

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:

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

Make the following entries/selections 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)

conversion units = appears in data file header; does not modify calculated values, which are controlled by multiplier entry **multiplier** = 1.0 for output units of $\mu\text{Einsteins}/\text{m}^2 \cdot \text{sec}$ (Note 4)

offset = 0, typically (Note 5)

Notes:

1. 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 $\mu\text{Einsteins}/\text{m}^2 \cdot \text{sec}$. 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 $\mu\text{Einsteins}/\text{m}^2 \cdot \text{sec}$ light level plot as 100 $\mu\text{Einsteins}/\text{m}^2 \cdot \text{sec}$.
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/cm²·sec) / nAmp]

Output in water from Biospherical calibration sheet (quanta/cm²·sec) = C_W * probe output (nAmp)

Output in water (quanta/cm²·sec) = C_W * 10⁹ * probe output (Amp)

I = probe output (Amp)

Output in water (quanta/cm²·sec) = C_W * 10⁹ * I

Output in water (quanta/m²·sec) = C_W * 10⁹ * I * 10⁴ = C_W * 10¹³ * I

Output in water (μEinsteins/ m²·sec) = C_W * 10¹³ * I / 6.022 x 10¹⁷

(see Application Note 11 General for conversion from quanta to μEinsteins)

Seasoft calculates: Light (μEinsteins/ m²·sec) = I x 10⁹ / C_S

where C_S = calibration constant

Equating the Biospherical and Seasoft relationships:

C_W * 10¹³ * I / 6.022 x 10¹⁷ = I x 10⁹ / C_S

C_W / 6.022 x 10¹³ = 1 / C_S

C_S = 6.022 x 10¹³ / C_W

Example:

C_W = Biospherical wet calibration factor from Biospherical calibration sheet = 4.77 x 10¹⁴ (quanta/cm²·sec) / nAmp

Calibration constant C_S = 6.022 x 10¹³ / C_W = 6.022 x 10¹³ / 4.77 x 10¹⁴ = 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).