Silicon-cell Pyranometers | SP-100 and SP-200 Series

Accurate and stable global shortwave radiation measurement

Accurate, Stable Measurements
Calibration in controlled laboratory conditions is traceable to the World Radiometric Reference in Davos, Switzerland. Pyranometers are cosine-corrected with directional errors less than ± 5% at a solar zenith angle of 75°. Long-term non-stability determined from multiple replicate pyranometers in accelerated aging tests and field conditions is less than 2% per year.

Rugged, Self-cleaning Head
Patented domed shaped sensor head (diffuser and body) facilitate runoff of dew and rain to keep the diffuser clean and minimize errors caused by dust blocking the radiation path. Sensors are housed in a rugged anodized aluminum body and electronics are fully potted.

Heated Option
A heated pyranometer (SP-230 All-season) is available with a 0.2 W heater to keep water (liquid and frozen) off the sensor and minimize errors caused by dew, frost, rain, or snow blocking the optical path.

Output Options
Multiple analog output options are available including: 0 to 350 mV, 0 to 2.5 V, 0 to 5.0 V, and 4 to 20 mA ranges. The silicon-cell pyranometer is also available attached to a hand-held meter with digital readout.

Typical Applications
Applications include shortwave radiation measurement in agricultural, ecological, and hydrological weather networks and solar panel arrays.
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.

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.

**Calibration Traceability**

Apogee Instruments SP series pyranometers are calibrated through side-by-side comparison to the mean of four Apogee 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.

**Dimensions**

- **Power Supply**
  - SP-110: Self-powered, 5 to 24 V DC with a nominal current draw of 300 µA
  - SP-214: 5 to 36 V DC with a maximum current drain of 22 mA (2 mA quiescent current drain)
  - SP-215: 5.5 to 24 V DC with a nominal current draw of 300 µA
  - SP-230: 5.5 to 24 V DC with a nominal current draw of 1.5 mA

- **Output (sensitivity)**
  - SP-110: 0.2 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: 0.2 mV per W m⁻²

- **Calibration Factor (reciprocal of output)**
  - 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, 4.0 mA offset
  - SP-215: 0.25 W m⁻² per mV
  - SP-230: 5.0 W m⁻² per mV

- **Calibrated Output Range**
  - SP-110: 0 to 350 mV
  - SP-212: 0 to 2.5 V
  - SP-214: 4 to 20 mA
  - SP-215: 0 to 5.0 V

- **Calibration Uncertainty**
  - ± 5 %

- **Measurement Repeatability**
  - Less than 1 %

- **Long-term Drift**
  - Less than 2 % per year

- **Non-linearity**
  - Less than 1 % up to 1750 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**
  - ± 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 depths of 30 m

- **Dimensions**
  - 24 mm diameter, 28 mm height

- **Mass (with 5 m of cable)**
  - SP-110: 90 g
  - SP-212: 140 g
  - SP-214: 90 g
  - SP-215: 140 g

- **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

- **Warranty**
  - 4 years against defects in materials and workmanship