




Annex to Solar Keymark Certificate					Licence Number		TSU 010-12					
					Date issued		2021-08-19					
					Issued by		TSU Piešťany, š.p.					
Licence holder		THERMO/SOLAR Žiar s.r.o.			Country		Slovak republic					
Brand (optional)					Web		www.thermosolar.sk					
Street, Number		Na vartičke 14			E-mail		info@thermosolar.sk					
Postcode, City		965 01 Žiar nad Hronom			Tel		+421 (0)456016080					
Collector Type					Flat plate collector							
Collector name					Power output per collector							
					Gb = 850 W/m <sup>2</sup> , Gd = 150 W/m <sup>2</sup> & u = 1.3 m/s $\vartheta_m - \vartheta_a$							
					0 K	10 K	30 K	50 K	70 K	90 K		
					m <sup>2</sup>	mm	mm	mm	W	W	W	
TS 500					2.53	2,009	1,259	75	1,817	1,733	1,551	
TS 300					2.03	2,009	1,009	75	1,458	1,391	1,244	
TS 250					2.03	2,009	1,009	75	1,458	1,391	1,244	
									0	0		
									0	0		
									0	0		
									0	0		
									0	0		
									0	0		
									0	0		
									0	0		
Power output per m <sup>2</sup> gross area					718	685	613	533	445	349		
Performance parameters test method		Steady state - outdoor										
Performance parameters (related to A <sub>G</sub> )		$\eta_0, b$	a1	a2	a3	a4	a5	a6	a7	a8	Kd	
Units		-	W/(m <sup>2</sup> K)	W/(m <sup>2</sup> K <sup>2</sup> )	J/(m <sup>3</sup> K)	-	J/(m <sup>2</sup> K)	s/m	W/(m <sup>2</sup> K <sup>4</sup> )	W/(m <sup>2</sup> K <sup>4</sup> )	-	
Test results		0.726	3.20	0.010	0.000	0.00	5,375	0.000	0.00	0.0E+00	0.92	
Incidence angle modifier test method		Steady state - outdoor										
Incidence angle modifier		Angle	10°	20°	30°	40°	50°	60°	70°	80°	90°	
Transversal		K <sub>θT, coll</sub>	1.00	1.00	0.99	0.97	0.95	0.92	0.84	0.60	0.00	
Longitudinal		K <sub>θL, coll</sub>	1.00	1.00	0.99	0.97	0.95	0.92	0.84	0.60	0.00	
Heat transfer medium for testing		Water										
Flow rate for testing (per gross area, A <sub>G</sub> )		dm/dt	0.011	kg/(sm <sup>2</sup> )								
Maximum temperature difference during thermal performance test		( $\vartheta_m - \vartheta_a$ ) <sub>max</sub>	60	K								
Standard stagnation temperature (G = 1000 W/m <sup>2</sup> ; $\vartheta_a = 30$ °C)		$\vartheta_{stg}$	196	°C								
Maximum operating temperature		$\vartheta_{max, op}$	100	°C								
Maximum operating pressure		p <sub>max, op</sub>	600	kPa								
Testing laboratory		Technický skúšobný ústav Piešťany, š.p					http://www.tsu.sk					
Test report(s)		210700002/PQ 210700002/P					Dated		16-8-2021 16-8-2021			
Comments of testing laboratory		Datasheet version: 6.1, 2019-09-26										
		 <p>TECHNICKÝ SKÚŠOBNÝ ÚSTAV PIEŠŤANY, š.p. Krajinská cesta 2929/9 92101 PIEŠŤANY -316/3-</p>										
<p><b>Technický skúšobný ústav Piešťany, š.p.</b> Address: Krajinská cesta 2929/9, 92101 Piešťany, Slovak Republic Phone: +421 33 79 57 111, Fax: +421 33 77 23 716, E-mail: sv@tsu.sk, web: www.tsu.eu</p>												

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<b>Annual collector output in kWh/collector at mean fluid temperature <math>\vartheta_m</math></b>													
Collector name	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
TS 500		2,940	2,149	1,462	2,258	1,605	1,056	1,661	1,117	706	1,804	1,210	751
TS 300		2,359	1,725	1,173	1,812	1,288	847	1,333	896	566	1,448	971	603
TS 250		2,359	1,725	1,173	1,812	1,288	847	1,333	896	566	1,448	971	603
Annual output per m <sup>2</sup> gross area		1,162	850	578	892	635	417	657	442	279	713	478	297
Annual efficiency, $\eta_a$		66%	48%	33%	55%	39%	26%	56%	38%	24%	57%	38%	24%
Fixed or tracking collector	Fixed (slope = latitude - 15°; rounded to nearest 5°)												
Annual irradiation on collector plane		1765 kWh/m <sup>2</sup>			1630 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. 6.1 (September 2019). A detailed description of the calculations is available at <http://www.estif.org/solarkeymarknew/>

<b>Additional Information</b>				
Collector heat transfer medium	Water-Glycole			
The collector is deemed to be suitable for roof integration	Yes			
The collector was tested successfully under the following conditions:				
Climate class (A+, A, B or C)			A	--
G (W/m <sup>2</sup> ) >	1000	$\vartheta_a$ (°C) >	20	$H_x$ (MJ/m <sup>2</sup> ) >
Maximum tested positive load			2300	Pa
Maximum tested negative load			2500	Pa
Hail resistance using steel ball (maximum drop height)			2	m

<b>Additional collector attribute(s)</b>				
<input type="checkbox"/>	Using external power source(s) for normal operation	<input type="checkbox"/>	Active or passive measure(s) for self-protection	
<input type="checkbox"/>	Co-generating thermal and electrical power	<input checked="" type="checkbox"/>	Façade collector(s)	

<b>Energy Labelling Information</b>		<b>Additional Informative Technical Data</b>	
	Reference Area, $A_{sol}$ (m <sup>2</sup> )	Hydraulic Designation Code	Aperture Area, $A_a$ (m <sup>2</sup> )
TS 500	2.53	1-V-1234S-A:9,26000-C:16,1300	2.26
TS 300	2.03	1-V-1234S-A:9,21000-C:16,1000	1.78
TS 250	2.03	1-V-12S-A:9,21000	1.78

<b>Data required for CDR (EU) No 811/2013 - Reference Area <math>A_{sol}</math></b>		<b>Data required for CDR (EU) No 812/2013 - Reference Area <math>A_{sol}</math></b>	
Collector efficiency ( $\eta_{col}$ )	57%	Zero-loss efficiency ( $\eta_0$ )	0.72
Remark: Collector efficiency ( $\eta_{col}$ ) 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/m <sup>2</sup> , expressed in % and rounded to the nearest integer. Deviating from the regulation $\eta_{col}$ is based on reference area ( $A_{sol}$ ) which is aperture area for values according to EN 12975-2 or gross area for ISO 9806:2017.		First-order coefficient ( $a_1$ )	3.20
		Second-order coefficient ( $a_2$ )	0.010
		Incidence angle modifier IAM (50°)	0.94
		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.	

### Technický skúšobný ústav Piešťany, š.p.

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