TVOC Gas Sensor AGS02MA User manual

Document modification record

Date	Version	Edit content
2019-11-01	V1.0	First edition
2020-03-06	V1.1	Modify the pin sequence and outline dimensions
2020-04-20	V1.2	Modify I2C communication speed is less than 30KHz

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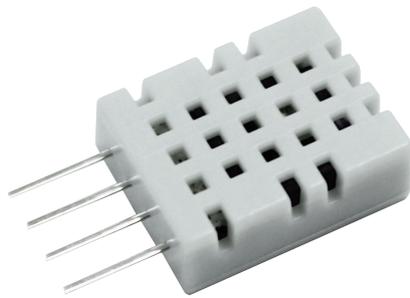
1. Product Overview

AGS02MA is a MEMS TVOC gas sensor with calibrated digital signal output. It uses special digital module acquisition technology and gas sensing technology to ensure that the product has extremely high reliability and excellent long-term stability.

This MEMS gas sensor has the characteristics of low power consumption, high sensitivity, fast response, high reliability and stability, low cost, and simple driving circuit.

2、Application range

It is mainly used to monitor the environment where the sensor is located, such as formaldehyde, carbon monoxide, combustible gas, alcohol, ammonia, sulfide, benzene vapor, smoke, and other harmful gases. It can be specifically used in air purifiers, household Electrical appliances, new fans, etc. The sensor can detect a variety of harmful gases.

3、Product characteristic

High cost performance, good long-term stability, excellent quality, ultra-fast response, high sensitivity, fast response and recovery time, long life, digital signal output, accurate calibration.

4、Dimensions（unit：mm）
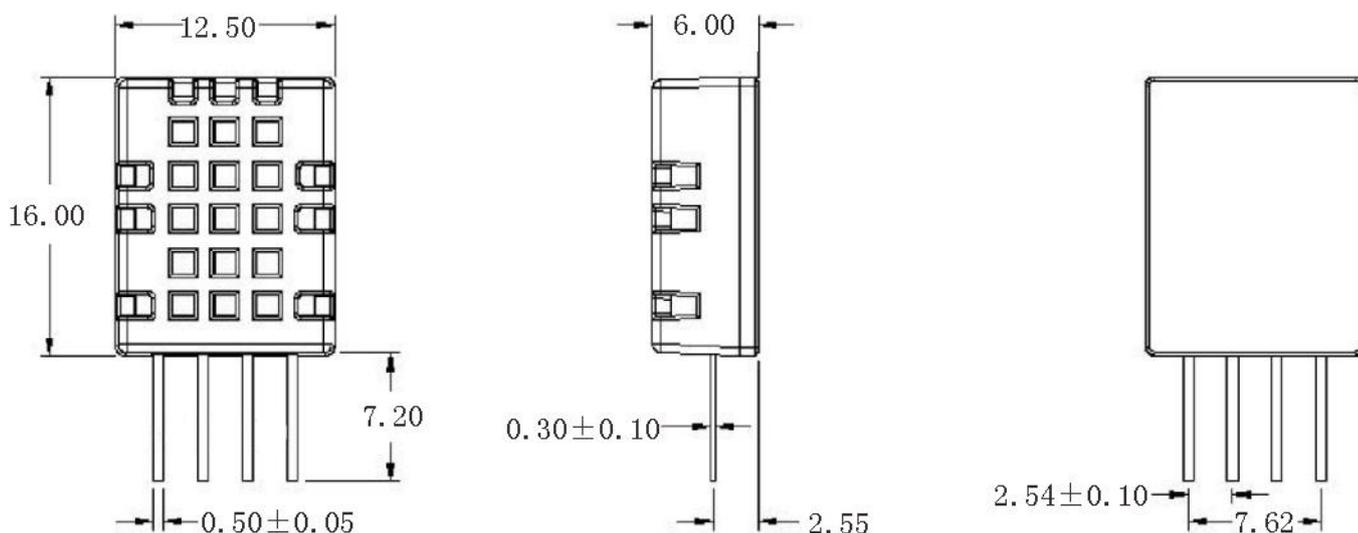
Unspecified tolerance：±0.5mm

Figure1: Product size

5、Product parameters

5.1 Electrical characteristics

Product number	AGS02MA
Supply voltage	3.3-5.5V DC
Minimum supply current	25mA
Typical supply current	28mA
Maximum supply current	33mA
Typical power（3.3V）	98mW
Typical power（5V）	130mW
Sampling period	>=2 Sec/time
Output type	I^2C Slave mode（＜30KHz）
Preheat time	>=120s
Operating temperature	0℃～50℃
Working humidity	0～95%RH
Package	4PIN
Weight	1g
Life	>5 Year

5.2 Sensor characteristics

Sensor category	MEMS Semiconductor metal oxide sensor
Output unit	ppb or ug/m3
Measuring range	0-99999ppb （Over the above of 9999ppb is extended range）
Typical accuracy（25℃ 50%RH）	30% F.S （Maximum 50% F.S）
Standard test gas	Ethanol

Note: The measurement range that meets the typical accuracy is 0-9999ppb, and the measurement error of the extended range is 50% F.S

6、Interface definition

6.1 AGS02MA Pin assignment
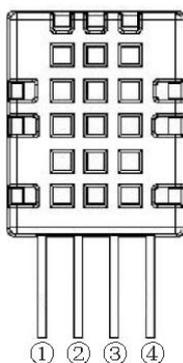
Figure 2 AGS02MA Pin

Pin	Name	Description
1	VDD	power supply
2	SDA	Serial data
3	GND	Ground
4	SCL	Serial clock

table 1：AGS02MA Pin assignment

6.2 Power pin（VDD GND）

The power supply voltage range of AGS02MA is 3.3V-5.5V.

6.3 Serial clock input （SCL）

The SCL pin must remain high until the I2C communication starts, otherwise it will cause poor I2C communication. When I2C communication, SCL is used to synchronize the communication between the microprocessor and AGS02MA.

6.4 Serial data（SDA）

The SDA pin is a three-state structure, used to read and write sensor data. For the specific communication sequence, see the detailed description of the I^2C communication part.

Note: The SDA pin and SCL pin must be connected to VDD through pull-up resistor of 1KΩ～10KΩ.

7、I^2C Bus communication protocol

The AGS02MA sensor uses a standard I2C communication protocol to adapt to a variety of devices. The protocol uses two data lines: a serial data bus (SDA) and a serial time bus (SCL). The two data lines need to be connected to a pull-up resistor to VDD. Multiple sensor devices can share the bus; but only one host device can appear on the bus. The sensor I2C address is 0x1A, the write command is 0x34, and the read command is 0x35.

AGS02MA is completely prepared according to the I2C standard protocol and can be directly hung on the I2C bus; the sensor SDA pin is used to connect the I2C data bus, and the SCL is connected to the I2C clock bus. The I2C communication rate cannot be higher than 30KHZ.

7.1 Sensor I^2C communication protocol timing and command format

Figure3: I²C Communication protocol timing diagram

Sensor communication command format:

1、The format of the host write command is as follows:

According to the I²C transmission protocol: high-order first and low-order second

☐ Host signal　　　S: I²C Start signal　　　P: I²C Stop signal

▨ Slave signal　　　ACK: Handshake signal　XCK: Ignore handshake signal

The sensor supports standard mode I²C, the bus clock is less than or equal to 30KHz
CRC 5th BYTE: CRC check byte is CRC check for DATA 1st to DATA 4st
REGISTER: Register address of operation

2、The host read command format is as follows:

3、The format of the simplified read command of the host is as follows: (Read the last operation register REGISTER address, power on default REGISTER=0X00)

7.2 Sensor data collection (REGISTER=0x00)

Send a command to read TVOC：

The host reads TVOC data (REGISTER=0X00)

Description of the composition of TVOC data received：

STAUS BYTE：Status byte。

TVOC DATA(24bits)：The concentration data read out is fixed at 3 bytes.

CRC BYTE：STAUS BYTE, TVOC DATA (24bits) CRC check code.

Description of TVOC data composition when the host reads (REGISTER=0X00)

I2C DATA 1st BYTE								I2C DATA 2nd BYTE								I2C DATA 3rd BYTE								I2C DATA 4th BYTE								I2C DATA 5th BYTE							
STATUS BYTE								TVOC DATA (24Bits)																								CRC BYTE (8bits)							
7	6	5	4	3	2	1	0	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
				CH[2:0]			RDY																																
R	R	R	R	W/R	W/R	W/R	R																																

STATUS BYTE Explanation

Bit	Name	description
Bit7-Bit4		Reserved bit, for internal use only (write 0 if writing)
Bit3-Bit1	CH[2:0]	TVOC data type: 000=Measure TVOC data mode unit ppb (power-up silent value) 001=Measure TVOC data mode unit ug/m3 Other = reserved
Bit0	RDY	Data ready bit, RDY=0 The latest data is currently read. RDY=1 data is not updated or warming up

The host modifies the measurement mode as follows:

⬚: User can change the bit corresponding to the measurement mode
STATUS BYTE: Status byte, see "Reading Description of TVOC Data Composition (REGISTER=0X00)"
REV_STATUS BYTE: Bitwise invert the status byte

7.3 Zero calibration (REGISTER=0x01)

The sensor has been calibrated for the zero point, but if the user needs to calibrate the zero point, the calibration data will not be saved and will be lost after power off. The sensor is placed in the fresh air for 5 minutes after being powered on for 5 minutes, and the following calibration commands can be sent to complete the zero calibration.

The user zero calibration command is as follows (REGISTER=0X01):

7.4 Version number read (REGISTER=0x11)

The reading data of the sensor version number is composed as follows:

Instructions for reading sensor information (REGISTER=0X11)

I2C DATA 1st BYTE								I2C DATA 2nd BYTE								I2C DATA 3rd BYTE								I2C DATA 4th BYTE								I2C DATA 5th BYTE							
Keep (24bits)																								Version Information (8bits)								CRC BYTE (8bits)							
23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0

7.5 I²C Slave address modification (REGISTER=0x21)

The sensor supports modifying the I2C address, which is convenient for users to use multiple AGS02MA sensors on the I2C bus. After sending this command, the new address will take effect immediately, and the address will be saved without loss after power-off.

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The command for the master to modify the I2C address of the slave is as follows:

New_I2C_Addr: Newly set sensor I2C address (1~127)
RevNew_I2C_Addr: Inverts the newly set sensor I2C address bit by bit
Note: After the transmission of this command is completed, the new address takes effect immediately
and is saved, and it will not be lost when the power is turned off.

7.6 Check code CRC calculation

AGS02MA sensor CRC check uses CRC8, the initial value is 0XFF, the polynomial is 0x31 (x8 + x5 + x4 + 1), please see the following code for details:

```
//*********************************************************
//Function name：Calc_CRC8
//Features    : CRC8 Calculation, Initial value: 0xFF, Polynomial: 0x31(x8 + x5 + x4 +1 )
//parameter    : u8 *dat: Need to verify the first address of the data; u8 Num: Length of CRC check data
//return    : crc: Calculated check value
//*********************************************************
u8 Calc_CRC8(u8 *dat, u8 Num)
{
  u8 i,byte,crc=0xFF;
  for(byte=0; byte<Num; byte++)
  {
    crc^=(dat[byte]);
    for(i=0;i<8;i++)
    {
      if(crc & 0x80) crc=(crc<<1)^0x31;
      else crc=(crc<<1);
    }
  }
    return crc;
}
```

7.7 Command set

operating	REGISTER	Command parameters including CRC check DATA 1st to DATA 4th, CRC	Returns the number of data bytes, including CRC check	Instruction processing time （ms）
Set the measurement mode to TVOC Unit: ppb	0x00	0x00, 0xFF, 0x00, 0xFF, 0x30	/	2000

Set the measurement mode to TVOC Unit: ug/m^3	0x00	0x02, 0xFD, 0x02, 0xFD, 0x00	/	2000
Data collection	0x00	/	5	1500
Zero calibration	0x01	0x00, 0x0C, 0xFF, 0xF3, 0xFC	/	30
Version number read	0x11	/	5	30
Modify slave address	0x21	Set according to the format described in 7.5	/	30

```
┌──────────────────────────────────────────────────────┐
│                                                      ↓ │
┌─────────────────────┐  2s   ┌─────────────────┐  1.5s ┌─────────────────┐
│ Set measurement mode│ ────→ │ data collection │ ────→ │ data collection │
└─────────────────────┘       └─────────────────┘       └─────────────────┘
```
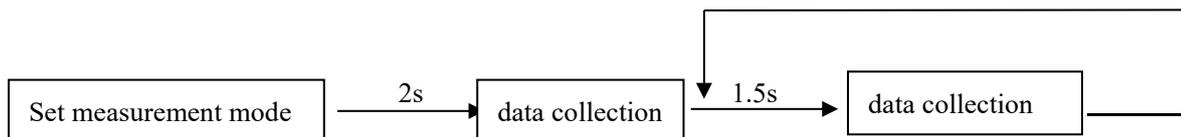
Note: 1. After the host sends a write command, it takes 30ms to send the next write command or read command.

2. After the host sends the "set measurement mode" command, it needs to wait for the sensor to complete the collection in 2 seconds before sending the "data collection" command.

3. Do not frequently send the "data collection" command, which will cause the sensor to fail to collect data normally, making the status bit RDY of STAUS BYTE always at 1. The interval between sending "Data Acquisition" commands should not be less than 1.5s.

8、Notes and application information

8.1、Water Environment：

8.1.1   If the AGS02MA sensor is splashed or immersed in water, the sensitivity characteristics of the sensor will be reduced, and even the sensor will be damaged and will not work.

8.1.2 Under indoor conditions, slight condensed water will have a certain impact on the performance of the sensor. Therefore, if water condenses on the surface of the sensitive layer and keeps it for a period of time, the sensor characteristics will decrease.

8.1.3 Water icing on the sensor surface will cause the sensor material layer to crack and lose its sensitive characteristics.

8.2. High concentration gas:

8.2.1 Regardless of whether the sensor is energized or not, long-term placement in high-concentration gas will affect the sensor characteristics. If the lighter gas is sprayed directly on the sensor, it will cause great damage to the sensor; or if the sensor is placed in a high concentration of hydrocarbons, hydrogen, etc. for a long time, it will cause serious damage to the sensor.

8.2.2 Avoid measuring the sensor in a place with large air flow, such as a vent or a fan blowing, which will cause inaccurate measurement.

8.2.3 When the CO2 gas concentration is high, it will have a slight effect on the AGS02MA sensor.

8.3. High voltage and polarity reversal:

8.3.1 When the applied voltage of the sensor module is too high, for example, the applied voltage exceeds 5.5V, it will directly cause irrecoverable damage to the sensor module.

8.3.2 When the positive and negative poles of the sensor are reversed, it will also cause damage to the sensor circuit. As a result, the sensor module does not work.

8.4. Pollution of alkaline, acidic environment and halogen:

8.4.1 After the sensor is contaminated with alkaline or acidic liquid spray, or exposed to halogen such as Freon, it will also cause performance degradation. The resulting data is incorrect.

8.4.2 Exposure of the sensor to high concentrations of corrosive gases (such as H2S, SO2, Cl2, HCL, etc.) will not only cause corrosion or destruction of the sensor module circuit and the sensor interior, but also cause irreversible deterioration of the performance of sensitive materials.

8.5. Exposure to volatile silicon compound vapor:

8.5.1 The sensor should avoid exposure to silicone adhesive, hair spray, silicone rubber, putty or other places where volatile silicon compounds are present. If the silicon compound vapor is adsorbed on the surface of the sensor, the sensitive material of the sensor will be wrapped by the silicon dioxide formed by the decomposition of the silicon compound, inhibiting the sensitivity of the sensor and irrecoverable.

8.6. Long-term storage:

8.6.1 If the sensor is stored for a long time without being energized, its resistance will produce a reversible drift, which is related to the storage environment. The sensor should be stored in a sealed bag without volatile silicon compounds. Sensors that have been stored for a long period of time need to be powered on for a longer period of time to stabilize them. The storage time and corresponding aging time recommendations are shown in the table "Storage and Aging".

Table "Storage and Aging"

Storage time	Recommended aging time
Less than 1 week	Not less than 2 hours
1 to 6 months	Not less than 12 hours
More than 6 months	Not less than 24 hours

8.7. Long-term exposure to extreme environments

8.7.1 Regardless of whether the sensor is powered on or exposed to extreme conditions for a long time, such as extreme conditions such as high humidity, high temperature or high pollution, the performance of the sensor will be seriously affected

8.8. Vibration

8.8.1 Frequent and excessive vibration will cause resonance and breakage of the internal lead of the sensor. Pneumatic screwdriver/ultrasonic welding machine will produce such vibration during transportation and assembly line.

8.9. Shock

8.9.1 If the sensor is subjected to strong impact or falls, it will cause its components

to loosen and the leads to break.

8.10. Conditions of use:

8.10.1 Manual welding is the most ideal welding method for the sensor. The recommended welding conditions are as follows:

    Flux: Rosin flux with least chlorine content

    Constant temperature soldering iron:

    Temperature: less than 300℃

    Time: less than 3 seconds

8.10.2 Over-wave soldering is prohibited.

8.10.3 It is forbidden to clean with alcohol, plate washing water or other liquids.

8.11. Wiring precautions

The quality of DATA signal wire will affect the communication distance and communication quality. It is recommended to use high quality shielded wire.

8.12. Product upgrade

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②The product should be sent back to the company by the buyer;

③ The product should be within the warranty period.

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