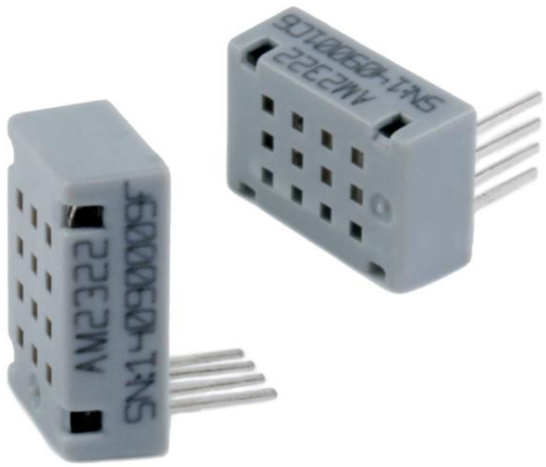
Humidity & Temperature Sensor

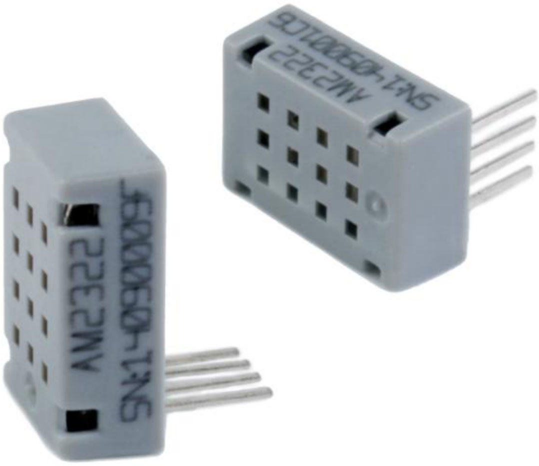
AM2322 Product Manuals



product Features

- Super Mini Size Easy Protable
- Ultra-Low Power State
- Ultra-low voltage work
- Excellent long-term stability
- Standard I^2C And single bus output

一、 Product Overview



AM2322 The digital temperature and humidity sensor is a kind of temperature and humidity composite sensor with the output of calibrated digitalsignal.The special temperature and humidity collection technology is adopted to ensure the high reliability and long-term stability of the product.The sensor includes a capacitive sensing element and a high-precision integrated temperature measurement element, which is connected to a high-performance microprocessor.The product has high quality, super fast response, strong anti-interference ability and high cost performance.

AM2322 communication mode adopts single bus, standard I squared C communication mode.Standard single bus interface makes system integration easy and fast.The super small volume, extremely low power consumption, the signal transmission distance can reach up to 20 meters, making it the best choice for all kinds of applications and even the most demanding applications.The I squared C communication mode adopts standard communication timing, and the user can be directly attached to the I squared C communication bus, with no additional wiring and simple use.

Two kinds of communication mode is used directly output after temperature compensation, humidity, temperature and the CRC check and other digital information, users need to secondary calculation of digital output, also need not to compensate the temperature humidity, accurate temperature and humidity information can be got.The two modes of communication are free to switch, users are free to choose, easy to use, and should be widely used.The product is 4 lead wire and convenient connection. Special packaging can be provided according to user's demand.

二、Range of application

Hvac, dehumidifier, testing and inspection equipment, consumer goods, automotive, automatic control, data recorder, weather stations, household appliances, humidity control, medical, and other relative humidity control

三、Product highlights

Completely interchangeable, the cost is low, long-term stability, relative humidity and temperature measurement, signal transmission distance long, digital signal output, accurate calibration, extremely low power consumption, standard single bus digital interface, I squared

四、Dimensions (unit: mm)

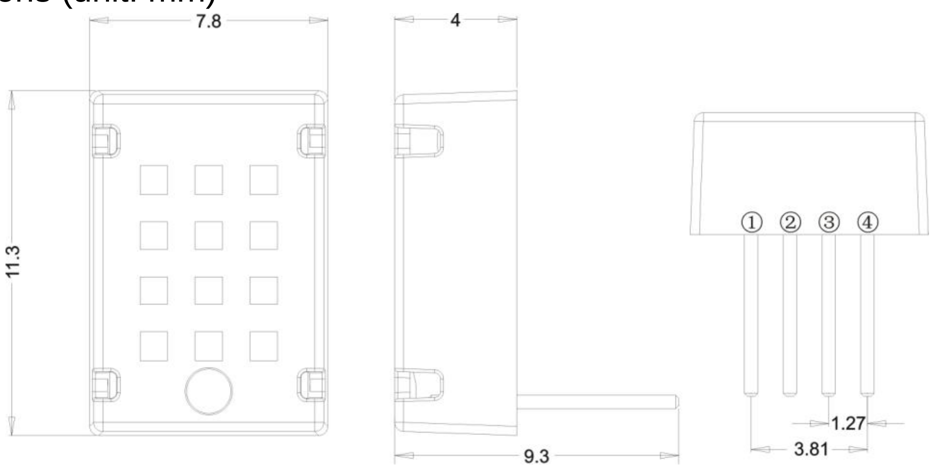


Figure 1. 1 AM2322 contour

External interface: 1:VDD 2:SDA 3: GND 4:SCL

五、Sensor performance

5.1 Relative humidity

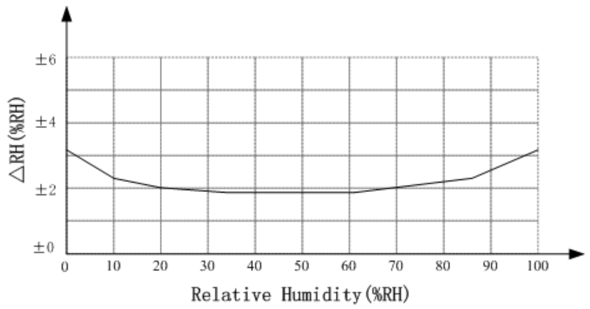
Table 1： AM2322 Relative humidity performance table

parameter	conditions	min	typ	max	unit
The resolution of the			0.1		%RH
Scale range		0		99.9	%RH
accuracy[1]	25℃		±2		%RH
repetitive			±0.1		%RH
interchangeability		Completely interchangeable			
The response time[2]	1/e(63%)		<5		S
hysteresis			±0.3		%RH
drift[3]	Typical values		<0.5		%RH/yr

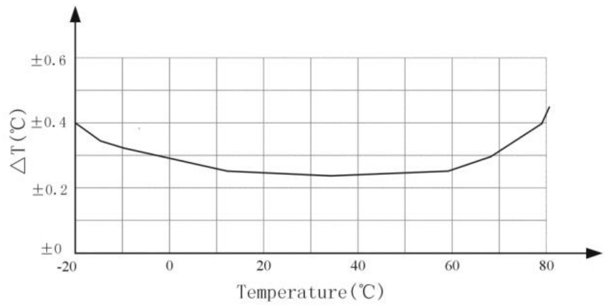
5.2 temperature

Table 2： AM2322 Relative temperature performance table

parameter	conditions	min	typ	max	unit
The resolution of the			0.1		℃
			16		bit
accuracy			±0.3		℃
repetitive		−40		80	℃
interchangeability			±0.2		℃
The response time		Completely interchangeable			
hysteresis	1/e(63%)		<5		S
drift			±0.1		℃/yr



picture 2: 25degree AM2322 Maximum relative humidity error



picture 3：The maximum temperature error of temperature sensor

六、Electrical characteristics

Electronic features, such as energy consumption, high, low level, input, output voltage, etc., depend on the power supply.Table 3 details the electrical characteristics of AM2322. If it is not indicated, the power supply voltage is 5V.If you want to get the best effect with the sensor, please strictly follow the conditions of table 3 and figure 14 and 27

Table 3： AM2322 The dc feature

Parameters'	conditions	min	typ	max	unit
The power supply voltage		3.1	5	5.5	V
Power consumption[4]	dormancy	8	10		μA
	measure		500		μA
	averaging		200	250	μA
Low level output voltage	I_{OL}[5]	0		300	mV
High level output voltage	Rp<25 kΩ	90%		100%	VDD
Low level input voltage	descend	0		30%	VDD
High level input voltage	uplift	70%		100%	VDD
Rpu[6]	VDD = 5V VIN = VSS	30	45	60	kΩ
The output current	open		8		mA
	Three states (close)	10	20		μA
Sampling period		2			S

1 The accuracy of this precision is that when the sensor is at 25 degrees and 5V at the time of factory inspection, the accuracy of the test is not retarded and non-linear, and only suitable for the non-condensable environment.

2 At 25 degrees and 1m/s air flow, the time required for a first order response is 63 per cent

3 The values may be higher in volatile organic compounds, and the instructions are used to store information.

4 Numerical value VDD =5.0V Temperature for 25 degrees 2S/ secondary Mean value

5 Low voltage output current

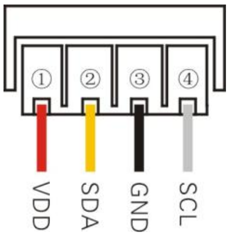
6 Represents the upper resistance

七、The interface definition

7.1 AM2322 Pin assignment

Table 4： AM2322 Pin assignment

pin	appellation	describe
1	VDD	Power supply（3.1V−5.5V）
2	SDA	Serial data, two-way port
3	GND	land
4	SCL	The serial clock, the input port single bus is grounded



Picture 4： AM2322 The wiring diagram

7.2 The power supply pins（VDD GND）

AM2322 Supply voltage range 3.1V − 5.5V。

7.3 Serial clock input（SCL）

SCL pin is used for the sensor communication mode selection I squared C clock line.When the electricity is on, the SCL maintains a low level of 500MS and even keeps the electricity normally, indicating that the user chooses the single bus mode to communicate, otherwise, the communication of I squared C is not possible.After choosing the communication mode, the communication mode of the sensor remains unchanged during the period of power. If you want to change the mode of communication, please rewire and select the mode of communication according to the operation requirement.When selecting I squared C communication, SCL is used for communication synchronization between microprocessor and AM2322.

7.4 Serial data（SDA）

SDA is a three-state structure for reading and writing sensor data.Specific communication timing, see the communication mode detailed description.

八、I^2C And single bus communication protocol

The serial interface of AM2322 is optimized for the sensor signal reading and power loss.The sensor adopts single bus I squared C two communication modes: when the electricity is up, the SCL keeps the low level as single bus communication mode;When the electricity is on, the SCL keeps the high level and is the I squared C communication mode.The single bus is fully compatible with the single bus communication of the company's other products.The I squared C communication is based on the I squared C standard protocol, which can be directly attached to the I squared C bus (only one long product is allowed on the bus), wireless additional wiring, and simple operation.
When reading the A2322 sensor, please follow the protocol of two communication modes in a timely manner.The specific communication

8.1 Standard I^2C Introduction of communication protocol

8.1.1 I^2C Introduction of bus

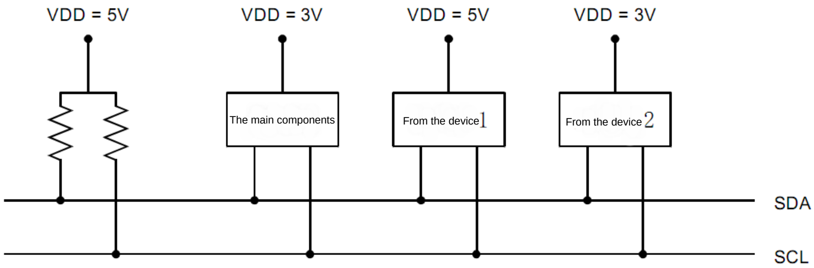
Another form I squared C serial bus with the interface of AM2322 and microcontroller is briefly introduced in this paper. I squared C bus protocol protocol standard.Limited to space, unable to list the entire contents of the agreement, further questions, please refer to the relevant information (refer to philips' website for reference)

8.1.2 I^2C Summary of the bus

Philips invented a simple two-way two-wire serial communication bus more than 20 years ago. The bus is called the Inter-I squared C bus.Now I squared C bus embedded application has become the industry standard solutions, are widely used in various professional based on micro control unit, consumption and telecommunication products, as a control, diagnosis and power management bus.Multiple devices that conform to the I squared C bus standard can communicate through the same I squared C bus without the address decoder.
The I squared C bus only needs to be composed of two signal lines, one is the serial data line SDA, the other is the serial clock line SCL.Both the SDA and SCL pins of the device with the I squared C bus are the output structures of the drain opening (or collector opening).So it's actually used.

SDA and SCL signal lines must be combined with resistance Rp, Pull Up Resistor.Pull-up resistors usually 3-10 k values ÿ. Therefore, when the bus is idle, the two signal lines all maintain a high level, almost no current consumption;Good electrical compatibility, support of various voltage logic device interface;The two different buses can be directly connected, without the need for additional switching circuits, and support multiple modes of communication - the most common form of communication.It also supports dual host communication, multi-host communication, and broadcast mode.

I^2C Configuration is shown in figure5



picture 5: I^2C configuration

8.1.3 I^2C Bus protocol specification

◎ I2C Bus term definition

I squared C bus through serial data on the SDA and the serial clock SCL line is connected to the bus, to transfer information between devices, each device has a unique address recognition, and can be used as a transmitter or receiver, is determined by the function of the device, the device when performing data transmission can also be seen as a host or from the machine, the host is the initialization of the bus data transmission and generate the clock signal allows the transmission device.In addition, any addressable device is considered to be from the machine.The I squared C bus term definitions are detailed in the table 5

◎ I2C Bus speed

The communication rate of the I squared C bus is controlled by the host and can be slow.But the maximum speed is limited, and the data transmission rate of the I squared C bus can be as fast as 100KB/S in standard mode.

◎ I2C Bus bit transmission

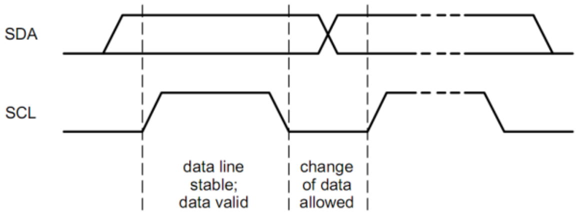
The bit transmission of the I squared C bus is accomplished through the data line SDA and the clock line SCL.During the high level of the clock line SCL, the data line SDA represents the current transmission level "0" for low level.During the high level of the clock line SCL, the data line SDA indicates the current transmission logic level "1" for high level.The level of the logic "0" (low) and "1" (high) is determined by the phase photoelectricity of the VDD (see table 3 AM2322 dc feature table in detail) at the same time that each data position is transmitted to generate a clock pulse.

Table 5: I^2C Definitions of bus terms

terminology	describe
The sender	The device that sends data to the bus
The receiver	The device that receives data from the bus
Main engine	Initializes the sending, producing the clock signal and terminating the sent device
From the machine	Device addressed by the host
multi-master	There are more than one host trying to control the bus without breaking the message
The arbitration	Is a process where multiple hosts try to control the bus at the same time, but allow one to control the bus and make the message unbroken
synchronizing	The process of synchronizing the clock signal between two or more devices

◎ Validity of data

The data of the data line SDA must remain stable at the high level of the clock.The high or low level state of the data line SDA is only allowed to change when the clock line SCL is at a low level.But at the beginning and end of the I squared C bus the exception is (see the starting conditions and stopping conditions in detail).Some other serial bus may change the data on the edge of the clock signal (rising along or falling edge), but the I squared C bus is the electric flat.The specific time sequence diagram is shown in figure 6



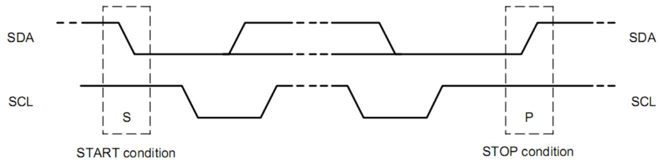
picture 6：I^2C Bit transport of the bus

◎ Start and stop conditions

Starting conditions: When the SCL is in the high level, SDA generates the initial conditions from high level to low level jump.The bus is in a busy state after the initial conditions are created.The initial conditions are often abbreviated to S

Stop condition: When the SCL is in high level, the SDA produces a stop condition from low level to high level jump. The bus is idle after the conditions are stopped.The stop condition is simply P

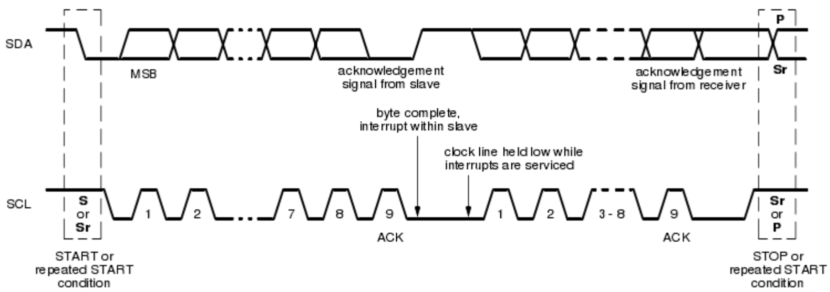
The initial and stop conditions are shown in figure 7



picture 7：Start and stop condition schematic

◎ Byte transport format

The I squared C bus receives and receives data in bytes.The number of bytes transferred to the SDA line must be 8 bits, and the number of bytes transmitted each time is not limited.First is the highest level of data transmission (MSB) 7 last transmission is lowest (LSB in addition) after each byte must with a response to the (ACK) I squared C to transmit data as shown in figure 8



picture 8： I^2C Data transmission of the bus

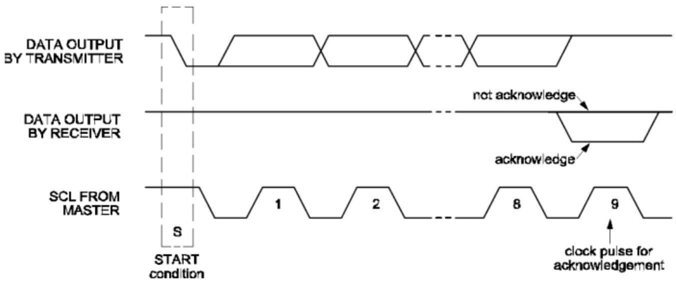
◎ I^2C Bus response

In the I squared C bus transport data, there is no transmission of one byte to a response state area.The receiver receives data that can be sent to the sender via a response.The clock pulse of the reply bit is still generated by the host, while the data state of the reply bit follows the principle of "who receives whom?

Is always generated by the receiver response, in response to the clock during the SDA line must be low, making it stable during this high level of the clock pulse of low level (as shown in figure 9), and, of course, must consider to build and maintain time (details please refer to table 6) to send data from the machine, the host response generated by the machine, the host from receiving data from the machine, the response generated by the host.

I squared C bus standard: response to 0 receiver response (ACK) said he was often shorthand for A, 1, said the response (NACK) often shorthand for NA, sender sends LSB, shall release the SDA line higher (SDA) to wait for the receiver generates A response.

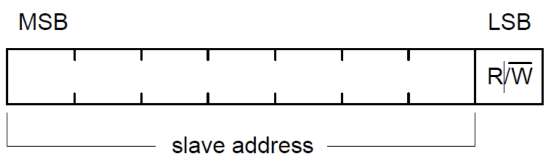
If the receiver receives the last byte of data or cannot receive more data, a non-reply signal should be generated to notify the sender.If the sender finds that the receiver produces a non-reply state, it should terminate the sending



Picture 9： I^2C Bus response

◎ From the machine address

The I squared C bus does not require additional address decoders and film selection signals.Multiple devices with the I squared C bus interface can be connected to the same I squared C bus, which is distinguished by the device address.I squared C bus addressing process is usually the first byte after starting conditions which determine the host selection from the machine, namely the seven addressing address (the other is a 10 addressing address, is different, the sensor adopts seven addressing address).The first byte of a defined as shown in figure 10, the first byte of the first seven formed from the machine address, the least significant bit (LSB) is the eighth, it determines the direction of the message, the first byte of the least significant bit (LSB) is "0", said the main chance to write information to the selected from the machine, "1" is the main opportunity to read information from machine.

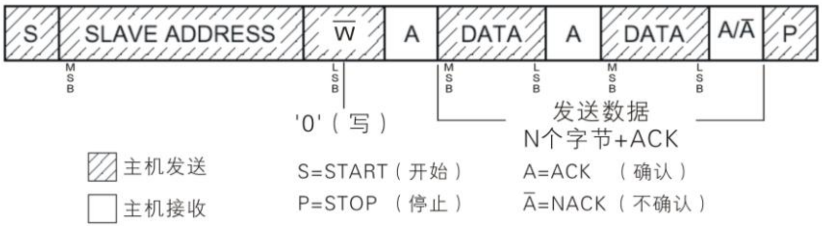


picture 10：The first byte after the initial condition

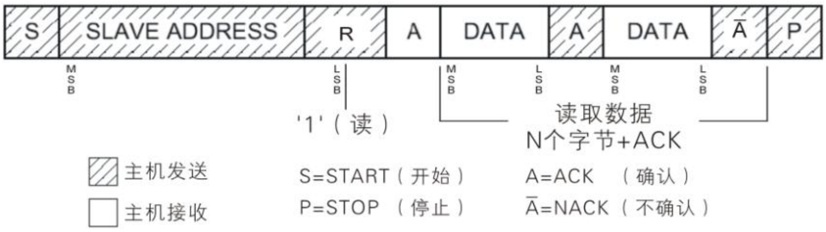
Send an address, each device in the system after the starting conditions, head seven if, as compared with his address device will think she is the host address and as for the receiver or transmitter from the machine from machine by R/W for the decision.Host is the main control device, he does not need the device address, other devices belong to the machine, must have the device address.You must ensure that all the addresses on the I squared C bus are unique and cannot be repeated, otherwise the I squared C bus will not work properly.

◎ Basic data transmission schematic diagram

Figure 11 and figure 12 show the basic format of sending and receiving data of I squared C respectively.Should note that figure 11 and figure 12, in figure 11, the host to send the last byte of data from the machine, the machine may or may not reply a reply, but no matter how host can produce stop condition.If the host detects a non-reply from the machine when it sends data from the machine (even from the machine address), it should stop the transmission in time.



picture 11： I^2C The bus host sends the data base format from the machine



picture12： I^2C The bus host receives the basic format from the machine

8.2 AM2322 sensor I^2C Communication protocol

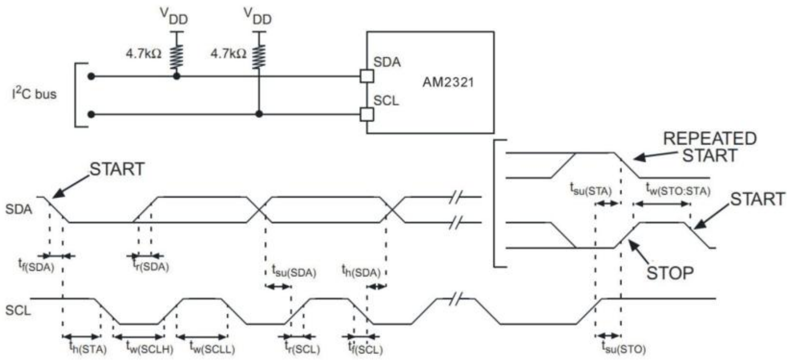
The serial interface of AM2322 is the I squared C bus, which is based solely on the I squared C standard protocol, which can be directly attached to the I squared C bus.The ADDRESS of the I squared C of the AM232 sensor (SLAVE ADDRESS) is OXB8. Based on the protocol of the I squared C standard bus, a unique communication protocol is developed based on the ModBus protocol, which reduces the transmission error rate.When the microcontroller reads the AM2322 sensor, please strictly follow the I squared c-modbus communication protocol of the AM2322 sensor to carry out the design in a timely manner

8.2.1 I^2C Interface specification

The AM2322 digital temperature and humidity sensor is adopted as the standard I squared C bus in the communication mode between the machine and the host (user microprocessor).To accurately measure the environment humidity, reduce the influence of temperature and humidity on moisture, AM2322 sensor during the non-working automatically translate into a dormant state, in order to reduce power consumption, to reduce heat sensor itself on the surrounding environment humidity value.The working mode of AM2322 adopts passive mode, namely, when the host awakens the sensor by instruction, then the corresponding instruction is sent to read the corresponding temperature and humidity value;After communication, the sensor triggers a temperature and humidity collection.Therefore, if the sensor is not read for a long time, please read the sensor twice in a continuous time (the minimum interval is 2S), and the second value is the latest measurement value.The sensor automatically becomes dormant after collection.The next time the host needs to read the sensor, the sensor needs to be reawakened. It should be noted that the host communication starts from beginning to end, and the longest time is 3S.If the communication is not completed within 3S, the sensor automatically ends the communication and automatically turns to hibernation. If the host is to read the sensor again, the wake-up command needs to be re-sent.

8.2.2 I^2C Interface characteristics

This summary introduces the features of the I squared C interface of the AM2322 sensor. If you want to get the best communication effect with the sensor, please design the design strictly according to the conditions of FIG. 13 and table 6



Picture 13：AM2322 Typical 12C bus application circuit and sequence diagram

Table 6：AM2322 sensor I^2C Interface characteristics

symbol	parameter	The standard model I2C		unit
		min	max	
The clock frequency SCL			100	kHz
tw(SCLL)	SCL Clock time	4.7		μs
tw(SCLH)	SCL Clock height	4.0		
tsu(SDA)	SDA Set up the time	250		ns
th(SDA)	SDA Data retention time	0[1]		
tr(SDA) tr(SCL)	SDA and SCL Rise time		1000	
tf(SDA) tf(SCL)	SDA and SCL Fall time		300	
th(STA)	Start the condition to keep the time	4.0		μs
tsu(STA)	Repeat the starting conditions to establish the time	4.7		
tsu(STO)	Stop setting up time	4.0		μs
tw(STO:STA)	Stop to start conditional time (bus idle)	4.7		μs
Cb	The capacitive load of each bus		400	pF

8.2.3 Communication protocol

The I squared C communication protocol of the AM2322 sensor is based on the standard I squared C bus protocol, which is based on the MODBUS protocol, and according to the characteristics of the AM2322 sensor itself, the combination of the I squared c-modbus protocol is as follows

◎ Communication data (information frame) format

Data format:	I2C address +R/W	Function code	Data area	CRC check[3]
Data length:	1 Byte [2]	1 Byte	N Byte	16bits CRC code Redundant loop code

[1] If the interface is not allowed to extend the low level time, it is only necessary to observe the longest maintenance time of the start condition.

[2] 1 byte consists of 8 bits and bytes (8 bit)

[3] CRC calibration algorithm, detailed see: CRC code calculation method;See below.

◎ Communication information transmission process

When the communication command is sent to the sensor by the sending device (host), the sensor is equipped with the command of the address of the sensor I squared C, and the sensor is received, and the information is read according to the function code and relevant requirements.The execution result (data) is then returned to the host.The returned information includes function code, post-execution data, and CRC check code (users do not read their CRC, but send the stop condition directly).

◎ Communication I^2C from the machine address

The AM2322 sensor has the same address for each I squared C and is 0xB8.Therefore, only one AM2322 sensor can be mounted on the same bus, and the sensor only responds to the host at the same time it receives the initial signal and its own I squared C address.

◎ Communication I^2C Function code

The function code is the first byte of each communication frame.The I squared C_ModBus rules, the defined function code is 1 to 127.As the host request sends, the function code tells the machine what action to perform.As a response from the machine, the function code returned from the machine is the same as the function code sent from the host, indicating that the machine has been responding to the host and has done the related operation.The function code of I2C_ModBus is shown in table 7.

Table 7：I^2C_ModBus Partial function code

Function code	Set the righteous	Operation (binary)
0x03	Read register data	Read data from one or more registers
0x10	Write multi-path registers	Write multiple sets of binary data to multiple registers

◎ Communication I^2C data area

The data area includes what information or action needs to be returned by the sensor.This information can be data (such as temperature value, humidity value, sensor device information, user write data, etc.), reference address, etc.For example, the host told sensors returned by function code 03 register values (including the starting address of the register to read and read the length of the registers), it returns the data including the data of length and registers the data content.

The sensor adopts a custom I squared C_Modbus communication protocol, and the host USES the communication command (function code 03) to read its data register at any time, and its data register table is shown in table 8.The data register of the sensor stores the temperature and humidity value and the corresponding equipment information and other relevant signals of the sensor;Each data register is a binary data of a single byte (8 bits);A maximum of 10 registers that can read the sensor, which exceeds the reading length, and the sensor returns the corresponding error code.The error code information is shown in schedule 1.

Table 8：AM2322 Data register

Register information	address	Register information	address	Register information	address	Register information	address
High humidity	0x00	Equipment model high	0x08	User register 1 high	0x10	retention	0x18
Humidity is low	0x01	Equipment model low	0x09	User register 1 low	0x11	retention	0x19
High temperature	0x02	Version number	0x0A	User register 2 high	0x12	retention	0x1A
High temperature	0x03	equipment ID(24－31) Bit	0x0B	User register 2 low	0x13	retention	0x1B
retention	0x04	equipment ID(16−23) Bit	0x0C	retention	0x14	retention	0x1C
retention	0x05	equipment ID(8 － 15) Bit	0x0D	retention	0x15	retention	0x1D
retention	0x06	equipment ID(0 － 7) Bit	0x0E	retention	0x16	retention	0x1E
retention	0x07	Status register	0x0F	retention	0x17	retention	0x1F

◎ Temperature output format

The temperature resolution is 16Bit, and the highest temperature (Bit15) is equal to 1, which means the negative temperature. The highest temperature (Bit15) equals 0 means positive temperature.Temperature except for the highest bit (Bit14 ~ Bit0) represents the temperature value of the sensor.The temperature value of the sensor string is 10 times the actual temperature value;

◎ Status register

Status register, Bit7-Bit0 bit, temporarily reserved

Status register	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Function introduction	retention	retention	retention	retention	retention	retention	retention	retention

◎ I^2C_ModBus Function code introduction

1. Function code "03" : read the multiplexer register of the sensor

Host send read frame format:

START+ (I squared C address + W) + function code (0x03) + START address + register number +STOP

Host read back data:

START+ (I squared C address + R) + continuously reads the data returned by the sensor +STOP

Sensor response frame format:

Function code (0x03) + register number + data +CRC[1]

For example: the host reads the data of the sensor continuously: the starting address is the register data of 4 sensors at 0x00.

The address and data of the data register of the sensor are:

Register address	Register data	Data description	Register address	Register data	Data description
0x00	0x01	High humidity	0x02	0x00	High temperature
0x01	0xF4	Humidity is low	0x03	0xFA	Low temperature

Message format sent by the host:

The host sends a	The number of bytes	Send message	For note
Sensor address	1	0xB8	Sensor I squared C address (0xB8) +W (0)
Function code	1	0x03	Read register
The starting address	1	0x00	The register start address is 0x00
Register number	1	0x04	Read the number of registers

The message format returned by the sensor response:

The response from the machine	The number of bytes	Send message	For note
Function code	1	0x03	Read register
Return bytes	1	0x04	Returns four registers for four bytes
Register 1	1	0x01	Content of 0x00 (high humidity byte)
Register 2	1	0xF4	Content of 0x01 (low humidity byte)
Register 3	1	0x00	Contents of 0x02 address (high temperature byte)
Register 4	1	0xFA	Content of 0x03 (low temperature byte)
CRC 码	2	31A5	The sensor calculates the return of CRC code, low byte before;

[1]：The CRC calibration is detailed in the following CRC calibration. The sensor returns all data with CRC calibration, and the user can choose to read or not read.

Numerical calculation:

Read from the sensors of temperature and humidity values, as long as the value converted to a decimal number is divided by 10 corresponding humidity value, the temperature of the corresponding unit for ÿ, humidity units for % RH.For example, the data read back:

humidity : $01F4 = 1 \times 256+15 \times 16+4 = 500$ =>humidity $= 500 \div 10 = 50.0\%RH$;

temperature : $00FA = 15 \times 16+10 = 250$ => temperature $= 250 \div 10 = 25.0$℃

➘ Note: CRC verification code can be calculated by CRC code, and then compared with the CRC code transmitted by the sensor.In the same way, the data is accepted correctly, otherwise, the data is considered to have a mis-code.

二、Function code "10" : write multi-path registers to the sensor

The host USES this function code to save multiple data to the storage of the sensor.The single register of the AM2322 sensor is 1 byte, or 8 bits.The sensor is allowed to hold up to 10 data registers at a time.Therefore, the host single time the most multi-directional sensor to save 10 registers.Over 10, the sensor returns the error code.

Host send frame format:

START+(I^2C address + W) + function code (0x10)+ START address + register number + save data +CRC+STOP

Host read confirmation instructions:

START+(I^2C address + R) + read the data returned by the sensor +STOP

Sensor response frame format:

Function code (0x10) + start address + register number +CRC

For example, the host will save 01,02 to the sensor register at the address of 10 and 11.

Message format sent by the host:

The host sends a	The number of bytes	Send message	For note
Sensor address	1	0xB8	Sensor I squared C address (0xB8) +W (0)
Function code	1	0x10	Write multi-path registers
Initial address	1	0x10	The starting address of the register to be writter
Save word length	1	0x02	The length of the word (2 words)
Save data 1	1	0x01	Save data (address: 10)
Save data 2	1	0x02	Save data (address: 11)
CRC code	2	C092	The CRC code obtained by the host computer, low byte in front (I2C address not included in CRC calculation)

传感器响应返回的报文格式：

The response from the machine	The number of bytes	Send message	For note
Function code	1	0x10	Write multi-path registers
The starting address	1	0x10	The starting address of the save
Save data length	1	0x02	The sensor holds the data length
CRC code	2	FC04	The sensor calculates the CRC code and the low byte before;

◎ CRC check

The host or sensor can be used to check whether the receiving information is correct. Due to electronic noise or other disturbance, the information in the process of transmission error sometimes, mistakes can check code (CRC) test host or whether the sensors in the transmission of the information in the process of communication data is wrong, wrong data can give up (either send or receive), so that increase the safety and efficiency of the system.

The CRC (redundant cyclic code) of the I squared C_ModBus communication protocol contains two bytes, that is, 16 bits.The CRC code is calculated by the sending device (host) and placed at the end of the sending information frame. The I squared C address is not included in the CRC calculation.CRC is sent or received by low-byte in front, high byte in the format of the post.The device that receives the information (sensor) recalculates the CRC receiving the information and compares the calculated CRC with the received, if the two do not match, the error is indicated.Users should pay special attention to reading sensor instructions without CRC check; When writing sensor, CRC check must be added.All returned data have CRC.

◎ CRC code calculation method

1.Preset a 16-bit register for hexadecimal FFFF (i.e. 1);Call this register CRC register;
2.The first 8-bit binary data (the first byte of the communication frame) differs from the low 8 bits in the 16-bit CRC register Or, put the result in the CRC register;
3.Move the contents of the CRC register to the right (low) to fill the highest position with 0, and check the shift after the right move;
4.If the shift is 0: repeat step 3 (move one again to the right);If the location is 1: CRC register and polynomial A001 (1010 0000 0001) for different or;
5.Repeat steps 3 and 4 until the right is shifted 8 times so that the whole 8-bit data is processed.
6.Repeat step 2 to step 5 to handle the next byte of communication information frame;
7.After all the bytes of the communication frame are calculated according to the above steps, the 16 CRC registers are high and low in b Exchange;
8.The final contents of CRC register are CRC code.

◎ CRC code C C C language calculation code

Note: this program calculates the CRC code of the previous len length bytes in * PTR.

```
unsigned short crc16(unsigned char *ptr, unsigned char len)
{
    unsigned short crc=0xFFFF;
    unsigned char i;
    while(len--)
    {
        crc ^=*ptr++;
        for(i=0;i<8;i++)
        {
            if(crc & 0x01)
            {
                crc>>=1;
                crc^=0xA001;
            }else
            {
                crc>>=1;
            }
        }
    }
    return crc;
}
```

8.2.4 I²C communication timing

The AM2322 sensor I squared C communication mode, although it is in accordance with the standard I squared C communication sequence, but must comply with our communication protocol and communication time series requirements, can accurately read and write sensor.Please strictly follow the communication protocol in order to read the design.

◎ I²C Read and write complete timing examples

Figure 14 shows the complete sensors sample to read and write and to read and write special time requirements, please in strict accordance with the special requirements for time to read and write, otherwise there will be unable to read sensor or data is not correct, and so on and so forth.The sequence of several times in the graph is particularly important

See the time requirement in detail;Host communication from start to finish, the longest time is 3S

picture 14： I^2C Complete sample diagram of read-write sensor

◎ I^2C Read and write time sequence decomposition

To read or write a sensor, you must do the following three steps, otherwise you will not be able to communicate or read the correct data:

Step 1: wake up the sensor

To reduce fever are part of the humidity sensor error, sensor in non-working state, dormant, so must wake up to read sensor sensor, can be sent to read and write instructions, otherwise the sensor may be as a response.It is important to note that when the sensor is awakened, the I squared C address is sent, and the sensor does not respond to the ACK, but the host must send the clock that confirms that the ACK is back, that is, the ninth SCL clock signal.The operation of the wake sensor is as follows:

After the host sends the initial signal and the initial address, wait for a period of time (wait time at least 800 mu s, Max 3ms;If the host is hardware I squared C, there is no need to wait, the hardware I squared C will wait automatically, then send the stop signal.

The initial signal +0xB8+ wait (>800us)+ stop signal timing diagram is shown in figure 15.

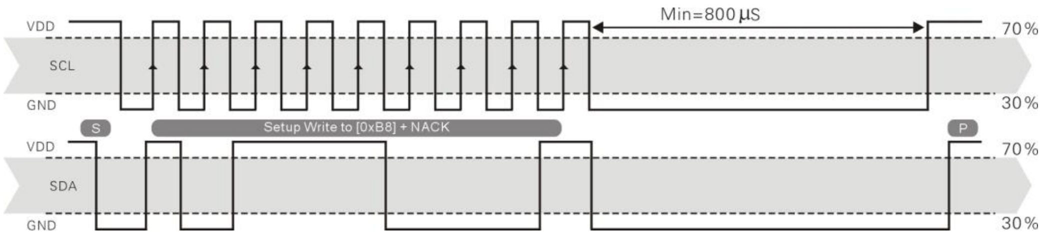


Table15：Wake up sensor

Step 2: send read instructions or send write instructions

After the AM2322 sensor is awakened, it can be read and read according to the standard I squared C, and the maximum speed is 100Kb/s.Read the temperature and humidity example, as shown in figure 16.

The host sends instructions: START+0xB8 (SLA) +0x03 (function code) +0x00 (starting address) +0x04 (register length) +STOP

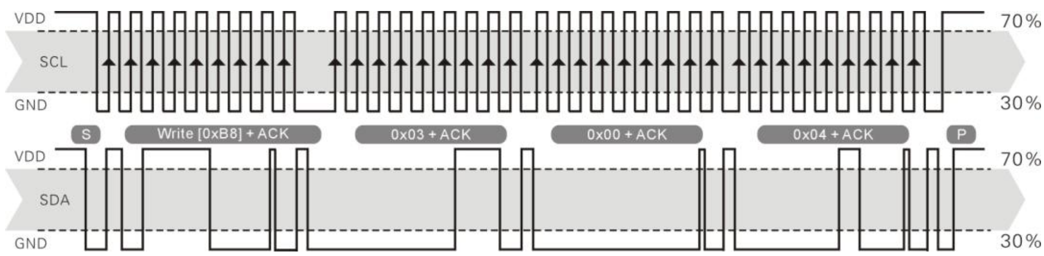


Table 16：Send examples of reading temperature and humidity instructions

Step 3 read back the data or confirm the signal

After the read/write instruction is sent, the host must wait at least 1.5 ms, then send the read sequence, and the sample return data is shown in figure 17;It is important to note that when you read the data, you need to wait at least 30 mu s to send the next serial clock to read the data, otherwise the communication will be wrong

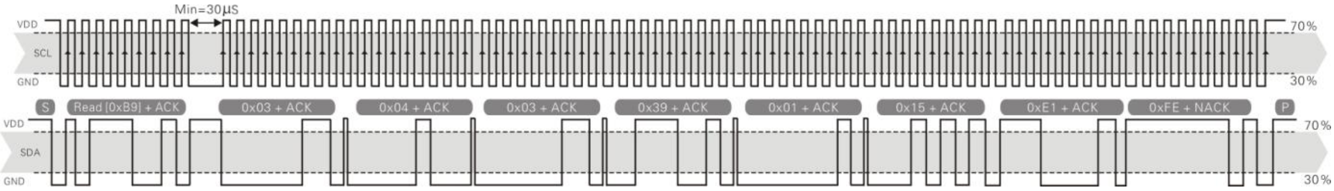


Table17：An example of reading the temperature and humidity value

The host reads the data as follows:

0x03 (function code) +0x04 (data length) +0x03 (humidity high) +0x39 (humidity low) +0x01 (temperature high) +0x15 (temperature low) +0xE1(CRC check code low byte) + 0xFE(CRC check code high byte);

So: 0339H = 3 times 256+3 times 16+9 = 825 => humidity = 825 and 10=82.5%RH;

0115 h = 1 + 1 x 16 + 5 = 277 x 256 = 277 present 10 = = > temperature 27.7 ÿ

Through the above three steps can be completed for all sensors register read and write operations (the user can write register, only five, namely the status register, four user register, at the same time, the status register, can only be written separately, otherwise an error),When designing, the user must follow the three steps above to read and write.After the sensor sends out the data, it triggers a temperature and humidity measurement.After the measurement is completed, the temperature and humidity value is recorded. Once the communication iscomplete, the sensor automaticall turns into a dormant state.Therefore, if the sensor is not read for a long time, the secondary sensor will be read continuously and the temperature and humidity of the second reading will be the latest value (continuous reading of the minimum interval is 2S).

8.2.5 Peripheral read flow chart

AM2322 sensor read I squared C flowchart diagram shown in figure 18, at the same time, our company also provides a C51 read code sample, need to download the client, please visit our company website (www.aosong.com) to download, this specification does not provide code said

In Ming dynasty.

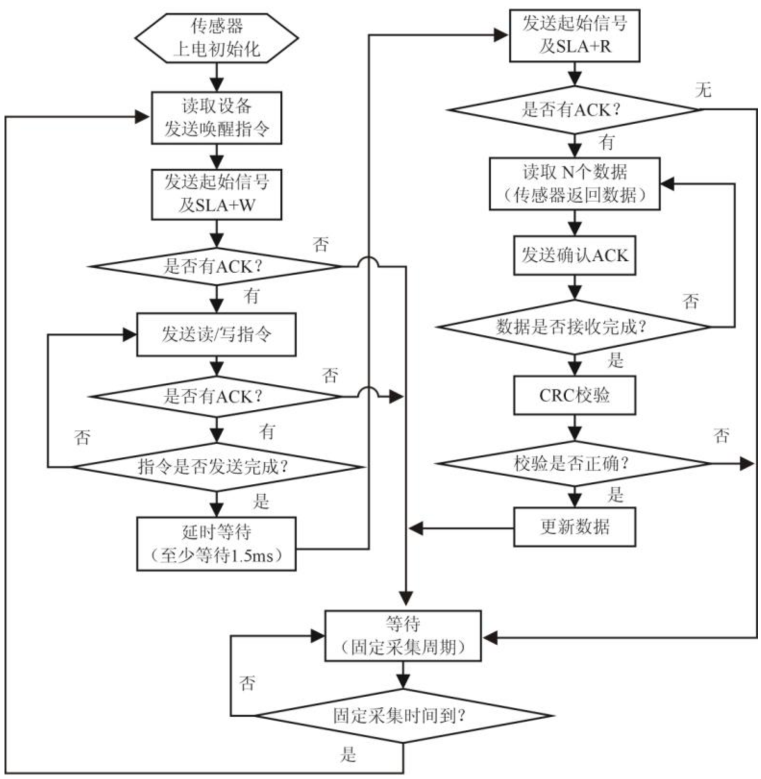


Table 18：I^2C Read the sensor flow chart

Schedule 1: I squared C_MODBUS communication protocol total table

Read the bus description: the address of I squared C is 0xB8;Access to 10 registers at a time;
The longest time to read a bus is 3 S.
Each time the sensor returns data with CRC check, the user can choose not to read CRC check.

Read sensor frame format: host frame format: (SLA+ W) + function code (0x03) + start address + register number
From machine frame format: function code (0x03) + data length + return data +CRC

Write sensor frame format: host frame format: (SLA+W)+ function code (0x10) + start address + register number + save data +CRC
From machine frame format: function code (0x03) + start address + register number +CRC

AM2322 Sensor register list:

Register information	address	Register information	address	Register information	address	Register information	address
High humidity level	0x00	Equipment model high	0x08	User register 1 high	0x10	retention	0x18
Low humidity	0x01	Equipment model low	0x09	User register 1 low	0x11	retention	0x19
High temperature	0x02	The version number	0x0A	User register 2 high	0x12	retention	0x1A
Low temperature	0x03	equipmentID(24−31) Bit	0x0B	User register 2 low	0x13	retention	0x1B
retention	0x04	equipmentID(16−23) Bit	0x0C	retention	0x14	retention	0x1C
retention	0x05	equipmentID(8 − 15) Bit	0x0D	retention	0x15	retention	0x1D
retention	0x06	equipmentID(0 − 7) Bit	0x0E	retention	0x16	retention	0x1E
retention	0x07	Status register	0x0F	retention	0x17	retention	0x1F

Status register definition: bit7-bit0 bit retention;

Temperature format: the highest temperature (Bit15) is equal to 1. Negative temperature, the highest temperature (Bit15) equals 0 means positive temperature;Temperature except for the highest bit (Bit14 ~ Bit0) represents the temperature value of the sensor.The temperature value of the sensor string is 10 times the actual humidity value;

Write sensor: the register can be written by the user (0x0F~ 0x13);Other registers are forbidden to write, and state registers can only be written separately.

Read and write examples:

Can work	Function code	Starting address	Frame data content
Reading temperature and humidity	0x03	0x00	Send: (SLA) + W + 0 x03 + 0 x00 + 0 x04
			Return: 0x03+0x04+ humidity high + humidity low + temperature high +CRC
Reading temperature	0x03	0x02	Send: (SLA) + W + 0 x03 + 0 x02 + 0 x02
			Return: 0x03+0x02+ temperature high + temperature low +CRC
Read the humidity	0x03	0x00	Send: (SLA) + W + 0 x03 + 0 x00 + 0 x02
			Return: 0x03+0x02+ humidity high + humidity low + CRC
Reading device information	0x03	0x08	Send: (SLA) + W + 0 x03 + 0 x08 + 0 x07
			Return: 0x03+0x07+ device model (16 bit) + version number (8-bit) + ID (32-bit) +CRC
Write state register	0x10	0x0F	Send: (SLA+W)+0x10+0x0F+0x01+0x01+0xF4 (low) +0xB7 (high) Note: function code + register start address + register number + save content +CRC
			Return: 0x10+0x0F+0x01+0xB4 (low byte) +0x35 (high byte) Note: function code + register starting address + register number + CRC
Write user register 1	0x10	0x10	Send: (SLA) + W + 0 x10 + 0 x10 + 0 x02 + 0 x01 + 0 x02 + 0 xc0 + 0 x92
			Return: 0 x10 + 0 x10 + 0 x02 + 0 XFC + 0 x04

Note: SLA= I squared C address 0xB8.The CRC in the table is the check digit, the CRC is 16 bits, the low byte is in front, and the high byte is in the back.

Return error code: 0x80: unsupported function code 0x81: read illegal address 0x82: beyond the scope of write data 0x83: CRC check error 0x84: no write.

8.3 unibus communication (one-wire) (ONE−WIRE)

8.3.1Single bus typical circuit

The typical application circuit of microprocessors and AM2322 is shown in figure 19.When single bus communication mode, SDA is pulled back and micro The I/O port of the processor is connected.

Special description of single bus communication:

1.In typical application circuit, it is recommended that the length of cable length should be less than 30 meters and a resistance of 5.1 K, more than 30 meters, according to the actual situationThe condition reduces the resistance of the pull-up resistor.

2.When using 3.3V voltage, the cable length shall not be greater than 30cm.Otherwise, the line pressure drop will cause thesensor to be underpowered.Cause measurement deviation.

3.The minimum interval time for reading the sensor is 2S;The reading interval is less than 2S, which may lead to temperature or humidity or no communication Work, etc.

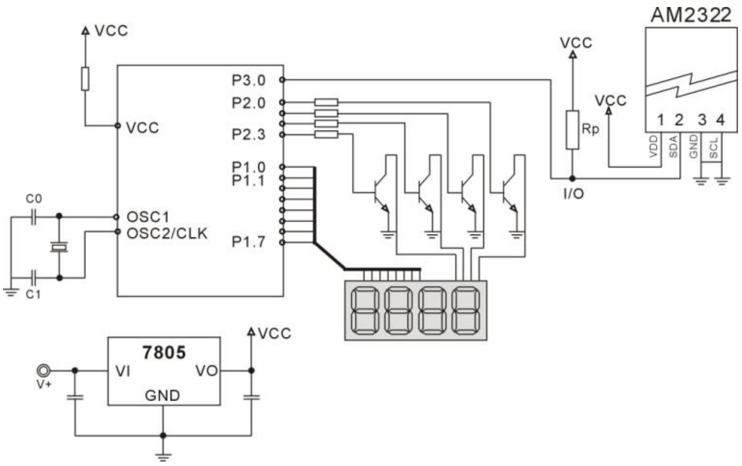


Table 19： AM2322 Single bus typical circuit

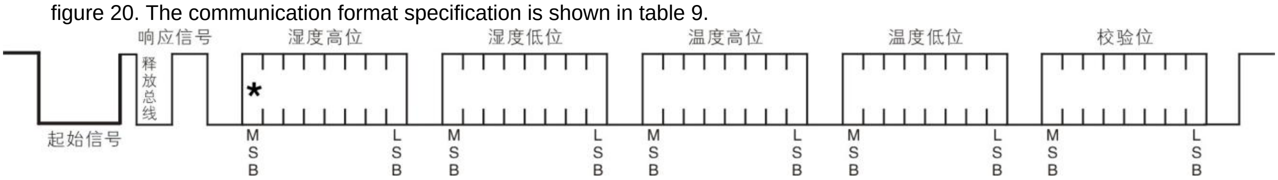
8.3.2 Single bus communication protocol

◎ Single bus specification

The AM2322 device USES a simplified single bus communication.The single bus is the only data line, and the data exchange and control in the system are all completed by the data line.The device (microprocessor) connects to the data line through a drain or triple port to allow the device to release the bus without sending the data, while other devices use the bus;Single bus usually require an external one is about 5.1 k ÿ pull-up resistors, so that when the bus is idle, its status as a high level.Because they are master-slave structure, only the host contact sensor, the sensor will reply, so host access sensor must be strictly follow the sequence of single bus, if there is a sequence of chaos, the sensor will not respond to the host.

◎ The single bus transmits data definitions

SDA is used for communication and synchronization between microprocessor and AM2322, and the single bus data format is used to transmit 40 bits of data at a time.The specific communication time sequence is shown in figure 20. The communication format specification is shown in table 9.



Picture 20： AM2322 Single bus communication protocol

Table 9：AM2322Communication format specification

The name says	Definition of single bus format
Start signal	Microprocessors pull the data bus (SDA) down for a period of time (at least 800)[1] Notify the sensor to prepare the data.
The response signal	The sensor USES the data bus (SDA) to lower 80 s and then the 80 s to respond to the host's initial signal.
The data format	After receiving the host initial signal, the sensor is sent out of the data bus (SDA) at one time with 40 data
humidity	Humidity resolution is 16Bit, high in front;The humidity value of the sensor string is 10 times the actual humidity value.
temperature	Temperature resolution is 16Bit, high in front;The temperature value of the sensor string is 10 times the actual temperature value; The highest temperature (Bit15) is equal to 1, which means negative temperature, and the highest temperature (Bit15) equals 0 means positive temperature. Temperature except for the highest bit (Bit14 ~ Bit0).
Check digit	Check position = humidity high + humidity low + temperature high + temperature low

[1] Detailed description 7.3

◎ An example of a single bus data calculation

Example 1: the 40 data received is:

0000 0010	1001 0010	0000 0001	0000 1101	1010 0010
Humidity high 8 bits	Low 8 bits in humidity	8 bits high	8 bits	Check digit

Calculation:

0000 0010+1001 0010 +0000 0001+0000 1101= 1010 0010 Check digit

Receiving data correctly:

Humidity: 0000 0010 1001 0010 = 0292H (十六进制)= 2×256 + 9×16 + 2 = 658

=> Humidity:= 65.8%RH

Temperature: 0000 0001 0000 1101 = 10DH(十六进制) = 1×256 + 0×16 + 13 = 269

=> Temperature: = 26.9℃

◎ Special instructions:

The highest position of temperature data is 1 when the temperature is below zero.

Example: negative 10.1 is represented as 1, 000 0110 0101

Temperature: 0000 0000 0110 0101 = 0065H (hexadecimal) = 6 x 16 +5 = 101

=> temperature = negative 10.1 degrees

Example 2: the 40 data received is:

0000 0010	1001 0010	0000 0001	0000 1101	1011 0010
Humidity high 8 bits	Low 8 bits in humidity	8 bits high	8 bits	Check digit

Calculation:

0000 0010+1001 0010 +0000 0001+0000 1101= 1010 0010 ≠ 1011 0010 Check the error

The received data is incorrect, give up, and receive data again.

8.3.3 Single bus communication timing

After the user host (MCU) sends a start signal (with the data bus SDA at least 800), AM2322 switches from hibernation mode to high speed mode.After the host starts the signal, AM2322 sends the response signal, sends 40Bit data from the data bus SDA serially, and sends the high number of bytes first;Data of high humidity and high humidity, low temperature, low temperature, parity, send data over trigger an information acquisition, acquisition end sensor automatically into sleep mode, until the next communication.

The detailed timing signal characteristics are shown in table 10, and the single bus communication time sequence diagram is shown in figure 21.

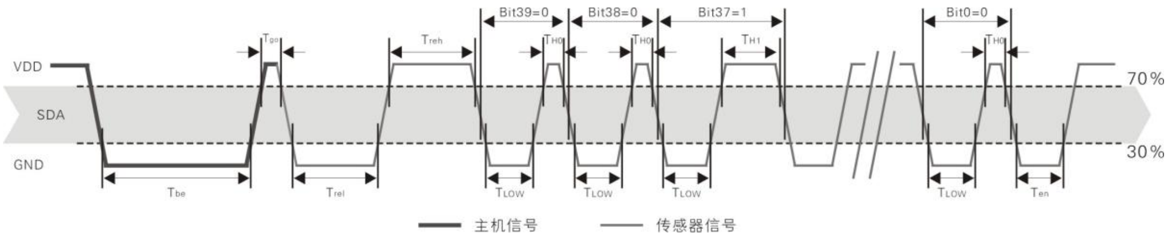


Table 21：AM2322 Single bus communication timing

Note: the temperature and humidity of the host from AM2322 read data is always the last measurements, such as measuring two intervals of time is very long, please read two consecutive times for the second time to obtain the value of the real-time temperature and humidity value, at the same time, the minimum time interval between two reads 2 s.

Table10:Single bus signal characteristics

symbol	parameter	min	typ	max	unit
T_{be}	Host start signal pull down time	0.8	1	20	mS
T_{go}	Host release bus time	20	35	200	μS
T_{rel}	The response time is low	75	80	85	μS
T_{reh}	Response high level time	75	80	85	μS
T_{LOW}	Signal "0", "1" low level time	48	50	55	μS
T_{H0}	Signal "0" high level time	22	26	30	μS
T_{H1}	Signal "1" high level time	68	70	75	μS
T_{en}	The sensor releases the bus time	45	50	55	μS

Note: in order to ensure the accurate communication of the sensor, the user should design the parameters and timing sequence of table 10 and figure 21 in strict accordance with table 10 and figure 21

8.3.4 An example of a read step

The communication between the host and the sensor can be read through the following three steps.

Step one:

AM2322 (such as transistors AM2322 electricity after waiting for 2 s to cross the unstable state, in the meantime reading devices cannot send any instruction), test environment temperature and humidity data, and record the data, then sensor is transferred to a dormant state.

The SDA data line of AM2322 is kept high by the pull up resistance, while the SDA pin of AM2322 is in the input state, detecting external signals at all times.

Step 2:

The I/O Settings for the output of the microprocessor, the output low level at the same time, and low level can not less than 800 us keep time, typical values are lower 1 ms, and then the I/O status is set to the input of the microprocessor, the release of the bus, because the pull-up resistors, the I/O of the microprocessor namely AM2322 SDA cable also will get higher, such as the host after the release of bus, AM2322 to

send response signal, the output low level as the response signal of 80 microseconds, followed by the output high level notice peripherals is ready to receive the data of 80 microseconds, signal transmission is shown in figure 22:

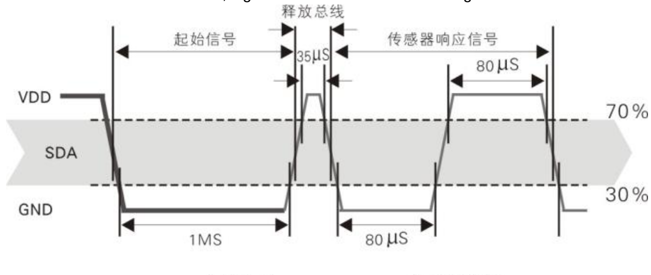


Figure 22: single bus decomposition sequence diagram

Step 3:

After the response was sent by AM2322, the data bus SDA serially output 40 bits of data, and the microprocessor based on I/O level The change takes 40 bits of data.

The format of the digit "0" is: the low level of 50 microseconds and the high level of 26-28 microseconds;

The format of digit "1" is: 50 microseconds of low level and 70 microseconds of high level;

The data "0" and bit data "1" format signal are shown in figure 23:

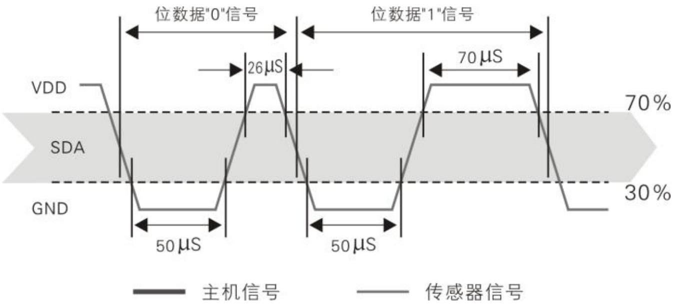


Figure 23: single bus decomposition sequence diagram

After the data bus SDA of AM2322 outputs 40 bits of data, it continues to output the low level 50 microsecond and then the input state, because the upper pull resistance then becomes high level.At the same time, AM2322 internal retest environment temperature and humidity data, and record the data, the test record is over, and the single chip automatically enters the dormant state.Only after receiving the initial signal from the host, the single chip can reawaken the sensor and enter the working state.

8.3.5 Peripheral read flow chart

AM2322 sensor read single bus flowchart diagram as shown in figure 24, at the same time, our company also provides a C51 read code sample, need to download the client, please visit our company website (www.aosong.com) to download, this specification does not provide code instructions.

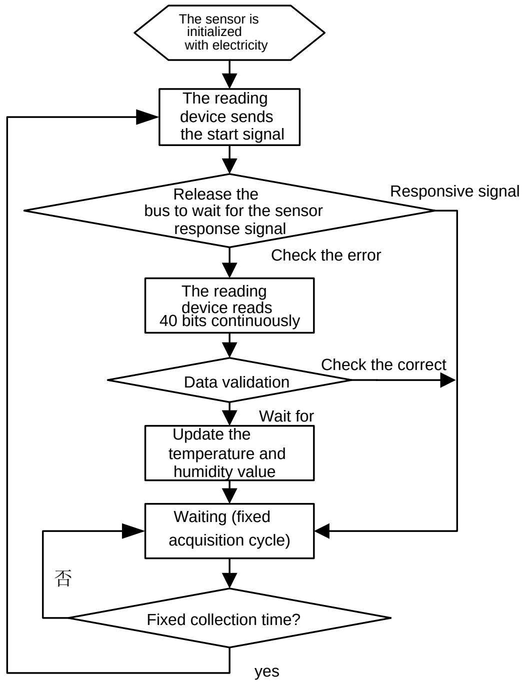


Figure 24: single bus reading flow chart

九、Application information

1. Work and storage conditions

The proposed working range may result in a temporary drift signal of up to 3% RH.
After returning to the normal working bar, the sensor will slowly recover from the calibration status.
To speed up the recovery process, see "recovery processing".
Prolonged use of non-normal working conditions will accelerate the aging process.
Avoid placing components in a dry and exposed environment for long periods of time.
A, salt fog
B, acidic or oxidized gases, such as sulfur dioxide, hydrochloric acid
Recommended storage environment
Temperature: 10~40 degree humidity: 60%RH

2. Exposure to chemicals

The induction layer of the capacitive humidity sensor is disturbed by chemical vapor. The diffusion of the chemical in the induction layer can lead to the drift of measured value and the decrease of sensitivity.
In a pure environment, the pollutants will release slowly.
The recovery process described below will speed up the implementation of this process.
A high concentration of chemical pollution can lead to complete damage to the sensor layer.

3. Temperature influence

The relative humidity of the gas depends largely on temperature.
Therefore, when measuring humidity, it is necessary to ensure that humidity sensors work at the same temperature.
If Shared with electronic components heat released a printed circuit board, should as far as possible when installing the sensor away from the electronic components, and installed at the bottom of the heat source, and at the same time to keep the good ventilation of the enclosure.
In order to reduce heat conduction, the copper plating of the other parts of the sensor and the printed circuit board should be as minimal as possible and allow a gap between the two.

4. Influence of light

Prolonged exposure to sunlight or intense ultraviolet radiation can degrade performance.

5. Recovery processing

The sensor, placed under extreme working conditions or chemical vapor, can be restored to the on-time status of the school by the following processing procedure.
Maintain 2 hours (drying) at 45 degrees and < 10%RH humidity.
Then in about 20 to 30 ÿ, and > 70% RH humidity to keep more than 5 hours.

6. Matters needing attention

The quality of the signal wire can affect the communication distance and the quality of communication.

7. Welding information

Manual welding, the contact time must be less than 10 seconds at maximum 300 degrees.

8. Product upgrading

Please refer to our technical department.

十、 License agreement

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Do not apply this product to safety protection device or emergency stop equipment, as well as any other applications that may cause bodily injury due to malfunction of this product.This product shall not be applied 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.If not complying with this advice, may result in death or serious bodily injury, the company will not assume the resulting all the compensation of personal injury and death, and thus for company managers and employees as well as auxiliary agents, distributors of any claim, including: all kinds of costs, damages, attorney fees, etc.

十二、Quality assurance

The company's direct buyer of its products shall provide quality assurance for 12 months (one year).
The technical specifications of the data manual for the product published by the company shall prevail.
If the product is defective in the warranty period, the company will provide free maintenance or replacement.Users shall meet the following conditions:
The product shall notify the company in writing within 14 days of discovery of defect;
The product shall be returned to the company by the buyer.
The product should be in the warranty period.
The company is solely responsible for the products that have been used to meet the technical conditions of the product.The company does not make any warranties,