CEA I PV MAGAZINE PROGRAM TEST REPORT

SUPPLIER | Aiko

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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.

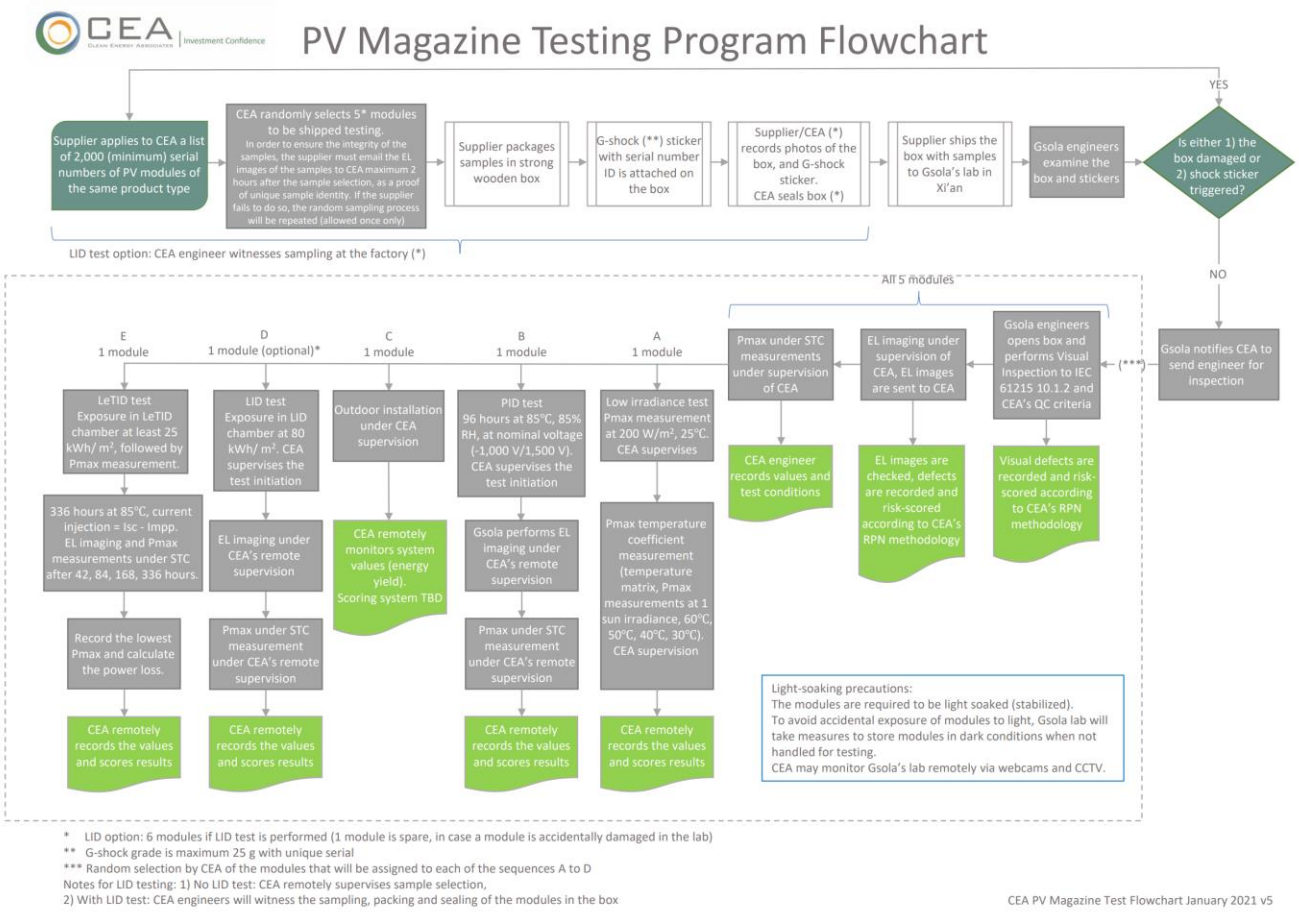


Figure 1 Test flowchart

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 AIKO-A-MAH72MW 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	Z012307E237000006
2	Z012307E237000014
3	Z012307E237000292
4	Z012307E237000250
5	Z012307E237000249

Table 4 Product information

Model	AIKO-A-MAH72MW
Cell technology	n-type Back Contact TOPCon
Cell number	144
Cell format	182x182 mm
Number of busbars	12
Junction box	IP68, 3 bypass diodes
Laminate construction	Glass
Bifaciality ratio	Not applicable

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

AIKO-A-MAH72MW	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

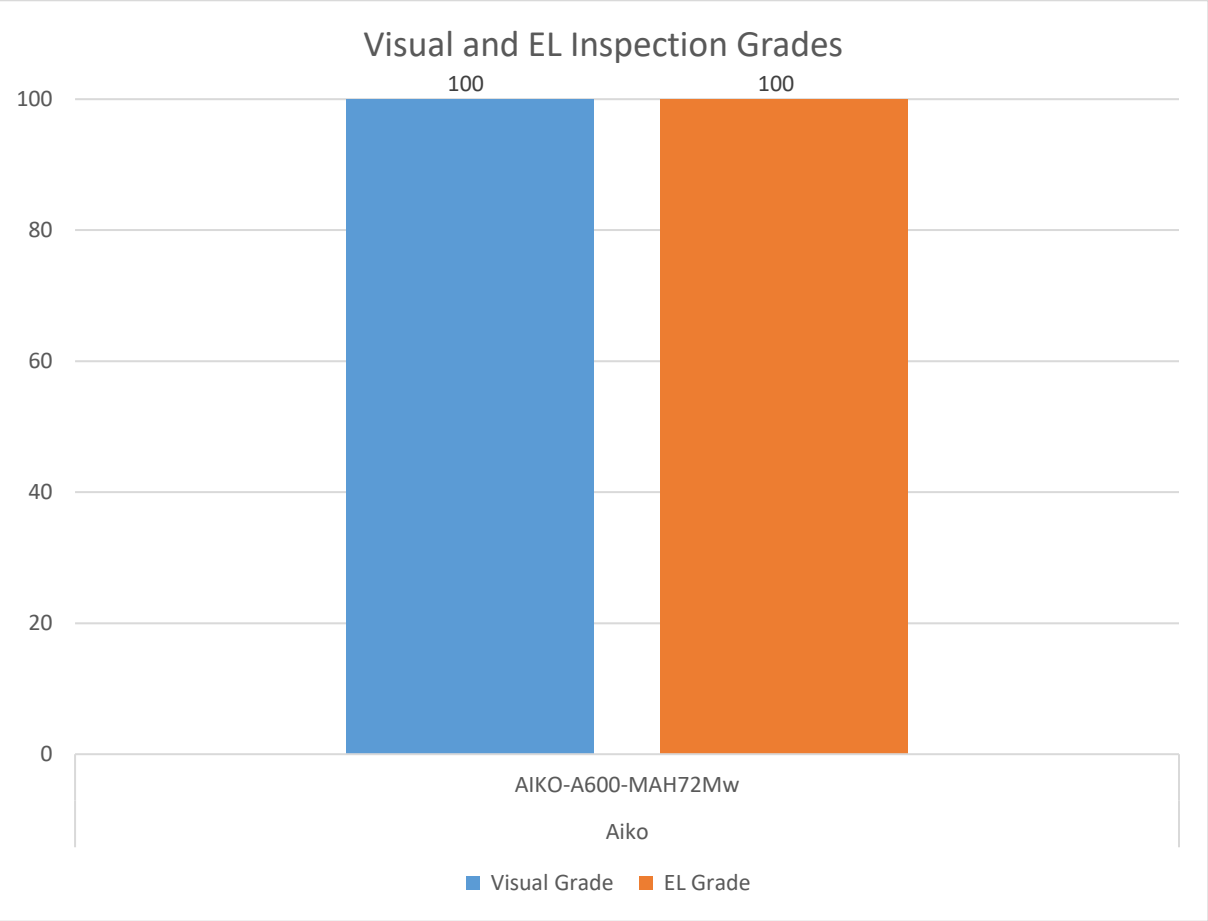


Figure 3.

Table 7 EL image inspection results

AIKO-A-MAH72MW	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Score	Grade
EL image inspection	None	None	None	None	None	0	100

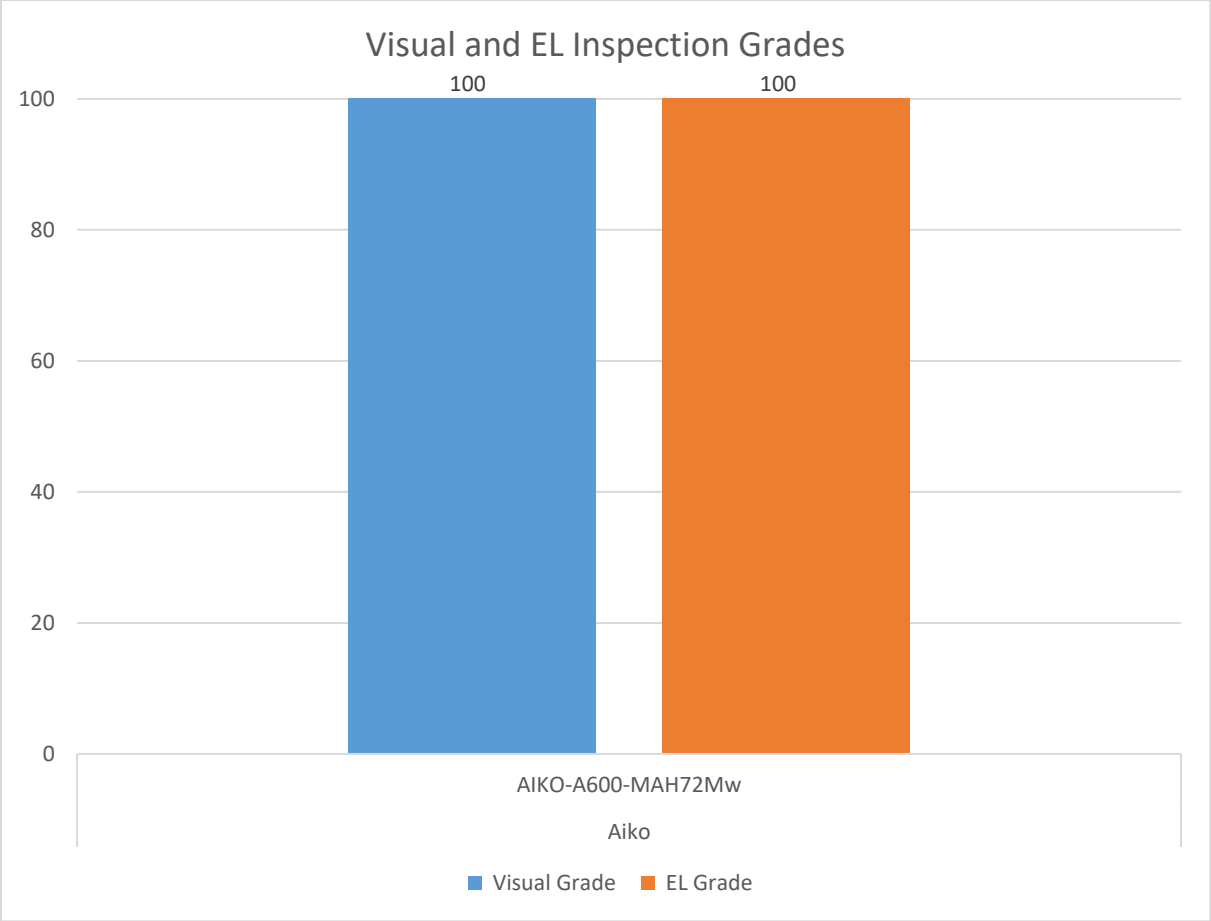


Figure 3 Visual and EL inspection results

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

AIKO-A-MAH72MW	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Front side low irradiance efficiency loss (%)	6.97%					42

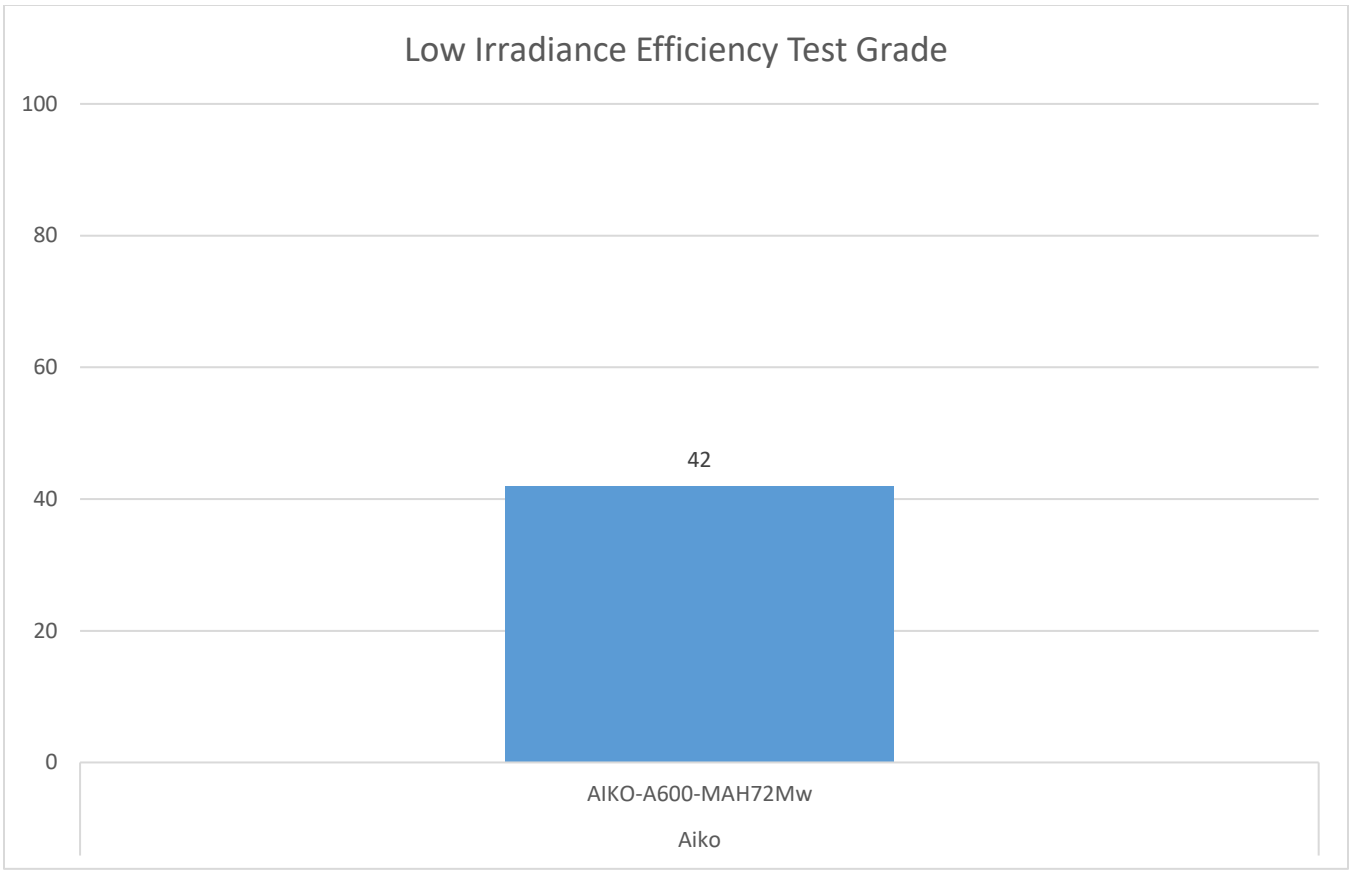


Figure 4 Low irradiance test result

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

AIKO-A-MAH72MW	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Pmax Temperature coefficient (%/°C)	-0.26%					107

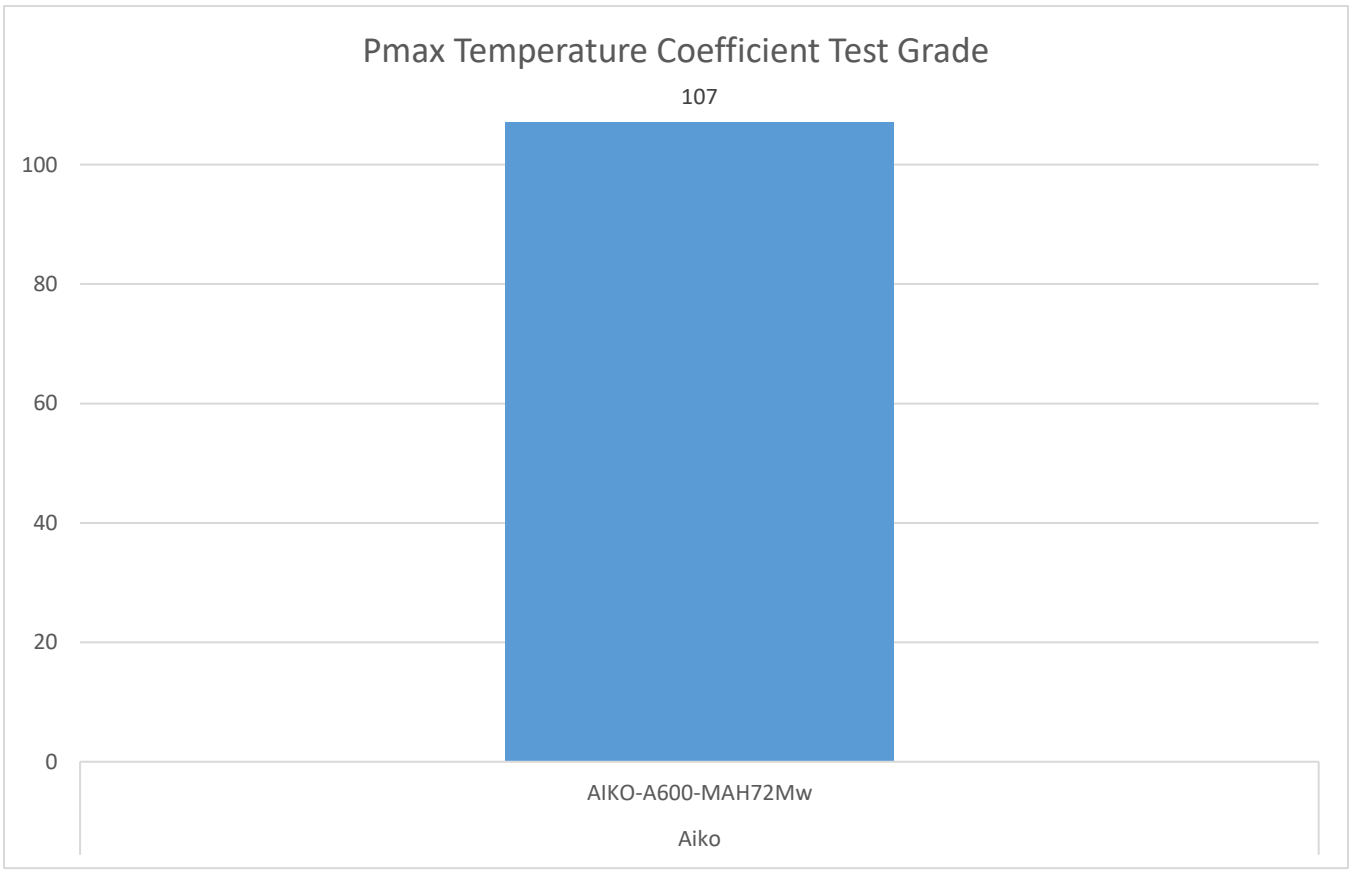


Figure 5 Pmax temperature coefficient test result

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

AIKO-A-MAH72MW	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Front side PID loss (%)		0.82%				88

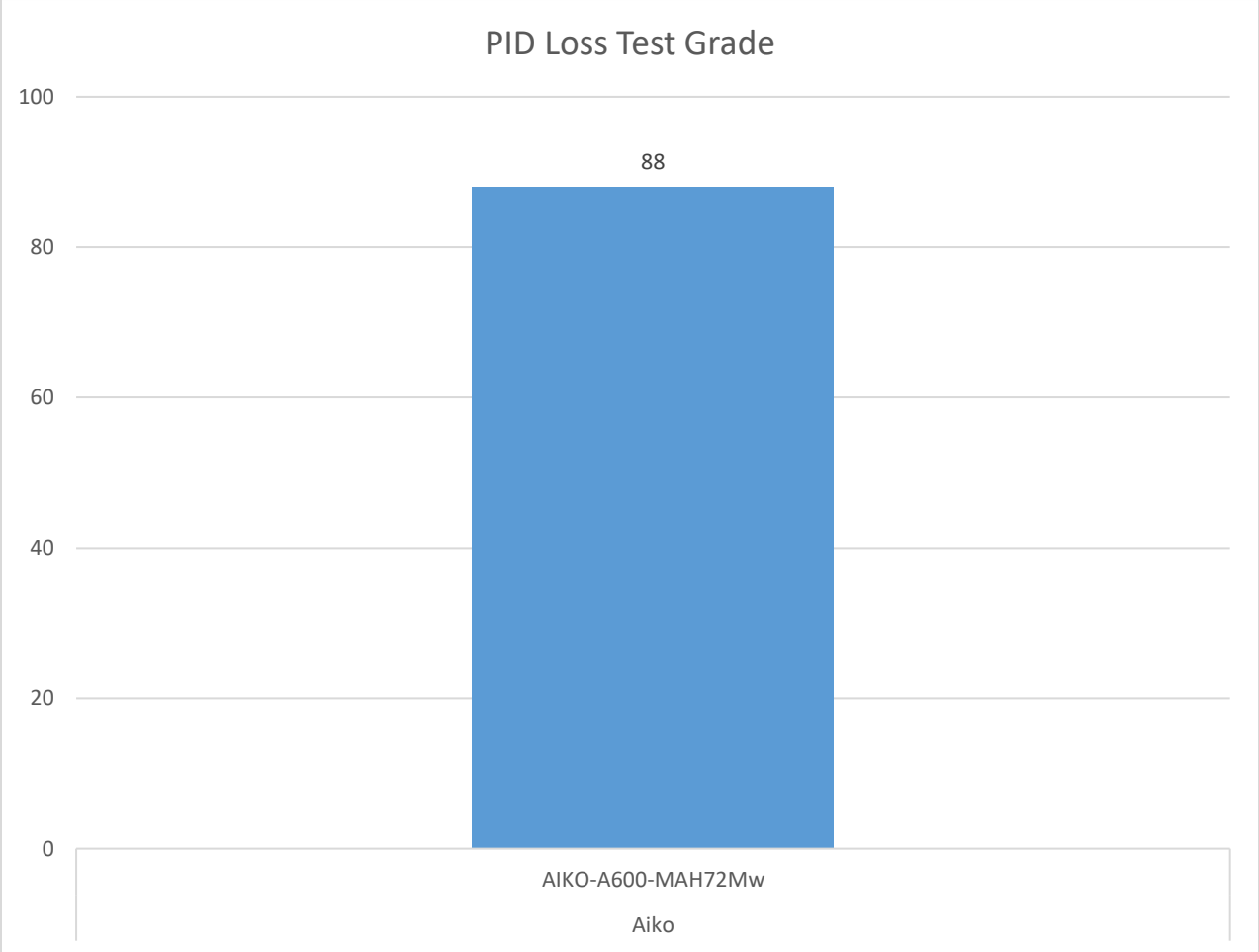


Figure 6 PID loss test result

3.6. LeTID loss test

Table 11 and Figure 6 depicts the LeTID loss test results:

Table 11 LeTID loss test result

AIKO-A-MAH72MW	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.

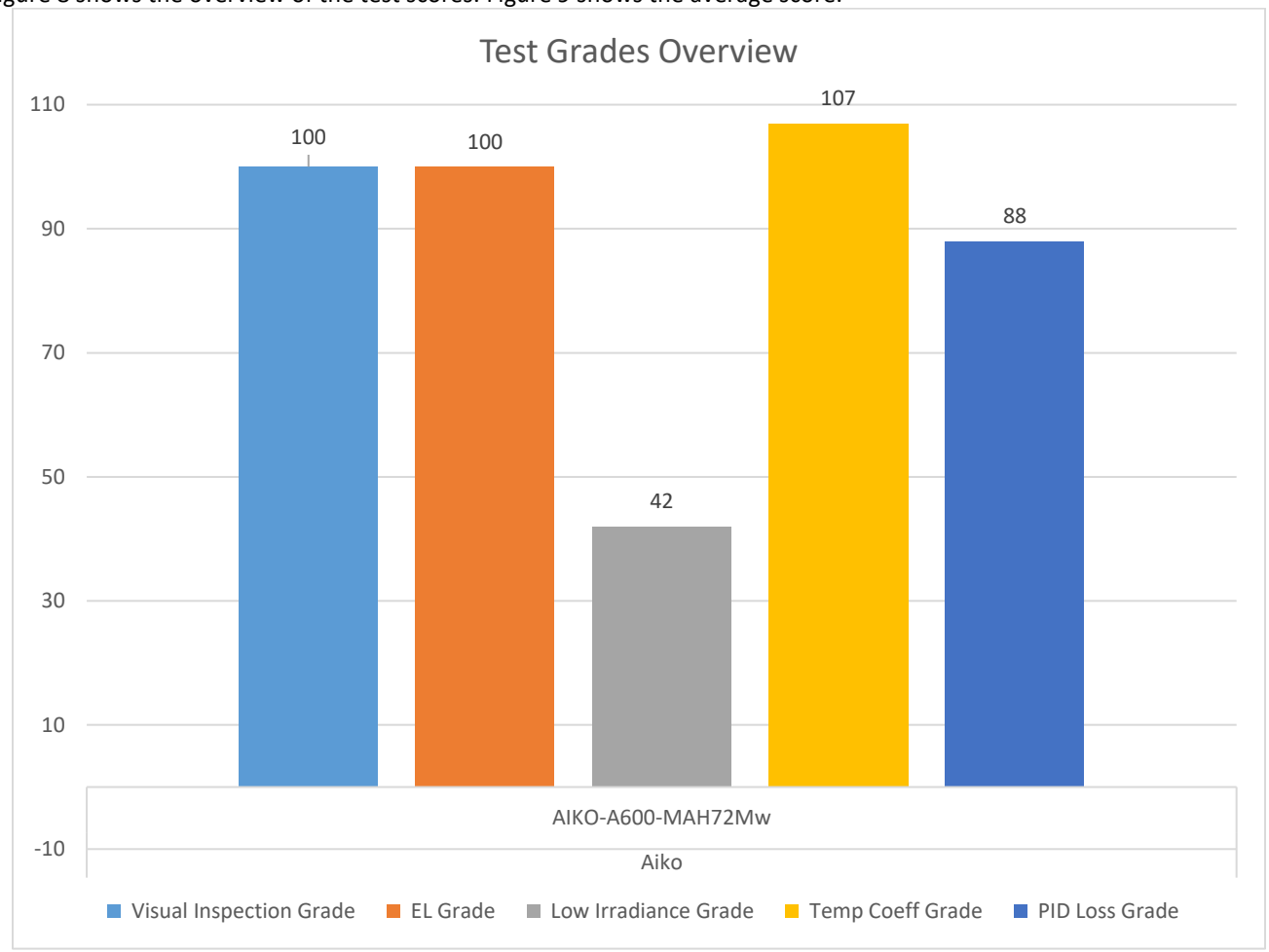


Figure 8 Test results overview

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

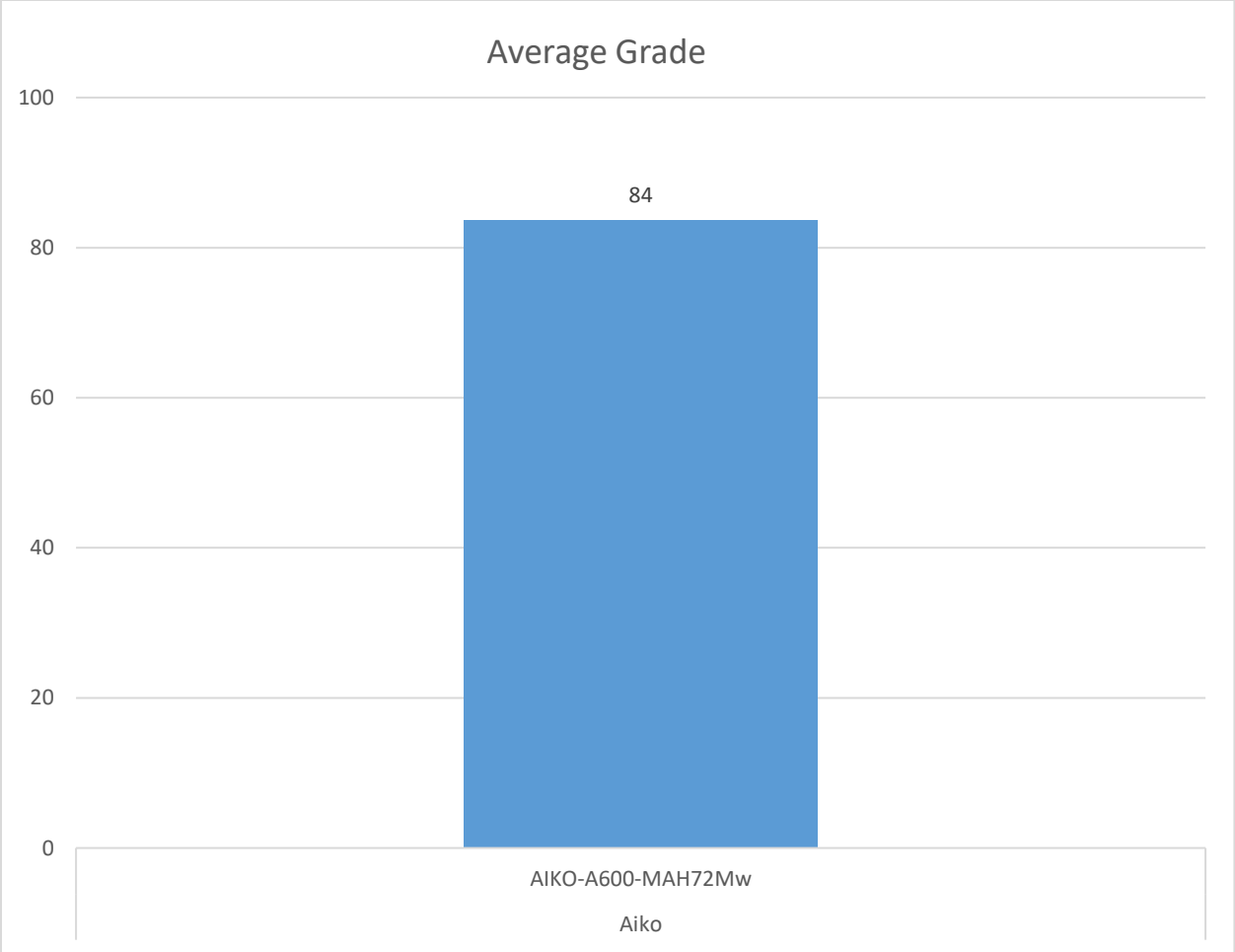


Figure 9 Average test grade

Appendix 1 – AIKO-A-MAH72MW Datasheet

AIKO

N-Type ABC
White Hole Series
AIKO-A-MAH72Mw

Up to **24.0%**
600W-620W

15 year Product Warranty

30 year Performance Warranty

reddot winner 2023

Premium Appearance
No grid lines on the front

Higher Power Output
Higher efficiency: 24.0%
Lower degradation: 1 Year≤1.0%, 2 -30 Year≤0.35%
Better Temperature Coefficient: -0.29%/ ℃

Optimized Balance of System (BOS)
Significant savings on mounting structure, cabling, and labour cost

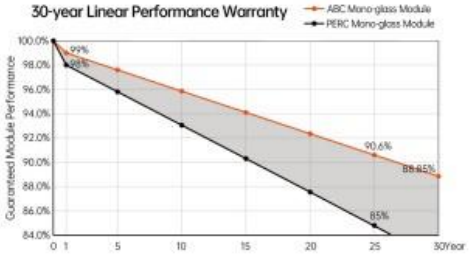
Complete Set of Quality Management System
IEC 61730 (2016) IEC 61215 (2021)
ISO 9001:2015 Quality Management System
ISO 14001:2015 Environmental Management System
ISO 45001:2018 Occupational Safety and Management System

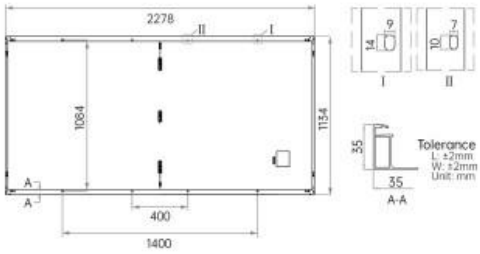
Munich RE CE TÜVRheinland CQC

N-Type ABC White Hole Series

AIKO-A-MAH72Mw

620W	24.0%	≤1%	≤0.35%
Output	Efficiency	First-year Degradation	Annual Degradation from Year 2-30





Electrical Characteristics (STC: AM1.5 1000W/m² 25℃ NOCT: AM1.5 800W/m² 20℃ 1m/s) Power Tolerance:0~ + 3% Max Power Test Uncertainty:±3%

Model	AIKO-A600-MAH72Mw		AIKO-A605-MAH72Mw		AIKO-A610-MAH72Mw		AIKO-A615-MAH72Mw		AIKO-A620-MAH72Mw	
Test Conditions	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT
P_{max} [W]	600	453	605	456	610	460	615	464	620	468
V_{oc} [V]	53.29	50.19	53.39	50.28	53.49	50.38	53.59	50.47	53.69	50.56
V_{mp} [V]	44.81	42.20	44.91	42.30	45.01	42.39	45.11	42.48	45.21	42.58
I_{sc} [A]	13.92	11.29	13.98	11.34	14.04	11.39	14.10	11.44	14.16	11.48
I_{mp} [A]	13.40	10.74	13.48	10.80	13.56	10.86	13.64	10.93	13.72	11.00
Module Efficiency	**23.2%**		**23.4%**		**23.6%**		**23.8%**		**24.0%**	

Mechanical Specification

Cell Type	Mono-crystalline Silicon
Front Cover Mono glass	3.2 mm tempered glass, with anti-reflection coating
Frame	Anodized aluminum
Cable	4mm²(IEC) 12AWG(UL) 350mm or Customized Length
No. of Cells	144(6*24)
Junction Box	IP68, three bypass diodes
Connector	MC4 compatible
Weight	28.2kg±3%
Dimension	2278*1134*35mm
Package Detail	31pcs per pallet/155 pcs per 20' GP/620pcs per 40' HQ

Temeprature Ratings (STC)

Temperature Coefficient of I_{sc}	+ 0.05%/ ℃
Temperature Coefficient of V_{oc}	- 0.24%/ ℃
Temperature Coefficient of P_{max}	- 0.29%/ ℃

Installation Guide

Operation Temperature	-40℃~+85℃
Maximum Series Fuse Rating	25A
Protection Class	Class II
V_{oc} and I_{sc} Tolerance	±3%
Maximum System Voltage	DC1500V
Maximum Static Loading	Front 5400Pa Back 2400Pa
Hail Test	25 mm diameter hail at 23 m/s
Fire Rating	IEC Class C

AIKO

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