Laser Dust Sensor

(Model: ZH06-IV)

Manual

Version: 1.2

Issue Date: 2019-04-28

Zhengzhou Winsen Electronics Technology Co., Ltd

Statement

Thanks for purchasing our product. In order to let customers using it better and reduce the faults caused by misuse, please read the manual carefully and operate it correctly in accordance with the instructions. If users disobey the terms or remove, disassemble, change the components inside of the sensor, we shall not be responsible for the loss.

The specific such as color, appearance, sizes & etc., please in kind prevail.

We are devoting ourselves to products development and technical innovation, so we reserve the right to improve the products without notice. Please confirm it is the valid version before using this manual. At the same time, users’ comments on optimized using way are welcome.

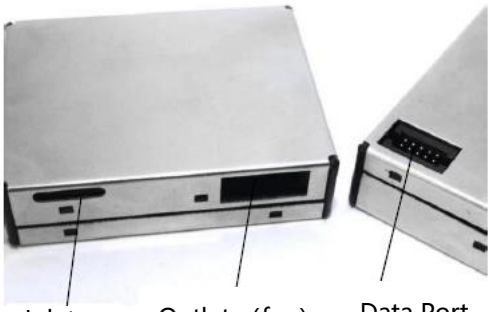
Please keep the manual properly, in order to get help if you have questions during the usage in the future.

Zhengzhou Winsen Electronics Technology CO., LTD

ZH06- I Laser dust sensor

Description:

Laser Dust sensor module is a common type, small size sensor, using laser scattering principle to detect the dust particles in air, with good consistency and stability. It is easy to use, with UART & PWM output;Small size is suitable for integrating.



Features:

Good consistency

Real time response

Accurate data

Low power consumption

Minus resolution of particle diameter is 0.3 μm

Main Applications:

Air purifiers

Ventilation systems

Portable instrument

Air quality monitoring equipment

Air conditioner

Smart home fields

Technical parameters: Table 1

Model	ZH06-IV
Detection Range	0.3-10μm
Effective Range	0-1000μg/m³
Detection Interval	1s
PM2.5 Detection Accuracy	0-100 μg/m³: ±15μg/m³ 101-1000 μg /m³: ± 15% Reading (Test Condition: 25 ± 2 ℃, 50 ± 10% RH,TSI8530, Cigarette, GBT18801-2015)
Preheating Time	30s
Output	UART_TTL Output (3.3V level)
	PWM Output (3.3V level)
Working Voltage	4.9V ~ 5.5V(DC)
Working Current	< 120mA
Dormancy Current	< 20mA
Response Time	T90 < 45s
Working Humidity	0 ~ 80%RH(No Condensation)
Working Tem	- 10 ~ 60℃
Storage Tem	- 30 ~ 70℃
Dimension	47×37×12.2mm(L×W×H)
Weight	< 30g
MTTF	Continuous > 10000H

Pin Order:

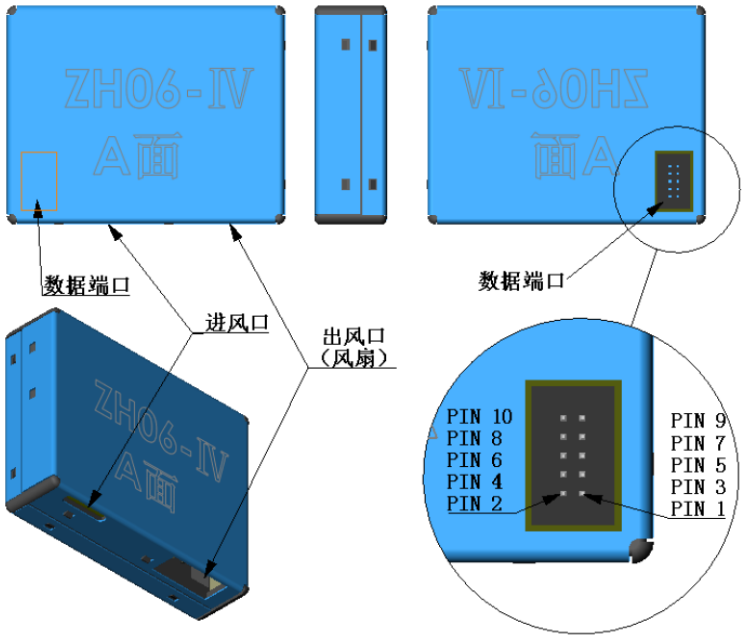


Fig1. Pin Order

Pin Definition: Table2.

P/N	Name	Description
PIN1, PIN2	VDD	4.9~5.5V
PIN3, PIN4	GND	
PIN5	Reserved	NC
PIN6	PWM output	TTL@3.3V
PIN7	RXD serial port receiving	TTL@3.3V
PIN8	Reserved	vacant
PIN9	TXD serial port sending	TTL@3.3V
PIN10	Reserved	NC

Communication Protocol

1. Serial communication settings

Baud rate	9600
Date bit	8
Stop bit	1
Check byte	None

2. Initiative upload mode

No.	Explanation			Data
0	Byte 1	Start byte 1		0x42
1	Byte 2	Start byte 2		0x4D
2	Byte 3	Frame length	high level 8	0x00
3	Byte 4		low level 8	0x1C
4	Byte 5	Data 1	High Level 8	Reserved
5	Byte 6		Low Level 8	
6	Byte 7	Data 2	High Level 8	Reserved
7	Byte 8		Low Level 8	
8	Byte 9	Data 3	High Level 8	Reserved
9	Byte 10		Low Level 8	
10	Byte 11	Data 4	High Level 8	PM1.0 concentration
11	Byte 12		Low Level 8	(ug/m³)
12	Byte 13	Data 5	High Level 8	PM2.5 concentration
13	Byte 14		Low Level 8	(ug/m³)
14	Byte 15	Data 6	High Level 8	PM10 concentration
15	Byte 16		Low Level 8	(ug/m³)
16	Byte 17	Data 7	High Level 8	reserved
17	Byte 18		Low Level 8	
18	Byte 19	Data 8	High Level 8	reserved
19	Byte 20		Low Level 8	
20	Byte 21	Data 9	High Level 8	reserved
21	Byte 22		Low Level 8	
22	Byte 23	Data 10	High Level 8	reserved
23	Byte 24		Low Level 8	
24	Byte 25	Data 11	High Level 8	reserved
25	Byte 26		Low Level 8	

26	Byte 27	Data 12	High Level 8	reserved
27	Byte 28		Low Level 8	
28	Byte 29	Data 13	High Level 8	reserved
29	Byte 30		Low Level 8	
30	Byte 31	Check	High Level 8	Initiative upload check=
31	Byte 32		Low Level 8	= byte1+……+byte 30

2-1 Explanation for initiative upload mode.
2-1-1 The default communication mode is initiative upload mode
2-1-2 Example for calculate method:

Data frames:

No.	0	1	2	3	4	5	6	7	8	9	10	11
Data	0x42	0x4D	0x00	0x1C	0x00	0x54	0x00	0x6E	0x00	0x7C	0x00	0x54
No.	12	13	14	15	16	17	18	19	20	21	22	23
Data	0x00	0x6E	0x00	0x7C	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
No.	24	25	26	27	28	29	30	31				
Data	0x00	0x00	0x00	0x00	0x00	0x00	0x03	0x27				

Check value=
0x42+0x4D+0x00+0x1C+0x00+0x54+0x00+0x6E+0x00+0x7C+0x00+0x54+0x00+0x6E+0x00

+0x7C+0x00+0x00+0x00+0x00+0x00+0x00+0x00+0x00+0x00+0x00+0x00+0x00+0x00+0x00+0x00=
0x0327

Check:

0x03 of High level 8 is in 31 byte of data frame, 0x27 of Low level 8 is in 32 byte of data frame.

2-1-3. The reading value in initiative upload mode (take above data as example).
PM1.0=0x00 *256 + 0x54 = 84 μg/m³;
PM2.5=0x00 *256 + 0x6E = 110 μg/m³
PM10= 0x00 *256 + 0x7C = 124 μg/m³
The detection range of PM1.0, PM2.5 and PM10 are all 0-1000ug/m3.

3. Question & answer mode

3-1.Users send command:

0	1	2	3	4	5	6	7	8
Starting	Reserve	**command**	reserved	reserved	reserved	reserved	reserved	Check value
0XFF	0x01	**0x86**	0x00	0x00	0x00	0x00	0x00	0x79

Return value as follow:

0	1	2	3	4	5	6	7	8
Starting	Command	PM2.5(ug/m3)		PM10(ug/m3)		PM1.0(ug/m3)		Check value
		High 8 Level	Low 8 Level	High 8 Level	Low 8 Level	High 8 Level	Low 8 Level	
0xFF	0x86	0x00	0x85	0x00	0x96	0x00	0x65	0xFA

Note: The question-and-answer data frame check value calculation method is **different with** the method for initiative upload data frames. Please refer to the question-and-answer check value calculation example code(3-4-1).

3-2. Switch between Q&A mode and Initiative upload mode

User sends command to set Q&A mode:

0	1	2	3	4	5	6	7	8
Starting	Reserve	command	**Q&A**	Reserve	Reserve	Reserve	Reserve	Check value
0XFF	0x01	0x78	**0x41**	0x00	0x00	0x00	0x00	0x46

User sends command to set initiative upload mode:

0	1	2	3	4	5	6	7	8
Starting	Reserve	Command	**Upload**	Reserve	Reserve	Reserve	Reserve	Check value
0xFF	0x01	0x78	**0x40**	0x00	0x00	0x00	0x00	0x47

3-3. Dormant mode

User sends command to set dormant mode:

0	1	2	3	4	5	6	7	8
Starting	Reserve	Main command	Dormant command	Reserve	Reserve	Reserve	Reserve	Check value
0xFF	0x01	0xA7	Enter: 0x01	0x00	0x00	0x00	0x00	0x57
			Quit: 0x00					0x58

Return value as follow:

0	1	2	3	4	5	6	7	8
Starting	Main command	Return Mark	Reserve	Reserve	Reserve	Reserve	Reserve	Check value
0xFF	0xA7	Success: 0x01	0x00	0x00	0x00	0x00	0x00	0x58
		Failture: 0x00						0x59

Note: Please refer to sample code for data frame check value calculation 3-4 ;

3-4.Calculate method for check value under Q&A mode:

3-4-1. Eg of code:

```
unsigned char FucCheckSum(unsigned char *i, unsigned char ln)
{
        unsigned char j,tempq=0;
        i+=1;
        for(j=0;j<(ln-2);j++)
        {
                tempq+=*i;
                i++;
        }
        tempq=(~tempq)+1;
        return(tempq);
}
```

3-4-2. Calculation of check value under Q&A mode.

0	1	2	3	4	5	6	7	8
Start	Command	PM 2.5(μg/m³)		PM 10(μg/m³)		PM 1.0(μg/m³)		Check value
		High 8 Level	Low 8 Level	High 8 Level	Low 8 Level	High 8 Level	Low 8 Level	
0xFF	0x86	0x00	0x85	0x00	0x96	0x00	0x65	0xFA

Check value== 0x86 + 0x00 + 0x85 + 0x00 + 0x96 + 0x00 + 0x65

= 0x06(keep low level 8 only)

= 0xF9(Invert)

= 0xFA(plus 1)

3-4-3. The reading value in Q&A mode (take above data as example).

PM1.0 = 0x00 *256 + 0x65 = 101 μg/m³;

PM2.5 = 0x00 *256 + 0x85 = 133 μg/m³;

PM 10 = 0x00 *256 + 0x96 = 150 μg/m³;

The detection range of PM1.0, PM2.5 and PM10 are all 0-1000ug/m3.

PWM Output way

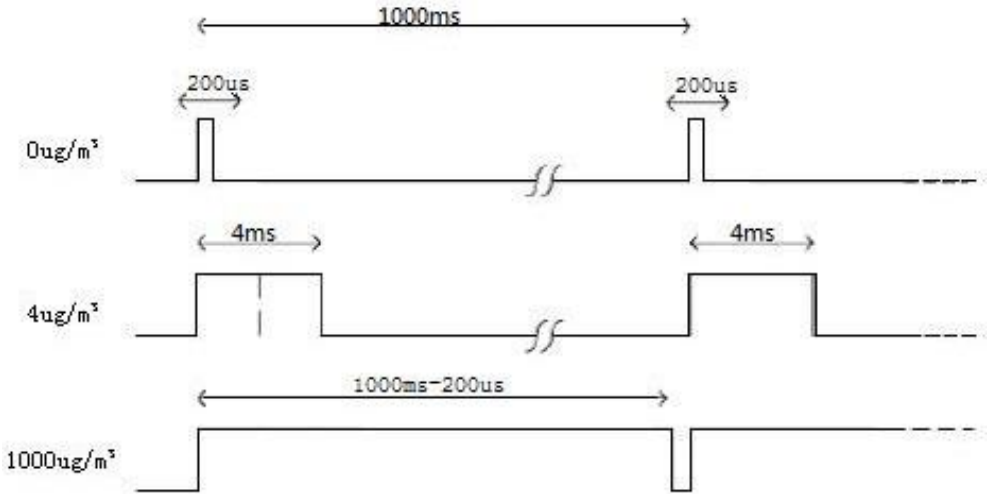


Fig.PWM singal

Calculation method of PM2.5 by PWM output

$P(\mu g/m^3) = 1000 \times (TH) / (TH + TL)$

P (ug/m^3) is calculated value of PM2.5 concentration, its unit is ug/m^3

TH is the time of high level during one period

TL is the time of low level during one period

Note. PWM signal outputs PM2.5 value only.

PWM output	
Detection range	0~1000ug/m^3
PWM singal voltage	3.3V-TTL level-default
PM2.5 concentration output range	0~1000ug/m^3
Period	1000ms±5%
High level output at the period start	200us(theoretical value)
Middle of the period	1000ms±5%
Low level output at the period end	200us (theoretical value)
To calculate PM2.5 through PMW: P (ug/m^3)=1000x(TH)/(TH+TL)	

Terminal specification

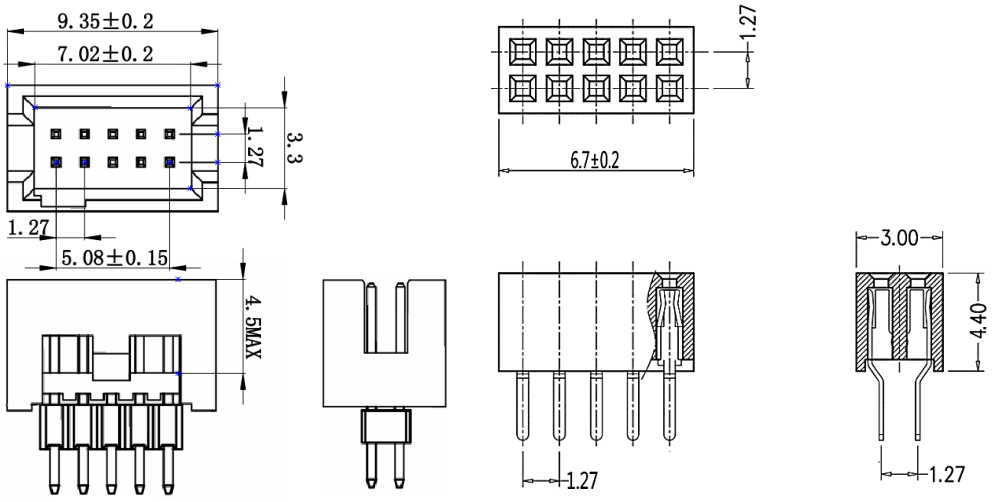


Fig1. Terminal Type（PH=2x5x1.27mm） **Fig2-1.**Matching Terminal Description: for reference only

NOTE. The Fig2-1 is just for reference. If users choose surfaced mount, please be sure about the safety distance between sensor's housing and terminal pins, avoiding short circuit or other malfunction.

Principle Description:

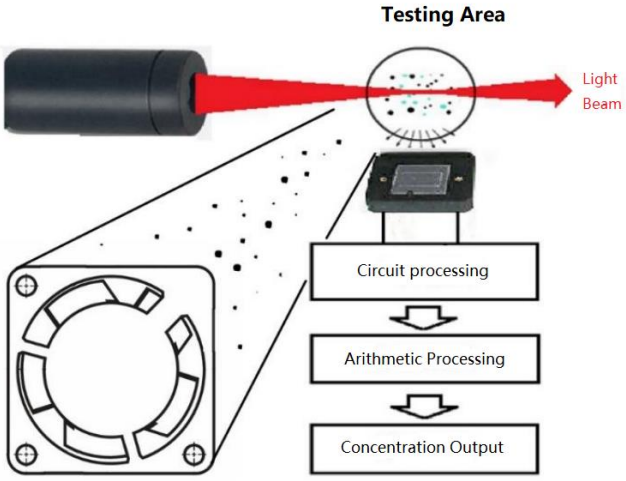


Fig3. Working principle

Sensor Construction:

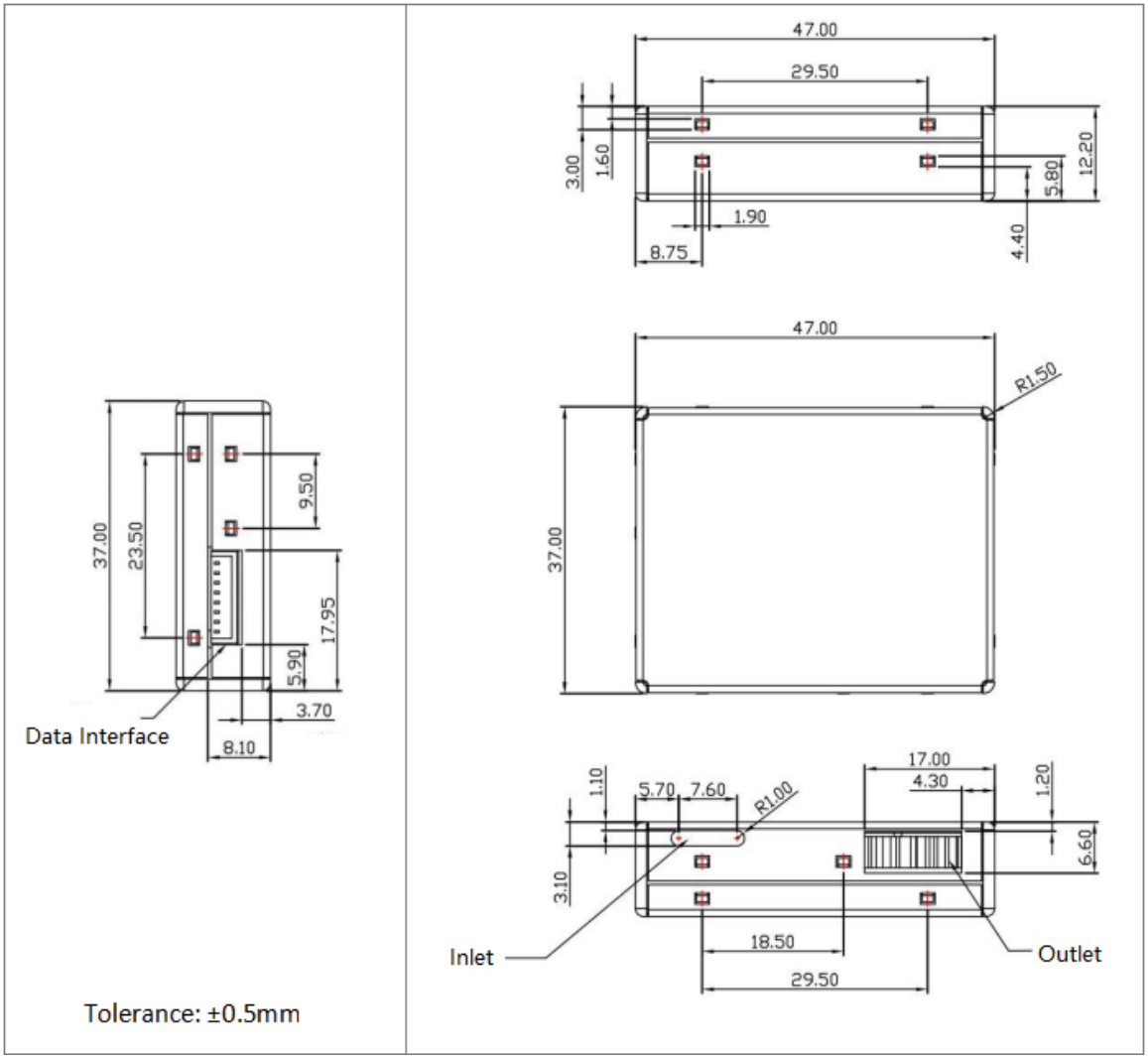


Fig4. Sizes

Installation Method:

The dust collection hole is the air inlet inside the sensor, which needs to keep good contact with the external air; the fan is installed at the air outlet inside the sensor. When the sensor is installed and working, must avoid strong airflow interference around the sensor; if it cannot be avoided, try to keep the external airflow direction perpendicular to the internal airflow direction of the sensor.

When designing the detection cavity of the whole machine, the effective area of the sampling port of the sensor should be fully considered to ensure the smoothness of the sampling gas path as much as possible. Small sampling area and large air resistance will seriously affect the accuracy of sensor data.

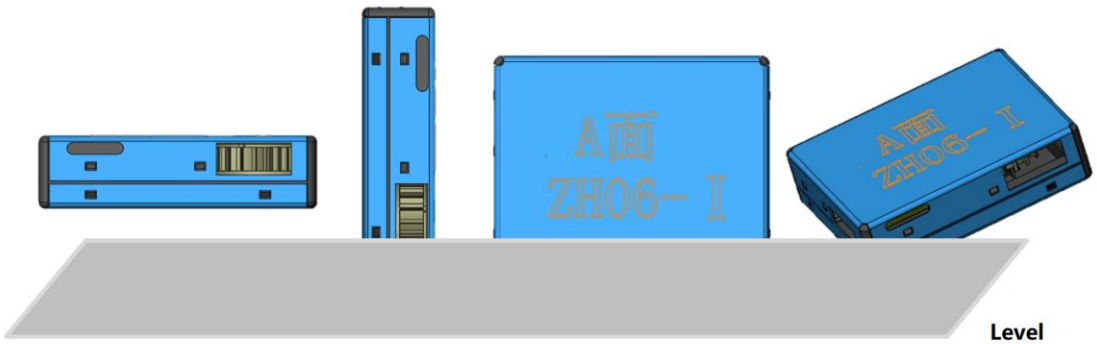


Fig5 Fig6 Fig7 Fig8

Arrows indicate the airflow perpendicular to the sensor surface

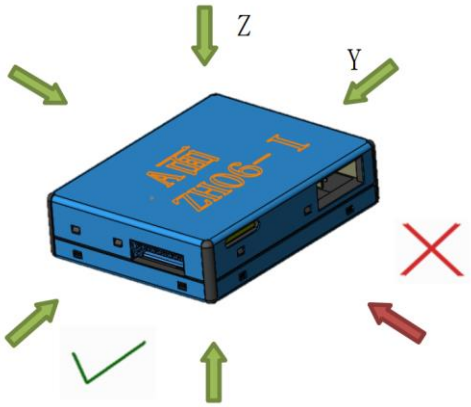


Fig9

Typical Output Characteristics:

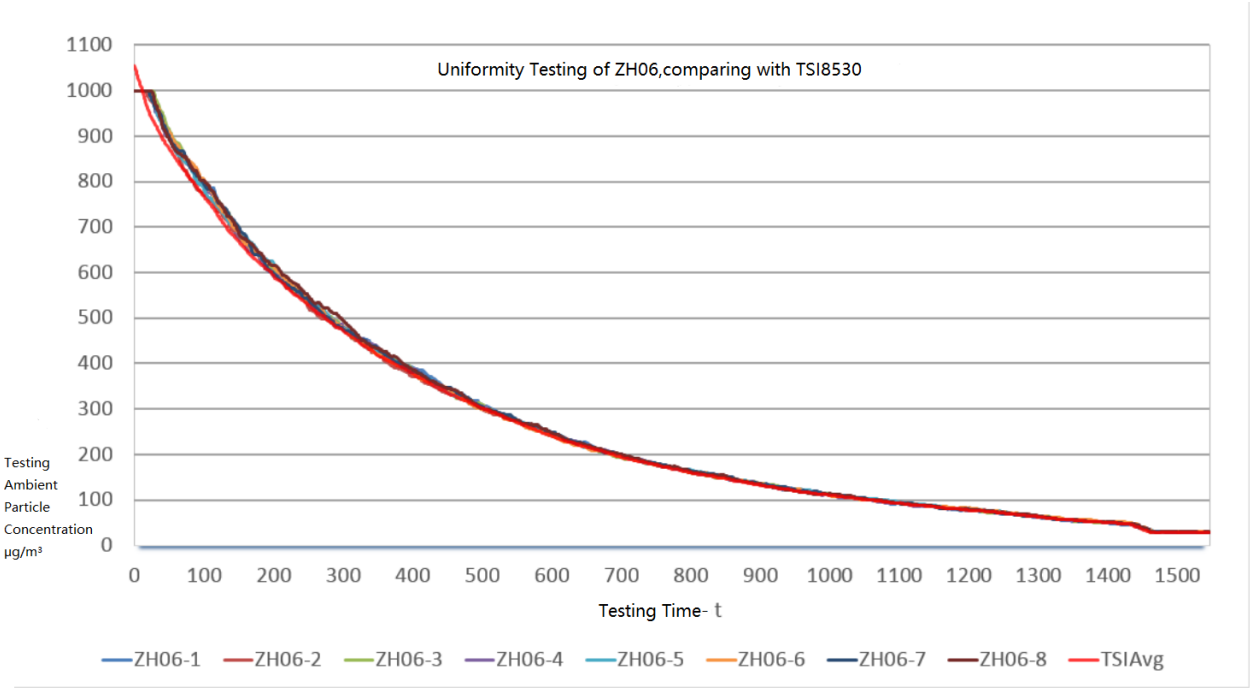


Fig10

Note:

The picture shows the data comparison between the conventional ZH06 laser particle sensor and TSI8530 in the test environment.

Abscissa : Testing time related parameters

Ordinate : The concentration of particles in the test environment (with TSI8530 data as reference, unit: μg /m³, environmental resolution: 1μg/m³).

Attentions:

1. It is forbidden to remove the shield cover of the sensor and the internal fixing screw of the sensor, because the shield cover of the sensor is connected with the internal power supply of the sensor through the internal spring. If the shield cover of the sensor is removed, the anti-interference ability of the sensor will be poor, the output value of the sensor will change, and the performance of the sensor will be poor. In addition, and please pay attention to the metal shield of the sensor, avoid contact with other external circuits or conductive parts, so as to reduce the impact of external interference on the sensor.

2. Excessive impact or vibration will affect the accuracy and life of the sensor detection value, so the sensor should avoid falling or vibration when installing and using.

3. This sensor is suitable for the detection of dust particles in the ordinary indoor environment. The actual working environment should try to avoid oil&smoke environment, too large dust particles, high humidity environment, such as: kitchen, bathroom, smoking room, outdoor environment, etc. If it is used in such environments, corresponding protective measures shall be added to the user's equipment to prevent viscous particles or large particles from entering the interior of the sensor and forming accumulation in the interior of the sensor which will affect the performance of the sensor. (for example, in the working environment with floccules or fibers, the corresponding coarse filter net should be added ahead the air inlet of the sensor to avoid floccules or large sundries from entering the sensor and blocking the light path of the sensor, thus affecting the detection accuracy of the sensor.)

4. The fan is the air outlet, and the dust collection hole is the air inlet. During the using of the sensor, the sensor should not be directly placed inside the air duct of the purifier. If it cannot be avoided, an independent space structure should be set up for the installation position of the sensor. The air flow direction is as shown in ‘Installation Method’. The sensor should not be impacted by the air flow in the direction of the red arrow. There should be no obstructions within 2cm around the outlet of the fan. In this independent space, it should be avoided that the air flow from the outlet directly flows back to the inlet, which will affect the accuracy of detection.

5. Under normal working condition of normal temperature&pressure, the key component of the sensor-laser,can work continuously for more than 10000 hours, and the life of the sensor can be greatly prolonged by setting the sensor's sleep mode and interval working time. The maximum cumulative life of the sensor can be more than 3 years. Please refer to the user interface instructions for detailed operation methods, or you can contact our technical service staff by telephone or email.

6. The sensor data mentioned in this manual is about to ensure the consistency of the sensors we produced, the comparison standard will not refer to any third-party testing instruments or data . If the user wants the final detection results to be consistent with the third-party testing instrument, the user can do data fitting correction according to the actual detection results.

Packing:

1. Put the sensor into the Pearl Foam Tray as shown in the picture below.
2. Put the whole plate of sensors in Small Box one by one, then puts a foam plate at the top. Each Small Box can hold 25 sensors.
3. Select the appropriate carton according to the quantity of the order:

Carton F: 355 x 310 x 285mm, can hold 200 sensors, total weight around 6.2kg.

Carton D: 630 x 280 x 405mm, can hold 600 sensors,total weight around 18.0kg.

Note: Please pay attention to water proof of the carton during transportation

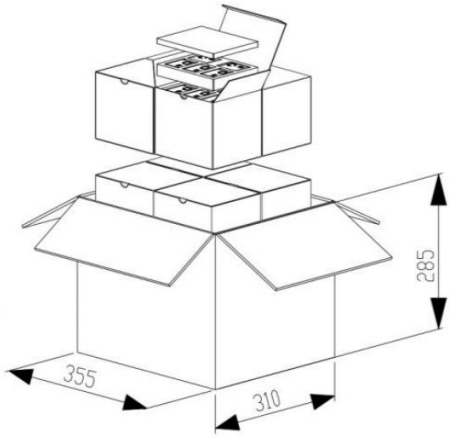
Size:154x131x130mm
P/N :10010795

Capacity:5x5=25pcs Sensors
Filler Material:White Pearl Cotton
Total weight:710g

Small Box

Size:355x310x285mm
P/N:10006388

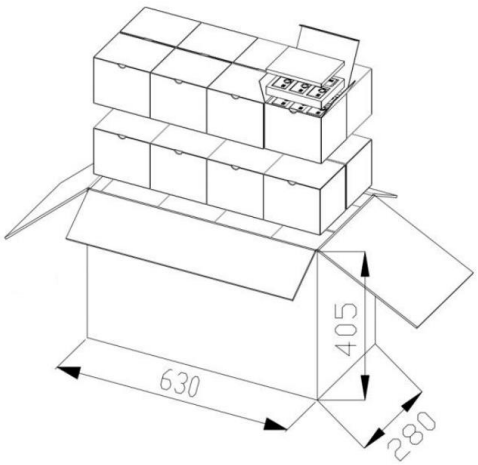
Capacity:2x2x2 Small Box
Totally 2x2x2x25=200pcs
Total weight:6.2kg



Carton F

Size:630x280x405mm
P/N:10006386

Capacity:2x4x3 Small Box
Totally 2x4x3x25=600pcs
Total weight:18.0kg



Carton D

Reliability Testing:

	Testing Item	Testing Condition	Decision Criteria	Number of Tests - n Number of Failures - c
1	Zero output range	The test cabin meets the requirements of clean air: the mass concentration of dust is not more than 5.0 μ g / m³, the sensor is powered on, and the output value is recorded six times.	Zero point output range: ＜15μg/m³	n=28 c=0
2	Uniformity	Record the output value of the sensor for 6 times at each concentration of 50, 130 and 260μg/m³, totally 18 times, take the maximum value respectively	Meet the description of "PM2.5 detection accuracy"	n=28 c=0
3	stability	The sensor is continuously powered on for 15d, Measure the output range and relative error of zero point.	Zero point output range: ＜15μg/m³ Relative error ± 15%	n=2 c=0

4	response time	When the output value of the sensor reaches 450 μ g / m³ for the first time, record the time T1 at this time. Calculate the response time T90 = t1-t0, repeat the measurement 3 times and take the average value	response time: T90 < 45s	n=2 c=0
5	High Concentration Inundation	The sensor is powered on for 10min under the environment of 2000 μg/m³. Measure the output range of zero point and relative error after completion.	Zero point output range: < 15μg/m³ Relative error ± 15%	n=2 c=0
6	Power on/off	Keep the voltage dc5 ± 0.1V for 5min; keep the power off for 5min and circulate for 24h. Measure the output range of zero point and relative error after completion.	Zero point output range: < 15μg/m³ Relative error ± 15%	n=2 c=0
7	Noise	The background noise is less than 30dB (a), the sensor works stably for 20min, and the sound level meter is placed on the same horizontal plane 0.8m high from the ground. The distance between the two is 1m. Each measurement is conducted three times, and the maximum value is taken	Working noise: ≤ 40dB (a)	n=2 c=0
8	Low Temperature Storage	The sensor is not powered on, under the environment condition of - 30 ± 2 ℃, the duration is 16h, and stable at room temperature for 2h.	There shall be no obvious dents, scratches, cracks, deformation and other defects on the	n=2 c=0

		Measure the output range of zero point and relative error after completion.	sensor surface, no bubbles, crazing and falling off on the coating and coating, no loosening and falling off on the connectors and parts, no rust and mechanical damage on the metal components. Zero point output range: < 15μg/m³ Relative error: ± 15%	
9	High Temperature Storage	The sensor is not powered on, under the environment of 70 ± 2 ℃, the duration is 16h, and stable at room temperature for 2h. Measure the zero point output range and relative error after completion		n=2 c=0
10	High Temperature Work	The sensor is powered on and operated under 50 ± 2 ℃ environmental conditions for 2h, Measure the zero output range after completion.	There shall be no obvious dents, scratches, cracks, deformation and other defects on the sensor surface, no bubbles, crazing and falling off on the coating and coating, no loosening and falling off on the connectors and parts, no rust and mechanical damage on the metal components. Zero point output range: <15μg/m³	n=2 c=0
11	Low Temperature Work	The sensor is powered on and operated under the ambient condition of - 10 ± 2 ℃, lasting for 2h, Measure zero point output range after completion		n=2 c=0
12	Vibration Test	The sensor is not packed and powered off. Frequency range: (10-150) Hz; Sine amplitude: 1.5mm; Frequency range: 1oct; X, y,	There shall be no obvious dents, scratches, cracks, deformation and other defects on the sensor surface, no	n=2 c=0

		Z three axes, each sweeping 15 times. Measure the output range of zero point and relative error after completion.	bubbles, crazing and falling off on the coating and coating, no loosening and falling off on the connectors and parts, no rust and mechanical damage on the metal components. Zero point output range: < 15μg/m³	
13	Drop Test	The packaged sensor, with a height of 1m, falls on a surface of concrete or a smooth and hard rigid surface. Each of the six different faces falls freely once. Measure the output range of zero point and relative error after completion.		n=2 c=0
14	Electrostatic Interference	When the sensor is electrified, the surface of 2000V metal shell is discharged 8 times, and the ground plate is discharged 2 times at 10cm around the sample. The time interval of each discharge is at least 1s. Measure the output range of zero point and relative error after completion.	Zero point output range: < 15μg/m³ Relative error: ± 15%	n=2 c=0