





Product Service

<b>TEST REPORT</b> <b>82/576/CD</b> <b>Salt mist corrosion testing of photovoltaic (PV) modules</b>	
Report Reference No.....	68.290.11.011.01
Compiled by (+ signature) .....	Laura Wang 
Approved by (+ signature) .....	Harry Zhang 
Date of issue.....	2011-07-25
<b>Testing Laboratory</b> .....	Jiangsu TÜV Product Service Ltd. - Shenzhen Branch
Address.....	6/F, H Hall, Century Craftwork Culture Square, No. 4001, Fuqiang Road, Futian District, Shenzhen 518048 P.R. China
<b>Applicant's name</b> .....	BYD CO LTD.
Address.....	Baolong Industrial Town, 1 Bao Ping Rd. , 518116 Longgang, Shenzhen, Guangdong, PEOPLE'S REPUBLIC OF CHINA
<b>Test specification:</b>	
Standard :	82/576/CD (IEC 61701 Draft D)
Test procedure .....	Test report
Non-standard test method.....	N/A
<b>Test Report Form No.</b> .....	TÜV_82/576/CD
Test Report Form Originator.....	TÜV SÜD Product Service
Master TRF.....	Dated 2011-07
<b>Test item description</b> .....	Poly-crystalline Silicon Photovoltaic (PV) Module(s)
Trade Mark .....	BYD
Manufacturer.....	Shanghai BYD Company Limited No. 999, Xiangjing Road, Songjiang 201611 Shanghai, PEOPLE'S REPUBLIC OF CHINA
Model/Type reference.....	BYD235P6-30
Ratings.....	$V_{oc}$ : 37.07 V; $I_{sc}$ : 8.69 A; $P_{max}$ : 235 W

**Summary of testing:**

**Tests performed (name of test and test clause):**

**Clause 6.1, Initial measurements:**

- MST 01: Visual inspection
- 10.2: Maximum power determination
- MST 16: Dielectric withstand test
- 10.15: Wet leakage current test
- MST 13: Ground continuity test

**Clause 9.1, Final measurements:**

- MST 01: Visual inspection
- 10.2: Maximum power determination
- MST 16: Dielectric withstand test
- 10.15: Wet leakage current test
- MST 12: Ground continuity test
- Bypass diode functionality test

**Clause 7: Salt mist corrosion test**

in accordance with DIN EN 60068-2-52 for Severity level 5

**Testing location:**

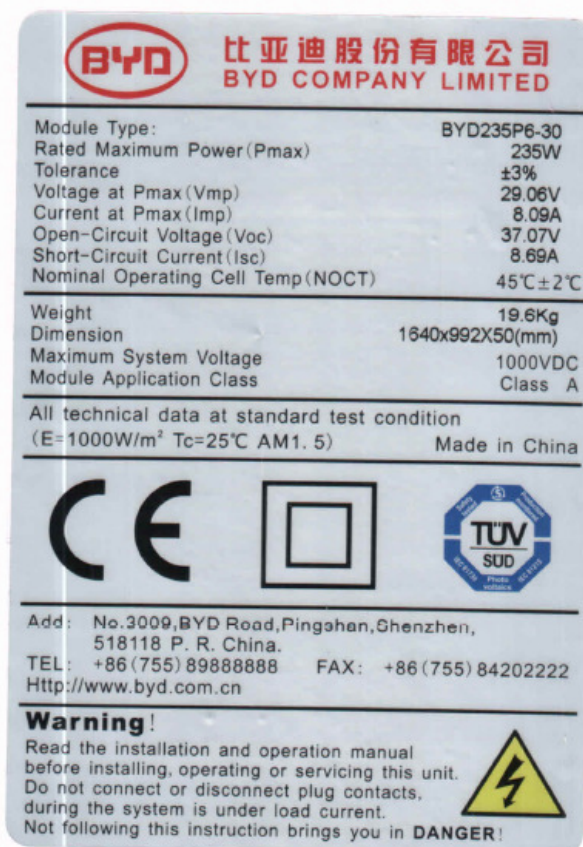
PI Photovoltaik-Institut Berlin AG  
 Wrangelstraße 100  
 D-10997, Berlin, Germany  
 (Performed initial and final measurements)

TechnoLab  
 Am Borsigturm 46  
 D-13507 Berlin, Germany  
 (Performed Salt mist corrosion test)

**Summary of compliance with National Differences:**

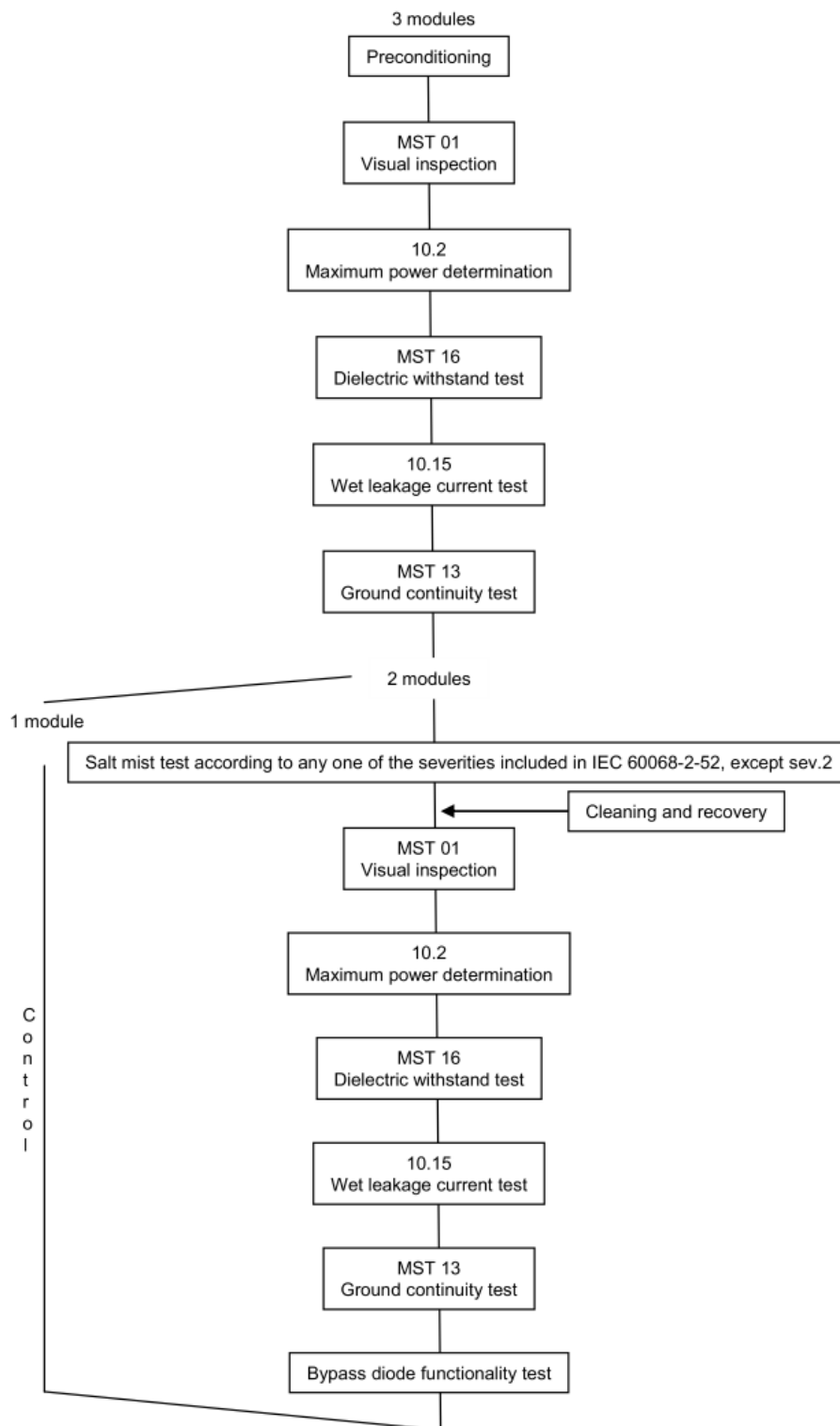
N/A

**Copy of marking plate:**



<b>Test item particulars</b> .....	
Accessories and detachable parts included in the evaluation.....	N/A
Option included.....	N/A
<b>Possible test case verdicts:</b>	
- test case does not apply to the test object .....	N/A
- test object does meet the requirement .....	P (Pass)
- test object does not meet the requirement .....	F (Fail)
<b>Testing</b> .....	
Date of receipt of test item.....	2011-04-16
Date (s) of performance of tests.....	2011-04-16– 2011-07-01
<b>Abbreviations used in the report:</b>	
STC – Standard Test Conditions	SMC – Salt Mist Corrosion
Imp – Maximum power current	Vmp – Maximum power voltage
Isc - Short circuit current	Voc – Open circuit voltage
Pmp – Maximum power	WL -- Wet leakage current
<b>General remarks:</b>	
<p>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.</p> <p>Throughout this report a point is used as the decimal separator.                  Summary of contents provided on the last page of this report.</p>	
<b>General product information and considerations:</b>	
<b>Product Electrical Ratings:</b>	
Type or model number	BYD235P6-30
Voc (Vdc)	37.07
Vmp (Vdc)	29.06
Imp (Adc)	8.09
Isc (Adc)	8.69
Pmax (W)	235
Maximum system voltage:	1000Vdc
Serial number (Sample #)	1. SH110324P630B-T-0086 2. SH110324P630B-T-0078 3. SH110324P630B-T-0106
Polarity of terminals or leads	"+" and "-" polarity is marked on the connectors

**Figure 1 Salt mist corrosion testing sequence for crystalline silicon PV modules (if it is not a full test, strikethrough non-performed test)**





82/607/CDV			
Clause	Requirement + Test	Result--Remark	Verdict
<b>3</b>	<b>Samples</b>		P
	— Three identical samples of the model of PV module or assembly of interest must be subjected to any of the testing sequences included in Figures 1, 2, or 3.		P
	— Full-size sample or representative sample	Full-size sample	P
	— PV module provided with means for grounding then they constitute a part of the test sample.		P
<b>4</b>	<b>Test procedures</b>		P
	— All tests included in Figures 1, 2 or 3, except the bypass diode functionality test, are fully described in the IEC standards	Figure 1 applied	P
4.1	Bypass Diode Functionality Test		P
<b>5</b>	<b>Preconditioning</b>		P
	— All test samples must be preconditioned with either global or direct normal sunlight according to the specifications given in the applicable Design Qualification and Type Approval IEC standard applicable.		P
<b>6</b>	<b>Initial Measurements</b>		P
6.1	Crystalline silicon	See appended table	
	— Tests according to IEC 61215 a) 10.2: Maximum power determination b) 10.15: Wet leakage current test	See appended table	P
	— Tests according to IEC 61730-2 c) MST 01: Visual inspection d) MST 12: Ground continuity test e) MST 16: Dielectric withstand test	See appended table	P
6.2	Thin-film technologies		N/A
	— Tests according to IEC 61646 a) 10.2: Maximum power determination b) 10.15: Wet leakage current test		N/A
	— Tests according to IEC 61730-2 c) MST 01: Visual inspection d) MST 12: Ground continuity test e) MST 16: Dielectric withstand test		N/A
6.3	Concentrator photovoltaic (CPV) modules		N/A

82/607/CDV			
Clause	Requirement + Test	Result--Remark	Verdict
	– Tests according to IEC 62108 a) 10.1: Visual inspection b) 10.2: Electrical performance measurement c) 10.3: Ground path continuity test d) 10.4: Electrical insulation test e) 10.5: Wet insulation test		N/A
<b>7</b>	<b>Salt mist corrosion test</b>		P
	Salt mist corrosion test in accordance with IEC 60068-2-52 following the general conditions, apparatus, characteristics of the salt solution, severities and other specifications included.		P
	– Severity level 3 For products which are under normal use exposed to frequent change between salt-laden and dry atmosphere.		N/A
	– Preconditioning: not required		N/A
	– Conditioning: specimen position: the inclination to the vertical of the face of the module normally exposed to solar irradiance shall be 15° to 30°		N/A
	– Duration of the test: 96h		N/A
	– Severity level 5 For products which are under normal use exposed to frequent change between salt-laden and dry atmosphere.		P
	– Preconditioning: not required		P
	– Conditioning: specimen position: the inclination to the vertical of the face of the module normally exposed to solar irradiance shall be 15° to 30°	30°	P
	– Duration of the test: 96h	See appended table	P
<b>8</b>	<b>Cleaning and recovery</b>		P
	– After the salt mist test all samples must be washed to remove the adherent salt using running tap water for a maximum time of 5 minutes per square meter of area of the sample.		P
<b>9</b>	<b>Final Measurements</b>		P
9.1	Crystalline silicon	See appended table	P
	– Tests according to IEC 61215 a) 10.2: Maximum power determination b) 10.15: Wet leakage current test	See appended table	P

82/607/CDV			
Clause	Requirement + Test	Result--Remark	Verdict
	<ul style="list-style-type: none"> <li>– Tests according to IEC 61730-2</li> <li style="padding-left: 20px;">c) MST 01: Visual inspection</li> <li style="padding-left: 20px;">d) MST 12: Ground continuity test</li> <li style="padding-left: 20px;">e) MST 16: Dielectric withstand test</li> </ul>	See appended table	P
9.2	Thin-film technologies		N/A
	<ul style="list-style-type: none"> <li>– Tests according to IEC 61646</li> <li style="padding-left: 20px;">a) 10.2: Maximum power determination</li> <li style="padding-left: 20px;">b) 10.15: Wet leakage current test</li> </ul>		N/A
	<ul style="list-style-type: none"> <li>– Tests according to IEC 61730-2</li> <li style="padding-left: 20px;">c) MST 01: Visual inspection</li> <li style="padding-left: 20px;">d) MST 12: Ground continuity test</li> <li style="padding-left: 20px;">e) MST 16: Dielectric withstand test</li> </ul>		N/A
9.3	Concentrator photovoltaic (CPV) modules		N/A
	<ul style="list-style-type: none"> <li>– Tests according to IEC 62108</li> <li style="padding-left: 20px;">a) 10.1: Visual inspection</li> <li style="padding-left: 20px;">b) 10.2: Electrical performance measurement</li> <li style="padding-left: 20px;">c) 10.3: Ground path continuity test</li> <li style="padding-left: 20px;">d) 10.4: Electrical insulation test</li> <li style="padding-left: 20px;">e) 10.5: Wet insulation test</li> </ul>		N/A
	<ul style="list-style-type: none"> <li>– Tests according to this standard:</li> <li style="padding-left: 20px;">f) By pass diode functionality test</li> </ul>		N/A

<b>10</b>	<b>Requirements</b>		P
<b>10.1</b>	Crystalline silicon		P
	– After the salt mist test, no evidence of major visual defects as described in IEC 61730-2;		P
	– After the salt mist test the maximum power shall not decrease by more than 5% of the initial value;	See appended table	P
	– All pass fail criteria corresponding to tests 10.15, MST 13 and MST 16 must be fulfilled;	See appended table	P
	– The requirement for the bypass diode functionality test must be also fulfilled.	See appended table	P
<b>10.2</b>	Thin-film technologies		N/A
	– After the salt mist test, no evidence of major visual defects as described in IEC 61730-2;		N/A
	– After the light soaking the maximum power at STC shall not be less than 90% of the minimum value specified by the manufacturer in the marking of the PV module;		N/A
	– All pass fail criteria corresponding to tests 10.15,10.19, MST 13 and MST 16 must be fulfilled;		N/A



82/607/CDV			
Clause	Requirement + Test	Result--Remark	Verdict
	— The requirement for the bypass diode functionality test must be also fulfilled.		N/A
<b>10.3</b>	Concentrator photovoltaic (CPV) modules		N/A
	— After the salt mist test, no evidence of major visual defects as described in IEC 62108 including also no mechanical deterioration or corrosion of test sample components which would significantly impair their function during their intended life. No significant amount of water should remain inside the test sample;		N/A
	— After the salt mist test the relative power degradation shall not exceed 7% if the I-V measurement is under outdoor natural sunlight, or 5% if I-V measurement is under solar simulator;		N/A
	— All pass fail criteria corresponding to tests 10.3, 10.4 and 10.5 must be fulfilled ;		N/A
	— The requirement for the bypass diode functionality test must be also fulfilled.		N/A





6-c)	TABLE: Visual inspection (Initial)	P
Test Date [MM/DD/YYYY].....:	2011-04-16	—
Sample No.	Nature and position of initial findings – comments or attach photos	Verdict
1	No major visual defects	P
2	No major visual defects	P
3	No major visual defects	P
Supplementary information: N/A		

6-a)	TABLE: I-V characteristic at STC (Initial)	P				
Test Date [MM/DD/YYYY].....:	2011-04-16	—				
Radiant Source.....:	<input checked="" type="checkbox"/> Solar simulator <input type="checkbox"/> Natural Sunlight	—				
Module temperature [°C]..... :	Corrected to 25	—				
Irradiance [W/m <sup>2</sup> ]..... :	Corrected to 1000	—				
Sample No.	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]
1	37.50	29.42	8.527	8.052	236.9	74.08
2	37.63	29.50	8.533	8.025	236.7	73.72
3	37.69	29.50	8.553	8.059	237.7	73.76
Supplementary information: Type of solar simulator: Class A type Pasan SS3b Temperature coefficients: $\alpha = 0.045\%/K$ $\beta = -0.34\%/K$ $\delta = -0.47\%/K$						

6-e)	TABLE: Insulation test (Initial)	P			
Test Date [YYYY-MM-DD]..... :	2011-04-16	—			
Test Voltage applied [V]..... :	1000/6000	—			
Sample #	Measured	Required	Dielectric breakdown		Result
	MΩ	MΩ	Yes (description)	No	
1	10000	24.7	--	No	P
2	10000	24.7	--	No	P
3	10000	24.7	--	No	P
Supplementary information: Size of module [m <sup>2</sup> ]: 1.62m <sup>2</sup>					

<b>6-b)</b>		<b>TABLE: Wet leakage current test (Initial)</b>	<b>P</b>
Test Date [MM/DD/YYYY].....:		2011-04-16	—
Test voltage applied [V] .....		1000 Vdc	—
Module maximum system voltage rating (V, DC).....:		1000	—
Solution resistivity [ $\Omega$ cm], < 3,500 $\Omega$ cm at 22 $\pm$ 3 $^{\circ}$ C.....:		Yes	—
Sample No.	Measured [ $M\Omega$ ]	Limit [ $M\Omega$ ]	Result
1	179.7	24.7	P
2	146.8	24.7	P
3	153.7	24.7	P
Supplementary information: Size of module [ $m^2$ ]: 1.62 $m^2$			

<b>6-d)</b>		<b>MST 13 – ground continuity test (Initial)</b>	<b>P</b>	
Maximum over-current protection rating (A) .....		15A	—	
Current applied (A) .....		15*2.5=37.5A	—	
Location of designated grounding point.....:		On the middle of the longest frame	—	
Location of second contacting point.....:		Adjacent frame	—	
Sample No.	Position in test sequence:	Volatge (V)	Resistance ( $\Omega$ )	
1	Initial examination	0.235	0.006	P
2	Initial examination	0.260	0.007	P
3	Initial examination	0.190	0.005	P
Supplementary information: N/A				

<b>7</b>		<b>TABLE: Salt mist corrosion test</b>	<b>P</b>
Temperature of test chamber .....		35 $^{\circ}$ C $\pm$ 2 $^{\circ}$ C	—
Salt solution concentration .....		5.0 % by weight	—
Test cycle sequence .....		Salt fog duration: 2h Humid storage: 22h Repeated 4 times = 4 days Subsequent drying at room temperature for 3 days	—
Total duration of one cycle.....:		7 days	—
Number of cycles .....		4	—
Humid storage .....		40 $^{\circ}$ C $\pm$ 2 $^{\circ}$ C, relative humidity 90% ~95%	—
Test duration.....:		28 days	—
Drying temperature .....		23 $^{\circ}$ C $\pm$ 2 $^{\circ}$ C	—
Supplementary information: Salt mist test based on DIN EN 60068-2-52.			

9-c)		TABLE: Visual inspection (Final)	P
Test Date [MM/DD/YYYY].....:		2011-06-27	—
Sample No.	Nature and position of initial findings – comments or attach photos		Verdict
2	No major visual defects, but on cells waste soldering and frame sealing delamination		P
3	No major visual defects, but frame sealing delamination.		P
Supplementary information:			

9-a)		TABLE: Maximum power determination (final)						P
Test Date [MM/DD/YYYY] start-end .....		2011-06-27						—
Module temperature [°C] low-high .....		corrected to 25						—
Irradiance [W/m <sup>2</sup> ] low-high.....		corrected to 1000						—
Sample #	V <sub>oc</sub> [V]	V <sub>mp</sub> [V]	I <sub>sc</sub> [A]	I <sub>mp</sub> [A]	FF [%]	P <sub>mp</sub> [W]	Degradation [%]	Limit [%]
2	37.33	29.88	8.446	7.821	74.10	233.7	-1.3	-5
3	37.37	29.55	8.457	7.935	74.18	234.5	-1.3	-5
Supplementary information:								
Type of solar simulator: Class A type Pasan SS3b								
Temperature coefficients:								
$\alpha = 0.045\%/K$								
$\beta = -0.34\%/K$								
$\delta = -0.47\%/K$								

9-e)		Table: Insulation test (initial)				P
Test Date [YYYY-MM-DD] .....		2011-6-28				—
Test Voltage applied [V] .....		1000/6000				—
Sample #	Measured	Required	Dielectric breakdown		Result	
	MΩ	MΩ	Yes (description)	No		
2	30	24.7	--	No	P	
3	36	24.7	--	No	P	
Supplementary information: Size of module [m <sup>2</sup> ]: 1.62m <sup>2</sup>						

9-b)		TABLE: Wet leakage current test (Final)	P
Test Date [MM/DD/YYYY].....:		2011-06-28	—
Test voltage applied [V] .....		1000 Vdc	—
Module maximum system voltage rating (V, DC)..... :		1000	—
Solution resistivity [Ω cm], < 3,500 Ω cm at 22 ± 3 °C..... :		Yes	—



Sample No.	Measured [MΩ]	Limit [MΩ]	Verdict
2	109	24.7	P
3	121	24.7	P
Supplementary information: Size of module [m <sup>2</sup> ]: 1.62m <sup>2</sup>			

9-d)	MST 13 – ground continuity test			P
	Maximum over-current protection rating (A) .....	15A		—
	Current applied (A) .....	15*2.5=37.5A		—
	Location of designated grounding point .....	On the middle of the longest frame		—
	Location of second contacting point .....	Adjacent frame		—
Sample No.	Position in test sequence:	Volatge (V)	Resistance (Ω)	
2	Salt mist corrosion	Preconditioning		—
	Final examination	0.312	0.008	P
3	Salt mist corrosion	Preconditioning		—
	Final examination	0.0875	0.002	P
Supplementary information: N/A				

9-f)	TABLE: Bypass diode functionality test						P
Test Date [MM/DD/YYYY] start-end .....	2011-06-29						—
Number of diodes in junction box .....	6						—
Diode manufacturer .....	HY Electronic						—
Diode type designation .....	10SQ050						—
Max. permissible junction temperature T <sub>Jmax</sub> [°C] (according to diode datasheet) .....	200						—
Sample No.	D1	D2	D3	D4	D5	D6	
2	P	P	P	P	P	P	—
3	P	P	P	P	P	P	—
Supplementary information: N/A							

*Photos of samples*



## Annex 1: List of measurement equipment

### List of measurement equipment: performed initial and final measurements in PI Photovoltaik-Institut Berlin AG

Origin: X:\QMB\Managementsystem\qma\Organisation\Kalibrierung\Geräteliste.xls

Updated [MM/DD/YYYY]: 11/12/2010

device	Identification	Application
Multimeter, Agilent	53	Wet leakage test
Dielectrimeter DXS50	54	Wet leakage test
Conductance measuring stick	55	Wet leakage test
Pt1000 thermometer	56	Wet leakage test/Iso
Dielectrimeter DXS56	73	Iso
PC	92	Sun simulator STC-Flasher
Camera	96	Visual Inspection
Infrared thermometer	105	Sun simulator STC-Flasher
Hair dryer	108	Wet leakage test
Monitor cell mtp	113	Sun simulator STC-Flasher
Humidity/temperature sensor	134	Wet leakage test/Iso
Camera	137	Visual Inspection
Camera	142	Visual Inspection
Camera	155	Visual Inspection
Lux Meter	157	Visual inspection
Precision multimeter	163	Iso
Data logger	174	Wet leakage test/Iso+accessibility test+ Impulse voltage test
Data logger	178	Wet leakage test/Iso+accessibility test+ Impulse voltage test
monitor cell mtfp	179	Sun simulator STC-Flasher
Pt1000 thermometer	199	Iso/Wet leakage test
Water boiler 1	209	Wet leakage test
Water boiler 2	210	Wet leakage test
Laptop	211	Wet leakage test/Iso+accessibility test+ Impulse voltage test
Power supply (STC-Flasher)	213	Sun simulator STC-Flasher
Sun simulator STC-Flasher	224	Sun simulator STC-Flasher
Temp. Sensor - Ambient	14-0	Temperature coefficient, NOCT, bypass diode
Temp. Sensor - Ambient	15-0	Temperature coefficient, NOCT, bypass diode
Temp. Sensor - Module	16-0	Temperature coefficient, NOCT, bypass diode
Temp. Sensor - Module	17-0	Temperature coefficient, NOCT, bypass diode
Pt-100 Sensor	18-0	Temperature coefficient, NOCT, bypass diode
Pt-100 Sensor	19-0	Temperature coefficient, NOCT, bypass diode
Pt-1000 Sensor	6-0	Sun simulator STC-Flasher
Power supply	4	Bypass Diode Test
Power supply	58	Bypass Diode Test
Test site	666	Bypass diode test

### List of measurement equipment: Performed Salt mist corrosion test in TechnoLab

device	Identification	Application
Temperature-Almemo 2590-4S	H10121127	Salt mist corrosion
Thermocouple Type K-M4052	RS397-1494	Salt mist corrosion
Reference Temperaturesensor-PT100	RS-236-4299	Salt mist corrosion

END OF REPORT