KIPP & ZONEN
SINCE 1830

CALIBRATION CERTIFICATE

CERTIFICATE NUMBER	005717110310
PYRANOMETER MODEL	CMP 22
SERIAL NUMBER	110310
SENSITIVITY	9.12 µV/W/m² at normal incidence on horizontal pyranometer
IMPEDANCE	27 Ohm
TEMPERATURE	22 ±2 °C
REFERENCE PYRANOMETER	Kipp & Zonen CM 22 snREF1 active from 03/01/2011
CALIBRATION DATE	22 November 2011 (recalibration is recommended every two years)
IN CHARGE OF CALIBRATION	M. Elshout

Calibration procedure

The indoor calibration procedure is based on a side-by-side comparison with a reference pyranometer under an artificial sun fed by an AC voltage stabiliser. It embodies a 150 W Metal-Halide high-pressure gas discharge lamp. Behind the lamp is a reflector with a diameter of 16.2 cm. The reflector is 1 m above the pyranometers producing a vertical beam. The reference and test pyranometers are mounted horizontally on a table, which can rotate. The irradiance at the pyranometers is approximately 500 W/m². During the calibration procedure the reference and test pyranometer are interchanged to correct for any non-homogeneity of the beam.

Hierarchy of traceability

The reference pyranometer was compared with the sun and sky radiation as source under mainly clear sky conditions using the "continuous sun-and-shade method". The measurements were performed in Davos (latitude: 46.8143°, longitude: -9.8458°, altitude: 1588 m above sea level). The readings are referred to the World Radiometric Reference (WRR) as stated in the WMO Technical Regulations. The originally estimated uncertainty of the WRR relative to SI is ±0.3%.

The inclination of the receiver surface versus the true horizontal plane was set to 0.0 degrees, the instrument signal wire to the north. During the comparisons, the instrument received global radiation intensities from 639 to 973 with a mean of 823 W/m². The angle between the solar beam and the normal of the receiver surface varied from 24.5 to 50.0 with a mean of 37.1 degrees. The ambient temperature ranged from +18.2 to +26.8 with a mean of +23.5 °C. The sensitivity calculation and the single measurements deviation (σ) are based on 384 individual measurements. The obtained sensitivity value and its expanded uncertainty (95% level of confidence) are valid for similar conditions and are: 8.92 ± 0.06 µV/W/m² (but is corrected by Kipp & Zonen to 8.91 µV/W/m². See "correction applied" below.)
Dates of measurements: 2010, July 7 - 9, 12

Global radiation data were calculated from the direct solar radiation as measured with the absolute cavity pyrheliometer PMO2 (member of the WSG, WRR-Factor: 0.998618, based on the last International Pyrheliometer Comparison IPC-2005) and from the diffuse radiation as measured with a continuous disk shaded pyranometer Kipp & Zonen CM 22 sn020059 with sensitivity 8.91 (ventilated with heated air, instrument-wire to the north).

Correction applied -0.1 %

This correction is necessary to compensate for the mean directional errors of the reference CM 22 in Davos. This error is estimated at Kipp & Zonen by measuring the directional error for the mean angle of incidence at azimuth S-30° and S+30°. The reference CM 22 now measures the vertical beam of the indoor calibration facility more correctly.

Justification of total instrument calibration uncertainty

The combined uncertainty of the result of the calibration is the positive "root sum square" of three uncertainties.
1. The expanded uncertainty due to random effects and instrumental errors during the calibration of the reference CM 22 as given by the World Radiation Center in Davos is ±0.06/8.92= ±0.67%. (See traceability text).
2. The uncertainty in the correction for the systematic effect of a directional error (cosine error) during the calibration in Davos. Based on experience this cosine error can be estimated with an expanded uncertainty of ±0.5%.
3. Also based on experience the expanded uncertainty of the transfer procedure (calibration by comparison) is estimated to be ±0.5%.
The estimated combined expanded uncertainty is the positive "root sum square" of these three uncertainties: √(0.67^2 + 0.5^2 + 0.5^2)= ±1.0%.

Notice

The calibration certificate supplied with the instrument is at the date of first use. Even though the calibration certificate is dated relative to manufacture, or recalibration, the instrument does not undergo any sensitivity changes when kept in the original packing. From the moment the instrument is taken from its packaging and exposed to irradiance the sensitivity may deviate with time. See the 'non-stability' value (% change in sensitivity per year) given in the radiometer specifications.

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