Quantum Sensors | SQ-100, SQ-200, and SQ-300 Series

Measure photosynthetically active radiation

Spectral Response

The original Apogee quantum sensor works well for broadband radiation sources (sun, and high pressure sodium, metal halide, cool white fluorescent lamps).

Accurate, Stable Measurements

Calibration in controlled laboratory conditions is traceable to an NIST lamp. Quantum sensors are cosine-corrected, with directional errors less than ± 5 % at a solar zenith angle of 75°. Long-term non-stability determined from multiple replicate quantum sensors in accelerated aging tests and field conditions is less than 2 % per year.

Rugged, Self-cleaning Housing

Patented domed shaped sensor head (diffuser and body) facilitate runoff of dew and rain to keep the sensor clean and minimize errors caused by dust blocking the reduced path. Sensors are housed in a rugged anodized aluminum body and electronics are fully potted.

Line Quantum Sensor Options

Sensors are available as line quantum sensors (multiple detectors mounted along the length of a rugged anodized aluminum bar), which provide spatially averaged PPFD measurements along the length of the bar. All sensors in the line are electrically connected, resulting in a single voltage output that is directly proportional to average PPFD.

Output Options

Multiple analog output options are available. Additionally, a digital 'smart' sensor that uses USB communication and custom software to interface directly to a computer is available. Sensors are also available attached to a hand-held meter with digital readout.

Typical Applications

PPFD measurement over plant canopies in outdoor environments, greenhouses, and growth chambers, and reflected or under-canopy (transmitted) PPFD measurements in the same environments. Quantum sensors are also used to measure PPFD in aquatic environments, including salt water aquariums where corals are grown.

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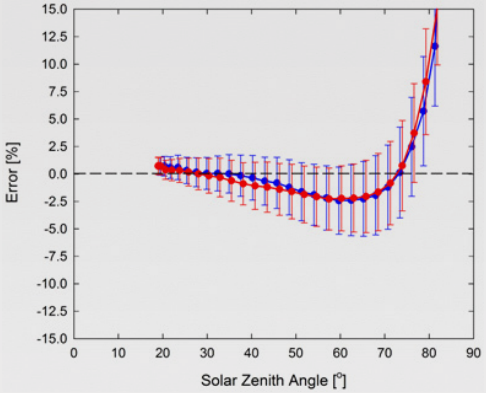
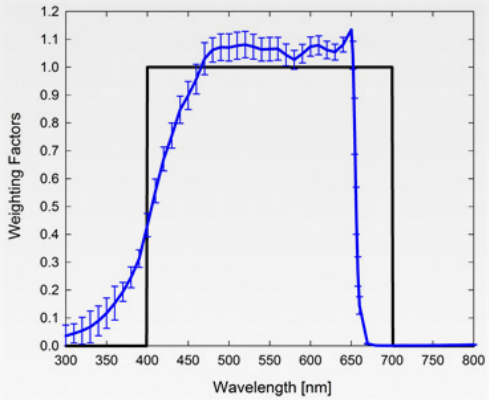
Cosine Response



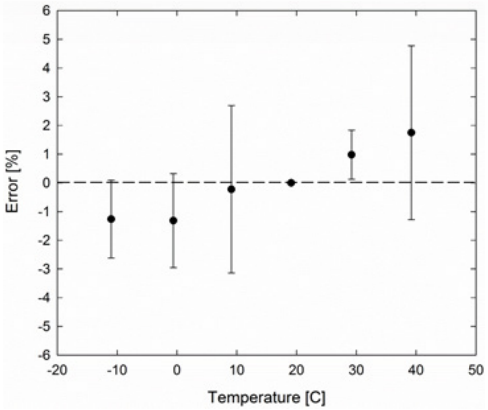
Mean cosine response of twenty-three SQ series quantum sensors (**error bars represent two standard deviations above and below mean**). Cosine response measurements were made by direct side-by-side comparison to the mean of four reference thermopile pyranometers, with solar zenith angle-dependent factors applied to convert total shortwave radiation to PPFD. Blue points represent the AM response and red points represent the PM response.

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

Temperature Response

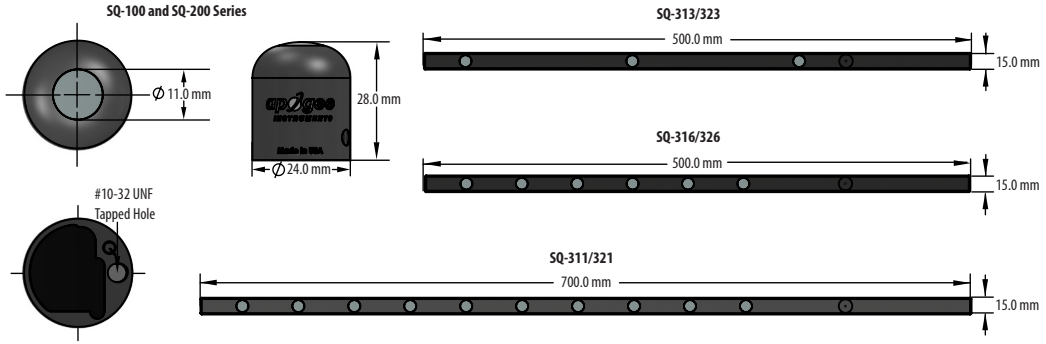


Mean temperature response of eight SQ series quantum sensors (**errors bars represent two standard deviations above and below mean**). Temperature response measurements were made at 10 C intervals across a temperature range of approximately -10 to 40 C in a temperature controlled chamber under a fixed, 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.

Calibration Traceability

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

Dimensions



	SQ-110/120	SQ-212/222	SQ-214/224	SQ-215/225	SQ-300 Series
Power Supply	Self-powered	5 to 24 V DC with a nominal current draw of 300 µA	5 to 36 V DC with a maximum current drain of 22 mA (2 mA quiescent current drain)	5.5 to 24 V DC with a nominal current draw of 300 µA	Self-powered
Output (sensitivity)	0.2 mV per µmol m^{-2} s^{-1}	1.0 mV per µmol m^{-2} s^{-1}	0.0064 mA per µmol m^{-2} s^{-1}	2.0 mV per µmol m^{-2} s^{-1}	0.2 mV per µmol m^{-2} s^{-1}
Calibration Factor (reciprocal of output)	5.0 µmol m^{-2} s^{-1} per mV	1.0 µmol m^{-2} s^{-1} per mV	156.0 µmol m^{-2} s^{-1} per mV	0.5 µmol m^{-2} s^{-1} per mV	5.0 µmol m^{-2} s^{-1} per mV
Calibrated Output Range	0 to 800 mV	0 to 2.5 V	4 to 20 mA	0 to 5.0 V	0 to 800 mV
Calibration Uncertainty	± 5 %				
Measurement Repeatability	Less than 0.5 %				
Long-term Drift	Less than 2 % per year				
Non-linearity	Less than 1 % (up to 4000 µmol m^{-2} s^{-1})	Less than 1 % (up to 2500 µmol m^{-2} s^{-1}; maximum PPFD measurement is 2500 µmol m^{-2} s^{-1})			Less than 1 % (up to 4000 µmol 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% of maximum)				
Spectral Selectivity	Less than 10 % from 469 to 653 nm				
Directional (Cosine) Response	± 5 % at 75° zenith angle				
Temperature Response	0.06 ± 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				SQ-313/316/323/326: 500 mm x 15mm x 15 mm; SQ-311/321: 700 mm x 15 mm x 15 mm
Mass	90 g (with 5 m of lead wire)		140 g (with 5 m of lead wire)	90 g (with 5 m of lead wire)	SQ-313/316/323/326: 275 g; SQ-311/321: 375 g
Cable	5 m of shielded, twisted-pair wire; additional cable available in multiples of 5 m; santoprene rubber jacket (high water resistance, high UV stability, flexibility in cold conditions); pigtail lead wires				
Warranty	4 years against defects in materials and workmanship				