SPN1 Sunshine Sensor in Photovoltaics Research

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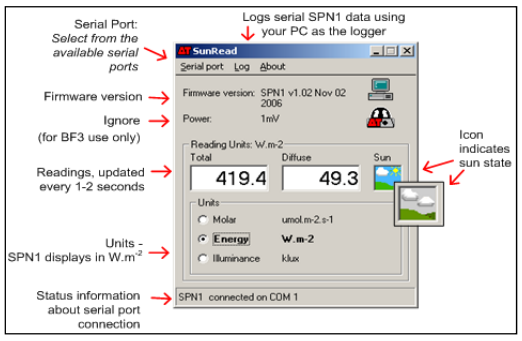
Abstract

The SPN1 Sunshine Sensor from Delta-T Devices Ltd is able to measure Total (Global) and Diffuse solar radiation without the use of a costly motorised tracking shade disk. This Poster shows how the SPN1 can be used to help establish the efficiency of photovoltaic technology. Hemispherical images of the sky taken during 3 months of field trials in Tenerife proved a useful adjunct in helping interpret results under rapidly changing cloud cover. The relative merits of mounting the SPN1 sensor horizontally or in the same plane as the photovoltaic device are also discussed.

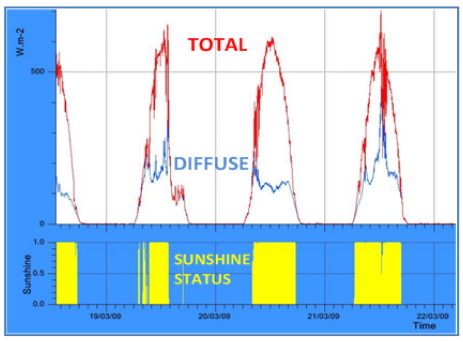
What does it measure?

The SPN1 Sunshine Pyranometer is one sensor with three output channels:-

- Total (global) solar radiation
- Diffuse radiation
- Sunshine status



Showing how SPN1 real-time readings appear on a PC running the SunRead program



Graphical representation of the SPN1 readings logged over several days. Upper chart: Total and Diffuse readings Lower chart: Sunshine hours

How does it work?

Seven sensors placed in a hexagonal pattern sit under a perforated hemispherical plate, called a shadow mask. The shadow mask design is unique. Generated using a specially designed evolutionary algorithm, it ensures that:-

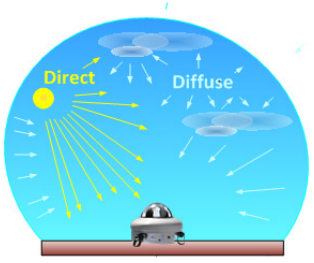
- at least one sensor is always exposed to the full sun
- at least one is completely shaded from the direct sun
- all sensors get equal amounts of light from the rest of the sky

Advantages of the SPN1 design

- The measurement of Direct and Diffuse sunlight normally requires two solar pyranometers plus a computer-controlled motorized sun-tracking shade disk. In contrast, the SPN1 has no moving parts.
- Being also much smaller, and lighter, and not needing to be aligned to north – it is easier to set up.
- Also the response time is much faster - being less than 200 milliseconds, compared to up to 5 minutes for some pyranometers, and so some customers are investigating their use on cars, planes, and even buoys and boats. In such situations it is thought necessary to record the tilt and correct the data accordingly.

What is Total or Global radiation?

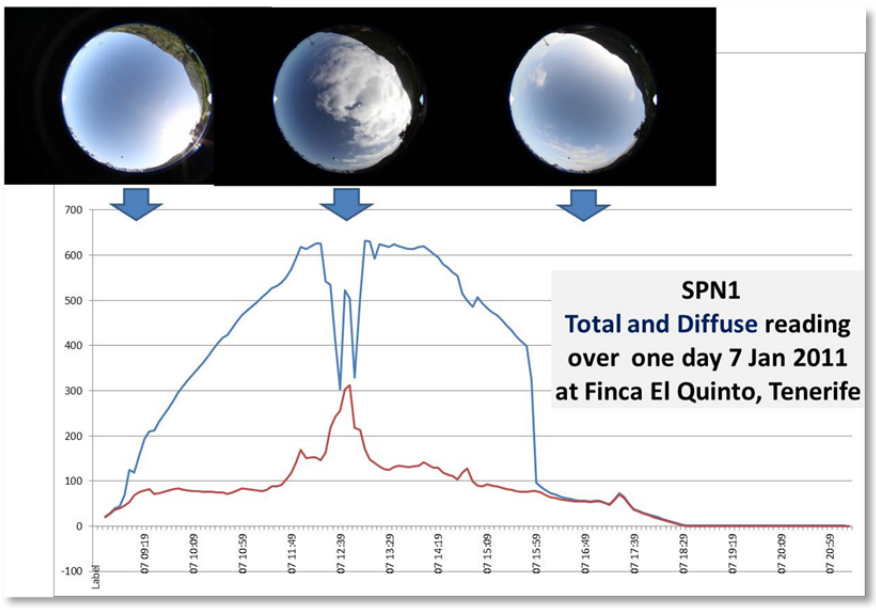
This is the radiation received from the whole of the sky, including the direct light from the sun and diffuse scattered light from the rest of the sky. This is what a standard, horizontal solar pyranometer will see.



What is Diffuse radiation?

Diffuse radiation is that which is received from the rest of the sky, excluding that received directly from the sun. Diffuse radiation can be a valuable source of energy for photovoltaic devices.

Direct radiation can be estimated from satellite data, but it is a lot harder to model all the scattering processes in the atmosphere and so it is simpler to measure the Diffuse radiation at a test site and over the time period of any photovoltaic trials.



Total and Diffuse readings with corresponding sky photos taken with a fisheye lens. Note the increase in Diffuse at midday – where the cloud lit up as it moved in front of the sun. Note also the removal of the Direct sunlight by a mountain range at dawn and dusk.

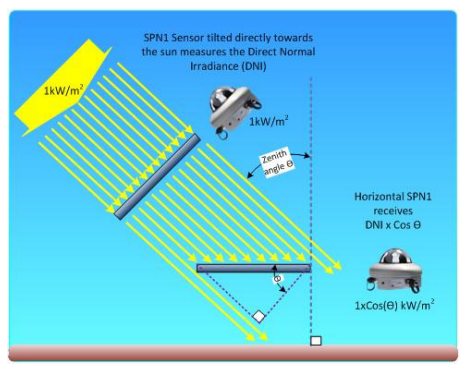
Tilted SPN1: What will it tell me?

Tilting an SPN1 can be particularly useful for recording the same Diffuse radiation as that received by a tilted photovoltaic panel (provided it does not see significant reflected radiation which may cause unreliable readings). A horizontal SPN1 can be useful as the maths is simpler when calculating DNI – Direct Normal Irradiance (if you don't have a sun tracking device).

Calculating DNI if SPN1 points directly at the sun

This requires a sun tracking device. The Direct Normal Irradiance is given, directly, by the equation:

DNI = Direct = Total(Global) –Diffuse.



Calculating DNI if SPN1 is horizontal

DNI = (SPN1 Direct)/Cos Θ

Where:-

Θ = zenith angle

SPN1 Direct = SPN1 Total(Global) – SPN1 Diffuse.

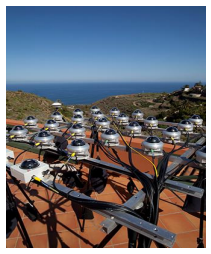
Note: We can provide an Excel spreadsheet add-in to help calculate DNI from the output of a horizontally mounted SPN1.

Calculating DNI if SPN1 is parallel to a fixed, tilted PV panel

An application note is available for other general fixed angles of tilt not normal to the sun.

Calibration

Calibration at the factory against transfer standards with a solar lamp is periodically checked at an outdoor location over a period of several weeks.



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