



# INSTRUCTION MANUAL

## Small Sensor

ML-020P

ML-020S-O/ML-020S-I

Version : 6



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## 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:

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### 2-1. Contact Information

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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.

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## 2-3. About Instruction Manual

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## 2-4. Environment

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

This product is not subjected to WEEE Directive 2002/96/EC however it should not be mixed with general household waste. For proper treatment, recovery and recycling, please take this product(s) to designated collection points.

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.

## 3. Safety Information

EKO Products are designed and manufactured with consideration for safety; however, please make sure to read and understand this instruction manual thoroughly to be able to operate the instrument safely in the correct manner.



### WARNING CAUTION

Attention to user; pay attention to the instructions given on the instruction manual with this sign.



### 3-1. WARNING/CAUTION

#### 1. Setup

When installing ML-020 use a proper base to mount the ML-020 with attached bolts and nuts. If the mounting plate and/or mast do not have enough strength, it can break and lead to unexpected accidents and/or injury due to strong wind or earthquake.

#### 2. Resin Diffuser

Giving strong impact to the resin diffuser may cause damage to the sensor. To clean the resin diffuser, use soft cloth without using any organic solvent, such as alcohol.

## 4. Introduction

Small sensor ML-020 series are all-weather type compact sensors which are developed for measuring solar radiation and artificial sun light in various wavelengths depending on the measurement purpose. Although these are small sensors, they use collector which is specially designed to improve the cosine response and increase the sensitivity; by the combinations of filter and photodiode for measurement purpose, 3 types of sensors are developed.

### 4-1. Main Features

#### 1. Excellent Characteristics

By the combination of special filter and the sensor, the Small Sensor ML-020 Series have spectral response closer to the ideal spectral response. The temperature dependency is also within the range of 1% maximum.

#### 2. Small and Light Weight

The sensors are very small in size and weight ( $\phi 22 \times 33 \text{mm}$ , 65g), which is convenient for carrying and suitable for taking measurements of irradiance and illumination distributions.

#### 3. All-Weather Use

The sensors can be used in all weather conditions allowing taking continuous and stable measurements.

### 4-2. Package Contents

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

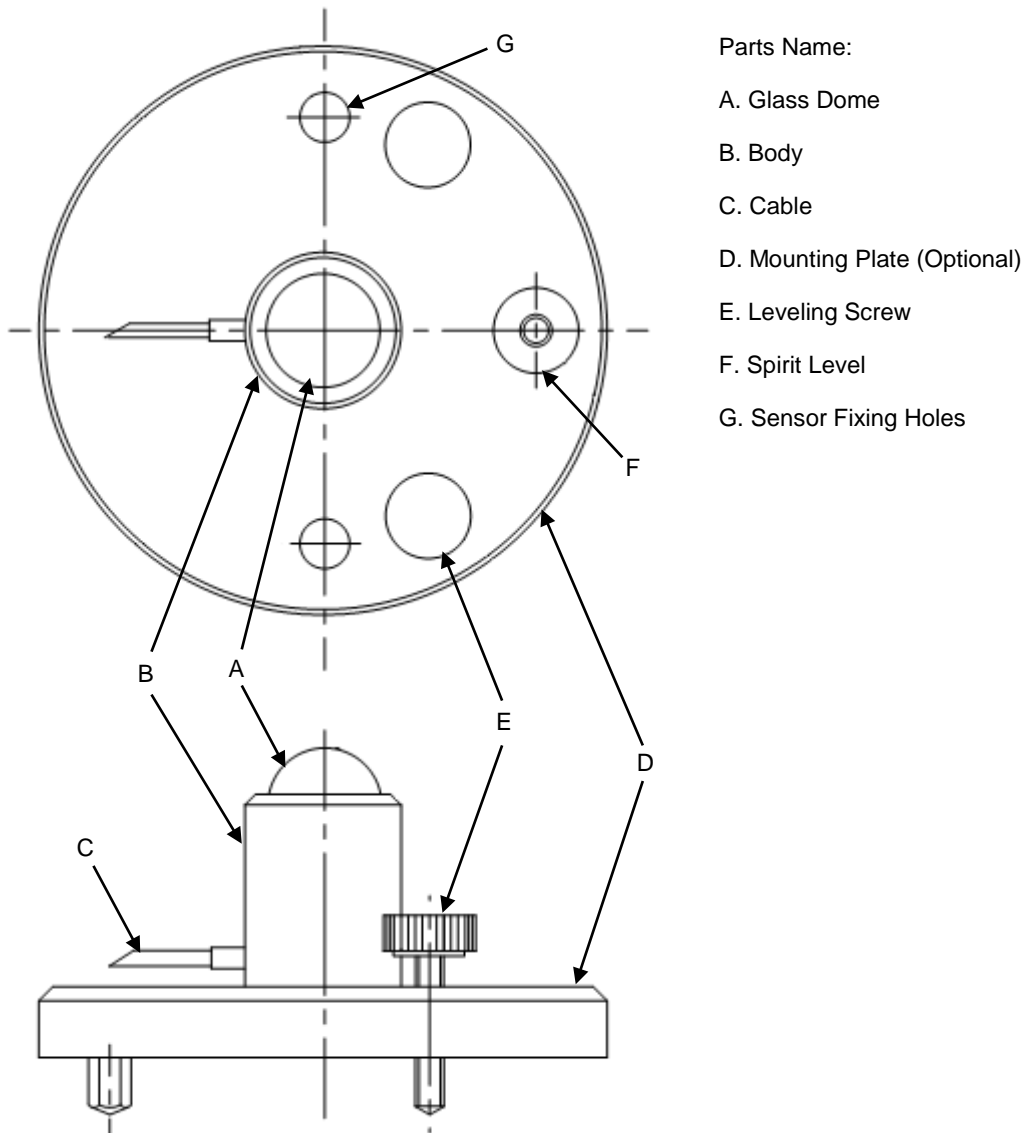
Table 4-1. Package Contents

Standard Items	Qty.	Remarks
Sensor	1	With cable already attached to the sensor
Leveling Plate (Optional)	1	Sensor Mounting Screws (M2x12mm, 3pcs) Fixing bolts (Bolts: M6x50mm, 2pcs, Washers: M6, 4pcs, Nuts: M6, 2pcs)
Calibration Certificate	1	
Instruction Manual	1	

# 5. Getting Started

## 5-1. Parts Name and Descriptions

Each part name and its main function are described below.



- Parts Name:
- A. Glass Dome
  - B. Body
  - C. Cable
  - D. Mounting Plate (Optional)
  - E. Leveling Screw
  - F. Spirit Level
  - G. Sensor Fixing Holes

Figure 5-1. Parts Name and Descriptions

1. Glass Dome

Glass dome protect the sensor part from outside environmental effects, such as dirt, rain drops and wind.

2. Diffuser

Diffuser improves the Cosine Response of the incident light from the hemispherical sky.

3. Body / Spirit Level (Mounting Plate)

Optional mounting plate with spirit level is available for checking and installing the sensor part at horizontal position.

#### 4. Cable

Small Sensors come with a single cable which is already attached and can be used right away.

At the end of signal cable has either a pin terminal for easier connection to measuring instruments such as data logger. Standard length of the signal cable is 5m; other lengths (10m, 30m, 50m) are available on request.

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## 5-2. Setup

In order to obtain representative measurements working with the ML-020, several criteria with respect to setup and mounting of the instruments have to be considered:

The ideal mounting position for solar sensors is a location which has a full hemispheric field-of-view without any obstructions (such as buildings, trees, and mountain). In practice, it might be difficult to find such locations. Therefore, some practical recommendations on how to minimize undesired effects of reflecting or obstructing surfaces are given next:

- Select a mounting position which it is free from obstructions at 5° above horizon.
- The setup location should be easily accessible for periodic maintenance (glass dome cleaning, desiccant replacement, etc.).
- Avoid surrounding towers, poles, walls or billboards with bright colors that can reflect solar radiation onto the pyranometer.
- A strong physical impact to the pyranometer can lead to product damage and/or may cause changes to the sensitivity.

### 1. Installing on Horizontal or Tilted Position

- 1) When installing the ML-020 without the optional leveling plate, three M2 screws must be prepared by user.  
Prepare three M2 screws that are 3~4mm longer than the installation base plate thickness which the pyranometer is mounted.
- 2) Check the installation base where the sensor has to be mounted and make sure it has two fixing holes with the appropriate pitch. (See [7-3. Dimension])
- 3) Setup the sensor with the signal cable facing the nearest Earth's pole. In the Northern hemisphere, the cable should be orientated North, in the Southern hemisphere, the cable should be orientated South.
- 4) [If optional Leveling Plate is used]  
Adjust the 3 leveling screws on the leveling plate, so that the air bubble in the spirit level will be positioned in the center of the circle on the spirit level. If the sensor is not leveled properly, the sensor readings are affected by cosine and azimuth errors. Periodically check the spirit level and adjust the sensor position if necessary.



[Installing in Tilted Position]

Ideally the sensor should be mounted to a tilted mounting base using the leveling plate with the 3 leveling feet.

Level the sensor on a leveled table in horizontal position before placing the sensor on the sloped mounting base.

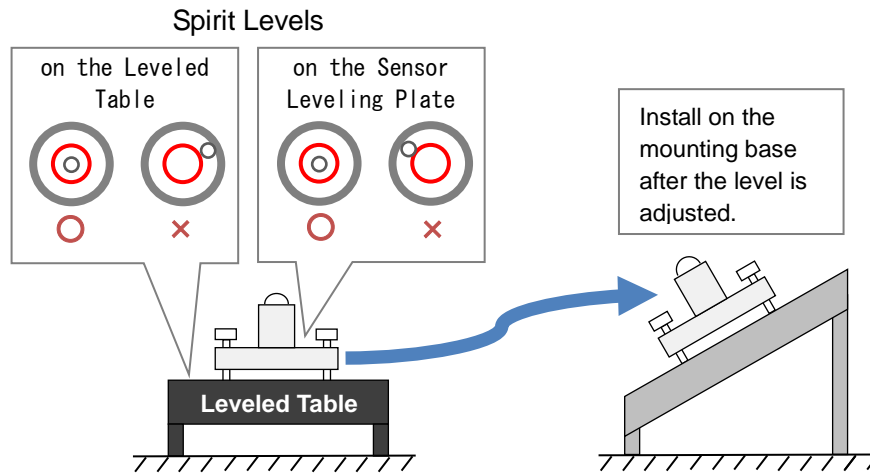


Figure 5-2. Installing in Tilted Position

- 5) Fasten the leveling plate to the tilted mounting base using the attached two bolts.  
Wrench and spanner (10mm) is required for fixing fastening the M6 fixing bolts

## 2. Wiring

To extend the cable life time, 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 on 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 sources can cause noise on the output signal.

Therefore the cable should be lined at a safe distance from a potential source generating EM noise, such as a power electronics, high voltage lines or telecom antenna.

Strongly pulling the signal cable will break the cable connections; make sure the cable is not forcibly pulled during the installation.

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## 5-3. Cable Connection

### 1. Connecting to Measuring Device

- 1) Connect the ML-020 signal cable ends to a measurement device or data logger. Polarities are as follow:

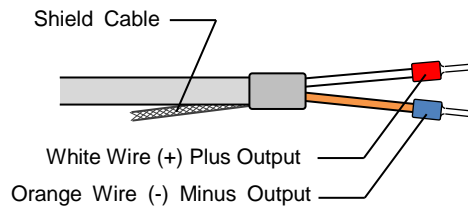


Figure 5-3. Signal cable Ends Polarity

- 2) Check the output voltage. If some noise is seen on the output voltage, connect the shield cable and minus (-) input terminal together.
- 3) Make sure to connect the cable with correct polarities to the measuring device input terminals. White wire with red terminal is (+), orange wire with blue terminal is (-). (It is recommended to use a measurement device with minimum 100k $\Omega$  input impedance).

### 2. Notes for Handling Cables

The sensor signal cable comes with standard length of 5m (directly connected to ML-020 body). In case the cable length is insufficient for your application, please request for desired length at the time of ordering. In case you want to extend the cable length use a shielded low noise cable.

(If approximately 10~20m cable is extended, use 0.5mm<sup>2</sup> x 2 pins shield cable).

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## 5-5. Measurement

### 1. Calculation

To obtain each physical value from the output of the sensor, calculate the following equation

$$Q = \frac{E}{K}$$

**Q**: Physical value [Lx,  $\mu\text{mol}\cdot\text{s}^{-1}\cdot\text{m}^{-2}$ ]

**E**: Output voltage from the sensor [ $\mu\text{V}$ (mV)]

**K**: Sensitivity [ $\mu\text{V}/\text{Lx}$ ,  $\mu\text{V}/\mu\text{mol}\cdot\text{s}^{-1}\cdot\text{m}^{-2}$ ]

\* The sensitivity of each sensor is indicated in the certificate.

### 2. Measuring Device Setting

A Si sensor is integrated in the Small Sensor ML-020 Series, and it generates current corresponding to the light intensity. Because this current is very small as only a few  $\mu\text{A}\sim\text{mA}$ , it is converted into voltage output by load resistance. Therefore, if the sensor is connected to a measuring device with low input impedance, the current generated by the Si sensor would flow into the measuring device causing inaccurate measurement. It is recommended to use measuring device with input impedance more than  $100\text{k}\Omega$  for connecting with these sensors.

If measurement range can be setup on the measuring device, select a measurement range which can take accurate measurement (ML-020S-O & ML-020S-I: 0~30mV, ML-020P: 0-10mV).

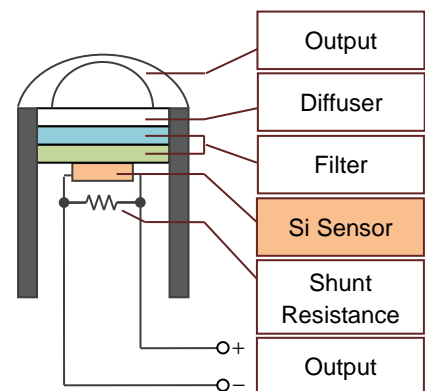


Figure 5-4. ML-020 Construction

# 6. Maintenance & Troubleshooting

## 6-1. Maintenance

EKO sensors will provide accurate measurement results if the diffuser and the condition of the instrument are maintained properly. Furthermore, regular maintenance and scheduled re-calibrations can extend the lifetime and precision. However, environmental conditions, such as for instruments mounted near highly frequented traffic lanes or airports, chemical industry, may have a deteriorating effect on the materials. Therefore, proper maintenance is needed and has to be adapted to the local environmental conditions.

The following table describes the common maintenance tasks that should be performed on a regular basis:

Table 6-1. Maintenance Items

Items Maintenance Item	Frequency	How To	Effect
Clean Glass Dome	Few times in a week (at least once per week)	Keep the diffuser clean by wiping it with a soft cloth.	If the diffuser gets soiled (by accumulation of dirt) the detector output will be affected due to a change in transmittance. This dirt can either be removed manually (not using alcohol) or it is washed off by rain (self-cleaning effect).
Check Glass Dome condition	Weekly	Check for crack and scratches on the glass dome and the rim.	May lead to water leakage due to rain/dew which causes damage of the detector inside the sensor
Check Spirit Level Bubble	Weekly	Verify if the pyranometer is leveled by checking the bubble is in the center ring of spirit level. (When the pyranometer is setup in horizontal position)	If a pyranometer in the horizontal measurement position is not leveled correctly an additional cosine/azimuth error will be introduced.
Check Cable Condition	Weekly	Verify if the cable is properly connected, 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 (ventilator AC power cable).
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.

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## 6-2. Calibration Method

It is recommended to recalibrate the instrument once every 2 years. For further information about the calibration and recalibration of your solar sensors, please contact EKO.

### **[Indoor Calibration Procedure]**

The ML-020 reference sensor is calibrated indoor using 1000W/m<sup>2</sup> AAA class solar simulator. The sensitivity figure of the production ML-020 is determined by calculating the output ratio multiplied by the sensitivity figure of the reference model.

#### *Traceability*

The ML-020 reference sensor maintained at EKO is traceable to the PMO-6 absolute cavity at EKO which is under the international radiation scale called WRR (World Radiometric Reference) Primary Standard (Absolute Cavity) maintained at PMOD (Davos, Switzerland). The data logger system used in the calibration measurement is traceable to JEMIC (Japan Electric Meters Inspection Corporation).

The ML-020 reference sensor is calibrated by direct comparison against the secondary standard reference pyranometer MS-802 and 2 units of internal reference pyranometers, which were calibrated against the PMO-6 absolute cavity according to the continuous sun-un-shade method [A New Method for Calibrating Reference and Field Pyranometers (1995)] Bruce W Forgan) every one year.

The PMO6 Absolute Cavity is

The absolute cavity (PMO6) maintained at EKO is directly traceable to WRR by comparing against WRR every 5 years.

See Appendix A-2 for traceability diagram.

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## 6-3. Troubleshooting

Check the following items in case of trouble with the instrument. If any questions should remain, 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 measurement device. To verify the sensor connection, measure the impedance of signal cable (between the "+" and the "-" wires) and check if the measured impedance is within the proper range as shown on the specification.
	Check whether the measurement range setup on the measuring device is appropriate.
Output value is too low	The diffuser maybe covered by rain drops or got soiled. Clean the diffuser with a soft cloth.

# 7. Specification

## 7-1. Main Unit

The spectral response for ML-020 is shown in graph in the Appendix A-1 section.

Table 7-1. Main Unit Specification

	ML-020P	ML-020S-O	ML-020S-I
Product Name	Photon Meter	Outdoor Luxmeter	Indoor Luxmeter
Measurement Range	0~3000 $\mu\text{mol}\cdot\text{s}^{-1}\cdot\text{m}^{-2}$	0~150,000 Lx	0~30,000 Lx
Output (Approx.)	0~10,000 $\mu\text{V}$ (0~10mV)	0~30,000 $\mu\text{V}$ (0~30mV)	
Internal Resistance (Approx.)	160 $\Omega$	280 $\Omega$	1.3k $\Omega$
Operating Temperature	-10~+50°C		
Temperature Response (-10~+50°C)	1.1%	0.4%	
Size	Sensor Only	$\phi 22 \times 33\text{mm}$	
	With Mounting Plate	$\phi 80 \times 51\text{mm}$	
Weight	Sensor Only	65g	
	With Mounting Plate	475g	

## 7-2. Cables

Table 7-2 Cable Specifications

Cables	Details	Terminal	Wire	Output
Signal cable	Diameter: 0.18mm <sup>2</sup> x 2pins $\phi 3.2\text{mm}$ Cable end: pin terminal	Red Blue	White Orange	(+) Plus (-) Minus

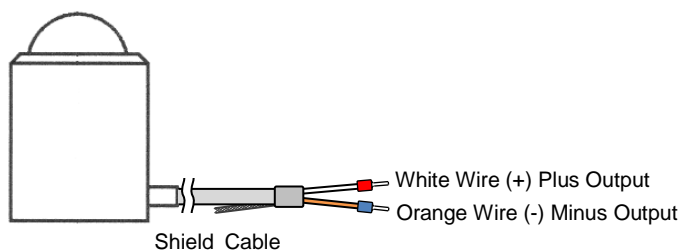


Figure 7-1. Signal cable

## 7-3. Dimensions

### 1. ML-020 Dimension (without Leveling Plate)

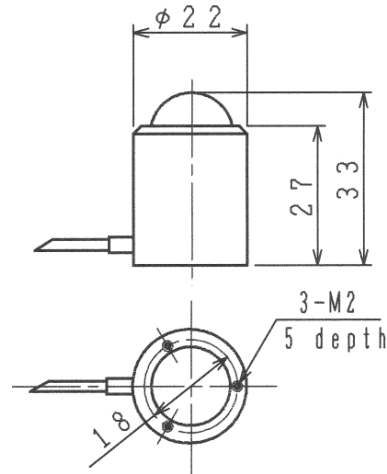


Figure 7-2. Outer Dimensions of Sensor

### 2. ML-020 Dimension (with optional Leveling Plate)

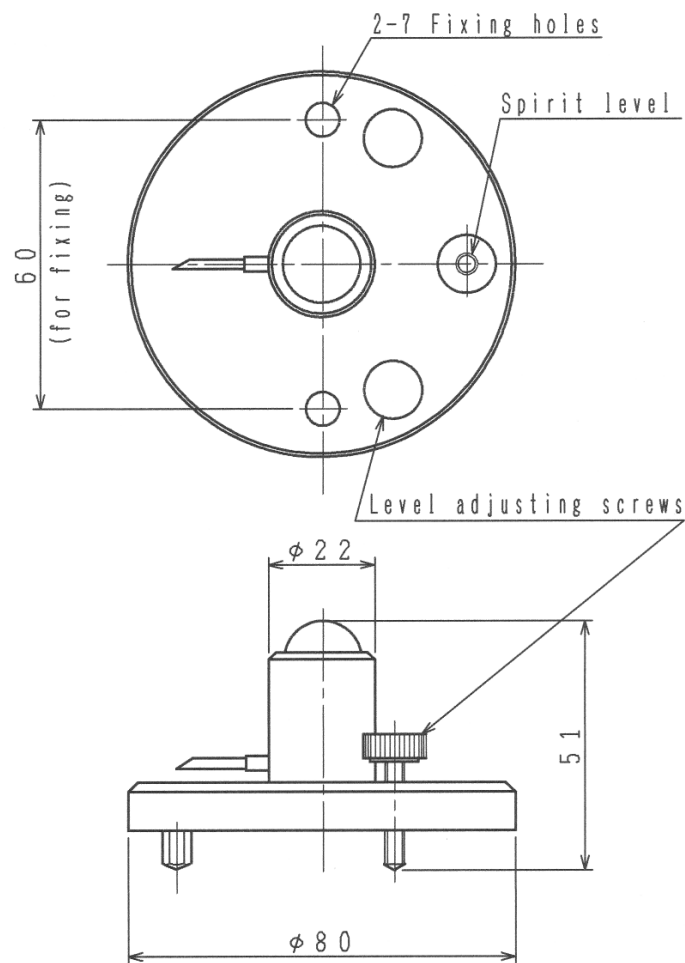


Figure 7-3. Outer Dimensions of Sensor and Leveling Plate

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## 7-4. Accessories List

Table 7-3. Accessories List

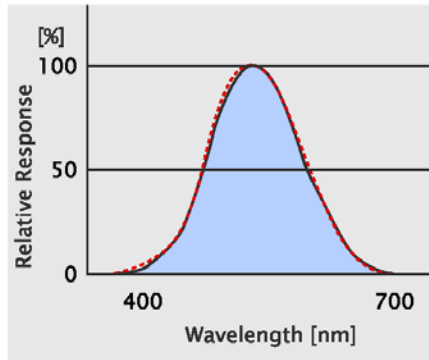
Option Items	Remarks
Leveling Plate	Sensor Mounting Screws (M2x6mm, 3pcs & extra 3pcs for spare) Leveling Screws(Bolts: M5x20mm, 3pcs) Fixing bolts (Bolts: M6x50mm, 2pcs, Washers: M6, 4pcs, Nuts: M6, 2pcs)
Cable length	5m (Optional 10m, 30m, 50m)



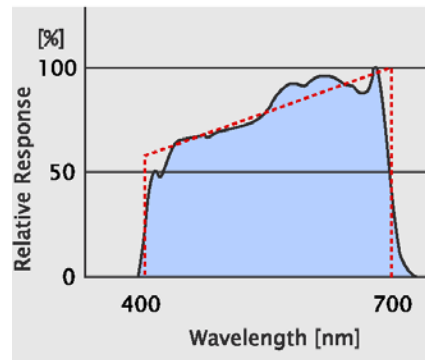
# APPENDIX

## A-1. Spectral & Directional Response Characteristics

Below are the typical values of the spectral response and directional response.



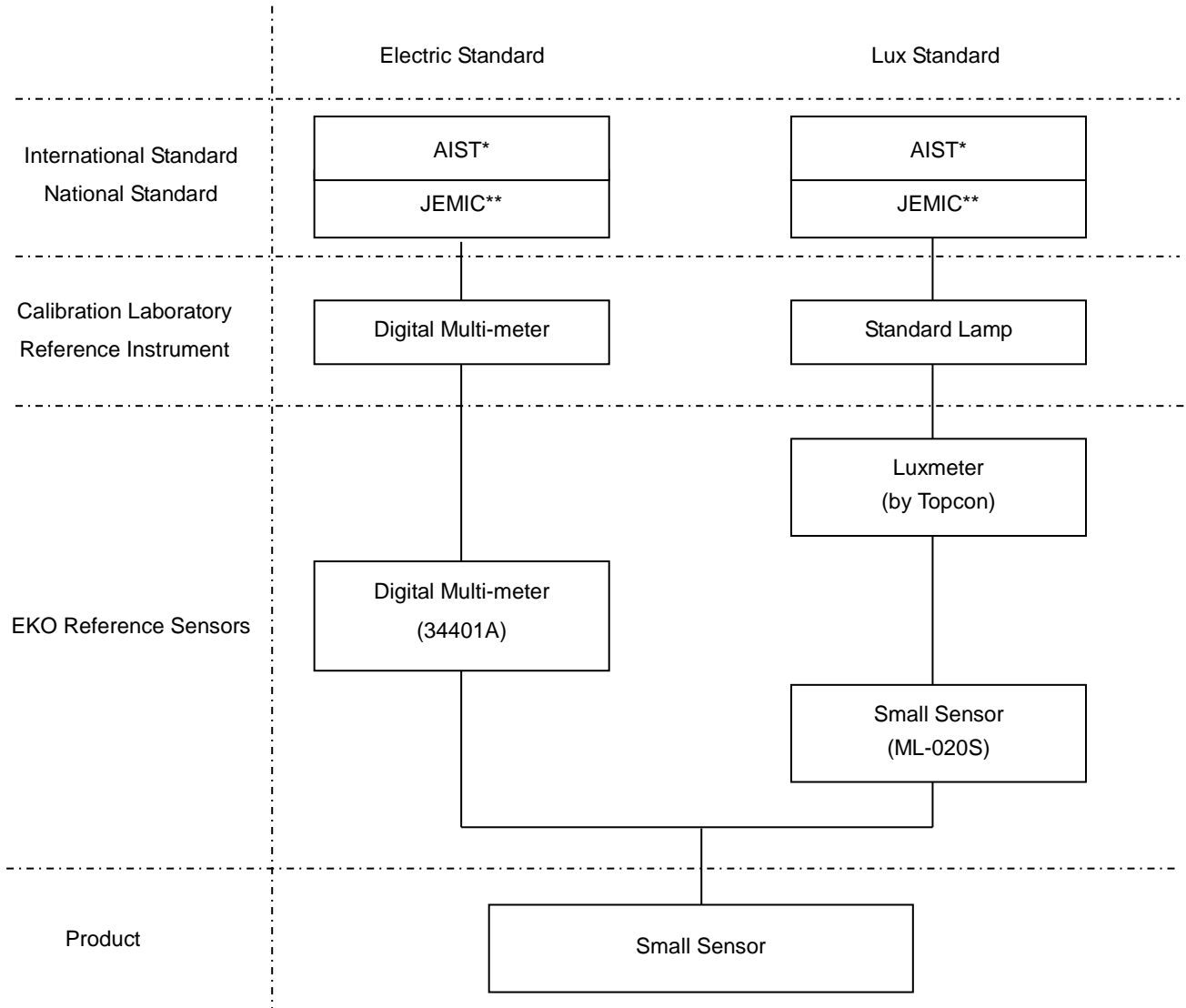
**Luxmeter**  
ML-020S-I, ML-020S-O



**Photon sensor**  
ML-020P

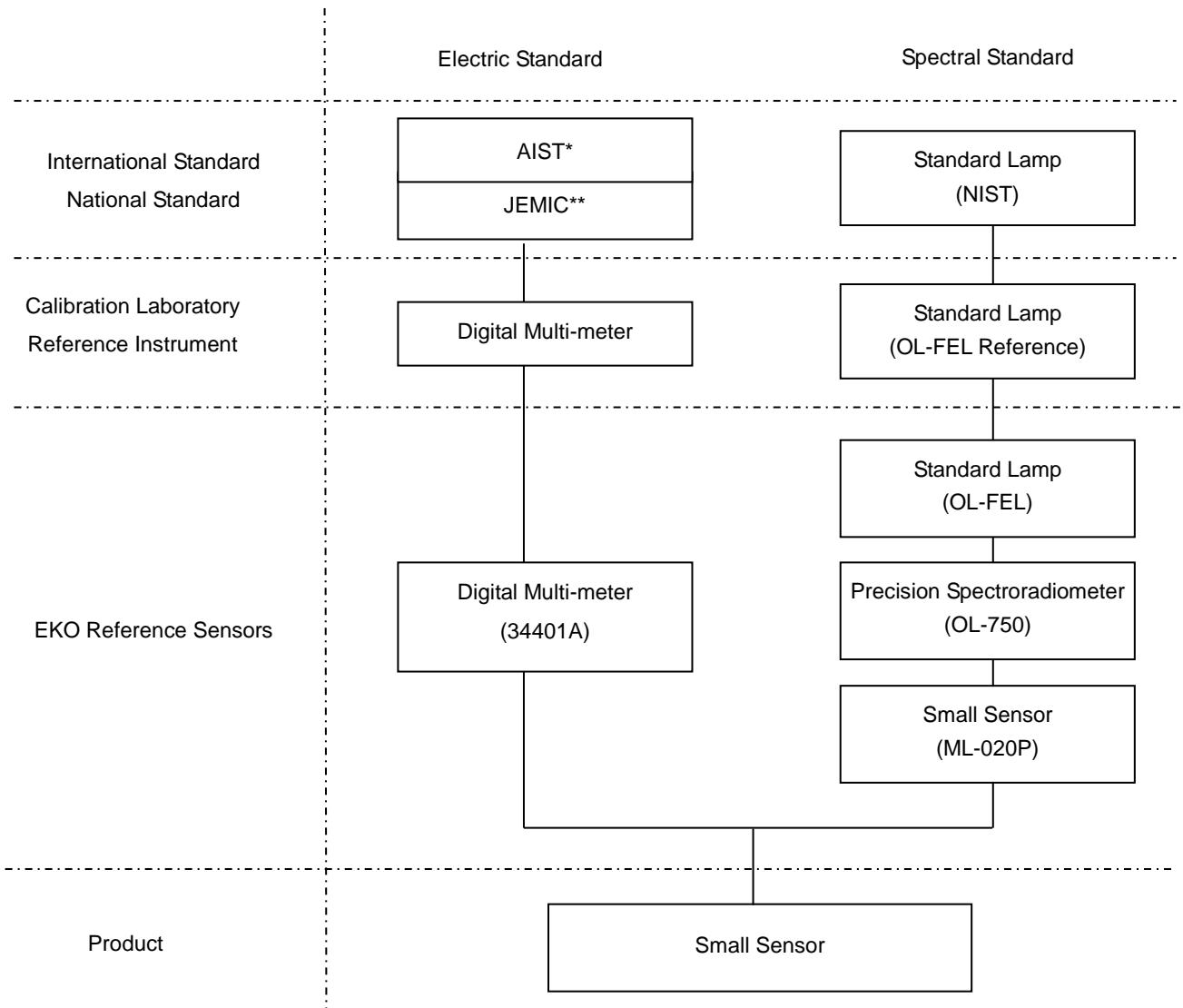
## A-2. Traceability

[ ML-020S-I, ML-020S-O ]



\*National Institute of Advanced Industrial Science and Technology

\*\*Japan Electric Meters Inspection Corporation



\*National Institute of Advanced Industrial Science and Technology

\*\*Japan Electric Meters Inspection Corporation



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