NCT475

Industry Standard Digital Temperature Sensor in CSP Package with 2-wire Interface

The NCT475 is a two−wire serially programmable temperature sensor with an over−temperature/interrupt output pin to signal out of limit conditions. This is an open−drain pin and can operate in either comparator or interrupt mode. Temperature measurements are converted into digital form using a high resolution (12 bit), sigma−delta, analog−to−digital converter (ADC). The device operates over the –55°C to +125°C temperature range.

Communication with the NCT475 is accomplished via the SMBus/I^2C interface which is compatible with industry standard protocols. Through this interface the NCT475s internal registers may be accessed. These registers allow the user to read the current temperature, change the configuration settings and adjust the temperature limits.

The NCT475 has a wide supply voltage range of 3.0 V to 5.5 V. The average supply current is 575 μA at 3.3 V. It also offers a shutdown mode to conserve power. The typical shutdown current is 3 μA.

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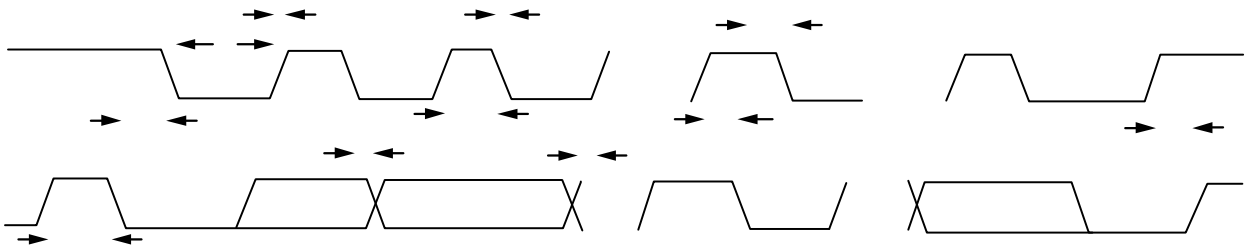


The NCT475 temperature sensor converts an analog temperature measurement to a digital representation by using an on−chip measurement transistor and a 12 bit Delta−Sigma ADC.

The device includes an open drain ALERT output which can be used to signal that the programmed temperature limit has been exceeded.

The two main modes of operation are normal and

shutdown mode. In normal mode the NCT475 performs a new temperature conversion every 80 ms. This new value is then updated to the temperature value register (address 0x00) and also compared to the TOS register limit (default = 80°C). If the temperature value register is read during the conversion sequence the value returned is the

previously stored value. A bus read does not affect the conversion that is in progress.

In shutdown mode temperature conversion is disabled and the temperature value register holds the last valid

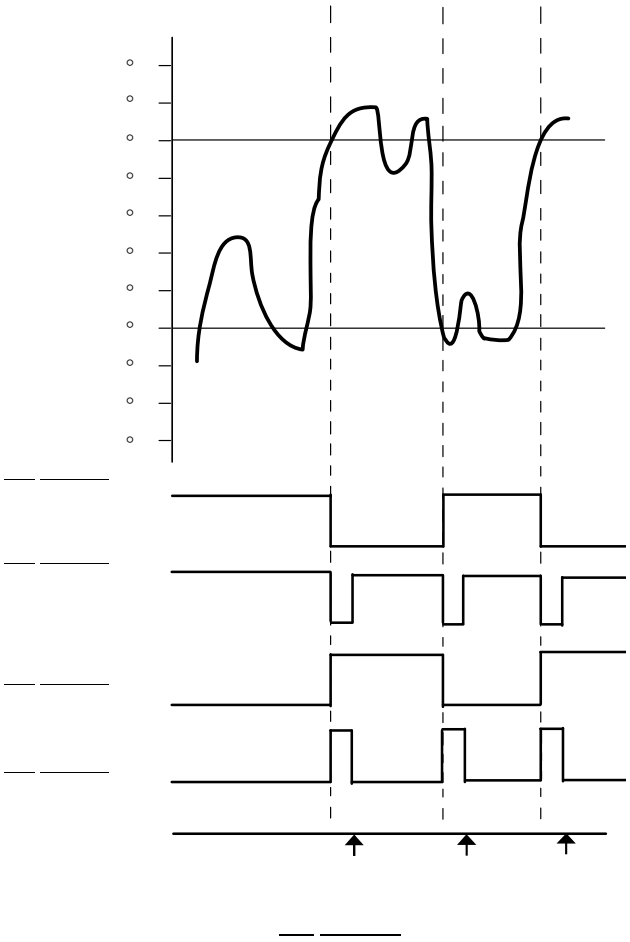
temperature reading. The NCT475 can still be communicated with in this mode as the interface is still active. The device mode is controlled via bit 0 of the configuration register. While in shutdown mode a conversion can be initiated by writing an arbitrary value to the one−shot register (0x04).

This has the effect of powering up the NCT475, performing a conversion, comparing the new temperature with the programmed limit and then going back into shutdown mode.

The OS/ALERT pin can be configured in many ways to allow it to be used in many different system configurations.

The over temperature output can be configured to operate as a comparator type output (which is self clearing once the temperature has returned below the hysteresis value) or an interrupt type output (which requires the master to read an internal register AND the temperature to return below the hysteresis value before going into an inactive state). The ALERT pin can also be configured as an active high or active low output.

While the ADC of the NCT475 can



A fault is defined as when the temperature exceeds a pre−defined temperature limit. This limit can be programmed in the T_{HYST} and the T_{OS} setpoint registers. Bits 3 and 4 of the configuration register determine the number of faults necessary to trigger the OS/ALERT pin. Up to six faults can be programmed to prevent false tripping when the NCT475 is used in a noisy temperature environment. In order for the OS/ALERT output to be set these faults must occur consecutively.

The NCT475 contains six registers for configuring and reading the temperature: the address pointer register, 4 data registers and a one−shot register. The configuration register, the address pointer register and the one−shot register are all 8 bits wide while the temperature register, T_{HYST} and T_{OS} registers are all 16 bits wide. All registers, except for the temperature register, can be be read from and written to (the temperature register is read only). The power on state and address of each register are listed in Table 4.

The address pointer register is used to select which register is to respond to a read or write operation. The three LSBs (P2, P1 & P0) of this write only register are used to select the appropriate register. On power up this register is loaded with a value of 0x00 and so points to the temperature register. Table 2 shows the bits of the address pointer register and Table 3 shows the pointer address selecting each of the registers available.

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The temperature measured by the parts internal sensor is stored Q.9071 re Tc(0x04 (R/W))TjET317.934 29egisn s8ng9( )209 r9070

This 8−bit read/write register is used to configure the NCT475 into its various modes of operation. The different modes are listed in Table 6 and explained in more detail below.

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D7: OS/SMBus Alert Mode.

D7 = 0 SMBus alert disabled, pin operates as an over temperature shutdown pin. (Default)

D7 = 1 Enable SMBus alert functionality for the NCT475.

D6: Reserved

Write 0 to this bit.

D5: One−Shot Mode

D5 = 0 Part is in normal mode and converting every 60 ms. (Default)

D5 = 1 Setting this bit puts the part into one−shot mode. The part is normally powered down in this mode until the one shot register is written to. Once this register is written to one conversion is performed and the part returns to its shutdown state.

D[4:3]: Fault Queue

D4 D3 These two bits determine how many over temperature conditions occur before the OS/Alert pin is triggered. This helps to prevent false triggering of the output.

0 0 = 1 Fault (Default)
0 1 = 2 Faults
1 0 = 4 Faults
2 1 = 6 Faults

D2: OS/Alert pin polarity

This selects the polarity of the OS/Alert output pin.
D2 = 0 Output is active low. (Default)
D2 = 1 Output is active high.

D1: Cmp/Int

D1 = 0 Comparator mode. (Default)
D1 = 1 Interrupt mode.

D0: Shutdown

D0 = 0 Normal mode – part is fully powered. (Default)

D0 = 1 Shutdown mode – all circuitry except for the SMBus interface is powered down. Write a 0 to this bit to power up again.

Control of the NCT475 is carried out via the SMBus/I^2Ccompatible serial interface. The NCT475 is connected to this bus as a slave device, under the control of a master device.

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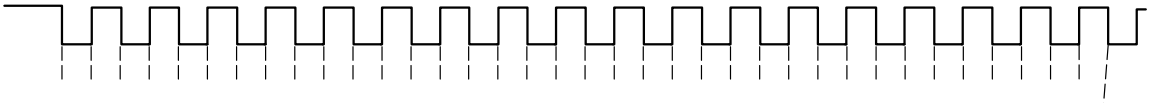
There are two NCT475 device options called NCT475A and NCT475B. Each device supports two possible addresses depending on Ball A2 (named A1) is connected high or low. The NCT475 has a 7−bit serial address. The four MSBs are fixed and set to 1001 while the 3 LSBs can be configured by the user using Ball A2 (named A1). The ball A2 can be connected to VDD or ground.



Reading data from the NCT475 is done in two different ways depending on the register being read. The configuration register is only 8 bits wide so a single byte read is used for this (shown in Figure 8). This consists of the device address followed by the data from the register.

Reading the data in the temperature value register requires a two byte read (shown in Figure 9). This consists of the device address, followed by two bytes of data from the temperature register (the first byte is the MSB). In both cases the address pointer register of the register being read must be written to prior to performing a read operation.

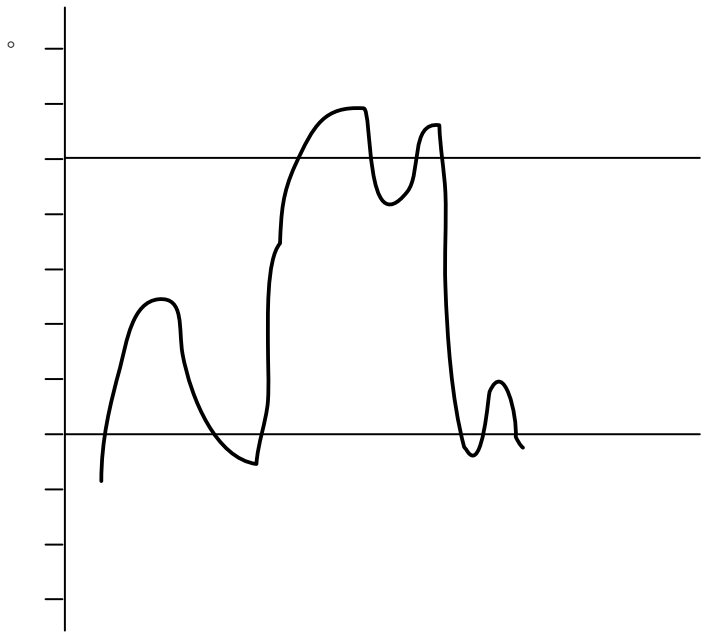
The OS/ALERT output pin can operate in two different modes – overtemperature mode and SMBus

alert mode. The pin defaults to overtemperature mode on power up. This means that it becomes active when the measured temperature meets or exceeds the limit stored in the T_{OS} setpoint register. At this point it can deal with the event in one of two ways which depends on the mode it is in. The two overtemperature modes are comparatormode and interrupt mode. Comparator is the default mode on power up. More information on comparator and interrupt modes alsong with the SMBus alert mode are explained below.

In Comparator Mode, the OS/ALERT pin becomes active when the measured temperature equals or exceeds the limit stored in the T_{OS} setpoint register. The pin returns to its inactive status when the temperature drops below the T_{HYST} setpoint register value.

NOTE: Shutdown mode does not reset the output state for comparator mode.

In the interrupt mode, the OS/ALERT pin becomes active when the temperature equals or exceeds the T_{OS} limit for a consecutive number of faults. It can be reset by performing a read operation on any register in the NCT475. The output can only become active again when the T_{OS} limit has been equalled or exceeded. Figure 11 shows how both the interrupt and comparator modes operate in relation to the output pin (OS/ALERT). It also shows the operation of the polarity in the configuration register.



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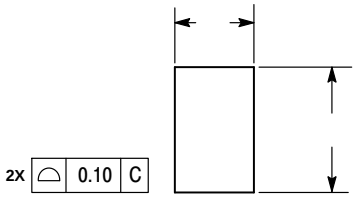

SEATING PLANE

NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. COPLANARITY APPLIES TO SPHERICAL CROWNS OF SOLDER BALLS.
4. DIMENSION b IS MEASURED AT THE MAXIMUM BALL DIAMETER PARALLEL TO DATUM C.

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