CUBIC

SPECIFICATION

Product Name: Laser Particle Sensor Module

Item No.: PM2105L

Version: V0.2

Date: January 26th, 2022

Revision

No.	Version	Content	Date
1	V0.1	The first edition	2019, 5.27
2	V0.2	Update MTTF and UART protocol	2022, 1.26

Laser Particle Sensor Module

PM2105L

Applications

- Air purifier
- Air quality monitor
- Air conditioner
- Ventilation system
- Consumer electronic products
- Environmental monitoring

Description

PM2105L is a laser particle sensor module for indoor use based on laser scattering technology. This sensor can measure particle concentration size between 0.3μm~10μm exactly and output particle mass concentration PM1.0, PM2.5, PM10 in μg/m^3 directly via mathematical algorithm and scientific calibration.

Features

- The smallest size of available measurement: 0.3μm
- Real-time output PM1.0, PM2.5, PM10 in μg/m^3 available
- High accuracy, high sensitive and quick response (≤4s)
- Signal output optional: UART, I^2C, PWM
- Four types of measuring mode for option: single/continuous/timing/dynamic
- RoHS and Reach compliant
- Air inlet and outlet on different side

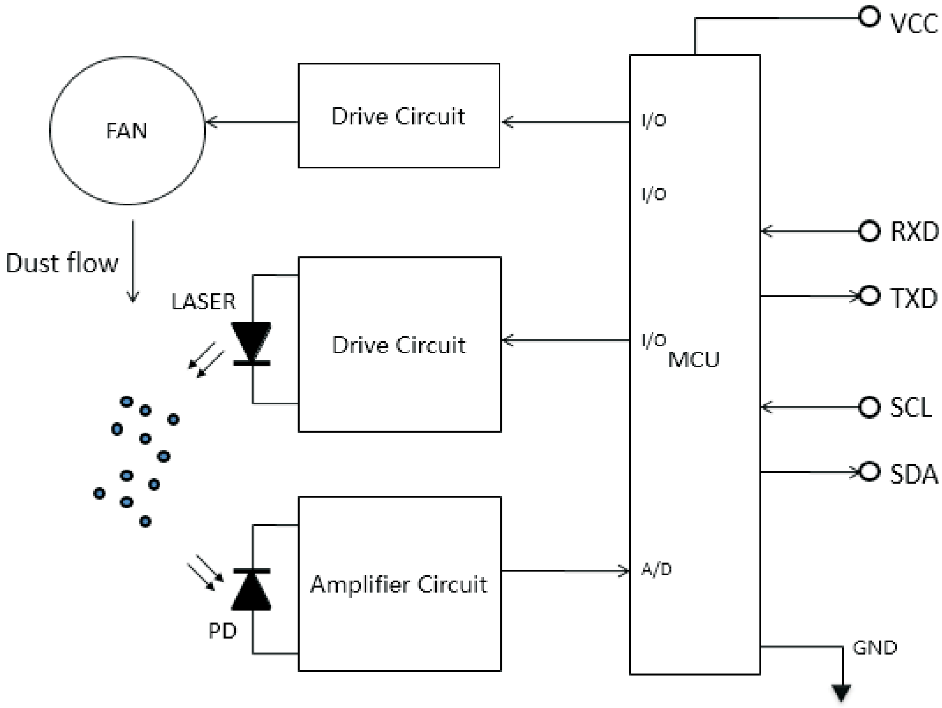
Working Principle

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 calculated. Thus, real-time measured data is obtained through measuring quantity and strength of scattered light.

Specifications

Laser Particle Sensor Specification	
Operating principle	Laser scattering
Measured particle range	0.3μm ~ 10μm
Measurement range	0~5000μg/m³
Resolution	1μg/m³
Working condition	-10°C ~ 60°C, 0-95%RH (non-condensing)
Storage condition	-40°C ~ 80°C, 0-95%RH (non-condensing)
Measurement accuracy for PM1.0&PM2.5	0 ~100μg/m³, ±10μg/m³ >100μg/m³, ±10% of reading Condition: 25±2℃, 50±10%RH, Reference instrument: GRIMM Dust source: Cigarette+A1
Measurement accuracy for PM10	0 ~100μg/m³, ±30μg/m³ 101 ~1000μg/m³, ±30% of reading Condition: 25±2℃, 50±10%RH, Reference instrument: GRIMM Dust source: Cigarette+A1
Response time	1sec
Time to first realiable reading	≤ 4 seconds
Power supply	DC 5V±0.1V Ripple wave＜50 mV
Working current	<53 mA
Standby current	<5 mA
Dimensions	42×35×23.7 mm
Digital output 1 (default)	UART_TTL_3.3V(default) I^2C_3.3V/5V(default)
Digital output 2	PWM (customized)
Output method	Default by active output after powering on, sampling time interval should be over 1,000 ms
MTTF	128,000 hrs (continuous operation)

Internal Architecture Description

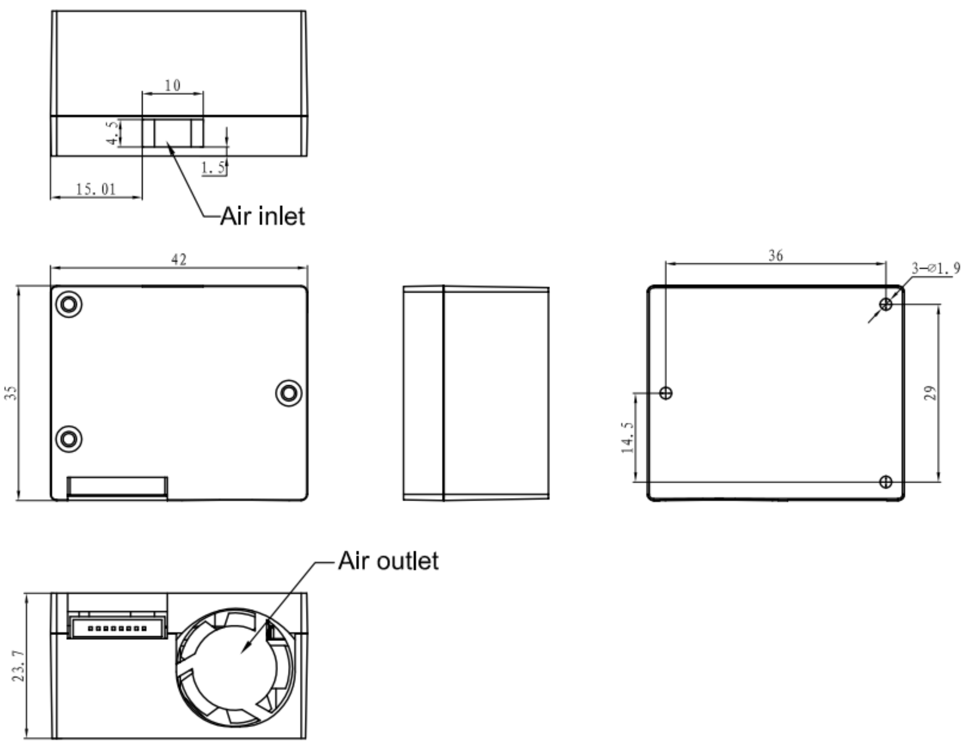


When the fan works, it will generate airflow. When the particles in the sampled gas pass through the beam of the light source (laser), a light scattering phenomenon occurs, and the scattered light is converted into an electrical signal (ie, a pulse) by the photoelectric transformer. The larger the particle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

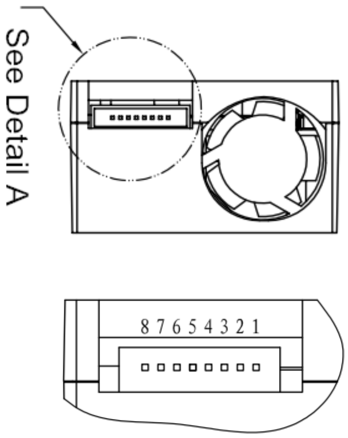
The number of particles of different sizes is calculated by comparing the peak value with the predetermined threshold value, and the mass concentration value is obtained by a professional algorithm. By testing the intensity of the scattered light, real-time test data is obtained.

Dimensions and Connector

1. Dimensions (Unit mm, tolerance ±0.2 mm)



2. I/O Connector Pinout



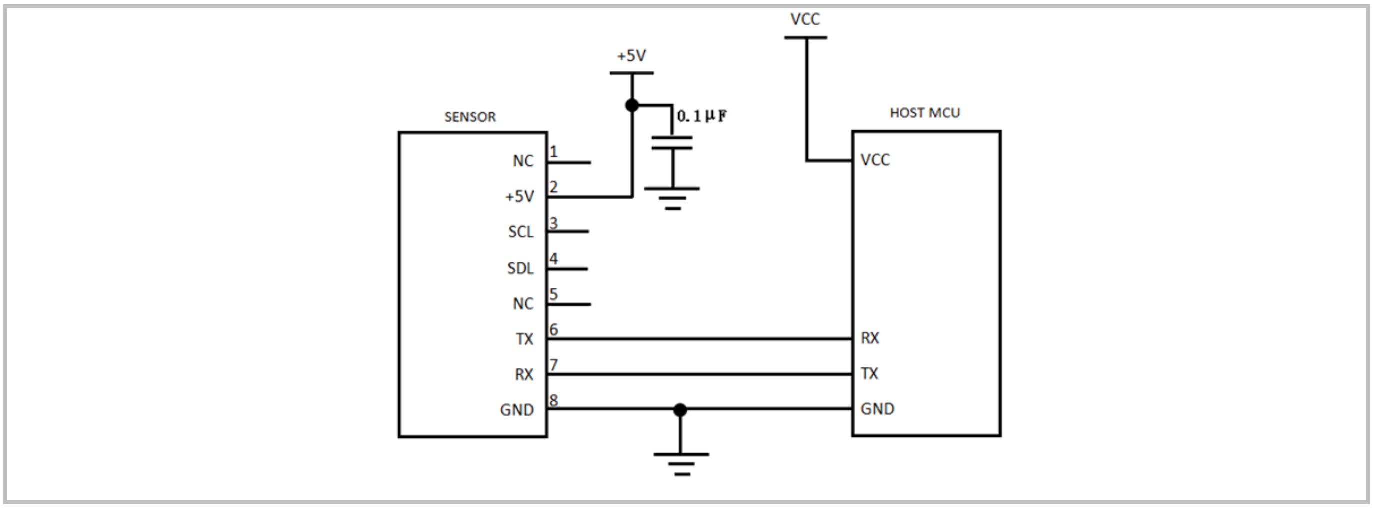
Detail A

No.	Pin	Description
1	NC	NC
2	5V	Power input (+5V)
3	SCL	I²C clock (3.3V/5V)
4	SDA	I²C data (3.3V/5V)
5	NC	Vacant (Do not connect)
6	TXD	UART-TX output (0-3.3V)
7	RXD	UART-RX input (0-3.3V)
8	GND	Power input (ground terminal)

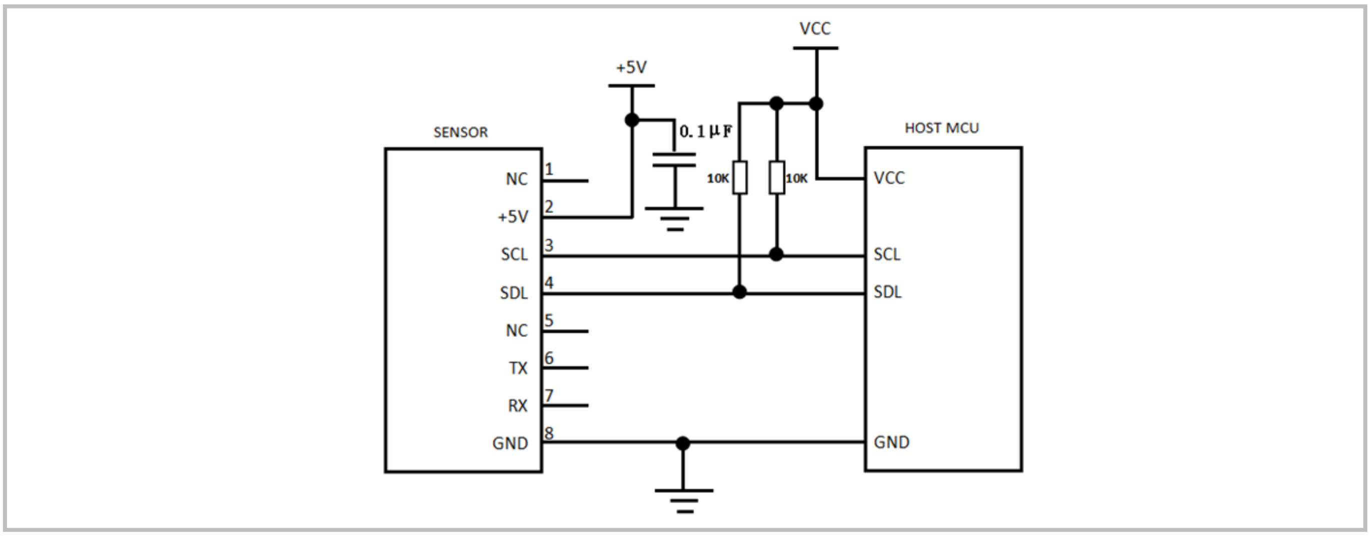
The interface connector is located at the side of the sensor. Corresponding female plug part number is SM08B-GHS-TB from JST. The pitch is 1.25mm.
The connection cable with female connector at both ends can also be customized.

Typical Application Circuit

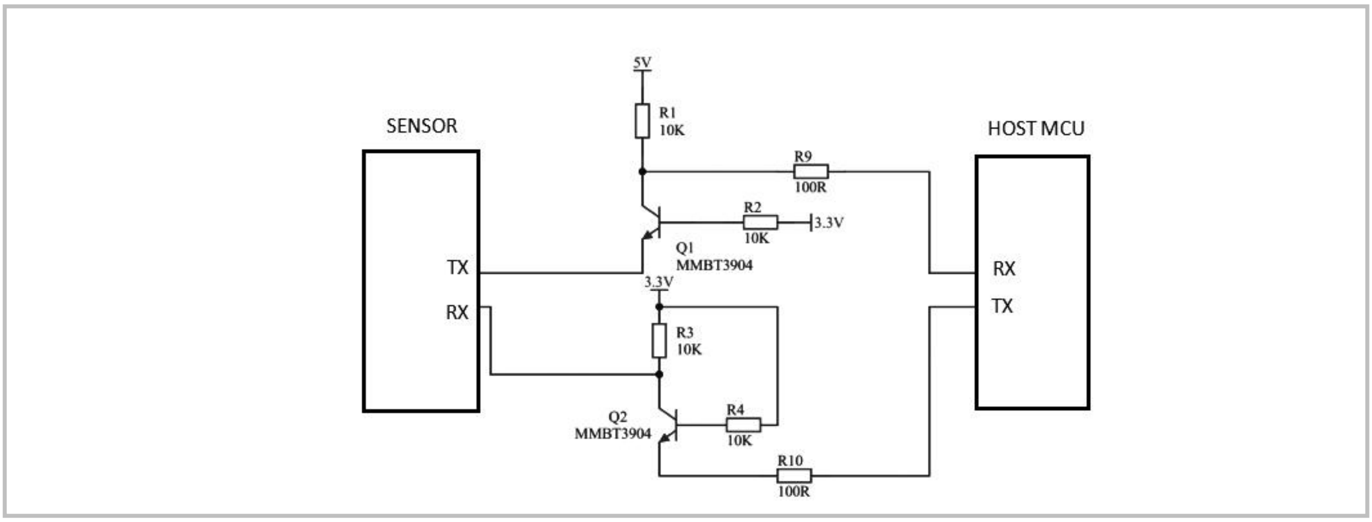
Case 1. UART3.3V Application



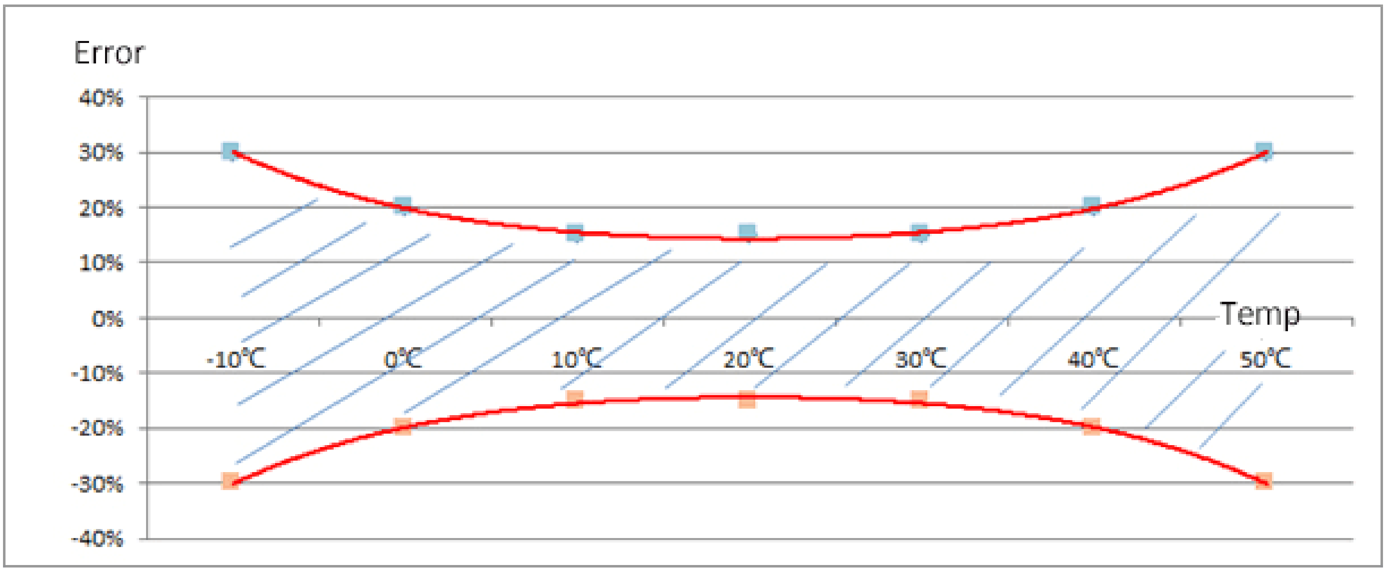
Case 2. I²C Application



Case 3: 5V-3.3V Level Shift, RX, TX Level Shift



Temperature Influence Curve



Particle measured error: under 25±2℃, 0~1,000μg/m³, consistency and accuracy of PM1.0/PM2.5 is either ±15% reading or ±15μg/m³, the bigger one is considered.

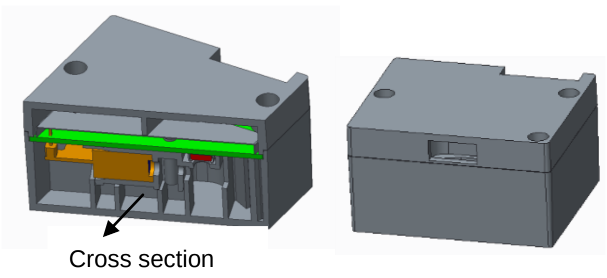
Temperature influence coefficient: 0.5%/℃ ~ 1%/℃ or 0.5μg/m³/℃ ~ 1μg/m³/℃, the bigger one is considered.

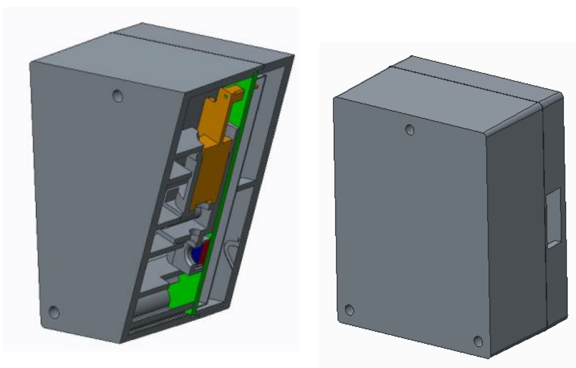
Product Installation

▪When install PM2105L sensor module in your system or equipment, please make sure that the air inlet and air outlet are unobstructed. And there is no huge airflow face to air inlet and air outlet.

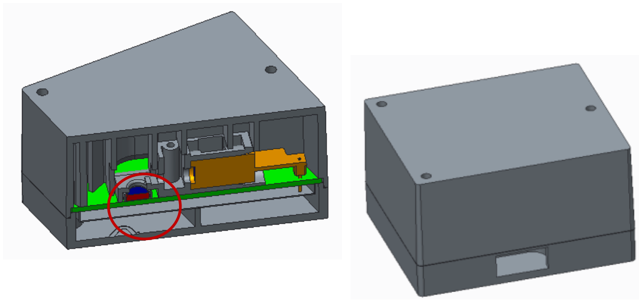
▪In order to avoid dust deposition on the surface of sensitive component (laser diode and photosensitive diode), which may affect the measurement accuracy of the sensor, the appropriate installation ways are recommended as below.

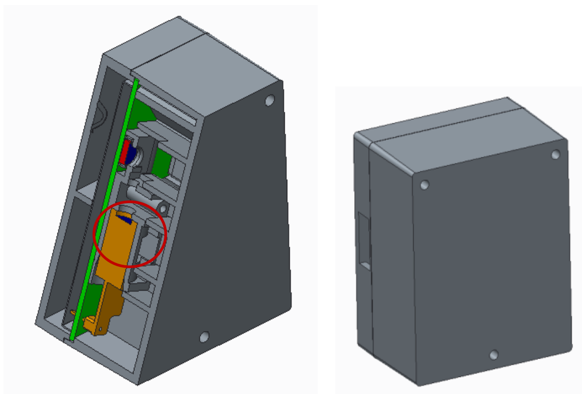
Recommended Installation

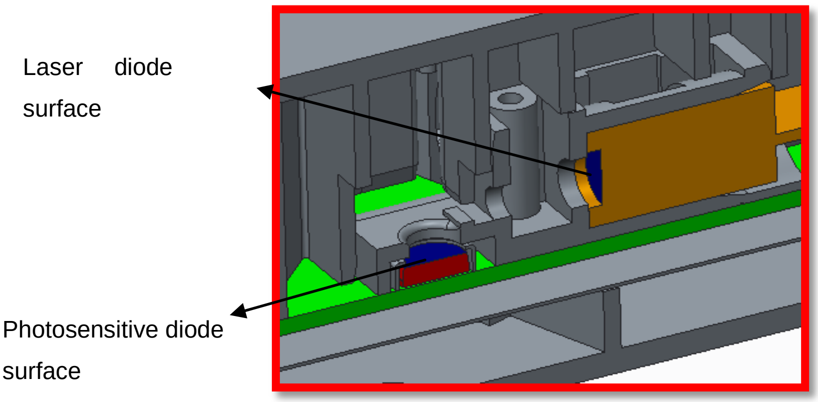


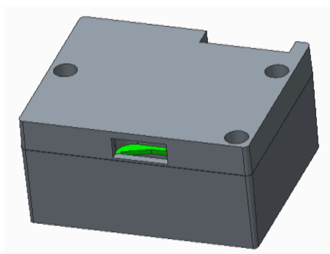


Non Recommended Installation









User Attention

▪The best installation way is to make the surface of air inlet and outlet of the sensor clings to the air vent in the inner wall of the user device that communicates with the outside. If it's not possible, then an air isolation structure between air inlet and air outlet is necessary to avoid the air back flow in the user's device.

▪Air vent size on the internal wall of user's device for airflow should be bigger than the size of air inlet of the sensor.

▪For purification products, sensor cannot be installed in the purifying air duct. If it's not possible, it's necessary to design a separate structure for sensor installation to isolate the sensor from air purifier duct.

▪For purifier and detector device, sensor should be installed above 20cm higher than floor to avoid contamination of large dust particles or even flocs near the ground entering the sensor, which will influence the measurement.

▪Sensor should be prohibited from using for outdoor inspection equipment. Dust storms, rain, snow, and willow flocs can have a significant impact on unprotected sensors.

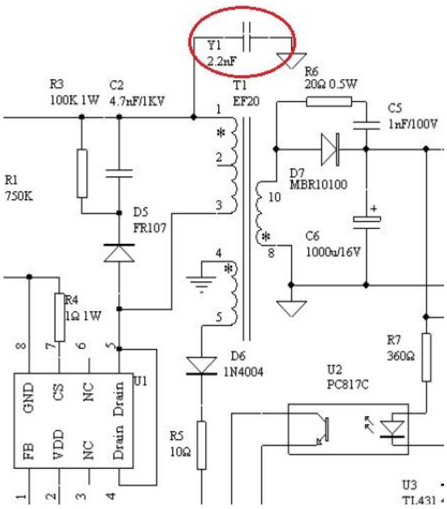
▪It is for household electronics products. For application of medical, mining, disaster preparedness, which needs high security and high dependence, this sensor is not suitable.

▪Avoid using the sensor under the condition with strong magnetic, such as situation close to stereo speaker, microwave oven, induction cooking.

▪There is no high pressure transient protection circuit of the sensor. The power supply of the sensor should be stable and low noise. Please refer to the working voltage in specification table.

▪The sensor needs 5V power supply because the fan needs a 5V power to drive. But all other data communication and control pins require 3.3V as a high level. Therefore, the main board MCU communication with the sensor should be the 3.3V communication level. If the main board MCU is 5V communication level, then it need to connect 5V to 3.3V level conversion chips or circuits outside the communication port (RX, TX) and control port (RET, RESET).

▪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.



This product is defined as 3R laser product according to 《GB7247.1-2012 laser product safety》 with laser radiation inside. Please avoid direct exposure to your eyes. Warning sign is as shown above.

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 continuous 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
6	Set up and read particle calibrated coefficient	0x07
7	Close/open laser diode	0x08
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)
PM1.0 GRIMM mass concentration = DF1*256^3 + DF2*256^2 + DF3*256^1 + DF4
PM2.5 GRIMM mass concentration = DF5*256^3 + DF6*256^2 + DF7*256^1 + DF8
PM10 GRIMM mass concentration = DF9*256^3 + DF10*256^2 + DF11*256^1 + DF12
PM1.0 TSI mass concentration = DF13*256^3 + DF14*256^2 + DF15*256^1 + DF16
PM2.5 TSI mass concentration = DF17*256^3 + DF18*256^2 + DF19*256^1 + DF20
PM10 TSI mass concentration = DF21*256^3 + DF22*256^2 + DF23*256^1 + DF24
Particles number >0.3um = DF25*256^3 + DF26*256^2 + DF27*256^1 + DF28
Particles number >0.5um = DF29*256^3 + DF30*256^2 + DF31*256^1 + DF32
Particles number >1.0um = DF33*256^3 + DF34*256^2 + DF35*256^1 + DF36
Particles number >2.5um = DF37*256^3 + DF38*256^2 + DF39*256^1 + DF40
Particles number >5.0um = DF41*256^3 + DF42*256^2 + DF43*256^1 + DF44
Particles number >10um = 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: low working temperature	1: high working temperature	1: Fan at low revolving speed	1: Fan at high revolving speed

DF50, DF51, 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=02 means measuring opened, DF1=01 means measuring closed;
4. When the sensor receives the command of opening measurement, it will be in default continuous testing mode. Pls check as below:

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 Calibrated Coefficient

Send: 11 02 07 DF1 [CS] // Set up particle calibrated coefficient
Send: 11 01 07 E7 // Read particle calibrated coefficient
Response: 16 02 06 DF1 [CS]
Function: Read/set up particle calibrated coefficient

Note:
1. Range 70~150 Corresponding coefficient: 0.7~1.5

Description:
1. When there is difference between standard device, calibrated coefficient can be set to correct the final value.
2. When calibrated coefficient is set, the value of PM1.0, PM2.5 and PM10 will be all corrected by this coefficient.

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: 126 2311 1806 3442

I²C Communication Protocol

1. Brief Introduction

a. This is an I²C protocol for PM2105L. 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. Communication clock frequency <=100Khz.

2. Communication Common Description

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 measurement: 2 Set up calibration coefficient:6
P4	Data 2, high byte	Calibration coefficient: (Range: 70~150, Corresponding: 0.7~1.5)
P5	Data 2, low byte	
P6	Data 3	Reserved
P7	Data check code	Check code= (P1^P2^……^P6)

3.2 Read Command Data

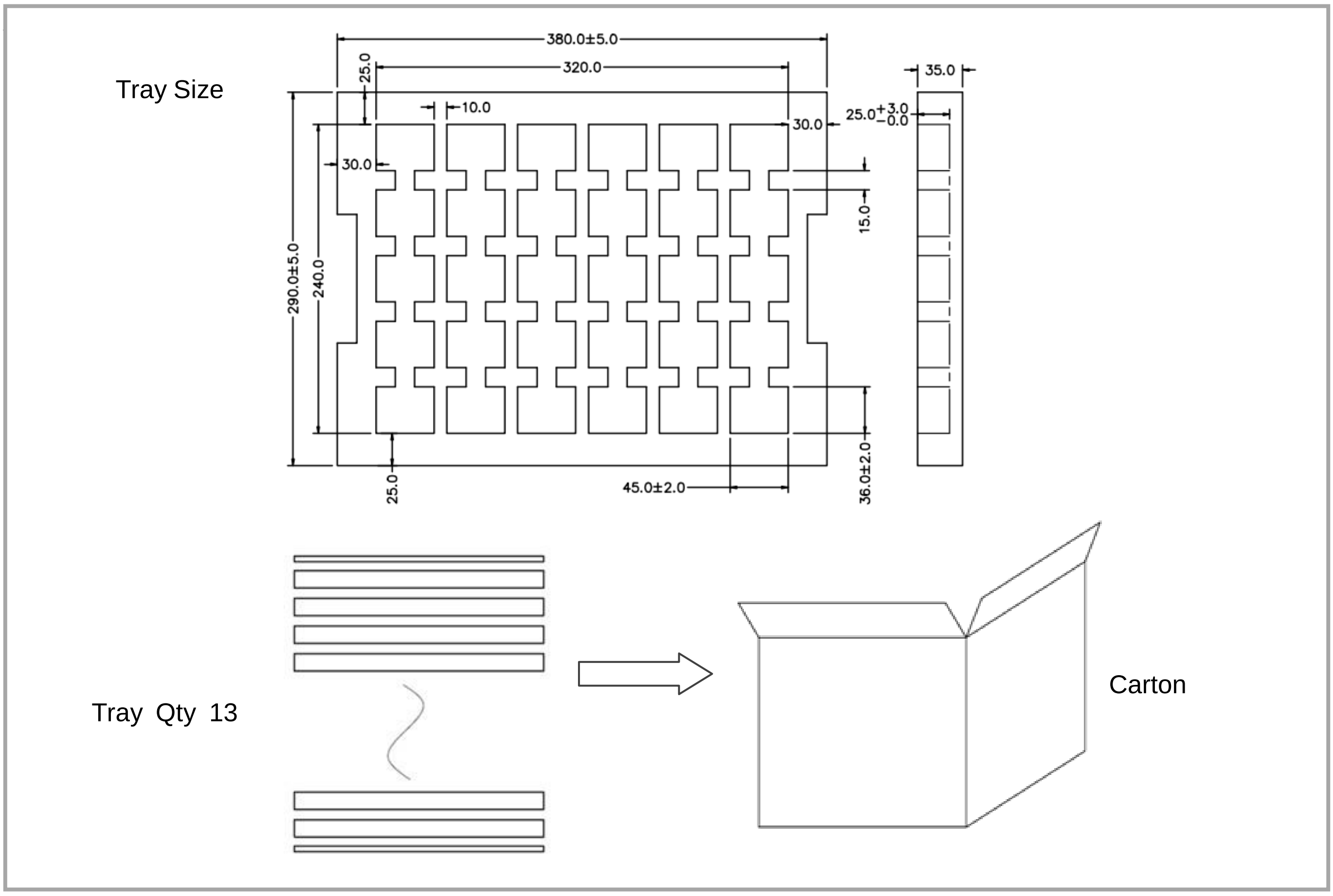
Send by main controlled board:

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 Other data is invalid. (Check 3.3 detailed introduction for every kinds of measurement mode)
P4	Data 1, high byte	The measuring mode of sensor as: Single measuring mode: 2 Continuous measuring mode: 3 Dynamic measuring mode: 5 Close laser diode: 7 Timing measuring mode: >= 180 (means measuring time)
P5	Data 1, low byte	
P6	Data 2, high byte	Calibration coefficient: (Range: 70~150, Corresponding: 0.7~1.5）
P7	Data 2, low byte	
P8	Data 3, high byte	PM1.0 concentration , unit: μg/m³, GRIMM
P9	Data 3, low byte	
P10	Data 4, high byte	PM2.5 concentration , unit: μg/m³, GRIMM
P11	Data 4, low byte	
P12	Data 5, high byte	PM10 concentration , unit: μg/m³, GRIMM
P13	Data 5, low byte	
P14	Data 6, high byte	PM1.0 concentration , unit: μg/m³, TSI
P15	Data 6, low byte	
P16	Data 7, high byte	PM2.5 concentration , unit: μg/m³, TSI
P17	Data 7, low byte	
P18	Data 8, high byte	PM10 concentration , unit: μg/m³ , TSI
P19	Data 8, low byte	
P20	Data 9, high byte	Number of PM0.3, unit: pcs/0.1L
P21	Data 9, low byte	
P22	Data 10, high byte	Number of PM0.5, unit: pcs/0.1L
P23	Data 10, low byte	
P24	Data 11, high byte	Number of PM1.0, unit: pcs/0.1L
P25	Data 11, low byte	
P26	Data 12, high byte	Number of PM2.5, unit: pcs/0.1L
P27	Data 12, low byte	
P28	Data 13, high byte	Number of PM5.0, unit: pcs/0.1L
P29	Data 13, low byte	
P30	Data 14, high byte	Number of PM10, unit: pcs/0.1L
P31	Data 14, low byte	
P32	Data check code	Check code = (P1^P2^……^P31)

Packing Information



Sensor per Tray	Tray Qty	Sensor per Carton	Carton Dimensions	Packing Material
30 pcs	13 layers	390 pcs	395*310*480 mm	Red pearl cotton (ESD)

After-Sales Services and Consultancy

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