PO Box 518
620 Applegate St.
Philomath, OR 97370

(541) 929-5650
Fax (541) 929-5277
www.wetlabs.com

Scattering Meter Calibration Sheet

6/16/2016
Wavelength: 700 S/N FLBBRTD-4391

Use the following equation to obtain either digital or analog "scaled" output values:

$$\beta(\theta_c)\ m^{-1}\ sr^{-1} = \text{Scale Factor} \times (\text{Output} - \text{Dark Counts})$$

• **Scale Factor for 700 nm**	=	1.620E-06	$(m^{-1}sr^{-1})$/counts	1.330E-03	$(m^{-1}sr^{-1})$/volts
• **Output**	=	meter output	counts	meter output	volts
• **Dark Counts**	=	46	counts	0.0619	volts
Instrument Resolution	=	1.0	counts	1.62E-06	$(m^{-1}sr^{-1})$
		1.3170	mV		

Definitions:

- **Scale Factor**: Calibration scale factor, $\beta(\theta_c)$/counts. Refer to User's Guide for derivation.
- **Output**: Measured signal output of the scattering meter.
- **Dark Counts**: Signal obtained by covering detector with black tape and submersing sensor in water.

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

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ECO Chlorophyll Fluorometer Characterization Sheet

Date: 6/16/2016 S/N: FLBBRTD-4391

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

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

	Analog		Digital	
Dark counts	0.070	V	42	counts
Scale Factor (SF)	6	µg/l/V	0.0073	µg/l/count
Maximum Output	4.98	V	4130	counts
Resolution	0.6	mV	1.0	counts
Ambient temperature during characterization			22.0	°C

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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ECO CDOM Fluorometer Characterization Sheet

Date: 1/14/2016 S/N: FLCDRTD-2344

CDOM (Quinine Dihydrate Equivalent) concentration expressed in ppb can be derived using the equation:

CDOM (QSDE) = Scale Factor * (Output - Dark Counts)

	Analog Range 1	Analog Range 2	Analog Range 4 (default)		Digital	
Dark Counts	0.086	0.044	0.025	V	60	counts
Scale Factor (SF)	20	40	79	ppb/V	0.0240	ppb/count
Maximum Output	4.98	4.98	4.98	V	16410	counts
Resolution	2.4	2.4	2.4	mV	2.5	counts

Ambient temperature during characterization 22.3 °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.

PSA916 Altimeter
Serial number 50414

Calibration Coefficients

```
<?xml version="1.0" encoding="UTF-8"?>
<AltimeterSensor SensorID="0" SB_ConfigCTD_FileVersion="7.23.0.2" >
  <SerialNumber>50414</SerialNumber>
  <CalibrationDate>24-Jun-10</CalibrationDate>
  <ScaleFactor>15.000</ScaleFactor>
  <Offset>0.000</Offset>
</AltimeterSensor>
```

Biospherical Instruments Inc.

CALIBRATION CERTIFICATE

LOG SENSOR

Calibration Date: 12/9/15
Model Number: QCP2300
Serial Number: 4664
Operator: TPC
Standard Lamp: V-033(3/3/15)
Operating Voltage Range: 6 to 15 VDC (+)

Note: The QCP-2300 uses a log amplifier to measure the detector signal current with V = log I (Amps) / I_{Ref}
To calculate irradiance, use this formula:

Irradiance = Calibration factor * (10^Light Signal Voltage - 10^Dark Voltage)

With the appropriate (solar corrected) Irradiance Calibration Factor:

Dry Calibration Factor:	**2.38E+11**	**quanta/cm²·sec/"amps"**	**3.94E-07**	**µEinsteins/cm²·sec/"amps"**
Wet Calibration Factor:	**2.50E+11**	**quanta/cm²·sec/"amps"**	**4.15E-07**	**µEinsteins/cm²·sec/"amps"**

Sensor Test Data and Results[4)]

Sensor Supply Current (Dark):	85.3	mA			
Supply Voltage:	6	Volts			
Lamp Integrated PAR Irradiance:	9.39E+15	quanta/cm^2·sec	0.01559	µEinsteins/cm²sec	
Q2-3 Immersion Coefficient:	0.95	Scalar Correction:	1	PAR Solar Correction:	1.0000

Nominal Filter OD	Calibrated Trans.	Sensor Voltage	Measured Trans.	Measured Signal (Amps)	Estimated Signal (Amps)	Calc. Output (Volts)	Error (Volts)	Error (%)	Test Irrad. (quanta/ cm^2·sec)
No Filter	100.00%	4.597	100.00%	3.95E-06	3.95E-06	4.597	0.000	0.0	9.39E+15
0.3	36.10%	4.161	36.64%	1.45E-06	1.43E-06	4.155	-0.006	-1.5	3.44E+15
0.5	27.60%	4.049	28.30%	1.12E-06	1.09E-06	4.038	-0.011	-2.5	2.66E+15
1	9.27%	3.593	9.91%	3.92E-07	3.67E-07	3.564	-0.029	-6.4	9.30E+14
2	1.11%	2.700	1.26%	5.00E-08	4.39E-08	2.644	-0.056	-12.2	1.19E+14
3	0.05%	1.574	0.09%	3.61E-09	2.11E-09	1.353	-0.221	-41.5	8.57E+12
RG780	0%	1.344	0.05%	2.07E-09	0.00E+00	0.151	-1.193	-100.0	4.91E+12

Dark Before: 0.151 Volts
Light - No Filter Hldr.: 4.597 Volts
Dark After - NFH: 0.151 Volts
Average Dark 0.1512

I_{Ref} = 1.00E-10 Amps
I_{Dark} = 1.42E-10 Amps
10^{VDark} = 1.416446 Amps

Notes:
1. Annual calibration is recommended.
2. There is increasing error associated with readings below zero.
3. The collector should be cleaned frequently with alcohol.
4) This section is for internal use and for more advanced analysis.

SeaBird SBE 3+ Temperature Sensor
Serial number 5307

Calibration Coefficients

```
<?xml version="1.0" encoding="UTF-8"?>
<TemperatureSensor SensorID="55" SB_ConfigCTD_FileVersion="7.23.0.2" >
  <SerialNumber>5307</SerialNumber>
  <CalibrationDate>22-Dec-15</CalibrationDate>
  <UseG_J>1</UseG_J>
  <A>0.00000000e+000</A>
  <B>0.00000000e+000</B>
  <C>0.00000000e+000</C>
  <D>0.00000000e+000</D>
  <F0_Old>0.000</F0_Old>
  <G>4.39600705e-003</G>
  <H>6.37462343e-004</H>
  <I>2.22794871e-005</I>
  <J>2.07724783e-006</J>
  <F0>1000.000</F0>
  <Slope>1.00000000</Slope>
  <Offset>0.0000</Offset>
</TemperatureSensor>
```

Sea-Bird Electronics, Inc.
13431 NE 20th St. Bellevue, Washington 98005 USA
www.seabird.com
Phone: (425) 643-9866
Fax: (425) 643-9954
Email: seabird@seabird.com

Pressure Test Certificate

Test Date: 2016-10-27

Description: SBE-3 Temperature Sensor

Sensor Information:

Model Number: SBE-3

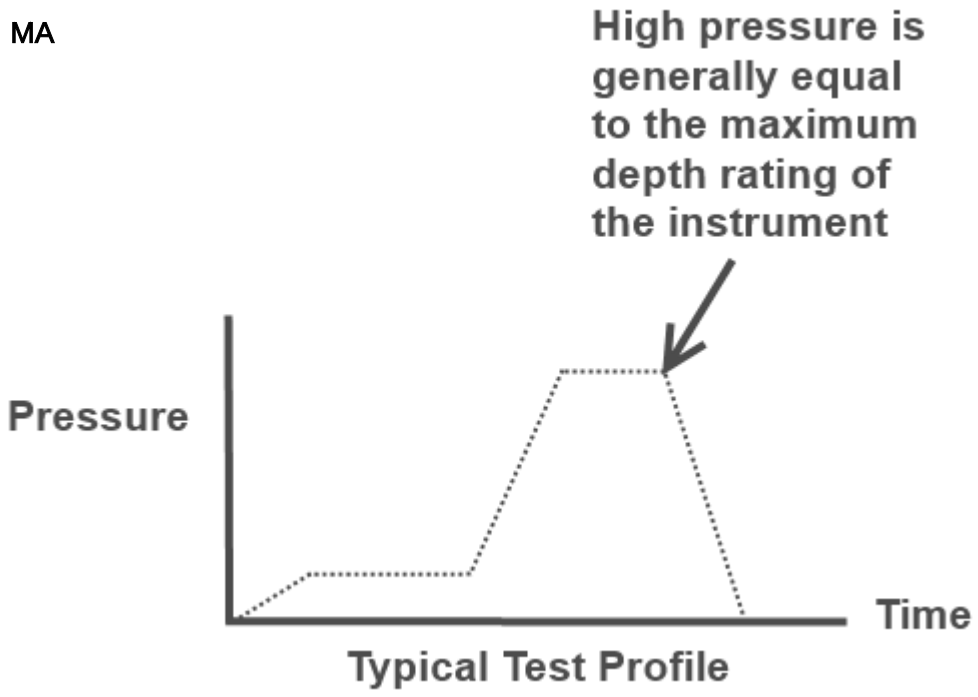
Serial Number: 6146

Pressure Test Protocol:

Low Pressure Test:	40	PSI	Held For:	15	Minutes
High Pressure Test:	10000	PSI	Held For:	15	Minutes

Passed Test: True

Tested By: MA



Typical Test Profile

Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA

Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 6146
CALIBRATION DATE: 18-Oct-16

SBE 3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

COEFFICIENTS:

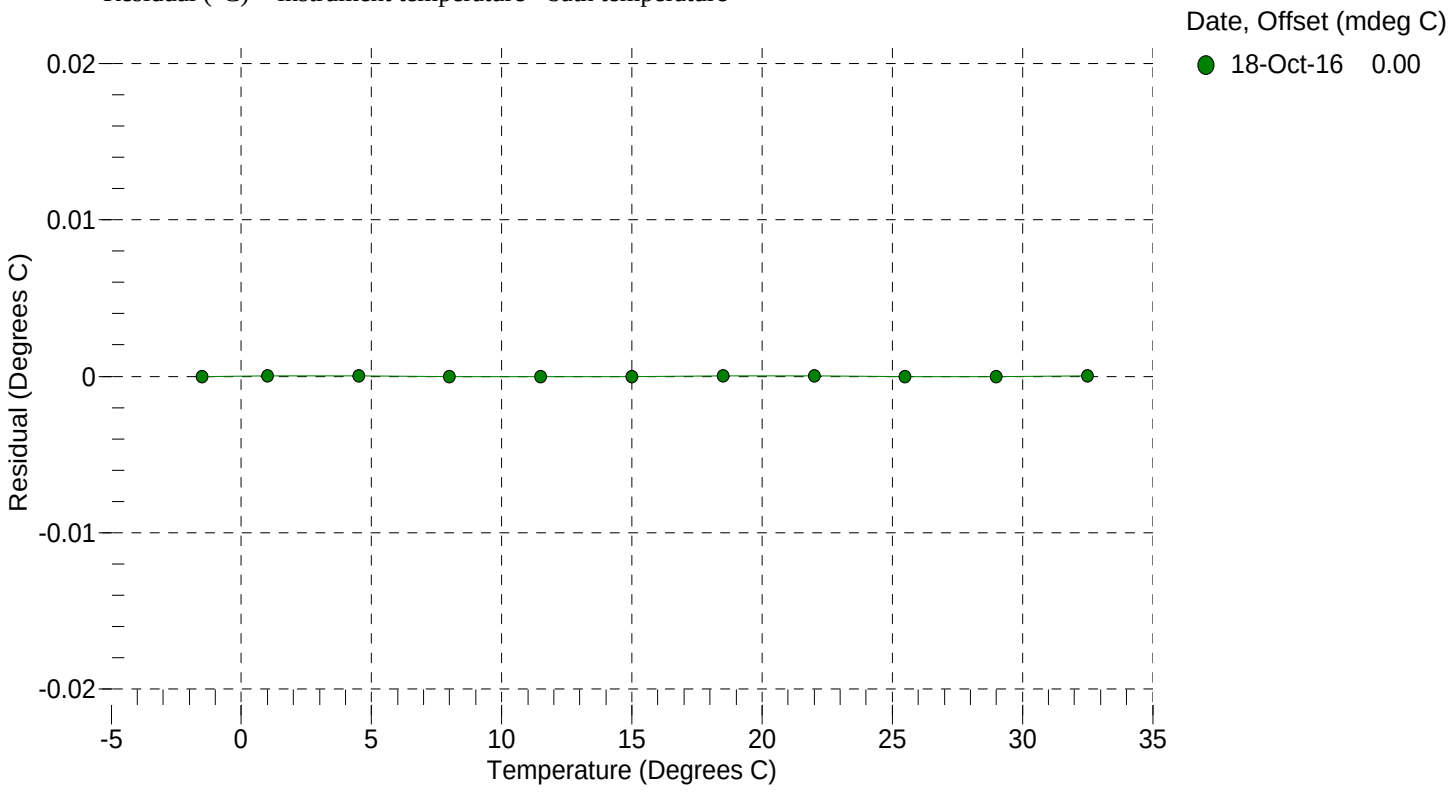
```
g =  4.35657614e-003
h =  6.37217402e-004
i =  2.23019622e-005
j =  2.09167184e-006
f0 =  1000.0
```

BATH TEMP (° C)	INSTRUMENT OUTPUT (Hz)	INST TEMP (° C)	RESIDUAL (° C)
-1.5000	2997.270	-1.5000	-0.00001
1.0000	3171.249	1.0000	0.00000
4.5000	3426.961	4.5000	0.00003
8.0000	3697.202	8.0000	-0.00002
11.5001	3982.388	11.5001	-0.00002
15.0001	4282.890	15.0001	-0.00000
18.5000	4599.083	18.5000	0.00002
22.0000	4931.346	22.0000	0.00002
25.5000	5280.024	25.5000	-0.00000
29.0001	5645.468	29.0001	-0.00003
32.5000	6027.981	32.5000	0.00002

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



Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA

Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 3430
CALIBRATION DATE: 18-Oct-16

SBE 43 OXYGEN CALIBRATION DATA

COEFFICIENTS:
Soc = 0.5541
Voffset = -0.4838
Tau20 = 1.94
A = -2.7702e-003
B = 1.3649e-004
C = -2.2345e-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

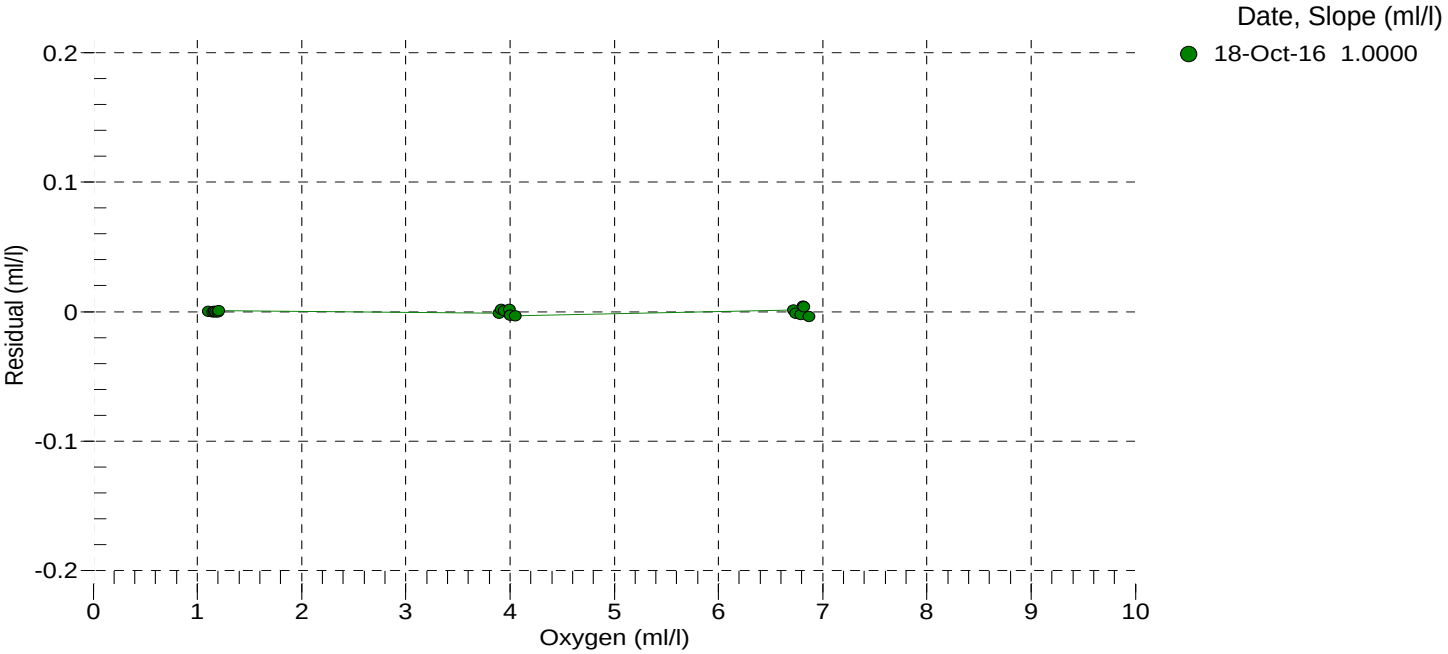
BATH OXYGEN (ml/l)	BATH TEMPERATURE (° C)	BATH SALINITY (PSU)	INSTRUMENT OUTPUT (volts)	INSTRUMENT OXYGEN (ml/l)	RESIDUAL (ml/l)
1.11	2.00	0.00	0.691	1.11	0.00
1.15	6.00	0.00	0.725	1.15	-0.00
1.16	12.00	0.00	0.767	1.16	0.00
1.17	20.00	0.00	0.823	1.17	-0.00
1.20	26.00	0.00	0.871	1.20	-0.00
1.20	30.00	0.00	0.903	1.20	0.00
3.90	2.00	0.00	1.214	3.90	-0.00
3.91	6.00	0.00	1.305	3.91	0.00
3.94	12.00	0.00	1.444	3.94	0.00
3.99	20.00	0.00	1.639	4.00	0.00
4.00	26.00	0.00	1.780	4.00	-0.00
4.05	30.00	0.00	1.893	4.05	-0.00
6.72	2.00	0.00	1.743	6.72	0.00
6.74	6.00	0.00	1.897	6.74	-0.00
6.79	12.00	0.00	2.137	6.79	-0.00
6.81	30.00	0.00	2.858	6.82	0.00
6.82	20.00	0.00	2.457	6.82	0.00
6.87	26.00	0.00	2.707	6.86	-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



Sea-Bird Electronics, Inc.
13431 NE 20th St. Bellevue, Washington 98005 USA
www.seabird.com
Phone: (425) 643-9866
Fax: (425) 643-9954
Email: seabird@seabird.com

Pressure Test Certificate

Test Date: 07/18/16

Description: SBE-43 DO Sensor

Sensor Information:

Model Number: 43

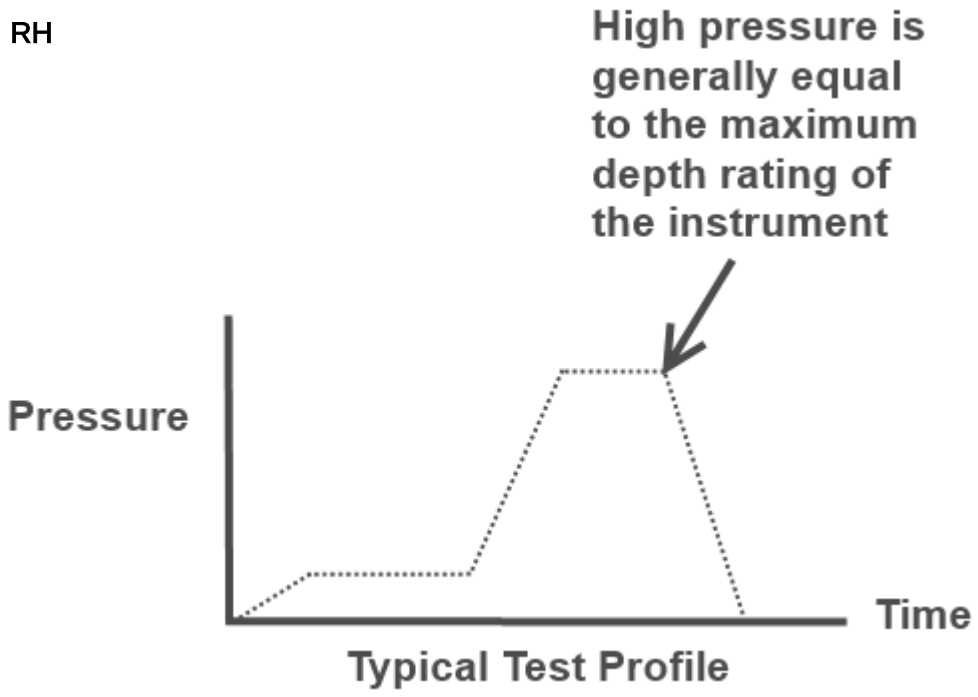
Serial Number: 3430

Pressure Test Protocol:

Low Pressure Test:	40	PSI	Held For:	15	Minutes
High Pressure Test:	10000	PSI	Held For:	15	Minutes

Passed Test: Yes

Tested By: RH



Typical Test Profile

SeaBird SBE 4C Conductivity Sensor
Serial number 3793

Calibration Coefficients

```
<?xml version="1.0" encoding="UTF-8"?>
<ConductivitySensor SensorID="3" SB_ConfigCTD_FileVersion="7.23.0.2" >
  <SerialNumber>3793</SerialNumber>
  <CalibrationDate>10-Dec-15</CalibrationDate>
  <UseG_J>1</UseG_J>
  <!-- Cell const and series R are applicable only for wide range sensors. -->
  <SeriesR>0.0000</SeriesR>
  <CellConst>2000.0000</CellConst>
  <ConductivityType>0</ConductivityType>
  <Coefficients equation="0" >
    <A>0.00000000e+000</A>
    <B>0.00000000e+000</B>
    <C>0.00000000e+000</C>
    <D>0.00000000e+000</D>
    <M>0.0</M>
    <CPcor>-9.57000000e-008</CPcor>
  </Coefficients>
  <Coefficients equation="1" >
    <G>-1.03242424e+001</G>
    <H>1.54005141e+000</H>
    <I>-1.07101801e-003</I>
    <J>1.80478166e-004</J>
    <CPcor>-9.57000000e-008</CPcor>
    <CTcor>3.2500e-006</CTcor>
    <!-- WBOTC not applicable unless ConductivityType = 1. -->
    <WBOTC>0.00000000e+000</WBOTC>
  </Coefficients>
  <Slope>1.00000000</Slope>
  <Offset>0.00000</Offset>
</ConductivitySensor>
```

Sea-Bird Electronics, Inc.

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Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 4624
CALIBRATION DATE: 06-Oct-16

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

COEFFICIENTS:

```
g =  -9.84048254e+000
h =   1.44191703e+000
i =  -4.24710763e-003
j =   3.90992198e-004

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

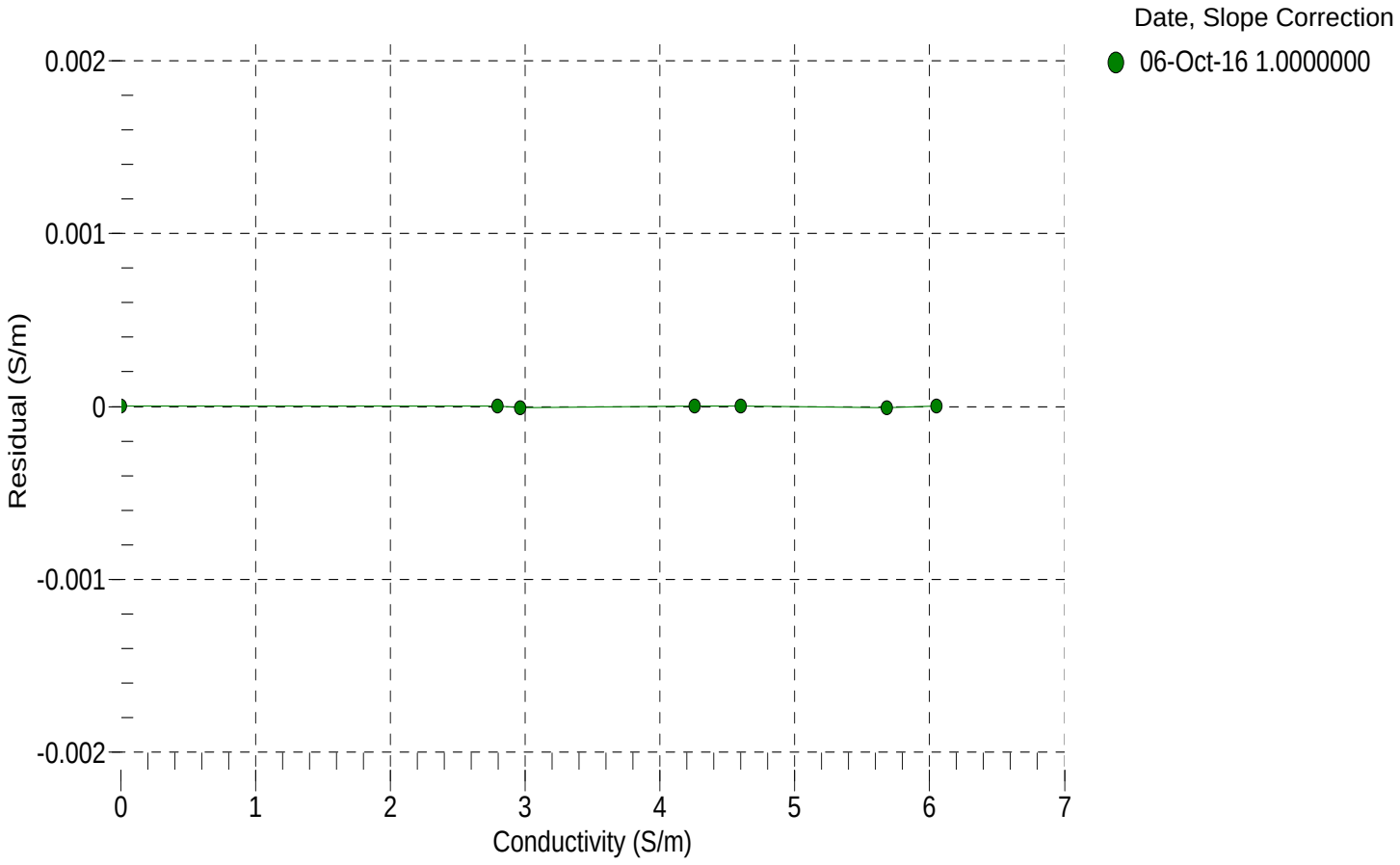
BATH TEMP (° C)	BATH SAL (PSU)	BATH COND (S/m)	INSTRUMENT OUTPUT (kHz)	INSTRUMENT COND (S/m)	RESIDUAL (S/m)
0.0000	0.0000	0.00000	2.62007	0.00000	0.00000
-1.0000	34.6648	2.79351	5.13894	2.79351	0.00000
0.9999	34.6658	2.96432	5.25389	2.96431	-0.00001
15.0000	34.6673	4.25526	6.05197	4.25527	0.00000
18.5000	34.6675	4.60075	6.24811	4.60076	0.00000
29.0000	34.6672	5.68064	6.82442	5.68063	-0.00001
32.5000	34.6625	6.05220	7.01158	6.05220	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



Sea-Bird Electronics, Inc.
13431 NE 20th St. Bellevue, Washington 98005 USA
www.seabird.com
Phone: (425) 643-9866
Fax: (425) 643-9954
Email: seabird@seabird.com

Pressure Test Certificate

Test Date: 03/17/16

Description: SBE-4 Conductivity Sensor

Sensor Information:

Model Number: 04

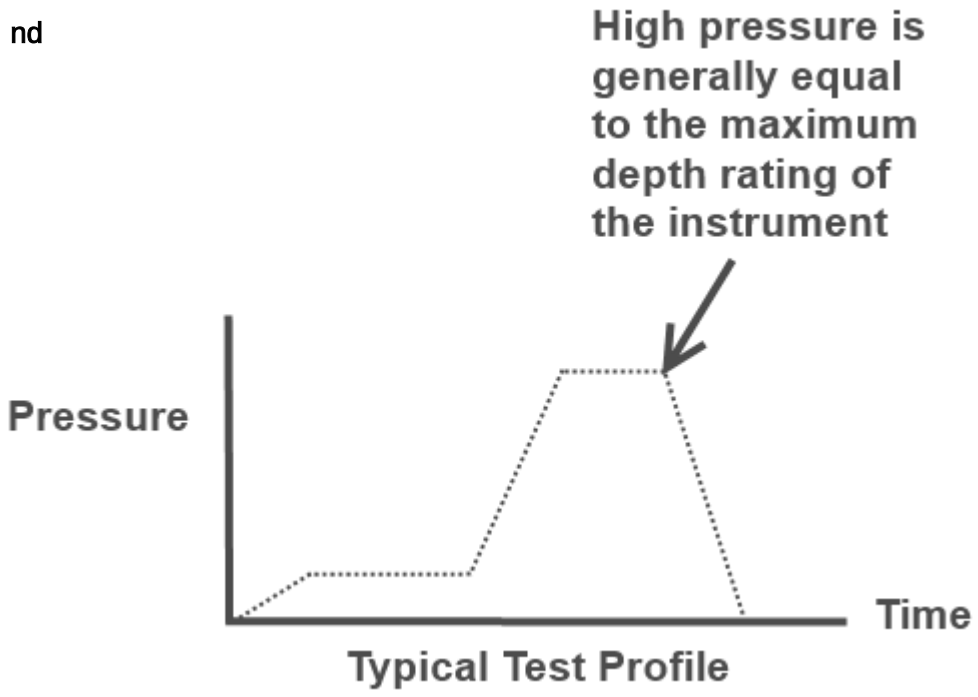
Serial Number: 4624

Pressure Test Protocol:

Low Pressure Test:	40	PSI	Held For:	15	Minutes
High Pressure Test:	10000	PSI	Held For:	15	Minutes

Passed Test: Yes

Tested By: nd



Typical Test Profile

Calibration Record

Date: January 27, 2015
Sensor Type: Seapoint Chlorophyll Fluorometer
Serial Number(s): 3120

A comparative calibration was performed using a calibrated reference fluorometer. The reference fluorometer was calibrated with the cultured algae Isochrysis galbana.

This Seapoint Chlorophyll Fluorometer meets or exceeds the specifications stated in the supplied User Manual.

If you have any questions please contact me at 603/642-4921 or seapoint@seapoint.com

01/27/15

Signature Date

Seapoint Sensors, inc.
PO Box 368 • Exeter, NH 03833 • USA
Tel: (603) 642-4921 • Fax: (603) 642-4922
seapoint@seapoint.com • www.seapoint.com

Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA

Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 6146
CALIBRATION DATE: 19-Apr-17

SBE 3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

COEFFICIENTS:

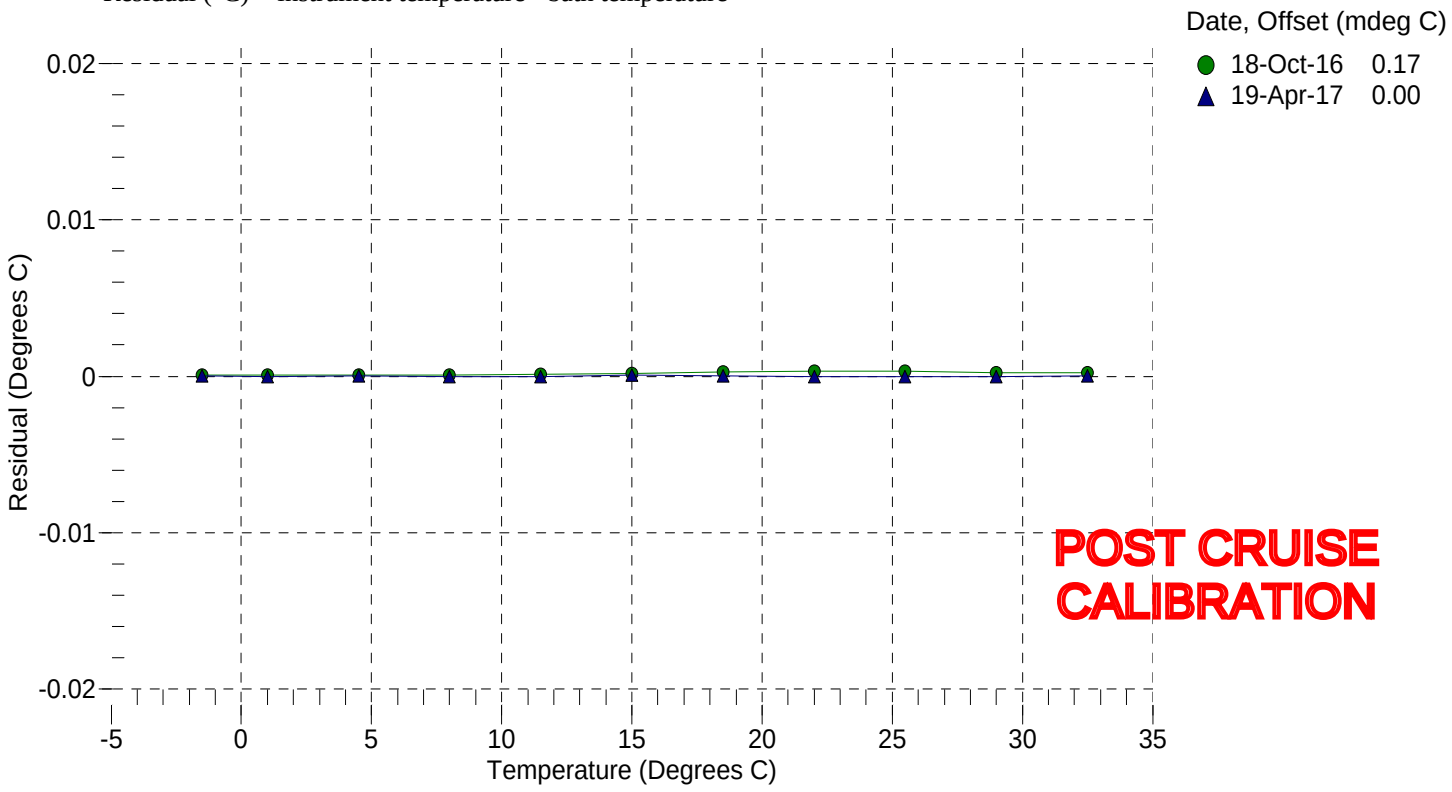
```
g =  4.35638771e-003
h =  6.36803077e-004
i =  2.20028262e-005
j =  2.02138975e-006
f0 =  1000.0
```

BATH TEMP (° C)	INSTRUMENT OUTPUT (Hz)	INST TEMP (° C)	RESIDUAL (° C)
-1.5000	2997.266	-1.5000	0.00002
1.0000	3171.244	1.0000	-0.00002
4.5000	3426.956	4.5000	0.00001
8.0000	3697.194	8.0000	-0.00004
11.5000	3982.370	11.5000	-0.00000
15.0000	4282.870	15.0001	0.00007
18.5000	4599.058	18.5000	0.00001
22.0001	4931.323	22.0001	-0.00002
25.5000	5279.991	25.5000	-0.00002
29.0001	5645.439	29.0001	-0.00003
32.5000	6027.961	32.5000	0.00003

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



Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA

Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 4624
CALIBRATION DATE: 19-Apr-17

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

COEFFICIENTS:

```
g =  -9.85244329e+000
h =   1.44409827e+000
i =  -4.52452600e-003
j =   4.04701891e-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	2.62025	0.00000	0.00000
-1.0000	34.7511	2.79981	5.14202	2.79979	-0.00002
1.0000	34.7513	2.97094	5.25709	2.97097	0.00003
15.0000	34.7517	4.26453	6.05587	4.26452	-0.00001
18.5000	34.7505	4.61058	6.25211	4.61056	-0.00002
29.0000	34.7423	5.69156	6.82843	5.69161	0.00005
32.5001	34.7269	6.06217	7.01489	6.06214	-0.00003

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