P.O. BOX 90216, 67005, Strasbourg
Headquarters: 2 rue fossé des tailleurs, 67000, Strasbourg
Deliveries: ROBIN SUN – 24 boulevard de la victoire, 67084, Strasbourg

Phone Number from France: + 33 (0) 388.228905
International Phone Number: +49 (0)7853.17347
Fax: + 33 (0) 388.144799
robinsun@robinsun.com
www.robinsun.com

TECHNICAL DOCUMENTATION
ROBIN SUN SOLAR THERMAL GLASS

011-7S918 F

Last updated in February 2011

Table of contents

I. OVERVIEW 3
1.1: Composition and operating 3
1.1.1: Standard composition 4
1.1.2: Operating 4
II. Performances 5
2.1: Solar thermal collector 5
2.2: thermal transmission 7
2.3: Energy transmission 7
2.4: Light transmission 8
2.5 Sound transmission 9
III. TECHNICAL CHARACTERISTICS 9
3.1: Dimensions 9
3.2: Design and operation of the collector field 14
3.3.1: Design recommendations for the glass units 14
Examples of connectors in aluminum frames with hydraulic connection area 17
3.3.3: drilling/machining of the vertical jabs 20
3.3.4: Design recommendations for the solar collector 21
3.3.5: Robin Sun solar thermal glass Worksite Planning 25
3.3.7: Monitoring and maintenance of the solar system 26
IV. GUARANTEE 26
V. QUALITY 27
VI. INSTALLATION AND CONNECTION INSTRUCTIONS 27
6.1: Instructions for installers responsible for the fitting of Robin Sun solar thermal glass in joinery or facades 27
6.1.1: As received by the joiner/façade specialists 27
6.1.2: Verifications on delivery 28
6.1.3: Handling and storage 28
6.1.4: Adjusting the tubes to length 29
6.2 Instructions for the Robin Sun solar thermal glass hydraulic connection installers 29
6.2.1: Flexible tubing 29
6.2.2: Connection 30
6.2.3 Degasser/Bleeder: 31
6.2.4 Temperature sensor 31
6.2.5: Temperature differential 32
6.2.6: Heat transfer fluid 32
6.2.7: Lagging of the tubing and insulation of the technical tube 32
APPENDIX 34
Tests 34

I. OVERVIEW

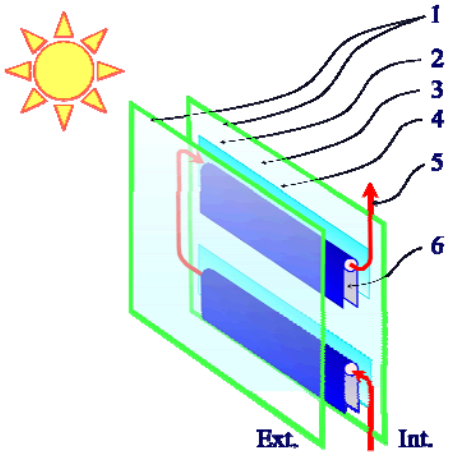
The Robin Sun solar thermal glass is a solar protection integrated in Insulating Glass Unit (I.G.U.) who works as semi-transparent solar thermal collector.

It is a multifunctional system that contributes to insulation, summer comfort, natural lighting as well as the production of sanitary hot water as well as heating and/or air conditioning.

It installs itself like a conventional glass window in fixed vertical frames or directly in the structure.
It operates and is connected like a conventional solar thermal collector.
Its verticality favors the production of energy in all seasons.

1.1: Composition and operating

Fig. 1 - Perspective view from the outside of the Robin Sun solar thermal glass:



1 – Extra white glass outside thermally tempered and inside a float glass with low-e coating+white glass both thermally tempered, glued over the reflector
2 - Sealed tight environment with an argon noble gas filling
3 - Insulating coating – highly reflective of infrared ray that are close[1]
4 – Aluminium lamellas with PVD reflector: 98% visible light – 95% total reflection
5 - Hydraulic circulation through a one piece copper serpentine
6 - ∩-shape profiles with a highly selective absorbing coating

[1] The glass is naturally opaque to infrared rays that are far away.

1.1.1: Standard composition

- The double-glazed unit consists of:
    - Outside, a tempered extra clear glass that is 4 mm thick which allows a light transmission equal to or greater than 91% and an energetic transmission equal to or greater than 90%.
    - Inside, a 4mm tempered glass, with a soft layer coating that is infra-red ray reflective on position 3[2] with 3% emissivity, UV-glued with 4mm extra white glass tempered or a 33.2 laminated glass.
    - Reflector strips with 98% visible reflection and 95% total reflectivity and 3 % low emissivity coating on position 3[3].
    - An aluminum spacer of 26.5 mm filled with desiccants on 3 sides.
    - Filling of the airspace with Argon gas equal to or greater than 85%.
    - A double seal of the perimeters with butyl joints and polyurethane adhesives.

- The thermal solar collector integrated in the glass consists of:
    - A one piece copper serpentine of 8.7 mm of diameter.
    - Aluminum lamellas which are 0.5 mm thick that are clipped on over half of the perimeter of the serpentine. These lamellas are covered with an external absorbing coating that is highly selective: 95% absorption and 5% of emissivity.
    - A special sealant/thermal overload between the tube and the spacer.
    - Insulating Teflon pads that insure the good positioning and guidance of the solar collector in the center of the glass. These are maintained in place on the collector with staples.

1.1.2: Operating

The solar flux passing through the Robin Sun solar thermal glass is broken down into three parts according to the seasons:

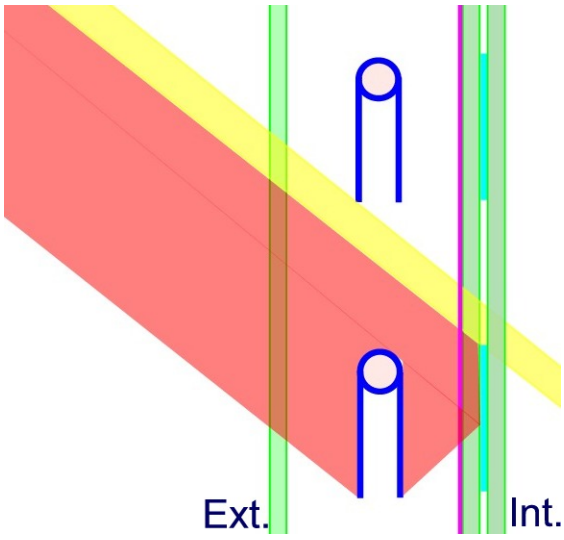
- A first part, that is almost constant all through the year, is directly intercepted by the front part of the lamellas.
- A second part is reflected by the reflectors strips in the direction of the back side of the horizontal lamellas to which they are associated. This interception of radiation increases gradually with the solar height until it becomes maximal starting at approximately 58 degrees.
- An eventual third part, which corresponds to the part not intercepted by the reflectors and their lamellas and that passes through the glass. It is the case of winter sun whose solar height is week and that passes through the glass to bring direct light and energy to the room.

The shade produced on the floor corresponds to the part of the solar flux intercepted by the thermal solar collector and the associated reflector strips. This energy/hot water is

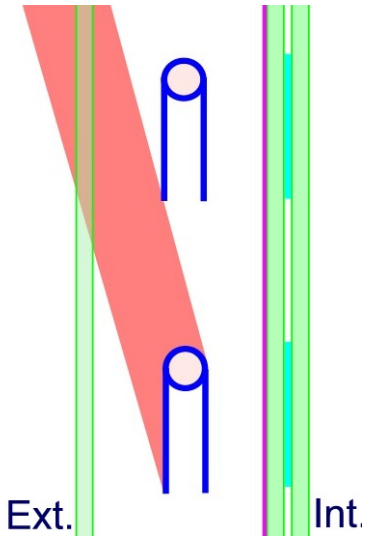
[2] The sides of the glass are numbered conventionally from the outside in.
[3] Between 0 (optical factor) and 20º of solar height, the solar flux is on the front and its energy is almost always unexploitable.

transferred by water circulation to a thermal exchanger equipped with a storage tank in order to be stored and then later on used to meet the hot water needs.

Winter operating



Summer operating



The Robin Sun solar thermal glass favors:

- The sun in the winter – passive heat and light supplies.
- The shade in the summer – summer comfort and diffuse lighting.

II. Performances

2.1: Solar thermal collector

Despite its transparency on over 40% of the surface, the Robin Sun solar thermal glass is comparable to a usual flat plate solar thermal collector installed vertically.

Characteristics:

The optical yield and the thermal losses indicated have been measured perpendicularly to the glass on the entry surface by the Fraunhofer ISE. The larger glasses offer a slightly better performance because the thermal losses on the sides of the glass are less important given their wider captation surface. The thermal loss of the thermal collector indicated does not take into account the insulation of the sides provided by the glass frame.

These values, on a facade, must be corrected to reflect the angle of incidence factors.

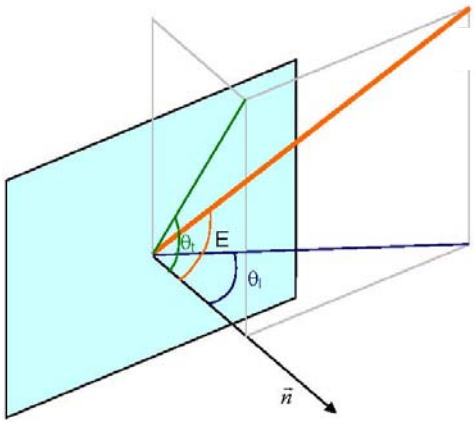
- ETA 0: 50.6 % is the optical yield measured on a standard solar thermal glass type H-1432.
- a1 : 3.839 [W m^{-2} K^{-1}]
- a2 : 0.0555 [W m^{-2} K^{-2}]
- Heat mass: 4.20 kJ/K

These angle of incidence factors or optical factor are corrective coefficients that allow calculating the optical yields for all the solar incidence angles:

θ en °	0	10	20	30	40	50	60	70	80	90
Kθb(θt)=	**1,00**	**1,02**	**1,08**	**1,12**	**1,18**	**1,23**	**1,30**	**1,02**	0,58	0
Kθb(θl)=	**1,00**	**1,00**	**1,00**	0,99	0,98	**0,94**	0,87	0,74	0,48	0

The optical yield factor must go over 1 to allow the reflector to be activated. Given that the optical yield is established using a solar flux that is perpendicular to the glass, i.e. for which only the front face of he lamellas are active[4], the optical factor is used to correct it in order to take into account close to the totality of the absorbing surface insulated depending on the solar height.

θt : Transversal optical factor
θl : Longitudinal optical factor



The T-Sol and Polysun software modelings for our Robin Sun solar thermal glass are available on demand for engineering burros.

For engineering firms that are not equipped with software capable of taking into account the optical factor variables, we offer energetic preliminary studies. A calculation worksheet that allows for the calculation of the RT2005 prescribed by regulation rate of coverage of a Robin Sun solar thermal glass installation can also be provided.

Stagnation:

The assessment of the maximum temperature that can be reached was made by the Fraunhofer ISE on a H-1432 model installed in a, in accordance with standard EN 12975-2:2006, i.e. with a tilt angle perpendicular to the solar flux and therefore without an incidence on the optical yield, an irradiation of 1000W/m² and a 30°C ambient temperature. Under these conditions, the maximum temperature that can be reached at the absorbing surface in the absence of circulating water is 97°C. If the optical factors are taken into consideration, the maximum stagnation temperature is 127°C.

Applied to extreme conditions on the façade and in the absence of circulating water, it has been shown that by taking into account the optical factors and by accumulating all the negative hypothesis possible (summer period, zone VE4 in the South of France, Western

[4] Between O (optical factor) and 20º of solar height, the solar flux is on the front and its energy is almost always unexploitable.

orientation[5], outside temperature of 38°C, altitude of 0 to 500 m, rural zone, building with no air conditioning), it would be possible to reach a temperature of 100 °C at the absorbing surface.

For properly working and dimensioned installations, this theoretical temperature is highly improbable in reality.

2.2: thermal transmission

A measure of the heat transmission at the center of the glass without water in serpentin and without taking into account the absorber position shows a thermal coefficient (Ug) value of 1.1 W/m²K. That data must be used to calculate the value of the thermal coefficient of the glass (Uw). This value is to be used when calculating Uw. The positive effect of the reduction of the emissivity of the reflective layer in face 3, from 5% when measured to 3% today, is not taken into account in this value.

Note: The conditions of measurements established by the CSTB have not assessed the role of the integrated solar collector as a radiation resistance. That role, evidenced by preliminary measures taken by the Fraunhofer ISE, heterogeneous transfer according to the zones, would justify measuring this data again.

However, the interest of the Ug value is limited to the characterization of the static transfer, for example during the night or when the sky is overcast. Given the dynamic of the Robin Sun solar thermal glass, we feel it is more interesting to assess how to act efficiently by day and by night on the thermal transmissions.

2.3: Energy transmission

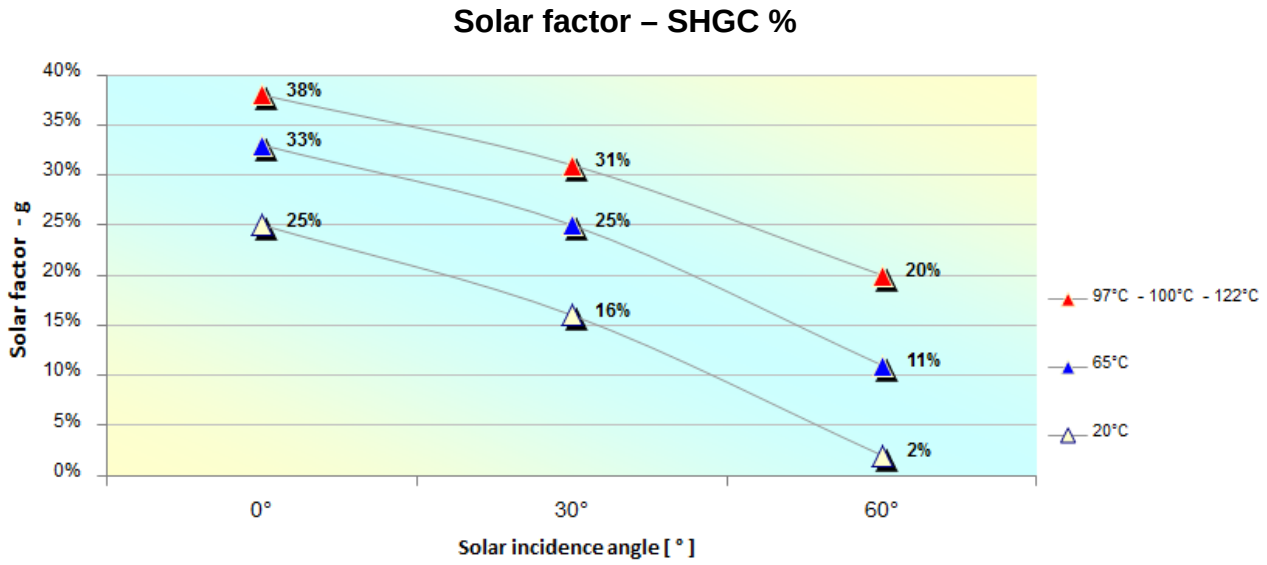
The solar function or solar factor has been measured by the Fraunhofer ISE for 3 characteristic solar heights (0°, 30° and 60°) and for 3 different temperatures at the absorbing surface:

- 20°C, i.e. the same temperature in the solar glass than in the room where it is installed[6], in order to measure the solar protection offered without taking into consideration any interaction due to the operating of the solar collector.

- 65°C, a usual temperature for production of hot sanitary water.

- 97°C - 100°C - 122°C, which are the maximum temperatures at angles of 0°, 30° and 60° respectively on the absorbing surface in the absence of circulating water, as measured under standard/artificial insulation on model H-732 in a vertical position.

[5] The Western orientation cumulates the important exterior temperature and the maximum effects of the optical factors.
[6] The water temperature can be below that value.



In order to take into account the limits of the thermal calculation of the RT2005 standard, it is suggested to bring the solar factor down to two values:

- Winter solar factor: mini. 20 %, solar angle of less than 30°, typically from end of October to mid February.
- Summer solar factor: max. 5%, solar angle of more than 60°, typically from end of April to mid October.

These values, recurring in our studies, represent the possible minimal values in the winter period and the maximal values in the summer period.

Note: The 5°C of difference between the possible maximal temperatures measured here and those used to define the stagnation is primarily due to their respective conditions of measurement.

2.4: Light transmission

Value of the light transmission factor (LT) in %:

Incidence Angle °	0°	30°	60°
LT %	35%	29%	7%

The measurements were taken on an extra clear Robin Sun solar thermal glass made of a 4 mm tick outside glass and an interior clear float 44.2 glass with reflective layers and strips on 3. The use of an extra clear 4 mm thick interior glass instead of the 44.2 glass would allow a 5% increase in these values.

The impact of the reflector strip that account for approximately 50% of the glass' interior surface on the artificial and natural light transmission in a building was evidenced by Raytracing (Radiance). Although this has not been measured and the economy realized has not been quantified, this impact has been observed at every site.

This impact also contributes, on the inside, to double the sense of space, and the reflections of the reflector strips contribute to the reinforcement of the space's tonalities (white wall perpendicular to the glass on this picture). The reflectors strips cannot be seen from the outside, because reflect the absorber.

2.5 Sound transmission

The acoustic insulation provided par the Robin Sun solar thermal glass (calculated values), with the stacking of 4/27/44.standard glasses, should be at least equal to:

$$R_w(C, C_{tr}) = 38\ (-2, -6)$$

For more precise data, measurements should be taken once the window is in the chosen sash.

III. TECHNICAL CHARACTERISTICS

3.1: Dimensions

In all our documents, the dimension provided is always the glass's raw dimension, excluding the tube.

The standard width is 1016 mm. The two tubes that go out of the glass on the sides add approximately 100 mm to that width.

The height at the lower tube's axis is located 51 mm from the bottom.
The position of the upper pipe is given by the A dimension which is a function of the standard height chosen.

Standard glazing size heights (standard modules, in grey the most usual choices):

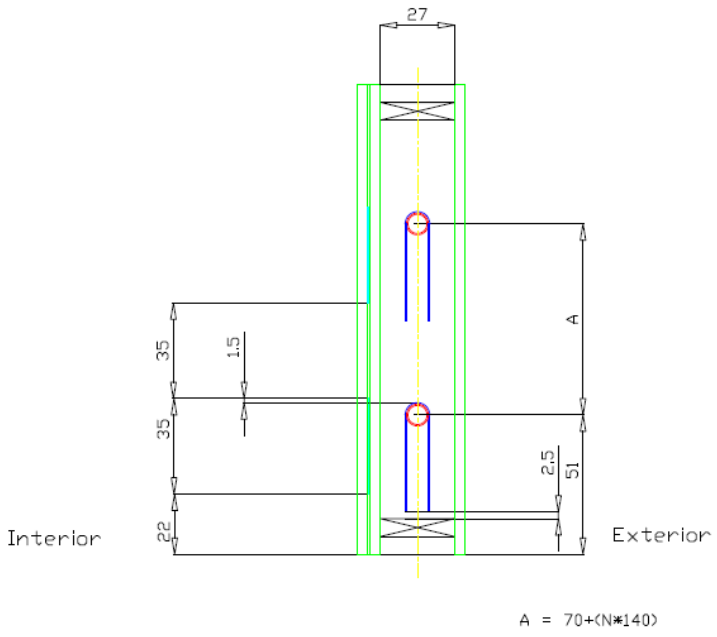
Modelle des Typs H-(Höhe in mm)	172	312	452	592	732	872	1012	1152	1292	1432	1572	1712	1852	1992	2132	2272	2412
Oberer Rohreausgang A in mm	121	261	401	541	681	821	961	1101	1241	1381	1521	1661	1801	1941	2081	2221	2361

For the non-standard size (ie not listed in the table above), the 2 vertical strips of the solar collector element are extended.
Example for a 731 mm height glazing: Exact value of standard glaziing: 592 mm (A side outlet pipe high: 541 mm).
With a standard height would be 33.5 mm clear at the top. The clear height will be in this case: (731-592) -33.5 = 105 mm

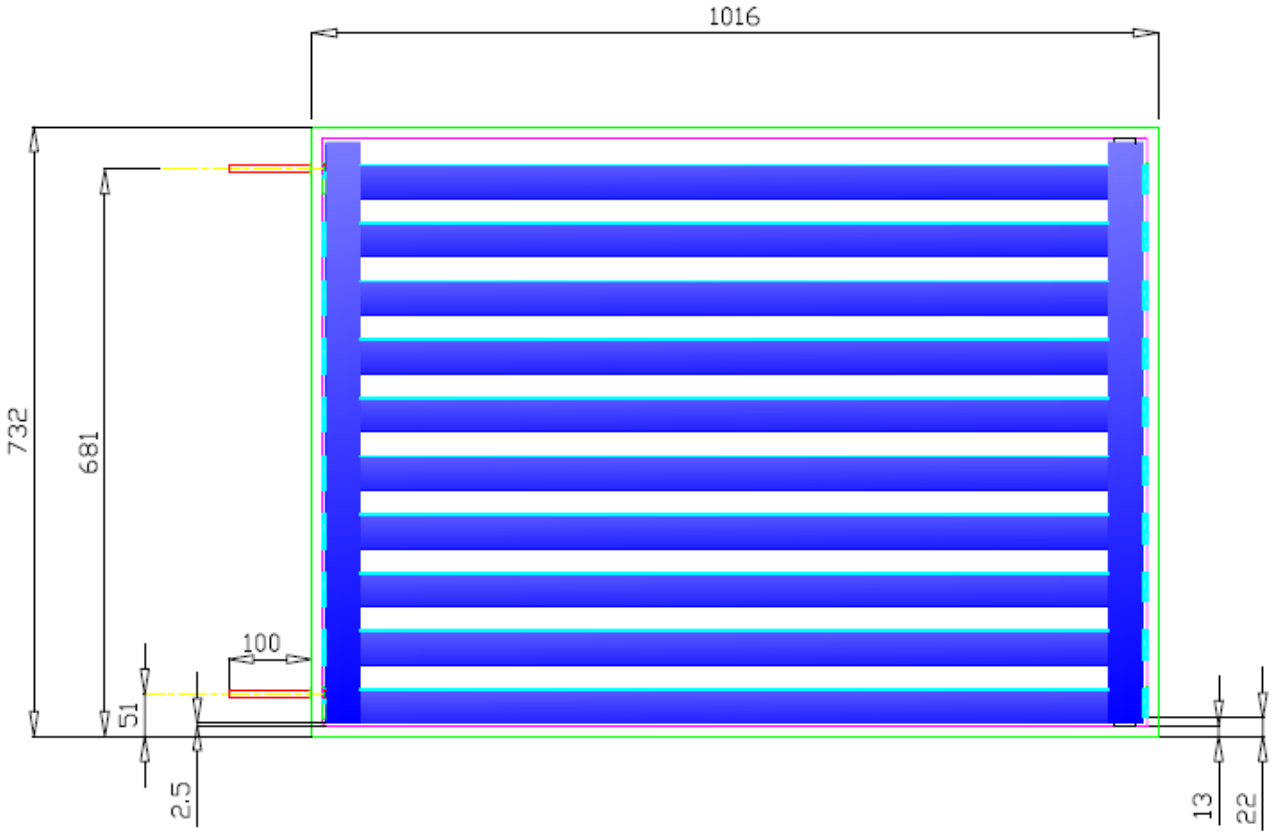
Maximum Range: 1500 x 2500 mm. Thicknesses and type of glasses are free.

Because the copper pipe goes outside the glazing always on the same side and progress with a fix step of 140 mm: Between each standard glazing size height, just the 2 vertical lamellas of the solar collector element are extended.

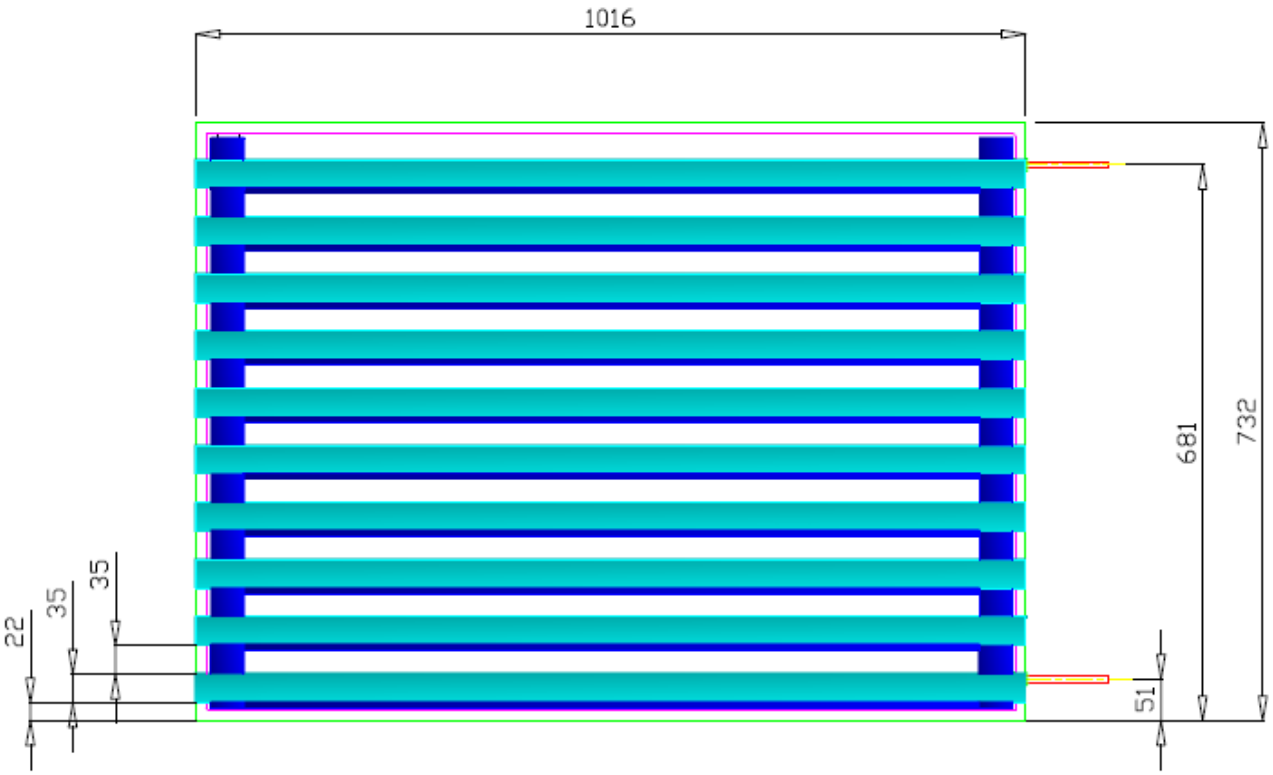
Side section vew of a Robin Sun thermal solar glass:



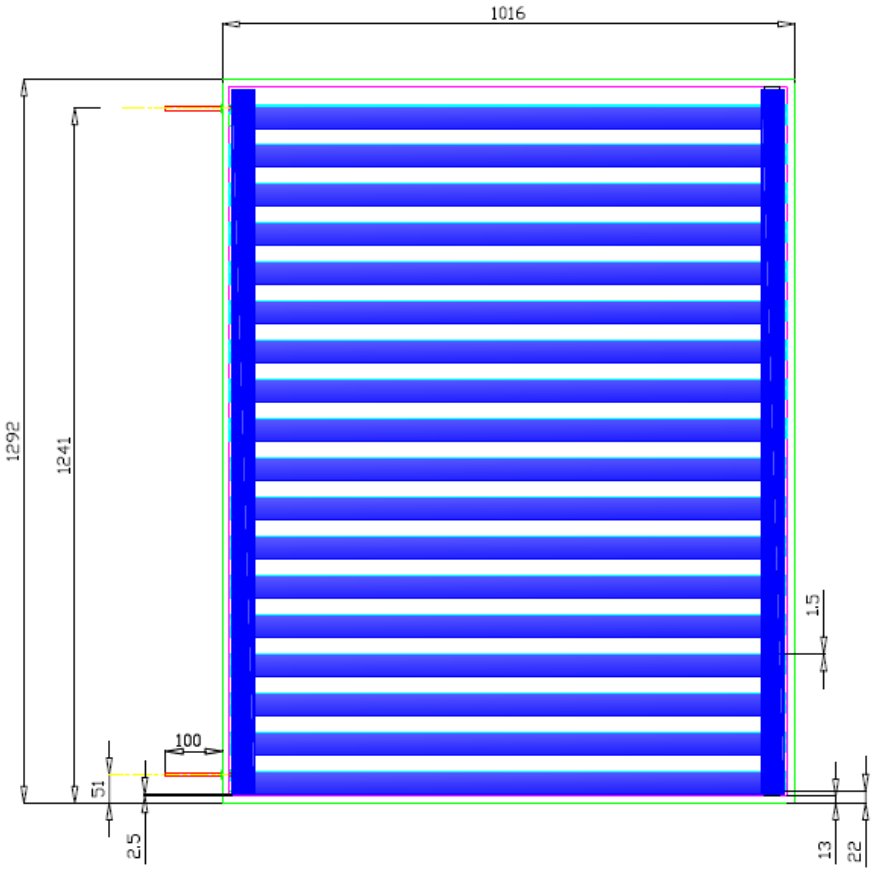
H-732 Robin Sun solar thermal glass seen from the exterior of the building



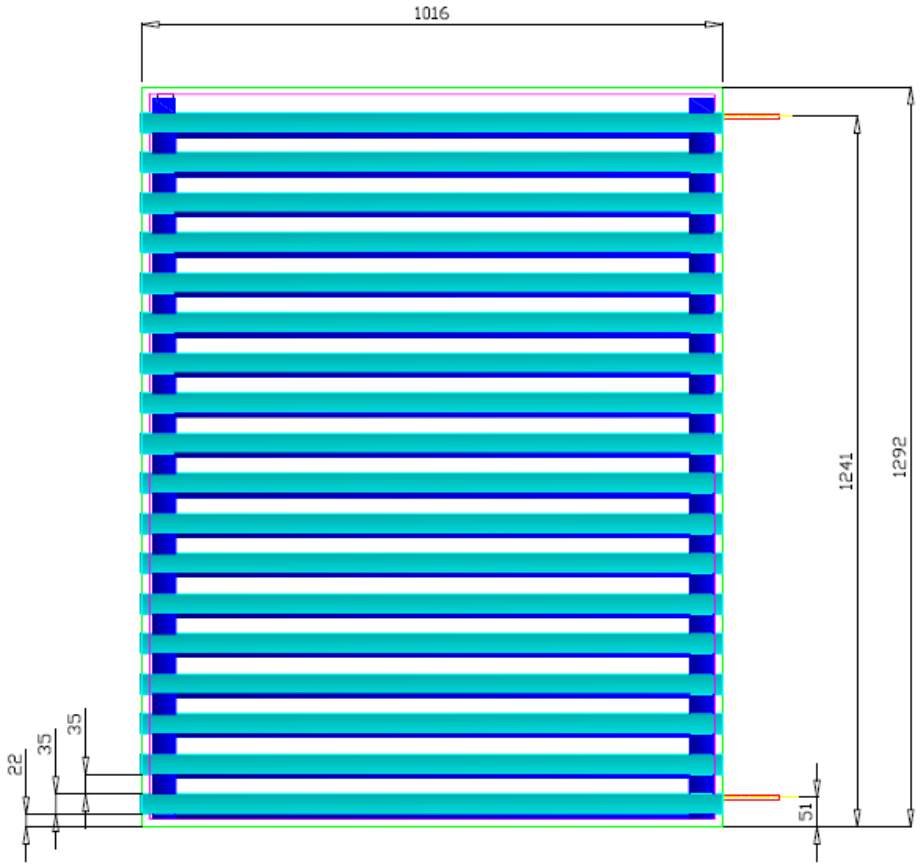
H-732 Robin Sun solar thermal glass seen from inside the building



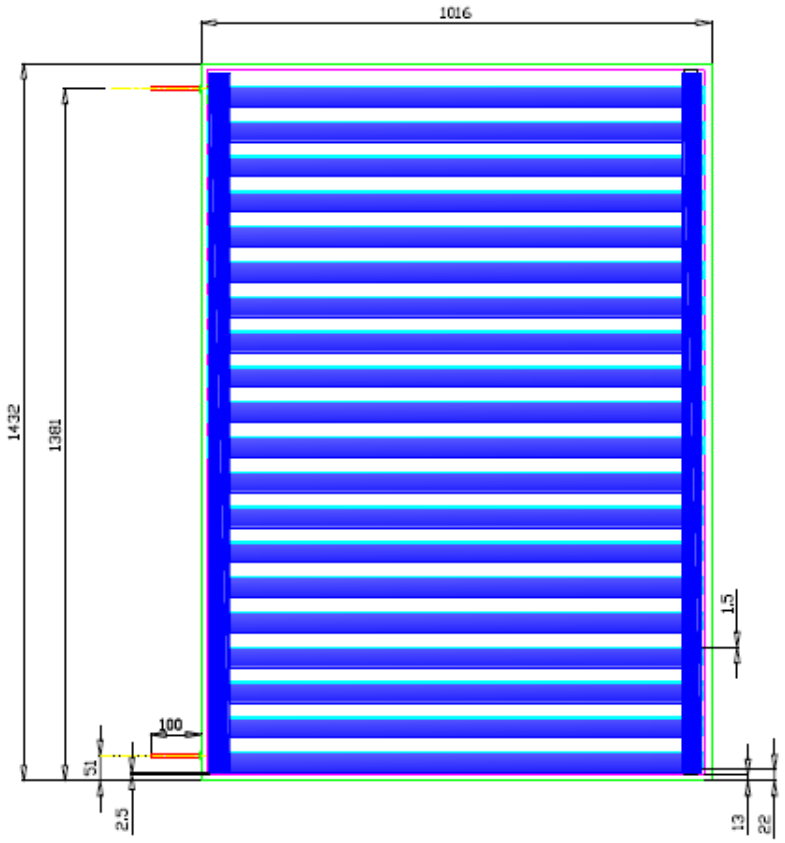
H-1292 Robin Sun solar thermal glass seen from the outside of the building



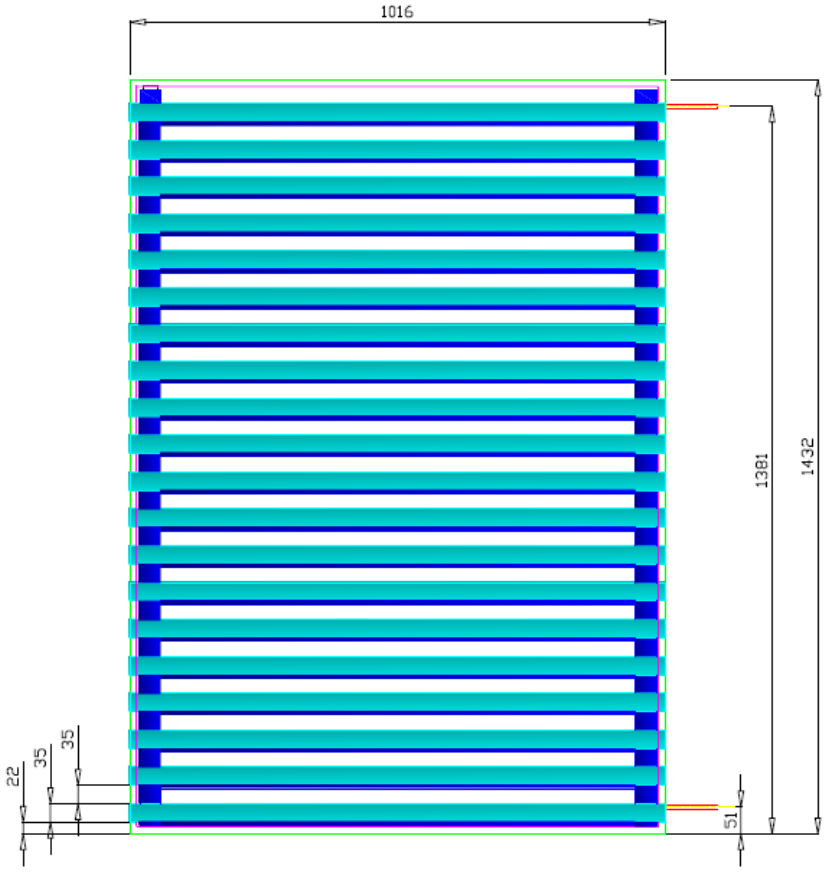
H-1292 Robin Sun solar thermal glass seen from the inside of the building



H-1432 Robin Sun solar thermal glass seen from the outside of the building



H-1432 Robin Sun solar thermal glass seen from the inside of the building



3.2: Design and operation of the collector field

The surfaces of the solar glasses are determined after a detailed exam of the energetic needs to fill, of the site of the project, of the orientation of the site and of any eventual masks. We look to optimize the available surfaces around the expected functionalities.

We offer planners with initial studies in order for them to evaluate the possible integration of the Robin Sun solar thermal glass in their projects, in terms of energy, architecture and operating.

For major projects requiring a global and precise evaluation, we can provide solar glass analyse made under TRNSYS that simultaneously take into account all the included functions.

Please note that Robin Sun regularly offers training for planners and installers about its technologies.

3.3.1: Design recommendations for the glass units

The measures relating to glass and reflector work stipulated by the current regulations, NF - DTU 39 and NF DTU 33 (when this applies), and XP P 20-650-1 and -2, are applicable.

Only the points requiring particular attention are listed below.

- Altitude: if the Robin Sun solar thermal glass has not been balanced in the factory, it must not be installed above altitudes of 500m (the H-732 model) or 800m (the H-1292 and 1432 models). Installation of solar thermal glass above these altitudes needs to be balanced before being dispatched from the factory.

- Fitting in rabbet: the Robin Sun solar thermal glass is designed to be integrated vertically in fixed drained frames with rabbet on 4 sides. The standard thickness of the 4/27/44.2 glass is 40.5mm. Because of the presence of the tubes, the use of rebate glazing beads is not recommended. The joint, glue, and spacer represent a total height of 13mm and need to be protected from the sun's rays. Whatever the material used, it is important to allow for a useful height – a UH for the rabbet of: 20mm.

- Mounting: the Robin Sun solar thermal glass can be mounted in a frame on site or in the workshop. The preparation of the space reserved for the hydraulic connection *must* be carried out in the workshop. The solar thermal glass must only be mounted vertically, but can (only in the workshop) be mounted horizontally, with the insulating layer facing upwards.

- Peripheral joints: unless there is a specific requirement for more frame clearance, this is a standard 5mm round the edging, and the other peripheral clearances.

- Choice of glass: standard Robin Sun solar thermal glass is supplied with double-sided laminated tempered 44-2 glass on the inside and 4mm-thick tempered glass on the outside. We can, on the customer's request, review the definition of these

thicknesses in order to propose a product adapted to the specific conditions of the worksite.

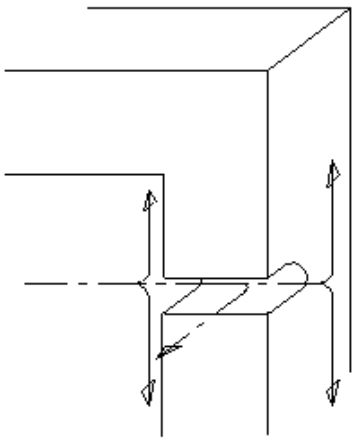
- Dimensions: the dimensions of the Robin Sun solar thermal glass listed in our documents are the gross height and width of the solar thermal glass, without tubes. The solar thermal glass is approximately 40.5mm thick (4/27/44.2). The H-XXX code refers to the height which is the only dimension that varies in the standard definition. The width does vary and remains at 1016 mm.

3.3.2 Recommendations regarding the hydraulic technical ducts

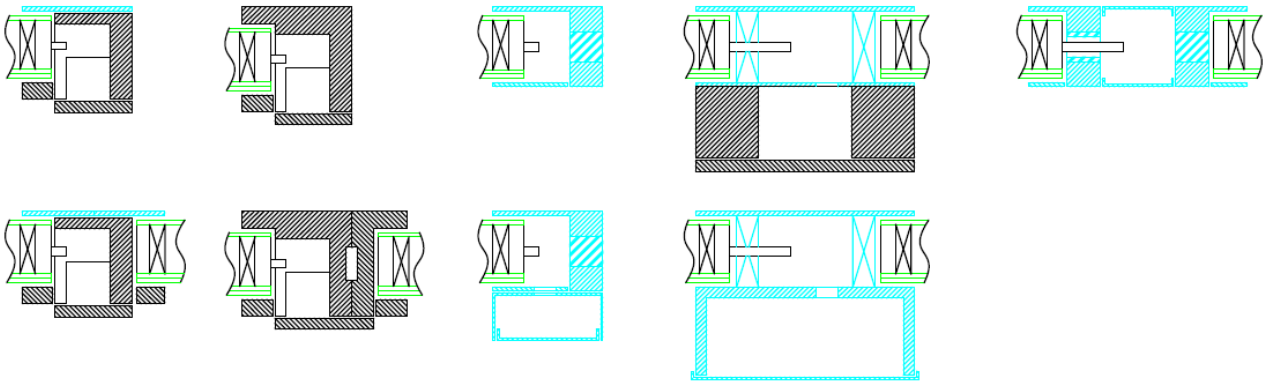
It is important to reserve a space, on the right side seen from the exterior, for the creation of an area dedicated to the hydraulic connection of the Robin Sun solar thermal glass . This space can be located:

- in front of or behind the vertical jamb
- in the vertical jamb
- in front of or behind the bottom of the rabbet

This installation must allow for connection, insulation, checks and eventual maintenance or removal of the ducts connected to the solar thermal glass es.



Perspective views and elevations from the interior of the building showing the various possible designs of the technical ducts to connect the glasses to the solar system.



This area must measure a minimum of 40mm in diameter or 40*40mm for the passage of each tube. Whatever option is chosen, it must be submitted to Robin Sun, which, after validation, will send it to the heating engineer for approval.

If the access for the connection and/or insulation cannot be guaranteed after the installation of solar thermal glass pre-mounted in the workshop, the connections and pipes will have to be preassembled and the sealing must be checked[7].

The connection to the solar system is done by the plumber/heating specialist.

Diagram showing the hydraulic circulation integrated into the joinery, viewed from the exterior of the building:

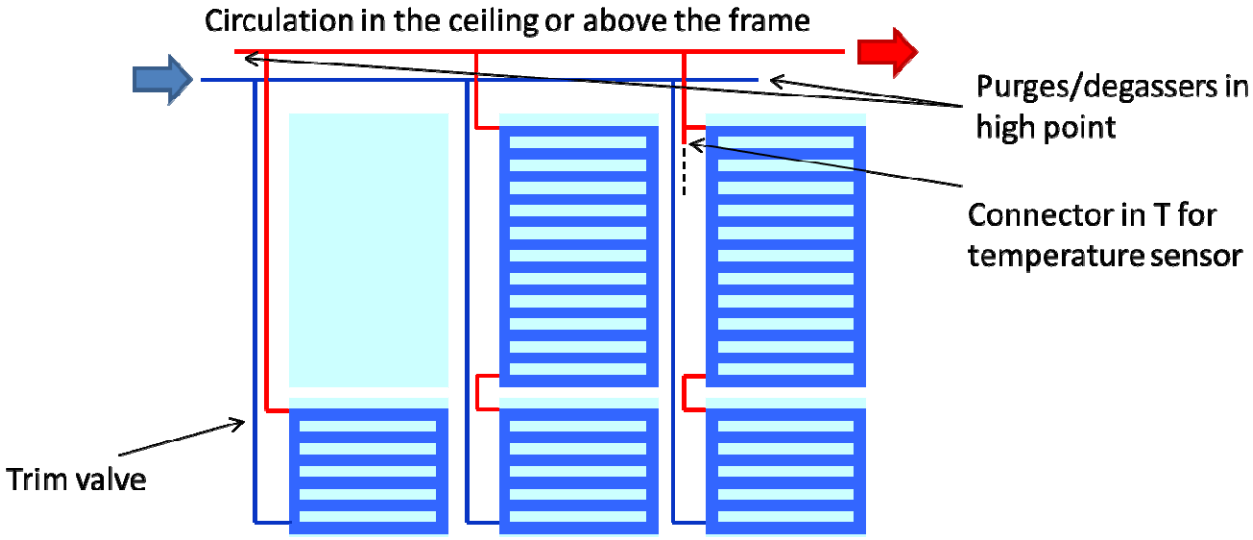
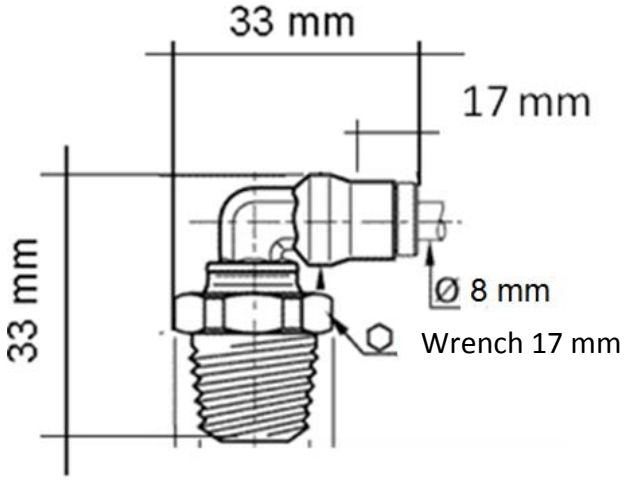


Diagram of the adjustable connector 8-3/8'', supplied as standard with the Robin Sun solar thermal glass:

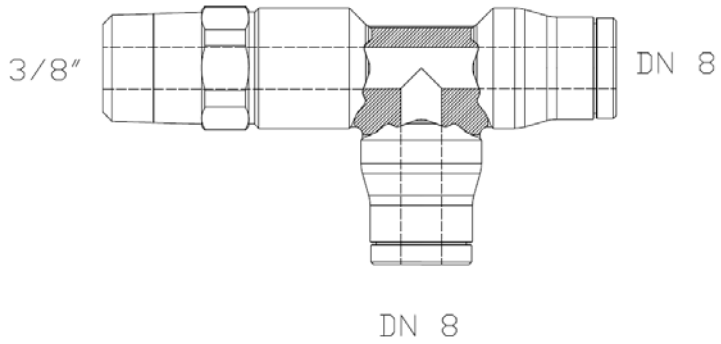


Because of the space occupied by the connector, and the encroachment on the tubing, a minimum space of 40mm is necessary for its installation and removal.

A free access of 17mm to the tubes is necessary to the installation/removal of the connector.

[7] For example, in the air network, 10 bars for 10 minutes.

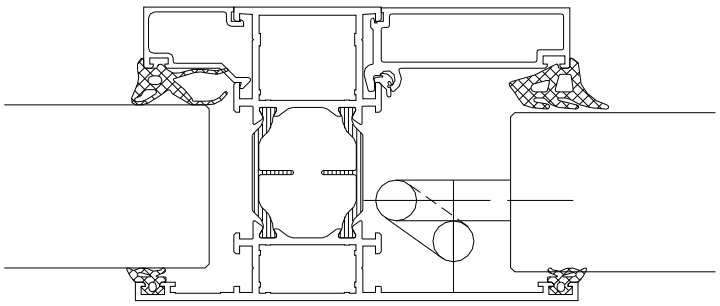
For each collector field, we provide a T-shape DN 8-8-3/8'' connector in order to install a 2-wire PT1000 temperature sensor.



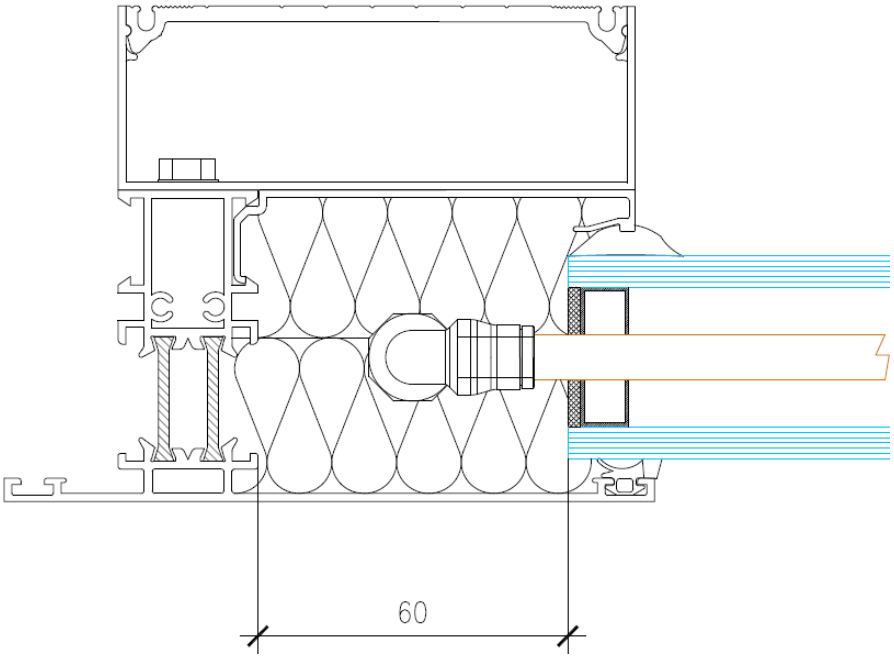
This connector needs to be placed on the high exit of a solar thermal glass which is representative of the collector field temperature.

Examples of connectors in aluminum frames with hydraulic connection area

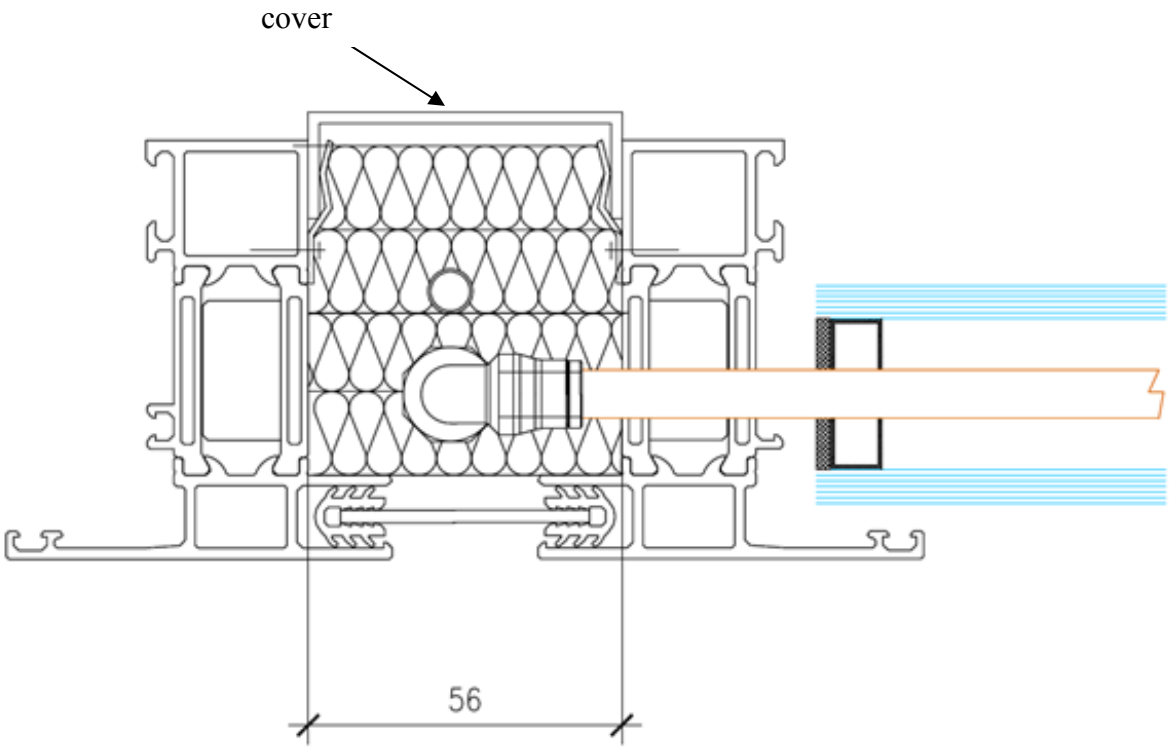
Aluminum joinery with technical ducts at the bottom of the rabbet



Aluminum joinery with technical ducts at the bottom of the rabbet and reinforced cover



Aluminum joinery with elongated cover and reinforcement against the wind impact that can act as technical ducts



Aluminum joinery with technical ducts between 2 jambs

A removable cover is required to the right of the tubes so that the technical tubing and insulation remain accessible for checks, maintenance, and possible removal after connection, testing, and insulation.

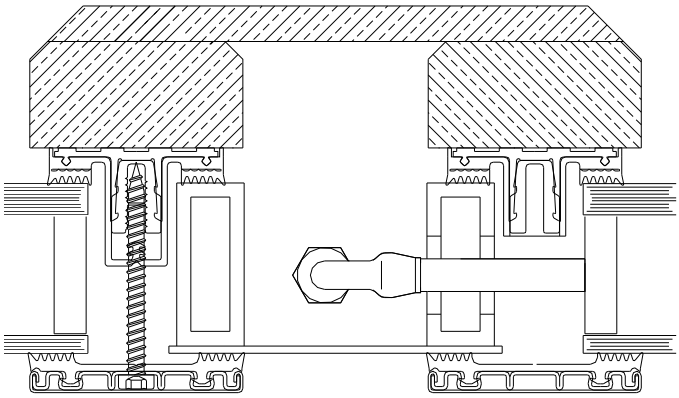
Tubes with a diameter of 8mm exiting from the Robin Sun solar thermal glass are delivered as standard, each with an approximate length of 120mm. The tubes must be cut with a casing cutter and the edge must be chamfered with a pencil sharpener. It is necessary to check that no asperity remains.

This adaptation must ensure full access along at least 17mm of the tubing in the technical tubing to facilitate the connection by the solar technician.

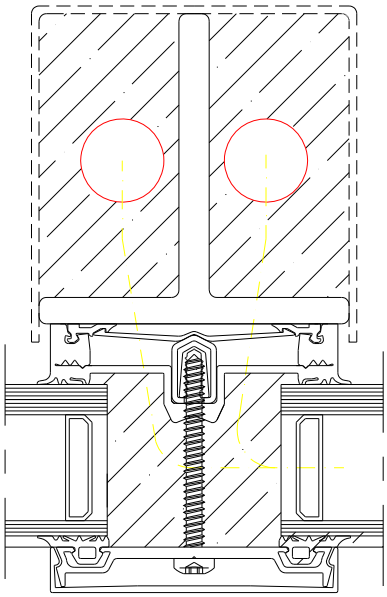
The sheets used for the expansion are slightly chamfered so as not to damage the joints. They must be designed to facilitate the expansion of the façade.

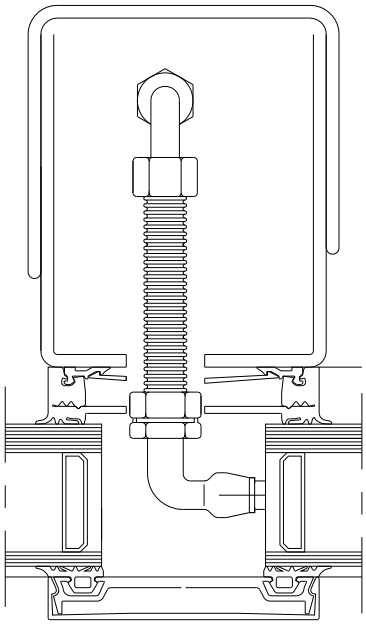
Examples of connectors with hydraulic connection area in curtain wall façade

Curtain wall façade in aluminum and wood



Curtain wall façade in steel





It is also possible to integrate a frame into a curtain wall façade.

3.3.3: drilling/machining of the vertical jabs

It is highly recommended to carry out the drilling/machining of the holes or channels necessary for the passage of the tubing across the vertical jambs in the workshop.

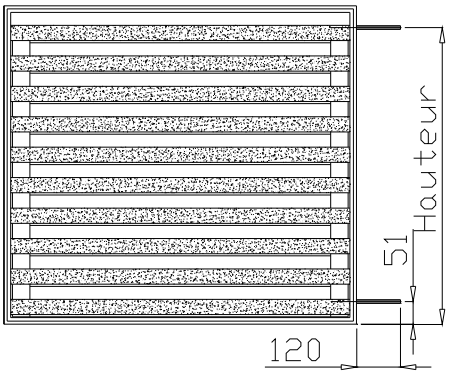
This is particularly true for wood joinery, in order for the area facilitating the connection to benefit from protective layers of wood.

The size of the machining necessary for the passage of the tubes exiting from the solar thermal glass depends on the width of the solar thermal glass, the type of passage in the technical tubing and length of the tubes, and the mounting method in the workshop.

In the case of drilling at the bottom of the rabbet, the passage must be modified/ adapted according to the thickness of the jambs and width of the glass panels.

View of a Robin Sun thermal solar glass from the inside of the building

Beware! Add the wedge thicknesses and clearance to define the sides of the drilled hole from the bottom of the rabbet.
.



Hauteur=Height

Tubes with a diameter of 8mm used to feed/evacuate the heat transfer fluid each exit the standard solar thermal glass to a length of 120mm.

The height of the 2nd tube is for the most usual modules:

- For H-732, at 681mm from the edge of the bottom of the glass
- For H-1292, at 1241mm from the edge of the bottom of the glass
- For H-1432, at 1381mm from the edge of the bottom of the glass

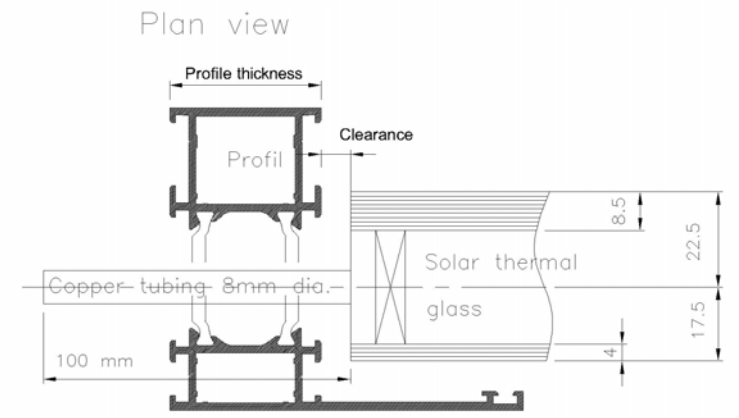
For other eight dimension look p.10

It is the joiner's responsibility to communicate the sectional view of the area to be used for hydraulic connection so that the size of the tubes can be adapted, if necessary. If no indications are supplied, the solar thermal glass is supplied in standard size with a tube extending approximately 120mm from the glass.

Before fitting the glass it is advisable to remove the silicone protection sleeves from the tubing and refit it after the installation of the glass in its frame.

This sleeve enables the passage through the joinery to be sealed with silicone and/or aluminum adhesive tape.

Important: the tubes always exit the solar thermal glass in the centre of the spacer [8] and not in the centre of the glass's thickness!
Diagram of a 4/27/44.2 glass:



Verify: once the Robin Sun solar thermal glass has been installed, the tube must be fitted in the centre of the drilled hole or counterbore. The tube must never come in contact with the frame.

3.3.4: Design recommendations for the solar collector

The rules governing the design, dimensions, and production of solar systems, such as NFEN12976-1 and 2, are applicable to Robin Sun solar thermal glass. Only specific aspects are dealt with here.

- Collector fields:

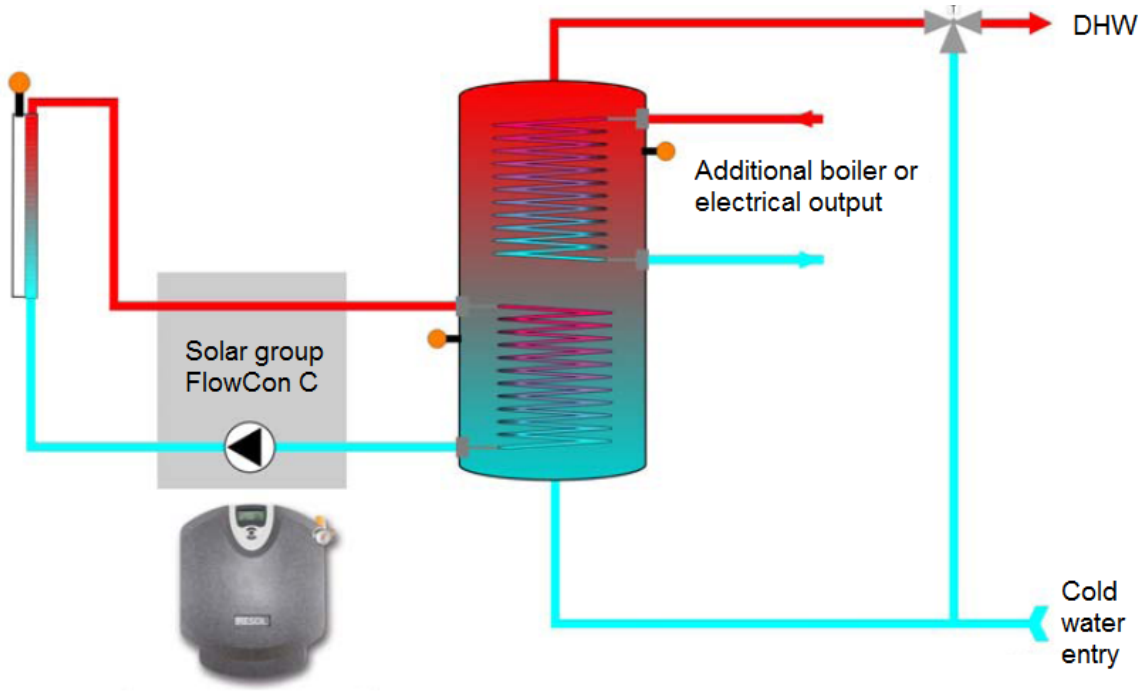
The hydraulic distribution of the Robin Sun solar thermal glass is realized by means of parallel collectors located at the bottom and/or top of the glass. This distribution can be integrated into the joinery work. It is important to ensure that the diameters chosen enable a natural balance to be achieved over the entire field. If this balance cannot be guaranteed, regulating devices and flow meters will be required.

The hydraulic circulation in the vertical jambs can be connected in series or parallel. Connection in series minimizes the space required for connection. In the case of a connection in series in the vertical jambs, it is advisable to avoid connecting more than 2 H-1432 solar thermal glass panels in series. This may change in accordance with the changing market in solar pumps.

The use of Robin Sun solar thermal glass with other solar collection technologies exposed and/or tilted differently for shared storage must be assessed by dynamic simulation beforehand.

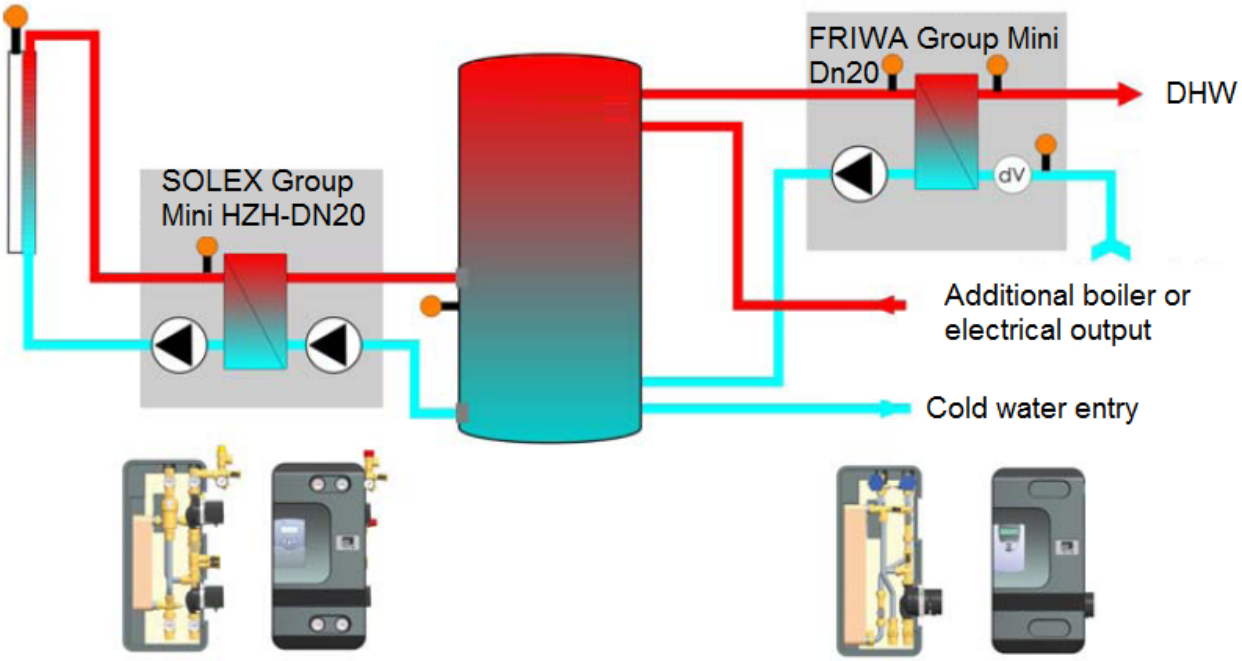
[8] Also (wrongfully) called the spacer

Simplified diagram, example of a solar system with solar thermal glass es for the production of instant DHW



Precabled and preset solar transfer group

Simplified diagram, example of a solar system with solar thermal glass es for the production of instant DHW and heating



Complete solar transfer group with plate heat exchanger, precabled and preset regulation

Instant production of hot sanitary water, integrated exchanger, precabled and preset regulation

- Bleeding:

It is recommended to carry out manual bleeding at the highest point of the fields.
It is recommended to integrate automatic degassing into the solar station.

- Instantaneous connectors:

With each Robin Sun solar thermal glass, two adjustable instantaneous connectors with a diameter of 8-3/8'', i.e. rotating, and an 8-8-3/8'' instantaneous connector in T for the installation of a 2-wire PT1000 temperature sensor are supplied.

The connection to the tubes in the solar thermal glass must absolutely be realized with connectors supplied by us. No other assembly method is authorized.

- Tubes:

The direct connection of the solar thermal glass must absolutely be realized with flexible tubes in stainless steel DN12 coiled tubing in order to prevent the expansion of the connection tubing from affecting the glass.

The entry and exit tubes of the solar thermal glass are not designed to provide support for the contiguous tubing.

Warning: connection to a galvanized steel circuit is forbidden. We do not advise using synthetic materials for the entire hydraulic distribution network when not explicitly recommended for use in solar circuits.

- Heat transfer fluid:

Only the pre-mixed liquids dedicated for use in solar systems and with anticorrosion additives are authorized. Its compatibility with the FKM/FPM joints used on the connectors must be verified.

Before filling with water, it is necessary to proceed with a complete rinsing of the installation, and the solar thermal glass, for at least 10 minutes. In the absence of specific provisions in the regulation, we recommend adding a heat transfer fluid with a percentage of glycol or polypropylene glycol (to be defined according to the climatic zone). In the absence of a precise definition of the conditions related to the climatic zone, this must be a 30% mixture in France.

The fluid used must be indicated on a label in the fill-up point and the installation and maintenance documents, in order to facilitate any eventual additional fill-ups. The fluid's quality must be checked at least annually. If its pH falls under 7, the heat transfer fluid will need to be replaced.

Warning: the circulation of water for human consumption in the solar thermal glass is not authorized.

- Head loss:

	H-732	H-1292	H-1432
Flow of 15l/h.m²	0.30 kPa	1.42 kPa	1.90 kPa
Flow of 40l/h.m²	1.55 kPa	7.30 kPa	9.66 kPa

- Sensors:

Detection of the water temperature is realized by thermal conduction from the tubing exiting from the upper part of the Robin Sun solar thermal glass, in a place chosen as representative of the field's average temperature.

The sensor must be placed in a thimble integrated into the hydraulic circuit via a T-connection delivered with the Robin Sun solar thermal glass. The temperature difference between the sensor and the storage must be set at 5K. The absorber's temperature is around 10K higher than that measured by thermal conduction from the exterior of the glass.

These recommendations do not apply to the FlowCon Sensor Regulation which works without temperature sensor.

For installations of more than 20m², we recommend the use of a solar sensor placed vertically on the façade.

- Energy:

We recommend the systematic use of energy meters.

- Pressure:

10 bars maximum (tested) for the solar thermal glass.

- Connection area:

It is recommended to allow at least 40*30mm per tube to be connected and circulated, in order to realize the connections and eventual specific insulation of the tubes contiguous to the solar thermal glass. This space must be insulated and sealed by a removable cover after the hydraulic connection and test has been carried out. The heating engineer who is responsible for the hydraulic connection must be consulted about this. Robin Sun will coordinate this when the company has received all the necessary information.

After hydraulic connection and testing, this area must be insulated and closed off with a removable cover (aluminum frame) or with a joint cover (wood frame and wood/aluminum frame). This operation is done by the heating engineer.

The façade specialist responsible for the realization of the frames that house our technological product must send us (at the commencement of the measurement phase) a view of the front of the façade and the sectional views of the connection points.

- Insulation:

We give priority to the global insulation of the technical ducts rather than the individual insulation of the tubes.

The insulation chosen must be capable of resisting a peak temperature of 125°c. Its thickness must be between 100 and 200% of the DN that requires insulating. Its lambda point at 40°C must ideally be inferior or equal to 0.04W/m.K.

In the event that the insulation of the technical tubing does not provide complete and adequate insulation of the tubes and connections, it is recommended to consult the joiner/façade specialist about insulating them, particularly when the connection area is integrated into places that are not continually heated or not heated, such as open balconies, double-skin façades, companies, and so on.

3.3.5: Robin Sun solar thermal glass Worksite Planning

The solar thermal glass is supplied by joiner/façade specialists and by professionals responsible for the installation of joinery/façades, and glass.

Plumbers and/or heating specialists trained in solar techniques and the specificities of our technology are responsible for the supply and installation of the solar system and the hydraulic connection of the solar thermal glass .

The collaboration between joiner/façade specialists/plumbers and/or heating specialists involves close coordination of their respective work.

All our glasses are delivered with a removable solar protection film on about 50% of the external face. This protection must be removed within 6 months of the installation of the Robin Sun solar thermal glass es.

The team coordinating the worksite will be responsible for assessing who will be responsible for removing this film.

The solar thermal glass is designed for the operation of a solar system throughout the year. If this isn't the case and in order to save the system components, it is necessary to plan for appropriate external solar occultation systems or circulation strategies such as nighttime thermal dissipation.

3.3.6: Maintenance of the solar thermal glass

The recommendations in use for insulating glass apply to the solar thermal glass[9].

The recommendations are as follows:

[9] Cf AGC notice: advice on the cleaning and maintenance of the solar thermal glass façade is available on: www.yourglass.com

- to clean each side of the glass at least twice a year, in order to promote the transmission of light and energy production of the solar collection element. The client is exclusively responsible for cleaning the solar thermal glass.

- to ensure that the natural convection around the glass is not altered by obstacles, films, or stickers.

These tasks are separate from the maintenance of the solar system (cf § below)

3.3.7: Monitoring and maintenance of the solar system

The client is responsible for regularly monitoring and ensuring that the solar system is working correctly.

The monitoring of the system mainly consists of regularly consulting the regulatory information and immediately informing the company responsible for the maintenance of the system of any malfunctions.

The client will be required (at least once a year during the product's guarantee period) to call upon the services of a climatic engineering, plumbing, or heating company that specializes in solar energy to carry out maintenance work on the system, in respect of all the requirements in this document.

The result of these checks must be recorded in writing in a report or maintenance book to be given to the client for archiving and prove the regular maintenance of the glasses at least once a year and according to our requirements. This proof as well as the bill of the Robin Sun solar thermal glass will be systematically required to justify any claim under the Robin Sun solar thermal glass guarantee.

The minimum check requirements are:

- Checking the condition and operation of the security devices
- Checking the quality of the heat transfer fluid
- Checking the settings of the regulation
- Checking the sealing in the hydraulic circuit
- Checking the pressure of the hydraulic circuit
- Checking the quality and continuity of the insulation in the hydraulic circuit

Where monitoring and maintenance is concerned, the client is responsible at his/her expense for ensuring that he/she has the necessary means to rectify the eventual point(s) that does/do not or no longer meets/meet the requirements set out in this document, which is the authentic text on these matters.

IV. GUARANTEE

Robin Sun solar thermal glass is guaranteed for a period of ten years.

The energy contribution of solar thermal glass in meeting requirements can be guaranteed under a private law contract, such as a *Garantie de Résultat Solaire* or *Fonds Chaleur renouvelable* (French contracts).

V. QUALITY

All of our industrial partners take part in a quality insurance process called ISO 9001. Our solar glasses are tracked for quality and functionality under the SolarKeymark label.

VI. INSTALLATION AND CONNECTION INSTRUCTIONS

6.1: Instructions for installers responsible for the fitting of Robin Sun solar thermal glass in joinery or facades

The measures relating to the mounting of solar thermal glass, particularly the clearance and wedges, must comply with those stipulated in NF DTU 39, or those relating to the façade or joinery system concerned.

Only the particularities of Robin Sun solar thermal glass are dealt with here. The design of the frame with technical ducts that was dealt with before the site is not mentioned again here.

6.1.1: As received by the joiner/façade specialists

- The solar thermal glass is supplied on racks made from waste wood or specially designed metal A-frames. They must be stored in a dry place and away from the sun.

- The surface on which the rack rests must be smooth and capable of taking the entire weight of the supports.

- Each solar thermal glass sheet is separated from the next sheet by foam sheeting or protective separators. These separators must be removed from the glass by the joiner/façade specialist during installation.

- Each tube exiting from the glass comprises a 50mm-long split silicon sleeve. That sleeve allows the dilation of the tubes after the reconstitution of the sealant with silicone and aluminum adhesive strips after the possible drilling of holes in the connector.

- Each solar thermal glass sheet comprises an upper and lower copper tube, each with a diameter of 8*7mm. These tubes must be perfectly circular and exit perpendicularly from the glass 120mm.

- The solar thermal glass panels are staggered on the racks in order to protect the tubes during transport.

- The tubes that exit from the glass located on the exterior of the rack are protected by rigid cardboard.

- The units are wrapped in a polyethylene film around the racks.

- A label stuck on the field, on the side with the tubing, provides information about the main references and characteristics of the solar collection element in conformity with the SOLAR KEYMARK standard. A label on the glass provides the CEKAL identification of the glass processor and the type of glass.

- Printed information on both sides of the glass indicates that it is tempered and names the company that carried this out.

- A label on the glass, on the spacer, gives the CEKAL certification assembly factory and the semester and year of manufacture.

- A label on the glass that faces inside the building enables the side to be identified and indicates which way round the glass is fitted in the frames. It also warns that the unit must never be turned round. This label must be removed by the joiner/façade specialist after installation of the solar thermal glass.

- A box contains the DN8-3/8 instantaneous connectors used for the connection and approximately 3m of DN12 stainless steel tube for each Robin Sun solar thermal glass .

6.1.2: Verifications on delivery

In addition to verifying that the dimensions and quantities match the order and the receiving notice, it is important to carry out a number of visual quality checks.

- The glass is staggered on the rack, in such a way that each glass unit protects the tubing of the next unit. The tubing at the top and bottom of the unit on the exterior is protected by rigid insulation material. This storage method facilitates visual checking of the external and internal sides of each Robin Sun glass unit in order to ensure that none of the units have been subjected to shock during transport: as the glass has been tempered, any shock to the glass will shatter the entire pane.

- The exit tubing – 2 for each glass at approx. 51mm from the top and bottom edge of the glass – must exit perpendicularly from the side of the glass.

- The tubes, as seen from their ends, must be perfectly circular.

If there’s the slightest doubt, it is imperative to mention the uncertainties on the bill of lading and record the fault detected (photos)!

The absence of any mention of the fault eliminates any possibility of a claim against the transportation company.

6.1.3: Handling and storage

All the recommendations on the handling and storage of the glass apply to Robin Sun solar thermal glass.

It is especially important, particularly when handling the glass, to ensure that:

- the solar thermal glass remains vertical and in the installation position – i.e. as delivered: silver strips (reflector aspect) orientated horizontally and with the ∩ shaped blades of the horizontal absorbers facing downward. This is reminded by a removable sticker located on the interior of the glass. Please remember that the silver strips are always to be installed on the interior side of the building and horizontally, which naturally places the tubes on the right side of the glass when looking from inside the building.

- The volume be locked in the joinery on all 4 sides.

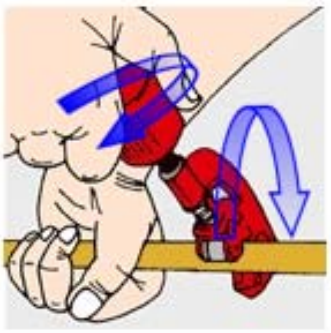
- The split silicon sleeve be removed before the installation of the glass frame and if necessary, be put back into place afterwards.

6.1.4: Adjusting the tubes to length

- The adjustment of the length of the copper tubing must only be done with a tube cutter, before fitting the glass into the frames.
- The vertical lamellas must rest on the high and low blind stops located perpendicularly to the exit on the inside of the glass, between the lamellas and the separator.
- At the end of the operation, ensure that there is no burr at the end of the exterior diameter of the copper tube to avoid damaging the joint of the instantaneous connector. Any eventual burr needs to be corrected with a pencil sharpener.

Description of copper tube length adjustment using the tube cutter:

After defining the length that needs to be cut with the installer responsible for the hydraulic connection, place the cutting wheel on the tube and at the end of each complete turn, tighten the knob until the tube is sectioned. Avoid flexing the tube during this operation



6.2 Instructions for the Robin Sun solar thermal glass hydraulic connection installers

Only the particularities that relate to the solar thermal glass are described below.

6.2.1: Flexible tubing

- The hydraulic distribution networks directly contiguous to Robin Sun solar thermal glass must use coiled DN12 stainless steel tubes provided with the glass.
- The outlet tubes of the glass are not designed to support contiguous tubing.
- It is very important to ensure that the tubing contiguous to the glass does not transmit its expansion to the glass.

Preparation of the stainless steel flexible tubing:

- After having introduced the nut, fold the split segment ring in the hollow part of the first ring in order to block it at the end of the flexible.

- Compress the end ring to create a collar span, ideally with a collar flaring tool or by fitting a flat washer with the correct size and resistance on the connector; make sure that the 2 rings are completely compressed and that the collar is flat.[10].

- Fit the joint and tighten the nut on the adjustable connector, i.e. rotating, using 2 flat keys, one of 17mm for the instantaneous connector and one of 19mm for the nut.

Important:

- Changes in plan and/or orientation must be done with elbows and never with the flexible tubing!

- Compressing the collar rings must never be done with the sealing joint in place.

6.2.2: Connection

The connection of the solar thermal glass must be carried out using instantaneous connectors supplied with the glass.

[10] Please check out the related video available on our Web site.

These connectors require a 17mm free access for installation and possible removal.

No other type of connector, adaptor, or means of connection should be utilized.

Before fitting, the tubing should be checked to ensure that it has no burr or sharp edge on the exterior edge. If these are found, they will need to be removed using a reamer and/or steel wool supplied with the glass, and verify once again.

Fitting the instant connector:

- If cleaning is required, only use the steel wool we supply with our glass.

- Maintain the copper tube exiting from the glass using multiple slip-joint pliers while taking care not to deform it and at the same time push the connector onto the tubing. The connector is fitted onto the tube to around 15mm and a there needs to be a reserve length of at least 2mm in case the connector needs replacing.

- After filling with water and testing, the connector/tube liaison requires additional tightening. This is possible to do without transmitting the torque to the copper tubing of the glass, because the connector screw thread is adjustable, i.e. rotating.

Removing the instant connector:

To remove the instant connector it is necessary and to lightly push in the direction of the body of the connector the collar at its end, using, for example, a slip-joint pliers.

The internal stainless steel claw and joints are thereby released, enabling the connector to be removed.

The instantaneous connectors must be replaced after 5 fittings/removals.

Important:

After removing the instant connector do not remove the notch made on the tube by the stainless steel claw. Before reconnection, check that the end of the copper tubing has no burrs.

6.2.3 Degasser/Bleeder:

Automatic degassing will have to be carried out from the solar station.
Manual bleeders will be placed at the top of the field so that they can be used during the filling stages of the installation.

6.2.4 Temperature sensor

Robin Sun solar thermal glass is sealed, so the collector measures the temperature for each field:

- on the outside of the Robin Sun solar thermal glass ,

- by thermal conduction from the upper outlet of the Robin Sun solar thermal glass ,
- at the point where the temperature best represents the entire field,
- with a thermal sensor fixed to the tubing with a thimble integrated into the solar circuit using a T-junction.

These indications do not apply to the FlowCon Sensor Regulation, which work without a temperature sensor.

6.2.5: Temperature differential

The temperature differential between storage and the collection element as measured on the exterior of the glass needs to be between 5K to engage and 3K to stop the pump.

These indications do not apply to the FlowCon Sensor Regulation.

6.2.6: Heat transfer fluid

Once the entire hydraulic network has been connected it must be rinsed for 10 minutes. Where there are several sensor fields, this operation must be conducted separately for each field.

Only pre-mixed liquids dedicated for use in solar systems are authorized. The antifreeze agent chosen must be explicitly certified for use in solar installations. It will also need to be compatible with FKM/FPM joints. If there is no precise definition about the conditions relating to the climatic region, the mixture for (European) France needs to be 30%. The pH after the mixing will need to be between 8 and 10. If it is below 7.5 the heat transfer fluid will have to be replaced. The fluid used must be indicated with a label in the filling zone or documents depending on the installation and its maintenance, in order to facilitate any additional filling.

6.2.7: Lagging of the tubing and insulation of the technical tube

After filing with water and testing, it is important to ensure that the tubes are all lagged and that the technical tube is insulated before fitting the cover.

The lagging must be able to support a peak temperature of 125°C (for example in EPDM). It may take the form of 2 half-shells positioned on each side of the tubing that insulate the entire connection zone. Once this insulation work is terminated a removable cover will need to be placed over the insulation.

It is recommended, before work commences, to specify who is responsible for the supply, type, and installation of the insulation and the fitting of the covers, and the final filling of the passages through the profiles.

After filing with water and testing of the hydraulic circuits of the solar system, when the joinery is integrated in the building, the hydraulic circulation reservation needs to be insulated.

This insulation can consist of the juxtaposition of an insulating material for the tube and of an insulating material for the reservation. It is however more efficient to use a unique and common insulanting material for the reservation and the tubes that are located in it.

After the insulation work is done and before adding a cover, it is best to verify that the vertical lamellas rest on the joints that form a blind stop on the separator at the place where the tubes come out of the glass.

APPENDIX

Tests

- Resistance test for moisture penetration - EN 1279-2 – parts 2 and 3
- Steam test for resistance to moisture penetration – NF P 78-451
- EN 12975-2 tests, including measurement of the IAM, in the framework of the Solar Keymark label
- Natural exposure aging tests – CSTB procedure and 12975-2
- Aging tests using radiating panels and steaming – CSTB procedure
- Measurement of thermal transfer – Ug - NF EN 674
- Measurement of the solar factor – g – F.ISE procedure
- Measurement of the filling rates and gas losses – CSTB procedure
- Aging and characterization test of the emissivity of the layers and of the reflection of the silver reflector strips – NFEN1096-3, NF EN 410, and NF EN 12898
- Measurement of light transmission at different angles– NF EN 410 and ASTM E 1175
- Air space temperature measurement when the system is not functioning – CSTB procedure
- Measurement of organic volatile components
- SOLAR KEYMARK: 011 – 7S918

The tests/measurements mentioned were or are being carried out in the framework of the double technical role as glass and solar collector in compliance with CSTB and Solar Keymark certification.