Digital universal partical concentration sensor

PMSA003I series data manual

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Main characteristics

- Zero false alarm rate
- Real-time response
- Correct data
- Minimum distinguishable particle diameter :0.3 micrometer
- High anti-interference performance because of the patent structure of six sides shielding
- Optional direction of air inlet and outlet in order to adapt the different design
- Smallest

Overview

PMSA003I is a kind of digital and universal particle concentration sensor,which can be used to obtain the number of suspended particles in the air,i.e.the concentration of particles,and output them in the form of digital interface. This sensor can be inserted into variable instruments related to the concentration of suspended particles in the air or other environmental improvement equipments to provide correct concentration data in time.

Working principle

Laser scattering principle is used for such sensor, i.e. produce scattering by using laser to radiate suspending particles in the air, then collect scattering light in a certain degree, and finally obtain the curve of scattering light change with time. In the end, equivalent particle diameter and the number of particles with different diameter per unit volume can be calculated by microprocessor based on MIE theory. Please find the functional diagram of each part of sensor from Figure 1 as follows.

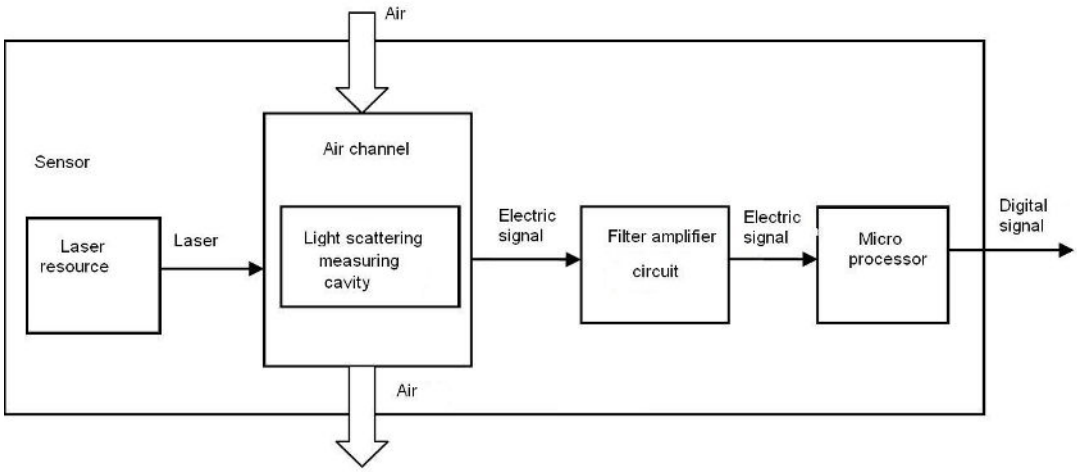


Figure 1 Functional block diagram of sensor

Technical Index

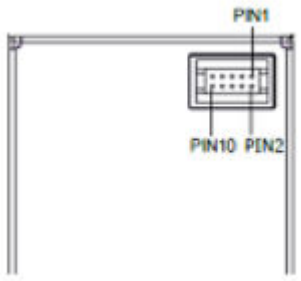
Parameter	Index	unit
Particle Range of measurement	0.3~1.0；1.0~2.5；2.5~10	Micrometer（μm）
Particle Counting Efficiency	50%@0.3μm 98%@>=0.5μm	
Particle Effective Range（PM2.5 standard）	0~500	μg/m^3
Particle Maximum Range（PM2.5 standard）*	≥1000	μg/m^3
Particle Resolution	1	μg/m^3
Particle Maximum Consistency Error (PM2.5 standard data)*	±10%@100~500 μg/m^3 ±10 μg/m^3 @0~100 μg/m^3	

Particle Standard Volume	0.1	Litre（L）
Single Response Time	＜1	Second（s）
Total Response Time	≤10	Second（s）
DC Power Supply	Typ:5.0 Min:4.5 Max: 5.5	Volt（V）
Active Current	≤100	Milliampere（mA）
Standby Current	≤200	Microampere（μA）
Interface Level	L <0.8 @3.3 H >2.7@3.3	Volt（V）
Working Temperature Range	-10~+60	℃
Working Humidity Range	0~99%	
Storage Temperature Range	-40~+80	℃
MTTF	≥3	Year（Y）
Physical Size	38×35×12	Millimeter（mm）

Note 1: Maximum range means that the highest output value of the PM2.5 standard data is not less than 1000.

Note 2:“PM2.5 standard data” is the “data2” in the appendix.

Pin Definition



引脚定义：

Pin1----------VCC
Pin2----------VCC
Pin3----------GND
Pin4----------GND
Pin5----------Reset
Pin6----------N/C
Pin7----------SCL
Pin8----------N/C
Pin9----------SDA
Pin10---------Set

Figure 2 Connector Definition

表 2 数字接口管脚定义

Pin number	Pin name	Description
PIN1	VCC	Positive power 5V
PIN2	VCC	Positive power 5V
PIN3	GND	Negative power
PIN4	GND	Negative power
PIN5	RESET	Module reset signal/TTL level@3.3V, low reset
PIN6	NC	
PIN7	SCL	I2C_SCL with drive mode of OD serial port receiving pin/TTL level@3.3V
PIN8	NC	
PIN9	SDA	I2C_SDA with drive mode of OD serial port receiving pin/TTL level@3.3V
PIN10	SET	Set pin/TTL level @3.3V, high level or suspending is normal working status, while low level is sleeping mode.

Output result

Mainly output as the quality and number of each particles with different size per unit volume, the unit volume of particle number is 0.1L and the unit of mass concentration is μg/m³.

There are two options for digital output: passive and active. Default mode is active after power up. In this mode sensor would send serial data to the host automatically. The active mode is divided into two sub-modes:stable mode and fast mode. If the concentration change is small the sensor would run at stable mode with the real interval of 2.3s.And if the change is big the sensor would be changed to fast mode automatically with the interval of 200~800ms, the higher of the concentration, the shorter of the interval.

Typical Circuit

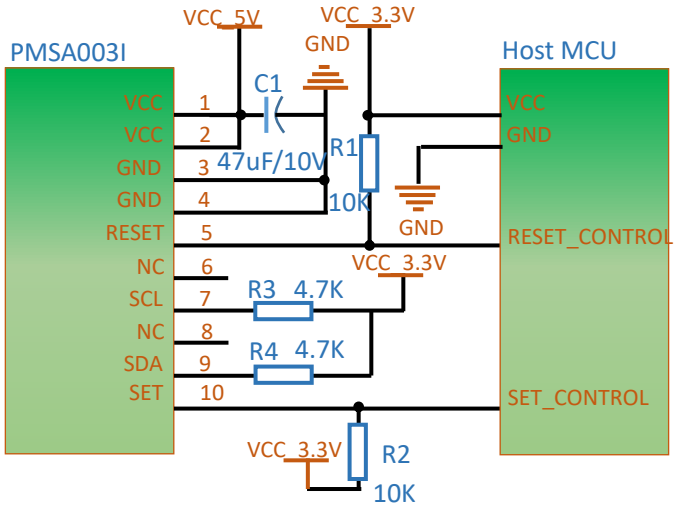


Figure 3 Typical Circuit

Typical Output Characteristic

Definition of axis Y: PM2.5 concentration, unit: μg/m³
Definition of axis X: number of samples, unit: time

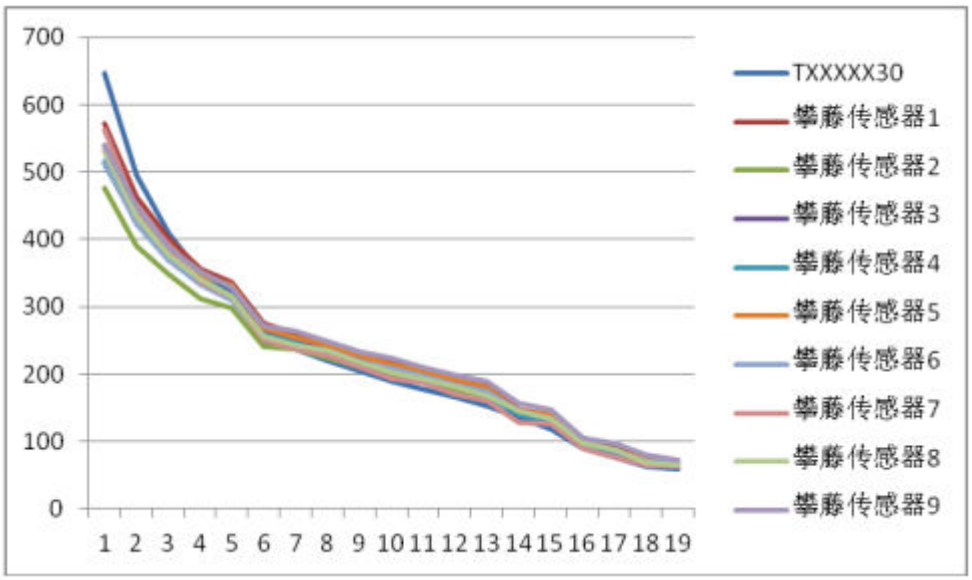


Figure 4-1 Consistency at 20℃

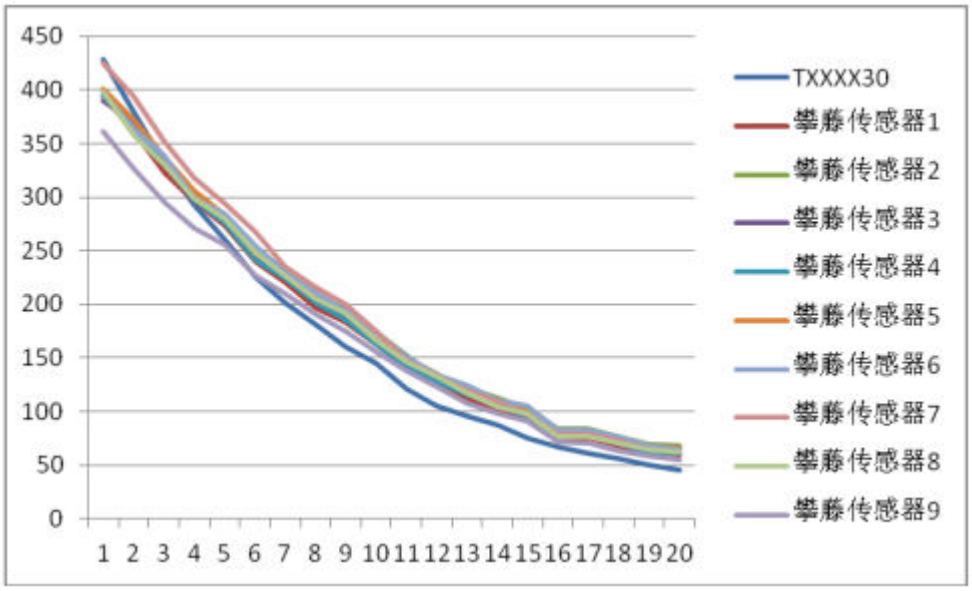


Figure 4-2 Consistency at 43℃

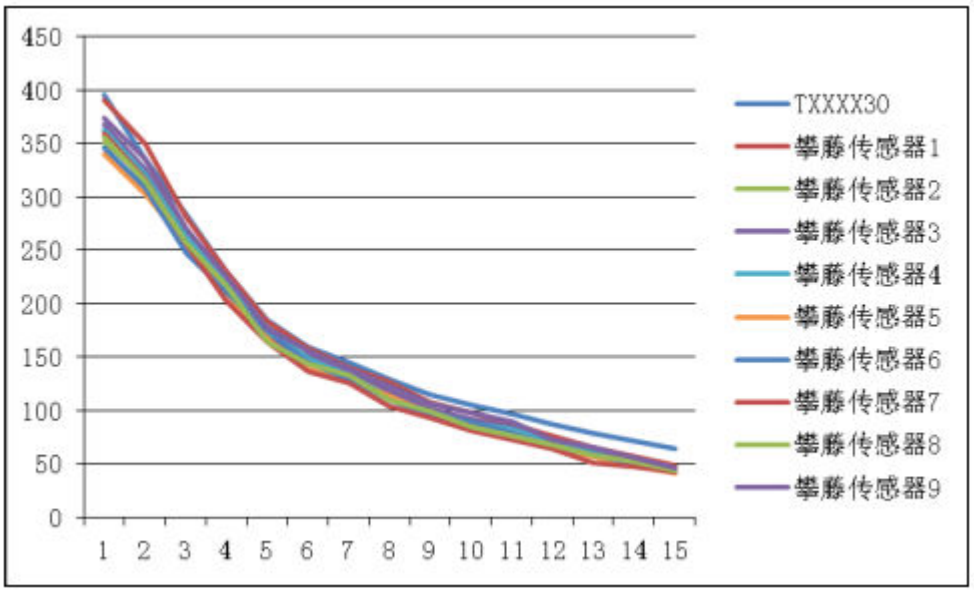


Figure 4-3 Consistency at -5℃

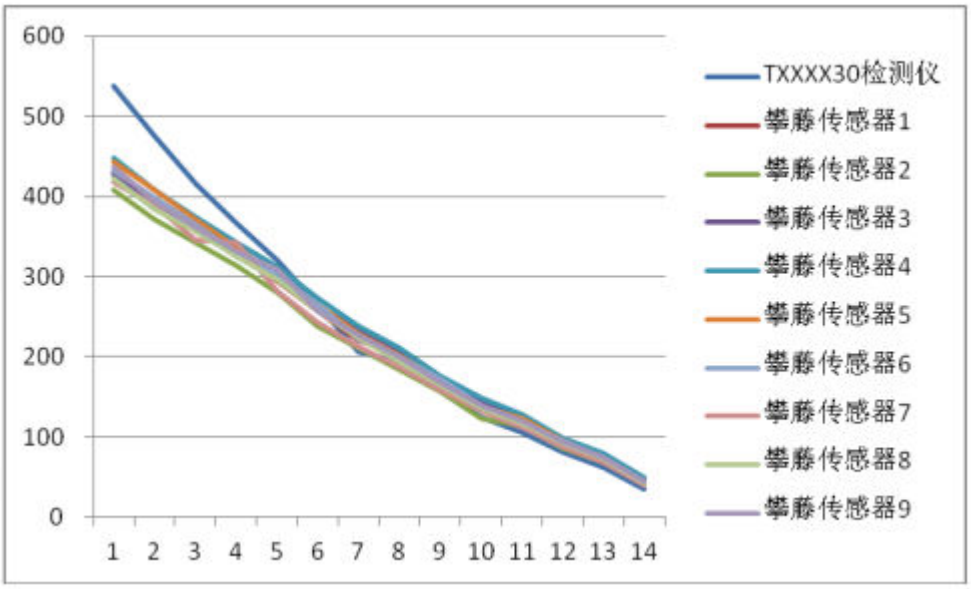


Figure 4-4 Consistency after 30 days running

Relationship of Temperature and Consistency

Definition of axis Y: Maximum Error Modulus(%)
Definition of axis X: Temperature(℃)

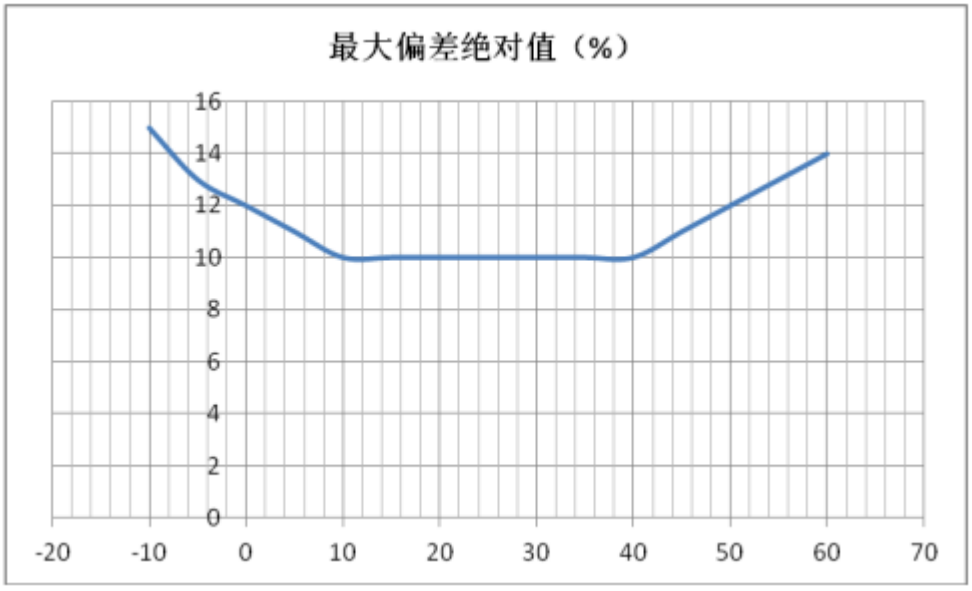


Figure 5 Consistency Vs Temperature

Endurance Characteristics

No	Item	Test Method	Characteristics	n C
1	Long Running	1. 10 ㎡ closed Lab,，20~25℃，humidity 30%~70%，particle generator and air cleaner 2. DC 5V power supply 3. Check consistency after 720 hours' running	10 samples during 0~500 μg/m³ 0~100 μg/m³ Maximum Error ≤ ±15 μg/m³	n=30 C=0
2	High Temperature Operation	1. 10 ㎡ constant temperature Lab 2. 43℃，humidity 70%， 3. particle generator and air cleaner 4. DC 5V power supply 5. Check consistency	100~500 μg/m³ Maximum Error ≤ ±15%	n=10 C=0
3	Cold Operation	1. 10 ㎡ constant temperature Lab 2. -5℃，humidity 30%， 3. particle generator and air cleaner 4. DC 5V power supply 5. Check consistency	FAN does not screeched	n=10 C=0
4	Vibration	1. 10 ㎡ closed Lab,，20℃，humidity 50%，particle generator and air cleaner 2. DC 5V power supply and check consistency 3. Frequency：50Hz。 4. acceleration：9.8/ S² 。 5. Direction：X、Y、Z 6. Vibration Amplitude：±2mm。 7. Time：X、Y、Z–way, Per 1 hour		n=5 C=0
5	High Temperature and Humidity Storage	1. Constant temperature cabinet 2. 70℃，humidity 90%~95， 3. Check consistency after 500 hours' storage	10 samples during 0~500 μg/m³ 0~100 μg/m³ Maximum Error ≤ ±10 μg/m³	n=10 C=0
6	Cold Storage	1. Constant temperature cabinet 2. -30℃，humidity 90%~95， 3. Check consistency after 500 hours' storage	100~500 μg/m³ Maximum Error ≤ ±10%	n=10 C=0

7	Variation of Power Supply	4. 10 ㎡ closed Lab,，20℃，humidity 50%，particle generator and air cleaner 5. Power varies as the cycles of 4.5V to 5.5V ,then 5.5V to 4.5V with the pace of 0.1V/min for 2 hours. 6. Check consistency during Variation	FAN does not screeched	n=5 C=0
8	Power On-Off Cycle	1. 10 ㎡ closed Lab,，20℃，humidity 50%，particle generator and air cleaner 2. DC 5V power supply，keep On-Off frequency 0.5Hz for 72 hours and check consistency		n=10 C=0
9	Sleep Set On-Off Cycle	1. 10 ㎡ closed Lab,，20℃，humidity 50%，particle generator and air cleaner 2. DC 5V power supply，keep Sleep Set Pin High-Low frequency 0.5Hz for 72 hours and check consistency		n=10 C=0
10	Laser On-Off Cycle	1. 10 ㎡ closed Lab,，20℃，humidity 50%，particle generator and air cleaner 2. keep laser On-Off frequency 50Hz for 240 hours and check consistency		n=10 C=0
11	Salt Spray	5% industrial salt water, hydrolysis spray 100 hours, clean with purified water and store for 48 hours	No rust and discoloration of metal parts	n=1 C=0

Circuit Attentions

1) DC 5V power supply is needed because the FAN should be driven by 5V. But the high level of data pin is 3.3V. Level conversion unit should be used if the power of host MCU is 5V.
2) The SET and RESET pins are pulled up inside so they should not be connected if without usage.
3) PIN6 and PIN8 should not be connected.
4) Stable data should be got at least 30 seconds after the sensor wakeup from the sleep mode because of the fan's performance.

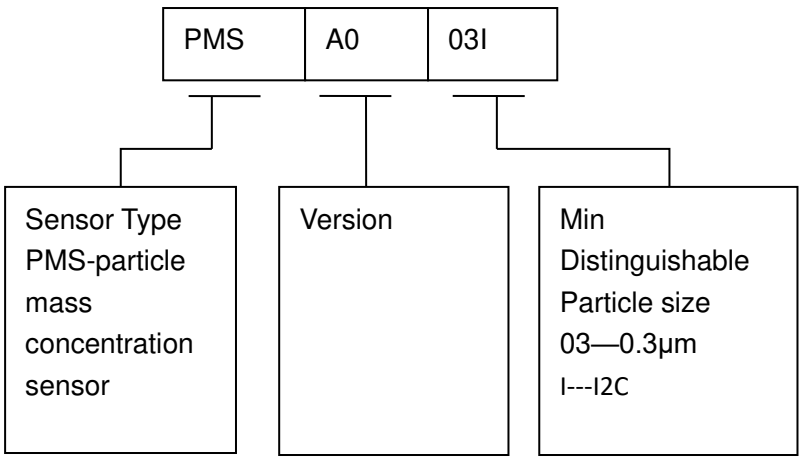
Installation Attentions

1) Metal shell is connected to the GND so be careful not to let it shorted with the other parts of circuit except GND.
2) The best way of install is making the plane of inlet and outlet closely to the plane of the host. Or some shield should be placed between inlet and outlet in order to prevent the air flow from inner loop.
3) The blowhole in the shell of the host should not be smaller than the inlet.
4) The sensor should not be installed in the air flow way of the air cleaner or should be shielded by some structure.
5) The sensor should be installed at least 20cm higher than the grand in order to prevent it from blocking by the flock dust.
6) When the sensor is used to outdoor fixed equipment, the equipment should be completed for the protection of sandstorm,rain,snow,etc.
7) Do not break up the sensor.
8) The two screw holes can be used for positioning and fixing,For fixing holes,the screw depth can reach 3.4mm,and the other shoule not exceed 1.9mm.

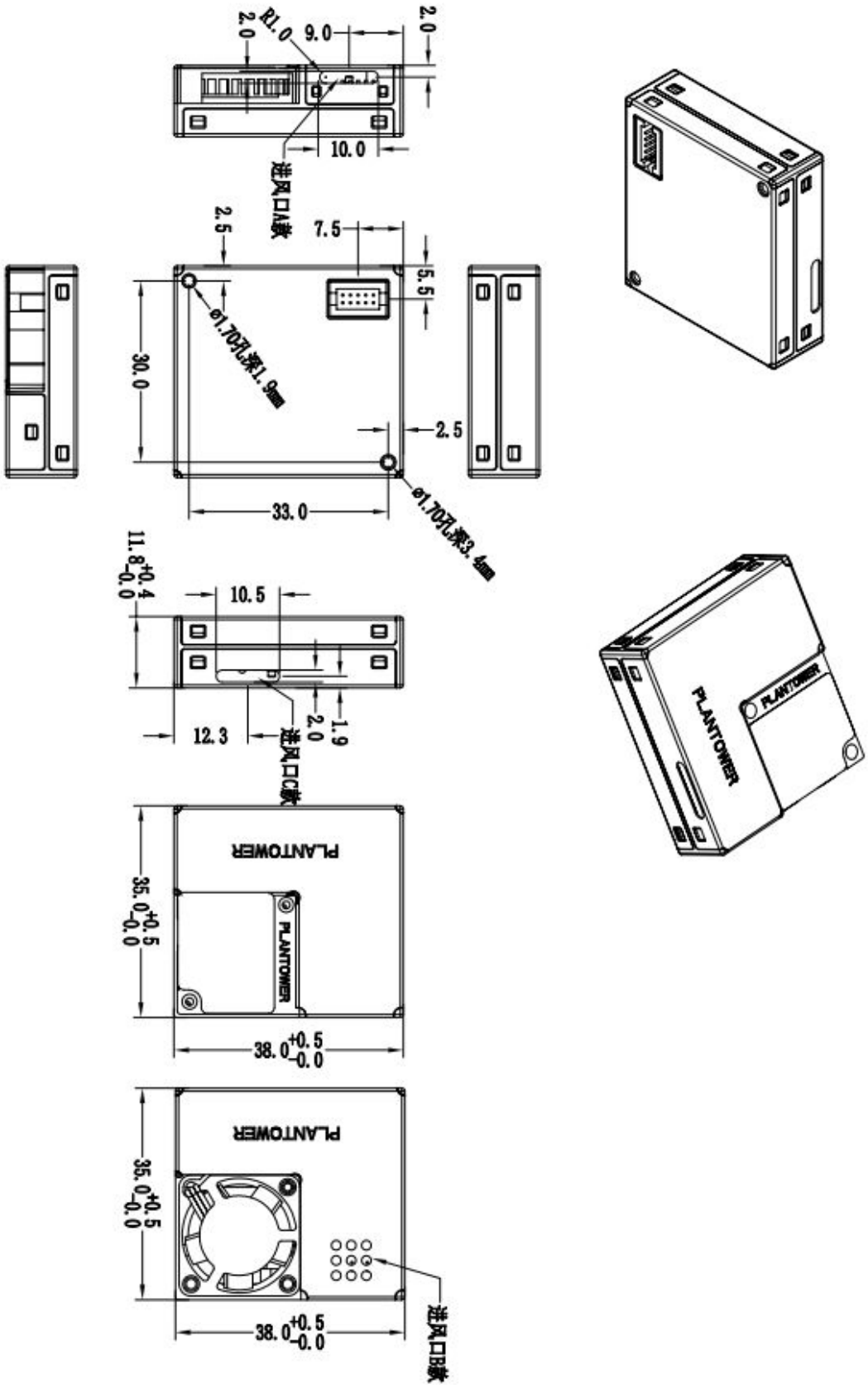
Other Attentions

1) Only the consistency of all the PM sensors of PLANTOWER is promised and ensured. And the sensor should not be checked with any third party equipment.
2) The sensor is usually used in the common indoor environment. So some protection must be added if using in the conditions as followed:
   a) The time of concentration ≥300 μg/m³ is longer than 50% of the whole year or concentration≥500 μg/m³ is longer than20% of the whole year.
   b) Kitchen
   c) Water mist condition such as bathroom or hot spring.
   d) Outdoor

Part Number Definition



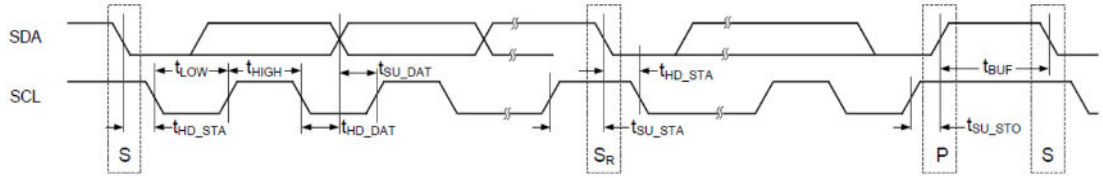
Physical Size(mm)



I2C Interface Protocol

1. 100K sps, Standard NXP EEPROM Protocol. Data are stored in the registers.

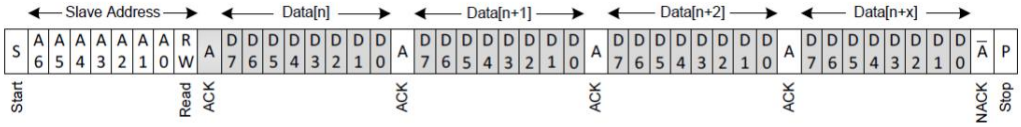
2. Timing Sequence



参数	t_{HD_STA}	t_{LOW}	t_{HIGH}	t_{HD_DAT}	t_{SU_DAT}	t_{SU_STA}	t_{SU_STO}	t_{BUF}
最小值	4.0	4.7	4.0	5.0	250	4.7	4.0	4.7
单位	μs	μs	μs	μs	ns	μs	μs	μs

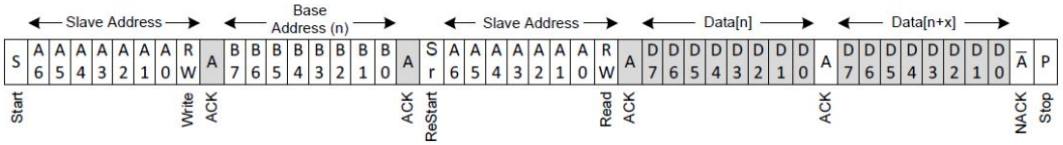
3. Command Sequence

3.1 Master reads from slave (sensor) continuously



Note: white-Master, gray-Slave

3.2 Master reads from slave at the appointed register.



Note: white-Master, gray-Slave

4. I2C Slave Address：0x12

5. Register Definition

Register Number	Definition	Data	
0x00	Start character 1	0x42(fixed)	
0x01	Start character 2	0x4d(fixed)	
0x02	Frame length high	……	Frame length=2x13+2(data+check bytes)
0x03	Frame length low	……	
0x04	Data 1 high	……	Data 1 refers to PM1.0 concentration unit: μg/m^3 (CF=1,standard particle)
0x05	Data 1 low	……	
0x06	Data 2 high	……	Data 2 refers to PM2.5 concentration unit：μg/m^3 (CF=1,standard particle)
0x07	Data 2 low	……	
0x08	Data 3 high	……	Data 3 refers to PM10 concentration unit：μg/m^3 (CF=1,standard particle)
0x09	Data 3 low	……	
0x0a	Data 4 high	……	Data 4 refers to PM1.0 concentration unit：μg/m^3 (under atmospheric environment)
0x0b	Data 4 low	……	
0x0c	Data 5 high	……	Data 5 refers to PM2.5 concentration unit：μg/m^3 (under atmospheric environment)
0x0d	Data 5 low	……	
0x0e	Data 6 high	……	Data 6 refers to PM10 concentration unit：μg/m^3 (under atmospheric environment)
0x0f	Data 6 low	……	
0x10	Data 7 high	……	Data 7 indicates the number of particles with diameter beyond 0.3 μm in 0.1L of air
0x11	Data 7 low	……	
0x12	Data 8 high	……	Data 8 indicates the number of particles with diameter beyond 0.5 μm in 0.1L of air
0x13	Data 8 low	……	
0x14	Data 9 high	……	Data 9 indicates the number of particles with diameter beyond 1.0 μm in 0.1L of air
0x15	Data 9 low	……	
0x16	Data 10 high	……	Data 10 indicates the number of particles with diameter beyond 2.5 μm in 0.1L of air
0x17	Data 10 low	……	

0x18	Data 11 high	……	Data 11 indicates the number of particles with diameter beyond 5.0 μm in 0.1L of air
0x19	Data 11 low	……	
0x1a	Data 12 high	……	Data 12 indicates the number of particles with diameter beyond 10 μm in 0.1L of air
0x1b	Data 12 low	……	
0x1c	Data 13 high	……	Version
0x1d	Data 13 low	……	Error code
0x1e	Data and check high 8 bits	……	Check code =Start character 1+Start character 2 +…….. + data 13 Low 8 bits
0x1f	Data and check high 8 bits	……	

Note: CF = 1 should be used in the factory environment.