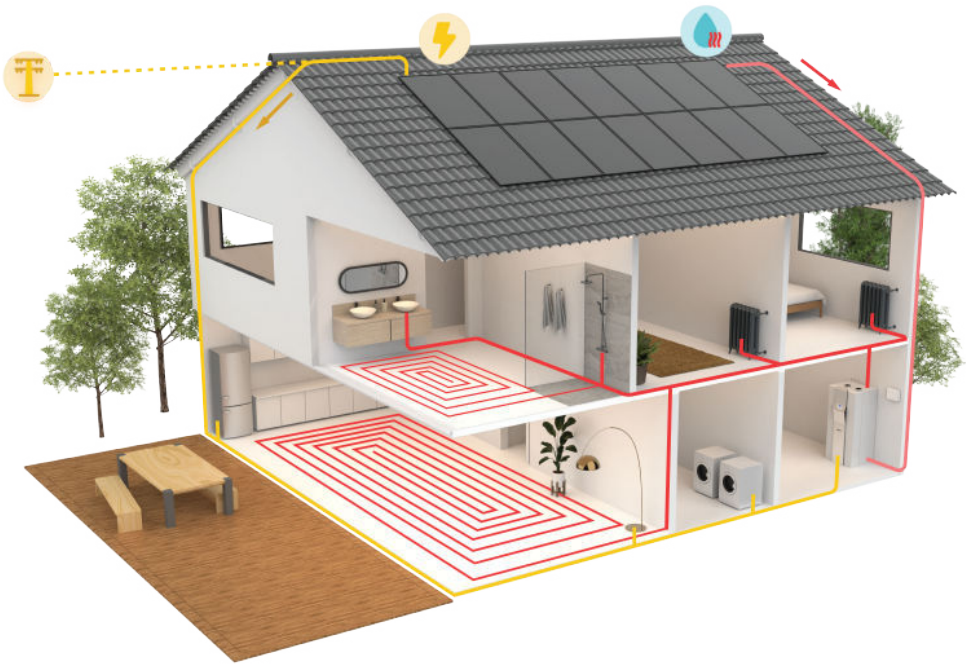

Solar thermal heat pump system installation and commissioning manual

V1.0
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1. Introduction

1.1. General safety instructions

Please read this installation manual thoroughly and in detail in order to be able to fully exploit the functionality of the product. DualSun disclaims all liability for defetcs and damages that would result from non-compliance with the installation instructions (improper use, incorrect installation, handling error, etc.).

IMPORTANT

- It is important to follow these instructions for personal safety. Improper mounting may cause serious injury. The end user must keep these safety instructions.
- The installation, control, commissioning, maintenance and repair of the installation must only be carried out by qualified personnel.
- The correct functioning of the installation is only guaranteed if the installation and assembly have been carried out in accordance with the rules of the art.

CAUTION

- The entire solar installation must be installed and operated in accordance with recognized technical rules.
- All electrical work must be done according to local guidelines.
- The installation must not be used if it shows signs of damage.

DANGER

- For installations on roofs, it is necessary to comply with personal safety standards, relating to roofing and waterproofing work and relating to scaffolding work with safety net by mounting the respective devices before starting work . Refer to the recommendation published by the national risk prevention organization.
- Gloves are compulsory when handling the panels to avoid any risk of injury or burns.
- Disconnect all connection cables from the power supply before working on the installation.

1.2. General standards to be observed

To ensure safe, ecological and economical operation, all applicable regional and national standards, rules and directives must be observed, particularly the international standards mentioned below:

1.2.1. Photovoltaic solar standards

- IEC / EN 61215 1 and 2: Design qualification and approval of crystalline silicon photovoltaic (PV) modules for terrestrial application.
- IEC / EN 61730 1 and 2: Photovoltaic (PV) module safety qualification - part 1: Requirements for construction and part 2: requirements for tests.

1.2.2. Solar thermal standards

- EN 12975 1 and 2: General requirements and control method for solar thermal collectors.
- EN 12976 1 and 2: General requirements and process for testing prefabricated solar thermal installations.

The installation instructions and safety instructions must be met.

Observe the regulations on the prevention of industrial accidents prescribed by professional associations, in particular those relating to work carried out on the roof.

1.3. Dimensional conventions

In the content of this notice we have chosen to follow the following convention:

Threads : use of the EN ISO 228/1 standard. All threads are defined in inches.

Pipe diameters : Use of the EN ISO 6708 standard. All internal diameters are defined in mm and preceded by the prefix DN.

2. Description of a solar thermal system

2.1. Principle of operation of a solar thermal system and definition of terms

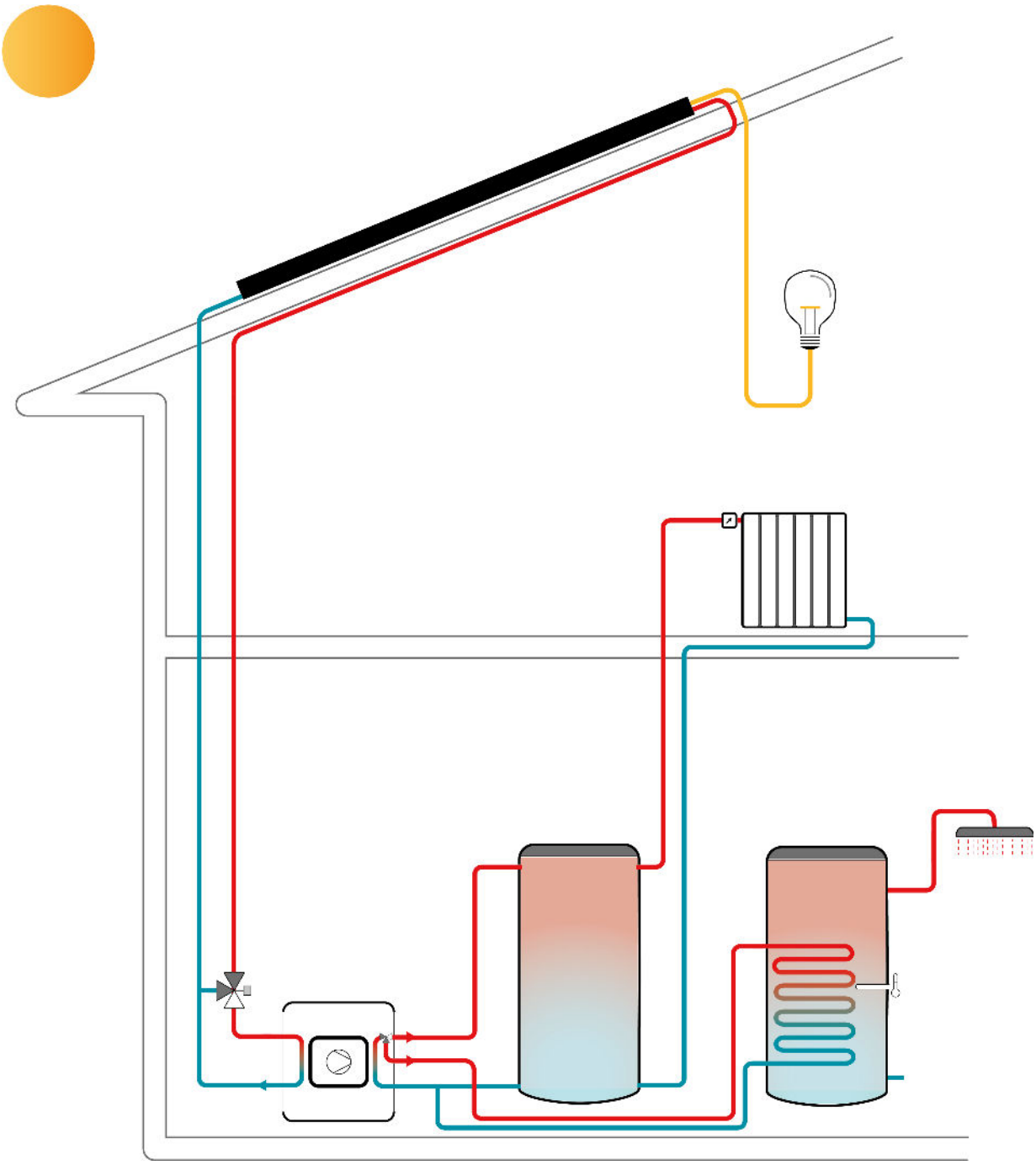
The purpose of this manual is to describe the operation and specificities of a coupling of DualSun hybrid solar panels on the primary (cold) circuit of a glycoled water to water heat pump.

The hydraulic circuit uses the exchanger located on the rear side of the SPRING4 winged

The two sides of the solar panel are used as follows:

- The heat exchanger integrated into the rear of the solar panels draws heat both from the outside air via the fins and from solar radiation to transfer it to the refrigerant of the heat pump via the evaporator .
- The photovoltaic cells on the front of the solar panels produce electricity to partly power the electricity consumption of the heat pump compressor.

This coupling makes it possible to significantly improve the performance of the heat pump, which makes it possible to largely reduce its electricity consumption on the electricity network. The schematic diagram of this coupling is illustrated in the following figure:



STANDARD CONFIGURATION SHOWN

Information: In this manual, all dimensions and descriptions consider a configuration that we have defined as standard: Water/water heat pump supplying a DHW tank and a heating circuit via a buffer tank. This tank can be integrated into the storage tank. domestic hot water (so-called combi tank) or separate. As shown in the chapter diagram Description of a solar thermal system [5]

2.2. List of components

The components of the system coupling the DualSun hybrid panels and the Water/Water heat pumps are described in the following diagram and table.

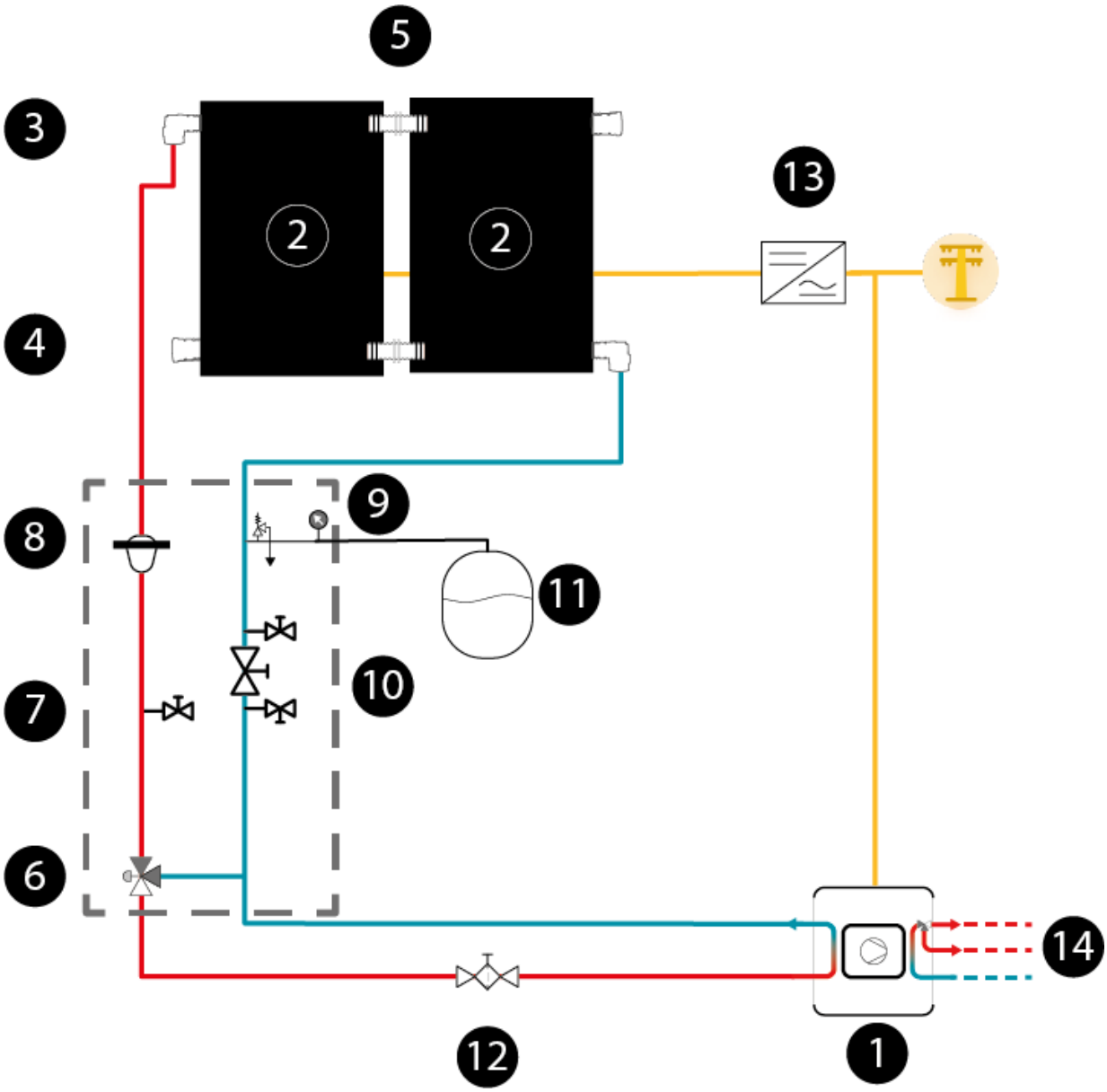


Table 1. Heat pump coupling diagram

Number	Description	Comment
1	Glycoled water to Water heat pump (HP)	
2	DualSun SPRING4 finned (PVT)	
3	1”¼ Inlet/Outlet fitting kit	Included in the inlet outlet fitting kit
4	Plugs	Included in the inlet outlet fitting kit
5	Inter-panel connections	Included in the inter-panel kit

Number	Description	Comment
6	Thermostatic mixing valve	included in the DualSun solar thermal station
7	draining valve	included in the DualSun solar thermal station
8	Deaerator	included in the DualSun solar thermal station
9	Visual pressure gauge and safety valve	included in the DualSun solar thermal station
10	Filling kit	included in the DualSun solar thermal station
11	Expansion tank	
12	Filter valve	
13	Inverter or microinverter	Not covered in this notice
14	To heating circuit	Not covered in this notice

2.3. The heat pump

2.3.1. Description

The heat pump is the central component of the system. It forms the link between the collection circuit, powered by the thermal circuit of the hybrid solar panels, and the production circuit, supplying the heating system and the domestic hot water tank.

2.3.2. Sizing

The criteria for choosing the heat pump are as follows:

- Heat pump with **Inverter technology**. This type of heat pump has the main advantage of modulating the speed as well as the electrical consumption of the compressor according to the thermal power requested in the home and the thermal power available in the solar collectors, unlike a pump ON/OFF heat pump more suitable for coupling with geothermal probes.
- **Low limit of the evaporator inlet temperature** less than or equal to -15°C. This limit significantly impacts the seasonal performance of the system as presented in the following table.

Minimum evaporator temperature	SPF (Seasonal performance factor)
-15	3,7
-10	2,8
-5	1,9

NOTE

Average data from digital simulations carried out by the Institute for Solar Energy Research (ISFH) via TRNSYS software for a 140m² house in Strasbourg with an annual consumption of 2 MWh of domestic hot water (approximately 150L/day) and a consumption annual heating of 6MWh (heated floor) or 13MWh (radiators).

- **Upper limit of the evaporator inlet temperature** above +15°C. Otherwise, another mixing valve with a lower temperature margin should be used.

- **Maximum service temperature** . This temperature must depend both on the services to which the heat pump responds (domestic hot water, for example), on the type of heat emitters for heating (underfloor heating, water radiators, etc.) and on the comfort level of the customer.
- **Integration of an electrical backup**. In most cases, the heat pump is not sized to fully meet the thermal needs of a home. If no backup is integrated into the heat pump, it will have to be added to the system (online at the outlet of the heat pump production circuit, or inserted in the hot buffer tanks).

The heat output of the heat pump is estimated based on heat losses from the home. A simple sizing method is proposed by DTU 65.16 with the following formula:

$P_{cal,HP}=n_{cov}*V*U*(T_{desired}-T_{base})$

Where

- $P_{cal,PAC}$ is the calorific power of the heat pump [kW] given to T_{base}
- n_{cov} is the coverage rate, it must be between 0.8 and 1.2
- V is the volume of the hearth to be heated [m^3]
- G is the volumetric heat loss coefficient [W/m3.K]
- $T_{desired}$ is the desired indoor temperature [°C]
- $T_{base}$is the minimum outside temperature [°C]

For the dimensioning of the electrical backup, the sum of its power and that of the heat pump must be greater than 1.2 of the heat losses of the home:

$P_{BU} \geqq 1.2*V*U*(T_{desired}-T_{base}) - P_{cal,PAC}$

2.3.3. Compatibility

DualSun has studied the compatibility of a number of heat pumps. The non-exhaustive compatibility list can be found in the Dedicated FAQ on our site.

2.4. DualSun SPRING4 panel

2.4.1. Description

The DualSun hybrid panels constitute the unique cold source of the heat pump: they are hydraulically connected to the primary circuit (collection circuit) of the heat pump. The solar installation is thus sized according to the characteristics of the heat pump to supply its evaporator with heat.

2.4.2. Sizing

We recommend the following sizing ratios depending on the heat pump technology and the low temperature limit of its evaporator:

Table 2. Sizing ratios

HP technology	Low limit temperature at evaporator inlet [°C]	Sizing ratio [SPRING4 number per calorific kW of the heat pump at B0/W35]
Inverter	-15°C	1,1
Inverter	-10°C	1,3
ON / OFF	-15°C	1,2
ON / OFF	-10°C	1,4

These ratios were deduced in order to ensure a better compromise between the initial cost of the solar installation and the energy performance of the system and can change depending on the detail of the configuration of the installation or the geographical area.

The rule is simple here: the greater the number of panels used, the better the thermal performance of the heat pump. It is recommended to round this number of panels according to the constraints of

the roof to favor an identical number of panels per hydraulic field. For example, if your dimensioning recommends 14 panels and the roof requires an installation on 3 lines, it is preferable to install 15 panels to have 3 hydraulic fields of 5 panels each).

It is essential to refine the sizing on a case-by-case basis by checking on the one hand that the solar thermal contribution of the hybrid panels is sufficient according to the data of your **geographical area** and on the other hand that the circulator integrated into the primary circuit of the heat pump is sufficient to circulate the heat transfer fluid in the hybrid panels.

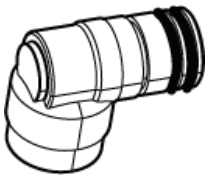
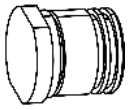
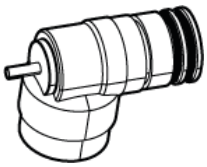
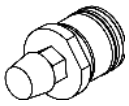
NOTE
For more information on pressure losses as well as thermal performance of DualSun hybrid panels, refer Installation, use, maintenance instructions SPRING4.

STANDARD CONFIGURATION SHOWN
Information: In this manual, all dimensions and descriptions consider a configuration that we have defined as standard: Water/water heat pump supplying a DHW tank and a heating circuit via a buffer tank. This tank can be integrated into the storage tank. domestic hot water (so-called combi tank) or separate. As shown in the chapter diagram Description of a solar thermal system [5]

2.5. Input-output kit

2.5.1. Description

The inlet/outlet kit allows you to connect a hydraulic panel line to the general piping of the heat pump's primary circuit.

Connection	Single cap	Connection with probe	Cap with drain
			
X1	X1	X1	X1

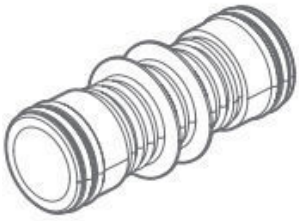
NOTE
The quantities presented here are in the case of a line of panels

For more information please consult Installation, use, maintenance instructions SPRING4

2.5.2. Sizing
You must count one hydraulic kit per hydraulic line of panels.

2.6. Inter-panel connections

2.6.1. Description



Each kit contains 2 fittings.

Inter-panel connections allow panels of the same hydraulic line to be connected in parallel to each other.

2.6.2. Sizing
You must count one inter-panel connection kit for each intersection of two panels, i.e. add the number of panels minus 1 for each line.

2.7. Expansion tank

2.7.1. Description
As with any pressurized heating system, an expansion tank is necessary to absorb/compensate for pressure variations linked to temperature variations in the solar circuit.

2.7.2. Sizing
The volume of the expansion tank must be dimensioned according to the total volume in the circuit: panels and pipes.

CAUTION
It should be checked **if the heat pump integrates an expansion tank in the primary circuit**

In this case, the volume of the expansion tank to be added is equal to the difference between the necessary dimensioned volume and the volume of the expansion tank integrated into the heat pump.

It is also necessary to check the preset pressure on the vessel integrated into the heat pump to adjust that of the external vessel. The pressures must be adjusted so as to guarantee sufficient pressure at all points in the circuit. The pressure at the heat pump evaporator should generally not exceed 3 bar gauge. However, the pressure at the installation level at the solar installation must not exceed 4 bar gauge.

We offer the following method for sizing the expansion tank:

2.8. The DualSun solar thermal station

The solar thermal solar station facilitates the installation of a PVT-PAC system by including all the hydraulic elements necessary for the installation and maintenance of the primary circuit of the heat pump.

NOTE

If you have ordered the DualSun solar thermal station, the elements detailed in the list of components are included in the kit and constitute a single element.

2.8.1. Thermostatic mixing valve

The mixing valve is an essential element to protect the heat pump evaporator from excessively high temperatures coming from the solar field.

It is installed at the outlet of the solar panels upstream of the heat pump. It is used to limit the temperature at the inlet of the evaporator of the heat pump when the temperature at the outlet of the solar field exceeds its set temperature by mixing with fluid coming from the evaporator as you can see in the diagram in the chapter Principle of operation of a solar thermal system and definition of terms [5].

We recommend the use of the ESBE brand thermostatic valve under this reference. *31700100 - ESBE VTA572 10-30°C G1 20-4.5.* There **set temperature of this valve can be adjusted between 10 and 30°C**, which corresponds to the upper limit accepted at the evaporator inlet of the majority of geothermal heat pumps on the European market.

Here are the positions to adjust depending on the desired set temperature:

Position	Temperature (°C)
1	10
2	14
3	18
4	22
5	26
6	30

Any other valve whose setpoint adjustment margin includes the acceptable upper limit at the inlet of the heat pump evaporator, thermostatic or electronic, can be used by applying the same hydraulic configuration.

NOTICE

Choice of set temperature:

In order to protect your heat pump, the thermostatic mixing valve must be set with a set temperature equal to the maximum inlet temperature of your heat pump - 5°C.

2.8.2. Visual pressure gauge

The use of a visual pressure gauge is necessary to monitor the pressure, particularly when filling and purging the system.

We recommend the use of a pressure gauge whose margin is between 0 and 6 bar.

2.8.3. Safety valve

A safety valve is essential to prevent overpressure in the hydraulic circuit, thus causing damage to pressure-sensitive components.

The safety valve of the DualSun solar thermal station is calibrated at 6 bar.

2.8.4. Filling kit

A filling kit is essential to ensure the filling and commissioning of the system. See the detailed filling and commissioning steps in the chapter Commissioning steps [18].

2.8.5. Flow meter

The flow meter integrated into the station allows you to check the flow rates and verify that there are no air bubbles in the system.

2.8.6. Degasser

A degasser is used to remove air bubbles present in the system when filling and purging the system. We recommend the use of a manual degasser.

NOTE

DualSun Inlet/Outlet kits include caps with integrated manual degassers, making it even easier to fill and purge the solar circuit.

2.9. Filter valve

2.9.1. Description

As provided in DTU 65.16 we recommend installing a filter valve.

The filter valve is a ball valve equipped with an integrated filter. It ensures filtration of the fluid contained in the solar circuit by retaining any deposits or impurities. The filter mesh size should not be greater than 1 mm.

It must be connected to the hot side of the evaporator in order to protect it from impurities upstream of the circuit.

CAUTION
We recommend cleaning the filter at least once a year.

2.10. Hydraulic lines

2.10.1. Description

It is necessary to use pipes with a material compatible with the operating temperatures and pressure of the solar circuit:

- -35°C to +85°C
- 6 bars

Stainless steel, polypropylene and copper pipes can be used.

NOTE
The pipes must have different specifications depending on whether they are located in the house or outside (on the roof).

- **Outside**: anti-UV hydraulic lines must be used.
- **Inside**: insulated and anti-condensation hydraulic lines must be used.
  The insulation must be waterproof to prevent the penetration of water vapor. This is to prevent condensation and icing phenomena from occurring in the technical room. In winter: the temperature of the fluid passing through these pipes often drops below the dew point temperature or even below 0°C.

IMPORTANT
We recommend the installation of isolation valves upstream and downstream of the various hydraulic components to facilitate maintenance and/or replacement of these components.

NOTE
It is important to limit the multiplication of materials used in the circuit.

2.10.2. Sizing

The diameter of the pipes depends on the power of the heat pump. We recommend the following minimum diameters (refer to the heat pump installation instructions for more details):

PAC heating power	Internal diameter of pipes
P_{th} < 8kW	DN26
9kW < P_{th} < 15kW	DN32
16kW < Pth < 30kW	DN40

NOTE
The inlet/outlet kits have a 1 ¼" male thread, when the diameter of the connected hydraulic transfer lines is different, hydraulic reducers must be used.

2.11. Coolant

2.11.1. Description

The main role of the heat transfer fluid is to transfer the thermal energy collected in the solar panel exchanger to the heat pump evaporator.

WARNING
When choosing the type of heat transfer fluid it is important to check the viscosity of the heat transfer fluid at very low temperatures (-20°C) so as not to damage the heat pump circulator.

It is a mixture of water and antifreeze (glycol type) with a freezing temperature well below zero.

The percentage of antifreeze must therefore be calculated according to the minimum temperature of the fluid. This temperature depends on both the extreme cold outside temperature and the low operating limit of the heat pump.

If the minimum temperature of the circuit is -15°C (inlet side of the heat pump), we recommend a concentration of **40% MEG (mono ethylene glycol) or 45% MPG (mono propylene glycol)** allowing protection down to approximately -25°C (10°C safety).

For other types of antifreeze or other minimum temperatures, refer to the antifreeze technical data sheet, aiming for protection with a safety of 10°C.

The heat transfer fluid must also be able to withstand high temperatures (up to the stagnation temperature of the solar panels, to be checked on the technical sheet depending on the SPRING4 model).

NOTE
We recommend the use of heat transfer fluids that are the least toxic to the environment and the least viscous at negative temperatures.

NOTE
We recommend using ready-to-use heat transfer fluids (already mixed) with an anti-corrosion effect.

Local regulations must also be taken into consideration when choosing the type of heat transfer fluid.

2.11.2. Sizing

The volume of the heat transfer fluid corresponds to the total volume of the solar circuit which corresponds to the sum of the following volumes:

- Volume of external hydraulic pipes, which depends on their length and radius
  $V = Pi \times r_{ext}^2 \times L_{ext}$
- Volume of internal hydraulic lines
  $V = Pi \times r_{int}^2 \times L_{int}$
- Volume of solar panels
  $V=N_{SPRING4} \times V_{SPRING4}$
- Heat pump evaporator heat exchanger volume
- Filling volume of the expansion tank

3. Installation of solar components

3.1. Heat pump installation

To install the heat pump please refer to the technical documentation provided by the heat pump manufacturer.

3.2. Installation of DualSun SPRING4 hybrid panels

To install the solar panels you can refer to the associated instructions:Installation, use, maintenance instructions SPRING4 in which you will find all the instructions.

3.3. Installation of the DualSun solar thermal solar station

The DualSun solar thermal station must be hydraulically connected to the heat pump (bottom) and the solar panels (top) respecting the rules of the art and using the fittings suitable for the selected piping.

3.3.1. Installing the Thermostatic Mixing Valve

A mixing valve is **essential** to the proper functioning of the system. It prevents liquid from getting too hot into the heat pump and damaging it. It must be chosen according to the characteristics of the heat pump. The mixing valve is included in the hydraulic unit supplied by DualSun. There is therefore no need to add it if you ordered this group.

IMPORTANT

The valve must be set to temperature: $T_{max\ heat\ pump}$ - 5°C

3.4. Installing the filter valve

In order to comply with DTU aPAC 65.16 you are asked to install a valve before the inlet of the heat pump in order to protect its evaporator as seen in the diagram in chapter List of components [7].

3.5. Circuit isolation

CAUTION

It is necessary to turn off the heat pump before undertaking any insulation work to ensure that there is no humidity on the pipes before covering them.

NOTE

We do not recommend insulating exterior pipes.

4. Commissioning steps

Once the entire hydraulic circuit is connected and isolated, be sure to follow the steps for complete commissioning.

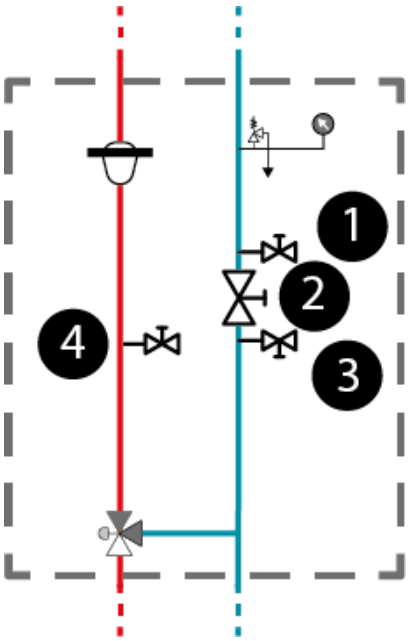
The commissioning steps are as follows:

1. Airtightness test [18]
2. Filling the lower part of the circuit [19]
3. Filling the upper part of the circuit [19]
4. Pressure adjustment [20]

NOTE
The lower part is defined as the hydraulic part located before the thermostatic valve and the filling kit. Or the heat pump evaporator.

The upper part is defined as the hydraulic part located after the thermostatic valve and the filling kit. Or hybrid panels

WARNING
The installation must be commissioned cold, ideally within a panel temperature range of between 10 and 45°C.



4.1. Preliminary leak test

We recommend before injecting glycol into the entire circuit to carry out an air test. Its goal: to identify parasitic infiltrations and determine if a leak is present. To do this, equip yourself with a compressor

and connect to the filling valve (number 1). Once the circuit is under pressure, take the time to check and listen to make sure that there is no whistling noise anywhere on the circuit and that the pressure remains stable for at least 5 minutes.

4.2. Filling the lower part of the circuit

NOTE
Filling is done first from the lower part to take advantage of the fluid at room temperature. Circulate the fluid in the opposite direction of normal circulation to fill the heat pump condenser and its connections.

To fill, you must connect the inlet of the filling station to valve 3 and the outlet to valve 4. Once connected, it is necessary to respect the following valve directions:

Table 3. Valve position

1	Closed
2	Closed
3	Opened
4	Opened

Once the circuit is connected, it must be filled with a minimum flow rate of 200l/h/panel while respecting the maximum pressure admissible by the heat pump.

Performing a few water hammer blows can help clear the circuit of any air bubbles.

4.3. Filling the upper part of the circuit

IMPORTANT
During this phase it is important to go to the roof in order to open the bleeders present on the plugs and allow better evacuation of air from the hydraulic circuit.

To proceed with filling, you must connect the inlet of the filling station to valve 2 and the outlet to valve 4. Once this connection is made, you must respect the following valve positions:

Table 4. Valve position

1	Opened
2	Closed
3	Closed
4	Opened

Next, manipulate the flow meter needle to allow the flow from the commissioning pump to be directed directly to the panels.

4.4. Pressurizing the circuit

WARNING
During this step it is important to take into account the maximum pressure of the heat pump and never exceed it.

To pressurize you will need to:

- Keep the same connection as in the previous step;
- Close the traps on the roof caps;
- Respect the following valve positions:

Table 5. Valve position

1	Opened
2	Opened
3	Closed
4	Closed

You can then slowly increase the pressure in the system to reach the operating pressure required by the heat pump then close valve 1. You can then slowly increase the pressure in the system to reach the operating pressure required by the heat pump then close valve 1.

Commissioning on the evaporator side of the heat pump is complete.

4.5. Commissioning of the heat pump

Once all these filling and pressurization steps have been completed, you can put the heat pump into service by following the recommendations of the heat pump supplier.