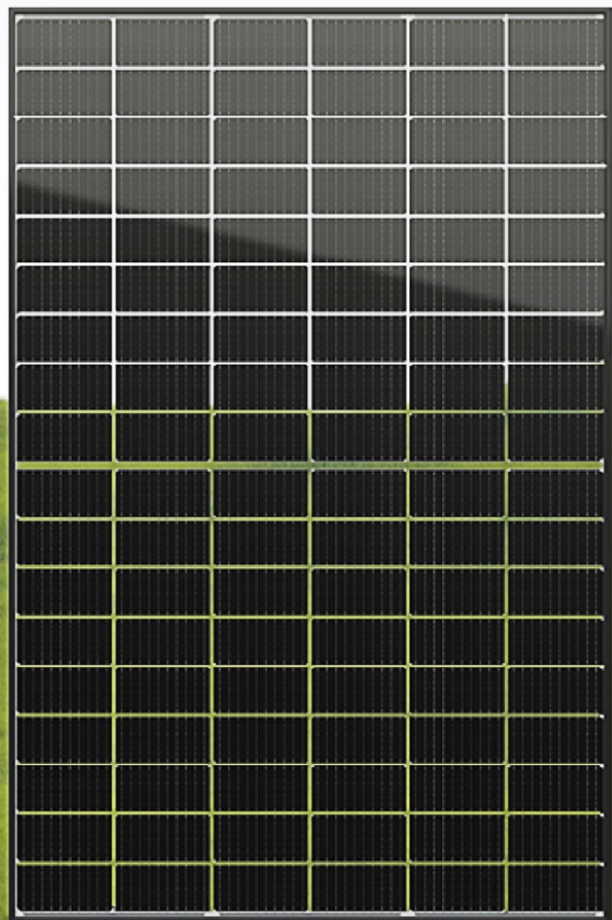


INSTALLATION MANUAL

Metawolf Solar
TOPCon Dual-glass
PV Module





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1 Basic Information

1.1 Preface

This manual contains the information of installation and safe operation of Meta Wolf Solar GmbH's TOPCon Dual-glass PV modules (hereafter referred to as "module").

All instructions should be read carefully before installation. Please contact our sales department for more information if you have any questions.

The installer should be familiar with the mechanical and electrical requirement of PV systems. The installer should comply with safety precautions listed in this manual and local law regulations when installing the modules.

According to IEC61730 standard, the safety class of solar module is class II; the fire protection grade of solar module is class A (refer to UL790).

1.2 Warnings

1.2.1 It requires specialized skills and knowledge for installation of solar photovoltaic systems. It should be operated by professional installation personnel who have qualified licenses.

1.2.2 When the modules are exposed to sunlight or other light sources, DC current is generated in the modules. At this time, if you touch the electrical parts of the modules, there may be an electric shock hazard.

1.2.3 The modules could be installed in outdoor environment, such as ground, roofs etc. If the modules are installed on the roof, the roof should have a certain fire protection capability. You can consult the local construction department to decide on the roof materials. Do not use this module to replace the whole or partial roofs/walls of the buildings. The system designer or installer is responsible for choosing proper support structure. When the modules are installed on brackets parallel to the roof or wall surface, there should be a minimum gap of 10cm between the module frame and the roof or wall surface. This is necessary to allow for proper air circulation and prevent damage to the wiring.

1.2.4 Do not disconnect any of the module's connector during work.

1.2.5 Do not disassemble the modules or move any nameplates or adhered components.

1.2.6 Do not place the modules near a supply/storage of combustible gases.

1.2.7 Do not use artificially concentrated sunlight on the module. Do not expose the back of the module to sunlight for a long time.

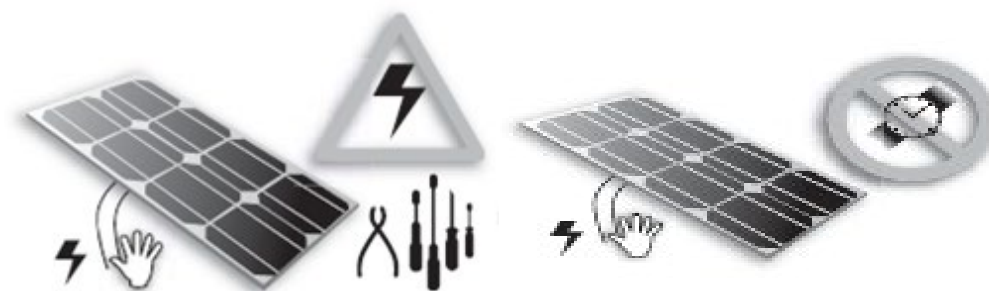
1.2.8 Do not allow any objects to fall on or cover the modules, and it is strictly prohibited to step, stand, or walk on the modules, as this can damage the modules and pose a potential risk of injury to individuals.



1.2.9 Avoid moving the modules by dragging the cables from the junction box.

1.2.10 Keep children away from modules during transportation and installation.

1.2.11 Avoid wearing metal rings, bracelet, earrings, nose rings, lip rings or any metal accessories during transportation and installation of the modules. Do not touch the electrical part of the modules by hand without any insulated protection. Use insulated tools which satisfy electrical requirement to connect electrical parts of the modules.



1.2.12 During transportation, ensure that the modules are not subjected to impacts or severe vibrations, as these could potentially lead to hidden cracks in the solar cells within the modules. Once the modules arrive at the installation site, if immediate installation is not possible, they should be placed on flag grounds and

provided with additional protection against moisture, wind, rain, and snow.

Unpacking should be done carefully.

1.2.13 Do not damage the glass of the modules, as the glass serves to protect the modules. Avoid damaging the seals at the edges of the modules, as this can lead to module failure. Damaged solar modules can be hazardous (risk of electric shock and fire), and such modules cannot be repaired or maintained; they should be replaced immediately.

1.2.14 In order to reduce the risk of electric shock or combustion, opaque material can be used to cover the front surface of the modules during installation.

1.2.15 Installation personnel must ensure that the connection between the mounting brackets and the photovoltaic modules is secure and free from any looseness.

1.2.16 All module frames and mounting structures must be properly grounded in accordance with the relevant National Electrical Code. Frameless double-glass modules, which lack frames, do not generate leakage current between the cells and encapsulation materials and, therefore, do not require grounding.

1.2.17 Do not clean the modules with corrosive chemicals.

1.2.18 Roof installations can impact the fire resistance of a building. According to IEC 61730, the fire resistance rating of the modules is Class A (referencing UL 790). The fire safety rating of the photovoltaic system should be evaluated in conjunction with the roof. The fire resistance rating of the modules is effective only when installed in the manner specified in the installation manual.

1.2.19 During storage, transportation, installation, and maintenance, it is strictly prohibited for the modules to come into contact with any form of oil or corrosive chemical agents.

1.3 Product Identification

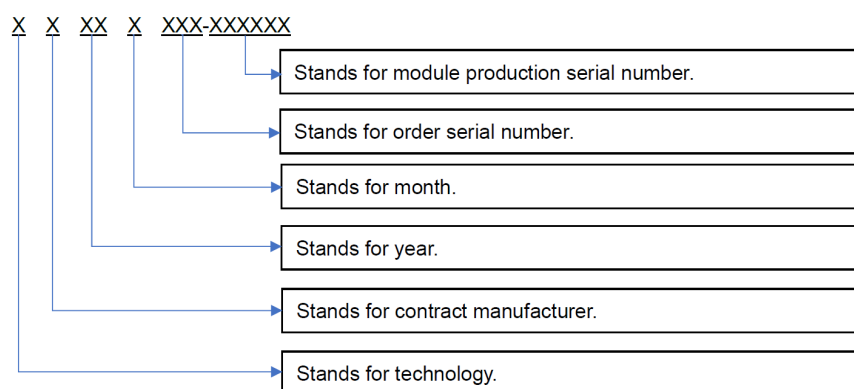
1.3.1 Each module has a label on the back, generally containing following information: Product type, weight, size, fuse current, the system max voltage, rated power measured under standard test conditions, rated current, rated voltage, open circuit voltage, short circuit current.

1.3.2 Barcode (serial number): The barcode (serial number) is a unique identifier for each module. It is permanently affixed inside the module and can be viewed from the front of the module.



Figure1 Bar Code

1.3.2.1 The module's barcode consists of 14 digits and a hyphen. Its meaning is as follows: The first digit represents technology; the second digit represents the contract manufacturer; the third to fifth digits represents production year and month; the sixth to eighth digits are serial numbers of the order, and the ninth to fourteenth digits are production serial numbers of the module.



2 System Design

2.1 Climatic Conditions

2.1.1 Relative humidity: < 85%.

2.1.2 The operating temperature of the module is - 40 °C - 85 °C.

Note: When calculating the mechanical load of components (including the pressure of wind and snow), the installation method and installation site should be considered. The calculation of mechanical load must be carried out by professional personnel according to the design requirements of the system.

2.2 Location Selection

2.2.1 The maximum altitude for PV module is 2000m.

2.2.2 Under standard test conditions (1000 W/m² irradiance, AM 1.5, and an environmental temperature of 25°C/77°F), the electrical performance parameters of the module, such as the nominal value of P_{max}, have an error tolerance of ±3% from the values obtained under standard test conditions. The error tolerance for I_{sc} and V_{oc} is ±5%.

2.2.3 In the Northern Hemisphere, it is recommended to install modules facing south, while in the Southern Hemisphere, it is advisable to orient them towards the north.

2.2.4 The tilt angle of solar modules refers to the angle between the module's surface and the horizontal plane. As shown in Figure 2, the power output is maximized when the module's surface is perpendicular to sunlight. It is recommended that the module installation angle is not less than 10 degrees. For detailed information on the optimal installation tilt angle, please consult a reputable local solar system installation company.

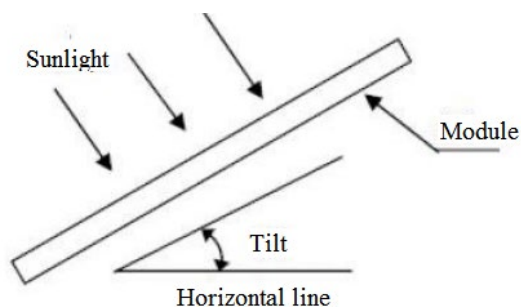


Figure 2 PV module tilt angle

2.2.5 The modules should be installed in the position where is full of sun exposure without shadow at any time.

2.2.6 All modules are compliant with the salt mist test optional; therefore, the modules can be installed as below:

Item	Distance from the sea	Installation	Maintenance
1	Distance≥500m	Standard	Standard

2	50m<Distance<500m	Corrosion protection	Standard plus additional maintenance
3	Distance ≤50m	Not recommended	—

2.2.7 When a storage battery is used in the photovoltaic system, the battery must be installed correctly to ensure the safe operation of the photovoltaic system. The installation, use, and maintenance of the batteries should follow the instructions provided by the battery manufacturer as outlined in their documentation.

2.2.8 The recommended height above the ground for mounting modules can vary depending on the specific environmental conditions and requirements. A height range of 0.3 to 1 meter (30 to 100 centimeters) is suggested.

2.3 Installation Inclination Angle Selection

2.3.1 PV modules connected in series should be installed in the same orientation and angle.

2.3.2 If connected to a standalone solar system, the installation angle should consider the seasonal sunlight change. In general, if the module's output at the chosen angle can meet the demand even during the lowest solar irradiance period within the year, then that angle is suitable for meeting the annual requirements. For grid-connected systems, the installation angle should be selected based on the fundamental principle of maximizing annual output.

2.4 Choosing the Photovoltaic Support

The system designer or installer is responsible for calculating the loads to ensure that the modules can withstand all specified load conditions. This is a guarantee that must be provided by the mounting structure manufacturer. The chosen mounting structure should be inspected and tested by a third-party testing organization with static mechanical analysis capabilities to ensure its safety and compliance with load-bearing requirements.

2.4.1 Installation of bifacial module without shading the back of module. During the design of the support structure, support components should not cross the areas where the solar cells are located on the modules. Instead, diagonal beams and connecting accessories should only be placed along the edges of the modules. Additionally, the inverter installation position should not be behind the modules but should be installed on the side of the modules to avoid interfering with the reflection of light from the module's backside.

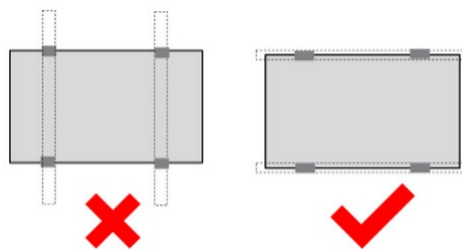


Figure 3 The bracket does not cover the backside of the PV module.

2.5 Choosing the Photovoltaic Inverter

When selecting an inverter type, it's essential to consider the output power, open-circuit voltage (Voc), and short-circuit current (Isc) of the photovoltaic module array. The minimum voltage of the module array should be higher than the inverter's startup voltage to ensure the inverter operates correctly.

2.5.1 Calculation of modules' number in series array

Please use equipment, connectors, wires, and mounting structures that are compatible with the solar power system. In specific systems, it's crucial to use components of the same type. When determining the rated voltage, wire capacity, fuse capacity, controller capacity, and other parameters related to the photovoltaic system components, please refer to the reasonable design based on the values of short-circuit current (Isc) and open-circuit voltage (Voc) displayed on the module label.

In normal outdoor conditions, the current and voltage generated by photovoltaic modules may differ from the parameters listed in the data sheets. The parameters in the data sheets are measured under Standard Test Conditions (STC). Therefore, when designing and installing photovoltaic power systems for different regions, such as determining rated voltage, wire capacity, fuse capacity, controller capacity, and module output power, it is typically advisable to use a redundancy factor of 1.25 times the values of Isc and Voc displayed on the module label. If bifacial modules

are installed in locations with good backside environmental reflection conditions, it may be necessary to increase the redundancy factor accordingly.

Make sure that the system voltage of each array does not exceed the maximum system voltage of the modules, as well as the rated current and voltage of subsidiary devices such as controllers and inverters.

The connection of modules: Based on the system design requirements for output voltage and current, modules can be connected in series or parallel using their own wires. The maximum number of modules in series (N) is recommended to be calculated using the following formula. The number of modules in parallel depends on the electrical equipment (inverter, controller) chosen under standard test conditions (STC).

$$N \leq \frac{V_{\max}}{V_{oc} * [1 + T_c(voc) * (T_{\min} - 25)]}$$

N: Number of modules in series.

V_{max}: Maximum system voltage

V_{oc}: Open circuit voltage of each module
(refer to product label or data sheet).

T_c (voc): Thermal coefficient of open circuit
voltage for the module (refer to data sheet).

T_{min}: The lowest ambient temperature

2.6 Bifacial Module Arrangement and Layout Optimization

Generally, for normal modules' array, there are 2 methods of module connection. The first method connects the upper module and the under module in series. The second method separates the upper and the under modules. The distance from the ground to the bottom row and the distance from the ground to the top row are significantly different, especially when modules are vertically arranged.

In the first configuration (top to bottom serial), the lower current generated by the bottom row of modules can influence the current of the top row, resulting in a reduction in the overall output power. In contrast, in the second configuration (separate serial connections), the top and bottom rows are independently connected in series and do not affect each other. This fully utilizes the performance of bifacial modules and increases electricity generation. The gain in output varies between the top and bottom rows, with the top row generally having a higher gain and the bottom row a relatively lower gain.

To minimize mismatching between strings, it is advisable to choose the second configuration and connect the top and bottom strings to different MPPT inputs on the inverter. This is currently considered the optimal wiring method.

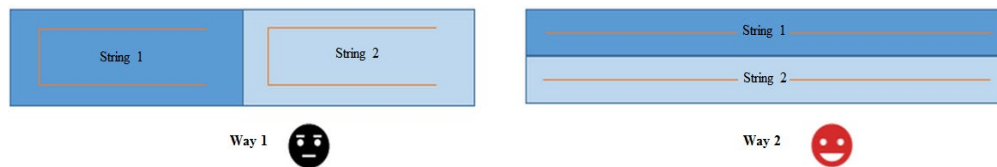


Figure 4 Optimization of modules' array connection

3 Installation

3.1 Installation Safety

3.1.1 When installing modules, it is important to wear protective headgear, insulating gloves, and rubber shoes.

3.1.2 During the installation process, standing on the modules should be strictly avoided as it can damage the modules and pose a risk to personal safety. It's essential to refrain from unnecessary touching of the modules, as the module surfaces and frames may become hot and pose a risk of burns or electrical shock.

3.1.3 Don't unpack the modules except for installing immediately. It's important not to install them in adverse weather conditions such as rain, snow, or high winds.

3.1.4 In order to reduce hazard of electric shock, stop installing if the junction box are wet.

3.1.5 During installation, do not indiscriminately drop anything, including modules and installation tools.

3.1.6 Ensure the correct and secure connection of the junction box connectors, inspect the wiring conditions, and ensure that all connecting wires remain attached to the modules. Additionally, take measures to prevent the connecting wires from chafing or crushing the modules to maintain the integrity and safety of the electrical connections.

3.1.7 Regardless of whether the modules are connected to the photovoltaic system or not, do not touch the junction box or connectors with bare hands during the installation process or when there is sunlight shining on the modules.

3.1.8 Avoid pressing or putting heavy objects on the module's surface or distorting the module's frame.

3.1.9 Do not place heavy objects on the glass of the modules or to subject them to impacts, as this can damage the solar cells or cause hidden cracks in them.

3.1.10 Avoid cleaning the modules with sharp tools, which may lead to scratch on the surface of modules.

3.1.11 Avoid digging holes on the module's frame without permission.

3.1.12 For BIPV or roof application, planned installation is essential. Please follow the installation rules of "from top to bottom" or / and "from left to right" as much as possible.

3.2 Modules Unpacking

3.2.1 When the modules arrive the destination, do not unpack the modules in humid and rainy weather.

3.2.2 After unpacking, the modules should be placed horizontally, and stacking methods such as tilting, heavy stacking, or leaning against other objects should be strictly prohibited.

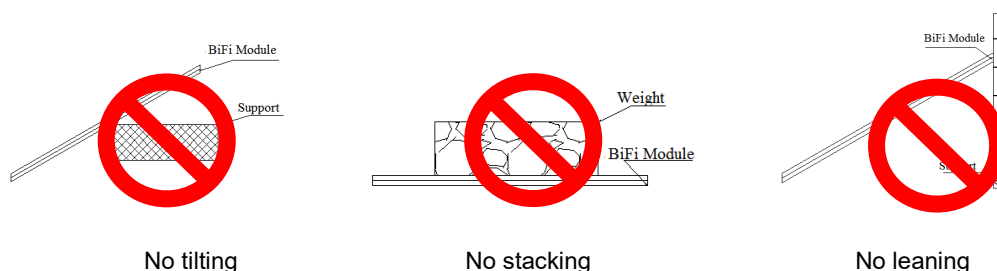
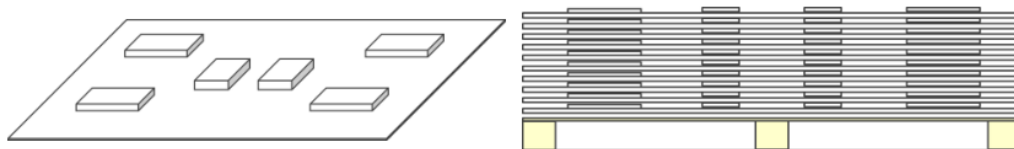


Figure 5 Modules stack illustration

3.2.3 Modules from two different batches should be stored separately. If stacking is necessary, modules with frames that weigh less than 20 kg each should not exceed 24 modules per stack. For modules that weigh more than 20 kg each, the stack should not exceed 20 modules per pallet.

For frameless modules, if stacking is required, the following guidelines should be followed:

The pallet should be placed on a flat surface, and the modules must be stacked on the pallet. The maximum number of modules per stack should not exceed 10 pieces. Stacking time should not exceed 5 days. Isolation materials must be used between two modules, with a thickness greater than the highest protrusion on the module (junction box or hooks) by 10mm. It is recommended to use EPE (Expanded Polyethylene) with a density greater than 28 kg/m³ for isolation. Place the isolation material at six points. During the stacking process, avoid any tilting or bending of the modules caused by uneven thickness of the isolation material. If such an issue arises, adjust it immediately. If isolation materials are not available, it is not recommended to stack frameless modules horizontally.

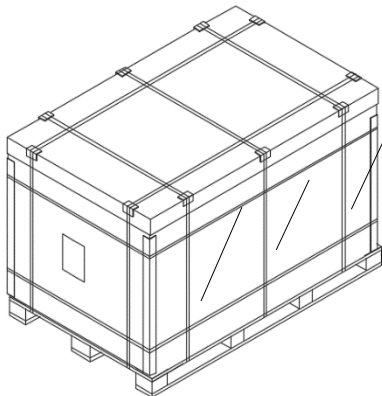
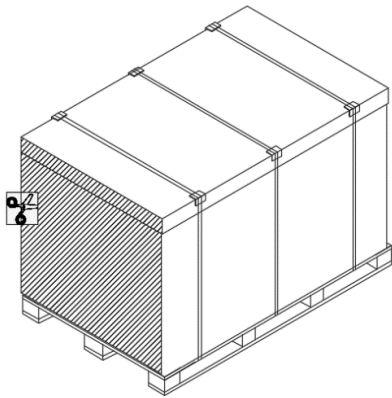
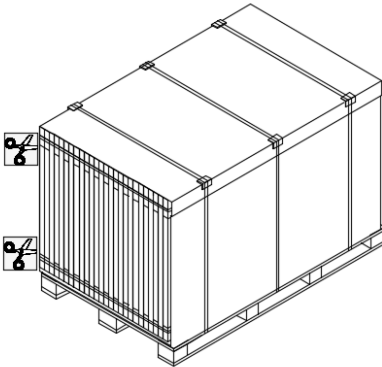
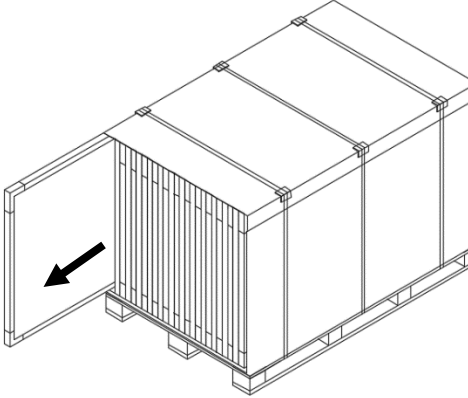


3.2.4 Unpacking process should follow the instructions shown in the figures below. Avoid rude operation or using crowbar to open the boxes. Pay attention to personal safety and modules safety during unpacking.

3.2.5 After unloading, the modules' box should be placed on dry and flat ground. Avoid placing them on wet, muddy or uneven surface.

3.2.6 Upon arrival at the construction site, the upper and lower boxes of the modules should be separated and placed individually. Stacking or piling two boxes of modules on top of each other should be avoided. If the modules cannot be installed immediately, it is essential to protect both the modules and their packaging boxes to prevent damage from rain, heavy snow, hail, typhoons, and other natural disasters.

3.2.7 For double glass modules with frames, the front glass of the two outermost modules should face the inside wall of the cardboard box. When loading and unloading the modules and during unpacking, it is important to take precautions to protect the modules from accidental damage.

The process of unpacking framed modules	
	
<p>1. Do not remove the 3 packing belts indicated by the arrow, and remove the other packing belts of the package.</p>	<p>2. Remove one side of the package (shaded part).</p>
	
<p>3. Cut the two horizontal packing straps inside the cardboard box, one at the top and one at the bottom.</p>	<p>4. Disassemble the modules and take appropriate anti-tilting measures based on the on-site conditions.</p>

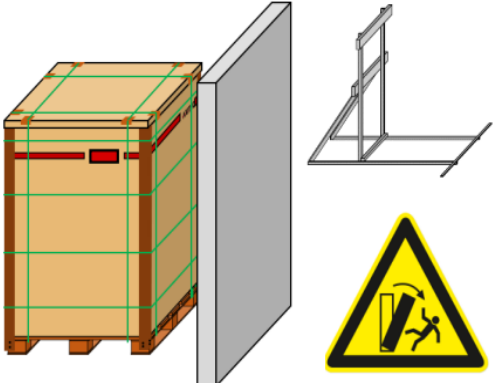
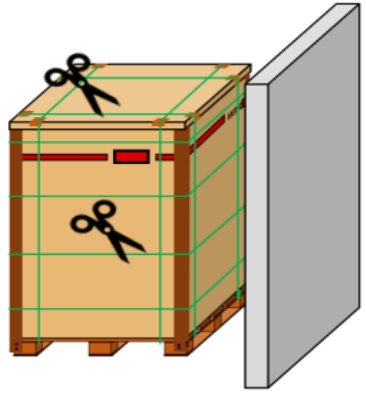
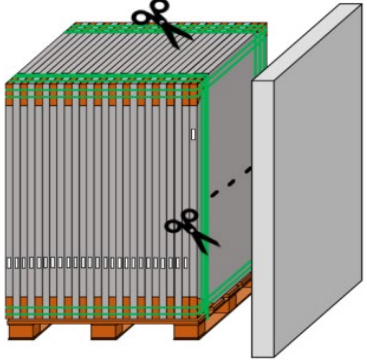
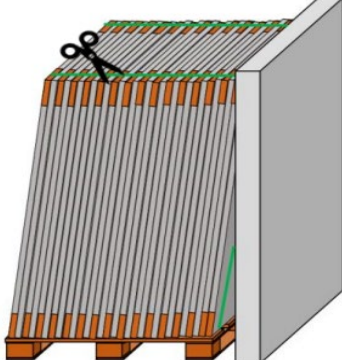
Unpacking process (Vertical type)	
	
<p>1. Place the pallet on a flat ground next to a solid wall or other support possibility.</p>	<p>2. Remove strapping and packaging box (There are Velcro strips on the diagonal of the packing case to facilitate quick unpacking).</p>
	
<p>3. Remove strapping from the modules (leave two straps on the module package. See the next picture).</p>	<p>4. Lean the banded module package against the support / wall. Remove the last strapping.</p> <p>Modules can be taken individually from the pallet.</p>

Figure 6 The process of unpacking framed modules

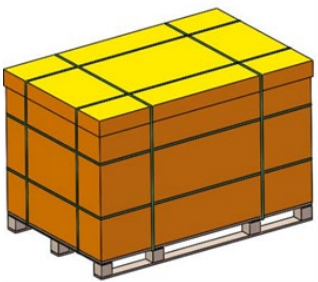
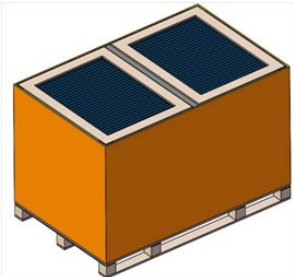
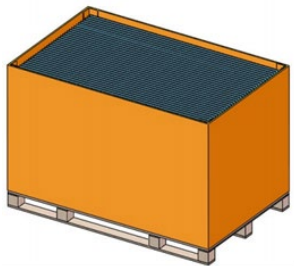
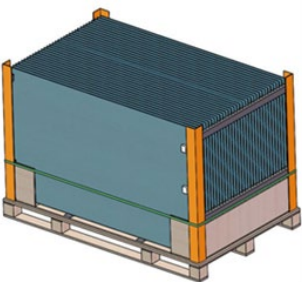
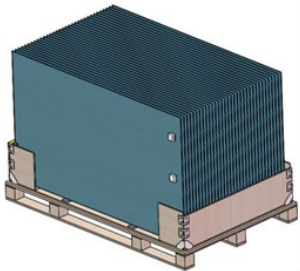
The process of unpacking frameless modules	
	
1. Use tools to remove the packing straps.	2. Dismantle the box cover.
	
3. Remove the lifting brackets and the cover	4. Remove the coaming.
	
5. Remove the packing belt and side liner.	
<p>Note: Different models of module packaging boxes may have slight differences in accessories, such as the number of packing straps or inner support bars. The specifics should be based on the actual delivery you receive.</p>	

Figure 7 Module without frame unpacking process

3.3 Introduction of Installation Method

The installation of modules can be done using the following methods: clamping installation and bolt installation.

3.3.1 All installation methods described in this manual are for reference only. We do not provide the relevant installation components, system design, or installation services. Mechanical loads and safety aspects must be handled by professional system installers or experienced individuals.

3.3.2 Before installation, it is important to confirm the following key aspects:

- 1) Before installation, it is important to inspect the modules for any defects, foreign objects, and ensure the safety performance of the junction boxes. If any issues are found, they should be addressed and corrected.
- 2) Please make sure that the serial number of the module is correct.

3.3.3 If the modules are installed in harsh environments, such as snowy or windy environments, extra measures are needed to protect the modules.

3.3.4 The safety factor for mechanical loads is 1.5 times. Effective Load on Modules = Design Load * Mechanical Load Safety Factor (1.5).

3.4 Installation of Clamps (Module with Frame)

For clamp installation, it is recommended to use M8 bolts for securing. The clamps must overlap the module frame by at least 7mm (0.28 inches) but not more than 10mm (0.39 inches). Please note that all installation methods described here are for reference only. We do not provide the related components, system design, or installation services. Mechanical loads and safety aspects of the modules must be handled by professional system installers or qualified individuals with the necessary expertise.

3.4.1 Use more than 4 clamps to fix modules on the support.

3.4.2 Clamps should not obstruct the front glass of the modules, and they should not cause deformation of the module frames.

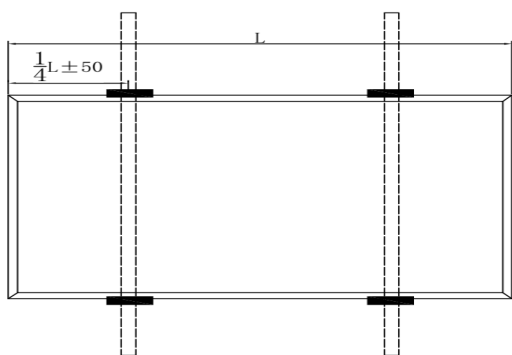
3.4.3 Ensure that the modules do not create shading effects.

3.4.4 The module frame is not to be modified under any circumstances.

3.4.5 The mounting bracket shall not be installed directly below the junction box.

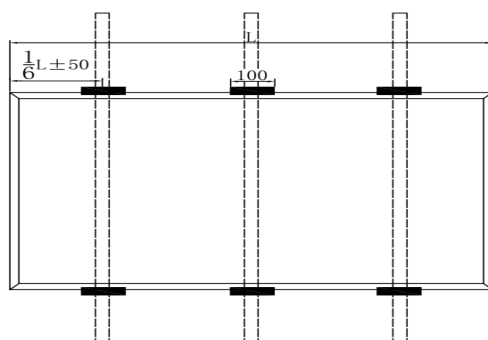
3.4.6 When choosing the clamp installation method, it is recommended to use at least 4 clamps per module. Depending on the local wind and snow loads, additional clamps may be required to ensure that the modules can withstand the loads. In severe environmental conditions such as storms or heavy snowfall that exceed the installation methods outlined below, it is advisable to add extra clamps for installation. Please consult our technical support for guidance in such cases.

3.4.7 Under no circumstances should clamps come into contact with the glass or cause deformation of the module frames. When installing clamps, the applied torque should be sufficient to securely fasten the modules. The applied torque should adhere to mechanical design standards and depend on the bolts used by the customer. Specific torque values should be obtained from the installation provider or mounting system supplier. For example, for M8 bolts, a reference torque value may be in the range of 16-20 N·m, but it's important to consult with the installation provider or supplier for precise torque values based on your specific installation requirements.

Method 1: Long-side clamping installation, effective load $\leq 5400\text{Pa}$ (front), 2400Pa (back) (using 4 clamps - clamp length $\geq 50\text{mm}$)		
	NO.	L*W(mm)
	1	1658*992
	2	1984*992
	3	1686*1008
	4	1704*1008
	5	1791*1052
	6	1755*1038
	7	1730*765
	8	1722*1134
	9	1909*1134
Notes: 1.L is the length of the PV module. W is the width of the module. The black shadow is the area of installation.		

Method2:

Long-side clamping installation, effective load $\leq 5400\text{Pa}$ (front), 3600Pa (back)
 (using 6 clamps - clamp length $\geq 50\text{mm}$)



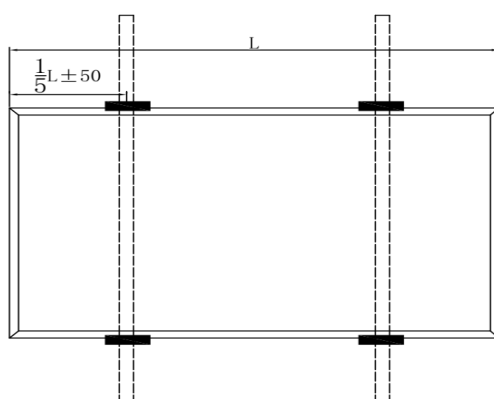
NO.	L*W(mm)
1	2009*1008
2	2031*1008
3	2131*1052
4	2094*1038
5	2094*1134
6	2278*1134
7	2465*1134

Notes:

1. L is the length of the PV module. W is the width of the module. The black shadow is the area of installation.

Method 3:

Long-side clamping installation, effective load $\leq 3600\text{Pa}$ (front), 2400Pa (back)
 (using 4 clamps - clamp length $\geq 50\text{mm}$)



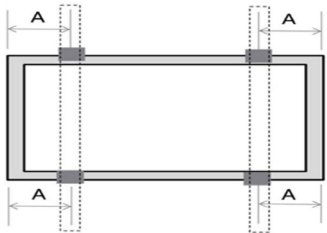
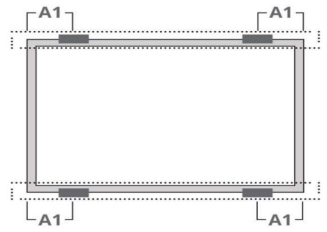
NO.	L*W(mm)
1	2009*1008
2	2031*1008
3	2131*1052
4	2094*1038
5	2094*1134
6	2278*1134
7	2465*1134

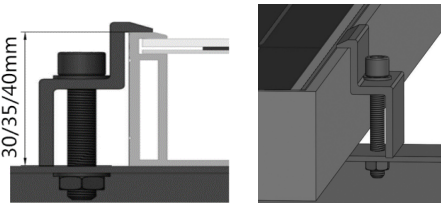
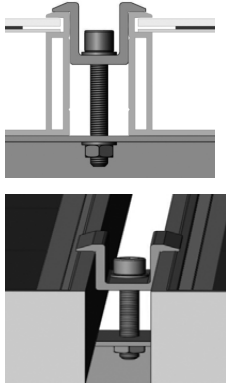
Method 4 (210 series):

Max Mechanical Load
 (Pa)

Four clamps on long side of frame and rails
 perpendicularly to the long side frame

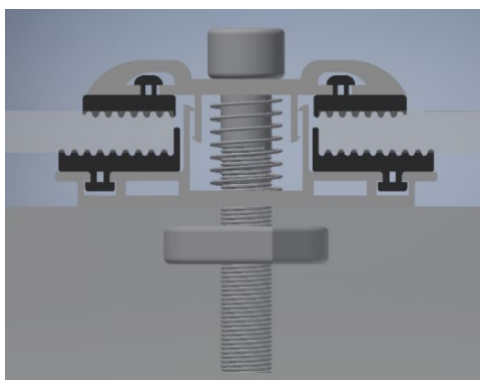
front 2400 back2400	front 5400 back2400
---------------------------	------------------------

	NO.	Dimension L*W(mm)	A Range (mm)	
	1	2172*1303	/	400-500
	2	2384*1303	/	400-500
Method 5 (210 series):			Max Mechanical Load (Pa)	
Four clamps on long side of frame and rails parallel to the long side frame.			front 3000 back 2400	front 3600 back 2400
	NO.	Dimension L*W(mm)	A1 Range (mm)	
	1	2172*1303	/	400-500
Notes: 1. L is the length of PV module. W is the width of module. The black shadow is the area of installation.				

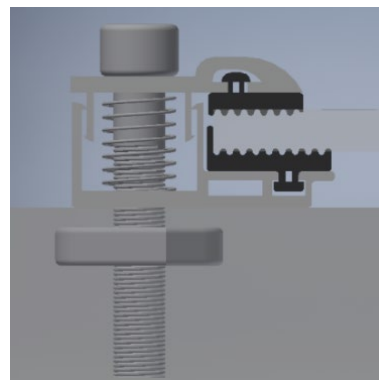
End clamp installation (30/35/40mm optional)	Middle clamp installation
	
PV module installed with clamp fitting method.	

3.5 Installation of Clamps (Module without Frame)

When modules are installed using clamps, the clamps need to be installed in conjunction with C-channel steel as shown in the clamp installation diagram provided in the illustration.



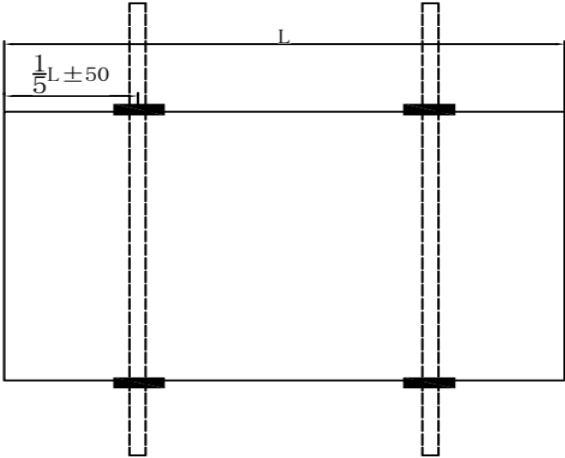
Double-side briquetting illustration

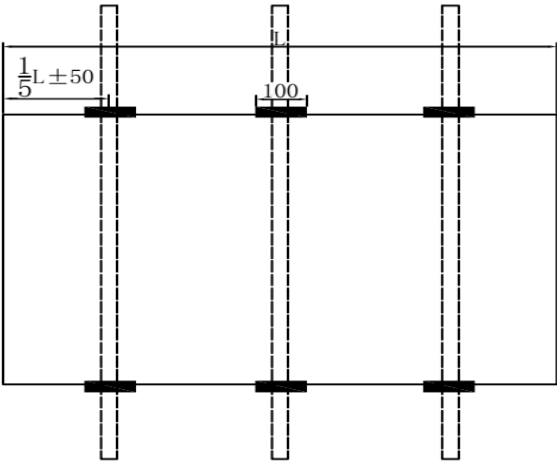


One-side briquetting illustration

The number of clamps used for module installation should ensure that they do not cast shadows on the glass surface of the modules. When selecting clamp installation, make sure there are 4 or 6 clamps on each module, with 2 or 3 clamps on each of the long sides. The number of clamps needed depends on the local wind

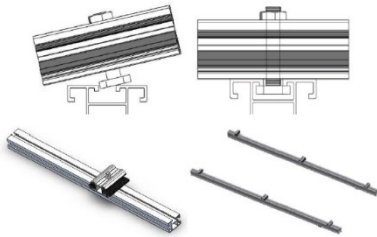
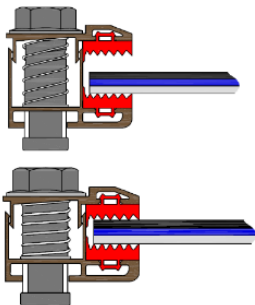
and snow load conditions. If the pressure exceeds the anticipated value, additional clamps or supports may be required to ensure that the modules can withstand the pressure. The applied torque during installation should be sufficient to securely fasten the modules, typically in the range of 16-20N·m (this is a reference value; the applied torque should adhere to mechanical design standards, and specific torque values should be obtained from the installation provider). The mounting structure should not be installed directly beneath the module's junction box. Please refer to the table for details:

Method 1: Long-side clamping installation, payload≤3600Pa (front),2400 Pa (back) (using 4 clamps - length of clamps 150mm)		
	NO.	L*W(mm)
	1	1658*992
	2	1978*992
	3	1680*1002
	4	2002*1002
	5	1698*1002
	6	2024*1002
	7	1785*1046
	8	2125*1046
	9	1749*1032
	10	2088*1032
	11	1716*1128
	12	1903*1128
	13	2088*1128
	14	2272*1128
Note: 1. L is the length of the PV module. W is the width of the module. The black shadow is the area of installation.		
Method 2: Long-side clamping installation, payload≤5400Pa(front),3600 Pa (back) (using 6 clamps - length of clamps 200mm)		

	NO.	L*W(mm)
	1	1658*992
	2	1978*992
	3	1680*1002
	4	2002*1002
	5	1698*1002
	6	2024*1002
	7	1785*1046
	8	2125*1046
	9	1749*1032
	10	2088*1032
	11	1716*1128
	12	1903*1128
	13	2088*1128
	14	2272*1128

1. L is the length of the PV module. W is the width of the module. The black shadow is the area of installation.

Installation process:

Step 1: Install the clamps	schematic diagram
Put the clamps into the rail bracket	
Step 2: Install the modules	schematic diagram
Place the modules into the clamps as required and tighten them.	

3.6 Installation of Bolts (Module with Frame)

Each module's frame has several 14x9mm mounting holes. Ideally, these holes can be used to optimize the module's load capacity and securely fasten the module to the support structure.

To extend the lifespan of the module support, we strongly recommend using corrosion-resistant (stainless steel) fasteners to secure the modules.

Use M8 bolts and flat washers, spring washers, and nuts (as shown in Figure 7) to secure the modules at each mounting position. Then, tighten them to a torque of 16-20 N·m (this is a reference value; the applied torque should comply with mechanical design standards, for specific torque values, please consult the installation provider).

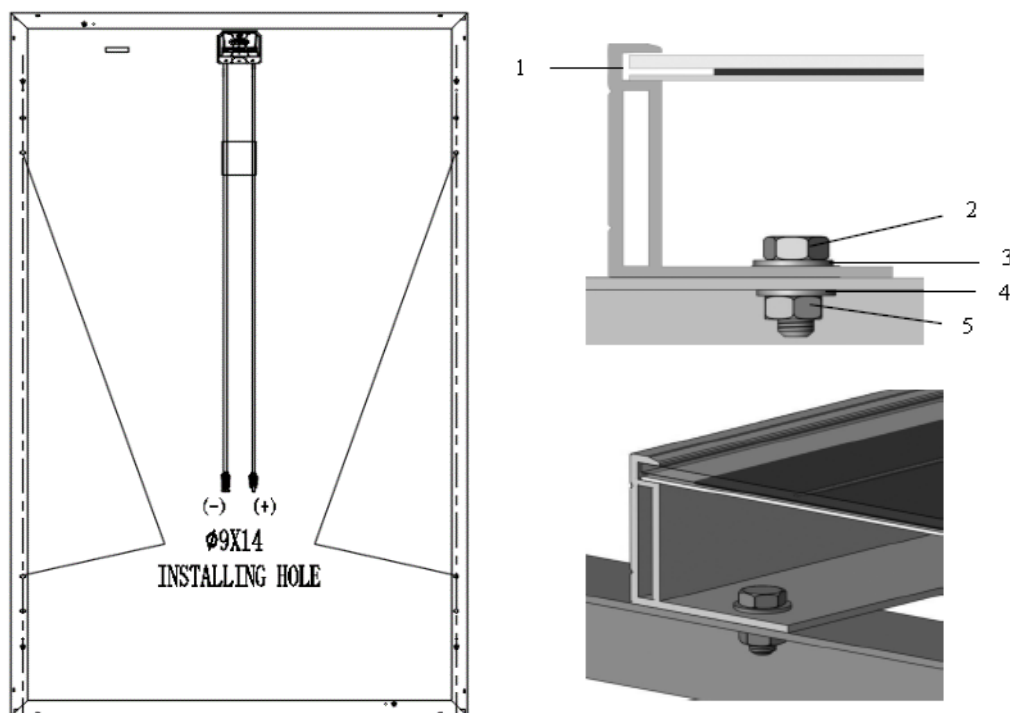


Figure 7. SPV module installed with Bolt fitting method

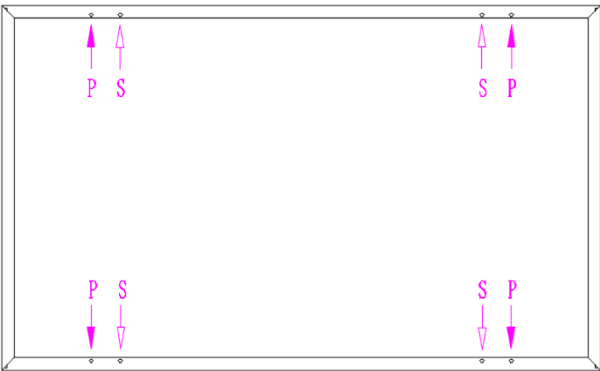
1 Aluminum Frame

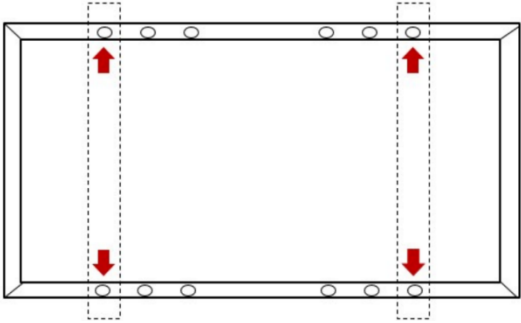
2 M8 Stainless Bolt

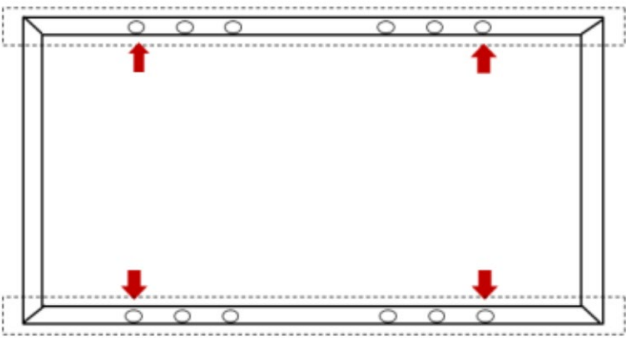
3 Flat Stainless Washer

4 Spring Stainless Washer

5 HEX Stainless Nut

Bolt Installation Method			
NO.	L*W(mm)	payload≤2400Pa(front), 1800 Pa (back)	payload≤5400Pa (front), 3600 Pa (back)
		Using 4 installation holes with S or P holes	Using 8 installation holes with S and P holes
1	1658*992		
2	1984*992		
3	1686*1008		
4	2009*1008		
5	1704*1008		
6	2031*1008		
7	1791*1052		
8	2131*1052		
9	1755*1038		
10	2094*1038		
11	1722*1134		
12	1909*1134		
13	2094*1134		
14	2278*1134		
15	2465*1134		

Bolt Installation Method (210 series) A		
NO.	Dimension L*W(mm)	Outer four holes installation
		Test Load≤5400Pa (front), 2400 Pa (back)
1	2172*1303	
2	2384*1303	

Bolt Installation Method (210 series) B		
NO.	Module Types	Outer four holes installation
		Test Load $\leq 3600\text{Pa}$ (front), 2400 Pa (back)
1	2172*1303	
2	2384*1303	

3.7 Installation of Single-axis Tracking System (Module with Frame)

Some module models have installation holes on the frame that are used for single-axis tracking system installation. These installation holes allow for secure attachment of the modules to the support structure to optimize their load-bearing capacity. Using bolts, secure the modules to the mounting brackets through the installation holes on the backside of the module frame, as shown in the diagram below. Use M6 bolts, flat washers, spring washers, and nuts to secure the modules at each mounting position, and tighten them to a torque of $16\text{-}20\text{ N}\cdot\text{m}$ (this is a reference value; the applied torque should comply with mechanical design standards, for specific torque values, please consult the installation provider). All parts of the module connected to the single-axis tracking system should use flat stainless steel washers with a minimum thickness of 1.5mm and an outer diameter of $16\text{-}20\text{mm}$ ($0.63\text{-}0.79$ inches). The front-facing effective load is 1800Pa , and the back-facing effective load is also 1800Pa .

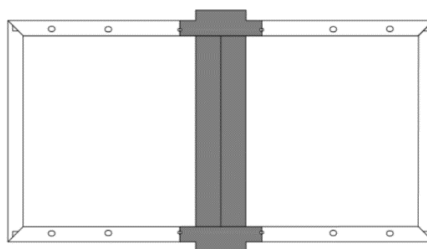


Figure 8 Installation diagram of module with single-axis tracking system

4 Electrical Connection

4.1 Precautions for Electrical Connection

4.1.1 Before connecting, please carefully review the electrical wiring diagram for the photovoltaic system. All wiring should be carried out by qualified installers following local regulations and procedures. The system's highest voltage must be lower than the highest certified voltage, as well as the highest input voltage of inverters and other electrical equipment within the system during installation.

4.1.2 Connection of Modules and Junction Boxes: Use DC cables to connect the modules in series to the junction box. The cross-sectional area of the cable and the capacity of the connectors must meet the system's short-circuit current. For individual modules, a recommended cable cross-sectional area is 4mm^2 , with a fuse current rating of greater than or equal to 20A (18X series modules and double-sided modules require $\geq 25\text{A}$). Connector rated current should be greater than 20A (18X series modules and bifacial modules require $\geq 25\text{A}$) to prevent overheating of cables and connectors due to high current. Please note that the maximum temperature rating for cables is 90°C , and for connectors, it is 125°C .

4.1.3 The aluminum frame and support of the module must be grounded, as shown in Figure 9. Each module has a grounding hole and is marked on the frame (it is recommended that the series / parallel connection of each module must be grounded once). The installation method of grounding bolt is shown in FIG. 10. The grounding wire and frame can be reliably grounded by the prepared grounding hole. And the flat washers, spring washers and nuts are matched by installing bolts $\text{M5} \times 10 \sim 15$. The modules and the earth wire shall be perfectly connected by connecting plugs. Negative grounding inverter can be installed to prevent PID phenomenon.

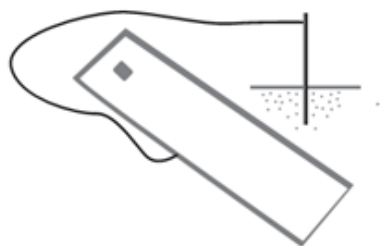


Figure 9 Module grounding circuit

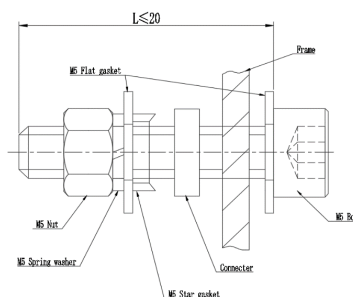


Figure 10 Installation diagram of grounding bolt

4.1.4 If common grounding hardware (nuts, bolts, star washers, split lock washers, flat washers, etc.) is used for grounding/connection devices, installation must be carried out in accordance with the instructions provided by the grounding hardware manufacturer.

4.1.5 The commonly used grounding connection hardware items such as nuts, bolts, star washers, locking washers, etc., which have not been assessed for electrical conductivity, can only be used for mechanical connections and to maintain the electrical conductivity of the appropriate grounding device. These hardware items are provided with the modules and are evaluated as required by UL 1703 standards, and they can be used for grounding connections in accordance with the module installation instructions.

4.1.6 The electrical connections must comply with local electrical regulations, and the electrical connection of the module system should not employ a 'Y' type electrical connection configuration.

4.1.7 The module is equipped with bypass diodes (rated voltage 45V, rated current 25A). Incorrect installation may result in damage to the diodes, cables, and junction box.

4.1.8 After removing the module from its packaging, if it is not immediately installed, it is important to protect the connectors to prevent damage from wind or rain. Using lubricants on the connectors is prohibited, and the connectors should not be exposed to direct sunlight.

4.1.9 Do not remove the waterproof sealing ring from the junction box or connectors.



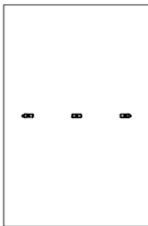
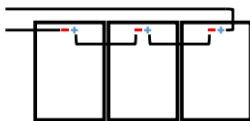
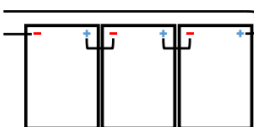
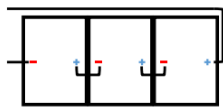
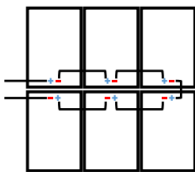
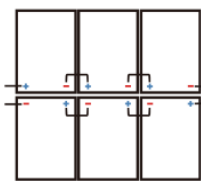
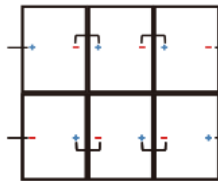
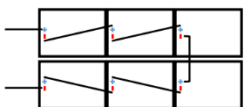
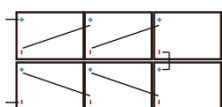
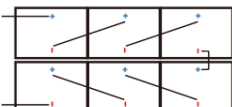
4.1.10 Do not use diesel for heating at the installation site. Gases produced by the combustion of diesel and other petroleum products may damage the connectors.

4.1.11 The minimum bending radius for the cable should be 43mm (1.69 inches).

4.2 Wiring and Connections

4.2.1 For vertically single-row modules, the cable length can be shorter, but for vertically double-row modules, an additional jumper cable is required for the connections between upper and lower modules, which should not be overlooked during initial estimation. Generally, for a 60-cell integrated junction box, the standard cable length is 0.9m, for a 72-cell integrated junction box, the standard cable length

is 1.1m, and for a split junction box, the standard cable lengths for positive and negative poles are 0.2m and 0.3m, respectively (for other larger or special-sized module types, refer to the corresponding product specification manual for cable lengths).

Junction box position style 1	Junction box position style 2	Junction box position style 3
		
Single row installation with long side of modules perpendicular to the ground		
		
Two row module installation		
		
Two row module installation with long side parallel to the ground		
		

If there is a possibility of reverse current exceeding the maximum fuse current rating of the module, it is necessary to use overcurrent protection devices of the same specifications to protect the module. If the number of modules in parallel is greater than or equal to 2 strings, there must be an overcurrent protection device on each string of modules.

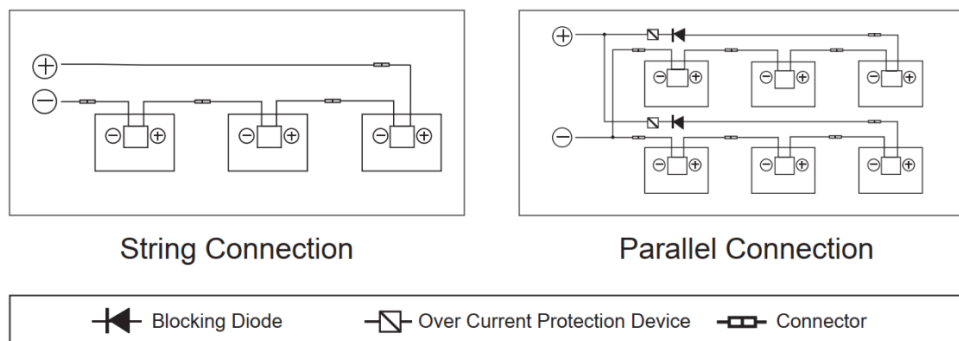
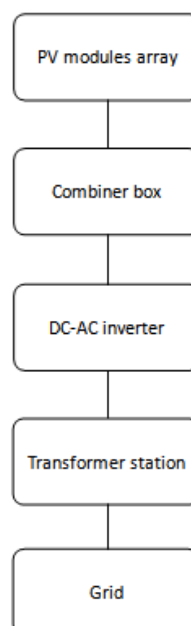


Figure 11 Series connection and parallel connection circuit diagram

4.3 Structure of PV station

The following diagram provides a basic structure for a solar photovoltaic (PV) power station. Actual installation and design must be carried out by registered professional engineers. The installation design and process must fully comply with all applicable local regulations and electrical standards.



5 Maintenance

The modules need to be regularly inspected and maintained, including their appearance and all electrical connections, to ensure there are no open circuits and that the connections are secure.

- 1) Inspect the open-circuit voltage of each module.
- 2) Completely cover the surface of the module exposed to light with opaque material. Modules exposed to sunlight can generate dangerous voltages.
- 3) Disconnect the wires from both sides of the module.
- 4) Remove the opaque material from the module, inspect, and measure the open-circuit voltage at the terminals.
- 5) If the measured voltage decreases by more than 1/4, it may indicate damage to the bypass diode. Please test the performance of the bypass diode.
- 6) Here are recommended maintenance measures to ensure optimal performance of the modules: Inspect the modules for external defects, such as surface damage or anomalies, obstructions blocking sunlight, and loose fastenings between the modules and support structures. If any anomalies are detected, it is essential to contact qualified and experienced maintenance personnel for necessary adjustments or repairs.
- 7) Clean the modules at least once a year, depending on local conditions. The presence of dirt on the module surface can reduce electricity generation. When cleaning, you can use a soft sponge or cloth dampened with water to clean the glass surface of the modules. Mild cleaning agents without abrasive properties can be used to remove stubborn stains. The use of corrosive chemical cleaners is strictly prohibited. To reduce the risk of electric shock or burns, it is advisable to perform module cleaning in the early morning or evening.
- 8) Perform mechanical and electrical inspections every 6 months to ensure that module connections are clean and reliable and that module electrical connections are in good condition without any signs of corrosion.
- 9) If you have any questions, please have qualified personnel conduct an inspection.

10) Adhere to the maintenance instructions for all components used in the system, such as support structures, charge controllers, inverters, batteries, etc..

11) The purpose of Cross-Wheeled trash bins:



12) Do not dispose of electrical appliances as unclassified urban waste; use separate collection facilities. For information on available collection systems, please contact local authorities. If electrical appliances are disposed of in landfills or garbage dumps, hazardous substances can leach into groundwater, enter the food chain, and harm your health. When replacing old appliances with new ones, retailers are legally obligated to take back the old appliances for disposal, at least free of charge.

6 Disclaimer

Due to the use of this manual and conditions related to the installation, operation, use, and maintenance of components being beyond our control, we do not assume any responsibility for losses, damages, or expenses incurred during installation, operation, use, or maintenance.

We do not assume any liability for any infringement of patents or third-party rights that may result from the use of our component products. The customer does not acquire any patent or patent rights license, whether express or implied, through the use of our products.

The information in this manual is based on our deemed reliable knowledge and experience, but including but not limited to the product specifications and related advice as described herein does not constitute any warranty, whether express or implied. We reserve the right to modify the manual, PV products, specifications, or product information without prior notice.