



Temperature and Humidity Sensor Module  
(Model: ZS21)

# Manual

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Zhengzhou Winsen Electronics Technology Co., Ltd

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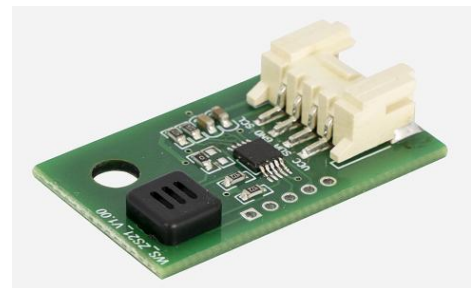
## ZS21 Temperature and Humidity Sensor Module

### Overview

ZS21 is a brand new product equipped with a dedicated ASIC sensor chip, a high-performance semiconductor silicon-based capacitive humidity sensor and a standard on-chip temperature sensor, and is connected with a high-performance 8-bit microcontroller to output standard I2C data signals. At the same time, each sensor is calibrated in a high-precision temperature and humidity verification box, so the product has good consistency; ZS21 products use special humidity-sensitive materials, so that their performance is extremely stable in high-temperature and high-humidity environments. It has the advantages of fast response, strong anti-interference ability, and high cost performance.

### Features

- Fully calibrated
- Wide power supply voltage range, from 2.0V to 5.5V
- Digital output, standard I<sup>2</sup>C signal
- Quick response and strong anti-interference ability
- Excellent long-term stability under high humidity condition
- Low power consumption and high precision



### Application

Home appliance fields: home appliance, humidity control, HVAC, dehumidifiers, smart thermostats, and room monitors ;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	-	0.024	-	%RH
Accuracy error <sup>1</sup>	Typical	-	±3	Refer to Figure 1	%RH
Repeatable	-	-	±0.1	-	%RH
Hysteresis	-	-	±1.0	-	%RH
Non-linear	-	-	<0.1	-	%RH
Response time <sup>2</sup>	τ63 %	-	<8	-	s
Scope of work <sup>3</sup>	-	0	-	100	%RH
Prolonged Drift <sup>4</sup>	Normal	-	< 1	-	%RH/yr

Table 1

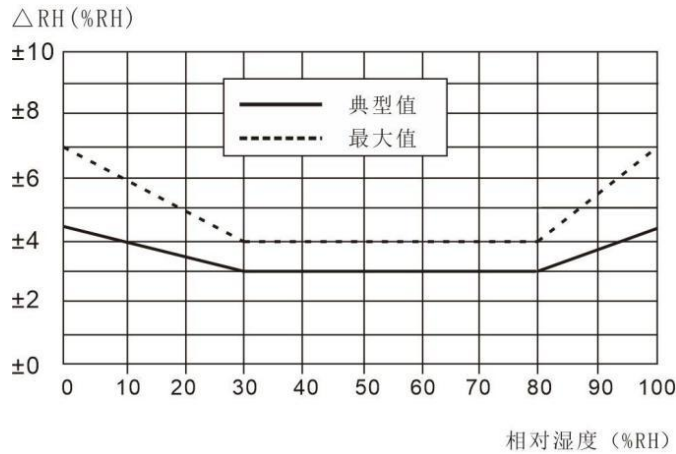


Fig 1 Maximum error of relative humidity at 25°C

**Technical parameters of temperature**

Parameter	Condition	Min	Typical	Max	Unit
Resolution	Typical	-	0.01	-	°C
Accuracy error <sup>5</sup>	Typical	-	±0.5	-	°C
	Max	See figure 2			-
Repeatable	-	-	±0.1	-	°C
Hysteresis	-	-	±0.1	-	°C
Response time <sup>6</sup>	τ63%	5	-	30	s
Scope of work	-	-40	-	85	°C
Prolonged Drift	-	-	<0.04	-	°C/yr

Table 2

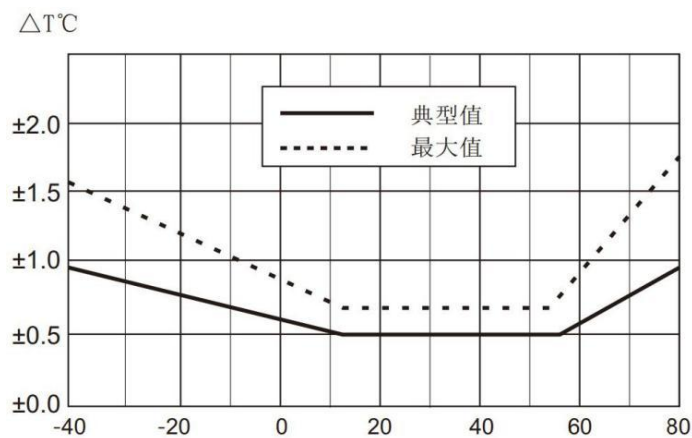


Fig 2 Temperature typical error and maximum error

**Electrical characteristics**

Parameter	Condition	Min	Typical	Max	Unit
Power Supply	Typical	2.2	5	5.5	V
Power Supply, IDD <sup>7</sup>	Sleep	-	3	-	nA
	Measure	-	2	-	μA
Low level input voltage	decline	0	-	30%	VDD
High level input voltage	rise	60%	-	100%	VDD
Sampling period	1 second				
Communication Format	I <sup>2</sup> C				

**Table 3**

1. This accuracy is the testing accuracy of the sensor under the condition of 25 °C power & supply voltage of 3.3V during delivery inspection. This value excludes hysteresis and nonlinearity and applies only to non condensing conditions.
2. the time required to reach 63% of the first-order response at 25 °C and 1m/s air flow.
3. Normal working range: 0-80% RH. Beyond this range, the sensor reading will deviate (after 200 hours under 90% RH humidity, it will temporarily drift < 3% RH). The working range is further limited to - 40 - 85 °C.
4. If there are volatile solvents, pungent tapes, adhesives and packaging materials around the sensor, the reading may be offset.
5. The accuracy of the sensor is 25.5 °C under the factory power supply condition. This value excludes hysteresis and nonlinearity and applies only to non condensing conditions.
6. The response time depends on the thermal conductivity of the sensor substrate.
7. The minimum and maximum supply current are based on VDD = 3.3V and T < 60 °C.
8. The minimum and maximum power consumption are based on VDD = 3.3V and T < 60 °C.

## User Guide

### 1. Performance Supplement

#### 1.1 Suggested working environment

The recommended temperature and humidity range of this sensor is 5~60 °C 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.

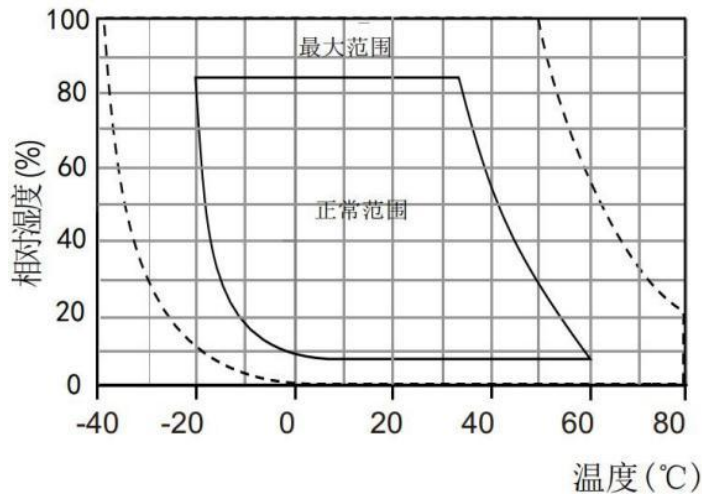


Fig 3 Working scope

**1.2 RH accuracy at different temperatures**

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

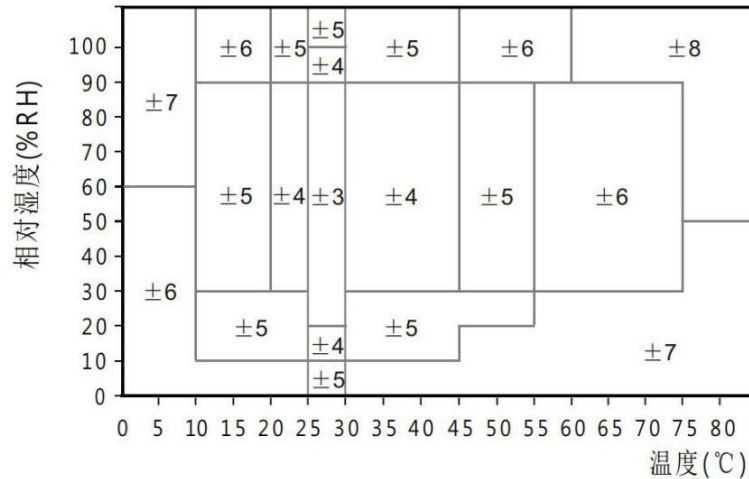


Figure 4 The maximum error of the corresponding humidity in the range of 0-80°C

**1. Application:**

**2.1 Welding instructions**

Reflow soldering or wave soldering is prohibited for products. For manual welding, the contact time must be less than 5 seconds under the temperature of up to 300 °C.

Note: after welding, the sensor shall be stored in the environment of > 75% RH for at least 12 hours to ensure the rehydration of the polymer. Otherwise, the sensor reading will drift. The sensor can also be placed in a natural environment (> 40% RH) for more than 2 days to rehydrate it. The use of low-temperature solder (such as 180 °C) can reduce the hydration time.

Do not use the sensor in corrosive gases or in environments with condensate.

**2.2 Storage Conditions and Operating instructions**

Humidity sensitivity level (MSL) is 1, according to IPC/JEDECJ-STD-020 standard. Therefore, it is recommended to use it within one year after shipment.

Temperature and humidity sensors are not ordinary electronic components and need careful protection, which users must pay attention to. Long term exposure to high concentration of chemical vapor will cause the reading of the sensor to drift. Therefore, it is recommended to store the sensor in the original package, including the sealed ESD pocket, and meet the following conditions: the temperature range is 10 °C - 50 °C (0-85 °C in a limited time); Humidity is 20-60% RH (sensor without ESD package). For those sensors that have been removed from their original packaging, we recommend storing them in antistatic bags made of metal containing PET/AL /CPE materials.

In the process of production and transportation, the sensor should avoid contact with high concentration of chemical solvents and long-term exposure. Avoid contact with volatile glue, tape, stickers or volatile packaging materials, such as foam foil, foam materials, etc. The production area should be well ventilated.

### **2.3 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 °C and <5% RH humidity for 10 hours;
- (2) (2) Re-hydration: Keep it at 20-30 °C and >75% RH humidity for 24 hours.

### **2.4 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.

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 ZS11 should not exceed 10% of the measurement time. It is recommended to measure the data every 2 seconds.

### **2.5 Materials for sealing and encapsulation**

Many materials absorb moisture and will act as a buffer, which increases response time and hysteresis. Therefore, the material of the surrounding sensor should be selected carefully.

Recommended materials are: metal materials, LCP, POM (Delrin), PTFE (Teflon), PE, peek, PP, Pb, PPS, PSU, PVDF, PVF.

Materials for sealing and bonding (conservative recommendation): it is recommended to use the method filled with epoxy resin for the packaging of electronic components, or silicone resin. Gases released from these materials may also contaminate ZS11 (see 2.2). Therefore, the sensor should be finally assembled and placed in a well ventilated place, or dried in an environment of > 50 °C for 24 hours, so that it can release the polluting gas before packaging.

### **2.6 Wiring rules and signal integrity**

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

## **3 Interface definition**

PIN	Name	Definition
V	VCC	Power 2.2-5.5V
D	SDA	Serial data, bidirectional
G	GND	Power -Ground
C	SCL	Serial data, bidirectional

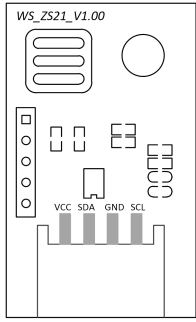


Table 4

### 3.1 Power pin(VDD,GND)

Power supply of ZS21 is 2.2-5.5V.

### 3.2 Serial data

See the specific description of the communication protocol

### 4.Sensor communication

ZS21 sensor adopts standard I2C communication protocol, which is suitable for a variety of devices. The protocol uses two data lines: serial data bus (SDA) and serial clock bus (SCL). The resistance is generally 4~10 kΩ . Multiple sensor devices can share the bus; however only one host device can be present on the bus, the sensor I2C address is 0x88.

#### 4.1 I2C Communication Interface Features and Timing

On the I2C bus, the ZS21 sensor supports communication rates up to 400kHz as a slave device. When the host sends a start signal (low level), the sensor starts to communicate, and when the host sends a stop signal (high level), the current communication ends. The start and stop signals are only valid when SCL is low, and SCL remains low for at least 300ms after power-on.

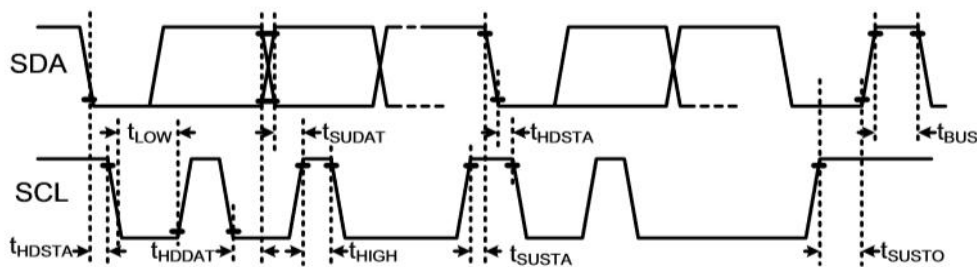


Figure 5 I2C Timing

Parameter	Condition	MIN	TYP	MAX	Unit
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I <sup>2</sup> C clock frequency	f <sub>SCL</sub>	20		400	KHz
start signal time	t <sub>HDSTA</sub>	0.1			μs
SCL Clock high width	t <sub>HIGH</sub>	0.6			μs
SCL Clock low width	t <sub>LOW</sub>	0.6			μs
Set time relative to SCL edge start condition	t <sub>SUSTA</sub>	0.1			μs
Data retention time relative to SCL SDA edge	t <sub>HDDAT</sub>	0		0.5	μs
Data Setup Time Relative to SCL SDA Edge	t <sub>SUDAT</sub>	0.1			μs
Set time in SCL stop condition	t <sub>SUSTO</sub>	0.1			μs
BUS Idle Time Between Stop and Start Condition	t <sub>BUS</sub>	1			μs

Table 6: I2C parameter

## 4.2 I<sup>2</sup>C output

When the host initiates a start signal, and the operation mode of the SCL bus satisfies the above time parameter conditions, the sensor will start communication. Commands or data are always sent when SCL is on the rising edge, until the sensor receives the stop signal sent by the host and ends the communication. .

After the start signal is sent, the host sends an 8-bit read and write command, including the upper 7-bit address, plus the 8th bit of read (1)/write (0), the read and write commands will directly determine the direction of data transmission. When the read command 0X89 is sent, it means that the master reads the slave data. The communication unit of the subsequent sensor reading and writing data includes 8 data bits and 1 response bit. When the response bit is 0 (low level), it is the ACK (data response) of the communication, and when the response bit is 1 (high level) It is NACK (data no response). When the slave receives the ACK signal sent by the master, it will send the next data unit, or when the master sends a stop signal, this communication will be terminated.

### ➤ Communication data (information frame) format

Send commands:

Data Format:	I <sup>2</sup> C address +W	function code
Data Length:	1 byte	2 bytes

Read data:

Data Format:	I <sup>2</sup> C address +R	temperature data	CRC checksum	Humidity data	CRC Checksum
Data Length:	1 byte	2 bytes	1 byte	2 bytes	1 byte

### Communication:

Send I2C address+W (0x88)——Send 2 bytes of function code (0x21+0x30)——Send I2C address+R——  
Read 6 bytes of temperature and humidity data

### Humidity data format

Temperature High Bit + Temperature Low Bit + Temperature CRC Check + Humidity High Bit + Humidity Low Bit + Humidity CRC Check

➤ Communication data (information frame) format

I.E:

Temperature:  $0110010000100010 = 6422_{S_T}$ ,  $= 100 * 256 + 34 = 25634$ ,  $T [^{\circ}C] = -45 + 175 \cdot \frac{S_T}{2^{16} - 1} = 23.4^{\circ}C$

Humidity:  $01011101 10101000 = 5DA8_{S_{RH}}$ ,  $= 93 * 256 + 168 = 23976$ ,  $RH = 100 \cdot \frac{S_{RH}}{2^{16} - 1} = 36.5\%RH$

➤ Check code calculation routine:

```
//CRC Check type: CRC8/MAXIM
//polynomial: X8+X5+X4+1
//Poly: 0011 0001 0x31
//Putting the high position in the back becomes 1000 1100 0x8c
//Creal code:
```

```
U8 Calc_CRC8(U8 *message,U8 Num)
{
    U8 i;
    U8 byte;
    U8 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;
}
```

**5 Product Dimension**

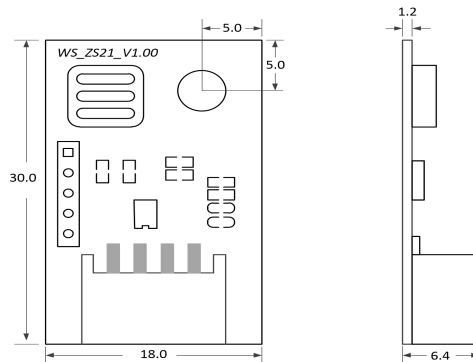


Fig 6 Dimensions (Unit: mm)

## 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.

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### 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 product should be within the warranty period.

The company is only responsible for products that are defective when used in applications that meet the technical conditions of the product. 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 about the reliability of its products when applied to products or circuits.

**Zhengzhou Winsen Electronics Technology Co., Ltd**

**Add:** No.299, Jinsuo Road, National Hi-Tech Zone,  
Zhengzhou 450001 China

**Tel:** +86-371-67169097/67169670

**Fax:** +86-371-60932988

**E-mail:** [sales@winsensor.com](mailto:sales@winsensor.com)

**Website:** [www.winsen-sensor.com](http://www.winsen-sensor.com)