



The photosynthetically active radiation measurement tool of choice for lighting researchers

## Features

Apogee Instruments Quantum Sensors are the tool of choice for researchers and agricultural professionals measuring photosynthetically active radiation (PAR) all over the world.

Apogee offers two types of quantum sensors: a **Full-spectrum Quantum (previously gold)** and **Original Quantum Sensor**. Consult our spectral response graph to decide which model is right for your application.

### Accurate, Stable Measurements

Cost-effective, original quantum sensors work well for broadband radiation sources (sun, high-pressure sodium, metal halide, cool white fluorescent lamps), while full-spectrum sensors are good for all light sources, including LEDs. Offers a self-cleaning, cosine-corrected head that is fully-potted for a waterproof design.

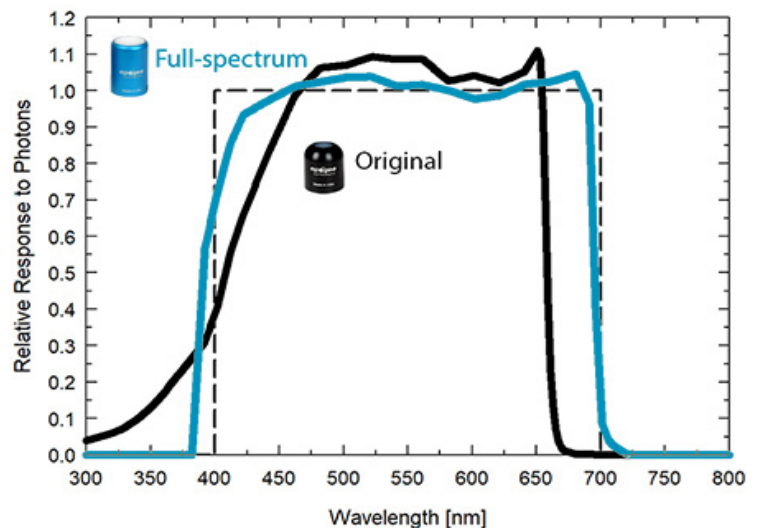
### Typical PPFD Measurement Applications

- 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

### Calibration Traceability

Apogee SQ series quantum 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).

## Spectral Response



Spectral response of original quantum sensor (black) and full-spectrum quantum sensor (blue) compared to defined response of plants to radiation (dashed).

## Spectral Errors

	Apogee SQ-500	Apogee SQ-110 SQ-120	LI-COR LI-190	Kipp & Zonen PQS 1
Sun (Clear Sky)	0.0	0.0	-0.4	-1.0
Sun (Cloudy Sky)	0.1	0.2	-0.2	-1.3
Sun (Reflected from Grass Canopy)	-0.3	3.8	-0.8	1.1
Sun (Transmitted below Wheat Canopy)	0.1	4.5	-0.1	-0.3
Cool White Fluorescent (T5)	0.0	0.0	0.0	0.0
Metal Halide	0.9	-2.8	0.2	-1.7
Ceramic Metal Halide	0.3	-16.1	0.4	-0.7
High Pressure Sodium	0.1	0.2	1.3	1.4
Red LED (667 nm peak, 20 nm full-width half-maximum)	2.8	-62.1	3.5	-1.8
Red, Blue, White LED Mixture (60 % Red, 25 % White, 15 % Blue)	-2.0	-35.5	2.6	-1.7

Provides research-grade measurements under all light sources, including LEDs

All other models

SQ-500 & SQ-520

### Output Options

- 0 to 40 mV
- 0 to 5 V
- USB
- Modbus
- 0 to 2.5 V
- 4 to 20 mA
- SDI-12
- or hand-held meter

MQ-500



### Product Specifications

	SQ-500-SS	SQ-512-SS	SQ-514-SS	SQ-515-SS	SQ-520	SQ-521-SS	SQ-522-SS
Power Supply	Self-powered	3.3 to 24 V DC	12 to 24 V DC	5.5 to 24 V DC	5 V USB power source	5.5 to 24 V DC	
Current Draw	–	At 12 V is 57 $\mu$ A	maximum of 20 mA	At 12 V is 57 $\mu$ A	61 mA when logging	1.4 mA (quiescent), 1.8 mA (active)	20 mA maximum
Output (sensitivity)	0.01 mV per $\mu$ mol m <sup>-2</sup> s <sup>-1</sup>	0.625 mV per $\mu$ mol m <sup>-2</sup> s <sup>-1</sup>	0.004 mA per $\mu$ mol m <sup>-2</sup> s <sup>-1</sup>	1.25 mV per $\mu$ mol m <sup>-2</sup> s <sup>-1</sup>	–		
Resolution	–				0.1 $\mu$ mol m <sup>-2</sup> s <sup>-1</sup>	–	
Calibration Factor (reciprocal of output)	100 $\mu$ mol m <sup>-2</sup> s <sup>-1</sup> per mV	1.6 $\mu$ mol m <sup>-2</sup> s <sup>-1</sup> per mV	250 $\mu$ mol m <sup>-2</sup> s <sup>-1</sup> per mA	0.8 $\mu$ mol m <sup>-2</sup> s <sup>-1</sup> per mV	Custom for each sensor and stored in the firmware		
Calibration Uncertainty	± 5 %						
Output Range	0 to 40 mV	0 to 2.5 V	4 to 20 mA	0 to 5 V	USB	SDI-12	Modbus
Measurement Repeatability	Less than 0.5 %	Less than 1 %	Less than 0.5 %	Less than 1 %	Less than 0.5 %	Less than 1 %	
Long-term Drift	Less than 2 % per year						
Non-linearity	Less than 1 % (up to 4000 $\mu$ mol m <sup>-2</sup> s <sup>-1</sup> )						
Response Time	Less than 1 ms				Software updates every second	Less than 0.6 s	320 ms
Field of View	180°						
Spectral Range	389 to 692 nm ± 5 nm (wavelengths where response is greater than 50 %)						
Spectral Selectivity	Less than 10 % from 412 to 682 nm ± 5 nm						
Directional (cosine) Response	± 2 % at 45°, ± 5 % at 75° zenith angle						
Temperature Response	-0.11 ± 0.04 % 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, 37 mm height	30.5 mm diameter, 37 mm height			24 mm diameter, 37 mm height	30.5 mm diameter, 37 mm height	
Mass (5 m of cable)	100 g	140 g			100 g	140 g	
Warranty	4 years against defects in materials and workmanship						



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

### Output Options

- 0 to 800 mV
- 0 to 5 V
- USB
- Modbus
- 0 to 2.5 V
- 4 to 20 mA
- SDI-12
- or hand-held meter

Sensors come calibrated for either sun or electric broadband light sources.



### Line Quantum Sensor Options

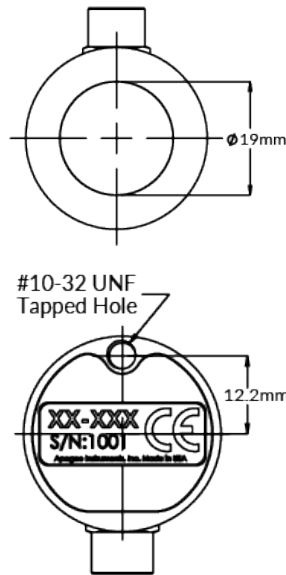
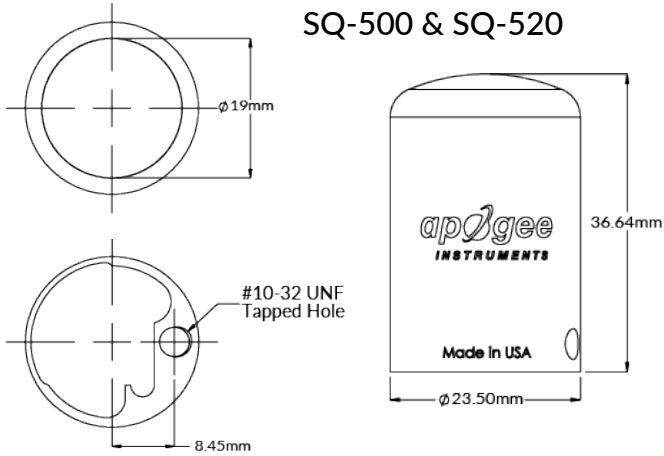
Sensors are available with multiple detectors mounted along the length of a rugged anodized aluminum bar, which provides spatially averaged PPFD measurements.



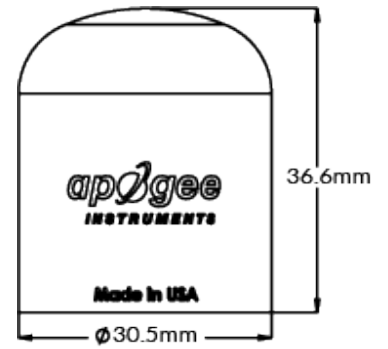
### Product Specifications

	SQ-110/120-SS	SQ-212/222-SS	SQ-214/224-SS	SQ-215/225-SS	SQ-300 Series	SQ-420	SQ-421-SS	SQ-422-SS
Power Supply	Self-powered	3.3 to 24 V DC	7 to 24 V DC	5.5 to 24 V DC	Self-powered	5 V USB power source	5.5 to 24 V DC	
Current Draw	—	10 $\mu\text{A}$	22 mA maximum; 2 mA quiescent	10 $\mu\text{A}$	—	61 mA when logging	1.4 mA (quiescent), 1.8 mA (active)	20 mA maximum
Output (sensitivity)	0.2 mV per $\mu\text{mol m}^{-2} \text{s}^{-1}$	0.625 mV per $\mu\text{mol m}^{-2} \text{s}^{-1}$	0.004 mA per $\mu\text{mol m}^{-2} \text{s}^{-1}$	1.25 mV per $\mu\text{mol m}^{-2} \text{s}^{-1}$	0.2 mV per $\mu\text{mol m}^{-2} \text{s}^{-1}$	—		
Calibration Factor (reciprocal of output)	5 $\mu\text{mol m}^{-2} \text{s}^{-1}$ per mV	1.6 $\mu\text{mol m}^{-2} \text{s}^{-1}$ per mV	250 $\mu\text{mol m}^{-2} \text{s}^{-1}$ per mA	0.8 $\mu\text{mol m}^{-2} \text{s}^{-1}$ per mV	5 $\mu\text{mol m}^{-2} \text{s}^{-1}$ per mV	Custom for each sensor and stored in the firmware		
Calibration for Uncertainty	± 5 %							
Output Range	0 to 800 mV	0 to 2.5 V	4 to 20 mA	0 to 5 V	0 to 800 mV	USB	SDI-12	Modbus
Measurement Repeatability	Less than 0.5 %						Less than 1 %	
Long-term Drift	Less than 2 % per year							
Non-linearity	Less than 1 % (up to 4000 $\mu\text{mol m}^{-2} \text{s}^{-1}$ )							
Response Time	Less than 1 ms					Software updates every second	Less than 0.6 s	320 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	± 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 30 m							
Dimensions	24 mm diameter, 33 mm height	30.5 mm diameter, 37 mm height			500 x 15 x 15 mm; SQ-311/321; 700 x 15 x 15 mm	24 mm diameter, 33 mm height	30.5 mm diameter, 37 mm height	
Mass (5 m of cable)	90 g	140 g			275 g; SQ-311/321: 375 g	90 g	140 g	
Warranty	4 years against defects in materials and workmanship							

## SQ-500 & SQ-520



All other full-spectrum quantum and original quantum models



## SQ-110/120 & SQ-420

