

# Pyranometers

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### Overview

EKO Pyranometer MS-802 / 402 / 410 / 602 measure solar energy that is received from the entire hemispherical sky. Output is expressed in  $W/m^2$ . Heat balance at the surface of the ground is largely affected by solar radiation, hence solar radiation is fundamental and important factor in climate. Furthermore, solar radiation is indispensable for climatology and agroclimatology. The measurement of solar radiation is also utilized in many thermal and photovoltaic solar energy applications.



### Measurement principle

#### MS-802 and MS-402

Thermopile, which has a flat spectral response at all wavelengths, is integrated as a sensor. Thermopiles generate electricity by thermo-electric effect, which is caused by the temperature difference between hot and cold junctions. This occurs when solar radiation is absorbed by the blackened surface of the sensor. Solar irradiance is obtained by measuring voltage from the thermopile sensor.

Glass domes to reject infrared radiation of wavelength above  $3\mu m$  is necessary for thermopile-type sensors. Otherwise, these sensors would detect all infrared radiation as well as solar radiation. Double-dome construction is adopted in MS-802 and MS-402 to eliminate secondary radiation, which is generated in the outer glass dome.

MS-802 is ISO Secondary Standard Instrument, whereas MS-402 conforms to the First Class specifications defined by ISO 9060.

Ventilators can be installed optionally on MS-802 and MS-402 to prevent the influence of frost, snow and dust (Models; MS-802F and MS-402F).

#### MS-410

The MS-410 is perfectly suited for sampling 10-minute averages of the solar radiative flux in horizontal or tilted configurations. The MS-410 is fully compliant with the

ISO9060 "First Class" norm. The flat sensor surface, coated with a special, highly absorbing black paint, is protected by two transparent hemispheric glass domes.

The MS-410 has a  $180^\circ$  field-of-view for measuring the hemispheric solar radiation with a cosine-weighting function. The two transparent glass domes protect the sensor efficiently from negative thermal effects. The MS-410 has a practical light-weight anodized aluminum housing and a highly efficient sensor coating. These features, together with the two, high quality machined hemispheric glass domes are the key to the excellent performance characteristics of the MS-410.

#### MS-602

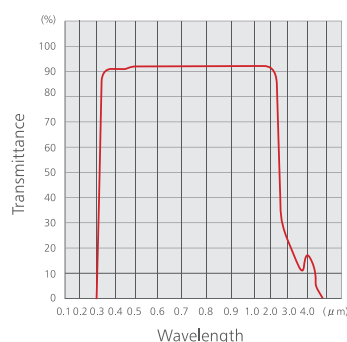
MS-602 detector consists of a special polymer film with the advantages of having very small temperature response and long-term durability. Thermopile detects temperature difference between the center- and peripherally mounted hot and cold junctions, respectively. Hot and cold junctions are positioned radially. Detector is coated by special black paint, which has independent wavelength. MS-602 conforms to the Second Class specifications defined by ISO 9060. MS-602 is appropriate for the measurement of solar irradiance at several field locations.

## Specifications

	MS-802	MS-402	MS-410	MS-602
ISO 9060 classification	Secondary Standard	First class	First Class	Second class
Response time 95% (sec)	approx. 5	approx. 8	approx. 18	approx. 17
<b>Zero offset</b>				
- Thermal radiation(200W/m <sup>2</sup> )	< 6W/m <sup>2</sup>	< 6W/m <sup>2</sup>	< 6W/m <sup>2</sup>	< 10W/m <sup>2</sup>
- Temperature change (5K/hr)	< 2W/m <sup>2</sup>	< 2W/m <sup>2</sup>	< 2W/m <sup>2</sup>	< 6W/m <sup>2</sup>
Long-Term-stability(change/year)	< 0.5 %	< 0.5 %	< 1.5 %	< 1.7 %
Non-linearity(at 1000W/m <sup>2</sup> )	< 0.2 %	< 0.2 %	< 1.0 %	< 1.5 %
Directional response(at 1000W/m <sup>2</sup> )	< 10 W/m <sup>2</sup>	< 20W/m <sup>2</sup>	< 20W/m <sup>2</sup>	< 25W/m <sup>2</sup>
Spectral selectivity(0.35-1.5μm)	< 1 %	< 1 %	< 1 %	< 1 %
Temp. response(for 50°C band)	< 1 %	< 1 %	< 2 %	< 2 %
Tilt response(at 1000W/m <sup>2</sup> )	< 0.2 %	< 0.2 %	< 2.0 %	< 2.0 %
Sensitivity(μV/W·m <sup>2</sup> )	Approx. 7.00	Approx. 7.00	Approx. 7.00~14.00	Approx. 7.00
Impedance (Ω)	Approx. 500	Approx. 500	20~140	20~140
Operating temperature, °C	-40 ~ +80	-40 ~ +80	-40 ~ +80	-40 ~ +80
Cable length	10m	10m	10m	10m
Wavelength range (more than 50% of transmittance)	285 - 3000 nm	285 - 3000 nm	285 - 3000 nm	285 - 3000 nm

Specifications are subject to change without notice.

### Transmission Curve of the Glass Dome



ISO 9060 classifies pyranometers into three categories as Secondary Standard, First Class and Second Class. In these classifications, the characteristics of each class are defined by temperature dependency, non-linearity, response time etc.

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### Outline drawing

ISO Secondary Standard  
**MS-802**    ISO First Class  
**MS-402**

ISO First Class  
**MS-410**

ISO Second Class  
**MS-602**

