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CLEAN ENERGY ASSOCIATES

CEA I PV MAGAZINE PROGRAM TEST REPORT

SUPPLIER | Trina

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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.

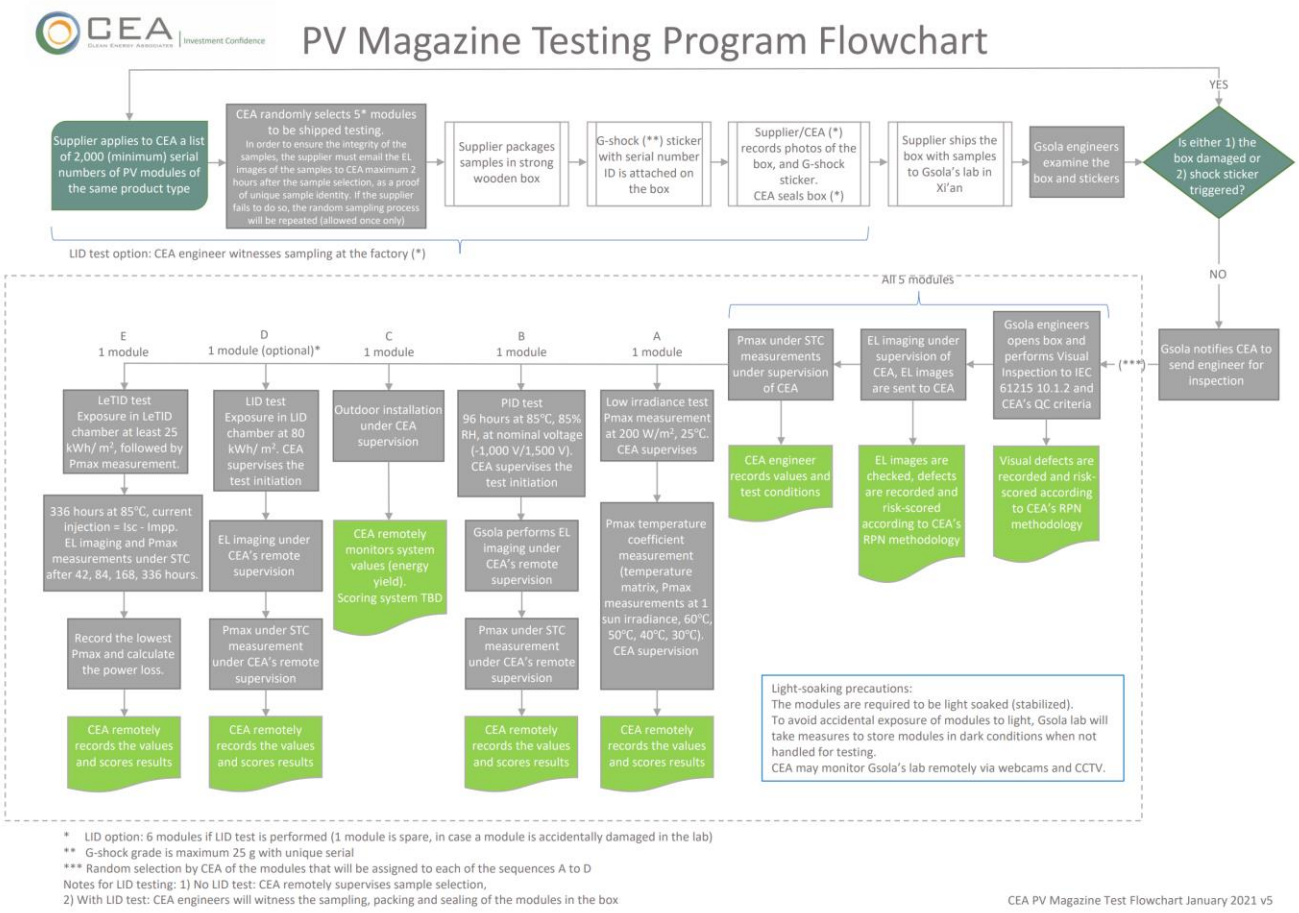


Figure 1 Test flowchart

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	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	H04210600111415
2	H04210600105101
3	H04210600106745
4	H04210600106756
5	H04210600111569

Table 4 Product information

Model	TSM-505DE18M
Cell technology	Mono PERC
Cell number	150
Cell format	210 mm
Number of busbars	MBB
Junction box	IP68 rated
Laminate construction	Framed glass/glass

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

TSM-505DE18M	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

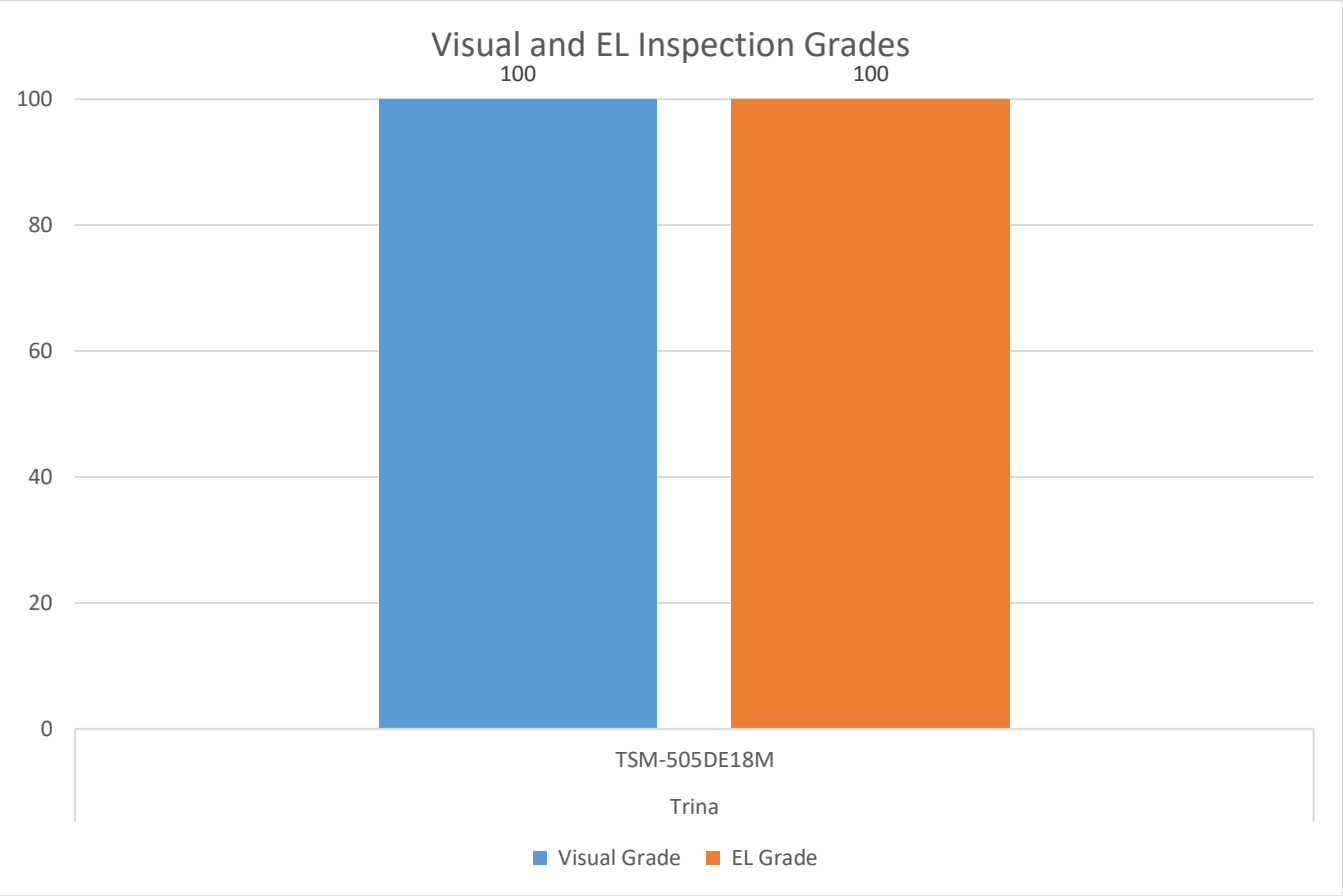


Figure 2.

Table 7 EL image inspection results

TSM-505DE18M	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Score	Grade
EL image inspection	None	None	None	None	None	0	100

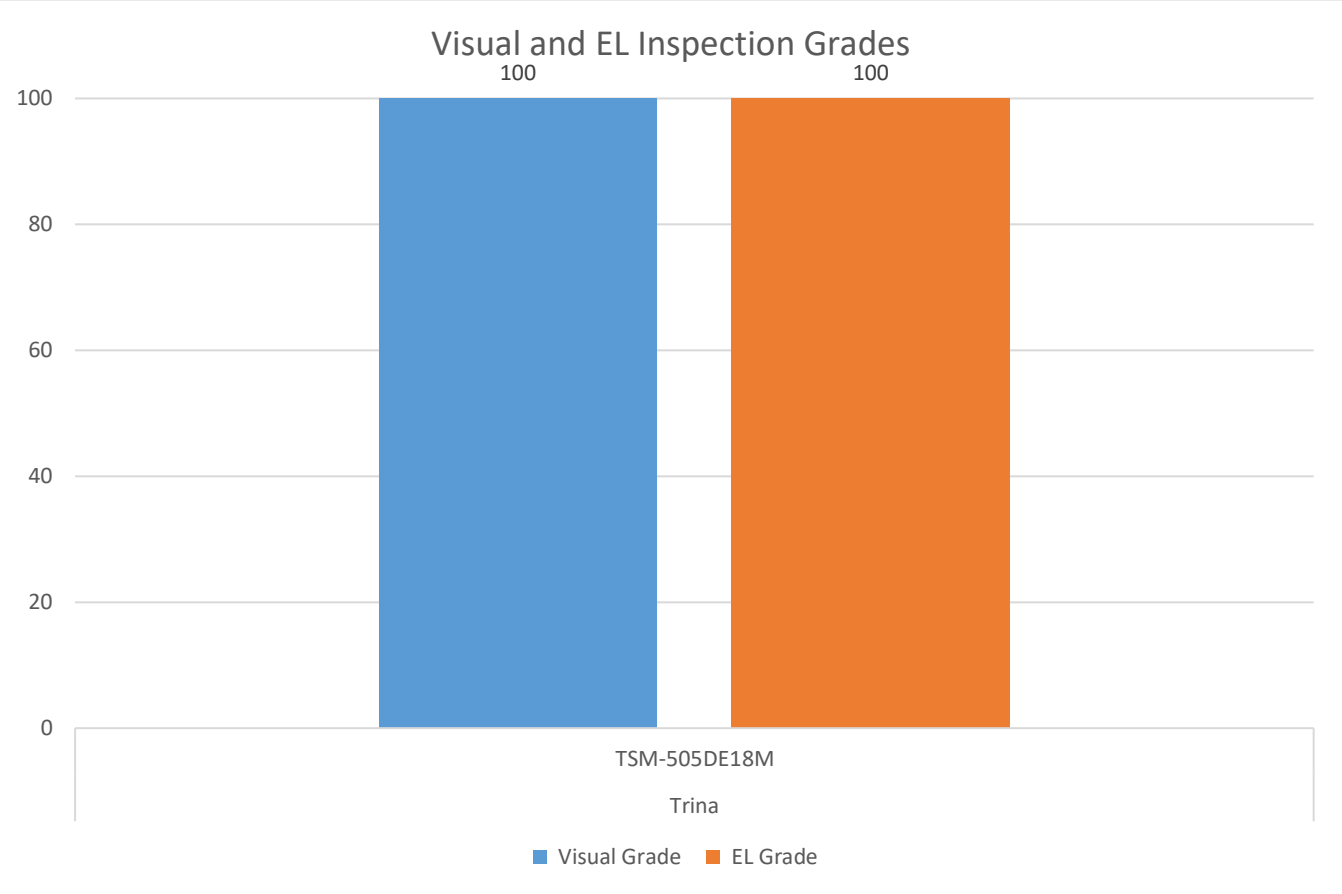


Figure 2 Visual and EL inspection results

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

Table 8 Low irradiance test results

TSM-505DE18M	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Front side low irradiance efficiency loss (%)	5.66%					54

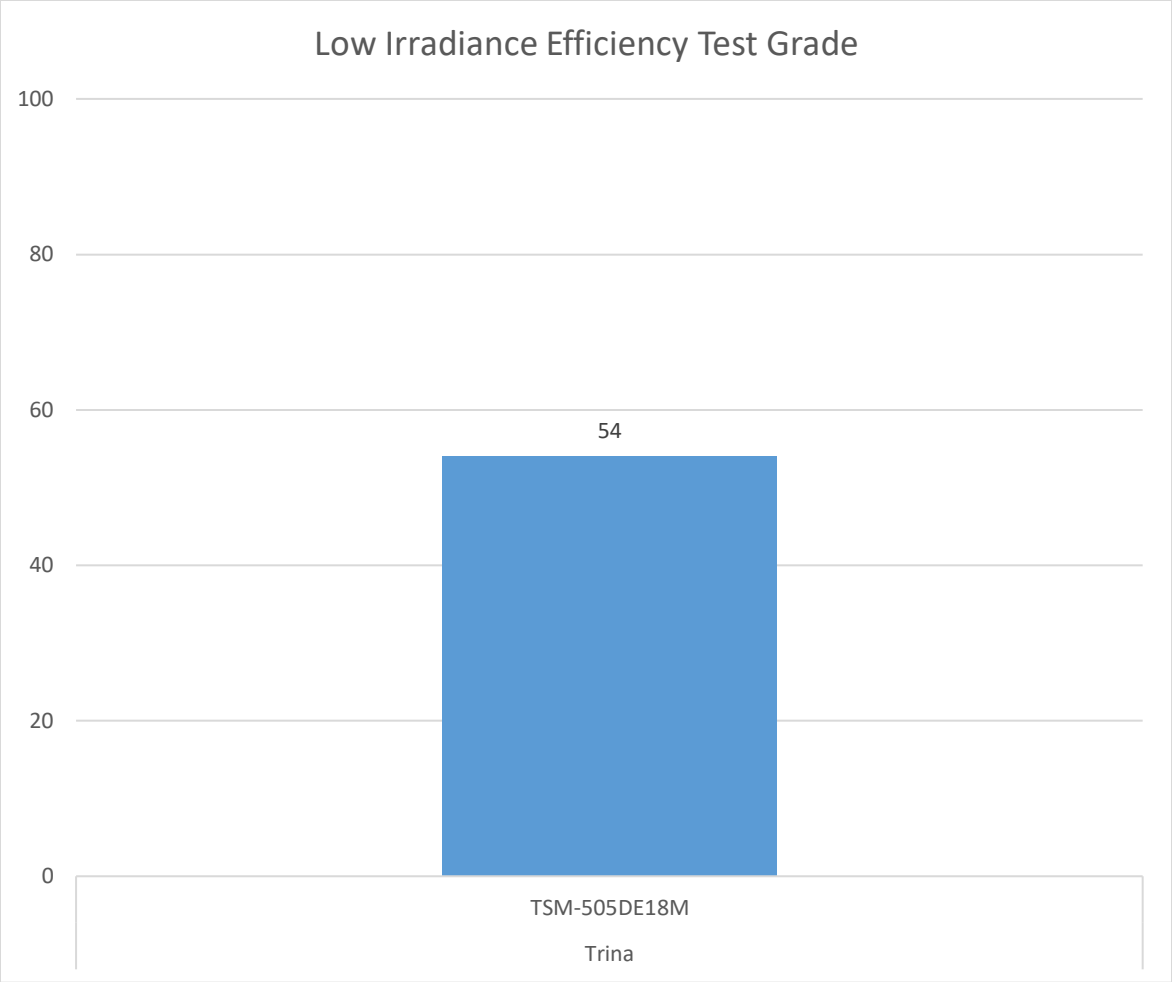


Figure 3 Low irradiance test result

3.4. Pmax temperature coefficient test

Table 9 and Figure 4 depict the Pmax temperature coefficient test results.

Table 9 Pmax temperature coefficient test result

TSM-505DE18M	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Pmax Temperature coefficient (%/°C)	-0.34%					91

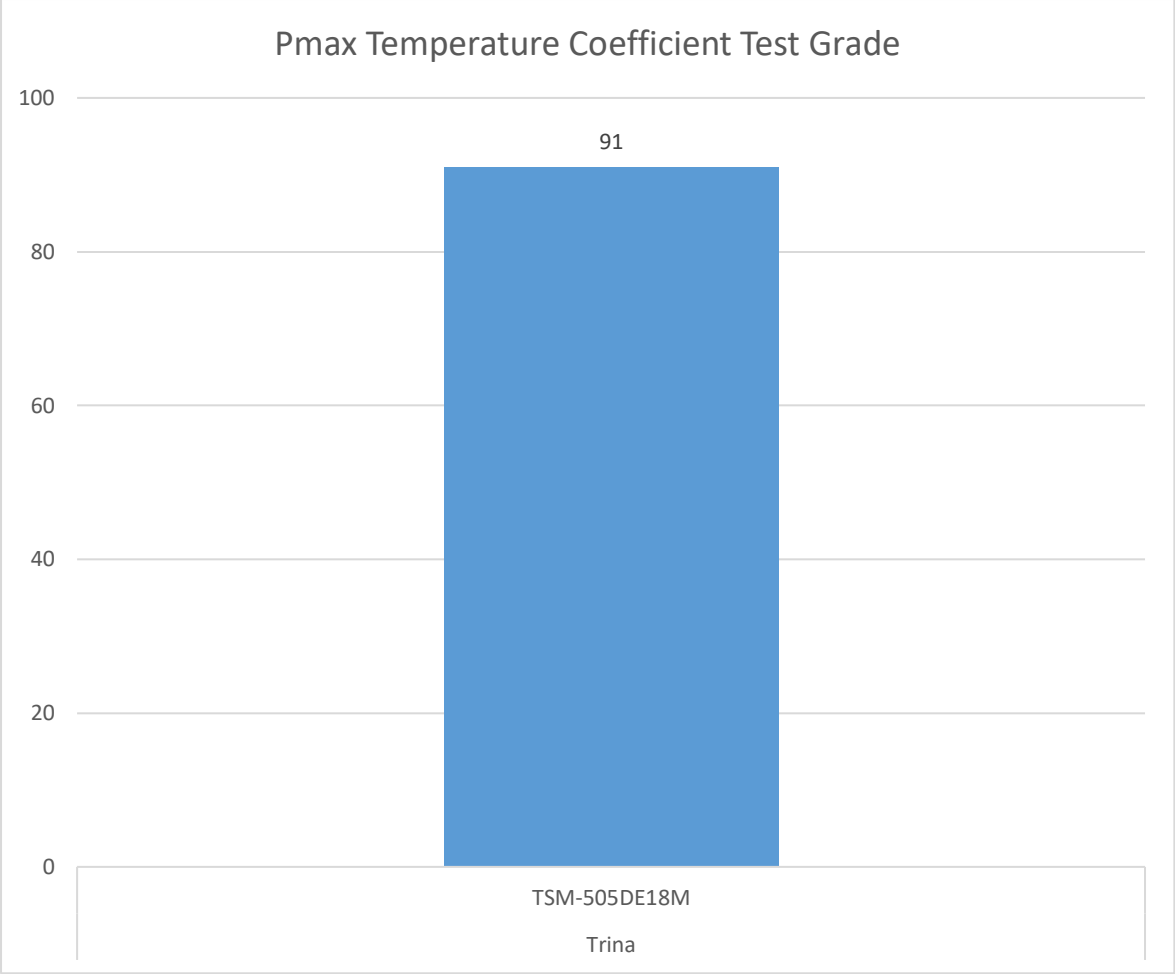


Figure 4 Pmax temperature coefficient test result

3.5. PID loss test

Table 10 and Figure 5 depicts the PID loss test results for the front side at **1500 V**:

Table 10 PID loss test result

TSM-505DE18M	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Front side PID loss (%)					-0.01%	100

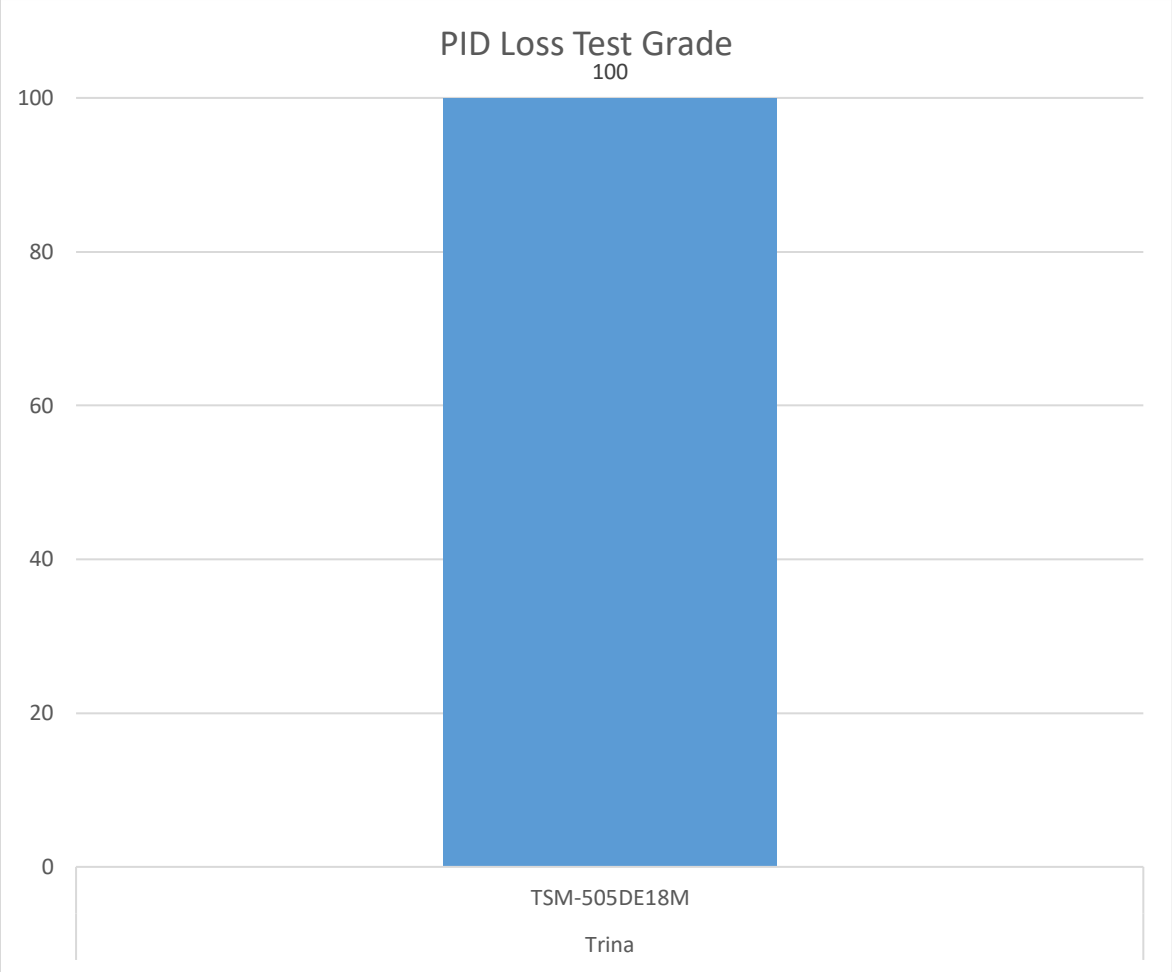


Figure 5 PID loss test result

3.6. LeTID loss test

Table 101 and Figure 5 depicts the LeTID loss test results:

Table 11 LeTID loss test result

TSM-505DE18M	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Front side LeTID loss (%)	-0.024%					100

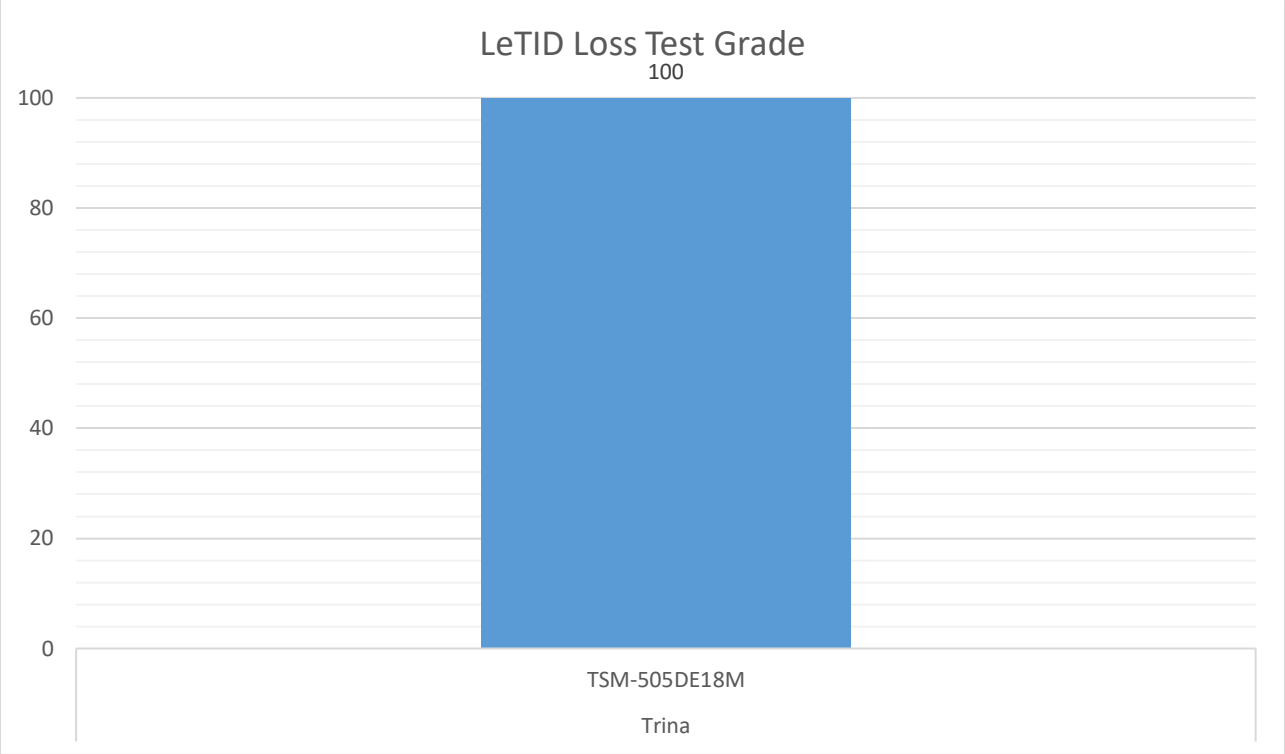


Figure 6 LeTID loss test result

3.7. Score overview

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

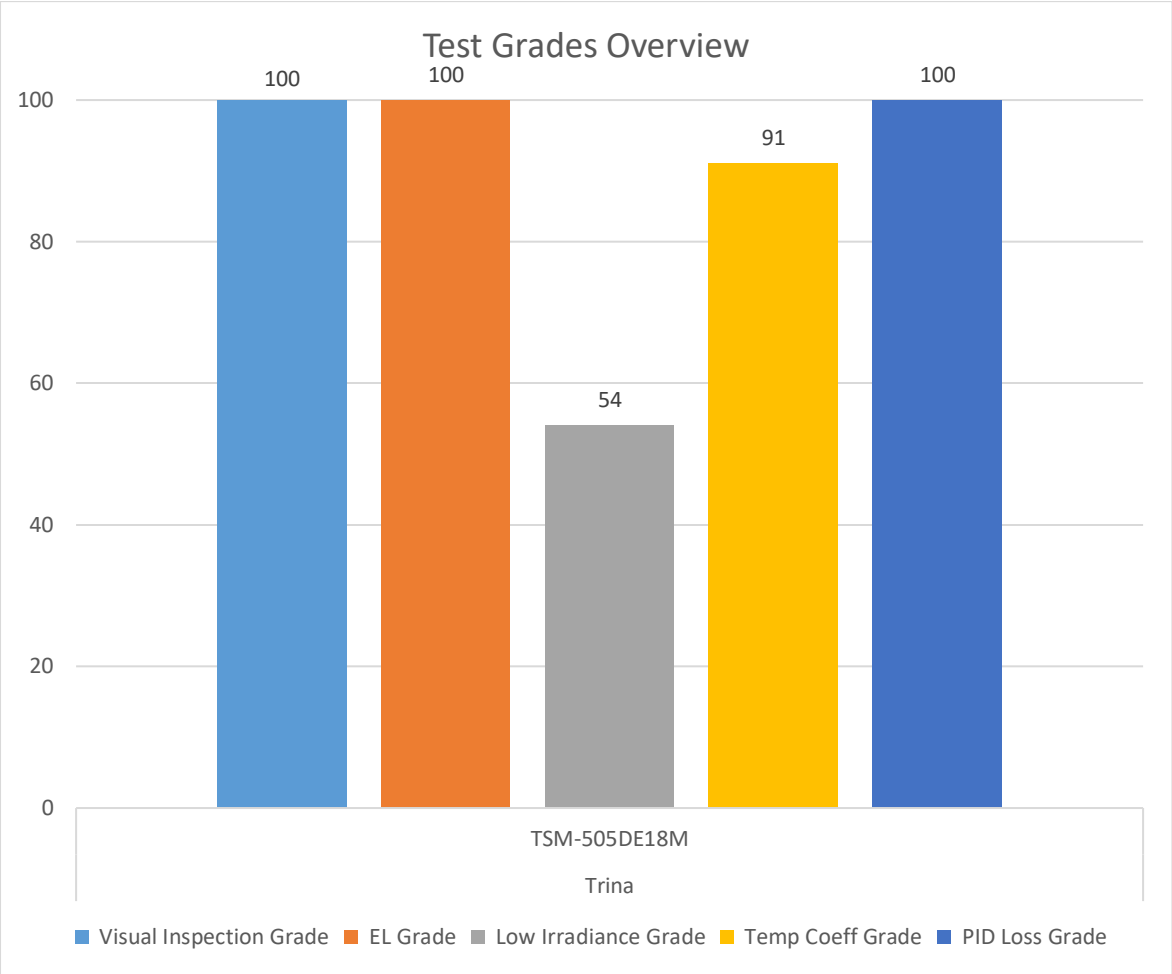


Figure 7 Test results overview

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

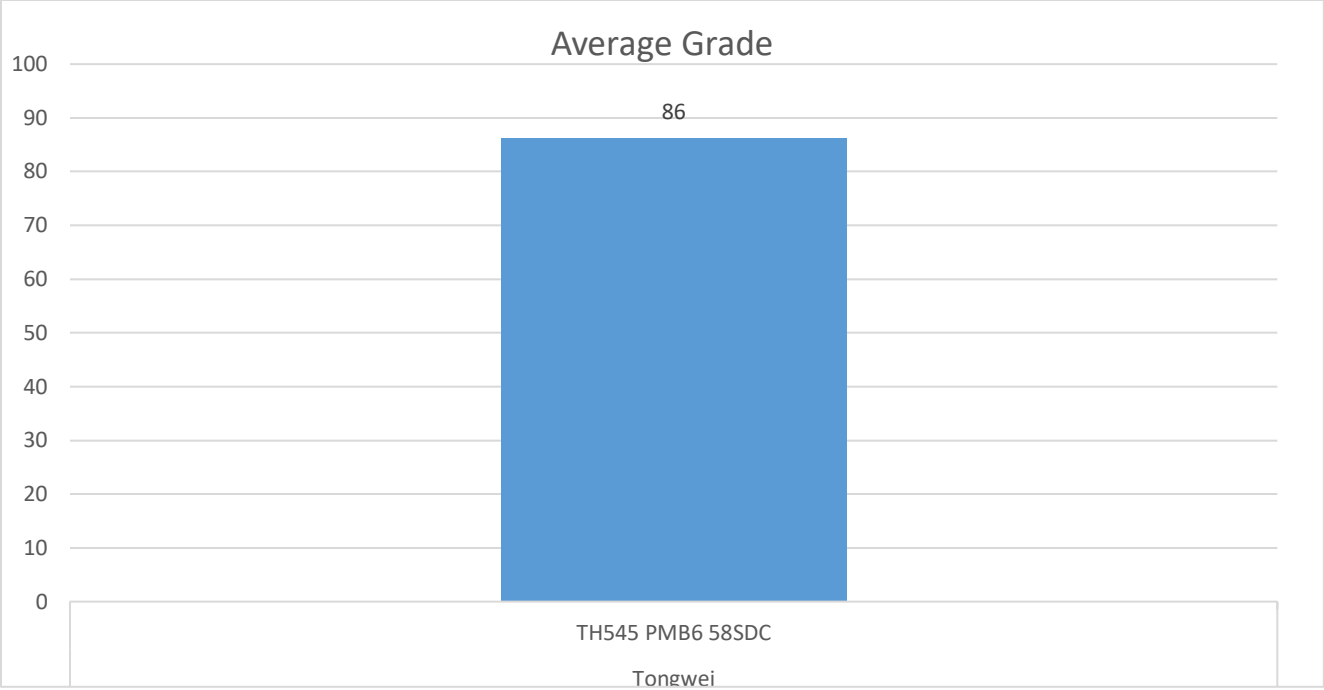


Figure 8 Average test grade

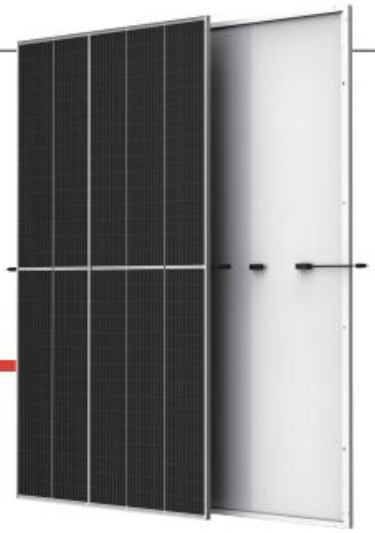
Appendix 1 – TSM-505DE18M Datasheet

Mono Multi Solutions

THE

Vertex

BACKSHEET MONOCRYSTALLINE MODULE



515W
MAXIMUM POWER OUTPUT

21.4%
MAXIMUM EFFICIENCY

0~+5W
POSITIVE POWER TOLERANCE

PRODUCTS	POWER RANGE
TSM-DE18M(II)	490-515W

High customer value
- Lower LCOE (Levelized Cost Of Energy), reduced BOS (Balance Of System) cost, shorter payback time
- Lower guaranteed first year and annual degradation
- Designed for compatibility with existing mainstream system components
- Higher return on Investment

High power up to 515W
- Large area cells based on 210mm silicon wafers and 1/3-cut cell technology
- Up to 21.4% module efficiency with high density interconnect technology
- Multi-busbar technology for better light trapping effect, lower series resistance and improved current collection

High reliability
- Minimized micro-cracks with innovative non-destructive cutting technology
- Ensured PID resistance through cell process and module material control
- Resistant to harsh environments such as salt, ammonia, sand, high temperature and high humidity areas
- Mechanical performance up to 5400 Pa positive load and 2400 Pa negative load

High energy yield
- Excellent IAM (Incident Angle Modifier) and low irradiation performance, validated by 3rd party certifications
- The unique design provides optimized energy production under inter-row shading conditions

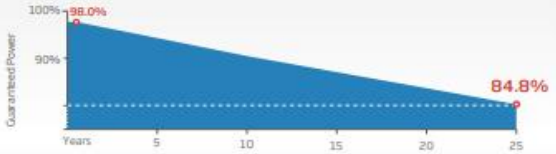
Founded in 1997, Trina Solar is the world's leading total solution provider for solar energy. With local presence around the globe, Trina Solar is able to provide exceptional service to each customer in each market and deliver our innovative, reliable products with the backing of Trina as a strong, bankable brand. Trina Solar now distributes its PV products to over 100 countries all over the world. We are committed to building strategic, mutually beneficial collaborations with installers, developers, distributors and other partners in driving smart energy together.

Comprehensive Products and System Certificates

IEC61215/IEC61730/IEC61701/IEC62716/UL61730
ISO 9001: Quality Management System
ISO 14001: Environmental Management System
ISO14064: Greenhouse Gases Emissions Verification
ISO45001: Occupational Health and Safety Management System

Trinasolar

Trina Solar's Vertex Backsheet Performance Warranty



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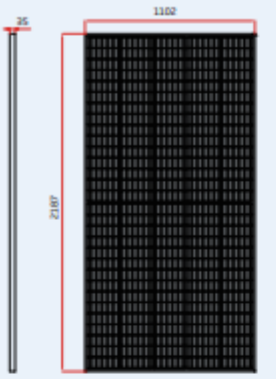
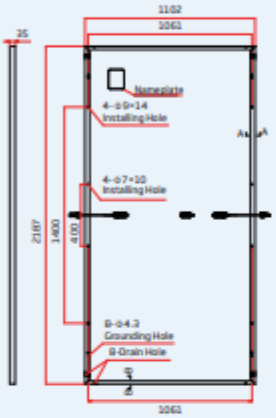
Vertex

BACKSHEET MONOCRYSTALLINE MODULE

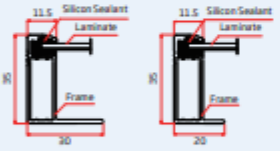
DIMENSIONS OF PV MODULE(mm)



Front View

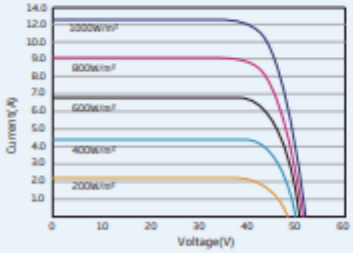


Back View

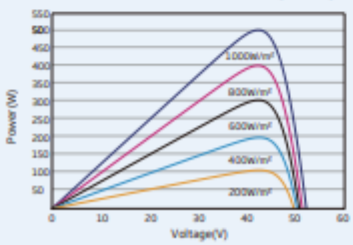


A-A B-B

I-V CURVES OF PV MODULE(500 W)



P-V CURVES OF PV MODULE(500W)



ELECTRICAL DATA (STC)

Peak Power Watts-P_{MAX} (Wp)*	490	495	500	505	510	515
Power Tolerance-P_{MAX} (W)	0 ~ +5					
Maximum Power Voltage-V_{MPP} (V)	42.4	42.6	42.8	43.0	43.2	43.4
Maximum Power Current-I_{MPP} (A)	11.56	11.63	11.69	11.75	11.81	11.87
Open Circuit Voltage-V_{OC} (V)	51.3	51.5	51.7	51.9	52.1	52.3
Short Circuit Current-I_{SC} (A)	12.14	12.21	12.28	12.35	12.42	12.49
Module Efficiency η_m (%)	20.3	20.5	20.7	21.0	21.2	21.4

STC: Irradiance 1000W/m², Cell Temperature 25°C, Air Mass AM1.5.
*Measuring tolerance: ±3%.

ELECTRICAL DATA (NOCT)

Maximum Power-P_{MAX} (Wp)	369	373	377	381	385	388
Maximum Power Voltage-V_{MPP} (V)	40.0	40.2	40.4	40.6	40.5	40.7
Maximum Power Current-I_{MPP} (A)	9.22	9.28	9.33	9.38	9.50	9.53
Open Circuit Voltage-V_{OC} (V)	48.2	48.4	48.6	48.8	49.0	49.2
Short Circuit Current-I_{SC} (A)	9.78	9.84	9.90	9.95	10.01	10.06

NOCT: Irradiance at 800W/m², Ambient Temperature 20°C, Wind Speed 1m/s.

MECHANICAL DATA

Solar Cells	Monocrystalline
Cell Orientation	150 cells
Module Dimensions	2187×1102×35 mm (86.10×43.39×1.38 inches)
Weight	26.3 kg (58.0 lb)
Glass	3.2 mm (0.13 inches), High Transmission, AR Coated Heat Strengthened Glass
Encapsulant Material	EVA
Backsheet	White
Frame	35 mm (1.38 inches) Anodized Aluminium Alloy
J-Box	IP 68 rated
Cables	Photovoltaic Technology Cable 4.0mm² (0.006 inches²), Portrait: N 280mm/P 280mm(11.02/11.02inches) Length can be customized
Connector	MC4 EVO2 / TS4*

*Please refer to regional datasheet for specified connector.

TEMPERATURE RATINGS

NOCT(Nominal Operating Cell Temperature)	43°C (±2°C)
Temperature Coefficient of P_{MAX}	- 0.34%/°C
Temperature Coefficient of V_{OC}	- 0.25%/°C
Temperature Coefficient of I_{SC}	0.04%/°C

MAXIMUMRATINGS

Operational Temperature	-40~+85°C
Maximum System Voltage	1500V DC (IEC)
	1500V DC (UL)
Max Series Fuse Rating	20A

WARRANTY

- 12 year Product Workmanship Warranty
- 25 year Power Warranty
- 2% first year degradation
- 0.55% Annual Power Attenuation

(Please refer to product warranty for details)

PACKAGING CONFIGUREATION

- Modules per box: 31 pieces
- Modules per 40' container: 620 pieces

Trinasolar

CAUTION: READ SAFETY AND INSTALLATION INSTRUCTIONS BEFORE USING THE PRODUCT.