

Digital universal particle concentration sensor

PMS7003I 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
- ◆ Very Slim



Overview

PMS7003I 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.

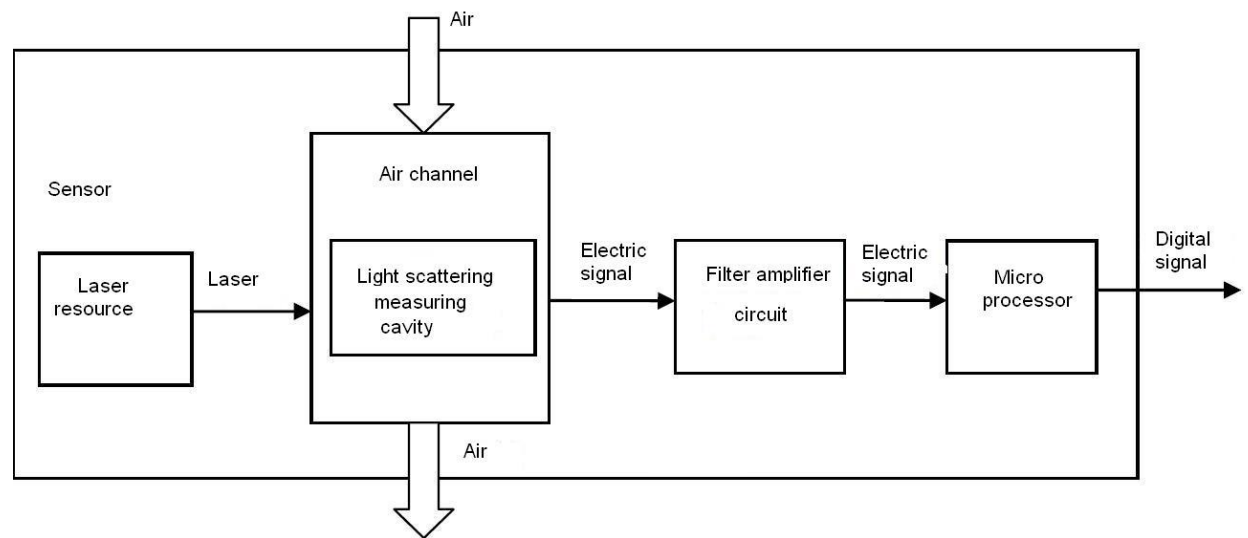


Figure 1 Functional block diagram of sensor

Technical Index

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

Maximum Consistency Error (PM2.5 standard data)*	$\pm 10\% @ 100 \sim 500 \mu\text{g}/\text{m}^3$ $\pm 10 \mu\text{g}/\text{m}^3 @ 0 \sim 100 \mu\text{g}/\text{m}^3$	
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	°C
Working Humidity Range	0~99%	
Storage Temperature Range	-40~+80	°C
MTTF	≥ 3	Year (Y)
Physical Size	48×37×12	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

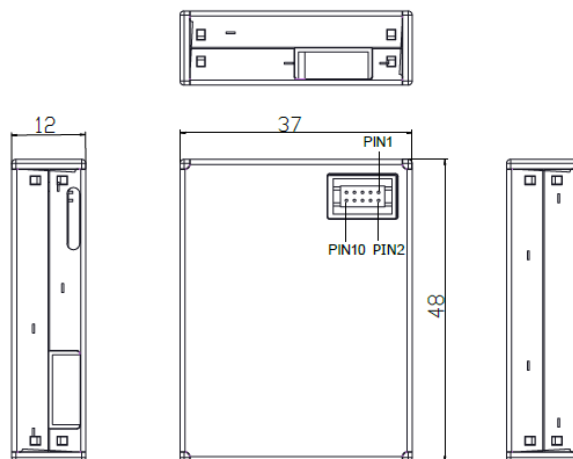


Figure 2 Connector Definition

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	I2C_SCL	I2C Clock pin/TTL level@3.3V
PIN8	NC	
PIN9	I2C_SDA	I2C DATA 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 $\mu\text{g}/\text{m}^3$.

Typical Circuit

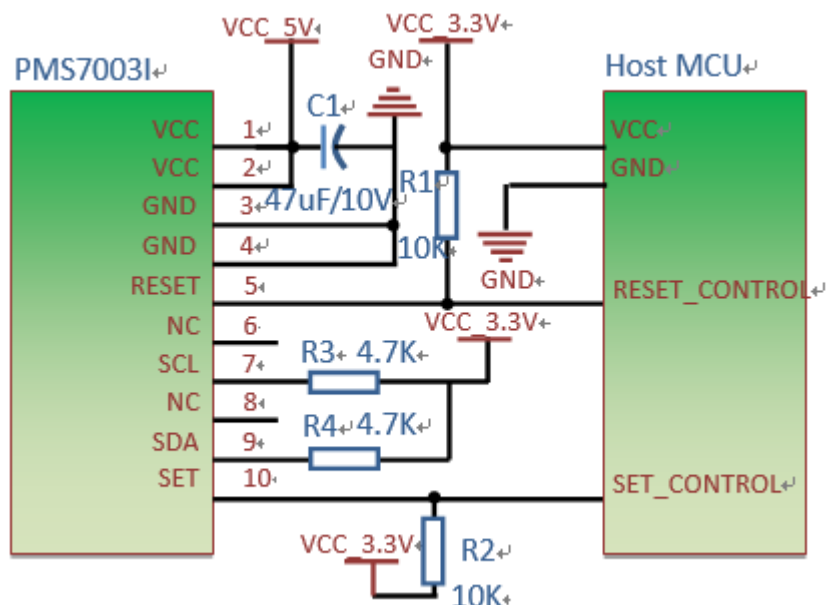


Figure 3 Typical Circuit

Typical Output Characteristic

Definition of axis Y: PM2.5 concentration , unit: $\mu\text{g}/\text{m}^3$

Definition of axis X: number of samples, unit: time

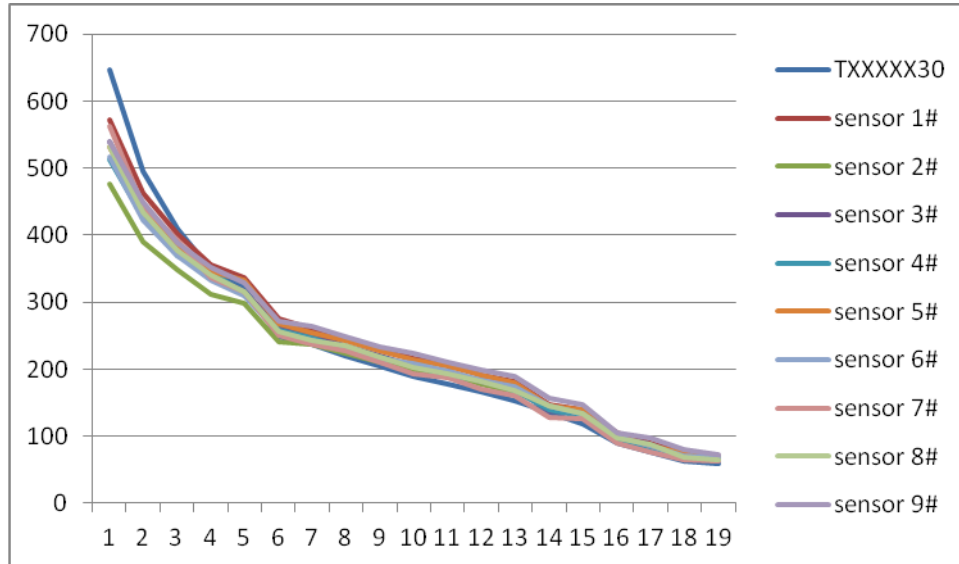


Figure 4-1 Consistency at 20°C

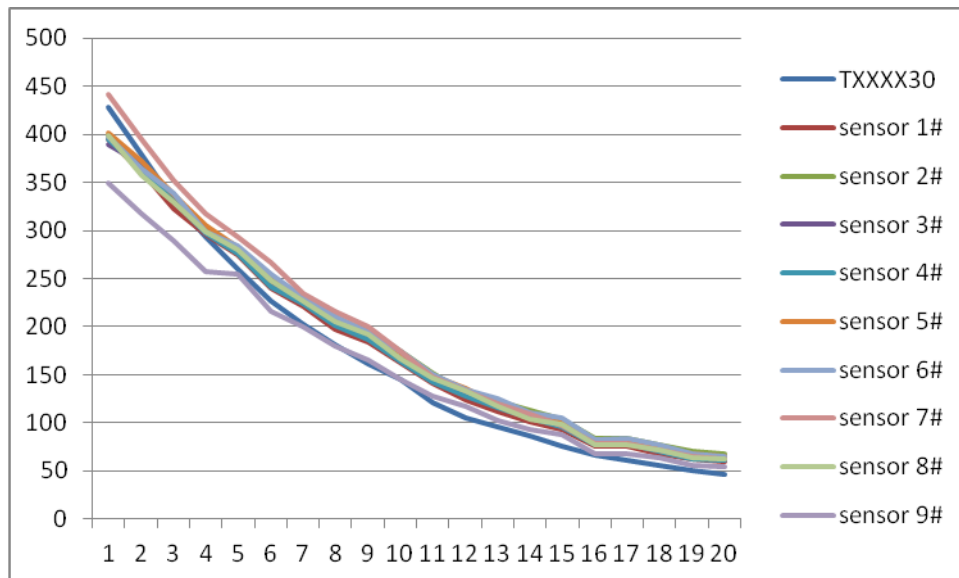


Figure 4-2 Consistency at 43°C

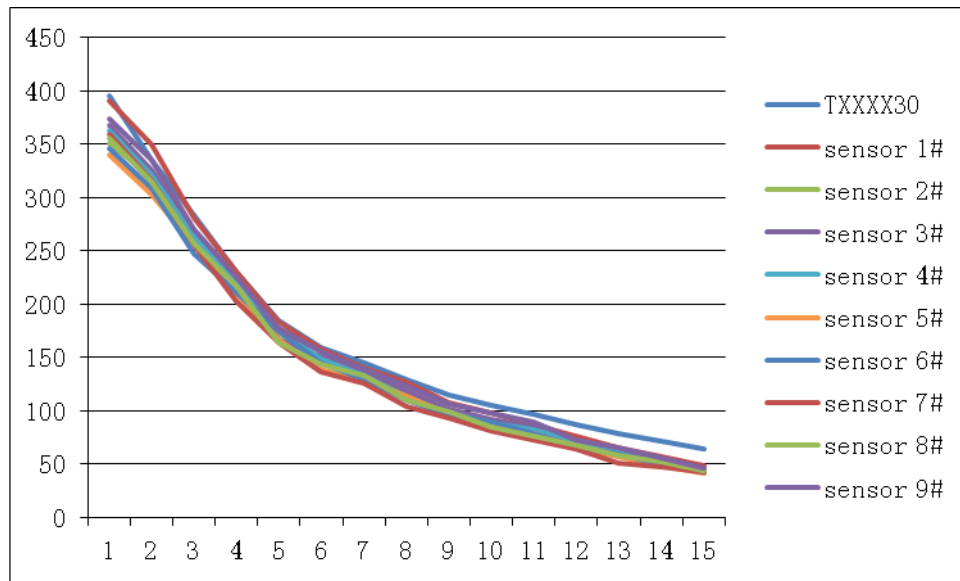


Figure 4-3 Consistency at -5°C

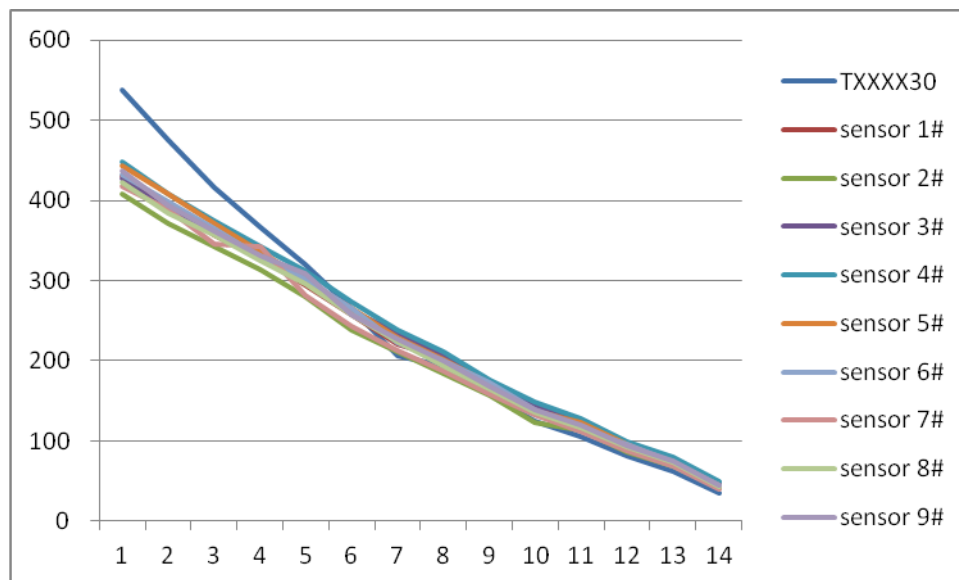


Figure 4-4 Consistency after 30 days' running

Relationship of Temperature and Consistency

Definition of axis Y: Maximum Error Modulus(%)

Definition of axis X: Temperature(°C)

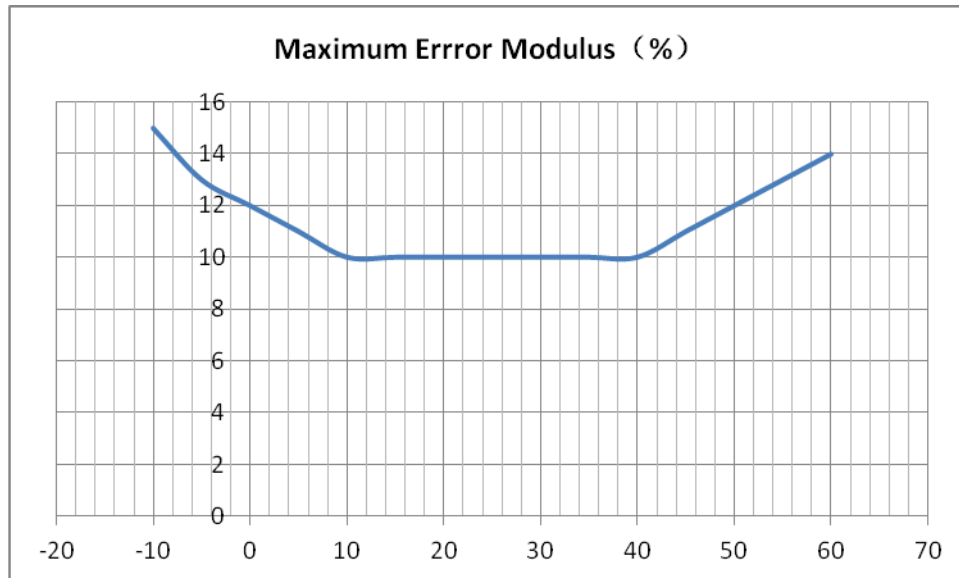


Figure 5 Consistency Vs Temperature

Endurance Characteristics

No	Item	Test Method	Characteristics	n C
1	Long Running	1. 10 m ² closed Lab,, 20~25°C , 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/m ³ 0~100 μg/m ³ Maximum Error ≤ ± 15 μg/m ³	n=30 C=0
2	High Temperature Operation	1. 10 m ² constant temperature Lab 2. 43°C , humidity 70%, 3. particle generator and air cleaner 4. DC 5V power supply 5. Check consistency	100~500 μg/m ³ Maximum Error ≤ ± 15%	n=10 C=0
3	Cold Operation	1. 10 m ² constant temperature Lab 2. -5°C , 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	<ol style="list-style-type: none"> 1. 10 m² 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	<ol style="list-style-type: none"> 1. Constant temperature cabinet 2. 70℃ , humidity 90%~95, 3. Check consistency after 500 hours' storage 	10 samples during 0~500 μ g/m ³ 0~100 μ g/m ³ Maximum Error ≤	n=10 C=0
6	Cold Storage	<ol style="list-style-type: none"> 1. Constant temperature cabinet 2. -30℃ , humidity 90%~95, 3. Check consistency after 500 hours' storage 	± 10 μ g/m ³ 100~500 μ g/m ³ Maximum Error ≤	n=10 C=0
7	Variation of Power Supply	<ol style="list-style-type: none"> 4. 10 m² 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	<ol style="list-style-type: none"> 1. 10 m² 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	<ol style="list-style-type: none"> 1. 10 m² 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	<ol style="list-style-type: none"> 1. 10 m² closed Lab., 20°C , 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. Level of SCL and SDA can only be pulled up to 3.8~4V by the resistances connected to power.
- 2) The SET and RESET pins are pulled up inside so they should not be connected if without usage.
- 3) PIN7 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.

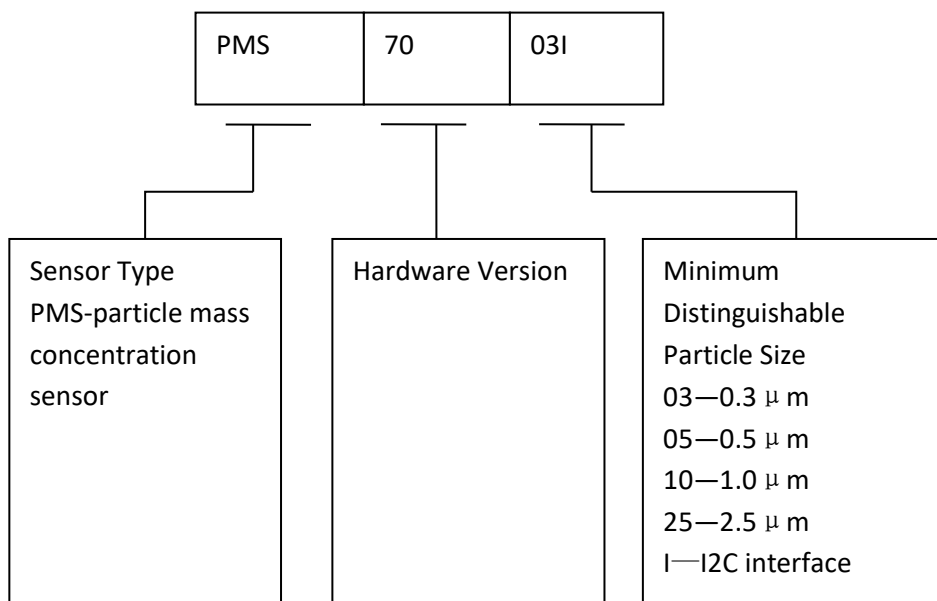
Installation Attentions

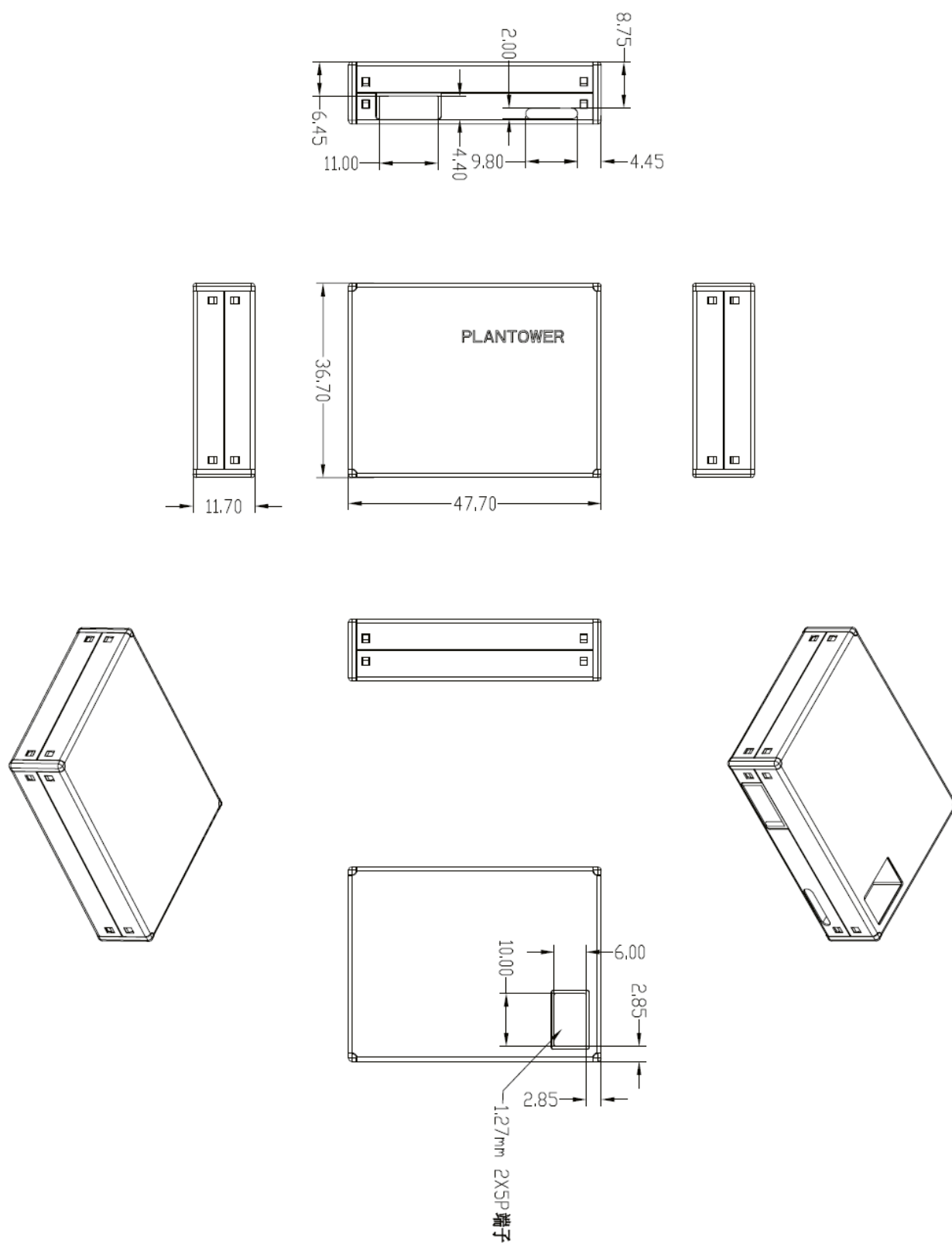
- 1) Metal shell is connected to the GND so be careful not to let it shorted with the other parts of circuit except GND.
- 2) The best way of install is making the plane of inset and outset closely to the plane of the host. Or some shield should be placed between inset and outset in order to prevent the air flow from inner loop.
- 3) The blowhole in the shell of the host should not be smaller than the inset.
- 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) Do not break up the sensor.

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 $\geq 300 \mu\text{g}/\text{m}^3$ is longer than 50% of the whole year or concentration $\geq 500 \mu\text{g}/\text{m}^3$ is longer than 20% of the whole year.
 - b) Kitchen
 - c) Water mist condition such as bathroom or hot spring.
 - d) outdoor

Part Number Definition

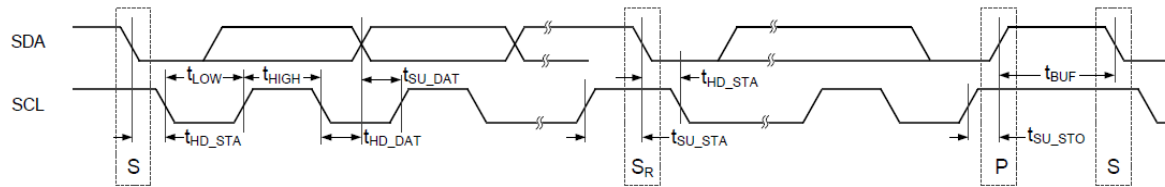




Appendix I: PMS7003I transport protocol

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

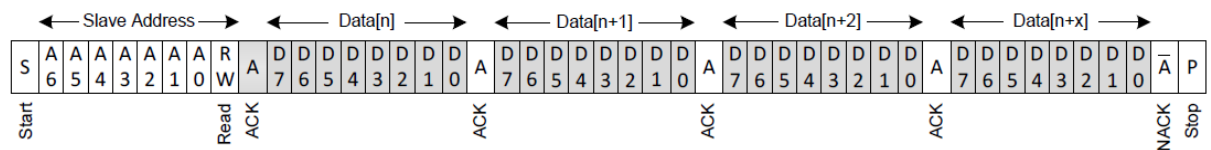
2. Timing Sequence



Parameter	t _{HD_STA}	t _{LOW}	t _{HIGH}	t _{HD_DAT}	t _{SU_DAT}	t _{SU_STA}	t _{SU_STO}	t _{BUF}
Min.	4.0	4.7	4.0	5.0	250	4.7	4.0	4.7
Unit	μs	μs	μs	μs	ns	μs	μs	μs

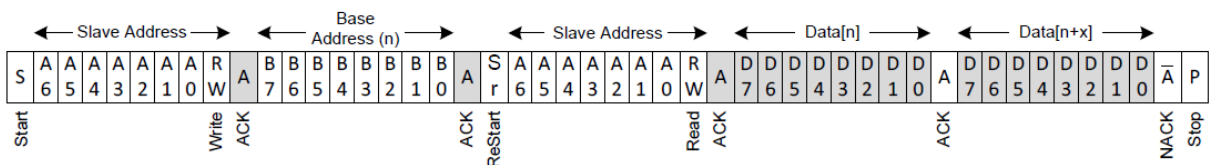
3. Command Sequence

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. Data Registers

Register	Definition	Data	
0x00	Start character 1	0x42	(Fixed)
0x01	Start character2	0x4d	(Fixed)
0x02	Frame length high 8 bits	.....	Frame length=2x13+2(data+check bytes)
0x03	Frame length low 8 bits	.....
0x04	Data 1 high 8 bits	.....	Data1 refers to PM1.0 concentration unit $\mu\text{g}/\text{m}^3$ (CF=1, standard particle) *
0x05	Data 1 low 8 bits	.....
0x06	Data2 high 8 bits	.....	Data2 refers to PM2.5 concentration unit $\mu\text{g}/\text{m}^3$ (CF=1, standard particle)
0x07	Data2 low 8 bits	.....
0x08	Data3 high 8 bits	.....	Data3 refers to PM10 concentration unit $\mu\text{g}/\text{m}^3$ (CF=1, standard particle)
0x09	Data3 low 8 bits	.....
0x0A	Data4 high 8 bits	.....	Data4 refers to PM1.0 concentration unit * $\mu\text{g}/\text{m}^3$ (under atmospheric environment)
0x0B	Data4 low 8 bits	.....
0x0C	Data5 high 8 bits	.....	Data 5 refers to PM2.5 concentration unit $\mu\text{g}/\text{m}^3$ (under atmospheric environment)
0x0D	Data5 low 8 bits	.....
0x0E	Data6 high 8 bits	.....	Data 6 refers to concentration unit (under atmospheric environment) $\mu\text{g}/\text{m}^3$
0x0F	Data6 low 8 bits	.....
0x10	Data7 high 8 bits	.....	Data7 indicates the number of particles with diameter beyond 0.3 μm in 0.1 L of air.
0x11	Data7 low 8 bits	.....
0x12	Data8 high 8 bits	.....	Data 8 indicates the number of particles with diameter beyond 0.5 μm in 0.1 L of air.
0x13	Data8 low 8 bits	.....
0x14	Data9 high 8 bits	.....	Data 9 indicates the number of particles with diameter beyond 1.0 μm in 0.1 L of air.
0x15	Data9 low 8 bits	.....

0x16	Data10 high 8 bits	.....	Data10 indicates the number of particles with diameter beyond 2.5 um in 0.1 L of air.
0x17	Data10 low 8 bits	.....
0x18	Data11 high 8 bits	.....	Data11 indicates the number of particles with diameter beyond 5.0 um in 0.1 L of air.
0x19	Data11 low 8 bits	.....
0x1A	Data12 high 8 bits	.....	Data12 indicates the number of particles with diameter beyond 10 um in 0.1 L of air.
0x1B	Data12 low 8 bits	.....
0x1C	Data13 high 8 bits	.....	Data13 Reserved
0x1D	Data13 low 8 bits	.....
0x1E	Data and check high 8 bits	.....	Check code=Start character 1+ Start character 2+.....+data 13 Low 8 bits
0x1F	Data and check low 8 bits	.....

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