MEMS type Temperature and Humidity Sensor

(Model: WHT30)

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

WHT30 MEMS type Temperature and Humidity Sensor

Overview

The WHT30 humidity sensor is filled in a double-row flat lead-free SMD package, temperature and humidity signals can be read out on different pins, bottom side 2.5×2.5 mm, height 1.0 mm. The sensor outputs a standard digital signal,Standard I2C format.

WHT30 humidity sensor, contains a newly designed ASIC dedicated chip built-inTransistor Vbe temperature characteristics, actual high temperature temperature detection;Humidity-capacitating chip, in which the humidity-sensitive material introduces electric constant after absorbing moisture to detect the humidity in the real environment Measurement. A dual-chip solution combined with the latest integrated circuit signal processing technology case. It has the advantages of small size, low performance, high reliability, and good compatibility.

Features

High accuracy ±3.0% RH and ±0.5℃

Wide power supply voltage range, from 2.0V to 5.5V

SMD package suitable for reflow soldering

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 etc ;

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

Stable1. humidity characteristic

Parameter	Condition	Min	Typical	Max	Unit
Resolution	Typical		0.01		%RH
Accuracy error[1]	Typical		±3.0		%RH
	Max	See figure 1			%RH
Repeatability			±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		<0.5		%RH/yr

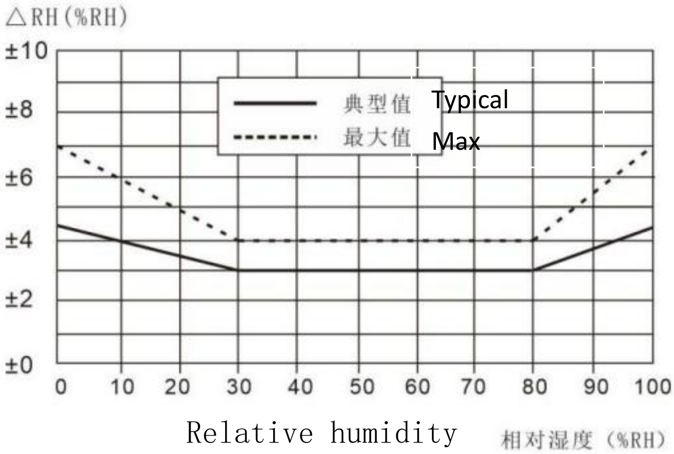


Figure 1 Maximum error of relative humidity at 25°C

Technical parameters of temperature

Parameter	Condition	Min	Typical	Max	Unit
Resolution	Typical		0.01		°C
Accuracy error	Typical		±0.5		°C
	Max	See figure 2			°C
Repeatability			±0.1		°C
Hysteresis			±0.1		°C
Response time[5]	$t_{63\%}$	5		30	s
Scope of work	extended[3]	-40		85	°C
Prolonged Drift			<0.04		°C/yr

stable2. temperature characteristic

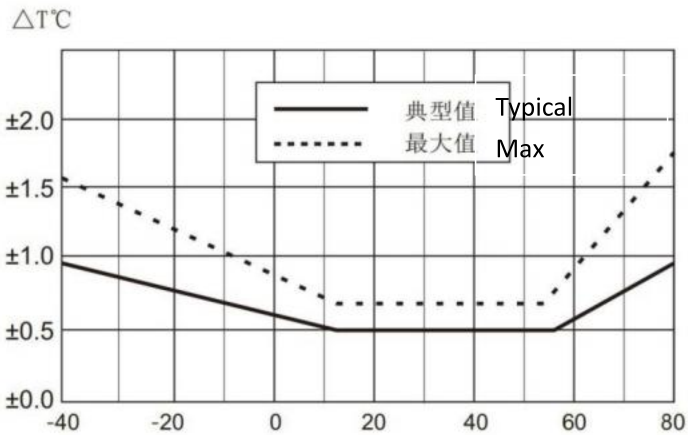


Figure 2 Temperature typical error and maximum error

Suggested working environment

The recommended temperature and humidity range of this sensor is 5~60℃ and 20~80% 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.

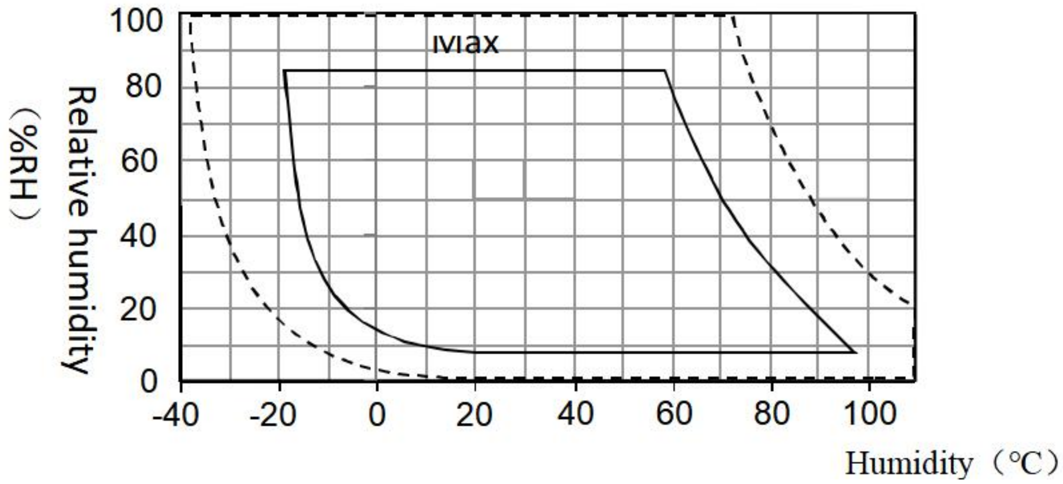


Figure 3 Working scope

RH accuracy at different temperatures

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

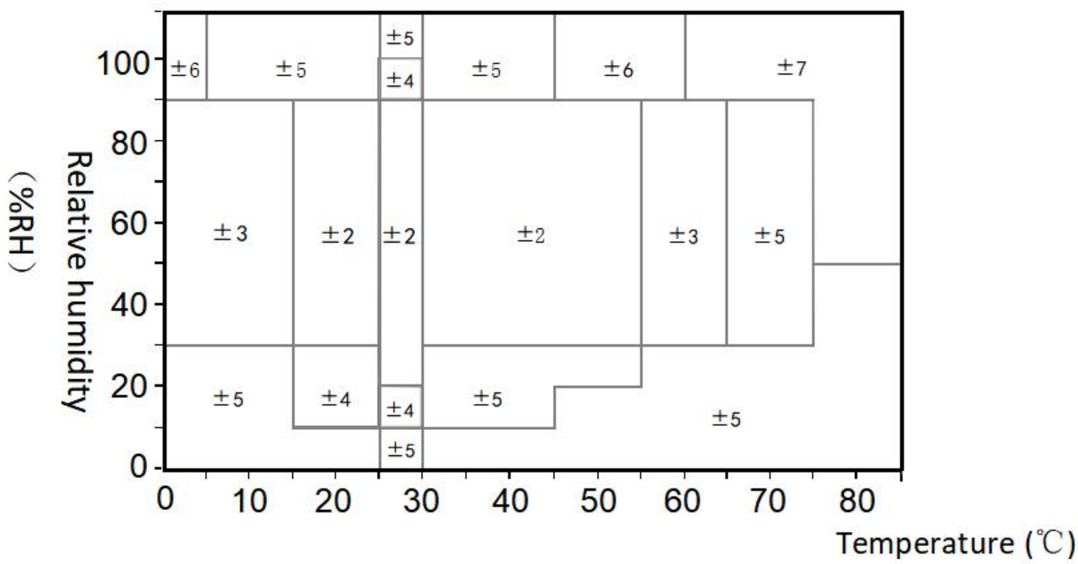


Figure 4 The maximum error of the corresponding humidity in the range of 0-80℃

Electrical specifications (Table 3)

Parameter	Condition	Min	Typical	Max	Unit
Voltage	Typical	2.0	3.3	5.5	V
Current, IDD[6]	Dormant	-	0.2	2.0	µA
	Measure		-	6	µA
Power consumption	Dormant	-		11	µW
	Measure			33	µW
	Average	-	8.25	-	µW
Communication	Dual-line digital interface, standard I^2C protocol				

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.

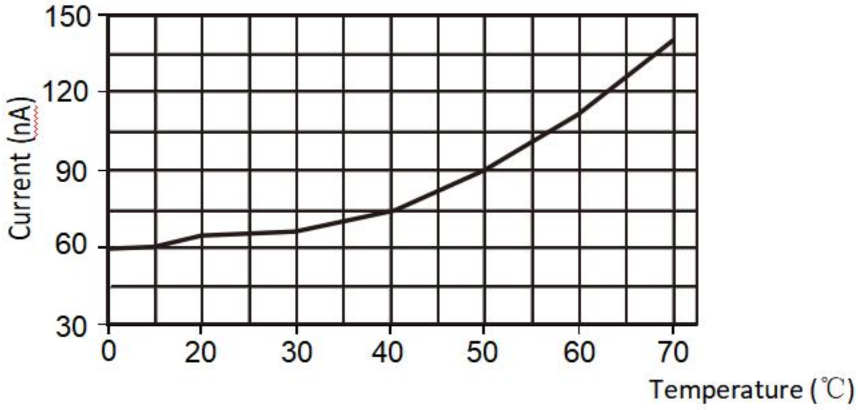


Fig. 5 Typical supply current vs. temperature curve (sleep mode) when VDD=3.3V. There is a deviation of approximately ±25% between these data and the displayed value.

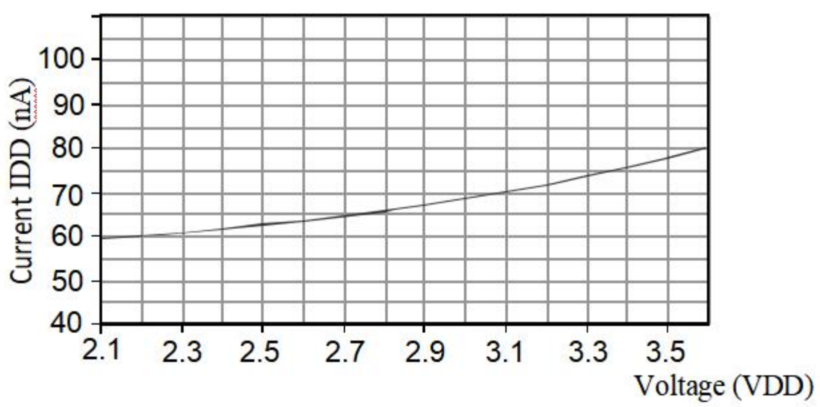


Figure 6 Typical supply current vs. supply voltage curve (sleep mode) at a temperature of 25 ℃. Note: The deviation between these data and the displayed value may reach ±50% of the displayed value. At 60 ℃, the coefficient is approximately 15 (compared to Table 3).

Package information

Part no.	Package	Quantity
WHT 30	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 200 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 get higher and speed up the drifting.
5. The response time depends on the thermal conductivity of the sensor substrate.
6. 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.

WHT30 Temperature and Humidity Sensor Application Information Guide

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. it is recommended to store the sensor in the original packaging including a sealed ESD bag, and meet the following conditions: temperature range 10℃-50℃ (within a limited time 0-85℃); humidity 20-60%RH (without ESD package sensor). For those sensors that have been removed from the original packaging, we recommend storing them in an anti-static bag made of PET/AL/CPE containing metal.

1.2 Recovery Processing

As mentioned above, the readings can drift if the sensor is exposed to extreme operating conditions or chemical vapors. It can be restored to the calibration state by the following processing. (1) Drying: Keep it at 80-85 ℃ and <5% RH humidity for 10 hours; (2) Re-hydration: Keep it at 20-30 ℃ and >75% RH humidity for 24 hours.

1.3 Temperature Effect

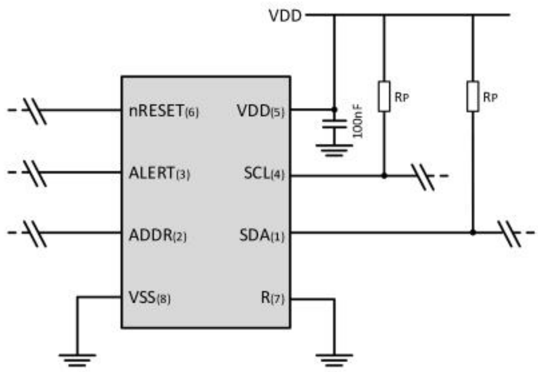
The relative humidity of gases depends largely on temperature. Therefore, when measuring humidity, all sensors measuring the same humidity should work at the same temperature as possible. When testing, it is necessary to ensure that the same temperature, and then compare the humidity readings.

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

High measurement frequency will also affect the measurement accuracy, because the temperature of the sensor itself will increase as the measurement frequency increases. To ensure that its own temperature rise is below 0.1°C, the activation time of WHT 20 should not exceed 10% of the measurement time. It is recommended to measure the data every 2 seconds.

1.4 Product application scenario design

In order to improve the stability of the system, the following power supply controllable scheme is provided:



Pic 7.Typical Application Circuit

1.5 Materials for Sealing and Encapsulation

To avoid the response time and hysteresis increase 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.
It is recommended to use epoxy resin to encapsulate electronic components, or silicone resin. However, the gas released by the packaging material may also contaminate WHT20 sensor. 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.

1.7 Signal integrity

Reducing SCL frequency may also improve the integrity of signal transmission. A 100nF decoupling capacitor should be added between the power supply pins (VDD, GND) for filtering.

1.8 Device function mode

WHT30 has two operating modes: sleep mode and measurement mode. After power-on, WHT30 enters sleep mode. In this mode, WHT30 waits for the I2C input configuration conversion time, reads the battery status, triggers the measurement, and reads the measured value. After completing the measurement, WHT30 returns to sleep mode.

1.9 Welding instructions

SMD I/O pads are made of copper lead frame plane substrates, except these pads are exposed and are used for mechanical and circuit connections. For use, both I/O pads and bare pads need to be soldered to the PCB. To prevent oxidation and optimize welding, the solder joints at the bottom of the sensor are coated with Ni/Au.
On the PCB, the length of the I/O contact surface should be 0.2-0.3mm larger than the sensor's I/O sealing pad, and the width should be 0.1-0.2mm larger than the sealing pad. The part near the inner side should match the shape of the I/O pad, and the ratio of the pin width to the SMD sealing pad width should be 1:1, as shown in Figure 8.
For mesh and solder layer designs, it is recommended to use copper foil defined pads (SMD) with openings in the solder layer larger than the metal pads. For SMD pads, if the gap between the copper foil pads and the solder resistance layer is 60μm-75μm, the size of the solder resistance layer opening should be greater than the size of the pad 120μm-150μm. The square portion of the sealing pad shall match the corresponding square solder mask opening to ensure that there is sufficient solder mask area (especially at the corners) to prevent solder intersecting. Each pad shall have its own solder layer opening to form a network of solder layers around adjacent pads.

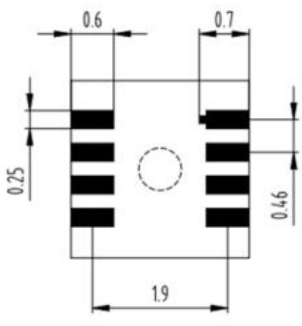


Figure 8: Recommend WHT 30 PCB design size (unit: mm) Top view

For solder printing, laser cutting stainless steel mesh with electronic polishing trapezoidal wall is recommended, with recommended thickness of 0.125 mm. The steel mesh size of the pad should be 0.1 mm longer than PCB pad and placed 0.1 mm away from the packaging center. Steel mesh with bare pads must cover 70% - 90% of the pad area.
Due to the low SMD mounting, it is recommended to use no-cleaning type3 solders tin and to purify it with nitrogen during reflux.
Sensor can be welded through standard reflow furnace. The sensor fully meets the IPC/JEDEC J-STD-020D welding standard. The best temperature for reflow soldering is lower than 200 ℃,the ultimate welding temperature that the sensor can withstand is 260℃, and the contact time should be less than 30 seconds at the highest 260℃ (see Fig. 9). It is recommended to use low temperature 180℃ when reflow soldering.

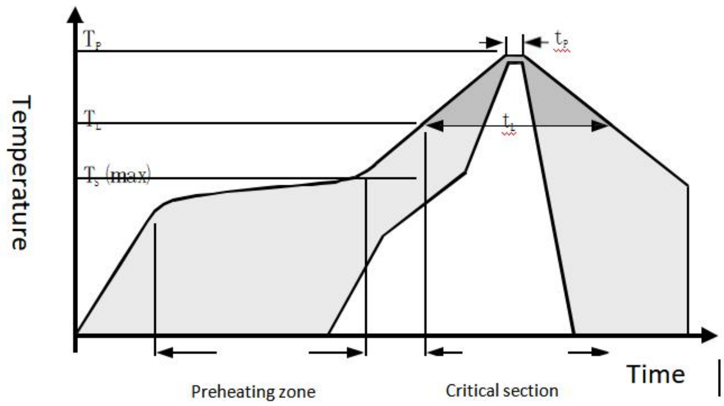
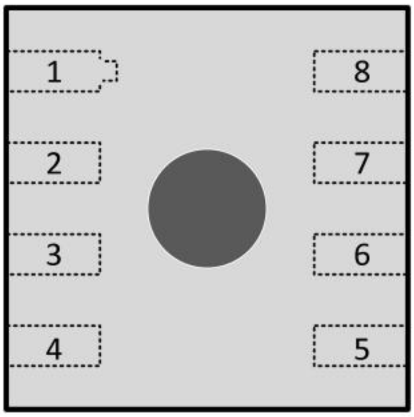


Figure 9: JEDEC standard welding process diagram, Tp<=260 ℃, tp<30 sec, lead-free soldering. TL<220 ℃, tl<150 sec, the temperature rise and fall speed during welding should be <5 ℃ /sec.

Note: After reflow soldering, the sensor should be stored in an environment of >75% RH for at least 24 hours to ensure the rehydration of the polymer. Otherwise, it will lead to sensor reading drift. The sensor can also be placed in a natural environment (>40% RH) for more than 5 days to rehydrate it. Using low temperature reflow soldering (for example: 180 ℃) can reduce the hydration time.
It is not allowed to rinse the circuit board after soldering. Therefore, it is recommended to use "no-clean" solder paste. If the sensor is used in corrosive gas or condensed water is generated (such as: high humidity environment), both the lead pad and PCB need to be sealed (such as: use conformal coating) to avoid poor contact or short circuit.

Interface Definition

Table 4 WHT30 pin-out (top view)

PIN	Name	Definition	
1	SDA	serial data line	
2	ADDR	Address, the low level address is 0x44, Connect to high level address is 0x45, not Can be suspended	
3	NC	Remain suspended	
4	SCL	serial clock line	
5	VDD	Power	
6	nRESET	Reset port, active low, not used When the pin is floating	
7	R	No electrical characteristics, grounded	
8	VSS	Ground	

Electrical Characteristics

Absolute Maximum Ratings

The absolute maximum ratings of WHT30 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

Parameter	Min	Max	Unit
VDD to GND	-0.3	5.5	V
Digital I/O Pins (SDA,SCL) to GND	-0.3	VDD+0.3	V
Input current per pin	-10	10	mA

Note: Long-term exposure to absolute maximum ratings may affect the reliability of the sensor.

I2C interface voltage

Electrical characteristics, such as power consumption, high and low voltages of input and output, etc., depend on the power supply voltage.

Table 6 DC characteristics of digital input and output pads, if there is no special statement, VDD=2.0 V to 5.5 V, T =-40 ℃ to 85℃

Parameter		Condition	Min	Typ.	Max	Unit
Low output voltage	VOL	VDD = 3.3 V Reverse current 3mA	0	-	0.4	V
High output voltage	VOH		0.7VDD	-	VDD	V
Output sink current	IOL		-	-	-4	mA
Low output voltage	VIL		0	-	0.3VDD	V
High output voltage	VIH		0.7VDD	-	VDD	V
Input current		VDD = 5.5 V,VIN = 0 V to 5.5 V	-	-	±1	uA

I2C interface timing

Table 7 Timing characteristics of I^2C fast mode digital input/output terminals

Parameter		I2C Standard		I2C Fast		Unit
		MIN	MAX	MIN	MAX	
SCL Frequency	f_{SCL}	0	100	0	400	kHz
SCL clock low level (width)	t_{LOW}	4.7		1.3		µs
SCL clock high level (width)	t_{HIGH}	4.0		0.6		µs
When start (restart), SDA is pulled low and SCL is high.Duration	$t_{HD;STA}$	4.0		0.6		µs
From the time when SCL is pulled low to when the SDA data changes Interval	$t_{HD;DAT}$	5.0				µs
The time from when the SDA data is stable to when the SCL is pulled high every other	$t_{SU;DAT}$	250		100 (2)		µs
When SDA is pulled low before restarting, when the high level of SCL is held between	$t_{SU;STA}$	4.7		0.6		µs
The time interval from SCL high to SDA high during stop	$t_{SU;STO}$	4.0		0.6		µs
The interval between start and stop	t_{BUF}	4.7		1.3		µs
Time required for SCL/SDA rising edge	tr	--	1000	20+0.1Cb (3)		µs
Time required for SCL/SDA falling edge	tr	2.5	300	20+0.1Cb (3)		µs

Notes:

1. All values are based on VIHmin and VILmax.
2. Fast device mode I^2C devices can work in standard mode, but the requirement of tSU;DAT=250ns

must be met.

3. Cb = total capacitance of the I²C bus.

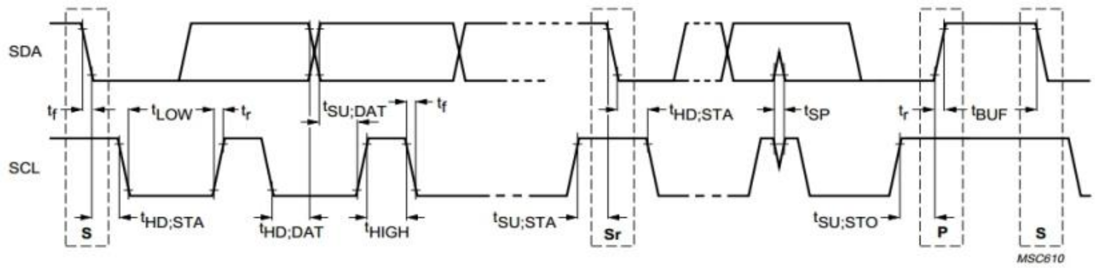


Figure 10 IIC Timing Parameters

Sensor Communication

WHT30 supports I²C Fast Mode (frequency up to 400 kHz). The clock can be enabled and disabled by the corresponding user commands to stretch

Start/Stop Sequence

After power-up, the sensor takes 2ms to enter the idle state. Once in the idle state, the master device (microcontroller) can receive command. Each transfer sequence begins with a START condition (S) and ends with a STOP condition (P), as in the I²C-bus specification mentioned. Whenever the sensor is powered but not performing measurements or communicating, it automatically goes into an idle state to save energy. Should The idle state cannot be controlled by the user.

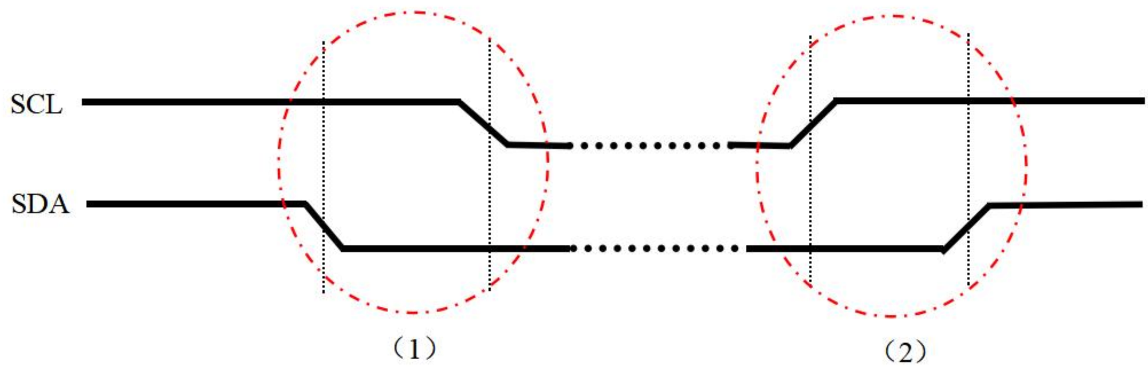


Figure 11 Start transmission state (S) and stop transmission state (P)

Start measuring

Measurement communication sequence includes START condition, I²C write header (7-bit I²C device address plus 0 as write bit) and 16-bit measurement command make. The sensor acknowledgment indicates correct reception of each byte. It pulls the SDA pin low after the falling edge of the 8th SCL clock (ACK bit) to indicate reception. By confirming the measurement command, the sensor starts measuring temperature and humidity. In addition, measuring repeatability and the single/continuous measurement mode is set by the corresponding control bit in the configuration register.

Table 8.Configuration Register Details

reset value	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
0X00	Reserved	Reserved	Clk_stretch	Mps2	Mps1	Mps0	Repeatbility1	RepeatbilIty0
describe	Reserved value, cannot be changed		IIC interface clock Stretch enable: 0: pull not allowed stretch 1: allow stretching	Period measurement frequency configuration MPS (Note 1) 000: single 001: 0.5 times per second 010: 1 time per second 011: 2 times per second 100: 4 times per second 101: 10 times per second			100: 4 times per second 101: 10 times per second Repeatability setting: (Note 2) 00: low repeatability 01: Medium repeatability 10: High repeatability	

Note:

1.The default cycle measurement configuration is a single measurement, and the measurement frequency can be configured according to the needs. The fastest is about 133 times/second under low repeatability, the fastest is about 111 times/second under medium repeatability, and the fastest is about 111 times/second under high repeatability.

Under renaturation, the fastest is about 70 times/second.

2.Repeatability and conversion time are a direct trade-off relationship, the higher the repeatability, the longer the conversion time; the lower the repeatability, the shorter the conversion time.

Sensor reading process

1. Wait for 20 ms after power-on, before measuring the temperature and humidity value, the user can configure the repetition by setting the configuration register command characteristics, period measurement frequency, and clock stretching enable. Send 0x5206 (set configuration register), this command has three bytes,The first byte is the value of the configuration register to be set, the second byte is 0xFF, and the third byte is the CRC check of the first two bytes test.

2.Send 0x2C10 (trigger measurement), after the command is sent, the sensor starts to measure temperature and humidity

3.Wait for 20ms to complete the measurement, and directly read the 6-byte temperature and humidity data (you can read it by sending 0x89)

4.Calculate temperature and humidity

Note: The operation of setting the configuration register in the first step only needs to be configured once after power-on, and there is no need to repeat the configuration during the normal acquisition process

Set configuration register

Start	I²C address + write								ACK	write register 0x52								ACK	Register address 0x06								ACK	set value								ACK
S	1	0	0	0	1	0	0	0		0	1	0	1	0	0	1	0		0	0	0	0	0	1	1	0		x	x	x	x	x	x	x	x	

0xFF								ACK	CRC data								ACK	Stop
1	1	1	1	1	1	1	1		x	x	x	x	x	x	x	x		P

Start	I²C address + write								ACK	trigger measurement 0x2C								ACK	trigger measurement 0x10								ACK	Stop
S	1	0	0	0	1	0	0	0		0	0	1	0	1	1	0	0		0	0	0	1	0	0	0	0		P

Read temperature and humidity data

Start	I²C address + read								ACK	temperature low byte								ACK	temperature high byte								ACK	CRC data								ACK
S	1	0	0	0	1	0	0	1		x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	

temperature low byte								ACK	temperature high byte								ACK	CRC data								NAK	Stop
x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x		P

Table 9 Description of sensor program commands

	Master to master
ACK	Master response ACK
ACK	Master response ACK
NAK	Master response NAK
S	Start
P	Stop

Signal conversion

Relative humidity conversion

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

$$\mathrm{RH}[\%] = 100 + \frac{S_{RH}}{2^{16} - 1}$$

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 ℃).

$$T[°C] = 40 + \frac{S_T}{256}$$

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, ensure that sufficient measurement time is reserved in the program design.

Package

WHT30 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.

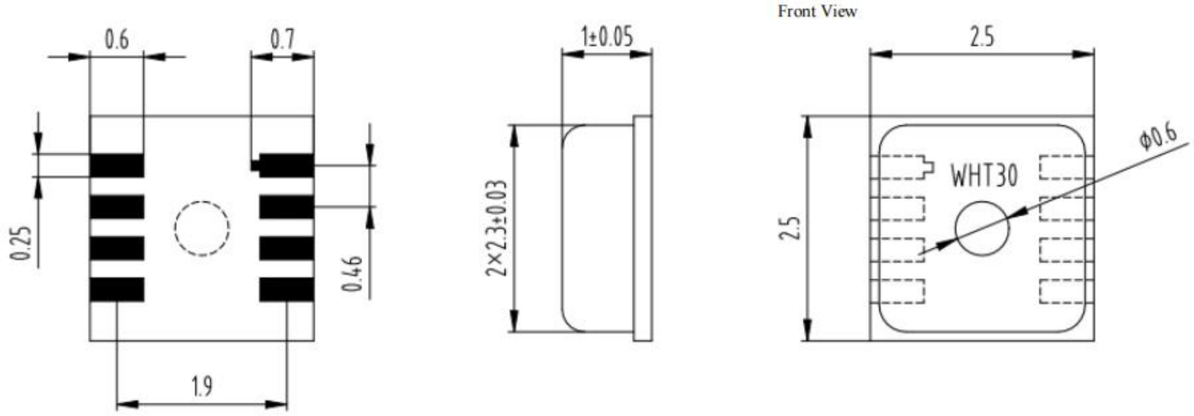


Figure 12 WHT30 sensor package diagram (unit: mm tolerance: ±0.1 mm)

WHT30 is packaged in tape and reel, sealed in an anti-static ESD bag. The standard packaging size is 5000 pieces per roll. For WHT30 packaging, the rear 400 mm (50 pcs sensors capacity) and front 200 mm (25 pcs sensors capacity) parts of each reel are empty.

The packaging diagram with sensor positioning is shown in Figure 13. The reel is placed in an anti-static bag.

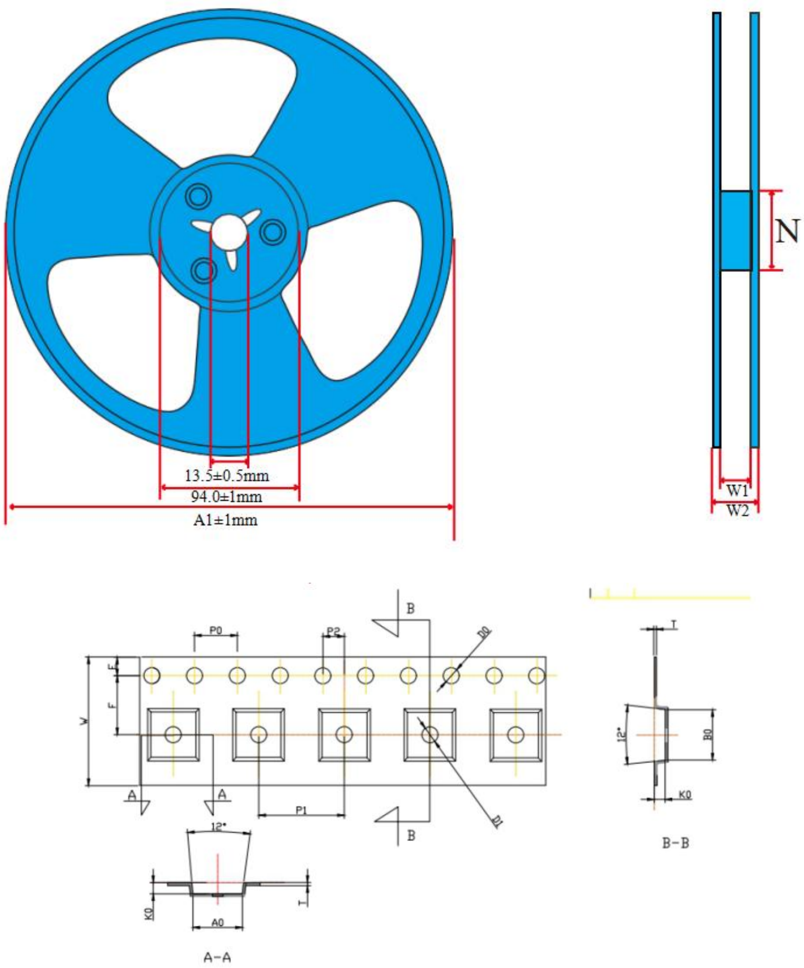


Fig13.Packaging tape and sensor location diagram

Model	A1	E	W1	W2	N
Scroll	330	2	12.5	16.7	100

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

Model	A0	B0	K0	P0	P1	P2
tape	3.23±0.1	3.23±0.1	1.05±0.1	4±0.1	8±0.1	2±0.1

Model	W	T	F	E	D0	D1
tape	12±0.3	0.2±0.05	5.5±0.1	1.75±0.1	Φ15±0.05	Φ15±0.05

Tracking information

All WHT30 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 154 Sensor laser marking

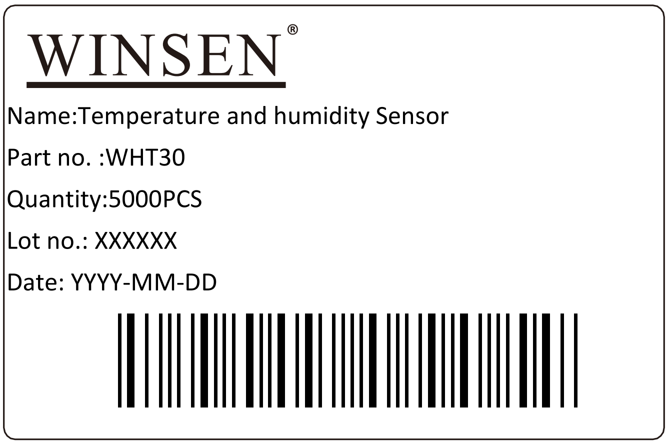


Figure 15 The label on the reel

Important notice

Warning, Personal Injury

Do not apply this product to safety protection devices or emergency stop equipment, and any other applications that may cause personal injury due to the product's 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.

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 guarantee (calculated from the date of shipment) to direct purchasers of its products, based on the technical specifications in the product data manual published by Winsen. If the product is proved to be defective during the warranty period, the company will provide free repair or replacement. Users need to satisfy the following conditions:

1. Notify our company in writing within 14 days after the defect is found.
2. The defect of this product will help to find out the deficiency in design, material and technology of our product.
3. The product should be sent back to our company at the buyer's expense.
4. The product should be within the warranty period.

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