

USB Smart Quantum Sensor | SQ-520

USB quantum sensor with an improved spectral response providing accurate PAR/PPFD measurements under all light sources, including LEDs.

Refined Spectral Response

Improved spectral response increases the accuracy of LED measurements making it ideal for use with both natural and electric light sources.

Internal Data Storage

Sensor has internal data storage capability with the ability to hold up to 10,000 measurements. This allows the sensor to collect data while connected to most stand-alone 5 V DC USB power sources.

Accurate, Stable Measurements

Calibration in controlled laboratory conditions is traceable to an NIST lamp. Quantum sensors are cosine-corrected, with directional errors less than $\pm 5\%$ 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.

No Datalogger Required

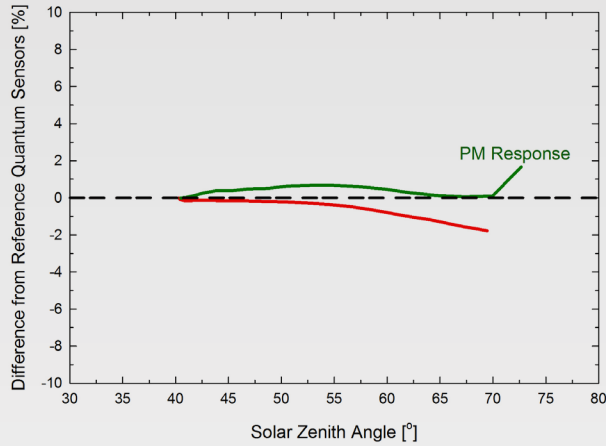
Sensor can be connected to a desktop, laptop, or tablet computer via a USB 2.0 type A plug, to be used with the ApogeeConnect software. The software gives the user control of data logging and calibration settings, provides real time output display and graph of PPFD measurements, and allows the data set to be saved as a csv file for further analysis.

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.

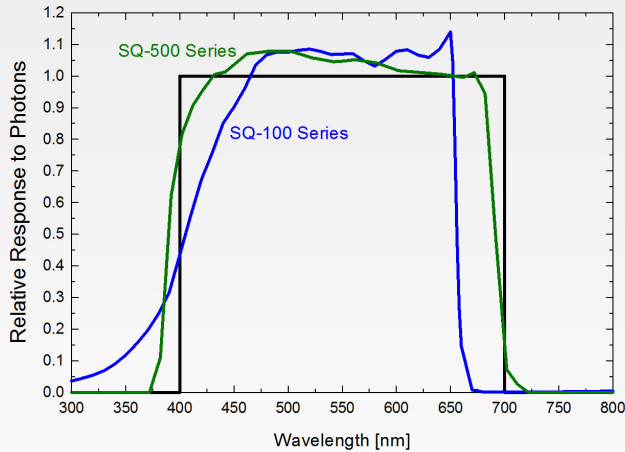


Cosine Response



Mean cosine response of seven 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 green data are PM measurements.

Spectral Response



Mean spectral response measurements of six replicate Apogee SQ-100 and SQ-500 series quantum sensors. Spectral response measurements were made at 10 nm increments across a wavelength range 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 Errors of Commercial Quantum Sensors

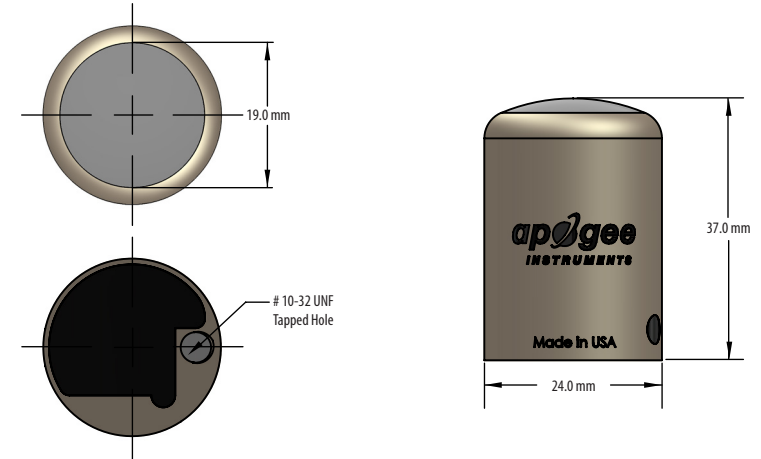
| Radiation Source | Apogee SQ-500 | Apogee SQ-110 SQ-120 | LI-COR LI-190 | Kipp & Zonen PQS 1 |
|---|---------------|----------------------|---------------|--------------------|
| Sun (Clear Sky) | -2.2 | 0.0 | -0.4 | -1.0 |
| Sun (Cloudy Sky) | -1.7 | 1.4 | -0.2 | -1.3 |
| Sun (Reflected from Deciduous Leaves) | -2.0 | 4.9 | -0.8 | 1.1 |
| Sun (Transmitted below Wheat Canopy) | -1.1 | 6.4 | -0.1 | -0.3 |
| Cool White Fluorescent (T5) | 0.0 | 0.0 | 0.0 | 0.0 |
| Metal Halide | 0.9 | -3.7 | 0.2 | -1.7 |
| Ceramic Metal Halide | -0.3 | -6.0 | 0.4 | -0.7 |
| High Pressure Sodium | 0.0 | 0.8 | 1.3 | 1.4 |
| Red/Blue LED (16 % 444 nm, 84 % 667 nm peaks) | -3.4 | -65.3 | 3.5 | -1.8 |
| Red/White LED (6.5 % 436 nm, 4.5 % 531 nm, 89 % 668 nm peaks) | -3.0 | -60.3 | 2.6 | -1.7 |

Spectral errors are theoretical errors calculated from sensor spectral responses (Apogee SQ-100 and SQ-500 series shown in graph above) and spectral output of radiation sources (measured with a spectroradiometer). Only spectral errors are listed in the table. Calibration, cosine, and temperature error can also contribute to measurement error.

Calibration Traceability

Apogee Instruments SQ-500 series quantum sensors are calibrated through side-by-side comparison to the mean of four Apogee model SQ-500 transfer standard quantum sensors under high output T5 cool white 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 that are traceable to the National Institute of Standards and Technology (NIST).

Dimensions



| | |
|---------------------------------|---|
| Power Supply | Uses a 5 V USB power source and has a 61 mA current draw |
| Resolution | 0.1 $\mu\text{mol m}^{-2}\text{s}^{-1}$ |
| Calibration Factor | Custom for each sensor and stored in the firmware |
| Calibration Uncertainty | $\pm 5\%$ |
| Measurement Repeatability | Less than 0.5 % |
| Long-term Drift (Non-stability) | Less than 2 % per year |
| Non-linearity | Less than 1 % (up to 4000 $\mu\text{mol m}^{-2}\text{s}^{-1}$) |
| Response Time | Software updates every second |
| Field of View | 180° |
| Spectral Range | 389 to 692 nm ± 5 nm (wavelengths where response is greater than 50% of maximum) |
| Spectral Selectivity | Less than 10 % from 412 to 682 nm ± 5 nm |
| Directional (Cosine) Response | $\pm 5\%$ at 75° zenith angle |
| Azimuth Error | Less than 0.5 % |
| Tilt Error | Less than 0.5 % |
| Temperature Response | -0.11 \pm 0.03 % per C |
| Uncertainty in Daily Total | Less than 5 % |
| Detector | Blue-enhanced silicon photodiode |
| Housing | Anodized aluminum body with acrylic diffuser |
| IP Rating | IP68 |
| 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 |
| Mass | 100 g (with 5 m of lead wire) |
| USB Cable | 4.6 m (15 ft) |
| Warranty | 4 years against defects in materials and workmanship |