

**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: 2326  
 CALIBRATION DATE: 23-Mar-00

SBE16 CONDUCTIVITY CALIBRATION DATA  
 PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

**GHIJ COEFFICIENTS**

g = -4.07123686e+000  
 h = 4.85185043e-001  
 i = 1.42951715e-003  
 j = -3.59720135e-005  
 CPcor = -9.5700e-008 (nominal)  
 CTcor = 3.2500e-006 (nominal)

**ABCDM COEFFICIENTS**

a = 5.89068481e-002  
 b = 4.21524905e-001  
 c = -4.05263641e+000  
 d = -1.37568061e-004  
 m = 2.1  
 CPcor = -9.5700e-008 (nominal)

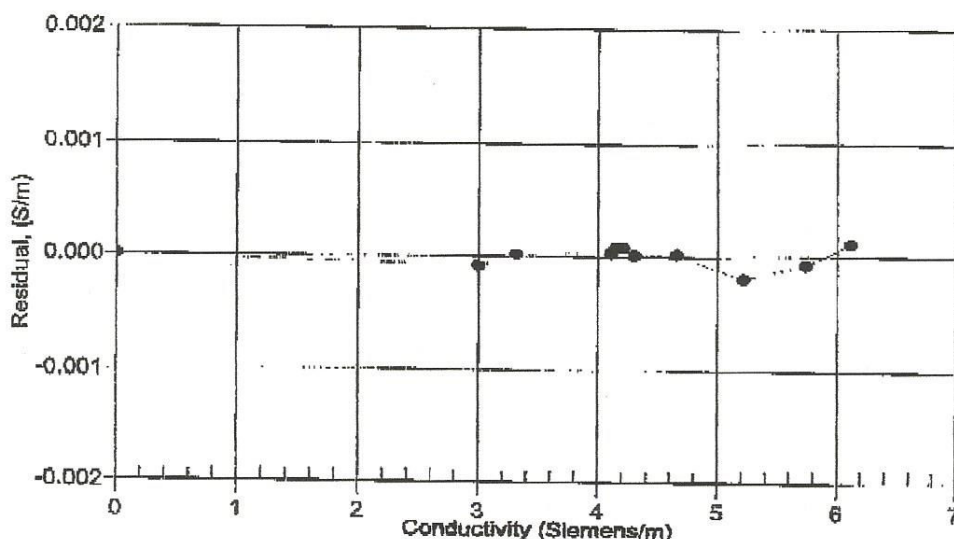
| BATH TEMP<br>(ITS-90) | BATH SAL<br>(PSU) | BATH COND<br>(Siemens/m) | INST FREQ<br>(kHz) | INST COND<br>(Siemens/m) | RESIDUAL<br>(Siemens/m) |
|-----------------------|-------------------|--------------------------|--------------------|--------------------------|-------------------------|
| 22.0000               | 0.0000            | 0.00000                  | 2.88540            | 0.00000                  | 0.00000                 |
| 0.9999                | 35.1055           | 2.99831                  | 8.29787            | 2.99822                  | -0.00009                |
| 4.5000                | 35.1039           | 3.30917                  | 8.66987            | 3.30918                  | 0.00001                 |
| 13.0000               | 35.1007           | 4.10700                  | 9.54447            | 4.10703                  | 0.00003                 |
| 13.5000               | 35.1007           | 4.15568                  | 9.59549            | 4.15576                  | 0.00008                 |
| 13.9999               | 35.1005           | 4.20451                  | 9.64634            | 4.20459                  | 0.00008                 |
| 15.0000               | 35.1005           | 4.30277                  | 9.74777            | 4.30278                  | 0.00001                 |
| 18.4999               | 35.0998           | 4.65188                  | 10.10008           | 4.65190                  | 0.00002                 |
| 24.0001               | 35.1005           | 5.21621                  | 10.64442           | 5.21602                  | -0.00019                |
| 29.0000               | 35.0985           | 5.74331                  | 11.12882           | 5.74324                  | -0.00007                |
| 32.5000               | 35.0949           | 6.11905                  | 11.46158           | 6.11916                  | 0.00011                 |

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  
 23-Mar-00 1.000000

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SENSOR SERIAL NUMBER: 2326  
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SBE16 TEMPERATURE CALIBRATION DATA  
 ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.17578854e-003  
 h = 6.03379598e-004  
 i = 1.22646309e-006  
 j = -2.36094980e-006  
 f0 = 1000.0

ITS-68 COEFFICIENTS

a = 3.64763710e-003  
 b = 5.95884700e-004  
 c = 7.48133904e-006  
 d = -2.36069625e-006  
 f0 = 2409.819

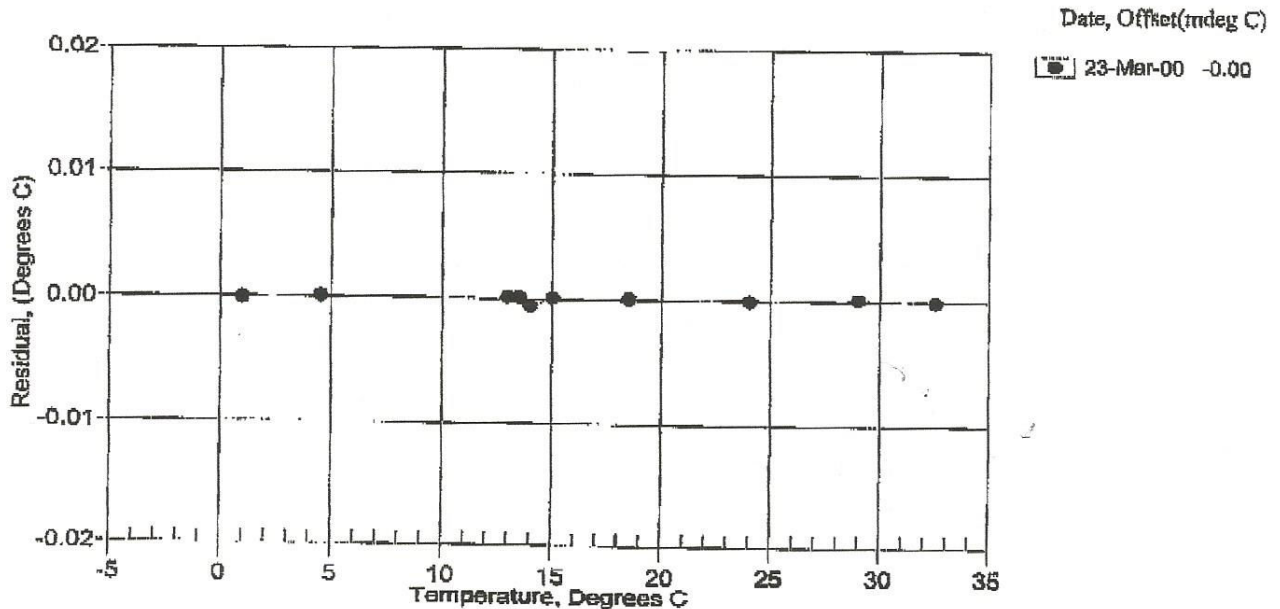
| BATH TEMP<br>(ITS-90) | INSTRUMENT FREQ<br>(Hz) | INST TEMP<br>(ITS-90) | RESIDUAL<br>(ITS-90) |
|-----------------------|-------------------------|-----------------------|----------------------|
| 0.9999                | 2409.819                | 0.9998                | -0.00006             |
| 4.5000                | 2603.398                | 4.5001                | 0.00011              |
| 13.0000               | 3118.105                | 13.0002               | 0.00018              |
| 13.5000               | 3150.411                | 13.5001               | 0.00013              |
| 13.9999               | 3182.900                | 13.9994               | -0.00055             |
| 15.0000               | 3248.725                | 15.0001               | 0.00009              |
| 18.4999               | 3486.342                | 18.5000               | 0.00009              |
| 24.0001               | 3883.579                | 24.0001               | -0.00005             |
| 29.0000               | 4270.784                | 29.0001               | 0.00012              |
| 32.5000               | 4557.041                | 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 ITS-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



Pressure Calibration Check

27 March 2000

pressure sensor model: DigiQuartz 410K-105  
 sensor serial number: 64857  
 installed in: CTD 1611148-2326

This pressure calibration is a check of the 'test' sensor against a stable reference pressure sensor. The reference pressure sensor is itself checked several times per year against a NIST-traceable pressure standard maintained at Paroscientific, Inc.. The circumstances of this pressure check introduce no more than 1.5 psia total error in 10,000 psi (0.015 %) in addition to the error resident in the Paroscientific site standard. The check offers a very high level certification of the health and proper operation of the 'test' sensor.

| Input Pressure* [psia] | Sensor Output [mV] | Sensor Temperature [deg C] | Pressure Factory Coef [psia] | Pressure Corrected [psia] | Error [psia] |
|------------------------|--------------------|----------------------------|------------------------------|---------------------------|--------------|
| 14.700                 | 33028.17           | 22.0                       | 14.463                       | 14.043                    | -0.657       |
| 2013.591               | 33694.71           | 22.1                       | 2014.255                     | 2013.531                  | -0.060       |
| 4012.646               | 34346.15           | 22.1                       | 4013.670                     | 4012.642                  | -0.004       |
| 6011.602               | 34983.45           | 22.1                       | 6013.021                     | 6011.689                  | 0.087        |
| 8010.390               | 35607.37           | 22.1                       | 8012.155                     | 8010.520                  | 0.130        |
| 10009.449              | 36218.47           | 22.1                       | 10010.703                    | 10008.764                 | -0.685       |
| 8010.253               | 35607.36           | 22.1                       | 8012.116                     | 8010.481                  | 0.228        |
| 6011.330               | 34983.47           | 22.2                       | 6012.996                     | 6011.664                  | 0.334        |
| 4012.346               | 34346.17           | 22.2                       | 4013.671                     | 4012.643                  | 0.297        |
| 2013.291               | 33694.73           | 22.2                       | 2014.219                     | 2013.495                  | 0.204        |
| 13.896                 | 33028.22           | 22.2                       | 14.443                       | 14.023                    | 0.127        |

Input pressure is generated with a Ruska model 5201 dead-weight tester, serial number 23330/380, and is determined by measurement with reference pressure sensor model DigiQuartz 410K-000, serial number 73292.

Sensor Temperature: pressure sensor internal temperature.

Pressure Corrected: pressure computed with original factory coefficients and then corrected with a slope and offset to give the best linear agreement with the 'reference' input pressure.

Error: Corrected pressure - Input pressure

A linear fit of this calibration data, between sensor pressure computed with factory coefficients and the input pressure, yields correction coefficients:

$$\text{Corrected pressure} = \text{psi\_slope} * \text{Factory pressure} + \text{psi\_offset [psia]}$$

$$\text{psi\_slope} = 0.99985 \text{ and } \text{psi\_offset} = -0.42 \text{ [psia]}$$

These are converted to Slope and Offset in decibars for use in the SEASOFT programs by: Slope = psi\_slope = 0.99985  
 Offset = C \* (psi\_offset - 14.7 \* (1 - psi\_slope)) = -0.2900 [dbars]  
 C = 0.689476 [dbar/psi]

Slope and Offset coefficients are entered into the pressure sensor calibration coefficient section of the <>.CON file using the program SEACON.

DigiQuartz Coefficients:

C1 = -4.894762e+04  
 C2 = -9.102170e-01  
 C3 = 1.593180e-02  
 D1 = 3.883600e-02  
 D2 = 0.000000e+00  
 T1 = 3.029141e+01  
 T2 = -5.307730e-04  
 T3 = 3.883590e-06  
 T4 = 4.607360e-09

Calibration Correction:

Slope = 0.99985  
 Offset = -0.2900