SPECIFICATION

Product Name: Outdoor Laser Particle Sensor Module

Item No.: PM3006S

Version: V0.1

Date: August 18, 2020

Revision

No.	Version	Content	Date
1	V0.1	1. First Edition	2020.08.18

Outdoor Laser Particle Sensor Module

PM3006S

Applications

- Outdoor Air Quality Monitoring
- Emissions Monitoring
- Construction Site Monitoring
- Mining Site Monitoring

Description

PM3006S is a linear light source-based particle sensor module with laser scattering technology. It is designed to measure the quantity per unit volume of different particle size and can output particle mass concentration PM1.0, PM2.5, PM10 and TSP in µg/m³ at the same time via mathematical algorithm and scientific calibration. Built-in Cubic auto particle identification technology for accurate measurement in different dust source environment.

Features

- Patented technology :intelligent automotive particle identification(API) technology.
- Constant current sampling.
- Better accuracy in both high and low mass-concentration sensing.
- High sensitivity and quick response (≤8s).
- Real-time output of PM1.0, PM2.5, PM10 and TSP in µg/m3 at the same time.
- Wide working temperature: -30℃~70℃ and sensor is also available in -40℃~85℃.
- Better fan with low noise.
- Longer lifetime with laser diode.
- Signal output optional: UART, I²C .
- With voltage regulator design and EMC compatibility, strong antistatic ability.
- Intelligent false alarm functions

Working Principle

Sampling by the internal pressure which occurs by fan, when sampling particles pass through light beam (laser), there will be light scattering phenomenon. Scattered light will be converted into electrical signal (pulse) via photoelectric transformer. The bigger particles will obtain stronger pulse signal (peak value). Through peak value and pulse value quantity concentration of particles in each size can be calculate. Thus, real-time measured data is obtained through measuring quantity and strength of scattered light.

Specifications

| Outdoor Laser Particle Sensor Specification	
Operating principle	Laser scattering
Measurement range	0~30,000μg/m³
Working condition	-30°C ~ 70°C,0-95%RH (non-condensing) -40℃~85℃ working temperature could be available.
Storage condition	-40°C ~ 85°C, 0-95%RH (non-condensing)
Accuracy of PM1.0/PM2.5	<50ug/m³: ±5μg/m³; 50~1000μg/m³: ±10% Condition: -20℃~70℃,50±10%RH, Reference instrument: GRIMM
Accuracy of PM10	≤100μg/m³:±15μg/m³ 100~1000μg/m³: ±15% of Reading Condition: -20℃~70℃, 50±10%RH, Reference instrument: GRIMM
Response time	1 second
Time to first reading	≤ 8 Second
Power supply	DC 5V±0.1V, ripple wave＜50mV
Working current	< 300mA
Standby current	< 20mA
Dimensions	W85*H74*D24.9 mm
Digital output 1 (default)	UART_TTL/I²C（3.3V/5V）
Life span	＞5 years(continuous working)

Internal Architecture Description
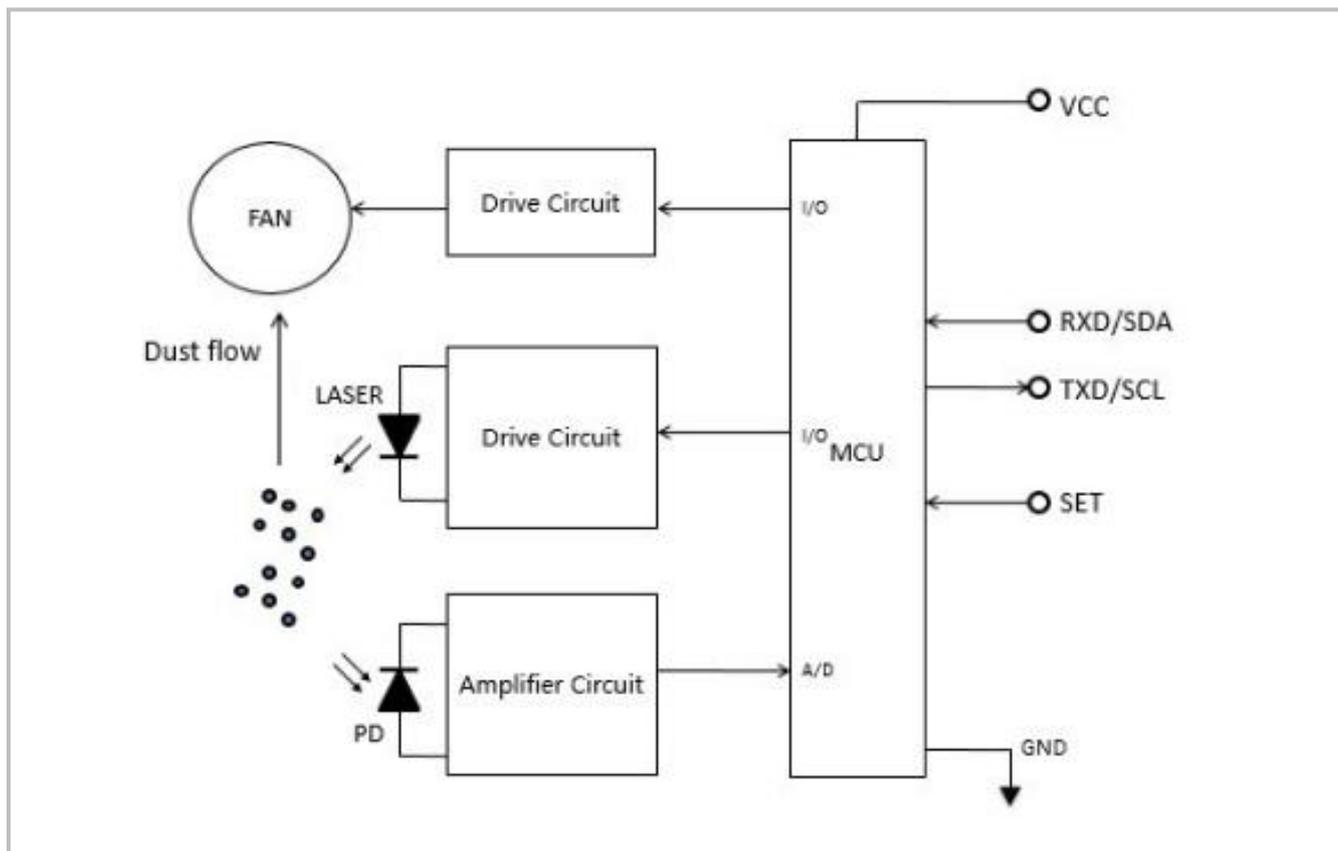
According to the diagram above, the light source part of PM3006S is composed of a laser diode that emits light to detect particles and a drive circuit. The detection part is composed of a photosensitive part that receives scattered light and an amplifier circuit. Data processing and communication output are completed by a microprocessor.

PM3006S's particle detection is that the fan operates to generate air flow, and the particles pass through the detection chamber, the light from the laser tube will be scattered by the particles and converted into electrical signals by the photosensitive device. After the electrical signal is processed by the amplifying circuit and MCU, it will be converted into a digital signal for particle concentration output.

Structure and Pin Definition
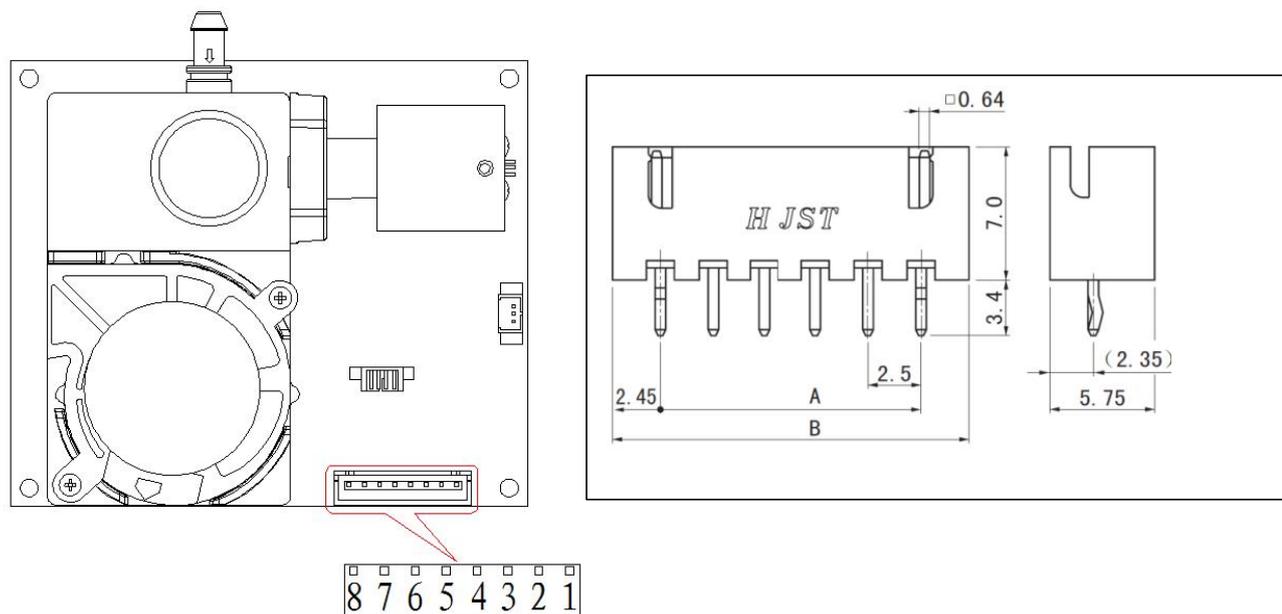
Table 1. Connector Pin Definition

| No.	Pin	Description
1	VCC	Power input (+5V)
2	VCC	Power input (+5V)
3	GND	Power input (GND)
4	GND	Power input (GND)
5	TXD /SCL	UART sending (TTL level @3.3V)/I^2C clock
6	RXD/SDA	UART receiving (TTL level @3.3V/5V)/I^2C data
7	CTR	level @3.3V high level or floating is UART communication mode, low level is I^2C communication mode
8	BT	NC

Connector Description

The interface connector of sensor is A2501WV-8P. The pitch is 2.5mm.

The connection cable with female connector at both ends can also be customized.

Typical Application Circuit

Case 1. UART TTL 3.3V Output
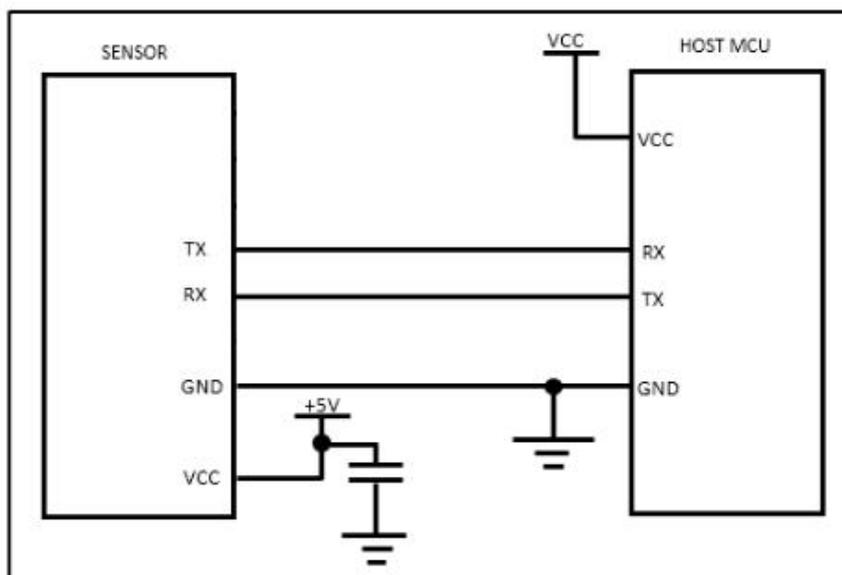
Case 2. I²C TTL 3.3V Output
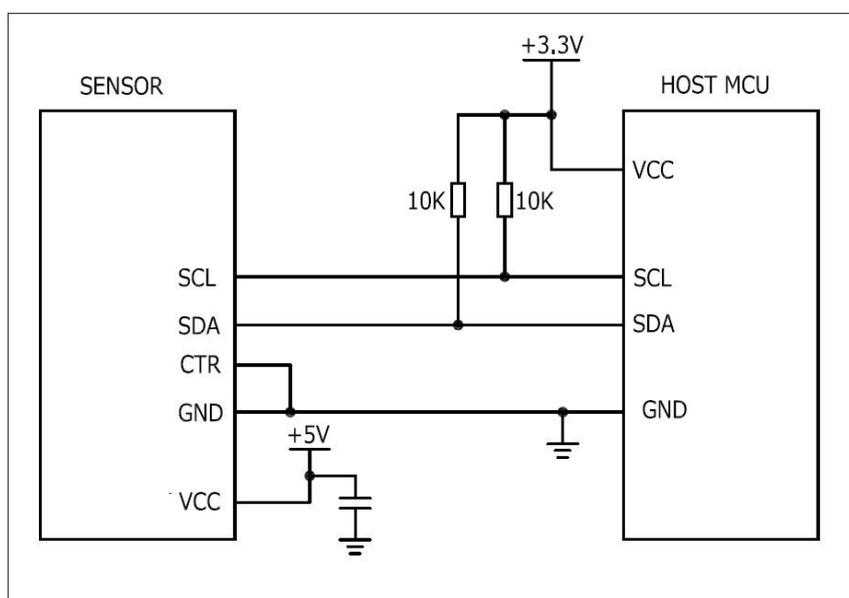
Note of Circuit Design

- UART and I²C communication compatibility with 3.3V and 5V level (receiving end).

- Pin 8 is the pin for manufacturer testing, should be floating in the application circuit.

Communication Protocol

◆ UART Communication Protocol

1) The data in this protocol is all hexadecimal data. For example,"46" for decimal [70].

2) [xx] is for single-byte data (unsigned, 0-255); for double data, high byte is in front of low byte.

3) Baud rate: 9600; Data Bits: 8; Stop Bits: 1; Parity: No

4) It is default by continuously mode after powering on. Working mode will not be saved after powering off.

2. Format of Serial Communication Protocol

Sending format of software:

Start Symbol	Length	Command	Data 1	……	Data n.	Check Sum
HEAD	LEN	CMD	DATA1	……	DATAn	CS
11H	XXH	XXH	XXH	……	XXH	XXH

Detail description on protocol format:

Protocol Format	Description
Start symbol	Sending by software is fixed as [11H], module respond is fixed as [16H]
Length	Length of frame bytes= data length +1 (including CMD+DATA)
Command	Command
Data	Data of writing or reading, length is not fixed
Check sum	Cumulative sum of data = 256- (HEAD+LEN+CMD+DATA)

3. Command Table of Serial Protocol

Item No.	Function Description	Command
1	Read particle measurement result	0x0B
2	Open/close particle measurement	0x0C
3	Set up and read particle calibration coefficient	0x14
4	Read software version number	0x1E
5	Read serial number	0x1F

4.1 Read Particle Measurement Result

Send: 11 02 0B 07 DB

Response: 16 35 0B DF1- DF52 [CS]

Function: Read concentration of particle and particles number.

Note: Read particle concentration (ug/m³)

Data	Description
DF1~DF4	PM1.0 measuring value , unit: µg/m³
DF5~DF8	PM2.5 measuring value, unit: µg/m³
DF9~DF12	PM10 measuring value, unit: µg/m³
DF13~DF16	TSP measuring value, unit: µg/m³
DF17~DF20	Reserved
DF21~DF24	Reserved
DF25~DF28	>0.3um particle quantity, unit: pcs/L
DF29~DF32	>0.5um particle quantity, unit: pcs/L
DF33~DF36	>1.0um particle quantity, unit: pcs/L
DF37~DF40	>2.5um particle quantity, unit: pcs/L
DF41~DF44	>5.0um particle quantity, unit: pcs/L
DF45~DF48	>10um particle quantity, unit: pcs/L
DF49~DF52	Reserved

PM1.0 = DF1*256^3 + DF2*256^2 + DF3*256^1 +DF4

PM2.5 = DF5*256^3 + DF6*256^2 + DF7*256^1 + DF8

PM10 = DF9*256^3 + DF10*256^2 + DF11*256^1 + DF12

TSP =DF13*256^3 + DF14*256^2 + DF15*256^1 + DF16

>0.3um particle quantity = DF25*256^3 + DF26*256^2 + DF27*256^1 + DF28

>0.5um particle quantity = DF29*256^3 + DF30*256^2 + DF31*256^1 + DF32

>1.0um particle quantity = DF33*256^3 + DF34*256^2 + DF35*256^1 + DF36

>2.5um particle quantity = DF37*256^3 + DF38*256^2 + DF39*256^1 + DF40

>5.0um particle quantity = DF41*256^3 + DF42*256^2 + DF43*256^1 + DF44

>10um particle quantity = DF45*256^3 + DF46*256^2 + DF47*256^1 + DF48

DF49: Alarm of sensor module working condition:

Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Alarm definition		1. Laser tube failure alarm	1. Fan failure alarm	1. Fouling alarm	1. Low temperature alarm	1. High temperature alarm	1: Fan at low revolving speed	1: Fan at high revolving speed

DF50, DF51, DF52: Reserved

Note: Part of reserved bit is used for internal testing. Reserved bit is not related to function

4.2 Open/Close Particle Measurement

Send: 11 03 0C DF1 1E CS

Response: 16 02 0C DF1 CS

Function: Open/ close particle measurement

Note:

1. When sending command, DF1=2 means opening measurement, DF1=1 means closing measurement;

2. When receiving response, DF1=2 means measuring opened, DF1=1 means measuring closed;

3. When the sensor receives the command of opening measurement, it will be in default continuous measurement mode.

Example:

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

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

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

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

4.3 Set up and Read Particle calibration coefficient

Send: 11 0A 14 01 DF1-DF8 CS // Set up particle calibrated coefficient

Response: 16 0A 14 01 DF1-DF8 CS

Send: 11 01 14 DA // Read particle calibrated coefficient

Response: 16 09 14 DF1-DF8 CS

Send: 11 02 14 64 75 // Dust calibration coefficient reset

Response: 16 02 14 64 70

Function: Read/set up particle calibration coefficient

Note:

PM1.0 calibration coefficient =（DF1 *256 + DF2）/100

PM2.5 calibration coefficient =（DF3 *256 + DF4）/100

PM10 calibration coefficient =（DF5 *256 + DF6）/100

TSP calibration coefficient =（DF7*256 + DF8）/100

Calibration coefficient setting valid range：0.01~10.

4.4 Read Software Version Number

Send: 11 01 1E D0

Response: 16 0E 1E DF1~DF13 [CS]

Function: Read software version

Note:

Software version="DF1~DF13"

Should change the HEX code to ASCII code.

Example:

HEX code: 16 0E 1E 50 4D 20 56 31 2E 32 36 2E 35 2E 32 38 E9

ASCII code: PM V1.26.5.28

4.5 Read Serial Number

Send: 11 01 1F CF

Response: 16 0B 1F DF1 DF2 DF3 DF4 DF5 DF6 DF7 DF8 DF9 DF10 CS

Function: Read serial number

Note:

Serial number =(DF1*256+DF2), (DF3*256+DF4), (DF5*256+DF6), (DF7*256+DF8), (DF9*256+DF10)

Example:

Response: 16 0B 1F 00 00 00 7E 09 07 07 0E 0D 72 9E

Serial number: 0 0   0 0 0   126   2311   1806   3442

Communication Protocol

◆ I²C Communication Protocol

a. This is an IIC protocol for PM3006S. The sensor module is lower computer, which is not able to initiate communication automatically. Communication is initiated via main controlled board, which reads data and sends control commands.

b. I²C communication clock frequency <=100Khz

2. Communication Common

START: start signal, send by main controlled board;

STOP: stop signal, send by main controlled board;

ACK: acknowledge signal, send by the sensor module if in bold; otherwise, send by main controlled board;

NACK: non-acknowledge signal, send by the sensor module if in bold; otherwise, send by main controlled board;

Px: receive and send data; send by the sensor module if in bold; otherwise, send by main controlled board.

3. Protocol Detailed Description

1.1 Send Command Data

Send by main controlled board:

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 measurement: 2
P4	Data 2, high byte	Reserved
P5	Data 2, low byte	
P6	Data 3	Reserved
P7	Data check code	Check code= (P1^P2^……^P6)

1.1.1 Close Measurement

Send: 16 07 01 00 00 00 10

Function: Close particle measurement

#### 1.1.2 Open Measurement

Send: 16 07 02 00 00 00 13

**Function:** Open particle measurement

1.2 Read Data Command

Send by main controlled board: START+READ+ACK+P1+ACK+P2+ACK+……+P32+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 P32, 32 bytes in total)
P3	Sensor status	Status "1" Means sensor is closing. Status "2" Means sensor is under measuring. Status "7" Alarming Status "0x80" Finish measurement
P4	Data 1, high byte	Reserved
P5	Data 1, low byte	
P6	Data 2, high byte	TSP concentration, unit: µg/m³
P7	Data 2, low byte	
P8	Data 3, high byte	PM1.0 concentration , unit: µg/m³
P9	Data 3, low byte	
P10	Data 4, high byte	PM2.5 concentration , unit: µg/m³
P11	Data 4, low byte	
P12	Data 5, high byte	PM10 concentration , unit: µg/m³
P13	Data 5, low byte	
P14	Data 6, high byte	>0.3um particle quantity, unit: pcs/L
P15	Data 6,middle byte	
P16	Data 6, low byte	
P17	Data 7, high byte	>0.5um particle quantity, unit: pcs/L
P18	Data 7, middle byte	
P19	Data 7, low byte	
P20	Data 8, high byte	>1.0um particle quantity, unit: pcs/L
P21	Data 8, middle byte	
P22	Data 8, low byte	
P23	Data 9, high byte	>2.5um particle quantity, unit: pcs/L
P24	Data 9, middle byte	
P25	Data 9, low byte	
P26	Data 10, high byte	>5.0um particle quantity, unit: pcs/L
P27	Data 10, middle byte	
P28	Data 10, low byte	
P29	Data 11, high byte	>10um particle quantity, unit: pcs/L
P30	Data 11, middle byte	
P31	Data 11, low byte	
P32	Data check code	Check code = (P1^P2^……^P31)

Sensor Dimension

Unit: mm
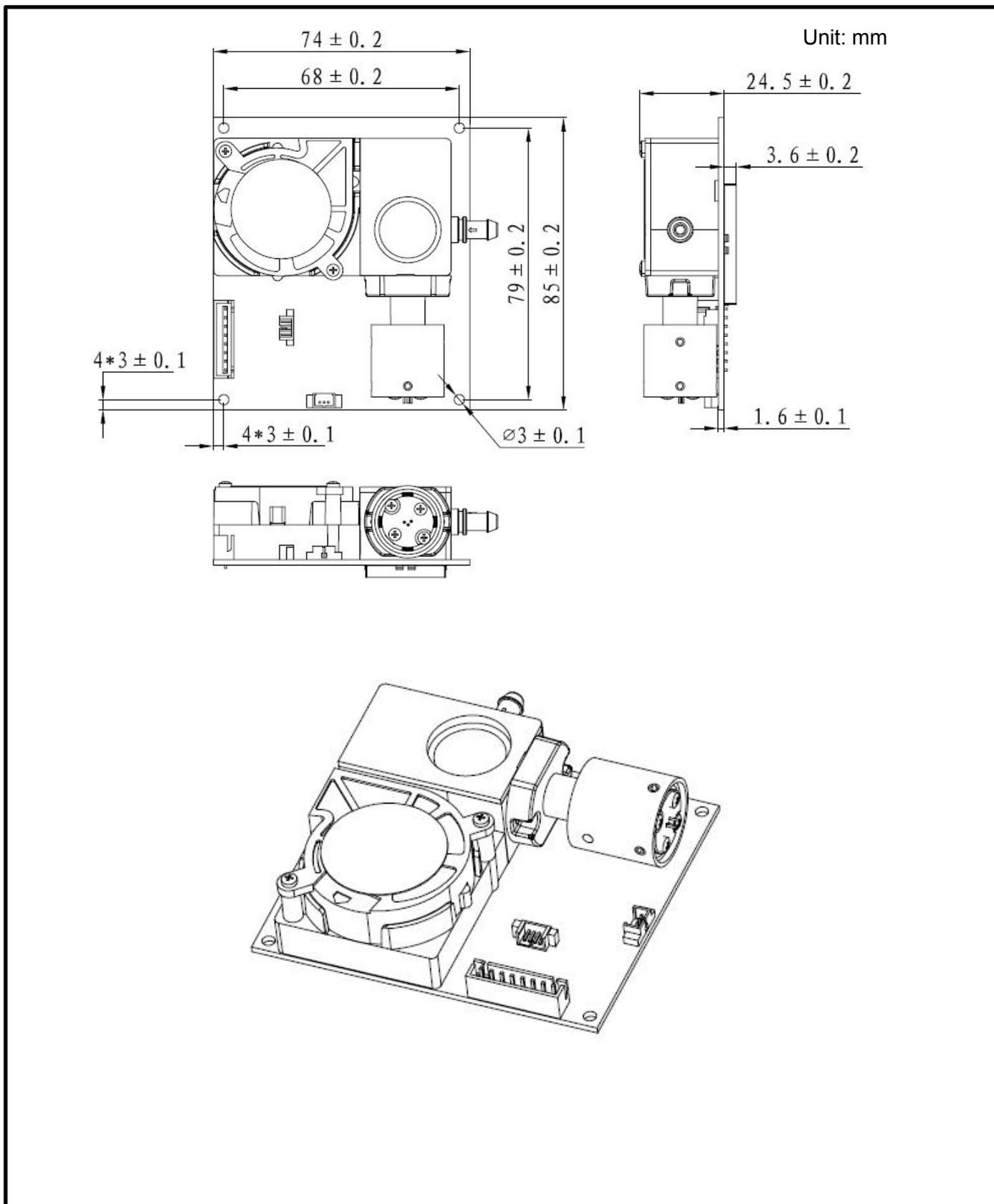
Product Code Description

```
┌────┐ ┌───┐ ┌─────┐ ┌───┐
│ PM │ │ 3 │ │ 006 │ │ S │
└────┘ └───┘ └─────┘ └───┘
```

| ※   Derivative Type |
| S |

| ※   Structure Type |
| 006：Structure Number |

| ※   Product Application |
| 3：Outdoor Dust |

| ※   Product Category |
| PM：Dust Sensor |
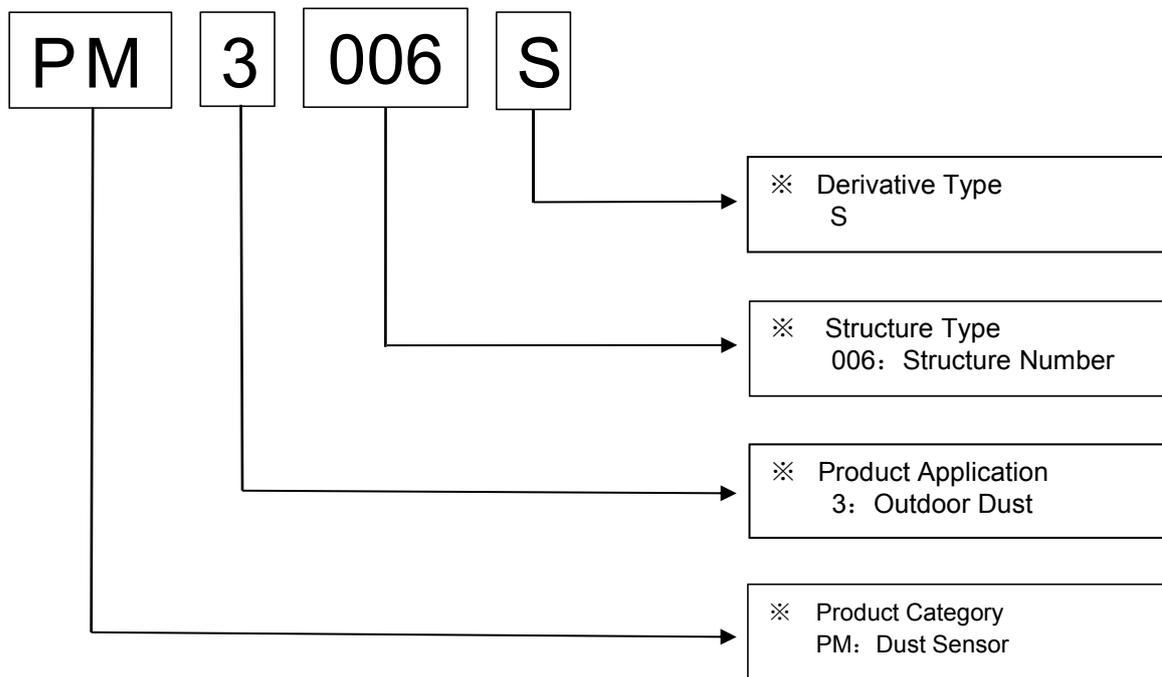
Accessories can be matched with sensor

Accessories PN	Picture	Description	Function
PMHT01		External Heater	To remove water mist in the air and avoid humidity influence to measuring performance
Gasboard-7500K-OAQ		Ultrasonic Flow Meter	To measure air flow rate ,measurement range is 0~20L/min
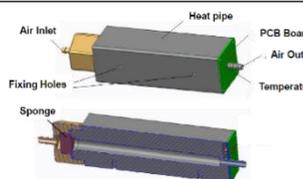
More information please contact with Cubic team.

Package Information
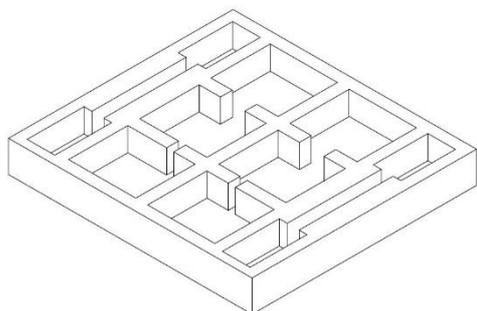
EPE Dimension：308*284*40mm
For 6pcs Sensor
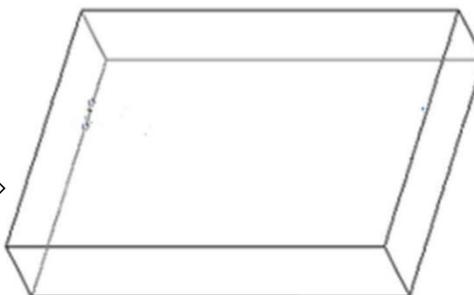
Carton inner frame size 285*305*47mm
The material is single mesh 3mm thick E
pit cardboard
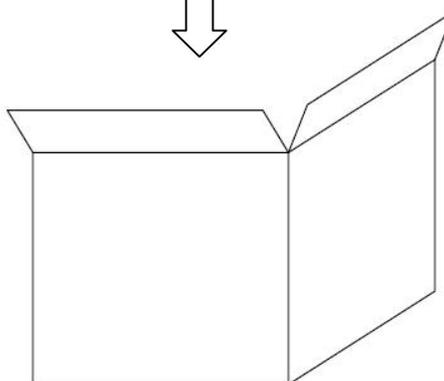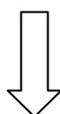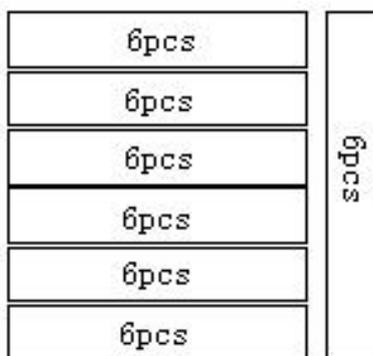
Table 3. Packing

Quantity per Tray	Quantity Per Sub-box	Quantity per Cart	Carton Dimensions	Packing Material
6pcs	6pcs	42pcs	W400 * L300 * H320 mm	Red anti-static EPE

Product Installation

When this product is installed and used in the system, should ensure that the airflow at the inlet and outlet is unobstructed. In order to avoid dust deposits on the surface of the sensitive device during use, affect the accuracy of the sensor measurement, it is recommended to install the sensor in the device in the following way:

Installation Method 1: Fan Type
The monitoring equipment uses the fan device configured by the sensor to generate internal negative pressure for air sampling, so as to realize the real-time detection of the mass concentration of PM2.5, PM10, and TSP in the atmospheric environment.
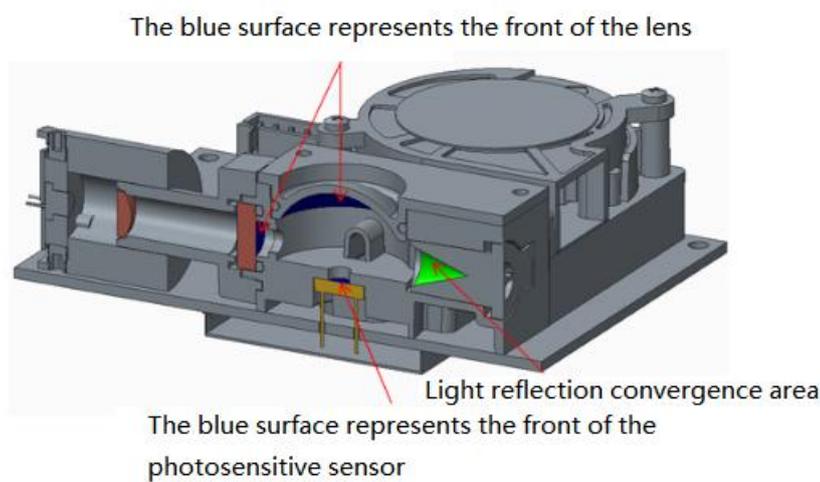

Figure 1. Sensor Internal Section View   Figure 2. Fan Type Installation Diagram
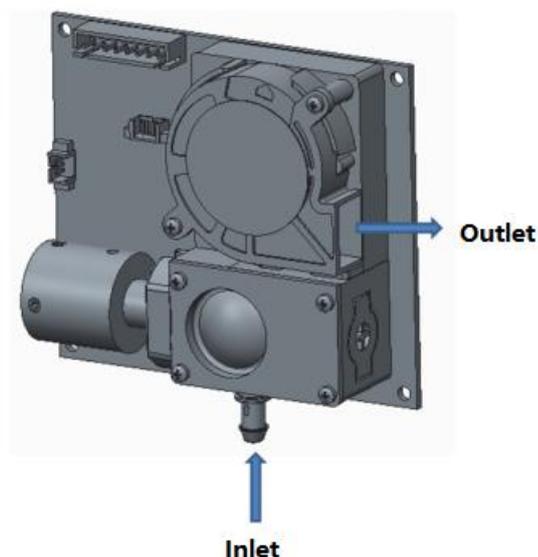
Installation Method 2: Pump Suction Type
The monitoring equipment is equipped with sensor housing (recommended housing size is 118*92*55mm), air pump (flow rate 4L/min is the best) and hose (10cm hose length is the best, and the material is fluorine rubber is the best). Sampling to achieve real-time detection of the mass concentration of PM2.5, PM10, and TSP in the atmospheric environment.
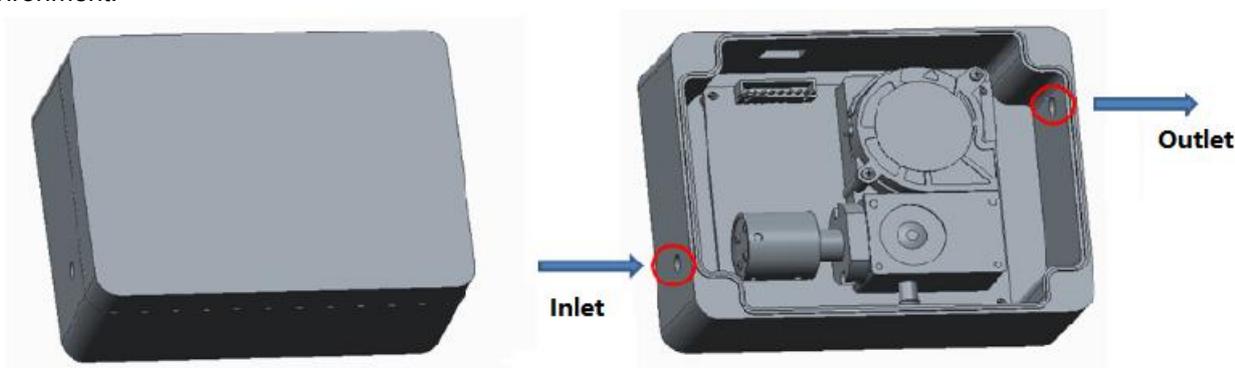

Figure 3. Pump Suction Type installation Diagram

User Attention

※ The best installation method is the plane where the air inlet and outlet are located close to the inner wall of the user machine and the air hole communicating with the outside world. If this is not possible, there should be a structure between the air inlet and outlet to isolate the air flow from the inlet and outlet to avoid the air flow back inside the user machine.

※ The size of the ventilation hole on the inner wall of the user machine for the air inlet should not be less than the size of the sensor's air inlet.

※ When use the product, it is recommended to add a 50-60 mesh protective filter to the sensor's air inlet to prevent flocs, hair, etc. from affecting the sensor's detection.

※ Sensor is an integral unit. In case of irreversible damage, the sensor cannot be disassembling.

※ This product is defined as 3B laser product according to《GB7247.1-2012 laser product safety》with laser radiation inside. Please avoid direct illumination on the eye. The warning signs are as follows:

After-Sales Services and Consultancy

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