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. 11 QSP-PD **Revised October 2012**

Calculating Calibration Coefficients for Biospherical Instruments PAR Light Sensor *without* Built-In Log Amplifier

This application note applies to the following current output Biospherical Instruments PAR light sensors:
- QSP-200(PD) (no longer in production)
- QSP 2200(PD) and QCP 2200(PD) *

*** Note**: Biospherical's 2200 series includes other instruments which are not compatible with Sea-Bird CTDs. Only the 2200(PD) sensors can be integrated with Sea-Bird CTDs.

These PAR sensors are compatible with the following Sea-Bird CTDs:
- SBE 16, 16*plus*, 16*plus*-IM, 19, or 19*plus* CTD configured with an optional log amplifier and PAR sensor connector
  Note: Optional log amplifier and PAR sensor connector are **not** available on **V2** SeaCATs (16*plus* V2, 16*plus*-IM V2, and 19*plus* V2)
- SBE 25 CTD configured with a log amplifier and PAR sensor connector (optional on older versions)
- SBE 9*plus*, 16, 16*plus*, 16*plus*-IM, 16*plus* V2, 16*plus*-IM V2, 19, 19*plus*, 19*plus* V2, 25, or 25*plus* CTD interfacing with a PN 90310 Log Amp Module. The Log Amp Module mounts on the CTD or cage, and connects to a single-ended or differential A/D voltage channel on the CTD.

The current output of these sensors is measured through a log amplifier in your CTD (or through the PN 90310 Log Amp Module) to obtain adequate resolution over the measurement range. Seasoft computes PAR using the following equation:

$$\mathbf{PAR = [multiplier * (10^9 * 10^{(V-B)/M}) / calibration\ constant] + offset}$$

Enter the following coefficients in the CTD configuration (.con or .xmlcon) file:

M = slope of log amplifier (Note 2)
B = offset of log amplifier (Note 2)
calibration constant $C_S = 6.022 \times 10^{13} / C_W$ (Note 3)
multiplier = 1.0 for output units of μEinsteins/m^2·sec (Note 4)
offset = 0, typically (Note 5)

Notes:

1. In our Seasoft V2 suite of programs, edit the CTD configuration (.con or .xmlcon) file using the Configure Inputs menu in Seasave V7 (real-time data acquisition software) or the Configure menu in SBE Data Processing (data processing software).
2. Sea-Bird provides two calibration sheets for the PAR sensor in the CTD manual:
   - Calibration sheet generated by Biospherical, which contains Biospherical's calibration data.
   - Calibration sheet generated by Sea-Bird, which incorporates the Biospherical data and generates M, B, and calibration constant C_C needed for entry in Sea-Bird software (saving the user from doing the math).
3. For calculation of C_W and C_S, see Mathematical Derivation below.
4. The multiplier can be used to calculate irradiance in units other than μEinsteins/m^2·sec. See Application Note 11General for multiplier values for other units.
   The multiplier can also be used to *scale* the data, to compare the *shape* of data sets taken at disparate light levels. For example, a multiplier of 10 would make a 10 μEinsteins/m^2·sec light level plot as 100 μEinsteins/m^2·sec.
5. Offset may be used to *offset* the data by a constant, if field data indicates sensor drift. To calculate the offset: Enter M, B, calibration constant, and multiplier, and set offset = 0 in the configuration (.con or .xmlcon) file. With the sensor dark (covered), display the *calculated PAR output* in Seasave V7; then enter the negative of this reading as the offset in the configuration file.

Mathematical Derivation

C_W = Biospherical wet calibration factor from Biospherical calibration sheet [(quanta/cm^2•sec) / nAmp]
Output in water from Biospherical calibration sheet (quanta/cm^2•sec) = C_W * probe output (nAmp)
Output in water (quanta/cm^2•sec) = $C_W * 10^9$ * probe output (Amp)
I = probe output (Amp)
Output in water (quanta/cm^2•sec) = $C_W * 10^9 * I$
Output in water (quanta/m^2•sec) = $C_W * 10^9 * I * 10^4 = C_W * 10^{13} * I$
Output in water (µEinsteins/ m^2•sec) = $C_W * 10^{13} * I / 6.022 \times 10^{17}$
(see Application Note 11General for conversion from quanta to µEinsteins)

Seasoft calculates: Light (µEinsteins/ m^2•sec) = $I \times 10^9 / C_S$
where C_S = calibration constant

Equating the Biospherical and Seasoft relationships:
$C_W * 10^{13} * I / 6.022 \times 10^{17} = I \times 10^9 / C_S$
$C_W / 6.022 \times 10^{13} = 1 / C_S$
$C_S = 6.022 \times 10^{13} / C_W$

Example:

C_W = Biospherical wet calibration factor from Biospherical calibration sheet = 4.77×10^{14} (quanta/cm^2•sec) / nAmp
Calibration constant $C_S = 6.022 \times 10^{13} / C_W = 6.022 \times 10^{13} / 4.77 \times 10^{14} = 0.126$ (for entry into .con or .xmlcon file)

Notes:

- See Application Note 11S for integrating a Surface PAR sensor with the SBE 11*plus* Deck Unit (used with the SBE 9*plus* CTD).
- See Application Note 47 for integrating a Surface PAR sensor with an SBE 33 or SBE 36 Deck Unit (used with the SBE 16, 16*plus*, 16*plus* V2, 19, 19*plus*, 19*plus* V2, 25, or 25*plus* CTD).

Application Note Revision History

Date	Description
	Initial release.
September 2001	Previously referred to SEACON in discussions of .con files. Added references to modifying .con file using Configure menu in Seasave or SBE Data Processing in Windows software.
October 2004	• Update with new (2003) Biospherical PAR sensor part numbers. • Expand / rewrite / reorganize.
June 2005	Provide output in microEinsteins/m^2 sec, and refer to Application Note 11General for conversion to other units.
May 2007	Incorporate Seasave V7, and eliminate discussion of Seasoft-DOS.
March 2008	Update to include V2 SeaCATs (16*plus* V2, 16*plus*-IM V2, 19*plus* V2).
February 2010	• Change Seasoft-Win32 to Seasoft V2. • Add information on .xmlcon files. • Update address.
October 2012	Update to include SBE 25*plus*.