附件一

溫鹽深儀及附屬探針校正表

SEA-BIRD ELECTRONICS, INC.
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Digiquartz Pressure Calibration dP/dT Corrected Coefficients

(Changed coefficients are posted in italics)

Pressure Transducer Serial Number: 141819
Original Calibration Date: 30-Jan-18
Date of Correction: 2018-02-08
Installed in: SBE 9Plus S/N 1351

PRESSURE COEFFICIENTS

C1	*-45143.35*	*psia*
C2	*-0.8987726*	*psia/deg C*
C3	1.301220e-002	psia/deg C^2
D1	3.661800e-002	
D2	0.000000e+000	
T1	*30.02393*	*µsec*
T2	*-5.28071e-04*	*µsec/deg C*
T3	4.321780e-006	µsec/deg C^2
T4	-8.859620e-011	µsec/deg C^3
T5	0.000000e+000	

Slope = 1.0
Offset = 0.0

AD590M = 1.278720e-002
AD590B = -9.081240e+000

Corrected at Sea-Bird Electronics as per Paroscientific Calibration and Sea-Bird Electronics dP/dT tests. The original calibration from Paroscientific assumes an operating temperature range of 0 to 125 degrees C. dP/dT correction adjusts this operating range to a nominal range of 0 to 22 degrees C. This increases the accuracy of the transducer in this temperature range.

NOTE: Original coefficients from Paroscientific are attached to this form for informational purposes and should not be used.

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SENSOR SERIAL NUMBER: 6284
CALIBRATION DATE: 08-Feb-18

SBE 3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

COEFFICIENTS:

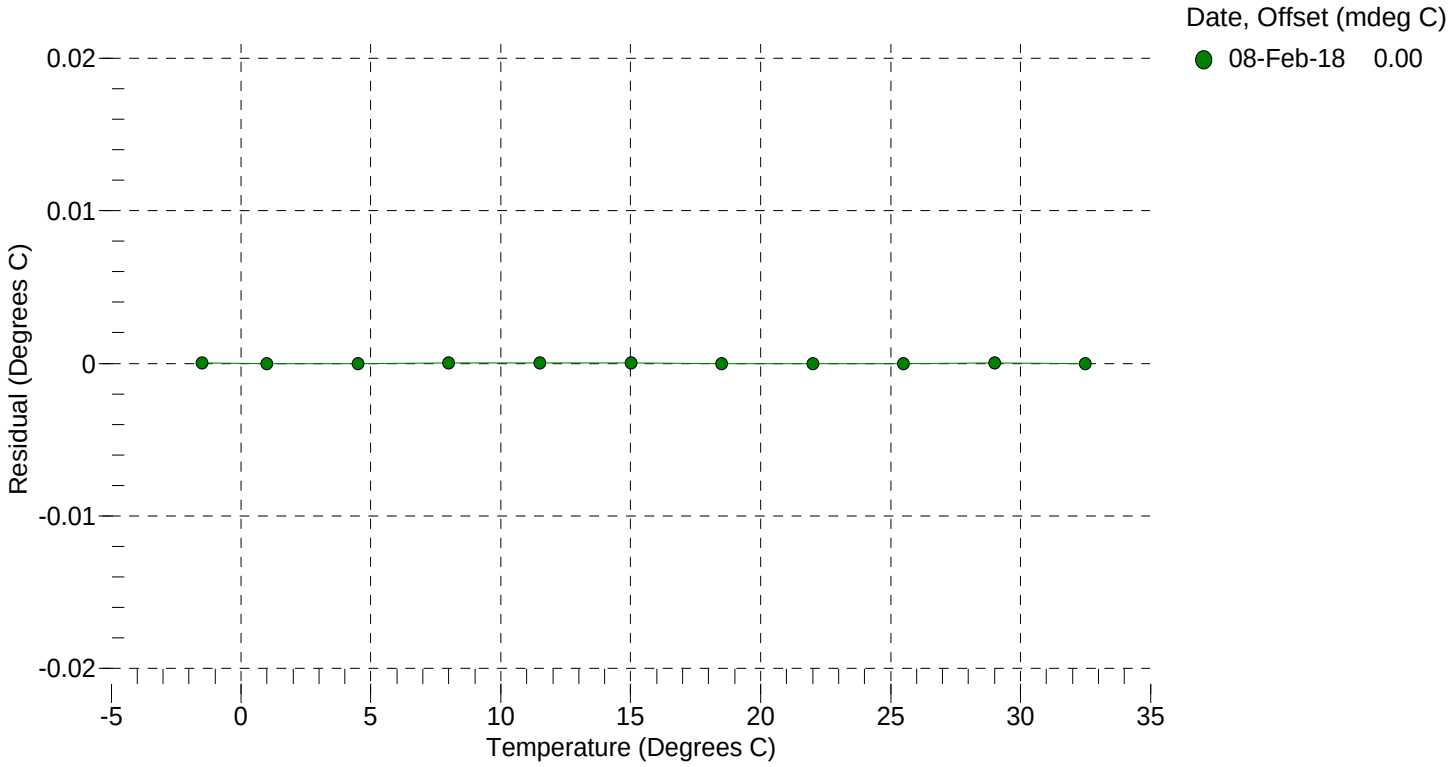
```
g =  4.34096627e-003
h =  6.33956920e-004
i =  2.17104420e-005
j =  1.97773688e-006
f0 =  1000.0
```

BATH TEMP (° C)	INSTRUMENT OUTPUT (Hz)	INST TEMP (° C)	RESIDUAL (° C)
-1.5000	2934.373	-1.5000	0.00001
1.0000	3105.208	1.0000	-0.00001
4.5001	3356.357	4.5001	-0.00002
8.0000	3621.831	8.0000	0.00001
11.5000	3902.048	11.5000	0.00003
15.0001	4197.395	15.0001	0.00000
18.5001	4508.239	18.5001	-0.00001
22.0001	4834.954	22.0001	-0.00002
25.5001	5177.898	25.5001	-0.00000
29.0000	5537.401	29.0000	0.00002
32.5000	5913.807	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: 4751
CALIBRATION DATE: 06-Feb-18

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

COEFFICIENTS:

```
g =  -1.01796669e+001
h =   1.31514169e+000
i =  -4.20995489e-004
j =   8.64698898e-005

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

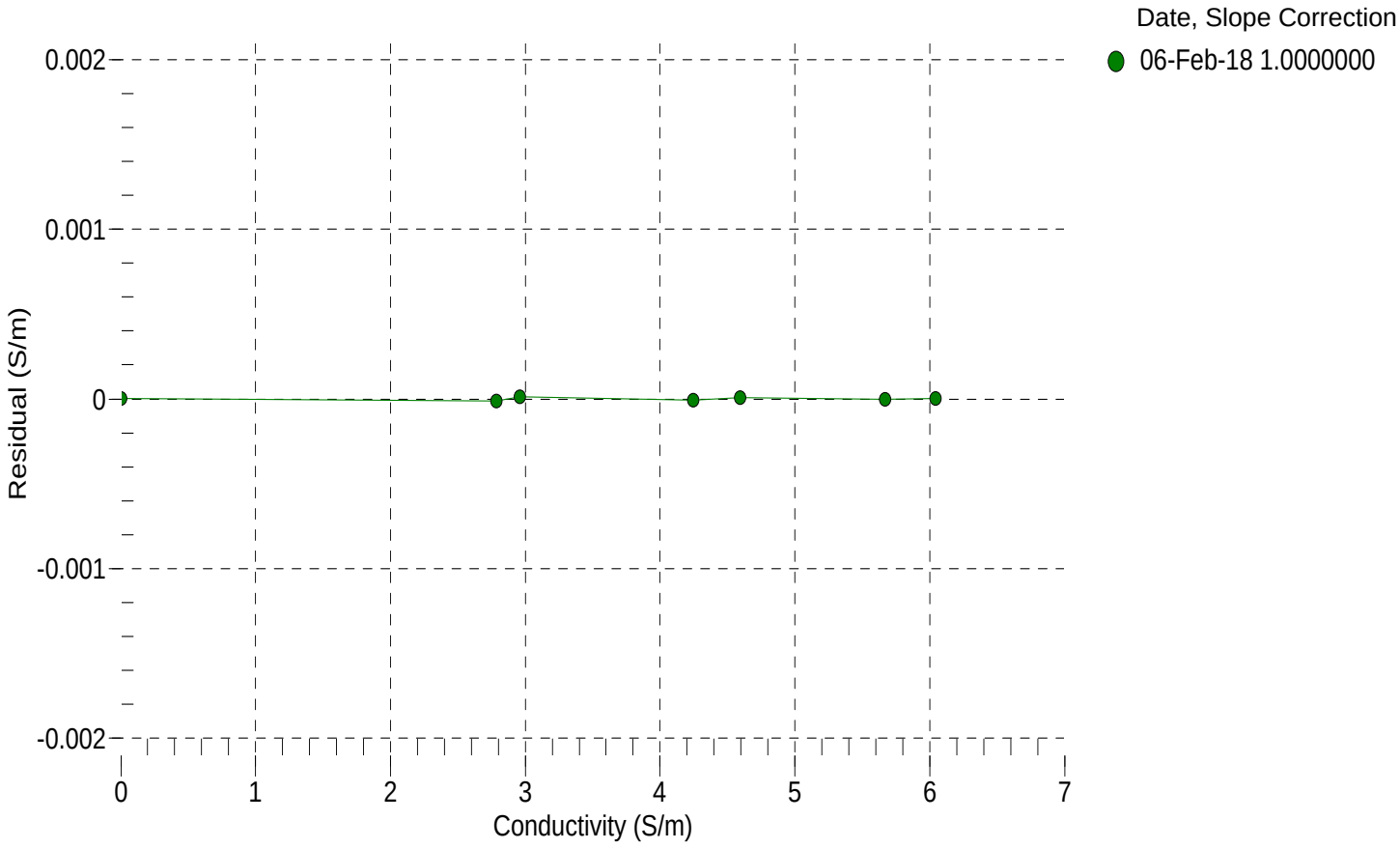
BATH TEMP (° C)	BATH SAL (PSU)	BATH COND (S/m)	INSTRUMENT OUTPUT (kHz)	INSTRUMENT COND (S/m)	RESIDUAL (S/m)
0.0000	0.0000	0.00000	2.78268	0.00000	0.00000
-1.0000	34.5942	2.78835	5.37930	2.78834	-0.00001
0.9999	34.5947	2.95881	5.49834	2.95883	0.00001
15.0000	34.5961	4.24745	6.32567	4.24744	-0.00001
18.4999	34.5958	4.59225	6.52920	4.59226	0.00001
28.9999	34.5940	5.66998	7.12767	5.66998	-0.00000
32.5000	34.5882	6.04070	7.32215	6.04070	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: 3667
CALIBRATION DATE: 09-Feb-18

SBE 43 OXYGEN CALIBRATION DATA

COEFFICIENTS:
Soc = 0.4417
Voffset = -0.4989
Tau20 = 1.32
A = -3.3238e-003
B = 1.5043e-004
C = -2.3166e-006
E nominal = 0.036

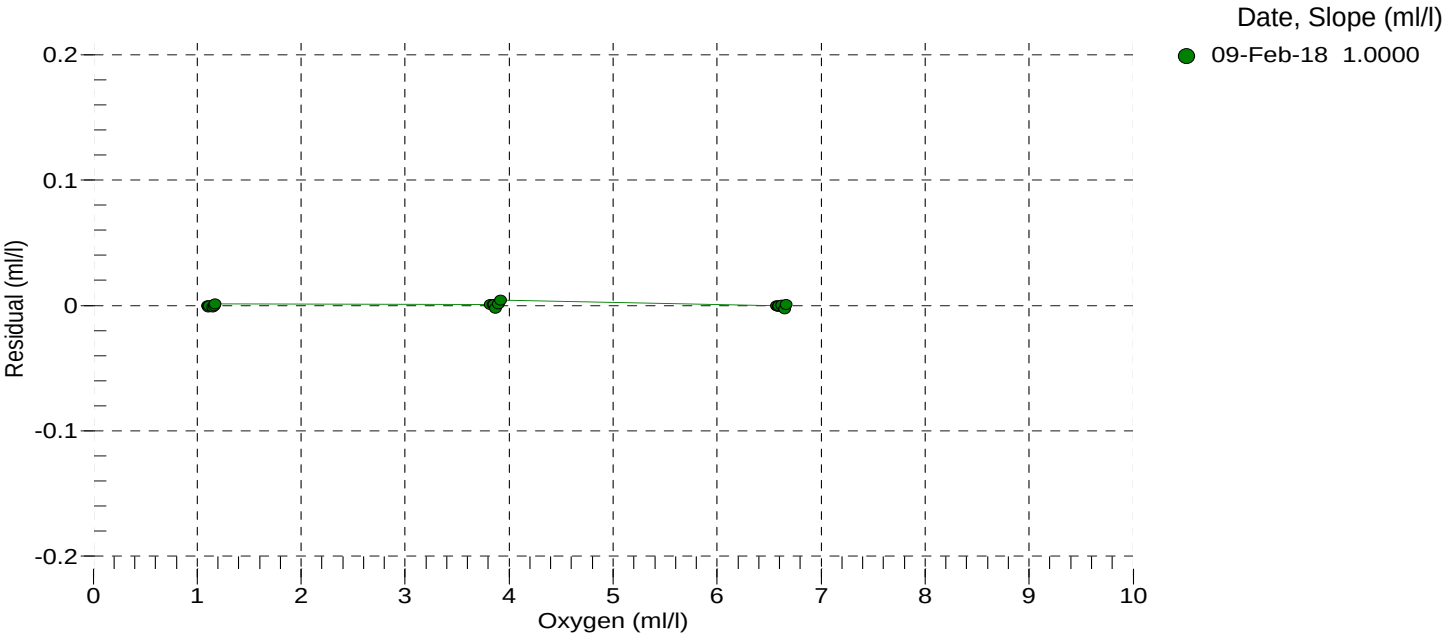
NOMINAL DYNAMIC COEFFICIENTS
D1 = 1.92634e-4
D2 = -4.64803e-2
H1 = -3.300000e-2
H2 = 5.00000e+3
H3 = 1.45000e+3

BATH OXYGEN (ml/l)	BATH TEMPERATURE (° C)	BATH SALINITY (PSU)	INSTRUMENT OUTPUT (volts)	INSTRUMENT OXYGEN (ml/l)	RESIDUAL (ml/l)
1.10	2.00	0.00	0.757	1.10	-0.00
1.11	12.00	0.00	0.839	1.11	-0.00
1.11	6.00	0.00	0.792	1.11	-0.00
1.15	20.00	0.00	0.917	1.15	-0.00
1.16	26.00	0.00	0.975	1.16	-0.00
1.17	30.00	0.00	1.014	1.17	0.00
3.81	2.00	0.00	1.397	3.82	0.00
3.85	6.00	0.00	1.514	3.85	0.00
3.86	12.00	0.00	1.683	3.86	0.00
3.87	20.00	0.00	1.908	3.86	-0.00
3.90	26.00	0.00	2.094	3.90	0.00
3.92	30.00	0.00	2.223	3.92	0.00
6.57	2.00	0.00	2.046	6.57	-0.00
6.59	6.00	0.00	2.236	6.59	-0.00
6.59	26.00	0.00	3.195	6.59	-0.00
6.62	12.00	0.00	2.532	6.62	0.00
6.65	30.00	0.00	3.422	6.65	-0.00
6.67	20.00	0.00	2.932	6.67	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)

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

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



Chelsea Technologies Group Ltd

Certificate Of Calibration

Fluorimeter calibration readings

Ambient temperature 20°C

Output for detector mechanically blanked 0.1256 Volts V_{Blank}

Output for pure water 0.1350 Volts

chlorophyll concentration in acetone (µg/l)	Output (volts)	
Acetone (pure)	0.2032	$V_{Acetone}$
0.1	1.0464	
0.3	1.4893	
1.0	2.0196	V_1
3.0	2.5135	
9.9	3.0366	
29.1	3.5121	
90.9	4.0062	

The uncertainty of the chlorophyll concentration is estimated not to exceed 3%. The uncertainty of output voltage measurement is estimated not to exceed 2mV.

Equipment used during calibration:-

Thurlby Dvm Cil 088
Weir Psu Cil 098

Signed

M.J.Nicholson

Date 21st March 2018

SN:18-0087-001

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TRANSMISSOMETER CALIBRATIONS S/N: CTD S/N 09-1351 CST-1840DR Date: 20-Feb-18

z	=	**0.250**	meters (transmissometer path length)
A0	=	**4.801**	(air calibration voltage from instrument manufacturer)
Y0	=	**0.005**	(blocked path voltage from instrument manufacturer)
W0	=	**4.702**	(voltage output in pure water from instrument manufacturer)
A1	=	**4.799**	(current [most recent] air voltage)
Y1	=	**0.002**	(current [most recent] blocked path voltage)
Tw	=	**100%**	(% transmission in pure water, **relative to water** – see application note 7)
M	=	(Tw / [W0 – Y0]) * (A0 - Y0) / (A1 - Y1)	
	=	(**100** / [**4.702** - **0.005**]) * (**4.801** - **0.005**) / (**4.799** - **0.002**)	
M	=	**21.286**	
B	=	-M * Y1	
B	=	**-0.043**	

M and B are based on the factory calibrations in water and in air performed by the instrument manufacturer, as well as calibrations performed in air at Sea-Bird Electronics. The calibrations at Sea-Bird (A1 and Y1) are done to account for any drift in the instrument response from when it was calibrated at Wet Labs to when it was integrated with a CTD at Sea-Bird.

Enter these values of z, M, and B in the transmissometer calibration section of the configuration (.con) file using the Configure menu in SEASAVE or SBE Data Processing (in the SEASOFT-Win32 suite of programs) or using SEACON (in the SEASOFT-DOS suite of programs).

Note on Transmissometer Measurements Relative to Air:

Many optical oceanographers prefer reporting transmissometer measurements relative to water, because they are not based on (the currently accepted) values of Tw, which are subject to interpretation and may change in the future. Consequently, as of April 2004, Sea-Bird is calculating M and B relative to water, and indicating those values on the Calibration Sheet and in the configuration (.con) file. However, if desired, you can recalculate M and B relative to air, using the following value of Tw with the equations above, and input those values in the .con file.

Tw = 90.2% (% transmission in pure water for this transmissometer, relative to air)

Transmissometer wave length and color = 660 nm, red

Refer to the instrument manufacturer's users manual and Sea-Bird Electronics Application Note 7 for further information

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SEA-BIRD SCIENTIFIC

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C-Star Calibration

Date 5.30.17 S/N# **CST-1824DR** Pathlength 25 cm

	Analog output	Digital output
V_d	0.007 V	0 counts
V_{air}	4.793 V	15726 counts
V_{ref}	4.702 V	15428 counts

Temperature of calibration water **22.1** °C
Ambient temperature during calibration **21.9** °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: $\mathbf{c = -1/x * \ln (Tr)}$

$Y_o = V_d$ Meter output with the beam blocked. This is the offset.
$A_o = V_{air}$ Meter output in air with a clear beam path.
$W_o = V_{ref}$ 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 voltage = 4.786 4.603 4.79121

Y_1 = current blocked path voltage = 0.005 0.005 0.00550

$Tw = 100\ \%$

$M = [Tw / (W_o - Y_o)] \times (A_o - Y_o) / (A_1 - Y_1)$

= 21.32152 94 22.17012 44 21.30052

$B = -M \times Y_1$

= -0.10660765 -0.11085062 -0.11705

2017/11/22 2018/04/16 2019/4/10

CALIBRATION CERTIFICATE
PAR Irradiance Meter

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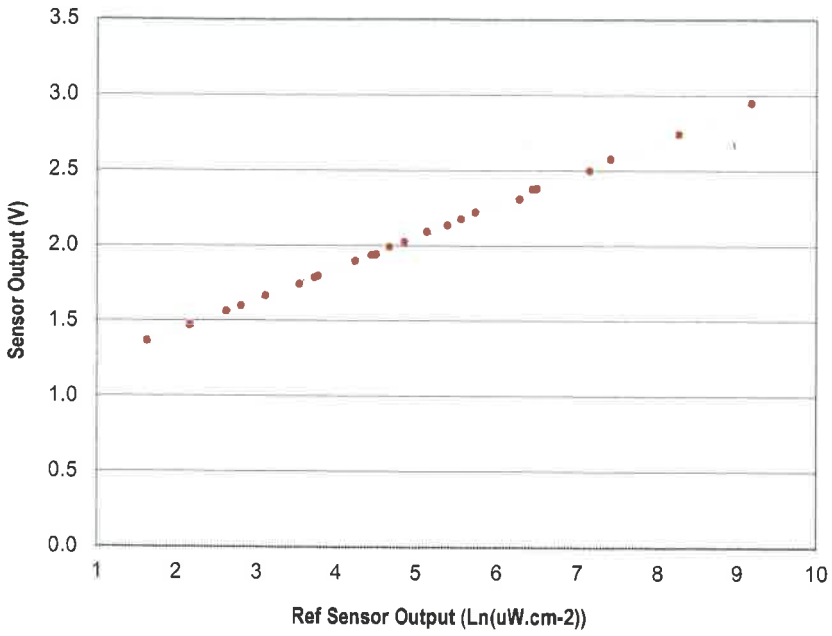
Surrey KT8 2QZ
United Kingdom
Tel: +44 (0)20 8481 9000
Fax: +44 (0)20 8941 9319
sales@chelsea.co.uk
www.chelsea.co.uk

Date of Cal: 28-Apr-2015
Part Number: 0046-3097
WOT Number: WO150118
Serial Number: 07-6118-01

Calibration Constant = 217391304.35
M = 1 / (0.434294481 x A1 x 1000) = 0.48198
B = − A0 / (A1 x 1000) = 1.68164

Calibration Equation
PAR (Ln(uW.cm-2)) = 0.0047773 x mVolts - 4.871694
PAR(uW.cm-2) = PAR(uE.m-2.s-1) / 0.04234
PAR (Ln(uE.m-2.s-1)) = 0.0047773 x mVolts - 8.033717
A1 A0



Calibration

Coeff A (slope):	0.0047773
Coeff B (intercept):	-4.871694
RSQ:	0.9995

Lamp Stability

Within cal:	1.28%
Between cal:	5.09%

Multimeter

Manufacturer:	Metrix Asyc II
SN:	206864BKH
Cal Due Date:	30-Sep-15

Supply Volts
15.00

Electral Offset (mv)
0.0

Observations:
Sensor Condition: na
Accessories:

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

Name: Dr John Attridge

Signed: John Attridge

Issue Date: 28-Apr-2015

Registration No: 00832429
Registered at the above address

Sea-Bird Electronics, Inc.

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SENSOR SERIAL NUMBER: 1853
CALIBRATION DATE: 27-Jan-15

SBE 21 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

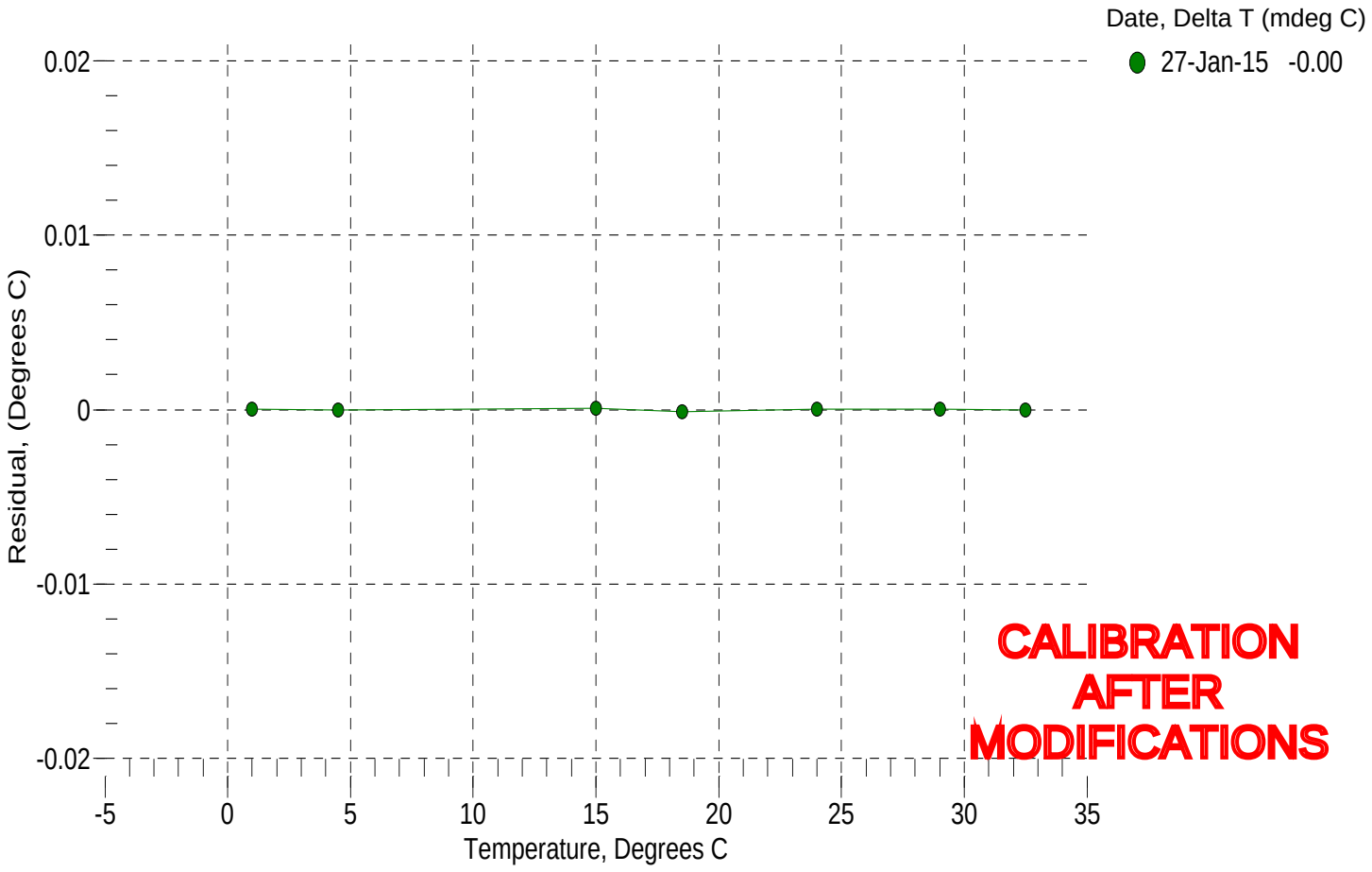
ITS-90 COEFFICIENTS:

```
g =  4.22759354e-003
h =  6.13965855e-004
i =  1.78683449e-005
j =  1.03295833e-006
f0 =  1000.0
```

BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	2639.205	1.0000	0.00001
4.5000	2856.550	4.5000	-0.00001
15.0000	3586.696	15.0001	0.00008
18.5000	3857.389	18.4999	-0.00011
23.9999	4311.816	23.9999	0.00005
29.0000	4756.763	29.0000	0.00000
32.5000	5086.836	32.5000	-0.00001

Temperature ITS-90 = $1/\{ g + h[ln(f_0/f)] + i[ln^2(f_0/f)] + j[ln^3(f_0/f)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature



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SENSOR SERIAL NUMBER: 1853
CALIBRATION DATE: 27-Jan-15

SBE 21 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

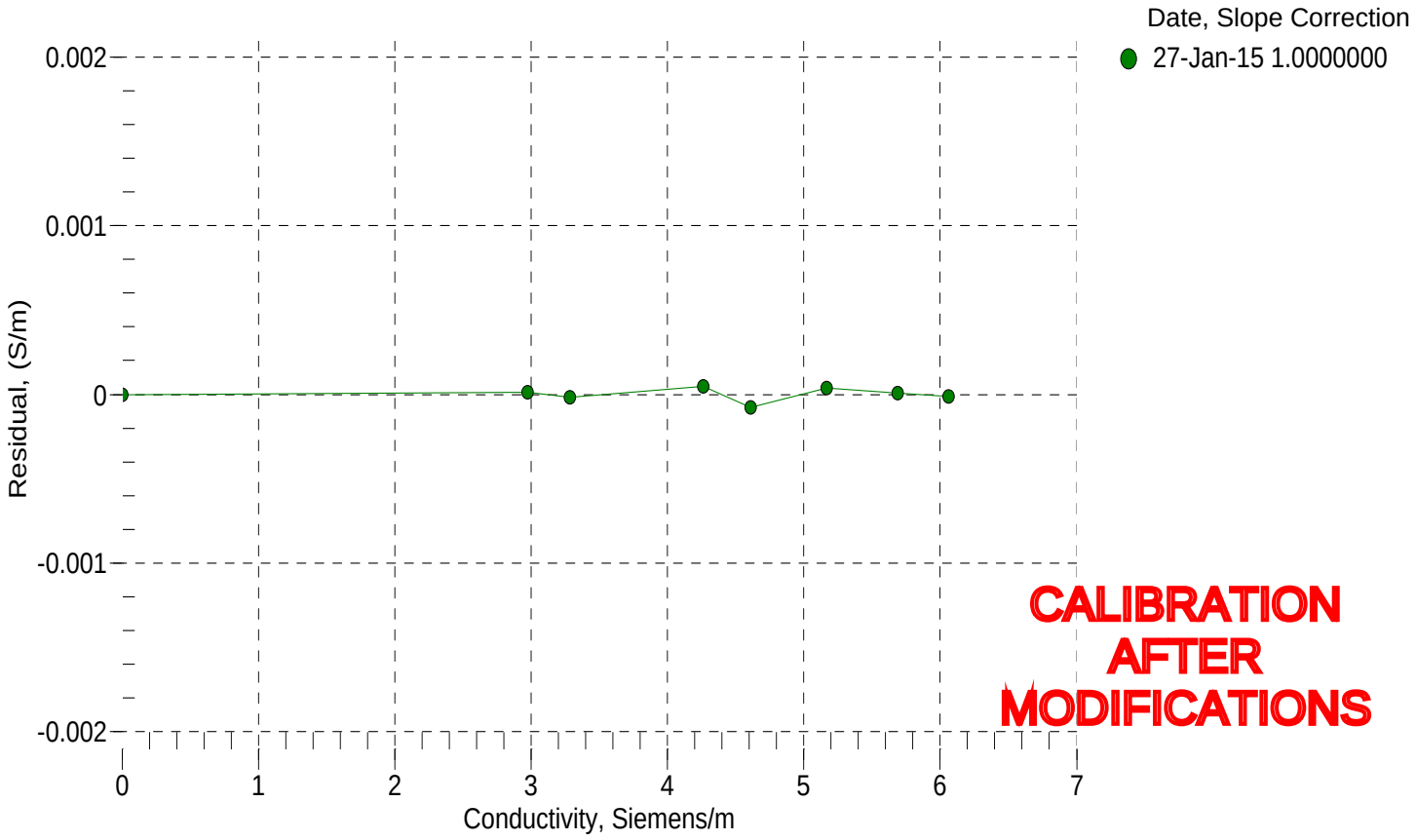
```
g =  -4.18323308e+000
h =   4.92603005e-001
i =  -4.50687789e-005
j =   2.66443533e-005

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

BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2.91384	0.00000	0.00000
1.0000	34.8025	2.97490	8.28739	2.97491	0.00001
4.5000	34.7827	3.28187	8.65284	3.28185	-0.00002
15.0000	34.7395	4.26319	9.72837	4.26323	0.00005
18.5000	34.7303	4.60819	10.07867	4.60812	-0.00007
23.9999	34.7200	5.16587	10.62033	5.16591	0.00004
29.0000	34.7142	5.68748	11.10244	5.68748	0.00001
32.5000	34.7109	6.05969	11.43376	6.05967	-0.00001

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

t = temperatur e[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = instrument conductivity - bath conductivity



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Chlorophyll WETStar Characterization

Date: February 9, 2017 S/N: WS3S-1369

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

CHL(µg/l) = Scale Factor x (Output - Clean Water Offset)

	Analog output	
Clean Water Offset (CWO)	0.057	V
Scale Factor (SF)	6.5	µg/l/V
Maximum Output	5.50	V
Resolution	0.32	mV
Ambient Characterization Temperature	22 ± 1	°C
Current Draw	30	mA @ 12V (typical)
12-hour Stability	0.42	mV/hr
Temperature Stability, 25–2 °C	0.20	mV/°C

Range	
15µg/l	0
32 µg/l	X
150 µg/l	0

Definitions:

CWO: Clean Water Offset value obtained using pure filtered de-ionized water.

SF: Scale Factor is used to convert the fluorescence response of the instrument into chlorophyll-a concentration. Scale Factor is determined at WET Labs during a cross calibration using a liquid fluorescent standard and a reference fluorometer whose chlorophyll fluorescence response has been characterized in a laboratory using a mono-species lab culture of *Thalassiosira weissflogii* phytoplankton.

Maximum Output: Maximum signal output of the fluorometer.

Resolution: Standard deviation of 1 minute of clean water data, sampled once per second.

Ambient Characterization Temperature: Room temperature at time of characterization.

Current Draw: The amount of current the instrument uses for operation.

12-hour Stability: Deviation of output averaged over 12 hours.

Temperature Stability: Measured output variation per degree.

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C-Star Calibration

Date 1.3.17 S/N# CST-521PR Pathlength 25 cm

	Analog output	Digital output
V_d	0.004 V	0 counts
V_{air}	4.515 V	14824 counts
V_{ref}	4.417 V	14502 counts

Temperature of calibration water	22.0 ℃
Ambient temperature during calibration	21.8 ℃

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: $c = -1/x * \ln(Tr)$

$Y_o = V_d$ Meter output with the beam blocked. This is the offset.
$A_o = V_{air}$ Meter output in air with a clear beam path.
$W_o = V_{ref}$ 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 voltage = 4.380 4.236

Y_1 : current blocked path voltage = 0.000 0.006

$T_W = 100\%$

$M = [T_W / (W_o - Y_o)] \times (A_o - Y_o) / (A_1 - Y_1) = 23.3380620$ 24.16565

$B = -M \times Y_1 = 0$ -0.14499

26-Feb-2018 22-Feb-2019