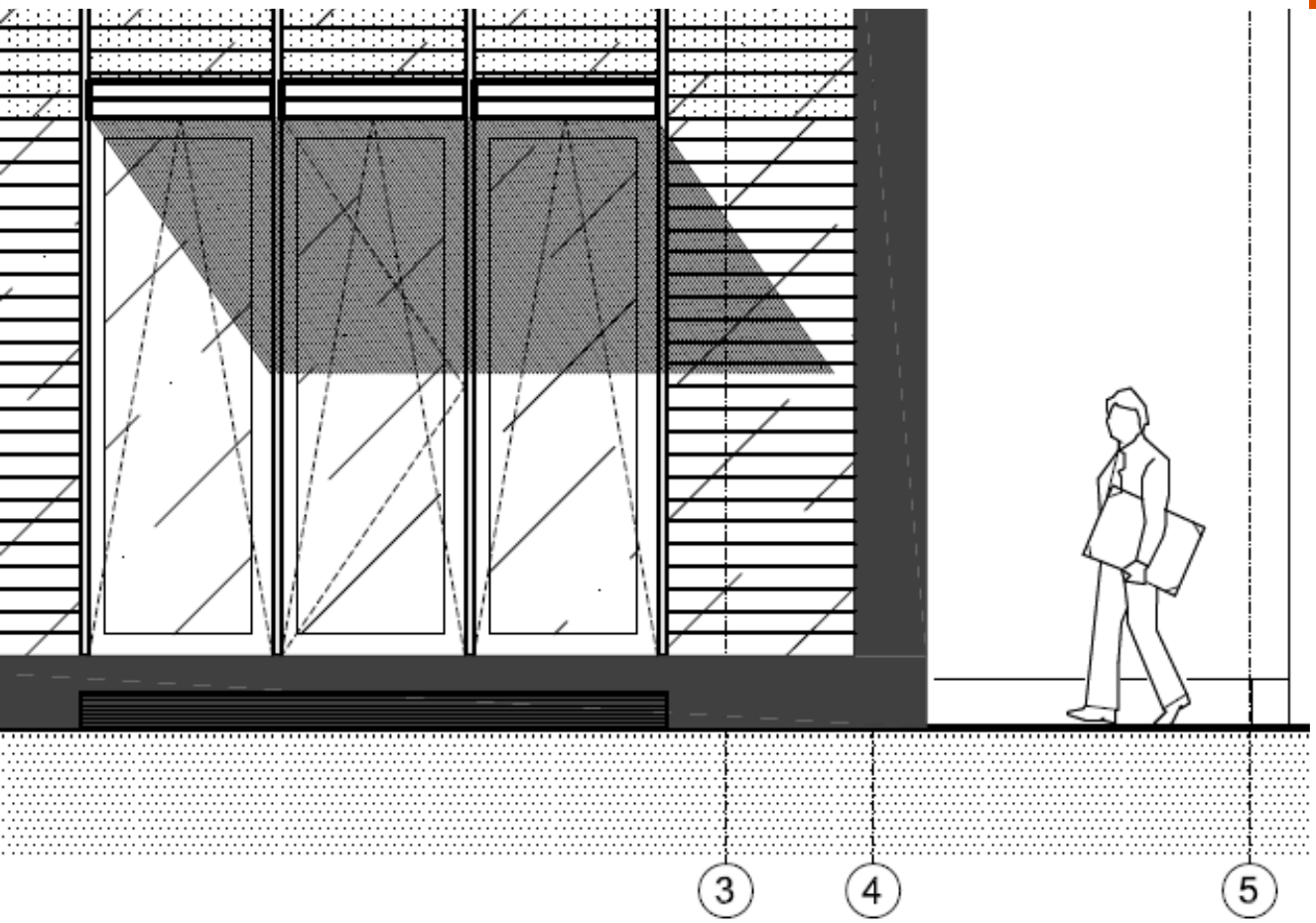
triple solar



design manual PVT M4

PVT-heat pump panels

The Triple Solar® PVT-heat pump panel consists of PV-laminate and a heat exchanger. This heat exchanger consists of copper tubing with aluminium fins with glycol running through (anti freeze). There are three different panels available.

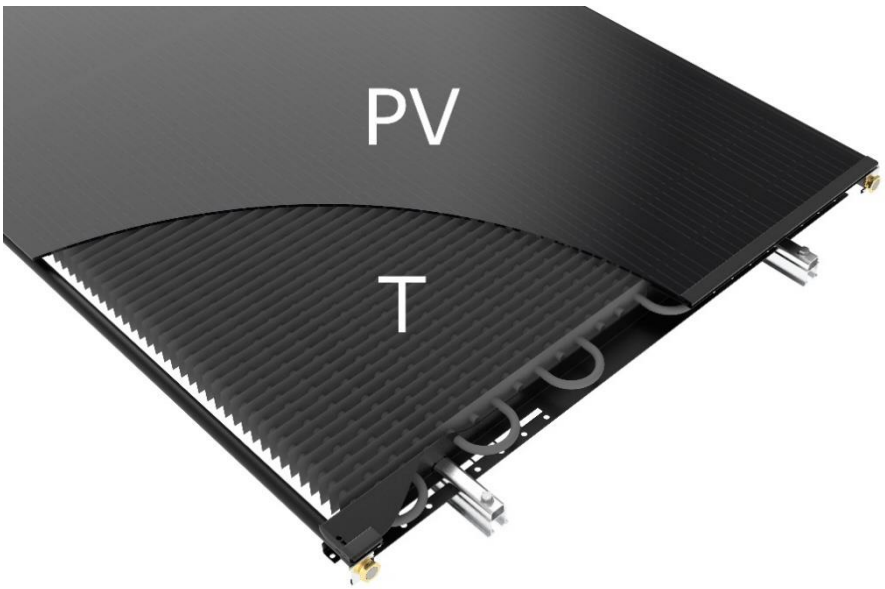
Specifications	Unit	M4 500 XL	M4 410 L	M4 410 P
Orientation		Landscape	Landscape	Portrait
Gross dimensions	mm	2115x1143x53	1743x1143x53	1156x1730x53
Aperature dimensions (T)	mm	2115x1128	1743x1128	1156x1715
Gross surface	m^2	2,25	1,89	1,90
Aperature surface(T)	m^2	2,4	2,0	2,0
PV power	Wp	500	410	410
Weight (excl. liquid)	kg	39	32	32
Contents volume	liter	4,2	3,4	3,4

* Length tolerance +/-10mm

To determine the number of heat pump panels for a specific heat pump, the aperture surface is used. This is the surface that can capture thermal energy, so excluding the edge finish. The gross dimensions of a panel are the outer dimensions.

Triple Solar PVT heat pump panels are 30% heavier than conventional PV panels. Keep in mind that the load on the roof construction should be approximately 25 kg/m2. Triple Solar can advise on ballast calculations for flat roofs.

The complete technical specifications of the heat pump panels can be found in the brochure Triple Solar *Technical Documentation Heat pump panels* (download from www.triplesolar.eu).



Installation dimensioning

Heat transmission calculation + heat pump capacity

The heat demand (kW) is determined based on the heat transmission loss, the user profile and the heat distribution system.

Rule of thumb for transmission loss (indicative)	*Unit*	*Property type*
Existing building		
70	W/m²	For a reasonable well insulated house up to 1980
60	W/m²	For a well- insulated house from 80s
50	W/m²	For a well -insulated house 90s
40	W/m²	For a very well insulated house after 2000
New construction		
35	W/m²	For a very well insulated house with heat recovery system.

Disclaimer

For the Triple Solar system to work properly it is a condition that the installer makes an extensive heat loss calculation. This can also be done by a specialized agency.

Example: A well insulated 80s house with 120 m² heated living space.

120 m² x 60 W/m² = 7200 W = 7,2 kW heat demand at –10 °C.

Example: A covered swimming pool of 60 m³:

The ΔT for a non covered swimming pool is approx. 5 °C per day, for a covered swimming pool 1 to 2 °C per day.

$Q = c*m*\Delta T$ where c of water = 4187 J/kgK

4187 * 60 * 2 °C / (3600 sec * 24 hour)= 5,8 kW average heat demand during the day.

Condition heat distribution system

For efficient operation of an all-electric heat pump, a low-temperature heat distribution system is required. This generally requires underfloor heating in a building or low-temperature convectors.
In some cases, traditional radiators are sufficient. For example when hybrid heating is used, there is a lot of heating capacity available and/or there is a low heat demand (e.g. in bedrooms).

When applying a low-temperature system in an existing home, it is also important that the pipes have sufficient flow (at least 15 mm diameter (outer measure) for the pipes to the individual radiators).

Cooling

The *Triple Solar PVT heat pump 3.5* can provide passive as well as active cooling. It uses ethylene glycol as the source fluid.

If a NIBE heat pump is used, an additional hydraulic module must be built into the circuit for active cooling. In addition, propylene glycol must be used as the source fluid.

- NIBE supplies the HPAC 40 cooling module for this purpose.

- Triple Solar supplies the CM-1 cooling module for this purpose, with the following advantages: compact, easy installation directly above the heat pump, built-in thermostatic mixing valve, built-in flushing and filling station, built-in circulation pump and built-in exchanger for separation of heating water and glycol.

Number of PVT panels

The examples below are based on the Dutch climate.

The following applies: Required aperture area [m2] = heat demand [kW] * factor

The heat demand is the starting point. At the coldest moments, at night in winter, the heat pump installation must be able to provide the required heat. The factor depends on:

- Is it an existing building or new built construction?
- At what height are the panels mounted.
- Are the panels in a sheltered area without much wind ('wind shadow', such as a courtyard or a forest).

With the values given below, we can calculate the required amount of PVT panels

type of construction	*factor*
all-electric new built construction	2,7
all-electric existing building	3,0
hybrid existing construction	2,0

Additional influence factors apply to all-electric heating in existing buildings. This additional calculation factor relates to the total required aperture surface of the PVT panels.

situation	*extra calculation factor*
slightly sloping roof (angle less than 20 degrees)	+ 10%
panel field in wind shadow	+ 10%
panel field at a height of more than 15 meters	- 10%

Example A

- It concerns a newly built house.
- Calculated heat demand of the house 5.3 kW.
- We want to heat all-electric and use a modulating heat pump of 6 kW (the heat demand here is therefore lower than the heat pump can deliver at its maximum)
- PVT panels model L are mounted on a south-facing sloping roof.

Calculation

Heat demand [kW] 5.3 * factor 2.7 = total aperture area required [m2] = 14.31 m2

14.31 / 2.0 = 7.15 panels -> this is rounded up so that the field is not under dimensioned.

So 8 pieces of M4 L panels of 2.0 m2 must be installed.

Example B

- It concerns en existing building (thorough renovation).
- Calculated heat demand of the house 7.4 kW.
- We want to heat all-electric and use a modulating heat pump of 8 kW.
- PVT panels model L are mounted on a slightly sloping roof of 10 degrees, in the forest.

Calculation

*Heat demand [kW] 7.4 * factor 3.0 = total aperture area required [m2] = 22.2 m2*

An additional 10% for the slightly sloping roof and 10% extra for the wind shadow should be calculated.

22.2 + 20% = 26.64 m2

26,64 / 2,0 = 13,32 L panels

14 pieces M4 L panels of 2.0 m2 must be installed.

Example C

- Calculated heat demand of the house 5.3 kW.
- We want to use hybrid heating (in combination with gas boiler) and use an on/off heat pump of 2.8 kW (the heat demand to which the panels are tuned depends on the maximum power that the heat pump can deliver and not the total heat demand of the house)
- PVT panels model L are mounted on a south-facing sloping roof.

Calculation

Heat demand [kW] 2.8 x factor 2.0 = total required aperture area [m2] = 5.6 m2

5,6 / 2,0 = 2,80 L panels

3 pieces of M4 L panels of 2,0 m2 must be installed.

Installing less panels than prescribed (i.e. under-dimensioning the panel field) has a negative impact on the electricity consumption of the heat pump, because it then has to work harder.

Note: For hybrid use, the field may be under-dimensioned.

Electrical output

PVT heat pump panels are identical to regular solar panels in terms of electrical output. By calculating the maximum amount of Watt peak (Wp) that a panel can provide, the orientation, the angle of inclination, and the aging over 10 years (8% according to the specification of the PV supplier Bisol), an estimate can be made of the electrical yield (kWh/year).

Example: 8 panels of 500 Wp on sloping roof of 30 degrees on the east delivers:

8 panels x 500 Wp x 82% x 92% = approx. 3018 kWh/year

Percentage of the maximum possible yield depending on the alignment and the roof slope

		Oriëntation (deviation in degrees from the south)																		
		South	South-East South-West								**East West**	Noth-East North-West								**North**
		0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°	110°	120°	130°	140°	150°	160°	170°	180°
roof pitch	**0°**	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%
	10°	93%	93%	93%	92%	92%	91%	90,0%	89%	88%	86%	85%	84%	83%	81%	81%	80,0%	79%	79%	79%
	20°	97%	97%	97%	96%	95%	93%	91%	89%	87%	85%	82%	80,0%	77%	75%	73%	71%	70,0%	70,0%	70,0%
	30°	100%	99%	99%	97%	96%	94%	91%	88%	85%	82%	79%	75%	72%	69%	66%	64%	62%	61%	61%
	40°	100%	99%	99%	97%	95%	93%	90,0%	86%	83%	79%	75%	71%	67%	63%	59%	56%	54%	52%	52%
	50°	98%	97%	96%	95%	93%	90,0%	87%	83%	79%	75%	70,0%	66%	61%	56%	52%	48%	45%	44%	43%
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	70°	88%	87%	86%	85%	82%	79%	76%	72%	68%	70,0%	58%	54%	49%	44%	39%	35%	32%	29%	28%
	80°	80,0%	79%	78%	77%	75%	72%	68%	65%	61%	56%	51%	47%	42%	37%	33%	29%	26%	24%	23%
	90°	69%	69%	69%	67%	65%	63%	60,0%	56%	53%	48%	44%	40,0%	35%	31%	27%	24%	21%	19%	18%

Flat roof: assume an angle of 10°

Extra PV solar panels

Triple Solar supplies higher rails for the PV panels, so that they end up at the same height as the PVT panels. PVT heat pump panels have a thickness of 53 mm and PV panels have a height of 35 or 30 mm depending on its size.

type	*dimensions (length x width x thickness)*
PV-panel M4 - 500 XL	2094 x 1134 x 35 mm
PV-panel M4 - 410 L or P	1722 x 1134 x 30 mm

Inverter

The heat pump panels can be used with any type of inverter. The inverter must be adjusted to the peak power of the heat pump panels and the orientation.

Example: Inverter power calculation (indicative): 8 XL panels * 500 Wp = 4.0 kWp

The inverter is connected to a separate group in the meter box. For specialist advice on the choice of inverter, we refer to your wholesaler.

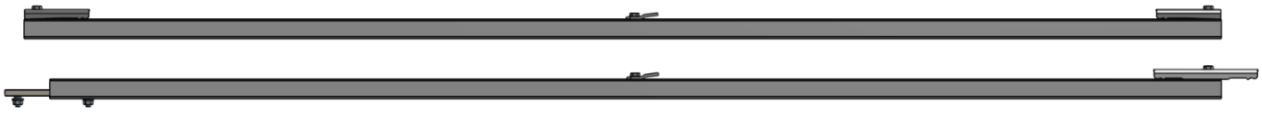
Placement of the panel field

Each panel is supported by two horizontal mounting rails. The mounting of these two rails depends on the type of roof: flat or sloping. The mounting of the panels on the mounting rails is identical for every situation.

Panels that are in the same row are hydraulically linked together by means of stainless steel connecting hoses. These are equipped with double o-rings on both sides.

Rails – Landscape panels

The mounting rails for the landscape PVT panels are supplied with pre-assembled clamps. There are two types of rails per panel size: a rail for the first panel in the row and a rail for the next panel in the row.

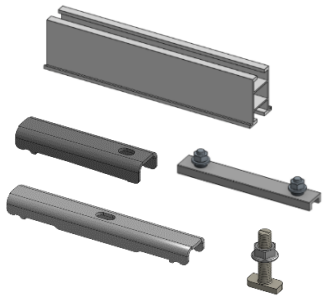


Top rail: for the first panel in the row
Bottom rail: for the next panel in the row

Depending on the rail variant, the following components are pre-assembled: end clamps and a centre hook or a connector, centre hook and a centre clamp. The rail variants for the M4 PVT Landscape panels are:

- Mounting rail 2193 mm, for the first panel M4 XL
- Mounting rail 2153 mm, for the next panel M4 XL
- Mounting rail 1821 mm, for the first panel M4 L
- Mounting rail 1781 mm, for the next panel M4 L

Rails – Portrait panels



Only one length of rail is supplied for PVT M4 portrait panels.

It is 1234 mm long and is supplied with separate clamps, hammerhead bolts, flange nuts and mounting rail connectors.

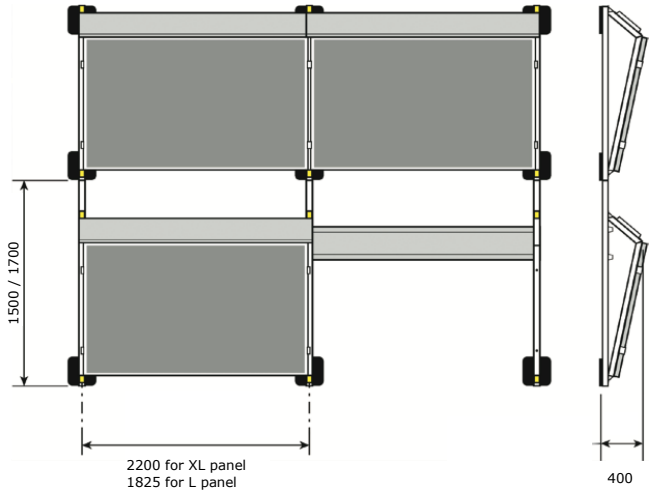
Flat roof alignment

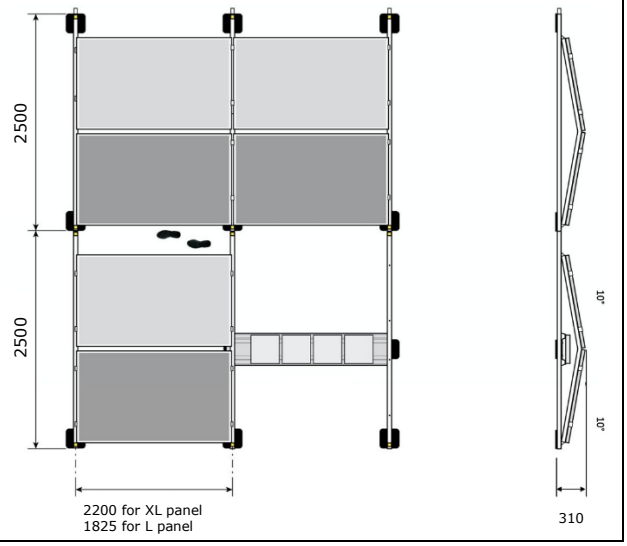
On flat roof, PVT panels are only placed in *landscape* configuration.

With a flat roof arrangement, the intermediate row distance of the panel rows must be taken into account.

Different row distances are available for south-facing setups. The larger the distance between the rows, the less shading and loss of yield. However, there is not always room for this on the roof.

orientation	South				East-West	
panel angle	12 degrees				10 degrees (2x)	
row distance	1500	1700	***mm***		2500	***mm***
shadow angle	22	16	***degrees***		9	***degrees***
power loss	2	0	***percent***		0	***percent***

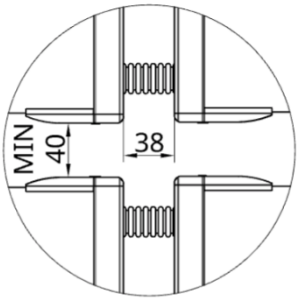




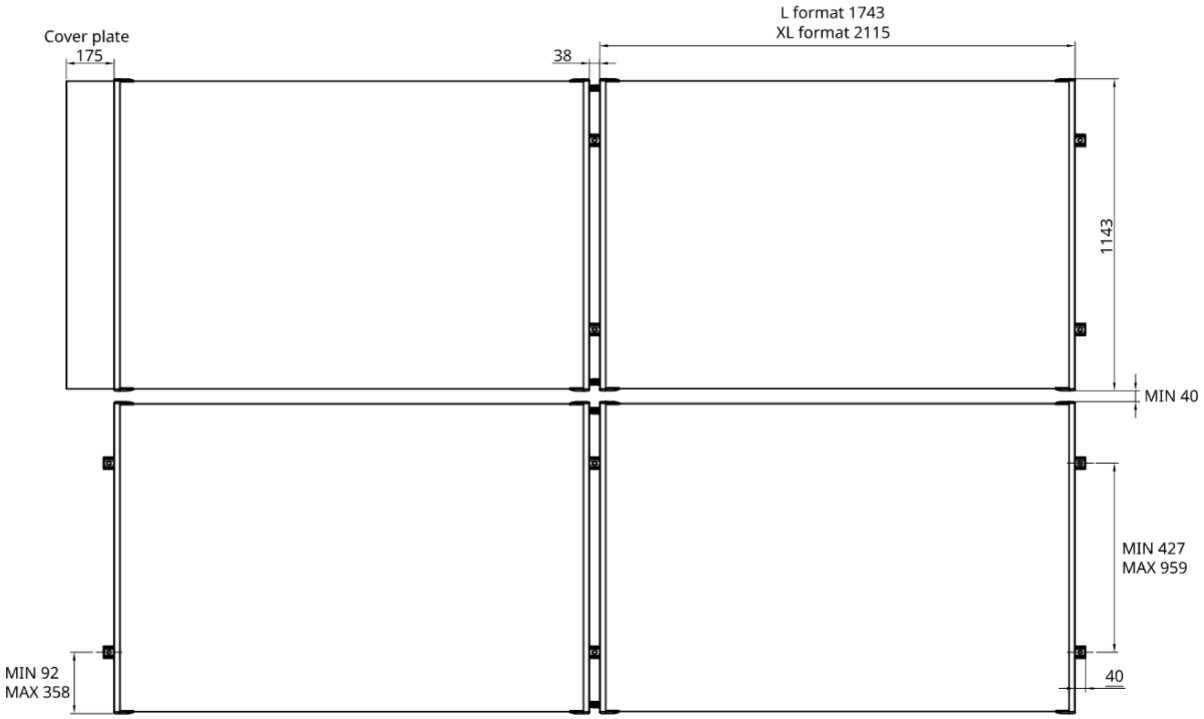
Sloped roof

The angle of inclination should be between 20° and 60°. If more than 60° or with a large wind load, more roof anchors may be needed than supplied as standard. Also when walking over the rails on steep roofs, extra roof anchors must be placed to prevent bending.

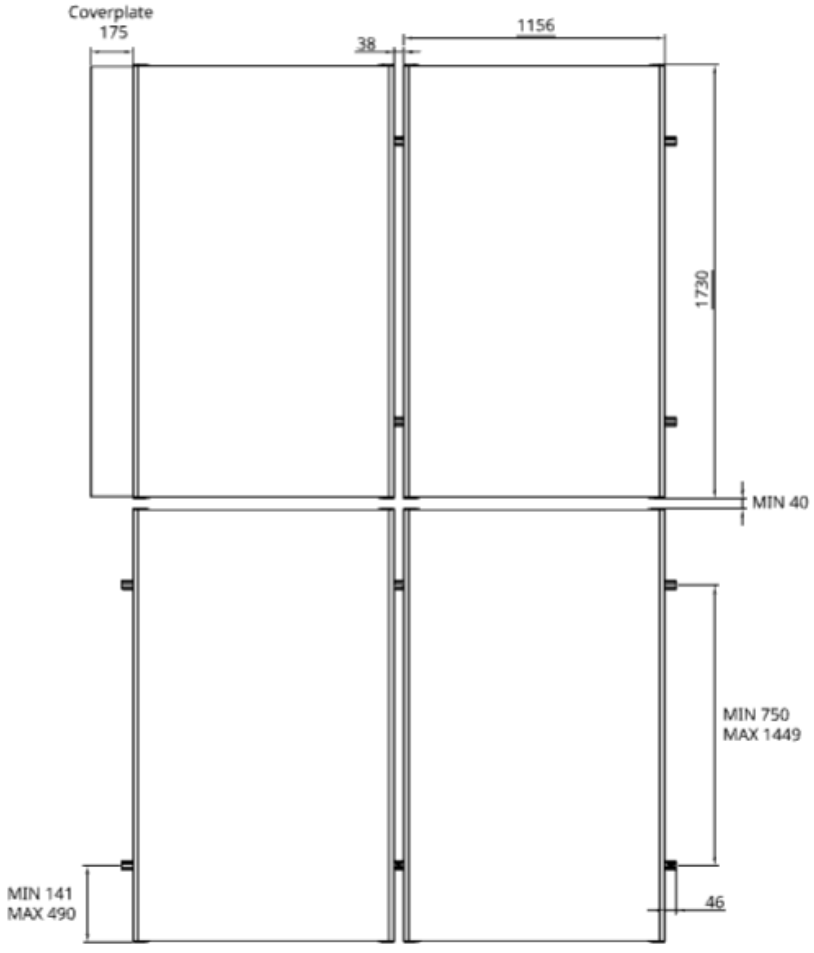
- Keep a minimum of 500 mm between the panel field and the edges of the roof. This has to do with the dragging force of the wind on the top and side. At the bottom, it has to do with rain, snow or ice that can slide off. In case the gutter is not wide enough to catch the rain etc, Triple Solar can provide a solution called the *TS waterline corner profile*.
- Keep a minimum of 40 mm between the rows of heat pump panels.
- Between the panels in the same row, 38 mm is needed for the *TS connecting hoses*.
- Take a minimum of 175 mm into account for the piping along the panels.



Sloped roof – Landscape alignment



Sloped Roof - Portrait Alignment



Sloped roof – roof anchor – Screw anchor

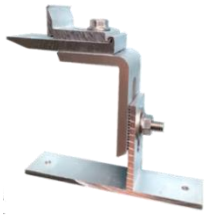
These roof anchors are screwed onto the roof underlayment, the slats or the roof tracks. In some cases, it is necessary to apply a number of additional slats or tracks to get the roof anchor to the right height between the roof tiles. Four screw anchors are supplied per L or P panel.

Sloped roof – roof anchor – hook anchor

In case the installer would rather not screw into the roof Triple Solar offers roof anchors that hook around the roof tracks and tiles. These hook anchors are adjustable for tile thickness and rail height. Six hook anchors are supplied per L or P panel.

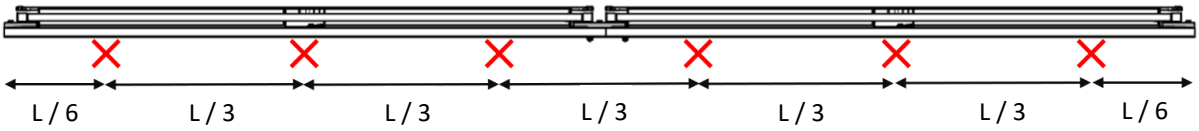
Sloped roof – roof anchor – EPDM roof anchor

For sloping EPDM/bitumen roofs, Triple Solar supplies roof hooks with an EPDM layer. These can be screwed onto vertical wooden beams (50x40 mm) that are mounted and EPDM wrapped to the roof in advance. These EPDM anchors are adjustable in height. Six hook anchors are supplied per L or P panel.

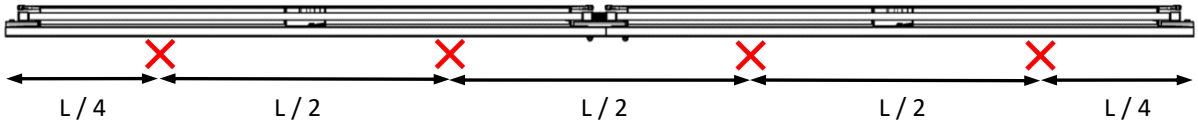


Sloped roof - Roof hook positioning

The positions of the roof hooks are determined before starting the project and marked on the roof tiles.



Position roof hooks with PV(T) panels with six roof hooks -> L = panel width



Position roof hooks with PV(T) panels with four roof hooks -> L = panel width

Hydraulic connection of the panel field

Pipes between panel field and heat pump, insulation and source fluid

The piping between the heat pump panel field and the heat pump can be realized in different ways: stainless steel pipe, copper pipe, plastic multilayer pipe (PEX) or plastic PP pipe. Plastic pipes that lie in the sun should always be protected from UV light by means of a UV-resistant jacket or UV-resistant lacquer. The plastic pipes must be suitable for the source fluid (glycol).

The pipe diameter between the heat pump panel field and the heat pump depends to a large extent on the power of the heat pump. In addition, the total length of the piping, the number of bends and the height difference between the heat pump and the panel field are important. The table below gives a guideline for the **inner diameter** of the pipework.

heat pump power	*minimum inner diameter piping*
6 kW to 8 kW	26 mm
8 kW to 15 kW	32 mm
15 kW to 28 kW	41 mm
28 kW to 50 kW	51 mm

Inside the building, the pipes from en to the PVT-panels must be finished with 19 mm vapour-tight insulation. This is due to the risk of condensation. The liquid temperatures can be -12 °C. The insulation in the roof passage can possibly be 13 mm thick due to the available space, but immediately after the roof passage, the insulation must be 19 mm thick again.

The source fluids that Triple Solar supplies as standard are: ethylene glycol with a ratio of 40% glycol in water and propylene glycol (when applying a cooling module or HPAC) with a ratio of 40% in water.

Insulation of piping

Inside the building, the pipes from en to the PVT-panels must be finished with 19 mm vapour-tight insulation. This is due to the risk of condensation. The liquid temperatures can get -20 °C. Vapour-tight insulation should be applied throughout the building up until the point where the pipes reach the outside air. This includes the space between the roof boarding and the outer roof covering. Outside, it is better not to insulate the pipes, as these pipes also contribute to absorbing heat from the outside air.

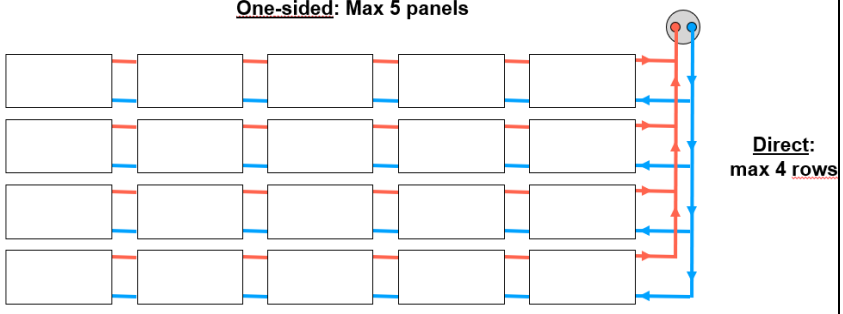
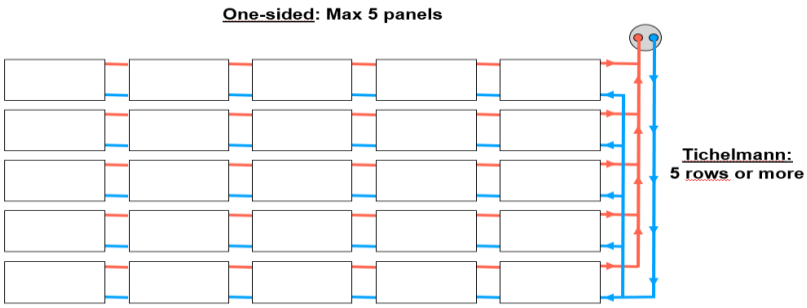
The source fluids that Triple Solar supplies as standard are: ethylene glycol at a ratio of 40% glycol in water and propylene glycol (when using a Triple Solar cooling module or NIBE HPAC) at a ratio of 40% in water.

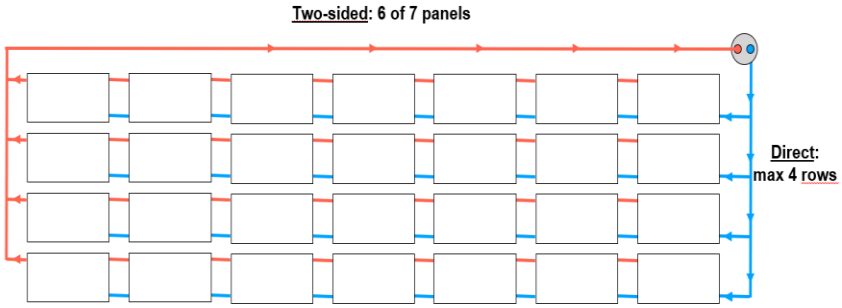
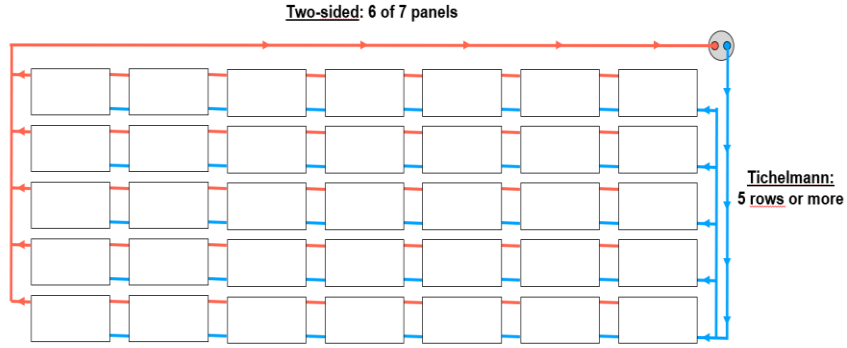
Piping along and between the panels

In the piping design, it is important that all PVT panels contribute proportionally to the heat supply. The table and graph below show the pressure loss for a different number of PVT panels in series when using ethylene glycol 40%. Pressure loss in the supply and return pipe to and from the PVT panels must be added to this. Check whether the pump's pump pressure in the selected heat pump is sufficient.

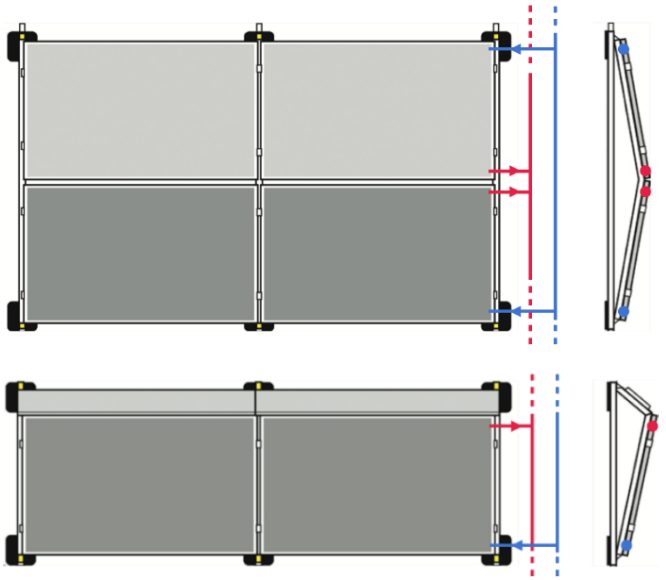
number of panels in a row	***V [l/h]***	***pressure loss [kPa]***					
		landscape L		***landscape XL***		***portrait P***	
		one-sided	*two-sided*	*one-sided*	*two-sided*	*one-sided*	*two-sided*
1	100	18,5	19	22	22	22	23
2	200	19	20	23	24	23	24
3	300	20	22	24	26	24	26
4	400	21	25	25	29	25	30
5	500	23	28	27	33	28	34
6	600	25	32	29	37	30	38
7	700	27	36	32	43	32	43

Depending on the size of the field, a different connection of the piping is required. A maximum of 7 panels in 1 row can be hydraulically coupled. The (heat) return pipe is always at the highest point, both with flat roof and sloped roof.

	One-sided, direct connection
	One-sided, Tichelmann connection Pay attention in case of a sloped roof: Tichel is in the cold pipe. At the highest point in the hot pipe, just inside the building, there will be an automatic vent.

	Two-sided, direct connection
	Two-sided, Tichelmann connection Pay attention in case of a sloped roof: Tichel is in the cold pipe. At the highest point in the hot pipe, just inside the building, there will be an automatic vent.

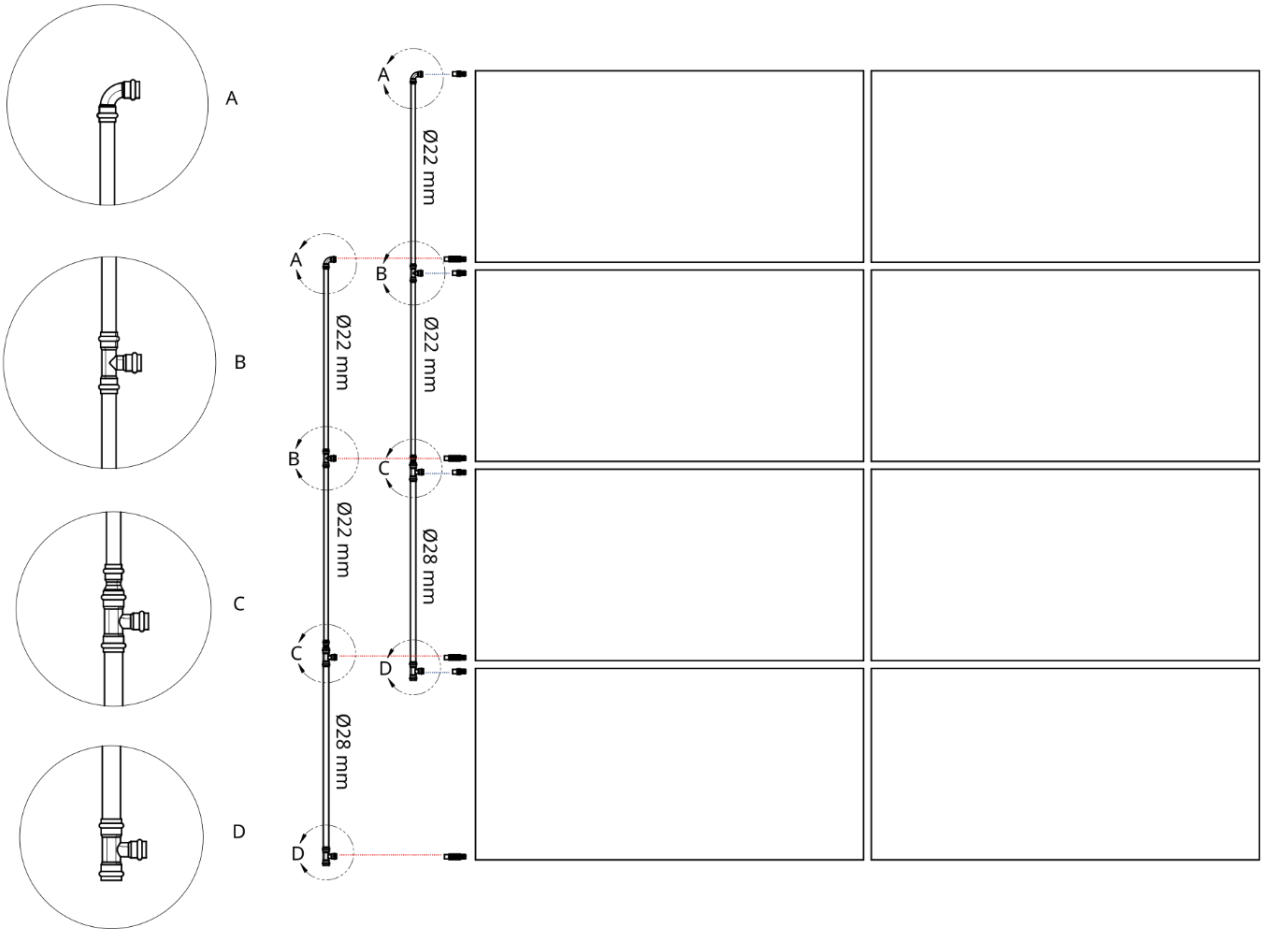
Even with East-West or South facing installation on flat roof, the return pipe (warm) is always at the highest point of the panels



Tips:

• If there are several panel fields, an optimal flow of glycol can be achieved by connecting fields in parallel and a smart distribution of the fluid-resistance over the fields.
• In case of a sloped roof, do not mount piping under the panels. It blocks the airflow underneath the panels, which will make the system perform less.
• The vents on the PVT panels must be accessible, also after commissioning.

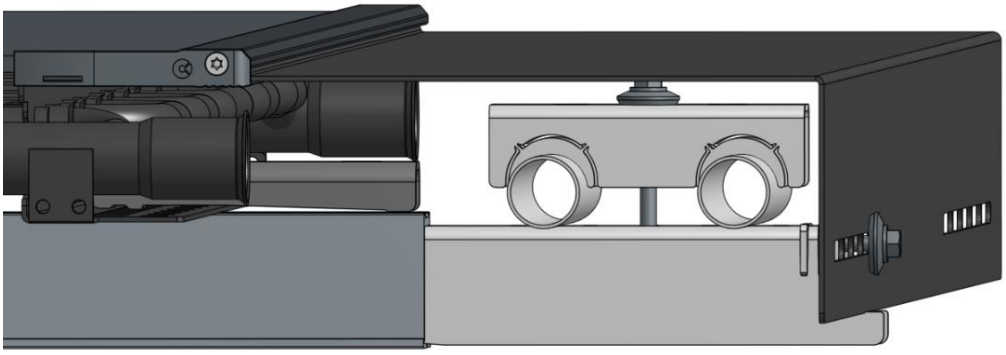
Piping in case of a smaller field on sloped roof



Sloped roof-pipe clamp set including cover plate

Triple Solar supplies as an option for pitched roofs a pipe mounting set including a cover plate. This set makes it possible to easily lay the piping tightly along the panel field and then finish it nicely with a black coated aluminium plate. The set is suitable for 22 and 28 mm pipes.

The cover plate hooks into the side profile of the PVT panel and is screwed into the pipe mounting profile. The cover plate adds 175 mm of width to the row of panels. But some extra space is needed next to the panel field to enable mounting.



Simplified view of an assembled pipe clamp set with cover plate

Sloping roof - roof duct

Triple Solar offers a roof penetration set with a double passthrough, suitable for tiled roofs. This is universal in terms of fit and therefore suitable for all types of roof tiles. They are available in two colours: anthracite and natural red.

Included are flexible stainless steel ribbed hoses with 28 mm pipe ends for through the roof passage and 19 mm vapor-proof insulation for over these hoses. The hoses are extendable from 1000 mm to 2000 mm. It is important to insulate the pipes inside the building up to a few centimetres outside the roof passage. The insulation has a length of 2000 mm and can be cut to length. In addition, two seals are included to finish the exit of the roof duct on the roof boarding.

The roof passage is best placed just next to and just above the top row of panels. Do not place roof ducts under the panels. This limits the airflow under the panel.

Hydraulic diagram

The specific requirements of the heat pump manufacturer apply to connecting the heat pump. Various hydraulic diagrams are available for download via www.triplesolar.eu. See also the PVT heat pump 3.5 Start guide.

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