Remote Measurements & Research Company
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Seattle WA 98122
michael@rmrco.com

~~rad208cal_2010~~ rad201cal.2112

December 14, 2021

CALIBRATION RESULTS

Instrument	Radiometer Analog to Digital Interface (RAD)
Serial Number	201
RMR Job#	426
Customer	URI -Endeavor
Cal ID	2112
PSP	35149 (8.16)
PIR	35116 (3.80)
Lead Tech	J. Reynolds
Location	RMRCO Seattle
System recvd and inspected.	approx 12/2021
Shipped to customer.	approx 12/2021
Calibration Type	Electronic gain and ADC conversion.
After calibration	Returned to ~~R/V Dyson~~ R/V Endeavor

Same as RAD S/N 217:

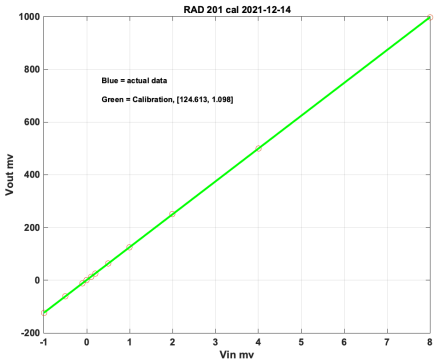
System recvd and inspected	<10/21
PIR & PSP Cal at Eppley Labs	10/1-10/23/21
Electronic Cal	12/7/2021
Burn-In Test	12/8 - 12/10/2021
Est Ship Date	12/10/2021
Actual Ship Date	12/16/2021

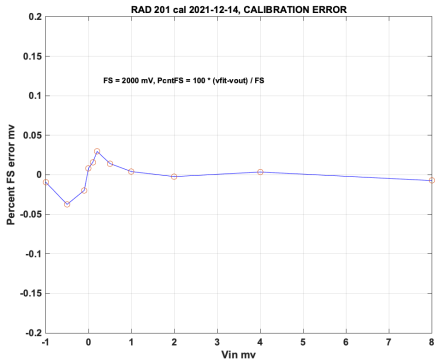
DISCUSSION: Excellent calibration. The equipment has been handled well.

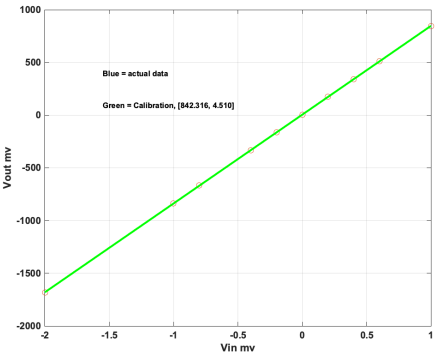
```
Program a1_radcal.m v3   Runtime:2021-12-14 (348) 08:37:26.0
Calibration date: 211212
SN: 201
Calpath: /Users/rmr/Dropbox/instruments/RAD/RAD_CALIBRATION/201_uri/2112
PLOT FILE NAME: radcalplot_201_2112
Reference voltage = 4070.0 millivolts (TP16)
PSPCAL
      -1.0,   -123.33
      -0.5,    -60.46
      -0.1,    -10.97
       0.0,      0.93
       0.1,     13.24
       0.2,     25.43
       0.5,     63.12
       1.0,    125.63
       2.0,    250.37
       4.0,    499.48
       8.0,    998.15
PIRCAL
      -2.0,  -1681.20
      -1.0,   -837.70
      -0.8,   -667.70
      -0.4,   -333.20
      -0.2,   -162.70
       0.0,      4.40
       0.2,    173.90
       0.4,    339.60
       0.6,    510.20
       1.0,    846.40
Reference Rcase=32960.0
Reference Rdome=32850.0
caseR
      5600,   589.000
     10000,   944.000
     15600,  1302.000
     20000,  1531.000
     25600,  1772.000
     30000,  1932.000
domeR
      5600,   590.000
     10000,   946.000
     15600,  1305.000
     20000,  1534.000
     25600,  1775.000
     30000,  1934.000

==== CASE TEMPERATURE ========
Case Rref = 32960, Rref based on measurements of v_t = 33156. %Error = -0.6
Case fit : -9.647e-07 -2.312e-03 -3.535e-01

CASE THERMISTOR MILLIVOLTS
      Meas        ADC    ADC-Corrected
```

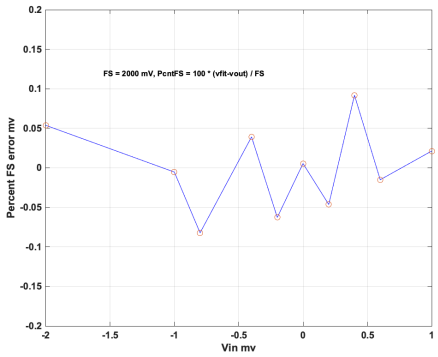
```
     589.0      587.1      589.1
     944.0      940.3      943.7
    1302.0     1297.3     1302.3
    1531.0     1524.8     1530.9
    1772.0     1764.7     1772.1
    1932.0     1923.5     1931.9

CASE THERMISTOR OHMS
      CalR       Meas        ADC  ADC-corrected
      5600       5577       5556 5578
     10000       9953       9902 9949
     15600      15504      15421 15508
     20000      19875      19746 19873
     25600      25416      25231 25419
     30000      29784      29536 29780

CASE THERMISTOR DEG C
      CalR       Meas        ADC   ADC-correc
     39.96      40.07      40.17        40.07
     25.00      25.12      25.24        25.13
     14.28      14.43      14.55        14.42
      8.58       8.72       8.87         8.72
      3.08       3.24       3.40         3.23
     -0.37      -0.21      -0.03        -0.21

==== DOME TEMPERATURE ========
Dome Rref = 32850, Rref based on measurements of v_t = 33067. %Error = -0.7
Dome fit :  1.271e-07, -3.467e-03,   1.116e+01

DOME THERMISTOR MILLIVOLTS
      Meas        ADC    ADC-Corrected
     590.0      599.1      590.0
     946.0      954.0      946.0
    1305.0     1312.1     1305.3
    1534.0     1539.8     1533.6
    1775.0     1780.4     1775.0
    1934.0     1939.0     1934.1

DOME THERMISTOR OHMS
      CalR       Meas        ADC  ADC-corrected
      5600       5569       5670       5569
     10000       9948      10057       9948
     15600      15504      15629      15509
     20000      19871      19991      19863
     25600      25407      25545      25408
     30000      29743      29890      29746

DOME THERMISTOR DEG C
      CalR       Meas        ADC   ADC-correc
     39.96      40.11      39.63        40.11
     25.00      25.13      24.86        25.13
     14.28      14.43      14.24        14.42
```

```
      8.58       8.72       8.59         8.73
      3.08       3.24       3.12         3.24
     -0.37      -0.18      -0.29        -0.19

==== PSP THERMOPILE CIRCUIT ========
PSP Calibration Gain (g) = 124.61,  Offset (o) = 1.1 millivolts

==== PIR THERMOPILE CIRCUIT ========
PIR Calibration Gain (g) = 842.32,  Offset (o) = 4.5 millivolts

RAD201
================================================
RAD201 SETUP COMMANDS
L : 10
k : 8.09e-6
K : 3.79e-6
A : 01
V : 4070
C 0 : 33156
C 1 : -9.647e-07
C 2 : -2.312e-03
C 3 : -3.535e-01
D 0 : 33067
D 1 : 1.271e-07
D 2 : -3.467e-03
D 3 : 1.116e+01
g : 124.61
o : 1.10
G : 842.32
O : 4.51

VERIFY CASE-DOME TEMPS
================================================
OHMS YSI CASE DOME
5600 39.96 39.85 39.75
10000 25.00 24.94 24.97
15600 14.28 14.30 14.38
20000 8.58 8.63 8.73
25600 3.08 3.19 3.29
30000 -0.37 -0.22 -0.12
```


RAD 201 cal 2021-12-14
Blue = actual data
Green = Calibration, [124.613, 1.098]
Vout mv
Vin mv


RAD 201 cal 2021-12-14, CALIBRATION ERROR
FS = 2000 mV, PcntFS = 100 * (vfit-vout) / FS
Percent FS error mv
Vin mv


Blue = actual data
Green = Calibration, [842.316, 4.510]
Vout mv
Vin mv


FS = 2000 mV, PcntFS = 100 * (vfit-vout) / FS
Percent FS error mv
Vin mv

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 35149F3

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 Standard Precision Pyranometer, Model SPP, Serial Number 37501F3

Results:

Sensitivity: **$S = 8.16\ \mu V / Wm^{-2}$**
Uncertainty: $U_{95} = \pm 0.91\%$ (95% confidence level, k=2)
Resistance: 727 Ω at 23°C

Date of Test: October 21, 2021

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 Twelfth International Pyrheliometric Comparisons (IPC XII) at Davos, Switzerland in September-October 2015. 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: URI // RMR
Narragansett, RI // Seattle, WA

In Charge of Test: Thomas J. Kuh

Eppley SO: 66054

Date of Certificate November 3, 2021

Remarks:

End of Report

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 Infrared Radiometer, Model PIR, Serial Number 35116F3
Procedure:	This pyrgeometer was compared against Eppley's Blackbody Calibration System under radiation intensities of approximately 350 Wm^{-2} with an average ambient temperature of 19°C according to procedures described in Technical Procedure, TP05 of The Eppley Laboratory, Inc.'s Quality Assurance Manual on Calibrations.
Transfer Standard:	Eppley Precision Infrared Radiometer, Model PIR, Serial Number 32227F3
Results:	**Sensitivity:** **$S = 3.80\ \mu V / Wm^{-2}$** Uncertainty: $U_{95} = \pm 1.7\%$ (95% confidence level, k=2) Resistance: 649 Ω at 23°C
	Date of Test: October 21, 2021
Traceability:	This calibration is traceable to the International Practical Temperature Scale (IPTS). Additionally, transfer standard PIR #32227F3 provides traceability to the World Infrared Standand Group (WISG) of pyrgeometers housed at the Infrared Radiometry Section of the World Radiation Centre (WRC-IRS). 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:	URI // RMR Narragansett, RI // Seattle, WA
In Charge of Test:	Thomas D Kuhn
Eppley SO:	66054
Date of Certificate	November 3, 2021
Remarks:	

End of Report