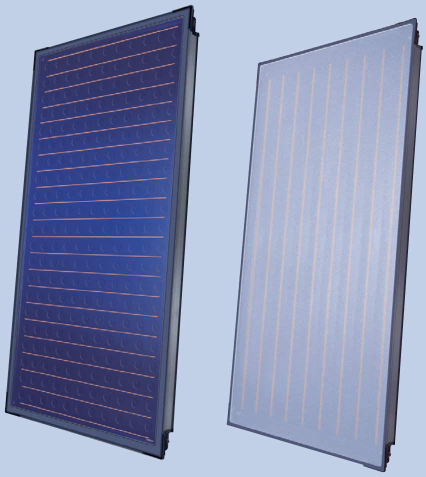
Planning guide

Commercial solar heating systems



Solar thermal technology for large-scale hot water and central heating backup

Intelligent Heating Solutions

Buderus

Contents

Regulations and guidelines for designing/engineering a solar collector system

→ The guidelines below provide an indication of basic requirements only. Regulations are continually updated and latest revisions should be taken into account prior to any work commencing.

Installation and commissioning must be carried out by a specialist contractor. Take appropriate accident prevention measures when carrying out any installation work on the roof. Observe all relevant accident prevention regulations.

Apply all current technical standards to all practical work. Design safety equipment in accordance with all locally applicable regulations. Also comply with the building regulations of the country concerned, the listed building regulations and any local building regulations that may apply to the assembly and operation of a solar collector system.

Technical rules for the installation of solar heating systems

Requirement	Description
	On-roof installation
BS EN 18338	VOB[1]; roofing and sealing work
BS EN 18339	VOB[1]; plumbing work
BS EN 18451	VOB[1]; scaffolding work
BS EN 1055	Design loads for buildings
	Connection of solar heating systems
BS EN 12975-1	Solar heating systems and components - Solar collectors - Part 1: General requirements
BS EN 12976-1	Solar heating systems and components - Factory made systems - Part 1: General requirements
BS V ENV 12977-1	Solar heating systems and components - Custom built systems - Part 1: General requirements
	Installation and equipment of DHW cylinders
BS EN 1988	Technical Regulations for Drinking Water Installations (TRWI)
BS EN 4753-1	Water heaters and water heating installations for drinking water and service water; requirements, marking, equipment and testing
BS EN 18380	VOB[1]; heating systems and central DHW heating systems
BS EN 18381	VOB[1]; gas, water and sewage plumbing works inside of buildings
BS EN 18421	VOB[1]; insulation work on technical installations
G3	Building regulations for unvented hot water storage
HSE ACOP L8	Legionnaires' disease. The control of legionella bacteria in water systems. Approved Code of Practice and guidance L8 (second edition)
	Electrical connection
BS EN VDE 0100	Installation of HV systems with rated voltages up to 1000 V
BS EN VDE 0185	Lightning protection systems
VDE 0190	Main earth bonding of electrical systems
BS EN VDE 0855	Antenna systems – to be applied analogous
BS EN 18382	VOB[1]; electrical cabling systems in buildings
BS 7671	IEE wiring regulations
BS EN 62305	Protection against lightning

3/1 Important standards, regulations and EC directives for the installation of solar collector systems
1) VOB – contract procedures for construction work – part C: General technical conditions of contract for construction services (ATV)
2) Invitation to tender templates for building work in overground workings, particularly with regard to residential building

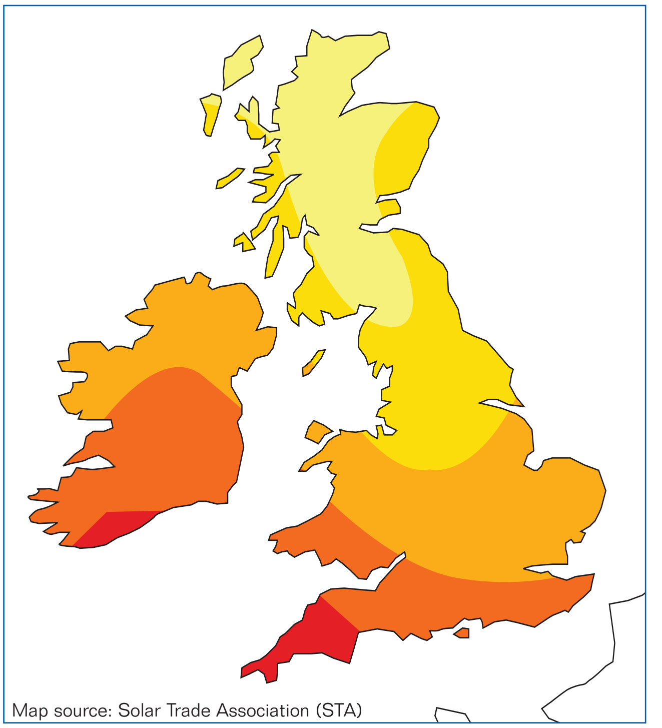
1 Principles

1.1 Free solar energy

The energy that is provided by the sun can be used effectively in almost any part of the British Isles and Ireland. The annual irradiation level lies between 900 - 1200kWh/m². The "irradiation map" gives you an idea of the average irradiation that can be expected in your region(→ *4/1*).

A solar thermal system uses the energy of the sun to heat domestic hot water (DHW), swimming pools and can also be used as space heating backup. Solar systems for DHW heating are energy-saving and environmentally friendly. Combined solar thermal systems for DHW heating and central heating backup are progressively becoming more popular.

A considerable proportion of solar energy can be used for heat generation using solar collector systems, saving valuable fuel, and fewer emissions reduce the burden on the environment.



Map source: Solar Trade Association (STA)

4/1 Average irradiation in the British Isles

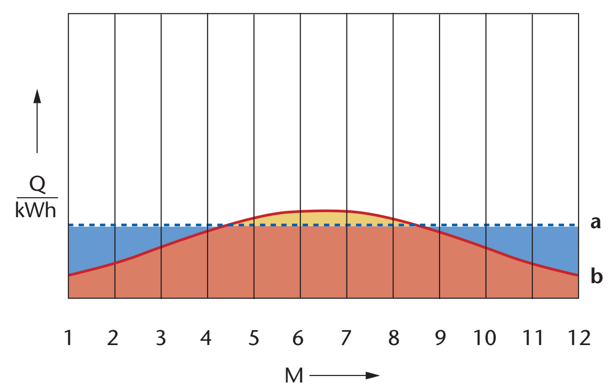
Caption

- Over 1200 kWh/m²
- 1100 to 1200 kWh/m²
- 1000 to 1100 kWh/m²
- 900 to 1000 kWh/m²
- Less than 900 kWh/m²

1.2 Energy supplied by solar collector systems in relation to the energy demand

Solar collector systems for DHW heating

DHW heating is the most obvious application for solar collector systems. The regular demand for hot water all year round means that the energy demand for DHW heating during the summer can be covered by a solar heating system (→ *5/1*). Nevertheless a conventional heating system, such as a condensing boiler, must still be installed to cover the DHW demand independently of solar heating. Long periods of bad weather may occur during which the supply of hot water still has to be assured.

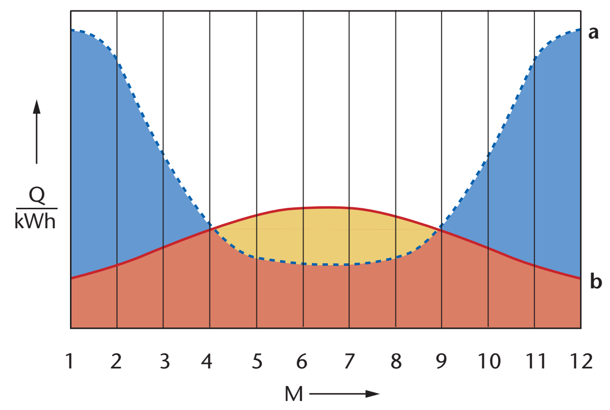


5/1 *Energy provided by a solar collector system in relation to the annual energy demand for DHW heating*

Solar collector systems for DHW heating and central heating backup

The energy conscious investor thinks of solar collector systems not just for DHW heating but also for central heating backup. However, the solar heating system can only contribute heat if the return temperature of the space heating system is lower than the temperature of the solar collector field. Large radiators with low system temperatures or underfloor heating systems are therefore ideal.

With an appropriate design the solar heating system will cover up to 30% of the annual heating energy that is needed for DHW heating and central heating. Combined with a condensing boiler, the requirement for fossil fuels can be reduced even further during the heating season. The residual energy is ideally provided by a condensing or a low temperature boiler.



5/2 *Energy provided by a solar collector system in relation to the annual energy demand for DHW and central heating*

Caption (→ *5/1* and *5/2*)

a Energy demand
b Energy provided by the solar heating system
M Month
Q Heating energy

- Solar energy surplus (available for a swimming pool, for example)
- Utilised solar energy (solar coverage)
- Energy demand that has not been covered (boiler back up)

2 Technical description of system components

2.1 Solar collectors

2.1.1 SKN3.0 flat-plate collector

Selected features and characteristics

- Favourable price/performance ratio
- Consistently high yield through robust, highly selective black chromium coating
- Independently tested connection technology
- Rapid tool free collector hose connection
- Easy handling because of light weight of 42kg
- Listed on Enhanced Capital Allowance (ECA) scheme
- Solar fluid has long-term stability due to fan absorber with extremely good stagnation characteristics
- Energy-saving manufacture with recyclable materials
- Solar keymark
- Available in portrait and landscape format.

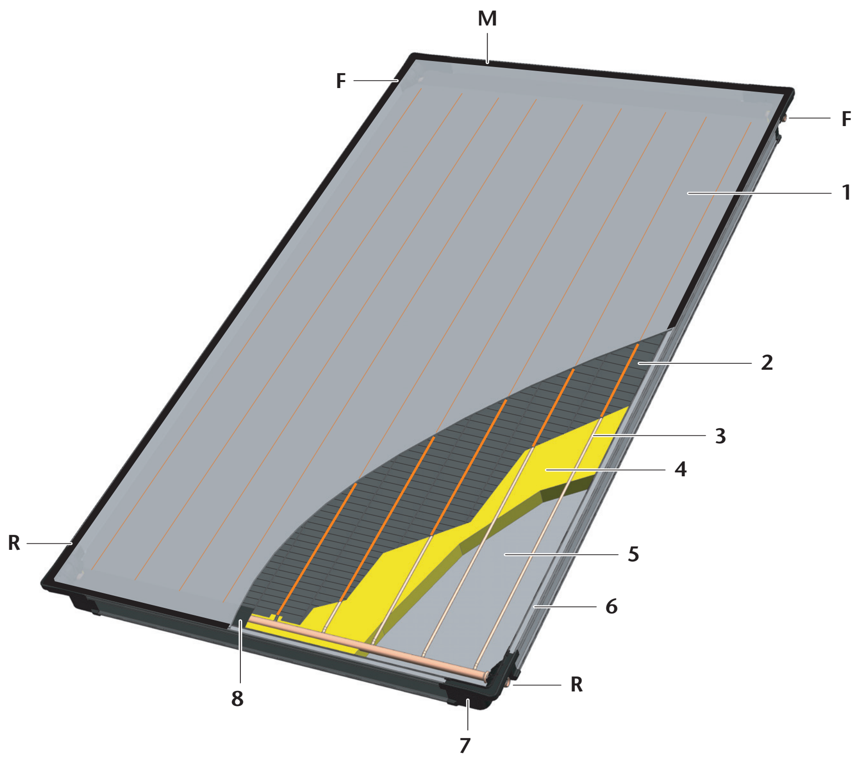
Component design and functions (→ *6/1*)

The casing of the SKN3.0 solar collector consists of a lightweight, extremely strong fibre glass frame profile. The back panel is made from 0.6 mm aluminium zinc-coated sheet steel. The collector is covered with 3.2mm thick single-pane safety glass. The low-ferrous, structured cast glass, is highly transparent (92% light transmission) and has extremely good load-bearing capability.

The 55mm thick mineral wool provides extremely good thermal insulation and high efficiency. It is heat resistant and inert.

The absorber consists of individual strips with a highly selective black chromium coating. The absorber is ultrasonically welded to the pipework in order to provide extremely good heat transfer.

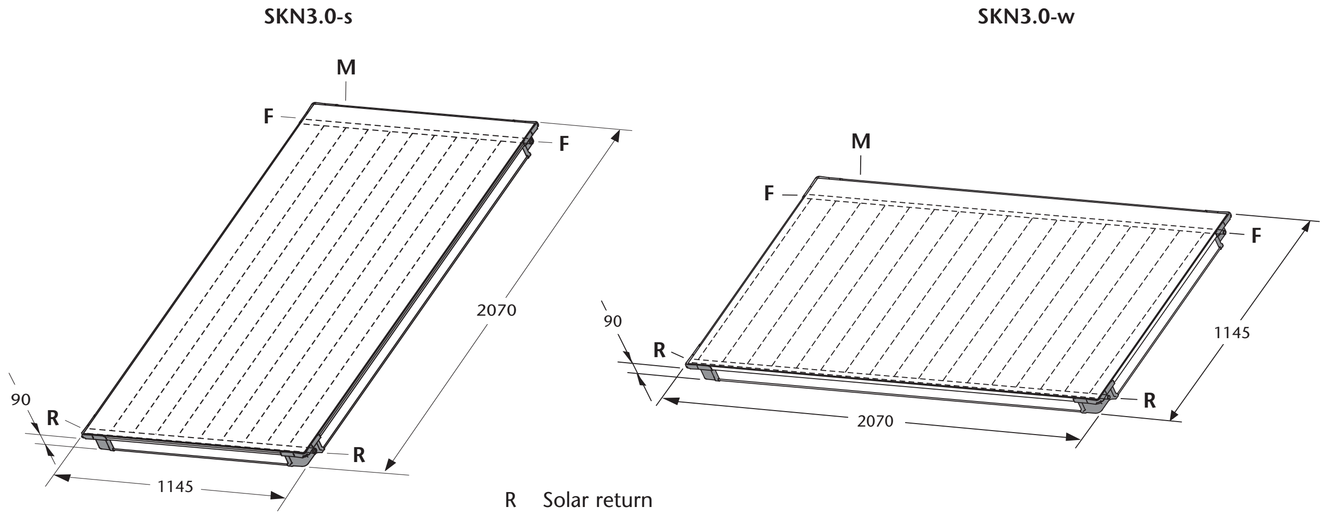
The SKN3.0 has four spigots for simple, rapid hydraulic connections. The solar hoses can be fitted using spring band clips that require no tools. They are designed for temperatures up to +170°C and pressures of up to 6bar in conjunction with the collector.



R Solar return
F Solar flow
M Measuring point (sensor pocket)
1 Glass cover
2 Strip absorber
3 Pipework
4 Mineral wool insulation
5 Aluminium zinc-coated sheet steel
6 Fibre glass frame profile
7 Moulded plastic corner
8 Header pipe cover
Dimensions and specification → *7/1* and *7/2*

6/1 *Design of SKN3.0-s flat-plate collector (portrait)*

Dimensions and specification for SKN3.0 flat-plate collectors



R Solar return
F Solar flow
M Measuring point (sensor well)

7/1 Dimensions of SKN3.0-s (portrait) and SKN3.0-w (landscape) flat-plate collectors; dimensions in mm

Flat-plate collector			SKN3.0-s	SKN3.0-w
Type of installation			portrait	landscape
Gross collector surface area		m^2	2.37	2.37
Aperture area (light entry area)		m^2	2.26	2.26
Net absorber surface area		m^2	2.23	2.23
Absorber fluid content		l	0.86	1.25
Selectivity	Level of absorption Level of emissions	% %	95±2 12±2	
Weight		kg	41	42
Optical efficiency	η_0	%	77	
Effective heat transfer coefficient	k1 k2	$W/(m^2 \cdot K)$ $W/(m^2 \cdot K^2)$	3,6810 0,0173	
Thermal capacity	c	$kJ/(m^2 \cdot K)$	2.96	
Irradiation angle correction factor	IAM^{dir} $\tau\alpha$ (50°) IAM^{dfu} $\tau\alpha$		0.911 0.900	
Nominal volumetric flow rate	$\dot{V}$	l/h	50	
Stagnation temperature		°C	188	
Max. operating pressure (test pressure)		bar	6	
Max. operating temperature		°C	120	
Collector yield (minimum yield verification[1)] of 525 kWh/($m^2 \cdot$ a) for BAFA)			> 525	
BS EN registration number			011-75050 F	

7/2 Specification for SKN3.0 flat-plate collectors
1) Minimum yield verification for BAFA (Bundesamt für Wirtschaft and Ausfuhrkontrolle, Eschborn, Germany) in conformity with BS EN 12975 for a fixed coverage of 40%, daily consumption 200 l and location Würzburg

2.1.2 SKS4.0 high performance flat-plate collector

Selected features and characteristics

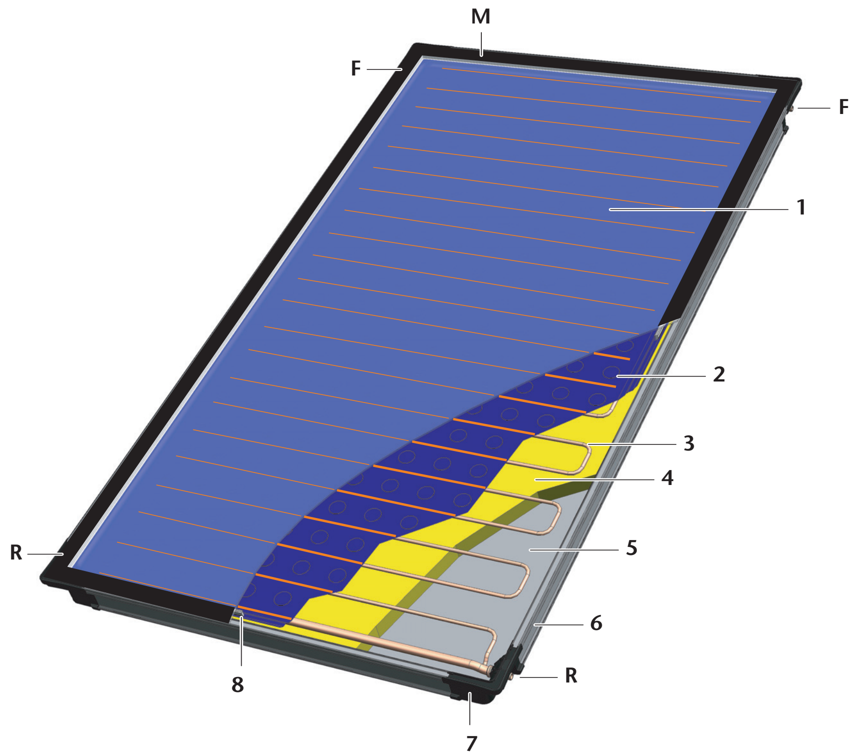
- High performance flat-plate collector
- Hermetically sealed with inert gas filling between glass and absorber
- No misting up inside the glass
- Rapid response, utilises early morning sunlight
- Absorber coating permanently protected against dust, moisture and airborne pollutants
- Listed on Enhanced Capital Allowance (ECA) scheme
- Optimised insulation from the glass cover
- Powerful full-area absorber with vacuum coating and double meander pipework
- Row connection for up to 5 collectors
- Rapid collector connection without the need for tools.

Component design and functions (→ *8/1*)

The casing of the SKS4.0 solar collector consists of a lightweight, extremely strong fibre glass frame profile. The back panel is made from 0.6mm aluminium zinc-coated sheet steel, with 3.2mm thick single-pane safety glass. The special low-ferrous glass is highly transparent (92% light transmission) and has extremely good load-bearing capability.

55mm thick mineral wool insulation provides extremely good thermal insulation and high efficiency. It is heat resistant and inert.

The surface of the copper absorber is vacuum coated with a highly effective light-capturing layer to maxmise efficiency. A double meander pipe system on the back is ultrasonically welded to the absorber to provide an extremely good heat transfer.



R Solar return
F Solar flow
M Measuring point (sensor well)
1 Glass cover
2 Full area absorber
3 Double meander pipework
4 Thermal insulation
5 Aluminium zinc-coated sheet steel
6 Fibre glass frame profile
7 Extruded plastic corner
8 Edge assembly
Dimensions and specification
→ *10/1* and *10/2*

8/1 *Design of the SKS4.0-s high performance flat-plate collector (portrait)*

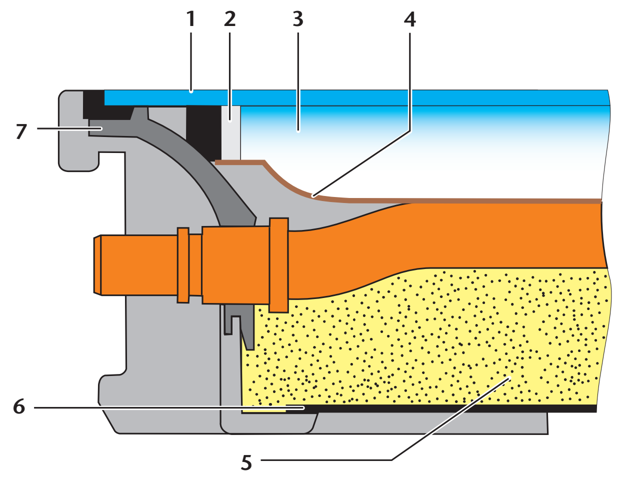
Inert gas filling

An inert gas filling (→ *9/1*, item 2) between the absorber and the pane of glass reduces heat loss. The enclosed space is filled with a heavy, convection-inhibiting inert gas as used in insulated windows. This hermetically sealed design also protects the absorber coating from environmental effects such as condensation, dust and airborne pollutants. This gives the equipment a longer service life and output is consistently high. The absence of condensate means the collector begins to collect energy with the first rays of morning sun.

Double meander absorber

The absorber is designed with a double meander pipework arrangement allowing the collector to be easily connected on one side into rows of up to 5 collectors. Connection at alternate sides is only required for larger collector rows to provide a homogeneous flow through the collectors.

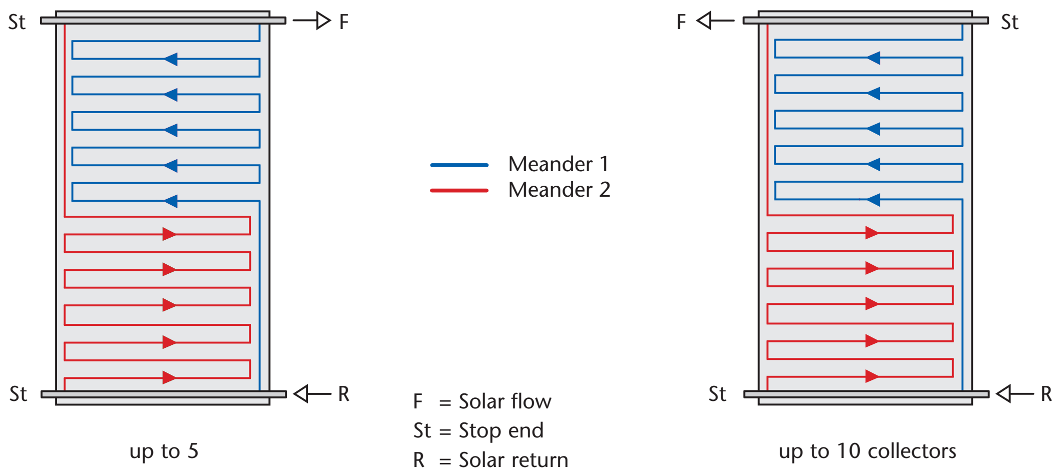
The meander design of the absorber makes the collector extremely efficient, since the flow is always turbulent over the entire flow rate range. The pressure drop is also kept low by connecting two meanders in parallel. The collective return pipe of the collector is at the bottom so that the hot solar fluid can escape from the collector in the event of stagnation.



9/1 *Sectional view of the SKS4.0 high performance flat-plate collector with inert gas filling*

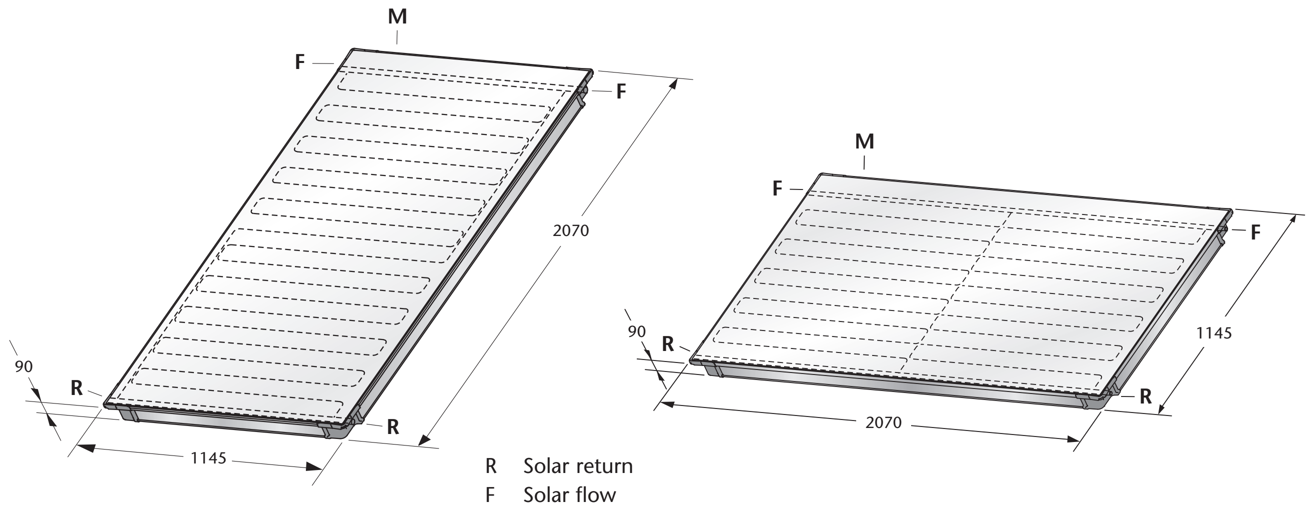
Caption (→ *9/1*)

1 Glass cover
2 Stainless steel spacer
3 Inert gas filling
4 Surface absorber
5 Thermal insulation
6 Bottom panel
7 Absorber pipe outlet



9/2 *Design and connection of the SKS4.0-s double meander absorber*

Dimensions and specification for SKS4.0 high performance flat-plate collectors



10/1 Dimensions of SKS4.0-s (portrait) and SKS4.0-w (landscape) high performance flat-plate collectors; dimensions in mm

High performance flat-plate collector			SKS4.0-s	SKS4.0-w
Type of installation			portrait	landscape
Gross collector surface area		m²	2.37	2.37
Aperture area (light entry area)		m²	2.1	2.1
Net absorber surface area		m²	2.1	2.1
Absorber fluid content		l	1.43	1.76
Selectivity	Level of absorption Level of emissions	% %	95±2 5±2	
Weight		kg	46	47
Optical efficiency	η_0	%	85.1	
Effective heat transfer coefficient	k1 k2	W/(m² · K) W/(m² · K²)	4.0360 0.0108	
Thermal capacity	c	kJ/(m² · K)	4.82	
Irradiation angle correction factor	IAM^{dir} $\tau\alpha$ (50°) IAM^{dfu} $\tau\alpha$		0.95 0.90	
Nominal volumetric flow rate	$\dot{V}$	l/h	50	
Stagnation temperature		°C	204	
Max. operating pressure		bar	10	
Max. operating temperature		°C	120	
Collector yield (minimum yield verification[1]) of 525 kWh/(m² · a) for BAFA)			> 525	
BS EN registration number			011-75052 F	

10/2 Specification for SKS4.0 high performance flat-plate collectors
1) Minimum yield verification for BAFA (Bundesamt für Wirtschaft and Ausfuhrkontrolle, Eschborn, Germany) in conformity with BS EN 12975 with fixed cover proportion of 40%, daily consumption 200 l and location Würzburg

2.2 Cylinders for solar DHW heating

2.2.1 Twin coil cylinders for DHW heating

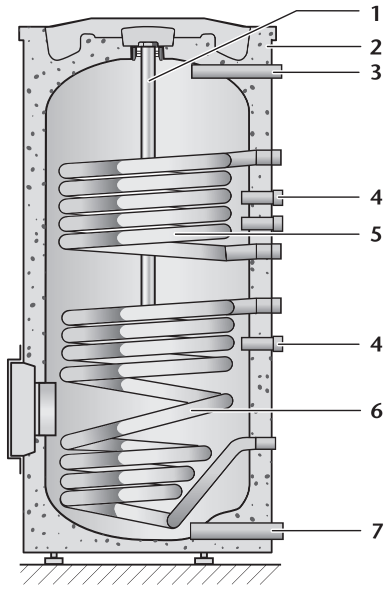
Many different cylinders are available for the storage of domestic hot water which are designed to be used with solar water heating.

Guidance on the sizing of solar cylinders can be found in section 5 of this planning guide.

The most common cylinder in use for solar water heating is an indirect dual coil cylinder, which incorporates a coil heat exchanger near the base of the cylinder for solar water heating.These types of cylinders also incorporate a coil heat exchanger in the top part of the cylinder, for use with a conventional heat source such as a condensing boiler.

Dual coil cylinders of both vented and un-vented designs are available and the manufacturers installation instructions should be followed for any special requirements.

Solar indirect coils should have an effective heat exchange area of not less than $0.25m^2$ for each square metre of collector area installed or have coils as least as large as those specified in BS 1566. The standby part of the cylinder needs to be sized in a way that it can cover the DHW demand of the building at any time, also when no solar gain is available.

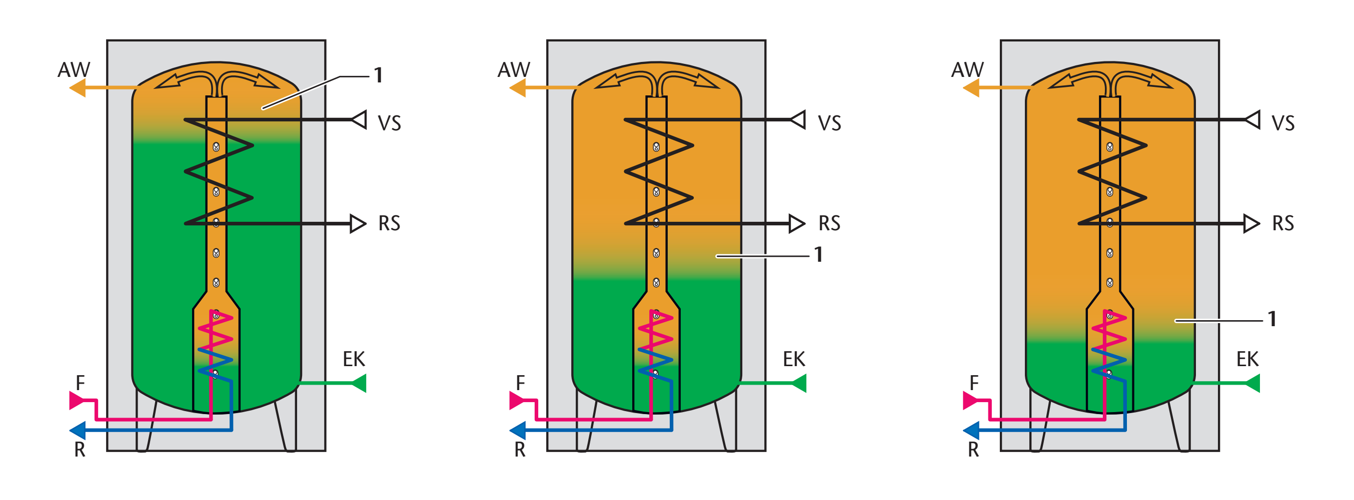


11/1 Typical dual twin coil cylinder

Caption

1 Sacrificial anode
2 Thermal insulation
3 DHW outlet
4 Sensor pocket
5 Upper indirect coil for back up heating with a conventional boiler
6 Solar indirect coil
7 Cold water inlet

2.2.2 Thermosiphon solar cylinders



12/1 Heating procedure for a thermosiphon cylinder at full insolation

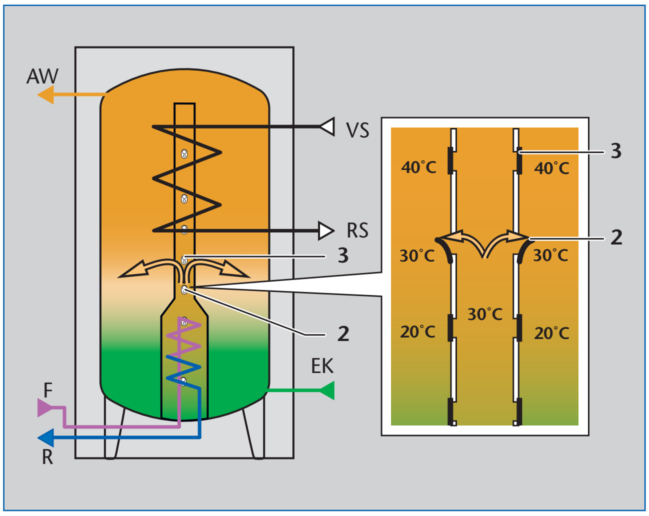
Thermosiphon solar cylinders

Stratified thermosiphon solar cylinders can help increase system efficiency and give more useful DHW temperatures. By allowing the heated water to settle out to a given level, a greater temperature difference can be maintained between the stored water around the solar coil and the heated solar fluid within the coil.

Thermosiphon principle with low insolation

In this example the water is only heated to 30°C and rises to the layer heated to that temperature.
The water flows through the gravity flaps to heat that area.

This prevents lower temperatures mixing with the high temperature areas at the top of the cylinder.



12/2 Hot water leaving the heating lance at low insolation

Caption (→ *12/1* and *12/2*)

1 Separating layer between temperature zones
2 Open gravity flap in heating lance
3 Closed gravity flap
AW DHW outlet
EK Cold water inlet
R Solar return
F Solar flow

2.2.3 Thermal stores PR500, PR750 and PR1000

Design and function

These mild steel thermal stores are available in the following sizes:

PR500 with a capacity of 500 litres

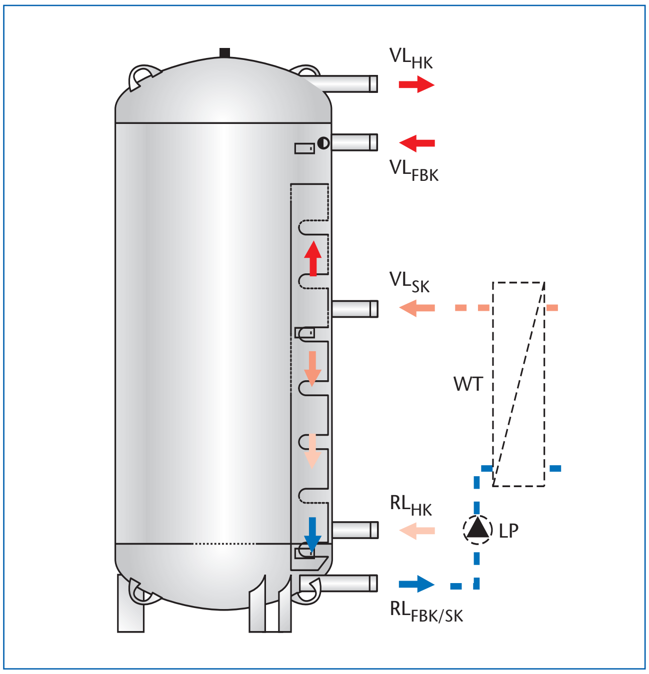
PR750 with a capacity of 750 litres

PR1000 with a capacity of 1000 litres

The thermal stores are direct storage vessels designed for primary heating water. They have flow and return tapings that can be used in a number of different ways depending on the hydraulic arrangement.

A stratification device helps make best use of the available temperatures.

Stores of similar size may be joined together to give a larger total storage capacity. Please contact the Buderus technical team for assistance with the hydraulic arrangements.



13/1 PR500, PR750 and PR1000 thermal stores

Thermal stores are available with either 80mm or 120mm insulating foam jackets

Lifting lugs welded to the top and bottom of the storage vessels, help with initial positioning.

The storage vessels have convenient sensor clips fixed to the side of the vessel at the correct sensing position.

13/2 Thermal stores shown above with insulation jacket

Buderus PR thermal stores are only suitable for use with primary water and should under no circumstances be used with potable water

2.3 Solar control unit

2.3.1 Selection aids

Selection and standard delivery of control unit

Various control units and function modules are available depending on the area of application and the boiler control unit:

- Heat source with EMS control system:
  (EMS boilers include GB162, GB312, GB402.
  Non EMS boilers refer to GE, SB, G Range boilers)
  – Solar heating systems for DHW heating:
  Programming unit RC35 with
  Solar function module SM10 (→ page 16)

  – Solar heating systems for DHW and central heating backup:
  4121 control unit with Solar function module FM443 (→ page 17)
- Heat source with 4000 control unit: Solar function module FM443 (→ page 17)
- Heat source with third party control unit:
  Control unit SC20 or SC40. Systems with multiple collector fields require the use of the SC40.
  (→ page 19)

The standard delivery of the solar function modules or the SC20 and SC40 control units includes:

- One collector temperature sensor FSK (NTC 20 K, Ø6mm, 2.5m lead) and
- One collector temperature sensor FSS (NTC 10 K, Ø9.7mm, 3.1m lead).

2.3.2 Control strategies

Temperature differential control

In "Automatic" mode the solar control unit monitors whether the solar cylinder can be heated with solar energy. To do this, the control unit compares the collector temperature using the FSK sensor and the temperature in the lower area of the cylinder (FSS sensor). If there is adequate irradiation, i.e. the set temperature differential between the collector and the cylinder is exceeded, the solar circuit pump starts and the cylinder is heated.

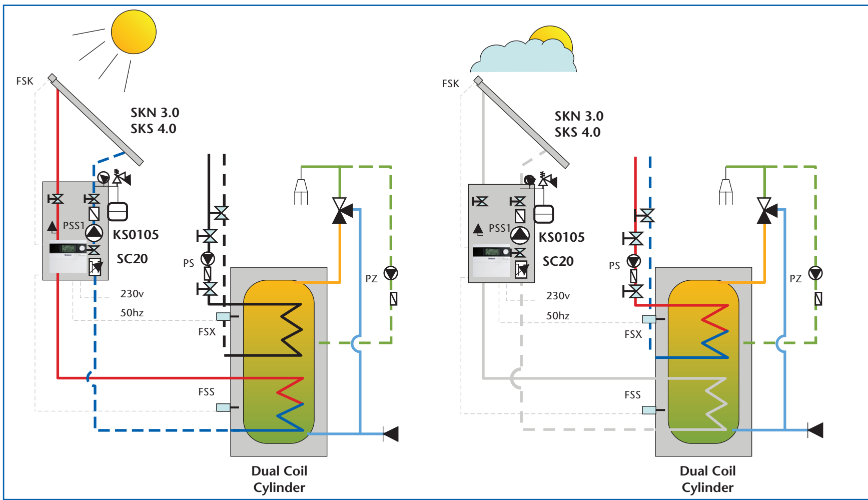
After a long period of irradiation and low DHW consumption, high temperatures occur in the cylinder. The solar circuit control unit switches the solar circuit pump off when the maximum cylinder temperature has been reached during heat up.

The maximum cylinder temperature can be adjusted at the control unit.

If there is little irradiation the pump speed is reduced to maintain a constant temperature differential. This allows the cylinder to be heated whilst reducing electricity consumption. The solar control unit does not switch the pump off until the temperature differential has dropped below the minimum temperature differential, and the speed of the circulation pump has already been reduced to its minimum value by the solar control unit.

If the cylinder temperature is inadequate to provide sufficient DHW the heating circuit control unit has to ensure the reheating of the cylinder by a conventional heat source.

Temperature differential control unit SC20 for one consumer



KS0105SC20	Solar pump station KS0105 with integral solar control unit SC20
FSK	Collector temperature sensor
FSS	Cylinder temperature sensor (bottom)
FSX	Cylinder temperature sensor (top; optional)
Other abbreviations	→ page 110

14/1 Function diagram of solar DHW heating with temperature differential control unit SC20 and flat-plate collectors with the system enabled (left) and conventional reheating if there is insufficient irradiation (right)

Double-Match-Flow

Solar function modules SM10, FM443 and control units SC20 and SC40 provide optimised heating of the thermosiphon cylinder using a special high-flow/lowflow strategy. The solar control unit monitors the cylinder heating status using a threshold sensor located in the centre of the cylinder. Depending on the heating status the control unit switches to high-flow or low-flow operation, whichever is currently the best. This changeover facility is known as Double-Match-Flow.

Prioritised heating of the standby part with low-flow operation

In low-flow operation the control unit attempts to achieve a temperature differential between the collector (FSK sensor) and the cylinder (FSS sensor). This is done by varying the flow rate via the solar circuit pump speed.

The standby part of the thermosiphon cylinder is heated with priority using the resulting high flow temperature. Conventional cylinder reheating is therefore suppressed as much as possible conserving primary energy.

Standard thermosiphon cylinder heating in high-flow operation

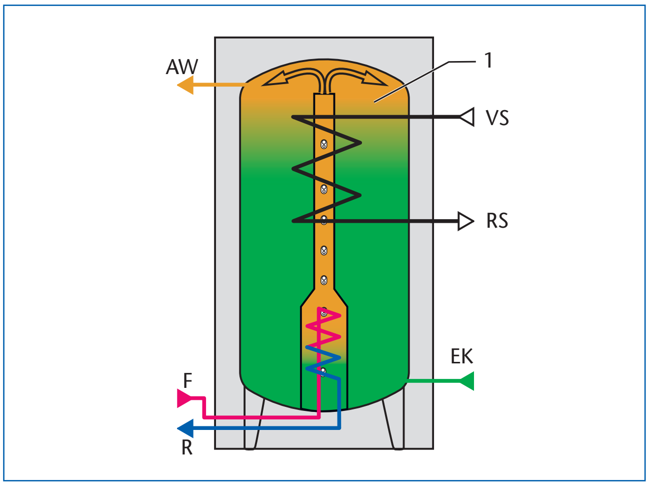
The solar control unit increases the speed of the solar circuit pump if the standby part of the cylinder has been heated up to 45°C (FSX threshold sensor). The set temperature differential between the collector (FSK sensor) and the lower cylinder area (FSS sensor) is 15 K. The system is then operating with a lower flow temperature. With this operating mode, less heat is lost in the collector circuit, and system efficiency is optimised during cylinder heating.

Subject to sufficient collector output being available, the control system reaches the set temperature differential and continues to heat the cylinder with optimum collector efficiency. If the set temperature differential can no longer be achieved, the control system uses the available solar heat at the slowest pump speed until the shut-off criterion is reached. The thermosiphon cylinder stores the heated water in the correct temperature layer (→ *15/3*). If the temperature differential drops below 5 K, the control unit switches the solar circuit pump off.

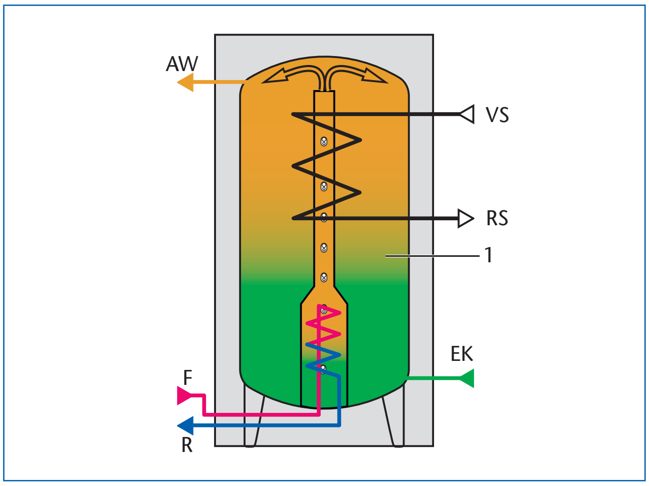
Caption (→ *15/1* to *15/3*)

∅ϑ Temperature differential between collector (FSK sensor) and lower cylinder area (FSS1 sensor)
R Solar return
F Solar flow

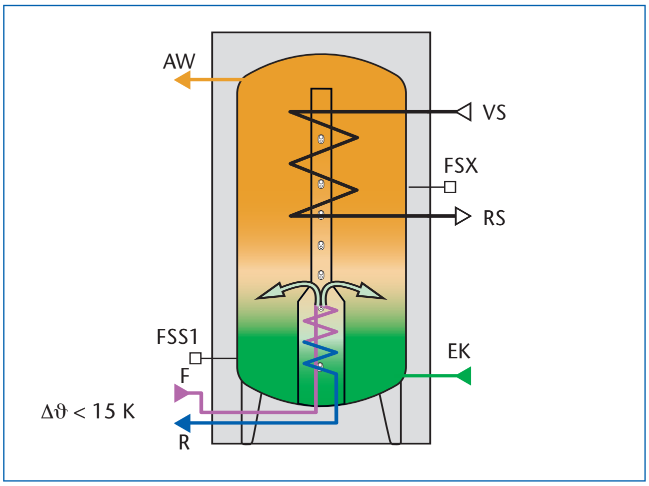
Other abbreviations → page 110.



15/1 *Prioritised heating of the standby section of a thermosiphon cylinder with ∅ϑ = 30 K using a variable, slow pump speed in low-flow operation, until 45°C is reached at the FSX threshold sensor*



15/2 *Heating of a thermosiphon cylinder with ∅ϑ = 15 K with strong irradiation using a fast pump speed in high-flow operation*



15/3 *Heating of a thermosiphon cylinder with the maximum possible flow temperature (∅ϑ < 15 K) using the slowest pump speed with low insolation*

Solar optimisation function of function modules SM10 and FM443

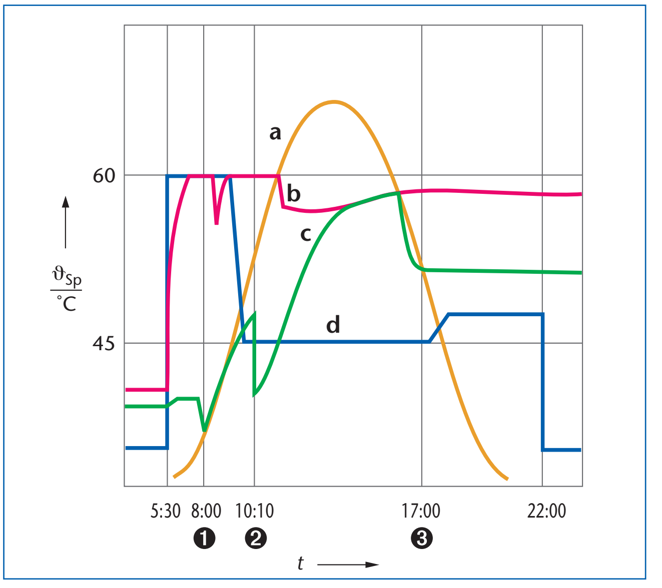
With the solar optimisation function, conventional energy is conserved and solar yield is increased by integrating the solar control in the boiler control unit. The consumption of primary energy by the boiler for heating DHW is reduced by up to 10% compared to conventional solar control units. The number of burner starts is reduced by up to 24%.

With the solar optimisation function the control unit captures whether

- solar yield is available, and whether
- the stored amount of heat is sufficient to provide DHW.

The general objective of the control unit is to temporarily reduce the set DHW temperature as much as possible whilst at the same time ensuring sufficient hot water is available, to prevent reheating by the boiler.

The standby volume of the cylinder is designed to cover the DHW demand at a storage temperature of 60°C. The lower coil of the cylinder is primarily heated by solar energy, but if the set temperature cannot be maintained then the boiler will fire to boost the temperature to the required level. The lowest acceptable DHW temperature can be set by the user using the "MINSOLAR" parameter within a range of 30°C to 54°C. With DHW heating using the flow-through principle, this temperature relates to the water in the upper section of the thermal store.



16/1 "Solar yield optimisation" control function

Caption

- ϑ_{Sp} DHW temperature in the cylinder
- t Time
- a Irradiation
- b DHW temperature at the top of the cylinder
- c DHW temperature at the bottom of the cylinder
- d Set DHW temperature
- ❶ First draw-off (reheating)
- ❷ Second draw-off (adequate solar yield)
- ❸ Third draw-off (adequate cylinder temperature)

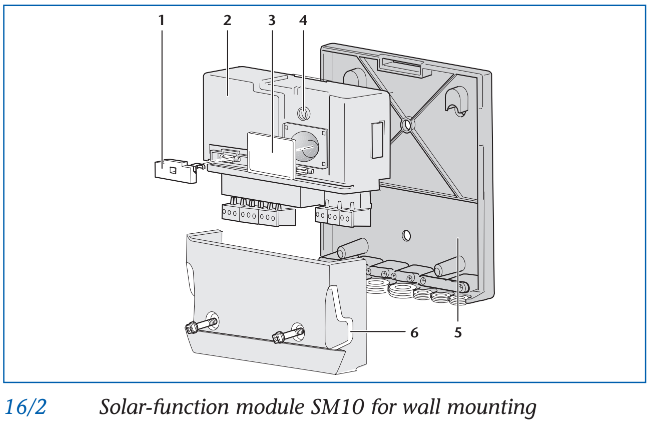
The solar optimisation function can only be used if the Buderus system has full control of the boilers and the DHW generation.

2.3.3 Solar control units and function modules

EMS control system with solar function module SM10

Features and characteristics

- Control of solar DHW heating for heat sources with EMS and control unit RC35
- Up to 10% primary energy saving and up to 24% fewer burner starts compared to conventional solar control units by means of system integration in the heating control unit (solar optimisation function)
- Prioritised heating of the standby section of thermosiphon cylinders and energy-optimised operation control using Double-Match-Flow (FSX sensor also used as threshold sensor)
- Optional for use with pre heat cylinder arrangement (→ page 31)
- Different version:
  – SM10: Module for wall mounting or integration within an alternative heat source, only suitable for combining with KS01 solar pump stations without control system.



16/2 Solar-function module SM10 for wall mounting

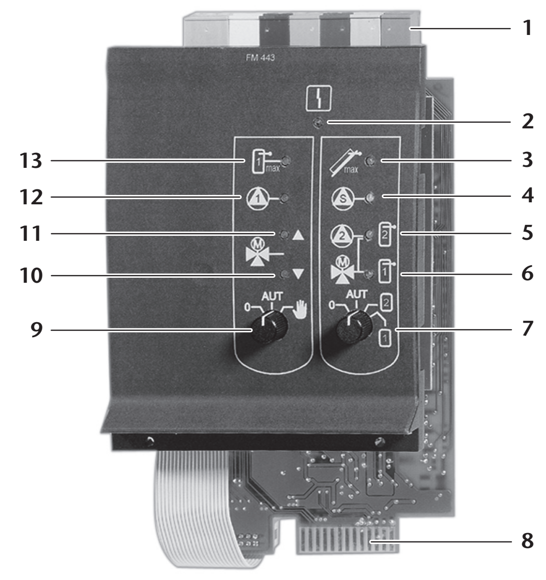
Caption (→ 16/2)

1. Access to equipment fuse
2. Solar function module SM10
3. Access to replacement fuse
4. Indicator (LED) for operation and alarm indication
5. Wall retainer
6. Terminal cover

4000 control system with solar function module FM443

Features and characteristics

- Solar function module FM433 enables the control of DHW heating or DHW and central heating backup in systems with a maximum of two solar consumers (cylinders)
- Up to 10% primary energy saving and up to 24% fewer burner starts compared to conventional solar control units by means of system integration in the heating control unit (solar optimisation function)
- Prioritised heating of the standby part of thermosiphon cylinders and energy-optimised operation control using Double-Match-Flow (FSX sensor also used as threshold sensor)
- For use with 4000 series controls; required for solar heating systems for DHW heating with central heating backup because of the external heat detection function
- Optional integrated heat meter function in combination with WMZ1.2 accessory kit
- Entire system, including the solar control unit, can be operated remotely using the optional MEC2 programming unit
- Only for combining with KS01... solar pump stations without control unit
- Transfer of hot water in dual-cylinder systems for DHW heating
- Intelligent buffer management
- Statistics function
- Basic function is destratification and thermal disinfection to allow protection against legionella bacteria developing in the DHW.



17/1 Solar function module FM443

Caption

1 Connection plug
2 LED indicator, module fault
3 LED maximum collector temperature
4 LED solar circuit pump 2 (secondary pump) running
5 LED solar circuit pump 2 running or three-way diverter valve in solar circuit 2 position
6 LED three-way diverter valve in solar circuit 1 position
7 Manual switch solar circuit selection
8 PCB
9 Manual switch, solar circuit function 1
10 LED three-way diverter valve in direction "Central heating backup via thermal store off" or "Pump off" (bypass operation)
11 LED three-way diverter valve in direction "Central heating backup via thermal store on" or "Pump running" (thermal store operation)
12 LED solar circuit pump 1 running
13 LED maximum temperature in cylinder 1

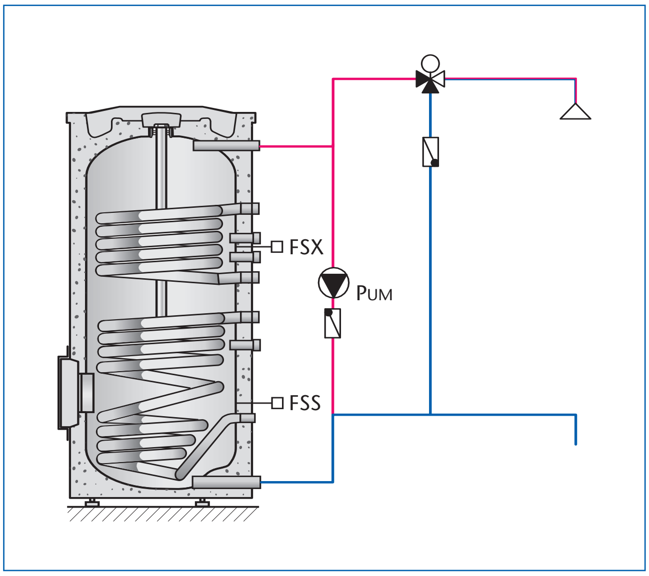
Stratification

If the pump function is set to "Stratification" with twin coil solar cylinders, the pump that is connected is used to heat up the solar pre-heating stage to 60°C once every day, if required, to provide thermal disinfection in accordance with G3 requirements and HSE ACOP L8.

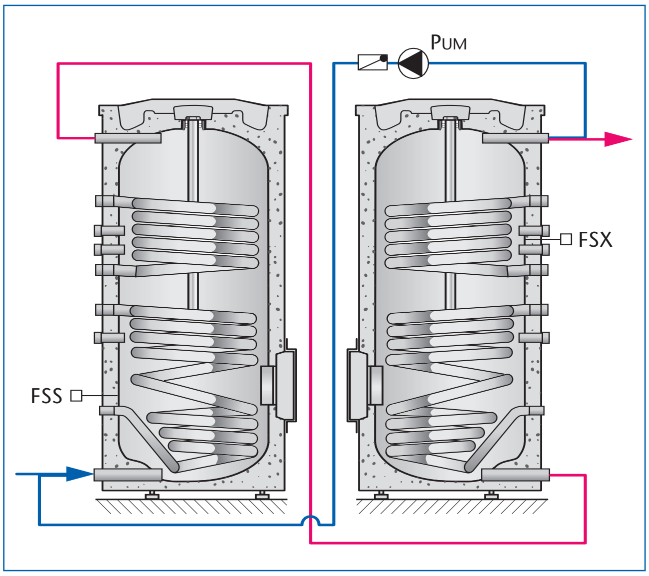
Transfer of hot water

If the pump function is set to "transfer", with cylinders connected in series the connected pump is used to transfer the water from the solar cylinder and the cylinder that is heated via the boiler. As soon as the solar cylinder is hotter than the cylinder that is heated by the boiler, pump PUM is switched on and the water in the cylinders is transferred.

This pump is also used to heat the solar cylinder, i. e. the solar pre-heating stage, to 60°C once every day if required to provide thermal disinfection in accordance with the G3 requirements and HSE ACOP L8.



18/1 Water transfer in a circuit with one solar cylinder



18/2 Transfer of hot water between cylinders connected in series

SC20 solar control unit

Features and characteristics

- Stand alone solar heating system control unit for DHW heating, independently of the heat generator control unit
- Prioritised heating of the standby part of thermosiphon cylinders and energy-optimised operation control using Double-Match-Flow (FSX threshold sensor available as accessory, AS1 or AS1.6 cylinder connection kit)
- Different versions:
  – SC20 integrated in the KS0105 solar pump station
  – SC20 for wall mounting in combination with KS01
- Easy operation and monitoring of single consumer systems with three sensor inputs and one switched output for single variable speed solar circuit pump with variable lower modulation limit
- Backlit segment LCD with animated system pictograph. Different system values (temperature values, hours run, pump speed) can be called up in automatic mode
- The pump is switched off when the maximum collector temperature is exceeded. The pump will not start if the temperature drops below the minimum collector temperature (20°C), even if the other switch-on conditions are met

Special displays and controls of the SC20 solar control unit

As well the above parameters, the digital display also allows the speed of the solar circuit pump to be displayed in percent.

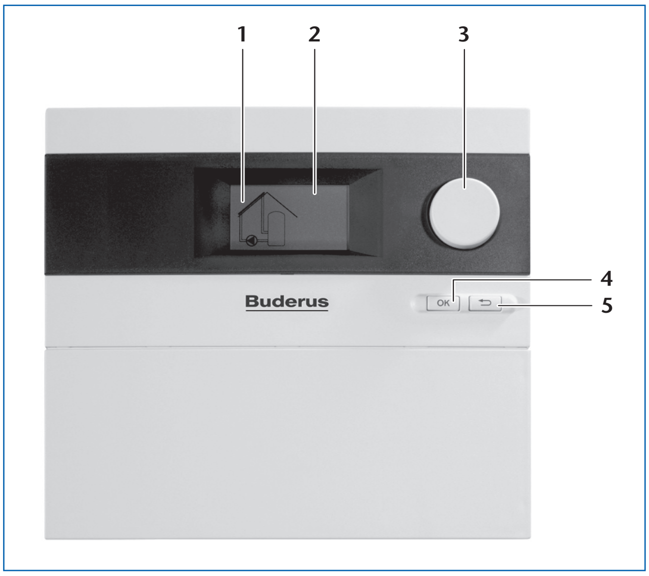
The following values can be optionally recorded with the FSX sensor accessory (cylinder connection kit AS1):

- The top cylinder temperature in the standby part of the DHW cylinder or
- The mid-cylinder temperature for Double-Match-Flow (here the FSX threshold sensor).

Standard delivery

The standard delivery includes:

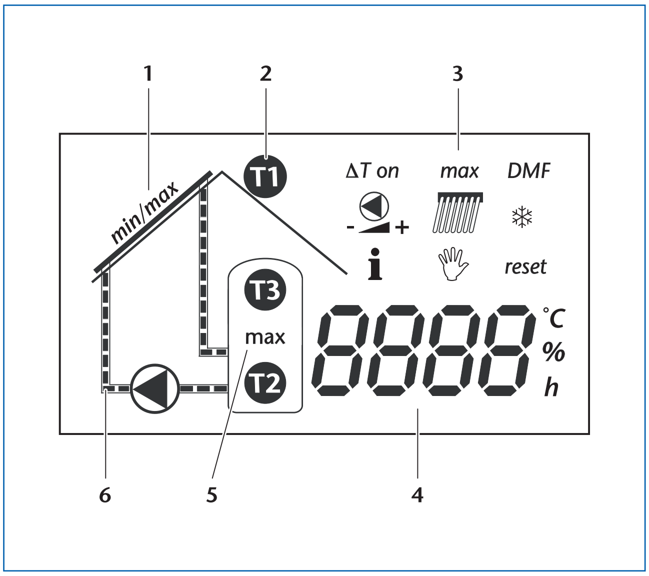
- One collector temperature sensor FSK (NTC 20K, Ø6mm, 2.5m lead)
- One collector temperature sensor FSS (NTC 10K, Ø9.7mm, 3.1m lead).



19/1 SC20 solar control unit

Caption (→ *19/1*)

1 System pictograph
2 Segment LCD
3 Rotary selector
4 Function key "OK"
5 Direction key "Back"



19/2 Segment LCD of the SC20 solar control unit

Caption (→ *19/2*)

1 Display "Maximum collector temperature or minimum collector temperature"
2 "Temperature sensor" symbol
3 Segment LCD
4 Multifunction display (temperature, hours run, etc.)
5 "Maximum cylinder temperature" display
6 Animated solar circuit

Control unit function

The required temperature differential between the two connected temperature sensors can be set to between 7 K and 20 K in automatic mode (factory setting 10 K). The pump starts if this temperature differential is exceeded between the collector temperature sensor (FSK sensor) and the bottom of the cylinder (FSS sensor). An animated display of the movement of the solar fluid appears on the display (→ *19/2*, item 6). The efficiency of the solar system is increased by the variable speed control provided by the SC20. A minimum speed can also be set. When the temperature differential drops below this value again the control unit switches the pump off. To protect the pump, it is automatically activated for about 3 seconds approximately 24 hours after it was last operated (pump kick).

The different system values (temperature values, hours run, pump speed) can be called up using the rotary selector (→ *19/1*, item 3). The temperature values are assigned in the pictograph using item numbers.

The SC20 solar control unit also enables the setting of a maximum cylinder temperature between 20°C and 90°C, which is displayed in the system pictograph, if required. Reaching of the maximum or minimum collector temperature is also visually indicated on the segment LCD, and the pump switched off if they are exceeded. If the temperature drops below the minimum collector temperature the pump will not start, even if the other switch-on conditions are met.

SC40 solar control unit

Features and characteristics

- Stand alone solar heating system control unit for different applications, independent of the heat source, with the option of selecting from 27 pre configured solar systems, from DHW heating and central heating backup to swimming pool water heating
- Easy operation and monitoring of systems with up to three consumers, eight sensor inputs and five switched outputs, two of which are for variable speed solar circuit pumps with adjustable lower modulation limit
- Backlit LCD graphic with depiction of the selected solar system. Different system values (pump status, temperature values, selected function, fault messages) can be called up in automatic mode to external monitoring system
- RS232 interface for transferring data and integral heat meter (accessory WMZ 1.2 required)
- Option for buffer bypass circuit in solar heating systems for central heating backup
- Daily heating of the pre-heating cylinder to provide thermal disinfection
- In solar heating systems with a pre-heating cylinder and standby cylinder, the cylinder contents are transferred by actuating a pump as soon as the temperature of the standby cylinder drops below the temperature of the pre-heating cylinder
- Setting priority of two consumers in the solar heating system and actuation of the 2nd consumer via a pump or a three-way diverter valve
- Optional actuation for two solar heating circuit pumps for a separate operation of a maximum of two collector rows, e.g. with east/west orientation
- Actuation of an external plate-type heat exchanger for heating the solar cylinder and buffer stores
- Collector row cooling for reducing the stagnation times by means of adapted solar circuit pump operation
- With the tube collector function, the solar circuit pump is activated briefly every 15 minutes at a collector temperature from 20°C to pump warm solar fluid to the sensor.

Special displays and controls of the SC40 solar control unit

The relevant system pictograph is selected from the 27 pre-programmed hydraulic schematics, and subsequently saved to the control unit.

Standard delivery

The standard delivery includes:

- One collector temperature sensor FSK (NTC 20 K, Ø6mm, 2.5m lead)
- One collector temperature sensor FSS (NTC 10 K, Ø9.7mm, 3.1m lead).

Control unit function

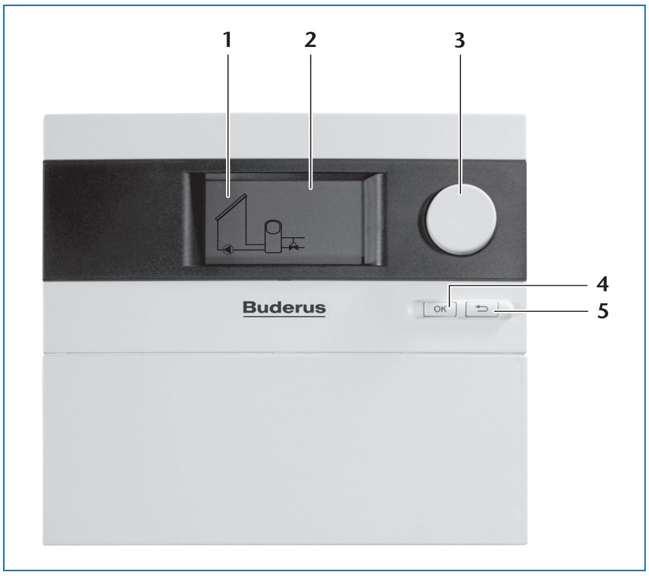
The control unit is divided into two operating levels. Various system values (temperatures, hours run, pump speed, amount of heat and bypass valve setting) can be displayed at the user level. The service level allows further adjustments of parameters and the selection of individual systems.

The system selection function is used to select the standard system at the SC40 solar control unit and the hydraulic schematics of the solar heating system. The selected hydraulic schematics defines the system configuration and function. The selection is made from systems for DHW heating, central heating backup or swimming pool water heating as per the system pictographs (→ *22/1*). The settings contain all decisive temperatures, temperature differentials, pump speeds and optional functions, e.g. capturing the heat amount, cylinder water transfer, daily heating of the pre-heating volume, Double-Match-Flow etc. required for the system operation. The marginal conditions for controlling two collector rows with different orientation and heating the cylinder via an external heat exchanger are also available for the SC40 (accessory collector sensor required).

The SC40 further provides the following extensions via the control facilities of the SC20 solar control unit:

- Central heating backup with buffer bypass actuation
- Swimming pool water heating using a plate-type heat exchanger
- Actuation of a 2nd consumer via a pump or three-way diverter valve
- Actuation of a water transfer pump with cylinders connected in series
- East/west control for separate operation of two collector rows (accessory collector sensor required)
- Daily heating of pre-heating cylinder for thermal disinfection purposes
- Integral capturing of the heat amount with flow meter
- Cylinder heating via an external heat exchanger
- Data transfers via an RS232 interface
- Collector row cooling for reducing stagnation times
- Rapid diagnosis and simple function tests.

Detailed descriptions of special functions → page 26.

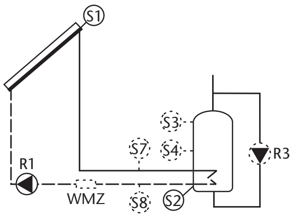
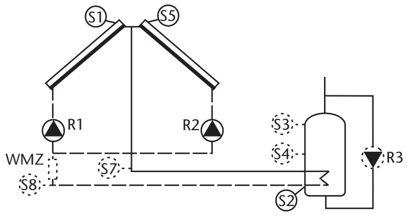
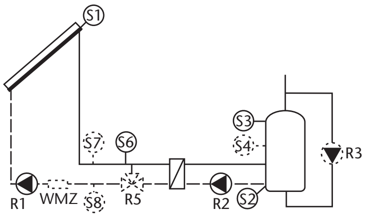
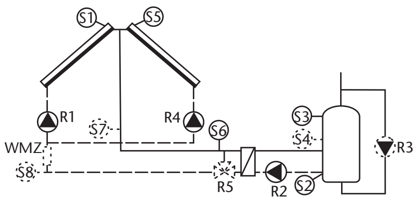
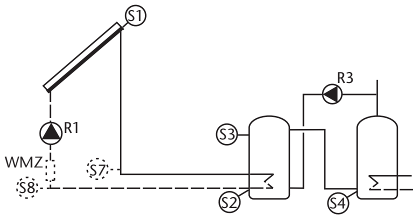
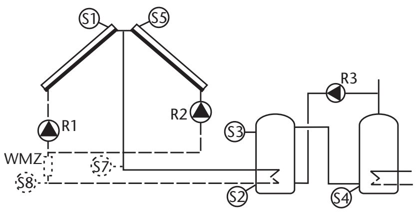
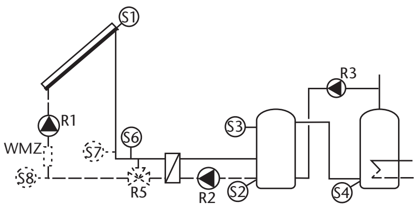


21/1 SC40 solar control unit

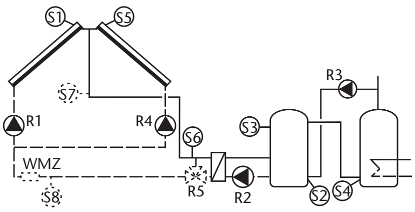
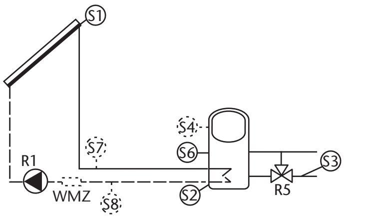
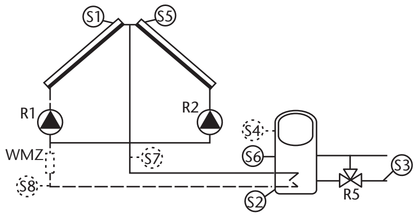
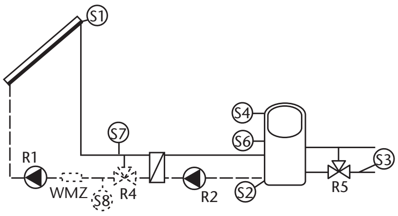
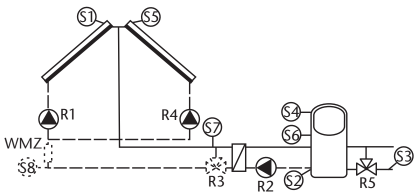
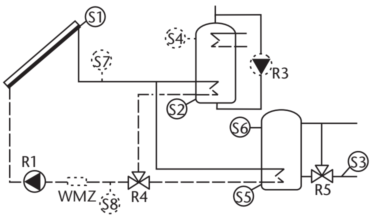
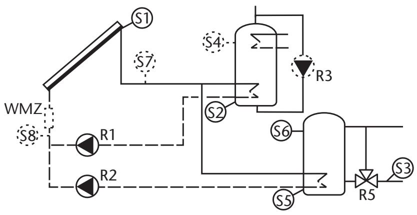
Caption

1 System pictograph
2 Segment LCD
3 Rotary selector
4 Function key "OK"
5 Direction key "Back"

SC40 solar control unit, system and function overview

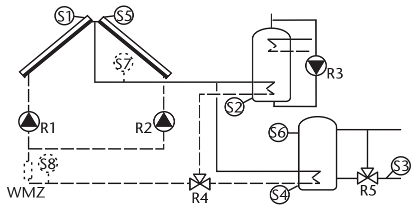
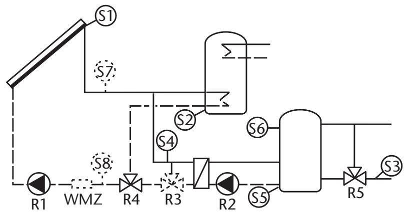
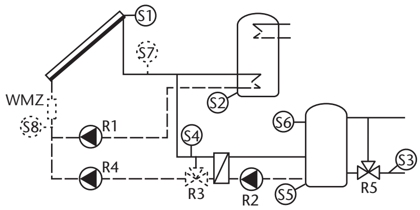
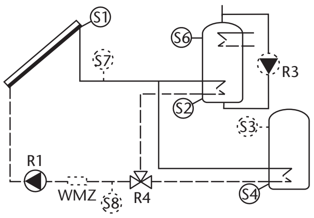
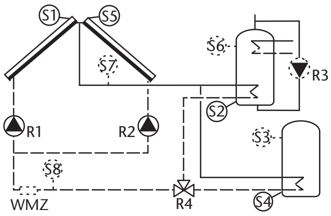
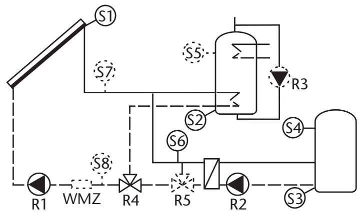
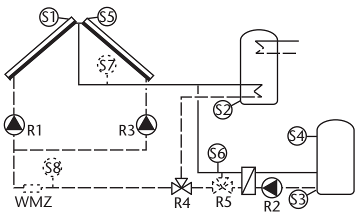
Hydraulic no.	System pictograph	Optional additional functions, subject to the hydraulic schematics			
		Double-Match-Flow	Cooling function	Daily heating	Heat exch. frost protection (for Southern Europe)
Domestic hot water heating					
T1		● (S4)	● (S1, S2)	● (S2, S3)	–
T2		● (S4)	● (S1, S2, S5)	● (S2, S3)	–
T3		● (S4)	● (S1, S2)	● (S2, S3)	● (S6)
T4		● (S4)	● (S1, S2, S5)	● (S2, S3)	● (S6)
T5		● (S3)	● (S1, S2)	● (S2, S3, S4)	–
T6		● (S3)	● (S1, S2, S5)	● (S2, S3, S4)	–
T7		● (S3)	● (S1, S2)	● (S2, S3, S4)	● (S6)

22/1 SC40 solar control unit, system and function overview
Symbols: ● Function available, – function unavailable, (S..) required temperature sensors

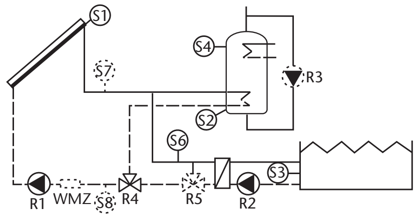
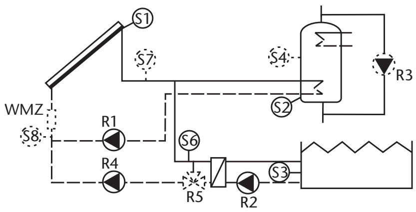
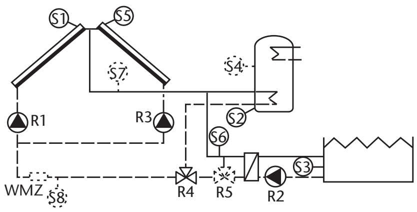
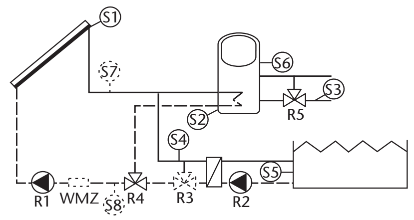
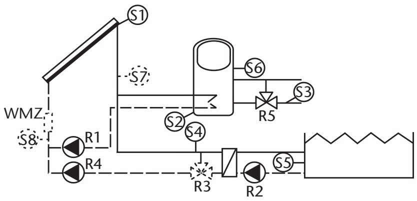
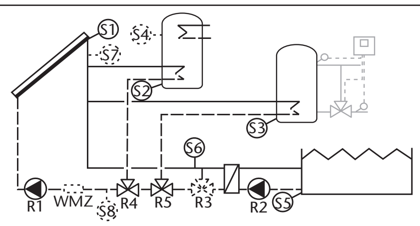
Hydraulic no.	System pictograph	Optional additional functions, subject to the hydraulic schematics			
		Double-Match-Flow	Cooling function	Daily heating	Heat exch. frost protection (for Southern Europe)
Domestic hot water heating					
T8		● (S3)	● (S1, S2, S5)	● (S2, S3, S4)	● (S6)
Central heating backup					
H1		● (S4)	● (S1, S2)	–	–
H2		● (S4)	● (S1, S2, S5)	–	–
H3		–	● (S1, S2)	–	● (S7)
H4		–	● (S1, S2, S5)	–	● (S7)
H5		● (S4)	● (S1, S2, S5)	● (S2, S4)	–
H6		● (S4)	● (S1, S2, S5)	● (S2, S4)	–

22/1 SC40 solar control unit, system and function overview
Symbols: ● Function available, – function unavailable, (S..) required temperature sensors

continued on next page

Hydraulic no.	System pictograph	Optional additional functions, subject to the hydraulic schematics			
		Double-Match-Flow	Cooling function	Daily heating	Heat exch. frost protection (for Southern Europe)
Central heating backup					
H7		–	● (S1, S2, S4, S5)	● (S2)	–
H8		–	● (S1, S2, S5)	–	● (S4)
H9			● (S1, S2, S5)	–	● (S4)
H10		● (S6)	● (S1, S2, S4)	● (S2)	–
H11		● (S6)	● (S1, S2, S4, S5)	● (S2)	–
H12		● (S5)	● (S1, S2, S3)	● (S2)	● (S6)
H13		–	● (S1, S2, S3, S5)	–	● (S6)

22/1 SC40 solar control unit, system and function overview
Symbols: ● Function available, – function unavailable, (S..) required temperature sensors

Hydraulic no.	System pictograph	Optional additional functions, subject to the hydraulic schematics			
		Double-Match-Flow	Cooling function	Daily heating	Heat exch. frost protection (for Southern Europe)
Swimming pool water heating					
S1		● (S4)	–	● (S2, S4)	● (S6)
S2		● (S4)	–	● (S2, S4)	● (S6)
S3		–	–	–	● (S6)
S4		–	–	–	● (S4)
S5		–	–	–	● (S4)
S6		● (S4)	–	–	● (S4)

22/1 SC40 solar control unit, system and function overview
Symbols: ● Function available, – function unavailable, (S..) required temperature sensors

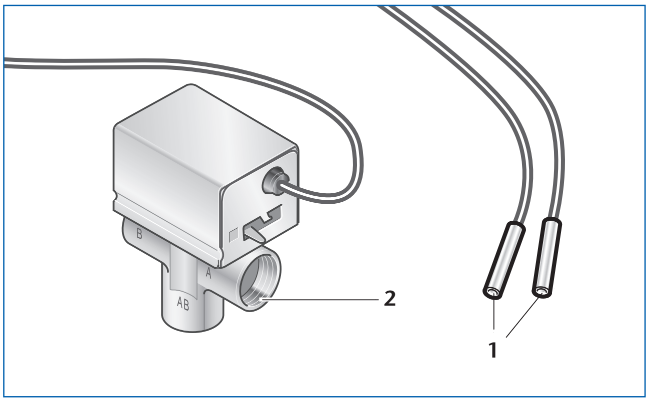
2.3.4 Special functions

Central heating backup via buffer bypass circuit

The solar central heating backup can be controlled with the FM443 solar function module and the SC40 solar control unit via a buffer bypass circuit using the HZG kit (→ *26/1*) available as an accessory. A buffer bypass circuit provides a hydraulic connection between the thermal store and the heating circuit return. If the temperature in the thermal store is higher than the heating circuit return temperature by an adjustable differential (ϑ_{On}), the three-way diverter valve opens in the direction of the thermal store. The thermal store heats the return water that is flowing to the boiler. If the temperature differential between the thermal store and the heating circuit return drops by an adjustable differential (ϑ_{Off}), the three-way diverter valve adjusts in the direction of the boiler and stops cylinder discharging.

The operating status of the three-way diverter valve is displayed by the FM443 solar function module and the SC40 solar control unit. The HZG kit includes:

- Two FSS temperature sensors (NTC 10 K, Ø9.7 mm, 3.1m lead) for connecting to the FM443 or SC40
- One three-way diverter valve (threaded connection Rp1"). On larger systems the size of this three-way valve has to match to the main system flow rate and increased if necessary.

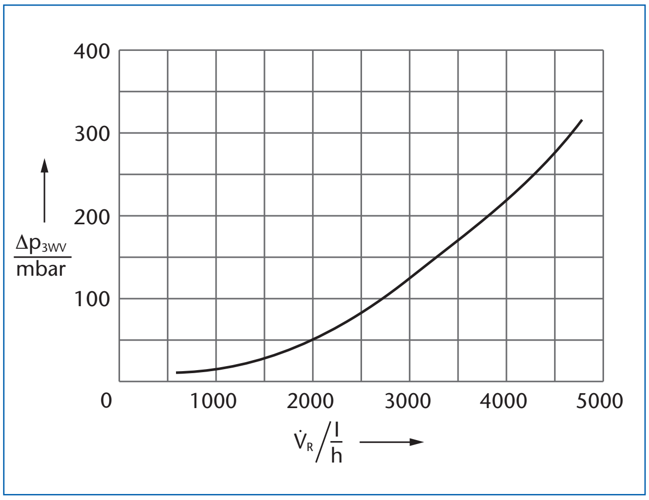


26/1 HZG kit with three-way diverter valve and two cylinder temperature sensors

Caption (→ *26/1*)

1 Cylinder temperature sensor (two sensors provided in the HZG kit; available as sensor kit for the 2nd consumer FSS)

2 Three-way diverter valve (included in HZG kit; available separately as diverter valve for the 2nd consumer VS-SU)



26/2 Pressure drop of three-way diverter valve (→ 26/2)

Caption (→ *26/2*)

$\varnothing p_{3WV}$ Pressure drop of three-way diverter valve (HZG kit or VS-SU)

$\dot{V}_R$ Heating system return flow rate

Solar heating systems with two consumers

A second consumer can be incorporated into a solar system to allow the excess energy to be used once the primary consumer is satisfied. The second consumer may be an additional DHW cylinder used for pre-heat, a thermal store or swimming pool.

Two solar consumers (cylinders) can be heated using the FM443 solar heating function module and the SC40 solar control unit in combination with the sensor kit 2nd consumer FSS and the diverter valve 2nd consumer VS-SU.

The single-line solar station KS01...E can be used as an alternative to the VS-SU. Priority is given to the first consumer (selectable with the SC40). If the temperature differential setting of 10 degrees is exceeded, the solar control unit switches on the supply pump in solar heating circuit 1 (high-flow/low-flow operation with thermosiphon cylinder → page 12).

The solar control unit optionally changes over to an additional solar circuit pump or the second consumer via a three-way diverter valve, if:

- The first consumer has reached the maximum cylinder temperature or
- The temperature spread in solar circuit 1 is no longer adequate for heating the first consumer, in spite of using the slowest pump speed.

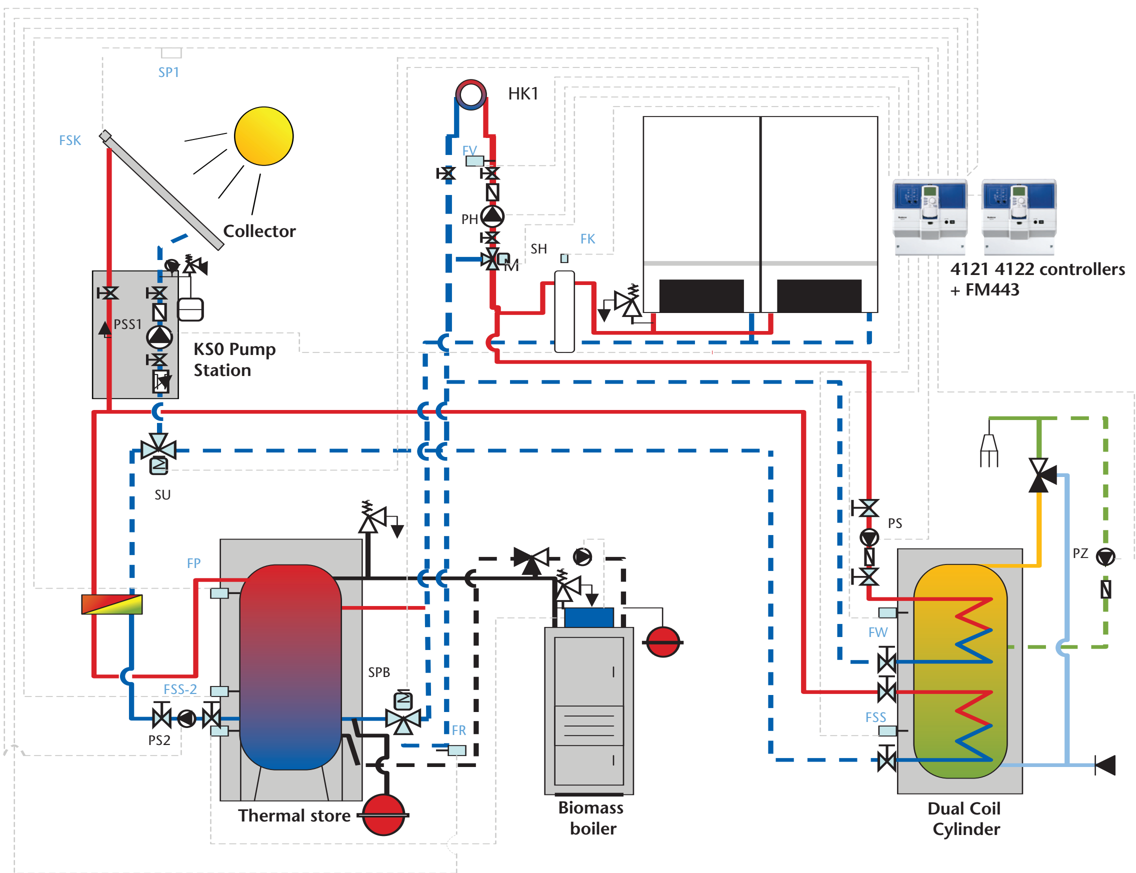
Heating of the second consumer is interrupted every 30 minutes to check the temperature rise in the collector. If the collector temperature increases by more than 1 degree per minute, the check is repeated until:

- The temperature increase at the collector temperature sensor is less than 1 degree per minute, or
- The temperature spread in solar circuit 1 will enable heating of the prioritised consumer again.

The solar function module FM443 and solar control unit SC40 indicate which consumer is currently being heated. The following are required as accessories for a second consumer:

- diverter valve for 2nd consumer VS-SU: Three-way diverter valve (threaded connection Rp1")
- Alternative: Single-line solar station KS01... E
- Sensor kit for 2nd consumer FSS: Cylinder temperature sensor as sensor FSS-2 (NTC 10K, Ø9.7mm, 3.1m lead).

This diagram is only a schematic representation that provides a guide to possible hydraulic schematics. Implement all safety equipment in accordance with local regulations.



27/1 Solar heating system with flat-plate collectors for two consumers with control via solar function module FM443 (abbreviations → page 110; additional sample systems → page 41)

Heat meter kit WMZ 1.2 (accessory)

The solar function module FM443 and solar control unit SC40 include the function of a heat meter. If heat meter kit WMZ 1.2 is being used, the amount of heat can be captured directly by the solar circuit taking the glycol content into consideration (adjustable from 0% to 50%). The amount of heat and the current output in the solar heating circuit (only with FM443) as well as the flow rate can be monitored this way.

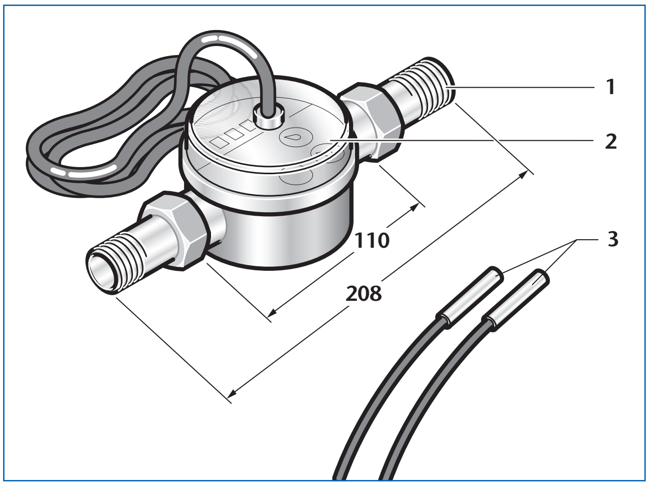
The WMZ 1.2 kit includes:

- Flow meter with two threaded 3/4" water meter connections
- Two temperature sensors as pipe contact sensors with clips for attaching to flow and return (NTC 10 K, Ø9.7mm, 3.1m lead) for connecting to FM443 or SC40

Because of the differing nominal flow rates there are three different WMZ 1.2 heat meter kits:

- For a maximum of five collectors (nominal flow rate 0.6m³/h)
- For a maximum of ten collectors (nominal flow rate 1.0m³/h)
- For a maximum of fifteen collectors (nominal flow rate 1.5m³/h)

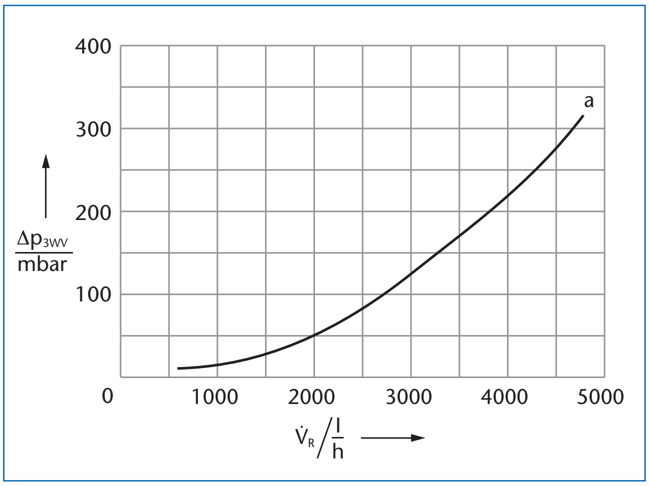
The flow meter must be installed in the solar return. The contact sensors can be attached to the flow and return using clips. The pressure drop of the three-way diverter valve and the flow meter must be taken into consideration when the solar pump stations are selected (→ *26/2* and *28/2*).



28/1 Heat meter kit WMZ 1.2 (dimensions in mm)

Caption (→ *28/1*)

1 Threaded water meter connection 3/4"
2 Flow meter
3 Contact temperature sensor



28/2 Pressure drop of WMZ 1.2 flow meter

Caption (→ *28/2*)

a WMZ 1.2 up to 5 collectors
Δp_{WMZ} Flow meter pressure drop
$\dot{V}_{Sol}$ Solar circuit flow rate

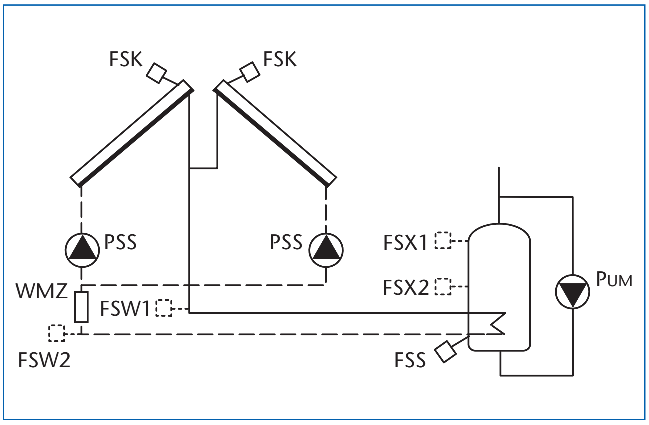
Two collector rows with different orientation (east/west control with SC40 only)

If insufficient space is available on a rooftop, select the system hydraulics of the east/west orientation. The collectors are distributed on two rooftops, which makes special demands of the hydraulic schematics and the control system.

The hydraulic system should be implemented using two solar stations (a 2-line station and a 1-line station). The advantage is that both collector rows can be operated at the same time at midday.

The circuits must be controlled separately when operating with two solar stations, which is taken care of by the SC40 and FM443 solar control unit (accessory collector sensor is required).

Two safety assemblies (part of the standard delivery) and two diaphragm expansions vessels are required for this arrangement.



29/1 East/west control via two solar stations

Caption (→ *29/1*)

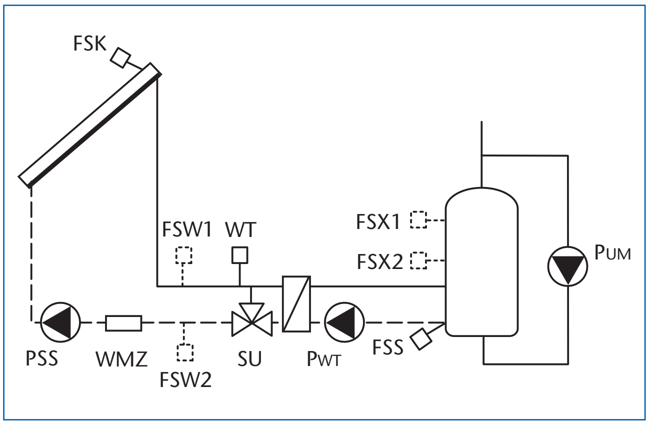
FSK	Collector temperature sensor
FSS	Cylinder temperature sensor (bottom)
FSX1	Cylinder temperature sensor (top; optional – required for water transfer)
FSX2	Cylinder temperature sensor (centre; optional – required for Double-Match-Flow function)
FSW1	Heat meter temperature sensor, flow (option)
FSW2	Heat meter temperature sensor, return (option)
PSS	Solar circuit pump
PUM	Water transfer pump (option)
WMZ	Heat meter kit

Solar cylinder heating via an external heat exchanger

These system hydraulics are chosen if a relatively small solar heating cylinder with high DHW usage is being used with a relative large collector area, or only a shared heat transfer is to be implemented with several solar heating cylinders (thermal stores). In both cases, a high heat exchanger output is required that cannot be provided by the indirect coils that are integrated inside the cylinders.

From a hydraulic point of view, another pump is required at the secondary side of the heat exchanger that has to be controlled. This function can be performed by the SC40 and FM443 solar control units.

A good hydraulic balance is required between the primary and secondary sides of the heat exchanger with this hydraulic schematics.



29/2 Control unit for heating a cylinder via an external heat exchanger

Caption (→ *29/2*)

FSK	Collector temperature sensor
FSS	Cylinder temperature sensor (bottom)
FSX1	Cylinder temperature sensor (top; option – required for water transfer)
FSX2	Cylinder temperature sensor (centre; option – required for Double-Match-Flow function)
WT	Sensor for heat exchanger, external
FSW1	Heat meter temperature sensor, flow (option)
FSW2	Heat meter temperature sensor, return (option)
PSS	Solar circuit pump
PWT	Heat exchanger pump
PUM	Water transfer pump (option)
SU	Diverter valve
WMZ	Heat meter kit

Multiple cylinders

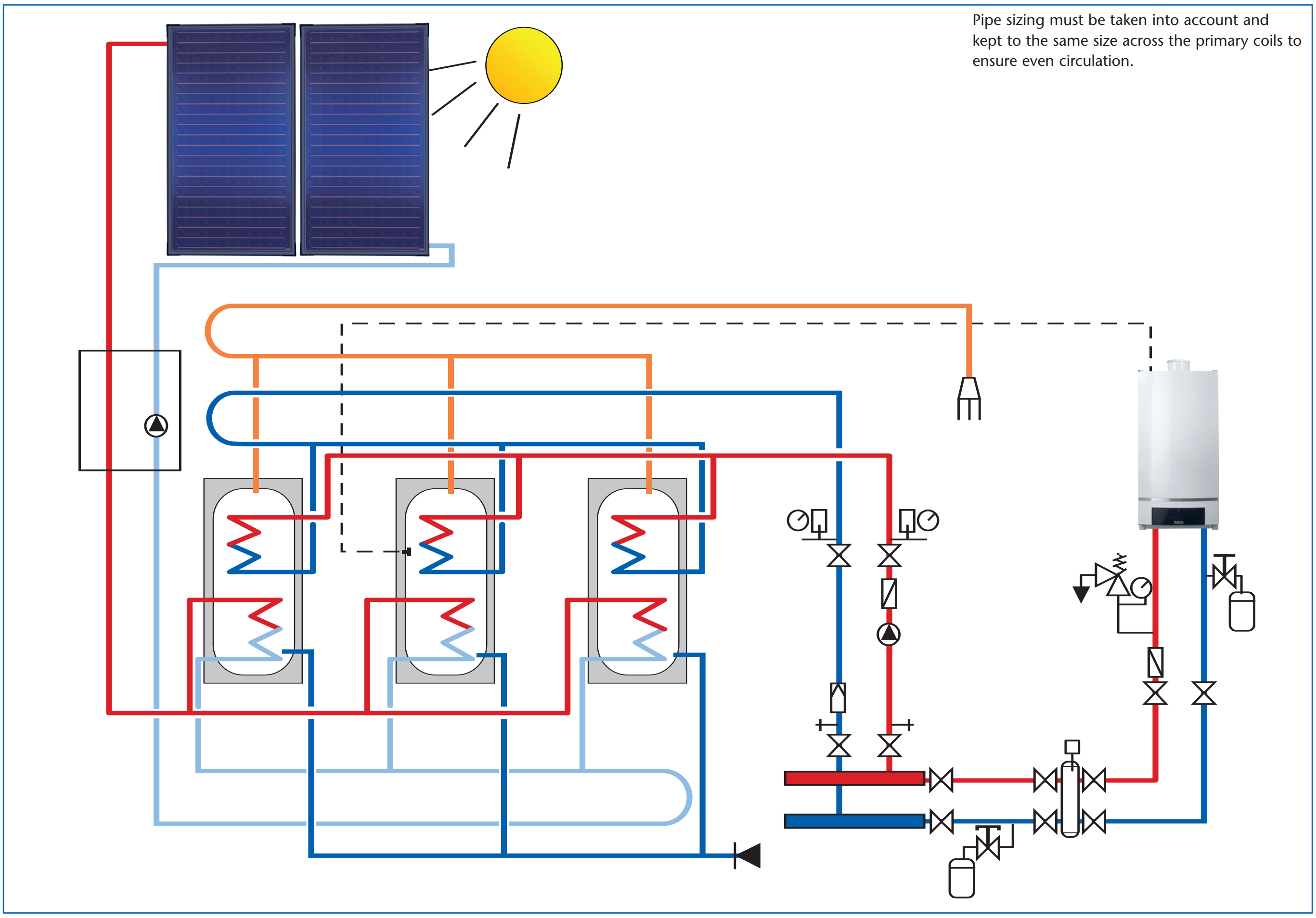
When installing multiple cylinders to work in parallel, the following points should be considered:

Hydraulic connections of flow and return pipework should incorporate a reverse return arrangement to equalise the pressure loss to each cylinder and ensure even heat up.

Hydraulic connections of cold feed and hot outlet should incorporate a reverse return arrangement to ensure even flow through the cylinders.

All safety requirements of building regulation G3 for un-vented cylinders must be complied with (where applicable).

Keep a common pipe size across the primary circuit to ensure an even circulation.



30/1 *Cylinder thermostat shown on centre cylinder as resistance and temperature through each cylinder will be the same.*
This diagram is only a schematic representation that provides a guide to possible hydraulic schemes.
Implement all safety equipment in accordance with local regulations.
Hydraulic schematic showing 3 twin coil cylinders linked together using a reverse return system.

Cylinders connected in series (pre-heat configuration)

When cylinders are connected in series, the preheating cylinder is heated via the solar heating system. The solar heating function module FM443 or solar control unit SC40 is used to control the solar heating system.

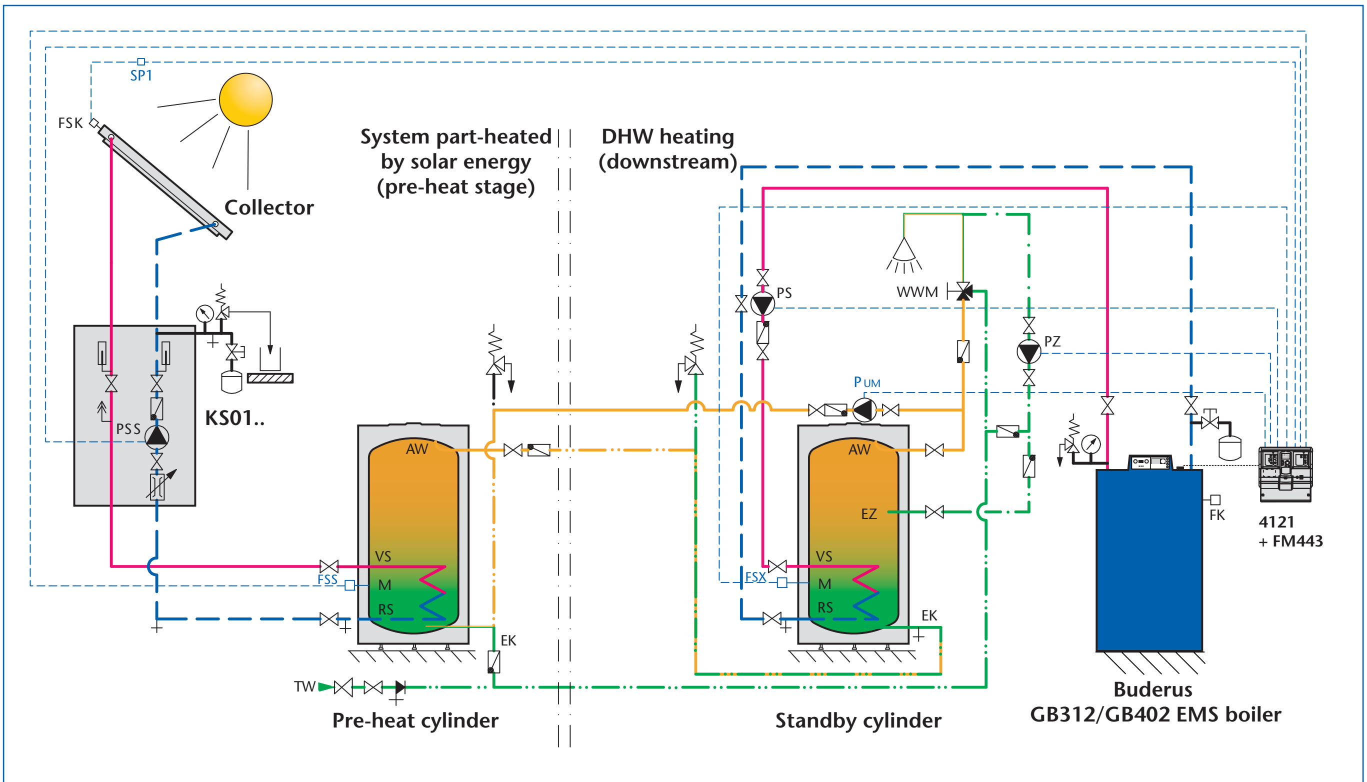
When hot water is drawn-off, the water that has been pre-heated using solar energy flows from the pre-heat cylinder (hot water outlet) to the standby cylinder (feeds into cold inlet) and is reheated by the boiler, if required (→ *31/1*).

With high levels of solar yield, the pre-heating cylinder can also achieve higher temperatures than the standby cylinder. To enable the use of the entire cylinder volume for solar heating, a pipe must be routed from the hot water outlet of the standby cylinder to the cold water inlet of the pre-heating cylinder. A pump is used to deliver the water in such cases (suitable for use with DHW).

A risk assessment in line with HSE ACOP L8 should be carried out for all stored hot water systems, regardless of size. Appropriate measures should be put in place to ensure that conditions for legionella growth are guarded against. A thermal disinfection regime and stored water temperatures of 60°C, together with regular monitoring and recording, should be included in the measures. If DHW is stored at 60°C, a means of preventing scalding will be necessary. The daily heating of the pre-heating stage can be carried out either in standard operation by solar heating or via conventional reheating.

In combination with the SC40 solar control unit, two additional cylinder sensors are needed that are installed at the top or bottom of the standby cylinder. Cylinders with insulation that can be removed allow the sensor to be freely secured with straps. The FSX sensor is installed inside the standby cylinder.

The control units FM443 or SC40 monitor the temperatures via the sensor in the pre-heating cylinder. If the required temperature of 60°C is not achieved in the pre-heating cylinder using solar energy, circulation pump P_{UM} between the hot water outlet of the standby cylinder and the cold water inlet of the pre-heating stage is started during a period when no hot water is drawn off (preferably at night). The P_{UM} pump remains on until the required temperature has been achieved at both sensors or the end of the specified period is reached.



31/1 *Example of a DHW pre-heating cylinder and standby cylinder connected in series, control of cylinder water transfer and thermal disinfection circuit in accordance with HSE ACOP L8, controlled by a FM443 (example system → 59/1; abbreviations → page 110)*

Note: Safety equipment required to comply with HSE ACOP L8 for un-vented cylinders has been removed for clarity.

2.3.5 Thermostatically controlled domestic hot water mixer

Anti-scalding protection

If the maximum cylinder temperature is set higher than 60°C, take suitable measures to ensure protection against scalding. The following options are available:

- Either install a thermostatically controlled DHW mixer downstream of the cylinder's DHW connection or
- At all draw-off points, limit the mixing temperature using thermostatic valves or pre-selectable monolever mixing taps (maximum temperatures of 45°C to 60°C are considered to be relevant in residential buildings).

For Nursing and residential homes where vulnerable people can get access to baths or showers, HSE strongly advises the fitting of thermostatic mixing valves that prevent water being discharged at more than 43°C. Valves should be fitted according to manufacturer’s instructions and need regular maintenance.

The pressure drop must be taken into consideration when designing a system with a thermostatically controlled DHW mixer.

2.4 KS... solar pump station

Features and characteristics

- The assembly consists of all required components such as the solar circuit pump, the gravity brake, the safety valve, the pressure gauge, a full bore isolating valve in the flow and return with integral thermometer, a flow meter and thermal protection
- Available as 1-line or 2-line solar station
- Four different output stages
- Optionally available with or without integral control unit only for KS0110, includes the SC20.

Configuration of the KS01.. solar pump station

Two versions and four different output levels of the KS01... solar pump station are available for optimum adaptation to the collector row.

The 2-line solar stations for collector rows with up to 50 collectors are already equipped with an air separator. The smallest version KS0105 is also available with an integral SC20 solar control unit.

1-line solar pump stations without air separators offer a solar circuit pump and shut-off valves for the additional return pipe in systems with two collector rows (east/west) or two consumers.

The table ***33/1*** shows the different versions and recommends the maximum number of collectors that can be operated with them. A pipework calculation is required to determine the correct output level.

Max. recommended no. of collectors	Without integral control unit	With integral control unit SC20	With integral air separator
5	KS0105 E	–	–
10	KS0110 E	–	–
5	KS0105	KS0105SC20	●
10	KS0110	–	●
20	KS0120	–	●
50	KS0150	–	●[1)]

33/1 Selection of a suitable KS... solar pump station subject to the number of collectors and their equipment level
Symbols: ● Integral, – not integral
1) Additional air separator at the roof level required for each collector row

KS01... solar pump stations are designed for one solar consumer. However, they are suitable for two consumers if a 2-line solar station is operated in combination with a 1-line solar station. This arrangement provides two separate return connections with separate pumps and flow meter (→ ***34/2***). This enables the hydraulic balancing of two consumers with different pressure drop values. One safety assembly is sufficient for this arrangement, provided that no pressure filling is required.

The two-consumer system is controlled either by an FM443 solar function module or an SC40 solar control unit in combination with the 2nd consumer sensor kit FSS.

As an alternative to the 1-line station, a VS-SU 2nd consumer diverter valve can also be used.

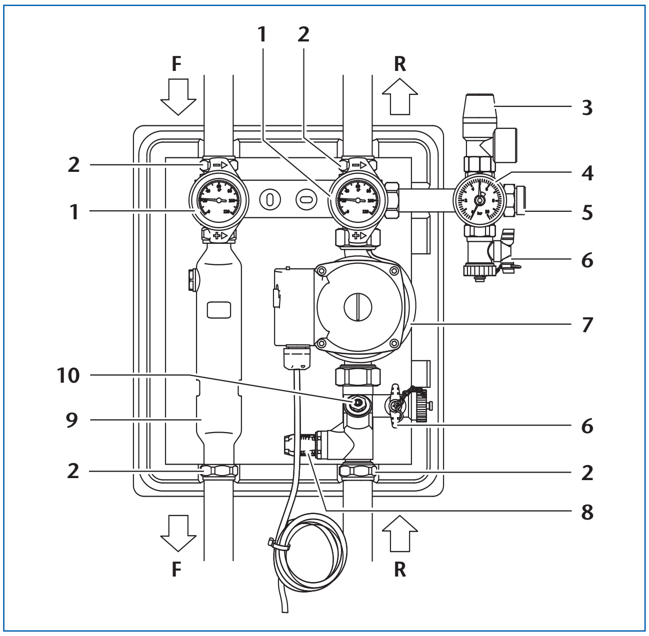
Another application for the combination of a 2-line solar station with a 1-line solar station is the implementation of a solar heating system with two collector rows in different orientation (east/west collector field control). Here too it is important to have two separate return connections with separate pumps and flow meter (→ ***34/2***). As previously described, hydraulic balancing of the two collector rows with different pressure drop values is now feasible. Two safety assemblies (part of the standard delivery) and two expansion vessels are required for this arrangement.

Two collector rows with different orientation are controlled using an SC40 solar control unit in combination with an additional collector row temperature sensor.

The KS01... solar pump station without integral control unit is specially designed for combination with solar function modules that are integrated into the boiler control unit. These include function modules FM443 and SM10.

The KS01.. solar pump station SM10 is connected to the EMS control system via a BUS line, enabling an intelligent combination of the boiler control and solar heating control units.

→ The essential expansion vessel is not part of the standard delivery of the KS... solar pump station. It must be sized for each individual case (→ page 76). An AAS/Solar connection kit with corrugated stainless steel pipe, a 3/4" quick release coupling and a wall retainer for a expansion vessel with a maximum of 25 l are available as accessories. The wall retainer cannot be used for expansion vessel with a capacity of 35 l to 50 l. The AAS/Solar connecting kit is unsuitable for expansion vessels with a capacity in excess of 50 l because the expansion vessel connection is larger than 3/4".

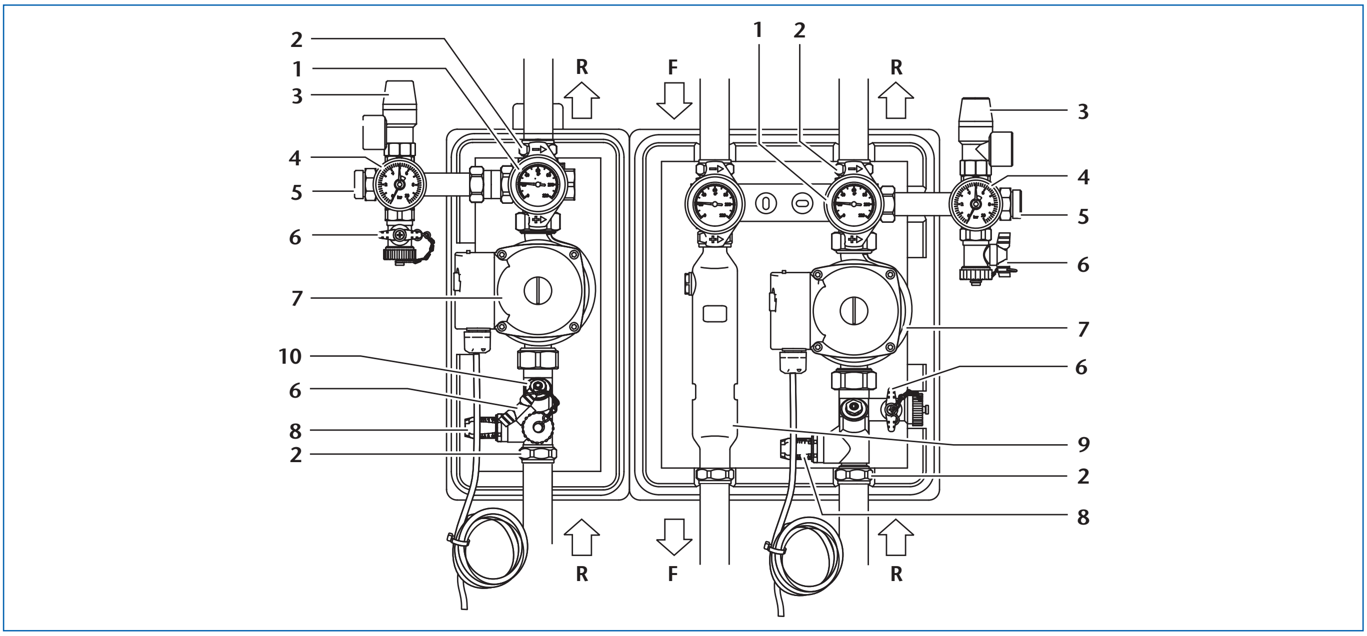


34/1 *Layout of the KS01... solar pump station without integral solar control unit*

Caption (→ *34/1* **and** *34/2*)

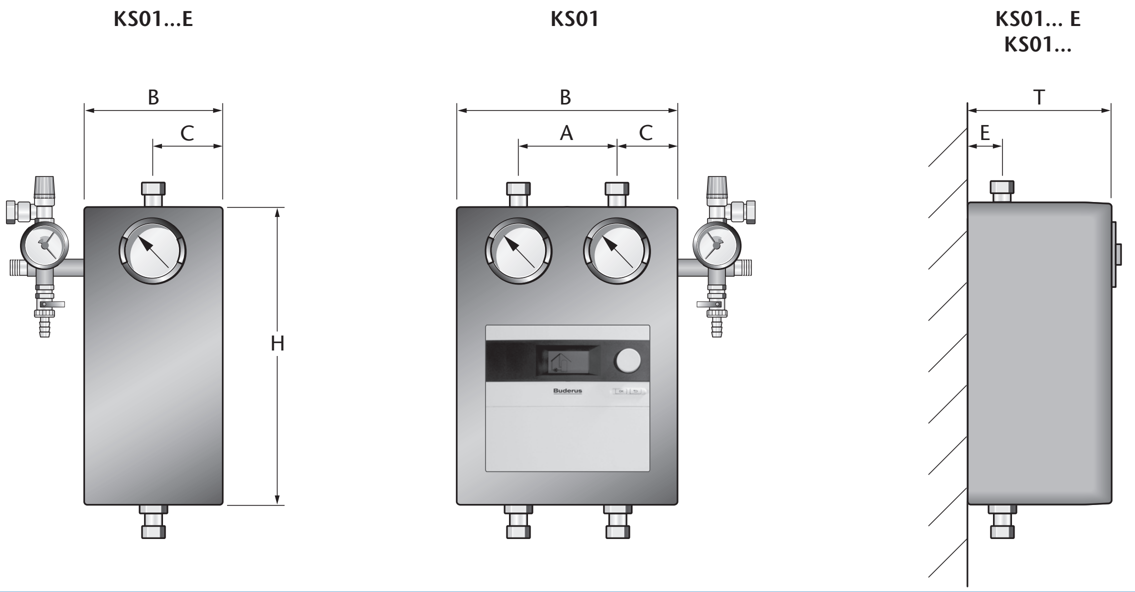
F Flow from collector to consumer
R Return from consumer to collector
1 Ball valve with thermometer and integral gravity brake
Position 0° = gravity brake ready for operation, ball valve open
Position 45° = gravity brake manually open
Position 90° = ball valve closed
2 Clamping ring fitting (all flow and return connections)
3 Safety valve
4 Pressure gauge
5 Connection for expansion vessel (expansion vessel and AAS/Solar not part of the standard delivery)
6 Fill & drain valve
7 Solar circuit pump
8 Flow meter
9 Air separator (not with 1-line solar stations)
10 Regulating/shut-off valve

Dimensions and specification → *35/1* and *35/2*



34/2 *Layout of the combination of KS01... 2-line solar pump station and KS01... 1-line solar pump station E*

Dimensions and specification of KS... solar pump station



35/1 Dimensions of the KS... solar pump station

Solar pump station			KS0105 E	KS0110 E	KS0105	KS0110	KS0120	KS0150
Number of consumers			1	1	1	1	1	1
Casing dimensions	Height H	mm	355	355	355	355	355	355
	Width W	mm	185	185	290	290	290	290
	Depth D	mm	180	180	235	235	235	235
Detailed dimensions	A	mm	–	–	130	130	130	130
	C	mm	93	93	80	80	80	80
	E	mm	50	50	50	50	50	50
Copper pipe connection size (compression joint fittings)	Flow/ return	mm	15 x 1	22 x 1	15 x 1	22 x 1	28 x 1	28 x 1
Expansion vessel connection			3/4"	3/4"	3/4"	3/4"	3/4"	1"
Safety valve		bar	6	6	6	6	6	6
Circulation pump	Type		Solar 15-40	Solar 15-70	Solar 15-40	Solar 15-70	Solar 25-80	Solar 25-120
	Finished length	mm	130	130	130	130	180	180
Electrical power supply		V AC	230	230	230	230	230	230
Frequency		Hz	50	50	50	50	50	50
Max. power consumption		W	60	125	60	125	195	230
Max. current strength		A	0.25	0.54	0.25	0.54	0.85	1.01
Flow meter adjusting range		l/min	0.5–6	2–16	0.5–6	2–16	8–26	20–42.5
Weight		kg	5.4	5.4	7.1 (8.0[1])	7.1	9.3	10.0

35/2 Specification and dimensions of the KS… solar pump station
1) KS0105 solar pump station with integral SC20 control unit

Selecting the KS... solar pump station

Information concerning the selection of a suitable solar pump station (→ page 76).

2.5 Other system components

2.5.1 Solar fluid

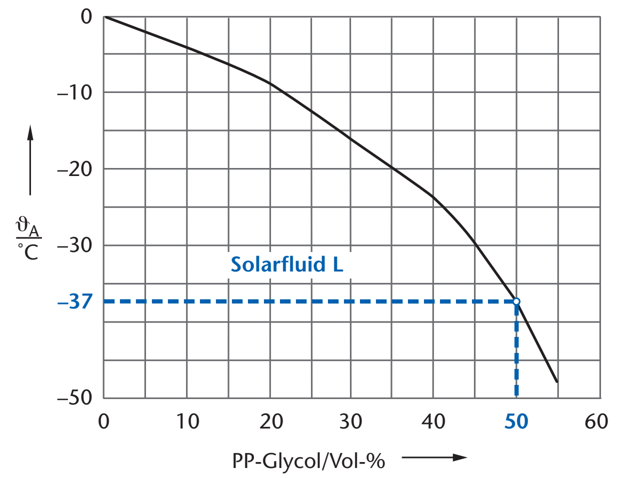
The solar heating system must be protected against frost. Either solar fluid L or Tyfocor LS antifreeze can be used for this purpose.

Solar fluid L

Solar fluid L is a ready-made mixture consisting of 50% PP glycol and 50% water. This clear mixture is non-toxic and biologically degradable.

We recommend solar fluid L but Tyfocor can be used as an alternative. Please refer to manufacturer's instructions if selecting Tyfocor.

Solar fluid L protects the system against frost and corrosion. It can be disposed of through the normal drainage system as long as it is permitted by the local Water Authority. As can be seen in the diagram ***36/1***, solar fluid L provides frost protection down to an outside temperature of -37°C. In systems with SKN3.0 and SKS4.0 collectors, solar fluid L ensures a reliable operation at temperatures from -37°C to +170°C.



36/1 Level of frost protection of heat transfer medium subject to the glycol:water mixture

Caption (→ *36/1*)

ϑ_A Outside temperature

Testing the solar fluid

Heat transfer media based on mixtures of propylene glycol and water age during operation in solar heating systems. This decay can be detected from the outside by dark colouration or opaqueness. Long periods of overheating (> 200°C) result in a characteristic pungent smell of burning. The fluid becomes almost black because of the increase in solid decomposition products of the propylene glycol or the inhibitors that are no longer soluble in fluid.

The main influences are high temperatures, pressure and the duration of the load. These factors are strongly influenced by the absorber geometry.

Favourable characteristics are obtained using fan-shaped absorbers such as the ones used in the SKN3.0, and double meander absorbers with return pipe at the bottom such as the ones used in the SKS4.0.

However, the locations of the connecting pipes on the collector also influence the stagnation characteristics and therefore the ageing of the solar fluid. It is therefore important to avoid running the flow and return pipes over long distances with inclines at the collector row, since solar fluid will run into the collector from these pipe sections in the event of stagnation and increase the vapour volume. Ageing is also accelerated by oxygen (air-borne) and impurities such as copper or iron swarf.

To check the solar fluid on site, determine the pH value and the antifreeze level. Suitable pH measuring sticks and a refractometer (frost protection) are included in the Buderus solar service case.

Ready-mixed solar fluid	pH value in the delivered condition	pH limit for replacement
Solar fluid L 50/50	approx. 8	≤7
Tyfocor LS 50/50	approx. 10	≤7

36/2 pH limits for checking ready-mixed solar fluid

2.5.2 Solar heating backup using a thermal store

Return temperature sensing

For central heating backup using a thermal store, an HZG-set is required.

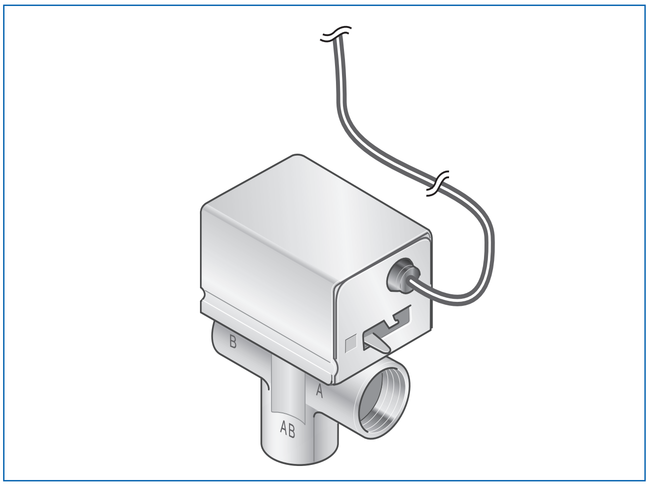
The standard delivery includes:

- One three-way valve with servomotor
- Two cylinder temperature sensors:
  NTC 10 K, Ø9.7mm, 3.1m lead and
  NTC 20 K, Ø6mm, 2.5m lead

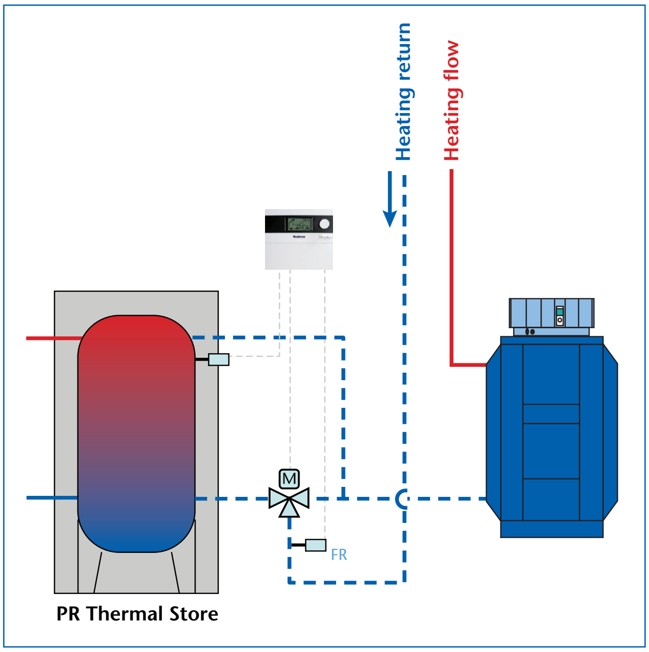
The return temperature sensing kit continuously compares the temperature in the heating return with the temperature in the thermal store. Subject to the return temperature, it directs the heating return through the thermal store or straight back to the boiler (→ *37/2*). The buffer bypass circuit can be realised with the HZG-set in conjunction with the FM443 solar function module or the SC40 solar control unit.

Water connection

To provide the optimum solar yield, size the heating surfaces for the lowest possible system temperature. Experience has shown that the lowest system temperatures are provided by area heating (e.g. underfloor heating system). To prevent unnecessarily high return temperatures, all heating surfaces must be calibrated in accordance with BS EN 18380 (VOB part C). Heating surfaces that have not been hydraulically balanced can significantly reduce the solar yield.



37/1 *HZG-set for systems with CH support when used as a buffer by-pass*



37/2 *Hydraulic connection of an HZG-set using the example of a PR thermal store*

2.5.3 Swimming pool water heat exchanger

Selected features and characteristics

- Stainless steel plate-type heat exchanger or shell and tube heat exchanger
- Removable moulded thermal insulation shells
- Heat transfer from the heat transfer medium in the solar heating circuit to the swimming pool water via liquids flowing in countercurrents
- The connection at the swimming pool end must be protected using a check valve and a dirt filter.

Sizing the circulation pump in the secondary circuit

The primary side flow rate depends on the number of collectors. The control unit in the solar pump station regulates both the solar circuit pump (primary) and the swimming pool water pump (secondary). The secondary pump must be resistant to chlorinated water. The inlet pressure at the inlet side must also be taken into consideration.

→ A relay is required for the swimming pool water pump if the total power consumption exceeds the maximum output current of the control unit. The circulation pump at the secondary side must be sized in accordance with the required flow rate using the following formula.

$$\dot{m}_{SP} = n \cdot 0.25$$

38/1 Secondary pump flow rate

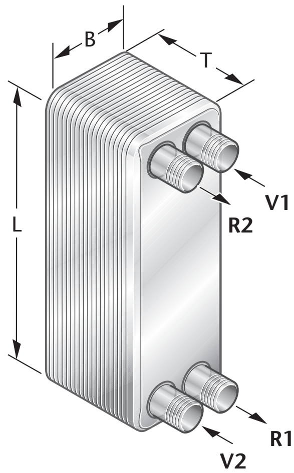
Calculating parameters (→ *38/1*)

$\dot{m}_{SP}$ Secondary pump flow rate in m³/h

n Number of solar collectors

Dimensions and specification of swimming pool water heat exchanger

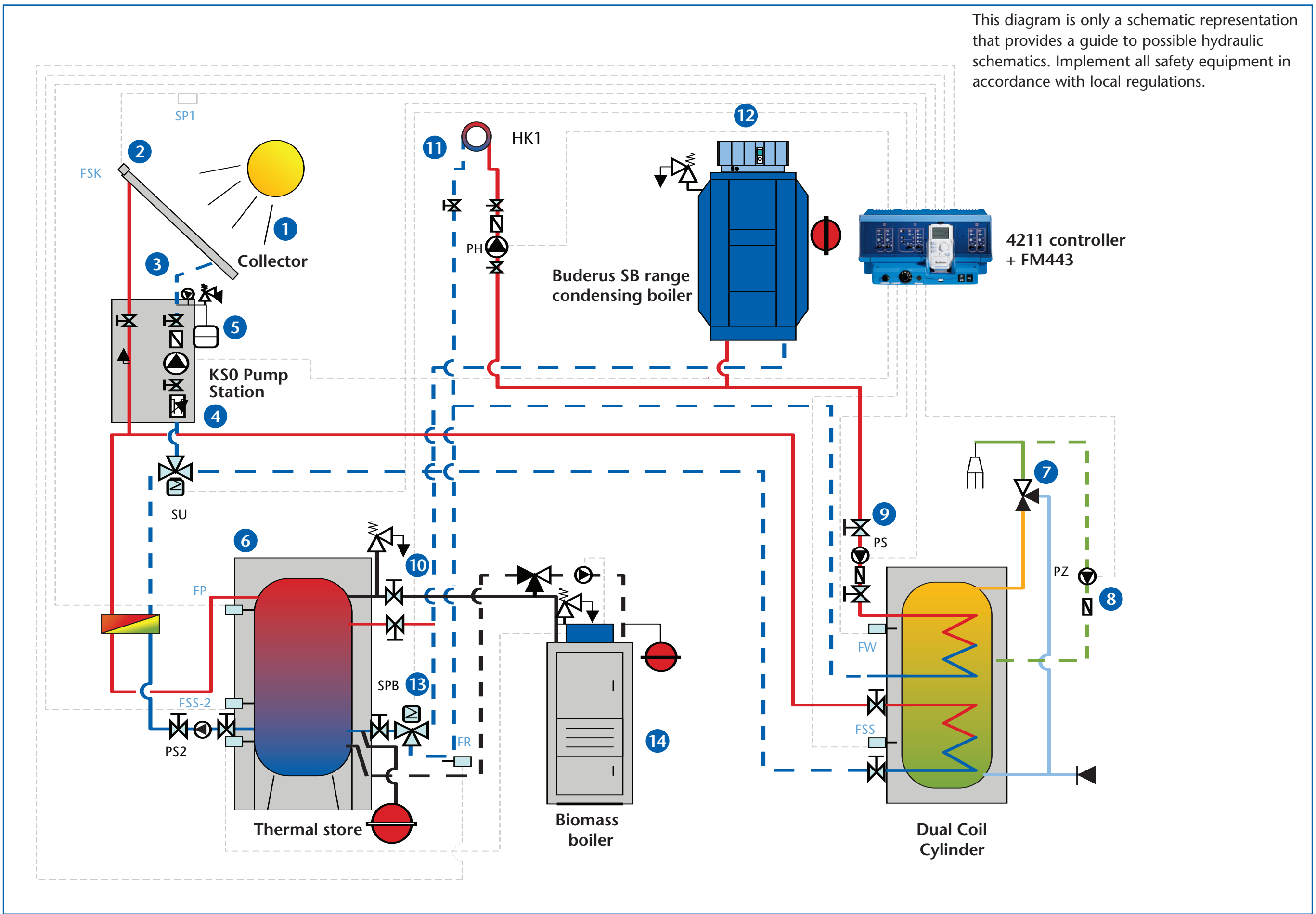
The swimming pool heat exchanger should be linked in parallel to the conventional heating system. This allows the solar heating system to heat the swimming pool water either alone or with boiler backup.



38/2 Swimming pool water heat exchangers

3 Notes regarding solar heating systems

3.1 General information



39/1 Specimen wiring diagram in connection with the general information regarding solar heating systems (abbreviations → page 110)

Item	System components	General design information	Further information
1	Collectors	The size of the collector rows must be determined independently of the hydraulic system.	→ page 51
2	Pipework with incline to the air vent valve (KS…)	Install an all-metal air vent valve at the highest point of the system if the system is not vented with "filling station and air separator" or the KS0150 solar pump station is used (collector accessories in Heating Technology catalogue). An air vent valve can also be installed wherever the pipework changes direction and goes downwards, and then rises again. The 2-branch solar pump station is equipped with an air separator.	→ page 84
3	Connection lines Twin-Tube	To make the connecting lines easier to install, the double copper tube Twin-Tube 15 or the stainless steel corrugated tube Twin-Tube DN20 is recommended, complete with heat and UV protection jacket and integral extension lead for the FSK collector temperature sensor. For larger installations or systems with very long pipe run the required pipe size might be larger than DN20.	→ page 75
4	Solar pump station	The KS... solar pump station contains all important hydraulic and control components for the solar circuit. The choice of solar pump station is subject to the number of consumers, the number/arrangement of collectors or connections, and the collector row pressure drop. AKS... solar pump station without control unit is recommended if the solar circuit control can be integrated into the boiler control unit via the SM10 or FM443 solar function module or the SC20 or SC40 solar control unit for wall mounting.	→ page 76 → page 33

39/2 General information regarding solar heating systems

continued on the next page

Item	System components	General design information	Further information
5	Diaphragm expansion vessel	Size the expansion vessel separately subject to the system volume and the safety valve release pressure so that it can withstand the volume expansion in the system. With east/west systems an additional expansion vessel is required for the 2nd collector row. A pre-cooling vessel is also required if the DHW heating coverage is above 60%, large scale systems or in central heating backup systems.	→ page 72
6	DHW cylinder	Determine the size of the cylinders independently of the hydraulic system. Unvented cylinders must comply with part G3 of the current building regulations and include all necessary safety equipment.	→ page 54
7	Hot water mixers	Reliable protection from excessive hot water temperatures (**risk of scalding!**) should be provided by a thermostatically controlled hot water mixer. To prevent gravity circulation, install the thermostatically controlled DHW mixer below the cylinder's DHW outlet. If this is not possible, provide a heat insulating loop or a non-return valve.	→ page 32
8	DHW water circulation	A DHW circulation pipe is not shown. DHW circulation causes standby losses. It should therefore only be used in widespread DHW networks. Using a poorly designed DHW circulation pipe or DHW circulation pump could reduce the net solar yield considerably. If DHW circulation is to be provided, the content of the DHW pipe must be circulated three times per hour in accordance with BS EN 1988, preventing a temperature drop in excess of 5 K. To retain the temperature stratification inside the cylinder, coordinate the flow rate and any DHW circulation pump cycling. The circulation pump can not be used to thermally disinfect pre heat cylinders. This function has to be provided by a special pump designed for the purpose.	→ page 18
9	Conventional reheating (boiler control unit)	The hydraulic integration of the heat source and the solar control unit that can be used are subject to the boiler type and the control unit that is used. A distinction can be drawn between the following boiler groups. Wall hung with EMS: e.g. GB162 Floorstanding with EMS: e.g. GB312 Floorstanding: e.g. G... GE..., SB...	→ page 41
10	Thermal store and buffer	Only heat from the solar heating system and (if available) other sustainable energy sources should be fed to the buffer part for central heating in the combi cylinder or thermal store. If the buffer area of the solar cylinder is heated by a conventional boiler, this part is blocked for energy consumption by the solar heating system.	→ page 13
11	Heating surface sizing and adjustment	When the central heating is being integrated into the solar system, size the radiators such that the return temperature is as low as possible. As well as sizing the radiators, pay special attention to balancing them in accordance with regulations. The lower the return temperature that can be selected, the greater the expected solar yield. In this case it is important for all radiators to be balanced in accordance with the applicable regulations (VOB part C: BS EN 18380). A wrongly balanced radiator can reduce the solar yield of the central heating considerably.	→ page 13
12	Control unit Heating circuit	The possibility of using the control unit must be checked with regard to the number of heating circuits.	→ page 16
13	Return temperature controller	A so-called return temperature controller (RW) must be installed for all central heating backup systems. This monitors the central heating return temperature and prevents the solar cylinder from being heated up via the central heating return at high temperatures using a three-way distribution valve. The HZG kit can be used in combination with the FM443 solar function module or the SC40 solar control unit.	→ page 37
14	Solid fuel boiler	**Occasional heating** If a wood burning fireplace insert or solid fuel boiler is only operated occasionally, the heat that is generated can be fed into the solar thermal store or combi cylinder. However, the solar yield is limited during this time. Simultaneous operation of the solar heating part of the system and solid fuel combustion must be minimised so that the solar yield is only reduced temporarily. This requires correct system design. **Permanent heating** If a wood burning fireplace insert or solid fuel boiler is to be used permanently in occasional alternating mode with an oil/gas fired boiler for central heating, a reduction in solar yield can be expected during the transition period due to the higher temperatures in the buffer part. Always comply with the current design/engineering document for solid fuel boilers.	

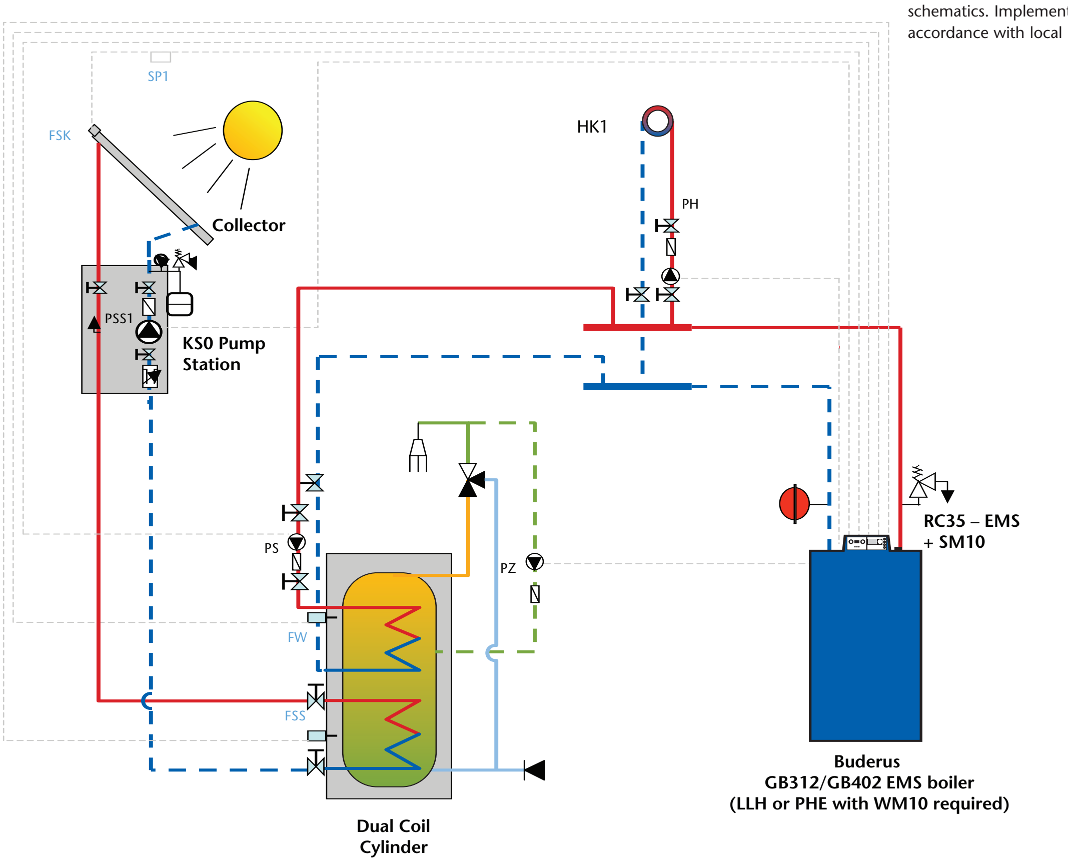
39/2 General information regarding solar heating systems

4 Sample systems

4.1 Solar heating systems for domestic hot water heating with conventional oil/gas fired boilers

4.1.1 Solar DHW heating: Floorstanding boiler and twin coil cylinder

This diagram is only a schematic representation that provides a guide to possible hydraulic schematics. Implement all safety equipment in accordance with local regulations.



Solar heating circuit	Heating circuit	DHW reheating
The 1st consumer (twin coil DHW cylinder) is heated subject to the temperature differential between FSK and FSS.	The boiler heats up the unmixed heating circuit.	The DHW is reheated to the set temperature by the boiler subject to the FW sensor, if required.

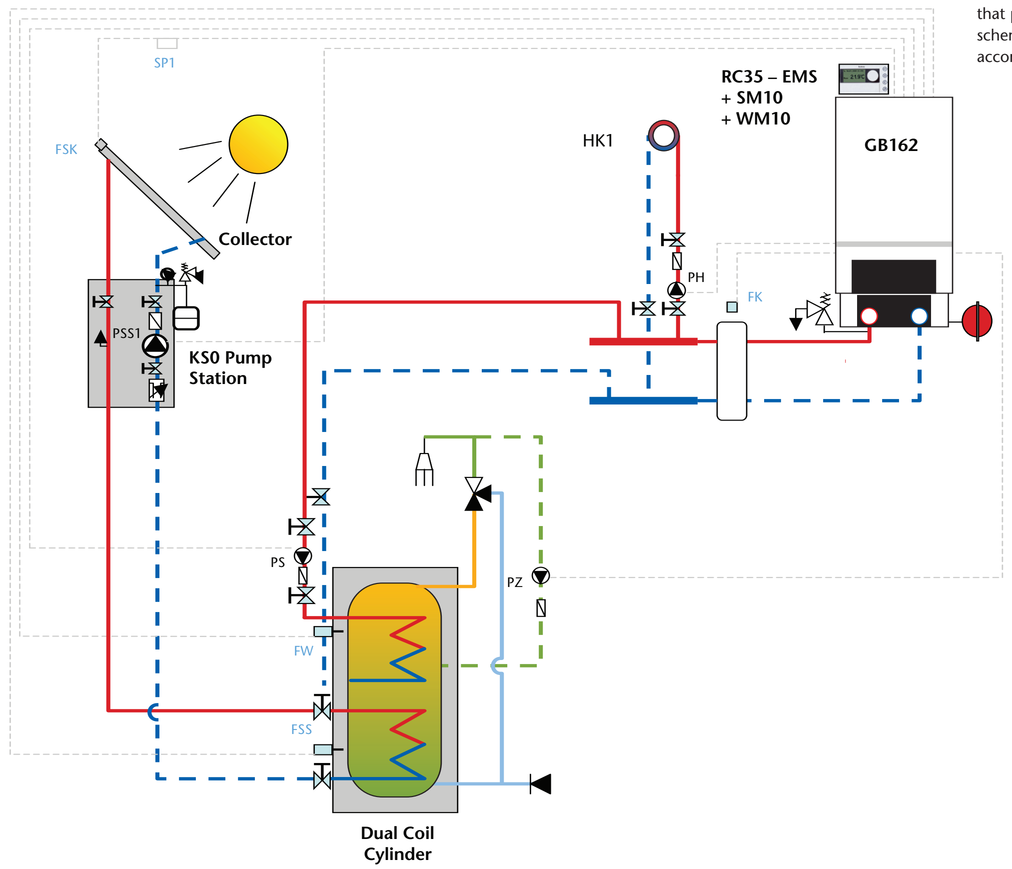
41/1 Wiring diagram with short description of the sample system (General instructions → page 39; abbreviations → page 110)

Floorstanding boiler	Boiler		Solar		
	Control unit	Type	Control unit	Component	
Boilers with EMS	EMS	RC35	SM10	KS01..	I
	4000	4121	FM443		
Non EMS boilers	4000	4211	FM443	KS01..	I
Third party	Third party	Third party	SC20	KS01.. SC..	I
			SC40 (hydraulic system T1 → 22/1)		

41/2 Possible control versions for the solar heating system

4.1.2 Solar DHW heating: Wall hung boiler and twin coil cylinder

This diagram is only a schematic representation that provides a guide to possible hydraulic schematics. Implement all safety equipment in accordance with local regulations.



Solar heating circuit	Heating circuit	DHW reheating
The 1st consumer (twin coil DHW cylinder) is heated subject to the temperature differential between FSK and FSS.	The boiler heats up the unmixed heating circuit.	The DHW is reheated to the set temperature by the boiler subject to the FW sensor, if required.

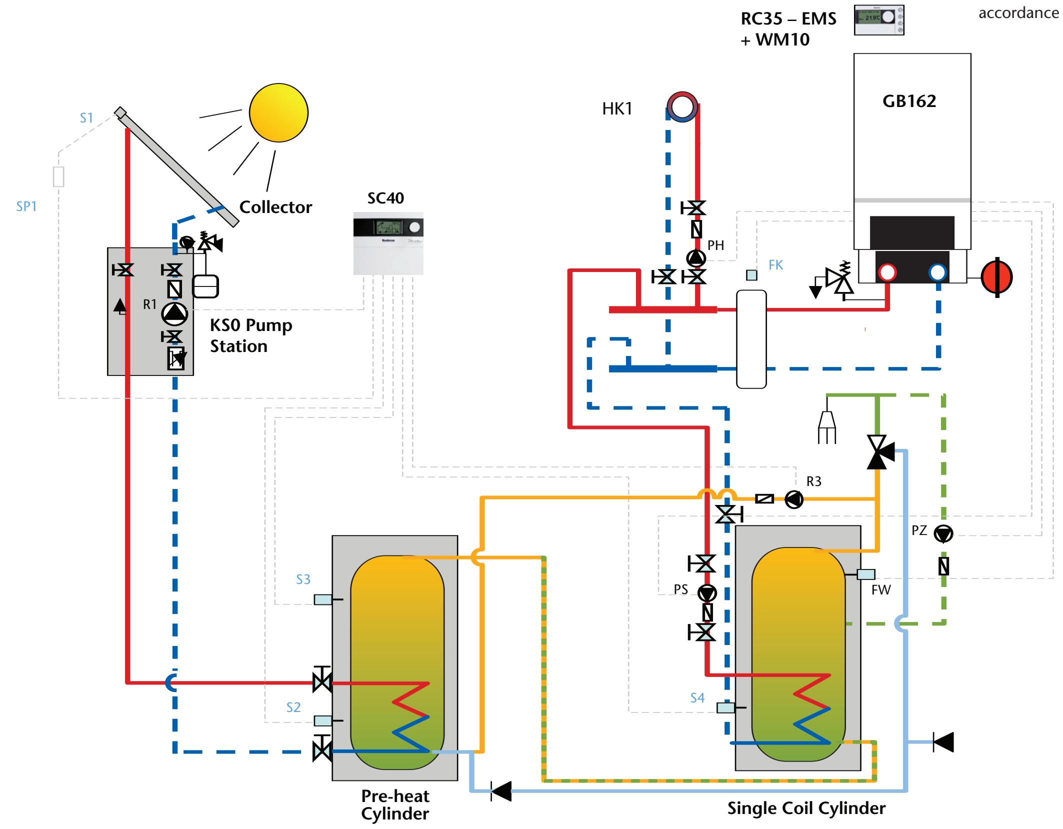
42/1 Wiring diagram with short description of the sample system (General instructions → page 39; abbreviations → page 110)

Wall hung boiler	Boiler		Solar		
	Control unit	Type	Control unit	Component	
Boiler with EMS	EMS	RC35	SM10	KS01..	I
	4000	4121	FM443		
Third party	Third party	Third party	SC20	KS01.. SC..	I
			SC40 (hydraulic system T1 → 22/1)		

42/2 Possible control versions for the solar heating system

4.1.3 Solar DHW heating: Wall hung boiler and pre-heat cylinder (retrofit solution)

This diagram is only a schematic representation that provides a guide to possible hydraulic schematics. Implement all safety equipment in accordance with local regulations.



Solar heating circuit	**Heating circuit**	**DHW reheating**
The 1st consumer (pre-heat cylinder) is heated subject to the temperature differential between FSK and FSS. The water from both cylinders is transferred, if the standby cylinder is cooler than the pre-heat cylinder.	The boiler heats up the unmixed heating circuit.	The DHW is reheated to the set temperature by the boiler subject to FW sensor, if required.

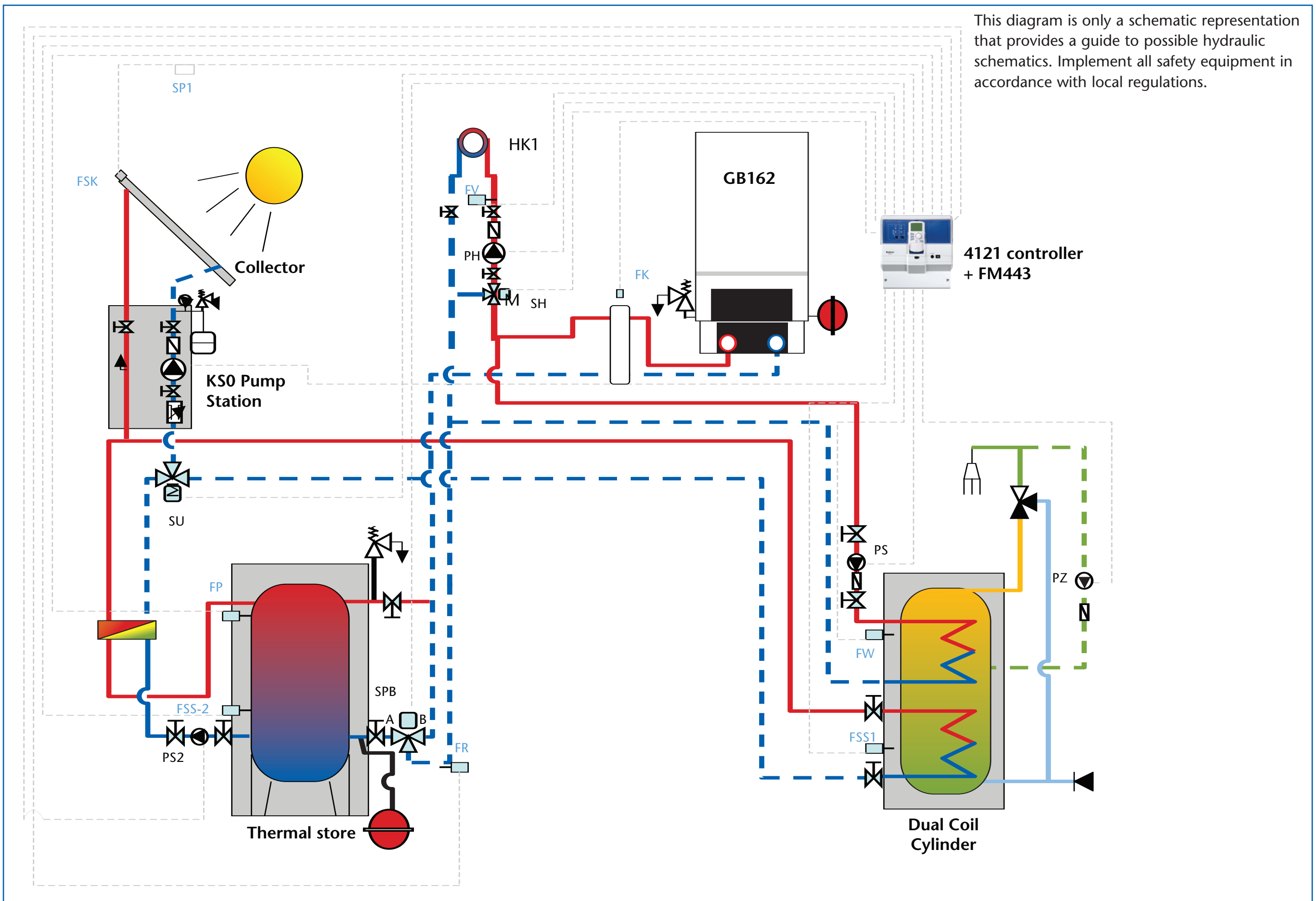
43/1 Wiring diagram with short description of the sample system (General instructions → page 39; abbreviations → page 110)

Wall hung boiler	Boiler		Solar		
	Control unit	Type	Control unit	Component	
Boiler with EMS	EMS	RC35	SC40	KS01.. P_{UM}	I II
	4000	4121	FM443	KS01.. P_{UM}1)	I II
Third party	Third party	Third party	SC40 (hydraulic system T5 → 22/1)	KS01.. P_{UM}	I II

43/2 Possible control versions for the solar heating system

4.2 Solar heating systems for DHW heating and central heating backup with conventional oil/gas fired boilers

4.2.1 Solar DHW heating and central heating backup: Wall hung boiler, twin coil DHW cylinder and thermal store



Solar heating circuit
The 1st consumer (twin coil DHW cylinder) is heated subject to the temperature differential between FSK and FSS1. If the 1st consumer can no longer be heated, the 2nd consumer is heated subject to the temperature differential between FSK and FSS-2. Possible heating of the 1st consumer is checked at frequent intervals.

Heating circuit
The system return temperature is raised by the solar thermal store if there is a positive temperature differential between the FP and the FR. The temperature is increased to the required flow temperature by the wall hung boiler. All heating circuits are equipped with a mixing valve.

DHW reheating
The DHW is reheated to the set temperature by the FW sensor, if required.

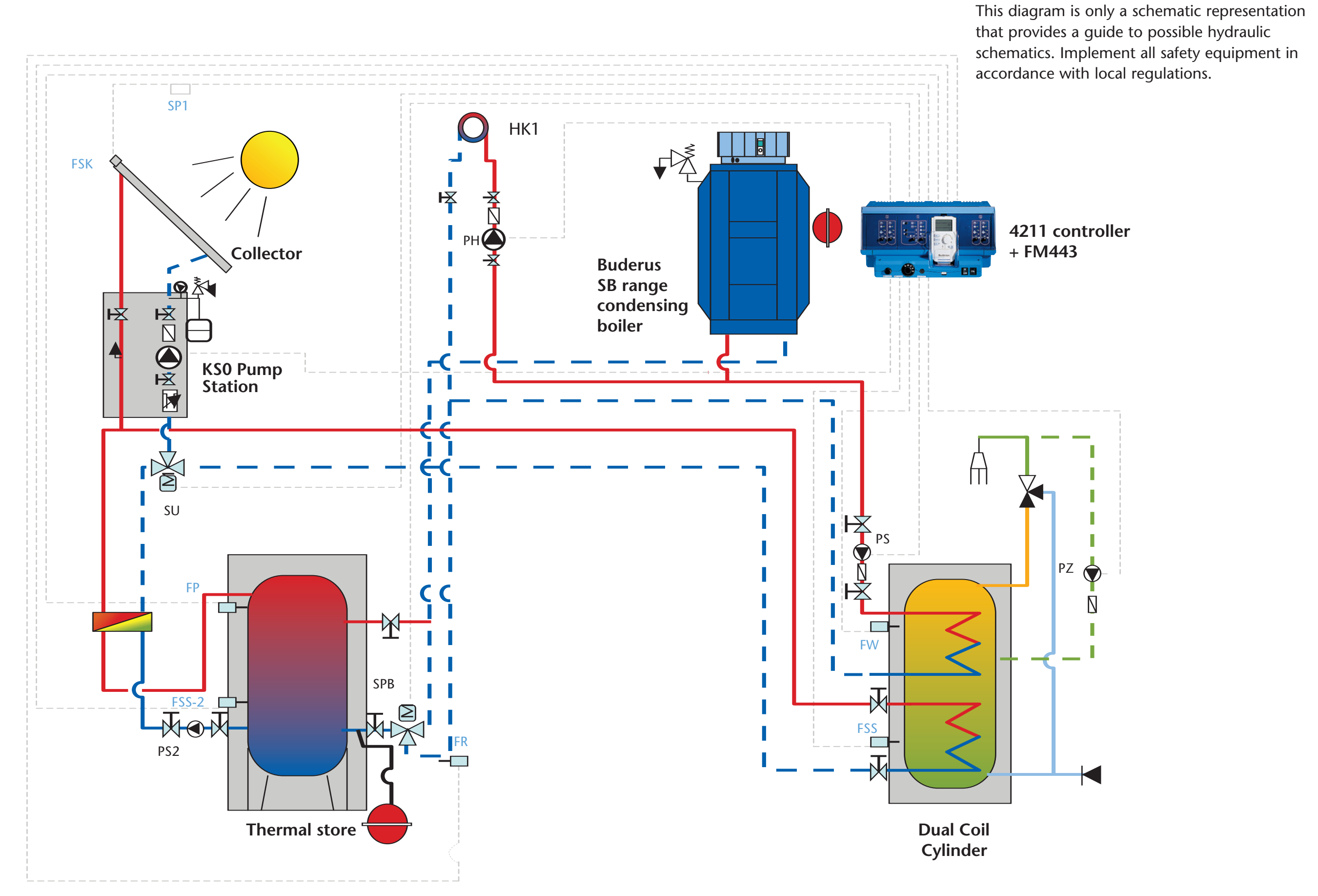
44/1 Wiring diagram with short description of the sample system (General instructions → page 39; abbreviations → page 110)

Wall hung boiler	Boiler		Solar		
	Control unit	Type	Control unit	Component	
Boiler with EMS	4000	4121	FM443	KS01.. VS-SU HZG kit	I II III
Third party	Third party	Third party	SC40 (hydraulic system H5 → 22/1)	KS01.. VS-SU HZG kit	I II III

44/2 Possible control versions for the solar heating system

4.3 Solar heating systems for DHW heating with solid fuel boiler

4.3.1 Solar DHW heating: Floorstanding boiler with twin coil DHW cylinder and thermal store



Solar heating circuit	Heating circuit	DHW reheating
The 1st consumer (twin coil DHW cylinder) is heated subject to the temperature differential between FSK and FSS1. If the 1st consumer can no longer be heated, the 2nd consumer is heated subject to the temperature differential between FSK and FSS-2. Possible heating of the 1st consumer is checked at frequent intervals.	The floorstanding boiler heats up the heating circuit.	The DHW is reheated to the set temperature by the FW sensor, if required.

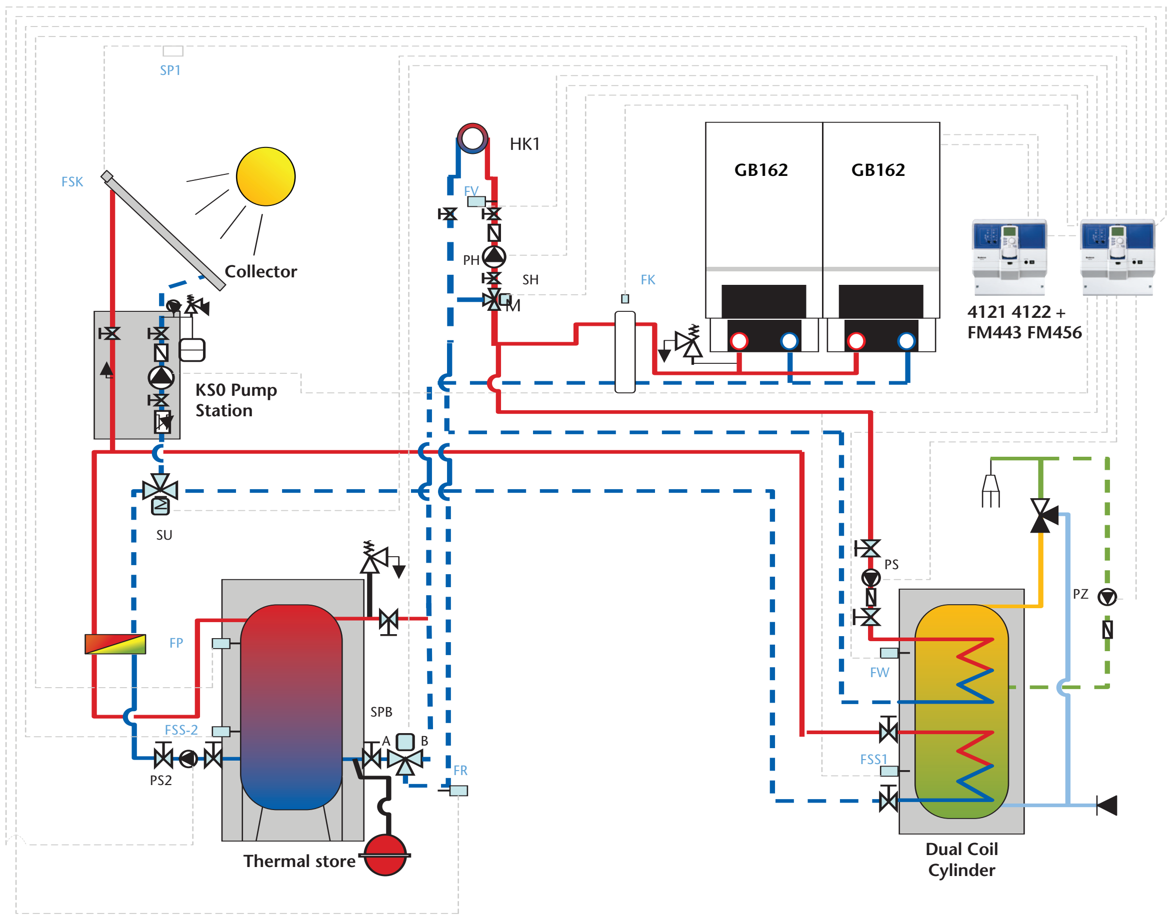
45/1 Wiring diagram with short description of the sample system (General instructions → page 39; abbreviations → page 110)

Floorstanding boiler	Boiler		Solar		
	Control unit	Type	Control unit	Component	
Boiler with EMS	4000	4121	FM443	KS01..	I
Non EMS boiler	4000	4211	FM443	KS01..	I
Third party	Third party	Third party	SC40 (hydraulic system T1 → 22/1)	KS01..	I

45/2 Possible control versions for the solar heating system

4.3.2 Solar DHW heating: Wall hung cascade with twin coil DHW cylinder and thermal store

This diagram is only a schematic representation that provides a guide to possible hydraulic schematics. Implement all safety equipment in accordance with local regulations.



Solar heating circuit
The 1st consumer (twin coil DHW cylinder) is heated subject to the temperature differential between FSK and FSS. If the 1st consumer can no longer be heated, the 2nd consumer is heated subject to the temperature differential between FSK and FSS-2. Possible heating of the 1st consumer is checked at frequent intervals.

Heating circuit
The system return temperature is raised by the solar thermal store if there is a positive temperature differential between the FP and the FR. The temperature is increased to the required flow temperature by the wall hung cascade. All heating circuits are equipped with a mixing valve.

DHW reheating
The DHW is heated to the set temperature by the FW sensor, if required.

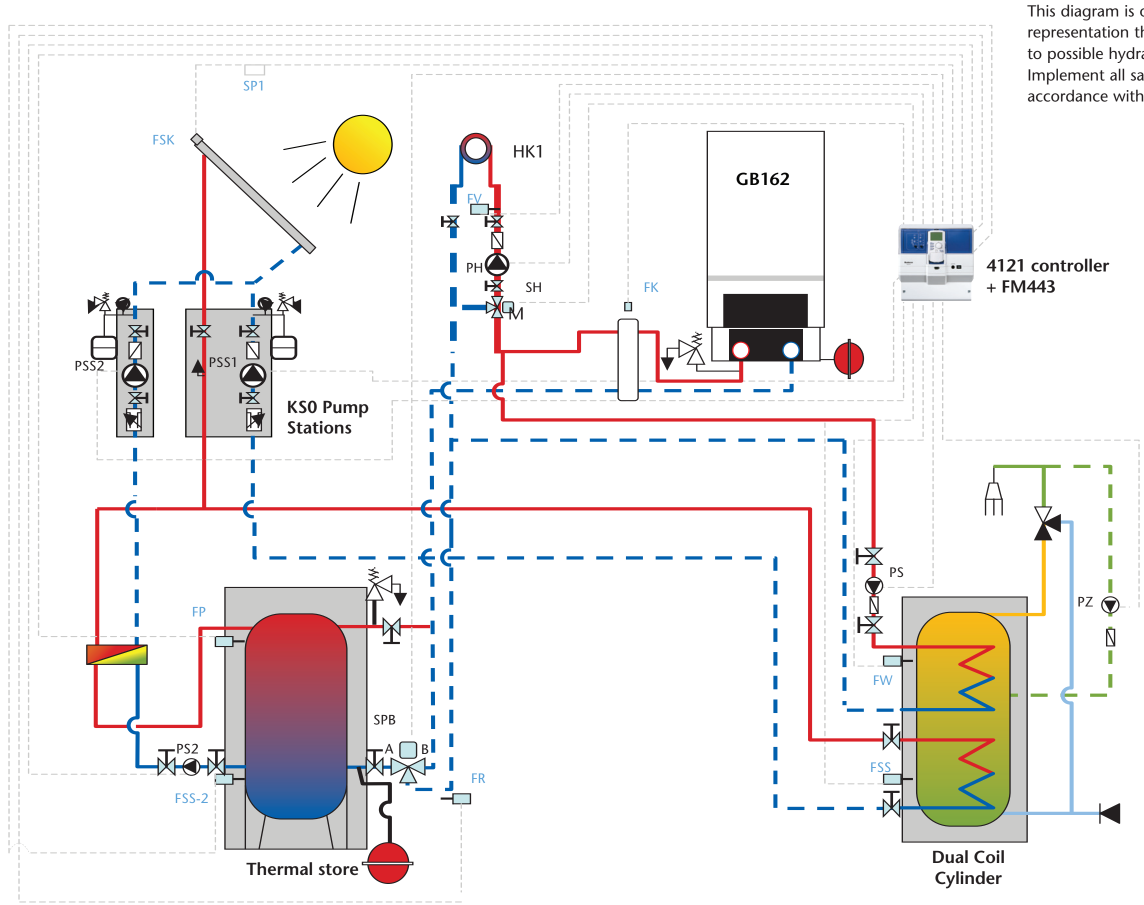
46/1 Wiring diagram with short description of the sample system (General instructions → page 39; abbreviations → page 110)

Wall hung boiler	Boiler		Solar		
	Control unit	Type	Control unit	Component	
Boiler with EMS	4000	4121	FM443	KS01..	I
Third party	Third party	Third party	SC40 (hydraulic system T1 → 22/1)	KS01..	I

46/2 Possible control versions for the solar heating system

4.4 Solar heating systems for DHW heating and central heating backup with solid fuel boiler

4.4.1 Solar DHW heating and central heating backup: Wall hung boiler with twin coil DHW cylinder and thermal store



Solar heating circuit
The 1st consumer (twin coil DHW cylinder) is heated subject to the temperature differential between FSK and FSS1. If the 1st consumer can no longer be heated, the 2nd consumer (solar buffer) is heated subject to the temperature differential between FSK and FSS-2. Possible heating of the 1st consumer is checked at frequent intervals.

Heating circuit
The system return temperature is raised by the solar thermal store if there is a positive temperature differential between the FP and the FR. The temperature is increased to the required flow temperature by the wall hung boiler. All heating circuits are equipped with a mixing valve.

DHW reheating
The DHW is reheated to the set temperature by the FW sensor, if required.

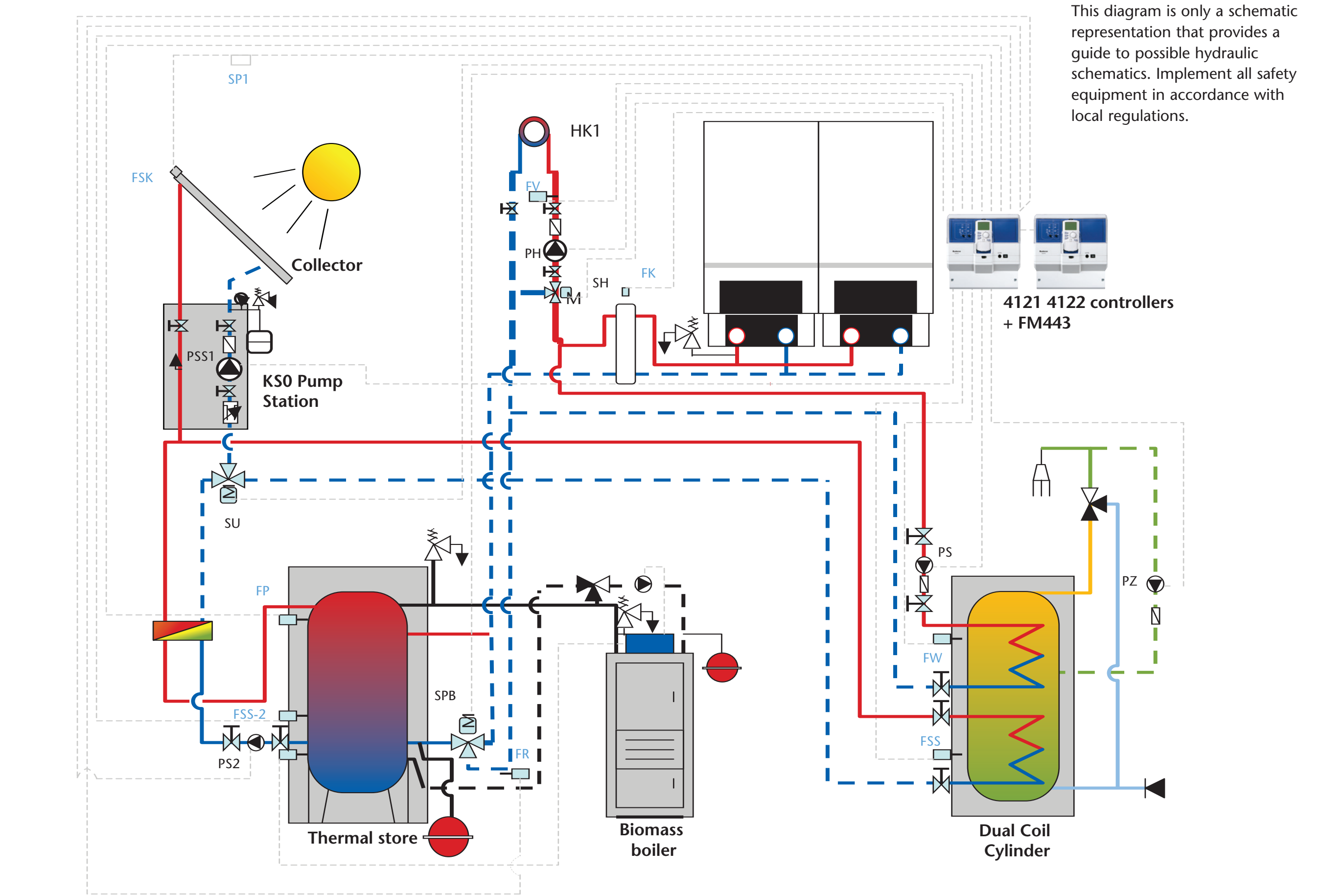
47/1 Wiring diagram with short description of the sample system (General instructions → page 39; abbreviations → page 110)

Floorstanding boiler	Boiler		Solar		
	Control unit	Type	Control unit	Component	
Boiler with EMS	4000	4121	FM443	KS01.. KS01.. E HZG kit	I II III
Third party	Third party	Third party	SC40 (hydraulic system H6 → *22/1*)	KS01.. KS01.. E HZG kit	I II III

47/2 Possible control versions for the solar heating system

4.4.2 Solar DHW heating and central heating backup: Wall hung boiler, solid fuel boiler with twin coil DHW cylinder and thermal store

This diagram is only a schematic representation that provides a guide to possible hydraulic schematics. Implement all safety equipment in accordance with local regulations.



Solar heating circuit	Heating circuit	DHW reheating
The 1st consumer (twin coil DHW cylinder) is heated subject to the temperature differential between FSK and FSS1. If the 1st consumer can no longer be heated, the 2nd consumer (solar buffer) is heated subject to the temperature differential between FSK and FSS-2. Possible heating of the 1st consumer is checked at frequent intervals.	The system return temperature is raised by the solar thermal store if there is a positive temperature differential between the FP and the FR. The temperature is increased to the required flow temperature by the wall hung boiler and the solid fuel boiler. The solar yield is reduced during solid fuel boiler operation. All heating circuits are equipped with a mixing valve.	The DHW is reheated to the set temperature by the FW sensor, if required.

48/1 Wiring diagram with short description of the sample system (General instructions → page 39; abbreviations → page 110)

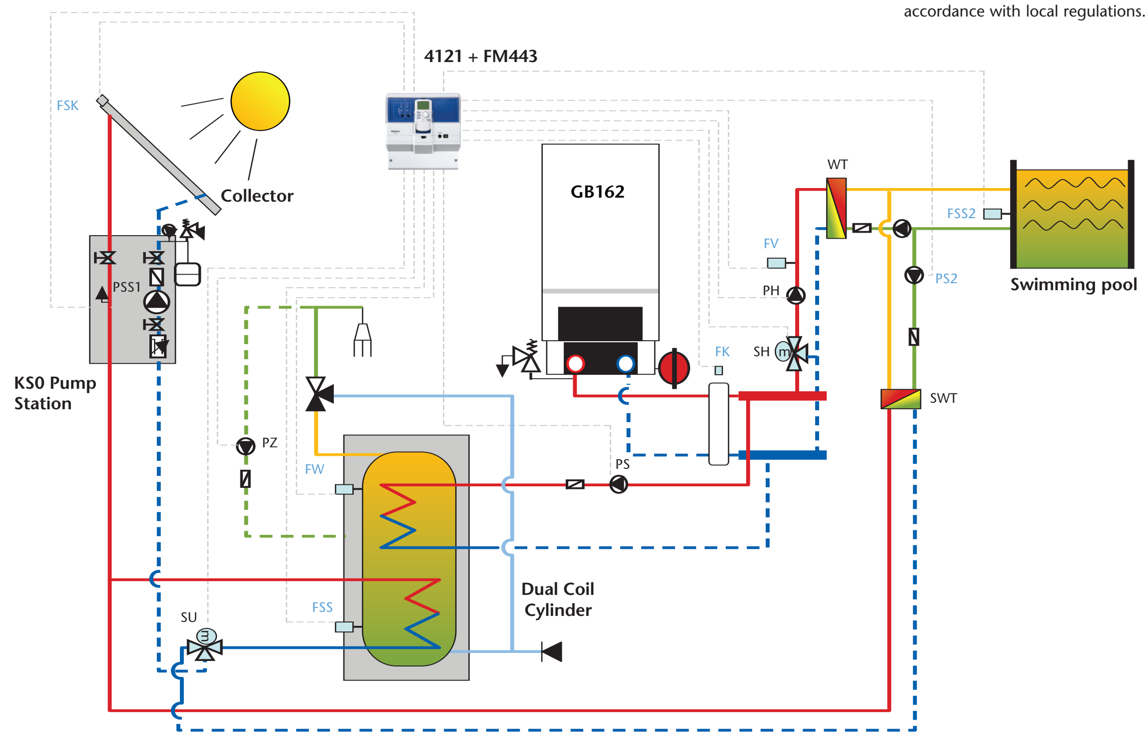
Wall hung boiler	Boiler		Solar		
	Control unit	Type	Control unit	Component	
Boiler with EMS[1]	4000	4121	FM443	KS01.. VS-SU HZG kit	I II III
Third party	Third party	Third party	SC40 (hydraulic system H5 → 22/1)	KS01.. VS-SU HZG kit	I II III

48/2 Possible control versions for the solar heating system
1) Every boiler requires its own chimney

4.5 Solar heating systems for DHW heating and swimming pool heating with conventional oil/gas-fired boilers

4.5.1 Solar DHW heating and swimming pool water heating: Wall hung boiler

This diagram is only a schematic representation that provides a guide to possible hydraulic schematics. Implement all safety equipment in accordance with local regulations.



Solar heating circuit	**DHW reheating**	**Swimming pool water reheating**
The 1st consumer (twin coil DHW cylinder) is heated subject to the temperature differential between FSK and FSS. If the 1st consumer can no longer be heated, the 2nd consumer (swimming pool) is heated via the swimming pool heat exchanger SWT and the secondary circuit pump PS2 subject to the temperature differential between FSK and FSS-2. Possible heating of the 1st consumer is checked at frequent intervals.	The DHW is reheated to the set temperature subject to the FW sensor, if required.	The wall hung boiler reheats the swimming pool water via a heating circuit with heat exchanger (WT).

49/1 Wiring diagram with short description of the sample system (General instructions → page 39; abbreviations → page 110)

Wall hung boiler	Boiler		Solar		
	Control unit	Type	Control unit	Component	
Boiler with EMS	4000	4121	FM443	KS01.. VS-SU SWT PS2	I II III IV
Third party	Third party	Third party	SC40 (hydraulic system S1 → 22/1)	KS01.. VS-SU SWT PS2	I II III IV

49/2 Possible control versions for the solar heating system

5 Sizing

5.1 Sizing principles

5.1.1 Solar DHW heating

Solar heating systems are most frequently used for DHW heating. Check each case individually as to whether it is possible to combine an existing heating system and a solar heating system. The conventional heat source must be able to provide the hot water in a building independently of the solar heating system. There is also an appropriate comfort requirement that must be reliably covered during periods of low solar radiation.

Solar fraction is the percentage of the total heating demand which is met by the solar thermal installation. In general 50-60% of DHW requirements is covered by solar for domestic dwellings.

Fraction of 50% to 60% is generally desirable for DHW heating systems for detached houses and two family homes. Sizing for less than 50% is also relevant if the available consumption values are unreliable. A fraction of less than 50% is generally appropriate in commercial buildings.

5.1.2 Domestic hot water (DHW) heating and central heating backup

Solar heating systems can also be designed as combination systems for DHW heating and central heating backup. Solar swimming pool water heating, combined with DHW heating and central heating backup is also possible.

Since the system is operated at low temperatures during the spring and autumn, the type of heat distribution only plays a minor part in the efficiency of the system. A solar heating system for providing central heating backup can be achieved in combination with an underfloor heating system and with low temperature radiators.

The desired coverage for DHW heating systems combined with central heating backup is between 15% and 35% of the total annual heating demand for DHW and central heating. The achievable coverage is largely dependent on the building's heating demand.

The SKS4.0 high-performance flat-plate collectors are particularly recommended as a solar collector for systems with central heating backup because of its high efficiency and dynamic response behaviour.

5.1.3 Sizing with computer simulation

We recommend the solar heating system is sized using a computer simulation:

- With six collectors or more, or
- If there is a significant difference from the calculation conditions in the sizing diagrams (→ ***51/1*** to ***52/1*** and ***55/1***)

Correct sizing essentially depends on the accuracy of the information concerning the actual DHW demand. The following values are important:

- Daily DHW demand
- Daily profile, DHW demand
- Weekly profile, DHW demand
- Seasonal influence on the DHW demand (e.g. campsite, schools with summer breaks)
- Set DHW temperature
- Existing DHW heating equipment (if an existing system is being extended)
- Circulation losses
- Location
- Orientation
- Slope.

The T-SOL simulation program is extremely practical for calculating solar heating systems. Simulation programs require consumption values as well as the size of the collector row and the cylinder. Consumption information should always be obtained, since values taken from literature are of little use.

The collector row and the solar heating cylinder must therefore be pre-sized for the computer simulation (→ page 51). The required output result is obtained in stages.

The T-SOL program stores results such as temperatures, energy levels, efficiencies and coverage in a file. This information can be displayed on screen in many different ways and can be printed out for further analysis.

The Buderus technical department uses T-Sol software to provide support for installers, investors and consultants.

5.2 Sizing the collector row and solar heating cylinder

5.2.1 Systems for DHW heating in large domestic and small commercial

Number of collectors

Standard values from large domestic and small commercial can be used when a small solar heating system for DHW heating is being sized. The following factors influence the optimum sizing of the collector row, the cylinder and the compact station for solar collector systems for DHW heating:

- Location
- Roof slope (collector angle of inclination)
- Roof orientation (south-facing collector)
- DHW consumption profile.

Take the draw-off temperature in accordance with the existing or intended sanitary equipment into consideration. As a general guideline the number of occupants and their average consumption of DHW per person per day should be considered. Information about particular draw-off habits and comfort requirements are ideal.

Calculation principles

Diagrams ***51/1*** to ***52/1*** are based on a sample calculation with the following system parameters:

- SKS4.0 high-performance flat-plate collectors and SKN3.0 flat-plate collectors
- SKN3.0 and SKS 4.0: 300 litre twin coil cylinder (for more than three collectors: 400 litre cylinder)
- South-facing roof orientation (correction factor → page 53)
- Roof incline 45° (correction factor → page 53)
- Location Exeter (S.W. England)
- Draw-off temperature 45°C.

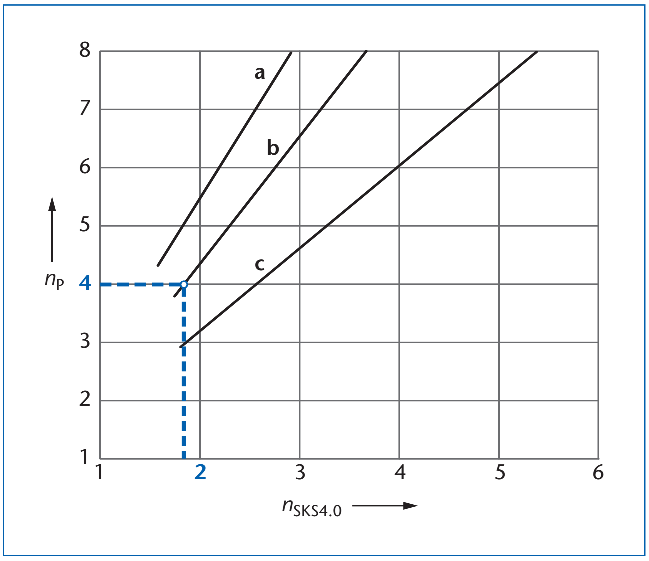
→ Determining the number of collectors in accordance with diagram ***51/1*** or ***52/1*** results in a solar coverage of approx. 60%.

Example

- Household with four occupants and a DHW demand of 200 l per day
- Solar heating system for DHW heating.

→ According to diagram ***51/1***, curve b, two SKS4.0 high-performance flat-plate collectors are required.

SKS4.0



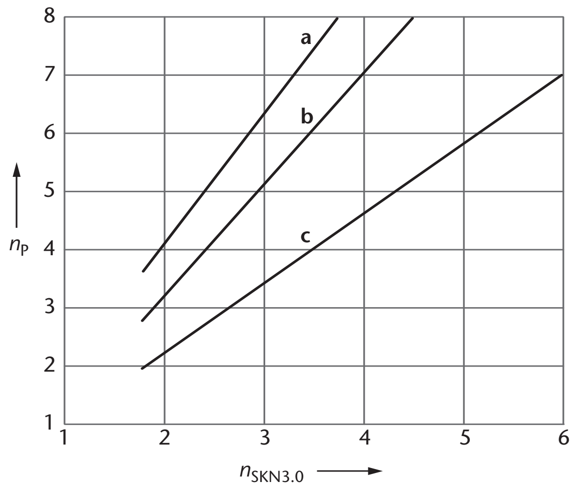
51/1 *Diagram for an approximate determination of the number of SKS4.0 collectors for DHW heating (example highlighted, observe calculation principles!)*

Caption (→ *51/1*)

$n_{SKS4.0}$ Number of collectors
n_P Number of occupants

DHW demand curves:
a Low (< 40 l per person per day)
b Average (50 l per person per day)
c High (75 l per person per day)

SKN3.0



52/1 Diagram for an approximate determination of the number of SKN3.0 collectors for DHW heating (observe calculation principles!)

Caption (→ *52/1*)

$n_{SKN3.0}$ Number of collectors
n_P Number of occupants

DHW demand curves:
a Low (<40 l per person per day)
b Average (50 l per person per day)
c High (75 l per person per day)

Influence of collector orientation and inclination on solar yield

Optimum angle of inclination for collectors

Use of solar heat for	Optimum angle of inclination of collectors
DHW	30° – 45°
Domestic hot water + central heating	45° – 53°
Domestic hot water + swimming pool water	30° – 45°
Domestic hot water + central heating + swimming pool water	45° – 53°

52/2 Angle of inclination of collectors subject to the use of solar heating system

The optimum angle of inclination depends on the use of the solar heating system. The shallower optimum angles of inclination for DHW and swimming pool water heating take into account the higher position of the sun in the summer The wider optimum angles of inclination for central heating backup are designed for the lower sun position in spring and autumn.

Collector orientation according to the points of the compass

Orientation in accordance with the points of the compass and the angles of inclination of the solar collectors have an influence on the thermal energy that is supplied by a collector row. Aligning the collector row south with a deviation of up to 10° east or west and an angle of inclination of 35° to 45° are the ideal conditions for maximum solar yield.

If the collector row is mounted on a steep roof or a wall, the orientation of the collector row is identical to that of the roof or wall. If the collector row orientation deviates to the east or west, the rays of the sun will no longer strike the absorber area in the most effective way. This will reduce the performance of the collector row.

According to table ***53/1*** there is a correction factor for every collector row deviation from the southern point of the compass, subject to the angle of inclination. The collector area that was determined under ideal conditions must be multiplied by this factor to achieve the same energy yield as is achieved with direct orientation south.

Correction factors for solar collectors SKN3.0 and SKS4.0 for DHW heating

Angle of inclination	Correction factors for collector orientation deviation from south												
	Deviation to the west by						South	Deviation to the east by					
	90°	75°	60°	45°	30°	15°	0°	-15°	-30°	-45°	-60°	-75°	-90°
60°	1.26	1.19	1.13	1.09	1.06	1.05	1.05	1.06	1.09	1.13	1.19	1.26	1.34
55°	1.24	1.17	1.12	1.08	1.05	1.03	1.03	1.05	1.07	1.12	1.17	1.24	1.32
50°	1.23	1.16	1.10	1.06	1.03	1.02	1.01	1.04	1.06	1.10	1.16	1.22	1.30
45°	1.21	1.15	1.09	1.05	1.02	1.01	1.00	1.02	1.04	1.08	1.14	1.20	1.28
40°	1.20	1.14	1.09	1.05	1.02	1.01	1.00	1.02	1.04	1.08	1.13	1.19	1.26
35°	1.20	1.14	1.09	1.05	1.02	1.01	1.01	1.02	1.04	1.08	1.12	1.18	1.25
30°	1.19	1.14	1.09	1.06	1.03	1.02	1.01	1.03	1.05	1.08	1.13	1.18	1.24
25°	1.19	1.14	1.10	1.07	1.04	1.03	1.03	1.04	1.06	1.09	1.13	1.17	1.22

53/1 Correction factors with south deviation of SKN3.0 and SKS4.0 solar collectors for different angles of inclination
Correction ranges: 1.00 - 1.05 1.06 - 1.10 1.11 - 1.15 1.16 - 1.20 1.21 - 1.25 >1.25

➞ The correction factors only apply to DHW heating and not for central heating backup.

Example

- Parameters
  – Household with four occupants with DHW demand of 200 l per day
  – Angle of inclination 25° with on-roof installation or in-roof (roof integrated) installation of SKS4.0 solar collectors
  – Deviation to the west by 60°
- Measure
  – 1.8 SKS4.0 collectors (➞ Diagram **51/1**)
  – Correction factor 1.10 (➞ Table **53/1**)
  – The calculation results in: 1.8 x 1.10 = 2.0

➞ To achieve the same energy yield as with direct southerly orientation, allow for 2 SKS4.0 solar collectors.

Cylinder selection (DHW only)

A suitable ratio between collector output (size of collector row) and cylinder capacity (cylinder volume) is required to make a solar heating system operate efficiently. The size of the collector row is limited subject to the cylinder capacity (→ ***54/1***).

Always operate solar heating systems for DHW heating in light commercial buildings with a dual coil cylinder, if possible. A dual coil solar cylinder has a solar heat exchanger and a heat exchanger for reheating by a boiler. In this concept the upper part of the cylinder acts as the standby part. Take this into consideration when selecting a cylinder.

Two-cylinder systems are only worthwhile for greater DHW demands than can be covered by a dual coil cylinder. In such systems, a single coil cylinder for accepting the solar heat is installed upstream of a conventional cylinder. The conventional cylinder must cover all DHW demands. The solar cylinder can therefore be somewhat smaller. The pre heat cylinder has to provide a possibility for thermal disinfection (such as immersion heater or circulation pump to the boiler cylinder).

This concept can also be used for retrofitting a solar heating system in a conventional system. However, the use of a dual coil cylinder should always be considered for energy and financial reasons.

Rule of thumb

A cylinder volume of twice the daily demand has proven to be adequate. Table ***54/1*** shows standard values for selecting the DHW cylinder subject to the DHW demand per day for the relevant number of occupants. A cylinder temperature of 60°C and a draw-off temperature 45°C have been assumed. In a multi-cylinder system the stored volume of DHW should be able to cover twice the daily demand with a draw-off level of 85%.

Cylinder capacity l	Recommended daily DHW demand in litres at a cylinder temperature of 60°C and draw-off temperature of 45°C	Number of occupants with DHW demand per person per day of: 40 l Low	50 l Average	75 l High	Rec. number[1] of collectors SKN3.0 or SKS4.0
290[4]	up to 200/250	approx. 5-6	approx. 4-5	approx. 3	2–3
390[4]	up to 250/300	approx. 6-8	approx. 5-6	approx. 3-4	3–4
490[4]	up to 300/400	approx. 8-10	approx. 6-8	approx. 4-5	4–5
160 (300)[2,3]	up to 200/250	approx. 5-6	approx. 4-5	approx. 3	2–3
200 (300)[2,3]	up to 200/250	approx. 5-6	approx. 4-5	approx. 3	2–3

54/1 Standard values for selecting the DHW cylinder

1) Determining the number of collectors → page 55

2) Subject to the system configuration; relative to a total DHW volume of 300 l and water transfer between the pre-heating stage and the standby cylinder (sample system → 31/1)

3) Pre-heat single coil cylinders

4) Twin coil cylinders

5.2.2 Systems for DHW heating and central heating backup in large domestic properties and light commercial buildings

Number of collectors

The sizing of the collector row for a solar heating system for DHW heating and central heating backup is directly dependent on the heating demand of the building and the required solar coverage. Only partial coverage is generally achieved during the heating season.

→ Diagrams ***55/1*** to ***56/1*** assume an average DHW demand for a 4-person household to be 50 l per person per day for DHW heating.

Calculation principles

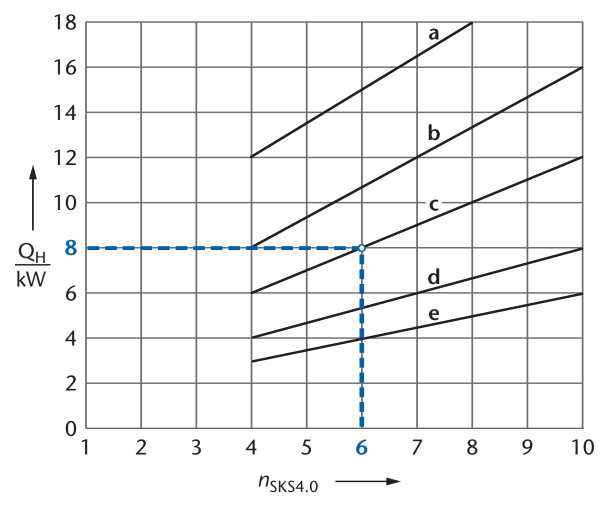
Diagrams ***55/1*** to ***56/1*** are based on a sample calculation with the following system parameters:

- SKS4.0 high-performance flat-plate collectors and SKN3.0 flat-plate collectors
- SKN3.0 and SKS4.0:
  P750 S combi cylinder (for more than six collectors: 1000 litre combi cylinder)
- Household with four occupants with a DHW demand of 200 l per day
- Roof orientation towards south
- Roof pitch 45°
- Location Exeter
- Low temperature heating systems with ϑ_V = 40 °C, ϑ_R = 30 °C.

Example

- Household with four occupants with a DHW demand of 200 l per day
- Solar heating system for DHW heating and underfloor heating backup
- Heating demand 8kW
- Required coverage 25%
- According to diagram ***55/1***, curve c, six SKS4.0 high-performance flat-plate collectors are required.

SKS4.0



55/1 *Diagram for an approximate determination of the number of SKS4.0 collectors for DHW heating and central heating backup (example highlighted, observe calculation principles!)*

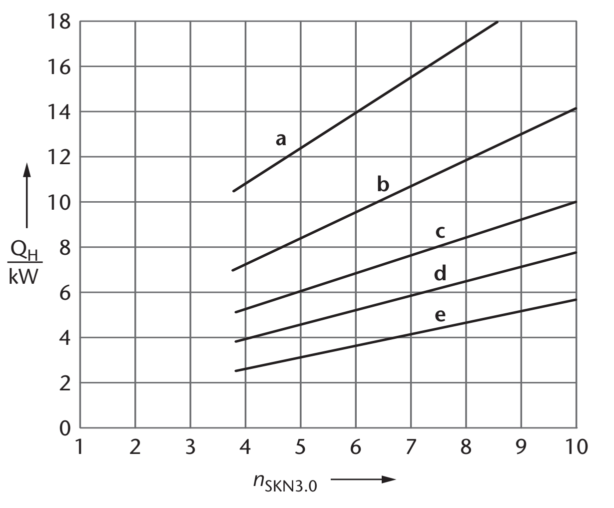
Caption (→ *55/1*)

$n_{SKS4.0}$ Number of collectors
Q_H Heat demand of the building

Curves for fraction of total annual heating demand for DHW heating and central heating

a Coverage of approx. 15%
b Coverage of approx. 20%
c Coverage of approx. 25%
d Coverage of approx. 30%
e Coverage of approx. 35%

SKN3.0



56/1 *Diagram for an approximate determination of the number of SKN3.0 collectors for DHW heating and central heating backup (observe calculation principles!)*

Caption (→ *56/1*)

$n_{SKN3.0}$ Number of collectors
Q_H Heat demand of the building

Curves for coverage of total annual heating demand for DHW heating and central heating

- a Coverage of approx. 15%
- b Coverage of approx. 20%
- c Coverage of approx. 25%
- d Coverage of approx. 30%
- e Coverage of approx. 35%

Cylinder selection (DHW & CH pre-heat)

Solar heating systems for DHW heating and central heating backup should be operated using a combination of a dual coil cylinder and PR thermal store. When a cylinder is being selected ensure that the DHW standby part corresponds to the user's usage pattern.

As well as providing an adequate supply of DHW, a solar heating system for DHW heating and central heating backup must also take the building heating demand into consideration.

A cylinder volume of at least 100 l must be available per flat-plate collector to minimise stagnation times.

The total coverage can be sized in accordance with diagrams ***55/1*** to ***56/1***. A detailed result is provided by simulation using a suitable simulation program.

Alternatively it is possible to install a two-cylinder system instead of a dual coil cylinder. This would be particularly advisable if an additional DHW demand or buffer water demand arises due to an additional consumer. The number of collectors must be adapted to the demand of the additional consumer in this case (e.g. swimming pool or thermal store).

Cylinder capacity	Daily DHW demand in l	Number of occupants with DHW demand per person per day of			Recommended number[1] of collectors SKN3.0 or SKS4.0
l	at a cylinder temperature of 60°C and draw-off temperature of 45°C	40 l Low	50 l Average	75 l High	
290	up to 200/250	approx. 5-6	approx. 4-5	approx. 3	2-3
390	up to 250/300	approx. 6-8	approx. 5-6	approx. 3-4	3-4
490	up to 300/400	approx. 8-10	approx. 6-8	approx. 4-5	4-5

57/1 Standard values for selecting the DHW cylinder for a two-cylinder system.
1) Determining the number of collectors → page 55

DHW cylinder	Buffer capacity	Recommended number of[1] SKN3.0 or SKS4.0 collectors
Buffer vessel	l	
PR750	750	4-8
PR1000	1000	4-8

57/2 Standard values for selecting the thermal store for a two-cylinder system.
1) Determining the number of collectors → page 55
The Buderus PR buffer vessels have to be installed with an external heat exchanger. This heat exchanger is not part of the standard kit and has to be bought separately

5.2.3 Twin coil cylinders in large systems

Residential blocks with multiple dwellings

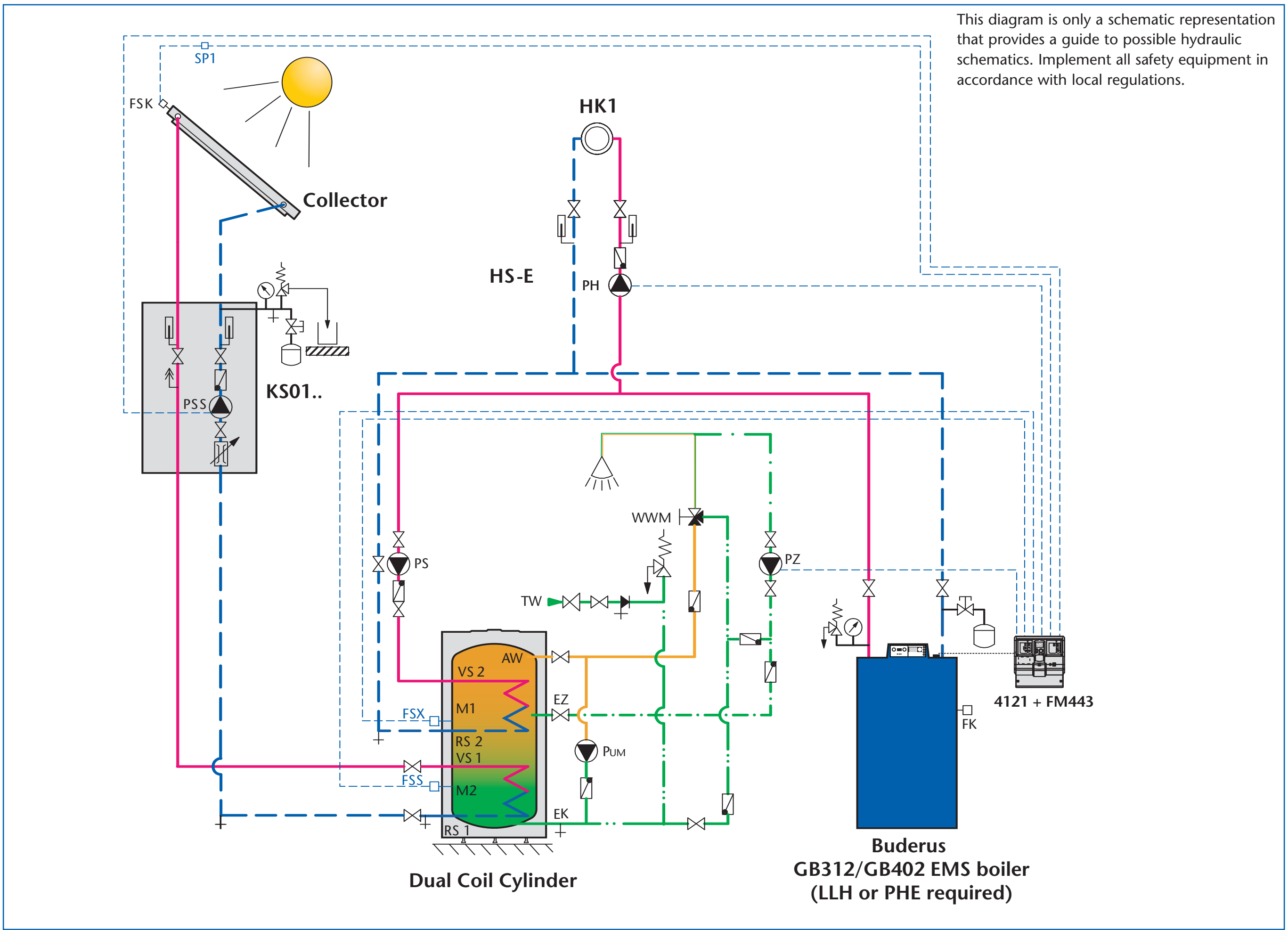
With large systems legionella protection is paramount and the water delivered by the DHW heating system must always be at a temperature of ≥ 60°C. The entire contents of pre-heating stages must be heated to ≥ 60°C at least once per day.

For small detached houses the pre-heating stage (the part of the cylinder volume that is heated by the solar heating system) and the standby part (conventionally heated cylinder volume) must also be combined in a dual coil cylinder. The daily heating is made possible by a water transfer between the standby part and the pre-heating stage. A connecting pipe with circulation pump is provided for this purpose between the DHW outlet and the cold water inlet of the dual coil cylinder. The pump is operated by the FM443 solar function module or an external control system.

→ When sizing the cylinder ensure that the DHW demand can also be covered without solar yield via conventional reheating.

Daily heating/thermal disinfection control

Thermal disinfection control can only be used and completed successfully if the same conditions as those for apartment blocks with up to 30 residential units are met (→ page 60).



58/1 Example of hydraulic integration of a twin coil cylinder in large systems for apartment blocks of 3 to 5 residential units; control of cylinder water transfer and thermal disinfection control in accordance with HSE ACOP L8 using solar function module FM443 (abbreviations → page 110)

5.2.4 Two cylinder system with pre-heating stage

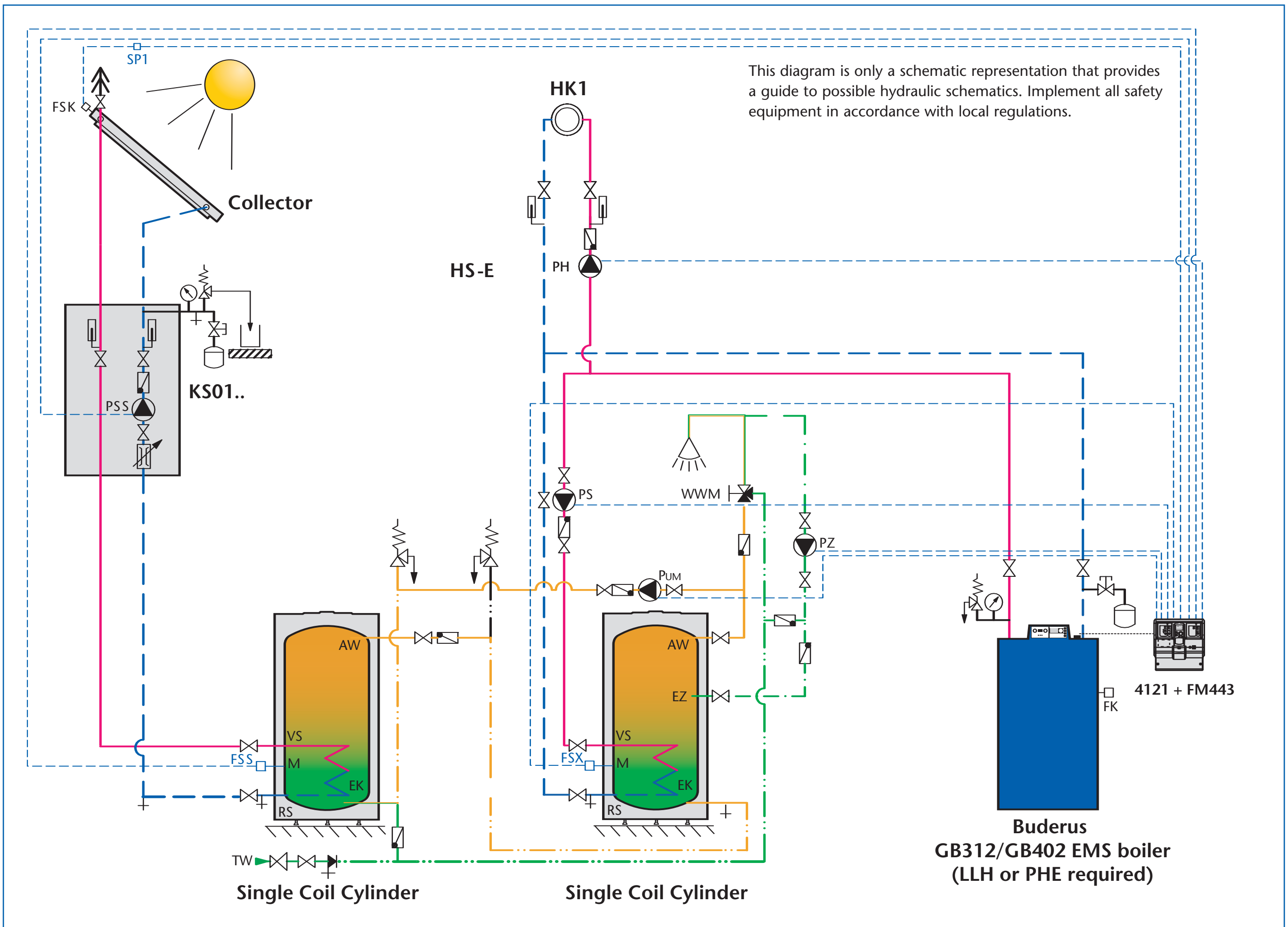
Two-cylinder system with pre-heating stage

The daily heating of the pre-heating stages must always be taken into consideration when solar heating systems are being planned in combination with large systems for DHW heating and legionella protection must always be provided. This ensures that hygiene is maintained, and simultaneously raises the average temperature level in the solar pre-heating stage.

In medium sized systems with a uniform consumption profile (e.g. an apartment block) or lesser coverage requirements of approx. 20% to 30%, systems with preheating stages filled with DHW for retrofit situations are frequently a financially interesting solution in spite of the required daily heating. However, the daily heating reduces the yield considerably in systems with greater coverage requirements of approx. 40% and the associated large solar buffer volumes. A switch to thermal stores filled with primary water with additional heat transfer to the DHW is a frequent solution for such systems. These also offer the advantage that integrating the solar heating system only leads to a slight increase in DHW volume with the SAT-VWS system. Please consult the Buderus planning department for these larger systems.

Systems with DHW cylinders are suitable for retrofitting, since the pre-heating stage and the standby part have separate cylinders. The pre-heating stage and the standby cylinder can be sized separately. The set temperature for the standby cylinder is at least 60°C. Solar heating must be enabled up to 75°C so that the solar heating system can utilise the entire cylinder volume. The solar function module FM443 or solar control unit SC40 switches pump PUM ON for a water transfer between the two cylinders if the preheating cylinder is hotter than the standby cylinder. This means that both cylinders are heated above the set temperature, and the heat loss due to DHW circulation can also be covered by solar energy.

The water transfer is started at a preset time during the night if the required thermal disinfection temperature of 60°C is not achieved during the day.



59/1 Diagram of a two-cylinder system as large system with pre-heat cylinder and standby cylinder filled with DHW; cylinder water transfer and thermal disinfection control regulated in accordance with HSE ACOP L8 by solar function module FM443 (abbreviations → page 110)

Daily heating/thermal disinfection control

The following conditions must be complied with to enable thermal disinfection control to be used and completed successfully:

- Thermal disinfection of the pre-heat stage must take place during periods where no DHW is drawn. This requirement is easiest to comply with at night.
- The flow rate for thermal disinfection should be selected so that the content of the pre-heat cylinder is circulated at least twice per hour. It is advisable to use a three-stage pump that delivers appropriate reserves.
- The temperature of the standby cylinder must not drop below the 60ºC limit whilst thermal disinfection is taking place. The output for thermal disinfection must not be greater than the maximum output for conventional reheating of the standby cylinder so that the temperature in the standby cylinder does not drop.
- To minimise the heat loss between the standby cylinder and the pre-heat cylinder, the pipe must be adequately insulated to a high thermal insulation standard.
- Keep the thermal disinfection pipe as short as possible (close proximity to pre-heat or standby cylinder).
- The DHW circulation must be switched off during preheat stage thermal disinfection (no cooling by circulation return into the standby cylinder).
- If the control unit for heating the standby cylinder has a function for temporarily increasing the set temperature in the cylinder, the time window of this function must precede (e.g. 1/2 h) the time window for pre-heat cylinder thermal disinfection (synchronise both time windows).
- Check the thermal disinfection function during the system commissioning. Select conditions that are identical to the subsequent operating conditions.

Collector area sizing (estimation)

Apply a daily consumption of approx. 70 l to 75 l of DHW at 60ºC per m² of collector area for sizing the collector area in properties with a uniform consumption profile, such as in apartment blocks.

Estimate the DHW demand with care, since less utilisation would lead to a considerable increase in the stagnation time of this system. Higher utilisation helps to improve the system resilience.

By way of simplification, the following formulae can be used taking the specified marginal conditions into consideration.

Please note this formula might not reflect the actual conditions and should only be used for guidance.

$$n_{SKS4.0} = 0.6 \cdot n_{WE}$$

$$n_{SKN3.0} = 0.7 \cdot n_{WE}$$

60/1 Formulae for the required number of SKS4.0 and SKN3.0 solar collectors in relation to the number of residential units (observe marginal conditions!)

Calculating sizes

$n_{SKS4.0}$ Number of SKS4.0 solar collectors
$n_{SKN3.0}$ Number of SKN3.0 solar collectors
n_{WE} Number of residential units

Marginal conditions for formulae → 60/1

- Thermal disinfection control at 02:00 h
- New building circulation cost: 100 W/apartment
  Old building: 140 W/RU
- Location Exeter (S.W. England)
- Pre-heat cylinder temperature max. 75°C, water transfer enabled
- 100 l/RU at 60°C

Cylinder volume sizing

The DHW cylinders connected in series must be equipped with a water transfer facility. Ensure that daily heating takes place, and also a transfer of hotter water from the pre-heat cylinder to the standby cylinder. The cylinder volume for the solar heating system then consists of the volume of the pre-heat cylinder plus the volume of the standby cylinder.

Observe the sensor positions that are required during cylinder selection. A cylinder with removable flexible foam insulation makes it possible to attach additional contact sensors, e.g. using straps.

Pre-heat cylinder

The minimum pre-heat cylinder volume should be approx. 20 l per square metre of collector area:

$$V_{VWS,min} = A_K \cdot 20\ l/m^2$$

61/1 Formula for minimum pre-heat cylinder volume in relation to the collector area

Calculating parameters (→ *61/1*)

A_K Collector area in m^2
$V_{VWS,min}$ Minimum pre-heat cylinder volume in l

An increase in the specific cylinder volume increases the system resilience regarding consumption fluctuations, on the other hand more conventional energy would be required for daily heating.

The pre-heat cylinder must provide a facility for positioning two additional sensors at 20% and 80% of the cylinder height.

The maximum number of collectors for the pre-heat cylinder as per table ***61/2*** applies to a maximum cylinder temperature of 75°C and solar heating system coverage of 25% to 30%. A heat transfer to the collector circuit is not safeguarded if the maximum cylinder temperature is exceeded. Simulations must be used to verify that stagnation is unlikely to occur. This is particularly important for properties with limited summer use (e.g. schools).

Pre-heat cylinder litres	Number of solar collectors SKN3.0	Number of solar collectors SKS4.0
400 litres	16	14
500 litres	20	16
750 litres	22	18
1000 litres	25	21

61/2 Maximum number of collectors for a pre-heat cylinder (with a maximum cylinder temperature of 75°C and solar heating system coverage of 25% to 30%)

Standby cylinder

The standby cylinder is not heated at a lower temperature differential (maximum temperature minus reheat temperature) than the pre-heat cylinder, but this cylinder provides about one third of the necessary cylinder capacity because of its larger volume. The heating of the standby cylinder also enables an integration and provision of solar coverage of the heat loss resulting from the DHW circulation.

The standby cylinder is sized in accordance with conventional heat demand without taking the preheat cylinder volume that is heated using solar energy into consideration. However, the specific total cylinder volume should be approx. 50 l per square metre of collector area:

$$\frac{V_{BS} + V_{VWS}}{A_K} \geq 50\ l/m^2$$

61/3 Formula for minimum total cylinder volume of pre-heat stage and standby part per square metre of collector area

Calculating parameters (→ *61/3*)

A_K Collector area in m^2
V_{BS} Standby cylinder volume in l
V_{VWS} Pre-heat cylinder volume in l

5.2.5 Swimming pool water heating systems

The weather conditions and the swimming pool heat loss into the ground have a considerable influence on sizing. For that reason, sizing a solar heating system for heating swimming pool water can only ever be approximate. Basically, the sizing has to be oriented to the area of the pool. The water cannot be guaranteed to be at a certain temperature over several months.

→ If the solar swimming pool water heating system is combined with DHW heating, we recommend the use of a dual coil solar heating cylinder with a large solar indirect coil and limited cylinder heating up to 60°C.

Standard values for indoor swimming pools with covers

Conditions for standard indoor swimming pool values

- Pool basin covered when not in used (insulation)
- Set pool water temperature 24°C

If the required set water temperature is higher than 24°C, the number of required collectors increases by the correction factor in table ***62/1***.

Please note this is an approximation so might not reflect actual conditions and should only be used for guidance.

Range	Reference size	Sizing with solar collectors	
		SKN3.0	SKS4.0
Pool surface	Pool surface in m²	1 collector for every 5m²	1 collector for every 6.4m²
Correction factor for pool water temperature	Deviation above 24°C pool water temperature	1.3 additional collectors For every +1°C above a pool water temp. of 24°C	1 additional collector

62/1 Standard values for calculating the number of collectors for swimming pool water heating for a covered indoor swimming pool (insulation).

Example

- Parameters
  - Indoor swimming pool, covered
  - Pool surface 32m²
  - Pool water temperature 25°C
- Wanted
  - Number of SKS4.0 solar collectors for solar swimming pool water heating

- Example (→ ***62/1***)
- 5 SKS4.0 solar collectors for pool area of 32m²
- 1 SKS4.0 solar collector as correction for +1°C above 24°C pool water temperature

→ Six SKS4.0 solar collectors are required for solar swimming pool water heating.

Standard values for outdoor swimming pools

The standard values only apply if the swimming pool is insulated and embedded in the ground in a dry condition. First insulate the pool if the swimming pool is at the level of groundwater without insulation. Then carry out a heat load calculation.

Covered outdoor swimming pool (or indoor swimming pool without insulation)

A ratio of 1:2 applies as standard value. This means that the area of a collector row with SKN or SKS must be half the size of the pool surface area.

Outdoor swimming pool without insulation

In this case the standard value ratio is 1:1. This means that the area of a collector row comprising SKN or SKS must be the same size as the pool surface.

If the solar heating system is intended for an outdoor swimming pool, DHW heating and/or central heating backup, add the required collector areas for the swimming pool water and DHW. Do not add the collector areas for central heating. The solar heating system heats the outdoor swimming pool in summer and central heating in winter. DHW is heated all year round.

5.3 Space requirements for solar collectors

5.3.1 Space requirement with on-roof and in-roof (roof integrated) installation

Solar collectors can be installed on roofs with a pitch of 25° to 65° and offer two installation options. These are on-roof installations (→ page 88) and in-roof (roof integrated) installations (→ page 95). Installation on corrugated sheets and sheet metal roofs (on-roof installation only) can only be carried out on roof pitches between 5° and 65°.

→ At the planning stage, the amount of space required beneath the roof must be taken into consideration as well as the area required on top of the roof.

Dimensions A and B represent the space requirement for the selected number and layout of collectors (→ *64/1* to *64/2*). With in-roof (roof integrated) installation they include the area required for the collectors and their connection kits. These dimensions must be considered to be the minimum requirements. Installation with two persons is made easier by also removing one or two rows of tiles around the collector row. For this, dimension C is regarded as the upper limit.

Dimension C represents at least two rows of tiles up to the roof ridge. If the tiles are laid in concrete there is a risk of damaging the roof cover at the roof ridge.

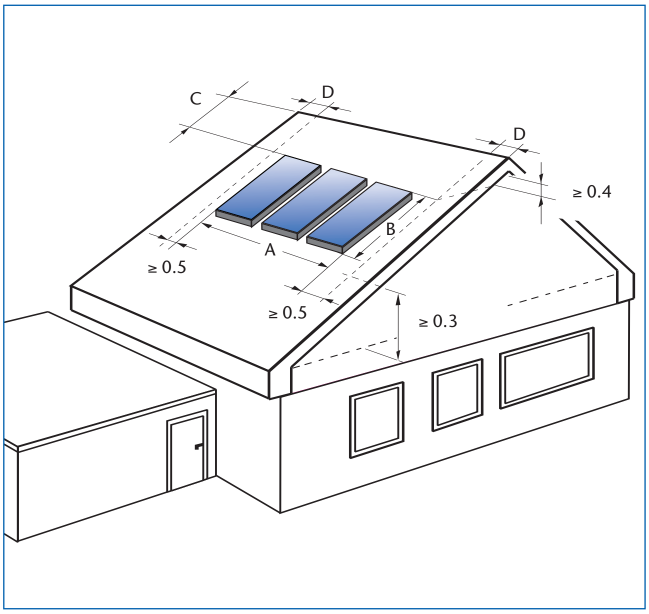
Dimension D represents the roof overhang, including the gable end thickness. The adjacent 0.5m space from the collector row is required beneath the roof, subject to the connection version (right or left).

Allow 0.5m to the right and/or left of the collector row for the connecting pipes (beneath the roof!).

Allow 0.3m beneath the collector row (beneath the roof!) for routing the return connecting pipe.

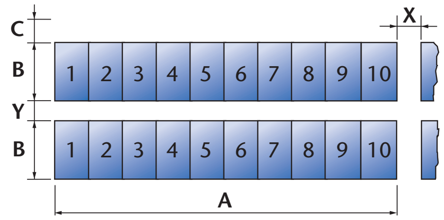
→ Route the return pipe with a rise to the automatic air vent valve if the system is not filled using a filling station.

Allow 0.4m above the collector row (beneath the roof!) for routing the flow header (rising) and the air cowl with automatic air vent valve if the system is not filled using a filling station.



63/1 *Space requirements for on-roof and in-roof (roof integrated) installation of solar collectors (explanation in the text body); dimensions in m*

Area required for solar collector on-roof and in-roof (roof integrated) installation



A Width of collector row
B Height of collector row
C Distance from roof ridge (at least two rows of tiles → *63/1*)
X Distance between collectors rows side by side
Y Distance between collectors rows above each other

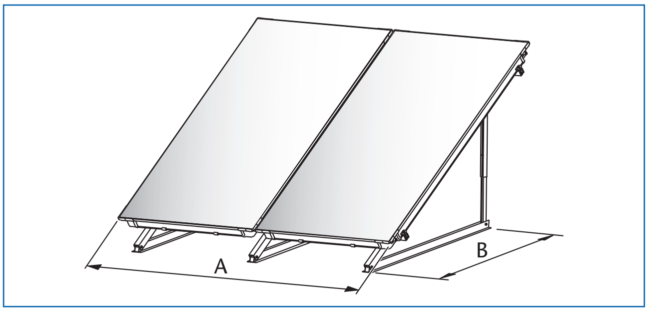
64/1 Area required for collector rows for on-roof and in-roof (roof integrated) installation (dimensions → 64/2)

Dimensions		Collector row dimensions for flat-plate collectors			
		SKN3.0 and SKS4.0 at on-roof installation		SKN3.0 and SKS4.0 at in-roof (roof integrated) installation	
		portrait	landscape	portrait	landscape
A for 1 collector	m	1.15	2.07	–	–
for 2 collectors	m	2.32	4.17	2.67	4.52
for 3 collectors	m	3.49	6.26	3.84	6.61
for 4 collectors	m	4.66	8.36	5.01	8.71
for 5 collectors	m	5.83	10.45	6.18	10.80
for 6 collectors	m	7.06	12.55	7.41	12.90
for 7 collectors	m	8.17	14.64	8.52	14.99
for 8 collectors	m	9.34	16.74	9.69	17.09
for 9 collectors	m	10.51	18.83	10.86	18.96
for 10 collectors	m	11.68	20.93	12.03	21.28
B	m	2.07	1.15	2.80	1.87
C		2 rows of tiles	2 rows of tiles	2 rows of tiles	2 rows of tiles
D (At each end of collector field)		0.5m	0.5m	0.5m	0.5m
X		≈ 0.20m	≈ 0.20m	3 rows of tiles	3 rows of tiles
Y		subject to roof construction (batten spacing)	subject to roof construction (batten spacing)	–	–

64/2 Collector row dimensions with flat-plate collectors for on-roof and in-roof (roof integrated) installation (→ 64/1)

5.3.2 Space required for flat roof installation

Flat roof installation is possible with portrait and landscape SKS4.0 or SKN3.0 collectors. The area required for the collectors corresponds to the installation area for the flat roof supports used plus a space for pipework routing. This space should be at least 0.5m to the left and right of the row. Maintain a minimum distance of one metre from the roof edge.



65/1 *Flat roof stand installation dimensions on the example of SKN3.0-s and SKS4.0-s portrait flat-plate collectors (dimension A → 65/2 and dimension B → 65/3)*

Number of collectors	Collector row dimensions for SKN3.0 and SKS4.0	
	portrait	landscape
	A m	A m
2	2.34	4.18
3	3.51	6.28
4	4.68	8.38
5	5.85	10.48
6	7.02	12.58
7	8.19	14.68
8	9.36	16.78
9	10.53	18.88
10	11.70	20.98

65/2 *Collector row dimensions when using flat roof supports*

Angle of inclination	Collector row dimensions for SKN3.0 and SKS4.0	
	portrait	landscape
	B m	B m
25°	1.84	1.06
30°	1.75	1.02
35°	1.68	0.96
40°	1.58	0.91
45°	1.48	0.85
50°	1.48	0.85
55°	1.48	0.85
60°	1.48	0.85

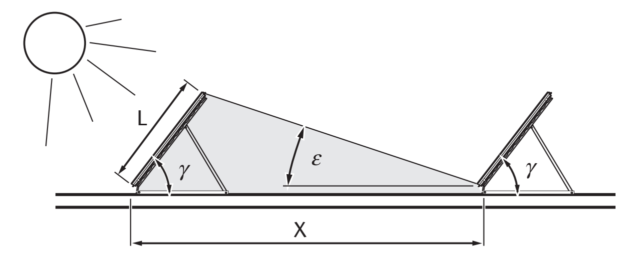
65/3 *Collector row dimensions when using flat roof supports*

Minimum space requirement per row

If several rows of collectors are installed behind each other, they must be a minimum distance apart to minimise the shading on the collectors at the back. Standard values that apply to standard sizing apply to this minimum spacing (→ **65/6**).

$$X = L \cdot \left(\frac{\sin \gamma}{\tan \varepsilon} + \cos \gamma\right)$$

65/4 *Formula for minimum row spacing for flat roof installation*



65/5 *Calculation parameter display (formula → 65/4)*

Calculation parameters (→ 65/4 and 65/5)

X Free minimum spacing between collector rows (standard values → 65/6)

L Length of solar collectors (either landscape or portrait)

γ Collector angle of inclination relative to the horizontal (standard values → 65/6)

ε Minimum solar altitude relative to the horizontal without shading

Angle of inclination[1]	Free minimum space X between collector rows for SKN3.0 and SKS4.0	
	portrait	landscape
γ	m	m
25°[2]	4.74	2.63
30°[3]	5.18	2.87
35°	5.58	3.09
40°	5.94	3.29
45°	6.26	3.46
50°	6.52	3.61
55°	6.74	3.73
60°	6.90	3.82

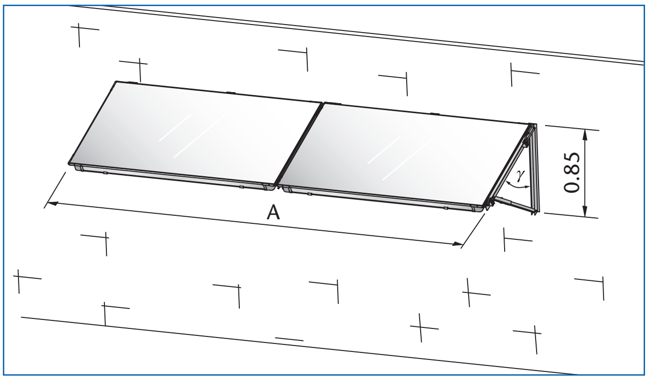
65/6 *The standard values for the minimum space between collector rows at different angles of inclination (→ 65/5; relative to the minimum solar altitude without shading of 17° as the mean between the Münster and Freiburg, Germany locations on the 21st December at 12.00 h (midday))*
1) Only these angles of inclination are approved by the manufacturer. The use of different positions could damage the system.
2) Adjustable by trimming the telescopic strut
3) Adjustable by trimming the telescopic strut with landscape collectors
4) Angle of inclination only meaningful for DHW heating
5) Angle of inclination only meaningful for combined DHW and central heating backup

5.3.3 Space requirements for wall mounting

Flat-plate collectors

Wall mounting is only suitable for SKN3.0-w and SKS4.0-w landscape flat-plate collectors, and is only approved for an installation height of up to 20m. The wall must have adequate load-bearing capacity (→ page 103)!

The space requirement on the wall for the collector rows depends on the number of collectors. In addition to the width of the collector row, allow at least 0.5m to the left and right (dimension A → *66/2*) for routing the pipework. The space between the collector row and the edge of the wall must be at least one metre.



66/1 Installation dimensions of wall mounting kits for SKN3.0-w and SKS4.0-w landscape flat-plate collectors; dimensions in m (dimension A → 66/2)

Number of collectors	Collector row dimensions for SKN3.0-w and SKS4.0-w
	landscape
	A m
2	4.17
3	6.26
4	8.36
5	10.45
6	12.55
7	14.64
8	16.74
9	18.83
10	20.93

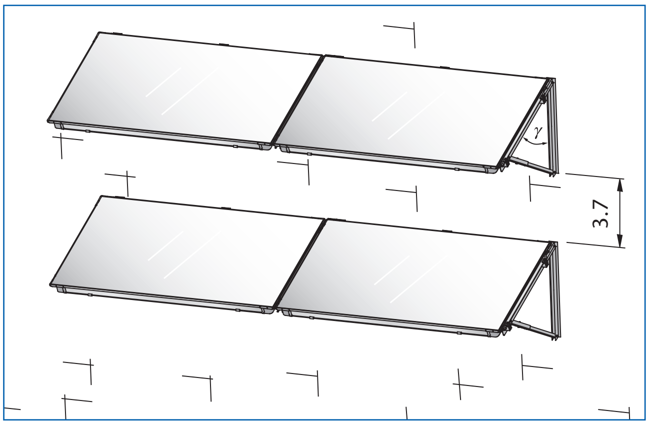
66/2 Collector row dimensions when using wall mounting supports

Minimum row spacing

The wall mounting kit is particularly suitable for buildings the roof orientation of which deviates considerably from south or for providing windows and doors with shade. From a technical point of view this allows the best possible use to be made of the sun, and also represents an architectural feature.

In summer the collector provides ideal shade for windows and keeps the rooms nice and cool. In winter, when the sun is at a low altitude, the rays if the sun can shine into the window below the collector and therefore provide an additional source of energy.

→ Several rows of collectors arranged above of each other must be kept at least 3.7m apart to prevent the collectors from casting shadows on each other (→ *66/3*). If shading on the collectors is acceptable, the space between the rows could be reduced.



66/3 Shade-free spacing for several rows of wall installation kits for landscape flat-plate collectors arranged above each other. SKN3.0-w and SKS4.0-w; dimension in m

5.4 Hydraulic system

5.4.1 Hydraulic circuit

Collector row

A collector row should consist of the same collectors and have the same collector orientation (all portrait or all landscape). This is necessary to achieve equal flow rates through all collectors without a need for balancing valves. A maximum of ten SKN3.0 or SKS4.0 flat-plate collectors may be installed next to each other and hydraulically connected in a collector row if the connections are on alternate sides. If the connections are all on the same side, a maximum of five SKS4.0 flat-plate collectors can be installed next to each other and hydraulically connected.

In small systems it is preferable to connect collectors in series. For larger systems the collectors should be installed in parallel to achieve a well balanced flow (see example diagrams ***68/1-3***, ***69/1***).

	Connection in series		Connection in parallel
Row(s)	Max. number of collectors per row with flat-plate collectors	**Row(s)**	Max. number of collectors per row with flat-plate collectors
1	10	**1**	With alternate connections max. 10 collectors per row or with connections on same side max. 5 SKS4.0 per row
2	5	**2**	
3	3	**3**	
4	Not possible	**4**	
		…	
		…	
		n	

67/1 Collector row layout options

Connection in series

The hydraulic connection of collector rows in series is quickly accomplished because of the ease of connection. Connection in series is the easiest way to balance the flow rates through the collectors. A balanced system flow through the individual collectors can be achieved, even if the collector rows are asymmetrically distributed.

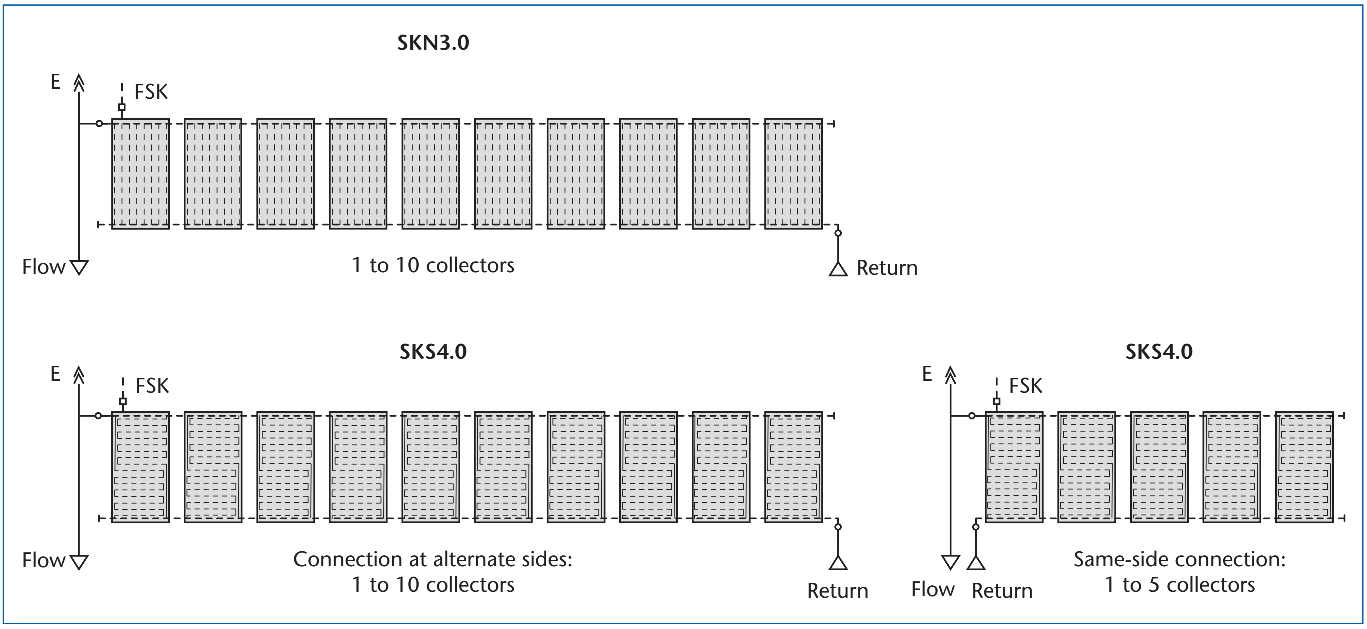
The number of collectors per row should be equal, if possible. However, the number of collectors in the individual rows must not differ by more than one.

The maximum number of flat-plate collectors connected in series is limited to 9 or 10 collectors and 3 rows (→ ***67/1***).

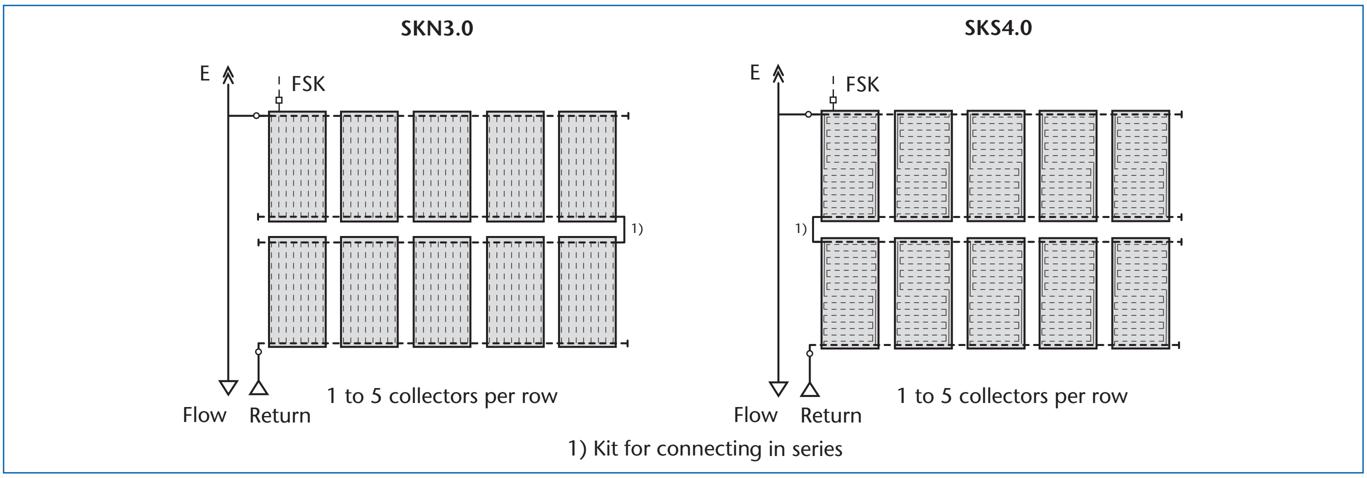
Allow for a higher pressure drop if SKS4.0 collectors are connected in series (→ ***71/2***).

The hydraulic connection is shown in the following diagram on the example of an on-roof installation. Additional automatic air vent valves may be required if such valves cannot be installed above the top row (i.e. flat roof installation) (→ page 84). As an alternative to the use of automatic air vent valves, the system can also be operated using an air separator in the plant room (separate or integrated into the KS01... compact station) if the system is filled via a filling station.

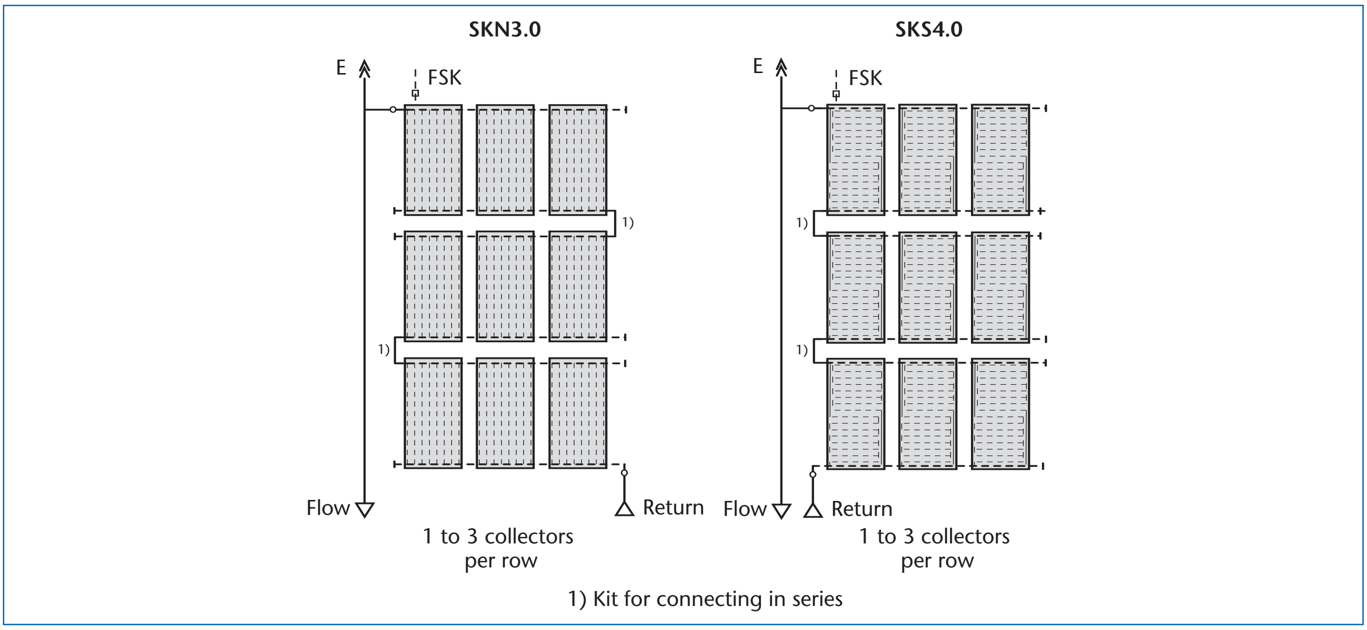
Examples of connections in series



68/1 Layout of a row of collectors



68/2 Two collector rows connected in series



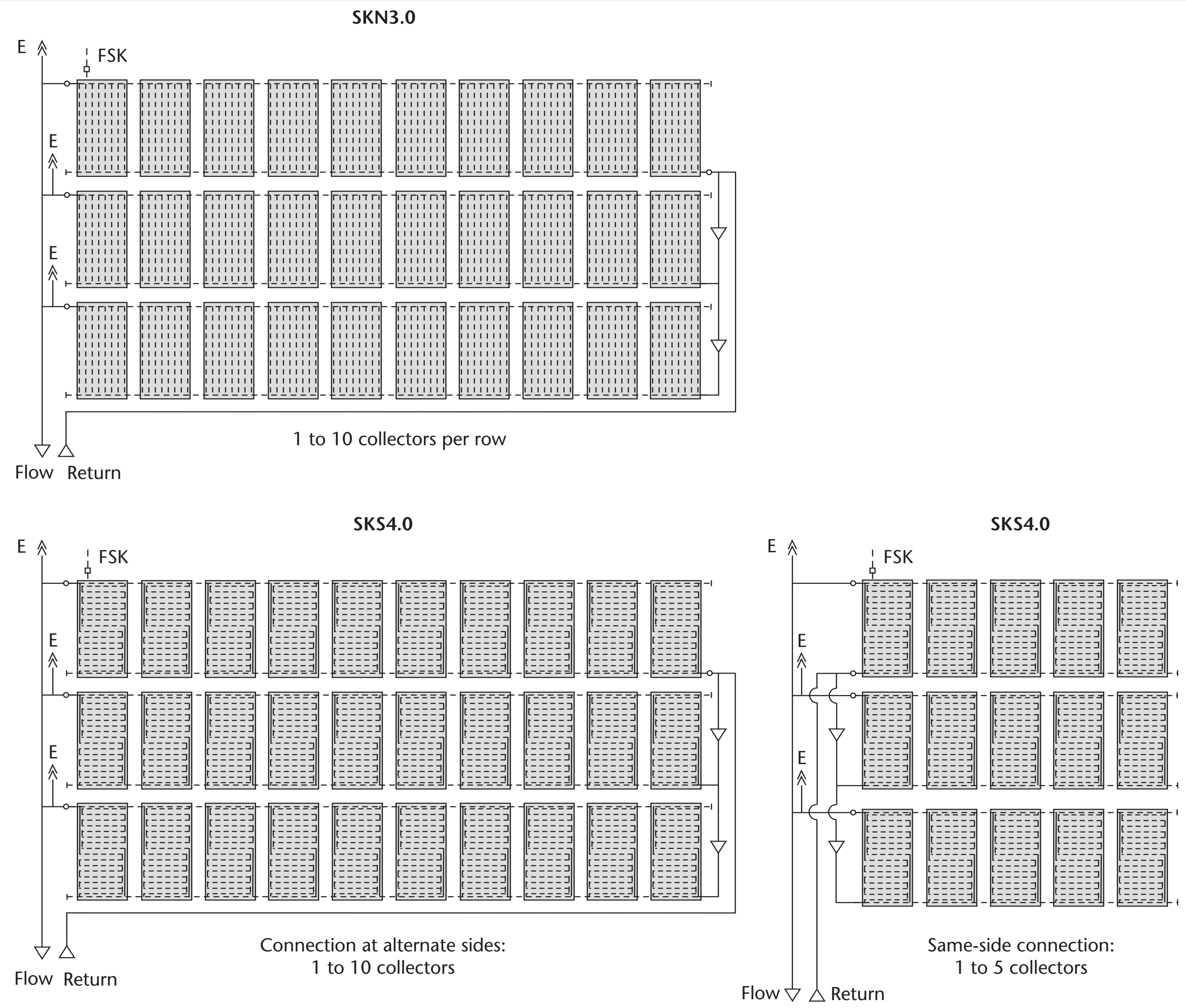
68/3 Three collector rows connected in series

Connection in parallel

Connect the collector rows in parallel if more than 10 flat-plate collectors. Rows connected in parallel must consist of the same number of collectors and must be hydraulically connected in accordance with the reverse return principle. Ensure that the pipe diameters are identical. Perform a hydraulic balancing if this is not possible. Provide a reverse return loop in the return to minimise heat losses. Collector rows that are installed side by side can be arranged in a mirror image so that both rows can be connected with a riser in the centre.

Ensure that only collectors of one type are used, since portrait and landscape collectors have a different pressure drop.

Each row requires a separate automatic air vent. As an alternative to the use of automatic air vent valves (→ page 84), the system can also be operated using an air separator in the plant room (separate or integrated into the KS01... compact station) if the system is filled via a BS01 filling station (→ page 85). In this case, a shut-off valve is required for each flow in a row.



1) For improved ventilation and for calibrating the collector rows install a shut-off ball valve in each outlet.

69/1 Connecting collector rows in parallel

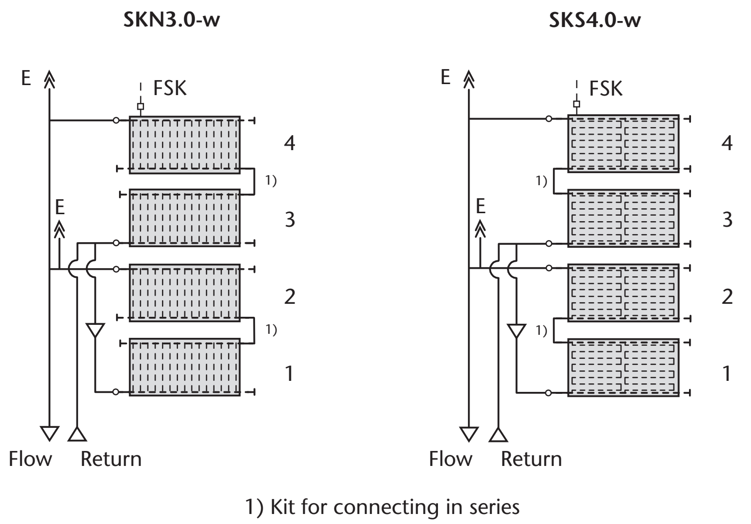
Combined connection in series and in parallel

It is only possible to hydraulically connect more than three collectors above or behind each other by using a combination of connection in series and connection in parallel. This is done by connecting the bottom two (1 + 2) and the top two (3 + 4) collectors in series (→ *70/1*).

Then connect rows 1 + 2 to rows 3 + 4 in parallel. Here too, observe the position of the automatic air vent valve.

→ The maximum permitted number of collectors per row is 5 if two collector rows connected in series are connected to each other in parallel.

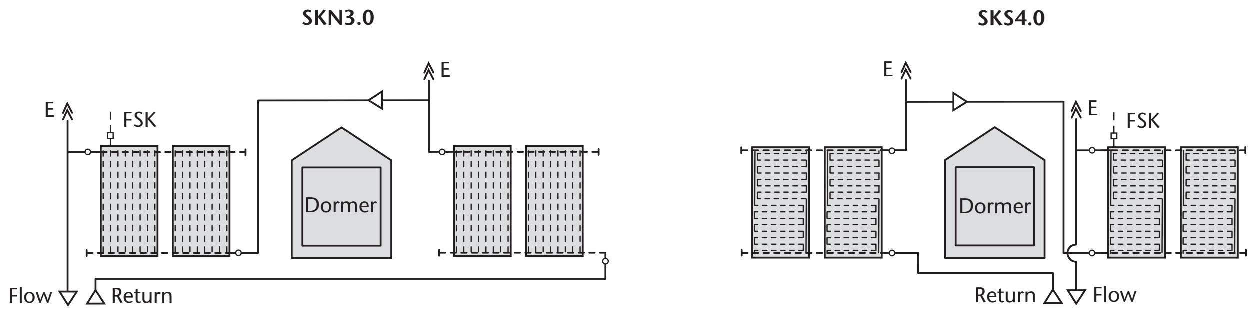
→ Take the pressure drop of the collector row into consideration when selecting the solar pump station.



70/1 *Connection of more than three landscape collectors above each other*

Collector row with dormer

The following hydraulic schematics represent one option for solving the problem of dormers. These hydraulic schematics generally equate to two rows of collectors connected in series. Observe the information concerning the maximum number of collectors that can be used in rows of collectors connected in series. As an alternative to the use of automatic air vent valves, the system can also be operated using an air separator in the airing cupboard (separate or integrated into the KS01... compact station) if the system is filled via a filling station.



70/2 *Hydraulic connection of collector rows that are interrupted by a dormer*

5.4.2 Flow rate in the collector row for flat-plate collectors

The nominal flow rate for engineering small and medium-sized systems is 50 l/h per collector, resulting in a total system flow rate as per formula ***71/1***.

→ A flow rate 10% to 15% lower (at full pump rate) does not usually lead to significant yield reductions. However, avoid higher flow rates to minimise the amount of power required by the solar circuit pump.

$$\dot{V}_A = \dot{V}_{K,Nom} \cdot n_K \qquad 50\ \text{l/h} \cdot n_K$$

71/1 Formula for total system flow rate

Calculating sizes

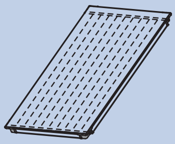
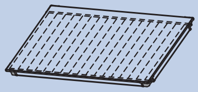
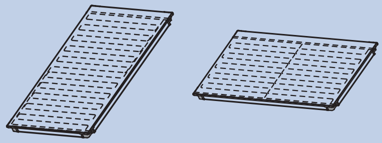
$\dot{V}_A$ Total system flow rate in l/h
$\dot{V}_{K,Nom}$ Nominal flow rate of collector in l/h
n_K Number of collectors

5.4.3 Pressure drop calculation in collector row for flat-plate collectors

Collector row pressure drop

The pressure drop of a collector row increases with the number of collectors per row. The pressure drop for a row including connecting accessories, subject to the number of collectors per row, can be found in the table ***71/2***.

→ The pressure drop values for the SKS4.0 and SKN3.0 collectors for a solar fluid mixture consisting of 50% glycol and 50% water at a mean temperature of 50°C are specified in the table ***71/2***.

Number of collectors	Pressure drop for a row consisting of n collectors								
	SKN3.0 portrait 			SKN3.0 landscape 			SKS4.0 portrait and landscape 		
	at a flow rate per collector (nominal flow rate 50 l/h)								
	50 l/h	100 l/h[1]	150 l/h[2]	50 l/h	100 l/h[1]	150 l/h[2]	50 l/h	100 l/h[1]	150 l/h[2]
n	mbar	mbar	mbar	mbar	mbar	mbar	mbar	mbar	mbar
1	1.1	4.7	10.2	0.4	1.7	4.3	30	71	131
2	1.5	6.5	13.2	1.9	6.9	14.4	31	73	133
3	2.1	13.5	26.3	5.6	18.1	35.1	32	82	153
4	6.5	22.1	–	9.3	29.7	–	39	96	–
5	11.1	34.5	–	14.8	46.8	–	44	115	–
6	15.2	–	–	21.3	–	–	49	–	–
7	21.0	–	–	28.9	–	–	61	–	–
8	28.0	–	–	37.6	–	–	73	–	–
9	35.9	–	–	47.5	–	–	87	–	–
10	45.0	–	–	58.6	–	–	101	–	–

71/2 Pressure drop values for collector rows with SKN3.0 or SKS4.0 including AAV and connection kit; pressure drop values apply to solar fluid L at an average temperature of 50°C
1) Flow rate per collector, connected in two rows (→ page 72)
2) Flow rate per collector, connected in three rows (→ page 72)
– Non-permissible number of collectors

Rows of collectors connected in series

The pressure drop of the row results from the total of all pipework drop values and the pressure drop for each row of collectors. The pressure drop of rows of collectors connected in series is cumulative.

$$\Delta p_{Array} = \Delta p_{Row} \cdot n_{Row}$$

72/1 *Formula for pressure drop of a collector row with rows of collectors connected in series*

As far as table ***71/2*** is concerned, take into consideration that the actual flow rate is calculated via the individual collectors connected in series from the number of collector rows and the nominal collector flow rate (50 l/h):

$$\dot{V}_K = \dot{V}_{K,Nom} \cdot n_{Row} = 50\ l/h \cdot n_{Row}$$

72/2 *Formula for flow rate through a collector with rows of collectors connected in series*

Calculation parameters (→ *72/1* and *72/2*)

$\varnothing p_{Array}$ Pressure drop for collector array in mbar
$\varnothing p_{Row}$ Pressure drop for one collector row in mbar
n_{Row} Number of collector rows
$\dot{V}_K$ Flow rate through the individual collectors in l/h
$\dot{V}_{K,Nom}$ Nominal flow rate of collector in l/h

Example

- Parameters
  – Connection in series of 2 collector rows, each with 5 SKN3.0-s solar collectors
- Wanted
  – Pressure drop of overall collector row
- Calculation
  – Flow rate through one collector:

  $\dot{V}_K = \dot{V}_{K,Nom} \cdot n$

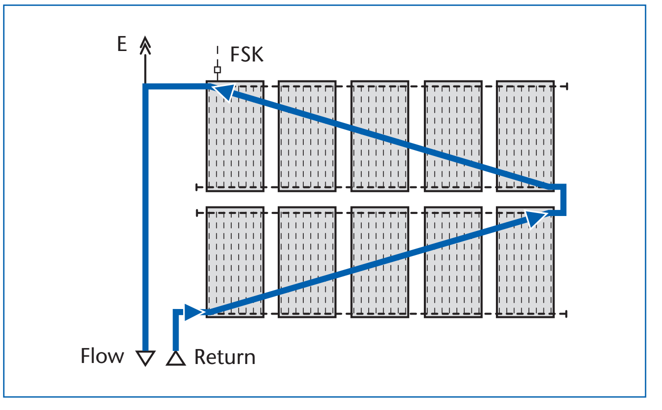
  $\dot{V}_K = 50\ l/h \cdot n_{Row} = 50\ l/h \cdot 2 = 100\ l/h$

  – Read-off from table *71/2*:
  34.5 mbar per collector row

  – Pressure drop of row:

  $\varnothing p_{Array} = \varnothing p_{Row} \cdot n_{Row} = 34.5\ mbar \cdot 2 = 69\ mbar$

→ The pressure drop of the collector row is 69 mbar.



72/3 *Connection in series of two SKN3.0 collector rows*

Collector rows connected in parallel

The pressure drop for the row results from the total of the pipework pressure drop values up to a collector row and the pressure drop of an individual collector row.

$$\Delta p_{\text{Array}} = \Delta p_{\text{Row}}$$

73/1 *Formula for the pressure drop of a collector row with rows of collectors connected in parallel*

Unlike the situation when connecting in series, the actual flow rate via the individual collectors corresponds to the nominal collector flow rate (50 l/h)

$$\dot{V}_{\text{K}} = \dot{V}_{\text{K,Nom}}$$

73/2 *Formula for the flow rate through a collector with rows of collectors connected in parallel*

Calculation parameters (→ *73/1* and *73/2*)

$\varnothing p_{\text{Array}}$ Pressure drop for collector array in mbar
$\varnothing p_{\text{Row}}$ Pressure drop for one collector row in mbar
$\dot{V}_{\text{K}}$ Flow rate through the individual collectors in l/h
$\dot{V}_{\text{K,Nom}}$ Nominal flow rate of collector in l/h

Example

- Parameters
  – Connection in parallel of 2 collector rows, each with 5 SKN3.0-s solar collectors
- Wanted
  – Pressure drop of overall collector row
- Calculation
  – Flow rate through one collector:

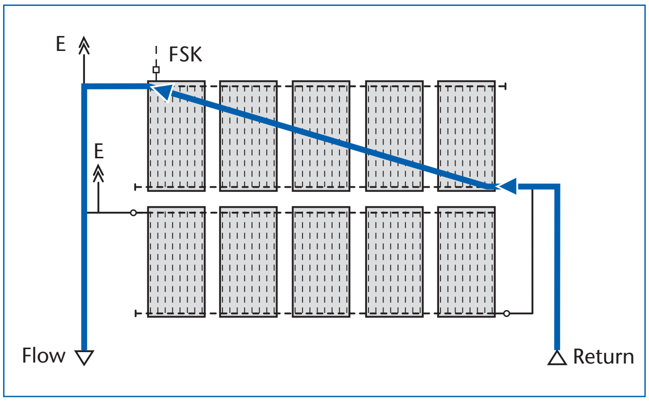
  $\dot{V}_{\text{K}} = \dot{V}_{\text{K,Nom}} = 50$ l/h

  – Read-off from table ***71/2***:
  11.1 mbar per collector row

  – Pressure drop of row:

  $\varnothing p_{\text{Array}} = \varnothing p_{\text{Row}} = 11.1$ mbar

→ The pressure drop of the collector row is 11.1 mbar.



73/3 *Two SKN3.0 collector rows connected in parallel using the reverse return principle*

Combined connection in series and in parallel

Illustration ***74/3*** shows an example of a combination of connections in series and in parallel. In each case, the top and bottom rows of collectors are connected in series to form a sub-row, meaning that only the pressure drop values of the sub-row collector rows connected in series will cumulate.

$$\Delta p_{Array} = \Delta p_{Sub\text{-}array} = \Delta p_{Row} \cdot n_{Row}$$

74/1 Formula for the pressure drop of a collector row consisting of a combination of collector rows connected in series and parallel

For this, take into consideration that the actual flow rate is calculated via the individual collectors connected in series from the number of collector rows connected in series and the nominal flow rate per collector (50 l/h):

$$\dot{V}_K = \dot{V}_{K,Nom} \cdot n_{Row} = 50\ l/h \cdot n_{Row}$$

74/2 Formula for the pressure drop through a collector row consisting of a combination of collector rows connected in series and in parallel

Calculation parameters (→ *74/1* and *74/2*)

$\varnothing p_{Array}$	Pressure drop for collector array in mbar
$\varnothing p_{sub\text{-}array}$	Pressure drop of the collector sub-array consisting of collector rows connected in series in mbar
$\varnothing p_{Row}$	Pressure drop for one collector row in mbar
$\dot{V}_K$	Flow rate through the individual collectors in l/h
$\dot{V}_{K,Nom}$	Nominal flow rate of collector in l/h

Example

- Parameters
  – Connection in parallel of 2 sub-rows consisting of 2 rows of collectors, each of which consists of 5 SKN3.0 solar collectors.
- Wanted
  – Pressure drop of overall collector row
- Calculation
  – Flow rate through one collector:

  $\dot{V}_K = \dot{V}_{K,Nom} \cdot n$

  $\dot{V}_K = 50\ l/h \cdot n_{Row} = 50\ l/h \cdot 2 = 100\ l/h$

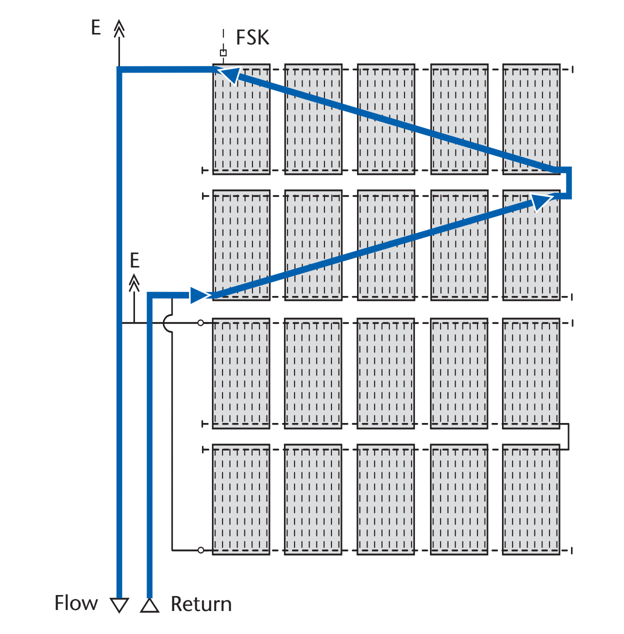
  – Read-off from table ***71/2***:
  34.5 mbar per collector row

  – Pressure drop of (sub-)row:

  $\varnothing p_{Array} = \varnothing p_{sub\text{-}array} = \varnothing p_{Row} \cdot n_{Row}$

  $\varnothing p_{Array} = 34.5\ mbar \cdot 2 = 69\ mbar$

→ The pressure drop of the collector row is 69 mbar.



74/3 Combination of connections in series and in parallel in a collector row consisting of SKN3.0 solar collectors

5.4.4 Pressure drop of pipework in the solar circuit

Calculating the pipework

The flow velocity in the pipework should be in excess of 0.4m/s to enable air remaining in the heat transfer medium to be transported to the next air separator in pipework with a slope. Interfering flow noise can occur from flow velocities of 1m/s and above. Take individual resistance values (caused by bends, for example) into consideration in the pressure drop calculation. In practice, this is often done by adding 30% to 50% to the pressure drop of the straight pipework. The actual pressure drops can vary more subject to the type of pipework.

In systems with collector rows aligned in different directions (split east/west systems), take the total flow rate into consideration when the common flow pipe is being sized.

Number of collectors	Flow rate	Flow velocity v and pressure drop R in copper pipes with pipe dimensions of							
		15 x 1		22 x 1		28 x 1.5		35 x 1.5	
	l/h	v m/s	R mbar/m	v m/s	R mbar/m	v m/s	R mbar/m	v m/s	R mbar/m
2	100	0.21	0.93	–	–	–	–	–	–
3	150	0.31	1.37	–	–	–	–	–	–
4	200	0.42	3.41	–	–	–	–	–	–
5	250	0.52	4.97	–	–	–	–	–	–
6	300	0.63	6.97	–	–	–	–	–	–
7	350	0.73	9.05	0.31	1.16	–	–	–	–
8	400	0.84	11.6	0.35	1.4	–	–	–	–
9	450	0.94	14.2	0.4	1.8	–	–	–	–
10	500	–	–	0.44	2.12	–	–	–	–
12	600	–	–	0.53	2.94	0.34	1.01	–	–
14	700	–	–	0.62	3.89	0.4	1.35	–	–
16	800	–	–	0.71	4.95	0.45	1.66	–	–
18	900	–	–	0.8	6.12	0.51	2.06	0.31	0.62
20	1000	–	–	0.88	7.26	0.57	2.51	0.35	0.75
22	1100	–	–	0.97	8.65	0.62	2.92	0.38	0.86
24	1200	–	–	–	–	0.68	3.44	0.41	1.02
26	1300	–	–	–	–	0.74	4.0	0.45	1.21
28	1400	–	–	–	–	0.79	4.5	0.48	1.35
30	1500	–	–	–	–	0.85	5.13	0.52	1.56

75/1 Flow velocity and pressure drop per metre of straight copper pipe for a 50/50 glycol:water mixture at 50°C

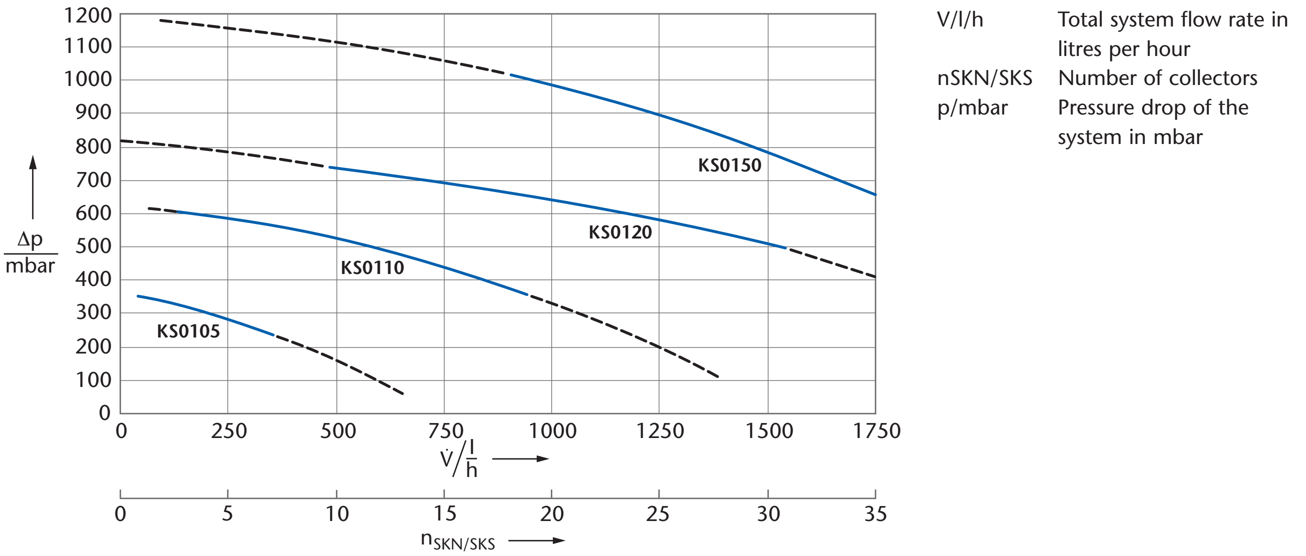
5.4.5 Pressure drop of the selected solar cylinder and heat exchangers

The pressure drop of the solar cylinder depends on the number of collectors and the flow rate. The indirect coils of the solar cylinder have different pressure drops. These have to be taken into consideration for the system pressure drop. Especially, the plate heat exchanger can have a very high pressure drop that can effect the pump sizing.

5.4.6 Selecting the KS... compact station

The selection of the suitable solar pump station can be approximately determined through the number of collectors. The pressure drop (residual head) and the flow rate in the collector circuit are required for finalising the selection. Take the following pressure drop values into consideration:

- Pressure drop in the collector row (→ page 71)
- Pipework pressure drop (→ page 75)
- Pressure drop in the solar cylinder (→ page 75)
- Additional pressure drop due to heat meter, valves or other fittings.



76/1 Residual head and application areas of the KS... solar pump stations subject to the flow rate and number of collectors (throughput limiter display range highlighted in blue)

5.5 Sizing of the diaphragm expansion vessel

5.5.1 System volume calculation

The volume of a solar heating system with the KS... solar pump station is significant in the sizing of the expansion vessel and the determination of the quantity of solar fluid. The following formula applies to the solar fluid content of the solar heating system with a KS... solar pump station:

$$V_A = V_K \cdot n_K + V_{WT} + V_{KS} + V_R$$

76/2 Formula for solar fluid content of solar heating systems with a KS... solar pump station

Calculating sizes

V_A Solar fluid content of the system
V_K Volume of one collector (→ *76/4*)
n_K Number of collectors
V_{WT} Solar indirect coil volume
V_{KS} Volume of a KS… solar pump station (approx. 1.0 l)
V_R Pipework volume (→ *76/3*)

Pipework volume

Copper pipe dimension Ø x wall thickness mm	Specific pipe volume l/m
15 x 1.0	0.133
22 x 1.0	0.314
28 x 1.5	0.491
35 x 1.5	0.804
42 x 1.5	1.195

76/3 Specific solar fluid content of selected copper pipework. If other types of pipe are used, please refer to manufacturer's instructions

Solar collector volume

Solar collectors			Collector content
Type		Version	l
Flat-plate collector	SKN3.0 SKN3.0	portrait landscape	0.86 1.25
High-performance flatplate collector	SKS4.0 SKS4.0	portrait landscape	1.43 1.76

76/4 Solar fluid content of solar collectors

5.5.2 Diaphragm expansion vessel for solar thermal systems

Calculation principles

Inlet pressure

Adjust the inlet pressure of the diaphragm expansion vessel prior to filling the solar heating system to take the system elevation into account. The required system inlet pressure be calculated using the following formula:

$$p_V = 0.1 \cdot h_{stat} + 0.4 \text{ bar}$$

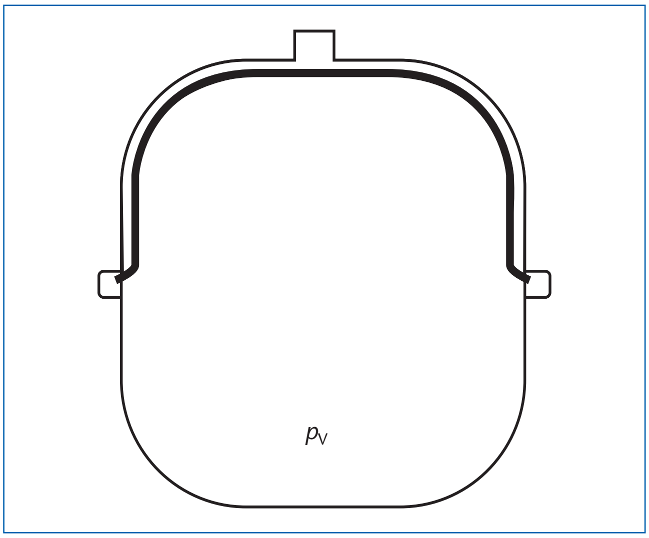
77/1 Formula for inlet pressure of a expansion vessel

Calculation parameters (→ 77/1) and picture legend (→ 77/2)

p_V Expansion vessel inlet pressure in bar

h_{stat} Static height in m between centre of the diaphragm expansion vessel and highest point of system

→ The minimum inlet pressure is 1.2 bar.



77/2 Inlet pressure of a diaphragm expansion vessel

Filling pressure

The expansion vessel creates a "membrane" when the system is filled, since an equilibrium between the fluid pressure and the gas pressure occurs at the diaphragm. The membrane (V_V → **77/4**) is introduced with the system in a cold state, and monitored via the filling pressure at the system pressure gauge on the water side after venting and degassing the system in a cold state. The system filling pressure should be 0.3 bar higher than the expansion vessel inlet pressure. A controlled evaporation temperature of 120°C is therefore reached in the event of stagnation.

The filling pressure is calculated using the following formula:

$$p_0 = p_V + 0.3 \text{ bar}$$

77/3 Formula for filling pressure of the diaphragm expansion vessel

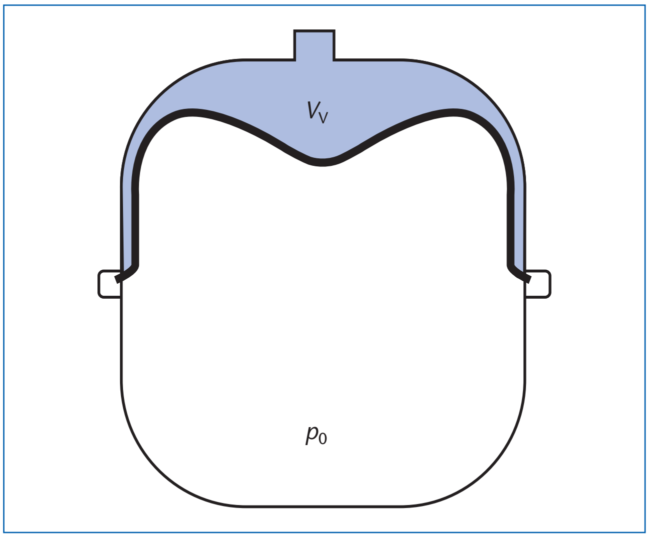
Calculation parameters (→ 77/3) and picture legend (→ 77/4)

p_0 Diaphragm expansion vessel filling pressure in bar

p_V Diaphragm expansion vessel inlet pressure in bar

V_V Membrane

→ A deviation from the optimum inlet pressure or filling pressure always leads to a reduction in the available volume. This can cause system malfunctions.



77/4 Filling pressure of a diaphragm expansion vessel

Working pressure

At the maximum collector temperature, the filling gas is compressed to the final system pressure by taking up additional expansion volume (V_e → *78/2*).

The working pressure of the solar heating system and therefore the pressure rating and the required size of the diaphragm expansion vessel are determined by the safety valve release pressure. The working pressure is determined using the following formula:

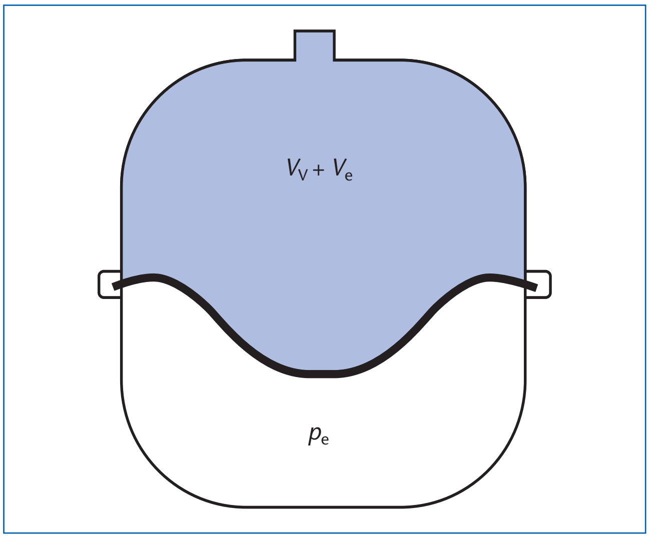
$$p_e \leq p_{SV} \angle 0.2 \text{ bar} \quad \text{for} \quad p_{SV} \leq 3 \text{ bar}$$

$$p_e \leq 0.9 \cdot p_{SV} \quad \text{for} \quad p_{SV} > 3 \text{ bar}$$

78/1 *Formulas for working pressure of a diaphragm expansion vessel subject to the safety valve release pressure*

Calculation parameters (→ *78/1*) and picture legend (→ *78/2*)

- p_e Diaphragm expansion vessel working pressure in bar
- p_{SV} Safety valve release pressure in bar
- V_e Expansion volume
- V_V Membrane



78/2 *Working pressure of a diaphragm expansion vessel*

Intrinsic safety of a solar heating system

A solar heating system is considered to be intrinsically safe if the diaphragm expansion vessel can absorb the volume change as a result of solar fluid evaporation in the collector and the connecting lines (stagnation). If a solar heating system is not intrinsically safe, the safety valve responds during stagnation. Then the solar heating system has to be re-started. A diaphragm expansion vessel is sized on the basis of the following assumptions and formulae:

Calculation parameters (→ *78/3* and *78/4*)

- $V_{n,min}$ Minimum D volume in l
- V_A Solar fluid content of the system in l (→ *76/2*)
- n Expansion coefficient (= 7.3% with $\Delta\vartheta$ = 100 K)
- V_D Evaporation volume in l
- p_e Diaphragm expansion vessel outlet pressure in bar
- p_0 Diaphragm expansion vessel filling pressure in bar
- n_K Number of collectors
- V_K Volume of one collector (→ *76/4*)

$$V_{n,\,min} = (V_A \cdot n + V_D) \cdot \frac{(p_e + 1)}{(p_e \angle p_0)}$$

78/3 *Formula for minimum expansion vessel volume*

$$V_D = n_K \cdot V_K$$

78/4 *Formula for the evaporation volume*

Nomograph for the graphical determination of the expansion vessel for solar heating systems with flat-plate collectors

The size of the expansion vessel in systems with a 6 bar safety valve can be determined graphically subject to the system configuration using the following nomograph. The above assumptions and formulae are based on this nomograph.

Sizing example

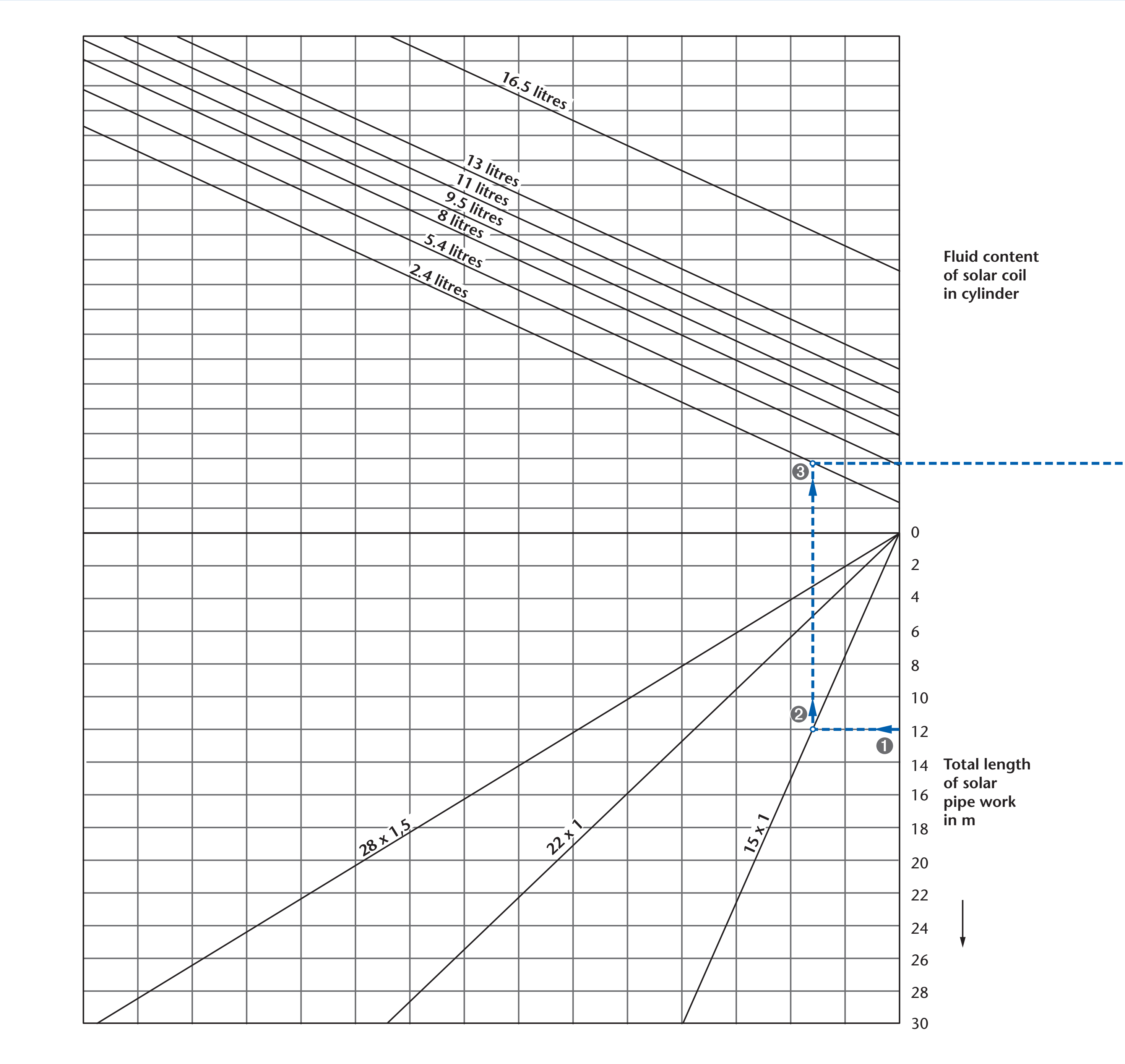
- Specified solar heating system with
  - 4 SKS4.0-s collectors and twin coil cylinder with a solar coil fluid content of 1.4 litres
  - 12m single pipe length between collector row and cylinder
  - Pipe dimension 15mm x 1.0mm
  - Static height between expansion vessel and the highest point of system = 10m
- Wanted
  - Required expansion vessel

→ The graphical determination of the expansion vessel is described in the nomograph on pages 80 and 81.

Item	Calculation principles and initial values	Required operation
1	The single pipe between the cylinder and the collector row is 12m in length.	Trace the "Single pipe length" axis at 12m horizontally to the left of the "Pipe dimensions" sub-diagram.
2	The pipe dimension that was used is 15 x 1.	Continue vertically upwards into the "DHW cylinder" sub-diagram at the intersection with pipe 15 x 1.
3	The solar fluid content of the cylinder is 1.4 litres.	At the intersection with the "1.4 litre coil" curve, go horizontally to part 2 of the nomograph into the "Collector solar fluid content" sub-diagram.
4	The system is operated using 4 SKS4.0-s collectors. The solar fluid content V_K of the collector row is 5.72 l.[1)]	Draw an additional pipe parallel to the existing pipes for a filling volume of 5.72 l in the "Collector row solar fluid content" sub-diagram. Go vertically down into the "static height" sub-diagram from the intersection point with the new pipe.
5	The static height between the highest point in the system (automatic air vent valve) and the expansion vessel is 10m.	At the intersection with pipe 10, go horizontally left and read off the minimum nominal volume of the expansion vessel (11.5 l). Result: Allow for an expansion vessel with 18 l (expansion vessel 10, white field).

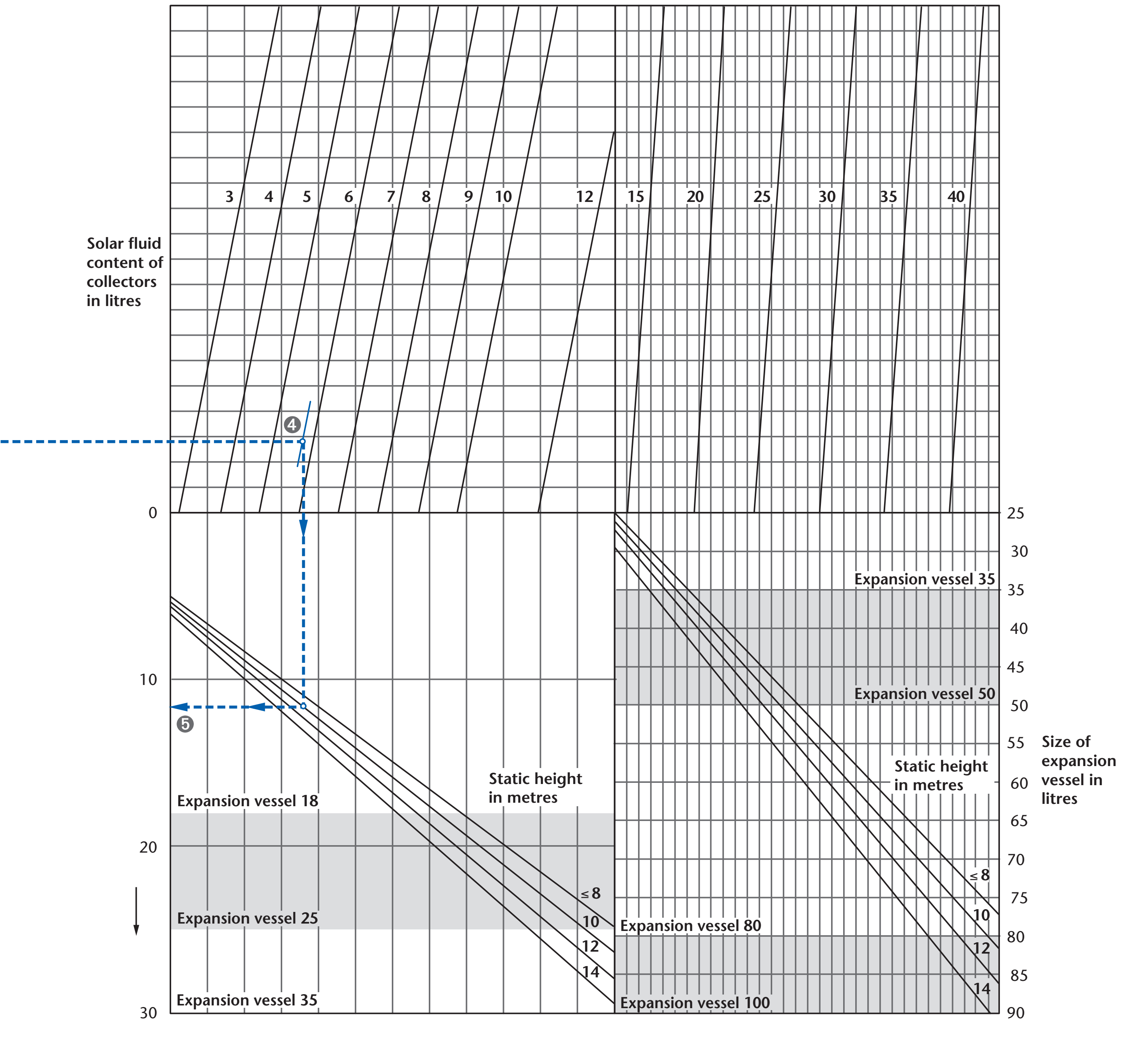
79/1 Description of operations for the example of expansion vessel sizing with nomograph (→ 80/1 and → 81/1)
1) The values in table → 76/4 apply to the collector solar fluid content

Nomograph for sizing the expansion vessel for solar heating systems with flat-plate collectors (part 1)



80/1 Nomograph for sizing the expansion vessels for systems with the KS... solar pump station and 6 bar safety valve (part 2 → 81/1) with sizing example highlighted in blue (description → page 79)

Nomograph for sizing the expansion vessel for solar heating systems with flat-plate collectors (part 2)



81/1 Nomograph for sizing the expansion vessel for systems with the KS... solar pump station and 6 bar safety valve with sizing example highlighted in blue (description → page 79)

Calculation basis for determining the pre-cooling vessel size

Install a pre-cooling vessel upstream of the expansion vessel to provide the expansion vessel with thermal protection, particularly with solar central heating backup, and systems for DHW heating with more than 60% coverage.

Pre-cooling vessel size		5 l	12 l
Height	mm	270	270
Diameter	mm	160	270
Connection	inch	2 x R3/4	2 x R3/4
Max. operating pressure	bar	10	10

82/1 Pre-cooling vessel specification

The following standard value applies with regard to the pre-cooling vessel size:

$$V_{Pre} \geq V_{Vapour} \angle V_{Pipe}$$

82/2 Formula for nominal pre-cooling vessel size

Calculating sizes

V_{Pre} Nominal pre-cooling vessel size
V_{Vapour} Content of collectors and pipework in the vapour area above the bottom edge of the collector
V_{Pipe} Pipework from the lower edge of the collector to the solar pump station

6 Design/engineering information regarding the installation

6.1 Pipework, thermal insulation and collector temperature sensor extension cable

Glycol and temperature-resistant sealing

All components of a solar heating system (including flexible seals for valve seats, diaphragms in expansion vessels etc.) must be made from glycol-resistant materials and carefully sealed, since water:glycol mixtures have a greater tendency to leak than pure water. Aramide fibre seals have proven to be effective. Graphited cord is suitable for sealing glands. Hemp seals must also be coated with temperature-resistant and glycol-resistant thread paste (observe the manufacturer's instructions).

The solar hose ferrules on the SKN3.0 collectors and the connectors of the SKS4.0 collectors provide an easy and reliable seal for collector connections.

Pipework routing

All connections in the solar circuit must be brazed. Alternatively, press fittings can be used, provided that they are suitable for use with a water:glycol mixture and respectively high temperatures (200°C). All pipework must be routed with a rise towards the collector row or the air vent valve, if installed. Heat expansion must be taken into consideration when the pipework is being routed. The pipes must be equipped with expansion facilities (bends, sliding clamps, compensators) to prevent damage and leaks.

→ Plastic pipework and galvanised components are not suitable for solar heating systems.

Thermal insulation

Connection lines may be routed in air shafts and wall ducts (in new buildings). Open shafts must be suitably sealed to prevent heat loss caused by rising air (convection).

The thermal insulation of the connection lines must be designed for the operating temperature of the solar heating system. Therefore use appropriate high temperature-resistant insulating materials such as insulating hoses made from EPDM rubber. The thermal insulation must be UV and temperature-resistant in external areas. The connection kits for the SKS4.0 solar collectors are fitted with UV and high temperature-resistant thermal insulation made from EPDM rubber. The solar collectors, and solar pump stations made by Buderus are fitted with efficient thermal insulation in the factory.

The table ***83/1*** shows standard values for the insulating thickness on pipework in solar heating systems. Mineral wool is unsuitable for external applications because it absorbs water and then fails to provide thermal insulation.

Pipe diameter mm	Twin-Tube (double tube) insulation thickness mm	Aeroflex SSH pipe diameter x insulation thickness mm	Aeroflex HT pipe diameter x insulation thickness mm	Mineral wool insulation thickness (in relation to λ = 0.035W/m·K) mm
15	15	–	15 x 24	20
18	–	18 x 26	18 x 24	20
20	19	22 x 26	22 x 24	20
22	–	22 x 26	22 x 24	20
28	–	28 x 38	28 x 36	30
35	–	35 x 38	35 x 36	30
42	–	42 x 51	42 x 46	40

83/1 Thickness of thermal insulation for solar heating system connection lines.

Collector temperature sensor extension lead

When routing the pipework, also route a two-core lead (up to 50m length 2 x 0.75mm²) for the collector temperature sensor alongside. Provide a shielded cable for the collector temperature sensor extension lead, if it is routed together with a 230V cable. Install the FSK collector temperature sensor near the flow header in the sensor lead pipe of the SKN3.0 and SKS4.0 collectors.

6.2 Air vent valve

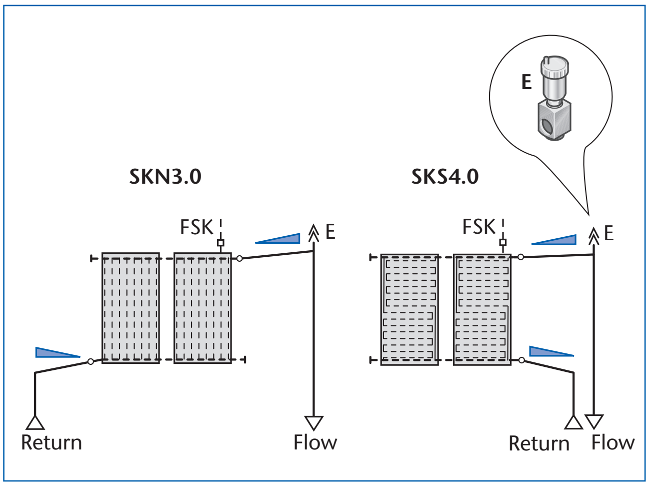
6.2.1 Automatic air vent valve

Unless "filling station and air separator" are being used (→ page 85), solar heating systems with flatplate collectors are ventilated via quick-acting air vent valves at the highest point of the system.

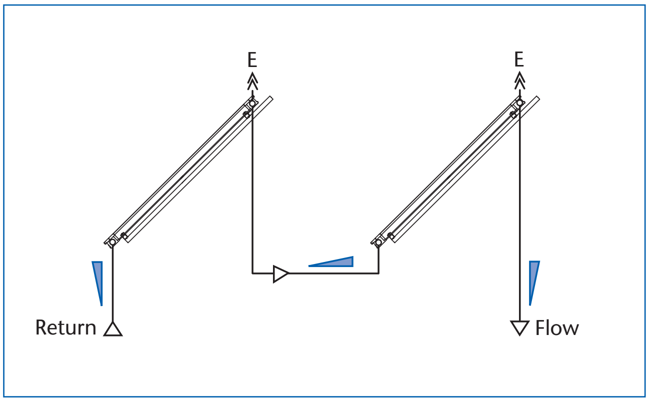
After filling has been completed, this valve must be closed to prevent gaseous solar fluid from escaping from the system in the event of stagnation.

Provide an air vent valve at the highest point of the system (detail E → *84/1*) and, for every change of direction, with a new rise (e.g. in dormers, → *70/2*). If there are several rows of collectors, provide an air vent valve for each row (→ ***84/2***), unless the system can be ventilated above the top row (→ ***84/3***). Order an automatic all-metal air vent valve in the form of an air vent valve kit.

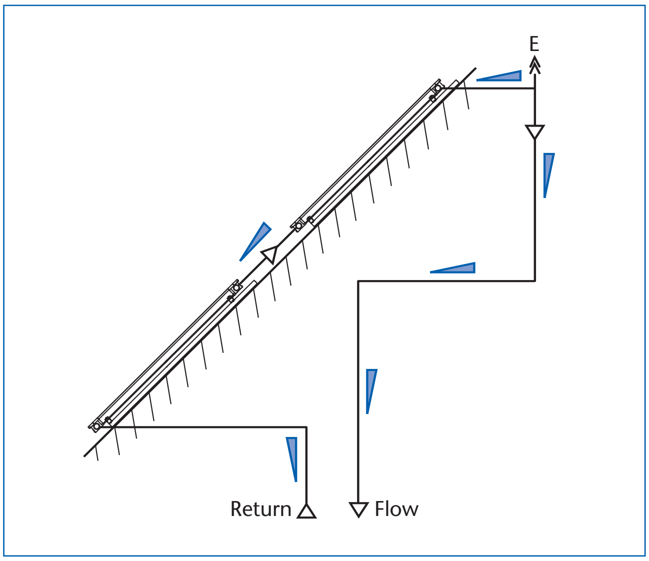
→ On collector fields with pipework greater than 19mm use one Buderus auto air vent per collector row.



84/1 *Hydraulic diagram with air vent valve at the highest point of system*



84/2 *Hydraulic diagram with air vent valve for each collector row on the example of flat roof installation (connection in series)*



84/3 *Hydraulic diagram with air vent valve above the top row on the example of an on-roof installation (connection in series)*

6.2.2 Filling station and air separator

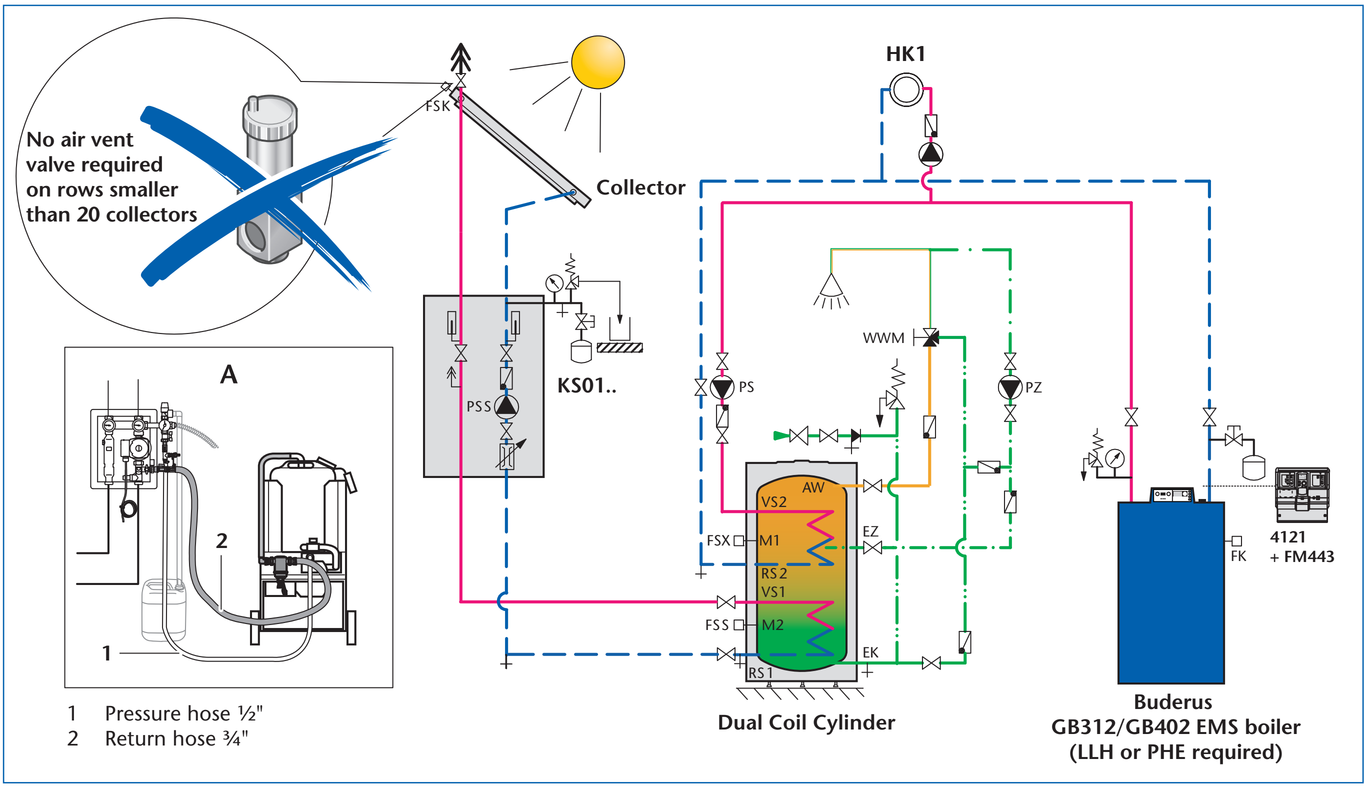
A solar heating system can also be filled with the Buderus filling station (→ *85/1*), resulting in a large proportion of the air being pushed out of the system during the filling procedure. An air vent on the roof is not required if our filling station is used. Instead, a central air separator is part of the KS01 2- branch solar pump station . (→ *85/1*). This separates the residual micro-bubbles out of the medium during operation.

Benefits of the system are:

- Reduced installation effort because no air vent valves are required on the roof
- Easy and quick commissioning, i.e. filling and ventilation in one step.
- Efficiently vented system
- Low-maintenance operation

If the collector row consists of several rows connected in parallel, provide each individual row with a shut-off valve in the flow. Each row is filled and ventilated individually during the filling procedure.

85/1 BS01 filling station



1 Pressure hose ½"
2 Return hose ¾"

85/2 System design; detail A: Filling procedure with filling pump (seal → 41/1; abbreviations → page 110)

6.3 Information regarding the different flat-plate collector installation systems

6.3.1 Permissible standard snow loads and building heights

The following table contains the permissible standard snow loads and building heights for the different installation options. Observe the information shown during engineering to safeguard a correct installation and to prevent damage to the collector row.

	On-roof installation Portrait/landscape	In-roof installation Portrait/landscape	Flat roof installation Portrait/landscape	Wall mounting 45-60°C, landscape
Roof cover/wall	Tiles, plain tiles, slate, shingle, corrugated sheets, sheet steel, bitumen	Tiles, plain tiles, slate, shingle	–	Load-bearing
Permissible roof pitch	25°–65°, 5°–65° (corrugated sheets, sheet steel roof)	25°–65°	0° (with slightly sloping roofs of up to 25°, protection from sliding off or on-site fixing)	–
Permissible building heights (wind loads) of up to 20m – at wind speeds of up to 80 mph	Without accessories	Without accessories	Without accessories (observe securing flat roof supports!)	Without accessories
Permissible building heights (wind loads) of up to 100m – at wind speeds of up to 94 mph	Only portrait collectors with on-roof installation kit	Not permissible	With flat roof support kit (observe flat roof support fixing!)	Not permissible
Standard snow loads in accordance with BS EN 1055, part 5 0–2 kN/m²	Without accessories	Without accessories	Without accessories	Without accessories
Standard snow loads in accordance with BS EN 1055, part 5 > 2 kN/m²	Only portrait collectors with on-roof installation kit up to 3.1 kN/m²	Without accessories up to 3.8 kN/m²	Without flat roof support kit up to 3.8 kN/m²	Not permissible

86/1 Permissible standard snow loads and building heights in accordance with BS EN 1055

6.3.2 Selection of hydraulic connection accessories

Provide suitable hydraulic connection accessories subject to the number of collectors and their hydraulic connections.

→ For further details regarding the various assembly systems, see the relevant "Hydraulic connection" section in the following sub-chapters.

Several collector rows connected in series

Number of collectors	Number of rows	Number of collectors per row	Connection kit	Air vent valve kit[1)]	Series connection kit
2	2	1	1	1	1
3	2	2 1	1	1	1
	3	1	1	1	2
4	2	2	1	1	1
5	2	3 2	1	1	1
6	2	3	1	1	1
	3	2	1	1	2
7	2	4 3	1	1	1
8	2	4	1	1	1
9	2	5 4	1	1	1
	3	3	1	1	2
10	2	5	1	1	1

87/1 Hydraulic connection accessories for connecting several collector rows in series

1) The air vent valve kit is not required if the system is filled with a "Filling station" (→ page 85). Additional air vent valve kits are required unless the system can be vented above the top row (e.g. with flat roof installation, → 84/2).

6.3.3 On-roof installation for flat-plate collectors

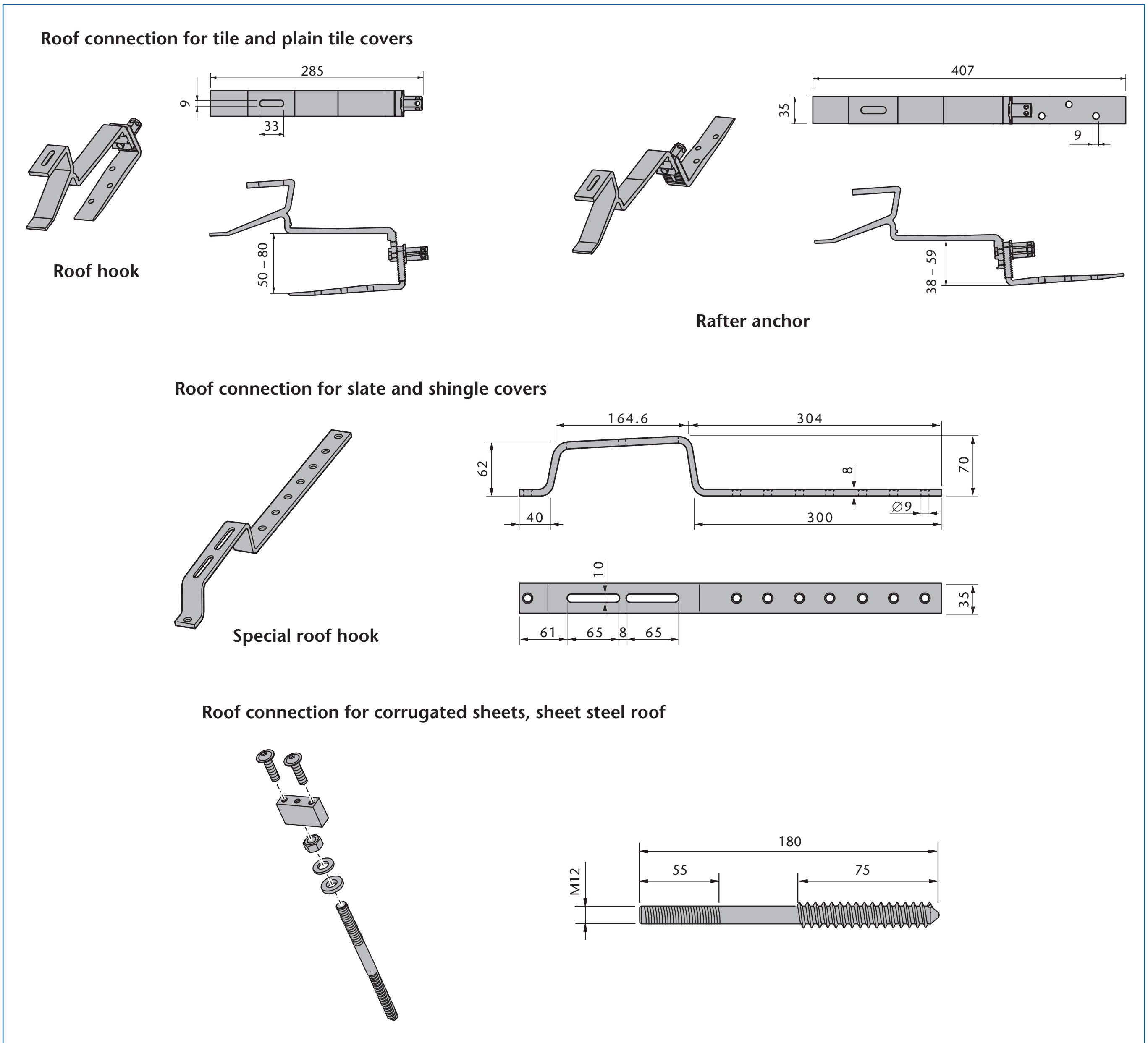
On-roof installation

The collectors are secured at the same angle as the pitched roof using the on-roof installation kit. The roof skin retains its sealing properties. It is recommended that you consult a structural engineer to ensure the roof can take load bearing.

The on-roof installation kit for SKN3.0 and SKS4.0 flat-plate collectors consists of a standard kit for the first collector in a row and an extension kit for each additional collector in the same row (→ *89/1*). Use the on-roof installation extension kit only in conjunction with a standard kit. In place of the single-side collector tensioner (item. 1 → *89/1*) the extension kit contains so-called double-sided collector tensioners (item 5 → *89/1*) and connectors for defining the correct spacing and securing two adjacent SKN3.0 or SKS4.0 flat-plate collectors.

Roof connections for different roof covers

The profile rails and collector tensioners of the various on-roof installation kits are identical for all roof connections. The various installation kits for tile and plain tile, slate and shingle cover as well as for corrugated sheet and sheet steel roofs only differ with regard to the type of roof hook (→ *88/1*) or special fixing materials used (→ *90/2, 90/1* and *91/2*).



88/1 *Roof connection versions for different roof covers (dimensions in mm)*

Roof connection for tiled roofs

Fig. 124/1 shows an example of the on-roof installation kits for tiled covers. The roof hooks (*88/1* and item 2 → *89/1*) are hooked over the existing roof battens (→ *89/2*) and fastened to the profile rails.

As an alterative to being hooked on, the roof hooks can also be fastened to a batten or a hard surface (→ *89/3*). This is done by turning the lower part of the roof hook. If additional height compensation is required, the lower section of the roof hook can be shimmed.

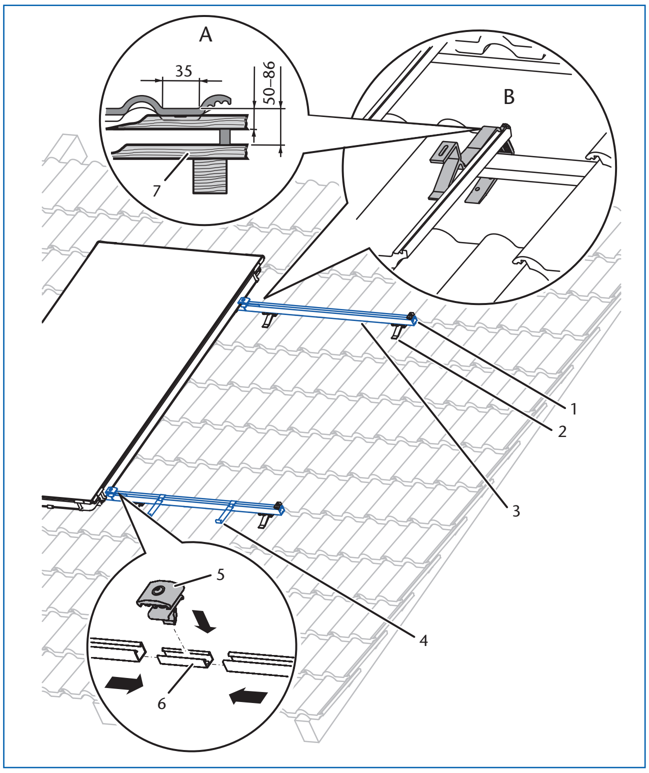
When on-roof installation on a tiled roof is envisaged, check whether the dimensions specified in fig. *89/1*, detail A must be complied with. Use the roof hooks supplied, if they

- fit into the valley of the roof tile and
- extend over the roof tile plus roof batten.

→ The tile cover should not exceed 120 mm. Where necessary, include a roofing contractor in the planning process.

Caption (→ *89/1*)

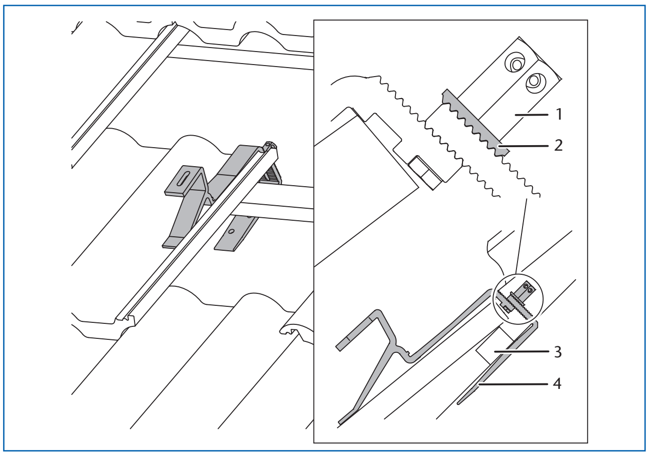
1 Single-sided collector tensioner (only in the standard kit)
2 Roof hook, adjustable
3 Profile rail
4 Anti-slippage protection for collectors (2x per collector)
5 Two-sided collector tensioner (only in the extension kit)
6 Connector (only in the extension kit)
7 Hard surface (cladding)



89/1 *On-roof installation standard kit and extension kit (highlighted in blue) for one SKN3.0 or SKS4.0 flat-plate collector (detail A: dimensions in mm)*

Caption (→ *89/2*)

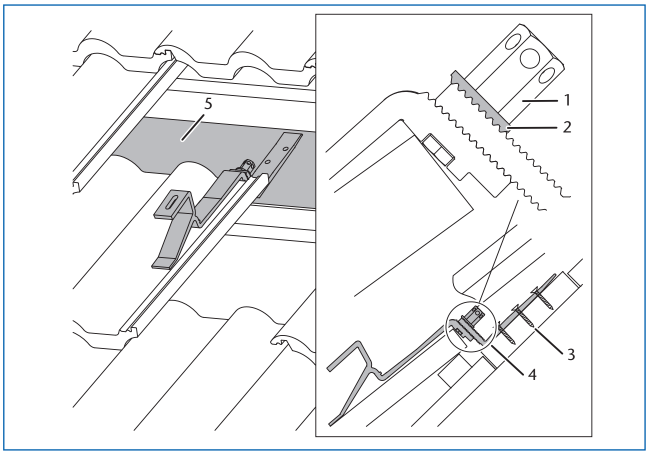
1 Hexagon nut
2 Serrated washer
3 Roof batten
4 Roof hook, lower part



89/2 *Hooked-on roof hook*

Caption (→ *89/3*)

1 Hexagon nut
2 Serrated washer
3 Fixing screws
4 Roof hook, lower part
5 Rafter/hard surface



89/3 *Roof hook fastened to the rafter*

Plain tile roof connection

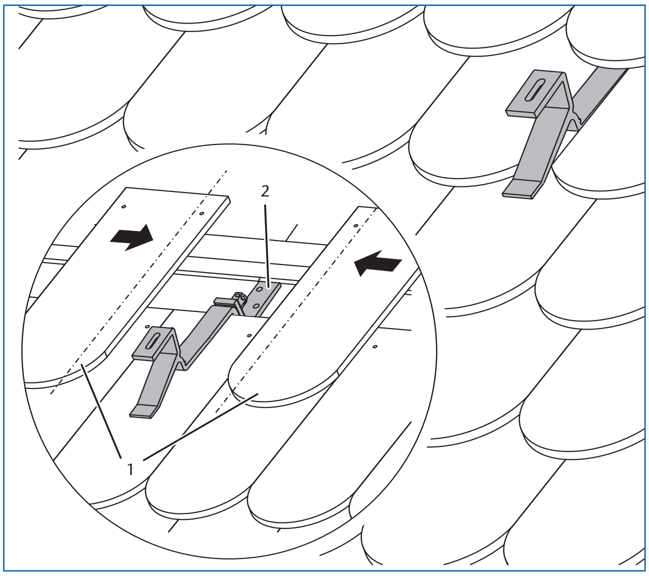
Fig. ***90/1*** shows the attachment of the roof hook (item 2) to a plain tile cover. Trim and attach the plain tiles on site.

The horizontal profile rails must be fastened to the roof hook in the same way as they are with tiles (→ ***89/1***).

→ Refer to a roofing contractor for on-roof installation on plain tiles, if required.

Caption (→ *90/1*)

1 Plain tiles (cut along the dotted line)
2 Roof hook, lower part fastened to a rafter or plank/board



90/1 Roof hook attached on a plain tile roof

Roof connection with slate or shingle

→ Special roof hook installations with slate or shingle cover must be carried out by a roofing contractor.

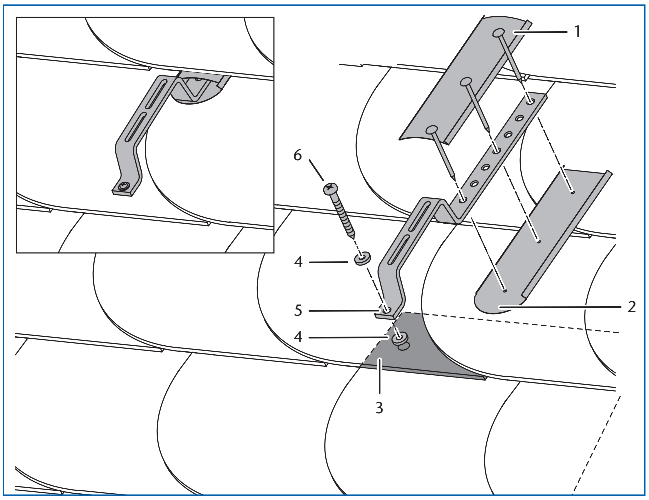
Fig. ***90/2*** shows an example of a waterproof installation of the special roof hooks (item 5 → ***90/2***) on a slate or shingle cover with seals and flashing to be provided on site.

The horizontal profile rails must be fastened to the special roof hooks in the same way as they are with tile cover (→ ***89/1***).

Caption (→ *90/2*)

1 Sheet steel above special roof hook (on site*)
2 Sheet steel below special roof hook (on site*)
3 Multiple overlap
4 Seal (on site*)
5 Special roof hook
6 Screw (standard delivery)

**Item not supplied by Buderus. Items must be sourced or fabricated by the roofing contractor.*



90/2 Special roof hook with waterproof cover for attaching an on-roof installation kit for flat-plate collectors to a slate or shingle cover

Roof connection in roofs with insulation on rafters

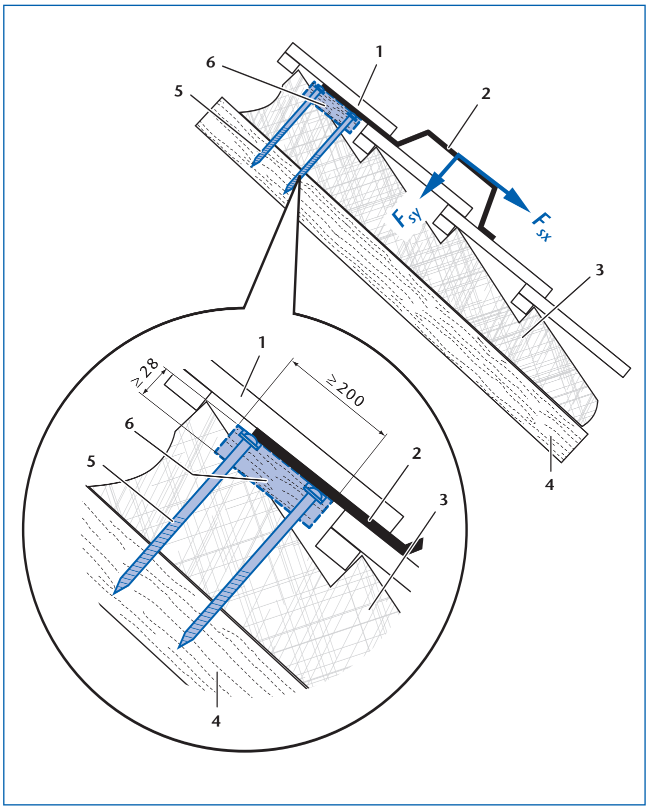
Fig. ***91/1*** shows the roof connection to a roof with insulation on rafters using the special hooks. The roofing contractor must secure a wooden board with a minimum cross-section of 28mm x 200mm to the rafter. The force that is introduced by the roof hook must be transferred by this board to the load-bearing rafters. With an assumed maximum snow load of 2 kN/m^2 (without accessories) or 3.1 kN/m^2 (with accessories), the following force per roof hook must be allowed for:

- Horizontal to roof F_{sx} = 0.8 kN
- Vertical to roof F_{sy} = 1.8 kN

The horizontal profile rails must be fastened to the special roof hooks in the same way as they are with a tile cover (→ ***89/1***).

Caption (→ *91/1*)

1 Roof tile
2 Special roof hook
3 Insulation on rafters
4 Rafter
5 On-site screw connection
6 Wooden board (at least 28 mm x 200 mm)
F_{sx} Load per roof hook, vertical to the roof
F_{sy} Load per roof hook, horizontal (parallel) to the roof



91/1 *On-site attachment of additional wooden boards on the insulation on rafters, to which the special hooks for attaching an on-roof installation kit are fastened (dimensions in mm)*

Roof connection with corrugated sheet roofs

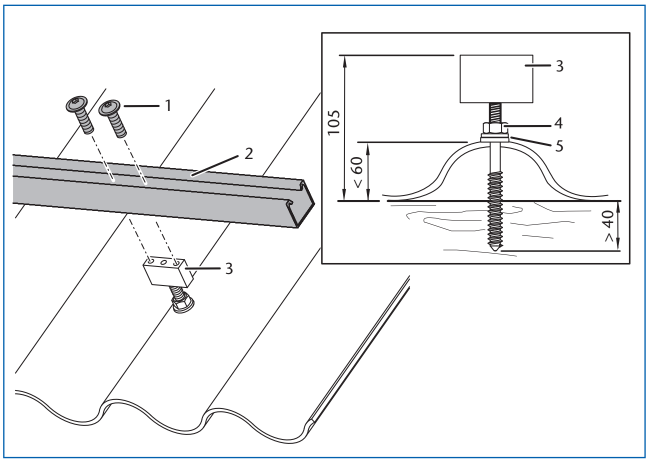
→ On-roof installation onto a corrugated sheet cover is only permissible if the headless spiral screws can be fastened at least 40mm into a wooden structure with adequate load-bearing capacity (→ ***91/2***).

The corrugated sheet roof connection contains headless spiral screws including retaining brackets and sealing washers that are used instead of the roof hooks in the on-roof installation kit.

Fig. ***91/2*** shows how the profile rails are attached to the retaining brackets of the headless spiral screws.

Caption (→ *91/2*)

1 M8 x 16 Allen screws
2 Profile rail
3 Retaining bracket
4 Hexagon nut
5 Seal washer



91/2 *Example of profile rail attachment with on-roof installation on a corrugated sheet cover (dimensions in mm)*

→ Do not secure in trough/valley.

→ On some roof materials a spacer/packer may be required to ensure a good fit.

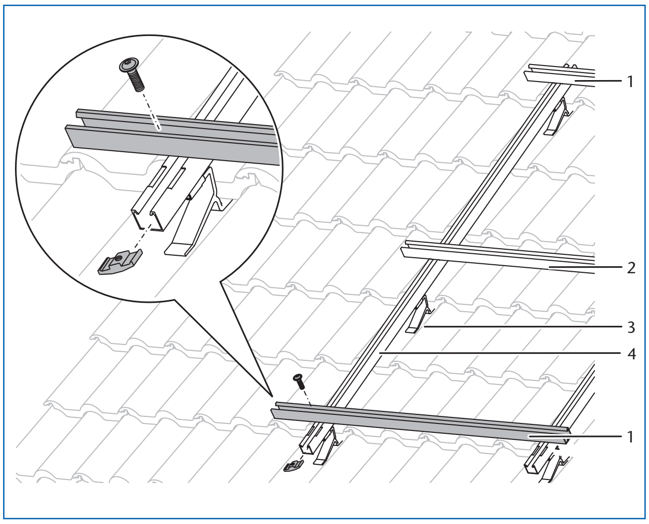
Snow load profile/additional rail

Also install a snow guard and an additional rail (accessories) during the on-roof installation of portrait flat-plate collectors on buildings between 20m and 100m in height in regions with snow loads of 2 kN/m² to 3.1 kN/m². These provide better distribution of the higher loads on the roof.

Fig. *92/2* shows the installation of a snow guard and an additional rail on the example of tile cover. Both accessories can also be fitted to installation systems for other roof covers.

Caption (→ *92/2*)

1 Profile rails from on-roof installation kit
2 Additional rails (including collector tensioner)
3 Additional roof connection (snow guard standard delivery)
4 Vertical profile rails (snow guard standard delivery)



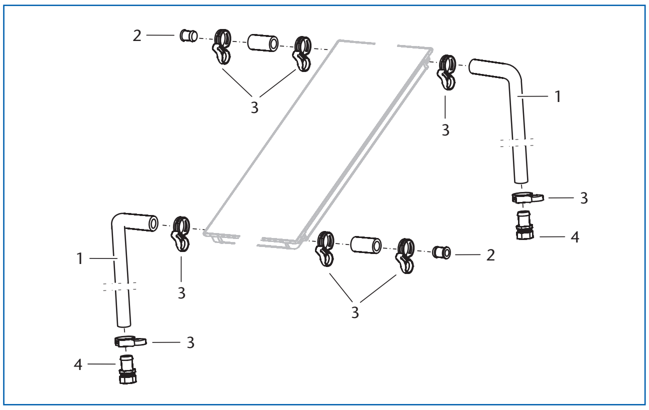
92/2 On-roof installation kit with snow guard and additional rail

Hydraulic connections

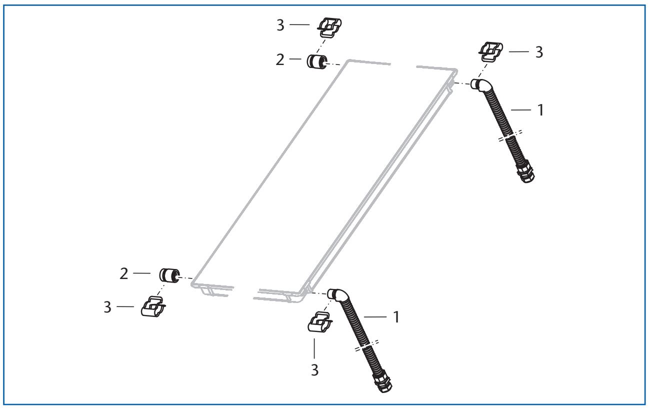
The rooftop connection kits are used to make the hydraulic collector connections during on-roof installation (figs. *93/1* and *93/2*).

Roof outlets are required for flow and return, since the collector connections are above roof level. A ventilation or lead tile (as shown in fig. *93/3*) can be used as a roof outlet for the flow and return pipes. The flow pipe is routed through the roofing skin with an incline to the air vent valve, if installed, via the upper ventilation tile. The lead from the collector temperature sensor also runs through this tile. Route the return pipe with a slope to the KS station. A ventilation tile can be used for this if the return pipe runs through the roof below or at the same level as the collector row return connection (fig. *93/3*). An additional air vent valve is not usually required, in spite of the change of direction in the tile.

➞ Involve a roofing contractor in the planning to prevent damage to the building.



93/1 *SKN3.0 on-roof connection kit*



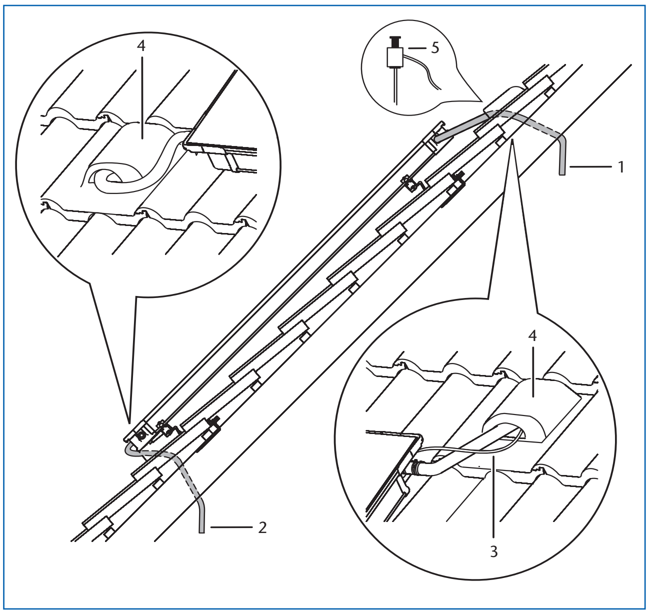
93/2 *SKS4.0 on-roof and in-roof (roof integrated) connection kit*

Caption (➞ *93/1*)

1 Connecting pipe 1000mm
2 Dummy plug
3 Spring clips
4 Hose coupling with R3/4" connection or 18 mm locking ring

Caption (➞ *93/2*)

1 1000 mm connection pipe with R3/4" connection or 18mm locking ring at the system side, insulated
2 Dummy plug
3 Clip



93/3 *Route connection pipes beneath the roof*

Caption (➞ *93/3*)

1 Flow pipe
2 Return pipe
3 Sensor lead
4 Ventilation tile
5 Air vent valve

Static requirements

➞ The on-roof installation kit is exclusively designed for the secure mounting of solar collectors. The attachment of other rooftop equipment such as aerials to the rooftop mounting kit is not permissible.

The roof and the substructure must have an adequate load-bearing capacity. A load of about 50 kg or 55 kg can be expected for each SKN3.0 or SKS4.0 flatplate collector. Also take the specific regional loads as per BS EN 1055 (or local regulations) into account.

The values in table *86/1* are the permissible standard snow loads and building heights for on-roof installation.

On-roof installation system component selection aid

Include appropriate connecting materials in the specification subject to the number of collectors and their hydraulic connections.

	Total number of collectors		2		3			4		5		6			7		8		9			10	
	Number of rows		1	2	1	2	3	1	2	1	2	1	2	3	1	2	1	2	1	2	3	1	2
	Number of collectors per row		2	1	3	2	1	4	2	5	3	6	3	2	7	4	8	4	9	5	3	10	5
						1					2					3				4			
SKN3.0-s and SKS4.0-s	Basic kit[1]	Tiled Tiled Plain tiled Slate Shingle Corrugated sheets Sheet steel roof	1	2	1	2	3	1	2	1	2	1	2	3	1	2	1	2	1	2	3	1	2
	Extension kit[1]	Tiled Tiled Plain tiled Slate Shingle Corrugated sheets Sheet steel roof	1	–	2	1	–	3	2	4	3	5	4	3	6	5	7	6	8	7	6	9	8
	Additional kit Standard kit[1]	Tiled Tiled Plain tiled Slate Shingle Corrugated sheets Sheet steel roof	1	2	1	2	3	1	2	1	2	1	2	3	1	2	1	2	1	2	3	1	2
	Additional kit Extension kit[2]	Tiled Tiled Plain tiled Slate Shingle Corrugated sheets Sheet steel roof	1	–	2	1	–	3	2	4	3	5	4	3	6	5	7	6	8	7	6	9	8
SKN3.0-w and SKS4.0-w	Standard kit[1]	Tiled Tiled Plain tiled Slate Shingle Corrugated sheets Sheet steel roof	1	2	1	2	3	1	2	1	2	1	2	3	1	2	1	2	1	2	3	1	2
	Extension kit[1]	Tiled Tiled Plain tiled Slate Shingle Corrugated sheets Sheet steel roof	1	–	2	1	–	3	2	4	3	5	4	3	6	5	7	6	8	7	6	9	8

94/1 Fixing materials for on-roof installation system
1) Consisting of installation kit and roof connection
2) Consisting of snow guard and additional horizontal rail, required for snow loads of 2 kN/m² to 3.1 kN/m² and building heights of 20m to 100m

6.3.4 In-roof (roof integrated) installation for flat-plate collectors

The in-roof (roof integrated) system is suitable for SKN3.0 and SKS4.0 portrait and landscape collectors. Individual installation kits are available for tile, shingle, slate and plain tile roof covers. The collectors seal the roof in conjunction with the metal surround (coated aluminium, anthracite RAL 7016).

The two outer collectors in a row are installed using a standard kit. Every other collector in the row is installed between the two outer collectors using an extension kit (fig. ***95/2***).

Fit additional roof battens on site for attaching the collectors, the metal surround and as support for the cover plate at the top and the flashing at the bottom (fig. ***95/3***).

During installation the collectors are first attached to the roof battens and then encased in the metal surround. The hydraulic connection lines can be routed through the roof inside the side cover plates. Another row consisting of the same number of collectors can be installed directly above the first row. Appropriate standard and extension kits are available for an additional row. The space between the top and bottom collector rows is closed off with a cover plate (fig. ***96/1***).

If two rows with a different number of collectors are installed above each other, leave a gap of at least two rows of tiles between each row.

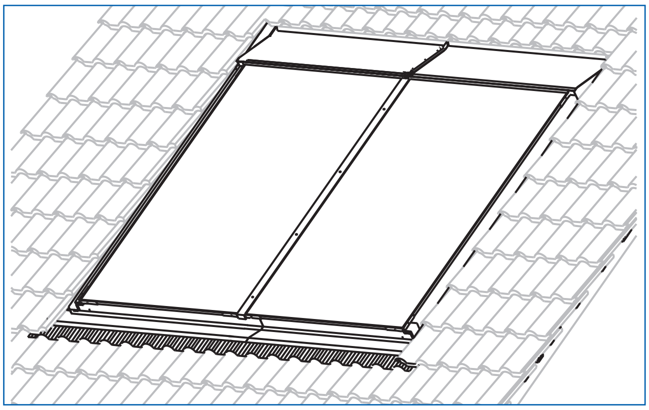
→ If necessary, include a roofing contractor in the planning and installation to prevent damage to the building.

Caption (→ *95/2*)

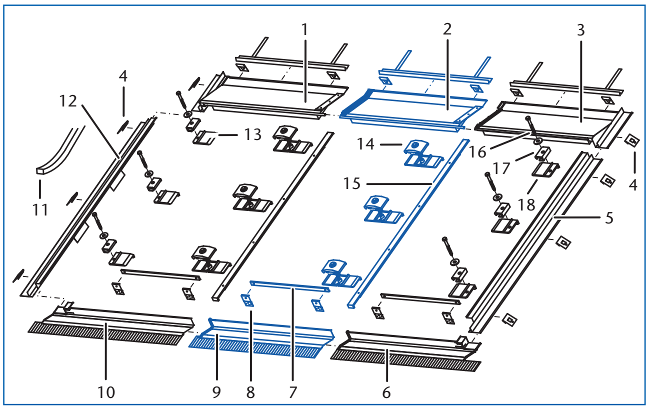
1 Top left cover plate
2 Top centre cover plate
3 Top right cover plate
4 Retainer
5 Right side cover plate
6 Bottom right cover plate
7 Batten to prevent slippage
8 Anti-slippage protection (with landscape: 5x)
9 Bottom centre cover plate
10 Bottom left cover plate
11 Roll of sealing tape
12 Left side cover plate
13 Left support plate
14 Double-sided hold-down retainer
15 Cover strip
16 Screw 6 x 40 with washer
17 Single-sided hold-down retainer
18 Right support plate

Caption (→ *95/3*)

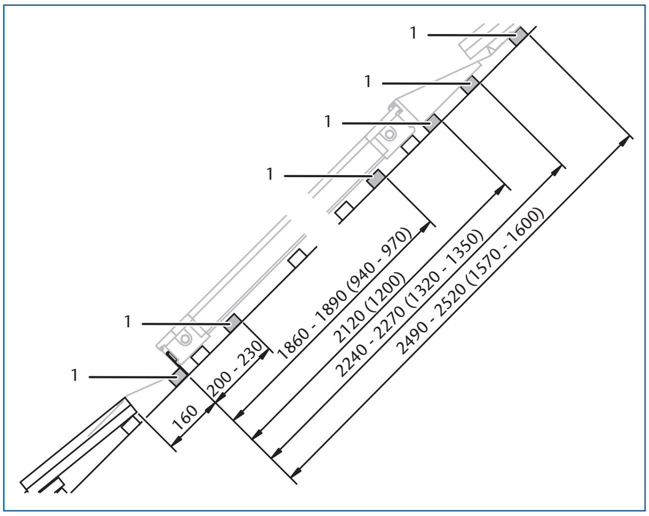
1 Additional roof battens



95/1 General layout, collector row integrated into the roof



95/2 1 standard kit for the two outer collectors and 1 extension kit for the centre collector (highlighted in blue)



95/3 Spacing between additional roof battens for single-row installation (dimensions in mm); values in brackets for portrait version

Hydraulic connections

The in-roof (roof integrated) connection kits are recommended for making the hydraulic collector connections during in-roof installation (figs ***96/2*** and ***96/3***).

The flow and return pipes can be routed through the roof inside the side cover plate using the connection kits.

If an air vent valve is installed, route the flow pipe beneath the roof with an incline. Route the return pipe to the KS station with a slope.

Static requirements

The values in table ***86/1*** are the permissible standard snow loads and building heights for in-roof (roof integrated) installation.

Caption (→ *96/1*)

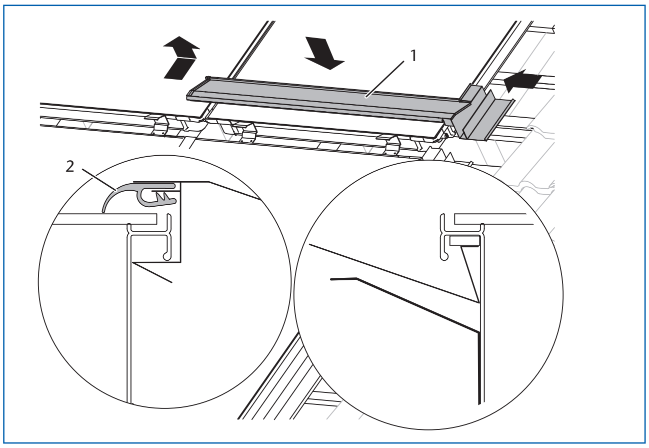
1 Centre cover plate (right)
2 Rubber lip

Caption (→ *96/2*)

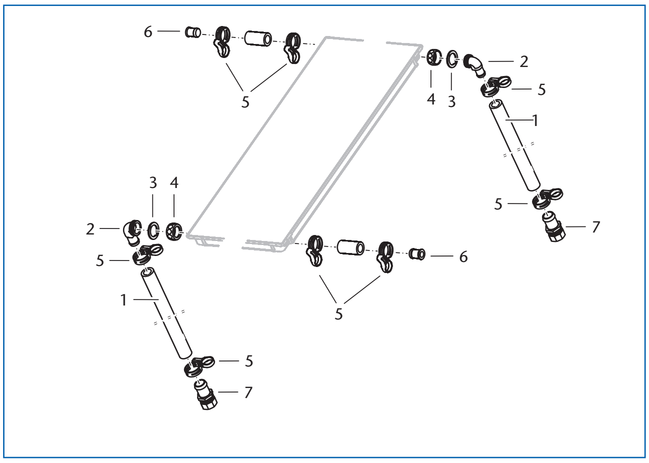
1 Connection pipe 1000 mm
2 Bracket
3 Clamping disk
4 Nut G1
5 Spring clip
6 Dummy plug
7 Hose ferrule with R3/4" connection or 18mm locking ring

Caption (→ *96/3*)

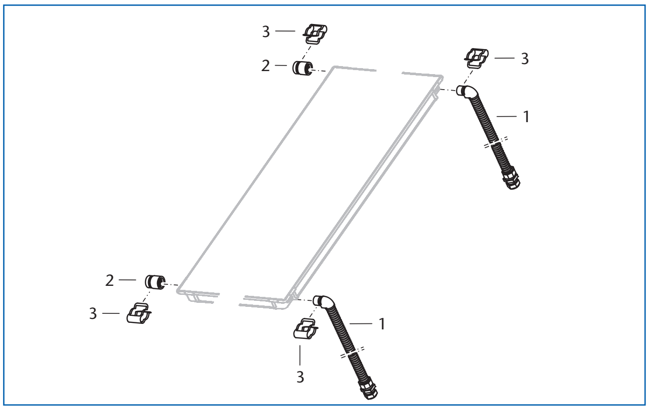
1 1000mm connection pipe with R3/4" connection or 18 mm locking ring at the system side, insulated
2 Dummy plug
3 Clip



96/1 *Cover plate between two rows of collectors arranged one above the other*



96/2 *SKN3.0 roof installation connection kit*



96/3 *SKS4.0 roof installation connection kit*

In-roof (roof integrated) installation system component selection aid

Include appropriate fixing materials in the specification subject to the number of collectors and rows.

		Total number of collectors	1	2		3		4		5	6			7	8		9		10	
		Number of rows	1	1	2	1	3	1	2	1	1	2	3	1	1	2	1	3	1	2
		Number of collectors per row	1	2	1	3	1	4	2	5	6	3	2	7	8	4	9	3	10	5
SKN3.0-s and SKS4.0-s	Individual installation	Row 1 Tiled Tiled / Row 1 Slate Shingle Plain tiled	1	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–
SKN3.0-s and SKS4.0-s	Individual installation	Additional row Tiled Tiled / Additional row Slate Shingle Plain tiled	–	–	1	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–
SKN3.0-s and SKS4.0-s	Standard kit for 2 collectors	Row 1 Tiled Tiled / Row 1 Slate Shingle Plain tiled	–	1	–	1	–	1	1	1	1	1	1	1	1	1	1	1	1	1
SKN3.0-s and SKS4.0-s	Standard kit for 2 collectors	Additional row Tiled Tiled / Additional row Slate Shingle Plain tiled	–	–	–	–	–	–	1	–	–	1	2	–	–	1	–	2	–	1
SKN3.0-s and SKS4.0-s	Extension kit	Row 1 Tiled Tiled / Row 1 Slate Shingle Plain tiled	–	–	–	1	–	2	–	3	4	1	–	5	6	2	7	1	8	3
SKN3.0-s and SKS4.0-s	Extension kit	Additional row Tiled Tiled / Additional row Slate Shingle Plain tiled	–	–	–	–	–	–	–	–	–	1	–	–	–	2	–	2	–	3

97/1 Fixing materials for in-roof (roof integrated) installation system

		Total number of collectors	1	2		3		4		5	6			7	8		9		10	
		Number of rows	1	1	2	1	3	1	2	1	1	2	3	1	1	2	1	3	1	2
		Number of collectors per row	1	2	1	3	1	4	2	5	6	3	2	7	8	4	9	3	10	5
SKN3.0-w and SKS4.0-w	Individual installation	Row 1 Tiled Tiled / Row 1 Slate Shingle Plain tiled	1	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–
		Additional row Tiled Tiled / Additional row Slate Shingle Plain tiled	–	–	1	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–
SKN3.0-w and SKS4.0-w	Standard kit for 2 collectors	Row 1 Tiled Tiled / Row 1 Slate Shingle Plain tiled	–	1	–	1	–	1	1	1	1	1	1	1	1	1	1	1	1	1
		Additional row Tiled Tiled / Additional row Slate Shingle Plain tiled	–	–	–	–	–	–	1	–	–	1	2	–	–	1	–	2	–	1
	Extension kit	Row 1 Tiled Tiled / Row 1 Slate Shingle Plain tiled	–	–	–	1	–	2	–	3	4	1	–	5	6	2	7	1	8	3
		Additional row Tiled Tiled / Additional row Slate Shingle Plain tiled	–	–	–	–	–	–	–	–	–	1	–	–	–	2	–	2	–	3

98/1 Fixing materials for in-roof (roof integrated) installation system

6.3.5 Flat roof installation for flat-plate collectors

Flat roof installation is intended for level roof surfaces. However, it is also suitable for roofs with minor slopes of up to 25° (→ *99/1*). For this, secure the flat roof support on site.

The flat roof installation kit for SKN3.0 and SKS4.0 flat-plate collectors consists of a standard kit for the first collector in a row and an extension kit for each additional collector in the same row (→ *99/2*). Accessories are required for buildings more than 20m high and with snow loads of > 2 kN/m² (→ *86/1*).

The angle of inclination of the flat roof support can be adjusted in steps of 5° as follows:

- Portrait flat roof support: 30° to 60° (adjustable by 25° by trimming the telescopic rail)
- Landscape flat roof support: 35° to 60° (adjustable by 25° or 30° by trimming the telescopic rail)

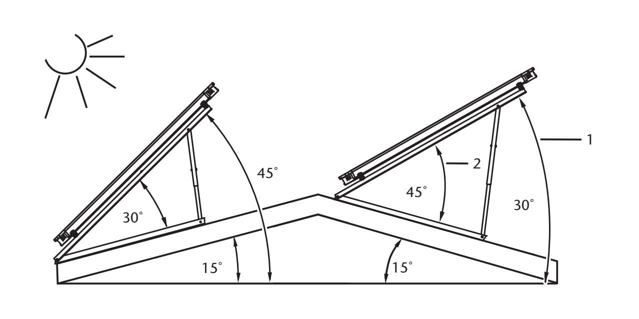
The flat roof supports can be fixed to the roof by means of weighting (ballast) or by attaching them to the roof structure.

On-site mounting

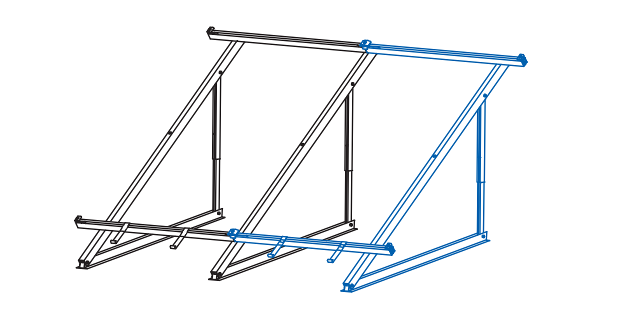
The flat roof supports can by mounted on on-site substructures consisting of double-T supports, for example (→ *99/3*). For this, there are holes in the bottom profile rails of the flat roof supports. The on-site substructure must be designed such that the wind force acting upon the collectors can be absorbed.

The support spacing dimensions can be found in figures *100/1* to *100/3*. The positions of the holes for attaching the flat roof supports to the on-site substructure can be found in figure *99/3*.

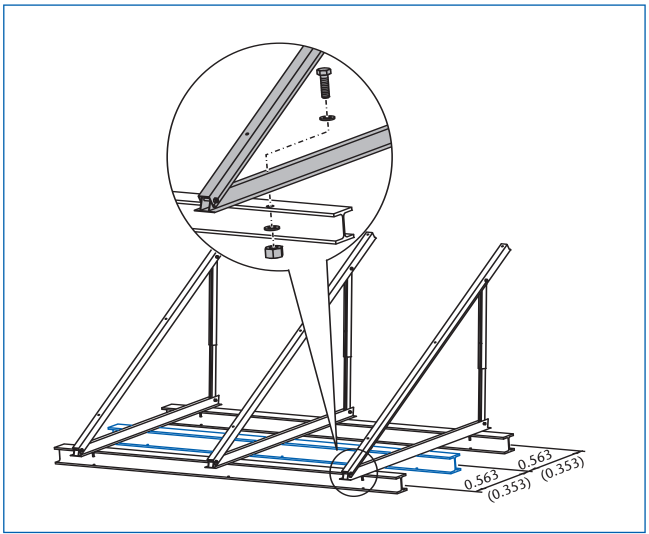
For buildings more than 20m in height or with snow loads of 2 kN/m² to 3.8 kN/m², each standard kit for portrait collectors must be fitted with an additional rail (standard kit addition) and each extension kit must be fitted with an additional rail and an additional support (extension kit addition). With landscape collectors, fit all installation kits with an additional rail (standard kit and extension kit addition).



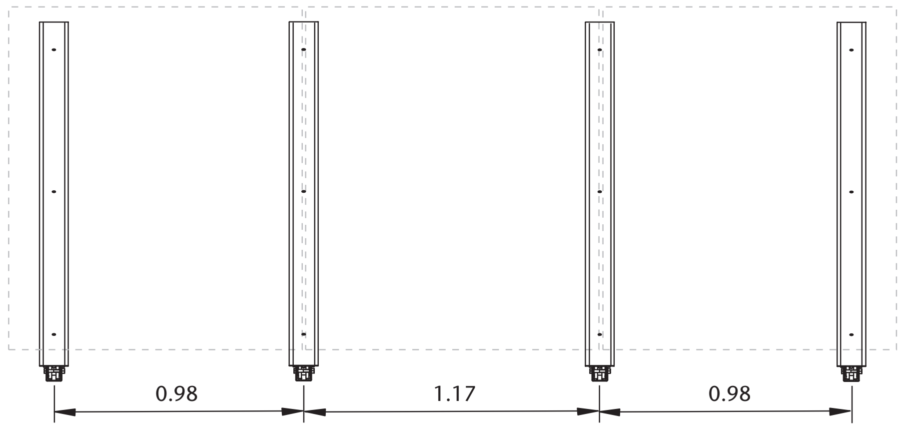
99/1 *Examples of actual flat-plate collector angle of inclination when using flat roof supports on a flat roof with a shallow pitch (< 25°) Item 1: pitch; item 2: collector angle of inclination*



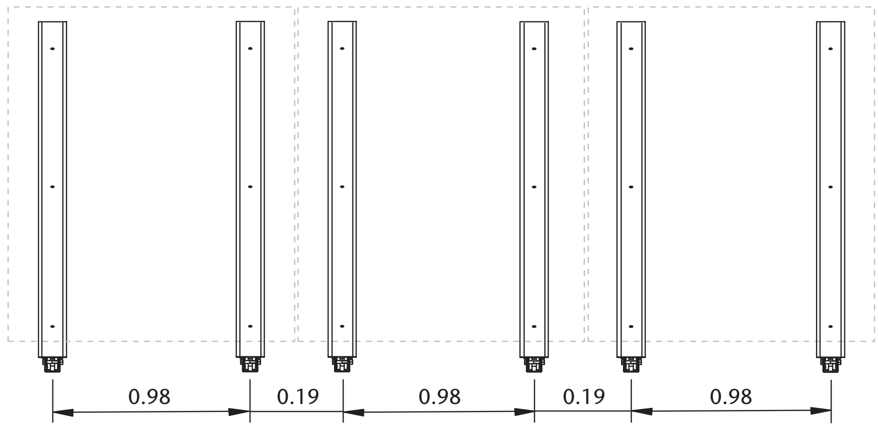
99/2 *Flat roof support standard kit and extension kit (blue) for one SKN3.0-s or SKS4.0-s flat collector*



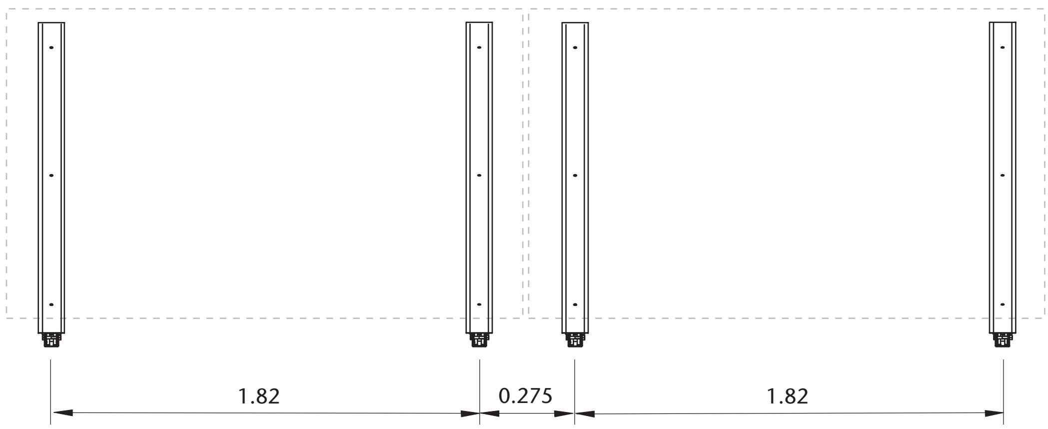
99/3 *Flat roof support fixed on site with base anchoring to a substructure consisting of double-T supports (dimensions in m); value in brackets for landscape version; centre contact surface (blue) only required for buildings above 20m in height.*



100/1 Collector support spacing in standard version with flat roof supports for portrait collectors SKN3.0-s and SKS4.0-s (dimensions in m)



100/2 Collector support spacing in standard version when using additional supports with flat roof supports for portrait collectors SKN3.0-s and SKS4.0-s (dimensions in m)



100/3 Distance between collector supports with flat roof supports for landscape SKN3.0-w and SKS4.0-w collectors (dimensions in m)

Securing by means of loading trays

Four loading trays are required for each flat roof support when the collectors are weighed down (dimensions: 950mm x 350mm x 50mm) - these are hooked into the flat roof support (→ *101/1*). They are filled with concrete slabs, gravel or the like to weigh them down. Use is subject to roof conditions, strength and the application of braided steel wire. See table *102/1* for the required ballast weight (maximum 320kg with gravel filling) subject to the height of the building.

With a building up to 20m high and snow loads of up to 2 kN/m², one additional support is required for the 4th, 7th and 10th collector in a row when loading trays are used in conjunction with portrait collectors. The installation kit includes one additional support when landscape collectors are used. The additional supports are required for hooking in the trays.

For buildings higher than 20m or with snow loads of 2 kN/m² to 3.8 kN/m², each standard kit must include an additional rail (standard kit addition) and each extension kit for portrait collectors must include an additional support and an additional rail (extension kit addition). With landscape collectors, all installation kits must be equipped with an additional rail (standard kit and extension kit addition).

Erect the entire structure on protective building mats to protect the skin of the roof.

Hydraulic connections

The flat roof connection kits are used to make the hydraulic collector connections during flat roof installation (fig. *101/2* and *101/3*). Route the flow pipe parallel to the collector to prevent damage to the connection due to the movement of the collector in the wind (fig. *101/4*).

Static requirements

The values in table *86/1* are the permissible standard snow loads and building heights.

Caption (→ *101/2*)

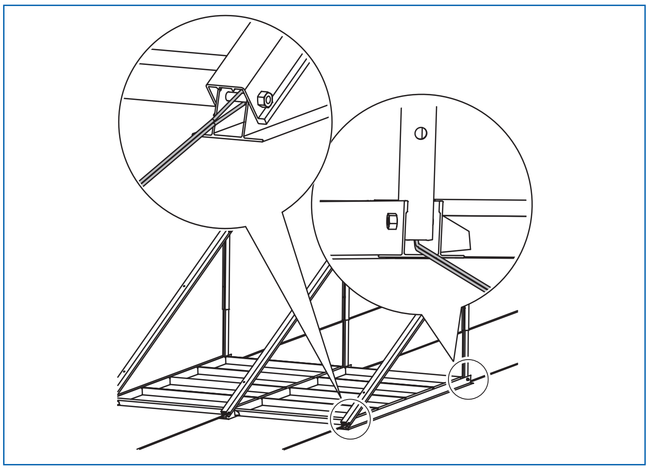
1 Bracket with R3/4" connection on the system-side or 18mm locking ring
2 Clamping disk
3 Nut G1
4 Dummy plug
5 Spring clips

Caption (→ *101/3*)

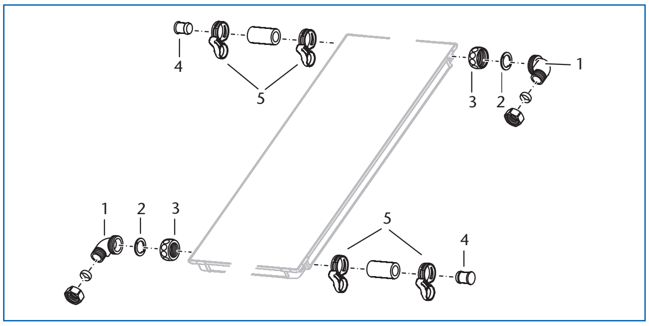
1 Bracket with R3/4" connection on the system side or 1 mm locking ring
2 Dummy plug
3 Clip

Caption (→ *101/4*)

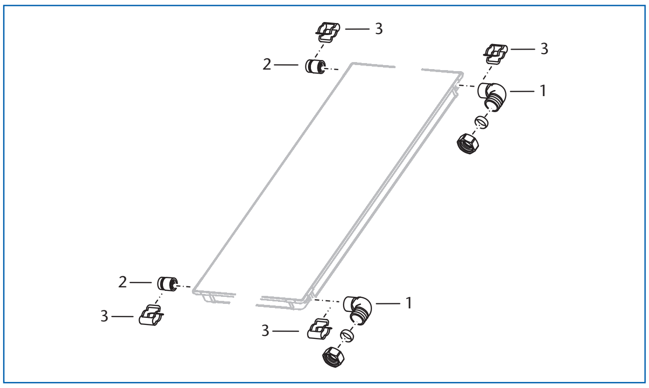
1 Pipe clamp (on site)
2 M8 thread
3 Bracket (connection kit standard delivery)
4 Flow pipe



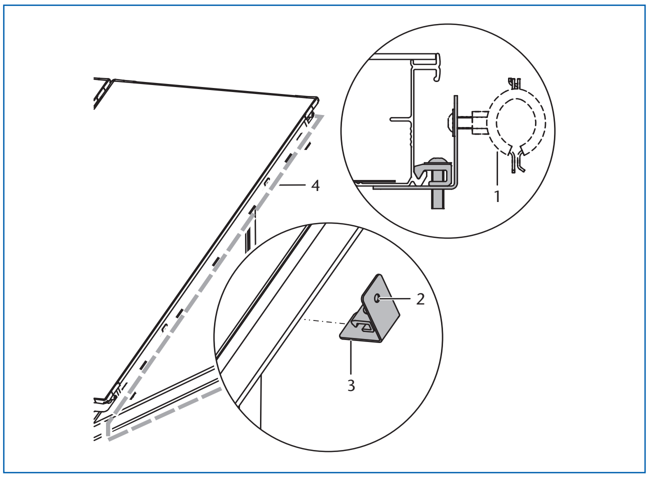
101/1 Flat roof support with loading trays and additional braided steel guy ropes



101/2 SKN3.0 flat roof connection kit



101/3 SKS4.0 flat roof connection kit



101/4 Collector flow pipe routing

Flat roof support weights

When the roof loads are being determined, the following weights can be assumed for flat roof installation kits:

- Standard kit, portrait: 12.2kg
- Standard kit, landscape: 8.7kg
- Extension kit, portrait: 7.2kg
- Extension kit, landscape: 8.7kg

Flat roof support fixing (collector stabilisation)

Building height	Wind velocity	Base anchoring	Ballast	Guy rope	
				Protection against tilting	Protection against slippage
		Number and type of screws[1]	Weight (e.g. concrete slabs)	Weight (e.g. concrete slabs)	Max. tensile strength per rope
m	km/h		kg	kg	kN
0 to 8	**102**	2x M8/8.8	270	180	1.6
8 to 20	**129**	2x M8/8.8	450	320	2.5
20 to 100[2]	**151**	3x M8/8.8	–	450	3.3

102/1 Options for securing flat roof supports for each collector to prevent tilting and sliding as a result of wind; version for SKN3.0 and SKS4.0 flat-plate collectors
1) Per collector support
2) Additional rail and additional support required for portrait collectors, and additional rail for landscape collectors

Flat roof installation system, component selection aid

Include appropriate fixing materials in the engineering subject to the number of collectors and their hydraulic connections.

	Total number of collectors	2		3			4		5		6			7		8		9			10	
	Number of rows	1	2	1	2	3	1	2	1	2	1	2	3	1	2	1	2	1	2	3	1	2
	Number of collectors per row	2	1	3	2 1	1	4	2	5	3 2	6	3	2	7	4 3	8	4	9	5 4	3	10	5
Installation kits with loading tray[1]																						
SKN3.0-s and SKS4.0-s	**Standard kit**	1	2	1	2	3	1	2	1	2	1	2	3	1	2	1	2	1	2	3	1	2
	Extension kit	1	–	2	1	–	3	2	4	3	5	4	3	6	5	7	6	8	7	6	9	8
	Additional support[2]	–	–	–	–	–	1	–	1	–	1	–	–	2	1	2	2	2	2	–	3	2
	Standard kit addition[3]	1	2	1	2	3	1	2	1	2	1	2	3	1	2	1	2	1	2	3	1	2
	Addition to extension kit[3]	1	–	2	1	–	3	2	4	3	5	4	3	6	5	7	6	8	7	6	9	8
SKN3.0-w and SKS4.0-w	**Standard kit**	1	2	1	2	3	1	2	1	2	1	2	3	1	2	1	2	1	2	3	1	2
	Extension kit	1	–	2	1	–	3	2	4	3	5	4	3	6	5	7	6	8	7	6	9	8
	Standard kit addition[3]	1	2	1	2	3	1	2	1	2	1	2	3	1	2	1	2	1	2	3	1	2
	Addition to extension kit[3]	1	–	2	1	–	3	2	4	3	5	4	3	6	5	7	6	8	7	6	9	8
Installation kits for on-site attachment																						
SKN3.0-s and SKS4.0-s	**Standard kit**	1	2	1	2	3	1	2	1	2	1	2	3	1	2	1	2	1	2	3	1	2
	Extension kit	1	–	2	1	–	3	2	4	3	5	4	3	6	5	7	6	8	7	6	9	8
	Standard kit addition[3]	1	2	1	2	3	1	2	1	2	1	2	3	1	2	1	2	1	2	3	1	2
	Addition to extension kit[3]	1	–	2	1	–	3	2	4	3	5	4	3	6	5	7	6	8	7	6	9	8
SKN3.0-w and SKS4.0-w	**Standard kit**	1	2	1	2	3	1	2	1	2	1	2	3	1	2	1	2	1	2	3	1	2
	Extension kit	1	–	2	1	–	3	2	4	3	5	4	3	6	5	7	6	8	7	6	9	8
	Standard kit addition[3]	1	2	1	2	3	1	2	1	2	1	2	3	1	2	1	2	1	2	3	1	2
	Addition to extension kit[3]	1	–	2	1	–	3	2	4	3	5	4	3	6	5	7	6	8	7	6	9	8

102/2 Fixing materials for the flat roof installation system
1) The standard installation and extension kits contain one set of loading trays each
2) Not required if the additional extension kit is selected
3) Required in addition to the standard and extension kit with snow loads in excess of 2 kN/m² or building height exceeding 20m

6.3.6 Wall installation for flat-plate collectors

Wall installation is only suitable for landscape SKN3.0-w and SKS4.0-w flat-plate collectors, and is only approved for building walls up to an installation height of 20m.

Wall mounting requires horizontal flat roof supports. The first collector in the row is installed using a wall support standard kit. Every additional collector in the same row is installed using a wall support extension kit. These kits include three supports (→ ***103/2***).

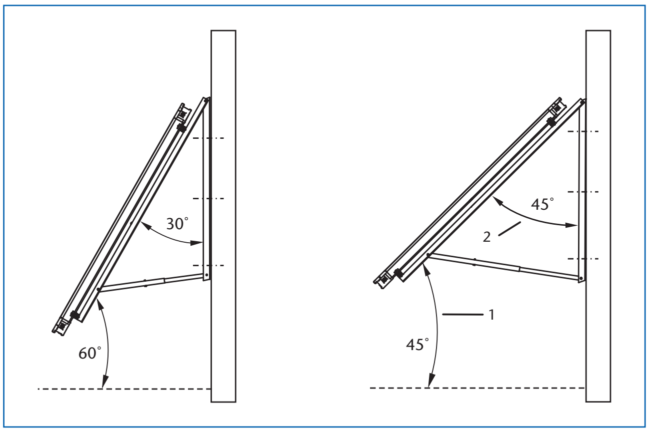
The pitch of the collectors on the wall may only be set to between 45° and 60° relative to the horizontal (→ ***103/1***).

On-site fixing

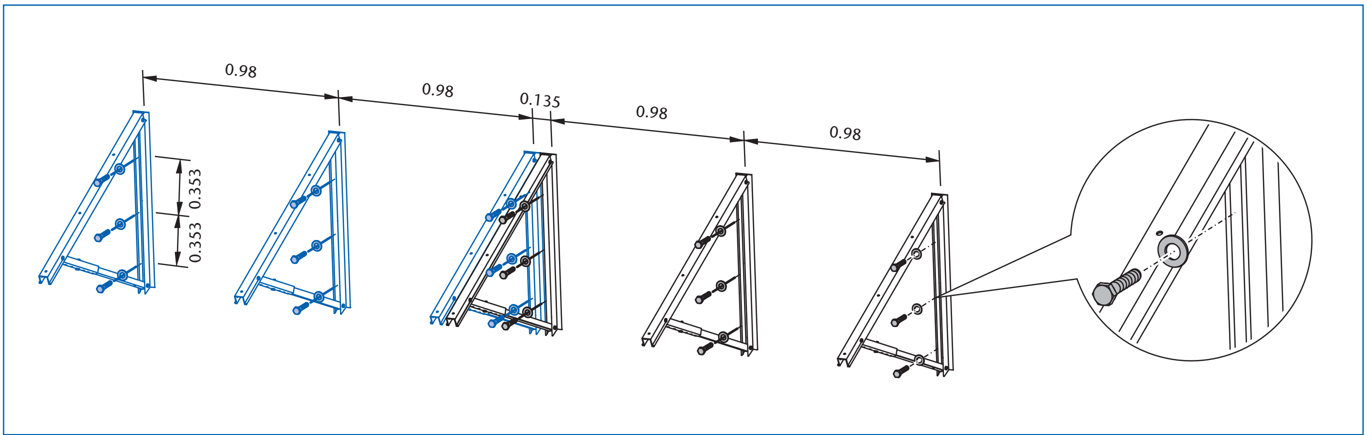
Secure the collector supports on site to a load-bearing surface using three bolts per support (→ ***103/3***).

Static requirements

The values in table ***86/1*** are the permissible standard snow loads and building heights.



103/1 Max. permitted collector pitch on a wall
Item 1: pitch (absolute angle relative to the horizontal)
Item 2: collector angle of inclination



103/2 Wall mounting with wall support standard kit and wall support extension kit (blue); dimensions in m

Wall construction[1]	Screws/dowels for each collector support	Distance from edge of wall m
Reinforced concrete at least B25 (min. 0.12m)	3x UPAT MAX Express-anchors, type MAX 8 (A4)[2] and 3x washers[3] in acc.with BS EN 9021	> 0.10
Reinforced concrete at least B25 (at least 0.12m)	3x Hilti HST-HCR-M8[2] or HST-R-M8[2] and 3x washers[3] in acc.with BS EN 9021	> 0.10
Steel substructure (e.g. double-T support)	3x M8 (4.6)[2] and 3x washers[3] in acc.with BS EN 9021	–

103/3 Fixing materials
1) Brick work on request
2) Each dowel/screw must be able to withstand a tensile force of at least 1.63 kN and a vertical force (shearing force) of at least 1.56 kN
3) 3x screw diameter = external washer diameter

Component selection aid for wall mounting system for SKN3.0-w and SKS4.0-w

Include appropriate fixing materials in the engineering subject to the number of collectors and their hydraulic connections.

	Total number of collectors	2		3			4		5		6			7		8		9			10	
	Number of rows	1	2	1	2	3	1	2	1	2	1	2	3	1	2	1	2	1	2	3	1	2
	Number of collectors per row	2	1	3	2 1	1	4	2	5	3 2	6	3	2	7	4 3	8	4	9	5 4	3	10	5
Installation kits																						
SKN3.0-w and SKS4.0-w	**Standard kit for wall mounting**	1	2	1	2	3	1	2	1	2	1	2	3	1	2	1	2	1	2	3	1	2
	Extension kit for wall mounting	1	–	2	1	–	3	2	4	3	5	4	3	6	5	7	6	8	7	6	9	8

104/1 Fixing materials for wall mounting system for SKN3.0-w and SKS4.0-w

6.4 Lightning protection and earth bonding for solar heating systems

Requirement for lighting protection

The requirement for lightning protection is defined in the building regulations with reference to BS EN 62305. Lightning protection is frequently required for buildings that

- are more than 20m high
- are significantly higher than the surrounding buildings
- are valuable buildings (monuments) and/or
- could cause panic if a lightning strike occurred (schools, etc.).

If a solar heating system is installed on top of a building with a high protection target (e.g. high-rise building, hospital, assembly buildings or shops) the lightning protection requirements should be discussed with an expert and/or the building operator. This discussion should take place in the planning phase of the solar heating system.

Since solar heating systems are not higher than the roof ridge (even in special cases), the probability of a direct lightning strike for a residential building is the same with or without a solar heating system.

Earth bonding for the solar heating system

Irrespective of whether a lightning protection system is present, the flow and return of a solar heating system must always be earthed with a copper cable with at least 10mm² cross-section at the earth bonding rail.

→ If a lightning protection system is installed, determine whether the collector and the installation system are outside the protection scope of this system. If this is the case, a **specialist electrical contractor** must connect the solar heating system to the existing lightning protection system. Electrically conducting parts of the solar heating circuit must be earthed with a copper cable with at least 10mm² cross-section at the earth bonding rail.

7 Regulations and Directives

Enquiry form for solar heating systems (page 1/2)
Details regarding the sizing of a solar heating system

Buderus

Project

Contact

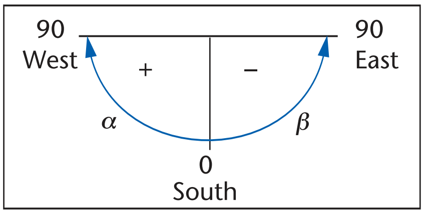
	Buderus		Design/Engineering
Mr./Mrs.		Mr./Mrs.	
Telephone		Telephone	
Fax		Fax	

Place of collector installation

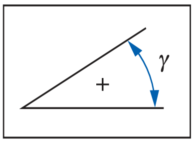
System location: Postcode Town

Collector orientation:

Point of the compass



Angle of inclination



γ =

α =

β =

Include scale drawings of southern aspect!

Collector model: ☐ SKN3.0 ☐ SKS4.0

Are collectors shaded? ☐ No ☐ Yes

Available roof area: m Length × Width m

Type of collector installation: ☐ Roof integration ☐ Rooftop installation ☐ Flat roof installation ☐ Wall mounting

Roof skin make-up:

Solar heating system pipework

Single pipe length in the system: m Outside the building m Inside the building

Static height: m Between the highest system point and the centre of the diaphragm expansion vessel

Boiler room / installation room of the cylinder(s)

Room dimensions: m Height

m Length × Width m

Smallest door size: m Height × Width m

Utilisation of solar energy ☐ DHW (WW) ☐ Central heating (H) ☐ Swimming pool (S)

Example details

Angle of inclination	γ = 45°
Orientation	0 south
Are collectors shaded?	No
Available roof area	Adequate space
Type of collector installation	Rooftop
Roof skin make-up	Tiled roof
Single pipe length	1 m / 8 m
Static height	8 m
Room height	> 2 m
Room length × width	Adequate space
Smallest door size	2.00 m × 1.20 m
Utilisation of solar energy	DHW (WW)

Enquiry form for solar heating systems
(Page 2/2)

Buderus

Example details (continued)

DHW heating

		Example details
No. of occupants:	[ ] persons	4 persons
Daily DHW demand: (Standard values in litres/person)	☐ Low (40 l/person) ☐ Medium (50 l/person) ☐ High (75 l/person)	50 l per person
Daily DHW volume:	[ ] litre (person × litres per person)	200 litres
Washing machine with hot fill?	☐ No ☐ Yes	No
Dishwasher with hot fill?	☐ No ☐ Yes	No
DHW draw-off temperature:	[ ] °ß°C (Std. value: 45° ß°C For detached and two-family homes, 60° ß°C for apartment buildings)	45° ß°C / 60° ß°C
Max. cylinder temperature:	[ ] °ß°C	60° ß°C
DHW circulation:	DHW circulation loss: [ ] W	None

Control	ON 1	OFF 1	ON 2	OFF 2	ON 3	OFF 3	Example details
Time	:	:	:	:	:	:	None

Reheating

		Example details
Available boiler output:	[ ] kW	18 kW
Boiler efficiency of:	[ ] %	90 %
Reheating in summer mode?	☐ No ☐ Yes, with	Yes, with …
Boiler efficiency (summer mode):	[ ] %	50 %
Additional cylinder volume?	[ ] litre ☐ Dual-mode ☐ Mono-mode	no
Fuel:	☐ Oil ☐ Gas ☐ LPG ☐ Biomass ☐ Elec. ☐ District heating	Fuel oil / Natural gas

Central heating back-up

		Example details
Standard outside temperature:	[ ] °ß°C	–14 ßC
Heat demand:	[ ] kW	6 kW
Flow temperature:	[ ] °ß°C Return temperature: [ ] °ß°C	35 / 30 ˚ ßC
Heating limit temp. (changeover to summer mode):	[ ] °ß°C	18 ˚ßC
Annual oil consumption:	[ ] l/p.a. Annual gas consumption: [ ] m^3/p.a.	1260 l/p.a. / 1160 m^3/p.a.

Swimming pool water heating

		Example details
Swimming pool water heating	☐ Private ☐ Public	Private
Operating period:	From [ ] to [ ]	May – September
Type:	☐ Indoor	Indoor pool
	☐ Outdoor ☐ Exposed ☐ Sheltered ☐ Sheltered from wind	Sheltered
Tile colour	[ ]	Blue
Basin: (Length x Width x Depth)	[ ] m × [ ] m × [ ] m	← Please state!
Pool cover:	☐ None ☐ Available Type of cover [ ]	Available
Set water temperature:	[ ] °ß°C	24 ßC
Reheating by boiler via heat exchange (HE)?	☐ Yes ☐ No, with …	Yes, with HE …
HE output (for reheating):	[ ] kW HE water content: [ ] m^3/h	← Please state!

Date: Signature:

Keyword index

S

T

V

List of abbreviations

Abb.	Description
AK	Cold water outlet (buffer system)
AV	Shut-off valve
AW/AB	DHW outlet
E	Air vent valve
EH	Immersion heater
EK	Cold water inlet
EL	Drain
EMS	Boiler control system used on GB boiler range
EW	DHW inlet (primary system)
EZ	DHW circulation inlet
F	Flow; solar flow
FA	Outside temperature sensor
FE	Fill & drain valve
FK	Boiler water temperature sensor
FR	Return temperature sensor
FSK	Collector temperature sensor
FP	Thermal store temperature sensor
FPO	Thermal store temperature sensor, top
FPU	Thermal store temperature sensor, bottom
FSB	Swimming pool water temperature sensor
FSS1	Cylinder temperature sensor (1st consumer)
FSS-2	Cylinder temperature sensor (2nd consumer)
FSW1	Heat meter temperature sensor Flow
FSW2	Heat meter temperature sensor return
FSX FSX1 FSX2 FSX3	Cylinder temperature sensor or threshold sensor for thermosiphon cylinder for High-Flow-/Low-Flow operation with solar function module FM443 or SM10 (Cylinder connection set AS1, AS16 or DHW temperature sensor FB or FW)
FV	Flow temperature sensor
HK	Heating circuit
HS (-E)	Heating circuit quick assembly set, optionally with self-regulating electronic pump
HSM (-E)	HS with actuator (mixer), optionally with self-regulating electronic pump
HZG	HZG set for central heating backup

Abb.	Description
LLH	Low loss header
M	Measuring point (e.g. cylinder), motor (e.g. actuator)
MB	Domestic hot water measuring point
PH	Heating circuit pump
PHE	Plate heat exchanger
PS	Cylinder primary pump
PSB	Swimming pool water pump
PSS	Solar circuit pump
PUM	Stratification pump
PWT	Heat exchanger pump
PZ	DHW circulation pump
R	Return; solar return
RK	Boiler return
RW	Cylinder return
RSB	Swimming pool control unit
RW	Return temperature limiter
SA	Line regulating and shut-off valve
SH	Heating circuit actuator
SMF	Dirt filter
SP1	Overvoltage protection
SU	Diverter valve
SV	Safety valve
SWT	Swimming pool water heat exchanger
TW	Drinking water/DHW
TWE	Domestic hot water heating
ÜV	Overflow valve
VK	Boiler flow
VS	Cylinder flow
VS-SU	Diverter valve to 2nd consumer VS-SU
Heat source	Residential unit
WT	Heat exchanger
WMZ	Heat meter set WMZ1.2 in conjunction with solar function module FM443
WWM	Thermostatically controlled DHW mixer

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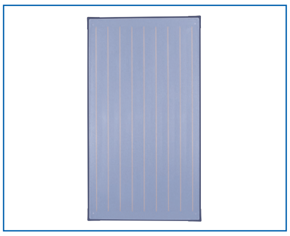
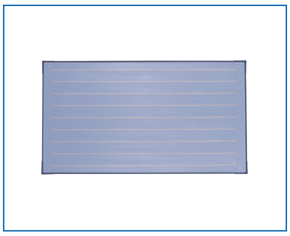
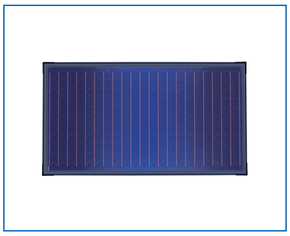


SKN 3.0 portrait collector
7 747 025 768



SKN 3.0 landscape collector
7 747 025 769

SKS 4.0 portrait collector
8 299 936 0



SKS 4.0 landscape collector
8 299 936 4

PR500
7 747 304 156 (80mm)
7 747 304 159 (120mm)

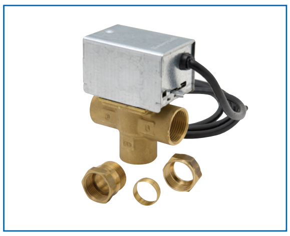
PR750
7 747 304 157 (80mm)
7 747 304 160 (120mm)

PR1000
7 747 304 158 (80mm)
7 747 304 161 (120mm)

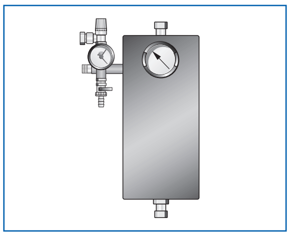
SC 20 stand alone controller
7 747 019 692

SC 40 stand alone controller
7 747 019 694

KS0105 standard
pump station & SC20
7 747 019 687

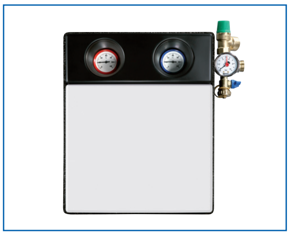


Diverter valve &
22mm adaptor VS-SU
85 103 220



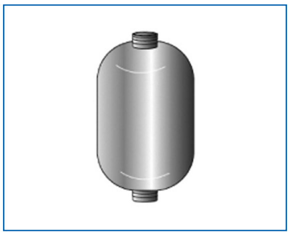
Single line pump station

KS0105E	7 747 019 685
KS0110E	7 747 019 686



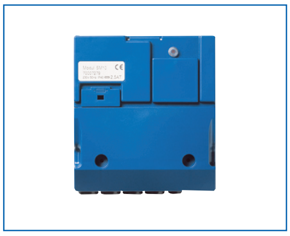
Dual line pump station

KS0105	7 747 019 688
KS0110	7 747 019 689
KS0120	7 747 019 690
KS0150	7 747 019 691



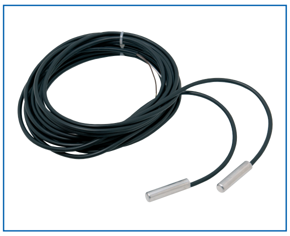
Pre-cooling vessel

5 litre	30 008 862
12 litre	30 008 863

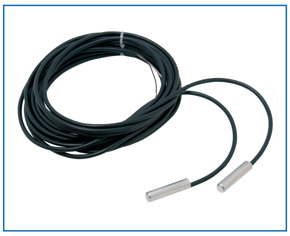


SM10 integrated EMS solar
module for DHW preparation only
30 008 448

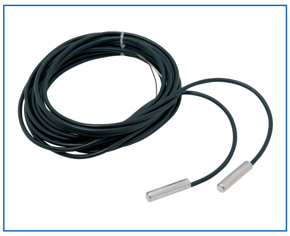
FM443 integrated 4000 series
solar module for DHW &
auxiliary heating preparation
7 747 300 910



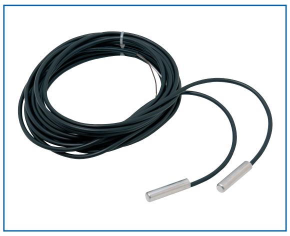
Storage sensor 9mm (AS1)
5 991 384



Storage sensor 6mm (AS1.6)
63 012 831



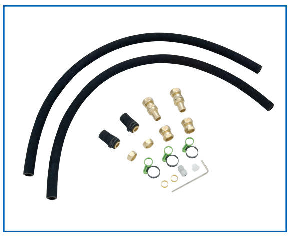
Collector sensor for 2nd field
7 747 009 883



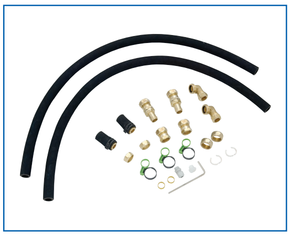
Sensor set for 2nd consumer (FSS)
5 991 520

Heat counter WMZ 1.2

for 5 collectors	83 004 271
for 10 collectors	83 004 272
for 15 collectors	7 747 004 456



On roof hose connection set
(SKN 3.0)
7 747 019 680



In roof hose connection set
(SKN 3.0)
7 747 019 679

Flat roof connection set
(SKN 3.0)
7 747 019 678

Appearance and contents may vary and be changed without notification.

Expansion vessel

18L, 6 bar white	7 747 202 342
25L, 6 bar white	7 747 202 343
35L, 6 bar white	7 747 202 344
35L, 6 bar blue	7 747 202 341
50L, 6 bar blue	80 432 066
80L, 6 bar blue	80 432 068
100L, 6 bar	80 657 080
140L, 6 bar	80 657 082
200L, 6 bar	80 657 084
250L, 6 bar	80 657 086
300L, 6 bar	80 657 088
400L, 6 bar	80 657 090
500L, 6 bar	80 657 092

Flat roof connection set
(SKS 4.0)
7 747 019 682

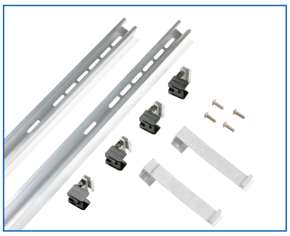
Pitched roof connection set
(SKS 4.0)
7 747 019 683

Series hose connection for
multiple rows (SKN 3.0)
7 747 019 681

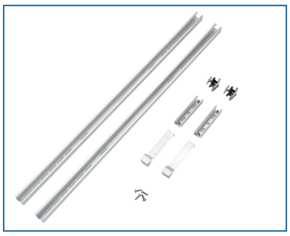
Air vent kit
(SKN 3.0)
83 077 200

Series hose connection for
multiple rows (SKS 4.0)
7 747 019 684

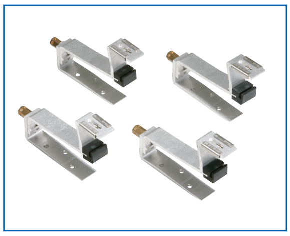
Air vent kit
(SKS 4.0)
83 077 210



On roof portrait basic 1 coll
7 739 300 440



On roof portrait exten 1 coll
7 739 300 441



Roof connection for tile/plain tile
7 739 300 436

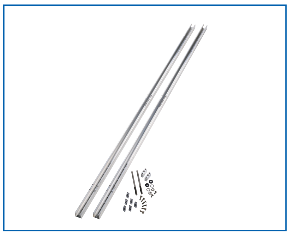
Roof connection
for corrugated/tin roof
7 739 300 439

Auxiliary rail portrait basic 1 coll
7 739 300 444

Auxiliary rail portrait exten 1 coll
7 739 300 445

Snow load profile portrait
tile/plain tile
7 739 300 448

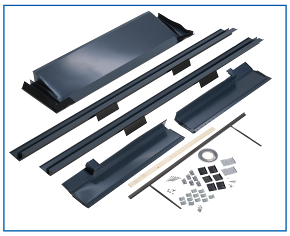
Snow load profile
portrait slate/shingle
7 739 300 449



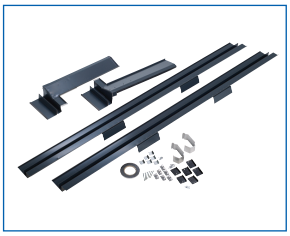
Snow load profile
portrait corrugated/tin roof
7 739 300 450

On roof landscape basic 1 coll
7 739 300 442

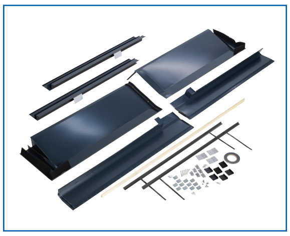
On roof landscape exten 1 coll
7 739 300 443



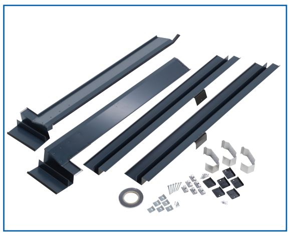
Roof integrated portrait
basic 1 coll tile
7 739 300 461



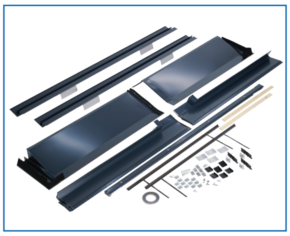
Roof integrated portrait
2 row 1 coll tile
7 739 300 462



Roof integrated landscape
basic 1 coll tile
7 739 300 486



Roof integrated landscape
2 row 1 coll tile
7 739 300 487



Roof integrated portrait
basic 2 coll tile
7 739 300 463

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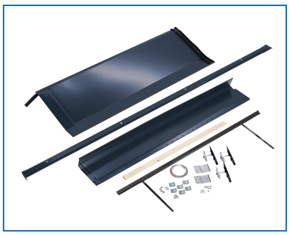
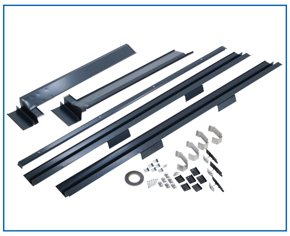
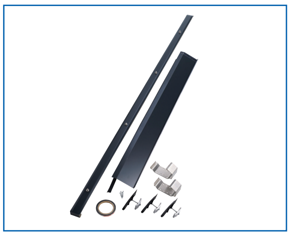


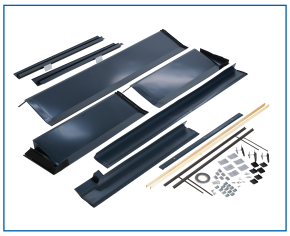
Roof integrated portrait exten tile
7 739 300 464



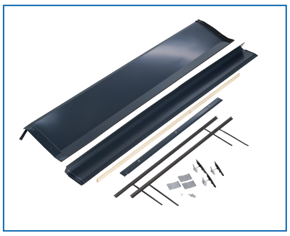
Roof integrated portrait
2 row 2 coll tile
7 739 300 465



Roof integrated portrait
2 row exten tile
7 739 300 466

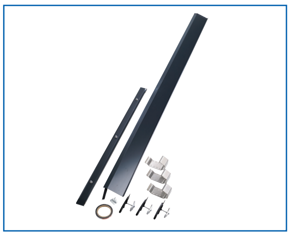


Roof integrated landscape
basic 2 coll tile
7 739 300 488

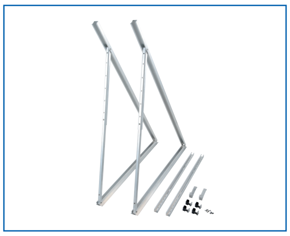


Roof integrated landscape
exten tile
7 739 300 489

Roof integrated landscape
2 row 2 coll tile
7 739 300 490

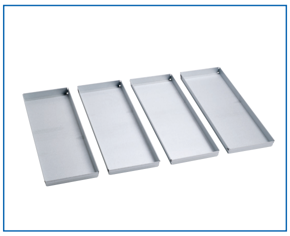


Roof integrated landscape
2 row exten tile
7 739 300 491

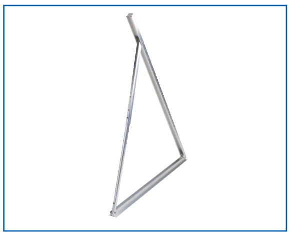


Flat roof support portrait
basic 1 coll
7 739 300 454

Flat roof support portrait
exten 1 coll
7 739 300 455



Loading tray set for
1 coll portrait
7 739 300 458



Auxiliary frame
portrait 1 coll flat roof
7 739 300 459

Auxiliary frame
landscape 1 coll flat roof
7 739 300 460

Auxiliary rail
landscape basic 1 coll
7 739 300 446

Auxiliary rail
landscape exten 1 coll
7 739 300 447

Flat roof support
landscape basic 1 coll
7 739 300 456

Flat roof support
landscape exten 1 coll
7 739 300 457

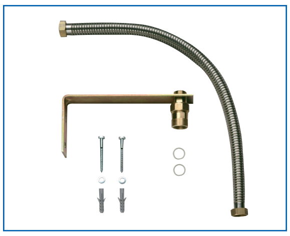
Slate/crown tile hook
7 739 300 281

Additional crown tile hook
7 739 300 282

Solar fluid 25L
7 739 300 057

Solar fluid 10L
7 739 300 058

Antifreeze tester
830 134 00



Expansion vessel connector
7 739 300 331

Solar service kit
83 001 990

Solar panel cover
7 747 025 484

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Greenskies 180 Cylinder
7 716 192 554

Greenskies 210 Cylinder
7 716 192 555

Greenskies 250 Cylinder
7 716 192 556

Greenskies 300 Cylinder
7 716 192 557

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