

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

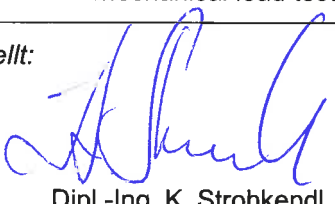
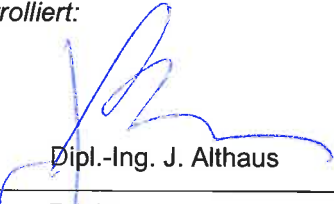
Test Report

**Mechanical load test (10.16) on PV modules
in combination with mounting substructures
according to IEC 61215:2005**

TÜV Report No. 21218035

Cologne, January 2012



Test report no.: <i>Prüfbericht - Nr.:</i>		21218035	
Client (Customer no. and address): <i>Auftraggeber</i> <i>(Kunden-Nr. u. Adresse):</i>		TRITEC Logistics GmbH Boschstraße 2/4 D-71287 Weissach	
Test item: <i>Gegenstand der Prüfung:</i>		PV-Modules and PV-Mounting structures	Date of receipt: <i>Eingangsdatum:</i> 28.09.2011
Module type designation: <i>Modultypen-Bezeichnung:</i>		Hareon Solar - HR-220P-18/Bb Suntech - STP185S-24/Ad+ (for details see Constructional Data Form no. 21218035)	
Mounting system <i>Montagesystem</i>		Tritec Logistics GmbH – TRI-STAND Aero 80 Tritec Logistics GmbH – TRI-STAND Aero 100	
Order no.: <i>Auftragsnummer:</i>		21218035	Quotation no.: <i>Angebotsnummer:</i> 1220111131
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>		IEC 61215: 2005 , EN 61215: 2005, Second Edition : "Crystalline silicone terrestrial photovoltaic (PV) modules – Design qualification and type approval"	
Test result: <i>Prüfergebnis:</i>		The mechanical load tests (10.16) (2400 Pa pressure/tension and 5400 Pa pressure) of the EN IEC 61215:2005 standard were passed according to its regulations of the pass criteria. Test specifics are documented in the section Summary of Testing. It is therefore declared, that the photovoltaic modules of the aforementioned type(s) in combination with the aforementioned mounting system(s) have passed the requirements of the EN IEC 61215:2005 mechanical load test (10.16).	
compiled by / erstellt:  19. January 2012 Dipl.-Ing. K. Strohkendl		reviewed by / kontrolliert:  19. January 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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IEC 61215 – Design qualification and type approval			
Clause	Requirement + Test	Verdict - Remark	Verdict

Summary of testing

According to the inquiry of the customer a mechanical load test have been performed with the following combination of PV modules and mounting systems.

Hareon Solar - HR-220P-18/Bb	-	Tritec Logistics GmbH – TRI-STAND Aero 100
Suntech - STP185S-24/Ad+	-	Tritec Logistics GmbH – TRI-STAND Aero 80

The aforementioned combinations (mounting system / PV module) have passed the mechanical load test according IEC 61215 with a pressure and tension of 2400 pa and also with a pressure of 5400 pa. The load was applied orthogonally to the PV modules.

Summary of test locations:

All tests were performed at the *Solar Energy Assessment Center Cologne* with the exception of the following test:

General information

Abbreviations used in the report:

HF	– Humidity freeze	TC	– Temperature cycling
DH	– Damp heat	V _{mpp}	– Maximum power point voltage
I _{mp}	– Maximum power point current	V _{oc}	– Open circuit voltage
I _{sc}	– Short circuit current	FF	– Fill factor
P _{mpp}	– 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 22.09.2011 until 01.12.2011

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.

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

Module group assignment:

Sample #	Sample S/N	Remarks / constructional characteristics (e.g. cell, back sheet, frame type)	Sample Group ID
20110007142	H11106041270	Reference module	A
20110007143	025112188910055310	Reference module	A
20110007144	025112186292995310	TRI-STAND Aero 80	B
20110007145	H11106040971	TRISTAND Aero 100	B

Test verdicts

	Initial examination	All modules	—
10.1	Visual inspection.....:	See table 10.1	
10.2	Maximum power determination	See table 10.2	
10.3	Insulation test	See table 10.3	
10.15	Wet leakage current test.....:	See table 10.15	
	Electroluminescence imaging	Annex 4	

Group B	2 Modules	Sample Group ID B	—
10.16	Mechanical load test (2400 Pa).....:	See table 10.16 E1	
10.16	Mechanical load test (5400 Pa).....:	See table 10.16 E1	

Tables**Visual inspection (Initial) (10.1)**

Test date [DD/MM/YYYY]: 03.11.2011		—
Sample #	Nature and position of initial findings	—
20110007142	Minor visual defects	P
20110007143	Minor visual defects	P
20110007144	Minor visual defects	P
20110007145	Minor visual defects	P
Supplementary information:		

Maximum power determination (Initial) (10.2)

Test date [DD/MM/YYYY]		11.11.2011				—
Module temperature [°C]		Corrected to 25 °C				—
Irradiance [W/m²]		1000 or *				—
Sample #	Pmpp [W]	Vmpp [V]	Impp [A]	Voc [V]	Isc [A]	FF [%]
20110007142	221.31	28.5	7.8	36.5	8.5	71.58
20110007143	192.45	36.6	5.3	44.8	5.7	75.58
20110007144	192.06	36.7	5.2	44.9	5.6	76.21
20110007145	226.88	28.8	7.9	36.7	8.4	73.16
* relative measurements with irradiance levels different from 1000 W/m² were performed						
Supplementary information:						

Insulation test (Initial) (10.3)

Test date [DD/MM/YYYY]		08.11.2011				—
Maximum system voltage [V _{DC}]		1000				—
High voltage applied [V _{DC}]		6000				—
Insulation resistance measured at [V _{DC}]		3000				—
Sample #	Measured	Area	Result*	Dielectric breakdown		—
	[GΩ]	[m²]	[GΩ * m²]	Yes (description)	No	
20110007142	124.9	1.62	202.3	—	X	P
20110007143	92.3	1.28	118.1	—	X	P
20110007144	135.8	1.28	173.8	—	X	P
20110007145	91.0	1.62	147.4	—	X	P
* Minimum requirement acc. to the standard is 0.04 GΩ*m².						
Supplementary information:						

Wet leakage current test (Initial) (10.15)

Test date [DD/MM/YYYY]	10.11.2011			—
Insulation resistance measured at [V _{DC}]	1000			—
Solution resistivity [Ω cm]	< 3,500			P
Solution temperature [°C]	22 ± 3			P
Sample #	Measured	Area	Result*	—
	[MΩ]	[m²]	[MΩ * m²]	
20110007142	62.5	1.62	101.3	P
20110007143	51.8	1.28	66.3	P
20110007144	65.8	1.28	84.2	P
20110007145	64.0	1.62	103.7	P
* Minimum requirement acc. to the standard is 40 MΩ*m².				
Supplementary information:				

Mechanical load test (10.16 E1) 2400 pa

Test date [DD/MM/YYYY]		28.11.2011	—
Pressure mechanical load applied [Pa].....		2400	—
Tensile mechanical load applied [Pa].....		2400	—
Sample #	Open circuits (yes/no)	Mounting structure	—
20110007144	No	TRI-STAND Aero 80	P
20110007145	No	TRI-STAND Aero 100	P
Supplementary information: Load was applied pneumatically;			

Visual inspection after Mechanical load test (10.1)

Test date [DD/MM/YYYY]		29.11.2011	—
Sample #	Nature and position of findings		—
20110007144	No visual defects		P
20110007145	No visual defects		P
Supplementary information:			

Maximum power determination after Mechanical load test (10.2)

Test date [DD/MM/YYYY]		29.11.2011,						—
Module temperature [°C]		Corrected to 25 °C						—
Irradiance [W/m²]		1000						—
Sample #	Pmpp [W]	Vmpp [V]	Impp [A]	Voc [V]	Isc [A]	FF [%]	Degradation [%]	—
20110007144	184.92	35.3	5.2	44.6	5.5	74.94	3.72%	P
20110007145	225.35	28.7	7.9	36.7	8.4	72.70	0.67%	P
Supplementary information: Maximum allowable Pmpp degradation after this test is 5%.								

Insulation test after Mechanical load test (10.3)

Test date [DD/MM/YYYY]				29.11.2011		—
Maximum system voltage [V _{DC}]				1000		—
High voltage applied [V _{DC}]				6000		—
Insulation resistance measured at [V _{DC}]				3000		—
Sample #	Measured	Area	Result*	Dielectric breakdown		—
	[GΩ]	[m ²]	[GΩ * m ²]	Yes (description)	No	
20110007144	166.1	1.28	212.6	—	X	P
20110007145	94.4	1.62	152.9	—	X	P
* Minimum requirement acc. to the standard is 0.04 GΩ*m ² .						
Supplementary information:						

Wet leakage current test after Mechanical load test (10.15)

Test date [DD/MM/YYYY]	29.11.2011	—		
Test voltage applied [V]	1000	—		
Solution resistivity [Ω cm]	< 3,500	P		
Solution temperature [$^{\circ}$ C]	22 \pm 3	P		
Sample #	Measured	Area	Result*	—
	[M Ω]	[m ²]	[M Ω * m ²]	
20110007144	64.7	1.28	104.8	P
20110007145	58.5	1.62	74.9	P
* Minimum requirement acc. to the standard is 40 M Ω *m ² .				
Supplementary information:				

Mechanical load test (10.16 E1) 5400 pa

Test date [DD/MM/YYYY]	01.12.2011	—
Pressure mechanical load applied [Pa].....	5400	—
Tensile mechanical load applied [Pa].....	—	—
Sample #	Open circuits (yes/no)	—
20110007144	No	P
20110007145	No	P
Supplementary information: Load was applied pneumatically		

Visual inspection after Mechanical load test (10.1)

Test date [DD/MM/YYYY]	01.12.2011	—
Sample #	Nature and position of findings	—
20110007144	No additional visual defects	P
20110007145	No additional visual defects	P
Supplementary information:		

Maximum power determination after Mechanical load test (10.2)

Test date [DD/MM/YYYY]				01.12.2011				—
Module temperature [°C]				Corrected to 25 °C				—
Irradiance [W/m²]				1000 or *				—
Sample #	Pmpp [W]	Vmpp [V]	Impp [A]	Voc [V]	Isc [A]	FF [%]	Degradation [%]	—
20110007144	183.71	35.8	5.1	44.5	5.6	74.22	0.65%	P
20110007145	220.79	28.7	7.7	36.6	8.4	71.47	2.02%	P
* relative measurements with irradiance levels different from 1000 W/m² were performed								
Supplementary information: Maximum allowable Pmpp degradation after this test is 5%.								

Insulation test after Mechanical load test (10.3)

Test date [DD/MM/YYYY]				01.12.2011		—
Maximum system voltage [V _{DC}]				1000		—
High voltage applied [V _{DC}]				6000		—
Insulation resistance measured at [V _{DC}]				3000		→
Sample #	Measured	Area	Result*	Dielectric breakdown		—
	[GΩ]	[m²]	[GΩ * m²]	Yes (description)	No	
20110007144	97.5	1.28	124.8	No	—	P
20110007145	91.8	1.62	148.7	No	—	P
Supplementary information:						

Wet leakage current test after Mechanical load test (10.15)

Test date [DD/MM/YYYY]	01.12.2011			—
Test voltage applied [V]	6000			—
Solution resistivity [Ω cm]	< 3,500			P
Solution temperature [$^{\circ}$ C]	22 \pm 3			P
Sample #	Measured	Area	Result*	—
	[M Ω]	[m 2]	[M Ω * m 2]	
20110007144	62.7	1.28	80.3	P
20110007145	65.9	1.62	106.8	P
Supplementary information:				

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.
- The calibration to STC was performed with a class AAA solar simulator. The extended measurement uncertainty is:
 - o $2\sigma (P_{mpp}) \leq \pm 2.5 \%$
 - o $2\sigma (I_{SC}) \leq \pm 2.3 \%$
 - o $2\sigma (V_{OC}) \leq \pm 1.0 \%$
- 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
PSL-LOAD.exe	2.5.6.5	December 2006	Operating software pulsed solar simulator
Sefelec SXS Pro	7.11.0397	October 2008	ISO / WL

Annex 3: Measurement reports

Flash curves without figures

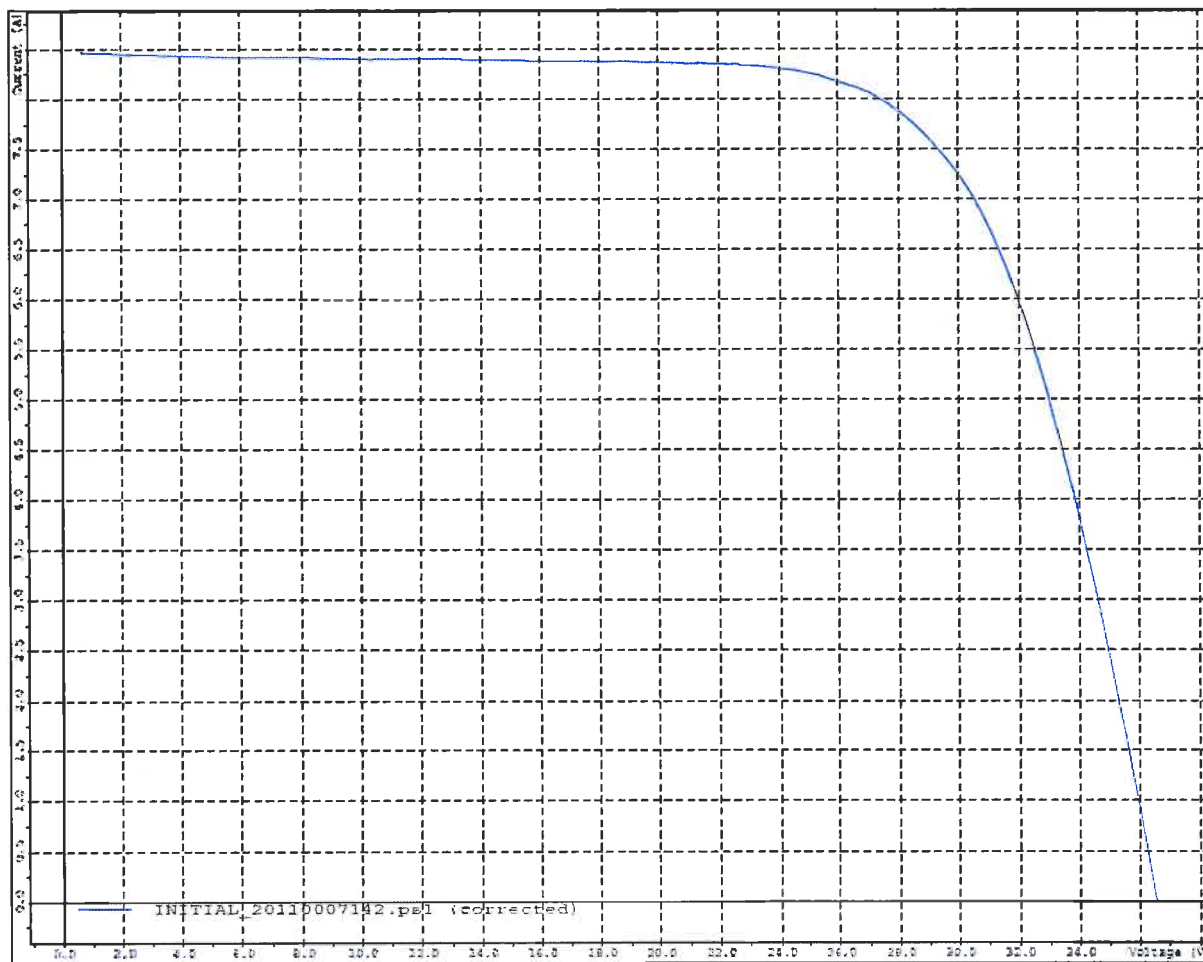


Fig. 1: Initial BC 20110007142

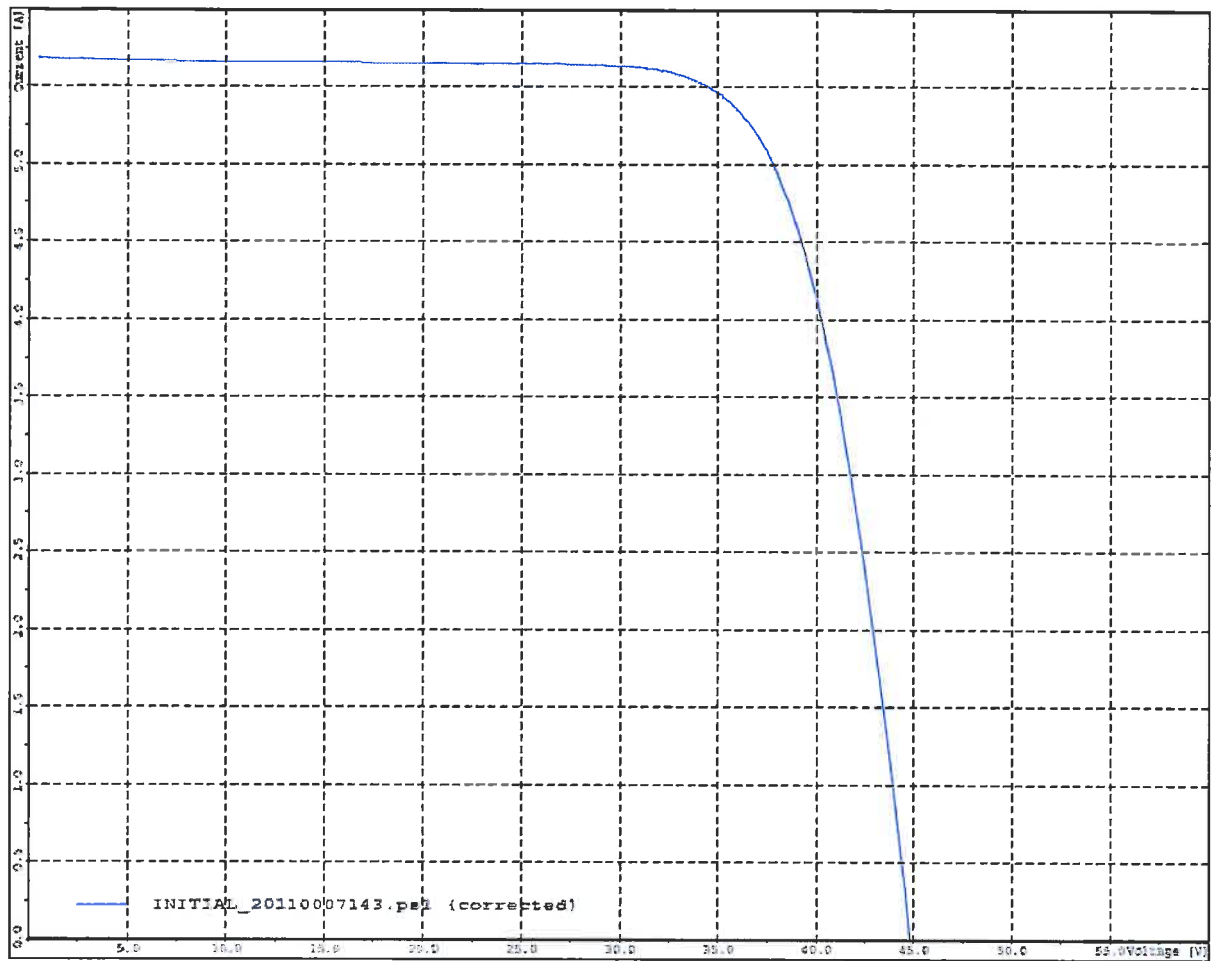


Fig. 2: Initial BC 20110007143

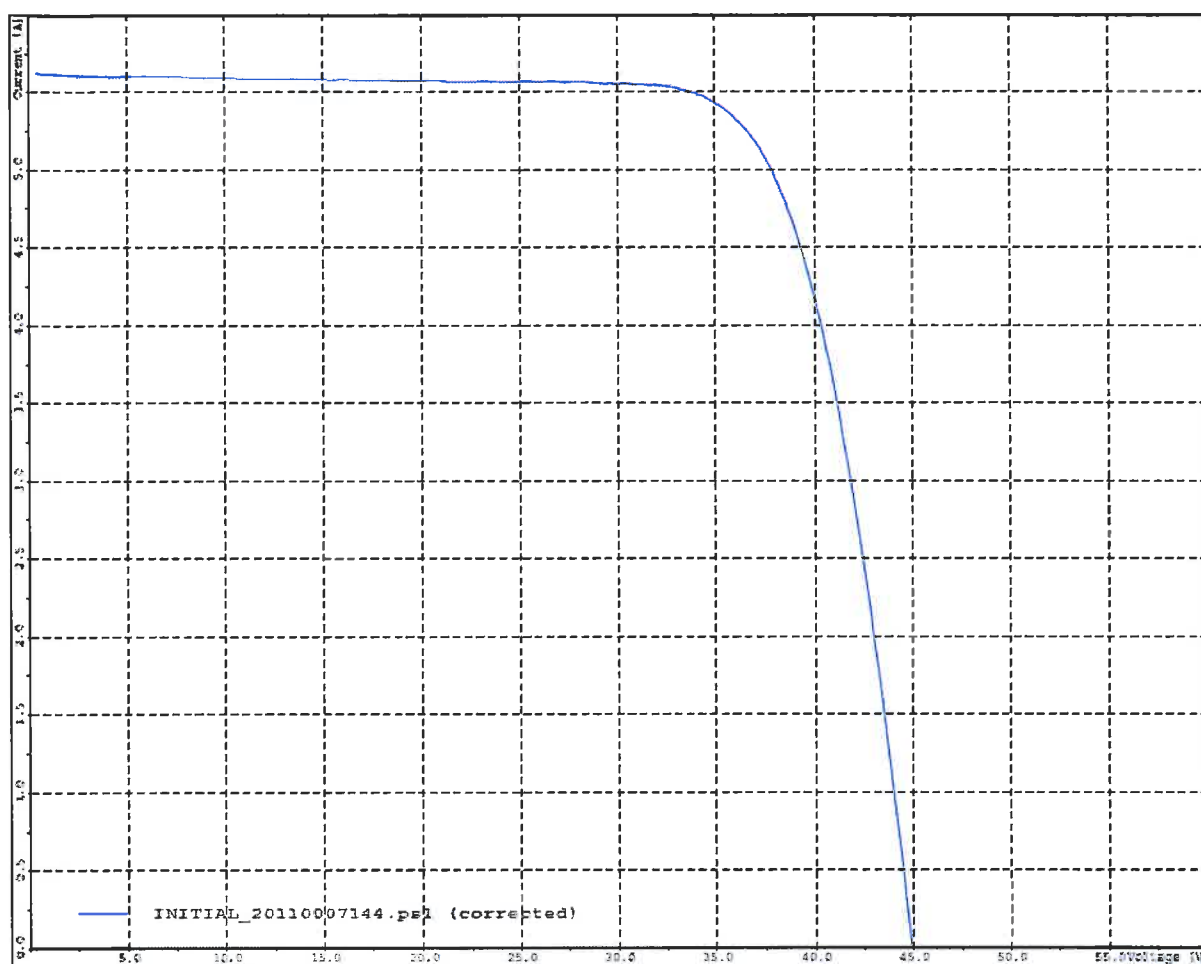


Fig. 3: Initial BC 20110007144

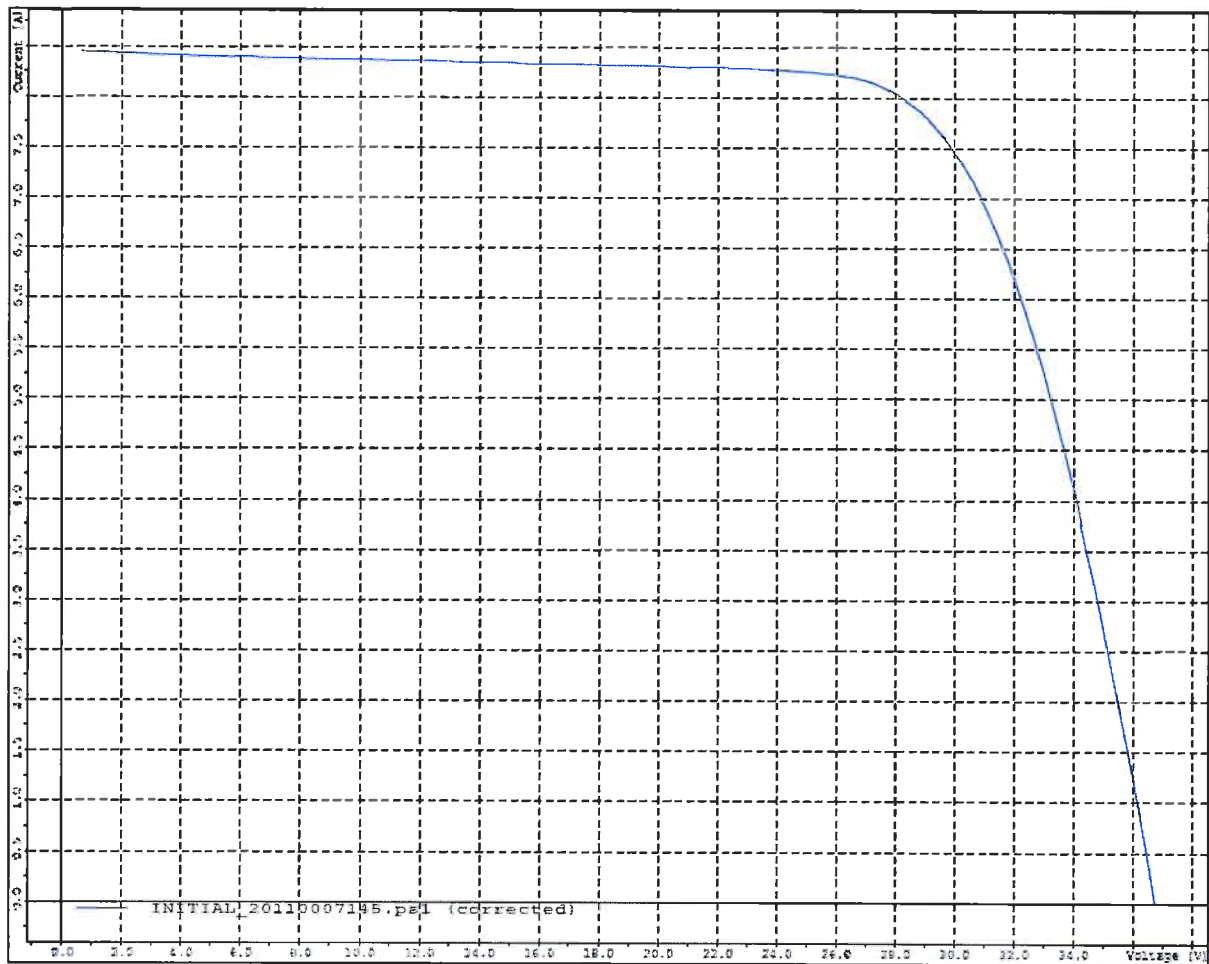


Fig. 4: Initial BC 20110007145

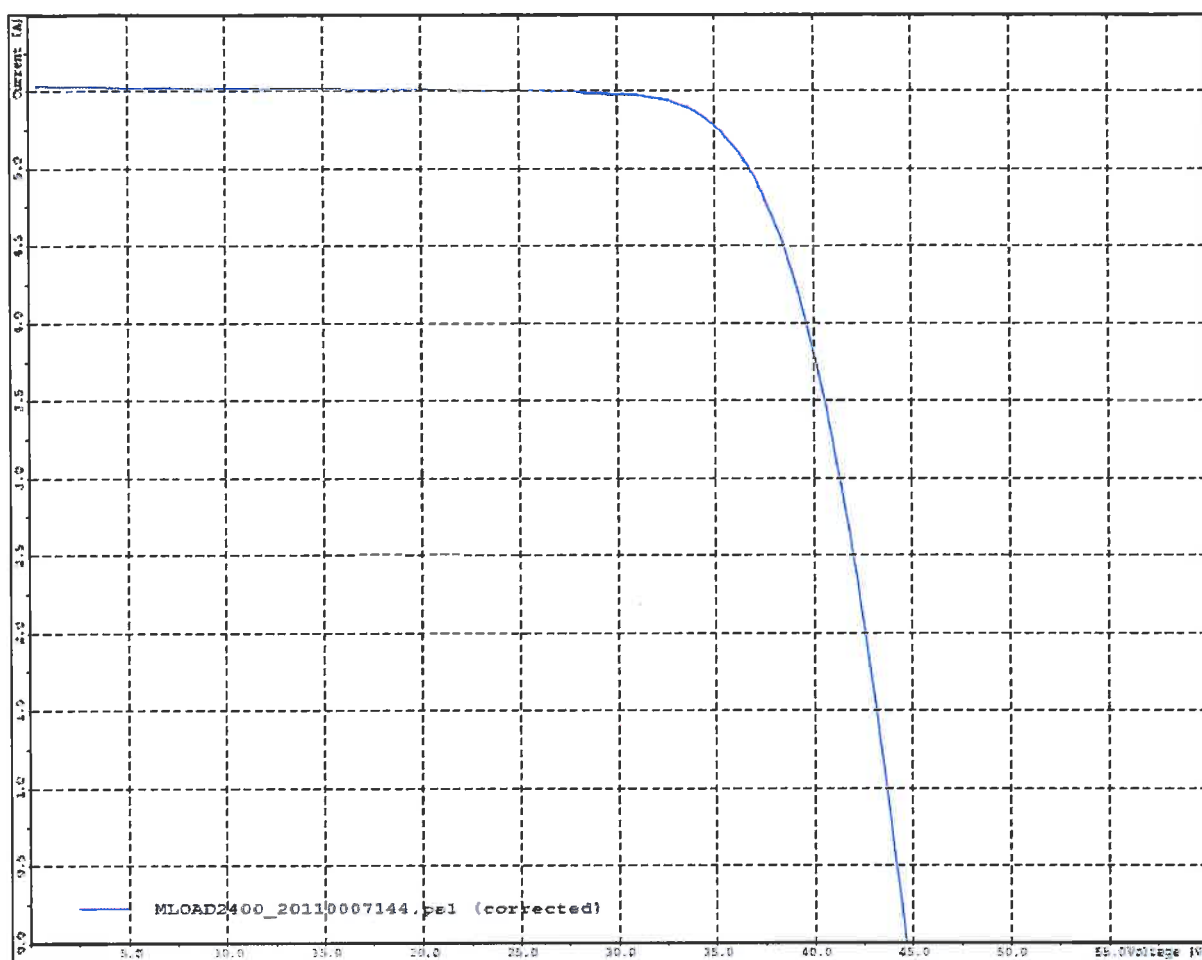


Fig. 5: NM 2400 Pa BC 20110007144

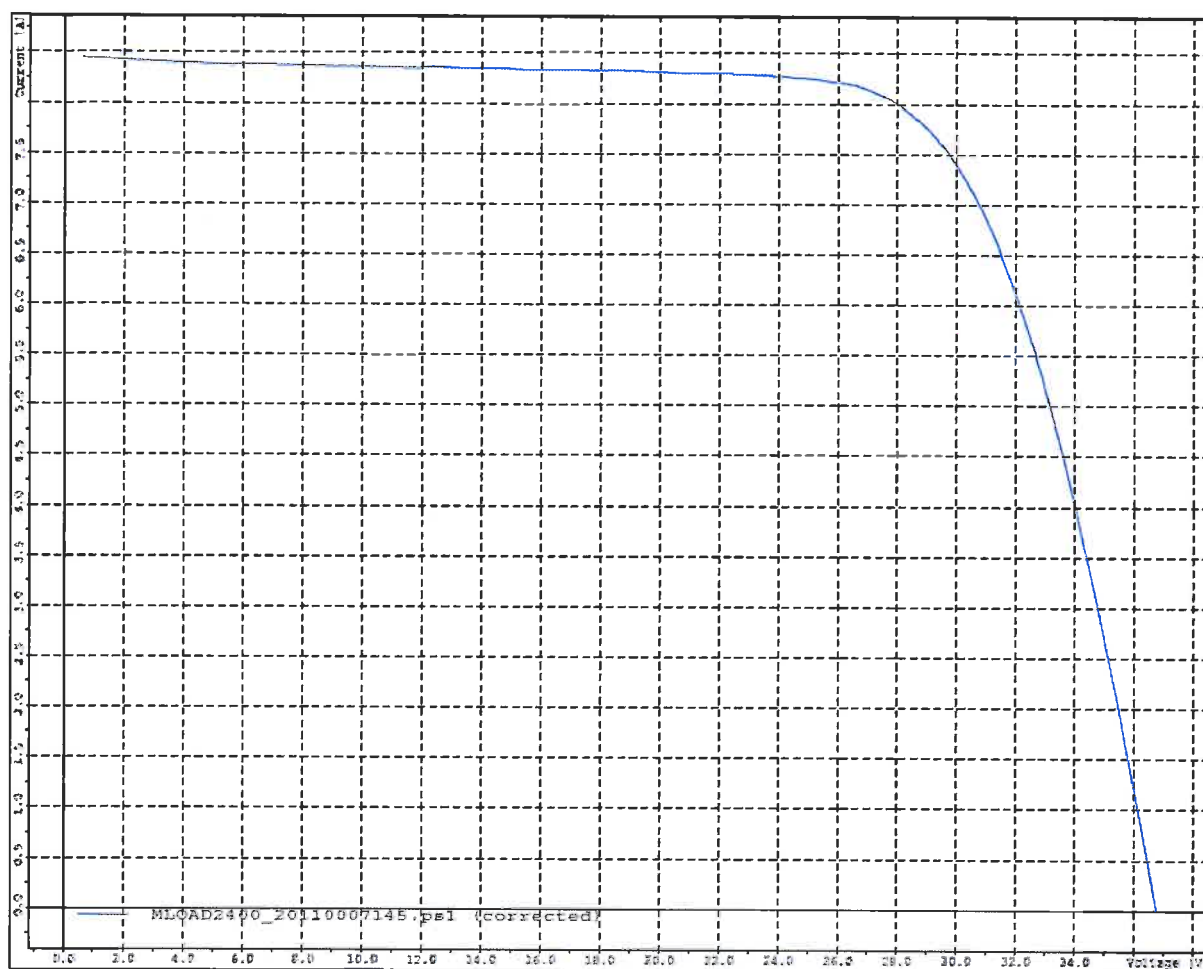


Fig. 6: NM 2400 Pa BC 20110007145

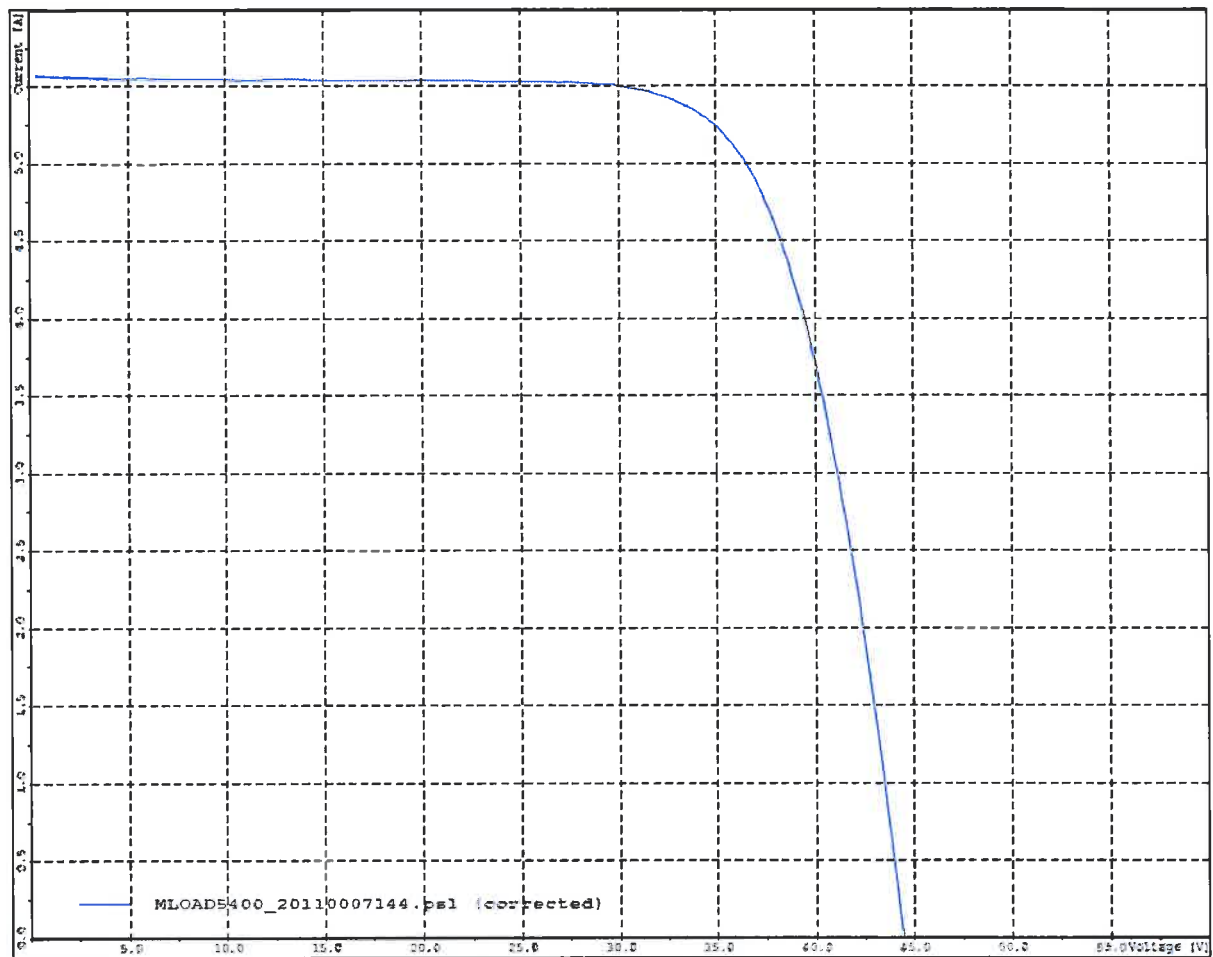


Fig. 7: NM 5400 Pa BC 20110007144

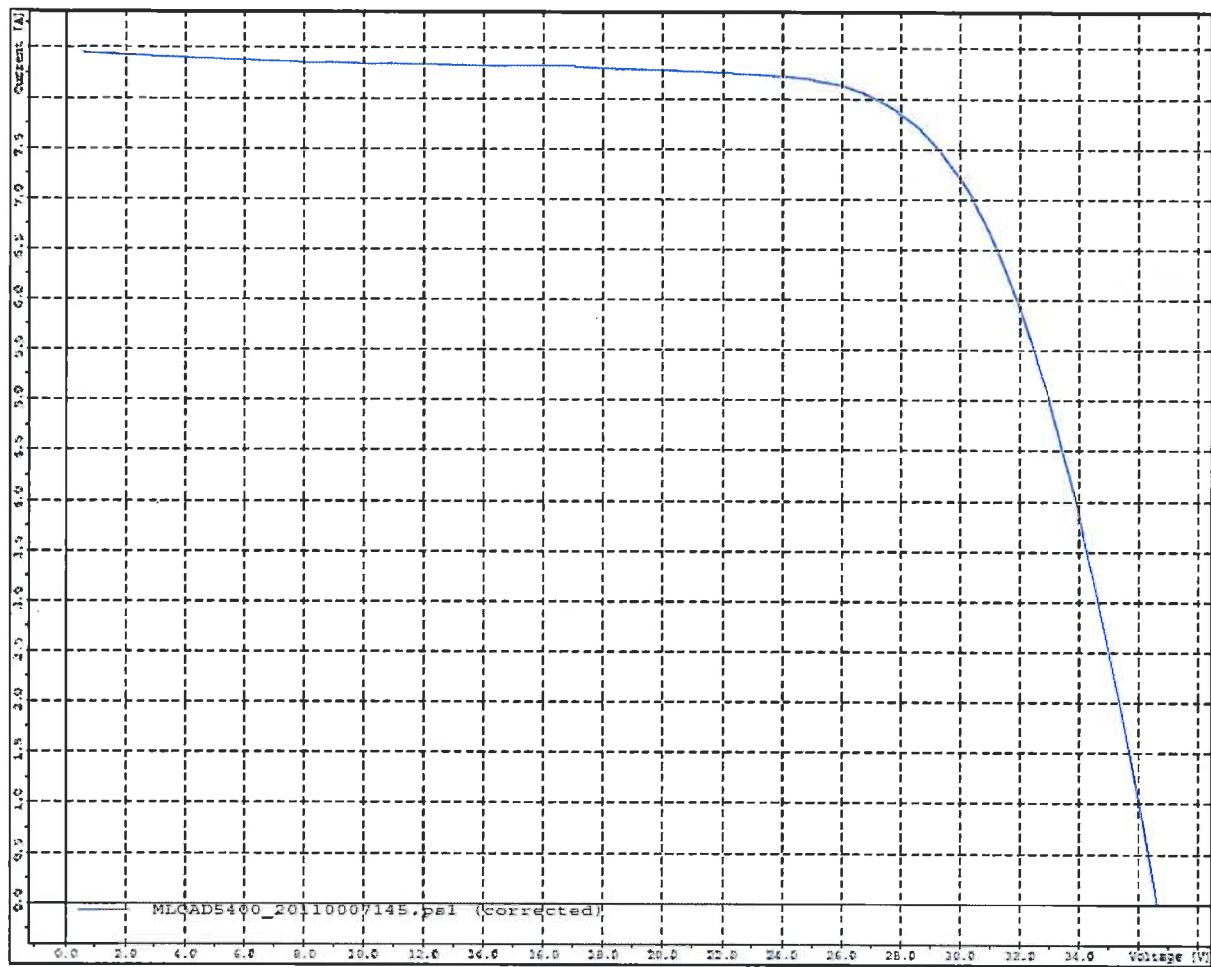


Fig. 8: NM 5400 Pa BC 20110007145

Annex 5: Electroluminescence picture

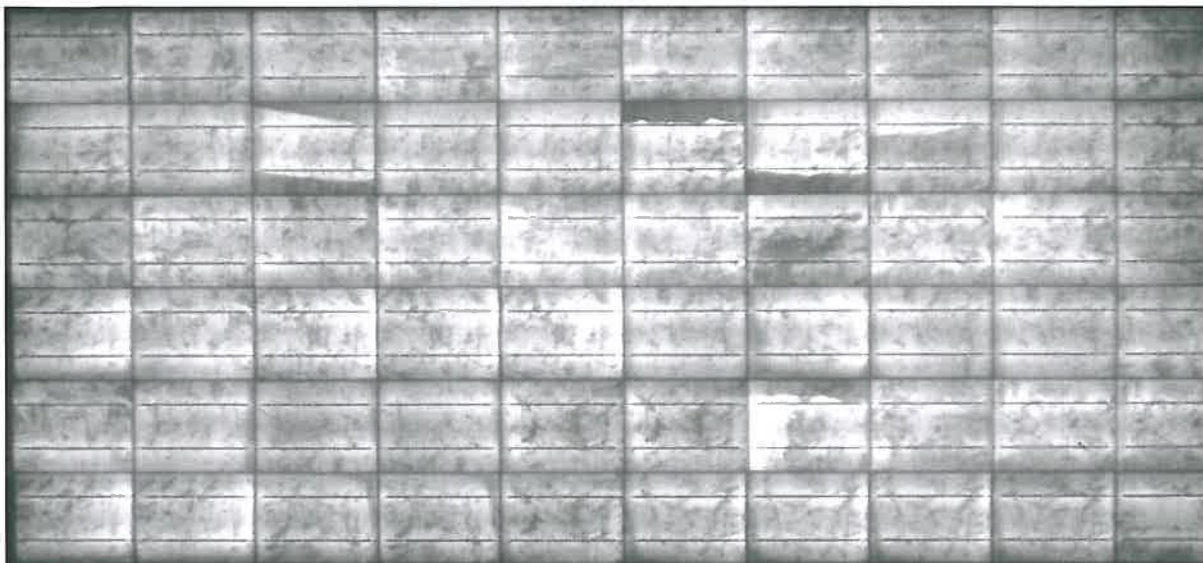


Fig. 9: Initial BC 20110007142

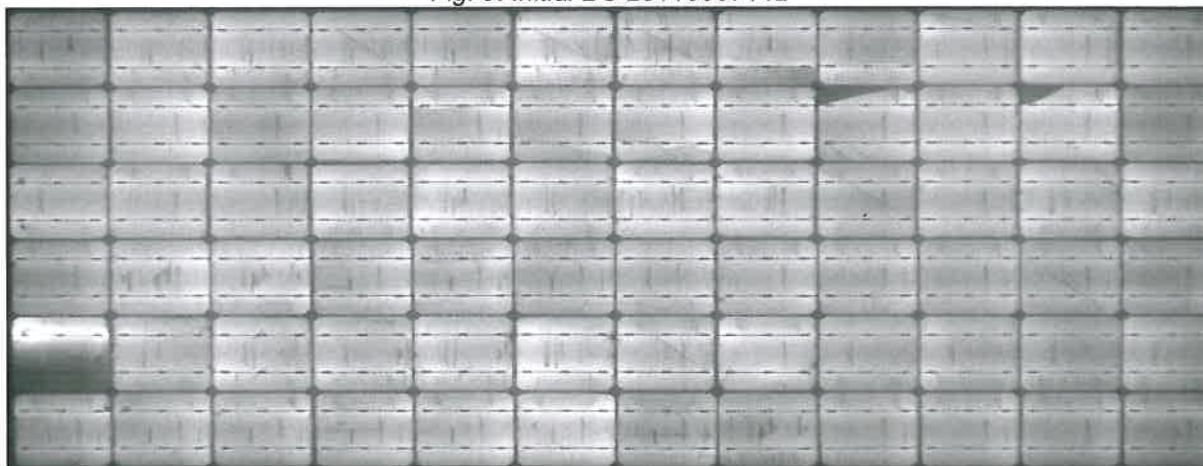


Fig. 10: Initial BC 20110007143

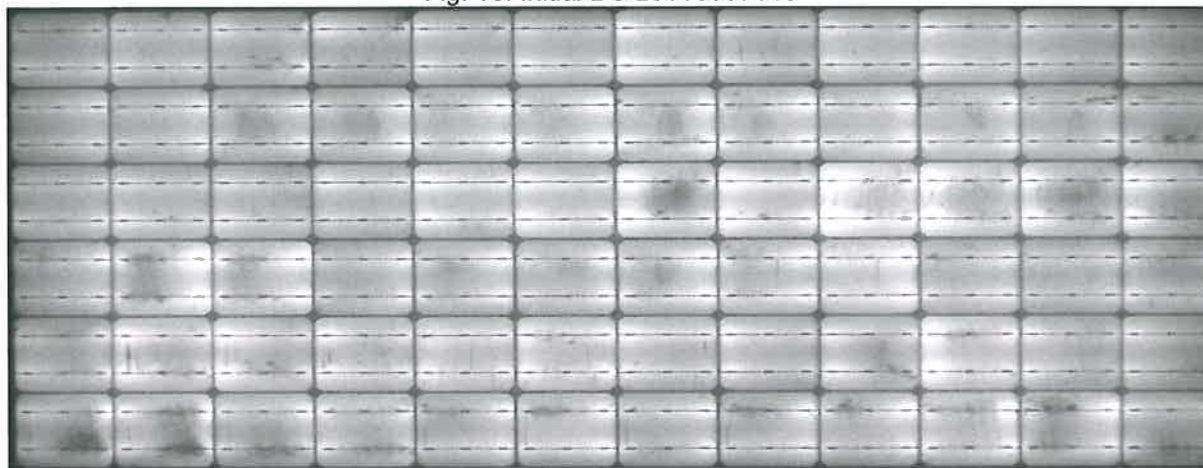


Fig. 11: Initial BC 20110007144

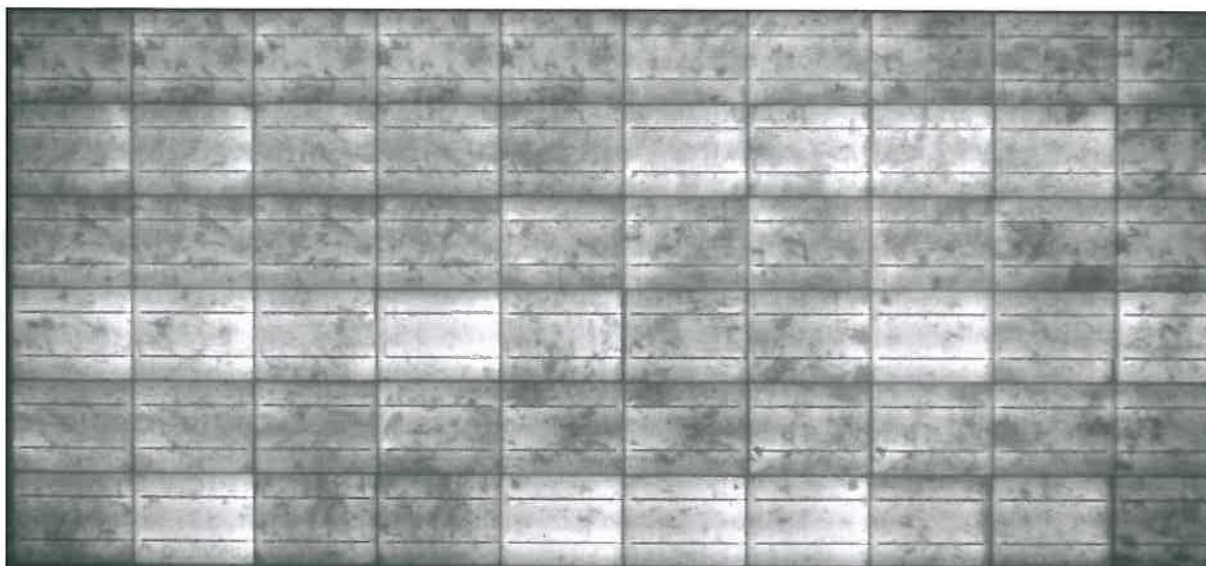


Fig. 12: Initial BC 20110007145



Fig. 13 NM 2400 Pa BC 20110007144

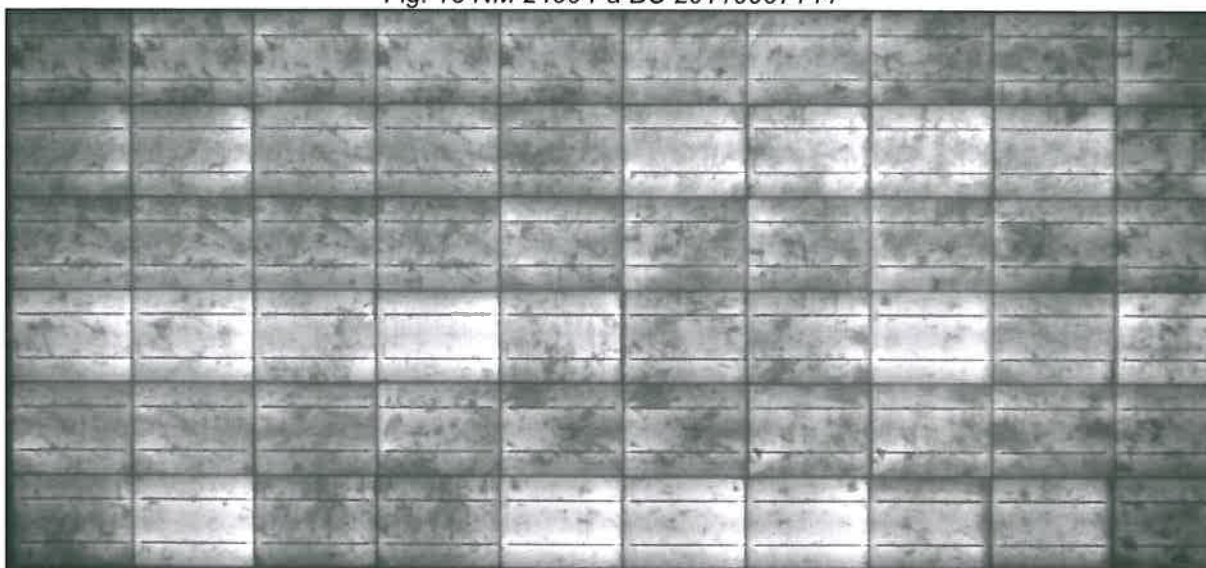


Fig. 14: NM 2400 Pa BC 20110007145

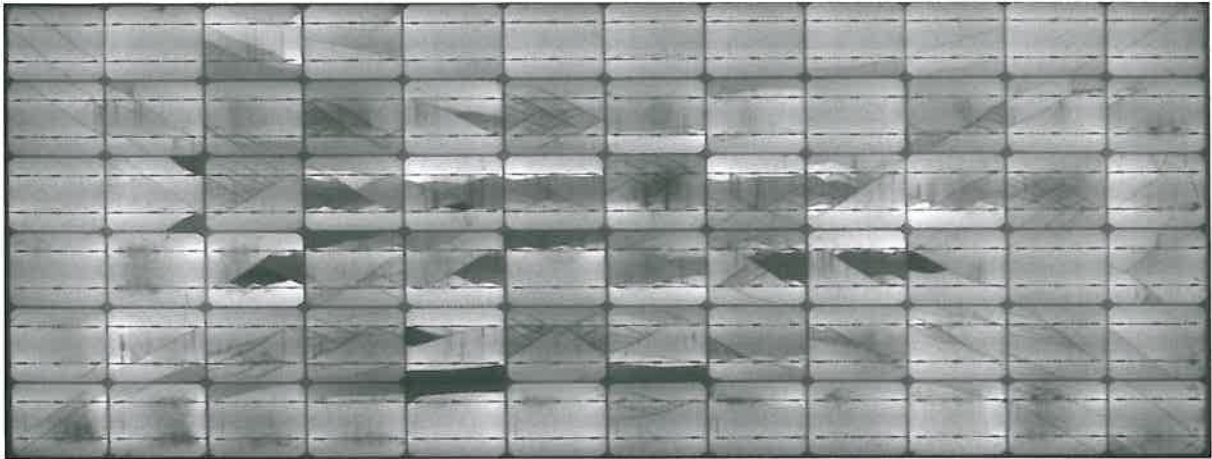


Fig. 15: NM 2400 Pa BC 20110007144

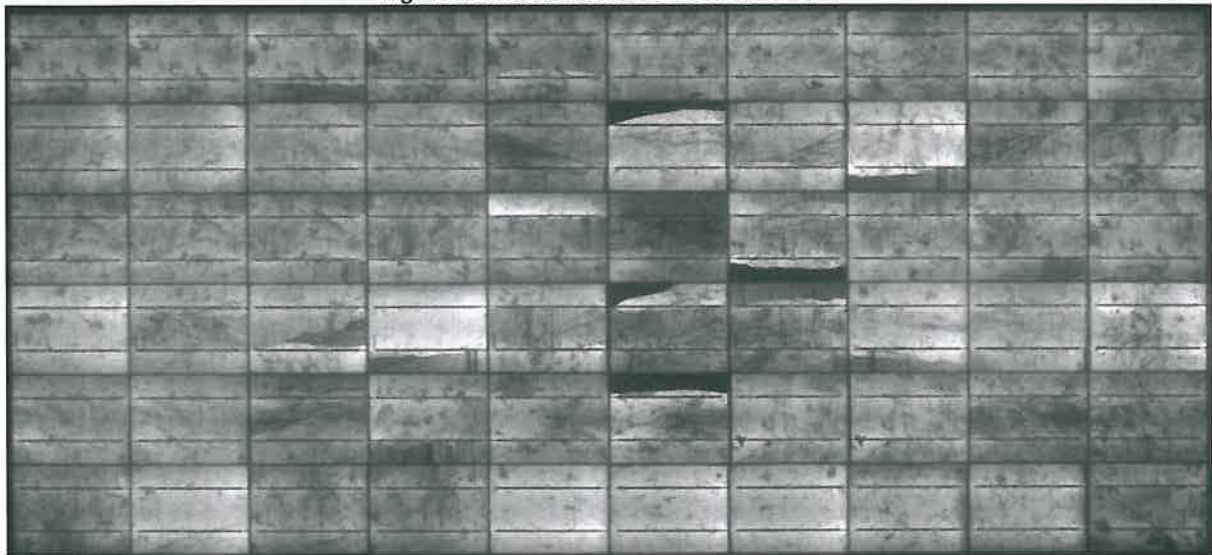


Fig. 16: NM 5400 Pa BC 20110007145

Annex 6: Photos of modules and visual defects

Hareon HR-220P

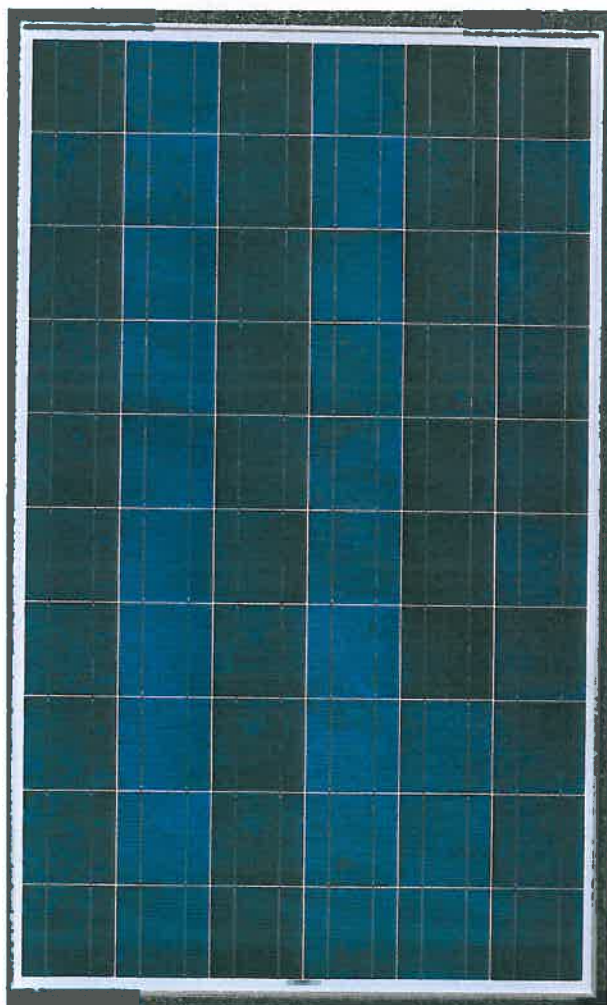


Fig. 17: front view of test sample

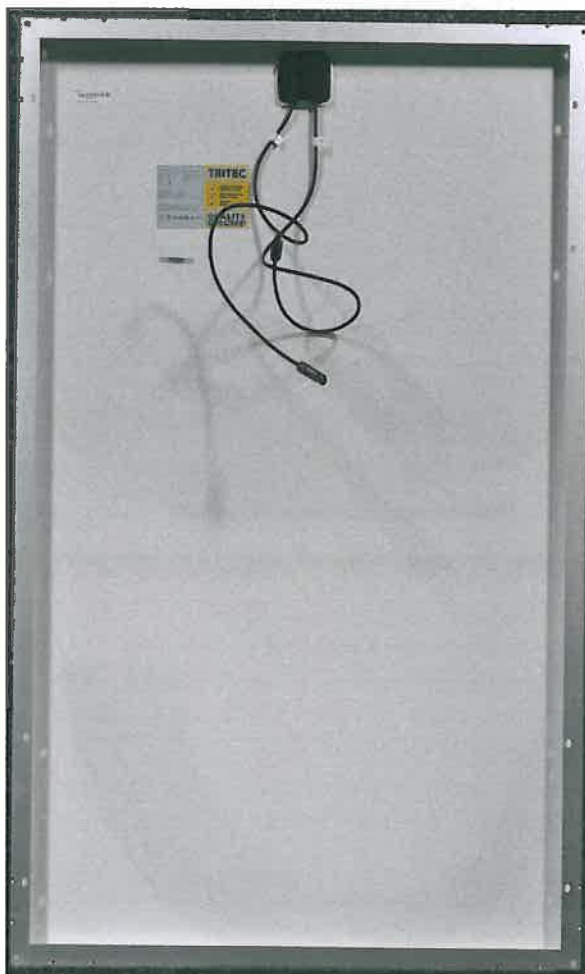


Fig. 18: rear view of test sample

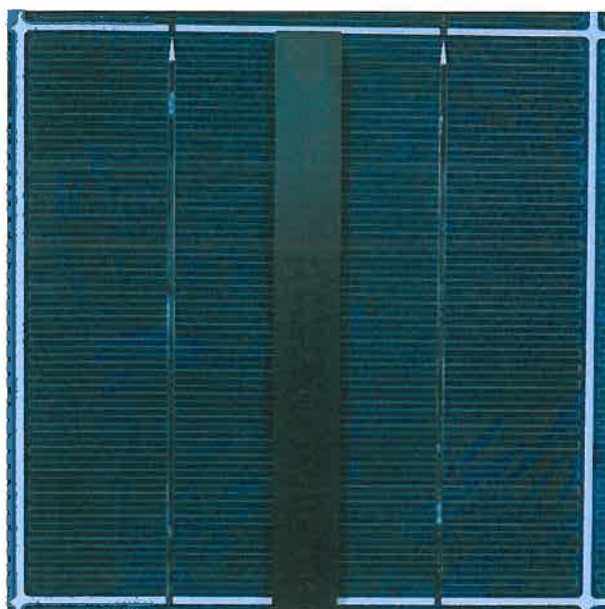


Fig. 19: detail view of solar cell



Fig. 21: detail view of closed junction box

Fig. 20: detail view of type label



Fig. 22: detail view of connectors



Fig. 23: detail view of cables

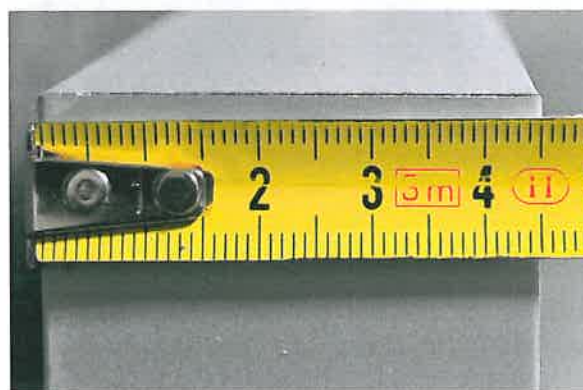
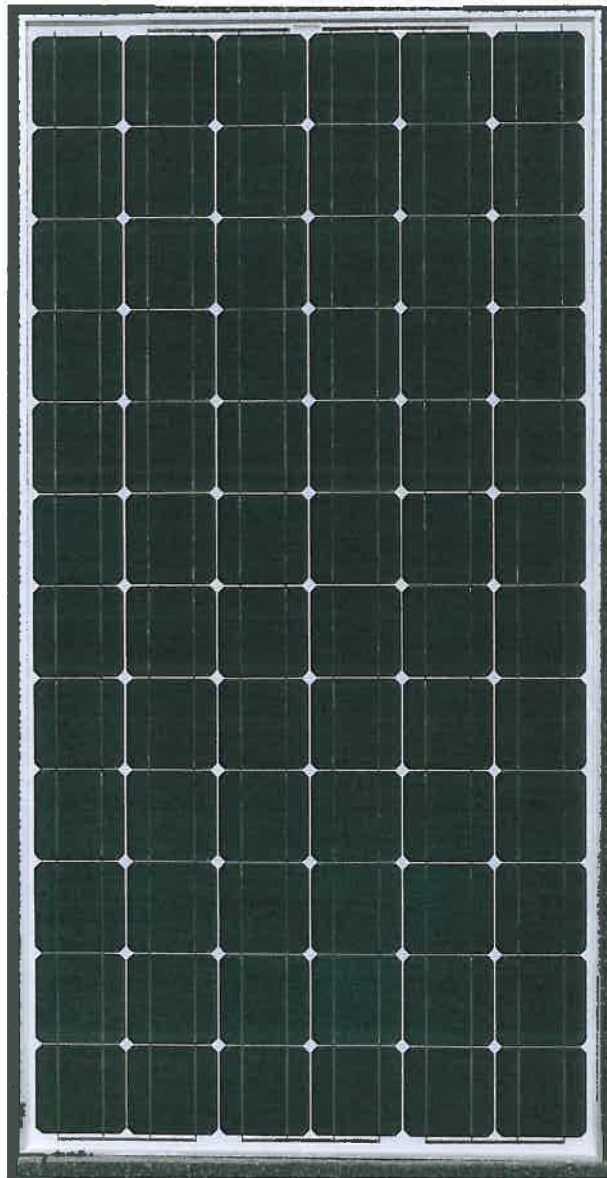
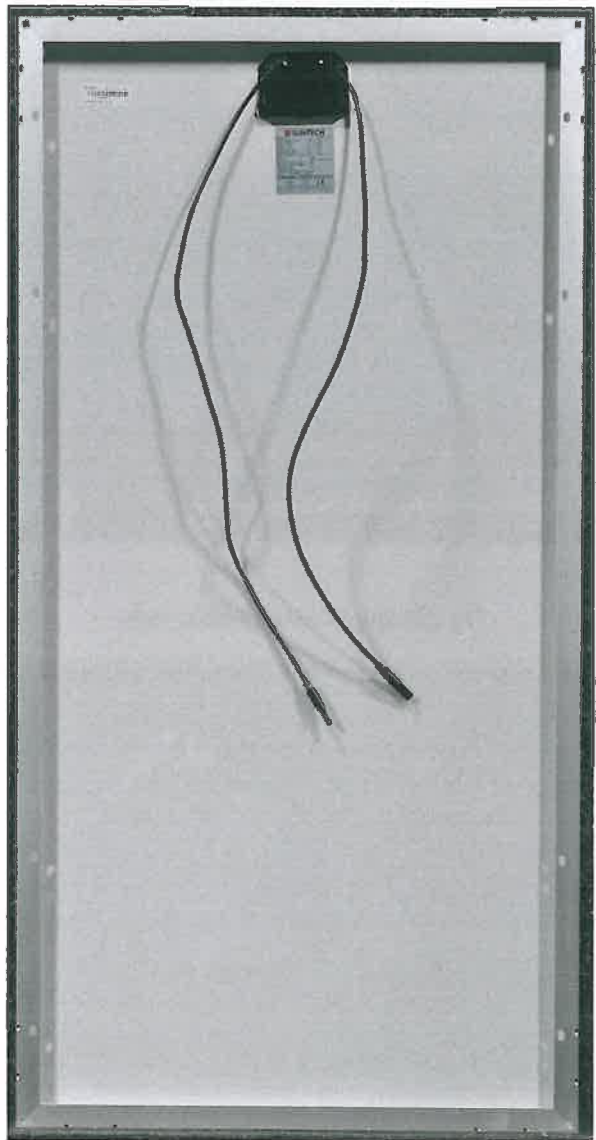


Fig. 24: detail view of frame corner

Suntech STP185S-24

*Fig. 25: front view of test sample**Fig. 26: rear view of test sample*

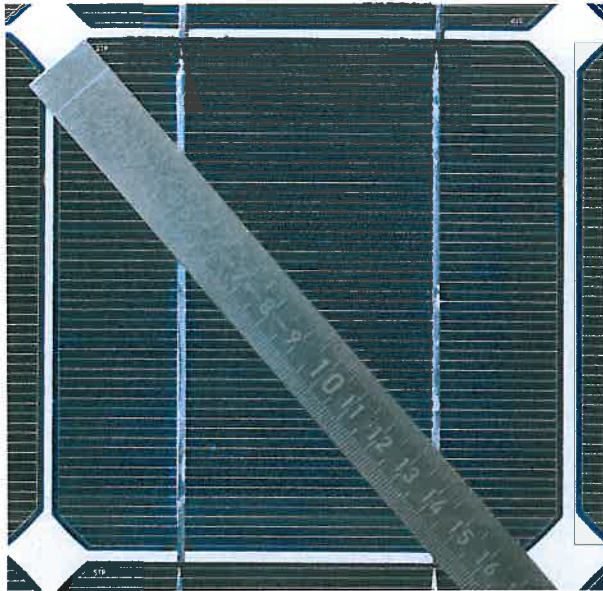


Fig. 27: detail view of solar cell

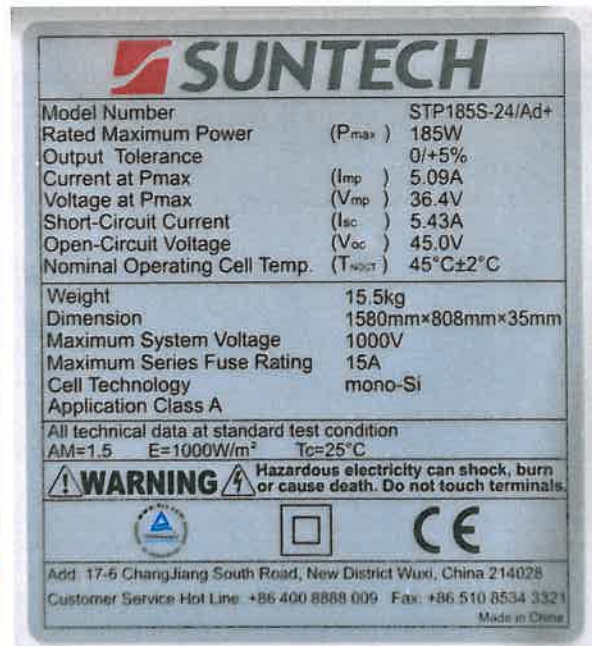


Fig. 28: detail view of type label



Fig. 29: detail view of closed junction box



Fig. 30: detail view of connectors

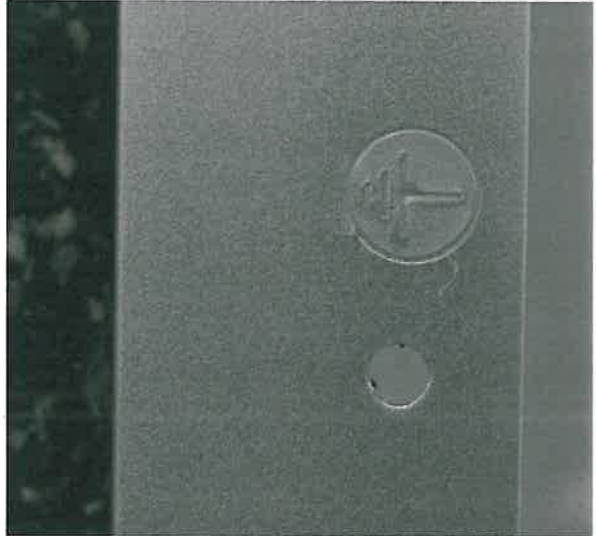


Fig. 31: detail view of cables

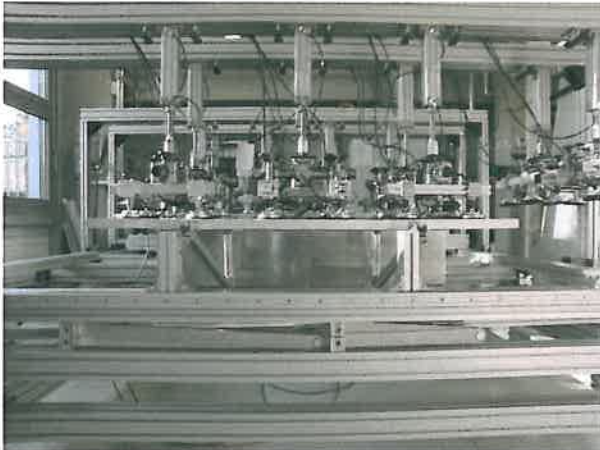


Fig. 33: mechanical load test setup Suntech / TRI-STAND Aero 80 (total view)

Fig. 32: detail view of grounding mark

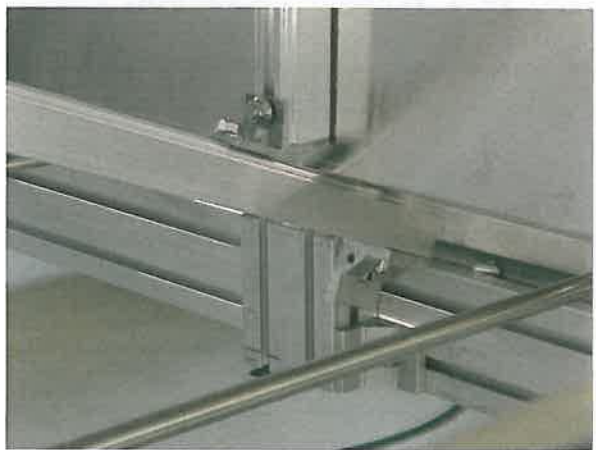


Fig. 34: mechanical test setup Suntech / TRI-STAND Aero 80 (mounting points)

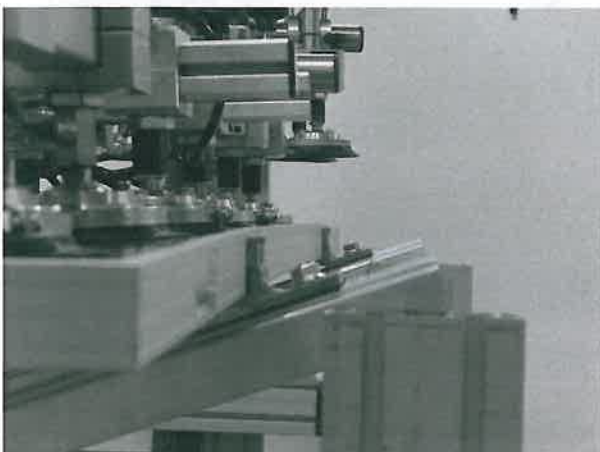


Fig. 35: deflection PV-module 2400 Pa pressure



Fig. 36: deflection PV-module 2400 Pa tension



Fig. 37: deflection PV-module 5400 Pa pressure

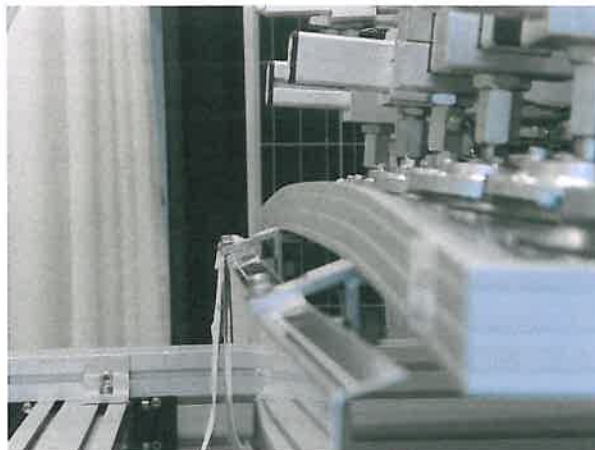


Fig. 38: Detail PV-module 5400 Pa pressure



Fig. 39: mechanical load test setup Hareon / TRI-STAND Aero 100 (total view)

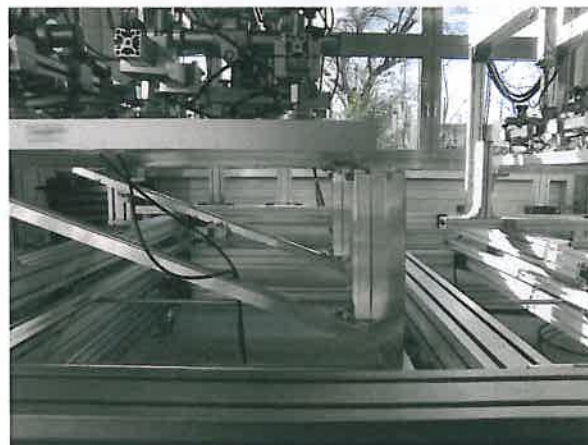


Fig. 40: mechanical load test setup Hareon / TRI-STAND Aero 100 (mounting points)



Fig. 41: deflection PV-module 2400 Pa pressure

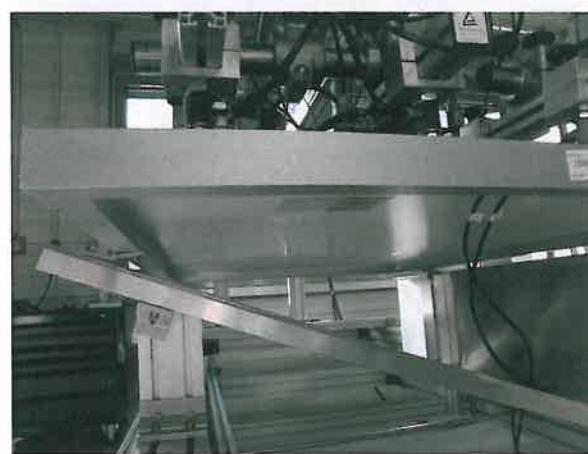


Fig. 42: deflection PV-module 2400 Pa tension

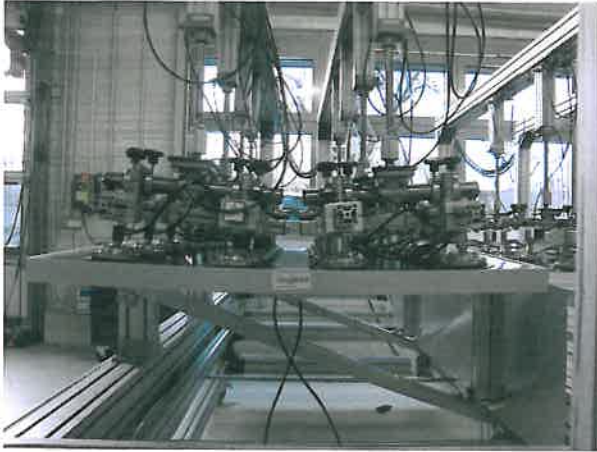


Fig. 43: deflection PV-module 5400 Pa pressure

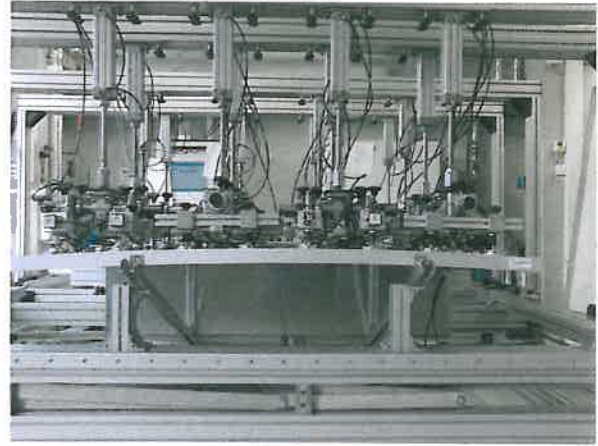


Fig. 44: Detail PV-module 5400 Pa pressure

