

S-Energy Co., Ltd.

Ammonia resistance

Solar module SM-XXXPL0 (215-240 Wp)

DLG Test Report 5943 F



Manufacturer/registering company

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Test conditions and realization of the test

The DLG FokusTest "Ammonia resistance" was carried out as a laboratory test according to the patented "DLG test standard for solar modules in agricultural use". This laboratory test is intended to determine the ability of the PV module to withstand the effects of animal house air over a period of use of at least 20 years.

The test was carried out in a gas-sing chamber under the following climate conditions:

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

For the evaluation of ammonia resistance, every module was inspected visually (10.1¹), and an insulation test (10.3¹), a test of insulation resistance under wet conditions (10.15¹), as well as power measurements (10.2¹) were carried out before and after the climate test.

In order to determine capacity under weaker radiation conditions, measurements at radiation intensities of 800 and 200 W/m² (radiation intensity comparable to cloudy weather) were carried out in addition to the STC setting (1,000 W/m², radiation intensity comparable to sunshine).

The unit registered for the test was the type "SM-230PL0" from the module type series "SM-215/220/225/230/235/240PL0". The two modules used for the test had the following serial numbers:
G230LW5MC010001 (Nr. 1)
G230LW5MC010002 (Nr. 2)

An identically designed reference module (number G230LW5MC 102001) was available for visual inspection after the climate test.

¹ Test step according to DIN EN 61215:2005 "Terrestrial crystalline silicon photovoltaic (PV) modules – design and type approval"

Main technical data (according to the manufacturer)

Design

- Solar module (PV module) made of polycrystalline silicon solar cells (mc-Si)
- consisting of:
 - Solar cells made of mc-Si, solar glass with an anti-reflexion layer, EVA-film, plastic film on the back side, and a hollow chamber frame made of anodized aluminium
 - 60 solar cells (□ 156 mm)
- Connection box: EPIC®, IP 65 with 3 bypass diodes
- Plug-and-socket connector: EPIC®
- Cable length per pole: 1,0 m

Elektric module data (type: SM-230PLO)

Power at maximum power point, P_{MPP}	230 Wp
Intensity at maximum power point, I_{MPP}	7,80 A
Voltage at maximum power point, U_{MPP}	29,5 V
Short circuit intensity, I_{SC}	8,39 A
Open-circuit voltage, U_{OC}	36,9 V
System voltage, U	1000 V
Module efficiency	14,5 %

Measurements and weight

Length / width / height	1620 mm / 980 mm / 50 mm
Weight	19 kg

Explantion of abbreviations:

- Intensity (I) and voltage (U) assume different values between zero and a maximum (short-circuit current at $U=0$ and open-circuit voltage at $I=0$). A large current flow, for example, causes voltage to drop and vice versa. Only at one operating point, namely the maximum power point (MPP), does the power output reach its maximum.
- For comparability, PV module parameters (PMPP, UMPP and IMPP) were measured under the following standard test conditions (STC) according to IEC 60904: cell temperature: 25 °C, radiation intensity: 1000 W/m² and a defined light spectrum (class A sun simulator) with an AnairMass of AM=1.5.

Evaluation – short version

Test criterion	Test result (Comparison before/after climate exposure to ammonia)	Evaluation
Power conservation	very small decrease of power, $\leq 0.5 \%$	++
Visual inspection	no damage, dull spots and slight coating on the glass surface	+
Insulation test and insulation resistance under wet conditions	<ul style="list-style-type: none"> – Requirements are fulfilled, – Insulation resistance increased under wet conditions, – Insulation resistance: normal to high overall level. 	No objection

Bewertungsbereich: ++ / + / ○ / - / -- (○ = Standard) / k.B. = keine Bewertung

Evaluation range

The following evaluation range is applied for the DLG FokusTest "Ammonia resistance":

Evaluation	Test result power conservation	Test result visual inspection
++	$\leq -2 \%$;	no noticeable changes
+	$> -2 \%$ to $\leq -3,5 \%$	very small changes
○	$> -3,5 \%$ to $\leq -5 \%$	small changes

The DLG-FokusTest "Ammonia resistance" is considered passed if the insulation requirements are fulfilled and the test criteria "output conservation" and "visual inspection" receive a grade of at least "standard".

Test results

The PV module of the type SM-230PL0 passed the DLG FokusTest "Ammonia resistance". Based on this result, one can assume that this module type is resistant to animal house air containing ammonia and that the aging process to be expected under normal circumstances is not accelerated.

Power conservation

The results of power measurement before and after the climate test are listed in Table 1 and Figure 1. The overall decrease of power must be considered very small (DLG evaluation: ++). The maximum decrease of power was -0.5 % (module 2 at a radiation of 800 W/m²).

Annotations

- The measured power values are relative and no absolute values. This is due to the fact that the flasher used for the measurement (type: PV-XF2M AM 1,5 Class A sun simulator) had not been calibrated with the same cell material as the tested units.
- For type approval according to DIN EN 61215, the drop in power may not exceed 5%. (This only applies under standard test conditions).

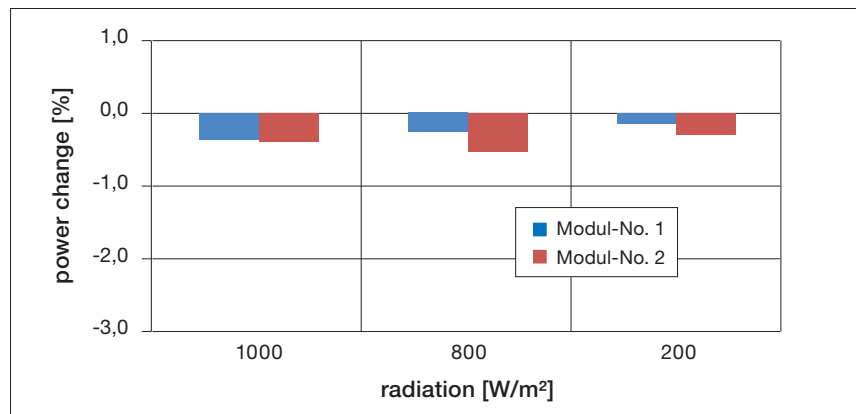


Figure 1:
Power change after the climate test under an ammonia atmosphere

Visual inspection

During visual inspection, no damage or noticeable alterations were found before or after the climate test.

Dull spots had formed on the entire glass surface after the climate test in the ammonia gassing chamber. In addition, slight coating had developed primarily in the lower area of the longitudinal side of the module.

On the frame, the backside film, and the connection box, no changes were visible.

Altogether, these alterations were considered very small.

Insulation test

During the insulation test, the requirements (no breakdown, no surface rupture, insulation resistance at least 40 MΩm²) were fulfilled.

Insulation resistance decreased from a measured value of > 1620 MΩm² when new to 730 MΩm² (module number 1) and 1460 MΩm² (module number 2) due to the climate test.

According to the DLG evaluation standard, this meant that the insulation values were at an elevated to high level (range of values: > 500 to ≤ 1500 MΩm²).

Insulation resistance under wet conditions

The required insulation resistance of at least 40 MΩm² was reached.

When the modules were new, resistance values of ca. 100 MΩm² were measured. After the climate test, insulation resistance increased by ca. 50% as compared with the initial values. At a measured 140 and 150 MΩm², the insulation resistance of both modules was virtually the same after the test.

Thus, the insulation resistance of a glass-film module under wet conditions is at a normal level (value range: > 100 to ≤ 150 MΩm²).

² DLG evaluation standard "Insulation resistance" for the DLG test "Ammonia resistance of PV modules".

Table 1:
Power conservation

Module number	Parameter	1000 W/m ²		Radiation intensity 800 W/m ²		200 W/m ²	
		before	after	before	after	before	after
1	Output at MPP	226,4 Wp	225,6 Wp	183,3 Wp	182,8 Wp	45,0 Wp	45,0 Wp
	Output change		-0,4%		-0,3%		-0,1%
2	Output at MPP	222,7 Wp	221,8 Wp	180,9 Wp	180,0 Wp	44,8 Wp	44,7 Wp
	Output change		-0,4%		-0,5%		-0,3%

The FokusTest included a climate exposure test under laboratory conditions.

Based on the available results, the PV-module of the type "SM-230PLO" fulfills the requirements for the awarding of the test sign DLG FokusTest with regard to the test criterion "ammonia resistance" (evaluation "o" or better).

The DLG test sign includes all types of the module type series "SM-215/220/225/230/235/240PLO".

Other criteria were not tested.

Realization of the test

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10-017
Juli 2010
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