



Sea-Bird Electronics, Inc.

1808 136th Place NE, Bellevue, Washington 98005 USA  
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## SBE Pressure Test Certificate

Test Date: 9/22/2008 Description: SBE-9Plus CTD

Job Number: 51342

Customer Name: NOAA/Office of Ocean Exploration

### SBE Sensor Information:

Model Number: 09  
 Serial Number: 0918

### Pressure Sensor Information:

Sensor Type: DigiQuartz  
 Sensor Serial Number: 113126  
 Sensor Rating: 10000

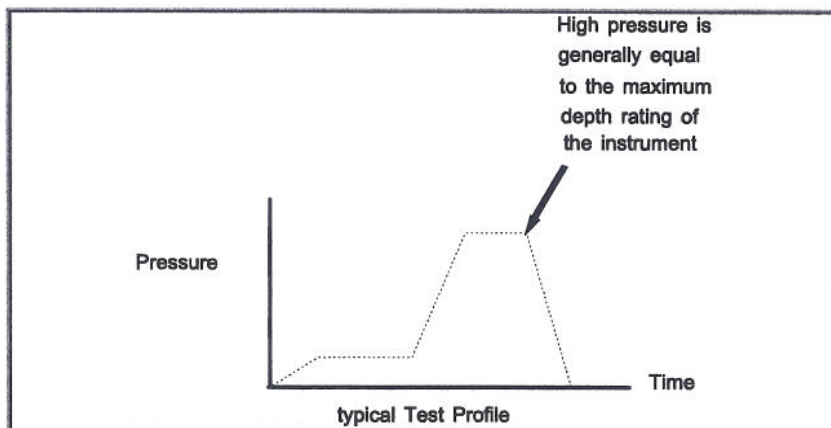
### Pressure Test Protocol:

Low Pressure Test: 40 PSI Held For 15 Minutes

High Pressure Test: 10000 PSI Held For 15 Minutes

Passed Test:

Tested By: nd



**CALIBRATION COEFFICIENTS**

SERIAL NO : 113126

PRESSURE TRANSDUCER

DATE : 08-11-2008

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

(only valid at specified temperature)

T = pressure period (μsec)

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)	-41898.68				
D	0.035800				
T <sub>0</sub> (μsec)	30.25468				

(08-11-2008)

**PAROSCIENTIFIC, INC.**

4500 148th AVENUE N.E.  
REDMOND, WA. 98052

CUSTOMER : SEABIRD ELECTRONICS, INC.



SALES ORDER : 25609

PREPARED BY : T.C.

# CALIBRATION COEFFICIENTS

PAROSCIENTIFIC  
PRESSURE TRANSDUCER

*Corrected coefficients for SBE-9plus, SN 0918.*

Serial No: **113126**  
Original Cal Date: **8/11/2008**  
Corrected Cal Date: **10/7/2008**

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

## PRESSURE COEFFICIENTS

U = temperature (deg C)

T = pressure period (μsec)

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

$$D = D_1 + D_2U$$

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

pressure: (psia)

$$P = C(1 - (T_0^2/T^2))(1 - D(1 - (T_0^2/T^2)))$$

<i>C1</i>	<i>-41891.13</i>	<i>psia</i>
<i>C2</i>	<i>-6.953845E-01</i>	<i>psia/deg C</i>
<i>C3</i>	<i>1.3933E-02</i>	<i>psia/deg C<sup>2</sup></i>
<i>D1</i>	<i>0.0358</i>	
<i>D2</i>	<i>0</i>	
<i>T1</i>	<i>30.26382</i>	<i>μsec</i>
<i>T2</i>	<i>-5.419485E-04</i>	<i>μsec/deg C</i>
<i>T3</i>	<i>4.31549E-06</i>	<i>μsec /deg C<sup>2</sup></i>
<i>T4</i>	<i>3.20538E-09</i>	<i>μsec /deg C<sup>3</sup></i>
<i>T5</i>	<i>0</i>	



## Digiquartz Pressure Calibration Coefficients

Corrected at Sea-Bird Electronics on **07-Oct-2008**  
as per Paroscientific Calibration and SBE dP/dT tests.

*(Changed coefficients are posted in italics.)*

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SENSOR SERIAL NUMBER: 5031  
 CALIBRATION DATE: 23-Sep-08

SBE3 TEMPERATURE CALIBRATION DATA  
 ITS-90 TEMPERATURE SCALE

### ITS-90 COEFFICIENTS

g = 4.33221359e-003  
 h = 6.37001068e-004  
 i = 2.11053224e-005  
 j = 1.86378381e-006  
 f0 = 1000.0

### IPTS-68 COEFFICIENTS

a = 3.68121179e-003  
 b = 5.98823553e-004  
 c = 1.52309955e-005  
 d = 1.86521085e-006  
 f0 = 2873.284

BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5000	2873.284	-1.5000	0.00004
1.0000	3039.236	1.0000	-0.00002
4.5001	3283.061	4.5000	-0.00009
8.0000	3540.628	8.0000	0.00001
11.5000	3812.315	11.5000	0.00004
15.0000	4098.484	15.0001	0.00008
18.5001	4399.484	18.5001	-0.00002
22.0001	4715.659	22.0001	-0.00004
25.5001	5047.344	25.5001	-0.00004
29.0000	5394.850	29.0000	0.00001
32.5000	5758.494	32.5000	0.00002

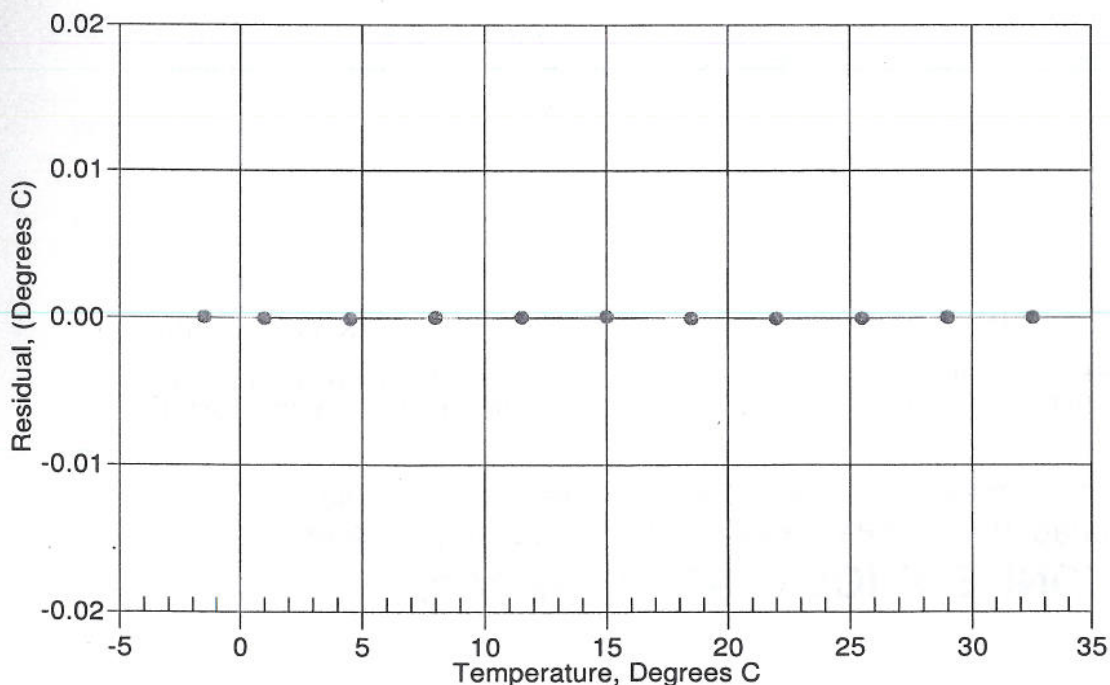
$$\text{Temperature ITS-90} = 1 / \{ g + h[\ln(f_0/f)] + i[\ln^2(f_0/f)] + j[\ln^3(f_0/f)] \} - 273.15 \text{ (}^\circ\text{C)}$$

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

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

Residual = instrument temperature - bath temperature

Date, Offset(mdeg C)



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SENSOR SERIAL NUMBER: 3508  
 CALIBRATION DATE: 06-Sep-08

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

### GHIJ COEFFICIENTS

g = -1.00167570e+001  
 h = 1.56939207e+000  
 i = -1.88484741e-003  
 j = 2.32967749e-004  
 CPcor = -9.5700e-008 (nominal)  
 CTcor = 3.2500e-006 (nominal)

### ABCDM COEFFICIENTS

a = 1.99324857e-006  
 b = 1.56467184e+000  
 c = -1.00077797e+001  
 d = -8.19891948e-005  
 m = 5.7  
 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	2.52902	0.00000	0.00000
-1.0002	34.8994	2.81063	4.93435	2.81063	0.00000
0.9998	34.9001	2.98243	5.04424	2.98242	-0.00001
14.9999	34.9003	4.28082	5.80752	4.28083	0.00001
18.4998	34.8996	4.62820	5.99515	4.62820	0.00000
28.9999	34.8963	5.71393	6.54666	5.71391	-0.00002
32.4999	34.8888	6.08719	6.72572	6.08720	0.00001

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

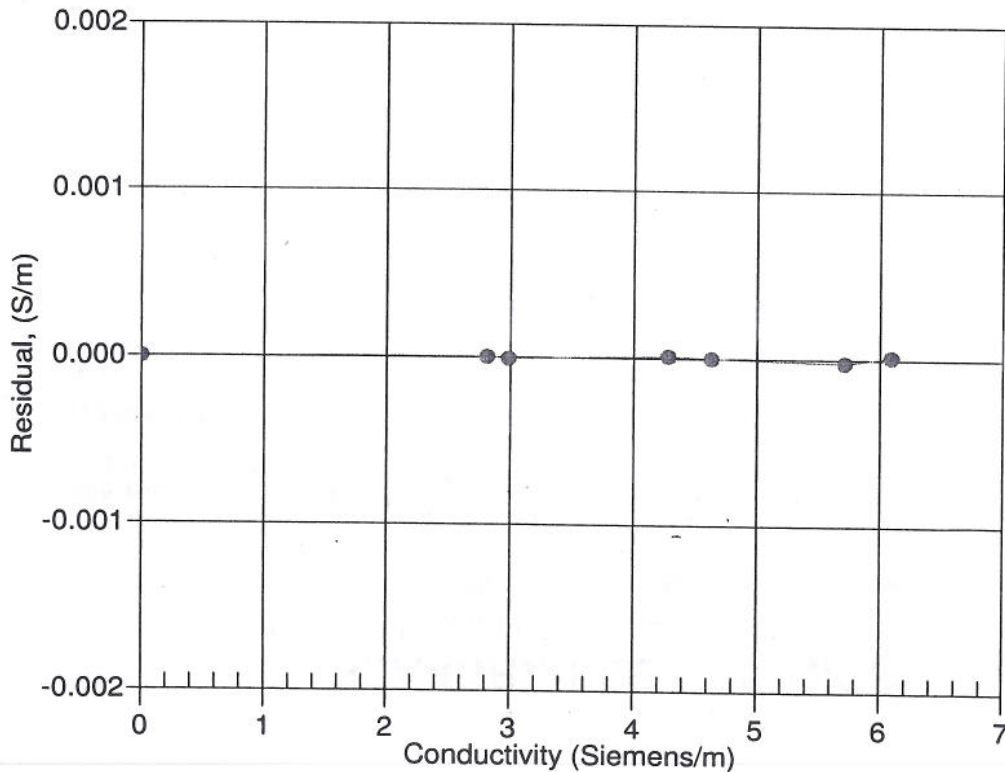
$$\text{Conductivity} = (af^m + bf^2 + c + dt) / [10(1 + \epsilon p)] \text{ Siemens/meter}$$

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-Sep-08 1.0000000





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## SBE 5T SUBMERSIBLE PUMP CONFIGURATION SHEET

Customer:   
 Serial Number:   
 Job Number:

Delivery Date:   
 MRP PN:

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:  RPM Max:  RPM (@ 12 Vin/300mA load)  
 Final Speed Setting:  RPM (TP1 =  Hz)

**Low voltage pumps only:**

Motor speed at 7.5 Vin with no load:  RPM (TP1 =  Hz)  
 Motor speed at 7.5 Vin with 200mA load:  RPM (TP1 =  Hz)  
 Motor dropout voltage:

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SENSOR SERIAL NUMBER: 1463  
 CALIBRATION DATE: 30-Sep-08p

## SBE 43 OXYGEN CALIBRATION DATA

### COEFFICIENTS

Soc = 0.3899  
 Voffset = -0.4503  
 Tau20 = 4.52

A = -2.6058e-003  
 B = 1.8711e-004  
 C = -3.4100e-006  
 E nominal = 0.036

### NOMINAL DYNAMIC COEFFICIENTS

D1 = 1.92634e-4  
 D2 = -4.64803e-2

BATH OX (ml/l)	BATH TEMP ITS-90	BATH SAL PSU	INSTRUMENT OUTPUT(VOLTS)	INSTRUMENT OXYGEN(ml/l)	RESIDUAL (ml/l)
1.23	2.00	0.00	0.779	1.23	0.00
1.24	6.00	0.00	0.818	1.24	-0.00
1.24	12.00	0.01	0.877	1.24	0.00
1.25	20.00	0.01	0.958	1.25	0.00
1.25	26.00	0.01	1.018	1.25	0.00
1.26	30.00	0.01	1.063	1.26	0.00
4.16	26.00	0.01	2.330	4.16	-0.00
4.16	20.00	0.01	2.135	4.16	-0.00
4.18	12.00	0.01	1.887	4.18	-0.00
4.18	6.00	0.00	1.694	4.18	-0.00
4.19	2.00	0.00	1.565	4.19	-0.00
4.20	30.00	0.01	2.490	4.20	-0.00
6.79	30.00	0.01	3.749	6.79	0.00
6.81	26.00	0.01	3.531	6.81	-0.00
6.83	20.00	0.01	3.218	6.83	0.00
6.84	12.00	0.01	2.802	6.84	-0.00
6.88	6.00	0.00	2.497	6.88	0.00
6.93	2.00	0.00	2.295	6.93	0.00

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

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

