

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



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



SQ-311

### Features

#### Multiple Output Options

- 0 to 800 mV
- 0 to 2.5 V
- 0 to 5 V
- 4 to 20 mA
- or hand-held meter

(For digital options, see SQ-400 series spec sheet)

#### Accurate, Stable Measurements

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

#### Unique Design

Cost-effective, original quantum sensors work well for broadband radiation sources. 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 provides spatially averaged PPFD measurements.

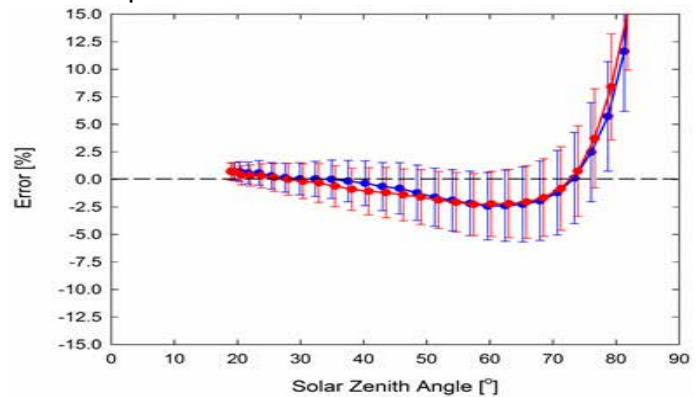
#### Typical PPFD Measurement Applications

- 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



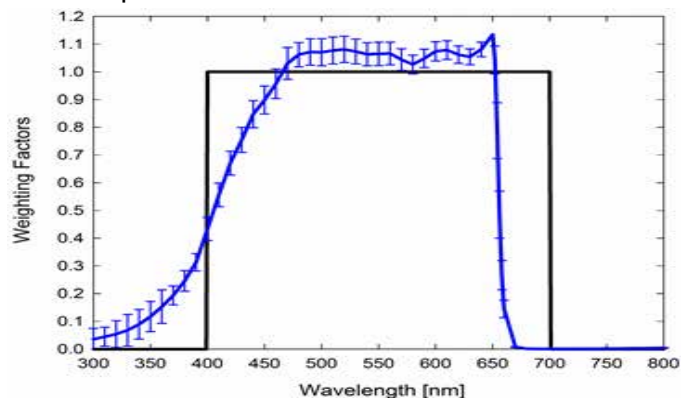
MQ-200

#### Cosine Response



Mean cosine response of seven Apogee SQ-110 quantum sensors. Cosine response was calculated as the relative difference of SQ-110 quantum sensors from the mean of replicate reference quantum sensors. The red data are AM measurements; the blue data are PM measurements.

#### Spectral Response

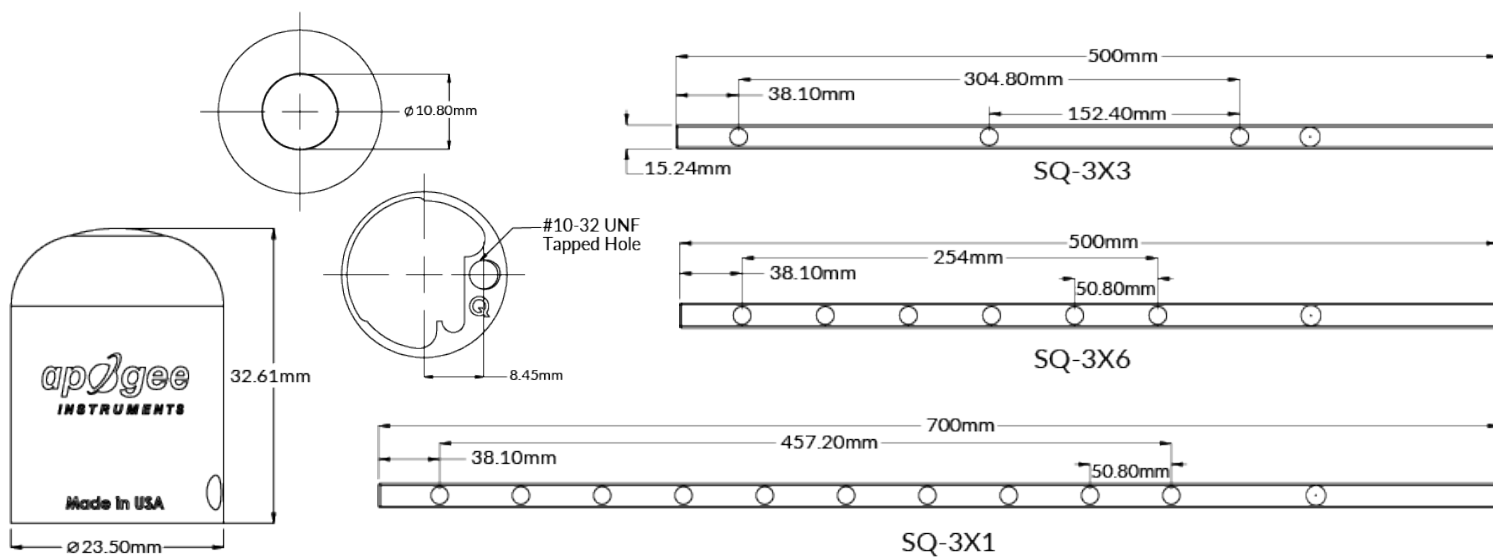


Mean spectral response of six SQ series quantum sensors (error bars represent two standard deviations above and below mean) compared to PPFD weighting function. Spectral response measurements were made at 10 nm increments across a wavelength of 300 to 800 nm in a monochromator with an attached electric 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.

## Calibration Traceability

Apogee SQ sensors are calibrated through side-by-side comparison to the mean of four transfer standard sensors under a reference lamp. The reference sensors are recalibrated with a quartz halogen lamp traceable to the National Institute of Standards and Technology (NIST).

## Dimensions



## 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; nominal current draw 300 $\mu$ 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; nominal current draw 300 $\mu$ A	Self-powered
Output (sensitivity)	0.2 mV per $\mu$ mol $m^{-2} s^{-1}$	0.6 mV per $\mu$ mol $m^{-2} s^{-1}$	0.004 mA per $\mu$ mol $m^{-2} s^{-1}$	1.25 mV per $\mu$ mol $m^{-2} s^{-1}$	0.2 per $\mu$ mol $m^{-2} s^{-1}$
Calibration Factor (reciprocal of output)	5 $\mu$ mol $m^{-2} s^{-1}$ per mV	1.6 $\mu$ mol $m^{-2} s^{-1}$ per mV	250 $\mu$ mol $m^{-2} s^{-1}$ per mA	0.8 $\mu$ mol $m^{-2} s^{-1}$ per mV	5 $\mu$ 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	Typically less than 1 % per year with a 2 % maximum				
Non-linearity	Less than 1 % (up to 4000 $\mu$ 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; 33 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, TPR jacket (high water resistance, high UV stability, flexibility in cold conditions), pigtail lead wires; stainless steel (316), M8 connector located 25 cm from sensor head				
Warranty	4 years against defects in materials and workmanship				