Annex to Solar Keymark Certificate

Licence Number	**OEM 9965/1/3**
Date issued	**2023-08-10**
Issued by	**DQS Hellas**

Licence holder	**MBM GROUP S.R.L.**	**Country**	Italy
Brand (optional)		**Web**	
Street, Number	Via di Vorno, 4	**E-mail**	info@zenithsolare.it
Postcode, City	55060 Capannori (LU)	**Tel**	+390 0583 25028

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	76 K
	m²	mm	mm	mm	W	W	W	W	W	W
STAR 1500	1,52	1.510	1.010	110	1.054	992	860	718	567	520
STAR 2000	2,03	2.010	1.010	110	1.408	1.325	1.148	959	757	694
STAR 2600	2,53	2.010	1.270	110	1.755	1.651	1.431	1.196	944	865
Power output per m² gross area					694	653	566	473	373	342

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	0,704	4,02	0,008	0,000	0,00	7.860	0,000	0,00	0,0E+00	0,90

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	1,00	0,99	0,98	0,94	0,87	0,73	0,48	0,00
Longitudinal	$K_{\theta L,coll}$	1,00	1,00	0,99	0,98	0,94	0,87	0,73	0,48	0,00

Heat transfer medium for testing	Water		
Flow rate for testing (per gross area, A_G)	dm/dt	0,022	kg/(sm²)
Maximum temperature difference during thermal performance test	$(\vartheta_m-\vartheta_a)_{max}$	46	K
Standard stagnation temperature (G = 1000 W/m²; ϑ_a = 30 °C)	ϑ_{stg}	174	°C
Maximum operating temperature	ϑ_{max_op}	100	°C
Maximum operating pressure	$p_{max,op}$	1000	kPa

Testing laboratory	NCSR Demokritos	www.solar.demokritos.gr	
Test report(s)	4188DE1 4189DE1 4023DQ2, 4046DQ2	**Dated**	27/7/2016 27/7/2016 5/9/2013

Comments of testing laboratory	Ver. 6.2 (13.01.2022)

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Supplementary Information	Issued	2023-08-10

Gross Thermal Yield 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
STAR 1500		1.670	1.121	689	1.226	804	478	908	559	319	990	602	338
STAR 2000		2.230	1.497	920	1.638	1.074	638	1.213	746	426	1.322	804	452
STAR 2600		2.779	1.866	1.147	2.041	1.339	796	1.511	930	531	1.648	1.002	563
Gross Thermal Yield per m² gross area		1.099	737	453	807	529	314	597	368	210	651	396	222
Annual efficiency, η_a		62%	42%	26%	49%	32%	19%	51%	32%	18%	52%	32%	18%
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. 6.2 (13.01.2022). 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				No	
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_x (MJ/m²) >	600
Maximum tested positive load				1000	Pa
Maximum tested negative load				1000	Pa
Hail resistance using steel ball (maximum drop height)					m

Additional collector attribute(s)

Using external power source(s) for normal operation	No	Active or passive measure(s) for self-protection	No
Co-generating thermal and electrical power	No	Façade collector(s)	No

Energy Labelling Information

	Reference Area, A_{sol} (m²)
STAR 1500	1,52
STAR 2000	2,03
STAR 2600	2,53

Additional Informative Technical Data

	Hydraulic Designation Code	Aperture Area, A_a (m²)
STAR 1500	10-V-1234S-A:7.2,1342-C:20.6,1060-D	1,34
STAR 2000	10-V-1234S-A:7.2,1842-C:20.6,1060-D	1,81
STAR 2600	13-V-1234S-A:7.2,1842-C:20.6,1320-D	2,32

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

Collector efficiency (η_{col})	52%

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.

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

Zero-loss efficiency (η_0)	0,69	--
First-order coefficient (a_1)	4,02	W/(m²K)
Second-order coefficient (a_2)	0,008	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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