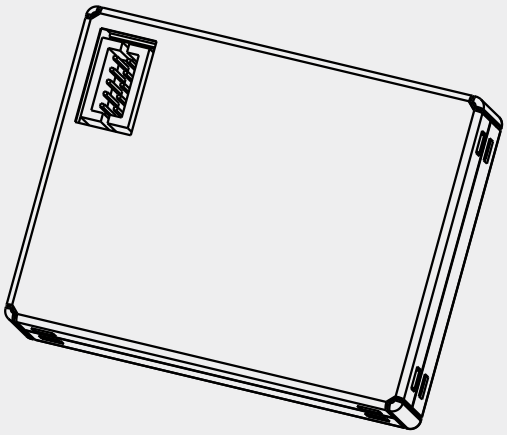
MEMSFRONTIER
美思先端

MPM11 series

Air Laser Particulate Matter Sensor



SPECIFICATION

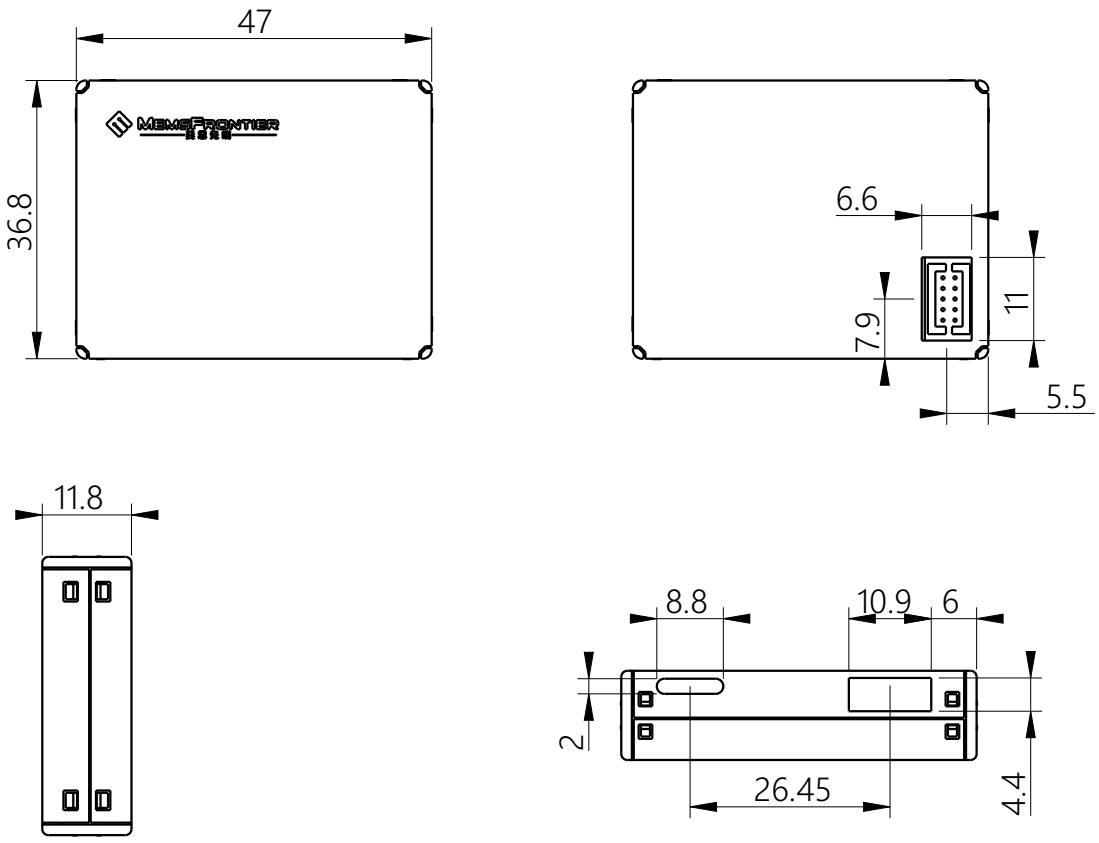
Shenzhen MemsFrontier Electronics Co., Ltd.

◆ Product Appearance

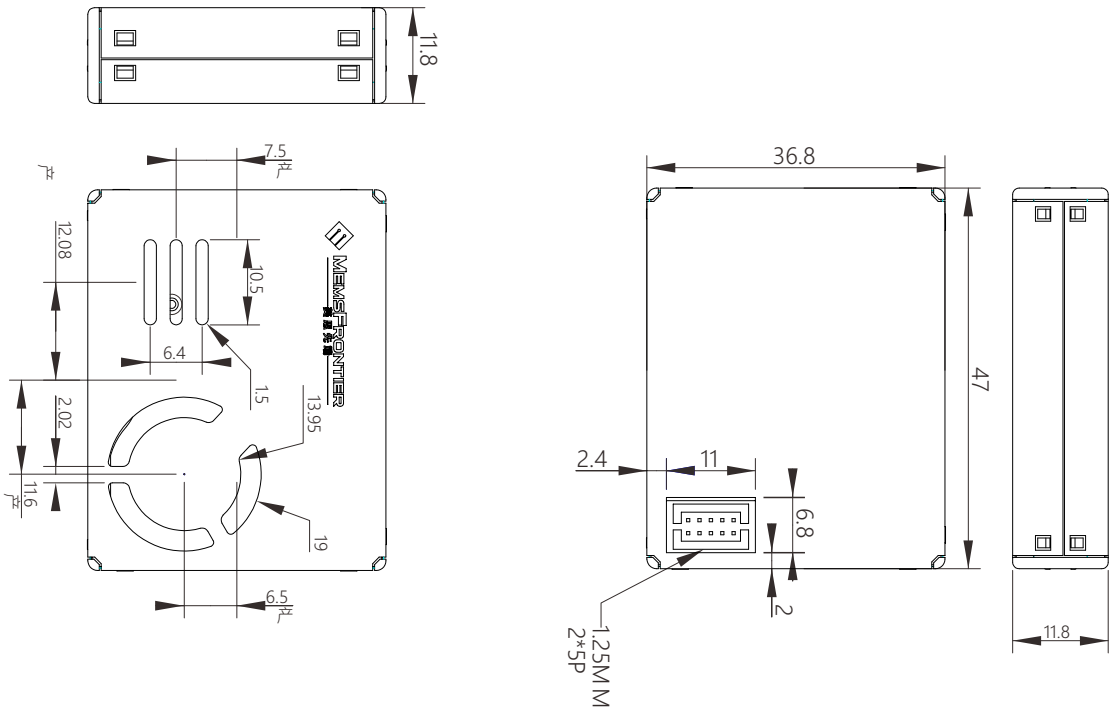
MPM11-AD	MPM11-BD	MPM11-BS
		

◆ Product Size

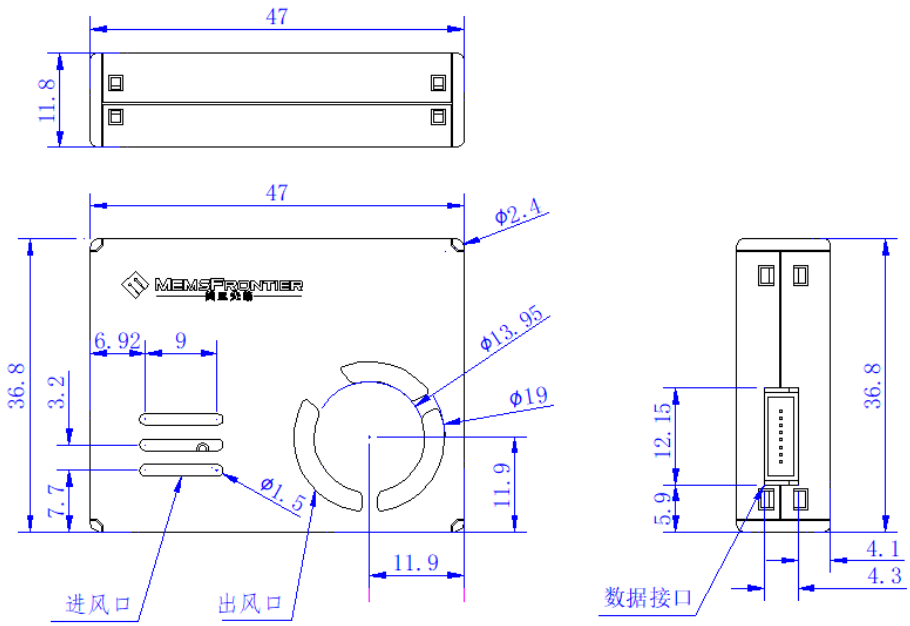
MPM11-AD



MPM11-BD



MPM11-BS

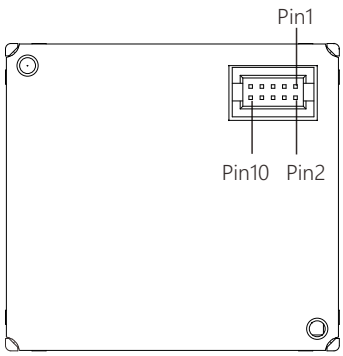


◆ Product parameters

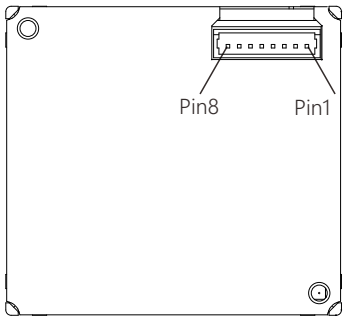
parameter	index
Types of particle detection	PM1.0, PM2.5, PM10
Particle detection diameter range	0.3-10μm
Particulate matter concentration range (PM2.5 standard value)	0~1000μg/m3
Particle Mass Concentration Resolution	1μg/m3
Consistency of particulate matter concentration (PM2.5 standard value) *Note	±10%(@100~500μg/m3) ±10μg/m3 (@ 0~100μg/m3)
single response time	≤1s
Comprehensive response time	≤10s
DC supply voltage	5.0V
Working current	≤85mA
Stand-by current	≤45μA
Output method	UART / IIC / PWM
Storage temperature	-30℃ ~ +70℃
Range of working temperature	-10℃~+60℃
Working humidity range	0~99%RH(no condensation)
Mean time between failures	≥3 Years
Dimensions	47*36.8*11.8mm(L×W×H)

Note: The particle concentration consistency data is data 2 in the communication protocol (test conditions: 25±2℃, 50±10%RH).

◆ Pin Diagram



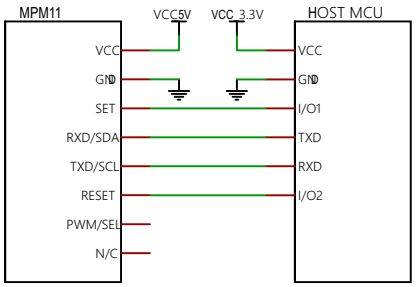
MPM11-AD / MPM11-BD



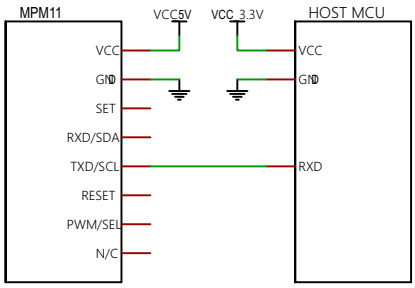
MPM11-BS

Pin number MPM11-AD MPM11-BD	Pin number MPM11-BS	Pin name definition	Pin function description	Pin Electrical Characteristics
Pin 1	Pin 1	VCC	Positive power supply (+5V)	No reverse polarity protection
Pin 2	–	VCC	Power supply negative (-5V)	
Pin 3	Pin 2	GND	negative power supply	No reverse polarity protection
Pin 4	–	GND	negative power supply	
Pin 5	Pin 6	RESET	Module reset signal input pin. Low level reset, should be left floating when not in use.	TTL level@3.3V; input pin with internal pull-up resistor.
Pin6	Pin8	N/C	This pin is left open	
Pin7	Pin4	RXD/SDA	RX of module UART interface, or SDA of IIC interface. Usually connected to TX of UART interface of client MCU, or SDA of IIC interface.	TTL level@3.3V; external pull-up resistor is required when used as IIC function.
Pin 8	Pin 7	PWM/SEL	The PWM output pin (active low) is also the selection pin of the UART or IIC communication interface. The module detects the level state of this pin within 1 second when it is powered on: the state is high level (the pin is externally pulled up or left floating): this pin is used as a PWM signal output pin, and enables RXD/SDA, TXD UART interface function of /SCL pin (IIC interface is not available). The state is low level (pin is connected to GND): This pin has no PWM output function, and enables the IIC interface function of RXD/SDA, TXD/SCL pins (The UART interface is not available).	TTL level@3.3V; push-pull output mode when used as PWM output pin.
Pin 9	Pin5	TXD/SCL	TX of the module UART interface, or SCL of the IIC interface. Usually connected to the RX of the UART interface of the client MCU, or the SCL of the IIC interface.	TTL level@3.3V; external pull-up resistor is required when used as IIC function.
Pin 10	Pin3	SET	Set the module to work normally or sleep. High level or floating: the module works normally, low level: the module sleeps.	TTL level@3.3V; input pin with internal pull-up resistor.

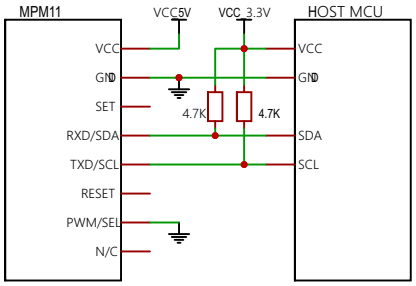
◆ circuit connection



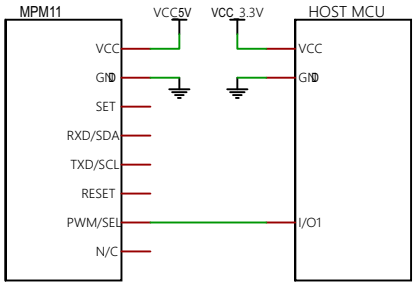
UART Typical Circuit Connection



UART Simplest Circuit Connection



Circuit connection of IIC interface



Circuit connection for PWM output

Circuit Design and Application Note:

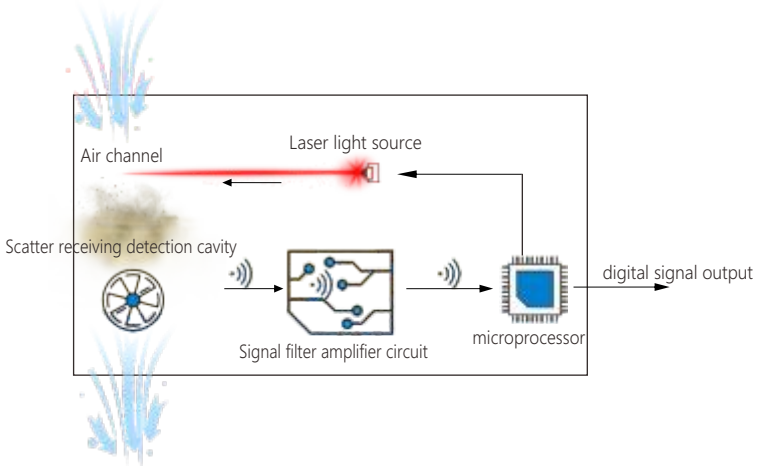
1. The power supply voltage of the module is 5V, and the data communication and control pins are both 3.3V as high level, so the mainboard MCU connected to it should be powered by 3.3V. If the mainboard MCU is powered by 5V, a level conversion chip or circuit should be added to the communication lines (RXD/SDA, TXD/SCL) and control lines (SET, RESET).

2. SET and RESET have internal pull-up resistors, if not used, they should be left floating.

3. Attention should be paid when applying the hibernation function: the fan stops working during hibernation, and it takes at least 30 seconds to stabilize the fan to restart. Therefore, in order to obtain accurate data, the working time of the module after hibernation and waking up should not be less than 30 seconds.

◆ working principle

According to the principle of laser scattering, the laser beam emitted by the laser irradiates the suspended particles in the air to generate scattering, and the laser photoelectric receiver is placed at a specific position to collect the scattered light, and the curve of the scattered light intensity with time is obtained. Microprocessing collects the electrical signal of the receiver in real time, and uses the algorithm based on Mie theory to obtain the equivalent particle size of the particles and the number of particles with different particle sizes per unit volume. The functional block diagram of the sensor is shown in the following figure:



◆ Communication Protocol

Serial communication:

Serial port settings	baud rate	data bits	stop bit	Check Digit	interface level
	9600bps	8 bits	1 bit	none	3.3V

The serial output of the module is divided into two modes: automatic output and passive output. After the module is powered on, the default mode is automatic output, that is, the module actively sends serial data to the host (the data format is shown in Table 3), and the sending interval is 1 second. The host MCU can send commands to turn the module into passive output mode, and for passive output, the host MCU sends a query command, and the module responds to output data once.

Table 3, the format of the output data of the module serial port (32 bytes):

Number	byte	Numerical value	Descriptions
1	frame header byte 1	0x42	(Fixed value)
2	frame header byte 2	0x4d	(Fixed value)
3	frame length high byte	**	Frame length=2x13+2(data+check digit)
4	frame length low byte	**	
5	Data 1 high byte	**	PM1.0 concentration value (standard particulate matter), unit μg/m3 *
6	Data 1 low byte	**	
7	Data 2 high byte	**	PM2.5 concentration value (standard particulate matter), unit μg/m3 *
8	Data 2 low byte	**	
9	Data 3 high byte	**	Pm10 concentration value (standard particulate matter), unit μg/m3 *
10	Data 3 low byte	**	
11	Data 4 high byte	**	PM1.0 concentration value (in atmospheric environment), unit μg/m3 *
12	Data 4 low byte	**	
13	Data 5 high byte	**	PM2.5 concentration value (in atmospheric environment), unit μg/m3 *
14	Data 5 low byte	**	
15	Data 6 high byte	**	Pm10 concentration value (in atmospheric environment), unit μg/m3 *
16	Data 6 low byte	**	
17	Data 7 high byte	**	The number of particles with a diameter of more than 0.3um in 0.1 liter of air
18	Data 7 low byte	**	
19	Data 8 high byte	**	The number of particles with a diameter of more than 0.5um in 0.1 liter of air
20	Data 8 low byte	**	
21	Data 9 high byte	**	The number of particles with a diameter of more than 1.0um in 0.1 liter of air
22	Data 9 low byte	**	
23	Data 10 high byte	**	The number of particles with a diameter of more than 2.5um in 0.1 liter of air
24	Data 10 low byte	**	
25	Data 11 high byte	**	The number of particles with a diameter of more than 5.0um in 0.1 liter of air
26	Data 11 low byte	**	

27	Data 12 high byte	**	The number of particles with a diameter of more than 10um in 0.1 liter of air
28	Data 12 low byte	**	
29	Data 13 high byte	**	reserve
30	Data 13 low byte	**	reserve
31	Data and parity high byte	**	Check code = frame header byte 1 + frame header byte 2 + ... + data 13 low byte
32	Data and check low byte	**	

Note: The standard particle mass concentration value refers to the mass concentration value obtained by using industrial metal particles as equivalent particles for density conversion, which is suitable for industrial production workshops and other environments. The mass concentration value of particulate matter in the atmospheric environment is converted into the density of the main pollutants in the air as equivalent particles, which is suitable for ordinary indoor and outdoor atmospheric environments.

Communication command format:

frame header byte 1	frame header byte 2	instruction byte	data byte 1	data byte 2	Check byte 1	Check byte 2
0x42	0x4d	CMD	DATAH	DATAL	SUMH	SUML

The checkword is generated from the cumulative sum of all bytes starting from the frame header byte.

Definition of commands and data bytes sent by the host:

CMD	DATAH	DATAL	explanation
0xE2	X	X	In passive output mode, the host sends this command to read the module data. The format of the module output data is shown in Table 3.
0xE1	X	0x00	The module switches to passive output mode.
		0x01	The module switches to automatic output mode.
0xE4	X	00H	Module enters standby mode.
		01H	The module enters normal working mode.

x represents any value

Serial communication application example:

1. Switch to passive mode command:

Host send: 42 4D E1 00 00 01 70

Module response: no response; the module switches to passive output mode and does not automatically output the number.

2. Passive reading command:

Host send: 42 4D E2 00 00 01 71

Module response: 42 4D 00 1C 00 26 00 38 00 44 00 1C 00 2A 00 36 1E 1F 05 B2 01 3D 00 2D 00 11 00 0A 00 00 03 43

Conversion of response data to measured values:

PM1.0 measurement value is: PM1.0 = 0x00 * 256 + 0x1C = 28 (ug/m3)
PM2.5 measurement value is: PM2.5 = 0x00 * 256 + 0x2A = 42 (ug/m3)
Pm10 measurement value is: PM10 = 0x00 * 256 + 0x36 = 54(ug/m3)

3. Switch to standby mode mode command:

Host send: 42 4D E4 00 00 01 73

Module response: no response; module enters standby mode.

◆I IC communication protocol

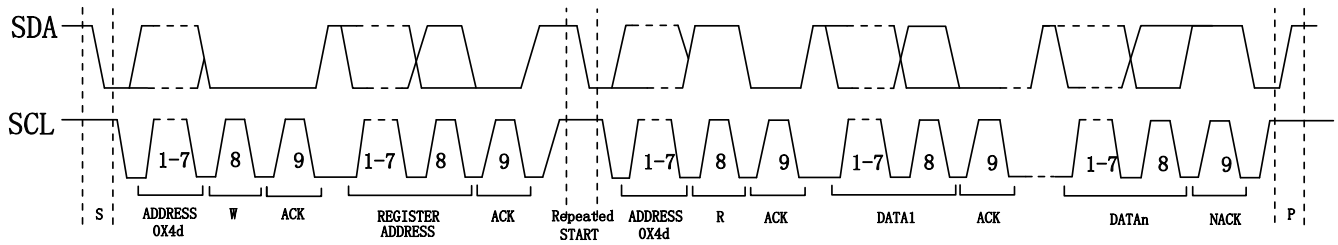
The module works in the slave mode of IIC and can be connected to an external MCU. The communication line needs to be connected with a pull-up resistor.

The slave address of the module device is: 0x4d (7-bit address)

The write operation address of the module is: 0x9a

The read operation address of the module is: 0x9b

When reading the MPM11-BD register data through the IIC interface, the communication timing waveform is as follows:



Host sending timing:

1: The host sends the IIC start signal.

2: Sending module device address 0x4d (7 bits) + W (write bits).

3: Send the address of the data register of the module (which register is to be read from which address is sent).

4: Send repeating IIC start signal (note that there is no stop signal here).

5: Sending module device address 0x4d (7 bits) + R (read bits).

6: The host receives n bytes of data output by the module (when the host receives data, it sends an ACK signal bit to the module. If the host does not send an ACK signal bit, the module stops data transmission).

7: The host sends the IIC stop signal.

IIC register address and data format

register address	data	explanation
0x20	Data 1 high byte	PM1.0 concentration value (standard particulate matter), unit μg/m3 *
0x21	Data 1 low byte	
0x22	Data 2 high byte	PM2.5 concentration value (standard particulate matter), unit μg/m3 *
0x23	Data 2 low byte	
0x24	Data 3 high byte	Pm10 concentration value (standard particulate matter), unit μg/m3 *
0x25	Data 3 low byte	
0x26	Data 4 high byte	PM1.0 concentration value (in atmospheric environment), unit μg/m3 *
0x27	Data 4 low byte	
0x28	Data 5 high byte	PM2.5 concentration value (in atmospheric environment), unit μg/m3 *
0x29	Data 5 low byte	
0x2A	Data 6 high byte	Pm10 concentration value (in atmospheric environment), unit μg/m3 *
0x2B	Data 6 low byte	
0x2C	Data 7 high byte	The number of particles with a diameter of more than 0.3um in 0.1 liter of air
0x2D	Data 7 low byte	
0x2E	Data 8 high byte	The number of particles with a diameter of more than 0.5um in 0.1 liter of air
0x2F	Data 8 low byte	

0x30	Data 9 high byte	The number of particles with a diameter of more than 1.0um in 0.1 liter of air
0x31	Data 9 low byte	
0x32	Data 10 high byte	The number of particles with a diameter of more than 2.5um in 0.1 liter of air
0x33	Data 10 low byte	
0x34	Data 11 high byte	The number of particles with a diameter of more than 5.0um in 0.1 liter of air
0x35	Data 11 low byte	
0x36	Data 12 high byte	The number of particles with a diameter of more than 10um in 0.1 liter of air
0x37	Data 12 low byte	

*Note: The standard particle mass concentration value in the table refers to the mass concentration value obtained by using industrial metal particles as equivalent particles for density conversion, which is suitable for industrial production workshops and other environments. The mass concentration value of particulate matter in the atmospheric environment is converted into the density of the main pollutants in the air as equivalent particles, which is suitable for ordinary indoor and outdoor atmospheric environments.

◆ PWM output method

The period of PWM is 1000ms

In the initial stage, the low level output is 0.25ms

Middle cycle 999.5ms

End stage high level output 0.25ms

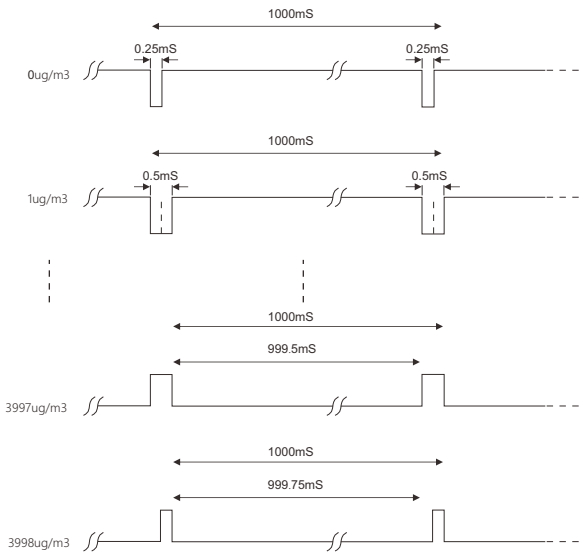
The calculation formula for obtaining the current PM2.5 concentration value through PWM:

PM2.5 = 4000 * (TL-0.25ms) / (TH+TL)

PM2.5 is the calculated PM2.5 mass concentration value, the unit is ug/m3

TH is the time that the output is high in one output cycle

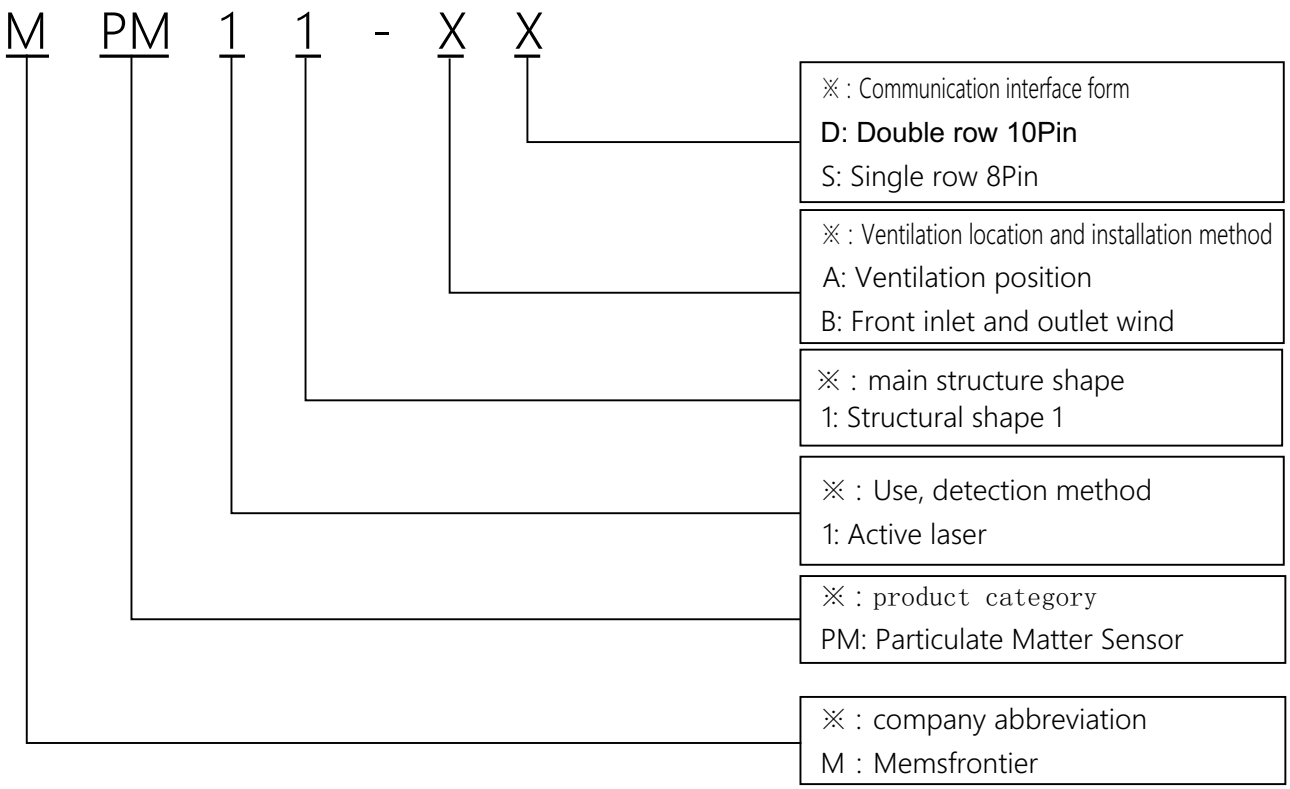
TL is the time when the output is low in one output cycle



◆Installation Precautions

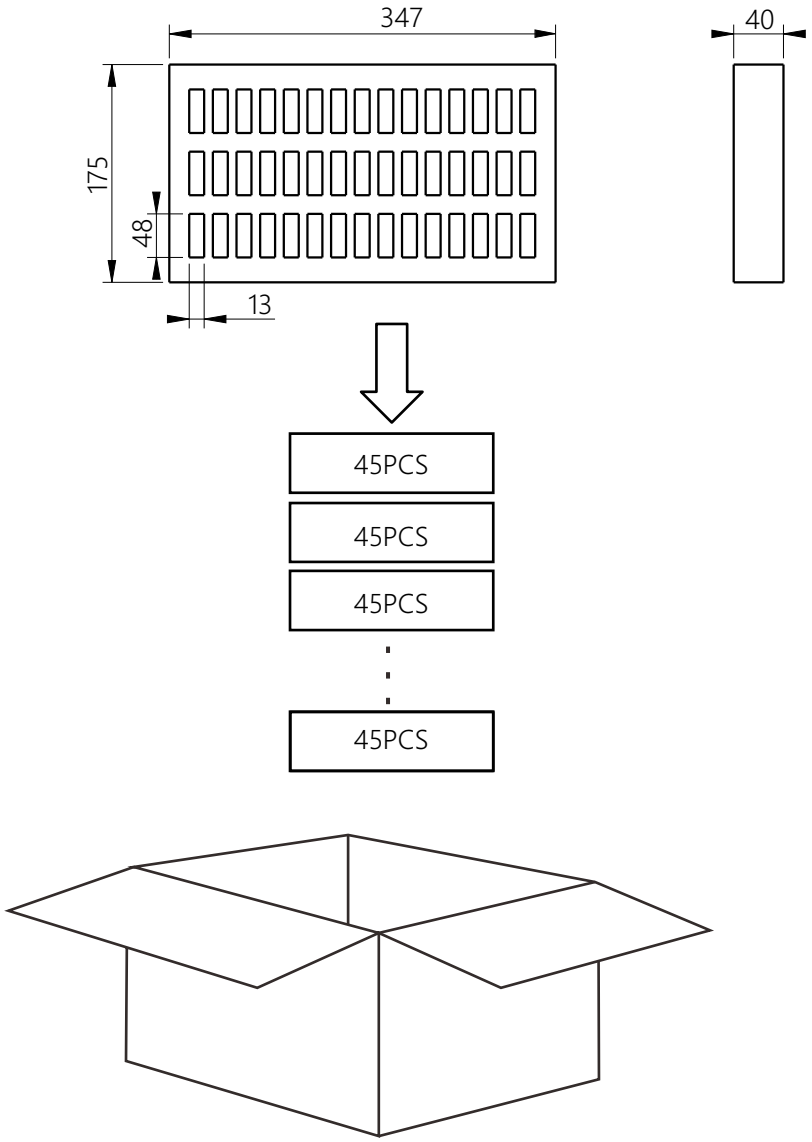
1. The metal shell of the module is connected to the internal power supply ground. Be careful not to short-circuit with other circuits or the chassis shell.
2. It is the best installation method that the plane where the air inlet and air outlet are located is close to the air hole on the inner wall of the user machine that communicates with the outside world. There should be a structure between the air inlet and the air outlet to isolate the airflow to prevent the airflow from directly flowing back from the air outlet to the air inlet inside the user machine.
3. The ventilation hole opened for the air inlet on the inner wall of the user machine should not be smaller than the size of the air inlet.
4. When applied to purifier products, try to avoid placing the module directly in the air duct of the purifier itself. If it is unavoidable, an independent structure space should be set up separately, and the module should be placed in it so that it is connected to the purifier itself. Air duct isolation.
5. When applied to purifiers or fixed testing equipment, the module position should be more than 20cm above the ground. Otherwise, it may be polluted by large dust particles or even flocs near the ground, causing the fan to wind up and stop rotating.
6. When the module is applied to outdoor fixed equipment, the protection against sandstorms, rain and snow, and willow catkins should be completed by the equipment.
7. The module is an integral component, users should not disassemble it, including the metal shielding case, to prevent irreversible damage.

◆ Number Description



Packing

Quantity per plate	Packaging layers	Packaging Quantity	carton size	Packaging material
45	15	675	L530*W320*H250	red pearl cotton



Version history

Date	Version	change
2022.8.10	1.00	initial version