Micro-inverters versus conventional (string or central) inverters

A company with over five decades of experience in various sectors, Spitzenberger & Spies GmbH is a firm believer in the mantra: "If there is a better way, we will find it". The company has underlined this with its range of PV applications – as we discover in this technical feature.

The relating standards:

- IEC/EN 50530
- IEC/EN 62116
- VDE 0126-2
- IEEE 1547

Testing possibilities

One of the main advantages of modern micro-inverters in comparison with conventional string – or central-inverters is the advanced efficiency. This efficiency is the result of a different solar system concept: In conventional installations of solar fields the panels are connected in series (as a string) with special DC safety connections. A string-inverter is connected to this panel field. To achieve the maximum available energy harvesting, the inverter is searching for the optimum working point.

This function is called the MPP-Tracking algorithm. The dynamically changing load condition is caused by the variation of the solar position during the day, by cloudy weather conditions and the resulting shadowing and by pollution of the panels. A power loss of the whole system is the result.

Even in the case of a partial disturbance, the whole panel string is affected by the power loss.

Each micro-inverter harvests optimum power by performing maximum power point tracking for its connected panel

This brings us to the two main disadvantages: the initial costs – which are significantly higher than with conventional installations – and the maintenance problem – micro-inverters are mounted on the roof.

On the other hand, no special DC safety connections are necessary for the interconnection between panels and inverter.

The inverter industry meanwhile reacts on the higher initial costs and produces micro-inverters with two independent panel inputs (one micro-inverter for two panels and independent maximum power point tracking on each connected panel).

The calculation of such a system gives nearly the same initial costs than with conventional string inverter installations. One more difference between conventional inverters and micro-inverters is the power rating of the inverter.

Calculation example

A string of 10 panels with 250W power each delivers a string power of 2500W. The power loss of 15% of one panel reduces the overall power to 2125W which is 15% total power reduction.

The same system with micro-inverters gives a different result:

The power loss of 15% of one panel reduces the power of this influenced panel to 212.5W, the others are delivering full power. The system overall performance is reduced only to 2462.5W – this is a power reduction of only 1.5%.

Fast response time

Due to the fast DSP based regulation system, the response time to load changes is very fast.

For the IEC/EN 50530 and the specified MPP tracking algorithm this fast response time is absolutely necessary. ■

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Panel technology

Solar panels produce direct current at a voltage depending on module design and irradiation. Modern panels with six inch cells typically contain 60 cells producing a nominal voltage of 30VDC. The panels are connected in series to produce an array that is effectively a single large panel with a nominal rating of 300 to 600 VDC. To get AC power, the panel string is connected to an inverter, which converts it into standard AC voltage, typically 230VAC/50 Hz in Europe.

The biggest problem with the 'string inverter' design is that the string of panels acts as if it was a single larger panel with a max current rating equivalent to the poorest performer in the string.

Conventional inverters are available in power rating stages (e.g. 2000W, 2500W, 3000W). Due to the rated output of modern panels between 220W and 245W (rarely produced in practice) the micro-inverters are typically rated between 190W and 220W.

This low-power design reliefs the development of micro-inverters, which need no large transformers, no cooling, no large electrolytic capacitors. Additionally, the MTBF is stated in decades and warranties are up to 25 years.

Micro-inverter panel arrays are connected in parallel and produce grid-matching power directly at the panels back. Such arrays are not power limited and can be extended at any time by adding more panels.

The current performance at 30VDC is 24ADC – the nominal power capability therefore is 720W in this example.

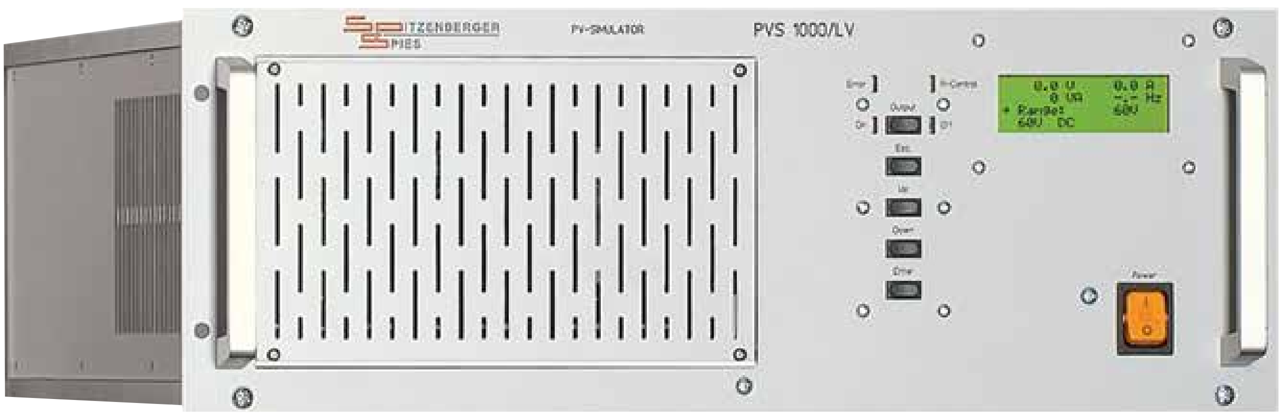
Performance testing of micro-inverters

The Spitzenberger & Spies PV simulator PVS1000/LV makes testing the efficiency of micro-inverters as easy as possible. And, it's absolutely compliant with the requirements according to IEC/EN 50530.

The low-voltage PV simulator has three desired voltage ranges: 37.5VDC, 75VDC and 150VDC to cover a wide range of modern micro-inverters.

With the freely programmable I/V characteristic, different panels and irradiation conditions can be simulated very accurately. The response time to load changes is less than 100µs.

An example of the power performance characteristic of the PVS 1000/LV is given in the diagram (left).



The PV-Simulator reproduces in real-time the behaviour of many different solar panels. The parameters influencing this behaviour in reality are the changing weather conditions, the variation of the irradiation during the day and also local conditions like shadowing and pollution. To simulate this condition, the PVS has a capability for fast control adjustments.