

Experiment 9

Shading of solar modules without bypass diode



Even if the shading of a solar module is locally limited, there can be unreasonably high energy yield losses unless bypass diodes are integrated into the modules. The shaded part of the cell behaves like a resistor in a closed circuit. The power converted in the shaded cells can lead to the part of the cell getting warmer. In the worst case this could result in the destruction of individual cells.

Experimental procedure



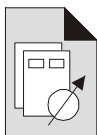
The effect of a missing bypass diode on the output power of a solar module is to be shown. For this purpose, connect two simulators (panel ST 02) in a series connection. One simulator is set to maximum current (1.5 A) (**switch position var., potentiometer max.**). To simulate shading, set the second simulator on a lower current (0.8 A). Remove the connector bridges of the bypass diodes.

Record the characteristic curve of the series connection with the specified variable load. Connect the loads specified below in a series connection. Start measuring in the short-circuit. From 35V onward, select the voltage values yourself.



Attention! Always observe the maximum current load for which the variable load is designed. Before connecting the experimental setup, think about the order of operation.

Panels and devices used:



- ST 02 panel solar module – simulated (2)
- ST 20 Adjustable resistor ca 170 Ohm / 1.7 A
- ST 20 Adjustable resistor ca 15.8 kOhm / 0.17 A
- ST 24 Multimeter (2)

Transfer the measured values to the tables. Calculate the power from current and voltage and transfer the calculated values to the table as well. Then draw both characteristic curves in the diagram prepared for this purpose. The characteristic curve of two unshaded modules is shown in the diagram.

U_s (V)	0	20	30	35							
I_s (A)											
P_s (W)											

Table 1: Measured values of a series connection without bypass diode

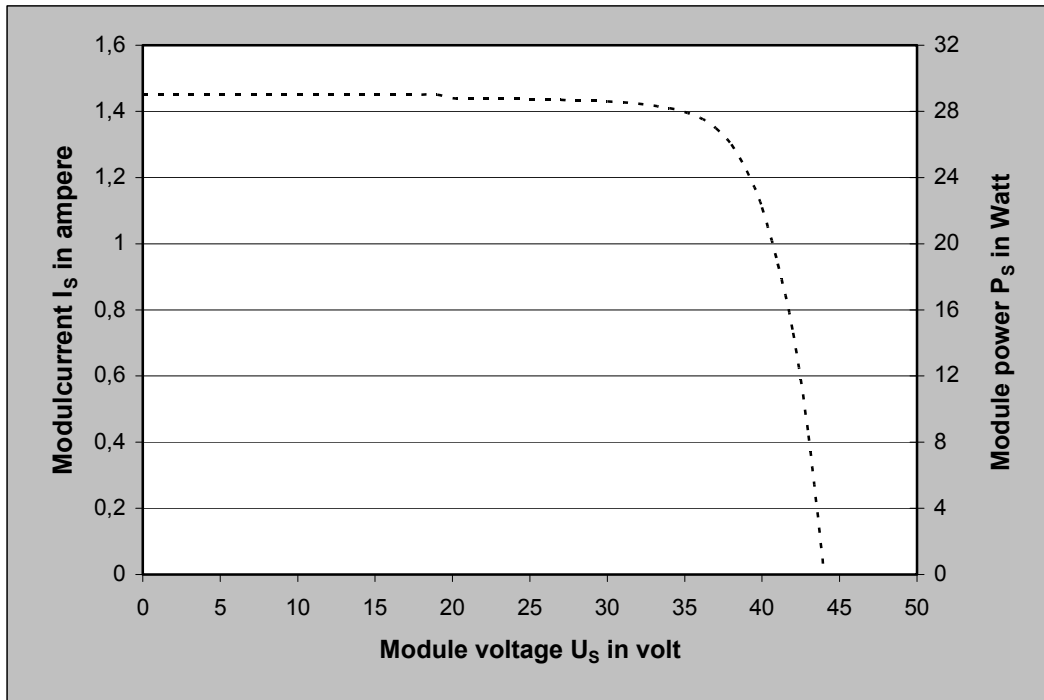


Diagram 1: Series connection of two modules with partial shading (without bypass diode)



Question 1:

How great is the maximum current of this setup? Explain why the current reaches this exact level.

Maximum current: A

Explanation:

Question 2:

What current flows if only one cell is shaded off completely?

Maximum current: A

Explanation:

Question 3:

By what percentage is the power output of the modules lower as compared to the unshaded modules?

approx. %

Solutions for Experiment 9

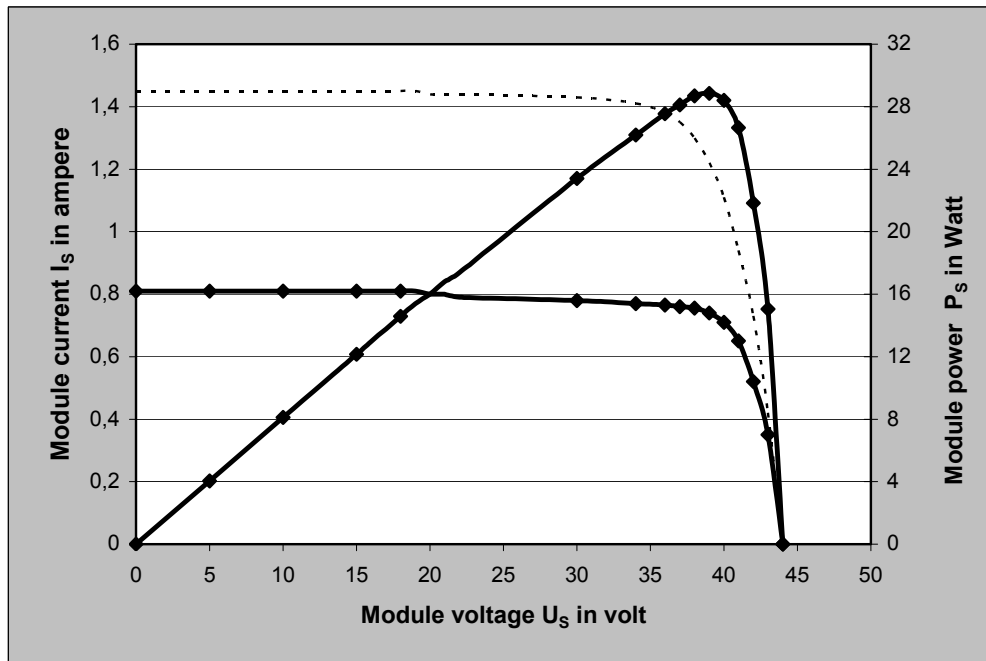


Diagram 1: **Series connection of two modules with partial shading (without bypass diode)**

- Question 1:** In case of a shaded layout without bypass diode, the current depends on the shaded module (in this case: 0.8 A).
- Question 2:** There is no current flowing through the setup (for reasons see answer to question 1).
- Question 3:** Approx. 40%! You can estimate the value from the characteristic curves.