

**TÜV Rheinland Energie und Umwelt GmbH
Solar Energy**

Test Report

Comparative mechanical load test

Report No. 21220567

Cologne, November 2012



Test report no.: <i>Prüfbericht - Nr.:</i>		21220567	
Client (Customer address): <i>Auftraggeber</i> <i>(Kundenadresse):</i>		Sven Heidbüchel Oberstrasse 7 52388 Nörvenich Germany	
Test item: <i>Gegenstand der Prüfung:</i>		Photovoltaic (PV) Module(s)	Date of receipt: <i>Eingangsdatum:</i> 31.08.2012
Module type designation: <i>Modultypen-Bezeichnung:</i>		Standard mono c-Si PV-module Prototype of a protection device for PV-Modules SMB (solar – multi board) (for details see Constructional Data Form no. 21220567)	
Order no.: <i>Auftragsnummer:</i>		21220567	Quotation no.: <i>Angebotsnummer:</i> 435/1220120796
Testing location: <i>Prüfart:</i>		Solar Energy Assessment Center Cologne TÜV Rheinland Energie und Umwelt GmbH Am Grauen Stein, 51105 Köln, Germany Tel.: +49 221 806-2477, Fax: +49 221 806-1350	
Test specification: <i>Prüfgrundlage:</i>		Based on IEC 61215: 2005, EN 61215: 2005, Second Edition : "Crystalline silicone terrestrial photovoltaic (PV) modules – Design qualification and type approval"	
Test result: <i>Prüfergebnis:</i>		A comparative mechanical load test in coordination with EN IEC 61215:2005 standard have been performed. Test specifics are documented in the section Summary of Testing.	
compiled by / erstellt:		reviewed by / kontrolliert:	
			
12 November 2012 Dipl.-Ing. K. Strohkendl		12 November 2012 Dipl.-Ing. J. Althaus	
Date <i>Datum</i>	Title/Name <i>Titel/Name</i>	Date <i>Datum</i>	Title/Name <i>Titel/Name</i>
<p>This test report relates to the listed test samples. Without permission of the test centre this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any safety mark on this or similar products.</p> <p>Dieser Prüfbericht bezieht sich nur auf die gelisteten Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens.</p>			

IEC 61215 – Design qualification and type approval			
Clause	Requirement + Test	Verdict - Remark	Verdict

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Summary of testing

According to the inquiry of the customer a comparative mechanical load test has been performed with 100 alternating pressure cycles on two PV-modules. The test has been performed on one module in combination with a protection device (type SMB (solar – multi board)). This board shall protect modules from damage which may be caused by someone who walks on the PV-modules for maintenance or repairing purposes.

For comparison reasons, a module from the same type has been tested with the same setup but without the SMB.

Representative for a human, a weight of 150 kg have been calculated. This weight has been applied as a concentrated force on 3 separate cells per module. 100 pressure cycles have been applied per cell.

The PV-module, which has been stressed without protection, does have a power degradation of 1.37%. It becomes visible on the EL-pictures, that two of the three stressed cells are heavily damaged.

The PV-module which has been tested in combination with the SMB, does have only very tiny power degradation (0.15%). On the electroluminescence pictures of this module are no additional micro cracks visible after the test has been performed.

Summary of test locations:

All tests were performed at the *Solar Energy Assessment Center Cologne* .

Summary of deviations from the standard:

- According to a decision made by the IEC standardization committee WG2 in May 2008, the test requirements of IEC 61646: 2008 shall be applied for test 10.10.
- To optimize testing the test sequence B has been separated into sequences B1 and B2 as described in the diagram in the section "Testing procedure" of this test report.
- The temperature coefficients determination and the STC measurements are performed on the control module.
- The Hot-spot endurance test is performed acc. to a draft for IEC 61215 ed.3; since test experience shows, that one 5 hour long cycle does not lead to additional information, separate cycles of 1 hour with different cells shaded are performed.

IEC 61215 – Design qualification and type approval			
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General information
Abbreviations used in the report:

HF	– Humidity freeze	TC	– Thermal cycling
DH	– Damp heat	Vmpp	– Maximum power point voltage
Imp	– Maximum power point current	Voc	– Open circuit voltage
Isc	– Short circuit current	FF	– Fill factor
Pmpp	– Maximum power	α	– Current temperature coefficient
NOCT	– Nominal Operating Cell Temperature	β	– Voltage temperature coefficient
STC	– Standard Test Conditions	γ	– Power temperature coefficient

Possible test case verdicts:

- test case does not apply to the test object.....: N/A
- test object does meet the requirement.....: Passed (P)
- test object does not meet the requirement.....: Failed (F)

Date(s) of performance of tests: From 31.08.2012 until 05.11.2012

General remarks:

The test verdicts presented in this report relate only to the object tested.
 This report shall not be reproduced, except in full, without the written approval of the issuing testing laboratory.
 "(see Enclosure #)" refers to additional information appended to the report.
 "(see appended table)" refers to a table appended to the report.

Throughout this report a point is used as the decimal separator.

Detailed product information are to be found in the CDF (constructional data form) no. 21220567

IEC 61215 – Design qualification and type approval			
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Module group assignment:			
Sample #	Sample S/N	Remarks / constructional characteristics (e.g. cell, back sheet, frame type)	Sample Group ID
20120005638	TB123001130006		A
20120005639	TB123001130002		B

Test verdicts			
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Group A	1 Modules	Sample Group ID E1, E2	—
10.16	Alternating mechanical load test	See table 10.16 E1	
Group B	1 Modules	Sample Group ID E1, E2	—
10.16	Alternating mechanical load test in combination with SMB.....	See table 10.16 E1	

IEC 61215 – Design qualification and type approval	
Requirement + Test / Remark	Verdict

Tables
Visual inspection (Initial) (10.1)

Test date [DD/MM/YYYY]	06.09.2012	—
Sample #	Nature and position of initial findings	—
20120005638	Minor visual defects	P
20120005639	Minor visual defects	P
Supplementary information:		

Maximum power determination (Initial) (10.2)

Test date [DD/MM/YYYY]	19.09.2012						—
Module temperature [°C]	Corrected to 25 °C						—
Irradiance [W/m ²]	1000 or *						—
Sample #	Pmpp [W]	Vmpp [V]	Imp [A]	Voc [V]	Isc [A]	FF [%]	
20120005638	245.0	30.24	8.10	37.35	8.60	76.3	
20120005639	244.5	30.23	8.09	37.33	8.63	75.9	
* relative measurements with irradiance levels different from 1000 W/m ² were performed							
Supplementary information:							

Mechanical load test (10.16 E1)

Test date [DD/MM/YYYY]	24.10.2012						—
Forcel load applied [N]	1500						—
Sample #	Open circuits (yes/no)						—
20120005638	No						P
20120005639	No						P
Supplementary information: Load was applied pneumatically; mounting on existing frame holes or with clamps.							

Visual inspection after Mechanical load test (10.1)

Test date [DD/MM/YYYY]	24.10.2012						—
Sample #	Nature and position of findings						—
20120005638	No additional visual defects						P
20120005639	No additional visual defects						P
Supplementary information:							

IEC 61215 – Design qualification and type approval	
Requirement + Test / Remark	Verdict

Maximum power determination after Mechanical load test (10.2)

Test date [DD/MM/YYYY]	24.10.2012							—
Module temperature [°C]	Corrected to 25 °C							—
Irradiance [W/m²]	1000 or *							—
Sample #	P _{mpp} [W]	V _{mpp} [V]	I _{mpp} [A]	V _{oc} [V]	I _{sc} [A]	FF [%]	Degradation [%]	
20120005638	241.8	30.08	8.04	37.25	8.59	75.5	1.33	P
20120005639	244.2	30.45	8.02	37.29	8.63	75.9	0.15	P
* relative measurements with irradiance levels different from 1000 W/m² were performed								
Supplementary information: Maximum allowable P _{mpp} degradation after this test is 5%.								

Annex 1: Statement of the estimated uncertainty of the test verdicts

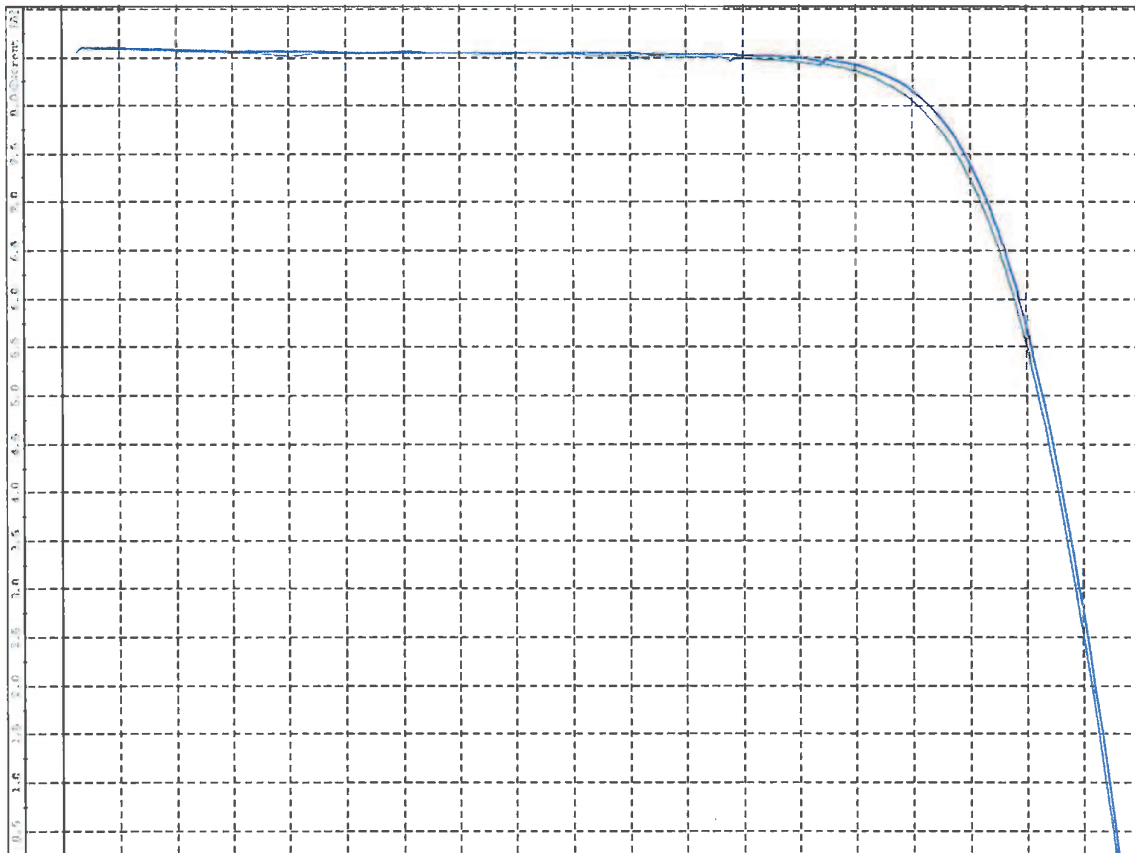
- Electrical performance rating is outside the scope of IEC 61215:2005 qualification testing. The verdicts of performance rating are only related to the test samples that were subjected to the tests. They cannot be generalised to the modules from the series production.
- Relative measurements were performed with a flash type solar simulator.
- The accuracy of measurement reproduction with the solar simulator is less than $\pm 1\%$.

Annex 2: Measuring software

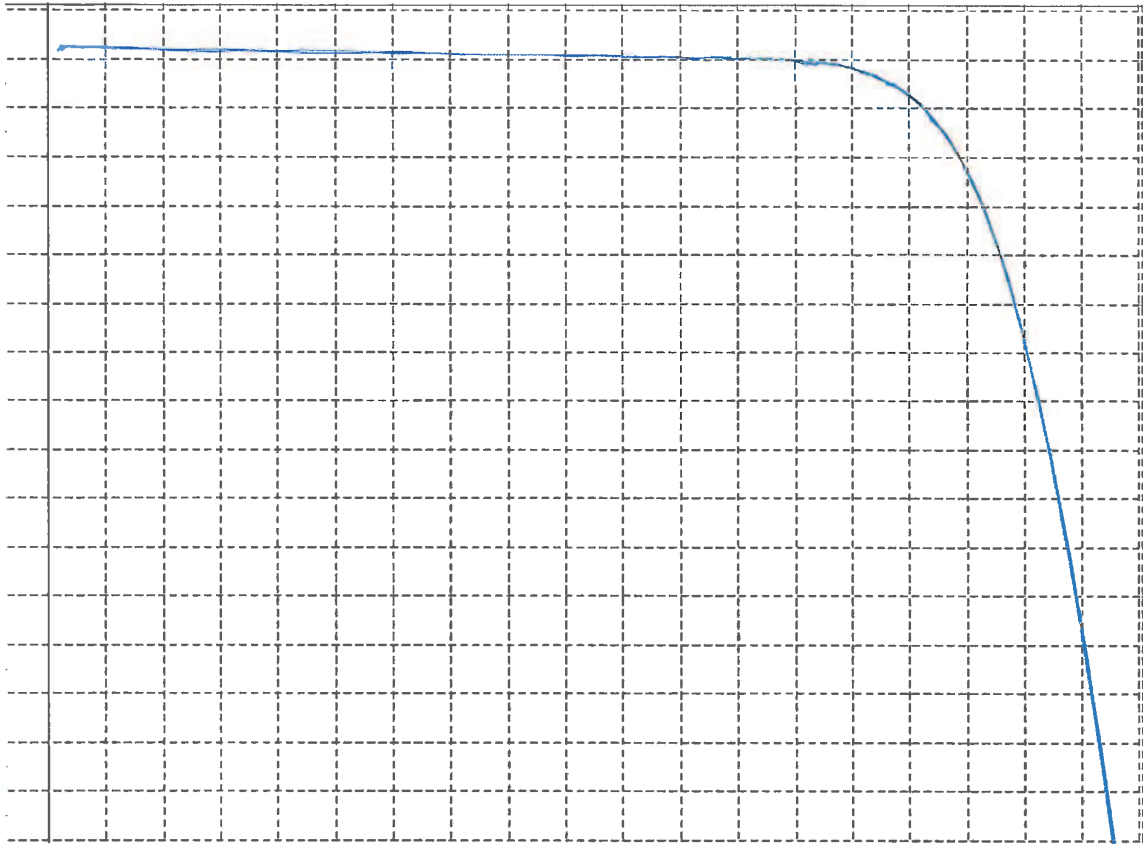
Program name	Version no.	Date	Application
PSLoad	2.6.11.3	July 2009	Operating software pulsed solar simulator

Annex 3: Measurement reports

Flash curves without figures



BC 20120005638 initial and final measurement



BC 20120005639 initial and final measurement

Annex 4: Photos from a test setup.



Fig. 1 Pressure element

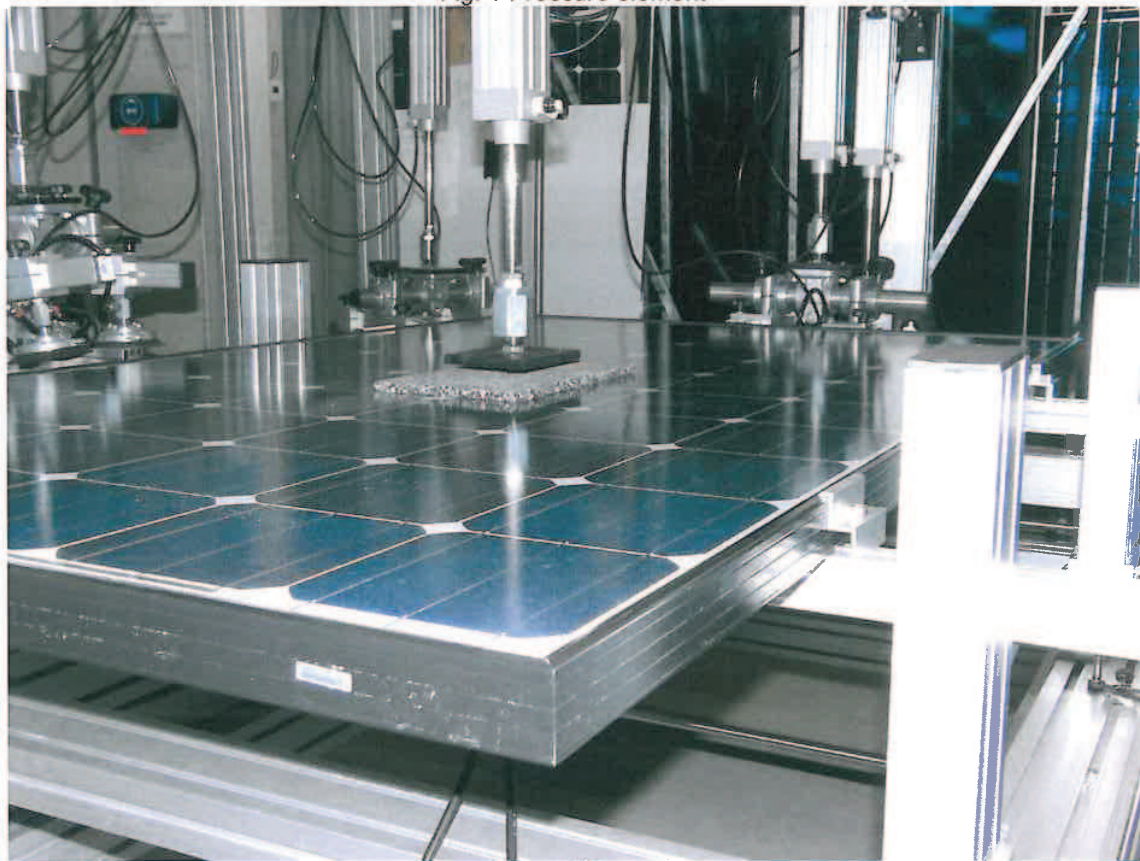


Fig. 2 Test setup 1st cell without SMB



Fig. 3 Test setup 2nd cell without SMB

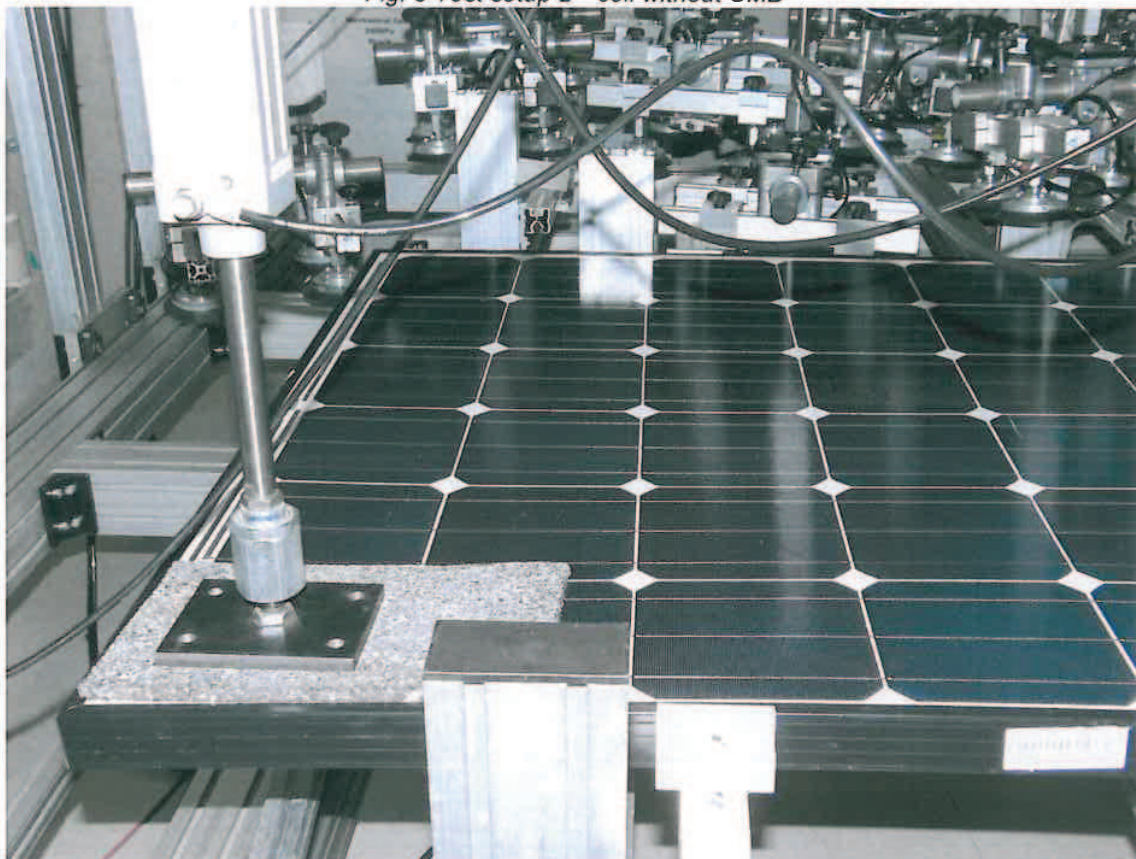


Fig. 4 Test setup 3rd cell without SMB



Fig. 5 Test setup 1st cell in combination with the SMB

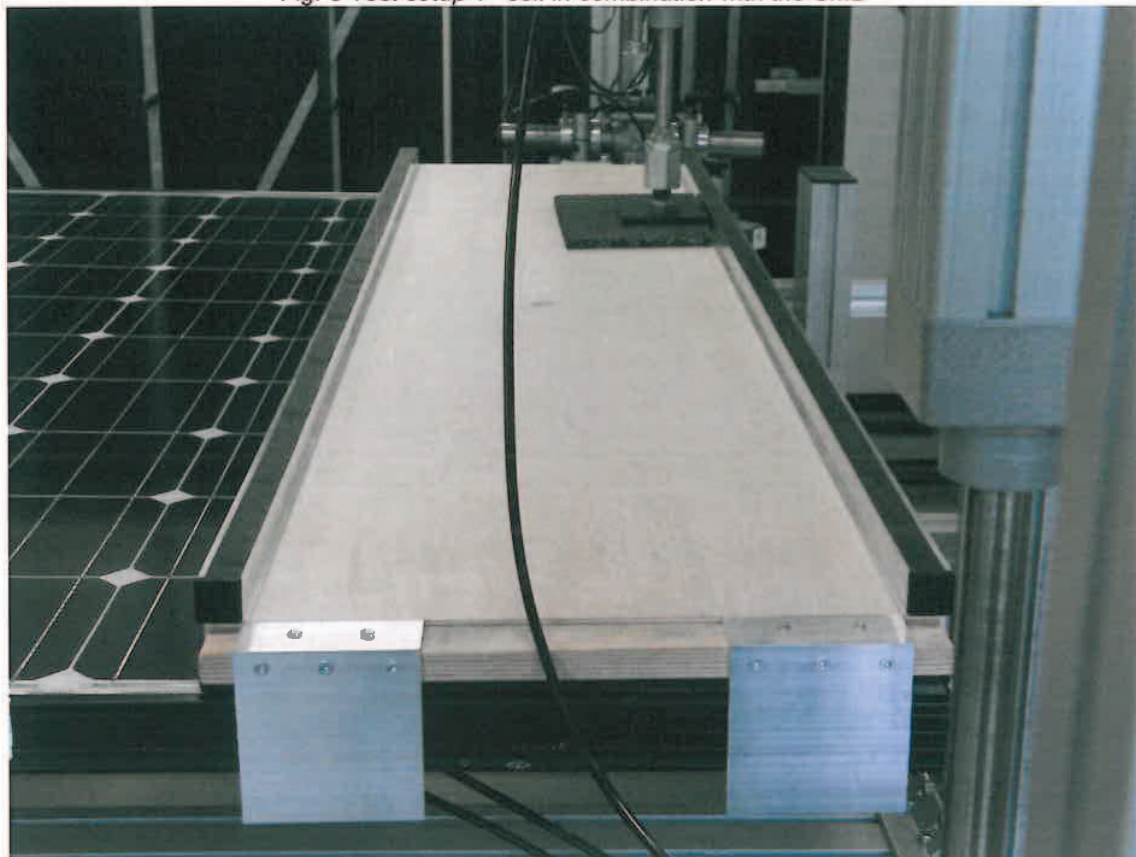


Fig. 6 Test setup 2nd cell in combination with the SMB

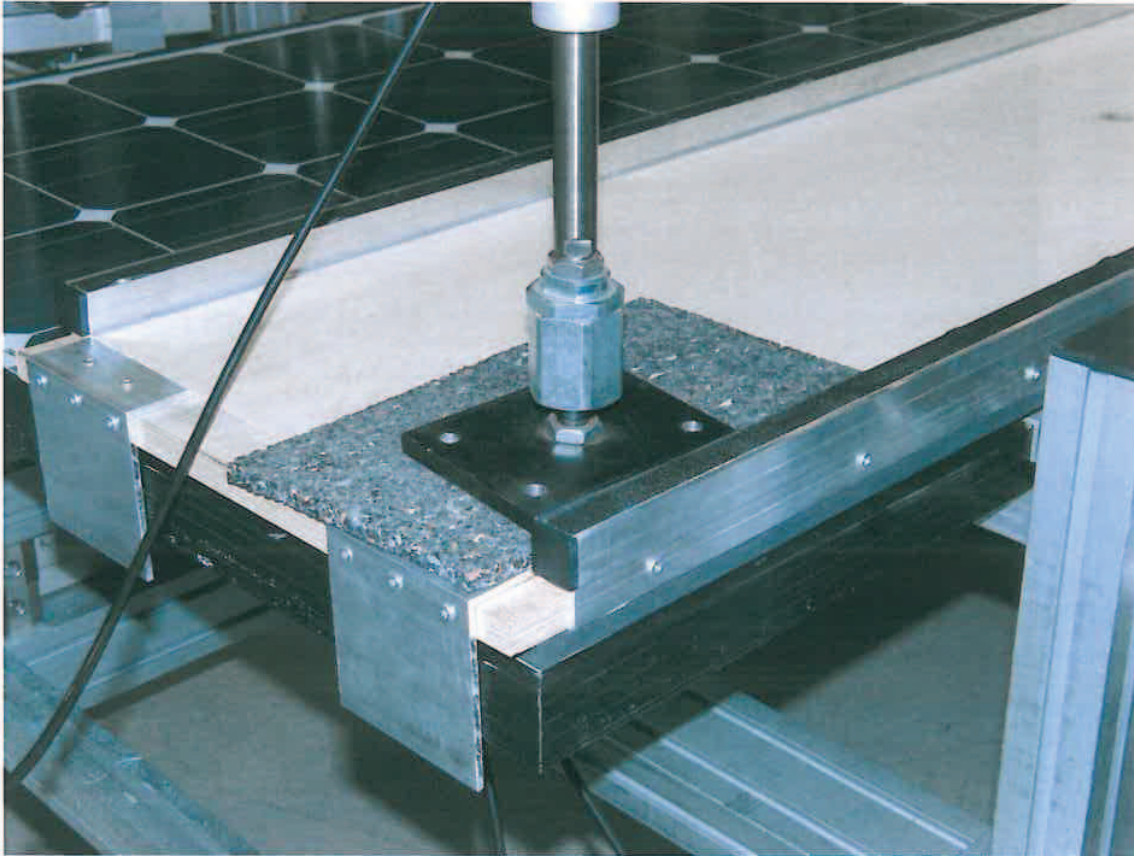


Fig. 7 Test setup 3rd cell in combination with the SMB

Annex 5: Electroluminescence images

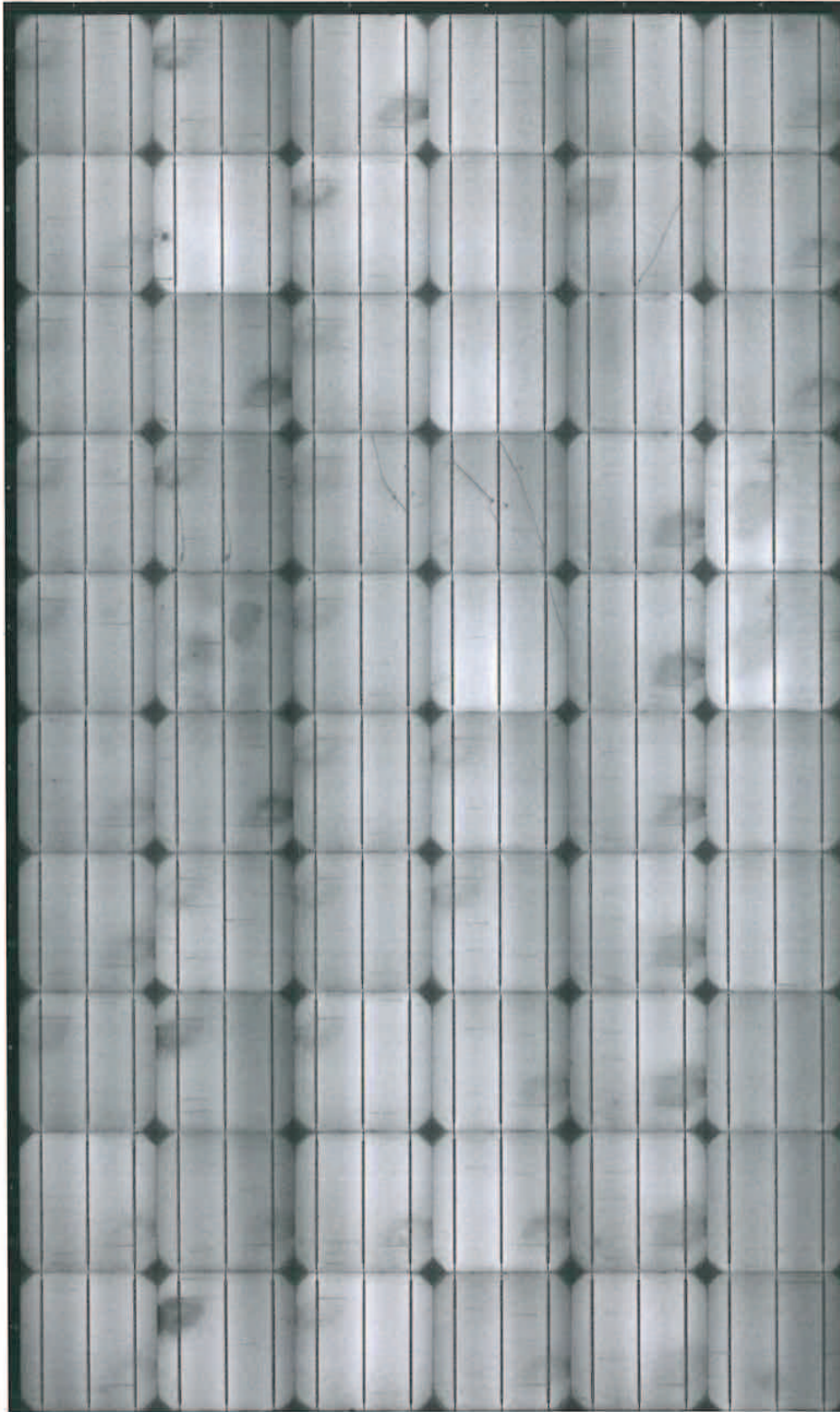


Fig. 8: initial electroluminescence image BC 20120005639



Fig. 9: follow-up electroluminescence image BC 20120005639
tested in combination with the SMB

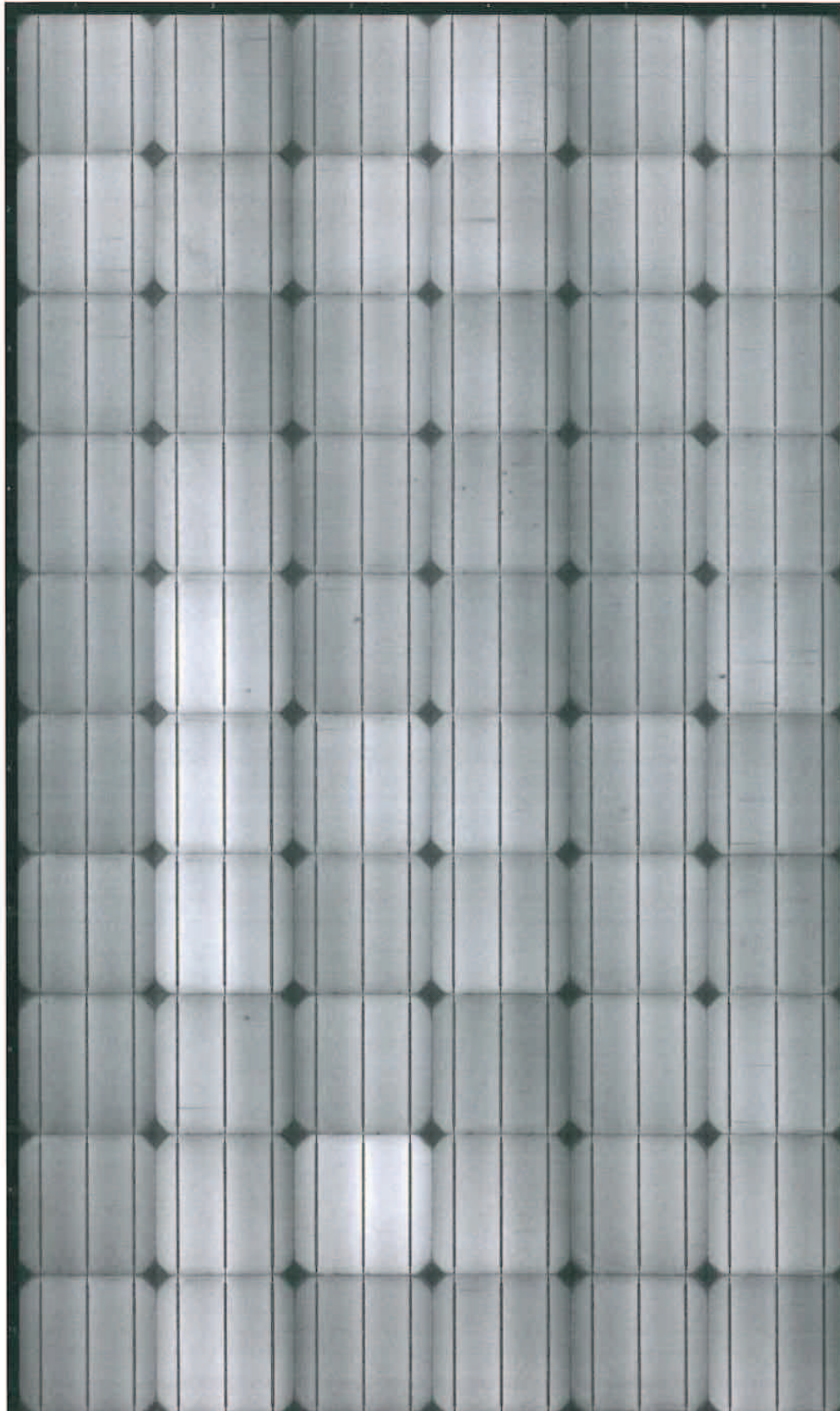


Fig. 10: initial electroluminescence image BC 20120005638



Fig. 11: follow-up electroluminescence image BC 20120005638
tested in combination without the SMB

