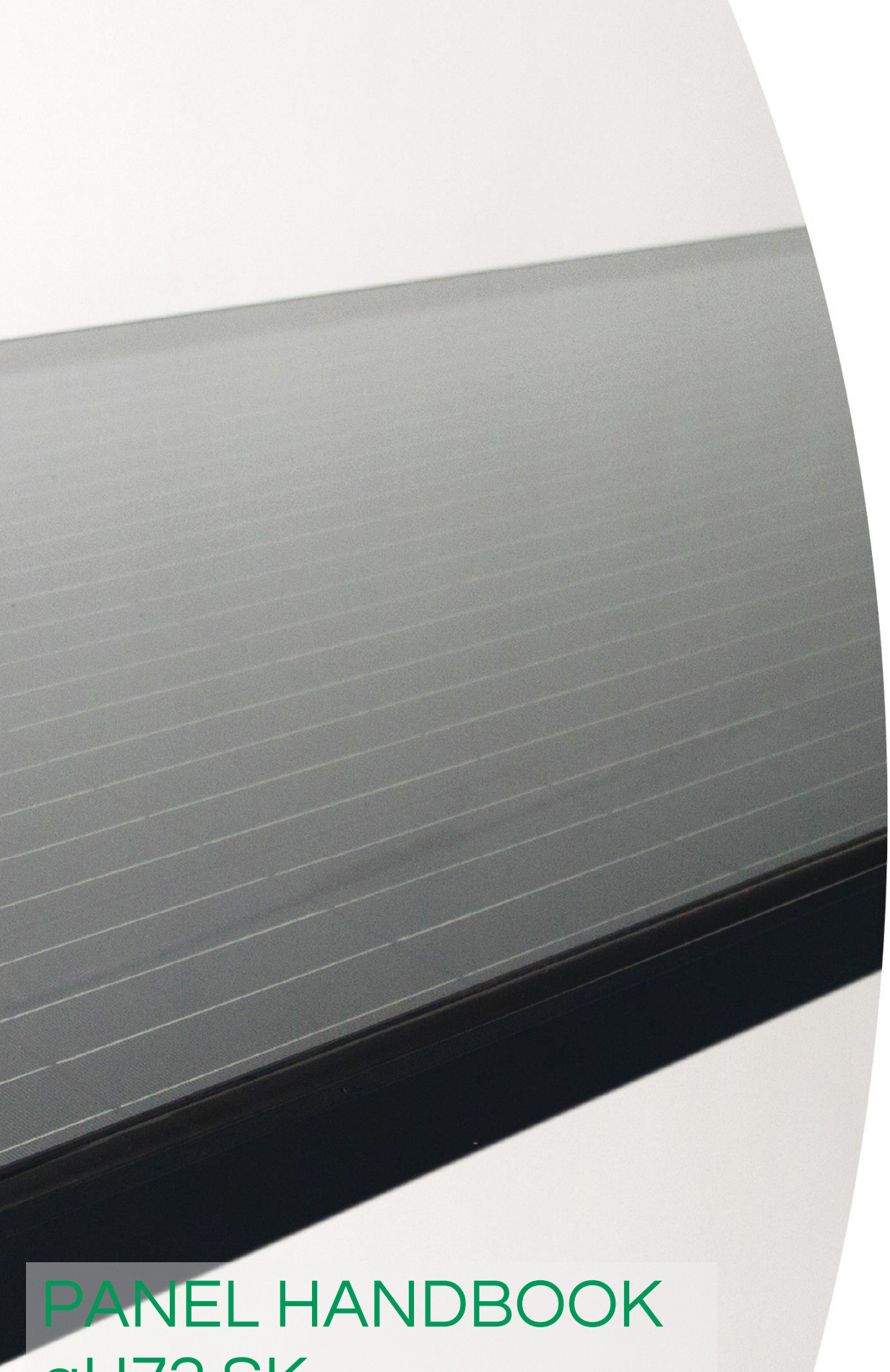

PANEL HANDBOOK
aH72 SK

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abora
Advanced Solar Technology

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1 CONTENT, WARNINGS AND PRECAUTIONS

Note: A copy of this document is sent inside the solar panel package and is the property of the customer. It must be kept by the person responsible for maintenance in a safe place.

Important: carefully read the information in this manual and follow the instructions to avoid the risk of incorrect operation or, if applicable, to minimize the damage of the components. Review the installation and components with the owner and managers of the building to explain the operating and maintenance requirements of the system.

1.1 Identification plate and panel code

A unit identification plate is affixed to each panel. It includes the unit model (aHXX) and panel code (aHXX-AFAXXXXXX), as well as other pertinent specifications that identify the features of each panel.

Fig. 1. Example of panel Identification plate

Every solar panels are identified by this code, which is composed of alphanumeric characters that precisely identify each particular panel, allowing their traceability starting from the manufacturing under Abora's quality controls.
When requesting service, please check the panel code printed on the panel's identification plate.

1.2 Transport, inspection, storage and handling of the product

When the hybrid solar panels arrive at the installation site, in order not to damage them and avoid accidents, please take into account the following instructions:

- The panels must only be unpacked when everything is ready for immediate installation.
- No pressure should be applied to the panels during transport. For example, modules or packing boxes should not be secured or tied with straps, nor should loads be placed on the packaging of the panels.

- If damages are discovered, a joint and immediate inspection by the carrier and the consignee will be requested. Damaged material shall not be removed from the receiving location. Photographs of the damages must be taken.
- The sales representative will be notified of a damaged panel by noting the identification code and it will not be installed.
- If necessary, the product will be stored in its original packaging and in a dry and secure location.
- Care should be taken when opening the packaging to ensure that the products are not scratched and that the glass is not exposed to impacts.
- Solar panels should always be handled with care to prevent them from being dropped or dragged. Possible scratches on the glass and on the rear casing must be prevented.
- Objects must be prevented from falling onto the panel.
- No heavy objects should be placed on the panel. Do not step on it.
- The modules must be transported by two workers. The panel must not be grasped or lifted by the junction box or by the electrical cables.
- In general, all system components and accessories should be handled with care during storage, transport and installation.
- After installation, all packaging materials should be disposed of properly and in accordance with appropriate waste management requirements.
- When handling solar fluids (e.g. propylene glycol and corrosion inhibitors), contact with the skin or eyes must be avoided.
- During manipulation, long-sleeved loose fitting clothing, gloves and eye protection should be worn.
- Solar fluids can reach high temperatures. Special care should be taken with liquids and hot surfaces.
- The panel must not be left exposed to solar radiation when the solar circuit has been drained.
- Those that will be exposed and empty must be covered to avoid long term damage.
- A thermal dissipation (thermal discharge) system, including all necessary components, is mandatory, as the collectors must not operate at temperatures above 85°C.
- The solar circuit pipes must be electrically grounded and the panel must be protected against lightning according to local regulations.
- The manufacturer will not assume any responsibility for damages to the equipment resulting from negligent storage or handling.

2 CARE, MAINTENANCE AND WARRANTY

2.1 Care and maintenance

There are several periodic maintenance requirements for hybrid solar panel installations. The following table summarizes the inspections and actions to be taken to obtain the maximum performance of the system.

Action	Recommended frequency
Glass cleaning	Quarterly
Solar fluid test	Quarterly
Pump performance test	Quarterly
Pump status	manufacturer's recommendation
Controls. Settings check	Quarterly
Electrical system	Annually
Piping system	Quarterly

The detailed maintenance plan for the system is detailed in section 7 of this manual.

2.1.1 Cleaning and inspection of the external system

WARNING:

Disconnect all electrical power before performing any maintenance work. Follow proper lockout/tagout procedures to ensure that electricity cannot be inadvertently turned on while work is being done. Failure to disconnect power before performing maintenance could result in death or serious injury.

Frequent cleaning of the glass surface is important so that dirt does not affect the performance of the panel. An accumulation of dust or dirt on the front face of the panel will cause a decrease in energy production.

- Surface cleaning should be done at least quarterly, after dust storms or after other weather events that may cause a build-up of dirt and particles on the glass resulting in limited solar absorption.
- Use a mild soap solution in spray bottles, a rubber squeegee and soft cloths to clean the panels.
- Examine hybrid solar panels for signs of deterioration (cracked glass or wiring, loose wires or conductors...).
- Check all wiring for possible damage from rodents or the weather and make sure all connections are tight and free of corrosion.
- Check for electrical leakage to ground.
- Check screws, mounting brackets and control components to make sure they are tight.

- Check for solar fluid leaks on a quarterly basis. Leaks can cause a dilution of the thermal fluid which, if not tested and maintained, could allow freezing due to loss of glycol. In addition, make-up water can cause the accumulation of hardness inside the heat absorber, thus decreasing the performance of the system.

2.1.2 Solar fluid test

It is recommended that the solar fluid is checked once a year by a qualified professional as a preventive measure. This person will perform a chemical test of the water in a closed circuit (solar fluid). The biological incrustations, the protection against freezing, the pH and the other chemical properties should be analysed.
Prevention of freezing is essential to avoid system failure or damage to collectors or pipes. With an automatic water replenishment system, a leak in a pipe can cause damage to the exterior and interior of the system and building which are costly to repair.

2.1.3 Hydraulic system maintenance

- Follow the pump manufacturer's recommendations for scheduled maintenance work and inspections. These inspections will check the pump seals and gaskets for leaks, ensuring that the flexible couplings are in good condition and that bearing lubrication is performed as required.
- Expansion vessels should also be inspected to ensure that the pressure control system is functioning. Follow the instructions and maintenance plan provided by the manufacturer of the expansion vessel.
- Pressure relief valves should be inspected to ensure that they are in good working order, at the intervals stated in the maintenance plan (Section 7 of this manual).
- Safety valves, storage tanks and their accessories shall be inspected for leakage (see frequency in the maintenance plan).
- For domestic hot water systems, the competent authorities may require that periodic disinfection of systems in contact with drinking water or food preparation be carried out, inspected and tested. Local regulations should be taken into account depending on the location of the facility in this respect.

2.1.4 Electrical and control system maintenance

Follow the recommendations of the manufacturers of auxiliary electrical equipment for preventive and predictive maintenance: regulation and control system, power supply system for pumping, heat dissipation equipment, automatic glycol supply (filling) system (if installed)

and photovoltaic inverter. It is also important to verify the configuration of the installation's control system during these inspections.

Make sure that all safety connections, junction boxes, connection points, string connectors, protective panels and other electrical connections are in good working order.

See the maintenance schedule (section 7 of the manual).

2.2 Warranty policy

ABORA ENERGY S.L. is the manufacturer of the hybrid solar panels aH60, aH60SK, aH72 and aH72SK. ABORA guarantees that the panel is free from malfunctions at the time of sale. For more information on product warranties, please read the conditions specified in the warranty document.

3 MOUNTING SYSTEM

IMPORTANT! This chapter details the assembly of the mounting system. Depending on the number of panels per row, the structure will have different sizes and number of elements.
The instructions in the assembly manual of the structure that is sent with it must be followed.

- Hybrid solar panels are designed for use on roofs with pitches between 0° and 90° and must be installed according to these instructions.
- The structure anchors, provided for the installation of the panels, with the mounting system will depend on the type of existing or planned roofing solution. These shall be defined by the designer or the structure calculator or by the technical department of the building site or by the installer, as appropriate, guaranteeing their correct fixing and resistance to the loads.
- It must be ensured that the roof bearing structure can withstand the loads transmitted to it by the panel set. In order to prevent water ingress, any perforations made in the roof must be properly sealed.
- When installed, hybrid solar panels (PVT) may experience uplift due to the action of wind (suction). It is essential to ensure the safety and stability of any roof-mounted solar installation.
- The minimum tilt of the panels should be 10º to allow rain to wash away dirt.
- The panels must be installed at an adequate distance from the edge of the roof to comply with building regulations, as well as having sufficient fixing to prevent movement.
- The panels should not be subjected to wind or snow loads that exceed the maximum allowable loads, nor should they be subjected to excessive forces due to thermal expansion.
- The allowable wind and snow loads are:

  -Wind resistance with speed up to 0.9 kN/m².

  -Snow load resistance up to 0.35 kN/m².

Note: The material breakdown and assembly sheet of the structure will be included in the packaging of the hybrid solar panels.

3.1 Panels mounting

3.1.1 Example of a mounting system assembly diagram for 4 collectors on a flat roof

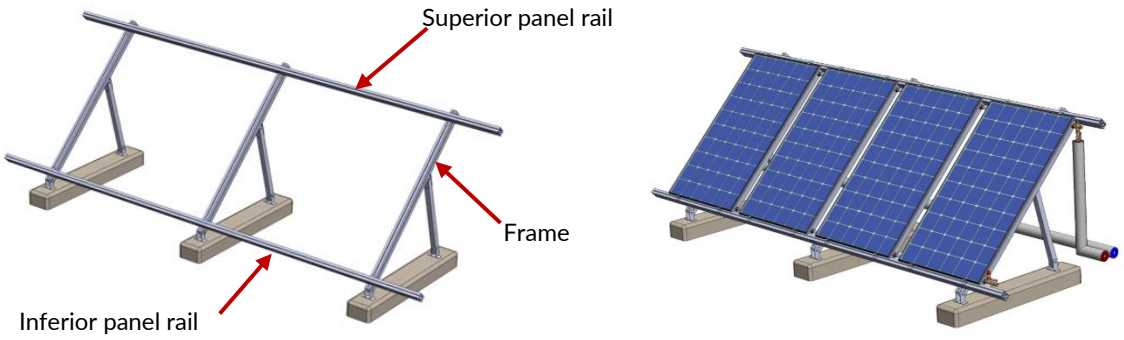


Fig. 2. Row for 4 collectors and flat cover

3.1.2 Separation between triangle supports

The panels will be fixed on a solid base that guarantees their resistance and is suitable for supporting the loads of the panels, as well as their correct anchorage and fastening. Once it has been checked that the base meets these requirements, the structure's triangle supports will be assembled and screwed. The separation between triangles will depend on the number of panels per row. Each structure has its assembly manual included where the corresponding separation is specified.

3.1.3 Distance between front and rear fixing on triangles

The distance between the front and rear fixing of the triangles will depend on the inclination at which the panels will be installed. This distance will be indicated in the assembly manual of the structure enclosed with it.

As an example, for structures with a 35° inclination, the separation between anchorages will be 1510 mm.

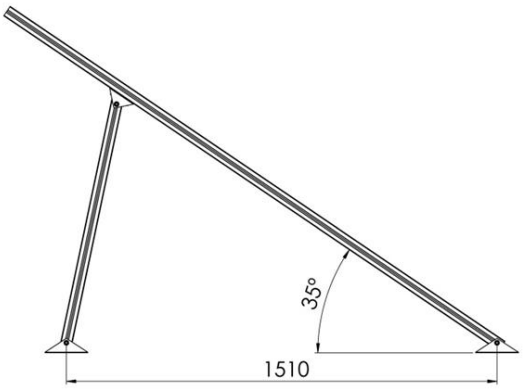


Fig. 3. Detail of the distances between triangle anchors depending on the inclination

3.1.4 Panel rails

The **panel rails**, upper and lower, are formed by joining the 50x85 profiles using the connecting strips supplied in the accessories set. The profiles are supplied in different sizes depending on the number of panels to be installed per row and, therefore, the final length of the rails varies according to this figure.

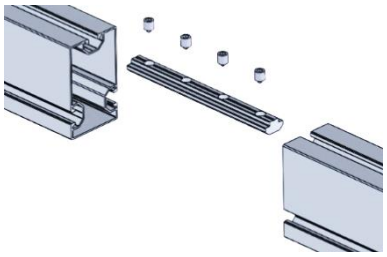


Fig. 4. Connecting strip for panel rails

The lower panel rail installation must have a distance of 1945mm from the upper panel rail, measured between the inner faces of the rails. This will be anchored to the triangles by means of two pre-assembled connecting clamps consisting of a clamp, a hammerhead screw and a flange nut. The flap of the clamp must be on the lower edge of the 40x40 profile of the triangle, thus marking exactly the separation between the upper and lower guides that will allow us to install the panels correctly.

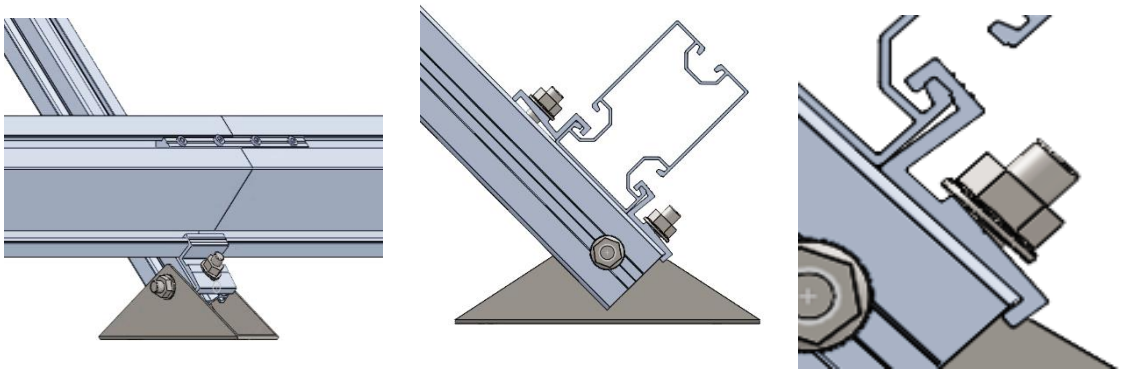


Fig. 5. Installation of lower panel rail

The upper panel rail will be installed in the same way as the lower.

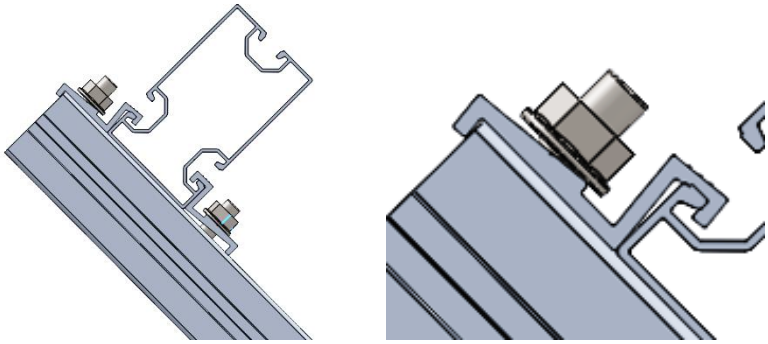


Fig. 6. Installation of upper panel rail

The panels shall be installed on the structure, anchored by means of 4 connecting clamps per panel, two upper and two lower, at distances to be indicated in the structure's assembly manual provided with it.

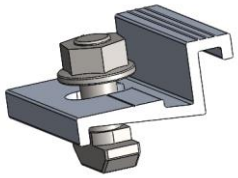


Fig. 7. Connecting clamp for structure rails

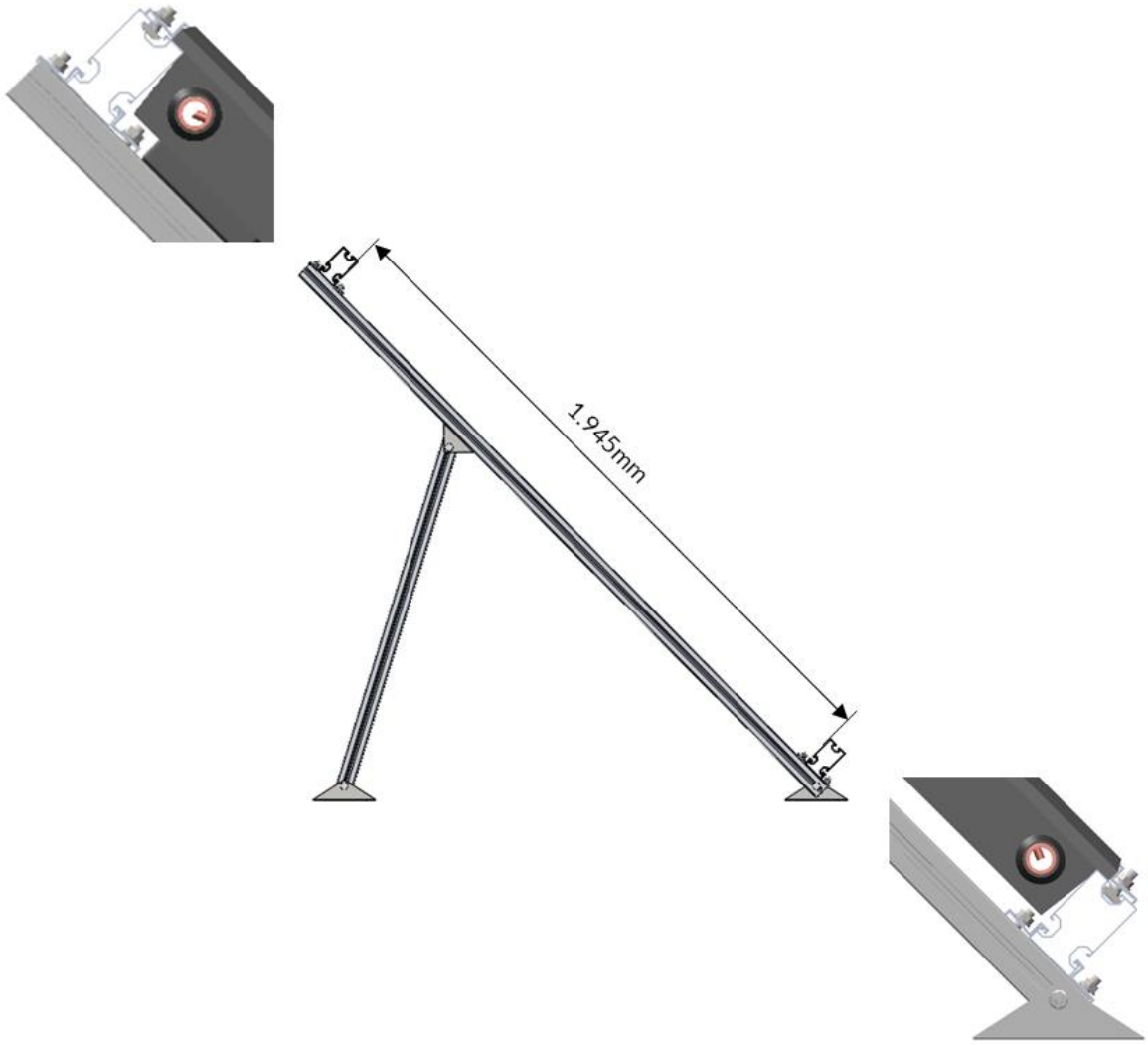


Fig. 8. Detail of the panel connection to the rails

3.2 Placing and connecting Abora's collectors

The positioning, anchoring and connection between collectors is done by following these steps:

- Position the first collector, leaving the distance indicated in the assembly manual, from the edge of the rail. (d1)
- Collector fastening with 4 anchors (connecting clamps), 2 at the top and 2 at the bottom, with a distance of 200mm from the ends of the collector.
- Connection between collectors by means of a flexible joint (expansion compensator) with O-rings and fastening clamps, supplied by Abora. The connection is made as shown in **Figure 10**.

- Place the next collector after the previous one to carry out the operations mentioned above until all the collectors are anchored and connected to each other.

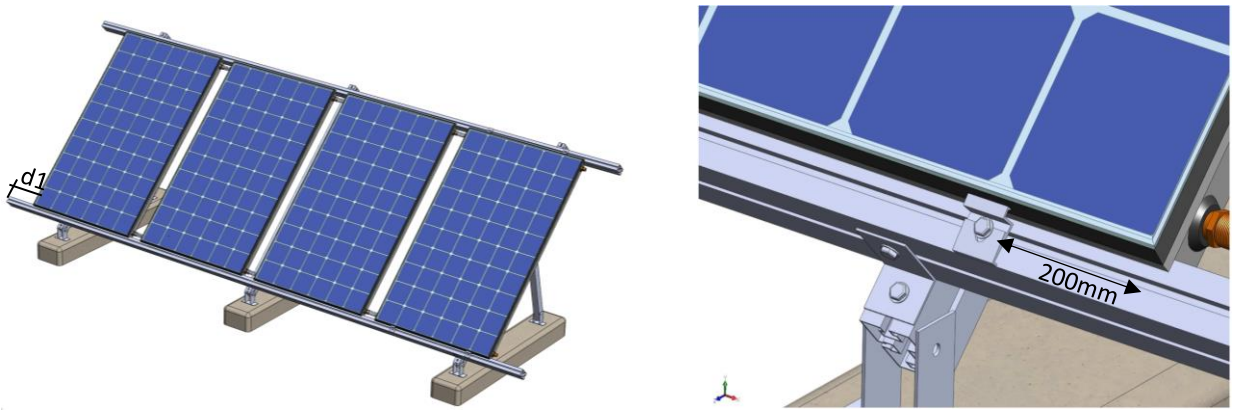


Fig. 9. Placement distance of first collector and anchorage detail to structure

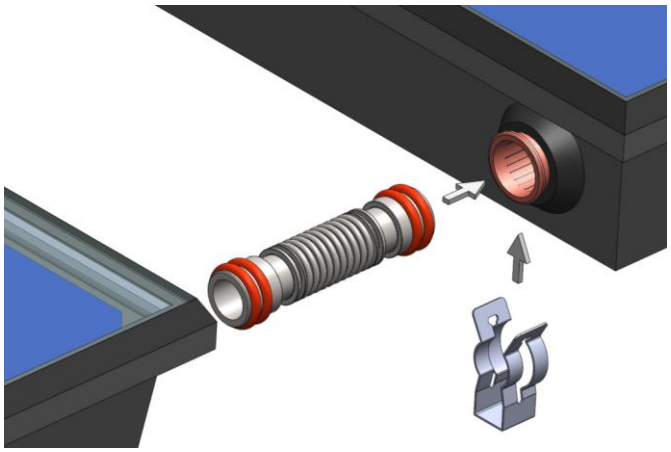


Fig. 10. Detail of expansion compensator between collectors

IMPORTANT! It is very important to use the washers supplied with the panels and make sure they are positioned correctly.

Note: The material breakdown sheet and the fitting assembly diagram will be included in the packaging of the hybrid solar panels.

4 HYDRAULIC SUSTEM

The thermal/hydraulic system of the hybrid solar panels is designed to absorb heat by receiving solar irradiation and transferring it to the circuit where it is to be used. Thermal collectors are generally used for domestic water heating, heating, swimming pool heating or industrial processes. A heat transfer fluid, usually a glycol solution, is used to transfer the thermal energy to a heat exchanger and prevent it from freezing.

4.1 System design considerations

Maximum operating pressure:
Although the maximum test pressure for the modules is 10 bar, a maximum system pressure of 3 bar is recommended.

A qualified installer must install the system in accordance with all requirements defined in the project, building regulations and codes, health and safety legislation and any local regulations in force at that time.

4.2 Temperature sensor

The temperature sensors must always be placed in the hot flow (top panel outlet) of the panel bank. The way the sensor is placed is by inserting the thermowell inside the panel. In **figure 11** you can see that the thermowell for the temperature sensor is placed inside the manifold.
It will be necessary to have temperature sensors and control capacity separately and for each orientation of hybrid panels.
For installations with all hybrid panels in the same orientation, the placement of a temperature sensor in one of the row will be sufficient.

4.3 Air outlet

Each panel row will have a purge system to allow air to escape from the circuit, placing it at the highest point of the row. In **figure 11** you can see the bleeding valve at the top of the cross.

4.4 Safety valve

Each group of panels must have a safety valve and a drain valve at the bottom of the bench. The setting of the safety valves must be calculated in the installation project, or by the qualified installer, and according to the current regulations.

4.5 Drain valve

Each group of panels will have a drain valve that guarantees the emptying of only one row, if necessary, without having to empty the whole solar installation.

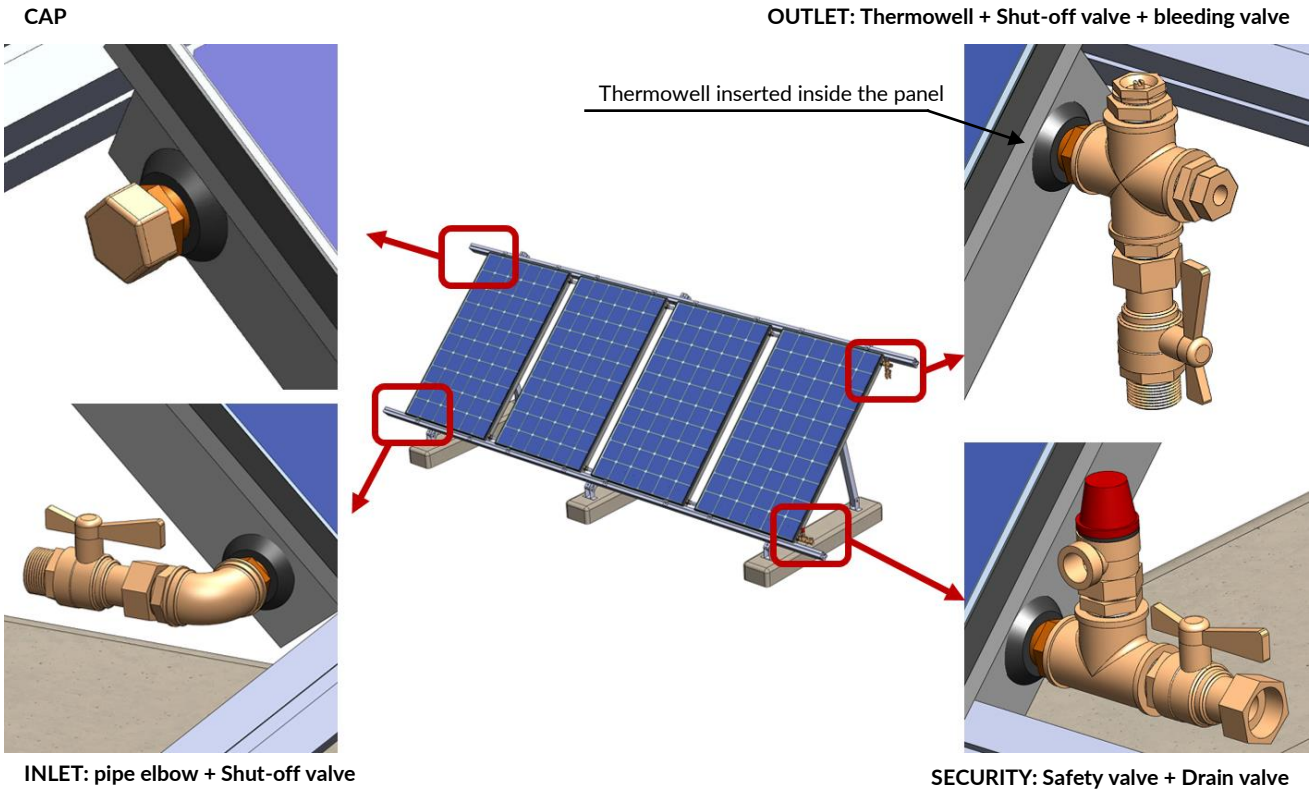


Fig. 11. Detail of rows connections

4.6 Circulator pump and piping

The selection of the pump is fundamental for the system to obtain its maximum efficiency and is determined at the design stage. For installation details please refer to the manufacturer's manual supplied with the pump. To size the circulator pump, the pressure drop of the system throughout the circuit at the known design flow rate must be calculated. Remember that as the system flow increases, so does the pressure drop exponentially. It is common practice to oversize the pump by at least 15%, i.e. the pump pressure, at a given flow rate, is at least 15% higher than the system pressure drop.

The selection of the piping is critical to the proper functioning of the system and will be determined at the design stage. The installation and pipe diameters will meet all standards and specifications applicable in the location where it is installed. As a general rule, the speed of the fluid inside the pipe should not exceed 2m/sec, although it is recommended that it be sized with 1m/sec, because, with the use of the installation, a layer tends to be deposited inside the pipe.

Note: **The recommended flow is 60 liters per hour per collector**.

4.7 Control system

There are many manufacturers of solar thermal controllers or regulators. Depending on the configuration of the installation, the controller that guarantees the perfect operation of the installation will be selected, taking into account that the simplest installation will include at least 2 temperature sensors: one in the panel and another in the tank and 2 relays or control capacity: one for the circulator pump and another for the heat sink (with 3-way valve or another pump).

The following figure shows a basic control scheme with S1, S2, R1 and R2 being mandatory parts in any installation.

S1: Sensor to be inserted in the interior part of the panel

S2: Sensor inserted in the tank

R1: Control over 3-way valve and heatsink

R2: Control over circulation pump

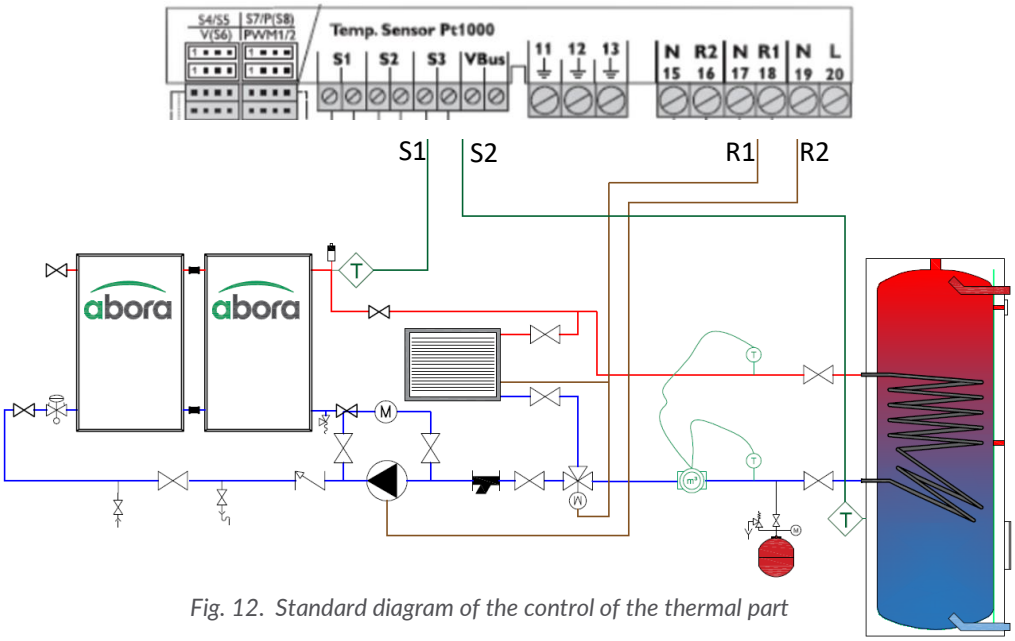


Fig. 12. Standard diagram of the control of the thermal part

4.8 Configuration and testing of the thermal system

Before filling the solar circuit, the tank must be flushed (cleaned) and filled according to the instructions in the corresponding manual. To fill and empty the solar system, a dedicated discharge pump is required.

There is a risk of burning caused by the hot fluid if there has been significant solar irradiation. For safety reasons, the solar system should only be filled when the fluid is cold. This work should be done by covering the panels completely and conveniently during the whole process.

It is necessary to initially flush the system with water, which can also be used for pressure testing.

4.8.1 Cleaning and filling the system

Once the installation is completed, it will be cleaned and filled.

4.8.2 Leakage check of the collector field

To avoid problems with faulty connections or possible pores, the first test for tightness should be carried out, using water or air. The air allows to retouch the welds without waiting time. This test will be carried out at high pressures (close to the maximum admissible ones for the collectors and pipes), making sure not to have connected the components of the installation whose maximum working pressure is lower than the one used for the test, i.e. expansion vessel, pumping system, air separator, etc.

4.8.3 Calibration of the expansion vessel

The expansion vessel must be capable of absorbing the fluid expansion that occurs in moments of stagnation with the consequent risk of overheating. Generally, expansion vessels are set at a higher pressure in the factory than the actual working pressure, so it will be necessary to adapt it to the needs of each installation. In the first instance, the circuit pressure must have been calculated**. The expansion vessel must be calibrated at a pressure equal to the initial pressure of the system without operation**.
It is important to remember that the content of the expansion tank is nitrogen, since inside it contains a membrane with metal parts that would oxidize with oxygen.
It is essential to have a pressure gauge to carry out this check.
All specifications of the expansion vessel manufacturer must be followed.

4.8.4 Cleaning, filling and tightness testing

It is advisable to clean the whole installation in an open circuit with water in order to eliminate possible remains of welds that would obstruct the passage of the fluid in addition to altering its properties. In installations with bleeding valves in the upper part and a single filling point in the lower part, it is not possible to carry out this type of cleaning.
Initially, the primary circuit will be filled with a pressure 1.5 times higher than the working pressure, which will be reduced later. It is very important that the filling phase is carried out with little solar radiation (at the first or last hour of the day) since, when the primary pump is stopped, the stagnant fluid could reach high temperatures and evaporate, forming air pockets in the installation and causing problems in the circulation and filling. The panels will be covered.
Due to the capacity of glycol to penetrate into fine grooves, due to its lower surface tension compared to water, it is necessary to make a new tightness test, this time with the heat transfer fluid.

Important. The heat transfer fluid is essential in areas with minimum temperatures equal to or below 0 degrees to avoid freezing, and must also be able to withstand high temperatures. Its freezing temperature should be checked with a density meter.
There are areas where recirculation of the heat transfer fluid may be sufficient to avoid freezing.
The filling station supplies pressure and flow rate that allow optimum fluid velocities for the dragging of air bubbles by purging the circuit. Thus, in addition to filling the system, the circuit is cleaned and the glycol is pre-mixed with water.

4.8.5 Installation system bleeding

In an installation, air pockets are one of the main problems: they affect the panel connections, reduce the flow of the working fluid and therefore the performance of the system, and also damage the glycol. For all these reasons, correct purging is essential. If this operation is carried out using air bleeders, it is important to place a shut-off valve before the air bleeders to ensure that the circuit is completely watertight; if air separators are used, they will have a bleeder with which to eliminate the micro-bubbles as many times as necessary during the start-up process.
There is a risk that the speed of the fluid is capable of drawing the bubbles into the circuit without the bleeders being able to evacuate them. This is why it is necessary to have an air separator. This must be installed in the hot pipe and at the lower part of the circuit, which facilitates maintenance.
A larger section reduces the circulation speed, allowing the bubbles to stop being dragged by the fluid and to rise. The air is expelled with the bleeder.

4.8.6 Pressure and flow adjustments

Pressure and flow are the last parameters to be controlled at start-up.
To regulate the final pressure of the installation, the drain valve will be opened until the appropriate pressure is reached. It is recommended that the expansion vessel is 0.3 bar below the final pressure of the installation. In this way, the remaining heat transfer fluid in the vessel can be released into the circuit in the event of outside temperatures lower than those at the time of filling, and dryness or sticking to the wall of the vessel can be avoided.

Example of recommended system pressure:

- **Initial pressure in the installation = 1.3 bar + 0.1 x H (height in meters of the installation)**
- **Pressure in the expansion vessel = Initial pressure of the system without operation**

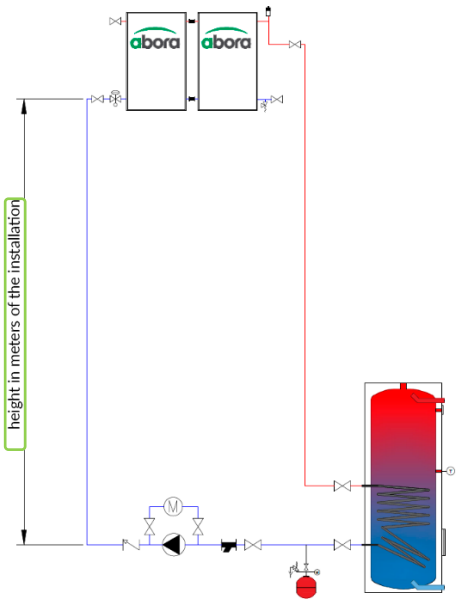


Fig. 13. Diagram of recommended initial pressure in the circuit

As for the final flow rate of the installation, it is recommended to adjust it to 50 liters hour per panel. Its adjustment will be done through the speed of the pump, throttling its shut-off valve until the desired flow is achieved.
The use of a flow meter is essential in order to read the flow rate of the installation.

4.8.7 Best practices

Automatic filling from the grid is not recommended. There is a risk of uncontrolled introduction of quicklime into the circuit, possible leaks in the system are not detected, the glycol is diluted without any control and the concentration of the heat transfer fluid is lost, with the consequent risk of freezing which will cause damage to the system. It is not good practice to lead the outlet of the safety valve to a drain, as this makes it very difficult to control and quantify possible losses in the installation. Furthermore, the regulations for thermal installations do not allow drainage at high temperatures. We recommend that the safety valve be directed to a container that is not connected to the drainage system, such as a bottle, for example.

5 PHOTOVOLTAIC SYSTEM

The photovoltaic subsystem works in the same way as a crystalline silicon photovoltaic panel of the same electrical power. Therefore, the instructions and applications are the common ones in photovoltaics.
Solar photovoltaic systems consist of:

- Photovoltaic solar modules
- String connectors
- Direct current (DC) and alternating current (AC) protections
- Direct current (DC) to alternating current (AC) inverters

Each installation has a specific number and configuration of solar panels, inverters and protections for its particular application. The designer of the solar photovoltaic system must configure it to meet the requirements and working ranges of the inverter.

5.1 Recommendations, precautions and characteristics

It is necessary to hire an installer with the capacity to issue the corresponding installation bulletins and to put it into service properly, in compliance with the specific regulations of each country.
In the northern hemisphere the optimum orientation of the panels is south, while in the southern hemisphere the optimum orientation of the panels is north. Panels that are 30 degrees from their optimum orientation will lose approximately 10 to 15 percent of their power output. If the panel is 60 degrees from its optimal orientation, the power loss will be 20 to 30 percent. When choosing a location, avoid trees, buildings, or obstacles that may cast shadows on the array.
Once the system is put into service (correctly adjusted and the installation checked) the electrical switches will be closed and the system will begin to allow the sun's energy to produce electrical current. The system will automatically direct the energy produced to the distribution system.
It is recommended that monitoring systems be used so that operators can be aware of possible system failures. When alarm situations arise, trained personnel should be hired to perform troubleshooting and system repairs.

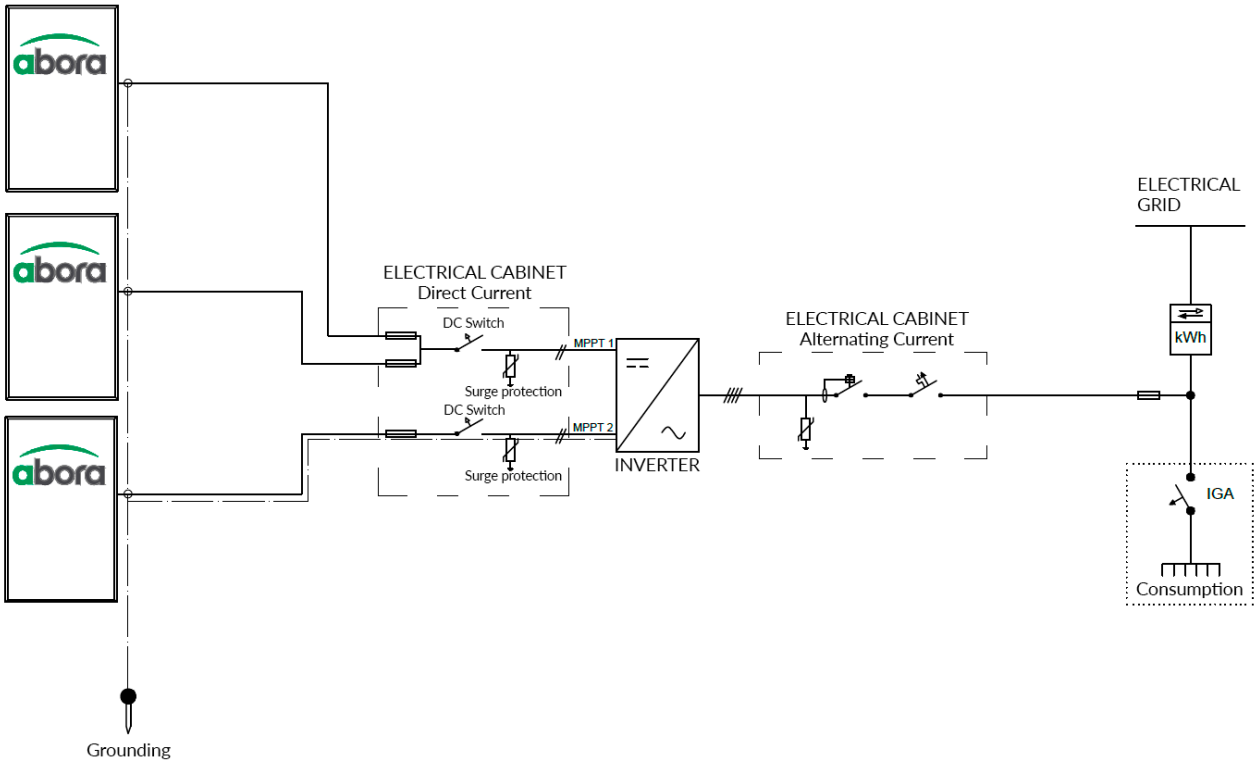


Fig. 14. Standard diagram of the photovoltaic part

WARNING

Risk of electrocution!

- Before starting work on the general electrical cabinets inside the building, you must disconnect the power supply entering the electrical cabinets and isolate the photovoltaic system to avoid double feeding and possible electrical shocks.
- In case of emergency, the AC power supply to the inverter should be isolated by switching off the magneto-thermal switch located in the AC electrical cabinet and the DC supply at the main DC disconnection point located in the DC electrical cabinet or in the inverter itself. All persons working on the DC wiring of a photovoltaic system must be qualified to work with such systems and be fully familiar with the voltages present in the system.

Failure to follow the above instructions may result in death or serious injury!

IMPORTANT: The DC cables connected to a PV module or strings are live at all times during the day and night. Therefore, DC cable runs should be as short as possible and cables should be carefully routed and secured.

Please consider the following precautions:

- Do not direct artificially concentrated sunlight at the panel.

- During installation, protect the hybrid solar panels from sunlight because, when solar radiation comes in contact with the surface of the panel, it will produce electrical energy. Only qualified technicians should install or perform maintenance work on the panels. For maintenance work, the panels should be properly covered.

  It's recommended that the panels are covered until the installation is completely finished and the relevant safety tests have been carried out. This includes hydraulic filling and tightness testing and leaving the installation running with water circulation, as well as electrical connections.

  IMPORTANT: the cover does not completely prevent the panel from having a DC voltage with solar radiation.
- Do not touch bare terminals with your bare hands. Use insulated tools for electrical connections.
- If batteries are installed, follow the manufacturer's recommendations.
- Under normal conditions, a photovoltaic panel is likely to experience conditions that produce more current and/or voltage than reported under standard test conditions. Therefore, the Short Circuit Current (I_{SC}) and Open Circuit Voltage (V_{oc}) value marked on this panel should be multiplied by 1.25 when determining component voltage ratings, conductor current ratings, fuse sizes, and the size of controls connected to the PV output.
- Do not connect any other devices (antennas, pipes, ducts, etc.) to the panel structure.

5.2 Installation Guidelines

5.2.1 Wiring and connection

Note: Connect the conductors between the PV panels in series or parallel connection. This will be determined by the DC input characteristics of the inverter to be installed.
The total voltage of the strings must not exceed the nominal working voltage of the selected inverter.

5.2.2 PV Voltage and String Voltages

Standard PV systems for self-consumption installations have maximum voltages of 1000V and recommended working ranges between 300 and 800V. In this case, the use of properly selected cables, connectors and cabinets for this type of system, together with controlled installation techniques carried out by qualified personnel, is of fundamental importance so that work is carried out with full safety guarantees.
External cables must be stable to UV rays and water resistant.
It is recommended that, once the panels have been connected together, the cables should not hang by their own weight and should be fixed to the structure itself. The mechanical stress generated by the

cable's own weight can generate electrical contact failures, which can lead to electrical arcs with the corresponding consequences, such as fires.

5.2.3 Direct Current PV connectors

The hybrid panels have a connection box on the back side from which two cable strands (one positive and one negative) with special PV connectors (**compatible with MC4 connectors**) male and female come out. These connectors provide a safe, durable and effective electrical contact. They also simplify and increase the safety of the installation work. The male and female connectors connected in a photovoltaic system should be of the same type and from the same manufacturer

5.2.4 Strings breaker of fuses

The DC breaker or fuses must have the following characteristics:

- The circuit breaker must isolate all active conductors (generally two poles to isolate the positive and negative conductors from the PV strings or set of strings).
- The breaker must be DC rated and capable of operating at the maximum calculated system voltage (typically 1000V and 15A-16A).

5.2.5 Direct current general circuit breaker

It must be installed in one of the following ways:

- A physically separated disconnect switch mounted next to the inverter.
- A disconnect switch that is mechanically connected to the inverter, which allows the inverter to be removed from the section containing the disconnect switch without electrical risk
- A disconnect switch that is built into the inverter, if the inverter includes an isolating means that can only operate when the disconnect switch is in the open position (e.g. plugs accessible only after the disconnect handle is removed from the switch)
- An integral disconnect switch on the inverter, if the inverter includes an isolating means that can only be operated with a tool and is labeled with a warning sign or text ("Do not disconnect under load").

5.2.6 General electrical installation information

Each hybrid panel has a positive and negative connector on the back of the panel. The panels must be interconnected in a series sequence according to the circuit diagram.

Note: A string is a number of photovoltaic panels (the glazed portion of the hybrid panels) connected in series (modules interconnected so that the positive in one module is connected to the negative in the next, and so on).

The positive and negative ends of each string or set of them must be connected to the inverter.

The DC cables must be securely fastened to the panel structure.

The DC cables must be visible and securely fastened to the connection point with the inverter or the DC circuit breaker.

Follow the manufacturer's requirements for installing the inverter and the electrical installation regulations for the protection of the DC and AC parts of the installation.

Note: Follow wiring diagrams and schemes designed specifically for connection to existing power service.

Once the system is fully connected and installed, it is important to check the installation to ensure that all terminals are tight.

5.2.7 Electrical grounding, equipotential bonding and lightning protection

Lightning protection

Where buildings or structures are considered to be at greater risk, for example when they are very tall, or in an exposed location, the designer of the electrical system must provide the necessary protective measures. In any case, protection against overvoltage must be provided on both the AC and DC parts. For an isolated installation without lightning conductors, the risk is on induction of lightning close to or between clouds, in which case Type 2 protectors would be appropriate, for both AC and DC side. For example, if you have 1000Vdc and 400V 3PH+N on the AC output, a proposal of equipment would be:

77707852 PSM3-40/1000 PV

77705451 CS4-40/400

Type 1, or better, Type1+2, will be used when there are lightning conductors in the installation. Type 1+2 can also be used on the AC side, on the safety side, when there is an air connection.

Protective equipotential bonding (electrical grounding)

The protective equipotential bonding is a measure that applies to parts of the electrical installation that, under fault conditions, may have a different potential to earth. When applying this measure, the risk of electric shock is limited since there must be little or no difference in the voltages between the parts (potential difference), which could otherwise be activated.

Joining must be carried out in accordance with local regulations.

Grounding is achieved by attaching the panel housing to the structure and connecting the structure to earth, in accordance with such regulations.

6 Start-up and Warranty Application

The system must be installed and commissioned by competent technicians and according to project specifications, drawings and diagrams and in accordance with these instructions. In addition, the conformity of the local electrical authority must be guaranteed and certified. In the same way, and depending on the size of the installation, the thermal part must also be certified with the local authority in this matter. The commissioning checklist must be completed at the time of start-up. A copy of the checklist must be kept with this manual and another copy must be sent to ABORA ENERGY SL. This requirement is part of the manufacturer's warranty.

We trust that the points discussed here will help guide a correct start-up process, which will reduce as much as possible the failures that installations and users suffer as a result of lack of rigor during the aforementioned process, and all this will serve to improve their performance and useful life.

Checklist to obtain the panel guarantee

The structures, panels and units are properly leveled and anchored.	YES	NO
The pipes are properly connected to the interior units and the solar collectors.	YES	NO
The photovoltaic connection has been carried out properly, checking the supply voltage and the electrical protections.	YES	NO
The inverter is switched on, tested and without alarms.	YES	NO
The equipment installed outside, with the exception of the hybrid solar panels, is properly protected against direct solar radiation, rain and frost.	YES	NO
Circuits and rows are adjusted to their nominal flows and are balanced.	YES	NO
In subsystems where the physical properties of the water are changed, it must be possible to measure at least the inlet and outlet temperatures.	YES	NO
Water-tightness and pressure tests have been carried out on water pipe networks.	YES	NO
Temperature sensors and probes are properly positioned and connected.	YES	NO
The power supply of all equipment is executed and checked.	YES	NO
The control system of the installation is programmed and working correctly. At no time does the hybrid collector exceed 85°C.	YES	NO
The hydraulic installation has a heat dissipation system with at least the same total thermal power of the installation.	YES	NO
If the installation includes the aH monitor, the system is fully installed, connected to the internet and working	YES	NO

Installation components

Panel model: | Number of panels: | Type of roofing:

Heat exchanger power (kW): | Operating pressure (bar): | Flow (l/h):

Height between panels and pumps (m): | Antifreeze (%):

Model of primary pump:

Model of secondary pump:

Accumulation volume (l): | Controller model:

Heat Sink model:

PV1 Inverter model:

PV2 Inverter model:

PV3 Inverter model:

PV4 Inverter model:

PV Cable size (mm): | Number of strings:

Attach hydraulic diagram: Specify rows distribution and flow rate of each row.

Attach photovoltaic diagram: Specify number of strings and quantity of panels per strings, as well as the components of electric panels DC, AC and electrical grounding.

Name: | Surname:

Company: | VAT number:

Location of the Installation:

Date:

Stamp and signature:

7 Maintenance plan

SURVEILLANCE PLAN

Installation component	Operation	Frequency (months)	Description
Collectors	Glass cleaning	1	With water and appropriate products
	Glass	3	Visual inspection: Condensation during the core hours of the day.
	Gaskets	3	Visual inspection: Cracks and deformations.
	Absorber	3	Visual inspection: Corrosion, deformation, leaks, etc.
	Hydraulic and electrical connections	3	Visual inspection: Leaks and connections
	Structure	3	Visual inspection: Degradation, signs of corrosion.
Primary circuit	Piping, insulation and filling system	6	Visual inspection: Absence of moisture and leaks.
	Purging	3	Empty air from container.
Secondary circuit	Thermometer	Daily	Visual inspection: Temperature.
	Piping and insulation	6	Visual inspection: absence of humidity and leaks.
	Solar tank	3	Purging of sludge accumulation at the bottom of the tank

MAINTENANCE PLAN

Installation component	Element	Frequency (months)		Description
		Collection area		
		≤ 20 m²	≥ 20m²	
Collection system	Collectors	12	6	Visual inspection: Differences since initial installation
	Glass	12	6	Visual inspection: Condensation and dirt
	Gaskets	12	6	Visual inspection: Cracking and deformation
	Absorber	12	6	Visual inspection: Corrosion and deformation
	Casing	12	6	Visual inspection: deformation, oscillations
	Connections	12	6	Visual inspection: Leakage occurrence
	Structure	12	6	Visual inspection: Degradation, corrosion and tightening of screws
Acumulation system	Tanks	12	12	Presence of sludge on the bottom
	Galvanic anodes	12	12	Wear and tear check
	Impressed current anodes	12	12	Checking the proper functioning
	Insulation	12	12	Check for moisture
Exchange system	Plate heat exchanger	12	12	Control of operation, efficiency and performance
	Coil heat exchanger	12	12	Control of operation, efficiency and performance
Hydraulic circuit	Cooling fluid	12	12	Check its density and pH
	Watertightness	24	24	Perform pressure test
	Exterior insulation	12	6	Visual inspection: Degradation, joint protection and absence of moisture
	Interior insulation	12	12	Visual inspection: joints and absence of moisture
	Automatic purge	12	12	Control of operation and cleaning
	Manual purge	12	6	Emptying air from the container
	Pump	12	12	Watertightness
	Closed expansion vessel	12	6	Checking the pressure
	Open expansion vessel	12	6	Checking the level
	Filling system	12	6	Operation and performance control
	Cutting valve	12	12	Operation and performance control
	Safety valve	12	12	Operation and performance control
Electrical and control system	Electric cabinet	12	12	Operation and performance control
	Differential control	12	12	Operation and performance control
	Thermostats and probes	12	12	Operation and performance control
	Measurement system verification	12	12	Visualization and operation control
	Security features	12	12	Functioning and performance control
	Wiring	12	12	Visualization of degradation and conduction
	Inverter	12	12	Control of operation and cleaning
Auxiliary energy system	Auxiliary system	12	12	Operation and performance control

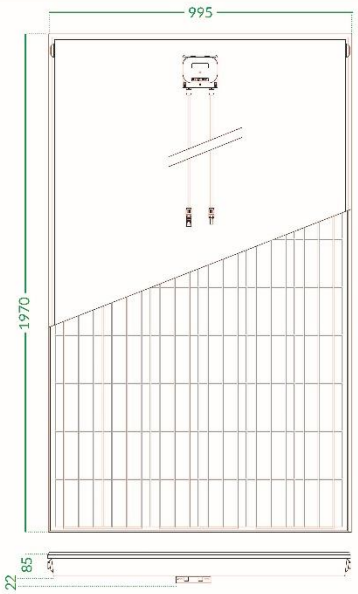
8 General specifications

aH72

Hybrid solar panel with simultaneous thermal and photovoltaic production.

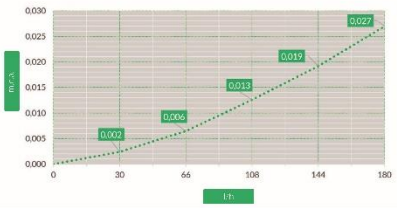
* All percentages of production are conditioned to the working temperature range of installation.

Dimensions



Loss of charge

Pressure drop: *T° max:* 20,13 °C / *T° min:* 19,39 °C



General specifications

Length x width x thickness	1.970 x 995 x (85–22) mm
Total area	1,96m²
Opening area	1,88 m²
Number of cells	72
Weight	50 kg.
Front glass	3,2 mm. tempered
Framework	Aluminum
Connection box protection	IP65
Number of diodes	3 diodes
Dimensions of the cell	156 x 156
Connection type PV / length cables	Solarlok PV4 / 1m

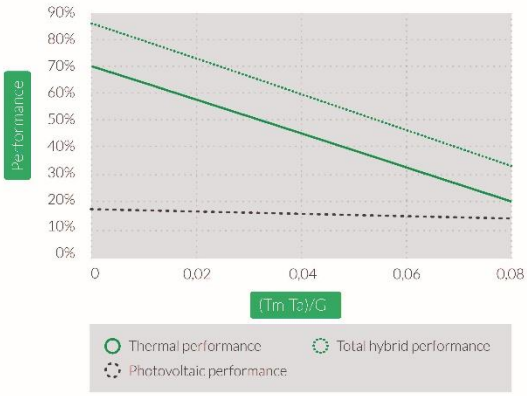
Electric specifications

Standard test conditions STC: AM 1.5, irradiation 1000 w / m²
Cell temperature 25 °C

Cell type	Mono-crystalline
Rated power (W)	350 W
Maximum power voltage (Vmpp)	39,18 V
Maximum power current (Impp)	8,98 A
Open circuit voltage (Voc)	48,82 V
Short circuit current (Isc)	9,73 A
Module efficiency (%)	18,70
Power tolerance (W)	0/+3%
Maximum system voltage	DC 1000 V (IEC)
Backsheet	Black
Temperature coefficient of Pmpp	-0,41%/°C
Temperature coefficient of Voc	-0,33%/°C
Temperature coefficient of Isc	+0,06%/°C
Maximum reverse current	15A
NOCT Temperature*	45+/-2 °C

Thermal specifications

Optical performance	0,7
Coefficient of thermal losses, a1	5,98 W/m².K
Coefficient of thermal losses, a2	0,00 W/m².K²
Internal liquid capacitance	1,78 L
Stagnation temperature	126ºC
Number of hydraulic connections	4 connections
Measure Hydraulic connection	quick connect
Maximum permissible pressure	10 bar
Nominal flow	60 L/h



CE

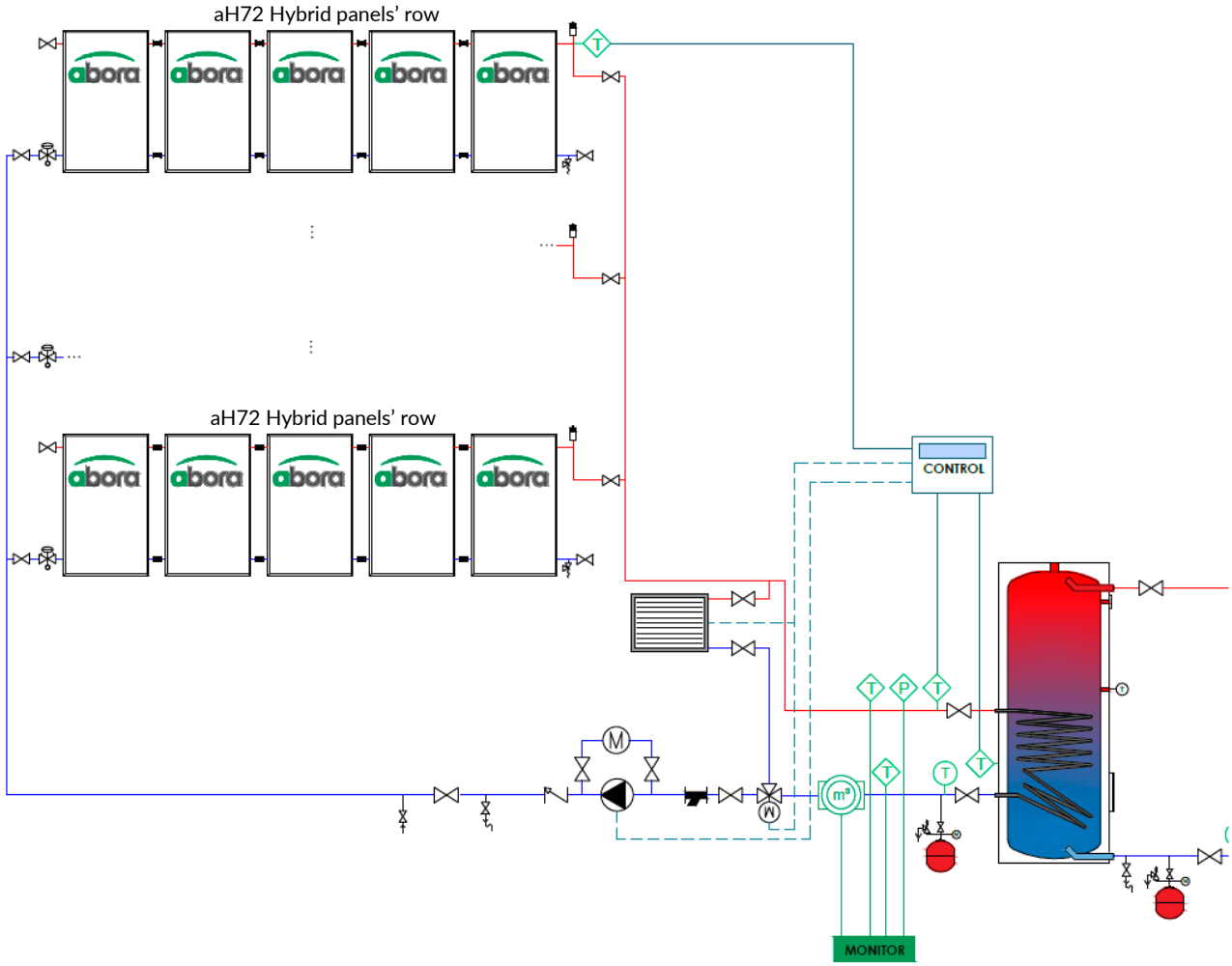
Conforming with Product Standards:
IEC 61215 Ed2; IEC 61730-1,-2:2004;
EN 12975-1:2006 + A1:2001 ; EN ISO 9806:2017

Subject to technical modifications without notice.
Guarantee of 10 years.

MORE INFO AT
www.abora-solar.com

9 Annex

9.1 Hydraulic diagram for collector field up to 50m².



Legend of installation principle diagram

Pump	Filter	Manometer
Ball valve	Check valve	Differential manometer
3-way motorized valve	Thermostatic valve	Visible thermometer
Drain valve	Filing valve	Pressure sensor
Balancing valve	Safety and emptying valve	Temperature sensor
Bleeding valve	Expansion compensator	Energy meter
Safety valve	Expansion vessel	MONITOR Monitor
Hot water tank	Heat Sink	CONTROL Control Unit