CMP/SMP-SERIES
PYRANOMETERS, FOR THE ACCURATE MEASUREMENT OF SOLAR IRRADIANCE

Product Description

If you want to measure solar radiation on Earth's surface, you start with a pyranometer. Solar radiation drives almost every dynamic process on the Earth from ocean current circulation to weather, climate and the biosphere. The determination of the radiation budget at the surface of the Earth is fundamental to understanding the Earth's climate system and weather patterns.

Solar irradiance:

PV systems harnessing solar irradiance are the most widely installed source of zero-emission renewable energy. High quality, reliable radiation data is crutial to the efficienct operation of solar energy projects in both photovoltaic (PV) and concentrating solar power (CSP) thermal systems.
A pyranometer is a radiometer designed for measuring the irradiance in W/m2 resulting from radiant fluxes incident upon a plane surface (horizontal or tilted) from the hemisphere above, and integrated over a wavelength range of at least 300 to 3000 nanometers.

Benefits and Features:

- The widest range of high quality, reliable pyranometers available
- ISO 9060:2018 Spectrally Flat, from Class C to beyond the requirements of Class A
- Accurate and independent data for performance ratio calculations
- Installed around the world by national meteorology and climate networks
- Used by major solar energy organisations for performance monitoring
- A choice of analog or industry standard Modbus® RTU outputs
- Mean Time Between Failures (MTBF) in excess of 10 years®.

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The different components of solar radiation:
A pyranometer measures global horizontal solar irradiance (GHI); which is composed of diffuse horizontal solar irradiance (DHI) from the sky and direct normal solar irradiance (DNI) from the sun. If shaded from the direct sun a pyranometer measures diffuse horizontal solar irradiance (DHI). Direct normal irradiance (DNI) is measured by a pyrheliometer continuously pointed at the centre of the sun by an automatic sun tracker.

Solar energy:
A pyranometer tilted in the plane of array (POA) of solar panels provides critical input data to the calculation of performance ratios and efficiencies in photovoltaic energy installations.
MUNRO has been manufactuing pyranometers since 1924. As the market leader, we produce models at all price and performance points, up to the very best available. All comply with the requirements of ISO 9060:2018 'Solar energy - Specification and classification of instruments for measuring hemispherical solar and direct solar radiation' and are fully traceable to the World Radiometric Reference (WRR) in Davos, Switzerland, where MUNRO instruments form part of the World Standard Group.

The best mtbf performance:
MUNRO pyranometers are designed for simple operation and maintenance and have a wide range of accessories available. The long operational life and reliability is proven by an MTBF (Mean Time Between Failures) of more than 10 years. Many have been in continuous operation for over 30 years.
MUNRO pyranometers have been developed to be suitable for use in all environments, from the Antarctic to deserts. They are installed around the world for meteorology, hydrology, climate research, solar energy, environmental and materials testing,
greenhouse control, building automation and many other applications.
Our top level pyranometers have individually optimized temperature compensation and individually measured directional response, with test results provided. These important features ensure the highest possible accuracy.

Choice of Pyranometer:
ISO 9060:2018 defines three classifications of pyranometer by their key performance parameters; from Class C, to Class B, to Class A and our top models considerably exceed ISO Class A requirements. In effect, this is the calculation of GHI from accurate DHI and DNI measurements.
The most appropriate model for an application largely depends upon the desired accuracy and performance, and the type of signal interface required. We offer two ranges of pyranometers, the passive CMP series and the Smart SMP series, both widely acknowledged by meteorological and solar energy customers.



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CMP-Series:
Our CMP series pyranometers are well known around the world for their high quality, durability and accuracy. The instruments do not require any power and are ideal for remote sites with limited power availability or for field studies. Each has an individual calibration factor/sensitivity to convert the mV output signal to W/m2 of irradiance.
The signal output is a very low voltage, typically around 10 millivolts on a bright sunny day. To measure 1 W/m2 of irradiance requires a data logger 'accuracy' of better than 10 microvolts. This normally means a specialized meteorological data logger. Industrial type analogue inputs do not usually have sufficient sensitivity and the SMP series should be used.
CMP3 and CMP10 have internal desiccant that lasts for at least 10 years to reduce maintenance costs. Other CMP models have self-indicating desiccant in an easily accessed drying cartridge that should be inspected monthly and the desiccant changed when necessary.

Smart SMP Series:
Our SMP range of pyranometers is based on the proven technology of the CMP series, but has a micro-processor, memory and firmware that makes them Smarter and faster.

Smart Interface:
Modbus® RTU interfaces directly to, PLC's, SCADA systems, industrial networks and controllers. Smart instruments are addressable, and up to 247 units can be connected to a single network. Measurement data is updated every second and the user can access irradiance, type and serial number, instrument settings, full calibration history, status information, & more. The digital signal avoids all the issues of analogue-to-digital conversion performance that arise with many industrial data loggers and input modules, preserving the accuracy of the pyranometer's 24-bit differential input ADC.
SMP Series pyranometers can operate from 5 to 30 VDC and the power input has both reverse polarity and over-voltage protection. They have a feed-forward algorithm that makes them faster than our passive CMP series and an integrated temperature sensor and polynomial functions for better temperature correction.

Smartexplorer windows software:
Our free, & easy to use, SmartExplorer Windows™ software enables configuration of Smart pyranometers communication settings, monitoring of measurements and status parameters, and logging of the data. Even if the communication parameters are lost, or unknown, the software is able to establish communication and set the instrument back to a defined state.

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SMP models have internal desiccant that lasts for at least 10 years to reduce maintenance costs. In addition, the new SMP12 introduces a tilt sensor and an internal humidity monitor. All pyranometers with a Smart Interface also have a 0 to 1 V (-V models) or 4 to 20 mA (-A models) analogue output. These fixed analogue outputs eliminate the need to adjust the data logger after re-calibration.

Spectrally Flat Class C Pyranometers:

Our Spectrally Flat Class C CMP3 pyranometer is smaller and lighter than the other CMP series pyranometers. It has a robust 4 mm thick glass dome to protect the thermopile from external influences. The small size and low cost make this the ideal choice for horticulture, entry-level weather stations and routine monitoring in solar energy installations. It does not have any compensation for change in sensitivity with temperature. A screw-in mounting rod is available for easy installation to a pole or mast. SMP3 is the Smart version of CMP3 and is ideal for routine monitoring in solar energy installations. Because of the faster response, standardized digital Modbus® RTU interface and the built-in digital temperature compensation the SMP3 is superior to the CMP3.

Spectrally Flat Class B Pyranometers:

CMP6 has a similar detector to CMP3, but has improved performance due to the increased thermal mass and the double glass dome construction, making it a Class B pyranometer. It is recommended for cost-effective, good quality, measurements in meteorological and hydrological networks and for agriculture. SMP6 has similar applications to CMP6. Internal temperature compensation in all SMP's is over a large range from -40°C to +70 °C and significantly reduces the measurement uncertainty.

Spectrally Flat Class A Pyranometers:

Each Class A instrument is supplied with its own temperature and directional (cosine) response data. CMP10 uses a temperature compensated detector with a superior technology to the CMP3 and CMP6. It has better linearity and long-term stability, lower thermal offset and faster response. It is a step up in performance and particularly suitable for upgrading meteorological networks. The faster response time meets the requirements for solar energy research and development applications. CMP10 is also ideal for use in sun tracker based solar monitoring stations. It has internal desiccant instead of the external drying cartridge fitted to the rest of the double dome CMP series.

The CMP21 is characterized and compensated over a larger temperature range. A sensor is fitted to monitor the housing temperature. It is the choice for scientific use and in top level solar radiation monitoring networks such as the Baseline Surface Radiation Network (BSRN) and Global Atmospheric Watch (GAW) of the World Meteorological Organisation (WMO).

CMP22 has all the features of CMP21 but uses vry high quality quartz domes for a wider spectral range, improved directional response, and reduced thermal offsets. MUNRO is confident that CMP22 is the best passive pyranometer currently available.

SMP10 is the Smart digital equivalent of the CMP10 series pyranometers. They have faster response and more flexible connectivity. Internal temperature compensation in all SMP's is over a large range from -40°C to +70°C. The digital polynomial temperature correction significantly reduces the measurement uncertainty provides better performance than the passive correction in the CMP versions, especially for extreme climates. The new SMP12 is a fast response spectrally flat Class A pyranometer combining solid-state dome heating, no moving parts, and best-in-class surge protection to maximize accuracy and minimize maintenance. The SMP22 shares all class-leading characteristics of the CMP22, in additional to the advantages of a smart pyranometer, including temperature compensation over a large range. A 10 K thermistor internal temperature sensor is standard, a Pt-100 sensor is optional.

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Building a System:
The system capabilities of MUNRO pyranometers can be extended with our wide range of compatible products and accessories.

Ventilation unit:
The CVF4 ventilation unit is designed for use with all CMP and SMP Series pyranometers (it is slightly less effective with the CMP3 and SMP3 because of the smaller dome diameter). Ventilation helps to keep the dome clean from soiling, evaporates dew and raindrops, and reduces infrared thermal offsets. The heating can be used to melt frost and snow. Ventilation provides better quality measurement data and reduces the frequency of cleaning, reducing maintenance costs. The CVF4 is waterproof to IP68 and has a 5-year warranty.

Sun trackers:
SOLYS sun trackers are all-weather reliable instruments used to accurately point a pyrheliometer at the sun for direct normal irradiance measurements (DNI). When fitted with an optional shading assembly and a pyranometer they measure diffuse horizontal irradiance (DHI) with no need for periodic manual adjustments. Adding a second pyranometer for global horizontal irradiance (GHI) makes a complete high quality solar monitoring station.

Shadow ring:
The combination of a pyranometer and a CM121 shadow ring offers a simple solution for measuring diffuse solar radiation from the sky. It does not require any power, but the ring requires a simple adjustment every few days to ensure that the shadow covers the pyranometer dome completely as the sun declination changes during the year.

Mountings:
We offer mounting fixtures for horizontal pyranometers. CMF1 is a small round plate with integral rod for mounting upward and/or downward facing pyranometers without a ventilation unit. CMF4 does the same for pyranometers fitted with the CVF4 ventilation unit. A screw-in rod is available for CMP3 & SMP3. The CMB1 is a mounting bracket for attaching mounting rods to a mast, pole or wall.

Data loggers:
MUNRO has a range of high performance products for use with CMP or SMP series pyranometers to acquire and store analogue or digital measurement data. The AMPBOX converts the mV output of a CMP pyranometer into a 4-20 mA signal.

Albedometer:
Two pyranometers, mounted back-to-back, make an albedometer. The albedo of a surface is the extent to which it diffusely reflects solar radiation. It is the ratio of the reflected radiation to the incoming radiation.

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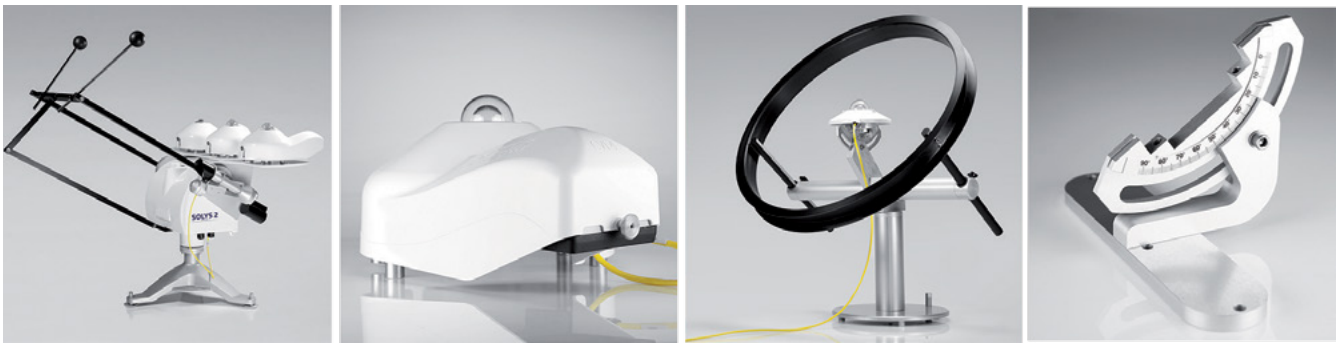
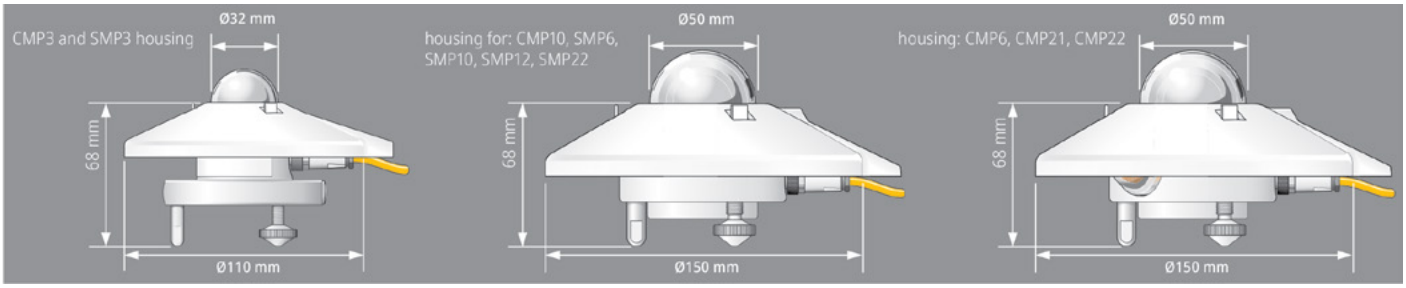


Adjustable tilt mounting kit:

Use the Adjustable Tilt Mounting Kit to securely and accurately mount a CMP or SMP pyranometer at a solar zenith angle between 0° and 90°, to measure global tilted irradiance (GTI) or POA radiation for fixed-angle PV arrays.

Glare screen kit:

A downward facing pyranometer used to measure reflected solar radiation should not see any radiation coming from the hemisphere above or from the sun when it is below the horizon of the detector.
To prevent this, a glare screen kit is available for use with CMP and SMP series pyranometers (except the SMP3 and CMP3).



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Technical Specifications

MODEL	CMP3	CMP6	CMP10	CMP21	CMP22
Classification to ISO 9060:2018	Spectrally Flat Class C	Spectrally Flat Class B	Spectrally Flat Class A	Spectrally Flat Class A	Spectrally Flat Class A
Sensitivity	24 to 32 µV/W/m²	5 to 20 µV/W/m²	7 to 14 µV/W/m²	7 to 14 µV/W/m²	7 to 14 µV/W/m²
Impedance	80 to 140 Ω	20 to 200 Ω	10 to 100 Ω	10 to 100 Ω	10 to 100 Ω
Expected output range(0 to 1500 W/m²)	0 to 48 mV	0 to 30 mV	0 to 21mV	0 to 21mV	0 to 21mV
Maximum operational irradiance	2000 W/m²	2000 W/m²	4000 W/m²	4000 W/m²	4000 W/m²
Response time (63 %)	< 6 s	< 6 s	< 1.66 s	< 1.66 s	< 1.66 s
Response time (95 %)	< 20 s	< 12 s	< 5 s	< 5 s	< 5 s
INSTRUMENT ACCURACY					
Spectral range (20% points)	285-3000 nm	270-3000 nm	270-3000 nm	270-3000 nm	210-3600 nm
Spectral range (50 % points)	300-2800 nm	285-2800 nm	285-2800 nm	285-2800 nm	200-3600 nm
Zero offsets (unventilated) **(a) thermal radiation (at 200 W/m²)** **(b) temperature change (5 K/h)** **(c) total zero offset**	< 15 W/m² < 5 W/m² < 20 W/m²	< 8 W/m² < 2 W/m² < 10 W/m²	< 7 W/m² < 2 W/m² < 9 W/m²	< 7 W/m² < 2 W/m² < 9 W/m²	< 3 W/m² < 1 W/m² < 4 W/m²
Additional signal processing errors	n.a.	n.a.	n.a.	n.a.	n.a.
Non-stability (change/year)	< 1 %	< 1 %	< 0.5 %	< 0.5 %	< 0.5 %
Non-linearity (100 to 1000 W/m²)	< ±3 %	< 1 %	< 0.2 %	< 0.2 %	< 0.2 %
Directional response (up to 80 ° with 1000 W/m² beam)	< 20 W/m²	< 20 W/m²	< 10 W/m²	< 10 W/m²	< 5 W/m²
Clear sky GHI spectral error	< 0.2 %	< 0.1 %	< 0.1 %	< 0.1 %	< 0.04 %
Spectral selectivity (350 to 1500 nm)	< 3 %	< 3 %	< 3 %	< 3 %	< 3 %
Tilt response (0° to 180° at 1000 W/m²)	< 1.5 %	< 1 %	< 0.2 %	< 0.2 %	< 0.2 %
Temperature response	<4% (-10°C - +40°C)	<2% (-10°C - +40°C)	<1% (-10°C - +40°C)	<1% (-20°C - +50°C)	<0.5% (-20°C - +50°C)
Field of view	180 °	180 °	180 °	180 °	180 °
Accuracy of bubble level	< 0.2 °	< 0.1 °	< 0.1 °	< 0.1 °	< 0.1 °
Temperature sensor output				10 k Thermistor (optional Pt-100)	
Detector type	Thermopile	Thermopile	Thermopile	Thermopile	Thermopile
Operating & storage temperature range	-40°C - +80°C	-40°C - +80°C	-40°C - +80°C	-40°C - +80°C	-40°C - +80°C
Humidity range	0 to 100 %	0 to 100 %	0 to 100 %	0 to 100 %	0 to 100 %
MTBF (Mean Time Between Failures)	> 10 years	> 10 years	> 10 years	> 10 years	> 10 years
Ingress Protection (IP) rating	67	67	67	67	67
Recommended applications	Economical solution for routine measurements in weather stations, field testing	Good quality measurements for hydrology networks, greenhouse climate control	Meteorological networks, PV panel and thermal collector testing, materials testing	Meteorological networks, reference measurements in extreme climates, polar or arid	Scientific research requiring the highest level of measurement accuracy and reliability

Note:
The performance specifications quoted are worst-case and/or maximum values.
Standard 10 k thermistor or optional Pt-100 temperature sensor with CMP21 and CMP22.
Individual directional response and temperature dependence test data with CMP10, CMP21 and CMP22.

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MODEL	SMP3	SMP6	SMP10	SMP12	SMP22
Classification to ISO 9060:2018	Spectrally Flat Class C	Spectrally Flat Class B	Spectrally Flat Class A	Fast Response Spectrally Flat Class A	Spectrally Flat Class A
Analogue output • V-version	0 to 1 V	0 to 1 V	0 to 1 V	N/A	0 to 1 V
Analogue output range • V-version*	-200 to 2000 W/m²			N/A	-200 - 2000 W/m²
Analogue output • A-version	4 to 20 mA	4 to 20 mA	4 to 20 mA	N/A	4 to 20 mA
Analogue output range • A-version*	0 to 1600 W/m²			N/A	0 - 1600 W/m²
Serial output	RS-485 Modbus®				
Serial output range*	-400 to 2000 W/m²		-400 to 4000 W/m²		
INSTRUMENT ACCURACY					
Response time (63 %)	< 1.5 s	< 1.5 s	< 0.7 s	< 0.15 s	< 0.7 s
Response time (95 %)	< 12 s	< 12 s	< 2 s	< 0.5 s	< 2 s
Spectral range (20% points)	285 to 3000nm	270 to 3000nm	270 to 3000nm	280 to 3000nm	210 to 3600nm
Spectral range (50 % points)	300 to 2800nm	285 to 2800nm	285 to 2800nm	285 to 2750nm	250 to 3500nm
Zero offsets (unventilated) (a) thermal radiation (at 200 W/m²) (b) temperature change (5 K/h) (c) total zero offset	< 15 W/m² < 5 W/m² < 20 W/m²	< 8 W/m² < 2 W/m² < 10 W/m²	< 7 W/m² < 2 W/m² < 9 W/m²	< 1 W/m² < 1.5 W/m² < 3 W/m²	< 3 W/m² < 1 W/m² < 4 W/m²
Additional signal processing errors	< 3 W/m²	< 2 W/m²	< 2 W/m²	< 3 W/m²	< 1 W/m²
Non-stability (change/year)	< 1 %	< 1 %	< 0.5 %	< 0.5 %	< 0.5 %
Non-linearity (100 to 1000 W/m²)	< 3 %	< 1 %	< 0.2 %	< 0.2 %	< 0.2 %
Directional response (up to 80 ° with 1000 W/m² beam)	< 20 W/m²	< 15 W/m²	< 10 W/m²	< 10 W/m²	< 5 W/m²
Clear sky GHI spectral error	< 0.2 %	< 0.1 %	< 0.1 %	< 0.1 %	< 0.04 %
Spectral selectivity (350 to 1500 nm)	< 3 %	< 3 %	< 3 %	< 3 %	< 3 %
Tilt response (0° to 180° at 1000 W/m²)	< 1.5 %	< 1 %	< 0.2 %	< 0.2 %	< 0.2 %
Temperature response	<3% (-20°C - +50°C) <4% (-40°C - +70°C)	<2% (-10°C - +40°C) <4% (-40°C - +70°C)	<1% (-20°C - +50°C) <2% (-40°C - +70°C)	<1% (-10°C - +40°C) <2% (-40°C - +70°C)	<0.3% (-20°C - +50°C) <0.3% (-40°C - +70°C)
Field of view	180 °	180 °	180 °	180 °	180 °
Accuracy of bubble level	< 0.2 °	< 0.1 °	< 0.1 °	< 0.1 °	< 0.1 °
Power consumption (at 12 VDC)	V-version: 55mW A-version: 100mW	V-version: 55mW A-version: 100mW	V-version: 55mW A-version: 100mW	V-version: 3.5mW	V-version: 55mW A-version: 100mW
Software, Windows™	SmartExplorer software, for configuration, test and data logging				
Supply voltage	5 to 30 VDC	5 to 30 VDC	5 to 30 VDC	10 to 30 VDC	5 to 30 VDC
Detector type	Thermopile	Thermopile	Thermopile	Thermopile	Thermopile
Operating & storage temperature range	-40°C to +70°C	-40°C to +70°C	-40°C to +70°C	-40°C to +70°C	-40°C to +70°C
Storage temperature range	-40°C to +80°C	-40°C to +80°C	-40°C to +80°C	-40°C to +80°C	-40°C to +80°C
Humidity range	0 to 100 %	0 to 100 %	0 to 100 %	0 to 100 %	0 to 100 %
MTBF (Mean Time Between Failures)**	> 10 years	> 10 years	> 10 years	> 10 years	> 10 years
Ingress Protection (IP) rating	67	67	67	67	67
Recommended applications	Economical solution for efficiency & maintenance monitoring of PV power installations, routine measurements in weather stations, agriculture, horticulture & hydrology	Good quality measurements for Solar Monitoring, hydrology networks, greenhouse climate control	High performance for PV panel & thermal collector testing, solar energy research, solar prospecting, materials testing, advanced meteorology & climate networks	High performance for PV panel & thermal collector testing, solar energy research, solar prospecting, materials testing, advanced meteorology and climate networks	Scientific research requiring the highest level of measurement accuracy & reliability under all conditions

* adjustable with SmartExplorer Software
** extrapolated after introduction in January 2012
Note: The performance specifications quoted are worst-case and/or maximum values.