

# CALIBRATION SHEETS

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# 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: 5534  
CALIBRATION DATE: 29-Nov-11

SBE3 TEMPERATURE CALIBRATION DATA  
ITS-90 TEMPERATURE SCALE

## ITS-90 COEFFICIENTS

g = 4.35028588e-003  
h = 6.30113455e-004  
i = 1.92446885e-005  
j = 1.29186421e-006  
f0 = 1000.0

## IPTS-68 COEFFICIENTS

a = 3.68121345e-003  
b = 5.92733912e-004  
c = 1.50243580e-005  
d = 1.29318360e-006  
f0 = 2991.614

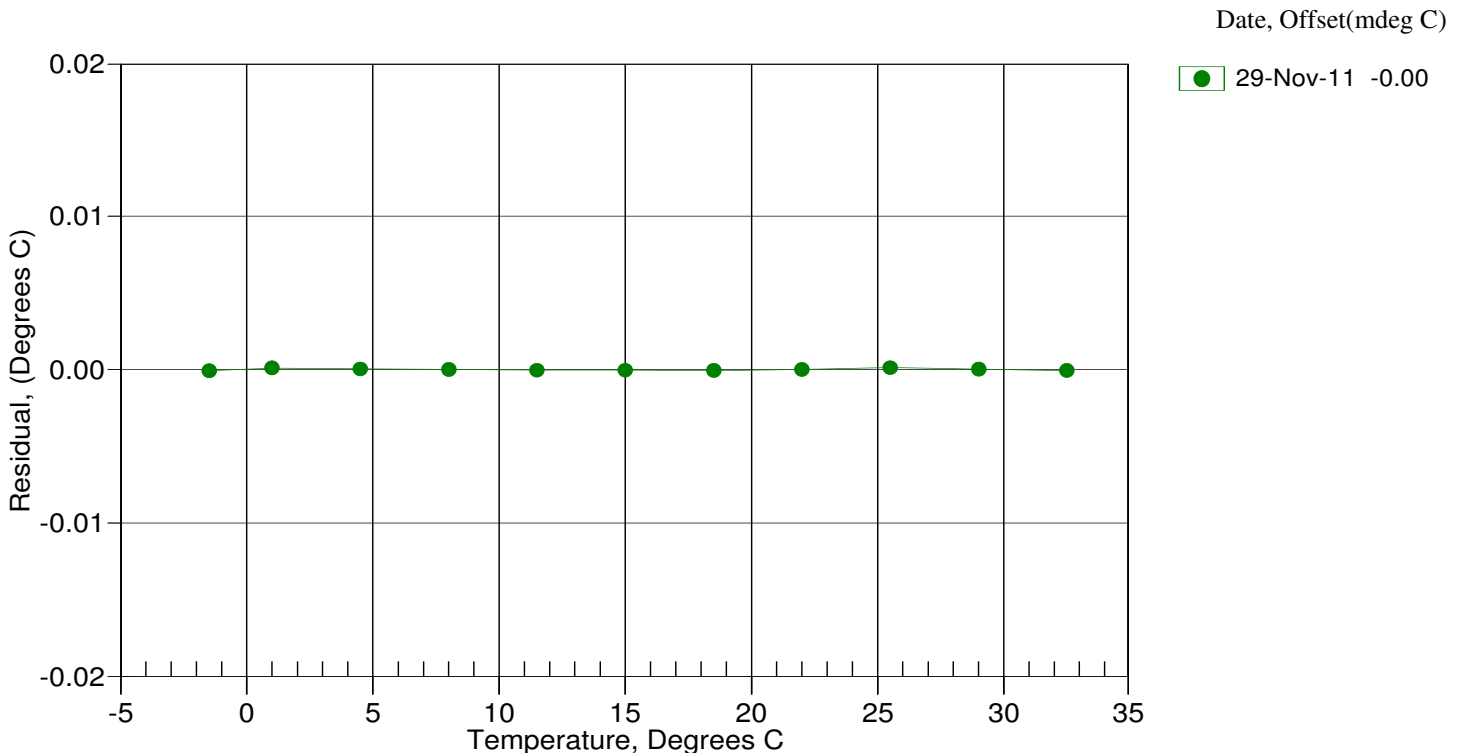
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5000	2991.614	-1.5001	-0.00008
1.0000	3166.246	1.0001	0.00010
4.5000	3422.982	4.5000	0.00004
8.0000	3694.428	8.0000	0.00000
11.5000	3981.008	11.5000	-0.00004
15.0000	4283.143	15.0000	-0.00004
18.5000	4601.235	18.4999	-0.00007
22.0000	4935.696	22.0000	0.00001
25.5000	5286.910	25.5001	0.00013
29.0000	5655.228	29.0000	0.00003
32.5000	6041.040	32.4999	-0.00007

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)

Temperature IPTS-68 =  $1/\{a + b[\ln(f_0/f)] + c[\ln^2(f_0/f)] + d[\ln^3(f_0/f)]\} - 273.15$  (°C)

Following the recommendation of JPOTS:  $T_{68}$  is assumed to be  $1.00024 * T_{90}$  (-2 to 35 °C)

Residual = instrument temperature - bath temperature



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SENSOR SERIAL NUMBER: 3923  
CALIBRATION DATE: 06-Dec-11

SBE4 CONDUCTIVITY CALIBRATION DATA  
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

## GHIJ COEFFICIENTS

g = -1.02433008e+001  
h = 1.34436951e+000  
i = -6.08242763e-004  
j = 1.14638750e-004  
CPcor = -9.5700e-008 (nominal)  
CTcor = 3.2500e-006 (nominal)

## ABCDM COEFFICIENTS

a = 2.07523225e-005  
b = 1.34292357e+000  
c = -1.02403781e+001  
d = -8.30368997e-005  
m = 4.5  
CPcor = -9.5700e-008 (nominal)

BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.76116	0.00000	0.00000
-1.0000	34.8912	2.81005	5.34052	2.81004	-0.00001
1.0000	34.8920	2.98182	5.45871	2.98183	0.00001
15.0000	34.8940	4.28013	6.27996	4.28014	0.00000
18.5000	34.8941	4.62757	6.48198	4.62757	-0.00000
29.0000	34.8926	5.71341	7.07593	5.71341	0.00000
32.5000	34.8866	6.08686	7.26888	6.08686	-0.00000

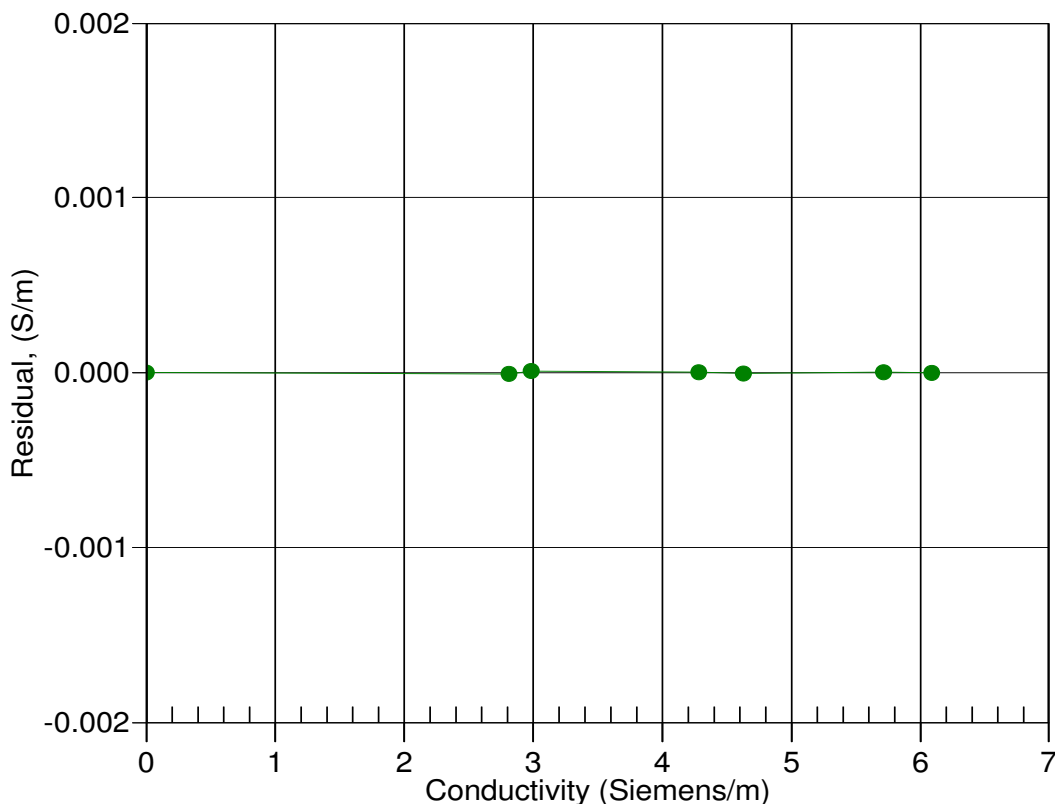
Conductivity =  $(g + hf^2 + if^3 + jf^4) / 10(1 + \delta t + \epsilon p)$  Siemens/meter

Conductivity =  $(af^m + bf^2 + c + dt) / [10(1 + \epsilon p)]$  Siemens/meter

t = temperature[°C]; p = pressure[decibars];  $\delta$  = CTcor;  $\epsilon$  = CPcor;

Residual = (instrument conductivity - bath conductivity) using g, h, i, j coefficients

Date, Slope Correction



06-Dec-11 1.0000000



## 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: 120011

Original Calibration Date: 2011-09-09

Date of Correction: 2011-12-14

Installed in: SBE 9Plus S/N 1069

### PRESSURE COEFFICIENTS

<i>C1</i>	<i>-43581.51</i>	<i>psia</i>
<i>C2</i>	<i>8.55674e-01</i>	<i>psia/deg C</i>
C3	1.4268e-02	psia/deg C <sup>2</sup>

D1 0.032342

D2 0.0

<i>T1</i>	<i>29.9756</i>	<i>μsec</i>
<i>T2</i>	<i>3.405748e-05</i>	<i>μsec/deg C</i>
T3	4.0297e-06	μsec/deg C <sup>2</sup>
T4	3.78967e-09	μsec/deg C <sup>3</sup>
T5	0e+00	

AD590M = 0.012806

AD590B = -9.087573

Slope = 1.0

Offset = 0.0

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.

**CALIBRATION COEFFICIENTS**

SERIAL NO : 120011

PRESSURE TRANSDUCER

DATE : 09-09-2011

MODEL :	PRESSURE RANGE :	TEMP. RANGE :	PORT :
410K-134	0 to 10000 psia	0 to 125 deg C	

**PRESSURE COEFFICIENTS**

U = temperature  
(deg C)

$$C = C_1 + C_2U + C_3U^2$$

$$D = D_1 + D_2U$$

$$T_0 = T_1 + T_2U + T_3U^2 + T_4U^3 + T_5U^4$$

T = pressure period  
(μsec)

Pressure : (psia)

$$P = C \left( 1 - \frac{T_0^2}{T^2} \right) \left( 1 - D \left( 1 - \frac{T_0^2}{T^2} \right) \right)$$

C <sub>1</sub>	-43580.70	psia
C <sub>2</sub>	8.77212E-01	psia/deg C
C <sub>3</sub>	1.42684E-02	psia/deg C <sup>2</sup>

D <sub>1</sub>	0.032342
D <sub>2</sub>	0

T <sub>1</sub>	29.97587	μsec
T <sub>2</sub>	4.09754E-05	μsec/deg C
T <sub>3</sub>	4.02971E-06	μsec/deg C <sup>2</sup>
T <sub>4</sub>	3.78967E-09	μsec/deg C <sup>3</sup>
T <sub>5</sub>	0	

(09-09-2011)

**PAROSCIENTIFIC, INC.**4500 148th AVENUE N.E.  
REDMOND, WA. 98052

CUSTOMER : SEABIRD ELECTRONICS, INC.

SALES ORDER : 27828

PREPARED BY : T.C.



**CALIBRATION COEFFICIENTS**SERIAL NO : **120011**

PRESSURE TRANSDUCER

DATE : 09-09-2011

MODEL : 410K-134	PRESSURE RANGE : 0 to 10000 psia	TEMP. RANGE : 0 to 125 deg C	PORT :
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**PRESSURE COEFFICIENTS AT FIXED TEMPERATURE**

(only valid at specified temperature)

T = pressure period ( $\mu\text{sec}$ )

Pressure equation : (psia)

$$P = C \left( 1 - \frac{T_0^2}{T^2} \right) \left( 1 - D \left( 1 - \frac{T_0^2}{T^2} \right) \right)$$

Temperature: 21.0 C

C (psia)	-43555.99				
D	0.032342				
T <sub>0</sub> ( $\mu\text{sec}$ )	29.97855				

(09-09-2011)

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## SBE 5T SUBMERSIBLE PUMP CONFIGURATION SHEET

Customer: **NMFS/LA JOLLA**

Delivery Date: **12/16/2011**

Serial Number: **6210**

MRP PN: **90740**

Job Number: **65118P**

Pressure Case: 10,500 meters (titanium)

### Pittman Motor Type:

**P/N 3711B113-R1, 18.02 ohms nominal (For applications up to 2000 RPM MAX)**

☐

5 Winding, low voltage input (jump P5 to P7)  
(80676 assy/3711B113-R1 motor)

☐

5 Winding, standard voltage input (jump P5 to P6)  
(80676 assy/3711B113-R1 motor)

☐

**P/N 3711B112-R1, 7.40 ohms nominal (For applications up to 4500 RPM MAX)**

☐

3 Winding, low voltage input (jump P5 to P7)  
(80675 assy/3711B112-R1 motor)

☐

3 Winding, standard voltage input (jump P5 to P6)  
(80675 assy/3711B112-R1 motor)

☐

**P/N 3711B112-R2, 3.55 ohms nominal (For applications up to 4500 RPM MAX)**

☒

3 Winding, low voltage input (jump P5 to P7)  
(801572 assy/3711B112-R2 motor)

☐

3 Winding, standard voltage input (jump P5 to P6)  
(801572 assy/3711B112-R2 motor)

☒

Speed Adjust Range: Min: **895** RPM Max: **5090** RPM ( @ 12 Vin/300mA load)

Final Speed Setting: **3000** RPM (TP1 = **100.0** Hz)

### Low voltage pumps only:

Motor speed at 7.5 Vin with no load: **0** RPM (TP1 = **0.0** Hz)

Motor speed at 7.5 Vin with 200mA load: **0** RPM (TP1 = **0.0** Hz)

Motor dropout voltage: **9.4**

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SENSOR SERIAL NUMBER: 2222  
CALIBRATION DATE: 20-Dec-11

## SBE 43 OXYGEN CALIBRATION DATA

### COEFFICIENTS

Soc = 0.4717

Voffset = -0.4786

Tau20 = 1.25

A = -3.6684e-003

B = 1.6855e-004

C = -3.0711e-006

E nominal = 0.036

### NOMINAL DYNAMIC COEFFICIENTS

D1 = 1.92634e-4 H1 = -3.30000e-2

D2 = -4.64803e-2 H2 = 5.00000e+3

H3 = 1.45000e+3

BATH OX (ml/l)	BATH TEMP ITS-90	BATH SAL PSU	INSTRUMENT OUTPUT(VOLTS)	INSTRUMENT OXYGEN(ml/l)	RESIDUAL (ml/l)
1.28	2.00	0.08	0.762	1.28	-0.00
1.29	6.00	0.08	0.798	1.29	0.00
1.30	12.00	0.08	0.856	1.31	0.01
1.31	20.00	0.07	0.935	1.33	0.01
1.33	26.00	0.07	0.999	1.34	0.01
1.34	30.00	0.08	1.046	1.36	0.02
4.22	2.00	0.08	1.403	4.19	-0.03
4.23	6.00	0.08	1.521	4.21	-0.02
4.26	12.00	0.08	1.702	4.24	-0.02
4.28	20.00	0.07	1.949	4.28	-0.01
4.31	26.00	0.07	2.147	4.31	-0.00
4.32	30.00	0.08	2.286	4.32	0.00
6.83	30.00	0.08	3.333	6.83	-0.01
6.98	20.00	0.07	2.878	6.98	0.00
6.98	26.00	0.07	3.183	6.98	0.00
6.99	12.00	0.08	2.498	7.00	0.01
7.04	6.00	0.08	2.226	7.06	0.02
7.08	2.00	0.09	2.045	7.10	0.02

Oxygen (ml/l) = Soc \* (V + Voffset) \* (1.0 + A \* T + B \* T<sup>2</sup> + C \* T<sup>3</sup>) \* OxSol(T,S) \* exp(E \* P / K)

V = voltage output from SBE43, T = temperature [deg C], S = salinity [PSU] K = temperature [deg K]

OxSol(T,S) = oxygen saturation [ml/l], P = pressure [dbar], Residual = instrument oxygen - bath oxygen

Date, Delta Ox (ml/l)

