



ORIGINAL QUANTUM SENSORS | SQ-100, SQ-200, & SQ-300 Series

Features

Multiple Output Options

- 0 to 800 mV
- 0 to 2.5 V
- 0 to 5 V
- 4 to 20 mA
- USB
- SDI-12

Accurate, Stable Measurements

Cosine-corrected with directional errors less than $\pm 5\%$ at a solar zenith angle of 75° . Long-term non-stability less than 2% per year.

Unique Design

Cost-effective, original quantum sensors work well for broadband radiation sources (sun, high-pressure sodium, metal halide, cool white fluorescent lamps). The patented, dome-shaped aluminum head is cosine-corrected, self-cleaning, and fully-potted for a waterproof design.

Line Quantum Sensor Options

Sensors are available with multiple detectors mounted along the length of a rugged anodized aluminum bar, which provide spatially averaged PPFD measurements along the length of the bar.

Typical PPFD Measurement Applications

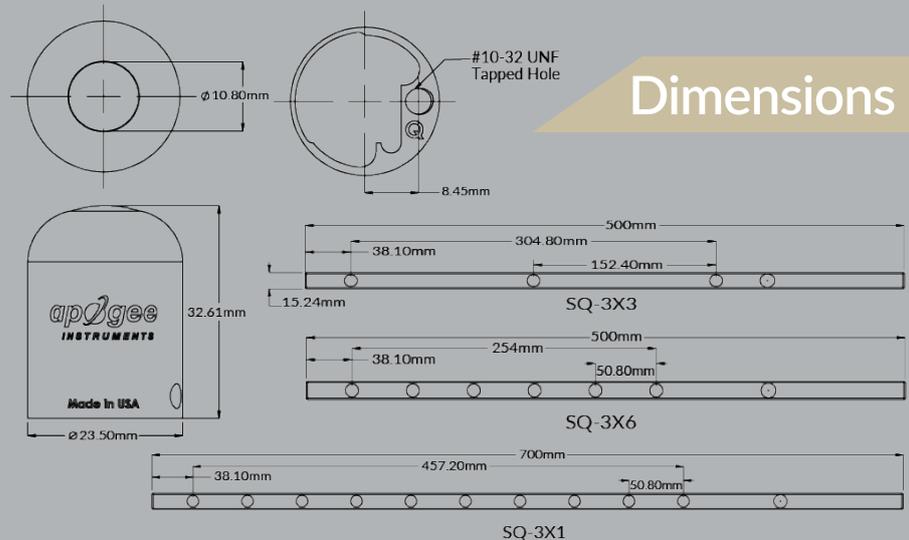
- Incoming and reflected PPFD over and under plant canopies in greenhouses, in fields, and in growth chambers
- Aquatic environments including salt water aquariums and freshwater lakes and streams

Measure photosynthetically active radiation (PAR) in $\mu\text{mol m}^{-2} \text{s}^{-1}$



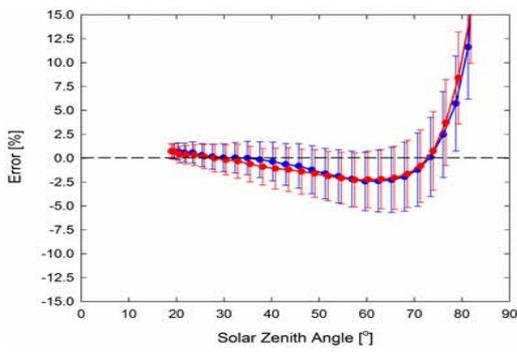
Calibration Traceability

Apogee SQ sensors are calibrated through side-by-side comparison to the mean of (4) Apogee model SQ-110 or SQ-120 transfer standard sensors under high output T5 cool white fluorescent lamps. The transfer standard sensors are calibrated through side-by-side comparison to the mean of at least (3) LI-COR model LI-190R reference quantum sensors under high output T5 cool white fluorescent lamps. The reference sensors are recalibrated on a biannual schedule with a LI-COR model 1800-02 and quartz halogen lamp that are traceable to the National Institute of Standards and Technology (NIST).



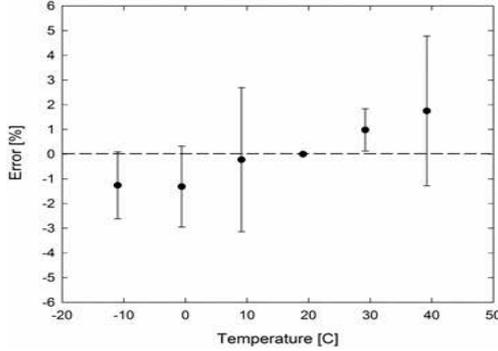
Dimensions

Cosine Response



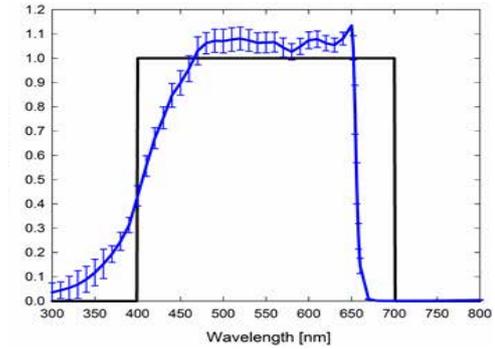
Mean cosine response of (7) Apogee SQ-500 quantum sensors. Cosine response measurements were made on the rooftop of the Apogee building in Logan, UT. Cosine response was calculated as the relative difference of SQ-500 quantum sensors from the mean of replicate reference quantum sensors (LI-COR models LI-190 and LI-190R, Kipp & Zonen model PQS 1). The red data are AM measurements; the blue data are PM measurements.

Temperature Response



Mean spectral response of (6) SQ series quantum sensors (error bars represent two standard deviations above and below mean) compared to PPFD weighting function. Spectral response measurements were made at 10 nm increments across a wavelength of 300 to 800 nm in a monochromator with an attached electric light source. Measured spectral data from each quantum sensor were normalized by the measured spectral response of the monochromator/electric light combination, which was measured with a spectroradiometer.

Spectral Response



Mean temperature response of (8) SQ series quantum sensors (errors bars represent two standard deviations above and below mean). Temperature response measurements were made at 10 C intervals across a temperature range of approximately -10 to 40 C in a temperature controlled chamber under a fixed, broad spectrum electric lamp. At each temperature set point, a spectroradiometer was used to measure light intensity from the lamp and all quantum sensors were compared to the spectroradiometer. The spectroradiometer was mounted external to the temperature control chamber and remained at room temperature during the experiment.

Product Specifications

	SQ-110/120-SS	SQ-212/222-SS	SQ-214/224-SS	SQ-215/225-SS	SQ-300-SS Series
Power Supply	Self-powered	3.3 to 24 V DC; current draw 300 μ A	7 to 24 V DC with a maximum current draw of 22 mA (2 mA quiescent current draw)	5.5 to 24 V DC; current draw 300 μ A	Self-powered
Output (sensitivity)	0.2 mV per μ mol $m^{-2} s^{-1}$	1 mV per μ mol $m^{-2} s^{-1}$	0.004 mA per μ mol $m^{-2} s^{-1}$	2 mV per μ mol $m^{-2} s^{-1}$	0.2 per μ mol $m^{-2} s^{-1}$
Calibration Factor (reciprocal of output)	5 μ mol $m^{-2} s^{-1}$ per mV	1 μ mol $m^{-2} s^{-1}$ per mV	250 μ mol $m^{-2} s^{-1}$ per mA	0.5 μ mol $m^{-2} s^{-1}$ per mV	5 μ mol $m^{-2} s^{-1}$ per mV
Calibrated Output Range	0 to 800 mV	0 to 2.5 V	4 to 20 mA	0 to 5 V	0 to 800 mV
Calibration Uncertainty	$\pm 5\%$				
Measurement Repeatability	Less than 0.5 %				
Long-term Drift	Less than 2 % per year				
Non-linearity	Less than 1 % (up to 4000 μ mol $m^{-2} s^{-1}$)	Less than 1 % (up to 2500 μ mol $m^{-2} s^{-1}$)	Less than 1 % (up to 4000 μ mol $m^{-2} s^{-1}$)	Less than 1 % (up to 2500 μ mol $m^{-2} s^{-1}$)	Less than 1 % (up to 4000 μ mol $m^{-2} s^{-1}$)
Response Time	Less than 1 ms				
Field of View	180°				
Spectral Range	410 to 655 nm (wavelengths where response is greater than 50 % maximum)				
Spectral Selectivity	Less than 10 % from 469 to 655 nm				
Directional (Cosine) Response	$\pm 5\%$ at 75° zenith angle				
Temperature Response	0.06 \pm 0.06 % per C				
Operating Environment	-40 to 70 C; 0 to 100 % relative humidity; can be submerged in water up to depths of 30 m				
Dimensions	24 mm diameter; 28 mm height				500 mm x 15 mm x 15 mm; SQ-311/321: 700 mm x 15 mm x 15 mm
Mass	90 g (with 5 m of lead wire)	100 g (with 5 m of lead wire)			275 g; SQ-311/321: 375 g
Cable	5 m of shielded, twisted-pair wire, additional cable available; TPR jacket (high water resistance, high UV stability, flexibility in cold conditions), pigtail lead wires				
Warranty	4 years against defects in materials and workmanship				