

# Pyranometers

SP-100 Series SP-200 Series



[www.apogeeinstruments.com](http://www.apogeeinstruments.com)

435.792.4700

- Next generation sensor head design
- Self-cleaning dome-shaped head
- Excellent cosine response
- Potted solid to withstand extreme and humid conditions, and reduce thermal based accuracy fluctuations
- Calibrated silicon-cell photodiode sensor accurate to  $\pm 5\%$ , under clear sky conditions
- Easily integrates with dataloggers
- Utilized by leading weather station manufacturers such as Campbell Scientific, Columbia Weather Systems and more
- Custom options available
- Four year warranty



Apogee Instruments pyranometers represent the next generation in pyranometer design maximizing accuracy, reliability and durability. Featuring a silicon-cell photodiode with excellent cosine response, our pyranometers measure total solar radiation to within  $\pm 5\%$  at a fraction of the price of black-body pyranometers, and at a far lower price-point than most other photodiode pyranometers on the market due to advancements in manufacturing.

Our pyranometers feature a fully potted, domed-shaped head making the sensor fully weatherproof, self-cleaning, and impervious to thermal based accuracy fluctuations. Apogee's latest pyranometer design is the culmination of over 16 years of field-testing and feedback from scientists all over the world. Apogee also subjects all sensor designs to unprecedented extreme accelerated aging tests to eliminate any weaknesses or design flaws. See our website for further information about our accelerated aging tests.

To ensure accuracy, each Apogee pyranometer is carefully pre-calibrated in controlled conditions and traceable to ISO class reference standards so your sensor is ready to go right out of the box. Our stock sensors come in several configurations and are readily compatible with most data-loggers. Our custom options can provide maximum flexibility by offering different multipliers, outputs, and cable lengths. With Apogee, you are dealing directly with the manufacturer and we can work with you to ensure a pyranometer that fits your specific need, no matter how large or small.



SP-230  
All-Season Pyranometer



AL-100 Leveling plate  
AM-110 Mounting Bracket

# SPECIFICATIONS

## Power Supply:

- SP-110 – None
- SP-212 – 5-24 VDC with a nominal current draw of 300  $\mu$ A
- SP-214 – 5-36 V DC with a maximum current drain 22 mA (2 mA quiescent current drain)
- SP-215 – 5-24 VDC with a nominal current draw of 300  $\mu$ A
- SP-230 – integrated heaters: 12 VDC with a nominal current draw of 15 mA

## Sensitivity:

- SP-110 – 0.20 mV per  $W m^{-2}$
- SP-212 – 2.0 mV per  $W m^{-2}$
- SP-214 – 0.013 mA per  $W m^{-2}$
- SP-215 – 4.0 mV per  $W m^{-2}$
- SP-230 – 0.20 mV per  $W m^{-2}$

## Calibration Factor (reciprocal of sensitivity):

- SP-110 – 5.0  $W m^{-2}$  per mV
- SP-212 – 0.5  $W m^{-2}$  per mV
- SP-214 – 78  $W m^{-2}$  per mA with an offset of 4.0 mA
- SP-215 – 0.25  $W m^{-2}$  per mV
- SP-230 – 5.0  $W m^{-2}$  per mV

**Calibration Uncertainty:**  $\pm 5\%$  (see Calibration Traceability below)

**Measurement Repeatability:**  $< 1\%$

**Non-stability (Long-term Drift):**  $< 2\%$  per year

**Non-linearity:**  $< 1\%$  (up to 1750  $W m^{-2}$ )

**Response Time:**  $< 1$  ms

**Field of View:** 180°

**Spectral Range:** 360 nm to 1120 nm (wavelengths where response is 10 % of maximum; see Spectral Response below)

**Directional (Cosine) Response:**  $\pm 5\%$  at 75° zenith angle (see Cosine Response below)

**Temperature Response:**  $-0.04 \pm 0.04\%$  per C (see Temperature Response below)

**Operating Environment:** -40 to 70 C

0 to 100 % relative humidity

Can be submerged in water up to depths of 30 m

**Dimensions:** 2.40 cm diameter and 2.75 cm height

**Mass:** 90 g (with 5 m of lead wire)

**Cable:** 5 m of shielded, twisted-pair wire.

Additional cable available in multiples of 5 m

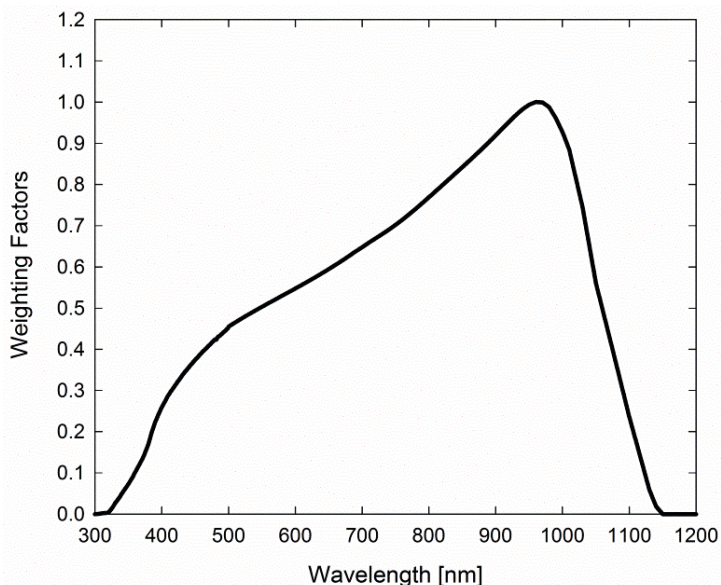
Santoprene rubber jacket (high water resistance, high UV stability, flexibility in cold conditions)

Pigtail lead wires

## Calibration Traceability:

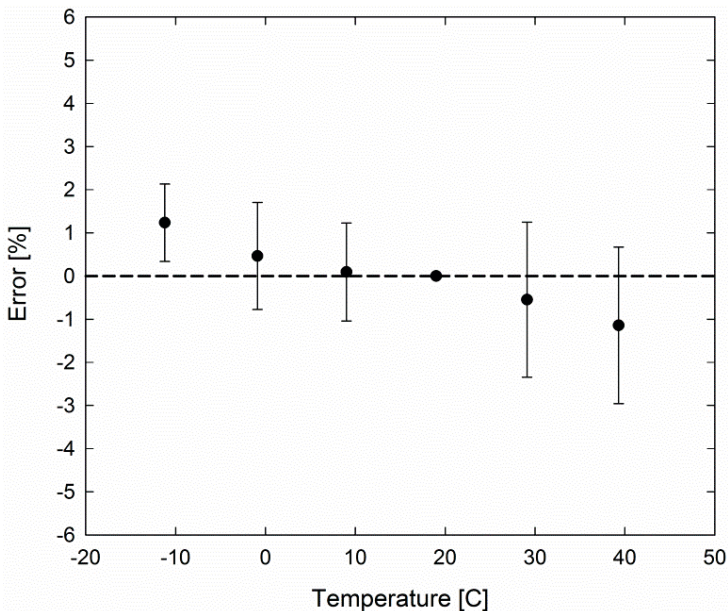
Apogee Instruments SP series pyranometers are calibrated through side-by-side comparison to the mean of four Apogee model SP-110 transfer standard pyranometers (shortwave radiation reference) under high intensity discharge metal halide lamps. The transfer standard pyranometers are calibrated through side-by-side comparison to the mean of at least two ISO-classified reference pyranometers under sunlight (clear sky conditions) in Logan, Utah. Each of four ISO-classified reference pyranometers are recalibrated on an alternating year schedule (two instruments each year) at the National Renewable Energy Laboratory (NREL) in Golden, Colorado. NREL reference standards are calibrated to the World Radiometric Reference (WRR) in Davos, Switzerland.

## Spectral Response:



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.

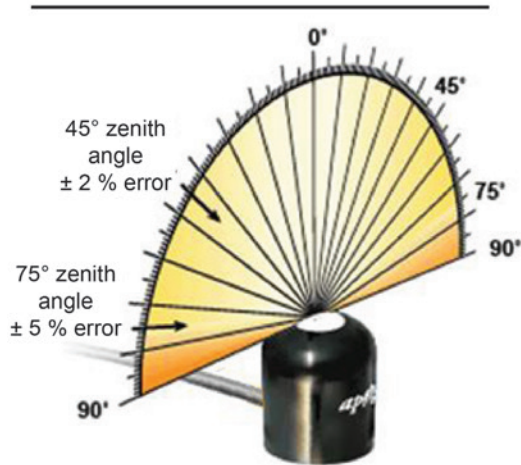
## Temperature response:



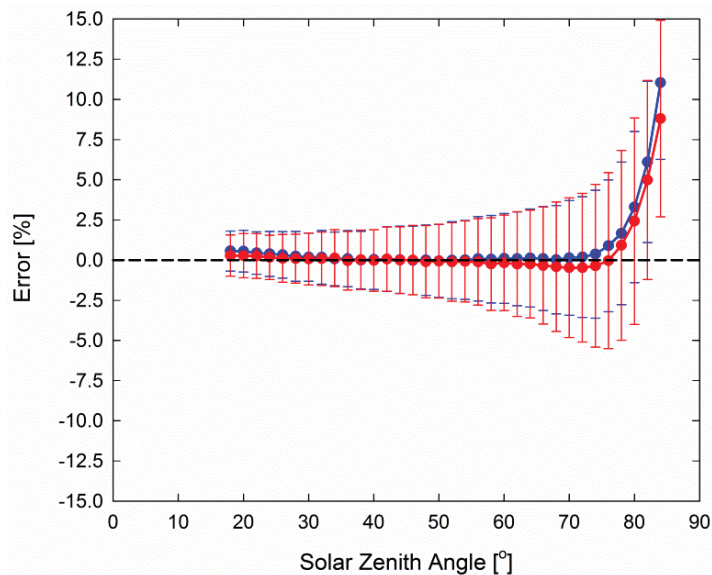
Mean temperature response of ten Apogee silicon-cell pyranometers (*errors bars represent two standard deviations above and below mean*). Temperature response measurements were made at 10 C intervals across a temperature range of approximately -10 to 40 C in a temperature controlled chamber under a fixed, 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.

Cosine Response:

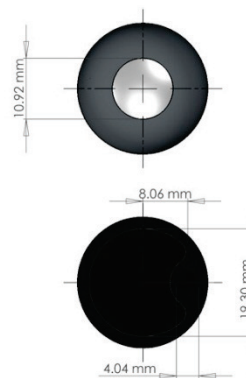
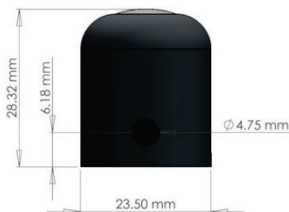
Cosine Response of Apogee SP Series Pyranometers



Directional, or cosine, response is defined as the measurement error at a specific angle of radiation incidence. Error for Apogee silicon-cell pyranometers is approximately  $\pm 2\%$  and  $\pm 5\%$  at solar zenith angles of  $45^\circ$  and  $75^\circ$ , respectively.



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 calibrations (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  $45^\circ$  solar zenith angle. The blue symbols are AM measurements, the red symbols are PM measurements.



APOGEE INSTRUMENTS, INC. 721 WEST 1800 NORTH, LOGAN, UTAH 84321, USA  
 TEL: (435) 792-4700 | FAX: (435) 787-8268 | WEB: APOGEEINSTRUMENTS.COM