Objects of the experiment

1. Investigate the power of a solar cell as a function of the load resistance
2. Compare the optimum load resistance with the internal resistance of the solar cell

Setup

Preparation of Joule and wattmeter for recording the power characteristic

- Connect the Joule and wattmeter to the computer.
- Run the CASSY Lab software.
- To activate the system, left-click on the 4 mm sockets in the OUTPUT field of the “Settings” window..
- Configure the following settings in the “Sensor input settings” window.
  Measured value: Voltage U, measuring range: 0 V - 15 V
  Measurements: Actual values, zero point: left
- Right-click on the measuring instrument “Current I”.
- Configure the following settings in the “Sensor input settings” window.
  Measured value: Current I, measuring range: -0.5 A - 0.5 A
  Measurements: Actual values, zero point: centre
- Click Manual measurement in the “Measurement parameters” window.

Since energy is supplied to the Joule and wattmeter by the solar cell, the current, resistance and power all have negative signs.
If this is a problem for educational purposes, it is possible to make it “invisible” to students.

- In the “Settings” (Parameters/Formulae/FFT) window, set up new variables for resistance R_1 and power P_1.
- Calculate the resistance using the formula $-\frac{U}{I}$ in a measuring range from 0 Ω - 100 Ω and the power using its own formula – P in a measuring range from 0 W - 4 W.
- In the “Settings” (View) window, set up R_1 along the x-axis and P_1 along the y-axis.

Preparation of Joule and wattmeter for measuring open-circuit voltage and short-circuit current

- Connect the solar cell to the sockets labelled *U* and *I*.
- Use the *U, I, P* button to select the measured variables to be voltage in mV or current in mA.

Apparatus

1 Solar module, 10 V/0.3 A	664 431
1 Floodlight lamp, 1000 W, with light shades	450 72
1 Rheostat, 100 ohms	537 34
1 Joule and wattmeter	531 831
1 Stand base, V-shaped, large	300 01
1 Stand rod, 10 cm	300 40
1 Leybold multiclamp	301 01
2 Pairs of connecting leads, 19 A, 100 cm, red/blue	501 46

Additionally required:

1 PC with Windows XP or higher

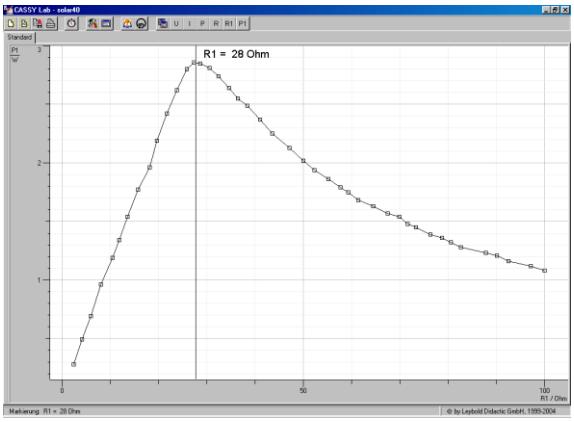
Procedure

- Set up the floodlight lamp about 40 cm from the solar cell.
- Set the load resistance R_1 to 2 Ω (use measuring instrument *R* in CASSY Lab).
- Press the F9 key to start measuring.
- Increase the load resistance in steps of 2 Ω and save the measurement results for each resistance R_1.
- Read off the load resistance R_1 from the graph when the power output of the solar cell is at its maximum.
- With the same amount of illumination, measure the open-circuit voltage U_0 and short-circuit current I_S for the solar cell and calculate the internal resistance R_i.

Remark:

The experiment can be extended to investigate the optimum load resistance when the solar cell is exposed to different levels of light.

Measurement results



U_0 =11 V, I_S = 0.38 A

$$R_i = \frac{U_0}{I_K} = \frac{11\,\text{V}}{0{,}38\,\text{A}} = 29\,\Omega$$

$$R_1 = 28\,\Omega$$

Evaluation

The power output *P* from a solar cell is dependent on the load resistance *R*.

Maximum power is achieved when the load resistance *R* closely matches the internal resistance of the solar cell R_i.

In this experiment, for example, the maximum power output is approximately 2.9 W, which happens when the load resistance is about 28 Ω. The internal resistance calculated for the solar cell is in the region of 29 Ω.

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