# LI-190SA Quantum Sensor

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## Measure Photosynthetically Active Radiation

During photosynthesis, plants use energy in the region of the electromagnetic spectrum from 400-700 nm (1,2). The radiation in this range, referred to as Photosynthetically Active Radiation (PAR), can be measured in energy units (watts $m^{-2}$) or as Photosynthetic Photon Flux Density (PPFD), which has units of quanta (photons) per unit time per unit surface area. The units most commonly used are micromoles of quanta per second per square meter (µmol $s^{-1}$ $m^{-2}$). Plant scientists, horticulturists, ecologists, and other environmental scientists use the LI-190SA Quantum Sensor to accurately measure this variable.




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Accurate measurements are obtained under all *natural and artificial lighting conditions* because of the computer-tailored spectral response of the LI-190SA. Colored glass filters are used to tailor the silicon photodiode response to the desired quantum response (Figure 1). An interference filter provides a sharp cutoff at 700 nm, which is critical for measurements under vegetation where the ratio of infrared to visible light may be high. A small response in the infrared region can cause an appreciable measurement error. This sensor, developed from earlier work (3), was pioneered by LI-COR and has become the standard for PPFD measurement in most photosynthesis-related studies.

The LI-190SA is also used in oceanography, limnology, and marine science as a reference sensor for comparison to underwater PAR measured by the LI-192SA Underwater Quantum Sensor.

## Quantum Sensors

LI-COR Quantum Sensors are used to measure PPFD of photosynthetically active radiation (PAR). A simple integral relationship exists between the number of molecules photochemically changed and the number of photons absorbed within a particular waveband regardless of photon energy (6). The ideal quantum sensor should have an equal response to all photons within the 400-700 nm waveband. A typical response curve of a LI-COR quantum Sensor plotted against the ideal quantum response is shown in Figure 1.

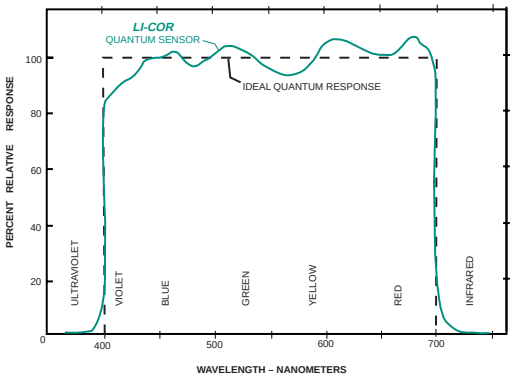



Figure 1. Typical spectral response of LI-COR Quantum Sensors vs. Wavelength and the Ideal Quantum Response (equal response to all photons in the 400-700 nm waveband).

* Units currently used are moles, einsteins, photons and quanta (2, 4, 5). 1 µmol $s^{-1}$ $m^{-2}$ ≡ 1 µE $s^{-1}$ $m^{-2}$ ≡ 6.02 × $10^{17}$ photons $s^{-1}$ $m^{-2}$ = 6.02 × $10^{17}$ quanta $s^{-1}$ $m^{-2}$.

## LI-190SA Specifications

**Absolute Calibration:** ± 5% traceable to the National Institute of Standards and Technology (NIST).

**Sensitivity:** Typical 5µA per 1000 µmol $s^{-1}$ $m^{-2}$.

**Linearity:** Maximum deviation of 1% up to 10,000 µmol $s^{-1}$ $m^{-2}$.

**Stability:** Typically < ± 2% change over a 1 year period.

**Response Time:** 10 µs.

**Temperature Dependence:** 0.15% per °C maximum.

**Cosine Correction:** Cosine corrected up to 80° angle of incidence.

**Azimuth:** < ± 1% error over 360° at 45° elevation.

**Tilt:** No error induced from orientation.

**Operating Temperature:** -40 to 65°C.

**Relative Humidity:** 0 to 100%.

**Detector:** High stability silicon photovoltaic detector (blue enhanced).

**Sensor Housing:** Weatherproof anodized aluminum case with acrylic diffuser and stainless steel hardware.

**Size:** 2.38 Dia. × 2.54 cm H (0.94" × 1.0").

**Weight:** 28 g (1 oz).

**Cable Length:** 3.0 m (10 ft).

## Ordering Information

The LI-190SA Quantum Sensor cable terminates with a BNC connector that connects directly to the LI-250 Light Meter or LI-1400 DataLogger. The 2290 Millivolt Adapter should be ordered if the LI-190SA will be used with a strip chart recorder or datalogger that measures millivolts. The 2290 uses a 604 Ohm precision resistor to convert the LI-190SA output from microamps to millivolts. The Quantum Sensor can also be ordered with bare leads (without the connector) and is designated LI-190SZ. Both are available with 50 foot cables, LI-190SA-50 or LI-190SZ-50. The 2003S Mounting and Leveling Fixture is recommended for each sensor unless other provisions for mounting are made. Other accessories are described on the Accessory Sheet.

**LI-190SA Quantum Sensor**
**LI-190SZ Quantum Sensor**
**LI-190SA-50 Quantum Sensor**
**LI-190SZ-50 Quantum Sensor**
**2290 Millivolt Adapter**
**2003S Mounting and Leveling Fixture**
**2222SB-50 Extension Cable**
**2222SB-100 Extension Cable**