INST No INE-221-P2CE

CHINO

IR-M1□□□□ Series
INFRARED MOISTURE METER
(Model:IR-M11□□□□,IR-M12□□□□,
IR-M13□□□)

INSTRUCTIONS

Always keep this instruction with the unit.

Please be sure to deliver this instructions
with the unit to the end user.

CHINO

■PREFACE Requests and notices

Thank you for your purchase of IR-M11□□series, IR-M12□□series, IR-M13□□series Infrared moisture meter designed as a fiber optic. Please read this instruction manual without fail for using this instrument correctly and safely and also preventing troubles in advance.

Request to designers, instrument controllers, and sale agents

Deliver this instruction manual to the operator of this instrument without fail.

Request to the operator of this instrument

This instruction manual is necessary for maintenance, too.
Keep this manual with due care until the instrument is discarded.

Note

1.For the contents of this manual, alteration is reserved without notice in the future.
2.This manual has been prepared by making assurance doubly sure about its contents.
However, if any question arises or if any error, an omission, or other were found, please inform your nearest CHINO's sales agent of them.
3.You are requested to understand that CHINO is not responsible for any operation results.

■FOR SAFE USE

For the purpose of using this unit safely, observe the following cautions for safety during the operation, maintenance, and repair of this unit without fail.
Take safety measures separately against wrong operation, troubles, and other circumstances of this unit.

●The following warning mark is struck to this unit to enable users to use this unit safely.

This warning mark is struck to the portions being subject to an electric shock accident. Turn off the power supply of the feed source without fail before starting wiring, maintenance, and repair.

●This instruction manual uses the following symbol marks for safe use.

Warning

Observe this caution item strictly for avoiding a danger, otherwise negligence of this caution may possibly cause troubles of this unit and accidents

Caution

Observe this caution item strictly, otherwise negligence of this caution may cause the damage of the unit or measuring errors.

Reference

Information when you can use this instrument as a reference.

This mark is described in each title covering or **Warning** instructions.

■CAUTIONS FOR SAFETY

●Power supply

Make sure that the power voltage of this unit meets the feed power voltage without fail before feeding power to this unit.

●Protective grounding

Perform the protective grounding without fail before turning on the power supply of this unit for the purpose of preventing an electric shock accident.

●Necessity of protective grounding

Don't cut the internal or external protective grounding wire of this unit nor disconnect the wiring at the protective grounding terminal.

●A defect of protective functions

Don't operate this unit, if the protective grounding, fuse, or other protective functions seem to be defective. Check the protective functions for defects before operating this unit.

●Use in a gaseous atmosphere

Never operate this unit at a place where a combustible gas, an explosive gas or their vapors exist., otherwise a very dangerous accident will occur.

●Never touch the interior by hand.

This unit is internally provided with high-voltage circuits. Never touch the interior by hand when the voltage is applied to this unit.

●External connections

Perform the protective grounding securely without fail before connecting this unit to a measuring object and/or an external control circuit.

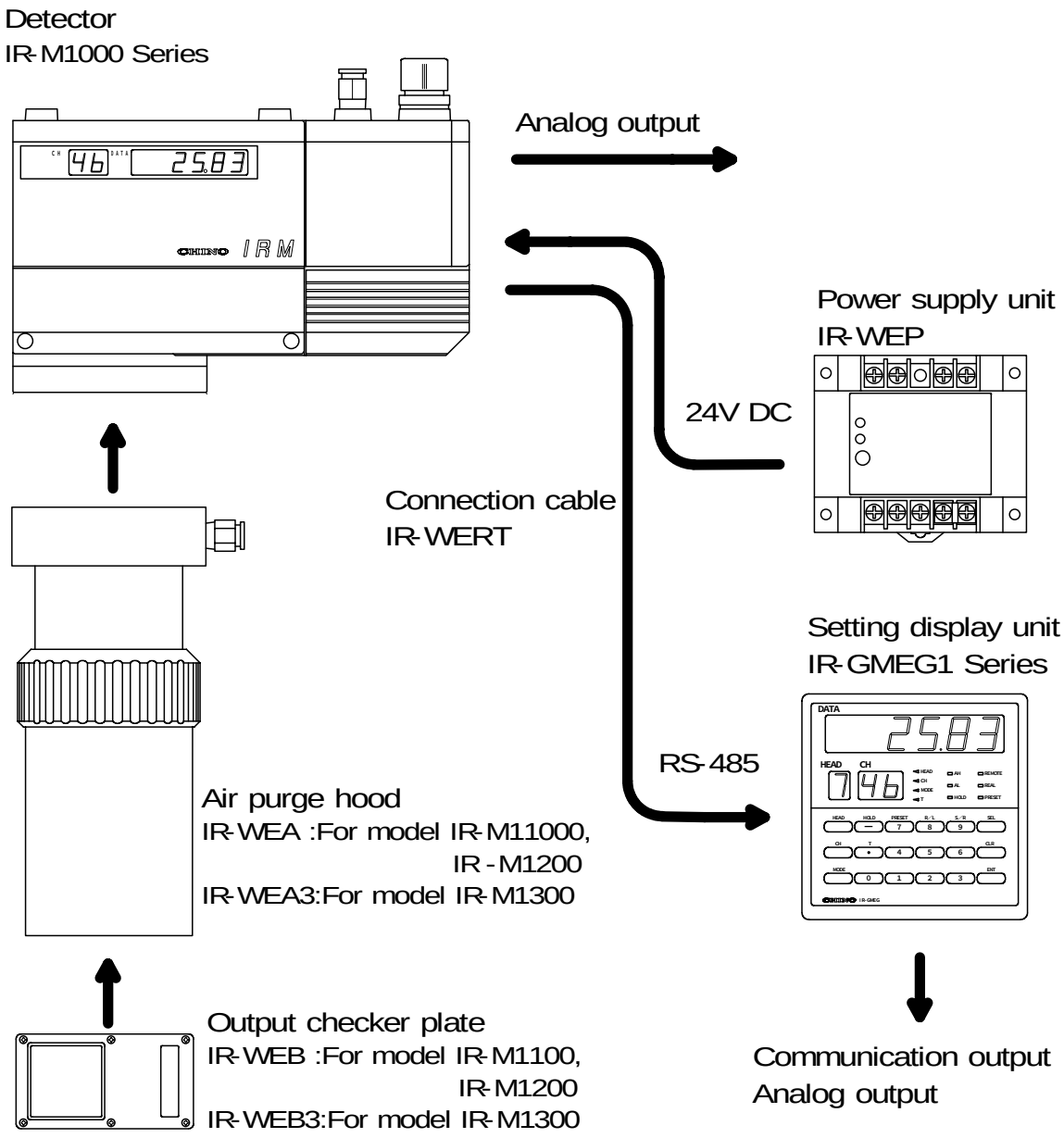
CONTENTS

1. Introduction

1.1 General

The infrared moisture meter IR-M1100, IR-M1200, IR-M1300 series is designed as a reflection system no-contact on-line moisture meter utilizing the infrared absorption of moisture, and it consists of the detector, setting display unit, and accessories.
The detector is provided with 99 built-in calibration curves to output linear analog signals according to the moisture. Since this instrument provides the keys display and communication functions, it can be used as a single unit or combined with a personal computer. Max. 9 detectors can be connected with the setting display unit that can set various parameters of the detectors and indicate the moisture value. Accessories comprise the connection cables, air purge hood, output checker plate, etc. This instruction manual describes the detector and accessories. For the setting display unit, refer to the separate instruction manual for setting display unit.

1.2 Configuration



2. Model and accessories

2.1 Model

2.1.1 Detector: IR-M1 □ □ □ □ □

Type
- 1: General-purpose
- 2: High-moisture
- 3: Micro-moisture

Measuring wavelength
- 0: Standard
- 9: Special wavelength

External input/output
- 0: Moisture output 4 to 20mADC (standard)
- 5: Correction input 4 to 20mADC (Optional)*1
- 8: Correction input Pt100(Optional)*1

Communications interface
- A: RS-422A*1
- R: RS-232C
- S: RS-485(standard)*
  *S; if combined with the setting display unit

Optional specifications
- Blank: None
- N: Neither keys nor display is provided
- S: Small-diameter type
- V: CE-marking conformance specifications*
- X: Other options

*The following model only conforms to CE-marking.
IR-M1□□□SV
CE-marking specifications (Standards)
・EN555011 Group 1 Class A
・EN50082-2 (Industrial standards)
(Directives)
89/366/EEC, 92/31/EEC(amendment)
93/68/EEC (amendment)

*1:Combination of “5” or “8” of optional external I/O and communications interface “A” is not possible.

2.1.2 Connection cable : IR-WERT

2.1.3 Air purge hood : IR-WEA (For Model IR-M1100, IR-M1200)
IR-WEA3 (For Model IR-M1300)

2.1.4 Output checker plate: IR-WEB (For Model IR-M1100, IR-M1200)
IR-WEB3 (For Model IR-M1300)

2.2 Accessories

Article names	Quantity	Remarks
Power supply	1	Manufactured by OMRON
Fuse	2	Manufactured by Daito Tsushin Co.
L-type hexagonal wrench key	1	Diameter across flats 3
L-type hexagonal wrench key	1	Diameter across flats 4
Ferrite core	2	Attached to CE-marking conformance product only
Instruction manual	1	This manual
Instruction manual for communication	1	Attached to IR-M1□□□ R/A □ only

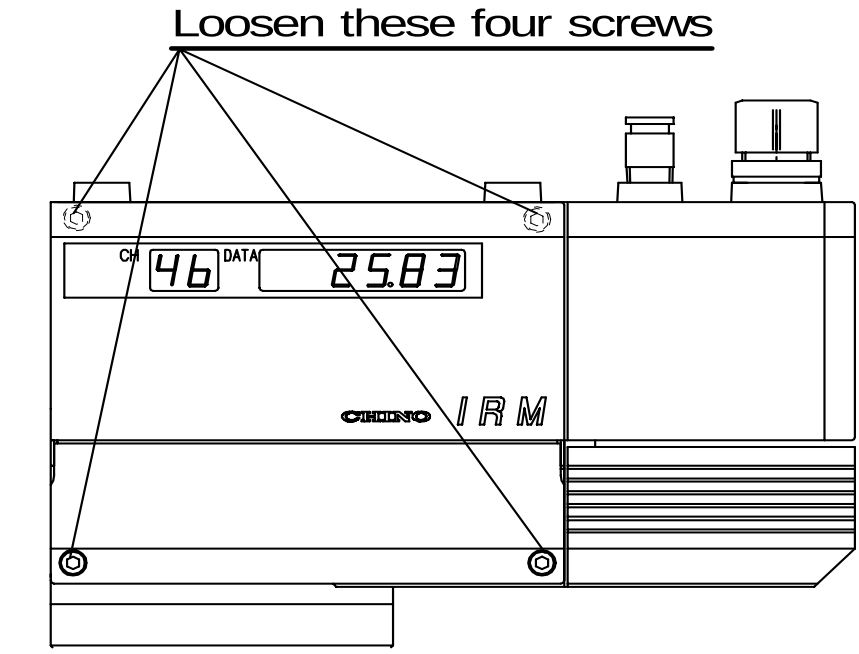
3. Setting and Installations ⚠

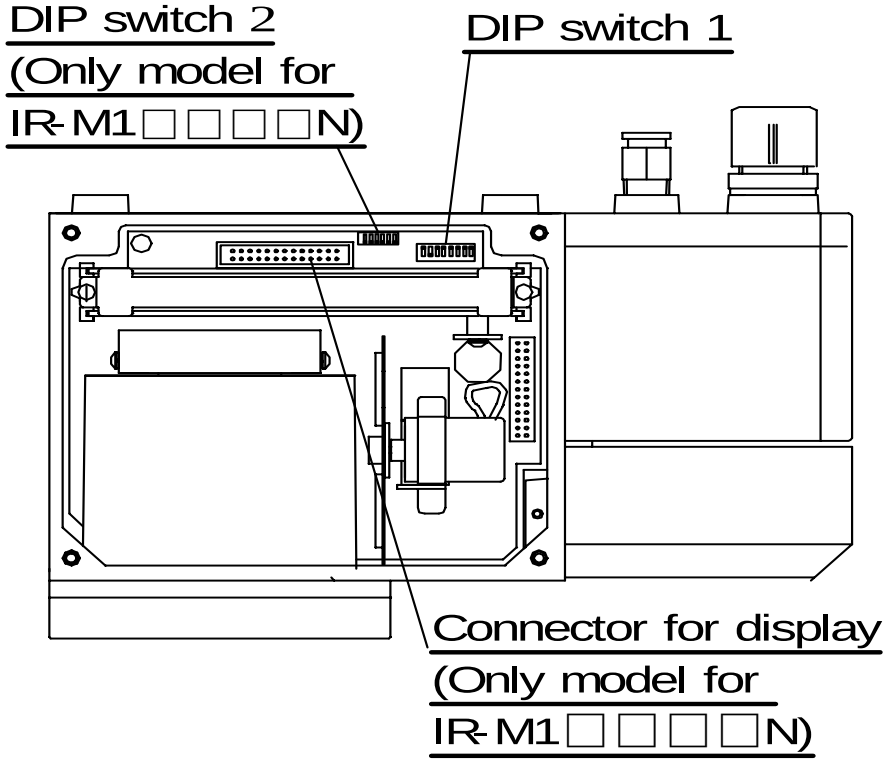
3.1 Setting of dipswitches ⚠

Set the internal dipswitches before installation of the detector unit.

1) Open a door, remove 4 screws for fixing a setting display part and then remove the setting display part.
2) The setting display part is connected to the interior through cables. Lift the setting display part with due care so as not to damage the cable and disconnect the connector for the setting display part at the position shown in the figure.
3) Set the dipswitches according to the working conditions.

Warning Turn off the power supply before removing the setting display part.





3. Setting and Installations ⚠

3.1.1 Setting of DIP switch 1

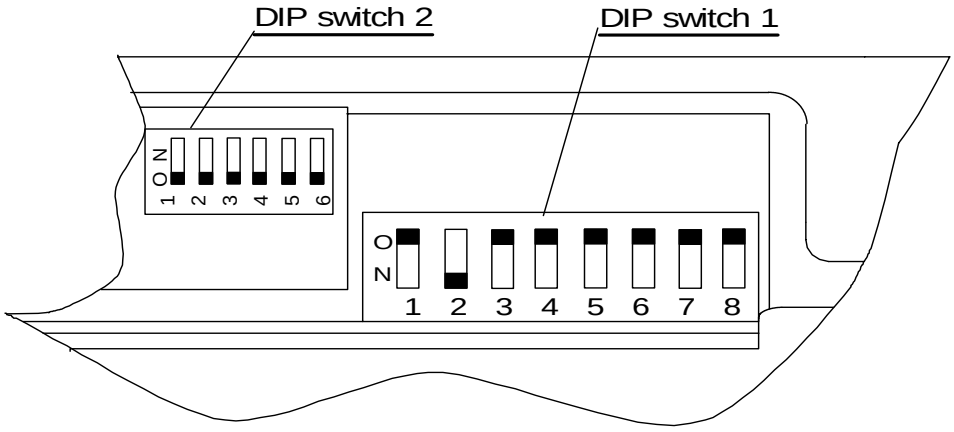
DIP switch No	Function	SW		Defaults
		OFF	ON	
1	Measurement/ Calibration mode	Measurement mode	Calibration mode	OFF (Don't change.)
2	Mathematical operation format	Logarithm operation	Ratio operation	ON (Don't change.)
3	No.2 calibration enable/disable	Disable	Enable	OFF
4	Connection destination	Setting display unit	PC	OFF : IR-M1□□□S ON : IR-M1□□□R IR-M1□□□A
5	Key/display enable/disable	Enable	Disable	OFF: IR-M1□□□□ O N : IR-M1□□□□N
6	Not used			OFF
7	Correction input enable/disable	Disable	Enable	OFF
8	Correction input	4 to 20mADC	Pt100	OFF

3.1.2 Setting of DIP switch 2 (Model for IR-M1□□□□N only)

Detector No.	**DIP switch No.**			
	1	**2**	**3**	**4**
1				
2				○
3			○	
4			○	○
5		○		
6		○		○
7		○	○	
8		○	○	○
9	○			
RAM clear	○	○	○	○

Communication Speed (bps)	**DIP switch No.**	
	5	**6**
2400		
4800		○
9600	○	
19200	○	○

○:ON



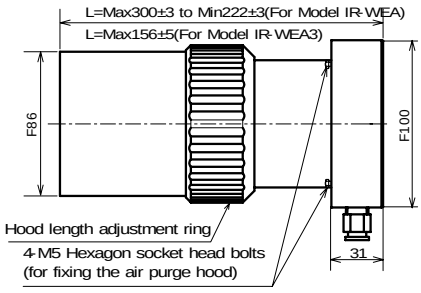
3. Setting and Installations

3.2 Mounting of "Air purge hood"(Model: IR-WEA or IR-WEA3)

The air purge hood is used for shielding the light when electric lamp, flames, direct sunlight, or other disturbance light directly radiate on to the measuring surface. And the air purge hood is used for securing the optical path by air purge when water drops, dust particles, smoke, steam, etc. exist between the detector and the measuring surface. The hood length is variable.

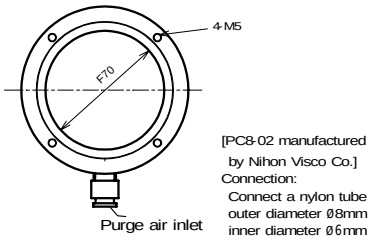
3.2.1 Mounting to detector

Position four hexagon socket head bolts of the air purge hood to the screw holes of "Air purge hood" mounting flange of the detector, and fix the air purge hood by fastening these bolts with a hexagonal wrench (diameter across flats 4).



3.2.2 Adjustment of hood length

Adjust the hood length after loosening the hood length adjusting ring counterclockwise, and fix the hood by fastening the hood length adjusting ring clockwise.



3.2.3 Air purge

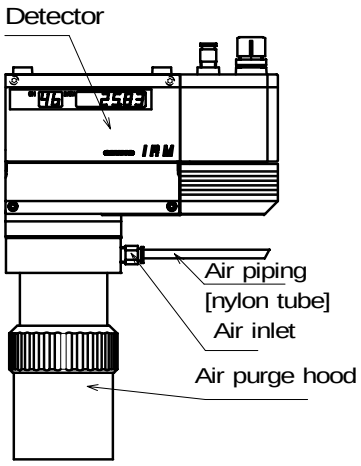
For air purge, feed a dry air excluding oil, dust, etc., through the purge air inlet.

Connect a nylon tube of 8mmϕin outer diameter and 6mmϕin inner diameter.

(The tube connection port is PC8-02 manufactured by Nihon Pisco Co.)

Purge air flow: 50 to 200Nl/min

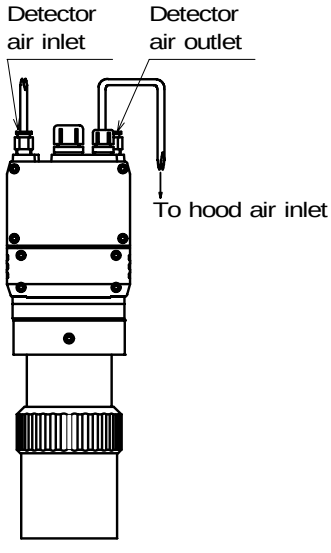
Purge air pressure: Lower than 200kPa ($2kgf/cm^2$)



3.2.4 For cooling the detector with air

When feeding the air after cooling the detector as a purge air, connect the air outlet and purge air inlet of the detector with a tube as shown in the figure.

The recommendable air flow is about 50Nl/min.



Caution

Cool down the detector with air as much as possible for enhancing the reliability of the detector.
Cool it down with air without fail when the ambient temperature exceeds 45°C

3. Setting and Installations ⚠

3.3 Installation of detector unit

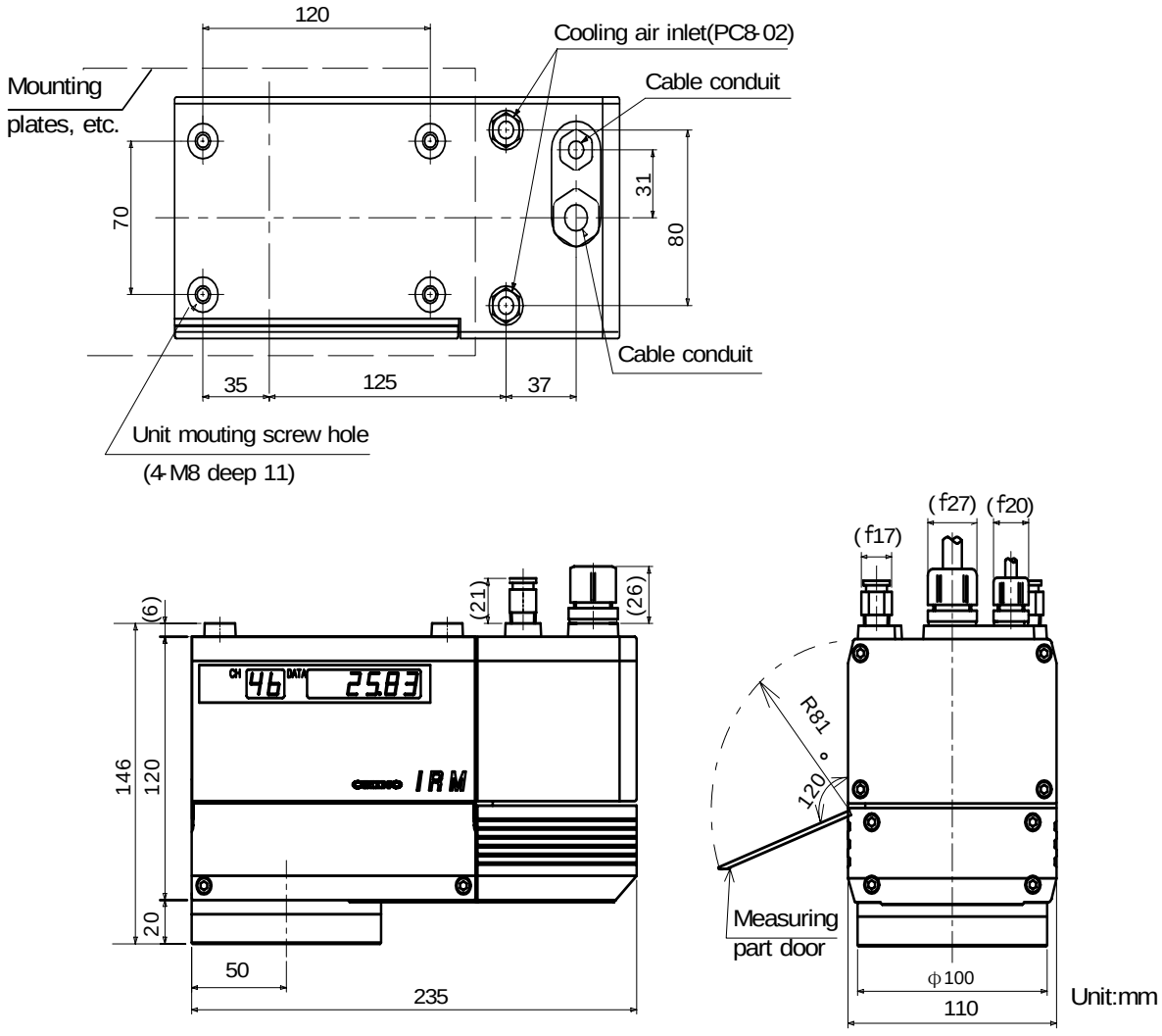
Four unit mounting screw holes (M8, 11mm in depth) are provided on the upper face of the detector. Fix the detector by a mounting plate with four M8 bolts. The external profile and mounting dimensions are as shown in the following figure.

(1) For model IR-M1100, IR-M1200, mount the detector so that the distance from the measuring surface becomes 300mm. (Mountable over a range from 200 to 400mm)
For model IR-M1300, mount the detector so that the distance from the measuring surface becomes 200mm. (Mountable over a range from 160 to 300mm)

(2) Since the visual light is radiated to the measuring surface, the measuring position can be confirmed.

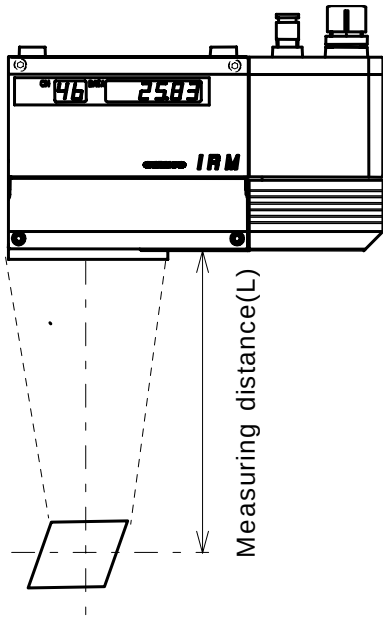
(3) Prepare the mounting plate according to the conditions at the mounting place. For the outer profile of the mounting plate, take the wiring space, etc. into account.

3.3.1 External profile and mounting dimensions



3. Setting and Installations ⚠

[Measuring distance/measuring area]



[For model IR-M1100, IR-M1200series]

[Standard type]

Measuring distance (mm)	Measuring area (mm)
200	□30
300	□50
400	□70

Measuring distance (mm)	Measuring area (mm)
200	□30
300	□30
400	□40

[For model IR-M1300 series]

Measuring distance (mm)	Measuring area (mm)
160	□30
200	□30
300	□30

3.4 Cautions on installation

3.4.1 Vibrations and impacts:

Mount the detector at a place where is free of any noticeable vibrations or impacts. If it is used at a place subjected to vibrations and impacts due to unavoidable circumstances, separate the mounting plate from the vibration source or spread a shock-absorbing rubber sheet between the detector and the mounting plate for preventing vibrations.

3.4.2 Induction:

The detector is designed by taking the induction resistance into account. However, separate it from the induction heating oscillator and power line as far as possible.

3.4.3 Ambient temperature and humidity:

The ideal ambient temperature of the detector is 10 to 30^{o}C. If the detector is used at a temperature higher than 45^{o}C, cool it down by means of air.

If the detector is used at a temperature lower than 10^{o}C, be careful with dew condensation on the cover glass face. Steam may cause the dew condensation on the cover glass face due to a change of the temperature under a very wet condition to resultantly cause a measuring error.

3.4.4 Optical path:

Select a place where none of water drops, dust particles, smoke, steam, etc. enters between the detector and the measuring surface.

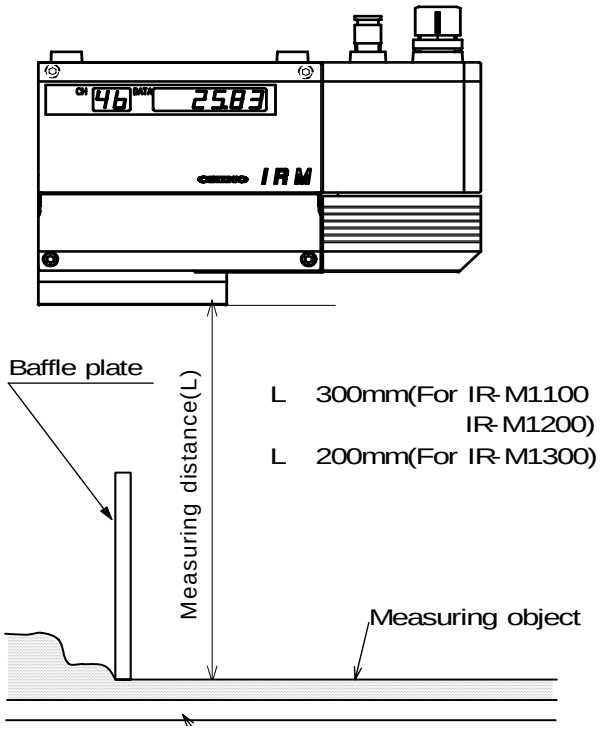
If these substances cannot be prevented due to unavoidable circumstances and their influences are not negligible, purge them with a compressed air or other remedial measure is necessary.

Out of the external light to the measuring surface, the light whose intensity does not change momentarily like the natural light does not act as the disturbance to the measurement. However, the light like an electric bulb, a flame, etc. acts as the disturbance. The intense light like the direct sunlight acts as the disturbance. In such a case, shield the disturbance light to prevent it from being radiated to the measuring surface directly.

3. Setting and Installations ⚠

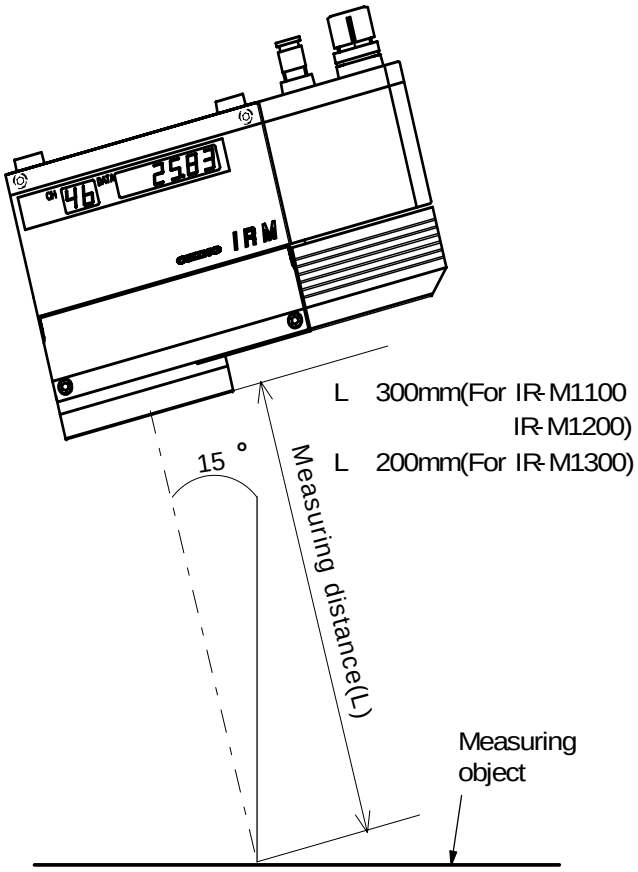
3.4.5 Measuring place (For objects of pulverized or granular substance):

When mounting the detector in the on-line, select a mounting place where the moisture difference is small between the surface and the interior of the measuring object, like the hopper outlet or just behind the belt conveyor transfer place. If such a place cannot be selected due to the system conditions, face the interior to the surface by using a baffle plate during measurement as illustrated right.



3.4.6 Measuring place (For objects in sheet state such as paper):

Tilt the detector by 15° from the vertical face as illustrated right.



4. Connections ⚠

4.1 Layout of connection cable

For connection of cables, be careful of the following points.

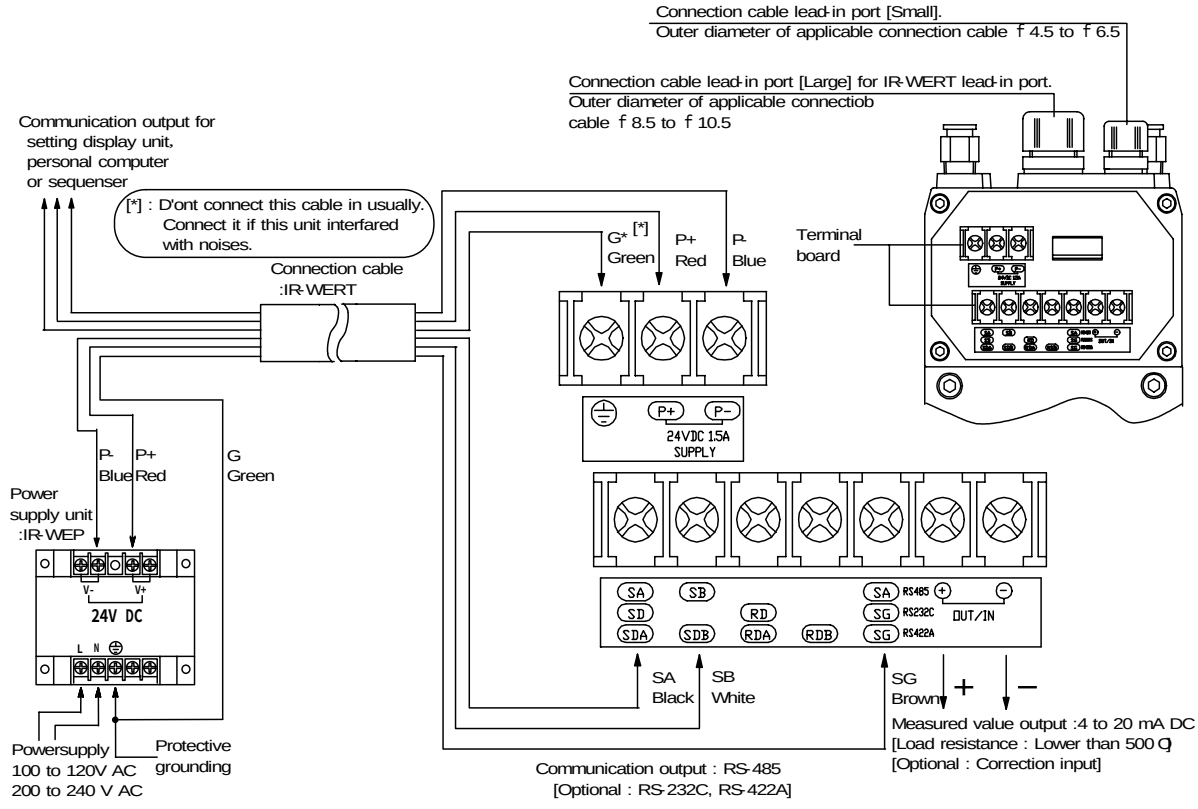
- Separate the cables from induction heating oscillator and power lines.
- Keep the cables free of deposit of water, oil, etc.
- Don't bend the cables extremely or apply any excessive force to them.
- For permanent layout, protect the cables with conduits, etc.

4.2 Single-detector connections:

The internal terminal board is accessible by removing the power supply cover of the detector. Lead in cables through the upper cable lead-in port, and connect them to individual terminals. Lead in the exclusive cable IR-WERT through the large lead-in port.

Warning For preventing electric shock, make sure to turn the power supply off before wiring.

Caution Use a cable conforming to the applicable outer diameter (ϕ4.5 to 6.5mm) of the small cable inlet; otherwise waterproofing of the detector unit may deteriorate. Tighten the nut at the cable inlet securely after connections.



4. Connections ⚠

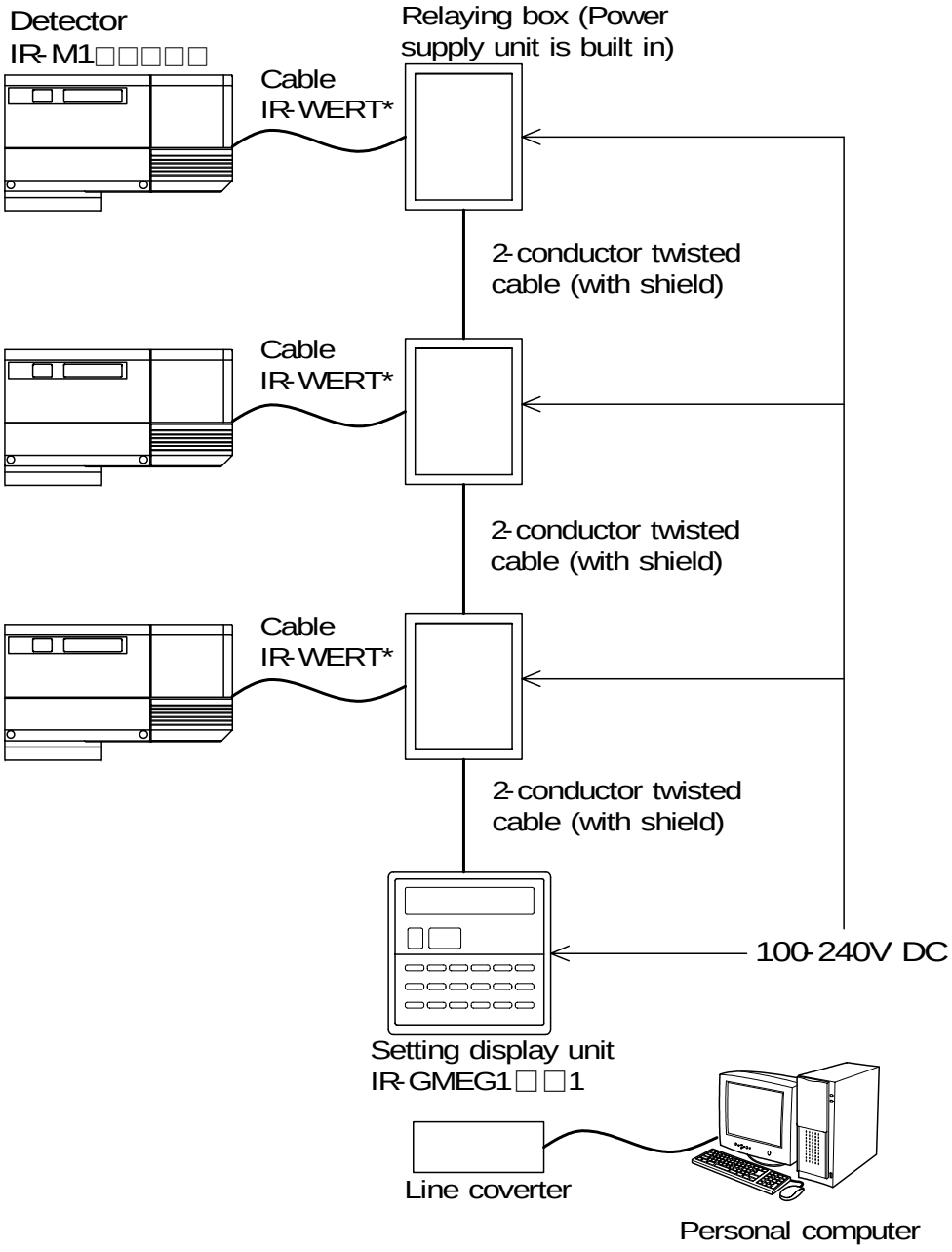
4.3 Multi-detector connections

By using the setting display unit, you can connect the detector unit up to 9 sets.
Two wiring methods are available. One is wiring through a relay box (IR-WEE□) and the other is without the relay box (IR-WEE□).

Caution

For both wiring methods, before connecting with the setting display unit or before turning on the power supply of the setting display unit, number setting to the detector units is required. For the number setting, be careful not to overlap any detector unit number of each detector unit.
Refer to [6.2 Setting of detector unit number] for the details.

4.3.1 Connections through the relay box (Model: IR-WEE1 or IR-WEE2)

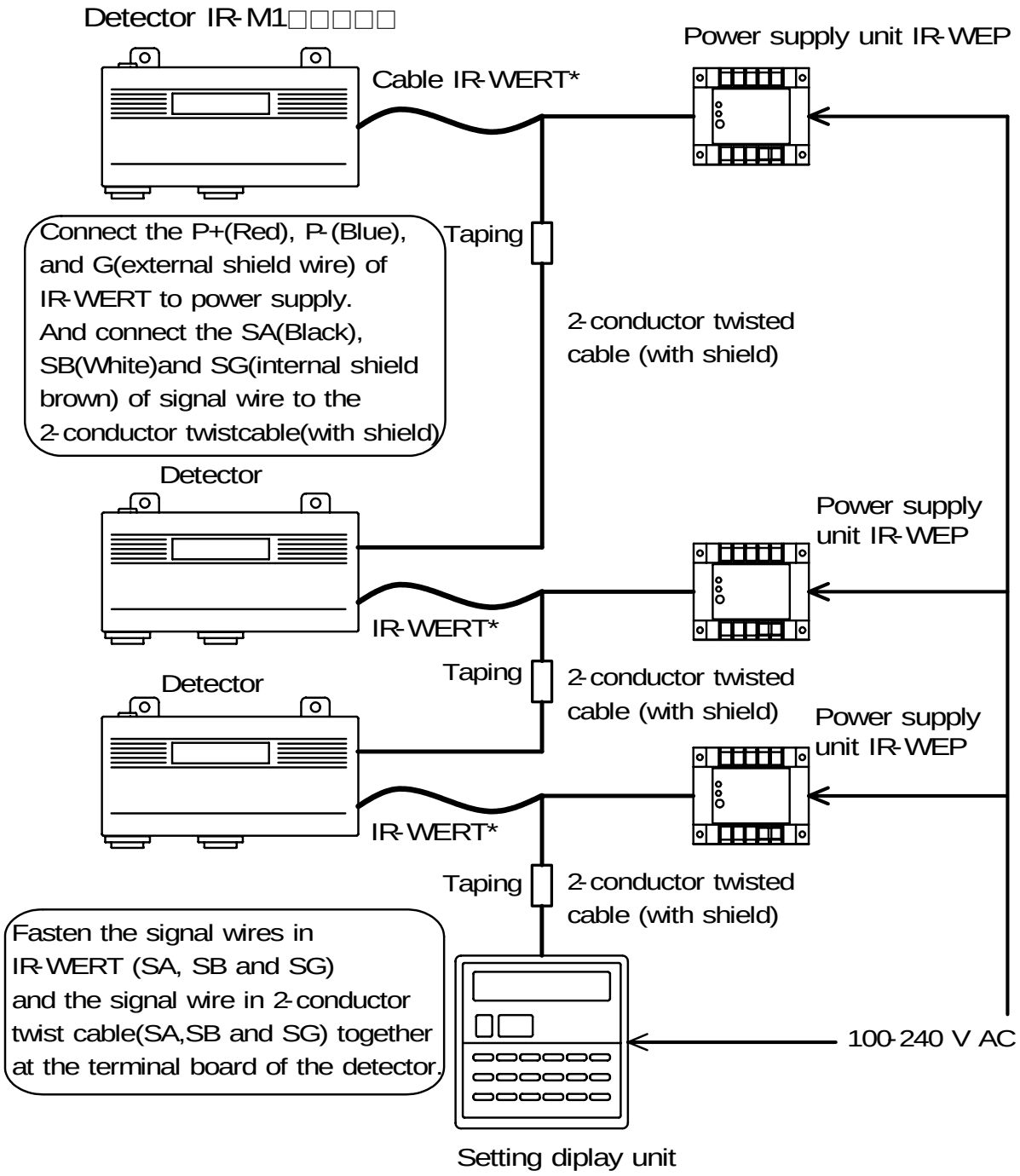


Caution

1. Shorten the length of exclusive cable (IR-WERT * mark) as much as possible.
2. For wiring to the relay box, refer to “Instruction manual of relay box”.

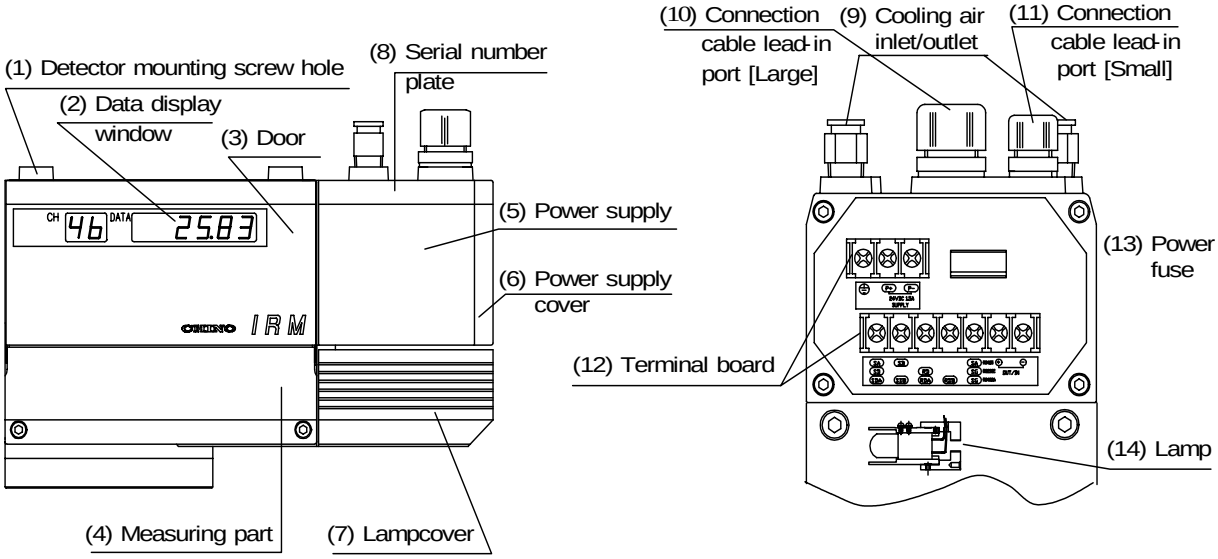
4. Connections ⚠

4.3.2 Connections without any relay box

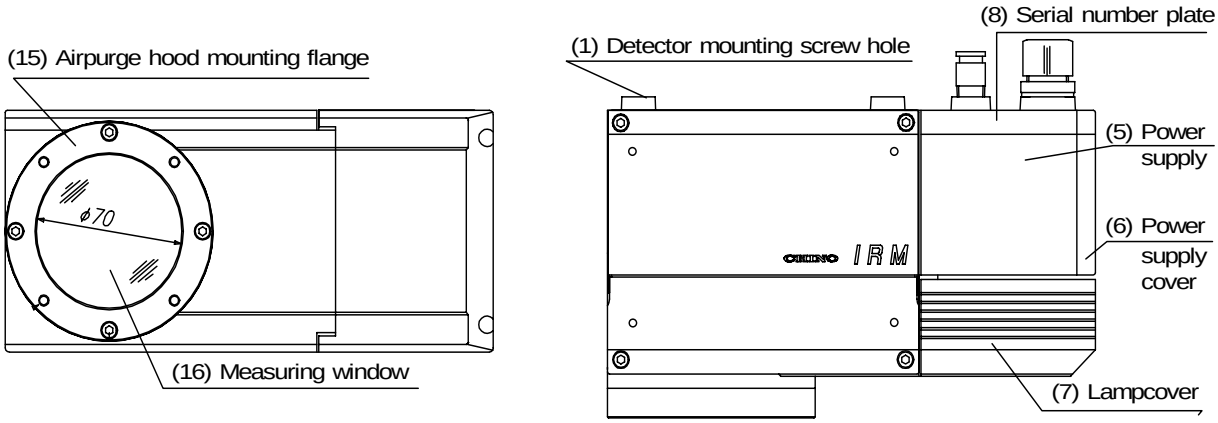


5. Names and Functions of Component parts ⚠

5.1 Names and functions of the Detector



[Front view of model "IR-M1□□□□N"]



(1) Detector mounting screw hole:
Four M8 screw hole (11mm in depth) for fixing the detector to the mounting plate, etc.

(2) Data display window (Except model for IR-M1□□□□N):
Displays the calibration curve numbers and measured values.

(3)Door (Except model for IR-M1□□□□N):

By opening this setting display door, setting key switches are accessible. Since this door is opened or closed by a magnet system, and can be opened by pulling its upper part downward.

(4) Measuring part:
The optical system, detection element, and electric circuits are assembled.

(5) Power supply:
Terminal board for wiring, power fuse, power supply unit and output part are built in.

(6) Power supply cover:
This cover is fixed with four M4 hexagon socket head bolts, and remove in connections.

5. Names and Functions of Component parts ⚠

5.1 Names and functions of the Detector

(7) Lamp cover:
This cover is fixed with four M4 hexagon socket head bolts, and lamp is located inside.

(8) Serial number plate:
This detector's serial number plate is mounted at the upper part.

(9) Cooling air inlet/outlet:
This air inlet/output is used for cooling the power supply with air. Connect a nylon tube of 8mm ϕ in outer diameter and 6mm ϕ in inner diameter to this air inlet/output. The tube connection joint is PC8-02 manufactured by Nihon PISCO Co. Use a dry cooling air excluding oil, dust, and other foreign substances.

Recommendable air flow:
Approx. 50Nl/min

Maximum air pressure:
Lower than 200kPa (2kgf/cm^2)

(10) Connection cable lead-in port (large):
The applicable connection cable to this connection cable lead-in port is 8.5mm ϕ to 10.5mm ϕ in outer diameter. Lead in exclusive cable IR-WERT through this port.

(11) Connection cable lead-in port (small):
The applicable connection cable to this connection cable lead-in port is 4.5mm ϕ to 6.5mm ϕ in outer diameter.

(12) Terminal board:
This internal terminal board is accessible by opening the power supply cover. For wiring of connection cables, and the terminal screw size is M4.

(13) Power fuse:
A 2A insertion type fuse of time-lag fusion type is mounted to the fuse holder.

Warning Make sure to turn off the power supply before replacement of power fuse.

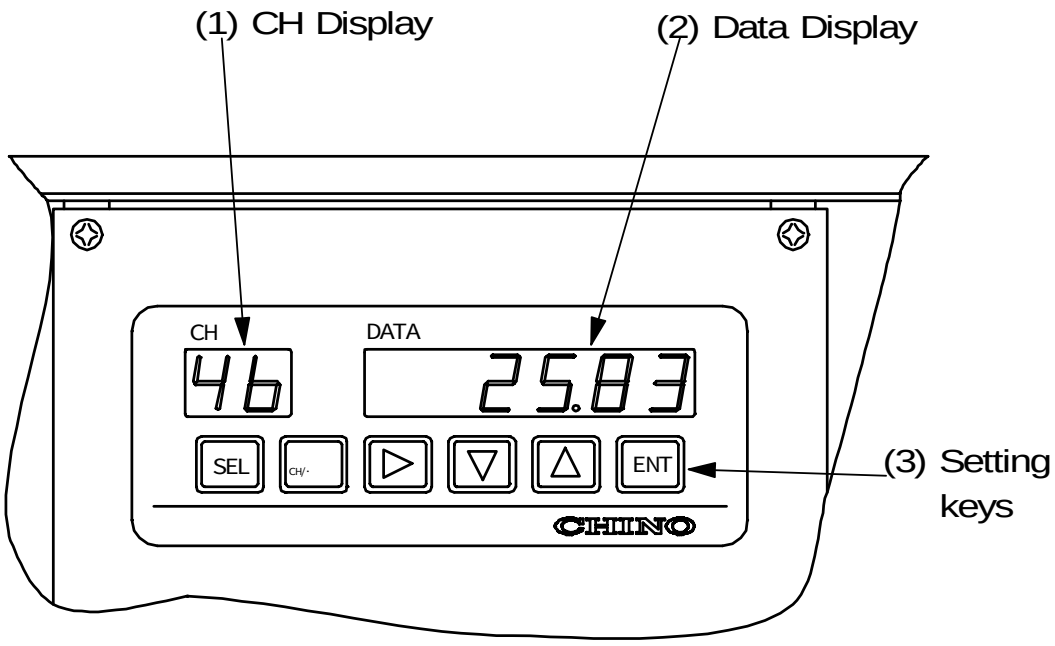
(14) Lamp:
Lamp for infrared moisture meter.

(15) Air purge hood mounting flange:
This flange is provided with four M5 screw holes.

(16) Measuring window:
Measuring window for light projection and reception.

5. Names and Functions of Component parts ⚠

5.2 Setting display unit (Except model for IR-M1□□□N):



(1) CH display: Displays a calibration curve number in measurement mode and a parameter item in setting mode.

(2) Data display Displays a measured value in the measurement mode and a parameter in the setting mode.

(3) Setting keys

SEL : For entering into the setting mode and switching a setting screen.

CH/・ : For setting a calibration curve number in the measurement mode and for entering a decimal point in the setting mode. When the key is pressed again, the decimal point disappears.

▷ : For entering into a parameter setting in the setting mode and changing the digit of the parameter.

▽ : For changing the parameter in the setting mode.

△ : For changing the parameter in the setting mode.

ENT : For storing the parameter in the setting mode.

6. Operation

6.1 Confirmation before operation

Check the following two points before turning on the power supply.

1) Have the dipswitches been set? (Refer to [3.1 Setting of dipswitches])
2) Is wiring correct? (Refer to [4. Connection])

6.2 Setting of detector unit number

6.2.1 Setting of detector unit number (Except model for IR-M1□□□N)

Detector unit numbers are for identifying each detector unit when multiple detector units are connected to the setting display unit. (Refer to [4.3 Multi-detector connection]). Set a detector unit number before connecting the setting display unit.

Reference

The default number of the detector unit is “1”.
For using it with a number other than 1, set the detector unit number by following order.

1) Enter into the operation condition setting mode by pressing SEL key and ENT key simultaneously to set CH display “t” for 2 seconds.
2) Press SEL key 4 times to set CH display to “Hn”.
3) By pressing ▷ key, the numeric blinks for entering a detector unit number.
4) Change the numeric by key or key.
   When △ key is pressed, the numeric is increased.
   When ▽ key is pressed, the numeric is decreased.
   When ▷ key is pressed, the blinking digit shifts.
5) When ENT key is pressed, the numeric stops blinking and the detector number is stored.
6) Return to the measurement mode by pressing SEL key for 2 seconds.

Reference

The following setting can be done from "Setting display unit” (Model: IR-GMEG).
Refer to the "Instructions for setting display unit".

6.2.2 Setting of detector unit number (Only model for IR-M1□□□N)

In case of using “IR-M1□□□N”, set the detector unit number by referring to [3.1.2 Setting of DIP switch 2 (Model for IR-M1□□□N only)

6. Operation

6.3 Setting of calibration curve (Except model for IR-M1□□□N)

Reference

When using models except for "IR-M1□□□N", the following setting can be done from "Detector unit " or "Setting display unit".
Set from "Setting display unit", if using "IR-M1□□□N".

The output characteristic of infrared moisture meter depends upon measuring objects. It may also change according to the process conditions and sample moisture measuring conditions. Therefore, it is necessary for accurate moisture measurements to perform a sample test of the object and obtain the correlation (This is called as calibration curve.) between the moisture value (%H_2O) obtained by a drying method or other measuring methods and the absorbance "x" measured by the moisture meter.

Reference

This paragraph describes the setting method for calibration curve data, assuming that calibration curves have been already created.
When the calibration curves have not been created yet, refer to [7.Creation of calibration curves].

6.3.1 Setting data

The followings are the setting data of calibration curve.

Data name	Display	Setting range	Default value	Remarks
(1) Calibration curve No.	CH	1 to 99	1	
(2) Polynomial coefficient $\mathbf{a_0}$	A0	0 to ±9999.9	0.0000	Effective numeric: 5 digits
(2) Polynomial coefficient $\mathbf{a_1}$	A1	0 to ±9999.9	0.0000	Effective numeric: 5 digits
(2) Polynomial coefficient $\mathbf{a_2}$	A2	0 to ±9999.9	0.0000	Effective numeric: 5 digits
(2) Polynomial coefficient $\mathbf{a_3}$	A3	0 to ±9999.9	0.0000	Effective numeric: 5 digits
(3) Correction expression coefficient $\mathbf{b_0}$	B0	0 to ±9999.9	0.0000	Effective numeric: 5 digits
(3) Correction expression coefficient $\mathbf{b_1}$	B1	0 to ±9999.9	1.0000	Effective numeric: 5 digits
(4) Output low limit moisture	Hi	0 to 9999.9	0.00	Decimal digit depends on specification.
(4) Output high limit moisture	Hi	0 to 9999.9	100.00	Decimal digit depends on specification.
(5) Low limit alarm moisture	AL	0 to 9999.9	0.00	Decimal digit depends on specification.
(5) High limit alarm moisture	AH	0 to 9999.9	100.00	Decimal digit depends on specification.
(6) Preset moisture	PS	0 to 9999.9	0.00	Decimal digit depends on specification.

(1) Calibration curve number

An optional number from 1 to 99 can be designated as the calibration curve. It is designated sequentially from "1" usually.

(2) Polynomial coefficient "a_0 to a_3"

Assume that the calibration curve is represented by third-degree or lower-degree polynomial as shown below.

$$y = a_3x^3 + a_2x^2 + a_1x + a_0$$

where, "y" is the moisture value (%H_2O) and "x" is the absorbance ("CH0" data of this moisture meter).

(3) Correction expression coefficient "b_0 to b_1"

These coefficients are provided for primary expression correction (zero and span correction) with reference to moisture value "y". Assuming that the moisture value after correction be "Y", we obtain. $y = b_1y + b_o$

6. Operation

(4) Output low limit moisture, output high limit moisture

These moisture values are specified as the output low limit and output high limit on the analog output scaling. These values are scaled to be 4mA at the output low limit moisture and 20mA at the output high limit moisture.

(5) Low limit alarm moisture, high limit alarm moisture

The low limit alarm activates when a measured value is lower than the low limit alarm moisture, while the high limit alarm activates when a measured value is higher than the high limit alarm moisture. Since the detector unit does not provide any alarm output function, the setting display unit is required when an alarm output is necessary.

(6) Preset moisture

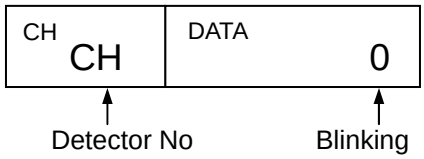
By turning on the preset output by key operations or through communications, the moisture value being set as preset moisture is displayed and output, regardless of the measured value.

6.3.2 Setting method of calibration curve

1) Press SEL key for 2 seconds to enter into the calibration curve data setting mode.

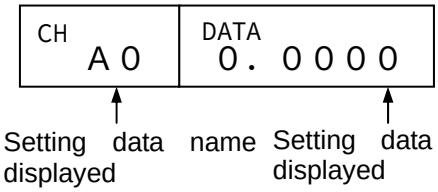
2) By pressing ▷ key, a numeric blinks for entering a calibration curve number.

3) Change the numeric by △ key, ▽ key or ▷ key.
When △ key is pressed, the numeric is increased.
When ▽ key is pressed, the numeric is decreased.
When ▷ key is pressed, the blinking digit shifts.



4) When ENT key is pressed, the numeric stops blinking and the calibration curve number is stored.

5) Press SEL key to enter into the setting mode for polynomial coefficient $\mathbf{a_0}$.



6) Enter into a numeric setting mode by pressing ▷ key. Change the numeric by △ key or ▽ key and store it by pressing ENT key.
For entering a decimal point, press CH/・ key at the blinking digit.

7) Press SEL key to enter into the next data setting mode.

8) Repeat the above procedure to set all data.

9) After the above setting procedure is completed, return to the measurement mode by pressing SEL key for 2 seconds. The automatic return is made if no key is pressed for one minute.

6.4 Setting of knee point approximation calibration curve (Except IR-M1□□□N)

Reference

When using models except for "IR-M1□□□N", the following setting can be done from "Detector unit" or "Setting display unit".
Set from "Setting display unit", if using "IR-M1□□□N".

When a calibration curve is obtained in a graph but it cannot be expressed in third-degree or lower-degree polynomial, the calibration curve can be created by knee point line approximation.

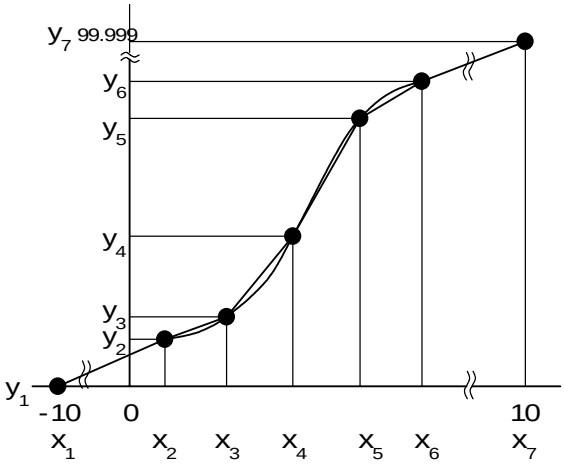
6. Operation

6.4.1 Setting of knee point data

1) Supposing that the calibration curve graph is as shown in the following figure.
2) Divide the calibration curve graph appropriately and express it with knee point line approximation.
3) In this case, the first junction point and the last junction point should sufficiently include the measuring range. You can plot up to 20 junction points including the first junction point and the last junction point. Determine intermediate junction points appropriately according to the approximation accuracy.
4) Supposing that the junction point data obtained by the above are as shown below.

First junction point d_1: (x_1, y_1)
d_2: (x_2, y_2)
Last junction point d_n: (x_n, y_n)

↑
Data number



6.4.2 Knee point line setting data:

The following data is necessary for the creation of the calibration curve by knee point line approximation.

Data name	Display	Setting range	Default	Remarks
(1) Calibration curve No	CH	1 to 99	1	
(2) Data count	N	3 to 20	3	
(3) Data number	Dn	1 to 20	1	
(3) Sample data x_n	Hn	0 to ±9999.9	0.0000	Valid number 5 digits
(3) Sample data y_n	yn	0 to ±9999.9	0.0000	Valid number 5 digits
(4) Regression/Knee point line	Pb	1 to 4	1	1 to 3: Polynomial expression degree (Regression operation) 4: Knee point line approximation
(5) Standard deviation	Sd	0 to 999.99	0.0000	Setting not required in knee point line approximation

(1) Calibration curve number:

Calibration curve number can be specified in optional numbers from 1 to 99 but usually it is specified in order from 1.

(2) Data count: It is the number of knee point data and the maximum is 20 points.

(3) Data number, sample data x_n, sample data y_n:

Enter the knee point data obtained in [6.4.1 Setting of knee point data].

(4) Regression/knee point line:

With entering 1, 2 or 3, the polynomial expression with that degree can be obtained according to the above sample data by regression operation.
When 4 is entered, knee point line approximation is obtained.

(5) Standard deviation:

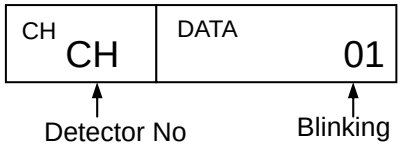
When the regression operation is specified, standard deviation is displayed.
This setting is not required in knee point line approximation.

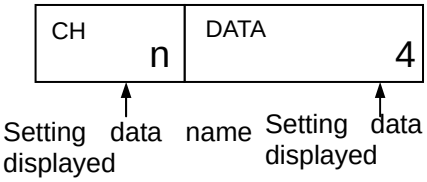
6. Operation

6.4.3 Setting of calibration curve data for knee point line approximation

(1) Setting of calibration curve number

1) Press SEL key and CH/. key simultaneously for 2 seconds to enter into the sample data setting mode.
2) By pressing ▷ key, a numeric blinks for entering a calibration curve number.
3) Change the numeric by △ key, ▽ key or ▷ key.
   When △ key is pressed, the numeric is increased.
   When ▽ key is pressed, the numeric is decreased.
   When ▷ key is pressed, the blinking digit shifts.
4) When ENT key is pressed, the numeric stops blinking and the calibration curve number is stored.



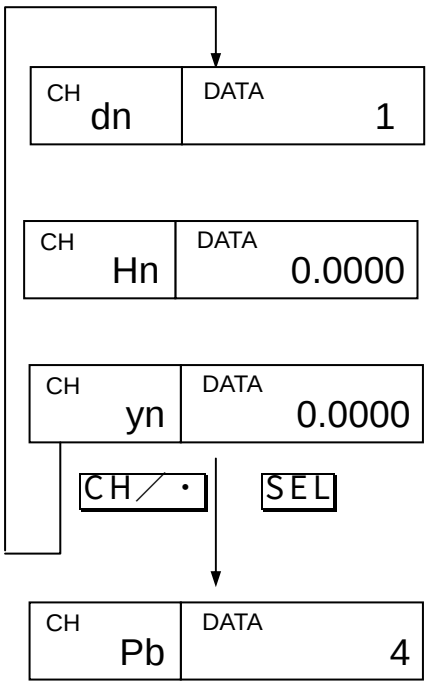


(2) Setting of data count

1) Press SEL key to enter into the data count setting mode.
2) Change a numeric by the procedure mentioned in the above "(1) Setting of calibration curve number 2) and 3)" and store it with ENT key.

(3) Setting of data number, sample data x_n and sample data y_n

1) Press SEL key to enter into the data number setting mode.
2) Change a numeric by the procedure mentioned in the above "(1) Setting of calibration curve number 2) and 3)" and store it with ENT key.
3) After setting the above, press SEL key for entering into the sample data x_n setting mode.
4) After setting the above, press SEL key for entering into the sample data y_n setting mode.
5) After setting the above, press CH/. key to return to "1) Data number setting mode" and then set the next data number.
6) Repeat the above procedures for setting all junction point data.



(4) Regression/Knee point line

1) After completing the setting of knee points, press SEL key to enter into the regression/knee point line setting mode.
2) Enter **"4"** in the selection of regression/knee point line.
3) After the settings are completed, press SEL key for 2 seconds to return to the measurement mode.
   Automatic return to the measurement mode is made if any key is operated for 1 minute.

6. Operation

6.5 Setting of operating conditions (Except model for IR-M1□□□N)

Reference

When using models except for “IR-M1□□□N”, the following setting can be done from “Detector unit ” or "Setting display unit”.
Set from "Setting display unit”, if using “IR-M1□□□N”.

Set the operating conditions including time constant and decimal place in the display.

6.5.1 Setting data: Set the following data in operating conditions.

However, the number of displayed setting data varies depending on the setting of dipswitches.

Data name	Display	Setting range	Default value	Remarks
(1) Time constant	t	0 to 9.9 to 99	0.0	Unit: Seconds
(2) Hold ON/OFF	Hd	ON, OFF	OFF	
(3) Preset output ON/OFF	PS	ON, OFF	OFF	
(4) Decimal place in display	Dt	0 to 4	1	
(5) Detector unit number	Hn	1 to 9	1	
(6) Communications speed *1	SP	1200, 2400, 4800, 9600, 19200	9600	
(6) Parity *1	P	nonE odd EVEn	EVEn	nonE :Non parity odd :Odd parity EVEn :Even parity
(6) Data length *1	D	7, 8	7	
(6) Stop bit length *1	B	1 to 2	1	
(6) BCC enable/disable *1	Bc	ON, OFF	OFF (disable)	
(7) Sample temperature correction enable/disable	St	ON, OFF	OFF (disable)	
(8) Correction input scaling L*2	TL	-999 to 999	0	
(8) Correction input scaling H*2	TH	-999 to 999	100	
〔Engineering mode〕				
(9) Weight α	Af	0 to 1.000	0.500	
(10) Calibration constant k1	k1	0 to ±9.9999	1.0000	
(11) Calibration constant k2 *3	k2	0 to ±9.9999	0.0000	

Note) The setting data of *1 to *3 is displayed or not depending on the setting of dipswitches.

Displayed data	Setting of dipswitch 1	Contents
*1 Setting data	No. 4 : ON	Connection destination: Personal computer
*2 Setting data	No. 7 : ON No. 8 : OFF	Corrected input: Enable Corrected input specification: 4 to 20mADC
*3 Setting data	No. 3 : ON	No. 2 Calibration: Enable

(1) Time constant: If a measured value fluctuates noticeably, the signal can be set to be dull by delaying the response of this moisture meter. Set the smoothing time (equivalent to the time constant of analog instrument) in 0.1-second increment for less than 10 seconds and in 1-second increment for more than 10 seconds.

(2) Hold ON/OFF: When holding of measured value is desired, turn it ON. At this time, analog output will also be held.

6. Operation

(3) Preset output ON/OFF: By turning on the preset output, this moisture meter displays the preset moisture value and the analog output becomes the value corresponding to the preset moisture value.

(4) Decimal place in moisture display: The decimal place can be set for easily monitoring the moisture value measured.

(5) Detector unit number: This is the number for identifying the detector unit for connection of multiple detector units. This setting has been completed in [6.2 Setting of detector unit number].

(6) Communications speed, Parity, Data length, Stop bit length, BCC enable/disable: These are for communications with a personal computer, a sequencer or other similar devices. These data are not necessary to set for combining this moisture meter with the setting display unit.

(7) Sample temperature correction enable/disable: These are used for sample temperature correction enabled.

(8) Correction input scaling L, Correction input scaling H: These are used for scaling of 4 to 20mA correction input.

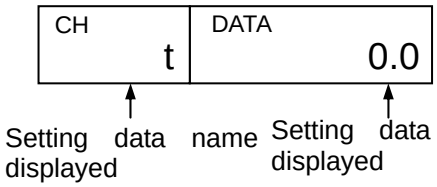
(9) Weight α: In 3-wavelength operation, the ratio of 2 comparative wavelengths is determined by this value.

(10) Calibration constant K1: This is the calibration constant at the time of zero side calibration.

(11) Calibration constant k2: This is the calibration constant at the time of span side calibration.

6.5.2 Setting

1) Press SEL key and ENT key simultaneously for 2 seconds to enter into the operation condition setting mode.
2) By pressing ▷ key, a numeric blinks for entering a data. △
3) Change the numeric by key, ▽ key or ▷ key. When ▷ key is pressed, the blinking digit shifts.
For entering the decimal point, press CH/. key.
4) When ENT key is pressed, the numeric stops blinking and the data is stored.
5) Press SEL key to enter into the setting mode of the next data. Repeat the above procedures to set all data except the engineering mode.
6) For setting of data in the engineering mode, press ENT key in the screen shown in the right side to enter into the setting mode of the engineering mode.
7) After the settings are completed, press SEL key for 2 seconds to return to the measurement mode. Automatic return to the measurement mode is made if any key is operated for 1 minute.



6. Operation

6.6 Calibration (Except model for IR-M1□□□N)

Reference

When using models except for “IR-M1□□□N”, the following setting can be done from “Detector unit ” or "Setting display unit”.
Set from "Setting display unit”, if using “IR-M1□□□N”.

For using this moisture meter accurately, regular calibration once in three months is requested.

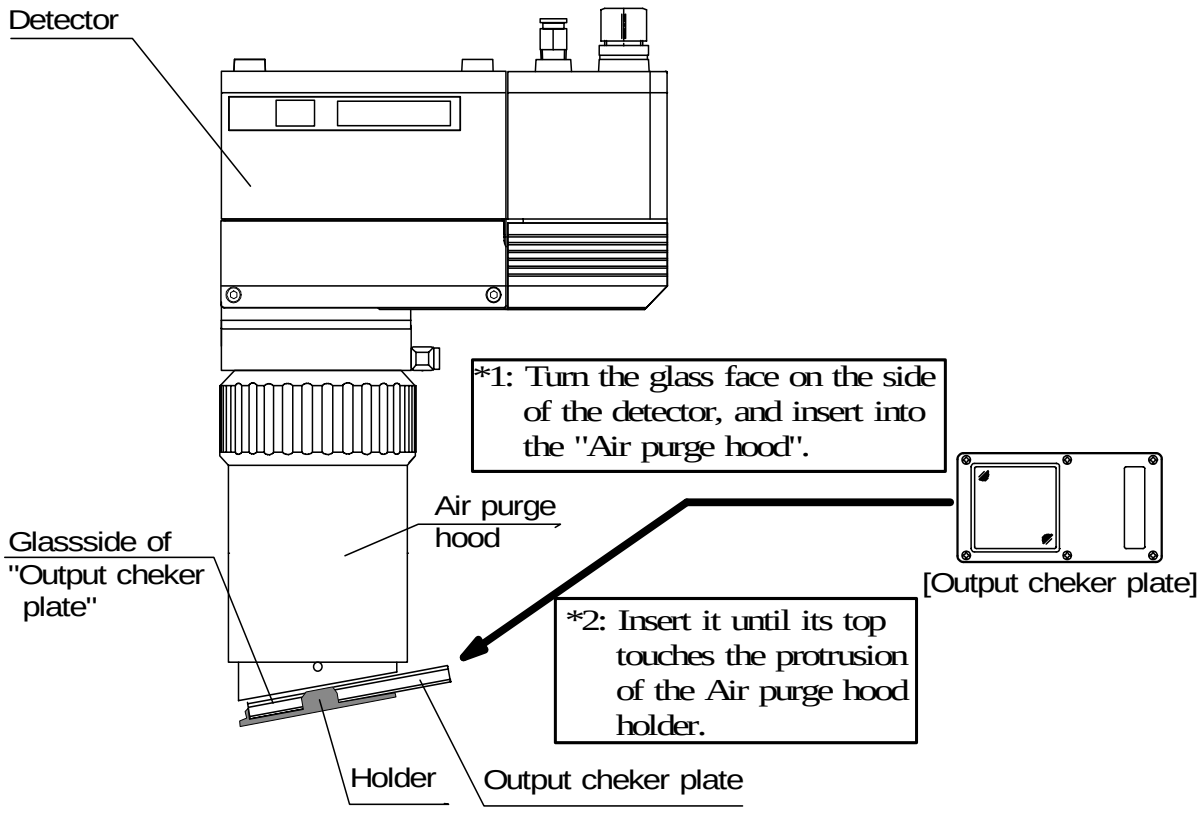
1) Supply power more than one hour to this moisture meter before calibration.
2) Turn the calibration curve number to 0. (For the change in calibration curve number, refer to [6.7 Setting of calibration curve number]. By this setting, absorbance “x” is displayed as a data.

CH	DATA
0	0.0021

3) Mount the output checker plate to the tip of the air purge hood, and face No.1 side of output checker plate.
4) Execute the calibration by pressing the three keys SEL , ▽, and ENT simultaneously.

CH	DATA
0	0. 0000

Make sure that light absorbance “x” is within 0.00000±0.0010 in the model of IR-M1100 and IR-M1200.
Make sure that light absorbance “x” is within 0.00000±0.005 in the model of IR-M1300.
The calibration is completed.



6. Operation

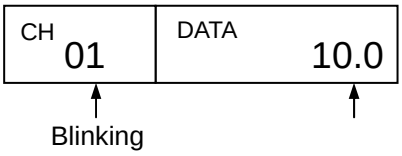
6.7 Setting of calibration curve number (Except model for IR-M1□□□N)

Reference

When using models except for “IR-M1□□□N”, the following setting can be done from “Detector unit ” or "Setting display unit”.
Set from "Setting display unit”, if using “IR-M1□□□N”.

Set the calibration curve number according to the measuring object.

1) By pressing CH/. key, a numeric blinks for entering a calibration curve number.
2) Change the numeric by △ key, ▽ key or ▷ key.
3) When ENT key is pressed, the numeric stops blinking and this moisture meter becomes the measurement mode at the calibration curve number changed.



6.8 Correction of calibration curve (Except model for IR-M1□□□N)

Reference

When using models except for “IR-M1□□□N”, the following setting can be done from “Detector unit ” or "Setting display unit”.
Set from "Setting display unit”, if using “IR-M1□□□N”.

If the actual moisture value is different from the moisture value being preset due to the difference of one-line and off-line, or other causes, correct it by the correction coefficients b_0 and b_1 in [6.3 Setting of calibration curve data]. Usually, the shift correction is done with b_0 only.

Reference

[Example]
When the measured moisture before correction is 15(%H_2O) and actual moisture value is 13 (%H_2O),Set b_0 = -2(%H_2O) .

7. Creation of calibration curves

7. Creation of calibration curves

The output characteristics of the moisture meter depend upon the measuring objects. Also, the output characteristics may also change according to the process conditions and moisture measurement conditions of samples for certain measuring objects.
Therefore, for accurate measurement of moisture, it is necessary to carry out the sample tests of each measuring object in advance and obtain the relative relation (this is called as calibration curve) between the moisture value ($\%H_2O$) obtained by the drying method or other measuring methods and the absorbance "x" measured by the moisture meter This chapter describes the measurement of the moisture value by the drying method. However, the method of creation of the calibration curves is same even if the moisture value is measured by the Karl Fischer method or other methods.

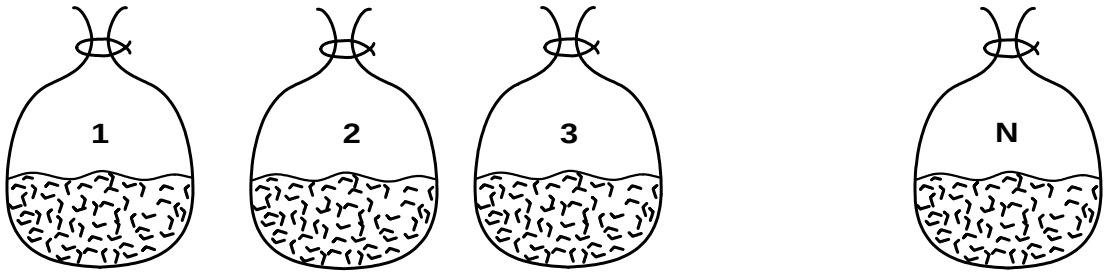
7.1 Sample preparation

7.1.1 Powder or granular

(1) Take a sample of about 2 to 4 liters from the measuring object.
(2) Dry up the sample up to the absolute dry condition by a dryer. Particularly be careful with the heating temperature so as not to denature the sample.
(3) Divide the dry sample every 100 to 200cc into 5 to 6 samples separately, although it is recommendable to divide the sample into many samples.
(4) Add water to these 5 to 6 samples bit by bit so that the moisture values of each sample divides the measuring range almost evenly.
(5) Stir each sample with water addition sufficiently, and put it into a polyethylene bag and seal it tightly.
(6) Leave each sample for about 2 days until its moisture is stabilized.

Caution

If a sample cannot be heated or it is hardened by adding water and thus can’t be measured, adjust the moisture correspondingly according to the procedure in case of a paper shown below.



7. Creation of calibration curves

7.1.2 Paper (sheet substance)

(1) Cut a sample to have a size of about 100 x 100mm by using a cutter or the like.
(Number of samples: 9 sheets)

(2) Divide nine sheets of the sample into 3 groups with 3 sheets in each group. Adjust the moisture of each group under the following conditions.

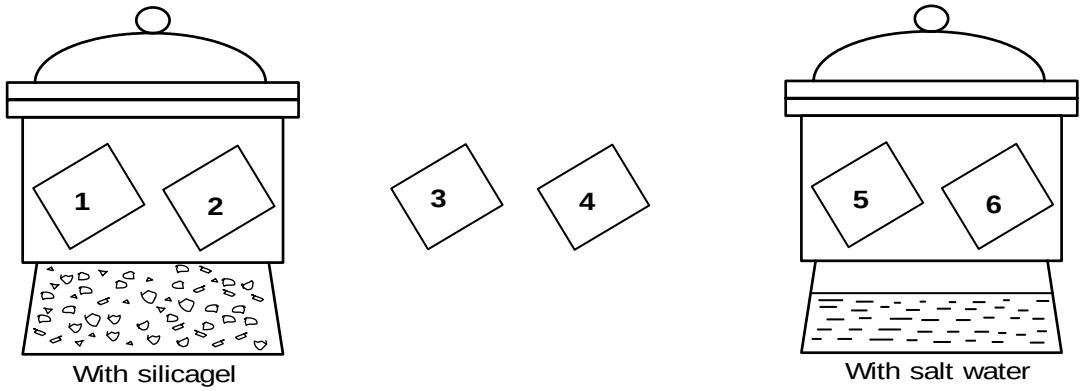
Drying : Leave the samples in a desiccator containing silica gel for 2 days. In case of papers, the moisture becomes about 4%H_2O.

In the air: Leave the samples in an indoor atmosphere.
In case of papers, the moisture becomes about 7%H_2O in summer or about 5%H_2O in winter.

Moistening: Leave the samples in a desiccator containing salt water for 2 days.
In case of papers, the moisture becomes 8 to 9%H_2O usually or maximum about 11% H_2O.

Caution

Wear clean gloves when handing samples so as not to touch them by naked hands directly.
It is convenient for you to mark the samples for identifying its front and rear surfaces and its flow direction.



7.2 Sample measurement

Be careful with the following cautions during measurement.

(1) Before measurement, warming-up of this moisture meter more than 1 hour is required.

(2) Place a sample at the same position as in actual measurement, set the calibration curve number to 0, and read the display (absorbance "x").

(3) Perform the measurement rapidly.

7.2.1 Powder or granular

(1) Prepare the trays (Diameter 100 to 150mm, Depth about 20mm) by the same quantity as the measuring sample quantity.

(2) Weigh the weight w_0 of each tray.

(3) Spread the sample being sealed in the polyethylene bag on the tray it till the surface becomes flat and the bottom cannot be seen.

(4) Put the tray at the measuring position, set the calibration curve number to 0, and read the display (absorbance "x"). If the measured value cannot be read easily, delay the response by the smoothing function.

(5) Stir the sample rapidly with a spoon and measure it again. Repeat this measurement 2 or 3 times per sample.

(6) Weigh the weight w_1 of the tray together with the sample.

7. Creation of calibration curves

7.2.1 Powder or granular

(7) Perform the same measurement sequentially about all samples.
(8) Put each sample together with its tray into a dryer, and dry it out to be the absolute dry condition (for longer than 2 hours at 105 to 110ºC usually).
(9) Cool down the sample after drying, and weigh the weight w_2 of each tray together with the sample.
(10) Record the measured value in the following table every measurement, and obtain the moisture value by the following formula.

$$\frac{w1-w2}{w1-w0} \times 100\ (\%H_2O)$$

No.	Absorbance "x"	w0	W1	w2	Moisture value (%H_2O)
1	x1				y1
2	x2				y2
3	x3				y3
:	:				:
N	xn				y4

7.2.2 Paper (Sheet substance)

(I) Weigh the weight w_1 of a sample before measurement.
(2) Hold the sample by a paper holder, put it by tilting at 15º to the measuring position, set the calibration curve number to 0, and read its display (absorbance "x"). In this case, match its front and back surfaces and flow direction of the samples.
(3) Weigh the weight w_2 of the sample after measurement. Perform the measurement from (1) to (3) as quickly as possible.
(4) Perform the same measurement sequentially for all samples.
(S) Put each sample into a dryer, and dry it out to be the absolute dry condition (for longer than 2 hours at 105ºC usually by using paper stand).
(6) Cool down all samples in a desiccator containing silica gel after drying.
(7) Weigh the weight w_3 of each sample.
(8) Record the measured value in the following table every measurement, and obtain the moisture value by the following formula.

$$\frac{(w1+w2)/2-w3}{(w1+w2)/2} \times 100\ (\%H_2O)$$

No.	Absorbance "x"	w0	W1	w2	Moisture value (%H_2O)
1	x1				y1
2	x2				y2
3	x3				y3
:	:				:
N	xn				y4

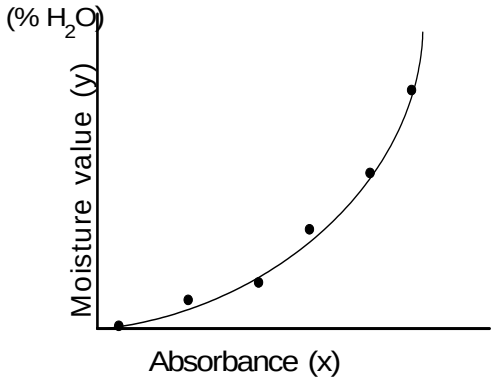
7. Creation of calibration curves

7.3 Creation of calibration curves (Except model for IR-M1□□□N)

Reference

When using models except for “IR-M1□□□N”, the following setting can be done from “Detector unit ” or "Setting display unit”.
Set from "Setting display unit”, if using “IR-M1□□□N”.

Create a calibration curve by plotting data obtained by [7.2 Sample measurement] on a graph. Plot the absorbance "x" of this moisture meter on the X-axis and also plot the moisture value (%H_2O) on the Y-axis.
Obtain a curve with minimize errors from this graph as a calibration curve. Usually the curve with minimize errors is obtained by the regression operation. For the creation of a calibration curve by the regression operation, refer to [7.3.1 Computation of regression expression] and [7.3.2 Confirmation of regression expression].



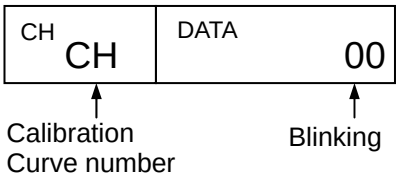
If a graph contains inflection points, use the creation of a calibration curve by broken line approximation. For the creation of a calibration curve by broken line approximation, refer to [6.4 Creation of calibration curve by knee point line approximation].

7.3.1 Computation of regression expression

This moisture meter has regression operation function by the minimum mean square method. By this function, first-degree to third-degree polynomials can be obtained by entering the data obtained in [7.2 Sample measurement].
Assume that there are “n” sets of sample data ("x_n, y_n). (in condition that “n” is 20 or less)

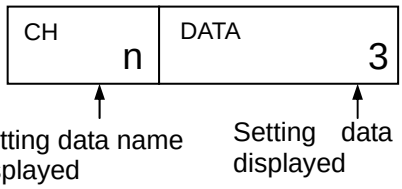
(1) Setting of calibration curve number

1) Press SEL key and CH/. key simultaneously for 2 seconds to enter into the sample data setting mode.
2) By pressing ▷ key, a numeric blinks for entering a calibration curve number.
3) Change the numeric by △ key, ▽ key or ▷ key.
When △ key is pressed, the numeric is increased.
When ▽ key is pressed, the numeric is decreased.
When ▷ key is pressed, the blinking digit shifts.
4) When ENT key is pressed, the numeric stops blinking and the calibration curve number is stored.



(2) Setting of data count

1) Press SEL key to enter into the data count setting mode.
2) Change a numeric by the procedure mentioned in the above “(1) Setting of calibration curve number 2) and 3)” and store it with ENT key.

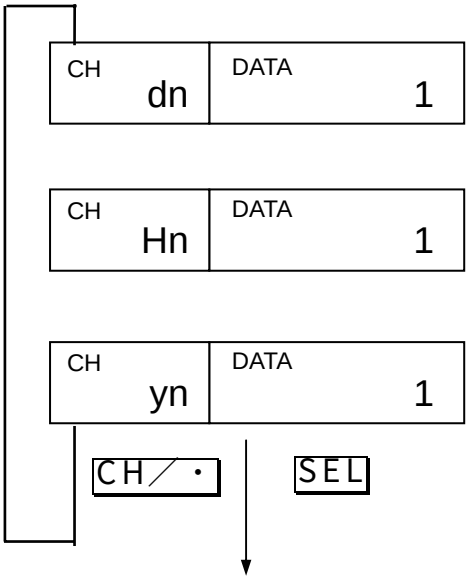


7. Preparation of calibration curves

7.3.1 Computation of regression expression

(3) Setting of data number, sample data x_n and sample data y_n

1) Press SEL key to enter into the data number setting mode.
2) Change a numeric by the procedure mentioned in the above "(1) Setting of calibration curve number 2) and 3)" and store it with ENT key.
3) After setting the above, press SEL key for entering into the sample data x_n setting mode.
4) After setting the above, press SEL key for entering into the sample data y_n setting mode.
5) After setting the above, press CH/. key to return to "1) Data number setting mode" and then set the next data number.
6) Repeat the above procedures for setting all sample data.



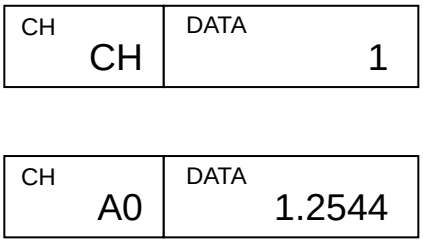
(4) Computation of regression expression

1) After completing the setting of sample data, press SEL key to enter into the regression/broken line setting mode.
2) Enter **"1, 2 or 3"** in the selection of regression/broken line. A polynomial with corresponding degree can be obtained.
3) By pressing SEL key, the standard deviation (approximate accuracy of the regression expression) of the above regression expression is displayed.
3) After the settings are completed, press SEL key for 2 seconds to return to the measurement mode.
Automatic return to the measurement mode is made if any key is operated for 1 minute.

7.3.2 Confirmation of regression expression

The coefficient of the regression expression obtained by the above can be confirmed by the following procedure.

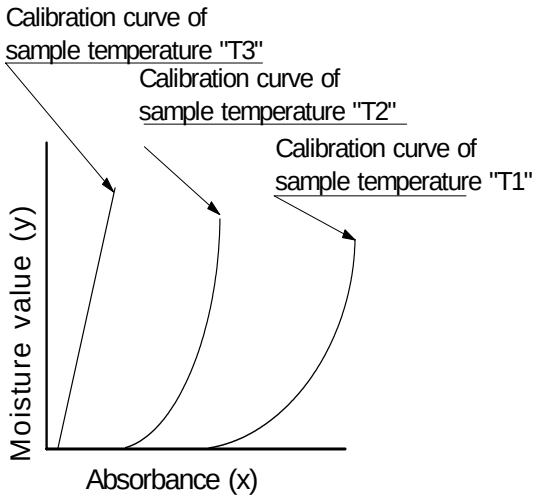
1) Press SEL key for 2 seconds to enter into the calibration curve setting mode.
2) Set calibration curve number, for which the regression expression is obtained.
3) Press SEL key to display the coefficient a_0 of the regression expression.
4) For displaying a_1 to a_3, press SEL key in the same way.
5) After the confirmation is completed, press SEL key for 2 seconds to return to the measurement mode.
Automatic return to the measurement mode is made if any key is operated for 1 minute.



8. Correction function by sample temperature from external input

8.1 Summary

When a calibration curve changes at the sample temperature Ts, this function enables to change the calibration curve to other one at this sample temperature. For the input of the sample temperature, a platinum resistance thermometer (Pt100), a radiation thermometer or a temperature/voltage converter with the output of 4 to 20mADC can be used. By utilizing this function, 10 calibration curves in one group (9 curves only in the group 10) are changed with the sample temperature Ts. Since 99 calibration curves can be stored, up to 10 groups can be set.

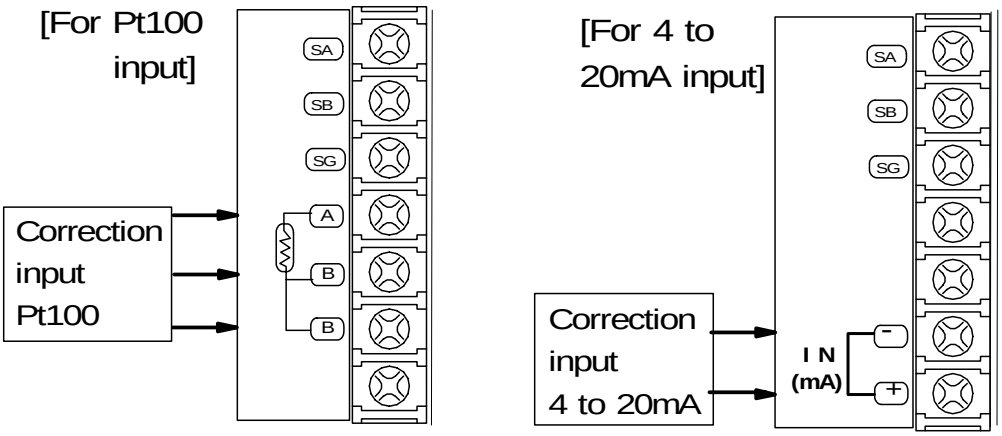


8.2 Model

This is an optional function. The model number of the detector unit with this optional function is as follows: **IR-M1**□□□□□

- External input
  - 5: Correction input 4 to 20 mA
  - 8: Correction input Pt100
- Communications
  - S: RS-485
  - R: RS-232C

8.3 Wiring of detector unit



8.4 Setting of dipswitch (Ref to [3.1 Setting of dipswitches])

(1) Turn off the power supply of the detector unit and the setting display unit.

(2) Switch the dipswitch 7 (Correction input enable/disable) of the detector unit to ON side.

(3) **For 4 to 20mA input:** Switch the dipswitch 8 (Correction input) to OFF side (4 to 20mADC).

For Pt100 input: Switch the dipswitch 8 to ON side (Pt100).

(4) Turn on the power supply of the detector unit and then turn on the power supply of the setting display unit.

8. Correction function by sample temperature from external input

8.5 Setting of correction enabled/disabled by sample temperature

Execute this setting to either the detector unit or the setting display unit. When the correction is disabled, the operation is normal which means the calibration curve is not changed according to the sample temperature. When it is enabled, the calibration curve is changed with the sample temperature.

8.5.1 Setting at the detector unit

(1) Enter into the operating conditions setting mode.
SEL + ENT for 2 seconds

CH	DATA
St	OFF

(2) Enter into the correction enable/disable setting mode (St). SEL Several times

(3) Select the correction enabled or disabled.
▷ ▽ ENT (OFF) Correction OFF (disable)
▷ △ ENT (ON) Correction ON (enable)

* For the setting of sample temperature scaling as the next step, skip (4) and step to (2) of [8.4 Setting of sample temperature scaling].

(4) Return to the measurement mode.
SEL for 2 seconds

8.5.2 Setting at the setting display unit

(1) Set the calibration curve number to 0.
CH 0 ENT

(2) Enter into the correction enable/disable setting mode (St).
MODE 1 9 ENT

(3) Select the correction enabled or disabled.
0 ENT (OFF) Correction OFF (disable)
1 ENT (ON) Correction ON (enable)

* For the setting of sample temperature scaling as the next step, skip (4) and step to (2) of [8.4 Setting of sample temperature scaling].

(4) Return the calibration curve number to the original one.

8. Correction function by sample temperature from external input

8.6 Setting of sample temperature scaling (Only 4 to 20mA DC)

In case of using radio thermometer or thermoelectric converter, it is necessary to match the temperature range of their 4 to 20mA DC output and the temperature range of 4~20mA DC input of this instrument.
Carry out scaling in either detector unit side or setting display unit side, following the main points given below.

8.6.1 Setting at the detector unit

CH	DATA
tL	0.0

(1) Enter into the operating condition setting mode.
SEL + ENT for 2 seconds
(2) Enter into the setting mode of sample temperature scaling low limit (tL).
SEL Several times
(3) Set the low limit (tL) of sample temperature scaling.
(Setting range: -999.9 to 999.9)
(4) Enter into the setting mode of sample temperature scaling high limit (tH). SEL Once
(5) Set the high limit (tH) of sample temperature scaling.
(Setting range: -999.9 to 999.9)

8.6.2 Setting at the setting display unit

(1) Set the calibration curve number to 0.
CH 0 ENT
(2) Enter into the sample temperature scaling setting mode
MODE 2 1 ENT
(3) Set the low limit (tL) of sample temperature scaling.
(Setting range: -999.9 to 999.9)
(4) Enter into the setting mode of sample temperature scaling high limit (tH). SEL Once
(5) Set the high limit (tH) of sample temperature scaling.
(Setting range: -999.9 to 999.9)

8.7 Setting of sample temperature

The key operation for this setting is common on the detector unit and the setting display unit.

CH	DATA
tS	999.9

(1) Enter into the calibration curve setting mode.
SEL for 2seconds
(2) Enter into the sample temperature setting mode (tS).
SEL several times
(3) Set the sample temperature.（Setting range: -999.9 to 999.9）

8. Correction function by sample temperature from external input

8.8 Setting of calibration curve data

(1) Specify a group for calibration curve number to be used.
The groups are from 1 to 10 and each one corresponds to the following calibration curve numbers respectively.

Group 1: Calibration curve number 1 to 10
Group 2: Calibration curve number 11 to 20
Group 3: Calibration curve number 21 to 30
Group 4: Calibration curve number 31 to 40
Group 5: Calibration curve number 41 to 50
Group 6: Calibration curve number 51 to 60
Group 7: Calibration curve number 61 to 70
Group 8: Calibration curve number 71 to 80
Group 9: Calibration curve number 81 to 90
Group 10: Calibration curve number 91 to 99

(2) Example: Select the group 1.
Set the following calibration curve at the sample low limit temperature T1 to the calibration curve No. 1.

$$Y = a3X^3 + a2X^2 + a1x + a0$$

Only the calibration curve by polynomial expression can be used. (The calibration curve by broken line approximation cannot be used.)
Further, set the sample temperature T1. For its setting, refer to [8.7 Setting of sample temperature].

(3) Set the calibration curves at the sample temperature Ti (i= 2 to 10) to the calibration curve numbers 2 to 10.
However, Ti should fulfill the following expression.

T1 (Sample low limit temperature) ≦ T2 ≦ ……. ≦ T9 ≦ T10 (Sample high limit temperature)

(4) Enter 999.9 at the Ti, which is not used. Be careful that, if this value is not entered, a calibration curve not used is computed as a data.

* The default of the sample temperature Ti is 999.9.

(5) For the correction expression coefficients b1 and b0 and the constants (low limit range, high limit range, low limit alarm, high limit alarm and preset value), use the values for the first calibration curve number in a group.

Group 1: Calibration curve number 1
Group 2: Calibration curve number 11
Group 3: Calibration curve number 21
Group 4: Calibration curve number 31
Group 5: Calibration curve number 41
Group 6: Calibration curve number 51
Group 7: Calibration curve number 61
Group 8: Calibration curve number 71
Group 9: Calibration curve number 81
Group 10: Calibration curve number 91

8. Correction function by sample temperature from external input

8.9 Measurement

(1) When the correction by sample temperature ON (enable) is selected and one calibration curve number in a group is set, the calibration curve number changes automatically corresponding to sample temperature.
For example, when the sample temperature Ts fulfills the following expression, the calibration curve number becomes “i”.

$$T1 \leqq \ldots\ldots \leqq Ti \leqq Ts < Ti + 1 \leqq \ldots\ldots \leqq T10$$

(3) However, the measured value Y is not the measured value T_1 on the calibration curve No. “i”. The measured value Y becomes the following value interpolated from the measured value Y_i and the measured value Y_{i+1} on the calibration curve No. “i+1”.

$$Y = (Y_{i+1} - Y_i) \times \frac{T_s - T_i}{T_{i+1} - T_i} + Y_i$$

(3) When the sample temperature Ts is lower than the sample temperature of the first calibration curve number in the group or when it is higher than the sample temperature of the last calibration curve number, the following error display appears.
However, the calibration curve, of which sample temperature is set as 999.9, is ignored.
* For the sample temperature lower than the sample temperature of the first calibration curve number in the group Er15 (Sample temperature too low)
* For the sample temperature higher than the sample temperature of the first calibration curve number in the group Er14 (Sample temperature too high)

8.10 Display of sample temperature Ts

8.10.1 Display at the detector unit

(1) Set the calibration curve number to 0. CH 0 ENT
(2) For canceling of the sample temperature display SEL for 2 seconds or CH 2 for seconds

8.10.2 Display at the setting display unit

(1) Set the calibration curve number to 0. CH 0 ENT
(2) For displaying the sample temperature display MODE 2 0 ENT
(3) For canceling of the sample temperature display SEL for 2 seconds or CH for 2 seconds

9. Inspection and maintenance

9.1 Periodical inspection

The following inspection is required periodically.

(1) Cleaning of detector cover glass surface:
Keep the detector cover glass surface clean all times. Wipe off dirt and flogging with gauze or the like. If the gauze is dipped in alcohol, it is more effective.

(2) Installation: Check the detector unit is installed firmly.

(3) Connections: Check the connections to the terminals of the detector unit, the setting display unit and other instruments are connected completely.

(4) Feed air for air purge:
Check the feed air flow, air pressure, and cleanness of air before starting air purge.

(5) Calibration: Regular calibration one in 3 months required by using the output checker plate.
Model IR-WEB : For IR-M1100 and IR-M1200.
Model IR-WEB3: For IR-M1300.

9. Inspection and maintenance

9.2 Self-diagnosis function

Error message for abnormal operation is displayed by the self-diagnosis function.
The same error message is displayed in the detector unit and the setting display unit.

Error No.	**Item**	**Contents**	**Measures**	Self-diagnosed abnormality
-----	High limit over range	Measured value is higher than display range.	Check calibration curve data. Check output by checker plate.	---
-----	Low limit over range	Measured value is lower than display range.	Check calibration curve data. Check output by checker plate.	---
Er01	Calibration data error	Calibration data is damaged.	Clear RAM.	○
Er02	RAM error	Detector unit ram data is damaged.	Clear RAM.	○
Er03	Motor rotation abnormal	Motor stops or rotates abnormally.	Exchange motor.	○
Er04	Lamp power supply abnormal	Lamp power supply is damaged.	Exchange lamp power supply unit.	○
Er05	A/D abnormal	A/D is over range.	Check output by checker plate.	○
Er06	Computation error	Computation is overflow.	Check output by checker plate.	○
Er07	Element temperature abnormal	Element temperature is abnormal.	Need to return detector unit to CHINO.	○
Er10	Calibration curve data error	Calibration curve data is not appropriate.	Reset calibration curve data.	---
Er11	Knee point line approximation error	Absorbance x is out of range of broken line approximation.	Reset broken line approximation data.	---
Er12	Ambient temperature too high	Ambient temperature of detector unit is too high	Lower ambient temperature.	---
Er13	Ambient temperature too low	Ambient temperature of detector unit is too low	Raise temperature.	---
Er14	Sample temperature too high	Sample temperature is higher than correction range	Widen correction range.	---
Er15	Sample temperature too low	Sample temperature is lower than correction range	Widen correction range.	---
Er16	Sample low reflection	Reflection rate of sample is low or the lamp is damaged.	Close distance to sample. If the lamp is damaged, exchange it.	---
Er17	Regression operation error	Regression operation is abnormal.	Check calibration curve sample data.	---

(Note) For the items filled with ○ in the self-diagnosed abnormality, an alarm output for self-diagnosed abnormality is activated from the setting display unit.

9. Inspection and maintenance

9.3 Measures against troubles not included in self-diagnosis

If a trouble occurred, take remedial measures referring to the corresponding items of this instruction manual after checking the following points. For the troubles of the setting display unit, refer to the separate instruction manual the setting display unit.

[1.] No display appears in detector unit. (Except model for IR-M1□□□N)

(1) Is the power supply normal?
(2) Is the fuse normal?
(3) Are cables connected completely?
(4) Are connectors connecting the setting display part and the internal CPU board connected securely?
(S) Turn off the power supply once and turn it on again.
(6) If the trouble cannot be repaired by the above check, the power supply unit in the detector may be defective.

[2.] Measured value remains unchanged.

(I) Is HOLD set to OFF?
(2) Is PRESET set to OFF?
(3) Are the calibration curve data correct?
(4) Turn off the power supply once and turn it on again.
(5) By using the output checker plate, check the display changing at the calibration curve number 0.
(6) Try RAM CLEAR if no change occurs. If the trouble can not be recovered yet, send back for repair.

[3.] Measured value fluctuates.

(1) Is the measuring surface flat?
(2) Is the measuring position correct? Make sure that the detector unit does not measure a bottom face like as a belt conveyor.
(3) Make sure that the disturbance light does not radiate onto the measuring surface.
(4) Is the smoothing time proper? Certain smoothing time is necessary for stable measurement.
(5) Make sure that any noise source does not exit around the detector unit or connection cables.
(6) By using the output checker plate, check if the display at the calibration curve number 0 fluctuate.
(7) If the display fluctuates in (6), clear RAM. If the trouble is not recovered yet, send back it to CHINO for repair.

[4.] Measured value is slightly higher than or lower than the actual value.

(1) Is the calibration curve number correct?
(2) Are the calibration curve data correct?
(3) Are HOLD and PRESET set to OFF?
(4) Is the measuring position correct?
(5) Is the detector cover glass surface of dirt and fogging?
(6) Correct the calibration curve. (Refer to [6.8 Correction of calibration curve])

9. Inspection and maintenance

9.4 Maintenance parts

9.4.1 List of maintenance parts

The replacing intervals are reference values. They vary according to the working condition.

Article name	Quantity	Replacing interval	Remarks
Light source lamp (With connector)	1	5 years	
Motor (with connector)	1	3 years	
Fuse	2		Attached as an accessory
Lithium battery (mounted on a printed circuit board)	1	3 years	3 years when no power is fed
Power supply unit (Note)	1	5 years	3 years when the ambient temperature is 40°C or higher

(Note): This is built in the detector unit. (not IR-WEP)

Warning For replacing maintenance parts, make sure to turn off the power source.

9.4.2 Replacement of light source lamp

(1) Turn off the power supply to the detector.

(2) Loosen four M4 hexagon socket head bolts of the lamp cover and remove the lamp cover.

(3) Disconnect the lamp connector, and remove the lamp by loosening the lamp fixing screws (M3 pan head screws).

(4) Fix the new lamp to the case temporarily by the lamp fixing screws with washers, and connect the connector.

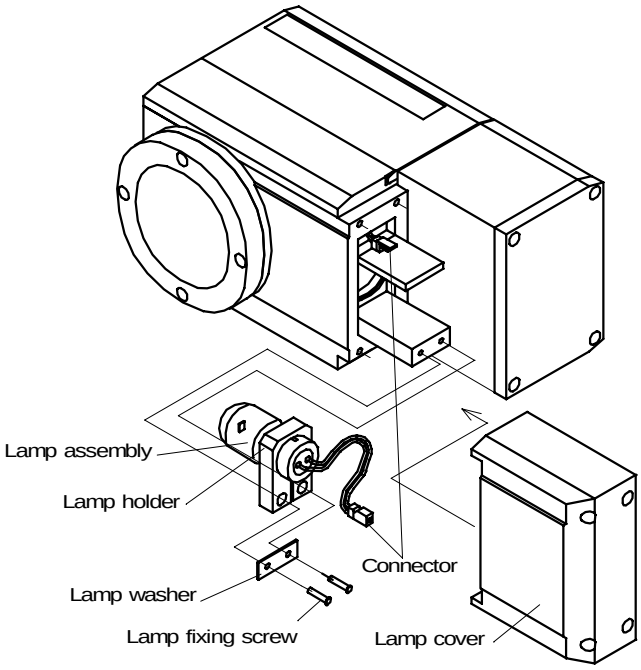
(5) Mount the air purge hood to the detector. Set the hood length to such an extent as the output checker plate holder is hidden (about 230mm).

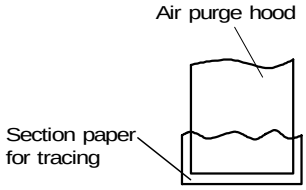
(6) Stick a plotting paper for tracing at the hood tip to project the lamp image on the plotting paper. In this case, stick it so that the center of the hood circle can be discriminated.

(7) Light the lamp by turning on the lamp power supply.

(8) Position the lamp image at the center of the plotting paper by moving the lamp holder vertically and horizontally.

(9) Reset the lamp cover as before. Now, the lamp exchange is completed.





9. Inspection and maintenance

9.4.3 Replacement of motor

(1) Turn off the power supply to the detector.

(2) Remove the measuring part cover by loosening the M4 hexagon socket head bolts or M4 pan head screws fixing the measuring part cover.

(3) The measuring part cover of the specifications with keys and display is connected to the interior by a cable. Disconnect the display unit connector shown in the figure by lifting the cover with due care so as not to damage the cable.

(4) Remove the rubber ring that fixes the motor lead wire.

(5) Loosen the motor fixing screws and remove the motor band by pulling it toward you while holding the motor.

(6) After lifting the motor, disconnect the motor connector below the motor, and then, remove the motor unit from the case.

(7) After erecting the motor unit as illustrated, hold the sector lightly, and separate the sector from the motor by removing four M2 screws which fix the sector.

(8) Erect the new motor to be replaced, and mount it, while taking care of the front and rear sides of the sector.

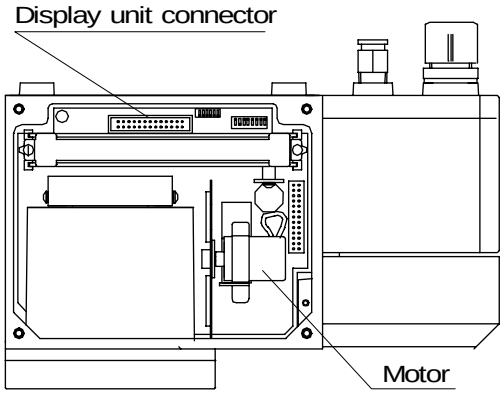
(9) Connect the lead wire of the motor to the connector.

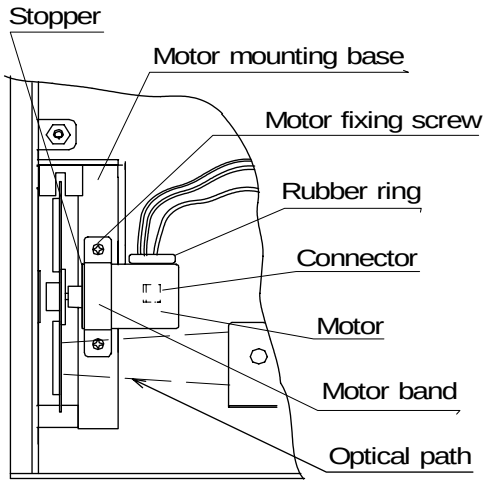
(10) Cover the motor with the motor band after placing the motor so that its tip touches the stopper of the motor mounting base. (In this case, position the motor lead wire as the illustrated position.)

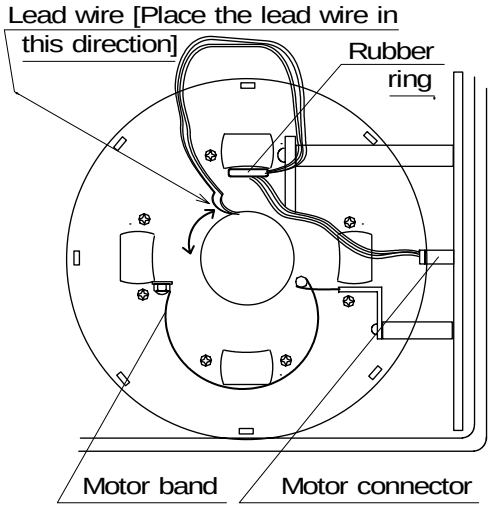
(11) Fix the motor band with the motor fixing screws.

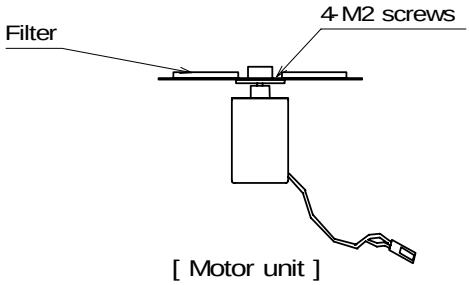
(12) Mount the motor ring to the motor lead wire as shown in the figure. Be careful not to allow the lead wire to interrupt the optical path.

(13) Reset the measuring part cover as before. Now, the motor has been replaced. (Insert the cover cable connector in case of the specifications with keys and display.)









Caution Never scratch the sector filter during replacement of the motor.

9. Inspection and maintenance ⚠

9.4.4 Replacement of lithium battery

The detector unit has a built-in lithium battery for memory backup. The setting data are kept, even if electricity is not supplied for 3 years or longer. When the battery has been consumed after 3 years or longer without supplying electricity, replace it with a new battery by the following procedure.

(1) Turn off the power source to the detector unit.

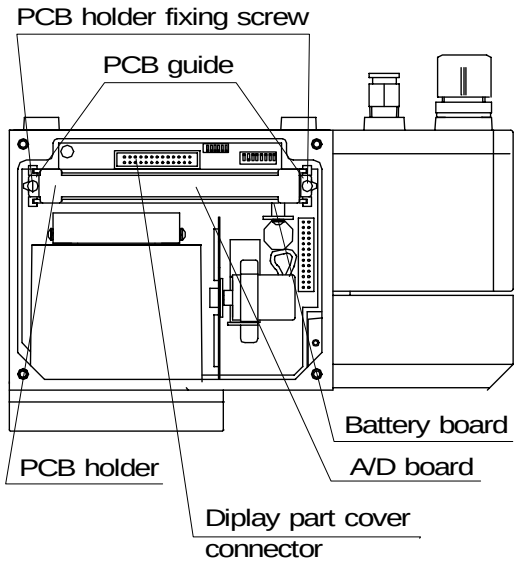
(2) Open the door of detector unit and take out the setting display part by removing four screws fixing it.

(3) The setting display part is connected with the interior by a cable. Lift the cable with care not to damage it and disconnect the connector for the setting display part as shown in the figure.

(4) Take out the holder for the PCB board by loosing 2 M2.6 pan head screw.

(5) Pull the A/D board forward.

(6) Replace the lithium batter with the mounting board by removing fixing screws for the mounting board placed on the A/D board.



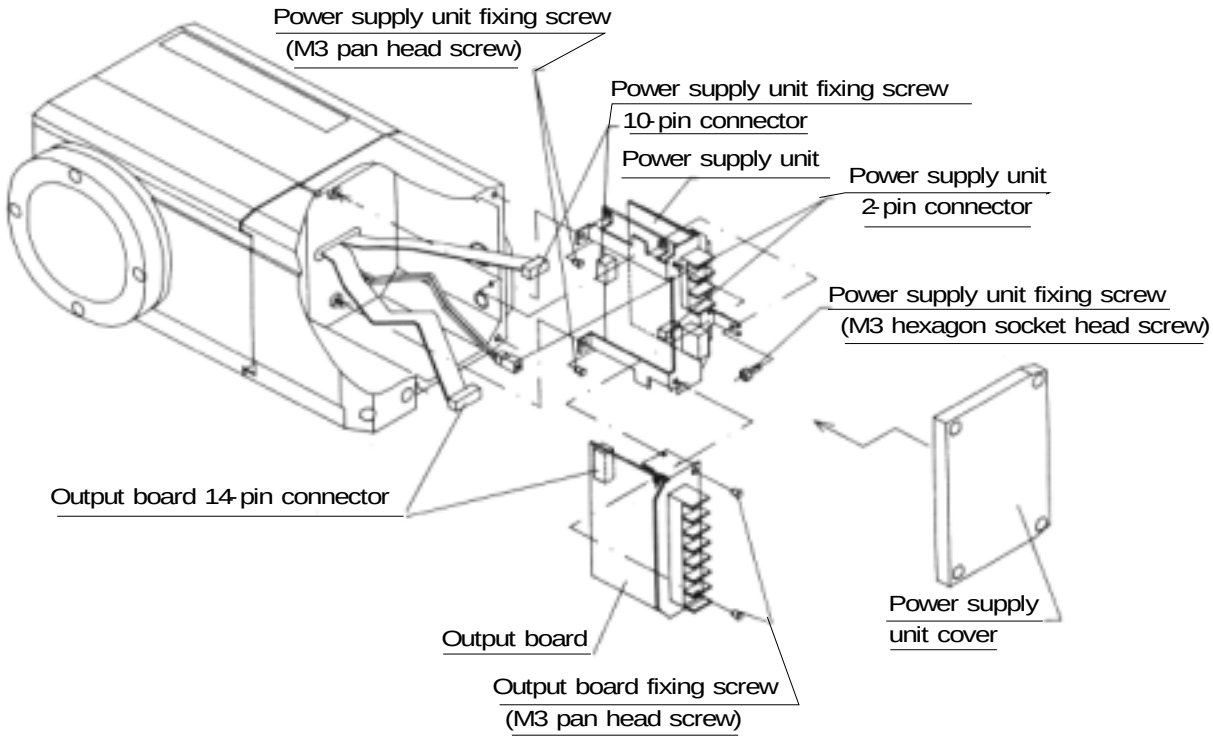
Warning Make sure polarities of the battery are correct.

(7) Insert the A/D board to the lower connector along the guide completely.
Return the holder for the PCB board and the door to the original positions.

9. Inspection and maintenance

9.4.5 Replacement of power supply unit

(1) Turn off the power source to the detector unit.
(2) Open the door of detector unit.
(3) Disconnect the connection cable and take out the connection cable from the cable inlet.
(4) Pull out the output board from the case inside by loosing two M3 pan head screws and by disconnecting the connector (14-pin).
(5) Pull out the power supply unit by loosing M3 nut and two M3 pan head screws and by disconnecting two connectors (10-pin, 2-pin).
(6) Connect the connector to a new power supply unit and assemble it by reversing the removing procedure. Be careful not to step the connection cable.
(7) Connect the connector to the output board taken out and fix it to the case inside.
(8) Connect the connection cable and return the door to the original position.



9.5 RAM clear

Try clearing the RAM contents, if a detector trouble cannot be repaired by all means.

9.5.1 RAM clear (Except model for IR-M1□□□N)

(1) Turn on the power supply by pressing [SEL] and [△] keys together.
(2) The RAM contents have been initialized. Reset the calibration curve data, etc. again.

Caution For Model IR-M13□□□N set the weight " α " to 1.000.
Refer to 〔5.5 Setting of operation conditions〕

9.5.2 RAM clear (Only model for IR-M1□□□N)

(1) Turn on the power supply after turning on all No. 1 to No. 4 switches of DIP switches 2. (Refer to [3.1 Setting of DIP switches])
(2) Reset the setting of DIP switches as before.
(3) The RAM contents have been initialized. Reset the calibration curve data, etc. again

Caution For Model IR-M13□□□N set the weight " α " to 1.000.
Refer to 〔5.5 Setting of operation conditions〕

10. Specifications and external dimensions

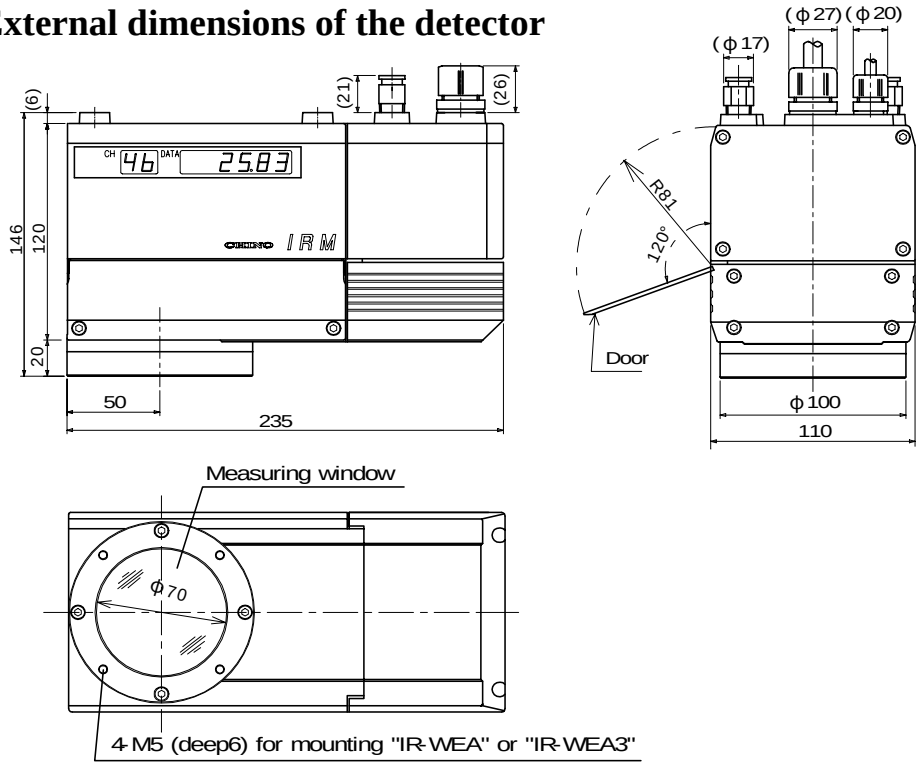
10. 1 Detector

10.1.1 Specifications of the detector

	IR-M11□□□□, IR-M12□□□□	**IR-M13□□□□**
Measuring system	Infrared reflection type 3-wavelength system	Infrared reflection type 2-wavelength system
Measuring distance	300mm (Mountable within a range of 200 to 400mm)	200mm (Mountable within a range of 160 to 300mm)
Measuring area	50*50mm (at a measuring distance of 300mm). For small diameter 30 x 30mm (option)	30*30mm (at a measuring distance of 200mm).
Reproducibility	Detector output " x " value ±0.003 with the output checker plate	Detector output "x" value ±0.015 with the output checker plate
	(under the same ambient temperature and humidity conditions). The above reproducibility is specified with the output checker plate and it is different from the reproducibility in actual measurement.	
Moisture output	4 to 20mADC (Load resistance Lower than 500Ω)	
Output accuracy	±0.5%FS	
Correction input (Optional)	4 to 20mADC (option for correcting the sample temperature, measuring distance, etc.) The correction input specification does not contain any moisture output.	
Communication output	RS-485, RS-232C or RS-422A is designated.(RS-485, if the unit is combined with the setting display unit.)	
Output update cycle	28ms	
Display	Data : LED 5 digits Calibration curve number : LED 2 digits	
Setting	Keys or communication	
Calibration curve	Polynomials of the degree one to three or knee point data	
Number of calibration curves	99	
Calibration curve correction	Zero and span correction	
Creation of calibration curve	Regression operation	
Smoothing	0 to 99sec (Every 0.1sec in case of shorter than 10 seconds or every second in case of longer than 10 seconds)	
Calibration	Executed with the output checker plate	
Self-diagnosis	Calibration data error, RAM error, motor rotation error, lamp power down, communication error, high or low ambient temperature, sample low reflection, etc. are output by LED display or communication.	
Working temperature range	0 to 50°C (Air cooling is necessary if the ambient temperature is higher than 45°C)	
Power voltage	24VDC, (Applicable to CE-marking conformance product only 24V DC±10%)	24VDC
Allowable voltage fluctuation	18 to 30VDC	
Power consumption	Max. approx.36VA, (Applicable to CE-marking conformance product only Max. approx.10VA)	Max. approx.36VA
Allowable vibrations	3G or less	
Connection	Terminal connection	
Case	Aluminum drip-proof structure (Conforming to IEC529 IP65)	
Mounting method	Bolt suspension method with four M8 bolts	
Weight	Approx. 4kg	
Accessories	Power supply unit IR-WEP 1 unit. Fuse 2 pcs.L-hexagonal wrench key 2 pcs. Ferrite core 2 pcs. (Attached to CE-marking conformance product only)	
Analog output (Applicable to CE-marking conformance product only)	4 to 20mADC (Load resistance Lower than 500Ω) 1 output [1] Output accuracy: ±0.5%FS [2] Stability: ±3%FS under EMC test environment.	—

10. Specifications and external dimensions

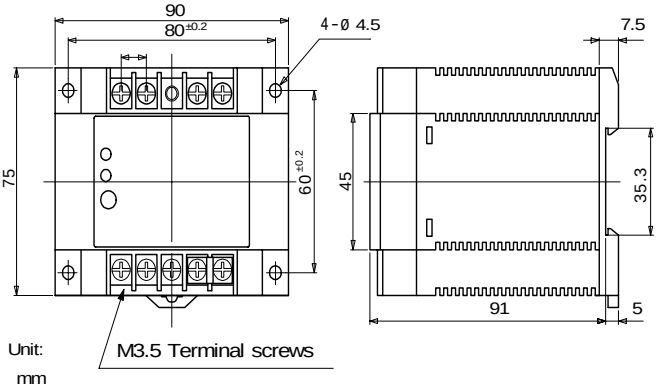
10.1.2 External dimensions of the detector



10.2 Power supply unit (conforming to CE): Model IR-WEP

Supplying 24VDC to the detector. It is attached to the detector as the accessories.

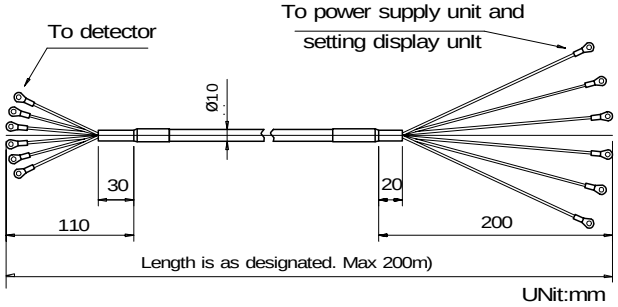
Item	Specification
Output voltage	24V DC
Output current	2.1A
Working temperature range	-10 to 50ºC
Power supply	100 to 240V/AC 47 to 450Hz
Allowable voltage fluctuation	+10% to (-) 15% of rated value
Power consumption	Maximum about 160VA
Case	Horizontal mounting holder, flange holder
Mounting	Wall mounting type (DIN rail)
Weight	About 380g



10.3 Connection cable: Model IR-WERT

It is the exclusive cable used for the connection between the detector unit and the setting display unit/power supply unit.

Item	Specification
Structure	4-core cab tire cable (With double shield)
External diameter	ϕ10mm
Length	Maximum 200m
Connection	Both end tips

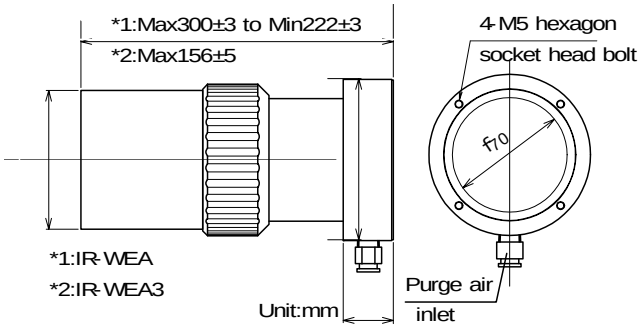


10. Specifications and external dimensions

10. 4 Air purge hood: Model IR-WEA for Model IR-M1100, IR-M1200 IR-WEA3for Model IR-M1300

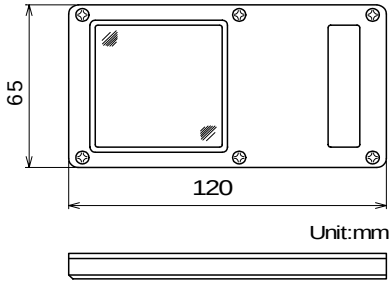
This is used for shielding the external light and purging the measuring window and measuring optical path by means of air. The output checker plate can be mounted at the tip of the hood.

Item	Specification
Purge air	50 to 200Nl/min Pressure Max. 200kPa (Use an instrumentation air excluding oil, dust, and foreign substances.)



10.5 Output checker plate: Model IR-WEB for Model IR-M1100, -M1200 IR-WEB3 for Model IR-M1300

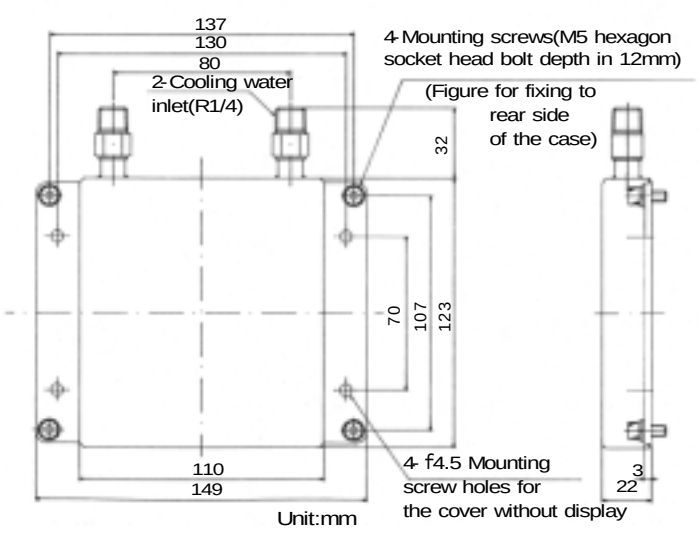
This is used for checking the detector output at site by mounting it at the tip of the air purge hood.



10.6 Water cooling plate: IR-WEW

This is used for mounting the detector to the high temperature atmosphere over 45 ℃. Use one sheet or 2 sheets according to situation. However, 2 sheets using only Model IR-M1□□□□N.

Item	Specification
Environment temperature	One using: 0 to 60 ºC Two using: 0 to 60 ºC
Cooling water	Flow: 0.5 to 1Nl/min Pressure: Max. 200kPa Temperature: Less than 30 ºC at the exit side.
Case	SUS304
Weight	About 0.8Kg

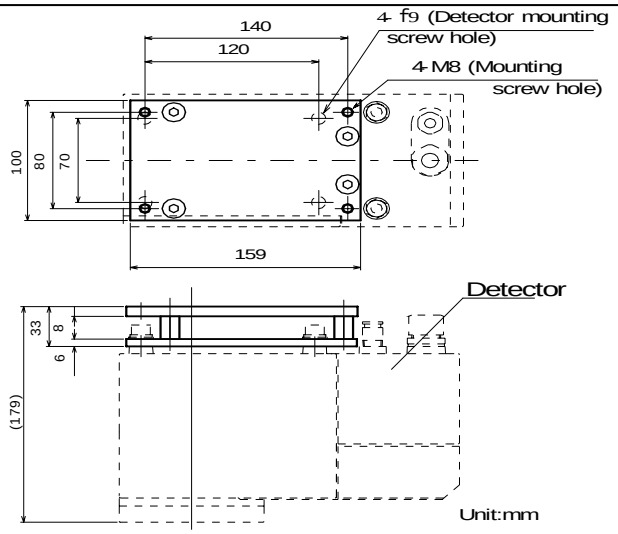


10. Specifications and external dimensions

10.7 Mounting adapter: IR-WED

This is used for replacing to IR-M1000 from IR-M100 that attached to before it uses.
There is not the change of an attachment place.

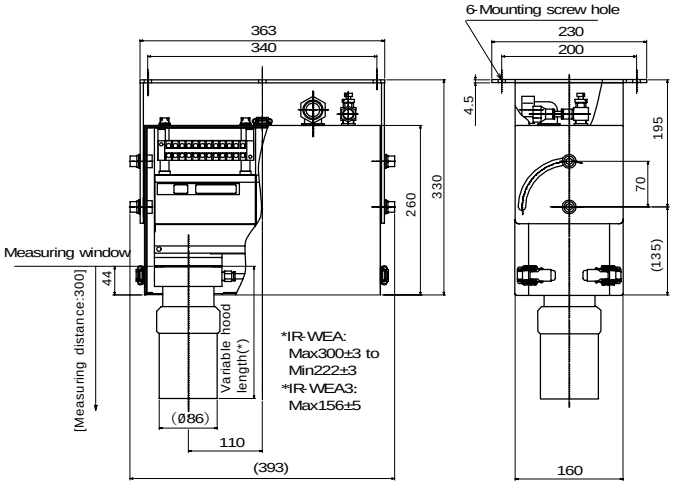
Item	Specification
Material	Aluminum
Weight	About 0.8Kg



10.8 Air cooling box: IR-WEX

This is used for cooling the detector, for dustproof of the detector by air purging.
(The detector is stored to IR-WEX.)

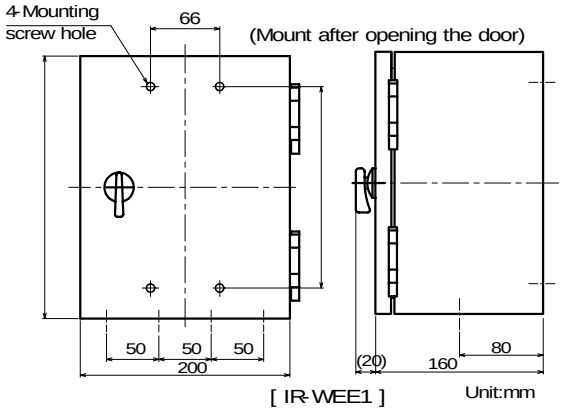
Item	Specification
Environment temperature	0 to 55 ºC
Cooling air	Flow: 100 to 500Nl/min
Material	Case department: SUS304 Mounting fittings department
Weight	About 14Kg

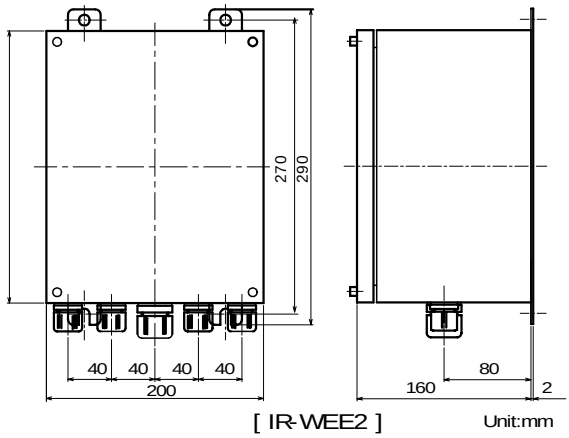


10.9 Relaying box: IR-WEE1, IR-WEE2

This is used for connecting the plural detectors as relay terminals.
(The power supply unit: IR-WEP is stored in IR-WEE.)

Item	IR-WEE1	IR-WEE2
Environment temperature	0 to 50 ºC	0 to 50 ºC
Material	Steel	SUS304
Color	5Y7/1	—
Weight	About 4Kg (The power supply unit is included)	About 14Kg (The power supply unit is included)





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INE-221-P2CE Oct -'02 IR-M1□□□Series INFRARED MOISTURE METER (IR-M11□□, IR-M12□□, IR-M13□□,) Printed in Japan (Kuki)