

# 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 and Original X 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.

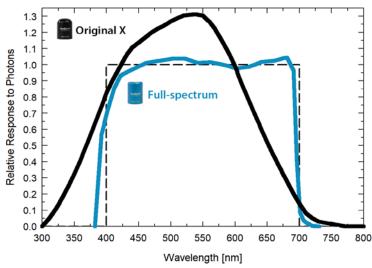
# Typical PPFD Measurement Applications

- 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 X quantum sensor** (black) and fullspectrum quantum sensor (blue) compared to defined response of plants to radiation (dashed).

#### **Spectral Errors**

	Apogee SQ-500	Apogee SQ-100X	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	5.0	-0.8	1.1
Sun (Transmitted below Wheat Canopy)	0.1	7.0	-0.1	-0.3
Cool White Fluorescent (T5)	0.0	7.2	0.0	0.0
Metal Halide	0.9	6.9	0.2	-1.7
Ceramic Metal Halide	0.3	-8.8	0.4	-0.7
High Pressure Sodium	0.1	3.3	1.3	1.4
Red LED (667 nm peak, 20 nm full-width half-maximum)	2.8	-56.7	3.5	-1.8
Red, Blue, White LED Mixture (60 % Red, 25 % White, 15 % Blue)	-2.0	-29.7	2.6	-1.7



# **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



# **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	5 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 μΑ	maximum of 20 mA	At 12 V is 57 μΑ	61 mA when logging	1.4 mA (quiescent), 1.8 mA (active)	RS-232 37 mA; RS-485 quiescent 37 mA, active 42 mA	
Output (sensitivity)	0.01 mV per μmol m <sup>-2</sup> s <sup>-1</sup>	0.625 mV per μmol m <sup>-2</sup> s <sup>-1</sup>	0.004 mA per μmol m <sup>-2</sup> s <sup>-1</sup>	1.25 mV per μmol m <sup>-2</sup> s <sup>-1</sup>	-			
Resolution	-			0.1 μmol m <sup>-2</sup> s <sup>-1</sup> –				
Calibration Factor (reciprocal of output)	100 μmol m <sup>-2</sup> s <sup>-1</sup> per mV	1.6 μmol m <sup>-2</sup> s <sup>-1</sup> per mV	250 μmol m <sup>-2</sup> s <sup>-1</sup> per mA	0.8 μmol 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 $^{-2}$ 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	389 to 692 nm ± 5 nm (wavelengths where response is greater than 50 %)							
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	(1) 5 mm diameter 3 / 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							



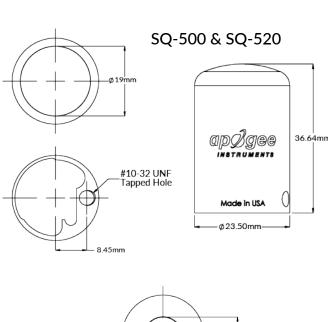
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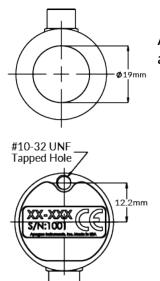
- 0 to 400 mV
- 0 to 5 V
- USB
- Modbus
- 0 to 2.5 V4 to 20 mA
- SDI-12
- or hand-held meter



# **Product Specifications**

	SQ-100X-SS	SQ-202X-SS	SQ-204X-SS	SQ-205X-SS	SQ-420X	SQ-421X-SS	SQ-422X-SS	
Power Supply	Self-powered	5 to 24 V DC	7 to 24 V DC	5.5 to 24 V DC	5 V USB power source	5.5 to 24 V DC		
Current Draw	-	10 μΑ	22 mA maximum; 2 mA quiescent	10 μΑ	61 mA when logging	1.4 mA (quiescent), 1.8 mA (active)	RS-232 37 mA; RS-485 quiescent 37 mA, active 42 mA	
Output (sensitivity)	$0.1 \text{ mV per}$ $\mu\text{mol m}^{-2} \text{ s}^{-1}$	$0.625 \text{ mV per}$ $\mu\text{mol m}^{-2} \text{ s}^{-1}$	0.004 mA per μmol m <sup>-2</sup> s <sup>-1</sup>	1.25 mV per μmol m <sup>-2</sup> s <sup>-1</sup>		-		
Calibration Factor (reciprocal of output)	10 μmol m <sup>-2</sup> s <sup>-1</sup> per mV	1.6 μmol m <sup>-2</sup> s <sup>-1</sup> per mV	250 μmol m <sup>-2</sup> s <sup>-1</sup> per mA	0.8 μmol m <sup>-2</sup> s <sup>-1</sup> per mV	Custom for each sensor and stored in the firmware			
Calibration for Uncertainty	± 5 %							
Output Range	0 to 400 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 %			
Long-term Drift	Less than 2 % per year							
Non-linearity	Less than 1 % (up to 4000 $\mu$ mol m $^{-2}$ s $^{-1}$ )							
Response Time	Less than 1 ms			Software updates every second	Less than 0.6 s	_		
Field of View	180°							
Spectral Range	370 to 650 nm (wavelengths where response is greater than 50 % maximum)							
Directional (cosine) Response	± 5 % at 75° zenith angle							
Temperature Response	-0.04 % per C							
Operating Environment	10 to 60 C; 0 to 100 % relative humidity; can be submerged in water up to 30 m							
Dimensions	24 mm diameter, 33 mm height	30.5 r	mm diameter, 37 mm	neight	24 mm diameter, 33 mm height	30.5 mm diameter, 37 mm height		
Mass (5 m of cable)	90 g		140 g		90 g	140 g		
Warranty	4 years against defects in materials and workmanship							





All other full-spectrum quantum and original X quantum models

