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

Phone: (425) 643-9866
Fax: (425) 643-9954
E-mail: seabird@seabird.com
Web: www.seabird.com

APPLICATION NOTE NO. 18-1 **Revised February 2010**

SBE 18, 27, and 30, and AMT pH Sensor Calibration (PHFIT Version 2.0)

This application note applies to the **SBE 18** pH sensor, **SBE 27** pH/ORP (Redox) sensor, **SBE 30** DO/pH/ORP sensor, and **AMT** Analysenmesstechnik GmBh pH sensor.

Sea-Bird software calculates pH as:

pH = 7 + (Vout - offset) / (1.98416 x 10^{-4} x T * slope) (see Appendix for derivation of equation)

where
T = temperature (ºK)
Vout = output voltage from pH sensor (0 - 5 volts)
Offset and slope = calibration coefficients, determined by a least-squares fit of voltage and pH in a series of buffer solutions, using the measured temperature of the buffer solutions; coefficients are calculated using PHFIT software

Sea-Bird includes a calibration sheet with the shipment. The calibration sheet provides values for *offset* and *slope*, which have been input by Sea-Bird in the configuration (.con or .xmlcon) file.

Note: If you purchase an AMT sensor as a separate item, not integrated with a Sea-Bird CTD, Sea-Bird provides only the calibration sheet from AMT. This calibration sheet calculates pH as:
pH = a + bV
where a and b are calculated by AMT using a least-squares fit of voltage and pH in a series of buffer solutions. If you will be integrating the AMT sensor with a Sea-Bird CTD, use the voltage and pH values from AMT's calibration sheet (and 25 ºC for the temperature) to generate the offset and slope as described below in User Recalibration.

User Recalibration

Sea-Bird provides PHFIT software for our customers to use when calibrating their pH sensors. PHFIT is part of the SEASOFT-DOS software package; the latest version of the software is available for download from our website. SEASOFT-DOS runs on an IBM PC/XT/AT computer or compatible, and usually performs correctly when run under Windows.

When needed, recalibrate the pH sensor as follows:

1. Prepare a series of buffer solutions (up to 25 solutions); maintain each at approximately the same temperature. Record the temperature.

2. Measure and record the output voltage from the pH sensor for each buffer solution.

   Note: For the SBE 18, 27, and 30, an electrical connection between the buffer solution and the anode on the top of the sensor must be made while measuring pH.

3. Run PHFIT:
   A. Once you have installed SEASOFT-DOS, type PHFIT.
   B. At the prompt, enter the sensor serial number and the temperature (in ºC) of the buffer solutions.
   C. At the prompt, enter the pH and output voltage (Vout) for up to 25 buffer solutions. When you have finished, the program outputs the offset and slope, along with the residuals.

4. Enter the new offset and slope in the CTD's configuration (.con or .xmlcon) file. Instructions are provided below for modifying the configuration file using SBE Data Processing (in SEASOFT V2 software suite):
   A. Once you have installed SBE Data Processing, click on SBEDataProc.exe.
   B. In the Configure menu, select the applicable CTD.
   C. In the dialog box, click Open and select the applicable .con or .xmlcon file for the CTD.
   D. In the sensor list, double click on the pH sensor.
   E. Enter the new offset and slope in the dialog box and click OK.
   F. Click Save or Save As to save the changed configuration (.con or .xmlcon) file.

Appendix - Derivation of Sea-Bird Equation

Vout = offset + [slope * (R * T / F) * ln (10) * (pH - 7)]

Where
R = gas constant = 8.31434
F = Faraday constant = 9.64867×10^{-4}
T = temperature (ºK)
Vout = output voltage from pH sensor (0 - 5 volts)

Substituting for R, F, and ln (10):

Vout = offset + [slope * 1.98416×10^{-4} * T * (pH - 7)]

Therefore,

pH = 7 + (Vout - offset) / (1.98416×10^{-4} x T * slope)