

CEA | PV MAGAZINE PROGRAM TEST REPORT

SUPPLIER | Risen

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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.

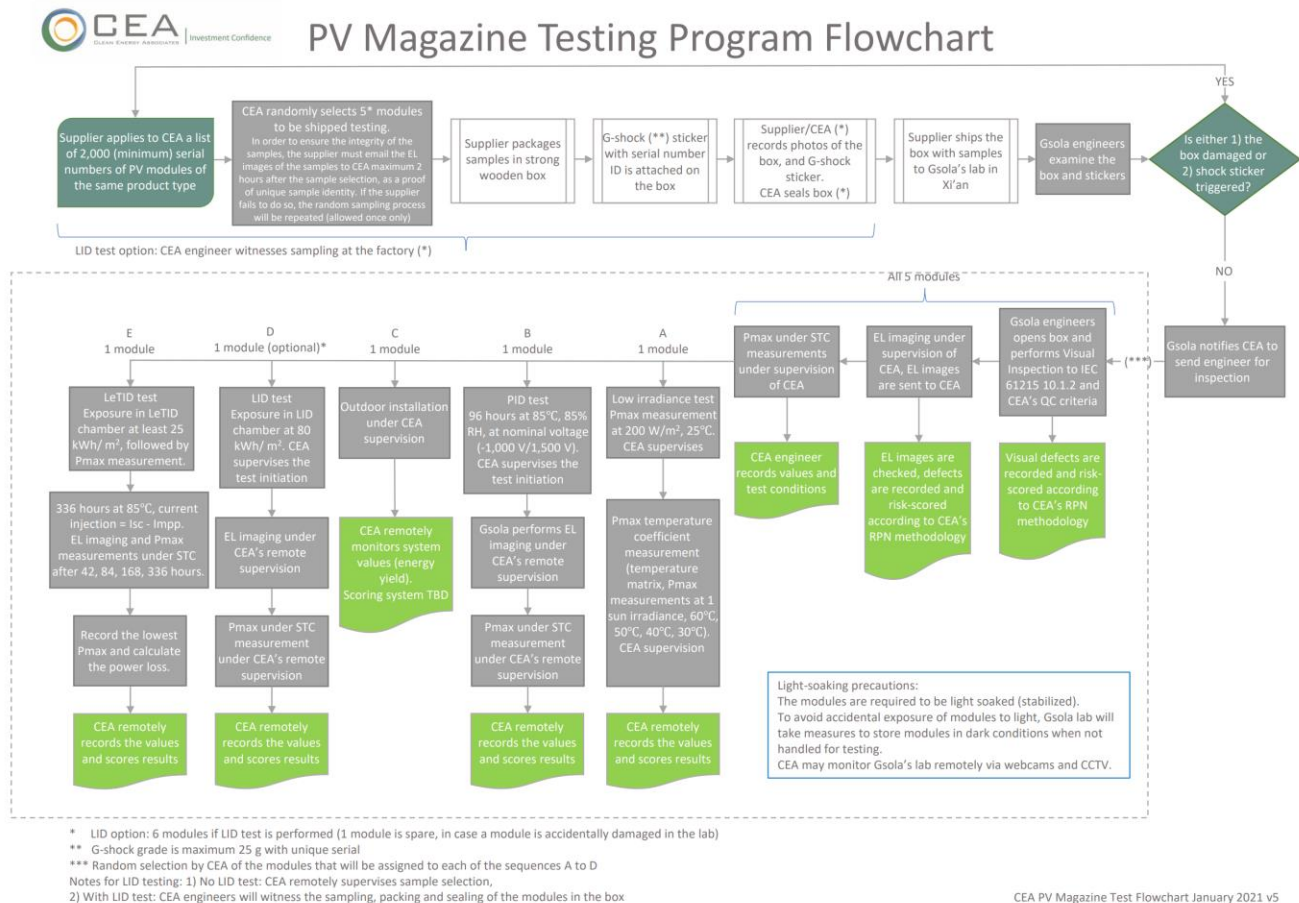


Figure 1 Test flowchart

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	LeTID	1	Test	%	NA	1-100
8	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%
7	LeTID	≤ 0%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.40%	2.70%	≥ 3.00%

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.

2.3. Selection methodology

We follow three testing sample selection methods:

- 1: Sample randomly selected by CEA from a large production lot
- 2: Sample purchased from the market by CEA
- 3: Sample provided by supplier, without random selection

The RSM132-8-700BHDG testing samples were selected according to method 3.

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
1	48211611501901
2	48172212500240
3	48172212500299
4	48172212500144
5	48172212500297

Table 4 Product information

Model	RSM132-8-700BHDG
Cell technology	n-type HJT
Cell number	132
Cell format	210x210 mm
Number of busbars	0
Junction box	IP68, 3 bypass diodes
Laminate construction	Glass
Bifaciality ratio	85±10%

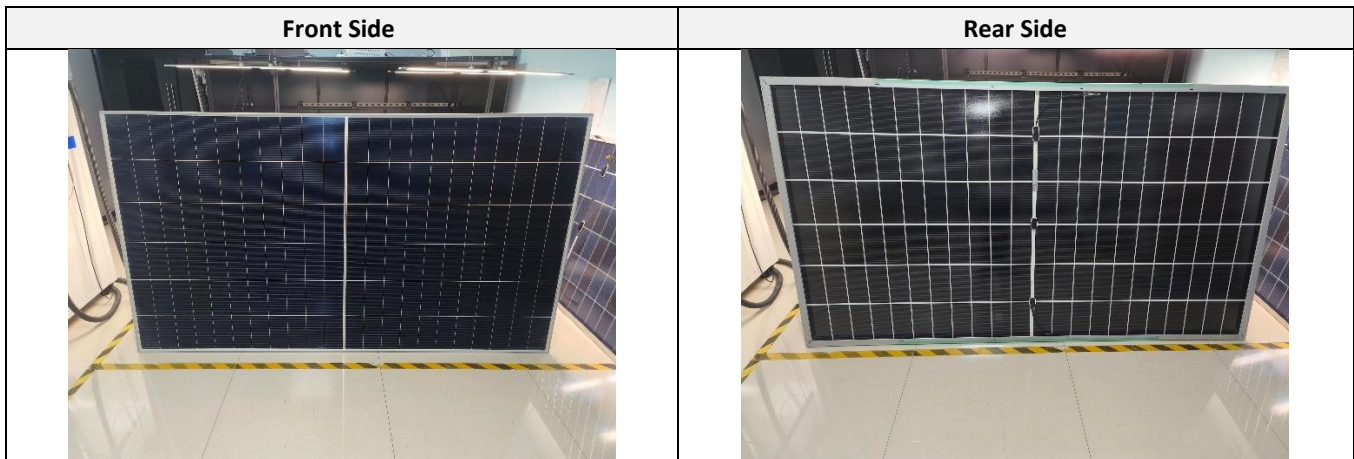


Figure 2 Product nameplate

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 $RPN\ score = Severity \times Detectability$.

Table 5 Product picture



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

Table 6 Visual inspection results

RSM132-8-700BHDG	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

RSM132-8-700BHDG	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Score	Grade
EL image inspection	None	None	None	None	None	0	100

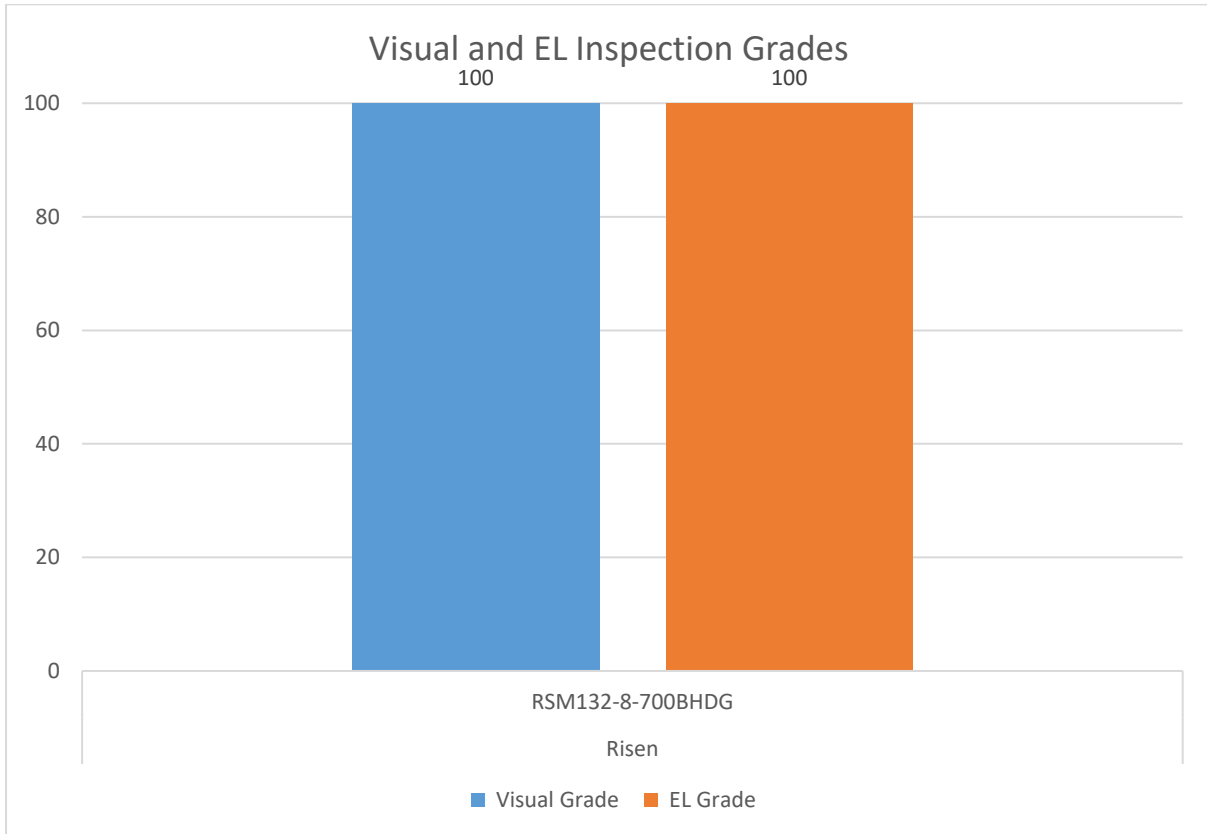


Figure 3 Visual and EL inspection results

3.3. Low irradiance efficiency loss test

The efficiency loss is calculated by the following formula:

$$\text{Efficiency loss} = 1 - \left[\left(\frac{\text{Pmax at low irradiance conditions}}{\text{Pmax at STC}} \right) * \left(\frac{1,000}{200} \right) \right]$$

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

Table 8 Low irradiance test results

RSM132-8-700BHDG	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Front side low irradiance efficiency loss (%)	2.23%					77

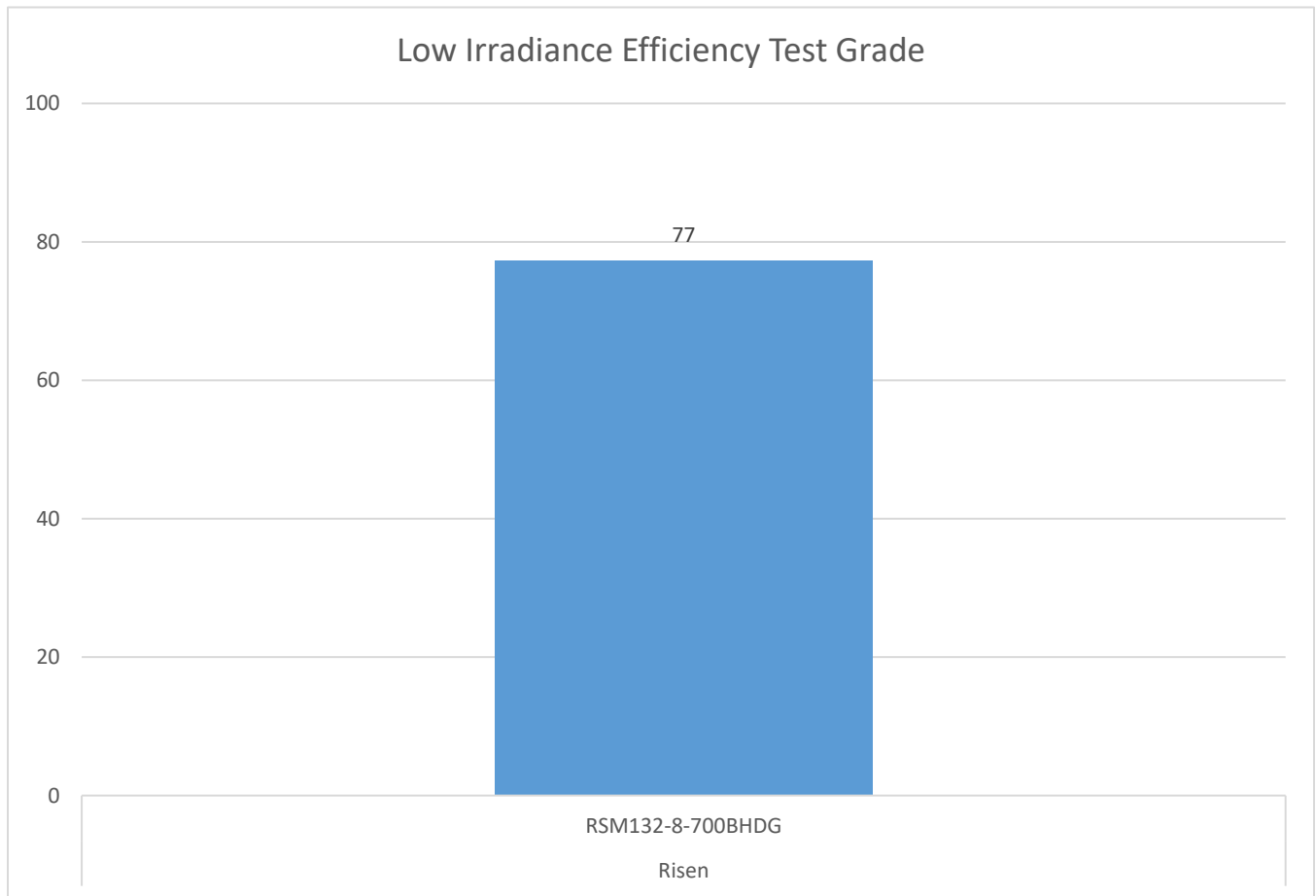


Figure 4 Low irradiance test result

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

RSM132-8-700BHDG	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Pmax Temperature coefficient (%/°C)	-0.247%					111

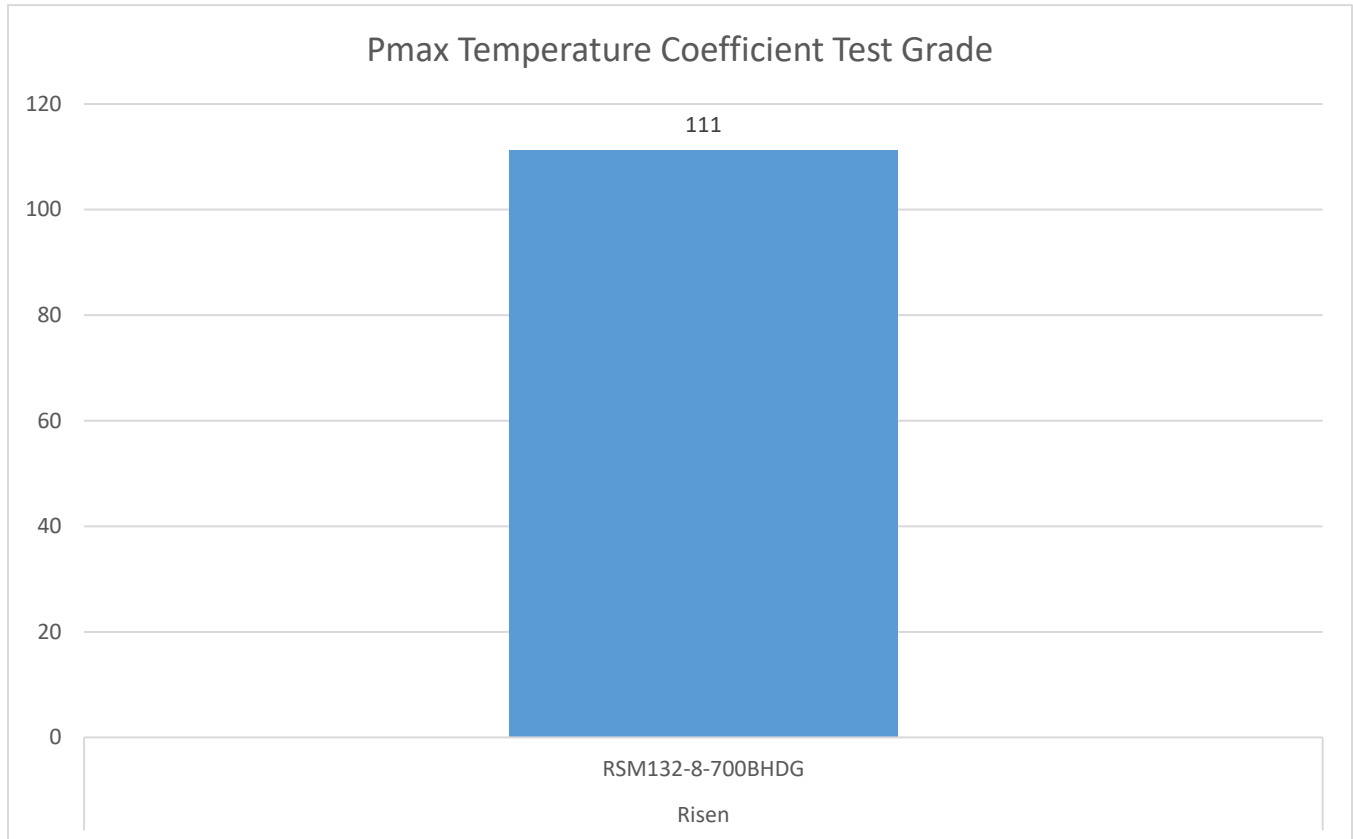


Figure 5 Pmax temperature coefficient test result

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

RSM132-8-700BHDG	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Front side PID loss (%)	2.17%					75

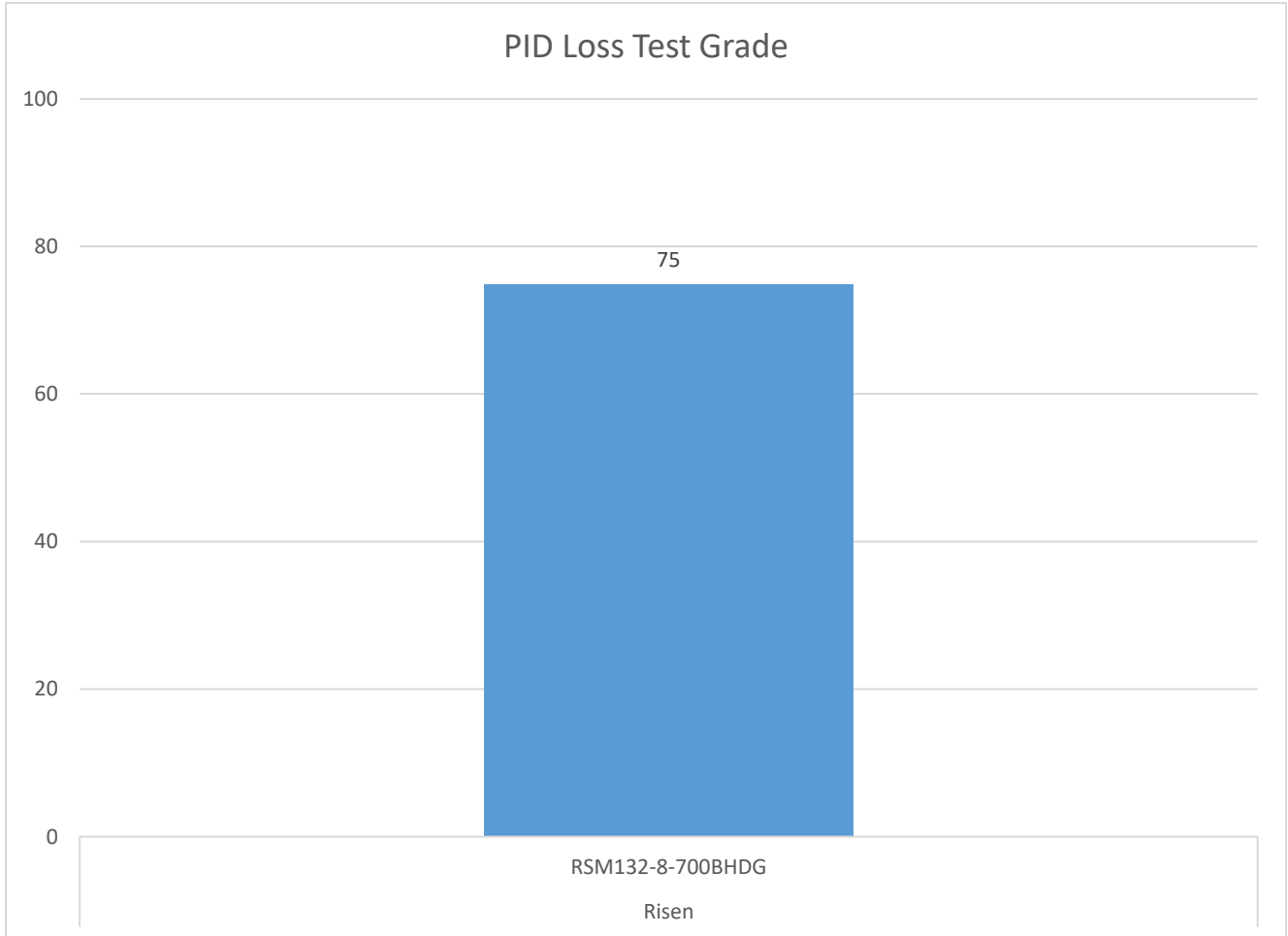


Figure 6 PID loss test result

3.6. LeTID loss test

Table 11 and Figure 7 depicts the LeTID loss test results:

Table 11 LeTID loss test result

RSM132-8-700BHDG	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Front side LeTID loss (%)						

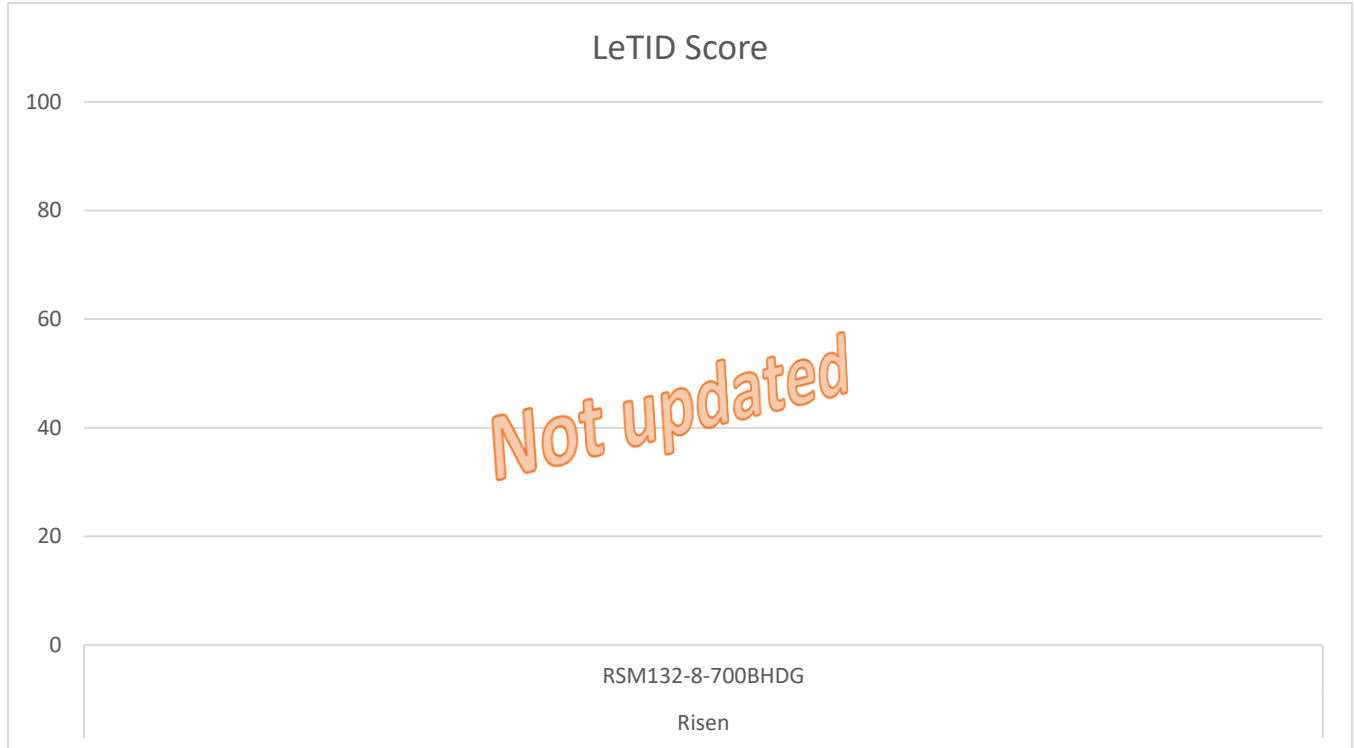


Figure 7 LeTID loss test result

3.7. Bifaciality ratio

The bifaciality ratio test result is not graded. We list the results here for informational purposes. The table below shows the bifaciality ratio results:

Table 12 Bifaciality ratio test results

RSM132-8-700BHDG	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Average
Bifaciality ratio (%)	81.50%	81.71%	81.20%	80.83%	82.66%	81.57%

The bifaciality ratio is calculated from the following formula:

$$\text{Bifaciality ratio} = (\text{Pmax rear surface} / \text{Pmax front surface}) * 100\%$$

3.8. Score overview

Figure 8 shows the overview of the test scores. Figure 9 shows the average score.

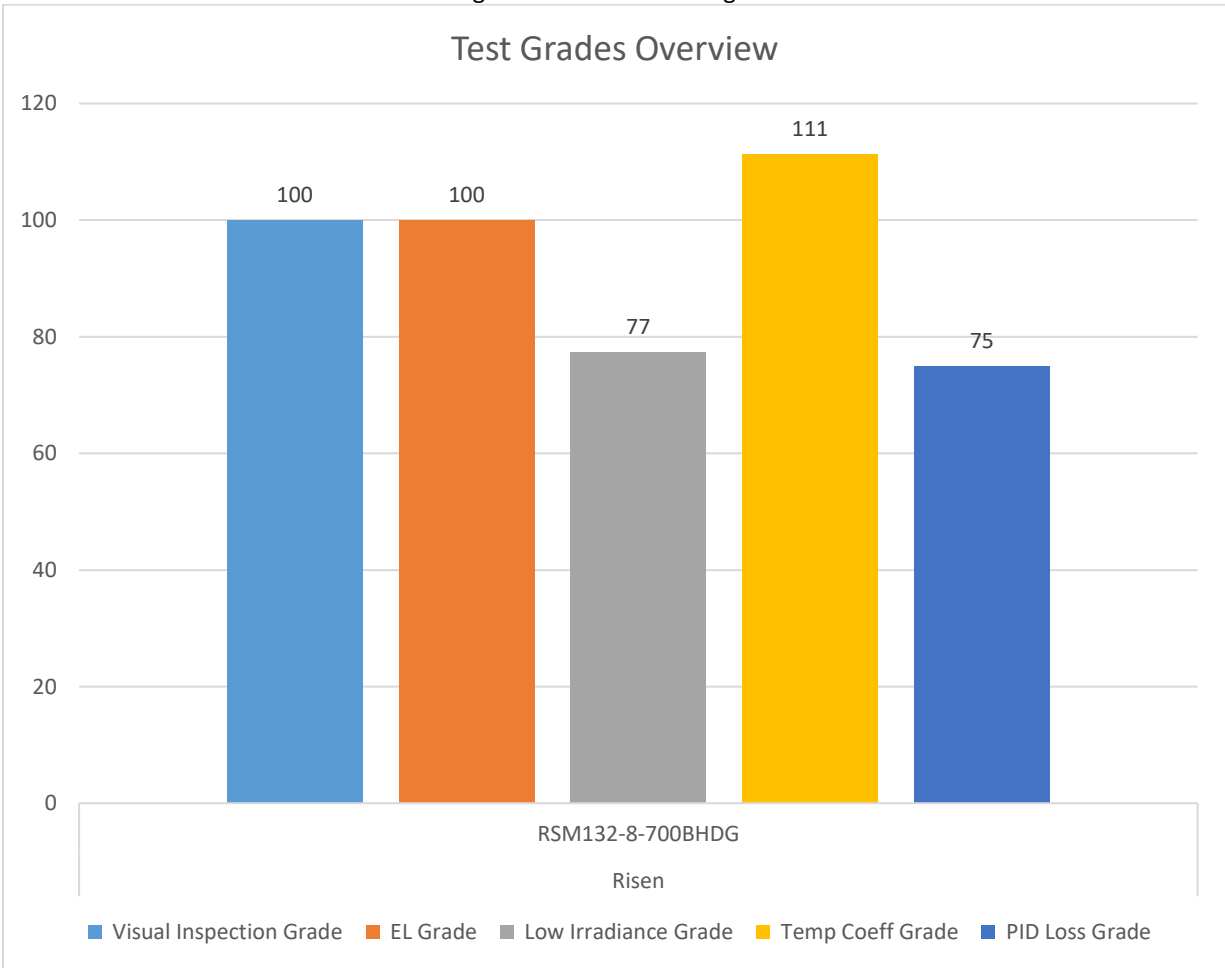


Figure 8 Test results overview

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

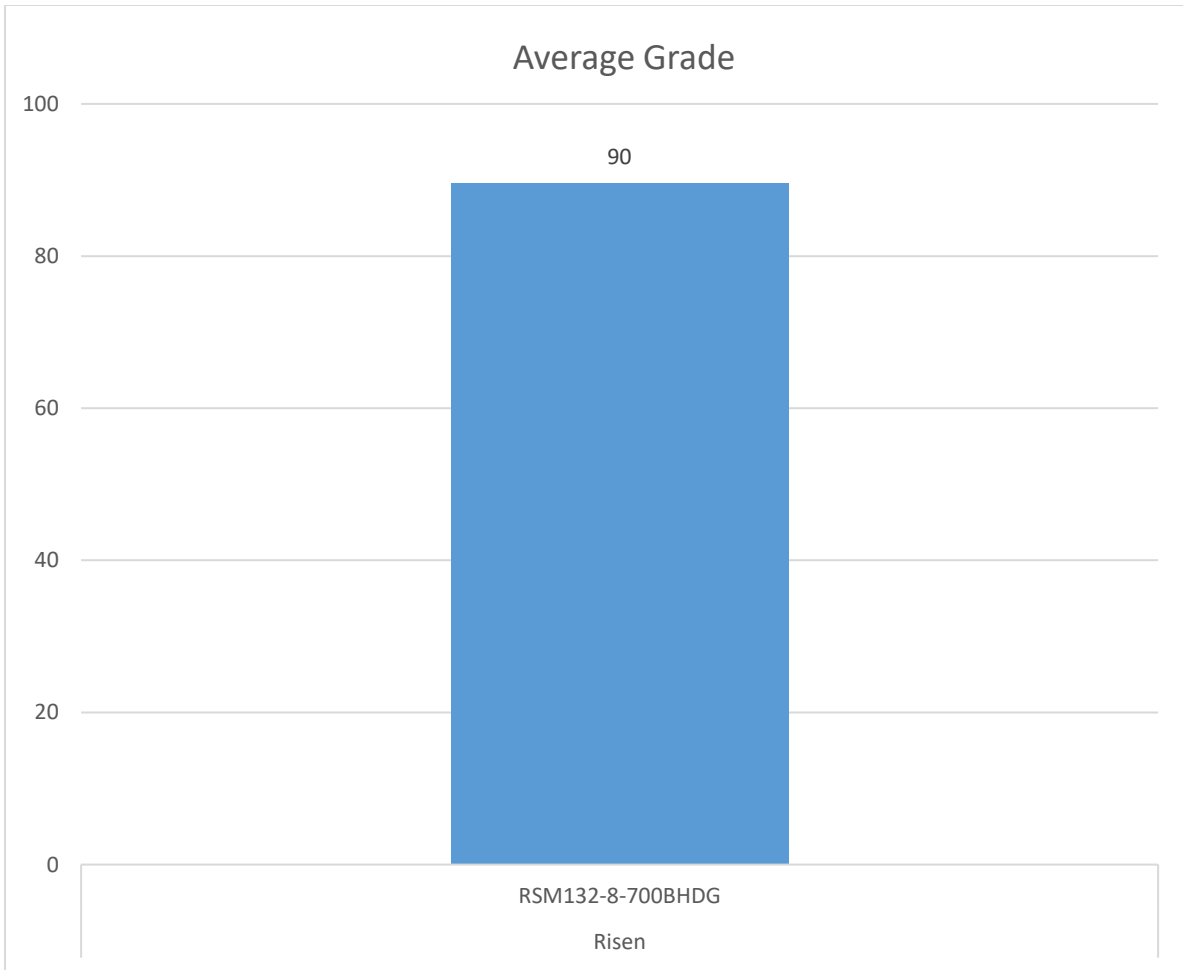


Figure 9 Average test grade

Appendix 1 – RSM132-8-700BHDG Datasheet



Hyper-ion™

Heterojunction Hyper-ion Series
Bifacial Module

RSM132-8-680-705BHDG

Hyper-link Interconnection

Patented Technology

680-705 Wp

Power Output Range

22.7 %

Higher Efficiency

0~+3%

Positive Power Tolerance



- No B-O caused LID
- Ultra-high bifacial factor
- Ultra-high power generation, ultra-low carbon emission
- Most stable power temperature coefficient
- Lead technology of metallization process
- Excellent anti-LID & anti-PID performance

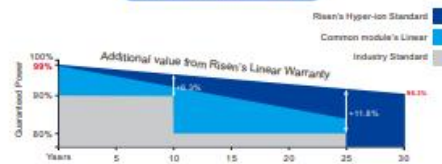


* As there are different certification requirements in different markets, please contact your local Risen Energy sales representative for the specific certificates applicable to the products in the region in which the products are to be used.

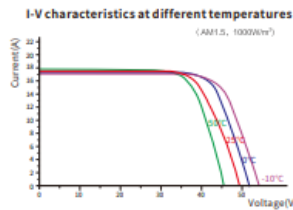
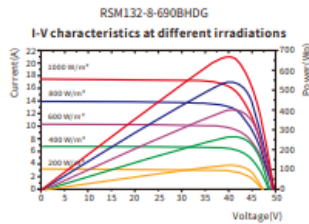
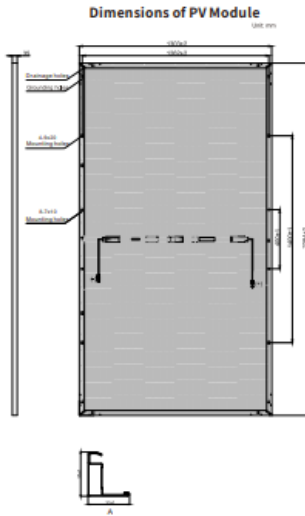
LINEAR PERFORMANCE WARRANTY

15 years product warranty / 30 years linear power warranty

0.3% Annual Degradation over 30 years



*Please check the valid version of Limited Product Warranty which is officially released by Risen Energy Co., Ltd



PACKAGING CONFIGURATION

	40ft(HQ)
Number of modules per container	558
Number of modules per pallet	31
Number of pallets per container	18
Packaging box dimensions (LxWxH) in mm	1320 × 1120 × 2520
Box gross weight[kg]	1300

ELECTRICAL DATA (STC)

Model Type	RSM132-8-680-705BHDG					
Rated Power in Watts-Pmax(Wp)	680	685	690	695	700	705
Open Circuit Voltage-Voc(V)	49.47	49.56	49.65	49.74	49.83	49.92
Short Circuit Current-Isc(A)	17.48	17.56	17.66	17.74	17.82	17.91
Maximum Power Voltage-Vmpp(V)	41.48	41.56	41.63	41.71	41.78	41.86
Maximum Power Current-Impp(A)	16.41	16.50	16.60	16.68	16.77	16.86
Module Efficiency (%) *	21.9	22.1	22.2	22.4	22.5	22.7

STC: Irradiance 1000 W/m², Cell Temperature 25°C, Air Mass AM1.5 according to EN 60904-3.
Bifacial factor: 85±10(%) * Module Efficiency (%): Rounding to the nearest number

Electrical characteristics with 10% rear side power gain

Total Equivalent power -Pmax (Wp)	748	754	759	765	770	776
Open Circuit Voltage-Voc(V)	49.47	49.56	49.65	49.74	49.83	49.92
Short Circuit Current-Isc(A)	19.23	19.32	19.43	19.51	19.60	19.70
Maximum Power Voltage-Vmpp(V)	41.48	41.56	41.63	41.71	41.78	41.86
Maximum Power Current-Impp(A)	18.05	18.15	18.26	18.35	18.44	18.55

Rear side power gain: The additional gain from the rear side compared to the power of the front side at the standard test condition. It depends on mounting (structure, height, tilt angle etc.) and albedo of the ground.

ELECTRICAL DATA (NMOT)

Model Type	RSM132-8-680-705BHDG					
Maximum Power-Pmax (Wp)	519.3	523.0	527.2	530.9	534.5	538.0
Open Circuit Voltage-Voc (V)	46.35	46.44	46.52	46.61	46.69	46.78
Short Circuit Current-Isc (A)	14.34	14.40	14.48	14.55	14.61	14.68
Maximum Power Voltage-Vmpp (V)	38.78	38.85	38.93	39.00	39.07	39.14
Maximum Power Current-Impp (A)	13.39	13.46	13.54	13.61	13.68	13.76

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

MECHANICAL DATA

Solar cells	n-type HJT
Cell configuration	132 cells (6 × 11 + 6 × 11)
Module dimensions	2384 × 1303 × 35mm
Weight	40.5kg
Superstrate	High Transmission, AR Coated Heat Strengthened Glass
Substrate	Heat Strengthened Glass
Frame	High strength alloy steel
J-Box	Potted, IP68, 1500VDC, 3 Schottky by pass diodes
Cables	4.0mm ² , Positive(+)350mm, Negative(-)230mm (Connector included)
Connector	Risen Twinsel PV-SY02, IP68

TEMPERATURE & MAXIMUM RATINGS

Nominal Module Operating Temperature (NMOT)	43°C ± 2°C
Temperature Coefficient of Voc	-0.22%/°C
Temperature Coefficient of Isc	0.047%/°C
Temperature Coefficient of Pmax	-0.24%/°C
Operational Temperature	-40°C ~ +85°C
Maximum System Voltage	1500VDC
Max Series Fuse Rating	35A
Limiting Reverse Current	35A



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CAUTION: READ SAFETY AND INSTALLATION INSTRUCTIONS BEFORE USING THE PRODUCT.

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