A New Approach for Holistic PV Module Quality Assurance by Extended Stress Testing and Production Monitoring

[1]D. W. Cunningham (BP)

[2]B. Jaeckel (Q-cells)

[3]A. Roth (VDE)

This presentation is based on a publication by the authors at the 26th EUPVSEC meeting in Hamburg, Germany, September 2011

1) daniel.cunningham@bp.com 2) B.Jaeckel@q-cells.com 3) Arnd.Roth@vde.com

Approach

- Validates the design/longevity of crystalline silicon PV products and improves product "bankability"

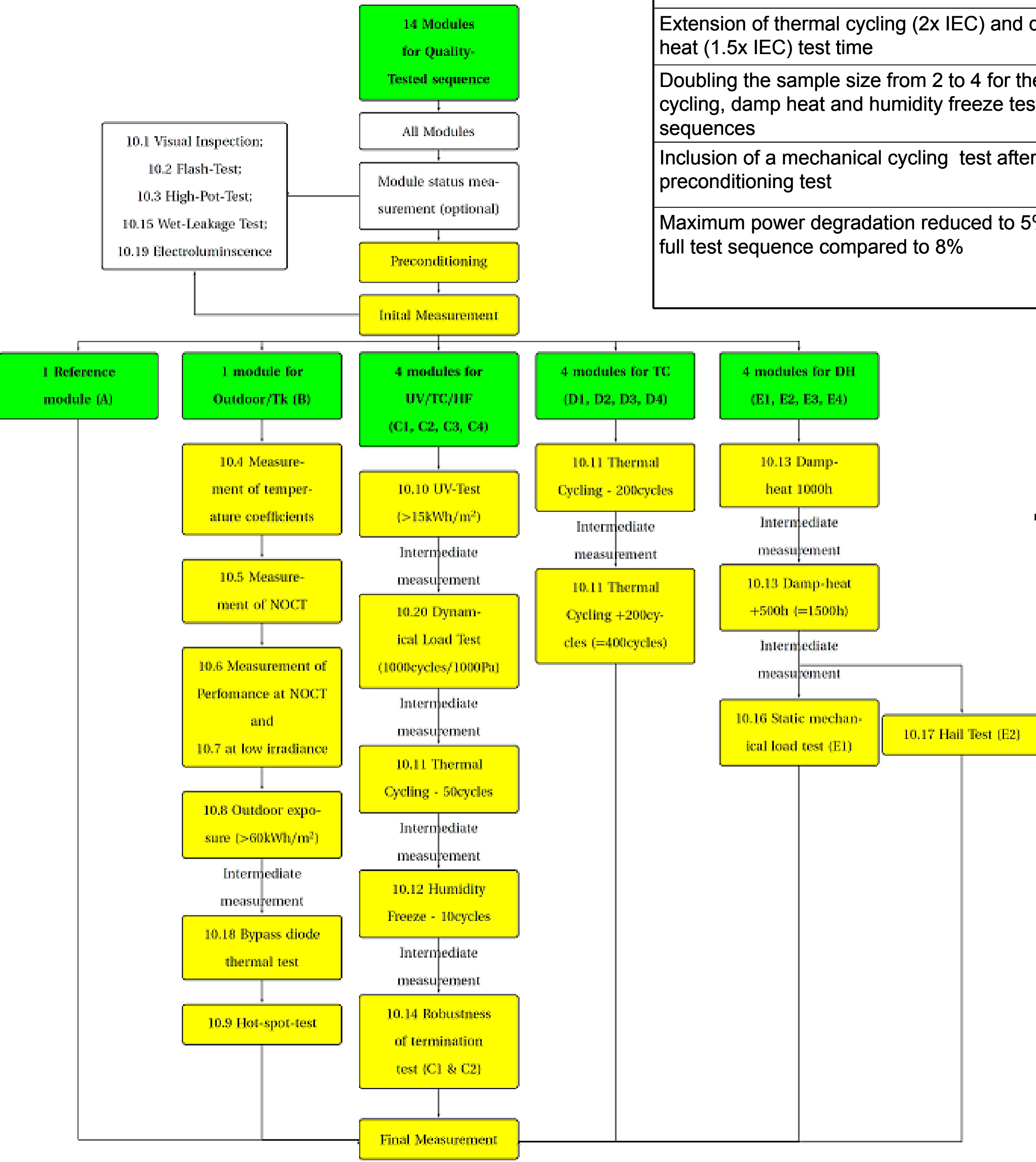
- Three areas of validation
  1. Robustness of design
  2. In line Quality monitoring
  3. Off line product quality assurance
- Available to the industry as a VDE standard

•The requirements for the quality standard are based on IEC61215/61730 and UL1703

•The conditions were extended to better validate the reliability and safety as well as activate potential latent failure mechanisms

•Based on real failure modes/mechanism from field data

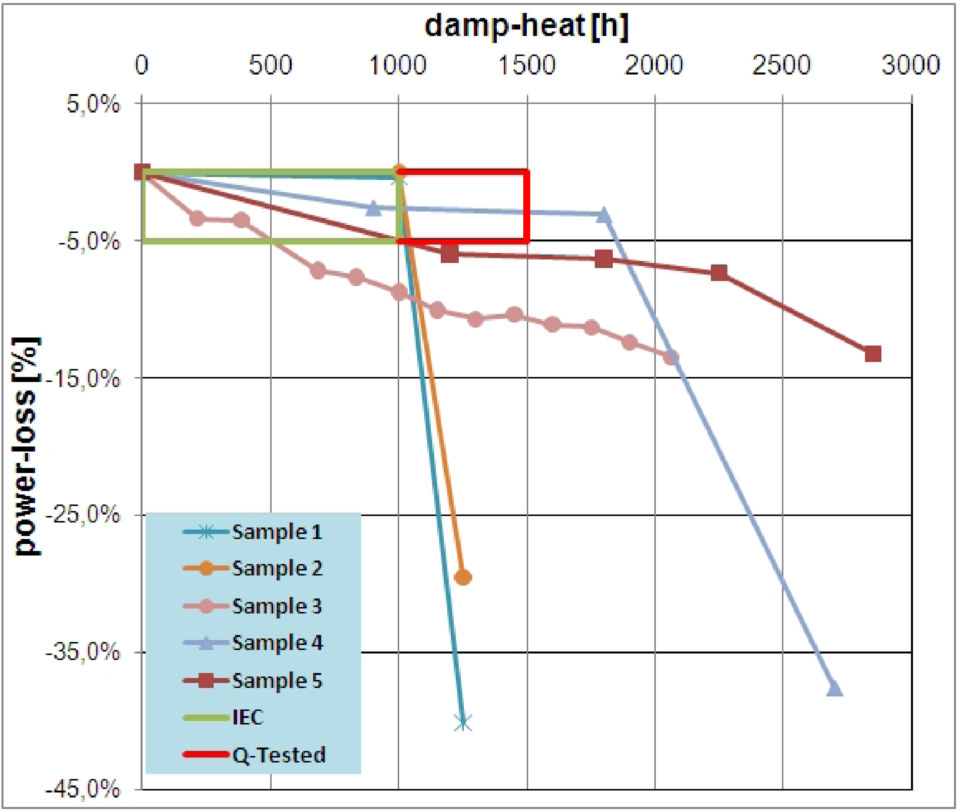
•The following table and flow chart describes the specific changes and provides an explanation for why those changes were included.

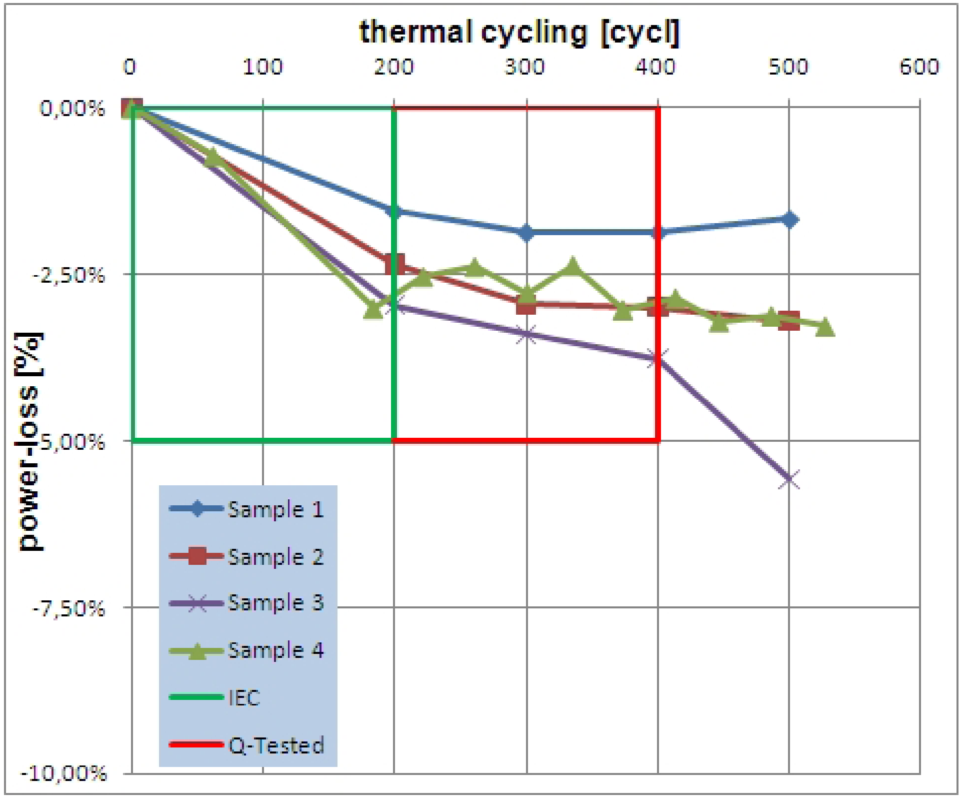


Changes compared to IEC	Reason for change
Extension of thermal cycling (2x IEC) and damp heat (1.5x IEC) test time	Better validate the reliability of products
Doubling the sample size from 2 to 4 for the thermal cycling, damp heat and humidity freeze test sequences	Increase statistical significance of results
Inclusion of a mechanical cycling test after the UV-preconditioning test	Study the impact of wind loading on the modules performance and reliability
Maximum power degradation reduced to 5% after a full test sequence compared to 8%	Increased confidence level for return of investment as well as minimizing the risk for early failures by combining lower allowed power degradation with increased test times.

1. Robustness of Design

Module Performance under extended accelerated testing





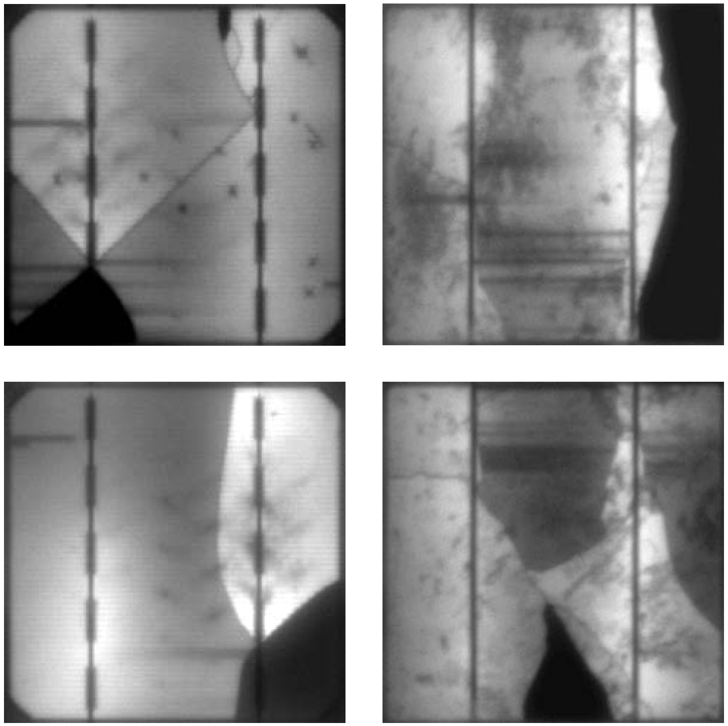
2. In line Quality monitoring

For a module to bare the quality label it must be produced in manufacturing facilities that use specific in-line testing. An example of some of the inline tests include:

Extra inline test	Reason for inclusion
Post lamination electroluminescence Imaging Standard includes a catalogue of EL images with failure modes and criteria for pass/fail	Cell cracking can cause performance, reliability and safety concerns. The EL-test is implemented to reduce the risk of power loss and loss in energy yield due to cracked of defective cells.
Wet-leakage test on 1% of production	A safety test designed to evaluate the insulation of the module.
Ground continuity test on 1 module per site per day	A safety test that ensures that a module can be adequately grounded in a PV system
Reverse current overload test on 1 module per site per day	A safety test that verifies a module’s ability to dissipate heat under reverse current fault conditions

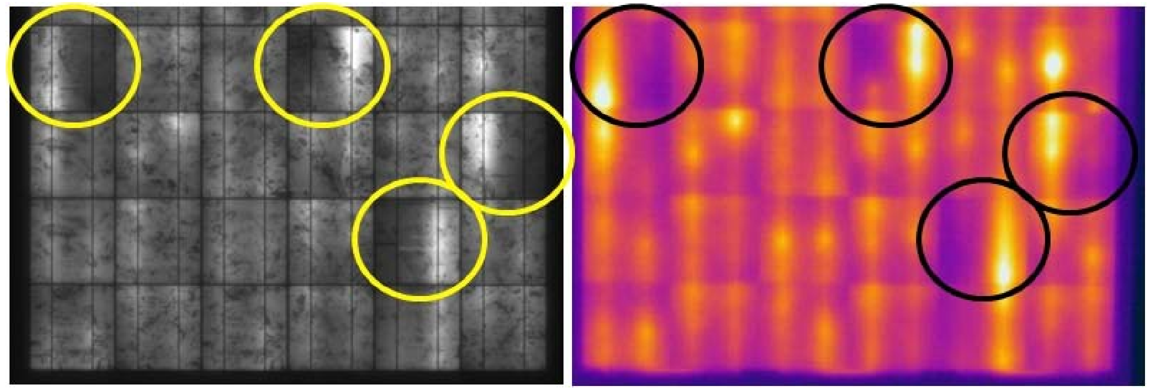
2. In line Quality monitoring

Electroluminescence testing



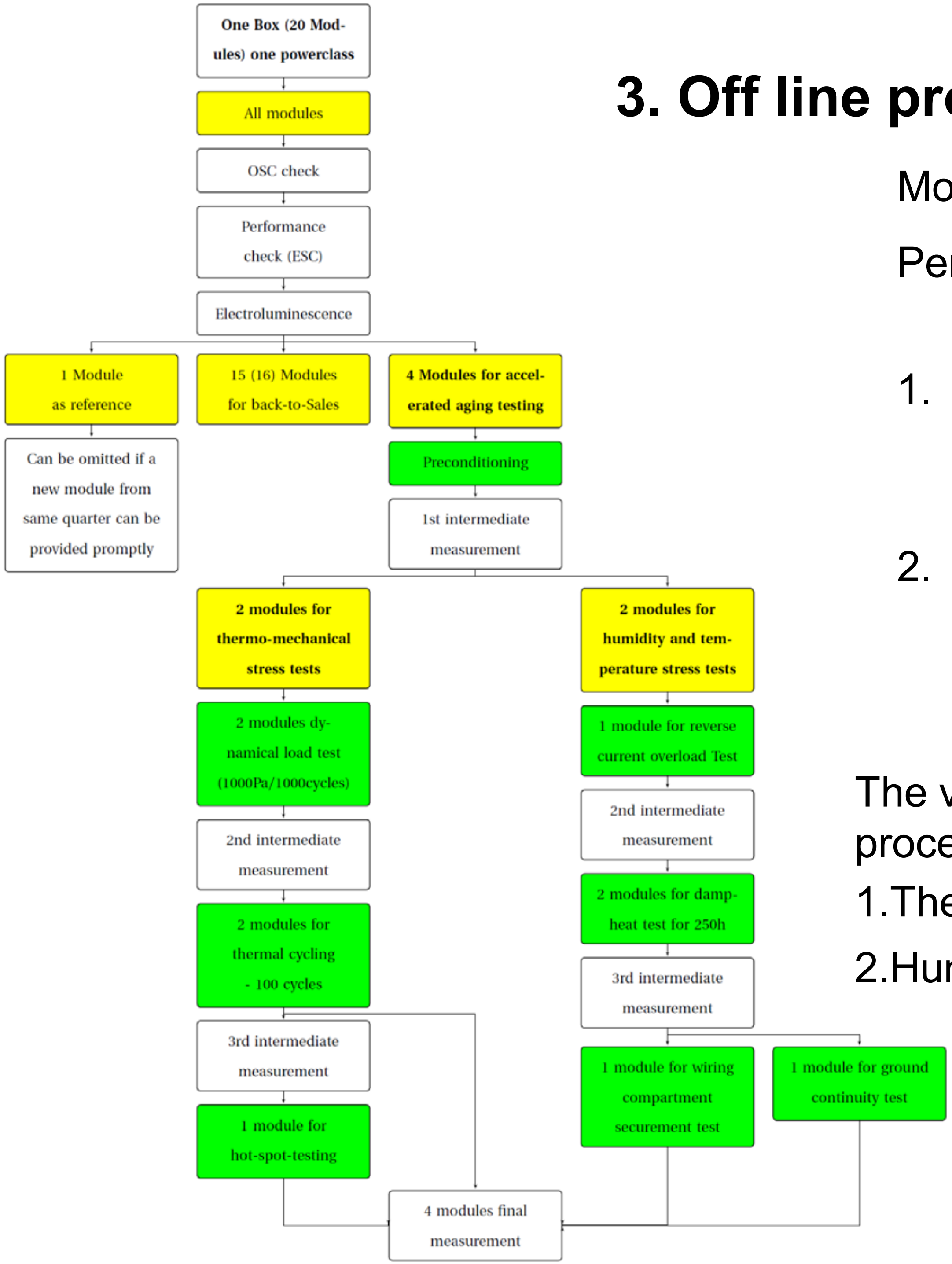
These images provide examples of cases in which modules would be rejected during electroluminescence testing due to excessive cell cracking

Reverse current overload testing



Example IR and EL images show how soldering problems can be detected using IR imaging. Left: electro-luminescence image; Right: corresponding IR image

Using IR imaging in the Reverse current overload test these soldering problems would be recognized quickly and the problem can be solved promptly.



3. Off line product quality assurance

Monitoring product manufactured.

Performed **quarterly** and serves two main purposes:

1. Confirmation that measurement systems used for inline quality checks are consistent
2. To verify, through a shortened environmental testing sequence that there are no manufacturing defects

The verification is done in a two sequence procedure:

1.Thermal mechanical stress tests

2.Humidity and temperature stress tests