

CEA | PV MAGAZINE PROGRAM TEST REPORT

SUPPLIER | AE Solar

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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.

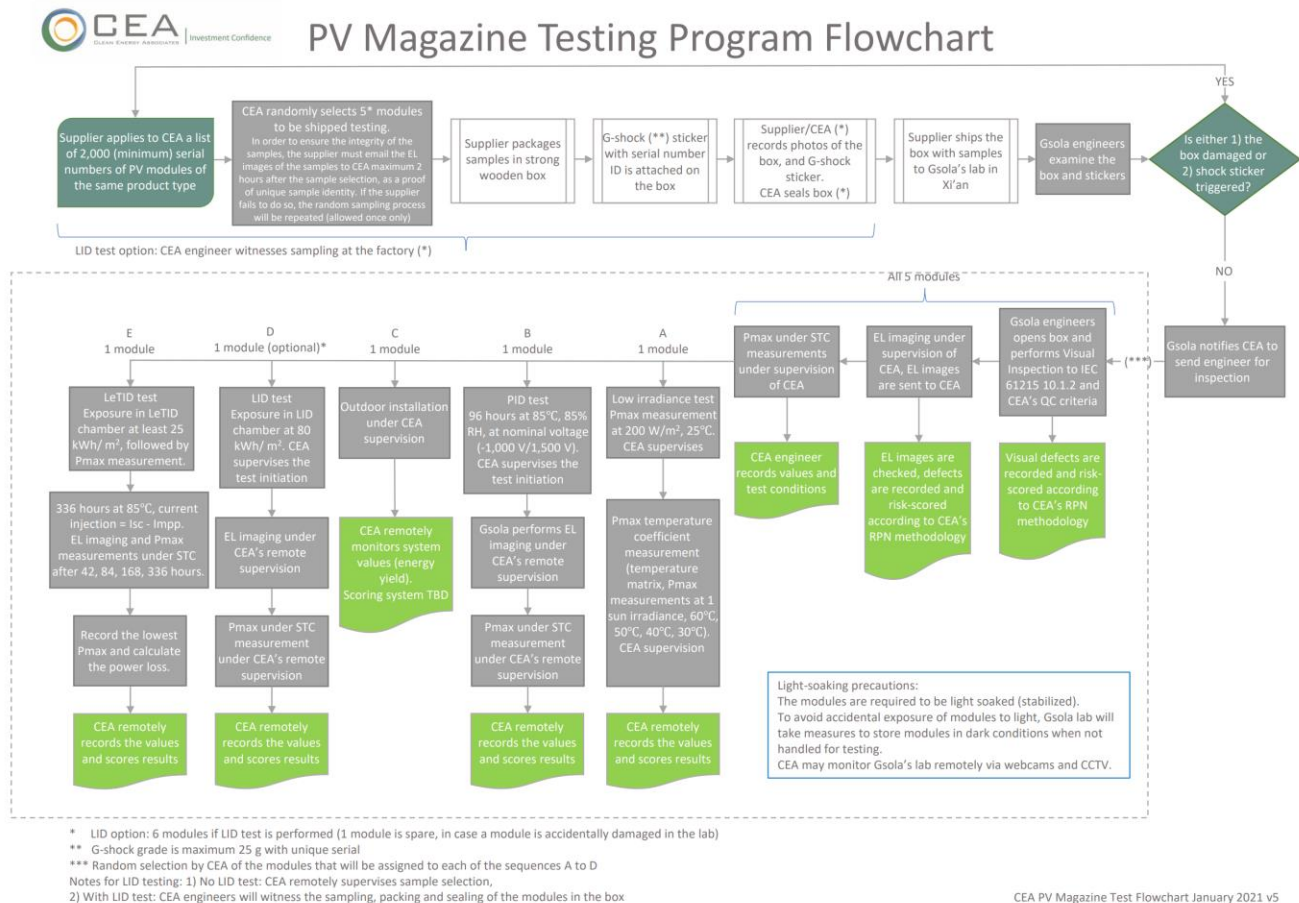


Figure 1 Test flowchart

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 AE570CMD-144BDS 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	AECA72CD240790008
2	AECA72CD240790009
3	AECA72CD240790011
4	AECA72CD240790010
5	AECA72CD240790012

Table 4 Product information

Model	AE570CMD-144BDS
Cell technology	TOPCon
Cell number	144
Cell format	182x182 mm
Number of busbars	16
Junction box	IP68, 3 bypass diodes
Laminate construction	Glass
Bifaciality ratio	80±5%

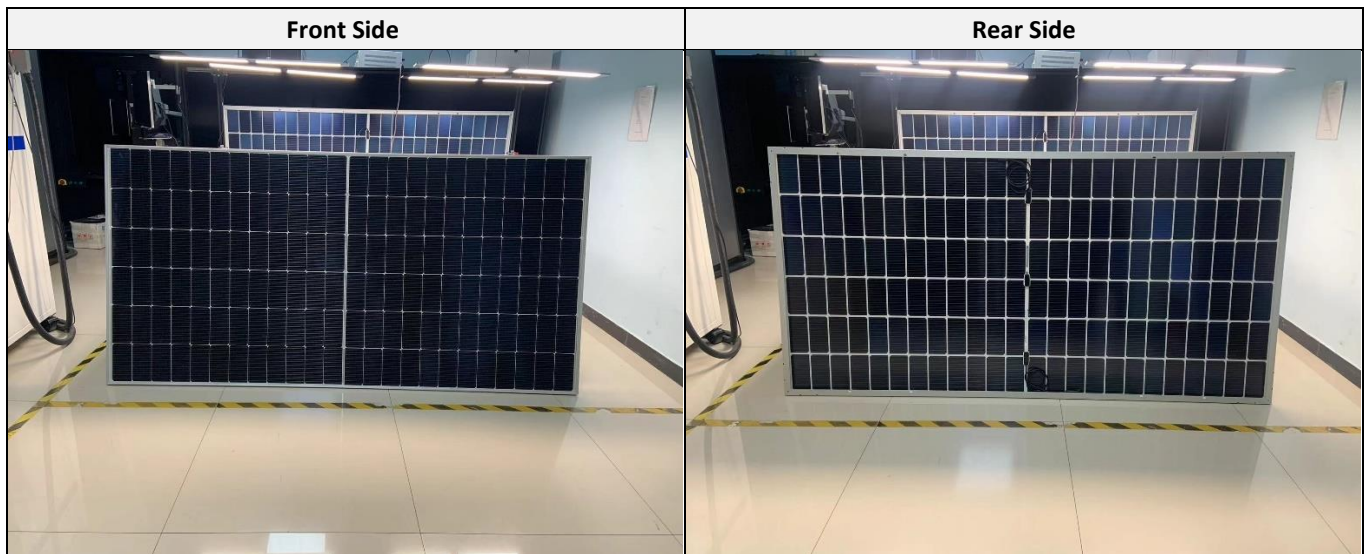


Figure 2 Product nameplate

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

AE570CMD-144BDS	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

AE570CMD-144BDS	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Score	Grade
EL image inspection	None	None	None	None	None	0	100

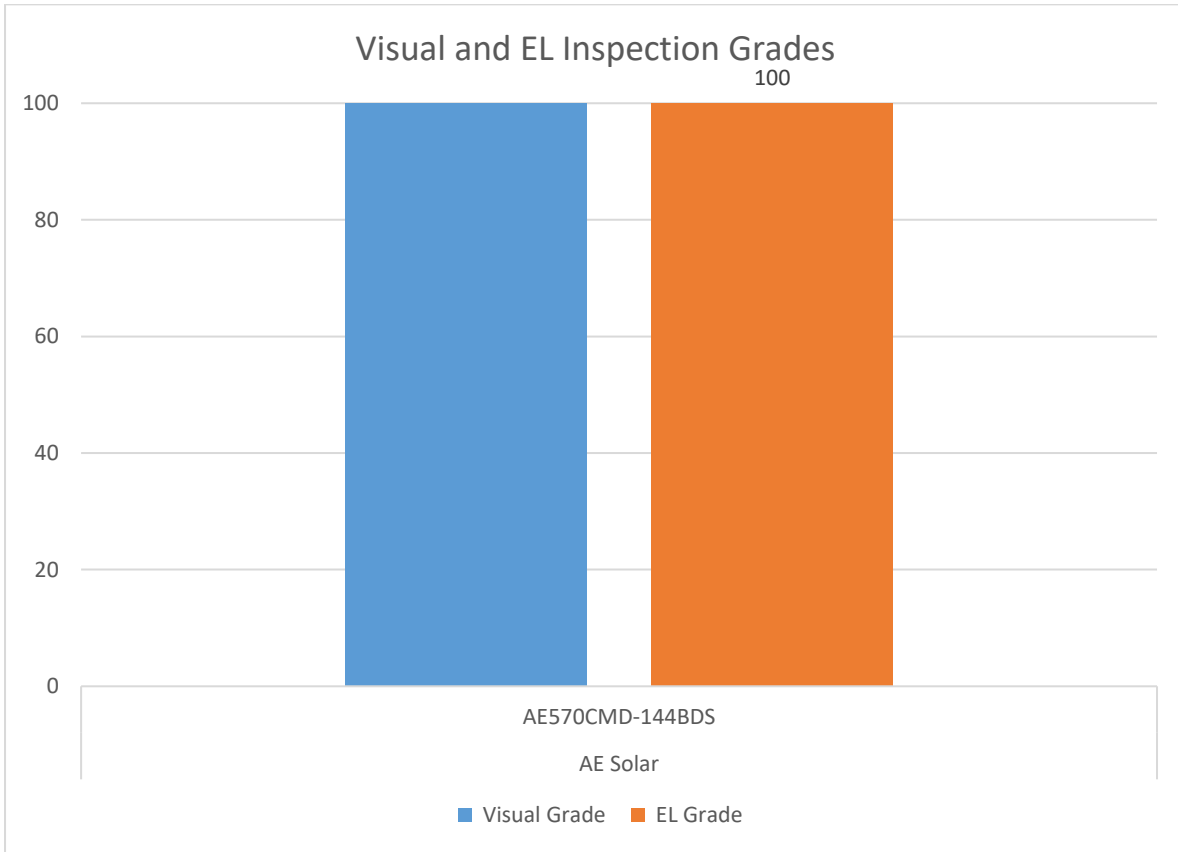


Figure 3 Visual and EL inspection results

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

AE570CMD-144BDS	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Front side low irradiance efficiency loss (%)	3.59%					69

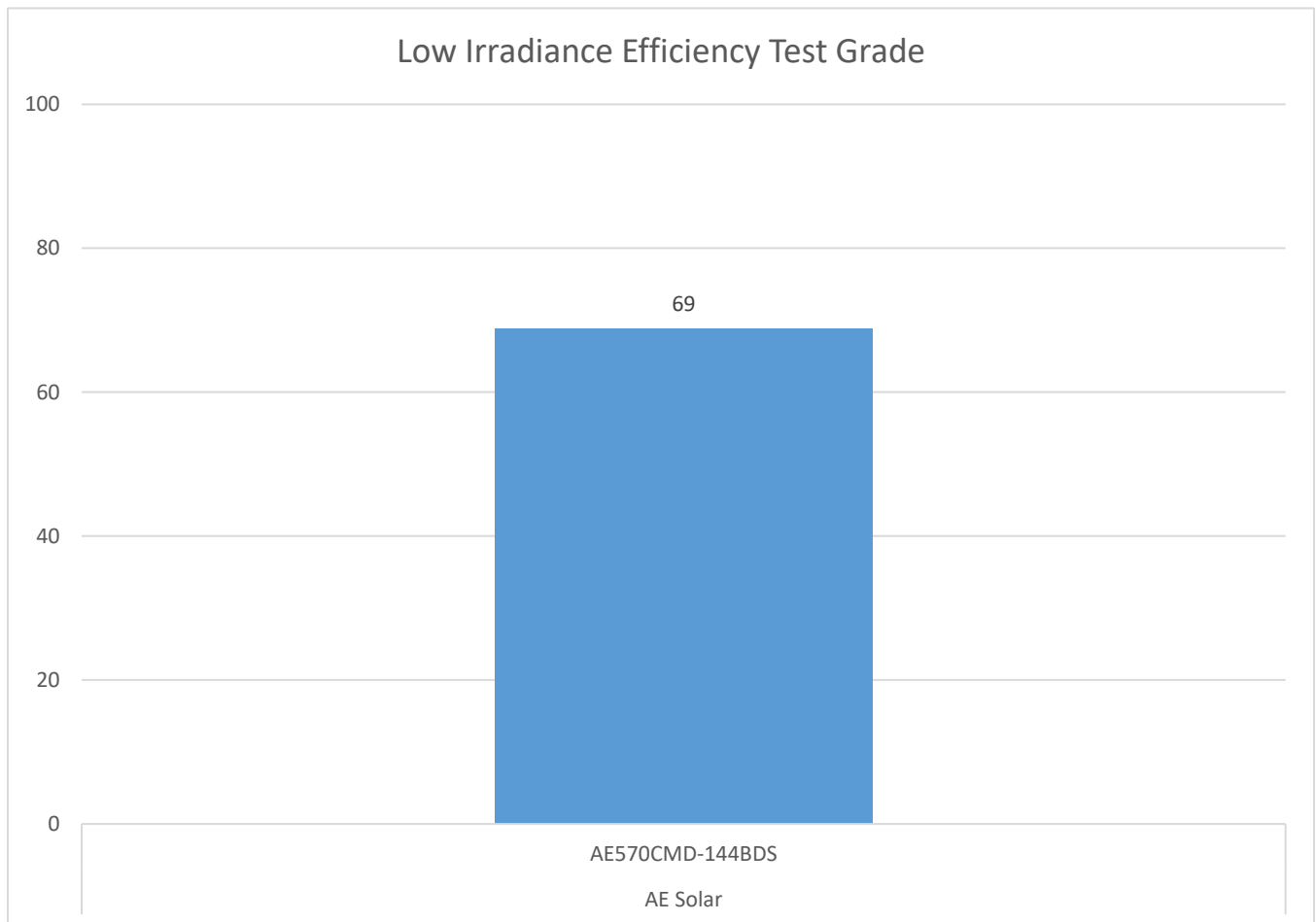


Figure 4 Low irradiance test result

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

AE570CMD-144BDS	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Pmax Temperature coefficient (%/°C)	-0.283%					104

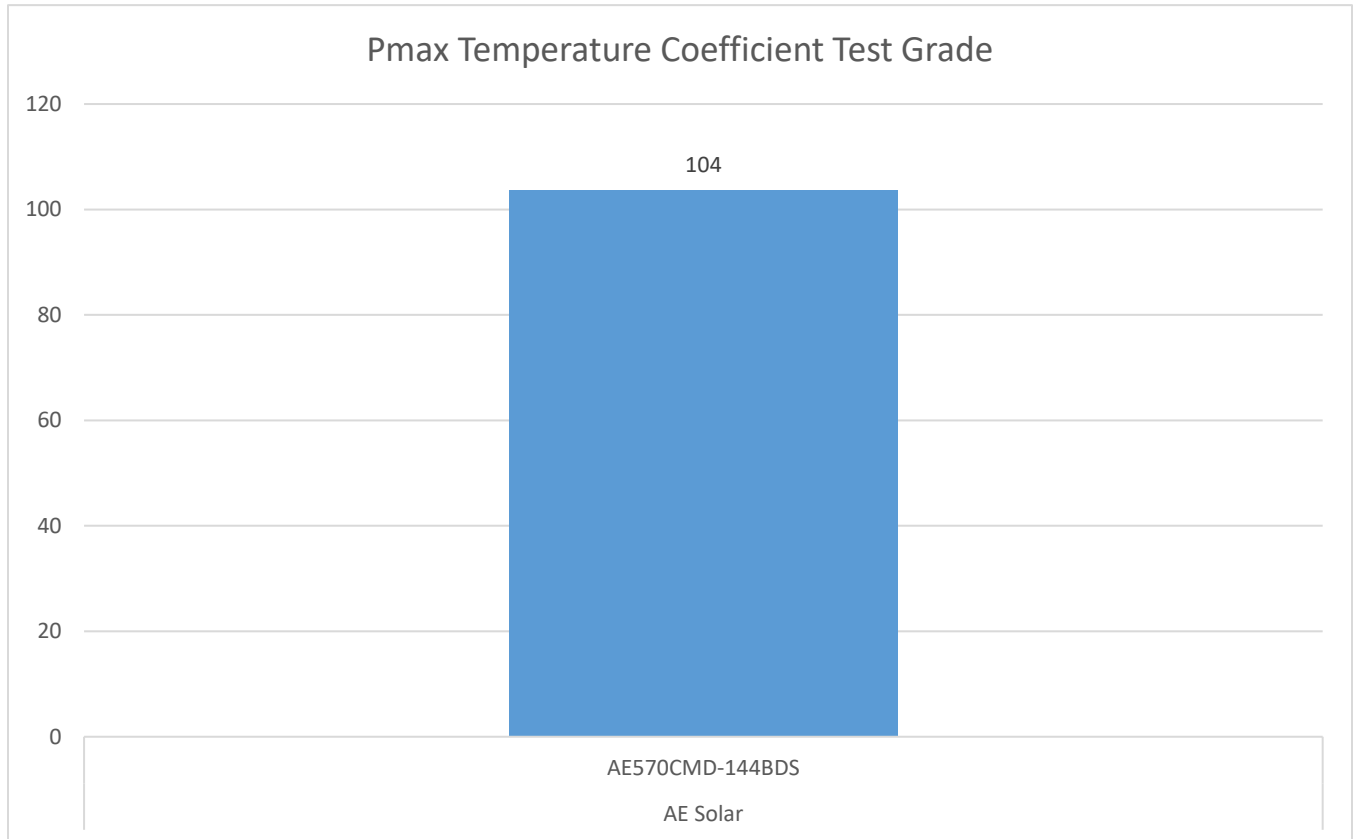


Figure 5 Pmax temperature coefficient test result

3.5. PID loss test

Table 10 and Figure 6 depicts the PID loss test results for the front side at **1500 V**. After PID stressing the sample is light soaked for two days outdoors to recover any PID-p (polarization). The remaining degradation is considered to be due to Na ion migration.

Table 10 PID loss test result

AE570CMD-144BDS	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Front side PID loss (%)		0.29%				96

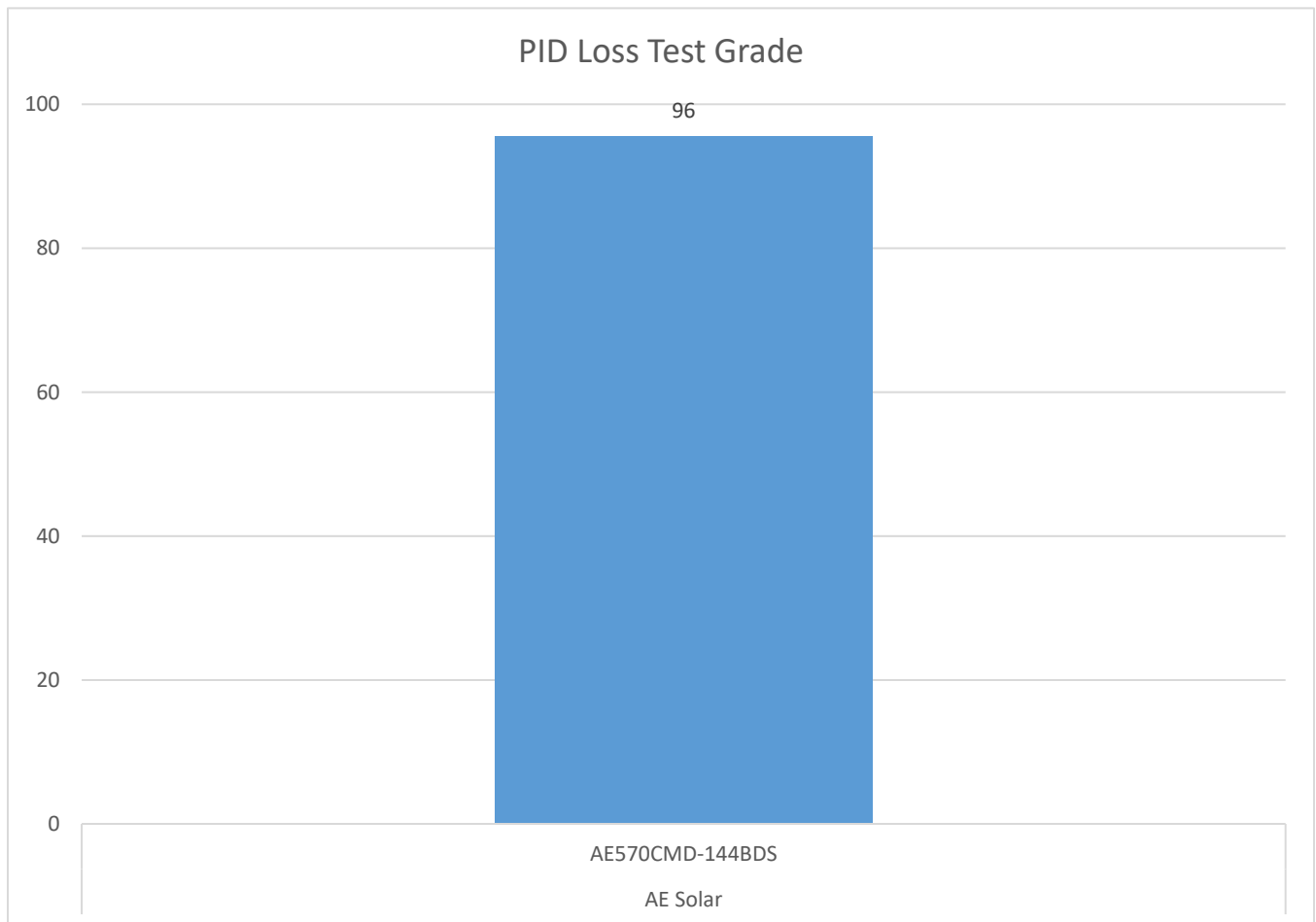


Figure 6 PID loss test result

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

AE570CMD-144BDS	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Average
Bifaciality ratio (%)	75.19%	75.27%	75.30%	75.46%	75.23%	75.29%

The bifaciality ratio is calculated from the following formula:

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

3.7. Score overview

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

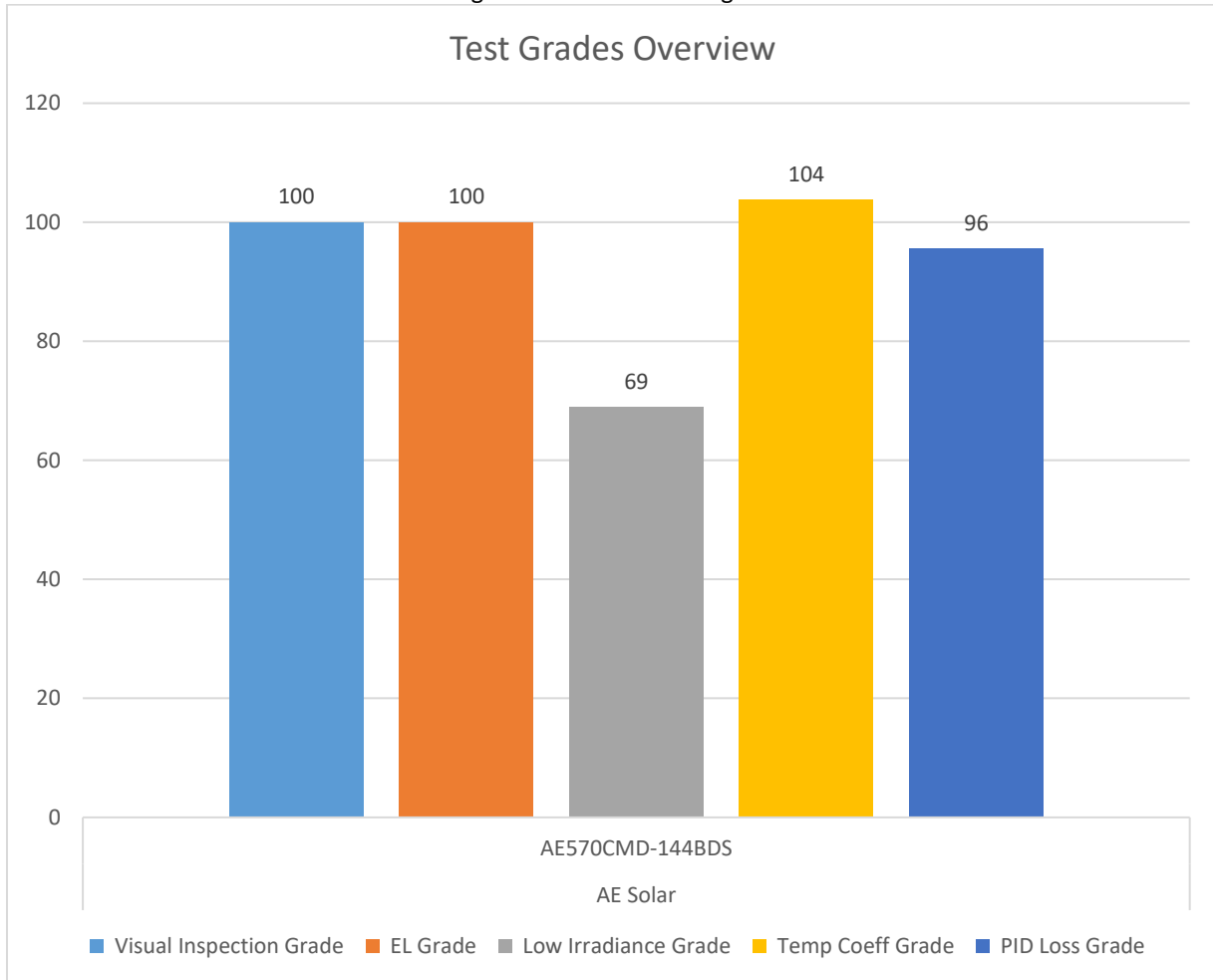


Figure 7 Test results overview

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

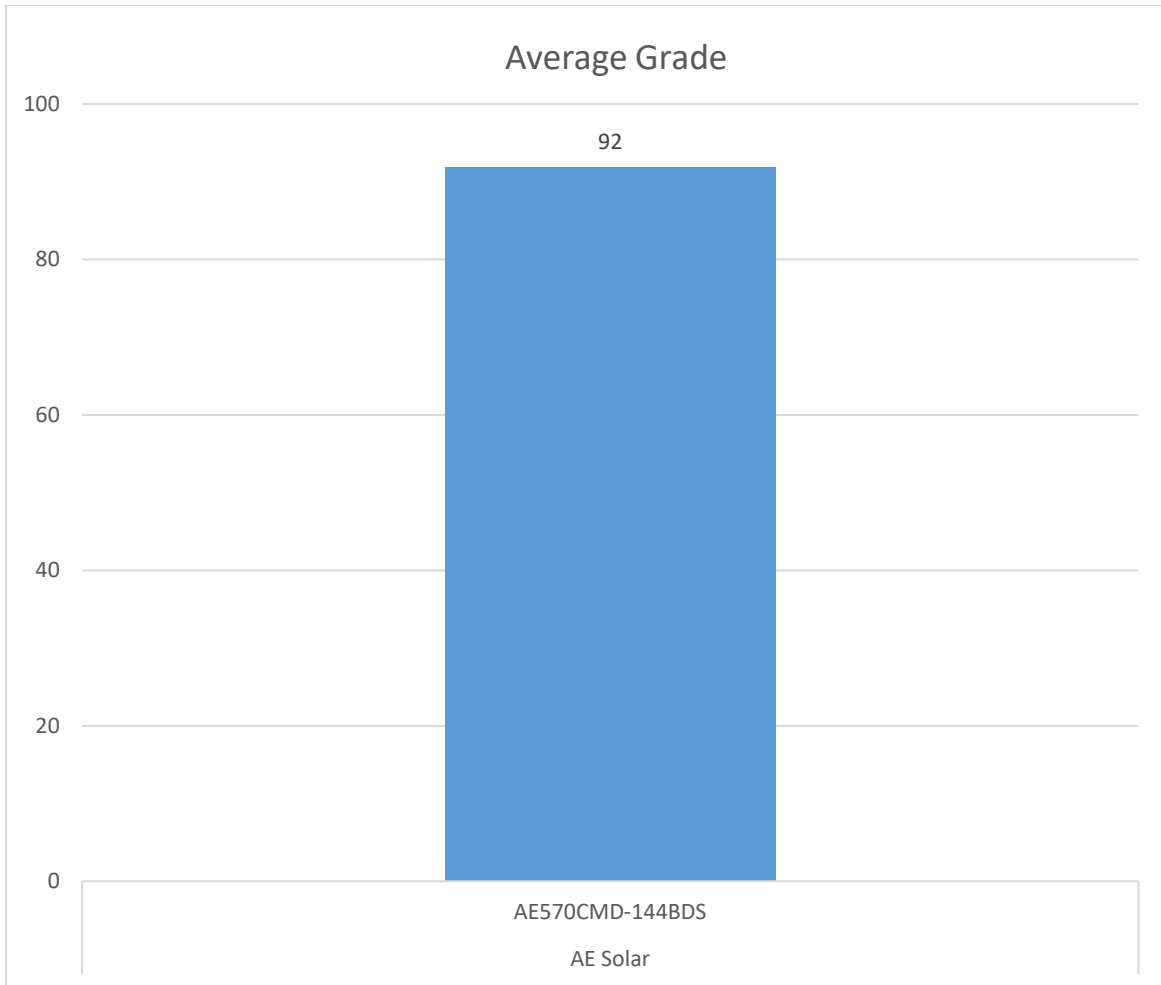


Figure 8 Average test grade

Appendix 1 – AE570CMD-144BDS Datasheet

Deutsche
Qualität
Garantiert





since 2003



METEOR

More power, less degradation

30
years
Performance
Warranty

15
years
Product
Warranty

560W-580W

AE CMD-144BDS Series

N-TYPE TOPCON TECHNOLOGY PV MODULES
HALF-CUT CELLS • BIFACIAL • DOUBLE-GLASS

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Ver. 24.1.1

144

182 mm













HALF CELLS

CELL SIZE

LID RESISTANT

PID RESISTANT

SALT CORROSION RESISTANT

SAND RESISTANT

AMMONIA RESISTANT

HIGHLY STABLE AND TOUGH









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IEC 61701 (Salt mist corrosion)
IEC 60068 (Sand and dust)
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AE CMD-144BDS Series 560W-580W



N-TYPE TOPCON TECHNOLOGY PV MODULES
HALF-CUT CELLS • BIFACIAL • DOUBLE-GLASS

Mechanical and design specification

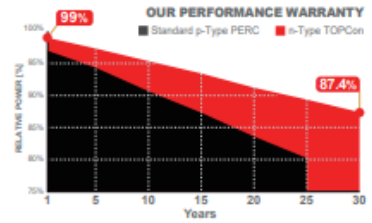
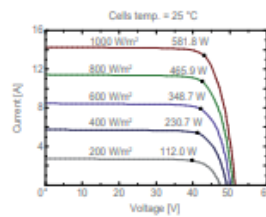
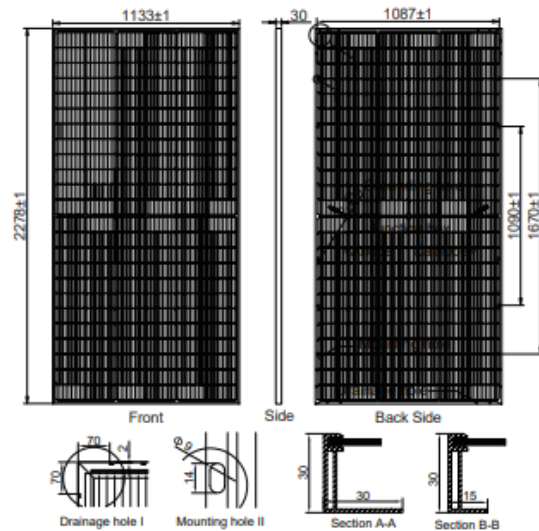
Cell type	n-Type TOPCon Technology, Half-cut cells, 182 mm
No. of cells	144
Bifaciality	80 ± 5%
Front cover	2.0 mm glass, high transmission, AR coated, tempered
Encapsulation	POE
Back cover	2.0 mm white glazed glass, tempered
Junction box	IP68 rated, 3 Bypass Diodes
Frame	30 mm anodized Aluminium alloy
Cable	1 x 4 mm ² , 350 mm length or customized
Connectors	MC 4 / MC 4 compatible
Dimension	2278 mm x 1133 mm x 30 mm
Weight	31 kg
Hail resistance	Max. Ø 25 mm at 23 m/s
Wind load	2400 Pa or 244 kg/m ²
Snow load	5400 Pa or 550 kg/m ²
Fire Rating	Class A (according to UL 790)

Packaging information

Packaging configuration	36 pcs / pallet
Loading capacity	720 pcs / 40 HQ
Size / Pallet	2310 mm x 1140 mm x 1245 mm
Weight	1160 kg / pallet

Temperature ratings

Operating temperature	(°C)	-40 to +85
Temp. coefficient of P _{max}	(%/°C)	-0.30
Temp. coefficient of V _{oc}	(%/°C)	-0.25
Temp. coefficient of I _{sc}	(%/°C)	0.046
Nom. operating temp. NOCT	(°C)	42 ± 2



Electrical specifications (STC)*: AE560CMD-144BDS AE565CMD-144BDS AE570CMD-144BDS AE575CMD-144BDS AE580CMD-144BDS

	P _{max} (Wp)	560	565	570	575	580
Nominal Max. Power	P _{max} (Wp)	560	565	570	575	580
Maximum operating voltage	V _{MPP} (V)	42.40	42.56	42.72	42.88	43.04
Maximum operating current	I _{MPP} (A)	13.21	13.28	13.34	13.41	13.49
Open-circuit voltage	V _{oc} (V)	50.23	50.39	50.55	50.68	50.86
Short-circuit current	I _{sc} (A)	14.14	14.20	14.26	14.33	14.40
Module efficiency	η (%)	21.70	21.89	22.08	22.28	22.47
Power tolerance	(W)	0~+5				
Maximum system Voltage	(V)	1500				
Maximum series fuse rating	(A)	25				

*STC: Standard test conditions (Irradiance 1000 W/m², Cell temperature 25°C and air mass of AM1.5), measurement tolerance P_{max}: ±3%

Electrical specifications (NMOT)*: AE560CMD-144BDS AE565CMD-144BDS AE570CMD-144BDS AE575CMD-144BDS AE580CMD-144BDS

	P _{max} (Wp)	426.0	430.1	434.0	437.4	440.0
Nominal Max. Power	P _{max} (Wp)	426.0	430.1	434.0	437.4	440.0
Maximum operating voltage	V _{MPP} (V)	39.30	39.50	39.70	39.80	39.90
Maximum operating current	I _{MPP} (A)	10.84	10.89	10.94	10.99	11.04
Open-circuit voltage	V _{oc} (V)	47.50	47.70	47.80	48.00	48.20
Short-circuit current	I _{sc} (A)	11.40	11.45	11.50	11.55	11.60

*NMOT: Normal Module Operating Temperature (Irradiance 800 W/m², Ambient temperature 20°C, air mass of AM1.5 and wind speed of 1 m/s)

The specifications and characteristics contained in this datasheet may deviate slightly from our actual products due to the product developments and uncertainty of measurement devices. The specifications included in the datasheet are subject to change without prior notice.

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