

Calibration Certificate

No. 2022-C-077

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

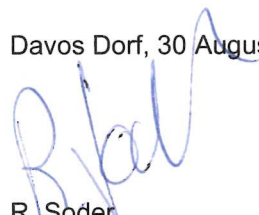
Calibration Mark

2022-C-077

Period of Calibration

2022 August 23 - 25, 29

Davos Dorf, 30 August 2022



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.

Certificate No. 2022-C-077

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 ± 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 679 W/m^2 to 919 W/m^2 , with a mean of 829 W/m^2 . The angle between the solar beam and the normal of the receiver surface varied from 35.5 degrees to 49.9 degrees, with a mean of 39.8 degrees. The ambient temperature ranged from $16.2 \text{ }^\circ\text{C}$ to $21.8 \text{ }^\circ\text{C}$, with a mean of $19.4 \text{ }^\circ\text{C}$. The sensitivity calculation and the single measurements deviation (σ) are based on 363 individual measurements. The obtained sensitivity value is valid for similar conditions.

Calibration results

Responsivity: $S = 9.074 \mu\text{V} / (\text{Wm}^{-2})$

Uncertainty: $U = \pm 0.059 \mu\text{V} / (\text{Wm}^{-2})$

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 pyrheliometer: PMO2
WRR-Factor of PMO2: 0.998477
(from the last International Pyrheliometer 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 DMM3, S.N. 0xEA17E2, last calibration 15.06.2020, last validation 31.3.2022. : Identifier DMM15, S.N. 0xEB29B2, last calibration 15.06.2020, last validation 31.3.2022 : Identifier DMM16, S.N. 0xEB18B3, last calibration 15.06.2020, last validation 31.3.2022 : Identifier DMM17, S.N. 0xEAD395, last calibration 15.06.2020, last validation 31.3.2022

Comments

Instrument Condition: The calibration item was received fully functional and did not show any erratic behavior or irregularities during calibration. The dome was cleaned daily. The calibration item was received without signal cable. A standard K&Z signal cable was used during the calibration.