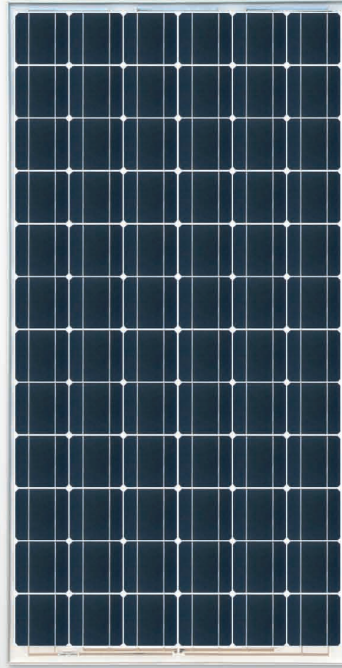


Shandong Linuo Photovoltaic Hi-Tech Co., Ltd.

Resistance to ammonia

Solar module LN180(36)M-XXX (170-210 Wp)

DLG Test Report 6061 F



Manufacturer

Shandong Linuo Photovoltaic
Hi-Tech Co., Ltd. · No.30766 East
Jingshi Road Jinan · 250103 · China
Telephone: +86 531 88729-682
Telefax: +86 531 88729-436
E-mail: gfrz@linuo.com
Internet: www.linuopv.com

Applicant

TÜV NORD (Hangzhou) Co., Ltd.



DLG e.V.
Test Center Technology
and Farm Inputs

Evaluation – short version

Test result (Comparison before/after ammonia climate exposure)	Assessment*
--	-------------

Power conservation

no drop in power conservation	++
-------------------------------	----

Visual inspection

minor alterations were ascertained, but no damage	○
---	---

Insulation test and insulation resistance under wet conditions

Requirements are satisfied.	n.e.
Despite a slight drop in the insulation resistance a high or normal level is maintained.	

Evaluation scale

The following evaluation scale is applied in the DLG FokusTest "Ammonia resistance":

Evaluation*	Test result: Power conservation	Test result: Visual inspection
++	≤ -2 %	no alterations
+	> -2.0 % to ≤ -3.5 %	very minor alterations
○	> -3.5 % to ≤ -5.0 %	minor alterations

The DLG-FokusTest "Ammonia resistance" is considered passed if the insulation requirements are fulfilled and the test criteria "power conservation" and "visual inspection" are evaluated at least "standard".

* Evaluation range: ++ / + / ○ / - / -- (○ = standard / n.e. = no evaluation)

Main technical data (according to the manufacturer)

Construction

Solar module (photovoltaic module) consisting of monocrystalline silicon solar cells (c-Si) comprising:

- solar cells in c-Si, 72 cell units (125 mm x 125 mm, 6 x 12)
- embedding material EVA (ethylene vinyl acetate)
- front cover glass in highly transparent and tempered 3.2 mm glass
- rear panel in white polyester
- frame in aluminium

Connection

Connection socket	1 connection socket, IP65, 3 bypass diodes
Plug connector	MC4-compatible
Connection line	Cross-sectional area 4 mm ²

Electrical module data (type: LN-180(36)M-185)

Rated power, P_{MPP}	185 Wp
Rated current, I_{MPP}	5.02 A
Rated voltage, U_{MPP}	36.86 V
Short-circuit current, I_{SC}	5.45 A
No-load voltage, U_{OC}	44.19 V
System voltage, U	1000 V
Module efficiency	14.4 %
Power tolerance at S_{TC}	-3 % to +3 %
Temperature coefficients	$TK P_{MPP} = -0.469 \%/K$
	$TK I_{SC} = 0.027 \%/K$
	$TK U_{OC} = -0.337 \%/K$

Dimensions and weight

Length/Width /Height	1580 mm / 808 mm / 35 mm
Weight	15.5 kg

Explanation of abbreviations

- Current (I) and voltage (U) assume different values between zero and a maximum depending on the load (short-circuit current at $U=0$ and no-load voltage at $I=0$). Thus, 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 (P_{MPP}).
- For the purpose of comparability, PV-module parameters (P_{MPP} , U_{MPP} and I_{MPP}) are determined under the following standard test conditions (S_{TC}) according to IEC 60904: cell temperature: 25 °C, irradiation intensity: 1000 W/m² and a defined light spectrum (class A sun simulator) with an AirMass of AM=1.5.

Test results

The PV module of type "LN180(36) M-185" 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 ageing 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 2. No reduction in power was ascertained (DLG evaluation: ++).

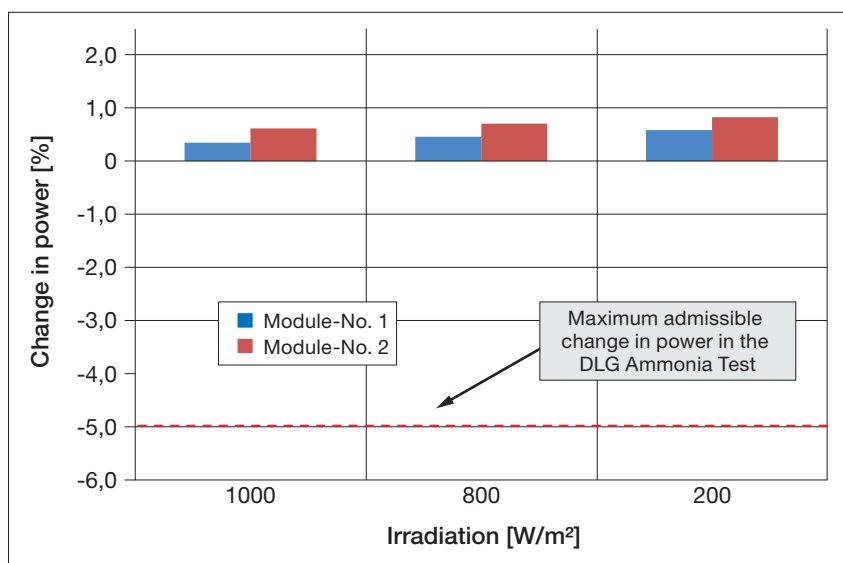


Figure 2: Power change after the climate test under an ammonia atmosphere

Notes

The measured power values are relative values and not 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) was not calibrated with the same cell material as the tested units.

For type approval according to DIN EN 61215, power decrease may not exceed 5% (this only applies under standard test conditions).

Visual inspection

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

After the climate test in the ammonia exposure chamber, slight deposits were visible on the glass surface and on the frame and the connection socket.

Very slight deposits could be seen on the plugs.

The rear film on the panel was slightly but perceptibly discolored after the ammonia test.

Corrosion of the cell connector occurred on one module.

Altogether, these alterations are considered to be slight.

Insulation test

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

Insulation resistance showed no change over new condition (measured value: > 1277 MΩm²) as a result of the climate test.

According to the DLG evaluation standard*, this meant that the insulation resistance values were at a high level (range of values: > 1000 to < 1500 MΩm²).

Insulation resistance under wet conditions

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

In the new condition, resistance levels of approx. 155 MΩm² were measured. After the climate test the insulation resistances had dropped slightly by up to 7% compared with the initial values. With values of 147 and 148 MΩm², the insulation resistance of both modules was roughly the same after the test.

Thus, insulation resistance under wet conditions is at a very high level given the glass-film design of the module (value range: > 100 to < 200 MΩm²)*.

* DLG evaluation standard "Insulation resistance" in the DLG Test "Resistance to ammonia for PV modules"

Table 1: Power conservation

Module No.	Parameter	Irradiation intensity					
		1000 W/m²		800 W/m²		200 W/m²	
		before	after	before	after	before	after
1	Power in MPP [Wp]	191.6	192.3	153.9	154.6	37.1	37.3
	Change in power [%]		0.4		0.5		0.6
2	Power in MPP [Wp]	192.4	193.6	154.5	155.6	37.1	37.5
	Change in power [%]		0.6		0.7		0.8

Test conditions and performance 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 climate conditions:

Duration of test	1500 h
Air temperature	70 °C
Rel. atmospheric humidity	70 %
Ammonia concentration	750 ppm

For the evaluation of ammonia resistance, each module was subjected to visual inspection (10.1*), an insulation test (10.3*), a test of insulation resistance under wet conditions (10.15*), as well as an output measurement (10.2*) before and after the climate test.

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

Type "LN180(36)M-185" from the module type series "LN180(36)M-XXX" was registered for the test.

The two modules used for the test had the following serial numbers: 11002850110890005 (No. 1), 11002850110890007 (No. 2).

A reference module with an identical design (serial number: 11002850110890010) was available for the visual inspection after the climate test.

* Test step according to DIN EN 61215:2005
"Crystalline silicon terrestrial photovoltaic (PV) modules: design qualification and type approval"

Test

The FokusTest included a climate exposure test under laboratory conditions.

On the grounds of these results the PV module "LN180(36)M-185" satisfies the requirements of the test criterion "Ammonia resistance" (evaluation "o" or better) for the award of the DLG FokusTest label.

The DLG test label applies for the power categories 170 Wp to 210 Wp of the same module type series.

Other criteria were not tested.

Realization of the tests

DLG e.V. –
Test Center Technology
and Farm Inputs,
Max-Eyth-Weg 1,
D-64823 Gross-Umstadt

Project director

Dipl.-Ing. (FH) S. Schwick, M.Sc.

Technology, safety, quality

Dipl.-Ing. W. Gramatte



ENTAM – European Network for Testing of Agricultural Machines, was created from the merger of European testing sites. ENTAM's objective is the Europe-wide distribution of test results for farmers, agricultural equipment dealers, and producers.

More information about the Network is available at www.entam.com or by writing.
E-mail Address: info@entam.com

11-535
April 2012
© DLG



DLG e.V. – Test Center Technology and Farm Inputs

Max-Eyth-Weg 1, D-64823 Gross-Umstadt,
Telephone +49 69 24788-600, Fax: +49 69 24788-690, E-mail: Tech@DLG.org,
Internet: www.DLG.org

Download of all DLG test reports at: www.DLG.org/testsagriculture.html!