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Test Report

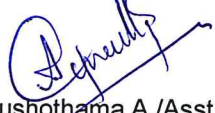
Photovoltaic module Testing

TÜV Report No. 19631329.001

Bangalore, April 2017



Certificate No. T-1543

Test report no.: <i>Prüfbericht - Nr.:</i>	19631329.001		
Client (Customer no. and address): <i>Auftraggeber</i> <i>(Kunden-Nr. u. Adresse):</i>	410949 Renewsys India Pvt Ltd. Division: Hyderabad Fab City (SEZ), Plot No.6, #114/P, Srinagar Village, Maheswaram Mandal, Rangareddy 501359 INDIA		
Test item: <i>Gegenstand der Prüfung:</i>	Photovoltaic (PV) Module(s)	Date of receipt: <i>Eingangsdatum:</i>	09-02-2017
Module type designation: <i>Modultypen-Bezeichnung:</i>	DESERVE 3M6-320		
Order no.: <i>Auftragsnummer:</i>	1803202861		
Testing location: <i>Prüfart:</i>	TUV Rheinland(India) Pvt.Ltd Plot No.17B,Electronic city, Phase II, Industrial Area,Begur Hobli, Bangalore(south)-560 100,India Tel: +91 80 3923 4301		
Test specification: <i>Prüfgrundlage:</i>	IEC 61853-1:2011 <i>Photovoltaic (PV) module performance testing and energy rating.</i> <i>Part 1: Irradiance and temperature performance measurements and power rating</i>		
Test result: <i>Prüfergebnis:</i>	Results enclosed		
compiled by / erstellt:		reviewed by / kontrolliert:	
 21-04-2017 Purushothama A./Asst. Manager		 21-04-2017 Kamalaksha C.S./Asst. General Manager	
Date <i>Datum</i>	Title/Name <i>Titel/Name</i>	Date <i>Datum</i>	Title/Name <i>Titel/Name</i>
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Address/es of the manufacturing site/s:

Name / Description:	Renewsys India Pvt Ltd. Division: Hyderabad
Street:	Fab City (SEZ), Plot No.6, #114/P, Srinagar Village,
Postcode / City:	Maheswaram Mandal, Rangareddy 501359
Country:	India
Type of production:	Solar Photovoltaic Modules
Inspection report no:	NA

Summary of testing:

According to the inquiry of the customer, for testing as per IEC 61853-1, *Photovoltaic (PV) module performance testing and energy rating – Part 1: Irradiance and temperature performance measurements and power rating* on PV module type **DESERVE 3M6-320**, the results are incorporated in this report no: **19631329.001**. The above listed module type have passed all tests of the IEC 61215:2005 standard before testing as per IEC 61853-1.

Pass criteria:

1. The values of STC power measured after preconditioning fall within the power range specified by the manufacturer of this product. (results enclosed)
2. After generating the matrix of parameters, the modules are remeasured at STC to verify that the performance is stable. (results enclosed)

All presented results are only valid for the exact tested module type and design (cell type, encapsulation material, glass type)

Summary of test locations:

All tests were performed at TUV Rheinland (India) Pvt Ltd, Bangalore.

Summary of deviations from the standard:

- NA

General product information:

PV module type reference.....:	WS 315
Nominal maximum power ($P_{\max}$)	320 W 0/+ 4.99 W
Nominal open circuit voltage at (V_{oc})	45.82 V
Nominal short circuit current at (I_{sc})	9.06 A
Nominal maximum power voltage ($V_{\max}$)	37.20 V
Nominal maximum power current ($I_{\max}$).....:	8.61 A
<u>Product Safety Ratings</u>	-
Maximum system voltage.....:	1000 V

Test procedure:

- ☐ Random sampling from production
- ☒ Prototype submitted by client

Test performed with a solar simulator.

In order to minimize the errors related to translations/interpolations, we used the irradiance-specific temperature coefficients as per IEC 60891:2009, and the temperature and irradiance conditions during the tests were maintained very close (within ± 1 °C and 10 W/m^2) to the reporting conditions of 15, 25, NOCT, 50 and 75 °C and 100, 200, 400, 500, 600, 800, 1000, and 1100 W/m^2 .

The linearity of the module and test setup meets the requirements as per IEC 60904-10

Description of similarity (differences) between the applied model and the previously tested model: NA

Table 1: Module group assignment

Sample no.	Client serial number
1803202861-25	RI000005171245273
1803202861-26	RI000005171243753
1803202861-27	RI000005171243752
1803202861-28	RI000005171245274

Table 2: Constructional characteristics

Components	Model/Type	Manufacturer
Junction Box	ZH009-1	Zhejiang Zhonghuan Sunter PV Technology PV
JB Sealant	HT906Z	Huitian
Frame Sealant	HT906Z	Huitian
Frame	Al alloy 6063 , 40mmX35mm ;Silver Anodizing of 15-18µm (For 72X)	Global Aluminium
EVA (FRONT)	Conserv A 360.2 14 FC	Renewsys
EVA (BACK)	Conserv A 360.2 14 FC	Renewsys
Backsheet	Preserv 1- 190WD	Renewsys
Glass	CSG	1950 x 983 x 3.2mm; Low Iron Tempered ARC glass
TCI	Dimensions: 1.2 mmx 0.18mm including Sn/Pb-60/40 coating thickness:20 ± 5 µm	Bruker
Bus bar	Dimensions: 6 mmx 0.4mm including Sn/Pb-60/40 coating thickness:20 ± 5 µm	Bruker
Flux	952 S	Kester
Cell	RESERV 624 4BB 156 x 156 Multi	Renewsys

Table 3: Marking requirements

Parameters	Verdict
Name, monogram or symbol of the manufacturer	P
Type or model number	P
Serial number	P
Polarity of terminals or leads (colour coding is permissible)	P
Nominal and minimum values of maximum output power at STC after preconditioning, as specified by the manufacturer for the product type (see Clause 5).	P
The date and place of manufacture shall be marked on the module or be traceable from the serial number.	P
Supplementary information: None	

Table 4: Visual inspection

Test date [DD/MM/YYYY]	03-04-2017	—
Sample no.	Nature and position of initial findings	—
1803202861-25	No major visual defects found	P
1803202861-26	No major visual defects found	P
1803202861-27	No major visual defects found	P
1803202861-28	No major visual defects found	P
Supplementary information: Visual inspection performed as per IEC 61215 clause 7		

Table 5: Maximum power determination after preconditioning

Test date [DD/MM/YYYY]:	25-02-2017									
Module temperature [°C] .	Corrected to 25									
Irradiance [W/m²]:	1000									
Sample no.	P _{max} [W]	V _{max} [V]	I _{max} [A]	V _{oc} [V]	I _{sc} [A]	FF [%]	M.efficacy in [%]	C.efficacy in [%]	Rsh in ohms	Rs in ohms
1803202861-25	321.63	38.13	8.434	45.84	8.956	78.34	16.66	18.36	616.395	0.463
1803202861-26	320.98	38.26	8.389	45.88	8.918	78.45	16.63	18.32	680.629	0.482
1803202861-27	322.04	37.96	8.483	45.89	8.924	78.65	16.68	18.38	614.608	0.467
1803202861-28	320.47	37.88	8.46	45.75	8.948	78.27	16.60	18.29	419.946	0.49
Supplementary information: Preconditioning done as per IEC 61215 clause 5										

Table 6: Comparison of measured power with name plate of the module after preconditioning

Test date [DD/MM/YYYY]:...	25-02-2017		
Sample no.	Power measured at STC after preconditioning in [W]	Power on name plate	-
1803202861-25	321.63	320 W 0/+ 4.99 W	P
1803202861-26	320.98		P
1803202861-27	322.04		P
1803202861-28	320.47		P
Supplementary information: None			

Table 7: Averaging of three test modules

Irrad [W/m ²]	Temp. [°C]	Sample no.	P _{max} [W]	V _{max} [V]	I _{max} [A]	V _{oc} [V]	I _{sc} [A]	FF [%]	M.Eff [%]	C.Eff [%]
1100	75	1803202861-26	278.7	29.72	9.377	38.72	10.135	71.01	13.12	14.46
		1803202861-27	279.52	30.26	9.239	38.95	10.069	71.27	13.16	14.50
		1803202861-28	280.23	30.27	9.259	38.93	10.111	71.20	13.20	14.54
		Average	279.48	30.08	9.292	38.87	10.105	71.16	13.16	14.50
	50	1803202861-26	314.64	33.65	9.35	42.46	9.966	74.35	14.82	16.32
		1803202861-27	316.17	33.77	9.362	42.48	9.941	74.87	14.89	16.40
		1803202861-28	315.38	33.69	9.362	42.49	9.958	74.54	14.85	16.36
		Average	315.40	33.70	9.358	42.48	9.955	74.59	14.85	16.36
	25	1803202861-26	349.93	37.36	9.365	45.86	9.841	77.54	16.48	18.16
		1803202861-27	349.31	37.64	9.281	45.84	9.811	77.67	16.45	18.12
		1803202861-28	352.31	37.43	9.412	45.91	9.854	77.87	16.59	18.28
		Average	350.52	37.48	9.353	45.87	9.835	77.69	16.51	18.19
1000	75	1803202861-26	254.07	29.85	8.512	38.6	9.225	71.35	13.16	14.50
		1803202861-27	254.92	29.9	8.525	38.82	9.165	71.65	13.20	14.55
		1803202861-28	255.73	29.99	8.528	38.89	9.158	71.81	13.25	14.60
		Average	254.91	29.91	8.522	38.77	9.183	71.60	13.20	14.55
	50	1803202861-26	286.62	33.94	8.446	42.39	9.055	74.68	14.85	16.36
		1803202861-27	287.62	33.94	8.475	42.31	9.05	75.11	14.90	16.41
		1803202861-28	288.42	33.95	8.495	42.31	9.083	75.06	14.94	16.46
		Average	287.55	33.94	8.472	42.34	9.063	74.95	14.90	16.41
	25	1803202861-26	320.98	38.26	8.389	45.88	8.918	78.45	16.63	18.32
		1803202861-27	322.04	37.96	8.483	45.89	8.924	78.65	16.68	18.38
		1803202861-28	320.47	37.88	8.46	45.75	8.948	78.27	16.60	18.29
		Average	321.16	38.03	8.444	45.84	8.930	78.46	16.64	18.33
	15	1803202861-26	331.81	39.32	8.439	47.33	8.919	78.61	17.19	18.94
		1803202861-27	330.54	39.36	8.399	47.22	8.904	78.63	17.12	18.86
		1803202861-28	332.30	39.05	8.511	47.22	8.964	78.51	17.21	18.96
		Average	331.55	39.24	8.450	47.26	8.929	78.58	17.17	18.92

Table 7: Averaging of three test modules (continued)

Irrad [W/m ²]	Temp. [°C]	Sample no.	P _{max} [W]	V _{max} [V]	I _{max} [A]	V _{oc} [V]	I _{sc} [A]	FF [%]	M.Eff [%]	C.Eff [%]
800	75	1803202861-26	203.48	29.87	6.812	38.1	7.391	72.26	13.18	14.52
		1803202861-27	203.10	29.76	6.825	38.04	7.373	72.42	13.15	14.49
		1803202861-28	204.93	29.76	6.886	38.03	7.428	72.55	13.27	14.62
		Average	203.84	29.80	6.841	38.06	7.397	72.41	13.20	14.54
	50	1803202861-26	230.53	33.79	6.822	41.96	7.262	75.66	14.93	16.45
		1803202861-27	228.28	33.8	6.755	41.61	7.248	75.69	14.78	16.29
		1803202861-28	231.03	34.08	6.779	41.89	7.263	75.93	14.96	16.48
		Average	229.95	33.89	6.785	41.82	7.258	75.76	14.89	16.41
	45	1803202861-26	236.03	34.61	6.819	42.63	7.29	75.95	15.28	16.84
		1803202861-27	234.42	34.22	6.850	42.52	7.285	75.67	15.18	16.72
		1803202861-28	235.94	34.63	6.813	42.57	7.308	75.84	15.28	16.83
		Average	235.46	34.49	6.827	42.57	7.294	75.82	15.25	16.80
	25	1803202861-26	256.74	37.79	6.795	45.38	7.202	78.56	16.62	18.32
		1803202861-27	255.66	37.57	6.804	45.31	7.164	78.76	16.55	18.24
		1803202861-28	257.85	37.62	6.853	45.37	7.209	78.83	16.70	18.39
		Average	256.75	37.66	6.817	45.35	7.192	78.72	16.62	18.32
	15	1803202861-26	266.11	39.24	6.782	46.94	7.156	79.22	17.23	18.98
		1803202861-27	265.32	38.94	6.814	46.89	7.133	79.34	17.18	18.93
		1803202861-28	267.05	38.92	6.862	46.85	7.204	79.12	17.29	19.05
		Average	266.16	39.03	6.819	46.89	7.164	79.23	17.23	18.99
600	75	1803202861-26	152.16	29.53	5.152	37.40	5.549	73.33	13.14	14.47
		1803202861-27	152.61	29.63	5.151	37.38	5.553	73.52	13.17	14.52
		1803202861-28	152.98	29.64	5.161	37.37	5.579	73.38	13.21	14.55
		Average	152.58	29.60	5.155	37.38	5.560	73.41	13.17	14.51
	50	1803202861-26	172.54	33.1	5.213	41.14	5.509	76.13	14.896	16.412
		1803202861-27	170.20	33.49	5.082	40.97	5.437	76.41	14.69	16.19
		1803202861-28	172.83	33.70	5.129	41.43	5.448	76.57	14.92	16.44
		Average	171.86	33.43	5.141	41.18	5.465	76.37	14.84	16.35
	25	1803202861-26	192.55	37.47	5.139	44.76	5.411	79.49	16.62	18.31
		1803202861-27	191.85	37.48	5.118	44.74	5.389	79.57	16.56	18.25
		1803202861-28	192.74	37.53	5.135	44.80	5.422	79.35	16.64	18.33
		Average	192.38	37.49	5.131	44.77	5.407	79.47	16.61	18.30
	15	1803202861-26	198.99	39.11	5.088	46.32	5.375	79.94	17.18	18.93
		1803202861-27	198.73	38.90	5.109	46.24	5.371	80.01	17.16	18.90
		1803202861-28	199.25	38.69	5.150	46.31	5.387	79.88	17.20	18.95
		Average	198.99	38.90	5.116	46.29	5.378	79.94	17.18	18.93

Table 7: Averaging of three test modules (continued)

Irrad [W/m ²]	Temp. [°C]	Sample no.	P _{max} [W]	V _{max} [V]	I _{max} [A]	V _{oc} [V]	I _{sc} [A]	FF [%]	M.Eff [%]	C.Eff [%]
500	15	1803202861-26	164.72	38.51	4.277	45.95	4.465	80.29	17.06	18.80
		1803202861-27	164.42	38.91	4.226	45.93	4.45	80.44	17.03	18.77
		1803202861-28	164.88	38.93	4.235	45.9	4.479	80.19	17.08	18.82
		Average	164.67	38.78	4.246	45.93	4.465	80.31	17.06	18.80
400	50	1803202861-26	112.60	33.10	3.401	40.35	3.612	77.27	14.58	16.07
		1803202861-27	113.09	32.91	3.436	40.31	3.606	77.79	14.64	16.14
		1803202861-28	113.10	33.32	3.394	40.36	3.618	77.45	14.65	16.14
		Average	112.93	33.11	3.410	40.34	3.612	77.50	14.62	16.12
	25	1803202861-26	126.46	37.3	3.391	43.89	3.583	80.43	16.38	18.04
		1803202861-27	125.87	36.96	3.406	43.86	3.574	80.30	16.30	17.96
		1803202861-28	126.83	37.35	3.396	43.94	3.596	80.26	16.42	18.1
		Average	126.39	37.20	3.398	43.90	3.584	80.33	16.37	18.03
	15	1803202861-26	131.39	38.79	3.387	45.48	3.58	80.70	17.01	18.75
		1803202861-27	131.37	38.53	3.41	45.48	3.571	80.88	17.01	18.74
		1803202861-28	131.71	38.43	3.427	45.46	3.593	80.62	17.06	18.79
		Average	131.49	38.58	3.408	45.47	3.581	80.73	17.03	18.76
200	25	1803202861-26	61.82	36.23	1.706	42.44	1.809	80.50	16.01	17.64
		1803202861-27	61.77	36.12	1.71	42.47	1.796	81.00	16.00	17.63
		1803202861-28	61.99	36.39	1.704	42.54	1.81	80.49	16.05	17.69
		Average	61.86	36.25	1.707	42.48	1.805	80.66	16.02	17.65
	15	1803202861-26	64.68	38.1	1.698	44.16	1.806	81.10	16.75	18.46
		1803202861-27	64.62	37.55	1.721	44.1	1.802	81.32	16.74	18.44
		1803202861-28	64.59	37.69	1.714	44.03	1.811	81.01	16.73	18.43
		Average	64.63	37.78	1.711	44.10	1.806	81.14	16.74	18.44
100	25	1803202861-26	30.08	35.41	0.849	41.03	0.918	79.82	15.58	17.17
		1803202861-27	30.15	35.39	0.852	41.03	0.913	80.49	15.61	17.20
		1803202861-28	30.17	35.19	0.858	41.08	0.918	79.97	15.63	17.22
		Average	30.13	35.33	0.853	41.05	0.916	80.09	15.61	17.20
	15	1803202861-26	31.77	36.38	0.873	42.75	0.92	80.79	16.46	18.13
		1803202861-27	31.66	36.61	0.865	42.73	0.917	80.83	16.4	18.07
		1803202861-28	31.55	36.59	0.862	42.61	0.922	80.32	16.34	18.00
		Average	31.66	36.53	0.867	42.70	0.920	80.65	16.40	18.07

Tables 8: Test matrix of module performance with respect to temperature and irradiance**Table 8.1: $P_{\max}$ [W] versus irradiance and temperature**

Irradiance	Spectrum	Module temperature				
		15 °C	25 °C	NOCT °C	50 °C	75 °C
1100 W/m ²	AM 1.5	NA	350.52	NA	315.40	279.48
1000 W/m ²	AM 1.5	331.55	321.16	NA	287.55	254.91
800 W/m ²	AM 1.5	266.16	256.75	235.46	229.95	203.84
600 W/m ²	AM 1.5	198.99	192.38	NA	171.86	152.58
500 W/m ²	AM 1.5	164.67	NA	NA	NA	NA
400 W/m ²	AM 1.5	131.49	126.39	NA	112.93	NA
200 W/m ²	AM 1.5	64.63	61.86	NA	NA	NA
100 W/m ²	AM 1.5	31.66	30.13	NA	NA	NA

Table 8.2: I_{sc} [A] versus irradiance and temperature

Irradiance	Spectrum	Module temperature				
		15 °C	25 °C	NOCT °C	50 °C	75 °C
1100 W/m ²	AM 1.5	NA	9.835	NA	9.955	10.105
1000 W/m ²	AM 1.5	8.929	8.930	NA	9.063	9.183
800 W/m ²	AM 1.5	7.164	7.192	7.294	7.258	7.397
600 W/m ²	AM 1.5	5.378	5.407	NA	5.465	5.560
500 W/m ²	AM 1.5	4.465	NA	NA	NA	NA
400 W/m ²	AM 1.5	3.581	3.584	NA	3.612	NA
200 W/m ²	AM 1.5	1.806	1.805	NA	NA	NA
100 W/m ²	AM 1.5	0.920	0.916	NA	NA	NA

Table 8.3: V_{oc} [V] versus irradiance and temperature

Irradiance	Spectrum	Module temperature				
		15 °C	25 °C	NOCT °C	50 °C	75 °C
1100 W/m ²	AM 1.5	NA	45.87	NA	42.48	38.87
1000 W/m ²	AM 1.5	47.26	45.84	NA	42.34	38.77
800 W/m ²	AM 1.5	46.89	45.35	42.57	41.82	38.06
600 W/m ²	AM 1.5	46.29	44.77	NA	41.18	37.38
500 W/m ²	AM 1.5	45.93	NA	NA	NA	NA
400 W/m ²	AM 1.5	45.47	43.90	NA	40.34	NA
200 W/m ²	AM 1.5	44.10	42.48	NA	NA	NA
100 W/m ²	AM 1.5	42.70	41.05	NA	NA	NA

Table 8.4: $V_{\max}$ [V] versus irradiance and temperature

Irradiance	Spectrum	Module temperature				
		15 °C	25 °C	NOCT °C	50 °C	75 °C
1100 W/m ²	AM 1.5	NA	37.48	NA	33.70	30.08
1000 W/m ²	AM 1.5	39.24	38.03	NA	33.94	29.91
800 W/m ²	AM 1.5	39.03	37.66	34.49	33.89	29.80
600 W/m ²	AM 1.5	38.90	37.49	NA	33.43	29.60
500 W/m ²	AM 1.5	38.78	NA	NA	NA	NA
400 W/m ²	AM 1.5	38.58	37.20	NA	33.11	NA
200 W/m ²	AM 1.5	37.78	36.25	NA	NA	NA
100 W/m ²	AM 1.5	36.53	35.33	NA	NA	NA

Table 8.5: $I_{\max}$ [A] versus irradiance and temperature

Irradiance	Spectrum	Module temperature				
		15 °C	25 °C	NOCT °C	50 °C	75 °C
1100 W/m ²	AM 1.5	NA	9.353	NA	9.358	9.292
1000 W/m ²	AM 1.5	8.450	8.444	NA	8.472	8.522
800 W/m ²	AM 1.5	6.819	6.817	6.827	6.785	6.841
600 W/m ²	AM 1.5	5.116	5.131	NA	5.141	5.155
500 W/m ²	AM 1.5	4.246	NA	NA	NA	NA
400 W/m ²	AM 1.5	3.408	3.398	NA	3.410	NA
200 W/m ²	AM 1.5	1.711	1.707	NA	NA	NA
100 W/m ²	AM 1.5	0.867	0.853	NA	NA	NA

Table 9: Summary of reference power conditions (at AM 1,5)

Irrad [W/m ²]	Temp. [°C]	$P_{\max}$ [W]	$V_{\max}$ [V]	$I_{\max}$ [A]	V_{oc} [V]	I_{sc} [A]	FF [%]	M.Eff [%]	C.Eff [%]
1000	25	321.16	38.03	8.444	45.84	8.930	78.46	16.64	18.33
800	NOCT	235.46	34.49	6.827	42.57	7.294	75.82	15.25	16.80
200	25	61.86	36.25	1.707	42.48	1.805	80.66	16.02	17.65
1000	75	254.91	29.91	8.522	38.77	9.183	71.60	13.20	14.55
500	15	164.67	38.78	4.246	45.93	4.465	80.31	17.06	18.80

Table 10: Maximum power determination after matrix generation

Test date [DD/MM/YYYY]:		04-04-2017								
Module temperature [°C]:		Corrected to 25								
Irradiance [W/m²]:		1000								
Sample no.	P _{max} [W]	V _{max} [V]	I _{max} [A]	V _{oc} [V]	I _{sc} [A]	FF [%]	M.efficacy in [%]	C.efficacy in [%]	Rsh in ohms	Rs in ohms
1803202861-25	322.39	37.89	8.507	45.86	8.976	78.32	16.70	18.40	742.188	0.467
1803202861-26	320.77	37.81	8.485	45.82	8.923	78.47	16.62	18.31	678.733	0.469
1803202861-27	321.64	38.37	8.382	45.88	8.927	78.53	16.66	18.36	896.419	0.476
1803202861-28	321.53	38.17	8.423	45.82	8.957	78.34	16.65	18.35	430.578	0.480
Supplementary information: None										

Table 11: Comparison of measured power with name plate of the module after matrix generation

Test date [DD/MM/YYYY]:...	04-04-2017		
Sample no.	Power measured at STC after matrix in [W]	Power on name plate	-
1803202861-25	322.39	320 W 0/+ 4.99 W	P
1803202861-26	320.77		P
1803202861-27	321.64		P
1803202861-28	321.53		P
Supplementary information: None			

Table 12: Measurement of temperature coefficients

Test date [DD/MM/YYYY].....	04-04-2017		
Ambient air temperature [°C]	25 ± 2		
Irradiance [W/m²]	1000		
Module temperature [°C] high/low	65 / 25		
Sample No.	α [%/K]	β [%/K]	γ [%/K]
1803202861-26	0.0533%	-0.3109%	-0.4131%
1803202861-27	0.0659%	-0.3062%	-0.3999%
1803202861-28	0.0645%	-0.3167%	-0.4142%
Average	0.0612%	-0.3113%	-0.4091%
Supplementary information: None			

Annex 1: Measurement Curve

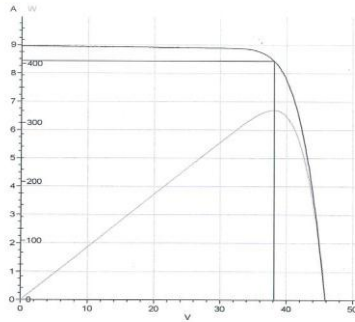
Measurement curve after preconditioning

1803202861-25

Performance measurement

PASAN SLAB Tester - STC + SM V2.4.4

22-02-17 03:07



Measurement Data (Temp. compensated results)

PASAN Tester version	2.4.4	Operator	1803202861-25@251000
Module ID Code	1245273	Serial number	071-2014
Standard temperature	25.0 °C	Monitor Cell	33.39 mV/(kW/m²)
Mean Irradiance	1.001 kW/m²	Calibration Value	25.7 °C
Module Temp.	25.3 °C	Mon. Cell Temp.	25.3 °C
Mask	NO-MASK 1.000 -	Cell Area	243.360 cm²
Module Area	19305.721 cm²	Cells in Parallel	1
Cells in Series	72	Measurement irradiance	1.000 kW/m²
Isc	8.958 A	Voc	45.835 V
Imp	8.434 A	Vmp	38.133 V
Pmax	321.626 W	Reference vlt 1	0.000 V
Reference vlt 2	0.000 V	Power ar ref 1	-1.000 W
Power ar ref 1	-1.000 W	Current at ref 1	0.000 A
Current at ref 2	0.000 A	Fill Factor	78.341 %
Cell Efficiency	18.356 %	Module Efficiency	16.660 %
Shunt res.	616.395 Ohm	Series res.	0.463 Ohm

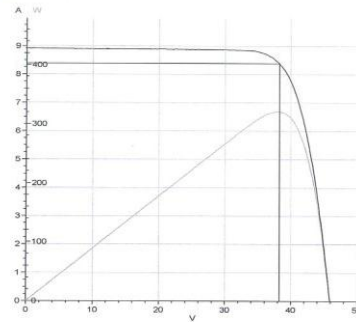

 22/2/17

1803202861-26

Performance measurement

PASAN SLAB Tester - STC + SM V2.4.4

22-02-17 02:50



Measurement Data (Temp. compensated results)

PASAN Tester version	2.4.4	Operator	1803202861-26@251000
Module ID Code	1243753	Serial number	071-2014
Standard temperature	25.0 °C	Monitor Cell	33.39 mV/(kW/m²)
Mean Irradiance	1.001 kW/m²	Calibration Value	25.2 °C
Module Temp.	25.2 °C	Mon. Cell Temp.	25.2 °C
Mask	NO-MASK 1.000 -	Cell Area	243.360 cm²
Module Area	19305.721 cm²	Cells in Parallel	1
Cells in Series	72	Measurement irradiance	1.000 kW/m²
Isc	8.918 A	Voc	45.878 V
Imp	8.386 A	Vmp	38.264 V
Pmax	320.980 W	Reference vlt 1	0.000 V
Reference vlt 2	0.000 V	Power ar ref 1	-1.000 W
Power ar ref 1	-1.000 W	Current at ref 1	0.000 A
Current at ref 2	0.000 A	Fill Factor	78.452 %
Cell Efficiency	18.319 %	Module Efficiency	16.626 %
Shunt res.	680.629 Ohm	Series res.	0.482 Ohm

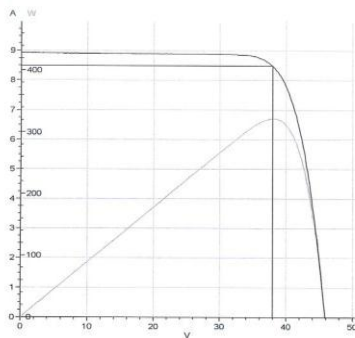

 22/2/17

1803202861-27

Performance measurement

PASAN SLAB Tester - STC + SM V2.4.4

22-02-17 03:15



Measurement Data (Temp. compensated results)

PASAN Tester version	2.4.4	Operator	1803202861-27@251000
Module ID Code	1243752	Serial number	071-2014
Standard temperature	25.0 °C	Monitor Cell	33.39 mV/(kW/m²)
Mean Irradiance	1.001 kW/m²	Calibration Value	25.7 °C
Module Temp.	25.7 °C	Mon. Cell Temp.	25.7 °C
Mask	NO-MASK 1.000 -	Cell Area	243.360 cm²
Module Area	19305.721 cm²	Cells in Parallel	1
Cells in Series	72	Measurement irradiance	1.000 kW/m²
Isc	8.924 A	Voc	45.885 V
Imp	8.463 A	Vmp	37.961 V
Pmax	322.041 W	Reference vlt 1	0.000 V
Reference vlt 2	0.000 V	Power ar ref 1	-1.000 W
Power ar ref 1	-1.000 W	Current at ref 1	0.000 A
Current at ref 2	0.000 A	Fill Factor	78.649 %
Cell Efficiency	18.379 %	Module Efficiency	16.681 %
Shunt res.	614.608 Ohm	Series res.	0.467 Ohm

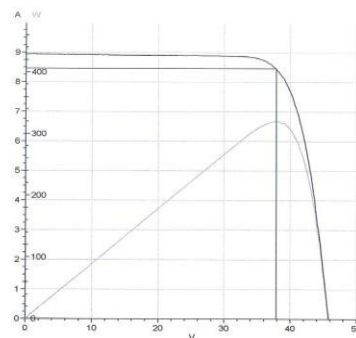

 22/2/17

1803202861-28

Performance measurement

PASAN SLAB Tester - STC + SM V2.4.4

22-02-17 03:02

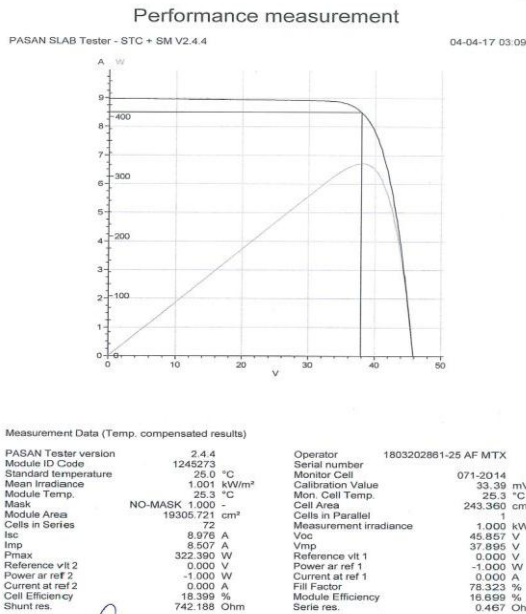
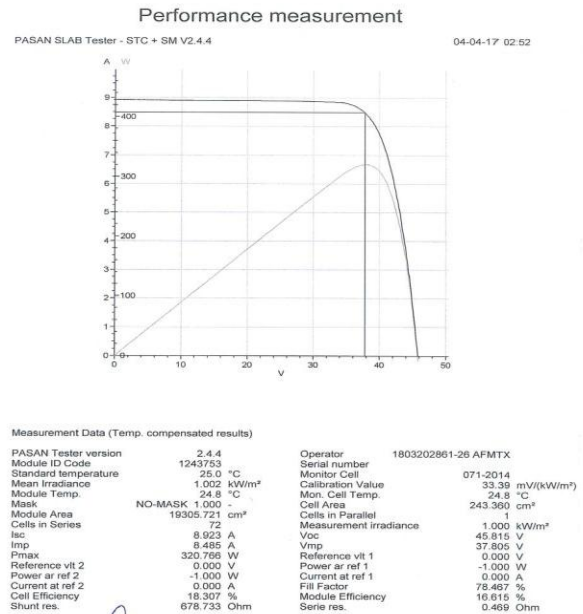
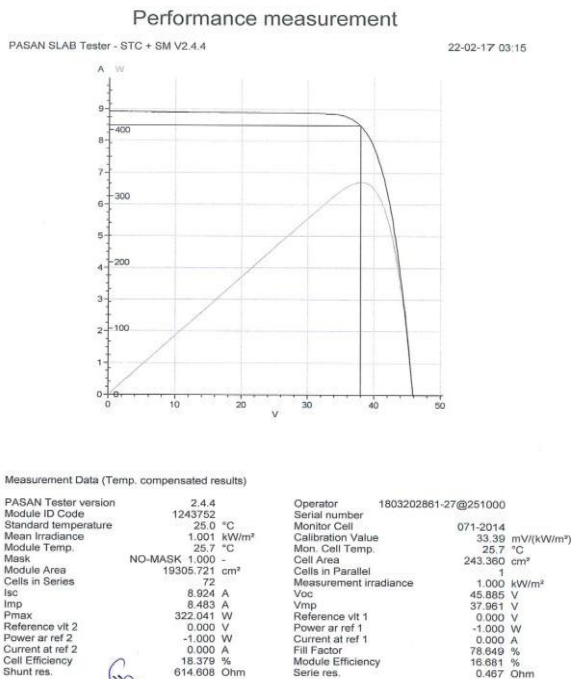
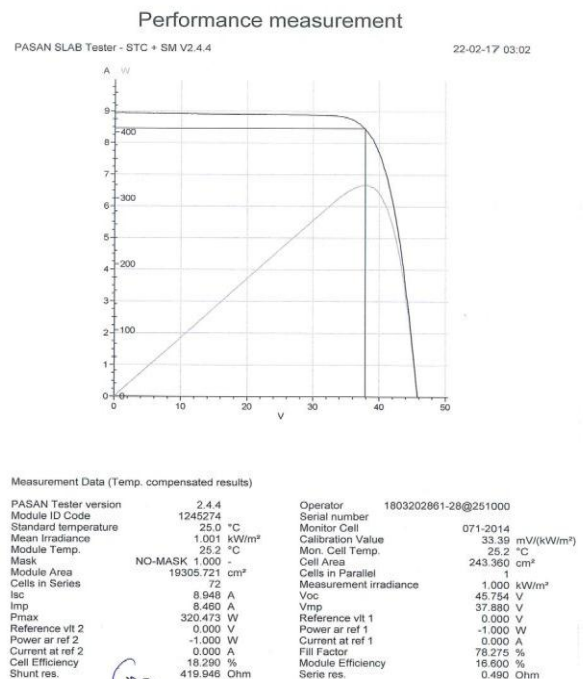


Measurement Data (Temp. compensated results)

PASAN Tester version	2.4.4	Operator	1803202861-28@251000
Module ID Code	1245274	Serial number	071-2014
Standard temperature	25.0 °C	Monitor Cell	33.39 mV/(kW/m²)
Mean Irradiance	1.001 kW/m²	Calibration Value	25.2 °C
Module Temp.	25.2 °C	Mon. Cell Temp.	25.2 °C
Mask	NO-MASK 1.000 -	Cell Area	243.360 cm²
Module Area	19305.721 cm²	Cells in Parallel	1
Cells in Series	72	Measurement irradiance	1.000 kW/m²
Isc	8.948 A	Voc	45.754 V
Imp	8.460 A	Vmp	37.880 V
Pmax	320.473 W	Reference vlt 1	0.000 V
Reference vlt 2	0.000 V	Power ar ref 1	-1.000 W
Power ar ref 1	-1.000 W	Current at ref 1	0.000 A
Current at ref 2	0.000 A	Fill Factor	78.275 %
Cell Efficiency	18.290 %	Module Efficiency	16.600 %
Shunt res.	419.946 Ohm	Series res.	0.490 Ohm


 22/2/17

Measurement curve after matrix generation

1803202861-25

1803202861-26

1803202861-27

1803202861-28


Annex 2: Equipment used

Equipment	Equipment ID	Cal Due date
Pasan Sun Simulator-3b	50-2010-0111	22-05-2017
Reference Module	50-2012-0230	15-05-2017
Reference cell - WPVS-RS-ID-4	50-2010-0111C	11-11-2017

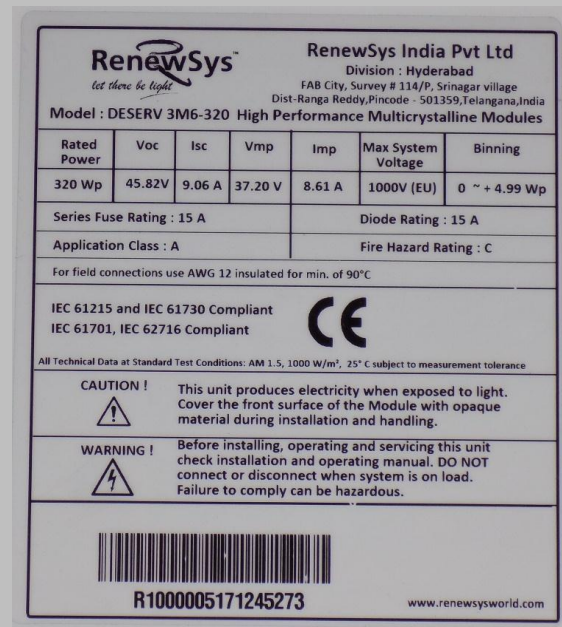
Annex 3: Statement of the estimated uncertainty of the test verdicts and spectrum at test plane

- Electrical performance rating is outside the scope of IEC 61215:2005 qualification testing. The verdicts of performance rating are only related to the test samples that were subjected to the tests. They cannot be generalised to the modules from the series production.
 - Pmax measurement: 2.45% with a coverage factor k=2
 - Current measurement: 2.27% with a coverage factor k=2
 - Voltage measurement: 1.39% with a coverage factor k=2
 - Relative measurements were performed with a flash type solar simulator.
- The accuracy of measurement reproduction with the solar simulator is less than $\pm 1\%$.

Annex 4: Pictures of Test Samples

Fig.01: Front view of test sample

Fig. 02: Rear view of test sample

Fig. 03: Detail view of Junction Box

Fig. 04: Detail view of Type label

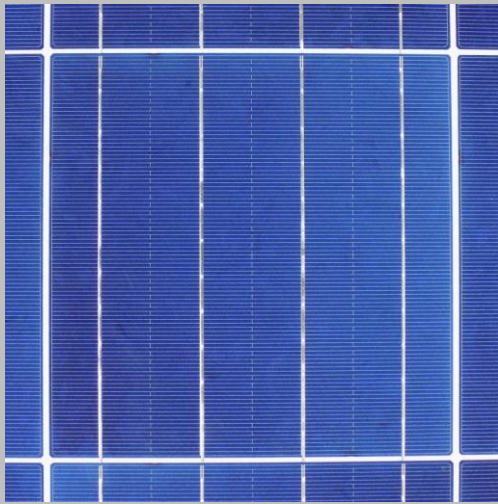


Fig. 05: Detail view of Solar cell



Fig. 06: Detail view of connector



Fig. 07: Detail view of Solar cable

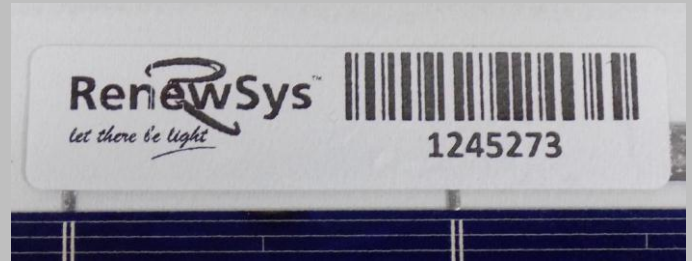
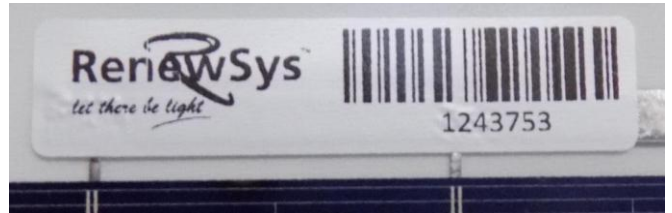
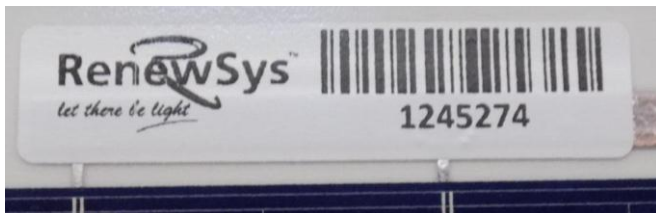


Fig. 08: Detail view of serial number

Annex 5: Serial numbers



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