PACKING LIST

The Eppley Laboratory, Inc.
12 Sheffield Ave.,P.O. Box 419
Newport, RI 02840-0419
Phone # 401-847-1020 Fed. ID No. 05-0136490

S.O. No. 62045

4/16/2009

Name / Address

N.O.A.A. US DOC ESRL
Physical Sciences Division
325 Broadway R/PSD3
Boulder, CO 80305-3328

Ship To

N.O.A.A. Dept.of Commerce
Shipping/Receiving Section
325 Broadway Bldg. 22
Boulder, CO 80305

P.O... RC133R09SU0669 Ship Date 6/25/2009 Ship Via FedEx COLLECT

	Ordered	Amount
Model PIR S/N 35765F3, 35835F3	2	6,800.00
Model VEN S/N V6-736, V6-737	2	1,800.00
Model PSP S/N 35828F3, 35829F3		
Model VEN S/N V6-739, V6-740		
Model 8-48 S/N 35360		
Model VEN S/N V6-738		
Model NIP S/N 35803		

Made in USA

Total

Terms Net 30

FOB Newport, RI USA

EPLAB

THE EPPLEY LABORATORY, INC.

12 Sheffield Avenue, PO Box 419, Newport, Rhode Island USA 02840
Phone: 401.847.1020 Fax: 401.847.1031 Email: info@eppleylab.com

STANDARDIZATION OF EPPLEY PRECISION SPECTRAL PYRANOMETER Model PSP

Serial Number: 35828F3

Resistance: 711Ω at 23°C
Temperature Compensation Range: -20° to +40°C

This radiometer has been compared with Standard Precision Spectral Pyranometer, Serial Number 21231F3 in Eppley's Integrating Hemisphere under radiation intensities of approximately 700 watts meter^{-2} (roughly one half a solar constant).

As a result of a series of comparisons, it has been found to have a sensitivity of:

8.51×10^{-6} volts/watts meter^{-2}

The calculation of this constant is based on the fact that the relationship between radiation intensity and emf is rectilinear to intensities of 1400 watts meter^{-2}. This radiometer is linear to within ± 0.5% up to this intensity.

The calibration of this instrument is traceable to standard self-calibrating cavity pyrheliometers in terms of the Systems Internationale des Unites (SI units), which participated in the Tenth International Pyrheliometric Comparisons (IPC X) at Davos, Switzerland in September-October 2005.

Eppley recommends a minimum calibration cycle of five (5) years but encourages annual calibrations for highest measurement accuracy. Unless otherwise stated in the remarks section below or on the Sales Order, the results are "AS FOUND / AS LEFT".

Useful conversion facts: 1 cal cm^{-2} min^{-1} = 697.3 watts meter^{-2}
1 BTU/ft^2-hr^{-1} = 3.153 watts meter^{-2}

Shipped to: N.O.A.A. Dept. of Commerce
Boulder, CO

Date of Test: May 15, 2009

S.O. Number: 62045
Date: May 21, 2009

In Charge of Test: Debra L. Gienty

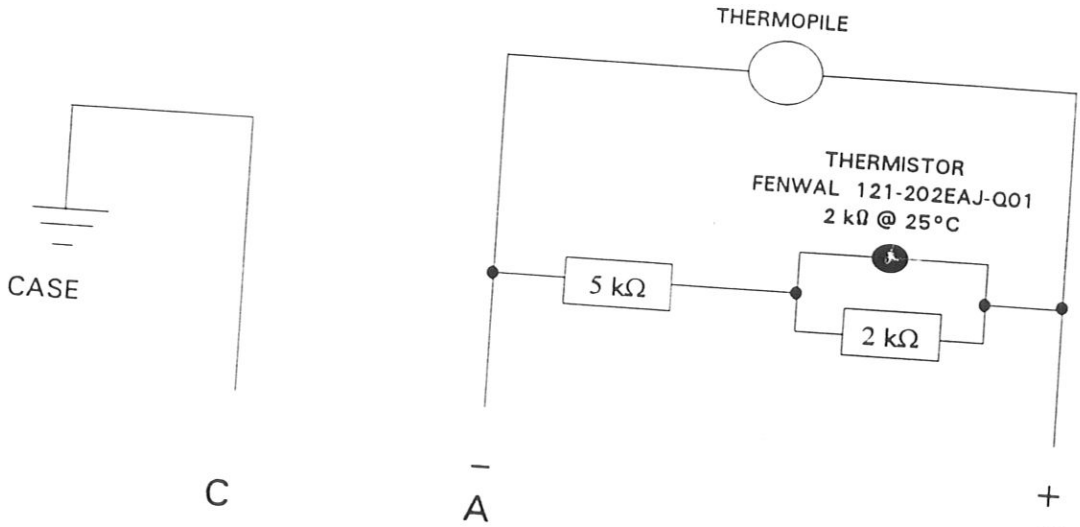
Reviewed by: Thomas J. Kahl

Remarks:

PRECISION SPECTRAL PYRANOMETER
MODEL PSP

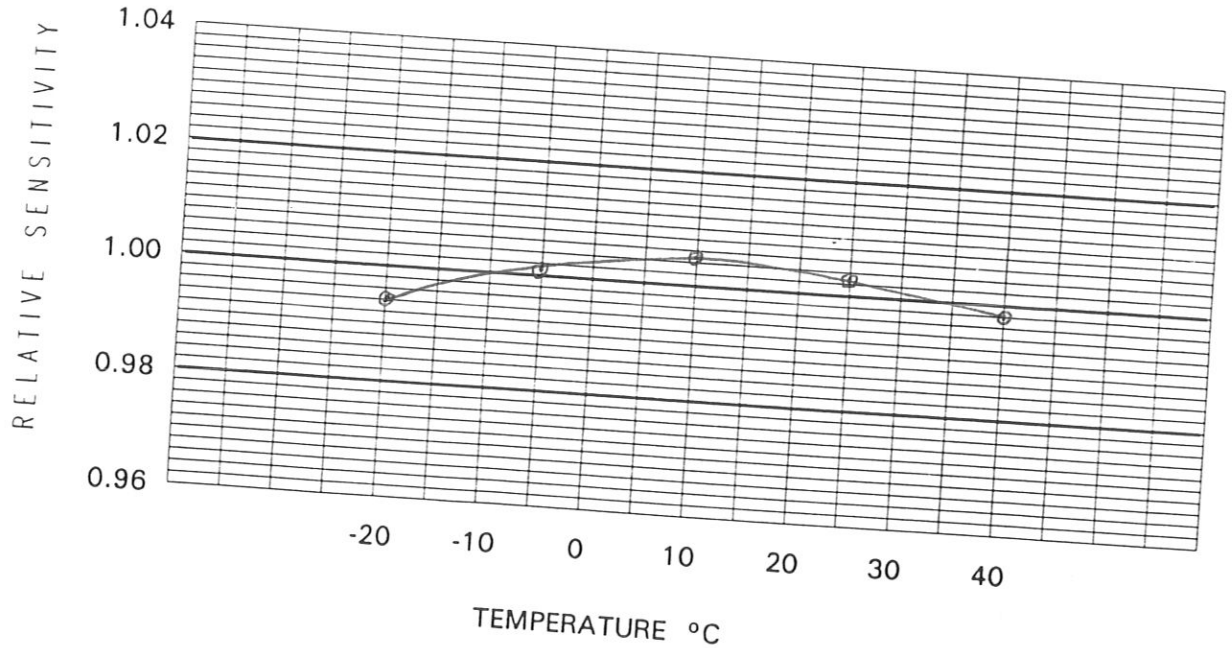
INSTRUMENT SERIAL NUMBER: 35828F3

INTERNAL WIRING



PIN CONNECTIONS ON PLUG

TEMPERATURE DEPENDENCE



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TESTED BY: D. Gresty

DATE: MAY 14, 2009

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THE EPPLEY LABORATORY, INC.

12 Sheffield Avenue, PO Box 419, Newport, Rhode Island USA 02840
Phone: 401.847.1020 Fax: 401.847.1031 Email: info@eppleylab.com

STANDARDIZATION OF EPPLEY PRECISION INFRARED RADIOMETER Model PIR

Serial Number: 35765F3

Resistance: 721Ω at 23°C
Temperature Compensation Range: -20° to +40°C

This pyrgeometer has been compared against Eppley's Blackbody Calibration System under radiation intensities of approximately 200 watts meter^{-2} and an average ambient temperature of 25°C as measured by Standard Omega Temperature Probe, RTD#1.

As a result of a series of comparisons, it has been found to have a sensitivity of:

3.74×10^{-6} volts/watts meter^{-2}

The calculation of this constant is based on the fact that the relationship between radiation intensity and emf is rectilinear to intensities of 700 watts meter^{-2}. This radiometer is linear to within ±1.0% up to this intensity.

The calibration of this instrument is traceable to the International Practical Temperature Scale (IPTS) through a precision low-temperature blackbody.

Eppley recommends a minimum calibration cycle of five (5) years but encourages annual calibrations for highest measurement accuracy. Unless otherwise stated in the remarks section below or on the Sales Order, the results are "AS FOUND / AS LEFT".

Shipped to: N.O.A.A. Dept. of Commerce
Boulder, CO

Date of Test: April 14, 2009

S.O. Number: 62045
Date: May 21, 2009

In Charge of Test: Debra L. Gueinty

Reviewed by: Thomas J. Kirk

Remarks:

EPLAB
FedID #05-0136490

THE EPPLEY LABORATORY, INC.

12 Sheffield Avenue, PO Box 419, Newport, Rhode Island USA 02840
Phone: 401.847.1020 Fax: 401.847.1031 Email: info@eppleylab.com

January 2008

NOTICE TO USERS OF THE EPPLEY PRECISION INFRARED RADIOMETER, MODEL PIR

Due to the discontinuation of mercury cells and advances in dataloggers/data acquisition systems as well and the general trend to make more precise measurements, The Eppley Laboratory, Inc. will no longer supply new PIR's with the "Radiation Compensation Circuitry" ("Battery Circuit").

We will continue to use the 10-pin connector and from outward appearances, there will be no change but the battery holder-potentiometer-resistor circuit across pins B&C will not be included. Therefore, the "Simple Method" can no longer be employed.

For existing instruments, we can no longer supply batteries as part of calibration or directly and we suggest you switch over to the "Precise Method" as soon as possible.

Please contact us at info@epplevlab.com if you have any questions.

Regards,
Thomas D. Kirk,
President

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Phone: 401.847.1020 Fax: 401.847.1031 Email: info@eppleylab.com

STANDARDIZATION OF EPPLEY PRECISION SPECTRAL PYRANOMETER Model PSP

Serial Number: 35829F3

Resistance: 725Ω at 23°C
Temperature Compensation Range: -20° to +40°C

This radiometer has been compared with Standard Precision Spectral Pyranometer, Serial Number 21231F3 in Eppley's Integrating Hemisphere under radiation intensities of approximately 700 watts meter^{-2} (roughly one half a solar constant).

As a result of a series of comparisons, it has been found to have a sensitivity of:

8.07×10^{-6} volts/watts meter^{-2}

The calculation of this constant is based on the fact that the relationship between radiation intensity and emf is rectilinear to intensities of 1400 watts meter^{-2}. This radiometer is linear to within ± 0.5% up to this intensity.

The calibration of this instrument is traceable to standard self-calibrating cavity pyrheliometers in terms of the Systems Internationale des Unites (SI units), which participated in the Tenth International Pyrheliometric Comparisons (IPC X) at Davos, Switzerland in September-October 2005.

Eppley recommends a minimum calibration cycle of five (5) years but encourages annual calibrations for highest measurement accuracy. Unless otherwise stated in the remarks section below or on the Sales Order, the results are "AS FOUND / AS LEFT".

Useful conversion facts: 1 cal cm^{-2} min^{-1} = 697.3 watts meter^{-2}
1 BTU/ft^2-hr^{-1} = 3.153 watts meter^{-2}

Shipped to: N.O.A.A. Dept. of Commerce
Boulder, CO

Date of Test: May 18, 2009

In Charge of Test: Debra L. Gentry

S.O. Number: 62045
Date: May 21, 2009

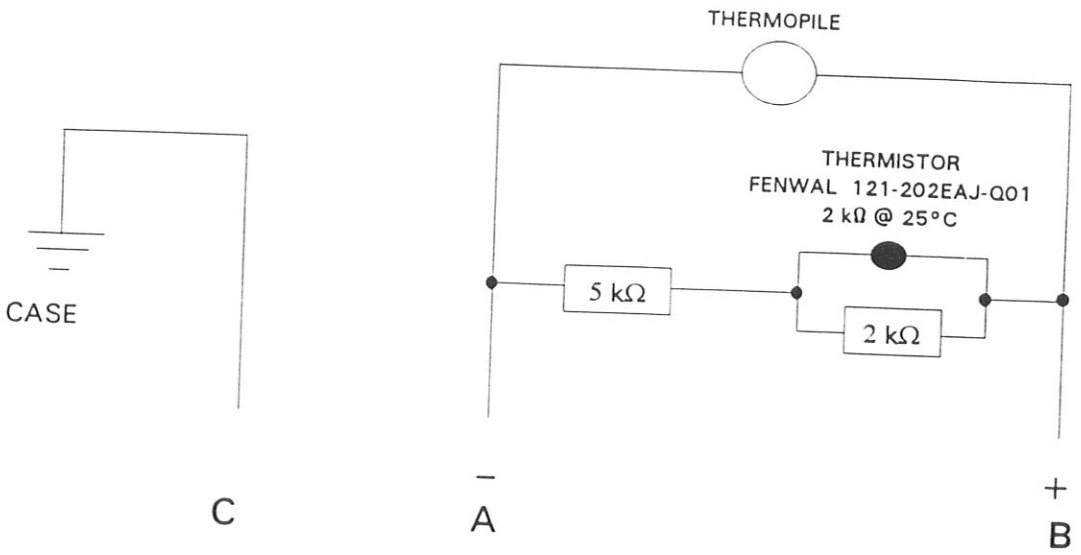
Reviewed by: Thomas J. Kah

Remarks:

PRECISION SPECTRAL PYRANOMETER
MODEL PSP

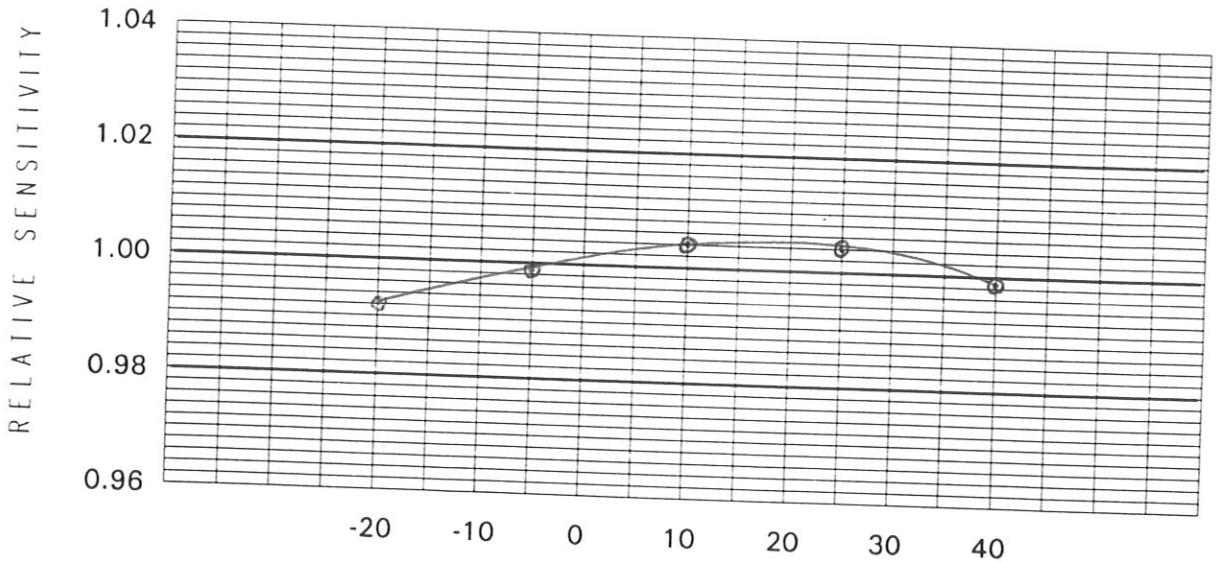
INSTRUMENT SERIAL NUMBER: 35829F3

INTERNAL WIRING



PIN CONNECTIONS ON PLUG

TEMPERATURE DEPENDENCE



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TESTED BY: D. Dienty

DATE: MAY 15, 2009

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STANDARDIZATION OF EPPLEY PRECISION INFRARED RADIOMETER Model PIR

Serial Number: 35835F3

Resistance: 728Ω at 23°C
Temperature Compensation Range: -20° to +40°C

This pyrgeometer has been compared against Eppley's Blackbody Calibration System under radiation intensities of approximately 200 watts meter^{-2} and an average ambient temperature of 24°C as measured by Standard Omega Temperature Probe, RTD#1.

As a result of a series of comparisons, it has been found to have a sensitivity of:

3.01×10^{-6} volts/watts meter^{-2}

The calculation of this constant is based on the fact that the relationship between radiation intensity and emf is rectilinear to intensities of 700 watts meter^{-2}. This radiometer is linear to within ±1.0% up to this intensity.

The calibration of this instrument is traceable to the International Practical Temperature Scale (IPTS) through a precision low-temperature blackbody.

Eppley recommends a minimum calibration cycle of five (5) years but encourages annual calibrations for highest measurement accuracy. Unless otherwise stated in the remarks section below or on the Sales Order, the results are "AS FOUND / AS LEFT".

Shipped to: N.O.A.A. Dept. of Commerce
Boulder, CO

S.O. Number: 62045
Date: May 21, 2009

Remarks:

Date of Test: May 20, 2009

In Charge of Test: Debra L. Guenty

Reviewed by: Thomas J. Kirk

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THE EPPLEY LABORATORY, INC.

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Phone: 401.847.1020 Fax: 401.847.1031 Email: info@eppleylab.com

FedID #05-0136490

January 2008

NOTICE TO USERS OF THE EPPLEY PRECISION INFRARED RADIOMETER, MODEL PIR

Due to the discontinuation of mercury cells and advances in dataloggers/data acquisition systems as well and the general trend to make more precise measurements, The Eppley Laboratory, Inc. will no longer supply new PIR's with the "Radiation Compensation Circuitry" ("Battery Circuit").

We will continue to use the 10-pin connector and from outward appearances, there will be no change but the battery holder-potentiometer-resistor circuit across pins B&C will not be included. Therefore, the "Simple Method" can no longer be employed.

For existing instruments, we can no longer supply batteries as part of calibration or directly and we suggest you switch over to the "Precise Method" as soon as possible.

Please contact us at info@epplevlab.com if you have any questions.

Regards,
Thomas D. Kirk,
President

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STANDARDIZATION OF EPPLEY PRECISION INFRARED RADIOMETER Model PIR

Serial Number: 36732F3

Resistance: 698 Ω at 23°C
Temperature Compensation Range: -20° to + 40°C

This pyrgeometer has been compared against Eppley's Blackbody Calibration System under radiation intensities of approximately 200 watts meter^{-2} and an average ambient temperature of 23°C as measured by Standard Omega Temperature Probe, RTD#1.

As a result of a series of comparisons, it has been found to have a sensitivity of:

3.30×10^{-6} volts/watts meter^{-2}

The calculation of this constant is based on the fact that the relationship between radiation intensity and emf is rectilinear to intensities of 700 watts meter^{-2}. This radiometer is linear to within ±1.0% up to this intensity.

The calibration of this instrument is traceable to the International Practical Temperature Scale (IPTS) through a precision low-temperature blackbody.

Eppley recommends a minimum calibration cycle of five (5) years but encourages annual calibrations for highest measurement accuracy. Unless otherwise stated in the remarks section below or on the Sales Order, the results are "AS FOUND / AS LEFT".

Shipped to: NOAA/ESRL/DOC
Boulder, CO

S.O. Number: 62816
Date: April 4, 2011

Remarks:

Date of Test: February 24, 2011

In Charge of Test: Debra L. Gentry

Reviewed by: George L Kirk

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THE EPPLEY LABORATORY, INC.

12 Sheffield Avenue, PO Box 419, Newport, Rhode Island USA 02840
Phone: 401.847.1020 Fax: 401.847.1031 Email: info@eppleylab.com

FedID #05-0136490

January 2008

NOTICE TO USERS OF THE EPPLEY PRECISION INFRARED RADIOMETER, MODEL PIR

Due to the discontinuation of mercury cells and advances in dataloggers/data acquisition systems as well and the general trend to make more precise measurements, The Eppley Laboratory, Inc. will no longer supply new PIR's with the "Radiation Compensation Circuitry" ("Battery Circuit").

We will continue to use the 10-pin connector and from outward appearances, there will be no change but the battery holder-potentiometer-resistor circuit across pins B&C will not be included. Therefore, the "Simple Method" can no longer be employed.

For existing instruments, we can no longer supply batteries as part of calibration or directly and we suggest you switch over to the "Precise Method" as soon as possible.

Please contact us at info@epplevlab.com if you have any questions.

Regards.
Thomas D. Kirk.
President

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12 Sheffield Avenue, PO Box 419, Newport, Rhode Island USA 02840
Phone: 401.847.1020 Fax: 401.847.1031 Email: info@eppleylab.com

STANDARDIZATION OF EPPLEY PRECISION SPECTRAL PYRANOMETER Model PSP

Serial Number: 36762F3

Resistance: 687 Ω at 23°C
Temperature Compensation Range: -20° to +40°C

This radiometer has been compared with Standard Precision Spectral Pyranometer, Serial Number 21231F3 in Eppley's Integrating Hemisphere under radiation intensities of approximately 700 watts meter^{-2} (roughly one half a solar constant).

As a result of a series of comparisons, it has been found to have a sensitivity of:

8.05×10^{-6} volts/watts meter^{-2}

The calculation of this constant is based on the fact that the relationship between radiation intensity and emf is rectilinear to intensities of 1400 watts meter^{-2}. This radiometer is linear to within ± 0.5% up to this intensity.

The calibration of this instrument is traceable to standard self-calibrating cavity pyrheliometers in terms of the Systems Internationale des Unites (SI units), which participated in the Tenth International Pyrheliometric Comparisons (IPC X) at Davos, Switzerland in September-October 2005.

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Useful conversion facts: 1 cal cm^{-2} min^{-1} = 697.3 watts meter^{-2}
1 BTU/ft^2-hr^{-1} = 3.153 watts meter^{-2}

Shipped to: NOAA/ESRL/DOC
Boulder, CO

Date of Test: March 14, 2011

In Charge of Test:

S.O. Number: 62816
Date: April 4, 2011

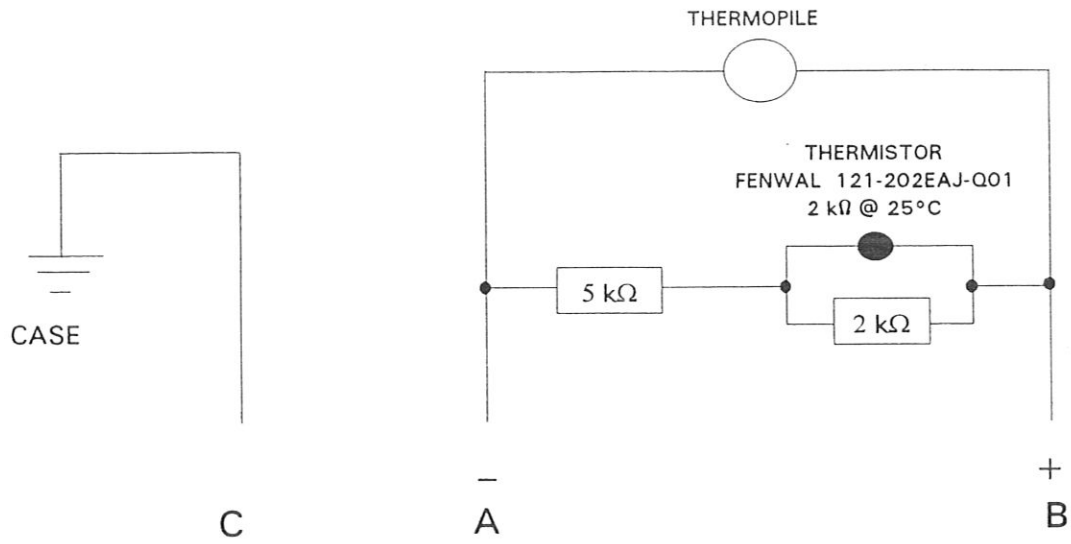
Reviewed by: George L. Kirk

Remarks:

PRECISION SPECTRAL PYRANOMETER
MODEL PSP

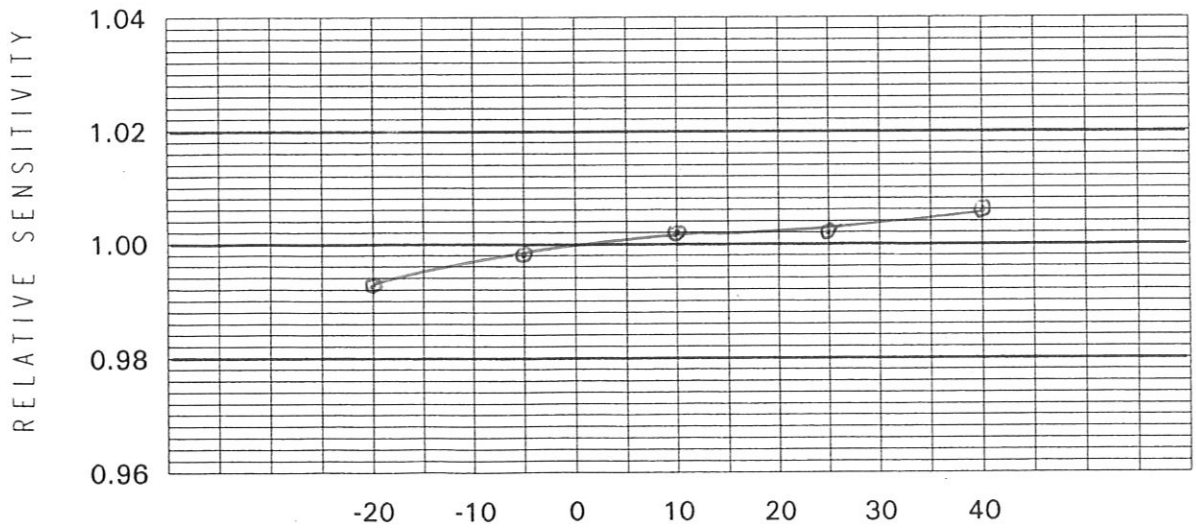
INSTRUMENT SERIAL NUMBER: 36762F3

INTERNAL WIRING



PIN CONNECTIONS ON PLUG

TEMPERATURE DEPENDENCE



EPLAB

TESTED BY: D. Gueny

DATE: MARCH 16, 2011

MEASUREMENT EXCELLENCE SINCE 1830

Kipp & Zonen 175 YEARS

Kipp & Zonen B.V.
Röntgenweg 1 2624 BD Delft
P.O. Box 507 2600 AM Delft
The Netherlands
T +31 (0)15 269 8000
F +31 (0)15 262 0351
E info@kippzonen.com
www.kippzonen.com

CALIBRATION CERTIFICATE
PYRANOMETER

PYRANOMETER MODEL	:	CM 22
SERIAL NUMBER	:	060126
SENSITIVITY at normal incidence on horizontal pyranometer	:	9.46 µV/W/m^2
IMPEDANCE	:	27 Ohm
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 110 cm 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. The dark offsets of both pyranometers are measured before and after the interchange and taken into account.
REFERENCE PYRANOMETER	:	Kipp & Zonen CM 22 snREF2 active from 01/01/2006.
hierarchy of traceability	:	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 readings are referred to the World Radiometric Reference (WRR) as stated in the WMO Technical Regulations. The measurements were performed in Davos (latitude: 46.8143°, longitude: -9.8458°, altitude: 1588m above sea level). The inclination of the receiver surfaces versus their horizontal position were set to 0.0 degrees, the instrument signal wire to the north. During the comparisons, the instrument received global radiation intensities from 620 to 989 with a mean of 836 W/m^2. The angle between the solar beam and the normal of the receiver surface varied from 23 to 50 with a mean of 37 degrees. The instrument temperature ranged from +11.4 to +27.3 with a mean of +18.4°C. The sensitivity calculation and the single measurements deviation (σ) are based on 932 individual measurements. The obtained sensitivity value and its expanded uncertainty (95% level of confidence) are valid for similar conditions and are: 8.26 ± 0.05 µV/W/m^2 (but is corrected by Kipp & Zonen to 8.24 µV/W/m². See "correction applied" below.) Dates of measurements: June 23, July 14, 20, 28, August 5, 9, 12, 17 and 18, 2005. Global radiation data were calculated from the direct solar radiation as measured with the absolute cavity pyrheliometer HF18748 (member of the WSG, WRR-Factor: 0.99568, based on the last International Pyrheliometer Comparison IPC-2000) 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	:	−0.3 % This correction was necessary to correct for the mean directional errors of the reference CM 22 in Davos. This error is estimated at Kipp & Zonen measuring the cosine error for the mean angle of incidence at azimuth S-30° and S+30°. The reference CM 22 now measures the vertical directed beam of the indoor calibration facility more correctly.
IN CHARGE OF TEST	:	F. de Wit Date:20 April 2006 Kipp & Zonen, Delft, Holland

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.

MEASUREMENT
EXCELLENCE
SINCE 1830
Kipp & Zonen
175 YEARS

Kipp & Zonen B.V.
Röntgenweg 1 2624 BD Delft
P.O. Box 507 2600 AM Delft
The Netherlands
T +31 (0)15 269 8000
F +31 (0)15 262 0351
E info@kippzonen.com
www.kippzonen.com

MEASUREMENT REPORT

PYRANOMETER

Routine measurement of temperature dependency during final inspection.

DATE OF MEASUREMENT : 18 April 2006

PERFORMED BY : F. de Wit

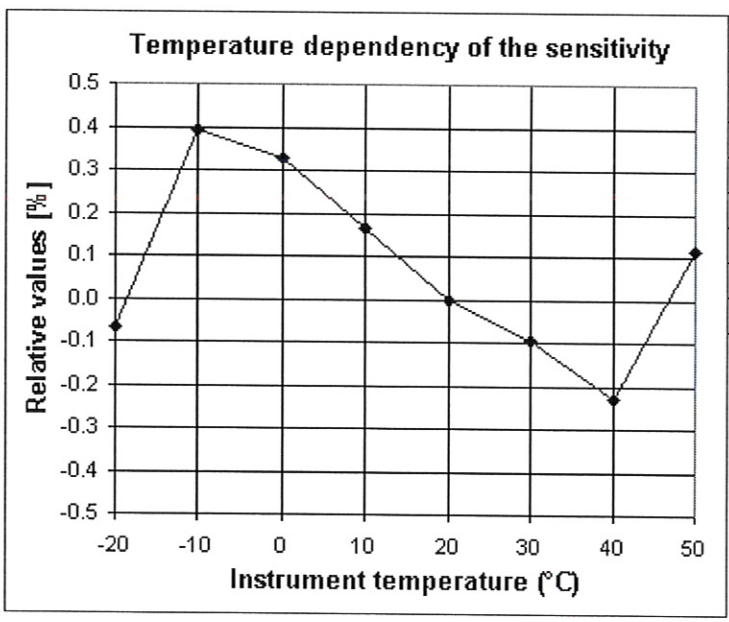
PYRANOMETER TYPE : CM22

SERIAL NUMBER : 060126

PROCEDURE:

The pyranometer is mounted on a vertical table in the climate chamber. Outside the chamber a 250 W Tungsten-Halogen lamp, at a distance of 60cm, illuminates the pyranometer at normal incidence. During the test, the pyranometer is ventilated at a windspeed of 5 m/s.

The pyranometer is tested in a temperature range over 50 °C down to -20 °C in steps of 10 °C. The relative temperature dependency is plotted below



T [C]	deviation [-]
50	0.11
40	-0.23
30	-0.10
20	0.00
10	0.16
0	0.33
-10	0.39
-20	-0.07

MEASUREMENT EXCELLENCE SINCE 1830
Kipp & Zonen 175 YEARS

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E info@kippzonen.com
www.kippzonen.com

MEASUREMENT REPORT
PYRANOMETER

Routine measurement of directional error during final inspection

Mean cosine error of each new pyranometer type CM 22 is measured by a simple routine.

Routine:

The pyranometerbase is placed against the vertical turntable of a goniometer in the parallel (0,5°) beam of a sunsimulator.
Voltage output U(z) is measured for beam incidence (zenith) angles of 0°,40°, 60°, 70° and 80° coming in over azimuth south (cable pointing to North).
Next the pyranometer output U(-z) is measured for incidence angles of -80°, -70°, -60°, -40° and 0° consequently for azimuth south. The dark signal is measured at the beginning of the routine in the middle and at the end. For each beam incident angle the dark signal is interpolated.

During the CM 22 measurement cycle, a check is done on the azimuth error at 40° and 70° by measuring voltages for azimuth-directions S, E, N and W . Also at -70° and -40° this azimuth error is measured and the mean of both azimuth measurements cancels out the eventual error in the 0° position.

With the extended procedure at both 40° and -40° and 70° and -70° the specific cosine error for 8 azimuth directions (40° S, W, N and E and 70° E, N, W, S) can be calculated according to formula 1 and verified whether it is within ± 10 W/m^2.

The applied formula for the relative cosine error is:

U(0°) Pyranometer output voltage for normal incidence
U(z) Pyranometer output voltage for angles (z)
Zero(z) Dark signal for angles

$$\frac{\frac{(U(z)+U(-z))}{2}-\text{zero}(z)}{\left(\frac{U(0°)+U(0°)}{2}-\text{zero}(z)\right)\cdot\cos(z)}\cdot 100\%$$

Formula 1.

Relative cosine error at zenith angle in %

Zenith angle	South	East	North	West
40	0.11	0.54	0.08	-0.29
60	0.15			
70	0.29	1.25	0.03	-0.80
80	0.81			

Absolute cosine error for 1000 W/m^2 beam radiation in W/m^2

Zenith angle	South	East	North	West
40	0.84	4.13	0.62	-2.21
60	0.74			
70	1.00	4.28	0.09	-2.74
80	1.40			

PYRANOMETER MODEL: CM 22 SERIAL NUMBER: 60126