

# Light Measurement



The Standard for over 40 Years

# Introduction

LI-COR radiation sensors measure the flux of radiant energy—the energy that drives plant growth, warms the earth, and lights our world. The properties of radiant flux depend on the wavelength of the radiation. Pyranometers are sensitive to the broadest waveband. Photometric sensors measure visible radiation (light). Quantum sensors measure Photosynthetically Active Radiation (PAR)—the radiant energy used in photosynthesis. These three sensor types cover a wide range of applications:



ecology



meteorology



solar energy



plant research



indoor lighting

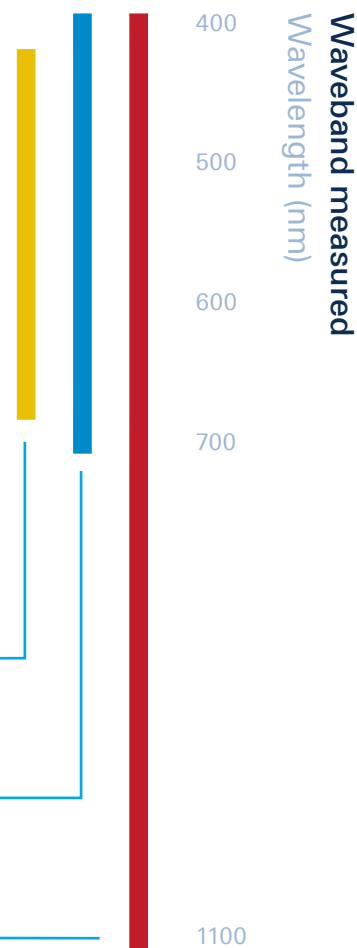


underwater

**Photometric Sensor**  
(Visible Light)

**Quantum Sensor**  
(Photosynthetically Active Radiation)

**Pyranometer**  
(Global Solar Radiation)





# LI-192 Underwater Quantum Sensor

The LI-192 Underwater Quantum Sensor measures PAR from all angles in one hemisphere. The LI-192 works in air or underwater at depths up to 560 meters. The measurements are cosine corrected and typically expressed as Photosynthetic Photon Flux Density (PPFD). For simultaneous measurements of downwelling and upwelling PAR, two sensors can be mounted on the 2009S Lowering Frame.

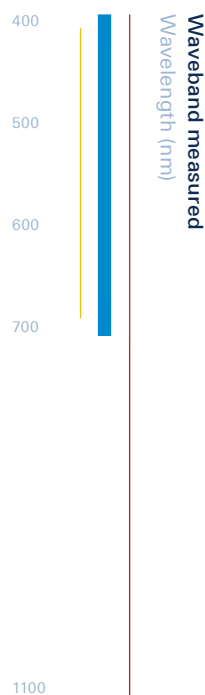


## Why choose the LI-192?

- Designed for immersion
- Rugged, corrosion-resistant sensors for use in fresh and saltwater environments
- Ideal for oceanography, limnology, turbidity, and vertical profiling
- Suitable for submerged and out-of-water measurements

## How does it work?

The LI-192 uses a silicon photodiode and a glass optical filter to 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. A precision optical filter blocks light with wavelengths beyond 700 nm, which is critical for measurements in a water column, where the ratio of infrared to visible light may be high.



### LI-192 Specifications

- Absolute Calibration:  $\pm 5\%$  in air traceable to NIST
- Sensitivity: Typically  $4 \mu\text{A}$  per  $1,000 \mu\text{mol s}^{-1} \text{m}^{-2}$  in water
- Linearity: Maximum deviation of  $1\%$  up to  $10,000 \mu\text{mol s}^{-1} \text{m}^{-2}$
- Response Time:  $10 \mu\text{s}$
- Temperature Dependence:  $\pm 0.15\%$  per  $^{\circ}\text{C}$  maximum
- Cosine Correction: Optimized for underwater and atmospheric use
- Azimuth:  $< \pm 1\%$  error over  $360^{\circ}$  at  $45^{\circ}$  elevation
- Operating Temperature Range:  $-40^{\circ}\text{C}$  to  $65^{\circ}\text{C}$
- Detector: High stability silicon photovoltaic detector (blue enhanced)
- Sensor Housing: Corrosion resistant metal with acrylic diffuser for both saltwater and freshwater applications. Waterproof to withstand approximately  $5500 \text{ kPa}$  ( $800 \text{ psi}$ ),  $560$  meters.
- Size:  $3.18 \text{ cm}$  diameter  $\times$   $4.62 \text{ cm}$  height ( $1.25'' \times 1.81''$ )
- Weight:  $227 \text{ g}$  ( $0.5 \text{ lbs.}$ )
- Mounting: Three  $6-32$  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.



# LI-193 Spherical Quantum Sensor



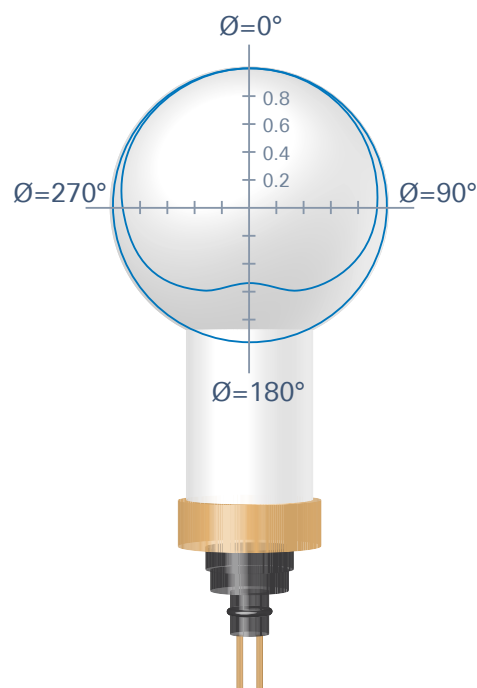
The LI-193 Spherical Quantum Sensor measures PAR in air or underwater from all directions at depths up to 350 meters. This sensor is useful for studies of phytoplankton, which uses radiation from all directions. The measurement is referred to as Photosynthetic Photon Flux Fluence Rate (PPFFR) or Quantum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

## Why choose the LI-193?

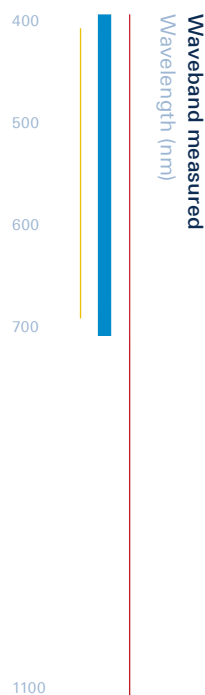
- Designed for immersion
- Measures PAR from all directions
- Ideal for oceanography, limnology, turbidity, and vertical profiling

## 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  $360^{\circ}$  at  $90^{\circ}$  from normal axis
- Operating Temperature Range:  $-40^{\circ}\text{C}$  to  $65^{\circ}\text{C}$
- 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  $3,400 \text{ kPa}$  ( $500 \text{ psi}$ ),  $350$  meters.
- Size:
  - Globe:  $6.1 \text{ cm}$  diameter ( $2.4''$ )
  - Housing:  $3.18 \text{ cm}$  diameter ( $1.25''$ )
  - Overall Height:  $10.7 \text{ cm}$  ( $4.2''$ )
- Weight:  $142 \text{ g}$  ( $0.31 \text{ lbs.}$ )
- 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.



# LI-1500 Light Sensor Logger



The LI-1500 Light Sensor Logger provides a direct digital readout and data logging from up to three LI-COR sensors at the same time. Log manually or set up one-time, daily, or continual logging routines. Take advantage of the intuitive, menu-driven interface, optional GPS system, high frequency measurements up to 500 Hz, and built-in math functions.



## Why choose the LI-1500?

- Large 1-GB memory for storing data and up to 100 sensor-specific multipliers
- Rugged, weather-resistant housing and optional GPS for outdoor use or transect measurements
- Eight math functions, including integration, natural logarithm, and underwater attenuation

### LI-1500 Specifications

Current Inputs: 3 BNC connectors for LI-COR sensors

Output Channels:

- Light
- 8 Math Channels: addition, subtraction, multiplication, division, natural logarithm, integration, daily integration, attenuation
- GPS (optional)
- Prompt
- Battery Voltage

Input Channel Specifications:

- Frequency Rejection: >70dB at 50 or 60 Hz (1 input channel @ sampling rates of 1, 2, 5, 10, 20Hz)
- Current Accuracy:  $\pm 0.3\%$  of full scale reading @25 °C
- Signal Ranges:

Range #	Current Range	Resolution (Typical)
1	0 – 0.250 $\mu$ A	0.0305 nA
2	0 – 2.50 $\mu$ A	0.1525 nA
3	0 - 25 $\mu$ A	1.525 nA
4	0 - 250 $\mu$ A	15.25 nA

- Raw Mode (1 – 500 Hz): Selectable Range
- Standard Modes (Continual, Manual, Daily, One Time):
  - Auto range for total sampling rate  $\leq 3$  Hz (e.g. 1 Hz sampling on three input channels)
  - Fixed range (selectable) for total sampling rates > 3 Hz (e.g. 2 Hz sampling on two input channels)

Sampling Rates:

- Standard Modes: 0.01 Hz, 0.1 Hz, 1 Hz, 2 Hz, 5 Hz, 10 Hz, 20 Hz
- Raw Mode: 1 – 500 Hz (1 Hz through 500 Hz in whole number increments)

Logging Rates:

- Standard Modes Sampling: Every Sample, 100 msec, 200 msec, 500 msec, 1 sec, 5 sec, 10 sec, 15 sec, 30 sec, 60 sec, 100 sec, 5 min, 15 min, 30 min, 1 hr, 2 hr, 3 hr, 6 hr, 12 hr, 24 hr
- Raw Mode Sampling: Every sample (1 – 500 Hz)

Averaging:

- Multiple averaging windows available with standard mode sampling

Display: 128 x 64 graphics display

Real-Time Clock:

- Year, Month, Day, Hour, Minute, Seconds
- Accuracy of  $\pm 3$  minutes per month

Data Storage Capacity: 1 GB (FAT16 file system)

Communications: USB (as mass storage device)

Global Positioning System (Option): GPS RADIONOVA® RF Antenna Module

Power Supply Options:

- 4 "AA" size batteries
- USB, AC-DC power adapter
- USB, external battery power pack (customer supplied)

Battery Life:

- 80 hours life (typical usage with 1 Hz sampling and logging rate)
- 40 hours life (typical usage with GPS option on)

Environmental Conditions:

- Operating Temperature Range: -20 to 50°C
- Humidity Range: 0 to 95% RH (non-condensing conditions)
- Storage Temperature Range: -40 to 65°C

Size: 20.9 x 9.8 x 3.5 cm (8.2" x 3.9" x 1.4")

Weight: 0.454 kg (1.0 lb) with batteries

Specifications subject to change without notice.



### 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.