Ultrafast Multi-MPPT
PV Inverter Test Bench

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PV-Lab
Topics

- Inverter Testing – What’s Important?
- Common Problems with PV Array Simulators
- PV Inverter Testing at Bern University of Applied Sciences
- The new Multi-MPPT PV Inverter Test Bench
- Conclusions and upcoming activities

Building “Tiergarten”, home of BFH-TI’s PV lab in Burgdorf, Switzerland.
Inverter Testing – What’s Important?

3 Things needed for Inverter Testing:

- **Precise Measurement Equipment** → No Problem, if you got the Money.

- **Good Quality PV Array Simulator** → This one is trickier than one might think. Let’s hear more about it!

- **Know-how & Experience** → This belongs into another presentation...
Inverter Testing – What’s Important?

**High Speed**
Solar modules have a fast transient response. A good simulator should behave the same way.

**High Stability**
Essential for reproducibility. Because of this, real PV arrays are not suitable for testing.

**Low Noise**
The simulator should not affect the D.U.T. or the measurement equipment. Especially not, if you are measuring the D.U.T.’s electromagnetic interference.
Common Problems with PV Array Simulators

Most commercially available PV Simulators work like this:

Standard programmable power supply (switched mode)

IV curve generation by software option or additional control hardware
Common Problems with PV Array Simulators

Most commercially available PV Simulators work like this:

- **Programmable power supply (switched mode):**
  - 0.0A
  - 0.0V

- **Filter Capacitor:**
  - Output capacitance makes the device slow.

- **Voltage Range:**
  - Many devices work up to only 600 volts.

- **Switching Noise:**
  - Makes EMC measurements impossible.
Common Problems with PV Array Simulators

Many commercially available PV array simulators emulate the DC characteristics of a PV array very well.

Often there are major differences between the AC characteristics of these simulators and the characteristics of a real PV array. Also, such simulators often generate a considerable amount of switching noise which can compromise the measurement.

Conclusion
A cheap way for rudimentary tests of PV inverters. Not suitable for a realistic & reproducible test environment.
Inverter Testing at Bern University of Applied Sciences

- The pv lab of BFH-TI has more than 20 years experience in testing of PV inverters.
- As there were no simulators available in the early nineties, first tests were performed with real PV arrays.
- After having made bad experiences with an industrial simulator, the pv lab developed its own PV array simulator (25 kW) in 1999.
- In 2001, an improved simulator of 20 kW became operational.
- In 2009 the construction of our PV array simulator of 100kW was finished. At this time, this was probably the most powerful simulator in the world.
BFH-TI’s 100 kW PV array simulator shortly before it became operational in 2009
Inverter Testing at Bern University of Applied Sciences

What makes our simulators special?

- **Linear design** → High speed, small output capacitance
- **High stability** → Thermal drift <0.1%
- No electromagnetic interference
The new Multi-MPPT PV Inverter Test Bench

- In summer 2013, construction of a PV array simulator for testing of multi-MPPT inverters began.

- The design is inspired by our existing simulators. All the same, it is a complete redesign.

**Projected technical data**

- **Topology:** 3 linear, individually programmable, liquid cooled sub array simulators
- **Voltage range:** 0...1000VDC
- **Output Power:**
  - 3 x 11.52kW (FF = 72%)
  - 3 x 12.8kW (FF = 80%)
- **Thermal Drift:** < 0.1%
- **Settling Time:** < 100μs
The new Multi-MPPT PV Inverter Test Bench

Prototype of a sub array simulator (under construction)
The new Multi-MPPT PV Inverter Test Bench

Challenges of a 1’000V linear Design

- Only very few high voltage linear semiconductors are available
- Most don’t have a 1’000V rating
- Peak power dissipation of 16kW per sub array simulator
- Liquid cooling required

Liquid cooled heatsink for the multistring-simulator
Conclusions

- The construction of a good quality PV array simulator is an often underestimated problem.
- Most commercially available simulators have unrealistic AC characteristics and can cause EMC problems.
- BFH-TI’s PV array simulators have a linear design, resulting in very good AC and DC behaviour with no switching noise.

Upcoming activities

- The new multi-MPPT PV inverter test bench will be operational by Spring 2015.
- Accreditation of the existing 100 kW and the new multi-MPPT test bench, making BFH-TI’s PV lab to Switzerland’s only test institute able to carry out certified tests on PV inverters.
- You are welcome to test your PV inverters and/or MPPT charge controllers at BFH-TI’s PV lab!
Thank you for your time!