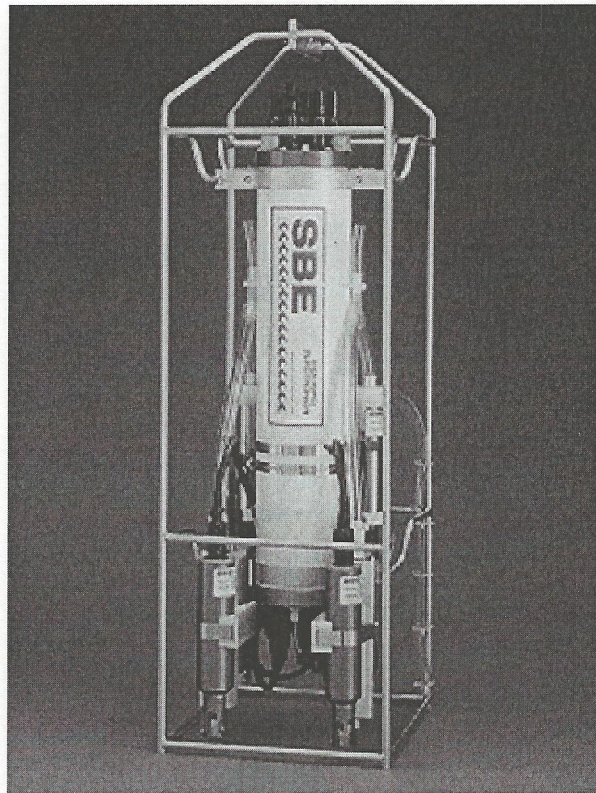


SBE 9plus UNDERWATER UNIT

911plus CTD System Operating and Repair Manual



Serial Number: 09P67149-1087

Sea-Bird Electronics, Inc.
13431 NE 20th Street
Bellevue, Washington 98005 USA
Tel: 425/643-9866
Fax: 425/643-9954

SYSTEM CONFIGURATION

26 March 2012

SBE 9plus CTD Underwater Unit

S/N 09P67149-1087

Depth Capability

6800 meters

Pressure Sensor Range

0-10000 psiaDigiquartz Pressure Sensor (w/ temp-comp)
Modulo 12P**S/N 122179****S/N MOD12P-1075**

AD590M (Pressure Temperature Coefficient)

0.012817

AD590B (Pressure Temperature Coefficient)

-9.046489

A/D Input Voltage Range

0 to 5 Volts DC

Logic Board EPROM

Version 1.0

Modem Interface Installed

Yes

Modem Board Microcontroller

V 1.3, PN 11194**Data Format:**

Frequency 0

Temperature

Frequency 1

Conductivity

Frequency 2

Pressure

Frequency 3

Temperature, Secondary

Frequency 4

Conductivity, Secondary**Temperature Sensor (SBE 3plus)****03P5483****Temperature Sensor (SBE 3plus)****03P5549****Conductivity Sensor (SBE 4C)****043916****Conductivity Sensor (SBE 4C)****043916****Pump (SBE 5T)****056361****Pump (SBE 5T)****056362**

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: 5483
CALIBRATION DATE: 23-Feb-12

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

$g = 4.29788686e-003$
 $h = 6.24754454e-004$
 $i = 1.90126087e-005$
 $j = 1.37626459e-006$
 $f_0 = 1000.0$

IPTS-68 COEFFICIENTS

$a = 3.68121303e-003$
 $b = 5.90520494e-004$
 $c = 1.48433555e-005$
 $d = 1.37757784e-006$
 $f_0 = 2762.642$

BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5000	2762.642	-1.5001	-0.00005
1.0000	2924.523	1.0000	0.00005
4.5000	3162.581	4.5001	0.00006
8.0000	3414.337	8.0000	-0.00001
11.5000	3680.198	11.5000	-0.00001
15.0000	3960.548	15.0000	-0.00005
18.5000	4255.773	18.4999	-0.00005
22.0000	4566.248	22.0000	-0.00001
25.5000	4892.335	25.5001	0.00008
29.0000	5234.376	29.0001	0.00008
32.5000	5592.705	32.4999	-0.00008

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)

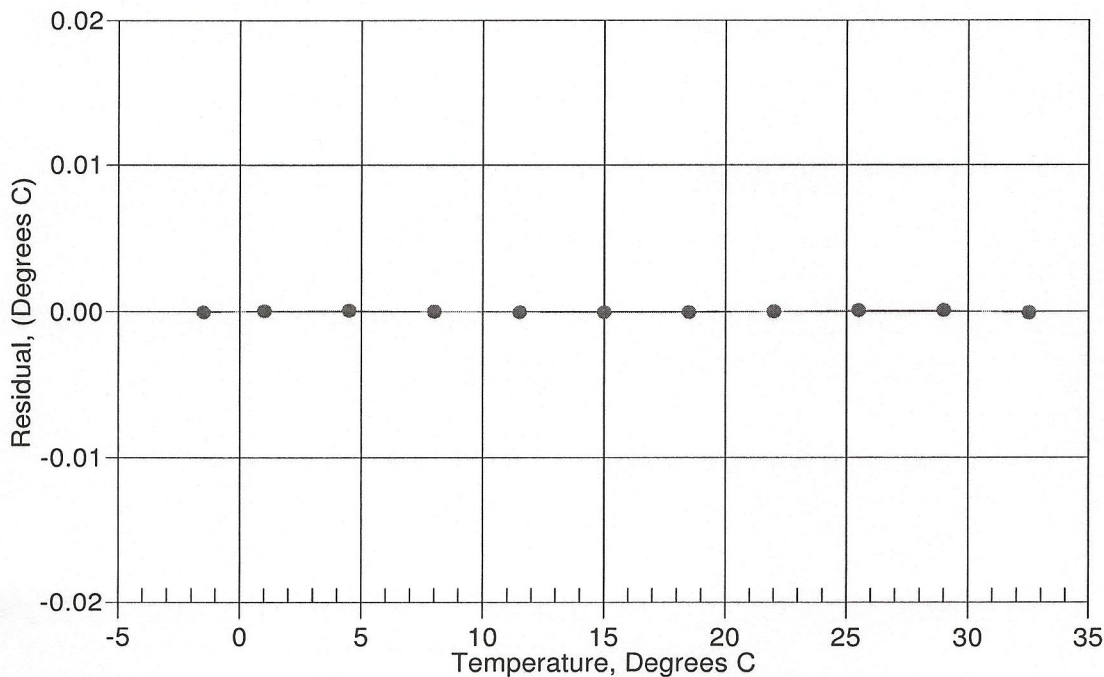
Temperature IPTS-68 = $1/\{a + b[\ln(f_0/f)] + c[\ln^2(f_0/f)] + d[\ln^3(f_0/f)]\} - 273.15$ (°C)

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

Residual = instrument temperature - bath temperature

Date, Offset(mdeg C)

● 23-Feb-12 -0.00



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Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 3916
CALIBRATION DATE: 15-Mar-12

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

GHIJ COEFFICIENTS

g = -1.03593733e+001
h = 1.60754577e+000
i = -8.03238200e-004
j = 1.59956234e-004
CPcor = -9.5700e-008 (nominal)
CTcor = 3.2500e-006 (nominal)

ABCDM COEFFICIENTS

a = 2.37107023e-005
b = 1.60587166e+000
c = -1.03568287e+001
d = -8.54537861e-005
m = 4.6
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	2.53934	0.00000	0.00000
-1.0001	34.7826	2.80211	4.88636	2.80208	-0.00002
0.9999	34.7831	2.97339	4.99412	2.97341	0.00002
14.9999	34.7857	4.26825	5.74311	4.26826	0.00001
18.4999	34.7864	4.61482	5.92742	4.61481	-0.00002
28.9999	34.7864	5.69796	6.46944	5.69796	-0.00000
32.4999	34.7816	6.07061	6.64560	6.07061	0.00000

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

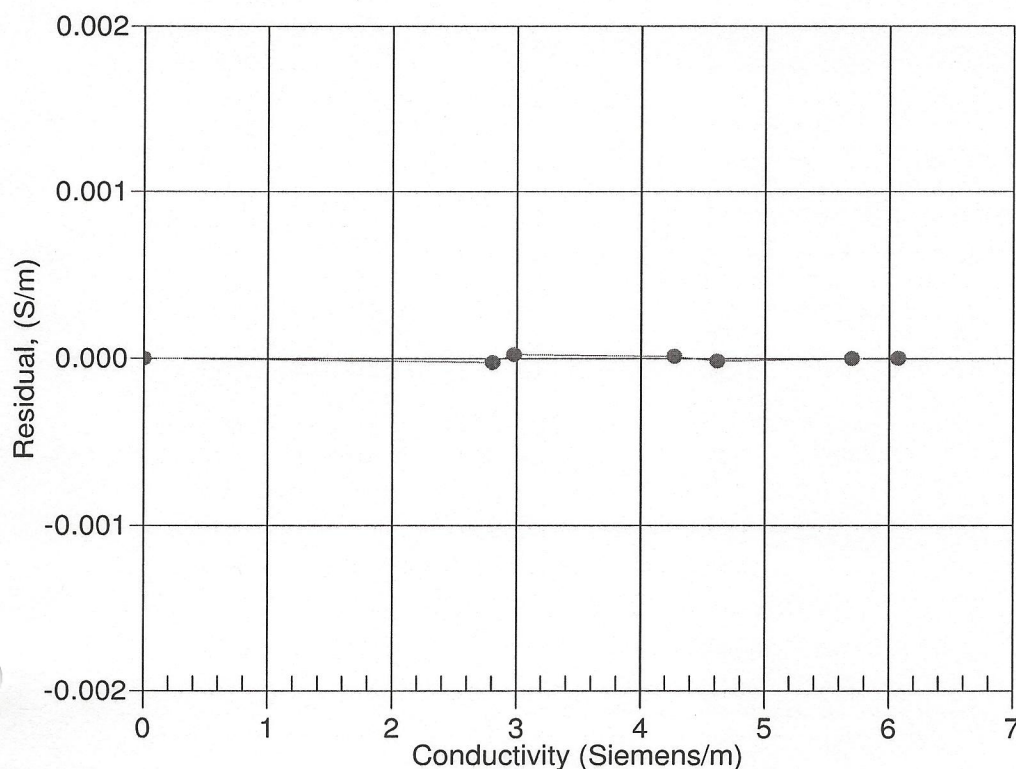
Conductivity = $(af^m + bf^2 + c + dt) / [10(1 + \epsilon p)]$ Siemens/meter

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

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

Date, Slope Correction

15-Mar-12 1.0000000





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Digiquartz Pressure Calibration dP/dT Corrected Coefficients

(Changed coefficients are posted in italics)

Pressure Transducer Serial Number: 122179

Original Calibration Date: 2011-12-14

Date of Correction: 2012-03-22

Installed in: SBE 9Plus S/N 1087

PRESSURE COEFFICIENTS

<i>C1</i>	<i>-38643.44</i>	<i>psia</i>
<i>C2</i>	<i>3.2417831e-01</i>	<i>psia/deg C</i>
<i>C3</i>	<i>1.3896e-02</i>	<i>psia/deg C²</i>

D1 0.033766

D2 0.0

<i>T1</i>	<i>30.1918</i>	<i>μsec</i>
<i>T2</i>	<i>-1.977133e-04</i>	<i>μsec/deg C</i>
<i>T3</i>	<i>4.5965e-06</i>	<i>μsec/deg C²</i>
<i>T4</i>	<i>4.01877e-09</i>	<i>μsec/deg C³</i>
<i>T5</i>	<i>0e+00</i>	

AD590M = 0.012817

AD590B = -9.046489

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 : 122179

PRESSURE TRANSDUCER

DATE : 12-14-2011

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 ₁	-38642.46 psia
C ₂	3.43533E-01 psia/deg C
C ₃	1.38964E-02 psia/deg C ²

D ₁	0.033766
D ₂	0

T ₁	30.19220 μsec
T ₂	-1.90672E-04 μsec/deg C
T ₃	4.59652E-06 μsec/deg C ²
T ₄	4.01877E-09 μsec/deg C ³
T ₅	0

(12-14-2011)

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 : 122179

PRESSURE TRANSDUCER

DATE : 12-14-2011

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

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)	-38629.11				
D	0.033766				
T ₀ (μsec)	30.19026				

(12-14-2011)

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

CUSTOMER : SEABIRD ELECTRONICS, INC.

SALES ORDER : 27828

PREPARED BY : T.C.





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Tel: (425) 643-9866

Email: seabird@seabird.com

Fax: (425) 643-9866

SBE 5T SUBMERSIBLE PUMP CONFIGURATION SHEET

Customer: **Schmidt Research Ves**

Delivery Date: **3/26/2012**

Serial Number: **6361**

MRP PN: **90741**

Job Number: **67149P**

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: **885** RPM Max: **4620** 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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Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 5549
CALIBRATION DATE: 13-Mar-12

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.32169056e-003
h = 6.25258783e-004
i = 1.90806457e-005
j = 1.37420650e-006
f0 = 1000.0

IPTS-68 COEFFICIENTS

a = 3.68121323e-003
b = 5.89707373e-004
c = 1.47543718e-005
d = 1.37551112e-006
f0 = 2874.206

BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5000	2874.206	-1.5001	-0.00007
1.0000	3042.864	1.0001	0.00005
4.5000	3290.907	4.5001	0.00008
8.0000	3553.245	8.0000	0.00001
11.5000	3830.301	11.4999	-0.00006
15.0000	4122.488	14.9999	-0.00007
18.5000	4430.205	18.5000	-0.00003
22.0000	4753.838	22.0000	0.00000
25.5000	5093.773	25.5001	0.00010
29.0000	5450.360	29.0001	0.00006
32.5000	5823.961	32.4999	-0.00008

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)

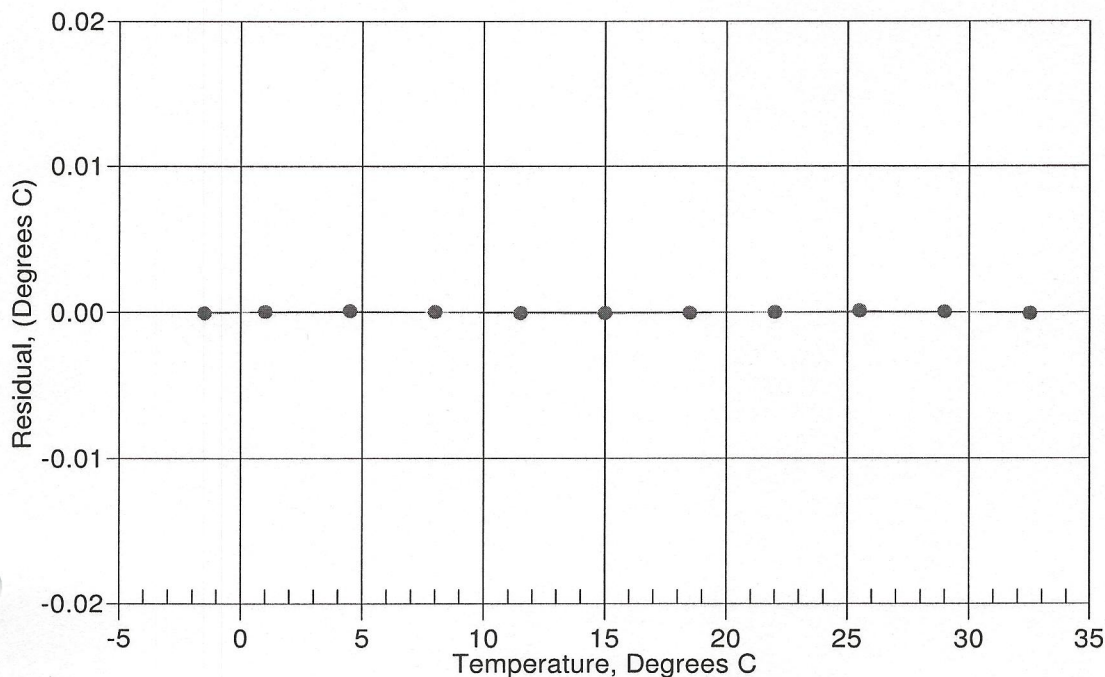
Temperature IPTS-68 = $1/\{a + b[\ln(f_0/f)] + c[\ln^2(f_0/f)] + d[\ln^3(f_0/f)]\} - 273.15$ (°C)

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

Residual = instrument temperature - bath temperature

Date, Offset(mdeg C)

13-Mar-12 -0.00



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: 4003
CALIBRATION DATE: 07-Mar-12

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

GHIJ COEFFICIENTS

g = -1.01978406e+001
h = 1.53524151e+000
i = -2.27452306e-003
j = 2.58938252e-004
CPcor = -9.5700e-008 (nominal)
CTcor = 3.2500e-006 (nominal)

ABCDM COEFFICIENTS

a = 8.30192472e-007
b = 1.52925495e+000
c = -1.01856288e+001
d = -8.02237974e-005
m = 6.1
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	2.58079	0.00000	0.00000
-1.0001	34.9033	2.81092	5.00316	2.81093	0.00001
0.9999	34.9042	2.98275	5.11409	2.98275	-0.00000
14.9999	34.9055	4.28139	5.88480	4.28138	-0.00000
18.4999	34.9051	4.62886	6.07433	4.62886	-0.00001
28.9999	34.9006	5.71456	6.63133	5.71458	0.00002
32.4999	34.8906	6.08747	6.81199	6.08745	-0.00001

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

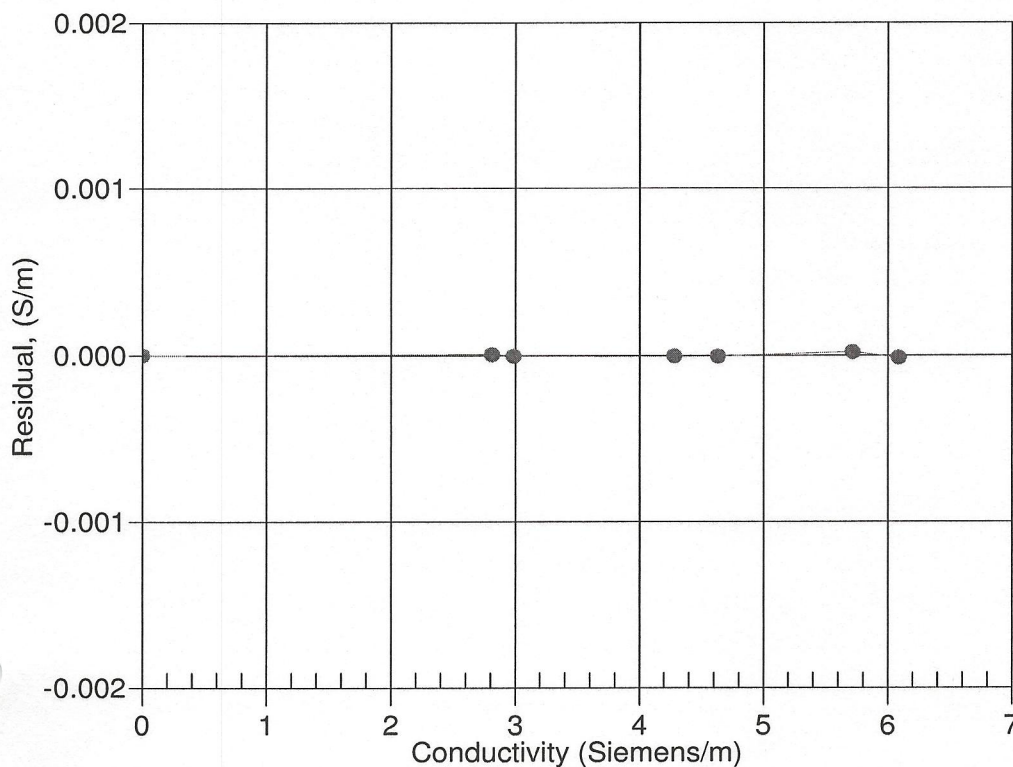
Conductivity = $(af^m + bf^2 + c + dt) / [10(1 + \epsilon p)]$ Siemens/meter

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

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

Date, Slope Correction

07-Mar-12 1.0000000





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Fax: (425) 643-9866

SBE 5T SUBMERSIBLE PUMP CONFIGURATION SHEET

Customer: **Schmidt Research Ves**

Delivery Date: **3/26/2012**

Serial Number: **6362**

MRP PN: **90741**

Job Number: **67149P**

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: **880** RPM Max: **4889** 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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Email: seabird@seabird.com

SBE Pressure Test Certificate

Test Date: 3/26/2012

Description SBE-9Plus CTD

Job Number: 67149

Customer Name Schmidt Research Vessel Institute

SBE Sensor Information:

Model Number: 09

Serial Number: 1087

Pressure Sensor Information:

Sensor Type: DigiQuartz

Sensor Serial Number: 122179

Sensor Rating: 10000

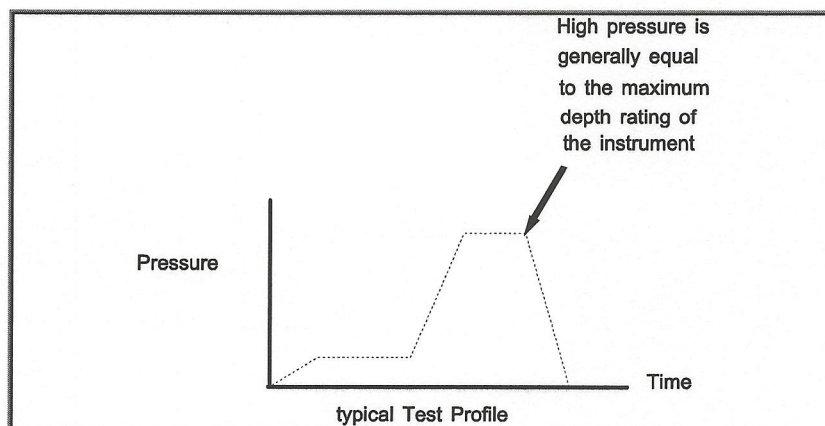
Pressure Test Protocol:

Low Pressure Test: 40 PSI Held For: 15 Minutes

High Pressure Test: 10000 PSI Held For: 15 Minutes

Passed Test: ☒

Tested By: nd





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SBE Pressure Test Certificate

Test Date: 4/8/2011

Description SBE-3 Temperature Sensor

Job Number: 67149

Customer Name Schmidt Research Vessel Institute

SBE Sensor Information:

Model Number: 03

Serial Number: 5483

Pressure Sensor Information:

Sensor Type: None

Sensor Serial Number: None

Sensor Rating: 0

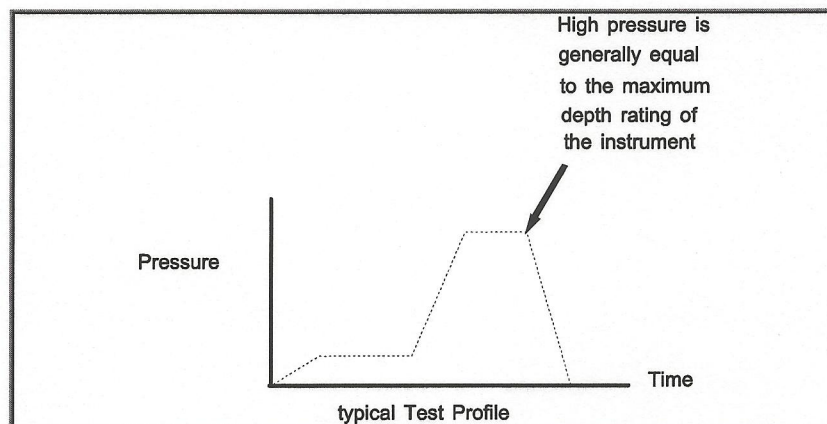
Pressure Test Protocol:

Low Pressure Test: 40 PSI Held For: 15 Minutes

High Pressure Test: 10000 PSI Held For: 15 Minutes

Passed Test: ☒

Tested By: VG





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Email: seabird@seabird.com

SBE Pressure Test Certificate

Test Date: 9/22/2011 Description SBE-4 Conductivity Sensor

Job Number: 67149

Customer Name Schmidt Research Vessel Institute

SBE Sensor Information:

Model Number: 04

Serial Number: 3916

Pressure Sensor Information:

Sensor Type: None

Sensor Serial Number: None

Sensor Rating: 0

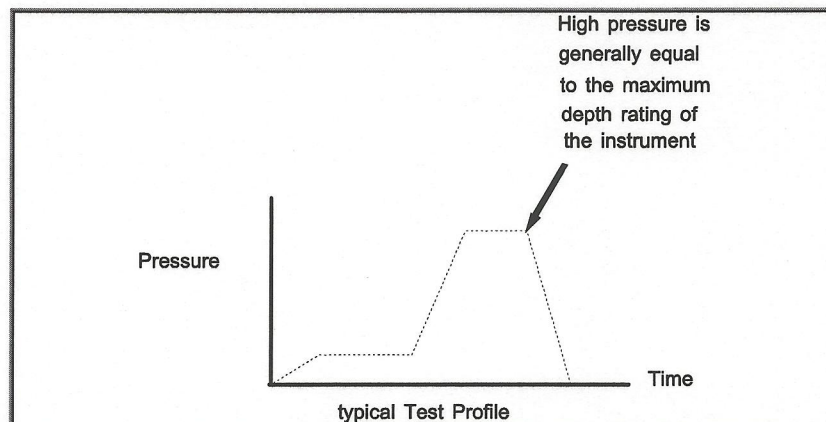
Pressure Test Protocol:

Low Pressure Test: 40 PSI Held For: 15 Minutes

High Pressure Test: 10000 PSI Held For: 15 Minutes

Passed Test: ☒

Tested By: VG





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SBE Pressure Test Certificate

Test Date: 3/20/2012 Description SBE-5T Submersible Pump

Job Number: 67149

Customer Name Schmidt Research Vessel Institute

SBE Sensor Information:

Model Number: 5T

Serial Number: 6361

Pressure Sensor Information:

Sensor Type: None

Sensor Serial Number: None

Sensor Rating: 0

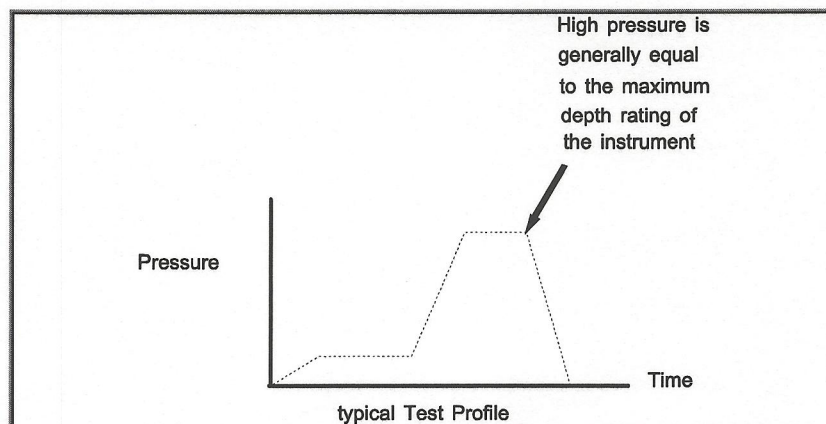
Pressure Test Protocol:

Low Pressure Test: 40 PSI Held For: 15 Minutes

High Pressure Test: 10000 PSI Held For: 15 Minutes

Passed Test: ☒

Tested By: ND





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Email: seabird@seabird.com

SBE Pressure Test Certificate

Test Date: 2/13/2012 Description SBE-3 Temperature Sensor

Job Number: 67149

Customer Name Schmidt Research Vessel Institute

SBE Sensor Information:

Model Number: 03

Serial Number: 5549

Pressure Sensor Information:

Sensor Type: None

Sensor Serial Number: None

Sensor Rating: 0

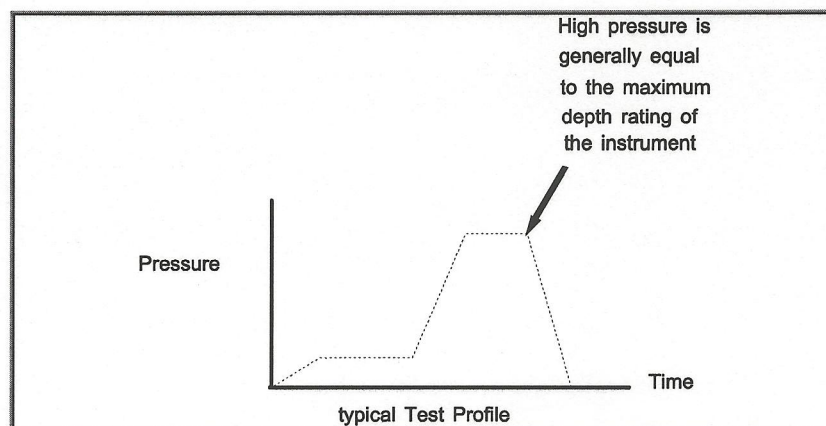
Pressure Test Protocol:

Low Pressure Test: 40 PSI Held For: 15 Minutes

High Pressure Test: 10000 PSI Held For: 15 Minutes

Passed Test: ☒

Tested By: VG





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Phone: (425) 643-9866

FAX: (425) 643-9954

Email: seabird@seabird.com

SBE Pressure Test Certificate

Test Date: 2/13/2012 Description SBE-4 Conductivity Sensor

Job Number: 67149

Customer Name Schmidt Research Vessel Institute

SBE Sensor Information:

Model Number: 04

Serial Number: 4003

Pressure Sensor Information:

Sensor Type: None

Sensor Serial Number: None

Sensor Rating: 0

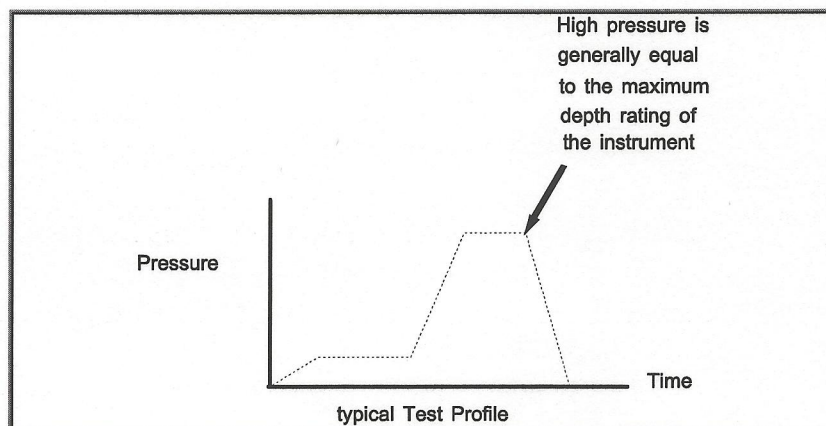
Pressure Test Protocol:

Low Pressure Test: 40 PSI Held For: 15 Minutes

High Pressure Test: 10000 PSI Held For: 15 Minutes

Passed Test: ☒

Tested By: VG





Sea-Bird Electronics, Inc.

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Phone: (425) 643-9866

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Email: seabird@seabird.com

SBE Pressure Test Certificate

Test Date: 3/20/2012 Description SBE-5T Submersible Pump

Job Number: 67149

Customer Name Schmidt Research Vessel Institute

SBE Sensor Information:

Model Number: 5T

Serial Number: 6362

Pressure Sensor Information:

Sensor Type: None

Sensor Serial Number: None

Sensor Rating: 0

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

