

Conergy AG

# Resistance to ammonia

Conergy PowerPlus 2xxP (200-230 Wp) solar module

## DLG Test Report 5929F



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### Test conditions and implementation

The DLG "ammonia resistance" focus test 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 ascertain the PV module's ability to resist the effects of barn/stable air over an operating life of at least 20 years.

The test took place in a gassing chamber with the following atmospheric loads:

Test duration	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 subjected to a visual examination (10.1<sup>1</sup>), insulation test (10.3<sup>1</sup>), a test of insulation resistance in moisture (10.15<sup>1</sup>) and a performance test

(10.2<sup>1</sup>) before and after the environmental test.

In order to determine its performance under weaker irradiation conditions, measurements were taken at irradiation intensities of 800 and 200 W/m<sup>2</sup> (irradiation intensities comparable to cloudy conditions) in addition to the STC setting (1000 W/m<sup>2</sup>, irradiation intensity comparable to bright sunlight).

Two modules with the following serial numbers were tested:

0000651551 (no. 1)

0000651680 (no. 2)

A similar reference module (no. 0000852610) was available for the visual inspection after the environmental test.

<sup>1</sup> Test step in accordance with DIN EN 61215:2005 "Crystalline Silicone Terrestrial Photovoltaic (PV) Modules – System Suitability and System Approval"

## Principal Technical Data (Manufacturer's information)

### Design

- Solar module (PV module) made of multi-crystalline silicon solar cells
- A solar module with a plastic film on the rear and a frame made of angled anodized aluminium sections
- 60 solar cells connected in series (□ 15.6 cm)
- Type of solar cell: 3 busbar cells
- IP 67 outlet socket with three bypass diodes,  
Plug-in connector: Huber + Suhner with integrated twist lock, Cable length for each terminal: 1.0 m

### Module electrical data

Nominal output, $P_{MPP}$	220 Wp
Nominal current, $I_{MPP}$	7,65 A
Nominal voltage, $U_{MPP}$	29,01 V
Short-circuit current, $I_{SC}$	8,15 A
Off-load voltage, $U_{OC}$	36,23 V
System voltage, U	1000 V
Module efficiency	13,51 %
Output tolerance	-0/+2,5 %
Temperature coefficient, $P_{MPP}$	-0,45 % / °C

### Dimensions and weight

Length / Width / Height	1651 mm / 986 mm / 46 mm
Weight	22 kg

#### Notes on abbreviations:

- Depending on the load, the current (I) and voltage (U) assume various values between zero and a maximum value (short-circuit current when  $U=0$ , and off-load voltage when  $I=0$ ). So, for example, a higher flow of current leads to a decrease in voltage, and vice versa. Maximum output is produced only at one operating point, the "Maximum Power Point", or MPP.
- For the purposes of comparability, PV module characteristic values, ( $P_{MPP}$ ,  $U_{MPP}$  and  $I_{MPP}$ ), are determined under the following Standard Test Conditions (STC) in accordance with IEC standard 60904: cell temperature: 25 °C, irradiation intensity: 1000 W/m<sup>2</sup> with a defined light spectrum (class A solar simulator) with an air mass of AM=1.5.

## Summarised Evaluation

Test criterion	Test result (comparison before/after ammonia-load in the environment)	Evaluation
<b>Performance stability</b>	Very slight decrease in performance, $\leq 0.5\%$	++
<b>Visual examination</b>	No damages, glass very slightly abraded	+
<b>Insulation test and insulation resistance in moisture</b>	Requirements met; despite decrease, there is still a very high level of insulation resistance	N.R.

Evaluation range: ++ / + / ○ / - / -- (○ = standard / N.R. = not rated)

### Evaluation table

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

Evaluation	Test result: Performance stability	Test result: Visual inspection
++	$\leq -2\%$ ;	no abnormalities
+	$> -2\%$ bis $\leq -3.5\%$	very slight abnormalities
○	$> -3.5\%$ bis $\leq -5\%$	slight abnormalities

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

# Test results

The "Conergy PowerPlus 220P" PV module has passed the "resistance to ammonia" DLG focus test. Based on this result, it can be assumed that this model of PV module is resistant to ammonia-bearing atmospheres in stables/barns, and that there is no additional acceleration in the normal deterioration expected.

## Performance stability

The performance measurement results before and after the environmental test are summarised in Table 1 and Figure 1. Overall, a decrease in performance of up to  $\leq 0.5\%$  is considered to be very slight.

## Visual examination

In the visual examination, no damage or significant abnormalities were observed, either before or after the environmental test. After the atmosphere test in ammonia gassing chamber, the entire glass surface displayed abraded areas. Their size ranged from a few cubic centimetres to cell transverse row.

Furthermore, slight discolouration could be seen on the connecting plug cable insulation and the cable's surface was slightly abraded. These abnormalities are considered to be very slight.

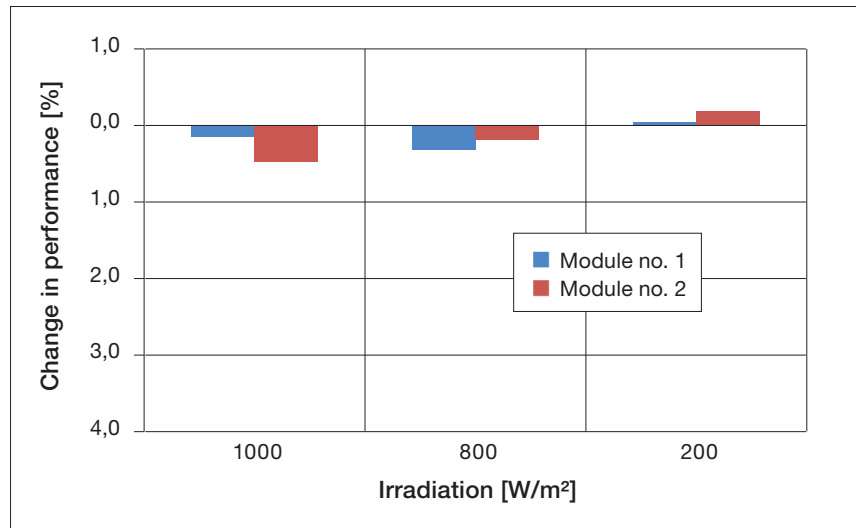


Figure 1: Change in performance after the environmental test in an ammonia-loaded atmosphere

## Insulation test

The requirements were met (no breakdown, no surface cracks, and insulation resistance of at least  $40\text{ M}\Omega\text{m}^2$ ) in the insulation test.

The insulation resistance in module no. 1 (requirement:  $> 1630\text{ M}\Omega\text{m}^2$ ) remained unchanged after the environmental test.

In module no. 2, the insulation resistance of  $> 1630\text{ M}\Omega\text{m}^2$  decreased slightly to  $1450\text{ M}\Omega\text{m}^2$  after the environmental test.

Very high insulation resistance values were achieved.

## Insulation resistance in moisture

The requirement of insulation resistance of a minimum of  $40\text{ M}\Omega\text{m}^2$  was met. In new condition was  $600\text{ M}\Omega\text{m}^2$  in new condition and  $300\text{ M}\Omega\text{m}^2$  was measured after the environmental test.

Therefore, the insulation resistance in moisture is at a very high level (values  $> 250\text{ M}\Omega\text{m}^2$ ) in a module with glass film design.

Table 1: Performance stability

Module no.	Criterion	Intensity of irradiation					
		1000 W/m²		800 W/m²		200 W/m²	
		before	after	before	after	before	after
1	Output at the MPP	225.1 Wp	224.8 Wp	180.0 Wp	179.4 Wp	42.7 Wp	42.8 Wp
	Change in performance	-0.15 %		-0.32 %		0.04 %	
2	Output at the MPP	225.9 Wp	224.8 Wp	180.0 Wp	179.6 Wp	42.9 Wp	43.0 Wp
	Change in performance	-0.48 %		-0.19 %		0.11 %	

## Comments

The performance values measured represent relative, not absolute, values. The reason is that the flasher used for the measurements (model: cetisPV-XF2M AM 1.5 Class A solar simulator) had not been calibrated with the cell material of the specimens.

For prototype certification in accordance with DIN EN 61215, the reduction in performance must not exceed 5% (applicable only to STC conditions).

The focus test included an atmospheric load test under laboratory conditions.

Based on the available results, the "Conergy PowerPlus 220P" PV module meets the requirements stipulated under the test criterion "resistance to ammonia", (rating "o" or better), for the awarding of the DLG focus test mark.

Other criteria were not tested.

### Realization of the test

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