

# TEST REPORT

**Nr AR 11 TEST 055**  
11/1010

**Cat. 0**

## AMMONIA RESISTANCE TEST

Issued to:

**Ferrania Solis S.r.l.**  
Viale della Libertà 57, Ferrania  
17014 Cairo Montenotte (SV) – Italy

Sample description:

**Tested PV module type: AP 60-225**

**Extended PV module type:**

Model name	Cell number	Cell size [mm]	Module size [mm]	Cell technology	Rated power [W]
AP 72-XXX	72	156 x 156	-	Polycrystalline	From 255 to 290 with 5W steps
AP 60-XXX	60	156 x 156	1663 x 998	Polycrystalline	From 210 to 240 with 5W steps
AP 54-XXX	54	156 x 156	-	Polycrystalline	From 190 to 220 with 5W steps
AP 48-XXX	48	156 x 156	-	Polycrystalline	From 170 to 195 with 5W steps
AP 36-XXX	36	156 x 156	-	Polycrystalline	From 125 to 145 with 5W steps
AP 32-XXX	32	156 x 156	-	Polycrystalline	124
AP 28-XXX	28	156 x 156	-	Polycrystalline	108
AP24-XXX	24	156 x 156	-	Polycrystalline	93
AP 21-XXX	21	156 x 156	-	Polycrystalline	81
AP 15-XXX	15	156 x 156	-	Polycrystalline	58
AP 12-XXX	12	156 x 156	-	Polycrystalline	46
AP 9-XXX	9	156 x 156	-	Polycrystalline	35
AP 6-XXX	6	156 x 156	-	Polycrystalline	23
AP 4-XXX	4	156 x 156	-	Polycrystalline	15

Annexes: 2

**Test result: Pass**

The test results indicated in this paper are exclusively referred to the describe sample and in the specified conditions of measure. Any other extension of the results to other samples or other conditions of measure outside to the scope of this document.

The partial replication of the present test report is forbidden if it is not authorized in writing by Albarubens S.r.l


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Issue date:  
May 4, 2011

Head of the laboratory:  
Dott. Ing Giuseppe Terzaghi

<b>Summary of testing:</b>	
<b>Tests performed (name of test and test clause):</b> Ammonia test	<b>Testing location:</b> Laboratorio Albacert via Consorziale Saronnino, 70 21040 Origgio (VA) - Italy

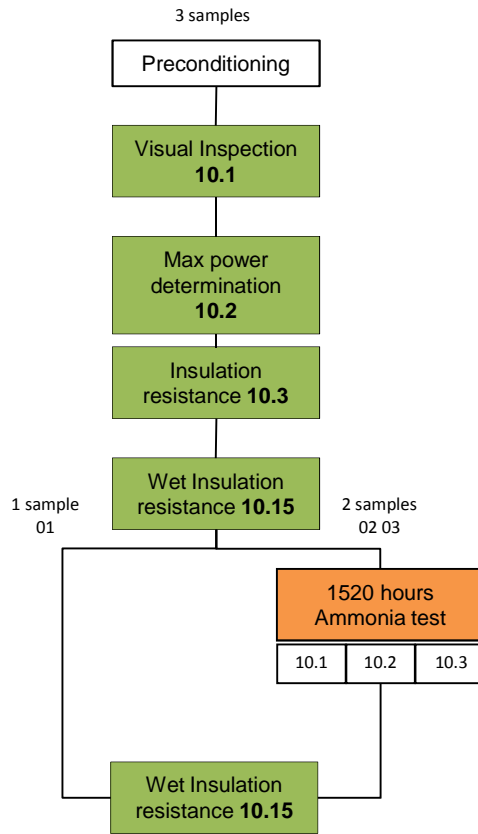
<b>GENERAL INFORMATION</b>	
<b>Possible test case verdicts:</b>	
- test case does not apply to the test object .....	N/A
- test object does meet the requirement .....	Pass (P)
- test object does not meet the requirement .....	Fail (F)
<b>General remarks:</b>	
The test results presented in this report 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.	
<b>Testing:</b>	
Date of receipt of test item [YYYY/MM/DD] .....	2011/01/14
Date (s) of performance of tests [YYYY/MM/DD] :	Start 2011/02/18 – End 2011/05/02
<b>Test item description:</b>	
<b>Trade Mark</b>	<i>ferrania solis</i>
<b>Manufacturer</b>	Ferrania Solis S.r.l.
<b>Module type</b>	AP 60-225
<b>Safety application class</b>	II
<b>Maximum system voltage [V]</b>	1000
<b>Maximum over-current protection rating [A]</b>	—

<b>Product Electrical Ratings:</b>		<b>Copy of marking plate:</b>	
<b>AP 60-225</b>			
<b>Voc [V]</b>	<b>37.41</b>		
<b>Vmp [V]</b>	<b>29.10</b>		
<b>Imp [A]</b>	<b>7.85</b>		
<b>Isc [A]</b>	<b>8.45</b>		
<b>Pmp [W]</b>	<b>225</b>		
<b>Maximum system voltage [V]</b>	<b>1000</b>		
<b>Series Fuse Rating [A]</b>	—		

<b>Description of module construction: (Manufactories and part numbers, unless otherwise specified)</b>	
Sample.....:	Random sampling from production <input checked="" type="checkbox"/> Prototype submitted by client <input type="checkbox"/>

<b><u>Module</u></b>	
Front Cover.....:	Tempered solar glass – 4mm
Rear Cover.....:	White polymeric laminate
Encapsulation material.....:	EVA
Frame.....:	Aluminum frame, anodized Al 6060 Anticorodal
Dimensions (l x w x h) [mm].....:	1663 x 998 x 45
Module area [m <sup>2</sup> ].....:	1.65
<b><u>Cell</u></b>	
Cell (include type).....:	Poly-Si
Cells (l x w) [mm].....:	156 x 156
Cell thickness [μm].....:	—
Cell area [cm <sup>2</sup> ].....:	243.36
Number of cells.....:	60
<b><u>Components and other</u></b>	
Cells per bypass diode.....:	20
Type of bypass diode.....:	—
No. of bypass diodes.....:	3
Junction box.....:	IP65 – Class II
Cable.....:	—
Connectors.....:	—
Adhesives (junction box).....:	—

**Testing procedure**



**Module assignment:**

Lab Serial Number	Sample
201165	FER60A110111AH0090
201167	FER60A110111AH0082
201168	FER60A110111AH0083

**AMMONIA resistance test**

Clause	Requirement + Test	Result - Remark	Verdict
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	<b>Initial examination</b>	All modules	—
10.1	Visual inspection..... :	See table 10.1 Int	P
10.2	Maximum power determination ..... :	See table 10.2 Int	P
10.3	Insulation test ..... :	See table 10.3 Int	P
10.15	Wet leakage current test	See table 10.15 Int	P

<b>Control Module</b>	Lab Serial Number: 201165		—
<b>Test Modules and procedure</b>	Lab Serial Number: 201167 Lab Serial Number: 201168		—
	Ammonia test		<b>Verdict</b>
	Final measurements:		
	10.1, 10.2, 10.3, 10.15	See table Ammonia test	<b>P</b>

<b>10.1 Initial</b>	<b>TABLE: Visual inspection (Initial).</b>		—
Test Date [MM/DD/YYYY].....:	2011/02/18		—
<b>Sample #</b>	<b>Nature and position of initial findings – comments or attach photos</b>		<b>Verdict</b>
201165	No visual defects		P
201167	The cell F10 is broken near the bus bar		P
201168	No visual defects		P

Supplementary information:



Figure 1: cell F10 of the sample # 201167 is broken near the bus bar.

<b>10.2 Initial</b>	<b>TABLE: Maximum power determination (initial)</b>			—
Test Date [MM/DD/YYYY].....:	2011/02/18			—
Module temperature [°C] .....	*			—
Irradiance [W/m <sup>2</sup> ] .....	*			—
	<b>Sample #</b>	<b>First Ratio <sup>1</sup> (A)</b>	<b>STD <sup>2</sup></b>	<b>Result</b>
	201167	1.007	0.0020	N/A
	201168	1.004	0.0019	N/A

Supplementary information:

\* Relative measurements with different module temperature and irradiance (between 700 W/m<sup>2</sup> and 1100 W/m<sup>2</sup>) were performed. All 10.2 test performed in this test the report uses 201165 as control module.

<sup>1</sup> First Ratio between control module and measured

<sup>2</sup> STD "standard deviation" this value be ≤ 0.01%

10.3 Initial		Table: Insulation test (initial)			—
Test Date [MM/DD/YYYY] .....		2011/02/18			—
Test Voltage applied [V] .....		3000 for dielectric breakdown 1000 for insulation resistance measurement			—
Sample #	Measured	Required	Dielectric breakdown		Result
	MΩ	MΩ	Yes (description)	No	
201165	2220	> 24		x	P
201167	2110	> 24		x	P
201168	2390	> 24		x	P
Supplementary information: Size of module [m <sup>2</sup> ] = 1.65					

10.15 Initial		TABLE: Wet leakage current test (Initial)			—
Test Date [MM/DD/YYYY] .....		2011/02/18			—
Test Voltage applied [V] .....		1000			—
Solution resistivity [Ω cm] .....		< 3,500			
Surface tension [Nm <sup>-2</sup> ] .....		N/A			
Solution temperature [°C] .....		24			
Sample #	Measured [MΩ]	Limit [MΩ]			Result
201167	532	> 24			P
201168	558	> 24			P
Supplementary information: Size of module [m <sup>2</sup> ] = 1.65					

<b>Ammonia test</b>	<b>TABLE: Ammonia Test</b>			—
Test Date [MM/DD/YYYY] start/end.....:	2011/02/28 – 2011/05/02			—
Total hours .....	1520			—
Air temperature [°C].....	70			—
Relative air humidity [%].....	70			—
Ammonia concentration [ppm].....	750			—
<b>Sample #</b>	<b>Open circuits (yes/no)</b>			<b>Verdict</b>
201167	Yes			P
201168	Yes			P
Supplementary information: none				
<b>(10.1 Visual inspection after ammonia test)</b>				—
Test Date [MM/DD/YYYY] .....	2011/05/02			—
<b>Sample #</b>	<b>Nature and position of initial findings – comments or attach photos</b>			<b>Verdict</b>
201167	Nothing to report			P
201168	Nothing to report			P
Supplementary information: none				
<b>(10.3 Insulation test after ammonia test)</b>				
Test Date [MM/DD/YYYY] .....	2011/05/02			—
Test Voltage applied [V] .....	3000 for dielectric breakdown 1000 for insulation resistance measurement			—
<b>Sample #</b>	<b>Measured</b>	<b>Required</b>	<b>Dielectric breakdown</b>	<b>Result</b>
	MΩ	MΩ	Yes (description) No	
201167	3860	> 24		X P
201168	3340	> 24		X P
Supplementary information: none				
<b>(10.15 Wet leakage current test after ammonia test)</b>				
Test Date [MM/DD/YYYY] .....	2011/05/02			—
Test Voltage applied [V] .....	1000			—
Solution resistivity [Ω cm] .....	< 3,500			—
Surface tension [Nm <sup>-2</sup> ].....	N/A			—
Solution temperature [°C].....	24			—
<b>Sample #</b>	<b>Measured [MΩ]</b>	<b>Limit [MΩ]</b>	<b>Result</b>	
201167	78	> 24	P	
201168	66	> 24	P	
Supplementary information: none				

<b>(10.2 Maximum power determination after ammonia test)</b>					—
Test Date [MM/DD/YYYY] .....	2011/05/03				—
Module temperature [°C].....	*				—
Irradiance [W/m <sup>2</sup> ] .....	*				—
<b>Sample #</b>	<b>Ratio after test (C)</b>	<b>A – C</b>	<b>STD</b>	<b>Result</b>	
201167	0.989	-1.8%	0.0027	—	
201168	1.001	-0.3%	0.0012	—	
Difference between First Ratio and Ratio after test (A-C) [%] ≤ 5%					P
Supplementary information: * Relative measurements with different module temperature and irradiance (between 700 W/m <sup>2</sup> and 1100 W/m <sup>2</sup> ) were performed. All 10.2 test performed in this test the report uses 201165 as control module.					

----- End of Test Report No. AR 11 TEST 055-----

**List of Annexes**

- Annex 1: List of measurement equipment
- Annex 2: Statement of the estimated uncertainty of the test results

**Annex 1: List of measurement equipment**

Description	Identification #	Application
Digital caliper	3.3	10.1
Millimetric scale LTF	3.8	10.1
Luxmeter, LP471PHOT, DeltaOhm	3.16	10.1
Examination table	6.28	10.1
Double support	6.5	10.2,
Pyranometer, CMP11, Kipp & Zonen	4.14 a1/a2	10.2
Consolle	4.14	10.2
Insulator tester, Metriso 5000 D-PI	3.10 / 3.25	10.3, 10.15
Conductivity meter	5.1	10.15
Tank	6.9	10.15
Ammonia test chamber	4.78	Ammonia resistance test
NH <sub>3</sub> sensor	4.78 a1	Ammonia resistance test
NH <sub>3</sub> sample	3.31	Ammonia resistance test

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

The measurement uncertainties stated in this document have been determined according to EA-4/02. they were estimated as expanded uncertainty obtained multiplying the standard uncertainty by the coverage factor k corresponding to a confidence level about 95%. Normally, this factor k is 2.

10.2 Maximum power determination = 2.0%

10.3 Insulation resistance test / 10.15 Wet leakage current test: Resistance = 30.1%

Temperature = 0.66%

Humidity = 3.44%