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CEA I PV MAGAZINE PROGRAM TEST REPORT

SUPPLIER | RISEN

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pv magazine
PHOTOVOLTAIC MARKETS & TECHNOLOGY

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.

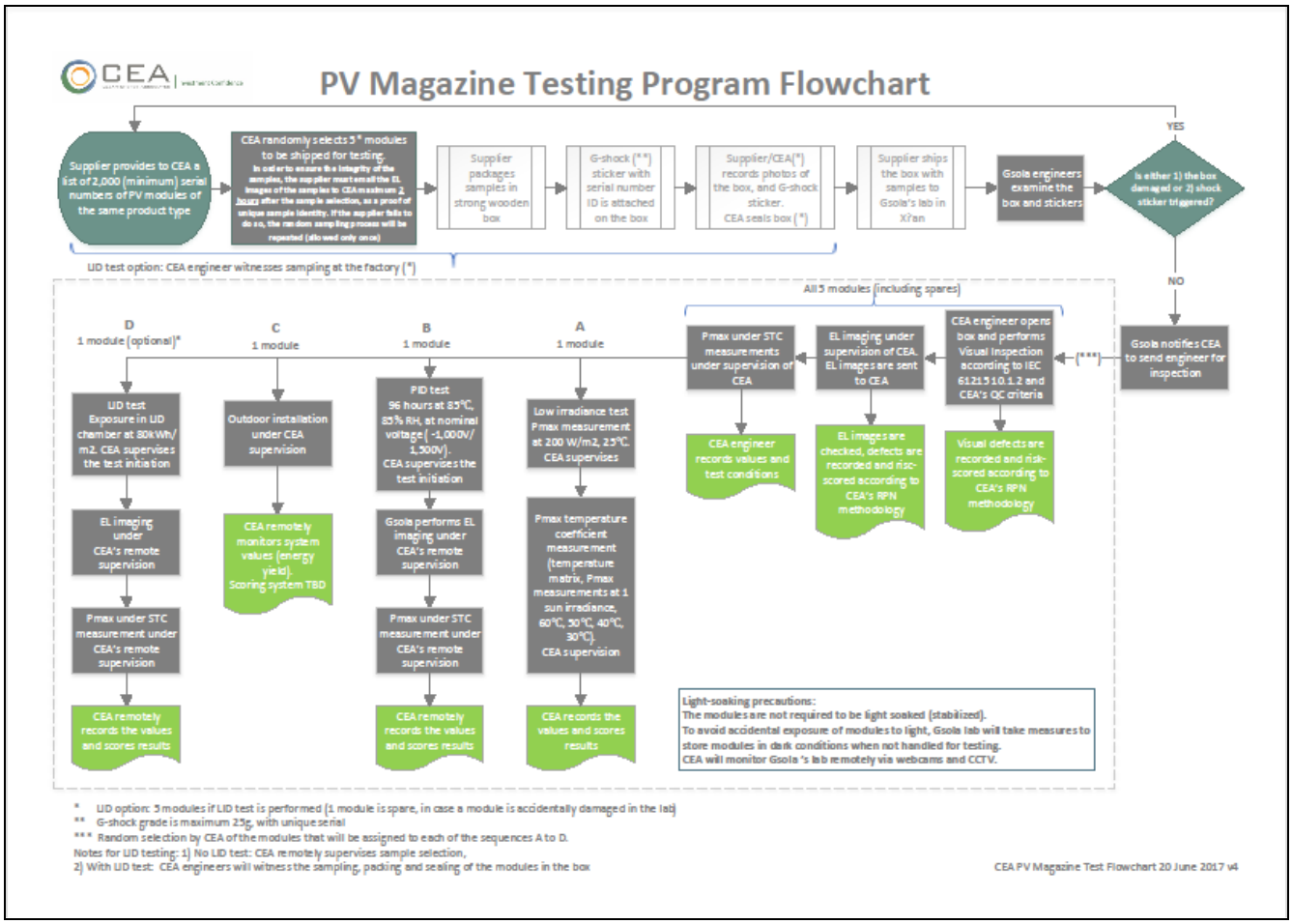

Figure 1 Test flowchart

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	451404I3202625	PVT200323A-05-01
2	451405I3201182	PVT200323A-05-02
3	451407I3202545	PVT200323A-05-03
4	451408I3201918	PVT200323A-05-04
5	451408I3203288	PVT200323A-05-05

Table 4 Product information

Model	RSM144-6-405BMDG
Cell technology	Bifacial Mono PERC
Cell number	144
Cell format	Half cut
Number of busbars	9
Junction box	IP68 rated
Laminate construction	Framed glass/glass
Bifaciality ratio	70%

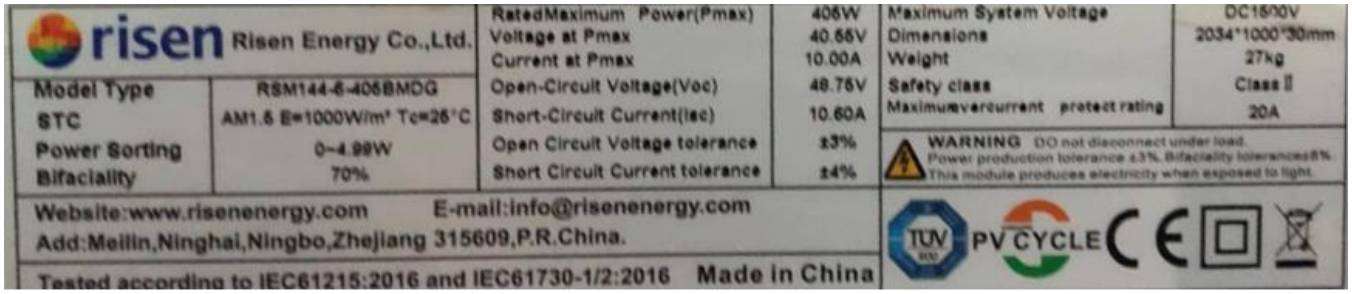

Figure 2 Product nameplate

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

RSM144-6-405BMDG	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

RSM144-6-405BMDG	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Score	Grade
EL image inspection	None	None	None	None	None	0	100

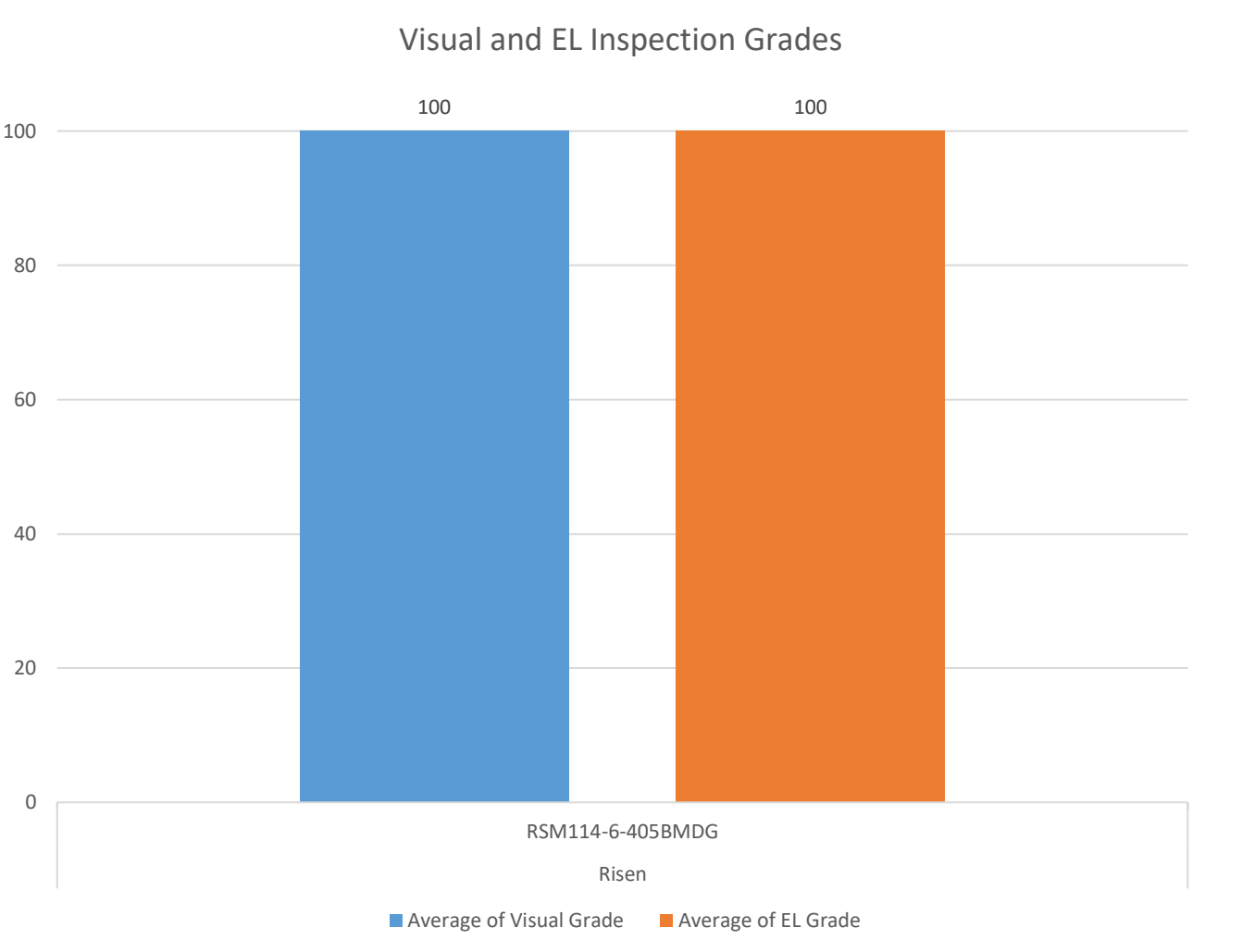

Figure 3 Visual and EL inspection results

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

RSM144-6-405BMDG	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Front side low irradiance efficiency loss (%)	5.20%					58

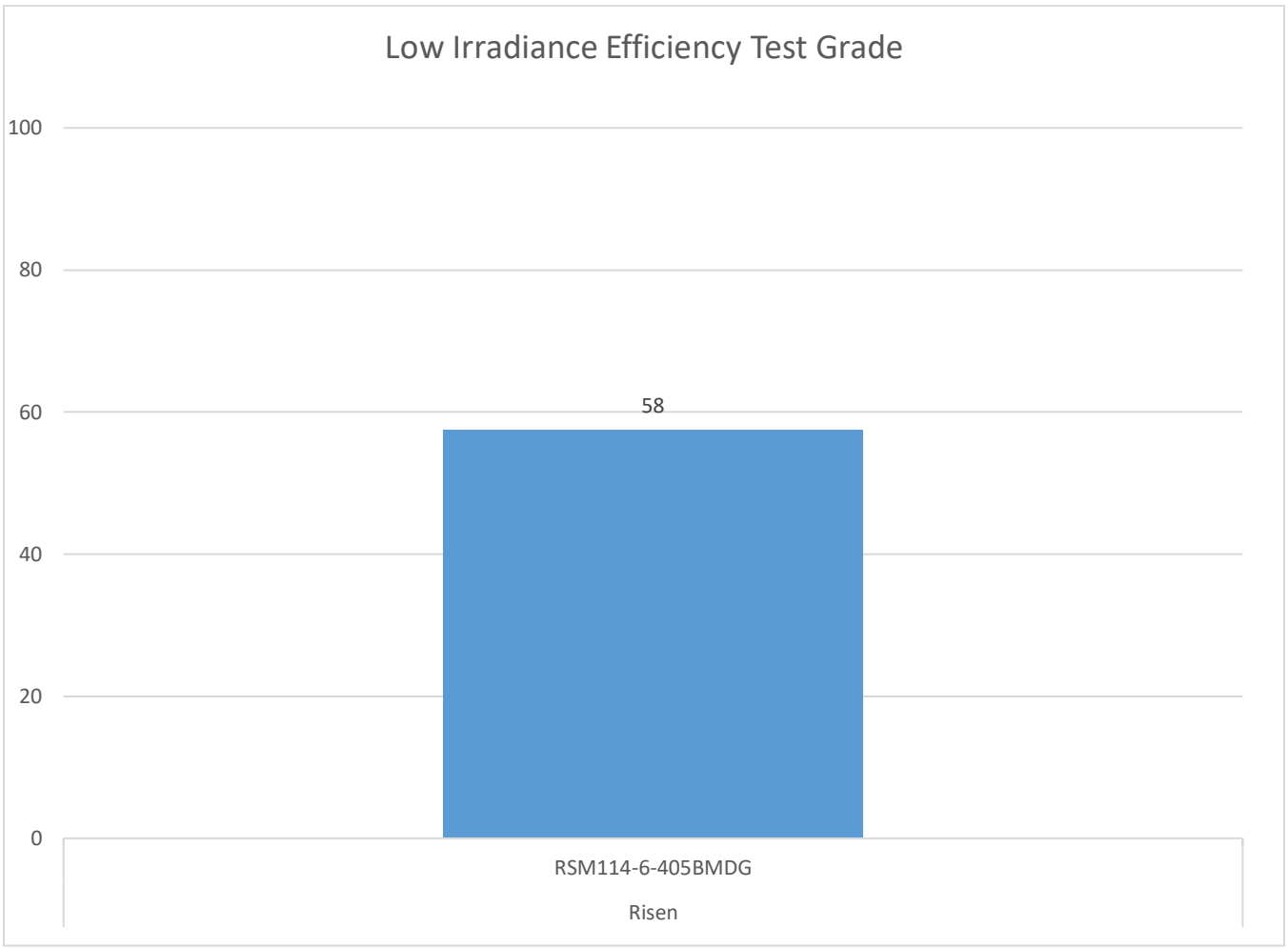

Figure 4 Low irradiance test result

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

RSM144-6-405BMDG	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Pmax Temperature coefficient (%/°C)	-0.39%					77

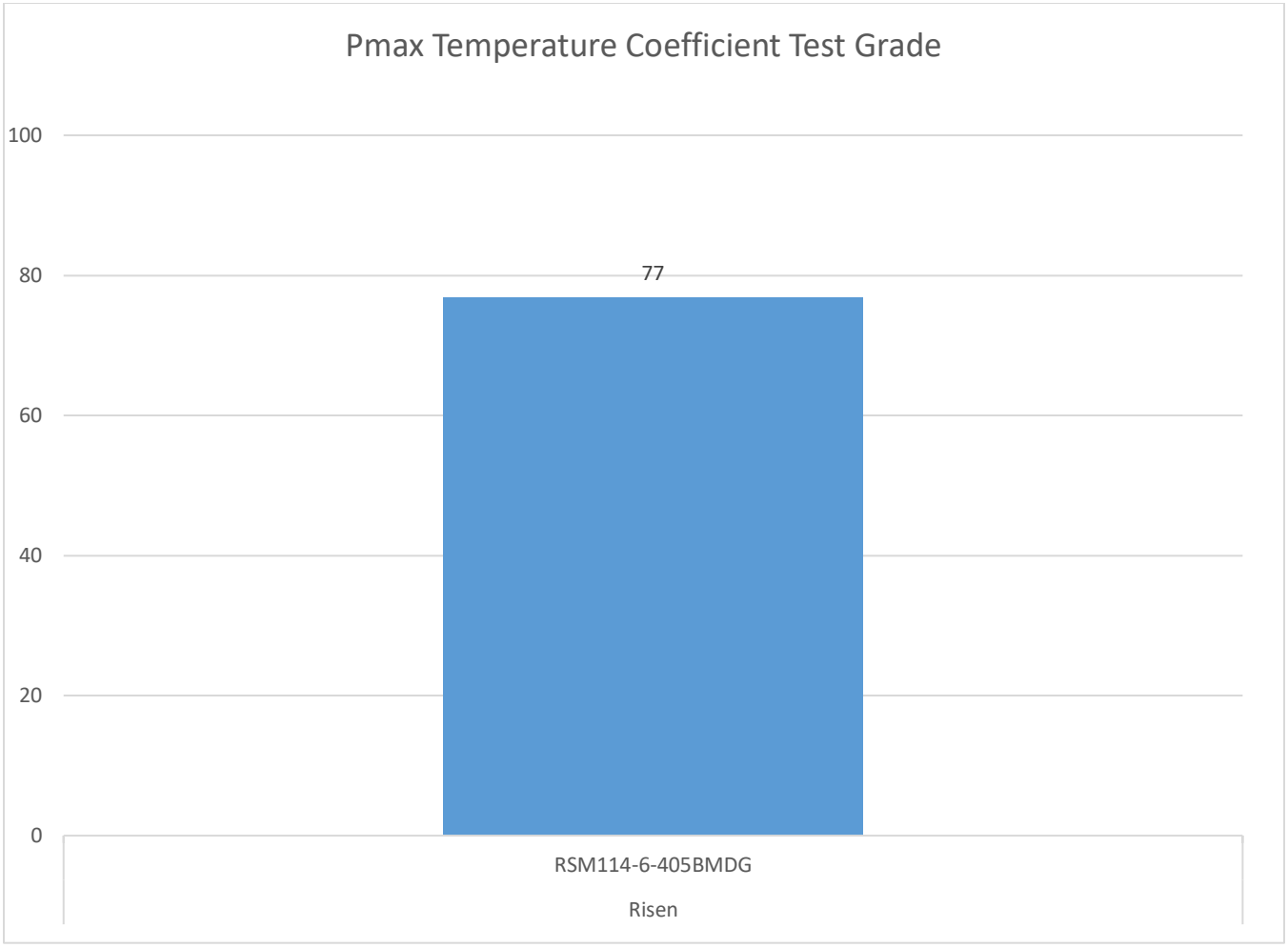

Figure 5 Pmax temperature coefficient test result

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

RSM144-6-405BMDG	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Front side PID loss (%)		3.48%				64

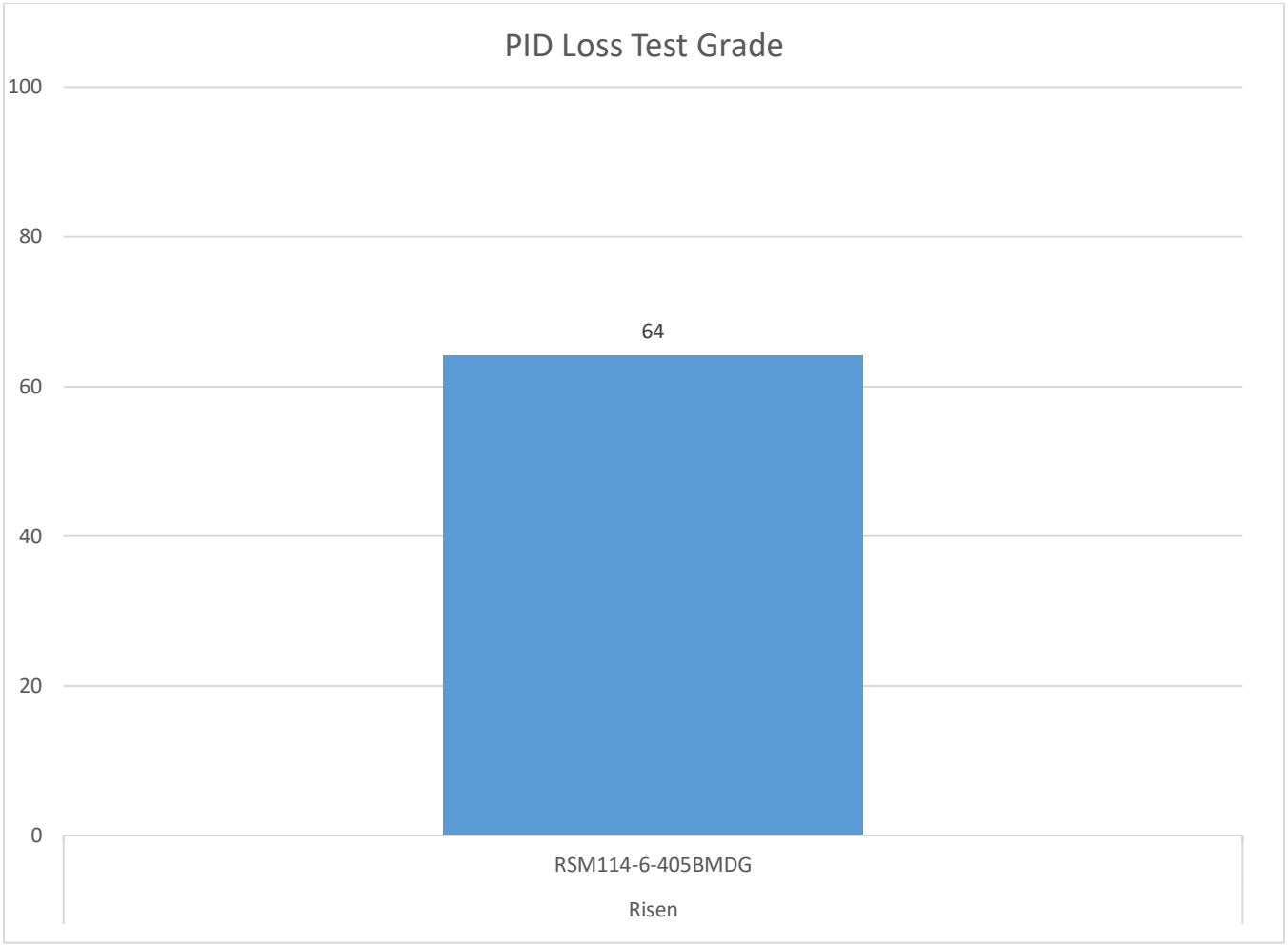

Figure 6 PID loss test result

3.6. 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 11 Bifaciality ratio test results

RSM144-6-405BMDG	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Average
Bifaciality ratio (%)	65.6	66.9	67.3	66.3	66.7	**66.6**

The bifaciality ratio is calculated from the following formula:

Bifaciality ratio = (Pmax rear surface / Pmax front surface) * 100%

3.7. Score overview

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

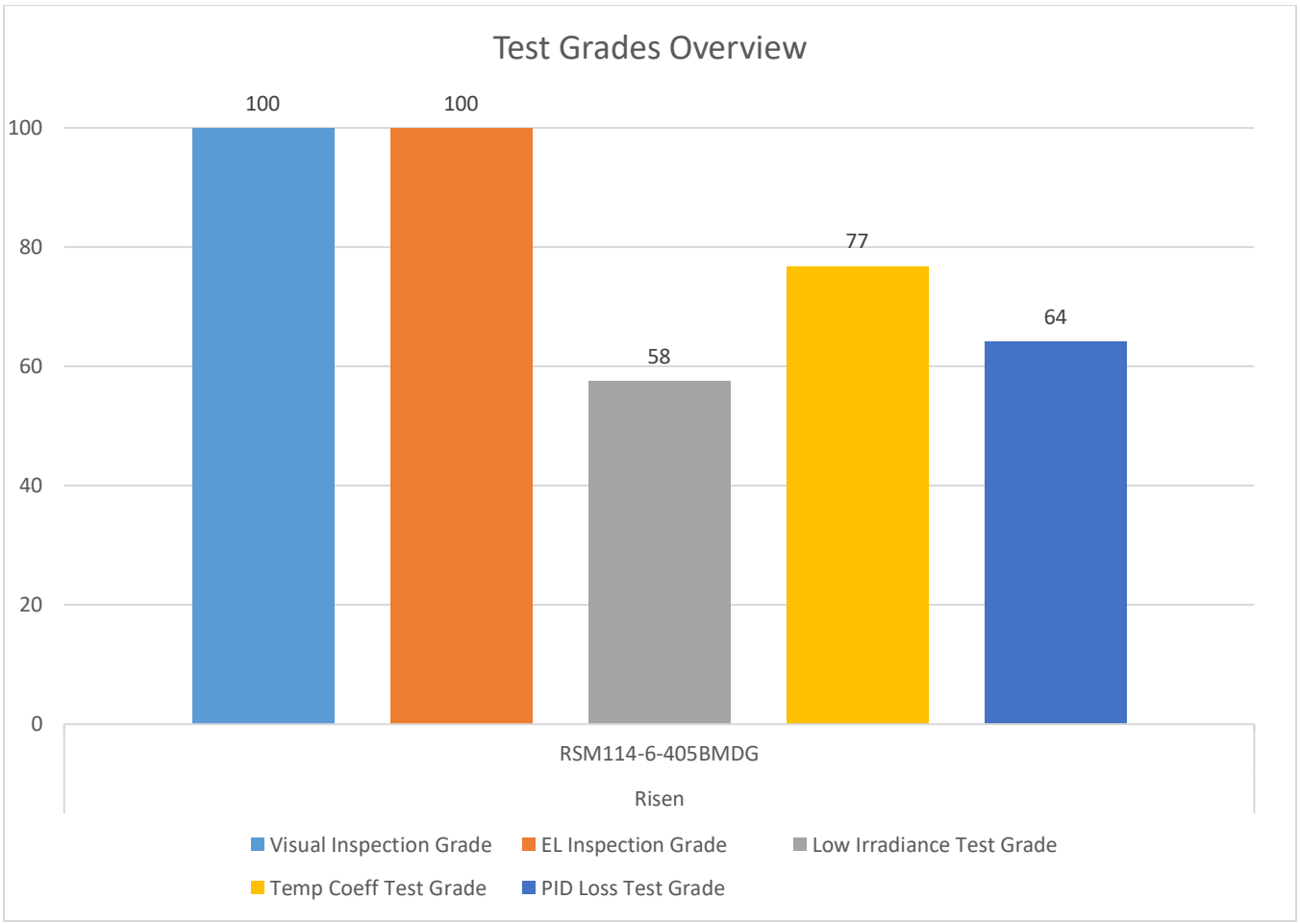

Figure 7 Test results overview

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

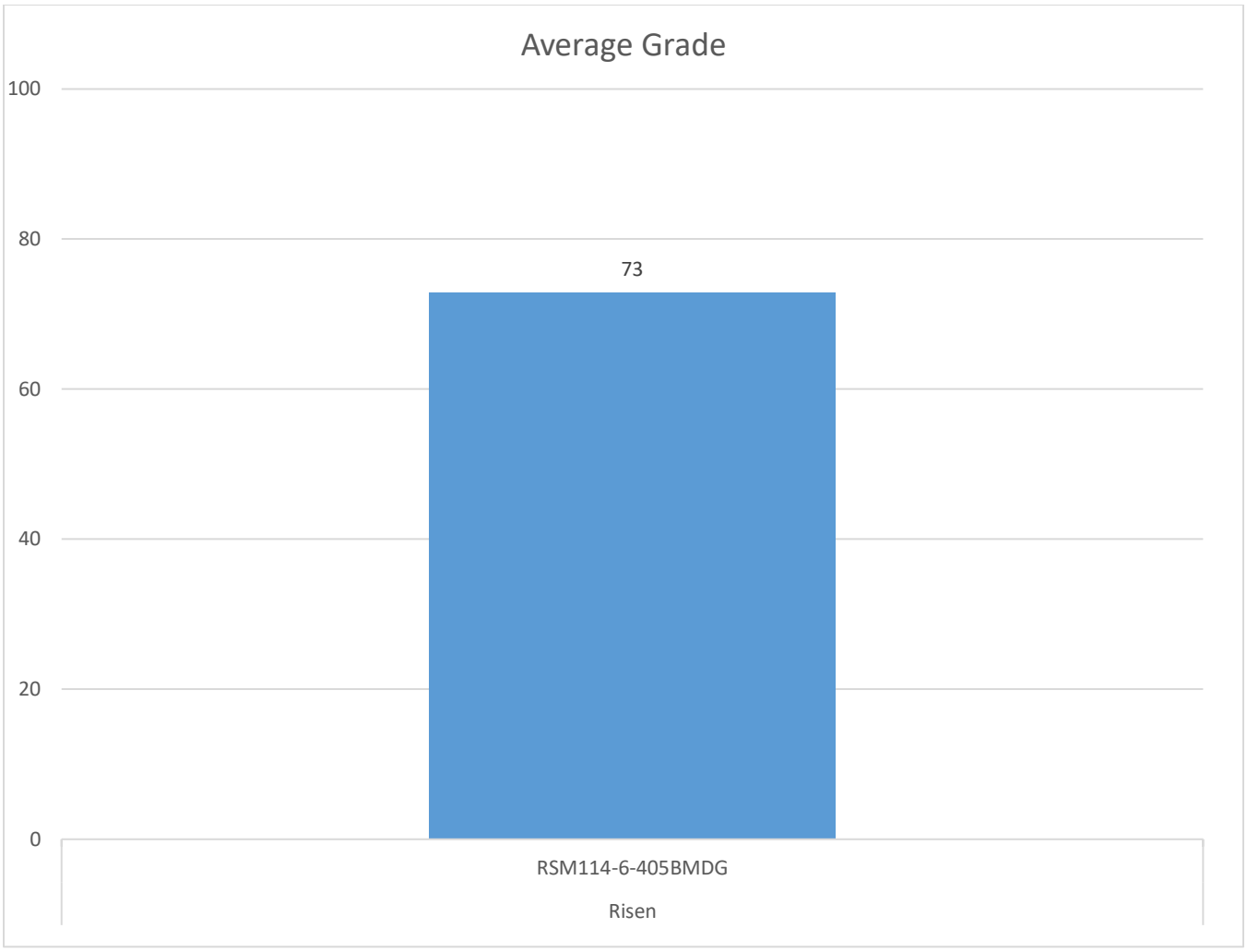

Figure 8 Average test grade

Appendix 1 - RSM144-6-405BMDG Datasheet

JäGer Plus

HIGH PERFORMANCE
BIFACIAL PERC MONOCRYSTALLINE MODULE

RSM144-6-395BMDG-420BMDG

144 CELL Mono PERC Module	**395-420Wp** Power Output Range
1500VDC Maximum System Voltage	**20.6%** Maximum Efficiency

ISO9001
ISO14001
OHSAS18001
IEC TS 62941

KEY SALIENT FEATURES

- Global, Tier 1 bankable brand, with independently certified state-of-the-art automated manufacturing
- Bifacial technology enables additional energy harvesting from rear side (up to 30%)
- Industry leading lowest thermal co-efficient of power
- Industry leading 12 years product warranty
- Excellent low irradiance performance
- Excellent PID resistance
- Positive tight power tolerance
- Dual stage 100% EL Inspection warranting defect-free product
- Module Imp binning radically reduces string mismatch losses
- Warranted reliability and stringent quality assurances well beyond certified requirements
- Certified to withstand severe environmental conditions
  - Anti-reflective & anti-soiling surface minimise power loss from dirt and dust
  - Severe salt mist, ammonia & blown sand resistance, for seaside, farm and desert environments
  - Excellent mechanical load 2400Pa & snow load 5400Pa resistance

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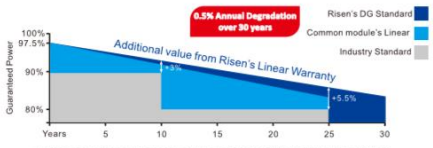
risen solar technology

LINEAR PERFORMANCE WARRANTY

12 year Product Warranty / 30 year Linear Power Warranty



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

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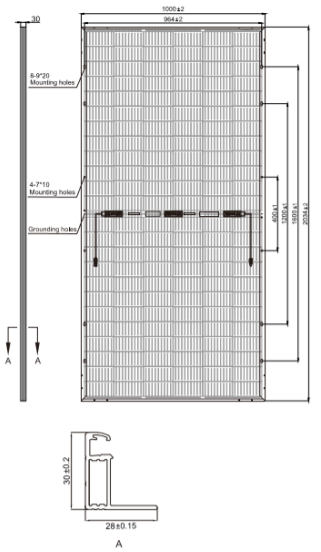
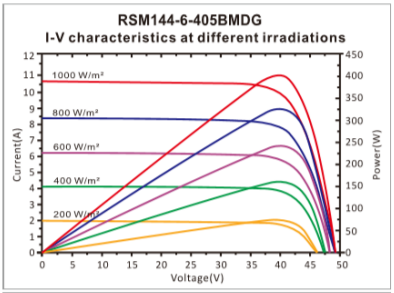
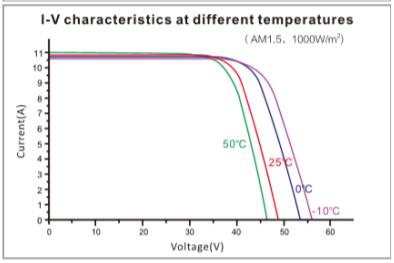
JäGer Plus

Dimensions of PV Module Unit: mm







Our Partners:

ELECTRICAL DATA (STC)

Model Number	RSM144-6-395BMDG	RSM144-6-400BMDG	RSM144-6-405BMDG	RSM144-6-410BMDG	RSM144-6-415BMDG	RSM144-6-420BMDG
Rated Power in Watts-Pmax(Wp)	395	400	405	410	415	420
Open Circuit Voltage-Voc(V)	48.45	48.60	48.75	48.90	49.00	49.10
Short Circuit Current-Isc(A)	10.40	10.50	10.60	10.70	10.80	10.90
Maximum Power Voltage-Vmpp(V)	40.35	40.45	40.55	40.65	40.70	40.80
Maximum Power Current-Impp(A)	9.80	9.90	10.00	10.10	10.20	10.30
Module Efficiency (%) ⋆	19.4	19.7	19.9	20.2	20.4	20.6

STC: Irradiance 1000 W/m², Cell Temperature 25°C, Air Mass AM1.5 according to EN 60904-3.
Bifacial factor: 70%±5 ⋆ Module Efficiency (%): Round-off to the nearest number

Electrical characteristics with different rear side power gain (reference to **405Wp** front)

Bifacial Gain ⋆	Pmax/W	Voc/V	Isc/A	Vmpp/V	Impp/A
5%	426	48.75	11.13	40.55	10.50
10%	446	48.75	11.66	40.55	11.00
15%	466	48.75	12.19	40.55	11.50
20%	487	48.75	12.72	40.55	12.00
25%	507	48.75	13.25	40.55	12.50
30%	527	48.75	13.78	40.55	13.00

★Bifacial 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 Number	RSM144-6-395BMDG	RSM144-6-400BMDG	RSM144-6-405BMDG	RSM144-6-410BMDG	RSM144-6-415BMDG	RSM144-6-420BMDG
Maximum Power-Pmax (Wp)	295.6	299.3	303.1	306.9	309.2	312.7
Open Circuit Voltage-Voc (V)	44.60	44.70	44.90	44.99	45.63	45.70
Short Circuit Current-Isc (A)	8.53	8.61	8.69	8.77	8.80	8.87
Maximum Power Voltage-Vmpp (V)	37.00	37.05	37.14	37.24	37.30	37.40
Maximum Power Current-Impp (A)	8.00	8.08	8.16	8.24	8.29	8.36

MECHANICAL DATA

Solar cells	Monocrystalline, 9BB
Cell configuration	144 cells (6×12+6×12)
Module dimensions	2034×1000×30mm
Weight	27kg
Superstrate	High Transmission, Low Iron, Tempered ARC Glass
Substrate	Tempered Glass
Frame	Anodized Aluminium Alloy type 6063T5, Silver Color
J-Box	Potted, IP68, 1500VDC, 3 Schottky bypass diodes
Cables	4.0mm² (12AWG), Positive(+) 270mm, Negative(-) 270mm
Connector	Risen Twinsel PV-SY02, IP68

TEMPERATURE & MAXIMUM RATINGS

Nominal Module Operating Temperature (NMOT)	45°C±2°C
Temperature Coefficient of Voc	-0.28%/°C
Temperature Coefficient of Isc	0.05%/°C
Temperature Coefficient of Pmax	-0.36%/°C
Operational Temperature	-40°C~+85°C
Maximum System Voltage	1500VDC
Max Series Fuse Rating	20A
Limiting Reverse Current	20A

PACKAGING CONFIGURATION

	40ft
Number of modules per container	770
Number of modules per pallet	35
Number of pallets per container	22
Packaging box dimensions (LxWxH) in mm	2100×1130×1135
Box gross weight[kg]	1000

CAUTION: READ SAFETY AND INSTALLATION INSTRUCTIONS BEFORE USING THE PRODUCT.
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REM144-BMDG-9BB-EN-H1-1-2020