

Amplified Quantum Sensor

SQ-200 Series



Measuring PPF with a Quantum Sensor

Photosynthesis is driven by the number of photons between 400 and 700 nanometers (nm). This is called the Photosynthetic Photon Flux (PPF) and is measured in $\mu\text{mol m}^{-2} \text{s}^{-1}$. PPF sensors are commonly called quantum sensors because a quantum refers to the amount of energy carried by a photon.

Quantum Sensor Models

US Patent No. D519,860



Calibrated for sunlight; SQ-212, SQ-215



Calibrated for electric light; SQ-222, SQ-225

Application

Quantum sensors are designed for use with dataloggers. They are often used to quantify the light available in greenhouse settings.

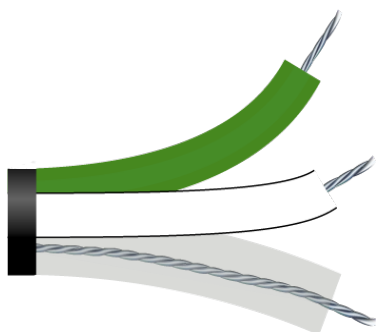
An innovative blue lens improves the accuracy of these sensors and meters. The pigments in the lens filter incoming light for an improved spectral response. The sensor has a domed diffusion disk and head for improved self-cleaning characteristics and long-term stability.

Cleaning

Debris on the sensor head is a common cause of low readings. The sensor has a domed head for improved self-cleaning from rainfall, but salt deposits can accumulate from evaporation of sprinkler irrigation water and dust can accumulate during periods of low rainfall. Salt deposits should be dissolved and removed with vinegar and a soft cloth or q-tip. Dust and other organic deposits are best removed with water, rubbing alcohol or window cleaner. *Never use an abrasive cleaner on the lens.*

Connection Instructions

Do not exceed 5.5 Volts in power supply.
Do not connect green wire to power supply.



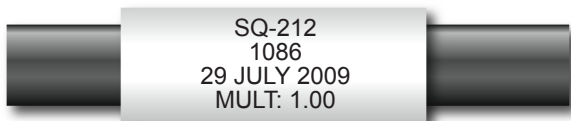
Green Positive
(signal from sensor)

White Input power

Clear Ground
(for sensor signal and
input power)

	<u>2.5 Option</u>	<u>5.0 Option</u>
Power Supply	2.5 to 5.5 V	5.0 to 5.5 V
Conversion Factor	1.0 $\mu\text{mol m}^{-2} \text{s}^{-1}$ per mV	0.5 $\mu\text{mol m}^{-2} \text{s}^{-1}$ per mV
Output (Volts)	0.0 to 2.5 V	0.0 to 5.0 V
Full Sunlight	2.0 V ($2000 \mu\text{mol m}^{-2} \text{s}^{-1}$)	4.0 V ($2000 \mu\text{mol m}^{-2} \text{s}^{-1}$)

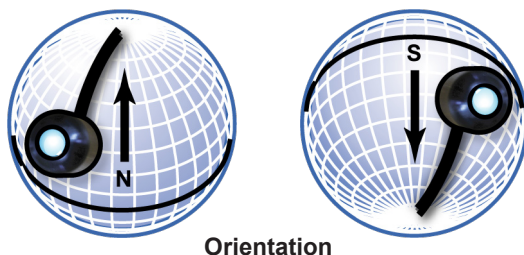
The model, serial number, production date, and calibration factor are located on the sensor cable.



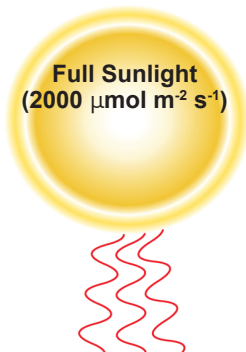
Mounting the Sensor



Mount the sensor to a solid surface with the nylon mounting screw. The sensor should be mounted level for the most accurate measurements. We recommend using our leveling plate (AL-100). The sensor should be mounted with the cable pointing toward true north in the northern hemisphere or true south in the southern hemisphere to minimize azimuth error. The azimuth error is typically less than 1%.



Calibration



All Apogee quantum sensor models have a standard calibration of exactly:

0.5 or 1.0 $\mu\text{mol m}^{-2} \text{s}^{-1}$ per mV

Use this conversion factor to convert the mV signal from the sensor to photosynthetic photon flux. Multiply the mV output by the conversion factor to get photosynthetic photon flux in $\mu\text{mol m}^{-2} \text{s}^{-1}$.



Sensor Output: 4 V (SQ-215 or -225)
Conversion Factor: 0.5 $\mu\text{mol m}^{-2} \text{s}^{-1}$ per mV







Sensor Output: 2 V (SQ-212 or -222)
Conversion Factor: 1.0 $\mu\text{mol m}^{-2} \text{s}^{-1}$ per mV

$$\begin{array}{rcl} \text{sensor output} & * & \text{conversion factor} & = & \text{PPF} \\ 400 \text{ mV} & * & 0.5 \mu\text{mol m}^{-2} \text{s}^{-1} \text{ per mV} & = & 2,000 \mu\text{mol} \\ \text{m}^{-2} \text{s}^{-1} & & & & \end{array}$$

Spectral Differences

Apogee quantum sensors are calibrated for either electric light or sunlight. The difference in calibration is close to 10%. A sensor calibrated for fluorescent lamps will read about 10% low in sunlight. A sensor calibrated for sunlight will read about 10% high under fluorescent lamps. The spectral errors are less than 2% for other common electric light sources.

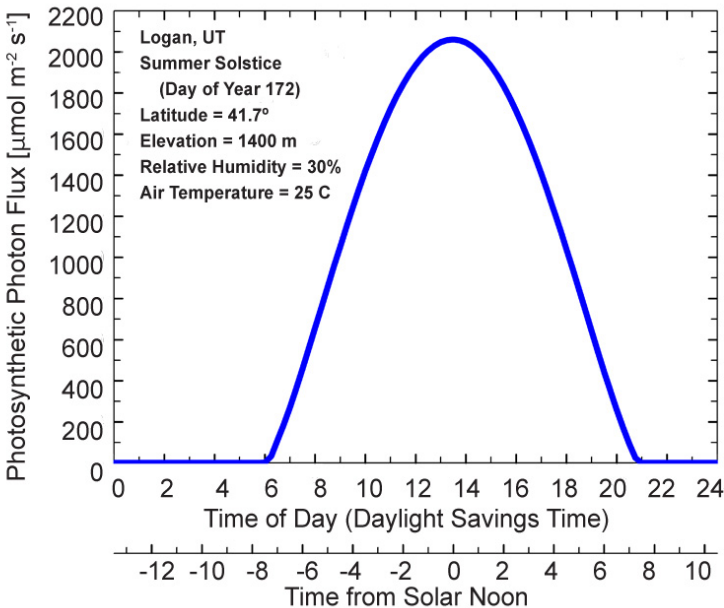
		Electric Calibration	Sunlight Calibration
	Cool White Fluorescent	Calibration Reference ↓	10% high
	Metal Halide	< 2% low	8% high
	High Pressure Sodium	< 2% low	8% high
	Sunlight	10% low	↑ Calibration Reference



The Clear Sky Calculator is designed to determine the need for radiation sensor recalibration. It determines the intensity of radiation falling on a horizontal surface at any time of the day in any location in the world. It is most accurate when used near solar noon in the summer months.

The calculator is found at www.clearskycalculator.com and is used by typing conditions into the Clear Sky model and comparing measured values with the calculated value for a clear sky. If the output of the sensor over multiple days at solar noon is consistently less than the model value (by more than 8%), the sensor should be cleaned and re-leveled. If the output is still low after a second test, email calibration@apogeeinstruments.com to discuss test results and the possible return of sensors. When used near solar noon over multiple clear, unpolluted days during the spring and summer months, it is estimated that the accuracy of the model can be $\pm 4\%$ in all climates and locations around the world.

Example of Model Output

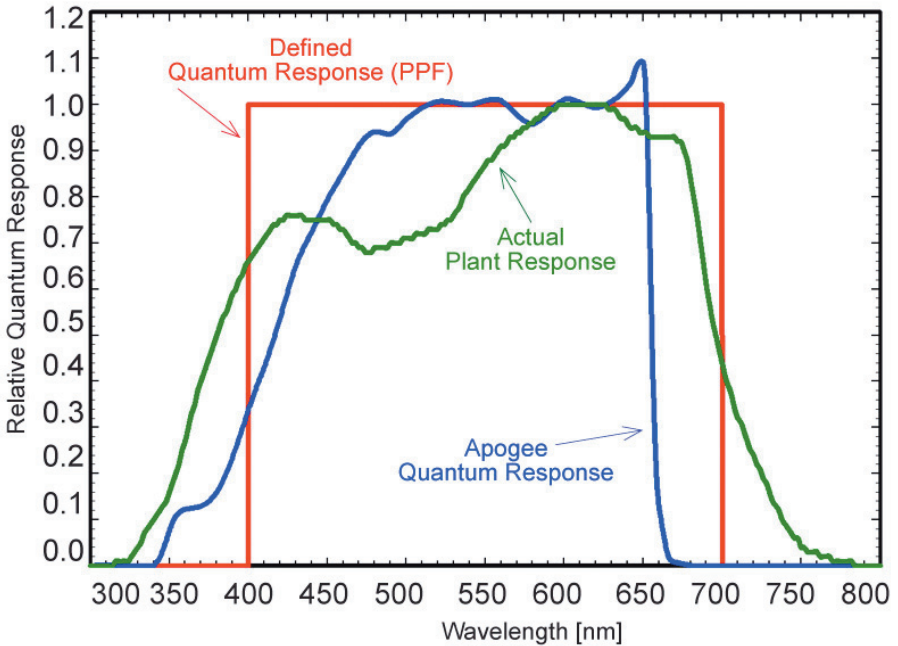


Characteristics

Cosine Response: The convex disc is designed to capture radiation at low angles and minimize cosine errors. The cosine error for integrated daily total measurements is less than 2%.

Temperature Response: Temperature response is less than 0.1% per degree Celsius.

Spectral Response: Quantum response is from 400 to 700 nm and gives equal emphasis to all photons. A blue lens filters the light and improves the spectral response. The spectral response of the Apogee sensor and a typical plant response are shown below.



Specifications

Sunlight Calibration (SQ-212 & 215)

- Absolute Accuracy: $\pm 5\%$
- Uniformity: $\pm 3\%$
- Repeatability $\pm 1\%$

Electric Lamps Calibration (11% Difference) (SQ-222 & 225)

- Absolute Accuracy: $\pm 5\%$
- Uniformity: $\pm 3\%$
- Repeatability: $\pm 1\%$

2.5 V Option

- Output: 0 to 2.5 V (2.0 V = full sunlight $2000 \mu\text{mol m}^{-2} \text{s}^{-1}$)
- Input Power: 2.5 to 5.5 VDC
- Sensitivity: Custom calibrated to exactly $1.0 \mu\text{mol m}^{-2} \text{s}^{-1}$

5.0 V Option

- Output: 0 to 5 V (4.0 V = full sunlight $2000 \mu\text{mol m}^{-2} \text{s}^{-1}$)
- Input Power: 5 to 5.5 VDC
- Sensitivity: Custom calibrated to exactly $0.5 \mu\text{mol m}^{-2} \text{s}^{-1}$

Current Draw

- 285 μA

Long-Term Drift

- Less than 3% per year

Operating Environment

- -25 to 55 C
- 0 to 100% relative humidity
- Designed for continuous outdoor use
- Can be submerged underwater with or without mounting screw

Materials

- Anodized aluminum with acrylic lens

Cable

- 5 meters of twisted-pair wire
- Foil shield
- Santoprene jacket
- Ending in pigtail leads
- Additional cable is available in multiples of 5 meters

Dimensions

- 2.4 cm diameter by 2.75 cm height

Mass

- 70 g (with 3 m lead wire)

Warranty

- 1 year against defects in materials and workmanship



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