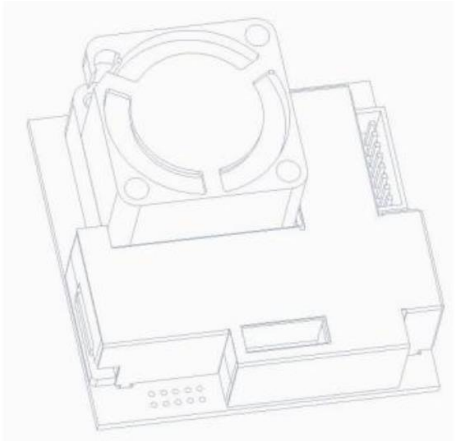
SPECIFICATION SHEET

Laser Particle Sensor Module
PM2036

Ver.:2017.06



1. Brief introduction

PM2036 particle sensor is a NanoSense product, which can measure different particle size (0.3μm to 10μm) in indoor and outdoor air and output PM2.5 and PM10 directly in μg/m^3.

2. Main features

- Smallest size of particles measured: 0.3μm
- Signal output: I^{2}C (PM10 & PM2.5 in μg/m^3)
- Single measurement mode, continuous measurement mode, timing work mode, dynamic work mode.
- Response time: 6s

3. Applications

- Building automation
- Indoor and outdoor monitoring
- Air cleaners

4. Principles of particle measurement

When sampling particles pass through light beam (laser), there will be light scattering phenomenon that will be converted into electrical signal (pulse). The bigger particles will generate stronger pulses (peak value). From peak value and pulse width, size of particle can be evaluated and counting per unit of volume performed for each size. An average weight is allocated for each size to the quantity of particles. The result is provided in real-time.

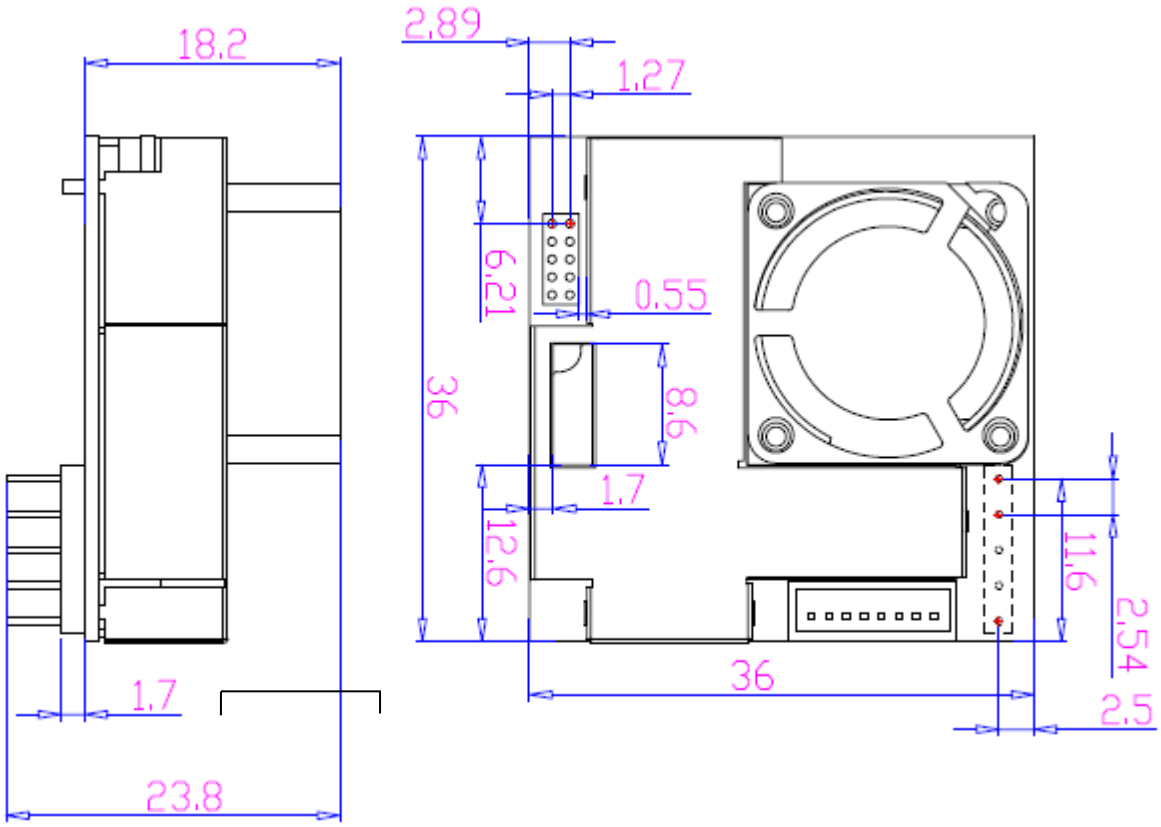
5. Specifications

Measurement range	0.3-10μm - 0 ~ 1000 μg/m^3
Measurement	PM2.5 in μg/m^3(optional PM10 with less accuracy TBD)
Accuracy	< 50μg/m^3: ± 10μg/m^3 50~100μg/m³： ± 15μg/m³ > 100μg/m^3: ± 15% reading
Response time	6 seconds
Size(mm)	36 x 36 x 18.2mm
Working temperature	-20°C to +50°C
Stable storage temperature	-30°C to+70°C
Working humidity	0-95% RH non-condensing
Power supply	Normal working: 5.0±1% DC; ripple < 50mV Working mode < 56mA, with 80mA pic. Sleep mode (Fan and laser off) < 0.4mA
Output Data	I^{2}C (0-3.3V interface)
Modes	Measurement rates settable via I^{2}C: Stop, Continuous, Timing, Dynamic
Lifespan	10 years in dynamic mode. From 8 to 13 years in Timing mode depending of setting One year in continuous mode (3 years optional).
Maintenance	No maintenance during 10 years under average of 40μg/m^3 in Dynamic mode.
Noise	≤ 20 dBA at 30cm away from the fan (background noise ≤ 16 dBA)
Weight	17.5g ± 1g

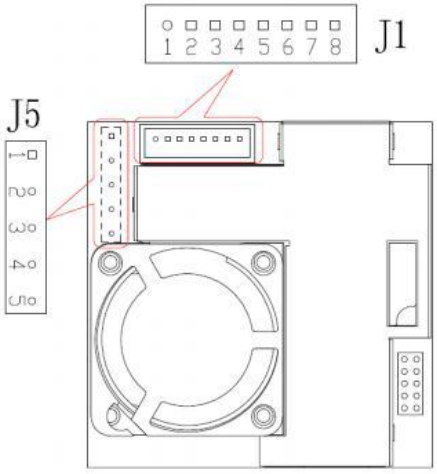
6. Dimensions

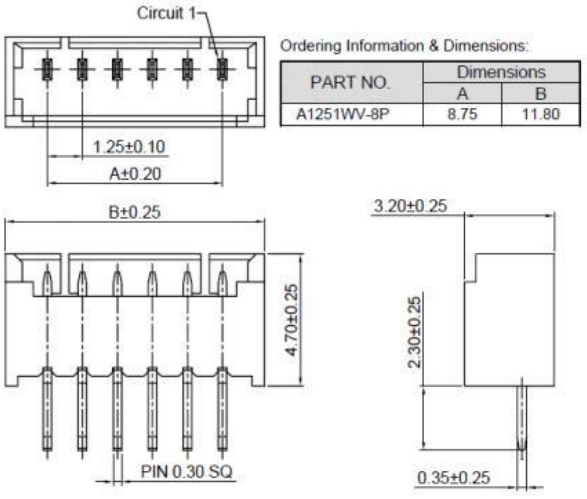
6.1mechanicaldiagram (Unit: mm)

2.89 mm



6.2 Input /Output





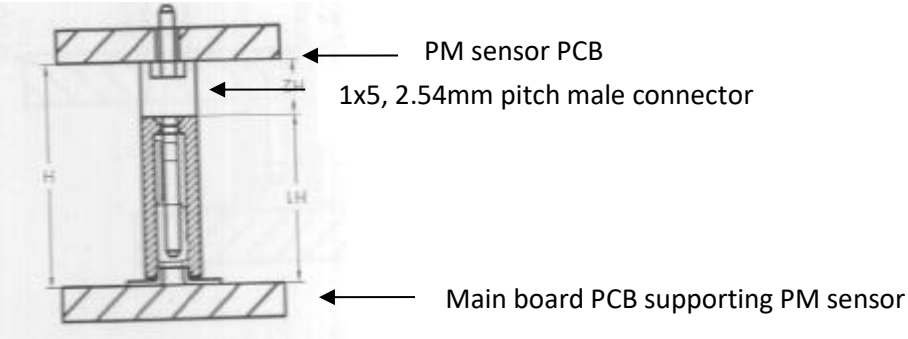
J1

No.	Name	Description
1	+3.3V	Power output（+3.3V/100mA）
2	5V	Power input（+5V）
3	SCL	I2C clock
4	SDA	I2C data
5	TEST	Suspend this pin without connecting
6	TX	UART-TX output (0-3.3V)
7	RX	UART-RX input (0-3.3V)
8	GND	Power input (ground terminal)

J5

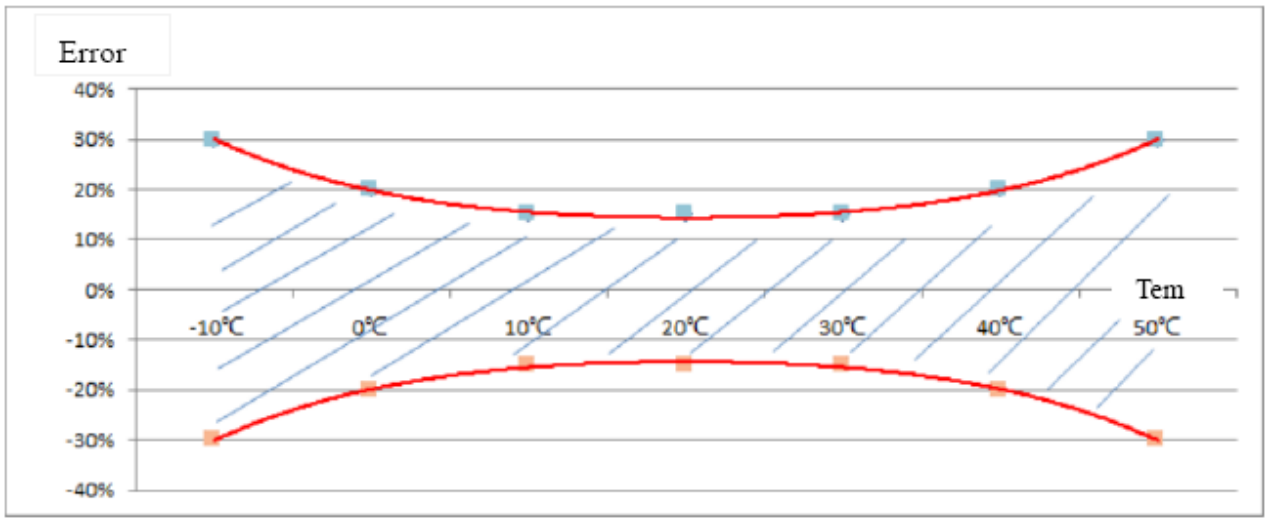
No.	Name	Description
1	+3.3V	Power output（+3.3V/100mA max）
2	5V	Power input（+5V）
3	SCL	I^2C clock
4	SDA	I^2C data
5	GND	Power input (ground terminal)

6.3 Connector (J5)



7. Temperature influence

0.5 to 1%/°C or 0.5 to 1μg/m^3/°C, whichever is larger.



8. Applications and Integration

This laser particles sensor module is designed for household electronics products and outdoor air monitoring. This sensor is not suitable for medical, mining, disaster preparedness, which needs high security and life dependence.

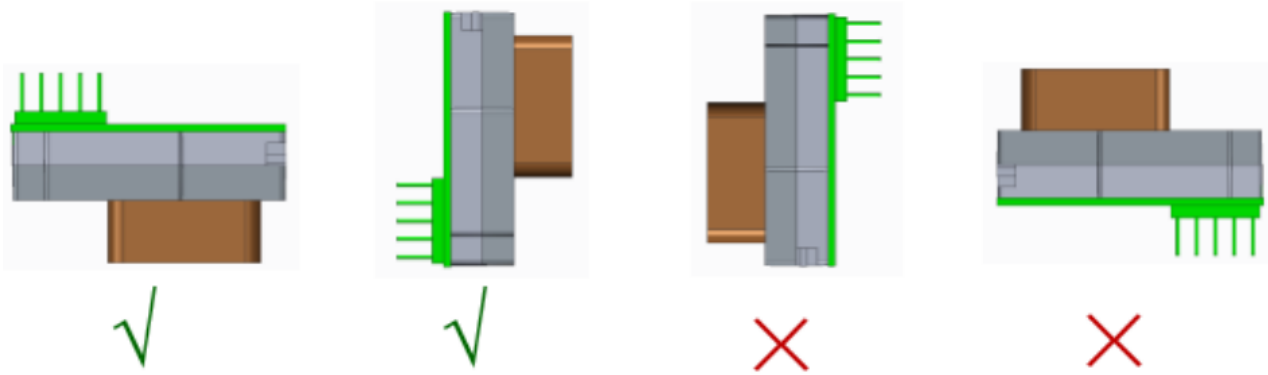
Not designed for use or in bad dusty environment.

In the final device, it is suggested to add an insulation structure on the shell cover to avoid air backflow because the air backflow will affect the accuracy of the sensor.

When this sensor module is integrated into 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 / or air-outlet.

When use in outdoor application, inlet and outlet facing down is recommended to avoid rain and limit influence from wind.

Correct installation position as below for reference:



1. Calibration

PM2.5: Use of cigarette smoke as particles source (particle size between 0.3-1μm) and reference sensor: TSI8530.

PM10: Use of Arizona A1/A2 powder as particles source (particle size is between 2.5-10μm) and reference sensor: TSI8530.

2. Conformity

a) Delivery inspection

The inspection is performed for each production lot.
Inspection method: Sampling procedure: ISO 2859, a single normal sampling plan, inspection level II

Item	Description	AQL (%)
Major defect	Sampling	0.4
Minor defect	Appearance and dimensions * Cracks, scratches, chippings and pollution	1.0

*: Ones which affect the electrical and optical characteristics in section 2.6 are considered as failure. Rust is applicable.

b) Safety

Comply with CEI/EN 60950-1 A1
PCB comply with UL94V0

3. Influence of electromagnetic noise

If the electromagnetic noise source such as an electrostatic precipitator is placed near the sensor, the sensor output may change by the induction of electromagnetic noise. And, the sensor output may change by the inducted electromagnetic noise and / or the noise inducted on the power line. Please use this product after fully confirming the effect of the noise source on the sensor output.

4. Influence of outside light

If the outdoor light enters into the air inlet, the output may be affected. This module should be placed on inner side of the instrument to prevent the sensor from being affected by outdoor light. Inner LEDs should not illuminate the sensor and especially the inlet for the same reason.

5. Installations location

Particles will come out from the fan after entering through the inlet hole. Please install this module in a good place to minimize interfere with inlet and outlet air flow.

6. Adherence of dust

Please take user's structure and mechanism into consideration in the apparatus side and consider about the maintenance such as vacuuming the dust with air, wiping, etc. when dusts adhere. Also consider a placement design for easy removal location and associated connector.

7. Disassembly)

Do not disassemble this product. After disassembling, the standard value of the specification may not be satisfying even if it is assembled again.

8. I^2C Protocol

a) Brief introduction

The sensor module is not able to initiate communication automatically, but will respond via main control board to read data and send command. Time clock frequency is ≤25KHz. Even if sleeping the sensor will wake up on I^2C address match.

b) Communication 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.

c) Protocol detailed description

a. Write data command

Main control board sends: **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 and 0x51 when read (0x28 without read or write bit)
P1	0x16	Frame header
P2	Frame length	Number of byte, not including length of device address (P1 to P7, 7 bytes total)
P3	Data 1	Control command of the sensor as: Measurement off: 1 (Sleep mode) Single measuring mode: 2 Continuous measuring mode: 3 (factory default mode) Timing measuring mode: 4 Dynamic measuring mode: 5 Others: invalid
P4	Data2, high byte	Timing measuring cycle:(range: 180-64800) unit: second
P5	Data2, low byte	
P6	Reserved	Reserved
P7.	Data check code	Check code=(P1^ P2^……^P6)

b. Read data command

The main control board sends: **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 (P1 to P22, 22 bytes total)
P3	Sensor situation	Sleep mode: 1 Malfunction: 2 Under measurement: 3 Stable data: 0x80 Other data is invalid. (please find detailed introduction of each type of measuring mode here under)
P4	Data 1, high byte	Reserved
P5	Data 1, low byte	
P6	Data 2, high byte	PM2.5 concentration, unit μg/m^3
P7	Data 2, low byte	
P8	Data 3, high byte	PM10 concentration, unit μg/m^3
P9	Data 3, low byte	
P10	Data 4, high byte	The measuring mode of sensor as: Single measuring mode: 2 Continuous measuring mode: 3 Timing measuring mode: >= 180 (means measuring time, mode 4) Dynamic measuring mode: 5
P11	Data 4, low byte	
P12	Data 5, high byte	Reserved
P13	Data 5, low byte	
P14	Data 6,highbyte	Reserved
P15	Data 6, High byte	
P16	Data 7, high byte	Reserved
P17	Data 7, high byte	
P18	Data 8, high byte	Reserved
P19	Data 8, high byte	
P20	Data 9, high byte	Reserved
P21	Data 9, high byte	
P22	Data check code	Check code=(P1^ P2^……^P21)

d) Description of each type of measuring mode and command

a. Single measuring mode

When the sensor receives command of starting measurement, it will activate fan and laser then start particle counting. During measuring period, Sensor situation will be 3. During warm-up period, it will provide the measured value of previous time. After 6 seconds, the sensor will start providing current measured value. Detecting time frame is 36 seconds. After 36 seconds of measurement, sensor situation will return 128 if data are stable. Then the sensor will stop measurement automatically. This measured data will be the final one.

b. Continuous measuring mode

When power on or switch into continuous measuring mode, the sensor situation will be 3 all the time.

c. Dynamic measuring mode

When the sensor is into dynamic measuring mode, timing is 1minutes: measurement starts one minute after the previous measurement cycle. Measuring time is 6 seconds (during those 6 seconds, sensor situation is 3). If measured value during those 6 seconds is slightly different compared to the value measured during the last cycle (condition as below), then measurement stop (sensor situation is 1). Otherwise, the sensor will continue measuring for 30 seconds (within those 30 seconds, sensor situation is 3). When measurement completed, sensor situation will be 0x80 (stable).

Under dynamic measuring mode, conditions for extending measurement time to 36 seconds detection or not are as follow:

1 Data change range > ±15μg/m^3 (measured value last time < 100μg/m3);
2 Data change range > ±15% (measured value last time > 100μg/m3).

Under dynamic measuring mode, the sensor will complete a fist measurement cycle of 36 seconds after powering on. After then, the measurement cycle will be 6 second unless there is an extension time because of the change.

Every time the dynamic measuring mode will be selected, the sensor will start with a completed 36 seconds detection cycle to get a first accurate measurement and provide data within 8 seconds.

d. Timing measuring mode

When starting timing measurement mode, the sensor will start a 36 seconds measurement cycle every XX seconds (settable timing). The sensor situation is 3 during measuring process. After 36 seconds measurement, the sensor situation will be 128.

Note: In every kinds of measuring mode, the sensor will stop measurement when forced in sleep mode. The sensor situation will then change into 1.