

QSR-2100

Scalar PAR Reference Sensor **with Digital Output**

User's Manual

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INITIAL INSPECTION AND SHIPPING PROCEDURES

This instrument was carefully inspected mechanically and electrically, and was calibrated before shipment. It should be free of marks or scratches and in perfect operating condition upon receipt. To confirm this, the instrument should be inspected for physical damage incurred in transit. If the instrument was damaged in transit, file a claim with the carrier. Check the instrument for proper operation as outlined in this manual. If there is damage or deficiency, see the Warranty in the preface of this manual.

WARNING: Read the sections on installation, operation and maintenance before attempting to operate or disassemble the instrument.

Retain original packing material for shipment to the factory. The instrument must be carefully wrapped and cushioned with appropriate packing material before it is shipped.

PRECAUTIONS

PROTECT THE WEATHERPROOF CABLE AND CONNECTOR. The sensor's weatherproof connector is the most vulnerable part of the system. Protect all connector contacts from moisture, during use and while in storage. Do not step on the cable, or strike it while it is plugged into the instrument.

PROTECT THE INTEGRATED CIRCUITS. A person walking across a carpet on a dry day can generate a static charge of more than 10,000 Volts. The resulting discharge can destroy an integrated circuit. Use standard anti-static equipment any time the instrument is opened up and the components are removed.

AVOID SHADOWS AND REFLECTIONS. During deployments or installations, be careful to keep the instrument away from reflections and shadows caused by surrounding structures. An underwater instrument package should be positioned for lowering on the side of the ship toward the sun. If the instrument is lowered into the shadow created by the ship, this shadow will contaminate measurements for depths up to 100 meters. When positioning a ship and deploying an underwater sensor, wind direction is also a factor since the wind or wind-driven currents can push the ship over the sensor when it is being lowered, thereby causing shadowing. A surface sensor should be mounted so that it will not be shaded by, or experience reflections from, surrounding structures.

CARRY SPARE CABLE AND POWER SUPPLIES. For extended operations, it is strongly recommended that the user maintain spare cables.

PROTECT THE SCALAR COLLECTOR. The Teflon[®] ball and mount are critical optical components. They have been aligned at the factory before calibration. It is possible to remove the ball, but this voids the calibration. The stainless steel mount contains a quartz light pipe and is FRAGILE. If you suspect damage, or if the ball has been removed, contact the factory.

1.0 INTRODUCTION

Biospherical Instruments' Quantum Scalar Reference Sensor (QSR-2100) is designed as a surface (non-submersible) instrument for monitoring total incident photosynthetically active radiation (between 400 nm and 700 nm) from the sun and sky. The QSR-2100 outputs a calibrated digital signal and allows direct connection to a PC or laptop computer. Power is supplied by the host computer's comport. This computer may either be equipped a serial comport or USB connector. When connecting the sensor to a USB port, use of a "High-Speed" USB-to-Serial adapter is required. Data may be displayed or logged on this host computer, using the supplied LOGGER-2100 software. See the LOGGER-2100 software manual for further details.

The QSR-2100 is a hemispherical reference sensor. It shares the scalar directional response of Biospherical Instruments' QSP-2100 series of sensors, but it includes a field-of-view cutoff plate that transforms its response to that of a hemispherical sensor.

In order to fully understand the capabilities of the QSR-2100, the user should read this manual carefully and thoroughly. The manual includes operating instructions, precautions, and compatibility notes that can help the user adapt the instrument to a specific application.

2.0 SPECIFICATIONS

IRRADIANCE COLLECTOR: 1.9 cm diameter solid Teflon[®] sphere optically connected to the main housing by a quartz fiber. This quartz light pipe is encased in a stainless steel tube.

PHOTODETECTORS: Blue-enhanced high-stability silicon photovoltaic detector with dielectric and absorbing glass filter assembly.

SPECTRAL RESPONSE: Equal (better than $\pm 10\%$) quantum response from 400 nm to 700 nm with response sharply attenuated above 700 nm and below 400 nm. Spectral response induced errors will cause less than 5% errors in naturally occurring light fields.

DIRECTIONAL RESPONSE: Each instrument's directional response is optimized before final calibration. The response is a constant $\pm 7\%$, between 0° to approximately 135° in solar zenith angle, with response falling off to zero as the light field becomes obscured by the instrument housing. Individual detector response plots are available upon request.

CALIBRATION: Calibrated using a National Institute of Standards and Technology (NIST)-traceable 1000-watt type-FEL Standard of Spectral Irradiance. Calibration factors are imbedded within the sensor housing as non-volatile memory. Annual recalibration is recommended.

ENVIRONMENTAL: O-ring sealed and uses a high-quality, oceanographic-type connector.

TEMPERATURE: -2 to 35°C . The QSR-2100 has a small temperature coefficient of sensitivity (typically less than $0.15\%/^\circ\text{C}$) and a small zero or dark signal temperature coefficient.

POWER REQUIREMENTS: All power is supplied by the host computer's serial port.

CABLE: QSC-240 shielded, weather resistant cable (ordered separately) is supplied with appropriate connectors.

3.0 INSTALLATION, OPERATION, AND MAINTENANCE PROCEDURES

3.1 INSTALLATION

The sensor should be installed in a place that is free of obstacles that might block its field of view. The QSR-2100 has a flat mounting base that may be secured to a variety of mounting platforms. When it is operated in high seas, it may be necessary to gimbal mount the sensor to prevent the data from changing rapidly, making them difficult to read and analyze.

Note that the QSR-2100 features a circular irradiance shield or "cut-off plate" that blocks irradiance from the lower hemisphere of the collector so as to permit monitoring of only total irradiance from the sun and sky. The plane of the shield must be level with the horizon and there should be no physical obstructions (buildings, masts, etc.) above this plane. For special applications this shield may be removed without otherwise affecting operation.

NOTE: Do not attempt to remove the irradiance collector sphere.

3.2 OPERATION

Note: Before leaving for the field, you should install the LOGGER-2100 software and then fully bench-test the sensor with your host computer. If the system does not operate properly, consult the factory for assistance.

It is recommended that the user check the instrument system, and all optical instruments in general, for gross error every two to three months depending on the amount of use. Weather conditions aside, perhaps the most dependable reference light source is the sun on a clear day. Solar irradiance at local noon, measured against a black surface, is typically 1.5×10^{17} to 2×10^{17} quanta/(cm² sec) on a clear day. Check your instrument system accordingly to make sure it measures correctly.

3.3 MAINTENANCE

When the sensor is mounted outside for long periods of time, it is important to periodically clean both the flat surface of the irradiance shield and the collector sphere itself. While cleaning the sphere and shield, **do not attempt to rotate or remove the collector sphere or the sensor calibration will be altered.** To clean the spherical collector, simply wipe it gently using a soft tissue or towel and warm water, soap or alcohol. Do not use any other solvents such as acetone, MEK, or Trichlor because these can dissolve the coatings on the shield. Also, do not use acids, abrasive cleaners, or brushes as this will mar the surface of the sphere and void the instrument's calibration. Should the sphere become damaged or heavily soiled, return the instrument to the factory for service and recalibration.

If the surface of the irradiance shield becomes soiled and its reflectance changes, the calibration of the instrument will be altered. Therefore, the user should keep the irradiance shield as clean as possible by periodically wiping it with a damp cloth. Remember to avoid moving or scratching the Teflon[®] sphere.

Annual optical recalibrations and biannual preventative maintenance inspection are recommended.

4. THEORY OF OPERATION:

The Teflon[®] sphere on the instrument serves as the irradiance collector. Light penetrating the surface of the sphere is diffused as it passes toward the center. A quartz optical conductor, inserted into the sphere, guides the diffuse light from the sphere to a special filter assembly and then to a low noise blue-enhanced silicon photodiode. The special filter assembly adjusts for the overall spectral response of the detector and collector to give the instrument a constant quantum response between 400 nm and 700 nm with negligible response outside this region.

The current from the photodiode is amplified and converted to digital signal. A calibration factor is contained within the sensor and is applied to this digital signal. Calibrated data are transferred to the host computer in a serial format.

