T1431, T1432, T2215, T2216, T2233, T2234

Test Report issued under the responsibility of:

Underwriters Laboratories

TEST REPORT **IEC 61215: 2005 2nd Edition** **Crystalline Silicon Terrestrial Photovoltaic (PV) Modules** **- Design Qualification and Type Approval**	
Report Reference No. ..... :	4786930293.1.1-NABL-MNRE-S1
Date of issue ..... :	09/09/2015
Total number of pages ..... :	25
Applicant's name.....:	**ICON SOLAR-EN POWER TECHNOLOGIES PVT LTD**
Address.....:	319-320, OFFIZO, 3RD FLOOR, MAGNETO MALL, G.E ROAD, RAIPUR, CHHATTISGARH 492001, INDIA
Test specification ..... **:**	IEC 61215 CRYSTALLINE SILICON TERRESTRIAL PHOTOVOLTAIC (PV) MODULES - DESIGN QUALIFICATION AND TYPE APPROVAL - Edition 2 - Issue Date 2005/04/01
Standard .....:	IEC 61215: 2005 2nd Edition
Test procedure .....:	NA
Non-standard test method .....:	NA
Test item description..... **:**	Crystalline Silicon Photovoltaic Modules (Multi-Crystalline)
Trade Mark .....:	EN-ICON Harvesting the Sun
Manufacturer .....:	ICON SOLAR-EN POWER TECHNOLOGIES PVT LTD
Address.....:	VILLAGE DIGHARI,MANDIR HASAUD,TEHSIL ARANG - 49441,RAIPUR,CHHATTISGARH(INDIA)
Model/Type reference.....:	IS-EN 310W
Ratings.....:	Please refer to the table in next page

Model Name	Wattage (Wp)	Maximum System Voltage (V dc)	Open Circuit Voltage @ STC, (V dc)	Rated Voltage @ STC, (V dc)	Rated Current @ STC, (A)	Short Circuit Current @ STC, (A)	Rated Maximum Power at STC, (Watts)	Maximum Series Fuse, (A)
ISEN3	3	NA	10.3	6.4	0.53	0.57	3.4	NA
ISEN5	5	NA	16.1	12.2	0.5	0.50	5.6	NA
ISEN10	10	NA	23.3	18.2	0.6	0.65	10.9	NA
ISEN20	20	NA	23.3	18.7	1.1	1.20	20.7	NA
ISEN30	30	NA	23.3	18.7	1.6	1.79	30.9	NA
ISEN37	37	NA	23.3	18.7	2.0	2.18	37.6	NA
ISEN40	40	NA	23.3	18.7	2.1	2.32	40.1	NA
ISEN50	50	NA	23.3	18.4	2.8	3.01	51.0	5
ISEN60	60	NA	23.3	18.8	3.2	3.47	60.2	5
ISEN74	74	NA	23.3	18.2	4.1	4.46	74.9	10
ISEN75	75	NA	23.3	18.2	4.2	4.52	75.9	10
ISEN80	80	NA	23.3	18.7	4.3	4.68	80.8	10
ISEN100	100	600	23.3	18.0	5.6	6.07	100.9	10
ISEN120	120	600	23.3	18.7	6.4	6.98	120.6	10
ISEN125	125	600	23.3	18.2	6.9	7.49	125.6	15
ISEN130	130	600	23.3	18.9	6.9	7.49	130.5	15
ISEN135	135	600	22.3	18.1	7.4	7.8	135.5	15
ISEN145	145	1000	22.0	18.0	8.0	8.5	145.3	15
ISEN150	150	1000	44.46	36.22	4.15	4.37	150.3	15
ISEN150	150	1000	22.23	18.11	8.31	8.74	150.5	15
ISEN165	165	1000	24.64	20.08	8.23	8.67	165.3	15
ISEN170	170	1000	24.78	20.18	8.43	8.84	170.1	15
ISEN195	195	1000	29.48	24.04	8.12	8.59	195.2	15
ISEN200	200	1000	44.41	36.18	5.56	5.86	201.2	15
ISEN200	200	1000	29.64	24.14	8.31	8.74	200.6	15
ISEN205	205	1000	29.77	24.24	8.47	8.87	205.3	15
ISEN220	220	1000	33.19	27.06	8.15	8.61	220.5	15
ISEN225	225	1000	33.35	27.16	8.31	8.74	225.7	15
ISEN230	230	1000	33.46	27.25	8.45	8.84	230.3	15
ISEN250	250	1000	44.46	36.18	6.92	7.28	250.4	15
ISEN250	250	1000	37.05	30.12	8.31	8.75	250.3	15
ISEN255	255	1000	37.18	30.27	8.43	8.84	255.2	15
ISEN260	260	1000	37.28	30.58	8.51	8.93	260.2	15
ISEN265	265	1000	37.36	30.69	8.64	9.01	265.2	15
ISEN270	270	1000	40.58	33.08	8.17	8.62	270.3	15
ISEN275	275	1000	40.76	33.20	8.31	8.74	275.9	15

ISEN280	280	1000	40.89	33.29	8.43	8.84	280.6	15
ISEN300	300	1000	44.45	36.18	8.30	8.75	300.3	15
ISEN305	305	1000	44.59	36.33	8.40	8.83	305.2	15
ISEN310	310	1000	44.70	36.43	8.51	8.93	310.0	15
ISEN315	315	1000	44.85	36.52	8.63	9.02	315.2	15
ISEN320	320	1000	45.00	36.59	8.75	9.12	320.2	15
ISEN325	325	1000	45.02	36.73	8.85	9.16	325.1	15
ISEN330	330	1000	45.07	37.2	8.88	9.21	330.3	15

Testing procedure and testing location:

☒ **Testing Laboratory……..**: UL India Pvt. Ltd.

Testing location/ address ..... : Kalyani Platina, Phase I, Whitefield, Bengaluru, KA-560066, INDIA

Tested by (name + signature) : Srimathy N 

Approved by (+ signature)..... : Mahesh V 

☐ Testing procedure: TMP NA

Tested by (name + signature)..... :

Approved by (+ signature)..... :

Testing location/ address ..... :

IEC 61215			
Clause	Requirement + Test	Result - Remark	Verdict

Summary of testing:

Tests performed (name of test and test clause):	**Testing location:**
Tests performed (name of test and test clause): **All tests required are listed in table 1 of IEC 61215.** **Model IS-EN 310W, 310Wp was used for test purposes.**	**UL India Pvt. Ltd.** **Kalyani Platina, Phase I, Whitefield,** **Bengaluru, KA-560066, INDIA**

Summary of compliance with National Differences: NA

Copy of marking plate:

IEC 61215			
Clause	Requirement + Test	Result - Remark	Verdict

GENERAL INFORMATION	
Test item particulars:	
Accessories and detachable parts included in the evaluation .....:	NA
Options included .....:	NA
Possible test case verdicts:	NA
Abbreviations used in the report:	
HF – Humidity Freeze	TC – Temperature Cycling
DH – Damp Heat	Vmp – Maximum power voltage
Imp – Maximum power current	Voc – Open circuit voltage
Isc - Short circuit current	FF – Fill Factor
Pmp – Maximum power	α – Current temperature coefficient
NOCT – Nominal Operating Cell Temperature	β – Voltage temperature coefficient
STC – Standard Test Conditions	δ – power temperature coefficient
Possible test case verdicts: - test case does not apply to the test object .....:	N/A
- test object does meet the requirement.....:	Pass (P)
- test object does not meet the requirement.....:	Fail (F)

General remarks:

The test results presented in this report relate only to the object tested.
This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory."(see Enclosure #)" refers to additional information appended to the report.
"(see appended table)" refers to a table appended to the report.
Throughout this report a comma (point) is used as the decimal separator.

General product information: Product Electrical Ratings:

PV module type reference	:	IS-EN 310W
Product Electrical Ratings at STC		
Nominal maximum power (Pmax)	:	310Wp
Nominal open circuit voltage at (Voc)	:	43.20 V
Nominal short circuit current at (Isc)	:	8.77 A
Nominal maximum power voltage (Vpm)	:	38.50 V
Nominal maximum power current (Ipm)	:	8.10 A
Product Safety Ratings		
Maximum system voltage	:	1000 Vdc
Maximum over-current protection rating	:	15 A
Safety application class	:	Class A
Safety class in accordance with IEC 61140:		Class-II
Fire safety class	:	NA

IEC 61215			
Clause	Requirement + Test	Result - Remark	Verdict

Description of module construction:
(Manufactories and part numbers, unless otherwise specified)

Sample.....:	Random sampling from production ☐ Prototype submitted by client ☒
Module	Multi-Crystalline – 310Wp - IS-EN 310W
Front Cover.....:	Gujarat Borosil Limited, Solar Tempered Glass 3.2 +/-0.2mm
Rear Cover .....:	MADICO Specialty Films, Reflekt-Light (Thickness 259µm, Wt 285g/sqm, Density 1.14gm/sqcm)
Encapsulation material .....:	TPI All seasons company Limited , Thailand, Grade ST 308 Fast cure EVA
Frame .....:	ULTRA Aluminum Pvt Ltd, Raipur, Model:6063 T6
Dimensions (l x w x h) [mm] .....:	1956x980x42
Module area [m²] .....:	1.916
Minimum distance between current-carrying parts and module edge[mm]	9.20
Cell	
Cell (include type).....:	SUNTECH,STP156M,Polycrystalline
Cells (l x w) [mm] .....:	156 X156 +/- 0.5
Cell thickness [µm] .....:	180 - 200 +/-20
Cell area [cm²] .....:	243.360
Number of cells.....:	72
Components and other	
Cells per bypass diode .....:	24
Type of bypass diode .....:	Schottky Barrier Rectifier - SL1515B, 40V/20A
No. of bypass diodes .....:	3
Cell- and string connectors.....:	Luvata Malaysia 1.5x0.18mm Cell Interconnect snpb 60/40 15 to 25 µm and 5x0.3 mm Bus bar Snpb 60/40 15 to 25 µm
Junction box .....:	Tyco Electronics Middle East FZE, Model Code: Z-CLA4GBN3K Part No : 8-2152080-6
Cable .....:	PV1-F, 4 mm2
Connectors .....:	PV 4,1000 VDC ,40 A
Adhesive for frame :	Pentagon Tapes Pvt. Ltd. (BOW tape) , PT390W(1mm Polyethylene foam Double side adhesive)
Adhesive for junction box :	Sikasil AS-60 CN
Potting (Inside Junction Box)…:	Not Used

IEC 61215			
Clause	Requirement + Test	Result - Remark	Verdict

Testing procedure

☒ New module type

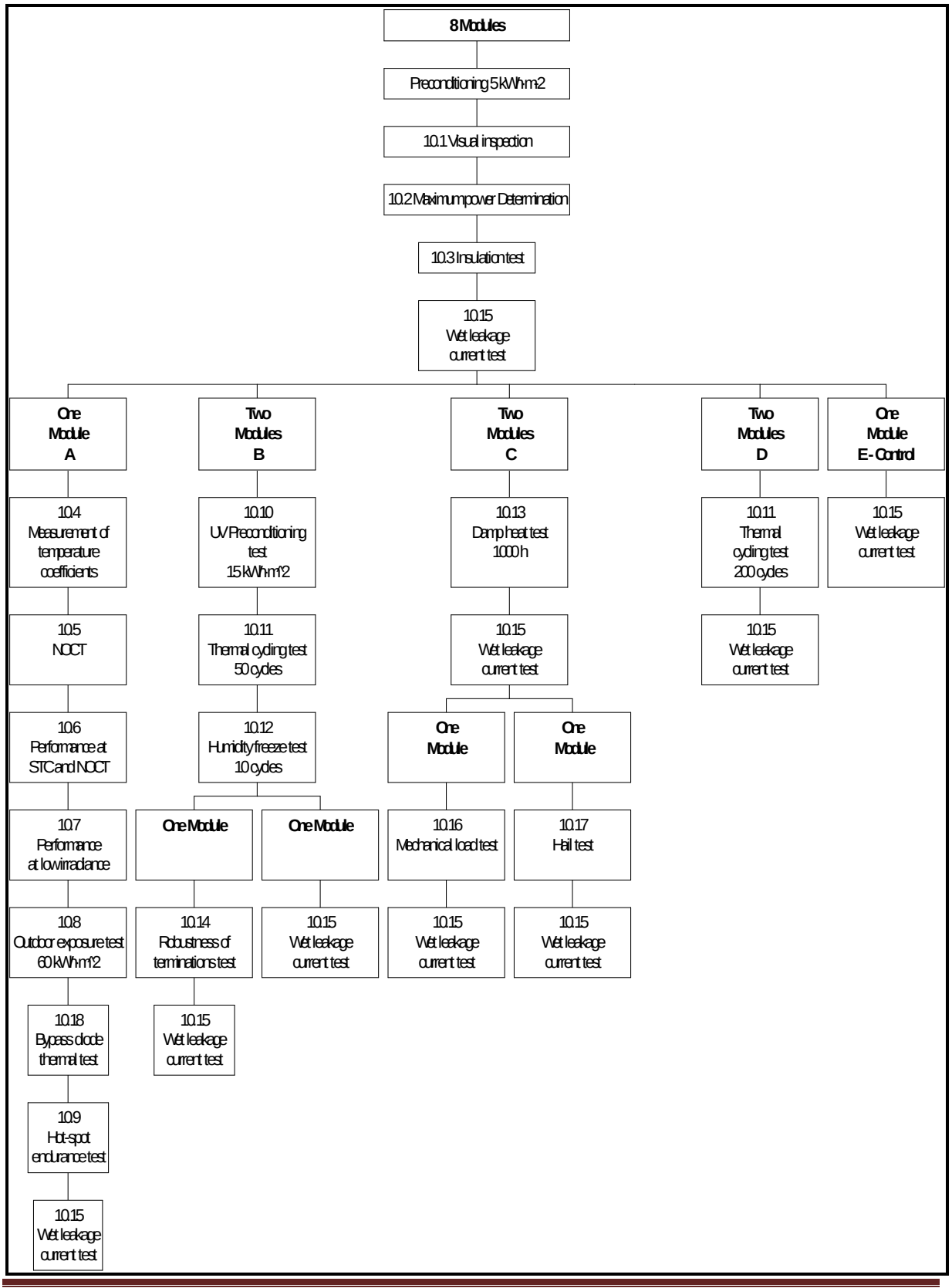
☐ Modifications (if yes, please choose the applicable modification according to the Retesting Guideline)

- ☐ Change in cell technology
- ☐ Modification to encapsulation system
- ☐ Modification to superstrate
- ☐ Increase in module size
- ☐ Modification to back sheet/ substrate
- ☐ Modification to frame and/ or mounting structure
- ☐ Modification to junction box/ electrical termination
- ☐ Change in cell interconnect materials or technique
- ☐ Change in electrical circuit of an identical package
- ☐ Higher or lower power output (by 10%) in the identical package including size and using the identical cell process
- ☐ Qualification of a frameless module after the design has received certification as a framed module
- ☐ Change in bypasses diode or number of diodes

Module group assignment:

Sample #	Sample Group ID	UL Sample No. & Module Serial number
1	Ctrl Module	2156789 & ICON31036A0105191013
2	A	2156792 & ICON31036A0105191012
3	B1	2156786 & ICON31036A0105191017
4	B2	2156788 & ICON31036A0105191018
5	C1	2156787 & ICON31036A0105191002
6	C2	2156793 & ICON31036A0105191015
7	D1	2156798 & ICON31036A0105191010
8	D2	2156799 & ICON31036A0105191014

10	**TEST PROCEDURES** Note: Deviations from test sequence are possible but must be documented.



IEC 61215 Ed.2 – Design qualification and type approval			
Clause	Requirement + Test	Result - Remark	Verdict

4	**MARKING**		P
	Name, monogram or symbol of manufacturer ..... :	ICON SOLAR-EN POWER TECHNOLOGIES PVT LTD	P
	Type or model number..... :	IS-EN 310W	P
	Serial number ..... :	Provided	P
	Polarity of terminals or leads ..... :	Provided	P
	Maximum system voltage ..... :	1000	P
	The date and place of manufacture..... :	Provided	P

	Initial examination	All modules	P
10	Preconditioning .....:	5.5kWh/m2	—
10.1	Visual inspection .....:	See table 10.1 Int	—
10.2	Maximum power determination.....:	See table 10.2 Int	—
10.3	Insulation test.....:	See table 10.3 Int	—
10.15	Wet leakage current test	See table 10.15 Int	—

Group A	Control Module	Sample Group ID A	—

Group B	1 Module	Sample Group ID B	—
10.4	Measurement of temperature coefficients	See table 10.4 B	—
10.5	Measurement of Nominal Operating Cell Temperature [NOCT, °C] .....:	See table 10.5 B	—
10.6	Performance at STC and NOCT.....:	See table 10.6 B	—
10.7	Performance at low irradiance .....:	See table 10.7 B	—
10.8	Outdoor exposure test	See table 10.8 B	—
10.18	Bypass diode thermal test	See table 10.18 B	—
	Maximum allowed junction temperature .....:		—
	Measured junction temperature .....:		—
10.9	Hot spot endurance test.....:	See table 10.9 B	—

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Clause	Requirement + Test	Result - Remark	Verdict

Group C	2 Modules	Sample Group ID C1, C2	—
10.10	UV test.....:	15 kWh/m²	—
	Final measurements	See table 10.10 C	—
10.11	Thermal cycling test (50 cycles).....:		P
	Final measurements	See appended table 10.11 C	—
10.12	Humidity freeze (10 cycles).....:		P
	Final measurements	See table 10.12 C	—

Group C1	1 Module	Sample Group ID C1	—
10.14	Robustness of terminations test ..... :		P
	Final measurements	See table 10.14 C1	—

Group D	2 Modules	Sample Group ID D1, D2	—
10.11	Thermal cycling test (200 cycles) ..... :		P
	Final measurements	See table 10.11 D	—

Group E	2 Modules	Sample Group ID E1, E2	—
10.13	Damp heat test ..... :		P
	Final measurements	See table 10.13 E	—

Group E1	1 Module	Sample Group ID E1	—
10.16	Mechanical load test..... :		P
10.16.4	-No open-circuits or ground faults detected		—
	Final measurements	See table 10.16 E1	—

Group E2	1 Module	Sample Group ID E2	—
10.17	Hail test		P
	Number of points impacted..... :		—
	Final measurements	See table 10.17 E2	—

	Final measurement	All modules	—
10.15	Wet leakage current test	See table 10.15 F	—

10.1 Initial	**TABLE: Visual inspection (Initial)**	—
Test Date [MM/DD/YYYY]..... :	07/09/2015	—
Sample #	Nature and position of initial findings – comments or attach photos	—
1	No Visible Defect	P
2	No Visible Defect	P
3	No Visible Defect	P
4	No Visible Defect	P
5	No Visible Defect	P
6	No Visible Defect	P
7	No Visible Defect	P
8	No Visible Defect	P
Supplementary information: NA		

10.2 Initial	**TABLE: Maximum power determination (Initial)**					—
Test Date [MM/DD/YYYY]..... :	07/09/2105					—
Module temperature [°C]..... :	25					—
Irradiance [W/m^2)..... :	1000					—
Sample #	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]
1	45.856	37.007	8.784	8.285	306.614	76.10
2	45.566	36.401	8.851	8.330	303.234	75.20
3	45.810	37.210	8.815	8.273	307.822	76.20
4	45.801	37.029	8.790	8.259	305.835	76.00
5	45.981	37.251	8.824	8.251	307.362	75.80
6	45.974	37.124	8.826	8.254	306.423	75.50
7	45.973	37.092	8.812	8.250	306.023	75.50
8	45.945	36.776	8.860	8.279	304.470	74.80
Supplementary information: NA						

10.3 Initial	**Table: Insulation test (Initial)**				—
Test Date [MM/DD/YYYY] ..... :			07/13/2015		—
Test Voltage applied [V] ..... :			3000 (for 1 min) 1000V for 2 min		—
Sample #	Measured	Required	Dielectric breakdown		Result
	MΩ	MΩ	Yes (description)	No	P
1	998	20.88	-	No	P
2	512	20.88	-	No	P
3	501	20.88	-	No	P
4	652	20.88	-	No	P
5	970	20.88	-	No	P
6	634	20.88	-	No	P
7	783	20.88	-	No	P
8	681	20.88	-	No	P
Supplementary information: Size of module [m²]: 1.916					

10.15 Initial	**TABLE: Wet leakage current test (Initial)**			—
Test Date [MM/DD/YYYY]..... :		07/13/2015		—
Test Voltage applied [V] ..... :		1000		—
Solution resistivity [Ω cm)..... :		< 3,500 Ω cm at 22 ± 3°C	3499	—
Surface tension [Nm^{-2})..... :		< 0.03 Nm^{-2} at 22 ± 3°C	—	—
Solution temperature [°C]..... :		25.1		
Sample #	Measured [MΩ]	Limit [MΩ]		Result
1	295	20.88		P
2	242	20.88		P
3	236	20.88		P
4	247	20.88		P
5	306	20.88		P
6	241	20.88		P
7	310	20.88		P
8	235	20.88		P
Supplementary information: Size of module [m²]: 1.916				

10.4 B	TABLE: Measurement of temperature coefficients		—
Test Date [MM/DD/YYYY]..... :		08/18/2015 to 08/19/2015	—
Ambient air temperature [°C] high/low..... :		25.3	—
Irradiance [W/m^2]high/low ..... :		1000	—
Module temperature [°C] high/low ..... :		65 - 30	—
Sample #	**Parameter**	**Calculated Value(Average)**	—
2	α [%/°C) ..... :	0.0369	—
	β [%/°C) ..... :	-0.3425	—
	δ [%/°C) ..... :	-0.4315	—
Supplementary information: NA			

10.5 B	TABLE: Measurement of Nominal Operating Cell Temperature [NOCT, °C)			—
Test Value:	1st run	2nd run	3rd run	—
Test Date [MM/DD/YYYY]..... :	08/21/2015	08/24/2015	08/25/2015	—
Wind velocity [m/s]high/low ..... :	1.69 – 0.25	1.73 – 0.26	1.71 – 0.25	—
Ambient temperature [°C] high/low..... :	27.67 – 20.33	26.78 – 20.00	28.33 – 19.44	—
Irradiance [W/m^2]high/low ..... :	984.05-505.94	991.78-527.54	999.18-567.45	—
Module temperature [°C] high/low ..... :	59.05 – 36.75	57.05 – 37.20	59.45 – 40.40	—
Wind velocity [m/s](average)..... :	0.955	0.959	0.972	—
Ambient temperature [°C] (average) ... :	24.685	24.016	24.672	—
NOCT correction factor [°C] ..... :	0	0	0	—
Calculated NOCT [°C] ..... :	45.89	45.76	46.53	—
Sample #	**Average NOCT [°C]**			—
2	(45.89 + 45.76 + 46.53)/3 = 46.06			—
Supplementary information: NA				

10.6 B	TABLE: Performance at STC and NOCT					—
Test Date [MM/DD/YYYY]..... :			08/26/2015			—
Wind velocity [m/s]high/low ..... :			NA			—
Test method ..... :			☒ indoor ☐ outdoor			—
Ambient air temperature [°C] high/low..... :			25.1			—
Irradiance [W/m^2]high/low ..... :			1000 / 800			—
Module temperature [°C] high/low ..... :			45.9 / 24.0			—
Condition	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]
STC	45.566	36.401	8.851	8.330	303.234	75.2
NOCT	41.583	33.044	7.134	6.581	217.464	73.3
Supplementary information: NA						

10.7 B	TABLE: Performance at low irradiance						—
Test Date [MM/DD/YYYY]..... :			08/26/2015				—
Ambient air temperature [°C] ..... :			25.1				—
Irradiance [W/m^2](200 W/m^2) ..... :			200				—
Module temperature [°C]..... :			24.0				—
Test method..... :			☒ Data corrected to a 25°C cell temperature and 200 W/m^2 irradiance ☐ Directly measured				—
Data corrected to a 25°C cell temperature and 200 W/m^2 irradiance							
Sample #	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]	
2	43.260	36.151	1.796	1.675	60.558	78.0	
Supplementary information: NA							

10.8 B	TABLE: Outdoor exposure test						
Test Date [MM/DD/YYYY] start/end..... :			08/26/2015 to 09/03/2015				—
Total irradiation dosage [kWh/m^2]..... :			60.43				—
Supplementary information: NA							
(10.1 Visual inspection after outdoor exposure test)							—
Test Date [MM/DD/YYYY] ..... :			09/03/2015				—
Sample #	Nature and position of initial findings – comments or attach photos						—
2	No Visible Defect						P
Supplementary information: NA							
(10.2 Maximum power determination after outdoor exposure test)							—
Test Date [MM/DD/YYYY] ..... :			09/03/2015				—
Module temperature [°C] ..... :			25.2				—
Irradiance [W/m^2] ..... :			1000				—
Sample #	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]	
2	45.480	36.448	8.765	8.206	299.106	75.0	
Pmp degradation after this test [%] ≤ 5%..... :			1.4				
(10.3 Insulation test after outdoor exposure test)							
Test Date [MM/DD/YYYY] ..... :			09/03/2015				—
Test Voltage applied [V] ..... :			1000V/3000V				—
Sample #	Measured	Required	Dielectric breakdown				Result
	MΩ	MΩ	Yes (description)		No		
2	501.3	>20.88	--		No		P
Supplementary information: Size of module [m²]: 1.916							

10.18 B	TABLE: Bypass diode thermal test				
Test Date [MM/DD/YYYY] start/end.....:	9-4-2015				—
Module temperature [°C] ..... :	72.5				—
Number of diodes in junction box..... :	3				
Diode manufacturer ..... :	SCHOTTKY BARRIER RECTIFIERS				
Diode type designation ..... :	SL1515B, 40V/20A				
Max. permissible junction temperature Tj_{max} [°C] (according to diode datasheet)..... :	200				
Diodes	1	2	3	Result	
Current flow applied [A] ..... :	9.1	9.1	9.1	P	
Max. diode surface temperature [°C] a or b :	121.3	128.7	125.5	P	
Voltage drop [V] ..... :	0.2690	0.2598	0.2679	P	
Power dissipation [W] ..... :	2.45	2.36	2.44	P	
Thermal resistance junction to leads (RTHJL)/to case (RTHJC) [K/W] (according to datasheet) :	2	2	2	P	
Calculated max. junction temperature Tj_{calc} [°C] a or b..... :	126.2	133.4	130.4	P	
Tj_{calc} < Tj_{max} (test Ped)? yes/no..... :	Yes	Yes	yes	P	
Current flow (1.25 * Isc) [A] ..... :	11.38	11.38	11.38	P	
Max. diode surface temperature [°C] a or b :	131.1	139.0	137.0	P	
Remarks: ([a] measured at diode case, [b] measured at diode leads)					
(10.1 Visual inspection after bypass diode thermal test)					—
Test Date [MM/DD/YYYY] .....:	09/04/2015				—
Sample #	Nature and position of initial findings – comments or attach photos				—
2	NO VISUAL DEFECTS				P
Supplementary information: NA					
(10.2 Maximum power determination after bypass diode thermal test)					—
Test Date [MM/DD/YYYY] .....:	09/08/2015				—
Module temperature [°C] .....:	24.6				—
Irradiance [W/m^2] .....:	1000				—

Sample #	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]
2	45.630	36.551	8.830	8.284	302.783	75.2

Pmp degradation after this test [%] ≤ 5%..... :	1.23	
Supplementary information: NA		
(10.3 Insulation test after bypass diode thermal test)		
Test Date [MM/DD/YYYY] .....:	09/08/2015	—
Test Voltage applied [V] .....:	1000 / 3000	—

Sample #	Measured	Required	Dielectric breakdown		Result
	GΩ	MΩ	Yes (description)	No	
2	1.249	>20.88	--	No	P
Supplementary information: NA					

10.9 B	**TABLE: Hot-spot endurance test**					—
Test Date [MM/DD/YYYY] start/end.....:			09/08/2015			—
Cell interconnection circuit.....:			☒ S ☐ SP ☐ SPS			—
Module temperature at thermal equilibrium [°C] .....:			53.7			—
Determination of worst case cell						—
Maximum measured cell temperature in 5 cycles [°C]:			73.4			—
Shading rate [%] ..... :			100%			—
Supplementary information: NA						
(10.1 Visual inspection after hot-spot endurance test)						—
Test Date [MM/DD/YYYY] .....:			09/08/2015			—
Sample #	Nature and position of initial findings – comments or attach photos					—
2	NO VISUAL DEFECTS					P
Supplementary information: NA						
(10.2 Maximum power determination after hot-spot endurance test)						—
Test Date [MM/DD/YYYY] .....:			09/08/2015			—
Module temperature [°C] .....:			25.6			—
Irradiance [W/m^2) .....:			1000			—
Sample #	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]
2	45.480	36.079	8.799	8.268	298.289	74.5
Pmp degradation after this test [%] ≤ 5%..... :			1.5			
Supplementary information: NA						
(10.3 Insulation test after hot-spot endurance test)						
Test Date [MM/DD/YYYY] .....:			09/09/2015			—
Test Voltage applied [V] .....:			1000 / 3000			—
Sample #	Measured	Required	Dielectric breakdown			Result
	GΩ	MΩ	Yes (description)	No		
2	1.142	>20.88	--	No		P
Supplementary information: NA						

10.10 C	**TABLE: UV preconditioning test**					—
Test Date [MM/DD/YYYY] start/end.....:			07/29/2015 - 08/10/2015			—
Module temperature [°C] ..... :			60			
Irradiation 280 - 385 nm [kWh/ m²] ..... :			14.231			
Irradiation 280 - 320 nm [kWh/ m²] ..... :			0.868			
Sample #	Open circuits (yes/no)					—
3	NO					P
4	NO					P
Supplementary information: NA						
(10.1 Visual inspection after UV preconditioning test)						—
Test Date [MM/DD/YYYY].....:			08/10/2015			—
Sample #	Nature and position of initial findings – comments or attach photos					—
3	NO VISUAL DEFECTS					P
4	NO VISUAL DEFECTS					P
Supplementary information: NA						
(10.2 Maximum power determination after UV preconditioning test)						—
Test Date [MM/DD/YYYY].....:			08/10/2015			—
Module temperature [°C].....:			25			—
Irradiance [W/m^2).....:			1000			—
Sample #	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]
3	45.816	36.976	8.815	8.268	305.703	75.70
4	45.817	36.99	8.791	8.258	304.784	75.70
Pmp degradation after this test [%] ≤ 5%..... :	3) 0.688 & 4) 0.343					
Supplementary information: NA						
(10.3 Insulation test after UV preconditioning test)						
Test Date [MM/DD/YYYY].....:			08/10/2015			—
Test Voltage applied [V] .....:			3000 (for 1 min) 1000V for 2 min			—
Sample #	Measured	Required	Dielectric breakdown			Result
	MΩ	MΩ	Yes (description)	No		
3	1222	>20.88	--	No		P
4	819	>20.88	--	No		P
Supplementary information: NA						

10.11 C	**TABLE: Thermal cycling 50 test**					—
Test Date [MM/DD/YYYY] start/end.....:			08/10/2015 - 08/21/2015			—
Total cycles (50) ..... :			50			—
Sample #	Open circuits (yes/no)					—
3	NO					P
4	NO					P
Supplementary information: NA						
(10.1 Visual inspection after thermal cycling 50 test)						—
Test Date [MM/DD/YYYY].....:			08/21/2015			—
Sample #	Nature and position of initial findings – comments or attach photos					—
3	NO VISUAL DEFECTS					P
4	NO VISUAL DEFECTS					P
Supplementary information: NA						
(10.2 Maximum power determination after thermal cycling 50 test)						—
Test Date [MM/DD/YYYY].....:			08/21/2015			—
Module temperature [°C].....:			25			—
Irradiance [W/m^2).....:			1000			—
Sample #	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]
3	45.650	36.739	8.911	8.319	305.643	75.10
4	45.662	36.730	8.894	8.314	305.730	75.20
Pmp degradation after this test [%] ≤ 5%..... :			3) 0.0196 & 4) 0.3103			
Supplementary information: NA						
(10.3 Insulation test after thermal cycling 50 test)						
Test Date [MM/DD/YYYY].....:			08/21/2015			—
Test Voltage applied [V] .....:			3000 (for 1 min) 1000V for 2 min			—
Sample #	Measured	Required	Dielectric breakdown			Result
	MΩ	MΩ	Yes (description)	No		
3	1481	>20.88	--	No		P
4	1460	>20.88	--	No		P
Supplementary information: NA						

10.12 C	**TABLE: Humidity freeze 10 test**					—
Test Date [MM/DD/YYYY] start/end.....:			08/21/2015 - 09/01/2015			—
Total cycles (10) ..... :			10			—
Sample #	Open circuits (yes/no)					—
3	NO					P
4	NO					P
Supplementary information: NA						
(10.1 Visual inspection after humidity freeze 10 test)						—
Test Date [MM/DD/YYYY].....:			09/01/2015			—
Sample #	Nature and position of initial findings – comments or attach photos					—
3	NO VISUAL DEFECTS					P
4	NO VISUAL DEFECTS					P
Supplementary information: NA						
(10.2 Maximum power determination after humidity freeze 10 test)						—
Test Date [MM/DD/YYYY].....:			09/01/2015			—
Module temperature [°C].....:			25			—
Irradiance [W/m^2).....:			1000			—
Sample #	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]
3	45.745	36.609	8.858	8.289	303.457	74.90
4	45.801	36.692	8.831	8.855	302.881	74.90
Pmp degradation after this test [%] ≤ 5%..... :			3) 0.715 & 4) 0.931			
Supplementary information: NA						
(10.3 Insulation test after humidity freeze 10 test)						
Test Date [MM/DD/YYYY].....:			09/01/2015			—
Test Voltage applied [V] .....:			3000 (for 1 min) 1000V for 2 min			—
Sample #	Measured	Required	Dielectric breakdown			Result
	MΩ	MΩ	Yes (description)	No		
3	927	>20.88	--	No		P
4	891	>20.88	--	No		P
Supplementary information: NA						

10.14 C1	**TABLE: Robustness of terminations test**					—
Test Date [MM/DD/YYYY] start/end...:			09/04/2015			—
Types of terminations			☐Type A: wire of flying lead ☐Type B: tags, threaded stubs, screws, etc. ☒Type C: connector			—
Applied force in all directions [N] ..... :			12.5			—
Sample #	Open circuits (yes/no)					—
3	NO					P
Supplementary information: NA						
(10.1 Visual inspection after robustness of terminations test)						—
Test Date [MM/DD/YYYY] ..... :			09/04/2015			—
Sample #	Nature and position of initial findings – comments or attach photos					—
3	NO VISUAL DEFECTS					P
Supplementary information: NA						
(10.2 Maximum power determination after robustness of terminations test)						—
Test Date [MM/DD/YYYY] ..... :			09/04/2015			—
Module temperature [°C] ..... :			25			—
Irradiance [W/m^2) ..... :			1000			—
Sample #	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]
3	45.827	36.435	8.848	8.287	301.944	74.50
Pmp degradation after this test [%] ≤ 5% ..... :			0.309			
Supplementary information: NA						
(10.3 Insulation test after robustness of terminations test)						
Test Date [MM/DD/YYYY] ..... :			09/04/2015			—
Test Voltage applied [V] ..... :			3000 (for 1 min) 1000V for 2 min			—
Sample #	Measured	Required	Dielectric breakdown			Result
	MΩ	MΩ	Yes (description)	No		
3	1051	>20.88	--	No		P
Supplementary information: NA						

10.11 D	**TABLE: Thermal cycling 200 test**					—
Test Date [MM/DD/YYYY] start/end.....:			07/22/2015 - 08/31/2015			—
Total cycles (200) ..... :			200			—
Applied current [A] ..... :			8.52			
Sample #	Open circuits (yes/no)					—
7	NO					P
8	NO					P
Supplementary information: NA						
(10.1 Visual inspection after thermal cycling 200 test)						—
Test Date [MM/DD/YYYY].....:			08/31/2015			—
Sample #	Nature and position of initial findings – comments or attach photos					—
7	NO VISUAL DEFECTS					P
8	NO VISUAL DEFECTS					P
Supplementary information: NA						
(10.2 Maximum power determination after thermal cycling 200 test)						—
Test Date [MM/DD/YYYY].....:			08/31/2015			—
Module temperature [°C].....:			25			—
Irradiance [W/m^2].....:			1000			—
Sample #	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]
7	45.877	36.53	8.741	8.126	296.843	74.00
8	45.836	36.435	8.831	8.217	299.391	74.00
Pmp degradation after this test [%] ≤ 5%..... :			7) 2.999 & 8) 1.668			
Supplementary information: NA						
(10.3 Insulation test after thermal cycling 200 test)						
Test Date [MM/DD/YYYY].....:			08/31/2015			—
Test Voltage applied [V].....:			3000 (for 1 min) 1000V for 2 min			—
Sample #	Measured	Required	Dielectric breakdown			Result
	MΩ	MΩ	Yes (description)	No		
7	816	>20.88	--	No		P
8	719	>20.88	--	No		P
Supplementary information: NA						

10.13 E	**TABLE: Damp heat 1000 test**					—
Test Date [MM/DD/YYYY] start/end..... :			07/17/2015 - 09/01/2015			—
Total hours (1000) ..... :			1000			—
Sample #	Open circuits (yes/no)					—
5	NO					P
6	NO					P
Supplementary information: NA						
(10.1 Visual inspection after damp heat 1000 test)						—
Test Date [MM/DD/YYYY] ..... :			09/01/2015			—
Sample #	Nature and position of initial findings – comments or attach photos					—
5	NO VISUAL DEFECTS					P
6	NO VISUAL DEFECTS					P
Supplementary information: NA						
(10.3 Insulation test after damp heat 1000 test)						
Test Date [MM/DD/YYYY] ..... :			09/01/2015			—
Test Voltage applied [V] ..... :			3000 (for 1 min) 1000V for 2 min			—
Sample #	Measured	Required	Dielectric breakdown			Result
	MΩ	MΩ	Yes (description)		No	
5	813	>20.88	--		No	P
6	719	>20.88	--		No	P
(10.15 Wet leakage current test after damp heat 1000 test)						
Test Date [MM/DD/YYYY] ..... :			09/01/2015			—
Test Voltage applied [V] ..... :			1000			
Solution resistivity [Ω cm) ..... :			< 3,500 Ω cm at 22 ± 3°C	3499		
Surface tension [Nm^{-2}) ..... :			< 0.03 Nm^{-2} at 22 ± 3°C	--		
Solution temperature [°C] ..... :			25			
Sample #	Measured [MΩ]		Limit [MΩ]			Result
5	310		>20.88			P
6	281		>20.88			P
Supplementary information: NA						
(10.2 Maximum power determination after damp heat 1000 test)						—
Test Date [MM/DD/YYYY] ..... :			09/01/2015			—
Module temperature [°C] ..... :			25			—
Irradiance [W/m^2) ..... :			1000			—
Sample #	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]
5	45.899	37.151	8.795	8.237	306.018	75.80
6	45.928	37.017	8.815	8.270	306.151	75.60
Pmp degradation after this test [%] ≤ 5% ..... :			5) 0.437 & 6) 0.088			

Supplementary information: NA

10.16 E1	**TABLE: Mechanical load test**			P
Sample # ..... :	5			—
Test Date [MM/DD/YYYY] ..... :	09/03/2015			—
Mounting method ..... :	AS PER MANUFACTURERS INSTRUCTIONS			
Load applied to ..... :	front side	back side		—
Mechanical load [Pa] ..... :	2400	2400		—
First cycle time (start/end) ..... :	10:30-11:30	11:30-12:30		—
Intermittent open-circuit (yes/no) ..... :	No	No		
Mechanical load [Pa] ..... :	2400	2400		
Second cycle time (start/end) ..... :	12:30-01:30	1:30-2:30		—
Intermittent open-circuit (yes/no) ..... :	No	No		
Mechanical load [Pa] ..... :	2400	2400		
Third cycle time (start/end) ..... :	2:30-3:30	3:30-4:30		—
Intermittent open-circuit (yes/no) ..... :	No	No		
Supplementary information: Such as Maximum bending at module center. NA				

(10.1 Visual inspection after mechanical load test)						—
Test Date [MM/DD/YYYY] ..... :	09/04/2015					—
Sample #	Nature and position of initial findings – comments or attach photos					—
5	NO VISUAL DEFECTS					P
Supplementary information: NA						
(10.2 Maximum power determination after mechanical load test)						—
Test Date [MM/DD/YYYY] ..... :	09/04/2015					—
Module temperature [°C] ..... :	25					—
Irradiance [W/m^2] ..... :	1000					—
Sample #	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]
5	45.743	36.991	8.751	8.193	303.081	75.70
Pmp degradation after this test [%] ≤ 5% ..... :	0.959					
Supplementary information: NA						
(10.3 Insulation test after mechanical load test)						
Test Date [MM/DD/YYYY] ..... :	09/04/2015					—
Test Voltage applied [V] ..... :	3000 (for 1 min) 1000V for 2 min					—

Sample #	Measured	Required	Dielectric breakdown		Result
	MΩ	MΩ	Yes (description)	No	
5	1298	>20.88	--	No	P
Supplementary information: NA					

10.17 E2	**TABLE: Hail impact test**					—
Test Date [MM/DD/YYYY] ..... :			09/04/2015			—
Ice ball size [mm] ..... :			24.9			—
Ice ball weight [g]			7.52			---
Ice ball velocity [m/s]			23.1			
Number of impact locations ..... :			11			
Sample #	Open circuits (yes/no)					—
6	NO					P
Supplementary information: (impact location descriptions) NA						
(10.1 Visual inspection after hail impact test)						—
Test Date [MM/DD/YYYY] ..... :			09/04/2015			—
Sample #	Nature and position of initial findings – comments or attach photos					—
6	NO VISUAL DEFECTS					P
Supplementary information: NA						
(10.2 Maximum power determination after hail impact test)						—
Test Date [MM/DD/YYYY] ..... :			09/04/2015			—
Module temperature [°C] ..... :			25			—
Irradiance [W/m^2) ..... :			1000			—
Sample #	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]
6	45.791	36.659	8.806	8.256	302.671	75.10
Pmp degradation after this test [%] ≤ 5% ..... :			1.136			
Supplementary information: NA						
(10.3 Insulation test after hail impact test)						
Test Date [MM/DD/YYYY] ..... :			09/04/2015			—
Test Voltage applied [V] ..... :			1000 / 3000			—
Sample #	Measured	Required	Dielectric breakdown			Result
	MΩ	MΩ	Yes (description)		No	
6	1058	>20.88	--		No	P
Supplementary information: NA						

10.2 F	TABLE: Maximum power determination (Final)							—
Module temperature [°C]..... :	25							—
Irradiance [W/m^2)..... :	1000							—
Sample #	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]	Degradation [%]	Limit [%]
1(Ctrl)	45.856	37.007	8.784	8.285	306.614	76.10	0	8
2	45.480	36.079	8.799	8.268	298.289	74.50	1.600	8
3	45.745	36.609	8.858	8.289	303.457	74.90	1.418	8
4	45.827	36.435	8.848	8.287	301.944	74.50	1.272	8
5	45.743	36.991	8.751	8.193	303.081	75.70	1.392	8
6	45.791	36.659	8.806	8.256	302.671	75.10	1.224	8
7	45.877	36.53	8.741	8.126	296.843	74.00	2.999	8
8	45.836	36.435	8.831	8.217	299.391	74.00	1.668	8
Supplementary information: NA								

10.15 F	TABLE: Wet leakage current test (Final)			—
Test Voltage applied [V] ..... :	1000			—
Solution resistivity [Ω cm)..... :	< 3,500 Ω cm at 22 ± 3°C	3499		
Surface tension [Nm^{-2})..... :	< 0.03 Nm^{-2} at 22 ± 3°C	--		
Solution temperature [°C]..... :	19/25			
Sample #	Measured [MΩ]	Limit [MΩ]		Result
1	170	>20.88		P
2	264.1	>20.88		P
3	277	>20.88		P
4	285	>20.88		P
5	297	>20.88		P
6	306	>20.88		P
7	279	>20.88		P
8	310	>20.88		P
Supplementary information: Size of module [m²] 1.916				

---------- End of TRF No. IEC61215----------