



**Delta-T Devices**

The SPN1 measures Global (Total) and Diffuse radiation and Sunshine Duration – in one instrument

The SPN1 Pyranometer is a patented, meteorological class instrument, with built-in heater, designed for long-term outdoor exposure. It is an affordable alternative to shade-ring pyranometers, pyrhemometers and traditional sunshine recorders.

The SPN1 is exceptionally easy to use; it needs no routine adjustment or polar alignment and works at any latitude.

### Unique design

The Sunshine Pyranometer uses an array of seven, miniature thermopile sensors and a computer-generated shading pattern to measure the direct and diffuse components of incident solar radiation.

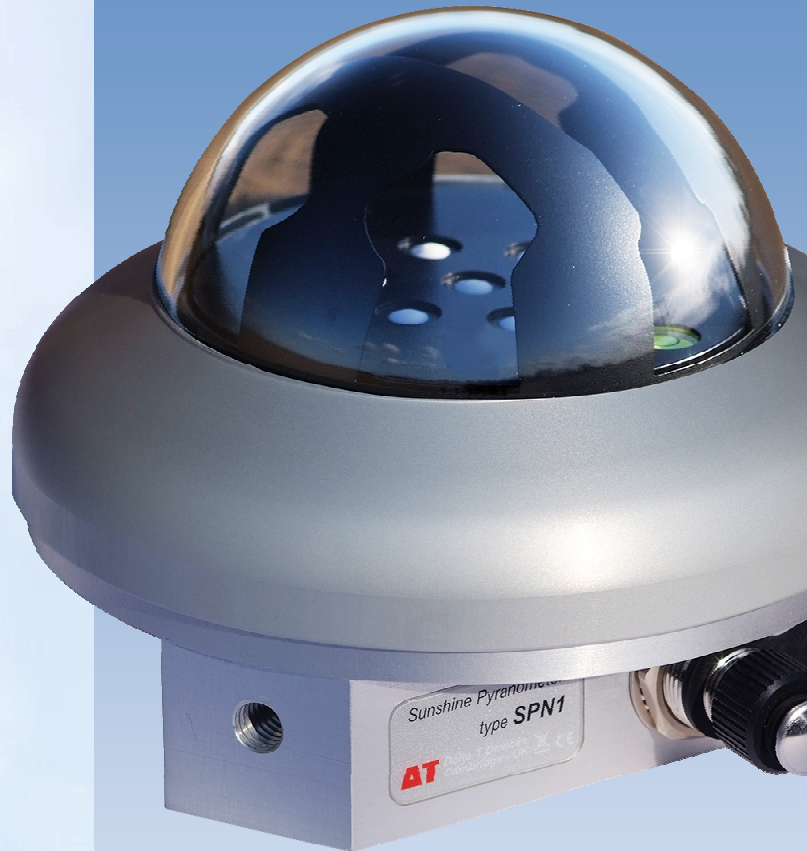
The shading pattern and thermopiles are arranged so that at least one thermopile is always fully exposed to the solar beam, and at least one is fully shaded from it, regardless of the position of the sun in the sky.

All seven thermopiles receive an equal amount of diffuse light. From the individual thermopile readings, a microprocessor calculates the global and diffuse horizontal irradiance and from these values an estimate of sunshine state is made.

The Sunshine Pyranometer is protected by patents EP 1012633 & US 6417500

# SPN1

## Sunshine Pyranometer



- Precision ground glass dome
- Wideband thermopile sensors
- Near ideal spectral and cosine response
- Standard output sensitivity

### Outputs

The Sunshine Pyranometer provides 2 analogue voltage outputs for global and diffuse radiation, and a digital output for sunshine duration, which can be connected to data loggers, such as the Delta-T GP2 and GP1. Readings can also be obtained directly from the RS232 port.

### Heater

An internal heater keeps the dome clear of dew, ice and snow down to -20°C (in still air conditions), ensuring reliable readings in difficult climatic conditions.

# SPN1 validation and testing - direct and diffuse

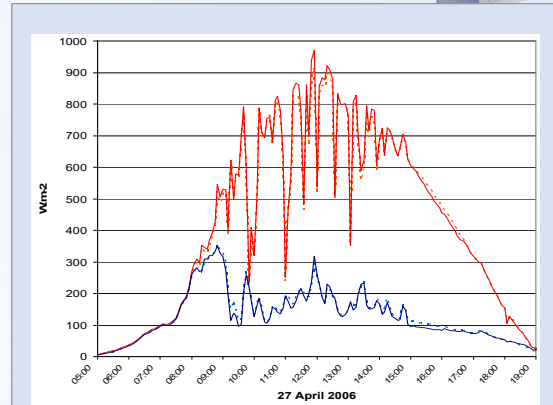


## SPN1 Design Principles

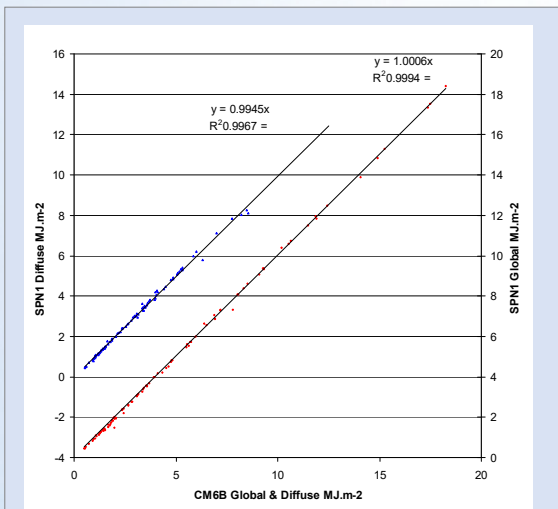
The principles used in the Sunshine Pyranometer have been tried and tested in the Delta-T BF3 Sunshine Sensor. The original design has been enhanced, using miniature thermopile sensors, a high-quality ground glass dome and aluminium housing. The electronics have also been redesigned for higher accuracy and lower power consumption. [The BF3 has since been upgraded to the BF5 model]. The SPN1 computes direct radiation by subtracting the diffuse from the global (total) radiation.

## Comparison Results

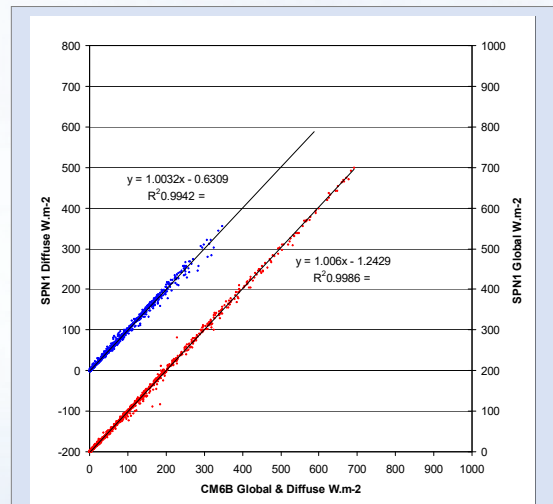
Prototype versions of the Sunshine Pyranometer were tested over several months against Kipp & Zonen CM6B sensors, one shaded by a solar tracking disk. Sample results appear on this page.



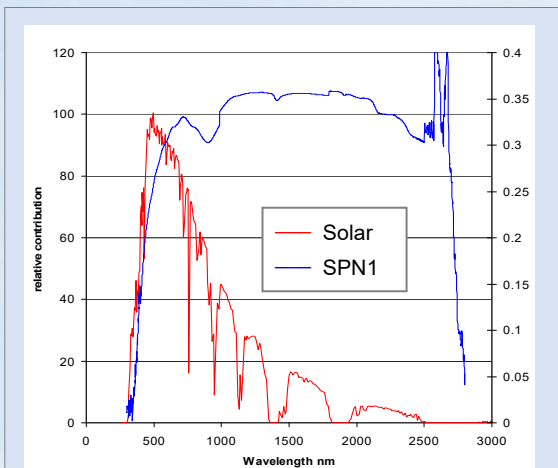
**SPN1 Direct and Diffuse Outputs** (solid traces) compared with a pair of Kipp CM6B pyranometers with solar tracking and shading disk (broken traces).



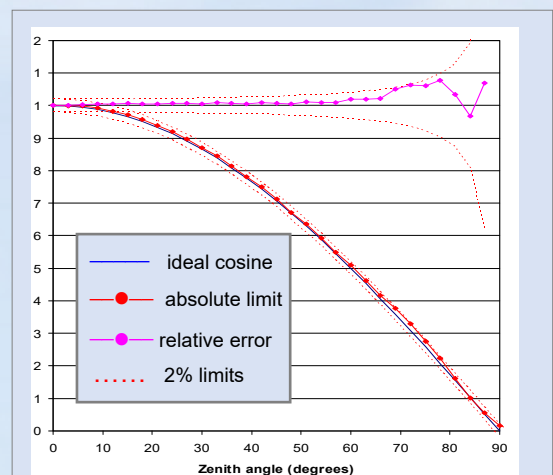
**SPN1 Daily Integrals** Global & diffuse compared with Kipp CM6B & tracking disk Sept - Dec 2004, daily integrals. (Note use of offset axes to make traces visible).



**SPN1 Hourly Averages** Global & diffuse compared with Kipp CM6B & tracking disk Sept - Dec 2004, hourly averages. (Note use of offset axes to make traces visible).

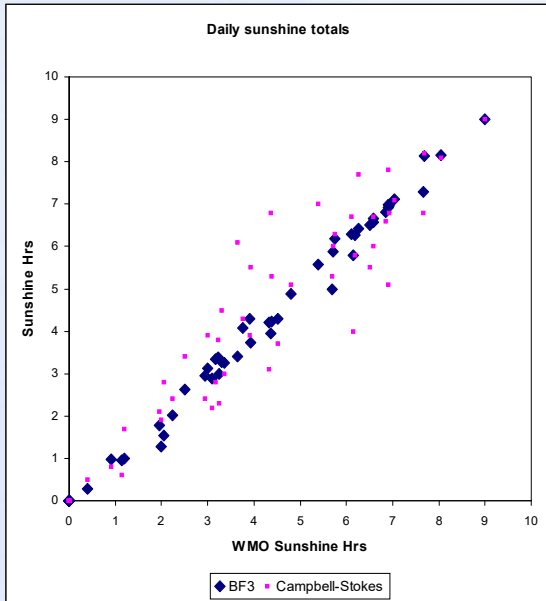


**SPN1 Spectral Response** Graph shows the spectral response of the SPN1 (thermopile, diffusers and dome combined) and the solar spectrum at ground level.



**SPN1 Cosine Response** Graph shows the typical cosine response of the SPN1 compared to the ideal cosine curve. The upper curve shows the relative accuracy.

# SPN1 validation and testing - sunshine duration



## Sunshine Duration

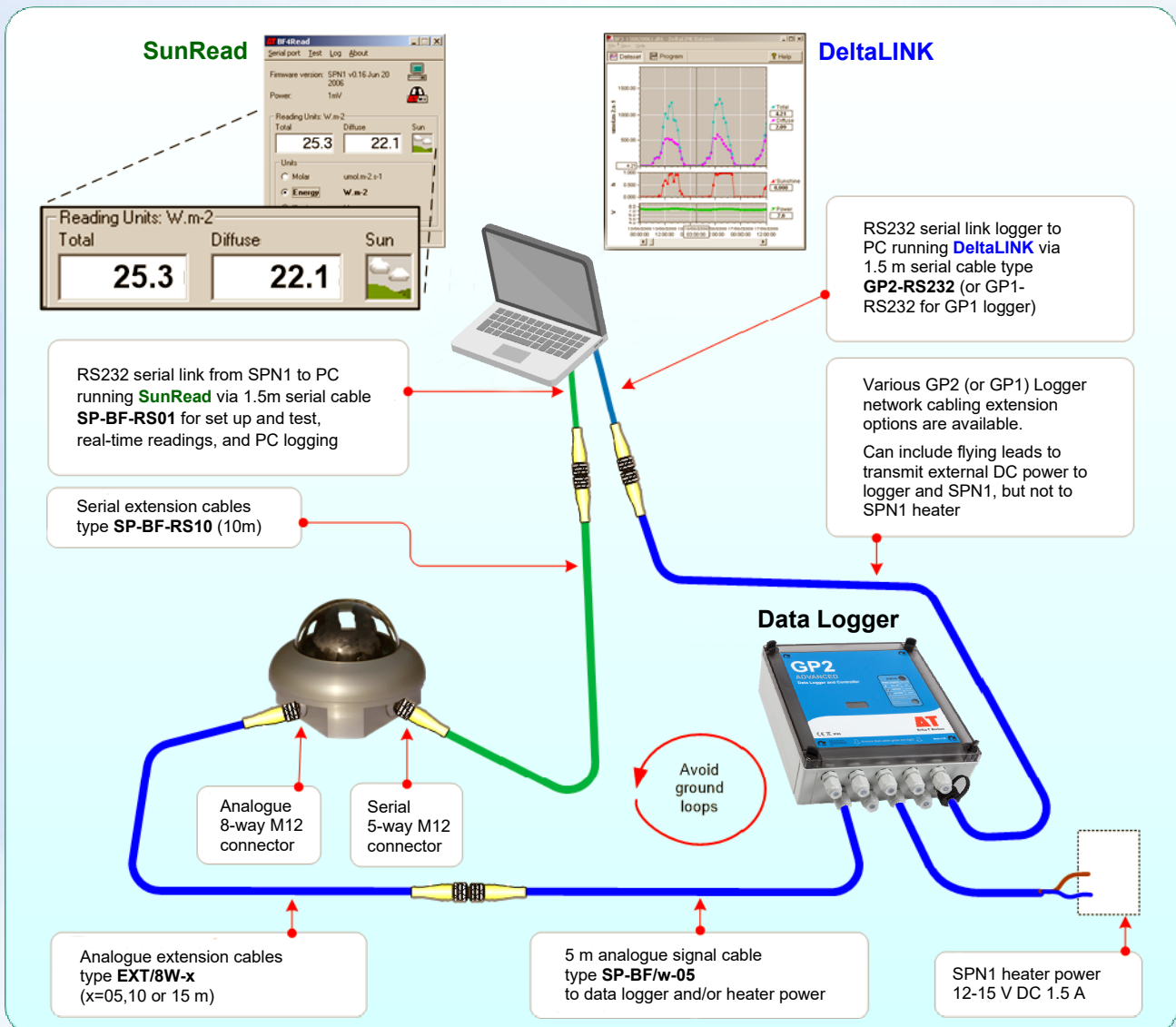
The WMO threshold for bright sunshine is  $120 \text{ W.m}^{-2}$  in a plane perpendicular to the direct solar beam. This cannot be measured directly using horizontal cosine-corrected sensors, and so the SPN1 uses an algorithm based on the ratio of direct to diffuse radiation, combined with their absolute values, to estimate this to within a few percent of the WMO standard.

The graph compares the performance of the BF3\* and a Campbell-Stokes sunshine recorder over a trial period of several months. Against the WMO standard, the BF3's typical daily error was 20 minutes. In contrast, the Campbell-Stokes was less precise, giving a typical daily error of nearly an hour.

\* The SPN1 is an advanced version of the BF3 Sunshine Sensor. Both devices use the same sunshine hours algorithm. The BF3 has since become the BF5.

## GP2 Data Logging Solution

The GP2 from Delta-T Devices is a powerful data logger that provides an ideal logging solution for the SPN1 Sunshine Pyranometer. The diagram below shows how a GP2 can log SPN1 readings and later upload to a PC. Also illustrated is an alternative recording method where the SPN1 serial output is connected directly to a PC or other serial device.





# Applications

## Meteorology

- Solar radiation
- Climate change
- Air pollution
- Sunshine duration
- Cloud cover research

## Agronomy & plant science

- ET and heat flux studies
- Canopy analysis and modelling

## Architecture and building design

- Building Management Systems
- PV efficiency and energy balance



## Specifications

<b>Overall accuracy: Global (Total) and Diffuse radiation</b>	±5% Daily integrals ±5% ±10 W.m <sup>-2</sup> Hourly averages ±8% ±10 W.m <sup>-2</sup> Individual readings <i>Accuracy figures give 95% confidence limits, i.e., 95% of individual readings will be within stated limits under normal climatic conditions.</i>
<b>Resolution</b>	0.6 W.m <sup>-2</sup> = 0.6mV
<b>Range</b>	0 to >2000 W.m <sup>-2</sup>
<b>Analogue output sensitivity</b>	1mV = 1 W.m <sup>-2</sup>
<b>Analogue output range</b>	0-2500mV
<b>Sunshine status threshold</b>	120 W.m <sup>-2</sup> in the direct beam
<b>Accuracy: Sunshine status</b>	±10% sun hours with respect to the threshold
<b>Accuracy: Cosine Correction</b>	±2% of incoming radiation over 0-90° Zenith angle
<b>Accuracy: Azimuth angle</b>	± 5% over 360° rotation
<b>Temp coefficient</b>	± 0.02% per °C typical (-20 to +70°C)
<b>Temperature range</b> <sup>1</sup>	-40 to +70°C

<b>Recalibration / stability</b>	Factory recalibration recommended every 2 years.
<b>Response time</b>	< 200ms
<b>Spectral response</b>	400-2700nm
<b>Spectral sensitivity variation</b>	10% typical
<b>Non-linearity</b>	<1%
<b>Tilt response</b>	Negligible errors
<b>Zero offsets</b>	<3 W.m <sup>-2</sup> for a change of 5°C/hr in ambient temperature <3 W.m <sup>-2</sup> dark reading
<b>Latitude capability</b>	-90° to +90°
<b>Environmental</b>	IP67 sealing
<b>Sunshine status output</b>	No sun = open circuit Sun = short circuit to ground
<b>Power requirement</b>	2mA (excluding heater power), 5V – 15V DC
<b>Heater power</b>	12V – 15V DC, up to 1.5A
<b>Heater control</b>	Continuously variable up to 20W output for external temperatures below 0°C
<b>Lowest snow &amp; ice-free temperatures (with heater in use)</b>	-20°C at 0 m/s wind speed -10°C at 2 m/s wind speed
<b>Mounting options:</b>	3 x M5 tapped holes in base: 108mm pcd, 120° spacing
<b>Size &amp; weight</b>	140mm dia x 100mm (h), 940g

<sup>1</sup> Provided: dome is frost-free, SP-BF-RS01 cable is not flexed when <-30°C and SP-BF/w-05 cable is not flexed when <-5°C.

## Ordering Information

Product	Item code	Description
<b>Sunshine Pyranometer</b>	SPN1	Fitted with 5 and 8 pole M12 plugs. Supplied with 5m data cable to bare wire, type SP-BF/w-05, 1.5 comms cable type SP-BF-RS01, spare desiccant canister, Quick Start Guide and calibration certificate. Does not include baseplate or support arm.
<b>Baseplate</b>	SPN1/BP	Levelling baseplate for SPN1. 125mm diameter, with 3 levelling screws.
<b>Support arm</b>	SPN1/ARM	Support arm for SPN1. Length 1m, suitable for mast mounting.
<b>Desiccant unit</b>	SPN1-SD	Spare desiccant unit for SPN1. 2 spare desiccant canisters (does not include RH indicator assembly).
<b>5m extn cable</b>	EXT/8W-05	5m SPN1 extension cable. IP68 M12 connector (f) to IP68 M12 connector (m)
<b>10m extn cable</b>	EXT/8W-10	10m SPN1 extension cable. IP68 M12 connector (f) to IP68 M12 connector (m)
<b>25m extn cable</b>	EXT/8W-25	25m SPN1 extension cable. IP68 M12 connector (f) to IP68 M12 connector (m)
<b>Recalibration</b>	SPN1-CAL	Factory recalibration and 2-year servicing of SPN1

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