Sea-Bird Scientific
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SENSOR SERIAL NUMBER: 1093
CALIBRATION DATE: 06-Apr-21

SBE 9plus PRESSURE CALIBRATION DATA
10000 psia S/N 121342

DIGIQUARTZ COEFFICIENTS:

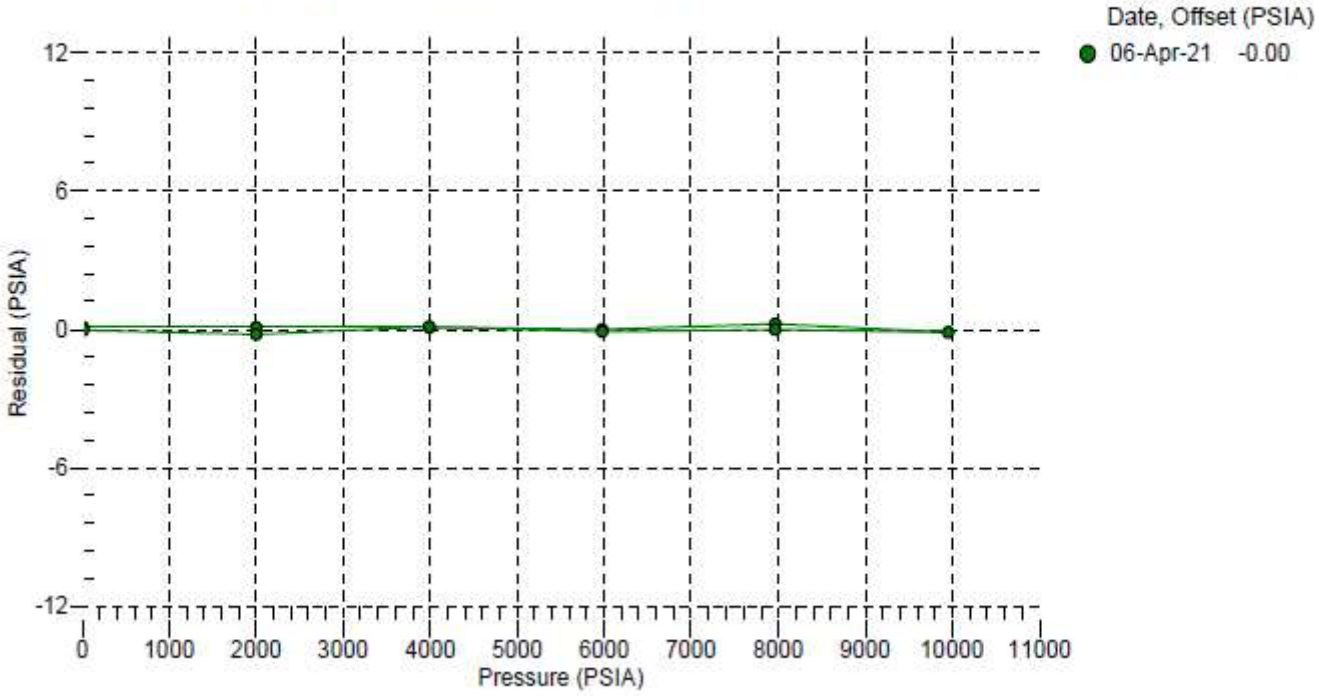
```
C1 =  -4.962086e+004
C2 =  -5.338120e-002
C3 =   1.472130e-002
D1 =   3.831600e-002
D2 =   0.000000e+000
T1 =   3.004597e+001
T2 =  -2.951930e-004
T3 =   3.717090e-006
T4 =   3.520660e-009
T5 =   0.000000e+000
```

AD590M, AD590B, SLOPE AND OFFSET:

```
AD590M =   1.28090e-002
AD590B =  -9.27151e+000
Slope  =   0.99994
Offset =  -0.3245 (dbars)
```

PRESSURE (PSIA)	INSTRUMENT OUTPUT (Hz)	INSTRUMENT TEMPERATURE (°C)	INSTRUMENT PRESSURE (PSIA)	CORRECTED PRESSURE (PSIA)	RESIDUAL (PSIA)
14.585	33292.50	21.5	15.138	14.668	0.083
2000.507	33951.10	21.6	2001.170	2000.584	0.077
3988.001	34595.70	21.7	3988.768	3988.066	0.065
5975.569	35226.60	21.6	5976.362	5975.545	-0.024
7963.219	35844.70	21.7	7964.387	7963.455	0.236
9951.136	36450.40	21.7	9952.054	9951.007	-0.129
7963.134	35844.60	21.7	7964.048	7963.115	-0.019
5975.901	35226.70	21.8	5976.613	5975.796	-0.105
3987.927	34595.70	21.8	3988.721	3988.019	0.092
2000.449	33951.00	21.8	2000.805	2000.219	-0.230
14.580	33292.50	21.8	15.004	14.533	-0.047

Residual (PSIA) = corrected instrument pressure - reference pressure



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SENSOR SERIAL NUMBER: 5710
CALIBRATION DATE: 14-Apr-21

SBE 3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

COEFFICIENTS:

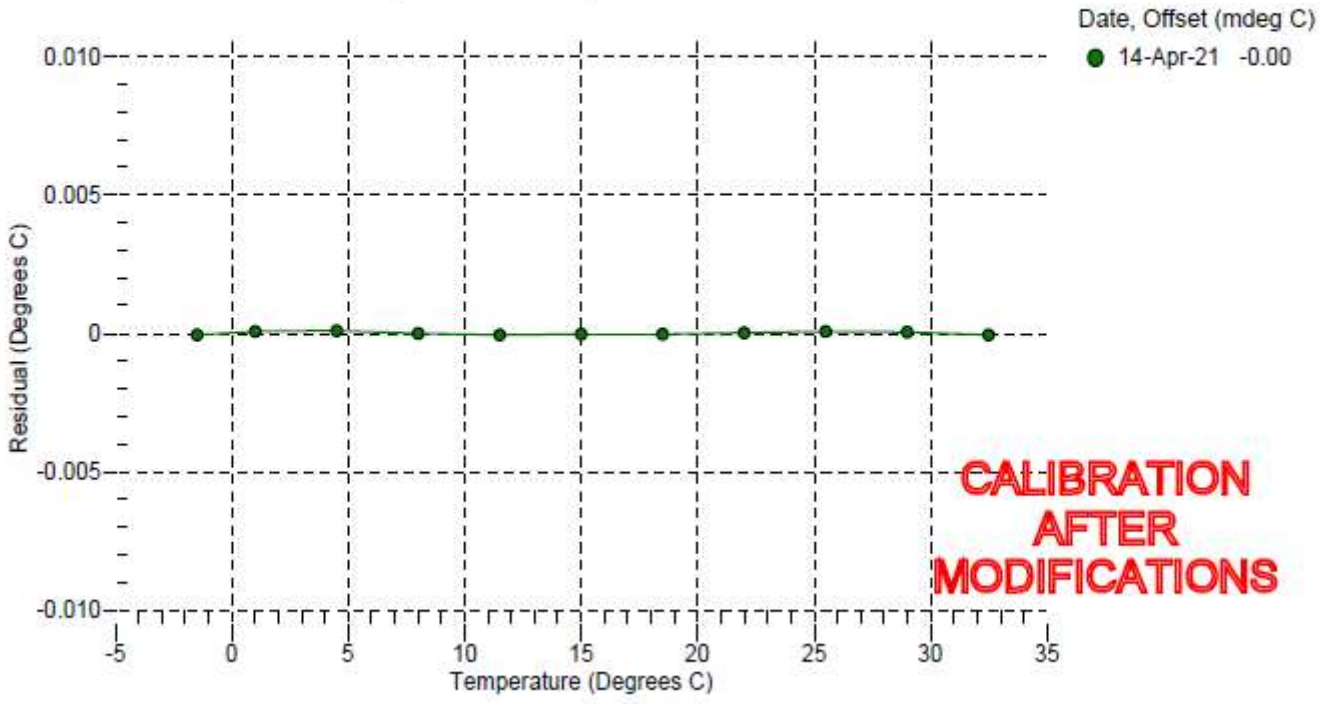
g = 4.35598515e-003
h = 6.29996003e-004
i = 1.92465420e-005
j = 1.26484271e-006
f0 = 1000.0

BATH TEMP (° C)	INSTRUMENT OUTPUT (Hz)	INST TEMP (° C)	RESIDUAL (° C)
-1.5000	3021.393	-1.5001	-0.00007
1.0000	3197.920	1.0001	0.00007
4.5000	3457.473	4.5001	0.00009
8.0000	3731.912	8.0000	-0.00002
11.5000	4021.685	11.4999	-0.00006
15.0000	4327.218	15.0000	-0.00004
18.5000	4648.921	18.5000	-0.00003
22.0000	4987.206	22.0000	0.00002
25.5000	5342.465	25.5001	0.00006
29.0000	5715.082	29.0000	0.00005
32.5000	6105.426	32.4999	-0.00006

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: 1344
CALIBRATION DATE: 30-Mar-21

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

COEFFICIENTS:

```
g =  -1.02163172e+001
h =   1.30580843e+000
i =   9.47049760e-004
j =   1.61715469e-006

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

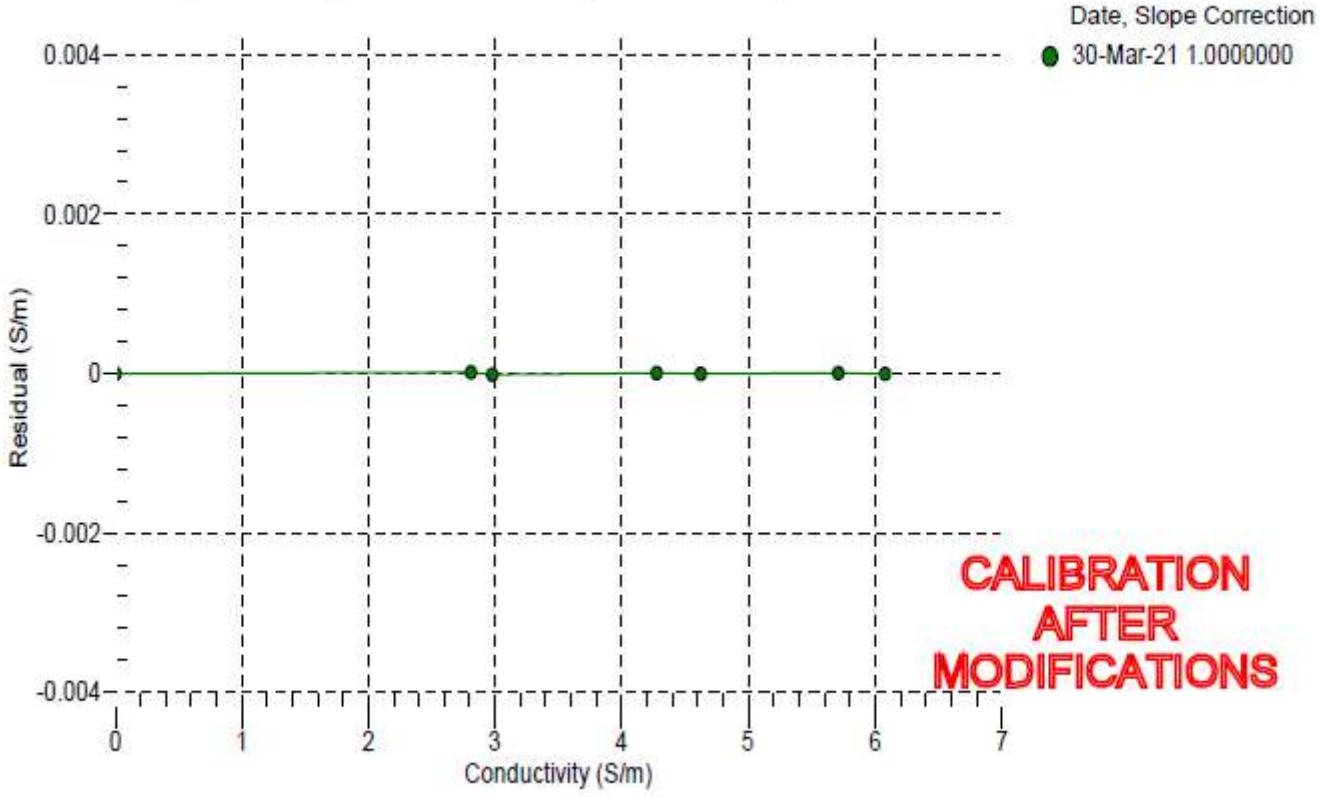
BATH TEMP (° C)	BATH SAL (PSU)	BATH COND (S/m)	INSTRUMENT OUTPUT (kHz)	INSTRUMENT COND (S/m)	RESIDUAL (S/m)
0.0000	0.0000	0.00000	2.79425	0.00000	0.00000
-1.0000	34.8628	2.80797	5.40480	2.80798	0.00001
0.9999	34.8626	2.97954	5.52430	2.97952	-0.00001
15.0000	34.8609	4.27650	6.35508	4.27651	0.00001
18.4998	34.8602	4.62354	6.55945	4.62354	-0.00000
28.9999	34.8537	5.70774	7.16022	5.70774	0.00000
32.5000	34.8368	6.07916	7.35468	6.07916	-0.00000

f = Instrument Output (kHz)

t = temperature (°C); p = pressure (decibars); δ = CTcor; ε = 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: 0460
CALIBRATION DATE: 08-Jan-21

SBE 43 OXYGEN CALIBRATION DATA

COEFFICIENTS:
Soc = 0.5553
Voffset = -0.5020
Tau20 = 1.54
A = -4.4213e-003
B = 2.1255e-004
C = -3.4382e-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

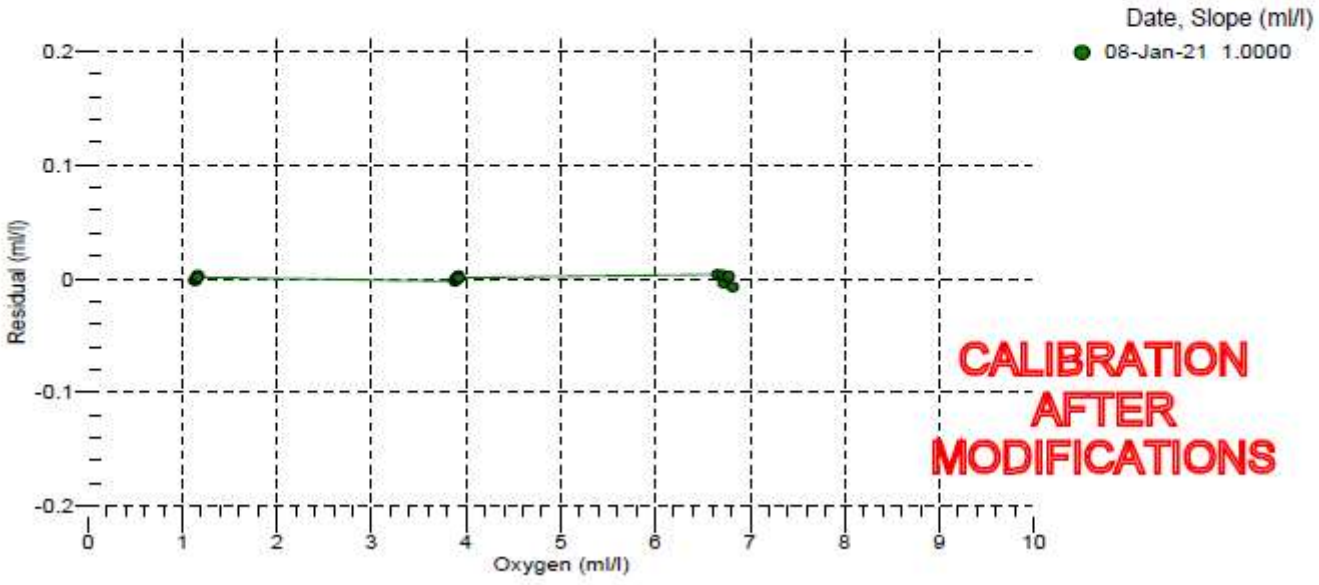
BATH OXYGEN (ml/l)	BATH TEMPERATURE (° C)	BATH SALINITY (PSU)	INSTRUMENT OUTPUT (volts)	INSTRUMENT OXYGEN (ml/l)	RESIDUAL (ml/l)
1.13	2.00	0.00	0.713	1.12	-0.00
1.13	6.00	0.00	0.740	1.13	-0.00
1.14	12.00	0.00	0.782	1.14	-0.00
1.15	20.00	0.00	0.840	1.16	0.00
1.16	30.00	0.00	0.912	1.16	0.00
1.16	26.00	0.00	0.883	1.16	0.00
3.88	2.00	0.00	1.229	3.88	-0.00
3.89	6.00	0.00	1.322	3.89	-0.00
3.89	12.00	0.00	1.459	3.89	0.00
3.91	26.00	0.00	1.783	3.91	0.00
3.92	20.00	0.00	1.647	3.92	0.00
3.92	30.00	0.00	1.885	3.92	0.00
6.66	2.00	0.00	1.752	6.66	0.00
6.71	20.00	0.00	2.463	6.71	0.00
6.72	6.00	0.00	1.918	6.71	-0.00
6.76	12.00	0.00	2.165	6.76	0.00
6.78	30.00	0.00	2.893	6.78	0.00
6.82	26.00	0.00	2.733	6.81	-0.01

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

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

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

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



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ECO Chlorophyll Fluorometer Characterization Sheet

Date: 4/12/2022 S/N: FLRTD-7511

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	0.048	0.019	0.011	V	48	counts
Scale Factor (SF)	6	13	25	µg/l/V	0.0076	µg/l/count
Maximum Output	4.97	4.97	4.97	V	16380	counts
Resolution	1.0	1.0	1.0	mV	1.0	counts

Ambient temperature during characterization 20.4 °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 May 18, 2022 S/N# CST-2189DR Pathlength 25 cm

	Analog output	Digital output
V_{dark}	0.013 V	0 counts
V_{air}	4.817 V	15794 counts
V_{ref}	4.701 V	15411 counts
Temperature of calibration water		24.0 °C
Ambient temperature during calibration		21.5 °C

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

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

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

Y_0 = V_{dark} Meter output with the beam blocked. This is the offset.
A_0 = V_{air} Meter output in air with a clear beam path.
W_0 = 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.

A_1: current air Votage = 4.5739

Y_1: current blocked path Voltage = 0.0024

T_W = 100 %

$M = [T_W / (W_0 - Y_0)] \times (A_0 - Y_0) / (A_1 - Y_1)$

$b = -M \times Y_1$