CUBIC

SPECIFICATION

Product Name: Laser Oil Fume Sensor Module

Item No.: PM3009BP

Version: V0.4

Date: August 23, 2020

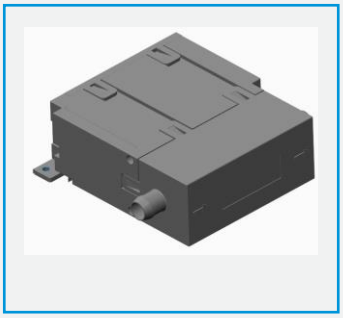
Writer	Audit	Approved
Qiu ShiHang		

Revision

No.	Version	Content	Reviser	Date
1	V0.1	Initial Version	Qiu ShiHang	2020/4/27
2	V0.2	The connection cable is added in the shipping state, and the length of the whole machine is modified to 80.5mm	Qiu ShiHang	2020/6/8
3	V0.3	Correct the description of communication switching	Qiu ShiHang	2020/7/23
4	V0.4	Communication protocol update	Qiu ShiHang	2020/8/23

Oil Fume Sensor Module

PM3009BP



Applications

- Oil fume particulate monitoring

Description

PM3009BP oil fume detect sensor is based on the principle of optical scattering, combined with CUBIC API technology can accurately detect and calculate the number of suspended particulates per unit volume in the oil fume emission, through mathematical algorithms and scientifically calibrate could real-time output PM2.5 particle ug/m3.

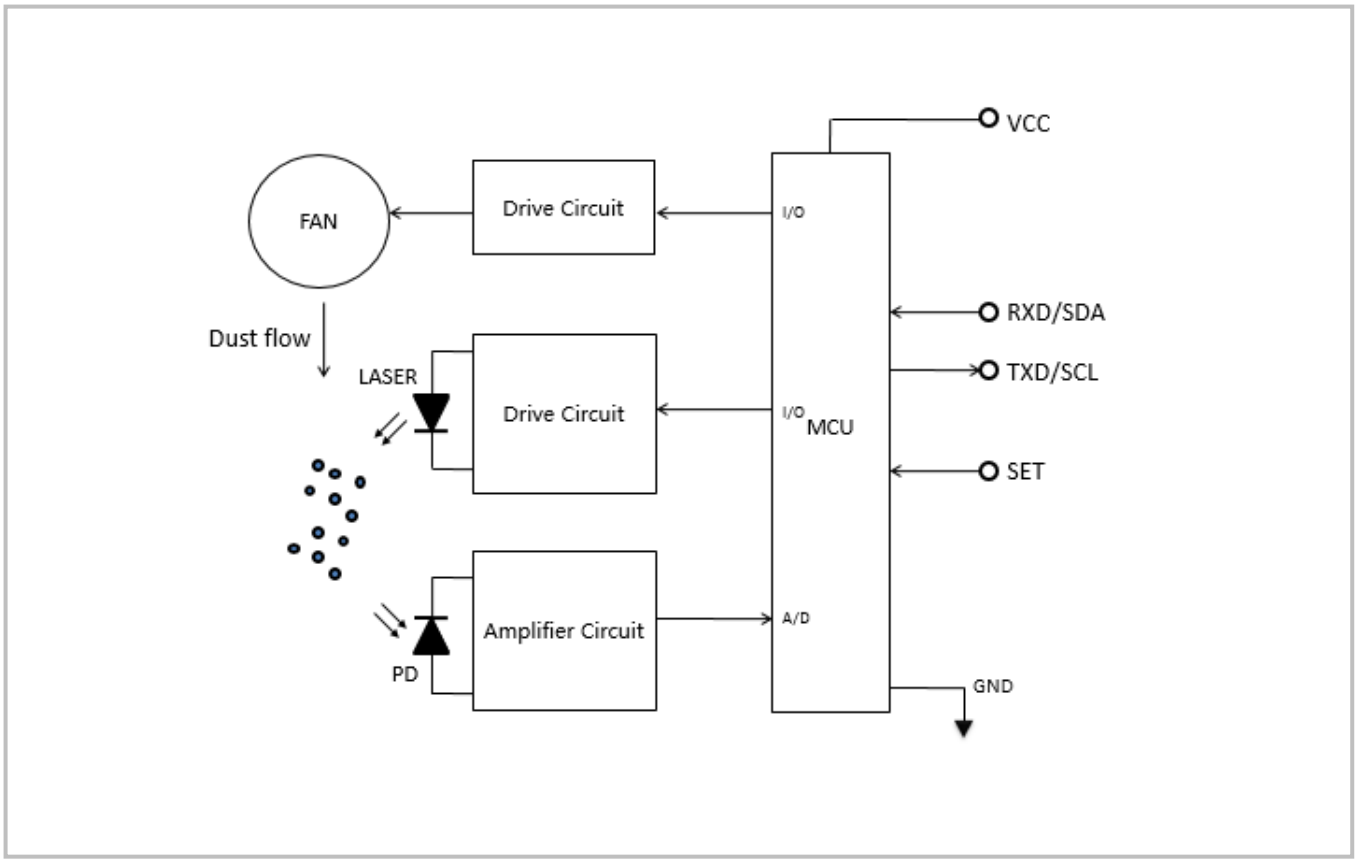
Features

- Real-time output PM2.5 in μg/m^3
- API technology for intelligent dust source identification
- Anti-dust structure, good at dust prevention
- Built-in heater to remove water mist, not affected by water vapor
- By-Pass flow design, not affected by the sampling flow rate
- Long life laser diode to increase the sensor life span

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.

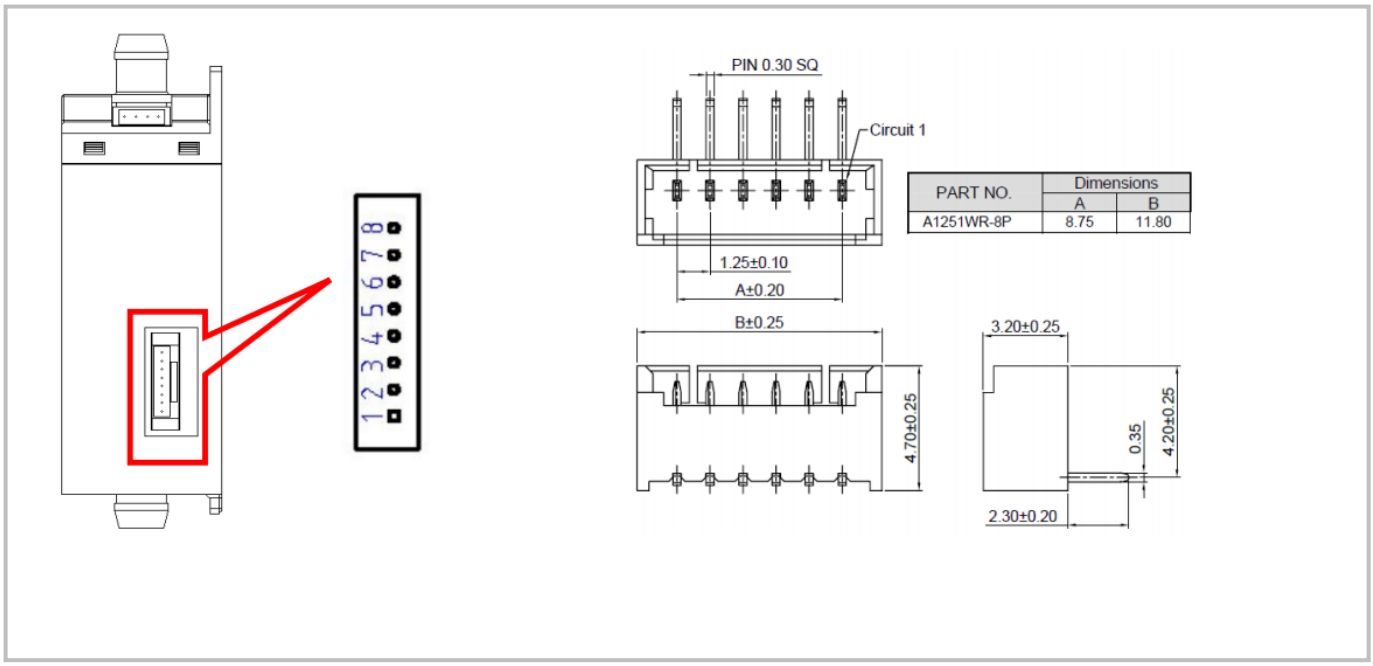
Laser Particle Sensor Specification	
Operating principle	Laser scattering
Measurement range	0~5,000μg/m³ (can extend to 50000ug/m³)
Resolution	1μg/m³
Working condition	-20°C ~ 60°C,0-95%RH (non-condensing)
Storage condition	-30°C ~ 70°C, 0-95%RH (non-condensing)
Accuracy for PM2.5	≤ 100μg/m³: ± 15μg/m³ >100μg/m³: ± 15% of reading Condition: 25±2℃, 50 ±10%RH, calibration instrument: Grimm
Response time	1sec
Time to first reading	≤ 8 seconds
Power supply	DC 5V±0.1V
Working current	≤1A
Suitable air pump size	2~8L/min
Dimensions	W88mm*H80mm*D28.3mm
Digital output	1. UART (3.3V/5V level) 2. I²C (3.3V/5V level)
MTTF	>3 years



When the fan works, it will generate airflow. When the particles in the sampled gas pass through the beam of the light source (laser), a light scattering phenomenon occurs, and the scattered light is converted into an electrical signal (ie, a pulse) by the photoelectric converter. The larger the particle size, the larger the amplitude of the pulse signal output.

The number of particles of different sizes is calculated by comparing the peak value with the predetermined threshold value, and the mass concentration value is obtained by a professional algorithm. By testing the intensity of the scattered light, real-time test data is obtained.

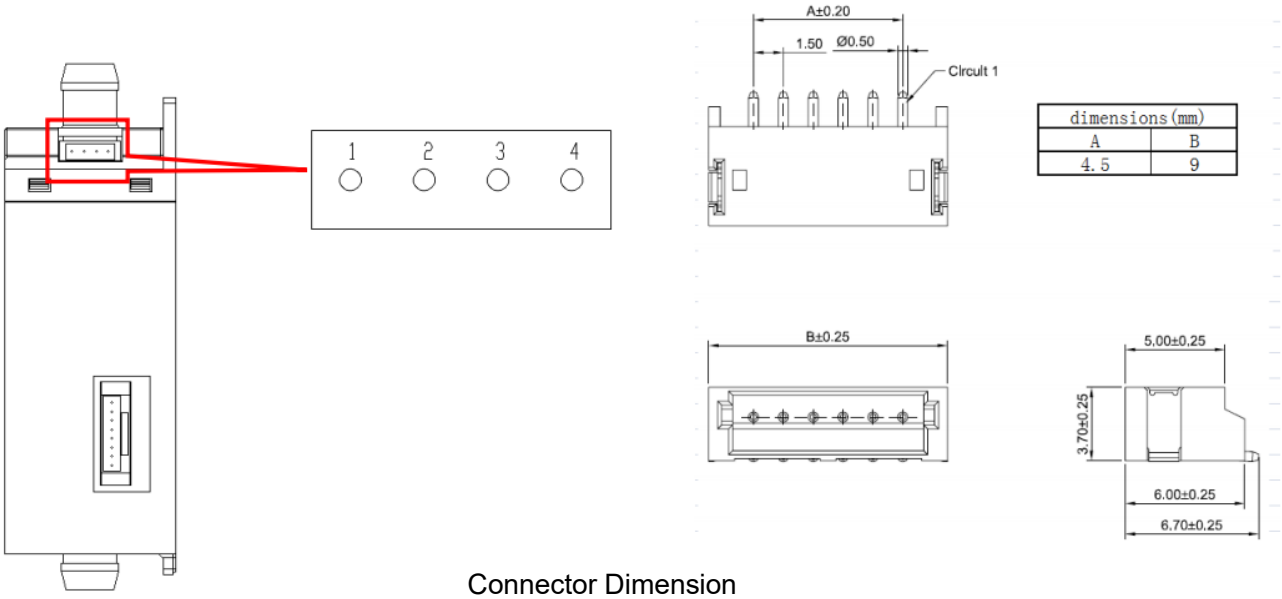
Pin Description and Connector



No.	Pin	Description
1	VCC	Power input(+5V)
2	GND	Power input (ground terminal)
3	NC	Reserved
4	TXD/SCL	UART-TX （TTL Level@3.3V/5V）/ I²C clock
5	RXD/SDA	UART-RX （TTL Level@3.3V/5V） / I²C data
6	NC	Reserved
7	NC	Reserved (Low level is protocol switch. Switch from UART to IIC)
8	NC	Reserved (Don’t connect)

Item	Part Number	Pitch
Connector	A1251WR-8P	1.25 mm Pitch

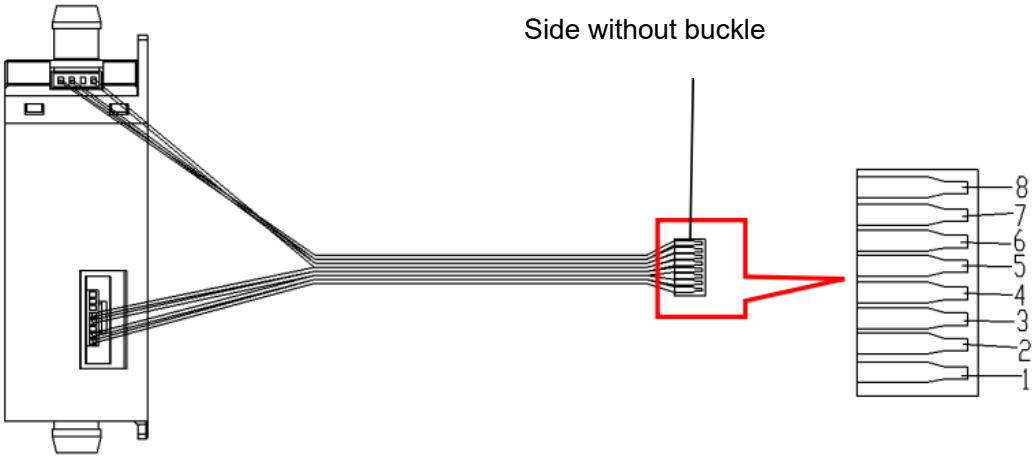
Pin Description and Connector



Connector Dimension

No.	Pin	Description
1	GND	Power input (ground terminal)
2	NC	Reserved (Don’t connect)
3	NC	Reserved
4	VCC	Power input(+5V)

Item	Part Number	Pitch
Connector	A1501WR-S-4P	1.5 mm Pitch



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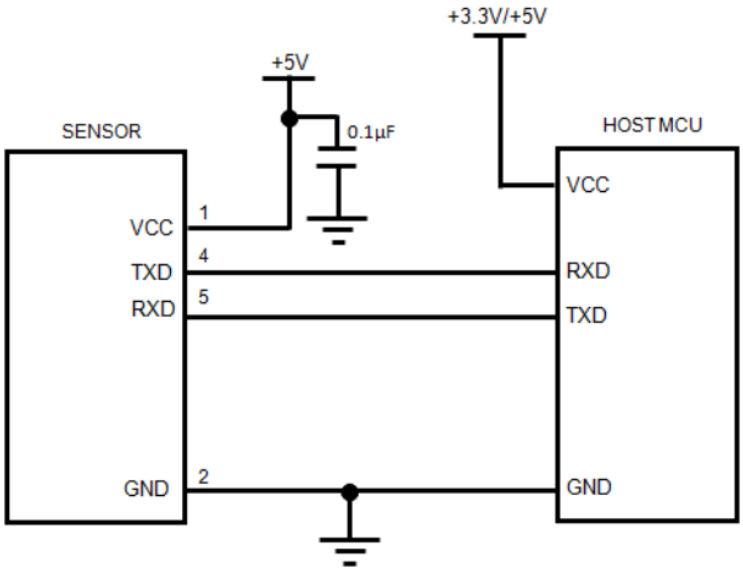
6	VCC	Power input(+5V)
7	NC	Reserved (Don’t connect)
8	GND	Power input (ground terminal)

Item	Part Number	Pitch
Connector	A1257H-8P	1.25 mm Pitch

Typical Application Circuit



Note of Circuit Design:

UART Protocol is compatible with 3.3V and 5V level.

※ PIN1、PIN2、PIN3、PIN6 The application circuit should be left floating.

※ The sensor does not have a high-voltage instantaneous protection circuit. The sensor's power supply should provide a stable 5V power supply with low noise. Please refer to Table 1 for the operating voltage.

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 measurement time	0x0D
4	Set up and read timing measurement mode	0x05
5	Set up and read dynamic working mode	0x06
8	Read software version number	0x1E
9	Read serial number	0x1F

4. Detail Description of RS232 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/m3) and particles number (pcs/0.1L)

Data	Description
DF5~DF8	PM2.5 measurement value, unit: ug/m3
DF13~DF16	Reversed
DF17~DF20	Reversed
DF21~DF24	Reversed
DF25~DF28	Reversed
DF29~DF32	Reversed
DF33~DF36	Reversed
DF37~DF40	Reversed
DF41~DF44	Reversed
DF45~DF48	Reversed
DF49~DF52	Reversed

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

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: low working temperature	1: high working temperature	1: Fan at low revolving speed	1: Fan at high revolving speed

DF13~DF24: Reserved

DF50~DF52: Reserved

Note: Part of reserved bit is used for our internal testing. The data changeable of reserved bit is nothing 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 sensor is power-on, it starts continuous measuring.
2. When sending command, DF1=02 means opening measurement, DF1=01 means closing measurement;
3. When receiving response, DF1=2 means measuring opened, DF1=1 means measuring closed;
4. When the sensor receives the command of opening measurement, it will be in default continuous testing 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 Measuring Time

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

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

Response: 16 03 0D DF1 DF2 [CS]

Function: Set up/Read particle measuring time

Note:

1. Particle measuring time = DF1*256+DF2, unit is second. Minimum measuring time is 36 seconds. Time range is 36-65535 seconds. After setting up successfully, the sensor will stop working first, then you can send “Open” command to start single xx seconds measuring.
2. When measuring time is ≥ 65531, it means module will be in continuous measuring mode once powered on. It will not stop until stop command is sent.

Example:

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

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

Send: 11 03 0D FF FF E1 // set up continuous measuring mode (Repowering on means to start measuring status)

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

Send: 11 01 0D E1// Read particle measuring time

Response: 16 03 0D 00 24 B6 // Read successfully

4.4 Set up Timing Measuring Mode

Send: 11 03 05 DF1 DF2 [CS] // set up particle timing measuring time

Send: 11 01 05 E9 // read particle timing measuring time

Response: 16 03 05 DF1 DF2 [CS]

Function: Set up/Read particle timing measuring time

Note:

1. Particle Timing measuring mode time value X = DF1*256+DF2, unit is second;
2. When X >=180, 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. Range for X is 180-3600*18, minimum timing period is 3 minutes, maximum timing period is 18 hours.

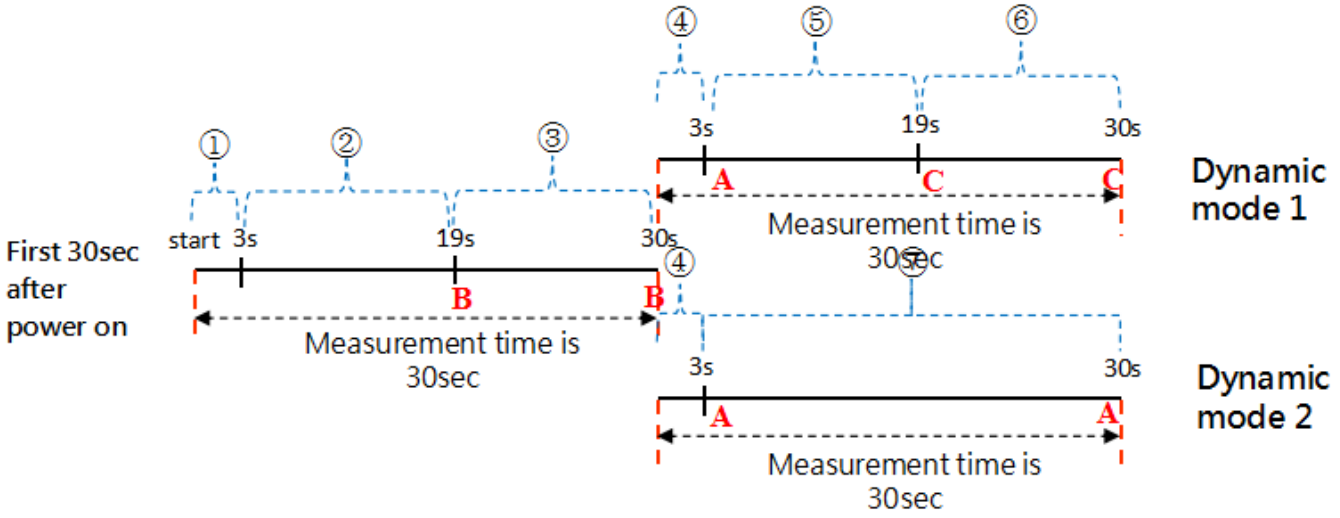
Send: 11 03 05 02 05 E0 // Set up as timing measuring mode, and timing cycle is 517seconds.
Response: 16 03 05 02 05 DB // Set up successfully

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
Response: 16 02 06 DF1 [CS]
Function: Set up/Read particle dynamic measuring mode

Note:
1. Particle dynamic measuring mode result DF1.
2. When DF1=00, close dynamic measuring mode. When DF1=01, start dynamic measuring mode.

Dynamic Working Mode Description:



After sensors are in dynamic working mode, start measuring every 30s. The sensor starts the measurement for the first 3 seconds.
After 3 seconds of measurement, the sensor starts measuring again continuously for 16 seconds and outputs the B value.
The laser diode turns off for 11 seconds, enters the standby state, and outputs the B value.
After the first 30 second period, the sensor starts a new 3 second measurement and outputs the A value.

① If | A-B |> 10 μg / m³ or | A-B | / B> 10%, the sensor selects Dynamic mode 1. The sensor measures continuously for 16 seconds and outputs the B value. The laser diode turns off for 11 seconds, enters the standby state, and outputs the C value.

②If | A-B | <10 μg / m³ or | A-B | / B <10%, the sensor selects Dynamic mode 2 and stores A value, then enters standby state for 27 seconds and outputs A value.
Remark: A, B, C value is related to PM1.0 Grimm mass concentration

Regardless of the dynamic mode 1 or 2, the sensor starts a new 30 second measurement cycle by starting the initial 3 second measurement. Compare the measured value with the previously stored value for the initial 3 seconds and select Dynamic mode 1 or 2 again.

Send: 11 02 06 01 E6 // Set up opening dynamic particle measuring mode
Response: 16 02 06 01 E1 // Set up successfully

Send: 11 02 06 00 E7 // Set up closing dynamic particle measuring mode
Response: 16 02 06 00 E2 // Set up successfully

Remark:
The module can support 4 kinds of working mode (Single+Continuous+Timing+Dynamic). It can be switched between these 4 kinds of working mode. It is continuous working mode by default after leaving factory. These 4 kinds of working mode can be switched by sending commands, as following (Working mode will not be saved after powering off):
1. Send: 11 03 0D 00 24 BB // Single measuring mode, time is 36s. After setting up successfully, the sensor will stop working first, then you can send “Open” command to start single 36s measuring.
2. Send: 11 03 0D FF FF E1 // Continuously measuring mode
3. Send: 11 03 05 02 05 E0 // Timing measuring mode, interval time is 517 seconds
4. Send: 11 02 06 01 E6 // Dynamic measuring mode

4.6 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.
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

4.7 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: 126 2311 1806 3442

1. Brief Introduction

a. This is an I²C protocol for PM3009BP. The sensor module not able to initiate communication automatically. Communication is initiated via main controlled board, which reads data and sends control commands.

b. Communication clock frequency <=100Khz

2. Communication Common Command

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

3.1 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 single measurement: 2 Set up continuously measurement: 3 (default mode) Set up timing measurement: 4 Set up dynamic measurement: 5
P4	Data 2, high byte	Measuring time: (range: 36~65535) unit: second. Measuring cycle: (range: 60~64800) unit: second. It should be 0xFF 0xFF when setting up continuously measurement here.
P5	Data 2, low byte	
P6	Data 3	Reserved
P7	Data check code	Check code= (P1^P2^……^P6)

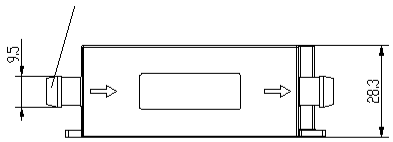
3.2 Read Data Command

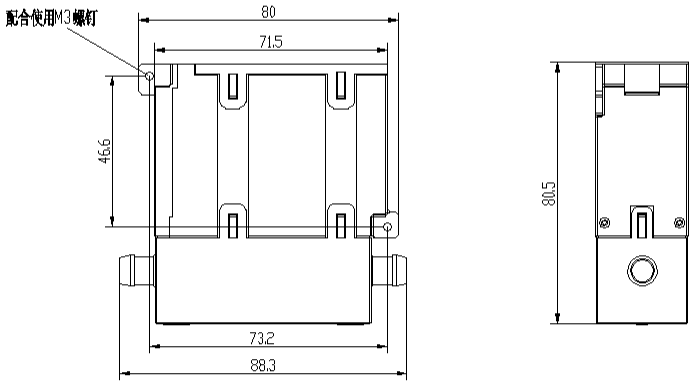
Send by main controlled board:

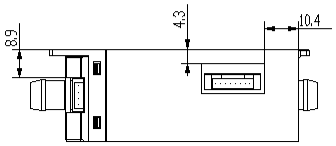
START+READ+ACK+P1+ACK+P2+ACK+……+P32+NACK+STOP

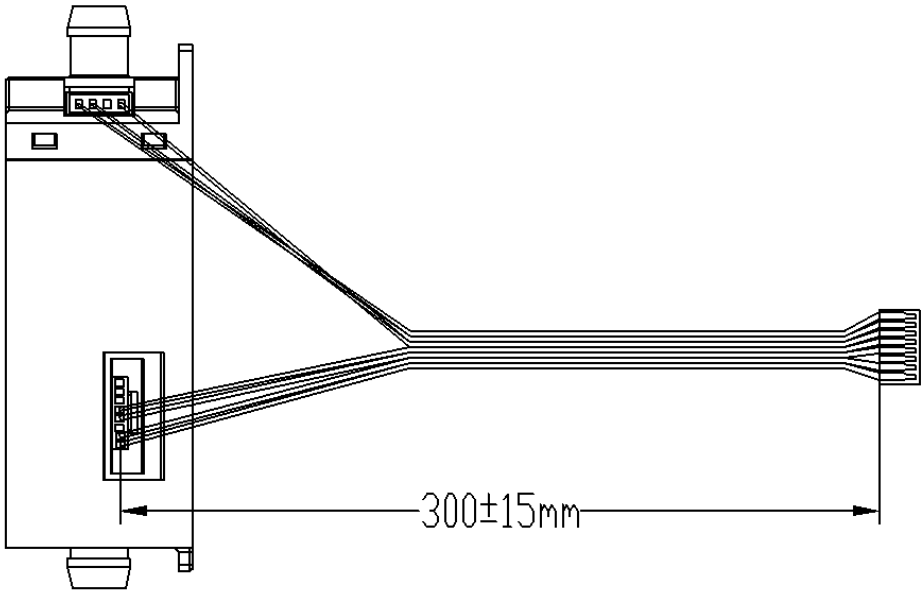
Data	Byte content	Description
Device address	Sensor address and read/write command	This byte is 0x51 when read data
P1	0x16	Frame header
P2	Frame length	Number of byte, not including length of device address (from P1 to P32, 32 bytes in total)
P3	Sensor status	Close: 1; Alarm: 7; Testing: 2; Data stable: 0x80
P4	Data 1, high byte	The measuring mode of sensor as: Single measuring mode: 2; Continuous measuring mode: 3 Dynamic measuring mode: 5; Timing measuring mode: >= 60 (means measuring time)
P5	Data 1, low byte	
P6	Data 2, high byte	Reserved
P7	Data 2, low byte	
P8	Data 3, high byte	Reserved
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	Reserved
P13	Data 5, low byte	
P14	Data 6, high byte	Reserved
P15	Data 6, middle byte	
P16	Data 6, low byte	
P17	Data 7, high byte	Reserved
P18	Data 7, middle byte	
P19	Data 7, low byte	
P20	Data 8, high byte	Reserved
P21	Data 8, middle byte	
P22	Data 8, low byte	
P23	Data 9, high byte	Reserved
P24	Data 9, middle byte	
P25	Data 9, low byte	
P26	Data 10, high byte	Reserved
P27	Data 10, middle byte	
P28	Data 10, low byte	
P29	Data 11, high byte	Reserved
P30	Data 11, middle byte	
P31	Data 11, low byte	
P32	Data check code	Check code = (P1^P2^……^P31)

It is air inlet, connect to the chimney duct







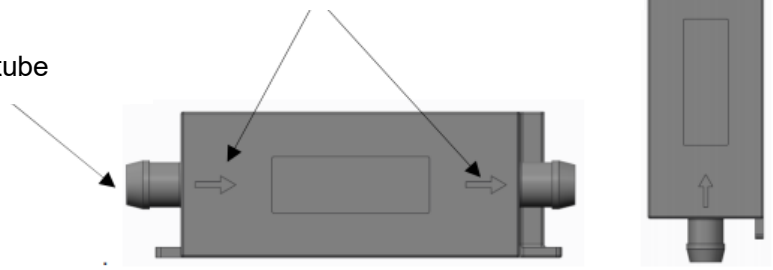


Use Attention

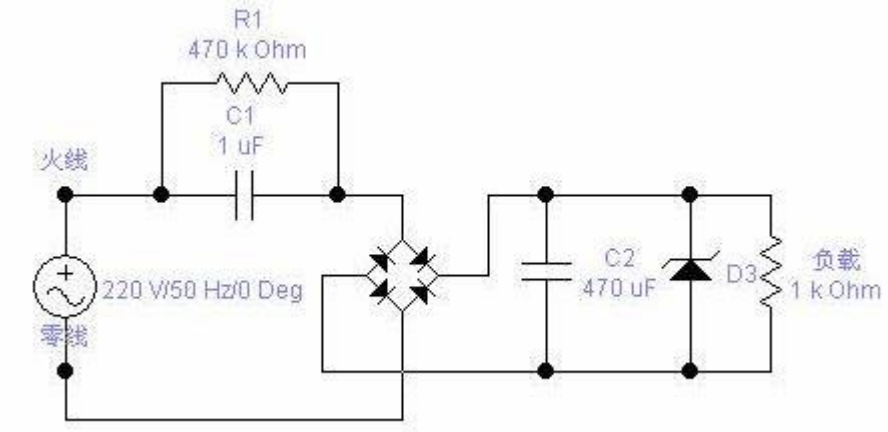
- PM3009BP laser particle sensor module is for household electronics products. For application of medical, mining, disaster preparedness, which need high security and high dependence, this sensor is not suitable.
- Avoid using the sensor under situation with strong magnetic, such as situation close to stereo speaker, microwave oven, induction cooking.

The direction of the arrow on the product is the airflow direction

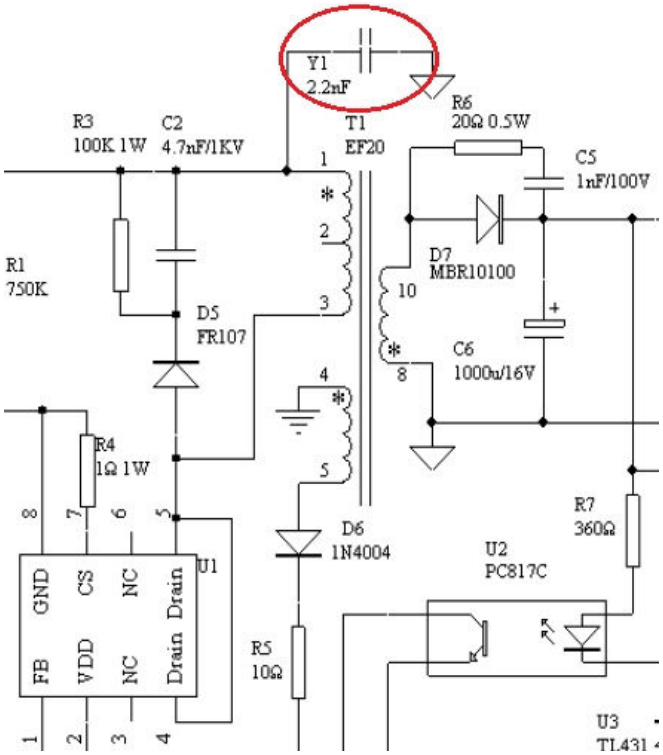
Inlet and outlet use φ10 tube



- There is no high voltage transient protection circuit, the power supply should be 5V with stable and low noise. Please reference to specification.
- When RC is used to reduce voltage, be cautious that the metal shell should be connected with either 220VAC live wire or the neutral wire.



- If isolated switch power supply is adopted to obtain DC power, please control the capacitance between the DC ground and the AC ground below 2.2nF and withstand voltage reaches to 3KV.



- The sensor itself is safe to use, what you should be cautious is the safety of power supply and structure design on the sensor.
- According to 《GB7247.1-2012 safety of laser particle product》, this product is defined as 3R level laser product. There is laser radiation inside the sensor. In order to avoid direct exposure to eyes, please refer to following alarming marking:

After-Sales Services and Consultancy

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