„We can make weather“

THE HIGH-LEVEL PHOTOVOLTAIC SIMULATOR PVS FROM SPITZENBERGER & SPIES

The relating standards:
EN 50530
IEC/EN61683
IEC/EN 61727
IEC/EN 62116
VDE 0126-2
IEEE 1547
and many manufacturers test specifications

The amount of generated energy of a solar panel field (and therefore the profitable efficiency) is mainly depending on varying weather conditions like cloudiness and adverse weather situations. To achieve the maximum energy rate at heavy varying irradiation modern intelligent solar inverters are used.

OVERALL EFFICIENCY OF SOLAR INVERTERS

The overall efficiency of solar inverters is tested according to EN 50530.

Compliant testing requires powerful voltage and current sources and analyzer units operating in excellent harmony.

The testing of modern solar inverters requires three main functions of the testing equipment:

1. *Simulation of solar panels for testing solar inverters according to EN 50530*
2. *Generation of typical loads for the anti-islanding tests according to IEC/EN 62116*
3. *Simulation of the connected grid*

Grid-connected photovoltaic systems are feeding the generated energy into the power distribution grid network. The amount of power fed into the grid defines the profitability of the whole solar site. The EN 50530 describes in detail the necessary calculation formulas and testing routines to evaluate the overall efficiency of solar inverters.
Solar inverters must be designed to be able to deal with many different operating conditions. Intensive testing during the development process of inverters as well as during their production is requested.

As a good strategy for a complete test of solar inverters three main tasks have to be carried out:

- simulation of a solar generator and operating the inverter in the MPP (maximum power point), testing of the MPP tracking function, evaluation and calculation of the overall efficiency
- simulation of varying load conditions and different disturbances like transients, harmonics, ripple, cosϕ etc.
- simulation of the connection to the public grid during normal operating conditions as well as during irregular conditions like voltage interruptions, variations and drops

Testing of solar inverters:
- *simulation of the energy generation*
- *MPP tracking testing*
- *simulation of different loads*
- *simulation of electric disturbances*
- *simulation of the public grid connection*

SIMULATION OF THE ENERGY GENERATION:

The generated energy of a solar site is varying in dependency of the intensity of the solar irradiation, partly cloudiness or shading as well as the ambient temperature and pollution of the panel surface. The conversion of the panel-power through the solar inverter should be carried out in the maximum power point(MPP).
To convert always the maximum available energy generated by the solar panels many inverters use a MPP tracking algorithm. This algorithm changes the load condition of the inverter so that the panel field always sees an ideal load and can transfer the maximum available energy.

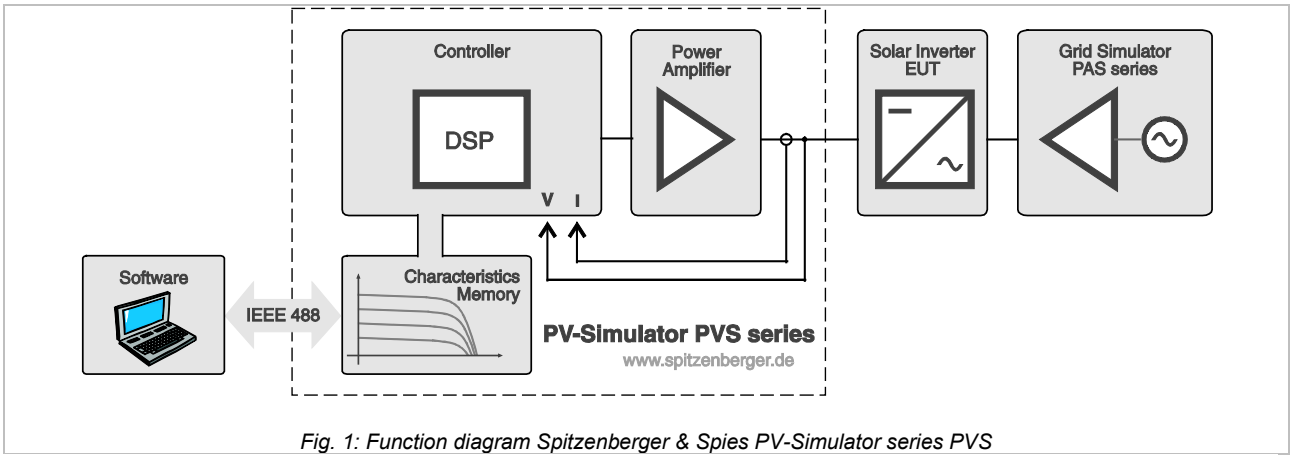

Fig. 1: Function diagram Spitzenberger & Spies PV-Simulator series PVS

The Photovoltaic-Simulator series **PVS** from Spitzenberger & Spies is **the perfect designed DC Source** to reproduce the I/V characteristic curves as required according to **IEC/EN 50530**.

With the PVS solar panels with different technologies can be simulated (e.g. mono-crystalline or poly-crystalline). The provided software package SPS_PVS offers an easy calculation of the necessary I/V characteristic (according to 1- or- 2-diode model). In addition, externally measured and stored characteristics can be imported if they have a CSV-Format.

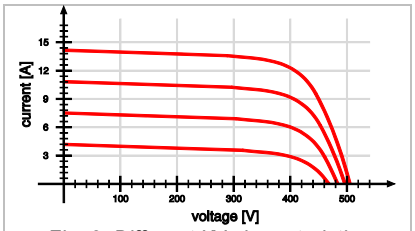

Fig. 2: Different I/V characteristics

The sequence of different characteristics, their duration and transition time is free adjustable. Complete test cycles can be set up easily. The evaluation of measured date ca be done graphically as well as in a numeric format. The evaluation can be stored for documentation.

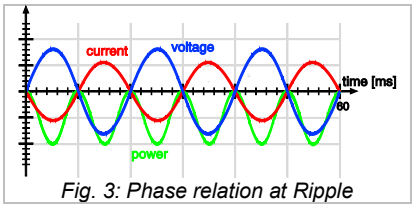

Fig. 3: Phase relation at Ripple

Many (single-phase) inverters are generating a type depending AC ripple on their DC input. The power fed into the grid has a pulse frequency of double the mains frequency (100Hz in Europe).
The inverter consumed power is fluctuating therefore with the same frequency (100Hz in Europe) and produces the described ripple. This ripple is very close to reality conditions, if the dynamic response of the PV simulator is very high.

It is very important, that the simulator power supply is not suppressing this ripple as a result of the voltage adjustment. More and more inverters use the amplitude and phase shift of the ripple voltage and current to achieve a very fast MPP tracking.
This method is much faster than the conventional method “disturb and perturbate”.
Especially at cloudy weather conditions, where the solar irradiation is changing rapidly, a fast MPP tracking algorithm gives a much higher overall efficiency. The number of inverters using this ripple-based MPP algorithm will increase steadily.
PV simulators have to have the ability, to reproduce the according current/voltage characteristic curves at ripple condition very precisely.

For a very precise simulation of the current-/voltage- characteristic a very fast response time of the PV simulator is essential.

While switch-mode amplifiers as the simulator source have a response time of typically 2-3ms, linear working transistor amplifiers have a response time in µs area.
When the PV simulators response time is too slow, the I/V-operating points are no longer located on the I/V-characteristic curve, they circle around the desired MPP area on the characteristic curve *(See application note “Necessity for high-speed PV simulators”)*.
A correct testing and evaluation of the solar inverter compliant to the IEC/EN 50530 is not possible with switch-mode amplifiers.

Above and beyond the IEC/EN 50530 the Spitzenberger & Spies software package offers the possibility to store panel values of solar irradiation and temperature variation in the course of the day.
External data values can be imported, if they have CSV-Format.

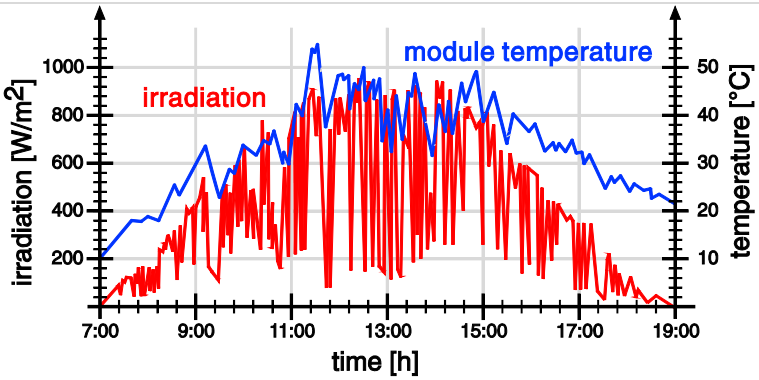

Fig. 4: Daily variation of irradiation intensity and temperature of the solar panel

The long term behavior of solar inverters can be tested with this functionality. Measured data from all locations of the earth can be simulated in laboratory.