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CEA I PV MAGAZINE PROGRAM TEST REPORT

SUPPLIER | Phono Solar

Author: George Touloupas
Date: 23 November 2018
Form Version: V2.2

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.

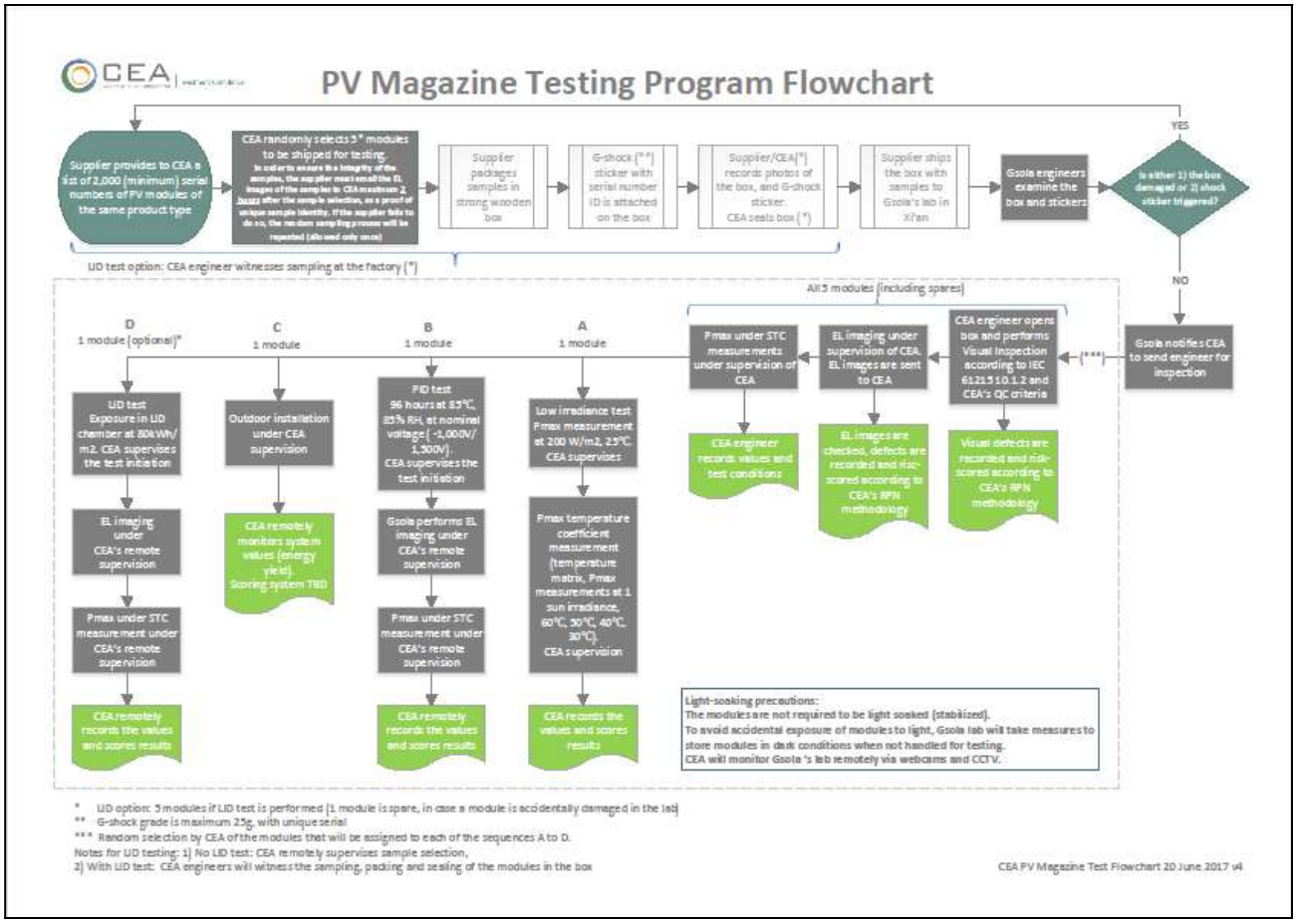


Figure 1 Test flowchart

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

	Score 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	Product code
1	PSTHM01809331018	PS380MH-24/TH
2	PSTHM14199331018	PS380MH-24/TH
3	PSTHM15689331018	PS380MH-24/TH
4	PSTHM18759331018	PS380MH-24/TH
5	PSTHM16589331018	PS380MH-24/TH

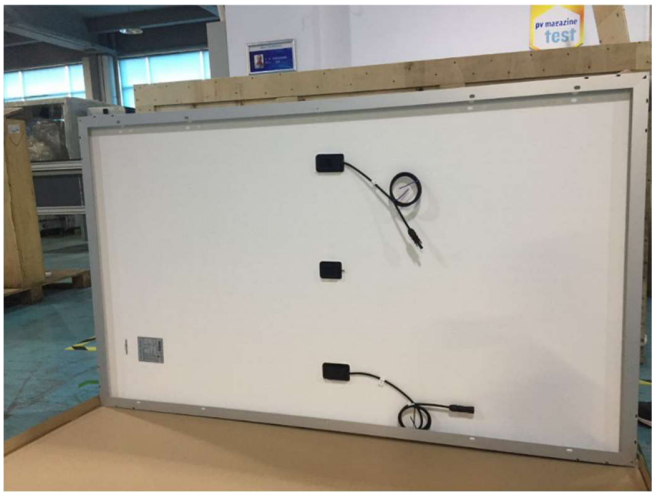
Table 4 Product information

Model	PS380MH-24/TH	Label picture
Cell technology	Mono PERC	
Cell number	2 x 72	
Cell format	Half cut	
Number of busbars	5	
Junction box	Split type	
Laminate construction	Framed, glass/backsheet	

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

PS380MH-24/TH	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Score	Grade
Visual inspection	None	None	None	None	None	0	100

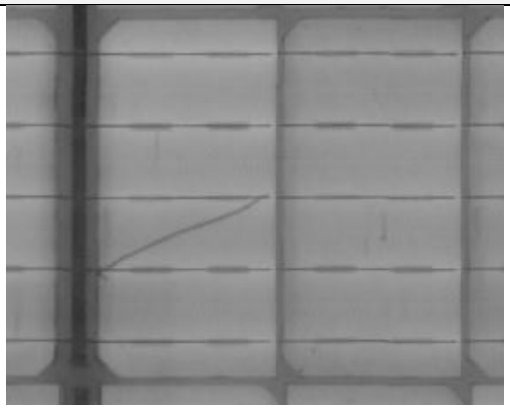
3.2. EL image Inspection

The same sample lot was inspected for EL defects.
Table 7 shows the EL inspection results normalized for the number of tested modules. Table 8 shows the image of the inspected defects. Visual and EL inspection scores are shown below in Figure 2.

Table 7 EL image inspection results

PS380MH-24/TH	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Score	Grade
EL image inspection	None	None	None	H3/Ma	None	4.8	79

Table 8 EL image defects

Defect type	Sample	Defect description	Image
H3/Ma	Sample 4	Tree shape micro cracks	

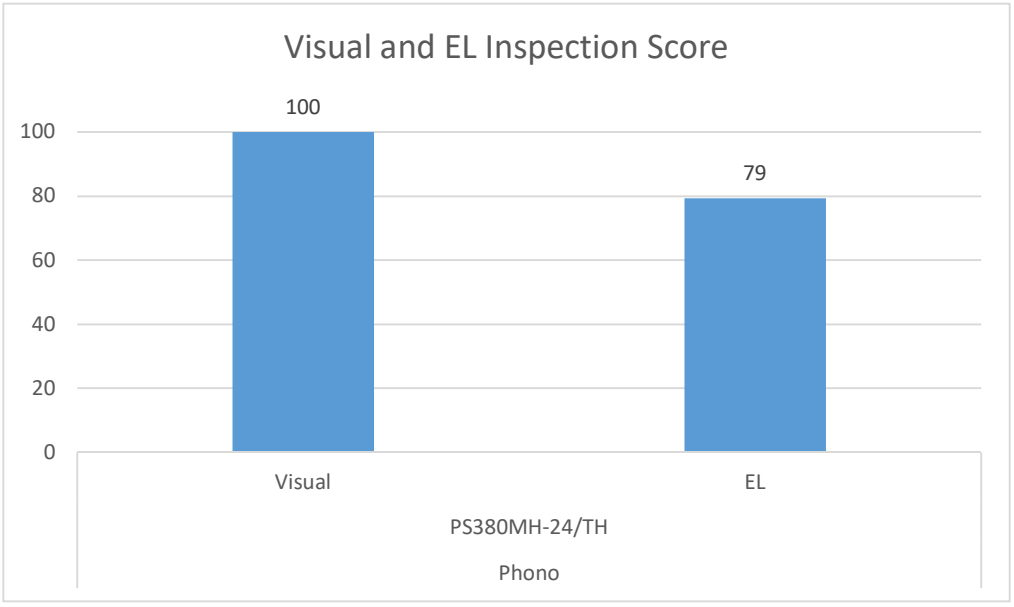


Figure 2 Visual and EL inspection results

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 9 and Figure 3 show the low irradiance efficiency test results for the front side.

Table 9 Low irradiance test results

PS380MH-24/TH	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Front side low irradiance efficiency loss (%)	5.92%					52

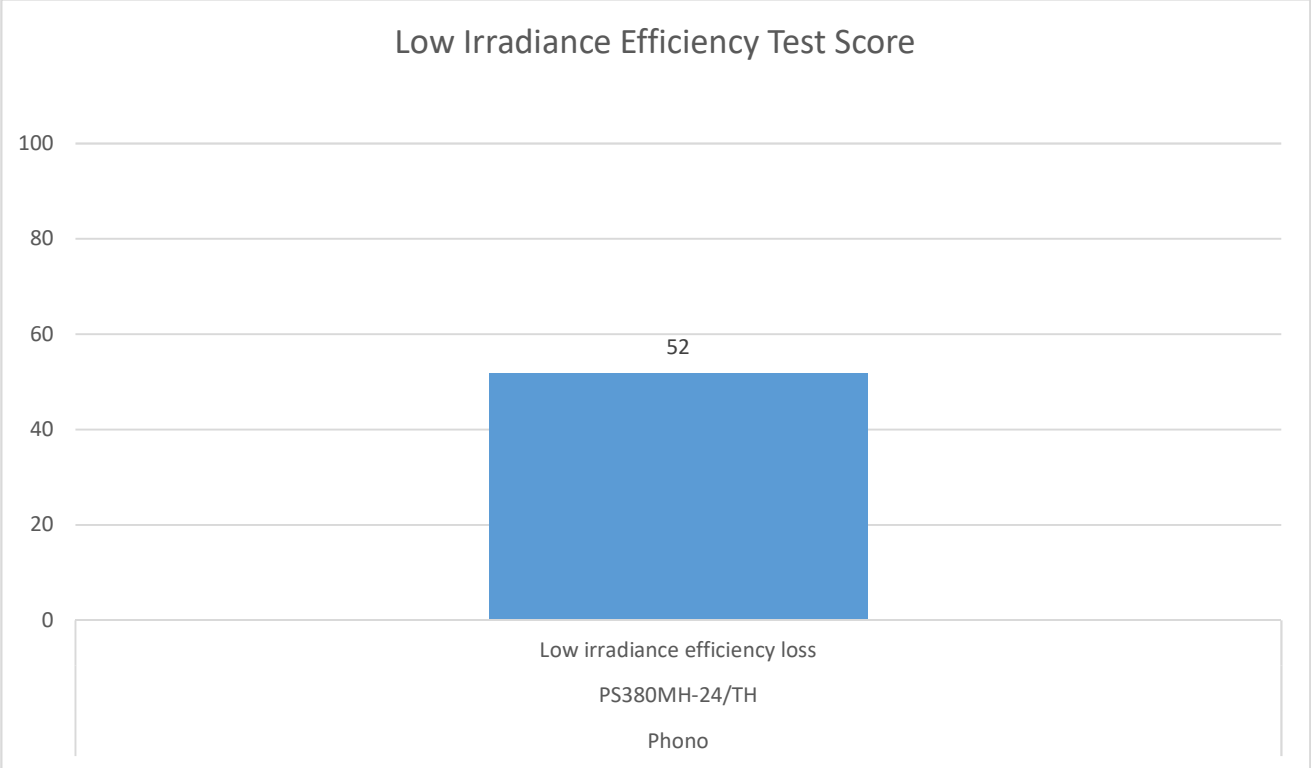


Figure 3 Low irradiance test result

3.4. Pmax temperature coefficient test

Table 10 and Figure 4 depict the Pmax temperature coefficient test results.

Table 10 Pmax temperature coefficient test result

PS380MH-24/TH	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Pmax Temperature coefficient (%/°C)	-0.39%					77

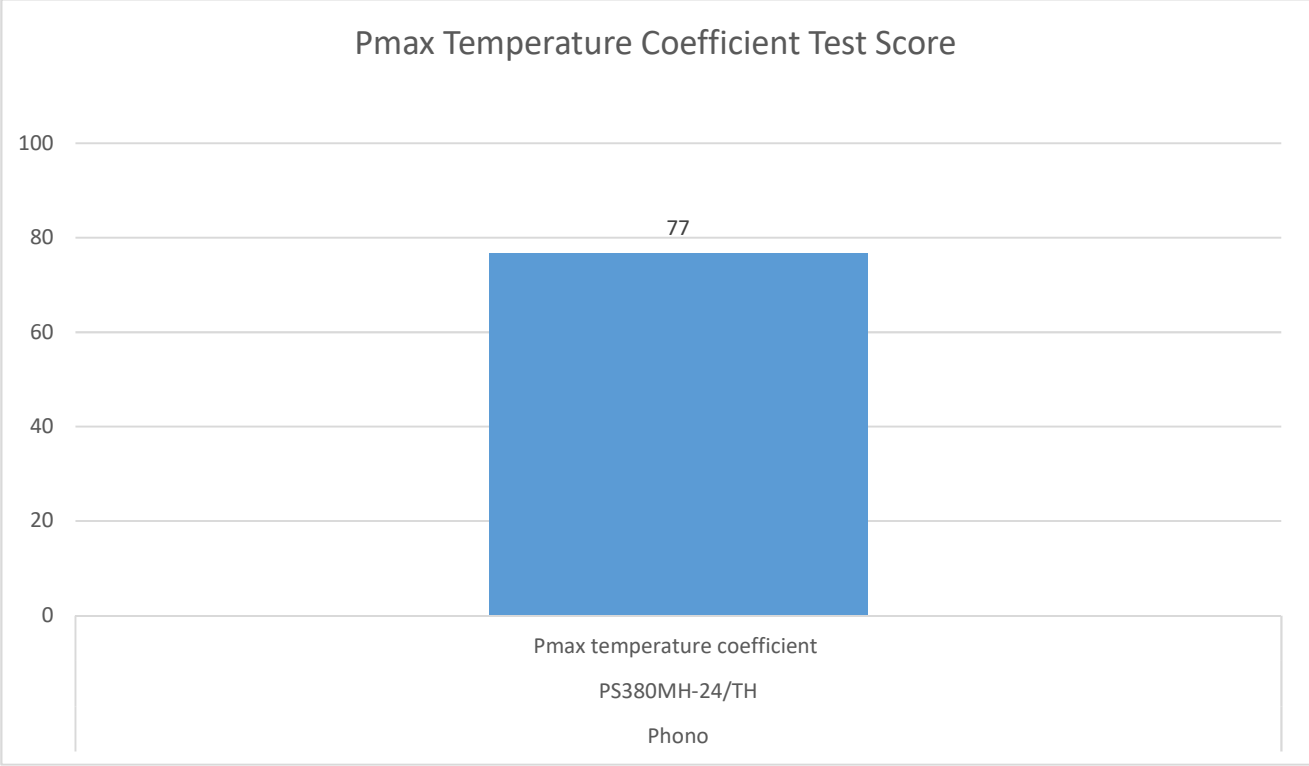


Figure 4 Pmax temperature coefficient test result

3.5. PID loss test

Table 11 and Figure 5 depicts the PID loss test results for the front side at **1500 V**:

Table 11 PID loss test result

PS380MH-24/TH	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Front side PID loss (%)		1.56%				81

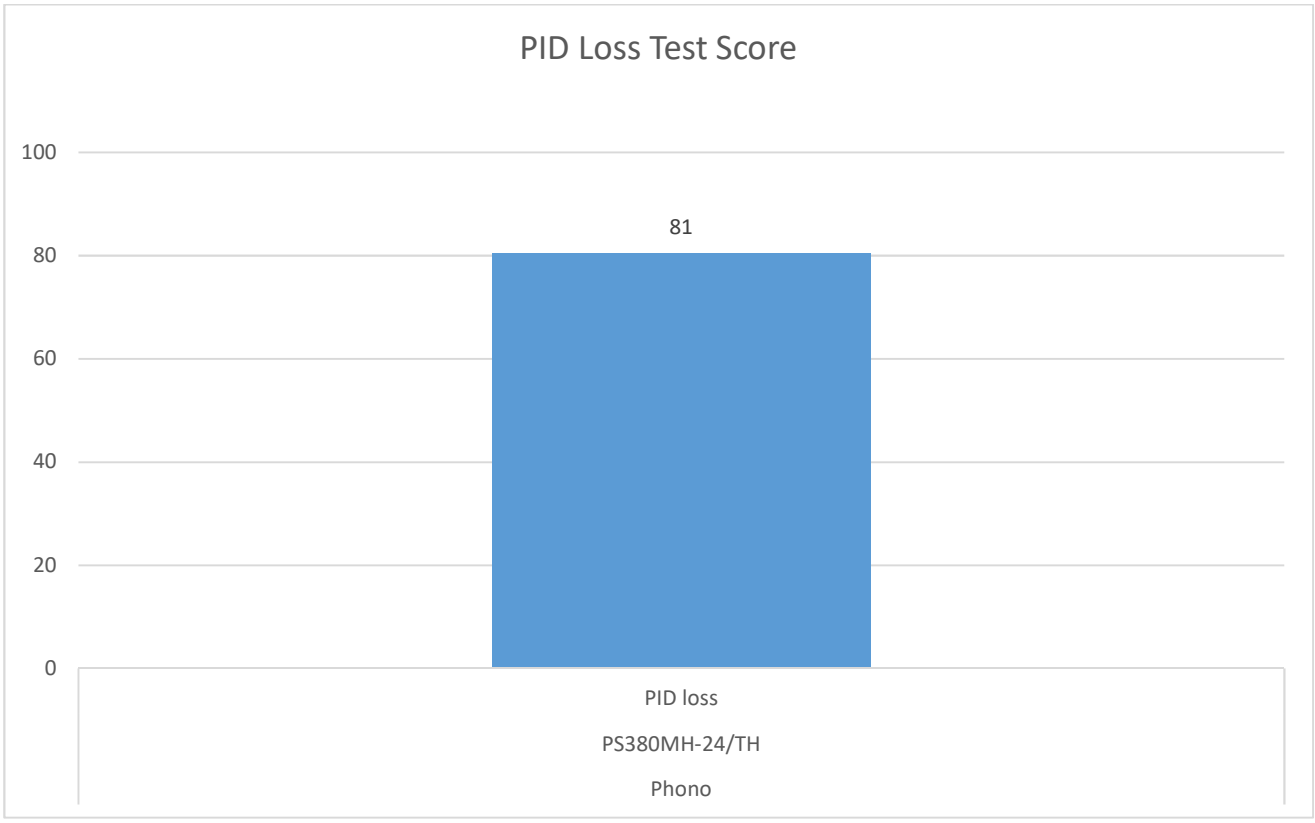


Figure 5 PID loss test result

3.6. Score overview

Figure 6 shows the overview of the test scores. Figure 7 shows the average score.

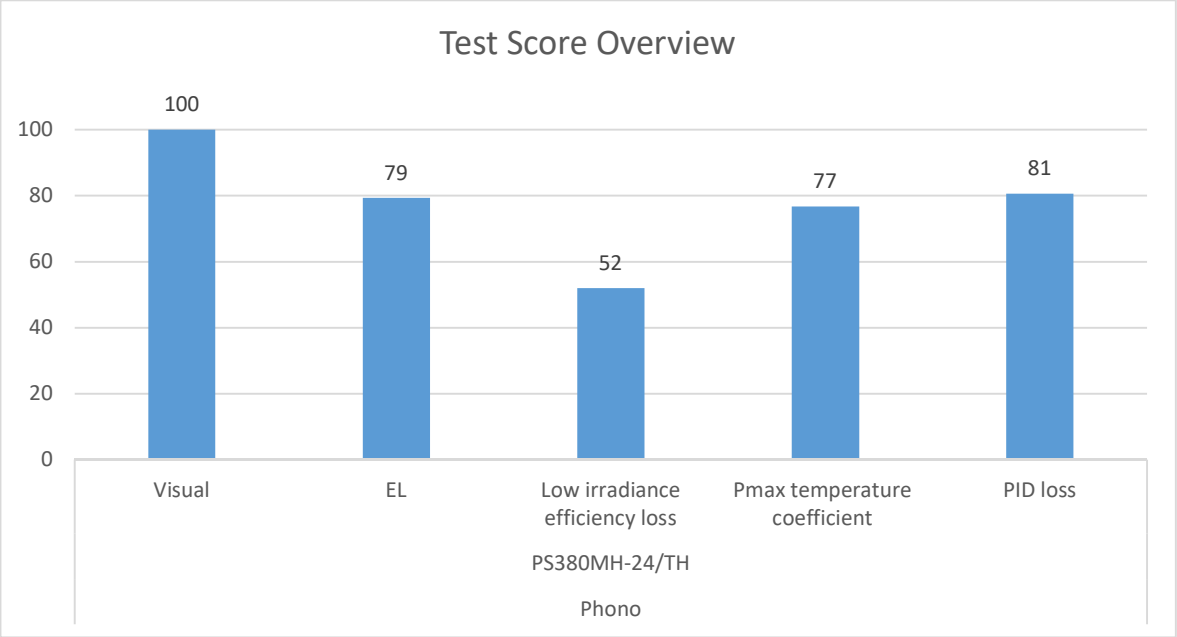


Figure 6 Test results overview

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

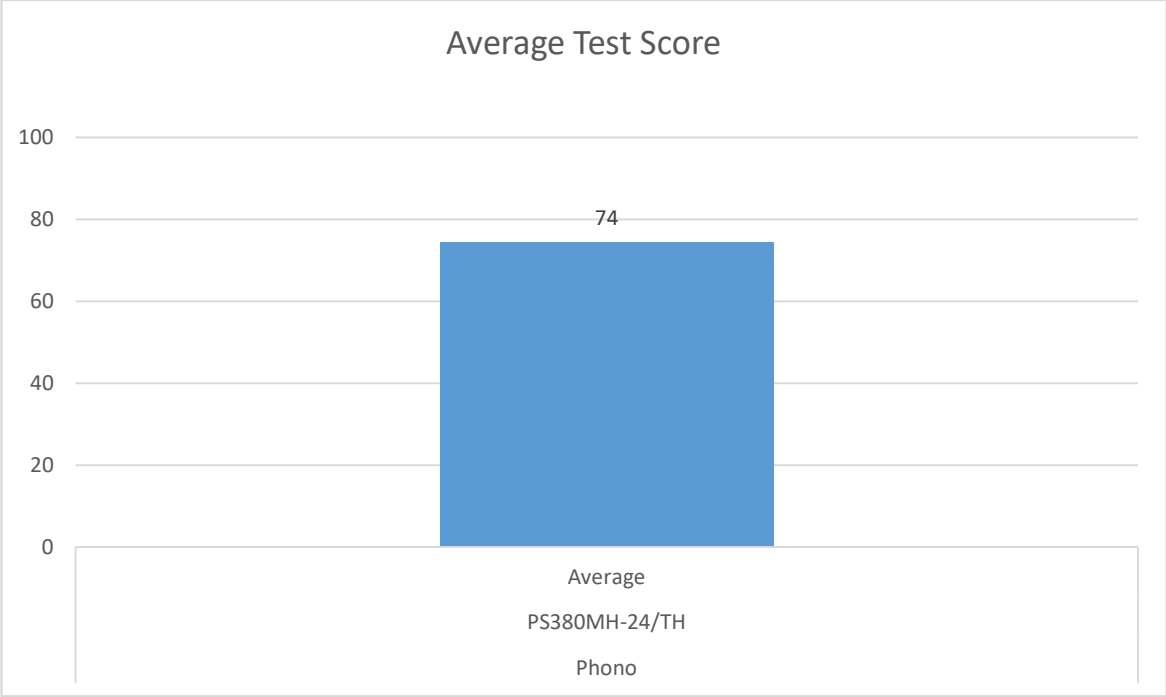


Figure 7 Average test score

Appendix 1 - PS380MH-24/TH Datasheet

Phono® Solar

TwinPlus Module

Perc/370-385W

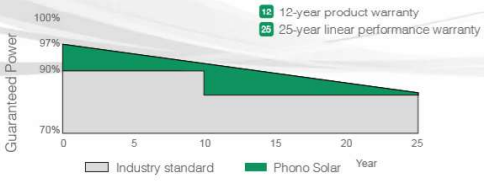
Bloomberg NEW ENERGY FINANCE Tier 1 | 2018 DNV·GL BY MODULE RELIABILITY SCORECARD TOP PERFORMER

PID Resistant

Better shading tolerance

More Reliable
Lower hot spot temperature

More Power
Low power loss in cell connection
Low temperature coefficient (Pmax): -0.37% / °C
Low NOCT: 43±2°C



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SINOMACH SUMEC
SUMEC GROUP CORPORATION

ELECTRICAL TYPICAL VALUES

Model	PS370M-24/TH PS370MH-24/TH	PS375M-24/TH PS375MH-24/TH	PS380M-24/TH PS380MH-24/TH	PS385M-24/TH PS385MH-24/TH
Type	Monocrystalline 6 inch x 3 inch square			
Rated Power (Pmpp)	370W	375W	380W	385W
Tolerance	0~+5w			
Rated Current (Impp)	9.29	9.35	9.42	9.48
Rated Voltage (Vmpp)	39.83	40.11	40.35	40.62
Short Circuit Current (Isc)	9.71	9.79	9.87	9.95
Open Circuit Voltage (Voc)	47.44	47.69	47.94	48.19
Module Efficency (%)	18.65	18.90	19.15	19.41
NOCT (Nominal Operation Cell Temperature)	43±2℃			
Voltage Temperature Coefficient	-0.286%/℃			
Current Temperature Coefficient	+0.051%/℃			
Power Temperature Coefficient	-0.368%/℃			

MECHANICAL CHARACTERISTICS

Dimension (L× W × H)	Length: 2000mm (78.75 inch) Width: 992mm (39.06 inch) Height: 40mm (1.57 inch)
Weight	22.6kg (49.8 lbs)
Front Glass	3.2mm toughened glass
Frame	Anodized aluminium alloy
Cable	4mm² (IEC) , Length:350mm (vertical) 1250mm (horizontal) or Customized length
Junction Box	IP 68 rated

ABSOLUTE MAXIMUM RATING

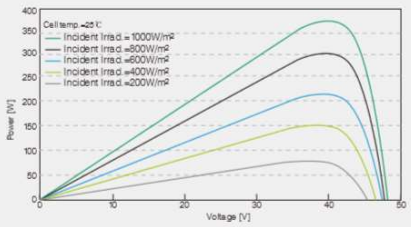
Parameter	Values
Operating Temperature	From -40 to +85°C
Hail Diameter @ 80km/h	Up to 25mm
Surface Maximum Load Capacity	Up to 5400Pa
Maximum Series Fuse Rating	20A
Application Class and Safety Class	II
Fire Rating (IEC61730)	C
Module Fire Performance (UL 1703)	Type1
Maximum System Voltage	DC 1000V/1500V (IEC/ETL)

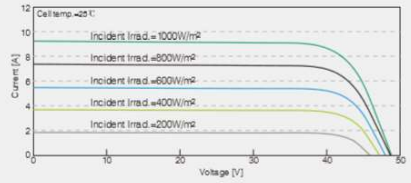
PACKING CONFIGURATION

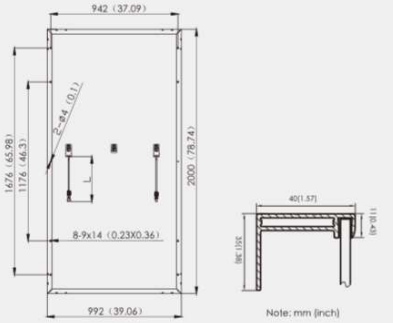
Container	20' GP	40' HQ
Pieces/Container	230	616

1. In compliance with our warranty terms and conditions.
2. Measurement conditions under irradiance level of Standard Test Conditions(STC): 1000W/m
Air mass 1.5 Spectrum, cell temperature of 25°C.

ELECTRICAL CHARACTERISTICS







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