



Annex to Solar Keymark Certificate - Summary of EN ISO 9806:2013 Test Results					Licence Number		011-7S 559 R							
					Date issued		2017-06-07							
					Issued by		TÜV Rheinland Energy GmbH							
Licence holder		D&K Solar GmbH			Country		Germany							
Brand (optional)		-			Web		www.dk-solar.de							
Street, Number		Bergheimer Str. 2			E-mail		info@dk-solar.de							
Postcode, City		53909 Zülpich			Tel		+49 (0)2252/ 83 49-71							
Collector Type					Evacuated tubular collector									
Collector name					Power output per collector G <sub>b</sub> = 850 W/m <sup>2</sup> ; G <sub>d</sub> = 150 W/m <sup>2</sup> ; u = 3 m/s ∅ <sub>m</sub> - ∅ <sub>a</sub>									
					0 K	10 K	30 K	50 K	70 K	90 K				
					m <sup>2</sup>	mm	mm	mm	W	W	W	W	W	W
Gravitation CPC 5					0.96	1 720	557	85	435	423	396	368	337	304
Gravitation CPC 10					1.89	1 720	1 097	85	856	832	780	724	663	598
Gravitation CPC 15					2.83	1 720	1 645	85	1 282	1 246	1 169	1 084	993	895
Gravitation CPC 20					3.78	1 720	2 193	85	1 713	1 664	1 561	1 448	1 327	1 196
Power output per m <sup>2</sup> gross area									453	440	413	383	351	316
Performance parameters test method					Quasi dynamic									
Performance parameters (related to AG)					η <sub>0,b</sub>	c <sub>1</sub>	c <sub>2</sub>	c <sub>3</sub>	c <sub>4</sub>	c <sub>6</sub>	K <sub>d</sub>			
Units					-	W/(m <sup>2</sup> K)	W/(m <sup>2</sup> K <sup>2</sup> )	J/(m <sup>3</sup> K)	-	s/m	-			
Test results					0.446	1.249	0.003	0.000	0.000	0.000	1.106			
Incidence angle modifier test method					Quasi dynamic - outdoor									
Bi-directional incidence angle modifiers					Yes									
Incidence angle modifier					Angle	10°	20°	30°	40°	50°	60°	70°	80°	90°
Transversal					K <sub>θT, coll</sub>	1.01	1.00	1.01	0.99	0.99	1.13	1.19		0.00
Longitudinal					K <sub>θL, coll</sub>	1.00	1.00	0.99	0.98	0.97	0.94	0.88		0.00
Heat transfer medium for testing					Water									
Flow rate for testing (per gross area, A <sub>G</sub> )					dm/dt	0.015	kg/(sm <sup>2</sup> )							
Maximum temperature difference for thermal performance calculations					(∅ <sub>m</sub> -∅ <sub>a</sub> ) <sub>max</sub>	90	K							
Standard stagnation temperature (G = 1000 W/m <sup>2</sup> ; ∅ <sub>a</sub> = 30 °C)					∅ <sub>stg</sub>	242	°C							
Effective thermal capacity, incl. fluid (per gross area, A <sub>G</sub> )					C/m <sup>2</sup>	26	kJ/(Km <sup>2</sup> )							
Maximum operating temperature					∅ <sub>max, op</sub>	150	°C							
Maximum operating pressure					p <sub>max, op</sub>	600	kPa							
Testing laboratory					TÜV Rheinland Energy GmbH				www.tuv.com/solarpower					
Test report(s)					21210433_Gravitation5 21210433_Gravitation20				Dated		06.06.2009 25.05.2009			
Comments of testing laboratory					Datashet version: 5.01, 2016-03-01									
<p><i>*This data sheet is not complete as the testing of the collector was not performed according to ISO 9806:2013. The steady state test evaluation was recalculated with gross area. The former values related to 0.786 m<sup>2</sup> aperture area (CPC 5) had been: eta0a,hem=0.552; a1a=1.522; a2a=0.004.</i></p>					 Genau. Richtig.  TÜV Rheinland Energy GmbH Am Grauen Stein 51105 Köln									
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**Annual collector output in kWh/collector at mean fluid temperature  $\vartheta_m$ , based on EN ISO 9806:2013 test results**

Standard Locations	Athens			Davos			Stockholm			Würzburg			
	$\vartheta_m$	25°C	50°C	75°C	25°C	50°C	75°C	25°C	50°C	75°C	25°C	50°C	75°C
Collector name													
Gravitation CPC 5		773	648	528	635	521	417	462	367	284	503	400	309
Gravitation CPC 10		1 522	1 275	1 039	1 250	1 025	821	910	722	559	990	788	609
Gravitation CPC 15		2 279	1 909	1 556	1 871	1 535	1 229	1 363	1 082	837	1 483	1 180	912
Gravitation CPC 20		3 043	2 550	2 078	2 499	2 050	1 642	1 820	1 445	1 118	1 981	1 576	1 218
Annual output per m <sup>2</sup> gross area		805	675	550	661	542	434	482	382	296	524	417	322
Fixed or tracking collector		Fixed (slope = latitude - 15°; rounded to nearest 5°)											
Annual irradiation on collector plane		1765 kWh/m <sup>2</sup>			1714 kWh/m <sup>2</sup>			1166 kWh/m <sup>2</sup>			1244 kWh/m <sup>2</sup>		
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  $\vartheta_m$  (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](http://www.solarkeymark.org/scenocalc)

**Additional Information**

Collector heat transfer medium	Water-Glycole
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)	--
Maximum tested positive load	Pa
Maximum tested negative load	Pa
Hail resistance using steel ball (maximum drop height)	m

**Energy Labelling Information**

	Reference Area, $A_{sol}$ (m <sup>2</sup> )	Data required for CDR (EU) No 811/2013 - Reference Area $A_{sol}$	
Gravitation CPC 5	0.96	Collector efficiency ( $\eta_{col}$ )	40 %
Gravitation CPC 10	1.89	<i>Remark: Collector efficiency (<math>\eta_{col}</math>) 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/m<sup>2</sup>, expressed in % and rounded to the nearest integer. Deviating from the regulation <math>\eta_{col}</math> is based on reference area (<math>A_{sol}</math>) which is aperture area for values according to EN 12975-2 or gross area for ISO 9806:2013.</i>	
Gravitation CPC 15	2.83		
Gravitation CPC 20	3.78		
		Data required for CDR (EU) No 812/2013 - Reference Area $A_{sol}$	
		Zero-loss efficiency ( $\eta_0$ )	0.453 --
		First-order coefficient ( $a_1$ )	1.25 W/(m <sup>2</sup> K)
		Second-order coefficient ( $a_2$ )	0.003 W/(m <sup>2</sup> K <sup>2</sup> )
		Incidence angle modifier IAM (50°)	0.97 --
		<i>Remark: The data given in this section are related to collector reference area (<math>A_{sol}</math>) 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.</i>	