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Delta-T Devices

SPN1
Sunshine Pyranometer

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

- **Global (Total) and Diffuse irradiance in W.m^{-2}**
- **WMO sunshine threshold: 120 W.m^{-2} direct beam**
- **No routine adjustment or polar alignment**
- **No moving parts, shade rings or motorised tracking**
- **Works at any latitude**



The Sunshine 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, pyrheliometers 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

- **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 DL2e 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

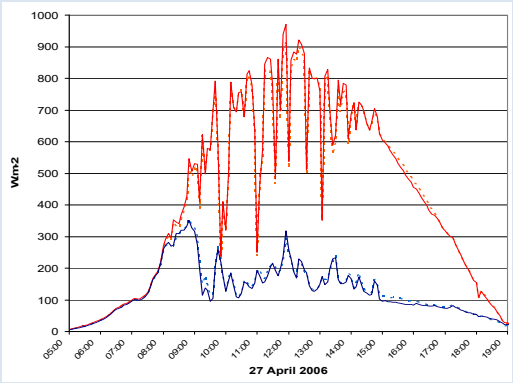
SPN1 Design Principles

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]

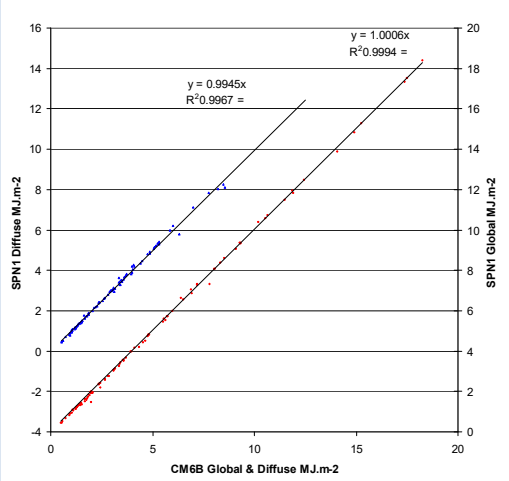
The SPN1 computes direct radiation by subtracting the diffuse from the global (total) radiation.

Comparison Results

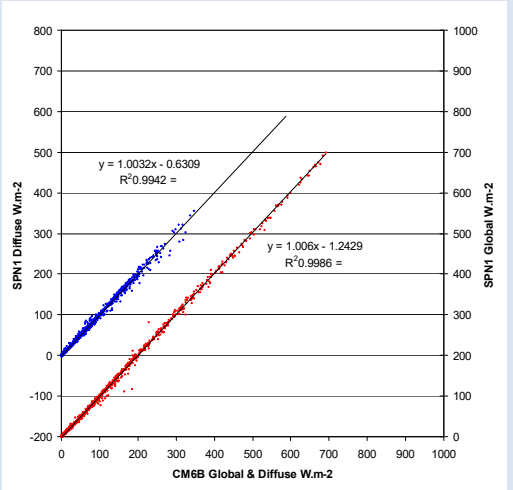
Prototype versions of the Sunshine Pyranometer were tested over several months against Kipp & Zonen CM6B sensors, one shaded by a solar tracking disk. Sample results appear on this page.



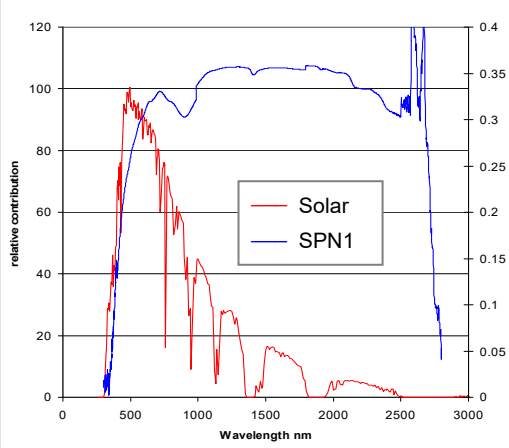
SPN1 Direct and Diffuse Outputs (solid traces) compared with a pair of Kipp CM6B pyranometers with solar tracking and shading disk (broken traces).



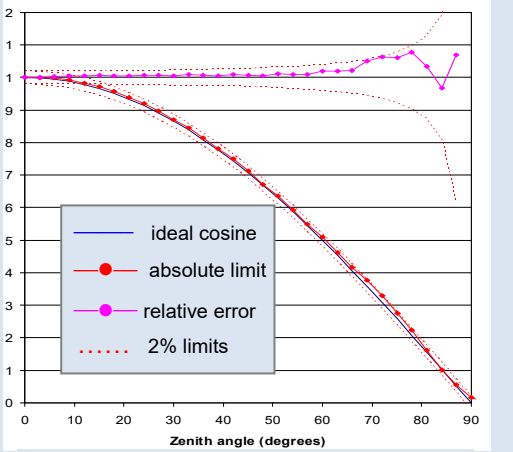
SPN1 Daily Integrals Global & diffuse compared with Kipp CM6B & tracking disk Sept – Dec 2004, daily integrals. (Note use of offset axes to make traces visible).



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).

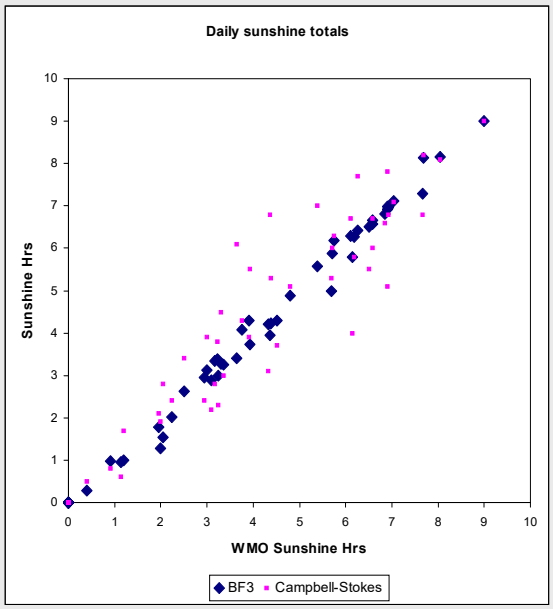


SPN1 Spectral Response Graph shows the spectral response of the SPN1 (thermopile, diffusers and dome combined) and the solar spectrum at ground level.



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 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.

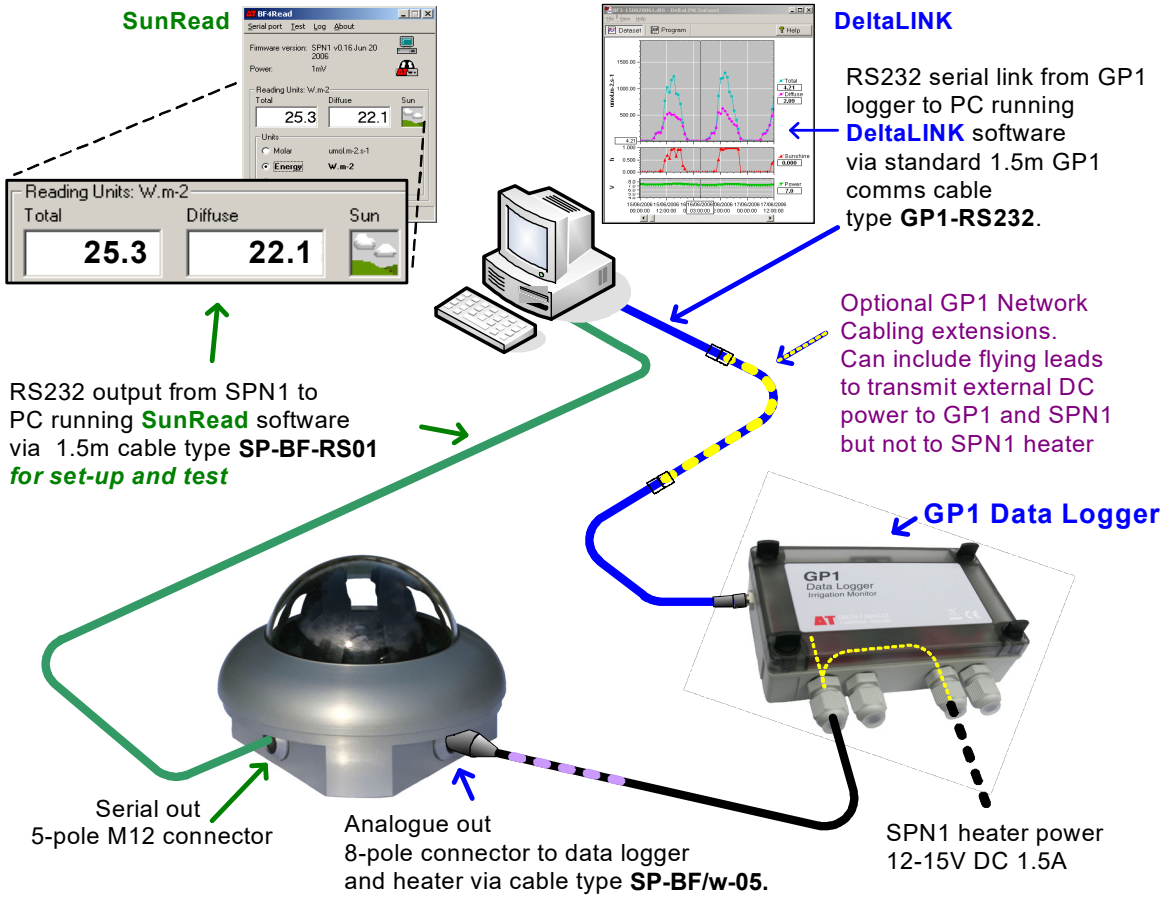
The graph compares the performance of the BF3* and a Campbell-Stokes sunshine recorder over a trial period of several months. Against the WMO standard, the BF3's typical daily error was 20 minutes. In contrast, the Campbell-Stokes was less precise, giving a typical daily error of nearly an hour.

** 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.*

GP1 Data Logging Solution

The GP1 Data Logger from Delta-T Devices is a powerful general purpose data logger that provides a low cost logging solution for the SPN1 Sunshine Pyranometer. The diagram below shows how a GP1 can log SPN1 readings and later upload them to a PC or PDA.

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

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

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

[1] 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
Sunshine Pyranometer	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.
Baseplate	SPN1/BP	Levelling baseplate for SPN1. 125mm diameter, with 3 levelling screws.
Support arm	SPN1/ARM	Support arm for SPN1. Length 1m, suitable for mast mounting.
Desiccant unit	SPN1-SD	Spare desiccant unit for SPN1. 2 spare desiccant canisters (does not include RH indicator assembly).
5m extn cable	EXT/8W-05	5m SPN1 extension cable. IP68 M12 connector (f) to IP68 M12 connector (m)
10m extn cable	EXT/8W-10	10m SPN1 extension cable. IP68 M12 connector (f) to IP68 M12 connector (m)
25m extn cable	EXT/8W-25	25m SPN1 extension cable. IP68 M12 connector (f) to IP68 M12 connector (m)
Recalibration	SPN1-CAL	Factory recalibration and 2 year servicing of SPN1

Delta-T Devices

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