SEA·BIRD SCIENTIFIC
Sea-Bird Scientific
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SENSOR SERIAL NUMBER: 1136
CALIBRATION DATE: 13-Apr-21

SBE 9plus PRESSURE CALIBRATION DATA
10000 psia S/N 127421

DIGIQUARTZ COEFFICIENTS:

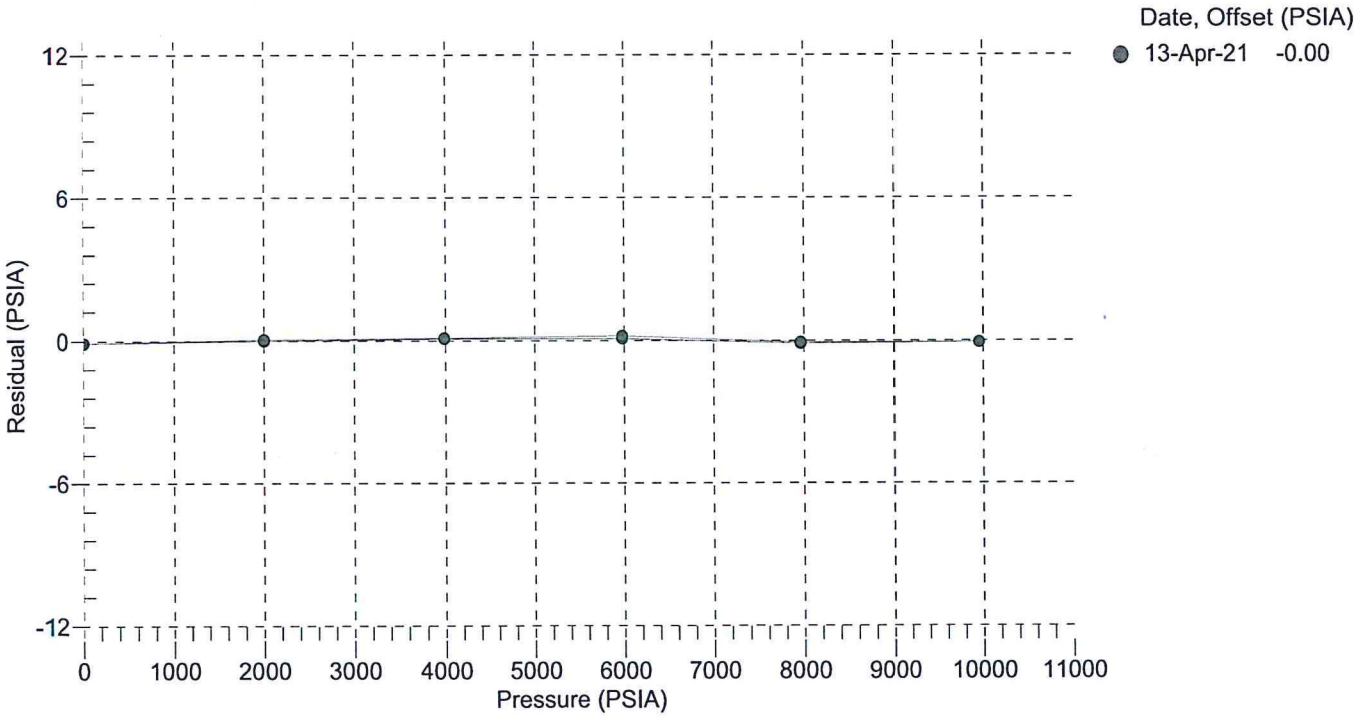
C1 = -4.373304e+004
C2 = 2.440268e-001
C3 = 1.442500e-002
D1 = 3.686900e-002
D2 = 0.000000e+000
T1 = 3.002769e+001
T2 = -1.951630e-004
T3 = 4.244630e-006
T4 = 2.954280e-009
T5 = 0.000000e+000

AD590M, AD590B, SLOPE AND OFFSET:

AD590M = 1.28120e-002
AD590B = -8.82994e+000
Slope = 1.00000
Offset = -2.5573 (dbars)

| PRESSURE (PSIA) | INSTRUMENT OUTPUT (Hz) | INSTRUMENT TEMPERATURE (°C) | INSTRUMENT PRESSURE (PSIA) | CORRECTED PRESSURE (PSIA) | RESIDUAL (PSIA) |
|---|---|---|---|---|---|
| 14.668 | 33312.00 | 21.3 | 18.282 | 14.573 | -0.095 |
| 2001.344 | 34058.90 | 21.3 | 2005.048 | 2001.338 | -0.006 |
| 3988.667 | 34787.60 | 21.3 | 3992.459 | 3988.748 | 0.081 |
| 5976.059 | 35499.00 | 21.4 | 5979.833 | 5976.120 | 0.061 |
| 7963.478 | 36194.10 | 21.4 | 7967.044 | 7963.330 | -0.148 |
| 9951.196 | 36874.10 | 21.4 | 9954.851 | 9951.136 | -0.060 |
| 7963.394 | 36194.10 | 21.4 | 7967.035 | 7963.321 | -0.073 |
| 5975.913 | 35499.00 | 21.5 | 5979.818 | 5976.105 | 0.192 |
| 3988.611 | 34787.60 | 21.5 | 3992.441 | 3988.730 | 0.119 |
| 2001.286 | 34058.90 | 21.5 | 2005.033 | 2001.323 | 0.037 |
| 14.670 | 33312.00 | 21.6 | 18.273 | 14.564 | -0.106 |

Residual (PSIA) = corrected instrument pressure - reference pressure



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SENSOR SERIAL NUMBER: 1572
CALIBRATION DATE: 18-Jun-21

SBE 3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

COEFFICIENTS:

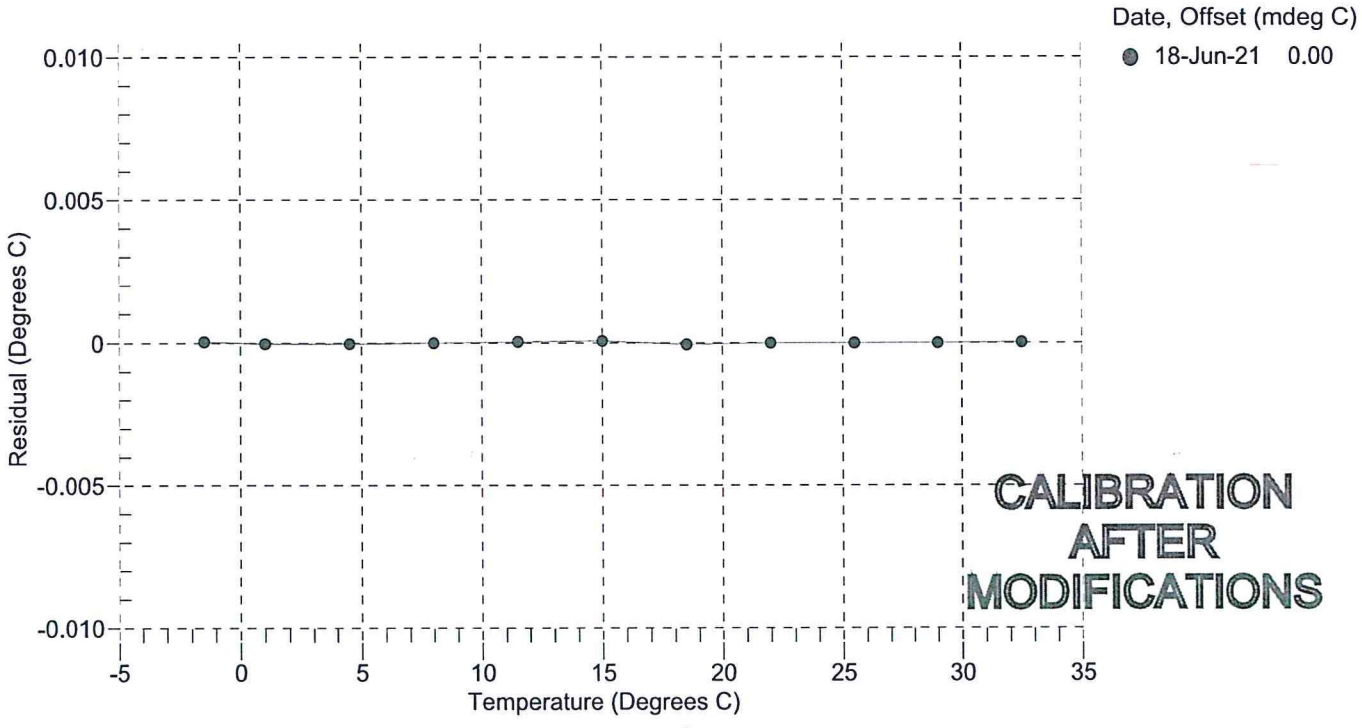
g = 4.31355871e-003
h = 6.36304659e-004
i = 2.13072570e-005
j = 1.94856415e-006
f0 = 1000.0

| BATH TEMP (° C) | INSTRUMENT OUTPUT (Hz) | INST TEMP (° C) | RESIDUAL (° C) |
|---|---|---|---|
| -1.5000 | 2789.084 | -1.5000 | 0.00004 |
| 1.0000 | 2950.155 | 1.0000 | -0.00004 |
| 4.5000 | 3186.811 | 4.5000 | -0.00004 |
| 8.0000 | 3436.813 | 8.0000 | -0.00001 |
| 11.5000 | 3700.522 | 11.5000 | 0.00005 |
| 15.0000 | 3978.286 | 15.0001 | 0.00007 |
| 18.5000 | 4270.437 | 18.4999 | -0.00006 |
| 22.0000 | 4577.331 | 22.0000 | -0.00002 |
| 25.5000 | 4899.274 | 25.5000 | -0.00000 |
| 29.0000 | 5236.572 | 29.0000 | -0.00001 |
| 32.5000 | 5589.526 | 32.5000 | 0.00001 |

f = Instrument Output (Hz)

Temperature ITS-90 (°C) = $1/\{g + h[ln(f0 / f)] + i[ln^2(f0 / f)] + j[ln^3(f0 / f)]\} - 273.15$

Residual (°C) = instrument temperature - bath temperature



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SENSOR SERIAL NUMBER: 4107
CALIBRATION DATE: 02-Sep-20

SBE 4 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

```
g =  -1.01897953e+001
h =   1.39751243e+000
i =  -6.71617376e-004
j =   1.22344702e-004

CPcor = -9.5700e-008 (nominal)
CTcor =  3.2500e-006 (nominal)
```

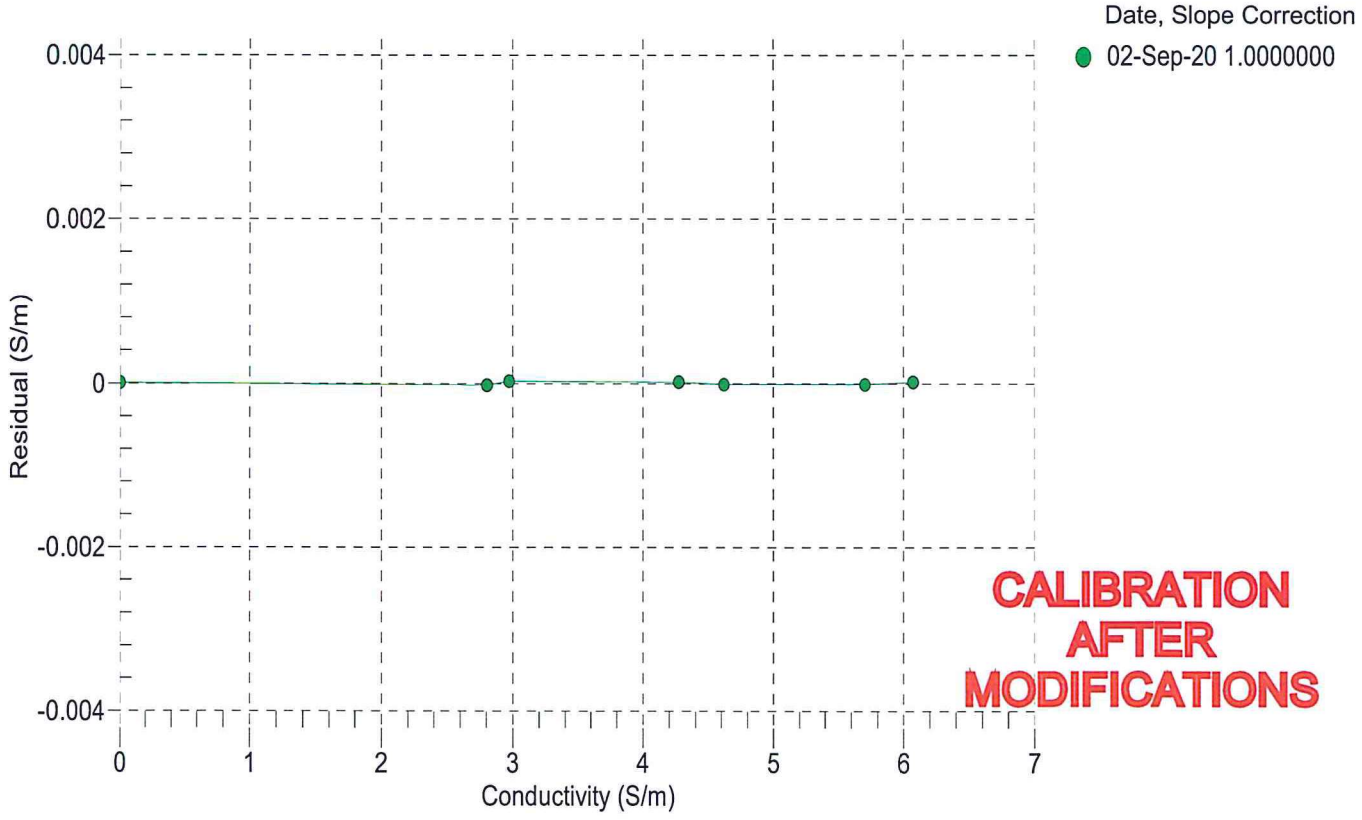
| BATH TEMP (° C) | BATH SAL (PSU) | BATH COND (S/m) | INSTRUMENT OUTPUT (kHz) | INSTRUMENT COND (S/m) | RESIDUAL (S/m) |
|---|---|---|---|---|---|
| 0.0000 | 0.0000 | 0.00000 | 2.70115 | 0.00000 | 0.00000 |
| -1.0003 | 34.8265 | 2.80530 | 5.23143 | 2.80527 | -0.00002 |
| 0.9997 | 34.8266 | 2.97674 | 5.34731 | 2.97676 | 0.00002 |
| 14.9997 | 34.8255 | 4.27259 | 6.15242 | 4.27261 | 0.00002 |
| 18.4997 | 34.8243 | 4.61929 | 6.35040 | 4.61927 | -0.00001 |
| 28.9997 | 34.8199 | 5.70281 | 6.93252 | 5.70279 | -0.00002 |
| 32.4997 | 34.8086 | 6.07477 | 7.12130 | 6.07478 | 0.00001 |

f = Instrument Output (kHz)

t = temperature (°C); p = pressure (decibars); $\delta$ = CTcor; $\varepsilon$ = CPcor;

Conductivity (S/m) = $(g + h * f^2 + i * f^3 + j * f^4) / 10 (1 + \delta * t + \varepsilon * p)$

Residual (Siemens/meter) = instrument conductivity - bath conductivity



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SENSOR SERIAL NUMBER: 3553
CALIBRATION DATE: 08-Jul-21

SBE 43 OXYGEN CALIBRATION DATA

COEFFICIENTS:
Soc = 0.4305
Voffset = -0.5047
Tau20 = 1.28
A = -4.3491e-003
B = 1.4728e-004
C = -1.7851e-006
E nominal = 0.036

NOMINAL DYNAMIC COEFFICIENTS
D1 = 1.92634e-4
D2 = -4.64803e-2
H1 = -3.300000e-2
H2 = 5.00000e+3
H3 = 1.45000e+3

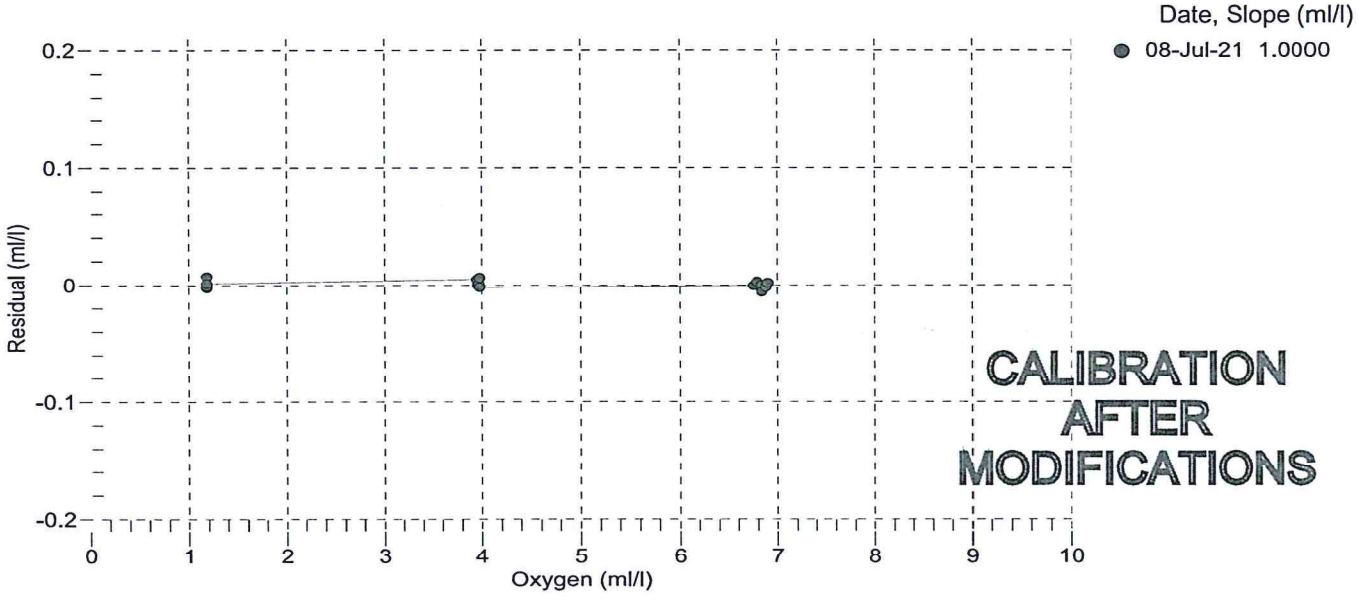
| BATH OXYGEN (ml/l) | BATH TEMPERATURE (° C) | BATH SALINITY (PSU) | INSTRUMENT OUTPUT (volts) | INSTRUMENT OXYGEN (ml/l) | RESIDUAL (ml/l) |
|---|---|---|---|---|---|
| 1.18 | 6.00 | 0.00 | 0.825 | 1.18 | -0.00 |
| 1.18 | 12.00 | 0.00 | 0.880 | 1.18 | -0.00 |
| 1.18 | 2.00 | 0.00 | 0.790 | 1.18 | -0.00 |
| 1.18 | 30.00 | 0.00 | 1.052 | 1.19 | 0.01 |
| 1.18 | 20.00 | 0.00 | 0.955 | 1.18 | -0.00 |
| 1.18 | 26.00 | 0.00 | 1.012 | 1.18 | 0.00 |
| 3.95 | 30.00 | 0.00 | 2.326 | 3.95 | 0.00 |
| 3.96 | 2.00 | 0.00 | 1.462 | 3.96 | -0.00 |
| 3.96 | 6.00 | 0.00 | 1.585 | 3.96 | 0.00 |
| 3.97 | 12.00 | 0.00 | 1.771 | 3.97 | 0.00 |
| 3.97 | 26.00 | 0.00 | 2.210 | 3.98 | 0.01 |
| 3.98 | 20.00 | 0.00 | 2.021 | 3.98 | -0.00 |
| 6.75 | 2.00 | 0.00 | 2.139 | 6.75 | -0.00 |
| 6.78 | 6.00 | 0.00 | 2.354 | 6.79 | 0.00 |
| 6.83 | 12.00 | 0.00 | 2.684 | 6.83 | -0.00 |
| 6.84 | 30.00 | 0.00 | 3.649 | 6.83 | -0.01 |
| 6.88 | 20.00 | 0.00 | 3.126 | 6.87 | -0.00 |
| 6.90 | 26.00 | 0.00 | 3.460 | 6.90 | 0.00 |

V = instrument output (volts); T = temperature (°C); S = salinity (PSU); K = temperature (°K)

Oxsol(T,S) = oxygen saturation (ml/l); P = pressure (dbar)

$$\text{Oxygen (ml/l)} = \text{Soc} * (V + \text{Voffset}) * (1.0 + A * T + B * T^2 + C * T^3) * \text{Oxsol}(T,S) * \exp(E * P / K)$$

Residual (ml/l) = instrument oxygen - bath oxygen



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# *ECO* Chlorophyll Fluorometer Characterization Sheet

Date: 10/20/2021 S/N: FLRTD-7158

Chlorophyll concentration expressed in µg/l can be derived using the equation:

**CHL (µg/l) = Scale Factor * (Output - Dark Counts)**

| | Analog Range 1 | Analog Range 2 | Analog Range 4 (default) | Digital |
|---|---|---|---|---|
| **Dark Counts** | 0.067 | 0.039 | 0.025 V | 46 counts |
| **Scale Factor (SF)** | 6 | 13 | 25 µg/l/V | 0.0076 µg/l/count |
| **Maximum Output** | 4.99 | 4.99 | 4.99 V | 16380 counts |
| **Resolution** | 0.5 | 0.5 | 0.5 mV | 1.0 counts |

Ambient temperature during characterization 22.5 °C

**Analog Range:** 1 (most sensitive, 0–4,000 counts), 2 (midrange, 0–8,000 counts), 4 (entire range, 0–16,000 counts).

**Dark Counts:** Signal output of the meter in clean water with black tape over detector.

**SF:** Determined using the following equation: SF = x ÷ (output - dark counts), where x is the concentration of the solution used during instrument characterization. SF is used to derive instrument output concentration from the raw signal output of the fluorometer.

**Maximum Output:** Maximum signal output the fluorometer is capable of.

**Resolution:** Standard deviation of 1 minute of collected data.

The relationship between fluorescence and chlorophyll-a concentrations *in-situ* is highly variable. The scale factor listed on this document was determined using a mono-culture of phytoplankton (*Thalassiosira weissflogii*). The population was assumed to be reasonably healthy and the concentration was determined by using the absorption method. To accurately determine chlorophyll concentration using a fluorometer, you must perform secondary measurements on the populations of interest. This is typically done using extraction-based measurement techniques on discrete samples. For additional information on determining chlorophyll concentration see "Standard Methods for the Examination of Water and Wastewater" part 10200 H, published jointly by the American Public Health Association, American Water Works Association, and the Water Environment Federation.

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# C-Star Calibration

Date September 23, 2021 S/N# CST-2151 Pathlength 25 cm

| | Analog output | Digital output | |
|---|---|---|---|
| $V_{dark}$ | 0.000 V | 0 counts | |
| $V_{air}$ | 4.802 V | 15784 counts | |
| $V_{ref}$ | 4.702 V | 15455 counts | |
| Temperature of calibration water | | | 23.4 °C |
| Ambient temperature during calibration | | | 23.2 °C |

Relationship of transmittance (Tr) to beam attenuation coefficient (c), and pathlength (x, in meters): $\mathbf{Tr = e^{-cx}}$

To determine beam transmittance: $\mathbf{Tr = (V_{sig} - V_{dark}) / (V_{ref} - V_{dark})}$

To determine beam attenuation coefficient: $\mathbf{c = -1/x * \ln (Tr)}$

$V_{dark}$ Meter output with the beam blocked. This is the offset.
$V_{air}$ Meter output in air with a clear beam path.
$V_{ref}$ Meter output with clean water in the path.
Temperature of calibration water: temperature of clean water used to obtain $V_{ref}$.
Ambient temperature: meter temperature in air during the calibration.
$V_{sig}$ Measured signal output of meter.

# CALIBRATION CERTIFICATE

**PAR Irradiance Meter**

Chelsea Technologies

| | |
|---|---|
| **Date of Cal:** | 19-Oct-2020 |
| **Part Number:** | 0046-3097 |
| **Job Number:** | JN34601i |
| **Serial Number:** | 19-0003-003 |

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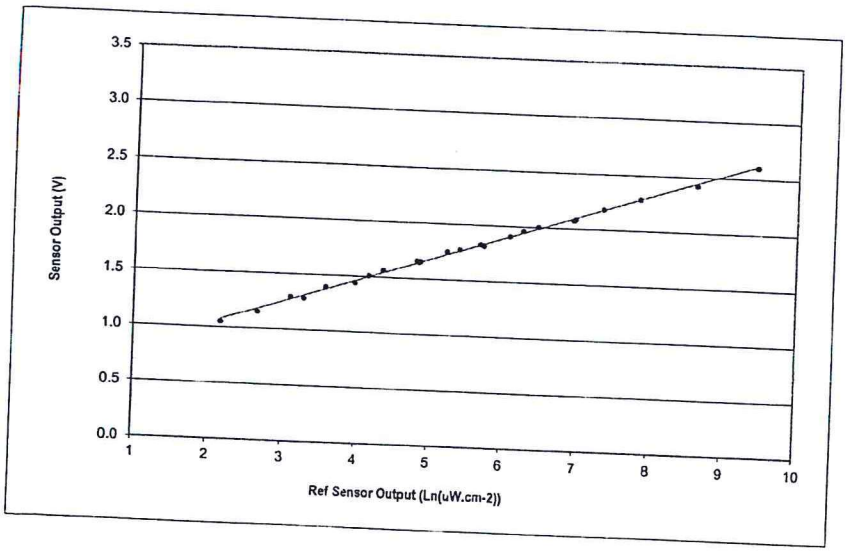
**Calibration Equation**

PAR (Ln(uW.cm-2)) = 0.0047143 x mVolts - 2.893023
PAR(uW.cm-2) = PAR(uE.m-2.s-1) / 0.04234
PAR (Ln(uE.m-2.s-1)) = 0.0047143 x mVolts - 6.055046




| **Calibration** | |
|---|---|
| Coeff A (slope): | 0.0047143 |
| Coeff B (intercept): | -2.893023 |
| RSQ: | 0.9981 |
| **Lamp Stability** | |
| Within cal: | 6.32% |
| Between cal: | 6.39% |
| **Multimeter** | |
| Manufacturer: | FLUKE 8846A |
| SN: | 4549021 |
| Cal Due Date: | Cal. Checked |
| **Supply Volts** | 12.00 |
| **Electral Offset (mv)** | 0.0 |

**Observations:**

Sensor Condition: na
Accessories: Sensor Cap

Instrument calibrated at Chelsea Technologies Group as described in section 3 of the PAR sensor handbook.

**Name:** LJ Gibson

**Signed:**

**Issue Date:** 19 October 2020