TECHNICKÝ SKÚŠOBNÝ ÚSTAV PIEŠŤANY, š.p.

Annex to Solar Keymark Certificate

Licence Number	**TSU 002-19**
Date issued	**2019-11-21**
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	**Gross area (A_G)**	**Gross length**	**Gross width**	**Gross height**	**Power output per collector** Gb = 850 W/m2, Gd = 150 W/m2 & u = 1.3 m/s $\vartheta_m - \vartheta_a$					
					0 K	10 K	30 K	50 K	70 K	100 K
	m²	mm	mm	mm	W	W	W	W	W	W
TS 350	2,03	2 010	1 010	74	1 447	1 378	1 229	1 065	886	591
Power output per m² gross area					713	679	605	525	437	291

Performance parameters test method	Steady state - outdoor									
Performance parameters (related to A_G)	η0, b	a1	a2	a3	a4	a5	a6	a7	a8	Kd
Units	-	W/(m²K)	W/(m²K²)	J/(m³K)	-	J/(m²K)	s/m	W/(m²K⁴)	W/(m²K⁴)	-
Test results	0,722	3,32	0,009	0,000	0,00	5 813	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	$K_{\theta T\ coll}$	1,00	0,99	0,98	0,97	0,95	0,91	0,83	0,57	0,00
Longitudinal	$K_{\theta L\ coll}$	1,00	0,99	0,98	0,97	0,95	0,91	0,83	0,57	0,00

Heat transfer medium for testing	Water		
Flow rate for testing (per gross area, A_G)	dm/dt	0,020	kg/(sm²)
Maximum temperature difference during thermal performance test	$(\vartheta_m-\vartheta_a)_{max}$	70	K
Standard stagnation temperature (G = 1000 W/m²; ϑ_a = 30 °C)	ϑ_{stg}	194	°C
Maximum operating temperature	$\vartheta_{max\ op}$	100	°C
Maximum operating pressure	$p_{max\ op}$	600	kPa

Testing laboratory	Technický skúšobný ústav Piešťany, š.p	http://www.tsu.sk	
Test report(s)	190700003/PQ	**Dated**	18.11.2019

Comments of testing laboratory

Datasheet version: 6.1, 2019-09-26

TECHNICKÝ SKÚŠOBNÝ ÚSTAV PIEŠŤANY, š.p.
Krajinská cesta 2929/9
92101 PIEŠŤANY
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Supplementary Information	Issued	2019-11-21

Annual collector output in kWh/collector at mean fluid temperature ϑ_m

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
TS 350		2 325	1 679	1 129	1 772	1 248	813	1 306	868	543	1 419	939	578
Annual output per m² gross area		1 145	827	556	873	615	401	643	428	268	699	463	285
Annual efficiency, η_a		65%	47%	32%	54%	38%	25%	55%	37%	23%	56%	37%	23%
Fixed or tracking collector		Fixed (slope = latitude - 15°; rounded to nearest 5°)											
Annual irradiation on collector plane		1765 kWh/m²			1630 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. 6.1 (September 2019). A detailed description of the calculations is available at http://www.estif.org/solarkeymarknew/

Additional Information

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/m²) >	1000	ϑ_a (°C) >	20	H_y (MJ/m²) >	600
Maximum tested positive load				2300	Pa
Maximum tested negative load				2500	Pa
Hail resistance using steel ball (maximum drop height)				2	m

Additional collector attribute(s)

☐ Using external power source(s) for normal operation	☐ Active or passive measure(s) for self-protection
☐ Co-generating thermal and electrical power	☑ Façade collector(s)

Energy Labelling Information

	Reference Area, A_{sol} (m²)
TS 350	2,03

Data required for CDR (EU) No 811/2013 - Reference Area A_{sol}

Collector efficiency (η_{col})	57%

Remark: Collector efficiency (ηcol) 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 ηcol is based on reference area (Asol) which is aperture area for values according to EN 12975-2 or gross area for ISO 9806:2017.

Additional Informative Technical Data

Hydraulic Designation Code	Aperature Area, A_a (m²)
{F}-{O}-{CL}-{A:Ø,L}-{C:Ø,L}-{D}	1,78
10-V-1234S-A:8,1863-C:18,1040-	

Data required for CDR (EU) No 812/2013 - Reference Area A_{sol}

Zero-loss efficiency (η_0)	0,71	--
First-order coefficient (a_1)	3,32	W/(m²K)
Second-order coefficient (a_2)	0,009	W/(m²K²)
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.

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