



PIDcheck – A novel measurement tool for in-field PID test and prognosis

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- + Established in 2005
- + 2012 integration of Magnostech, 25 years experience in electron spin resonance
- + 2015 integration of EFG technology on x-ray diffraction
- + located in Silicon Saxony
- + 36 employees as of 2016 (excluding global sales & support team)
- + Installed base: more than 1000 systems worldwide





MDP series

μ PCD/Minority Carrier Lifetime



Semiconductor
Microelectronics

Photovoltaic

XRD series

Ultra-fast crystal orientation
and Rocking curve
measurements



PID series

PID tester for solar cells
and single modules



Crystal Orientation

ESR

Electron Spin Resonance



Medical

Chemical applications

TL/OSL

Luminescence Dosimetry
and Dating



Dosimetry

Dating



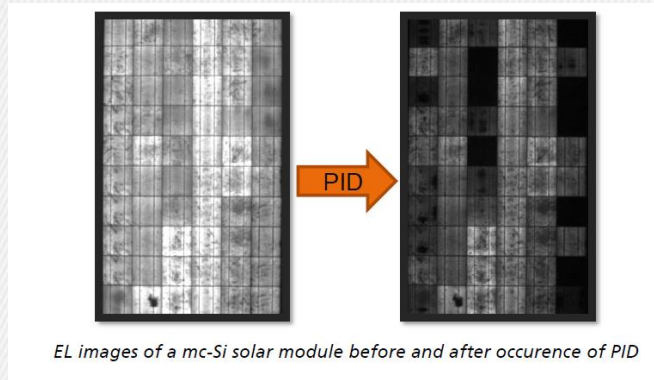
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Motivation

Experimental setup

Results

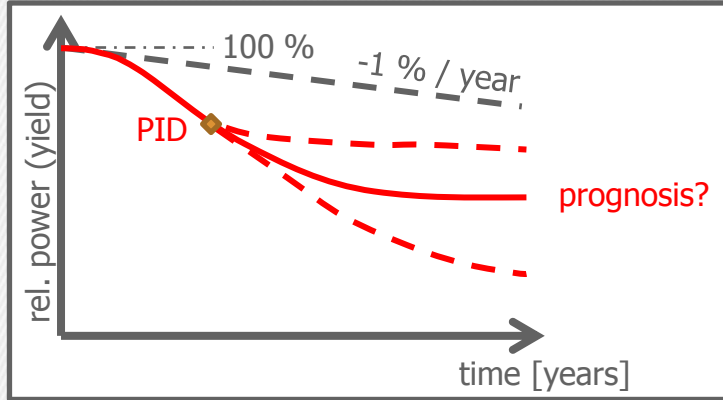
Summary



PV power plants with PID in Europe [1]

- PID-s results in a strong power decrease of c-Si solar modules, due to massive shunting
- Responsible: Sodium decorated stacking faults like defects decorated by high voltage
- huge problem in already existing solar parks
- Conventional methods currently used as e.g. electroluminescence or thermoluminescence can detect failures, but reasons unknown and not able to predict failures

[1] C. Hinz et al., PADCON PID Workshop, 10.11.2015, http://padcon.de/content/site/dateien/2620Vergleich_von_unterschiedlichen_Regenerationsmethoden_fuer_PID.pdf



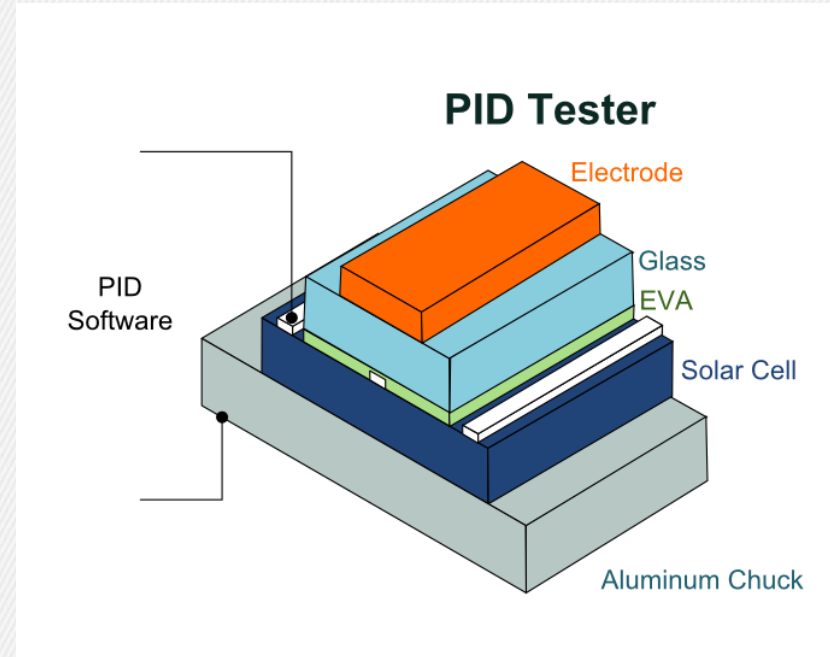
Conventional test laboratory

- if user can make sure PID is present, several recovery methods can be applied, i.e. efficiency of modules can be increased again by reversing the polarity
 - So far modules need to be uninstalled and send to a laboratory for PID testing
 - expensive and time-consuming, during which modules can not be operated
- PIDcheck enables **fast** and **simple** PID testing directly at the solar park

Measurement scheme similar to PIDcon

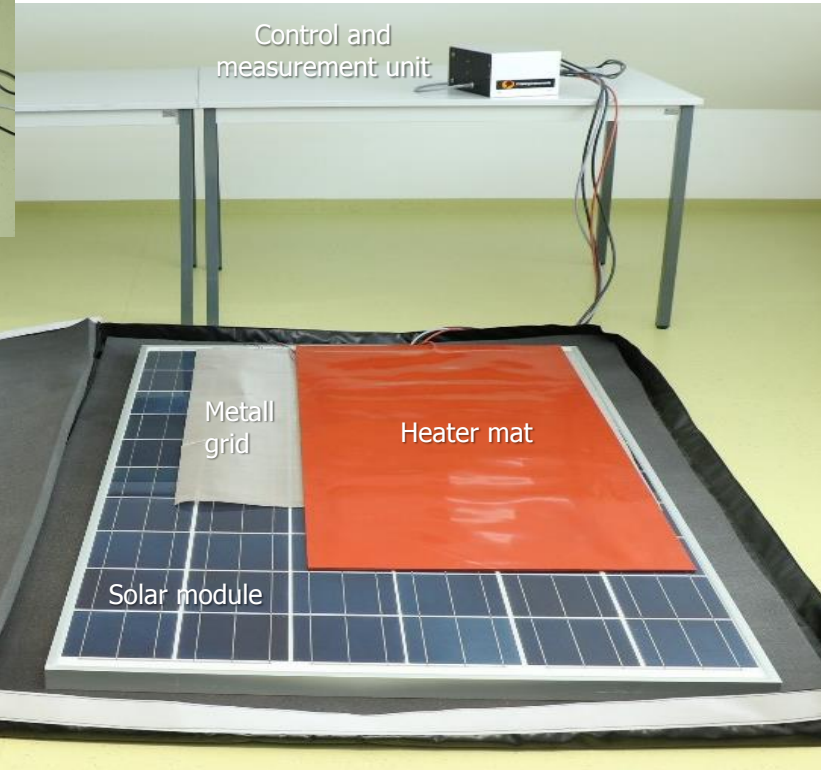
Standard test conditions:

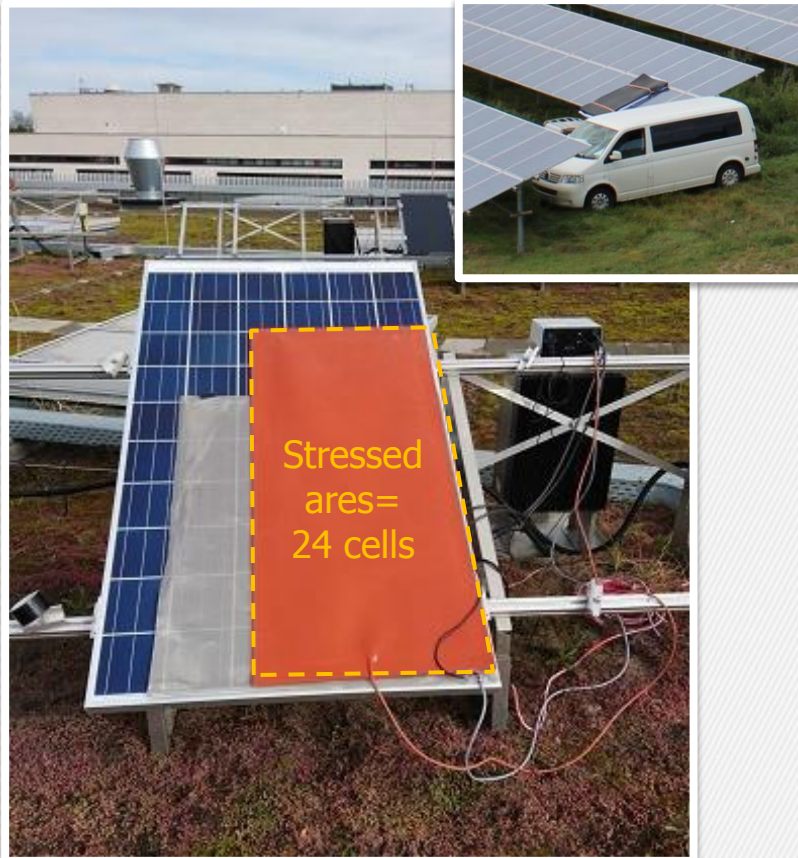
- Voltage: 1000...1500 V
- Temperature: 85 °C
- Test duration: common 8 hours
- Dry conditions, no use of water





- Solar module is placed in an isolated bag during measurement
- Metall grid and heater mat are placed on top
- Control unit is connected to solar module and heater map



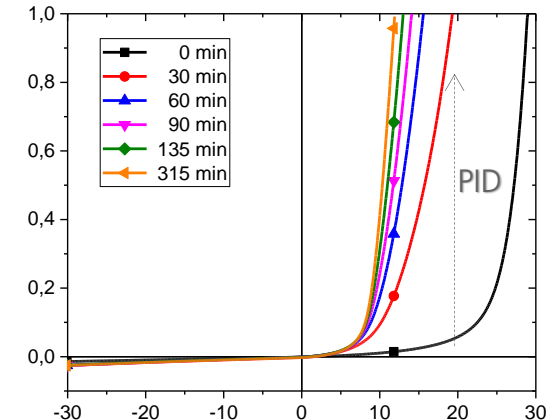
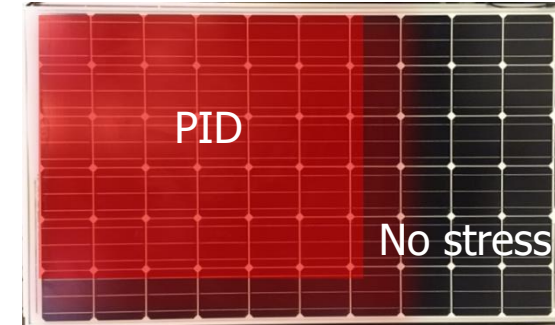


- prototype: 24 cells are stressed with high voltage
- Measurement of dark current in forward
- Successfully demonstrated in active module field
- Filing of patent in 2015 *
- Development to product by Freiberg Instruments
- Market launch in 2018
- User: Assessor, Operators, Service specialists, installers, module producer

* Patent pending „Verfahren und Anordnung zur Prüfung eines Solarmoduls auf Anfälligkeit für Potentialinduzierte Degradation“, DE 10 2015 213 047 A1

measurement

- Part of solar cells in the module is stressed with 85 °C and 1000 V (PID)
- 2 hours pre heating
- every 5 min dark I-U-curve is measured
- PID susceptible solar modules shows increasing dark current
- Prediction of power loss in module
- Afterwards recovery by reversing the polarity





PV modules

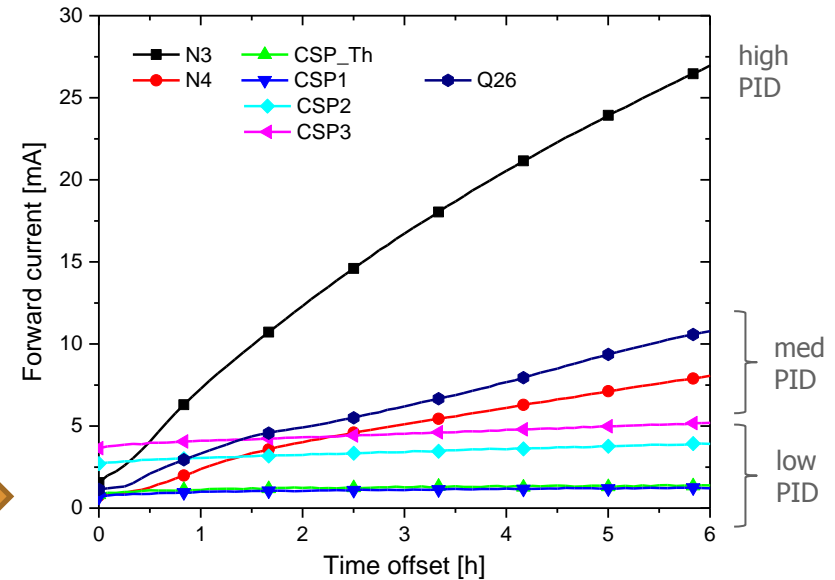
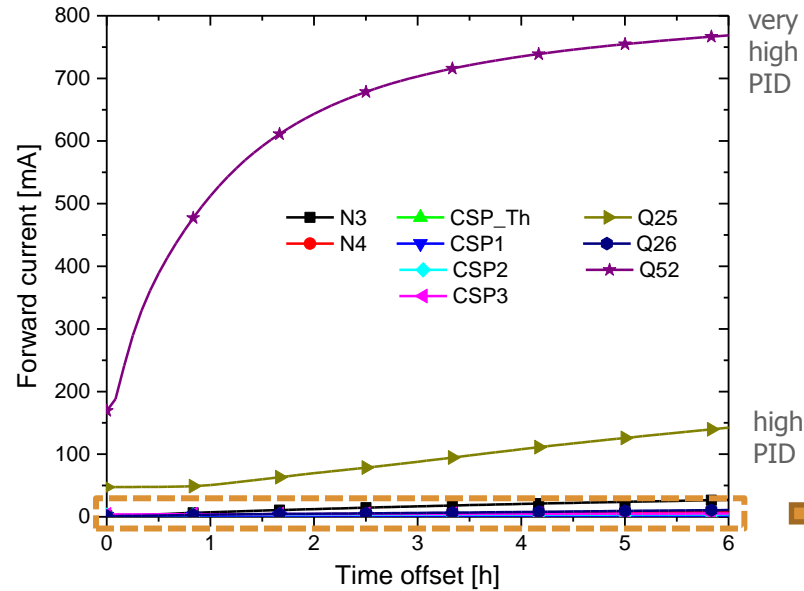
- 9 PV modules with c-Si solar cells
- 60 cells per module → $V_{oc} = 36...37\text{ V}$
- Modules have different levels of PID-sensitivity as well as pre-existing PID

Module	PID sensitivity	pre-existing PID?
N3	high	--
N4	moderate	--
CSP_Th	low	--
CSP1	low	--
CSP2	low	x (low)
CSP3	low	x (low)
Q25	high	x (moderate)
Q26	moderate	--
Q52	very high	x (strong)



PID-testing with PIDcheck

Measurement of dark forward current at $+12.3 \text{ V} \approx 1/3 V_{oc}$

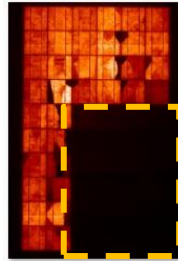




Electroluminescence after PID tests

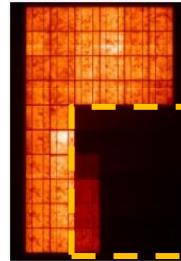


N3



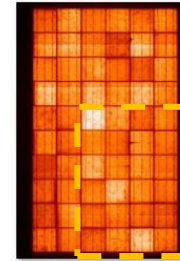
high sensitivity

N4



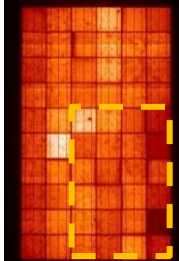
moderate sensitivity

CSP 2



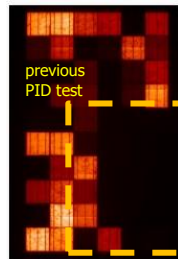
low sensitivity

CSP 3



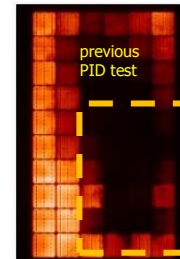
low sensitivity

Q25



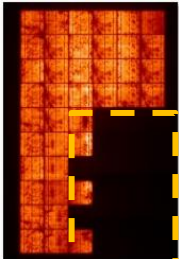
high sensitivity

Q52



high sensitivity

Q26



moderate



Comparison of in-field PID assessment methods

	Time to result	Significance	Forecast possible?	Control of test conditions	Cost per test (incl. equipment)
In-field measurement					
- thermography	+++	--	--	0	+
- EL	++	-	--	+	
PID regeneration box with V_{mpp} monitoring	--	0	+	0	-
PID test in lab					
- standard	0	+	+	+	-
- cyclic PID/recovery	0	++	++	+	--
PIDcheck	+	+	+	+	+



laboratory-
test

dismounting and
transport necessary



Climate chamber in
test laboratory



duration > weeks
(additional loss of
yield!)



In-field -
test

PID-Test without
dismounting on-site



Low-priced
equipment easy to
handle



Test duration only a
few hours





Europa fördert Sachsen.



Europäische Union

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Leakage current

Measurement of
leakage current
through glass/EVA

