

SCHOTT SOLAR AG

Resistance to ammonia

Thin film PV module ASI™ 110 DG (97-105 Wp)

DLG Test Report 5970F



Manufacturer/applicant

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Evaluation in summary form

Test criteria	Test result (comparison before/after climate chamber test with ammonia)	Rating*
Performance stability		
	Slight increase in performance, depends on the cell technology	++
Visual examination		
	No damage, spots on the surface of the glass	+
Insulation test and wet insulation resistance		
	The requirements were met. In spite of a decrease, there is a sufficient level of insulation resistance remaining	N.R.

Evaluation table

The following evaluation table is used for the DLG focus test "Resistance to ammonia":

Evaluation	Test result: performance stability	Test result: visual examination
++	≤ -2%	no abnormalities
+	> -2,0% to ≤ -3,5%	very low abnormalities
○	> -3,5% to ≤ -5,0%	slight abnormalities

The DLG focus test "Resistance to ammonia" is considered to have been approved if the insulation requirements are met and the "performance stability" and "visual examination" test criteria are rated as at least "standard".

* Range of evaluations: ++/+/○/-- (○ = standard)/N.R. = no result

Principal technical data (Manufacturer's information)

Design

Thin film double glass solar module (PV module) made from amorphous silicon solar cells (a-Si) consisting of:

- solar cells made from a-Si/a-Si tandem cells. 96 cells in 3 strings of 32 cells. embedded in double glass
- front glass 1.8 mm. rear glass 3.2 mm and a frame made from an aluminium profile

Connection

Connection	2 junction boxes. single pole IP65 without bypass diode from Lumberg. sealed with 2K silicone
Cable	Solar cable 2.5 mm ² with LC4 connectors. 800 mm long

Module electrical data (Type: SCHOTT ASI™ 100 DG)

	stable value	initial value
Nominal power, P _{MPP}	≥ 100.0	122.0
Current at nominal power, I _{MPP}	2.38	2.65
Voltage at nominal power, U _{MPP}	42.0	46.1
Short-circuit current, I _{SC}	2.67	2.96
Open-circuit voltage, U _{OC}	51.0	56.7
Module efficiency	7.0 %	
Nominal performance tolerance	± 5 %; for the remaining values ± 10 %	
Temperature coefficients	TK P _{MPP} = -0.20 %/K; TK I _{SC} = 5.2 mA/K; TK U _{OC} = 72 mV/K	

Dimensions and weight

Length / width / height	1100 / 1300 / 35 mm
Weight	20.8 kg

Limiting values

Max. permitted voltage	1000 VDC
Max. reverse current	no external voltage > U _{OC}
Permitted module temperature	-40 bis +85 °C
Max. load (pressure or suction)	2400 N/mm ²
Application classification	(in accordance with IEC 61730) A
Flammability rating	(in accordance with IEC 61730) C

Notes on the abbreviations

- Depending on the load, the current (I) and voltage (U) assume various values between zero and a maximum value (the short-circuit current when U=0 and the off-load voltage when I=0). For example, a higher flow of current leads to a decrease in voltage, and vice versa. Only at one operating point, the "Maximum Power Point", or MPP is the maximum power produced.
- For the purposes of comparability, PV module characteristic values (PMPP, UMPP and IMPP) are determined under the following Standard Test Conditions (STC) in accordance with IEC standard 60904: cell temperature: 25 °C, irradiation intensity: 1000 W/m² with a defined light spectrum (class A solar simulator) and an air mass of AM = 1.5.

Test results

The thin film PV module "SCHOTT ASI™ 110 DG" passed the DLG focus test "Resistance to ammonia".

Based on this result, it can be assumed that this type of PV module is resistant to ammonia-bearing atmospheres in buildings for livestock and that no additional degradation beyond what is normally expected occurs.

Maintenance of performance

The performance measurements before and after the climate chamber tests are summarised in table 1 and figure 2. There was no loss of performance but rather a slight increase of up to 2.3% was observed in the STC performance (DLG evaluation: ++).

From specialist literature it is known that there is an improvement in modules with amorphous silicon solar cells at high temperatures (in this case at a temperature of 70 °C in the climate chamber test) and that the effect of light causes deteri-

oration in performance (Staebler Wronski effect). The increase in performance established in the climate chamber test was a result of the high temperature therefore confirms the typical behaviour of thin film modules using this design of cell technology. The effect of corrosive gases was therefore only slight when ammonia was used.

Comments

The performance values measured represent relative and not absolute values. For certification of the design in accordance with DIN EN 61646 the reduction in performance should not exceed 10 % (only applies with respect to STC conditions).

Table 1:
Maintenance of performance

Module no.	Criterion	Intensity of radiation					
		1000 W/m ²		800 W/m ²		200 W/m ²	
		before	after	before	after	before	after
1	Performance at the MPP [Wp]	123.3	125.0	unavailable	97.7	unavailable	19,8
	Change in performance [%]	1.4 (1.4)		unavailable (-2.3)		unavailable (-3.1)	
2	Performance at the MPP [Wp]	118.8	121.6	unavailable	95.1	unavailable	18.2
	Change in performance [%]	2.3		unavailable		unavailable	

Comments on table 1

Because of a technical limitation on the experiment there were no initial values for irradiation intensities of 800 and 200 W/m². As a replacement a value for the change in performance from an additional measurement was provided for module 1 (values in brackets). The measurements that were undertaken here did not result from calibration using the same cell material that was used to produce the specimens. (The reference module was with polycrystalline cells.)

Visual examination

Upon visual examination, no damage or significant abnormalities were observed either before or after the climate chamber test.

Following the climate test in the ammonia gas chamber, the surface of the glass was indeed extensively covered in spots, however it was not dull. Overall the abnormalities were classified as very slight. No coatings were visible.

The frame and the junction box showed no visible changes. The abnormalities were assessed as being very slight.

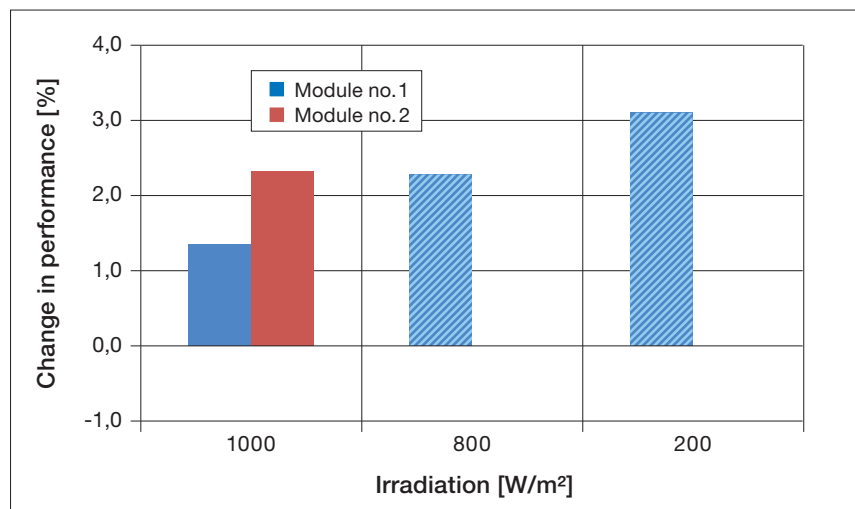


Figure 2:
Change in performance after the environmental test in an ammonia atmosphere (for comments see table 1)

Insulation test

In the insulation test, the requirements were met (no breakdown, no surface cracks, and insulation resistance of at least 40 MΩm²).

As a result of the climate chamber test, the insulation resistance had been reduced from the initial values, when new, (module no. 1: 306 MΩm² and module no. 2: 314 MΩm²) to 64 MΩm² for module no. 1 and 67 MΩm² for module no. 2.

According to the DLG assessment criteria* the insulation resistance values were therefore at a sufficiently high level (range: > 40 to < 100 MΩm²).

* DLG assessment criterion "Insulation resistance" in the DLG test for "Resistance to ammonia for PV modules"

Wet insulation resistance

The requirement for an insulation resistance of at least 40 MΩm² was met.

The initial resistance values, when new, of 55 and 56 MΩm² were measured. Following the climate chamber test the insulation resistances had not changed from the initial values.

For a thin film module in a double glass design the wet insulation resistance is therefore at a sufficiently high level (range: > 40 to < 100 MΩm²)*.

Test conditions and the performance of the test

The DLG focus test "Ammonia resistance" was carried out as a laboratory test in accordance with the patented "DLG test standard for solar modules for agricultural use". This laboratory test is intended to determine the PV module's ability to resist the effects of the air in buildings for livestock during an operating life of at least 20 years. The test took place in a climatic test chamber under the following conditions:

Test period	1500 h
Air temperature	70 °C
Relative air humidity	70 %
Ammonia concentration	750 ppm

In order to assess the resistance to ammonia, each module was subject to a visual examination (10.1*), an insulation test (10.3*), a wet insulation test (10.15*) and a performance measurement (10.2) before and after the environmental test.

The procedures for measuring the performance were co-ordinated with the manufacturer's specifications. Amongst other things the IU measuring device used for the measurement of performance before and after each exposure to the climatic conditions was calibrated using an in-house daughter reference module which used the same cell technology. In this way it was ensured that no spectral mismatching occurred during the measurement of performance. Treatment of the modules using light in accordance with 10.19* was not undertaken.

In order to determine its performance under weaker irradiation conditions, in addition to the STC setting (1000 W/m², irradiation intensity comparable to bright sunlight) measurements were taken at irradiation intensities of 800 and

200 W/m² (irradiation intensities comparable to cloudy conditions).

Samples registered for testing were from the "SCHOTT ASI™ 110 DG" range of products with classifications "97 DG/100 DG/103 DG/105 DG" and of type "100 DG". The samples which were made available for testing were not stabilised i.e. their performance characteristics were at the level of the initial values. Two modules were tested with the following serial numbers:

15011001017311 (no. 1),
15011001017316 (no. 2).

For the visual examination following the climate chamber test an identical reference module (serial no. 15011001017313) was available.

* Test step in accordance with DIN EN 61646:2009 "Terrestrial thin film photovoltaic (PV) modules - design qualification and type approval"

Test

The focus test included a climate chamber test under laboratory conditions.

Based on the available results the "SCHOTT ASI™ 110 DG" thin film PV module meets the requirements of the test criterion "Resistance to ammonia", (rating "O" or better) for the award of the DLG focus test seal of approval.

The DLG seal of approval applies to all members of the "SCHOTT ASI™ 110 DG" range of products with classifications "97 DG / 100 DG / 103 DG / 105 DG".

Other criteria were not tested.

Performance of the tests

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10-235

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