



## PRR-800 Profiling Reflectance Radiometer

Building on more than 25 years of experience designing spectroradiometers for the aquatic sciences, Biospherical Instruments Inc. (BSI) introduces its newest tool for ocean color research—the PRR-800 High Resolution Profiling Reflectance Radiometer (PRR). The instrument combines high-resolution radiance and irradiance optics, a high-speed data acquisition system, and advanced electronics with a compact, rugged design.

The instrument incorporates 15 wavelengths per end standard, with the option to upgrade to as many as 19 wavelengths per end. Researchers can utilize the PRR-800's high channel-count by choosing from among nearly 30 specialized, highly accurate, low-noise detector channels. In addition, the technology's modular construction allows the instrument to be further expanded to 38 wavelengths of  $E_a$  and  $L_v$ , thereby approaching hyper-spectral resolution without the sacrifices in dynamic range and spectral purity inherent in spectrometer-based designs.

A shared single cosine collector simplifies optical calibrations and is optimized for underwater (PRR-800) or surface (PRR-810) use. In addition, the PRR-800's internal data acquisition system incorporates the newest advances in dynamic range, allowing the instrument to be used over a greater range of turbidities and incident irradiances.

Three deployment strategies are supported. The standard configuration uses a stainless steel lowering frame fixed to a Kevlar® reinforced cable for both telemetry and to support the instrument during profiles. For highly turbid waters, a split instrument configuration is optionally available that divides the PRR-800 into two housings. This allows the irradiance and radiance collectors to be mounted on the same optical plane. Finally, a syntactic foam collar and wing assembly can be used for free-fall deployments away from the influence of the vessel.



PRR-800 profiling system showing optional PRR-810 surface reference system, deployment cable, and lowering frame.

### Key Features

- 15 wavelengths standard per end, expandable to 19 wavelengths allows combined measurement of all SeaWiFS and most MODIS wavelengths
- Small instrument size (10 cm x 56 cm) and battery power minimizes self-shading and allows hand deployment and shallow water use
- Optional PRR-810 matching surface reference
- Optional free-fall collar split housing configurations
- A shared single cosine collector that simplifies optical calibrations and is optimized for use underwater (PRR-800) or surface (PRR-810)
- High-speed sampling of underwater radiance and irradiance and surface irradiance (maximum 15 Hz with 19 wavelengths)
- Dynamic range approaching 10 decades

## **Features**

The PRR-800 is ideal for high-speed, high-spectral-resolution measurements of ocean color throughout the euphotic zone.

The instrument's small size (10 cm x 56 cm) minimizes shadow and allows the instrument to be hand-deployed from vessels as small as out-board-powered inflatables.



The PRR-800 is intended to be lowered from a vessel supported by its own cable. The instrument can be used in traditional vertical profiling or, when fitted with an optional free-fall collar (shown above), in free-descent mode. The free-fall system allows the researcher to “kite” the instrument away from the vessel, thereby avoiding problems caused by ship shadow.

The PRR-800 is also available in an optional split configuration for use in turbid waters. The split configuration separates the  $E_d$  and  $L_v$  heads and orients them on a special “T”-shaped lowering frame so that the optical sensors are aligned on a horizontal plane. This configuration is in-

tended for turbid water applications where minimal distance between heads is desirable.

In addition to the standard 15-channel irradiance and radiance arrays, each PRR-800 is equipped with a dual-axis instrument inclinometer, PRT water temperature sensor, pressure/depth sensor, and a detector array temperature sensor. Optional sensors include dark diodes, transmissometer, fluorometer, and four auxiliary sensors (e.g., backscatter).

The instrument is shipped with a rechargeable battery-powered deckbox, AC adapter/charger, and Windows®-based PROFILER data-acquisition software.

Accessories—including stainless steel lowering frames, free-fall system, and underwater shielded Kevlar® cable—must be ordered separately.

## **PRR-810 Surface Radiometer**

The PRR-810 is a downwelling surface irradiance sensor designed to radiometrically match the underwater sensor, but optimized for use in air. The PRR-810 may also be fitted with pitch and roll sensors to support post-processing only near-zenith datasets.

## **Calibration**

Optical calibrations are performed in accordance with the methods outlined by the National Institute of Standards and Technology (NIST), National Bureau of Standards (U.S.) Technical Note 594-13 and NBS Special Publication 250-20. For radiance calibrations, we employ a Spectralon® (Lab-sphere) plaque functioning as a near-perfect “Lambertian” diffuser with a NIST-traceable working Standard of Spectral Irradiance. The protocol has no formal NIST reference, but was systematically reviewed in the context of the NASA-sponsored SeaWiFS Round Robin Intercomparison Experiment (SIRREX).

## **Sampling Strategy**

Each sensor head contains an independent microprocessor and complete data acquisition system. These microprocessors sample synchronously and the individual modules compile data streams for transmission to the surface. With 19 wavelengths per end, data can be obtained at a maximum rate of 15 Hz. Sampling speed increases with fewer wavelengths.

# Specifications

## PRR-800 Physical

**Diameter:** 10.2 cm (without fins); 42 cm (with fins)

**Length:** 55.9 cm

**Depth Range:** 350 m (recommended max. operating)

**Materials:** PET plastic housing; plastic fins (optional); stainless steel lowering frame (optional)

**Weight:** 4.8 kg in air, near neutral in water

**Temperature Rating:** -5°C to 50°C

## Optical Features

**Bandwidth:** 10 nm FWHM standard

**Spectral Range:** 305-875 nm

**Standard Wavelengths:** 305, 313, 320, 330, 340, 380, 395, 412, 443, 465, 490, 510, 520, 532, 555, 560, 565, 589, 625, 665, 670, 683, 694, 710, 765, 865, and 875nm. EdZPAR channels (Photosynthetically Active Radiation--400-700 nm), and Natural Fluorescence LuZChL channels are also available

## Sensors

**Standard:** Upwelling radiance (15 wavelengths standard, up to 19); downwelling irradiance (15 wavelengths standard, up to 19); dual-axis instrument inclinometer; detector array temperature; PRT water temperature; and pressure/depth

**Optional Sensors:** Dark diodes, transmissometer, fluorometer, and four auxiliary analog sensors (e.g., backscatter)

## Irradiance Array

**Filter Photodetectors:** 15 wavelengths standard; up to 19 wavelengths (optional)

**Filter Type:** Custom, hardcoat, multi-cavity, low-fluorescence interference with out-of-band blocking

**Cosine Collector:** Teflon<sup>®</sup>-covered quartz

**Collector Area:** 3.81 cm<sup>2</sup>

**Out-of-band Rejection:**  $1 \times 10^{-6}$

**Angular Response:**  $\pm 2\%$  from 0° to 65°;  $\pm 10\%$  from 65° to 85°

**Typical Saturation:**

$10^5 \mu\text{W} \cdot \text{cm}^{-2} \cdot \text{nm}^{-1}$

**Noise Equivalent Irradiance:**

$10^{-5} \mu\text{W} \cdot \text{cm}^{-2} \cdot \text{nm}^{-1}$

## PAR

**Typical Saturation:**  $0.4 \mu\text{E} \cdot \text{cm}^{-2} \cdot \text{s}^{-1}$

**Noise Equivalent Irradiance:**

$4 \times 10^{-10} \mu\text{E} \cdot \text{cm}^{-2} \cdot \text{s}^{-1}$

## Radiance Array

**Filter Photodetectors:** 15 wavelengths standard; up to 19 wavelengths (optional)

**Detectors:** Custom 13 mm<sup>2</sup> silicon photodiodes

**Filter Type:** Custom low-fluorescence interference

**Field of View:** 10° half angle in water (SeaWiFS-compatible)

**Out-of-band Rejection:**  $1 \times 10^{-6}$

**Typical Saturation:**

$10^{-3} \text{W} \cdot \text{cm}^{-2} \cdot \text{nm}^{-1} \cdot \text{sr}^{-1}$

**Noise Equivalent Radiance:**

$10^{-12} \text{W} \cdot \text{cm}^{-2} \cdot \text{nm}^{-1} \cdot \text{sr}^{-1}$

## Natural Fluorescence

**Typical Saturation:**

$2 \times 10^{-6} \text{nE} \cdot \text{m}^{-2} \cdot \text{sr}^{-1} \cdot \text{s}^{-1}$

**Noise Equivalent Radiance:**

$2 \times 10^{-14} \text{nE} \cdot \text{m}^{-2} \cdot \text{sr}^{-1} \cdot \text{s}^{-1}$

## System Electronics

**System Data Rate:** maximum 15 Hz with 19 wavelengths (varies with number of wavelengths)

**Interchannel Sampling Delay:** 500  $\mu\text{s}$   $\pm 175 \text{ nsec}$

## Data Acquisition

**Data Acquisition Subsystems:** 29 channels per head with PGA and 16-bit A/D combination to yield 10 VFS and 1.2  $\mu\text{V}$  LSB; preamps designed to cover 10 decades of signal by manual or auto-ranging

**Output:** RS-232 full duplex at 57 kbaud; single COM port for both instruments (PRR-800 and PRR-810)

## Deckbox

**Cable:** RS-232 serial interface; custom 6-conductor red braided-jacket Kevlar<sup>®</sup> cable (custom lengths available up to 350 m)

**Battery Power:** Rechargeable 12-V gel cell battery; LED indicator light for low battery voltage

**AC Adapter/Charger:** Universal 90-240 VAC, 50-60 Hz

## PRR-810 Surface Sensor

**Diameter:** 10.2 cm

**Length:** 37.8 cm

**Materials:** Aluminum housing

**Weight:** 3 kg in air

**Temperature Rating:** -10°C to 50°C

**Channels:** 15 wavelengths standard; up to 19 wavelengths (optional)

**Bandwidth:** 10 nm FWHM, 20 nm FWHM optional

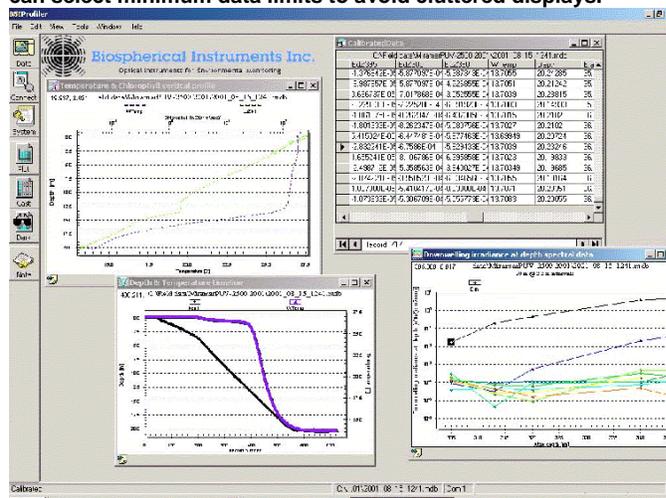
**Standard Sensors:** Downwelling irradiance (15 wavelengths standard; up to 19 wavelengths optional) and detector array temperature

**Optional Sensors:** Dual-axis instrument inclinometer and dark diodes

## Software

The PRR-800 utilizes our Windows®-based, PROFILER operating and data-acquisition software. PROFILER is fully compatible with Windows 7, VISTA or XP, allowing the host PC to acquire and display data in real time. This custom software offers full-color graphical display with multiple, user-selected channels and affords a high degree of interaction and customization. Software includes user-specified configurations for sampling speed, averaging, and profile setup. When profiling, the user can view three plots (Time, Profile, and Spectral Plots), as well as a live-channel display and a large, easy-to-read instrument depth, inclination, and record number display. The software allows the user to annotate plots, such as to mark the beginning or end of an upcast or downcast or to define dark segments, facilitating dark corrections.

BSI's PROFILER software allows the user to select and process different regions of the dataset. Using interactive zooming, you can select minimum data limits to avoid cluttered displays.



Data are stored in Microsoft Access® data tables for compatibility with a wide variety of software and ease of post-processing.



The PRR-800 is also available in an optional split configuration for use in turbid waters.



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