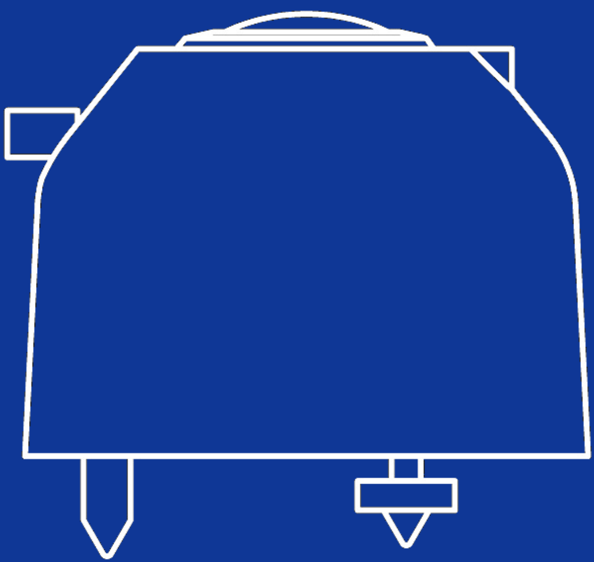
INSTRUCTION MANUAL

Pyrgeometer

MS-20



1. Index

2. Important User Information

Thank you for using EKO Products

Make sure to read this instruction manual thoroughly and to understand the contents before starting to operate the instrument. Keep this manual at safe and handy place for whenever it is needed.
For any questions, please contact us at one of the EKO offices given below:

2-1. Contact Information

EKO INSTRUMENTS CO., LTD.			
Asia, Oceania Region			
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2-2. Warranty and Liability

For warranty terms and conditions, contact EKO or your distributor for further details.
EKO guarantees that the product delivered to customer has been verified, checked and tested to ensure that the product meets the appropriate specifications. The product warranty is valid only if the product has been installed and used according to the directives provided in this instruction manual.

In case of any manufacturing defect, the product will be repaired or replaced under warranty. However, the warranty does not apply if:

- Any modification or repair was done by any person or organization other than EKO service personnel.
- The damage or defect is caused by not respecting the instructions of use as given on the product brochure or the instruction manual.

2-3. About This Instruction Manual

This manual was issued:	2019/05/24
Version Number:	1

2-4. Environment

1. WEEE Directive 2002/96/EC (Waste Electrical and Electronic Equipment)

In August of 2005, the European Union (EU) implemented the EU WEEE Directive 2002/96/EC and later the WEEE Recast Directive 2012/19/EU requiring Producers of electronic and electrical equipment (EEE) to manage and finance the collection, reuse, recycling and to appropriately treat WEEE that the Producer places on the EU market after August 13, 2005. The goal of this directive is to minimize the volume of electrical and electronic waste disposal and to encourage re-use and recycling at the end of life.

EKO products are subject to the WEEE Directive 2002/96/EC. EKO Instruments has labeled its branded electronic products with the WEEE Symbol (figure Trash bin) to alert our customers that products bearing this label should not be disposed of in a landfill or with municipal or household waste in the EU.

If you have purchased EKO Instruments branded electrical or electronic products in the EU and are intending to discard these products at the end of their useful life, please do not dispose of them with your other household or municipal waste. Disposing of this product correctly will help save valuable resources and prevent any potential negative effects on human health and the environment, which could otherwise arise from inappropriate waste handling.

2. RoHS Directive 2002/95/EC

EKO Instruments has completed a comprehensive evaluation of its product range to ensure compliance with RoHS Directive 2002/95/EC regarding maximum concentration values for substances. As a result all products are manufactured using raw materials that do not contain any of the restricted substances referred to in the RoHS Directive 2002/95/EC at concentration levels in excess of those permitted under the RoHS Directive 2002/95/EC, or up to levels allowed in excess of these concentrations by the Annex to the RoHS Directive 2002/95/EC.

2-6. CE Declaration

IMPORTANT USER INFORMATION

DECLARATION OF CONFORMITY

We: EKO INSTRUMENTS CO., LTD
1-21-8 Hatagaya Shibuya-ku,
Tokyo 151-0072 JAPAN

Declare under our sole responsibility that the product:

Product Name: Pyrgeometer
Model No.: MS-20

To which this declaration relates is in conformity with the following harmonized standards of other normative documents:

Harmonized standards:
EN 61326-1:2013 (Emission)
CISPR11 Class A
EN 61326-1:2013 (Immunity)
EN 61000-4-2 EN 61000-4-3
EN 61000-4-4 EN 61000-4-5
EN 61000-4-6
Following the provisions of the directive:
EMC-directive : 2014/30/EU
LowVoltage-directive: 2014/35/EU

Date: Mar. 20, 2019

Position of Authorized Signatory: General Manager of R & D Department

Name of Authorized Signatory: Shuji Yoshida

Signature of Authorized Signatory: Shuji Yoshida

3. Safety Information

EKO products are designed and manufactured under the consideration of the safety precautions. Please make sure to read and understand this instruction manual thoroughly in order to be able to operate the instrument safely and in the correct manner.

WARNING CAUTION	Attention to the user; pay attention to the instructions given on the instruction manual with this sign.
HIGH VOLTAGE WARNING	High voltage is used; pay special attention to instructions given in this instruction manual with this sign to prevent electric leakage and/or electric shocks.

3-1. WARNING/CAUTION

1. Setup

- The installation base or mast should have enough load capacity for the instrument to be mounted. Fix the pyrgeometer securely to the base or mast with bolts and nuts; otherwise, the instrument may drop due to gale or earthquake, which may lead to unexpected accidents.
- Make sure the instrument and the cables are installed in a location where they will not get soaked.
- When using this instrument by connecting to a measuring instrument, make sure to connect the shield cable to either the signal ground terminal on the measuring instrument side or GND (the reference potential on the single end input side). Noise may be included in the measurement data.
- Although this product is tested to meet EMC Directive compliance requirements, it may not fully satisfy its primary specification/performance when using this product near following locations where strong electromagnetic wave is generated. Please pay attention to the installation environment.

  Outdoor: High voltage power line, power receiver/distribution facility, etc.

  Indoor: Large-size chiller, large rotation device, microwave, etc.
- Do not use this product in environment where corrosive gas, such as ammonia and sulfurous acid gas, are generated. It may cause malfunction.
- Do not install in area that cause salt damages. It may cause malfunction by paint peeling off or corrosion. When installing in area with risk of salt damages, make sure to take following measures: 1. Wrap the connector with self-fusing tape, 2. Change the fixing screw to bolt screw made of aluminum, 3. Run the cables in resin pipe or metal pipe treated with salt-resistant paint such as molten zinc plating, 4. Periodically clean.
- Do not use this instrument in vacuum environment.
- If the cable and main unit are in risk for getting damaged by birds and small animals, protect the cable and the main unit by using: 1. Reflective tape, 2. Repellent, 3. Cable duct, 4. Installing bird-spike

2. Handling

- Be careful with silicon lens when handling instruments. Strong impact to this part may damage the silicon lens and may cause injuries by broken silicon lens parts.
- When carrying any MS-20 model with the sunscreen attached, always hold the instrument from the bottom. Holding only the sunscreen part may lead to dropping the sensor as it comes off from the sunscreen.

4. Introduction

4-1. About the Pyrgeometer Series

In meteorology, wavelengths from 3 to 4µm are called solar radiation from the sun irradiated from the sky, and wavelengths above that are called long wavelength radiation. The Pyrgeometer MS-20 is a highly accurate and robust infrared radiometer that can measure only long wavelength radiation of 4.5µm or more so that it does not receive the light from solar radiation.

MS-20 has specially coated silicon lens and is able to detect and measure only the long wavelength radiation even during the day by shutting out the unnecessary solar radiation. As temperature sensor, it is integrated with Pt100 Class A element which can accurately measure the downward (upward) radiation.

Moreover by installing the optional ventilation unit with heater, unnecessary window heating offset can be eliminated, and it provides the effects to remove frosts and snow during winter time.

Main Characteristics:

- With the specially coated silicon lens, only the long wavelengths can be detected by shutting out the wavelengths below 4.5µm
- Robust and weather-proofed for continuous measurement outdoor
- By attaching sun shade, temperature increase/decrease of body, which affects the measurement results, can be prevented
- No need of drying agent replacement for 5 years (replaced at EKO during recalibration)

All MS-20 are manufactured at EKO and calibrated against the reference unit traceable to WISG (World Infrared Standard Group), which is managed at PMOD/WRC*.
Term of warranty for this product is 5 years; recommended recalibration period is 2 years(**).

(*) PMOD/WRC: Physikalisch-Meteorologisches Observatorium Davos/World Radiation Center
(**) Should be in a condition without condensation inside.

4-2. Package Contents

Check the package contents first; if any missing parts or any damage is noticed, please contact EKO immediately.

Table 4-1. Package Contents

Contents	MS-20
Pyrgeometer	○
Output Cable*	○
Sunscreen	○
Instruction Manual	Not included in the package (Please download from EKO Website)
Inspection Report	○
Fixing Bolts	(M5) x2, Length: 75mm
Washers	(M5) x4
Nuts	(M5) x2

*Standard length is 10m for both signal cable. For different length of cables (e.g. to meet your application needs) please contact EKO or your local distributor.

5. Getting Started

5-1. Part Names and Descriptions

Each part name and its main function is described below.

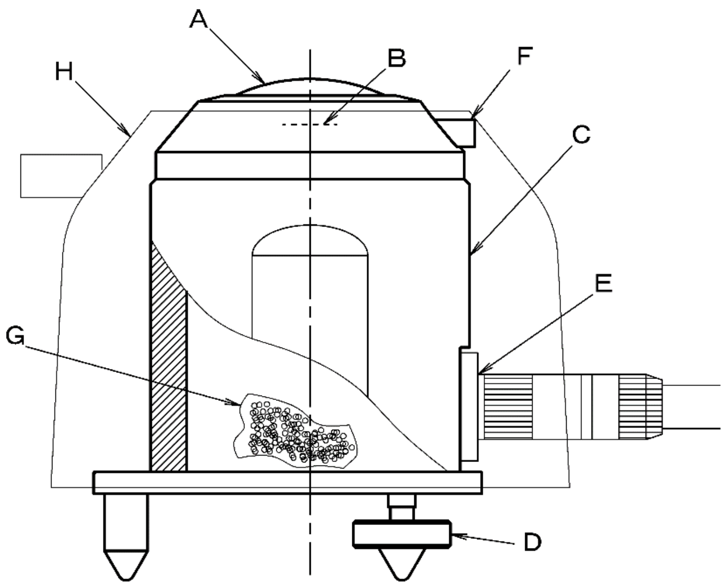


Figure 5-1. Parts Name

Table 5-1. Parts Name

Parts Name
A. Silicon Lens
B. Sensor (Thermopile)
C. Body
D. Levelling Screw
E. Cable, Connector
F. Bubble Level
G. Drying Agent
H. Sunscreen

1. Silicon Lens

Inner side of the silicon lens is treated with a coating (Solar Blind Coating) to prevent transmitting unnecessary solar radiation, and outer side of the silicon lens is coated with diamond-like carbon for protecting the surface.

Also by making the lens in a lunular shape, error is reduced since the radiation received by the lens can be transmitted to the sensor part without loss while ensuring the 180° field of view.

2. Sensor Part

For the sensor part, using a thermopile, which has two types of metals with different electromotive force alternately connected, and voltage is generated in proportion to temperature difference (Seebeck Effect). When the sensor part temperature increases, electromotive force is generated to thermopile by the temperature difference created with the body part (cold conjunction). This electromotive force (mV) is divided by the sensitivity constant obtained by calibration, and the infrared radiation intensity can be obtained by adding σT^4 (T = Kelvin) obtained by the sensor temperature (°C).

The sensor part is the most important part of the pyrgeometer, and it affects the response time, nonlinearity, temperature response and sensitivity.

3. Sunscreen, Sensor Body, and Level

MS-20 have a sunscreen to prevent body temperature increase generated by direct sun light. Weather resistant metal is used for the body, which has resistant against decrease of nocturnal radiation and heat radiation, and rain and dusts. The integrated sprit level is used for setup and maintaining the sensor in a horizontally levelled position.

4. Drying agent

Enclosed drying agents inside the sensor body keep the sensor inside dry, prevents condensation of humidity inside of the silicon Lens. There is no need to replace the drying agents as they are replaced when sensor is recalibrated at EKO.

5. Cable and Cable Connector

MS-20 are shipped with a 10 meter long output cable as standard length*.

Durable materials are used for the cable and connector, and pin terminals are attached at the end of the cable for easy connection with data logger terminal block.

*If longer cables, round terminals or fork terminals are required, please contact EKO Instruments or your distributor. (Also see [7. Specification, 7-4. Accessories List] for optional items.)

5-2. Setup

In order to obtain high quality measurements from pyrgeometers, several criteria with respect to set-up and mounting of the instruments have to be considered.

The ideal mounting position for pyrgeometers is a location which has a full hemispheric field-of-view without any obstructions (such as buildings, trees, and mountain); however, it might be difficult to find such locations. Therefore in practice, it is ideal to install in a position which is free from obstructions at 5° above horizon.
The setup location should be easily accessible for periodic maintenance (silicon lens cleaning, replacement, etc.), and make sure there are no heat source such as walls or billboards in surrounding area.
A strong physical impact to the pyrgeometer can lead to product damage and/or may cause changes to the sensitivity. Silicon lens may also be cracked by the impact.

1. Installing at Horizontal or Tilted Positions

1) Check the installation base where the pyrgeometer has to be mounted and make sure it has two fixing holes with the appropriate pitch. The pitch sizes of the fixing holes are as follows (in mm):

Table 5-2. Fixing Hole Pitch and Bolt Size for Pyrgeometer

	MS-20
Fixing Hole Pitch	65 mm
Fixing Bolt Size	M5 x 75 mm

2) Setup the pyrgeometer with the signal cable connector facing the nearest Earth's pole.
In the Northern hemisphere, the connector should be orientated North, in the Southern hemisphere, the connector should be orientated South. If the signal cable connector is facing towards the sun, the temperature of the connector increases and may cause measurement error due unwanted thermoelectric power invited by the connector temperature increase.

3) Remove a sunscreen
The sunscreen can be removed by loosening the knurling screw and sliding it towards the bubble level direction.
*When carrying the MS-20 with sunscreen attached, always hold the instrument from the bottom. Holding only the sunscreen part may lead to dropping the sensor as it comes off from the sunscreen.

4) Adjust the pyrgeometer in a horizontal position by using the 2 levelling screws observing the air bubble in the bubble level while manipulating the levelling screws. The instrument is levelled horizontally if the air bubble is in the centre ring.
If the pyrgeometer is not levelled properly, the pyrgeometer readings are affected by cosine and azimuth errors. Periodically check the bubble level and adjust the pyrgeometer's position if necessary.

[Installing at Tilted Position]

MS-20

After the MS-20 is adjusted to horizontal position in levelled surface, install it on tilted mounting position. *When installing the instrument, do not remove the levelling feet or fixed feet; if the levelling feet are removed, it may cause abnormal output values due to the thermal effects from the mounting part.

5) Fasten the pyrgeometer to the base with the 2 bolts (included) and put the sunscreen back on the pyrgeometer.

2. Wiring

To extend the cable lifetime, make sure that the cables are not exposed to direct sun light or rain/wind by lining the cable through a cable conduit. Cable vibrations will potentially cause noise in the output signal. Fasten the cable so that the cable does not swing or move by wind blowing.

Exposure of the signal cable to excessive electromagnetic emissions can cause noise in the output signal as well. Therefore the cable should be lined at a safe distance from a potential source generating Electromagnetic noise, such as an AC power supply, high voltage lines or telecom antenna.

■ Wiring Procedure

1) Connect the output cable to the pyrgeometer by inserting the cable connector to the connector on the body then turn the screw cap.

   *Make sure to check the pin layout of the connector before connecting the cable. If the connector cannot be easily inserted, DO NOT use any force as it will damage the connector. Visually check the pin layout again before retrying to insert the connector.

   *Make sure to fasten the screw cap by turning it all the way.

2) Connect the output cable:

   2-1. How to Connect MS-20 (See Table 5-3. Wire Color Codes also)

   Connect the wires with colors that corresponds to each terminal to voltmeter or data logger.

   *Always connect the shield cable. Failing to do so, it will lead to causing noise.

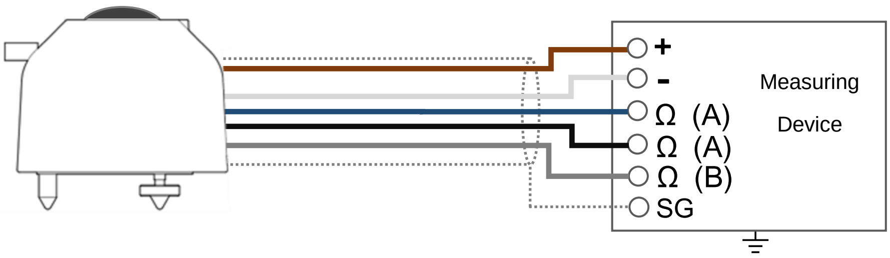


Figure 5-2. How to Connect MS-20

(*) Please select the ohmmeter or data logger which can measure the resistance value (Ω), in case of measuring the detector temperature (10kΩ@25°C). Please also see the Appendix A-6.

   2-5. Wire Assignments

   Also see [7-3. Output Cables].

Table 5-3. MS-20 Wire Color Codes

No.	**Cable Color**	**MS-20**
1.	Brown	mV (+)
2.	White	mV (-)
3.	Blue	Pt100 (A)
4.	Black	Pt100 (A)
5.	Gray	Pt100 (B)
Shield	Shield	FG

5-3. Measurement Principle

Pyrgeometer measures the exchange of radiations between the sensor part and observed object (sky or ground surface).

1) Sensor part receives the radiation from the object, and on the other hand, the sensor part itself, which is at absolute temperature T, also emits energy equivalent to σT^4 according to the Law of Stefan-Boltzmann.
   These radiation balances are shown as the temperature of sensor part, and the temperature difference between this sensor part and reference point (cold junction) is output as voltage using thermopile.

2) When the incident radiation to the sensor part from the observed object is R_{in}, radiation emitted from the sensor part is R_{out}, and the balance of these are R_{net}, the equation will be as follows:

   $$R_{net} = R_{in} - R_{out}$$

3) R_{net} can be measured as voltage output of thermopile; R_{out} can also be obtained by measuring the sensor part temperature. Therefore, radiation amount incident to the sensor part can be measured with following equation:

   $$R_{in} = R_{net} + R_{out}$$

4) Next, correct the measured sensor part temperature to absolute temperature (K, kelvin) to obtain the radiation amount (σT^4), and lastly the infrared radiation amount can be determined with following equation (refer to the appendix table for the result of infrared radiation amount conversion from temperature °C).

   $$R_{in} = R_{net} + \sigma T^4$$

   $\sigma = 5.670367 \times 10^{-8}$ (Stefan-Boltzmann constant)
   T = unit(K, kelvin) ･･･ Example: 25°C = 298.15K (273.15 + 25°C)

5-4. Measurement Method

Net radiation [W/m^2] can be determined by measuring the output voltage [mV] divided by the individual sensor sensitivity [μV/W・m^{-2}]. The output voltage is measured by a measuring device such as voltmeter or data logger. If solar irradiance is measured continuously, it is recommended to use data logger which has sufficient recording capacity and calculation function.
Procedure for Net radiation measurement is described below:

a. Configuration with a Data Logger
If the measurement range can be selected on the data acquisition system, select the measurement range which can accurately measure the signal over a range of 0 to 20mV.

b. Calculate the Net radiation [W/m^2].
The net radiation in Watts per meter squared (W/m^2) is obtained when the output voltage ***V*** [μV] is divided by the sensitivity of the pyrgeometer ***S*** [μV/W・m^{-2}]. This calculation is expressed by the following formula:

$$\boldsymbol{R_{net}}\ (\mathrm{W/m^2}) = \frac{\boldsymbol{V}\ (\mu\mathrm{V})}{\boldsymbol{S}\ (\mu\mathrm{V/W{\cdot}m^{-2}})}$$

*The sensitivity ***S*** for the pyrgeometer is stated on the calibration certificate and the product label.
To make more accurate measurements, calculate the infrared irradiance after performing temperature correction of sensitivity using the following formula. Temperature coefficients a,b and c are stated on the calibration certificate.

$$V\ (\mu\mathrm{V}) = V_0 + V_0 \times (at^2 + bt + c)$$

S = Sensitivity [μV/W・m^{-2}]
V = Signal output applied the Temperature Coefficient correction [μV]
V_0 = Original output [μV]
a,b,c = Temperature coefficient parameters [1/℃^{2}, 1/℃, -]
t = sensor temperature [℃]

c. Calculate the Infrared irradiance [W/m^2].
Correct the measured sensor temperature to absolute temperature (K, kelvin) to obtain the radiation amount (σT^4), and lastly the infrared radiation can be determined by adding the net radiation.

$R_{in} = R_{net} + \sigma T^4$

$\sigma = 5.670367\mathrm{x}10^{-8}$ [W・m^{-2}・K^{-4}] : Stefan-Boltzmann constant

5-5. Pt100 Measurement & Calculation

From the measured resistance value (Ω), please the temperature (°C) is converted from the equation according to the temperature range of (1) (2) below.

※Refer to JIS C1604-2013

(1) Range of −200°C to 0°C: $R_t = 100\ [1 + At + Bt^2 + C(t-100)\ t^3]$

(2) Range of 0°C to 850°C: $R_t = 100\ (1 + At + Bt^2)$

Where:

$A = 3.9083\times10^{-3}\ ℃^{-1}$

$B = -5.775\times10^{-7}\ ℃^{-2}$

$C = -4.183\times10^{-12}\ ℃^{-4}$

NOTE:

R_t is the resistance value at t ℃

6. Maintenance & Troubleshooting

6-1. Maintenance

To maintain accurate measurement, it is recommended to check and do the following:

Table 6-1. Maintenance Items

Maintenance Item	Frequency	How To	Effect
Clean Silicon Lens	Several times per week	Keep the silicon lens clean by wiping with a soft cloth and alcohol	The infrared irradiance measurement will be affected due to a change in transmittance.
Check Appearance Condition	Weekly	Check for cracks and scratches on the silicon lens and body.	May lead to water leakage due to rain/dew which causes damage of the detector inside the pyrgeometer.
Check Bubble Level	Weekly	Verify if the pyrgeometer is levelled by checking the bubble is in the center ring of bubble level. (When the pyrgeometer is setup in horizontal position)	An additional cosine/azimuth error will be introduced.
Check Cable Condition	Weekly	Verify if the cable connector is properly connected, tightened to the instrument, and how cable is lined; make sure the cable is not swinging by wind.	A disconnected cable will cause sporadic reading errors or failure of operation. If the cable is damaged, it may lead to noise or electric shock.
Check Setup Base Condition	Weekly	Check if the instrument is tightened properly to the mounting base plate and the base plate and/or table is securely fastened in a proper condition.	Loose instruments and/or mounting plates can lead to damages of the instruments and/or injury.
Check the Sunscreen[*]	Weekly, Before/After Bad Weather	Verify if the sunscreen is securely fixed on the body, and knurling screw is securely tightened.	May lead to damaging the instrument and/or lead to increasing measurement error due to temperature increase by sunscreen coming off.
Recalibration	Every 2 Years	To maintain the best possible measurement accuracy, recalibration of the pyrgeometer is recommended. Contact EKO for more details and requests for a recalibration and maintenance service.	Due to natural aging of materials the detector properties of the pyrgeometer can change in time which affects the sensor sensitivity.

6-2. Calibration and Measurement Uncertainty

It is recommended to recalibrate MS-20 pyrgeometer once every 2 years in order to verify the good quality of the solar radiation measurements. Below explains about the calibration methods of EKO pyrgeometers and their calibration uncertainty. For further information about recalibration and maintenance procedures, please contact EKO or find on the EKO website (http://eko-eu.com).

1. Calibration Method

This pyrgeometer is calibrated by taking outdoor measurement simultaneously with our reference pyrgeometer during night time without clouds.

Outdoor Calibration Procedure

Setup the reference unit and product pyrgeometer in horizontal position outdoor, and simultaneously take measurement output (mV) at night during there are no clouds.

1) From reference unit output (mV) and sensitivity (μV/W/m^2), calculate the net radiation amount (W/m^2), then

2) the value obtained from dividing the product pyrgeometer output (mV) similarly measured by the radiation balance of the reference unit (W/m^2) is calculated as the sensitivity (μV/W/m^2).

2. Calibration Traceability

The Internal reference pyrgeometer maintained at EKO is traceable to the pyrgeometer which is directly compared against the WISG (World Infrared Standard Group) maintained at PMOD (Davos, Switzerland). The logger system used for the calibration measurement is traceable to JEMIC (Japan Electric Meters Inspection Cooperation).

6-3. Troubleshooting

Read the following in case of any sensor trouble. If any questions should remain, please contact EKO for further technical support.

Table 6-2. Troubleshooting

Failure	Action
There is no output.	Make sure that the sensor cable is connected properly to the instrument. To verify the connection, measure the impedance of output cable (between the “+” and the “-” wires) and check if the measured impedance is within the proper range as shown in the specification table. Refer to the product label for the internal resistance value of the product. Check that the measurement range of the output measuring instrument is correct.
Output value is too low	The silicon lens maybe soiled with rain or dust. Clean the glass dome with a soft cloth. The output may be decreased due to regular change. Recalibrate periodically.

7. Specifications

7-1. Specifications

1. Pyrgeometer Specifications

Table 7-1. Pyrgeometer specifications

Characteristics	MS-20
Response time 95% output	＜18 Sec
Window heating offset	＜6 W/m^2
Nonlinearity	1%
Temperature response *	＜1 % (−10 to +40°C)
Operating Temperature	-40 to +80°C
Wavelength range	4.5 to 40µm
Impedance	Approx. 50 to 100Ω
Sensitivity	Approx. 20 µV/W/m^2
Field of View	2π (sr)
Detector Temperature sensor	Pt-100 Class A
Bubble level accuracy	0.3°
Environmental Protection (IP Code)	IP67 Equivalent (IEC60529)
Output Cable (outer diameter)	AWG20 : 0.5mm^2 x 5 pins (φ6.7mm)
Output Cable Terminal	Pin-Terminal (0.3-9.5)
Output (or Signal)	Voltage (mV)
Mass	0.35 kg

* The value applied the Temperature Coefficient correction

7-2. Dimensions

Table 7-2. Dimensions

	MS-20
A. Fixing Hole Pitch	65 mm
B. Body Height	76.6 mm
C. Levelling Screw Height	16 mm
D. Width (including Sunscreen/Cover)	Φ96 mm
E. Overall Height (approx.)	92.6mm

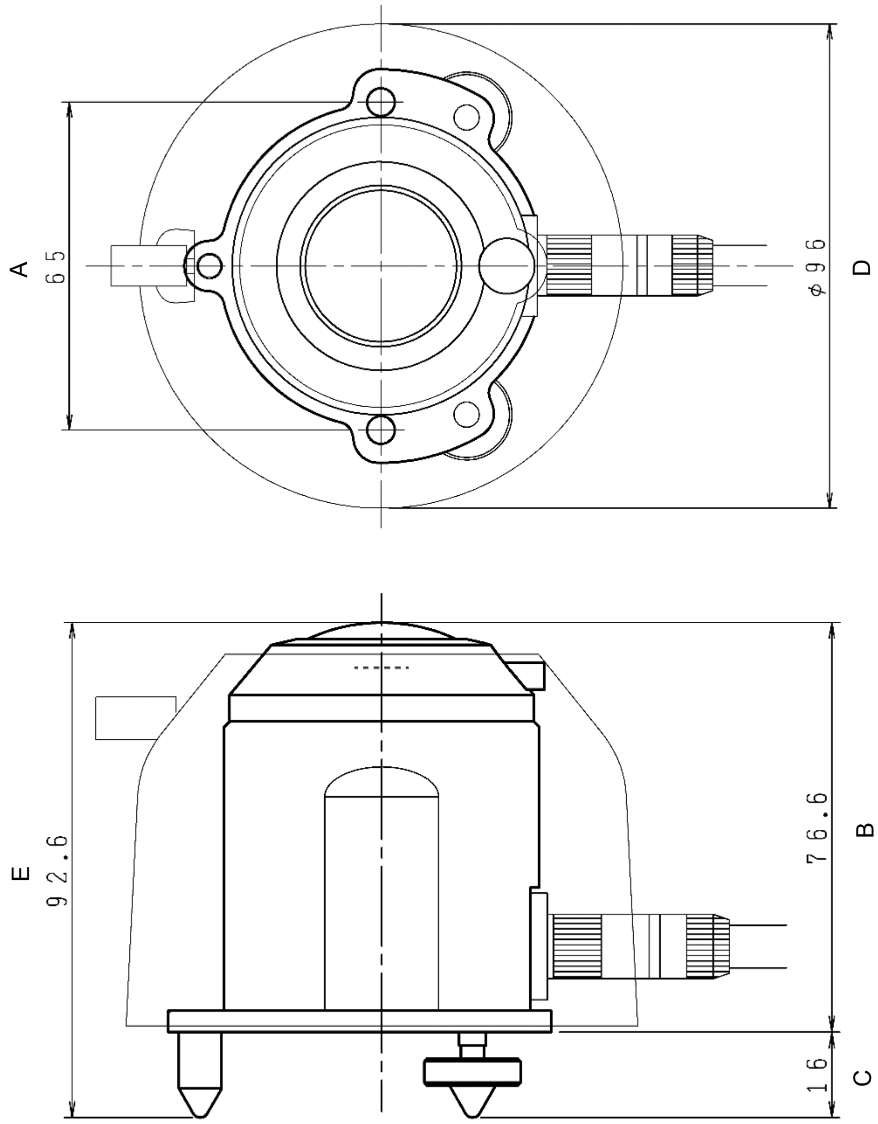


Figure 7-1. Outer Dimensions

7-3. Output Cables

See [5-2. Installation, 2. Wiring] for instruction

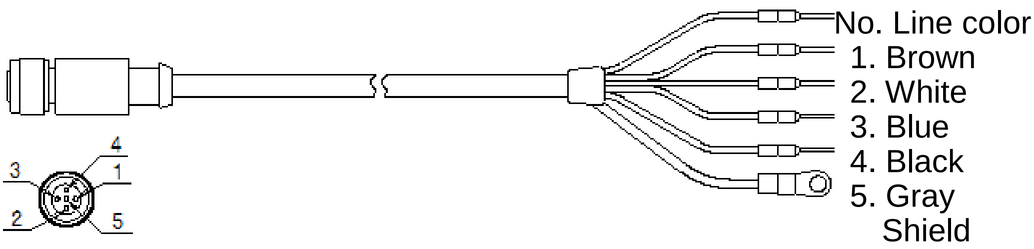


Figure 7-2. Output Cables

7-4. Accessories List

Table 7-3. Accessories List

Option Items	Remarks
Output Cable*	Cable Length: 20m, 30m, 50m Terminals: Fork Terminals, Round Terminals, Pin Terminals
Ventilation Unit	Model: MV-01

*Standard cable length is 10m.

APPENDIX

A-1. Conversion Table from Temperature to Radiation

Table A-1. Conversion table from temperature to radiation

Radiation ($E = \sigma T^4$)

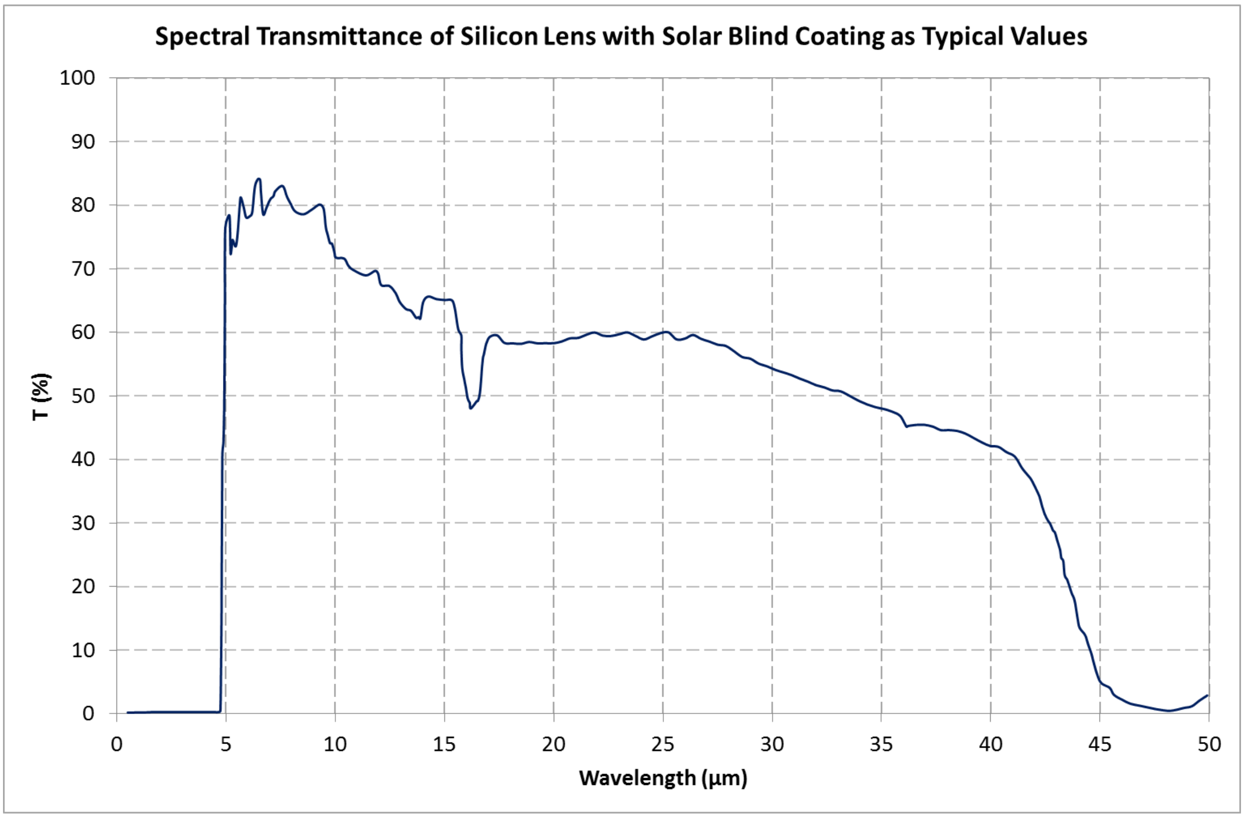
σ = 5.670367×10^{-8} [W/m^2K^{-4}] (Stefan-Boltzmann constant)

T = 273.15 + °C [K] (kelvin, Absolute temperature)

Temp [℃]	-40	-39	-38	-37	-36	-35	-34	-33	-32	-31
E [W/m²]	167.55	170.45	173.38	176.34	179.35	182.4	185.48	188.6	191.76	194.96
Temp [℃]	-30	-29	-28	-27	-26	-25	-24	-23	-22	-21
E [W/m²]	198.2	201.48	204.8	208.17	211.57	215.01	218.5	222.03	225.6	229.22
Temp [℃]	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11
E [W/m²]	232.88	236.58	240.32	244.11	247.95	251.83	255.75	259.72	263.74	267.8
Temp [℃]	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
E [W/m²]	271.91	276.07	280.27	284.52	288.82	293.17	297.57	302.02	306.51	311.06
Temp [℃]	0	1	2	3	4	5	6	7	8	9
E [W/m²]	315.66	320.31	325	329.75	334.56	339.41	344.32	349.28	354.29	359.36
Temp [℃]	10	11	12	13	14	15	16	17	18	19
E [W/m²]	364.48	369.66	374.89	380.18	385.52	390.92	396.37	401.88	407.45	413.08
Temp [℃]	20	21	22	23	24	25	26	27	28	29
E [W/m²]	418.77	424.51	430.31	436.17	442.09	448.07	454.12	460.22	466.38	472.61
Temp [℃]	30	31	32	33	34	35	36	37	38	39
E [W/m²]	478.9	485.25	491.66	498.14	504.68	511.28	517.95	524.68	531.48	538.35
Temp [℃]	40	41	42	43	44	45	46	47	48	49
E [W/m²]	545.28	552.28	559.35	566.48	573.68	580.95	588.29	595.7	603.17	610.72
Temp [℃]	50	51	52	53	54	55	56	57	58	59
E [W/m²]	618.34	626.03	633.79	641.62	649.53	657.51	665.56	673.68	681.88	690.16
Temp [℃]	60	61	62	63	64	65	66	67	68	69
E [W/m²]	698.51	706.93	715.43	724.01	732.66	741.39	750.2	759.09	768.06	777.1
Temp [℃]	70	71	72	73	74	75	76	77	78	79
E [W/m²]	786.23	795.43	804.72	814.08	823.53	833.06	842.67	852.37	862.15	872.01

A-2. Spectral transmittance

The following is a typical value of the spectral transmittance of a silicon lens.



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