Datasheet AGS02MA

TVOC Sensor

- Fully calibrated
- I²C digital output
- Long-term stability
- Rapid response
- Short recovery time
- Strong anti-interference ability
- Wide operating voltage range

Summary

AGS02MA is a high-performance TVOC sensor which is equipped with a dedicated ASIC chip, adopting special digital module acquisition technology and gas sensing technology to ensure good performance of high reliability, long-term stability, low power consumption, high sensitivity. Each sensor is fully calibrated and tested before delivery to meet the large-scale applications of customers.

Application

AGS02MA is developed to detect and monitor variety of organic volatile gases, such as ethanol, ammonia, sulfide, benzene steam, smoke. It can be applied in air purifiers, home appliances, fresh air system, and other equipment.

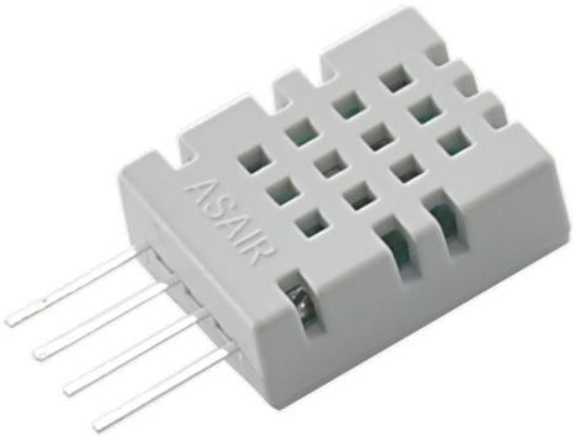


Figure 1. AGS02MA

1. Principle

An advanced MEMS technology is adopted in the sensor to fabricate a micro-thermal plate on a silicon substrate, and the gas-sensitive material used is a metal oxide semiconductor material with low conductivity in clean air. When the sensor works in air environment, the conductivity of the gas-sensitive material changes with the concentration of the gas being detected in the air. The higher the concentration of the gas being detected, the higher the conductivity of the gas-sensitive material will be. Based on this principle, a special integrated circuit is adopted to convert the change in conductivity into an output signal corresponding to the concentration of the gas.

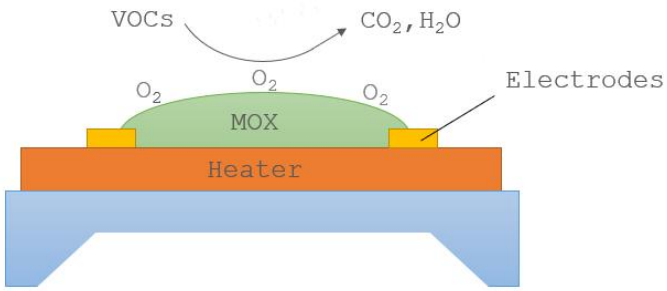


Figure 2. Working principle

2. Sensor characteristic

Table 1. Electrical characteristic

Operating voltage	3.3～5.5 V DC
Operating current	28±5 mA
Typical power consumption	98 mW@3.3 V；130 mW@5 V
Sampling period	≥ 2 s
Output mode	I^2C slave mode (≤30 kHz)
Preheating time	≥120 s
Operating temperature	0～50 ℃
Operating humidity	0～95%RH
Life span	＞5 years (@25 ℃, clean air)
Sensor category	Semiconductor sensor
Output unit	ppb
Measuring range	0～99999 ppb
Typical accuracy (25℃/50%RH)	25% reading
Standard test gas	Ethanol

3. I^2C Interface definition

The AGS02MA sensor uses the standard I^2C communication protocol, adapted to a variety of devices. The protocol uses two lines: serial data (SDA) and serial clock (SCL), and the two lines need to be connected to the VDD through pull-up resistors of 1 kΩ~10 kΩ. Multiple sensors can share one bus, but only one master device can be connected to the bus. The sensor I^2C address is 0x1A (7-bit mode). The write and read instructions are 0x34 and 0x35, respectively. I^2C communication speed cannot be higher than 30 kHz.

3.1 Timing and command format for I²C communication protocol

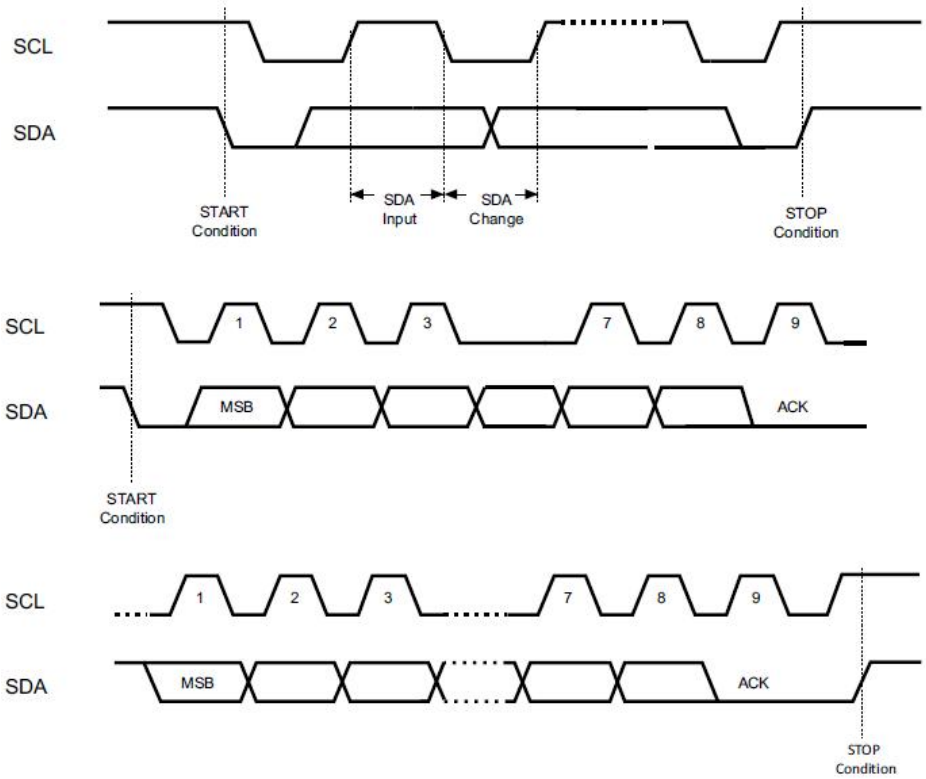
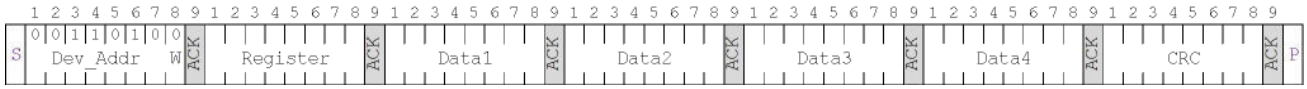
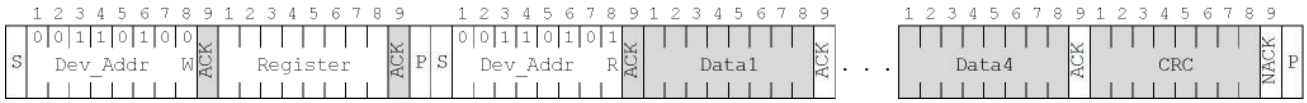


Figure 3. I²C-bus timing diagram

a) Format of master write command:

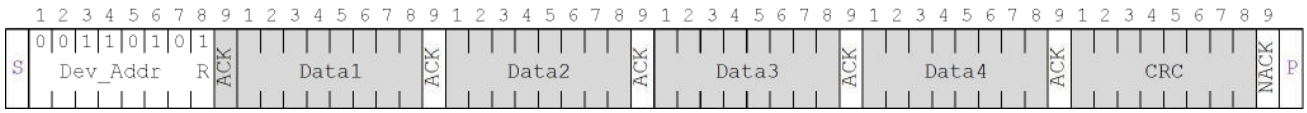


b) Format of master read command:



c) Format of master direct read command:

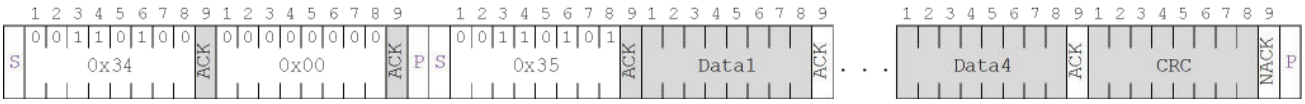
Writing Reg is not required to read data by master direct read command. Reg is 0x00 by default after power on or after the Reg was written.



☐ Master signal ☐ Slave signal S: Start P: Stop
Dev_Addr(W/R): Write/Read instruction
Register: Register to be read from or written in
ACK: Acknowledge
NACK: Not acknowledge
Data1~Data4: 1 byte data to be written in register
CRC: Cyclic redundancy check for Data1~Data4

3.2 Data acquisition

The TVOC data can be read by the following command:



Format of received data:

Data1								Data2	Data3	Data4	CRC
Status								TVOC Data			CRC
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	RW	RW	RW	RW				

The unit of TVOC is ppb.

Format of Data1(Status):

Bit7~Bit4	Reserved	0
Bit3~Bit1	CH[2:0]	TVOC data type: 000, unit is PPB(default after power-on)
Bit0	RDY	Ready status of data: RDY=0, ready; RDY=1, not ready or senor in pre-heat stage

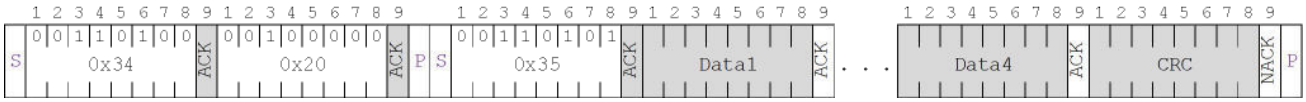
3.3 Zero-point calibration

AGS02MA has been conducted zero-point calibration before leaving factory. Users can re-calibrate the zero-point as needed, and the calibrated data will be lost after power-off. After placing the sensor in fresh air, and the sensor is powered on for 5 minutes, zero-point calibration can be conducted by sending the following command.

Data1~Data4 are 0x00 0x0C 0xFF 0xF3, respectively.

3.4 Read resistance

The resistance can be read by the following command:

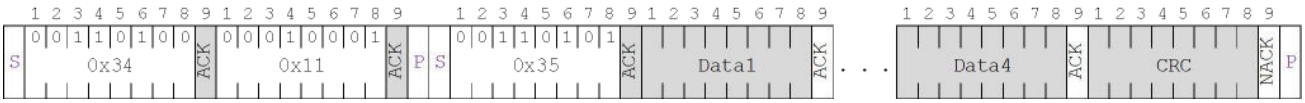


Data1								Data2								Data3								Data4								CRC							
Res																																CRC							
23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0

Data1 is the most significant byte; the unit of reading resistance is 0.1 kΩ.

3.5 Read version

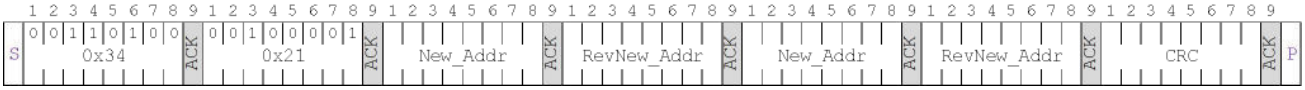
The firmware version can be read by the following command:



Data1								Data2								Data3								Data4								CRC							
Reserved																								Version								CRC							
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

3.6 Modify slave address

I²C address of AGS02MA can be modified, and it is possible to use multiple AGS02MA sensors on one bus. After sending the command for address changing, the new address is saved and takes effect immediately even after power-off.



New_Addr: new slave address after modification(1～127).
RevNew_Addr: inverted logic value of new slave address.

3.7 CRC calculation

AGS02MA adopts CRC8 calculation with an initial value of 0xFF and polynomial of 0x31 ($x^8+x^5+x^4+1$) to check data integrity. The code is as follows:

```
//***************************************************************
// Function name: Calc_CRC8
// Function: CRC8 calculation, initial value: 0xFF, polynomial:
// 0x31 (x8+ x5+ x4+1)
//***************************************************************
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;
}
```

3.8 Command list

Table 2. Command list

Process	Register	Command parameter Data1～4、CRC	Number of returned bytes (Including CRC)	Instruction processing time(ms)
Data acquisition	0x00	N.A.	5	1500
Zero-point calibration	0x01	0x00, 0x0C, 0xFF, 0xF3, 0xFC	N.A.	30
Read version	0x11	N.A.	5	30
Read current resistance	0x20	N.A.	5	1500
Modify slave address	0x21	Set the format described in 3.6	N.A.	30

Note:

1) The host needs a 30 ms interval after sending a write command before sending the next write command or read command.

2) After the host sends the "set measurement mode" command, it needs to wait for 2 s for the sensor to finish acquisition before sending the "data acquisition" command.

3) The "Data Acquisition" command must not be sent too often, otherwise the sensor will not be able to collect data properly, and the status bit RDY of STATUS BYTE will always be 1. The "Data Acquisition" command must not be sent at intervals of less than 1.5 s.

4. Interface

4.1 Pin definition

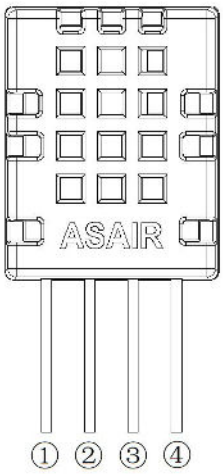


Figure 4. AGS02MA pinout

Table 3. Pin definition

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

5. Dimension

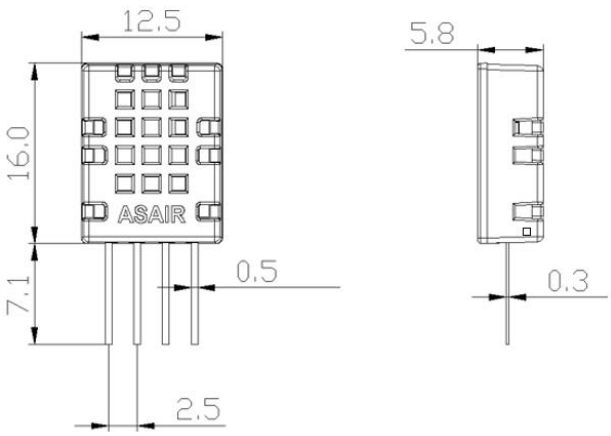


Figure 5. AGS02MA dimensions (unit: mm, general tolerances: ISO2768-mK)

6. Caution

6.1 Water environment

(a) If the sensor is splashed with or immersed in water, it can cause sensor sensitivity properties decrease, and even result in sensor damage and function failure.

(b) If water condensation on the sensitive layer surface and remains for a while, sensor sensitivity will be affected.

(c) Icing on sensor surface will cause fragmentation of the material layer and loss of sensitive properties.

6.2 High concentration of VOC gas or CO_2 gas

(a) Longtime exposure in high concentrations of VOC gas affects the sensor characteristics, regardless of whether the sensors are energized. If the butane used in the lighter is blown directly into the sensor, it will cause great damage to the sensor. Placing the sensor in high concentrations of hydrocarbons, hydrogen and other gases for a long time can cause serious damage to the sensor.

(b) High concentration of CO_2 has a slight effect on the measurement values.

6.3 Excessive airflow or airflow direct blowing

Avoid measuring in places with excessive airflow or direct airflow, such as ventilation openings or direct frontal blowing of fans, which can cause inaccurate measurements

6.4 High voltage or polarity reversal

(a) Appling excessive voltage (> 5.5 V) on sensor can cause permanent damage on sensor immediately.

(b) It will also cause permanent damage to the sensor circuits, when the positive and negative polarity of sensor are reversed.

6.5 Alkaline, acidic environment, and halogen contamination

(a) Sensors contaminated with alkaline or acidic liquid spray or exposed to halogens such as Freon can also cause poor performance, resulting in incorrect measurement values.

(b) Sensors exposed to high concentration of corrosive gases, such as H_2S, SO_2, Cl_2 and HCl, will not only cause the corrosion and damage of the circuits in sensor, but also cause irreversible deterioration in the performance of sensor materials.

6.6 Exposure to volatile silicon compound vapor

Sensors should be avoided to be exposed to silicon adhesives, such as rubber, silicone rubber, putty, or other places where volatile silicon compounds are present. If the surface of the sensor adsorbs the silicon compound vapor, the sensitive materials of the sensor will be wrapped with silica, which is formed by the silicon compound decomposition. As a result, the sensitivity of the sensor is permanently affected.

6.7 Storage

The sensor should be stored in a sealed bag without volatile silicon compounds. After storing for a long period of time, a reversible drift of resistance can appear in sensor. The amount of drift depends on the store time and environment. The longer sensors are stored, the longer stability time is required after being powered on. The storage time and corresponding power-on stabilization time are shown in Table 4.

Table 4. Storage and recommended power-on stabilization time

Period of storage	Recommended to age
⩽1 week	⩾12 hours
1week~6 months	⩾72 hours
⩾6 months	⩾96 hours

6.8 Exposure to extreme environments

The sensor performance will be severely affected by exposure to extreme conditions for a long period of time, such as high humidity, high temperature or severe pollution. Thus, do not place the sensor in extreme environments.

6.9 Vibrate

Frequent or excessive vibration can cause sensor internal bonding wires to resonate and break. Such vibrations are generated by using pneumatic screwdriver or ultrasonic welding equipment during transmit or on the assembling line.

6.10 Shock

If sensor is strongly impacted, it can cause loose of its components or break of lead wire.

6.11 Soldering and cleaning

(a) Manual welding is the ideal welding method for sensors, and the recommended welding conditions are as follows:

Flux: rosin flux containing minimum chlorine.

Constant temperature soldering iron: temperature less than 350 ℃ and soldering time less than 5 s.

(b) Prohibit the use of wave soldering.

(c) It is prohibited to clean with alcohol, board washing water or other liquids.

6.12 Installation

Ideally, the sensor is placed as close as possible to the device's outer shell using large openings allowing the sensor to be exposed to the ambient. The larger the opening, the better the air exchange between the sensor and the ambient, resulting in faster response times. A tightly sealed separation between inlet and outlet will result in the best performance.

6.13 Wire selection

The quality of the signal wires will affect the communication distance and communication quality. Use of high-quality shielded wires is recommended.

7. Common fault guide

7.1 High measurement values after power-on for the first time

When the sensor is powered on for the first time, or after a long power failure by the user, it needs to be powered on according to the recommended power-on stabilization time in Table 4, and the sensor measurement values will return to normal.

7.2 High measurement values after power-on stabilization

(a) Sensors may be in a polluted environment. Place sensors outdoors or in the fresh air.

(b) Sensors may be in a high temperature and/or high humidity environment. See Figure 5 for the influence of temperature and humidity on sensor measurements.

7.3 Low measurement values

The sensor is placed in an environment with convection or there are obstacles blocking the sensor's air vents.

7.4 Communication failure

(a) Hardware problems: the sensor's SDA pin and/or the SCL pin do not connect to pull-up resistors, and the power supply voltage is less than 3.0 V.

(b) Software problems: the slave address sent by host is incorrect (the initial value is 0x1A); the CRC verification code sent by host is incorrect; register address sent by host is incorrect; the communication speed is greater than 30 kHz.

7.5 Inaccurate measurement values (high/low) due to the use of intermittent power supply

When continuous measurement is required, a continuous power supply is needed. Using an intermittent power supply will result in inaccurate measurement values.

Warning and personal injury

Do not apply this product to safety protection devices or emergency stop equipment, and any other applications that may cause personal injury due to the product's failure. Do not use this product unless there is a special purpose or use authorization. Refer to the product data sheet and application guide before installing, handling, using or maintaining the product. Failure to follow this recommendation may result in death and serious personal injury.

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Description of warranty period

Accessories category	Shelf life
AGS02MA TVOC sensor	12 Months

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