Matsushima
Matsushima Measure Tech

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INSTRUCTION MANUAL
FOR
Dust Monitor with Density compensation

TYPE

PFM-KCU04 (Transducer)
PFM-M01PEX (Sensor)
Z961／Z964 (Zener barrier)

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※ You, an excellent operator, please read the manual for Model thoroughly and operate Model effectively for your factory and for yourself and thank you!!

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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, Cl_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.

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

Electric charge will generate when a number of corpuscle contained in gas pass through and/or get in touch with probe of dust monitor equipped with duct, plumbing pipe, etc.
The dust monitor amplifies this "Displacement of the charge" with the sensor, and sends the amplified slight signal to the output unit.
This electric signal "Displacement of the charge" is both filtered and amplified and then output instrumentation signal of 4～20mA in proportion to dust amount and contact signal as well.

⚠ Important : View for density of dust monitor per Friction Electrification Mechanism

Output value of Friction Electric Charge Mechanic dust monitor will be variable due to various environmental factors such as 「kind of particle」「particle diameter」「specific gravity 「current speed」through measure principle.

Under a regular environment, however, linear characteristic will not of course vary under that environment.
As to considering density regarding to Dust Monitor of Friction Electric Charge Mechanism, it requires you to consider influence due to variation of particle characteristics as afore mentioned and it does not always meet density specified.
Density indicated on specification is for design development of machinery and is publicized for you customers to use as a guideline in deciding the range.
When you customers decide the range, you please find the range and set it in which alarm level is easy to set strictly from 0—100% signal and becomes pulse signal.
By doing so, you can realize your management of exhaust drift.
If there is a need hereby to execute density management, you are recommended to decide density equivalent to 0 - 100%.
On deciding above, you please investigate density of pulse and you can read signal as density from current signal of machinery by jointly utilizing integral function, etc to get the range acquiring signal nearest to actual density of 0—100%.
(The value you can get is compensated and is a relative conversion value but not absolute.)

The explosion-proof construction of this product is Ex ib Ⅱ B T4 (TIIS) .
It is composed of Sensor, Zener barriers, and Transducer.
Please set up Sensor in hazardous area, and set up Zener barriers and Transducer in Safety area.
The range of Hazardous area is Zone1 or Zone2.
This Sensor cannot be installed on the place of Zone0.
Please wire for Sensor and Zener barrier with a exclusive line shilded cable.
Please wire between Zener barriers and the Output unit by similar exclusive line shilded cable.

2. Specification

1. Type		Sensor	PFM-M01PEX
		Output unit	PFM-KCU04
		Zener barrier	Z961
		Zener barrier	Z964
2. Structural		Sensor＋Zener barrier＋Output unit(Separate)	
3. Necessary conditions for measuring			
	1)Gas emissions terms	Temperature	≦60℃
		Pressure	≦200kPa
		Humidity	≦40vol%
		Flow rate	≧4m／s
	2)Dust terms	Size	≧0.3μm
		Concentration	0.1～1000mg／m^3
4. Equipment specification			
	Sensor		
	1)Approval		Ex ib ⅡB T4 (TIIS)
	2)Protection		Dust-proof and Splash-proof construction
	3)Rating		Uo＝17.4V, Io＝190.3mA, Po＝430mW
	4)Temperature (※1)		-20℃～+60℃ ※Non condensing
	5)Humidity (※2)		≦95%RH ※Condition :State of case sealing up
	6)Mounting		R1 Screw (1" Socket belonging)
	7)Wiring distance (max.100m) (※3)	Between Sensor and Zener barrier	5m (Exclusive use cable)
		Between Sensor and Zener barrier	0.4m (Exclusive use cable)
	8)Length (※4)	Probe L1	300mm
		Isolation L2	58mm (Permissible length : 50～550mm)
	9)Mass.		Approx. 1.3kg
	Zener barrier (Z961)		
	1)Approval		〔Exib〕ⅡB
	2)International Protection		IP20
	3)Rating		Uo＝17.4V, Io＝190.3mA, Po＝430mW Um＝AC250V 50/60Hz, DC250V
	4)Temperature		-20℃～+60℃ ※Non condensing
	5)Humidity		Max. 75%
	6)Mass.		Approx. 150g
	Zener barrier (Z964)		
	1)Approval		〔Exib〕ⅡB
	2)International Protection		IP20
	3)Rating		Uo＝17.4V, Io＝190.3mA, Po＝430mW Um＝AC250V 50/60Hz, DC250V
	4)Temperature		-20℃～+60℃ ※Non condensing
	5)Humidity		Max. 75%
	6)Mass.		Approx. 150g

4. Equipment specification			
Output unit			
	1)Power supply(Please specify it)		AC110V／220V -15%／+10%　50／60Hz
	2)Power consumption		16VA
	3)Output signal	Analog signal	DC4～20mA ×1 (max.23.3mA) Load : Max.500Ω (Isolated)
		Relay output signal	1-Alarm : 1C (AC250V,2A／DC30V,2A) 2-Upper limit : 2C (AC250V,2A／DC30V,2A)
	4)Display	Power	Green (ON＝点灯)
		Alarm	1-Alarm　　: Red (ON＝点灯) 2-Upper limit : Yellow (ON＝点灯)
		Concentration	Digital 4 segment display (mg／m^3)
	5)Measuring range (※５)		９ changes Range１ : 0.1～1000mg／m^3 Range２ : 0.1～ 500mg／m^3 Range３ : 0.1～ 200mg／m^3 Range４ : 0.1～ 100mg／m^3 Range５ : 0.1～ 50mg／m^3 Range６ : 0.1～ 20mg／m^3 Range７ : 0.1～ 10mg／m^3 Range８ : 0.1～ 5mg／m^3 Range９ : 0.1～ 2mg／m^3
		Set value when shipping	Range４
	6)Integration time		0～30s
	7)Correction		×0.1～×2.0　(0.1 carving)
	8)Temperature		-20℃～+50℃　※Non condensing
	9)International Protection		IP20
	10)Mounting		Wall tapestry or DIN-Rail
	11)Mass.		Approx. 0.7kg

※１) The maximum temperature is different according to the range.(Refer to a figure 1.)
※２) The permissible humidity is different according to the cooking stove.(Refer to a figure 1.)
※３) Wiring distance is addition between Sennsor, Barrier, and Output unit.
The cable is a special cable.
※４) The maximum length is 1000mm.
Please calculate "Maximum length" by the calculating formula of L1+L2.
※５) The reference density when standard fine particle "Talc" is measured at flow velocity 10m/s is shown.
The difference is in this density because of an actual measurement fine particle and the environment.
※The probe should not be touched directly by hand.
※A safe circuit is grounded.
Therefore, please avoid the execution of the withstand voltage test.

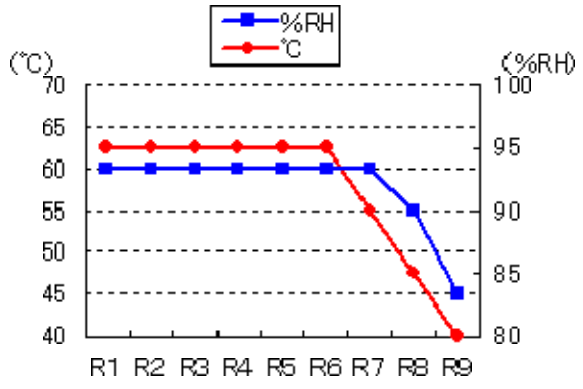


Fig.1. Graph of temperature and humidity

3. System configuration chart

Hazardous area that can be installed (※This Sensor cannot be installed on the place of Zone0.)
Zone1／Zone2

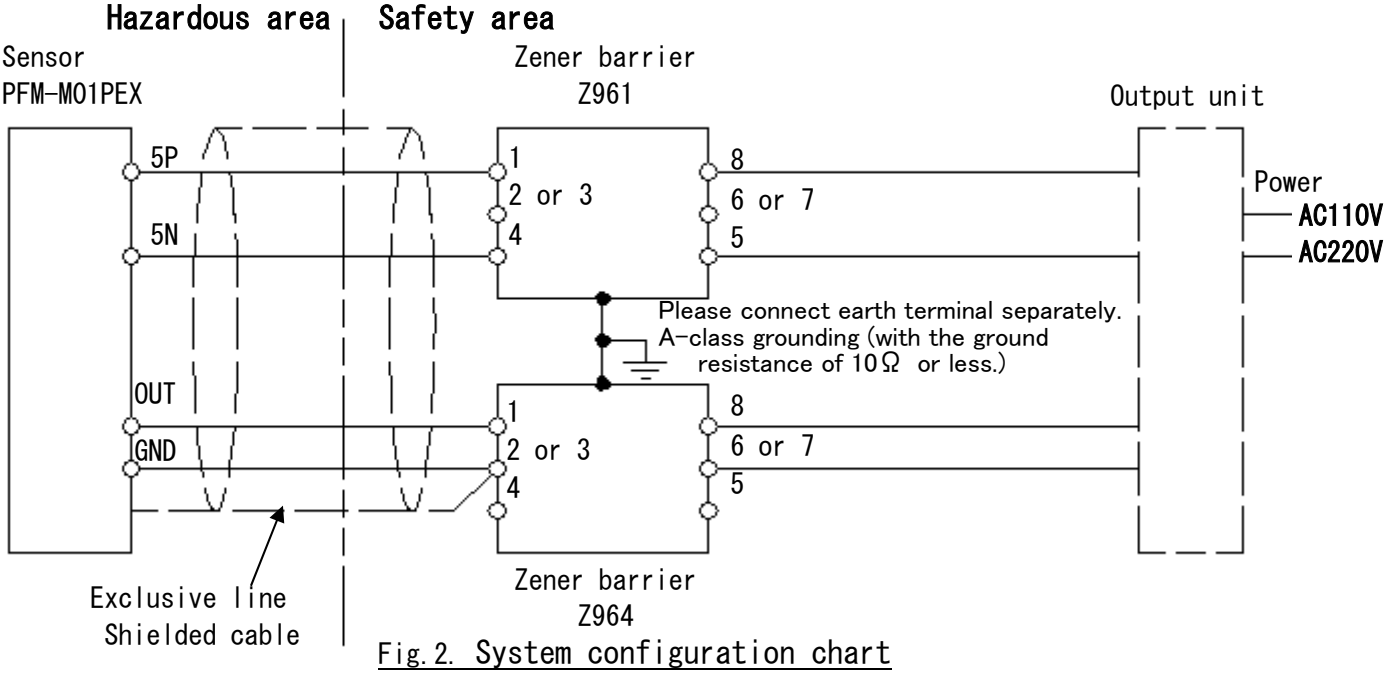
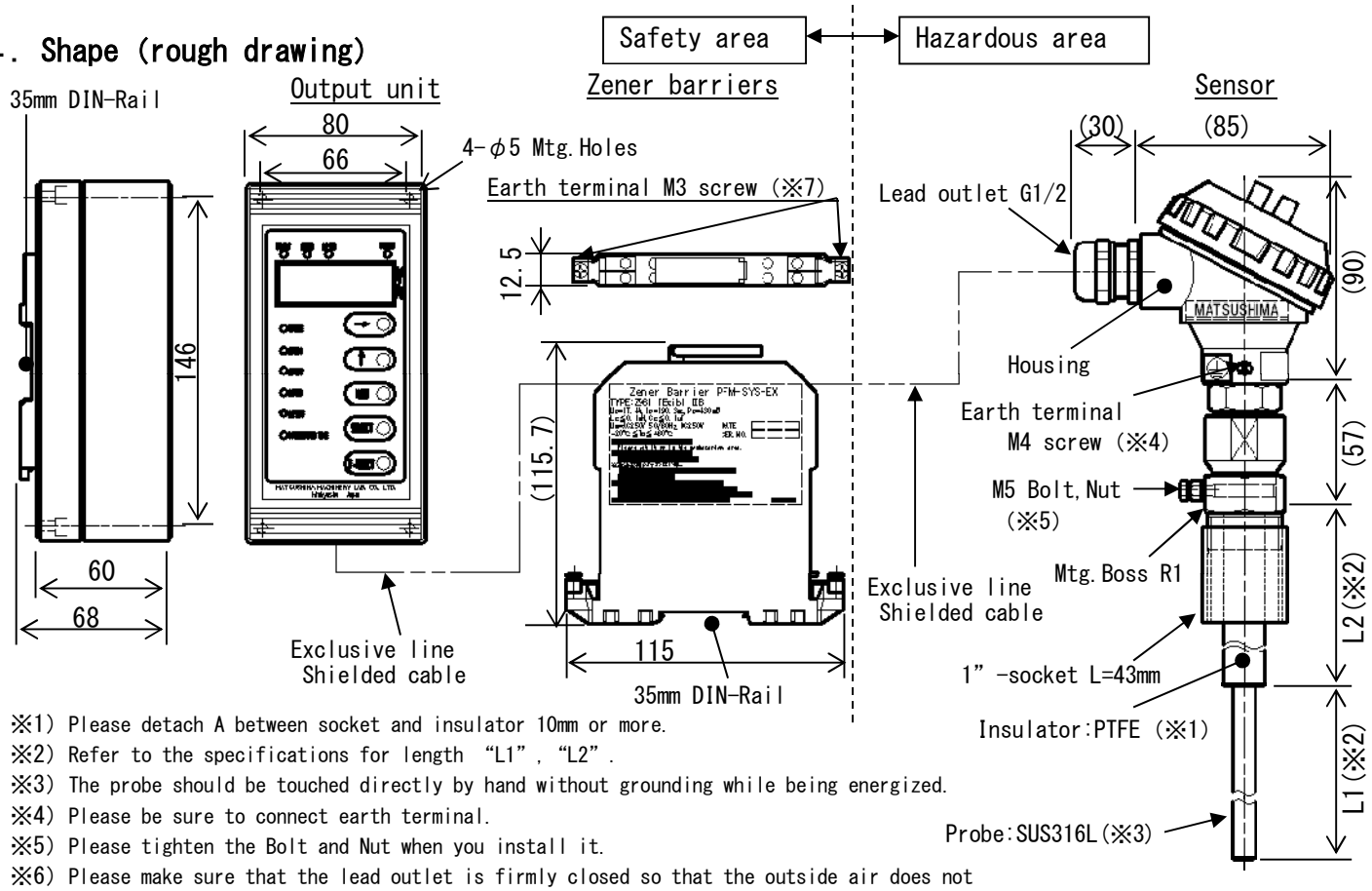


Fig.2. System configuration chart

・It becomes the system configuration of the explosion-proof with Sensor×1 set and Zener barrier×2 sets.
・Rating:「Uo = 17.4V, Io = 190.3mA, Po = 430mW」

4. Shape (rough drawing)



※1) Please detach A between socket and insulator 10mm or more.
※2) Refer to the specifications for length "L1", "L2".
※3) The probe should be touched directly by hand without grounding while being energized.
※4) Please be sure to connect earth terminal.
※5) Please tighten the Bolt and Nut when you install it.
※6) Please make sure that the lead outlet is firmly closed so that the outside air does not invade inside the unit.
Where it is connected by piping construction such as conduit system,
please apply putty and so on to the lead cable entry so that the outside air does not invade inside the unit.
※7) Please comply to A-class grounding (With the ground resistance of 10Ω or less) alone.

Fig.3. Shape (rough drawing)

5. Mounting method

To mount Dust Monitor, 1" -socket is provided with.
Weld the socket onto the pipe. Install the dust monitor so it is horizontal or vertical.
Welding should execute all around the pipe to shut off gas.

5-1. Precaution for mounting

Dust Monitor may mal-function in an environment as listed hereunder.
Mounting Monitor in such environment should be refrained from, please.

(1) Plumbing pipe to be extremely squeezed or close to a place bending.
(2) Mounting position within diameter of duct or 1.5 of vertical dimension.
(3) Near a fan
(4) Fitting plumbing pipe・short pipe・duct are nonconductive.
(5) Measure environment and conditions are out of specification.
(6) In case raising bulk up with short pipe in a place where dusts accumulate between short pipe and probe.
(7) Place where tip of probe is within 20mm from plumbing pipe.

Important : Wiring of power and signal should be independent, please.
Cap is for transport protection and is not a raincoat.

Attention :・Exclusive cable is transmitting very weak signal.
Cable should be protected with, by all means, steel made electric wire pipe independently so that inductive noise form ambient area does not bother signal.
・Securely close the lead outlet to prevent outside air from entering in the main unit.
Do not remove the accessory Silica gel. (for dehumidification)
・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.
・Isolate the Output unit from the outer noise sources and take any measure against noise if there may be any noise from power supply/signal lines.

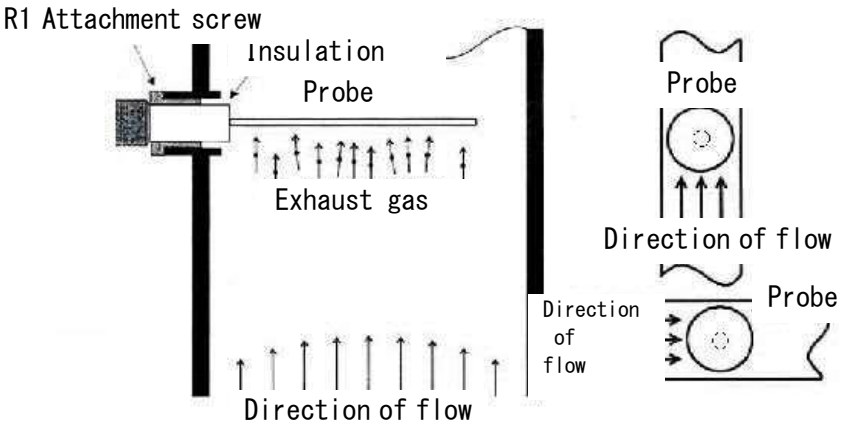


Fig.4. Installation

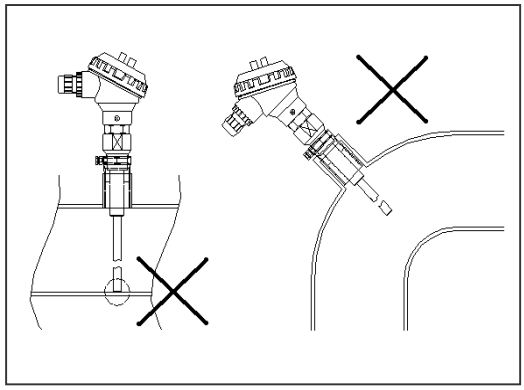
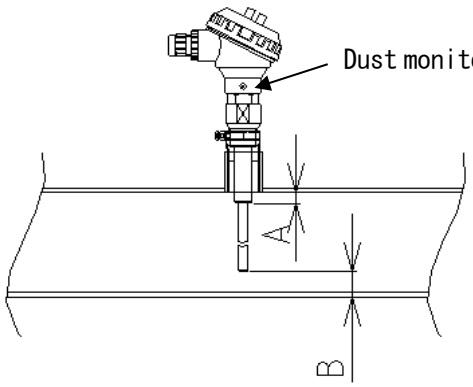


Fig.5. Example)Installation not good

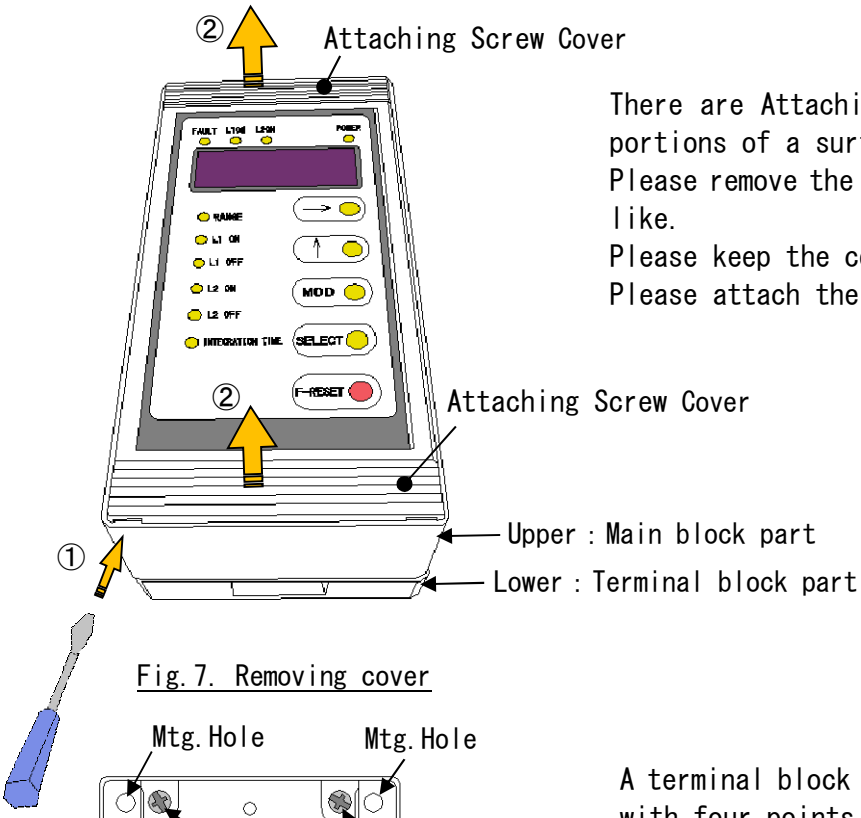


※Clearance A ≧ 10mm
※Clearance B ≧ 20mm

Important :
For installation of Probe, Place R1 Attachment screw, then insert Probe and tighten M5 bolt and nut on the side of R1 Attachment screw.
For maintenance, by loosening bolt and nut, you can pull out Probe.

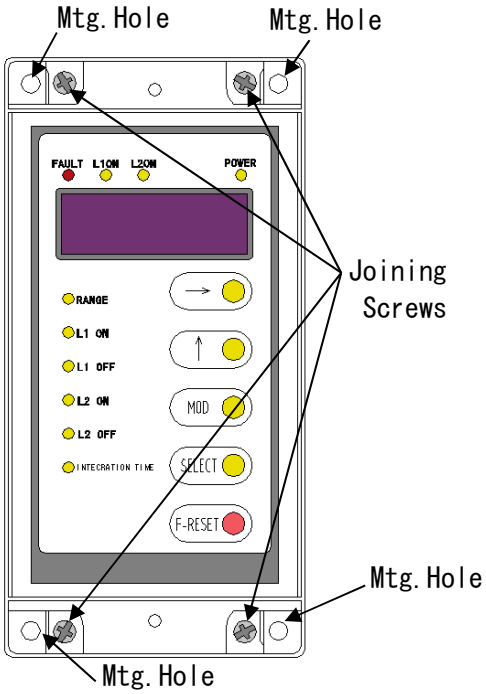
Fig.6. Installation reference figure

6. How to connect



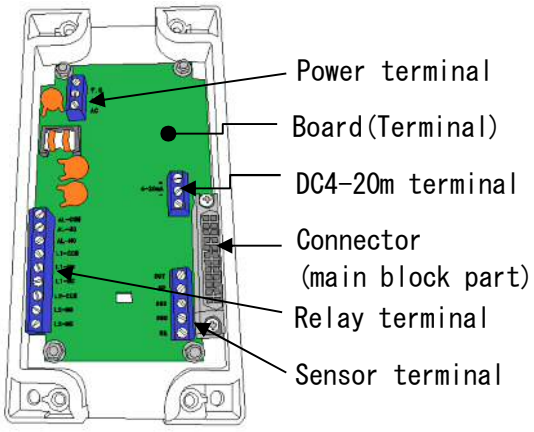
There are Attaching Screw Covers at upper and lower portions of a surface of a Transducer.
Please remove the covers with a negative driver or the like.
Please keep the covers which you removed.
Please attach the cover which you kept after wiring.

Fig.7. Removing cover



A terminal block part is joined to a main block part with four points of screws and connectors.
You can see a screw joining to the terminal block part under holes for Transducer attaching when you remove the attaching screw covers.
Please loosen these joining screws of the terminal block part with a Phillips driver.
You can see the terminal block of the Transducer when you remove the main block part from the terminal block part after having loosened these Joining Screws.

Fig.8. Joining screws of terminal and main block part



When you wire the terminal block of the converter, you must not make any false wiring.
After wiring, please attach the main block part with the procedure the reverse of how to remove the main block part.

Fig.9. Terminal part

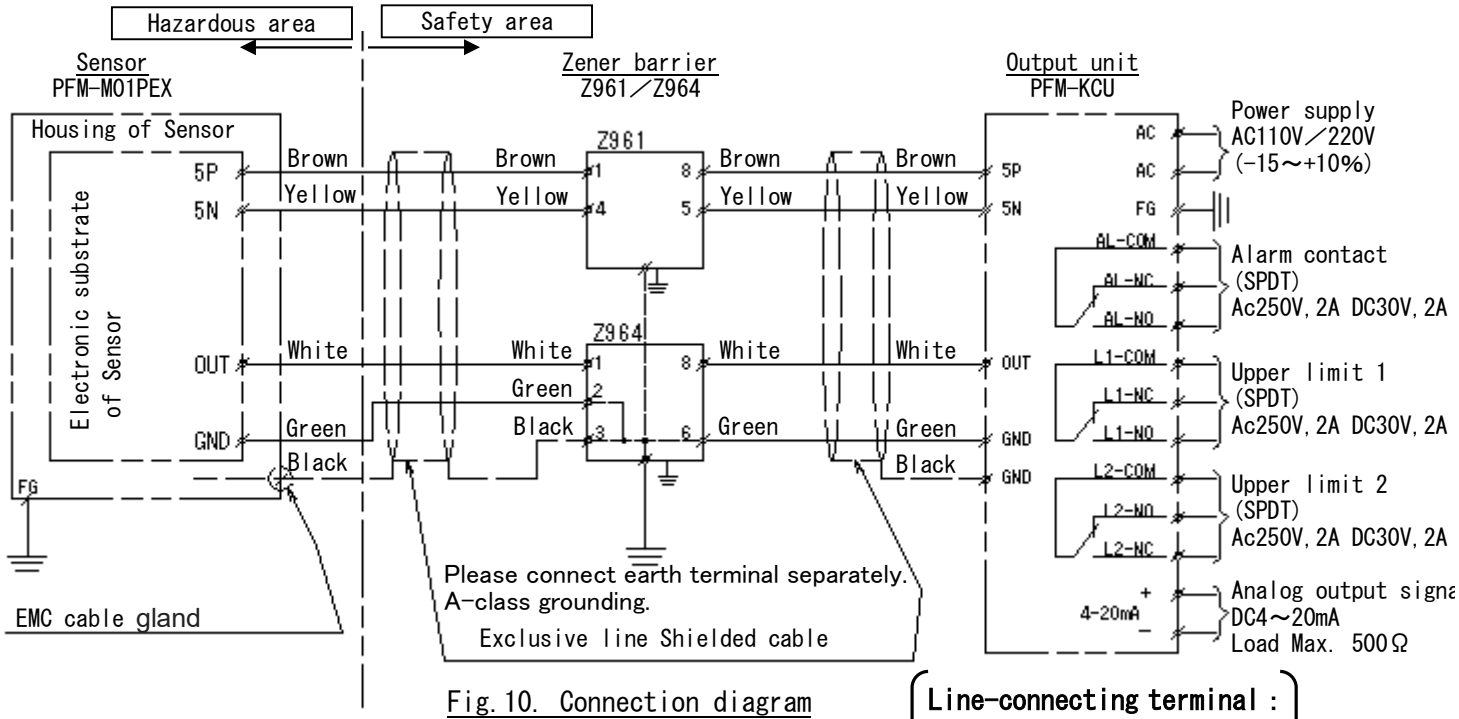
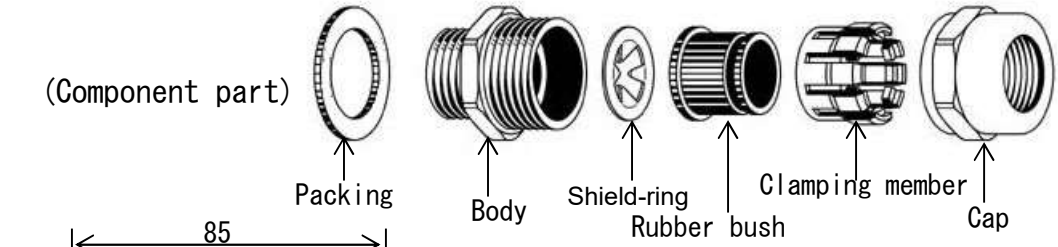


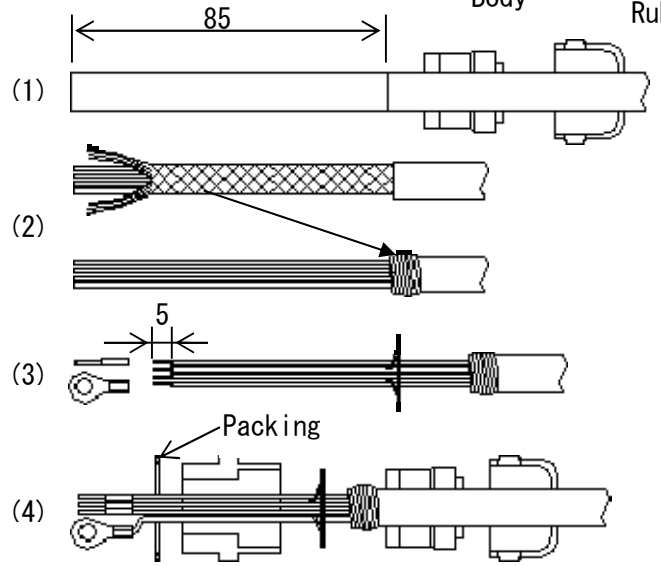
Fig.10. Connection diagram

Line-connecting terminal : Max. 1.5mm² (Output unit)

※About the grounding construction of Zener barriers.
Please comply to A-class grounding (With the ground resistance of 10Ω or less) alone.

⚠ **Important : EMC-cable gland is used for Sensor.**
Again, when wiring. Figure.11. becomes points of wiring.





(1)
Please pass Cap, Clamping member, and Rubber bush through the cable.
Please peel off the cable covering from the verge by the length of 85mm.

(2)
Please make the shield line asunder.
Please wrap an asunder shield line as shown in left figure.

(3)
Please pass Shield-ring through the cable.
Please peel off the cover of the core wire by 5mm.
Please use solderless terminal with insulating coating of Stick-type by three (brown, yellow, and white) core wires.
A green core wire must use the pressure terminal of R type(R1.25-4).

(4)
Please pass Body and Packing through the cable, and install it so that the shield line may surely come in contact with the Shield-ring.

Fig.11. becomes points of wiring.

7. Part names and functions

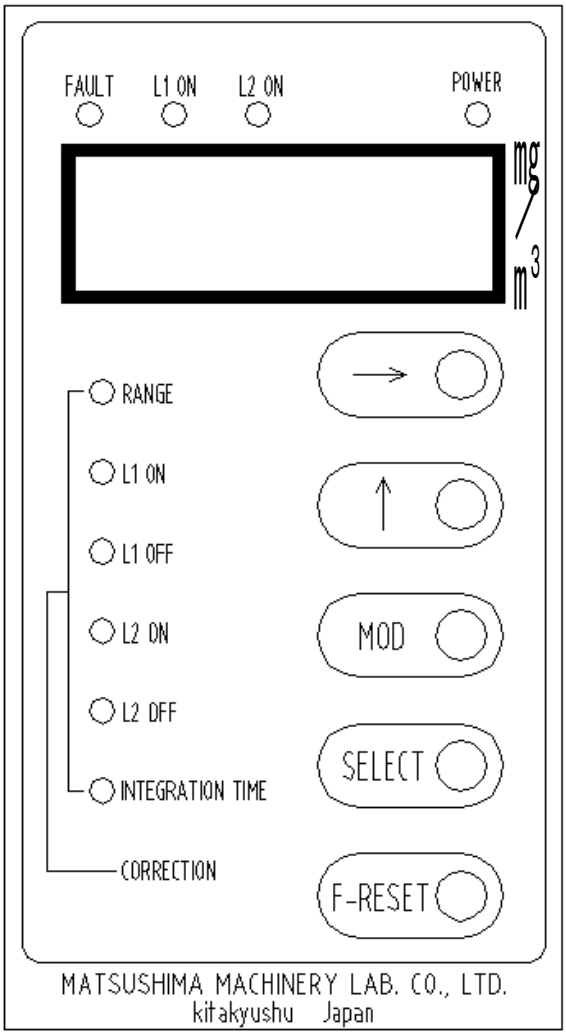


Fig.12. Front panel of Output unit

【for indication】
POWER LED : Light on as power on
FAULT LED : CPU on when abnormal
L1 ON LED : Light on over limit1set
L2 ON LED : Light on over limit1set
4 beams indicate LED: detection density will indicate per 0-100% complying with setup.

【for button】
→ : use when changing beam of number/value.
↑ : use when increasing number/value.
MOD : use when switching parameter set mode and measure mode.
Pushing after set change will memorize parameter and return to measure mode.
SELECT :
Use when switching set items.
F−RESET :
U se when setting measure again.

(1) RANGE : measure range (1、2、3、4、5、6、7、8、9) set
(2) L1 ON : setON point of limit 1 (Range of each cooking stove)
(3) L1 OFF: setOFF point of limit 1 (Range of each cooking stove)
(4) L2 ON : setON point of limit 2 (Range of each cooking stove)
(5) L2 OFF: setOFF point of limit 2 (Range of each cooking stove)
Minimum range of Hysteresis is still 1%.
(6) INTEGRATION TIME : Integral time set (set range : 0～30s)
(7) CORRECTION : Compensation value set (set range : 0.1～2.0)

8. Start up

8-1. Warm up operation

Dust Monitor requires warm up operation for about 1 hour after switch on.

8-2. Measure range set

After finishing warm up operation, you please set most appropriate measure range.
You please set the range at 1 - 4 if the condition in which normal flow speed is regular, filter is correct and measure environment is appropriate.
In case requiring observation of smaller change, you please set the range at 5～9 so that you can observe smaller change.
(In case density is high however, you may get over range.)

	4mA		20mA		4mA		20mA
Measure range 1 :	0.1	～	1000mg/m^3	Measure range 6 :	0.1	～	20mg/m^3
Measure range 2 :	0.1	～	500mg/m^3	Measure range 7 :	0.1	～	10mg/m^3
Measure range 3 :	0.1	～	200mg/m^3	Measure range 8 :	0.1	～	5mg/m^3
Measure range 4 :	0.1	～	100mg/m^3	Measure range 9 :	0.1	～	2mg/m^3
Measure range 5 :	0.1	～	50mg/m^3				

This range (density), utilizing「Talc」as standard powder, is designed to get 20mA output under an environment of flow speed of 10m/s and the maximum range of 1000mg/m^3.
As to other ranges, the maximum value of 20mA of each range is designed to output due to its output linear.

【Reference: Talc】
（Ｔａｌｃ）is non organic powder made from ore called Talc being crushed into gray white particle and smooth powder.
Talc, with its chemical name: hydrous magnesium silicate ($Mg_3Si_4O_{10}(OH)_2$) containing main ingredient of SiO_2 approx 60%, MgO approx 30% and combined water of 4.88%.
As its physical nature, Talc of true specific gravity 2.7～2.8 is a substance having lowest hardness, superior in heat resistance in addition to chemically stable nature among non organic mineral.

8-3. Integral set

Integration will even off measure signal per time fixed number up to maximum 30 minutes. (optional set)

※ Trouble of filter system will indicate through sudden rise of output signal.
When doing analysis of filter system, set integral at 0 minute, please.
By setting integral at 0 minute, you can monitor sudden change of dust density.
As measure example, bag filter observation example is indicated for you in Fig.13 in which Dust Monitor is used for 13 lines.
Dust exhaust is indicating its respective amount to transact as 1～6 lines, and 12, 13 lines are low but 7～11 lines pretty high peak.
You can decide when you change filter based on your observation.

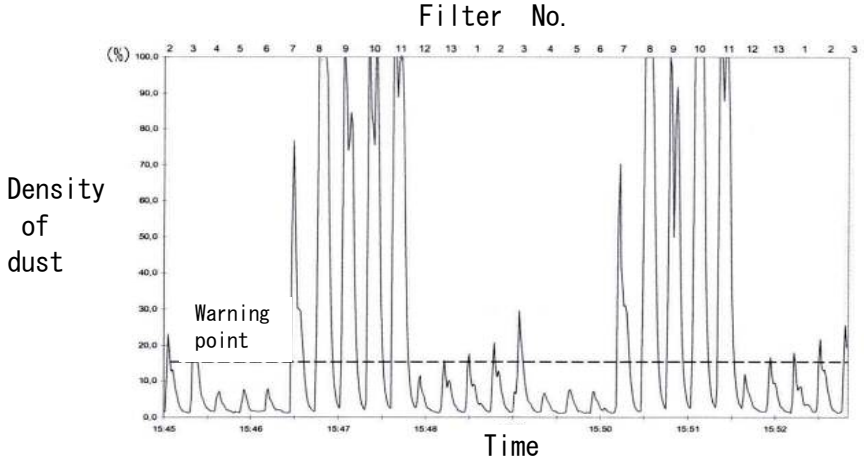


Fig.13. Filter observation picture (example)

8-4. Limit set

Limit set can be done 2 different upper limits (alarm) in the range of 4～20mA (signal level 0～100%)

In case signal change gets severe however, chattering might rise often.

In such case you may be recommended to use integral function or delay function at/from higher position (Customers expertise) respectively.

【Limit 1, 2 and action chart of trouble alarm】

Limit output (upper limit alarm)

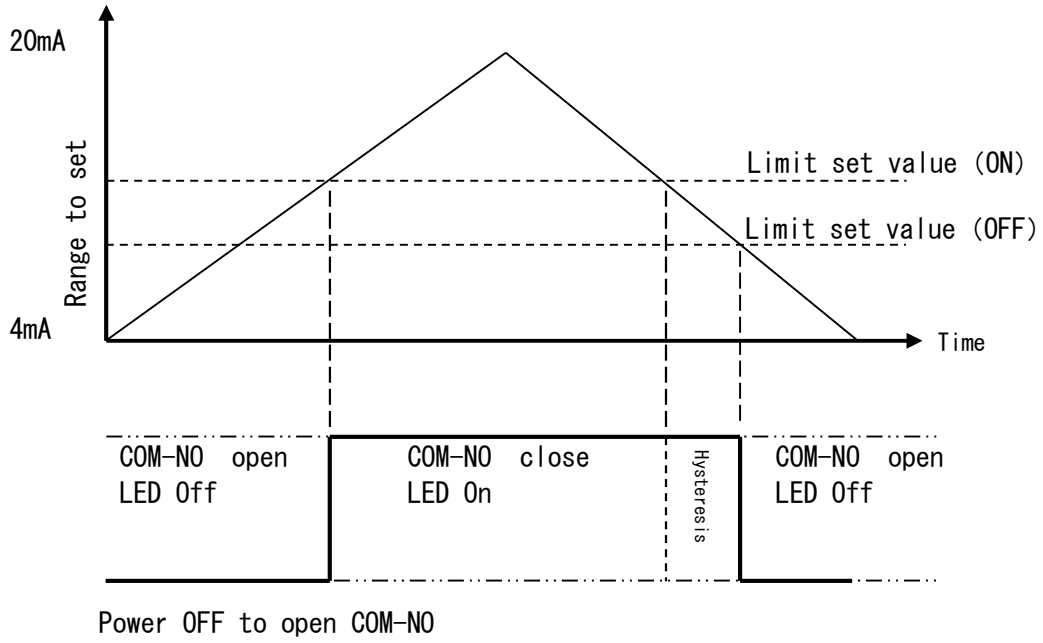


Fig.14. Operation chart (upper limit alarm)

Trouble alarm

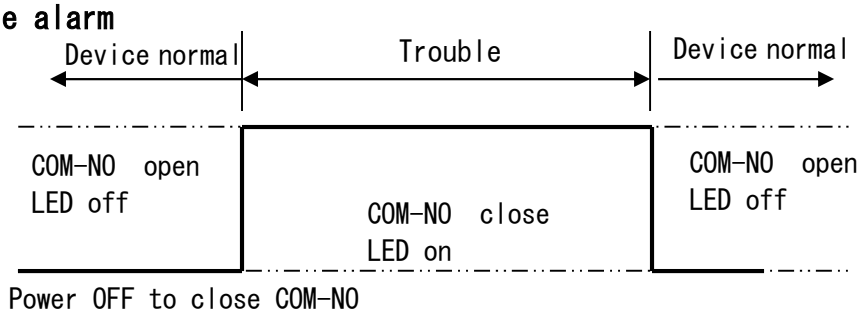


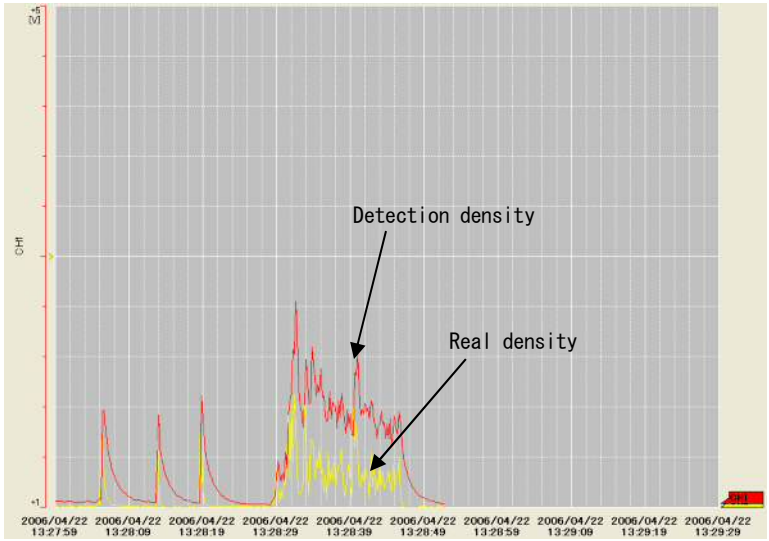
Fig.15. Operation chart (Trouble alarm)

8-5. Compensation value set

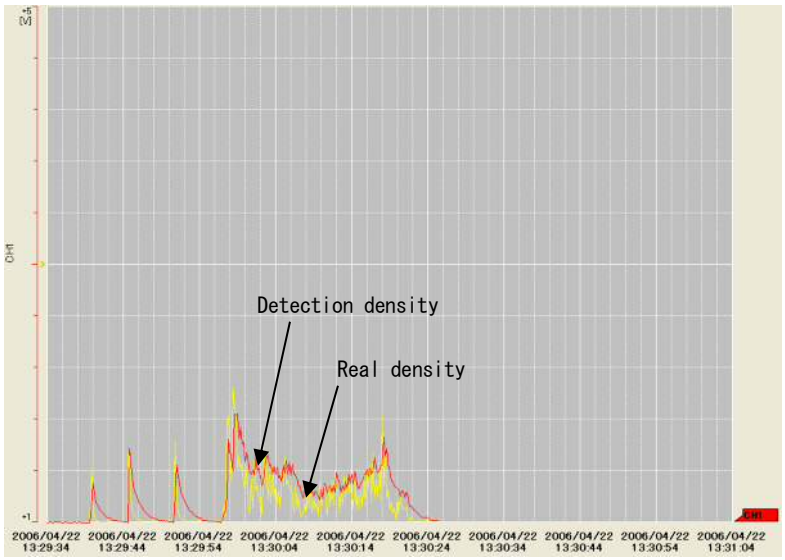
Compensation value can output in a range of 0.1～2.0 (double) as compensation coefficient.

In such case as output is too high or too low for actual density when standard coefficient is 1.0, this function can output nearest density to actual density by multiplying output.

Utilizing this function, output can be compensated as shown hereunder.



Compensation value 1.0 trend
For actual density,
detect density outputs high.



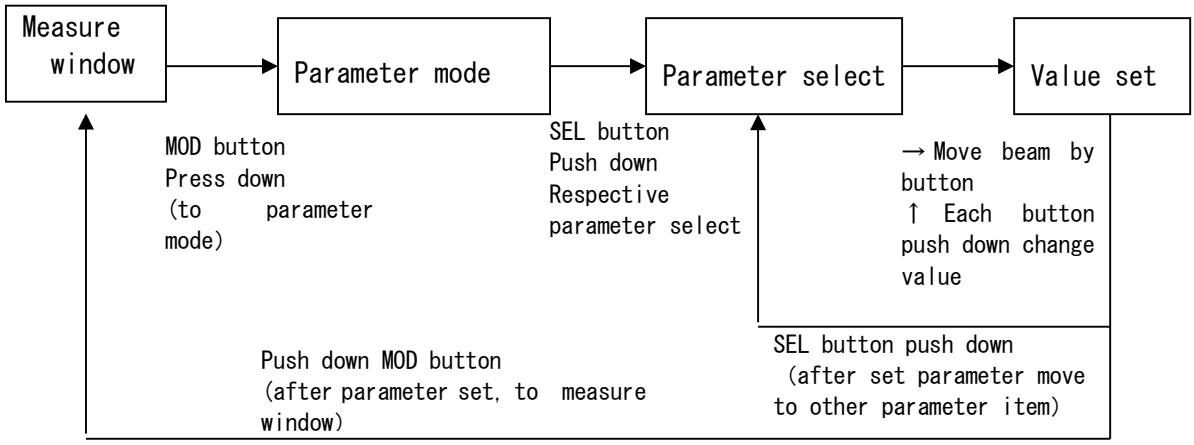
Compensation value 0.5 trend
For actual density,
Detect density outputs almost all alike and understood compensation is effective.

This function is 0.1 in increments of input in the range of 0.1～2.0 (default is 1.0). If management is only for trend of dust exhaust, you can do without using this function (=set value 1.0). In case management requires the nearest value to actual density, you seize actual density such as counter wash pulse time, etc by manual analysis first and then set counter wash pulse shown by device very much close to value of manual analysis.

９. Set example of parameter

9-1. Flow of parameter set

Parameter should set according to the flow as shown hereunder.



※ **In case setting up value over input range exceeding specification, setup value of parameter will indicate 「Ｅｒｒ」on indication ＬＥＤ, let you know setup value is wrong and do not accept next operation.**

※ **In this case, please change to correct set value again.**

・RANGE： measure range（１、２、３、４、５、６、７、８、９）set
・L1 ON ： setＯＮ point of limit 1 (set range：0～100%)
・L1 OFF: setＯＦＦ point of limit 1 (set range：0～100%)
・L2 ON ： setＯＮ point of limit 2 (set range：0～100%)
・L2 OFF: setＯＦＦ point of limit 2 (set range：0～100%)
Minimum range of Hysteresis is still 1%.
・INTEGRATION TIME： Integral time set (set range：0～30s)
・CORRECTION ： Compensation value set (set range：0.1～2.0)

9-2. Example of parameter set

Following is a set example to set integral time at 15 second.
(Providing that set value was 0 minute before change.)

(1) Push MOD button 1 time・・・・・・・・・・・move to parameter window and LED(orange). written Range on the left will light on.

(2) Push SEL button ５ times・・・・・・・・・ LED (orange) lit goes down in turn and INTEGRATION TIME LED will light.

(3) By using both → button and ↑button, set Indication LED at「１５」.

(4) Push MOD button１ time・・・・・・・・・・return to measure window and start measure again at integral 15 second.

You operate other parameters with same procedure, please.
In case setting other parameters continuously, at (4) above instead of MOD you push SEL and can perform both setting parameter and moving to plural items at the same time.

Reference： Parameter and light up of corresponding ＬＥＤ

RANGE	：	only RANGE LED light up
L1 ON	：	only L1 ON LED light up
L1 OFF	：	only L1 OFF LED light up
L2 ON	：	only L2 ON LED light up
L2 OFF	：	only L2 OFF LED light up
INTEGRATION TIME	：	only INTEGRATION TIME LED light up
CORRECTION	：	both RANGE LED and CORRECTION LED light up same time

10. Maintenance

Measure probe should regularly be wiped and cleaned with dry rag.
You please keep it cleaned once in every 3 months but more often because of changing media or measure environment, you see.
When cleaning, you please switch off power.

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

11. Trouble shooting

As soon as you find your machinery is functioning/operating funny, by referring to following particulars, you solve problems, please.
After those confirmations listed on the right below have been taken care of and mishaps do not return to normal, please kindly contact Matsushima.

Table 1. Trouble shooting

Contents	Cause thinkable	Items to confirm
Both lamps of power and LED of controller are off.	・Power is shot off. ・Power specification is different since agreement on delivery.	・Confirm wiring of terminal stand. (See if Terminal No. AC been wired?) ・Confirm if name plate of device and power supply are correct.
Output Direction is unstable.	・Warm up operation after setup is not complete. ・Earth (earth) is not provided. ・Wirings of exclusive cables between sensor controllers are either off or wrong. ・Material sticking on terminal. ・Terminal gets dew condensation. ・A bit of material is flowing.	・Execute warm up operation for 1 hour. ・Confirm D type earth is done. ・Confirm wiring of exclusive cable. ・Remove probe and confirm if any sticking on terminal. If yes, switch off and wipe them off with rag. ・Remove probe and confirm if terminal is dew condensed. If yes, switch off and wipe it off with dry rag, please.
Output direction sever itself and does not return.	・Duct or plumbing pipe is short circuit from detection terminal due to terminal having sticking with material. ・Terminal has dew condensation. Electric charge does not generate. ・Terminal is contacting with pipe inside (GND). ・Machinery is in trouble. ・Big amount of material is flowing. **Attention:** **(1) In case removing detection probe from machinery, do it after loosening M5 bolt and nut. Please. To fit it back after cleaning, screw them back securely, please.** **(2) If insulation extension is required, please consult with Sales Dept of Matsushima. (on your account though)** **(3) Your attention is cordially invited not to cut probe length too short as you may be unable to detect electric charge.**	・Remove probe and confirm if any sticking on terminal. If yes, switch off and wipe them off with dry rag. (Remark) ・Confirm if insulation is pushed in inside of duct or pipe more than 10mm. ・Insulation should be extended as required (Remark) ・Remove probe and confirm if terminal has dew condensation. If yes, switch off and wipe them off with dry rag, please. ・Measure pipe inside diameter and terminal length and confirm if they do not contact If yes, change terminal length, please. (Remark)
Output direction does not change.	・Power is not supplied. ・Wiring of exclusive cable between sensor controllers is either off or wrong. ・Terminal has material stick on. ・Terminal contacts with inside of pipe (GND). ・Machinery is in trouble.	・Confirm terminal wiring. ・Confirm wiring of exclusive cable. ・Remove probe and confirm if any sticking on terminal. If yes, switch off and wipe them off with rag. (Remark) ・Measure pipe inside diameter and terminal length and confirm if contacting. If yes, you will change length of terminal, please. (Remark)