leXsolar-SmartGrid Professional

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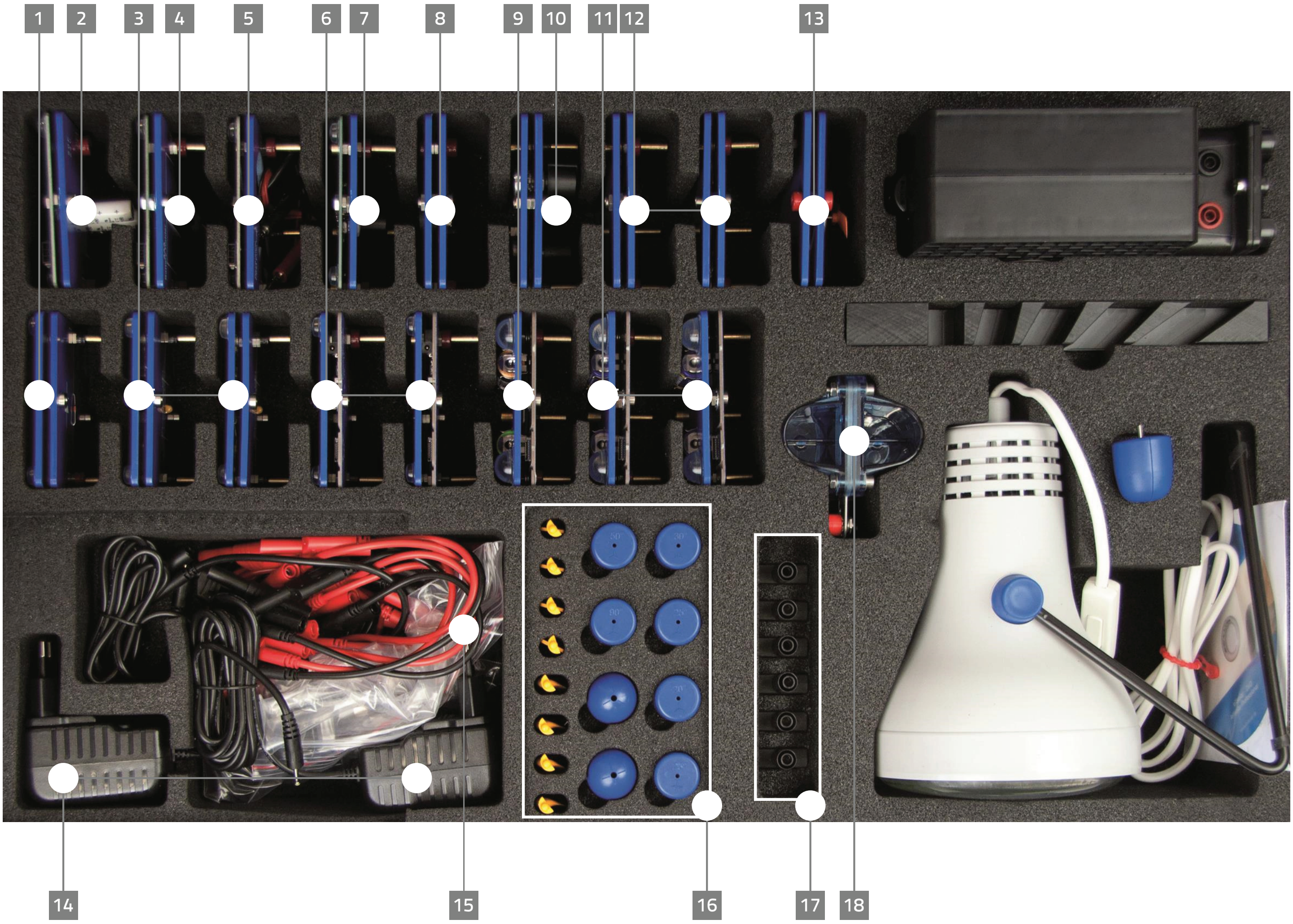
Layout diagram leXsolar-SmartGrid Professional

Item-No.1607

Bestückungsplan leXsolar-SmartGrid Professional

Art.-Nr.1607



- **1** 1118-05 Diode module Pro
  1118-05 Diodenmodul Pro
- **2** 1118-11 Capacitor module Pro
  1118-11 Kondensatormodul Pro
- **3** 2x1607-01 Grid module Pro
  2x1607-01 Stromnetzmodul Pro
- **4** 1800-08 Battery module holder 1xAAA Pro with 1801-06 LiFePo-battery AAA
  1800-08 Akkuhalterungsmodul 1xAAA Pro mit 1801-06 LiFePo-Akku AAA
- **5** 1800-12 Fuel cell holder Pro with 18
  1800-12 Halterung Brennstoffzelle Pro mit 18
- **6** 2x9100-05 PowerModule with 14
  2x9100-05 PowerModule mit 14
- **7** 1118-13 MPP-Tracker Pro
  1118-13 MPP-Tracker Pro
- **8** 1118-03 Wind turbine module with 25
  1118-03 Windturbinenmodul Pro mit 25
- **9** 9100-03 AV-Module
  9100-03 AV-Module
- **10** 1100-62 Potentiometer module 110 Ohm Pro
  1100-62 Potentiometermodul 110 Ohm Pro
- **11** 2x9100-04 SmartMeter
  2x9100-04 SmartMeter
- **12** 2x1118-01 Light bulb module Pro
  2x1118-01 Glühlampenmodul Pro
- **13** 1118-02 Motor module with L2-02-017 Yellow propeller
  1118-02 Motor module mit L2-02-017 Luftschraube (Propeller) gelb
- **14** 2xPower supply for 6
  2xStromversorgung für 6
- **15** 5xL2-04-066 Safety test lead 25 cm, red
  4xL2-04-067 Safety test lead 25 cm, black
  4xL2-04-059 Safety test lead 50cm, red
  4xL2-04-060 Safety test lead 50 cm, black
  5xL2-04-066 Sicherheitsmessleitung 25 cm, rot
  4xL2-04-067 Sicherheitsmessleitung 25 cm, schw.
  4xL2-04-059 Sicherheitsmessleitung 50 cm, rot
  4xL2-04-060 Sicherheitsmessleitung 50 cm, schw
- **16** 1400-12 leXsolar-Wind rotor set
  1400-12 leXsolar-Windrotoren
- **17** 6xL2-05-068 Safety short-circuit plug
  6xL2-05-068 Sicherheits-Kurzschlussstecker
- **18** L2-06-067 Reversible Fuel cell
  L2-06-067 Reversible Brennstoffzelle

Version number
Versionsnummer
L3-03-171_20.11.2015

CE RoHS2

Layout diagram leXsolar-SmartGrid Professional

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Bestückungsplan leXsolar-SmartGrid Professional

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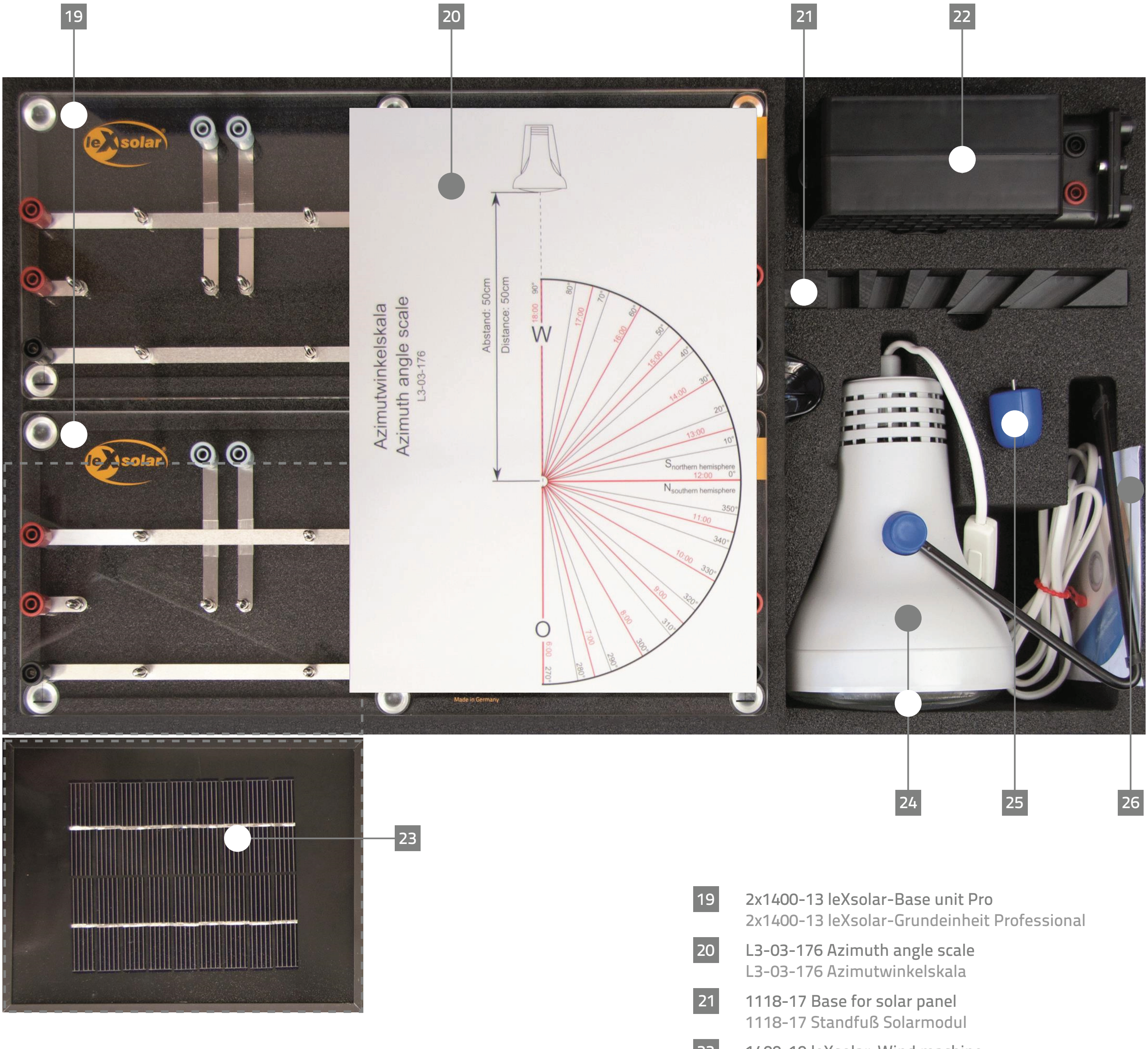

19	2x1400-13 leXsolar-Base unit Pro 2x1400-13 leXsolar-Grundeinheit Professional
20	L3-03-176 Azimuth angle scale L3-03-176 Azimutwinkelskala
21	1118-17 Base for solar panel 1118-17 Standfuß Solarmodul
22	1400-19 leXsolar-Wind machine 1400-19 leXsolar-Winderzeuger
23	1100-04 Solar panel 5.22 V, 380 mA 1100-04 Solarmodul 5.22 V, 380 mA
24	L2-04-080 Lamp housing with L2-04-116 Illuminant 120W L2-04-080 Lampengehäuse mit L2-04-116 Leuchtmittel 120W
25	Wind turbine module with 8 Windturbinenmodul Pro mit 8
26	L3-03-081 leXsolar-DVD Pro L3-03-081 leXsolar-DVD Pro

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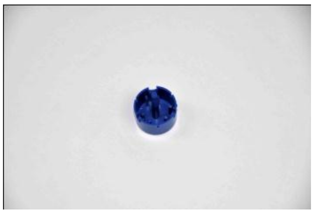
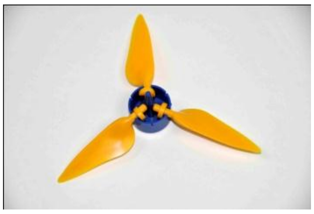
Wind rotor set 1400-12

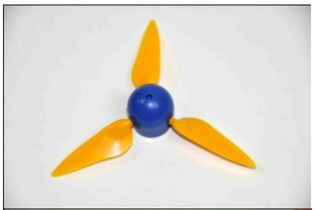
With the available components, rotors with 2, 3 or 4 blades and with a flat or an optimized profile can be created. There is a hub for 4 blades with a pitch angle of 25° and hubs for 3 blades with pitch angles of 20°, 25°, 30°, 50° and 90°. To assemble you should proceed in the following way:



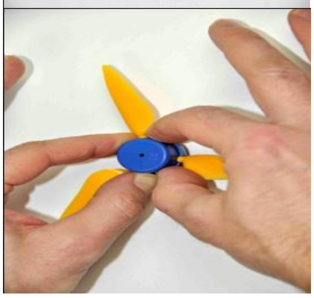
First, a hub with the desired rotor blade pitch and the number of blades should be selected. (The hubs are labelled on the back.) The Two-blade rotor and the Four-blade rotor can both be constructed with the Four-blade hub.



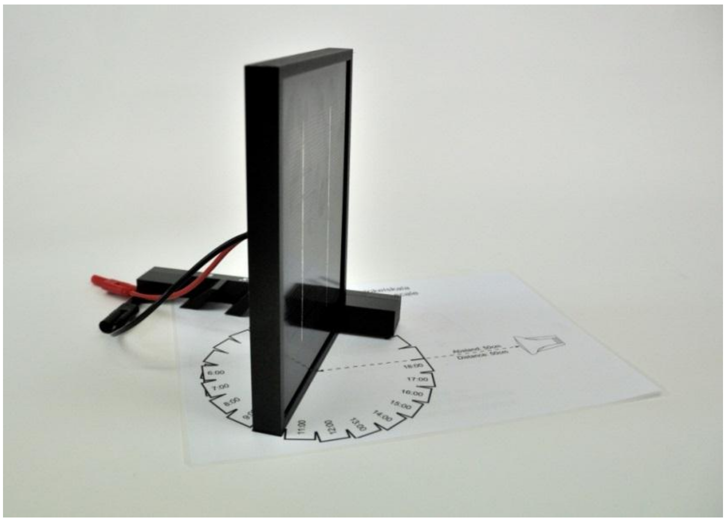
After that, the rotor blades are installed. During the insertion of the blades, make sure that they are installed with the rounded side up.



After installation of the rotor blades, the hub-cap will be mounted and lightly pressed against the hub.

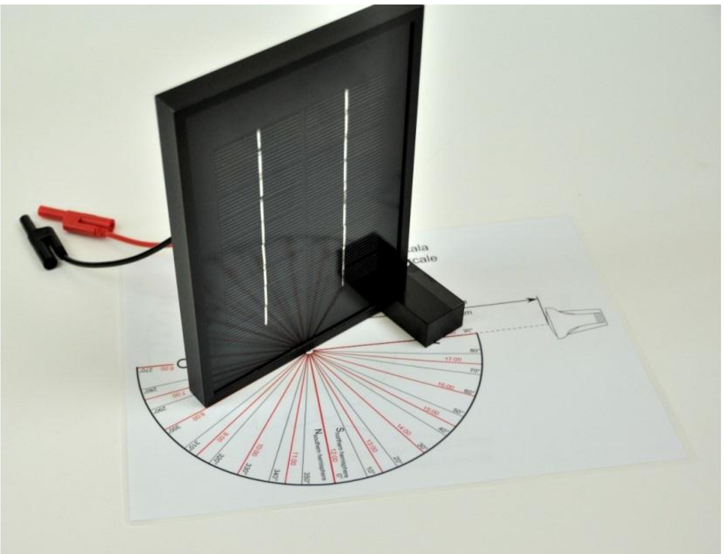


To replace the blades, a small nose is located on the head of the hub. If the nose is pressed lightly on a hard surface, the hub-cap can be removed easily.



Solar module in 10 o’clock position

With the azimuth angle scale it is possible to set up the azimuth angle between the solar module and the lamp. On one page there are rectangles arranged in a circle and labelled with corresponding times of day. If the solar module is placed in a certain rectangle, the azimuth angle is set up for the chosen time of day. For example, in the alongside figure the solar module is arranged in the 10 o’clock position.

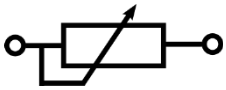


Solar module in 8 o’clock position

The second page can be used for a more exact configuration of a specific azimuth angle. The angle is set up, when the leading edge of the solar module is located at the corresponding line.
In the alongside figure the solar module is arranged in an azimuth angle of 300°. On both scales the position of the lamp is marked. The distance between the lamp and the center of the solar module has to amount to at least 50 cm.
The center of the solar module has to be located at the center of the angle scale.

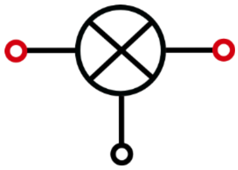
Advice: The azimuth angle scale does not name the deviation angle of the solar module concerning the south, but name the azimuth angle of the sun in the astronomic meaning! In the experiment is assumed that the solar module is aligned to south (optimal direction). Therefore the used azimuth angle is not the term used in solar engineering, where 0° describe an aligned solar module to the south (-90° to the east, +90° to the west).

Potentiometer module 1100-62



The potentiometer module holds a 0-10-Ω-potentiometer and a 0-100-Ω-potentiometer. Both are serially conneted, so that the potentiometer can attain resistances between 0 Ω bis 110 Ω. The measuring error amounts to 0.5 Ω for the small resistor and 5 Ω at other one.

Light bulb module 1118-01

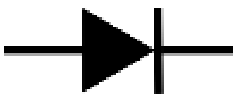


The light bulb module acts as a consumer in SmartGrid experiments.

<u>Specifications:</u>

Light bulb P_{typ} = 200 mW (at 3.5 V)
Fuses work up to maximum voltage of 6 V

Diode module 1118-05



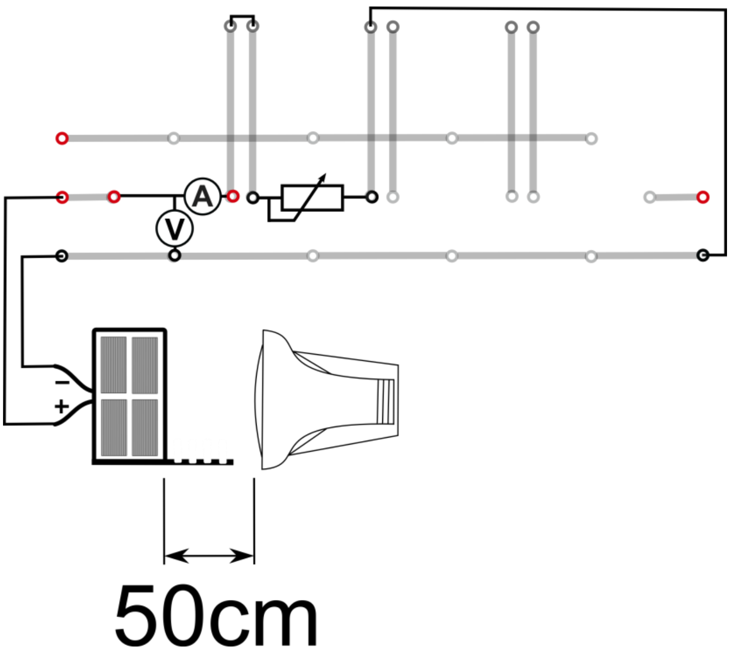
The diode module is used to avoid a return current to the wind turbine in SmartGrid experiments with many voltages sources. Without the diode the turbine could act as a motor.

1.1 The I-V-characteristic of a solar module

Task

Measure the I-V-characteristic of the solar module.

Setup



Equipment

- Base unit
- Lamp
- Solar module
- AV-Module
- Potentiometer
- Cables and short circuit plugs

Procedure

1. Set up the experiment according to the circuit diagram. Set the maximum resistance on the potentiometer. Arrange the solar module vertically in front of the lamp in a distance of 50 cm so that it will be illuminated entirely. The lamp should be aligned horizontally.
2. Switch on the lamp and measure voltage and current. Decrease the resistance of the potentiometer and measure further voltage and current values. You will measure useful values, if you note the values after a variation of 20 mA of current or a variation of 0.5 V of voltage. Measure the open circuit voltage and the short circuit current as well.
3. Calculate the power of the module for each measuring point.

1.1 The I-V-characteristic of a solar module

Measured values

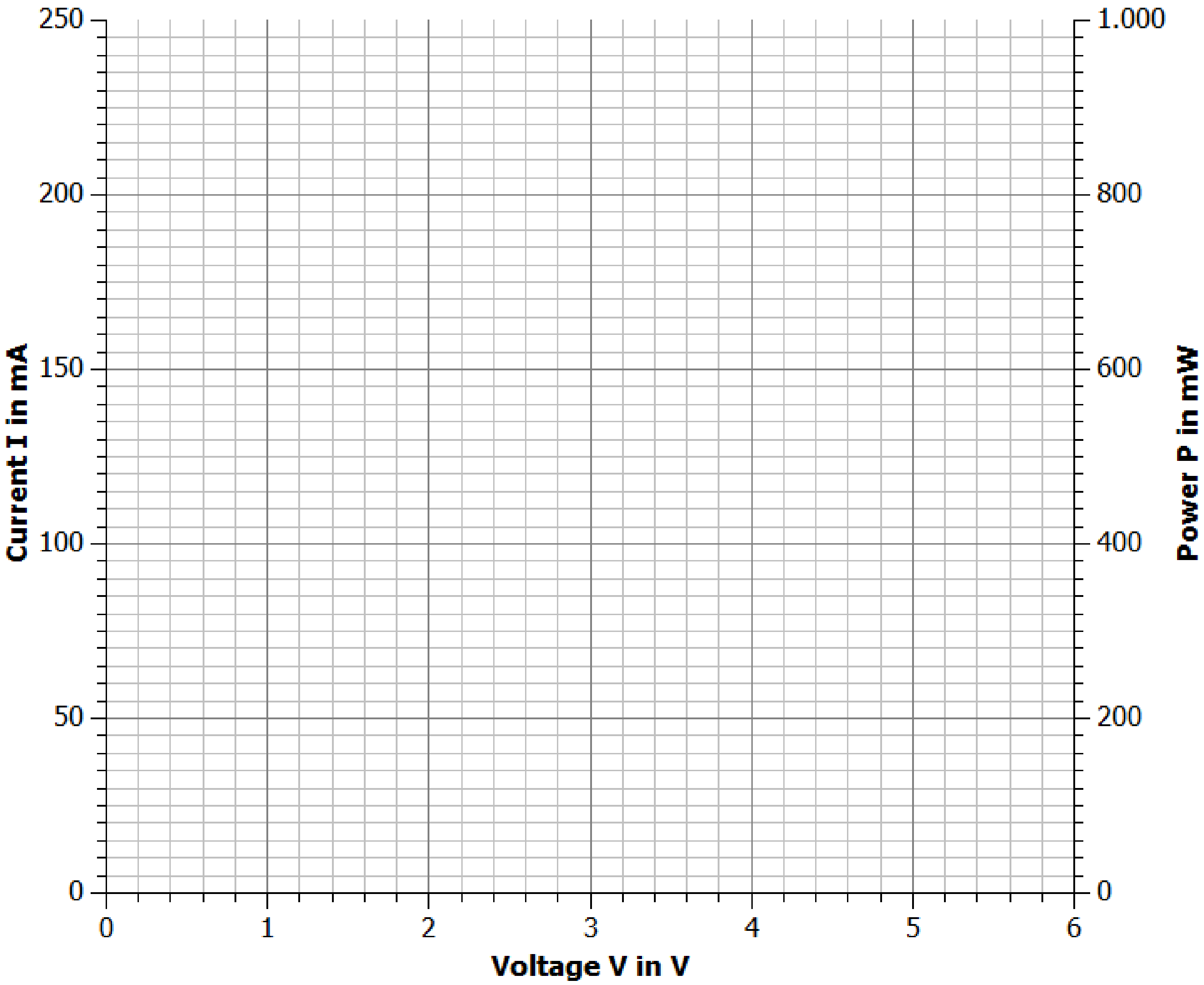
V in V										
I in mA										
P in mW										

V in V										
I in mA										
P in mW										

Evaluation

1. Plot your measuring points in the I-V- and V-P-diagram and draw the according curves.

I-V- and V-P-characteristic of the solar panel



1.1 The I-V-characteristic of a solar module

2. Describe the behavior of the curves.

3. Draw the I-V-characteristic of a 10 Ω- and a 100 Ω-resistance into your diagram. Explain the meaning of the intersection points between the characteristic curves of the solar module and the resistances.

4. Evaluate the voltage and energy output of the solar module depending on the connection of a certain consumer.

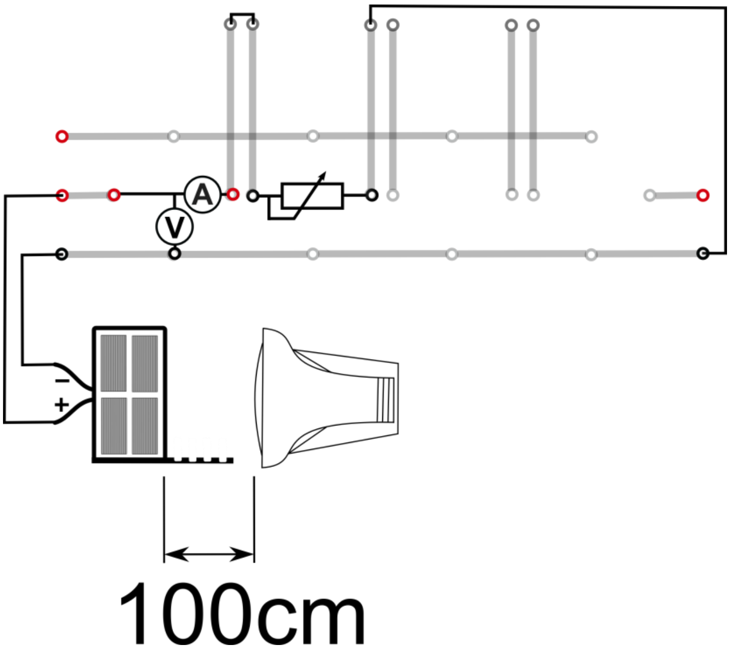
5. Calculate the resistance, which generates the highest power of the solar module.

1.2 The I-V-characteristic of a solar module depending on the illuminance

Task

Measure the I-V-characteristic of the solar module with a lower illuminance as in experiment 1.1.

Setup



Equipment

- Base unit
- Lamp
- Solar module
- AV-Module
- Potentiometer
- Cables and short circuit plugs

Procedure

1. Set up the experiment according to the circuit diagram. Set the maximum resistance on the potentiometer. Arrange the solar module vertically in front of the lamp in a distance of 100 cm so that it will be illuminated entirely. The lamp should be aligned horizontally.
2. Switch on the lamp and measure voltage and current. Decrease the resistance of the potentiometer and measure further voltage and current values. You will measure useful values, if you note the values after a variation of 20 mA of current or a variation of 0.5 V of voltage. Measure the open circuit voltage and the short circuit current as well.
3. Calculate the power of the module for each measuring point. Calculate the power of the solar module for each measuring point.

1.2 The I-V -characteristic of a solar module depending on the illuminance

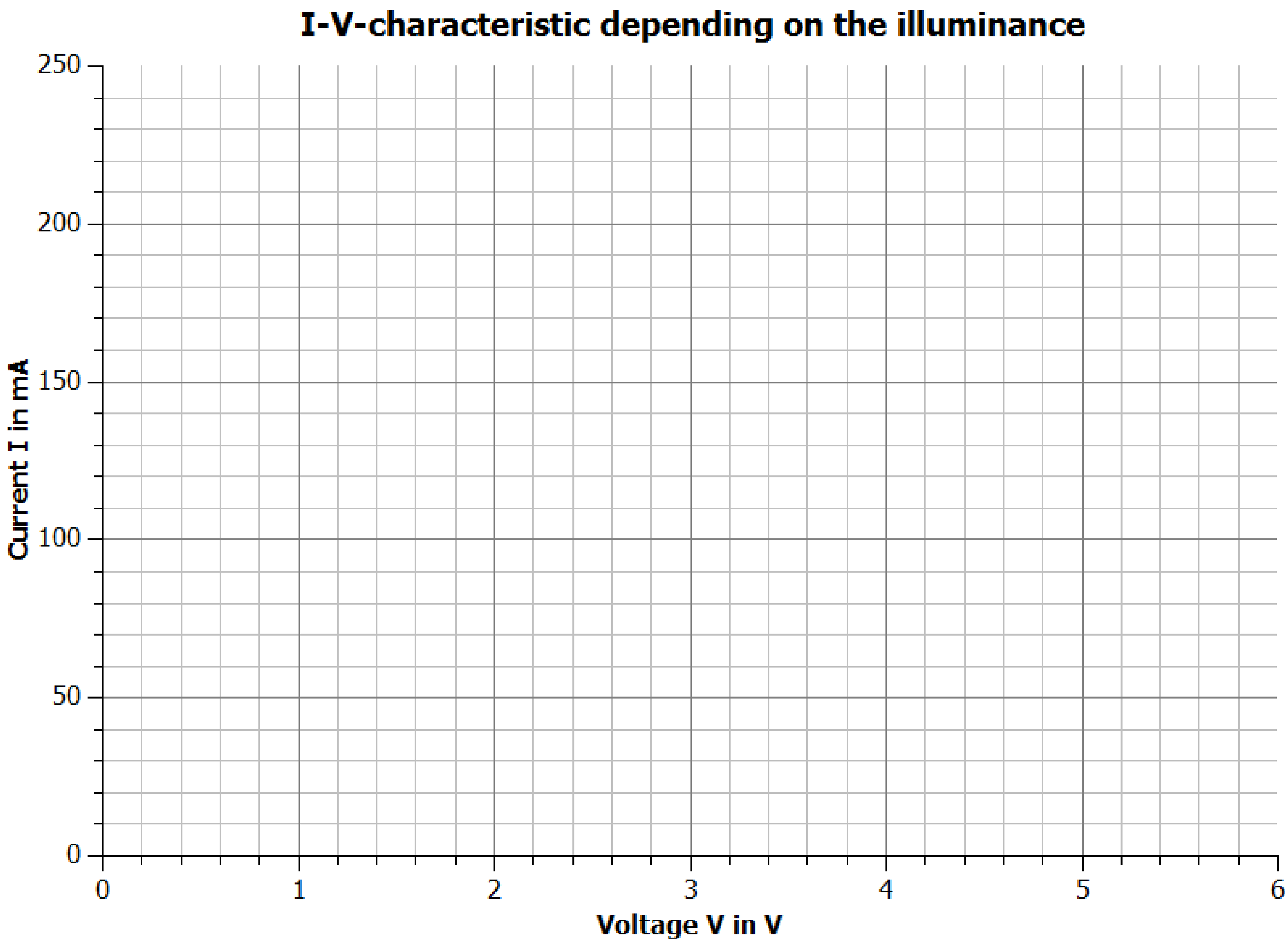
Measured values

V in V								
I in mA								
P in mW								

V in V								
I in mA								
P in mW								

Evaluation

1. Plot your measuring points in the I-V-diagram and the V-P-diagram. Add the measuring points of experiment 1.1.



4.1 The power fluctuations of a photovoltaic station

Task

Measure the power graph of a photovoltaic station (of the solar module) during a simulated day.

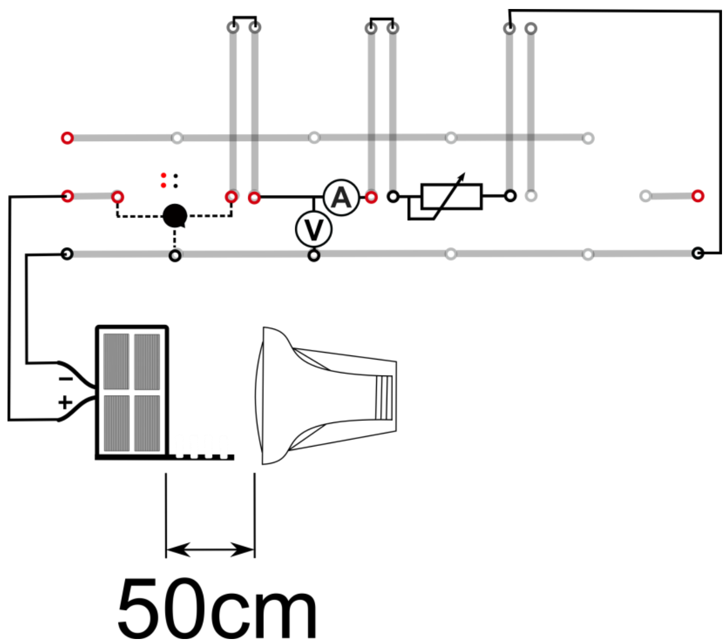
Primary notes

In this simulation the solar module represents a photovoltaic station and the lamp simulates the sun. In reality the sun is moving in the sky and permanently changes the angle of incidence respective to the photovoltaic station. In this simulation we are not going to move the lamp. Instead we are going to rotate the solar module by using the azimuth angle scale. In this way we get a better measurement accuracy.
Take care, that you do not stand to close to the light beam. Shadings and reflections can affect the results.

Equipment

- Lamp (sun)
- Solar module with base 0° (photovoltaic station)
- MPP-tracker
- AV-Module
- Potentiometer module 20 Ω (consumer)
- Cables and short circuit plugs
- Azimuth angle scale

Setup



4.1 The power fluctuations of a photovoltaic station

Procedure

1. Set up the experiment according to the circuit diagram. Stick the solar module into the base with an angle of 0° and adjust it with an angle of 270° on the azimuth angle scale. Arrange the lamp vertically in front of the solar module in a distance of 50 cm. The lamp should be aligned horizontally. Set a resistance of 20 Ω on the potentiometer.
2. Switch on the lamp. Use the “MPP-search“-mode of the MPP-tracker and wait until the LED stops blinking. Measure both voltage and current for the different given azimuth angles. For very low irradiances, “MPP search” mode might not work properly. In this case try to find the maximum power by using the control knob. Take care that the MPP-tracker is switched back to “MPP-search“-mode for the next measurement.
3. Calculate the power of the solar module by using the voltage and current measurement values.

Measured values

α in °	270	285	300	315	330	345	0
time	6:00	7:00	8:00	9:00	10:00	11:00	12:00
V in V							
I in mA							
P in mW							

α in °	15	30	45	60	75	90
Time	13:00	14:00	15:00	16:00	17:00	18:00
V in V						
I in mA						
P in mW						

4.1 The power fluctuations of a photovoltaic station

2. Name factors, which influence the power of photovoltaic stations in reality.

3. Evaluate the reliability and the predictability of the energy generation of photovoltaic stations. Compare them with fossil fuel power plants.

4.13 Power line monitoring

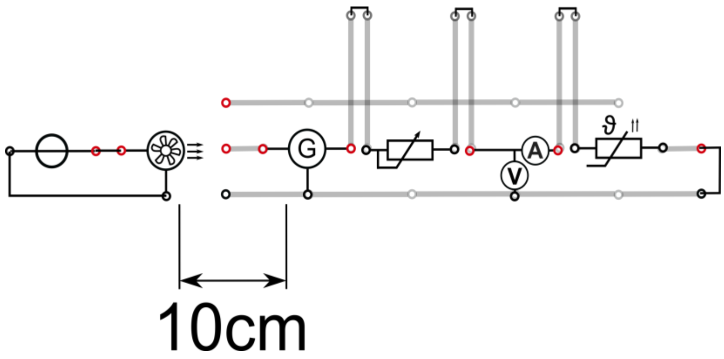
Task

Measure voltage and current on and in an electric cable (grid module).

Primary notes

This experiment simulates a high-voltage line with a high energy flow.
Take care that there are no objects near the wind turbine to avoid injury and falsifying the measurement.
In reality, the high-voltage lines are located between the wind turbines and the consumer. Because of the voltage metering, the electric cable is located behind the consumer.

Setup



Equipment

- Base unit
- PowerModule
- Wind machine
- Wind turbine (wind farm)
- Optimized profile with 25° and 3 blades
- AV-Module
- Grid module (high-voltage line)
- Potentiometer module (Supply center)
- Cables and short circuit plugs
- Clock

Procedure

1. Set up the experiment according to the circuit diagram. There should be a distance of 10 cm between the wind machine and the rotor. The turbine should directly face the wind machine. Set the minimum resistance on the potentiometer to simulate high energy demand.
2. Switch on the PowerModule at a voltage of 6 V. Measure voltage and current of the grid module after 30 s and 60 s. Afterwards, incrase the voltage by 1 V.
3. Repeat the measurement until you reach a voltage of 12 V.
4. Calculate the resistance and the power drain of the grid module.

Measured values

V_{Power} in V	6		7		8		9	
v_{wind} in $\frac{m}{s}$	4		4.7		5.3		6	
	30s	1min	30s	1min	30s	1min	30s	1min
V_{grid} in mV								
I_{grid} in mA								
P in mW								
R in Ω								

4.14 Scenario experiment: Smart Grid

Evaluation

1. With the help of your observations, describe the real processes during the scenarios. Also include excess voltage.

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