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CALIBRATION CERTIFICATE

QUANTUM SENSOR

Kipp & Zonen B.V.

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CALIBRATION DATE : 11-Jul-05

CALIBRATED BY : G.Lindner

MODEL : PAR LITE

SERIAL NUMBER : 050596

SENSITIVITY ($\pm 2\%$) : 5.27 $\mu\text{V}/\mu\text{mol}/\text{s}\cdot\text{m}^2$
at normal incidence
and solar radiation at airmass 1.5

IMPEDANCE : 240 Ohm

CALIBRATION PROCEDURE : Exact interchange of test PAR LITE and reference PAR LITE in a horizontal parallel beam of filtered light (NIR reducing filter) from a Xenon lamp. The photosynthetic photon flux density is approx. 400 $\mu\text{mol}/\text{s}\cdot\text{m}^2$. The Instrument temperature was approx. 25°C.

REFERENCE QUANTUM SENSOR : Kipp & Zonen PAR LITE sn980004

hierarchy of traceability : The reference PAR LITE has been calibrated against a standard of known spectral irradiance, the 1000 W DXW tungsten halogen lamp OL 200A-H-S, S/N: S-1074 supplied and calibrated by Optronics Laboratories Inc. The standard lamp S-1074 has been calibrated directly against NIST certified FEL 1000 W lamp standard of spectral irradiance S/N: F-525 for a distance of 499.0 mm on April 27, 2003.

The calibration of the reference PAR LITE has been done at Kipp & Zonen on November 8, 2004 at a shorter distance of 411.5 mm between lamp reference point and PAR LITE diffuser surface. The theoretically calculated PAR irradiance at the diffuser surface should be 256.8 $\mu\text{mol}/\text{s}\cdot\text{m}^2$. The calculation takes into account the deviating distance, assuming a $1/R^2$ law, and a polynomial interpolation is done between the supplied spectral irradiance values at intervals of 10 nm. The instrument temperature was approx. 25°C.

Correction for false NIR-response during calibration of the reference PAR LITE is necessary. With a RG780 cut-on filter, covering the PAR LITE, the response to the abundant NIR radiation in the lamp spectrum was measured. The response on NIR is divided by 0.917 to correct for the reflection losses of the filter. (Fortunately the amount of NIR is negligible during calibration of production PAR LITE's in the beam of a Xenon lamp, because of the NIR-absorbing heat filter). The three measured sensitivities were 59.63, 59.71 and 59.71 with a mean of: 59.68 $\mu\text{V}/\mu\text{mol}/\text{s}\cdot\text{m}^2$.

correction applied : A second correction factor of 1.011 is applied to this sensitivity figure to give proper $\mu\text{mol}/\text{s}\cdot\text{m}^2$ results under hemispherical sunlight at airmass 1.5. This is necessary because of the non-ideal quantum-response curve of the PAR LITE. The correction is calculated by convoluting the spectral response of an ideal PAR sensor and of the PAR LITE sn980004 with resp. the DXW lamp spectrum and the airmass 1.5 spectrum. The airmass 1.5 spectrum is taken from the international standard ISO 9845-1 and also with this radiation spectrum the false NIR response is negligible. The sensitivity of the reference PAR LITE for AM1.5 radiation is: 60.3 $\mu\text{V}/\mu\text{mol}/\text{s}\cdot\text{m}^2$

Notice

The calibration certificate supplied with the instrument is valid from the date of shipment to the customer. 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 will deviate with time. See also the 'non-stability' performance (max. sensitivity change / year) given in the radiometer specification list.