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	First version	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 API(intelligent automotive particle identification) technology
- Constant current sampling.
- High accuracy for whole measurement range
- High sensitivity and quick response (≤8s).
- Real-time PM1.0, PM2.5, PM10 and TSP concentration output in μg/m³ at the same time
- Wide working temperature: -30℃~70℃
- Cubic fan in super low noise
- Longer lifetime with laser diode.
- Signal output optional: UART, I²C.
- Good EMC compatibility, strong antistatic ability.

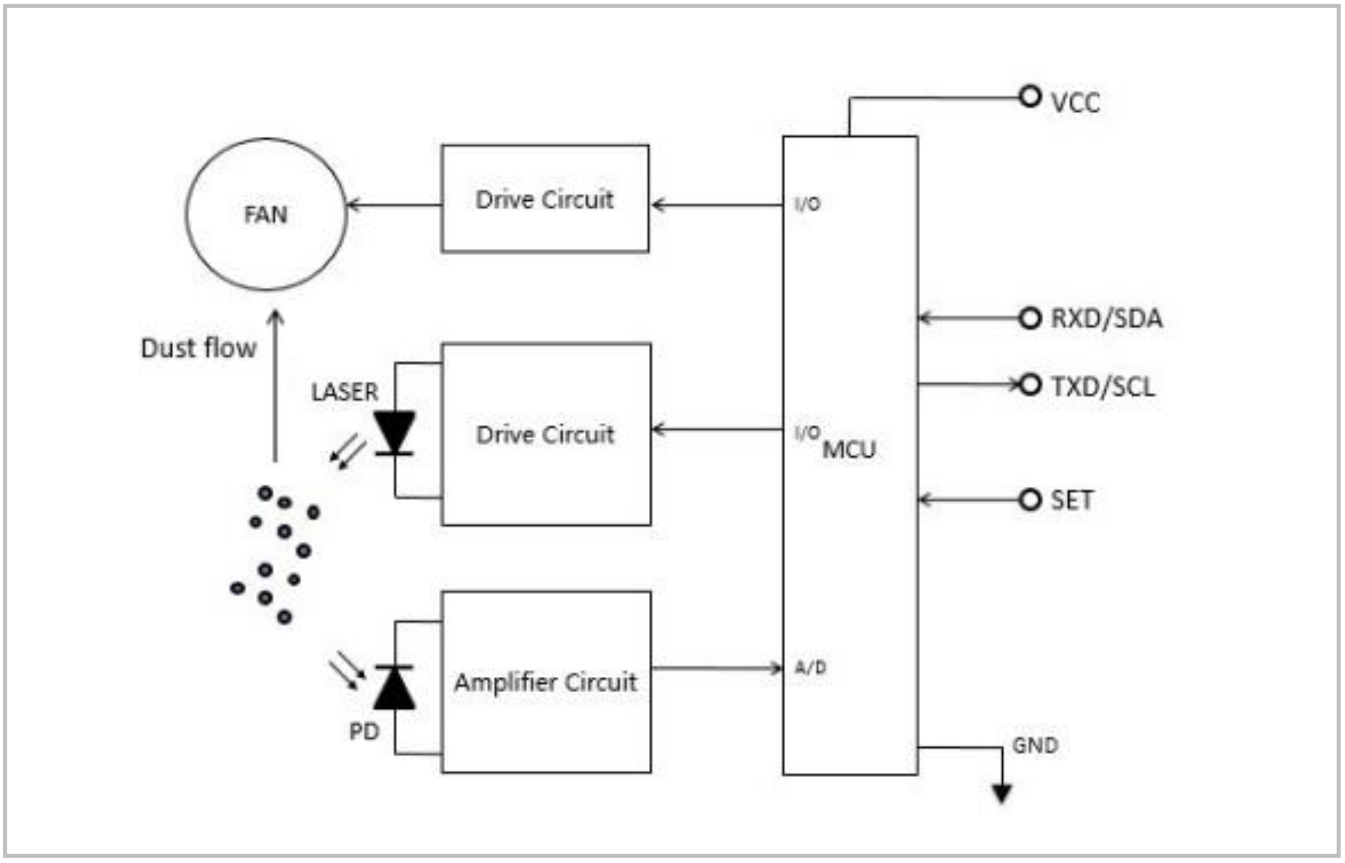
Working Principle

When sampled 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 Module PM3006S Specification	
Operating principle	Laser scattering
Measurement range	0~1,000μg/m³ Maximum display 30,000μg/m³
Working condition	-30°C ~ 70°C,0-95%RH (non-condensing)
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: -30°C ~70°C, 50±10%RH Reference instrument: GRIMM
Accuracy of PM10	≤100μg/m³: ±15μg/m³ 100~1000μg/m³: ±15% of Reading Condition: -30°C ~70°C, 50±10% RH Reference instrument: GRIMM
Data refresh time	1s
Time to first reading	⩽8s
Power supply	DC 5V±0.1V, ripple wave < 50mV
Working current	< 250mA
Standby current	< 25mA
Dimensions	W85*H74*D24.9 (mm)
Digital output 1 (default)	UART_TTL/I²C（3.3V/5V)
Lifetime	⩾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

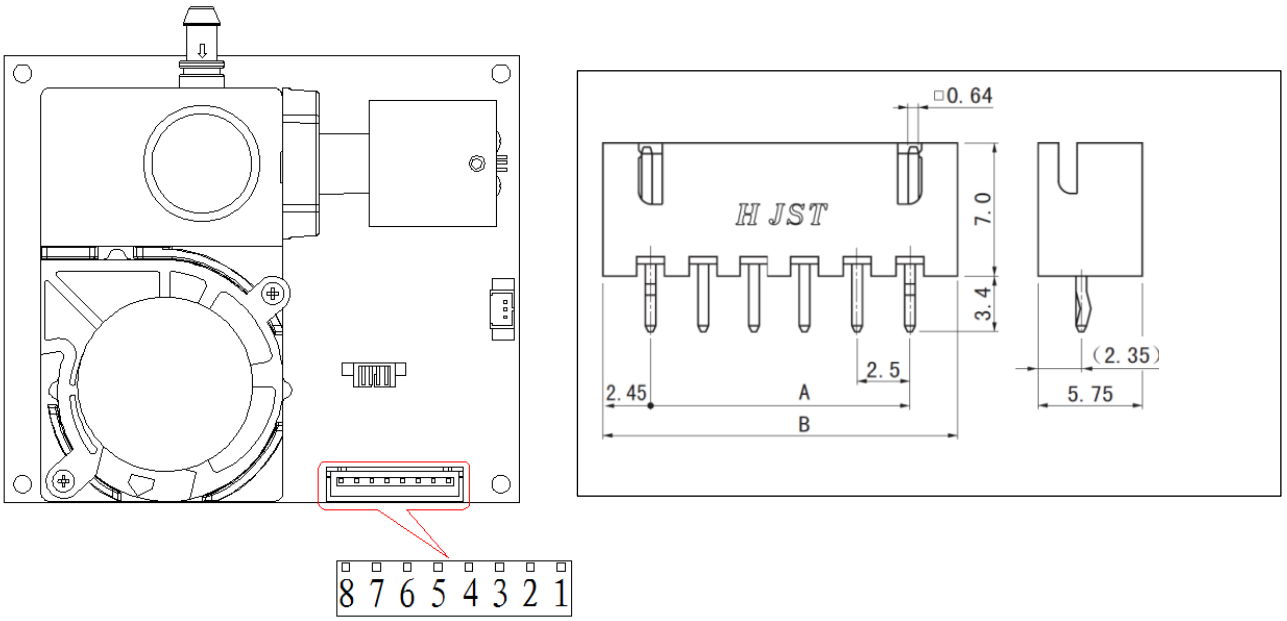


Table 1. Connector Pin Definition

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)/I²C clock
6	RXD/SDA	UART receiving (TTL level @3.3V/5V)/I²C data
7	CTR	level @3.3V high level or floating is UART communication mode, low level is I²C communication mode
8	BT	NC

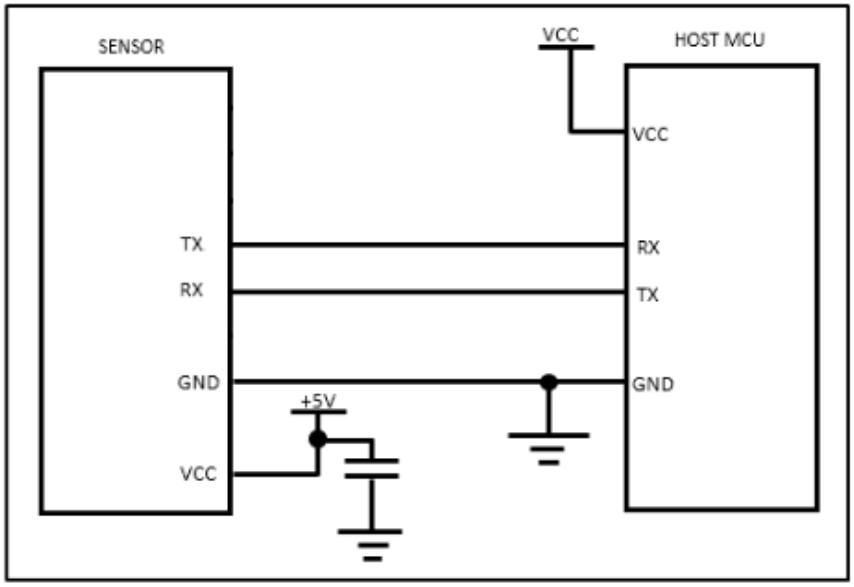
Connector Description

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

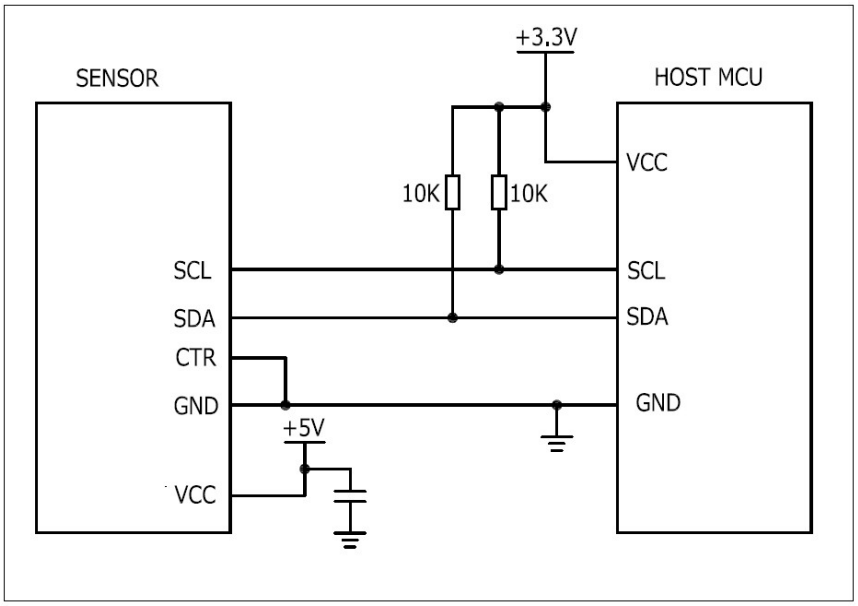
The connection cable with female connector at both ends can also be customized.

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. General Statement

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. Detail Description of UART Protocol

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/m^3)

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

1. Brief Introduction

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

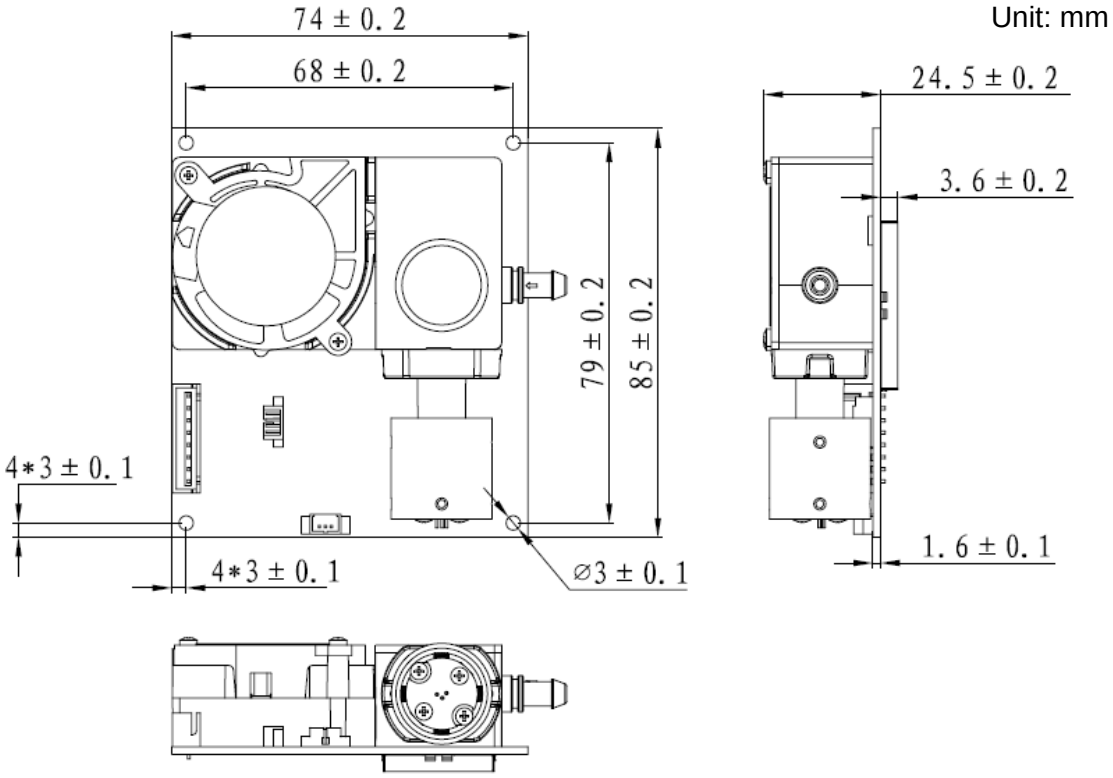
1.2 Read Data Command

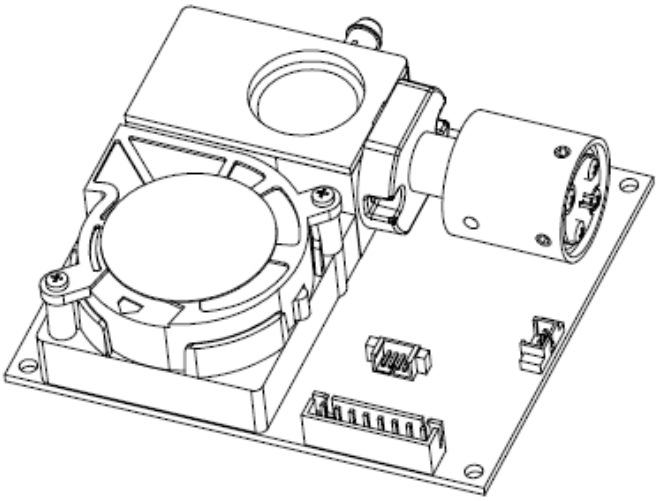
Send by main controlled board: START+READ+ACK+P1+ACK+P2+ACK+……+P32+NACK+STOP

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)

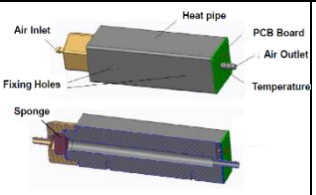
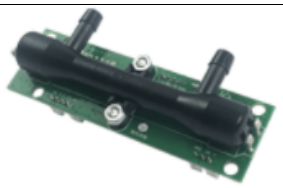
Sensor Dimension

Unit: mm





Accessories

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
Gasboard-7500H-OPC		Ultrasonic Flow Meter	To measure air flow rate, measurement range is 0~5L/min

More information please contact with Cubic team.

Package Information

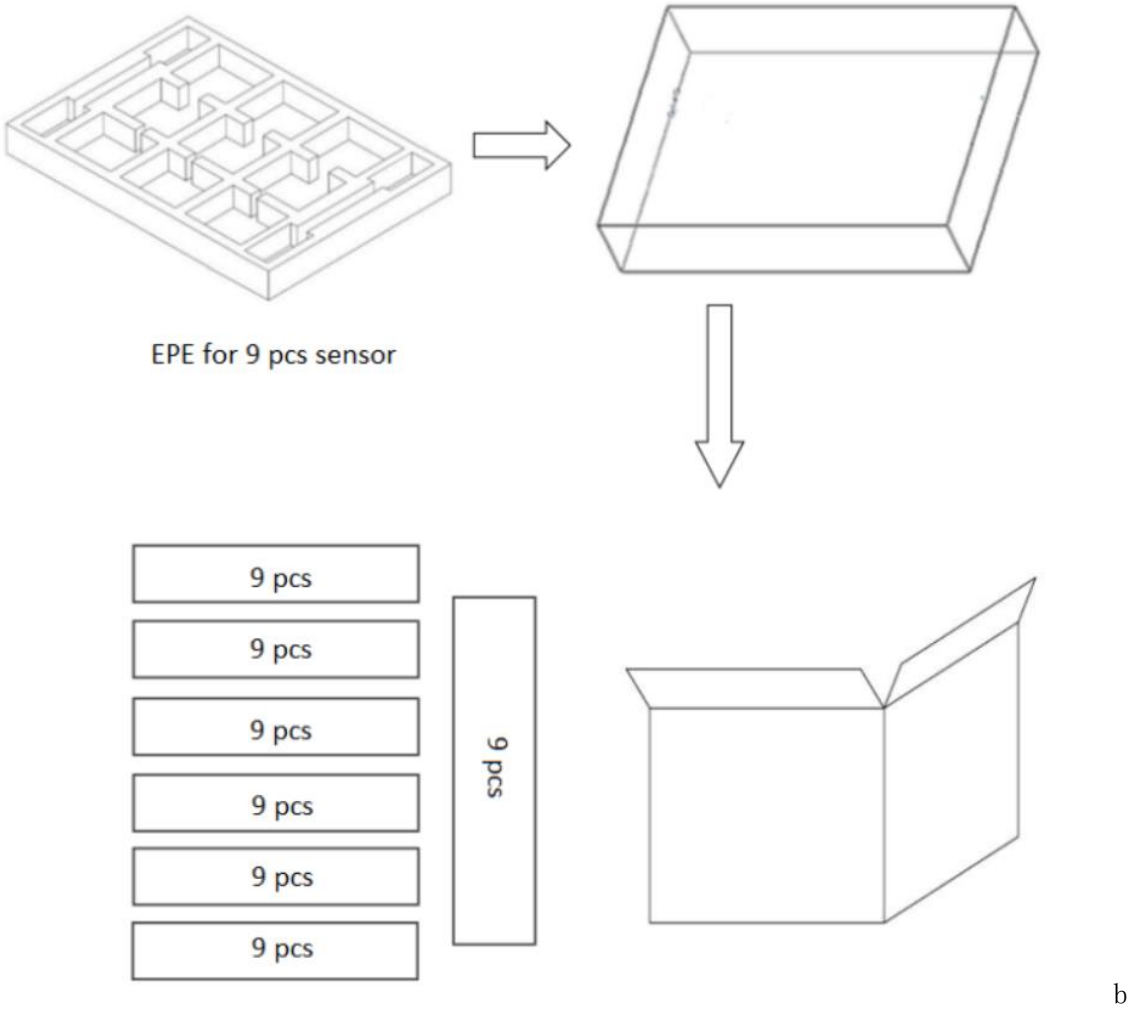


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Table 3. Packing

Sensor per Tray	Tray Qty	Sensor per Carton	Carton Dimensions	Packing Material
9 pcs	7 layers	63 pcs	395*310*330 mm	Red anti-static EPE

Product Installation

When the sensor is installed and used in user's system, it should ensure that the airflow at the sensor's air inlet and outlet is unobstructed. To ensure sensor's measurement accuracy, the surface of sensor sensitive elements as shown in figure 1 shall be protected from dust depositing. It is recommended to install the sensor in user's system following the way shown in figure 2.

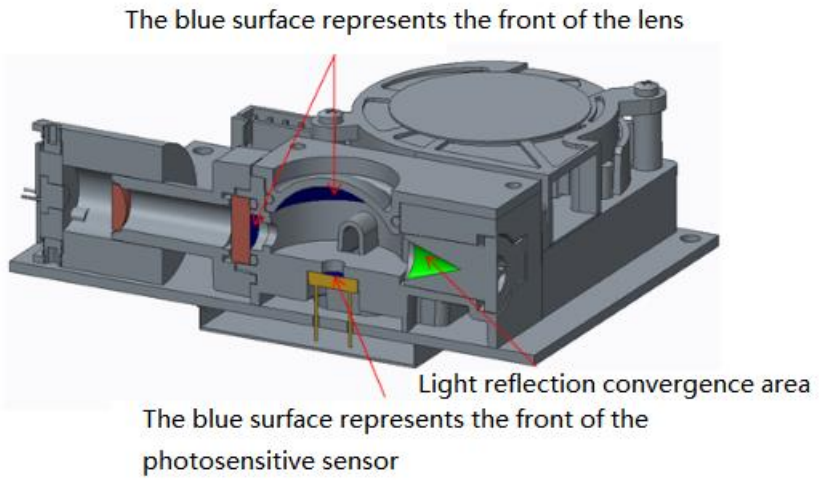

Figure 1. Sensor Internal Section View

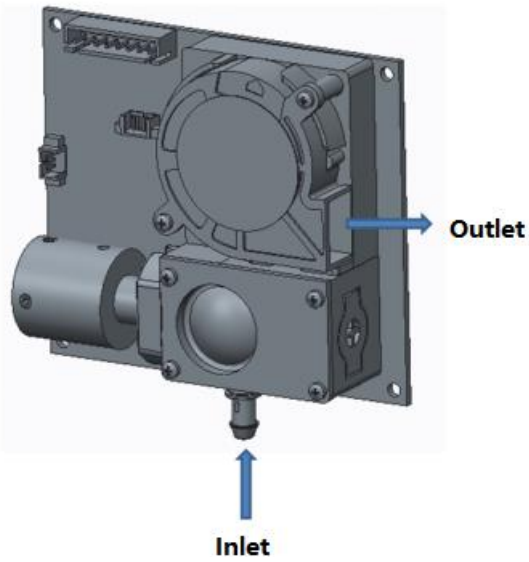

Figure 2. Recommended installation

User Attentions

※ The air inlet inside diameter of user equipment should not be less than the sensor’s air inlet diameter

※ 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.

※ The product is an integral unit that shall not be disassembled to avoid any irreversible damages.

※ 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:

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