



# PV MODULES INSTALLATION MANUAL

Regular Single-glass Modules

## **REGULAR SINGLE-GLASS MODULES INSTALLATION MANUAL**

1. INTRODUCTION TO INSTALLATION MANUAL.....	- 2 -
1.1. DISCLAIMER.....	- 2 -
1.2. LIMITATION OF LIABILITY.....	- 2 -
2. SAFETY PRECAUTIONS.....	- 2 -
2.1. WARNING.....	- 2 -
2.2. GENERAL SAFETY.....	- 3 -
2.3. HANDLING SAFETY.....	- 3 -
3. UNLOAD/TRANSPROTATION/STORAGE.....	- 4 -
3.1. MARKERS ON OUTER PACKAGING.....	- 5 -
3.2. UNLOADING WARNING.....	- 6 -
3.3. SECONDARY TRANSPORT AND WARNING.....	- 7 -
3.4. STORAGE.....	- 8 -
4. UNPACKING SAFETY.....	- 8 -
5. INSTALLATION.....	- 10 -
5.1. INSTALLATION SAFETY.....	- 10 -
5.2. ENVIRONMENT CONDITIONS AND SITE SELECTION.....	- 11 -
5.3. TILT ANGLE OF INSTALLATION.....	- 13 -
5.4. INSTALLATION REQUIREMENTS FOR BIFACIAL CELLS MODULE.....	- 15 -
5.5. INSTALLATION METHOD.....	- 15 -
6. MODULE MAINTENANCE.....	- 24 -
6.1. PANEL VISUAL INSPECTION AND REPLACEMENT.....	- 25 -
6.2. CONNECTOR AND CABLE INSPECTION.....	- 25 -
6.3. CLEANING.....	- 25 -
7.0 Attachment Electrical Rating Parameter Table.....	- 28 -

## **1. INTRODUCTION TO INSTALLATION MANUAL**

Thank you for choosing Houen Solar Brand Photovoltaic Modules.

This INSTALLATION MANUAL applies to installing, maintaining, and using the single glass solar modules manufactured by Houen Solar America Inc. and its cooperated or affiliated companies. (hereinafter referred to as "Houen"). Failure to follow this INSTALLATION MANUAL could result in personal injury or property damage.

Installation and operation of PV modules require professional skills and should only be performed by qualified professionals. Please read the "Safety and Installation Instructions" carefully before using and operating the modules.

The word "module" or "PV module" used in this Manual refers to one or more single glass solar modules. Please keep this Manual for future reference.

### **1.1. DISCLAIMER**

1. Houen reserves the right to change this installation manual without prior notice. Please refer to our product lists and documents published on our website at <https://houensolar.com>, as these lists are updated regularly.
2. In the event of any inconsistency among different language versions of this document, the English version shall prevail.
3. Failure of the customer to follow the requirements outlined in this Manual during the installation (including without limitation to packing/unpacking, loading/unloading, transportation, storage, installation, use, operation or maintenance, etc.) of the module will result in the invalidity of product's limited warranty.
4. Houen is not responsible for any infringement of third-party patents or other rights arising from using solar PV modules.
5. The information in this Manual is based on Houen's knowledge and experience and is believed to be reliable, but such information, including product specification (without limitations) and suggestions, does not constitute a warranty, expressed or implied.

### **1.2. LIMITATION OF LIABILITY**

Houen is not responsible for any damages of any kind, including but not limited to any product damages, personal injury, or any other property losses, resulting from any improper operations or faults by the customers during the handling of the products as failure to follow the instructions in this Manual.

## **2. SAFETY PRECAUTIONS**

### **2.1. WARNING**

All instructions should be read and understood before attempting to install, wire, operate, and/or service the module and other electrical equipment. 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 the death of personnel whether connected to the module or not.

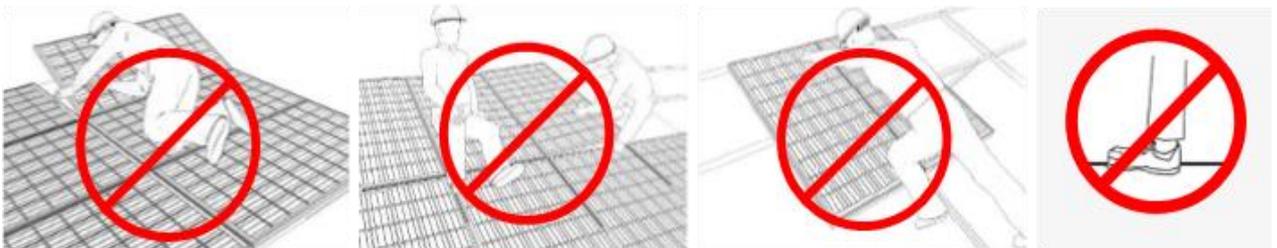
## 2.2. GENERAL SAFETY

The application level of the Houen Single-glass module is Class II, which can be used in systems operating at  $> 50$  V DC or  $>240$  W, where general contact access is anticipated.

1. All installation work must comply with the local codes and the relevant international electrical standards.
2. Houen recommends that PV module installation is conducted by personnel professionally trained in PV system installation. Operations by personnel unfamiliar with the relevant safety procedures will be hazardous.
3. Do not allow unauthorized persons to access the installation or module storage areas.
4. Protective clothing (non-slip gloves, clothes, etc.) must be worn during installation to prevent direct contact with 30V DC or greater and to protect hands from sharp edges.
5. Before installation, remove all metallic jewelry to prevent accidental exposure to live circuits.
6. When installing modules in light rain morning dew, take appropriate measures to prevent water ingress into the connectors, e.g., using connector endcaps.
7. Use electrically insulated tools to reduce the risk of electric shock.
8. Do not use or install broken modules.
9. External or artificially concentrated sunlight shall not be directed onto the front or back face of the PV module.
10. Do not contact the module if the front or rear glass is broken. This action may cause electric shock.
11. Do not attempt to repair, disassemble, or move any part of the PV module. The module does not contain any reusable components.
12. Do not connect or disconnect the module when energized or connected to an external power supply.

## 2.3. HANDLING SAFETY

1. Do not stand, walk on, or lean on the module directly.



2. Do not damage or scratch the front or backside surfaces of the module.
3. Do not drag, scratch, or bend the output cable with force or too tight a connection. The insulation of the output cable can break and may result in electricity leakage or shock.
4. If there is an open fire, please extinguish it with a dry powder extinguisher after disconnecting the power supply. You cannot use liquid such as water to extinguish the fire.
5. Do not install or handle modules under wet, rain, snow, or windy conditions. Place disassembled PV modules correctly.
6. 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 connections may corrode. Any module with corroded contacts should not be used.
7. Do not loosen, unscrew, or peel the PV module bolts and frame glue. This may lead to a reduction of the module's load rating and potential damage from a fall.
8. Do not drop PV modules or allow objects to fall on the PV modules.
9. During installation or under sunlight, it is forbidden to directly touch the junction box, connector, cable, and other electrified bodies of the module without any protection, regardless of whether the PV module

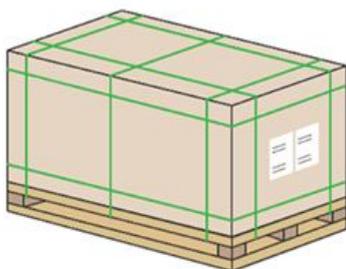
is connected to the system. There is a risk of scalding or electric shock.

10. Do not discard the modules at will; special recycling is required.

### 3. UNLOAD/TRANSPORTATION/STORAGE

Precautions and general safety rules:

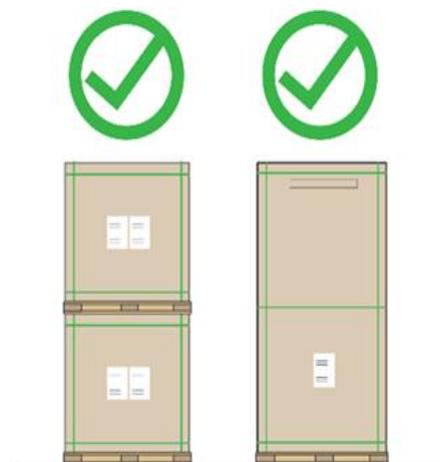
1. Modules should be stored in a dry and ventilated environment to avoid direct sunlight and moisture, and extra precautions should be taken to prevent connectors from being exposed to moisture or sunlight, like using connector endcaps.
2. The modules should be stored in the original Houen package before installation. Protect the package from damage. Unpack the modules as per the recommended unpacking procedures. The unpacking, transporting, and storing process should be handled with care.
3. Unpacking must be carried out by two or more people simultaneously.
4. Handling the modules requires two or more people with non-slip gloves and both hands.
5. Do not pull the cables, junction boxes, or frames to handle modules.
6. Do not handle the modules overhead or stack the modules.
7. Do not place excessive loads on the module or twist the module.
8. Do not drop or place objects (such as tools) on the modules.
9. Do not put the modules in a place that is not supported or stable.
10. Please 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.
11. Do not expose the modules and their connectors to chemical substances (e.g., oil, lubricant, pesticide).
12. Before starting the secondary vehicle, it should be bundled with net ropes. The rope should be fastened to prevent module damage during transportation. If the safety rope is used, the contact part between the safety rope and the carton shall be separated by paper corrugated or other cushioning materials. The speed of the vehicle carrying the modules should be  $\leq 5$  km/h and  $\leq 3$  km/h for turning to avoid sudden stop and rapid start.
13. In any circumstances, vertical landscape packages shall not be stacked more than two layers; for vertical portrait packages, stacking is not allowed. Example of vertical landscape package and vertical portrait package is shown as follows:



**Vertical landscape package  
(short-side vertically placed)**



**Vertical portrait package  
(long-side vertically placed)**



**Right Examples**

3.1. MARKERS ON OUTER PACKAGING

3.1.1. Need both hands to handle it carefully.



3.1.2. Uninstalled modules must be kept dry and not exposed to rain or moisture.



3.1.3. Modules in cartons are fragile and must be handled with care.



3.1.4. The packaging must be transported upright.



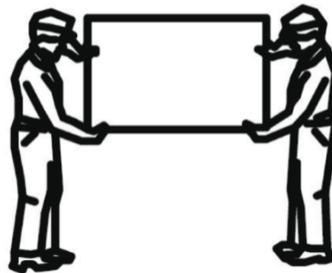
3.1.5. Do not step on the package and module.



3.1.6. Modules shall be stacked as required, not exceeding the maximum number of layers printed on the outer packaging. (no more than two layers).



3.1.7. One module shall be handled by at least two people together. Modules are placed vertically.

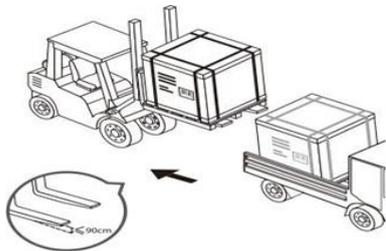


3.2. UNLOADING WARNING

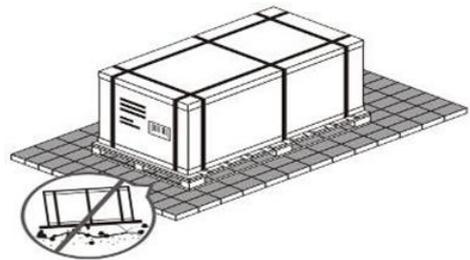
3.2.1. When a crane is used to unload the modules, please choose and use specialized tooling according to the weight and size of the module. Before lifting, check whether the pallet and the carton are damaged and whether the hoisting ropes are firm. Please adjust the position of the sling to keep the modules steady. To ensure the module's safety, wooden sticks, boards, or other fixtures of the same width as the outer packing cases should be used on the upper part of the box to prevent the sling from squeezing the pallet and damaging the modules. When placing the modules, do not lower the packing box too quickly. Two people shall gently support the righting carton's two sides to place it on flat ground. **For vertical landscape packages, do not lift more than FOUR pallets of modules at once; for vertical portrait packages, do not lift more than TWO pallets of modules at once. Do not unload modules under the weather conditions of wind more than 6 class (in Beaufort scale), heavy rain, or heavy snow.**



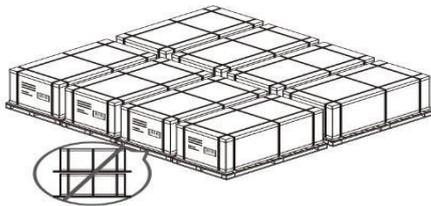
3.2.2. Use a forklift to remove the module pallets from the truck.



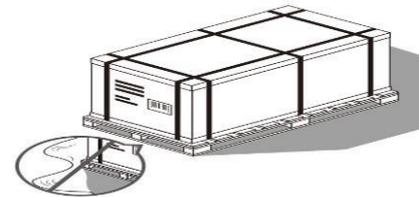
3.2.3. Put the modules on level ground.



3.2.4. Do not stack the modules at the project site.



3.2.5. Store the Module in a dry and ventilated place.

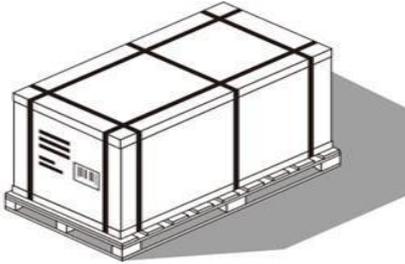


3.2.6. Cover the Module with waterproof material to prevent it from moisture.

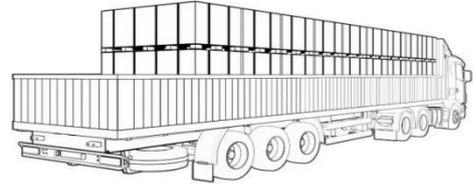


3.3. SECONDARY TRANSPORT AND WARNING

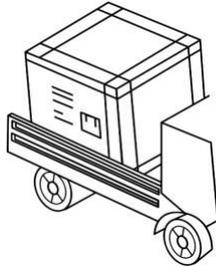
3.3.1. Do not remove the original packages if the modules require long-distance transport or long-term storage.



3.3.2. Packaged products can be transported by land, sea, or air. During transportation, ensure the package is securely fixed to the shipping platform without movement. Do not Stack more than two layers on a truck.



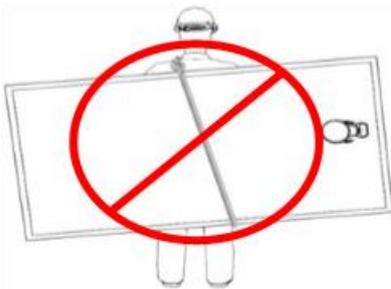
3.3.3. Only one layer stacking is allowed for transport at the project site.



3.3.4. No transport or handling by pedicab or improper vehicle, as shown below.



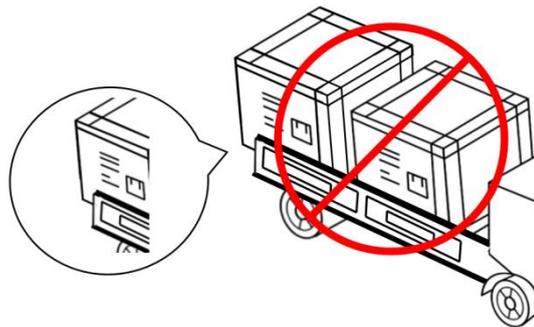
3.3.5. Do not transport the module with rope, as shown below.



3.3.6. Do not carry the modules on the back of one person as shown below.



3.3.7. Do not allow pallets to exceed the loading area of the transport vehicle.

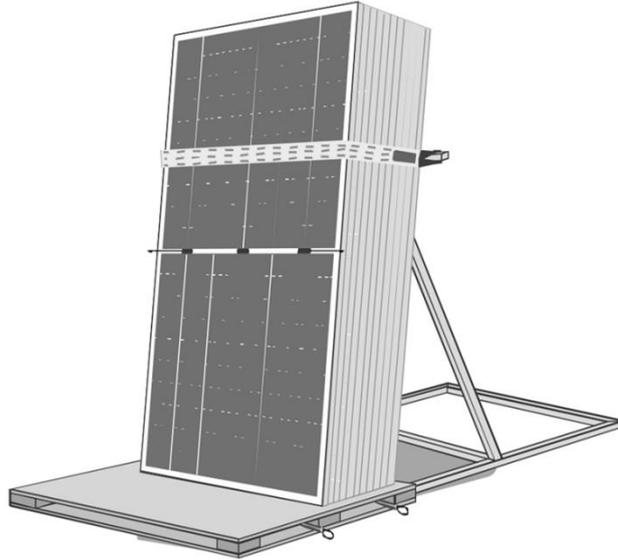


### 3.4. STORAGE

- 1) Do not remove the original package and keep the wrapping film and carton box in good condition if the modules require long-distance transport or long-term storage.
- 2) For long-term storage, it is recommended to store the modules in a standard warehouse with regular inspection, and under confirming of your personal safety, reinforce the package promptly if any anomalies are found.
- 3) Storage in project site warehouse or normal warehouse (moisture < 85%RH, temperature in the range from -40°C to +50°C): Do not stack different types of PV modules together.
- 4) Do not expose the modules to rain or moisture. Store the finished product in a well-ventilated, waterproof, dry, and smooth place (for a vertical portrait package, the inclination of the ground needs to be less than 4°) to avoid damage or dumping of the modules due to ground deformation or collapse. The modules should be centrally stored with pallet spacing within 10cm. The modules should be covered with waterproof material.
- 5) If you need to store the modules on the project site, do not choose soft ground and ground that is easy to collapse; you should choose hard ground or a higher ground with a flat surface to ensure the module packages are not collapsing and tilting for long-term storage.
- 6) The module must be installed as soon as possible on the project site and must not be exposed to rain or dampness. Houen shall not be responsible for any damage or collapse of the modules caused by moisture in the packaging.

### 4. UNPACKING SAFETY

- 1) For unpacking outdoors, it is prohibited to operate in rainy conditions. Because the carton will become soft and damaged after it gets wet in the rain, the stacked PV modules (hereinafter referred to as "modules") may tip over, which may cause damage or injury to personnel.
- 2) For a windy site, paying particular attention to safety is necessary. Transporting or unpacking the modules in high wind conditions is not recommended. The unpacked modules must be tied down to avoid any unwanted movement.
- 3) The work surface must be level to ensure the package can be placed stably, avoiding sliding.
- 4) Wear protective gloves during unpacking to avoid hand injury and fingerprints on the glass surface.
- 5) If all the modules are not taken out after unpacking, the remaining modules shall be placed horizontally and repackaged to prevent them from tipping. When packaging, please note that the glass side of the bottom module should face up, the glass side of the middle module should face down, and the glass side of the top module should face up. Stacks of modules should contain no more than 16 modules, and the frames should be aligned.
- 6) If the unpacked modules are not installed immediately, they should be fixed to the stand supporter with a safety rope under the weather of 6-class wind (the modules should be less than 12 pieces).

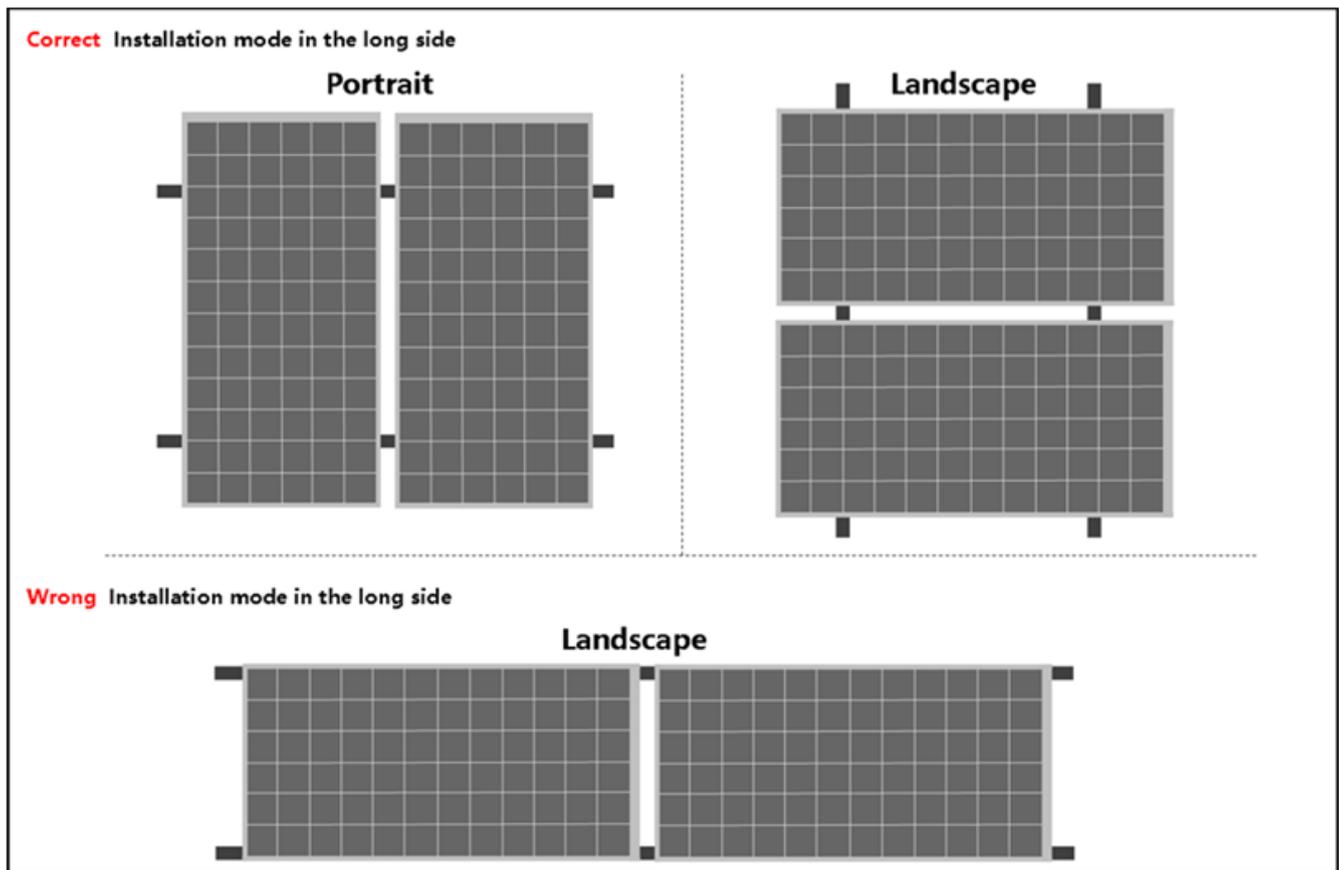


**In addition to the above points for attention, consider professional on-site unpacking exception handling rules; please refer to Houen “Spec. for PV Module Unloading, unpacking and Secondary Transferring”.**

## 5. INSTALLATION

### 5.1. INSTALLATION SAFETY

- 1) Hounen modules can be mounted in landscape or portrait orientation; the impact of dirt shading the solar cells can be minimized by orienting the product in the landscape. Please pay attention that the modules can only be installed on vertical racking, not horizontal racking, when customers choose landscape mode. For all PV modules, Hounen does not recommend short-side installation.



- 2) Always wear dry insulation protection equipment: insulated tools, headgear, insulated gloves, safety belts, and safety shoes (with rubber soles).
- 3) Make sure flammable gases are not generated or present near the installation site.
- 4) Keep the PV module packed in the carton until installation. Please install it immediately after unpacking. Please keep the connector dry and clean during installation to avoid the risk of electric shock. Do not perform any work if the terminals of the PV module are wet until they are dry.
- 5) Please take measures to insulate during PV module installation and wiring.
- 6) Do not hit or put excessive load on the front or back of PV modules; this may break the cells or cause microcracks.
- 7) Do not unplug the connector if the system circuit is connected to a load.
- 8) Do not stand on the module glass. There is a risk of injury or electric shock if the glass is broken.
- 9) Do not work alone (always work as a team of 2 or more people).
- 10) Do not damage the back glass of PV modules when fastening the PV modules to a support with bolts.
- 11) Do not drill holes in the frame. It may cause corrosion of the frame or PV modules to burst.
- 12) Do not damage the surrounding PV modules or mounting structure when replacing a PV module.

- 13) Cables should be fixed in areas not exposed to direct sunlight to prevent cables aging.
- 14) Protective measures must be taken in the installation process to avoid force extrusion or impact on the modules.
- 15) The open area should minimize the arc coil, which can reduce the risk of induced lightning impact on the PV module.
- 16) When installing modules on roof-mounted structures, please try to follow the "from top to bottom" and/or "from left to right" principle, and don't step on the module. This will damage the module and would be dangerous for personal safety.
- 17) The mechanical loads described in this Manual are the test loads. For calculating the equivalent maximum design loads, a safety factor of 1.5 (Test loads=Design loads×1.5 security coefficient) needs to be considered in compliance with the requirements of the local laws and regulations. The design loads are strongly related to the construction, applied standards, location, and local climate conditions; therefore, they must be determined by the racking suppliers and/or professional engineers. Please follow the local structural code or contact your professional structural engineer for detailed information. The mechanical load bearing depends upon the mounting methods used, and failure to follow the instructions of this Manual may result in different capabilities to withstand snow and wind loads.
- 18) We recommend that you insure your solar system against natural hazards (e.g., against lightning strikes).

**5.2. ENVIRONMENT CONDITIONS AND SITE SELECTION**

Houen module should be installed in the following environmental conditions:

**Table 5-1 Operation condition**

NO	Environmental conditions	Range
1	Recommended Working temperature	-20°C~+50°C
2	Extreme Working temperature	-40°C~+85°C
3	Storage temperature	-40°C~+50°C
4	Humidity	<85RH%

**Remarks:** The working environment temperature is the installation site's monthly average maximum and minimum temperature. The mechanical load-bearing capacity of the solar PV modules is determined based on the installation method. The professional solar PV system installer must calculate the solar PV system machinery when designing the solar PV system load-bearing capacity.

If you plan to use the PV modules where water damage (Humidity: >85RH%) may be possible, please consult with Houen technical support first to determine an appropriate installation method or whether the installation is possible.

The modules are certified according to the CSA/UL 61730 norm for safe operation in moderate climates. The operator needs to consider the effect of the high altitude on the module's operation when the modules are installed at high altitudes. The maximum altitude allowed for PV Module installation is 2000m.

For most places, PV modules should be installed where the sunlight can be maximally acquired throughout the year. In the Northern Hemisphere, the PV modules should typically face south; in the Southern Hemisphere, the PV modules should typically face north.

When selecting the installation location, avoid areas with trees, buildings, or obstacles because these objects will form shadows on solar PV modules, especially when the sun is at the lowest position on the horizon in winter. The shadow will cause the loss of the output power of the solar photovoltaic system. Although the bypass diode installed in the PV module can reduce this loss, do not ignore the shadow factor.

Do not install solar PV modules near fire or flammable materials. Do not install solar PV modules where there is water soaking, sprinkler, or water spray.

Position the modules to minimize the chances of shading at all times of the day. Try to install modules in a location where there is minimum shading throughout the year.

According to IEC 61701, salt mist corrosion testing of photovoltaic (PV) Houen PV 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 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. It's not recommended to install the modules when the distance is less than 100m, and it's recommended to install the modules with the anti-salt function when the distance is between 100m and 1km. So, stainless steel or aluminum materials must be used to contact the PV modules and the installation position must be processed with anti-corrosion treatment. When modules are installed on land less than 1km away from the sea or in an area where the annual rainfall hours / total annual hours exceed 25%, the connectors are recommended to install waterproof cold shrinkable tubes to prevent the connector from the water inlet and corrosion; Silicone rubber is recommended for the material of the cold shrinkable tube.

**Table 5-2 Photovoltaic module connector accessories**

Procedure	Method	Explanatory Chart
①	After unplugging the photovoltaic connector, take either end and cover the cold shrinkable tube to the connector in the direction shown on the right.	
②	Slide the cold shrinkable tube over the head of the connecting head and expose the head.	
③	Connect the positive and negative connectors in the correct way.	
④	Move the connection to the middle of the cold, shrinkable tube.	

<p>⑤</p>	<p>Pull the inner ring exposed in the cold shrinkable tube by hand, rotate, and pull it out again and again until the inner ring is completely pulled out.</p>	
<p>⑥</p>	<p>The cold shrinkable tube has completely cold shrinkable seal connectors.</p>	

**●Notes for installation of cold shrinkable pipe**

- ① Before installation, make sure that there is no sand, water, sharp objects and other sundries inside the cold shrinkable tube;
- ② It is forbidden to tie the label on the shrink tube to prevent the tie from scratching the shrink;
- ③ Pay attention to environmental protection on site (handling of support strips/instructions/packaging bags);
- ④ There are no cracks or gaps at both ends of the cold shrinkable tube and no cracks on the surface;
- ⑤ The cold shrinkable tube should be affixed to the connector and cable naturally, and no wrinkle or bulge is allowed;

According to the surrounding environment of the project, use the appropriate protective measures to ensure the safety of the module installation and reliability. For example, it needs to have windproof measures like the design of windbreaks in strong wind areas.

The system design needs to have a lightning protection function; it must pay more attention, especially on the installation ground where there are more lightning strikes.

Please refer to local laws and regulations before installing modules and abide by requirements on building fire protection. According to the corresponding certification standards, the fire rating of Hounen Single-glass Module modules is UL type 1.

When installing PV 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 of the module and the installation surface. A safe working area must also be left between the roof's edge and the solar array's external edge.

In the case of residential installations on the ground, modules must be installed following local regulations, e.g., using a fence.

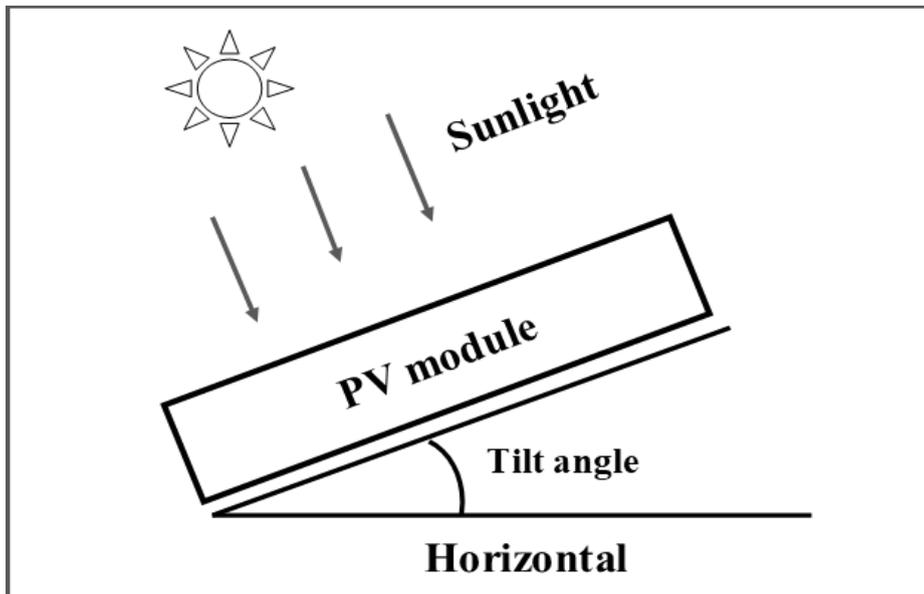
**5.3. TILT ANGLE OF INSTALLATION**

The installation of the PV module string should be in the same orientation and the same installation angle. Different installation directions and angles will lead to mismatches in current and voltage, which is caused by different light absorption of different PV modules, and this mismatch will cause the PV system power output loss.

The largest power will be generated When direct sunlight is on the solar PV module. The best installation angle should be selected for modules installed on the fixed brackets to ensure the maximum power output can be generated in wintertime. If the angle can guarantee enough power output during the winter, the whole solar PV system will have enough power output for the rest of the year.

Solar modules should be installed at an optimized tilt angle to maximize the energy output. For detailed information on the best installation angle, please refer to standard solar photovoltaic installation guides or consult a reputable solar installer or systems integrator. Dust building up on the surface of the modules can impair module performance. Houen recommends installing the modules with a tilt angle of at least 10°, making it easier for dust to be washed off by rain. Any faults caused by and/or attributable to a tilt angle less than 10 degrees are not covered by the manufacturer's warranty. It is roughly equal to the latitude of the project site, as a rule of thumb, facing toward the equator. Optimized system designs must incorporate other local requirements.

Installation inclination refers to the angle between the module and the ground plane, as shown in Figure 5.3-1.



**Fig. 5.3-1 Tilt angle**

**Table 5.3-2 Recommended tilt angle for fixed systems**

Latitude	Tilt angle
0°~15°	15°
15°~25°	The same latitude
25°~30°	Same latitude +5°
30°~35°	Same latitude +10°
35°~40°	Same latitude +15°
40°+	Same latitude +20°

**5.4. INSTALLATION REQUIREMENTS FOR BIFACIAL CELLS MODULE**

Under certain installation conditions, the backside of the bifacial cells module will also generate electricity after receiving the reflected light, which will bring additional power generation gain to the power station system.

The shading on the module surface will affect the power generation much; the module should be installed in a place where the module cannot be shadowed totally (such as the shadow from a building, chimney, or a tree, etc.), and even the partially shading (such as the dirt, snow and aerial wire, etc.) should be avoided.

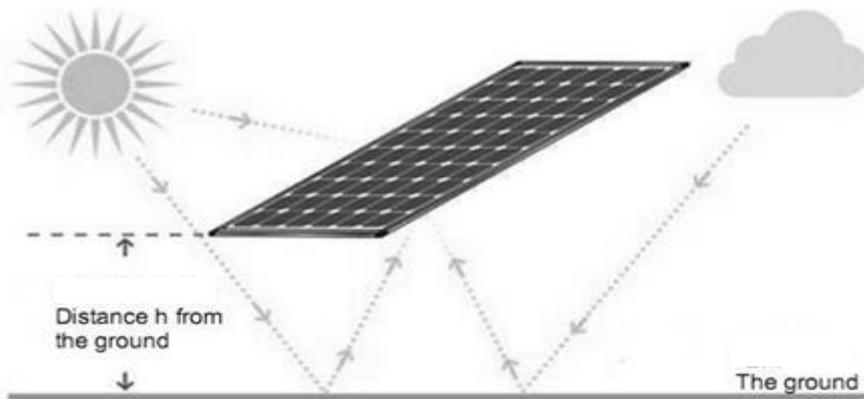
The generation gain is related to the ground reflectivity, the module installation height to the ground, the array spacing, and the shadow shading to the module backside.

Generally speaking, the reflectance varies with the different ground (See table 5.4-1), leading to different power generation gains.

**Table 5.4-1 Reflectivity of different surfaces**

The ground type	Water	Grassland	Ground	Concrete	Sand	Snow
Reflectivity range (%)	5-12	12-25	20-33	20-40	20-40	80-85

Due to the different ground clearance heights affecting the power generation gain, installing the module at a height from 1m to 2m is recommended. See Fig. 5.4-2



**Fig. 5.4-2 Distance from the earth**

In the system design, besides the ground type and the module installation height to the ground, the proper array spacing and how to avoid shadow shading on the back need to be considered, too; please consult with a professional system designer.

**5.5. INSTALLATION METHOD**

**5.5.1. MECHANICAL INSTALLATION AND WARNING**

PV modules can be installed through the bolt method and clamp method. The modules must be installed according to the following examples and recommendations. If a different installation method is desired, please get in touch with Houen customer service or technical support team for consultation. Improperly mounted modules may be damaged. If an alternative mounting method is used that has not been approved by Houen, the modules will not continue to carry a valid warranty.

Modules shall not be subjected to wind or snow loads that exceed the maximum permissible designed loads and shall not be subjected to excessive forces due to the thermal expansion of the support structures. The selection and design of the mounting bracket shall be carried out by professional system engineers after the load calculation

according to the climatic conditions of the installation site. Ensure the installation method and supporting system of modules are strong enough to withstand all the load conditions. The installer must provide this guarantee. The installation supporting system must be tested by the third-party organization with the analysis ability of Static Mechanical, according to local, national, or international standards.

The modules shall be mounted on continuous rails that extend beneath the modules. If modules are mounted without continuous rails, the maximum allowable load will be reduced, which needs to be re-evaluated by Hounen.

Please ensure that the modules with the same color cells are installed together.

A clearance of at least 115mm (recommended) is provided between modules and the surface of the wall or roof.

The minimum clearance between two adjacent single-cell modules must not be less than 10mm. The minimum clearance between two adjacent bifacial cell modules must not be less than 20mm. The proper gap can protect against jarring during the neighboring modules due to the size tolerance or expansion and contraction of modules; it also can reduce the wind pressure on the square array. If there are special requirements, please confirm with Hounen and install it.

The module frame drain holes cannot be blocked during installation or use.

Always keep the back of the PV module from coming into contact with foreign bodies or support components, which may damage the module when subjected to mechanical load.

The module frames will warp at low temperatures. Avoid the frame from receiving the lateral tension and pressure, causing the frame to turn off or crushing the glass.

The mounting method must not result in the direct contact of dissimilar metals with the aluminum frame of the module, as it will result in galvanic corrosion. IEC 60950-1 standard recommends metal combinations not exceed an electrochemical potential difference of 0.6V.

Hounen strongly recommends using corrosion-proof (stainless steel) attachment hardware to maximize mounting longevity.

Secure the module in each mounting location with an M8 bolt (full thread recommended) and a flat washer, spring washer, and nut, and tighten to a torque of 16~20 N.m. The yield strength of the bolt and nut should not be less than 450 MPa. The tightening step is as follows:

- a. Use a torque wrench to tighten the nut to target torque: 16~20NM;
- b. Loosen nut 90~180 degrees;
- c. Finally, tighten the nut to the target torque and reduce the torque attenuation.

All parts in contact with the modules should use flat stainless-steel washers of a minimum 1.5mm thickness with an outer diameter of 16-20mm. (Except for the Single-axis tracking system)

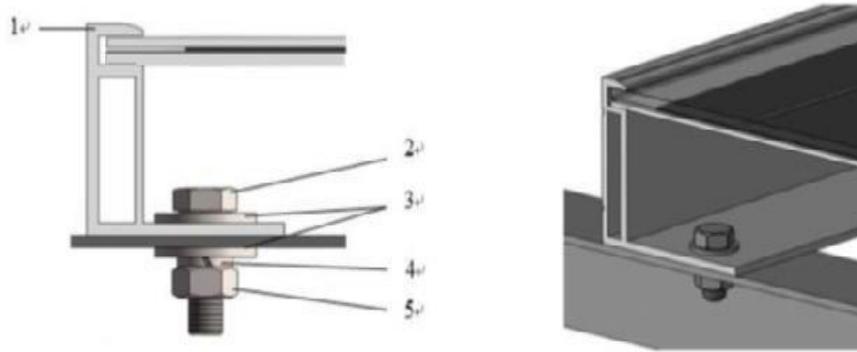
The installation methods listed below are for your reference only; the PV system installer or the trained professionals should take responsibility for the PV system design, mechanical load calculation, installation, maintenance, and safety. Hounen will not supply the related material for system installation.

**Tools:** screwdriver, wrench, stainless steel screw/bolt, clamp, nut and spring washer, plain washer.

#### **A. Mounting with Bolts 4- $\phi$ 9\*14mm mounting holes**

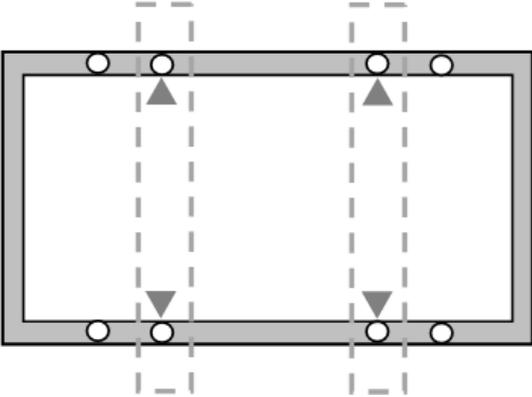
Modules can be attached using the mounting holes 4- $\phi$ 9\*14mm on the back of the module frame by fixing the module to the support rails with bolts. The mounting details are shown in the following figures.

The frame of each module has 8- $\phi$ 9\*14mm mounting holes, ideally placed to optimize the load handling capability to secure the modules to the supporting structure. The middle four mounting holes are used for normal installation, as shown in Figure 5.5-1. It is recommended that you put the PV module vertically when you use the bolt to fix it so that the module will not slide easily and be used more safely.



**Fig.5.5-1 Single-glass module with frame**

- 1. Aluminum frame
- 2. M8 hex bolt M8
- 3. Flat stainless washer
- 4. Spring stainless washer
- 5. Hex stainless nut

Module	Test Load	Mounting Direction
Length≤2300mm	Uplift load ≤2400Pa Downforce load ≤5400Pa	 <p><b>*NOTE:</b></p> <ul style="list-style-type: none"> <li>1. The crossbeam is perpendicular to the long side frame.</li> <li>2. Need two support rails below the PV module to ensure the Mechanical load.</li> <li>3. The load is an empirical value of a standard module based on a standard installation mode, and Houen shall consult the specific information.</li> </ul>
2300<Length≤2400mm	Uplift load ≤2400Pa Downforce load ≤3600Pa	

**B. Mounting with Clamps**

Houen has tested its modules with a number of clamps from different manufacturers, and it is recommended to use fixing bolts of at least M8. It is recommended to use a clamp with a length of  $\geq 60\text{mm}$  and thickness of  $\geq 4\text{mm}$ , aluminum alloy 6005-T6. The clamp shall not be malfunctioned due to deformation or corrosion during the loading process. If the customer needs a different size of clamps, it should be fully evaluated and approved by Houen.

The clamp must overlap the module frame by at least 7mm but no more than 10mm.

Use at least 4 clamps to attach modules to the mounting rails.

Module clamps should not come into contact with the front glass and must not deform the frame.

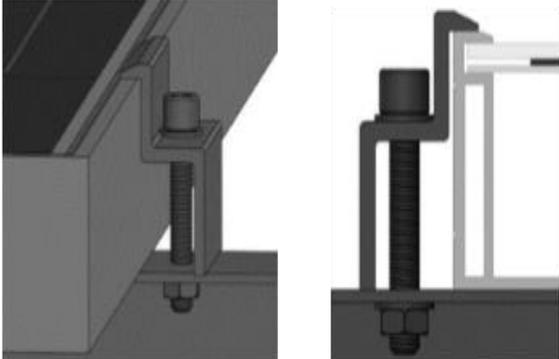
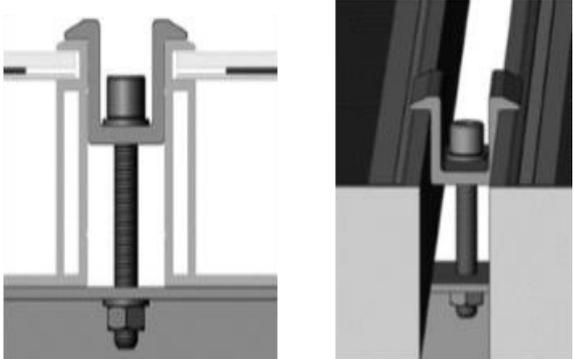
The clamps shall not be out of the edge of the module under any circumstances. Be sure to avoid shadowing effects on the solar cells from the module clamps.

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

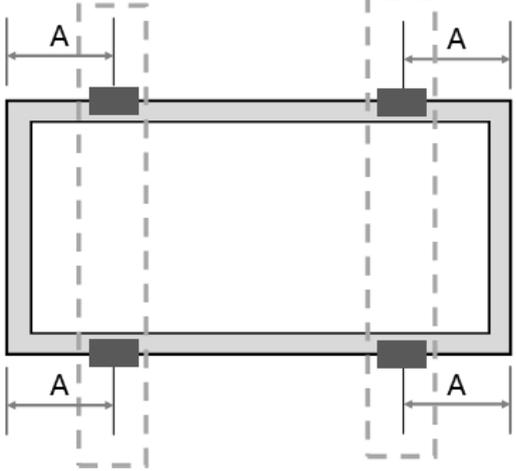
When choosing this type of clamp-mounting method, use at least four clamps on each module; two clamps should be attached on each long side of the module (for portrait orientation). Depending on local wind and snow loads, additional clamps may be required to ensure that modules can bear the load.

Applied torque should refer to mechanical design standards according to the type of customer's bolt, e.g., M8 16-20N.m.

Clamp positions are of crucial importance for the reliability of the installation. Depending on the configurations and loads, the clamp centerlines must only be positioned within the ranges indicated in the table below.

End Clamp installation	Middle Clamp installation
	

Module	Test Load	Mounting Direction
<p>Length <math>\leq 2300\text{mm}</math></p>	<p>Uplift load <math>\leq 2400\text{Pa}</math> Downforce load <math>\leq 5400\text{Pa}</math></p>	

<p>2300 &lt; Length ≤ 2400mm</p>	<p>Uplift load ≤ 2400Pa Downforce load ≤ 3600Pa</p>	 <p style="text-align: center;"><math>1/6L \leq A \leq 1/4L</math>; L=Module length</p> <p><b>*NOTE:</b></p> <ol style="list-style-type: none"> <li>1. The crossbeam is perpendicular to the long side frame.</li> <li>2. The above-described distance is from the module edge to the middle of the clamp. Clamps length ≥ 60mm.</li> <li>3. Need two support rails below the PV module to ensure the Mechanical load.</li> <li>4. The load is an empirical value of a standard module based on a standard installation mode, and Houen shall consult the specific information.</li> </ol>
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**\*NOTES:**

Houen does not recommend short-side installation. When the short side is installed, the support point of the module is far away. Under the module's weight or the action of a small load, there will be a slight deformation in the middle of the module, which is elastic deformation. After the module or the load is removed, it can be restored to its original state without causing the battery to crack and power attenuation; however, it is easy to increase the amount of ash, which requires frequent cleaning of the surface of modules.

In severe environments such as snowstorms, when the modules are subjected to heavy snow load, the central part will produce large shape variables, affecting the modules' appearance. In the process of module deformation, if the junction box or glass is in contact with the obstacles below, the glass on the back will produce a large stress, and the module will have the risk of rupture. The distance between the obstacles below the module and the junction box or glass is required to be more than 120mm by day rise.

When installing with short side pressing block, load calculation, and support structure, professional structural engineers shall carry out the design according to the project climate conditions, and foreign bodies under the positive projection of the module glass shall be avoided. The appearance caused by dead weight or other loads shall not be considered a defect and shall not be within the scope of the warranty.

Other mounting configurations can be used. However, failure to comply with the above recommendations will lower the load handling capabilities below the empirical value, and Houen's warranty will not cover product failure due to an overload situation.

**5.5.2 ELECTRICAL INSTALLATION**

**1. Cable layout**

The recommended vertical installation connection methods for the module with split J-Box are as follows (The extension cable is required).

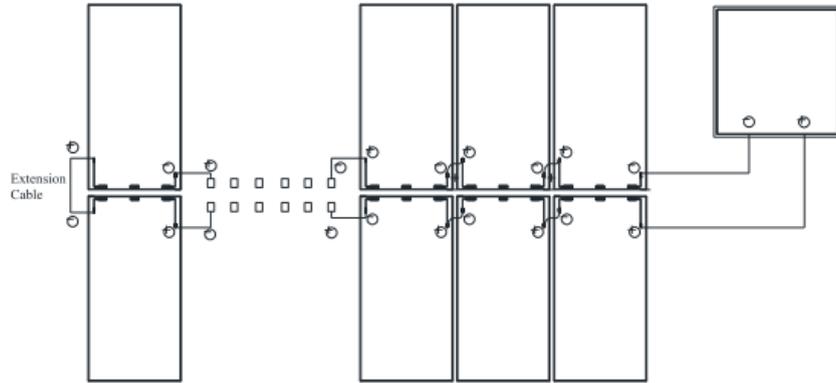


Fig. 5.5-2 Split J-Box at module side position for vertical direction

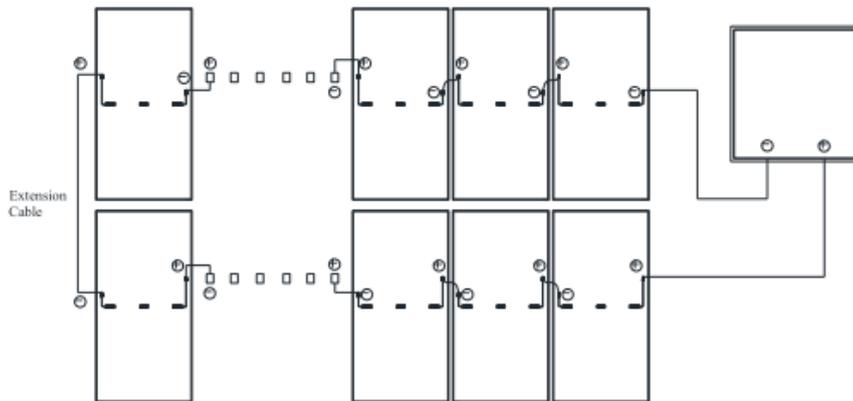


Fig. 5.5-3 Split J-Box at module middle position for vertical direction

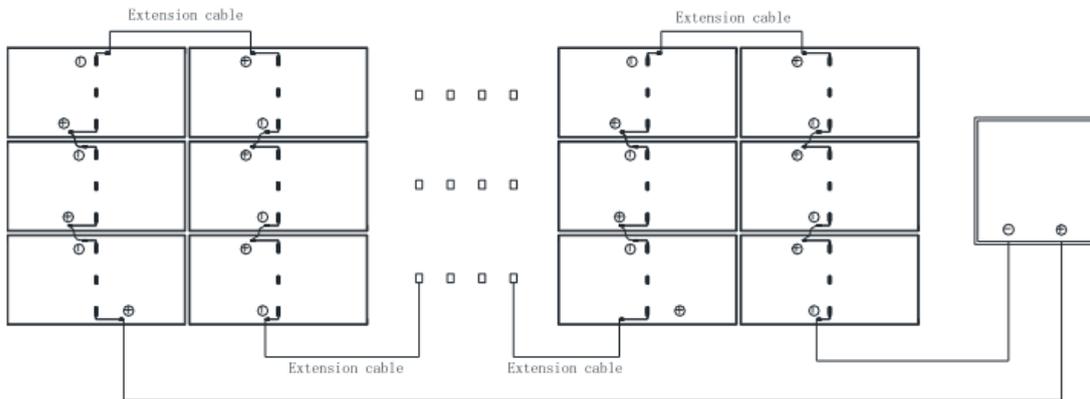


Fig. 5.5-4 Split J-Box at module middle position for horizontal direction

**Precautions:** To minimize risk in the event of an indirect lightning strike, avoid forming loops when designing the system. To avoid a bad or damaged connection between the cable and connector, the cable and junction box caused by human factors, affecting the electrical safety or service life of the product, it is recommended that the force applied between the cable and connector cable and junction box shall not be greater than 60N during the installation, dismantling, maintenance and any other related process of the product.

Pay attention to the direction of the wire when installing the modules. It should be connected along the wire direction to avoid bending the wire.

## 2. Electrical Connection

The Direct Current (DC) generated by the PV system can be converted to Alternating Current (AC) and connected to the public power grid. Different regions may have different policies, laws, and regulations to stipulate

the installation and grid-connection requirements of PV systems. Therefore, during the PV system's design, installation, and grid connection, please comply with the local policies, laws, and regulations.

PV modules can obtain different current and voltage outputs through series and parallel connections. Read this installation manual carefully before electrical connection and installation. Please design and connect according to the current and voltage required by customers. Before connection, please ensure that the connection part is free from corrosion and keep it clean and dry.

Different types of modules cannot be connected in series. Modules connected in series should ensure the consistency of their current. (For the rest of the modules with different current classes, the modules with adjacent current classes can be installed in one given string.) The voltage of the module string should not exceed the allowable system voltage value, which can be found on the nameplate or datasheet of the module.

The standard copper cables in Houen modules are UV resistant and have a cross-sectional area of  $\geq 4 \text{ mm}^2$  (12 AWG). All other cables used to connect the DC system should have a similar (or better) specification.

The maximum number of modules in a series depends on the system design, the type of converter used, and the environmental conditions. In general, the maximum number (N) of PV modules in series can be calculated by dividing the maximum system voltage by the open circuit voltage of the relevant solar PV modules. When designing the solar PV system, it is necessary to consider the characteristic that the voltage of the solar PV module changes with the temperature. Considering the voltage increase caused by temperature drops in extreme environments in winter, the maximum series connection number of solar PV modules can be calculated by the following formula.

**Table 5.5-5 Maximum series connection number calculation**

<b>Formula</b>	Maximum system voltage $V \geq N \cdot V_{oc} \cdot [1 + \beta \cdot (T_{min} - 25)]$
<b>V</b>	Maximum system voltage
<b>N</b>	The number of maximum solar PV modules in series
<b>V<sub>oc</sub></b>	The open circuit voltage of each module (see product label or datasheet)
<b>TC<sub>voc</sub></b>	Temperature coefficient of open circuit voltage of the module (refer to datasheet)
<b>T<sub>min</sub></b>	The lowest ambient temperature at the installation site

If the modules are connected in parallel, the recommended number of modules in parallel is maximum series fuse rating/Isc + 1

The number of modules that can be connected shall be determined by a qualified institution or person in accordance with the design specifications of the photovoltaic system and the local electrical design specifications. The calculation formula recommended by Houen shall be for reference only.

If the modules can be installed in parallel electrically, each module (or series string of modules so connected) shall be provided with the maximum series fuse as specified. For applications requiring high currents, several photovoltaic modules can be connected in parallel; the total current is equal to the sum of individual currents, and each module (or series string of modules so connected) shall be provided with the maximum series fuse as specified. The recommended number of modules in parallel is only one. The modules' electrical performance in a system is the same. When connected in series, all modules must have the same amperage. When connected in parallel, the modules must all have the same voltage. Connect the quantity of modules that match the voltage specifications of the devices used in the system. The modules must not be connected to create a higher voltage than the permitted system voltage.

A product can be irreparably damaged if an array string is connected in reverse polarity to another. Always verify the voltage and polarity of each 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.

Before wiring the module, ensure the contact points are corrosion-resistant, clean, and dry. If a string of

modules is reversed, irreparable damage can be caused.

During field wiring, only single-wire photovoltaic special copper cables with a minimum temperature resistance of 90°C, sunlight resistance (UV), and cross-sectional area of no less than 4mm<sup>2</sup> can be used as photovoltaic connecting wires. The cable's minimum and maximum outer diameters are 5 to 7mm. The minimum bending radius of the cables must be 43mm. Any cable damage caused by bending too much or the cable management system is not covered under Hounen's warranty. When installing modules on the roof, it is recommended to use a 4~6mm<sup>2</sup> special photovoltaic cable. Plug & Play connectors are included at the end of each cable. All other cables used to connect the direct current system shall have similar (or higher) specifications and should have the suitable insulation ability which can suffer the possible maximum system  $V_{oc}$  (as defined in UL 12 AWG, EN50618 (H1Z2Z2-K) or 62930 IEC 131 1x4mm<sup>2</sup>). Hounen requires all cables and electrical connections to comply with the electrical regulations of the countries where the PV system is installed.

Under normal conditions, a PV module is likely to experience conditions that produce higher current and/or voltage than reported at standard test conditions. Accordingly, the  $I_{sc}$  and  $V_{oc}$  values marked on this PV module should be multiplied by a factor of 1.25 when determining component voltage ratings, conductor current ratings, and size of controls (e.g., inverter) connected to the PV output.

When selecting a cable, the minimum current-carrying capacity of the cable can be calculated by the following formula.

The minimum current-carrying capacity of the cable =  $1.25 * I_{sc} * N_p$

$I_{sc}$ : short-circuit current of PV module (unit: A)

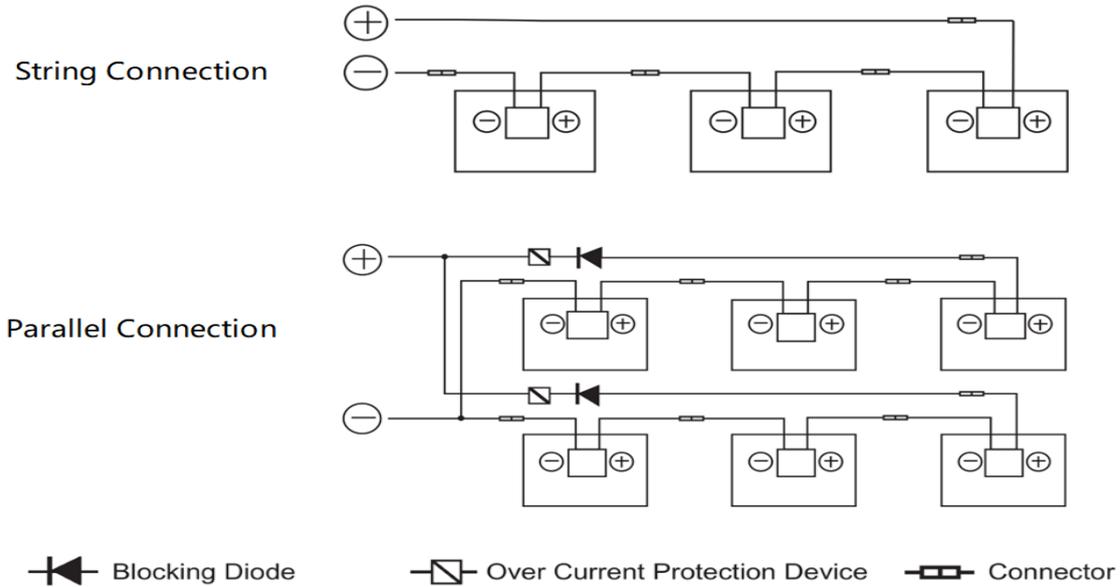
$N_p$ : the number of modules in parallel or module strings

The safety factor of 1.25 for the minimum voltage rating of the components can be modified during the design of a system according to the minimum temperature of the location of the installation and the temperature coefficient for  $V_{oc}$ .  $I_{sc}$  can be adjusted based on maximal temperature, irradiance, and module orientation. To this end, a full simulation for the specific location is required using long-term weather data.

To ensure proper system operation, the correct cable connection polarity should be observed when connecting the modules or to a load, such as an inverter, a battery, etc. If modules were not connected correctly, the bypass diodes could be destroyed.

Before connecting the module, please use the connector approved by Hounen. Otherwise, Hounen is not responsible for any potential defects or risks. When conducting the electrical connection of the modules, please use diagonal pliers to cut the cable tie. When cutting the tie, be careful not to scratch the cables or the backside of the module, according to the electrical requirements. The positive and negative connectors should be connected, and confirm that you hear a "click" to indicate that the connection is successful. Otherwise, during the operation of the modules, this could lead to an electric arc due to poor connections and can burn the connectors. It is not recommended to interconnect different types of connectors. Please pay attention that the unlock method of connectors differs according to local laws and regulations.

When modules are in a series connection, the string voltage is the sum of every module in one string. When modules are in parallel connection, the current is the sum of the individual modules, as shown in Figure 5-7. Modules with different electric performance models cannot be connected in one string. If there is no protection for string due to suitable anti-reverse devices and fuse, do not connect two or more strings with a Y or T connector. Do not connect the fuse in the Combiner Box or string inverter with two or more strings in parallel connection without any anti-reverse devices or functions.



**Fig. 5.5-6 Series Connection and Parallel Connection Circuit Diagram**

Before the commissioning and operation of the power station, please check the electrical connection of modules and strings, ensuring all connection polarity is correct and the open circuit voltage meets the acceptance criteria requirements.

The number of modules in series and parallel shall be designed reasonably according to the system configuration.

To clear or trim excess cables, Houen recommends that all cables be away from standing water and placed in proper pipework to avoid accelerated aging due to UV irradiation.

Houen recommends using lightning protection devices that comply with local laws and electrical regulations.

All the above instructions must be followed to meet Houen warranty conditions.

**3. Bypass secondary**

If the PV module is part by shadow block, which can lead to reverse voltage related to solar cells, PV modules in other unaffected battery strings or other PV modules in the system and current will force through keep out part of the power loss and heat affected cell. When the PV module is connected in parallel with the bypass diode, the current in the system will flow directly through the diode to bypass the PV module's blocked part and minimize the PV module's heating degree and power consumption. Bypass diodes are not over-current protective devices.

Each module has three diodes. Please do not try to open the junction box to replace the diode, or even when there is a diode problem. Please complete this work by professionals.

Please guard against inductive lighting, backflow, and wrong connection.

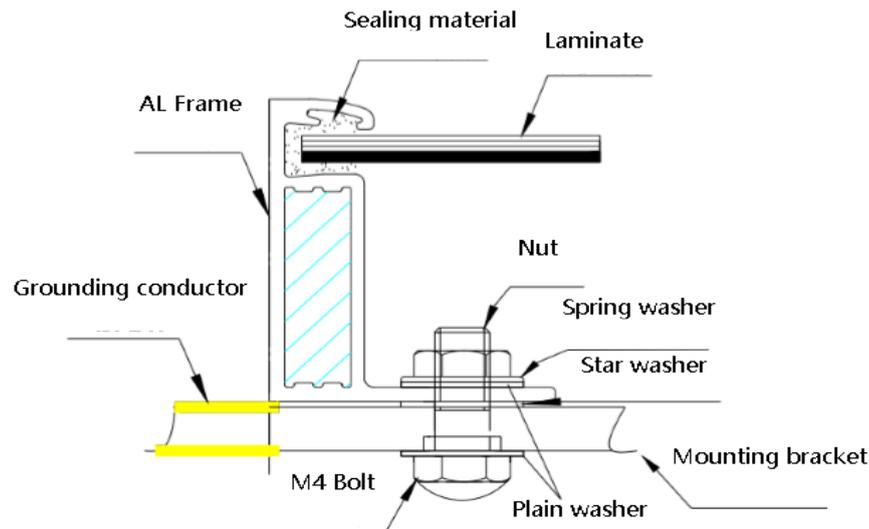
**4. Grounding**

All module frames and mounting racks must be properly grounded in accordance with the electrical design and construction specifications, procedures, regulations, and other special grounding requirements applicable to the installation sites.

Proper grounding can be achieved by connecting the module frame(s) and all metallic structural components using a suitable grounding conductor. The grounding conductors or wires may be copper, alloy, or any other materials that are in accordance with the local electrical design and construction specifications, procedures, and regulations. It is recommended to use the copper wire 4-14mm<sup>2</sup>(AWG 6-12) as the grounding wire. The signal "⏏" can be found at the grounding hole position. The ground wire must also be connected to the ground through a suitable ground electrode. The tight connection of all the joint points should be ensured.

On a grounding hole with a diameter of  $\phi 4$  mm, use a separate grounding wire and related accessories to connect the aluminum frame of the solar PV module and the grounding wire to the ground. The grounding uses the M4\*12mm bolts and M4 nuts, star washers, and plain washers, ensuring the modules are firmly grounded. You can find the corresponding product drawing in the module datasheet to know the grounding holes' detailed number, size, and position. The torque applied to ground fixation is  $4\text{N}\cdot\text{m} \sim 8\text{N}\cdot\text{m}$ . Do not drill any extra ground holes for convenience, and this will void the module's warranty. Houen recommends using grounding wires with resistances that are less than  $1\Omega$ .

Suppose the Grounding of the Module is through mounting holes using serrated washers or nuts without any additional requirement of grounding arrangement. In that case, the ground resistance of the whole racking system shall be less than  $4\Omega$ . New serrated washers shall be used, and any re-use of used washers will not be allowed.



**Fig. 5.5-8 Grounding Diagram**

Each module can be grounded directly in series or parallel when grounding. If you choose the latter two options, it is recommended that the maximum number of modules connected in parallel should not exceed four and, in series, should not exceed eight.

In addition to using the grounding hole, you can also choose the following grounding ways:

- (1) Grounding by unused mounting holes
- (2) Other professional grounding devices

The electrical contact points of all the above grounding methods should penetrate the anodized film of the aluminum frame. PV modules can be grounded by other grounding devices, which must be reliable and certified. The manufacturer's requirements should be followed.

The module is considered to be in compliance with this standard only when the module is either mounted in the manner specified by the mounting instructions or when the mounting means have been evaluated with this PV module to UL 2703. A module with exposed conductive parts is considered to be in compliance with this standard only when it is either electrically grounded in accordance with the manufacturer's instructions and the requirements of the National Electrical Code, ANSI/NFPA 70 (2014-2017), or when the bonding means has been evaluated with this PV module to UL 2703.

## 6. MODULE MAINTENANCE

To ensure the long-term use of the installed PV system and maximize the Power output performance of the modules, the installed PV modules need to be inspected and maintained regularly, which is the responsibility of the users. The PV array modules' inspection and maintenance shall be carried out by personnel who have received

professional PV system maintenance training and obtained relevant qualifications and authorization.

### 6.1. PANEL VISUAL INSPECTION AND REPLACEMENT

The modules in a PV array should be regularly checked for damage. Factors such as glass breakage, cable breakage, junction box damage, and the terminals not being connected well may lead to function and safety problems. In the case of a damaged module, replace it with the same type of module. Do not touch live parts of cables and connectors. When handling modules, use appropriate safety equipment (insulated tools, insulating gloves, etc.). Refer to the appropriate Product Installation Manual for the installation and disassembly of the module.

Check the electrical, grounding, and mechanical connections once at least every 6 months to ensure they are clean and safe, free from damage or rust. Check that all string fuses in each non/earthed pole are operating. Check that the mounting parts are tight. Check all cables and make sure that the connectors are secure. PV modules, frames, and brackets should be well mechanically connected.

Check whether there is any foreign body on the surface of the PV modules and whether there is any shielding. The vegetation should be cut regularly to avoid shading and thus affecting the module's performance.

When repairing PV modules, cover the surface of PV modules with opaque material to prevent electric shock. Exposure of PV modules to sunlight will generate high voltages, which is dangerous. Please adhere to safety rules when professionals must do maintenance.

Wear cut-resistant gloves and other personal protective equipment required for the particular installation. Isolate the impacted array string to prevent current flow before attempting to remove the module. Disconnect the connectors of the affected module using the related disconnect tool provided by suppliers. Replace the damaged module with a new functional module of the same type.

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.

When the irradiance is no less than 200W/m<sup>2</sup>, if the terminal voltage is more than 5% different than the rated value, it illustrates the connection of the modules is not good.

Comply with maintenance instructions for all modules used in the PV system, such as brackets, charging rectifiers, inverters, batteries, lightning protection systems, etc.

**Warning:** The warning signs on the PV modules must not be lost. Any electrical maintenance must shut down the PV system first. Improper system maintenance may cause fatal dangers such as electric shock and burning. Observe the safety precautions listed earlier in this Manual.

### 6.2. CONNECTOR AND CABLE INSPECTION

It's recommended to implement the following preventive maintenance every 6 months:

- (1) Check the sealing gels of the junction box for any damage.
- (2) Examine the PV module(s) for signs of deterioration. Check all wiring for possible rodent damage weathering and that all connections are tight and corrosion-free. Check electrical leakage to ground.
- (3) Inspect all cables to verify that connections are tight, are protected from direct sunlight, and are sited away from water collection areas.
- (4) Check the torque of terminal bolts and the general condition of wiring. Also, check that the mounting hardware is properly torqued. Loose connections will result in damage to the array.

### 6.3. CLEANING

This manual covers the requirements for the cleaning procedures of Hounen PV modules. Professional installers should read these guidelines carefully and strictly follow these instructions. Failure to follow these

instructions may result in death, injury, or property damage. Damages induced by inappropriate cleaning procedures will void Houen's warranty.

The power output of the module is related to the received sunlight. Dust accumulation on the glass surface of the module will reduce its power output and may even cause hot spots. So, the surface of PV modules should be kept clean. Maintenance work should be performed at least once every six months or more frequently. The debris, such as bird droppings, leaves, and dust, must be cleaned.

**Warning:** It should be carried out by trained personnel. Workers should wear PPE, such as goggles, electric insulation gloves, and safety shoes. The gloves should withstand DC voltages of no less than 2000V.

Improper cleaning activities create a risk of damaging the modules and array components, as well as increasing the potential electric shock hazard. Cracked or broken modules represent an electric shock hazard due to leakage currents, and the shock risk increases when modules are wet. Before cleaning, thoroughly inspect modules for cracks, damage, and loose connections.

During daylight, the voltage and current in the array are sufficient to cause a fatal electric shock. Clean PV modules when the irradiance is below 200W/m<sup>2</sup>. Before cleaning, please ensure the circuit is disconnected; otherwise, contact with the exposed part of live parts will cause injury. When cleaning the modules, wear suitable protective clothing (clothes, insulating gloves, etc.). Do not immerse the module, partially or totally, in water or any other cleaning solution. Do not use such lubricants and organic solvents to clean the connectors.

Use a dry or wet, soft and clean cleaning cloth, sponge, or soft-bristled brush to gently wipe the modules. Please ensure the cleaning tools do not wear out the glass, EPDM, silicon, aluminum alloys, or steel. Do not use corrosive solvents or wipe the PV modules with hard objects. The module must not be subjected to additional external force. If there is greasy dirt and other substances on the surface of the PV module that are difficult to clean, conventional household glass cleaning agents can be used. Do not use alkaline and strong acid solvents, including hydrofluoric acid, alkali, or acetone. If necessary, use isopropyl alcohol (IPA) or other solution according to the safety instructions to clean and ensure that no solution flows into the gap between the edge of the module and the module frame.

When cleaning the modules, use a soft cloth, mild detergent, and clean water. Take care to avoid severe thermal shocks, which might damage the module, by cleaning modules with water, and make sure the temperature difference between the water and the module is in the range of -5°C~10°C. For example, do not use cold water to clean the module when the temperature is high during the day; otherwise, there will be the risk of module damage.

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

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

The back surface of the module normally does not need to be cleaned. However, if this is deemed necessary, avoid using sharp projects that might damage the penetrating substrate material. When cleaning the back surface of the module, take care to avoid penetrating the substrate material. The other cleaning requirements are the same as the front side.

Do not scrape or grind stains off surfaces while PV modules are dry, as this can cause minor scratches on the surface of the glass.

## CLEANING METHODS

Method A: Compressed water

Requirement for water quality:

- (1) pH: 6~8;
- (2) Chloride or salt content: 0 ~3000 mg/L

- (3) Turbidity: 0~30 NTU
- (4) Conductivity: 1500~3000  $\mu\text{s}/\text{cm}$
- (5) Total dissolved solids (TDS):  $\leq 1000$  mg/L
- (6) Water hardness (calcium and magnesium ions): 0~40 mg/L
- (7) Recommend to use soft water to wash.
- (8) Water pressure on the glass surface of the module must not exceed 700 KPa.

#### **Method B: Compressed Air**

Hounen recommends using this method to clean the soft dirt (like dust) on modules. This technique can be applied if the method is efficient enough to clean the modules considering the on-site conditions.

#### **Method C: Wet cleaning**

If excessive soiling is present on the module surface, a non-conductive brush, sponge, or other mild agitating method may be used cautiously.

Please ensure that any cleaning tools are constructed with non-conductive materials to minimize the risk of electric shock and that they are not abrasive to the glass or the aluminum frame.

If grease is present, an environmentally friendly cleaning agent may be used cautiously. Do not use the alkaline and strong acid solvents. If necessary, use isopropyl alcohol (IPA) or other solution according to the safety instructions to clean and ensure that no solution flows into the gap between the edge of the module and the module frame.

#### **Method D: Cleaning robot**

Suppose a cleaning robot is used for cleaning. In that case, the brush material is required to be soft plastic material with famous brands such as Dupont, and the cleaning method is required to be wet cleaning, and the module's glass surface and aluminum alloy frame will not be scratched during the cleaning process and after cleaning. The weight of the cleaning robot should not be too large. Hounen's warranty does not cover the resulting module damage and power attenuation if the cleaning robot is improperly used.

### **6.3.1. MODULE INSPECTION AFTER CLEANING**

- (1) Ensure that the module under visual inspection is clean, bright and free of stains;
- (2) Spot check to verify whether there is a soot deposit on the module surface;
- (3) Check whether there are visible scratches on the surface of the module or not;
- (4) Check whether there are no man-made cracks on the module surface or not;
- (5) Check whether the module support structure is leaning or bent or not;
- (6) Check whether the connectors of the module are detached or not;
- (7) After cleaning, fill out the PV module cleaning record.

### **6.3.2. TROUBLESHOOTING**

Please inform your installer immediately if the PV system does not work properly. It is recommended to perform a preventive inspection at least every six months. If electrical or mechanical properties are required for inspection or maintenance, qualified professionals should be advised to avoid electric shock or loss of life.

## 7.0 Attachment Electrical Rating Parameter Table

The electrical characteristics are within  $\pm 3$  percent of the rated values of  $I_{sc}$ ,  $V_{oc}$ , and  $P_{max}$  under standard test conditions (irradiance of 1000W/m<sup>2</sup>, AM 1.5 spectrum, and a cell temperature of 25°C (77°F)).

Model	Open Circuit Voltage at STC (V dc)	Short Circuit Current at STC (A dc)	Rated Voltage at STC (V dc)	Rated Current at STC (A dc)	Rated Maximum Power at STC (Watts)
HNM7-SPDB156-xxx/M (xxx=560-610 in steps of 5W) Temperature coefficient of $P_{max}$ : -0.35%/ °C Temperature coefficient of $V_{oc}$ : -0.29%/ °C Temperature coefficient of $I_{sc}$ : 0.05%/ °C					
HNM7-SPDB156-560/M	52.2	13.53	43.9	12.76	560
HNM7-SPDB156-565/M	52.4	13.58	44.1	12.82	565
HNM7-SPDB156-570/M	52.6	13.63	44.3	12.87	570
HNM7-SPDB156-575/M	52.8	13.68	44.5	12.93	575
HNM7-SPDB156-580/M	53.0	13.73	44.7	12.98	580
HNM7-SPDB156-585/M	53.2	13.78	44.9	13.03	585
HNM7-SPDB156-590/M	53.4	13.83	45.1	13.09	590
HNM7-SPDB156-595/M	53.6	13.88	45.3	13.14	595
HNM7-SPDB156-600/M	53.8	13.93	45.5	13.19	600
HNM7-SPDB156-605/M	54.0	13.98	45.7	13.24	605
HNM7-SPDB156-610/M	54.2	14.03	45.9	13.29	610
HNM7-SHDB156-xxx/M (xxx=560-610 in steps of 5W) Temperature coefficient of $P_{max}$ : -0.35%/ °C Temperature coefficient of $V_{oc}$ : -0.29%/ °C Temperature coefficient of $I_{sc}$ : 0.05%/ °C					
HNM7-SHDB156-560/M	52.2	13.53	43.9	12.76	560
HNM7-SHDB156-565/M	52.4	13.58	44.1	12.82	565
HNM7-SHDB156-570/M	52.6	13.63	44.3	12.87	570
HNM7-SHDB156-575/M	52.8	13.68	44.5	12.93	575
HNM7-SHDB156-580/M	53.0	13.73	44.7	12.98	580
HNM7-SHDB156-585/M	53.2	13.78	44.9	13.03	585
HNM7-SHDB156-590/M	53.4	13.83	45.1	13.09	590
HNM7-SHDB156-595/M	53.6	13.88	45.3	13.14	595
HNM7-SHDB156-600/M	53.8	13.93	45.5	13.19	600
HNM7-SHDB156-605/M	54.0	13.98	45.7	13.24	605
HNM7-SHDB156-610/M	54.2	14.03	45.9	13.29	610
HNM7-SPDB144-xxx/M (xxx=520-560 in steps of 5W) Temperature coefficient of $P_{max}$ : -0.35%/ °C Temperature coefficient of $V_{oc}$ : -0.29%/ °C Temperature coefficient of $I_{sc}$ : 0.05%/ °C					
HNM7-SPDB144-520/M	49.0	13.53	40.7	12.79	520

HNM7-SPDB144-525/M	49.2	13.59	40.9	12.85	525
HNM7-SPDB144-530/M	49.4	13.65	41.1	12.91	530
HNM7-SPDB144-535/M	49.6	13.71	41.3	12.96	535
HNM7-SPDB144-540/M	49.8	13.77	41.5	13.02	540
HNM7-SPDB144-545/M	50.0	13.83	41.7	13.07	545
HNM7-SPDB144-550/M	50.2	13.89	41.9	13.13	550
HNM7-SPDB144-555/M	50.4	13.95	42.1	13.19	555
HNM7-SPDB144-560/M	50.6	14.01	42.3	13.24	560
HNM7-SHDB144-xxx/M (xxx=520-560 in steps of 5W) Temperature coefficient of Pmax: -0.35%/ °C Temperature coefficient of Voc: -0.29%/ °C Temperature coefficient of Isc: 0.05%/ °C					
HNM7-SHDB144-520/M	49.0	13.53	40.7	12.79	520
HNM7-SHDB144-525/M	49.2	13.59	40.9	12.85	525
HNM7-SHDB144-530/M	49.4	13.65	41.1	12.91	530
HNM7-SHDB144-535/M	49.6	13.71	41.3	12.96	535
HNM7-SHDB144-540/M	49.8	13.77	41.5	13.02	540
HNM7-SHDB144-545/M	50.0	13.83	41.7	13.07	545
HNM7-SHDB144-550/M	50.2	13.89	41.9	13.13	550
HNM7-SHDB144-555/M	50.4	13.95	42.1	13.19	555
HNM7-SHDB144-560/M	50.6	14.01	42.3	13.24	560
HNM7-SPDB132-xxx/M (xxx=475-515 in steps of 5W) Temperature coefficient of Pmax: -0.35%/ °C Temperature coefficient of Voc: -0.29%/ °C Temperature coefficient of Isc: 0.05%/ °C					
HNM7-SPDB132-475/M	44.8	13.54	37.2	12.77	475
HNM7-SPDB132-480/M	45.0	13.60	37.4	12.84	480
HNM7-SPDB132-485/M	45.2	13.66	37.6	12.90	485
HNM7-SPDB132-490/M	45.4	13.72	37.8	12.97	490
HNM7-SPDB132-495/M	45.6	13.78	38.0	13.03	495
HNM7-SPDB132-500/M	45.8	13.84	38.2	13.09	500
HNM7-SPDB132-505/M	46.0	13.90	38.4	13.16	505
HNM7-SPDB132-510/M	46.2	13.96	38.6	13.22	510
HNM7-SPDB132-515/M	46.4	14.02	38.8	13.28	515
HNM7-SHDB132-xxx/M (xxx=475-515 in steps of 5W) Temperature coefficient of Pmax: -0.35%/ °C Temperature coefficient of Voc: -0.29%/ °C Temperature coefficient of Isc: 0.05%/ °C					
HNM7-SHDB132-475/M	44.8	13.54	37.2	12.77	475
HNM7-SHDB132-480/M	45.0	13.60	37.4	12.84	480
HNM7-SHDB132-485/M	45.2	13.66	37.6	12.90	485
HNM7-SHDB132-490/M	45.4	13.72	37.8	12.97	490
HNM7-SHDB132-495/M	45.6	13.78	38.0	13.03	495

HNM7-SHDB132-500/M	45.8	13.84	38.2	13.09	500
HNM7-SHDB132-505/M	46.0	13.90	38.4	13.16	505
HNM7-SHDB132-510/M	46.2	13.96	38.6	13.22	510
HNM7-SHDB132-515/M	46.4	14.02	38.8	13.28	515
HNM7-SPDB120-xxx/M (xxx=435-470 in steps of 5W) Temperature coefficient of Pmax: -0.35%/ °C Temperature coefficient of Voc: -0.29%/ °C Temperature coefficient of Isc: 0.05%/ °C					
HNM7-SPDB120-435/M	40.9	13.55	34.0	12.80	435
HNM7-SPDB120-440/M	41.1	13.62	34.2	12.87	440
HNM7-SPDB120-445/M	41.3	13.69	34.4	12.94	445
HNM7-SPDB120-450/M	41.5	13.76	34.6	13.01	450
HNM7-SPDB120-455/M	41.7	13.83	34.8	13.08	455
HNM7-SPDB120-460/M	41.9	13.90	35.0	13.15	460
HNM7-SPDB120-465/M	42.1	13.97	35.2	13.22	465
HNM7-SPDB120-470/M	42.3	14.04	35.4	13.28	470
HNM7-SHDB120-xxx/M (xxx=435-470 in steps of 5W) Temperature coefficient of Pmax: -0.35%/ °C Temperature coefficient of Voc: -0.29%/ °C Temperature coefficient of Isc: 0.05%/ °C					
HNM7-SHDB120-435/M	40.9	13.55	34.0	12.80	435
HNM7-SHDB120-440/M	41.1	13.62	34.2	12.87	440
HNM7-SHDB120-445/M	41.3	13.69	34.4	12.94	445
HNM7-SHDB120-450/M	41.5	13.76	34.6	13.01	450
HNM7-SHDB120-455/M	41.7	13.83	34.8	13.08	455
HNM7-SHDB120-460/M	41.9	13.90	35.0	13.15	460
HNM7-SHDB120-465/M	42.1	13.97	35.2	13.22	465
HNM7-SHDB120-470/M	42.3	14.04	35.4	13.28	470
HNM7-SPDB108-xxx/M (xxx=390-420 in steps of 5W) Temperature coefficient of Pmax: -0.35%/ °C Temperature coefficient of Voc: -0.29%/ °C Temperature coefficient of Isc: 0.05%/ °C					
HNM7-SPDB108-390/M	36.7	13.54	30.5	12.79	390
HNM7-SPDB108-395/M	36.9	13.62	30.7	12.87	395
HNM7-SPDB108-400/M	37.1	13.70	30.9	12.95	400
HNM7-SPDB108-405/M	37.3	13.78	31.1	13.03	405
HNM7-SPDB108-410/M	37.5	13.86	31.3	13.10	410
HNM7-SPDB108-415/M	37.7	13.94	31.5	13.18	415
HNM7-SPDB108-420/M	37.9	14.02	31.7	13.25	420
HNM7-SHDB108-xxx/M (xxx=390-420 in steps of 5W) Temperature coefficient of Pmax: -0.35%/ °C Temperature coefficient of Voc: -0.29%/ °C Temperature coefficient of Isc: 0.05%/ °C					

HNM7-SHDB108-390/M	36.7	13.54	30.5	12.79	390
HNM7-SHDB108-395/M	36.9	13.62	30.7	12.87	395
HNM7-SHDB108-400/M	37.1	13.70	30.9	12.95	400
HNM7-SHDB108-405/M	37.3	13.78	31.1	13.03	405
HNM7-SHDB108-410/M	37.5	13.86	31.3	13.10	410
HNM7-SHDB108-415/M	37.7	13.94	31.5	13.18	415
HNM7-SHDB108-420/M	37.9	14.02	31.7	13.25	420
NA.					