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CEA I PV MAGAZINE PROGRAM TEST REPORT

SUPPLIER | JOLYWOOD

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GSOLA 陕西众森电能科技有限公司
GSOLAR POWER CO.,LTD

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1. INTRODUCTION

As part of CEA's engagement in developing and supervising PV Magazine's test program at Gsola, CEA has developed a testing protocol and flowchart, a scoring system, a methodology and a reporting structure that it will be used to run this program. This report presents the test results and scoring grades for this product.

2. SCORING SYSTEM

2.1. Test flowchart and protocol

The following is a high-level flowchart of the testing procedure, describing the steps, and tests to be followed. Detailed checklists have been delivered to Gsola, that will also serve as records of the process.

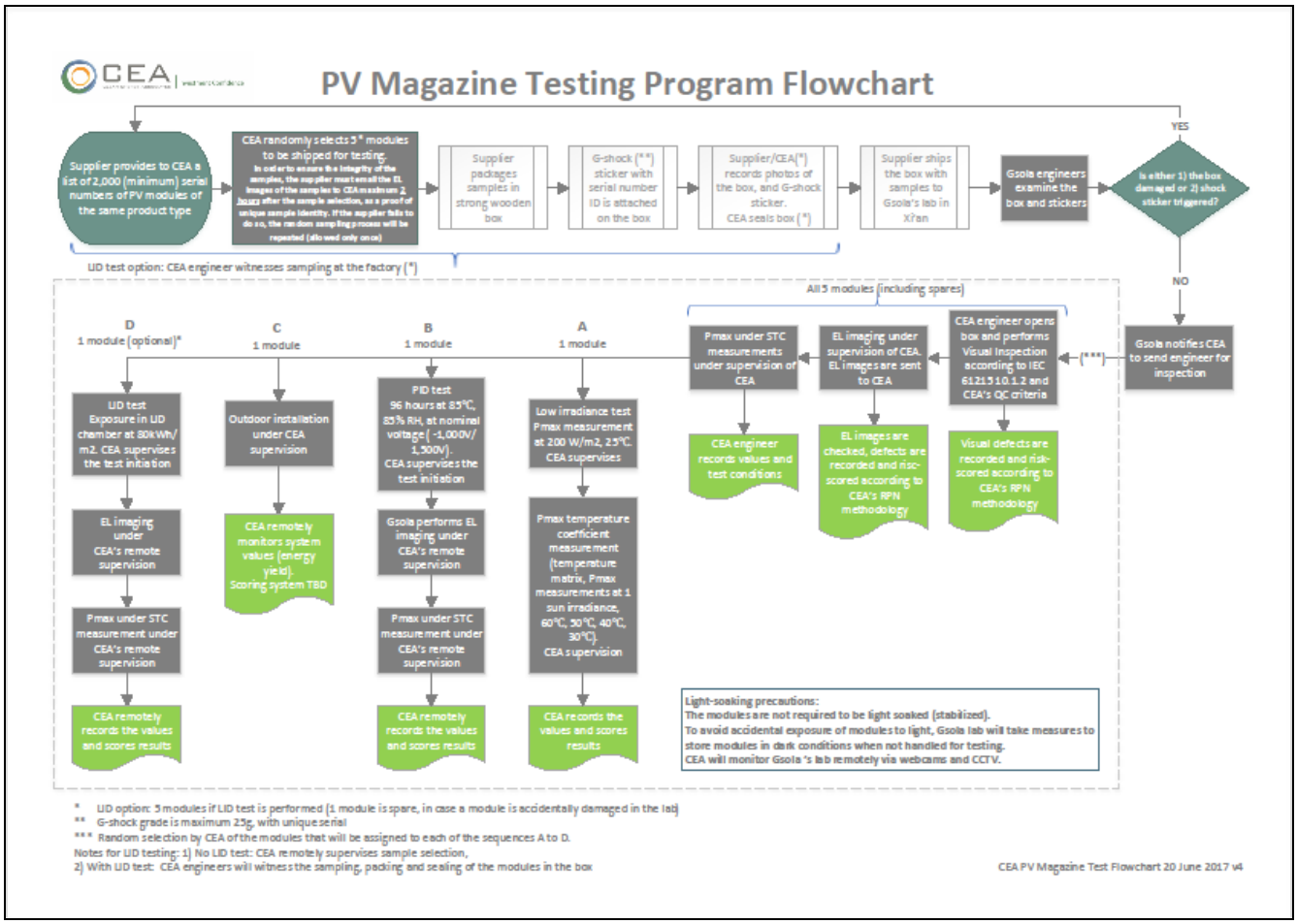


Figure 1 Test flowchart

2.2. Scoring methodology

For every product, 5 samples have been shipped to Gsola's lab to conduct the tests and inspections according to the above flowchart.

The following table describes the inspections and tests that have been applied on all products:

Table 1 Test/inspection grading system overview

	Test/inspection	# of samples	Method	Values	Average grade weight	Grades
1	Visual inspection	5	Inspection	RPN Scores	10%	1-100
2	EL image inspection	5	Inspection	RPN Scores	10%	1-100
3	Low irradiance efficiency loss	1	Test	%	25%	1-100
4	Pmax Temperature coefficient	1	Test	%/°C	25%	1-100
5	PID loss	1	Test	%	30%	1-100
6	LID loss (optional)	1	Test	%	NA	1-100
7	Outdoor installation and yield measurement	1	Energy Yield Monitoring	Periodic kWh/kWp	NA	NA

Notes:

1. The RPN scoring method has been developed by CEA and is used to evaluate and create risk scores of Visual and EL defects.
2. The weights are used to calculate the average grade for tests 1-5.

A number within the 1-100 range will be used to grade the results, so that the overall ranking of the products will reflect general industry practices and requirements:

Table 2 Detailed scoring system

	Grade range:	100	90	80	70	60	50	40	30	20	10	0
1	Visual inspection (RPN scores)	0	0.74	2.20	4.39	7.30	10.94	15.30	20.39	26.20	32.74	≥ 40
2	EL image (RPN scores)	0.00	2.03	4.62	7.75	11.43	15.65	20.43	25.75	31.62	38.03	≥ 45.00
3	Low irradiance loss	≤ -2.00%	-0.02%	1.78%	3.41%	4.87%	6.16%	7.27%	8.21%	8.98%	9.58%	≥ 10.00%
4	Pmax Temp. coefficient	≥ -0.300%	-0.343%	-0.382%	-0.417%	-0.448%	-0.475%	-0.498%	-0.517%	-0.532%	-0.543%	≤ -0.550%
5	PID loss	≤ 0.0%	0.7%	1.6%	2.7%	4.0%	5.5%	7.2%	9.1%	11.2%	13.5%	≥ 16.0%
6	LID loss (optional)	≤ -0.50%	0.35%	1.20%	2.05%	2.90%	3.75%	4.60%	5.45%	6.30%	7.15%	≥ 8.00%

Notes:

1. The Visual and EL Inspection RPN scores will be divided by the number of samples, to normalize the score, as the total number of samples may vary.
2. The correspondence of the scores/test results to the grades follows a binomial or linear relationship, anchored to certain key values that are generally accepted and employed in the PV industry. For example, a PID loss of 5%, which is the pass/fail threshold of the related IEC standard, will give a grade close to 50. In this sense, grades below 50 indicate a product performance that is below a generally acceptable threshold.

The scoring system shown in Table 2 is preliminary, and will be adjusted as the testing program develops, in order to better reflect the products standing per industry standards.

3. TEST DETAILS

A sample lot consists of 5 modules, one of which has been used as a spare for the chamber and outdoor testing, in case a module is accidentally damaged during handling at the lab. Refer to Table 3 and Table 4 for test sample and product information.

Table 3 Test sample information

Sample #	Serial number	Lab code
1	JW24221910010930020	PVT191612A-06-01
2	JW24221910010930016	PVT191612A-06-02
3	JW24221910010930014	PVT191612A-06-03
4	JW24221910010930012	PVT191612A-06-04
5	JW24221910010930011	PVT191612A-06-05

Table 4 Product information

Model	JW-D72N-400
Cell technology	Bifacial Mono TOPcon
Cell number	72 (6 x 12)
Cell format	Full cell
Number of busbars	12
Junction box	IP67 rated
Laminate construction	Framed

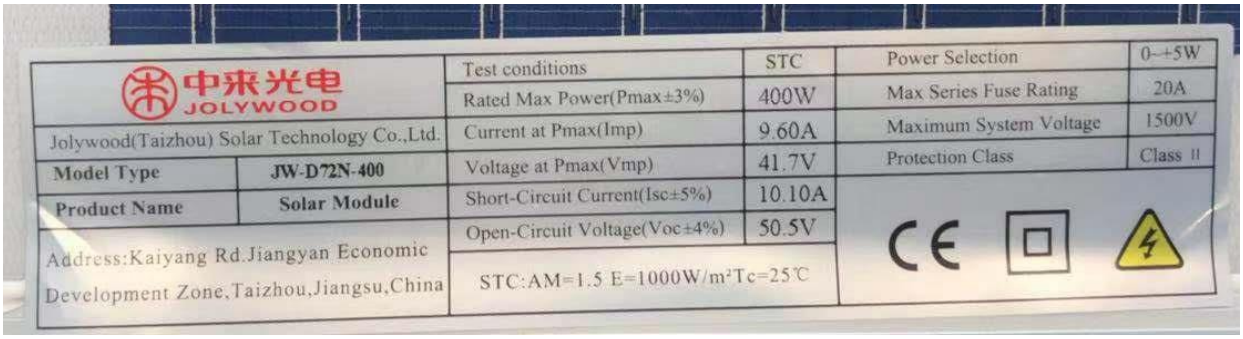


Figure 2 Product nameplate

3.1. Visual inspection

All 5 modules of each product sample lot have undergone visual inspection, according to CEA's quality criteria for visual inspection. The defects found has been evaluated according to CEA's scoring system. The scoring system is a modified version of CEA's proprietary RPN (risk priority number) system, based on the formula RPN score = Severity x Detectability.

Table 5 Product picture

Front Side	Rear Side
	

The following table shows the visual inspection results, normalized for the number of tested modules:

Table 6 Visual inspection results

JW-D72N-400	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Score	Grade
Visual inspection	None	None	None	None	None	0	100

3.2. EL image Inspection

The same sample lot was inspected for EL defects.
Table 7 shows the EL inspection results normalized for the number of tested modules. Visual and EL inspection scores are shown below in Figure 3.

Table 7 EL image inspection results

JW-D72N-400	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Score	Grade
EL image inspection	None	None	None	None	None	0	100

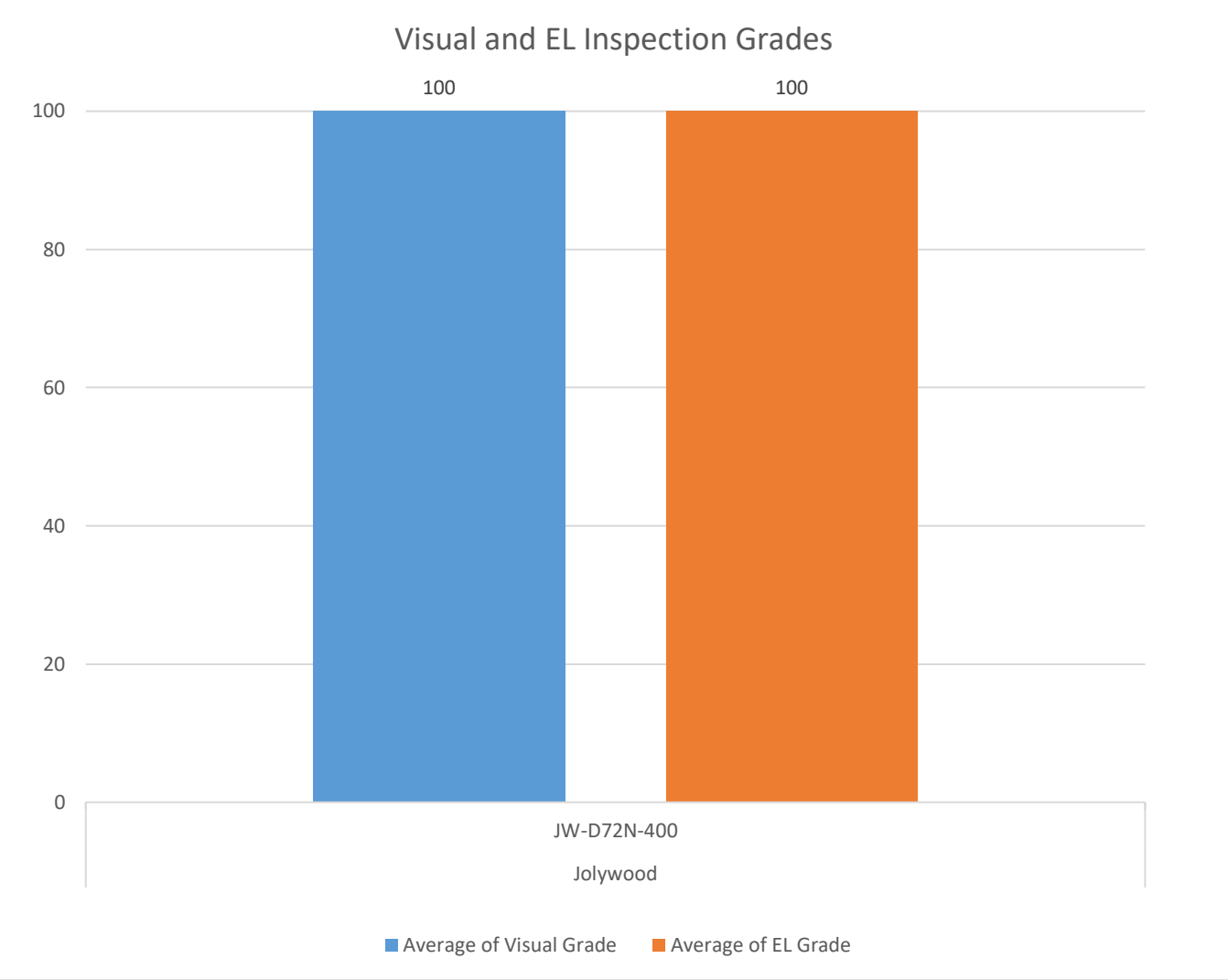


Figure 3 Visual and EL inspection results

3.3. Low irradiance efficiency loss test

The efficiency loss is calculated by the following formula:

Efficiency loss = 1- [(Pmax at low irradiance conditions / Pmax at STC) * (1,000/200)]

Table 8 and Figure 4 show the low irradiance efficiency test results for the front side.

Table 8 Low irradiance test results

JW-D72N-400	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Front side low irradiance efficiency loss (%)	4.19%					65

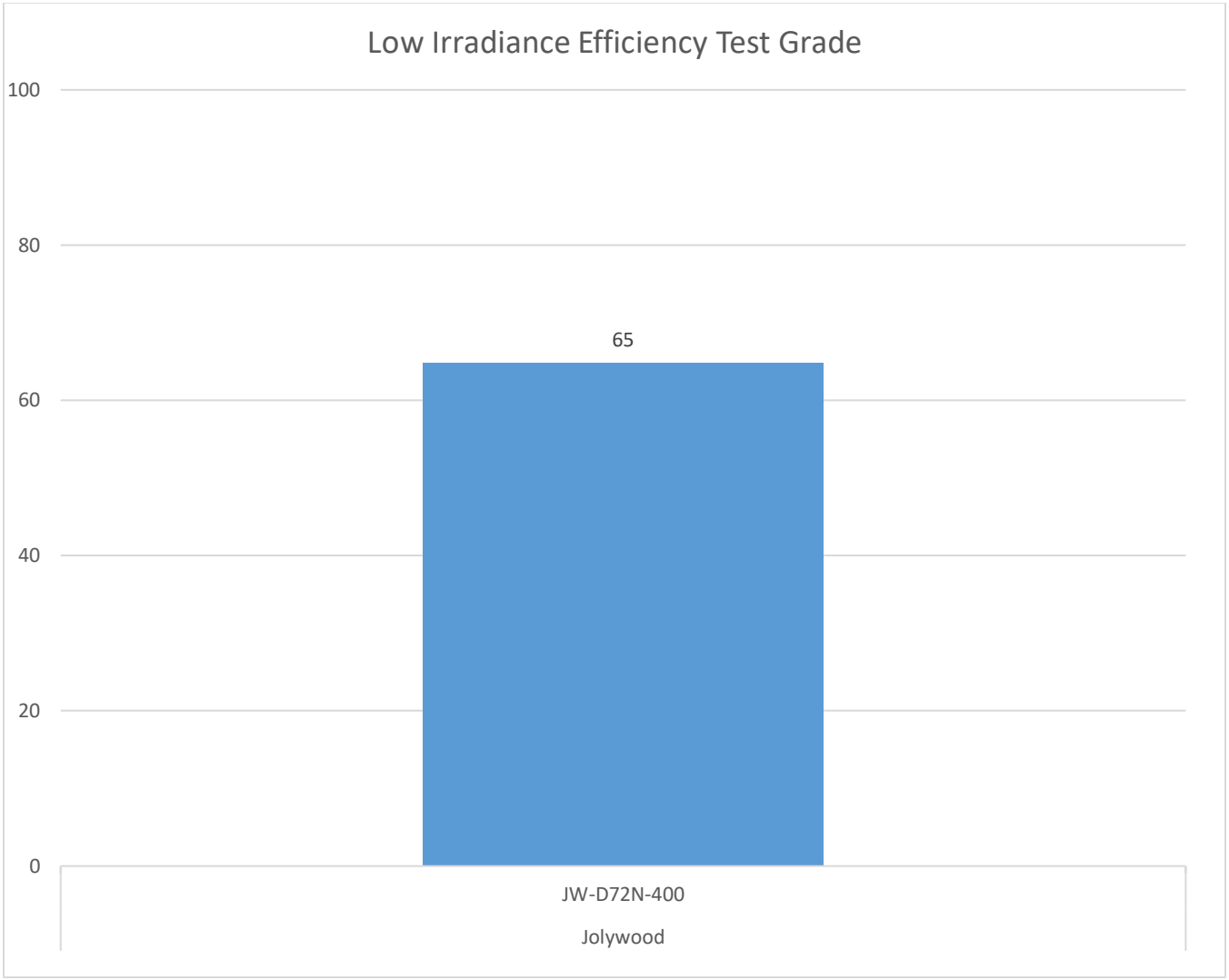


Figure 4 Low irradiance test result

3.4. Pmax temperature coefficient test

Table 9 and Figure 5 depict the Pmax temperature coefficient test results.

Table 9 Pmax temperature coefficient test result

JW-D72N-400	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Pmax Temperature coefficient (%/°C)	-0.38%					80

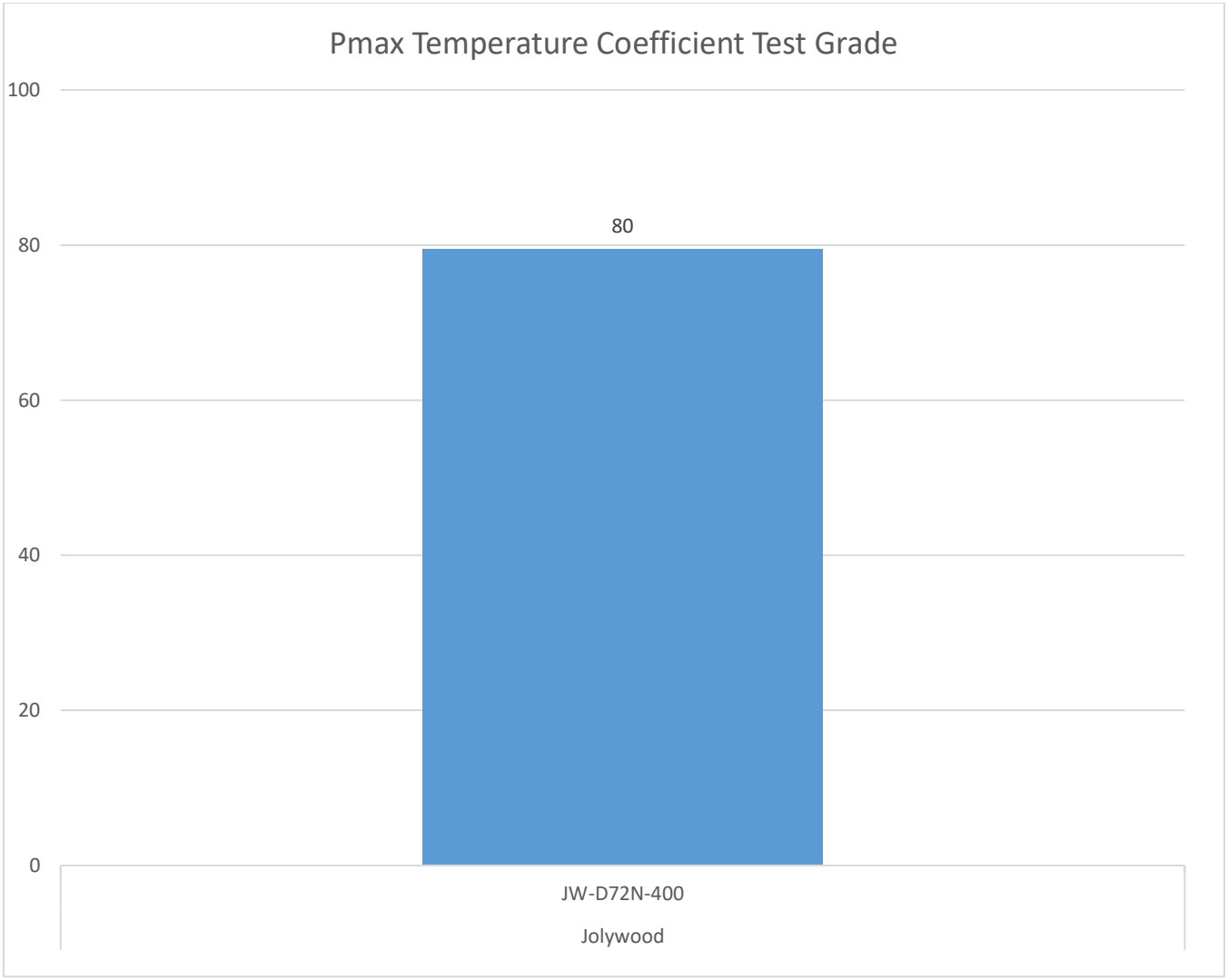


Figure 5 Pmax temperature coefficient test result

3.5. PID loss test

Table 10 and Figure 6 depicts the PID loss test results for the front side at **1500 V**:

Table 10 PID loss test result

JW-D72N-400	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Front side PID loss (%)		1.01%				87

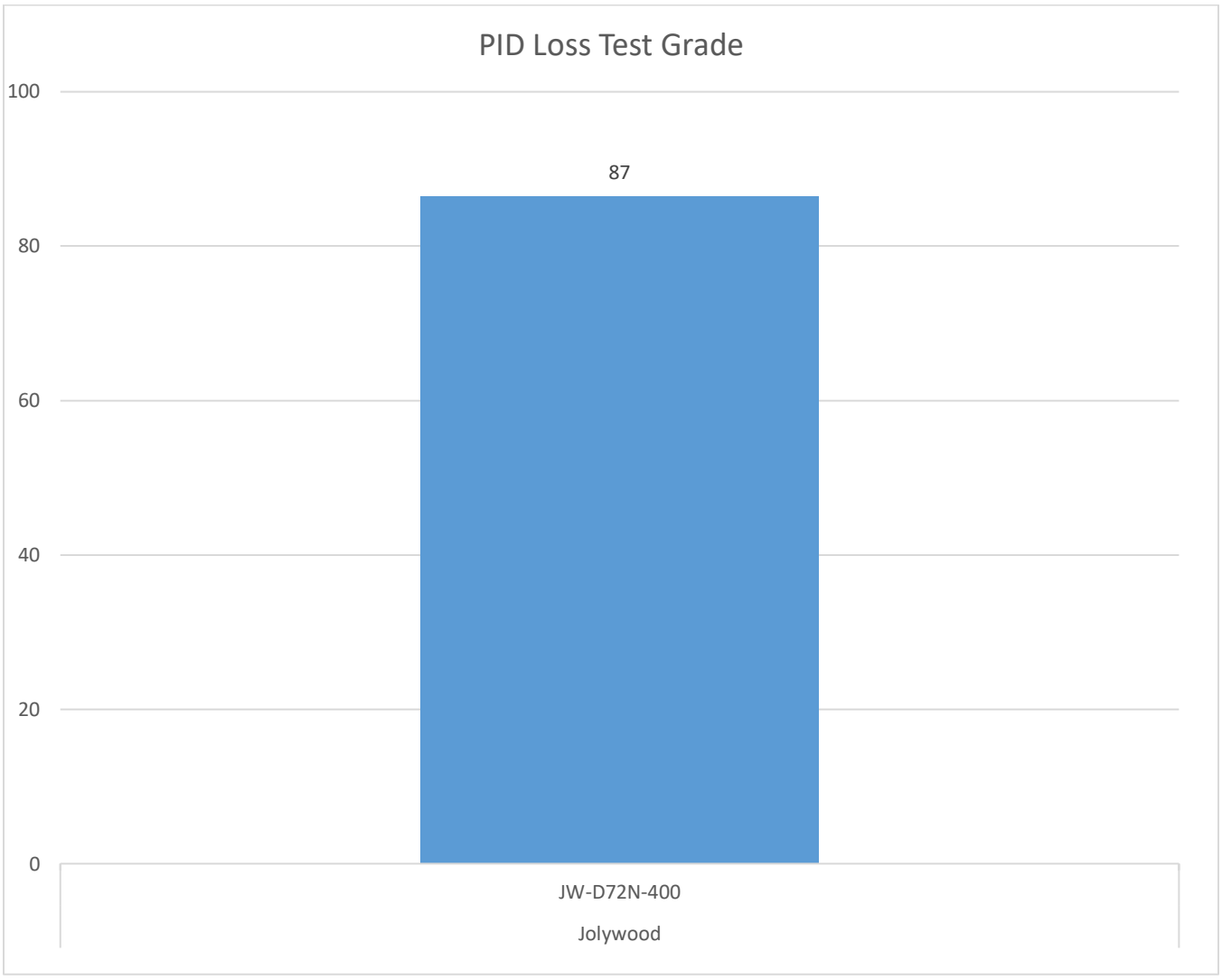


Figure 6 PID loss test result

3.6. Score overview

Figure 7 shows the overview of the test scores. Figure 8 shows the average score.

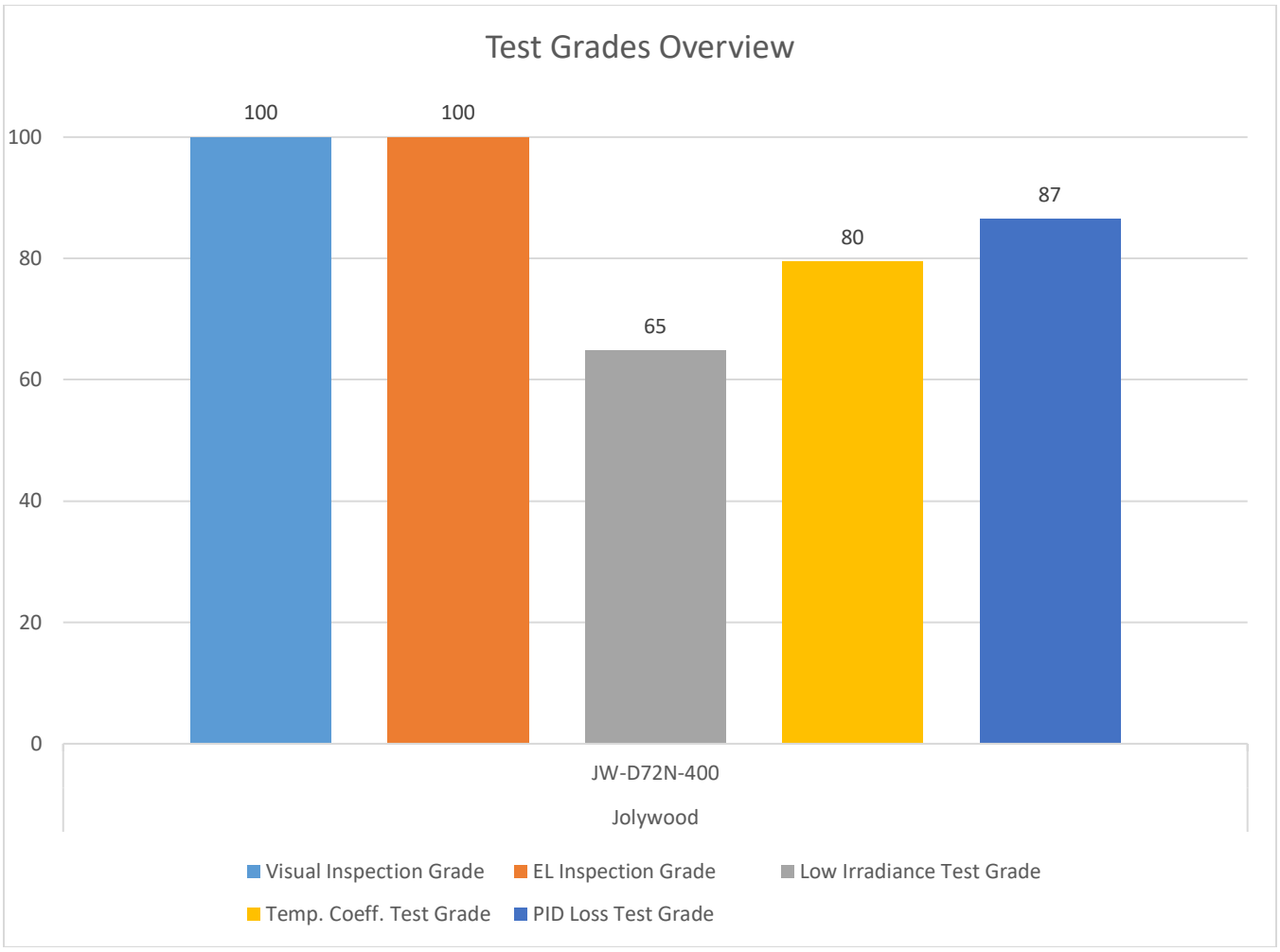


Figure 7 Test results overview

NOTE: The Average grade does **NOT** include the LID test, as it is optional and not performed for all products.

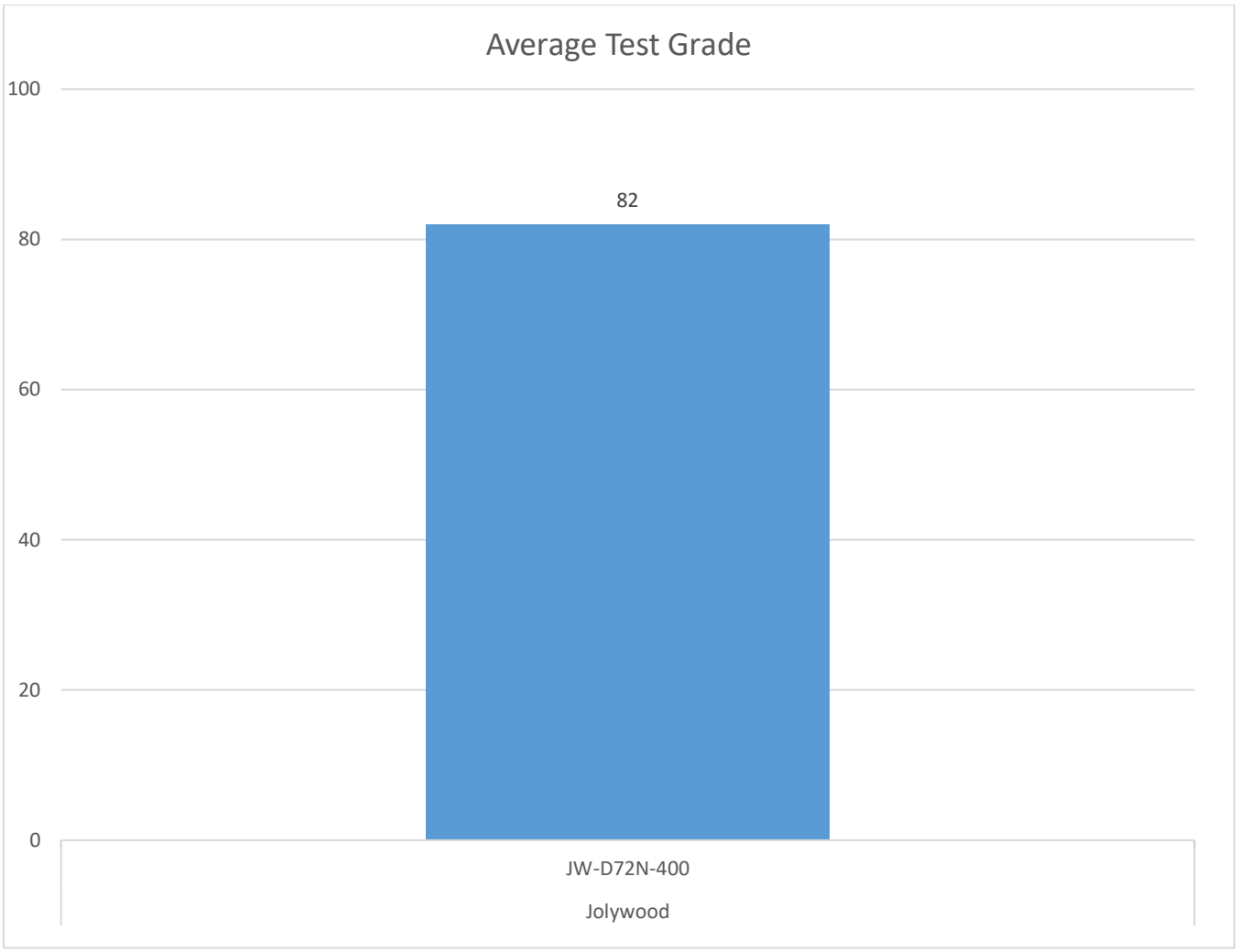


Figure 8 Average test grade

Appendix 1 - JW-D72N-400 Datasheet

JW-D72N Series (12BB Full Frame)

Jolywood N-type Bifacial High Efficiency Monocrystalline Silicon Double Glass Module

- JW-D72N-390
- JW-D72N-395
- JW-D72N-400
- JW-D72N-405
- JW-D72N-410
- JW-D72N-415

Additional Power Generation Gain
At least 30-year product life, more than 10% - 30% additional power gain comparing with conventional module

ZERO LID (Light Induced Degradation)
N-type solar cell has no LID naturally, can increase power generation

Excellent PID Free (Potential Induced Degradation)
With double glass design and POE material, of which the WVTR is only 1/10 of conventional EVA, there is no need to worry about the module power degradation caused by PID.

Lower Micro-crack Risk
No internal stress from the symmetrical N-Bifacial cell design

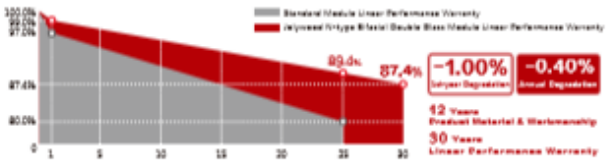
Higher Reliability
Successfully passed various strict tests (IEC61215, IEC61730 etc.)

Better Weak Illumination Response
Wide spectral response, higher power output even under low-light settings like smog or cloudy days.

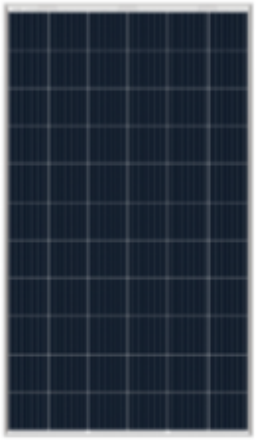
Better Temperature Coefficient
Higher power generation under working conditions, thanks to Passivating Contact Cell technology

Wider Applicability
BIPV,Vertical Installation, Snowfield, High-humid Area, Windy and dusty area

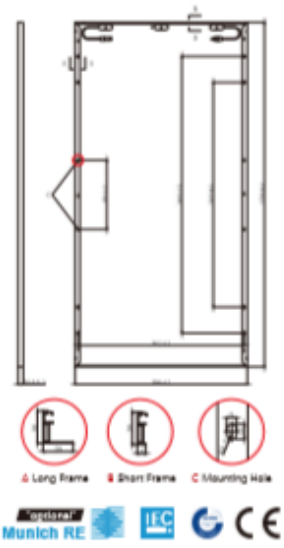
Linear map



Module diagram



Engineering drawing (unit : mm)



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Jolywood (Taizhou) Solar Technology Co., Ltd. is the world's leading manufacturer of N-type bifacial solar cells and modules. At present, we have more than 3GW production capacity of N-type monocrystalline bifacial solar cells and modules, and our technology covers the world-leading N-PERT, Passivating Contact, IBC, TBC and other cell and module technology. The parent company, Jolywood (Suzhou) Sunwatt Co.,Ltd. (stock code: SZ300393), which is established in 2008 and successfully listed in the GEM in 2014, is the world's largest professional PV backsheet manufacturer, committing to becoming the world's top manufacturer of advanced integrated PV products.

JW-D72N Series | Jolywood N-type Bifacial High Efficiency Monocrystalline Silicon Double Glass Module

ELECTRICAL PROPERTIES | STC*

Module Type	JW-D72N-390	JW-D72N-395	JW-D72N-400	JW-D72N-405	JW-D72N-410	JW-D72N-415
Testing Condition	Front Side	Front Side	Front Side	Front Side	Front Side	Front Side
Peak Power (Pmax) (W)	390	395	400	405	410	415
MPP Voltage (Vmp) (V)	40.8	41.2	41.5	41.8	42.1	42.4
MPP Current (Imp) (A)	9.56	9.60	9.64	9.69	9.74	9.79
Open Circuit Voltage (Voc) (V)	49.2	49.5	49.8	50.1	50.4	50.7
Short Circuit Current (Isc) (A)	10.02	10.08	10.14	10.19	10.24	10.29
Module Efficiency (%)	19.66	19.91	20.16	20.41	20.66	20.92

*STC: Irradiance 1000 W/m², Cell Temperature 25°C, Air Mass AM1.5
The data above is for reference only and the actual data is in accordance with the pratical testing

ELECTRICAL PROPERTIES | NOCT*

Testing Condition	Front Side	Front Side	Front Side	Front Side	Front Side	Front Side
Peak Power (Pmax) (W)	295	299	303	306	310	314
MPP Voltage (Vmp) (V)	38.3	38.6	38.9	39.2	39.5	39.8
MPP Current (Imp) (A)	7.71	7.74	7.77	7.81	7.85	7.89
Open Circuit Voltage (Voc) (V)	47.0	47.3	47.6	47.9	48.2	48.5
Short Circuit Current (Isc) (A)	8.08	8.13	8.18	8.22	8.26	8.30

*NOCT: Irradiance at 800 W/m², Ambient Temperature 20°C, Wind Speed 1 m/s

OPERATING PROPERTIES >

Operating Temperature (℃)	-40℃~+85℃
Maximum System Voltage (V)	1500V (IEC)
Maximum Series Fuse Rating(A)	20
Power Tolerance	0~+5W
Bifaciality^	80%

^Bifaciality=Pmaxrear (STC) /Pmaxfront (STC) , Bifaciality tolerance ±5%

TEMPERATURE COEFFICIENT >

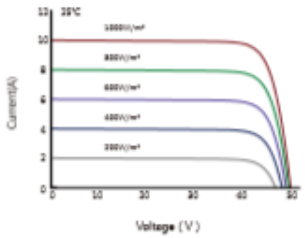
Temperature Coefficient of Pmax*	-0.32%/℃
Temperature Coefficient of Voc	-0.26%/℃
Temperature Coefficient of Isc	+0.046%/℃
Nominal Operating Cell Temperature (NOCT)	42±2℃

*Temperature Coefficient of Pmax±0.03%/℃

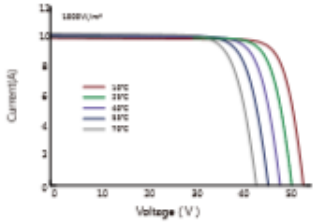
MECHANICAL PROPERTIES >

Cell Type	158.75mm*158.75mm
Number of Cells	72pcs(6*12)
Dimension	1992mm*996mm*30mm
Weight	29.5Kg
Front/Rear Glass	2.5mm/2.5mm
Frame	Anodized Aluminium
Junction Box	IP67 (3 diodes)
Length of Cable	4.0mm², 300mm
Connector	MC4 Compatible

Irradiance Dependence of Isc, Voc and Pmax >



Temperature Dependence of Isc, Voc and Pmax >



With Different Power Generation Gain (regarding 405W as an example) >

Power Gain (%)	Peak Power (Pmax) (W)	MPP Voltage (Vmp) (V)	MPP Current (Imp) (A)	Open Circuit Voltage (Voc) (V)	Short Circuit Current (Isc) (A)
10	437	41.8	10.46	50.1	10.98
15	454	41.9	10.84	50.2	11.38
20	470	41.9	11.22	50.2	11.78
25	486	41.9	11.60	50.2	12.18
30	502	41.9	11.99	50.2	12.57

Packaging Configuration >

Packing Type	20'GP	40'GP	40'HQ
Piece/Pallet		35	
Pallet/Container	5	11	22
Piece/Container	175	385	770

*The specification and key features described in this datasheet may deviate slightly and are not guaranteed. Due to ongoing innovation, R&D enhancement,Jolywood (Taizhou) Solar Technology Co., Ltd. reserves the right to make any adjustment to the information described herein at any time without notice. Please always obtain the most recent version of the datasheet which shall be duly incorporated into the binding contract made by the parties governing all transactions related to the purchase and sale of the products described herein.

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