



# INTRODUCTION

## Laser Particle Sensor Module PM2005

——Fan Series



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## 1. Brief introduction

PM2005 is one type of laser particle sensor module, which can measure indoor particle concentration PM2.5 exactly and output  $\mu\text{g}/\text{m}^3$  directly. It is widely used for air purifier, IAQ monitor, air conditioner with purifier function, ventilation system, cars and other consumer electronics etc.

## 2. Main features

- The smallest size of available measurement:  $0.3\mu\text{m}$
- Three types of optional signal output: UART-TTL(default); I<sup>2</sup>C(default); PWM(customized)
- Four types of measuring mode for option
- High sensitive and quick response
- It is with compacted structure, light weight and easy for installation and maintenance

## 3. Principle of particle measurement

When sampling particles pass through light beam (laser), there will be light scattering phenomenon. And it will be converted into the electrical signal (pulse). The bigger particles will obtain stronger pulse single (peak value). Through peak value and pulse value can calculate quantity concentration of particles in each size. That is real-time data.

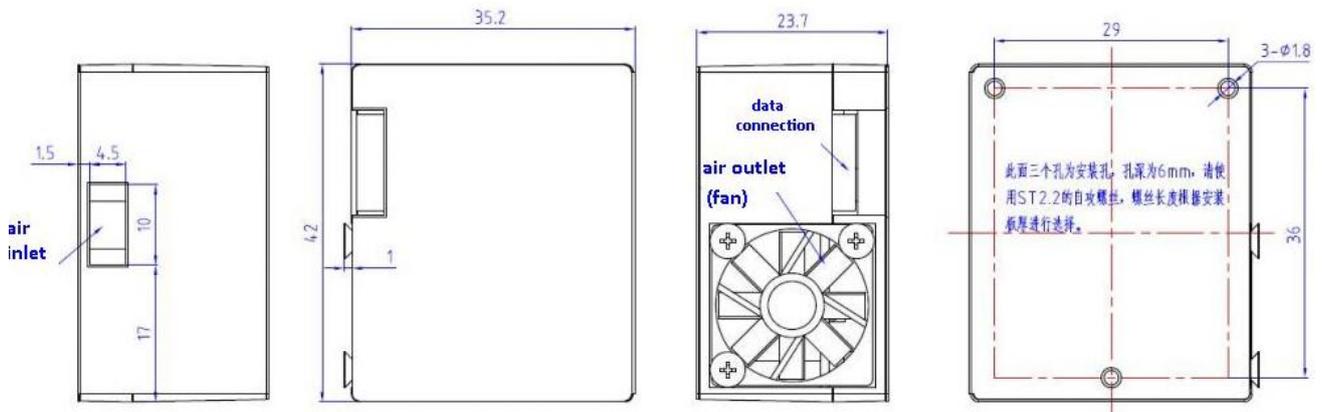
## 4. Specification

Measurement range	PM2.5: 0-500 $\mu\text{g}/\text{m}^3$ 0-2000 $\mu\text{g}/\text{m}^3$ (optional)
Accuracy	PM2.5: < 100 $\mu\text{g}/\text{m}^3$ : $\pm 15\mu\text{g}/\text{m}^3$ > 100 $\mu\text{g}/\text{m}^3$ : $\pm 15\%$ reading
temperature influences coefficient	0.5%/ $^{\circ}\text{C}$ or 0.5 $\mu\text{g}/\text{m}^3/^{\circ}\text{C}$
Respond time	1 seconds
Time to first reading	$\leq 36$ seconds
Working temperature	-10 ~ +50 $^{\circ}\text{C}$
Stable storage temperature	-20 ~ +60 $^{\circ}\text{C}$
Working humidity	0-95% RH non-condensing
Power supply	5.0 $\pm$ 0.1 VDC; ripple wave < 50mV
Working current	Working current: < 160mA Standby current: < 30mA
Signal outputs	UART-TTL (electrical level 3.3V) (default) Data bit: 8; Stop bit: 1; Check bit: null; Baud rate: 9600bps
	I <sup>2</sup> C (electrical level 3.3V) (default)
	PWM (customization)
Dimension(mm)	35.2*36*23.7
Life Span	Under ambient temperature and pressure, in the condition of continuous switch-on, lifespan is 10000 hours (28000 hours is optional). Lifespan can reach 8-13 years by controlling working time interval of the optical source.

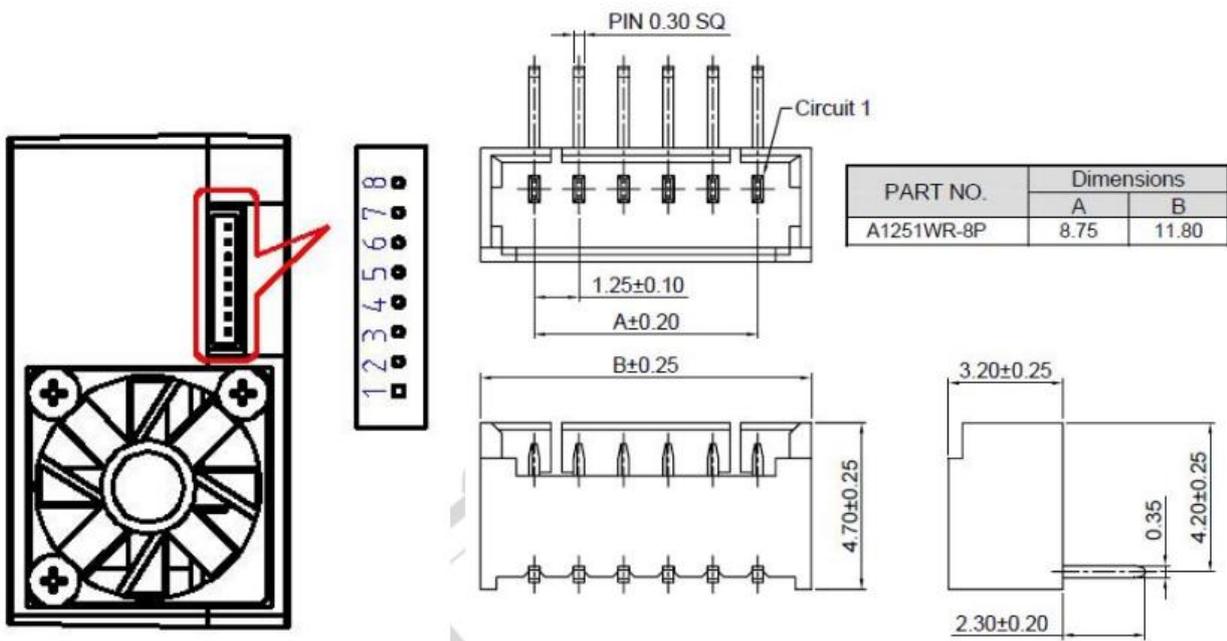
Signal outputs (option)	<del>UART-TTL (0-3.3V interface) (default)</del>
	<del>Data bit: 8; Stop bit: 1; Check bit: null; Baud rate: 9600bps</del>
	<del>I<sup>2</sup>C(0-3.3V interface) (default)</del>
	PWM (customization)

## 6. Dimension

### 6.1 schematic diagram



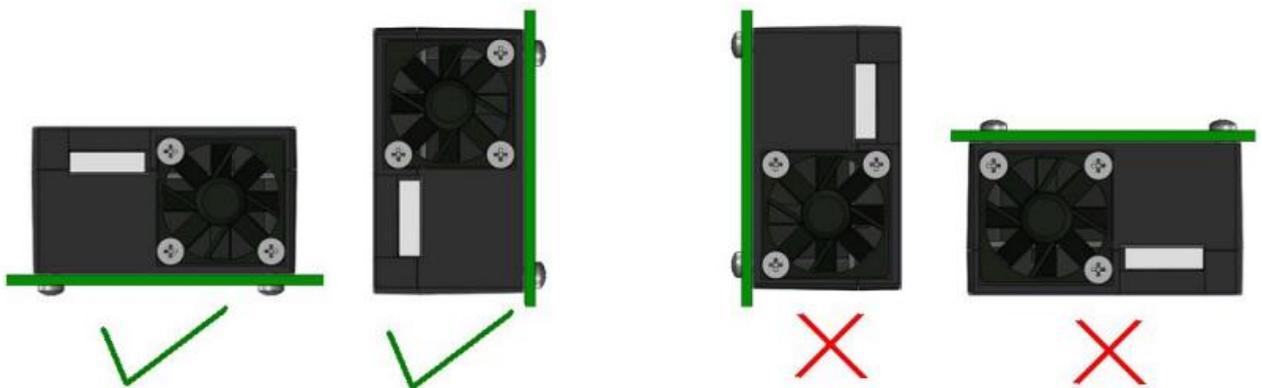
### 6.2 I/O definitions



No.	Item	Description
1	+3.3V	Power output (+3.3V/100mA)
2	5V	Power input (5V)
3	SCL	I <sup>2</sup> C Clock
4	SDA	I <sup>2</sup> C Data
5	TEST	For testing
6	TX	UART-TX output (0-3.3V)
7	RX	UART-RX input (0-3.3V)
8	GND	Power input(ground terminal)

## 7. User attention

- PM2005 laser particle sensor module is for household electronics products, not suitable to medical, mining equipment etc. application;
- PM2005 adopts no static adsorption material like metal plate etc. Please do not use it in bad dusty environment. And please turn off sampling inlet when not working;
- When install PM2005 sensor module in your system or equipment, please make sure of unobstructed air-inlet and air-outlet. And there is no huge airflow faced to air-inlet and air-outlet. **Correct installation position as below for reference:**



Correct installation

Wrong installation

#### 4. Detail Description of RS232 Protocol

##### 4.1 Open/ close particle measurement

**Send:** 11 03 0C DF1 1E C2

**Response:** 16 02 0C DF1 CS

**Function:** Open/ close particle measurement

**Note:**

1. In sending command, DF1=2 means measuring open, DF1=1 means measuring closed;
2. In responding command, DF1=2 means measuring open, DF1=1 measuring closed;
3. When the sensor receives the command of opening measurement, it will be in default continuous testing mode. And if,

**Send:** 11 03 0C 02 1E C0 //open particle measurement

**Respond:** 16 02 0C 02 DA //module is under particle measurement open status

**Send:** 11 03 0C 01 1E C1 //close particle measurement

**Respond:** 16 02 0C 01 DB // module is under particle measurement closed status

##### 4.2 Read particle measuring results

**Send:** 11 02 0B 01 E1

**Response:** 16 11 0B DF1- DF4 DF5- DF8 DF9- DF12 DF13 DF14 DF15 DF16 [CS]

**Function:** Read weight of particle (ug/m3)

**Note:**

PM2.5 measured data =  $DF1 * 256^3 + DF2 * 256^2 + DF3 * 256^1 + DF4$

PM10 measured data =  $DF5 * 256^3 + DF6 * 256^2 + DF7 * 256^1 + DF8$

Data bit: 16 11 0B    00 02 83 C9    00 00 00 EC    00 00 00 67    00 00 00 00 2D  
    PM<sub>2.5</sub>     PM<sub>10</sub>     Reserved     Reserved

**DF13:** Alarm of sensor module working condition:

Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit0
Alarm Definition					1: low working temperature	1: high working temperature	1: laser scatterer at low revolving speed	1: laser scatterer at high revolving speed

**DF15:** Reserved. Alarm of sensor module calibrated status:

Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit0
Alarm Definition						1: uncalibrated	1: uncalibrated	1: uncalibrated

**DF16:** reserved

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#### **4.3 Set up and read particle measuring time**

**Send:** 11 03 0D DF1 DF2 [CS] // set up particle measuring time

**Send:** 11 01 0D E1 // read particle measuring time

**Respond:** 16 03 0D DF1 DF2 [CS]

**Function:** to read particle measuring time

**Note:**

1. Particle measuring time =  $DF1 * 256 + DF2$ , unit is second. Minimum measuring time is 36 seconds. Factory default set-up time is 36 seconds. Available time range for set-up is 36-65535 seconds.
2. When measuring time is  $\geq 65531$ , it means module will be in continuous measuring mode once powered on. It will not stop until stop command is sent.

**Send:** 11 03 0D 00 24 BB // set up single measuring mode; measuring time is 36s

**Respond:** 16 03 0D 00 24 B6 // measuring time is set up successfully

**Send:** 11 03 0D FF FF E1 // set up continuous measuring mode

**Respond:** 16 03 0D FF FF DC //continuous measuring mode is set up successfully

**Send:** 11 01 0D E1 // read particle measuring time

**Respond:** 16 03 0D FF FF DC // read measuring time successfully

#### **4.4 Set up timing measuring mode**

**Send:** 11 03 05 DF1 DF2 [CS] // set up particle measuring mode

**Send:** 11 01 05 E9 // read particle measuring mode

**Respond:** 16 03 05 DF1 DF2 [CS]

**Function:** to read particle measuring time

**Note:**

- 1、 Particle measuring mode value  $X = DF1 * 256 + DF2$ , unit is second;
- 2、 When  $X \geq 60$ , it means module is under timing measuring mode. Measurement timing cycle is X seconds. The sensor module will start measurement every X seconds. Default measuring time is 36 seconds.
- 3、 The shortest timing cycle set by X value is 1 minute;

**Send:** 11 03 05 02 05 E0 // Set up as timing measuring mode, and timing cycle is 517seconds.

**Respond:** 16 03 05 02 05 DB // Set up successfully

#### **4.5 Set up dynamic measuring mode**

**Send:** 11 02 06 DF1 [CS] // Set up dynamic particle measuring mode

**Send:** 11 01 06 E8 // Read dynamic particle measuring mode

**Respond:** 16 02 06 DF1 [CS]

**Function:** Read/set up particle dynamic measuring mode

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**Note:**

- 1、 Particle dynamic measuring mode data DF1;
- 2、 When DF1=0 , close dynamic measuring mode. When DF1=1 , open dynamic measuring mode.

**Analysis of dynamic measuring mode:**

- 1、 When dynamic measuring mode is open, there will be a single measurement for completed 36 seconds automatically proceeded once the module is powered on.;
- 2、 After the first single measurement, it will open measurement every minute. And if the measurement data of initial 6 seconds cannot meet “completed 36 seconds measuring condition”, then the sensor will stop working and keep last measuring result. Otherwise, the sensor will go ahead for the second completed 36 seconds measurement and update the latest measurement data accordingly.
- 3、 Each time when dynamic working mode is set , the sensor will restart completed 36 seconds measurement.
- 4、 Conditions to start completed 36s measurement under dynamic working mode:
  - 1) Change range is  $> \pm 10\mu\text{g}$  (when last measured result  $< 100\mu\text{g}/\text{m}^3$ );
  - 2) Change range is  $> \pm 10\%$  (when last measured result  $> 100\mu\text{g}/\text{m}^3$ ).

**Send:** 11 02 06 01 E6 //Set up open of dynamic measurement mode

**Respond:** 16 02 06 01 E1 // Set up successfully

**Send:** 11 02 06 00 E7 // Set up close of dynamic measurement mode

**Respond:** 16 02 06 00 E2 //Set up successfully

PM2005 sensor module supports 4 types of working modes (single measuring mode + continuous measuring mode + timing measuring mode + dynamic measuring mode). Factory default one is continuous measuring mode. It can be switched among these 4 types of modes by commands as below:

1) **Send:** 11 03 0D 00 24 BB // single measuring mode; measuring time is 36 seconds

2) **Send:** 11 03 0D FF FF E1 // continuous measuring mode

3) **Send:** 11 03 05 02 05 E0 // timing measuring mode; default cycle is 517 seconds

4) **Send:** 11 02 06 01 E6 // dynamic measuring mode

**Setting of mode can not be saved once the sensor is powered off.**

# I<sup>2</sup>C Protocol V0.04

## for Laser Particle Sensor Module PM2005

### 1. Brief introduction

This is an I<sup>2</sup>C protocol for PM2005. The sensor module is lower computer, it is not able to initiate communication automatically. Communication is initiated via main control board, it reads data and sends control commands.

Communication clock frequency is  $\leq 25$  KHz

### 2. Communication common description

- ❖ **START**: start signal, send by main control board;
- ❖ **STOP**: stop signal, send by main control board;
- ❖ **ACK**: acknowledge signal, if in bold, it means sending by the sensor module; otherwise, send by main control board;
- ❖ **NACK**: non-acknowledge signal, if in bold, it means sending by the sensor module; otherwise, send by main control board;
- ❖ **Px**: receive and send data; if in bold, it means sending by the sensor module; otherwise, send by main control board.

### 3. Protocol detailed description

#### 3.1 Send command data

Main control board send:

START+WRITE+**ACK**+P1+**ACK**+P2+**ACK**..... +P7+**ACK**+STOP

Data	Byte content	Description
Device address	Sensor address and read/write command	This byte is 0x50 when write data
P1	0x16	Frame header
P2	Frame length	Number of byte, not including length of device address (From P1 to P7, 7 bytes in total)
P3	Data 1	Control command of the sensor as: Close measurement: 1 Open single measuring mode: 2 Set up measurement time: 3 (default is 36s) Set up timing measuring mode: 4 (defaults to off) Set up dynamic measuring mode: 5 Others: invalid
P4	Data 2, high byte	Measuring time: (range:36-65530) unit: second Timing measuring cycle: (range:300-64800) unit: second
P5	Data 2, low byte	
P6	Reserved	
P7	Data check code	Check code= (P1^P2^.....^P6)

### 3.2 Read data command

The main control board send:

START+READ+ACK+P1+ACK+P2+ACK+.....+P22+NACK+STOP

Data	Byte content	Description
Device address	Sensor address and read/write command	This byte is 0x51 when read data.
P1	0x16	Frame header
P2	Frame length	Number of byte, not including length of device address (from P1 to P22, 22 bytes in total)
P3	Sensor situation	Close: 1 Malfunction : 2 Under detecting : 3 Detecting completed: 0x80; other data is invalid.
P4	Data 1, high byte	Reserved, default value is 0.
P5	Data 1, low byte	
P6	Data 2, high byte	PM2.5 concentration , unit: ug/m3
P7	Data 2, low byte	
P8	Data 3, high byte	PM10 concentration, unit: ug/m3
P9	Data 3, low byte	
P10	Data 4, high byte	The measuring mode of sensor as: Single measuring mode: 2 Continuous measuring mode: 3 Dynamic measuring mode: 5 Timing measuring mode: >= 300 (means measuring time)
P11	Data 4, low byte	
P12	Data 5, high byte	Reserved, default value is 0.
P13	Data 5, low byte	
P14	Data 6, high byte	Reserved, default value is 0.
P15	Data 6. high byte	
P16	Data 7, high byte	Reserved, default value is 0.
P17	Data 7, high byte	
P18	Data 8, high byte	Reserved, default value is 0.
P19	Data 8,high byte	
P20	Data 9, high byte	Reserved, default value is 0.
P21	Data 9, high byte	
P22	Data check code	Check code = (P1^P2^.....^P21)

The sensor will start measuring particles after receiving command of opening measuring. Measured value of last measurement will be output automatically in preheating. After preheating for 6 seconds, current measured data will be output. Measurement is to be

completed in 36s, and then it will be closed automatically.

After delivering the command of opening measurement, the main control board will start sending command of reading data and read current measured value of particles and sensor situation in real time. In measurement, sensor situation is under detecting. The situation changes to measuring finished after completed 36s measurement, and then data received is final measured value.

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