



Sea-Bird Electronics, Inc.
 13431 NE 20th Street
 Bellevue, WA 98005 United States

Phone
 Fax

+1-425-643-9866
 +1-425-643-9954
 www.seabird.com
1005508829
 26-DEC-2019
 315756594

SERVICE REPORT

Service Request
Date
Sales Order

CUSTOMER INFORMATION

Name: TELEDYNE WEBB RESEARCH
 Account : 40280819
 CHUCK STILL
 CHARLES.STILL@TELEDYNE.COM
 508-563-1000

PO Number:

Bill To Address

ATTN: ACCOUNTS PAYABLE
 1026 N. Williamson Blvd.
 Daytona Beach,FL,32114,US

Ship To Address

BUSINESS UNIT OF TELEDYNE INSTRUMENT INC
 49 EDGERTON DRIVE
 NORTH FALMOUTH,MA,02556,US

PRODUCT INFORMATION

Item: SLOCUM.LEGACY
 Item Description: (LEGACY) Slocum Glider
 Serial: 9089

Special Notes

Services Requested:
 Evaluate/Repair Instrumentation.
 Perform Routine Calibration Service.

Problems Found:

The conductivity was found to have high residuals. Replacement required.

Services Performed:

Performed initial diagnostic evaluation.
 Performed "POST" cruise calibration.
 Performed pressure calibration.
 Replaced the conductivity cell.
 Replaced the temperature probe.
 Replaced the lithium back-up battery(s).
 Replaced the O-rings.
 Performed a hydrostatic pressure test.
 Performed a "Final" Calibration.
 Replaced pump motor and pump driver cup.
 Installed NEW AF24173 Anti-foulant cylinder.

Item	Item Description	Qty
CAL_SLOCUM	Calibrate SLOCUM conductivity and temperature sensors	1
REPGLIDERCELL	Extra charge to replace broken SBE Glider conductivity cell	1
CNCRTSLOCUM	Confirm & Re-certify Webb SLOCUM Glider CTD	1
REPLACEAF	Extra charge to install one antifoulant device, includes one 801542.1.	1
PCAL_SLOCUM	Calibrate SLOCUM pressure sensor	1



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Unbilled Items

Part Number	Description	Quantity
801801	GLIDER TEMPERATURE PROBE ASSY, FENWAL	1
801542.1	AF24173 ANTI-FOULANT, SINGLE CYLINDER, V2	1
801845	NEODYMIUM MAGNET CUP ASSEMBLY, SHORT	1
22096	LITHIUM COIN BATTERY, WITH TABS, BR1632A/HA	1
802599	SBE37 V2.5 CONDUCTIVITY CELL ASSY, NO WRAP	1
20199	MOTOR, PUMP, MAXON REMAX 24, PN 284336, 36V	1



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SENSOR SERIAL NUMBER: 9089
CALIBRATION DATE: 17-Dec-19

Slocum Payload CTD TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

COEFFICIENTS:

a0 = -1.527680e-004
a1 = 3.116982e-004
a2 = -4.569581e-006
a3 = 2.043665e-007

BATH TEMP (° C)	INSTRUMENT OUTPUT (counts)	INST TEMP (° C)	RESIDUAL (° C)
0.9999	562865.2	1.0000	0.0001
4.5000	482293.1	4.4999	-0.0001
15.0000	309377.4	15.0001	0.0001
18.5000	268476.1	18.5000	0.0000
24.0000	216126.9	24.0000	-0.0000
29.0000	178529.0	28.9999	-0.0001
32.5000	156690.2	32.5001	0.0001

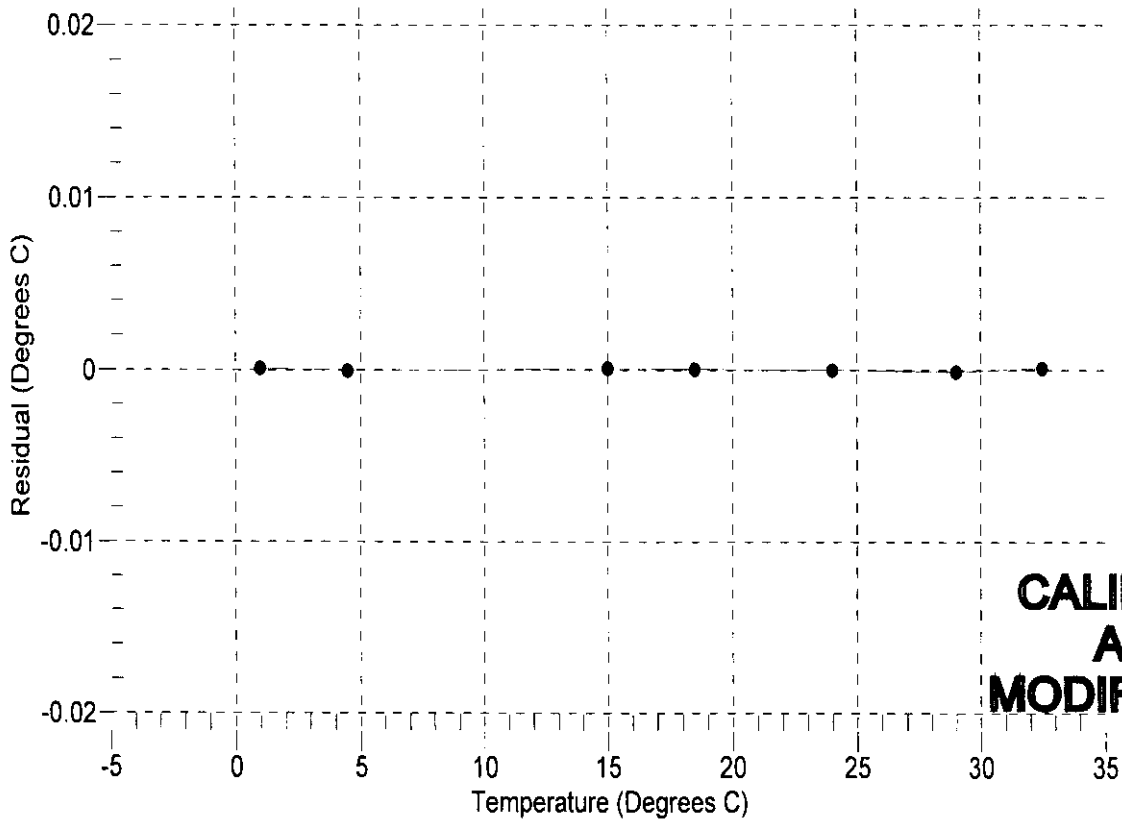
n = Instrument Output (counts)

Temperature ITS-90 (°C) = $1/\{a_0 + a_1[\ln(n)] + a_2[\ln^2(n)] + a_3[\ln^3(n)]\} - 273.15$

Residual (°C) = instrument temperature - bath temperature

Date, Offset (mdeg C)

● 17-Dec-19 0.00



**CALIBRATION
AFTER
MODIFICATIONS**



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SENSOR SERIAL NUMBER: 9089
 CALIBRATION DATE: 04-Oct-19

Slocum Payload CTD TEMPERATURE CALIBRATION DATA
 ITS-90 TEMPERATURE SCALE

COEFFICIENTS:

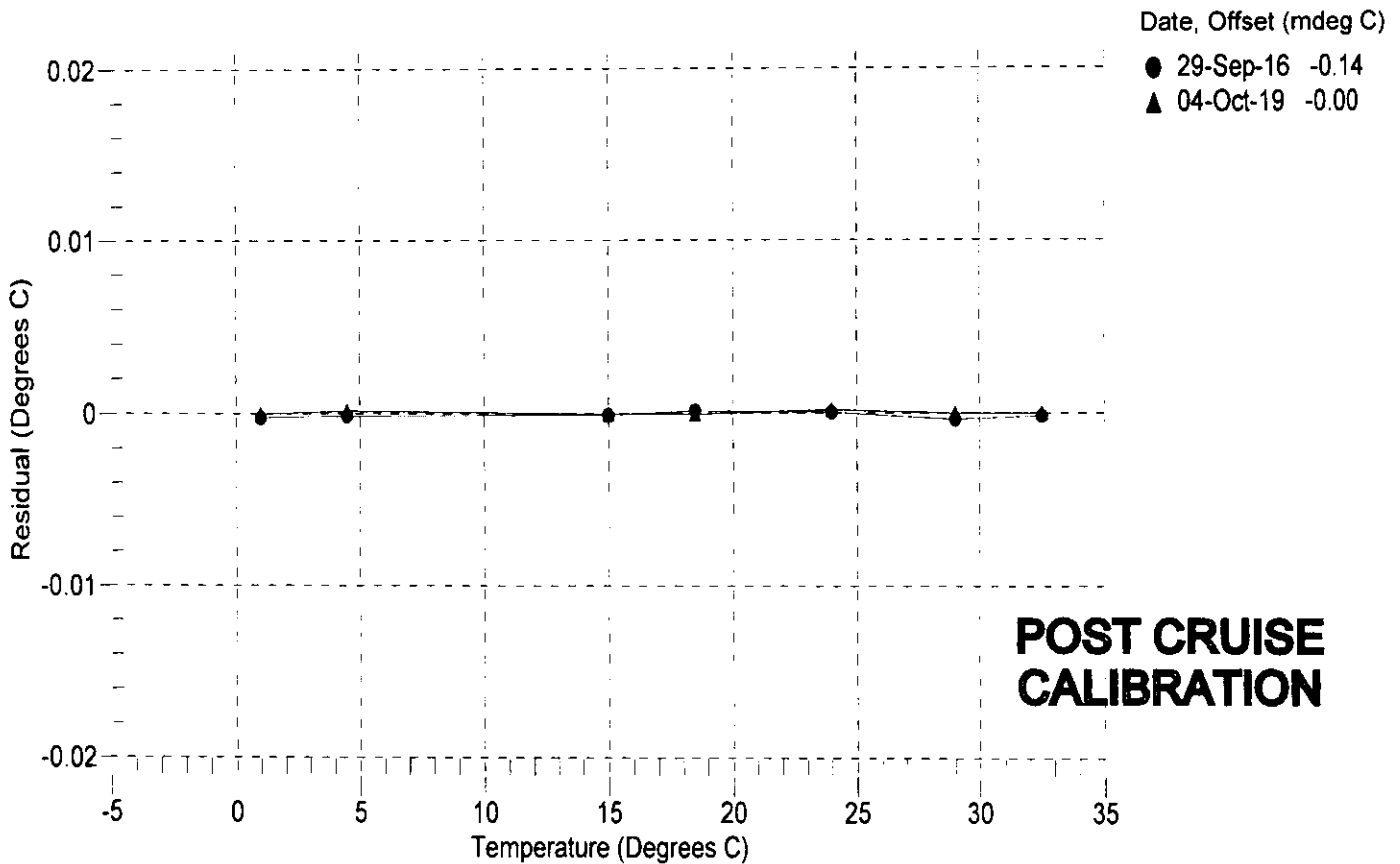
a0 = -1.327282e-004
 a1 = 3.139190e-004
 a2 = -5.022232e-006
 a3 = 2.144813e-007

BATH TEMP (° C)	INSTRUMENT OUTPUT (counts)	INST TEMP (° C)	RESIDUAL (° C)
1.0000	575324.2	0.9999	-0.0001
4.5000	491849.0	4.5001	0.0001
15.0000	313453.6	14.9999	-0.0001
18.5000	271441.7	18.4999	-0.0001
24.0000	217808.6	24.0002	0.0002
29.0000	179408.5	29.0000	-0.0000
32.5000	157157.9	32.5000	-0.0000

n = Instrument Output (counts)

$$\text{Temperature ITS-90 (°C)} = 1 / \{a_0 + a_1[\ln(n)] + a_2[\ln^2(n)] + a_3[\ln^3(n)]\} - 273.15$$

$$\text{Residual (°C)} = \text{instrument temperature} - \text{bath temperature}$$





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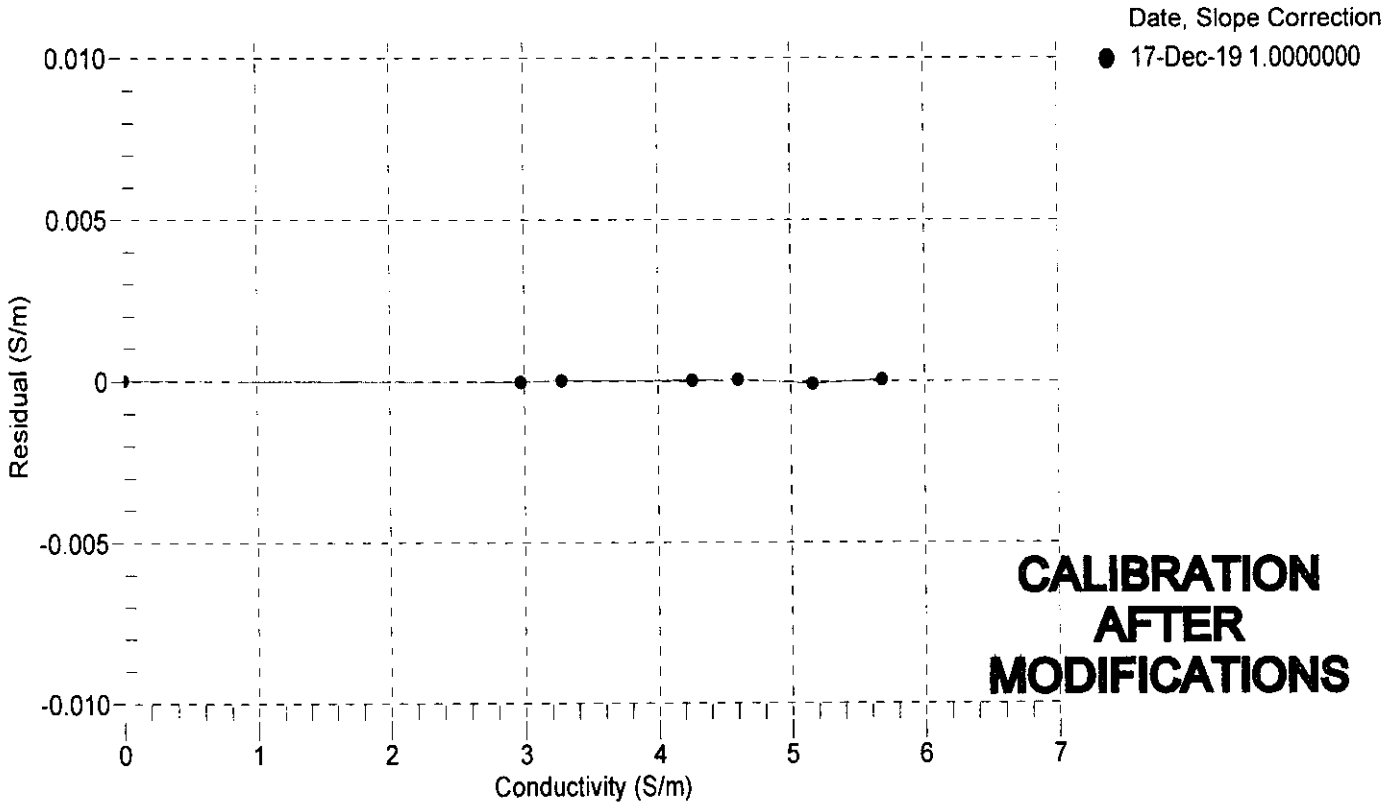
Slocum Payload CTD CONDUCTIVITY CALIBRATION DATA
 PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

g = -1.014211e+000 CPcor = -9.5700e-008
 h = 1.423181e-001 CTcor = 3.2500e-006
 i = -3.154308e-004 WBOTC = 6.2311e-008
 j = 4.243456e-005

BATH TEMP (° C)	BATH SAL (PSU)	BATH COND (S/m)	INSTRUMENT OUTPUT (Hz)	INSTRUMENT COND (S/m)	RESIDUAL (S/m)
22.0000	0.0000	0.00000	2674.61	0.00000	0.00000
0.9999	34.7720	2.97253	5301.65	2.97250	-0.00003
4.5000	34.7523	3.27928	5501.34	3.27931	0.00002
15.0000	34.7101	4.25996	6095.15	4.25998	0.00001
18.5000	34.7007	4.60469	6290.33	4.60472	0.00003
24.0000	34.6900	5.16191	6593.22	5.16183	-0.00008
29.0000	34.6837	5.68304	6864.19	5.68308	0.00004
32.5000	34.6790	6.05475	7050.79	6.05462	-0.00013

f = Instrument Output(Hz) * sqrt(1.0 + WBOTC * t) / 1000.0
 t = temperature (°C); p = pressure (decibars); δ = CTcor; ε = CPcor;
 Conductivity (S/m) = (g + h * f² + i * f³ + j * f⁴) / (1 + δ * t + ε * p)
 Residual (Siemens/meter) = instrument conductivity - bath conductivity





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CALIBRATION DATE: 04-Oct-19

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

COEFFICIENTS:

g = -4.401165e+002
h = 2.665484e+002
i = -1.118716e+002
j = 1.316844e+001

CPcor = -9.5700e-008
CTcor = 3.2500e-006
WBOTC = 6.2311e-008

BATH TEMP (° C)	BATH SAL (PSU)	BATH COND (S/m)	INSTRUMENT OUTPUT (Hz)	INSTRUMENT COND (S/m)	RESIDUAL (S/m)
22.0000	0.0000	0.00000	2674.59	0.08757	0.08757
1.0000	34.8556	2.97900	3193.53	4.37436	1.39536
4.5000	34.8352	3.28633	3250.89	4.11246	0.82613
15.0000	34.7921	4.26896	3420.96	4.01270	-0.25626
18.5000	34.7820	4.61431	3505.90	4.77620	0.16189
24.0000	34.7695	5.17243	3382.23	3.88622	-1.28621
29.0000	34.7593	5.69403	3571.31	5.95145	0.25742
32.5000	34.7469	6.06526	3066.06	4.87953	-1.18572

$$f = \text{Instrument Output(Hz)} * \text{sqrt}(1.0 + \text{WBOTC} * t) / 1000.0$$

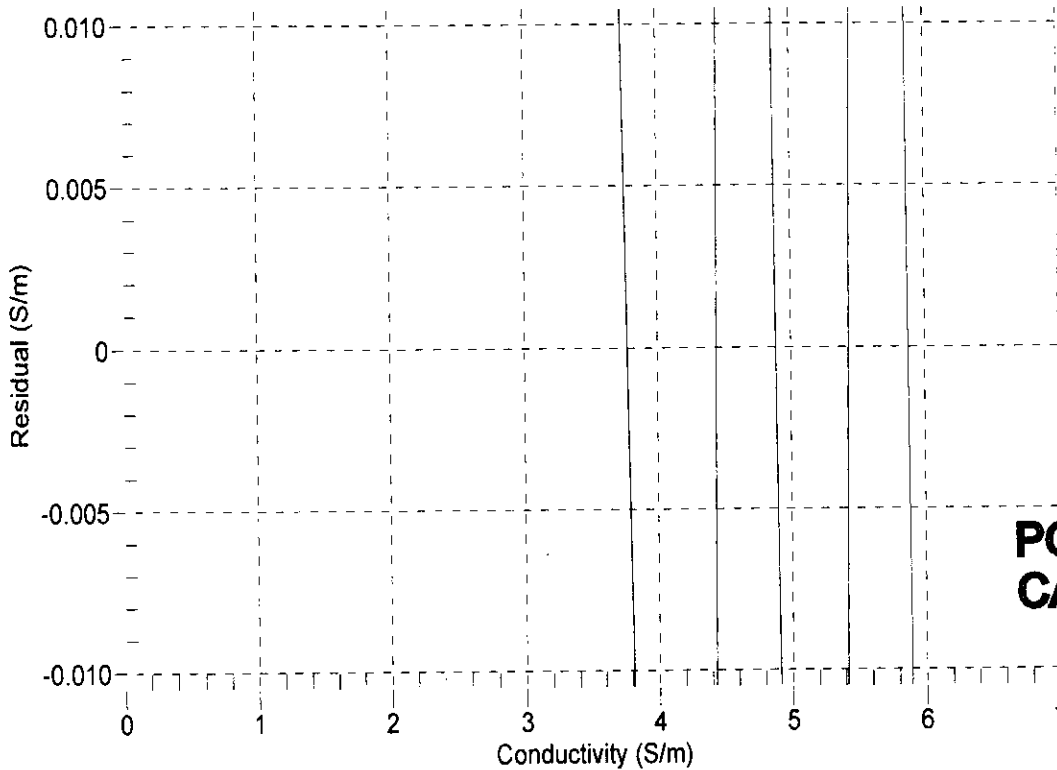
t = temperature (°C); p = pressure (decibars); δ = CTcor; ϵ = CPcor;

$$\text{Conductivity (S/m)} = (g + h * f^2 + i * f^3 + j * f^4) / (1 + \delta * t + \epsilon * p)$$

Residual (Siemens/meter) = instrument conductivity - bath conductivity

Date, Slope Correction

- 29-Sep-16 0.0011229
- ▲ 04-Oct-19 0.9999894



**POST CRUISE
CALIBRATION**



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SENSOR SERIAL NUMBER: 9089
CALIBRATION DATE: 02-Oct-19

Slocum Payload CTD PRESSURE CALIBRATION DATA
1450 psia S/N 3819476

COEFFICIENTS:

PA0 =	-1.050247e-001	PTCA0 =	5.244248e+005
PA1 =	4.626302e-003	PTCA1 =	-2.090843e+000
PA2 =	-1.898791e-011	PTCA2 =	4.834108e-002
PTEMPA0 =	-7.258789e+001	PTCB0 =	2.539825e+001
PTEMPA1 =	5.124303e-002	PTCB1 =	5.000000e-005
PTEMPA2 =	-4.819209e-007	PTCB2 =	0.000000e+000

PRESSURE SPAN CALIBRATION

THERMAL CORRECTION

PRESSURE (PSIA)	INSTRUMENT OUTPUT (counts)	THERMISTOR OUTPUT (volts)	COMPUTED PRESSURE (PSIA)	RESIDUAL (%FSR)	TEMP (°C)	THERMISTOR OUTPUT (volts)	INSTRUMENT OUTPUT (counts)
14.51	527567.0	1891.0	14.54	0.00	32.50	2092	527631.00
314.74	592459.0	1893.0	314.64	-0.01	29.00	2021	527634.30
614.74	657373.0	1893.0	614.69	-0.00	24.00	1920	527632.70
914.78	722324.0	1893.0	914.76	-0.00	18.50	1808	527628.00
1214.72	787286.0	1894.0	1214.71	-0.00	15.00	1738	527627.20
1464.77	841458.0	1895.0	1464.72	-0.00	4.50	1526	527644.00
1214.69	787299.0	1894.0	1214.77	0.01	1.00	1456	527649.30
914.70	722322.0	1896.0	914.75	0.00			
614.74	657393.0	1895.0	614.79	0.00	TEMPERATURE (°C)	SPAN	
314.73	592474.0	1896.0	314.71	-0.00	-5.00	25.40	
14.49	527564.0	1896.0	14.52	0.00	35.00	25.40	

y = thermistor output (counts)

$$t = PTEMPA0 + PTEMPA1 * y + PTEMPA2 * y^2$$

$$x = \text{instrument output} - PTCA0 - PTCA1 * t - PTCA2 * t^2$$

$$n = x * PTCB0 / (PTCB0 + PTCB1 * t + PTCB2 * t^2)$$

$$\text{pressure (PSIA)} = PA0 + PA1 * n + PA2 * n^2$$

$$\text{Residual (\%FSR)} = (\text{computed pressure} - \text{true pressure}) * 100 / \text{Full Scale Range}$$

Date, Offset (%FSR)

● 02-Oct-19 -0.00

