



APEX PV-MODULE INSTALLATIONSHANDBUCH

APEX GROUP TECHNOLOGY (PVT.) LIMITED

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1. Introduction for User Manual

This manual applies to the installation, maintenance and use of the single and double glass series of solar modules produced by Apex solar and provides important safety instructions. Users and installers must read carefully and follow strictly. Failure to follow these safety guidelines can result in casualties or property damage.

Installation and operation of solar modules require specialized skills, and only professional personnel can engage in the work. Please read the “Safety and Installation Instructions” carefully before using and operating the modules. The installer must inform the end customer (or consumer) of the above matters accordingly.

The term “Module” or “PV Module” in this Manual refers to one or more framed series solar modules. Please keep this Manual for future reference.

1.1. Disclaimer

Apex solar reserves the right to change this installation manual without prior notice. Apex solar does not guarantee any express or implied information contained in this Statement. As this manual will be updated regularly, please refer to the products and documents on the Heran New Energy website (www.Apexsolar.pk)

1.2. Limitation of Liability

APEX solar is not responsible for any form of injury, including but not limited to component operations, system installation errors, and bodily injuries, injuries and property losses from failure to follow the instructions given in this manual.

2. Safety Precautions

2.1. Warning

Before installing, wiring, operating, or maintaining Apex modules, you should read and understand all safety precautions. Direct current (DC) is generated when the battery surface of the module is exposed to direct sunlight or other light sources, and direct contact with the live parts of the module, such as terminals, may result in death of personnel whether connected to the module or not.

2.2. General Safety

- ◆ All installation work must comply with the local codes and the relevant international electrical standards.
- ◆ Apex recommends that PV module installation is conducted by personnel with experience in PV system installation. Operation by personnel who are not familiar with the relevant safety procedures will be very dangerous.



- ◆ Use appropriate precautions (skid gloves, overalls, etc.) to avoid direct contact with 30V DC or higher, and avoid direct contact with sharp edges to protect the installer's hand during installation.



- ◆ Please do not wear metal ornaments during installation, so as not to puncture the components and cause electric shock danger.



- ◆ If installed in rainy and foggy weather, appropriate measures should be taken to avoid water immersion in the connector.



- ◆ Children or unauthorized personnel are not allowed to approach the installation area or the component storage area.

- ◆ Do not install components in windy weather.
- ◆ Do NOT install modules with damaged glass or damaged backsheet
- ◆ Do NOT disassemble or move any part of the module.
- ◆ Do NOT artificially focus light on the module.
- ◆ Do NOT connect or disconnect the module when it is energized or connected with an external power supply.
- ◆ During component installation or wiring, if the circuit breaker and the overcurrent protection circuit breaker cannot open, or the inverter cannot close, an opaque material is applied over the array assembly to stop the power output.
- ◆ Do not try to repair any part of the component, no is available within the component.
- ◆ The lid of the junction box shall always be sealed.
- ◆ Do not split the components or move any part of the component

2.3. Handling Safety

- ◆ Do NOT stand, walk on or lean on the module directly.



- ◆ Do NOT damage or scratch the front or backside surfaces of the module.
- ◆ Do NOT scratch the output cable or bend it with force. The insulation of output cable can break and may result in electricity leakage or shock.
- ◆ Do NOT use water to extinguish fires of an electrical origin.

- ◆ Do NOT install or handle modules when they are wet or during periods of high wind. At the installation site, take care to keep modules and in particular their electrical contacts, clean and dry before installation. If connector cables are left in damp conditions then the contacts may corrode. Any module with corroded contacts should not be used.
- ◆ Please do NOT loosen or unscrew the PV module bolts. This may lead to a reduction of the module's load rating and potential damage from a fall.
- ◆ Do NOT drop PV modules or allow objects to fall down on the PV modules.
- ◆ Do NOT touch the terminal box or the ends of the output cables (connectors) with bare hands under sunlight, regardless of whether the PV module is connected to or disconnected from the system.

3. Unload/Transportation/Storage







Precautions and General Safety Rules:

- ◆ The components should be stored in the original packing box before installation. Please protect the packaging from damage. Follow the recommended unpacking procedure to open the component package. Open, transport and store procedures carefully;
- ◆ Do NOT stand, climb, walk or jump on unpacked pallets of modules;
- ◆ Before installation, ensure that all modules and electrical contacts are clean and dry;
- ◆ If the modules are required to be stored temporarily, they should be stored under dry and ventilated conditions;
- ◆ Unpacking must be carried out by two or more persons at the same time. It is forbidden to use the wires or junction boxes of the modules to carry the modules. Handling the modules requires two or more people with non-slip gloves; Do NOT handle the modules over-head or stack the modules;
- ◆ Do NOT put the modules in a place that is not supported or stable;
- ◆ Do NOT allow the modules to come in contact with sharp-pointed objectives to prevent them from scratches, avoiding a direct impact on the safety of modules;
- ◆ Do not drop or stack items (such as mounting tools) on the assembly;
- ◆ Do not place components in unsupported or unsecured environments;
- ◆ Do not expose components or their electrical interfaces to chemicals (e. g. oil, lubricants, pesticides, etc.).

Product identification

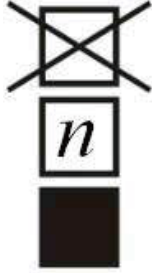
- ◆ Each component has three identical bar codes as a unique logo (one in the laminated component, the other is pasted on the back panel of the component, and one on the border of the component). Each component has a unique serial number consisting of 16 digits.
- ◆ Each assembly has a nameplate on the back, with its model number, main electrical performance, and safety specifications indicated.

3.1. Marker on Outer Packaging

<p>3.1.1 Do NOT discard the modules at will, special recycling is required;</p> 	<p>3.1.2 Modules must be kept dry, not expose to rain or moisture;</p> 
<p>3.1.3 Modules in carton are fragile, which must be handled with care;</p> 	<p>3.1.4 The packaging must be transported upright;</p> 
<p>3.1.5 Do NOT step on the package and module;</p> 	<p>3.1.6 The carton can be recycled;</p> 

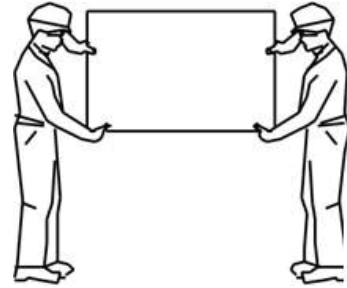
3.1.7

Modules shall be stacked as required, not exceeding the maximum number of layers printed on the outer packaging. ($n = 2$ means no more than two layers and $n = 3$ means no more than three layers);



3.1.8

One module shall be handled by at least two persons together;



3.2. Unloading Warning

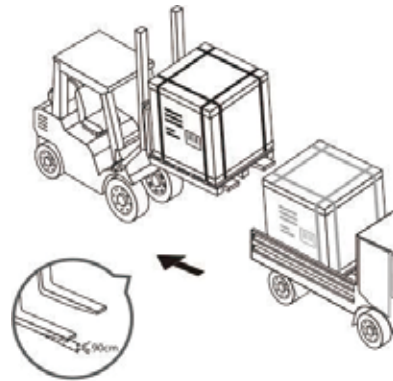
3.2.1

Use the correct (as picture) lifting fixture to handle, no more than 2 pallets per lift. Before lifting, please confirm the tray and the carton are NOT damaged and the hoisting rope is firm and solid. Before lowering the carton back on the ground, two persons must support the two sides of the carton gently to put it on a relatively flat place;

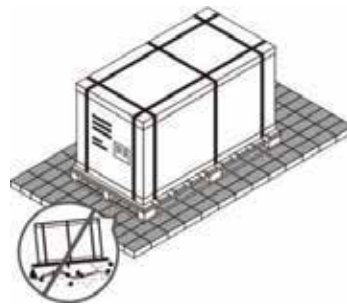


3.2.2

If the condition permits, use a fork lift to remove the module pallets from the truck

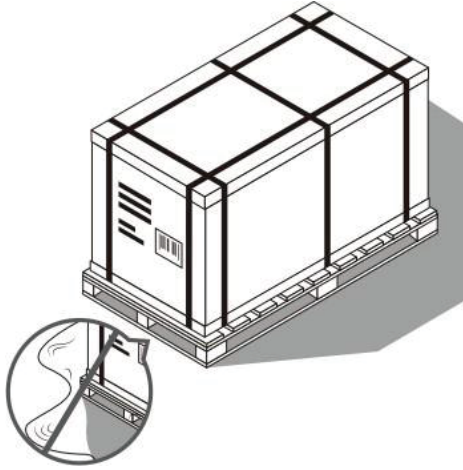


Put the modules on level ground



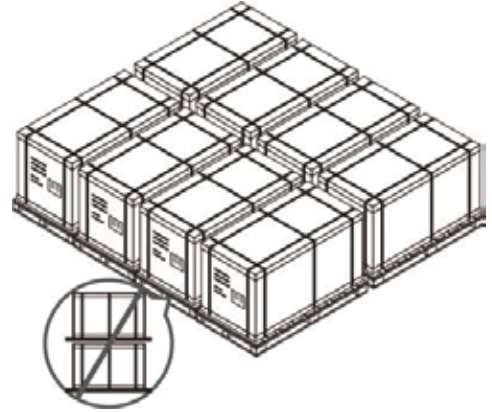
3.2.3

Store the module in a dry and ventilated place;



3.2.4

Do Not stack the modules at the project site;



3.2.5

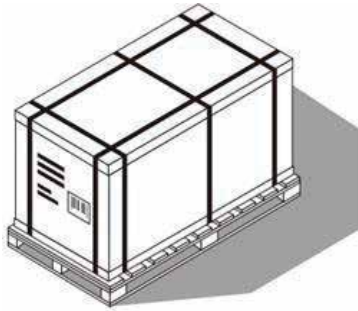
Cover the module with waterproof material to prevent it from moisture;



3.3. Secondary Transport and Warning

3.3.1

Do NOT remove the original packaging if the modules require long-distance transport or long-term storage;



3.3.2

The finished package can be transported by land, sea or air. During transport, make sure that the package is fixed securely to the shipping platform without movement;



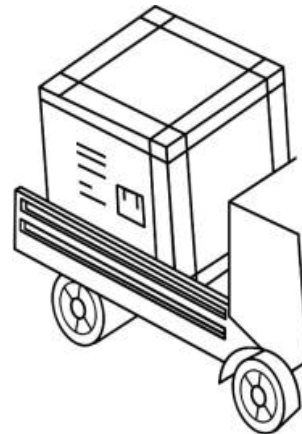
3.3.3

Transport: Do Not stack more than two layers on a truck;



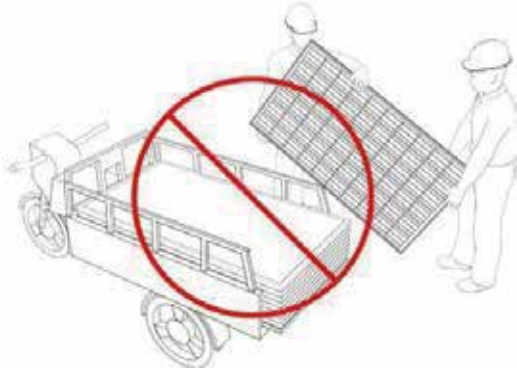
3.3.4

Only one layer stacking is only allowed for transport at the project site;



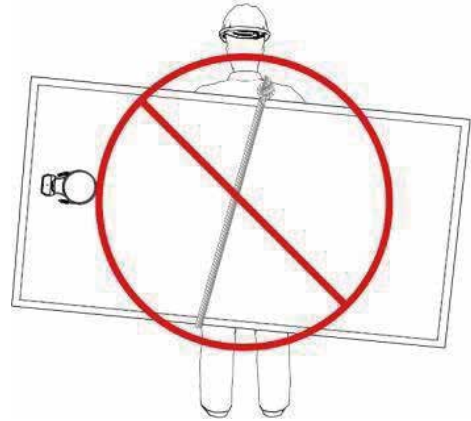
3.3.5

No transport or handling by pedi-cab as shown below;



3.3.6

Do Not transport the module with rope as shown below;



3.3.7

Do Not carry the modules on the back of one person as shown below;



3.4. Storage

Do NOT expose the modules to rain or moisture. Store the finished product in a well ventilated, waterproof and dry place.

Do NOT remove the original packaging if the module requires long-distance transport or long-term storage.

3.4.1

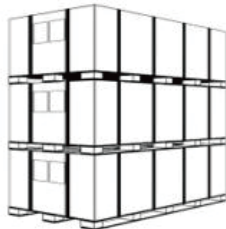
Storage in project site warehouse (moisture < 85%, temperature range from -20°C to + 50 °C).



3.4.2

Normal warehouse storage (moisture < 85% and temperature range from -20°C to + 50 °C): 54-cell frame module to be stacked no more than three layers and 72-cell frame module to be stacked no more than two layers (take 72-cell frame module for example)

54 cell



72 cell



3.5. Unpacking Introduction

3.6. Unpacking Safety

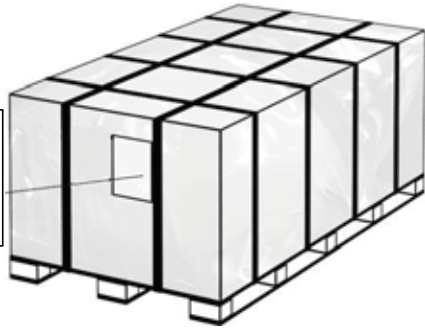
- ◆ For unpacking outdoors, it is prohibited to operate in rainy conditions. Because the carton will become soft and damaged after it gets wet in the rain. The stacked PV modules (hereinafter referred to as "modules") may tip over, which may cause damage or injury to personnel;
- ◆ For a windy site, it is necessary to pay special attention to safety. Especially, it is NOT recommended to transport the modules in high wind conditions. The unpacked modules must be tied down to avoid any unwanted movement;
- ◆ The work surface is required to be level to ensure that the package can be placed stably, avoiding sliding;
- ◆ Wear protective gloves during unpacking to avoid hand injury and fingerprints on the glass surface;
- ◆ Module information and unpacking instructions can be found on the outside of each package. Please read the instructions before unpacking;
- ◆ Each module shall be handled by two persons. It is forbidden to use the wires or junction boxes of the modules to carry the module. Do NOT take the module out of the carton by pulling on the long side frame.

3.7. Unpacking Step

4.2.1

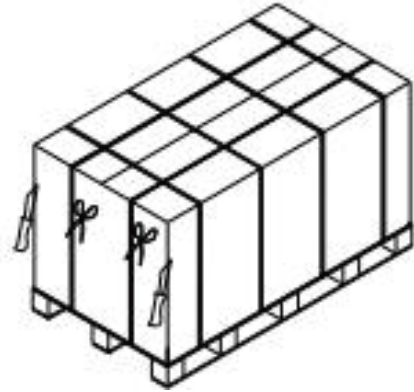
Before unpacking, please check the product name, serial number and related suggestions on the A4 paper. Please read the unpacking instructions carefully. NO other customized unpacking method is allowed;

A4 paper (product name, serial number, related suggestions, etc.)



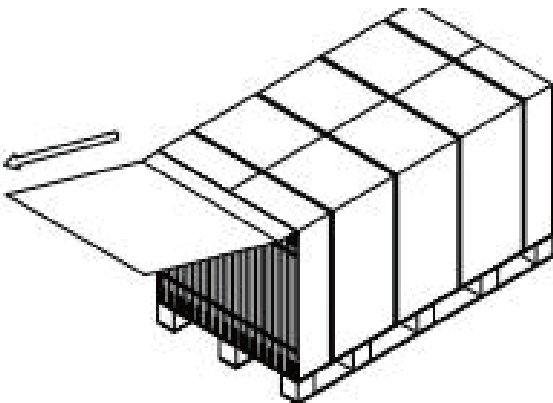
4.2.2

Cut the two packing belts at shorter sides of the tray with blade or scissors, and unpack the side surface of the carton along the vertical direction;



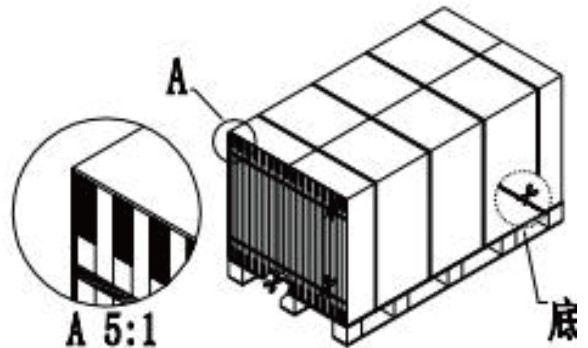
4.2.3

Cut the tape at shorter edge and hold it up by 90° from the bottom; and pull out the cardboard to expose the modules;



4.2.4

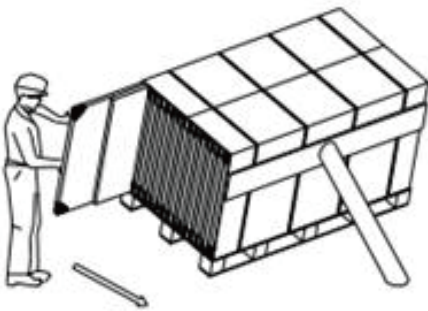
Cut the two horizontal packing belts in the carton and cut the two packing belts near the bottom of the tray, and remove the packing belts;



4.2.5

When unpacking on a level surface, take out the module from one side of package to the other, and then carry it with two persons (Please refer to 3.1.8);

When unpacking on a sloping surface, please protect the modules from tipping over or sliding. As shown below;



4.2.6

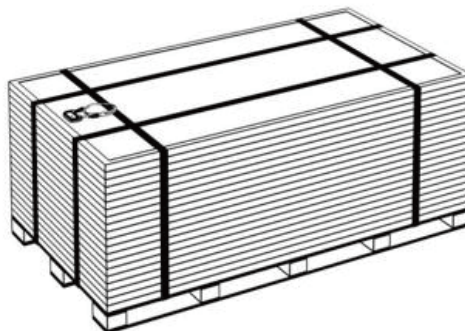
Do NOT lean the module on the mounting posts;



4.2.7

If all the modules are NOT removed after unpacking and some of them are left in the package, the remaining modules shall be laid flat and repackaged to prevent from falling down. Must be placed by horizontal.

The stacked number of modules: 54-cell frame modules to be stacked NOT more than 20 pieces, 72-cell frame modules NOT more than 16 pieces;



4. Site Selection

Solar modules are recommended to be installed at an optimized tilt angle to maximize the energy output. It is roughly equal to the latitude of the project site as a rule of thumb, facing toward the equator. Optimized system designs incorporate other local requirements.

When installing solar modules on a roof, the roof must be covered with a layer of fireproof material applicable to this class, and adequate ventilation must be ensured between the back sheet and the installation surface. A safe working area also must be left between the edge of the roof and the external edge of the solar array.

In the case of residential installations on the ground, modules shall be installed following local regulations,

e.g. using fence.

Position the modules to minimize the chances of shading at any time of the day.

Apex Solar recommends that the module should be installed at a working ambient temperature of -20°C ~ 50°C . The module's limit working ambient temperature range is from -40°C to 85°C . Maximum altitude less than or equal to 2000m .The maximum mechanical load is 5400 on the front and 2400 on the back.

Try to install modules in a location where there is rare shading throughout the year.

If you are planning to use the PV modules where the water damage (Humidity: $> 85\text{RH}\%$) may be possible, please consult with Trina local technical support first to determine an appropriate installation method , or to determine whether the installation is possible.

If the module is installed in an area with frequent lightning and thunder, the module must be protected against lightning strikes. Refer to Trina Solar's declaration document for lightning protection. Please contact with local technical support or contact us from (www.apex-solarenergy.com).

Make sure flammable gases are NOT generated near the installation site.

According to Intertek-conducted IEC 61701, salt mist corrosion testing of photovoltaic (PV), Apex Solar modules can be installed in corrosive salt areas within proximity of the ocean or sulfurous areas. The module must not be soaked in the water or in the environment (i.e., fountain, spindrift, etc.) where the module would touch water (pure water or brine) for a long term. If the modules are placed in an environment of salt fog (i.e., marine environment) or sulfur (i.e., sulfur sources, volcanoes, etc.), there is a risk of corrosion.

In locations that are 50m ~ 500mm from the ocean, stainless steel or aluminum materials must be used to contact the PV modules, and the installation position must be processed with anti-corrosion treatment; refer to the "Trina Solar Coastal Application White Paper"for detailed installation requirements . Please

contact with local technical support or contact us from (www.Apexsolar.pk)

According to IEC62716:2013 “Ammonia corrosion testing of photovoltaic (PV) modules” and DLG Fokus testing for ammonia resistance, Apex Solar modules can be safely installed in ammonia-heavy environments, such as farm houses.

5. Tilt Angle

The tilt angle measurement of the PV module refers to measuring the angle between the module and the horizontal ground surface. For different projects there are different mounting angles. Apex Solar recommends that the mounting tilt angle should be NOT less than 10°, or in accordance with local regulations or follow the recommendations of experienced PV module installers.

The tilt angle of the PV module is measured between the PV module and a horizontal ground surface.

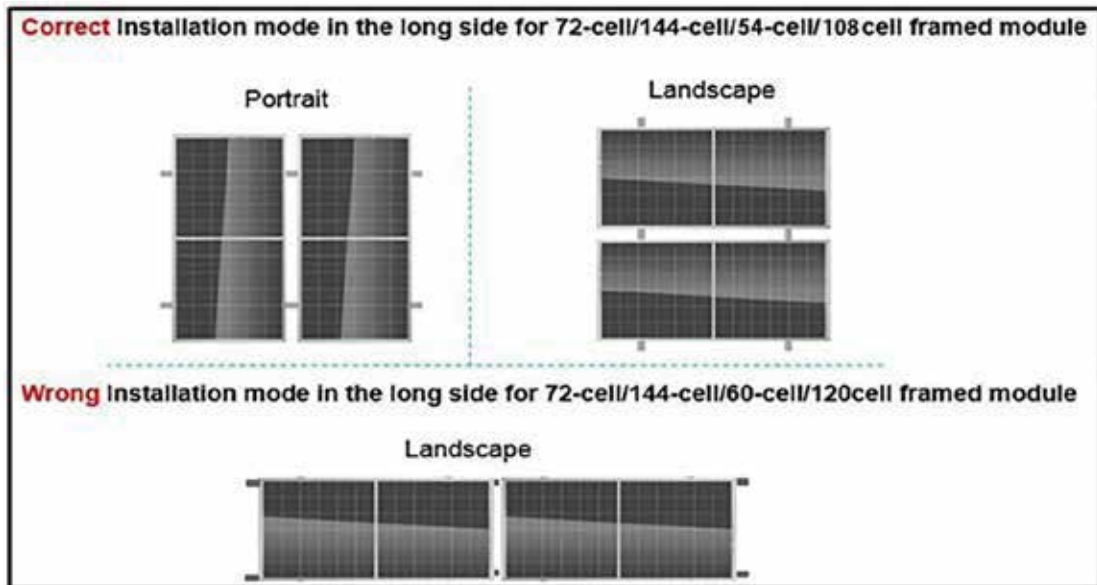
In the Northern Hemisphere, the PV modules should typically face south, and in the Southern Hemisphere, the PV modules should typically face north.

A clearance of at least 115mm (4.5in) (recommended) is provided between modules frame and the surface of the wall or roof. If other mounting means are employed this may affect the UL Listing or the fire class ratings.

6. Installation

6.1. Installation Safety

- ◆ Apex Solar Modules can be mounted in landscape or portrait orientation (the distance between the racking and the long side is 150-250mm), and however the impact of dirt shading the solar cells can be minimized by orienting the product in landscape. Please pay attention that 72-cell/144-cell framed modules can only be installed in the long side frame on vertical racking not horizontal racking when customers choose landscape mode, and they cannot be installed in the short frame side. 54-cell/108-cell framed modules can be installed in both long side frame and short side frame, but 54-cell/108-cell framed modules cannot installed in the long frame shared with the same horizontal racking when customers choose landscape mode. Details as shown picture below.



- ◆ Wear protective headgear, insulating gloves and rubber insulated shoes and other protective measures when installation;
- ◆ During the installation or maintenance of the photovoltaic system, it is forbidden to wear metal rings, watches and other metal materials, so as not to cause electric shock danger and damage to the components;
- ◆ When installing, unpacking the components. Once the components are removed from the packing box, they need to be installed and connected to the inverter in time. If not installed immediately, it is necessary Take protective measures for the connector (such as adding rubber joint cover, etc.);
- ◆ During the installation process, avoid unnecessary touch of the components, the components surface and frame may be very hot, there is a risk of burn or electric shock.rack-mounting set Standard safety tools and equipment should be used;
- ◆ Installation is prohibited in weather conditions of rain, snow or strong winds;
- ◆ Due to the risk of electric shock, any operation is prohibited when the terminals of the component junction box are wet;
- ◆ Use of insulated and dry tools, and prohibit the use of wet tools;
- ◆ The components in series in the same circuit shall be the components of the same size and specification model;
- ◆ Connect the male and female connector correctly, check the wiring condition, all connecting wires shall not be separated from the assembly, and the wire shall be tied or other means Fiure to avoid scratching or squeezing the assembly backplane;
- ◆ Regardless of whether the module is connected to the photovoltaic system, do not contact the

junction box or the connector bus during installation or when the module is exposed to light head;

- ◆ No drilling in the module frame without Apex Solar permission, otherwise it may cause corrosion or other damage to the module; for photovoltaic systems installed on the roof, please try to follow the "top to bottom" and / or "left to right" safety principles;
- ◆ The components will have a thermal expansion and cold contraction effect. The recommended interval between the two adjacent single-sided components is 10mm during installation; the minimum gap between the two adjacent double-sided components Recommended for 20mm; with special requirements, please confirm with Apex Solar for installation;
- ◆ For roof installation, the minimum spacing between the components and the roof is 10cm to facilitate the ventilation and heat dissipation of the components, and the passage should be reserved for this purpose In cleaning, repair and maintenance;
- ◆ The recommended components apply between the cable and connectors, cable and junction box during installation, removal, maintenance and any other related processes Force is not greater than 60N.
- ◆ Do NOT wear metallic jewelry which can cause electric shock during installation.
- ◆ Do NOT install modules under rain, snow or windy conditions.
- ◆ Please keep the connector dry and clean during installation to avoid the risk of electric shock. It is recommended to install it immediately after unpacking.
- ◆ Due to the risk of electrical shock, do NOT perform any work if the terminals of PV module are wet. Please install immediately after you unpacking.
- ◆ The application level of Apex Solar module is Class A, which can be used in systems operating at greater than 50 V DC or 240 W, where general public contact access is anticipated;
- ◆ Keep the PV module packed in the Trina carton until installation.
- ◆ Please use an opaque material to completely cover the PV module surface during PV module installation and wiring.
- ◆ Do NOT unplug the connector if the system circuit is connected to a load.
- ◆ Do NOT stand on the module glass while installing. There is a risk of injury or electric shock if glass is broken.
- ◆ Do NOT work alone (always work as a team of 2 or more people).
- ◆ Do NOT damage the back sheet of PV modules when fastening the PV modules to a support with bolts.
- ◆ Do NOT damage the surrounding PV modules or mounting structure when replacing a PV module.

- ◆ Cables shall be located and secured so that they will not be exposed to direct sunlight after installation to prevent degradation of cables. Low drooping of cables from the terminal box must be avoided. Low hanging cables could cause various problems such as animal biting, electricity leakage in water, and fire.
- ◆ Modules with different color codes are not recommended to be installed in one block or the same rooftop.

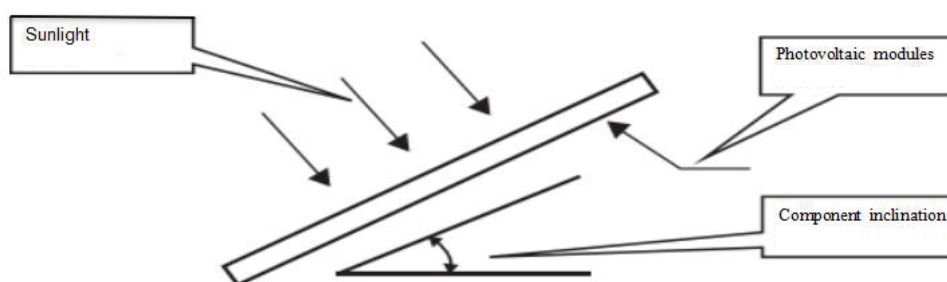
6.2. Installation Location and Working Environment

- ◆ Components are not suitable for the space environment.
- ◆ Do not use a mirror or a magnifying glass to manually focus the sunlight on the components.
- ◆ Apex Solar modules must be installed on a suitable building, or other places suitable place for module installation (e. g. ground, garage, building wall, roof, photovoltaic tracking), and the modules must not be installed on any type of movable vehicle.
- ◆ Do not install components where they may be flooded.
- ◆ Apex Solar recommends for the components to be installed in a working environment temperature of -40°C to 40°C, which is the average monthly maximum and minimum temperature of the installation site. The limit operating environment temperature of the assembly is -40°C to 85°C.
- ◆ Ensure that the wind or snow pressure received after the assembly installation does not exceed the maximum allowable load.
- ◆ The components need to be installed in a place without shadows throughout the year round, ensuring that there are no obstacles that may not block the light.
- ◆ If the component is installed in a place with frequent lightning activity, the component must be protected by lightning protection.
- ◆ Do not install the components near the flame or combustible material.
- ◆ Components are strictly prohibited to be installed and used in hail, snow, sand, dust, air pollution, soot and other excessive environments. Assemblies are not installed or used in an environment of strongly corrosive substances (such as salt, salt spray, brine, active chemical steam, acid rain, or any other substances that will corrode the components or affect the safety or performance of the components).
- ◆ When there is heavy snow, extreme cold, strong wind or near water, near salt fog on islands or desert and other harsh environments, please take appropriate protection measures to ensure the reliable and safe installation of components.

- ◆ Apex Solar 's components have passed the IEC61701's salt spray corrosion test, but the corrosion may occur where the component frame is connected to the bracket, or where the ground is connected. Apex Solar components can be installed at 50m away from the seaside, but the relevant parts need to be treated for corrosion prevention.
- ◆ Generally, components should be installed to receive the most light throughout the year. In the northern hemisphere, components are recommended to face south; in the southern hemisphere, facing north. If the component tilt angle deviates by 30 degrees due south (or due north), the component power output will lose approximately 10% to 15%, and if tilted by 60 degrees due south (or due north), the component power output loses approximately 20% to 30%. Refer to the latitude and longitude of the installation site to determine the best azimuth of the assembly installation.
- ◆ When choosing a site, avoid trees, buildings, or other obstacles that can shadow the components. Shadows can cause a loss of power output of the component, which still affects the best performance and the operating safety of the component. Operation under permanent shade conditions is not recommended.
- ◆ When the component is installed on the roof, it must be installed on a roof with a certain fire prevention capacity (please see the local regulations), please consult the local construction department Doors to determine the type of roof material used.

6.3. The Choice of Tilt Angle

The inclination of the component: the angle between the surface of the assembly and the horizontal surface. And the component receives the maximum power output when the component is facing sunlight.



Installed in the northern hemisphere, preferably south, in the southern hemisphere and preferably north.

For detailed installation angles, follow the standard module installation guidelines or the recommendations given by an experienced PV module installer.

Apex Solar suggests that the installation Angle of the component is not less than 10 degrees, so that the surface dust of the component is easily taken away by the rain when it rains, thus reducing the number

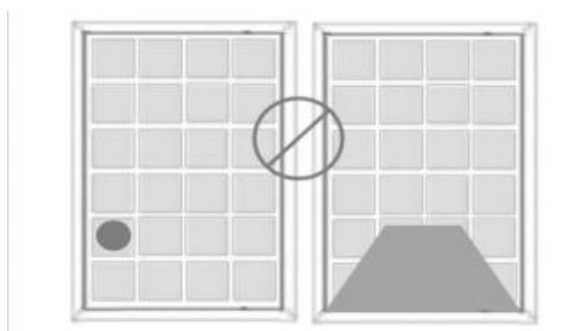
of component cleaning; at the same time, it helps the water on the surface of the component to avoid a large amount of water on the glass, and then affect the appearance and performance of the component.

Serial connected modules shall be installed at the same orientation and angle. Different orientation or angle may vary in the amount of solar radiation received by each module, resulting in a loss of output power. To achieve the maximum annual power generation, the optimal orientation and inclination of the PV components in the installed area should be selected to ensure that the sunlight can still shine on the components even on the shortest sunshine day throughout the year.

If it is connected to an independent photovoltaic system, the installation Angle of the module should obtain the maximum power output according to the season and light conditions. Generally speaking, if the output of the module has the lowest light intensity within a year, the output of the selected Angle can meet the annual demand; for the grid-connected system, the installation Angle of the module should be selected based on the basic principle of maximizing the output of the whole year.

6.4. Avoid Shadows

In any case, the component shall not be permanently blocked (including local surface occlusion on the surface of the component, point occlusion, uniform occlusion, uneven occlusion, etc.). Permanent occlusion means that occlusion occurs repeatedly for a long time on the same battery, in the same area of the same row of batteries or components (e. g., for more than 200 hours within the service life of the warranty). When photovoltaic modules in cells are permanently completely blocked or partially blocked, can cause blocked cell cannot photoelectric conversion, so not only can reduce the output performance of photovoltaic modules, resulting in the entire photovoltaic array performance attenuation, but also lead to be blocked cell local overheating, lead to EVA aging and diode long-term uninterrupted heating, greatly reduce the service life of the components. Therefore, in the case of permanent occlusion, the company's limited warranty will fail, unless the MLPE technology is properly used to effectively reduce or eliminate the negative impact of the occlusion.



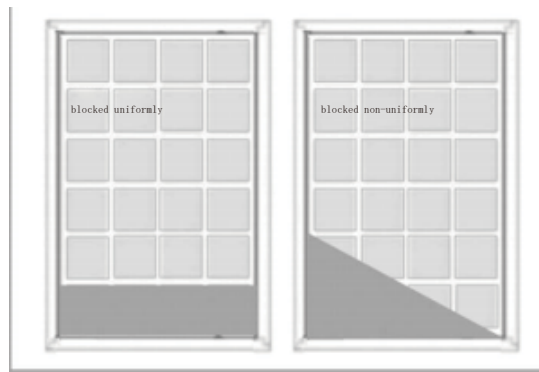
Regular and regular maintenance management should be performed to keep components clean and special measures should be taken to avoid permanent shielding caused by dust or debris (e. g., leaves, branches, guano, etc.).

Do not install components directly behind buildings (e. g. chimneys, etc.) or trees to avoid permanent

occlusion.

Even temporary shadow shading can cause a drop in power generation. The component is considered Shless if all surfaces are not cured throughout the year. Ensure that the sun can still shine on the components even on the shortest sunshine day of the year.

In order to maximize the power generation on the back side of the double-sided photovoltaic module, the shielding of the back side by the back obstacles should be avoided.



7. Mechanical Installation

7.1. Conventional Requirements

Ensure that the assembly is installed, and that the bracket system is strong enough for the assembly to withstand all the predetermined load conditions, which is a guarantee that the bracket installer must provide. The mounting bracket system must be inspected and tested by a third-party testing agency with static mechanical analysis capability, using the local national, regional or corresponding international standards.

The assembly mounting bracket must be made of durable, corrosion-resistant, UV-resistant material.

The assembly must be firmly secured to the mounting bracket.

In areas with large snow in winter, choosing a higher installation bracket can avoid the lowest point of the component being covered by snow for a long time. In addition, the lowest point of the component should have a certain height to avoid the component being blocked by weeds and shrubs growing on the ground, and reduce the damage by flying sand and stone.

When the component is mounted on a bracket parallel to the roof or wall. The minimum clearance between the component frame and the roof or wall is 10cm, which is conducive to air circulation and accelerates the dissipation of condensate or moisture.

Before installing the roof components, make sure the building is suitable for installation. Moreover, any infiltration of the roof must be properly sealed to prevent leakage.

The frame of components will have thermal expansion and cold contraction effect, and the frame interval of two adjacent components should not be less than 10mm when installation.

Ensure that the backplane of the assembly does not touch the bracket or building structure that can enter inside the assembly, especially when there is external pressure on the surface of the assembly.

The maximum static load through which the component passes is: back 2400Pa and front 5400Pa / 2400Pa, depending on the type of installation of the assembly (see the installation method below), and the load described in this manual is the test load. Note: According to the installation requirements of IEC61215-2:2016, 1.5 times the corresponding maximum design load.

The installation direction of the component can be installed either horizontally or vertically. When installing the components, it should be noted that the frame drainage hole shall not be blocked.

7.2. Mechanical Installation of A Single-face Assembly

The assembly and bracket system can be installed with bolts, fixtures, or embedded systems. The components must be installed in accordance with the following examples and suggestions. If there are other installation methods, please consult Heran New Energy and get the consent of Heran New Energy, otherwise the warranty will fail.

7.2.1. Bolt Installation Components

These mechanical loads were all tested according to the IEC61215 standards.

The assembly should be bolted on the support structure using the mounting holes on the back of the frame.

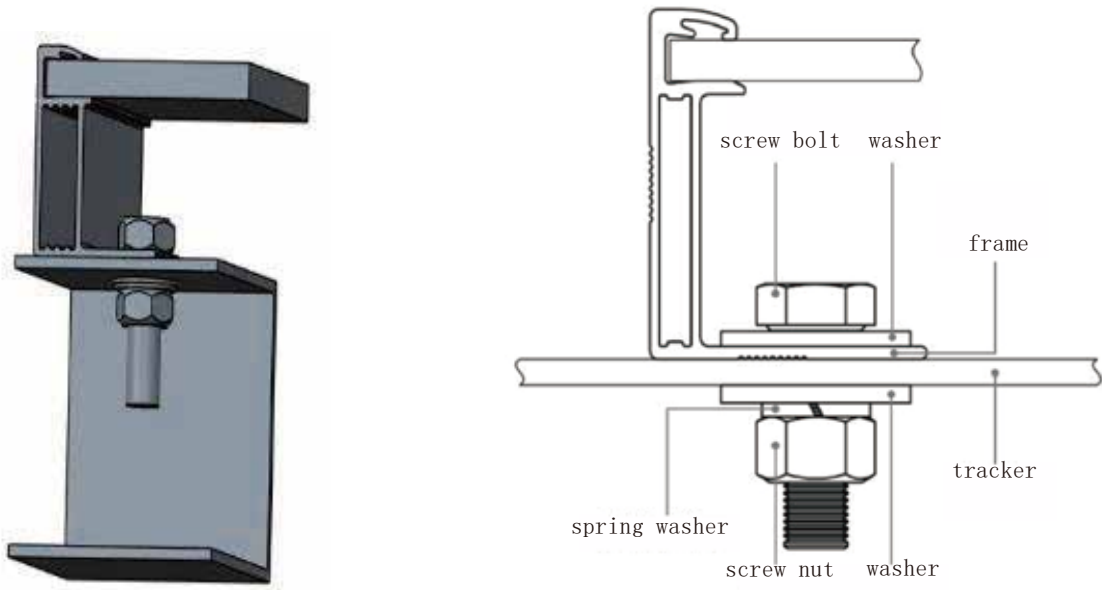
Each component needs to be tightened by at least two 4 points on the edge. According to the following diagram, flat and elastic washers and washers must be used. The washer size and thickness shall be the standard size not less than the national standard.

Bolts and nuts of hot-dip galvanized or A2-70 stainless steel shall be used.

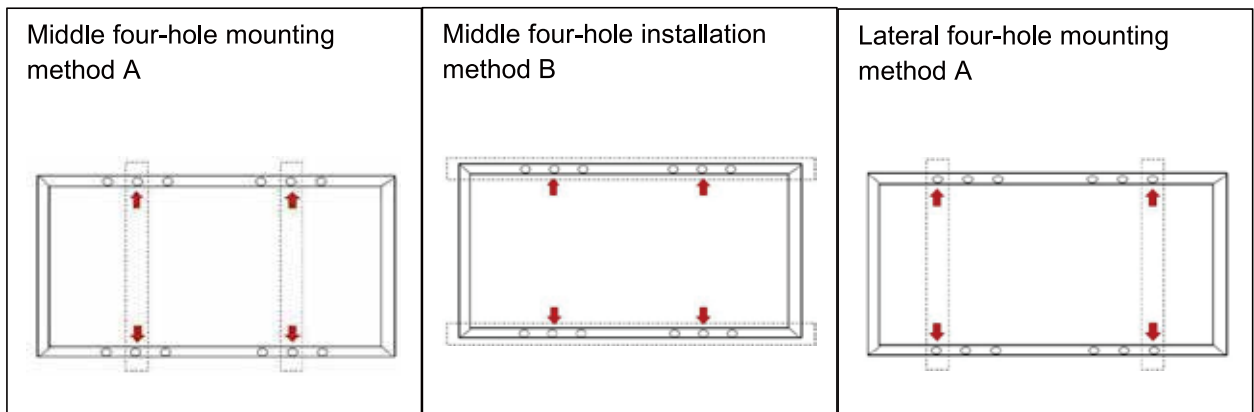
The yield strength of the bolts and nuts shall not be less than 450MPa.

According to the bolt grade, the tightening torque of M8 is 16 ~ 20 Nm.

Additional installation points are used in heavy snow or high wind load areas. It is the responsibility of the system designer and installer to calculate the load and ensure that the support structure meets the requirements.

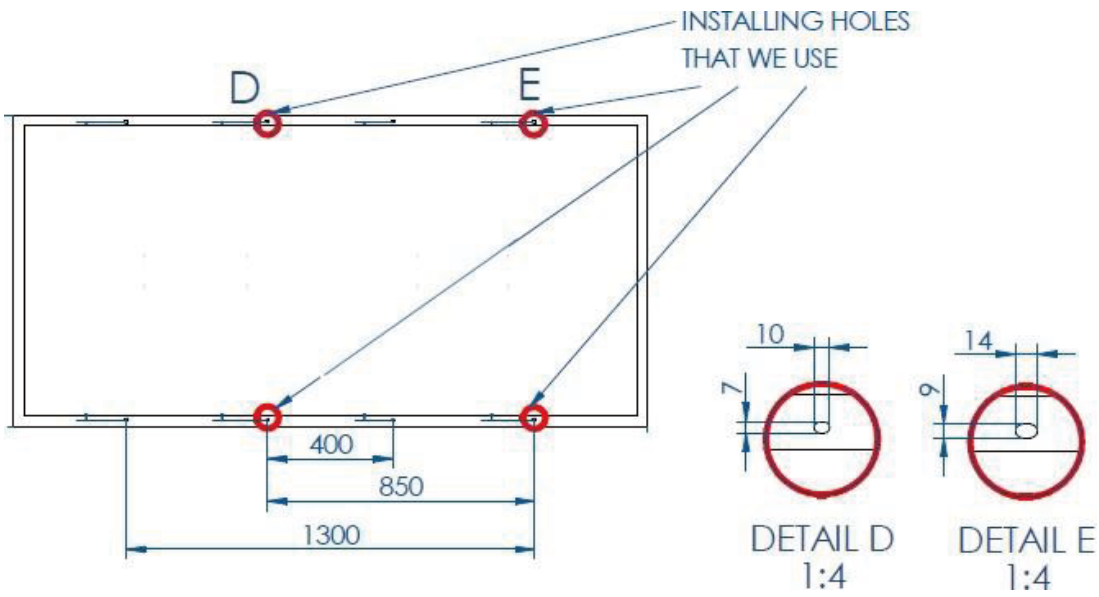


The assembly shall be bolted at the position of the following mounting holes according to the structural and load requirements:



7.2.2. 2V Installation Method 2V

The single module is installed with two $\phi 7*10\text{mm}$ mounting holes and two $\phi 9*14\text{mm}$ mounting holes, as shown in figure 3. The overall installation method is shown in the table below.



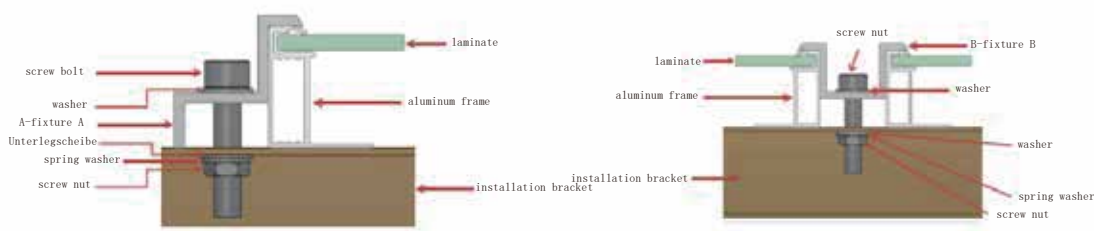
7.2.3. Figure 3: Mounting Holes Schematic of Single Module for 2V Installation Method

Module 组件	Mechanical Load Pressure 载荷	Safety factor 安全系数	Mounting Direction 安装图
72/144 pcs Backsheet-Glass 72/144片单玻	+1600 Pa /-1600 Pa	1.5	

In any case, the fixture is forbidden to contact the glass or deform the component frame. The front contact surface of the fixture and the frame must be smooth and smooth, otherwise the frame will be damaged And cause component breakage.

Avoid the shadow occlusion effect. Avoid drain holes blocked by fixps. For framed components, the fixture must be overlapped with at least 8mm but not exceeding 11mm (the fixture section can be changed for reliable installation); for unframed components, the fixture must not exceed 15mm and the

bolt torque shall be determined on the mechanical design standards of bolts and blocks, such as: M8- - - 14-18 N m.



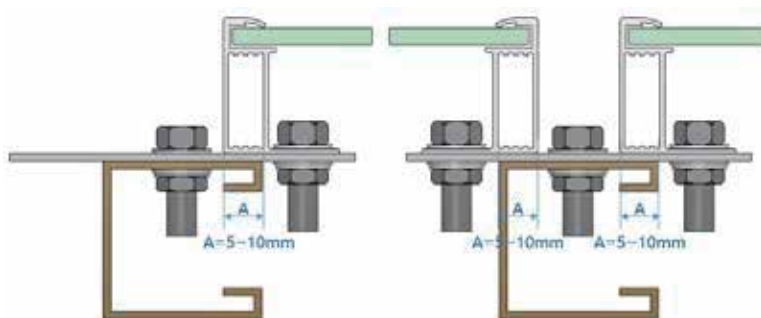
Installation Diagram of Monofacial Module Fixture

7.3. Mechanical Installation of Double-sided Assembly

The assembly and bracket system can be installed with bolts, fixtures, or embedded systems. Installation components must be following the examples and, if any, recommendations To install the way, please consult Heran New Energy, and get the consent of Heran New Energy, otherwise the failure will lead to the warranty.

7.3.1. Install Components through Mounting Hole

Apex Solar components are equipped with 8 mounting holes matching M8 bolts (marked with blue dotted box according to the position distribution below, referred to as inner four holes and outer four holes); Type 72 and some type 66 components (marked with red circle as shown below, hereinafter referred to as 400 holes) for matching installation of support products by NEXTracker and other manufacturers. Bolt the assembly on the bracket through the mounting hole on the back frame of the assembly. The installation details are shown in the figure:

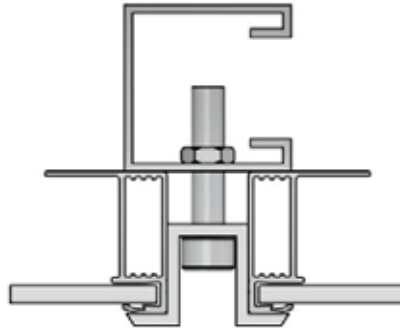


7.3.2. Jacket Insta

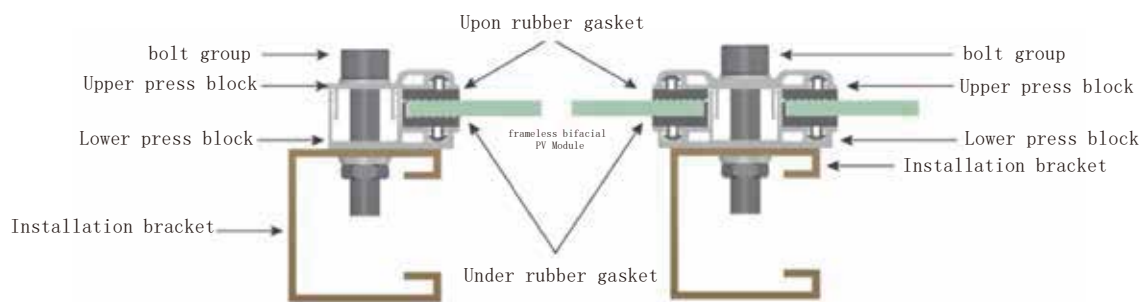
In any case, the fixture must not contact the glass or deform the component frame. The contact surface of the fixture and the front frame front must be smooth and smooth, otherwise the frame will be damaged and damage the component.

Avoid the shadow occlusion effect of the fixture. Avoid the drain holes from being blocked by the fixtures. For the framed assembly, the fixture must be overlapped with a frame of at least 8mm but not more than 11mm (in the condition of reliable installation); for the unframed assembly, the fixture and the bolt torque

of the fixed block shall be determined according to the mechanical design standards of bolts and blocks used by the customer, such as M8- -14-18 Nm.



Framed double-sided double-glass assembly



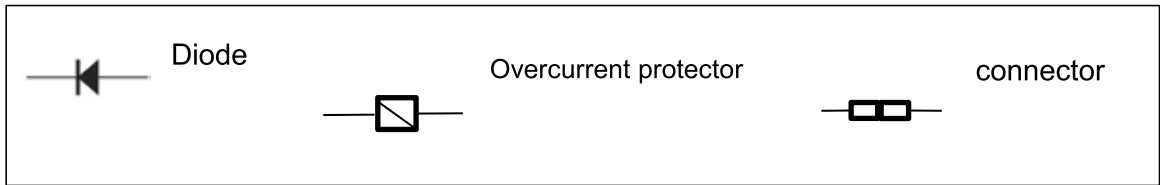
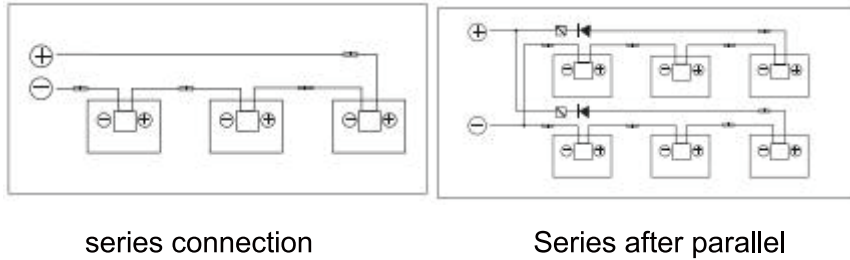
frameless bifacial PV Module

Installation Diagram of bifacial Module Fixture

7.4. Electrical Performance

The nominal values of the electrical performance parameters of the components, such as I_{sc} , V_{oc} , and P_{max} , are associated with a $\pm 3\%$ error under the standard test conditions. Standard component test conditions: irradiance 1000 W/m², battery temperature 25°C, air quality AM1.5.

When the components are connected into a string, the final voltage is the sum of a single component, and when the components are in parallel in parallel, the final current is the sum of the single component, as shown in Fig. The components of the different electrical performance models cannot be connected in a string.



The maximum number of single string components must be calculated according to the requirements of the open circuit voltage under the local expected minimum air temperature conditions shall not exceed the maximum system voltage value and other DC components.

The open-circuit voltage correction factor can be calculated according to the following formula: $V_{oc} = V_{oc} (1 - \beta (25 - T))$. T is the lowest expected ambient temperature expected at the system installation position, and β (% / °C) is the temperature coefficient of the selected component V_{oc} (see the corresponding component parameter table).

If there may be a reverse current exceeding the maximum fuse current passing through the assembly, the assembly must be protected using the same specification of overcurrent protection for the assembly. If the number of parallel connections is greater than or equal to 2 strings, there must be an overcurrent protection device on each string assembly.

7.5. Cable and Connection

The components shall be connected with an IP67 protection grade junction box, and shall provide safety protection for the conductor and its corresponding connections, and shall provide accessible protection for non-insulated live parts.

The junction box consists of connected cables and IP67 protection level connector to facilitate series between components. A single component has two wires connected to the junction box, a positive electrode and one negative electrode. The two components can be connected in series by inserting the positive electrode interface at the other end of a component lead into the socket of the negative lead of the adjacent component.

According to local fire protection, building and electrical codes, use dedicated solar cables and suitable connectors (wires should be coated in anti-aging tubes and should have aging resistance if exposed to air) and ensure good electrical and mechanical properties of the cables.

Insters shall only use single wire solar cables, not less than 4mm² (12 AWG), 90°C, with suitable insulation to withstand the maximum possible system open circuit voltage (as approved by EN50618). Appropriate wire specifications need to be selected to reduce the voltage drop.

Apex New Energy requires all wiring and electrical connections to meet the corresponding National Electrical Code requirements.

When the cable is fixed to the support, it is necessary to avoid mechanical damage to the cable or components. Do not press the cable hard. The cable shall be fixed to the support by specially designed aging resistant wires and wire cards. Although the cable is aging-resistant and waterproof, but also to avoid direct sunlight and rain immersion.

The minimum bending radius of the cable shall be 43mm.

7.6. Connector

Keep the connector dry and clean, and make sure the screws is fastened before connecting.

Do not connect the connector if it is wet, dirty, or otherwise unfavorable.

If the connector is not positive or negative connected, the connector is not waterproof. The components should be connected as soon as possible, or appropriate measures should be taken to avoid infiltration of water vapor and dust.

Avoid direct sunlight and immersion in water.

Avoid the connector landing on the ground or on the roof.

The wrong connection can generate arcs and shocks.

Make sure that all the electrical connections are strong.

Ensure that all connectors with locks are fully connected.

Different models of connectors are not recommended to connect together (if you need to use them, please contact the customer service staff of Apex New Energy).

7.7. Bypass Diode

The battery strings in the Apex solar module are protected by bypass diodes in parallel and packaged in the junction box.

When the hot spot phenomenon occurs locally in the component, the diode will start working, so that the main current no longer flows through the hot spot cell, thus limiting the heating and sex of the component loss of energy.

Note that the bypass diode is not an overcurrent protection device.

When the diode is confirmed or suspected, the installer or system maintenance provider should contact the customer service staff. Do not try to open the junction box of the assembly by yourself.

7.8. Anti-PID and Inverter Compatibility

Apex new energy photovoltaic modules have passed the most stringent PID test before leaving the factory, and the negative modules usually do not need to be grounded, so they can be compatible with isolated type (with transformer) or non-isolated type inverter.

1 Under the combination of high humidity, high temperature and high voltage, photovoltaic modules will sometimes appear electric potential-induced attenuation (PID). PID attenuation may occur if:

- Installed in warm and humid climates;
- Install at long-term wet sites (e. g. near water bodies).

② In order to reduce the risk of PID, we recommend correctly grounding the DC side negative electrode of the photovoltaic array in a high temperature and humidity installation environment. The grounding mode of the inverter is recommended as follows:

- For the isolated photovoltaic inverter, the photovoltaic DC measuring negative electrode can be directly grounded
- For the non-isolated photovoltaic inverters, the virtual grounding method can be adopted after adding the isolation transformer (usually the inverter manufacturers need to provide the grounding method guidance).

The following are the recommended grounding methods:

1. Ground with a ground fixture

There is a grounding hole $\varnothing 4.2\text{mm}$ in the middle of the frame on the back of the assembly. The grounding hole is identified by the typical grounding symbol according to the IEC61730-1 standard.

The grounding between the components must be confirmed by a qualified electrician, and the grounding device must be manufactured by a qualified electrical manufacturer. The recommended torque value is 2.3N m. The ground fixture uses copper cores of 12 AWG size. Copper wire shall not be damaged when installation.

2. Use the unused installation hole for ground

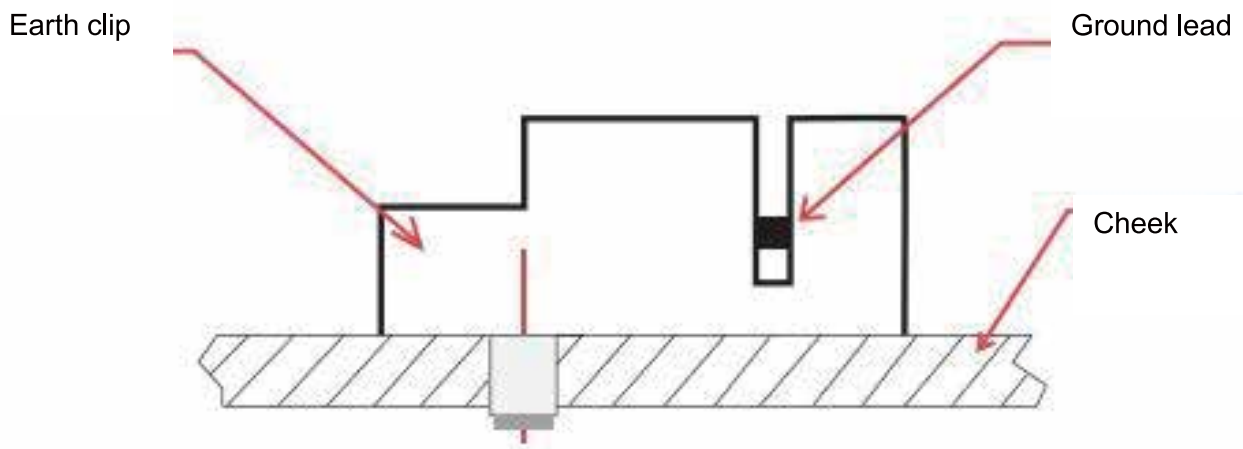
Existing but unused mounting holes on the assembly can be used to install ground devices.

Place the ground clip at the frame mounting hole. Use the ground bolts through the ground clip and frame.

Place the tooth spacer on the other side and screw on the lock nut.

Pass the grounding wire through the grounding clip. The material and size of the grounding wire shall meet the relevant national, regional or international local regulations, laws and standards.

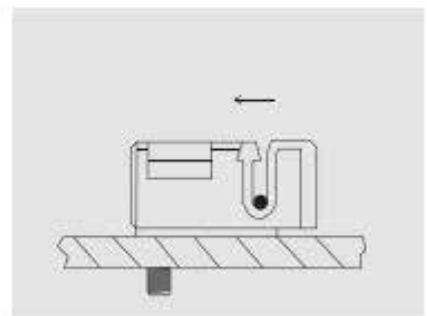
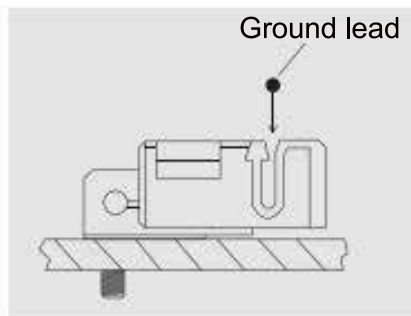
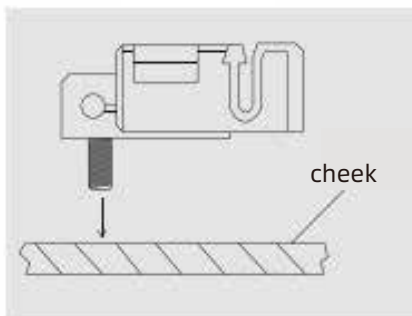
Tighten the fastening bolts of the ground wire. Then the installation ends.



Install

Card line into the trough

Push in the direction



8. Module Maintenance for PV Module PV

8.1. Panel Visual Inspection and Replacement

The modules in a PV array should be regularly checked for damage. Factors such as glass breakage, cable breakage, and junction box damage may lead to function and safety problems. In the case of a damaged module, replace it with the same type of module. Refer to the appropriate Product Installation Manual for installation and dis-assembly of module.

It is recommended to perform a preventive inspection every six months without changing the components of the module. If electrical or mechanical appliances are used for inspection or maintenance, they should be operated by qualified professionals to avoid any electric shock or loss of life.

Trim any vegetation which may shade the solar array, thus impacting performance.

Check that mounting hardware is properly tightened.

Check that all string fuses in each non/earthed pole are operating.

Replacement modules must be of same type. Do NOT touch live parts of cables and connectors. Use appropriate safety equipment (insulated tools, insulating gloves, etc.) when handling modules.

Cover the front surface of modules by an opaque material when repairing. Modules when exposed to sunlight generate high voltage and are dangerous.

The company's photovoltaic module junction box is equipped with bypass diodes, which minimizes the module heating and current loss.

- Do NOT open the junction box to change the diodes even if they malfunction.
- In a system using a battery, blocking diodes are typically placed between the battery and the PV module output to prevent battery discharge at night.
- In the event that a module is damaged (broken glass or a scratch on back sheet) and needs to be replaced.
- Observe the safety precautions listed earlier in this Manual.
- Wear cut resistant gloves and other personal protective equipment required for the particular installation.
- Isolate the impacted array string to prevent current flow before attempting to remove the module.
- Disconnect the connectors of the affected module using the related disconnect tool provided by suppliers.
- Replace the damaged module with a new functional module of the same type.

- Check the open circuit voltage of the array string and verify that this is within 10V of the other strings to be connected in parallel.
- Turn the breaker back on.

8.2. Connector and Cable Inspection

Inspect all cables to verify that connections are tight; the cables are protected from direct sunlight and sited away from areas of water collection.

It is recommended to check the torque of terminal bolts and the general condition of wiring at least once a year. Also, check that mounting hardware is properly torqued. Loose connections will result in damage to the array.

8.3. Cleaning

The amount of electricity generated by a solar module is proportional to the amount of light falling on it. A module with shaded cells will produce less energy and therefore it is important to keep all PV modules clean.

Clean PV modules when the irradiance is below 200W/m²; liquid with a large temperature difference from the modules must not be used for cleaning the modules.

It is forbidden to clean PV modules under the weather conditions of wind more than 4 grades, heavy rain or heavy snow.

When cleaning with pressurized water, the water pressure on the glass surface of the module must not exceed 700 KPa (14619.80psf); the module must Not bear the extra force.

When cleaning PV modules, do NOT step on the modules; do NOT spray water on the backside of the module or the cables; keep the connectors clean and dry; prevent fire and electrical shock from occurring; do NOT use as steam cleaner.

The back surface of the module normally does not need to be cleaned but, in the event this is deemed necessary, avoid the use of any sharp projects that might damage the penetrating the substrate material.

Periodically trim any vegetation which may shade the solar array thus impacting performance.

When cleaning the modules, use a soft cloth together with a mild detergent and clean water. Take care to avoid severe thermal shocks which might damage the module by cleaning modules with water which has a similar temperature to the modules being cleaned.

Use dry or wet soft clean cloth to clean the PV modules; non-corrosive solvents or hard objects are strictly prohibited.

If there is greasy dirt and other substances on the surface of the PV module which are difficult to clean,

conventional household glass cleaning agents can be used; Do NOT use the alkaline and strong acid solvents.

When cleaning the back surface of the module, take care to avoid penetrating the substrate material. Modules that are mounted flat (0° tilt angle) should be cleaned more often, as they will NOT "self- clean" as effectively as modules mounted at a 10° tilt or greater.

If you are unsure whether the array or section there of needs to be cleaned, first select an array string that is particularly soiled, then;

Measure & record the inverter feed in current from that string.

- Clean all modules in the string.
- Measure the inverter feed in current again and calculate the % improvement from cleaning.

8.4. Requirements for Water Quality

- PH: 5 ~7;
- Chloride and Salinity: 0 - 3,000 mg/L;
- Turbidity: 0-30 NTU;
- Conductivity: 1500~3000 $\mu\text{s}/\text{cm}$;
- Total dissolved solids (TDS): ≤ 1000 mg/L;
- Water Hardness—calcium and magnesium ions: 0-40 mg/L;
- Non-alkaline water must be used; demineralized water shall be used if the condition permits.

8.4.1. Module Inspection after Cleaning

- Ensure that the module under visual inspection is clean, bright and free of stains;
- Spot check to verify whether there is soot deposit on the module surface;
- Check to see there are no visible scratches on the surface of the module;
- Check to see there are no man-made cracks are on the module surface;
- Check to see whether the module support structure is leaning or bent after cleaning;
- Check to see whether the wiring terminals of the module are detached;
- After cleaning PV modules, fill out the PV module cleaning record.

8.4.2. Troubleshooting

- If your installation does not work properly, please inform your installer immediately. It is

recommended to perform a preventive inspection every six months without changing the components of the modules. If electrical or mechanical appliances are used for inspection or maintenance, they should be operated by qualified professionals to avoid any electric shock or loss of life.

9. Release and Execution

This document is managed by Apex Solar Product Management Department, and is responsible for the final execution and interpretation.

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