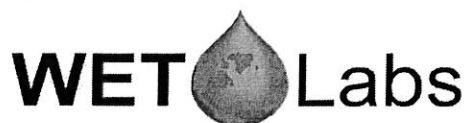


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Volume Scattering Function Calibration Sheet

Date: 1/31/2011
Wavelength: 700

S/N: VSFSLK-147

Use the following equation to obtain "scaled" output values for 100-, 125-, and 150-degree measurement angles:

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

• Scale Factor for 660 nm	100°	=	4.820E-06 (m ⁻¹ sr ⁻¹)/counts	
	125°	=	3.527E-06 (m ⁻¹ sr ⁻¹)/counts	
	150°	=	3.006E-06 (m ⁻¹ sr ⁻¹)/counts	
• Output	100°	=	meter reading counts	
	125°	=	meter reading counts	
	150°	=	meter reading counts	
• Dark Counts	100°	=	49 counts	
	125°	=	50 counts	
	150°	=	40 counts	
Instrument Resolution	100°	=	1.2 counts	5.55E-06 (m ⁻¹ sr ⁻¹)
	125°	=	1.2 counts	4.33E-06 (m ⁻¹ sr ⁻¹)
	150°	=	1.0 counts	2.74E-06 (m ⁻¹ sr ⁻¹)

Definitions:

- **Scale Factor:** Calibration scale factor $\beta(\theta_c)/\text{counts}$. Refer to User's Guide for derivation.
- **Output:** Measured signal output of the VSF 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.

SEA-BIRD ELECTRONICS, INC.

1808 136th Place N.E., Bellevue, Washington, 98005 USA

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

SENSOR SERIAL NUMBER: 0140
CALIBRATION DATE: 20-Jun-08

WEBB GLIDER PRESSURE CALIBRATION DATA
508 psia S/N 2616334

COEFFICIENTS:

PA0 = 3.237342e-003
PA1 = 2.382803e-002
PA2 = 3.375335e-009
PTHA0 = -6.566415e+001
PTHA1 = 4.932352e-002
PTHA2 = 2.722763e-007

PTCA0 = 6.408814e+000
PTCA1 = 2.884733e-001
PTCA2 = -1.098527e-002
PTCB0 = 2.643413e+001
PTCB1 = -1.575000e-003
PTCB2 = 0.000000e+000

PRESSURE SPAN CALIBRATION

PRESSURE PSIA	INST OUTPUT	THERMISTOR OUTPUT	COMPUTED PRESSURE	ERROR %FSR
14.60	618.8	1835.4	14.62	0.00
112.88	4740.7	1837.1	113.06	0.04
210.74	8822.2	1838.6	210.65	-0.02
309.07	12931.2	1838.3	309.02	-0.01
407.44	17036.0	1840.1	407.40	-0.01
505.61	21132.3	1841.1	505.68	0.01
407.47	17038.4	1841.2	407.45	-0.00
309.16	12933.9	1844.1	309.09	-0.01
211.01	8840.8	1845.4	211.10	0.02
112.40	4715.1	1847.0	112.45	0.01
14.59	611.3	1847.4	14.44	-0.03

THERMAL CORRECTION

TEMP ITS90	PRESS TEMP	INST OUTPUT
32.50	1969.40	621.19
29.00	1898.60	622.38
24.00	1799.70	623.68
18.50	1690.70	624.76
15.00	1621.50	625.45
4.50	1411.10	624.37
1.00	1341.80	623.52

TEMP (ITS90)	SPAN (mV)
-5.00	26.44
35.00	26.38

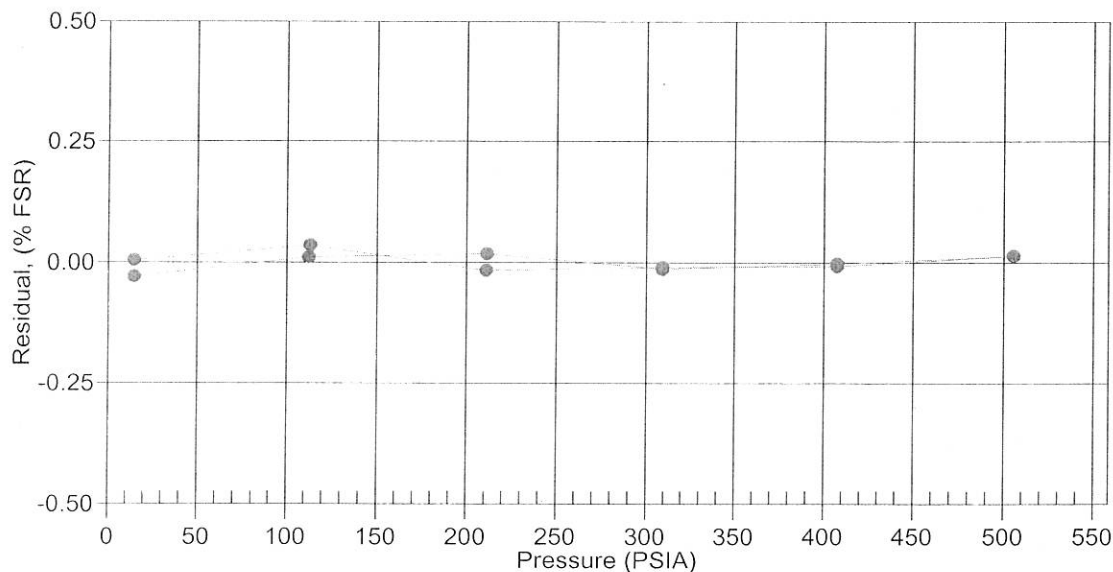
$$y = \text{thermistor output}; t = P\text{TEMPA}0 + P\text{TEMPA}1 * y + P\text{TEMPA}2 * y^2$$

$$x = \text{pressure output} - PTCA0 - PTCA1 * t - PTCA2 * t^2$$

$$n = x * PTCB0 / (PTCB0 + PTCB1 * t + PTCB2 * t^2)$$

$$\text{pressure (psia)} = PA0 + PA1 * n + PA2 * n^2$$

Date, Avg Delta P %FS



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

SENSOR SERIAL NUMBER: 0140
CALIBRATION DATE: 08-Aug-08

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

COEFFICIENTS:

g = -1.006574e+000
h = 1.571895e-001
i = -3.643381e-004
j = 5.212950e-005

CPcor = -9.5700e-008
CTcor = 3.2500e-006
WBOTC = -3.6152e-007

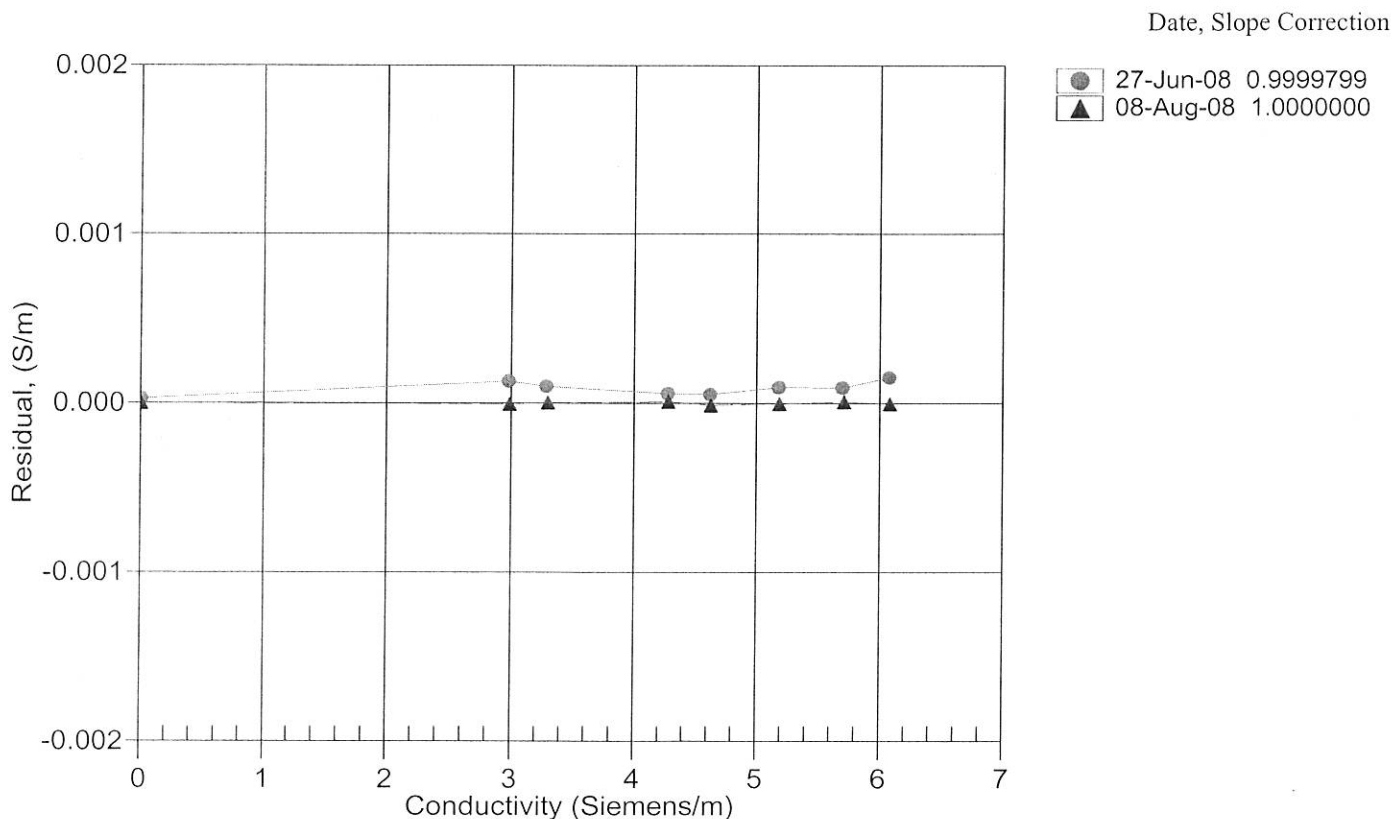
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2535.29	0.00000	0.00000
1.0000	34.9408	2.98559	5047.77	2.98559	-0.00000
4.5000	34.9206	3.29359	5238.36	3.29360	0.00000
15.0000	34.8778	4.27836	5805.15	4.27837	0.00001
18.4999	34.8690	4.62459	5991.42	4.62458	-0.00001
24.0000	34.8592	5.18430	6280.60	5.18430	-0.00000
29.0000	34.8541	5.70781	6539.18	5.70782	0.00001
32.5000	34.8516	6.08145	6717.45	6.08144	-0.00000

$$f = \text{INST FREQ} * \sqrt{1.0 + \text{WBOTC} * t} / 1000.0$$

$$\text{Conductivity} = (g + hf^2 + if^3 + jf^4) / (1 + \delta t + \epsilon p) \text{ Siemens/meter}$$

t = temperature[°C]; p = pressure[decibars]; δ = CTcor; ϵ = CPcor;

Residual = instrument conductivity - bath conductivity



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SENSOR SERIAL NUMBER: 0140
CALIBRATION DATE: 08-Aug-08

WEBB GLIDER TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

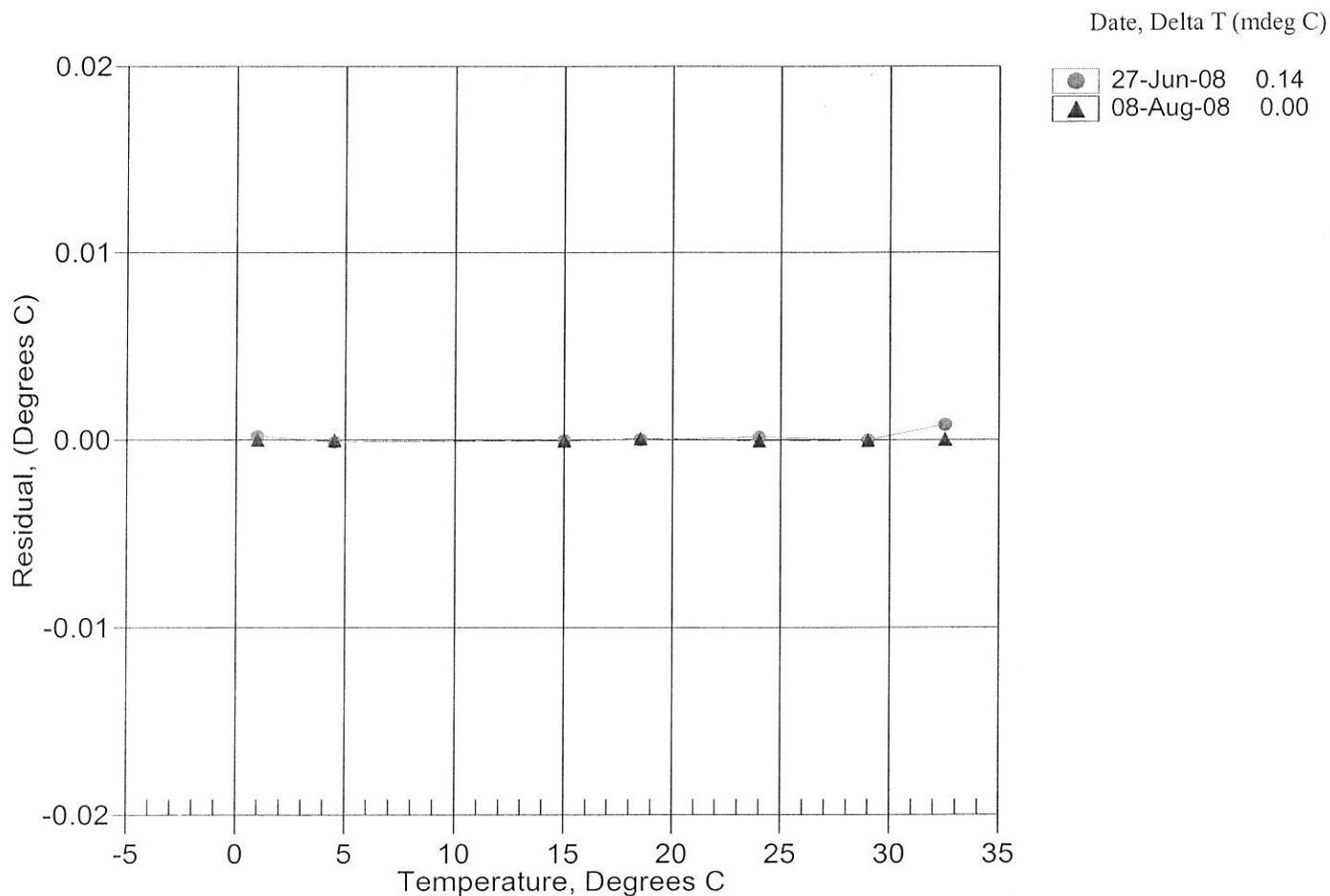
ITS-90 COEFFICIENTS

a0 = 2.096809e-005
a1 = 2.669692e-004
a2 = -1.941781e-006
a3 = 1.355572e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	846216.9	1.0000	0.0000
4.5000	721804.0	4.5000	-0.0000
15.0000	456893.4	15.0000	-0.0000
18.4999	394763.3	18.5000	0.0001
24.0000	315640.9	24.0000	-0.0000
29.0000	259143.9	29.0000	-0.0000
32.5000	226483.2	32.5000	0.0000

Temperature ITS-90 = $1 / \{a_0 + a_1[\ln(n)] + a_2[\ln^2(n)] + a_3[\ln^3(n)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature





AANDERAA DATA INSTRUMENTS

TEST & SPECIFICATIONS

Form No. 712, Feb2006

Layout No: 1308E, 1299G
Circuit Diagram No: 0.88
Program Version: 3, Build: 11

Product: Oxygen Optode 5013W
Serial No: 1296

1. Visual and Mechanical Checks:

- 1.1. O-ring surface
- 1.2. Soldering quality
- 1.3. Visual surface
- 1.4. Pressure test (60MPa)
- 1.5. Galvanic isolation between housing and electronics

2. Current Drain and Voltages:

- | | |
|--|--------|
| 2.1. Average current drain at 0.5Hz sampling (Max: 38mA) | 31 mA |
| 2.2. Current drain in sleep (Max: 300µA) | 166 µA |
| 2.3. DSP voltage, IC5.1 (3.3 ±0.15V) | 3.31 V |
| 2.4. Excitation driver voltage, IC1.1 (3.3 ±0.15V) | 3.32 V |
| 2.5. Flash/RS232 driver voltage, IC7.4 (5 ±0.2V) | 5.08 V |

3. Receiver test:

- | | |
|--|---------|
| 3.1. Average of Receiver readings (0 ±50mV) | -3 mV |
| 3.2. Standard Deviation of Receiver readings (Max: 10mV) | 1.58 mV |

4. Performance Test in Air, 0°C Temperature:

- | | |
|--|-----------|
| 4.1. Amplitude measurement (Blue: 220 – 470mV) | 364.74 mV |
| 4.2. Phase measurement (Blue: 30 ±5) | 33.6 ° |
| 4.3. Standard deviation of Phase measurement: (Max: 0.02°) | 0.001 ° |
| 4.4. Temperature measurement: (700 ±300mV) | 707.91 mV |

5. Performance Test in Air, 20°C Temperature:

- | | |
|--|------------|
| 5.1. Amplitude measurement (Blue: 290 – 470mV) | 382.07 mV |
| 5.2. Phase measurement (Blue: 25 ±5°) | 28.7 ° |
| 5.3. Standard deviation of Phase measurement: (Max: 0.02°) | 0.010 ° |
| 5.4. Temperature measurement: (100 ±300mV) | -114.53 mV |

6. Performance Test in Air, 40°C Temperature:

- | | |
|--|------------|
| 6.1. Amplitude measurement (Blue: 320 – 500mV) | 370.84 mV |
| 6.2. Phase measurement (Blue: 22 ±5°) | 25.8 ° |
| 6.3. Standard deviation of Phase measurement: (Max: 0.02°) | 0.015 ° |
| 6.4. Temperature measurement: (-500 ±300mV) | -575.12 mV |

Date: 28 May 2010

Sign:

Vidar Selsvik, Production Engineer

AANDERAA DATA INSTRUMENTS AS



CALIBRATION CERTIFICATE

Form No. 710, Dec 2005

AANDERAA DATA INSTRUMENTS

Sensing Foil Batch No: 5009

Certificate No:

Product: Oxygen Optode 5013W

Serial No: 1296

Calibration Date: 27 May 2010

This is to certify that this product has been calibrated using the following instruments:

Parameter: Internal Temperature:

Calibration points and readings:

Temperature (°C)	1.12	11.98	23.97	35.87
Reading (mV)	681.17	323.33	-82.19	-450.17

Giving these coefficients

Index	0	1	2	3
TempCoef	2.14908E01	-2.98872E-02	2.72435E-06	-4.05390E-09

Parameter: Oxygen:

	O2 Concentration	Air Saturation
Range:	0-500 μM ¹⁾	0 - 120%
Accuracy ¹⁾ :	< $\pm 8\mu\text{M}$ or $\pm 5\%$ (whichever is greater)	$\pm 5\%$
Resolution:	< 1 μM	< 0.4%
Settling Time (63%):	< 25 seconds	

Calibration points and readings ²⁾:

	Air Saturated Water	Zero Solution (Na_2SO_3)
Phase reading (°)	3.18138E+01	6.55343E+01
Temperature reading (°C)	9.92926E+00	2.07673E+01
Air Pressure (hPa)	1.00556E+03	

Giving these coefficients

Index	0	1	2	3
PhaseCoef	-3.02587E00	1.14828E00	0.00000E00	0.00000E00

¹⁾ Valid for 0 to 2000m (6562ft) depth, salinity 33 - 37ppt

²⁾ The calibration is performed in fresh water and the salinity setting is set to: 0

Date: 28 May 2010

Sign:

Tor-Ove Kvalvaag, Calibration Engineer

AANDERAA DATA INSTRUMENTS AS



CALIBRATION CERTIFICATE

Form No. 621, Dec 2005

AANDERAA DATA INSTRUMENTS

Certificate No: 3853_5009_40331
Batch No: 5009

Product: O2 Sensing Foil PSt3 3853
Calibration Date: 2 June 2010

Calibration points and phase readings (degrees)

Calibration points and phase readings (degrees)						
Temperature (°C)		3.97	10.93	20.15	29.32	38.39
Pressure (hPa)		977.00	977.00	977.00	977.00	977.00
O2 in % of O2+N2	0.00	73.18	72.63	71.62	70.72	69.77
	1.00	68.01	67.02	65.42	63.92	62.31
	2.00	64.39	63.16	61.20	59.44	57.57
	5.00	55.80	54.16	51.76	49.56	47.45
	10.00	46.27	44.47	41.97	39.75	37.69
	20.90	35.09	33.38	31.14	29.24	27.56
	30.00	29.85	28.30	26.31	24.64	23.19

Giving these coefficients ¹⁾

Index	0	1	2	3
C0 Coefficient	4.53793E+03	-1.62595E+02	3.29574E+00	-2.79285E-02
C1 Coefficient	-2.50953E+02	8.02322E+00	-1.58398E-01	1.31141E-03
C2 Coefficient	5.66417E+00	-1.59647E-01	3.07910E-03	-2.46265E-05
C3 Coefficient	-5.99449E-02	1.48326E-03	-2.82110E-05	2.15156E-07
C4 Coefficient	2.43614E-04	-5.26759E-06	1.00064E-07	-7.14320E-10

¹⁾ Ask for Form No 621S when this O2 Sensing Foil is used in Oxygen Sensor 3830 with Serial Numbers lower than 184.

Date: 8/12/2010

Sign:

Tor-Ove Kvalvaag, Calibration Engineer

AANDERAA DATA INSTRUMENTS AS

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ECO CDOM Fluorometer Characterization Sheet

Date: 8/12/2010

S/N: FLBBCDSLK-1861

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

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

Dark Counts	Digital
Scale Factor (SF)	30 counts
Maximum Output	0.0893 ppb/count
Resolution	4130 counts
	1.4 counts
Ambient temperature during characterization	21.5 °C

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

SF: Determined using the following equation: $SF = x + (\text{output} - \text{dark counts})$, 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.

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Scattering Meter Calibration Sheet

8/16/2010

Wavelength: 700

S/N FLBBCDSLK-1861

Use the following equation to obtain "scaled" output values:

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

- **Scale Factor for 700 nm** = 1.728E-06 (m⁻¹sr⁻¹)/counts
- **Output** = meter reading counts
- **Dark Counts** = 33 counts

Instrument Resolution = 1.2 counts 2.07E-06 (m⁻¹sr⁻¹)

Definitions:

- **Scale Factor:** Calibration scale factor, $\beta(\theta_c)/\text{counts}$. 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: 8/16/2010

S/N: FLBBCDSLK-1861

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

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

Dark counts	Digital 44 counts
Scale Factor (SF)	0.0121 $\mu\text{g/l/count}$
Maximum Output	4130 counts
Resolution	1.2 counts
Ambient temperature during characterization	21.4 °C

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

SF: Determined using the following equation: $\text{SF} = x + (\text{output} - \text{dark counts})$, 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.