Matsushima
Matsushima Measure Tech

TPFM-004E
Rev8:May.5.2018

INSTRUCTION MANUAL FOR DUST MONITOR

TYPE
ＰＦＭ－Ｍ０１Ｅ
(COMPACT TYPE)

Contents

※The operator should read this Instruction Manual carefully and handle the device correctly.

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Safety Precautions

- Be sure to thoroughly read the instruction manual before using the products.
- Keep the instruction manual in a safe, convenient location for future reference.
- All or part of the contents described in this manual may be changed without any notice.
- Due to our constant striving for further improvement of products, parts or products that differ from those described in this manual may be substituted.

⚠ WARNING (Failure to observe this WARNING may cause a fatal or serious injury.)

- Be sure to confirm that any peripheral equipment does not move before installation work. In addition, observe safety requirements for installation work where high-place work is expected.
- Be sure to turn off the power source before wiring, mounting and transportation work. (Failure to observe this WARNING may result in an electric shock/ injury or equipment damage due to short-circuit.)
- Carry out wiring work correctly with reference to a proper drawing.
- Never disassemble the equipment. (Failure to observe this WARNING may result in an electric shock.)
- Do not open the cover under an explosive environmental condition when power is entered. (Failure to observe this WARNING may result in an injury or equipment damage.)
- Do not place or store the equipment in any hostile environmental place where it will be subjected to direct sunlight, rain, water droplet, hazardous gas/water, etc..

⚠ CAUTION (Failure to observe this CAUTION may cause a moderate injury or equipment damage.)

- Do not use the equipment for any purpose other than the original purpose of use.
- Be sure to confirm the specification of equipment and use the equipment within the range of specification. (Mounting conditions such as temperature, power source, frequency, etc.)
- Make sure a correct wiring before applying power source.
- Do not have a shock or strong impact to the equipment. (Failure to observe this CAUTION may result in equipment damage.)
- Be sure to connect necessary terminals (grounding, etc.).
- Remove all wiring to the equipment before doing electrical welding work near the equipment.
- Do not forcedly bend or pull the lead wire also do not use unnecessarily long wire.
- Tighten the cover, lead outlet, etc. properly so that dust, rainwater, etc. do not enter inside the equipment.
- Do not use the equipment under a corrosive condition (NH_3, SO_2, CI_2, etc.).
- Be sure to tighten the cable grand so that outer air does not enter inside the equipment.
- When applying piping connection such as conduit, etc. instead of cable grand, apply putty or equivalents on the cable entry so that outer air does not enter inside the equipment.
- Do not directly touch the probe with hands regardless of power ON or OFF. If you unavoidably have to touch the probe with hands when installation or maintenance process, be sure to turn OFF the power and use non-conductive gloves such as rubber gloves during the process. *Touching the probe with hand directly may cause a failure due to static electricity charge in a human body.
- MAINTENANCE: When you clean the probe, be sure to turn OFF the power, put on non-conductive gloves such as rubber gloves to clean the probe with moist cloth.*Touching the probe with hand directly may cause a failure due to static electricity charge in a human body.Cleaning the probe with dry cloth may also cause a failure due to friction charge generated between the cloth and probe.

⚠ IMPORTANT (indicates notes or information to help customers.)

Limitations of Warranty:

- Warranty period shall be one year from the date of delivery (ex-factory).
- Any damage of any other products that have occurred for use of the equipment is not covered by this warranty. Also any loss induced by failure or malfunction of the equipment is not covered by this warranty.
- Failure or malfunction caused by following are not covered by this warranty:
  a. Modification or repair by a party other than MATSUSHIMA's authorized personnel, or replacement of parts not recommended by MATSUSHIMA.
  b. Inadequate storage, installation, use, inspection or maintenance that does not comply with specifications.
  c. Cause for any peripheral equipment or device.
  d. Accident beyond control and force majeure (fire, earthquake, flood, riots, etc.).

Lack of instructions to MATSUSHIMA for information or safety requirements that can be predicted only by customers' side.
This warranty conditions do not limit customers' legal right.
Price for the equipment does not include any charge for services such as commissioning, supervising, etc..

1. OUTLINE

An electric charge is generated when solid particles in the gas passes through the probe of the dust monitor on the duct or pipe.
This electric charge is known as frictional static electricity or contact electrification.
The size of the electric charge can be calculated by the following equation and be regarded as the value of the electrical current and is in proportion to the amount of dust.

$$I = \frac{K \cdot M \cdot V^{b}}{d}$$

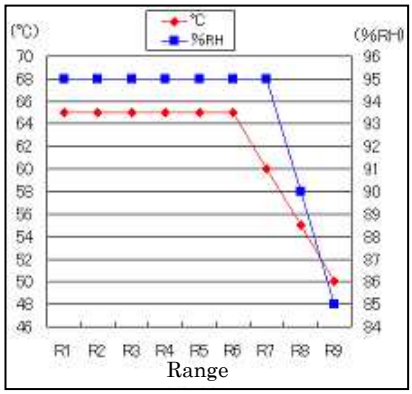
I = Current signal
V = Flow velocity
K = Constant depending on a particle
b = Coefficient
M = Particle mass
d = Diameter of a particle

After the signal for the current is filtered and amplified, an instrumentation signal and a contact signal between 4mA to 20mA in proportion to the amount of dust are sent.

2. SPECIFICATION

2-1.	Power supply	
	2-1-1. Voltage	AC 80V～240V 50/60Hz
	2-1-2. Power consumption	4VA
2-2.	Measurement material	Solid particle in gas
2-3.	Particle type of the material	All solid particles
2-4.	Dust size	≧ 0.3 μm
2-5.	Dust concentration	0.1mg/m^3 ～ 1000mg/m^3
2-6.	Measurement principle	Tribo-electric charge detection method
2-7.	Measurement conditions (process conditions)	
	2-7-1. Temperature	≦ 250℃
	2-7-2. Pressure	≦ 200kPa
	2-7-3. Velocity	≧ 4m/s
	2-7-4. Humidity	≦ 40vol%
2-8.	Ambient conditions	
	2-8-1. Temperature(※1)	-20 ～ 65℃ (Non condensing)
	2-8-2. Humidity	≦ 95%RH (Condition: State of case sealing up)
2-9.	Output signal	
	2-10-1. Analog signal	DC 4 ～ 20mA×1 (max. 23.3mA) Load: Max500Ω (Isolated)
	2-10-2. Relay output signal	Alarm contact: 1b×1 (AC250V,2A／DC30V,2A) Upper limit contact: 1a× 1 (AC250V,2A／DC30V,2A)
2-10.	Mounting	R1 Screw(1" Socket) A flange is also possible as an option.
2-11.	Measuring range	9 ranges switchable
2-12.	Protection	IP65(With the cover and cable grand tightened)

※1:The maximum temperature is different according to the range.



⚠ **Attention : When only one side of the cable gland is used, replace the unused side of the cable gland and plug in order to maintain the protective structure.**

3. INSTALLATION

To install the Dust Monitor, use the one-inch socket that is provided.
Weld the socket onto the pipe. Install the Dust Monitor so it is horizontal or vertical.
Weld around the entire circumference of the pipe to prevent gas from leaking.

(Attention in installation)
The Dust Monitor may malfunction under the following environmental conditions.
Do not install the Dust Monitor under such conditions.

4-1. In a location too close to the pipe flue or near the inflections.
4-2. In a location within a distance 1.5 times longer than the diameter or the length of the duct measured vertically from the inflections.
4-3. Near the fan.
4-4. A pipe, short pipe, or duct that is nonconductive.
4-5. Any environment or conditions other than those in the specifications.
4-6. In a place where dust may accumulate between the short pipe and the probe if the short pipe is used.
4-7. In a location where the gap between the end of probe and the pipe is 20 mm or less.

⚠ **Importance: The cap attached to lead outlet is for the transportation protection.**
(The drip-proofness is not effective in the cap.)

⚠ **Attention : When only one side of the cable gland is used , replace the unused side of the cable gland and plug in order to maintain the protective structure.**
Securely close the lead outlet to prevent outside air from entering in the main unit.
Do not remove the accessory silica gel. (for dehumidification)
Separately wire a power supply line and a signal line.
Where using conduit piping and so on instead of cable grand, be sure to apply putty or like at cable entry so that ambient air does not come into the unit.

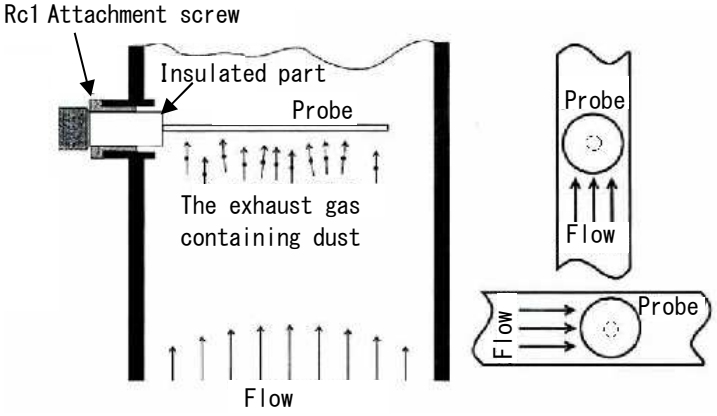


Fig.1. Installation

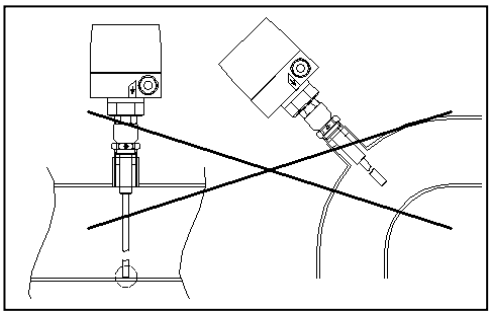
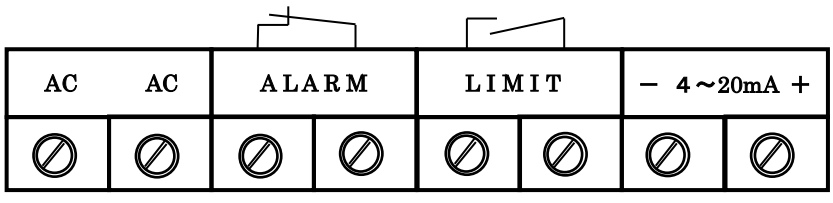


Fig.2. Installation not good

⚠ **Importance: For installation of main unit, place Rc1 Attachment screw, then insert Probe and tighten M5 bolt and nut on the side of Rc1 Attachment screw.**

4. WIRING



AC80～240V
50/60Hz

b Contact
AC250V 2A
DC 30V 2A

a Contact
AC250V 2A
DC 30V 2A

DC4～20mA
Max500Ω

Fig.3. Connection

Line-connecting terminal :
Max. 1.5mm²

5. OPERATION METHOD

Please refer to table 1 and figure 4 for indicator and the operation switch relation on the panel. Maintenance mode can be used to confirm "current signal adjustment", "simulated alarm output", "limit setting value", and "integral setting value" by setting the Range Switch to "0". Details have been described to *10. MAINTENANCE MODE*.

If you do not use the Maintenance mode, set the optimum range other than "0".

Table.1 Display color

No.	Name	LED lighting condition	Display color
1	POWER	"Power supply turn on"	Green
2	ALARM	"Device breakdown"	Red
3	LIMIT	"More than set value." (Setting range : 0-100%)	Yellow
4	LIMIT SET	"During Limit setting" (In the maintenance mode.)	Green
5	I.TIME SET	"During Integration setting" (In the maintenance mode.)	Green
6	VALUE DISPLAY	" 「%」 display. (Carving of 10%.)" 《Value of rough standard. Density》	Yellow (10-LED)

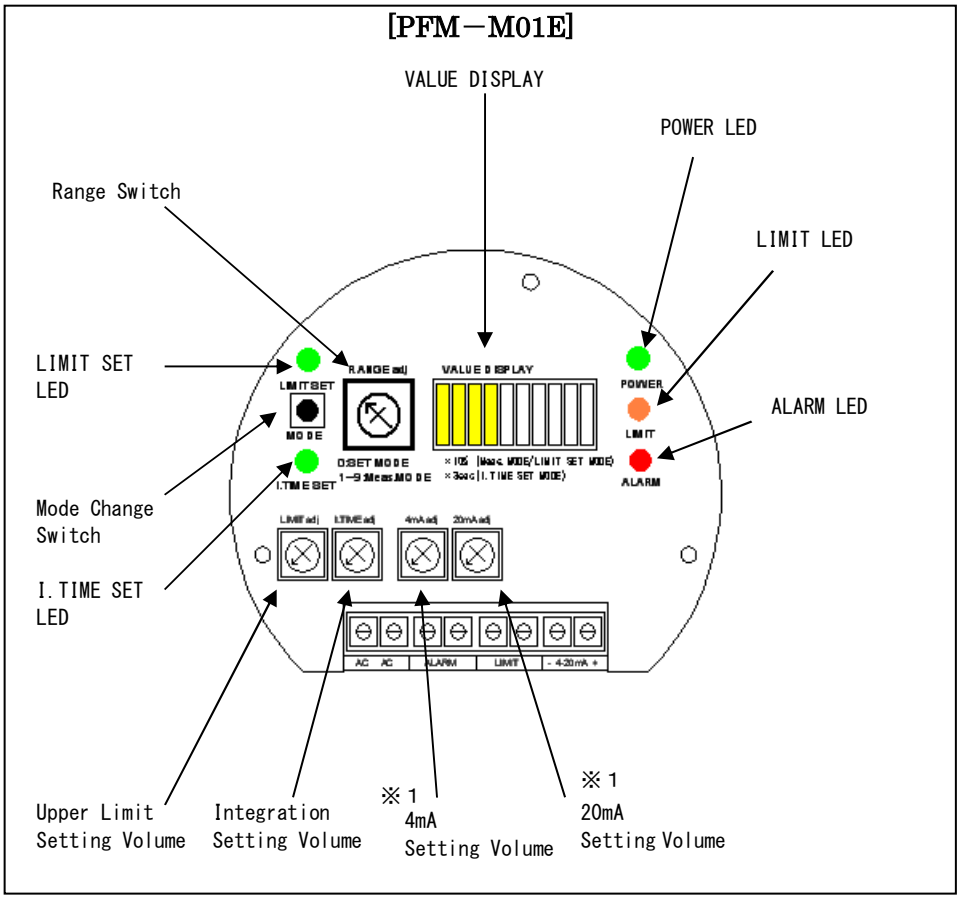


Fig.4. Arrangement plan

⚠ ※1 Do not touch the adjustment of 4-20mA since they are optimized at our factory before shipment.
Please refer to "10. MAINTENANCE MODE" when the readjustment is necessary.

6. STARTUP

6-1. Warming-up

The Dust Monitor needs to warm up for approximately one hour after the power supply is turned on.

6-2. Measuring Range

After warming up, set the optimum measuring range. First, set the Range Switch to "1～4" if the flow speed is constant, the operation of the filter is normal, and the dust is the environmental conditions are normal.
When the watch of a smaller change is necessary, a detailed change can be observed by setting the range between "5～9".
(However, it becomes easy for the overrange to do when the density is high.)

	4mA(0%)		20mA(100%)		4mA(0%)		20mA(100%)
Measuring range**1**	: 0.1	～	1000mg/m^3	Measuring range**6**	: 0.1	～	20mg/m^3
Measuring range**2**	: 0.1	～	500mg/m^3	Measuring range**7**	: 0.1	～	10mg/m^3
Measuring range**3**	: 0.1	～	200mg/m^3	Measuring range**8**	: 0.1	～	5mg/m^3
Measuring range**4**	: 0.1	～	100mg/m^3	Measuring range**9**	: 0.1	～	2mg/m^3
Measuring range**5**	: 0.1	～	50mg/m^3				

Use the Range Switch described in section *5. OPERATION METHOD* to set the measuring range.
The numbers on the switch correspond to the ranges.

⚠ **Attention: The rotate switch has numbers from 0 to 9 on the switch, but only 1 to 9 are used. Number 0 is the Maintenance mode .**
(Refer to *10. MAINTENANCE MODE*.)

The Dust Monitor uses "talc" as standard powder and is designed so that 20mA will be output at 1000 mg/m^3, which is the maximum range in a 10 m/s flow speed environment. Each range is designed so that 20mA will be output at the maximum value of each range. The linearity of the output at 1000 mg/m^3 will not change.

【Reference: Talc】
Talc is finely pulverized ore and gray-white, smooth inorganic powder.
Talc is chemically called hydro-silica magnesium [Mg3Si4010 (OH)] of which main components are; approx. 60% of SiO2, approx. 30% of MgO, and 4.88 % of crystal water.
Its physical characteristics are; true specific gravity of 2.7 to 2.8, the hardest among the inorganic minerals (Mohs' hardness 1), excellent in heat resistance, and chemically stable.

6-3. Precautions: What Is Density of Tribo-electric System Dust Monitor

The output value of the Dust Monitor of the Tribo-electric System varies according to various environmental factors such as "kind of particle", "diameter of particle," "gravity," or "flow speed" due to its measurement principle, which can be seen in the formula in section 1.
However, the linearity will not change except under certain environmental conditions.
For the density of the Dust Monitor of the Tribo-electric System, consideration must be given to the influence by changes of physical characters as mentioned above.
Therefore, it does not always correspond to the density specified in section 6-2.
The density described in section 6-2 is assumed to be at the stages of design and development of the Dust Monitor, and announced as the guideline for the user to determine the range.
When the user determines the range, check the pulse signal percentages output between 0% and 100%, and then set the appropriate values.
In this way, the tendency of the discharged dust density in the facility can be controlled.
When the density control is needed, the user must determine the density corresponding to 0% to 100% signals.
After determining the range (0% to 100%) of the density control, check the actual density when a pulse signal is input to the Dust Monitor.
After that, adjust the range or integral function to obtain the current signal optimal to the actual density so that the user can read the signal as density from the current signal of the Dust Monitor.
(This value is not an absolute value but a relatively converted value.)

7. INTEGRAL SETTING

The Dust Monitor can be set to output an averaged measuring signal by adjusting the Integration Volume (Data averaging).
Follow the procedures below to carry out integral setting.
(The Integration Volume is set to "0 s" at our factory before shipment, unless otherwise requested.)

1) Set the Range Switch to "0".
2) Press the Mode Change Switch until the LED lamp "I.TIME SET" lights up.
   (The integral setting can be adjusted while "I.TIME SET" is lit.)
3) Turn the Integration Volume clockwise (Arbitrary setting).
   (For your reference: Each LED lamp on the display shows three seconds. (30 seconds max.))
4) To complete the integral setting, change the Range Switch to a value other than "0".
   If the Integration Volume is turned fully counterclockwise, the integral time will be set to 0 seconds.

If a more detailed setting is needed, connect a tester to the output terminal of 4mA to 20mA and adjust the Integration Volume by referring to the current value.
0 s (4mA) to 30 s (20mA)
Refer to *10. MAINTENANCE MODE*.

The rapid rise of an output signal shows an error in the filter system.
Analyze the filter system under the Normal mode.
Turn off the Integral mode.
In Normal mode, rapid variation of the dust density can also be monitored.
Figure 5 shows an example of monitoring a 13-line bug filter using the Dust Monitor.
Regarding dust emissions, the signal peaks indicate a low amount of dust being processed in lines 1 to 6 as well as in line 12 and 13, and a high amount of dust being processed in line 7 to 11.
According to this, the judgment whether or not the filter needs to be replaced is possible.

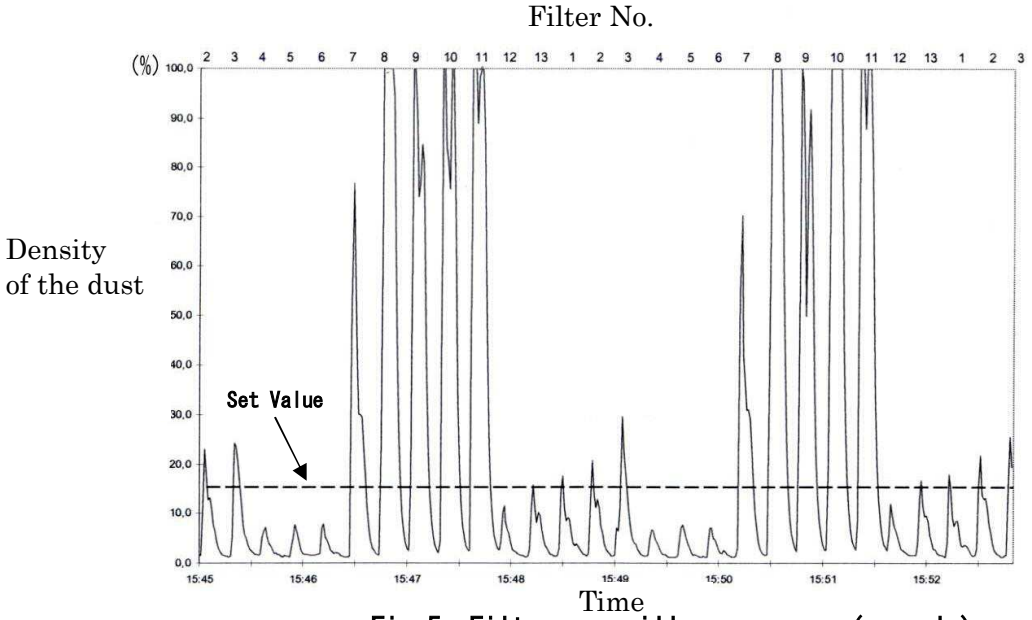


Fig.5. Filter surveillance screen (example)

8. LIMIT SETTING

In limit setting, the upper limit point (contact output point) can be set within the range of 4mA (0%) to 20mA (100%).
Follow the procedures below to carry out limit setting.
(The Limit Setting Volume is set to 12mA (50%) at our factory before shipment, unless otherwise requested.)

1) Set the Range Switch to "0".
2) Press the Mode Change Switch until the LED lamp "LIMIT SET" lights up.
   (The limit setting can be adjusted while "LIMIT SET" is lit.)
3) Turn the Limit Setting Volume clockwise (Arbitrary setting).
   (For your reference: Each LED lamp on the display shows 10%. (100% max.))
4) To complete the limit setting, change the Limit Setting Volume to a value other than "0".
   If the Limit Setting Volume is turned fully counterclockwise, an upper limit alarm will be output at 4mA (0%) or more.

However, there is a possibility that a lot of chattering is generated when the change in the signal is extreme.
In such a case, we recommend the integration mode or use the delay function by customer .

If a more detailed setting is needed, connect a tester to the output terminal of 4mA to 20mA, and adjust the Limit Setting Volume by referring to the current value.
0% (4mA) to 100% (20mA)
Refer to *10. MAINTENANCE MODE*.

【Operation chart : LIMIT 1/2 and ALARM detection】

(LIMIT output) TYPE:PFM-M01E

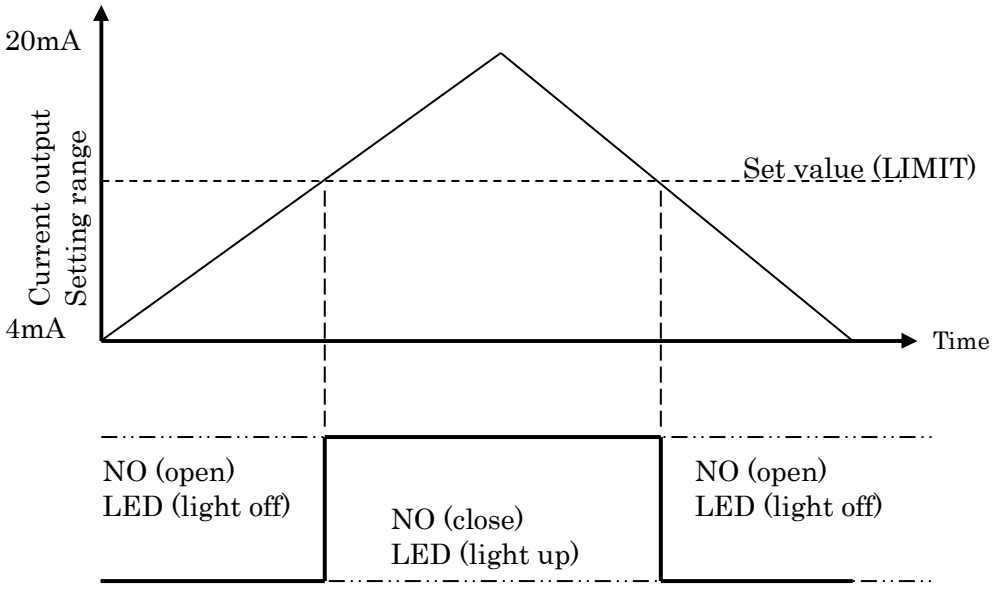


Fig.6. Limit output operation chart

(ALARM)

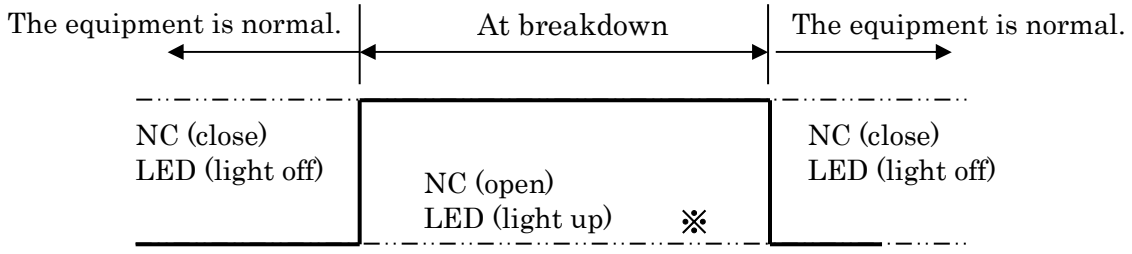


Fig.6. Alarm operation chart

Attention: Alarm contact is open and LED is light off if there is no power supply.

Importance: When switching from the maintenance mode to the measurement mode, please reset the power supply.

９. MAINTENANCE

Use a rag to periodically clean the probe.
Maintenance scheduling depends on what is being measured and under what conditions.
As outlined in the guidelines, we recommend cleaning the probe at least once every three months.
Turn off the power before cleaning.
Be careful not to burn yourself when removing the probe.
As the temperature in the pipe increases, the temperature of the dust monitor also increases.

⚠ **Caution: The earth line should not be removed even at the maintenance in case it may cause a fault.**

１０. MAINTENANCE MODE

Maintenance mode can be used to confirm “current signal adjustment”, “simulated alarm output”, “limit setting value”, and “integral setting value” by setting the Range Switch to “0”.
To use maintenance mode, connect a device with 4 to 20 DC mA measurements such as a tester to the current output terminal.

⚠ **Importance: During maintenance mode, the LED lamp “Alarm” (red) will light up and output an alarm contact.**
This mode can also be used for a loop check of the alarm when performing a trial operation.
If you change to maintenance mode during normal operation, an alarm signal will be output. Be careful when using maintenance mode.

⚠ **Importance: When switching from the maintenance mode to the measurement mode, please reset the power supply.**

10-1. Adjustment for current signal

1) Set the Range Switch to “0” while pressing the Mode Change Switch.
2) Keep pressing the Mode Change Switch (for more than five seconds) and both the LED “LIMIT SET” and “I.TIME SET” will light up.
   The current signal can be adjusted in this condition.
3) Release your finger from the Mode Change Switch, and 4mA will be forced to output.
   If the output value differs considerably from 4mA, adjust it to 4mA with the 4mA Volume.
4) Press the Mode Change Switch again, and 20mA will be forced to output.
   (At the same time, all LEDs will light up.)
   If the output value differs considerably from 20mA, adjust it to 20mA with the 20mA Volume.
5) After that, each time you press the Mode Change Switch, 4mA or 20mA will alternately be forced to output.
   To return to the normal setting mode, change the Range Switch to a value other than “0”.

10-2. Confirmation for Limit and Integration

1) Set the Range Switch to “0”.
2) Press the Mode Change Switch once.
   The LED lamp “LIMIT SET” (Limit setting LED) will light up. Limit setting can be adjusted in this condition.
   (For your reference: Each LED lamp on the display shows 10%.)
   If a more detailed setting is needed, adjust the “LIMIT adj.” Volume by referring to the current output signal using a tester.
3) After the limit adjustment is completed, press the Mode Change Switch again.
4) The LED lamp “LIMIT SET” (Limit setting LED) will go out and the LED lamp “I.TIME SET” (Integral setting LED) will light up. The integral setting can be adjusted in this condition.
   (For your reference: Each LED lamp on the display shows 3 seconds.)
   If a more detailed setting is needed, adjust the “I TIME adj.” Volume by referring to the current output signal using a tester.
   (For a current output value corresponding to the time (second) to be set, use the formula below.)
5) After that, each time you press the Mode Change Switch, the limit setting or integral setting can be alternately adjusted.
   To return to the normal setting mode, change the Range Switch to a value other than “0”.

ｅｑ.：Ｔｉｍｅ (s) ×０. ５３３＋４ ＝ Ａ (mA)

Ｔｉｍｅ：Number of seconds necessary to integrate.
Ａ　　：Current value necessary to integrate.

Example. Current value necessary for integrating 3.5 seconds.
３．５×０．５３３＋４＝５．８７ｍＡ

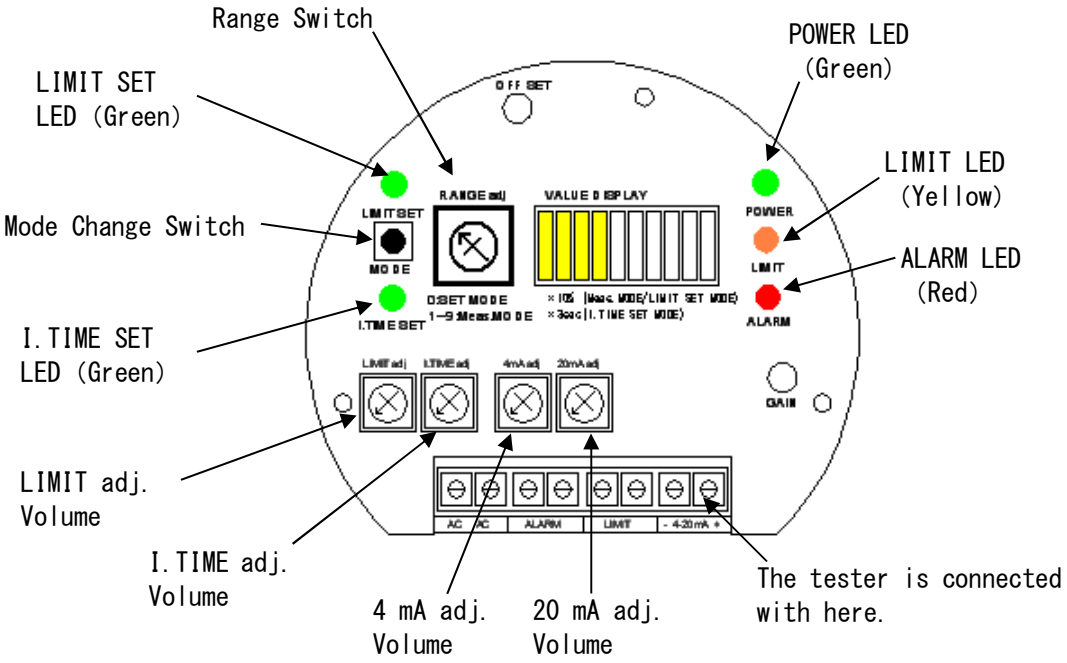


Fig. 7. Operation panel

１１．TROUBLESHOOTING

If a malfunction occurs, refer to the following table to determine and eliminate the cause.
If the problems persist despite taking the recommended corrective actions contact us.

Malfunction	Possible Cause	Corrective Action
The power-supply LED, the power bar indicator or the converter LED do not light up.	・ Power is not supplied from the power source. ・ A power supply with specifications that differ from those of the selected source is connected.	・ Check the connection to the terminal block. (The power cable must be connected to the AC terminal.) ・ Check to see if the specifications of the power supply meet with those indicated on the product's nameplate.
The output value fluctuates.	・ The Dust Monitor was not warmed up before being used. ・ The Dust Monitor was not grounded. ・ The cable between the sensor and the converter is disconnected or incorrectly connected. ・ Some materials are stuck onto the electrode surface. ・ Condensation on the electrode. ・ A small quantity of materials is still flowing.	・ Warm up the Dust Monitor for one hour before use. ・ Check and correct the cable connection. ・ Remove the sensor and check if any material is stuck onto the electrode surface. If so, turn off the power supply, and then clean the electrode with moist cloth. ・ Remove the sensor and check if any condensation is on the electrode. If so, turn off the power supply, and then clean the electrode with moist cloth.

Malfunction	Possible Cause	Corrective Action
The output value is too high.	・ Short-circuited between the electrode and the duct or pipe because of material stuck onto the electrode surface. ・ No electrical charge because of condensation on the electrode. ・ The electrode touches the inner surface of the pipe. ・ Component failure. ・ A very large quantity of materials is still flowing. Notes ・ **Loosen the M5 bolt and nut to remove the probe from the Dust Monitor. Be sure to securely tighten the screw after cleaning the probe.** ・ **Contact us for extension of the insulation. (Additional fee to be charged)** ・ **If the probe is too short, the electric charge cannot be detected correctly.**	・ Remove the sensor and check if any material is stuck onto the electrode surface. If so, turn off the power supply, and then clean the electrode with moist cloth. ***Notes*** ・ Check to see if at least 10 mm of the insulation is out of the socket. ・ Pull out more of the insulation if necessary. ***Notes*** ・ Remove the sensor and check if any condensation is on the electrode. If so, turn off the power supply, and then clean the electrode with moist cloth. ・ Measure the length of the electrode and the inner diameter of the pipe and check to see if the electrode touches the inner surface. If so, change the length of the probe. ***Notes***
The output value does not change.	・ Power is not supplied from the power source. ・ The cable between the sensor and the converter is disconnected or incorrectly connected. ・ Some materials are stuck onto the electrode surface. ・ The electrode touches the inner surface of the pipe. ・ Device failure.	・ Check the connections to the terminal block. ・ Check and correct the cable connection. ・ Remove the sensor and check if any material is stuck onto the electrode surface. If so, turn off the power supply, and then clean the electrode with moist cloth. ***Notes*** ・ Measure the length of the electrode and the inner diameter of the pipe and check to see if the electrode touches the inner surface. If so, change the length of the probe. ***Notes***
The Alarm LED lights up.	・ 1) Be in the Maintenance mode. ・ 2) Device failure.	・ 1) If so, change it in the normal setting mode. ・ 2) Contact us.

１２. DIMENSION DRAWING (OUTLINE)

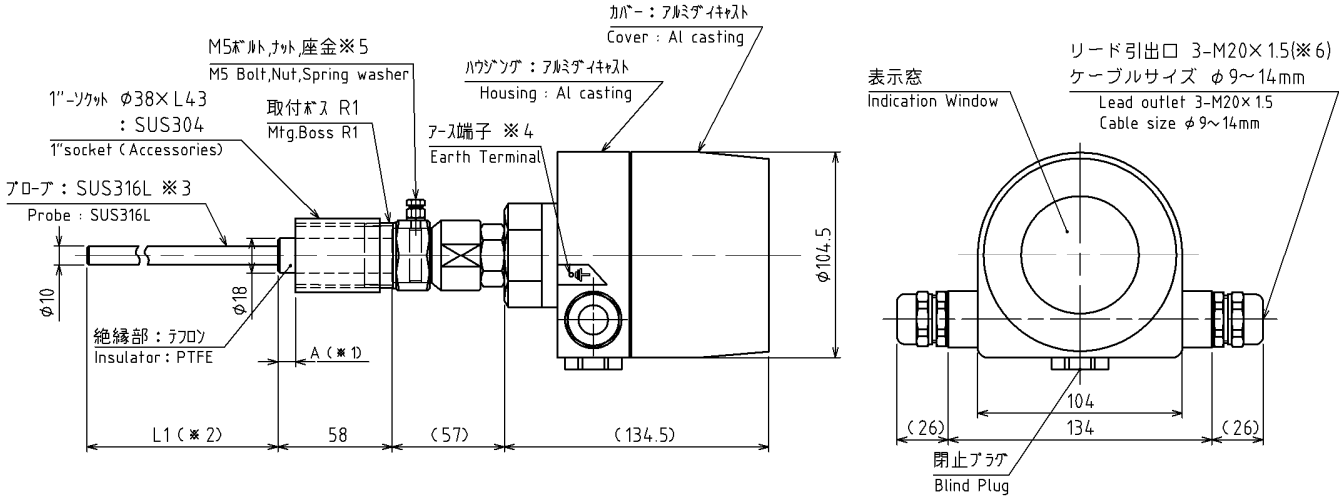
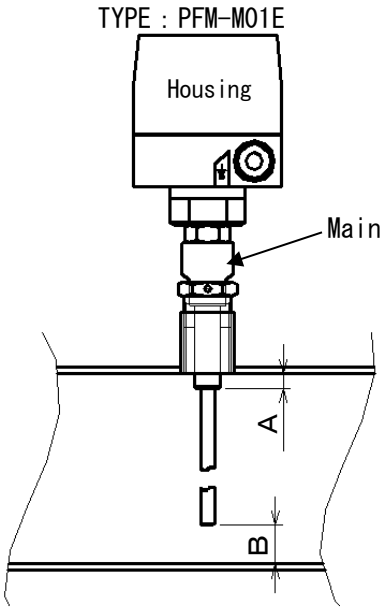


Fig.8. Dimension drawing of Dust Monitor



※Please give A 10mm or more.
※Please give B 20mm or more.
Please have not accumulated dust in B.

Fig.9. Installation reference figure