CEA I PV MAGAZINE PROGRAM TEST REPORT

SUPPLIER | DAS SOLAR

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TABLE OF CONTENTS

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.

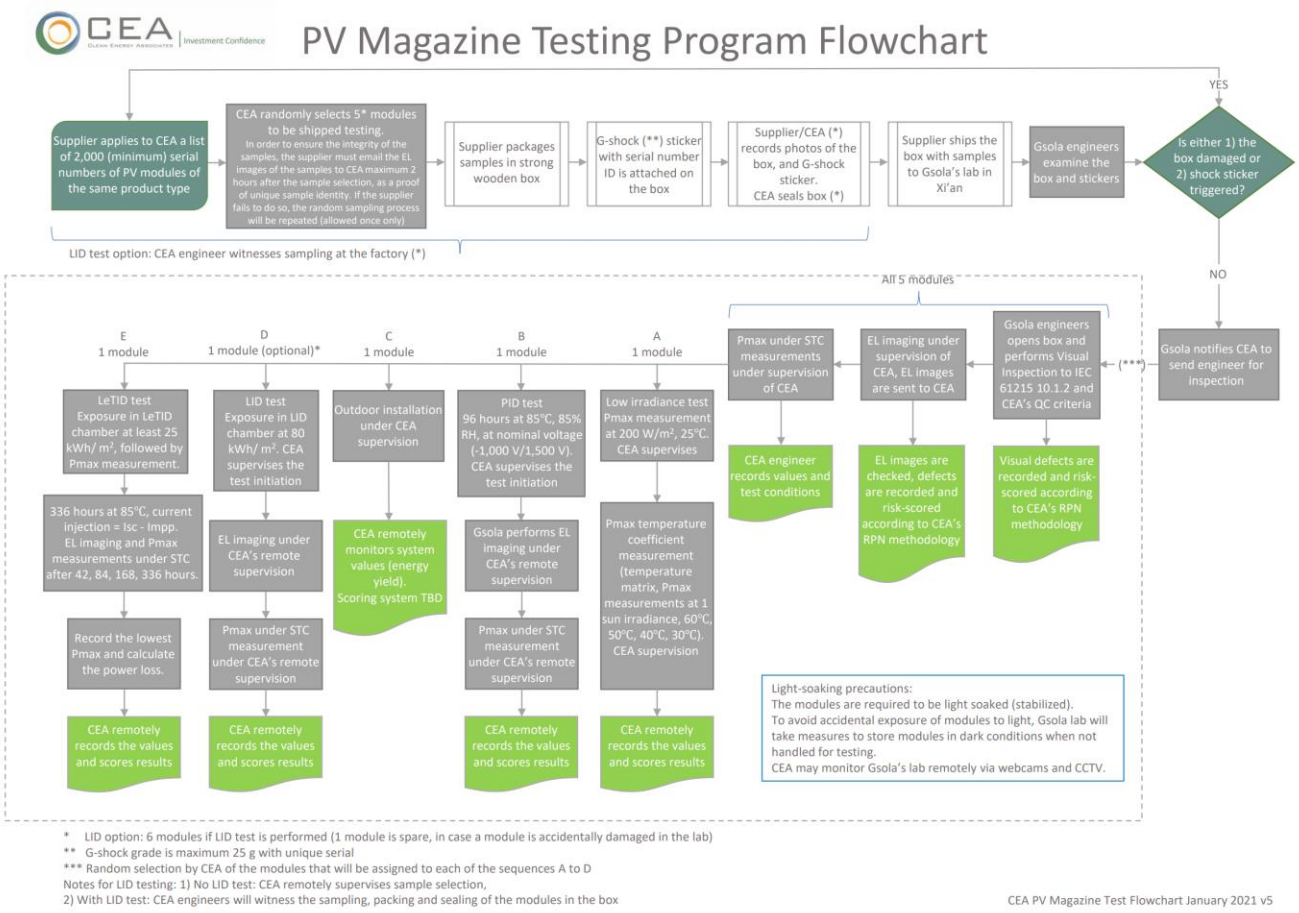


Figure 1 Test flowchart

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.

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	23B0110601914663
2	23B0110601910132
3	23B0110601910148
4	23B0110601910181
5	23B0110601910338

Table 4 Product information

Model	DAS-DH144NA-570
Cell technology	N Type
Cell number	144
Cell format	182x182 mm
Number of busbars	16
Junction box	IP68, 3 bypass diodes
Laminate construction	Glass
Bifaciality ratio	73%

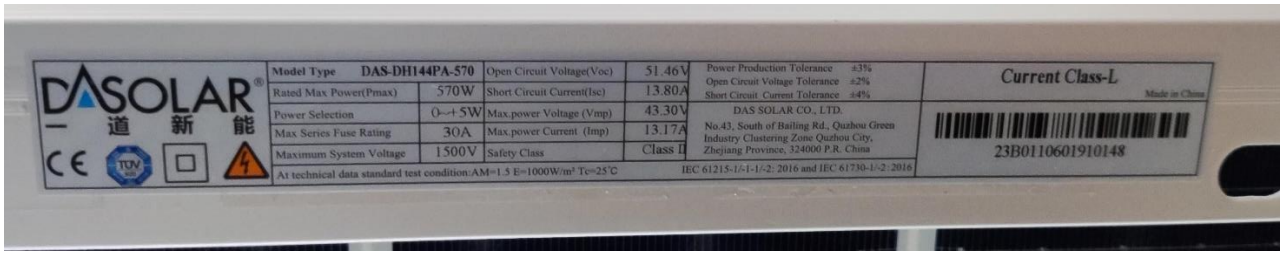


Figure 2 Product nameplate

Notes:

1. The sample type is DAS-DH144NA-570, the product nameplate is wrong.

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

TH545 PMB6 58SDC	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

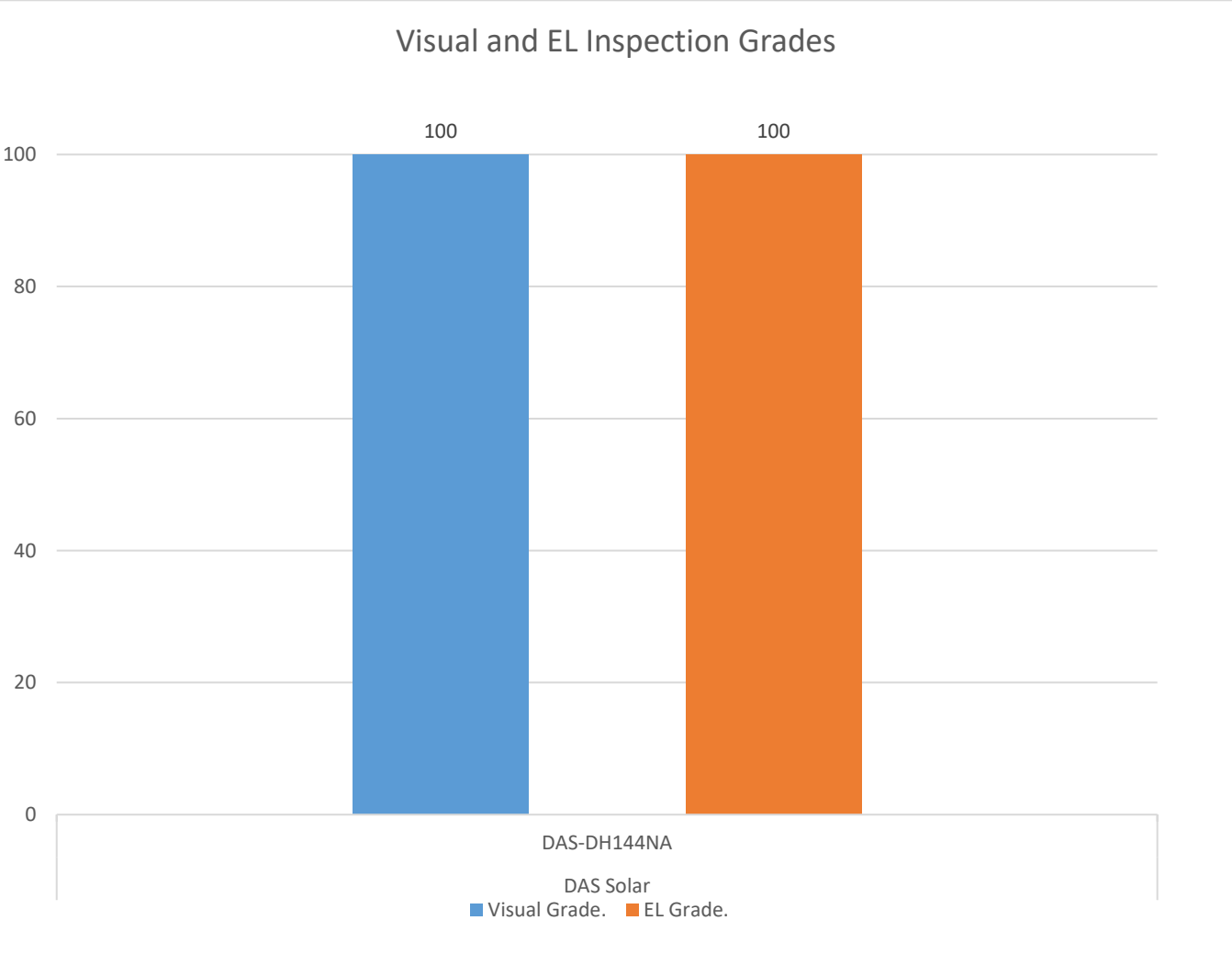


Figure 3.

Table 7 EL image inspection results

TH545 PMB6 58SDC	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Score	Grade
EL image inspection	None	None	None	None	None	0	100

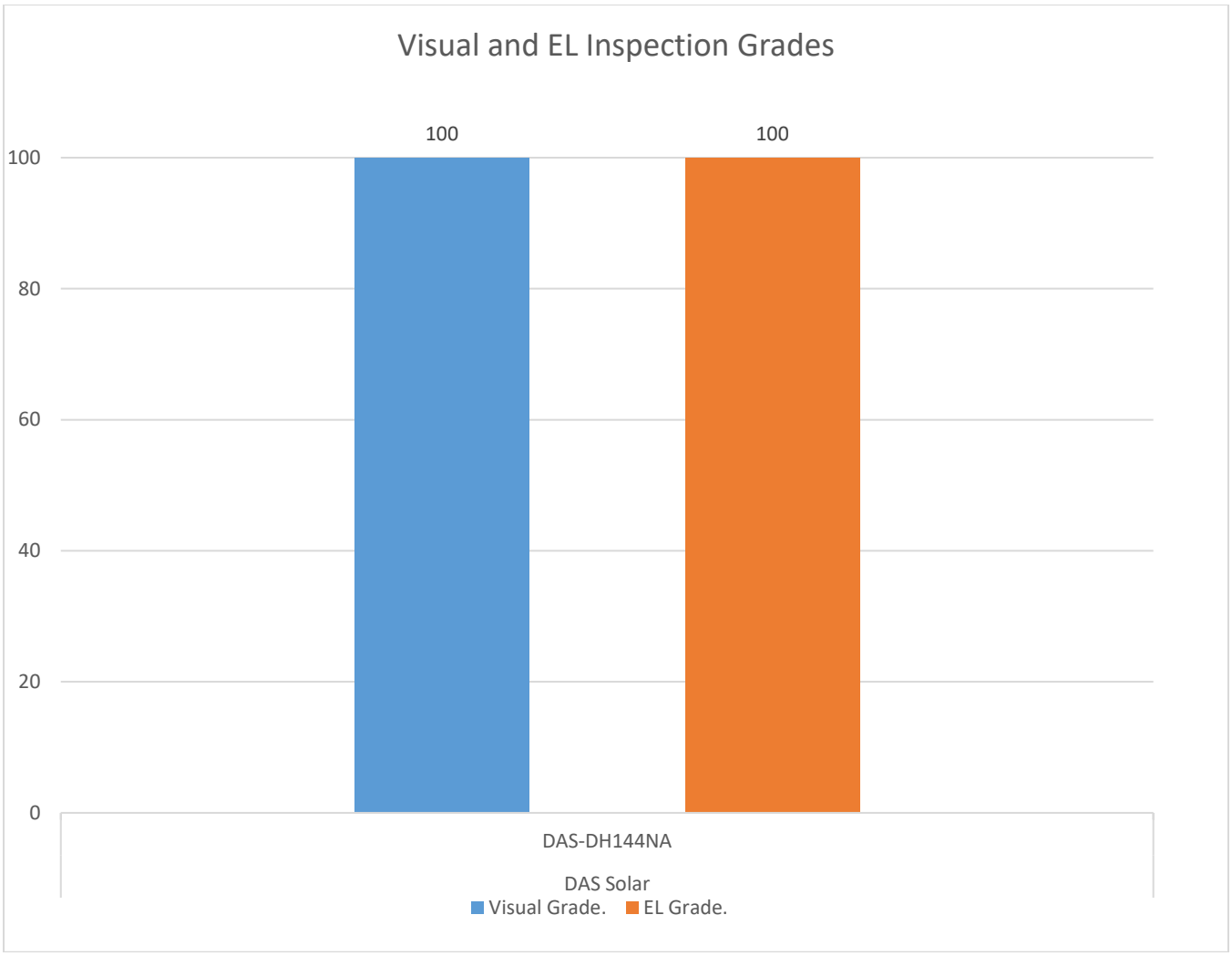


Figure 3 Visual and EL inspection results

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

TH545 PMB6 58SDC	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Front side low irradiance efficiency loss (%)	3.83%					67

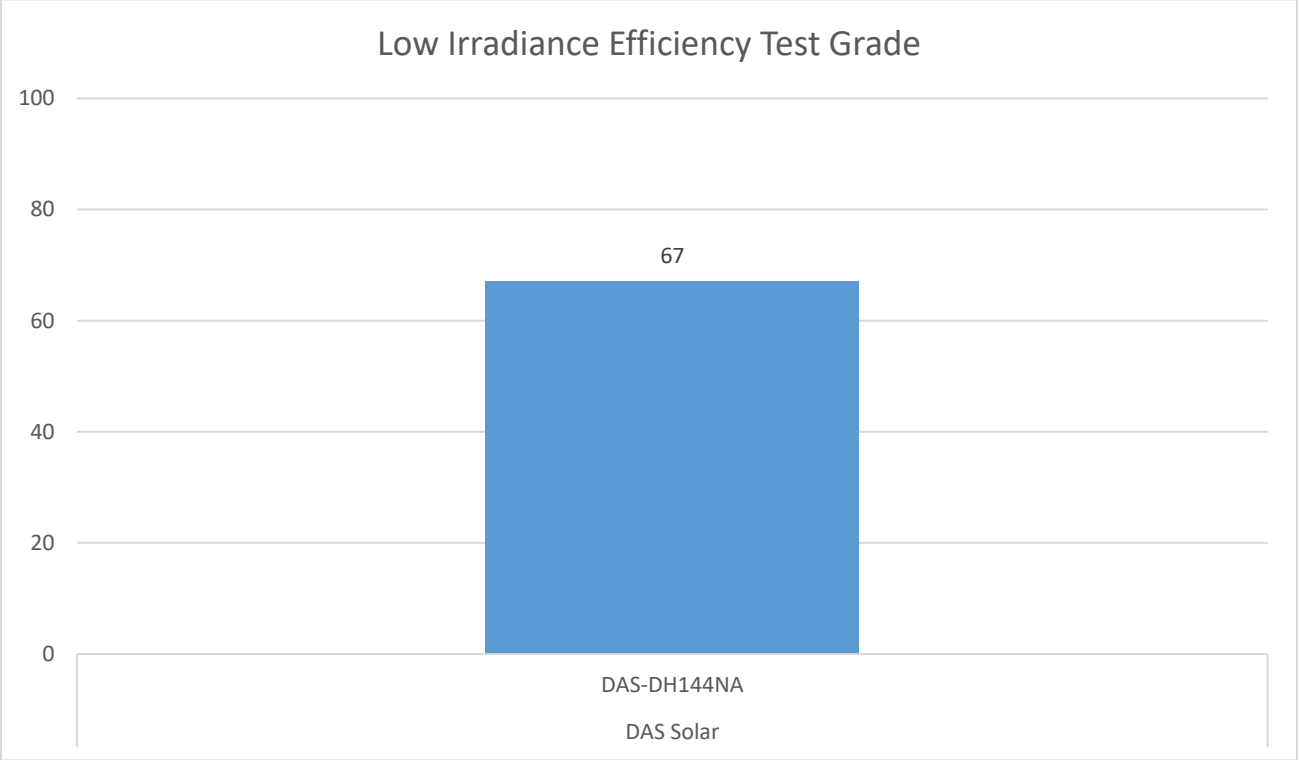


Figure 4 Low irradiance test result

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

TH545 PMB6 58SDC	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Pmax Temperature coefficient (%/°C)	-0.30%					98

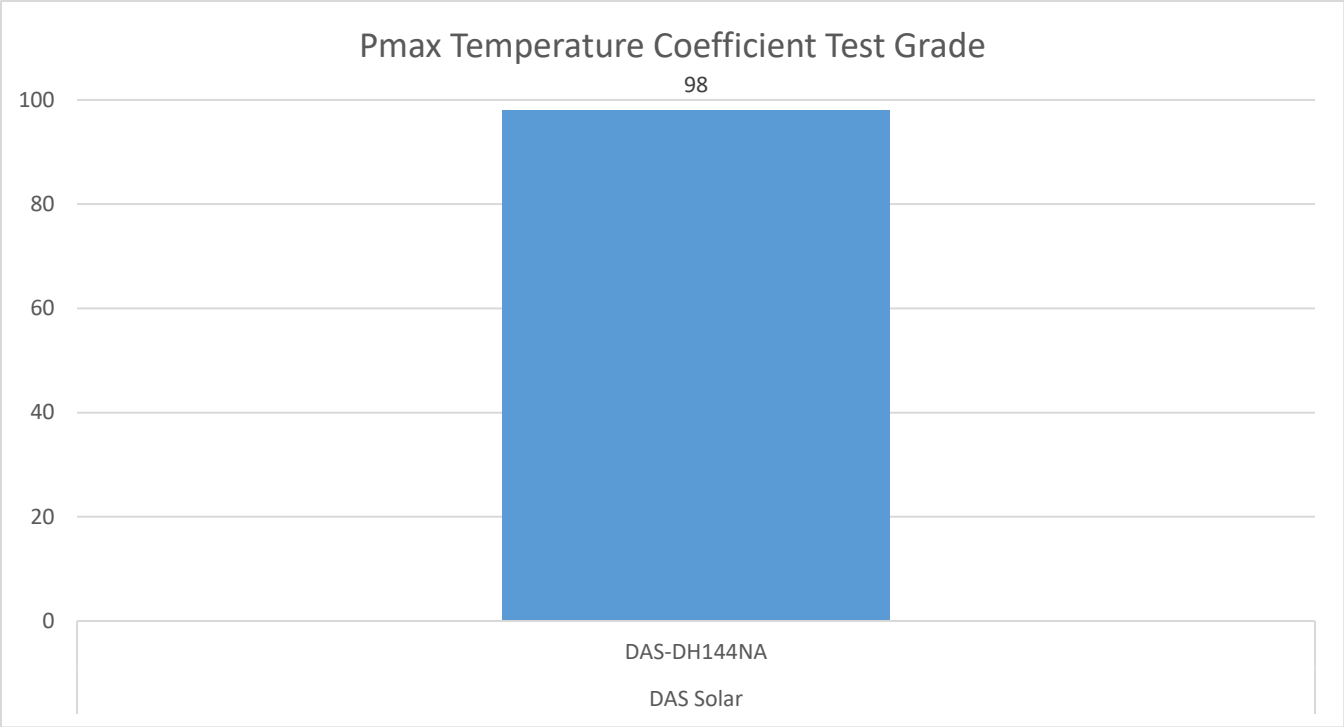


Figure 5 Pmax temperature coefficient test result

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

TH545 PMB6 58SDC	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Front side PID loss (%)		1.14%				85

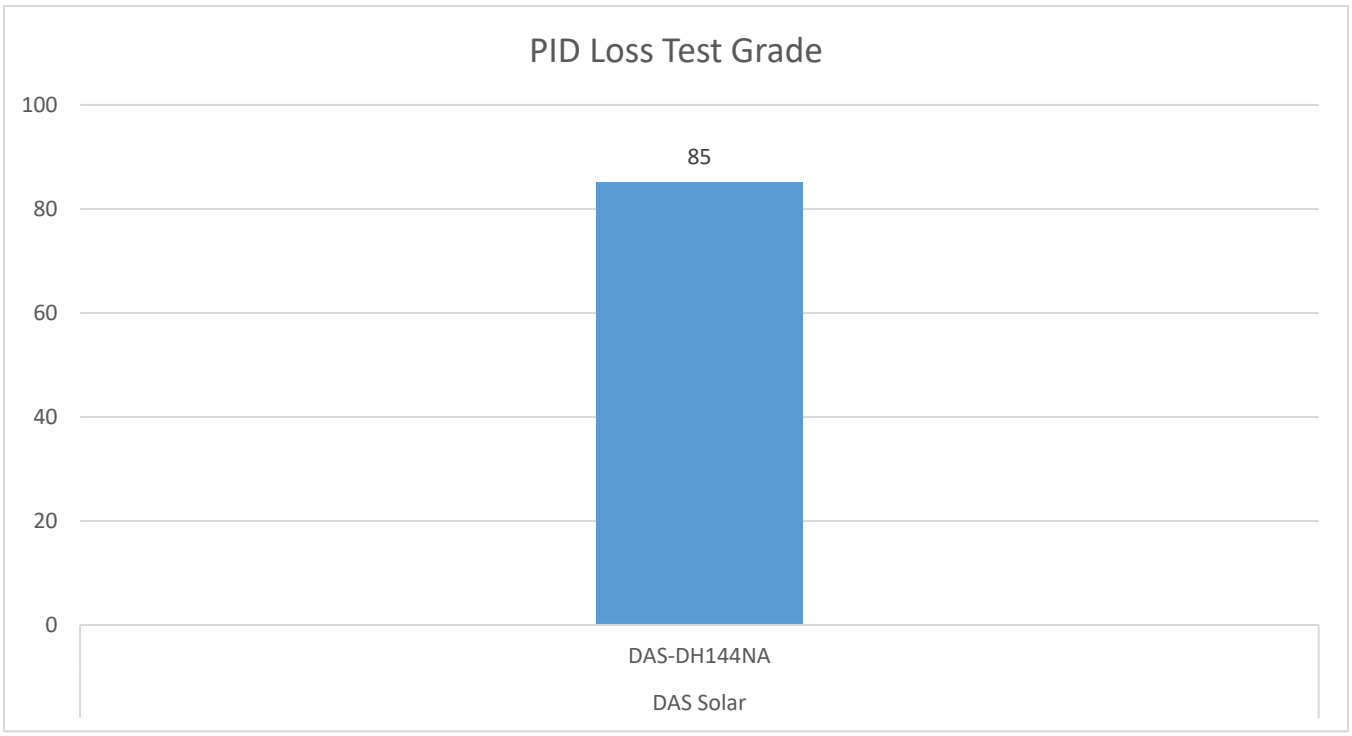


Figure 6 PID loss test result

3.6. LeTID loss test

Table 101 and Figure 6 depicts the LeTID loss test results:

Table 11 LeTID loss test result

TH545 PMB6 58SDC	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Front side LeTID loss (%)						

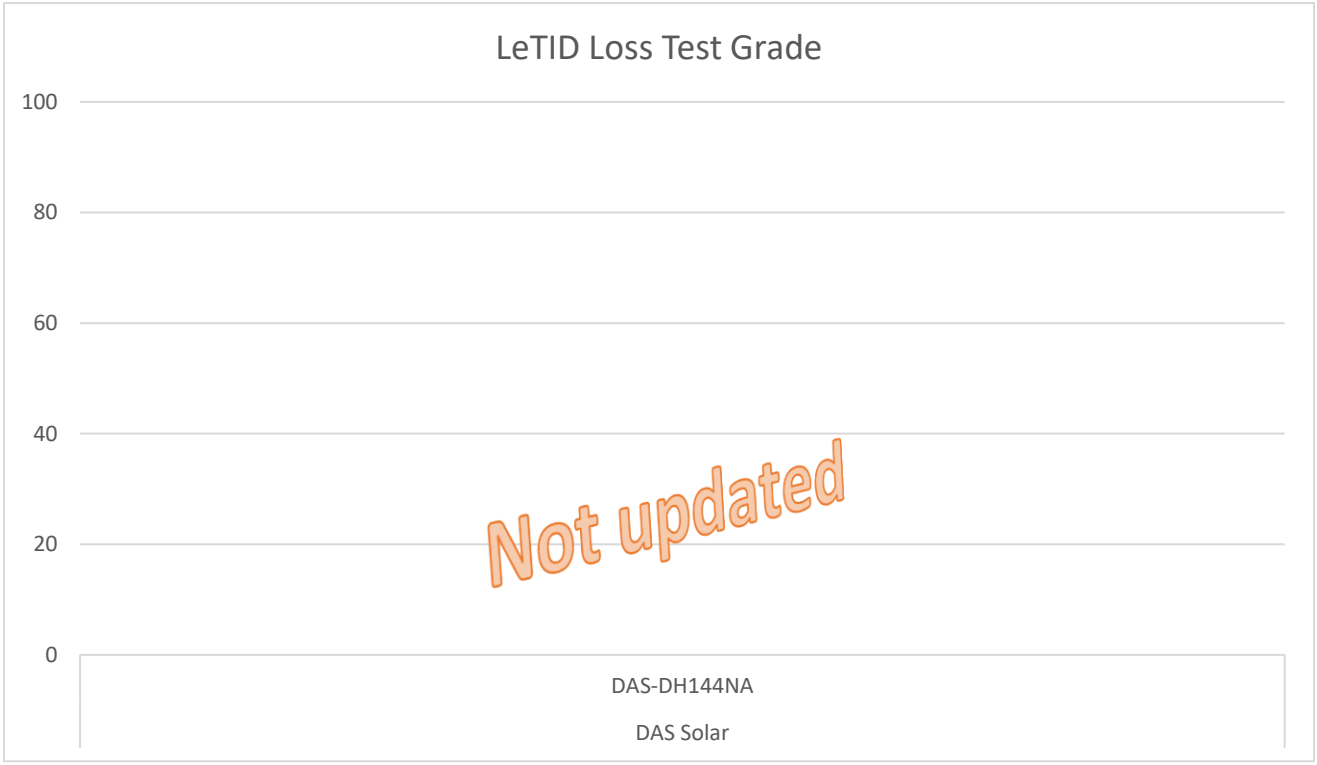


Figure 7 LeTID loss test result

3.7. Score overview

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

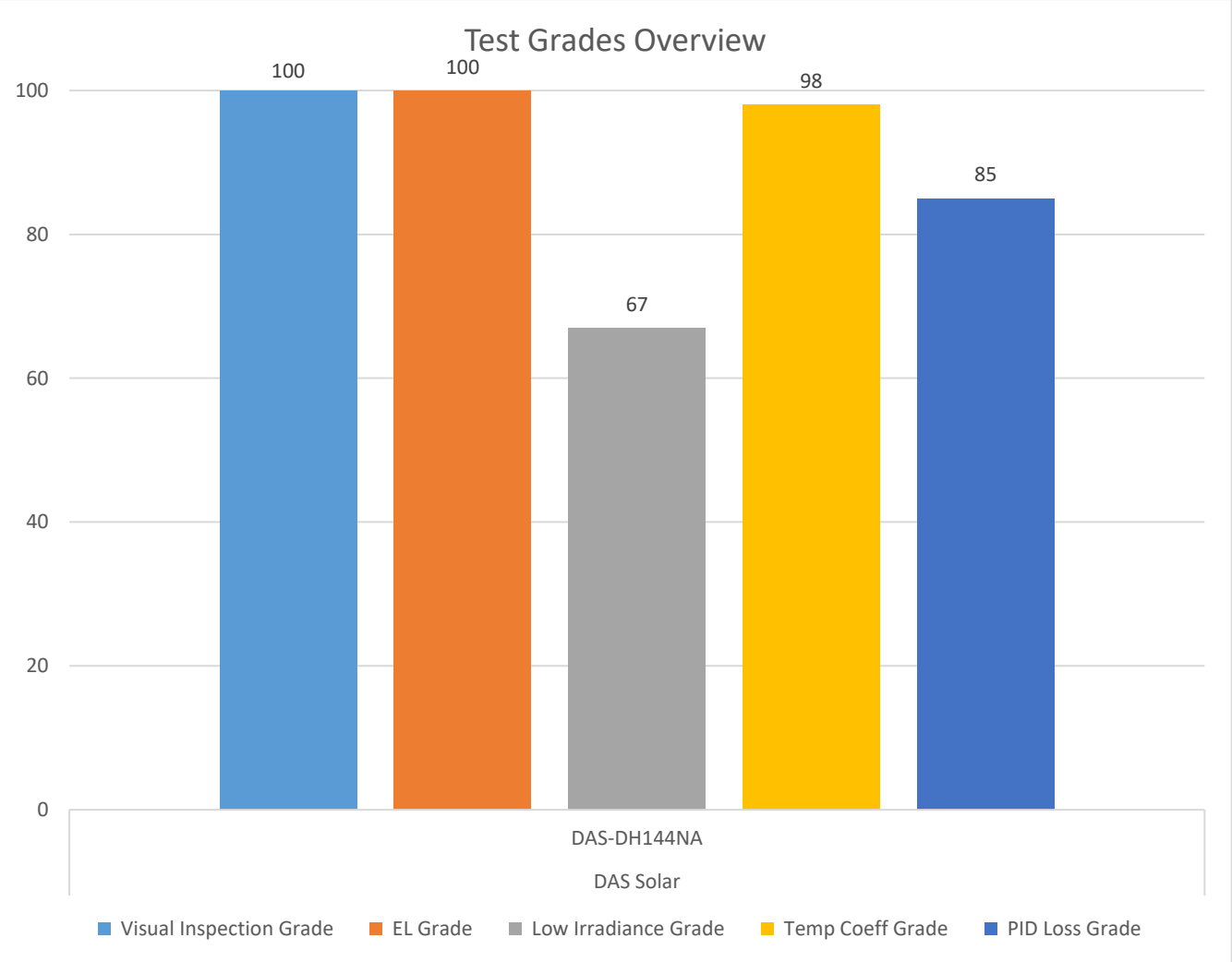


Figure 8 Test results overview

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

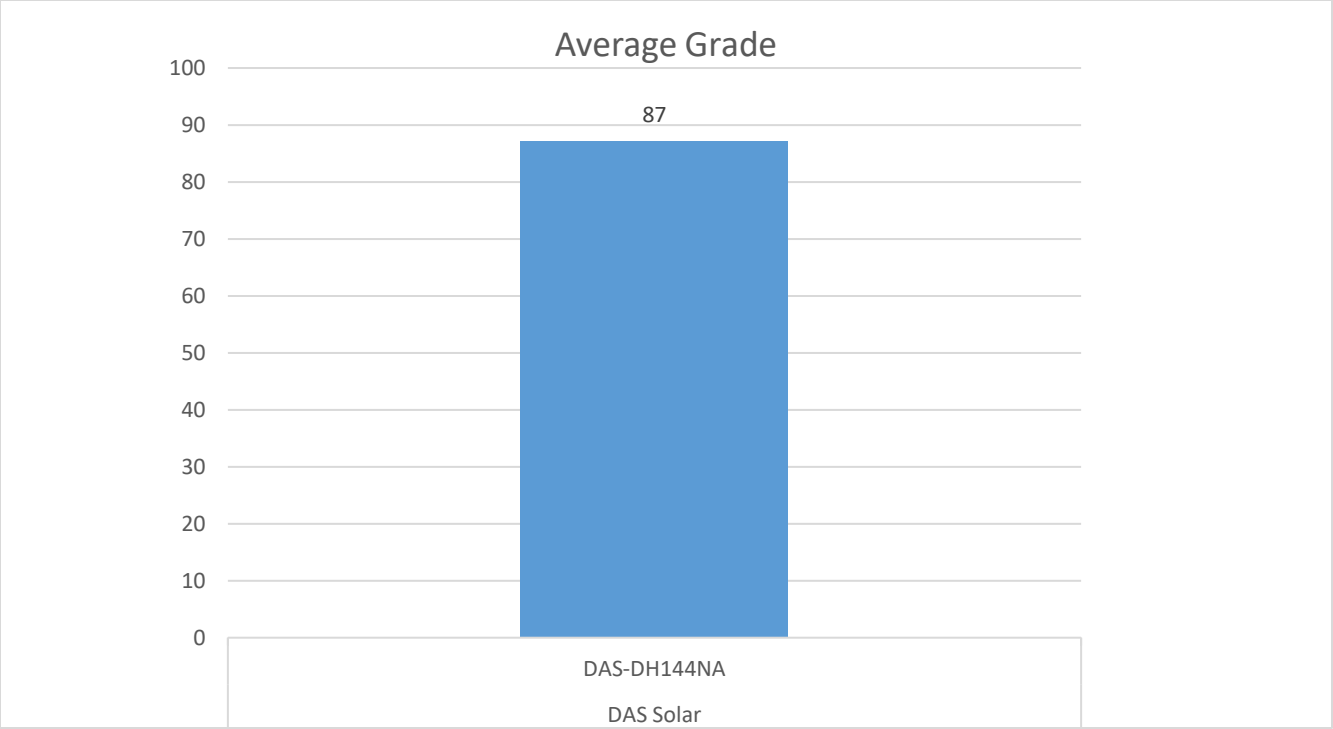


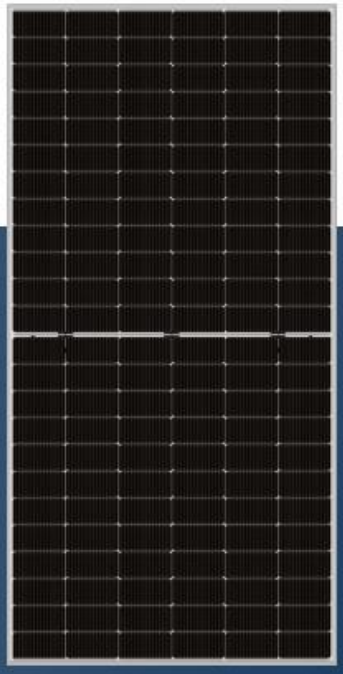
Figure 9 Average test grade

Appendix 1 – DAS-DH144NA-570 Datasheet

N Type P Type

Bifacial Double Glass Module
DAS-DH144NA

565W~585W



Key Features

High Efficiency
Leading module efficiency in industry, up to 22.6%

Excellent Appearance and Performance
Bifacial solar cell, symmetrical design, low risk of micro-crack

High Reliability
Passed 3*IEC standard test，15 years materials warranty, 30 years power warranty

Excellent Rear Side Power Generation
Bifaciality is up to 80%, up to 30% more energy yield than conventional modules

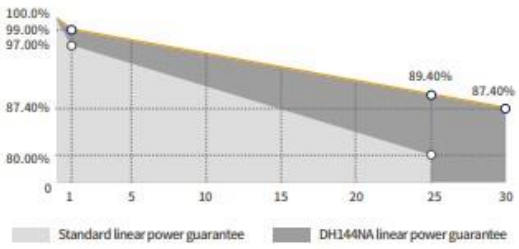
Better low irradiance performance
Higher power output even under low irradiance environments like on cloudy or foggy days

Extensive Application Scenes
More extensive application scenes, such as BIPV, snow field, vertical installation, high humidity, strong wind and desert region

Maximum Power Output	Maximum Module Efficiency	Power Output Tolerance
585W	22.6%	0~+5W

Product and Quality Certifications

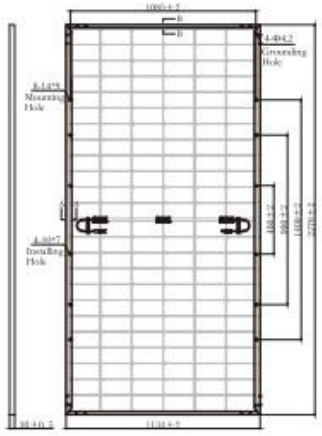
IEC 61215, IEC 61730
ISO 9001：Quality Management System
ISO 14001：Environment Management System
ISO 45001：Occupational Health and Safety Management System
IEC 62716, IEC 61701：Ammonia, Salt mist corrosion test
IEC TS 62804-1, IEC 60068-2-68：PID test, Dust and Sand test

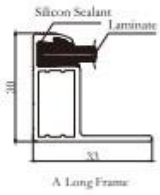


Leading product and power warranty

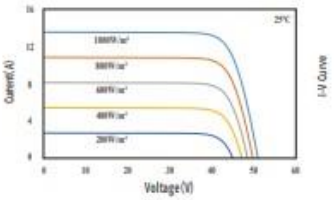
-1.00% 1st-year Degradation -0.40% Annual Degradation 15 Materials and workmanship warranty 30 Linear power warranty

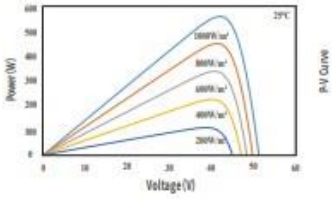
Engineering Drawing (mm)





Characteristic Curves(570W)





Electrical Parameters (STC *)

Nominal Max. Power(Pmax/W)	565	570	575	580	585
Open Circuit Voltage(Voc/V)	51.39	51.60	51.80	52.00	52.20
Short Circuit Current(Isc/A)	13.79	14.25	14.30	14.37	14.43
Operating Voltage(Vmp/V)	43.00	42.32	42.50	42.69	42.87
Operating Current(Imp/A)	13.14	13.47	13.53	13.59	13.65
Efficiency(%)	21.9	22.1	22.3	22.5	22.6

STC * : Irradiance = 1000 W/m², Cell Temperature = 25°C, AM = 1.5
Test condition is based on the front side

Mechanical Parameters

Cell Type	N Type
Module Size	2278×1134×30mm
Glass Thickness	2.0mm
Module Weight	31.3Kg
Output Cable	4mm², cable length 300mm (can be customized)
Connector	MC4 compatible
Junction Box	IP68, 3 bypass diodes
Frame	Anodized aluminium alloy

Electrical Parameters (NMOT *)

Nominal Max. Power(Pmax/W)	427.0	430.0	433.0	437.0	441.0
Open Circuit Voltage(Voc/V)	48.61	48.70	48.89	49.08	49.27
Short Circuit Current(Isc/A)	11.12	11.13	11.17	11.22	11.27
Operating Voltage(Vmp/V)	40.53	40.73	40.93	41.19	41.49
Operating Current(Imp/A)	10.54	10.56	10.58	10.61	10.63

NMOT *: Irradiance = 800 W/m², Ambient Temperature = 20°C, AM = 1.5,
Wind Speed = 1 m/s
Test condition is based on the front side

Temperature Coefficients

Short Circuit Current(Isc)	+0.045%/°C
Open Circuit Voltage(Voc)	-0.250%/°C
Nominal Max. Power(Pmax)	-0.300%/°C
NMOT	42±2°C

Backside Power Gain (For 570W)

Power Gain	10%	15%	20%	25%	30%
Nominal Max. Power(Pmax/W)	627.0	655.5	684.0	712.5	741.0
Open Circuit Voltage(Voc/V)	51.60	51.60	51.70	51.70	51.70
Short Circuit Current(Isc/A))	15.68	16.39	17.10	17.81	18.53
Operating Voltage(Vmp/V)	42.32	42.32	42.42	42.42	42.42
Operating Current(Imp/A)	14.82	15.49	16.12	16.80	17.47

Operating Parameters

Max. System Voltage	DC1500V
Power Tolerance	0 ~ +5 W
Operating Temperatue	-40°C ~ +85°C
Max. Fuse Rated Current	30A
Front Static Load	Snow load 5400Pa, Wind load 2400Pa
Packing Data	36 pcs/Pallet; 180(20GP); 720(40HQ)

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