

Sovello AG

# Ammonia resistance

Solar module Sovello Pure Power X Series, SV-X-xxx (195-205 Wp)

## DLG Test Report 5931 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 gassing chamber under the following climatic 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 subject to visual inspection (10.1<sup>1</sup>), an insulation test (10.3<sup>1</sup>), a test of insulation resistance under wet con-

ditions (10.15<sup>1</sup>) as well as output measurement (10.2<sup>1</sup>) after the climate test.

In order to determine capacity under weaker radiation conditions, measurements at radiation intensities of 800 and 200 W/m<sup>2</sup> (radiation intensity comparable to cloudy weather) were carried out in addition to the STC setting (1,000 W/m<sup>2</sup>, radiation intensity comparable to sunshine).

The test was carried out using two modules, which had the following serial numbers:

4903200911100020039 (Nr. 1)  
4903200911040020351 (Nr. 2)

An identically designed reference model was available for visual inspection after the climate test (number 49032010030010020155).

<sup>1</sup> Test report according to DIN EN 61215:2005 "Terrestrial crystalline silicon photovoltaic (PV) modules – suitability and approval of a model"

## 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, hardened solar glass with anti-reflex coating, EVA sealing material, plastic film on the back side, and a frame made of double-walled, anodized aluminium
  - 114 solar cell units (15 x 8 cm), with internal string connection, three cell strings are connected parallel, Cell production according to the patented STRING RIBBON™ wafer technique,
  - Connector box IP 65 with two bypass diodes, Plug-and-socket connector MC® click plug (type 4), Cable length per pole: 1,07 m

### Electrical module data

Rated power, $P_{MPP}$	200 Wp
Rated current, $I_{MPP}$	10,93 A
Rated voltage, $U_{MPP}$	18,3 V
Short-circuit current, $I_{SC}$	11,71 A
No-load voltage, $U_{OC}$	22,9 V
System voltage, U	1000 V
Module efficiency	12,7 %
Power tolerance	0/+2,5 %
Temperature coefficient, $P_{MPP}$	-0,49 %/°C

### Measurements and weight

Length / width / height	1650 mm / 951 mm / 46 mm
Weight	18,6 kg

### Explanation of abbreviations

- Current (I) and voltage (U) vary depending on the load between zero and a maximum (short-circuit current at  $U=0$  and no-load voltage at  $I=0$ ). A strong current, for example, causes voltage to drop and vice versa. The greatest output is produced only at one operating point, the maximum power point (MPP).
- For comparability, PV-module parameters ( $P_{MPP}$ ,  $U_{MPP}$  und  $I_{MPP}$ ) are determined under the following standard test conditions (STC) according to IEC 60904: Cell temperature: 25°C, radiation intensity: 1,000 W/m<sup>2</sup>, defined light spectrum (class-A sun simulator) with an AirMass of AM=1.5.

## Evaluation – short version

Test criterion	Test result (Comparison before/after climate exposure to ammonia)	Bewertung
<b>Output conservation</b>	Largely very slight drop in power between 1 and 2 %	+ +*
<b>Visual inspection</b>	No damage, slight, even yellowing of the interconnected cells	+
<b>Insulation test and insulation resistance under wet conditions</b>	The requirements are fulfilled. Due to only moderate alterations, insulation resistance remains at a very high level.	k.B.

\_\_\_\_\_ Evaluation range: + + / + / ○ / - / -- (○ = Standard) / n.e. = no evaluation

\_\_\_\_\_ \* One measurement value was slightly above 2 %

### Evaluation criteria

The following evaluation criteria are applied in the DLG-FokusTest "Ammonia resistance":

Evaluation	Test result output conservation	Test result visual inspection
+ +	≤ -2 %;	No noticeable alterations
+	> -2 % bis ≤ -3,5 %	Very slight alterations
○	> -3,5 % bis ≤ -5 %	Slight alterations

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 "Sovello Pure Power SV-X-200" has 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.

### Output conservation

The results of output measurement before and after the climate test are listed in Table 1 and Figure 1. At average radiation intensity (800 W/m<sup>2</sup>), a maximum drop in power of 2.1 % was measured in module number 1. In most cases, however, the drop in power was between 1 and 2 % and thus within the range considered "very low" (DLG evaluation: ++).

### Visual inspection

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

Even though the gloss on the entire glass surface decreased after the climate test in the ammonia gassing chamber, the surface does not appear dull. In addition, direct visual comparison with a new module showed slight, even yellowing of the space between the cells and the edge area.

Moreover, the color of the insulation of the socket cable had become slightly lighter.

Altogether, these alterations were considered very small.

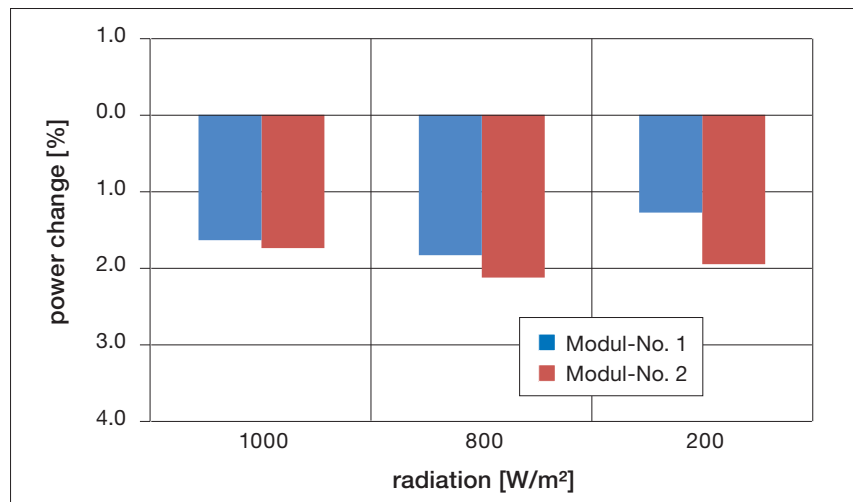


Figure 1: Output change after the climate test under an ammonia atmosphere

### Insulation test

During the insulation test, the requirements (no breakdown, no surface rupture, insulation resistance at least 40 MΩm<sup>2</sup>) were fulfilled.

In module number 1 (measurement value: >1650 MΩm<sup>2</sup>), insulation resistance did not change. In module number 2, insulation resistance decreased only very slightly from >1650 MΩm<sup>2</sup> to 1560 MΩm<sup>2</sup> afterwards. Thus, very high insulation resistance values were reached.

### Insulation resistance under wet conditions

The required insulation resistance of at least 40 MΩm<sup>2</sup> was reached. In new condition, resistance values between 370 and 420 MΩm<sup>2</sup> were measured. After the climate test, insulation resistance decreased

by up to 25 % as compared with the initial values. The minimum value was 280 MΩm<sup>2</sup>.

For a module with a glass-film design, insulation resistance under wet conditions is at a very high level (values >250 MΩm<sup>2</sup>).

### Annotations

The measured output values are relative values and no absolute values. This is due to the fact that the flasher used for the measurement (type: cetisPV-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).

Table 1: Output conservation

Module #.	Parameter	Radiation intensity					
		1000 W/m <sup>2</sup>		800 W/m <sup>2</sup>		200 W/m <sup>2</sup>	
		before	after	before	after	before	after
1	Output at MPP	200,8 Wp	197,5 Wp	161,5 Wp	158,5 Wp	38,8 Wp	38,3 Wp
	Output change		-1,64 %		-1,83 %		-1,28 %
2	Output at MPP	200,1 Wp	196,6 Wp	161,2 Wp	157,7 Wp	38,9 Wp	38,1 Wp
	Output change		-1,74 %		-2,13 %		-1,95 %

The FokusTest included a climate exposure test under laboratory conditions.

Based on the available results, the PV-module of the type "Sovello Pure Power SV-X-200" fulfills the requirements for the awarding of the test sign DLG-FokusTest with regard to the test criterion "ammonia resistance" (evaluation "o" or better).

Other criteria were not tested.

### Realization of the tests

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