

Installation and Operation Manual

Solar System with KPG1-ALC Collectors



EN
v. 1.2

Regulus[®]

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GENERAL INSTALLATION AND OPERATION INSTRUCTIONS

Collector description

REGULUS Flat Plate Solar Collectors are designed for solar domestic hot water heating (DHW), backup- and pool heating with solar energy. Solar radiation penetrates the glass and is intercepted by an efficient absorption layer applied on an all aluminum absorber. The heat is then transferred into heat transfer fluid. The absorber is sealed in a compact frame with high quality thermal insulation. The collectors are designed for year round operation, that's why they work in a separate primary circuit filled with antifreeze heat carrier.



The collectors are **not intended** for direct water heating. If different heat transfer fluid is used than specified by the manufacturer, irreversible damage to the collector may be done.

Transport, handling and storing

Collectors shall be transported in their original packing, in upright position (standing on their shorter side) or lying horizontal with glass upwards, stack of max. 14 pieces on a pallet.

During handling the collector glass shall be always facing upwards.

Please check the condition of the collector upon reception from your supplier or forwarder. Later claimed mechanical damage (frame, glass, connection) will be refused.

When stored, the collector shall not be exposed to rain and its absorber exposed to solar radiation.

Scope of supply

1. KPG1-ALC collector
2. Instruction manual
3. Warrant Certificate

General instructions for installation

The installation must be done by a trained worker or a specialized company.

During installation and before commissioning, it is necessary to cover collectors in order to avoid overheating and possible burn injury to the installer.

Prior to installation, conditions set by the roofing manufacturer and the max. permissible roof load shall be checked.

Mounting method for solar collectors shall always respect local conditions, i.e. roof inclination and weather influence on the overall load on the collector. Kindly consult the fixing method with a structural statics expert.

During installation the collectors and accessories shall be handled carefully. Defects caused by improper handling or DIY installation are not covered by warranty.

Generally valid rules and standards for occupational safety shall be respected during installation. This concerns mainly technicians walking on a roof and the securing the area against objects falling down from a roof.

Only REGULUS fixing elements may be used. Other fixing elements may be used only with a written approval from REGULUS company.

Collectors shall not be exposed to solar radiation until commissioned. The absorption surface may get damaged.

Collectors shall be installed and operated in compliance with this Manual and with respective generally valid rules and norms.

Collector placing

The collector must be placed outdoors. The glass absorption surface should be orientated to South, with deviations not over 45° (Southwest or Southeast). For a year round operation the right inclination angle is 40°-50°, for summer operation smaller inclination is better (30°).

Collectors are installed according to marking.



The collectors shall be installed at an angle between 15° and 75°.

On inclined roofs it is recommended to install solar collectors as close to the roof ridge as possible. Should this solution be impossible, then protections against snow slide shall be installed above the collectors.

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

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





$\leq 1,8 \text{ kN/m}^2$





$\leq 1,00 \text{ kN/m}^2$

1. DELIVERY OF MOUNTING SYSTEM

| Mounting kits for fixing and connecting KPG1-ALC solar collectors | | Code |
|--|---|-------|
|  | Connection kit for a KPC collector array (3/4" M inlet and 3/4" M outlet with a pocket for solar temperature sensor) | 7710 |
| | Fixing kit for one KPG 1 collector *[for 4 anchors or 2 supports+1 strut] | 10538 |
| | Fixing and interconnection kit for 2 KPG 1 collectors* *[for 6 anchors or 3 supports+1 strut] | 10539 |
| | Fixing and interconnection kit for 3 KPG 1 collectors *[for 8 anchors or 4 supports+1 strut] | 10540 |
| | Fixing and interconnection kit for 4 KPG 1 collectors *[for 10 anchors or 5 supports+1 strut] | 10541 |
| <p>* 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.</p> | | |

| Supports and struts for flat roof installation | | Code |
|---|---|------|
|  | Triangle support strut 45° | 6859 |
| | Strut incl. screws for triangle support | 9563 |

| Supports for sloping roof installation | | Code |
|---|--------------------|-------|
|  | Triangle strut 25° | 8805 |
| | Triangle strut 45° | 10094 |
| | Triangle strut 60° | 9631 |

| Anchors for various roofing types | | Code |
|---|---|-------|
|  | Aluminum anchor for slate roofs | 6920 |
| | Aluminum anchor for pantiles - adjustable height | 7013 |
| | 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 MOUNT

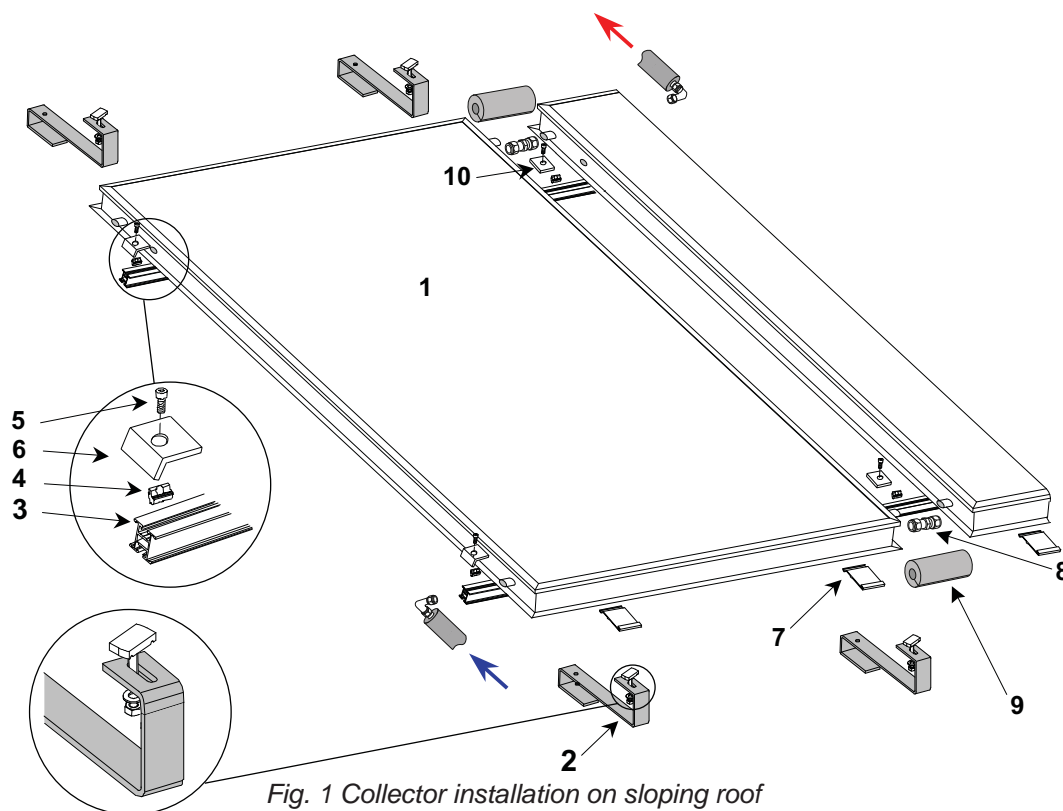


Fig. 1 Collector installation on sloping roof

| Pos. | Item | Code |
|------|---|--|
| 1 | Flat plate collector | 10336 |
| 2 | Roof anchor with M8 bolt/special head for rails | 6857 or other, depending on roofing type |
| | Triangle struts for inclination adjustment, suitable for anchors for sloping roofs - 25°, 45° and 60° angle | 8805, 10094, 9631 |
| | Interconnecting pipes | |

| Fixing and interconnection kits | | | | | | |
|---------------------------------|---|------------------------------|---------|---------|---------|-----------|
| | | No. of collectors (kit code) | | | | Item code |
| | | 1 | 2 | 3 | 4 | |
| | | (10538) | (10539) | (10540) | (10541) | |
| 3 | Aluminum rail, 2 pieces | 1.22 m | 2.44 m | 3.66 m | 4.88 m | 6949 |
| 4 | M8 nut for the rails | 4 pcs | 6 pcs | 8 pcs | 10 pcs | 6925 |
| 5 | M8 × 18 bolt with allen head | 4 pcs | 4 pcs | 4 pcs | 4 pcs | 6926 |
| 6 | Retaining side bracket | 4 pcs | 4 pcs | 4 pcs | 4 pcs | 10522 |
| 10 | Retaining bracket between 2 collectors | - | 2 pcs | 4 pcs | 6 pcs | 10673 |
| 7 | Retaining bracket for collector bottom | 2 pcs | 4 pcs | 6 pcs | 8 pcs | 6916 |
| 8 | Compression nut and ring for collector inter-connection | - | 2 pcs | 4 pcs | 6 pcs | 7629 |
| 9 | Insulation 35 mm diam., 19 mm thick | 0.5 m | 0.75 m | 1 m | 1.5 m | 7188 |
| | Insulation tape | 0.8 m | 1 m | 1.5 m | 2 m | 7227 |

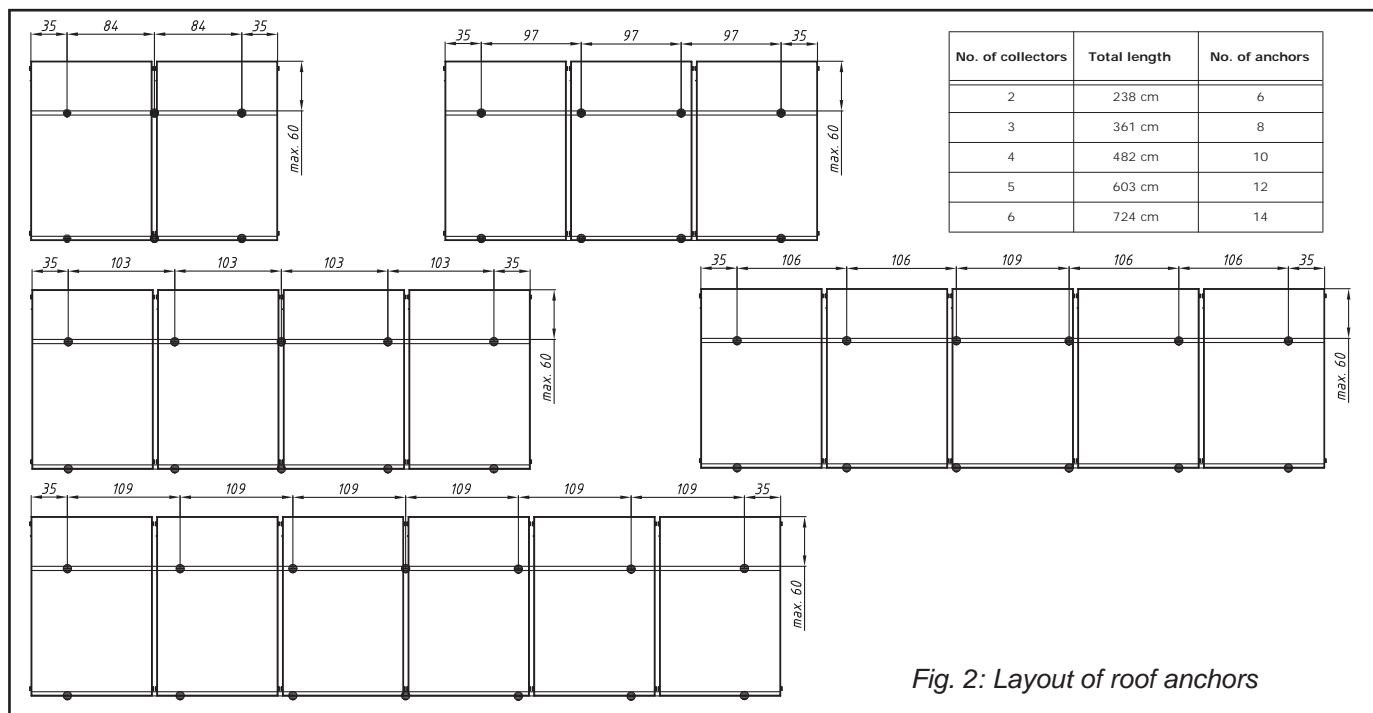


Fig. 2: Layout of roof anchors

2.1 Prior to installation

Prior to installation of solar collectors, select a suitable position respecting the following conditions:

- roof facing South
- roof inclination (25° - 45°)
- unshaded place
- accessible for servicing
- permissible roof load
- shortest possible distance between the collectors and (accumulation) tank

Further have ready the necessary material, tools and safety equipment for working on a roof.

Check if the roofing manufacturer offers roof hooks and if the roof warranty will not be violated.

2.2 Roof anchor installation for sloping roofs



The numbers of anchors shown in the Mounting kits for fixing and connecting Regulus collectors are intended for the following load:

- max. load by wind and snow pressure 0.7 kN/m²
- max. load by wind – negative pressure 1.0 kN/m²

Customers shall be informed about this fact prior to solar system installation. If a load higher than shown above can be expected in the installation area, then a statics expert shall be consulted or more anchors used, or other measures taken to ensure safe fixing. Regulus bears no responsibility for a damage caused by an improper design of collector fixing.

2.2.1 Installation with roof anchors and auxiliary boards

Prior to installing anchors on auxiliary boards, the following shall be ensured:

- The auxiliary board length shall exceed the length of the rail by at least 200 mm on each end.
- The auxiliary board width shall be between 100 and 200 mm.

- It shall be 30 mm thick.
- The height of the auxiliary board from the counter batten shall be equal to the batten thickness which can be reached by underlying the auxiliary board (see Fig. 3).

Installation

- Remove roofing so that auxiliary boards can be inserted (approx. distance between boards 1600-1800 mm). For roof tiles, just shifting them upwards in the length of the auxiliary board is sufficient (see Fig. 4).
- Fix the auxiliary boards to battens so that the distribu-

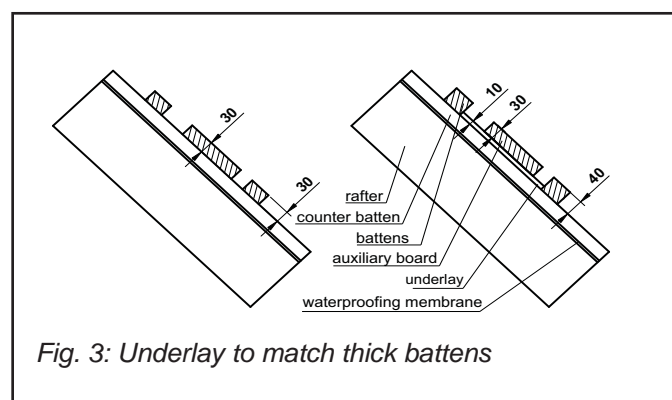


Fig. 3: Underlay to match thick battens

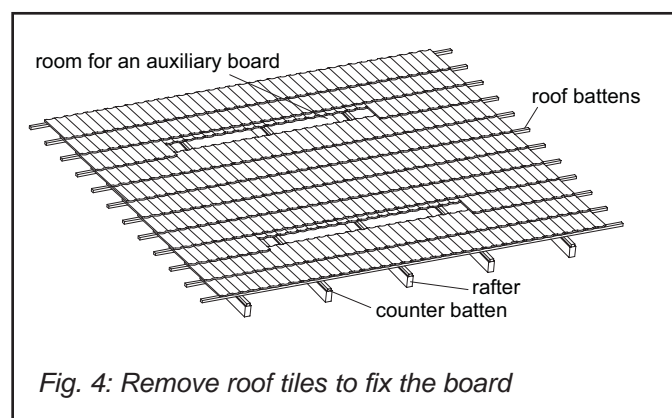


Fig. 4: Remove roof tiles to fix the board

tion of anchors resembles the positions in Fig. 2. At the same time screw the boards so high that the roof anchor does not hinder placing the roof tile with the right overlap (see Fig. 8).

- Hang the roof anchors onto the auxiliary board respecting their distribution shown in Fig. 2.
- Fix the anchors using stainless steel screws.

2.2.2 Installation with roof anchors for rafters

For tiled roofs, rafter anchors can be used. Either a fixed (not adjustable) stainless-steel hook (Fig. 7a) can be used, or an adjustable aluminum anchor (Fig. 7b) that enables horizontal shift of the anchor along the fixing board. For this anchor type also the rail fixing height can be adjusted.

Installation

- Remove roofing in places where anchors shall be fixed (Fig. 5). The distance "a" between anchors is defined in Fig. 2.
- Cut the counter batten used for fixing the waterproofing membrane.
- Prior to the installation itself, use an underlay for anchors according to the thickness of battens and counter battens so that the anchors installed do not hinder proper positioning of the roof tiles.
- Screw the adjustable aluminum anchor to a rafter and move it in the groove horizontally so that it doesn't hinder proper positioning of the roof tile. If a fixed stainless steel anchor is used, its position shall be adjusted before fixing.
- Fix all the other roof anchors in the same way.
- When installing roof anchors, maintain a direction parallel to the roofing (horizontal).

2.2.3 Installation with roof anchors for shingle or metal roofs

- Depending on the number of collectors, measure and calculate the positions for fixing roof anchors (Fig. 2). Such places shall be selected for mounting where anchors can be fixed sufficiently into the roof frame (rafter or similar).
- Prior to fixing the anchor, apply suitable silicone putty on the contact surface (adjacent to the roofing) in order to prevent water leaking, or possibly use a sealing method recommended by the roofing manufacturer.
- Simply lay the anchor onto the roof tiles and fix it with stainless-steel bolts.



If the roofing is made of e.g. copper or zinc-plated iron, then the anchor contact surface shall be isolated using suitable underlay (rubber). Otherwise there is a risk of contact corrosion.

2.2.4 Installation using bolts for fixing rails onto a roof

This method of installation is preferably used for roofs of bitumen corrugated sheets like Gutta or Onduline etc., or for corrugated eternit or metal sheets.

Installation:

- Depending on the number of collectors, locate the places for drilling holes and installing bolts into the roofing (Fig. 6f). Pre-drill 6 mm diam. holes into a rafter or another massive wooden roof element for the bolts.



Holes should be always drilled in the crest of the roofing wave, not in its valley, to avoid leakage.

- The bolt shall be screwed into a rafter or another massive wooden roof element (see 2.2.3) using spanner No. 7.
- After screwing the bolt in, put on the rubber seal (Fig. 6f) and using a washer and nut, seal the drilled hole.
- Then mount the U-shaped bracket (Fig. 9) on the bolt, between two nuts with a serrated washer.
- 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.

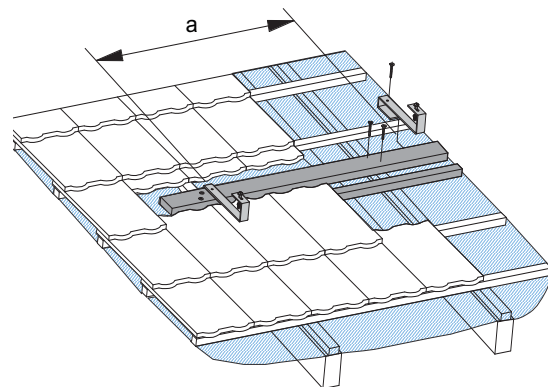


Fig. 5: Fixing an auxiliary board and roof anchors

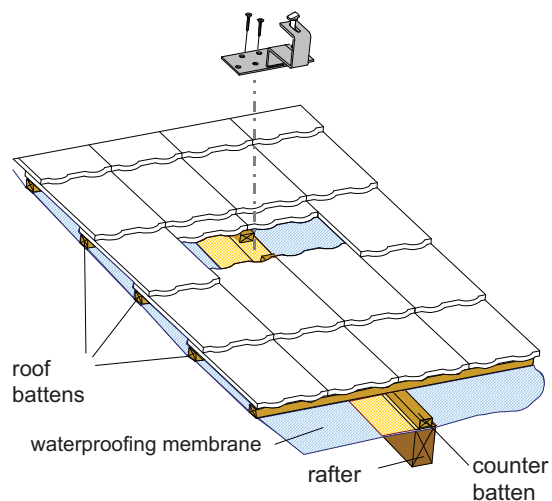
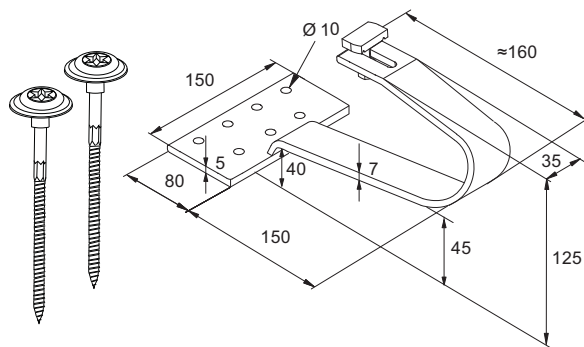
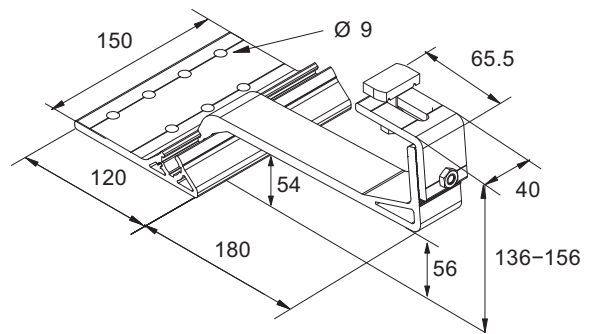


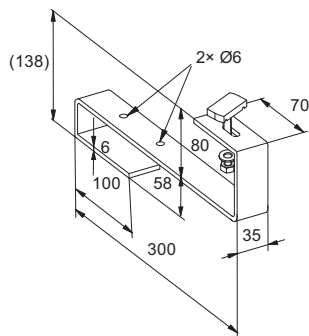
Fig. 6: A place for mounting a roof anchor on a rafter - detail



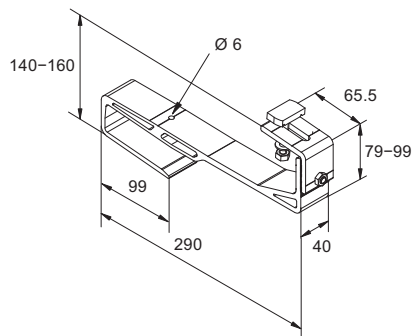
a) Stainless steel anchor on rafter, for pantiles, incl. screws



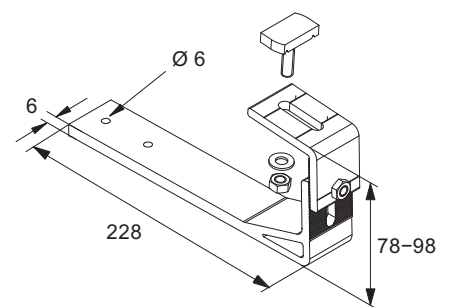
b) Aluminum anchor on rafter, for pantiles



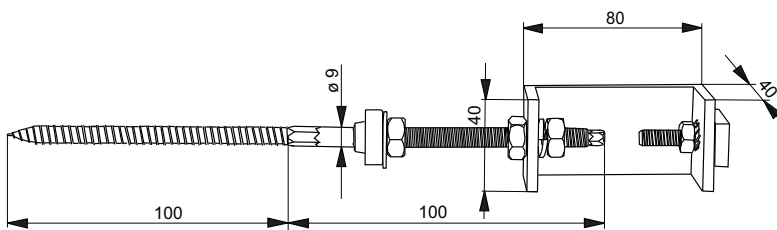
c) Roof anchor of stainless steel or zinc-plated steel for pantiles



d) Aluminum roof anchor for pantiles, adjustable height



e) Aluminum roof anchor for metal or slate roofing



f) Roofing bolt for rail fixing



Fig. 7: Basic overview of fixing elements

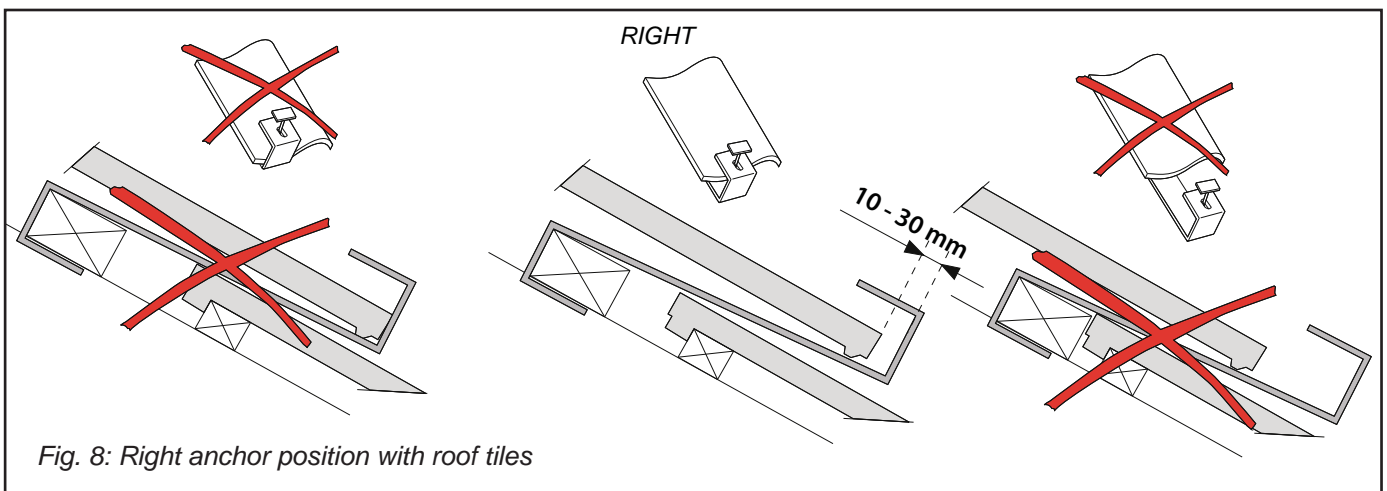


Fig. 8: Right anchor position with roof tiles

2.3 Fixing rails on roof anchors

- have ready two rails in the length required for the number and type of collectors to be installed.
- Align the travelling screw head (Fig. 9) with the horizontal rail and shift the rail onto it, or shift the screws into the rail first 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: $D1 = D2$ (Fig. 10).
- Then tighten the nuts on fixing bolts.

2.4 Collector mounting



Collectors shall be covered during mounting.

Installation:

- Insert safety retaining brackets (Fig. 11) into the bottom rail, 2 brackets per collector.
- Insert the retaining brackets into the bottom rail about 100 mm from the collector edge.
- Lay the first collector carefully on the rails and align it in the brackets.



Collectors shall be placed on the rails with marking upwards. The distance between the bottom edge of the collector and of the base rail depends on the design and size of the retaining brackets. The collector bottom edge is by circa 75 mm lower.

- The distance between the collector edge and the end of the bottom rail is $B = 35$ mm (Fig. 12).

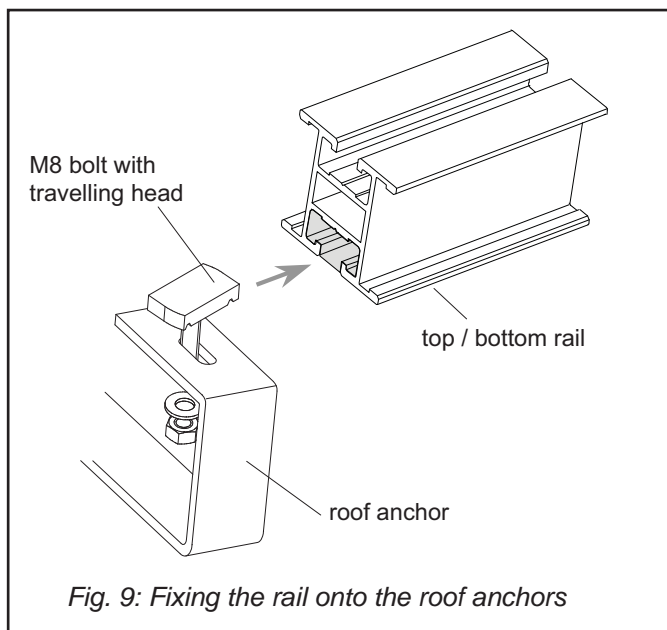


Fig. 9: Fixing the rail onto the roof anchors

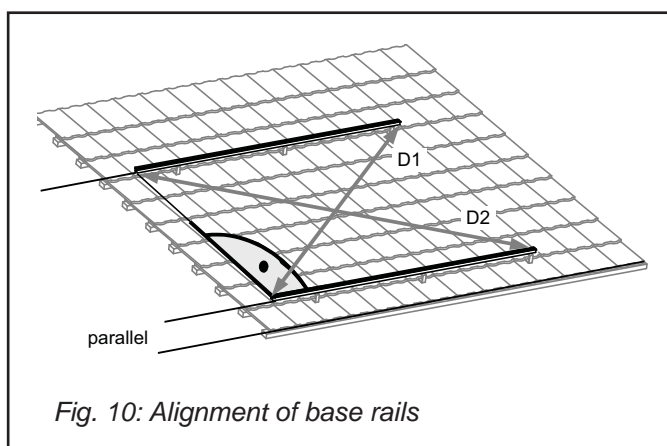


Fig. 10: Alignment of base rails

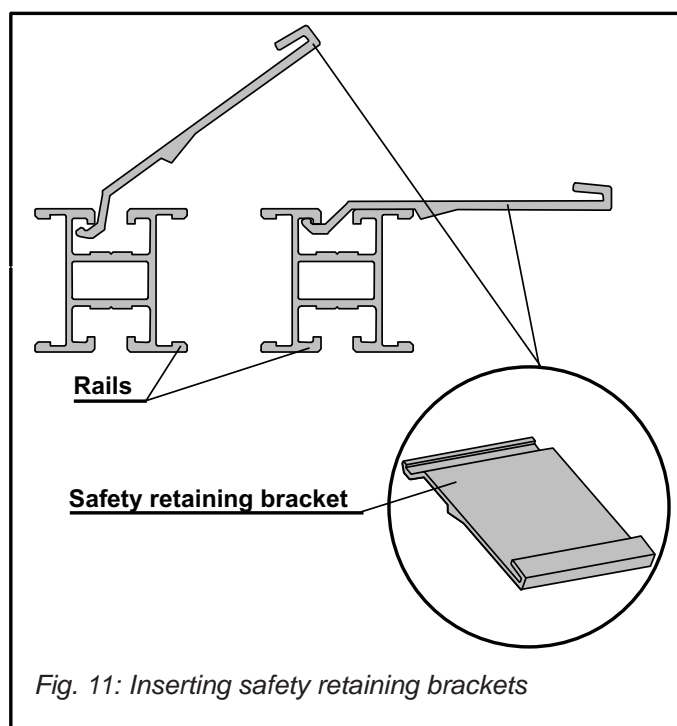


Fig. 11: Inserting safety retaining brackets

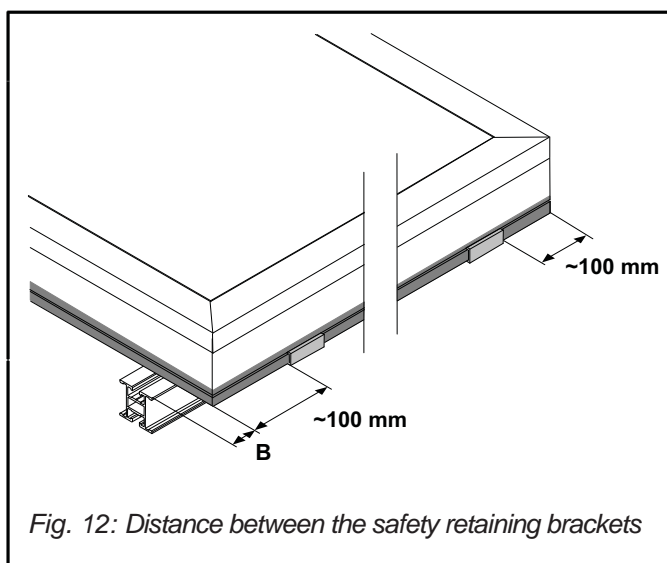
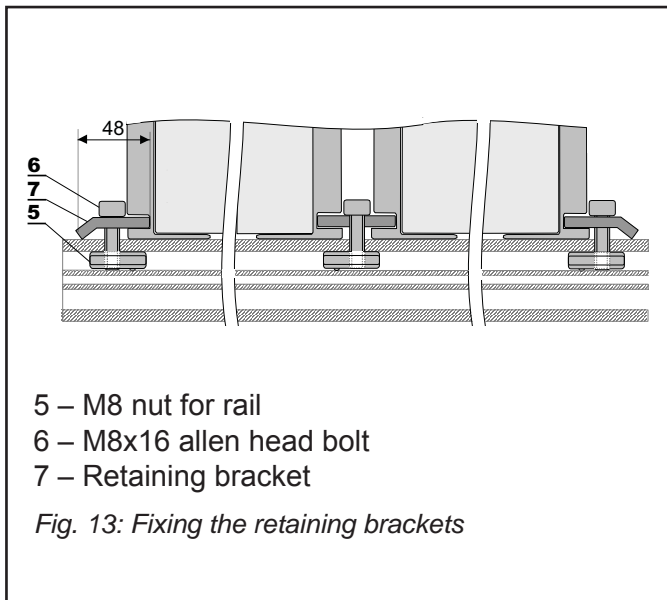


Fig. 12: Distance between the safety retaining brackets

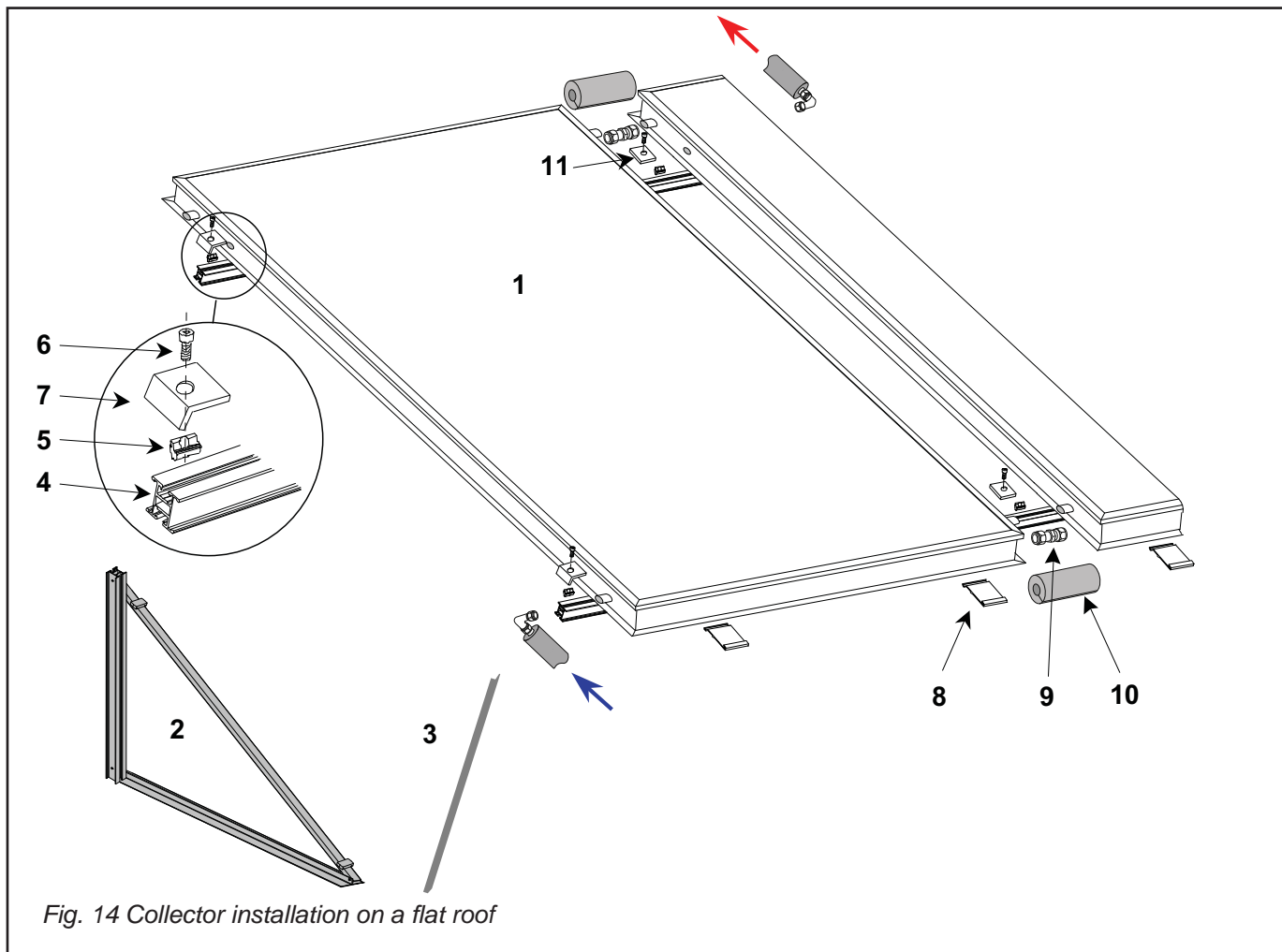


- Insert nuts into both the rails (Fig. 13). Put the retaining side brackets on the rails and fix the collector using M8x16 bolts.
- Lay the following collector next to the first one, maintaining a sufficient gap. Then put on the threaded fittings (Fig. 14, pos. 9) and push the collector to the already 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 mounting further collectors in the same way (see page 14).

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. Anyway standards of the roofing manufacturer shall be respected for pipe passage through a roof.

4. FLAT ROOF MOUNT



4.1 - Overview

| Pos. | Item | | | | | Code |
|---------------------------------|--|--|---------|---------|---------|-----------|
| 1 | Flat plate collector | | | | | 10336 |
| 2 | Triangular support | Number of collectors (number of supports needed) | | | | 6859 |
| | | 1 | 2 | 3 | 4 | |
| | | (2) | (3) | (4) | (5) | |
| 3 | Strut incl. bolts for triangular support | | | | | 9563 |
| | Interconnection pipes | | | | | |
| Fixing and interconnecting kits | | | | | | |
| | | Number of collectors (kit code) | | | | Item code |
| | | 1 | 2 | 3 | 4 | |
| | | (10538) | (10539) | (10540) | (10541) | |
| 4 | Aluminum base rail, 2 pieces | 1.22 m | 2.44 m | 3.66 m | 4.88 m | 6949 |
| 5 | M8 nut for the base rail | 4 pcs | 6 pcs | 8 pcs | 10 pcs | 6925 |
| 6 | M8x16 stainless-steel bolt (allen head) | 4 pcs | 4 pcs | 4 pcs | 4 pcs | 6926 |
| 7 | Retaining side bracket | 4 pcs | 4 pcs | 4 pcs | 4 pcs | 10522 |
| 11 | Retaining bracket between 2 collectors | - | 2 pcs | 4 pcs | 6 pcs | 10673 |
| 8 | Retaining bracket for collector bottom | 2 pcs | 4 pcs | 6 pcs | 8 pcs | 6916 |
| 9 | Compression nut and ring for collector interconnection | - | 2 pcs | 4 pcs | 6 pcs | 7629 |
| 10 | Insulation 35 mm diam., 19 mm thick | 0.5 m | 0.75 m | 1 m | 1.5 m | 7188 |
| | Insulation tape | 0.8 m | 1 m | 1.5 m | 2 m | 7227 |

4.2 - Flat roof support mounting

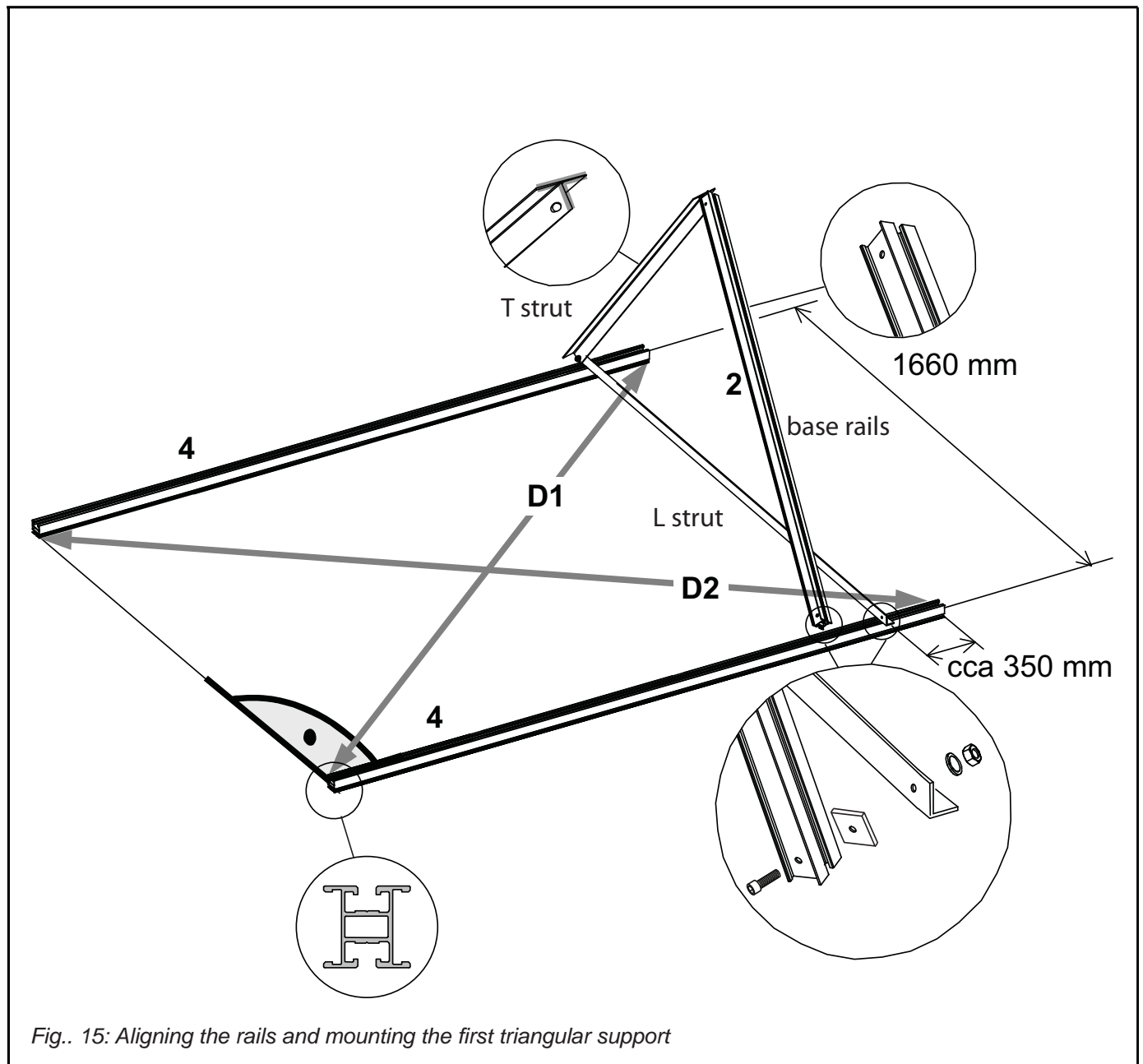
A flat roof support consist of two base rails, triangular supports and one strut.

The number of triangular supports depends on the number of collectors. One strut is sufficient for supports for up to 5 collectors.

Installation:

- Lay two rails in parallel on the mounting surface, their pitch shall be 1660 mm.
- The diagonals between the rails shall be of the same length: $D1 = D2$ (Fig. 15)
- Insert the M8 bolt with a special head (Fig. 17) into the rail grooves.

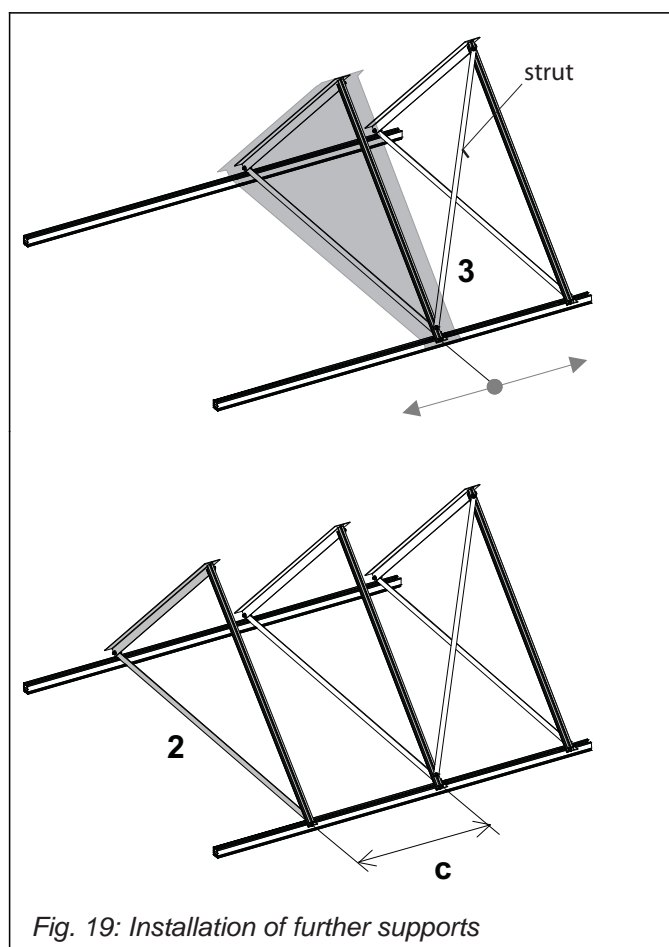
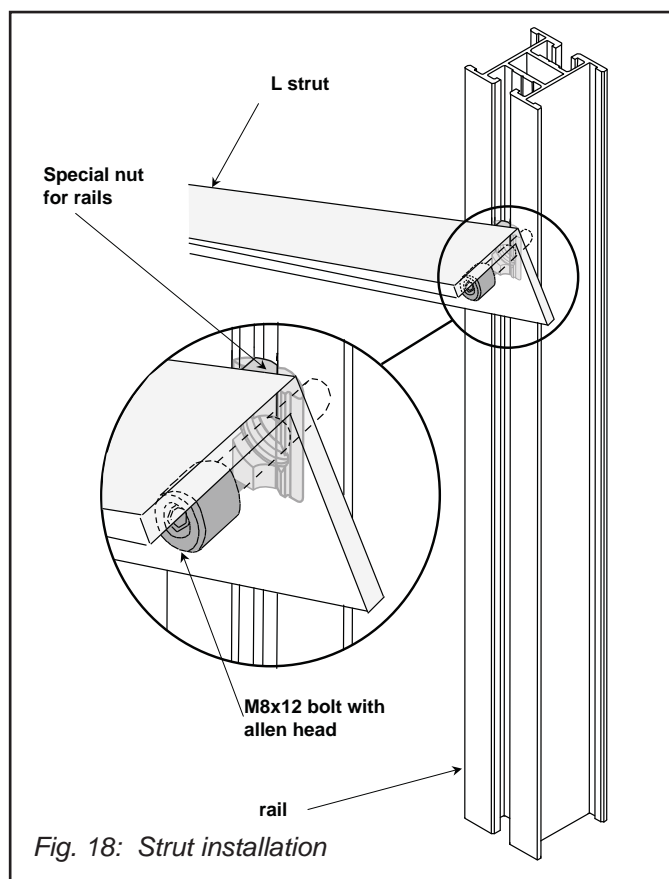
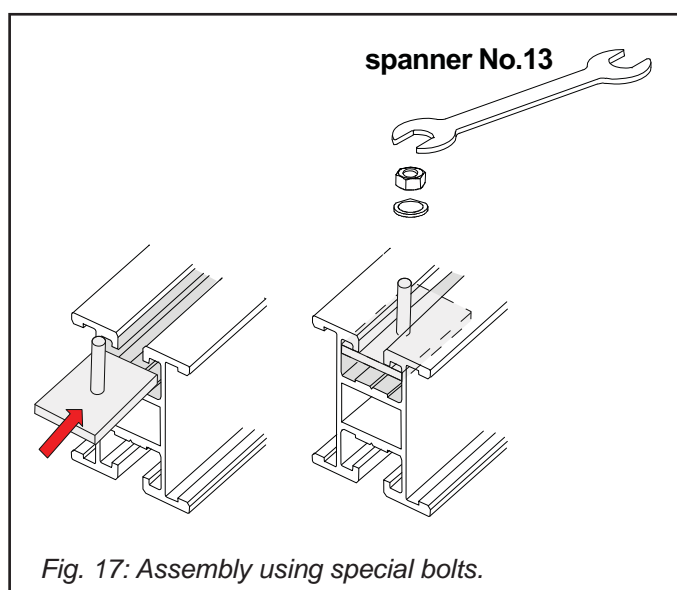
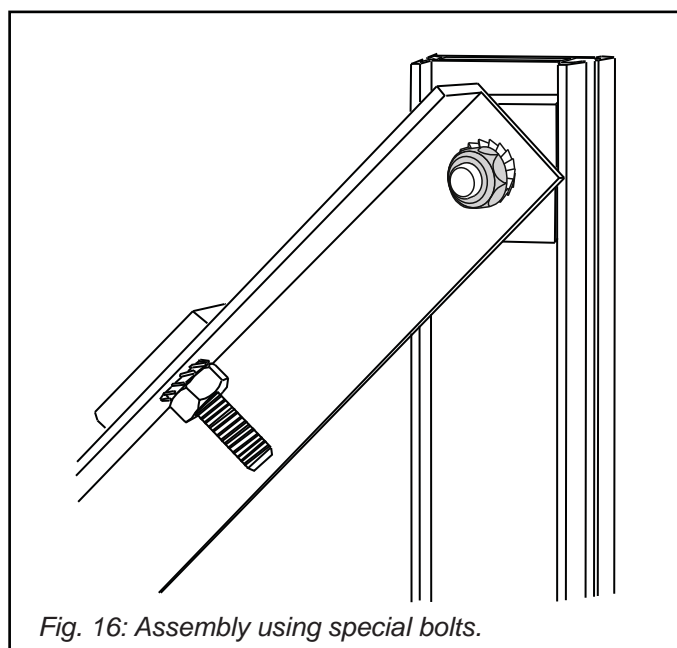
- Assemble the triangular supports that come partially screwed together (Fig. 16). Fix the loose support ends with a bolt (Fig. 16) and tighten all connections.
- Locate the positions to fix triangular supports. The distance of the first triangular support from the end of the rail shall be about 350 mm.
- Fix the L-support of the triangle to the base rail using screws, serrated lock washers and nuts for rails (Fig. 18) and tighten the connections.
- Install the next triangular support in the same way. Its distance is the same as that of the roof anchors in Fig. 2.



- 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. 18).
- Continue assembling the remaining triangular supports with a pitch as shown in Fig. 2. Adjust this distance so that the pitch of the triangular supports is similar to that of roof anchors in Fig. 2 and the last support shall be located about 350 mm from the ends of both rails.



After fixing the strut and other 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.



In no event the permissible roof load shall be exceeded. Consulting a statics expert in advance is necessary. A damaged roof must be re-insulated by a specialist.

Fix the collectors to the rails in the same manner as if installing on an inclined roof (see point 2.4).

Minimum distance between collector fields see Fig. 21.

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

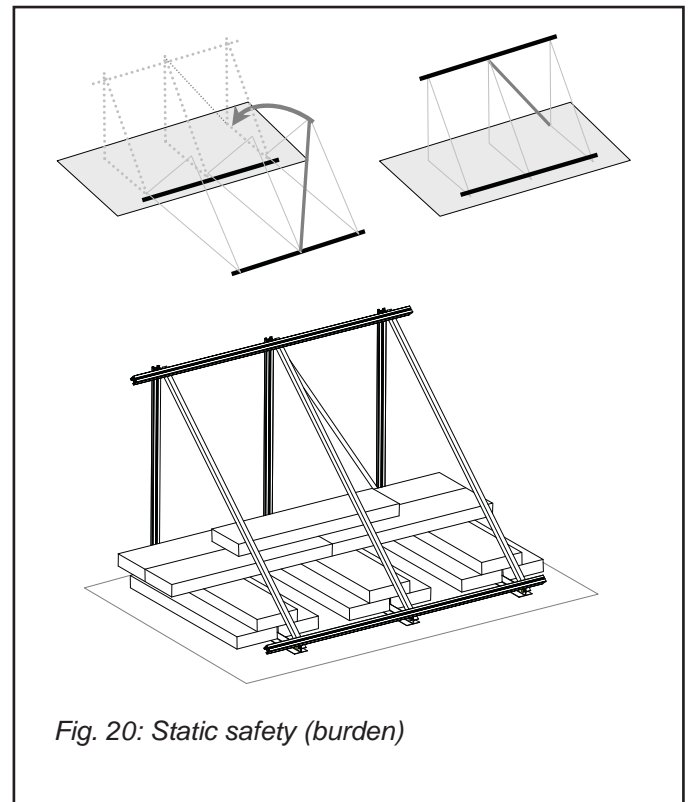


Fig. 20: Static safety (burden)

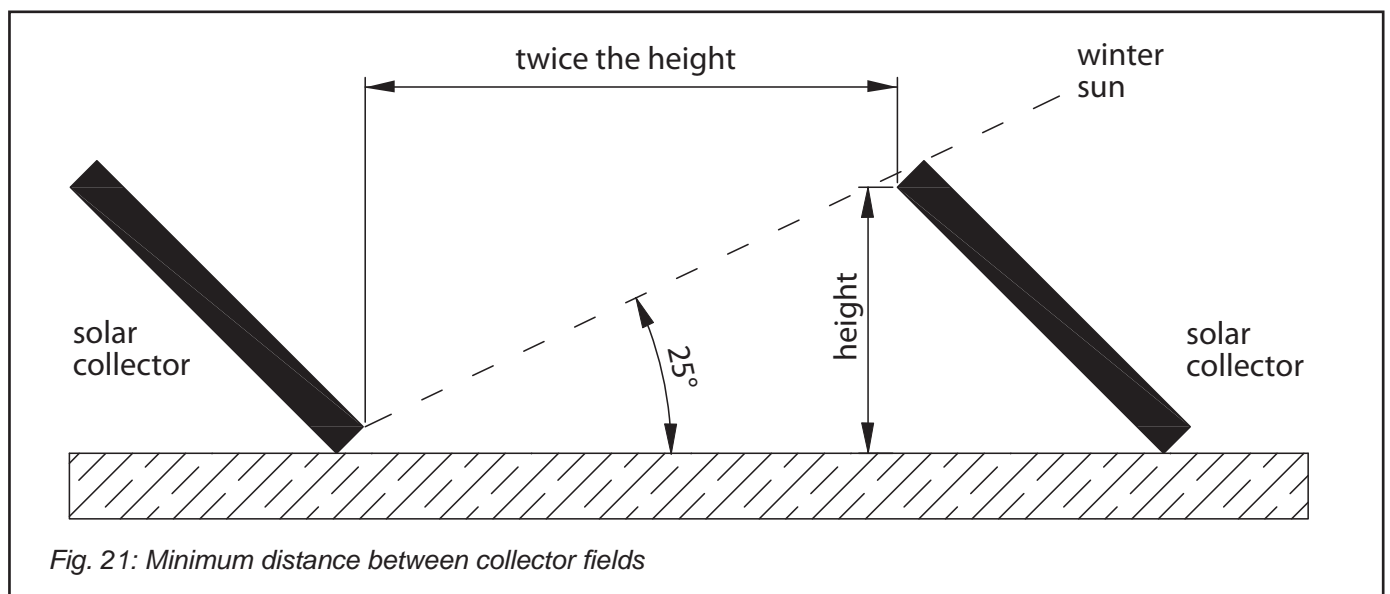


Fig. 21: Minimum distance between collector fields

5. HYDRAULIC CONNECTION

5.1 - Collector connecting

For collector mounting follow the instructions in chapter 5.2. Fasten the first collector and lay the following one next to the first one, maintaining a sufficient gap. Then put the threaded fittings on both the upper and lower outlets and push the collector to the already mounted one until stop. Hold the fitting with a spanner (Fig. 23) to prevent turning, and tighten the nuts. Continue in the same way with further collectors.



Put the insulation on the threaded fittings only after a successful leak test.

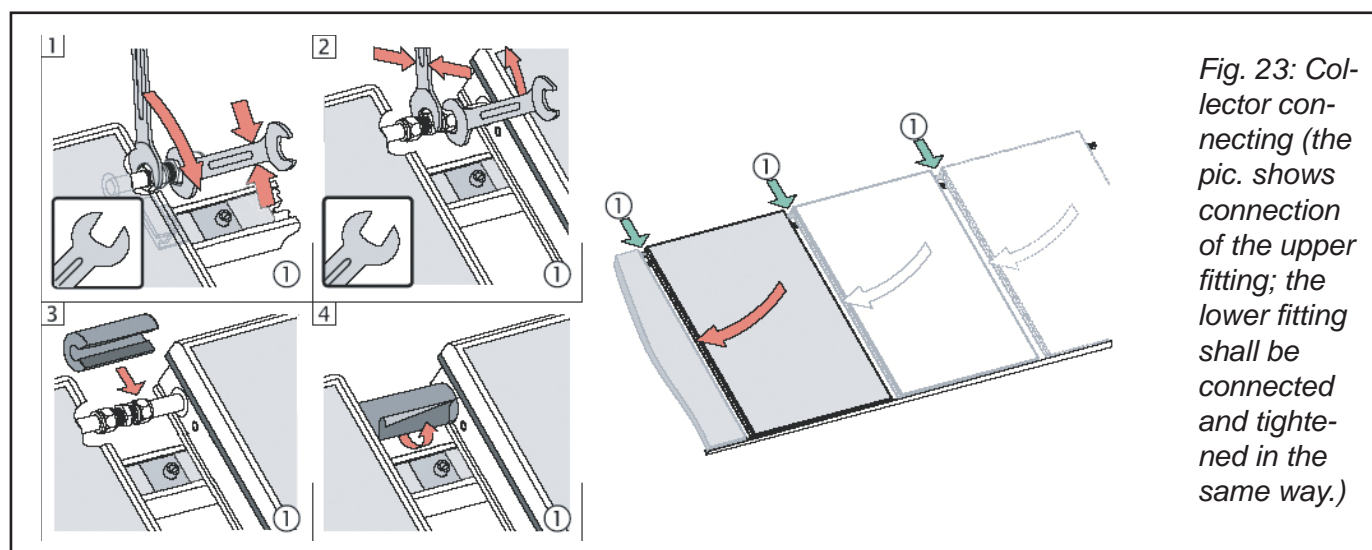
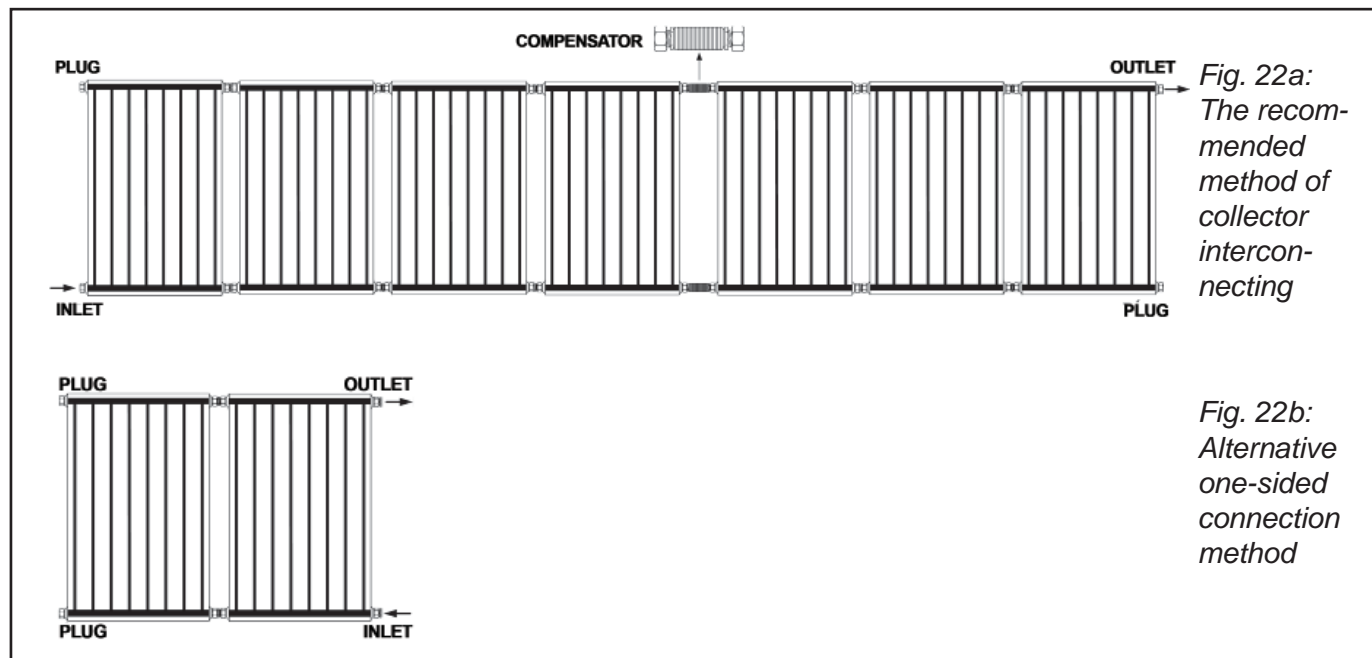
5.2 - Collector interconnecting

Hydraulic interconnection of collectors shall be done according to Fig. 22a. Maximum of 6 collectors may be connected with threaded fittings in a row. If there are more than 6 collectors in a row, a compensator shall be installed in the middle of the array. With a compensator, max. 8 collectors in a row may be installed. The connecting pipes shall be lead the shortest way. The recommended pipe diameters and flow rates through collector arrays are shown in Tab. 1.

Collectors may be also connected as shown in Fig. 22b. This kind of connection is permitted when only **max. 2 collectors** are used and **the max. flow rate is 1l/min/collector**. Then the cold liquid inlet is at one side bottom and the hot liquid outlet is at the same side top. Both the other ends shall be plugged.

At the inlet into a collector array, a brass elbow shall be installed with a reducing piece to the connecting pipe.

A brass X-piece shall be installed to the outlet from the collector array that will enable connection to the piping, sheath installation for the collector temperature probe and eventual installation of a ball valve and an automatic air discharge valve. The brass elbow and X-piece are involved in Regulus connection kit, code 7710.



All solar components must be carefully and safely sealed and must 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 event plastic tubes can be used for inlet/outlet piping as they do not meet the operation requirements for solar systems.

Pipes for collectors can be lead through disused 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.



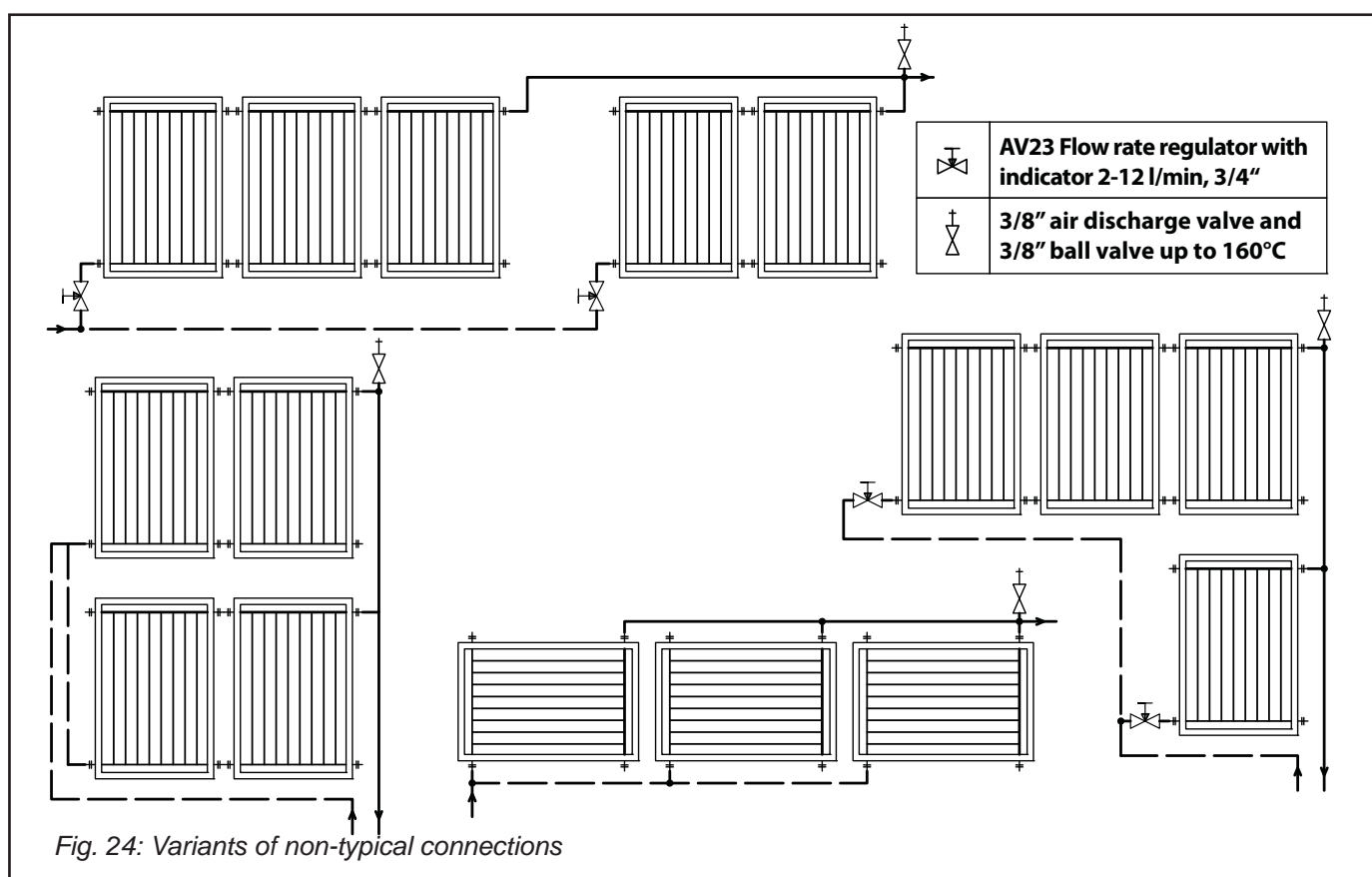
Piping shall be connected to the house earthing.

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.

| Number of collectors | Connection type | Max.recomm. flow rate | Connecting pipe | |
|----------------------|-------------------|-----------------------|-----------------|-----------|
| | array x collector | | Copper | Kombiflex |
| 1 | 1 × 1 | 2 l/min | Cu 15 × 1 | DN 12 |
| 2 | 1 × 2 in series | 4 l/min | Cu 15 × 1 | DN 16 |
| 3 | 1 × 3 in series | 6 l/min | Cu 18 × 1 | DN 16 |
| 4 | 1 × 4 in series | 8 l/min | Cu 18 × 1 | DN 20 |
| 6 | 2 × 3 in parallel | 12 l/min | Cu 22 × 1 | DN 25 |
| 8 | 2 × 4 in parallel | 16 l/min | Cu 28 × 1.5 | DN 25 |
| 9 | 3 × 3 in parallel | 18 l/min | Cu 28 × 1.5 | DN 25 |
| 12 | 3 × 4 in parallel | 24 l/min | Cu 28 × 1.5 | - |

Max. 30 m of the inlet and outlet piping together.

Tab. 1: Recommended pipe diameters



6. TEMPERATURE SENSOR POSITIONING

Place the thermal probe into the pocket of the X-piece at the outlet from the last collector, see pic. 25.

A twisted wire 2x1 mm², non-shielded should be used, separated from power cables.

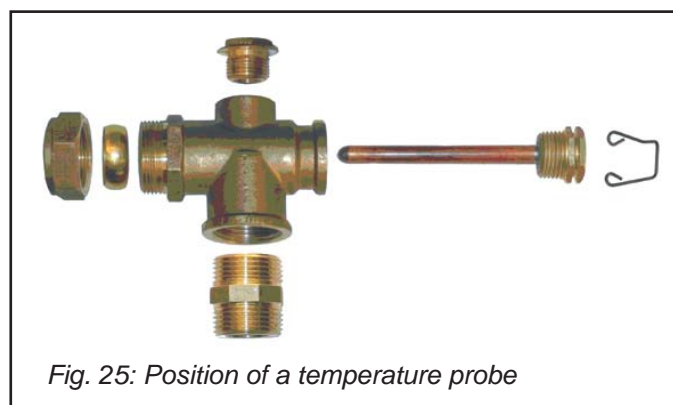
Its maximum length is 100 m. Minimize the number of electrical boxes a terminal blocks.

connection length: up to 25 m cross section: 0.25 mm²

connection length: up to 50 m cross section: 0.5 mm²

connection length: up to 100 m 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 principal components shown in Fig. 26:

Safety valves are always included in pump stations.

If no pump station is used in the installation, the solar system shall be equipped with a 6 bar safety valve, resistant to high temperatures (usually up to 160 °C).

No shut-off valve shall be installed between a safety valve and collectors.

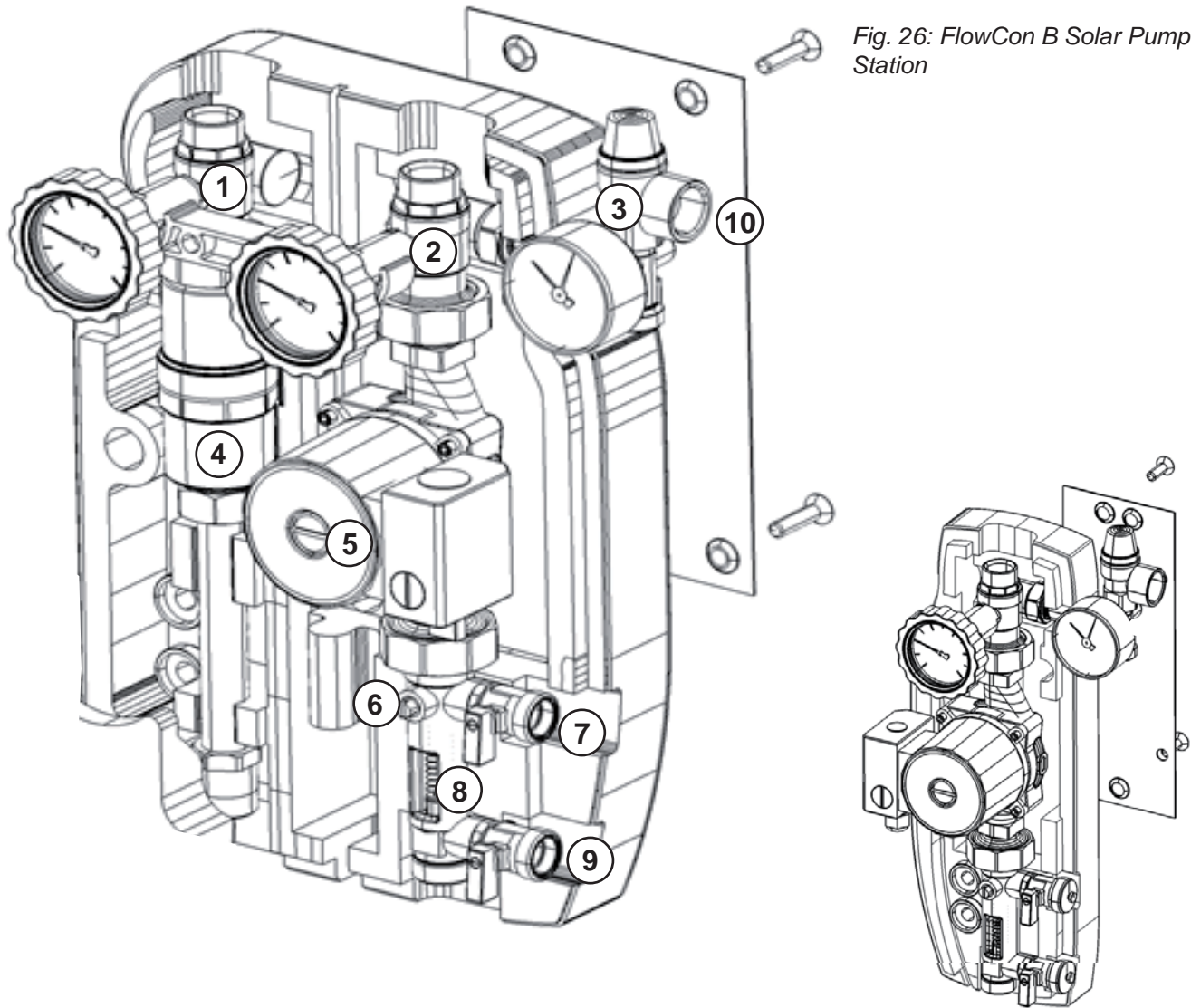


Fig. 26: FlowCon B Solar Pump Station

- 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 tank.

- 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

8. EXPANSION VESSEL SIZING AND WORKING PRESSURE CALCULATION

(Tab. 2 is valid for height up to 20 m only, otherwise the size shall be calculated.)

8.1 - Expansion vessel sizing

A solar expansion vessel shall be sized for a temperature difference between the min. winter temperature and the max. summer temperature. The working range of expansion vessels is from -10 °C to +130 °C. Further it shall be able to contain fluid volume of all collectors in case of stagnation (max. collector temperature at no flow and high sunshine intensity). In solar systems with forced circulation such pressure expansion vessels shall be only used that are fitted with a propylene-glycol resistant membrane and whose min. working pressure is 6 bar. Installation shall be done in a position with the diaphragm flooded. In case the hear carrier starts boiling, the diaphragm mustn't get in touch with steam!

The recommended size of an expansion vessel see **Table 2.**

| Number of collectors | Expansion vessel size | Max. piping length |
|----------------------|-----------------------|---|
| 3 | 18 | Max. 30 m of the inlet and outlet piping together |
| 4 | 25 | |
| 5 | 40 | |
| 6 | 60 | |
| 8 | 60 | |
| 9 | 80 | |
| 10 | 80 | |
| 12 | 100 | |

Tab. 2: Expansion vessel recommended size. Max. 30 m of the inlet and outlet piping together.

8.2 - Calculation of a system working pressure

The pressure in the solar system is calculated using the relation

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

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.



Fig. 27: Expansion vessel

8.3 - Calculation of expansion vessel preset pressure

Before filling the system, adjust the initial overpressure in the expansion vessel to a value by 0.5 bar below the calculated system pressure.

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

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):

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

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:

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

9. INSTALLATION OF AIR RELEASE VALVES

Install the air vent to the highest point of the system. Should there be more places with a risk of air pockets, air vents should be installed also there.

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 pic. 29).

A ball valve shall be always installed under the automatic air vent valve, so that the automatic air vent can be closed after the system commissioning. Solar liquid leaks can be avoided in case of system stagnation.

For an efficient removal of bubbles from the system it is advisable to fit the pump station with an air eliminator (see Fig. 28).



Fig. 28: Air eliminator



Fig. 29: Horizontal air eliminator and an automatic air vent

10. SYSTEM FILLING, FLUSHING, LEAK TEST AND AIR BLEEDING

The below listed procedures are valid when a Regulus 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. 30)
- attach the filling hose to the feed valve and open the valve completely
- 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 horizontal).
- open the check valve (valves - two for a twin-pipe solar pump station) above the pump by turning the ball valve by 45° (intermediate position between open and closed)
- pour sufficient quantity of solar fluid into the reservoir of the filling device, turn on the filling pump and fill the solar system.

10.2 Flushing

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

10.3 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 speed 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

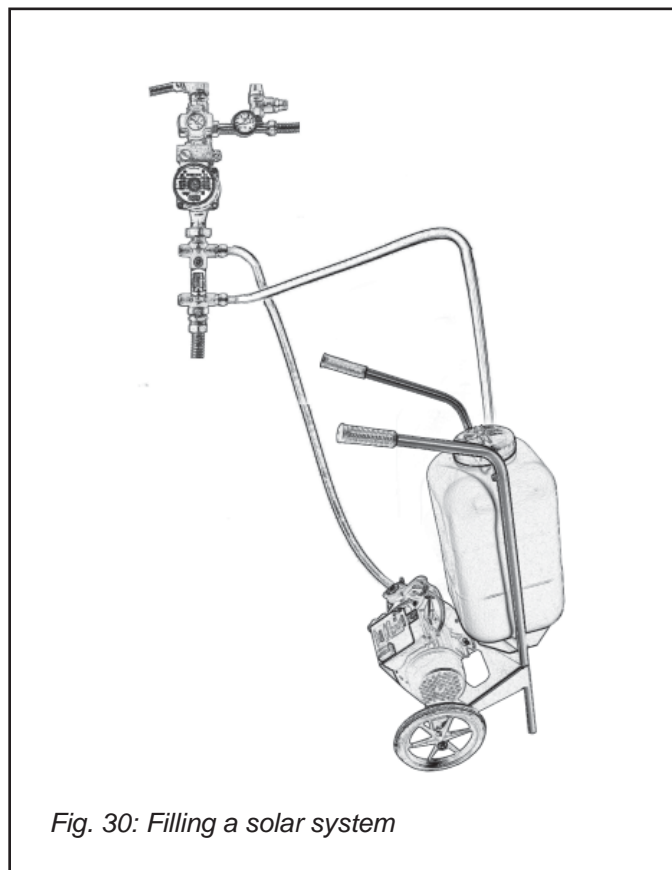


Fig. 30: Filling a solar system

10.4 Leak test

- examine the whole system at 5 bar pressure (all connections, solar collectors, valves etc.), no visible leaks are allowed. Leave the system under pressure for at least 2 hours, then examine the system once again
- consider the test result successful if no leaks appear and/or no noticeable pressure drop appears in the system
- set the working pressure by point 8.2 Calculation of system working pressure
- set the pump to a suitable speed and set the flow by the flowmeter and data in Tab. 1
- disconnect the hoses of the filling device and screw caps on the feed and bleed valves
- **open entirely** the ball valve(s) 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, a risk of frost damage appears.

11. COMMISSIONING

- Adjust the solar controller.
- Select an appropriate hydraulic variant in the controller menu. Check the controller settings and adjust parameters.



During solar controller setup, activate the respective safety functions (collector protection, night recooling).

- uncover the collectors
- place a sufficiently sized vessel (to hold the entire solar fluid volume) under the safety valve spillway
- check if the circulation pump switches 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 the temperature, system pressure and pump operation 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 vessel) 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. Always use solar liquid supplied by Regulus.

13. SERVICING AND WARRANTY

Service or maintenance of the appliance may be done exclusively by an authorized person, holder of a valid authorization issued by Regulus, spol. s r.o.

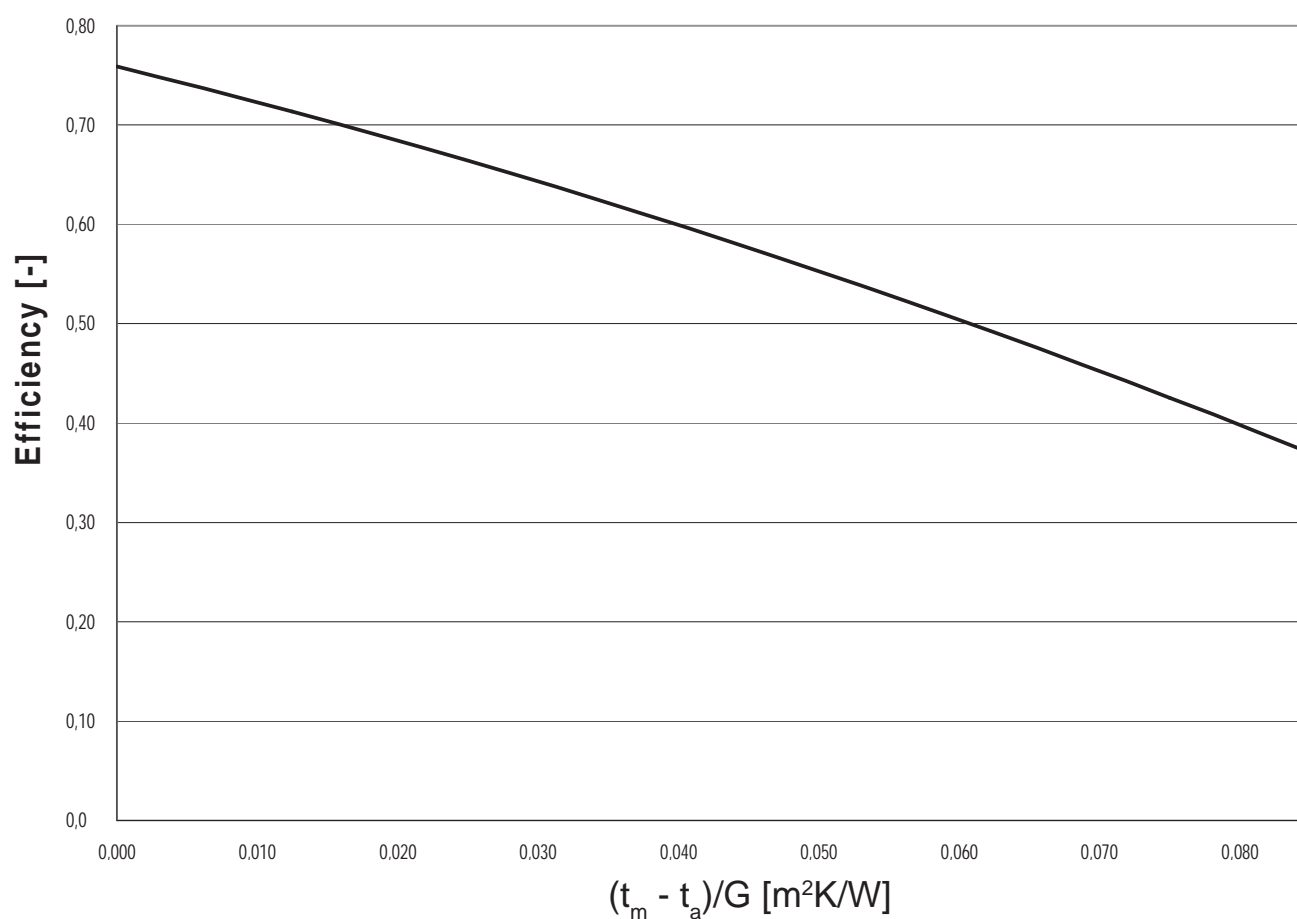
Regulus offers warranty for this product under the conditions specified in the Warranty Certificate. The Warranty Certificate is an integral part of the documents supplied with the product.

In case you wish to claim warranty, please contact your system supplier - installer.

14. DATA SHEET FOR KPG1-ALC SOLAR COLLECTOR

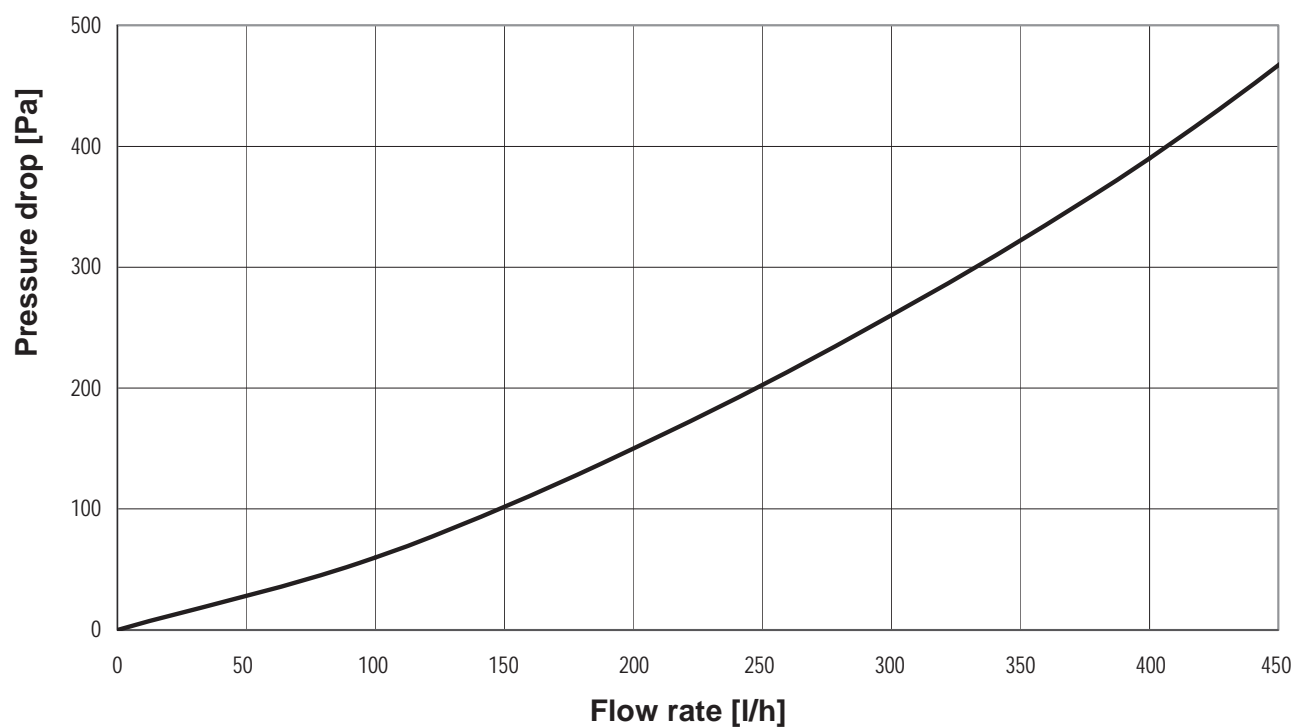
| Dimensions and Weight | |
|---|--|
| height × width × thickness | 2151 × 1170 × 84 mm |
| pitch of 22 mm Ø tubes | 2010 mm |
| total area | 2.517 m ² |
| aperture area | 2.392 m ² |
| absorber area | 2.309 m ² |
| empty weight | 47 kg |
| Glass | |
| material | tempered low-iron glass |
| thickness | 3.2 mm |
| permeability | 90.8 ± 2 % |
| Absorber | |
| material | aluminum, 0.5 mm thick |
| surface finish | Blue Tec Eta Plus |
| design | harp type, laser welded |
| connection pipes material | copper |
| connection pipes dimension | 4 × Ø 22 mm × 0.8 mm |
| absorber tube material | copper |
| absorber tube dimension | 12 × Ø 8 mm × 0.5 mm |
| solar absorptance | 94 ± 2 % |
| emmisivity | 5 ± 2 % |
| max. working pressure | 10 bar |
| max. working temperature | 120 °C |
| stagnation temperature | 234 °C |
| heat carrier | solution of monopropylene glycol in water, 1:1, 1.7l |
| recommended flow rate | 60 – 120 l/h |
| Thermal Insulation | |
| material | mineral wool |
| insulation thickness | 40 mm |
| Frame | |
| material | aluminum alloy |
| color | silver |
| back plate | aluminum alloy, 0.5 mm thick |
| Momentary efficiency per aperture / absorber area | |
| η_{0a} | 0.759 / 0.794 |
| a_{1a} | 3.48 / 3.639 W/m ² K |
| a_{2a} | 0.0161 / 0.0168 W/m ² K |

Momentary efficiency per aperture area

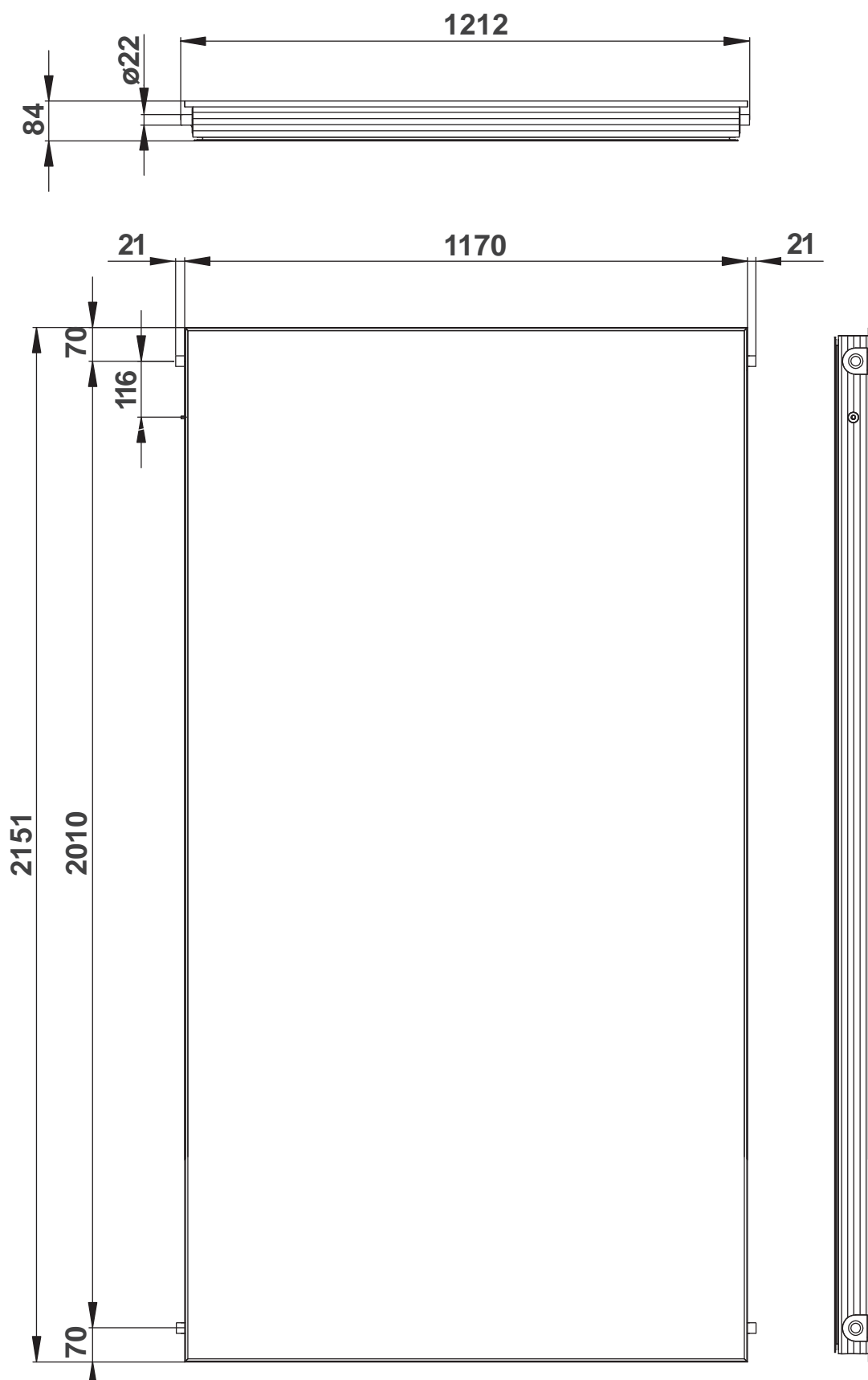


Collector power output in zero point for $G=1000$ W/m² is 1839 W.

Collector pressure drop [Pa]



15. CONNECTION DIMENSIONS



16. 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.*

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:

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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:

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:

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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:

REGULUS spol. s r.o.

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143 00 Praha 4

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Your service: