TÜV NORD (Hangzhou) Co., Ltd.

Room 217, Building 17, No.57,
Kejiyuan Road, Baiyang Street,
HEDA, Hangzhou, Zhejiang
Province, China, 310019

Phone: +86 (0) 571 8538 6989
Fax: +86 (0) 571 8538 6986

hzpcert@tuv-nord.com
www.tuv-nord.com/cn

Test Report
No. TRPVP07120/23P/01

Performance Measurement about PV Modules

Applicant: **Guangdong Lesso Banhao New Energy Technology Group Co., Ltd**
Liansu Industrial Estate, Longjiang, Shunde, Foshan, Guangdong, China

File No.: PVP07120/23P-01

Designed: Sep. 13. 2023 by: Ruan Zhu
(Project Engineer)

Reviewed: Sep 13, 2023 by: Ny Zy
(Technical Certifier)

Applicant ..... :	**Guangdong Lesso Banhao New Energy Technology Group Co., Ltd** Liansu Industrial Estate, Longjiang, Shunde, Foshan, Guangdong, China
Manufacturer ..... :	**Guangdong Lesso Banhao New Energy Technology Group Co., Ltd** Liansu Industrial Estate, Longjiang, Shunde, Foshan, Guangdong, China
Order No. ..... :	QT-PVP07120/23P
Date of Application ..... :	07/21/2023
Product ..... :	PV Modules and mounting bracket
Module type(s) ..... :	144 cells: 565C(HBD)72(182) 132 cells: 655D(HBD)66(210)
General Information • Maximum System Voltage.... : • Application Class ..... : • Electrical Protection Class.... : • Fire Safety Class ..... :	 DC 1500V Class A Class II N/A
Type of examination ..... :	Commission testing only
Testing Period ..... :	08/08/2023 - 09/05/2023
Testing Laboratory..... :	**NOA Testing & Inspection Technology Ltd.** Building 3, 169 Lianchuan Road, Minhang District, Shanghai, China **Engineering Research Center of Style of Study in Central South University (For Wind tunnel test only)** No.22, South Shaoshan Road, Tianxin District, Changsha City, Hunan Province, P.R. China

Test results listed in this test report refer exclusively to the mentioned test sample.

List of contents

Summary of testing
According to the enquiry of the applicant, a commission testing was performed. The initial and final test were based on IEC 61215-2:2016, IEC 61730-2:2016, and wind tunnel test was based on the requirement of applicant. The testing items are listed in page 7 in this report. Module types 565C(HBD)72(182) and 655D(HBD)66(210) were delivered to testing lab as test samples and conducted with all the related tests.

General remarks

Test item particulars:	
Accessories and detachable parts included in the evaluation .....:	N/A
Options included.....:	N/A
Abbreviations used in the report:	
HF - Humidity Freeze	TC - Temperature Cycling
DH - Damp Heat	Vmpp - Maximum power voltage
Impp - Maximum power 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
CTI - Comparative Tracking Index	PD - Partial Discharge
Possible test case verdicts:	
Test case does not apply to the test object.....:	Not Applicable (N/A)
Test object does meet the requirement.....:	Pass (P)
Test object does not meet the requirement.....:	Fail (F)
Other 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 Annex #)” refers to additional information appended to the report. “(see Table #)” refers to a table appended to the report. Power degradation data expressed in negative value indicates a reduction of maximum power output. Power degradation data expressed in positive value indicates an increment of maximum power output. The power parameter included in the module types only indicates maximum power output of front side. Throughout this report, a point is used as the decimal separator.	

Module group assignment

Module type: 565C(HBD)72(182)

Sample #	Serial number	Dimension (l x w x h) [mm]	Remark
1	BH1F61LAC230723030380	2278 x 1134 x 35	Wind tunnel test

Module type: 655D(HBD)66(210)

Sample #	Serial number	Dimension (l x w x h) [mm]	Remark
2	0534373123760124171	2384 x 1303 x 35	Wind tunnel test

Clause	Requirement + Test	Result - Remark	Verdict

Test result overview

Initial examinations			-
MQT01/MST01	Visual inspection ..... :	See table 4.1 & 10.2	N/A
MQT03/MST16	Insulation test ..... :	See table 4.3 & 10.13	N/A
MQT15/MST17	Wet leakage current test ..... :	See table 4.15 & 10.14	N/A
MQT02/MST03	Maximum power determination ..... :	See table 10.4	N/A
MST13	Continuity test for equipotential bonding ..... :	See table 10.11	N/A

6	Wind tunnel test Install sample according to customer requirement. Turn on the fan and apply wind loads (10m/s, 35m/s, 45m/s, 60m/s) in turn, with a duration of 1 minute for each wind load (Except for 60m/s). When the specified wind speed (60m/s) is reached and stable, continue the test for 10 minutes. Check the samples in 2 kinds of condition (windward 90 ° and leeward 90 °) whether the deformation and vibration, damage or loose.	See table 6	N/A

Final examinations			-
MQT01/MST01	Visual inspection ..... :	See table 4.1 & 10.2	N/A
MQT03/MST16	Insulation test ..... :	See table 4.3 & 10.13	N/A
MQT15/MST17	Wet leakage current test ..... :	See table 4.15 & 10.14	N/A
MQT02/MST03	Maximum power determination ..... :	See table 10.4	N/A
MST13	Continuity test for equipotential bonding ..... :	See table 10.11	N/A

WIND TUNNEL TEST			
Clause	Requirement + Test	Result - Remark	Verdict

Test results of Wind tunnel test

Module type: 565C(HBD)72(182)

4.1 Visual inspection (initial) - MQT01/MST01		-
Test date [MM/DD/YYYY].....:	08/08/2023	-
Sample #	Nature and position of initial findings - comments or attach photos	-
1	No visual defects	N/A
Supplementary information: N/A		

WIND TUNNEL TEST			
Clause	Requirement + Test	Result - Remark	Verdict

4.3 Insulation test (initial) - MQT03/MST16				-
Test date [MM/DD/YYYY].....:		08/08/2023		-
Test voltage applied [V].....:		2 minutes of 1500 and 1 minute of 8000		-
Sample #	Required [MΩ]	Measured [MΩ]	Dielectric breakdown?	-
1	15.5	>1000	No	N/A
Supplementary information: Minimum requirement according to the standard is 40MΩ·m^2. Area of the module is 2.58m^2.				

WIND TUNNEL TEST			
Clause	Requirement + Test	Result - Remark	Verdict

4.15 Wet leakage current test (initial) - MQT15/MST17			-
Test date [MM/DD/YYYY].....:		08/08/2023	-
Test voltage applied [V].....:		2 minutes of 1500	-
Solution resistivity [Ω/cm] / <3500 .....:		2331	-
Solution temperature [°C] / 22±2 .....:		22.4	-
Sample #	Required [MΩ]	Measured [MΩ]	-
1	15.5	>1000	N/A
Supplementary information: Minimum requirement according to the standard is 40MΩ·m^2. Area of the module is 2.58m^2.			

WIND TUNNEL TEST			
Clause	Requirement + Test	Result - Remark	Verdict

10.4 Maximum power determination (initial) - MQT02/MST03							-
Test date [MM/DD/YYYY].....:			08/08/2023				-
Ambient temperature [°C].....:			Corrected to 25.0				-
Irradiance [W/m^2].....:			Corrected to 1000				-
Sample #	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]	-
1	51.96	44.20	13.55	12.93	571.4	81.17	-
Supplementary information: Exposure under 1000W/m^2 on the front side with rear side covered by black cover.							

WIND TUNNEL TEST			
Clause	Requirement + Test	Result - Remark	Verdict

10.11 Continuity test of equipotential bonding (initial) - MST13			-
Test date [MM/DD/YYYY].....:		08/08/2023	-
Current applied [A] .....:		75	-
Location of designated grounding point :		The center of one longer side	-
Location of second contacting point .....:		A: Adjacent shorter side with greatest distance from the grounding point B: The center of another longer side C: The center of the other shorter side	-
Sample #	Position in test sequence	Resistance [Ω]	-
1	Initial examination	A: 0.002 B: 0.009 C: 0.003	N/A
Supplementary information: N/A			

WIND TUNNEL TEST			
Clause	Requirement + Test	Result - Remark	Verdict

6 Wind tunnel test					-
Test date [MM/DD/YYYY] / start - end .... :	08/28/2023				-
Sample #..... :	1				-
The direction of the wind ..... :	Windward				-
Wind attack angle ..... :	20	20	20	20	-
Wind velocity [m/s]..... :	10	35	45	60	-
Duration [minute] ..... :	1	1	1	10	-
The direction of the wind ..... :	Leeward				-
Wind attack angle ..... :	20	20	20	20	-
Wind velocity [m/s]..... :	10	35	45	60	-
Duration [minute] ..... :	1	1	1	10	-
Supplementary information: N/A					

WIND TUNNEL TEST			
Clause	Requirement + Test	Result - Remark	Verdict

4.1 Visual inspection (final) - MQT01/MST01			-
Test date [MM/DD/YYYY].....:		09/05/2023	-
Sample #	Nature and position of initial findings - comments or attach photos		-
1	No visual defects		N/A
Supplementary information: N/A			

WIND TUNNEL TEST			
Clause	Requirement + Test	Result - Remark	Verdict

4.3 Insulation test (final) - MQT03/MST16				-
Test date [MM/DD/YYYY].....:		09/05/2023		-
Test voltage applied [V].....:		2 minutes of 1500 and 1 minute of 8000		-
Sample #	Required [MΩ]	Measured [MΩ]	Dielectric breakdown?	-
1	15.5	>1000	No	N/A
Supplementary information: Minimum requirement according to the standard is 40MΩ·m^2. Area of the module is 2.58m^2.				

WIND TUNNEL TEST			
Clause	Requirement + Test	Result - Remark	Verdict

4.15 Wet leakage current test (final) - MQT15/MST17			-
Test date [MM/DD/YYYY].....:		09/05/2023	-
Test voltage applied [V].....:		2 minutes of 1500	-
Solution resistivity [Ω/cm] / <3500 .....:		1908	-
Solution temperature [°C] / 22±2 .....:		22.8	-
Sample #	Required [MΩ]	Measured [MΩ]	-
1	15.5	>1000	N/A
Supplementary information: Minimum requirement according to the standard is 40MΩ·m^2. Area of the module is 2.58m^2.			

WIND TUNNEL TEST			
Clause	Requirement + Test	Result - Remark	Verdict

10.4 Maximum power determination (final) - MQT02/MST03							-
Test date [MM/DD/YYYY].....:			09/05/2023				-
Ambient temperature [°C].....:			Corrected to 25.0				-
Irradiance [W/m^2].....:			Corrected to 1000				-
Sample #	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]	-
1	51.97	44.19	13.46	12.86	568.2	81.21	-
Pmpp degradation after test [%].....:			Sample 1#: -0.56%				N/A
Supplementary information: Exposure under 1000W/m^2 on the front side with rear side covered by black cover.							

WIND TUNNEL TEST			
Clause	Requirement + Test	Result - Remark	Verdict

10.11 Continuity test of equipotential bonding (final) - MST13			-
Test date [MM/DD/YYYY].....:		09/05/2023	-
Current applied [A] .....:		75	-
Location of designated grounding point :		The center of one longer side	-
Location of second contacting point .....:		A: Adjacent shorter side with greatest distance from the grounding point B: The center of another longer side C: The center of the other shorter side	-
Sample #	Position in test sequence	Resistance [Ω]	-
1	Initial examination	A: 0.003 B: 0.008 C: 0.006	N/A
Supplementary information: N/A			

WIND TUNNEL TEST			
Clause	Requirement + Test	Result - Remark	Verdict

Module type: 655D(HBD)66(210)

4.1 Visual inspection (initial) - MQT01/MST01		-
Test date [MM/DD/YYYY].....:	08/08/2023	-
Sample #	Nature and position of initial findings - comments or attach photos	-
2	No visual defects	N/A
Supplementary information: N/A		

WIND TUNNEL TEST			
Clause	Requirement + Test	Result - Remark	Verdict

4.3 Insulation test (initial) - MQT03/MST16				-
Test date [MM/DD/YYYY].....:		08/08/2023		-
Test voltage applied [V].....:		2 minutes of 1500 and 1 minute of 8000		-
Sample #	Required [MΩ]	Measured [MΩ]	Dielectric breakdown?	-
2	12.9	>1000	No	N/A
Supplementary information: Minimum requirement according to the standard is 40MΩ·m^2. Area of the module is 3.11m^2.				

WIND TUNNEL TEST			
Clause	Requirement + Test	Result - Remark	Verdict

4.15 Wet leakage current test (initial) - MQT15/MST17			-
Test date [MM/DD/YYYY].....:		08/08/2023	-
Test voltage applied [V].....:		2 minutes of 1500	-
Solution resistivity [Ω/cm] / <3500 .....:		2331	-
Solution temperature [°C] / 22±2 .....:		22.4	-
Sample #	Required [MΩ]	Measured [MΩ]	-
2	12.9	>1000	N/A
Supplementary information: Minimum requirement according to the standard is 40MΩ·m^2. Area of the module is 3.11m^2.			

WIND TUNNEL TEST			
Clause	Requirement + Test	Result - Remark	Verdict

10.4 Maximum power determination (initial) - MQT02/MST03							-
Test date [MM/DD/YYYY].....:			08/08/2023				-
Ambient temperature [°C].....:			Corrected to 25.0				-
Irradiance [W/m^2].....:			Corrected to 1000				-
Sample #	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]	-
2	45.68	38.58	18.08	17.26	666.0	80.66	-
Supplementary information: Exposure under 1000W/m^2 on the front side with rear side covered by black cover.							

WIND TUNNEL TEST			
Clause	Requirement + Test	Result - Remark	Verdict

10.11 Continuity test of equipotential bonding (initial) - MST13			-
Test date [MM/DD/YYYY].....:		08/08/2023	-
Current applied [A] .....:		75	-
Location of designated grounding point :		The center of one longer side	-
Location of second contacting point .....:		A: Adjacent shorter side with greatest distance from the grounding point B: The center of another longer side C: The center of the other shorter side	-
Sample #	Position in test sequence	Resistance [Ω]	-
2	Initial examination	A: 0.010 B: 0.004 C: 0.011	N/A
Supplementary information: N/A			

WIND TUNNEL TEST			
Clause	Requirement + Test	Result - Remark	Verdict

6 Wind tunnel test					-
Test date [MM/DD/YYYY] / start - end .... :	08/28/2023				-
Sample #..... :	2				-
The direction of the wind ..... :	Windward				-
Wind attack angle ..... :	20	20	20	20	-
Wind velocity [m/s]..... :	10	35	45	60	-
Duration [minute] ..... :	1	1	1	10	-
The direction of the wind ..... :	Leeward				-
Wind attack angle ..... :	20	20	20	20	-
Wind velocity [m/s]..... :	10	35	45	60	-
Duration [minute] ..... :	1	1	1	10	-
Supplementary information: N/A					

WIND TUNNEL TEST			
Clause	Requirement + Test	Result - Remark	Verdict

4.1 Visual inspection (final) - MQT01/MST01			-
Test date [MM/DD/YYYY].....:		09/05/2023	-
Sample #	Nature and position of initial findings - comments or attach photos		-
2	No visual defects		N/A
Supplementary information: N/A			

WIND TUNNEL TEST			
Clause	Requirement + Test	Result - Remark	Verdict

4.3 Insulation test (final) - MQT03/MST16				-
Test date [MM/DD/YYYY].....:		09/05/2023		-
Test voltage applied [V].....:		2 minutes of 1500 and 1 minute of 8000		-
Sample #	Required [MΩ]	Measured [MΩ]	Dielectric breakdown?	-
2	12.9	>1000	No	N/A
Supplementary information: Minimum requirement according to the standard is 40MΩ·m^2. Area of the module is 3.11m^2.				

WIND TUNNEL TEST			
Clause	Requirement + Test	Result - Remark	Verdict

4.15 Wet leakage current test (final) - MQT15/MST17			-
Test date [MM/DD/YYYY].....:		09/05/2023	-
Test voltage applied [V].....:		2 minutes of 1500	-
Solution resistivity [Ω/cm] / <3500 .....:		1908	-
Solution temperature [°C] / 22±2 .....:		22.8	-
Sample #	Required [MΩ]	Measured [MΩ]	-
2	12.9	>1000	N/A
Supplementary information: Minimum requirement according to the standard is 40MΩ·m^2. Area of the module is 3.11m^2.			

WIND TUNNEL TEST			
Clause	Requirement + Test	Result - Remark	Verdict

10.4 Maximum power determination (final) - MQT02/MST03							-
Test date [MM/DD/YYYY].....:			09/05/2023				-
Ambient temperature [°C].....:			Corrected to 25.0				-
Irradiance [W/m^2].....:			Corrected to 1000				-
Sample #	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]	-
2	45.74	39.00	17.98	17.20	670.6	81.56	-
Pmpp degradation after test [%].....:			Sample 2#: +0.69%				N/A
Supplementary information: Exposure under 1000W/m^2 on the front side with rear side covered by black cover.							

WIND TUNNEL TEST			
Clause	Requirement + Test	Result - Remark	Verdict

10.11 Continuity test of equipotential bonding (final) - MST13			-
Test date [MM/DD/YYYY].....:		09/05/2023	-
Current applied [A] .....:		75	-
Location of designated grounding point :		The center of one longer side	-
Location of second contacting point .....:		A: Adjacent shorter side with greatest distance from the grounding point B: The center of another longer side C: The center of the other shorter side	-
Sample #	Position in test sequence	Resistance [Ω]	-
2	Initial examination	A: 0.008 B: 0.002 C: 0.014	N/A
Supplementary information: N/A			

Annex 1: List of measurement equipment

NOA Testing & Inspection Technology Ltd.

No.	Equipment	Identification	Next calibration date
1	Pulsed solar simulator	NOANE082	09/21/2023
2	Withstanding voltage / Insulation resistance tester	NOANE098	08/23/2024
3	Withstanding voltage / Insulation resistance tester	NOANE099	01/09/2024
4	Conductivity meter	NOANE086	09/04/2024
5	Multimeter	NOANE072	08/27/2024

Engineering Research Center of Style of Study in Central South University

No.	Equipment	Identification	Next calibration date
1	Digital pressure gauge	GM511-1345602	N/A
2	Wireless strain tester	N/A	N/A

Annex 2: Statement of the estimated uncertainty of the test results

The total measuring uncertainty of Pmpp is ≤ 2.4%

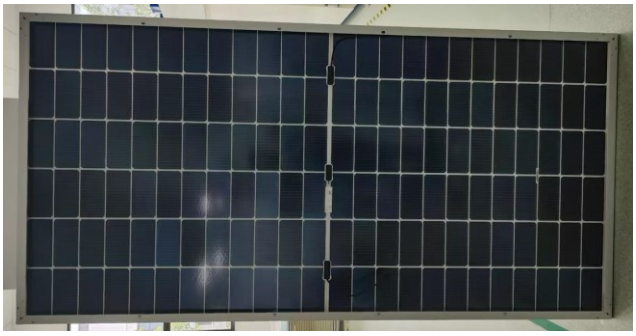
The total measuring uncertainty of Isc is ≤ 2.2%

The total measuring uncertainty of Voc is ≤ 1.0%

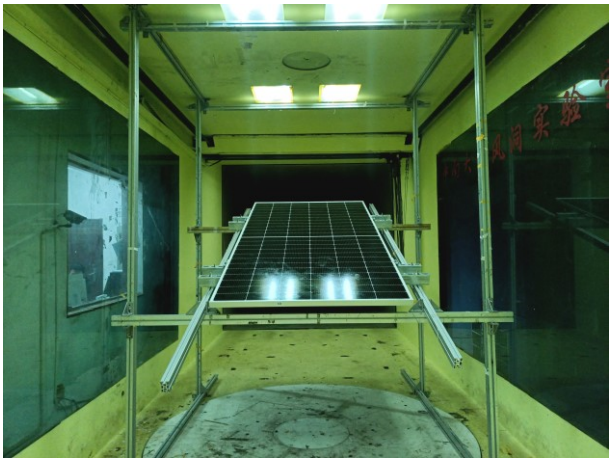
Annex 3: Photos

Module type: 565C(HBD)72(182)

Front overview



Back overview

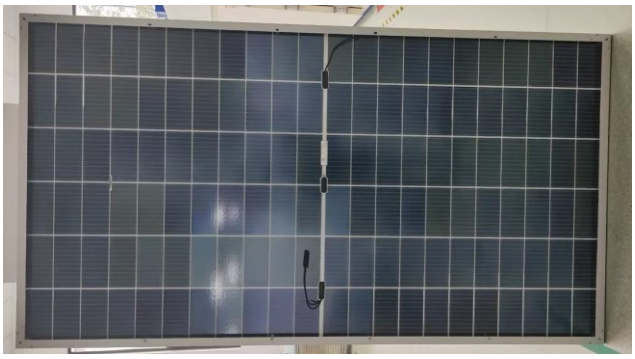


Test at Windward-Attack Angle 20°

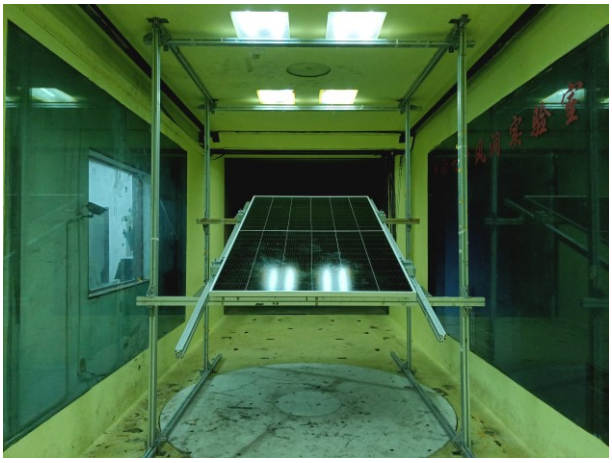
Test at Leeward-Attack Angle 20°

Module type: 655D(HBD)66(210)

Front overview



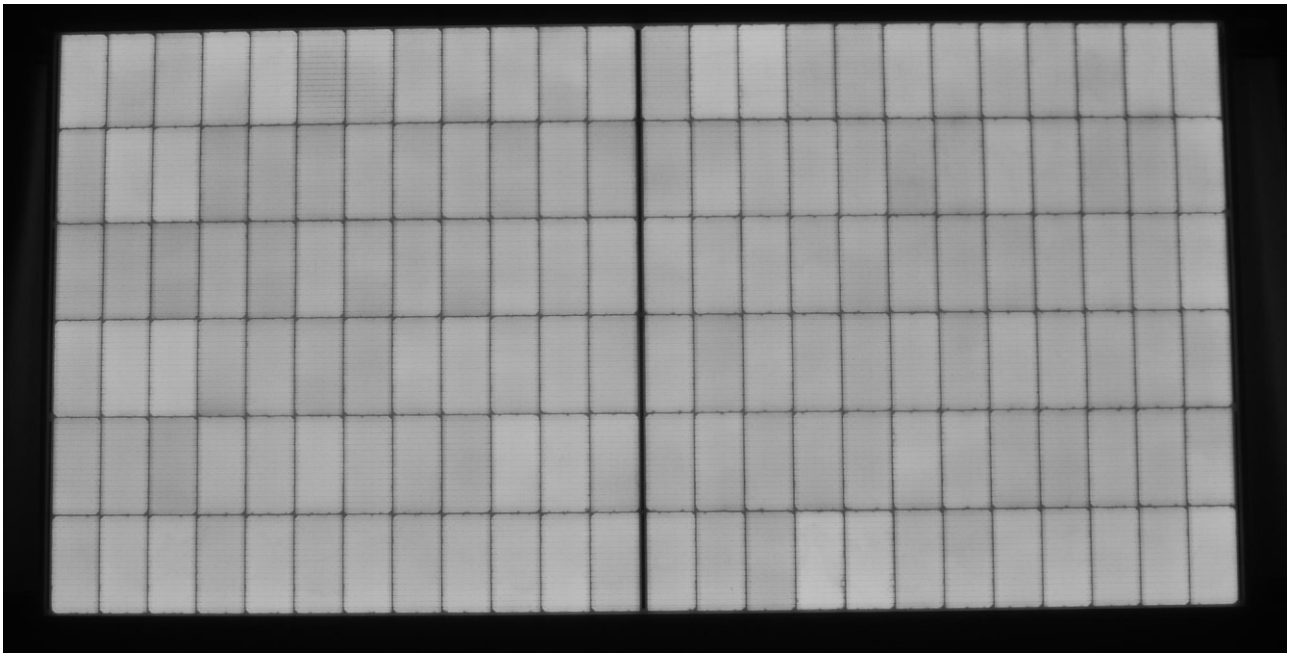
Back overview



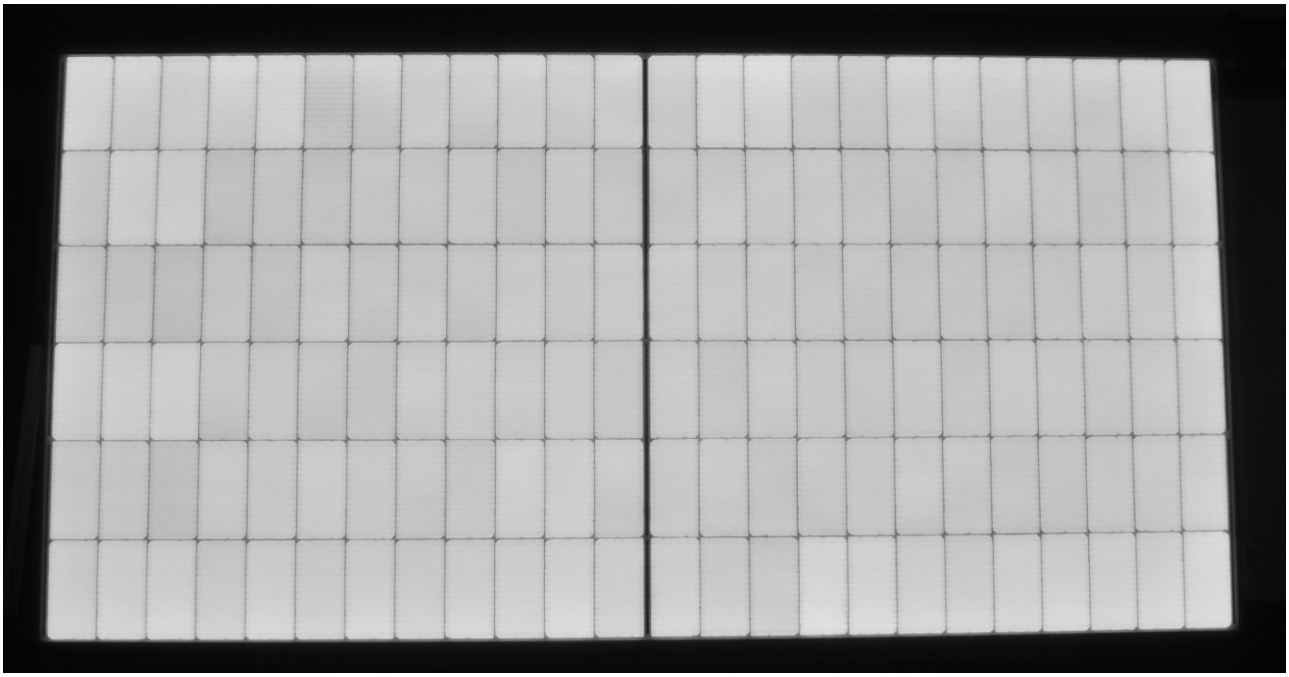
Test at Windward-Attack Angle 20°

Test at Leeward-Attack Angle 20°

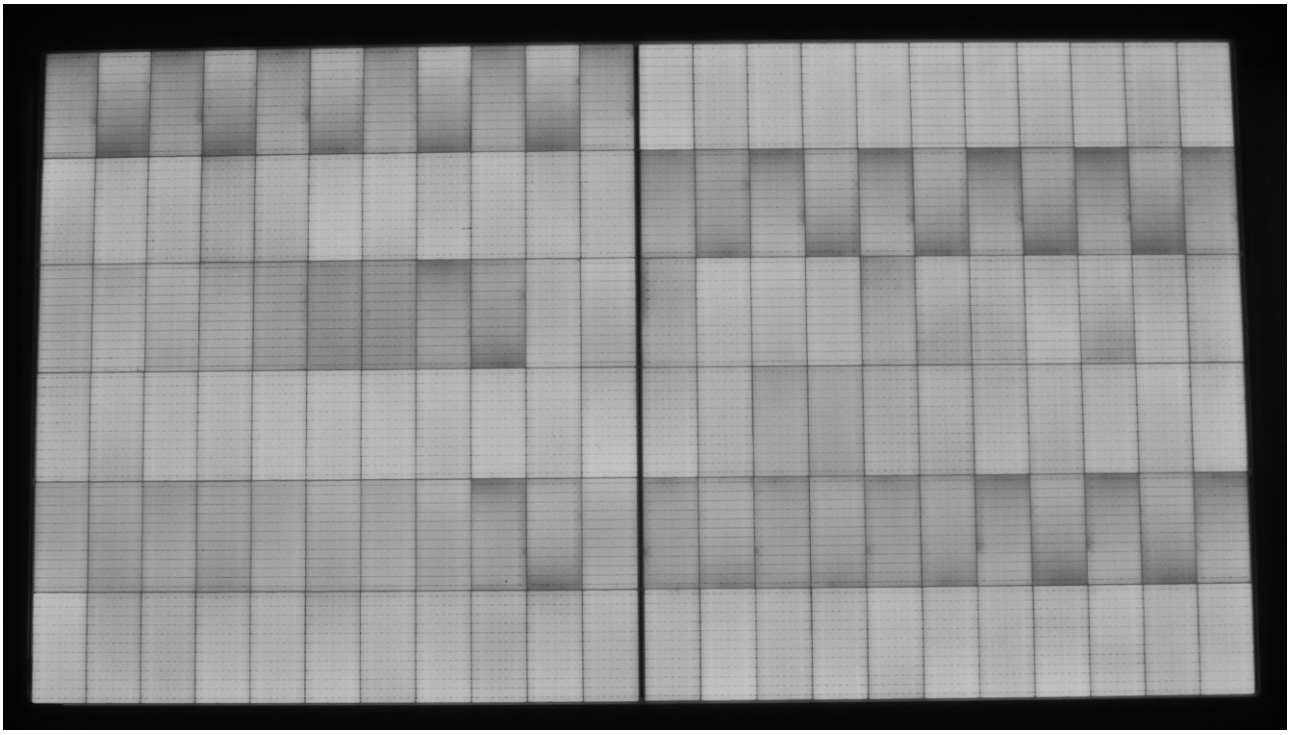
Annex 4: EL images



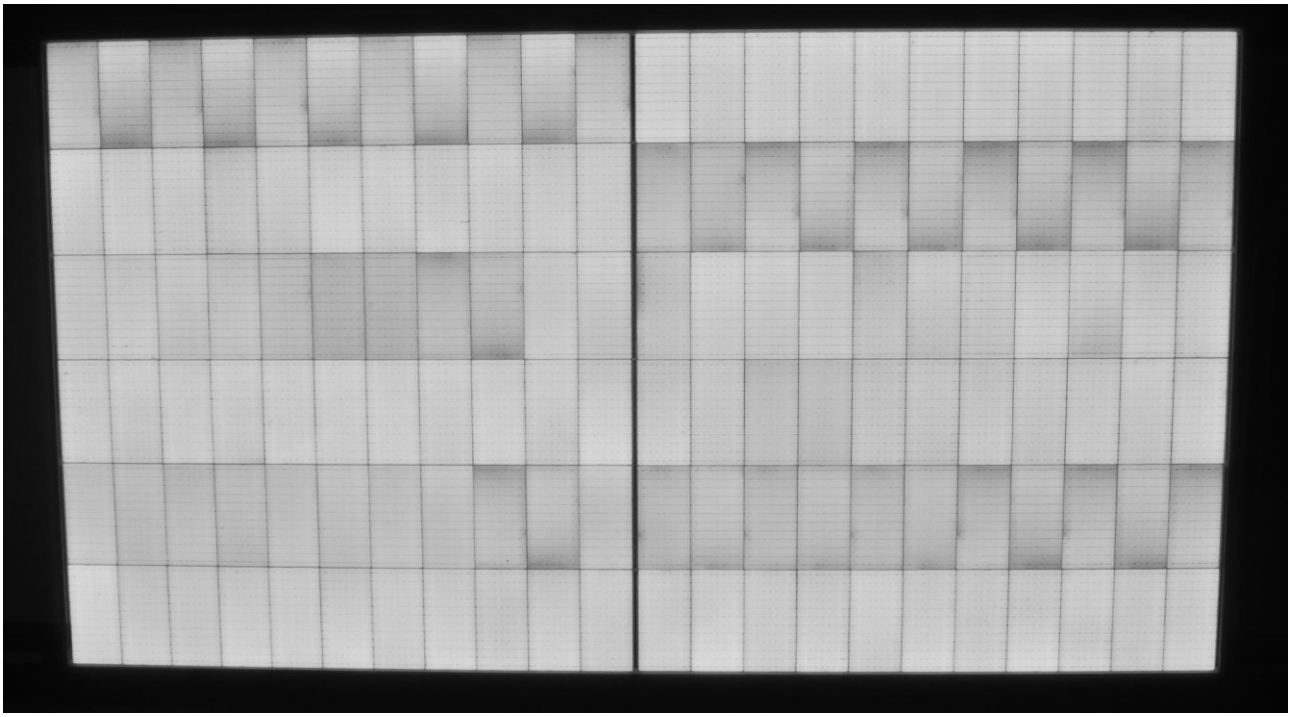
Sample #1-initial



Sample #1-final



Sample #2-initial



Sample #2-final

---------- End of test report ----------