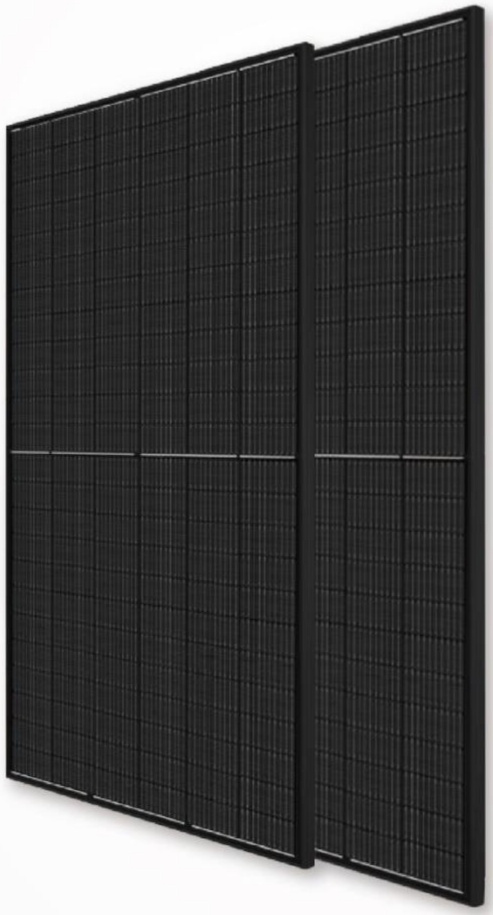
APEX SOLAR



APEX PV MODULES INSTALLATION MANUAL

Apex Solar Energy Technology GmbH

Contents

1. Introduction for User Manual

This manual applies to the installation, maintenance and use of the **flexible** 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 flexible 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.apex-solarenergy.com).

1.2. Limitation of Liability

APEX solar is not responsible for any form of injury, including but not limited to module 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 front 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 the 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 modules 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 module storage area.
- Do not install any modules 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 PV module 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 modules to stop the power output.
- Do not try to repair any part of the PV module, nothing is available within the module.
- The lid of the junction box shall always be sealed.
- Do not split the module or move any part of the module.

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. Or the insulation of output cable may 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 the 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 module should be stored in the original packing box before installation. Please protect the packaging from damage. Follow the recommended unpacking procedure to open the module 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;
- It is forbidden to use the wires or junction boxes of the modules to carry the modules. Handling the modules requires the 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 modules;
- Do not place the modules in unsupported or unsecured environments;
- Do not expose the modules or their electrical interfaces to chemicals (e. g. oil, lubricants,

pesticides, etc.).

Product identification

- Each module has three identical bar codes as a unique logo. Each module has a unique serial number consisting of 16 digits.
- Each module has a nameplate on the back, with its model number, main electrical performance, and safety specifications indicated.

3.1. Marker on Outer Packaging

3.1.1 Do NOT discard the modules at will, special recycling is required; 	3.1.2 Modules must be kept dry, not expose to rain or moisture; 
3.1.3 Modules in carton are fragile, which must be handled with care; 	3.1.4 The packaging must be transported upright; 

3.1.5 Do NOT step on the package and module; 	3.1.6 The carton can be recycled; 
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); 	

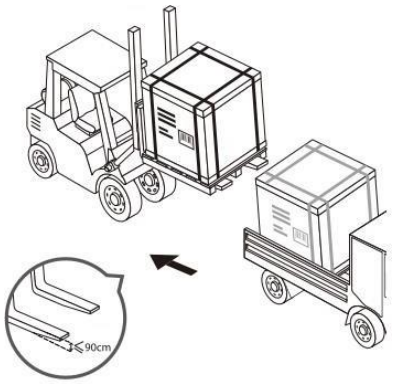
3.2. Unloading Warning

3.2.1

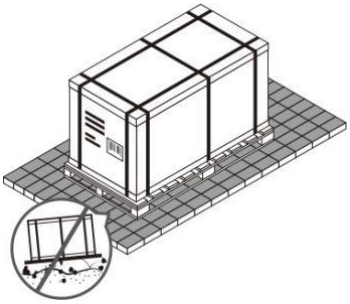
Use the correct (as picture) lifting fixture to handle, no more than 2 pallets per lift. Before lifting, please confirm the tray and the carton are NOT damaged and the hoisting rope is firm and solid. Before lowering the carton back on the ground, two persons must support the two sides of the carton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

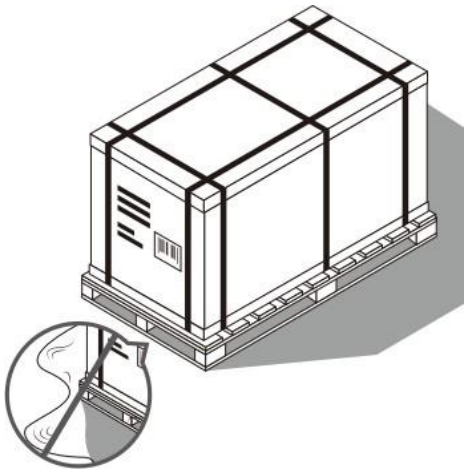


Put the modules on horizontal ground;



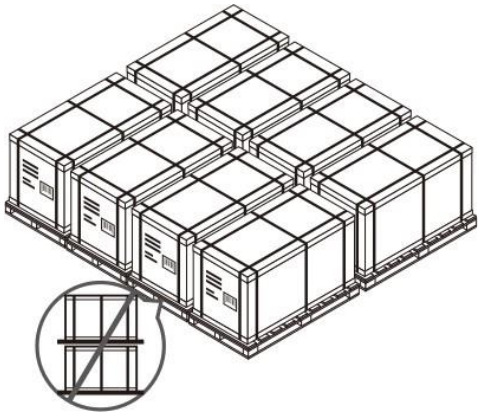
3.2.3

Store the module in a dry and ventilated place;



3.2.4

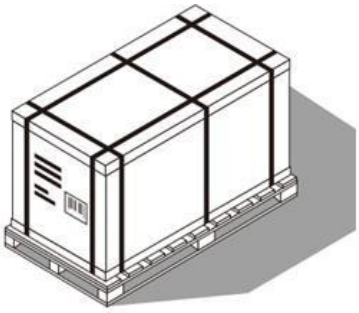
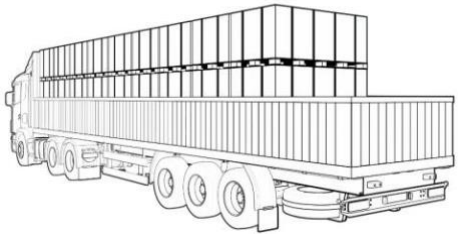
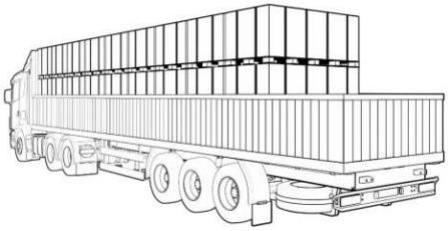
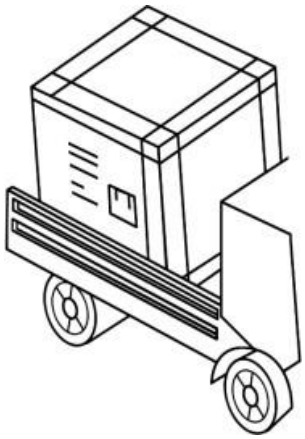
Do Not stack the modules at the project site;



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; 

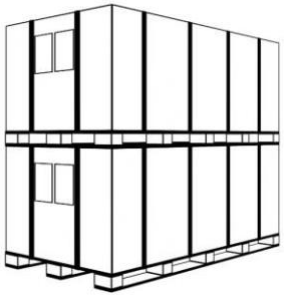
3.4. Storage

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

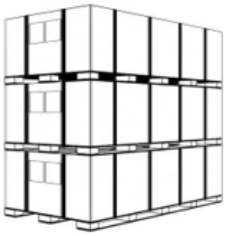
Storage in project site warehouse (moisture < 85%, temperature range from -20°C to + 50 °C).



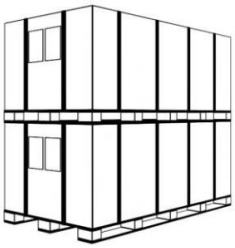
3.4.2

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

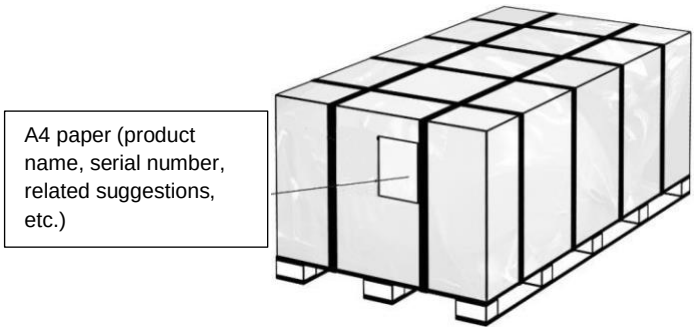
3.6. Unpacking Safety

- 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

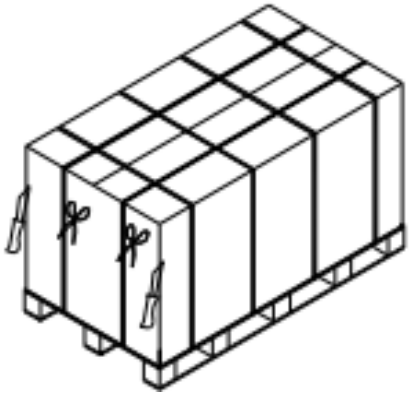
4.2.1

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;



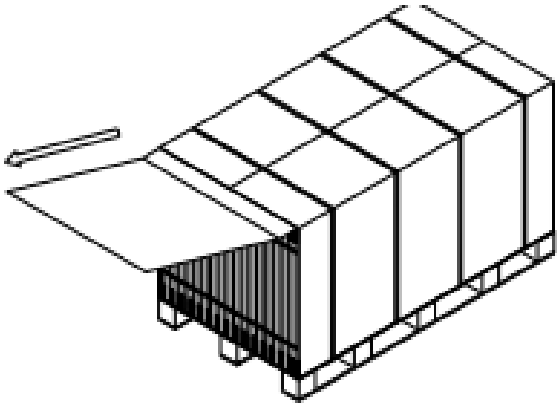
4.2.2

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;



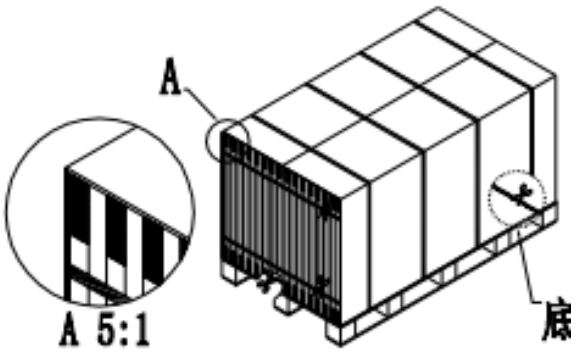
4.2.3

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

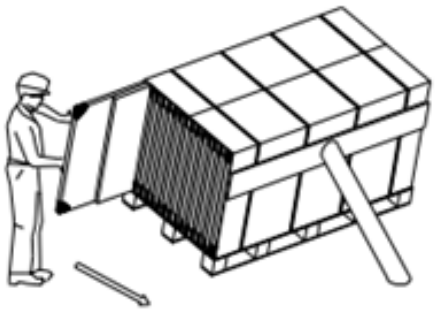
Cut the two horizontal packing belts in the carton and cut the two packing belts near the bottom of the tray, and remove the packing belts;



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;



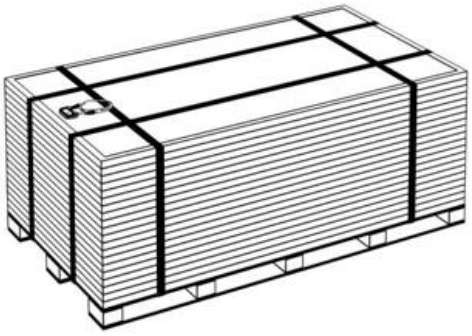
4.2.6

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

Flexible 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.

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 -40℃~40℃. The module's working ambient temperature range is from -40℃ to 85℃. Maximum altitude less than or equal to 2000m. Do not apply mirrored, magnifiers or other concentrate light onto the modules.

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

If the module is installed in an area with frequent lightning and thunder, the module must be protected against lightning strikes. 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.

Apex Solar Flexible modules must be mounted on buildings or other structures suitable for modules installation (e.g. ground. rooftop). Modules can be installed in seaside with a distance of 50m to 500m from sea. Corrosion may happen to joints between frame and supporter, or and grounding; Must use stainless steel or aluminum metal to directly contact modules in seaside and do antiseptic treatment on joints to prevent corrosion; Modules must not be installed, nor operated in area with strong corrosive matter, such as salt, salt mist, salt-water, active chemical vapors, acid rain, any other type of corrosive matter. In addition, Modules must not be sat in locations where hail, snow, sand, smoke, air pollution, soot, etc. are excessive, this could affect the safety and/or performance of the modules.

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.

6. Installation

6.1. Installation Safety

- Apex Solar Flexible Modules can be mounted in landscape or portrait orientation, and however the impact of dirt shading the solar cells can be minimized by orienting the product in landscape.
- 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 modules;
- When installing, unpacking the modules. Once the modules 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 modules, the modules surface and frame may be very hot, there is a risk of burn or electric shock. Standard safety tools and equipment should be used during the installation;
- 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 module junction box are wet;
- Use well-insulated and dry tools, and prohibit the use of wet tools;
- The modules in series in the same circuit shall be the modules with the same size and same specification;
- Connect the male and female connector correctly, check the wiring condition, all connecting wires shall not be separated from the PV modules, and the wire shall be fixed with a cable tie or other means to avoid scratching or squeezing the module backsheet;
- Regardless of whether the module is connected to the photovoltaic system, do not contact the junction box body or the connectors during installation or when the module is exposed to light;
- For photovoltaic systems installed on the roof, please try to follow the "top to bottom" and / or "left to right" safety principles;
- The modules will have a thermal expansion and cold contraction effect. The recommended interval between the two flexible modules is 10mm during installation; with special requirements, please confirm with Apex Solar for installation;
- During the installation, removal, maintenance or any other related actions, the recommended

force between the cable and connectors, cable and junction box is not greater than 60N.

- Do NOT wear metallic jewelry which may 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 carry out any installation work if the terminals of PV module are wet. Please install immediately after 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 APEX 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 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.

6.2. Installation Location and Working Environment

- Flexible Modules are not suitable for the space environment.
- Do not use a mirror or a magnifying glass to manually focus the sunlight on the PV modules.
- 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 the modules in the location where they may be flooded.
- Apex Solar recommends for the flexible modules to be installed in a working environment temperature of-40℃ to 40℃, which is the average monthly maximum and minimum temperature of the installation site. The limit operating environment temperature of the module is-40℃ to 85℃

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- Ensure that the wind or snow load will not exceed the max load of the flexible modules.
- The modules should to be installed in a place without any shadow throughout the whole year. Please ensure that there are no obstacles that may block the light.
- If the modules are installed in a place with frequent lightning activity, the modules must be protected by lightning protection.
- Do not install the modules near the flame or combustible material.
- Modules are strictly prohibited to be installed and used in hail, snow, sand, dust, air pollution, soot and other excessive environments. Modules should not be 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 modules or affect the safety or performance of the modules).
- please take proper protection measures to ensure the reliability and security of modules when the modules are used in the environment with heavy snow, extreme cold, strong winds, near water or be installed on islands with salt spray or deserts.
- When choosing a site, avoid trees, buildings, or other obstacles that can shadow the modules. Shadows can cause a loss of power output of the module. Operation under permanent shade conditions is not recommended.
- When the module is installed on the roof, it must be installed on a roof with a certain fire prevention treatment (please refer to the local regulations), contact local authorities for detailed governing regulations, acquire confirmation and relevant permission.

6.3. The Choice of Tilt Angle

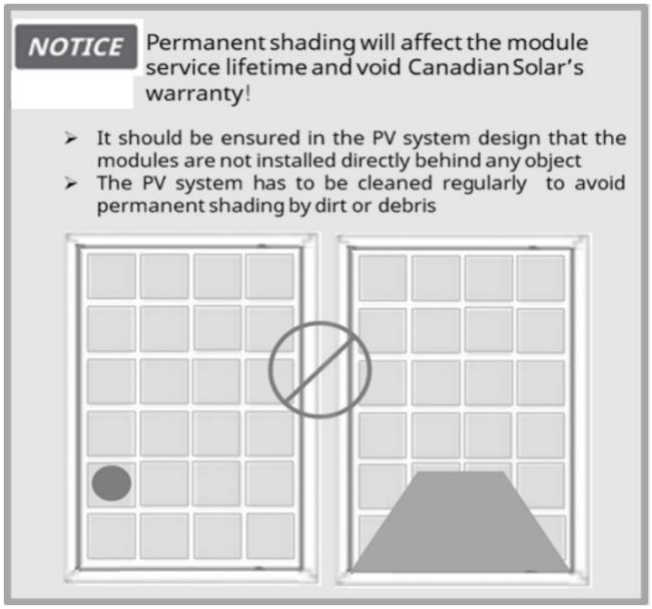
For detailed installation angles, follow the standard module installation guidelines or the recommendations given by an experienced PV module installer.

Apex Solar suggests that the installation angle of the modules is not less than 10 degrees, so that the dust on the surface of the modules is easily taken away by the rain; at the same time, it helps to avoid large amounts of stagnant water on the surface of the module and then affect the appearance and performance of the module.

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 modules in the location should be selected to ensure that the sunlight can still shine on the modules even on the shortest sunshine day throughout the year.

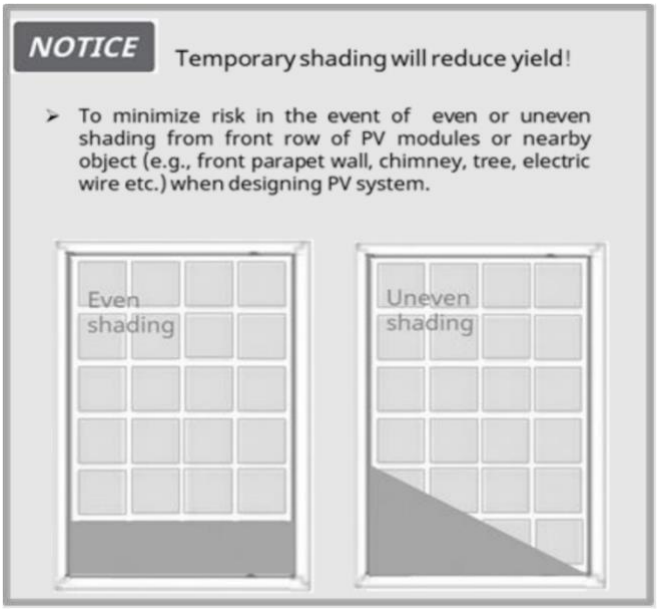
6.4. Avoid Shadows

Modules shall not be permanently shaded (including partial shading, spot shading, even shading or uneven shading) under any circumstances. Permanent shading includes shading of the same cell, cell row, or module portion for extended and repeated periods of time (e.g., more than 200 daylight hours over the warrantied service lifetime). Power dissipated in fully or partially shaded cells will result in power loss, reduced yield and can cause localized overheating, which in turn may negatively impact the module service lifetime. Permanent shading may cause accelerated ageing of the encapsulation material and place thermal stress on the bypass diodes. This would void the module's warranty unless properly mitigated through the use of Module Level Power Electronic (MLPE) devices.



Regular maintenance is required to keep modules clean. Particular measures should be taken to avoid permanent shading from dirt or debris (e.g., plants, bird droppings, etc.). Do not install modules directly behind any object (e.g., tree, antenna, etc.) to prevent occurrence of permanent shading. Even temporary partial shading will reduce the energy yield. A module can be considered to be unshaded if its

entire surface is free from shading all year round, including on the shortest day of the year.



7. Mechanical Installation

7.1. General Requirements

Ensure that the installation method and supporting system of modules is strong enough to make the modules to be able to withstand all the pre-established load conditions. The installer must provide the guarantee. The installation supporting system must be tested by the third-party organization with the analysis ability of Static Mechanical, according to the local national or international standards such as DIN1055 or equivalent standards. The modules mounting structure must be made of durable, corrosion-resistant and UV-resistant material; Modules must be securely attached to the mounting structure;

In regions with heavy snowfall in winter, select higher mounting system. So that the lowest edge of the modules will not be covered by snow for long time. In addition, ensure that the lowest portion of the modules is placed high enough so that it will not be shaded by plants or trees, or damaged by flying sand; Because of thermal and expansion of the module frames, must ensure that the minimum distance between neighboring frames is 10mm;

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

7.2. Mechanical installation

7.2.1. Installation via industrial structural adhesive

7.2.1.1 Cleaning the surface carefully

- Clean the whole surface where the flexible will be installed

- If the surface is too dirty, please use the special cleaner to clean the roof carefully and then use the washer to clean the whole roof; Please make sure the cleaner is rinsed clean, otherwise it will affect the adhesion effect.

7.2.1.2 Fix the installation positions and areas for flexible modules

Fix the installation positions and areas for flexible modules according to the PV project design.

7.2.1.3 Gluing

- Double check the area for the glue, and clean again if any dirty;
- Make sure no water stain on the area before gluing;
- Use a glue gun to glue along the center of the wave crest, Adhesive column width should no less than 10mm and the height should no less than 4mm;
- Glue must be uniform, continuous, before pasting the flexible module to the roof, it is not allowed to scrape the glue;
- In order to achieve the best bonding performance, it is required to install the modules within 5 minutes once the adhesive is applied on the wall;
- The gap between each module shall be kept around 1cm;
- It will take 48 hrs. when the curing depth can reach 2-3mm for the structural adhesive, before the fully curing, please DO NOT move nor force the flexible module;

Figure 1 Gluing

7.2.1.4 Install the flexible module

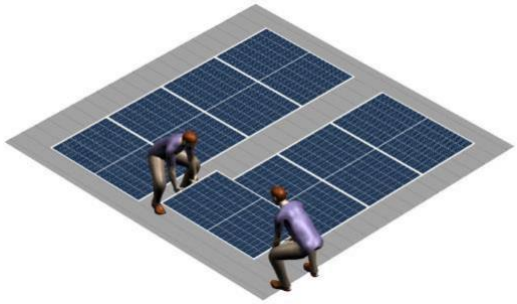


Figure 2 Pasting the module

Following figure 2, the module should be lifted by two installers, and be pasted gradually on the glued area of the roof from one end to the other end along the longitudinal direction of the modules. Make sure that the module is pasted to the roof flatly and no secondary pasting.

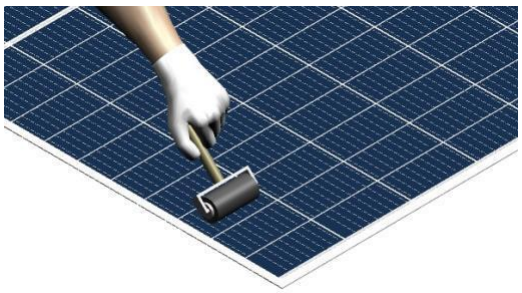


Figure 3 Pressing the module

Press the flexible gently against the surface by special plastic rollers along the gluing direction to make the modules be pasted well with the structural adhesive.

7.2.2. Installation via adhesive tape

7.2.2.1 Cleaning the surface carefully

- Clean the whole surface where the flexible will be installed
- If the surface is too dirty, please use the special cleaner to clean the roof carefully and then use the washer to clean the whole roof; Please make sure the cleaner is rinsed clean, otherwise it will affect the adhesion effect.

7.2.2.2 Fix the installation positions and areas for flexible modules

Fix the installation positions and areas for flexible modules according to the PV project design.

7.2.2.3 Pasting

- Double check the area for the glue, and clean again if any dirty;
- Make sure no water stain on the area before gluing;
- Paste the adhesive tape along the center of the wave crest, make sure the paste is straight;
- Tear off the release film or release paper on the surface of the double-sided adhesive tape, do not have residue on the tape surface or adhesion with other items;
- Do NOT tread or stain the surface of the adhesive tape after removing the release film or release paper;

Figure 4 Pasting the adhesive tape

7.2.2.4 Install the flexible module

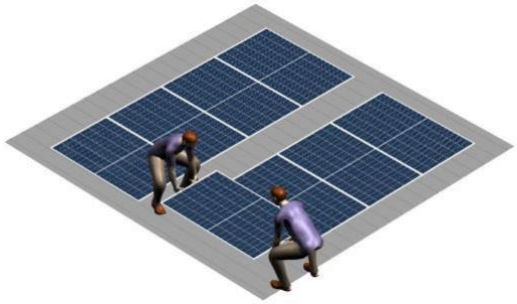


Figure 5 Pasting the module

Following figure 5, the module should be lifted by two installers, and be pasted gradually on the glued area of the roof from one end to the other end along the longitudinal direction of the modules. Make sure that the module is pasted to the roof flatly and no secondary pasting.

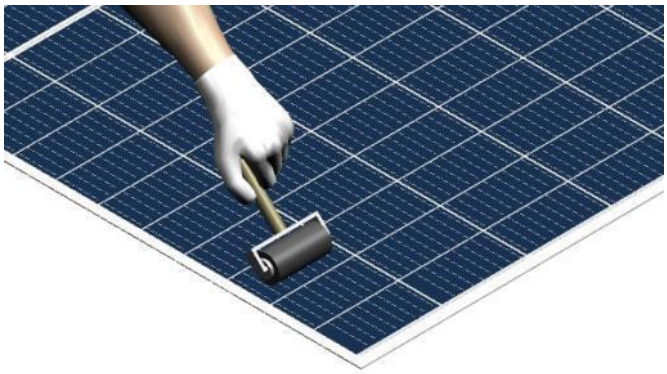


Figure 6 Pressing the module

Press the flexible gently against the surface by special plastic rollers along the adhesive tape direction to make the modules be pasted well with the structural adhesive tape (Figure 6).

7.2.3. Installation on PVC rooftop

The Upper 7.2.1 and 7.2.2 installation methods can be used for the PVC rooftop and please be noted as below:

- Use the NLJ-16032 to clean the PVC rooftop if the rooftop is too dirty and then use the washer to clean the rooftop; Please make sure the cleaner is rinsed clean, otherwise it will affect the adhesion

effect.

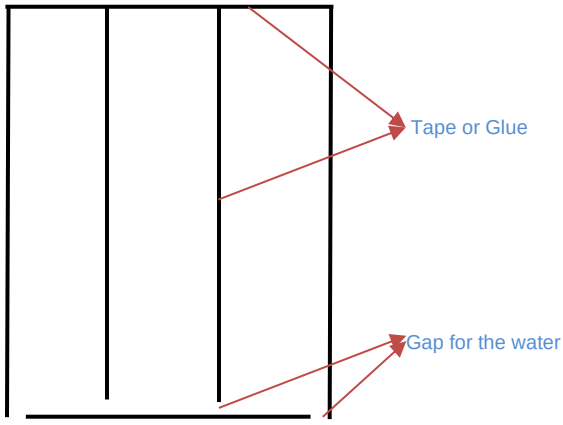
- Before the installation, please survey and set out the installation position according to the project design shown as Figure 7 & Figure8

Figure 7

Figure 8

- If use the structural adhesive to install the flexible modules, then use the glue gun to glue in the mapped area and should be glued as shown in Figure 9, please leave a 30mm gap between the longitudinal glue column and the down glue column to allow water vapor to escape;
- If use the adhesive tape to install the flexible modules, then paste the tape in the mapped area and should be pasted as shown in Figure 9, please leave a 30mm gap between the longitudinal tape column and the down tape to allow water vapor to escape;

Up side



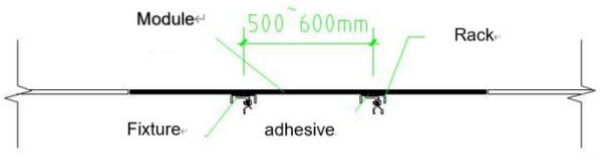
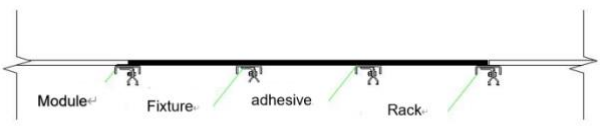
Down side

Figure 9

7.2.4. Installation on the rooftop with color steel tile with vertical locking edge

When install the flexible module on the rooftop with color steel tile with vertical locking edge, the instructions are as below:

- Install the special fixtures for the color steel tile with vertical locking edge;
- Fix the racks on the fixture with flat head tapping screws;
- Clean the surface of the racks and ensure that the surface is clean enough;
- Glue the structural adhesive on the racks;
- Connect the terminals of the modules;
- Paste the flexible module on the racks and make sure the left and right reservations are symmetrical;
- Check the electrical connection in 30 minutes after the pasting;

No.	Installation Method	Installation diagram
1	2400pa by fixture on long sides 2 racks (Beam parallel to long sides) the rack is pasted on the 1/4 of the module width	
2	5400pa by fixture on long sides 4 racks (Beam parallel to long sides) the inner rack is pasted on the 1/3 of the module width and the outer rack is pasted on the edge of the long side	

7.3. Electrical Performance

Rated electrical characteristics such as Pmax Voc and Isc is within +/- 3% of tolerance values at Standard Test Conditions. Standard Test Conditions: 1000W/m^2 Irradiance, 25℃ Cell Temperature and 1.5 Air Mass.

Under normal conditions, the photovoltaic Modules may experience conditions that produce more current and/or voltage than reported at Standard Test Conditions. Accordingly, the values of short circuit current, Isc, and open circuit voltage, Voc, marked on Modules should be muliplied by a factor of 1.25 when determining component voltage ratings, conductor capacities, fusing sizes, and size of controls connected to the Modules output.

Voltages are additive when Modules are connected directly in series, and Modules currents are additive when Modules are connecteddirectly in parallel, as illustrated in Figure 10.

Modules with different electrical characteristics must not be connected directly in series.

The number of modules in series shall be calculated reasonably according to the system configuration and corresponding rules. The open circuit voltage under the condition of local minimum temperatures expected value cannot exceed the maximum module system voltage (according to IEC61730, the maximum system voltage of APEX flexible module are 1000 V and 1500 V, the client may calculate according to the actual voltage of module) and the required value of the other DC electrical components.

The maximum number of the modules can be installed in a string can be calculated based on below formula: $N=Vmax/Voc(1-\beta(25-X))$.

Voc: Open circuit voltage of each module (refer to product label or data sheet)

Vmax: Maximum system voltage

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

X: The lowest expected ambient temperature for the installation location

N: The maximum number of modules in series

An appropriately rated over-current protection device must be used when the reverse current could exceed the value of the maximum fuse rating of the Modules. An over-current protection device is required for each series sting if more than two series strings are connected in parallel, as illustrated in Figure 10.

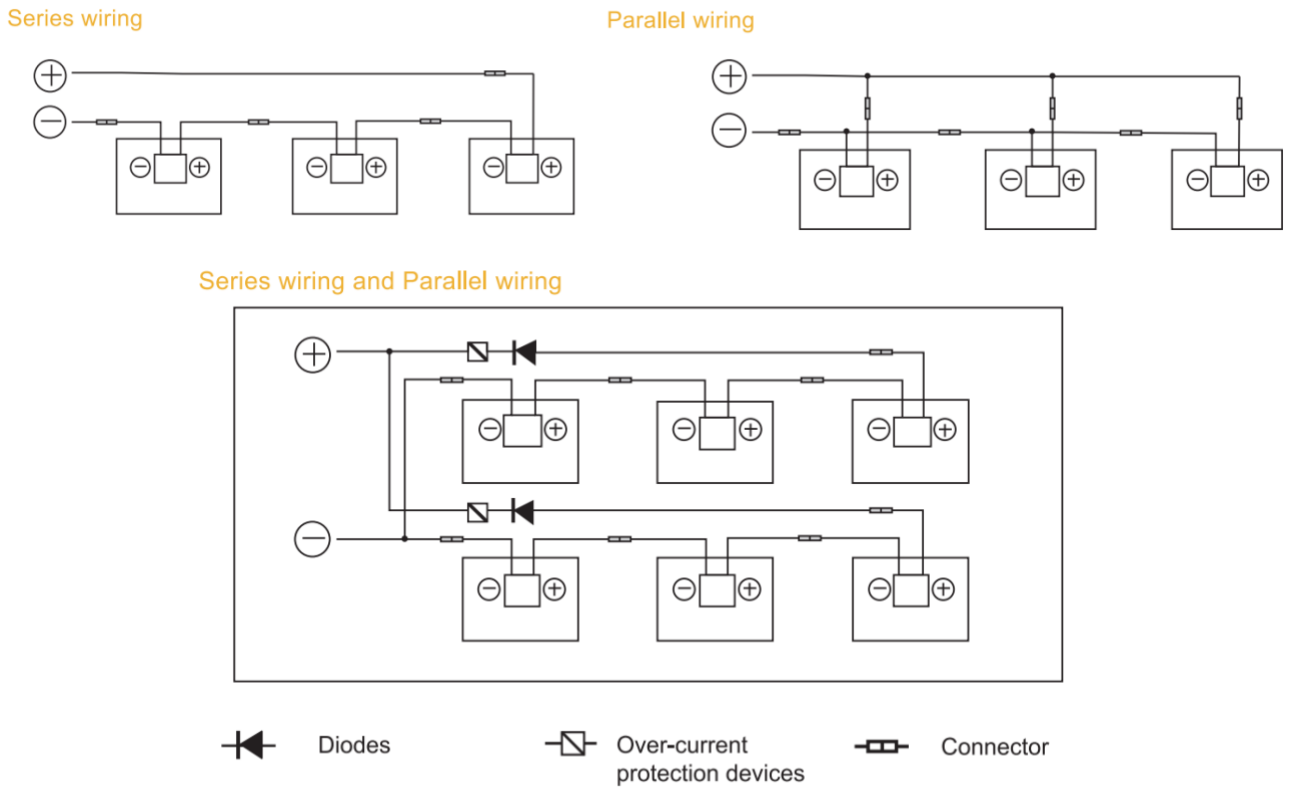


Figure 10: Electrical diagrams of series and parallel wiring

7.4. Cable and Connection

The modules 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 modules. A single module has two wires connected to the junction box, a positive electrode and one negative electrode. The two modules can be connected in series by inserting the positive electrode interface at the other end of a module lead into the socket of the negative lead of the adjacent module.

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℃, 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 modules. 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.

7.5. 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 modules 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).

7.6. 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 module, 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 module 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 module by yourself.

7.7. 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 Ø 4.2mm in the middle of the frame on the back of the module. The grounding hole is identified by the typical grounding symbol according to the IEC61730-1 standard.

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

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.

APEX Flexible PV module are equipped with bypass diodes in the junction box. This minimizes module heating and current losses.

- 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/m^2; 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 spay 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; 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 μs/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;
- Random check whether there is soot deposit on the module surface;
- Check whether there are no obvious scratches on the surface of the module;
- Check whether there are man-made cracks on the module surface;
- Check whether the module support structure is leaning or bent after cleaning;
- Check whether the wiring terminals of the modules 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.