HI PHYSIX
testing & calibration laboratory
TC-5100

HI PHYSIX LABORATORY INDIA PVT. LTD.
B-32/1/2, MIDC, Ranjangaon, Pune, Maharashtra
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TEST REPORT
IEC 61701: 2011
Salt mist corrosion testing of photovoltaic (PV) modules

ULR-TC510023000000262F **Discipline:** Electronics Testing **Group:** Miscellaneous Products	
Report Number.....: **Date of Issue** .....: **Total no. of pages**.....:	HPLI/Test/2211050702 14/03/2023 19
Manufacturer's Name.....: **Address**.....:	**SWELECT HHV SOLAR PHOTOVOLTAICS PRIVATE LIMITED.** SF. NO. 166,169, SEMBAGOUNDEN PUDUR, NO 51, KUPPAEPALAYAM VILLAGE, SARCARSAMAKULAM, COIMBATORE DIST, TAMIL NADU, India-641107 **Contact Person** :Mr.Mirunalini Chellappan **Contact number** : 9900015990
Name of test laboratory.....: **Address of laboratory**.....:	**HI PHYSIX LABORATORY INDIA PVT. LTD.** B-32/1/2, MIDC, RANJANGAON, PUNE, MAHARASHTRA - 412220
Test Specification Standard.....:	**IEC 61701: 2011 (Severity 6)**
Test Procedure .....:	Compliance Report
Non- Standard Test Method.....:	N/A
Test Report Form No.....: **Test Report Form(s) Originator**.....: **Test Report Form** .....:	IEC 61701: 2011/HPLI_PV Hi Physix Laboratory India Pvt. Ltd., Pune Dated 11-2018
Test item Description .....: **Trade Mark**.....:	Crystalline silicon terrestrial photovoltaic (PV) module swelect

FOR HI PHYSIX LABORATORY INDIA PVT. LTD.

Ashutosh Pathak
(Chief Technical Manager)

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Model / Type reference .....:	**SWM11BN6540 (Representative Model).** SWM11BN6535, SWM11BN6530, SWM11BN6525, SWM11BN6520, SWM11BN6515, SWM11BN6510, SWM11BN6505, SWM11BN6500 SWM11BN4495, SWM11BN4490, SWM11BN4485, SWM11BN4480, SWM11BN4475, SWM11BN4470, SWM11BN4465, SWM11BN4460, SWM11BN4455 SWM11BN2450, SWM11BN2445, SWM11BN2440, SWM11BN2435, SWM11BN2430, SWM11BN2425, SWM11BN2420, SWM11BN2415, SWM11BN2410 SWM11BN0405, SWM11BN0400, SWM11BN0395, SWM11BN0390, SWM11BN0385, SWM11BN0380, SWM11BN0375, SWM11BN0370, SWM11BN0365
Ratings.....:	See copy of marking plate on page no. 5
Remark:	The Test performed on Model No. **SWM11BN6540 (Representative Model).** All series models mentioned in this test report as per customer request only.

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Testing procedure and testing location:		
☒ **Testing Laboratory**:		
Testing location/ address.....:	Hi Physix Laboratory India Private Limited B-32/1/2 M.I.D.C, Ranjangaon Pune Maharashtra -412220	
Tested by (name + signature) .....:	Santosh Tawhare (Testing Engineer)	
Approved by (name + signature).:	Ashutosh Pathak (Chief Technical Manager)	(FOR HI PHYSIX LABORATORY INDIA PVT. LTD.) Ashutosh Pathak (Chief Technical Manager)
Issued by (name, function, Signature).....	(K. K. Jayaswal/ Chief Quality Manager)	HI PHYSIX LABORATORY INDIA PVT. LTD. Hi PHYSIX ★ INDIA ★

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Summary of testing:	
Tests performed (name of test and test clause): IEC 61701: 2011 **Severity 6**	**Testing location:** Hi Physix Laboratory India Private Limited. B-32/1/2 M.I.D.C, Ranjangaon Pune Maharashtra - 412220.
Preconditioning	
MST 01 Visual Inspection (Initial and Final)	
10.2 Maximum power determination (Initial and Final)	
MST 16 Dielectric withstand test (Initial and Final)	
10.15 Wet leakage current test (Initial and Final)	
MST 13 Ground continuity test (Initial and Final)	
Salt mist test according to IEC 60068-2-52, Severity 6	
Bypass diode functionality test	

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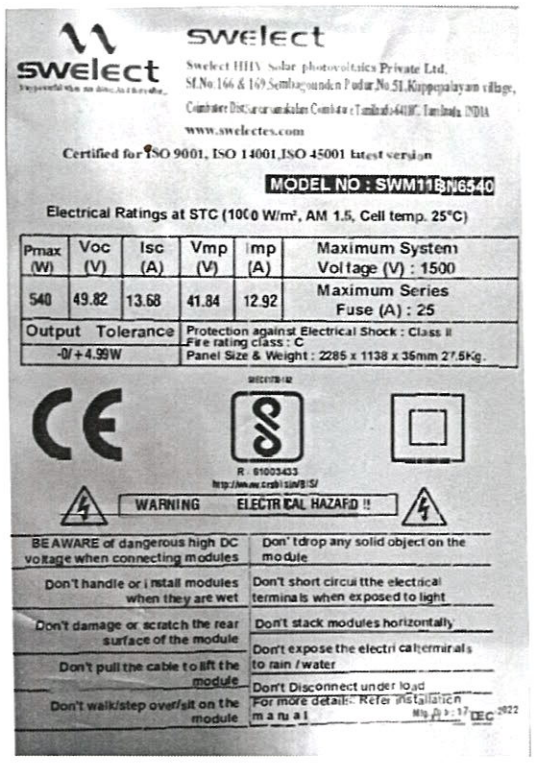
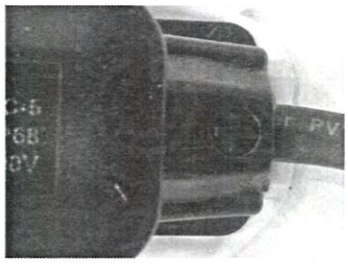
Copy of marking plate on the backside of the Module:



Copy of marking laminated inside the glass:

(All serial No: mention on page No: 7)

Polarity of terminals or leads:



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Test item particulars:	Crystalline silicon terrestrial photovoltaic (PV) modules. (Poly-crystalline)
Accessories and detachable parts included in the evaluation .....:	N/A
Options included .....:	N/A
Abbreviations used in the report:	
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	STC – Standard Test Conditions
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)
- Date(s) of performance of tests.....:	07/01/2023 to 13/03/2023
- Receipt Number.....:	22110507
- Date of Deposit.....:	15/11/2022

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.
The Management System is maintained in accordance with IS/ISO/IEC 17025:2005 and testing Standards/Instruments are traceable to National / International Standards.
"(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 point is used as the decimal separator.

Module group assignment:

Sample #	Sample Group ID	Sample No. & S/N
SWM11BN6540	1	1 & SW13622A00119
	2	2 & SW13622A00055
	3	3 & SW13622A00030

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Sr. No.	Tests with clause reference	Specified Requirements	*Covered under our NABL Scope (Yes/No)*	RESULTS	Verdict
1.	Cl. No. 4.2 of IEC 61701: 2011 **(Bypass diode functionality test)**	a) To verify that the diodes(s) of the samples remains functional following the salt fog exposure	Yes	Complies	P
2.	Cl. No. 6 of IEC 61701: 2011 **(Initial Measurements)**	The following initial measurements shall be performed on the selected sample depending on the PV module technology being evaluated	Yes	See below	P
		a) Maximum power determination (10.2) according to IEC 61215		See table 10.2	P
		b) Wet leakage Test 10.15) according to IEC 61215		See table 10.15	P
		c) Visual inspection (MST01) according to IEC 61730-2		See table MST01	P
		d) Ground continuity Test (MST13) according to IEC 61730-2		See table MST13	P
		e) Dielectric withstand test (MST16) according to IEC 61730-2		See table MST16	P
3.	Cl. No. 7 of IEC 61701: 2011 **(Salt mist test procedure)**	Apply to the test samples under study the salt mist test as described in IEC 60068-2-52.	Yes	See table Performance of salt mist corrosion test (Severity 6)	P
4	Cl. No. 9 of IEC 61701: 2011 **(Final Measurements)**	After the salt mist test the test samples shall be subjected to the following tests depending on the PV module technology	Yes	See below	P
		a) Maximum power determination (10.2) according to IEC 61215		See table 10.2	P
		b) Wet leakage Test 10.15) according to IEC 61215		See table 10.15	P
		c) Visual inspection (MST01) according to IEC 61730-2		See table MST01	P

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Sr. No.	Tests with clause reference	Specified Requirements	*Covered under our NABL Scope (Yes/No)*	RESULTS	Verdict
		d) Ground continuity Test (MST13) according to IEC 61730-2	Yes	See table MST13	P
		e) Dielectric withstand test (MST16) according to IEC 61730-2		See table MST16	P
		f) Bypass diode functionality test		See table Bypass diode functional test after salt mist corrosion test	P

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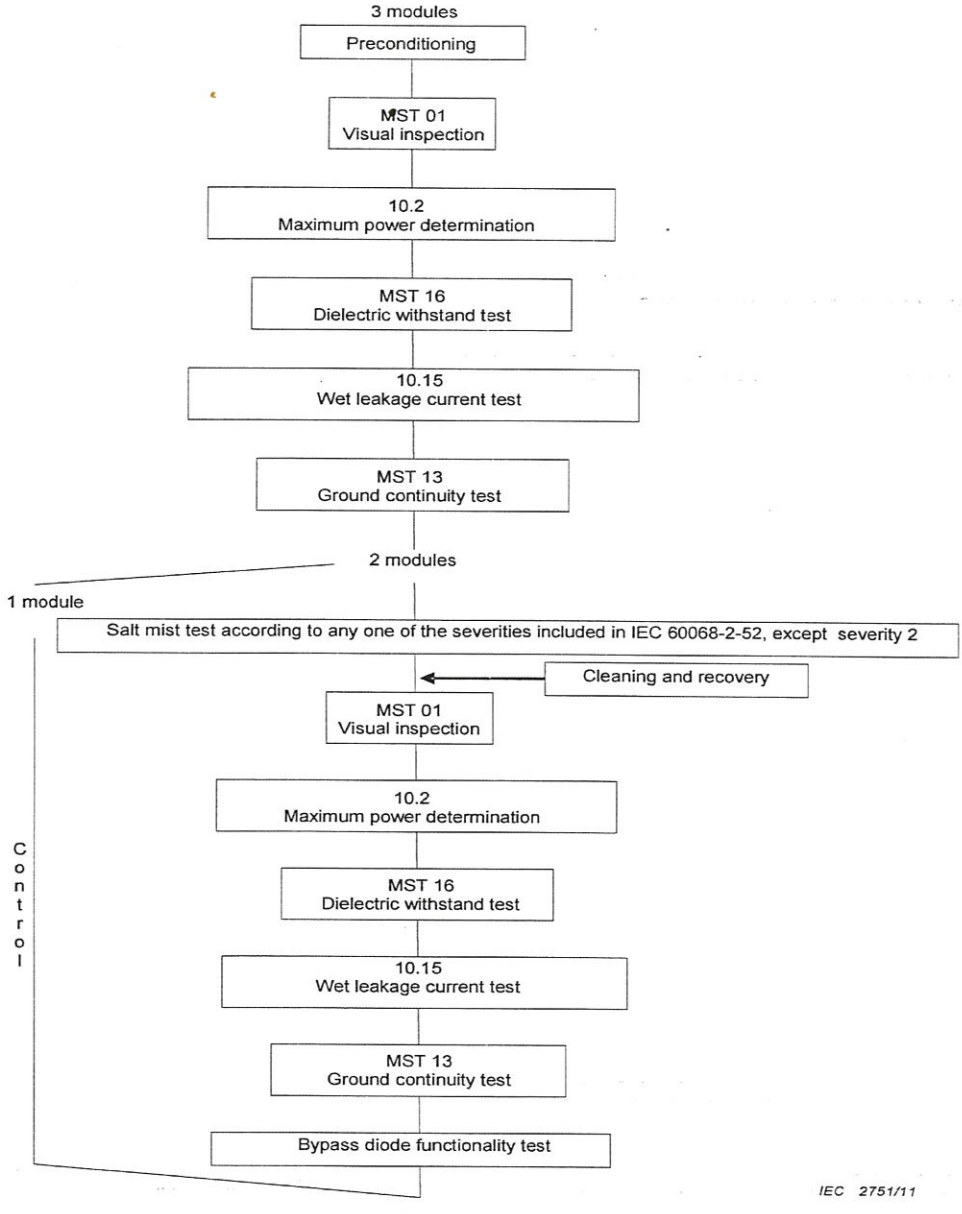

NOTE 1 Preconditioning and tests 10.2 and 10.15 are taken from IEC 61215. Tests MST 01, MST 13 and MST 16 are taken from IEC 61730-2.

NOTE 2 The control module should be used as a check every time the test modules are measured to evaluate the effect of the salt mist test.

Figure 1 – Salt mist corrosion testing sequence for crystalline silicon PV modules

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TABLES

Visual Inspection (Initial) (MST01)

TABLE: Visual inspection (Initial)		**P**
Test Date [MM/DD/YYYY]..... :	01/07/2023	—
Sample #	Nature and position of initial findings – comments or attach photos	—
1	No visual defects observed	P
2	No visual defects observed	P
3	No visual defects observed	P
Supplementary information: Nil		

Maximum power determination (Initial) (10.2)

TABLE: Maximum power determination (Initial)						P
Test Date [MM/DD/YYYY]..... :	01/08/2023					—
Module temperature [°C]..... :	25					—
Irradiance [W/m²)..... :	1000					—
Sample #	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]
1	49.768	41.200	14.039	13.169	542.59	77.65
2	49.753	41.202	13.962	13.101	539.80	77.70
3	49.756	41.169	14.008	13.151	541.45	77.68
Supplementary information: Temperature corrected to 25°C and Irradiance corrected to 1000 W/m²						

Dielectric withstand test (Initial) (MST 16)

TABLE: Dielectric Withstand Test - MST 16 (Initial)				**P**
Test Date [MM/DD/YYYY]..... :	01/08/2023			—
	Maximum system voltage [V_{DC}] ..... :	1500V		—
	Test voltage applied V_{TEST} [V_{DC}] ..... :	2 minutes of 1500V and 1 minute of 8000V		—
	Module area A [m²] ..... :	2.60		—
Sample No.	Dielectric breakdown	Insulation resistance at V_{TEST} [MΩ]	Insulation resistance x A [MΩ·m²]	—
1	☒	>2000	40	P
2	☒	>2000	40	P
3	☒	>2000	40	P
Supplementary information: ☒ Means **No** Dielectric breakdown, Minimum requirement according to the standard is 40 MΩ·m².				

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Wet leakage current test (Initial) (10.15)

TABLE: Wet leakage current test (Initial)				P
Test Date [MM/DD/YYYY]..... :		01/09/2023		—
Test Voltage applied [V] ..... :		1500		—
Solution resistivity [Ω cm)..... :		< 3,500 Ω cm at 22 ± 3°C	2440	—
Surface tension [Nm^{-1}) .....:		< 0.03 Nm^{-1} at 22 ± 3°C	0.025	—
Solution temperature [°C].....:		24°C		—
Sample #	Measured [MΩ]	Limit [MΩ]		Result
1	>2000	15.38		P
2	>2000	15.38		P
3	>2000	15.38		P
Supplementary information: Size of module 2.60 [m^2], Minimum requirement according to the standard is 40MΩ-m^2.				

Ground continuity test (Initial) (MST 13)

TABLE: Ground Continuity Test - MST 13 (Initial)				P
Test Date [MM/DD/YYYY] .....:		01/09/2023		—
	Maximum system voltage [V_{DC}].....:	1500V		—
	Current applied [A].....:	62.5A		—
	Location of designated grounding point .....:	Two grounding holes on sides of frames		—
	Location of second contacting point .....:	Greatest physical displacement from the grounding point.		—
Sample No.		Voltage [V_{DC}]	Resistance [Ω]	—
1		0.20	0.003	P
2		0.30	0.005	P
3		0.20	0.003	P
Supplementary information: Nil				

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Performance of salt mist corrosion test (Severity 6)

Test Date [MM/DD/YYYY] ..... :	01/09/2023 to 03/06/2023	—
NaCl concentration..... :	5%	—
Course of cycle	Test method 6 of IEC 60068-2-52 used	—
Duration..... :	8 cycles = 56 Days (one cycle = 7days)	—
Sample No.	--	—
2	--	P
3	--	P
Supplementary information: Nil		

Visual inspection after salt mist corrosion test (MST 01)

TABLE: Visual inspection		**P**
Test Date [MM/DD/YYYY] ..... :	03/10/2023	—
Sample #	Nature and position of initial findings – comments or attach photos	—
2	No visual defects observed	P
3	No visual defects observed	P
Supplementary information: Nil		

Maximum power determination after salt mist corrosion test (10.2)

TABLE: Maximum power determination						P
Test Date [MM/DD/YYYY] ..... :	03/10/2023					—
Module temperature [°C] ..... :	25					—
Irradiance [W/m²) ..... :	1000					—
Sample #	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]
2	49.741	41.214	13.849	12.984	535.14	77.68
3	49.745	41.181	13.934	13.074	538.42	77.67
Pmp degradation after this test [%]				2: - 0.86	3: - 0.56	P
Supplementary information: Temperature corrected to 25°C and Irradiance corrected to 1000 W/m²						

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Dielectric withstand after salt mist corrosion test (MST 16)

TABLE: Dielectric Withstand Test - MST 16				**P**
Test Date [MM/DD/YYYY]..... :	03/10/2023			—
	Maximum system voltage [V_{DC}] ..... :		1500V	—
	Test voltage applied V_{TEST} [V_{DC}] ..... :		2 minutes of 1500V and 1 minute of 8000V	—
	Module area A [m²] ..... :		2.60	—
Sample No.	Dielectric breakdown	Insulation resistance at V_{TEST} [MΩ]	Insulation resistance x A [MΩ·m²]	—
2	☒	>2000	40	P
3	☒	>2000	40	P
Supplementary information: ☒ Means **No** Dielectric breakdown, Minimum requirement according to the standard is 40 MΩ·m².				

Wet leakage current test after salt mist corrosion test (10.15)

TABLE: Wet leakage current test				P
Test Date [MM/DD/YYYY]..... :		03/10/2023		—
Test Voltage applied [V] ..... :		1500		—
Solution resistivity [Ω cm) ..... :		< 3,500 Ω cm at 22 ± 3°C	2550	—
Surface tension [Nm^{-1}) ..... :		< 0.03 Nm^{-1} at 22 ± 3°C	0.025	—
Solution temperature [°C]..... :		24°C		—
Sample #	Measured [MΩ]	Limit [MΩ]		Result
2	>2000	15.38		P
3	>2000	15.38		P
Supplementary information: Size of module 2.60 [m²], Minimum requirement according to the standard is 40MΩ-m².				

FOR HI PHYSIX LABORATORY INDIA PVT. LTD.
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Chief Technical Manager

Ground continuity test after salt mist corrosion test (MST 13)

TABLE: Ground Continuity Test - MST 13			**P**
Test Date [MM/DD/YYYY] .....:	03/10/2023		—
	Maximum system voltage [V_{DC}] .....:	1500V	—
	Current applied [A] .....:	62.5 A	—
	Location of designated grounding point .....:	Two grounding holes on sides of frames	—
	Location of second contacting point .....:	Greatest physical displacement from the grounding point.	—
Sample No.	Voltage [V_{DC}]	Resistance [Ω]	—
2	0.10	0.002	P
3	0.20	0.003	P
Supplementary information: Nil			

Bypass diode functional test after salt mist corrosion test

Test Date [MM/DD/YYYY] ..... :	03/13/2023		—
Number of diodes in Junction box.....:	3		
Sample No.	Diode 1	Diode 2	Diode 3
2	P	P	P
3	P	P	P
Supplementary information: Nil			

List of Annexes

Annex 1: List of measurement equipment

Annex 2: Statement of the estimated uncertainty of the test results

Annex 3: Enclosures

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Annex 1: List of measurement equipment

Description	Identification #	Application
1.Visual inspection test setup	HPLI/U2/TEST/145	Visual inspection test
2.GSolar Simulator	HPLI/T-E/651	Maximum power determination
3. Large area steady state solar simulator with I-V Tracer	HPLI/U2/TEST/025	Maximum power determination, Bypass diode functionality test,
4.DC Voltage source & insulation tester	HPLI/U2/TEST/151	Insulation test & wet leakage current test
5. Wet leakage test setup	HPLI/U2/TEST/202	Wet leakage current test
6. Heating chamber	HPLI/U2/TEST/038	Bypass diode thermal test
7. Measuring tape	HPLI/U2/TEST/007	For dimension of PV modules.
8. Preconditioning test setup	HPLI/U2/TEST/056	For preconditioning test
9. Salt Mist Chamber	HPLI/U2/TEST/039	Salt Mist exposure

Annex 2: Statement of the estimated uncertainty of the test results

The total measuring uncertainty of Pmpp is ±2.4%

The total measuring uncertainty of Isc is ±2%

The total measuring uncertainty of Voc is ±0.9%

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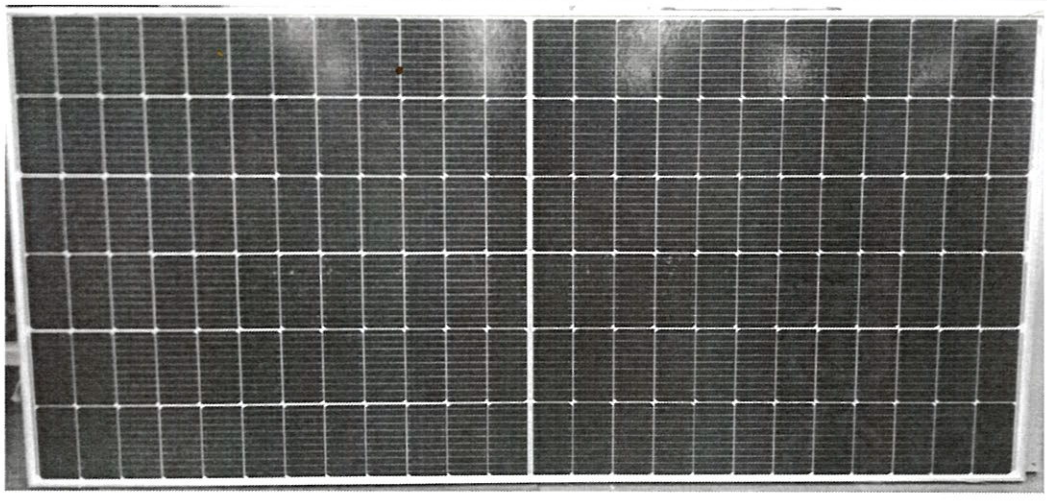
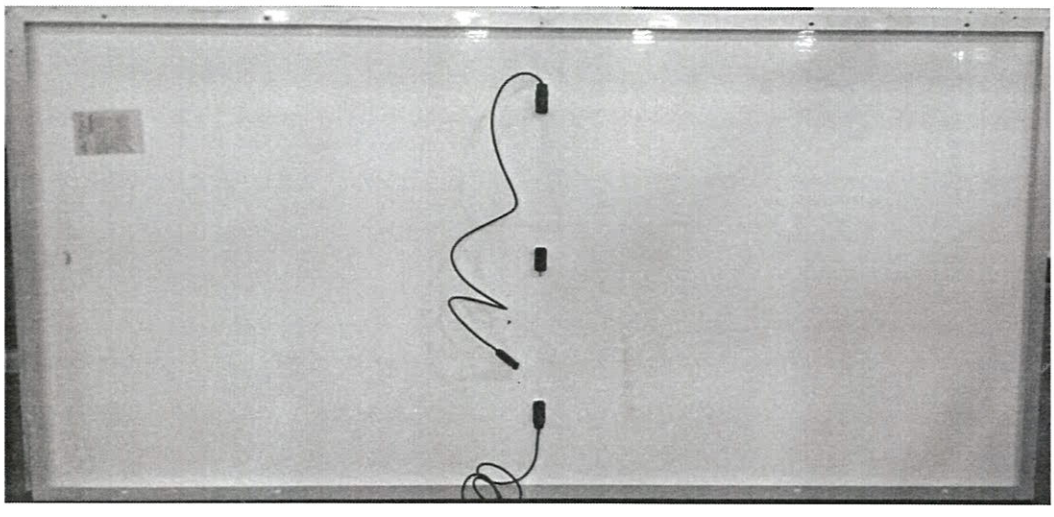
Annex 3: Enclosures (PHOTOGRAPHS OF PV MODULE UNDER TEST)



Front View



Rear View

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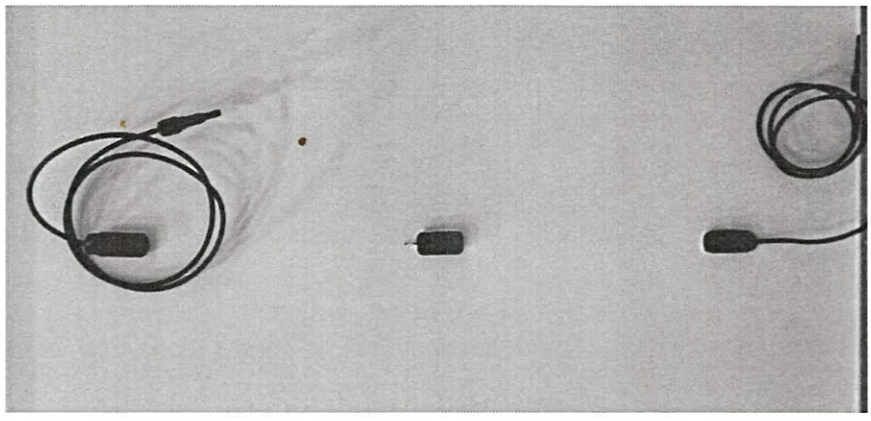
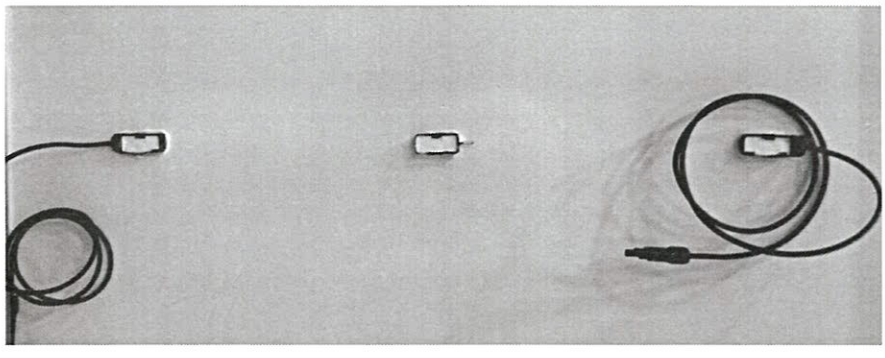
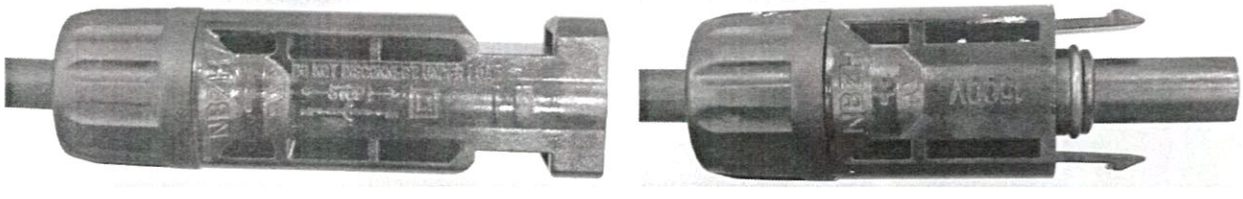


Junction box closed view



Junction box Opened view



Connector view

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Annex 4: Bill of Material		
Sr No.	**Objective / part no.**	**Type/model/ Technical data**
1	Bypass diode	35SQ045, Tj: -55 to 200C, Manufactured by Zhejiang Zhonghuan Sunter PV Technology Co.Ltd.
2	Front Cover	Shakti Matt-Matt, Transmission data: >94%, Thickness: 3.2mm, Manufactured by Borosil Renewables Limited. Alternate Manufacturer: Dongguan CSG Solar Glass Co. ltd
3	Rear cover (Backsheet)	Cynagard 205A(R), Thickness: 320± 20µm, RTI: 120°C Max.sys voltage:1500VDC, FSI:30.67, Manufactured by Cybrid Technologies Inc.
4	Encapsulation material	CONSERV P 360-14FC, CONSERV P UVT-14FC,Top EVA Thickness: 0.6mm, Bottom EVA Thickness:0.55mm, Manufactured by RenewSys India Private Limited.
5	Frame parts	Material/Coating:6063-T5, Drawing no.:SW1C0000002_REV00 Sh 1 of 2- Long Frame, SW1C0000002_REV00 Sh 2 0f 2-Short Frame, SW1C0000018_REV00 Sh 1 of 1-Profile, SW1C0000019-REV00 Sh 1 of 1-Corner Key, Manufacturer by Jiangyin Optimal Metal Technology Co.Ltd, **Alternate Manufacturer** Jiangyin Tianmu Green Energy Technology Co.Ltd, Lead Solar Holdings Co.Ltd.
6	Cell & String connectors:	**Cell Connector:** TPVIR3260, Dimension: 0.32, Composition of alloy: ≥99.97% Copper, Manufactured by Valeo Products LLP. **Alternate manufacture:** Taicang Juren PV Material Co., Ltd Wexi Sveck Technology co., Ltd
		String connectors: TPVB603560, dimension: 0.35x6 mm, Composition of alloy: ≥ 99.97% Copper, Manufactured by Valeo Products LLP. **Alternate manufacture:** Taicang Juren PV Material Co., Ltd Wexi Sveck Technology co., Ltd
7	Junction box	PV-ZH011C-5, Max. Voltage: 1500V, Max. Current: 25A, RTI: 110°C, Manufactured by Zheijiang Zhonghuan Sunter PV Technology Co.Ltd
8	Cable	Max. Voltage: 1500V, RTI: 120°C, Manufactured by Zheijiang Zhonghuan Sunter PV Technology Co.Ltd

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9	Connector	PV-ZH202B, Max. Voltage: 1500V, Max. Current: 30A RTI: 110°C, Manufactured by Zheijiang Zhonghuan Sunter PV Technology Co.Ltd.
10	Fluxing Agent	952-S, Flux Type-018S, Manufactured by Kester, Metal Chem.
11	Soldering Material	Sn/Pb- 60/40, Manufactured by Hybrid Metals Pvt.Ltd.
12	Adhesive for frame	HT906Z, Manufactured by Shanghai Huitian New Material Co.Ltd.
13	Adhesive for junction box	HT906Z, Manufactured by Shanghai Huitian New Material Co.Ltd.
14	Potting material	5299W-S, Manufactured by Shanghai Huitian New Material Co.Ltd.
15	Solar Cell	60002517/60002528, Type: 7M9E1018A-L1, dimensions: 182mm x 182mm±0.25mm, Power classes:7.66 W, Manufactured by Zhejiang Aiko Solar Energy Technology Co., Ltd.
16	Cell Fixing Tape	8306, FF-3665, Manufactured by 3M, Cybrid Technologies Inc.

All Bill of materials are declared by manufacturer.

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Ashutosh Pathak
(Chief Technical Manager)