



Test Report No.704062504933-00

Dated 2025-04-30

Client: LONGi Green Energy Technology Co., Ltd.
No. 388, Middle Hangtian Road, Chang'an District, Xi'an, Shaanxi
710100, P.R. China

Manufacturer: LONGi Green Energy Technology Co., Ltd.
No. 388, Middle Hangtian Road, Chang'an District, Xi'an, Shaanxi
710100, P.R. China

Test subject: Product: Photovoltaic modules

Test specification: IEC 61853-1:2011
IEC 61853-2:2016
IEC 60891:2009

Purpose of examination: PAN File Parameters Determination

Test result: The test results for the present samples are show in clause3

1 Description of the test subject

1.1 Function

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Manufacturer's specification for intended use:

The PV modules for electricity generation systems with max. voltage of 1500 V DC

1.2 Consideration of the foreseeable misuse

- ☒ Not applicable
- ☐ Covered through the applied standard
- ☐ Covered by the following comment
- ☐ Covered by attached risk analysis

1.3 Technical Data

Type or model number	LR7-72HVHF-650M
Voc (Vdc)	53.90±5%
Vmp (Vdc)	44.56
Isc (Adc)	15.29±5%
Imp (Adc)	14.59
Pmp (W)	650
Bifaciality factor, if bi-facial module	N/A
Power tolerance	0~+3%
Maximum system voltage (V)	1500
Maximum over-current protection rating (A)	25
Application Class	Class II

2 Order

2.1 Date of Purchase Order, Customer's Reference

2024-12-27

2.2 Receipt of Test Sample, Location

Zhejiang HJE Co., LTD



3-4/F., Building 1, No. 3556, Linggongtang Road, Nanhu District, Jiaxing , Zhejiang, China

2.3 Date of Testing

2024-03-25 to 2025-04-22

2.4 Location of Testing

Zhejiang HJE Co., LTD

3-4/F., Building 1, No. 3556, Linggongtang Road, Nanhu District, Jiaxing , Zhejiang, China

2.5 Points of Non-compliance or Exceptions of the Test Procedure

N/A

3 Test Results

3.1 Sample Information

Sample #	Model	Sample S/N	Remark
1	LR7-72HVHF-650M	LRE004134241100800025	61853-1
2	LR7-72HVHF-650M	LRE004134241100800038	61853-1
3	LR7-72HVHF-650M	LRE004134241100800039	61853-1

3.2 Flash Tests According to Table 2 of the IEC 61853-1

To determine the relationship between efficiency and irradiance & temperature, PV modules are tested across a matrix of operating conditions according to the standard IEC 61853-1:2011, ranging in irradiance from 100 W/m² to 1100 W/m² and ranging in temperature from 15 °C to 75 °C.

To determine the temperature coefficients, PV modules are tested according to IEC 60891:2009, under irradiance 1000W/m² and ranging in temperature from 25 °C to 55 °C.

Based on the laboratory measurement data, PAN file can be optimized, then match ability between the resulting efficiencies in PVsyst software and the lab data can be compared.

3.3 Raw Data

TABLE 2:



Flash test data for each sample at the real irradiance and temperature conditions in table 2 of the
IEC 61853-1

LRE004134241100800038							
T _{TARGET} [°C]	IRR _{TARGET} [W/m ²]	Isc [A]	Voc [V]	Imp [A]	Vmp [V]	Pmp [W]	FF [%]
15	100	1.549	51.002	1.421	44.892	63.809	80.75
15	200	3.050	52.227	2.876	45.760	131.592	82.60
15	400	5.995	53.410	5.672	47.149	267.431	83.52
15	600	8.883	54.048	8.469	47.462	401.975	83.72
15	800	11.748	54.474	11.200	47.774	535.067	83.61
15	1000	14.610	54.744	13.896	47.923	665.944	83.26
25	100	1.567	49.600	1.434	43.356	62.178	80.01
25	200	3.076	50.910	2.893	44.319	128.233	81.88
25	400	6.027	52.075	5.714	45.604	260.601	83.03
25	600	8.942	52.715	8.457	46.335	391.835	83.12
25	800	11.821	53.153	11.266	46.295	521.553	83.01
25	1000	14.677	53.449	13.952	46.513	648.919	82.72
25	1100	16.132	53.605	15.286	46.669	713.379	82.50
50	400	6.088	49.121	5.712	42.688	243.825	81.53
50	600	9.019	49.749	8.519	43.031	366.573	81.70
50	800	11.895	50.292	11.259	43.333	487.884	81.56
50	1000	14.773	50.605	13.934	43.559	606.947	81.19
50	1100	16.304	50.585	15.520	42.962	666.758	80.85
75	600	9.174	46.560	8.538	39.911	340.752	79.78
75	800	12.119	47.023	11.441	39.618	453.281	79.54
75	1000	14.994	47.534	14.149	39.882	564.284	79.18
75	1100	16.614	47.384	15.578	39.813	620.213	78.79

LRE004134241100800039							
T _{TARGET} [°C]	IRR _{TARGET} [W/m ²]	Isc [A]	Voc [V]	Imp [A]	Vmp [V]	Pmp [W]	FF [%]
15	100	1.560	50.936	1.427	44.902	64.073	80.62
15	200	3.065	52.148	2.873	45.873	131.778	82.44
15	400	6.007	53.335	5.671	47.195	267.627	83.53
15	600	8.905	53.989	8.458	47.574	402.396	83.70
15	800	11.779	54.407	11.195	47.802	535.139	83.50
15	1000	14.624	54.654	13.881	47.995	666.230	83.36
25	100	1.575	49.539	1.433	43.400	62.190	79.73
25	200	3.082	50.854	2.884	44.495	128.322	81.87
25	400	6.045	52.015	5.722	45.563	260.720	82.91



25	600	8.958	52.644	8.455	46.339	391.803	83.09
25	800	11.838	53.112	11.258	46.321	521.479	82.94
25	1000	14.704	53.476	13.953	46.522	649.117	82.55
25	1100	16.149	53.575	15.310	46.607	713.525	82.47
50	400	6.110	49.018	5.715	42.690	243.959	81.45
50	600	9.035	49.700	8.518	43.036	366.562	81.63
50	800	11.896	50.307	11.247	43.378	487.848	81.52
50	1000	14.804	50.553	13.948	43.523	607.039	81.11
50	1100	16.334	50.617	15.309	43.601	667.488	80.73
75	600	9.198	46.537	8.551	39.952	341.624	79.81
75	800	12.101	47.156	11.277	40.260	454.025	79.56
75	1000	15.066	47.419	14.174	39.884	565.321	79.13
75	1100	16.590	47.472	15.594	39.853	621.468	78.91

LRE004134241100800025							
T _{TARGET} [°C]	IRR _{TARGET} [W/m ²]	Isc [A]	Voc [V]	Imp [A]	Vmp [V]	Pmp [W]	FF [%]
15	100	1.552	50.980	1.423	44.828	63.799	80.63
15	200	3.054	52.209	2.869	45.885	131.622	82.56
15	400	6.001	53.362	5.664	47.190	267.271	83.46
15	600	8.886	54.027	8.457	47.503	401.719	83.68
15	800	11.754	54.447	11.183	47.816	534.726	83.55
15	1000	14.626	54.666	13.878	47.956	665.535	83.24
25	100	1.572	49.575	1.434	43.344	62.147	79.77
25	200	3.073	50.889	2.886	44.432	128.247	82.00
25	400	6.045	52.056	5.719	45.596	260.781	82.88
25	600	8.947	52.692	8.435	46.438	391.701	83.09
25	800	11.830	53.132	11.259	46.288	521.178	82.92
25	1000	14.682	53.465	13.926	46.594	648.861	82.66
25	1100	16.141	53.595	15.315	46.583	713.426	82.47
50	400	6.106	49.025	5.710	42.679	243.714	81.42
50	600	9.032	49.706	8.513	43.035	366.363	81.61
50	800	11.913	50.261	11.255	43.332	487.713	81.45
50	1000	14.786	50.596	13.929	43.561	606.771	81.11
50	1100	16.257	50.756	15.324	43.563	667.553	80.90
75	600	9.172	46.586	8.533	39.951	340.890	79.78
75	800	12.135	46.997	11.444	39.617	453.391	79.50
75	1000	15.075	47.311	14.186	39.764	564.085	79.09
75	1100	16.623	47.358	15.616	39.724	620.336	78.80

Table 3:

Temperature Coefficients Measurement Data at the 1000 W.m⁻² Irradiance

LRE004134241100800002				
T [°C]	IRR _{TARGET} [W/m ²]	Voc [V]	Isc [A]	Pmp [W]
24.88	1000	53.465	14.682	648.861
30.75	1000	52.937	14.710	640.676
35.50	1000	52.374	14.755	631.651
40.75	1000	51.806	14.783	623.331
45.12	1000	51.305	14.833	614.983
51.30	1000	50.749	14.865	606.247
55.20	1000	50.235	14.905	598.062

3.3.1 Test Data Analysis

3.3.1.1 Temperature Coefficients

Figure 1:

Plot of measured P_{MAX}, Voc vs. temperature of flash-tests taken at 1000 W/m² for each sample

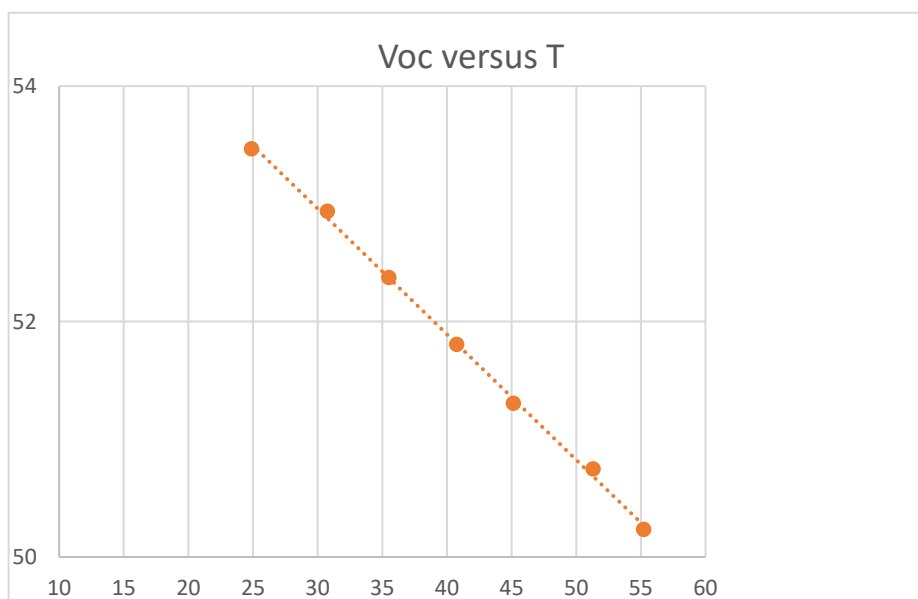


Figure 2:

Plot of measured Isc vs. temperature of flash-tests taken at 1000W/m² for each sample

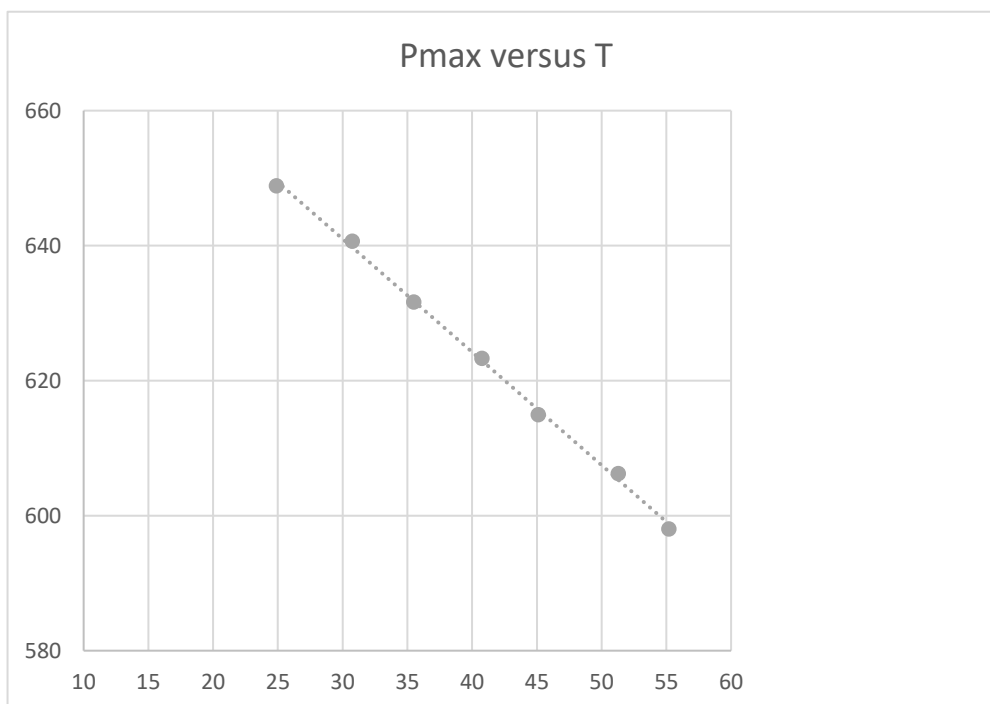
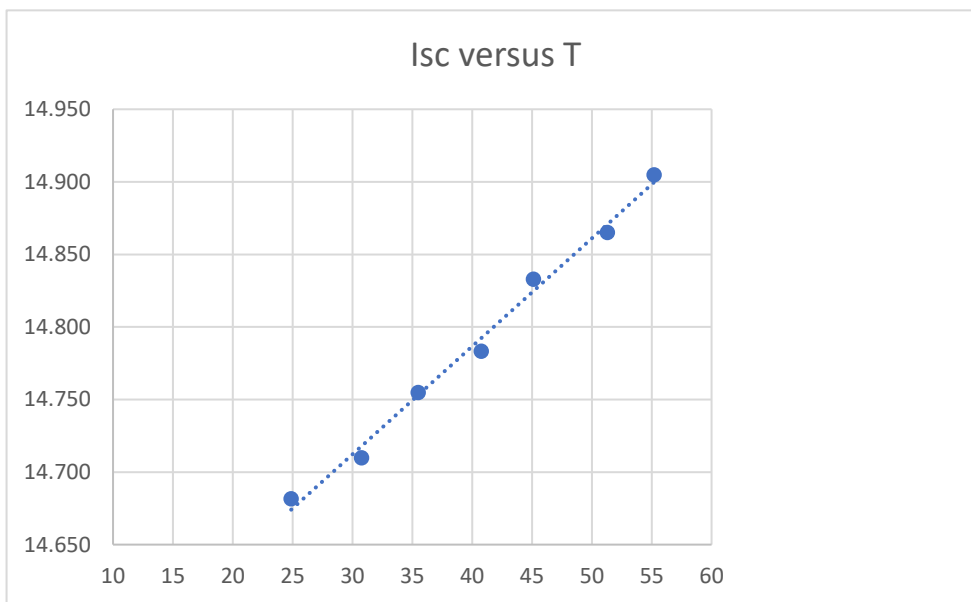


Table 4:
Average Temperature Coefficients Determined by Laboratory Results

Sample No	Alpha (α) ISC [%]	Beta (β) VOC [%]	Gamma (γ) PMAX [%]
1	0.051	-0.199	-0.258

3.3.1.2 P_{MAX} vs. Irradiance & Temperature

Table 5:

Average P_{MAX} Determined by Laboratory Results according to the IEC 61853-1 based on Table 2

Average Pmax [W] Results Acquired over Multiple Irradiances per Temperature				
Irradiance [W/m ²]	Module Temperature			
	15 °C	25 °C	50 °C	75 °C
100	63.894	62.172	-	-
200	131.664	128.267	-	-
400	267.443	260.701	243.833	-
600	402.030	391.780	366.499	341.0887
800	534.977	521.403	487.815	453.5657
1000	665.903	648.966	606.919	564.5633
1100	-	713.443	667.266	620.672

Table 6:

P_{MAX} Determined by Laboratory Results Scaled to Nameplate Power at STC

Average Pmax [W] Results Acquired over Multiple Irradiances per Temperature				
Irradiance [W/m ²]	Module Temperature			
	15 °C	25 °C	50 °C	75 °C
100	63.996	62.271	-	-
200	131.874	128.472	-	-
400	267.869	261.116	244.221	-
600	402.671	392.404	367.083	341.632
800	535.830	522.234	488.592	454.289
1000	666.964	650.000	607.886	565.463
1100	-	714.580	668.330	621.662

Table 7:

Relative Efficiency by Laboratory Results Scaled to Nameplate vs. Irradiance at 25°C

Sample No	Irradiance [W/m ²]						
	100	200	400	600	800	1000	1100
Average	95.80%	98.82%	100.43%	100.62%	100.43%	100.00%	99.94%

4 PAN File Creation

4.1 PAN File Creation Method

The PAN file contains a number of model parameters organized in different tabs within PVsyst. The



parameters which affect the model results in forward bias (normal operation) are located in the tabs labeled

“Basic Data” and “Model Parameters”. TUV-SUD’s approach to PAN file creation is as following:

1. Enter manufacturer specifications on the “Basic Data” tab;
2. Enter the relative efficiency test results in **Table 7** under different irradiance at 25°C into “Additional Data/Low-light data” , and optimized the Rserie; It is mentioned that the relative efficiency is calculated after scale

the average measured P_{MAX} lab data from **Table 5** to the manufacturer’s nameplate power. The scaled data is shown in **Table 6** and **Table 7**.

3. Define the R_{sh}, R_{sh0} and R_{exp} (on the “Model parameters” tab) for default values;
4. Enter the P_{max}, I_{sc}, V_{oc} temperature coefficient in **Table 4** into “Model parameters” tab;

4.2 Optimized PAN File Results

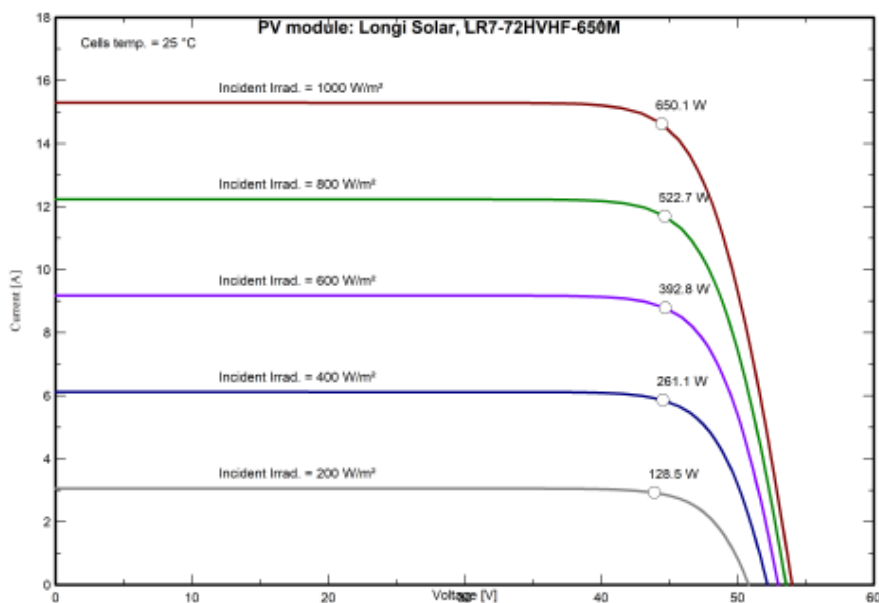


PVsyst V7.4.8

TUV SUD Certification and Testing Co., Ltd Shanghai Branch (China)

PV module - LR7-72HVHF-650M

Manufacturer	Longi Solar	Commercial data	
Model	LR7-72HVHF-650M	Availability :	Prod. Since 2025
		Data source :	TUV SUD
Pnom STC power (manufacturer)	650 Wp	Technology	SI-mono
Module size (W x L)	1.134 x 2.382 m ²	Rough module area (Amodule)	2.70 m ²
Number of cells	2 x 72	Sensitive area (cells) (Acells)	2.52 m ²
Specifications for the model (manufacturer or measurement data)			
Reference temperature (TRef)	25 °C	Reference irradiance (GRef)	1000 W/m ²
Open circuit voltage (Voc)	54.0 V	Short-circuit current (Isc)	15.29 A
Max. power point voltage (Vmpp)	44.6 V	Max. power point current (Impp)	14.59 A
-> maximum power (Pmpp)	650.1 W	Isc temperature coefficient (mulsc)	7.6 mA/°C
One-diode model parameters			
Shunt resistance (Rshunt)	10500 Ω	Diode saturation current (IoRef)	0.022 nA
Series resistance (Rserie)	0.23 Ω	Voc temp. coefficient (MuVoc)	-115 mV/°C
Specified Pmax temper. coeff. (muPMaxR)	-0.26 %/°C	Diode quality factor (Gamma)	1.07
		Diode factor temper. coeff. (muGamma)	0.000 1/°C
Reverse Bias Parameters, for use in behaviour of PV arrays under partial shadings or mismatch			
Reverse characteristics (dark) (BRev)	3.20 mA/V ²	(quadratic factor (per cell))	
Number of by-pass diodes per module	3	Direct voltage of by-pass diodes	-0.7 V
Model results for standard conditions (STC: T=25 °C, G=1000 W/m², AM=1.5)			
Max. power point voltage (Vmpp)	44.5 V	Max. power point current (Impp)	14.65 A
Maximum power (Pmpp)	650.1 Wp	Power temper. coefficient (muPmpp)	-0.26 %/°C
Efficiency/(Module area) (Eff_mod)	24.1 %	Fill factor (FF)	0.787
Efficiency/(Cells area) (Eff_cells)	25.8 %		



4.3 PAN File Result Verification

After creating the PAN file, a quality check is implemented in order to compare the PAN file model consistence with measurements from the laboratory. The laboratory test results scaled are plotted as efficiency vs. irradiance curves for each temperature of the IEC61853-1 test matrix, as shown in **Table 8**. Similarly, efficiency vs. irradiance curves are generated using PVsyst and the newly created PAN file, as shown in **Table 9**. Comparison between the model and the measurements is represented with the following graph and table.

Table 8:

Efficiency Determined by Laboratory Results Scaled to Nameplate Power at STC

Average Pmax [W] Results Acquired over Multiple Irradiances per Temperature				
Irradiance [W/m ²]	Module Temperature			
	15 °C	25 °C	50 °C	75 °C
100	23.69%	23.05%	-	-
200	24.41%	23.78%	-	-
400	24.79%	24.17%	22.60%	-
600	24.85%	24.21%	22.65%	21.08%
800	24.80%	24.17%	22.61%	21.02%
1000	24.69%	24.06%	22.50%	20.93%
1100	-	24.05%	22.49%	20.92%

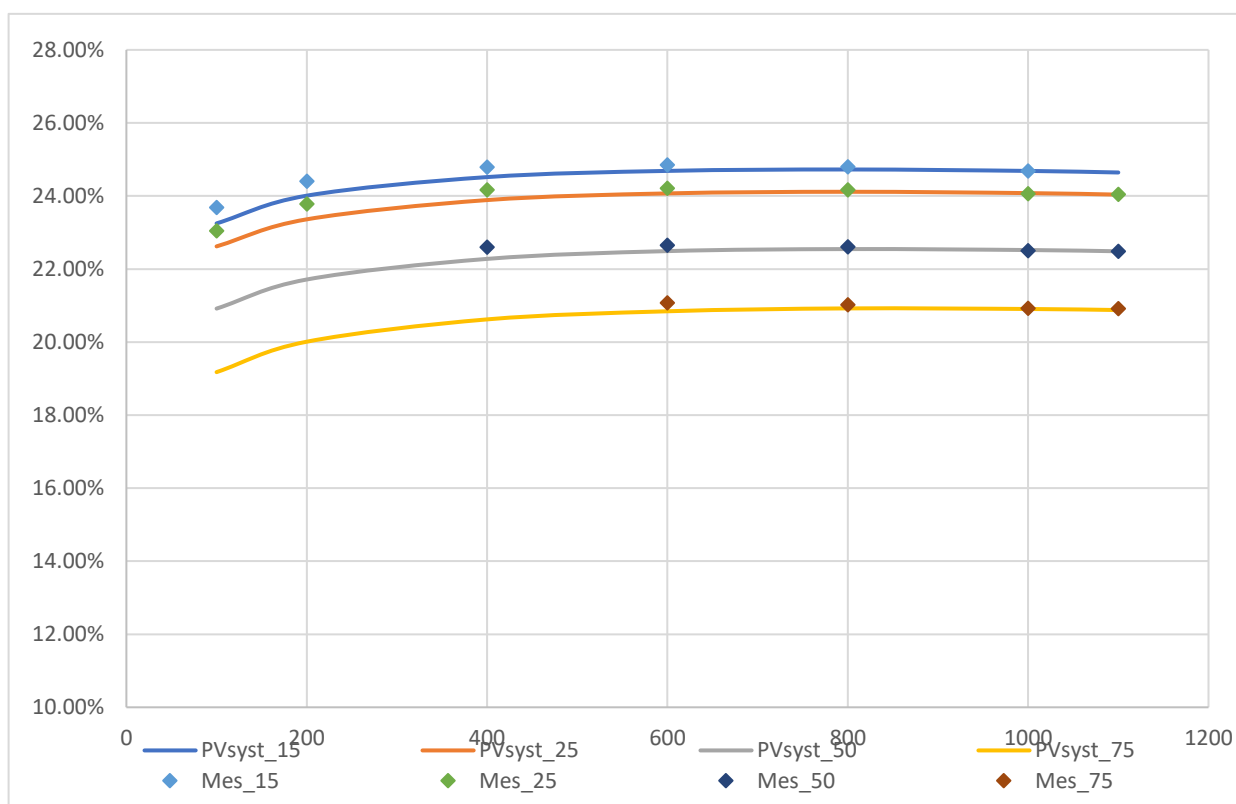
dn-lbzvhbc1zklot5jowx4vt44sz99yz5n1

Table 9:

Efficiency Generated Using PVsyst and the Newly Created PAN file.

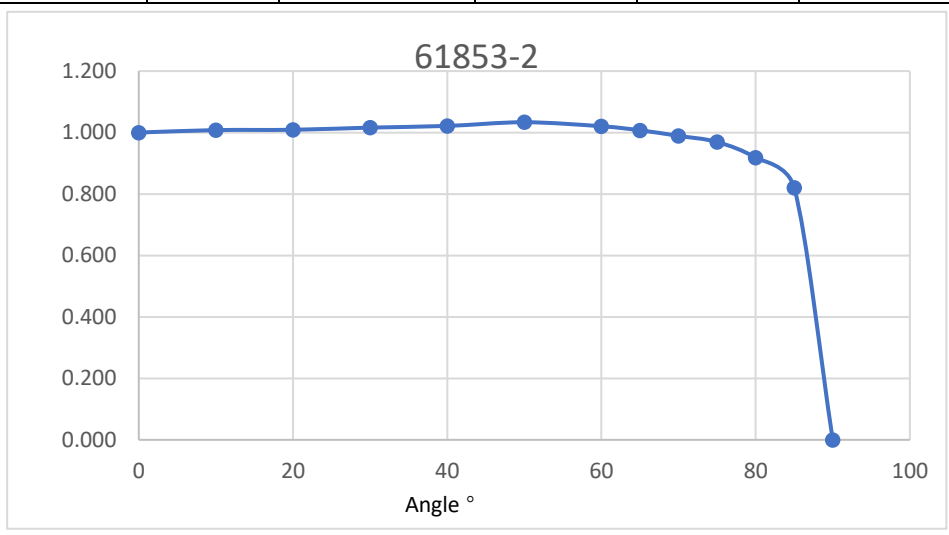
Average Pmax [W] Results Acquired over Multiple Irradiances per Temperature				
Irradiance [W/m ²]	Module Temperature			
	15 °C	25 °C	50 °C	75 °C
100	23.36%	22.66%	20.92%	19.10%
200	24.03%	23.36%	21.66%	19.90%
400	24.53%	23.88%	22.23%	20.54%
600	24.69%	24.06%	22.45%	20.78%
800	24.73%	24.11%	22.51%	20.87%
1000	24.69%	24.07%	22.50%	20.87%
1100	24.65%	24.04%	22.47%	20.85%

Figure 4:
Comparison of PVsyst Model, Using the Optimized PAN file, to the Laboratory Testing Results



4.4 Measurement of incidence angle effects

Sample No				4			—
Module Angle	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]	IAM value according to IEC61853-2
0	—	—	14.330	—	—	—	1.000
10	—	—	14.223	—	—	—	1.000
20	—	—	13.587	—	—	—	1.000
30	—	—	12.610	—	—	—	1.000
40	—	—	11.213	—	—	—	1.000
50	—	—	9.520	—	—	—	1.000
60	—	—	7.311	—	—	—	1.000
65	—	—	6.101	—	—	—	1
70	—	—	4.847	—	—	—	0.989
75	—	—	3.595	—	—	—	0.969
80	—	—	2.284	—	—	—	0.918
85	—	—	1.024	—	—	—	0.820

Fitted curve		

5 Documentation

List of measurement equipment

Identification #		Calibration Due Date (DD/MM/YYYY)
Light Meter	210904231	2024.03.12-2025.03.11
Measuring tape	/	2025.02.25-2026.02.24
Pulsed Solar Simulator	CS0105849	2025.01.08-2026.01.07
WPVS Reference Cell	200657	2024.12.26-2025.12.25

6 Summary

Below parameters are measured on three representative PV modules:

- The relative efficiency test results under different irradiance at 25°C
- Performance at the real irradiance and temperature conditions in table 2 of the IEC 61853-1

Based on the test results, PANFILE are optimized in Pvsyst. Efficiency vs. irradiance curves are generated using Pvsyst and the newly created PAN file, which is highly matched with the test results in lab.

According to the customer's requirements, the PAN Files were extended based on the measured parameter model of LR7-72HVHF-650M.

**TÜV SÜD Certification and Testing (China) Co., Ltd, Shanghai branch,
TÜV SÜD Group**

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