



INSTALLATION MANUAL OF PHOTOVOLTAIC MODULE
——Double Glass

INSTALLATION MANUAL

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1. INTRODUCTION FOR INSTALLATION MANUAL

This Manual applies to the installation, maintenance and use of the dual glass series solar modules manufactured by Huansheng Photovoltaic (Jiangsu) Co., Ltd (hereinafter referred to as “HUANSHENG SOLAR”). Failure to follow these safety instructions could result in personal injury 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 dual glass series solar modules. Please keep this Manual for future reference.

This Manual applies to the below model number series:

HSM-ND48-DR435	HSM-ND48-GR435	HSM-ND54-GR495	HSM-ND72-GF580
HSM-ND48-DR440	HSM-ND48-GR440	HSM-ND54-GR500	HSM-ND72-GF585
HSM-ND48-DR445	HSM-ND48-GR445	HSM-ND54-GR505	HSM-ND72-GF590
HSM-ND48-DR450	HSM-ND48-GR450	HSM-ND54-GR510	HSM-ND72-GF595
	HSM-ND48-GR455	HSM-ND54-GR515	HSM-ND72-GF600

1.1 DISCLAIMER

HUANSHENG SOLAR reserves the rights to change this INSTALLATION MANUAL without prior notice. Failure of the customer to follow the requirements outlined in this Manual during the installation of the module will result in the invalidity of product's limited warranty.

1.2 LIMITATION OF LIABILITY

HUANSHENG SOLAR is not responsible for any form of damage, including but not limited to module operation and system installation error, and personnel injury, hurt, and property loss resulted from failure to follow the instructions in this Manual.

2. SAFETY PRECAUTIONS

2.1 WARNING

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

2.2 GENERAL SAFETY

- All installation work must comply with the local codes and the relevant international electrical standards.
- HUANSHENG 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.
- Do NOT allow unauthorized persons to access the installation area or module storage area.
- Do NOT install modules with damaged glass or damaged backsheet .
- Do NOT disassemble or move any part of the module.
- Do NOT artificially focus the light on the module.

- Do NOT connect or disconnect the module when it is energized.

- Meaning of crossed –out wheeled dustbin on label:



Do not dispose of electrical appliances as unsorted municipal waste, use separate collection facilities. Contact your local government for information regarding the collection systems available. If electrical appliances are disposed of in landfills or dumps, hazardous substances can leak into the groundwater and get into the food chain, damaging your health and well-being.

2.3 HANDLING SAFETY

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



- Do NOT damage or scratch the front or backside surfaces of the module. Do NOT scratch the output cable or bend it with force. The insulation of output cable can break and may result in electricity leakage or shock.
- Do NOT use water to extinguish fires of an electrical origin.
- Do NOT install or handle modules when they are wet or during periods of high wind. At the installation site, take care to keep modules and in particular their electrical contacts, clean and dry before installation. If connector cables are left in damp conditions then the contacts may corrode. Any module with corroded contacts should not be used.
- Please do NOT loosen or unscrew the PV module bolts, which may lead to the module loading drop or even fall down.
- 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 modules should be stored in the original package before installation. Protect the package from damage. Unpack the modules as per the recommended unpacking procedures. The whole

process of unpacking, transport and storing should be handled with care.

- Do NOT stand, climb, walk or jump on unpacked pallets of modules.
- Before installation, ensure that all modules and electrical contacts are clean and dry. If the modules are required to be stored temporarily, they should be stored under dry and ventilated conditions.
- Unpacking must be carried out by two or more persons at the same time. It is forbidden to pull the wires or junction boxes of the modules to carry the modules. Handling the modules requires two or more people with non-slip gloves; do NOT handle the modules in an overhead way or stack the modules.
- Do NOT put the modules in a place that is not supported or fixed.
- 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.

3.1 MAKERS ON OUTER PACKAGING

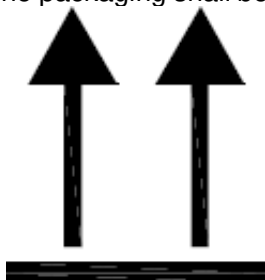
3.1.1 Modules shall be kept dry, not exposing to the rain or moisture.



3.1.2 Modules in carton are fragile, which shall be handled with care.



3.1.3 The packaging shall be transported upright.



3.1.4 Do NOT step on the package and module.



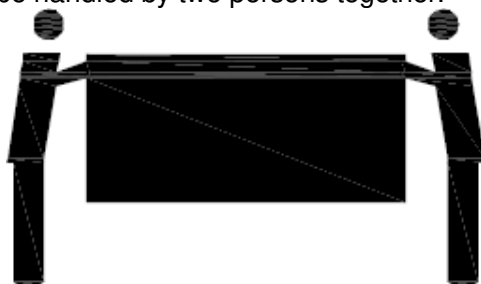
3.1.5 The carton can be recycled.



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

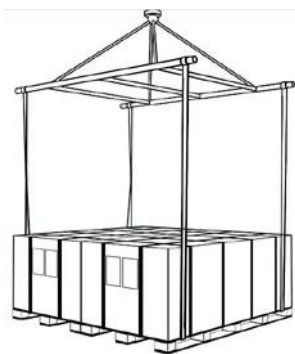


3.1.7 One module shall be handled by two persons together.

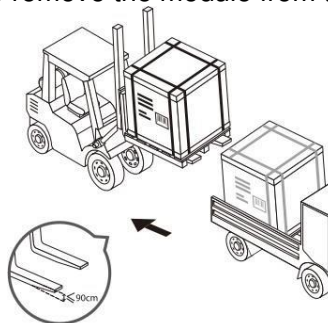


3.2 UNLOADING WARNING

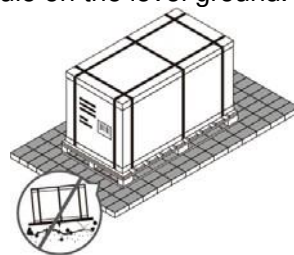
3.2.1 Use the correct (as picture) lifting fixture to handle, no more than 2 pallets for one time lifting. Before lifting, please confirm whether the tray and the carton are damaged and the hoisting rope is firm and solid or not. Before lifting touchdown, two persons shall support at two sides of the righting carton gently to put it on a relatively flat place.



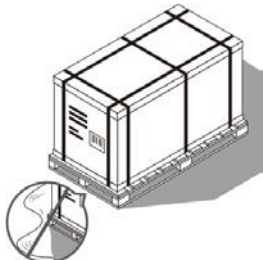
3.2.2 If the condition permits, use a fork lift to remove the module from the truck.



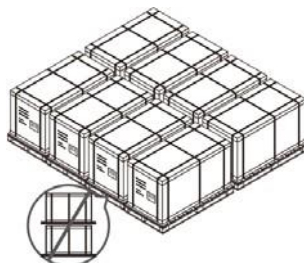
Put the module on the level ground.



3.2.3 Store the module in a dry and ventilated place.



3.2.4 No stacking the modules at the project site.



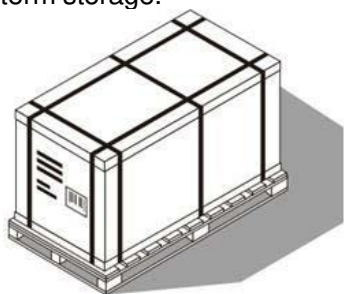
3.2.5

Cover the module with waterproof cloth to prevent it from moisture.

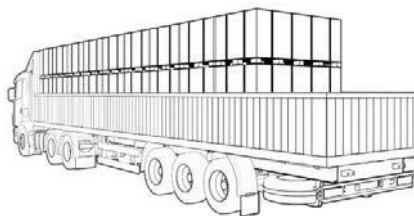


3.3 SECONDARY TRANSPORT AND WARNING

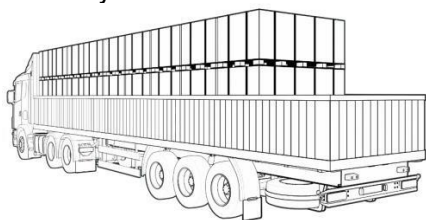
3.3.1 Do NOT remove the original packaging if the modules require long-distance transport or long-term storage.



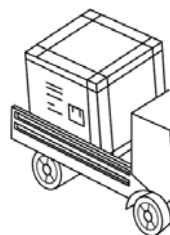
3.3.2 The finished package can be transported by land, sea or air. During transport, make sure that the package is fixed to the shipping platform without moving.



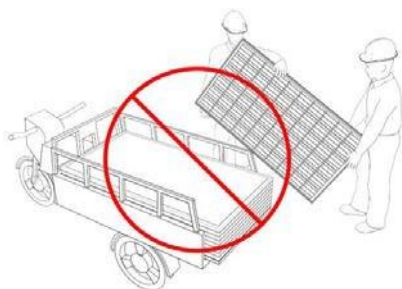
3.3.3 Transport: stacking no more than two layers by truck normally.



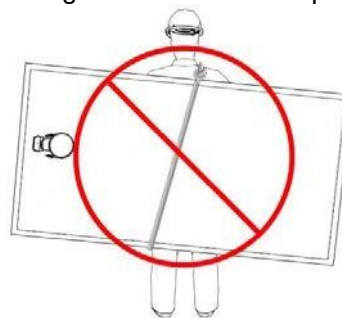
3.3.4 One layer stacking for transport is only allowed at project site.



3.3.5 No transport or handling by pedi-cab as below.



3.3.6 No handling the module with rope.



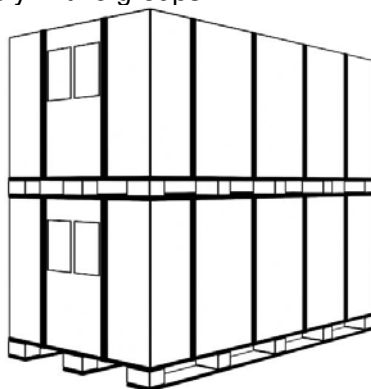
3.3.7 No carrying the modules on the back of one person;



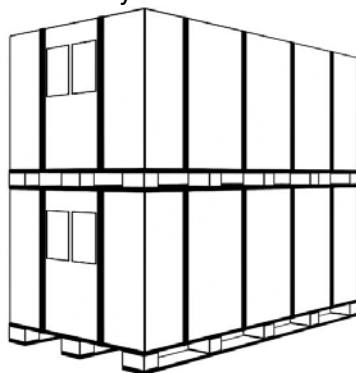
3.4 STORAGE

- Do NOT expose the modules to rain or moisture. Store the finished product in a 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 in the range from -20°C to + 50 °C): Be stacked separately in two groups.



3.4.2 Normal warehouse storage (moisture < 85% and temperature in the range from -20°C to + 50 °C): Be stacked no more than two layers.



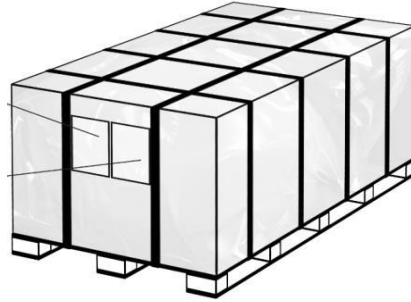
4. UNPACKING INTRODUCTION

4.1 UNPACKING SAFETY:

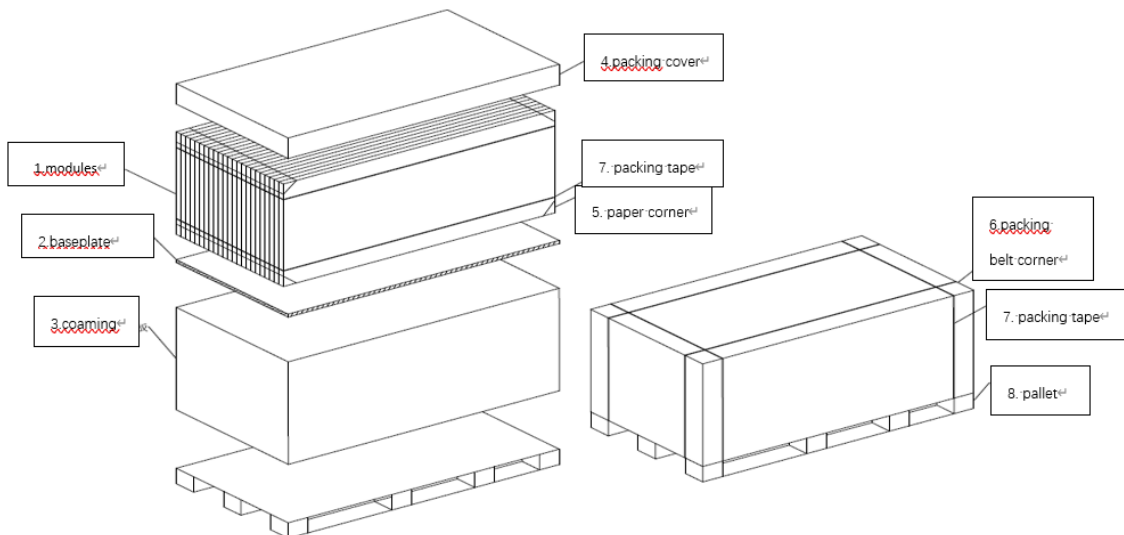
- As for outdoors unpacking, it is prohibited to operate in rainy conditions. Because the carton will become soft and damaged after it gets wet in the rain. The PV modules (hereinafter referred to as "modules") inside the pallet will release, which may cause damage or injury to personnel. If there is wind at site, it is necessary to pay special attention to safety; especially in high wind conditions, it is NOT recommended to transport the modules, and the unpacked modules shall be fixed properly.
- The work surface is required to be level to ensure that the package can be placed stably, avoiding dumping.
- 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 outer package. Please read the instructions before unpacking., .
- Each module shall be handled by two persons. It is forbidden to pull the wires or junction boxes of the modules to carry the module. No pulling the long side frame to take out the module.

4.2 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 and the customized unpacking method is not allowed.



- 4.2.2** The packing box structure consists of modules (no. 1), baseplate (no. 2), coaming (no. 3), packing cover (no. 4), paper corner (no. 5), packing belt corner (no. 6), packing tape (no. 7), and pallet (no. 8).



- 4.2.3** Use an art cutter or other hard object to break out the protective film outside the box. Be careful not to damage the carton and remove the protective film around the box.
- 4.2.4** Cut the outer packing belt of the packing box with an art cutter or scissors, and remove the paper corner and packing tape.
- 4.2.5** One person stands at each end of the box, slowly open the box cover.
- 4.2.6** One person stand at each end of the short side of the box, lift the carton coaming slowly from the bottom. After the carton casing board is separated from the modules, the casing board is removed and then placed between the box and the support to protect the modules from the scratch of the support.
- 4.2.7** One person at each end of the short side of the box to hold the assembly. At the same time, remove the fixed packing tape on the module and slowly tilt the support when removing the packing tape.
- 4.2.8** Two people hold the short edge of the module and lift it to the designated location for installation. (protective gloves must be worn during unpacking to avoid scratches. Please grab the inner side of the border and move the modules. Do not touch the glass

surface with your fingers.

- 4.2.9** If the module is not installed immediately after disassembly, it needs to be moved from vertical to horizontal. Please place a box bottom plate on the tray and stack the glass face down on the tray, but the maximum number of pieces is not more than one box. Note: modules must be aligned after stacking, otherwise they will fall off in transit.

- 4.2.10** Do NOT lean the module on the mounting posts.



5. SITE SELECTION

- Solar modules are recommended to be installed at an optimized tilt angle to maximize the energy output. It is roughly equal to the latitude of the project site as a rule of thumb, facing toward the equator. Optimized system designs incorporate other local requirements.
- When installing solar modules on a roof, the roof must be covered with a layer of fireproof material applicable to this class, and adequate ventilation must be ensured between the back sheet and the installation surface. A safe working area also must be left between the edge of the roof and the external edge of the solar array.
- In the case of residential installations on the ground, modules shall be installed following local regulations, e.g. using fence.
- Position the modules to minimize the chances of shading at any time of the day.
- HUANSHENG SOLAR recommends that the module should be installed at an ambient temperature of $-40^{\circ}\text{C} \sim 40^{\circ}\text{C}$. The module's operating temperature range is from -40°C to 70°C ($T_{98 \text{ max}}$).
- Try to install modules in a location where there is rare shading throughout the year.
- If you are planning to use the PV modules where the water damage (Humidity: $> 85\text{RH}\%$) may be possible, please consult with HUANSHENG technical support first to determine an appropriate installation method, or to determine whether the installation is possible.
- If the module is installed in an area with frequent lightning and thunder, the module must be protected against lightning strikes.
- Make sure flammable gases are NOT generated near the installation site.
- According to salt mist corrosion testing of photovoltaic (PV) in IEC 61701, HUANSHENG SOLAR modules can be installed in corrosive salt areas within proximity of the ocean or sulfurous areas. The module must not be soaked in the water or in the environment (i.e., fountain, spindrift, etc.) where the module would touch water (pure water or brine) for a long term. If the modules are placed in an environment of salt fog (i.e., marine environment) or sulfur (i.e., sulfur sources, volcanoes, etc.), there is a risk of corrosion.
- In locations that are 50m ~ 500m from the ocean, stainless steel or aluminum materials must be used to contact the PV modules, and the installation position must be processed with anti-corrosion treatment.

- Modules should be installed in locations where the altitude is less than 2000m.

6. 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. HUANSHENG SOLAR recommends that the mounting tilt angle should be NOT less than 10°, or in accordance with local regulations or follow the recommendations of experienced PV module installers.
- The tilt angle of the PV module is measured between the PV module and a horizontal ground surface.
- In the Northern Hemisphere, the PV modules should typically face south, and in the Southern Hemisphere, the PV modules should typically face north.
- A clearance of at least 115mm (4.5in) (recommended) is provided between modules frame and the surface of the wall or roof. If other mounting means are employed this may affect the UL Listing or the fire class ratings.

7. INSTALLATION

HUANSHENG SOLAR modules may be installed in the following conditions for more than 30 years.

7.1 INSTALLATION SAFETY

- HUANSHENG SOLAR Modules can be mounted in landscape or portrait orientation however the impact of dirt and marginal dirty shading the solar cells can be minimized by orienting the product in landscape., °
- Always wear dry insulation protection equipment: insulated tools, head gear, insulated gloves, safety belt and safety shoes (with rubber soles).
Do NOT wear metallic jewelry which can cause electric shock during installation.
- Do NOT install modules under rain, snow or windy conditions.
- Please keep the connector dry and clean during installation to avoid the risk of electric shock. It is recommended to install it immediately after unpacking.
- Due to the risk of electrical shock, do NOT perform any work if the terminals of PV module are wet. Please install immediately after you unpacking.PV, ° °
- The safety class of HUANSHENG SOLAR module is Class II , which can be used in systems operating at greater than 50 V DC or 260 W, where general contact access is anticipated.
- Keep the PV module packed in the carton until installation.
- Please use an opaque material to completely cover the PV module surface during PV module installation and wiring.
- Do NOT unplug the connector if the system circuit is connected to a load., °
- Do NOT stand on the module glass while installing. There is a risk of injury or electric shock if glass is broken.

- Do NOT work alone (always work as a team of 2 or more people).
- Do NOT damage the back sheet of PV modules when fastening the PV modules to a support with bolts.
- Do NOT damage the surrounding PV modules or mounting structure when replacing a PV module.
- Cables shall be located and secured so that they will not be exposed to direct sunlight after installation to prevent degradation of cables. Low drooping of cables from the terminal box must be avoided. Low hanging cables could cause various problems such as animal biting, electricity leakage in water, and fire.

7.2 INSTALLATION METHOD

7.2.1 MECHANICAL INSTALLATION AND WARNING

The connection of the module to the racking system can be created through the mounting holes, with clamps, or an embedded system on the frame. The modules must be installed according to the following examples and recommendations. If a different installation method is desired, please contact HUANSHENG SOLAR customer service or technical support team for consultation. Improperly mounted modules may be damaged. If alternative mounting method is used and not approved by HUANSHENG, the modules will not continue to have a valid warranty.

- The minimum distance between two modules is 10mm (0.4in).
- Panels shall not be subjected to wind or snow loads exceeding the maximum permissible loads, and shall not be subjected to excessive forces due to the thermal expansion of the support structures.
- The module frame drain holes cannot be blocked in any situation during installation or use.
- To maximize mounting longevity, HUANSHENG SOLAR strongly recommends the use of corrosion proof (stainless steel) attachment hardware.
- Secure the module in each mounting location with a bolt, flat washer, spring washer and nut and tighten to a torque of 16~20N.m(140-180lbf.in.).

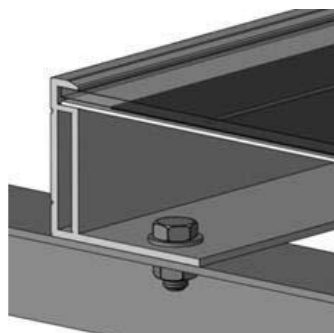
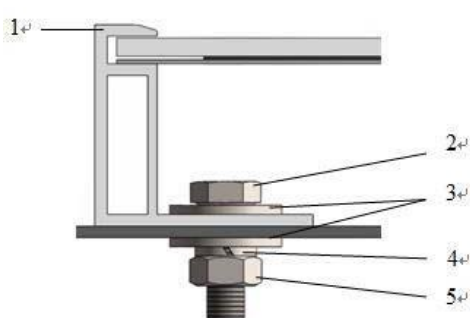
The tightening step is as follows :

- a. Use torque wrench to tighten nut to target torque: 16~20N.m;
- b. Nut loosen 90~180 degrees;
- c. Finally tighten the nut to the target torque and reduce the torque attenuation.

- It is recommended that flat stainless steel washers with a thickness of 1.6mm and an outside diameter of 16mm (0.63 inch) be used at all parts in contact with the modules.

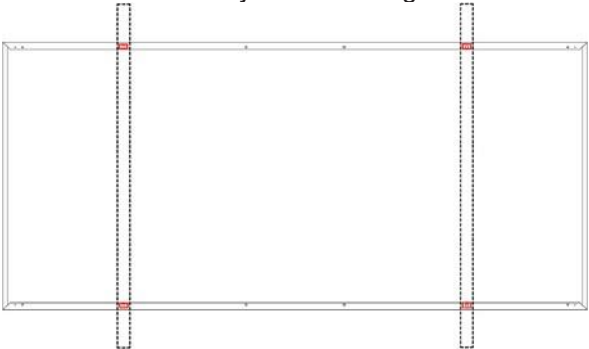


A. Mounting with mounting holes

- Modules can be attached through the mounting holes on the back frame of the module, by fixing the module to the support rails with bolts. The mounting details are shown in the following figures.



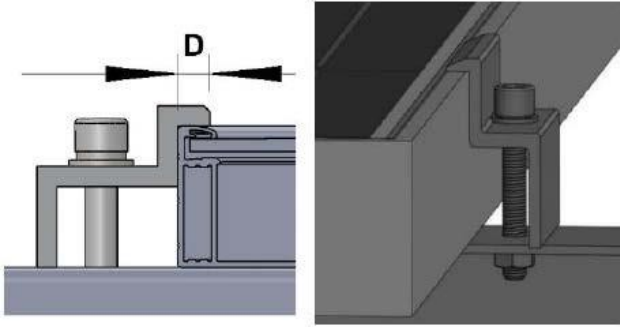
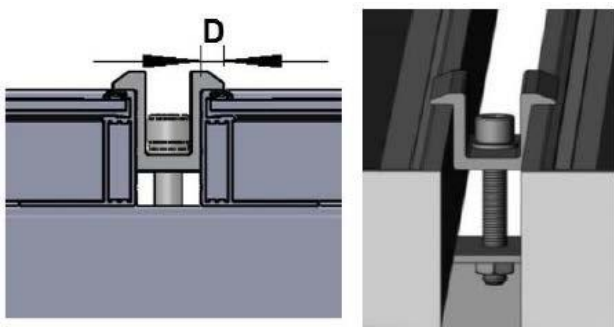
1. Frame; 2. M8 Stainless steel bolt; 3. Flat stainless steel washer; 4. Spring stainless steel washer; 5. HEX Stainless Nut

- The frame of each module has mounting holes compatible with M8 bolt, ideally placed to optimize the load handling capability, to secure the modules to supporting structure.

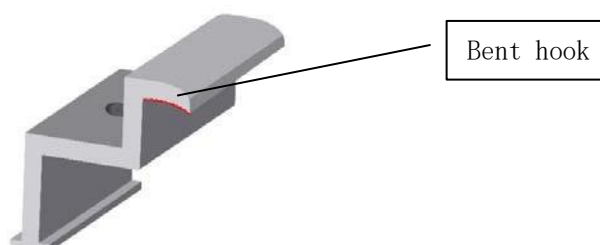
Module	Mechanical Load Pressure	Mounting Direction
Bifacial Dual Glass Frame Module	Front load $\leq 5400\text{pa}$ Reverse load $\leq 2400\text{pa}$	Use four outer mounting holes and the guide rail is installed vertically with the long frame. 
	Front load $\leq 5400\text{pa}$ Reverse load $\leq 2400\text{pa}$ Suitable for modules with width of not longer than 1.2m	Use four outer mounting holes and the guide rail is installed parallelly with the long frame. 
	Front load $\leq 3600\text{pa}$ Reverse load $\leq 2400\text{pa}$ Suitable for modules with width of longer than 1.2m	

B. Mounting with Clamps

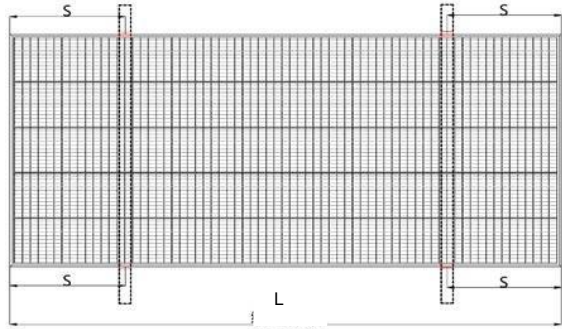
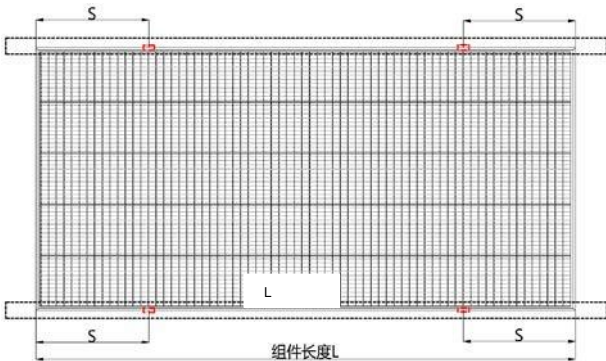
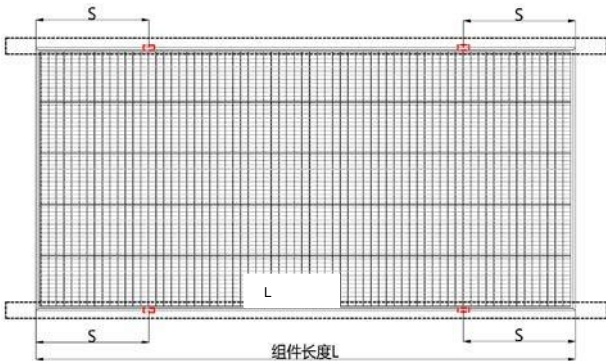
HUANSHENG SOLAR has tested its modules with different clamps from several manufacturers and recommends to use clamps that can hold M8 bolt at least . The clamps shall meet the following requirements.

Clamp	
End Clamp installation	Middle Clamp installation
	
Clamp specification: Length \geq 50mm, Thickness \geq 4mm, Material: 6005-T6, Rp0.2 \geq 225Mpa, Rm \geq 265 MPa	
Parts : M8 bolts, nuts, spring washers, flat washers	

- The "A surface Matching Clamp" has a bent hook structure where contacts with the frame to increase the friction, it can better fix the module, so it is recommended to install modules with a width more than 1.2m.



- Use at least 4 clamps to attach modules to the mounting rails.
- Be sure to avoid shadowing effects from the module clamps. At the same time, ensure that the contact distance between one clamp and the A side of the module frame is $8\text{mm} \leq D \leq 10\text{mm}$
- When choosing this type of clamp-mounting method, use at least four clamps on each module, two clamps should be attached on each long sides of the module. Depending on local wind and snow loads, additional clamps may be required to ensure that modules can bear the load.

Module	Mechanical Load Pressure	Mounting Direction
Bifacial Dual Glass Frame Module	Front load $\leq 5400\text{pa}$ Reverse load $\leq 2400\text{pa}$	<p>8. clamps are used for the long side of module, and the guide rail is installed vertically with the long side.</p> <p>$S=1/5*L$</p> 
	Front load $\leq 5400\text{pa}$ Reverse load $\leq 2400\text{pa}$ Suitable for modules with width of not longer than 1.2m	<p>4 clamps are used for the long side of module, and the guide rail is installed parallelly with the long side.</p> <p>$S=1/5*L$</p> 
	Front load $\leq 3600\text{pa}$ Reverse load $\leq 2400\text{pa}$ Suitable for modules with width of longer than 1.2m	

7.2.2 GROUNDING

- Frameless module do not need grounding because there will be no leakage current between cell and encapsulation material due to non-frame structure.
- All module frames and mounting racks must be properly grounded in accordance with appropriate respective National Electrical Code.
- Proper grounding is achieved by bonding the module frame(s) and all metallic structural members together continuously using a suitable grounding conductor. The grounding conductor or strap may be copper, copper alloy, or any other material acceptable for use as an electrical conductor per respective National Electrical Codes. The grounding conductor must then make a connection to earth using a suitable earth ground electrode.
- HUANSHENG SOLAR modules can be installed with the use of third party listed grounding devices for grounding the metallic frames of PV modules. The devices have to be installed in accordance with the grounding device manufacturer's specified instructions.PV。。

7.2.3 ELECTRICAL INSTALLATION

- All wiring should be performed, by qualified installers, in accordance with the local codes and regulations.
- Modules can be connected in series to increase the operating voltage by plugging the positive plug of one module into the negative socket of the next. Before connecting modules always ensure that the contacts are corrosion free, clean and dry.
- Product can be irreparably damaged if an array string is connected in reverse polarity to another. Always verify the voltage and polarity of each individual string before making a parallel connection. If you measure a reversed polarity or a difference of more than 10V between strings then check the string configuration before making the connection.
- HUANSHENG SOLAR modules are provided with stranded copper cables with a cross sectional area of 4mm²(0.006in²) which are rated for 1500V DC, 90°C and are UV resistant.HUANSHENG SOLAR recommends that all cables are run in appropriate conduits and sited away from areas prone to water collection.
- The maximum voltage of the system must be less than the maximum certified voltage 1500V typically and the maximum input voltage of the inverter and of the other electrical devices installed in the system. To ensure that this is the case, the open circuit voltage of the array string needs to be calculated at the lowest expected ambient temperature for the location. This can be done using the following formula.

$$\text{Max System voltage} \geq N * 1.25 * \text{Voc} * [1 + \text{TCvoc} * (\text{Tmin} - 25)]$$

Where N : Number of modules in series

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

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

Tmin : The lowest expected ambient temperature

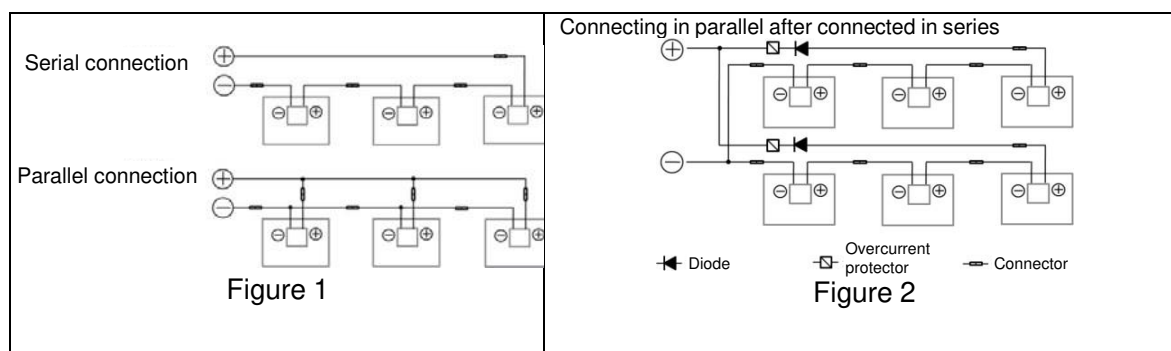
- Each module has two standards 90°C sunlight resistant output cables each terminated with plug & play connectors. The wire type and gauge of the output cables are 1500V rated PV Wire cable

and are 12AWG in size. This cable is suitable for applications where wiring is exposed to the direct sunlight. We require that all wiring and electrical connections comply with the appropriate National Electrical Code.

- The minimum and maximum outer diameters of the cable are 5 to 7mm(0.20 to 0.28in).
- For field connections, use at least 4mm² copper wires insulated for a minimum of 90°C and sunlight resistance with insulation designated as PV Wire.
- The minimum bending radius cables should be 43mm (1.69in).
- Under normal conditions, a photovoltaic module is likely to experience conditions that produce more current and/or voltage than reported at standard test conditions. Accordingly, the values of Isc and Voc marked on this module should be multiplied by a factor of 1,25 when determining component voltage ratings, conductor current ratings, fuse sizes, and size of controls connected to the PV output.

7.2.3.1 WIRING

- To ensure proper system operation the correct cable connection polarity (Figures 1 & 2) should be observed when connecting the modules to each other or to a load, such as inverter, a battery etc. If modules were not connected correctly, the bypass diode could be destroyed. PV modules can be wired in series to increase voltage. A series connection is made when the wire from the positive terminal of one module is connected to the negative terminal of the next module. Figure 1 shows modules connected in series. PV modules can be connected in parallel to increase current (Figure 2). A parallel connection is made when the wire from the positive terminal of one module is connected to the positive terminal on the next module.



- The number of modules in series and in parallel shall be designed reasonably according to the system configuration.
- All instructions above have to be obeyed to maintain HUANSHENG SOLAR's limited warranty.

7.2.3.2 FUSING

- When fuses are fitted they should be rated for the maximum DC voltage and connected in each, non-grounded pole of the array (i.e. if the system is not grounded then fuses should be connected in both the positive and negative poles).
- The maximum rating of a fuse connected in series with an array string is 30A for the models covered by this installation manual.
- This fuse rating value also corresponds to the maximum reverse current that a module can withstand (when one string is shaded then the other parallel strings of modules will be loaded by the shaded string and current will flow) and therefore impacts the number of strings in parallel.
- Do NOT share a fuse in a Combiner Box with two or more strings in parallel connection.

8. INVERTER SELECTION AND COMPATIBILITY

- When installed in systems governed by IEC regulations, HUANSHENG SOLAR modules normally do not need to be electronically connected to earth and therefore can be operated together with either galvanically isolated (with transformer) and transformerless inverters.
- Choose inverters with isolation transformers in hot and wet areas (such as shores, wetlands), to ensure proper module function under positive voltage.

9. MODULE MAINTENANCE FOR PV MODULE

9.1 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.

- It is recommended to perform a preventive inspection every six months without changing the components of the module. If electrical or mechanical properties are required for inspection or maintenance, qualified professionals should be advised 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.
- HUANSHENG SOLAR PV modules are equipped with bypass diodes in the junction box which would minimize module heating and current losses. The diode type is UKTH3045-12/ FMK5040D/3045S/35SQ045/40SQ045/MD3045S/30ST045C /40ST045C (The junction box type: UKT PV-JB12x / ZJRH FT50xy / Zerun Z8 / Huanxin PV-JB2101/ Huanxin PV-JB2203).
 - 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 the 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 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.

9.2 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.

9.3 CLEANNING

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 modules clean.

- Clean PV modules when the irradiance is below 200W/m²; liquid with a large temperature difference from the modules shall 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 shall not exceed 700 Kpa (14619.80psf); the module is prohibited to bear the extra force.
- When cleaning PV modules, do NOT step on the modules; do NOT spray water on the backside of the module or the cables; do NOT clean the backside of the modules; keep the connectors clean and dry; prevent fire and electrical shock from occurring; do NOT use as steam cleaner.
- Periodically trim any vegetation which may shade the solar array thus impacting performance.
- When cleaning the modules, use a soft cloth together with a mild detergent and clean water. Take care to avoid severe thermal shocks which might damage the module by cleaning modules with water which has a similar temperature to the modules being cleaned.
- Use dry or wet soft clean cloth to clean the PV modules; non-corrosive solvents or hard objects are strictly prohibited.
- If there are 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 thereof needs to be cleaned, then first select an array string that is particularly soiled.
- 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.
- 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.

9.3.1 REQUIREMENTS FOR WATER QUALITY

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

9.3.2 MODULE INSPECTION AFTER CLEANING

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

9.3.3 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 properties are required for inspection or maintenance, qualified professionals should be advised to avoid any electric shock or loss of life.
- Contact your installer.
- Contact HUANSHENG SOLAR after sales service team.