Introducing the PV-100
PV Monitoring Package

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PV Monitoring Package

Introducing the new PV monitoring package (PV-100) designed to work with an SMA cluster controller and offered at a reduced package price. The package includes a silicon-cell pyranometer with a mounting bracket, Class A PRT back-of-panel temperature sensor with Kapton tape, fan-aspirated solar radiation shield with a 24 V-12 V DC converter, and a Class A PRT air temperature sensor with a TS-100 port adapter.

Solar Radiation Sensor (SP-214)

- High accuracy, silicon-cell pyranometer
- 4-20 mA output signal
- Measures Global Horizontal Irradiance (GHI) or Plane of Array (PoA) Irradiance

- Includes AL-120 mounting bracket

Air Temperature Sensor (ST-150)

- 1/8 inch diameter, Class A PRT
- IP67 rated
- Meets IEC 61724-1 requirements

- Includes port adapter for TS-100

Back-of-Panel Temperature Sensor (CS240)

- PT1000 Class A PRT
- Self-adhesive aluminum disk promotes heat transfer from panel surface

- Includes Kapton tape to secure sensor

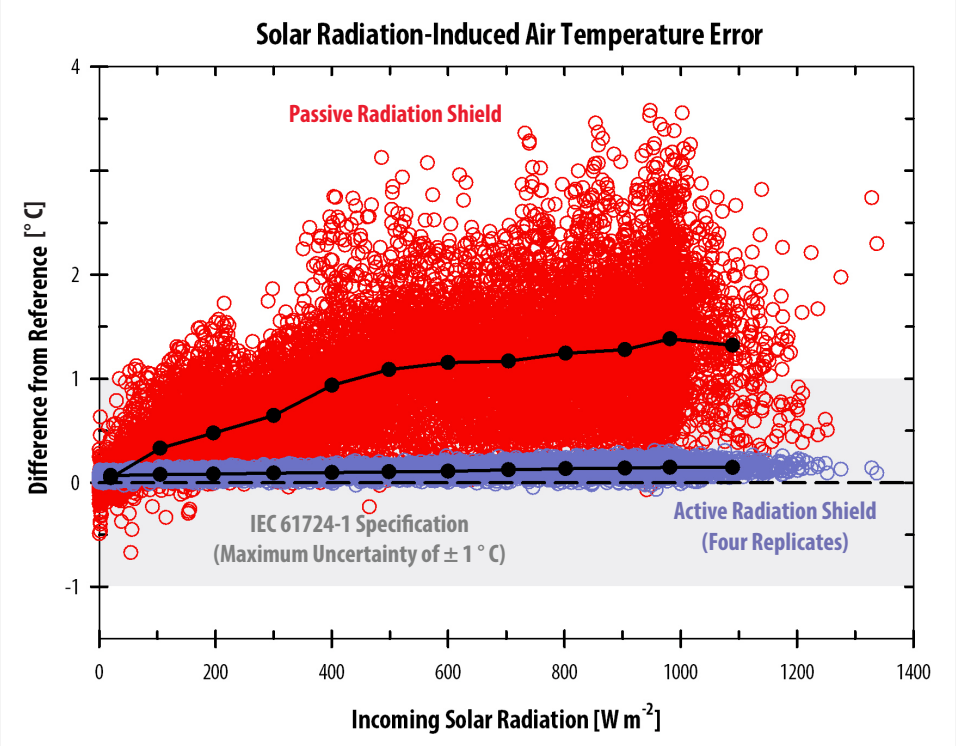
Fan-Aspirated Solar Radiation Shield (TS-100)

- Prevents solar radiation-induced errors
- Long life, IP55 rated fan

- Includes 24 V-12 V DC converter

Air Temperature Errors Caused by Multi-Plate Solar Shields

Did you know multi-plate radiation shields can cause air temperature measurement errors commonly ranging from 0 to 4 C in high solar conditions? This frequently overlooked phenomenon results in significant errors outside of the IEC 61724-1 specification requiring a measurement uncertainty of less than 1 C. The TS-100 is the solution. **Housing the Class A PRT inside the fan-aspirated shield ensures air temperature measurements with an uncertainty of only 0.3 C in all conditions.**



Solar radiation-induced temperature error of Apogee's Class A PRTs (model ST-150) in active shields (Apogee model TS-100) and a passive shield (RM Young six plate) installed on a typical high-reflectance, white-membrane commercial rooftop.

Red data demonstrate the error introduced by installing the Class A PRT inside a passive shield (naturally-aspirated, multi-plate) and comparing it to the average of the two 1/10 DIN PRTs inside the two fan-aspirated shields.

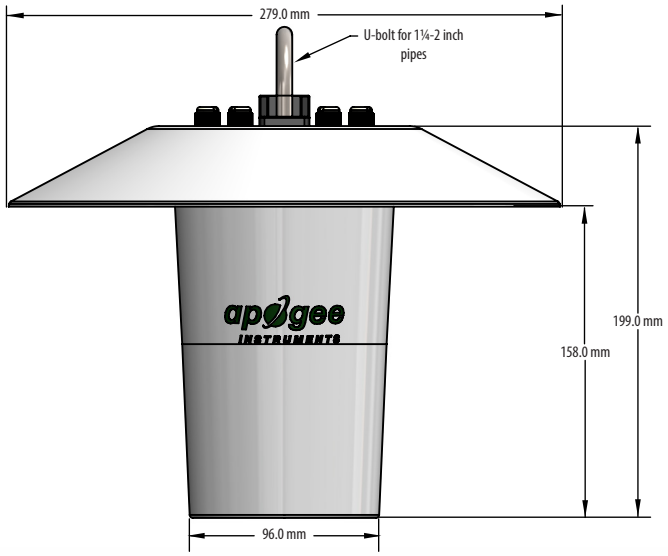
Blue data compare the average of four Class A PRTs to two 1/10 DIN PRTs (Apogee model ST-300) all housed inside two TS-100 shields. These sensors clearly meet the Class A accuracy standards.

Conclusion: These data indicate that Class A PRTs meet the temperature accuracy requirement of the IEC 61724-1 specification (maximum uncertainty of ± 1 ° C, gray box) when installed inside fan-aspirated solar radiation shields, but *not* when installed in naturally aspirated multi-plate shields.

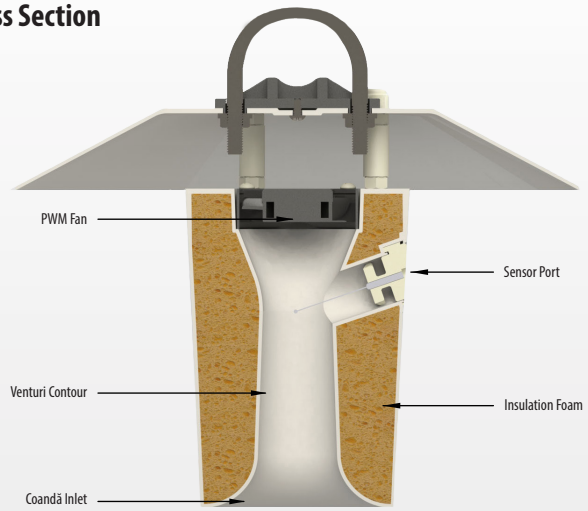
Aspirated Radiation Shield | TS-100

Accurate measurement of air temperature.

Dimensions



Cross Section



Aerodynamic Shape

The curved inlet facilitates the redirection of air into the shield through the Coandă effect (tendency of fluid flow to follow a convex surface). The tapered diameter of the internal surface enhances air velocity through the Venturi effect (reduction in fluid pressure after flowing through a constriction). Both effects contribute to more efficient air flow and allow for a lower power fan than other fan-aspirated radiation shields on the market.

Sensor Compatibility

Sensor port adapter plugs can accommodate multiple sensors. When ordered as part of the PV-100 package the adapter plug needed for the ST-150 is included.

Rugged, Low-power Fan

The fan has an ingress protection (IP) rating of 55, virtually eliminating moisture and dust ingress. At full speed the power requirement is 1 W (80 mA at 12 V DC). To conserve power fan speed can be reduced, via pulse width modulation (PWM), to 0.3 W. If the fan is continuously operated at full speed, lifetime is rated at 50,000 hours (5.7 years). The fan includes a tachometer, allowing RPM to be monitored to detect obstruction to the fan.

TS-100

Difference Among Individual Replicate Shields	Less than 0.1 C
Aspiration Rate	6 m s^{-1} at full speed; 3 m s^{-1} at half speed
Fan Input Voltage Requirement	10.8 to 13.2 V DC
Fan Current Drain	80 mA at full speed; 25 mA at half speed
Fan Dust and Water Protection	IP55
Dimensions	220 mm height, 270 mm diameter
Mass	840 g
Cable	5 m of shielded, twisted-pair wire for fan and air temperature sensors; 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

Silicon-cell Pyranometer | SP-214

Accurate and stable global shortwave radiation measurement

Accurate, Stable Measurements

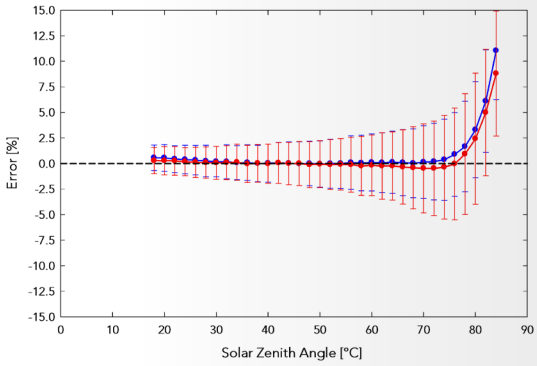
Calibration in controlled laboratory conditions is traceable to the World Radiometric Reference in Davos, Switzerland. Pyranometers are cosine-corrected with directional errors less than ± 5 % at a solar zenith angle of 75°. Long-term non-stability determined from multiple replicate pyranometers in accelerated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

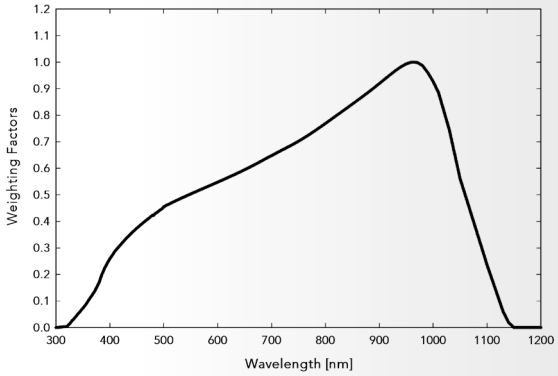
SP-214	
Power Supply	5 to 36 V DC with a maximum current drain of 22 mA (2 mA quiescent current drain)
Output (Sensitivity)	0.013 mA per W m^{-2}
Calibration Factor (Reciprocal of Output)	78 W m^{-2} per mA, 4.0 mA offset
Calibration Uncertainty	± 5 %
Measurement Repeatability	Less than 1 %
Long-term Drift	Less than 2 % per year
Non-linearity	Less than 1 % up to 1250 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)	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

Cosine Response



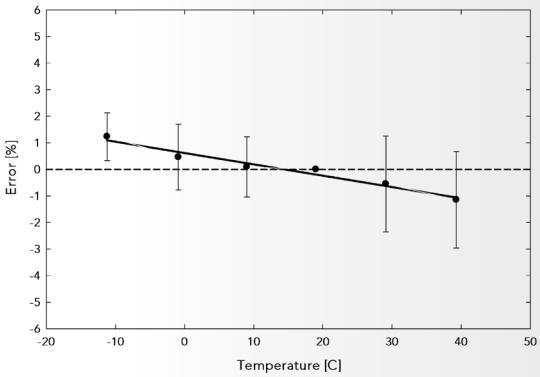
Mean cosine response of eleven Apogee silicon-cell pyranometers **(error bars represent two standard deviations above and below mean).** Cosine response measurements were made during broadband outdoor radiometer calibration (BORCAL) performed during two different years at the National Renewable Energy 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



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.

Temperature Sensors | ST-150 and CS240

ST-150 Air Temperature Sensor

The ST-150 is a 1/8 inch, Class A PRT (Platinum Resistance Thermometer) with an IP67 rating. White heat shrink is used on the cable behind the PRT to minimze heat transfer to the sensor. PRT sheath dimensions are 3mm diameter and 56 mm length, minimizing thermal mass.

	ST-150
Measurement Range	-50 to 70 C
Measurement Uncertainty	0.3 C (-50 to 70 C), Class A
Measurement Repeatability	Less than 0.01 C
Long-term Drift	Less than 0.05 C per year
Equilibration Time	15 s
Self-heating	Less than 0.01 C (typical, assuming pulsed ecitation of 2.1 V DC; 0.09 C at 5 C (max. assuming continuous input excitation of 2.1 V DC)
Operating Environment	-50 to 70 C; 0 to 100 % relative humidity
Input Voltage Requirement	Datalogger dependent
Output Voltage Requirement	Datalogger dependent
Current Draw	Datalogger dependent
Dimensions	16 to 27 mA DC (excitation of 2.1 V DC)
Mass	56 mm length, 3 mm diameter

CS240 Back-of-Panel Temperature Sensor

The CS240 is a surface mountable PT100 Class A PRT designed to measure back-of-panel temperature with the highest accuracy. The PRT is housed inside a rugged, self-adhesive aluminum disk designed to withstand harsh environments and promote heat transfer from the panel surface. Kapton tape is required for cable strain relief and to fasten the CS240 to the back of a solar panel.

	CS240
Element Type	Precision 1000 Ohm class A platinum sensing element
Tolerance	± (0.15 + 0.002t)
Temperature Coefficient	TCR = 3850 ppm/K
Long-term Stability	Maximum R_0 drift 0.04 % (after 1000 h at 400 C)
Measuring Current	0.1 to 0.3 mA
Operating Temperature Range	-40 to 105 C
Disk Material	Anodized aluminum
Cable Jacket Material	Black semi-gloss PVC, UL VW-1 sunlight resistance for outdoor use
Disk Diameter	2.54 cm
Overall Probe Length	6.35 cm
Overmolded Joint Dimensions	5.72 x 1.12 x 1.47 cm
Weight	90.7 g with 3.2 m cable

More information available at apogeeinstruments.com/pv-100-pv-monitoring-package.