

# ET 250

## Solar module measurements



### Learning objectives/experiments

- physical behaviour of solar modules under a variety of effects
  - ▶ illuminance
  - ▶ temperature
  - ▶ shading
- familiarisation with key parameters
  - ▶ short-circuit current
  - ▶ open-circuit voltage
  - ▶ current at maximum output
  - ▶ voltage at maximum output
- relationship between module inclination, illuminance, short-circuit current and electrical output
- recording a module's current-voltage curve
- determining the efficiency
- connection types for the modules
  - ▶ series connection
  - ▶ parallel connection
- how cells covered by shadow affect the current-voltage curves

### Description

- two pivotable solar modules on mobile frame
- series and parallel connection
- adjustable electrical load
- measuring amplifier for current, voltage, illuminance and temperature
- suitable for sunlight and artificial light
- expandable with the experimental units ET 250.01 and ET 250.02 or with the trainer ET 255

Photovoltaic solar modules convert sunlight directly into electrical current and are therefore an ideal component for renewable energy supply. Typical solar modules from the field of photovoltaics are made of several silicon solar cells connected in series.

The ET 250 trainer contains two such solar modules. The inclination of the modules can be adjusted. Cables can be used to connect the two modules in series or in parallel. A slide resistor simulates varying loads. Thus the slide resistor makes it possible to record current-voltage curves.

The separate measuring amplifier provides displays for all relevant variables. Two power resistors in the measuring amplifier are used to expand the measuring range for measurements at low illuminance. Sensors on the solar module detect illuminance and temperature.

In order to ensure there is sufficient illuminance, the trainer should be operated with sunlight or the optionally available artificial light source HL 313.01.

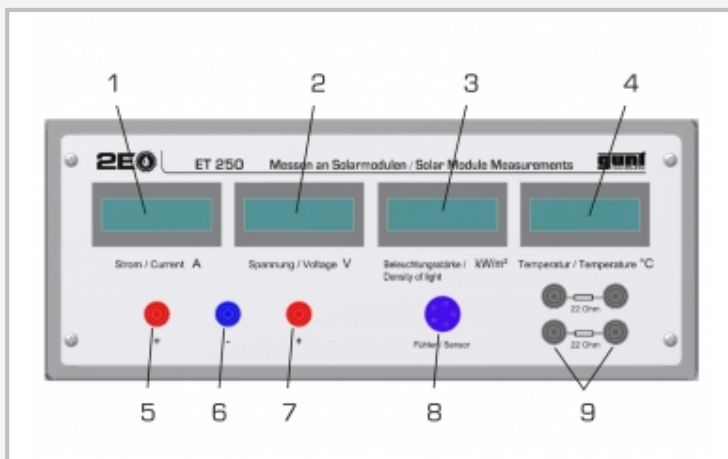
ET 250 can be expanded easily by using ET 250.01 Photovoltaic in grid-connected operation and ET 250.02 Stand-alone operation of photovoltaic modules. The trainer ET 255 Using photovoltaics: grid connected or stand-alone can be used as an alternative to ET 250.01 and ET 250.02 and provides significantly extended experimental possibilities.

# ET 250

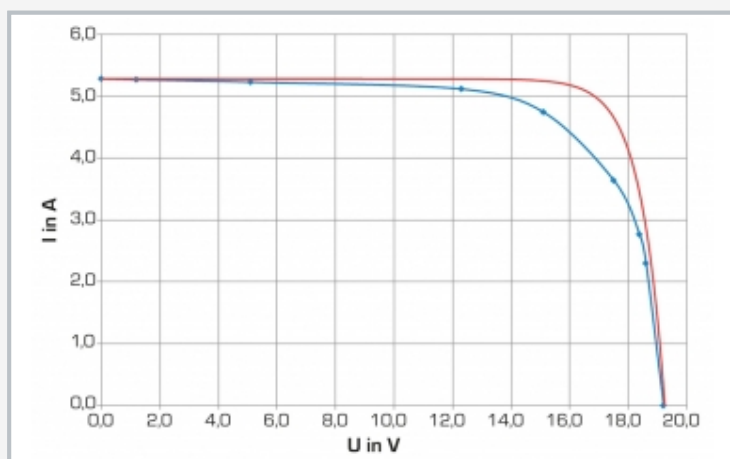
## Solar module measurements



1 slide resistor, 2 power cable, 3 set of cables for parallel and series connection, 4 measuring cable, 5 measuring amplifier, 6 inclination axis, 7 inclinometer, 8 illuminance sensor, 9 temperature sensor, 10 solar modules



Displays: 1 current, 2 voltage, 3 irradiation intensity, 4 temperature; connections: 5 current and voltage, 6 sensors, 7 power resistors



Current-voltage curve of a solar module (module temperature 55°C): theoretical after single diode model (red), measured (blue)

### Specification

- [1] trainer for solar module measurements
- [2] 2 pivoting solar modules on mobile frames
- [3] series and parallel connection options
- [4] slide resistor as variable load
- [5] 2 power resistors for expanding the measuring range
- [6] measuring amplifier with digital displays for current, voltage, illuminance and module temperature
- [7] reference cell as illuminance sensor

### Technical data

#### Module design

- number of cells: 36
- cell material: monocrystalline silicon
- module area: 0,64m<sup>2</sup>

#### Typical module parameters under STC (Standard Test Conditions)

- max. output: 85W
- short-circuit current: approx. 5,3A
- open-circuit voltage: approx. 22V

Slide resistor: 0...10Ω

Two power resistors: 22Ω/50W

#### Measuring ranges

- temperature: 0...100°C
- voltage: 0...200V
- current: 0...20A
- illuminance: 0...3kW/m<sup>2</sup>
- inclination: 0...90°

230V, 50Hz, 1 phase  
 230V, 60Hz, 1 phase  
 120V, 60Hz, 1 phase  
 UL/CSA optional  
 LxWxH: 1400x800x1490mm  
 Weight: approx. 93kg

### Scope of delivery

- 1 trainer
- 1 slide resistor
- 1 measuring amplifier
- 1 set of cables
- 1 inclinometer
- 1 set of instructional material

# ET 250

## Solar module measurements

### Optional accessories

061.25001	ET 250.01	Photovoltaic in grid-connected operation
061.25002	ET 250.02	Stand alone operation of photovoltaic modules
061.25500	ET 255	Using photovoltaics: grid-connected or stand-alone
065.31301	HL 313.01	Artificial light source