

Installation and Operation Manual

for Solar Systems with KTU R2 Collectors



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GENERAL INSTALLATION AND OPERATION INSTRUCTIONS

Collector Description

REGULUS evacuated tube solar collectors with U tubes are designed for heating DHW, additional heating and pool heating by solar energy. Solar radiation passes through an evacuated glass tube having an absorption coating applied on the outer side of the inner tube.

The heat is then lead via special aluminum lamellas into a copper tube through which heat carrying fluid flows and gets collected. The tubes incl. the distributor and manifold are fitted in an insulated stainless-steel case on aluminum rails. The collectors are designed for all-year-round operation, and for this reason they have a separated primary circuit filled with antifreeze heat transfer fluid. The collectors **are not intended** for direct water heating.

Transport and Handling

The collectors shall be transported in original packing, lying flat horizontally, in stacks of max. 8 pcs for KTU 9R2 collectors and max. 8 pcs for KTU 6R2 collectors

Collector Installation

The installation must be done by a trained worker or a specialized company. During the installation and before commissioning, it is necessary to cover the collectors, in order to avoid overheating and possible burn injury to the installer. If the collector is to be set on a roof, please respect appropriate safety rules.

Collector Placing

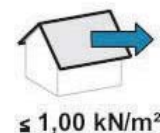
Collectors are placed outside. The glass absorption surface should be facing South, with deviations not over 45° (Southwest or Southeast). For a year round operation the right inclination angle is 40° - 50°, in summer smaller inclination is better (30°). The collector can be positioned also vertically (inclination angle of 90°, e.g. onto a façade): that is the best for winter operations. The inclination angle must not be less than 20°. It is recommended to place collectors near the ridge, with respect to their snow load in the winter.

The numbers of roof anchors shown in the Mounting Kits for Fixing and Connecting Regulus Solar Collectors are designed for the following load:

Max. permissible snow and wind load $\leq 1,8 \text{ kN/m}^2$



Max. permissible wind load - negative pressure $\leq 1,0 \text{ kN/m}^2$



The customer/user shall be informed about this fact prior to starting installation of a solar system. If a higher load than shown above is expected in the area in question, a statics expert shall be consulted and more roof anchors designed, or other measures taken that would ensure safe collector fixing. Regulus refuses any responsibility for damage caused by wrong design of collector fixing.

Safety warning

It is recommended not to touch a solar collector without wearing personal protective equipment as there is a risk of burning due to high temperatures (even 200 °C) that a collector may reach.

Lightning protection

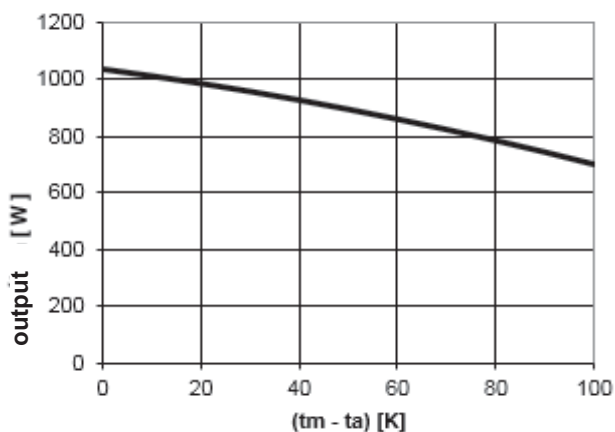
Lightning protection is obligatory for solar systems. When installed on a roof, collectors must be wired to lightning protection equipment. Czech norm ČSN EN 62 305 shall be observed.

Collector Technical Data

Model	KTU 6R2	KTU 9R2
Dimensions w x l x h [mm]	920 × 1970 × 141	1350 × 1970 × 141
Installation width [mm]	1000	1430
Connection sizes	4 × tube Cu 22	
Max. working pressure [bar]	10	
Fluid volume [l]	0.92	1.37
Recommended flow rate [l/h]	60 - 120	
Weight [kg]	32	44
Collector gross area [m ²]	1.81	2.66
Aperture [m ²]	1.43	2.15
Number of tubes	6	9

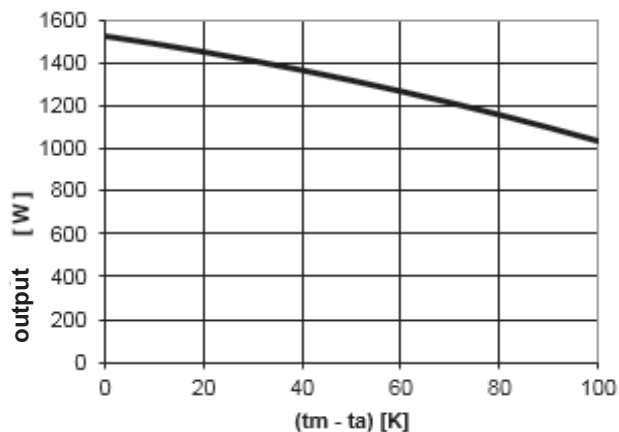
KTU 6R2

Momentary collector output for insolation of 1000 W/m²

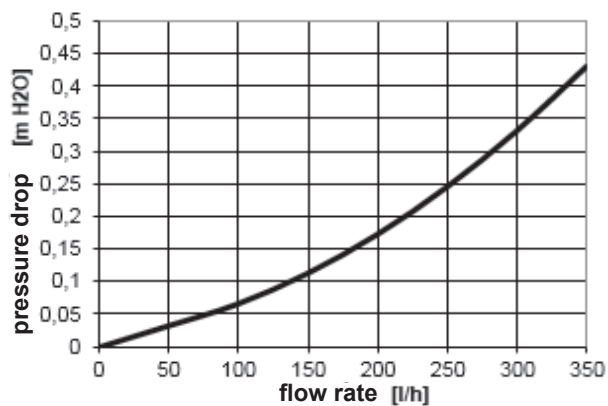


KTU 9R2

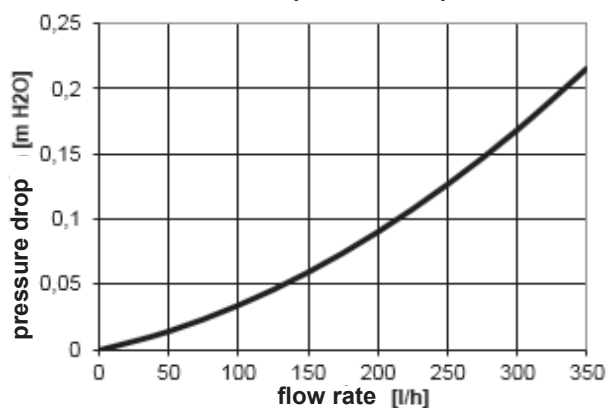
Momentary collector output for insolation of 1000 W/m²



Collector pressure drop





Collector pressure drop





1 - Mounting System Delivery

Handle the collectors and accessories with care, do claim immediately any possible damage during transport

Mount kits for fixing and connecting KTU R2 collectors		Kód
	Connection kit (3/4" M inlet and M outlet)	7710
	Fixing and interconnecting kit for 2 KTU 6R collectors *[for 6 roof anchors or 3 supports +1 strut]	7241
	Fixing and interconnecting kit for 3 KTU 6R collectors *[for 8 roof anchors or 4 supports +1 strut]	7242
	Fixing and interconnecting kit for 4 KTU 6R collectors *[for 10 roof anchors or 5 supports +1 strut]	7243
	Fixing and interconnecting kit for 5 KTU 6R collectors *[for 10 roof anchors or 5 supports +1 strut]	7244
	Fixing and interconnecting kit for 2 KTU 9R collectors *[for 6 roof anchors or 3 supports +1 strut]	7245
	Fixing and interconnecting kit for 3 KTU 9R collectors *[for 8 roof anchors or 4 supports +1 strut]	7246
	Fixing and interconnecting kit for 4 KTU 9R collectors *[for 10 roof anchors or 5 supports +1 strut]	7247
<p><i>* Roof fixing and interconnecting kits are necessary to create a hydraulically connected collector array fixed to 2 mounting rails. The kits contain interconnecting fittings with insulation, two mounting rails, fastening material for mounting collectors onto the rails. They do not involve any roof anchors, supports, struts. These shall be selected from the following chart by the roof type and roofing material.</i></p>		

Supports and struts for flat roof installation		Code
	Triangle support strut 15°	11979
	Triangle support strut 25°	10975
	Triangle support strut 45°	6859
	Strut incl. screws for triangle support	9563

Supports for sloping roof installation		Code
	Triangle strut 15°	10748
	Triangle strut 25°	8805
	Triangle strut 45°	10094
	Triangle strut 60°	9631

Anchors for various roofing types		Code
	Stainless steel anchor for slate roofs	11574
	Anchor for pantiles - hot-dip galvanized steel	7929
	Aluminum anchor for pantiles - rafter mounted	6932
	Stainless-steel anchor for pantiles	6857
	Stainless steel anchor for pantiles - rafter mounted, incl. self tapping screws	10159
	Bolt for fixing rails onto a roof	7320

2 Sloping Roof Mounting

2.1 Overview

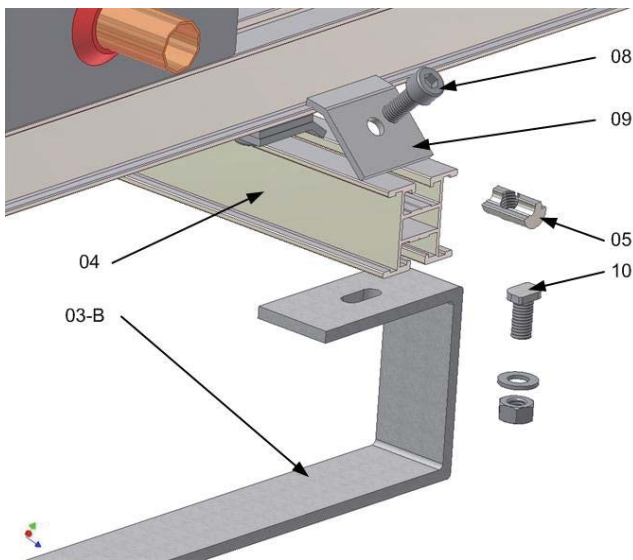
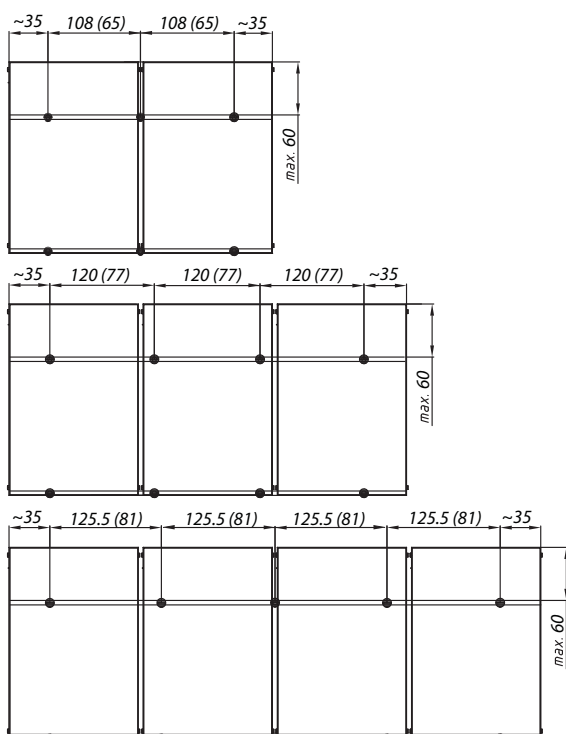
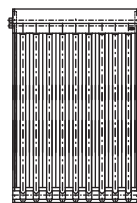
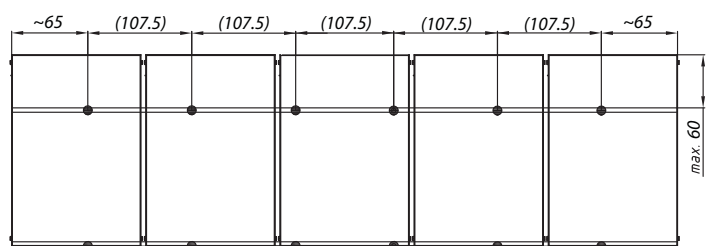


Fig. 1: Collector field and positions of fixing elements

Fig. 1b: Layout of roof anchors



No. of collectors	Total length KTU 9R2 (KTU 6R2)	No. of anchors
2	286 (200) cm	6
3	430 (301) cm	8
4	572 (400) cm	10
5	(500) cm	10



KTU 9R2



(KTU 6R2)

Pos.	Item	Code						
01	Evacuated Tube Collector	7342, 7343						
03-B 10	Roof anchor with M8 bolt/special head for rails	6857 or other depending on the roofing type						
	Triangle brackets for inclination adjustment, suitable for anchors for sloping roofs - 15°, 25°, 45° and 60° angle	11748, 8805, 10094, 9631						
Fixing and interconnection kits								
		Number of collectors (kit code)					Item code	
		1	2	3	4	5		
		for KTU 6R2	(7415)	(7241)	(7242)	(7243)	(7244)	6949
		for KTU 9R2	(7414)	(7245)	(7246)	(7247)		
04	Aluminum rails, 2 pcs	KTU 6R2	1.01 m	2 m	3.01 m	4 m	5 m	6949
		KTU 9R2	1.44 m	2.86 m	4.3 m	5.72 m		
05	M8 nut for the rails		4 pcs	8 pcs	12 pcs	16 pcs	20 pcs	6925
08	M8x18 bolt, Allen head		4 pcs	8 pcs	12 pcs	16 pcs	20 pcs	7259
09	Retaining side bracket		4 pcs	8 pcs	12 pcs	16 pcs	20 pcs	10522
	H-rail end plug		4 pcs	4 pcs	4 pcs	4 pcs	4 pcs	11773
	Interconnection screw joints		-	2 pcs	4 pcs	4 pcs	6 pcs	7629
	Insulation 35 mm diam., 19 mm thick		0.5 m	0.75 m	1 m	1.5 m	2.5 m	7188
	5 cm insulation tape, 3 mm thick, sold by meter		0.8 m	1 m	1.5 m	2 m	2.5 m	7227

Expansion mount and interconnection kits for 1 KTU R2 solar collector	Code
Expansion mount and interconnection kit for 1 KTU 6R solar collector	11991
Expansion mount and interconnection kit for 1 KTU 9R solar collector	11990

2.2 Roof anchor installation for inclined roofs

Pay attention to situations when battens are thicker than the auxiliary board (30 mm). Then the auxiliary board shall be underlaid with extra material so that its new thickness equals to the thickness of the battens (see Fig.)

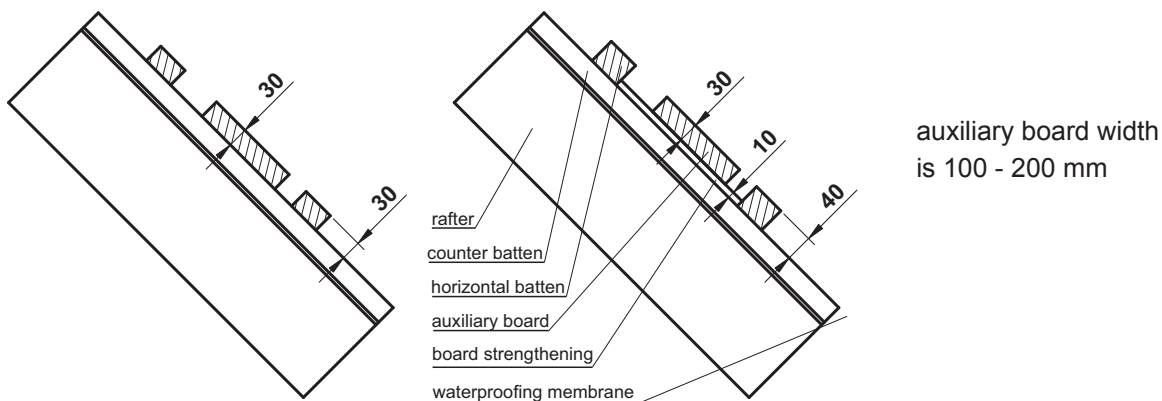
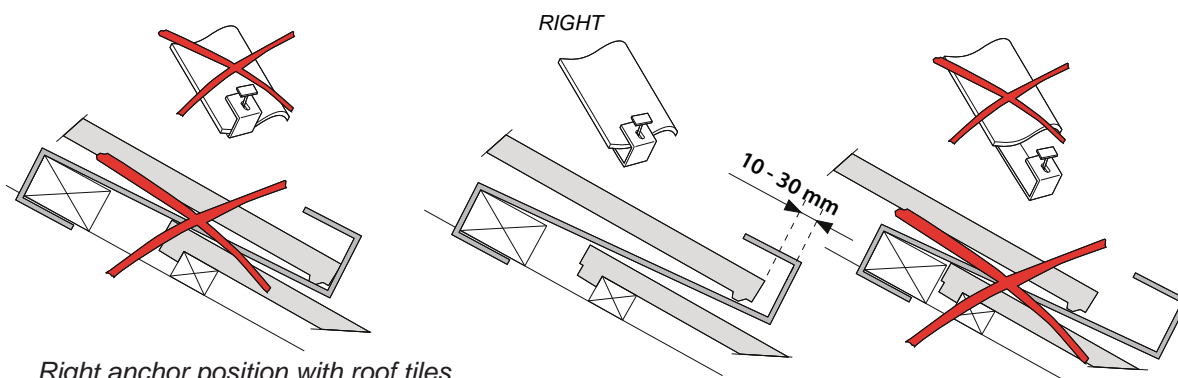


Fig. 2: Auxiliary board underlay

When installing anchors onto rafters, use an underlay of proper thickness so that the anchors installed do not prevent tiles from being laid to their desired position.



Right anchor position with roof tiles

2.2.1 Installation with roof anchors and auxiliary boards

- for tile roofs, 3cm thick additional auxiliary boards shall be mounted to the bottom roof side. Hook then the roof anchors onto the board and fix with a screw.

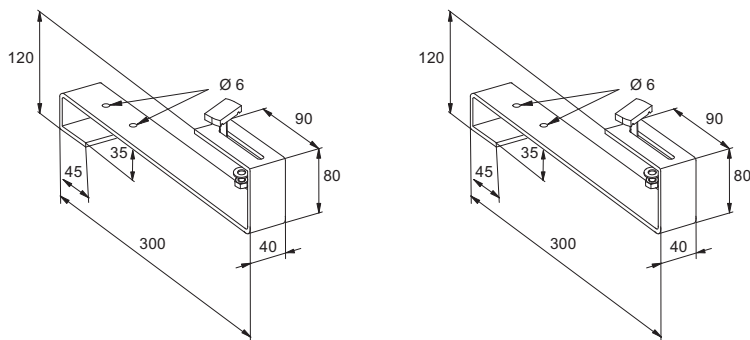


Fig. 3: Stainless-steel roof anchor Roof anchor of zinc-plated steel

- remove roof tiles in a line as long as the auxiliary board. Usually it is sufficient to shift the tiles upwards.

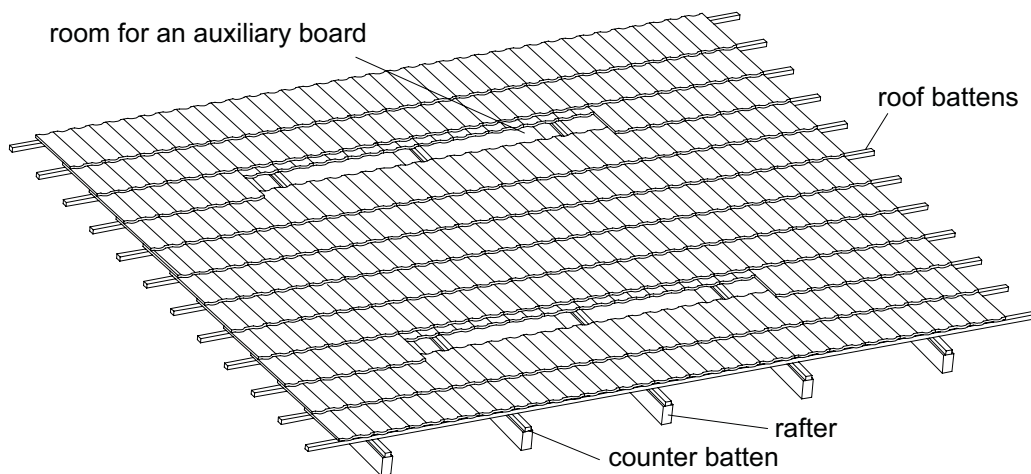


Fig. 4: Remove roof tiles to fix the board

- screw the auxiliary boards so high that the roof anchor does not hinder placing the roof tile with the right overlap
- hang the roof anchor onto the auxiliary board in a place where it will not hinder the right tile positioning, and screw the roof anchor with stainless-steel screws
- the spacing of roof anchors shall follow the layout shown in Fig. 1b

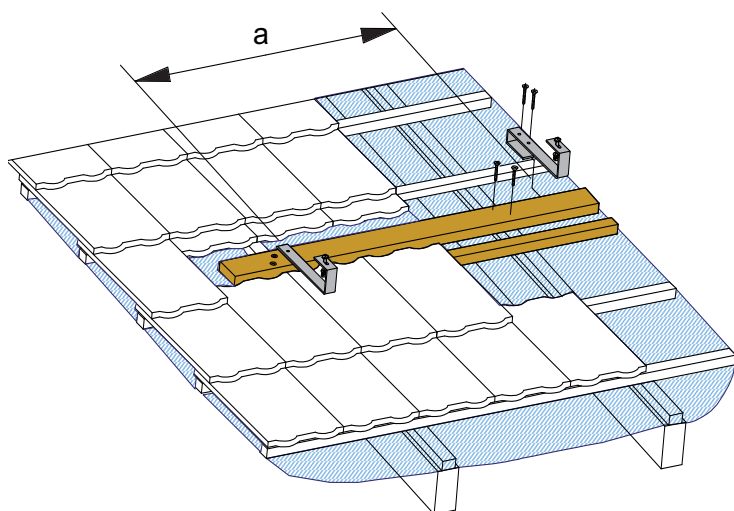


Fig. 5: Fixing an auxiliary board and roof anchors

2.2.2 Installation with roof anchors and rafters

For tiled roofs, anchors for rafters can be used. The anchor with a board is made of aluminum and enables horizontal shift of the anchor along the fixing board.

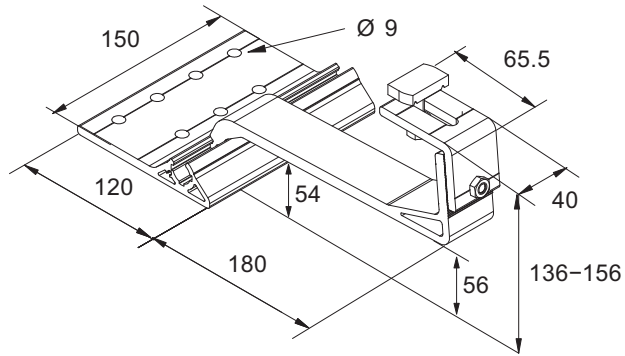


Fig. 6: Roof anchors for rafters

- remove roof tiles where the roof anchors shall be mounted

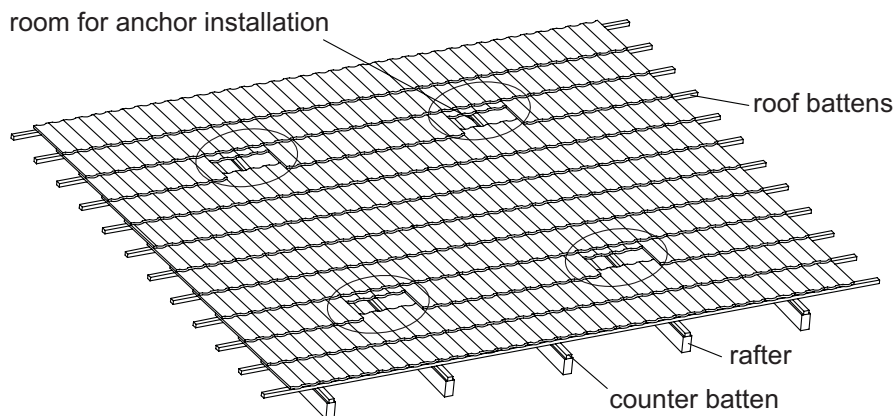


Fig. 7: Opening the room for anchor installation

- cut the counter batten that holds the waterproofing membrane and if necessary, use an underlay depending on the desired anchor's height for passing through the tiling

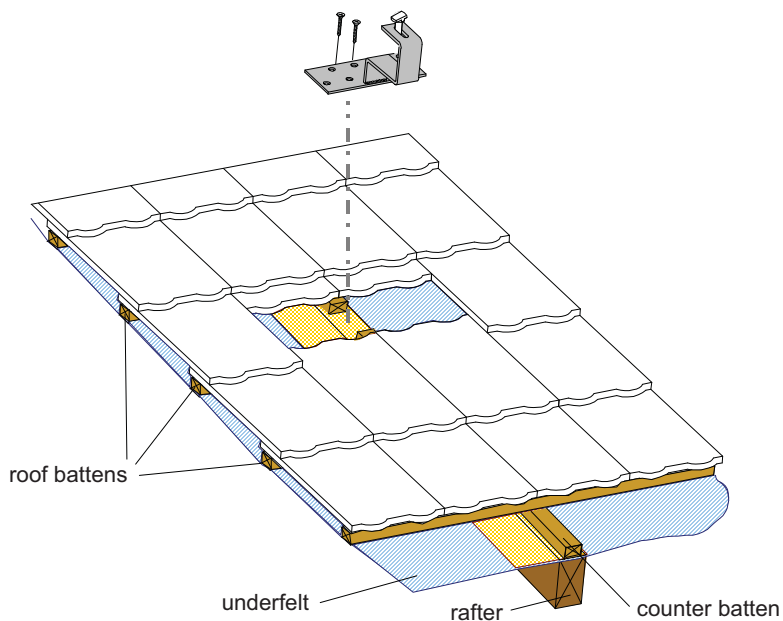
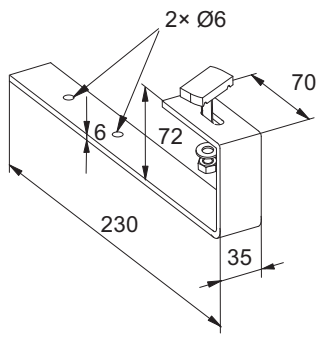


Fig. 8: A place for installing a roof anchor onto a rafter - detail

- screw a roof anchor to a rafter and shift it in the groove horizontally so that it does not hinder the right tile positioning
- the spacing of roof anchors shall follow the layout shown in Fig. 1b

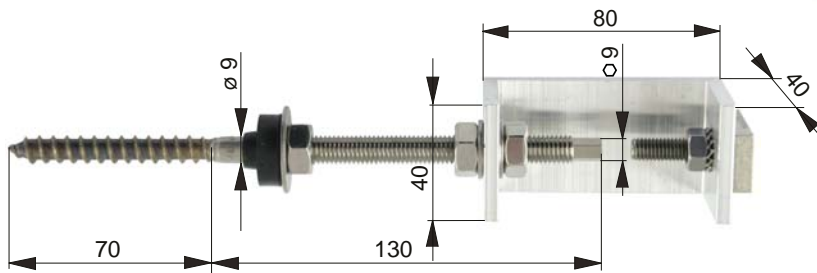
2.2.3. Installation with roof anchors for slate, shingle or sheet metal roofs



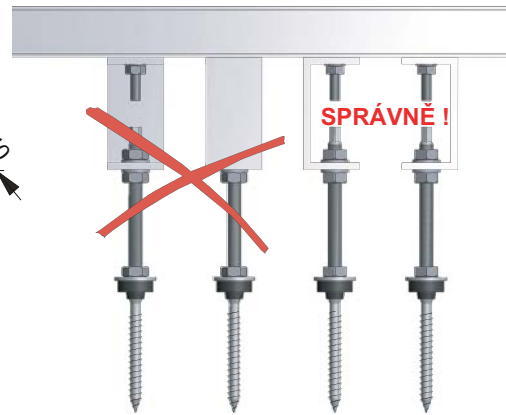
- Simply lay the anchor onto the roof tiles in a place where the roof is supported with a strong construction (a beam or another support) and fix it with stainless-steel screws. Cover the anchors with sheet metal to prevent water leakage or use another suitable method recommended by the roofing manufacturer.

Fig. 9: Anchor for slate, shingle or sheet metal roofing

2.2.4 Installation with roof bolts for fixing rails



Roofing bolt and its proper fixing to the rail



This installation method is used mainly for roofs of bitumen corrugated sheets like Gutta or Onduline and roof sheets by other manufacturers, or for roofs of corrugated Eternit or sheet metal. Using spanner No. 8, the threaded bolt shall be screwed with the threaded end into the rafter or another massive wooden roof element. It is recommended to drill holes of 6mm diam. for the bolts. Holes in the corrugated sheet shall be always drilled in the crown of the corrugations in order to minimize leakage. When the bolt is screwed in, put on a rubber gasket and seal it with a washer and nut. Then mount the U-shaped bracket on the bolt, between two nuts and washers. Then M8 bolt with floating head (for rails) shall be mounted into the other end of the bracket. First insert the floating head into the groove of the rail, and then tighten the bolt together with the rail to the U-shaped bracket using a nut and a serrated washer.

2.3 Installing rails onto roof anchors

- Prepare two rails in the length required for the number and type of collectors to be installed. Align the travelling screw head (10) with the horizontal rail and shift the rail onto it, or shift the screws into the rail and fix to the anchors. Use serrated lock washers to fix the nuts.
- Align the rails so that they lie in parallel to roof tiles. The diagonal between the rails must be of the same length:

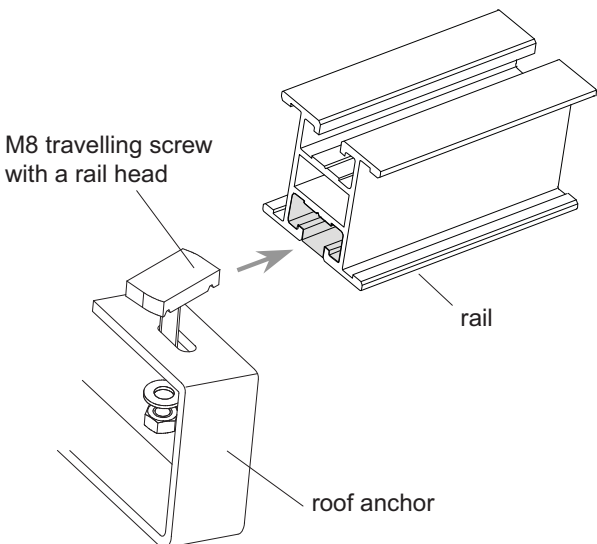


Fig. 10: Fixing the rail onto the roof anchors

$$D1 = D2$$

Then tighten the nuts on fixing screws.

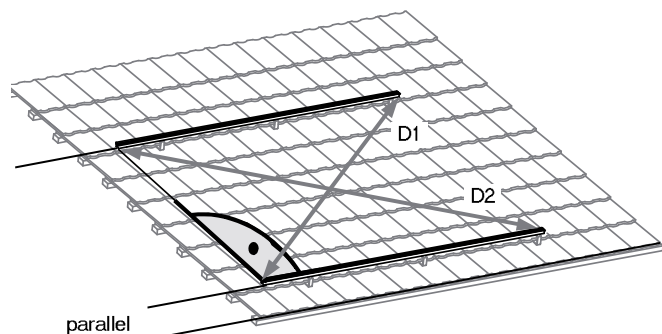


Fig. 11: Alignment of base rails

2.4 Collector mounting

- collectors shall be covered during mounting
- for easier handling the collectors, an auxiliary sling with a hook can be used (see Fig. 12a)

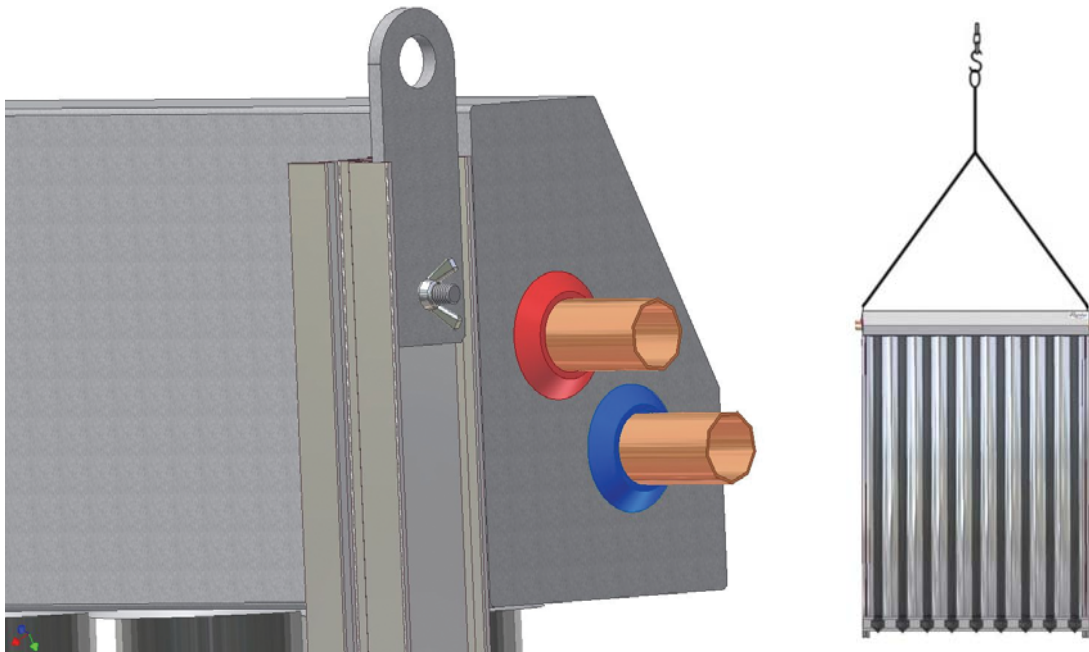


Fig. 12a: handling using an auxiliary sling

Handling Kit for KTU-type collectors	Code
KTU Handling Kit	7413
The kit contains	
Sling with a hook	7412
Bolt M6x40	7410
Wing nut M6	7411

- place the first collector onto the rails, secure it to the upper rail by means of the fixing plates located at its rear side (see Fig. 12b)

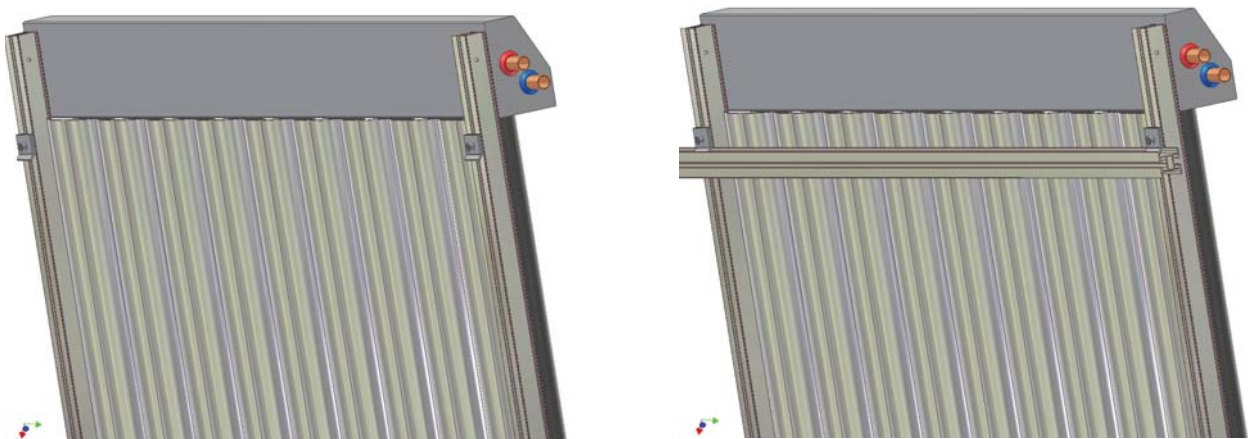


Fig. 12b: fixing a collector to an rail

- align the collector. The distance between the collector's edge and the edge of the rail B = 35 mm.

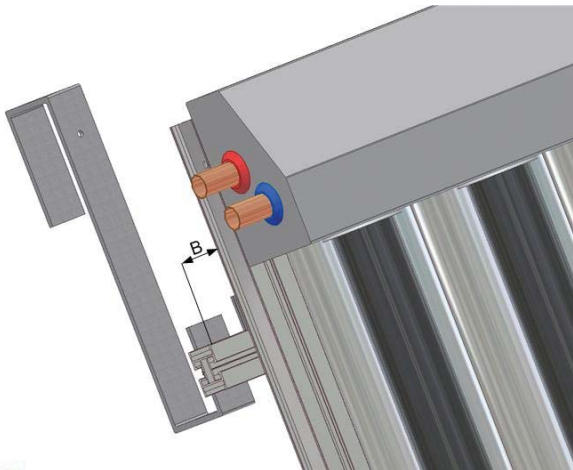


Fig. 13: Distance between the collector's edge and the edge of the rail

- insert nuts into both the rails. Put fixing plates on the rails and fix the collector through them with M8x18 bolts.

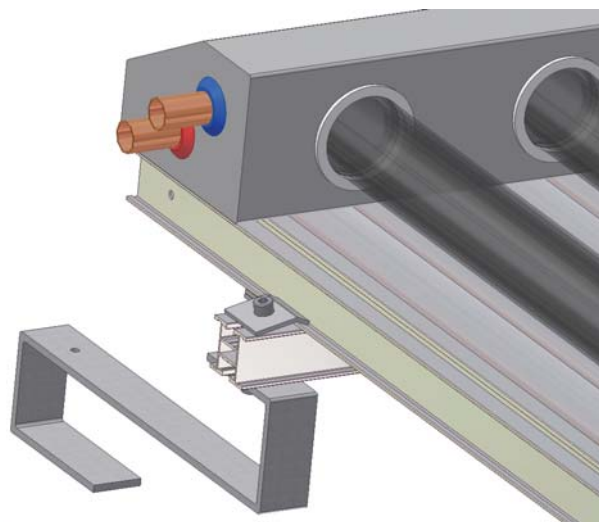


Fig. 14: Mounting a fixing plate

- Lay the following collector next to the first one, maintaining a sufficient gap. Then put on the threaded fittings and push the collector to the already mounted one until stop. Hold the fitting with a spanner to prevent turning and tighten the nuts. More on this in chapter **5 Hydraulic Connection**.
- continue in the same way with further collectors.

3 Connection Pipe Passage through a Roof

For passing the connection pipes through a roof e.g. ventilation tiles can be used, where the hole is modified according to the diameter of the pipe with insulation. However, any method selected must comply with the standards of the roofing manufacturer.

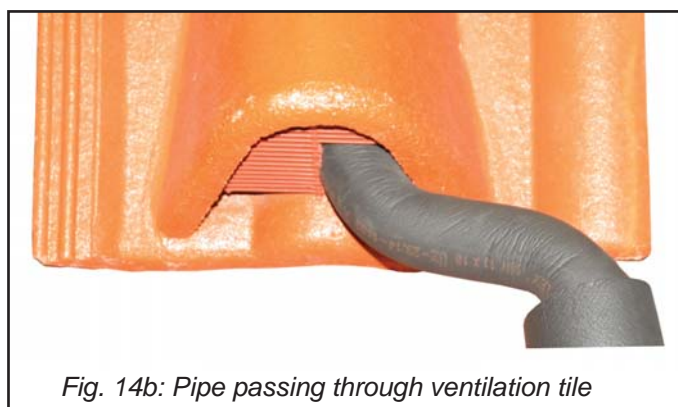


Fig. 14b: Pipe passing through ventilation tile

4 Flat Roof Mount

4.1 Overview

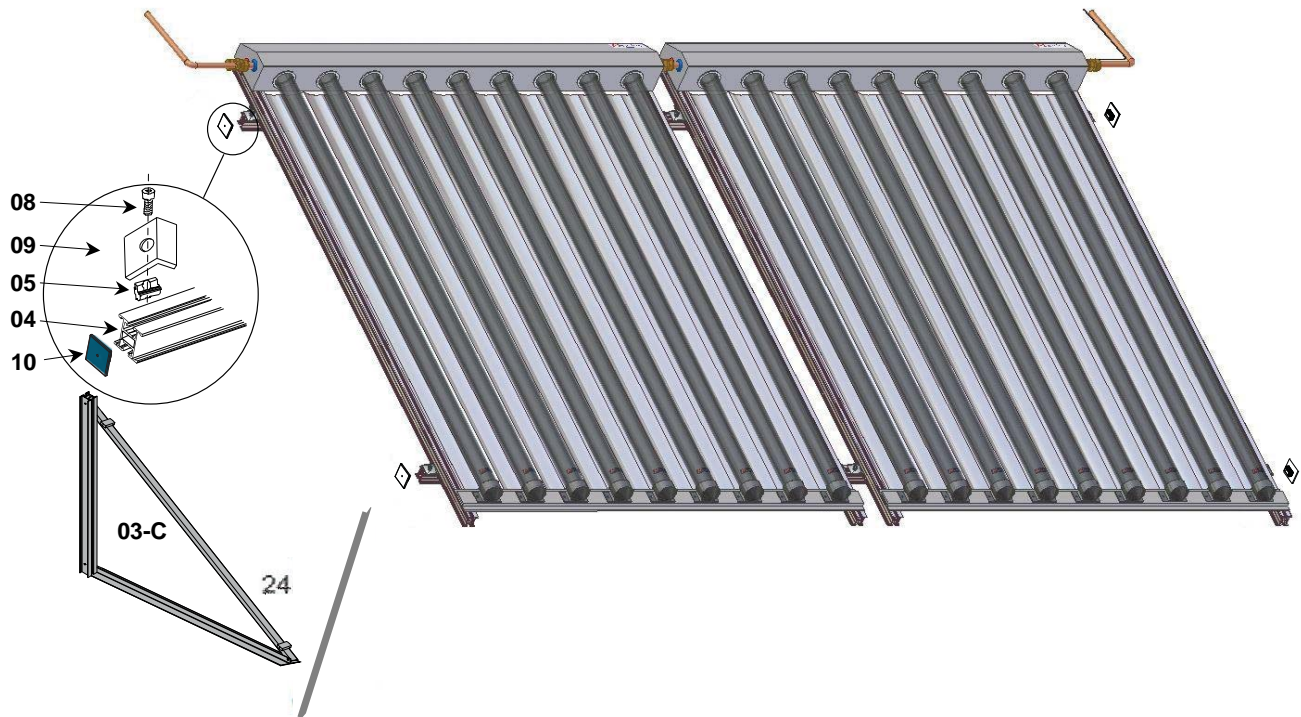


Fig. 15: Triangular support and strut

Fig. 16: Collector field

Pos.	Item	Code					
01	Evacuated Tube Collector	7342,7343					
03-C	Triangular support	6859, 10975, 11979					
24	Strut incl. bolts for triangular support	9563					
Fixing and interconnecting kits							
		Number of collectors (kit code)					Item code
		1 (7415) for KTU 6R2 (7414) for KTU 9R2	2 (7241) (7245)	3 (7242) (7246)	4 (7243) (7247)	5 (7244)	
04	Aluminum rails, 2 pcs	KTU 6R2 1.01 m	2 m	3.01 m	4 m	5 m	6949
		KTU 9R2 1.44 m	2.86 m	4.3 m	5.72 m		
05	M8 nut into rail	4 pcs	8 pcs	12 pcs	16 pcs	20 pcs	6925
08	M8x18 bolt, with Allen head	4 pcs	8 pcs	12 pcs	16 pcs	20 pcs	7259
09	Retaining side bracket	4 pcs	8 pcs	12 pcs	16 pcs	20 pcs	10522
10	H-rail end plug	4 pcs	4 pcs	4 pcs	4 pcs	4 pcs	11773
	22-22 threaded fittings - straight	-	2 pcs	4 pcs	4 pcs	6 pcs	7629
	Insulation 35 mm diam., 19 mm thick	0.5 m	0.75 m	1 m	1.5 m	2.5 m	7188
	5 cm insulation tape, 3 mm thick, sold by meter	0.8 m	1 m	1.5 m	2 m	2.5 m	7227

Expansion mount and interconnection kits for 1 KTU R2 solar collector	Code
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Expansion mount and interconnection kit for 1 KTU 9R solar collector	11990

4.2 Flat roof support mounting

A flat roof support consist of two rails, triangular supports and one strut windbrace. The number of triangular supports depends on the number of collectors. One strut is sufficient up to the rail length of 6.15 m.

- lay two rails on the mounting surface and insert the nuts into their grooves

Distance between rails = 1620 mm

(the smaller hole distance)

The diagonals between the base rails shall be of the same length: **D1 = D2**

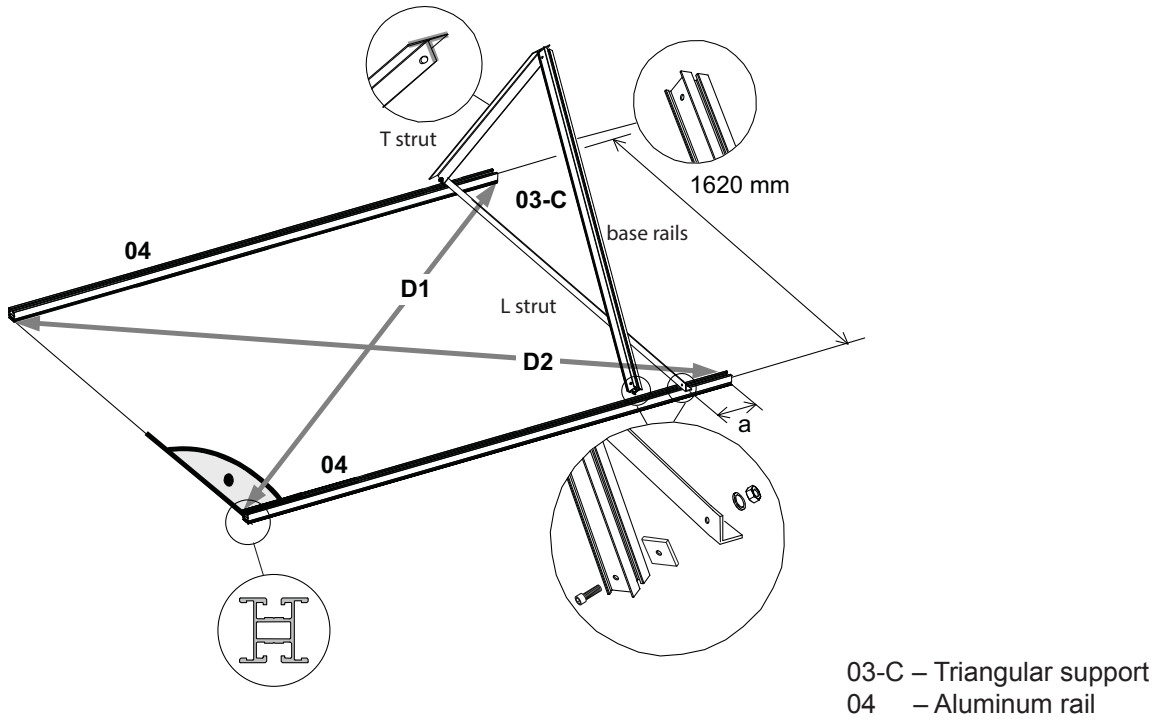


Fig. 17: Aligning the rails and mounting the first triangular support

- the triangular supports come screwed together with two bolts. Fix the loose support ends with a bolt. The distance of the first triangular support from the end of the H rail is **a ≈ 350 mm** (650 mm for 5pcs KTU 6R2).
- screw the triangular support to the rail with travelling screws with specially shaped head, serrated lock washers and nuts. Secure the travelling screws inside the rail by 90° turn (see Fig. 18).

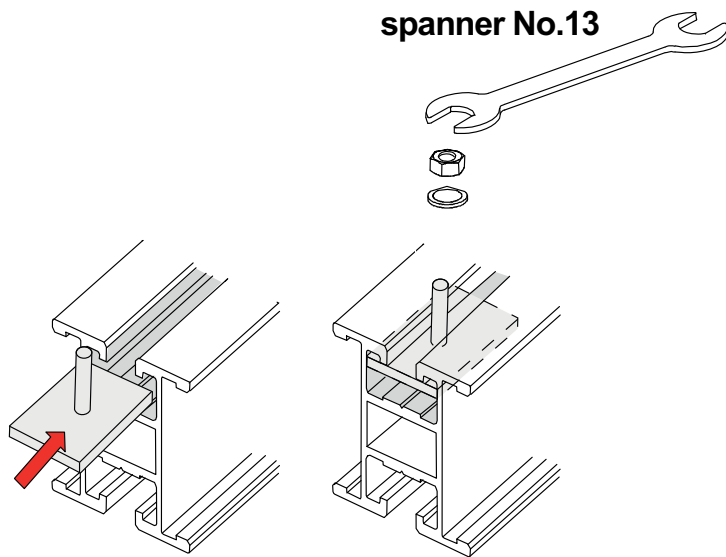


Fig. 18: Assembly by means of the travelling screws with a special head

- fix further triangular supports to the rails in the same manner. Always adjust the distance between them following the layout shown in Fig. 1b.
- fix the strut to a triangular support and to the rail (see Fig. 19). One strut is sufficient for one set of supports (up to the rail length of 6.15 m).

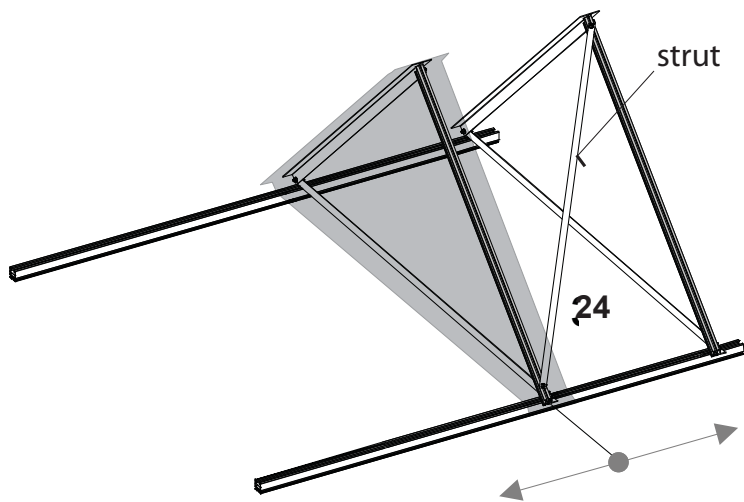


Fig. 19: Fixing the strut

- insert M8 nuts (23) into the rail (04). Install the strut between the two triangular supports (Fig. 18). Following Fig. 18, insert special M8 nuts into the triangle support rail. Then lay the strut onto the rails and fix it with M8x12 bolts with washers.

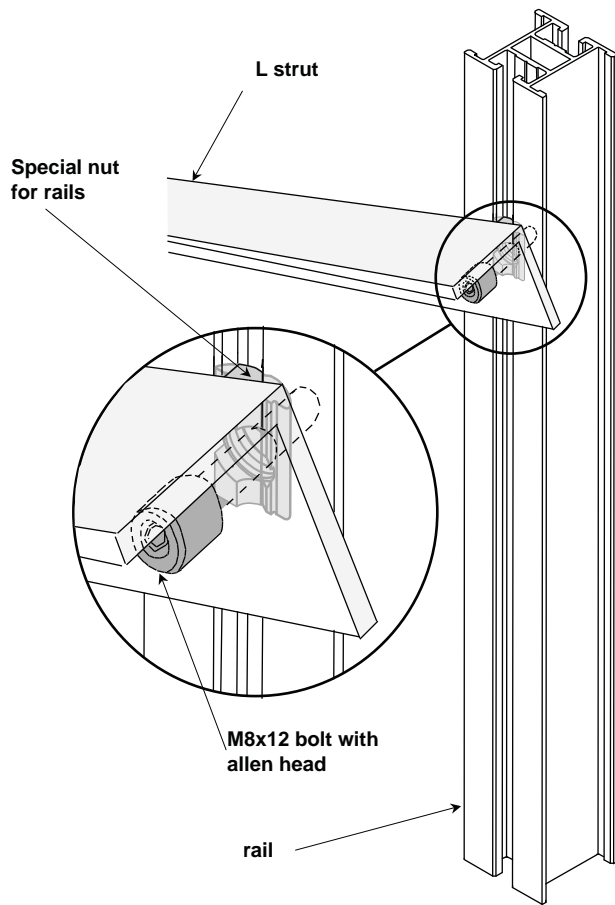


Fig. 20: Strut installation

- go on assembling the remaining triangular supports following the layout shown in Fig. 1b.

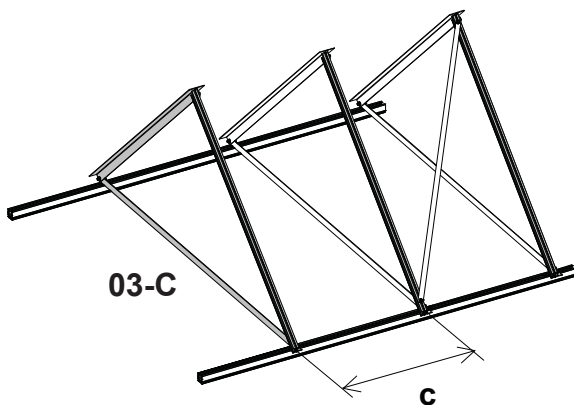


Fig. 21: Mounting further supports

- kip the entire structure into the position intended for collector installation. (The strut is upright, T rail of each triangular support lies on the ground.) Secure the support structure either by screwing it into the roof, or applying a burden. If secured with a burden, for the wind load up to 8 m building height the burden must be distributed according to the following table:

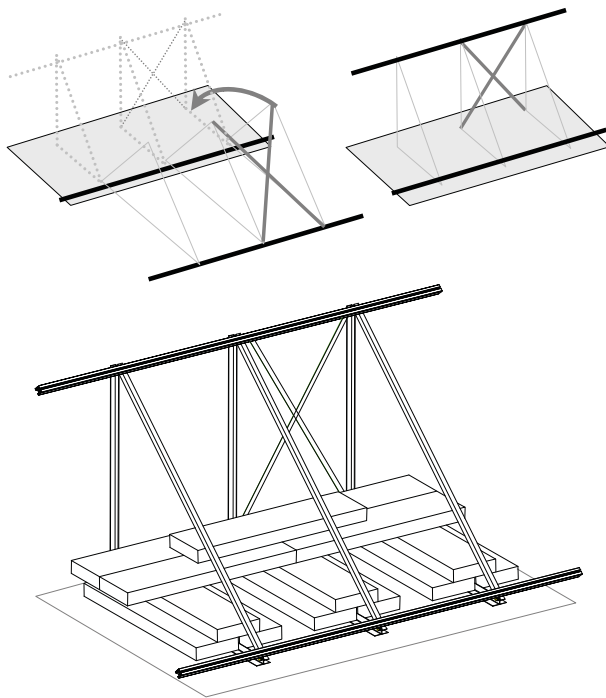


Fig. 22: Static safety (burden)

Flat roof mount	up to 8 m
1 collector	290 kg
2 collectors	580 kg
3 collectors	870 kg
4 collectors	1160 kg
5 collectors	1450 kg

In no case the permissible roof load shall be exceeded, consulting a static expert in advance is recommended. A damaged roof shall be re-insulated by a specialist.

Place the collectors on the holders and fix to the rails in the same manner as when installing on an inclined roof (see point 2.4).

Minimum distance between collector fields see Fig. 23.

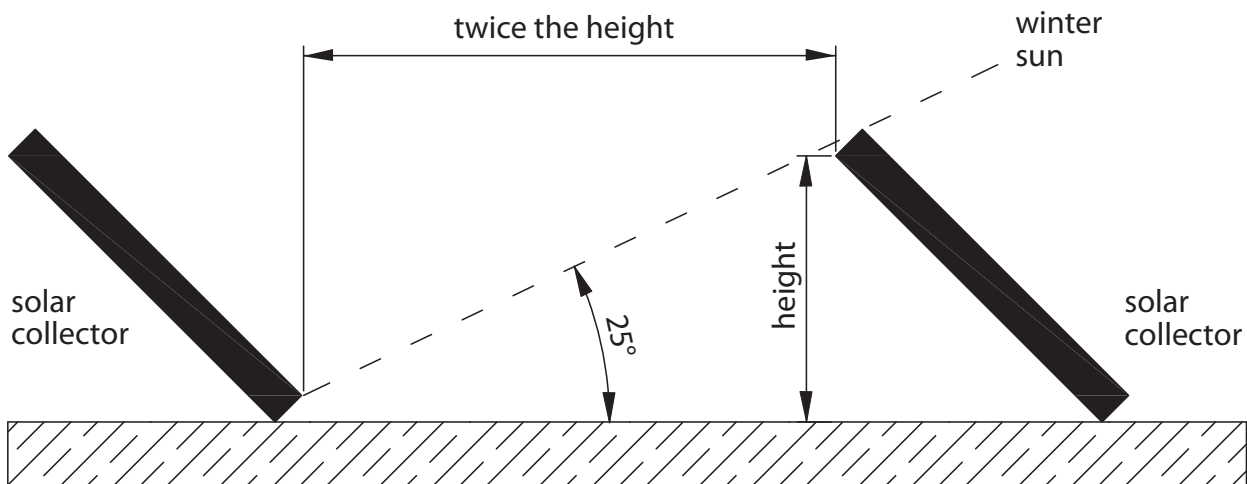


Fig. 23: Minimum distance between collector fields

5 Hydraulic Connection

5.1 Collector connecting

In order to mount the collectors, follow the instructions in Chapter 2.4. Fix the first collector and then lay the following one next to the first one, maintaining a sufficient gap. Then mount the connection screw joints to both the outlets, and push the collector to its neighbor as close as possible. Hold the screw joint with a spanner to avoid turning and tighten the nuts.

Continue in the same way also for further collectors. **Put the insulation on the screw joints only after a successful pressure test.**

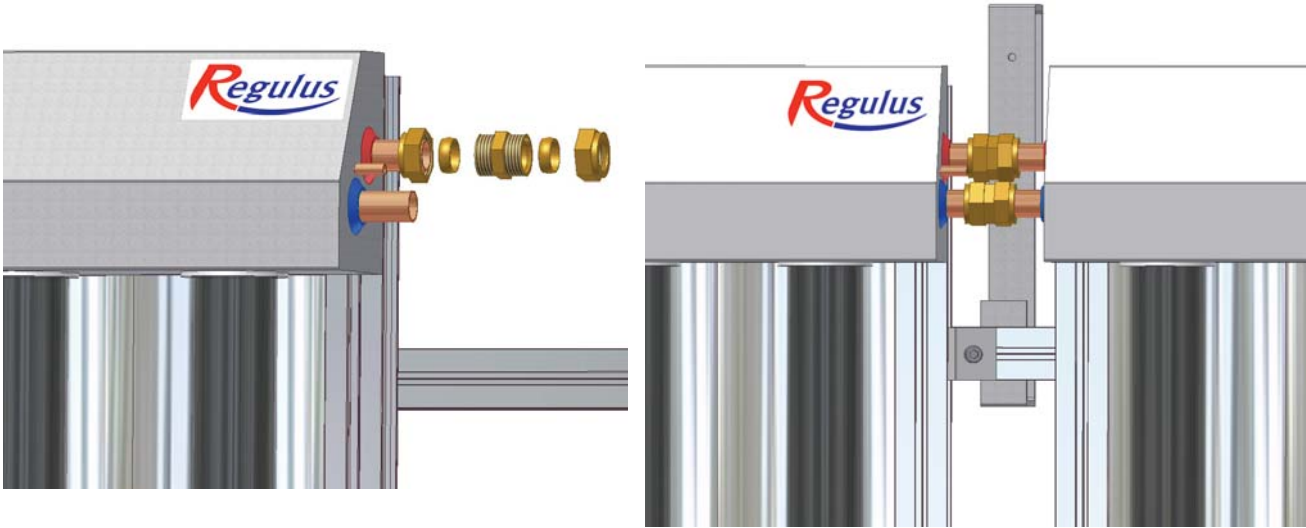
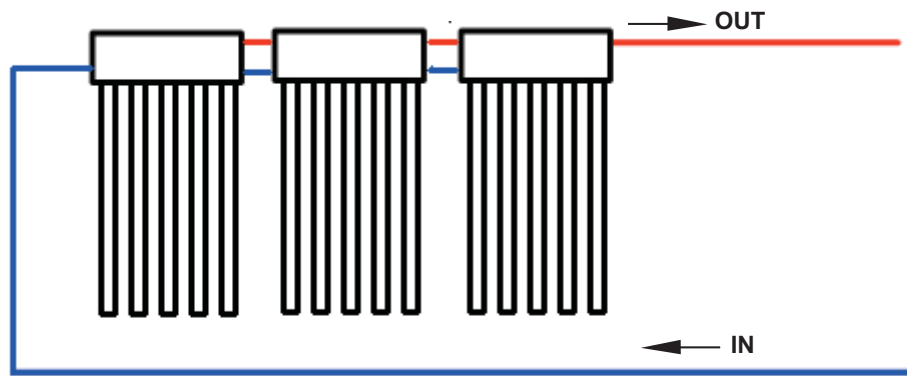


Fig. 24: Collector interconnecting



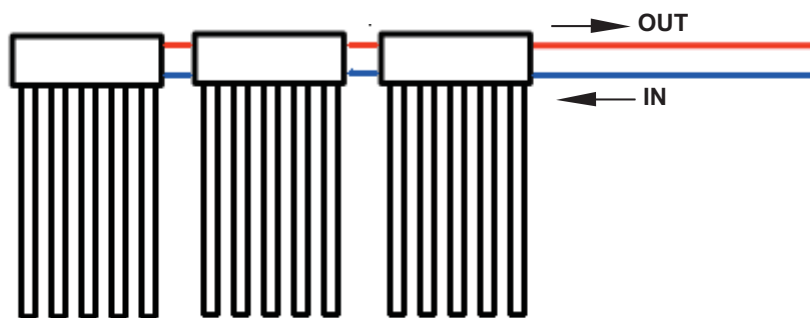
Fig. 25: Collector connecting (position of the inlet and outlet pipes and plugs)

5.2 Method of collector interconnecting



The inlet of colder fluid (blue in the pic.) is located on one side, lower position, and the outlet of warm fluid (red) is on the other side, upper position.

Fig. 26: The best collector interconnection



The inlet of colder fluid (blue) is the lower one, the outlet of warm fluid (red) is on the same side, the upper one. Both the connections shall be plugged at the other collector end.

Fig. 27: Variant of interconnecting the collectors from one side only

With respect to measurements done, also the one-sided connection as in Fig. 27 can be recommended, however **only** under these **conditions**:

- max. 3 KTU 6R2 collectors and a max. flow rate of 1l/min/collector
- max. 2 KTU 9R2 collectors and a max. flow rate of 1l/min/collector

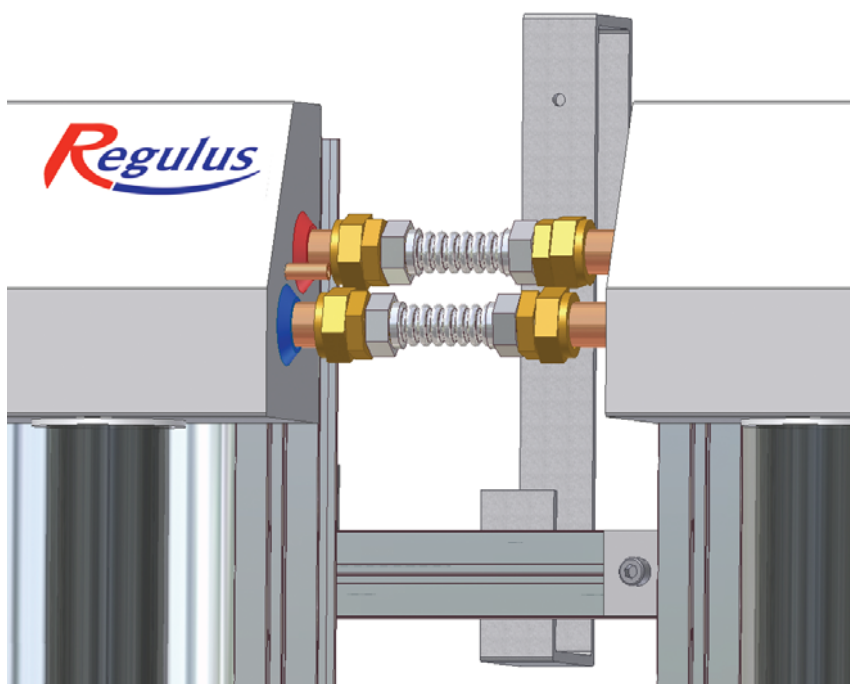


Fig. 28: Placing compensators between collectors

Max. four KTU 9R or five KTU 6R collectors in a line may be connected through threaded fittings. The next connection must be done via a compensator. Further collectors connected through threaded fittings may follow. The connection piping from collectors shall be lead the shortest possible way. See Table 1 for the recommended pipe diameters and flow rates through collectors for various connection schemes.

Number of KTU 9R2 collectors	Connection scheme	Flow rate	Connecting pipes	Max. pipe length
1	1 x 1	2 l/min	Cu 18 x 1	Max. 30 m in the inlet and outlet piping altogether
5	1 x 5 series	10 l/min	Cu 18 x 1	
6	2 x 3 parallel	12 l/min	Cu 18 x 1	
8	2 x 4 parallel	16 l/min	Cu 22 x 1	
9	3 x 3 parallel	18 l/min	Cu 22 x 1	
10	5 x 2 parallel	20 l/min	Cu 28 x 1.5	
12	4 x 3 parallel	24 l/min	Cu 28 x 1.5	

Table 1a: Recommended pipe diameters for KTU 9R2

Number of KTU 6R2 collectors	Connection scheme	Flow rate	Connecting pipes	Max. pipe length
1	1 x 1	1.3 l/min	Cu 15 x 1	Max. 30 m in the inlet and outlet piping altogether
5	1 x 5 series	6.5 l/min	Cu 15 x 1	
6	2 x 3 parallel	7.8 l/min	Cu 15 x 1	
8	2 x 4 parallel	10.4 l/min	Cu 18 x 1	
9	3 x 3 parallel	11.7 l/min	Cu 18 x 1	
10	5 x 2 parallel	13 l/min	Cu 22 x 1	
12	4 x 3 parallel	15.6 l/min	Cu 22 x 1	

Table 1b: Recommended pipe diameters for KTU 6R2

All components of a solar system shall be carefully and safely sealed and shall be made of material resistant to glycol and temperatures up to 160 °C.

For connection piping we recommend using KOMBIFLEX, stainless-steel flexible pipes, or copper pipes connected by soldering. **In no case plastic tubes can be used for inlet/outlet piping as they do not meet the requirements for solar systems.**

Pipes for collectors can be lead through existing chimneys, ventilation shafts or grooves in a wall. In order to prevent high thermal losses through convection, open shafts shall be properly sealed. Also thermal dilatation shall be remembered and pipes fitted with compensators or other compensation elements. Piping shall be connected to the house earthing.

Pipes of the solar system must be fitted with thermal insulation e.g. of AEROFLEX type, so that thermal dissipation from the pipes does not deteriorate a total efficiency of the solar system. The thermal insulation must be resistant to temperatures up to 160 °C, for outdoor piping also a UV protection is essential as well as non-deliqescence of the material. For indoor piping, the thermal insulation should be at least 13 mm thick, for outdoor piping at least 19 mm.

6 Temperature Sensor Placement

- place the temperature sensor to the outlet from the collector array
- use a twisted wire 2x1mm², non-shielded, separated from power cables
Its maximum length is 100m. Minimize the number of electrical boxes a terminal blocks
connection length: up to 25m cross section: 0.25 mm²
connection length: up to 50m cross section: 0.5 mm²
connection length: up to 100m cross section: 1.0 mm²
- the thermal and mechanical resistance of the wire used shall correspond to the environs the wire passes through

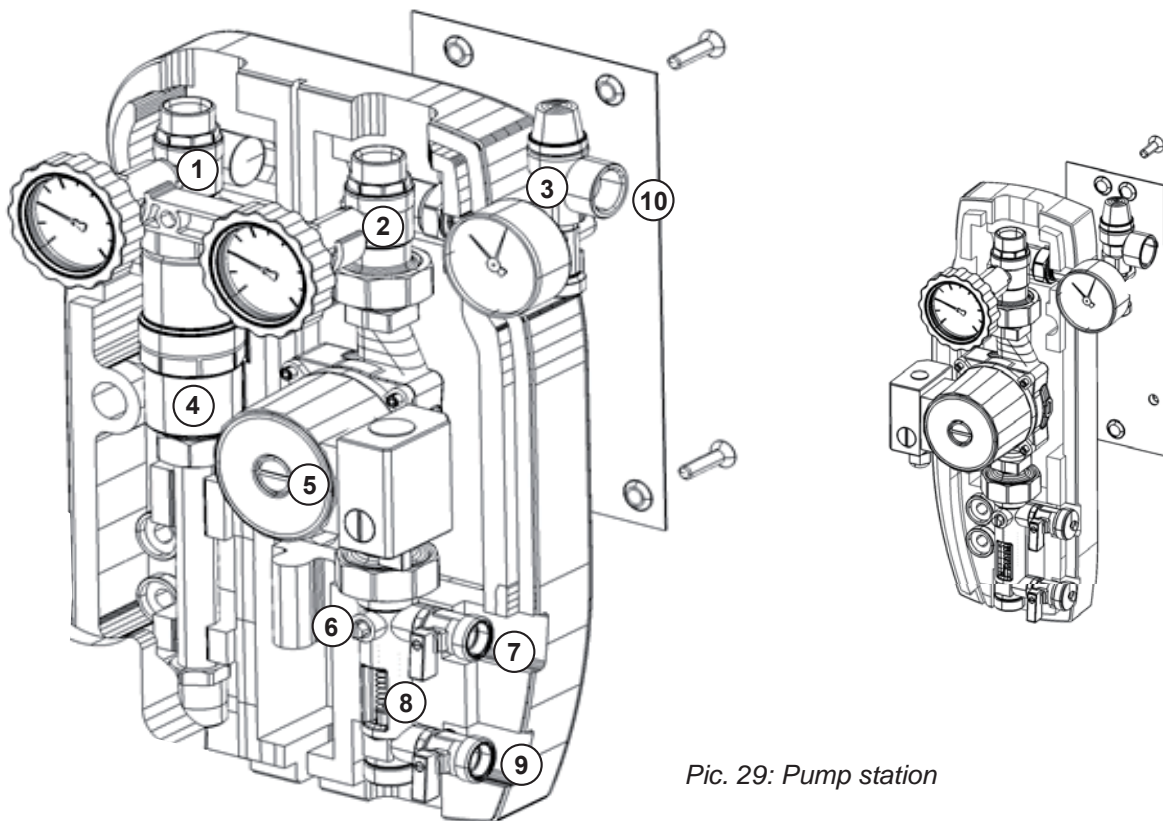
7 Solar Pump Station

The pump station shall be installed in accordance with the respective manual.

Regulus pump stations contain the following principal components:

- circulation pump
- thermometer for the return pipe, or even for the feed one – in a 2-pipe solar station
- return pipe with a ball valve and a check valve
- integrated flow meter
- safety valve, pressure gauge and connection to an expansion tank
- feed and bleed valves
- thermal insulation

Fig. 29 shows an example of a pump station.



Pic. 29: Pump station

- 1 - Ball valve on flow line (red frame thermometer, 0-120 °C dial), with check valve
- 2 - Ball valve on return line (blue frame thermometer, 0-120 °C dial), with check valve
- 3 - Safety unit protects the installation from overpressure. It involves a 6 bar safety valve, manometer and G ¼" connection to expansion vessel.

- 4 - Air eliminator
- 5 - 3-speed circulation pump, manual control
- 6 - Flow control screw
- 7 - Filling valve
- 8 - Flowmeter
- 9 - Drain valve
- 10 - Safety valve spillway connection

Safety valves are always included in pump station. If a pump station is not used, a solar set must be equipped with a safety valve of 6 bar opening overpressure and resistant to higher temperatures (usually up to 160 °C).

8 Expansion Vessel Sizing and Working Pressure Calculation (valid only for height up to 20m, otherwise its size must be calculated)

8.1 Expansion vessel sizing

A solar expansion vessel shall be sized for a temperature difference between the min. winter temperature (as low as -20 °C) and the max. summer temperature and further for accommodating the fluid volume of all collectors in case of stagnation (max. collector temperature at stopped flow and high intensity of solar radiation). In solar systems with forced circulation, pressure expansion vessels with a propylene-glycol resistant membrane and of max. working pressure of at least 6 bar are principally used.

A recommended size of an expansion vessel see Table 2.

Number of collectors		Expansion vessel size	Max. piping length
KTU 9R2	KTU 6R2		
3	4	18	Max. 30 m in the inlet and outlet piping altogether
4	6	25	
5	7	40	
6	9	50	
8	12	50	
9	13	80	
10	15	80	
12	18	100	

Table 2: Expansion vessel recommended size



Fig. 30: Expansion vessel

8.2 Calculation of a system working pressure
The pressure in the solar system is calculated by using the relation

$$p = 1.3 + (0.1 h)$$

p...pressure in a solar system [bar]
h...height from a pressure gauge to the middle of a collector field [m]

Adjust the pressure by discharging solar liquid after the pressure test is done.

8.3 Calculation of an expansion vessel preset pressure
Before filling the system, adjust the initial pressure in the expansion vessel to a value by 0.5 bar below the calculated system pressure.

$$p_{\text{exp}} = p - 0.5 \text{ [bar]}$$

In order to set the pressure, use a current car-tyre pressure gauge of a suitable pressure range. The expansion vessel has a current tyre valve under its lid.

8.4 Examples of calculating working pressure and expansion vessel pressure

8.4.1 An example of calculating system working pressure
The height from a pressure gauge to the middle of a collector:

$$h = 10\text{m}$$

Pressure in the solar system (the solar system is to be pressurized to this value):

$$p = 1.3 + (0.1 h) = 1.3 + (0.1 \cdot 10) = 2.3 \text{ bar}$$

8.4.2 An example of calculating expansion vessel pressure
Before filling the system, the preset pressure in the expansion vessel shall be adjusted to the value of

$$p_{\text{exp}} = p - 0.5 = 2.3 - 0.5 = 1.8 \text{ bar}$$

9 Installation of air release valves

Install the air vent to the highest point of the system. It is recommended to amend the air vent with a local pipe widening that calms down the stream and helps in good separating bubbles from the fluid (see Fig. 31). For efficient removal of bubbles from the system it is advisable to fit a pump station with an air separator (see Fig. 32).



Fig. 31: Horizontal air separator and an automatic air vent



Fig. 32: Air separator

10 System Filling, Flushing, Leak Test and Air Bleeding

The below listed procedures are valid when a Regulus solar pump station is used.

10.1 Filling

- in order to fill the system, use a filling device with a reservoir for solar liquid and a filling pump (see Fig. 33)
- attach the filling hose to the feed valve and open the valve completely
- please use antifreeze solar fluid Regulus - Solarten HT to fill the system
- attach the return hose to the bleed valve and open the valve completely
- close the integrated ball valve in the flowmeter (the groove in the flowmeter's adjusting screw must be in a horizontal position). Open the check valve above the pump by turning the ball valve by 45° (intermediate position between opening and closing).



Fig. 33: Filling a solar system

- turn on the filling pump and pour sufficient quantity of solar fluid into the reservoir of the filling device and fill the solar system

10.2 Flushing

- flush the solar system for at least 15 minutes with the filling device. In order to bleed air from the system perfectly, from time to time open shortly the integrated ball valve of the flowmeter (the groove vertically).

10.3 System air bleeding

- with the filling pump running, close the bleed valve and increase the pressure up to about 5 bar
- close the feed valve and turn off the filling pump, open the regulation screw on the flowmeter (groove horizontally), do not disconnect the filling-pump hoses!
- set the circulation pump(s) to the highest stage and repeat switching on and off to air-bleed the system (an air-free pump works almost noiselessly)
- watch the system pressure and when it starts falling, increase it by turning on the filling pump and opening the feed valve to 5 bar
- repeat air bleeding so long until the float in the flowmeter's regulation valve takes a steady position during pump operation and bubbles stop appearing in the flowmeter. After that, let the circulation pump run for at least 5 minutes.
- in case an automatic air vent/s is/are used anywhere in the solar system, close this valve after air bleeding.

10.4 Leak test

- examine the whole system at 5 bar pressure (all connections, solar collectors, valves etc.), no visible leaks are allowed. Let the system under pressure for at least 2 hours, then examine the system repeatedly.
- consider the test result successful if no leaks appear and/or no noticeable pressure drop shows in the system
- set the working pressure according to the point **8.2 Calculation of a system working pressure**
- set the pump to a suitable speed and set the flow by the flowmeter and data in Table 1
- disconnect the hoses of the filling device and screw caps on the feed and bleed valves
- **open entirely** the ball valve **above the pump**
- after several days of operation, air-bleed the system again

Do not flush the system with water. Since it is impossible to empty it completely, there is a risk of frost damage.

11 Commissioning

- set the solar regulator according to the respective instruction manual
- remove collector covers
- place a sufficiently sized vessel (to hold the entire solar fluid volume) under the outlet of the safety valve
- check if the circulation pump gets switched by a regulator when the preset temperature difference between solar collectors and secondary circuit is reached

12 Operation, checks and maintenance

The solar system offers unmanned and almost maintenance-free operation. Despite that, it is important to check the right functioning of the system within the first days of operation. First of all temperature, system pressure and pump running shall be checked. Once a year, preferably during a sunny day, it is necessary to check the working order and tight fixing of the collectors, verify the system tightness and pressure (incl. pressure in the expansion tank) and the pump operation. At least once in every 2 years the heat carrying fluid shall be checked for its antifrost properties. The system shall be always replenished with the same fluid as the original filling was. **The system must not be replenished with water.**

13 Description of procedures for annual prevention checks



Warning: Prevention examination and eventual intervention may be carried out by a qualified person only. Any work on electric wiring may be done by an authorized electrician. Maximum care shall be taken during checks. In case the procedure requires a person to get on a roof, a fall arrest is necessary.

Check procedures	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Check the pressure in expansion vessel, replenish if necessary	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Check system visually for leaks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Check the collector glazing cleanness, wash if necessary	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Check ambient trees for possible shading	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Check pipe insulation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Check the proper flow rate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Check temperature probes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Check the quality of antifreeze liquid (with a refractometer)*	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Check the heat carrier pressure, replenish if necessary	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Check the controller settings	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Check for possible error messages in the controller and their reason	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Check wiring	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Check backup heating function (el. heating rod, gas-fired boiler)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Check the magnesium anode rod in the tank, substitute if necessary (see Instruction Manual)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Check the function of all system valves and fittings	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Check the collector fixing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
If needed, check the pressure in the heating system expansion vessel	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
If needed, clean the filter and de-aerate the heating system	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Preventive training in system maintenance and controller setting for the operating staff	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**If the test result shows the necessity, fill new heat carrier.*

14 Service action form

This Service Action Form is intended to register service intervention done. Entries may be recorded by an authorized servicing company.

This Service Action has been carried out by an authorized servicing company

Date of Service Action:
Name of the servicing company:
Address of the servicing company:
.....
.....
Name of the servicing person:
Contact phone:
Description of the intervention:
.....
.....
.....
.....
.....
.....
Signature of the person who has carried out the service action:

This Service Action has been carried out by an authorized servicing company

Date of Service Action:
Name of the servicing company:
Address of the servicing company:
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Name of the servicing person:
Contact phone:
Description of the intervention:
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Signature of the person who has carried out the service action:

This Service Action has been carried out by an authorized servicing company

Date of Service Action:
Name of the servicing company:
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Name of the servicing person:
Contact phone:
Description of the intervention:
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Signature of the person who has carried out the service action:

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Your service: