



PRESSURE TRANSDUCER CALIBRATION DATA

<i>Customer</i> TELEDYNE BENTHOS	<i>Date</i> 22 DEC 20
<i>Model Number</i> 141698-2000A	<i>Serial Number</i> 126620

<i>Diaphragm Materials</i> TITANIUM	<i>Excitation</i> 5 VDC	<i>Pressure Range</i> 2000 PSIA	<i>Excitation Type</i> Constant Voltage
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Pressure Calibration Data all readings are in mV DC						<i>Date of Pressure Calibration</i> 9 SEP 20
Pressure	Increase	Decrease	Ideal	Linearity (%FS)	Hysteresis (%FS)	<i>STATIC ERROR BAND</i> ± .10% FS BFSL
0 PSIA	.50	.54	.50		.04%	
1000 PSIA	49.23	49.23	49.03	.21%	0.00%	
2000 PSIA	97.56		97.56			
SENSITIVITY	97.06					

Thermal Calibration Data all readings are in mV DC						<i>Date of Thermal Calibration</i> 9 SEP 20
	Low Temp.	Ambient	High Temp	Temperature Range	Thermal Balance Shift	Thermal Sensitivity Shift
Temperature	35 °F	75 °F	75 °F			
0 PSIA	.40	.55	.55	35°F to 75°F	.15%FS	-1.07%FS
2000 PSIA	98.45	97.56	97.57	75°F to 75°F	0.00%FS	.01%FS
Sensitivity	98.05	97.01	97.02	AVERAGE	± .002% FS/°F	± .013% FS/°F

Notes	<div style="text-align: center;"> <p>DATE OF LAST MEASUREMENT: 16 SEP 20</p> <p>BALANCE OUTPUT: .40 mV DC</p> </div> <div style="text-align: center; margin-top: 20px;"> </div> <div style="margin-top: 20px;"> <p>INPUT RESISTANCE 1121 Ohms</p> <p>OUTPUT RESISTANCE 738 Ohms</p> </div>
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<i>Data Entered and Reviewed By</i> THARIN THAV	<i>Date Data Entered</i> 22 December 2020
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Program Version: 5.1.1

Product: Oxygen Optode 4831IW

Serial No: 910

Visual and Mechanical Checks:

- 1.1 Soldering quality
- 1.2 Visual surface
- 1.3 Galvanic isolation between housing and electronics

Current Drain and Voltages:

2.1 Average current drain at 0.5 Hz sampling (Max.: 33 mA)	23.6	mA
2.2 CANBus Current drain at 0.5 Hz sampling (Max.: 33 mA)		mA
2.3 Current drain in sleep (Max.: 270 μ A)	229	μ A
2.4 CANBus Current drain in sleep (Max.: 180 μ A)		μ A
2.5 DSP IO voltage, J4.18 (3.3 ± 0.15 V)	3.31	V
2.6 DSP Core voltage, J4.17 (1.8 ± 0.05 V)	1.81	V
2.7 Excitation driver voltage, C4 Analog Board (4.3 ± 0.1 V)	4.33	V

Performance test:

	Channel:	Blue	Red
3.1 Average of Receiver readings (0 ± 150 mV)		-12.2 mV	-8.5 mV
3.2 Standard Deviation of Receiver readings (Max.: 45mV/10mV)		1.72 mV	0.30 mV
3.3 Amplitude measurement with non-fluorescence foil (<60mV/650-1200mV)		10 mV	919 mV
3.4 CANBus Output test			

Function test from 0 to 40°C:

	Channel:	Blue	Red
4.1 Minimum amplitude measurement (Blue: >550 mV, Red >550 mV)		708.4 mV	692.7 mV
4.2 Maximum amplitude measurement (Blue: <1600 mV, Red <1400 mV)		1114.3 mV	1074 mV
4.3 Minimum phase measurement (Blue: >32°, Red: >3°)		33.98 °	7.59 °
4.4 Maximum phase measurement (Blue: <45°, Red: <10°)		41.02 °	8.42 °
4.5 Maximum standard deviation of Phase measurement: (< 0.07°)		0.05 °	0.03 °
4.6 Minimum temperature raw data measurement: (<-200 mV)			-469.2 mV
4.7 Maximum temperature raw data measurement: (>450 mV)			757.5 mV

Date: 13 Jul 2020

Sign:



Vidar Selsvik, Production Engineer



PRESSURE CERTIFICATE

Form No. 667, Sept 2009

Product: Oxygen Optode 4831IW
Serial No: 910
Date: 29.06.2020

Certificate No: 173003260910

This is to certify that this product has been pressure tested with the following instrument, and we confirm that no irregularities were found during the test:

Autoklav 800 bar – sn: 0210005

Pressure readings:

Pressure (Bar)	Pressure time (hour)
300	1

Date: 13 Jul 2020

Sign:

Vidar Selsvik, Production Engineer



a xylem brand

CALIBRATION CERTIFICATE

Form No 830, Juli 2012

Certificate no: 4831_910_00180295
Foil batch no: 1824M

Product: 4831
Calibration date: 08.01.2021

Serial no: 910
Page 1 of 2

Index	Temperature reference(°C)	[O2] Reference(µM)	Temperature raw data(mV)	Phase reading(°)
0	30.189	1.92	-124.493	58.26
1	19.993	1.13	207.120	59.36
2	10.144	0.88	529.440	60.13
3	0.820	0.78	812.440	60.77
4	0.804	19.12	812.913	58.46
5	0.790	41.76	813.313	55.88
6	0.780	63.66	813.600	53.65
7	0.770	108.16	813.887	49.72
8	0.761	150.22	814.107	46.63
9	0.754	218.06	814.300	42.59
10	0.748	329.36	814.500	37.65
11	0.744	433.03	814.600	34.27
12	0.740	544.21	814.733	31.50
13	10.452	15.35	519.513	57.45
14	10.358	32.63	522.513	54.68
15	10.291	50.08	524.673	52.21
16	10.233	83.79	526.527	48.13
17	10.192	118.95	527.833	44.67
18	10.154	169.15	529.073	40.74
19	10.125	255.85	529.980	35.77
20	10.103	338.43	530.700	32.40
21	10.088	426.94	531.173	29.69
22	20.373	12.44	194.427	56.40
23	20.317	25.98	196.287	53.38
24	20.277	39.93	197.607	50.66
25	20.246	67.32	198.673	46.22
26	20.223	93.95	199.427	42.77
27	20.202	133.84	200.113	38.73
28	20.187	200.77	200.600	33.88
29	20.179	271.85	200.900	30.32
30	20.173	336.84	201.053	27.94
31	30.248	10.37	-126.420	55.34
32	30.288	21.00	-127.680	52.17
33	30.330	32.11	-128.987	49.28
34	30.365	54.45	-130.113	44.55
35	30.399	76.23	-131.173	40.94
36	30.428	109.26	-132.060	36.77
37	30.457	162.76	-132.953	32.05
38	30.463	222.84	-133.180	28.51
39	30.467	279.42	-133.293	26.13

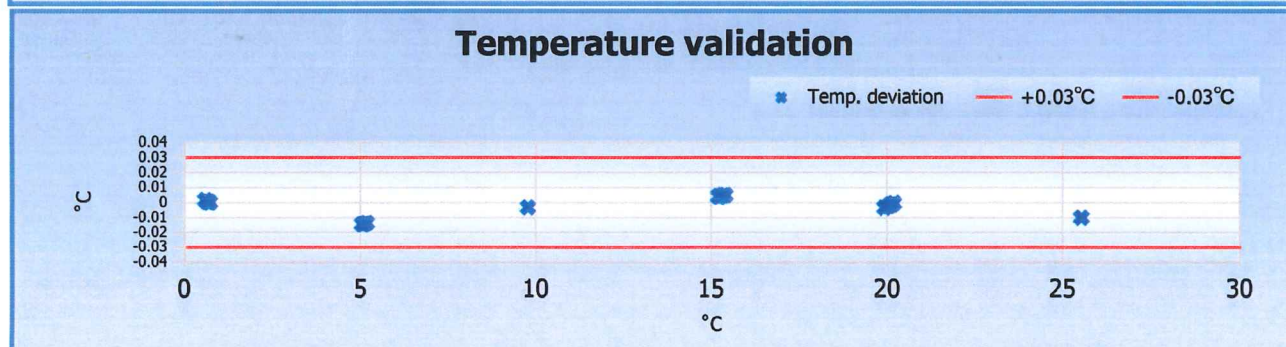
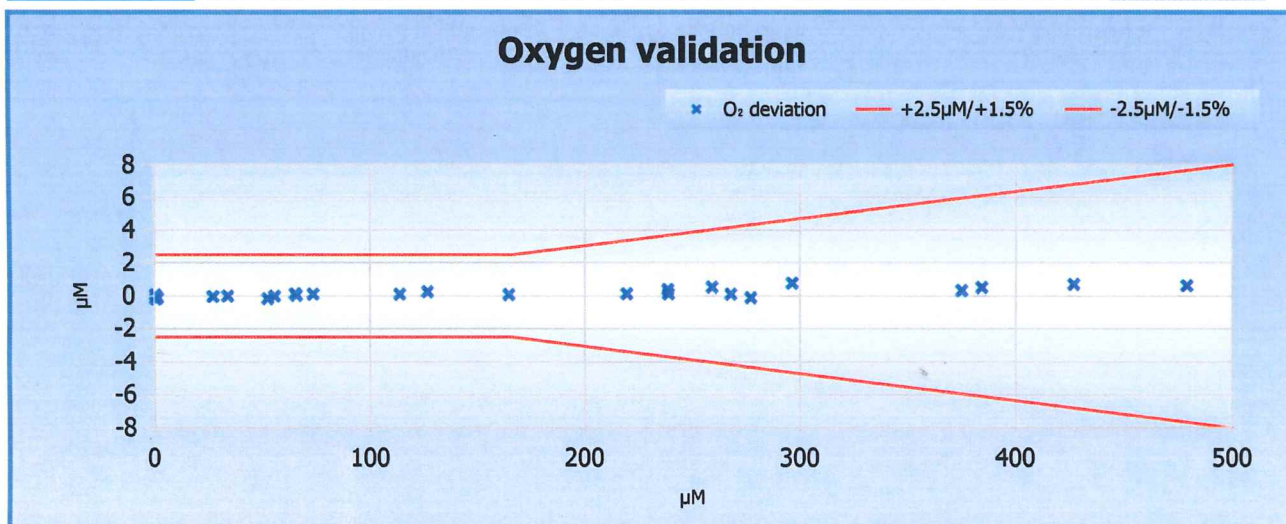
Certificate no: 4831_910_00180295
Foil batch no: 1824M

Product: 4831
Calibration date: 08.01.2021

Serial no: 910
Page 2 of 2

Giving these coefficients

Index	0	1	2	3	4	5	6
SVUFoilCoef	2.62307E-03	1.07671E-04	2.30850E-06	1.83919E02	-2.43517E-01	-4.00488E01	3.72055E00
TempCoef	2.62898E01	-3.08512E-02	3.05387E-06	-4.51456E-09	0.00000E00	0.00000E00	



With following settings

Index	0	1	2	3
PhaseCoef	-7.56000E-01	1.00000E00	0.00000E00	0.00000E00

Index	0 (Offset)	1 (Slope)
ConcCoef	0.00000E00	1.00000E00

Salinity	0.00
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Firmware Version	5.1.1
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Date:08.01.2021

Tor-Ove Kvalvaag

Tor-Ove Kvalvaag, Calibration Engineer

Pressure Calibration Certificate

RBRlegato³ C.T.D, Teledyne Webb Slocum, dry bay (1000dbar) s/n: 207227

Instrument rating: 1,000 dbar s/n: M100163

Nominal accuracy: 0.05%FS (0.5 dbar)

Reference instrument: Mensor CPC6050 s/n: 41000CAM

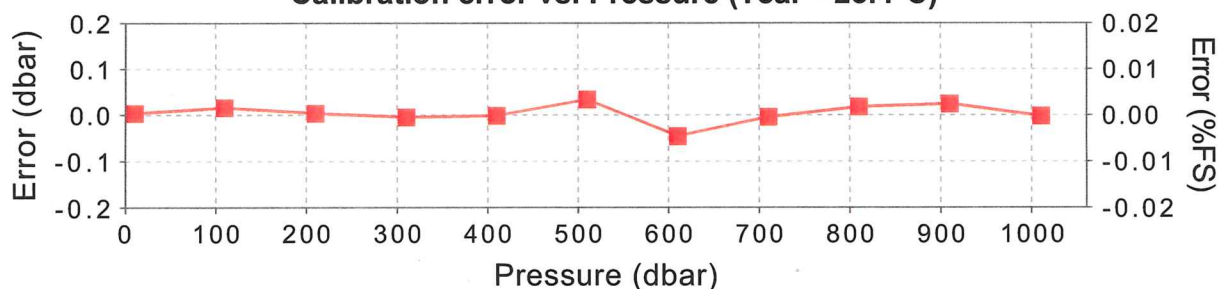
Applied pressure, P _{app} (dbar)	Voltage ratio, V	Measured pressure, P _c (dbar)	Calibration error (dbar)	Coefficients
10.189	0.018121	10.1930	0.0038	C0: -33.16552
110.000	0.059587	110.0159	0.0159	C1: 2.405024E3
209.997	0.101082	210.0004	0.0034	C2: 33.25079
309.999	0.142548	309.9941	-0.0049	C3: -35.869003
409.998	0.183992	409.9963	-0.0017	X0: 10.1892
510.002	0.225431	510.0362	0.0342	X1: 57.555284E-3
610.000	0.266808	609.9541	-0.0459	X2: -8.652275E-6
709.992	0.308224	709.9878	-0.0042	X3: -567.13947E-9
810.006	0.349643	810.0240	0.0180	X4: -145.4078E-6
910.003	0.391053	910.0274	0.0244	X5: 23.387949
1009.990	0.432457	1009.9877	-0.0023	

$$P_c = X_0 + \frac{P_m - X_0 - X_1(T - X_5) - X_2(T - X_5)^2 - X_3(T - X_5)^3}{1 + X_4(T - X_5)}$$

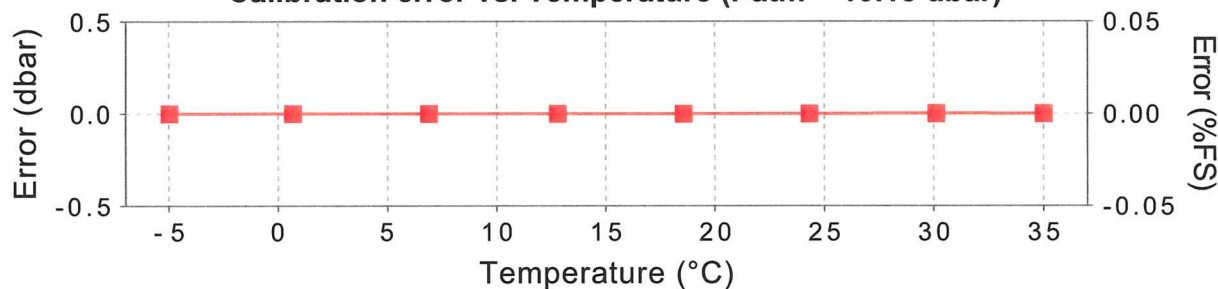
Head (mm) = 244

$$P_m = C_0 + C_1V + C_2V^2 + C_3V^3$$

Calibration error vs. Pressure (Tcal = 23.4°C)



Calibration error vs. Temperature (P_{atm} = 10.18 dbar)



Calibration Date: 2021-05-20

Issue Date: 2021-05-20

File Name: 207227_20210520_1323P.rsk

Operator:

Adam Fulin
afalicki

Approver:

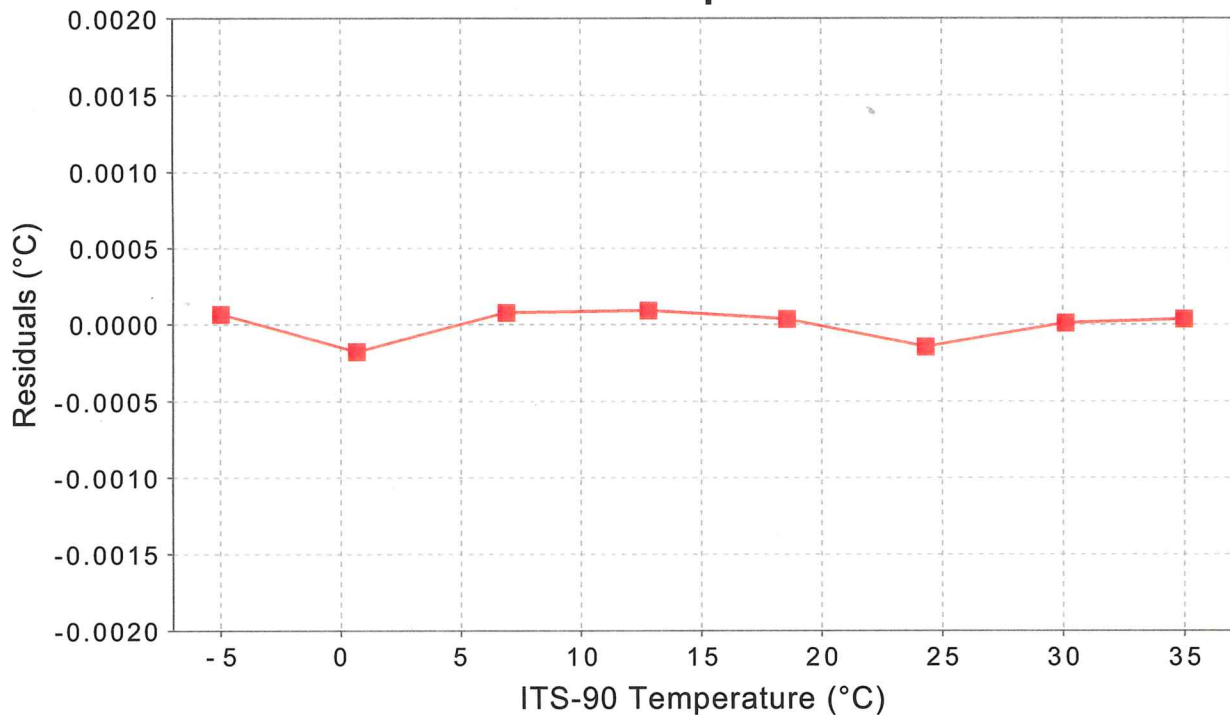
Kmalorny
kmalorny

Temperature Calibration Certificate

Logger ID: RBRlegato³ Serial No: 207227 Channel No: 2

Reference Temperature, ITS-90	Voltage ratio, V	Measured Temperature, ITS-90	Calibration error	Coefficients	
-4.97448	0.701956	-4.97442	0.00007	C0:	3.5127292E-3
0.67084	0.635001	0.67066	-0.00018	C1:	-250.1528E-6
6.89722	0.557668	6.89730	0.00008	C2:	2.488352E-6
12.80501	0.484328	12.80510	0.00009	C3:	-90.727404E-9
18.57351	0.415752	18.57355	0.00004		
24.31879	0.352666	24.31865	-0.00014		
30.11367	0.295712	30.11368	0.00001		
34.99951	0.253371	34.99954	0.00004		

Residuals vs. Temperature



Calibration Date: 2021-05-18
Issue Date: 2021-05-20
Calibration ID: 46704

Operator:

Adam Fulin
afalicki

Approver:

K. Malorny
kmalorny

Conductivity Calibration Certificate

RBRlegato³ C.T.D, Teledyne Webb Slocum, dry bay (1000dbar) s/n: 207227

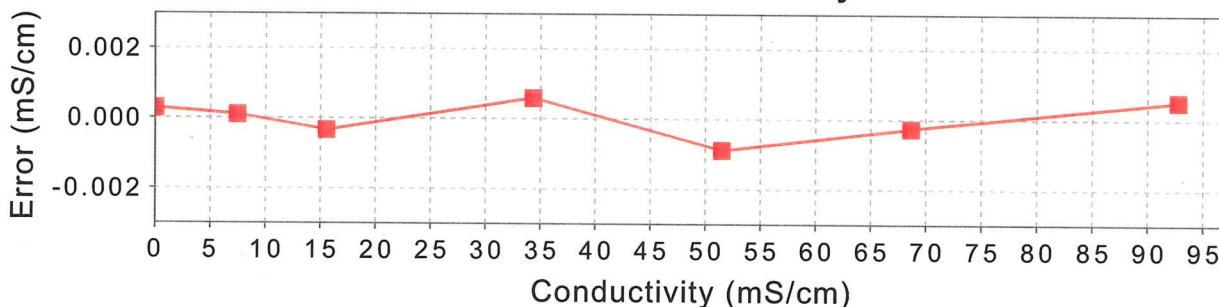
References: Autosal8400B#66289, MS-315#15506, SSW P163, RC#002

Reference Resistance (ohm)	Reference Conductivity (mS/cm)	Voltage Ratio, V	Measured Conductivity (mS/cm)	Calibration Error (mS/cm)	Coefficients	
open	0.0000	-0.000200	0.0003	0.0003	C0:	38.249377E-3
694.042	7.4186	0.038866	7.4187	0.0001	C1:	189.8949
331.926	15.5120	0.081484	15.5117	-0.0003	(K) C2:	1.001942
150.019	34.3212	0.180540	34.3218	0.0006	X0:	762.39085E-6
100.016	51.4804	0.270893	51.4795	-0.0009	X1:	-16.255424E-6
75.023	68.6298	0.361207	68.6295	-0.0003	X2:	0.0
55.520	92.7392	0.488173	92.7397	0.0005	X3:	0.0
					X4:	0.0
					X5:	15.010555
					X6:	10
Bath	Voltage Ratio	Temperature (ITS-90)	Salinity (PSS-78)	Conductivity (mS/cm)		
T15S35	0.2258099	15.01055	34.9913	42.9184		
T25S35	0.2878612	26.54702	35.0071	54.7031		

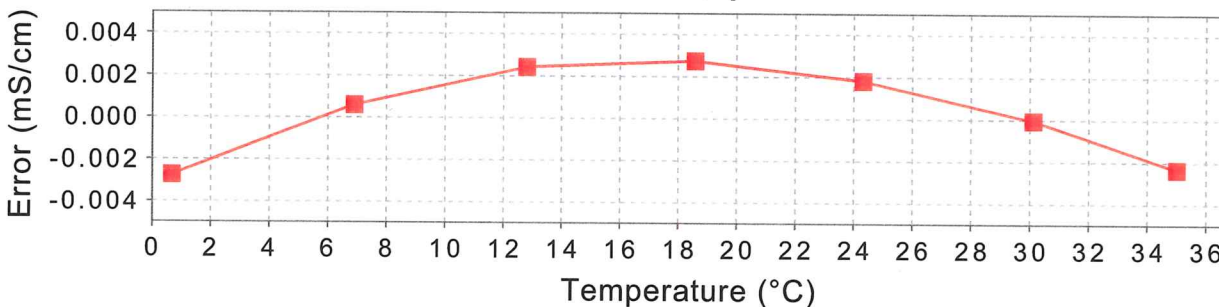
Cell Constant @T15S35 = 5.14883 1/cm

$$C_c = \frac{C_0 + C_1 * C_2 * V - X_0 * (T - X_5)}{1 + X_1 * (T - X_5) + X_2 * (P - X_6) + X_3 * (P - X_6)^2 + X_4 * (P - X_6)^3}$$

Calibration error vs. Conductivity



Calibration error vs. Temperature



Calibration Date: 2021-05-26

Issue Date: 2021-05-26

File Name: 207227_20210526_1425C.rsk

Operator:

Jeff Walker

jwalker

Approver:

[Signature]

kmalorny

Biospherical Instruments Inc.

CALIBRATION CERTIFICATE

Calibration Date 08/17/20
Model Number QSP2155 Firmware Version v 1.2
Serial Number 50340
Operator TPC
Standard Lamp V-040(1/3/19)
Sensor Operating Voltage Range: 6 to 15 VDC (+)
Output Polarity: Positive

A=125

Sensor Output Voltage:

Sensor Illuminated	<u>169.5</u>	mV
Sensor Dark	<u>10.3</u>	mV
Sensor Net Response	<u>159.1</u>	mV
RG780	<u>10.4</u>	mV

Corrected Lamp Output:

Output In Air (same condition as calibration):

1.561E-02 uE/cm²sec

Output Corrected for Immersion in Water: Using Immersion Coefficient of:

2.756E-02 uE/cm²sec 0.5664 (Collector Type: SC-3)

Calibration Scale Factor:

(To calculate irradiance, divide the net voltage reading in Volts by this value.)

Dry:	1.019E+01 Volts/(uE/cm ² sec)
Wet:	5.773E+00 Volts/(uE/cm ² sec)
Dry:	1.019E-03 Volts/(uE/m ² sec)
Wet:	5.773E-04 Volts/(uE/m ² sec)

Notes:

1. Annual calibration is recommended.
2. Calibration is performed using a Standard of Spectral Irradiance traceable to the National Institute of Standards and Technology (NIST).
3. To approximate the sensor's saturating irradiance, multiply the calibration factor by the sensor power supply voltage, minus one volt.
4. The collector should be cleaned frequently with alcohol.

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620 Applegate St.
Philomath, OR 97370



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

ECO Chlorophyll Fluorometer Characterization Sheet

Date: 3/18/2021

S/N: FLBBCDSLC-6745

Chlorophyll concentration expressed in $\mu\text{g/l}$ can be derived using the equation:

$$\text{CHL } (\mu\text{g/l}) = \text{Scale Factor} * (\text{Output} - \text{Dark counts})$$

	Digital
Dark counts	77 counts
Scale Factor (SF)	0.0073 $\mu\text{g/l/count}$
Maximum Output	4130 counts
Resolution	1.2 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: $\text{SF} = x \div (\text{output} - \text{dark counts})$, 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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www.wetlabs.com

ECO CDOM Fluorometer Characterization Sheet

Date: 3/18/2021

S/N: FLBBCDSLC-6745

CDOM concentration expressed in ppb can be derived using the equation:

$$\text{CDOM (ppb)} = \text{Scale Factor} * (\text{Output} - \text{Dark Counts})$$

	Digital
Dark Counts	49 counts
Scale Factor (SF)	0.0890 ppb/count
Maximum Output	4130 counts
Resolution	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: $SF = x \div (\text{output} - \text{dark counts})$, 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.