into conversion mode. When  $V_{CC}$  drops below the POR trigger level, the device will power down into Reset mode.

This bi-directional POR behavior protects CAT34TS00 against brown-out failure following a temporary loss of power. The POR trigger level is set below the minimum operating  $V_{CC}$  level.

#### **Device Interface**

The CAT34TS00 supports the Inter–Integrated Circuit (I<sup>2</sup>C) and the System Management Bus (SMBus) data transmission protocols. These protocols describe serial communication between transmitters and receivers sharing a 2–wire data bus. Data flow is controlled by a Master device,





## Manufacturer ID Register (Read Only)

The manufacturer ID assigned by the PCI–SIG trade organization to the CAT34TS00 device is fixed at 0x1B09.

## Device ID and Revision Register (Read Only)

This register contains specific device ID and device revision information.

## Table 7. THE TEMPERATURE SENSOR REGISTERS

Register Address	Register Name	Power-On Default	Read/Write
0x00	Capability Register	0x0077	Read
0x01	Configuration Register	0x0000	Read/Write
0x02	High Limit Register	0x0000	Read/Write
0x03	Low Limit Register	0x0000	Read/Write
0x04			

## Table 9. CONFIGURATION REGISTER

B15	B14	B13	B12	B11	B10	B9	B8
RFU	RFU	RFU	RFU	RFU	HYST [1:0]		SHDN
B7	B6	B5	B4	B3	B2	B1	B0
TCRIT_LOCK	ALARM_LOCK	CLEAR	EVENT_STS	EVENT_CTRL	TCRIT_ONLY	EVENT_POL	EVENT_MODE

Bit	Description
B15:B11	Reserved for future use; can not be written; should be ignored; will read as 0
B10:B9 (Note 11)	00:       Disable hysteresis         01:       Set hysteresis at 1.5°C         10:       Set hysteresis at 3°C         11:       Set hysteresis at 6°C
<b>B8</b> (Note 15)	<ol> <li>Thermal Sensor is enabled; temperature readings are updated at sampling rate</li> <li>Thermal Sensor is shut down; temperature reading is frozen to value recorded before SHDN</li> </ol>
<b>B7</b> (Note 14)	<ol> <li>0: Critical trip register can be updated</li> <li>1: Critical trip register cannot be modified; this bit can be cleared only at POR</li> </ol>
<b>B6</b> (Note 14)	

Table 10. HIGH LIMIT REGISTER

B15	B14	B13	B12	B11	B10	B9	B8
0	0	0	Sign	128°C	64°C	32°C	16°C
B7	B6	B5	B4	B3	B2	B1	B0
8°C	4°C	2°C	1°C	·		-	

### **Register Data Format**

The values used in the temperature data register and the 3 temperature trip point registers are expressed in two's complement format. The measured temperature value is expressed with 12–bit resolution, while the 3 trip temperature limits are set with 10–bit resolution. The total temperature range is arbitrarily defined as 256°C, thus yielding an LSB of 0.0625°C for the measured temperature and 0.25°C for the 3 limit values. Bit B12 in all temperature registers represents the sign, with a '0' indicating a positive, and a '1' a negative value. In two's complement format, negative values are obtained by complementing their positive counterpart and adding a '1', so that the sum of opposite signed numbers, but of equal absolute value, adds up to zero.

Note that trailing '0' bits, are '0' irrespective of polarity. Therefore the "don't care" bits (B1 and B0) in the 10–bit resolution temperature limit registers, are always '0'.

Table 14. 12-BIT TEMPERATURE DATA FORMAT

Binary (B12 to B0)	Hex	Temperature
1 1100 1001 0000	1C90	–55°C
1 1100 1110 0000	1CE0	–50°C
1 1110 0111 0000	1E70	–25°C
1 1111 1111 1111	1FFF	–0.0625°C
0 0000 0000 0000	000	0°C
0 0000 0000 0001	001	+0.0625°C
0 0001 1001 0000	190	+25°C
0 0011 0010 0000	320	+50°C
0 0111 1101 0000	7D0	+125°C

#### **Event Pin Functionality**

The  $\overline{\text{EVENT}}$  output reacts to temperature changes as illustrated in Figure 9, and according to the operating mode defined by the Configuration register.

In **Interrupt Mode**, the (enabled)  $\overline{\text{EVENT}}$  output will be asserted every time the temperature crosses one of the alarm window limits, and can be de–asserted by writing a '1' to the clear event bit (B5) in the configuration register. Once the temperature exceeds the critical limit, the  $\overline{\text{EVENT}}$  remains asserted as long as the temperature stays above the critical limit and cannot be cleared. A clear request sent to the CAT34TS00 while the temperature is above the critical limit will be acknowledged, but will be executed only after the temperature drops below the critical limit.

In **Comparator Mode**, the **EVENT** output is asserted outside the alarm window limits, while in **Critical Temperature Mode**, **EVENT** is asserted only above the critical limit. Clear requests are ignored in this mode. The exact trip limits are determined by the 3 temperature limit settings and the hysteresis offsets, as illustrated in Figure 10.

Following a TS shut-down request, the converter is stopped and the most recently recorded temperature value present in the TDR is frozen; the EVENT output will continue to reflect the state immediately preceding the shut-down command. Therefore, if the state of the EVENT output creates an undesirable bus condition, appropriate action must be taken either before or after shutting down the TS. This may require clearing the event, disabling the EVENT output or perhaps changing the EVENT output polarity.

In normal use, events are triggered by a change in recorded temperature, but the CAT34TS00 will also respond to limit register changes. Whereas recorded temperature values are updated at sampling rate frequency, limits can be modified at any time. The enabled  $\overline{\text{EVENT}}$  output will react to limit changes as soon as the respective registers are updated. This feature may be useful during testing.



Clear request executed immediately

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Figure 9. Event Detail

## Example of Ordering Information

Device Order Number	Specific Device Marking	Package Type	Shipping <sup>†</sup>
CAT34TS00VP2GT4A	ΟΤΑ	TDFN8	Tape & Reel, 4,000 Units / Reel

19. All packages are RoHS-

#### **TDFN8, 2x3, 0.5P** CASE 511AK ISSUE B

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NOTES:

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