



## 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-510



SP-110



Blackbody accuracy with a cost-effective design

### Output Options

- 0 to 114 mV
- Downward sensor available for measuring shortwave reflectance, or combine with an upward head to measure albedo (see SP-700-SS albedometer)



### Product Specifications

	SP-510-SS	SP-610-SS
ISO 9060:2018	Class C	N/A
Sensitivity (variable from sensor to sensor, typical values listed)	0.057 mV per W m <sup>-2</sup>	0.15 mV per W m <sup>-2</sup>
Calibration Factor (reciprocal of sensitivity) (variable from sensor to sensor, typical values listed)	20 W m <sup>-2</sup> per mV	6.7 W m <sup>-2</sup> per mV
Calibration Uncertainty	± 5 %	
Output Range	0 to 114 mV	0 to 300 mV
Measurement Range	0 to 2000 W m <sup>-2</sup> (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°
Spectral Range (50 % points)	385 nm to 2105 nm	295 nm to 2685 nm
Directional (Cosine) Response	Less than 30 W m <sup>-2</sup> at 80° solar zenith	Less than 20 % for angles between 0 and 60°
Temperature Response	Less than 5 % from -15 to 45 C	
Zero Offset A	Less than 5 W m <sup>-2</sup> ; Less than 10 W m <sup>-2</sup> (heated)	
Zero Offset B	Less than 5 W m <sup>-2</sup>	
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	
Dimensions	28.7 mm height, 23.5 mm diameter	
Mass	90 g	100 g
Cable	5 m of four conductor, shielded, twisted-pair wire; additional cable available in multiples of 5 m; TPR jacket (high water resistance, high UV stability, flexibility in cold conditions); pigtail lead wires	
Warranty	4 years against defects in materials and workmanship	



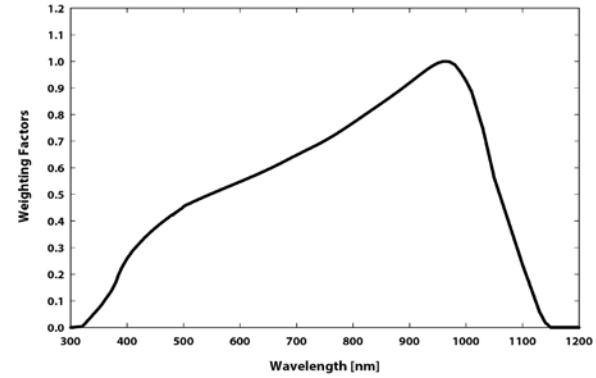
Accurate and stable global shortwave (solar) radiation measurement

### Spectral Response

### Output Options

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

MP-200

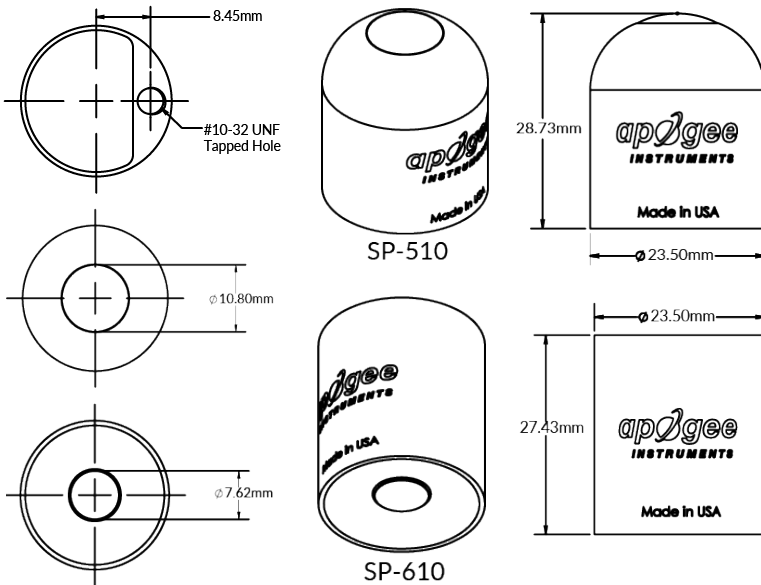


Spectral response estimate of Apogee silicon-cell pyranometers.

### Product Specifications

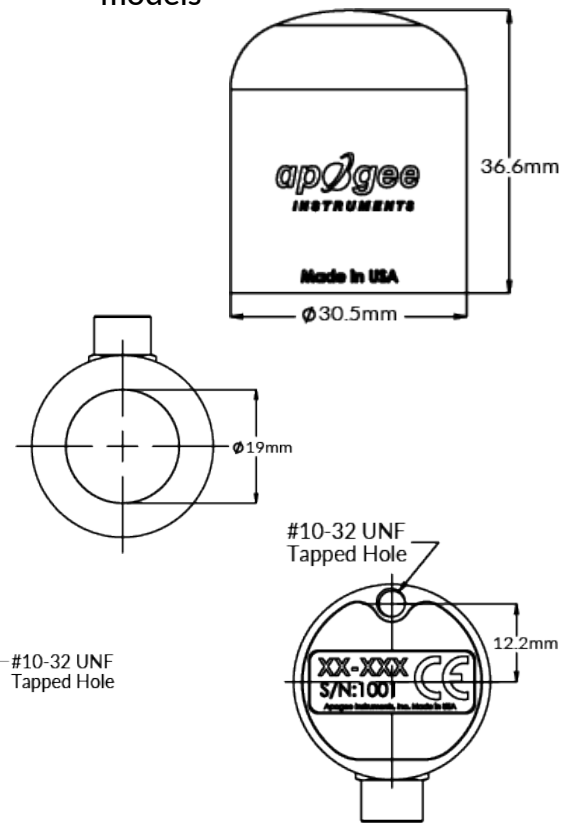
	SP-110-SS	SP-212-SS	SP-214-SS	SP-215-SS	SP-230-SS	SP-420	SP-421-SS	SP-422-SS
ISO 9060:2018	Class C							
Power Supply	Self-powered	3.3 to 24 V DC	7 to 24 V DC	5.5 to 24 V DC	12 V DC for heater	5 V	5.5 TO 24 V DC	
Current Draw	–	10 $\mu$ A	22 mA maximum, 2 mA quiescent	10 $\mu$ A	15.4 mA	61 mA when logging	0.6 mA (quiescent); 1.3 mA (active)	20 mA maximum
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	$\pm 5 \%$							
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					Software updates every second	Less than 0.6 s	320 ms
Field of View	180°							
Spectral Range	360 to 1120 nm							
Directional (Cosine) Response	$\pm 5 \%$ at 75° zenith angle							
Temperature Response	0.04 $\pm$ 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 diameter, 33 mm height	30.5 mm diameter, 37 mm height				24 mm diameter, 33 mm height	30.5 mm diameter, 37 mm height	
Mass (with 5 m of cable)	90 g	140 g				90 g	140 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							

## Thermopile Models

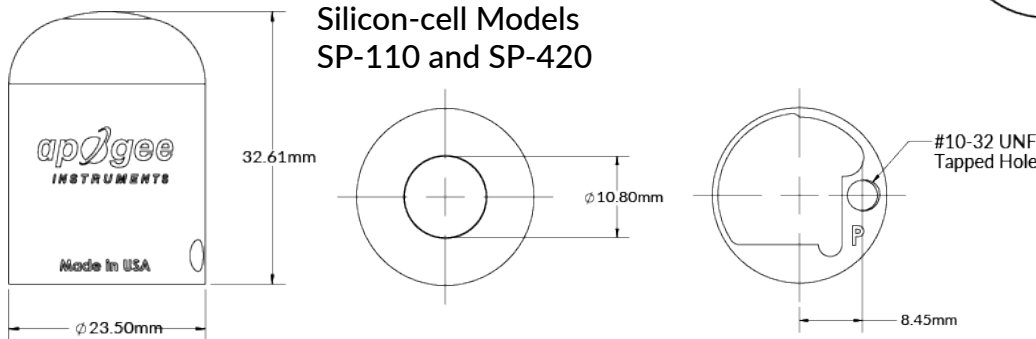


## Dimensions

### All other silicon-cell pyranometer models



### Silicon-cell Models SP-110 and SP-420



### SP-420 USB

Sensor connects to computers and tablets via USB using ApogeeConnect software for Windows 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 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 many industries.

Apogee Modbus Sensor Communication

Defaults: Modbus RTU

Slave address: 0x1

Baudrate: 115200

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.

## Digital Models