


<b>Annex to Solar Keymark Certificate - Summary of EN ISO 9806:2013 Test Results</b>					<b>Licence Number</b>		<b>TSU 008-13</b>																	
					<b>Date issued</b>		<b>2018-11-07</b>																	
					<b>Issued by</b>		<b>TSU Piešťany, š.p.</b>																	
<b>Licence holder</b>		<b>Jozef Kukuča LAUGOTHERM</b>			<b>Country</b>		Slovak republic																	
<b>Brand (optional)</b>					<b>Web</b>		www.laugotherm.sk																	
<b>Street, Number</b>		Kostolná - Záriečie 187			<b>E-mail</b>		laugotherm@laugotherm.sk																	
<b>Postcode, City</b>		913 04 Kostolná - Záriečie			<b>Tel</b>		+421 3265626767																	
<b>Collector Type</b>					Flat plate collector, glazed																			
<b>Collector name</b>					<b>Gross area (<math>A_G</math>)</b>		<b>Gross length</b>		<b>Gross width</b>		<b>Gross height</b>		<b>Power output per collector</b> Gb = 850 W/m <sup>2</sup> ; Gd = 150 W/m <sup>2</sup> $\vartheta_m - \vartheta_a$											
					m <sup>2</sup>		mm		mm		mm		0 K		10 K		30 K		50 K		70 K		90 K	
<b>Ramzes</b>					2,03		2 210		1 010		85		1 449		1 376		1 222		1 056		878		690	
<b>Power output per m<sup>2</sup> gross area</b>					714		678		602		520		433		340									
<b>Performance parameters test method</b>					Steady state - outdoor																			
<b>Performance parameters (related to <math>A_G</math>)</b>					$\eta_{0,hem}$		a1		a2															
<b>Units</b>					-		W/(m <sup>2</sup> K)		W/(m <sup>2</sup> K <sup>2</sup> )															
<b>Test results</b>					0,714		3,528		0,007															
<b>Incidence angle modifier test method</b>					Steady state - outdoor																			
<b>Bi-directional incidence angle modifiers</b>					Yes																			
<b>Incidence angle modifier</b>					Angle		10°		20°		30°		40°		50°		60°		70°		80°		90°	
<b>Transversal</b>					$K_{\theta T, coll}$										0,97								0,00	
<b>Longitudinal</b>					$K_{\theta L, coll}$										0,97								0,00	
<b>Heat transfer medium for testing</b>					Water																			
<b>Flow rate for testing (per gross area, <math>A_G</math>)</b>					dm/dt		0,015		kg/(sm <sup>2</sup> )															
<b>Maximum temperature difference for thermal performance calculations</b>					$(\vartheta_m - \vartheta_a)_{max}$		90		K															
<b>Standard stagnation temperature (<math>G = 1000</math> W/m<sup>2</sup>; <math>\vartheta_a = 30</math> °C)</b>					$\vartheta_{stg}$		190		°C															
<b>Effective thermal capacity, incl. fluid (per gross area, <math>A_G</math>)</b>					C/m <sup>2</sup>		4,13		kJ/(Km <sup>2</sup> )															
<b>Maximum operating temperature</b>					$\vartheta_{max, op}$		90		°C															
<b>Maximum operating pressure</b>					$p_{max, op}$		600		kPa															
<b>Testing laboratory</b>		Technický skúšobný ústav Piešťany, š.p			http://www.tsu.sk																			
<b>Test report(s)</b>		130700007/1/PQ			<b>Dated</b>		4.11.2013																	
<b>Comments of testing laboratory</b>					Datashet version: 5.01, 2016-03-01																			
Performance parameters - complete re-evaluation of the test data of the previous test (according to EN 12975-2:2006) taking into account gross area.					 <b>TECHNICKÝ SKÚŠOBNÝ ÚSTAV PIEŠŤANY, š.p.</b> Krajinská cesta 2929/9 92101 PIEŠŤANY -316/3-																			
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<b>Annual collector output in kWh/collector at mean fluid temperature <math>\vartheta_m</math>, based on ISO 9806:2013 test results</b>													
Standard Locations		Athens			Davos			Stockholm			Würzburg		
Collector name	$\vartheta_m$	25°C	50°C	75°C	25°C	50°C	75°C	25°C	50°C	75°C	25°C	50°C	75°C
Ramzes		2 221	1 568	1 040	1 690	1 179	773	1 231	809	509	1 337	868	537
Annual output per m <sup>2</sup> gross area		1 094	772	512	832	581	381	606	399	251	659	428	264
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)	C	--
Maximum tested positive load	1000	Pa
Maximum tested negative load	1000	Pa
Hail resistance using steel ball (maximum drop height)		m

#### Energy Labelling Information

	Reference Area, $A_{col}$ (m <sup>2</sup> )	Data required for CDR (EU) No 811/2013 - Reference Area $A_{sol}$	
Ramzes	2,03	Collector efficiency ( $\eta_{col}$ )	56 %
		<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>	
		<b>Data required for CDR (EU) No 812/2013 - Reference Area <math>A_{sol}</math></b>	
		Zero-loss efficiency ( $\eta_0$ )	0,714 --
		First-order coefficient ( $a_1$ )	3,53 W/(m <sup>2</sup> K)
		Second-order coefficient ( $a_2$ )	0,007 W/(m <sup>2</sup> K <sup>2</sup> )
		Incidence angle modifier IAM (50°)	0,00 --
		<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>	

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