Annex to Solar Keymark Certificate - Summary of EN ISO 9806:2013 Test Results		Licence Number	011-7S2741 L
		Date issued	2017-08-30
		Issued by	Din Certco

Licence holder	**Grammer Solar GmbH**	**Country**	Deutschland
Brand (optional)		**Web**	www.grammer-solar.de
Street, Number	Oskar-von-Miller-Straße 8	**E-mail**	r.ettl@grammer-solar.de
Postcode, City	92224, Amberg	**Tel/Fax**	09621-30857-13 / 9621-30857-83

Collector Type	Flat plate collector, glazed

Collector name	Gross area (A_G)	Gross length	Gross width	Gross height	Power output per collector G = 1000 W/m²		
					Tm - Ta [K] =	11	15	16
	m²	mm	mm	mm	ṁ [kg/h] =	108	75	60
Twinsolar Duo	1,11	1.712	646	106	Power output [W] =	667	599	558
Power output per m² gross area						603	542	504

Performance parameters test method	Steady state - indoor		
Performance parameters (related to AG)	η (108 kg/h)	η (75 kg/h)	η (60 kg/h)
Units	-	-	-
Test results	0,603[1]	0,542[1]	0,504[1]

Incidence angle modifier test method		Steady state - indoor								
Bi-directional incidence angle modifiers	No									
Incidence angle modifier	Angle	10°	20°	30°	40°	50°	60°	70°	80°	90°
Transversal	$K_{\theta T,coll}$					0,92[2]				0,00
Longitudinal	$K_{\theta L,coll}$									0,00

Heat transfer medium for testing	Air		
Flow rate for testing (per gross area, A_G)	dm/dt	98/68/55	kg/(sm²)
Maximum temperature difference for thermal performance calculations	$(\vartheta_m-\vartheta_a)_{max}$	-	K
Standard stagnation temperature (G = 1000 W/m²; ϑ_a = 30 °C)	ϑ_{stg}	101	°C
Effective thermal capacity, incl. fluid (per gross area, A_G)	C/m²	3,8	kJ/(Km²)
Maximum operating temperature	ϑ_{max_op}	90	°C
Maximum operating pressure	$p_{max,op}$	0,2	kPa

Testing laboratory	TestLab Solar Thermal Systems, Fraunhofer ISE		http://www.collectortest.com
Test report(s)	ktb-2017-01	**Dated**	29.08.2017

Comments of testing laboratory — Datasheet version: 5.01, 2016-03-01

1 For open to ambient solar air collectors, sucking in ambient air, it is only possible to determine the instantaneous efficiency at certain mass flow rates and ambient temperatures. More information are given within test report ktb-2017-01. The calculation of the annual collector performance with ScenoCalc is not possible for open to ambient solar air heating collectors.

2 IAM estimated based on the IAM of the glass cover and geometrical calculations of the shadow effect.

TestLab Solar Thermal Systems
Heidenhofstraße 2
D-79110 Freiburg
Tel: +49 (0)761 4588 5354

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Supplementary Information	Issued	2017-08-30

Annual collector output in kWh/collector at mean fluid temperature ϑ_m, based on EN ISO 9806:2013 test results

Standard Locations	Athens			Davos			Stockholm			Würzburg		
Collector name ϑ_m	25°C	50°C	75°C	25°C	50°C	75°C	25°C	50°C	75°C	25°C	50°C	75°C
Twinsolar Duo												
Annual output per m² gross area												
Fixed or tracking collector	Fixed (slope = latitude - 15°; rounded to nearest 5°)											
Annual irradiation on collector plane	1765 kWh/m²			1714 kWh/m²			1166 kWh/m²			1244 kWh/m²		
Mean annual ambient air temperature	18,5°C			3,2°C			7,5°C			9,0°C		
Collector orientation or tracking mode	South, 25°			South, 30°			South, 45°			South, 35°		

The collector is operated at constant temperature ϑm (mean of in- and outlet temperatures). The calculation of the annual collector performance is performed with the official Solar Keymark spreadsheet tool Scenocalc Ver. 5.01 (March 2016). A detailed description of the calculations is available at www.solarkeymark.org/scenocalc

Additional Information

Collector heat transfer medium	Air	
Hybrid Thermal and Photo Voltaic collector	No	
The collector is deemed to be suitable for roof integration	No	
The collector was tested successfully according to EN ISO 9806:2013 under the following conditions:		
Climate class (A, B or C)	B	--
Maximum tested positive load	3250	Pa
Maximum tested negative load	-3250	Pa
Hail resistance using ice balls (diameter)	35	mm

Energy Labelling Information

	Reference Area, Asol (m2)	Data required for CDR (EU) No 811/2013 - Reference Area A_{sol}		
Twinsolar Duo	1,11	Collector efficiency (η_{col})	[1]see p.1	%
		Remark: Collector efficiency (η_{col}) is defined in CDR (EU) No 811/2013 as collector efficiency of the solar collector at a temperature difference between the solar collector and the surrounding air of 40 K and a global solar irradiance of 1000 W/m², expressed in % and rounded to the nearest integer. Deviating from the regulation η_{col} is based on reference area (A_{sol}) which is aperture area for values according to EN 12975-2 or gross area for ISO 9806:2013.		
		Data required for CDR (EU) No 812/2013 - Reference Area A_{sol}		
		Zero-loss efficiency (η_0)	[1]see p.1	--
		First-order coefficient (a_1)	-	W/(m²K)
		Second-order coefficient (a_2)	-	W/(m²K²)
		Incidence angle modifier IAM (50°)	0,92	--
		Remark: The data given in this section are related to collector reference area (A_{sol}) which is aperture area for values according to EN 12975-2 or gross area for ISO 9806. Consistent data sets for either aperture or gross area can be used in calculations like in the regulation 811 and 812 and simulation programs.		