SENSYLINK Microelectronics

(CT7302)
Digital Temperature Sensor

CT7302 is a Digital Temperature Sensor with ±0.2°C Accuracy Compatible with SMBus, I²C and 2-wire Interface. It is ideally used in Cold-Chain, Thermal management and Portable Devices etc.
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Description

CT7302 is a digital temperature sensor with ±0.2°C accuracy. Temperature data can be read out directly via digital interface (compatible with SMBus, I²C or 2-wire) by MCU, Bluetooth Chip or SoC chip.

CT7302 supports I²C communication with speed up to 400 kHz.

Each chip is specially calibrated for ±0.2°C (Max.) accuracy over 0°C to 50°C range in factory before shipment to customers. There is no need for re-calibration anymore for ±0.2°C accuracy.

It includes a high precision band-gap circuit, a 14-bit analog to digital converter, a calibration unit with non-volatile memory, and a digital interface block.

It has ALERT logic output pin with open drain structure, which is active low.

The chip supports up to 4 devices in one I²C bus by setting different slave address via AD0 pin.

Available Package: SOT-23-5, DFN3x3-8 package

Features

- Operation Voltage: 2.5V to 5.5V
- Average Quiescent Current: 15µA (Typ.), 30µA (Max.)
- Standby Current: 0.1µA (Typ.), 0.3µA (Max.)
- Temperature Accuracy without calibration:
  - Maximum: ±0.2°C from -10°C to 80°C
  - Maximum: ±0.5°C from -20°C to 100°C
  - Maximum: ±1.0°C from -55°C to 125°C
- 14 bit ADC for Temperature
- Compatible with SMBus, 2-wire and I²C interface
- Programmable Alert response of Over Temperature
- Generate 4 different slave address by setup AD0 pin
- Temperature Range: -40°C to 125°C

Applications

- Cold-Chain
- Smart HVAC System
- Thermal Management

PIN Configurations (Top View)

![PIN Configurations Diagram]

Typical Application

![Typical Application Diagram]

Figure 1. Typical Application of CT7302
Pin Description

<table>
<thead>
<tr>
<th>PIN Name</th>
<th>PIN No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDA</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>VCC</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>SCL</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>AD0</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>GND</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>ALERT</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>NC</td>
<td>4, 5</td>
<td>No connection.</td>
</tr>
</tbody>
</table>

Digital interface data input or output pin, need a pull-up resistor to VCC.
Power supply input pin, using 0.1uF low ESR ceramic capacitor to ground.
Digital interface clock input pin, need a pull-up resistor to VCC.
Address selection pins, the chip can be defined total 4 different slave addresses by connecting these pins to GND, VCC, SCL or SDA pin respectively. Do not leave this pins open. See Slave Address for detail.
Ground pin.
To Indicate ALERT of over Temperature programmed by setting T_{HIGH} register, it is open drain output with active low. Need a pull-up resistor to VCC in application.

Function Block

![Function Block Diagram](image)

Figure 2. CT7302 function block
Ordering Information

**CT7302**

X X

**Package Type**

K5 : SOT-23-5
DN : DFN-3x3-8

**Packing**

R : Tape & Reel

<table>
<thead>
<tr>
<th>Order PN</th>
<th>Accuracy</th>
<th>Green</th>
<th>Package</th>
<th>Marking ID</th>
<th>Packing</th>
<th>MPQ</th>
<th>Operation Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT7302K5R</td>
<td>±0.2°C</td>
<td>Halogen free</td>
<td>SOT-23-5</td>
<td>AFXX</td>
<td>Tape &amp; Reel</td>
<td>3,000</td>
<td>-40°C~+125°C</td>
</tr>
<tr>
<td>CT7302DNR</td>
<td>±0.2°C</td>
<td>Halogen free</td>
<td>DFN3x3-8</td>
<td>7302YYWAXX</td>
<td>Tape &amp; Reel</td>
<td>3,000</td>
<td>-40°C~+125°C</td>
</tr>
</tbody>
</table>

**Notes**

1. Based on ROHS Y2012 spec, Halogen free covers lead free. So most package types Sensylink offers only states halogen free, instead of lead free.

2. Marking ID includes 2 rows of characters. In general, the 1st row of characters are part number, and the 2nd row of characters are date code plus production information.
   1) Generally, date code is represented by 3 numbers. The number stands for year and work week information. e.g. 501 stands for the first work week of year 2015; 621 stands for the 21st work week of year 2016.
   2) Right after the date code information, the next 2-3 numbers or letters are specified to stands for supplier or production location information.

3. For very small outline package, there’s 4 digits to stands for product information and date code. first 2 digits represent product code, and the other 2 digits stands for work week.
Absolute Maximum Ratings (Note3)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>$V_{CC}$ to GND</td>
<td>-0.3 to 5.5</td>
<td>V</td>
</tr>
<tr>
<td>SDA, SCL, AD0 Voltage</td>
<td>$V_{SDA/V_{SCL}/V_{AD0}}$ to GND</td>
<td>-0.3 to 5.5</td>
<td>V</td>
</tr>
<tr>
<td>ALERT Voltage</td>
<td>$V_{ALERT}$ to GND</td>
<td>-0.3 to 5.5</td>
<td>V</td>
</tr>
<tr>
<td>Operation junction temperature</td>
<td>$T_J$</td>
<td>-50 to 125°C</td>
<td></td>
</tr>
<tr>
<td>Storage temperature Range</td>
<td>$T_{STG}$</td>
<td>-65 to 150°C</td>
<td></td>
</tr>
<tr>
<td>Lead Temperature (Soldering, 10 Seconds)</td>
<td>$T_{LEAD}$</td>
<td>260°C</td>
<td></td>
</tr>
<tr>
<td>ESD MM</td>
<td>$ESD_{MM}$</td>
<td>600 V</td>
<td></td>
</tr>
<tr>
<td>ESD HBM</td>
<td>$ESD_{HBM}$</td>
<td>6000 V</td>
<td></td>
</tr>
<tr>
<td>ESD CDM</td>
<td>$ESD_{CDM}$</td>
<td>1000 V</td>
<td></td>
</tr>
</tbody>
</table>

Note3

1. Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at the "Absolute Maximum Ratings" conditions or any other conditions beyond those indicated under "Recommended Operating Conditions" is not recommended. Exposure to "Absolute Maximum Ratings" for extended periods may affect device reliability.

2. Using 2oz dual layer (Top, Bottom) FR4 PCB with 4x4 mm² cooper as thermal PAD

Recommended Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>$V_{CC}$</td>
<td>2.5 ~ 5.5</td>
<td>V</td>
</tr>
<tr>
<td>Ambient Operation Temperature Range</td>
<td>$T_A$</td>
<td>-40~+125</td>
<td>°C</td>
</tr>
</tbody>
</table>
**Electrical Characteristics (Note4)**

Test Conditions: $C_{\text{IN}} = 0.1 \mu\text{F}$, $V_{\text{CC}} = 3.3\text{V}$, $T_A = -40$ to $125^\circ\text{C}$ unless otherwise specified. All limits are 100% tested at $T_A = 25^\circ\text{C}$.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>$V_{\text{CC}}$</td>
<td>$T_A = -40$ to $125^\circ\text{C}$</td>
<td>2.5</td>
<td>5.5</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Temperature Accuracy</td>
<td>$T_{\text{AC}}$</td>
<td>$T_A = -10$ to $80^\circ\text{C}$</td>
<td>-0.2</td>
<td>0.2</td>
<td>$^\circ\text{C}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$T_A = -20$ to $100^\circ\text{C}$</td>
<td>-0.5</td>
<td>0.5</td>
<td>$^\circ\text{C}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$T_A = -55$ to $125^\circ\text{C}$</td>
<td>-1.0</td>
<td>1.0</td>
<td>$^\circ\text{C}$</td>
<td></td>
</tr>
<tr>
<td>Average Operating Current</td>
<td>$I_{\text{AOC}}$</td>
<td>$V_{\text{IN}} = 3.3\text{V}$, $1.0$ con/s</td>
<td>15</td>
<td>30</td>
<td></td>
<td>$\mu\text{A}$</td>
</tr>
<tr>
<td>Shutdown Current</td>
<td>$I_{\text{SHUTDOWN}}$</td>
<td>Enable STB bit, force SDA/SCL to VCC or GND</td>
<td>0.1</td>
<td>0.3</td>
<td></td>
<td>$\mu\text{A}$</td>
</tr>
<tr>
<td>Open Drain Output Voltage</td>
<td>$V_{\text{OL}}$</td>
<td>ALERT pin, sink $5\text{mA}$</td>
<td>0</td>
<td>0.5</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Open Drain Leakage</td>
<td>$I_{\text{ODL}}$</td>
<td>ALERT pin</td>
<td>-1.0</td>
<td>1.0</td>
<td></td>
<td>$\mu\text{A}$</td>
</tr>
<tr>
<td>Conversion time</td>
<td>$t_{\text{CON}}$</td>
<td>From active to finish completely</td>
<td>10</td>
<td></td>
<td></td>
<td>ms</td>
</tr>
</tbody>
</table>

**Digital Interface**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logic Input Capacitance</td>
<td>$C_{\text{IL}}$</td>
<td>SDA, SCL pin</td>
<td>3.0</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>Logic Input High Voltage</td>
<td>$V_{\text{IH}}$</td>
<td>SDA, SCL pin</td>
<td>$0.7\times V_{\text{CC}}$</td>
<td>$V_{\text{CC}}$</td>
<td>$V_{\text{CC}}$</td>
<td>$V$</td>
</tr>
<tr>
<td>Logic Input Low Voltage</td>
<td>$V_{\text{IL}}$</td>
<td>SDA, SCL pin</td>
<td>0</td>
<td></td>
<td></td>
<td>$0.2\times V_{\text{CC}}$</td>
</tr>
<tr>
<td>Logic Input Current</td>
<td>$I_{\text{INL}}$</td>
<td>SDA, SCL pin</td>
<td>-1.0</td>
<td></td>
<td></td>
<td>$1.0$</td>
</tr>
<tr>
<td>Logic Output Sink Current</td>
<td>$I_{\text{OLS}}$</td>
<td>SDA, ALERT pin, forced $0.2\text{V}$</td>
<td>5.0</td>
<td></td>
<td></td>
<td>$\text{mA}$</td>
</tr>
<tr>
<td>SCL frequency</td>
<td>$f_{\text{CLK}}$</td>
<td>Fast Mode</td>
<td>1</td>
<td>400</td>
<td></td>
<td>$\text{kHz}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High Speed Mode</td>
<td>0.001</td>
<td></td>
<td></td>
<td>$3$</td>
</tr>
</tbody>
</table>

| Timeout of detecting clock low     | $t_{\text{TOUT}}$ | SMBus Communication | 30   |      |      | ms   |
| period time                        |                    |                  |      |      |      |      |
| Clock low period time              | $t_{\text{LOW}}$ | High Speed Mode | 1300 |      |      | ns   |
| Clock high period time             | $t_{\text{HIGH}}$ | High Speed Mode | 600  |      |      | ns   |
| Bus free time                      | $t_{\text{BUF}}$ | Between Stop and Start condition | 1200 |      |      | ns   |
| Hold time after Start condition    | $t_{\text{HD:STA}}$ |                  | 600  |      |      | ns   |
| Repeated Start condition setup time| $t_{\text{SU:STA}}$ |                  | 600  |      |      | ns   |
| Stop condition setup time          | $t_{\text{SU:STO}}$ |                  | 600  |      |      | ns   |
| Data Hold time                     | $t_{\text{HD:DAT}}$ |                  | 100  | 900  |      | ns   |
| Data Setup time                    | $t_{\text{SU:DAT}}$ |                  | 100  |      |      | ns   |
| Clock/Data fall time               | $t_{\text{f}}$ |                  | 300  |      |      | ns   |
| Clock/Data rise time               | $t_{\text{BR}}$ |                  | 300  |      |      | ns   |

**Note 4:**

1. All devices are 100% production tested at $T_A = +20^\circ\text{C}$; All specifications over the automotive temperature range is guaranteed by design, not production tested.

2. No parasitic diode between EN pin and VIN pin.
Figure 3. SMBus/I²C Timing Diagram
1 Function Descriptions

The chip can sense temperature with high precision, an analog-to-digital converter, signal processing, calibration, polynomial fit correction, and an \( \text{i}^2\text{C} \) interface all in a single chip. The chip is calibrated for temperature before shipment using on-chip non-volatile memory. It is permitted to connect 4 devices at the same \( \text{i}^2\text{C} \) bus by setting AD0 PIN. The SDA and SCL pins integrate spike-suppression filters and Schmitt triggers to minimize the effects of input spikes and bus noise. After power-up, the sensor enters standby mode until a communication or temperature measurement is performed. All output data bytes are transmitted MSB first. Also the chip supports programmable high-limit of temperature settings. If the measured temperature and/or meets or exceeds the high-limit threshold \( (T_{TH}) \), ALERT pin will be asserted low. Once the measured temperature goes below the high-limit threshold, ALERT pin will be released.

1.1 Register map

The sensor has 4 registers that user can access. The detail information is shown as below.

Table 1. Register Maps Definition

<table>
<thead>
<tr>
<th>Register Address</th>
<th>Name</th>
<th>Default</th>
<th>Attribution*</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x00</td>
<td>Temperature</td>
<td>0x0000</td>
<td>R/O</td>
<td>Temperature measurement data, 16-bit format.</td>
</tr>
<tr>
<td>0x02</td>
<td>Config</td>
<td>0x1000</td>
<td>R/W</td>
<td>Sensor for configuration and status.</td>
</tr>
<tr>
<td>0x03</td>
<td>Alert Setup</td>
<td>0xCD36</td>
<td>R/W</td>
<td>High-limit setup for Temperature and Humidity</td>
</tr>
<tr>
<td>0xFE</td>
<td>Manufacture ID</td>
<td>0x5959</td>
<td>R/O</td>
<td>Manufacture ID</td>
</tr>
</tbody>
</table>

*Note: R/O, means ready only; R/W means readable/writable.

1.1.1 Temperature Measurement Data [Add: 0x00]

The temperature measurement data is stored in Read Only temperature register. The temperature register is in 14-bit binary format with 2-Bytes. This 2-Bytes Temperature data must be read at the same time in each reading cycle, 1\(^{\text{st}}\)-Byte is MSB followed by 2\(^{\text{nd}}\)-Byte, the LSB. The relationship between Temperature data in Celsius degree and binary data is shown as below tables.

Table 2. 14-bit Temperature Data

<table>
<thead>
<tr>
<th>Bit</th>
<th>Attribution</th>
<th>Temperature Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit15 to bit2</td>
<td>Read only</td>
<td>Valid data, 0 or 1</td>
</tr>
<tr>
<td>Bit1 to bit0</td>
<td>Read only</td>
<td>Always 0</td>
</tr>
</tbody>
</table>

\[
\text{Temperature} (^\circ\text{C}) = 165 \times \frac{\text{Temperature[bit15:0]}}{2^{16-1}} - 40......(1)
\]

1.1.2 Config Register [Add: 0x02]

The chip has a 16-bit (2-Bytes) configuration register, which is readable/writable attribution for user. User can change related bit to setup features, like Alert trigger, clock stretching etc. Also user can read out register data to check the chip working status. And the register will reset to default data after power-up. 16 bits definition is shown as below table.

Table 3. Status Register Definition

<table>
<thead>
<tr>
<th>BIT</th>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>definition</td>
<td>SRST</td>
<td>CLKSTR</td>
<td>Reserved</td>
<td>Reserved</td>
<td>VCCS</td>
<td>T RES</td>
<td>Reserved</td>
<td></td>
</tr>
</tbody>
</table>

Jun. 2018 Rev. 1.0 SENSYLINK Microelectronics Co., LTD
SRST, Software Reset bit

- ‘1’ -- means soft reset.
- ‘0’ -- means normal operation.

default: 0

CLKSTR, clock stretching

- ‘1’ -- means clock stretching enable.
- ‘0’ -- means clock stretching disable.

default: 0

VCCS, Supply Voltage Status bit

- ‘1’ -- means <2.5V.
- ‘0’ -- means >2.5V.

default: 0

TALT, Temperature Alert Status bit

- ‘1’ -- means alter.
- ‘0’ -- means no alter.

default: 0

T_RES, Temperature resolution bit

- ‘1’ -- means 11-bit.
- ‘0’ -- means 14-bit.

default: 0

ALTM, Alert trigger mode selection bit

- ‘00’ or ‘01’ -- once T happens, ALT pin is active.
- ‘10’ or ‘11’ -- even T happens, ALT pin is NOT active.

default: 0

APS, Alert Pending Status bit

- ‘1’ -- means at least one pending alert.
- ‘0’ -- means no pending alert.

default: 0

1.1.3 Alert High Limit Setup [Add: 0x03]

The chip features high-limit of temperature at ALERT pin. When temperature of measured achieves or exceeds threshold temperature setup by user, ALERT pin will be active. Once temperature measured falls below threshold value, ALERT pin will be released from active status. ALERT pin is open drain output with active low. It is necessary to use external pull-up resistor of 4.7k to 10k in application. The default status of ALERT pin is NOT active after power on or soft reset the chip. ALERT pin trigger happens after each measurement cycle. In each measurement cycle, the chip will compare data of temperature register to that of threshold register. Compare result will be performed at both ALERT pin and related bit of configuration register (bit3).

For threshold temperature data, the format is shown as below.

Table 4. Threshold Bit definition

<table>
<thead>
<tr>
<th>BIT</th>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Default: 0xCD36, T= 60°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reserved</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Temperature</td>
<td></td>
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The 1st 7bits are reserved and the last 9bits are used for temperature threshold data. The relationship between binary data and threshold data is shown as below sample.

Step 1, using zero ‘0’ as LSB to complete 16 bits format data.
for 1st reserved word (2 bytes), \[1100 \ 1100 \ 0000 \ 0000\]
for 2nd reserved word (2 bytes) is for Temperature, \[1001 \ 1011 \ 0000 \ 0000\]
Step 2, using above formula to calculate temperature and humidity respectively.

\[
\text{Temperature} (\degree C) = 165 \times \frac{\text{Temperature}[\text{bit15: 0}]}{2^{16} - 1} - 40 = 165 \times \frac{39680}{65535} - 40 = 59.9\degree C \approx 60\degree C
\]

Conversely, it is easy to convert threshold data into binary format for 9-bits temperature. For example, set threshold 80\degree C for temperature.

Step 1, convert threshold data into binary according to above formula.
Keep the fist 7-bits [1110 011], as default data, \[1100 \ 110\].

Temperature, \[1011 \ 1010 \ 0010 \ 1101\], only keep the fist 9-bits[1011 1010 0], remove all rest bits.
Step 2, then combine reserved 7-bits and Temperature binary data to compose full 16 bit format

<table>
<thead>
<tr>
<th>BIT</th>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
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<td>1</td>
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</table>

Table 5. Combination for humidity and temperature high-limit

Based on above example, the threshold resolution for temperature is \(128/65535 \times 175 = 0.34\degree C\). The binary threshold data can be read & write by reading and writing command shown as below.

1.1.4 Manufacture ID [Add: 0xFE]
Manufacture ID is the ready only register, for this sensor, the data is 0x5959.

1.2 Soft Reset
Generally the chip will reset itself internally during power up every time. Also the chip supports to perform reset without removing the power supply, using soft reset command. When bit15 of config register is set to '1', the sensor will perform reset. After finishing reset, all registers will become the default data and the chip will reload calibration data from the memory. And bit15 will be read as '0'.

1.3 Do Measurement Procedure
The sensor can be easily used to read out temperature data just follow below steps.
1.3.1 Step 1, setup the sensor
It is necessary to setup the sensor by writing proper data into config register [Add: 0x03], like, temperature resolution (bit10, T_RES), or using default data.

1.3.2 Step 2, trigger temperature measurement
Trigger temperature measurement by writing register address, 0x00 into the sensor via I²C bus.

1.3.3 Step 3, waiting for conversion time
The typical conversion time of temperature/humidity is 6.50ms with 14-bit, during the conversion, the sensor will NOT ACK reading action at I2C bus until one-time conversion is finished. Also the clock will be stretching if user set CLKSTR ‘1’ (bit12 of config).

1.3.4 Step 4, read out temperature measurement data
Once conversion is finished, temperature raw data can be obtained by reading register 0x00, respectively via I²C bus.

1.3.5 Example C++ Code for reading out temperature data
Here is the C++ code as example, to show one way of reading out temperature register data.

```c++
DWORD wLength;
BYTE* pReadBuf_CHT8305_Temp_Reg = new BYTE[wLength];
BYTE com_CHT8305_T_Reg[4]; com_CHT8305_T_Reg[0]=0x00;
//get Temperature Data
DoWrite(0x80,com_CHT8305_T_Reg,1); //write Reg add, 0x00, 0x80 is I2C slave add.
Sleep(20);   //waiting 20ms for temperature conversion.
DoRead(0x80,pReadBuf_CHT8305_Temp_Reg,2,0,com_CHT8305_T_Reg); //reading 2-bytes, and put them into pReadBuf_CHT8305_Temp_Reg variable.
```

1.4 Digital Interface
1.4.1 Slave Address
The chip is compatible with industry standard I²C protocol as slave device communication with host via SDA and SCL pin. Both SDA and SCL pin are open drain structure, so it is necessary to use 2 pull-up resistors of 4.7k to 10k. The communication speed supports up to 400 kHz. The I²C slave address of this device can be configured 4 different addresses by setting AD0 pin. See below table for detail. This permits connecting total 4 devices in one same bus. If keeping AD0 pin float is the same as connecting AD0 pin to GND.

<table>
<thead>
<tr>
<th>No.</th>
<th>AD0</th>
<th>R/W bit</th>
<th>Slave Address in Hex</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GND</td>
<td>1/0</td>
<td>0x81/0x80</td>
</tr>
<tr>
<td>2</td>
<td>VCC</td>
<td>1/0</td>
<td>0x89/0x88</td>
</tr>
</tbody>
</table>

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1.4.2 Read/Write Operation

The chip supports basic standard protocols of Read, Write operation, shown as below figures. For CT7302, all register data is 16bit, 2-Bytes format.

Read Operation, host generates start ‘S’ signal in first, then sends slave address (R/W bit=0) of the chip set by user, the chip will ACK the slave address by pull SDA low, then host sends register address, the chip will acknowledge. Host will generate re-start ‘Sr’, then send slave address again (R/W bit=1), the chip will ACK again, the output 16-bit (2-Bytes) data with MSB first, then LSB, host have to ACK the MSB byte. Then host send ACK or NACK with stop ‘P’ at last.

Write Operation, host generates start ‘S’ signal in first, then sends slave address (R/W bit=0) of the chip set by user, the chip will acknowledge the slave address by pull SDA low, then host sends register address. The chip will acknowledge. Host will send 16-bit (2-Bytes) data to be write with MSB first, then LSB, the sensor will ACK byte by byte. Then host send stop ‘P’ at last.

*Note: the chip will NOT ACK the slave address byte until conversion is finished if read 0x00 register.
±0.2°C Digital Temperature Sensor with Digital Interface

Figure 4 \(i^2C\) Write Word (2-Bytes) Timing Diagram

Clock stretching

If CLKSTR bit is enabled during read 0x00
Until conversion is finished

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1.5 ALERT Output

ALERT pin is open drain output with active low. And it is triggered when the measured temperature equals or exceeds the high-limit threshold of temperature setup by user. The ALERT pin can be used to connect to the interrupt pin of a microcontroller. It should be connect a pull-up resistor in application shown in Figure 1. The logic status of ALERT pin is shown as in Figure 6.
2 Application Information

2.1 How to Improve Temperature Accuracy

The temperature measurement of the chip is based on semiconductor physics principle -- Forward voltage of diode is a function of temperature. The formula is shown as below.

\[ V_F = \frac{kT}{q} \ln \left( \frac{I_F}{I_S} \right) \]

Here,
- \( V_F \) -- forward voltage
- \( I_F \) -- forward current
- \( I_S \) -- reverse saturation current
- \( k \) -- Boltzmann constant
- \( T \) -- Temperature in K
- \( q \) -- electric charge constant

To cover wide temperature range, i.e. -40°C to 125°C, a very small voltage variation is corresponding to every degree C temperature change. Sensylink has applied many ways to improve measurement accuracy in chip circuits design, such as compensation, trimming etc. In real system design, however, some factors that can increase measurement error need to be considered. Most issues that usually occur are highlighted as below.

2.1.1 Noise between VCC and GND

It is very necessary to place a low ESR ceramic cap (CIN) between VCC and GND pin to filter digital noise, although suppression noise circuit has been built inside the chip. This filter cap should be placed as close as possible to the chip. The recommended capacitance is 0.1μF.

2.2 PCB Layout

Cautions below are important to improve temperature measurement accuracy in PCB layout design.

2.2.1 Device placement

It is better to place the chip away from any thermal source (e.g. power device in board), high speed digital bus (e.g. memory bus), coil device (e.g. inductors) and wireless antenna (e.g. Bluetooth, WiFi, RF). It is recommended to place the chip close to the remote diode.

2.2.2 Cin, Pull-up resistor

It is better to place Cin as close as possible to VCC and GND pins of the chip. The recommended Cin value is 0.1μF with low ESR ceramic cap although using multi caps, such as 1.0μF plus 0.1μF or 0.01μF, is ok, which can suppress digital noise with different frequency range.

User has to put a pull-up resistor with 4.7k to 10k for SDA and SCL pins respectively. It is ok to use smaller resistors such as 2k-3k in real application, if multi SMBus/I2C devices are used in the same bus.
Package Outline Dimensions (SOT-23-5)

Symbol | Dimensions in Millimeters | Dimensions in Inches
---|---|---
A | 1.000 – 1.450 | 0.039 – 0.057
A1 | 0.000 – 0.150 | 0.000 – 0.006
A2 | 1.000 – 1.200 | 0.039 – 0.047
b | 0.300 – 0.500 | 0.012 – 0.020
c | 0.100 – 0.200 | 0.004 – 0.008
D | 2.720 – 3.120 | 0.107 – 0.123
E | 1.400 – 1.800 | 0.055 – 0.071
E1 | 2.600 – 3.000 | 0.102 – 0.118
e | 0.950 (BSC) | 0.037 (BSC)
e1 | 1.800 – 2.000 | 0.071 – 0.079
L | 0.300 – 0.600 | 0.012 – 0.024
θ | 0° – 8° | 0° – 8°
Package Outline Dimensions (DFN3x3-8)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Dimensions in Millimeters</th>
<th>Dimensions in Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.700 - 0.800</td>
<td>0.028 - 0.031</td>
</tr>
<tr>
<td>A1</td>
<td>0.000 - 0.050</td>
<td>0.000 - 0.002</td>
</tr>
<tr>
<td>A3</td>
<td>0.203REF.</td>
<td>0.008REF</td>
</tr>
<tr>
<td>D</td>
<td>2.900 - 3.100</td>
<td>0.114 - 0.122</td>
</tr>
<tr>
<td>E</td>
<td>2.900 - 3.100</td>
<td>0.114 - 0.122</td>
</tr>
<tr>
<td>D1</td>
<td>2.200 - 2.600</td>
<td>0.087 - 0.102</td>
</tr>
<tr>
<td>E1</td>
<td>1.400 - 1.800</td>
<td>0.055 - 0.071</td>
</tr>
<tr>
<td>k</td>
<td>0.250MIN.</td>
<td>0.010REF</td>
</tr>
<tr>
<td>b</td>
<td>0.250 - 0.350</td>
<td>0.010 - 0.014</td>
</tr>
<tr>
<td>e</td>
<td>0.650TYP.</td>
<td>0.026TYP</td>
</tr>
<tr>
<td>L</td>
<td>0.200 - 0.400</td>
<td>0.008 - 0.016</td>
</tr>
</tbody>
</table>
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