

LI-193 Spherical Quantum Sensor



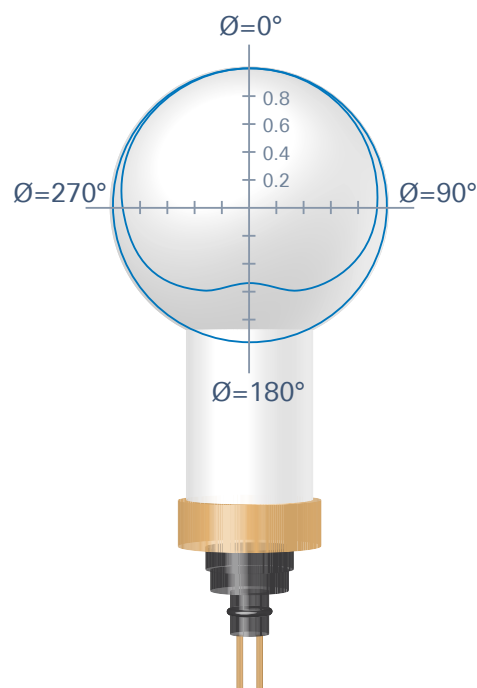
The LI-193 Spherical Quantum Sensor measures PAR in air or underwater from all directions at depths up to 350 meters. This sensor is useful for studies of phytoplankton, which uses radiation from all directions. The measurement is referred to as Photosynthetic Photon Flux Fluence Rate (PPFFR) or Quantum Scalar Irradiance.

Why choose the LI-193?

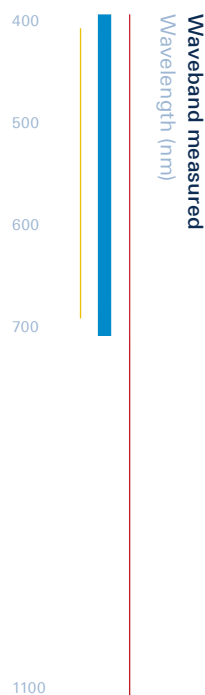
- Designed for immersion
- Measures PAR from all directions
- Ideal for oceanography, limnology, turbidity, and vertical profiling

How does it work?

The LI-193 uses a diffusive sphere to direct light through glass optical filters to the silicon photodiode. The filters create nearly uniform sensitivity to light between 400 and 700 nm, which closely corresponds to light used by most terrestrial and aquatic plants and algae. The angular response of a typical LI-193 is slightly lower in the direction of the cable connection. When mounted, the low response is usually not significant due to the small proportion of upwelling radiation compared to the total.



Typical angular response of the LI-193.



LI-193 Specifications

- Absolute Calibration: $\pm 5\%$ in air traceable to NIST
- Sensitivity: Typically $7 \mu\text{A}$ per $1,000 \mu\text{mol s}^{-1} \text{m}^{-2}$ in water
- Linearity: Maximum deviation of 1% up to $10,000 \mu\text{mol s}^{-1} \text{m}^{-2}$
- Stability: $< \pm 2\%$ change over a 1 year period
- Response Time: $10 \mu\text{s}$
- Temperature Dependence: $\pm 0.15\%$ per $^{\circ}\text{C}$ maximum
- Angular Response: $< \pm 4\%$ error up to $\pm 90^{\circ}$ from normal axis (see Angular Response chart)
- Azimuth: $< \pm 3\%$ error over 360° at 90° from normal axis
- Operating Temperature Range: -40°C to 65°C
- Detector: High stability silicon photovoltaic detector (blue enhanced)
- Sensor Housing: Corrosion resistant metal for both saltwater and freshwater applications with an injection molded, impact resistant, acrylic diffuser. Units have been tested to $3,400 \text{ kPa}$ (500 psi), 350 meters.
- Size:
 - Globe: 6.1 cm diameter ($2.4''$)
 - Housing: 3.18 cm diameter ($1.25''$)
 - Overall Height: 10.7 cm ($4.2''$)
- Weight: 142 g (0.31 lbs.)
- Mounting: Three 6-32 mounting holes are tapped into the base for use with the 2009S Lowering Frame or other mounting devices.
- Cable: Requires 2222UWB Underwater Cable (available in 3, 10, 30, 50, 100 meter lengths)

Specifications subject to change without notice.

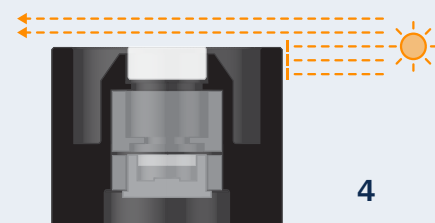
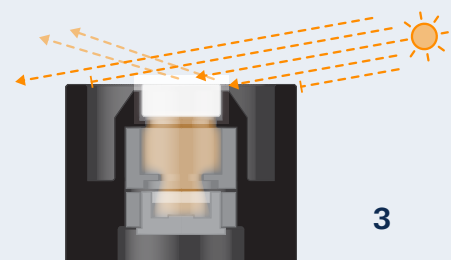
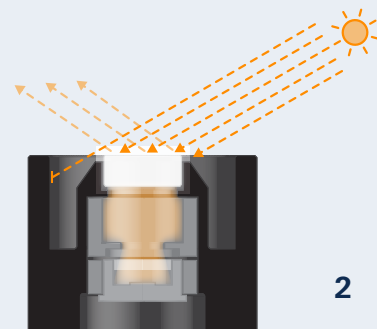
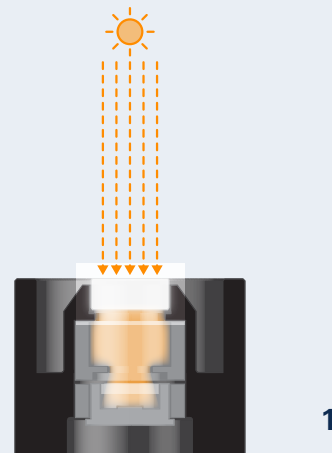
Science

LI-COR terrestrial light sensors are cosine-corrected, following Lambert's cosine law. A cosine-corrected sensor provides the most accurate measurements of radiation on a flat surface from all angles. Cosine correction ensures accurate measurements under various conditions such as low light levels and low solar elevation angles.

The design of the sensor creates the proper cosine response at angles of incidence up to 82° . Radiation is received by an acrylic disc called a diffuser, or "eye". When radiation strikes with a greater angle of incidence, more is received by the edge of the diffuser. This compensates for increasing reflection from the top surface as the angle of incidence grows larger. Beyond an angle of about 80° , the rim of the sensor begins to block some light in order to maintain the correct response as more radiation is received by the edge of the diffuser. At a 90° angle of incidence, the rim completely blocks the diffuser, in keeping with a proper cosine response.

LI-COR light sensors create the proper cosine response at various angles of incidence.

1. 0° : Light is received only by the top surface of the sensor eye.
2. 60° : Light is received by the edge of the eye, compensating for increasing reflection from the top.
3. 80° : The rim of the sensor begins to block some light, preventing too much from striking the edge.
4. 90° : The rim completely blocks the sensor eye, in keeping with a proper cosine response.



LI-COR Calibration Standards

Calibration is an integral step in the manufacture of all LI-COR optical radiation-measuring instruments. Because of slight variation in internal optical components, it is necessary to characterize each individual sensor before it leaves LI-COR. This calibration data is supplied as a “calibration constant,” which indicates the amount of sensor output for a given amount of measurable energy input.

Calibration constants are used to convert the raw signal into the appropriate units of solar radiation. A readout device such as the LI-1500 Light Sensor Logger or LI-250A Light Meter can store calibration multipliers to do this conversion automatically. Other loggers and meters must have their data scaled by a factor determined from the calibration constant to derive the appropriate units.

The characteristics of the optical components may be affected by environmental conditions. We recommend recalibration every two years to ensure correct measurements.

Pyranometer Calibration

LI-200R Pyranometers are calibrated against an Eppley® Precision Spectral Pyranometer (PSP) under natural daylight conditions. Calibration uncertainty under these conditions is estimated as $\pm 3\%$ typical, within $\pm 60^\circ$ angle of incidence.*

Quantum Sensor Calibration

Quantum sensors, including the LI-190R, LI-191R, LI-192, and LI-193, are calibrated using working standard quartz halogen lamps, which have been calibrated against reference standard lamps traceable to the U.S. National Institute of Standards and Technology (NIST). The absolute calibration specification for quantum sensors is $\pm 5\%$ (typically $\pm 3\%$) traceable to NIST.

Photometric Sensor Calibration

The LI-210R photometric sensors are calibrated using 683 lumens per watt as a value of spectral luminous efficiency at a wavelength of 555 nm. This value conforms to the recommendations of the International Committee for Weights and Measures (CIPM). Calibration is performed using working standard quartz halogen lamps, which have been calibrated against reference standard lamps traceable to the NIST.

*Preliminary specification

Specifications subject to change without notice.

Ordering Information

Sensors

Terrestrial Sensors

Sensor: LI-190R Quantum Sensor, LI-200R Pyranometer, or LI-210R Photometric Sensor

Cable length: 2 m, 5 m, 15 m, or 50 m

Termination type: BNC, bare leads, millivolt adapter, or SMV (Standard Output Millivolt Adapter)

LI-191R Line Quantum Sensor

Each LI-191R includes a bubble level and carrying case.

Cable length: 2 m or 5 m

Termination type: BNC, Millivolt Adapter, or SMV (Standard Output Millivolt Adapter)

Underwater Quantum Sensors

Sensor: LI-192 Underwater Quantum Sensor or LI-193 Spherical Underwater Quantum Sensor

Cable length: 3 m, 10 m, 30 m, 50 m, or 100 m

Termination type: BNC or Millivolt Adapter

Logger and Meter

LI-1500 Light Sensor Logger

The LI-1500 connects up to three light sensors with BNC terminals. Includes four AA batteries, USB cable, AC power supply adapter, carabiner clip, carrying case, Windows® file viewer software. Sensors sold separately.

LI-1500G Light Sensor Logger with GPS

GPS-enabled.

LI-1500G-UW Light Sensor Logger with GPS – Underwater Package

GPS-enabled. Includes underwater lowering frame and carrying case for underwater light sensors, lowering frame, and cables.

LI-1500-UW Light Sensor Logger – Underwater Package

LI-1500 without GPS. Includes underwater lowering frame and carrying case for underwater light sensors, lowering frame, and cables.

LI-250A Light Meter

Connects to any light sensor with a BNC terminal and displays instantaneous or 15-second averaged measurements.

Accessories

1500GPS Upgrade Kit

User-installable upgrade adds GPS functionality to any LI-1500.

1500-01 Underwater Carrying Case

Case holds one LI-1500, underwater lowering frame, two LI-192 Underwater Quantum Sensors, two LI-193 Spherical Underwater Quantum Sensors, one terrestrial sensor (LI-190R, LI-200R, or LI-210R), and 3-meter or 10-meter underwater cable.

LI-250A Carrying Case

Fabric case for the LI-250A and one light sensor.

2001S Sensor Base Cover

Protects the base and cable when the sensor head is removed.

2003S Mounting and Leveling Fixture

For the LI-190R, LI-200R, and LI-210R Sensors. Anodized aluminum with stainless steel leveling screws and a weatherproof spirit level. 7.6 cm diameter (3.0") and 95 g (0.21 lbs.).

2009S Lowering Frame

Mounts one or two LI-192SA or LI-193SA sensors for lowering into water.

2420 Light Sensor Amplifier

Amplifies signal from light sensors. For use with logging devices that require an amplified voltage signal. Provides 15 gain settings to accommodate a wide variety of data loggers.

2420-BNC – For light sensors with BNC connectors.

2420-BL – For light sensors with bare leads.

Millivolt Adapters

Convert BNC connector to bare leads and the output signal to millivolts (mV). For use with logging devices that require a voltage signal. SMV-type adapters feature a standard output (0 to 10 mV) so that multipliers do not need to be changed when changing sensors. SMV-type adapters are factory adjusted to match a particular sensor's output. Provide the sensor's serial number when ordering.

2220 Millivolt Adapter – For the LI-200R Pyranometer.

2290 Millivolt Adapter – For the LI-190R Quantum Sensor, LI-210R Photometric Sensor, and LI-191R Line Quantum Sensor.

2291 Millivolt Adapter – For the LI-192SA and LI-193SA Underwater Sensors.

2320 (SMV) – For the LI-200R Pyranometer.

2319 (SMV) – For the LI-190R Quantum Sensor or LI-191R Line Quantum Sensor.

2321 (SMV) – For the LI-210R Photometric Sensor.