HYSOLAR

EFFICIENT NET-ZERO PV INDUSTRY INTEGRATOR

PV Module
Installation Manual

V.2604

List of Applicable Modules

Module type	Module model
Single-glass module	HY-NT10/54H HY-NT10/54BH
	HY-NT10/60H
	HY-NT10/72H
	HY-P10/54H HY-P10/54BH
	HY-P10/60H
	HY-P10/72H
	HY-NT11/48H HY-NT11/48BH
	HY-NT11/54H HY-NT11/54BH
	HY-NT11/60H
	HY-NT11/66H
	HY-NT12/60H
	HY-NT12/66H
	HY-P12/60H
	HY-P12/66H
Double-glass module	HY-NT10/54GDF HY-NT10/54BGDF
	HY-NT10/60GDF HY-NT10/60BGDF
	HY-NT10/72GDF
	HY-NT10/78GDF
	HY-P10/54GDF
	HY-P10/60GDF
	HY-P10/72GDF
	HY-NT11/48GDF HY-NT11/48BGDF
	HY-NT11/48GSF HY-NT11/48BGSF
	HY-NT11/54GDF HY-NT11/54BGDF
	HY-NT11/54GSF HY-NT11/54BGSF
	HY-NT11/48QGDF HY-NT11/48QGSF
	HY-NT11/60GDF
	HY-NT11/66GDF
	HY-NT11/66QGDF
	HY-NT11/78GDF
	HY-NT12/60GDF
	HY-NT12/66GDF
	HY-P12/60GDF
	HY-P12/66GDF

CONTENTS

01 Introduction

First of all, thank you very much for using the photovoltaic modules produced by HONGYUAN GREEN ENERGY CO.,LTD. (hereinafter referred to as HY SOLAR)

Please read all instructions in this manual and the electrical and mechanical requirements carefully before installation.

The installation and operation of PV modules requires professional skills, and only professionals are allowed to engage in this work. All safety precautions in this manual must be strictly observed during installation, and this manual shall be kept for further reference. At the same time, the installer must inform the end customer (or consumer) of the above matters correspondingly.

1.1 Purpose

This manual provides detailed instructions and important safety precautions , to electrical connection and maintenance of crystalline silicon PV modules (hereinafter referred to as PV modules) manufactured by HY SOLAR.

1.2 Scope of liability

Since the use of this manual and the installation, operation, use and maintenance of PV modules are beyond the control of HY SOLAR, this manual does not have the any significance of warranty, whether expressed or implied. HY SOLAR will not be liable for any kind of injury, including but not limited to loss, damage, personal injury or extra expenses caused by improper installation, operation, use and maintenance of PV modules and systems.

HY SOLAR reserves the right to update this manual without prior notice. In case of any inconsistency between different language versions of this manual, the Chinese version shall prevail.

02 Law rules and regulations

The mechanical and electrical installation of PV modules shall refer to corresponding laws and regulations, including requirements of electrical laws, building laws and electric connection. These regulations vary depending on the location of the installation, e. g. building roofs, and water surfaces, etc.; and they may also vary depending on the voltage of the installation system and the use of DC or AC. Please contact the local authority for specific terms.

03 Safety measures

The design of HY SOLAR’ s PV module meets the standards of IEC61215, IEC61730 and UL61730. The PV module meets the requirements of Safety Class II and its application level is Class A.

PV modules can be used in systems that are accessible to the public, greater than DC 50V or 240W. It can meet Class C fire rating (IEC61730) and Category 4 fire rating (UL61730)

⚠ Warning

All safety articles should be read and understood prior to operations such as installation and wiring, etc. or maintenance of PV modules. The PV module will generate direct current when exposed to sunlight or other light sources. Whether or not connecting with PV modules, any direct contact with live parts of PV modules, such as connecting terminals, may result in personal injury or death.

3.1 General safety measures

- Prior to installation, please contact the relevant local authority to determine the installation license and installation inspection requirements that meet local requirements. The installation shall follow the safety rules applicable to all parts and components in the system, including cables, connector, charge monitors, storage batteries, and inverters, etc.
- The installation and maintenance of PV modules must be done by qualified engineers, and they must wear safety helmets, insulating gloves, safety shoes and use insulating tools to avoid direct contact with 30V DC or higher voltage.
- During the installation and transport of module at the project site, rain-proof measures shall be taken to prevent the outer box from being got wet by rain.
- If PV modules are installed or operated on rainy days or in the morning with dew, appropriate protection is required to avoid moisture penetration into the connectors.
- Unauthorized access to the installation area or PV module storage area is prohibited.
- Installation or use of damaged PV modules is prohibited.
- It is prohibited to repair PV modules by users themselves, including but not limited to replacing any PV module parts (diode, junction box, or connector, etc.).
- Interconnecting connectors of different types and models is prohibited.
- The PV module is prohibited to be used in the environment containing or in contact with the following substances: grease or organic ester compounds (such as DOP, or plasticizer), aromatic, phenolic, ketone, halogenated substances, mineral oil, butter, edible oil, alkane (such as gasoline, cleaning lubricant, or electronic reactivator), alcohol, certain drugs (BaiHuaYou, woodlock medicated balm, bonesettin, banana oil, or essential balm), adhesive board and potting (only for connectors) that can generate oxime gas.
- TBP (plasticizer), cleaning agent, herbicide, paint remover, adhesive, rust inhibitor, descaling agent, emulsifier, or cutting oil, cosmetics, etc., so as to avoid chemical damage and impact on the electrical safety performance of PV modules.
- It is forbidden to install the PV module in windy weather
- It is forbidden to irradiate the PV module with focused sunlight.
- It is forbidden to use PV module in places where flammable gases may be generated.
- It is forbidden to use PV module in places related to mobile platforms, etc.(except for tracker).
- It is prohibited to disassemble and move any part of PV module;
- If the PV module connector is wet, do not perform any action to avoid electric shock hazard.
- Do not connect or disconnect PV module when there is current or external current in the PV module.
- The cover of the junction box shall be kept closed at all times.
- And the PV module shall be prevented from partial shadow for a long time. Otherwise, the temperature of the shadow solar cell will rise (hot spot effect), and in serious cases, the PV module may be burnt and even a fire may be caused.
- For PV modules used in desert or sandy areas, it is recommended to use connector dust cap before installation, or take other measures to prevent sand from entering the connector, otherwise it may cause plugging problems or electrical safety hazards.
- After the module is installed on the rack, it is recommended to interconnect the connector on the same day to prevent moisture or sand entering metal parts, which may cause plugging or use problems.
- For field wiring, special photovoltaic cables with minimum 90℃ temperature resistance, light resistance, and cross section of not less than 4mm² shall be used as the PV connection line.

3.2 Operation safety measures

- During transportation and storage, avoid damage or drop of the package; ensure that the packaging box is ventilated, rain-proof and dry; after arriving at the installation site, carefully open the outer package to prevent the PV modules from being scratched and bumped due to improper unpacking behavior; and the stacking of PV module shall be in strict accordance with the stacking requirements.
- Any part of the PV module shall be prevented from being bumped or scratched, so as not to affect the reliability and safety of the PV module; it is prohibited to stand or walk on the PV module; meanwhile, in order to avoid glass damage, it is forbidden to apply excessive load on the PV module or twist the PV module.
- Do not install or carry the PV module by one person, and it is forbidden to lift, drag or move the PV module by grasping the junction box (including the box body, cable and connector); and when placing a PV module on the plane, be careful and pay attention to the collision of edges and corners.
- When installing or maintaining the PV system, do not wear any metal accessories to avoid an electric shock hazard, or please wear a safety belt if installing far above the ground.
- Please use insulated tools, wear rubber gloves and protective clothing when operating the PV module in the sun. Also, to avoid the risk of arcing and electric shock, please do not touch the junction box and the output cable ends (connectors) directly with naked hands.
- When the PV modules are electrically connected, select the morning or evening with dry and low irradiance; or completely cover the PV module surface with an opaque material to prevent the generation of electric current.
- The PV module and the mounting surface shall be spaced to avoid direct contact with the junction box.
- When installing on the roof, the fire resistance requirements of the building must be observed. It is recommended that the PV module be installed on fireproof and insulating roof covering layer with adequate ventilation between the PV module and the mounting surface. To ensure the fire rating on the roof, the minimum distance between the PV module frame and the roof surface is 10cm.
- The connectors must be fully plugged when wiring. If the cable is too long, it is recommended to fix the cable on the installation system with a nylon cable tie with UV resistance. When fixing the conducting wire to the rack, the bending radius of the wire shall not be less than 48mm.
- Avoid direct exposure of cables and connectors to sunlight. Use UV resistant cables.
- Please do not disconnect the electrical connection under load.
- It is forbidden to attempt to disassemble the PV module, remove the nameplate of the PV module or other components on the PV module.
- It is strictly prohibited to paint or apply any adhesive on the surface of PV module.
- It is forbidden to drill holes in the PV module frame.
- It is forbidden to scratch anodized coating on the surface of aluminum alloy frame (except for grounding connection). Scratches may cause corrosion of the frame, affecting its load resistance and long-term reliability.
- If the PV module glass or other encapsulated material is damaged, please wear personal protective equipment to separate the PV module from the field or circuit.
- Do not touch the wet PV module unless wearing the qualified anti-electric shock equipment.
- When professional personnel replace or repair PV modules, please do not damage the peripheral PV modules or their support structure.
- When cleaning the PV module, the cleaning requirements of PV modules must be followed.
- Connectors must be kept dry and clean to ensure they are in good working condition. Do not insert other metal objects into the connector or make electrical connections in any other way.

04 Handling & unloading and unpacking

If the PV module is not used for the time being, please do not open the product package. The goods shall be stored in a dry and ventilated place protected from light.

It is suggested to unpack an appropriate amount of PV modules every day according to the progress of the project, and the unpacked PV modules shall be installed within the same day. Since the PV modules are stacked on the ground after unpacked, the PV modules may be immersed in water for a long time in case of severe weather such as rainstorm, which may affect the reliability of the product. In case of severe weather such as typhoon, the uninstalled PV modules may also be blown away.

4.1 Handling & unloading

When the PV module is transported to the project site, it must be transported in the packing box provided by HY SOLAR, and shall be stored in the original packing box before installation. Please protect the packing from damage.

The safety of the PV module shall be protected during unloading, especially during the hoisting of roof projects. The PV modules shall be placed in protective devices before being hoisted to the roof to avoid collision with the wall during hoisting.

There are two packing methods for modules: short-side vertical and long-side vertical. The two packing methods have different unloading and unpacking requirements. And the packing mode is as follows;

Long-side vertical

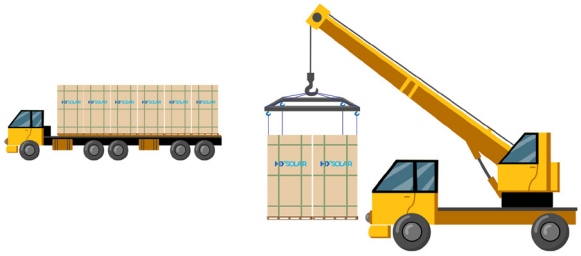
Short-side vertical

Precautions for unloading by crane are as follows:

1. When the crane is used for unloading from the flat truck (as shown in the figure), please use the special tooling for operation. Before hoisting, select the hoisting tools with sufficient tension and size according to the weight and size of the modules. During hoisting, adjust the position of the sling to ensure the stable center of gravity. Operate the crane at a constant speed. When it is near the ground, keeping the package upright, place it lightly on the flat ground, and transfer to the flat hard ground for storage.

2. It is strictly forbidden to hoist in case of wind force greater than Level 6, or in rainy and snowy days.

3. For long-side vertical packing, maximum 2 pallets of modules can be hoisted at most at a time,; and for short-side vertical packaging, a maximum of 2 horizontal modules can be hoisted at a time. Before hoisting, cut off the module stacking straps.



Schematic Diagram of Crane Unloading

Precautions for forklift truck unloading are as follows:

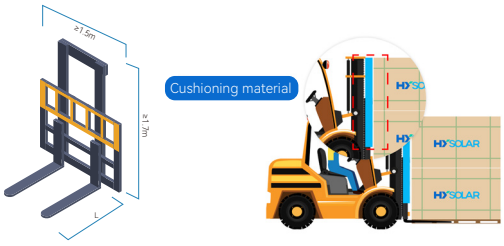
1. When the forklift truck unloading is adopted for the platform truck, it shall be unloaded from both sides of the vehicle.

2. Select the forklift truck with proper tonnage. The distance between the teeth of the forklift truck is adjustable, and the teeth shall be close to the foot piers on both sides of the pallet as much as possible. The teeth of the forklift truck can be insert deeply into the position L≥3/4 at the bottom of the pallet. The height of the forklift truck mast shall be ≥1.7M, and the width of the forklift truck mast shall be ≥1.5M.

3. Put cushion materials such as EPE or rubber cushion in front of the forklift truck mast. It is strictly forbidden for the forklift to directly contact the module package to prevent the modules from being broken due to external force impact.

4. In the process of unloading, if the package blocks the driver's sight, it is recommended to reverse the vehicle and arrange personnel to command to prevent personnel or articles from being collided during the driving, resulting in personal injury or package falling.

Schematic Diagram of Forklift Unloading



Forklift truck mast: height ≥1.7M, width ≥1.5M; cushion materials such as EPE or rubber cushion shall be placed in front of the forklift truck mast

Special Notes

Due to the limitation of the container height, when the PV module is moved out of the container, the forklift truck shall lift the module, and the distance between the bottom surface of the package and the bottom surface of the container shall be less than 50mm; otherwise, the product package may collide with the door frame of the container, which may cause damage to the PV module. When unloading from the container, after each row of products is unloaded, the modules in the front row can be lifted and unloaded in turn.

Special Notes

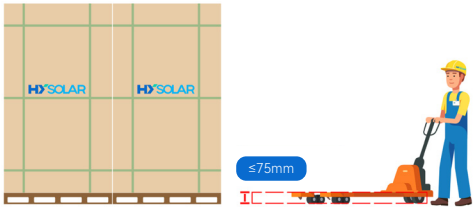
Precautions for packaging turnover are as follows:

1. During turnover of long-side vertical modules, the packing box shall be propped against the forklift truck mast. The mast shall be vertical to the fork. The mast structure shall be firm (bearable pressure≥1.5t). When the whole pallet of module leans against the mast, the mast shall not be deformed due to the pressure. Two safety ropes with tensile strength ≥2000kgf shall be fastened on the forklift truck, and safety guardrails shall be installed on both sides of the front end of the forklift.

2. The straight-line running speed of the vehicle shall be controlled to be ≤5km/h, and the turning speed shall be ≤3km/h to avoid emergency stop and rapid start.

3. When the manual hydraulic lift is used for turnover, the distance between the upper surface of the forks and the ground shall be ≤75mm.

Schematic Diagram of Forklift Turnover



Schematic Diagram for Height Requirement of Turnover Forks of Hydraulic Forklift Truck

4.2 Unpacking

Before unpacking, please confirm that the outer package is intact. It is recommended to use an art knife to remove the packing straps and wrapping film. It is forbidden to dismantle by force so as to avoid scratching the modules in the box. It is forbidden to unpack in case of wind force > Level 6, in rainy or snowy weather.

Follow the recommended steps below to unpack the modules. When unpacking, there shall be more than 2 persons working, and insulating gloves shall be worn during handling.

If it is not installed in a short time after unpacking, it shall be fixed on the leaning frame with safety rope; in case of long-term non-operation, the modules shall be laid flat on two pallets with suitable size, and it is recommended no more than 14 pieces of modules on a single pallet.

1. Prepare tools before unpacking: art knife (scissors), safety helmet, anti-falling bracket, safety shoes, and insulating gloves, etc.

2. For the long-side vertical unpacking steps, a special anti-falling bracket must be used:

(1) Cut the wrapping straps, get rid of the wrapping film, and remove the upper cover and the carton;

(2) Insert the anti-falling bracket into the bottom of the pallet from the glass surface or the back plate surface of the module;

(3) Insert the fixing pin into the front hole of the bracket;

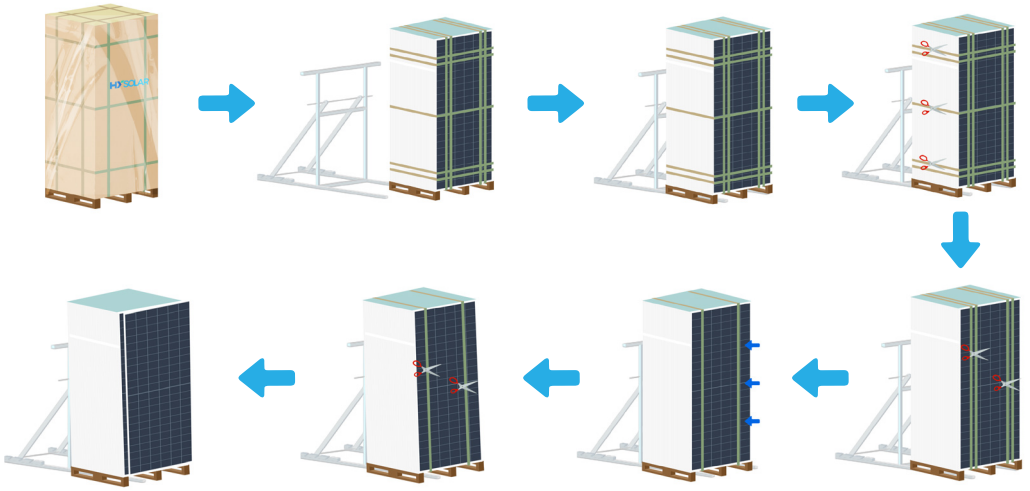
(4) Cut off all the transverse packing straps inside;

(5) Cut off the rest packing straps in the longitudinal direction except the inner two;

(6) Slowly push the module against the bracket;

(7) Cutting off the remaining packing straps;

(8) Tear off the anti-dump adhesive tape on both sides, notice to tear off only one piece of anti-dump adhesive tape with module thickness at a time, and then take out the modules one by one in sequence.



Long-side vertical unpacking steps

3. For the short-side vertical unpacking steps, the module shall be provided with fixed supports (wall surfaces, brackets, or unpacked modules, etc.):

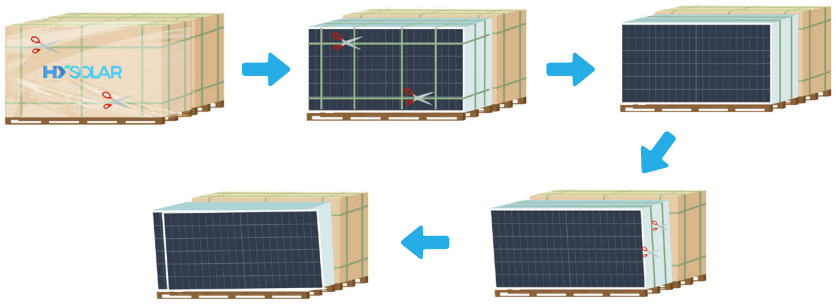
(1) Cut all the packing straps of the outer box, remove the wrapping film, and remove the upper cover and the carton;

(2) Cut off all the transverse packing straps inside, and cut off the rest packing straps in the longitudinal direction except the two inside packing belts;

(3) Push the module against the stable support;

(4) Cutting off the remaining packing straps;

(5) Take out the modules one by one in sequence.



Short-side vertical unpacking steps

4.3 Stacking of PV modules

When the PV module is taken out of the packaging box, the cardboard shall be laid on the ground to prevent the PV module from being scratched due to collision and friction with hard objects on the cement surface/ground, or color steel tiles, or metal corrugations, etc.

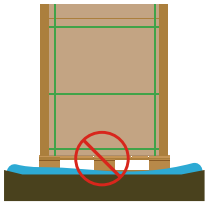
The PV modules shall be stacked on the horizontal plane in an orderly and stable manner. The piece of module at the bottom shall be stacked with the glass upside and the rest shall be stacked with the glass downside. At the same time, cardboard shall be laid under the PV modules. The stacking quantity is recommended to be no more than 14 pieces. Objects such as installation tools, etc. shall be avoided from being placed on the surface of the PV module.

Current classification is adopted for HY SOLAR modules. The handling personnel shall place them separately and mark them according to the identification on the power list of the outer package of PV modules. According to the requirements of system design, the same current grade is generally required in the same array during installation.

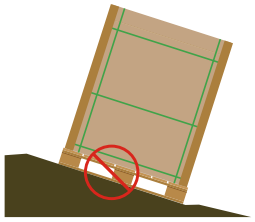
If the customer requires the PV modules to be distinguished by color, the outer packing box has been marked accordingly, and the PV modules shall be marked to avoid confusion when they are taken out of the packing box and stacked. According to the requirements of system design, the colors of PV modules in the same row or in the same matrix shall be consistent.

It is forbidden to store modules in soft geological conditions or where there is ponding, and it is forbidden to place modules on slopes > 4°.

If the modules need to be stored for a long time, it is recommended to store them in a standard warehouse, check them regularly, and reinforce the abnormal inclined packages in the warehouse in time.



It is forbidden to stack in the place where the floor is soft and there is ponding.



It is forbidden to stack on the slope> 4°.

05 Mechanical installation

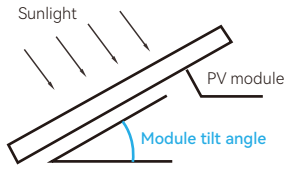
5.1 Installation environment

- Recommended ambient temperature:-20° C to+50° C; extreme operating ambient temperature of PV module:-40° C to+85°C.
- PV module mechanical load: Under standard installation conditions, the maximum test snow/wind load is 5400Pa/2400Pa respectively , and the design load (considering 1.5 safety factor) is 3,600Pa/1,600Pa. For specific installation method and mechanical load value of PV module, please refer to 5.3 Detailed Installation Instructions for PV Module.
- It is forbidden to install and use PV modules in extreme environments such as hail, snow, hurricane, sandstorm, smoke, air pollution and soot. It is forbidden to install and use the PV module in the environment with strong corrosive substances (such as salt, salt mist, salt water, active chemical vapor, acid rain, strong vapor enclosed environment or any other substances that will corrode the PV module and affect the safety or performance of the PV module).
- If PV modules are to be installed in high-temperature and high-humidity environment, wet salt mist environment (in the C3 area and above specified in ISO9223), water, farms and other special environments, the Buyer or the user shall inform HY SOLAR in advance. The type, BOM and quality warranty of PV modules used in such areas shall be determined by both parties through re-agreement.

If the above precautions are not observed, the warranty of HY SOLAR shall be invalid.

5.2 Selection of installation inclination angle

- The installation angle of the PV module refers to the angle between the PV module surface and the ground plane, as shown in the Figure. The maximum power output is obtained when the PV module is directly facing the sun.
- When installed in the northern hemisphere, the PV modules should preferably face south. When installed in the southern hemisphere, the PV modules should preferably face north. For detailed installation inclination angle, please follow local regulatory guidelines or recommendations from experienced PV module installers. The installation tilt angle of the PV module recommended by HY SOLAR is not less than 10 ° , so that the dust on the surface of the PV module is easy to be taken away by rain when it rains, so as to reduce the cleaning times of the PV module; mean while, it is beneficial for the accumulated rainy water on the surface of PV modules to flow away, so as to avoid a large amount of long-time accumulated water from leaving marks on the glass surface, thereby affecting the appearance and performance of the PV module.
- The PV modules connected in series shall be installed in the same orientation and angle. Different orientations and angles may result in different amounts of solar radiation received by each module, resulting in a loss of power.



Schematic Diagram of Installation Tilt Angle of PV Module

5.3 Installation guidelines

- The PV module mounting rack must be made of durable, corrosion-resistant and ultraviolet-resistant materials, and the mounting rack system must be subjected to static mechanical analysis test by the competent third-party testing agency to meet the requirements of the country, region or corresponding international standards.
- The PV module must be securely fastened to the mounting rack. If the PV module is installed in snowy areas, the height of the rack shall ensure that the lowest point of the PV module will not be covered by snow. In addition, ensure that the lowest point of the PV module is not shadowed by surrounding trees or other vegetation.
- When the PV module is mounted on the ground, it is recommended that the minimum distance from the floor to the

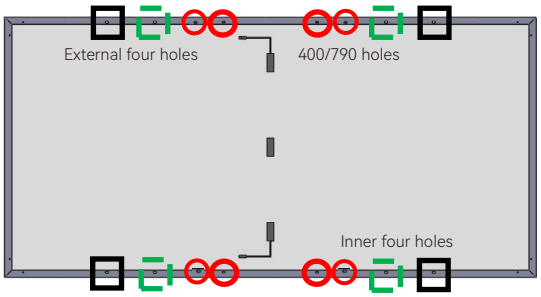
bottom of the module be at least 60cm.

- When the PV module is mounted on a support parallel to the roof, the minimum clearance between the PV module frame and the roof is 10cm and air circulation is required, so as to prevent the PV module from being damaged.
- The PV module frame will have the effect of temperature expansion and cold contraction, and the spacing between two adjacent PV module frames during installation shall not be less than 20mm.

For specific installation methods, please refer to the following installation specifications.

5.3.1 Fixing method of bolt

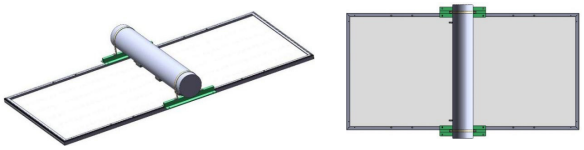
There are at least 4ϕ9*14mm mounting holes matching M8 bolts on the frame of each module (most of version modules have 8, hereinafter referred to as external four holes and inner four holes), and some of version modules have additional 7*10mm mounting holes (hereinafter referred to as 400/790 holes) matching M6 bolts. (Note: All parts in contact with the frame shall use flat washers with a minimum thickness of 2mm and an outer diameter ≥18mm.)



Installation Diagram of Component Mounting Hole

Installation of single-axis tracking system:

Single-axis tracking method: M6 bolt, two flat washers, one spring washer and nut are usually adopted to connect the 400/790 holes on the long frame of the module to fix the module on the tracking axis. Installation torque range of fasteners: 8~14N·m. When installing accessories, take care to avoid the junction box or provide buffer protection measures.



Schematic Diagram of Installation of Single-Axis Tracking System Module

The installation method in this manual is only for guidance. The design of tracking support system, selection of accessories and installation of modules shall be completed by professional installer. The load of single-axis support system refers to the installation load value of 400/790-hole bolt, but it is affected by the material and design of rack manufacturer.

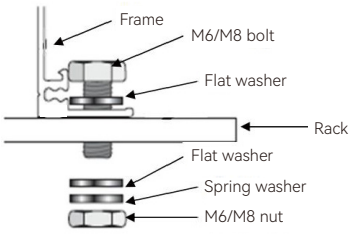
All fittings shall be kept and tightened on tracker by wrench when using a cushion block *. And parts shall be kept in the center of the module without connecting junction box directly to avoid force caused.

For maximum safety protection against wind and snow loads, it is recommended that all available mounting holes be used; and in coastal areas, it is recommended to use four bolts plus medium pressure clamp. **The bolt installation steps are as follows:**

① The PV module is placed on the support rack.

② As shown in the above bolt installation diagram, insert 4 stainless steel bolts (M8) into the mounting hole (9x14mm).

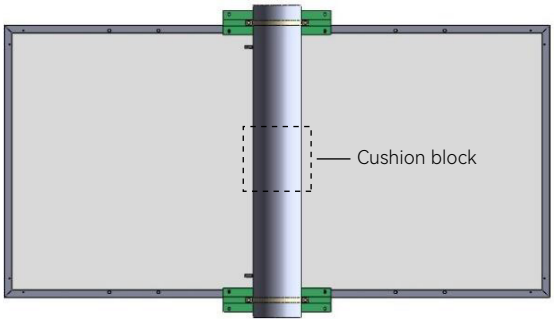
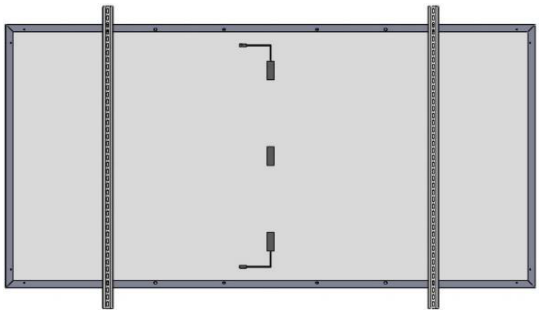
The size of mounting holes shall be 7x10mm at 400/790mm spacing and 4 stainless steel bolts of M6 type shall be used.



③ Ensure that two stainless steel washers are adopted for each bolt, one on the upper side and one on the lower side of the rack. The washer shall have a minimum thickness of 2mm and an outside diameter of 18mm, and is screwed on a stainless steel spring washer or toothed lock washer. Finally, lock with stainless steel nut, square nut is recommended

④ The tightening torque of M6 bolt is recommended to be 9~12Nm, and the tightening torque of M8 bolt is recommended to be 17~23Nm.

Due to possible differences in bolt material, the specific torque value shall be subject to the information confirmed by the bolt supplier.

Installation mode A: installation of single-axis tracking system	Installation mode B: the beam perpendicular to the long frame
	

Maximum design load corresponding to installation of single-glass module				
Product type	Mounting mode A		Mounting mode B	
	400 holes	790 holes	Inner four holes	External four holes
HY-NT10/54H	---	---	3600/1600	---
HY-NT10/54BH	---	---	3600/1600	---
HY-P10/54H	---	---	3600/1600	---
HY-P10/54BH	---	---	3600/1600	---
HY-NT10/60H	---	---	3600/1600	---
HY-P10/60H	---	---	3600/1600	---
HY-NT10/72H(35H)	1600/1266	---	---	3600/1600
HY-NT10/72H(30H)	---	1600/1600	---	3600/1600
HY-P10/72H(35H)	1600/1266	---	---	3600/1600
HY-P10/72H(30H)	---	1600/1600	---	3600/1600
HY-NT12/60H	1266/1266	1600/1600	---	3600/1600
HY-NT12/66H	1266/1266	1600/1600	---	3600/1600
HY-NT11/48H	---	---	---	3600/1600
HY-NT11/48BH	---	---	---	3600/1600
HY-NT11/54H	---	---	---	3600/1600
HY-NT11/54BH	---	---	---	3600/1600
HY-NT11/60H	---	1600/1600	---	3600/1600
HY-NT11/66H	---	1600/1600	---	3600/1600

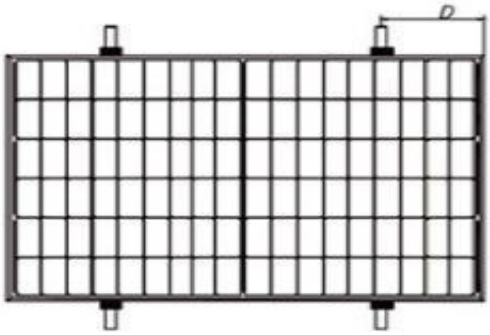
Maximum design load corresponding to installation of double-glass module				
Product type	Mounting mode A		Mounting mode B	
	400 holes	790 holes	Inner four holes	External four holes
HY-NT10/54GDF	---	---	3600/1600	---
HY-NT10/54BGDF	---	---	3600/1600	---
HY-P10/54GDF	---	---	3600/1600	---
HY-NT10/60GDF	---	---	3600/1600	---
HY-NT10/60BGDF	---	---	3600/1600	---
HY-P10/60GDF	---	---	3600/1600	---
HY-NT10/72GDF	1200/1200	1600/1600*	---	3600/1600
HY-P10/72GDF	1200/1200	1600/1600*	---	3600/1600
HY-NT10/78GDF(35H)	---	---	---	3600/1600
HY-NT10/78GDF(30H)	---	1600/1600*	3600/1600	2400/1600
HY-NT12/60GDF(35H)	1466/1466	---	---	3600/1600
HY-NT12/60GDF(33H)	1333/1333	1866/1600*	---	3600/1600
HY-NT12/66GDF (35H)	1466/1466	---	---	3600/1600
HY-NT12/66GDF(33H)	1333/1333	1866/1600*		3600/1600
HY-NT11/48GDF	---	---	---	3600/1600
HY-NT11/48BGDF	---	---	---	3600/1600
HY-NT11/48GSF	---	---	---	3600/1600
HY-NT11/48BGSF	---	---	---	3600/1600
HY-NT11/48QGDF	---	---	---	3600/1600
HY-NT11/48QGSF	---	---	---	3600/1600
HY-NT11/54GDF	---	---	---	3600/1600
HY-NT11/54BGDF	---	---	---	3600/1600
HY-NT11/54GSF	---	---	---	3600/1600
HY-NT11/54BGSF	---	---	---	3600/1600
HY-NT11/60GDF	1066*	1600/1600*	---	3600/1600
HY-NT11/66GDF	1066*	1600/1600*	---	3600/1600
HY-NT11/66QGDF	1066*	1600/1600*	---	3600/1600
HY-NT11/78GDF	---	---	3600/1600	3600/1600

Maximum design load corresponding to installation of double-glass module				
Product type	Mounting mode A		Mounting mode B	
	400 holes	790 holes	Inner four holes	External four holes
HY-NT10/54GDF（188）	---	---	3600/1600	---
HY-NT10/54BGDF（188）	---	---	3600/1600	---
HY-NT10/60GDF（188）	---	---	3600/1600	---
HY-NT10/60BGDF（188）	---	---	3600/1600	---

Note: Test load=ym (1.5 times safety factor)×design load. Cushion blocks are used for those marked with "*". "(188)" represents a 182.2*188 cell.

5.3.2 Fixing method of clamp

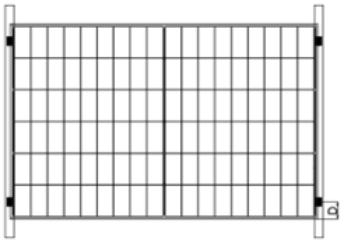
The quantity and position of clamp are very crucial for the reliability of installation. Generally, the number of clamp must not be less than 4. According to the requirements of different loads and installation methods, the position of the center line of the clamp is specified. During installation, the clamp must be within the allowable installation range.

Installation mode C: four clamps are fixed, and the beam is perpendicular to the long frame		
		
Maximum design load corresponding to installation of single-glass module		
Product type	Mounting mode C	
	Installation range D (mm)	Design load (pa)
HY-P10/54H	316≤D≤416	3600/1600
HY-P10/54BH	316≤D≤416	3600/1600
HY-NT10/54H	316≤D≤416	3600/1600
HY-NT10/54BH	316≤D≤416	3600/1600
HY-P10/60H	335≤D≤435	3600/1600
HY-NT10/60H	335≤D≤435	3600/1600
HY-P10/72H	400≤D≤500	3600/1600
HY-NT10/72H	400≤D≤500	3600/1600
HY-NT12/60H	385≤D≤485	3600/1600
HY-NT12/66H	450≤D≤550	3600/1600
HY-NT11/48H	316≤D≤416	3600/1600
HY-NT11/48BH	316≤D≤416	3600/1600
HY-NT11/54H	345≤D≤445	3600/1600
HY-NT11/54BH	345≤D≤445	3600/1600
HY-NT11/60H	385≤D≤485	3600/1600
HY-NT11/66H	475≤D≤525	3600/1600

Maximum design load corresponding to installation of double-glass module		
Product type	Mounting mode C	
	Installation range D（mm）	Design load（pa）
HY-P10/54GDF	316≤D≤416	3600/1600
HY-P10/54BGDF	316≤D≤416	3600/1600
HY-NT10/54GDF	316≤D≤416	3600/1600
HY-NT10/54BGDF	316≤D≤416	3600/1600
HY-P10/60GDF	335≤D≤435	3600/1600
HY-NT10/60GDF	335≤D≤435	3600/1600
HY-NT10/60BGDF	335≤D≤435	3600/1600
HY-P10/72GDF	440≤D≤490	3600/1600
HY-NT10/72GDF	440≤D≤490	3600/1600
HY-NT10/78GDF	480≤D≤580	3600/1600
HY-NT12/60GDF	450≤D≤530	3600/1600
HY-NT12/66GDF	440≤D≤540	3600/1600
HY-NT11/48GDF	316≤D≤416	3600/1600
HY- NT11/48BGDF	316≤D≤416	3600/1600
HY-NT11/48GSF	316≤D≤416	3600/1600
HY-NT11/48BGSF	316≤D≤416	3600/1600
HY-NT11/48QGDF	316≤D≤416	3600/1600
HY-NT11/48QGSF	316≤D≤416	3600/1600
HY-NT11/54GDF	345≤D≤445	3600/1600
HY-NT11/54BGDF	345≤D≤445	3600/1600
HY-NT11/54GSF	345≤D≤445	3600/1600
HY-NT11/54BGSF	345≤D≤445	3600/1600
HY-NT11/60GDF	385≤D≤485	3600/1600
HY-NT11/66GDF	440≤D≤540	3600/1600
HY-NT11/66QGDF	440≤D≤540	3600/1600
HY-NT11/78GDF	480≤D≤580	3600/1600
HY-NT10/54GDF（188）	316≤D≤416	3600/1600
HY-NT10/54BGDF（188）	316≤D≤416	3600/1600
HY-NT10/60GDF（188）	335≤D≤435	3600/1600
HY-NT10/60BGDF（188）	335≤D≤435	3600/1600

Note: Test load=ym (1.5 times safety factor)×design load."(188)" represents a 182.2*188 cell.

Installation mode D:Short edge installation. Four clamps are fixed, and the beam is perpendicular to the long frame.
Overlap width between the beam and the short side of the module shall be≥ 20mm.
The length of the clamps shall be ≥60mm. It is recommended to use clamps with an arc design to fit the A-side frame, featuring a non-slip and anti-detachment design.



Maximum design load corresponding to installation of double-glass module

Product type	Mounting mode D	
	Installation range D (mm)	Design load (pa)
HY-NT11/48GDF	50≤D≤150	1066/1066
HY-NT11/48BGDF	50≤D≤150	1066/1066
HY-NT10/54GDF（188）	50≤D≤150	1066/1066
HY-NT10/54BGDF（188）	50≤D≤150	1066/1066
HY-NT10/60GDF（188）	50≤D≤150	866/666
HY-NT10/60BGDF（188）	50≤D≤150	866/666

Note: Test load=ym (1.5 times safety factor)×design load."(188)" represents a 182.2*188 cell.

⚠ Special Notes

The length of the rack must be longer than the size of the PV module, or it shall be confirmed by HY SOLAR in advance;

The above two diagrams show the installation method by using aluminum clamp . "D" indicates the allowable installation range of aluminum clamp, and the specific recommended installation position and corresponding load are as shown in Table 1("---" indicates that the PV module is not applicable to the above installation method).

Each aluminum clamp is matched with an M8 bolt, a flat washer, a spring washer and an M8 nut, square nut is recommended, and the fixing steps are as follows:

① Place the PV module on two racks (not provided). Which must be made of stainless steel or be treated with corrosion protection (e. g. hot-dip galvanized treatment). Each PV module needs at least 4 clamps to fix. During installation, please do not let the clamp directly contact the glass and deform the frame, otherwise it will result in PV module damaged.

② Be sure to avoid the shading effect of the PV module due to the shadow formed by the clamp. The drain hole shall not be covered by the clamp . The clamp must have an overlap of at least 10mm with the PV module frame (the section of the clamp can be changed on the premise of ensuring the reliable installation of the PV module).

③ The upper surface of the rack in contact with the PV module frame shall be provided with a groove matched with the M8 bolt.

④ If there is no groove on the rack, a hole of appropriate diameter shall be drilled at the position mentioned above for bolt fixing.

⑤ Make sure that the installation sequence of each clamp is flat washer, spring washer and nut.

⑥ Figure 1 shows the middle mounting clamp , and Figure 2 shows the edge mounting clamp and its cross section view. The size of the middle and side pressing blocks are a≥50mm, b≥26mm, c≥5mm, d≥28mm, ☒=9mm and the recommended wall thickness≥4mm. When the bolts and screws are of Grade 8.8, the recommended tightening torque is 17-23Nm. Consult the installer or rack supplier for specific torque values.

⑦ In order to prevent the module from falling off from the frame after installation, it is recommended to select the clamp with patterned groove structures for edge and intermediate clamp k with contact surfaces with frame A. The recommended number of groove structures is about 9, the distance between adjacent grooves is recommended to be about 1.2mm, and the groove depth is recommended to be about 0.6mm, as shown in Figure 2.

⑧ The PV module shall be fixed by using professional solar clamp (as shown in Figure 3), and the overlapping part between the surface C of PV module and the guide rack shall be ≥15mm. If improper clamp or incorrect installation method is used, the warranty of HY SOLAR will be invalid.

⑨ For the modules with the length of more than 2.2m or the width of more than 1.3m, it is recommended to use the clamp with special anti-skidding design. If it is attached to the arc-shaped pressing surface of side A of the frame, or with the structure design of clamping, the clamp shall meet the requirements of length a≥ 60mm, thickness ≥5mm, material 6005-T6, Rp0.2>225MPa, and Rm265MPa. Technical requirements and details of pressing clamps can be consulted by after-sales service team of HY SOLAR.

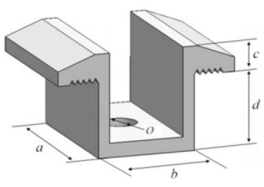


Figure 1
Schematic Diagram of Intermediate Clamp

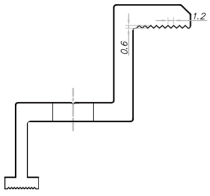


Figure 2 Schematic Diagram of Cross Section of Edge Clamp

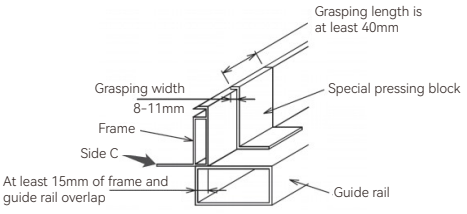


Figure 3 Requirements for Installation of Clamp for Ovrlapping Long Frame of guide rail

06 Electrical installation

6.1 Electrical performance

The rated electric performance data of the modules were measured under standard test conditions (STC: irradiance 1000W/m2, AM1.5, cell temperature 25°C). For the main electric performance parameters, maximum system voltage and Isc, Voc and Pmpp, please refer to the product datasheet or nameplate of HY SOLAR Module.

In some circumstances, the current or voltage generated by the PV Module may be greater than the operating current or voltage in its standard testing environment (STC). Therefore, in determining ratings and loads of the module, the module short-circuit current at the STC should be multiplied by 1.25 and the open-circuit voltage should be multiplied by a more conservative correction factor (see Table 2 below), and the module short-circuit current should be multiplied by 1.25(i. e., multiplied by 1.56) according to local regulations when determining the appropriate conducting wire and fuse specification.

In addition, a more accurate open circuit voltage correction coefficient can be calculated according to the following formula:

$$Cvoc=1-\alpha voc \times (25-Tmin)$$

Where: Cvoc is the open circuit voltage correction coefficient. αvoc (%/ ° C) is the temperature coefficient of the open-circuit voltage of the selected module (refer to the module specification). Tmin (° C) is the lowest expected ambient temperature where the system is installed.

The voltage of the string shall not be higher than the maximum voltage that the system can withstand as well as the maximum input voltage of the inverter and other electrical equipment in the installation system. To ensure this, the string open-circuit voltage can be calculated by using the following formula:

$$\text{Maximum system voltage} \geq N*Voc*Cvoc$$

Where: N-Number of serial module. Voc-open circuit voltage of each PV module (refer to nameplate or product manual).

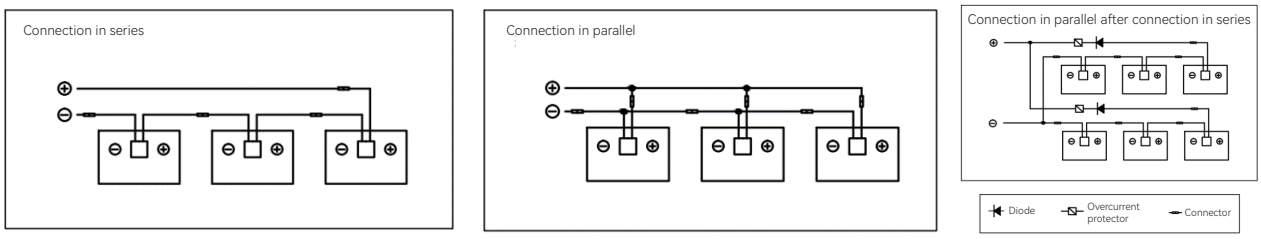
⚠ Special Notes

According to the maximum rated fuse current of the PV module and local electrical installation standards, suitable fuses or anti-reverse diodes are required for the parallel connection of the PV module based on circuit protection principles.

The electrical design and calculation of the system shall be determined by the qualified electrical engineers.

6.2 Electric connection

In order to ensure the normal operation of the system, when connecting the PV module or connecting the load (such as frequency converter, or battery, etc.), it is necessary to observe and ensure that the polarity of the cable is connected correctly. If the PV module is not connected correctly, the bypass diode may be damaged. The Figure shows the connection of PV modules in series and in parallel. The PV module can be wired in series to increase voltage by connecting the wiring from the positive terminal of one PV module to the negative terminal of the next PV module. The PV module can be connected in parallel to increase current by connecting the wiring from the positive terminal of one PV module to the positive terminal of the next PV module.



Schematic Diagram of Electric Connection

Special Notes

If one group of arrays is connected to another with opposite polarity, irreparable damage to the product can occur. Be sure to verify the voltage and polarity of each string before connection in parallel. If the measurement shows that the polarity between the string is reversed or the voltage difference is greater than 10V, the structural configuration must be checked before making the connection.

The number of PV modules connected in series and in parallel shall be reasonably designed according to the system configuration. The PV modules of different electric performance models cannot be connected in one string.

Solar dedicated cables and connectors shall be used in the system, and all connections shall be securely fastened. The cable size shall be not less than 4mm²(12AWG), and must withstand the maximum open circuit voltage of the PV system.

When the cable is fixed on the rack, it is necessary to avoid mechanical damage to the cable or PV module, and do not press the cable with force. Cables shall be fixed by proper means, and shall be fixed on the rack by specially designed binding coils and wire clamps that are resistant to ultraviolet light. Avoid direct sunlight and water soaking of cables.

Keep the connector dry and clean, and make sure that the nut of the connector is in a tightened state before connecting. Do not connect the connector when it is found to be wet, dirty or in other bad conditions. Protect connectors from direct sunlight and immersion in water. Avoid landing the connector on the ground or on the roof.

When the PV module is in load condition , please do not insert or unplug the connector. When it is necessary to disconnect the connector, it is required to ensure that the PV module is in load condition and professional unlocking tools and safety protection measures must be used. It is forbidden to pull or damage the locking structure.

The junction box of the PV module contains a bypass diode which is connected in parallel with the cell string of the PV module. The bypass diode in the junction box can avoid the PV module performance degradation caused by shadow or covering. Please refer to the junction box diode specification provided in the relevant product specification.

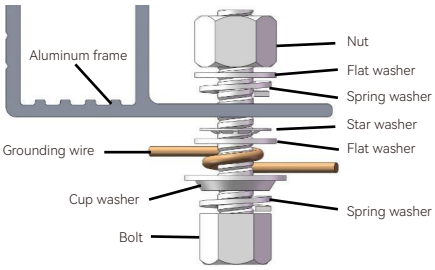
When the local hot spot phenomenon of the PV module occurs due to shadow or covering, the diode in the junction box is triggered in active condition, so that the current of the PV module does not flow through the hot spot cell any more, thereby limiting the heating and performance loss of the PV module. When suspecting or finding that the diode is faulty, please contact HY SOLAR and do not try to open the junction box cover by yourself.

6.3 Grounding

In the design of the PV module, the anodized corrosion-resistant aluminum alloy frame is adopted as the rigid support. In order to ensure the safety in use and avoid the PV module from being damaged by lightning and static electricity, the frame of the PV module must be grounded. When grounding, the grounding device must be in full contact with the interior of the aluminum alloy to penetrate the anodized coating on the surface.

There is a grounding hole with a diameter of about Φ4mm on the edge of the module frame. As well as standard grounding symbol mark "⏚" beside the grounding hole. The grounding wire can be connected with bolts. Please do not drill holes in the module frame or modify the standard holes, otherwise the warranty will be invalid.

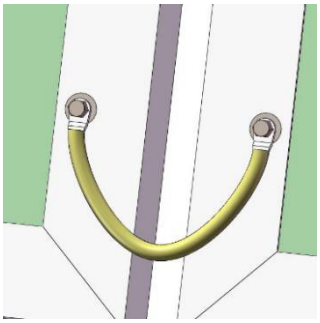
The grounding bolt is made of stainless steel. First insert the bolt through the spring washer, cup washer, flat washer and star washer, and then pass through the grounding hole, spring washer and flat washer of the frame, and finally tighten the bolt with the nut. Please note: the upper limit of temperature of the wire is 85° C. Refer to the Figure for installation of grounding hole for installation diagram.



Grounding Aluminum Bezel With Copper Cable

Modules are grounded to each other:

4mm² copper core wire can be adopted between modules to contact the grounding holes of adjacent modules for mutual connection to complete the safety grounding between modules.

Connection mode	Parts	Schematic diagram
Place the washer and the grounding wire in sequence, use the bolt to pass through the grounding hole of the adjacent modules, and then use the nut to tighten and fix the grounding wire to complete the grounding of the adjacent modules.		

⚠ Warning

The welding and grounding devices, including Burndy (formerly Wiley Electronics) WEEB and similar equipment such as barb washers, to compliance with the UL-467 and suitable for electrical welding and grounding of PV modules.

Other methods of grounding may be used when testing support systems as required by UL2703. Do not drill any additional grounding holes in the frame of the PV module.

Holes marked with grounding marking on the frame can only be used for grounding, and cannot be used for PV module installation.

Do not do electrical connections between modulesbefore grounding.

07 Maintenance

The PV modules must be checked and maintained regularly, especially during the warranty period. This is the liability that the user shall undertake, which will help to identify and eliminate problems in time and ensure the safe and effective operation of the PV system.

7.1 Routine inspection

Regularly check must be conducted to see whether the PV modules in the PV array are damaged, such as broken glass, broken cables, damaged junction boxes, damaged cells, cracked back-sheet and other factors that may lead to functional and safety failures of PV modules. In case of the above problems, the supplier shall be informed to replace the PV module of the same type in time.

It is recommended to perform a preventive inspection every 6 months, and not to replace components of PV modules without authorization. If inspection or maintenance of electrical or mechanical performance is required, it is recommended that the operation be carried out by a qualified professional to avoid electric shock or personal injury or death.

Routine maintenance measures shall be taken to keep PV modules free of snow, bird droppings, seeds, pollen, leaves, branches, dust, and stains, etc.

7.2 PV module cleaning

If there is a lot of dirt accumulation on the surface of PV module, which has seriously affected the power generation, the cleaning shall be carried out in the early morning, evening, or cloudy day (when the irradiance is lower than 500W/m^2), and it is strictly prohibited to carry out the cleaning operation before or after noon or in the period of strong direct sunlight; and when cleaning in the morning and evening, it shall be carried out in the period with weak sunlight, so as to prevent the glass cover plate from cracking due to the heat and cold action of the PV module.

Requirements of Cleaning Fluid:

1) Water shall be neutral, with PH: 6-8;
2) Electroconductibility: ≤500μs/cm;
3) Total dissolved solid volume: ≤1000mg/L;
4) Water hardness: ≤300mg/L;
5) Water pressure at nozzle: not more than 0.5Mpa.

Precautions for cleaning:

1) The temperature difference between the water used for PV module cleaning and the module shall not be greater than 10° C; and when the ambient temperature is lower than 5° C, the PV module shall not be cleaned to avoid cracking PV glass;
2) It is forbidden to clean the PV module under the meteorological conditions including wind force greater than level 4, heavy rain or heavy snow, heavy rain, sand blowing and hail;
3) The PV modules shall be wiped with dry or damp soft and clean cloth. It is strictly forbidden to use corrosive solvents or hard objects to clean PV modules;
4) It is forbidden to wipe the PV module with materials with high roughness and hardness;
5) Do not clean module when glass is broken or wires are exposed to avoid electric shock;
6) Do not leave any cleaned tools on the glass to avoid hot spots;
7) Please do not stand on the surface of the module glass to avoid micro crack of the cell.
8) The PV module shall be cleaned by qualified professionals, and they must wear safety helmets, safety belts, insulation gloves, safety shoes, protective clothing and other safety protection tools correctly before and during cleaning to prevent falling and electric shock.

Appendix A: Installation Guidelines for Offshore Photovoltaic Modules

In accordance with the conditions specified in the HY SOLAR Module Installation Manual and the warranty statement, the installation of our company's photovoltaic modules in offshore areas must be carried out strictly in accordance with this installation guide.

This appendix is intended to allow customers to install photovoltaic modules within offshore areas. It specifies the general requirements for ensuring the correct and reliable installation of our company's photovoltaic modules in offshore areas, including but not limited to the anti-corrosion principles for modules and related installation systems.

Before installing photovoltaic modules in offshore areas, please carefully read this appendix and strictly follow the relevant guidelines. Failure to comply with these guidelines and other general anti-corrosion principles may result in environmental corrosion damage to photovoltaic modules and bracket systems, and render HY SOLAR's product and performance limited warranty invalid. For further consultation, please contact our technical after-sales service department for more information.

The reliability of photovoltaic modules is closely related to their distance from the coastline. Offshore land areas are divided according to their distance from the coastline. HY SOLAR usually divides coastal photovoltaic installation types into 5 different usage scenarios, as shown in the following table:

Scenario Definition	Module	Mounting Structure Requirements
Offshore (Floating)	Double-glass with front-side double coating + AA20 aluminum frame + IP68 junction box and connectors + caps. Recommendation: Dual protection for connectors + waterproof cables.	Anti-corrosion
Nearshore (Floating / Pile foundation)	Double-glass with front-side double coating + AA20 aluminum frame + IP68 junction box and connectors + caps. Recommendation:Dual protection for connectors.	Anti-corrosion
Tidal Flat (Pile Foundation)	Double-glass with front-side double coating + AA20 aluminum frame + IP68 junction box and connectors + caps. Recommendation:Dual protection for connectors.	Anti-corrosion
Distance from Sea: 500m - 2000m	Standard double-glass product.	Standard
Distance from Sea: ≥2000m	Standard double-glass or conventional single-glass product.	Standard

1."Offshore photovoltaic" module products refer to a type of module products specially designed for offshore areas. These module products have undergone special material matching and strict third-party reliability enhanced testing, and can meet the anti-corrosion installation and use requirements in offshore areas.

2.For "offshore photovoltaic" module products, they must be installed above the sea level, and after installation, the modules must not come into contact with the highest water level during high tide.

3.The local environmental conditions have a significant impact on the salt mist deposition rate, which depends to a large extent (but not absolutely) on the specific area and local wind patterns. HY SOLAR reserves the right to modify the above definitions in specific cases. Please contact HY SOLAR's pre-sales technical support to determine the type of your photovoltaic system.

4.The "coastline" mentioned in this manual refers to the boundary line between seawater and land at high tide.

5.The "distance from the coastline" mentioned in this manual refers to the shortest straight-line distance between the photovoltaic modules, strings and the coastline.

6.Please contact HY SOLAR's technical support department for more information on the installation of anti-corrosion modules. During installation, the surface of the module must not come into contact with sharp objects, and there must be no scratches on the surfaces of glass, frames, connectors, junction boxes, etc.

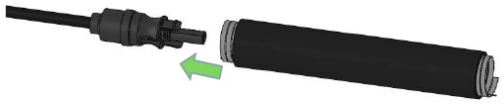
7.Do not alter the module structure, such as drilling holes in the module frame.

8.The process specifications of parts and components must comply with relevant international anti-corrosion standards.

9.Regularly maintain anti-corrosion coatings (photovoltaic brackets, fasteners, grounding devices, etc.).

10.Modules (glass, junction boxes, connectors, etc.) are prohibited from long-term exposure to environments containing sulfur, strong acids, strong alkalis, and other substances that pose a corrosion risk to the products. They are also prohibited from contacting organic solvents that can damage the anti-reflective coating of the front glass or the polymers of the junction boxes and backsheets.

11.Before installation, the connectors are protected by dust plugs/waterproof plugs (blocking plugs). After removing the dust plugs, the connectors should be connected immediately to prevent moisture, mud, and other foreign objects from entering and corroding the conductive metals inside the connectors. If further enhancement of anti-corrosion performance is required, add cold shrink tubes to protect the connectors after installation. The connectors and cold shrink tubes are prohibited from being used underwater. (The cold shrink tubes must meet the quality and technical requirements of HY SOLAR.)

Guidelines and Recommendations for Cold Shrink Tube Installation		
Step	Method Description	Example
1	After disconnecting the photovoltaic connector, take either end and slide the cold shrink tube onto the connector in the direction shown in the right figure.	

Guidelines and Recommendations for Cold Shrink Tube Installation		
Step	Method Description	Example
2	Slide the cold shrink tube over the head of the connector, leaving the head exposed.	
3	Connect the positive and negative poles of the connector in the correct manner.	
4	Position the connection interface at the middle of the cold shrink tube.	
5	Pull the inner ring strip exposed in the cold shrink tube by hand, rotating it while pulling outward until the inner ring is completely removed.	
6	The cold shrink tube has completely shrunk and sealed the connector.	

Installation and Precautions for Cold Shrink Tubes:
① Before installation, ensure there are no foreign objects such as sand, water droplets, or sharp objects inside the cold shrink tube;
② It is prohibited to tie nameplates to the cold shrink tube to prevent the cable ties from scratching the tube;
③ Pay attention to on-site environmental protection (proper disposal of support strips, instructions, and packaging bags);
④ There shall be no cracks or gaps at both ends of the cold shrink tube, and no holes on the surface;
⑤ The cold shrink tube shall shrink smoothly and naturally to fit tightly on the connector and cable, with no wrinkles or bulges allowed.

12.When installing offshore photovoltaic modules, all requirements listed in the HY SOLAR Installation Manual shall be followed.

13.To minimize salt mist corrosion, HY SOLAR recommends the following:

13.1 It is recommended to use anti-corrosion materials for the 支架 (supports) and system-related installation components (such as SUS 316 stainless steel, hot-dip galvanized carbon steel, new anti-corrosion materials like Zn-Al-Mg composite coated steel, etc.).

13.2 To avoid torque attenuation of module mounting bolts caused by eddy currents, wind vibration, etc., it is recommended to use anti-loosening bolts.

13.3 The coating thickness of hot-dip galvanized and anodized components must meet the minimum requirements specified in JIS H 8641 and JIS H 8601 standards.

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