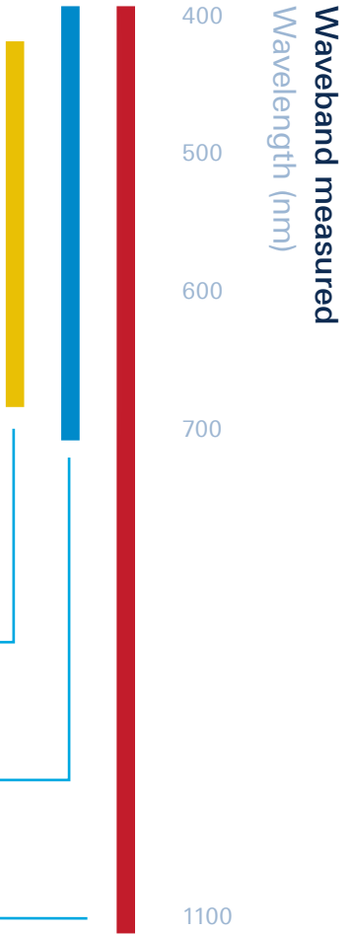
Light Measurement

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-191R Line Quantum Sensor

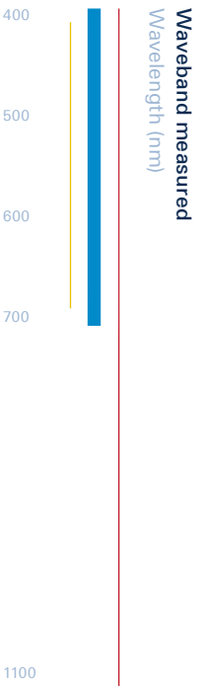
The LI-191R Line Quantum Sensor measures PAR integrated over its 1-meter length. It is used to measure sunlight under a plant canopy, where the light field is non-uniform. The LI-191R makes it easy to measure under-canopy light in many plots quickly and consistently. It measures light in units of Photosynthetic Photon Flux Density (PPFD), which is expressed as µmol s^{-1} m^{-2}.

Why choose the LI-191R?

- Improved water resistance for long-term outdoor deployment
- Integrated measurements using a single detector prevents variance found in sensors that use multiple detectors
- Selected by the National Ecological Observatory Network (NEON®) for integrated PAR measurements

How does it work?

The LI-191R uses a 1-meter long quartz rod under a diffuser to direct light to a single filtered silicon photodiode. The entire LI-191R diffuser is sensitive to light over its 1-meter length. Since the diffuser is one continuous piece, the LI-191R essentially integrates an infinite number of points over its surface into a single value that represents light from the entire 1-meter length. Optical filters block radiation with wavelengths beyond 700 nm, which is critical for under-canopy measurements, where the ratio of infrared to visible light may be high. The unique design of the LI-191R provides an excellent quantum response that is close to the ideal quantum response.



LI-191R Line Quantum Sensor Specifications

- Absolute Calibration: ± 10% traceable to National Institute of Science and Technology (NIST). The LI-191R is calibrated via transfer calibration using a reference LI-190R Quantum Sensor. Transfer error is ± 5% (included in the ± 10%)
- Sensitivity: Typically 7 µA per 1,000 µmol s^{-1} m^{-2}
- Linearity: Maximum deviation of 1% up to 10,000 µmol s^{-1} m^{-2}
- Response Time: 10 µs
- Temperature Dependence: ± 0.15% per °C maximum
- Cosine Correction: Acrylic diffuser
- Azimuth: < ± 2% error over 360° at 45° elevation
- Operating Temperature Range: –40 °C to 65 °C
- Relative Humidity Range: 0% to 95% RH, Non-Condensing
- Sensitivity Variation over Length: ± 7% maximum using a 2.54 cm (1") wide beam from an incandescent light source.
- Sensing Area: 1 m x 12.7 mm (39.4" x 0.50")
- Detector: High stability silicon photovoltaic detector (blue enhanced)
- Sensor Housing: Weatherproof anodized aluminum housing with acrylic diffuser and stainless steel hardware.
- Size: 121.3 L x 2.54 W x 2.54 cm D (47.7" x 1.0" x 1.0")
- Weight: 1.4 kg (3.0 lbs.)
- Cable Length: 2 m, 5 m (6.5', 16.4')

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.

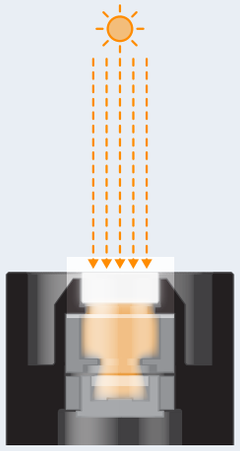
LI-COR light sensors create the proper cosine response at various angles of incidence.

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.



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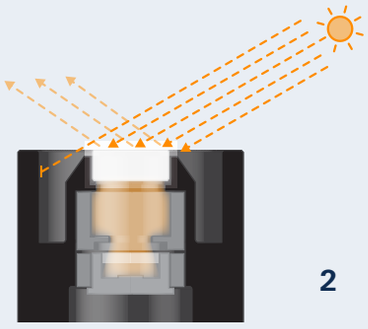

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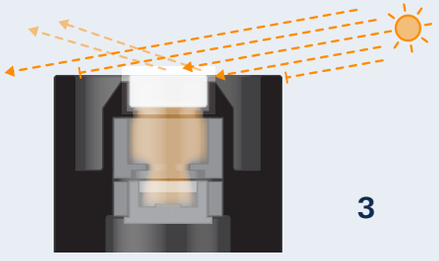

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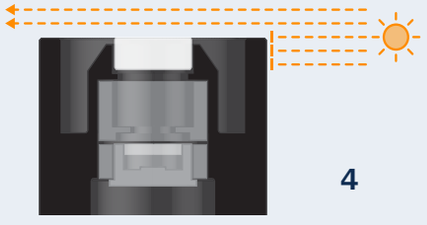

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LI-COR Calibration Standards

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 ± 3% typical, within ± 60° 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 ± 5% (typically ± 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

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