Datasheet AHT30

Temperature and Humidity Sensor

- Fully calibrated
- Digital output, I²C interface
- Excellent long-term stability
- Quick response, strong anti-interference ability
- Wide voltage support 2.2-5.5 VDC

Product Summary

AHT30 is a new temperature and humidity sensor with the advantages of low power consumption and high precision. It is embedded in a dual row flat no-lead SMD package suitable for reflow soldering. It has a strong shell and very small size, can be easily integrated into various design with high reliability.

AHT30 is equipped with a new optimized ASIC dedicated chip, an improved MEMS semiconductor capacitive humidity sensing element and a standard on-chip temperature sensing element, its performance has been significantly improved, even in harsh environments it can maintain stable performance.

AHT30 temperature and humidity sensor can save power consumption, it's very cost-effective.

Applications

Widely used in smart home, consumer electronics, medical, automotive, industrial, meteorological and other fields, such as home appliances (air conditioners, HVAC, dehumidifiers and refrigerators,etc), test and inspection equipment and other related temperature and humidity detection and control products.

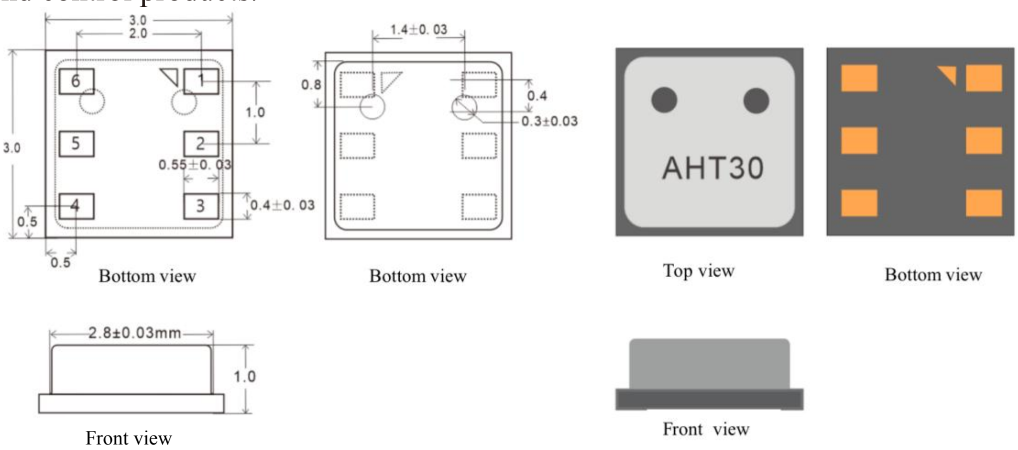


Figure 1: AHT30 temperature and humidity sensor (Unit: mm Tolerance: ±0.1 mm)

Sensor Performance

Relative Humidity

Table 1. Relative Humidity Parameters

Parameters	Status	MIN	TYPICAL	MAX	Unit
Resolution	Typical	-	0.024	-	%RH
Accuracy[1]	Typical	-	±3	-	%RH
	MAX	See Figure 2		-	%RH
Repeatability	-	-	±0.1	-	%RH
Hysteresis	-	-	±1	-	%RH
Non linear	-	-	<0.1	-	%RH
Response time[2]	τ 63%	-	<8	-	s
Measure range	extended[3]	0	-	100	%RH
Long time drift[4]	Normal	-	<1	-	%RH/yr

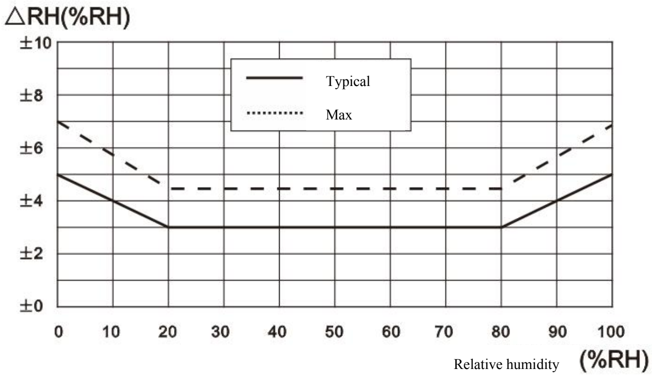


Figure 2. The typical error and Max error of Relative humidity at 25℃

Electric Specification

Table 2. Electric Specification

Parameter	Status	MINI	TYPICAL	MAX	Unit
Power supply	Typical	2.2	3.3	5.5	V
Supply current IDD[4]	Dormant	-	-	0.2	uA
	Measure	-	570	600	µA
Power consumption[5]	Dormant	-	-	0.8	µW
	Measure	-	1.8	1.9	mW
Communication	Two wire digital interface, I^2C protocol				

[1] This accuracy is the test accuracy under clean air condition of 25°C during factory inspection, excluding hysteresis and nonlinearity。

[2] The time required to reach 63% of the first order response at 25°C and 1m/s airflow.

[3] Beyond the 8~85% RH range, please refer to User Guide 1.1 for sensor reading deviation.

[4] The test data is in clean air. If there are volatile solvents, tapes, adhesives and packaging materials with pungent odors around the sensor, this parameter may be too large. For details, refer to the "User's Guide".

Temperature

Table 3. Temperature Parameters

Parameters	Status	MINI	TYPICAL	MAX	Unit
Resolution	Typical	-	0.01	-	℃
Accuracy	Typical	-	±0.5	-	℃
	MAX	See Figure 3			℃
Repeatability	-	-	±0.1	-	℃
Hysteresis	-	-	±0.1	-	℃
Response time[5]	τ63%	5	-	30	s
Measure range	-	-40	-	120	℃
Long time drift	-	-	<0.1	-	℃ /yr

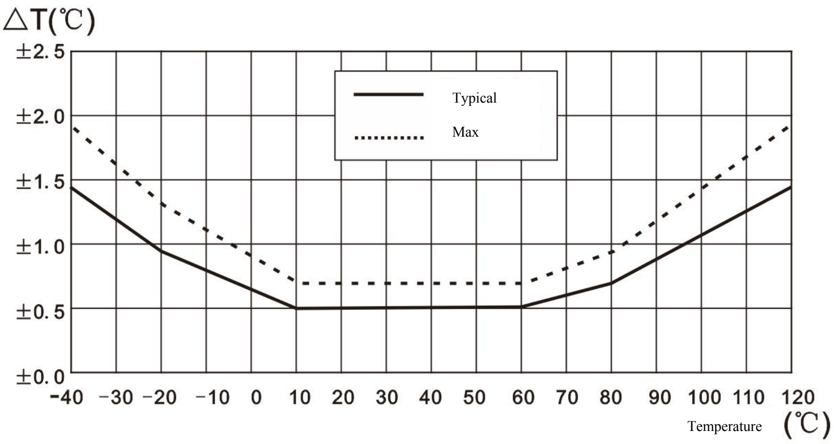


Figure 3. The typical error and Max error of Temperature

Package

Table 4. Package

Model	Package	Quantity
AHT30	Tape package	5000PCS/tape(MAX)

[5] Response time may vary due to the PCB layout and installation.

AHT30 User Guide

1 Performance Expansion

1.1 Work conditions

The sensor works in the recommended "normal range" environment, and its performance is relatively stable (see Figure 4), but if it is exposed to work outside the "normal range" for a long time, especially in high temperature and high humidity (such as being in the environment 85°C/85%RH for more than 12 hours), temporary drift errors may occur, and the errors are generally within the typical accuracy + 3% RH. When returning to the "normal range" region, the sensor will slowly return to the typical accuracy status in Table 1. If you need to speed up the recovery, you can refer to "Recovery Processing" in Section 2.3. Prolonged use outside the "maximum range" area will shorten product life and affect product performance.

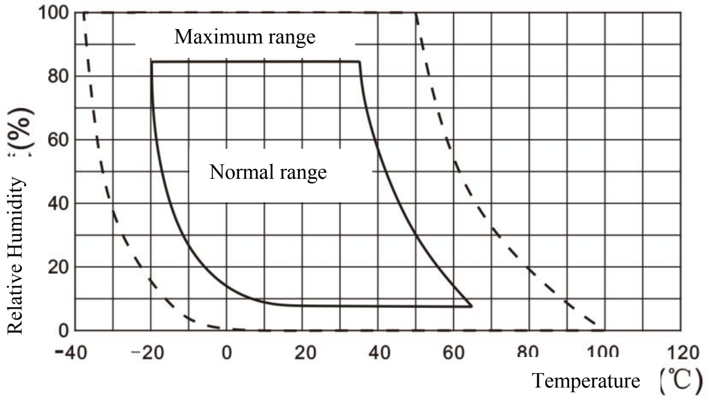


Figure 4. Work conditions

1.2 Relative humidity accuracy in different temperature

Figure 2 shows the relative humidity error at 25°C, and Figure 5 provides the typical errors of relative humidity in other temperature ranges.

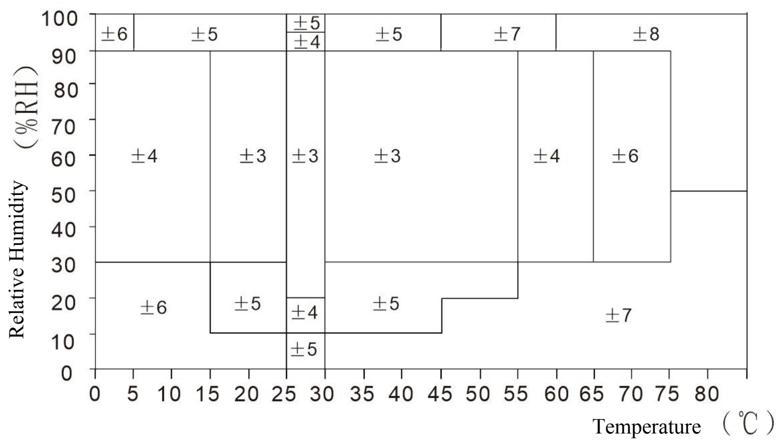


Figure 5. Typical error of relative humidity in the range of 0~80℃ Δ%RH

Please note: the above error is the typical error of relative humidity standard test with chilled mirror precision dew point meter (not including hysteresis).

2 Application Information

2.1 Solder specifications

To prevent oxidation and optimize soldering, the solder joints on the bottom of the sensor are plated with Ni/Au. On the PCB, the length of the I/O[7] contact surface should be 0.2~0.3mm larger than the I/O package pad of the sensor, and the width should be 0.1~0.2mm larger than the package pad, and the inner part should be in line with the I/O pad. Shape matching, the ratio of pin width to SMD package pad width is 1:1, see Figure 8. For stencil and solder mask designs[8], copper foil defined pads (SMD) with solder mask openings larger than metal pads are recommended. For SMD pads, if the gap between the copper foil pad and the solder mask is 60µm~75µm, the opening size of the solder mask should be 120µm~150µm larger than the pad ruler. The square part of the package pad should match the corresponding square solder mask opening to ensure that there is enough solder mask area (especially at the corners) to prevent the solder from meeting. Each pad must have its own solder mask opening, forming a solder mask network around adjacent pads.

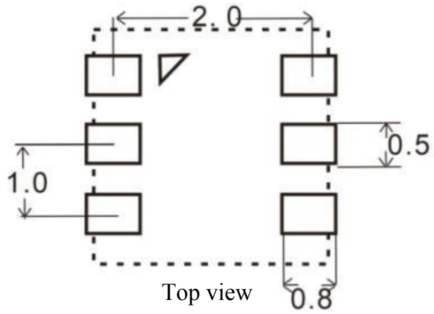


Figure 8 Recommended sensor PCB design dimensions (unit: mm), the outer dashed line part is the external dimension of the SMD package.

For solder printing, it is recommended to use a laser-cut stainless steel mesh with electronically polished trapezoidal walls. The thickness of the steel mesh is recommended to be 0.125mm. For the pad part, the size of the steel mesh must be 0.1mm longer than the PCB pad, and it should be placed away from the center of the package with 0.1mm. The stencil of the exposed pad should cover 70%-90% of the pad area—that is, 1.4mmx2.3mm in the center of the heat dissipation area. Due to the low mounting height of SMD, it is recommended to use no-clean type 3 solder[9,] and purged with nitrogen at reflux.

[7]The contact surface refers to the metal layer on the PCB, where the SMD pads are soldered.
[8]The solder mask refers to the insulating layer on the top layer of the PCB that covers the connecting wires.
[9]The type of solder is related to the size of the particles inside the solder. Type3 is a 25–45 µm powder in the size range.

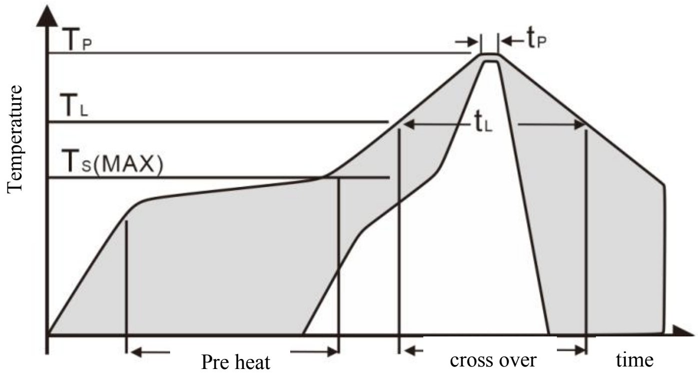


Figure 9. JEDEC standard soldering process diagram, T_P <200℃, t_P <30sec, lead-free soldering. T_L<180℃, t_L <150sec, and the rate of temperature rise and fall during soldering should be <5℃/sec.

Please use a standard reflow oven to solder the sensor. The sensor complies with the IPC/JEDEC J-STD-020D soldering standard. The optimum temperature for reflow soldering is lower than 190°C, and the limit soldering temperature that can be tolerated is 210°C. At a maximum temperature of 200°C, the contact time should be less than 30 seconds (see Figure 9). Therefore, it is recommended to use a low temperature of 180°C during reflow soldering.

NOTE: The sensor may experience temporary low readings after soldering.

2.2 Storage conditions and handling instructions

The temperature and humidity sensor is not an ordinary electronic component, and the user must pay attention and take good care of it. Long-term exposure of the sensor to high concentrations of chemical vapors will cause reading drift. Therefore, it is recommended to place the sensor in an anti-static packaging bag and store it in a temperature range of 10~50°C. If the sensor is not sealed in the ESD bag, the storage humidity should be between 20~60%RH. For sensors that have been removed from their original packaging, we recommend storing them in anti-static bags made of metal PET/AL/CPE.

During production and transportation, the sensor should avoid contact with high concentrations of chemical solvents and long-term exposure. Avoid contact with volatile glues, tapes, stickers or volatile packaging materials, such as bubble foil, foam materials, etc. Production areas should be well ventilated.

2.3 Recovery processing

Readings can drift if the sensor is exposed to extreme operating conditions or chemical vapors. It can be restored to the calibration state through the following processing.

If the humidity is high, it can be dried: it is recommended to leave for 6 hours under the humidity conditions of 60°C and 5%RH.

If the humidity is low, it can be hydrated: it is recommended to leave the sensor in an environment of 25°C and 75%RH for 24 hours.

2.4 Temperature influence

The relative humidity of the gas is calculated through the ambient temperature and dew point, so the ambient temperature has a great influence on it. Therefore, when measuring relative humidity, it should be ensured that all sensors that measure the same relative humidity work in the same temperature environment as much as possible, so that it is meaningful to compare the sensor readings. If the sensor is on the same printed circuit board as the heat-prone electronic components, measures should be taken when designing the circuit.

Minimize the effects of heat transfer as much as possible. For example: to keep the shell well ventilated, the copper plating of the sensor and other parts of the printed circuit board should be as minimal as possible, or leave a gap of 1.5mm between the two. (See Figure 10).

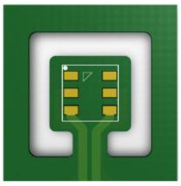


Figure 10. Top view of the sensor PCB with milled slits to minimize heat transfer.

In addition, when the measurement frequency is too high, the temperature of the sensor itself will increase and affect the measurement accuracy. If it is necessary to ensure that its own temperature rise is lower than 0.1°C, it is recommended that the I2C frequency be between 10K and 400KHz during measurement, which should not be too high, and the data collection cycle should be greater than 1 second/time.

2.5 Product application scenario design

In terms of product design, pls pay attention to below:

a. The sensor shall in full contact with the outside air

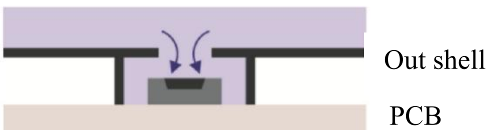


Figure 11. A suitable window on the housing provides good access for ambient measurements and more air exchange.

b. The sensor is completely isolated from the air inside the shell

Figure 12. The sensor is isolated from the air inside the enclosure to minimize the effect of the enclosed air inside the enclosure on the sensor.

c. Make sure the measurement blind zone around the sensor is small

Figure 13. The smaller measurement blind zone the better, which is beneficial for the sensor to quickly and comprehensively detect environmental changes.

d. The sensor is isolated from the heat source

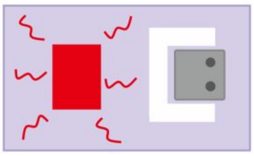


Figure 14. Isolating the sensor from internal heat sources minimizes the effect of internal heat on sensor measurements.

e. Sensor power controllable

In order to improve the stability of the system, the following power supply control solutions are recommended:

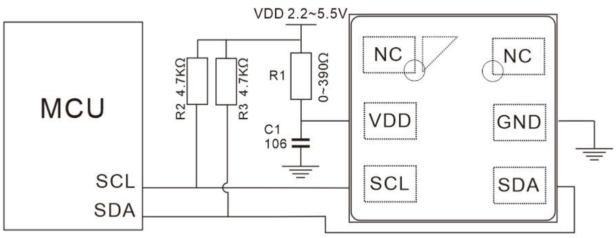


Figure 15. Typical Application Circuit

Note:

1. The host MCU supplies the sensor with a voltage range of 2.2~5.5V.
2. When the sensor is first powered on, the MCU supplies power to VDD first, and the SCL and SDA high levels can be set after 5ms.
3. The VDD of the sensor needs to add an RC filter circuit, such as R1 and C1 in the figure.

f. Wiring rules of sensors on PCB

In order to improve the reliability of the sensor, the layout of the circuit board should avoid wiring or copper-clad design at the bottom of the sensor. Do not apply the sensor in corrosive gas or condensed water.

2.6 Materials used for sealing and encapsulation

In the applications, some materials will absorb and slowly release water vapor, which will weaken the response of AHT30. Therefore, the materials around the AHT30 should be carefully selected. Recommended materials include: metal materials, LCP, POM (Delrin), PTFE (Teflon), PE, PEEK, PP, PB, PPS, PSU, PVDF, and PVF.

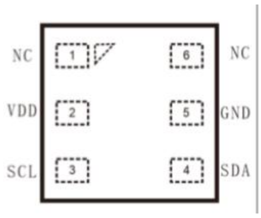
For the application scenarios of AHT30 that require glue sealing or bonding process, it is recommended to choose epoxy encapsulant, silicone grease, polyurethane encapsulant and ultraviolet light curing encapsulant. Also note that gases released from these materials may contaminate the sensor (see 2.2.). Therefore, in the pre- and post-assembly processes involving AHT30 on the product side, good ventilation or drying at 60°C should be ensured to release residual odors.

2.7 Routing rules and signal integrity

If the SCL and SDA signal lines are parallel and very close to each other, it may cause signal crosstalk and communication failure. The solution is to place VDD or GND between the two signal lines, separate the signal lines, and use shielded cables. In addition, reducing the SCL frequency may also improve the integrity of the signal transmission.

3 Pin definition

Pin	Name	Description
1	NC	Empty
2	VDD	Supply voltage
3	SCL	Serial clock, bidirectional
4	SDA	Serial clock, bidirectional
5	GND	Ground
6	NC	Empty



Bottom view

Table 5. AHT30 Pin

3.1 Serial Clock SCL

SCL is used for communication synchronization between the microprocessor and AHT30. Since the interface contains completely static logic, there is no minimum SCL frequency.

3.2 Serial Data SDA

The SDA pin is used for data input and output of the sensor. When sending commands to the sensor, SDA is valid on the rising edge of the serial clock (SCL), and must remain stable while SCL is high. After the falling edge of SCL, the SDA value can be changed. To ensure communication security, the valid time of SDA should be extended to TSU and THO respectively before the rising edge of SCL and after the falling edge of SCL. Refer to figure 16. When reading data from the sensor, SDA is valid (TV) after SCL goes low, and remains until the next falling edge of SCL.

To avoid signal conflict, the microprocessor (MCU) can only drive SDA and SCL at low level, and an external pull-up resistor (for example: 2.0~4.7kΩ) is needed to pull the signal to high level. Refer to Table 7 and Table 8 for details on the sensor input/output characteristics.

4 Electrical Specifications

4.1 Absolute maximum ratings

The electrical characteristics of the sensor are defined in Table 2. Absolute maximum ratings as given in Table 6 are stress ratings only and are for extra information. Under such conditions, functional operation of the device is undesirable. Prolonged exposure to absolute maximum rating conditions may affect sensor reliability.

Table 6. Electrical Absolute Maximum Ratings

Parameters	MINI	MAX	Unit
VDD to GND	-0.3	5.5	V
Digital I/O pin (SDA, SCL) to GND	-0.3	VDD+0.3	V
Input current for each pin	-10	10	mA

ESD electrostatic discharge complies with JEDEC JESD22-A114 standard (Human body model ± 4kV), JEDEC JESD22-A115 (Machine model ± 200V). If the test conditions exceed the nominal limit index, the sensor needs to add additional protection circuit.

4.2 Input/Output Characteristics

Electrical characteristics, such as power consumption, input and output high and low level voltages, etc., depend on the power supply voltage. For smooth sensor communication, it is important to ensure that the signal design is strictly within the limits given in Tables 7, 8 and Figure 16.

Table 7. DC characteristics of digital input and output pads, unless otherwise stated, VDD=2.2V to 5.5V, T=-40℃ to 120℃

Parameter	Condition	MIN	Typical	MAX	Unit
Output low voltage V_{OL}	VDD=3.3V, $-4mA<I_{OL}<0mA$	0	-	0.4	V
Output high voltage V_{OH}	-	70%VDD	-	VDD	V
Input low voltage V_{IL}	-	0	-	30%VDD	V
Input high voltage V_{IH}	-	70%VDD	-	VDD	V

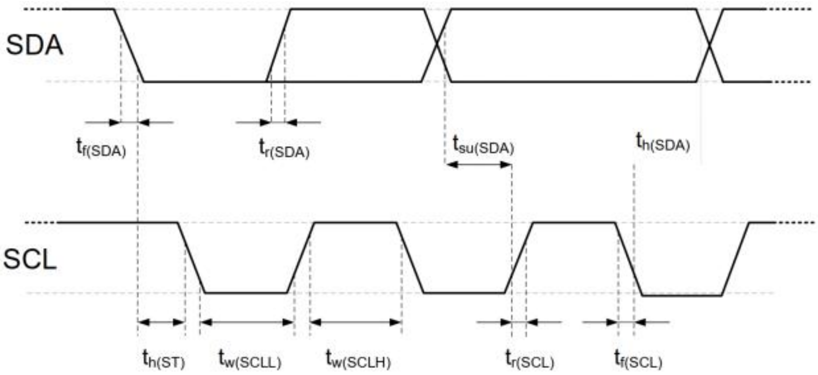


Figure 16. Timing Diagram for Digital I/O Terminals, Abbreviations are explained in Table 7. The thicker SDA line is controlled by the sensor, and the ordinary SDA line is controlled by the microcontroller. Note that the SDA valid read time is triggered by the falling edge of the previous conversion.

Table 8. Timing Characteristics of I 2 C Fast-Mode Digital Input/Output Terminals. The specific meaning is shown in Figure 16, unless otherwise noted。

		I^2C standard mode		I^2C high speed mode		Unit
Mark	Parameters	MIN	MAX	MIN	MAX	
f (SCL)	SCL Clock frequency	0	100	0	400	KHz
tw (SCLL)	SCL low level time	4.7	/	1.3	/	µs
tw (SCLH)	SCL high level time	4.0	/	0.6	/	µs
tsu (SDA)	SDA start time	250	/	100	/	ns
th (SDA)	SDA data keep time	0.09	3.45	0.02	0..9	µs
Both pins are measured from 0.2VDD to 0.8VDD. The above I2C timing is determined by the following internal delay The internal SDI input pin is delayed relative to the SCK pin, the typical value is 100ns The internal SDI output pin is delayed relative to the falling edge of SCK, the typical value is 200ns						

5 Sensor communication

AHT30 uses standard I²C protocol for communication. For information about the I²C protocol other than the following chapters, please refer to the following website: www.aosong.com provides program samples for reference.

5.1 Sensor I2C communication protocol timing and command format

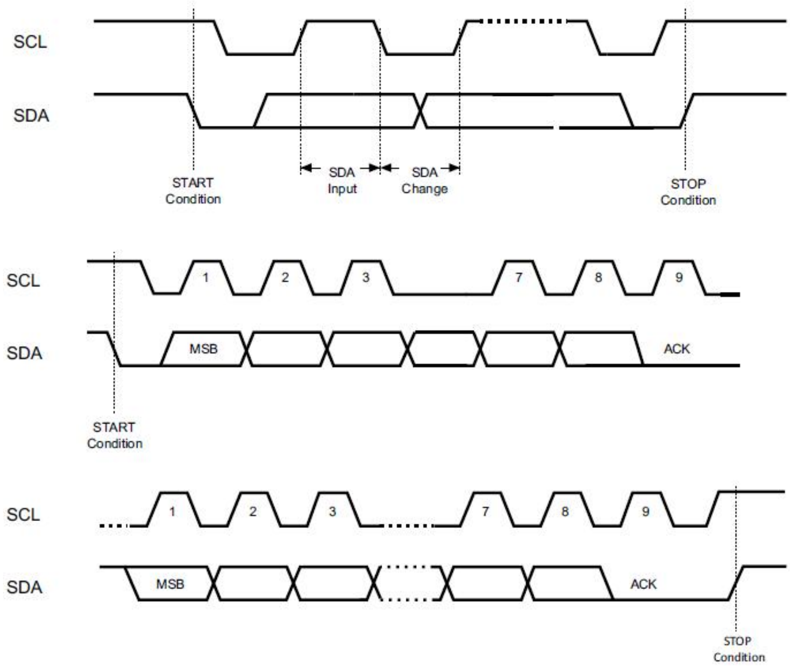
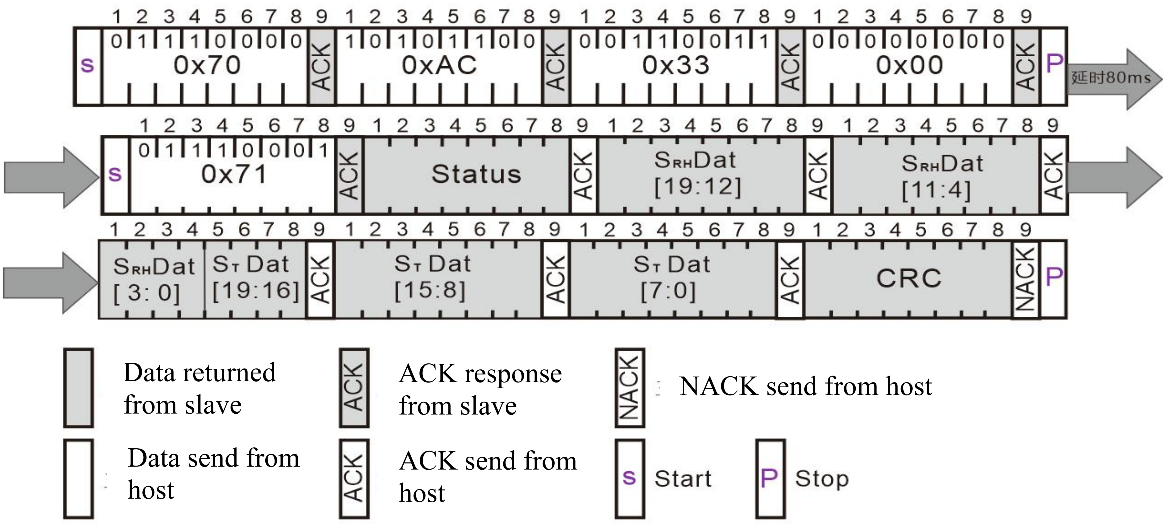


Figure 17. I²C bus timing diagram



0x70 0xAC 0x33 0x00 is to send the write measurement command byte segment to the sensor;
Status is the status byte, see Table 9 for details;
SRH[19:0] is 20-bit relative humidity data;
ST[19:0] is 20-bit temperature data;
CRC is the check byte, which is the result of CRC8 check on Status, SRH[19:0], ST[19:0];

Figure 18. Description of reading and writing data

Table 9. Status description

Staus	Bit	Meaning	Description

	Bit[7]	Busy or idle (Busy indication)	1 -- Sensor is busy, measuring in progress 0 -- Sensor idle, in sleep state
	Bit [6:5]	Current work mode (Mode Status)	00 -- NOR mode 01 -- CYC mode 1x -- CMD mode
	Bit [4]	CRC_flag	1-- Indicates that the OTP memory data integrity test (CRC) passed, 0-- Indicates that the integrity test failed, indicating that there is an error in the OTP data,
	Bit [3]	Calibration calculation enable (Calibration Enable)	0 -- The calibration calculation function is disabled, and the output data is the raw data output by the ADC 1 -- The calibration calculation function is enabled, and the output data is the calibrated data
	Bit [2]	CMP interrupt	0 --The calibrated capacitance data is within the CMP interrupt threshold range 1 --The calibrated capacitance data is outside the CMP interrupt threshold range
	Bit [1]	Reserved	——
	Bit [0]	Reserved	——

5.2 Sensor reading process

1. Send measurement command:

Wait for 5ms after the VDD of the sensor is powered on, send the write measurement command 0x70 0xAC 0x33 0x00, and wait for 80ms to complete the measurement;

2. Obtain temperature and humidity calibration data:

After waiting for 80ms to complete the measurement, send 0x71 to read the sensor to obtain the status word Status, temperature and humidity calibration data S_{RH}[19:0] 、 S_T[19:0] And the calibration CRC; as shown in Figure 18. The description of reading and writing data, the description of the status word is shown in Table 9;

3.CRC check:

Read the measurement Status、S_{RH}[19:0]、S_T[19:0] and do CRC8 check, CRC initial data 0xFF, CRC8 check polynomial is: $CRC[7:0]=1+x^4+x^5+x^8$, CRC calculation code is as follows:

```
//**********************************************************//
//CRC check type: CRC8
//polynomial: X8+X5+X4+1
//Poly:0011 0001 0x31
unsigned char Calc_CRC8(unsigned char *message,unsigned char Num)
{
   unsigned char i;
   unsigned char byte;
   unsigned char crc =0xFF;
  for (byte = 0;byte<Num;byte++)
```

```
    {
     crc^=(message[byte]);
     for(i=8;i>0;--i)
    {
     if(crc&0x80)
        crc=(crc<<1)^0x31;
     else
        crc=(crc<<1);
    }
  }
Return crc;
}
//********************************************************//
```

4. Calculate the temperature and humidity value:
Relative Humidity Conversion Formula:

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

Temperature conversion formula:

$$T[℃] = \left(\frac{S_T}{2^{20}}\right) * 200-50$$

Example: ST:0x2FFAB, convert to decimal number 196523, T=(196523/1048576)*200-50=12.5℃

Note: The sensor takes time to collect. After the host sends out the measurement command (0xAC, 0x33, 0x00), if there is no delay of 80ms, the status word Bit7 may be 1. At this time, the temperature and humidity data of the previous measurement command are read. After the measurement is completed, it will enter the sleep state until the next communication wakes up.

6 Environmental Stability

If the sensor is used in equipment or machinery, ensure that the sensor used for the measurement is sensing the same conditions of temperature and relative humidity as the sensor used for the reference. If the sensor is placed in the equipment, the reaction time will be extended, so in the program design to ensure that enough measurement time is reserved. The sensor is tested according to the enterprise standard of Aosong temperature and humidity sensor. We do not guarantee the performance of the sensor under other test conditions, and it cannot be used as a part of the sensor performance. Especially for specific occasions requested by users, no promises are made.

7 Packaging

It is packed in a tape-and-roll anti-static bag, 5000PCS per roll, with a label on the outer anti-static bag, as shown in Figure 20, and tracking information is provided.

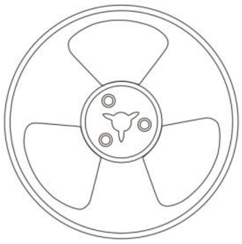


Figure 19.Reel tape

Figure 20. Label on Antistatic bag

Warnings and Personal Injury

Do not use this product in safety protection devices or emergency stop equipment, and in any other application where failure of the product may cause personal injury, unless there is a specific purpose or authorization for use. Refer to the product data sheet and instruction manual before installing, handling, using or maintaining this product. Failure to follow recommendations could result in death or serious personal injury. The company will not be responsible for all compensation for personal injury and death arising therefrom, and exempt any claims that may arise from the company's managers and employees, affiliated agents, distributors, etc., including: various costs, claims fees, attorney fees, etc.

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Guangzhou Aosong Electronics Co., Ltd. provides the direct purchasers of its products with the quality assurance in the following table (calculated from the date of delivery), and indicates the technical specifications in the Aosong Electronics product manual. If within the warranty period, the product is proven to be defective, the company will provide free repair or replacement services。

Product	Warranty
AHT30 temperature and humidity sensor	12 months

The company is only responsible for the products that are defective due to the application in the occasions that meet the technical conditions of the product. The company does not make any guarantees for product applications in special scenarios that are not recommended. The company also does not make any commitment to the reliability of the product applied to other non-company supporting products or circuits.

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