Conductivity Sensor

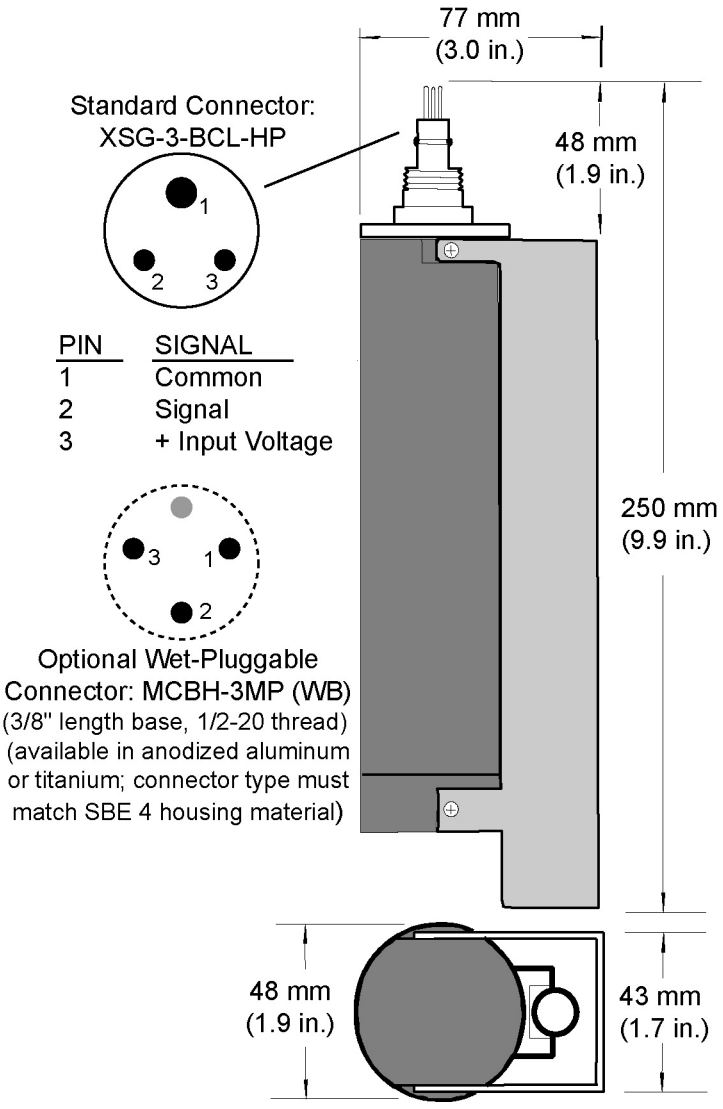
SBE 4

SBE 4 series conductivity sensors are modular, self-contained instruments that measure conductivity from 0 to 7 S/m (Siemens/meter), thus covering the full range of lake and oceanic applications. The sensors (Version 2; S/N 2000 and higher) have electrically isolated power circuits and optically coupled outputs to eliminate any possibility of noise and corrosion caused by ground loops. Interfacing is also simplified by the square-wave variable frequency output signal (nominally 2.5 to 7.5 kHz, corresponding to 0 to 7 S/m). The sensors offer improved temperature compensation, smaller fit residuals, and faster turn-on stabilization times. Supply voltage range is 6 to 24 volts.

SBE 4C;
4M is similar, but does not include Quick disconnect

The **SBE 4C** is a primary sensor for the SBE 9*plus* CTD Underwater Unit and SBE 25 SEALOGGER CTD. Available in 6800 m aluminum or 10500 m titanium housing, the SBE 4C has a quick-disconnect fitting to simplify plumbing to the CTD pump. The **SBE 4M** is intended for long-term moored deployments. Available with a 3400 m or 6800 m aluminum housing or 10500 m titanium housing, the SBE 4M is supplied without the quick-disconnect fitting.

The sensing element is a cylindrical flow-through borosilicate glass cell with three internal platinum electrodes. The electrode arrangement offers distinct advantages over inductive or *open* external field cells. Because the outer electrodes are connected together, electric fields are confined inside the cell, making the measured resistance (and instrument calibration) independent of calibration bath size or proximity to protective cages or other objects. The cell resistance controls the output frequency of a Wien Bridge oscillator circuit. A unique Sea-Bird design feature introduces a fixed conductivity offset, permitting the instrument to measure conductivity down to 0 for *fresh* water work.



APPLICATION

Because of the SBE 4's low noise characteristics, hybrid frequency measuring techniques (used in Sea-Bird's CTD instruments) may be used to obtain rapid sampling with very high temporal and spatial resolution. The SBE 4 is ideally suited for obtaining horizontal data with towed systems or vertical data with lowered systems. Because of its small size, it is especially useful for moorings, portable CTD systems, or through-the-ice work.

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Conductivity Sensor SBE 4

SPECIFICATIONS [1]

Measurement Range	0.0 to 7.0 Siemens/meter (S/m)	**Settling Time**	0.7 seconds to within 0.0001 S/m
Initial Accuracy	0.0003 S/m	**Supply Voltage**	6 - 24 VDC
Stability [2]	0.0003 S/m/month	**Supply Current**	18 ma at 6V; 12 ma 10 - 24 V
Resolution [3]	0.00004 S/m at 24 Hz	**Signal Output**	1V square wave capacitively coupled
Time Response [4]	0.060 seconds (pumped)		

[1] Typical specifications, referenced to NIST-traceable calibration.
[2] Not applicable in areas of high biofouling activity or highly contaminated waters, or if procedures in Application Note 2D are not followed.
[3] Achieved with SBE 9 CTD. In custom applications, resolution will depend on the frequency measuring technique used.
[4] Time to reach 63% of final value following a step change in conductivity.

Housing	Depth Rating	Weight
6061-T6 aluminum	3400 meters	0.7 kg (1.6 lbs) in air; 0.34 kg (0.75 lbs) in water
7075-T6 aluminum	6800 meters	0.7 kg (1.6 lbs) in air; 0.34 kg (0.75 lbs) in water
6Al-4V titanium	10500 meters	1.1 kg (2.4 lbs) in air; 0.7 kg (1.5 lbs) in water

CALIBRATION

Sea-Bird calibrates the sensor over the range of 2.6 to 6 S/m in a computer-controlled bath, using natural seawater; a water sample at each point is compared to IAPSO seawater using a Guildline AutoSal. A least-squares fitting technique (also including a zero conductivity point in air) yields calibration coefficients for use in the following equation:

$$\text{Conductivity} = \frac{g + hf^2 + if^3 + jf^4}{10\,[1 + \delta t + \varepsilon p]} \quad \text{[S/m]}$$

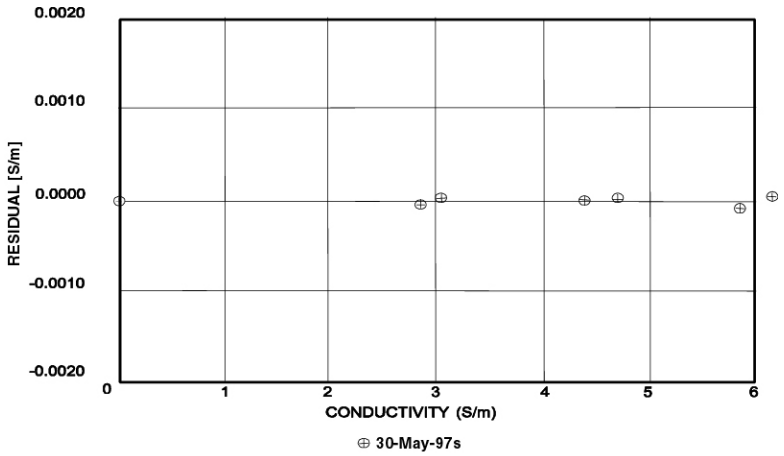
where f is instrument frequency [kHz], t is temperature [°C], p is pressure [decibars], and δ is thermal coefficient of expansion (3.25×10^{-06}) and ε is bulk compressibility (-9.57×10^{-08}) of the borosilicate cell. The resulting coefficients g, h, i, and j are listed on the calibration certificate. Residuals are typically less than 0.0002 S/m.

SAMPLE CALIBRATION DATA

CALIBRATION DATA FOR SENSOR SERIAL NUMBER = 2020
CALIBRATION DATE: 30 May 97
Practical Salinity Scale 1978: C(35,15,0) = 4.2914 [Siemens/meter]

g = -1.05697877e+01 i = -4.32023820e-03
h = 1.42707291e+00 j = 4.53455585e-04

BATH TEMP [°C68]	BATH SAL [ppt]	BATH COND [S/m]	INST FREQ [kHz]	INST COND [S/m]	RESIDUAL (INST - BATH) [S/m]
0.0000	0.0000	0.00000	2.72957	0.00000	0.00000
-1.3428	35.2722	2.80855	5.22318	2.80850	-0.00005
1.0942	35.2724	3.01943	5.36370	3.01947	0.00004
15.2226	35.2731	4.34337	6.17207	4.34338	0.00001
18.6914	35.2731	4.69132	6.36724	4.69135	0.00003
29.0800	35.2708	5.77613	6.93974	5.77603	-0.00010
32.6309	35.2657	6.15878	7.13053	6.15885	0.00007



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