AM2322 Product Manual

Temperature and humidity sensor

- Fully calibrated
- Digital signal output
- Excellent long-term stability
- Low power consumption, high cost performance
- Standard I2C bus output
- Standard single bus output

Product reviews

AM2322 digital temperature and humidity sensor is a contain calibration digital composite signal output of the temperature and humidity sensor. Using special technology of collecting the data of temperature and humidity, ensure that the product has a very high reliability and excellent long-term stability. Includes a capacitive moisture sensor element and a high precision integrated temperature measuring element, And connected to a high performance microprocessor. The product has excellent quality, super fast response, strong anti-interference ability, extremely high performance-price ratio. AM2322 communication mode using single bus and standard I2C , two kinds of communication mode. Standard single bus interface, make the system integration becomes simple and fast.

Super small volume, low power consumption, signal transmission distance of 20 meters, making it a all kinds of application of the best choice for even the most demanding applications. I2C communication mode with a standard communication sequence, the user can be directly hung on I2C communication bus, no additional wiring, simple to use. Two kinds of communication mode is used directly output after temperature compensation, humidity, temperature and calibration of CRC and other digital information, users need to secondary calculation of digital output, No need to compensate the temperature humidity, accurate temperature and humidity information can be got. Two kinds of communication mode are free to switch, users can choose, easy to use, wide application field. Product is 4 wire, convenient connection, special packaging format can be provided according to user requirements.

Applied range

Hvac, dehumidifier, testing and inspection equipment, consumer goods, automobile, automatic control, data recorder, meteorology station, home appliance, humidity control,medical treatment and other related temperature and humidity detection control.

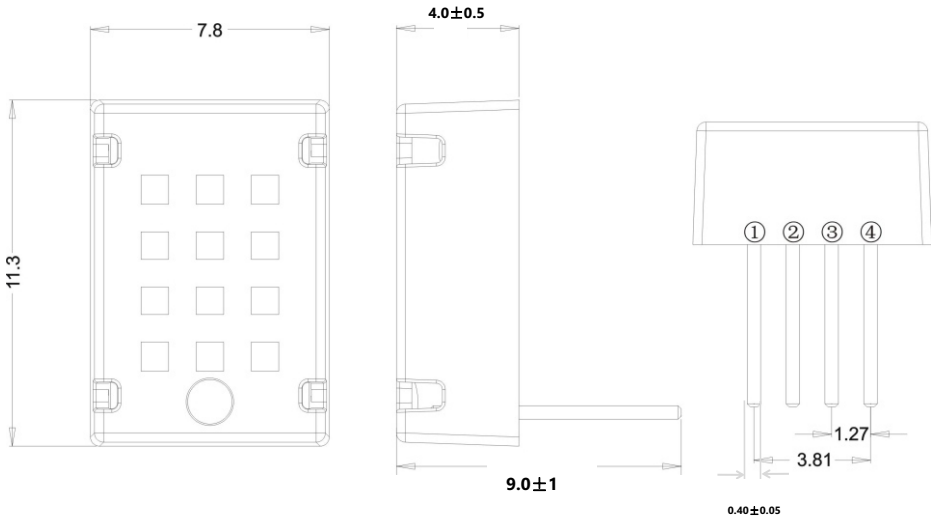

Figure 1:AM2322 shape inch (Unit: mm Not specified tolerance: ±0.2mm)
External Interface: 1:VDD 2:SDA 3:GND 4:SCL

Sensor capability

Relative humidity

parameter	condition	min	typical	max	unit
resolution	typical		0.024		%RH
Accuracy error [1]	typical		±2		%RH
	max		See Figure 2		%RH
repeatable			±0.1		%RH
hysteresis			±1		%RH
nonlinear			<0.1		%RH
Response time	t 63%		8		S
Scope of work	extended [3]	0		100	%RH
Prolonged Drift	normal		<1		%RH/yr

Table 1 Table of humidity characteristics

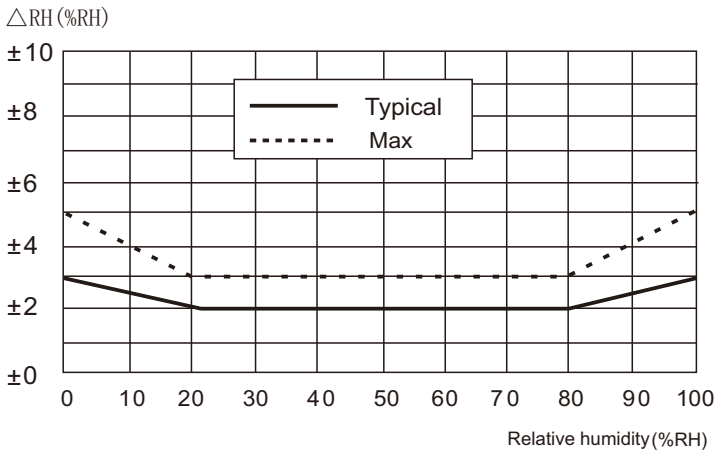

Figure 2 Maximum error in relative humidity at 25°C

Temperature

parameter	condition	min	typical	max	unit
resolution	typical		0.01		℃
Accuracy error [1]	typical		±0.3		℃
	max		See Figure 3		℃
repeatable			±0.1		℃
hysteresis			±0.1		℃
nonlinear					℃
Response time	t 63%	5		30	S
Scope of work	extended [3]	-40		80	℃
Prolonged Drift	normal		<0.1		℃/yr

Table 3 Temperature characteristics table

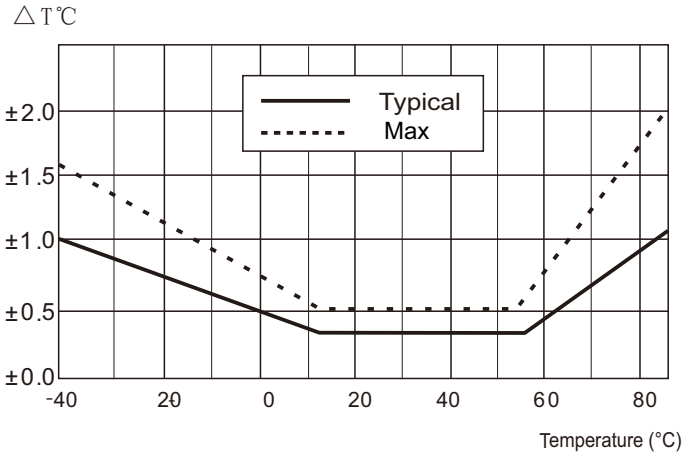

Figure 3 Typical and maximum temperature errors

Electrical specification

Parameter	Condition	min	typ	max	Unit
The power supply voltage		3. 1	5	5. 5	V
Power dissipation [5]	Sleep mode	2	15		μA
	Measure		1200		μA
	Average		600		μA
Low level output voltage	I_{OL} [6]	0		300	mV
High level output voltage	Rp<25 kΩ	90%		100%	VDD
Low level input voltage	Decline			30%	VDD
High level input voltage	Rise	70%		100%	VDD
Rpu [7]	VDD = 5V VIN = VSS	1	5. 1	100	kΩ
The output current	Open		8		mA
	Tristate (close)	10	10		μA
Sampling period		2			S

Table 2 Electrical characteristics

1 Work scope: 0-80% RH, beyond this range, sensor readings will have deviation (H humidity 90% after 200 hours, drift < 3% RH). The scope of work further limit in - 40-80 ℃.

2 The accuracy of factory inspection, sensors in 25 ℃ under the condition of the power supply voltage of 5 v test precision .This value does not include the hysteresis and nonlinear and applies only to the cooling conditions.

3 25 ℃ and 1 m/s air conditions, 63% of first order responsetime.

4 If the sensor is surrounded by volatile solvent , with a pungent odor tape, adhesives and packaging materials, reading may be on the high side.Details please refer to the relevant documents.

5 Minimum and maximum values are based on the power consumption of VDD = 5 v and T < 60 ℃ condition. In the average of every two seconds, the value of ameasurement.

6 Low-level output current.

7 Denotes the pull-up resistance.

8 The response time depends on the thermal conductivity of the sensorsubstrate.

AM2322 User Guide

1 Expansion of performance

1. 1 Operating conditions

The performance of the sensor is stable within the recommended operating range. See Figure 4. Long-term exposure to conditions outside the normal range, Especially when the humidity > 80%, may cause signal temporary sexual drift (drift +3%RH after 60 h). When to return to after normal working conditions, the sensor will slowly recover to school positive state. See "Recovery Processing" in section 2.3 Accelerate the recovery process. under abnormal conditions for a long time use , will accelerate the aging of the product.

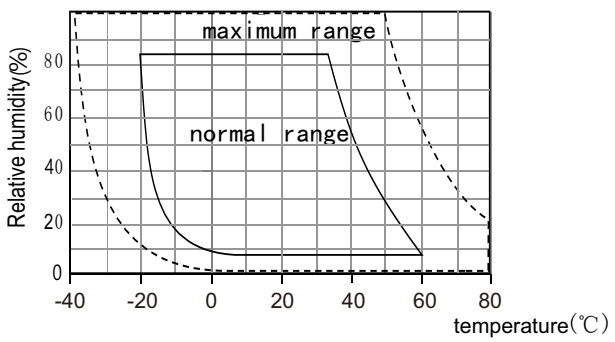

Figure4: Working conditions

1. 2 RH accuracy at different temperatures

The RH accuracy at 25℃ is defined in Figure 2 and shown in Figure 5 maximum humidity error in other temperature segments.

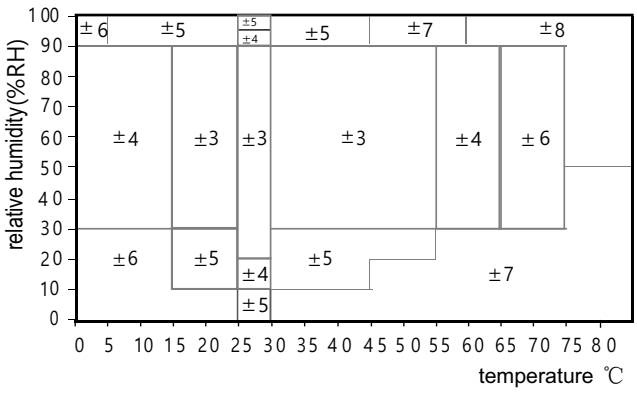

Figure 5 : The maximum error of humidity in the range of 0~80 ℃, unit: (%RH)

Note : the above error is a typical high precision Dew-point meter for your reference instrument testing in error (not including hysteresis).ranges, the typical value is 1/2 of the maximum error value.

2 Applications

2.1 Storage conditions and operating instructions

Humidity Sensitivity Level (MSL) is 1, according to 1PC/JEDEC.J-STD-020 standard. Therefore,it is recommended to be used within one year after shipment.Temperature and humidity sensors are not ordinary electronic components and require careful protection, which the user must pay attention to. Prolonged exposure to high concentrations of chemical vapors will cause the sensor's readings to drift. It is therefore recommended that the sensor be stored in its original packaging, including a sealed ESD pocket, and under the following conditions: Temperature range 10℃-50℃ (0-85℃ for a limited time); humidity 20- 60%RH (for sensors without ESD package). For those sensors that have been removed from their original packaging , we recommends to ring them in an ESD bag made of PET/AL/CPE metal inside. The anti-static bag. During production and transport, the sensor should be protected from high concentrations of chemical solvents and prolonged exposure to the elements. Avoid contact with volatile glues, tapes, stickers or volatile packaging materials such as blister packs, foams, etc. The production area should be well ventilated.

2.2 Restoration processing

As mentioned above, readings can drift if the sensor is exposed to extreme operating conditions or chemical vapors. It can be brought back to calibration by the following treatments.Drying: 10 hours at 80-85°C and <5% RH humidity Re-hydration: 24 hours at 20-30°C and >75% RH.

2.3 Temperature effects

The relative humidity of a gas is very much dependent on temperature. When measuring humidity, therefore, it should be ensured, as far as possible, that all sensors measuring the same humidity are operating at the same temperature. When doing the test, ensure that the sensor under test and the reference sensor are at the same temperature and then compare the humidity readings.

In addition, when the measuring frequency is too high, sensor's temperature rises and affect measurement accuracy. If you want to ensure That its own temperature rise of less than 0. 1℃, the activation of AM2322 time should not exceed 10% of the measurement of time suggest data measured once every 2 seconds.

9 75% RH can be readily generated from saturated NaCl

2. 4 Product Application Scenario Design

Many materials absorb moisture and will act as buffers, increasing response time and lag. Therefore, the material around the sensor should be carefully selected. The recommended materials are: metal materials, LCP, POM (Delrin), PTFE (Teflon), PE, PEEK, PP, PB, PPS,PSU, PVDF,PVF.

Material for sealing and bonding (conservative Recommendation) : It is recommended that the electronic components be encapsulated with epoxy resin, or silicone. Gases released by these materials may also contaminate AM2322(see 2.1). Therefore, the sensor should be finally assembled and placed in a w ell ventilated place, or dried in >50 ℃ environment for 24 hours , so that it will release the polluting gas before packaging.

3 Interface definition

Pins	Name	Describe
1	VCC	Supply voltage
2	SDA	Serial Data, Bidirectional Port
3	GND	Ground
4	SCL	Serial clock line

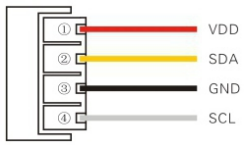

Figure 6: AM2322 wiring diagram

3.1 The power supply pins（VDD,GND）

AM2322 spoon power supply range of 3.1-5.5 V, recommend to voltage 5v.

4 Electrical characteristics

4.1 Absolute maximum rating

AM2322 electrical properties de fined in table 2. As for the maximum rating as given in table 4. Insuch conditions, the device for function operation is not Desirable. Prolonged exposure to absolute maximum rating conditions, mayAffect the reliability of the sensor.

Parameter	Min	Max	Unit
VDD to GND	- 0.3	5.5	V
Digital I/O pins (SDA) to GND	- 0.3	VDD + 0.3	V
The input current of each pin	- 10	10	mA

Table 4 Electric absolute maximum rating

ESD static discharge according to JEDEC JESD22 -A114 (human mode ± 4KV), JEDEC JESD22-A115 (machine mode ± 200V). If the test conditions exceed the nominallimits, the sensor requires additional protection circuitry .

4. 2 Input／Output characteristics

Electrical characteristics , such as power consumption, the high and low level of input and output voltage, etc. , depends on the power supply voltage. In order to make the sensor communication is smooth , it is important to ensure that the signal design strictly limited scope as given in table 2 and figure 10.

5 I2C communication protocol

5.1 Introduction to I2C Bus

The interface form of AM2322 and microprocessor is I2C serial bus. The I2C bus protocol standard is brie fly introduced here. Due to the space limitation, it is impossible to list all contents of the agreement. For further problems, please refer to relevant information (please refer to the website of Philips).

5.2 Overview of I2C Bus

Philips of more than 20 years ago created a simple two-way two wire serial communication bus,the bus is called system-I2C. The I2C bus has become the industry standard of the embedded application solutions, are widely used in various professional based on micro control unit, consumption and telecommunication products , as a control, diagnosis and power management bus. More than I2C bus standard components can all be the same of I2C bus to communicate , without the need to address decoder. Need only I2C bus consists of two signal lines,is a serial data line SDA, the other is a serial clock line SCL, generally has I2C bus device, the SDA and SCL pins are drain open or open collector output structure. So the actual when using, SDA and SCL signal lines will be must be combined with pull resistance (Rp, Pull-Up Resistas) resistance generally 3 to 10k values. Therefore, when the bus is idle, the two signal lines all maintain a high level, almost no current consumption ; Electrical good compatibility , support a variety of different voltage logic device interface; Different between two bus can be directly connected, requires no additional conversion circuit , support for multiple communication from more than a master is the most common way of communication. In addition to support more than double host communication,communication and broad casting mode , and so on. I2C typical configuration as shown in figure7.

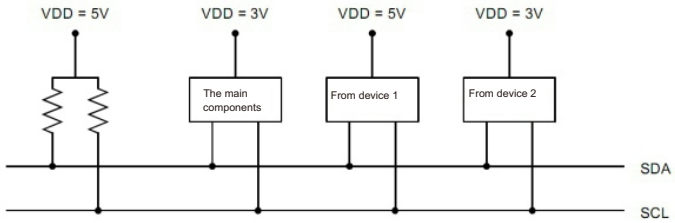

Figure 7: typical I2C configuration

5.3 I2C bus protocol specification

◎ I2C Term definitions

I2C bus through serial data on the SDA and the serial clock SCL line is connected to the bus, the device information transmission between each device has a unique address recognition, and can be used as a transmitter or receiver (determined by the function of the device), when performing data transmission device also can 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. At this point, any device addressed is considered to be from the machine.The I2C bus terminology definitions are detailed in Table 5.

◎ I2C bus transmission speed

The communication rate of I2C bus is controlled by the host, which can be fast or slow. However, the maximum rate is limited, and the data transfer rate on the I2C bus can be as high as 100 b/s in standard mode.

◎ I2C bus bit transfer

I2C bus transmission is through the data line SDA and SCL clock line two lines together. During the high level of SCL clock line and data line SDA logic level to low level said current transmission "0"; During the high level of the clock line SCL The data line SDA for high level according to the current transmission logic level "1". Logic "0" (low) and "1"(high) level, is determined by the relevant level of VDD (see table 2 AM2322 electric property table) . At the same time for every transmission data bits produces a clock pulse.

Table 5: Definitions of I2C bus terms

Term	Describe
TRansmitter	A device that sends data to a bus
Receiver	A device that receives data from a bus
Host	Initialization sending the clock signal and terminate the sending device
Slave	A device addressed by the host
Multiple host	More than one host simultaneously attempts to control the bus without destroying the message
Arbitrament	A process in which multiple hosts attempt to control the bus at the same time but allow only one of them to control the bus and keep messages from being corrupted
Synchronous	A process in which multiple hosts attempt to control the bus at the same time but allow only one of them to control the bus and keep messages from being corrupted

◎ Validity of data

Data line SDA data must remain stable in the high level of the clock cycle. Cable high or low level state of the SDA only during the clock line SCL is in low level are allowed to change. But at the beginning and end of the I2C bus exception (details see the start and stop condition). Some other serial bus can specify data in the edge of the clock signal (along the rising or falling) effectively, it is I2C bus level effectively. Specific sequence diagram as shown in figure 8.

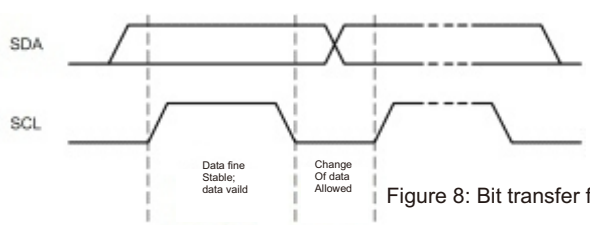

Figure 8: Bit transfer for the I2C bus

◎ Start and stop conditions

Starting conditions: when the SCL at a high level during the SDA from high level to low level jump starting conditions.The bus after the initial conditions and is in a state of busy starting conditions often shorthand for S.

Stop condition: when the SCL at a high level during the SDA from low level to high level jump stop , when conditions. The bus is idle after stop conditions. Stop condition is shorthand for P. start and stop conditions diagram is shown in figure 9.

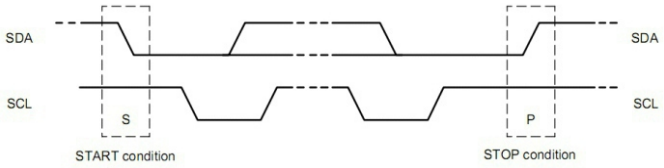

Figure 9 : schematic start and stop conditions

◎ Byte transfer format

The I2C bus sends and receives data in bytes.Each byte transmitted to the SDA line must be 8 bits. There is no limit to the number of bytes per transfer The highest bit of data (MSB bit 7) is transferred first, and the lowest bit (LSB, bit 0) is transferred last. In addition each byte must befollowed by a response bit (ACK). The I2C transfer data is shown in Figure 10.

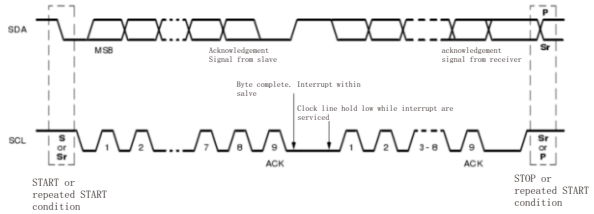

Figure 10: Data transfer on the I2C bus

◎ I2C bus response

During data transmission on the I2C bus, each byte is followed by a reply status bit. The receiver can receive data via the reply bit Tell the sender. Response a clock pulse is generated by the host, while answering a state of the data to follow the principle of "whoever receives", which is always generated by the receiver response, in response to the receiver during the clock pulse of the SDA line must be lower, making it the clock pulse remained stable during the period of the high level of low level (see figure 11), of course must be taken into account to build and maintain time (details please refer to table 7). When the host sends data to the slave, the reply bit is generated by the slave. When the host receives data from the slave, the reply bit is generated by the host.

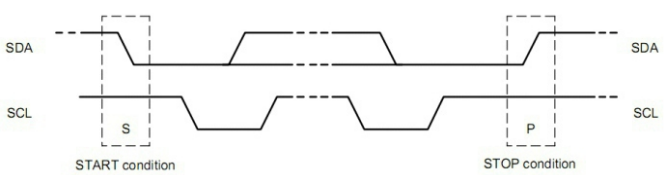

Figure 11: start and stop conditions

◎ Slave address

I2C bus does not need additional address decoder and select signal. Multiple has I2C bus interface device can be connected to the same article I2C bus, cattle by device address to distinguish between them. I2C 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 definition as shown in figure 12, 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 chosen from the machine; "1", said the opportunity to read information from machine.

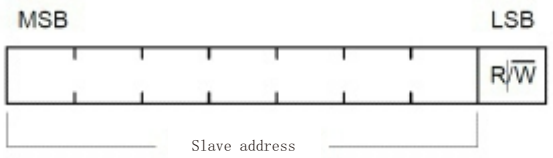

Figure 12: the first byte after starting conditions

Send an address, each device in the system after the starting conditions, head seven if compared with its own address, device will think it is the host address, as for the receiver or transmitter from the machine from machine are determined by the R/W bit. Host is the master device, it does not require the device device address, and other devices belong to from the machine, to have the device address.Must ensure that the same article I2C on the bus all the address from the machine is the only sure, there can be repeated, or I2C bus will not work properly.

◎ Basic data transmission formats

Figure 13 and Figure 14 show the basic formats of I2C's sending and receiving data, respectively. It should be noted that, unlike Figure 17, in Figure 13,when the host sends the last byte of data to the slave,the slave may or may not reply, but either way the host can generate a stop condition. If the host detects that the slave is not answering when sending data to the slave (even including the slave address) , the Transmission should be stopped promptly.

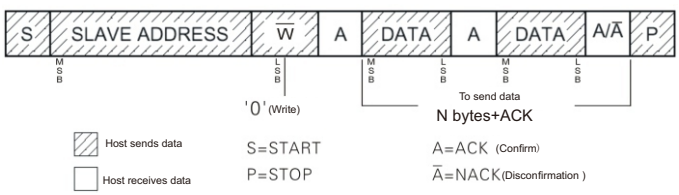

Figure 13: I2C bus host from machine to send data to the basic format

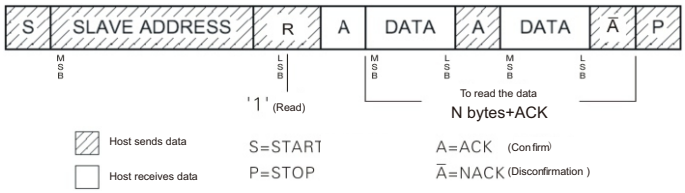

Figure 14: I2C bus host from the basic format of receiving data from the machine

5.4 AM2322 sensor I2C communication protocol

AM2322 serial interface for I2C bus, completely according to I2C standard protocol addressing, can be directly hung on the I2C bus On.AM2322 sensor I2C ADDRESS (SLAVE ADDRESS) to 0xb8, based on the agreement of the I2C standard bus and based on the ModBus protocol, made the unique communication association Discussion and reduce the transmission error rate. Micro control unit to read AM2322 sensing, please in strict accordance with the I2C_modbus AM2322 sensors communication protocol in time sequence.

5.4.1 I2C interface description

AM2322 digital temperature and humidity sensor as slave, and the communication mode between the host (user microprocessor) adopts the standard I2C bus mode. In order to accurately measure the environmental humidity and reduce the influence of temperature on humidity, The AM2322 sensor will automatically turn into a dormant state during non-working period to reduce the work consumption and reduce the influence of the sensor's own heating on the ambient humidity value. The working mode Of AM2322 adopts the passive type, that is, after the host awakens the sensor through instructions, it sends corresponding instructions and reads the corresponding temperature and humidity values. After the communication,the sensor triggers the sub-temperature and humidity collection; Therefore, if the sensor has not been read for along time, please read the sensor twice consecutively (the minimum interval of two reads is 2S), and take the second value as the latest measured value; After the acquisition,the sensor will automatically turn to sleep state. The next time the host needs to read the sensor again, the sensor should be reawakened. It should be noted that the maximum time for host communication is 3S from start to finish. If the communication is not completed within 3S, the sensor will automatically end the communication and automatically turn to sleep state. If the host wants to read the sensor again, it needs to send the wake instruction again.

5.4.2 I2C interface characteristics

This section introduces the AM2322 I2C interface characteristic of sensor, with sensors to obtain the best effect of communication, the design, please strictly follow the design of figure 15 and the conditions of table 6.

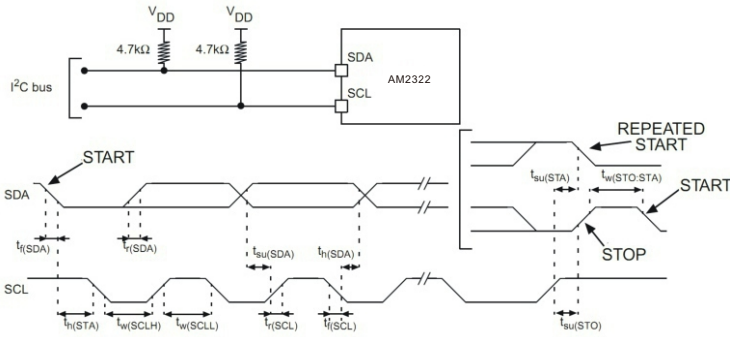

Figure 15: AM2322 typical I2C bus application circuit and sequence diagram

Table 6: Interface characteristics of AM2322 sensor I2C

Symbol	Parameter	Standard I2C mode		Units
		min	max	
SCL clock frequency			100	kHz
tw(SCLL)	Low SCL clock time	4.7		μs
tw(SCLH)	High SCL clock time	4.0		
tsu(SDA)	SDA setup time	250		ns
th(SDA)	SDA data hold time	0 [1]		
tr(SDA) tr(SCL)	SDA and SCL rise time		1000	
tf(SDA) tf(SCL)	SDA and SCL down time		300	
th(STA)	Start condition holding time	4.0		μs
tsu(STA)	Repeat the start condition setup time	4.7		
tsu(STO)	Stop condition setup time	4.0		μs
tw(STO:STA)	Stop to start conditional time (bus idle)	4.7		μs
Cb	Capacitive load per bus		400	pF

I2C AM2322 sensor communication protocols, is the standard I2C bus protocol, on the basis of reference to the ModBus protocol,according to its own characteristics, AM2322 sensor , a blend of I2C_modbus agreement.Specific format is as follows:

◎ Communication data (information frame) format

The data format:	I2C address + R/W	Function code	Data area	CRC check[3]
The data length:	1 byte[2]	1 byte	N byte	16-bit CRC code (Redundant cyclic code)

[1] if the interface is not allowed to extend the time of low level, then only need to comply with the longest holding time starting conditions.
[2] 1 byte is composed of 8 bit binary number (8 bit).
[3] CRC checking algorithm, See below in detail; the calculation method of CRC code, See below in detail.

◎ The process of transmitting communication information

When communication command sent by equipment(host) sent to the sensor, the sensor I2C address command , sensor to receive, and according to the function code and the related request read information; And then give the execution results(data) to return to the host. Return information includes function code , after execution of data and CRC check code (users can not read the CRC, can be directly sent to stop condition.

◎ Communication I2C slave address

AM2322 sensor each I2C address are the same, and 0xb8, so on the same bus can only hang a AM2322 sensors, sensor the starting signal has been received and with I2C address itself will host response at the same time.

◎ communication function code of I2C

Function code is every time communication information transmit the first byte of the frame. I2C_modbus communication rules , can define the function of the code is 1 to 127, as a host request,through the function code tell what action should be performed from the machine. As a response from the machine, the function of return from machine code and sent from the host to the function of the code, the show from the machine has been in response to Host and related operations. I2C_modbus section function code are shown in table 7.

Table 7: partial function codes of I2C_ModBus

Function code	Definition	Operation(binary)
0x03	Read the register data	Reads one or more register data
0x10	Write multiple registers	The more groups of binary data to multiple registers

◎ The data area for communicating I2C

The data area includes what information needs to be returned by the sensor or what action needs to be performed. This information can be data (such as temperature, humidity values, sensor device information, user write data , etc.), reference addresses, etc. For example, the host tells the sensor through function code 03 to return the value of the register (including the starting address of the register to be read and the length of the register to be read), then the data returned includes the length of the register and the content of the register. The sensor adopts the custom I2C_MODBUS communication protocol, and the host can arbitrarily read its data register by using the communication command (function code 03). The table of data register is shown in Table 8. The data register of the sensor stores the temperature and humidity values , the information of the corresponding equipment of the sensor and other relevant signals. Each data store should be a single byte (8 bits) of binary data; Up to 10 registers of the sensor can be read at one time. If the reading length is exceeded, the sensor will return the corresponding error code. The error code information is shown in Schedule 1.

Table 8: AM2322 data register table

Register Information	Address	Register Information	Address	Register Information	Address	Register Information	Address
High humidity	0x00	Equipment model and high position	0x08	User register 1 high	0x10	Reserve	0x18
Low humidity	0x01	Equipment model and low position	0x09	User register 1 low	0x11	Reserve	0x19
High temperature	0x02	Version number	0x0A	User register 2 high	0x12	Reserve	0x1A
Low temperature	0x03	The device ID (24 -31) Bit	0x0B	User register 2 low	0x13	Reserve	0x1B
Reserve	0x04	The device ID (16 -23) Bit	0x0C	Reserve	0x14	Reserve	0x1C
Reserve	0x05	The device ID (8-15) Bit	0x0D	Reserve	0x15	Reserve	0x1D
Reserve	0x06	The device ID (0 -7) Bit	0x0E	Reserve	0x16	Reserve	0x1E
Reserve	0x07	State register	0x0F	Reserve	0x17	Reserve	0x1F

◎ Temperature output format

The temperature resolution is 16 bits, the highest temperature bit (Bit15).Equal to 1 means negative temperature, and the highest temperature bit (Bit15) equals 0 means positive temperature. Temperature except for the highest bit(Bit14 Bit0) represents the temperature value of the sensor string.The temperature value produced by the sensor is 10 times of the actual temperature value.

◎ The status register

Status register, Bit7-Bit0, reserved temporarily.

Status register bit	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Function Introduction	Reserve	Reserve	Reserve	Reserve	Reserve	Reserve	Reserve	Reserve

◎ Introduction to I2C _ModBus function code

1.Function code "03" : read sensor multiplexing register

Host send reading frame format:
START + (I2C address + W) + function code (0 x03) + START address + Number of registers + STOP

Host read return data:
START + (I2C address + R) + Continuously read the data returned by the sensor + STOP

Sensor response frame format:
Function code (0x03) + Number of registers + data +CRC[1]

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

The address and data of the sensor data register are:

Register address	Register data	Data declaration	Register address	Register data	Data declaration
0x00	0x01	High humidity	0x02	0x00	High temperature
0x01	0xF4	Low humidity	0x03	0xFA	Low temperature

Format of message sent by host:

Host transmission	The number of bytes	Message sent	Note
Sensor address	1	0xB8	Sensor I2C address (0xB8) + W (0)
Function code	1	0x03	Read the register
The starting address	1	0x00	The register start address is 0x00
Register number	1	0x04	Read the register number

Sensor response returned message formats:

The response from the machine	The number of bytes	Message sent	Note
Function code	1	0x03	Read the register
Returns the number of bytes	1	0x04	Return four register a total of four bytes
Register 1	1	0x01	Contents of address 0x00 (humidity high bytes)
Register 2	1	0xF4	Contents of address 0x01 (humidity low bytes)
Register 4	1	0x00	Contents of address 0x02 (temperature high bytes)
Register 5	1	0xFA	Contents of address 0x03 (temperature low bytes)
CRC code	2	31A5	The sensor computes the returned CRC code, with the low byte before

[1] : The calculation of CRC check is detailed in the following INTRODUCTION of CRC check. All data returned by the sensor have CRC check, and the user can choose to take or not read.

Value 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 units for ℃, humidity units for % RH. For example, read back above data:

Humidity: 01F4 = 1×256+15×16+4 = 500
=>Humidity = 500÷10=50.0%RH;

Temperature: 00FA= 15×16+10 = 250
=>Temperature = 250÷10 = 25.0℃

Note: the CRC verification code can be obtained from the calculation of the CRC code , and then compared with sensors CRC code; The same the think data reception right, otherwise, think that there is error data.
2.The function code "10" : to write multiple sensor registers host t he function code can be used to store multiple data into the register of sensors. Single AM2322 sensors A register is 1 byte, or 8 bits. Sensor once allowed to save up to 10 data registers. Therefore, the host single save 10 registers the multidirectional sensors. More than 10, the sensor will return the corresponding error code.
The host sends the write frame format:
START + (I2C address + W) + function code (0x10) + article starting address + number of register + data + CRC + STOP
Host read that command:
START+ (I2C address + R) + Continuously read the data returned by the sensor + STOP

Sensor response frame format:
Function code (0x10) + start address + number of registers + CRC

For example: the host to 01 and 02 saved to the address as 10 and 11 of the sensor registers.

Format of message sent by host:

Host transmission	The number of bytes	Message sent	Note
Sensor address	1	0xB8	Sensor I2C address (0xB8) + W (0)
Function code	1	0x10	Write multiplexer registers
The starting address	1	0x10	The starting point t of the register to be written
Save the data length	1	0x02	Word length to save data (2 words in total)
Preserve data 1	1	0x01	Save data (Address: 10)
Preserve data 2	1	0x02	Save data (Address: 11)
CRC code	2	C092	The host calculated CRC code and the low byte in the front (I2C address is not included in the CRC calculation)

Format of message returned by sensor response:

The response from the machine	The number of bytes	Message sent	Note
Function code	1	0x10	Write multiplexer registers
The starting address	1	0x10	Save the starting address
Save the data length	1	0x02	The length of data saved by the sensor
CRC code	2	FC04	The sensor computes the returned CRC code, with the low byte before

◎ CRC check

The discriminant receiving host or sensors available check code 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 safetyand efficiency ofthesystem.I2C_modbus communication protocol of CRC (redundant Loop Code) contains 2 bytes, namely 16-bit binary number. CRC code by sending equipment (host), placed in, the tail of the send information I2C address is not included in CRC calculation. CRC either sent or received by the low byte in the former, high byte in the format. Receive information equipment (sensor) to receive information of CRC calculation, again more calculated CRC is consistent with the received, if the two is not consistent, is wrong. Users need to pay special attention to, read sensor instructions without add CRC check; Write a sensor, necessary and CRC check; And all return data with CRC.

◎ CRC code calculation method

1. Preset a 16-bit registers for hexadecimal FFFF (that is, the total for 1); Called the register for CRC register;
2. The first eight binary data (communication and information both frames the first byte) and 16-bit CRC register low 8 dissimilar or, put the result in CRC register;
3. Move the contents of the CRC register right a (the) low with fill the highest, and check the moves to the right after the shift stand out; Would stand out ;
4. If moving stand out as 1: repeat step 3 (again right shift) ;if moving stand out as 1: CRC register with polynomial A001 xor (1010, 0000, 0000, 0001);
5. Repeat steps 3 and 4, 8 times, until he moves to the right so that the whole 8 bits of data processing;
6. Repeat steps 2 through 5, communicate information frame next byte processing;
7. The communication information frame, after the completion of all bytes according to the above steps to calculate Six CRC register of high and low byte exchanged;
8. The resulting CRC register content is: CRC code.

◎ CRC code of C language calculation code

Description: this program before * PTR calculated length len bytes of CRC code

```
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;
}
```

5. 4. 3 I2C communication timing

The I2C communication mode of AM2322 sensor is in accordance with the standard I2C communication timing, but it must be in accordance with our communication protocol and communication timing requirements to accurately read and write the sensor Please read in strict accordance with the communication protocol in a timely manner

◎ I2C read and write complete timing example

Figure 16 shows a complete example of a read-write sensor and the special time requirements for reading and writing . Please read and write in strict accordance with the special time requirements, otherwise the sensor can not be read or the data is incorrect. Several timing sequences in the figure deserve special attention, as detailed in the time requirements in the figure ; The maximum host communication time is 3S from start to finish.

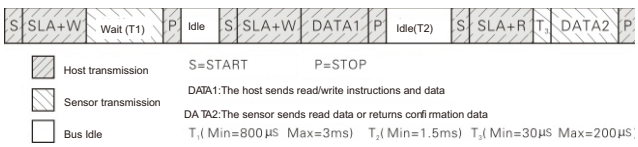

Figure 16： I2C read-write sensor complete example figure

◎ I2C read-write time sequence decomposition

To read or write sensor, it is necessary, according to these three steps will not be able to communicate or won't be able to read the correct number:

Step one: wake sensor

In order to reduce the humidity error caused by the heat of the sensor itself, the sensor is in a non- working state and is in a dormant state. Therefore, to read the sensor, it must first wake up the sensor before sending read and write instructions, otherwise the sensor will not respond.It should be noted that when the sensor is awakened, the sensor will not respond to the ACK if the I2C address is sent, but the host must send the clock to confirm whether the ACK is returned, that is, the ninth SCL clock signal. The operation to wake up the sensor is as follows:After the host sends the starting signal plus the starting address, it waits for a period of time (the waiting time is at least 800 us, and the maximum is 3ms; If the host is hardware I2C, there is no need to wait, and hardware I2C will automatically wait), and then send a stop signal. That is: start signal + 0XB8 + wait (800us-3ms) + stop

shown in figure 17.

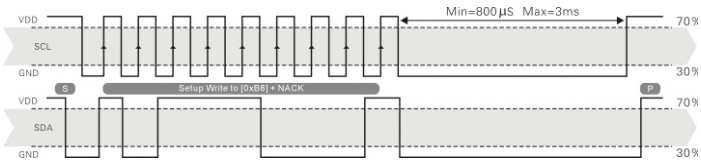

Figure 17: Wake up sensor

Step two: Send read or write instructions

After waking up the AM2322 sensor, you can read and write in full I2C with a maximum speed of 100Kb/s. Read the temperature and humidity example, As shown in Figure 18. The host sends instructions as: START + 0xB8 (SLA)+0x03 (function code)+ 0x00 (starting address) + 0x04 (register length)+ STOP

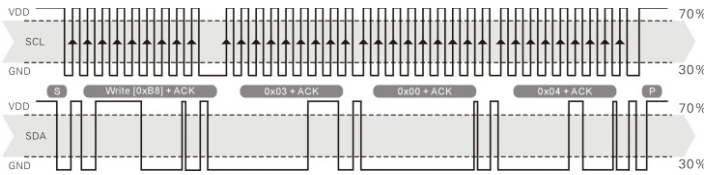

Figure 18: Sending an example read temperature and humidity instruction

Step three: reading data returned or acknowledgments

Send a read/write command, the host needs to wait at least 1.5ms, and then send to readsequence, read the data returned sample as shown in figure 19. Is important to note that when You read the data, after sending the I2C address, need to wait at least more than 30us again send next serial clock , read data, or communication will appear error.

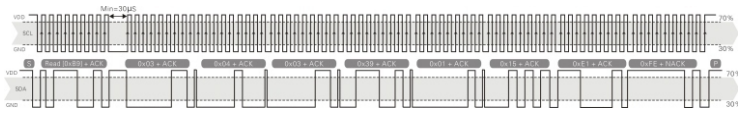

Figure19: Example of reading temperature and humidity values

Host read back the data as follows:
0x03 (function code) + 0x04 (data Length) + 0x03 (high humidity) + 0x39 (low humidity) 0x39 (low humidity)+ 0x01 (high Temperature) 0x15 (low temperature) + 0xe1 (CRC check Code low byte) + 0xFE (CRC check Code high byte);

So: 0339H = 3×256+3×16+9 = 825 =>
Humidity = 825÷10=82.5%RH;
0115H = 1×256+1×16+5 = 277 =>
Temperature = 277÷10=27.7℃

Through the above three steps can be completed all register of sensor read and write operations (the user can write registers, only five, namely the status register, four user register, at the same time, the status register, can only be written separately, otherwise an error). User, when the design must be fully in accordance with the above three steps to read and write. Sensor after sending the data, triggering a temperature and humidity measurement; Record temperature and humidity value, after the completion of measurement,communication is complete, the sensor automatically into a dormant state; So if long time not read sensor, continuous read: the data of temperature and humidity sensor, with the second read back for the latest value (continuous read the minimum interval of 25).

5.4.4 Peripherals read flowcharts

The flow diagram of AM2322 sensor reading I2C is shown in Figure 20. At the same time, our company also provides a sample of C51 reading code. For customers who need to download, please log in our company's website (www. aosong. com) for relevant downloading.

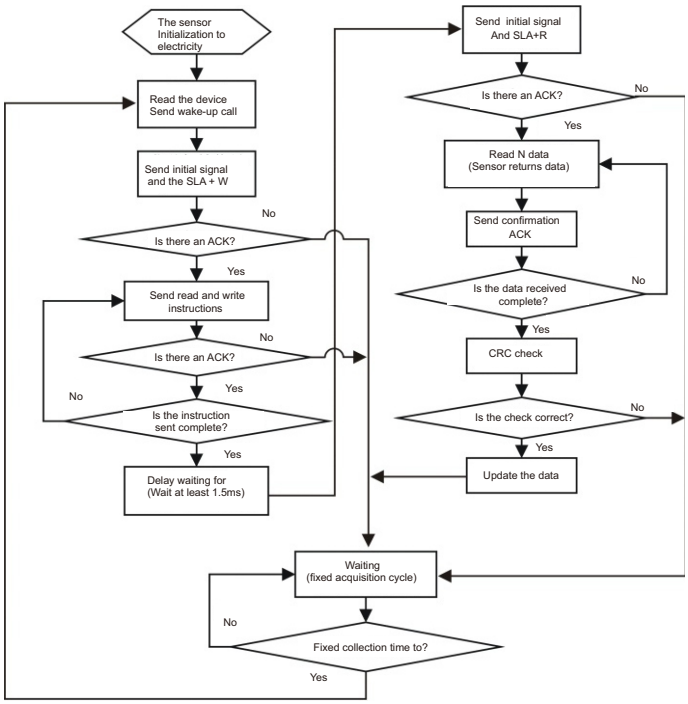

Figure 20: Sensor flow chart read with I2C

6 Single bus communication

6.1 Single bus typical circuit

Microprocessor connected with AM2322 typical application circuit is shown in figure 21. Single bus communication mode, the SDA pull-up after connected with the I/O port of the microprocessor.

Single bus communication special instructions:

1. The typical application circuit suggested in cable length less than 30 When, with 5. 1k pull-up resistors , more than 30m according to the actual situation to reduce the resistance of the resistance.

2. The cable length shall not when using 3.3 V voltage supply. In 100cm. Or line pressure drop will cause the sensor power supply shortage, Cause Measurement deviation.

3. Read sensor minimum time interval for 2s ; Read the time interval is less than 2s , can lead to temperature and humidity or communication is not allowed, you don't succeed, and so on and so forth. Sensor atthe beginning of electricity should wait for more than 2s time, to read the sensors, to overcome the instability of the transducer.

4. Every time the temperature and humidity of the readout value is the result of the last measurement, for real-time data, need to read two consecutive times, suggested that continuous read sensor for many times, and each read sensor interval greater than 2 seconds, can obtain the accurate data.

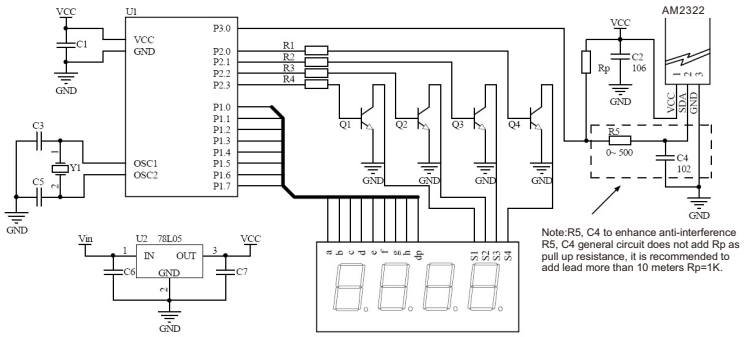

Figure 21: AM2322 single bus typical circuit

6.2 Single bus communication protocol

◎ Single bus specification

AM2322 device adopts a simplifi ed single bus communication. Single bus that is only a data line,the system of data exchange, control are completed by cable. Equipment (microprocessor) through a drain or three states open port, even to the cable to allow equipment when not to send data to release the bus, and other devices to usebus; Single bus usually require an external about 5. 1k pull-up resistor, so, 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.

◎ Single bus transmits data definition

SDA with microprocessor and AM2322 communication between and Synchronization,Using the single bus data format, send 40 data at a time, high in first out. Specific communication sequence as shown in figure 22, communication format specification are shown in table 9.

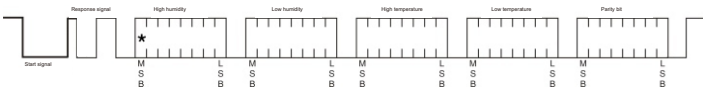

Figure 22: AM2322 single bus communication protocol

Name	Single bus format definition
Start signal	The microprocessor to pull the data bus (SDA) is low for a period of time (at least 1 ms), notify the sensor to data.
Response signal	Sensors to pull the data bus (SDA) 80 us less, after 80 us in response to a start signal in the host.
Data format	After receiving the host start signal, sensor at once from the data bus (SDA) string out 40 bits of data, high out first.
Humidity	High humidity resolution is 16 bit, in the former; Value of humidity sensor series was 10 times higher than the actual humidity value.
Temperature	The temperature resolution is 16 bit, high in the former; Series of temperature sensor was 10 times higher than the actual temperature value, the temperature is highest (Bit15) is equal to 1 for negative temperature, highest temperature (Bit15) is equal to 0 means positive temperature;In addition to the highest temperature (Bit14Bito) temperature.
Parity bit	Parity bit = humidity high + humidity low + temperature high + temperature low

Table 9: AM2322 communication format specification

◎ Example of single-bus data calculation

Example 1: the received 40 data as follows:

00000010 10010010 00000001 00001101 10100010

HH 8bits HL8bits TH8bits TL8bits Parity bit

Calculation：

00000010+10010010+00000001+00001101 = 10100010 (parity bit)

Data received correctly:：

Humidity：00000010 10010010 = 0292H(hexadecimal) = 2×256+9×16+2 = 658

=> humidity = 65.8%RH

Temperature：00000001 00001101 = 10DH(hexadecimal) = 1×256+0×16+13=269

=> temperature= 26.9℃

◎ Special note:

When the temperature is lower than 0 ℃ temperature data of the highest position 1.

Example: -10.1 ℃ represented 10000000 01100101

Temperature：00000000 01100101=0065H(hexadecimal)=6×16+5=101

=> temperature = -10.1℃

Example 2：the received 40 data as follows:

00000010 10010010 00000001 00001101 10110010

HH8bits HL8bits TH8bits TL8bits Parity bit

Calculation：

00000010+10010010+00000001+00001101 = 10100010≠10110010

(ECC Error)

The received data is not correct, give up, to receive data.

6.3 Single bus communication sequence

User host (MCU) to send a start signal (pull data bus SDA low at least 1 ms) after AM2322 from sleep mode conversion to high speed mode. To the host after the start signal, AM2322 to send response signal, from the data bus SDA serial send 40 bits of data, to send the first byte of high; Data of high humidity and low humidity, high Temperature, low temperature, parity, send data over trigger an information acquisition, acquisition end sensor automatically into sleep mode, until the next communication.

Detailed timing signal characteristics are shown in table 10, single bus communication sequence diagram as shown in figure 23.

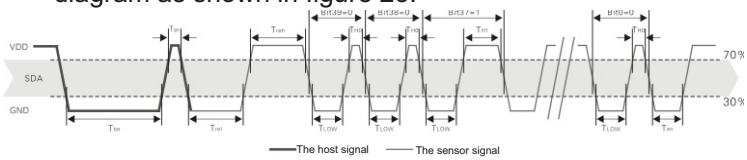

Figure 23: AM2322 single bus communication sequence

Note: the temperature and humidity of the host from AM2322 read data is always the lastmeasurements, 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 2S.

Table 10: Single-bus signal characteristics

Symbol	Parameter	Min	Typ	Max	Unit
T_{be}	Host initial signal pull down time	0. 8	1	20	ms
T_{go}	Host releases bus time	10	30	200	us
T_{rel}	Response low level time	75	80	85	us
T_{reh}	Response high level time	75	80	85	us
T_{LOW}	Signal “0”and“1” low level time	48	50	55	us
T_{h0}	Signal “0” low level time	22	26	30	us
T_{h1}	Signal “1” high level time	68	70	75	us
T_{en}	Sensor release bus time	45	50	55	us

6.4 Example of a peripheral read step

The communication between the host and the sensor is accomplished by reading the data in the following three steps.

Step 1 ：

AM2322 (such as transistors AM2322 after power on to wait for at least 2s to cross the unstable state, in the meantime reading devices cannot send any instruction), test environment temperature and humidity data, and record the data, since sensors automatically into a dormant state AM2322 pull up resistors by raising the SDA cable has maintained high level , mean while AM2322 SDA input pin, moment external signal detection.

Step 2 ：

The I/O of the microprocessor is set as output, and the low level is output and the low level holding time cannot be less than 1ms. Then the microprocessor is set as input mode immediately after I/O is set as high level, and the bus is released. After the host machine releases the Bus,AM2322 sends a response signal, that is, it outputs a low level of 80 microseconds as The response signal, and then outputs a high level notification peripheral of 80 microseconds to prepare for receiving data. The signal transmission is shown in Figure 24:

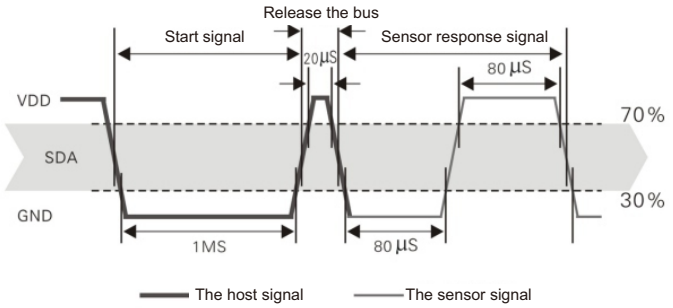

Figure 24: Single bus decomposition sequence diagram

Step 3 :

After AM2322 sends the response, the data bus SDA continuously outputs 40-bit data, and the microprocessor receives 40-bit data according to the change of I/O level. The format of the bit data "0" is: low level of 50 Microseconds plus high level of 26-28 microseconds;The format of bit data "1" is: low level of 50 microseconds plus high level of 70 microseconds; The format signal of "0" bit and "1" bit is shown in Figure 25:

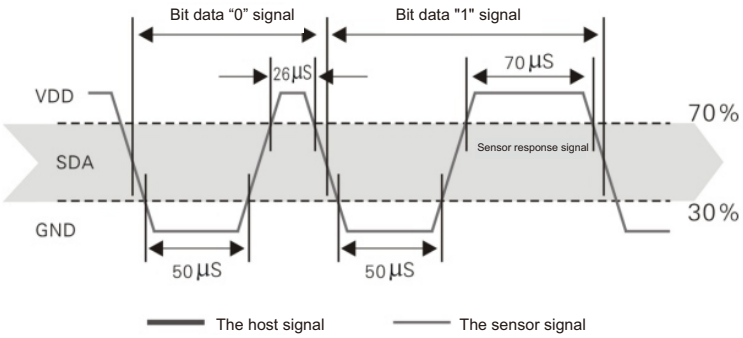

Figure 25: single bus decomposition sequence diagram

AM2322 data bus SDA output after 40 data, keep the output low level 50 microseconds to input state, because the pull-up resistance to high level. AM2322 internal heavy environmental temperature and humidity measurement data at the same time, and record the data, the end of the test records, single chip microcomputer automatic enter a dormant state. MCU only after receiving the host start signal, to awaken the sensors, into the working state.

6.5 Peripherals read flowcharts

The flow diagram of AM2322 sensor reading single Bus is shown in Figure 26. Meanwhile, our company also provides the reading code example. For customers who need to download, please log in our website (www.aosong.com) for relevant download.

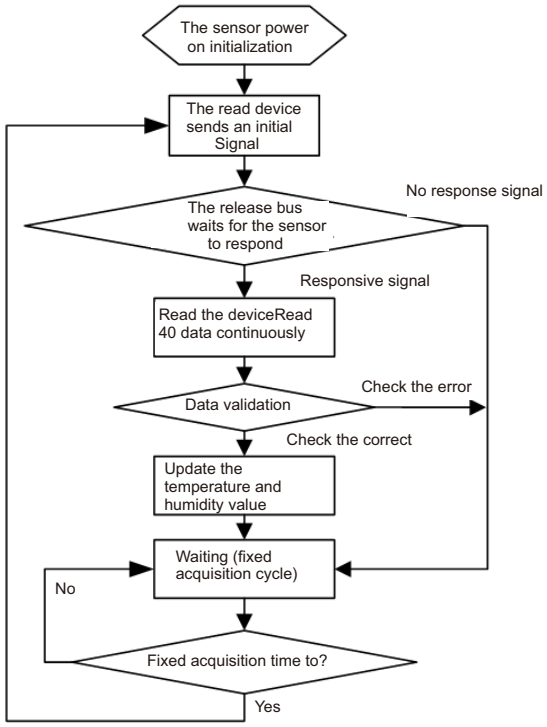

Figure 26: single bus read flow charts

Schedule 1: I2C_MODBUS Communication Protocol Summary

Read bus description: address of I2C is 0xE8; Access up to 10 registers at a time;
The maximum time for a read bus communication is 3S;
Each time the sensor returns data, it adds a CEC check, the user can choose not to read the CEC check.

Read sensor frame format:
host frame format: (SLA+W)+ function code (0x03) + Starting address + number of registers
slave frame format: function code (0x03) + data length + return data +CRC

Write sensor frame format:
host frame format: (SLA+ W)+ function code (0 x10) + starting address + number of registers r + data + CRC
slave frame format: function code (0x03) + starting address +number of registers + CRC

AM2322 Sensor register list:

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

Type A mailing device definition: bit7-bit0 bit reserved;

Temperature format: Bit15 equal to 1 means negative temperature, while Bit15 equal to 0 means positive temperature. Except for the highest temperature Bit (Bit14~Bit0) represents the temperature value of the sensor string. The Temperature Value produced by the sensor is 10 times of the actual humidity value.

Write sensor: Register (0x0f~0x13) for user to write; Other registers are not allowed to write, and the status register can only be written separately.

Read and write examples:

Function	Function code	Starting Address	Frame data content
Read the temperature and humidity	0x03	0x00	Send: (SLA+ W) + 0x03 + 0x00 + 0x04
			Return: 0x03+0x04+ humidity high + humidity low + temperature high + temperature low +CRC
Read the Temperature	0x03	0x02	Send: (SLA+ W) + 0x03 + 0x02 + 0x02
			Return: 0x03+0x02+temperature high + temperature low+CRC
Read the humidity	0x03	0x00	Send:(SLA+ W) + 0x03 + 0x00 + 0x02
			Return: 0x03+0x02+ humidity high + humidity low + CRC
Read device information	0x03	0x08	Send: (SLA+ W) + 0x03 + 0x08 + 0x07
			Return: 0x03+0x07+ device model (16 bits)+ version number (8 bits)+ ID (32 bits)+CRC
Write status register	0x10	0x0F	Send: (SLA+ W) + 0x10 + 0x0F + 0 x01 + 0x01 + 0xF4 (low) + 0xB7(high) Note: function code + starting address+ Register number +Saved data + CRC
			Return: 0x10+0x0F+0x01+0xB4 (low bytes) +0x35 (high bytes) Comment: function code + starting address + number of registers + CRC
Write the user register 1	0x10	0x10	Send: (SLA + W)+0x10 + 0x10 + 0x02 + 0x01 + 0x02 + 0xc0 + 0 x92
			Return: 0x10 + 0x10 + 0x02 + 0xFC + 0x04

Note: SLA=I2C address:0xB8. In the table, CRC is the check bit, CRC is 16 bits, low byte before, high byte after.
Return error code: 0x80: function code is not supported 0x81: Reads the illegal address
0x82: Out of write data range 0x83: CRC check error 0x84: write prohibited.

7 Environmental stability

If the sensor is used in equipment or machinery, make sure that the sensor used for measurement senses the same conditions of temperature and humidity as the sensor used for reference. The AM2322 sensor is tested in accordance with the Ozon corporate standard for temperature and humidity sensors . The performance of the sensor Under other test conditions is not guaranteed and cannot be considered as part of the sensor's performance. In particular, no promises are made with respect to the specific conditions required by the user.

8 packaging

8.1 Tracking information

All the AM2322 sensors have laser markings on Their surfaces, as shown in Figure 27.

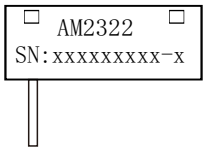

Figure 27: Laser identification of the AM2322 sensor

8.2 Transportation Packing

AM2322 is packaged with PVC tubes, and each PVC tube is packed with 50 AM2322 modules , as shown in Figure 28.

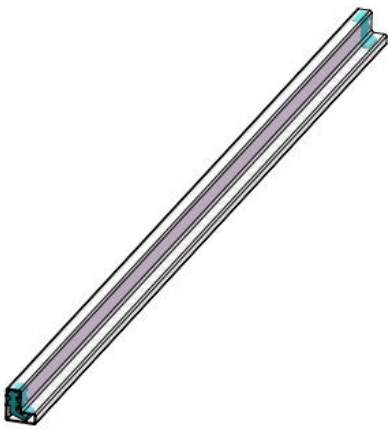

Figure 28: PVC packaging figure

There are labels on the PVC packing pipes, as shown in Figure 29.

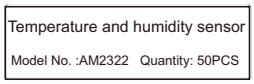

Figure29: AM2322 packing label on the tube

Version information

Date	Version	Page	Modify
2021/01	V1.0	1-16	The first version

This manual may be subject to change without prior notice.

Attention

Warning of personal injury

Do not apply this product to safety protection devices or emergency stop equipment, as well as any other applications that may cause personal injury due to the failure of the product. This product cannot be used unless there is a special purpose or with an authorization to use it. Please refer to the product data sheet and Application guide before installing processing, using or maintaining the product. Failure to comply with this recommendation may result in death and serious bodily injury.

If the Buyer intends to purchase or use the Aosong products without any application license and authorization , the buyer shall bear all compensation for personal injury and death resulting therefrom, and shall not claim for compensation including various costs, compensation fees, lawyers, etc. Expenses and so on with the managers and employees of Aosong Company, as well as subsidiaries , agents , distributors, etc.

ESD Protection

Due to the inherent component design , it is sensitive to static electricity. In order to prevent the damage and the reduction of the product's performance caused by static electricity, the necessary anti-static measures should be taken when applying this product.

Quality Assurance

Our company provides 12-month (1-year) quality assurance for buyers of its products (calculated from the date of delivery) based on the technical specifications in the data manual of the product published by Aosong . If the product is found to be defective under warranty. our company will provide free maintenance or replacement. Users need to satisfy the following conditions :

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

Our company is only responsible for the defective products which are used in the occasions that meet the technical requirements of the product . Our company makes no warranties or written representations regarding the use of its products in special application occasions at the same time, the company does not make any commitment to the reliability of the products applied to products or circuits.