Remote Measurements & Research Company
214 Euclid Av.
Seattle WA 98122
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CALIBRATION RESULTS

Instrument	Radiometer Analog to Digital Interface (RAD)
Serial Number	223
ID	1507
SPP	38214F3
PIR	3138F3
Lead Tech	J. Reynolds
Calibration Start Time	20150720
Calibration End Time	20150730
Location	RMRCO Seattle
Calibration Type	Electronic gain and ADC conversion. PIR & PSP calibration at Eppley. System setup and burn in.
Results	Attached sheets.
After calibration	Shipped as new to Customer.

DISCUSSION:

These were all new units.

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CALIBRATION RESULTS FOR RAD SN 222.  CAL DATE = 2015-07-30.
RUN TIME: 20150730,173611
setupfile: ~/Dropbox/instruments/RAD/RAD_CALIBRATION/223_whoi/1507/radcal_setup_223_1507.txt
SN: 222
calpath: ~/Dropbox/instruments/RAD/RAD_CALIBRATION/223_whoi/1507
caldate: 150717
Reference voltage = 4093.0 millivolts (TP16)
PSPCAL
      -1.0,   -119.26
      -0.5,    -59.66
      -0.1,    -12.31
       0.0,      0.27
       0.1,     12.42
       0.2,     24.07
       0.5,     59.94
       1.0,    119.09
       2.0,    237.66
       4.0,    474.98
       8.0,    949.63
PIRCAL
      -2.0,  -1676.48
      -1.0,   -837.72
      -0.8,   -668.85
      -0.4,   -334.28
      -0.2,   -167.74
       0.0,      0.69
       0.2,    163.59
       0.4,    329.78
       0.6,    497.62
       1.0,    833.09
caseR
      5600,   595.000
     10000,   953.300
     15600,  1314.000
     20000,  1545.000
     25600,  1788.000
     30000,  1949.000
domeR
      5600,   594.000
     10000,   952.000
     15600,  1314.000
     20000,  1544.000
     25600,  1787.000
     30000,  1948.000

==== CASE TEMPERATURE ========
Case Rref = 30860, Rref based on measurements of v_t = 32972. Error = -6.8
Case fit : -6.680e-05  9.574e-02 -3.389e+01

CASE THERMISTOR MILLIVOLTS
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      Meas        ADC    ADC-Corrected
     595.0      595.1      595.7
     953.3      948.5      951.7
    1314.0     1292.8     1314.6
    1545.0     1504.5     1545.6
    1788.0     1721.7     1788.8
    1949.0     1861.0     1948.1

CASE THERMISTOR OHMS
      CalR       Meas        ADC  ADC-corrected
      5600       5249       5250 5256
     10000       9370       9309 9349
     15600      14592      14247 14601
     20000      18712      17937 18723
     25600      23938      22406 23956
     30000      28053      25730 28028

CASE THERMISTOR DEG C
      CalR       Meas        ADC   ADC-correc
     39.96      41.71      41.70        41.67
     25.00      26.62      26.78        26.67
     14.28      15.85      16.41        15.84
      8.58      10.09      11.06        10.08
      3.08       4.55       6.02         4.54
     -0.37       1.07       2.97         1.09

==== DOME TEMPERATURE ========
Dome Rref = 30950, Rref based on measurements of v_t = 33010. %Error = -6.7
Dome fit : -4.201e-05,  7.104e-02,  -2.730e+01

DOME THERMISTOR MILLIVOLTS
      Meas        ADC    ADC-Corrected
     594.0      594.8      594.7
     952.0      952.8      950.6
    1314.0     1307.3     1313.5
    1544.0     1528.8     1545.7
    1787.0     1755.5     1787.6
    1948.0     1902.7     1946.9

DOME THERMISTOR OHMS
      CalR       Meas        ADC  ADC-corrected
      5600       5254       5262       5262
     10000       9381       9391       9362
     15600      14634      14525      14627
     20000      18747      18453      18780
     25600      23984      23244      23998
     30000      28108      26886      28078

DOME THERMISTOR DEG C
      CalR       Meas        ADC   ADC-correc
     39.96      41.68      41.64        41.65
     25.00      26.59      26.56        26.64
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     14.28      15.78      15.96        15.80
      8.58      10.05      10.41        10.01
      3.08       4.51       5.21         4.50
     -0.37       1.03       2.00         1.06

==== PSP THERMOPILE CIRCUIT ========
PSP Calibration Gain (g) = 118.72,  Offset (o) = 0.1 millivolts

==== PIR THERMOPILE CIRCUIT ========
PIR Calibration Gain (g) = 835.75,  Offset (o) = -2.2 millivolts

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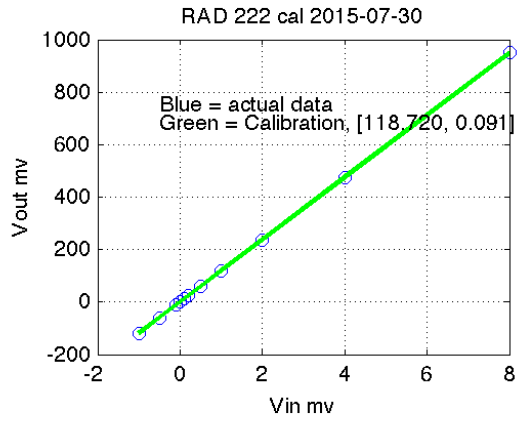
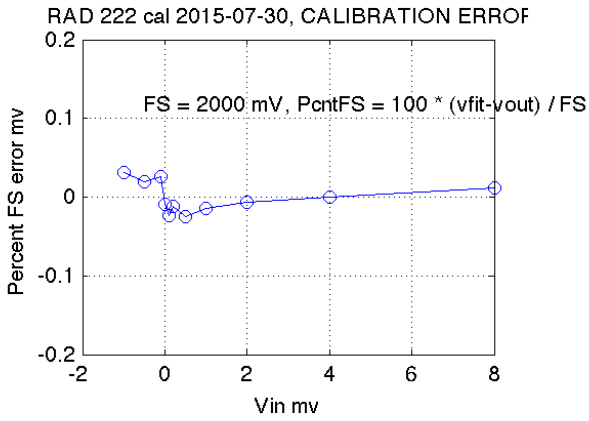
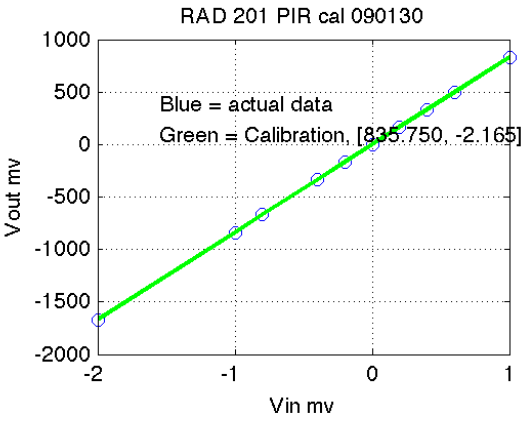
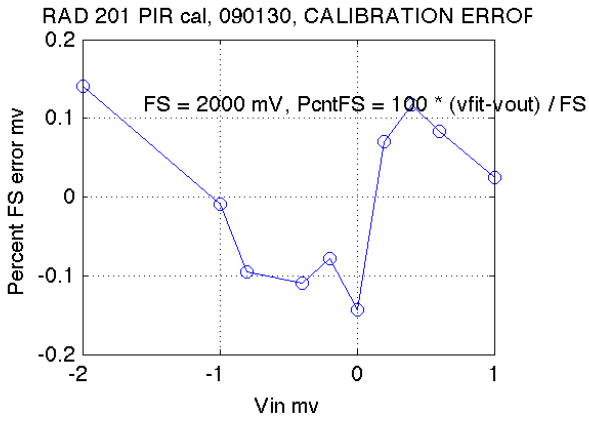
RAD SETUP COMMANDS
L : 10
k : 8e-6 (Eppley PSP cal)
K : 4e-6 (Eppley PIR cal)
A : 02 (Experiment or SN, 2 digits)
V : 4093
C 0 : 32972
C 1 : -6.680e-05
C 2 : 9.574e-02
C 3 : -3.389e+01
D 0 : 33010
D 1 : -4.201e-05
D 2 : 7.104e-02
D 3 : -2.730e+01
g : 118.72
o : 0.09
G : 835.75
O : -2.17
```


RAD 222 cal 2015-07-30
Blue = actual data
Green = Calibration, [118.720, 0.091]
Vout mv
Vin mv
1000
800
600
400
200
0
-200
-2
0
2
4
6
8


RAD 222 cal 2015-07-30, CALIBRATION ERROF
FS = 2000 mV, PcntFS = 100 * (vfit-vout) / FS
Percent FS error mv
Vin mv
0.2
0.1
0
-0.1
-0.2
-2
0
2
4
6
8


RAD 201 PIR cal 090130
Blue = actual data
Green = Calibration, [835.750, -2.165]
Vout mv
Vin mv
1000
500
0
-500
-1000
-1500
-2000
-2
-1
0
1


RAD 201 PIR cal, 090130, CALIBRATION ERROF
FS = 2000 mV, PcntFS = 100 * (vfit-vout) / FS
Percent FS error mv
Vin mv
0.2
0.1
0
-0.1
-0.2
-2
-1
0
1

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

Calibration Certificate

Instrument:	Precision Spectral Pyranometer, Model PSP, Serial Number 38214F3
Procedure:	This pyranometer was compared in Eppley's Integrating Hemisphere according to procedures described in ***ISO 9847 Section 5.3.1*** and Technical Procedure, TP01 of The Eppley Laboratory, Inc.'s Quality Assurance Manual on Calibrations.
Transfer Standard:	Eppley Precision Spectral Pyranometer, Model PSP, Serial Number 18851F3
Results:	**Sensitivity:** **$S = 8.04\ \mu V / Wm^{-2}$** Uncertainty: $U_{95} = \pm 0.91\%$ (95% confidence level, k=2) Resistance: 696 Ω at 23°C
	Date of Test: June 25, 2015
Traceability:	This calibration is traceable to the World Radiation Reference (WRR) through comparisons with Eppley's AHF standard self-calibrating cavity pyrheliometers which participated in the Eleventh International Pyrheliometric Comparisons (IPC XI) at Davos, Switzerland in September-October 2010. Unless otherwise stated in the remarks section below or on the Sales Order, the results of this calibration are "AS FOUND / AS LEFT".
Due Date:	Eppley recommends a minimum calibration cycle of five (5) years but encourages annual calibrations for highest measurement accuracy.
Customer:	RMR Co Seattle, WA
Signatures:	Debra L. Hinty — In Charge of Test: Thomas D. Kirk — Reviewed by:
Eppley SO:	64457
Date of Certificate:	July 8, 2015
Remarks:	

End of Report

EPLAB

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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 INFRARED RADIOMETER Model PIR

Serial Number: 38138F3

Resistance: 654 Ω at 23°C
Temperature Compensation Range: -30° to +50°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:

3.20×10^{-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: RMR, Co.
Seattle, WA

S.O. Number: 64457
Date: July 8, 2015

Remarks:

Date of Test: June 25, 2015

In Charge of Test: Debra L. Henry

Reviewed by: Thomas D. Kuh

End of Report