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The solar radiation measurement module SUSE 4.24A

Analogue irradiance measurement device for measuring the solar radiation

Technical manual and user guide

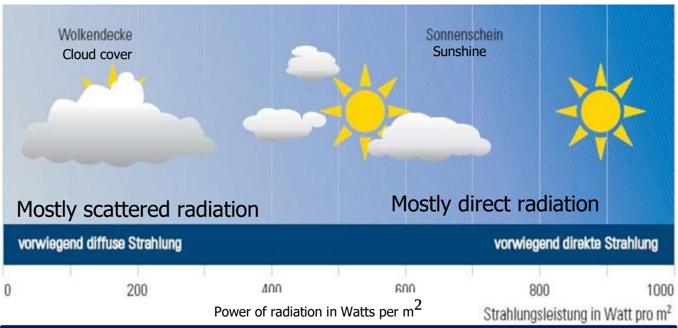
The radiation measurement device SUSE 4.24A, on the top roof side the solar cell is placed, on the lower roof side the display instrument, a 100 mA meter.
Display: 40 multiplied by 10 =
irradiance 400 W/m²
on a cloudy day.

The solar module **SUSE 4.24A is an analogue measurement device for measuring the irradiance S of the sunlight** or the light of light sources in the international measuring unit W/m².
For measurements, the short-circuit current of the solar cell is used, which is proportional to the irradiance S. A mA meter with a 100 mA range serves as the display, the value "100" corresponds to an irradiance of 1000 W/m². The smallest scale division is 50 W/m².
A value of 1000 W/m² corresponds to the solar radiation of the summer sun at noon with bright blue and cloudless skies, this value is the standard test value for solar cells. 0 W/m² is absolute darkness, a dull, heavily clouded day has about 50- 100 W/m², a sunny day with misty clouds about 700 – 800 W/m². The device is available as a construction kit or a calibrated ready-to-use device.

Theory of operation:
The solar cell used in the solar module SUSEmod5 has a short-circuit current of 450mA with S = 1000 W/m². This value is supposed to lead to a display of "100" on the mA meter.
Therefor a current of I = 100 mA has to flow through the mA meter, the rest, 350 mA, through an appropriate shunt resistance in parallel connection around the measuring element.

The proper low-ohm shunt resistance is crafted from a piece of hookup wire, the dimensions, the exact kind of wire, and the method of calibration are included in each construction kit. For ready-to-use devices the calibration takes place at SUNdidactics.

Global radiation: What's measured is the global radiation, so all light coming from the sky and hitting the solar cell, the direct sunlight, light of the blue sky, and light of the white clouds. The international unit of measurement is W/m²



Technical Data:
Precision of measurements ± 3%
Plexiglass support: 160mm x 80 mm, bent to 75°
Solar cell: SUSEmod5, 60mm x 30mm, V_{oc}= 0,64 V /I_{sc}= 450 mA
Measurement device: Analogue amperemeter 100 mA DC, class 2,5

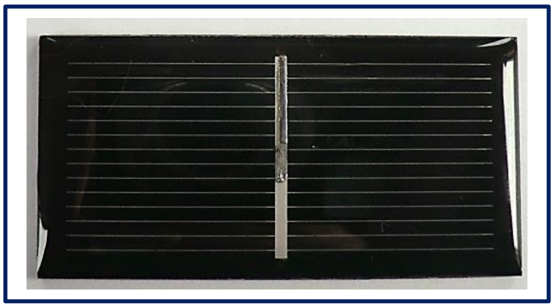
User guide:
The device is adjusted with the solar cell towards the sun or another light source, the display on the measurement device is multiplied by 10, this results in the current irradiance in W/m².

Under a clouded sky, the irradiance is different for different positions towards the sky, the varying values can be measured by adjusting the solar cell towards these zones.

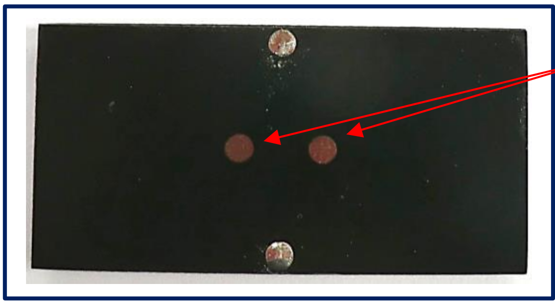
An extensive experimentation manual for this device is available at SUNdidactics.
The technical data of the used solar cell is included on page 2.

SUSEmod5- a powerful and robust solar module for PV experiments

The **solar module SUSEmod5** contains a solar cell with exactly half the area of the solar module SUSEmod215, solar cell dimensions 52 x 26 mm, module dimensions 60mm x 30mm.



Front side



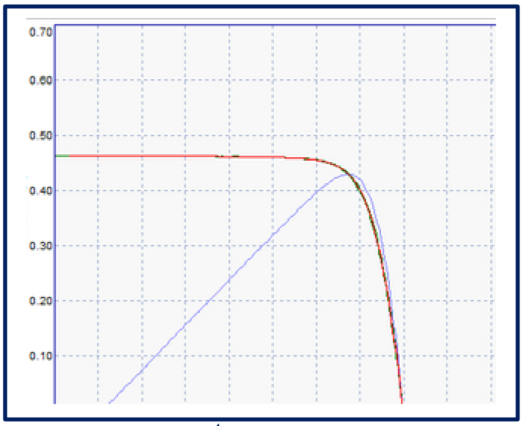
Back side

The two Cu platelets in the middle are the (marked) poles of the solar cell. Cell connectors or hookup wire can be soldered onto them.

The solar module **SUSEmod5** contains a solar cell with half the area of the well-known SUSE solar cell SUSEmod215, the length of the solar cell is 52 mm, the width 26 mm. The solar cell is embedded break-proof in a plastic plate of the dimensions 60 x 30 mm. The surface on the solar cell is grouted/laminated super-transparent with plastic. On the back side there are 2 soldering contacts to solder on the positive and negative conductors. On the rear side the solar module can be stuck to smooth surfaces with double-faced adhesive tape or with glue. With this solar cell single experiments as well as experiments on series and parallel connections can be conducted, e.g. in the modules SUSE CM3xx, SUSE 4.31, and other devices.
Module: Plastic base plate 60 mm x 30 mm with super-transparent surface, mechanically very robust
Solar cell: Monocrystalline solar cell 52 x 26 mm

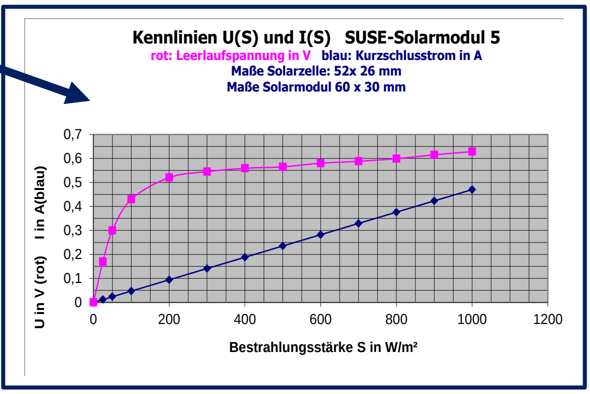
Technical data with an irradiation of 1000 W/m², T = 25°C, AM = 1.5

Physical value	Symbol	Numerical value	Physical unit	Annotations
Dimensions of the solar cell		52 x 26	mm	Monocrystalline cell
Open circuit voltage	V_{oc}	0,63	V	Typical for silicon
Short-circuit current	I_{sc}	0,468	A	Proportional to light intensity S
El. power	P	0,228	W	With solar spectrum, AM 1.5
Efficiency factor	η	17,0	%	Efficiency factor of the energy conversion
Filling factor	FF	77,3	%	FF is a quality feature
Current density	j	34,7	mA/cm²	j is a quality feature
Thermal behaviour open circuit voltage U_{oc}		- 0,36	% /K	The voltage decreases with an increase in temperature with 0.36% per 1K
Thermal behaviour short-circuit current I_{sc}		+ 0,06	% /K	The short-circuit current increases with 0.06 % per 1K
Voltage at MPP	V_{MPP}	0,52	V	**MPP= Maximum Power Point**
Current at MPP	I_{MPP}	0,44	A	The product of both values is the el. power.
Power at MPP	P_{MPP}	0,23	W	



The I(V) and the P(V) characteristic curves
Recorded at the ISFH characteristic curves lab

The V(S) (pink) and I(S) (blue) characteristic curves
The characteristic curves show the dependency of the open circuit voltage V and the short-circuit current I on the irradiance S (Light intensity)
0 = absolute darkness
1000 = bright sunshine in the summer half-year with deep blue sky



The red I(V) characteristic curve shows the dependency of the solar cell current on the solar cell voltage with a resistive load of the solar cell. The intersection point with the x-axis is the open circuit voltage of the solar cell (0.63 V), the intersection point with the y-axis is the short-circuit current (0.468 A).
The power curve P(V) (blue) shows the maximum power point (MPP) = 0.23 W at the highest point.