

SYSTEM CONFIGURATION

15 July 2009

SBE 9plus CTD Underwater Unit **S/N 09P54528-0954**Depth Capability **6800 meters**

Pressure Sensor Range **0-10000 psia**
 Digiquartz Pressure Sensor (w/ temp-comp) **S/N 114729**
 Modulo 12P **S/N MOD12P-0939**
 AD590M (Pressure Temperature Coefficient) **0.012815**
 AD590B (Pressure Temperature Coefficient) **-9.225127**

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 |
| Voltage 0 | Oxygen, SBE 43 |
| Voltage 1 | Free |
| Voltage 2 | Oxygen, SBE 43 |
| Voltage 3 | Free |

| | |
|---------------------------------------|----------------|
| Temperature Sensor (SBE 3plus) | 03P5146 |
| Temperature Sensor (SBE 3plus) | 03P5147 |
| Conductivity Sensor (SBE 4C) | 043678 |
| Conductivity Sensor (SBE 4C) | 043679 |
| Pump (SBE 5T) | 055351 |
| Pump (SBE 5T) | 055352 |
| DO Sensor (SBE 43) | 431638 |
| DO Sensor (SBE 43) | 431639 |

CALIBRATION SHEETS

| | |
|--|----|
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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: 5146
CALIBRATION DATE: 06-Jun-09

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.36713215e-003
h = 6.40543964e-004
i = 2.23395463e-005
j = 2.11304980e-006
f0 = 1000.0

IPTS-68 COEFFICIENTS

a = 3.68121372e-003
b = 5.98928709e-004
c = 1.53349275e-005
d = 2.11451780e-006
f0 = 3032.100

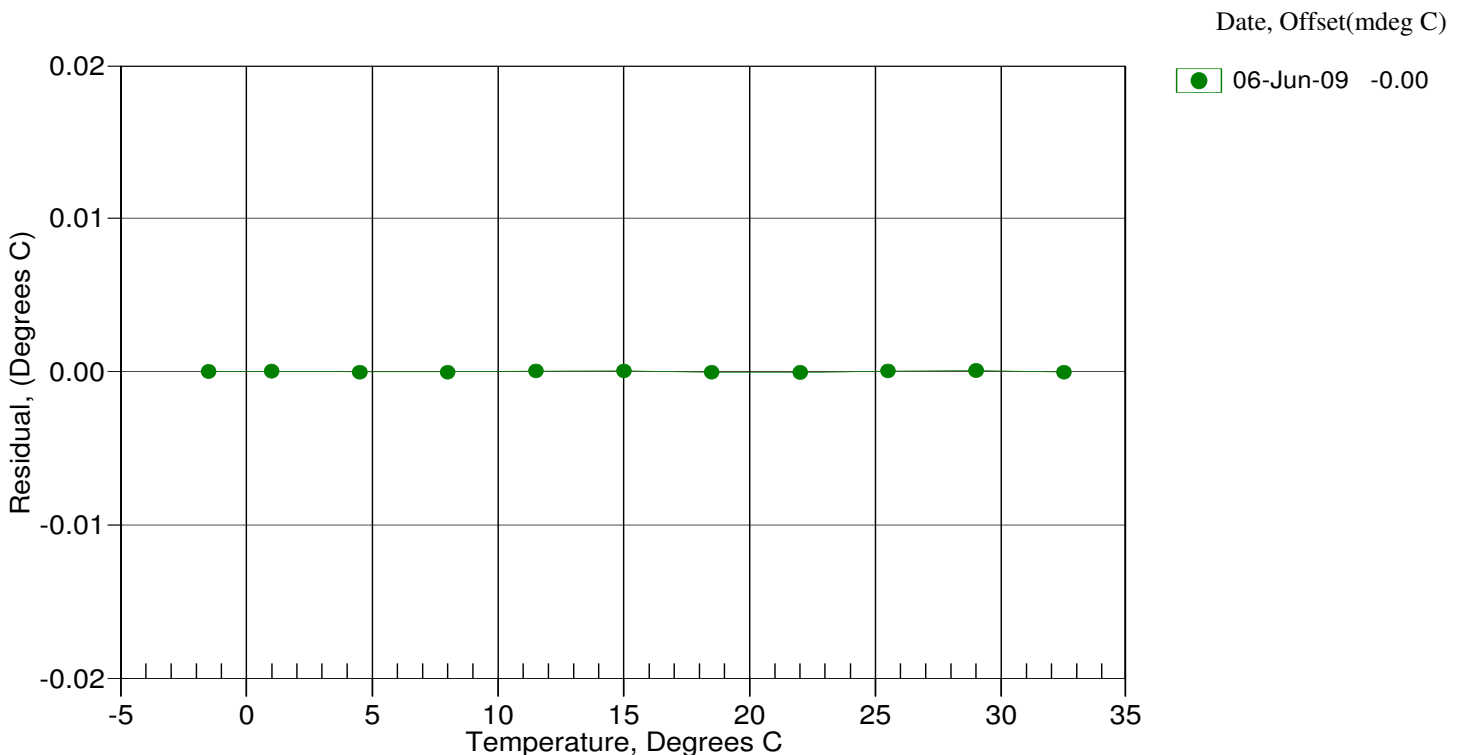
| BATH TEMP (ITS-90) | INSTRUMENT FREQ (Hz) | INST TEMP (ITS-90) | RESIDUAL (ITS-90) |
|-----------------------|-------------------------|-----------------------|----------------------|
| -1.5001 | 3032.100 | -1.5001 | -0.00000 |
| 0.9999 | 3207.200 | 0.9999 | 0.00001 |
| 4.4999 | 3464.454 | 4.4999 | -0.00001 |
| 7.9999 | 3736.208 | 7.9999 | -0.00002 |
| 11.4999 | 4022.854 | 11.4999 | 0.00003 |
| 14.9999 | 4324.763 | 14.9999 | 0.00005 |
| 18.5000 | 4642.304 | 18.4999 | -0.00005 |
| 22.0000 | 4975.830 | 21.9999 | -0.00007 |
| 25.4999 | 5325.686 | 25.4999 | 0.00004 |
| 28.9999 | 5692.201 | 29.0000 | 0.00006 |
| 32.5000 | 6075.683 | 32.5000 | -0.00004 |

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: 3678
CALIBRATION DATE: 30-Jun-09

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

GHIJ COEFFICIENTS

g = -9.78560569e+000
h = 1.54371529e+000
i = -8.44485414e-004
j = 1.54505960e-004
CPcor = -9.5700e-008 (nominal)
CTcor = 3.2500e-006 (nominal)

ABCDM COEFFICIENTS

a = 1.73305637e-005
b = 1.54190966e+000
c = -9.78278046e+000
d = -8.52988142e-005
m = 4.7
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 | 2.51867 | 0.00000 | 0.00000 |
| -1.0000 | 34.8024 | 2.80356 | 4.95037 | 2.80354 | -0.00002 |
| 0.9999 | 34.8025 | 2.97489 | 5.06117 | 2.97491 | 0.00003 |
| 15.0000 | 34.8036 | 4.27022 | 5.83052 | 4.27021 | -0.00001 |
| 18.5000 | 34.8033 | 4.61683 | 6.01963 | 4.61683 | -0.00000 |
| 29.0000 | 34.8016 | 5.70018 | 6.57542 | 5.70020 | 0.00002 |
| 32.5000 | 34.7974 | 6.07307 | 6.75602 | 6.07305 | -0.00001 |

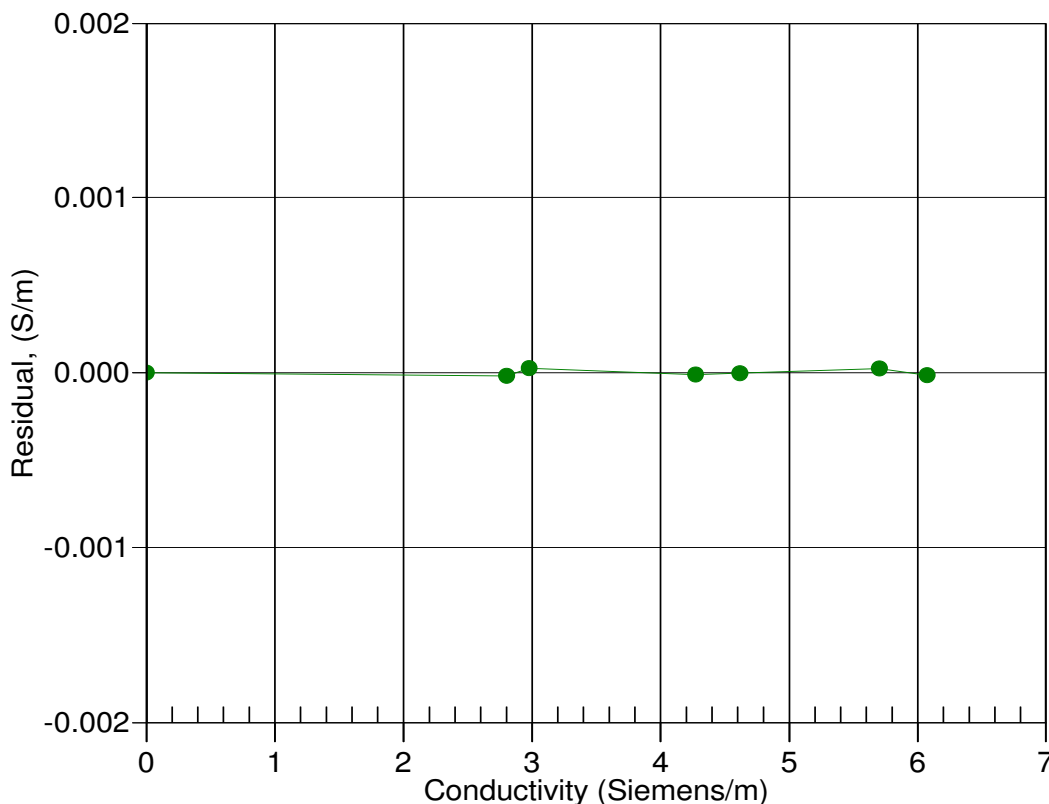
Conductivity = $(g + hf^2 + if^3 + jf^4) / 10(1 + \delta t + \epsilon p)$ Siemens/meter

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





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Digiquartz Pressure Calibration dP/dT Corrected Coefficients

(Changed coefficients are posted in italics)

Pressure Transducer Serial Number: 114729

Original Calibration Date: 2009-06-02

Date of Correction: 2009-07-14

Installed in: SBE 9Plus S/N 0954

PRESSURE COEFFICIENTS

| | | |
|-----------|-----------------------|-------------------------|
| <i>C1</i> | <i>-39662.19</i> | <i>psia</i> |
| <i>C2</i> | <i>-2.1274942e-01</i> | <i>psia/deg C</i> |
| C3 | 1.2186e-02 | psia/deg C ² |
| D1 | 0.035926 | |
| D2 | 0.0 | |
| <i>T1</i> | <i>30.0169</i> | <i>μsec</i> |
| <i>T2</i> | <i>-3.352912e-04</i> | <i>μsec/deg C</i> |
| T3 | 4.0057e-06 | μsec/deg C ² |
| T4 | 2.90708e-09 | μsec/deg C ³ |
| T5 | 0e+00 | |

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 information purposes and should not be used.

CALIBRATION COEFFICIENTS

SERIAL NO : 114729

PRESSURE TRANSDUCER

DATE : 06-02-2009

| | | | |
|----------|------------------|----------------|--------|
| 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 | -39661.08 psia |
| C ₂ | -1.98094E-01 psia/deg C |
| C ₃ | 1.21865E-02 psia/deg C ² |

| | |
|----------------|----------|
| D ₁ | 0.035926 |
| D ₂ | 0 |

| | |
|----------------|-------------------------------------|
| T ₁ | 30.01725 μsec |
| T ₂ | -3.30149E-04 μsec/deg C |
| T ₃ | 4.00572E-06 μsec/deg C ² |
| T ₄ | 2.90708E-09 μsec/deg C ³ |
| T ₅ | 0 |

(06-02-2009)

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

CUSTOMER : SEABIRD ELECTRONICS, INC.

SALES ORDER : 26474

PREPARED BY : T.C.



CALIBRATION COEFFICIENTSSERIAL NO : **114729**

PRESSURE TRANSDUCER

DATE : **06-02-2009**

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

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) | -39659.87 | | | | |
| D | 0.035926 | | | | |
| T ₀ (μsec) | 30.01211 | | | | |

(06-02-2009)

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SALES ORDER : 26474

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Website: <http://www.seabird.com>

Tel: (425) 643-9866

Email: seabird@seabird.com

Fax: (425) 643-9866

SBE 5T SUBMERSIBLE PUMP CONFIGURATION SHEETCustomer: Delivery Date: Serial Number: MRP PN: Job Number:

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

SENSOR SERIAL NUMBER: 1638
CALIBRATION DATE: 15-Jul-09p

SBE 43 OXYGEN CALIBRATION DATA

COEFFICIENTS

Soc = 0.5854

Voffset = -0.4855

Tau20 = 1.98

A = -4.0257e-003

B = 1.4109e-004

C = -1.8468e-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

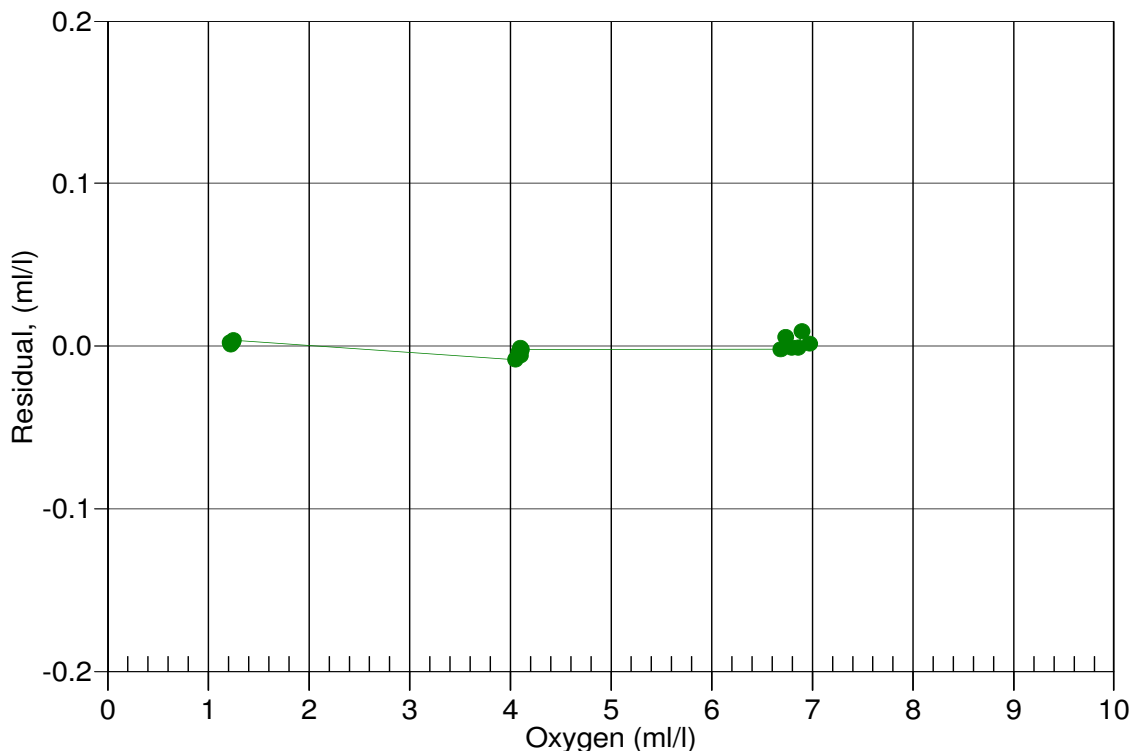
| BATH OX (ml/l) | BATH TEMP ITS-90 | BATH SAL PSU | INSTRUMENT OUTPUT(VOLTS) | INSTRUMENT OXYGEN(ml/l) | RESIDUAL (ml/l) |
|-------------------|---------------------|-----------------|-----------------------------|----------------------------|--------------------|
| 1.21 | 2.00 | 0.00 | 0.702 | 1.22 | 0.00 |
| 1.22 | 6.00 | 0.01 | 0.730 | 1.22 | 0.00 |
| 1.24 | 12.00 | 0.01 | 0.775 | 1.24 | 0.00 |
| 1.24 | 20.00 | 0.01 | 0.833 | 1.24 | 0.00 |
| 1.25 | 26.00 | 0.01 | 0.879 | 1.25 | 0.00 |
| 1.26 | 30.00 | 0.01 | 0.911 | 1.26 | 0.00 |
| 4.05 | 2.00 | 0.00 | 1.204 | 4.04 | -0.01 |
| 4.08 | 6.00 | 0.01 | 1.301 | 4.08 | -0.00 |
| 4.10 | 12.00 | 0.01 | 1.442 | 4.09 | -0.01 |
| 4.10 | 26.00 | 0.01 | 1.772 | 4.10 | -0.00 |
| 4.10 | 20.00 | 0.01 | 1.630 | 4.10 | -0.00 |
| 4.11 | 30.00 | 0.01 | 1.873 | 4.11 | -0.00 |
| 6.68 | 30.00 | 0.01 | 2.742 | 6.68 | -0.00 |
| 6.73 | 26.00 | 0.01 | 2.601 | 6.74 | 0.01 |
| 6.79 | 20.00 | 0.01 | 2.382 | 6.79 | -0.00 |
| 6.86 | 12.00 | 0.01 | 2.089 | 6.86 | -0.00 |
| 6.90 | 6.00 | 0.01 | 1.867 | 6.91 | 0.01 |
| 6.97 | 2.00 | 0.00 | 1.726 | 6.97 | 0.00 |

Oxygen (ml/l) = Soc * (V + Voffset) * (1.0 + A * T + B * T² + C * T³) * 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)



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

SENSOR SERIAL NUMBER: 5147
CALIBRATION DATE: 12-Jun-09

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.40606823e-003
h = 6.44363290e-004
i = 2.32348798e-005
j = 2.22306676e-006
f0 = 1000.0

IPTS-68 COEFFICIENTS

a = 3.68121330e-003
b = 5.99309710e-004
c = 1.54679898e-005
d = 2.22456114e-006
f0 = 3217.696

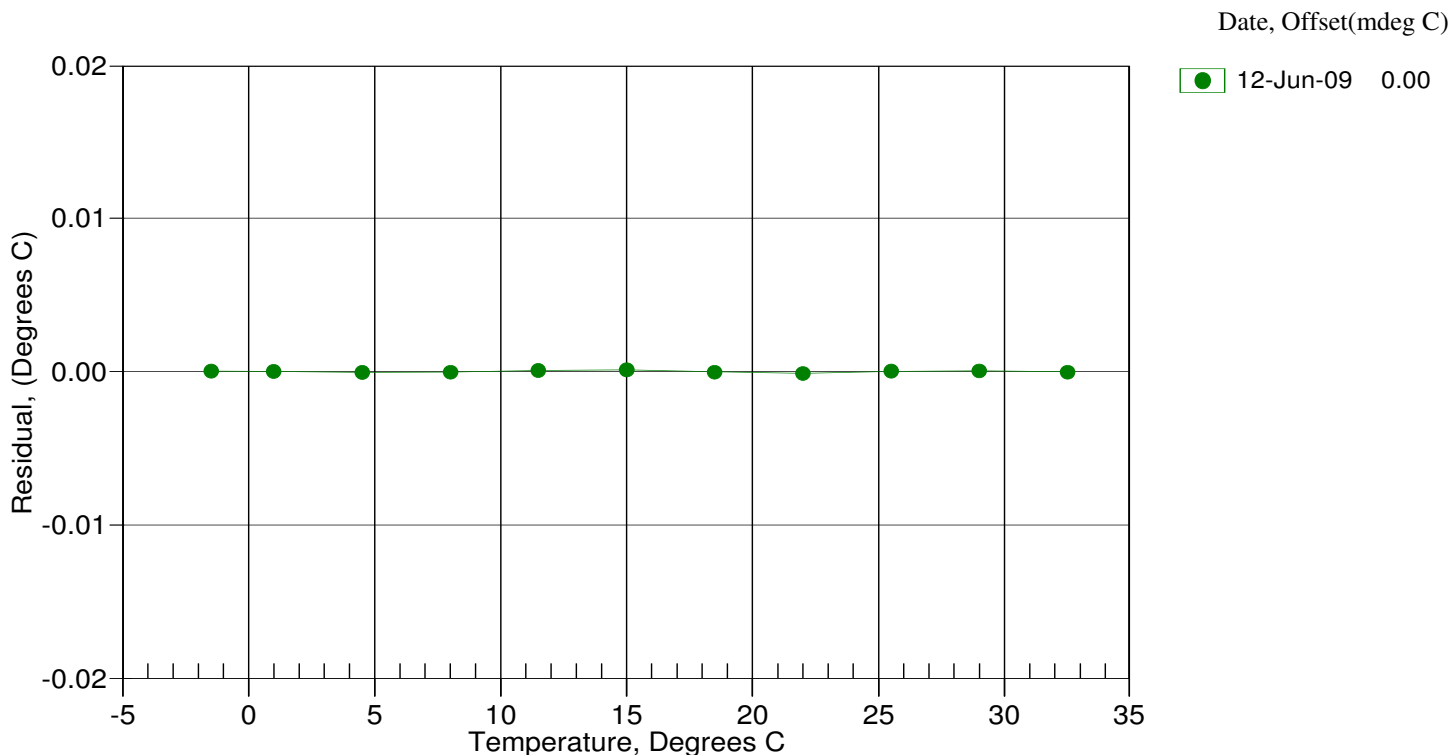
| BATH TEMP (ITS-90) | INSTRUMENT FREQ (Hz) | INST TEMP (ITS-90) | RESIDUAL (ITS-90) |
|-----------------------|-------------------------|-----------------------|----------------------|
| -1.5001 | 3217.696 | -1.5001 | 0.00003 |
| 1.0000 | 3403.398 | 1.0000 | -0.00001 |
| 4.5000 | 3676.216 | 4.4999 | -0.00006 |
| 8.0000 | 3964.407 | 8.0000 | -0.00004 |
| 11.4999 | 4268.375 | 11.5000 | 0.00006 |
| 14.9999 | 4588.524 | 15.0000 | 0.00010 |
| 18.4999 | 4925.221 | 18.4999 | -0.00002 |
| 22.0000 | 5278.865 | 21.9999 | -0.00012 |
| 25.4999 | 5649.808 | 25.4999 | 0.00001 |
| 28.9999 | 6038.391 | 29.0000 | 0.00005 |
| 32.5000 | 6444.942 | 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)

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: 3679
CALIBRATION DATE: 30-Jun-09

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

GHIJ COEFFICIENTS

g = -1.01107594e+001
h = 1.52750820e+000
i = -6.57509437e-004
j = 1.40573070e-004
CPcor = -9.5700e-008 (nominal)
CTcor = 3.2500e-006 (nominal)

ABCDM COEFFICIENTS

a = 2.72213639e-005
b = 1.52613189e+000
c = -1.01086238e+001
d = -8.50925561e-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 | 2.57341 | 0.00000 | 0.00000 |
| -1.0000 | 34.8024 | 2.80356 | 4.99691 | 2.80354 | -0.00002 |
| 0.9999 | 34.8025 | 2.97489 | 5.10779 | 2.97491 | 0.00002 |
| 15.0000 | 34.8036 | 4.27022 | 5.87822 | 4.27021 | -0.00001 |
| 18.5000 | 34.8033 | 4.61683 | 6.06769 | 4.61683 | -0.00000 |
| 29.0000 | 34.8016 | 5.70018 | 6.62477 | 5.70021 | 0.00003 |
| 32.5000 | 34.7974 | 6.07307 | 6.80584 | 6.07305 | -0.00002 |

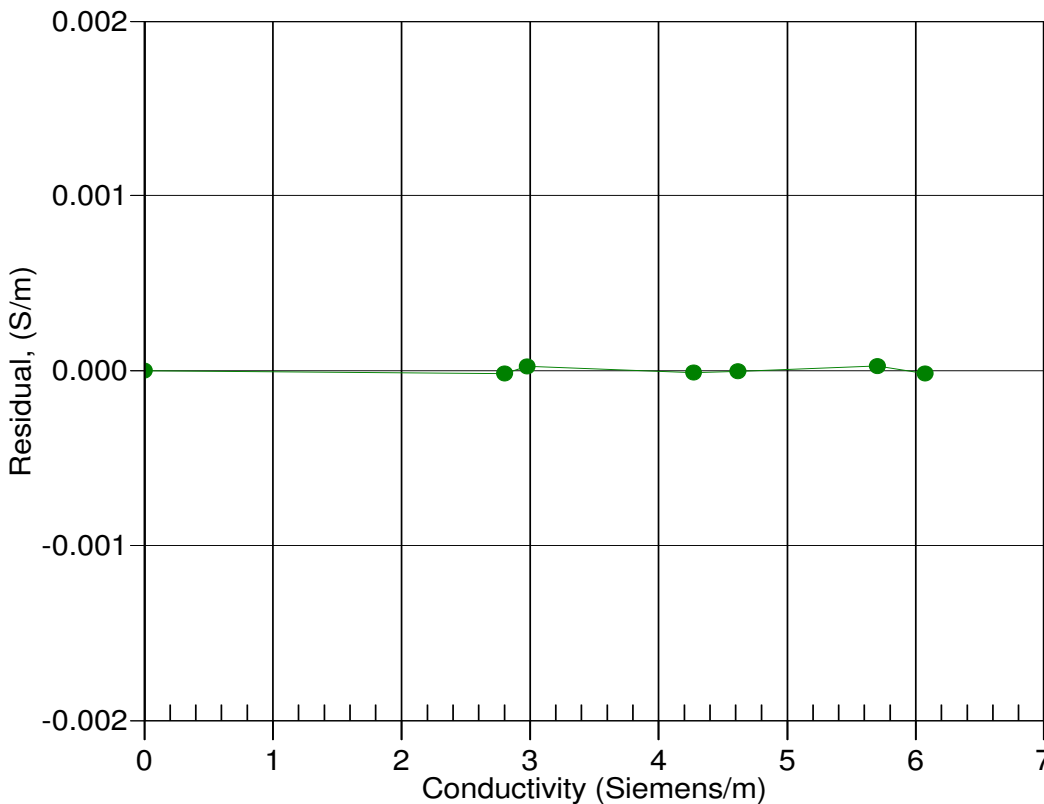
Conductivity = $(g + hf^2 + if^3 + jf^4) / 10(1 + \delta t + \epsilon p)$ Siemens/meter

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





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SBE 5T SUBMERSIBLE PUMP CONFIGURATION SHEETCustomer: Delivery Date: Serial Number: MRP PN: Job Number:

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: 1639
CALIBRATION DATE: 15-Jul-09p

SBE 43 OXYGEN CALIBRATION DATA

COEFFICIENTS

Soc = 0.4554

Voffset = -0.5014

Tau20 = 1.62

A = -1.5075e-003

B = 1.8029e-004

C = -2.8964e-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) |
|-------------------|---------------------|-----------------|-----------------------------|----------------------------|--------------------|
| 1.21 | 2.00 | 0.00 | 0.777 | 1.21 | -0.00 |
| 1.22 | 6.00 | 0.01 | 0.811 | 1.22 | 0.00 |
| 1.24 | 12.00 | 0.01 | 0.861 | 1.24 | 0.00 |
| 1.24 | 20.00 | 0.01 | 0.924 | 1.25 | 0.00 |
| 1.25 | 26.00 | 0.01 | 0.972 | 1.25 | 0.00 |
| 1.26 | 30.00 | 0.01 | 1.006 | 1.26 | 0.01 |
| 4.05 | 2.00 | 0.00 | 1.421 | 4.04 | -0.01 |
| 4.08 | 6.00 | 0.01 | 1.532 | 4.08 | -0.01 |
| 4.10 | 12.00 | 0.01 | 1.690 | 4.09 | -0.00 |
| 4.10 | 26.00 | 0.01 | 2.037 | 4.10 | -0.00 |
| 4.10 | 20.00 | 0.01 | 1.889 | 4.10 | -0.00 |
| 4.11 | 30.00 | 0.01 | 2.144 | 4.11 | 0.00 |
| 6.68 | 30.00 | 0.01 | 3.171 | 6.68 | -0.00 |
| 6.73 | 26.00 | 0.01 | 3.026 | 6.73 | 0.00 |
| 6.79 | 20.00 | 0.01 | 2.802 | 6.79 | 0.00 |
| 6.86 | 12.00 | 0.01 | 2.493 | 6.86 | 0.00 |
| 6.90 | 6.00 | 0.01 | 2.247 | 6.90 | 0.00 |
| 6.97 | 2.00 | 0.00 | 2.088 | 6.98 | 0.00 |

Oxygen (ml/l) = Soc * (V + Voffset) * (1.0 + A * T + B * T² + C * T³) * 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)

