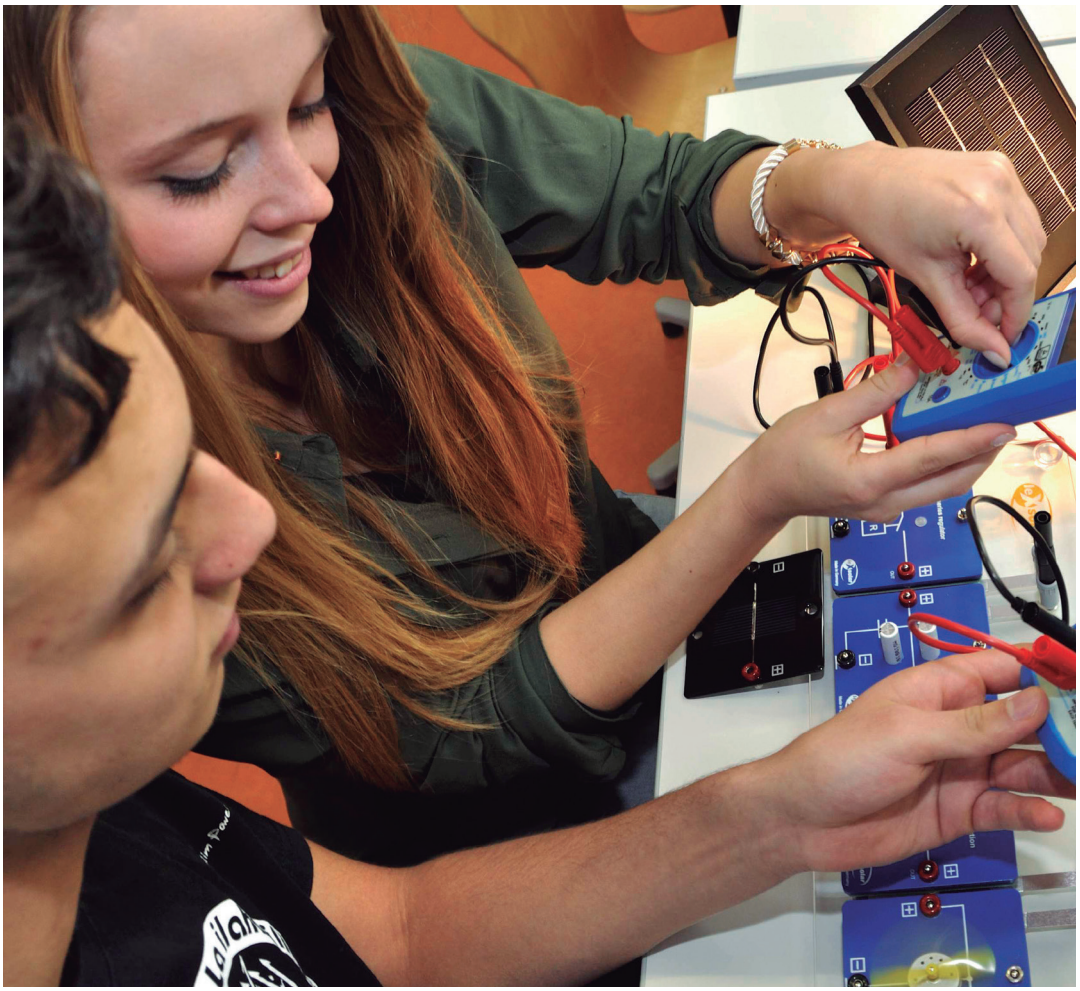
leXsolar-PV Professional



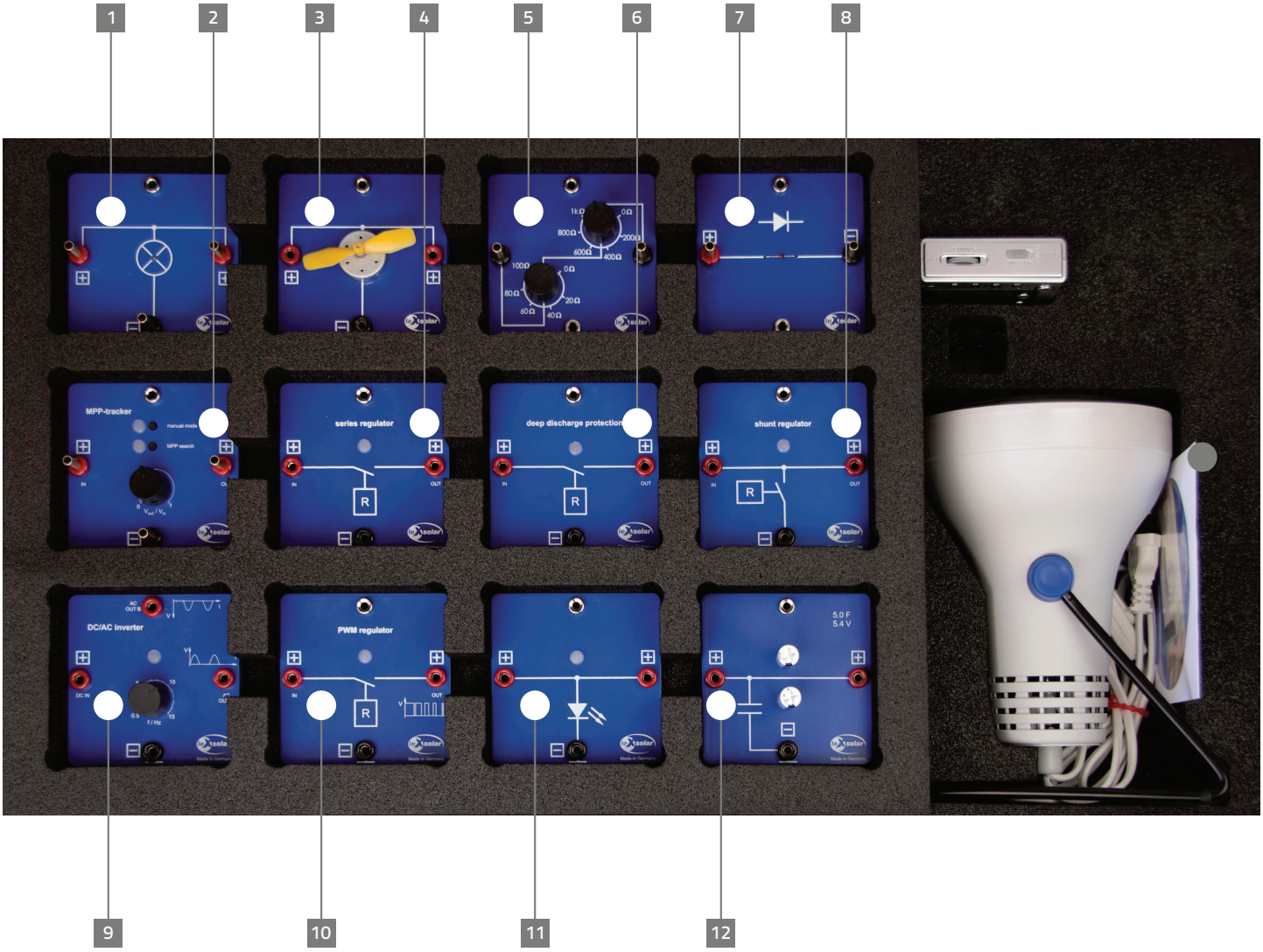
Instructions manual

Layout diagram leXsolar-PV Professional

Item-No.1118

Bestückungsplan leXsolar-PV Professional

Art.-Nr.1118



1 1118-01 Light bulb module Pro
1118-01 Glühlampenmodul Pro

2 1118-13 MPP-Tracker Pro
1118-13 MPP-Tracker Pro

3 1x 1118-02 Motor module Pro with L2-02-017 Propeller
1118-02 Motormodul Pro mit L2-02-017 Propeller

4 1118-10 Series regulator module Pro
1118-10 Serienregler Pro

5 1118-04 Potentiometer module Pro
1118-04 Potentiometermodul Pro

6 1118-07 Deep discharge protection module Pro
1118-07 Tiefentladeschutzmodul Pro

7 1118-05 Diode module Pro
1118-05 Diodenmodul Pro

8 1118-06 Shunt regulator module Pro
1118-06 Shunt-Regler-Modul Pro

9 1118-12 DC/AC-inverter module Pro
1118-12 DC/AC-Inverter Pro

10 1118-15 PWM regulator Pro
1118-15 PWM-Laderegler Pro

11 1118-08 LED module high brightness Pro
1118-08 LED-Modul superhell Pro

12 1118-11 Capacitor module Pro
1118-11 Kondensatormodul Pro

Version number
Versionsnummer

L3-03-181_07.06.2017

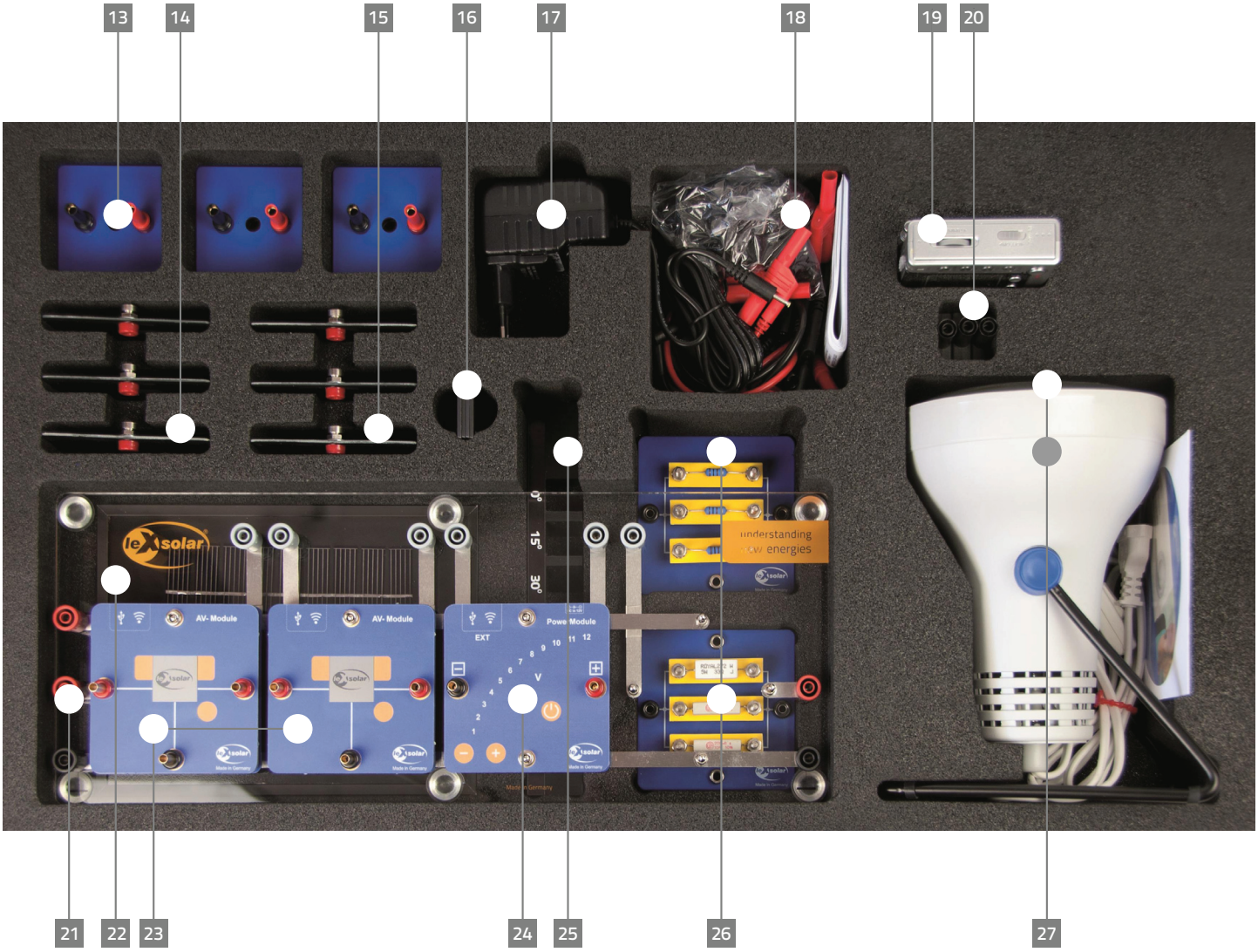
CE RoHS2

Layout diagram leXsolar-PV Professional

Item-No.1118

Bestückungsplan leXsolar-PV Professional

Art.-Nr.1118



13 3x 1100-20 Lighting module with 3xL2-05-035/036 Safety sockets
3x 1100-20 Beleuchtungsmodul Pro mit 3xL2-05-035/036 Sicherheitsbuchsen

14 3x 1100-02 Solar module 0,5 V, 840 mA
3x 1100-02 Solarmodul 0,5 V, 840 mA

15 3x 1100-01 Solar module 0,5 V, 420 mA
3x 1100-01 Solarmodul 0,5 V, 420 mA

16 1100-29 Solar cell cover set
1100-29 Satz Abdeckung f. Solarzelle

17 Power supply for 25
Stromversorgung für PowerModule für 25

18 4xL2-04-066/3xL2-04-067 Test lead red/black 25 cm
2xL2-04-059/1xL2-04-060 Test lead red/black 50 cm
4xL2-04-066/3xL2-04-067 Messleitung rot/schw. 25 cm
2xL2-04-059/1xL2-04-060 Messleitung rot/schw. 50 cm

19 1118-16 Radio module Pro
1118-16 Radiomodul Pro

20 3xL2-05-068 Safety short-circuit plug
3xL2-05-068 Sicherheits-Kurzschlussstecker

21 1400-13 leXsolar-base unit Professional
1400-13 leXsolar Grundeinheit Groß

22 1100-04 Solar module 5.22 V, 380 mA
1100-04 Solarmodul 5.22 V, 380 mA

23 2x9100-03 AV-Modul
2x9100-03 AV-Modul

24 9100-05 PowerModul
9100-05 PowerModul

25 1118-17 Base for solar panel
1118-17 Standfuß Solarmodul

26 2x 1800-01 Resistor module (triple) Pro with
3x 1800-04 Resistor plug element 100 Ohm
2x 1800-05 Resistor plug element 10 Ohm
1x 1800-06 Resistor plug element 33 Ohm
2x 1800-01 Widerstandsmodul 3-fach Pro mit
3x 1800-04 Widerstands-Steckelement 100 Ohm
2x 1800-05 Widerstands-Steckelement 10 Ohm
1x 1800-06 Widerstands-Steckelement 33 Ohm

27 L2-04-080 Lamp housing with L2-04-093 Illuminant 80W
L2-04-080 Lampengehäuse mit L2-04-093 Leuchtmittel 80W

CE RoHS2

leXsolar-PV Professional

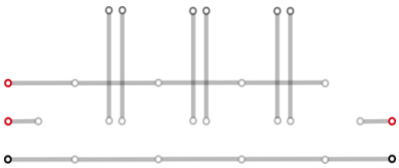
Instructions manual

1. General Information

1.1 Components

The following part contains information about the components of the experimental system. There is sketched a photograph and a small pictogram how the modules are displayed in the experimental setup. Furthermore you get information about the handling of the components.

Base unit



Solar module, small

Specifications:
V=0.5 V
I=420 mA

Solar module, large

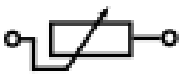
Specifications:
V=0.5 V
I=840 mA

Solar module, extra large

Specifications:
V=5 V
I=420 mA

Diode module

Potentiometer module

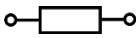


Radio module

Resistor plug module (triple) with resistor plug elements

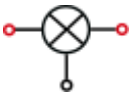
The following resistor plug elements are included:

2 x R=10Ω
1 x R=33Ω
3 x R=100Ω



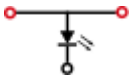
Light bulb module

The light bulb module starts lighting at a voltage of about 0.5V. However, the light bulb is more glowing, than lighting very bright. For an optimum visibility the light bulb should be shaded from other light sources.



LED module

The LED module corresponds to a LED lamp in a real solar off-grid system. For efficiency reasons nearly exclusively LEDs are used in such systems.

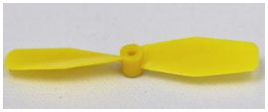


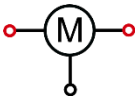
Motor module

Starting current I=20mA

Starting voltage V= 0.4V

Running voltage V=0.4V…12V





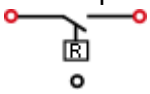
Capacitor module

Specifications:

Double module:	Single module:
V=5.4 V	Internal resistance R < 34mΩ
C=5.0F	Max. current I=10A

Deep discharge protection

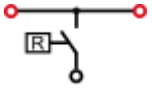
A deep discharge protection is a device that protects an accumulator from dropping below the minimum charging voltage. Deep discharge is harmful for many types of accumulators; especially for lead accumulators, that are often used in off-grid systems; and leads to a drastic increase of their lifetime. In real systems the deep discharge protection is integrated in the charge control, but in this experimental system both devices are divided due to didactic reasons. The



leXsolar deep discharge protection is a so called two-level controller that disconnects the consumer from the accumulator when the loading voltage is dropping below 2.8V. Only when the accumulator is charged again up to 3.16V, the consumer is switched on. The control LED is lighting, as long as the consumer is switched on.

Shunt-regulator

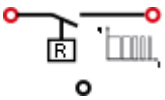
The shunt-regulator is a charge controller that short circuits the input voltage when reaching the charge end voltage to protect the accumulator from overload. It is a two-level controller with an upper switching threshold of 4.2V and a lower switching threshold of 3.6V. The working principle of the control LED is identical to the series regulator. Before starting the experiment, the capacitor should be



loaded up to 2V to ensure the correct operation of the control LED.

PWM-regulator

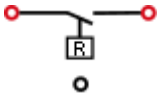
So called pulse width modulators do not load the accumulators continuously but with pulses of fixed frequency and different length. The ratio of pulse duration and pulse period – the so called duty cycle – determines how fast the accumulator is loaded. With this process one can ensure that the accumulator is kept on its maximum capacity as long as no consumer is connected. The advantage over the



two-level regulators is that the loading voltage is not dropping to the lower switching threshold. The leXsolar PWM-regulator has two operating modes: Until a loading voltage of 3.7V the PWM regulator fully interconnects the input voltage. Accordingly it begins to pulse and reduces the duty voltage until a constant loading voltage of 4.1V is adjusted. The control LED is lighting as long as the PWM-regulator is loading.

Series regulator

The leXsolar series regulator is a two-level regulator that disconnects the accumulator from the solar module when the charging voltage of 4.1V is reached. When discharging the accumulator the series regulator interconnects the input voltage of the solar module not before dropping below the lower threshold of 3.5V. The control LED is lighting as long as the series regulator is loading.

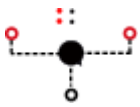


DC/AC inverter module

DC/AC inverters are used to convert the DC voltage of the solar module into an AC voltage to either feed the electricity into the grid or to operate customary domestic appliances in a smart-grid system. The leXsolar DC/AC inverter module does not produce mains voltage but an AC voltage with an amplitude of 2.5V and a variable frequency that can be adjusted with the potentiometer between 0.5 and 15 Hz. To reduce the power dissipation the process of inverting the voltage has been kept on a simple level. Therefore the output voltage is sinusoidal only in a first approximation.

MPP - Tracker

When connecting an arbitrary consumer to the solar module, it will commonly not operate at the MPP (Maximum Power Point) of the module. Therefore, often a part of the solar cell power is lost because of not using the possible maximum power. An MPP-Tracker is a so called DC/DC inverter which can increase or decrease the input voltage. The power as the product of voltage and current remains constant but the operating point can be adapted to a more convenient part of the I-V-characteristic. The leXsolar MPP-Tracker module has two operation modes that can be chosen with pushbuttons. When choosing the “automatic mode” the output voltage is varied in a broad range (LED is blinking) and the operating point with the maximum output power is automatically selected (LED shines continuously). Afterwards, the operating point is slightly shifted, to ensure that the consumer always extracts the maximum power from the solar module (dissipation power is disregarded). When using the “manual mode”, the ratio between output and input voltage can be adjusted manually with the potentiometer and a manual tracking is possible. To reduce the power dissipation of the MPP-Tracker module, it is only possible to reduce the output voltage against the input voltage. This is an advantage when the consumer has a lower internal resistance than the solar module.



PowerModule

The PowerModule is a compact and intuitively usable voltage source. First, the attached power adapter has to be connected to a power outlet and to the top right input jack. The voltage can be chosen with the „+“- and „-“ -buttons and will be displayed by LEDs. When the desired voltage is chosen, the voltage will be applied by using the yellow on/off- button. In case of a short circuit or currents greater than 2 A the PowerModule will switch off immediately.

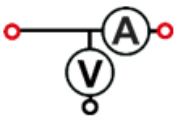
Specifications:

- Output voltage: 0-12 V
- Output power: max. 24 W
- Adjustable in 0.5 V steps
- Overcurrent detection >2 A and automatic shutoff

Input voltage: 110-230 V, 50-60 Hz (with enclosed power adapter)

AV-Module

The AV-Module is a combined voltage and current meter. It holds 3 buttons, whose features are described in the display respectively. By pushing a random button the module will switch on. In the disabled state the display shows the leXsolar emblem. When the display does not show anything or the word „Bat“ is shown, it is necessary to change the batteries in the back (2 x AA batteries 1.2 to 1.5V; Take care of the polarity marked on the bottom of the battery case! Do not touch the button while inserting the batteries).



With the top right button the measuring mode can be switched between voltage mode, current mode or combined voltage-current mode. Both measurement mode and required cable connection will be indicated by the circuit symbols on the display. Take care that in voltage mode no current is applied to the right jack. In the combined mode the voltage can be measured with the right jack as well as with the left one. The influence of the internal resistance of the current measurement is compensated internally. The measured values are signed. When the positive pole is connected to a red jack and the negative pole is connected to the black jack, the value of the voltage will be positive. When current is applied from the left to the right, the current value will be positive, as well. The other way around, the algebraic sign changes.

After 30 min without pushing a button or after 10 min of measuring a constant value, the module will switch off automatically. It can measure voltages up to 12 V and currents up to 2 A. In case of exceeding one of the values, the module interrupts the current flow and shows “overcurrent“ or “overvoltage”. This error message can be confirmed by touching a button. The module will resumes measuring, when the values attain acceptable values.

Specifications:

Voltage metering:
- range: 0...12 V
- accuracy: 1 mV
- automatic shutoff in case of overvoltage >12 V

Current metering:
- range: 0...2 A
- accuracy: 0.1 mA (0...199 mA) und 1mA (200 mA...1 A)
- automatic shutoff in case of overcurrent >2 A
- internal resistance <0.5 Ohm (0...200 mA); <0.2 Ohm (200 mA...2 A)

1

1.2 Handling and safety

Solar module with stand

The solar module is adjusted against the lamp and stabilized with the stand. The minimum distance between the lamp and the solar module should be **25cm**.

The angle of incidence can be varied by means of the stand. The following angles can be adjusted (printed on the stand):

0°,15°,30°,45° und 55°.

The short circuit current of the solar module can be adjusted by the variation of the angle or the distance between lamp and solar module.

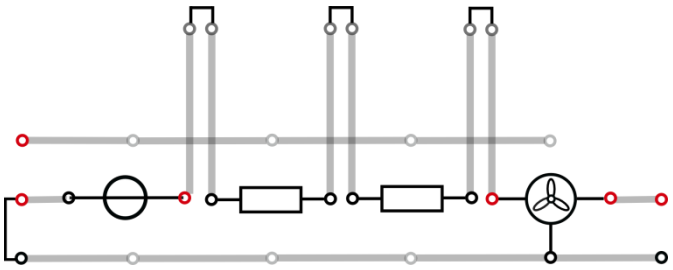
The lamp may become very hot during operation! After using it, the lamp should cool down and not be put back into the case before it is cold enough. Otherwise the foam insert could be damaged.

B.1 Setup of a simple circuit

Task

Set up a simple electrical circuit.

Setup



Required devices

- base unit
- 1 PowerModule (V=5V)
- 1 resistor module, triple
- 2 resistor plug elements (R=100Ω)
- 1 motor module

Execution

1. Set up the experiment according to the circuit diagram. Plug in every resistor module one resistor.
2. Open and close the electrical circuit by:
   a) Plug in/plug off a cable.
   b) Plug in/plug off a current bridge.
   c) Plug in/plug off a resistor
3. Note your observations.

Observation

Evaluation

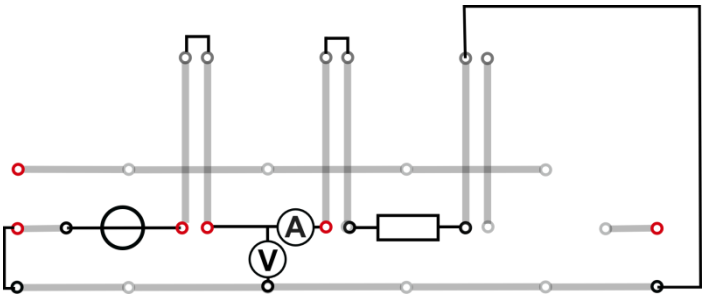
1. Formulate reasons for the behaviour of the motor.

B.2 Ohm`s law

Task

Investigate Ohm`s law with several resistors.

Setup



Required devices

- base unit
- 1 PowerModule
- 1 resistor module, triple
- 3 resistor plug elements (R=100Ω, R=33Ω, R=10Ω)
- 1 AV-Module

Execution

1. Set up the experiment according to the circuit diagram.
2. Measure voltage and current for various resistances:
   - R=100Ω
   - R=33Ω
   - R=10Ω

3. Note your measured data in the table and calculate each the ratio V/I.

Measurement

R (Ω)	100	33	10
V (V)			
I (mA)			
V/I (Ω)			

Evaluation

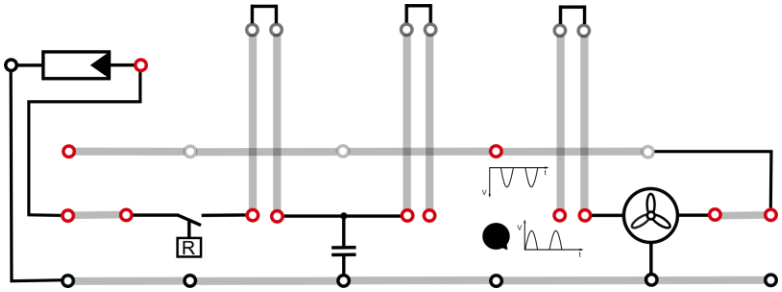
1. Deduce a connection between resistance R and ratio V/I. Which lawfulness can be derived?

11.1 Working principle of a DC/AC inverter module

Task

Determine the working principle of a DC/AC inverter.

Setup



Required devices

- base unit
- 1 solar module
- 1 halogen lamp
- 1 series regulator
- 1 capacitor module
- 1 DC/AC inverter module
- 1 LED module
- 1 lamp module
- 1 motor module

Execution

1. Set up the experiment as shown in the circuit diagram, initially without the DC/AC inverter. Charge the capacitor completely until the charging control LED of the series regulator turns off.
2. Now plug in the DC/AC inverter module and connect the motor module to both outputs of the DC/AC inverter module.
3. Adjust the frequency initially to the minimum (0.5Hz). Observe the behaviour of the motor module.
4. Now slowly increase the frequency, what do you observe?
5. Apply the lamp module and the LED module instead of the motor module. Compare the behaviour of both modules.

Evaluation

1. Describe the behaviour of the motor module and name reasons for this!

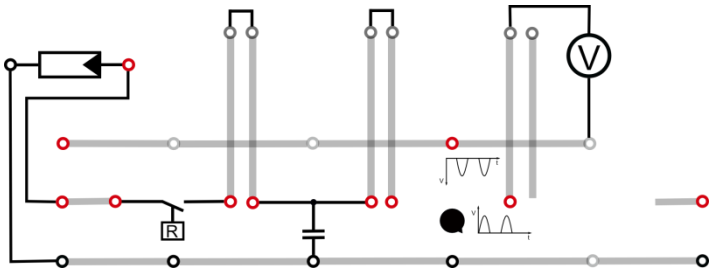
2. What is the difference between the lamp module and the LED module?

11.2 Determination of the output voltage course at the DC/AC inverter

Task

Determine the voltage course at the output of the DC/AC inverter module.

Setup



Required devices

- base unit
- 1 solar module
- 1 halogen lamp
- 1 capacitor module
- 1 DC/AC inverter module
- 1 shunt regulator
- (potentiometer module)
- data logging system and PC

Execution

1. Set up the experiment as shown in the circuit diagram, initially without the DC/AC inverter. Charge the capacitor completely until the charging control LED of the shunt-regulator turns off.
2. Now plug in the DC/AC inverter module and connect the voltage sensor of the data logging system to both outputs of the DC/AC inverter module.
3. Start the data logging and consider the course of voltage. Adjust slowly the frequency of the DC/AC inverter module and observe the course.
4. Record the course of voltage respectively for three frequencies for 10 seconds. (Interval: 50 samples per second)

Addition:

Connect the potentiometer module in series to a current sensor with both outputs of the DC/AC inverter module. Adjust the 1kΩ–potentiometer to the minimum and the 100Ω-potentiometer to the maximum. Record voltage and current with the data logging system.

Evaluation

1. Mark the three measurements at different frequencies in a diagram and calculate the frequencies.

leXsolar GmbH
Strehlener Straße 12-14
01069 Dresden / Germany

Telefon: +49 (0) 351 - 47 96 56 0
Fax: +49 (0) 351 - 47 96 56 - 111
E-Mail: info@lexsolar.de
Web: www.lexsolar.de