



# SILICON-CELL PYRANOMETERS | SP-100 & SP-200 Series

## Features

### Output Options

- 0 to 350 mV
- 0 to 2.5 V
- 0 to 5 V
- 4 to 20 mA
- USB
- SDI-12

### 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 Measurement Applications

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

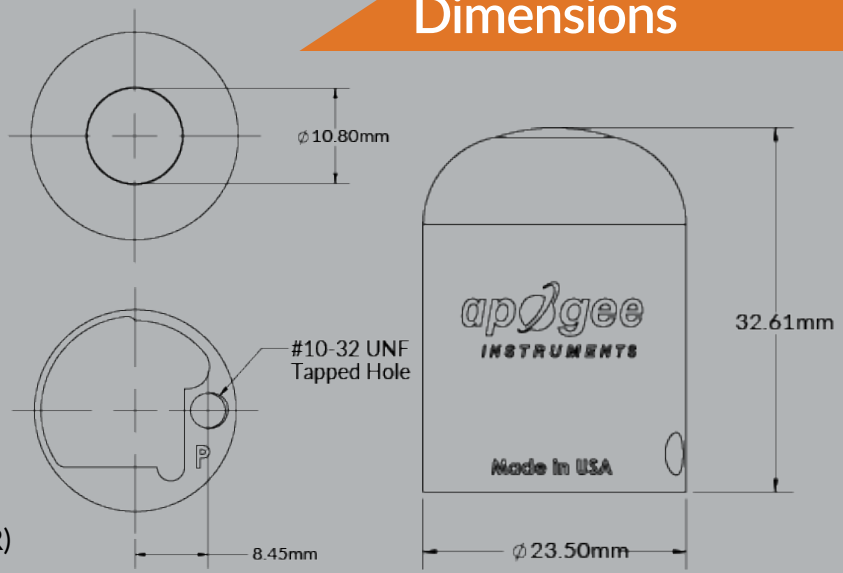
### Calibration Traceability

Apogee SP sensors are calibrated through side-by-side comparison to the mean of (4) Apogee SP-110 transfer standard sensors under high intensity discharge metal halide lamps. The transfer standard sensors are calibrated through side-by-side comparison to the mean of at least (2) ISO-classified reference pyranometers under sunlight in Logan, UT. Each of (4) ISO-classified reference sensors are recalibrated on an alternating year schedule at the National Renewable Energy Laboratory (NREL) in Golden, Colorado. NREL reference standards are calibrated to the World Radiometric Reference (WRR) in Davos, Switzerland.

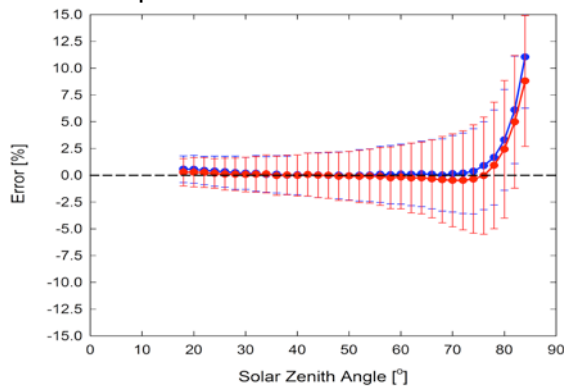
Accurate and stable global shortwave (solar) radiation measurement



## Dimensions



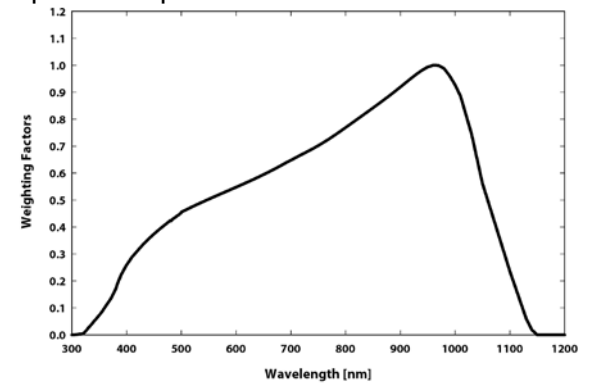
## Cosine Response



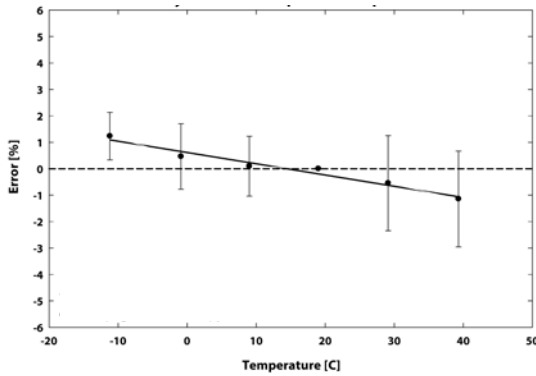
Mean **cosine response** of eleven Apogee silicon-cell pyranometers (error bars represent two standard deviations above and below mean). Cosine response measurements were made during broadband outdoor radiometer calibration (BORCAL) performed during two different years at the National Renewable Energy Laboratory (NREL) in Golden, Colorado. Cosine response was calculated as the relative difference of pyranometer sensitivity at each solar zenith angle to sensitivity at 45° solar zenith angle. The blue symbols are AM measurements; the red symbols are PM measurements.

**Spectral response** estimate of Apogee silicon-cell pyranometers. Spectral response was estimated by multiplying the spectral response of the photodiode, diffuser, and adhesive. Spectral response measurements of diffuser and adhesive were made with a spectrometer, and spectral response data for the photodiode were obtained from the manufacturer.

## Spectral Response



## Temperature Response



Mean **temperature response** of ten Apogee silicon-cell pyranometers (error bars represent two standard deviations above and below mean). Temperature response measurements were made at 10 C intervals across a temperature range of approximately -10 to 40 C in a temperature controlled chamber under a fixed, broad spectrum, electric lamp. At each temperature set point, a spectroradiometer was used to measure light intensity from the lamp and all pyranometers were compared to the spectroradiometer. The spectroradiometer was mounted external to the temperature control chamber and remained at room temperature during the experiment.

# Product Specifications

	SP-110-SS	SP-212-SS	SP-214-SS	SP-215-SS	SP-230-SS
Power Supply	Self-powered	3.3 to 24 V DC; current draw 300 $\mu$ A	7 to 24 V DC, maximum current draw of 22 mA (2 mA quiescent current draw)	5.5 to 24 V DC; current draw 300 $\mu$ A	12 V DC for heater with a current draw of 15.4 mA
Output (sensitivity)	0.2 mV per $W m^{-2}$	2 mV per $W m^{-2}$	0.008 mA per $W m^{-2}$	4 mV per $W m^{-2}$	0.2 mV per $W m^{-2}$
Calibration Factor (reciprocal of output)	5 $W m^{-2}$ per mV	0.5 $W m^{-2}$ per mV	125 $W m^{-2}$ per mA, 4 mA offset	0.25 $W m^{-2}$ per mV	5 $W m^{-2}$ per mV
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 $W m^{-2}$	Less than 1% up to 1250 $W m^{-2}$	Less than 1% up to 2000 $W m^{-2}$	Less than 1% up to 1250 $W m^{-2}$	Less than 1% up to 1750 $W m^{-2}$
Response Time	Less than 1 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 depths of 30 m				
Dimensions	24 mm diameter, 33 mm height				
Mass (with 5 m of cable)	90 g				
Cable	5 m of 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				