

TUV Rheinland (India) Pvt. Ltd.
Product Safety & Quality

Test Report

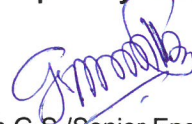
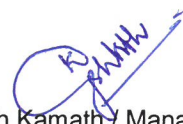
Photovoltaic module Testing

TÜV Report No. ULR: TC568819400000317F

Bangalore, JULY 2019



Certificate No. TC- 5688

Test report no.: <i>Prüfbericht - Nr.:</i>		ULR: TC568819400000317F	
Client (Customer no. and address): <i>Auftraggeber</i> <i>(Kunden-Nr. u. Adresse):</i>		410949 RenewSys India Pvt Ltd Sy. No. 114/P, Srinagar(V), Fabcity, Maheswaram(M), Ranga Reddy, District, Hyderabad – 501359 India	
Test item: <i>Gegenstand der Prüfung:</i>		Photovoltaic (PV) Module(s)	Date of receipt: <i>Eingangsdatum:</i> 30-10-2018
Module type designation: <i>Modultypen-Bezeichnung:</i>		DESERV-3S6-350	
Order no.: <i>Auftragsnummer:</i>		1803364604	
Testing location: <i>Prüfart:</i>		TUV Rheinland(India) Pvt.Ltd 27/B,Electronic city, Phase I, Bangalore-560 100,India Tel: +91 80 46498000	
Test specification: <i>Prüfgrundlage:</i>		IEC 61853-1:2011 Photovoltaic (PV) module performance testing and energy rating. Part 1: Irradiance and temperature performance measurements and power rating	
Test result: <i>Prüfergebnis:</i>		Results enclosed	
compiled by / erstellt:  01-07-2019 Prashanth G S./Senior Engineer		reviewed by / kontrolliert:  01-07-2019 K. Ganesh Kamath./ 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
Street:	Sy. No. 114/P, Srinagar(V), Fabcity, Maheswaram(M), Ranga Reddy, District
Postcode / City:	Hyderabad – 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 **DESERV-3S6-350**, the results are incorporated in this report no: **ULR: TC568819400000317F**. 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 TÜV Rheinland (India) Pvt Ltd, Bangalore.

Summary of deviations from the standard:

- NA

General product information:

PV module type reference.....:	DESERV-3S6-350
Nominal maximum power ($P_{\max}$)	350 Wp (-0 +4.99Wp)
Nominal open circuit voltage at (V_{oc})	47.92 V
Nominal short circuit current at (I_{sc})	9.55 A
Nominal maximum power voltage ($V_{\max}$)	39.05 V
Nominal maximum power current ($I_{\max}$).....:	8.97 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/m²) to the reporting conditions of 15, 25, NOCT, 50 and 75 °C and 100, 200, 400, 500, 600, 800, 1000, and 1100 W/m².

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
A000830016-024	R1000043181957401
A000830016-068	R1000040181925116
A000830016-069	R1000040181925113
A000830016-070	R1000040181925118

Table 2: Constructional characteristics

Components	Model/Type	Manufacturer		
Junction Box	PV- ZH011-3D	Sunter		
JB Sealant	HT906Z	Hutian		
Frame Sealant	HT906Z	Hutian		
Frame	40x35- 1mmWall thickness	Lutong		
EVA (FRONT)	Conserv A 360.2 14 FC	RenewSys		
EVA (BACK)	Conserv A 360.2 14 FC	RenewSys		
Backsheet	PRESERV A 125WN	RenewSys		
Glass	ARC	CSG		
Bus bar	SnPb	LUVATA		
Flux	952-S	Kester		
Cell	Mono 5BB (156.75)	UREC		
Module parameters				
Module dimensions (L x W x T) in mm	Cell technology	Number of cells	Number of bus bars	Cell area in cm²
1958 x 987 x 40	Mono	72	5BB	244.42

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]	12-02-2018	—
Sample no.	Nature and position of initial findings	—
A000830016-024	No major visual defects found	P
A000830016-068	No major visual defects found	P
A000830016-069	No major visual defects found	P
A000830016-070	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]:	12-02-2019 to 05-06-2019								
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 [%]	Rsh in ohms	Rs in ohms
A000830016-024	350.82	38.84	9.031	47.24	9.522	78.00	18.20	329.97	0.519
A000830016-068	349.07	38.89	8.980	47.31	9.470	77.90	18.10	364.69	0.520
A000830016-069	349.51	38.77	9.015	47.26	9.512	77.76	18.15	288.38	0.253
A000830016-070	352.07	38.97	9.030	47.42	9.700	76.60	18.20	94.20	0.522
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]:	12-02-2019 to 05-06-2019		
Sample no.	Power measured at STC after preconditioning in [W]	Power on name plate	-
A000830016-024	350.82	350 Wp (-0 +4.99Wp)	P
A000830016-068	349.07		P
A000830016-069	349.51		P
A000830016-070	352.07		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 [%]
1100	75	A000830016-068	308.25	31.13	9.900	40.66	10.700	70.80	14.50
		A000830016-069	310.72	31.38	9.902	40.81	10.694	71.20	14.67
		A000830016-070	310.92	31.51	9.867	40.92	10.733	70.80	14.68
		Average	309.96	31.34	9.890	40.79	10.709	70.93	14.62
	50	A000830016-068	348.87	35.23	9.900	44.43	10.530	74.60	16.40
		A000830016-069	347.31	35.04	9.913	44.13	10.576	74.42	16.40
		A000830016-070	347.95	35.09	9.917	44.26	10.630	73.95	16.43
		Average	348.04	35.12	9.910	44.27	10.578	74.32	16.41
	25	A000830016-068	382.22	38.20	10.010	47.47	10.380	77.60	18.00
		A000830016-069	384.00	38.70	9.922	47.46	10.462	77.34	18.13
		A000830016-070	384.82	38.81	9.915	47.60	10.535	76.74	18.17
		Average	383.68	38.57	9.949	47.51	10.459	77.23	18.10
1000	75	A000830016-068	282.81	31.27	9.040	40.60	9.750	71.40	14.60
		A000830016-069	282.97	31.45	8.998	40.57	9.755	71.50	14.69
		A000830016-070	283.21	31.49	8.995	40.68	9.796	71.07	14.71
		Average	283.00	31.40	9.011	40.62	9.767	71.32	14.67
	50	A000830016-068	320.09	35.49	9.020	44.26	9.590	75.40	16.60
		A000830016-069	316.41	35.06	9.024	43.92	9.632	74.80	16.43
		A000830016-070	320.20	35.36	9.050	44.12	9.810	74.00	16.60
		Average	318.90	35.30	9.031	44.10	9.677	74.73	16.54
	25	A000830016-068	349.07	38.89	8.980	47.31	9.470	77.90	18.10
		A000830016-069	349.51	38.77	9.015	47.26	9.512	77.76	18.15
		A000830016-070	352.07	38.97	9.030	47.42	9.700	76.60	18.20
		Average	350.22	38.88	9.008	47.33	9.561	77.42	18.15
	15	A000830016-068	360.21	40.50	8.890	48.57	9.380	79.10	18.60
		A000830016-069	362.41	40.23	9.008	48.56	9.467	78.83	18.82
		A000830016-070	363.49	40.28	9.024	48.70	9.549	78.16	18.88
		Average	362.04	40.34	8.974	48.61	9.465	78.70	18.77

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 [%]
800	75	A000830016-068	228.39	31.73	7.200	40.10	7.810	73.00	14.80
		A000830016-069	226.96	31.47	7.211	40.03	7.766	73.01	14.73
		A000830016-070	227.25	31.55	7.202	40.15	7.797	72.59	14.75
		Average	227.53	31.59	7.204	40.09	7.791	72.87	14.76
	50	A000830016-068	255.20	35.55	7.180	43.59	7.690	76.10	16.50
		A000830016-069	256.80	35.54	7.225	43.82	7.673	76.37	16.67
		A000830016-070	254.21	35.54	7.240	43.56	7.723	75.56	16.50
		Average	255.40	35.54	7.215	43.66	7.696	76.01	16.56
	NOCT	A000830016-068	259.62	35.72	7.268	43.96	7.708	76.60	16.80
		A000830016-069	259.02	35.56	7.284	43.90	7.701	76.60	16.80
		A000830016-070	261.28	36.08	7.242	44.21	7.830	75.50	16.90
		Average	259.97	35.79	7.265	44.02	7.746	76.23	16.83
	25	A000830016-068	280.37	38.71	7.240	46.80	7.580	79.00	18.10
		A000830016-069	280.06	38.77	7.224	46.79	7.606	78.69	18.18
		A000830016-070	280.77	38.77	7.242	46.93	7.660	78.09	18.23
		Average	280.40	38.75	7.235	46.84	7.615	78.59	18.17
	15	A000830016-068	289.14	40.40	7.160	48.13	7.510	80.00	18.70
		A000830016-069	290.20	40.21	7.217	48.11	7.572	79.67	18.84
		A000830016-070	291.44	40.30	7.231	48.27	7.642	79.00	18.92
		Average	290.26	40.31	7.203	48.17	7.575	79.56	18.82
600	75	A000830016-068	171.51	31.22	5.490	39.42	5.840	74.50	14.80
		A000830016-069	169.83	31.33	5.421	39.32	5.828	74.10	14.70
		A000830016-070	170.19	31.38	5.424	39.45	5.854	73.70	14.73
		Average	170.51	31.31	5.445	39.40	5.841	74.10	14.74
	50	A000830016-068	192.09	35.25	5.450	42.91	5.770	77.60	16.60
		A000830016-069	189.77	35.00	5.422	42.76	5.760	77.05	16.42
		A000830016-070	190.16	35.07	5.423	42.90	5.790	76.56	16.46
		Average	190.67	35.11	5.432	42.85	5.773	77.07	16.49
	25	A000830016-068	210.11	38.90	5.400	46.19	5.690	80.00	18.10
		A000830016-069	209.46	38.66	5.419	46.18	5.697	79.61	18.13
		A000830016-070	210.15	38.74	5.424	46.32	5.747	78.94	18.19
		Average	209.91	38.77	5.414	46.23	5.711	79.52	18.14
	15	A000830016-068	217.08	40.75	5.330	47.63	5.630	81.00	18.70
		A000830016-069	217.23	40.16	5.410	47.52	5.673	80.58	18.80
		A000830016-070	218.07	40.20	5.424	47.69	5.730	79.81	18.87
		Average	217.46	40.37	5.388	47.61	5.678	80.46	18.79

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 [%]
500	15	A000830016-068	179.94	40.81	4.410	47.21	4.690	81.20	18.60
		A000830016-069	180.51	40.03	4.510	47.16	4.734	80.86	18.75
		A000830016-070	181.13	40.12	4.514	47.31	4.780	80.11	18.81
		Average	180.53	40.32	4.478	47.23	4.734	80.72	18.72
400	50	A000830016-068	127.07	35.08	3.620	41.94	3.860	78.40	16.40
		A000830016-069	126.88	34.61	3.666	41.84	3.902	77.72	16.47
		A000830016-070	127.27	34.70	3.668	41.99	3.927	77.17	16.52
		Average	127.07	34.80	3.651	41.93	3.896	77.76	16.46
	25	A000830016-068	138.66	38.81	3.570	45.32	3.800	80.50	17.90
		A000830016-069	140.54	38.37	3.663	45.36	3.863	80.19	18.24
		A000830016-070	141.04	38.42	3.671	45.52	3.894	79.58	18.31
		Average	140.08	38.54	3.634	45.40	3.852	80.09	18.15
	15	A000830016-068	143.56	40.62	3.530	46.76	3.760	81.60	18.60
		A000830016-069	145.79	39.83	3.660	46.73	3.846	81.12	18.93
		A000830016-070	146.39	39.89	3.670	46.88	3.882	80.44	19.01
		Average	145.25	40.11	3.620	46.79	3.829	81.05	18.85
200	25	A000830016-068	66.95	38.37	1.750	43.85	1.900	80.50	17.30
		A000830016-069	68.51	37.49	1.827	43.93	1.934	80.64	17.79
		A000830016-070	68.82	37.54	1.833	44.06	1.948	80.16	17.87
		Average	68.09	37.80	1.803	43.95	1.927	80.43	17.65
	15	A000830016-068	69.18	40.17	1.720	45.37	1.880	81.00	17.90
		A000830016-069	71.24	39.04	1.825	45.36	1.929	81.44	18.50
		A000830016-070	71.58	39.11	1.830	45.50	1.942	81.01	18.58
		Average	70.67	39.44	1.792	45.41	1.917	81.15	18.33
100	25	A000830016-068	32.46	37.78	0.860	42.45	0.960	79.70	16.80
		A000830016-069	33.09	36.31	0.911	42.52	0.970	80.25	17.18
		A000830016-070	33.32	36.44	0.914	42.63	0.976	80.10	17.30
		Average	32.95	36.84	0.895	42.53	0.968	80.02	17.09
	15	A000830016-068	33.44	39.26	0.850	43.99	0.950	80.30	17.30
		A000830016-069	34.44	37.87	0.909	43.99	0.967	80.95	17.88
		A000830016-070	34.72	37.99	0.914	44.11	0.973	80.88	18.03
		Average	34.20	38.37	0.891	44.03	0.963	80.71	17.74

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	383.68	NA	348.04	309.96
1000 W/m ²	AM 1.5	362.04	350.22	NA	318.90	283.00
800 W/m ²	AM 1.5	290.26	280.40	259.97	255.40	227.53
600 W/m ²	AM 1.5	217.46	209.91	NA	190.67	170.51
500 W/m ²	AM 1.5	180.53	NA	NA	NA	NA
400 W/m ²	AM 1.5	145.25	140.08	NA	127.07	NA
200 W/m ²	AM 1.5	70.67	68.09	NA	NA	NA
100 W/m ²	AM 1.5	34.20	32.95	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	10.459	NA	10.578	10.709
1000 W/m ²	AM 1.5	9.465	9.561	NA	9.677	9.767
800 W/m ²	AM 1.5	7.575	7.615	7.746	7.696	7.791
600 W/m ²	AM 1.5	5.678	5.711	NA	5.773	5.841
500 W/m ²	AM 1.5	4.734	NA	NA	NA	NA
400 W/m ²	AM 1.5	3.829	3.852	NA	3.896	NA
200 W/m ²	AM 1.5	1.917	1.927	NA	NA	NA
100 W/m ²	AM 1.5	0.963	0.968	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	47.51	NA	44.27	40.79
1000 W/m ²	AM 1.5	48.61	47.33	NA	44.10	40.62
800 W/m ²	AM 1.5	48.17	46.84	44.02	43.66	40.09
600 W/m ²	AM 1.5	47.61	46.23	NA	42.85	39.40
500 W/m ²	AM 1.5	47.23	NA	NA	NA	NA
400 W/m ²	AM 1.5	46.79	45.40	NA	41.93	NA
200 W/m ²	AM 1.5	45.41	43.95	NA	NA	NA
100 W/m ²	AM 1.5	44.03	42.53	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	38.57	NA	35.12	31.34
1000 W/m ²	AM 1.5	40.34	38.88	NA	35.30	31.40
800 W/m ²	AM 1.5	40.31	38.75	35.79	108.44	31.59
600 W/m ²	AM 1.5	40.37	38.77	NA	35.11	31.31
500 W/m ²	AM 1.5	40.32	NA	NA	NA	NA
400 W/m ²	AM 1.5	40.11	38.54	NA	34.80	NA
200 W/m ²	AM 1.5	39.44	37.80	NA	NA	NA
100 W/m ²	AM 1.5	38.37	36.84	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	9.949	NA	9.910	9.890
1000 W/m ²	AM 1.5	8.974	9.008	NA	9.031	9.011
800 W/m ²	AM 1.5	7.203	7.235	7.265	7.215	7.204
600 W/m ²	AM 1.5	5.388	5.414	NA	5.432	5.445
500 W/m ²	AM 1.5	4.478	NA	NA	NA	NA
400 W/m ²	AM 1.5	3.620	3.634	NA	3.651	NA
200 W/m ²	AM 1.5	1.792	1.803	NA	NA	NA
100 W/m ²	AM 1.5	0.891	0.895	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 [%]
1000	25	350.22	38.88	9.008	47.33	9.561	77.42	18.15
800	NOCT	259.97	35.79	7.265	44.02	7.746	76.23	16.83
200	25	68.09	37.80	1.803	43.95	1.927	80.43	17.65
1000	75	283.00	31.40	9.011	40.62	9.767	71.32	14.67
500	15	180.53	40.32	4.478	47.23	4.734	80.72	18.72

Table 10: Maximum power determination after matrix generation

Test date [DD/MM/YYYY]:		25-06-2019							
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 [%]	Rsh in ohms	Rs in ohms
A000830016-024	350.50	38.53	9.096	47.26	9.524	77.90	18.10	305.33	0.526
A000830016-068	351.47	38.67	9.090	47.22	9.519	78.20	18.20	333.70	0.513
A000830016-069	351.39	38.69	9.080	47.19	9.570	77.80	18.20	248.03	0.520
A000830016-070	351.77	38.73	9.080	47.19	9.570	77.90	18.20	252.00	0.520
Supplementary information: None									

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

Test date [DD/MM/YYYY]:	25-06-2019		
Sample no.	Power measured at STC after matrix in [W]	Power on name plate	-
A000830016-024	350.50	350 Wp (-0 +4.99Wp)	P
A000830016-068	351.47		P
A000830016-069	351.39		P
A000830016-070	351.77		P
Supplementary information: None			

Table 12: Measurement of temperature coefficients

Test date [DD/MM/YYYY].....	25-06-2019		
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]
A000830016-068	0.0650	-0.2748	-0.3625
A000830016-069	0.0557	-0.3060	-0.4014
A000830016-070	0.0495	-0.2916	-0.3872
Average	0.05673	-0.2908	-0.3837
Supplementary information: None			

Annex 1: Equipment used

Equipment	Equipment ID	Cal Due date
Pasan Sun Simulator-3b	50-2010-0111	04-08-2019
Reference Module	50-2018-0297	15-08-2019

Annex 2: 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 $\pm 1\%$.

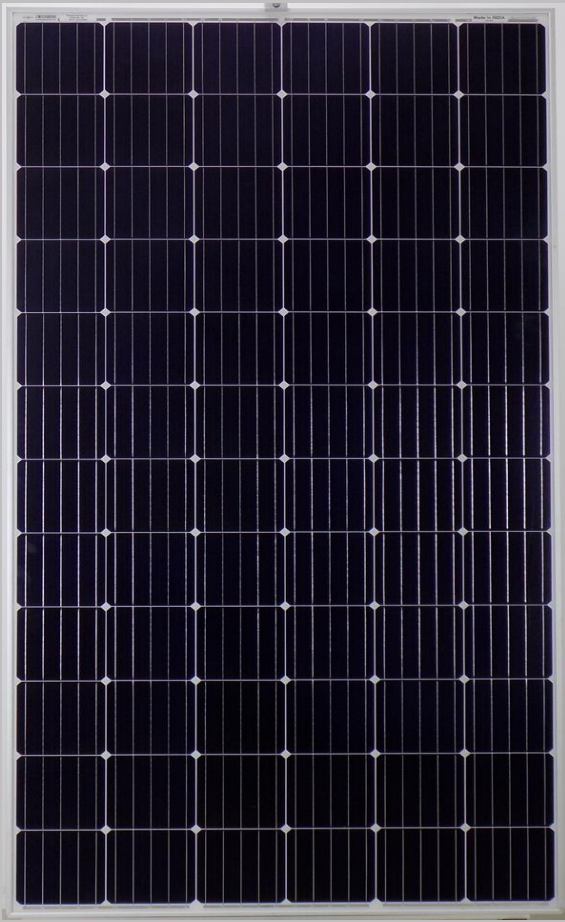
Annex 3: Pictures of Test Samples


Fig.01: Front view of test sample



Fig. 02: Rear view of test sample



Fig. 03: Detail view of Junction Box

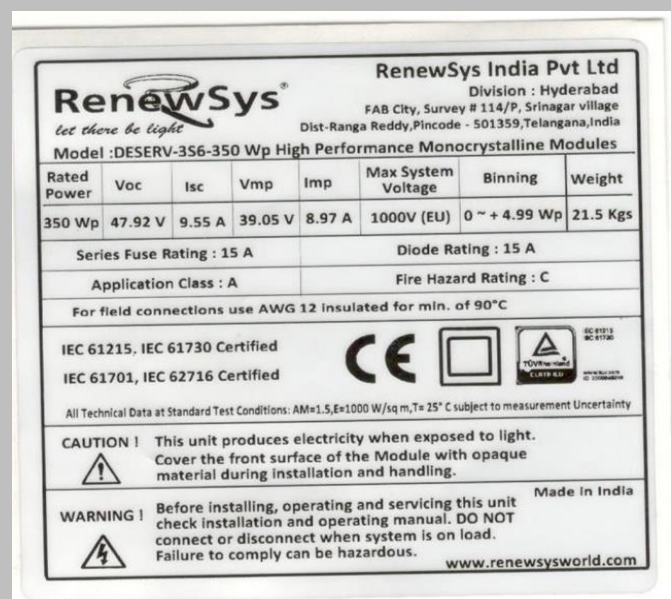


Fig. 04: Detail view of Type label



Fig. 05: Detail view of Solar cell



Fig. 06: Detail view of connector



Fig. 07: Detail view of Solar cable

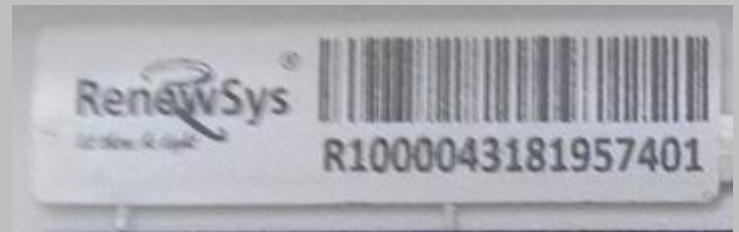
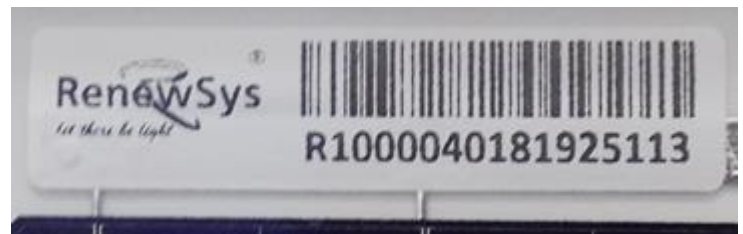
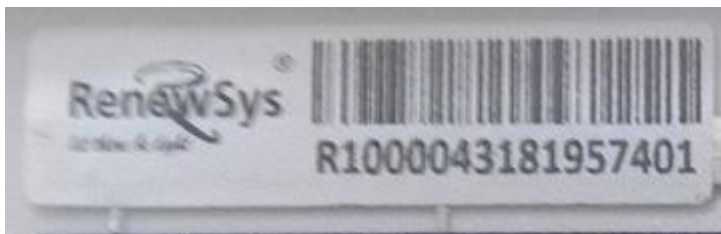


Fig. 08: Detail view of serial number

Annex 4: Serial numbers



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