



**APPLICATION NOTE NO. 11 QSP-PD**

**Revised February 2010**

**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, *16plus*, *16plus-IM*, 19, or *19plus* 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 (*16plus* V2, *16plus-IM* V2, and *19plus* V2)
- SBE 25 CTD configured with a log amplifier and PAR sensor connector (standard on current production SBE 25s, optional on older versions)
- SBE *9plus*, 16, *16plus*, *16plus-IM*, *16plus* V2, *16plus-IM* V2, 19, *19plus*, *19plus* V2, or 25 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:

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

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  $\mu\text{Einsteins}/\text{m}^2\text{-sec}$  (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  $\mu\text{Einsteins}/\text{m}^2\text{-sec}$ . 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  $\mu\text{Einsteins}/\text{m}^2\text{-sec}$  light level plot as 100  $\mu\text{Einsteins}/\text{m}^2\text{-sec}$ .
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/cm<sup>2</sup>·sec) / nAmp]

Output in water from Biospherical calibration sheet (quanta/cm<sup>2</sup>·sec) =  $C_W$  \* probe output (nAmp)

Output in water (quanta/cm<sup>2</sup>·sec) =  $C_W$  \*  $10^9$  \* probe output (Amp)

I = probe output (Amp)

Output in water (quanta/cm<sup>2</sup>·sec) =  $C_W$  \*  $10^9$  \* I

Output in water (quanta/m<sup>2</sup>·sec) =  $C_W$  \*  $10^9$  \* I \*  $10^4$  =  $C_W$  \*  $10^{13}$  \* I

Output in water (μEinsteins/ m<sup>2</sup>·sec) =  $C_W$  \*  $10^{13}$  \* I /  $6.022 \times 10^{17}$

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

SEASOFT calculates: Light (μEinsteins/ m<sup>2</sup>·sec) = I x  $10^9$  /  $C_S$

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 =  $4.77 \times 10^{14}$  (quanta/cm<sup>2</sup>·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, or 25 CTD).