Temtop

PMS 10

Specifications of

Pump-suction Laser PM Sensor

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1. Product Overview

The PMS 10 series, which is a pump-suction laser sensor, is specially designed to provide solutions for the online monitoring industry of atmospheric environment, which can be widely used in micro air monitoring stations, dust monitoring, oil-smoke monitoring and other air monitoring systems.

2. Produce Features

- Benchmarking β-ray method adopted, enjoying higher accuracy and correlation;
- Equipping brushless vacuum pump, which can provide higher sampling efficiency;
- All-metal precise optical-mechanical structure, stable operation in multiple scenes;
- Small size, convenient for integrated use of multiple devices;
- Working more than 10000 hours normally;

3. Working Principle

This sensor relies on the MIE scattering principle to monitor the concentration of particles. When the outside air passes through the light collection chamber uniformly, the particles in the sampled gas will scatter through the light beam. The photoelectric collection unit converts the scattered light signal into a voltage pulse signal, which is converted into a digital signal after pre-amplification and AD conversion. The number of voltage pulses measured is the number of particles, and the amplitude of voltage pulses reflects the size of optical equivalent size of particle. The standard substance is used to calibrate the senor after particle conversion, so as to determine the concentration of particles in the testing environment.

3.1 MIE scattering principle

Mie scattering theory is the exact solution of Maxwell's equation for a single medium sphere with homogeneous homogeneity in homogeneous medium under irradiation of monochromatic parallel light. A scattering occurrs when the diameter of particles in the atmosphere is equal to the wavelength of radiation is called the MIE scattering. Unlike Rayleigh scattering enjoying a symmetrical distribution, MIE scattering has stronger scattering in the forward direction than in the backward direction, with a more obvious directivity. When the particle diameter is large, Mie scattering can be approximated as Fraunhofer diffraction.

3.2 Optical-mechanical structure and principle

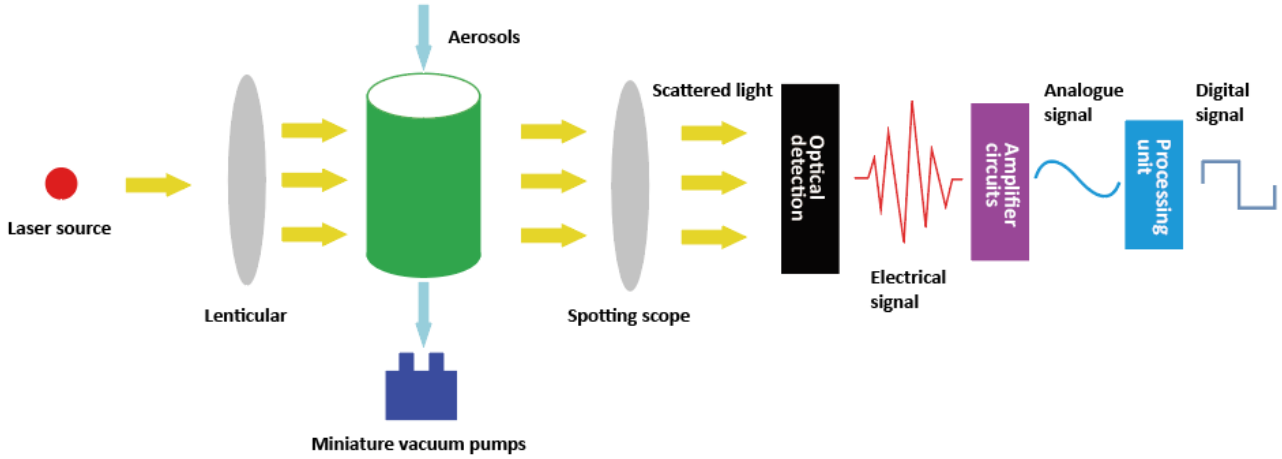

Fig. 1 principle of sensor

4. Sensor's Specifications

Parameters		Values	Unit	Remarks
Particle size		PM1.0, PM2.5, PM10, TSP	-----	-----
Measurement range		0-10000	μg/m³	0-10mg/m³
Resolving power		1	μg/m³	-----
Accuracy*	PM1.0	±10（0-100μg/ m³）	μg/m³	-----
		±10%（100-10000μg/m³）		
	PM2.5	±10（0-100μg/ m³）	μg/m³	-----
		±10%（100-10000μg/m³）		
	PM10	±15（0-100μg/m³）	μg/m³	-----
		±15%（100-10000μg/m³）		
	TSP	±20（0-100μg/m³）	μg/m³	-----
		±20%（100-10000μg/m³）		
Sample time		10~3,600	s	Can be set, default is 60sec
Intermittent time		10~3,600	s	Can be set, default is 60sec
Service life		10000	hr	Intermittent working mode
Counting efficiency		50％ for 0.3μm	-----	-----
		100% for more than 0.5μm		
Flow		1.1	L/min	Error±5%
Weight		345	g	-----
Maximum size		133*88*38	mm	Excluding the size of air inlet and outlet, terminal

Table 1 Specifications of Particle Monitor

*This is the data measured under the general atmospheric environment, with the Temtop instrument as a reference, the ambient temperature is 25±1℃, and the humidity is 50±3%RH. The actual use time depends on the environment in which it is used.

5. Electrical Specifications

5.1 Electrical Properties

The electrical properties under standard output (temperature 25℃, humidity 50%RH and 12V power supply voltage) are shown in Table 2.

Parameters	Values	Unit
Rated voltage	DC 12-24	V
Standby current	30	mA
Average current	250	mA
Maximum current	500	mA
Rated power	6	W

Table 2 Electrical Properties

5.2 Absolute Limit Values

The reliability of the device may be affected under the limited conditions for a long time. Exceeding the following parameters range (Table **3**) may cause permanent damage to the device.

Parameters	Range
Power supply voltage	11.5~28V
Voltage at I/O pin	-6~6 V
Working temperature range	0~ 50 °C
Storage temperature range	-10 ~ 60 °C
Working humidity range	0-95%RH（non-condensation）
Static electricity	1KV for terminal test 8KV for test voltage of other surfaces
Power ripple	100mV

Table 3 Absolute Limit Values

6. Hardware Interface

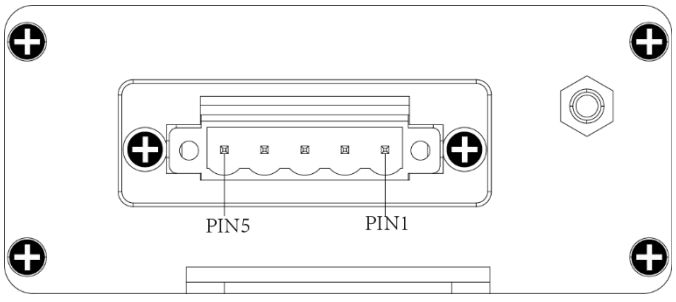

Fig.2 Hardware Interface

Pin	Name	Description	Note
1	VCC	Device power supply (positive)	12V
2	GND	Device grounding	——
3	TX（A）	Communication sending pin	(RS485+) serial sending
4	RX（B）	Communication receiving pin	(RS485-) serial receiving
5	NC	——	——

Table 4 Definition of Hardware Interface

7. Communication Protocol

UART parameters:

- Baud rate: 9600
- Data bit: 8
- Check bit: None
- Stop bit: 1

Communication mode:

- RS485(Modbus RTU)

Command mode:

- The slave (sensor) is in the receiving state, only responding to the command of the host, not actively sending the command; The sensor needs 3 seconds to start, so it will not respond to command within 3 seconds when just powering on;
- The sensor can work in continuous measurement mode or intermittent mode, the user can set the intermittent time; in intermittent mode, the sensor can respond to host commands normally; the default setting of the sensor is intermittent mode;

Checksum:

- CRC-16(Modbus), with low bytes before high bytes.

7.1 Register

Restrictions：

1. Input register and holding register are not allowed to overlap.
2. Bit addressing (coil and discrete input) cannot be realized.
3. The total number of registers is limited; it currently supports 32 input registers and 32 holding registers.
4. The current version does not support file transfer with a large amount of data.
5. See table 5 and table 6 for register details. All registers are 16-bit words and the register address is register number – 1.

See Table 5 for description of input Register.

Register number	Address	Definition
IR1	0	For later extended use
IR2	1	For later extended use
IR3	2	For later extended use
IR4	3	PM1.0 mass concentration
IR5	4	PM2.5 mass concentration

IR6	5	PM10 mass concentration
IR7	6	TSP mass concentration
…	…	…
IR32	31	For later extended use

Table 5 input register

See Table 6 for description of holding register

Register number	Address	Definition	Meaning
IR1	0	For later extended use	For later extended use
IR2	1	Special command register	0x0000 Stop Measurement
			0x0001 Start Measurement
IR3	2	Address setting register	Slave Address（1-247）
IR4	3	Mode switching register	0x0000 Continuous Working Mode
			0x0001 Intermittent Working Mode
IR5	4	Sample time register (1)	0xxx Sample time setting(10~3600s)
IR6	5	Intermittent time register (1)	0xxx Intermittent time setting(10~3600s)
IR7	6	Zero calibration register (2)	0x0001 Start zero point calibration Others : no response
IR8	7	PM1.0 correction factor register (3)	Value range: 1000-65535, expanded by 10000 times
IR9	8	PM2.5 correction factor register (3)	Value range: 1000-65535, expanded by 10000 times
IR10	9	PM10 correction factor register (3)	Value range: 1000-65535, expanded by 10000 times
IR11	10	TSP correction factor register (3)	Value range: 1000-65535, expanded by 10000 times
IR12	11	Flow regulation register(4)	0x0000 reduce flow 0x0001 increase flow
…	…	…	…
IR32	31	For later extended use	For later extended use

Table 6 holding register

(1) No response to values outside the range;

(2) After starting, the user needs to wait for 3s, and the register value will automatically return to 0 after completion;

(3) The register had been calibrated before sensors left the manufacturer, and it is not recommended for users to modify; if there is a demand, please modify it carefully;

(4) Step is 0.01L (for reference only, the actual adjustment value is subject to measurement);

7.2 Protocol

7.2.1 Protocol Description

The MODBUS protocol consists of 4 parts: additional address, function code, data and error check. The additional address is used to indicate the address of the sensor which should receive this data; the function code is used to instruct the sensor to perform a certain operation; the data has different data structures according to different function code.

Fig.3 general MODBUS frame

7.2.2 Additional Address Description

Address	MODBUS	PMS 10
0	broadcast	Broadcast is not support temporarily
1-247	Slave device address	Slave device address
248-253	For later extended use	Nothing
254	For later extended use	Any Sensor
255	For later extended use	Nothing

Table 7 Address description

7.2.3 Function Code Description

The sensor supports 4 function codes, see Table 8 for details.

Function code	Function description	Corresponding operation
0x03	Read holding registers	Used to read sensor configuration parameters, including: ✓ Get address of sensors; ✓ Get work mode; ✓ Get sample time; ✓ Get Intermittent time; ✓ Get correction factors;
0x04	Read input registers	Get mass concentration
0x06	Write single register	Used for setting separately, including: ✓ Set work mode; ✓ Set address of sensors; ✓ Set sample time; ✓ Set intermittent time; ✓ Start or Stop sensors; ✓ Set correction factors; ✓ Regulate the flow; ✓ Start zero calibration;
0x10	Write multiple registers	Used for setting continuously

Table 8 Function code description

7.2.4 Data Description

For different function codes, the corresponding format of the data items is different. The protocol uses a 'big-endian' representation. The specific format is shown in Fig.4.

Fig.4 format of data item

7.3 Examples

Application Conditions:

1. Assume as a single sensor, with address 254(any sensor);
2. Display with hexadecimal data;

7.3.1 Get Mass Concentration

(1) Get mass concentration of PM1.0

The mass concentration of PM1.0 is 0x0016 (actual value is 22ug/m^3).

host	0xFE 0x04 0x00 0x03 0x00 0x01 0xD5 0xC5
slave	0xFE 0x04 0x02 0x00 0x16 0x2C 0xEA

(2) Get mass concentration of PM2.5

The mass concentration of PM2.5 is 0x002D (actual value is 45ug/m^3).

host	0xFE 0x04 0x00 0x04 0x00 0x01 0x64 0x04

slave	0xFE 0x04 0x02 0x00 0x2D 0x6D 0x39

(3) Get mass concentration of PM10

The mass concentration of PM10 is 0x0043 (actual value is 67ug/m^3).

host	0xFE 0x04 0x00 0x05 0x00 0x01 0x35 0xC4
slave	0xFE 0x04 0x02 0x00 0x43 0xEC 0xD5

(4) Get mass concentration of TSP

The mass concentration of TSP is 0x0053 (actual value is 83ug/m^3).

host	0xFE 0x04 0x00 0x05 0x00 0x01 0x35 0xC4
slave	0xFE 0x04 0x02 0x00 0x53 0xED 0x19

(5) Get mass concentrations of PM1.0, PM2.5, PM10, TSP continuously;

The mass concentration of PM1.0 is 0x0016 (actual value is 22ug/m^3);

The mass concentration of PM2.5 is 0x002D (actual value is 45ug/m^3);

The mass concentration of PM10 is 0x0043 (actual value is 67ug/m^3)

The mass concentration of TSP is 0x0053 (actual value is 83ug/m^3);

host	0xFE 0x04 0x00 0x03 0x00 0x04 0x15 0xC6
slave	0xFE 0x04 0x08 0x00 0x16 0x00 0x2D 0x00 0x43 0x00 0x53 0x7D 0x34

7.3.2 Start/Stop Sensors

(1) Start sensors

Write the holding register IR2 with value 0x0001;

host	0xFE 0x06 0x00 0x01 0x00 0x01 0x0D 0xC5
slave	0xFE 0x06 0x00 0x01 0x00 0x01 0x0D 0xC5

(2) Stop sensors

Write the holding register IR2 with value 0x0000;

host	0xFE 0x06 0x00 0x01 0x00 0x00 0xCC 0x05
slave	0xFE 0x06 0x00 0x01 0x00 0x00 0xCC 0x05

7.3.3 Setting Address

Set address to 03: write the holding register IR3 with value 0x0003;

host	0xFE 0x06 0x00 0x02 0x00 0x03 0x7C 0x04
slave	0xFE 0x06 0x00 0x02 0x00 0x03 0x7C 0x04

7.3.4 Setting Work Mode

(1) Set work mode to continuous mode;

Write holding register IR4 with value 0x0000;

host	0xFE 0x06 0x00 0x03 0x00 0x00 0x6D 0xC5
slave	0xFE 0x06 0x00 0x03 0x00 0x00 0x6D 0xC5

(2) Set work mode to Intermittent mode;

Write holding register IR4 with value 0x0001;

host	0xFE 0x06 0x00 0x03 0x00 0x01 0xAC 0x05
slave	0xFE 0x06 0x00 0x03 0x00 0x01 0xAC 0x05

7.3.5 Setting Sample Time

Set sample time to 1 minute: Write holding register IR5 with value 0x003C;

host	0xFE 0x06 0x00 0x04 0x00 0x3C 0xDC 0x15
slave	0xFE 0x06 0x00 0x04 0x00 0x3C 0xDC 0x15

7.3.6 Setting Intermittent Time

Set intermittent time to 1 minute: write holding register IR6 with value 0x003C;

host	0xFE 0x06 0x00 0x05 0x00 0x3C 0x8D 0xD5
slave	0xFE 0x06 0x00 0x05 0x00 0x3C 0x8D 0xD5

7.3.7 Start Zero Calibration

Start zero calibration: write holding register IR7 with value 0x0001, users need to wait 3s for sensors to operate.

host	0xFE 0x06 0x00 0x06 0x00 0x01 0xBC 0x04
slave	0xFE 0x06 0x00 0x06 0x00 0x01 0xBC 0x04

7.3.8 Setting Correlation Factors

(1) Set correlation factors for PM1.0

Set correlation factors for PM1.0 with value 1.1: write holding register IR8 with value 0x2AF8.

host	0xFE 0x06 0x00 0x07 0x2A 0xF8 0x32 0xE6
slave	0xFE 0x06 0x00 0x07 0x2A 0xF8 0x32 0xE6

(2) Set correlation factors for PM2.5

Set correlation factors for PM2.5 with value 1.1: write holding register IR9 with value 0x2AF8.

host	0xFE 0x06 0x00 0x08 0x2A 0xF8 0x02 0xE5
slave	0xFE 0x06 0x00 0x08 0x2A 0xF8 0x02 0xE5

(3) Set correlation factors for PM10

Set correlation factors for PM10 with value 1.1: write holding register IR10 with value 0x2AF8.

host	0xFE 0x06 0x00 0x09 0x2A 0xF8 0x53 0x25
slave	0xFE 0x06 0x00 0x09 0x2A 0xF8 0x53 0x25

(4) Set correlation factors for TSP

Set correlation factors for TSP with value 1.1: write holding register IR11 with value 0x2AF8.

host	0xFE 0x06 0x00 0x0A 0x2A 0xF8 0xA3 0x25
slave	0xFE 0x06 0x00 0x0A 0x2A 0xF8 0xA3 0x25

(5) Set correlation factors for PM1.0, PM2.5, PM10 and TSP

Set correlation factors for PM1.0, PM2.5, PM10, TSP with value 1.1: write holding registers IR8, IR9, IR10, IR11 with value 0x2AF8.

host	0xFE 0x10 0x00 0x07 0x00 0x04 0x08 0x2A 0xF8 0x2A 0xF8 0x2A 0xF8 0x2A 0xF8 0x36 0x4C
slave	0xFE 0x10 0x00 0x07 0x00 0x04 0x64 0x04

7.3.9 Regulating Flow

(1) Increase the flow

Increase the flow: write holding register IR12 with value 0x0001.

host	0xFE 0x06 0x00 0x0B 0x00 0x01 0x2D 0xC7
slave	0xFE 0x06 0x00 0x0B 0x00 0x01 0x2D 0xC7

(2) Reduce the flow

Reduce the flow: write holding register IR12 with value 0x0000.

host	0xFE 0x06 0x00 0x0B 0x00 0x00 0xEC 0x07
slave	0xFE 0x06 0x00 0x0B 0x00 0x00 0xEC 0x07

7.3.10 Get Address

Read the value of holding register IR3, 0x0003 represents the address of sensors is 3.

host	0xFE 0x03 0x00 0x02 0x00 0x01 0x31 0xC5
slave	0xFE 0x03 0x02 0x00 0x03 0xEC 0x51

7.3.11 Get Working Mode

Read the value of holding register IR4, 0x0001 represents the sensor is working in continuous mode.

host	0xFE 0x03 0x00 0x03 0x00 0x01 0x60 0x05
slave	0xFE 0x03 0x02 0x00 0x01 0x6D 0x90

7.3.12 Get Sample Time

Read the value of holding register IR5,0x003C represents that the sample time is 1 minute.

host	0xFE 0x03 0x00 0x04 0x00 0x01 0xD1 0xC4
slave	0xFE 0x03 0x02 0x00 0x3C 0xAC 0x41

7.3.13 Get Intermittent Time

Read the value of holding register IR6,0x003C represents that the intermittent time is 1 minute.

host	0xFE 0x03 0x00 0x05 0x00 0x01 0x80 0x04
slave	0xFE 0x03 0x02 0x00 0x3C 0xAC 0x41

7.3.14 Get Correlation Factors

(1) Get the correlation factors for PM1.0

Read the value of holding register IR8, 0x2AF8 represents that the correlation factor for PM1.0 is 1.1.

host	0xFE 0x03 0x00 0x07 0x00 0x01 0x21 0xC4
slave	0xFE 0x03 0x02 0x2A 0xF8 0xB2 0xB2

(2) Get the correlation factors for PM2.5

Read the value of holding register IR9, 0x2AF8 represents that the correlation factor for PM2.5 is 1.1.

host	0xFE 0x03 0x00 0x08 0x00 0x01 0x11 0xC7
slave	0xFE 0x03 0x02 0x2A 0xF8 0xB2 0xB2

(3) Get the correlation factor for PM10

Read the value of holding register IR10, 0x2AF8 represents that the correlation factor for PM10 is 1.1.

host	0xFE 0x03 0x00 0x09 0x00 0x01 0x40 0x07
slave	0xFE 0x03 0x02 0x2A 0xF8 0xB2 0xB2

(4) Get the correlation factors for TSP

Read the value of holding register IR11, 0x2AF8 represents that the correlation factor for TSP is 1.1.

host	0xFE 0x03 0x00 0x0A 0x00 0x01 0xB0 0x07
slave	0xFE 0x03 0x02 0x2A 0xF8 0xB2 0xB2

(5) Get the correlation factors for PM1.0, PM2.5, PM10 and TSP.

Read values of holding registers IR8, IR9, IR10 and IR11, 0x2AF8 represents that the correlation factors for PM1.0, PM2.5 PM10 and TSP are 1.1.

host	0xFE 0x03 0x00 0x07 0x00 0x04 0xE1 0xC7
slave	0xFE 0x03 0x08 0x2A 0xF8 0x2A 0xF8 0x2A 0xF8 0x2A 0xF8 0x6C 0x7D

7.3.15 Get Settings Continuously

Read values of 4 holding registers from IR3, the address is 3, the work mode is Intermittent mode, the sample time is 1 minute, the intermittent time is 1 minute.

host	0xFE 0x03 0x00 0x02 0x00 0x04 0xF1 0xC6
slave	0xFE 0x03 0x08 0x00 0x03 0x00 0x01 0x00 0x3C 0x00 0x3C 0x68 0x1D

7.3.16 Setting Continuously

Set address to 3, work mode to intermittent mode, sample time to 1 minute.

host	0xFE 0x10 0x00 0x02 0x00 0x04 0x08 0x00 0x03 0x00 0x01 0x00 0x3C 0x00 0x3C 0x3E 0x20
slave	0xFE 0x10 0x00 0x02 0x00 0x04 0x74 0x05

8. Dimension Drawing

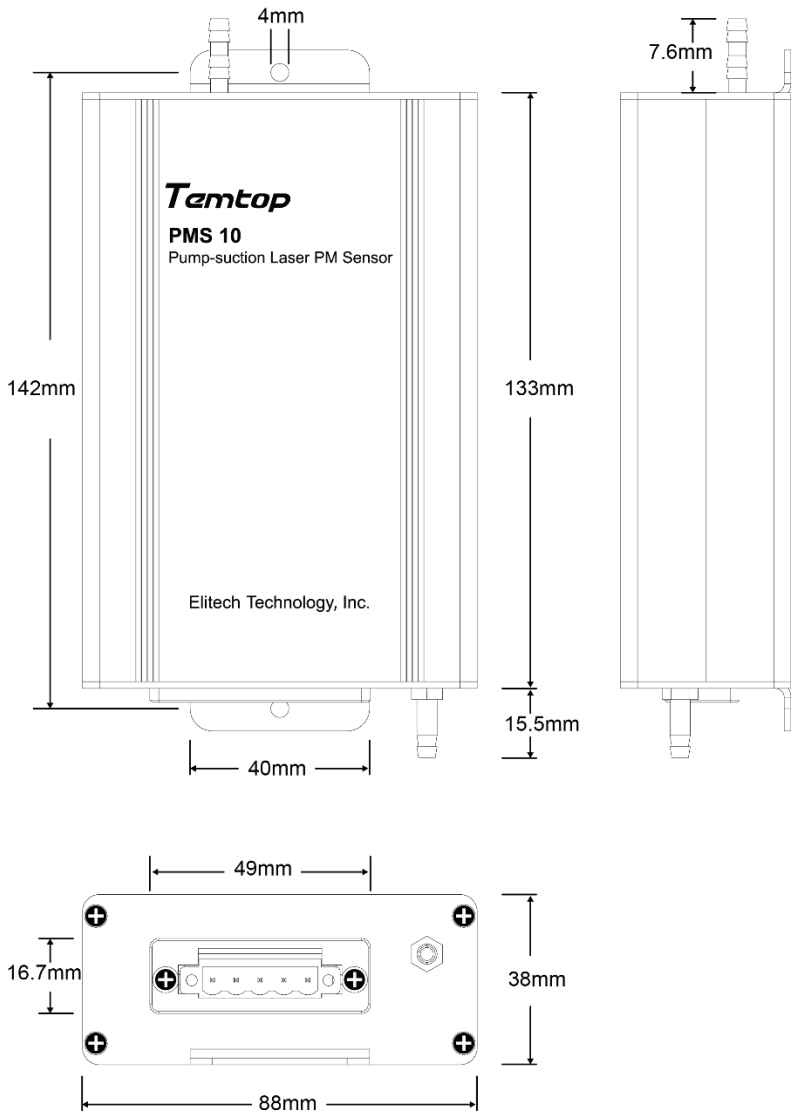

Fig.5 Dimension Drawing of PMS 10

9. Precautions

- Make sure that the ground wire in the power cord is well grounded when installing;
- When installing, the outer shell is recommended to be grounded or insulated, and the outer shell is not allowed to be charged;
- It is forbidden to knock, shake, or drop the product to avoid damage to the circuit board and optical structure;
- When the sensor is used for outdoor fixed equipment, the protection of sandstorms, rain, snow and other weather and fluffy catkins should be completed by the outdoor equipment provider;
- Without permission, please do not disassemble the sensor, and it is forbidden to repair it privately, so as to avoid accidents or aggravate the damage of the sensor. The sensor should be repaired by the

manufacturer's special personnel;

- The sensor will heat up when it is working, so it is necessary to maintain good ventilation in the working environment to avoid damage to the machine due to excessive temperature;
- When this product is installed in the system, ensure that the inlet and outlet are unobstructed, and there should be no large airflow directly facing the inlet and outlet;
- The size of the ventilation on the inner wall of the user machine for the air inlet should not be smaller than the size of the sensor's air inlet;
- The sensor is not in direct contact with the monitoring environment (for example, installed in the equipment enclosures). In order to measure the results accurately, please connect the sensor's air inlet to the external probe of the enclosure, and the length of the connecting hose between them should be controlled within 30cm;
- The external probe of the enclosure shall have the ability of wind proof, coarse filtration and water proof;
- l When the humidity increases, the data of the sensor and the Beta attenuation mass monitor may have a positive deviation, so the users need to provide a dynamic heating system to ensure the data correlation with the Beta attenuation mass monitor;
- The recommended installation is shown in Fig.6 below.

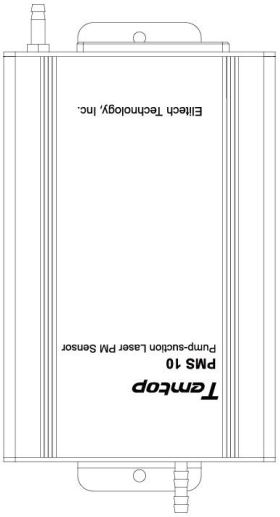

Fig.6 recommended installation

10. Maintenance

- This product is a particle sensor based on the principle of laser scattering, which is a precision optoelectronic instrument. A good use environment is conducive to the maintenance of the instrument and its service life. Keep it dry and clean, excessive humidity and dust will corrode the circuit board and optical structure and shorten service life;

- If the product is used in a highly dusty environment, it is recommended that you use the intermittent mode and increase the sample time and reduce the intermittent time;
- If the sensor does not work normally, please send it back to the manufacturer for repair, and professionals will provide you with help services, and it is forbidden to disassemble the machine privately;
- In order to ensure the safe and reliable use of the product, it is recommended that the user send back the sensor to the manufacture for calibration once a year. We only charge a small maintenance fee.

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