APOGEE PYRANOMETERS

Silicon-cell & Thermopile Series

Features

Apogee offers **silicon-cell** and **thermopile** pyranometers that are both rated ISO 9060:2018 Class C. Our popular silicon-cell models are less expensive and have a faster response time, but can have errors under cloudy conditions. Our thermopile pyranometers feature a unique, cost-effective design with an inexpensive diffuser and blackbody thermopile detector that provides a broader and more uniform spectral response for better performance in all atmospheric conditions.

STABLE MEASUREMENTS

Long-term non-stability determined from multiple replicate pyranometers in accelerated aging tests and field conditions is less than 2 % per year.

UNIQUE DESIGN

An accurate, cosine-corrected patented design sheds water and dirt for a self-cleaning performance. A heated option is available with a 0.2 W heater to minimize errors caused by dew, frost, or snow.

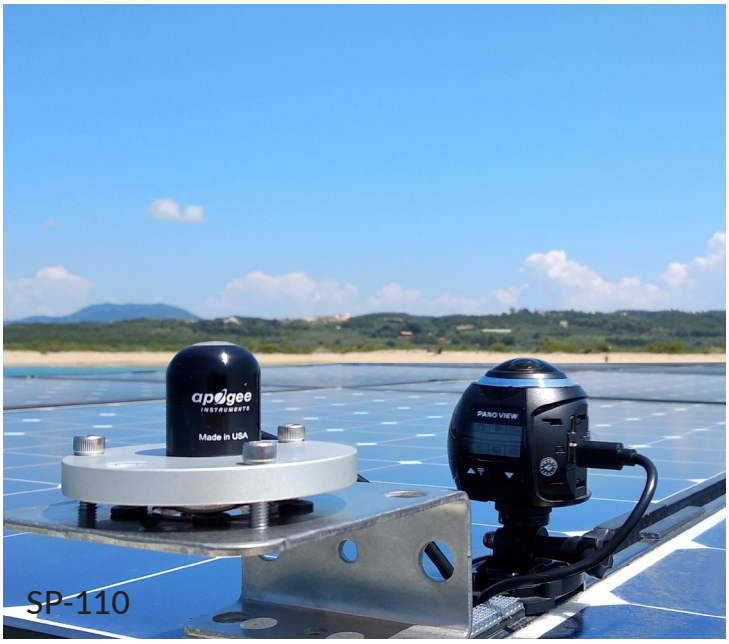
TYPICAL APPLICATIONS

- Solar panel arrays
- Agricultural, ecological, and hydrological weather networks

CALIBRATION TRACEABILITY

Apogee SP series pyranometers are calibrated through side-by-side comparison to the mean of four transfer standard sensors under a reference lamp. The reference sensors are recalibrated under sunlight in Logan, UT traceable to the World Radiometric Reference (WRR) in Davos, Switzerland.

SP-522



SP-110

THERMOPILE PYRANOMETERS

SP-510, SP-610, & SP-522

Blackbody accuracy with a cost-effective design

Output Options

- 0 to 114 mV
- Modbus
- Downward sensor available for measuring shortwave reflectance, or combine with an upward head to measure albedo (see SP-710-SS albedometer package)

SP-522

SP-510

SP-610

Product Specifications

	SP-510-SS	SP-610-SS	SP-522-SS
ISO 9060:2018	Class C	N/A	Class C
Sensitivity (variable from sensor to sensor, typical values listed)	0.045 mV per W m^{-2}	0.035 mV per W m^{-2}	–
Calibration Factor (reciprocal of sensitivity) (variable from sensor to sensor, typical values listed)	22 W m^{-2} per mV	28.5 W m^{-2} per mV	–
Input Voltage Requirement	–		5.5 to 24 V
Calibration Uncertainty at 1000 W m^{-2}	Less than 3 %		
Output Range	0 to 90 mV	0 to 70 mV	Modbus
Measurement Range	0 to 2000 W m^{-2} (net shortwave radiation)		
Measurement Repeatability	Less than 1 %		
Long-term Drift	Less than 2 % per year		
Non-linearity	Less than 1 %		
Detector Response Time	0.5 s		
Field of View	180°	150°	180°
Spectral Range (50 % points)	385 nm to 2105 nm	370 nm to 2240 nm	385 nm to 2105 nm
Directional (Cosine) Response	Less than 30 W m^{-2} at 80° solar zenith	Less than 20 W m^{-2} for angles between 0 and 60°	Less than 30 W m^{-2} at 80° solar zenith
Temperature Response	Less than 5 % from -15 to 45 C		
Zero Offset A	Less than 2 W m^{-2}; Less than 10 W m^{-2} (heated)	Less than 1 W m^{-2}; Less than 5 W m^{-2} (heated)	Less than 2 W m^{-2}; Less than 10 W m^{-2} (heated)
Zero Offset B	Less than 5 W m^{-2}		
Uncertainty with Daily Total	Less than 5 %		
Operating Environment	-50 to 80 C; 0 to 100% relative humidity		
Heater	780 Ω, 15.4 mA current draw and 185 mW power requirement at 12 V DC		4 mA (heater off); 30 mA (heater on)
Dimensions	23.5 mm diameter, 28.7 mm height	23.5 mm diameter, 27.5 mm height	30.5 mm diameter, 37 mm height
Mass	90 g	100 g	140 g
Cable	5 m of four conductor, shielded, twisted-pair wire; TPR jacket (high water resistance, high UV stability, flexibility in cold conditions); pigtail lead wires		
Warranty	4 years against defects in materials and workmanship		

SILICON-CELL PYRANOMETERS

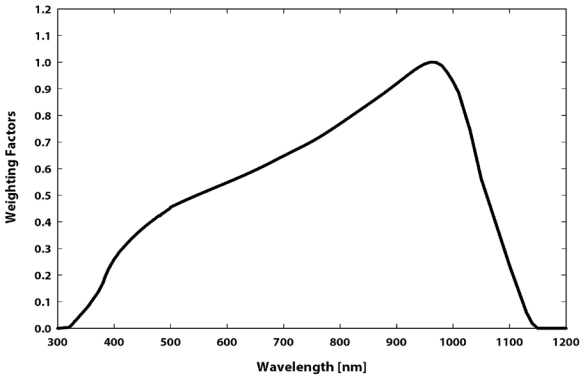
SP-100, SP-200, & SP-400 Series

Accurate and stable global shortwave (solar) radiation measurement

Output Options

- 0 to 350 mV
- 0 to 5 V
- USB
- Modbus
- 0 to 2.5 V
- 4 to 20 mA
- SDI-12
- Hand-held meter

Spectral Response



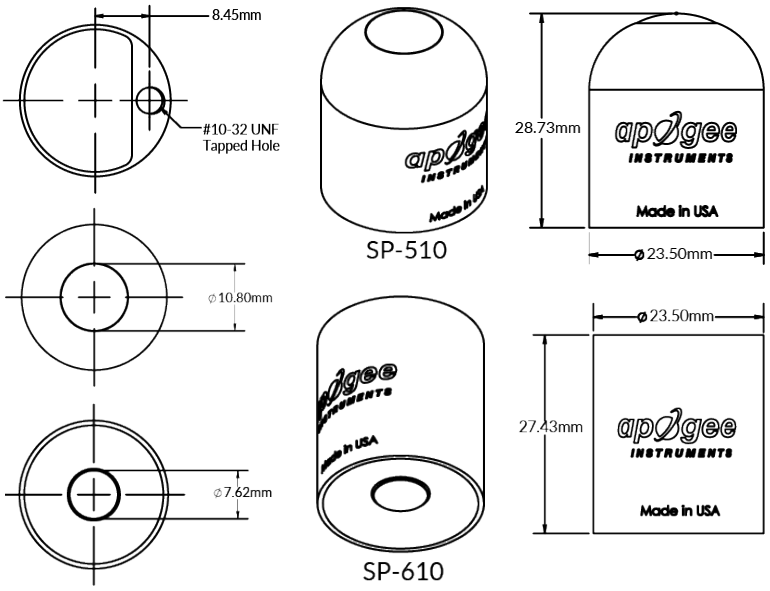
Spectral response estimate of **Apogee silicon-cell pyranometers.**

Product Specifications

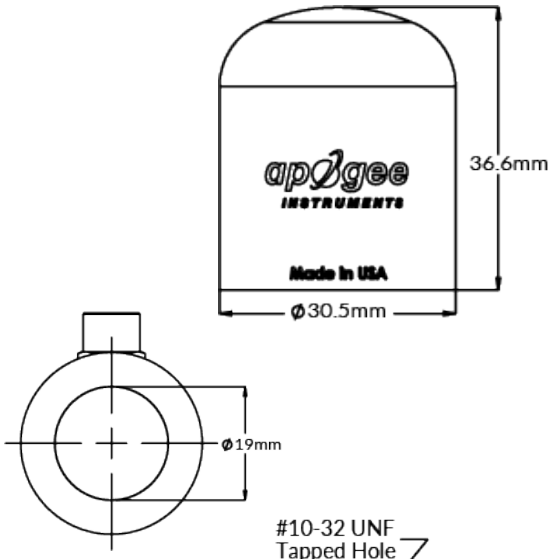
	SP-110-SS	SP-212-SS	SP-214-SS	SP-215-SS	SP-230-SS	SP-420	SP-421-SS	SP-422-SS
ISO 9060:2018	Class C							
Power Supply	Self-powered	5 to 24 V DC	7 to 24 V DC	5.5 to 24 V DC	12 V DC for heater	5 V USB	5.5 T0 24 V DC	
Current Draw	–	300 µA	22 mA maximum, 2 mA quiescent	300 µA	15.4 mA	61 mA when logging	1.5 mA (quiescent); 1.9 mA (active)	RS-232 37 mA; RS-485 quiescent 37 mA, active 42 mA
Output (sensitivity)	0.2 mV per W m^{-2}	1.25 mV per W m^{-2}	0.008 mA per W m^{-2}	2.5 mV per W m^{-2}	0.2 mV per W m^{-2}	USB	SDI-12	Modbus
Calibration Factor (reciprocal of output)	5 W m^{-2} per mV	0.8 W m^{-2} per mV	125 W m^{-2} per mA, 4 mA offset	0.4 W m^{-2} per mV	5 W m^{-2} per mV	Custom for each sensor and stored in firmware		
Calibration Uncertainty at 1000 W m^{-2}	Less than 3 %							
Measurement Repeatability	Less than 1 %							
Long-term Drift	Less than 2 % per year							
Non-linearity	Less than 1 % up to 2000 W m^{-2}							
Response Time	Less than 1 ms						Less than 0.6 s	Less than 200 ms
Field of View	180°							
Spectral Range	360 to 1120 nm							
Directional (Cosine) Response	± 5 % at 75° zenith angle							
Temperature Response	0.04 ± 0.04 % 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 diam-eter, 33 mm height	30.5 mm diameter, 37 mm height						
Mass (with 5 m of cable)	90 g	140 g			90 g			
Cable	5 m of shielded, twisted-pair wire; TPR jacket (high water resistance, high UV stability, flexibility in cold conditions); pigtail lead wires							
Warranty	4 years against defects in materials and workmanship							

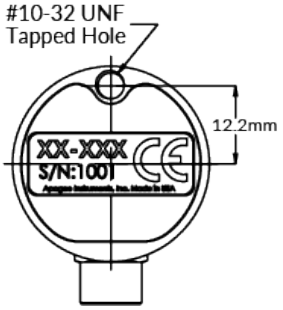
Dimensions

Thermopile Models

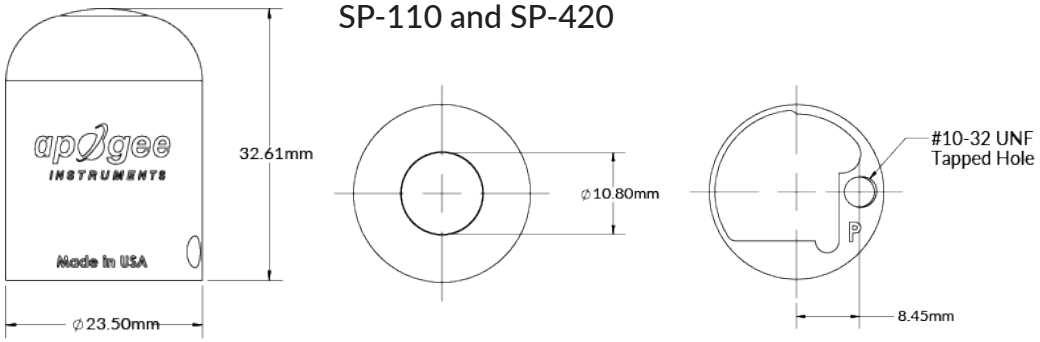


All other silicon-cell pyranometer models and SP-522-SS





Silicon-cell Models
SP-110 and SP-420



Digital Models

SP-420 USB

Sensor connects to computers and tablets via USB using ApogeeConnect software for Widows and Mac for data logging, graphs, calibration, real-time PPFD readings, and storing downloadable CSV files for further analysis. Sensor can also store 10,000 measurements internally while connected to a stand-alone 5 V DC USB “always-on” power source.

SP-421 SDI-12

Uses the SDI-12 communication protocol, which is low-power and has the ability to connect multiple sensors to one long bus cable making them ideal for remote locations. Cables only have 3 conductors including a serial data line, a ground, and a 12-volt line. Complex self-calibration algorithms are done in an internal microprocessor making the sensors compatible with a wide variety of data recorders.

SP-422 & SP-522 Modbus

The SP-422 outputs a digital signal using Modbus RTU digital signal over RS-232 or RS-485, based on wiring configuration. Modbus is open protocol and used by many manufacturers in numerous industries.

Apogee Modbus Sensor Communication
Defaults: Modbus RTU
Slave address: 0x1
Baudrate: 19200
Data bits: 8
Stop bits: 1
Parity: None
Byte order: Big Endian (most significant Byte sent first)
*User configurable values include the baudrate and slave address.

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