

Test-Report

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PI-China Report-Number: 2012020CN

2012/11/05

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Proposal number:	20125950
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Order date:	2012/10/24
Delivery date:	-
Test start:	2012/10/31
Test end:	2012/11/04
Responsible project engineer:	Dipl. Phys. Alexander Preiss



Person in charge
Dipl. Phys. Alexander Preiss



Checked by
Dipl.-Ing. (FH) Carsten Kühler

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The test results in this report relate just to the test objects. The sampling was done by the client.



Table of Contents

1	General Information about the Test Objects.....	4
2	Test description	5
2.1	Polarisation analysis	5
2.2	I-V Curve Determination at Standard Test Conditions (STC).....	6
3	Test Results.....	7
3.1.1	STC Result Compilation.....	7
3.1.2	Detailed Results of I-V Curve Determination at STC and Electroluminescence Analysis	8
3.1.2.1	Modul SN:PSUP03458881012	8
3.1.2.2	Modul SN:PSUP03478881012	13

1 General Information about the Test Objects

Serial number	Producer	Type	Cell material	Number of cells
PSUP03458881012*	Phono Solar	245W	multi-c-Si	60
PSUP03478881012*	Phono Solar	245W	multi-c-Si	60

* Tests were performed in PI-China

2 Test description

2.1 Potential induced degradation (PID) analysis

To analyse the potential induced degradation problem the following test sequence was implemented:

- I-V measurement in accordance with IEC60904-1 before PID test.
- Initial electroluminescence analysis according to the PI standard.
- Grounding of the module as described in the manual (via frame).
- Temperature of 85 °C.
- Relative humidity of 85%.
- The voltage applied between the cells and the frame corresponds to the maximum system voltage given by the label.
- Period of testing 48 hours and repeating 48 hours.
- Final I-V measurement in accordance with IEC 60904-1 within four hours after finishing the test.
- Final electroluminescence analysis.

For assessing the tested objects the modules will be classified in three PID quality categories A, B and C. "A" classifies modules with power degradation below 5%, "B" between 5 and 30% and "C" all modules with a power degradation higher than 30%.

2.2 I-V Curve Determination at Standard Test Conditions (STC)

General information about the measuring system:

The I-V curve has been determined at Standard Test Conditions (STC) in accordance with IEC 60904-3. Thereby a solar simulator Class A type Pasan SS3b has been used. The calibration of the solar simulator has been performed with a stabilized cell with WPVS (World Photovoltaic Standard) cell format. The calibration of the cell is traceable to PTB and calibrated by ISE Freiburg on the 2012/04/23, calibration sign 100446PIB-DKD-K-47101.

The spectrum of the simulator is always verified with an internal spectrometer calibrated by PTB.

The measuring system error referring to the maximum power is $< \pm 3\%$. The mismatch correction value for multi-c-Si and the solar simulator mentioned above is 1.007.

Corrected with STC-Tool-Version: 2.0.6

Temperature coefficients (PI standard values):

$T_{\text{coeff}}(V_{\text{oc}})$: -0.326 %/K

$T_{\text{coeff}}(I_{\text{sc}})$: 0.052 %/K

Statement of the estimated uncertainty of the 'Maximum Power Determination' (IEC 10.2) test results:

Updated: 2011/03/23

<u>IEC Test</u>	<u>Measurand</u>	<u>Measurement uncertainty</u>	<u>Repeatability</u>
10.2	P_{MPP}	2.9%	0.33%
	V_{OC}	1.3%	0.12%
	I_{SC}	2.2%	0.13%

3 Test Results

3.1.1 STC Result Compilation

Serial number	Status	P_{MPP} [W]	V_{MPP} [V]	I_{MPP} [A]	V_{OC} [V]	I_{SC} [A]	FF [%]	Power deviation to initial [%]
PSUP03458881012	initial	246.3	30.56	8.058	37.77	8.632	75.52	-
	after PID	246.5	30.24	8.151	37.77	8.648	75.47	0.1
	after PID 96h	246.4	30.16	8.168	37.76	8.691	75.06	0.0
PSUP03478881012	initial	245.3	30.18	8.126	37.81	8.603	75.39	-
	after PID 48h	245.7	30.46	8.067	37.80	8.614	75.46	0.2
	after PID 96h	245.9	30.44	8.077	37.82	8.668	75.01	0.3

3.1.2 Detailed Results of I-V Curve Determination at STC and Electroluminescence Analysis

3.1.2.1 Modul SN:PSUP03458881012

I-V Curve Determination at STC initial – SN: PSUP03458881012

The measurements are accomplished at an irradiance of 1000 W/m² and a sweep time of 8 ms (1-flash). The results are then corrected to 25 °C.

	Label data		
Producer:	Phono Solar		
Serial number:	PSUP03458881012		
Module type:	245W	Test results	Deviation to label [%]
P _{MPP} [W]:	-	246.3	-
V _{MPP} [V]:	-	30.56	-
I _{MPP} [A]:	-	8.058	-
V _{OC} [V]:	-	37.77	-
I _{SC} [A]:	-	8.632	-
FF [%]:	-	75.52	-

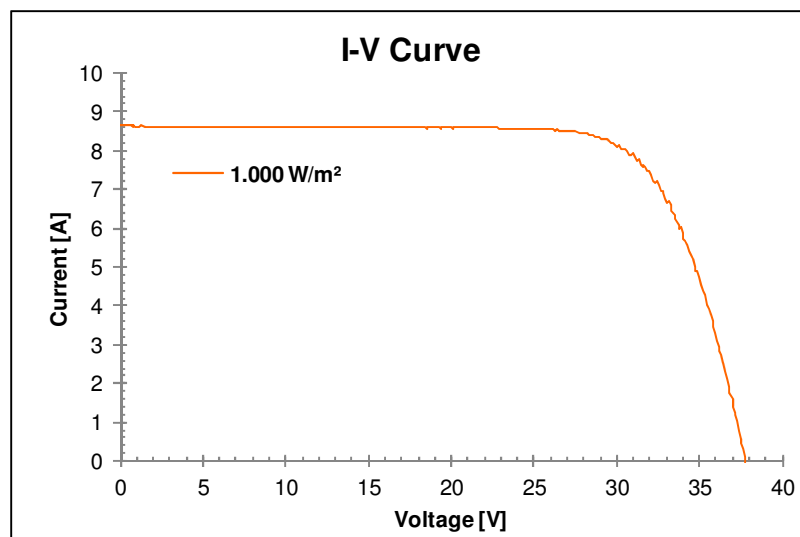


Figure 1: Temperature corrected I-V curve of module PSUP03458881012.

II-V Curve Determination at STC after 48 h of PID – SN: PSUP03458881012

The measurements are accomplished at an irradiance of 1000 W/m² and a sweep time of 8 ms (1-flash). The results are then corrected to 25 °C.

	Initial data		
Producer:	Phono Solar		
Serial number:	PSUP03458881012		
Module type:	245W	Test results	Deviation to initial [%]
P _{MPP} [W]:	246.3	246.5	0.1
V _{MPP} [V]:	30.56	30.24	-1.1
I _{MPP} [A]:	8.058	8.151	1.2
V _{OC} [V]:	37.77	37.77	0.0
I _{SC} [A]:	8.632	8.648	0.2
FF [%]:	75.52	75.47	-0.1
PID quality categorization	- A -		

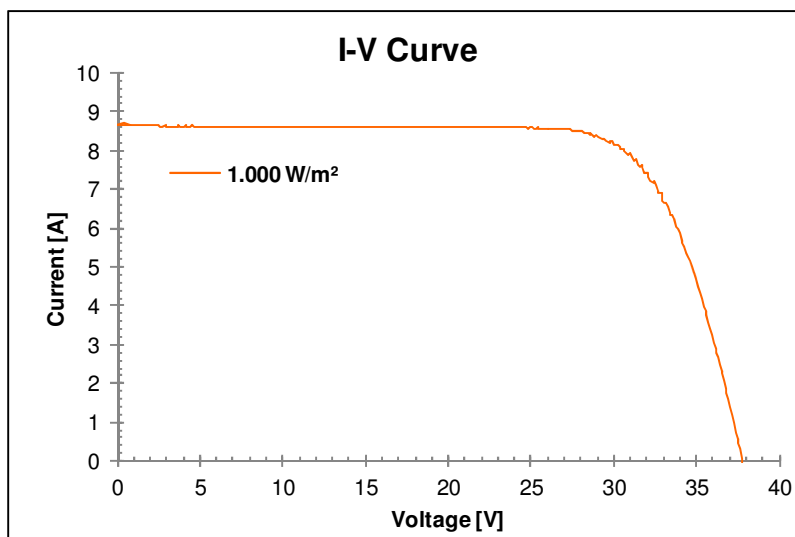
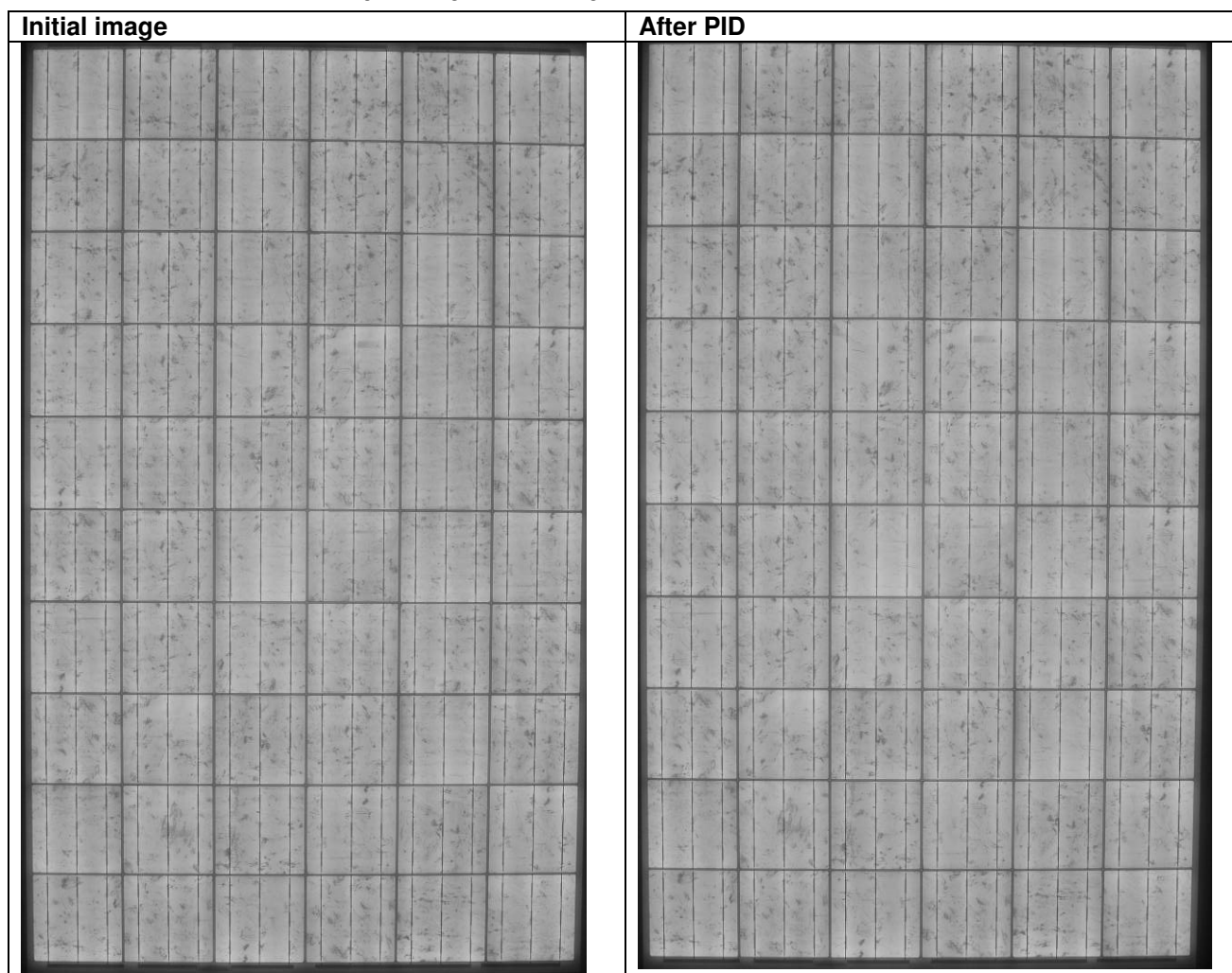


Figure 2: Temperature corrected I-V curve of module PSUP03458881012.

Electroluminescence analysis before and after PID (DH 48h) – SN: PSUP03458881012

I-V Curve Determination at STC after 96 h of PID – SN: PSUP03458881012

The measurements are accomplished at an irradiance of 1000 W/m² and a sweep time of 8 ms (1-flash). The results are then corrected to 25 °C.

	Initial data		
Producer:	Phono Solar		
Serial number:	PSUP03458881012		
Module type:	245W	Test results	Deviation to initial [%]
P _{MPP} [W]:	246.3	246.4	0.0
V _{MPP} [V]:	30.56	30.16	-1.3
I _{MPP} [A]:	8.058	8.168	1.4
V _{OC} [V]:	37.77	37.76	0.0
I _{SC} [A]:	8.632	8.691	0.7
FF [%]:	75.52	75.06	-0.6
PID quality categorization	- A -		

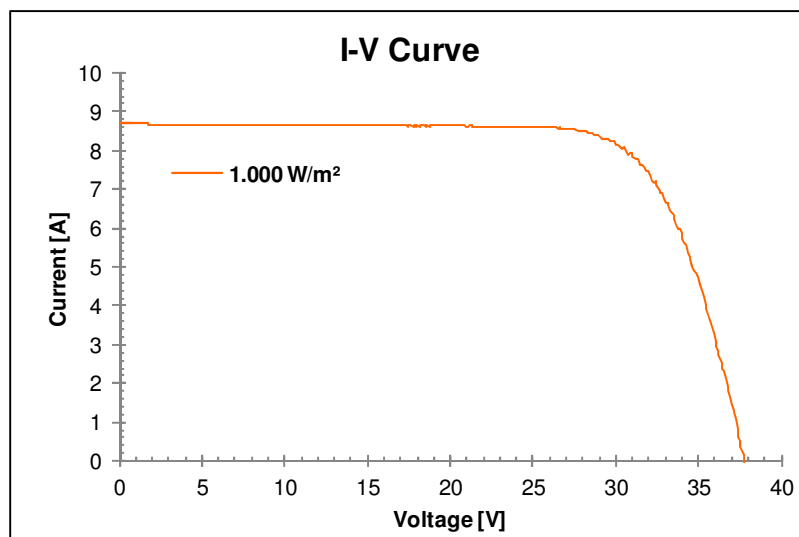
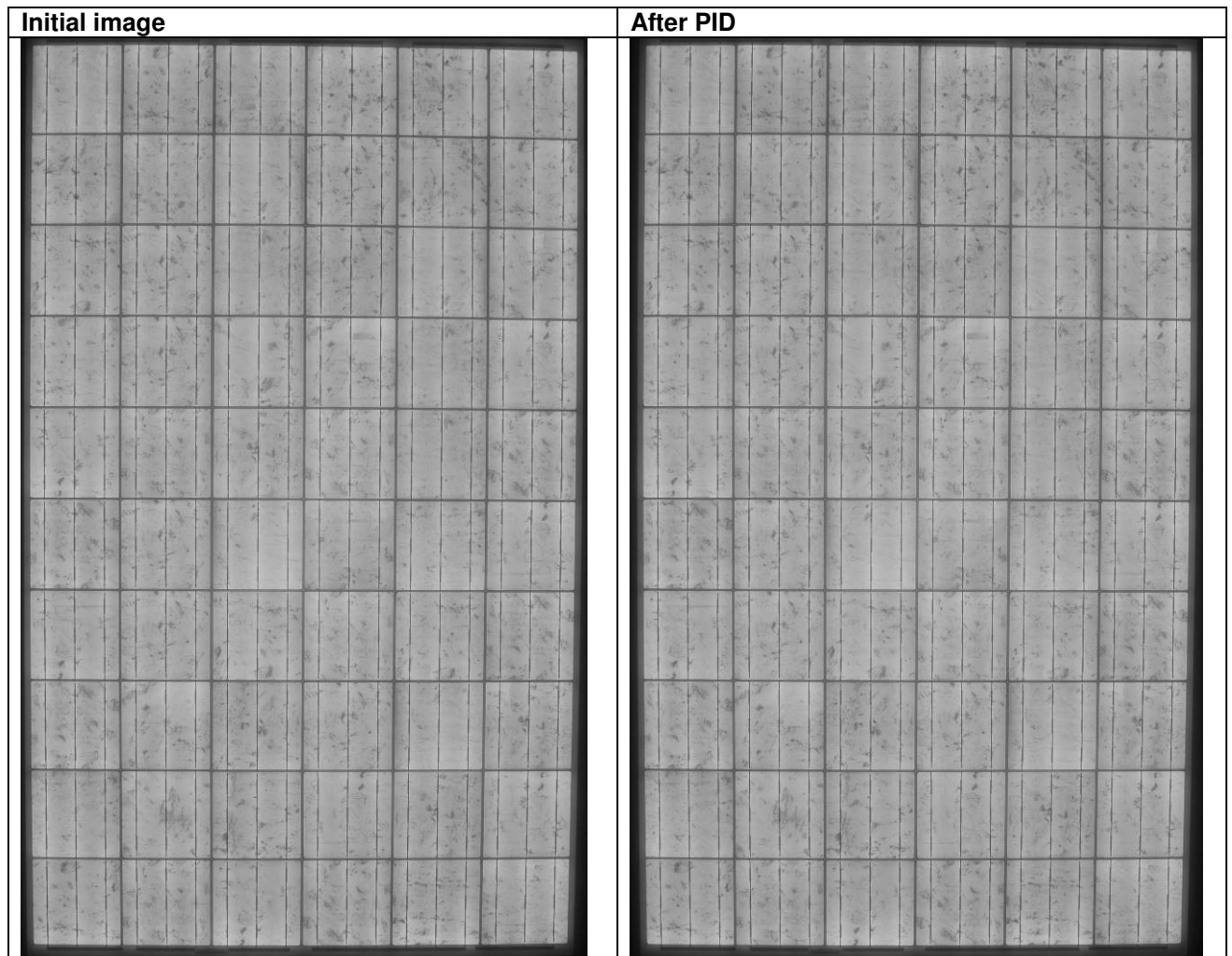


Figure 3: Temperature corrected I-V curve of module PSUP03458881012.

Electroluminescence analysis before and after PID (DH 96 h) – SN: PSUP03458881012

3.1.2.2 Modul SN:PSUP03478881012

I-V Curve Determination at STC initial – SN: PSUP03478881012

The measurements are accomplished at an irradiance of 1000 W/m^2 and a sweep time of 8 ms (1-flash). The results are then corrected to 25°C .

	Label data		
Producer:	Phono Solar		
Serial number:	PSUP03478881012		
Module type:	245W	Test results	Deviation to label [%]
P_{MPP} [W]:	-	245.3	-
V_{MPP} [V]:	-	30.18	-
I_{MPP} [A]:	-	8.126	-
V_{OC} [V]:	-	37.81	-
I_{SC} [A]:	-	8.603	-
FF [%]:	-	75.39	-

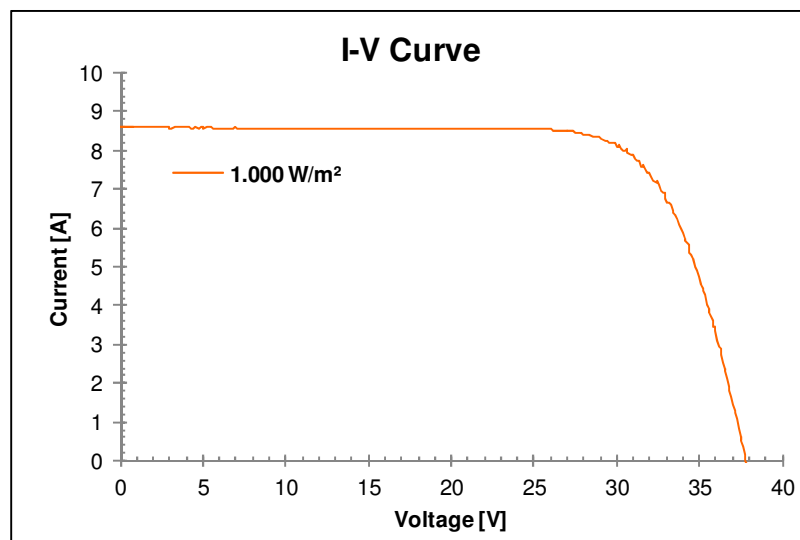
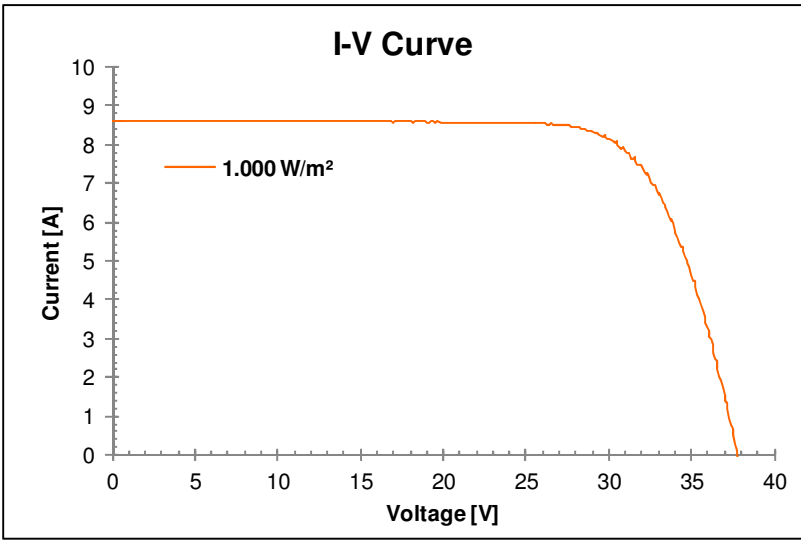


Figure 4: Temperature corrected I-V curve of module PSUP03478881012.

I-V Curve Determination at STC after 48 h of PID – SN: PSUP03478881012

The measurements are accomplished at an irradiance of 1000 W/m² and a sweep time of 8 ms (1-flash). The results are then corrected to 25 °C.

	Initial data		
Producer:	Phono Solar		
Serial number:	PSUP03478881012		
Module type:	245W	Test results	Deviation to initial [%]
P _{MPP} [W]:	245.3	245.7	0.2
V _{MPP} [V]:	30.18	30.46	0.9
I _{MPP} [A]:	8.126	8.067	-0.7
V _{OC} [V]:	37.81	37.80	0.0
I _{SC} [A]:	8.603	8.614	0.1
FF [%]:	75.39	75.46	0.1
PID quality categorization	- A -		



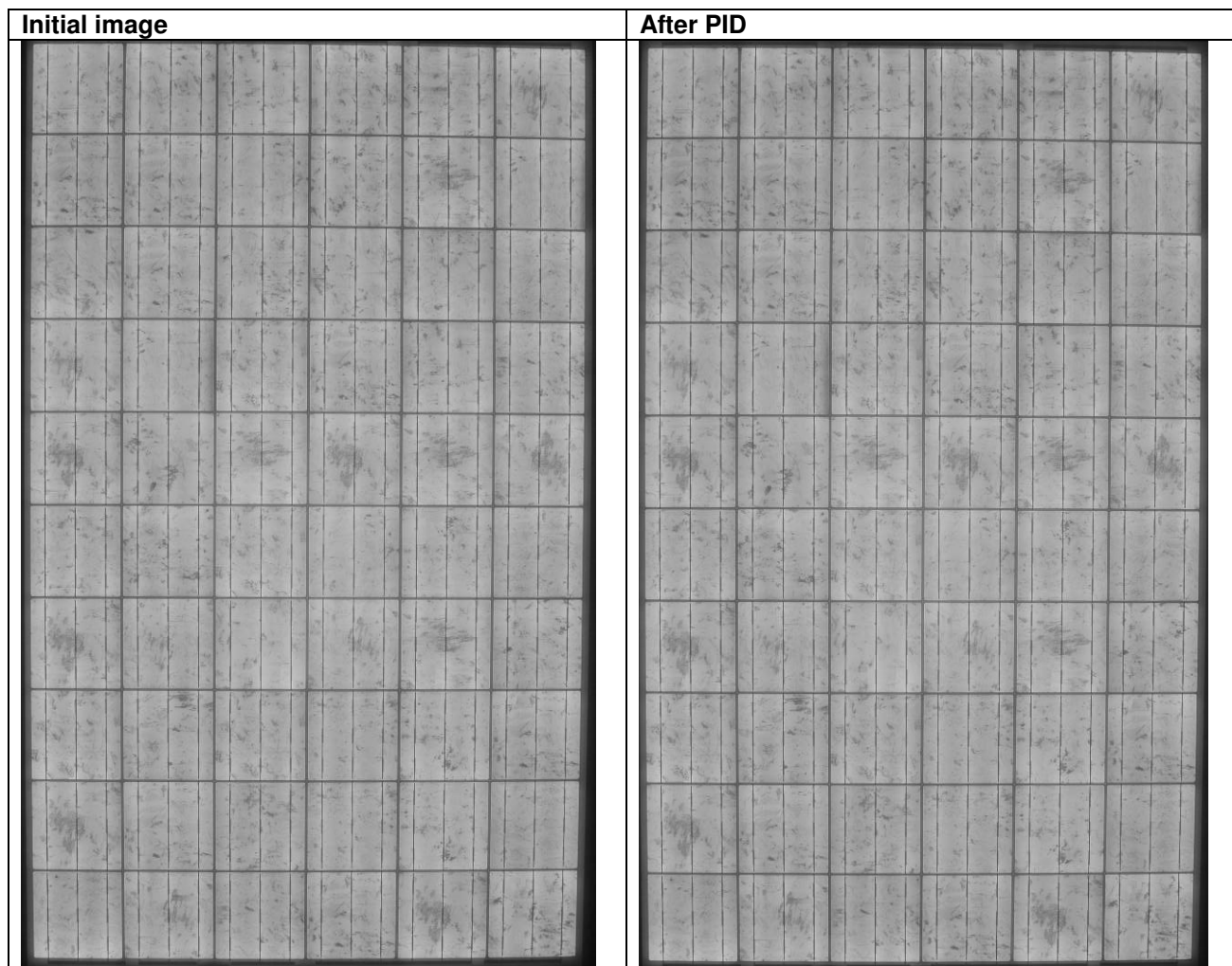
I-V Curve

Current [A]

Voltage [V]

1.000 W/m²

Figure 5: Temperature corrected I-V curve of module PSUP03478881012.

Electroluminescence analysis before and after PID (DH 48h) – SN: PSUP03478881012

I-V Curve Determination at STC after 96 h of PID – SN: PSUP03478881012

The measurements are accomplished at an irradiance of 1000 W/m² and a sweep time of 8 ms (1-flash). The results are then corrected to 25 °C.

	Initial data		
Producer:	Phono Solar		
Serial number:	PSUP03478881012		
Module type:	245W	Test results	Deviation to initial [%]
P _{MPP} [W]:	245.3	245.9	0.3
V _{MPP} [V]:	30.18	30.44	0.9
I _{MPP} [A]:	8.126	8.077	-0.6
V _{OC} [V]:	37.81	37.82	0.0
I _{SC} [A]:	8.603	8.668	0.8
FF [%]:	75.39	75.01	-0.5
PID quality categorization	- A -		

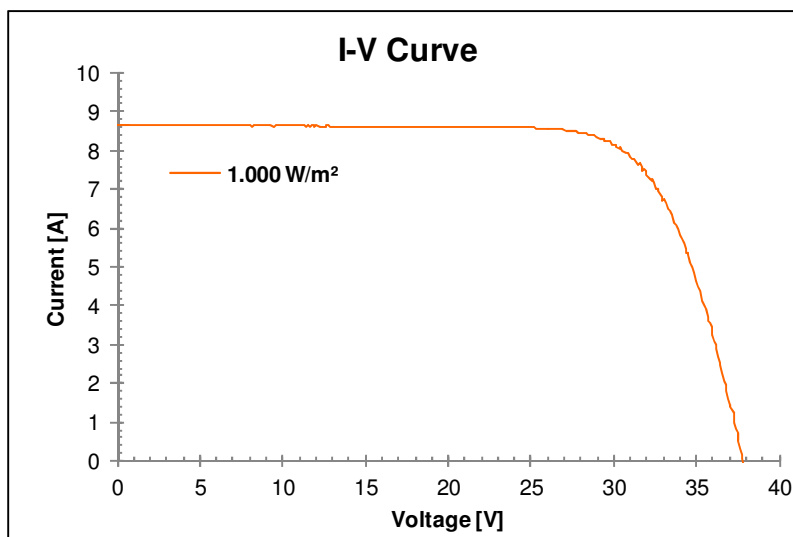


Figure 6: Temperature corrected I-V curve of module PSUP03478881012.

Electroluminescence analysis before and after PID (DH 96h) – SN: PSUP03478881012