SolData Pyranometer 80SPC
USER'S GUIDE

Purpose
The purpose of the instrument is to measure global radiation: *diffuse plus direct solar radiation.* The pyranometer can be mounted on a horizontal surface or parallel to the plane of a solar heating system or photovoltaic (PV) system when the global radiation on these surfaces is of interest.

Calibration factor
The pyranometer can be used to find the instantaneous solar irradiance in W/m^2 or by integration to determine the total solar radiation energy per unit area striking the instrument during a time period. The calibration factor K can be expressed e.g.

$$K = 160\ mV/(kW/m^2) \qquad (1)$$

This value means that when the solar irradiance S is 1 kW/m^2 (typical for a clear, sunny day around noon) the pyranometer will provide an output voltage around 160 mV. If the output voltage is found to be 80 mV, this indicates that the solar irradiance is about 0.5 kW/m^2 = 500 W/m^2. In other words:

$$S[kW/m^2] = U[mV]/K \qquad (2)$$

where U is the signal voltage in millivolts, and S is measured in kW/m^2.

Cable connections
The 80SPC is supplied with a 3 meter long connection cable with a weather-proof connection to the instrument. The electrical connections to the cable are as follows:

blue: voltage plus (0-180 mV)
black: signal ground

Experience has shown that cable length is non-critical, and lengths of up to 30 meters have been used successfully. Atmospheric disturbances such as lightning can of course affect measurements.

Shielded cable is unnessary unless a very high electrical noise level is anticipated. The three meter cable will probably be adequate for most applications. If not the extension cable connection should, if

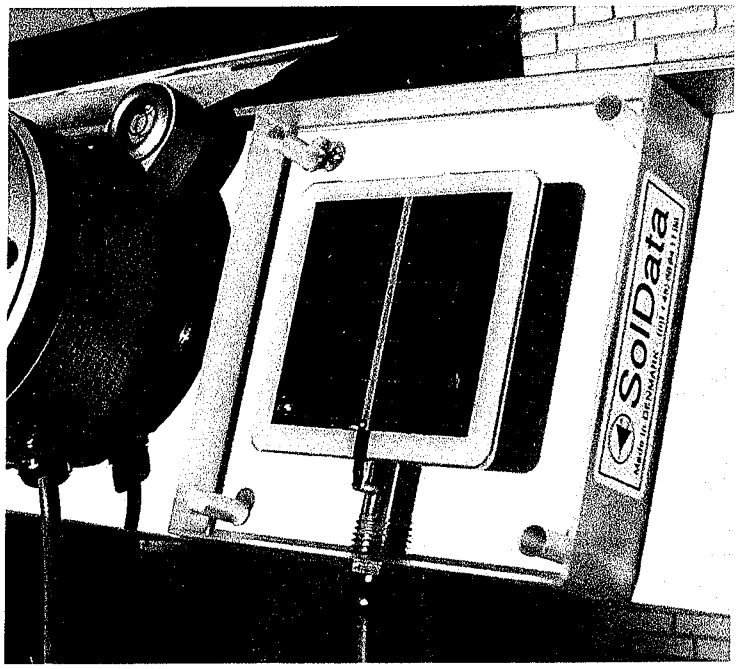

Figure 1: *The SolData 80SPC pyranometer is supplied with a 3 meter cable and a weatherproof IP68 housing connection.*

possible, be mounted indoors and protected against moisture penetration.

Signal integration
In order to measure the *total* solar energy striking each square meter of a particular surface, e.g. a solar collector, a number of options are available.

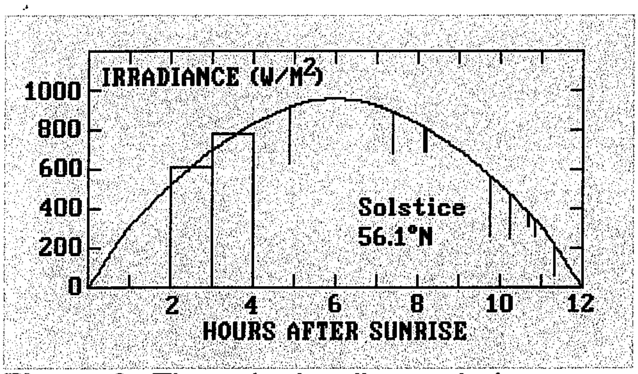

Figure 2: *The solar irradiance during a clear day around the spring solstice in Denmark. The area under the curve equals the total energy per unit area.*

CHART RECORDER METHOD:
Figure 2 shows a graph which could have

been recorded during a "good", sunny day. Note that the time axis can be divided up into a number of small time intervals each with roughly constant irradiance. In each interval the product of the mean irradiance and the time interval corresponds to the total energy. Adding up all of these contributions throughout the day will yield the total daily global irradiation on the surface. A quick estimate of the area in Figure 2 yields a value of about 6 kWh/m². It is also possible to determine the area by using a sensitive laboratory balance. The graph can be cut out and weighed: knowledge of the paper mass per unit area allows the global radiation to be computed.

In connection with the study of solar heating systems it is naturally of considerable interest to compare the global radiation on the solar collector or panel with the total energy yield in the same period. This can be determined by regarding the solar energy storage tank as a calorimeter. The heat energy content before and after the measuring period can be determined by appropriate temperature measurements and knowledge of the heat capacity of the storage tank. The daily yield divided by the daily global radiation is one measure of the efficiency of the solar heating system.

All days are of course not cloudless, and one will most often experience considerable variations in solar radiation intensity during partly cloudy days. In this case it is more difficult to estimate the global radiation by simple graphical methods.

ELECTRONIC INTEGRATOR METHOD:
It is possible to save a great deal of effort when measuring global radiation by purchasing or building an electronic integrator. The integrator can continuously add up $S \cdot \Delta t$ throughout the day. The integrator is designed to transform the pyranometer output continuously to a chain of pulses proportional to the pyranometer voltage signal.

An integrator is usually implemented by means of a digital circuit to perform the transformation of pyranometer voltage to pulses with a frequency proportional to the voltage. A rather high frequency must be used to achieve good precision. Because a simple pulse counter can not record more than about 10 pulses per second, the high frequency is divided electronically 100 or 1000 times. An appropriate choice of voltage-frequency converter and frequency divider must be made to design an integrator so that a convenient number of counts corresponds to a given voltage-time product. For example 1000 counts might correspond to 100 mV for one hour.

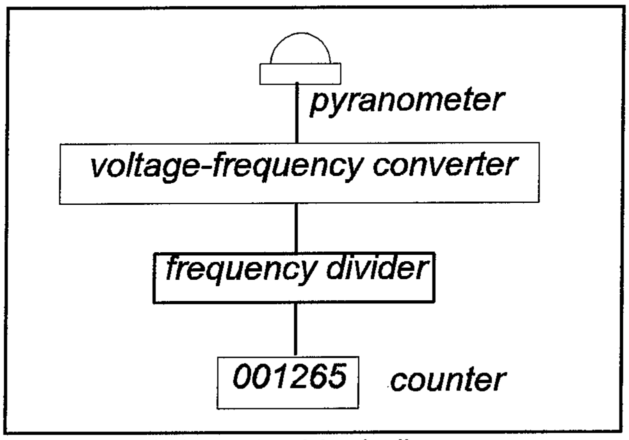

Figure 3: *Integrator block diagram.*

DATA ACQUISITION
Professional data acquisition systems transform an input voltage e.g. from a pyranometer to digital form for computer processing. Equation (2) can be used in the program with the calibration constant provided with your instrument to continuously record the momentary solar irradiance $S(t)$. The global radiation energy G per unit area is the time integral:

$$\int_{t_1}^{t_2} S(t)\,dt = G \approx \Sigma_i S(t_i) \cdot \Delta t_i \qquad (1)$$

The programmer will usually choose a time interval Δt in harmony with the acquisition of other quantities in the program. It is of course necessary to be careful to use correct units. In the international literature *kWh/m²* or *MJ/m²* are most commonly used.

1 kWh/m² = 3.6 MJ/m²

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