



## SILICON-CELL PYRANOMETERS | SP-421-SS & SP-422-SS

Accurate and stable global shortwave radiation measurement

### 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

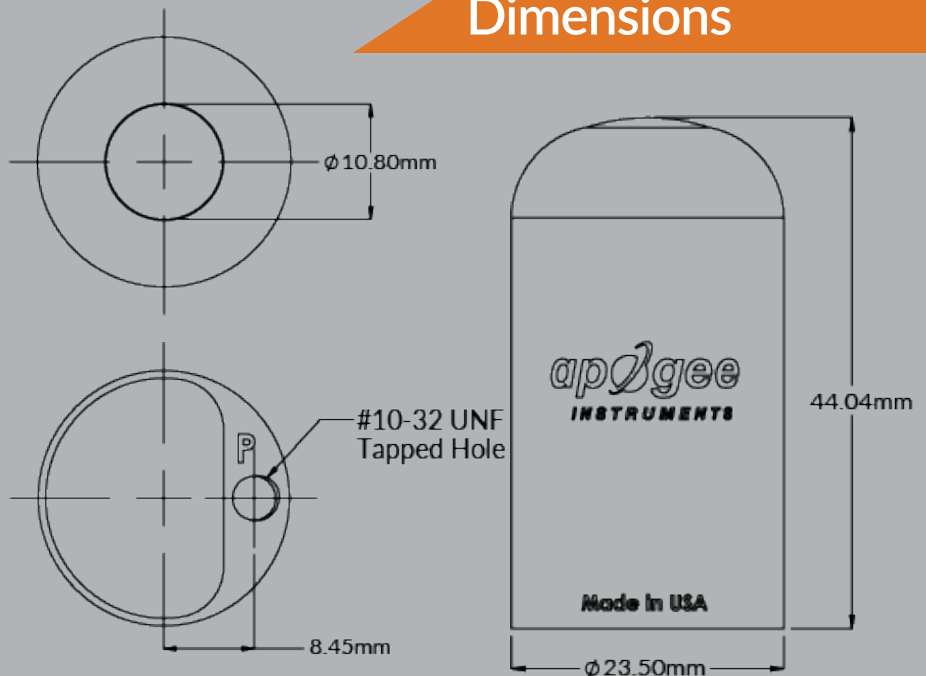
#### Mounting

The AM-110 mounting bracket facilitates mounting the AL-100 leveling plate to a mast or pipe. The bubble level in the plate makes leveling simple and accurate.

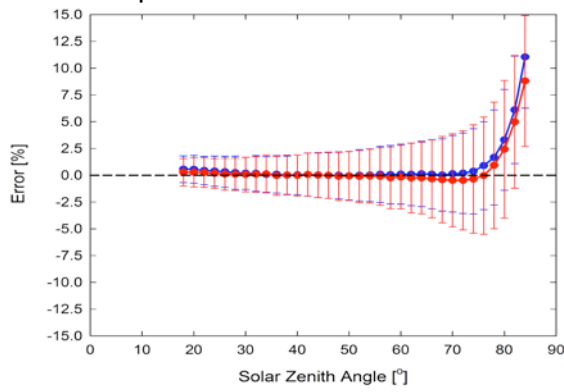
#### Calibration Traceability

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.

### Dimensions



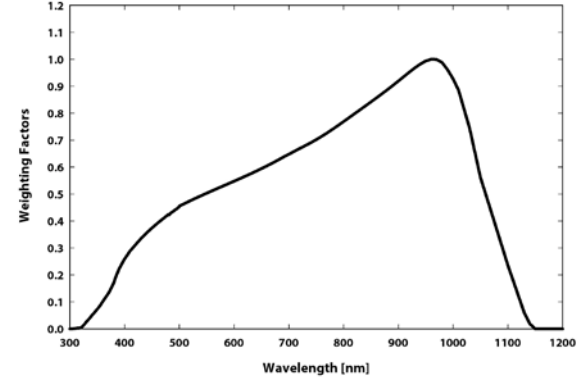
## Cosine Response



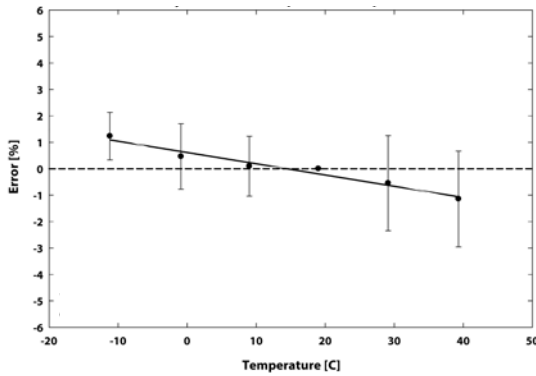
Mean **cosine response** of eleven Apogee silicon-cell pyranometers (error bars represent two standard deviations above and below mean). Cosine response measurements were made during broadband outdoor radiometer calibration (BORCAL) performed during two different years at the National Renewable Energy 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-421-SS	SP-422-SS
Power Supply	5.5 to 24 V DC	
Current Draw	0.6 mA (quiescent), 1.3 mA (active)	20 mA maximum
Output	Digital (SDI-12)	Modbus
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 <sup>-2</sup>	
Response Time	0.6 s, time for detector signal to reach 95 % following a step change; fastest data transmission rate for SDI-12 circuitry is 1 s	320 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, 44 mm height	
Mass (with 5 m of cable)	117 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	