

## Calibration Certificate

No. 2023-C-040

### Calibration Item

### Pyranometer

Manufacturer	Kipp & Zonen
Type	CMP22
Serial Number	160403

### Customer

Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und Meeresforschung  
Am Handelshafen 12  
27570 Bremerhaven  
Germany

### Calibration Mark

2023-C-040

### Period of Calibration

2023 June 29, July 3, 5, 7, 11, 14, August 2

Davos Dorf, 03.08.2023

  
R. Soder  
In charge of measurements

  
Dr. W. Finsterle  
Head WRC Solar Radiometry Section



*This certificate is consistent with the capabilities that are included in Appendix C of the CIPM MRA drawn up by the CIPM. Under the CIPM MRA, all participating institutes recognize the validity of each other's calibration and measurement certificates for the quantities, ranges and measurement uncertainties specified in Appendix C (for details see <http://www.bipm.org>).*

*Calibration certificates without signature are not valid. This calibration certificate shall not be reproduced except in full, without the written approval of the Physikalisch-Meteorologisches Observatorium Davos and World Radiation Center.*

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## Calibration procedure

This pyranometer was compared with the sun and sky radiation as source under mainly clear sky conditions using the "continuous sun-and-shade method". The calibration procedure follows QM-SOP-SRS-0025. The direct solar radiation is determined using the PMO2, member of the World Standard Group (WSG) and the diffuse radiation is measured using the shaded standard pyranometer of the World Radiation Center (WRC). The measurements were performed in Davos (latitude: 46.8143°, longitude: -9.8458°, altitude: 1588m). The readings are referred to the World Radiometric Reference (WRR) as stated in the WMO Technical Regulations. The ratio between the WRR and SI scales is  $1.00336 \pm 0.00092$  ( $k=1$ , Metrologia **49** (2012) S34-S38).

The inclination of the receiver surfaces versus their horizontal position were set to 0 degrees, the instrument signal wire to the north. During the comparisons, the instrument received global radiation intensities ranging from  $626 \text{ W/m}^2$  to  $1084 \text{ W/m}^2$ , with a mean of  $912 \text{ W/m}^2$ . The angle between the solar beam and the normal of the receiver surface varied from 23.9 degrees to 49.9 degrees, with a mean of 32.8 degrees. The ambient temperature ranged from  $15.1 \text{ }^\circ\text{C}$  to  $27.8 \text{ }^\circ\text{C}$ , with a mean of  $21.4 \text{ }^\circ\text{C}$ . The sensitivity calculation and the single measurements deviation ( $\sigma$ ) are based on 417 individual measurements. The obtained sensitivity value is valid for similar conditions.

## Calibration results

**Responsivity:**  $S = 9.104 \text{ } \mu\text{V} / (\text{Wm}^{-2})$

**Uncertainty:**  $U = \pm 0.060 \text{ } \mu\text{V} / (\text{Wm}^{-2})$

The reported expanded uncertainty of measurements is stated as the standard uncertainty of measurement multiplied by the coverage factor  $k=1.96$ , which for a normal distribution corresponds to a coverage probability of approximately 95%.

## Calibrations Remarks

Reference: WRR represented by the absolute pyrliometer: PMO2  
WRR-Factor of PMO2: 0.998477  
(from the last International Pyrliometer Comparison, IPC-2021  
Diffuse radiation: Pyranometer CM22 S.N. 020059 with calibration factor: 8.92  
(Ventilated with heated air, automatic shading disk, instrument-wire opposite sun)  
External calibration: Identifier DMM1, S.N. 0xEB29D4, last calibration 2011, last validation 4.4.2023: Identifier DMM15, S.N. 0xEB29B2, last calibration 18.4.2013, last validation 4.4.2023: Identifier DMM16, S.N. 0xEB18B3, last calibration 18.4.2013, last validation 4.4.2023: Identifier DMM17, S.N. 0xEAD395, last calibration 8.3.2016, last validation 4.4.2023.

## Comments

Instrument Condition: The calibration item was received fully functional and did not show any erratic behavior or irregularities during calibration.