Temperature and Humidity Sensor

(Model: WHTC3)

Manual

Version: V1.0

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Zhengzhou Winsen Electronics Technology Co., Ltd

Statement

Thanks for purchasing our product. In order to let customers use it better and reduce the faults caused by misuse, please read the manual carefully and operate it correctly in accordance with the instructions. If users disobey the terms or remove, disassemble, change the components inside of the sensor, we shall not be responsible for the loss.

The specific such as color, appearance, sizes &etc, please in kind prevail.

We are devoting ourselves to products development and technical innovation, so we reserve the right to improve the products without notice. Please confirm it is the valid version before using this manual. At the same time, users' comments on optimized using way are welcome.

Please keep the manual properly, in order to get help if you have questions during the usage in the future.

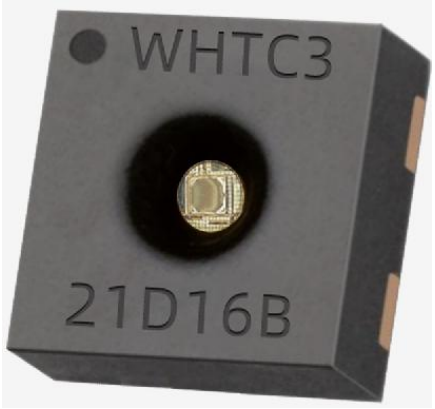
Zhengzhou Winsen Electronics Technology CO., LTD

WHTC3 MEMS type Temperature and Humidity Sensor

Overview

The WHT C3 temperature and humidity sensor is embedded in a dual-row flat no-lead SMD package suitable for reflow soldering. The temperature and humidity signals can be read on different pins. The bottom surface is 2.5 x 2.5 mm and the height is 0.9 mm. The sensor outputs a calibrated digital signal in a standard I2C format.

WHT C3 is equipped with an ASIC chip, a MEMS capacitive humidity sensor element and a temperature sensor element. WHT C3 temperature and humidity sensors have been calibrated and tested, with excellent reliability and long-term stability.



Features

Fully calibrated
±3.0% RH and ±0.3℃ Accuracy
Wide power supply voltage range, from 2.2V to 5.5V
SMD package suitable for reflow soldering
Temperature and humidity parallel measurement on different pins
Quick response and strong anti-interference ability
Excellent long-term stability under high humidity condition

Application

Home appliance fields: home appliance, humidity control, HVAC, dehumidifiers, smart thermostats, and room monitors etcs;
Industrial fields: automobiles, testing equipment, and automatic control devices;
Other fields: data loggers, weather stations, medical and other related temperature and humidity detection devices.

Technical parameters of relative humidity

Parameter	Condition	Min	Typical	Max	Unit
Resolution	Typical		0.01		%RH
Accuracy error[1]	Typical		±3.0		%RH
	Max	See figure 2			%RH
Repeatable			±0.1		%RH
Hysteresis			±1.0		%RH
Non-linear			<0.1		%RH
Response time[2]	$t_{63\%}$		8		s
Scope of work	extended[3]	0		100	%RH
Prolonged Drift[4]	Normal		<0.25		%RH/yr

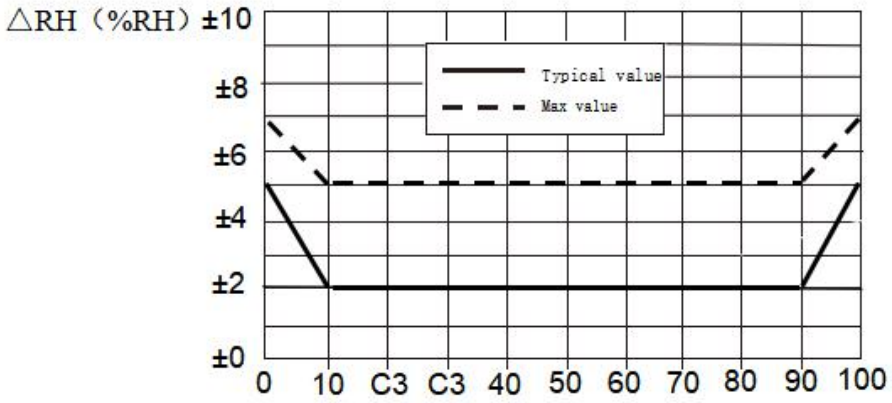


Figure 1 Maximum error of relative humidity at 25°C

Technical parameters of temperature

Parameter	Condition	Min	Typical	Max	Unit
Resolution	Typical		0.015		°C
Accuracy error[1]	Typical		±0.3		°C
	Max	See figure 3			°C
Repeatable			±0.12		°C
Hysteresis			±0.1		°C
Response time[6]	$t_{63\%}$	2		C3	s
Scope of work	extended[3]	-40		85	°C
Prolonged Drift[4]			<0.03		°C/yr

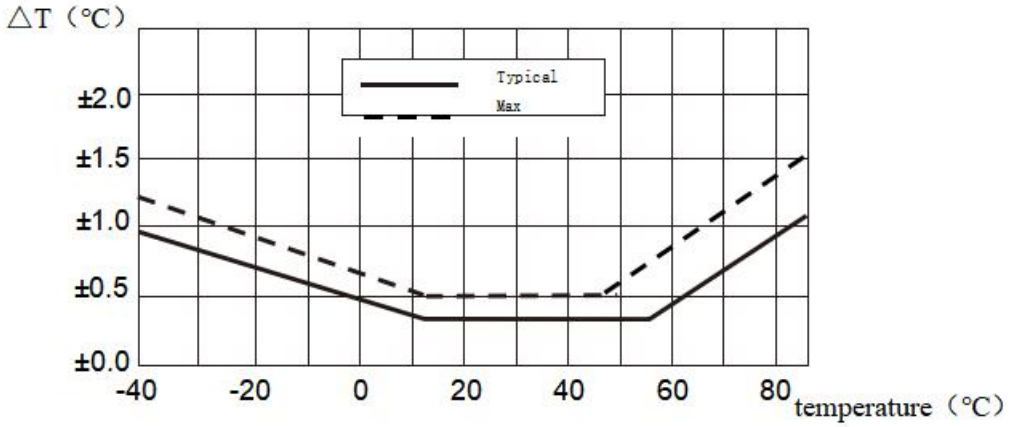


Figure 2 Temperature typical error and maximum error

Suggested working environment

The recommended temperature and humidity range of this sensor is 5~60℃ and 30~80% RH, as shown in Figure 3.

Long-term exposure in the non-recommended range, such as high humidity, may cause

temporary signal drift (for example, >80%RH, drift +3% RH after 60 hours). After returning to the recommended range environment, the sensor will gradually return to the calibration state. Long-term exposure to the non-recommended range may accelerate the aging of the product.

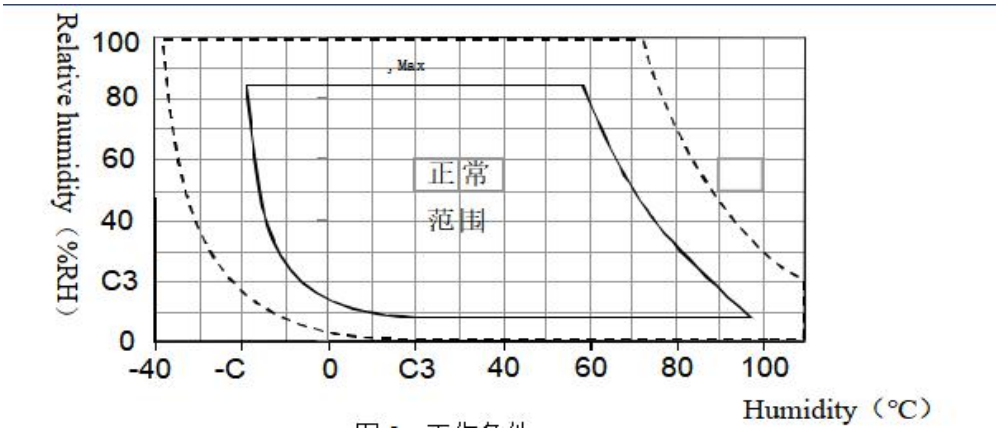


Figure 3 Working scope

RH accuracy at different temperatures

Figure 4 shows the maximum humidity error for other temperature ranges.

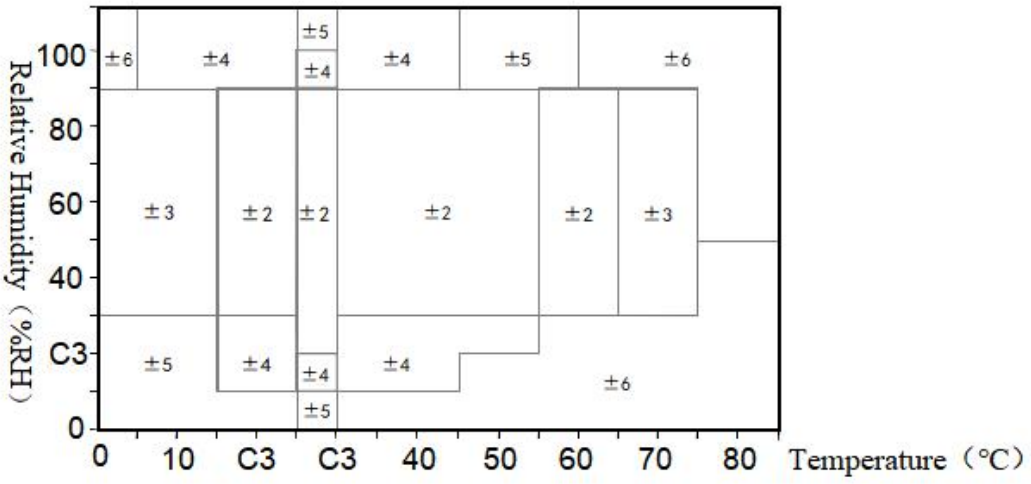


Figure 4 The maximum error of the corresponding humidity in the range of 0-80℃

Electrical specifications (Table 3)

parameter	Mark	Condition	Min	Typical	Max	Unit
Voltage	VDD		1.62	3.3	5.5	V
Power-on reset voltage	VPOR		1.28	1.4	1.55	V
Supply voltage slew rate	VDD				20	V/ms

Current	IDD	Dormant T=25℃	-	0.3	0.6	μA
		Standby	-	45	70	μA
		Measure	-	4C3	900	μA
		Average	-	4.9	-	μA
Low input voltage	V_{IL}		-	-	0.42	V
High input voltage	V_{IH}		0.7	-	-	V
Low output voltage	V_{OL}		-	-	$0.2V_{DD}$	V

The power consumption given in Table 3 is related to temperature and supply voltage VDD. See Figures 5 and 6 for power consumption estimates. Please note that the curves in Figures 5 and 6 are typical natural characteristics, and there may be deviations.

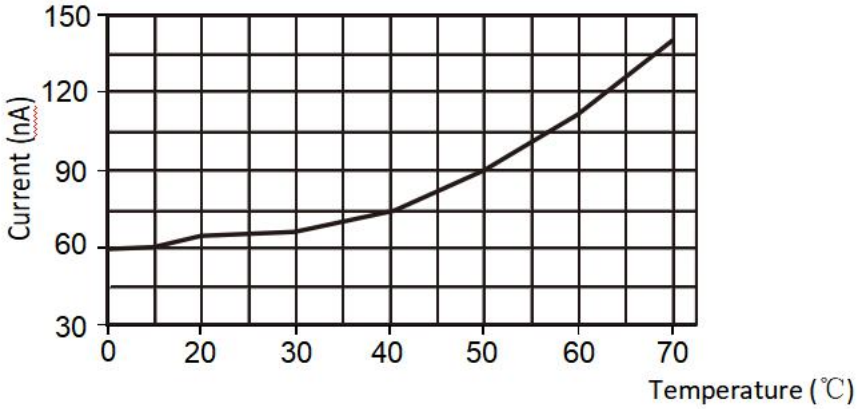


Fig. 5 Typical supply current vs. temperature curve (sleep mode) when VDD=3.3V. There is a deviation of approximately ±25% between these data and the displayed value.

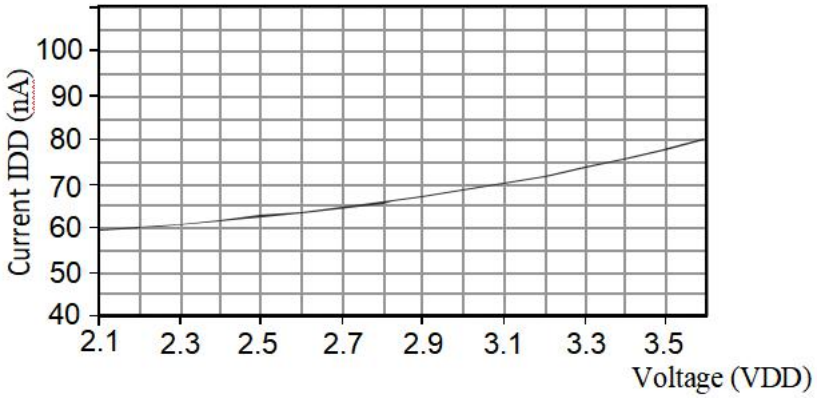


Figure 6 Typical supply current vs. supply voltage curve (sleep mode) at a temperature of 25 ℃.

Note: The deviation between these data and the displayed value may reach ±50% of the displayed value. At 60 ℃, the coefficient is approximately 15 (compared to Table 3).

Package information

Part no.	Package	Quantity
WHT C3	Tape package	5000PCS/Roll (MAX)

Note: 1. This accuracy is the test accuracy of the sensor at 25℃ and the supply voltage is 3.3V during the factory inspection.
2. The time required to reach 63% response under the conditions of 25°C and 1m/s airflow.
3. Normal working range: 0-80%RH, beyond this range, the sensor reading will be biased (after 30 hours under 90%RH humidity, drift <3%RH). The working range is limited to -40-80℃.
4. If there are volatile solvents, tapes with pungent odors, adhesives and packaging materials around the sensor, the readings may be high.
5. The minimum and maximum values of supply current and power consumption are based on the conditions of VDD = 3.3 V and T <60°C.
6. The response time depends on the thermal conductivity of the sensor substrate.

1. Application:

1.1 Storage Conditions

The temperature and humidity sensor should not be exposed to volatile chemicals, such as organic solvents or other inorganic compounds, otherwise it will cause irreversible drift in humidity output readings. Therefore, it is recommended that the storage conditions of the sensor sealed in the ESD pocket are: temperature range 10-50 ℃ (0-85 ℃ within a limited time); humidity C3-60% RH (sensor without ESD package). The sensor that has been taken out of the original packaging is recommended to be stored in an anti-static bag made of PET/AL/CPE containing metal.

1.2 Recovery Processing

If the sensor is exposed to extreme working conditions, the value drifts. In order to restore it to the calibration state, the following processing can be performed. (1) Drying: Keep it at 80-85 ℃ and <5% RH humidity for 10 hours; (2) Rehydration: Keep it at C3-C3 ℃ and >75% RH humidity for 24 hours.

1.3 Temperature Effect

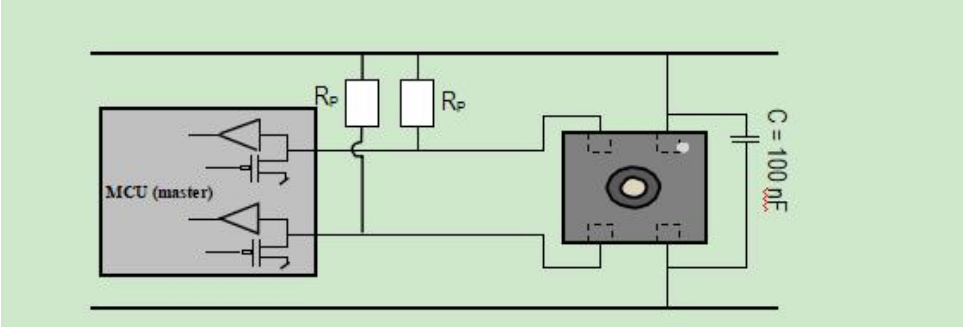
Temperature affects the relative humidity of the environment. Therefore, in the process of measuring the same humidity, the temperature of all sensors should be the same. Secondly, during the test, the temperature of the sensor being tested should be the same as the temperature of the reference sensor.

On the same printed circuit board, in order to minimize the influence of heat transfer, the sensor should be isolated from electronic components that are prone to heat as much as possible.

Too high a measurement frequency will also affect the measurement accuracy, because the temperature of the sensor itself will increase as the measurement frequency increases. If you want to ensure that its own temperature rise is below 0.1°C, the activation time of WHT C3 should not exceed 10% of the measurement time. It is recommended to measure the data every 2 seconds.

1.4 Typical application circuit

In order to improve the stability of the system, one of the following power control solutions is provided:



1.5 Materials for Sealing and Encapsulation

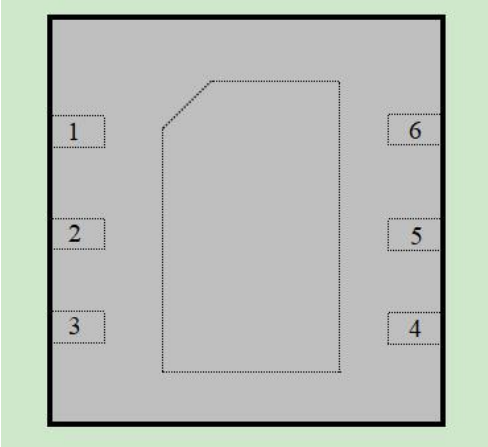
In order to avoid the increase in response time and hysteresis caused by the moisture absorption of the surrounding materials, the following materials are recommended: metal materials, LCP, POM (Delrin), PEEK, PVDF, PTFE (Teflon), PP, PB, PPS, PSU , PE, PVF.

When encapsulating electronic components, a method filled with epoxy resin or silicone resin can be used. However, the gas released by the packaging material may cause WHTC3 to be contaminated. Therefore, the final assembly of the sensor should be done in a well-ventilated place, and the contaminated gas can also be released before packaging.

1.6 Wiring rules

To avoid signal crosstalk and communication failure caused by wiring, do not place SCL and SDA signal lines in parallel or very close to each other. The solution is to place VDD and/or GND between the SCL and SDA signal lines, or use shielded cables.

2. Interface Definition



PIN	Name	Definition
VDD	1	Power port; input
SCL	3	Clock port; input/output
SDA	4	Data port; input/output
GND	6	Power ground
NC	2,5	Remain suspended

Table 4 WHTC3 pin-out (top view)

3. Electrical Characteristics

3.1 Absolute Maximum Ratings

The absolute maximum ratings of WHTC3 are shown in Table 5. In addition, Table 5 also provides information such as pin input current. If the test condition exceeds the nominal limit index, the sensor needs to add an additional protection circuit.

Table 5 Electrical absolute maximum ratings

参数	额定值	单位
Power voltage VDD	-0.3 to 6	V
Operating temperature range	-40 to 125	℃
Storage temperature range	-40 to 125	℃
ESD HBM (human body model)	-8 to 8	kV
ESD CDM (charge device model)	-500 to 500	V

3.2 I2C interface timing

Table 7 I²C Timing characteristics of fast mode digital input/output terminals

Parameter	Mark	Condition	Standard mode		Fast mode		Faster mode		Unit
			Min	Typ.	Min	Typ.	Min	Typ.	
SCL Clock frequency	f_{SCL}	-	0	100	0	400	0	1000	kHz
Hold time of start signal	$t_{HD;STA}$	After the hold time, the first SCL clock starts to be generated	4.0	-	0.6	-	0.26	-	μs
SCL low level duration	t_{LOW}	-	4.7	-	1.3	-	0.5	-	μs
SCL high level duration SCL	t_{HIGH}	-	4.0	-	0.6	-	0.26	-	μs
Start signal establishment time	$t_{SU;STA}$	-	4.7	-	0.6	-	0.26	-	μs
SDA Hold time	$t_{HD;DAT}$	-	0	-	0	-	0	-	μs
SDA Establishment time	$t_{SU;DAT}$	-	250	-	100	-	50	-	ns
SCL/SDA Rise Time	t_R	-	-	1000	20	300	-	120	ns
SCL/SDA Fall time	t_F	-	-	300	20 x (V_{DD} / 5.5V)	300	20 x (V_{DD} / 5.5V	120	ns
SDA Effective time	$t_{VD;DAT}$	-	-	3.45	-	0.9	-	0.45	μs
Termination signal establishment time	$t_{SU;STO}$	-	4.0	-	0.6	-	0.26	-	μs
Bus load capacitance	C_B	-	-	400	-	400	-	550	pF

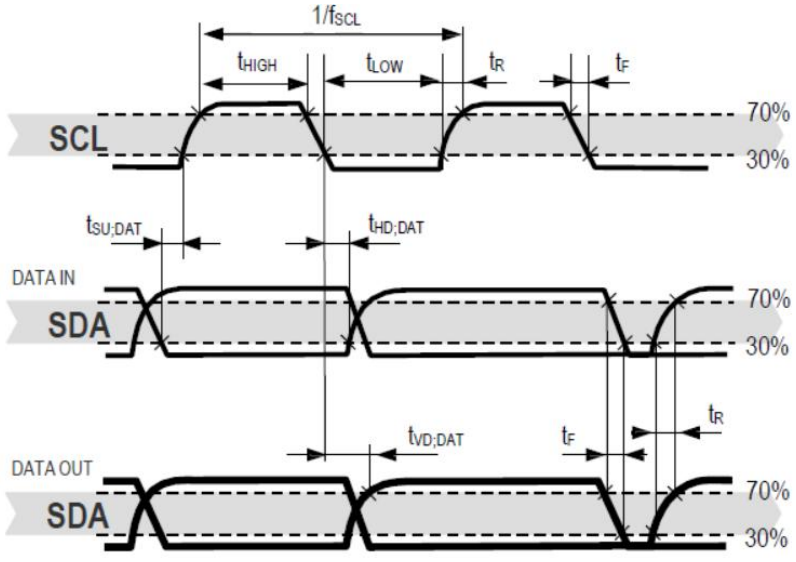


Figure 10 Timing diagram of input and output pad. The SDA direction is based on the sensor chip end. The bold SDA is controlled by the sensor, and the ordinary SDA line is controlled by the host computer.

4. Sensor communication

WHT C3 communicates as a slave of the I2C bus interface.

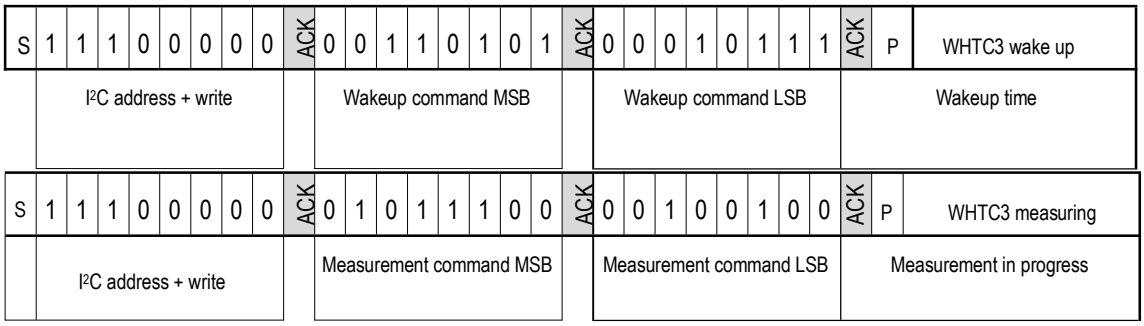
4.1 Power on and communication

When the power supply voltage exceeds VPOR, the sensor starts to enter the initialization process of the power-on process, at least it needs to wait for tPU. to complete the power-on initialization process and enter the idle state. Once entering the idle state, the chip can receive commands and data from the host computer.

4.2 Sensor reading process

For temperature and humidity measurement, you need to send a start signal first, and then send an I2C write operation header. After the sensor receives each byte of data sent by the host computer, it will give an ACK signal by pulling the SDA bus to a low level. Each measurement process includes four modes, which are wake-up mode, measurement mode, read mode, and sleep state. Each state starts with start and ends with stop.

Trigger measurement data



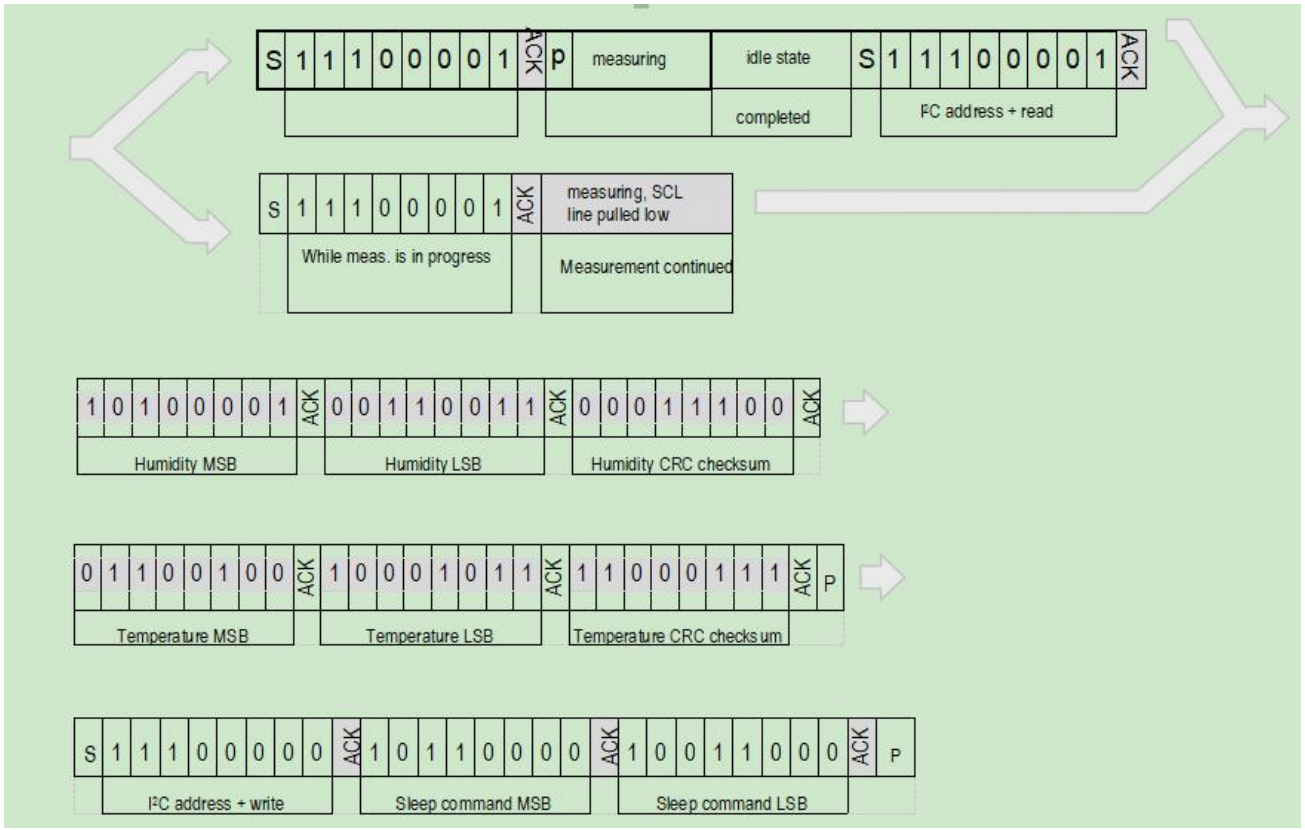


Table 10 Sensor program command description The first SCL idle time period means waiting at least 1ms.

5 Signal Conversion

5.1 Relative humidity conversion

The relative humidity RH can be calculated according to the relative humidity signal SRH output by SDA through the following formula (the result is expressed in% RH).

$$RH[\%]=(\frac{S_{RH}}{2^{20}})\times 100\%$$

5.2 Temperature conversion

The temperature T can be calculated by substituting the temperature output signal ST into the following formula (the result is expressed in temperature ℃).

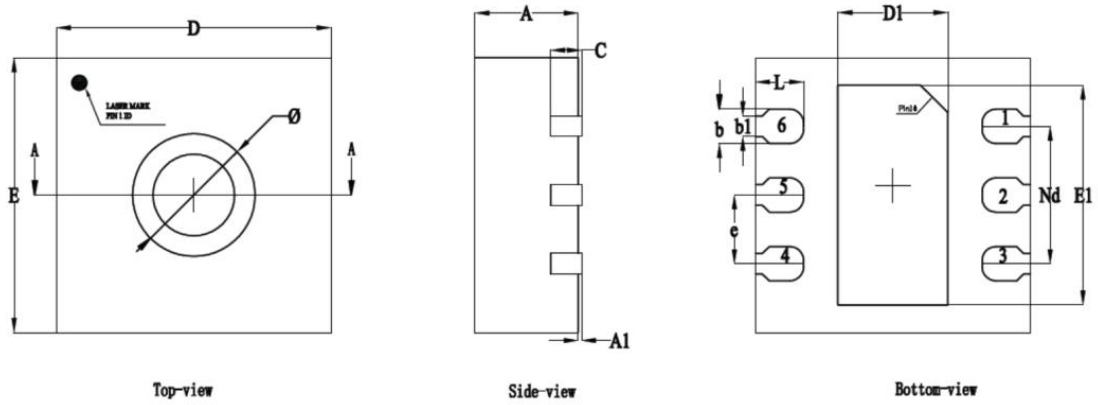
$$T[℃]=(\frac{S_T}{2^{20}})\times 300-50$$

6 Environmental stability

When the sensor is used in equipment or machinery, it is necessary to place the sensor and the reference sensor under the same temperature and humidity conditions. In order to prevent errors caused by insufficient test time, when the sensor is placed in equipment or machinery, it is necessary to program design to ensure sufficient measurement time.

7 packaging

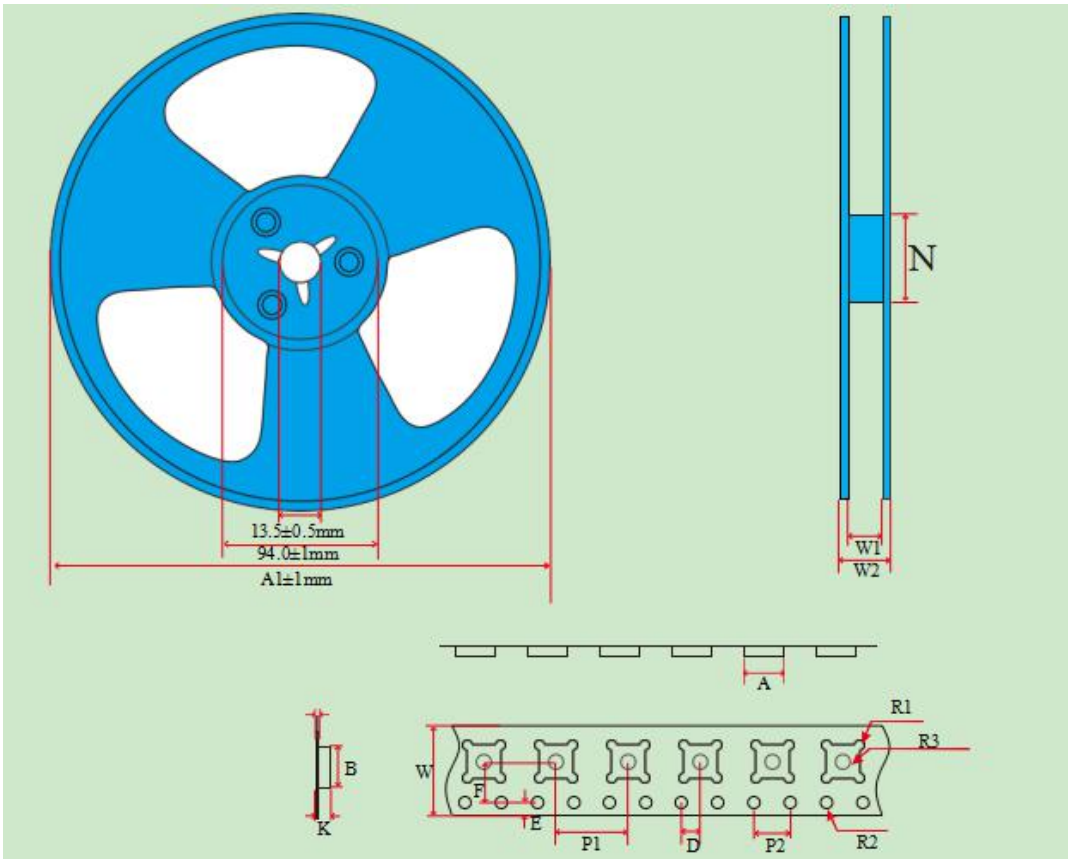
WHTC3 adopts double-sided no-lead flat package. The sensor chip is made of Ni/Au-plated copper lead frame. The weight of the sensor is about 19 mg, and the specific dimensions of the sensor are shown in Figure 12.



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	—	0.02	0.05
b	0.20	0.25	0.30
b1	—	0.15	—
L	0.30	0.35	0.40
c	0.203 REF		
D	1.90	2.00	2.10
E	1.90	2.00	2.10
D1	0.60	0.70	0.80
E1	1.50	1.60	1.70
Nd	1.0 BSC		
e	0.50 BSC		
Ø	0.70	0.80	0.90
h	—	0.29	—

Figure 12 WHT C3 sensor package diagram (unit: mm tolerance: ±0.1 mm)

WHTC3 is packaged in tape and reel and sealed in an antistatic ESD bag. The standard packaging size is 5000 pieces per roll. For WHTC3 packaging, the 440 mm (55 sensor capacity) and the first 3000 mm (C3 sensor capacity) part of each reel is empty. The packaging diagram with sensor positioning is shown in Figure 13. The reel is placed in an anti-static bag.



Model	A1	E	W1	W2	N
reel	233/3C3	2	12	16	100

Model	Unit	Tolerance	Quantity	Weight
reel	mm	±0.5	5000(AMX)	500/g

Model	A/B	K	W	R2/R3	R1
Taping	$3.30^{+0.1}_{-0.0}$	$1.2^{+0.01}_{-0.0}$	12.5±0.3	$1.50^{+0.01}_{-0.0}$	$0.50^{+0.01}_{-0.0}$

Model	P1	P2	I	F	E	D
Taping	8.25±0.1	4.25±0.1	0.4±0.05	5.5±0.1	1.8±0.1	2.0±0.1

Figure 13 Packaging tape and sensor positioning diagram

8 Tracking information

All WHTC3 sensors have laser markings on the surface. See Figure 14. There are labels on the reels, as shown in Figure 15, and other tracking information is provided.

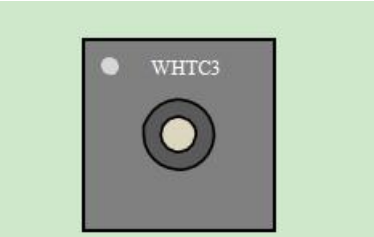


Figure 14 Sensor laser marking

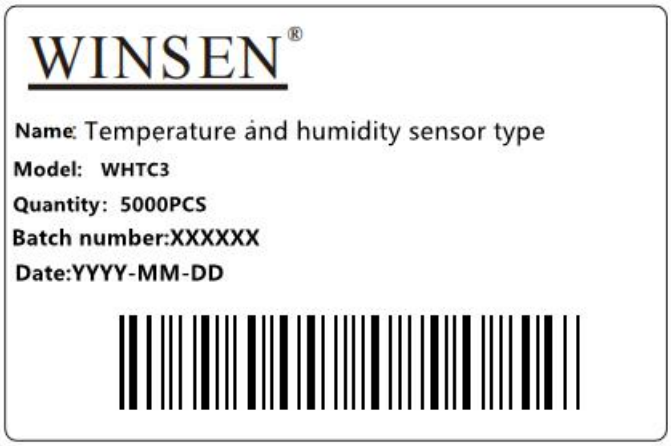


Figure 15 The label on the reel

Precautions

Warning, personal injury

Do not use this product in safety protection devices or emergency stop equipment, and any other applications that may cause personal injury due to product failure. Do not use this product unless there is a special purpose or use authorization. Refer to the product data sheet and application guide before installing, handling, using or maintaining the product. Failure to follow this recommendation may result in death and serious personal injury.

If the buyer intends to purchase or use Winsen ' s products without obtaining any application licenses and authorizations, the buyer will bear all compensation for personal injury and death arising therefrom, and exempt the managers and employees of Weisheng Company and its affiliated subsidiaries. , Agents, distributors, etc. may incur any claims, including: various costs, compensation fees, attorney fees, etc.

ESD protection

Due to the inherent design of the component, it is sensitive to static electricity. In order to prevent the damage caused by static electricity or reduce the performance of the product, please take necessary anti-static measures when using this product.

Quality Assurance

The company provides a 12-month (1 year) quality assurance (calculated from the date of shipment) to direct purchasers of its products, based on the technical specifications in the product data manual published by Weisheng. If the product is proved to be defective during the warranty period, the company will provide free repair or replacement. The user needs to meet the following conditions:

1. The product shall be notified to the company in writing within 14 days after the defect is discovered;
2. The product defect will help to find the company's design, material, and workmanship deficiencies;
3. The product should be purchased by the purchaser Pay and send it back to our company;

4. The product should be within the warranty period.

The company is only responsible for those products that are used in the occasions that meet the technical conditions of the product and produce defects. The company does not make any guarantees, guarantees or written statements about the application of its products in those special applications. At the same time, the company does not make any promises regarding the reliability of its products when applied to products or circuits.

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