

HES INSTALLATION MANUAL (IEC)

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HYUNDAI ENERGY SOLUTIONS

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HJT PV MODULE INSTALLATION MANUAL

1 General Information	3
1.1 Overview	3
1.2 Installation Manual Disclaimer	3
1.3 Limitation of Liability	4
1.4 Fire Safety	4
2 Installation	5
2.1 Installation Safety	5
2.2 Installation Condition	6
2.3 Mechanical Installation Introduction	7
3 Module Wiring	13
3.1 Correct Wiring Scheme	13
3.2 Correct Connection of Plug Connectors	13
4 Electrical Specification	14
4.1 Test Conditions	14
4.2 Electrical Installation	14
5 Grounding	15
6 Maintenance and Care	17
6.1 Visual Inspection	17
6.2 Module Cleaning	18
6.3 Inspection of Connector and Cable	18

1. General Information

1.1 Overview

This general manual provides important safety information relating to the installation, maintenance and handling of heterojunction(HJT) solar modules. Professional installer must read these guidelines carefully and strictly follow these instructions. Failure to follow these instructions may result in death, injury or property damage. The installation and handling of HJT PV modules requires professional skills and should only be performed by qualified professionals. Installers must inform end-users (consumers) about the aforesaid information accordingly.

The "module" or "HJT module" in this specification refers to one or more series HJT photovoltaic modules. Please keep this manual for future reference.

It is recommended to visit the HD HYUNDAI ENERGY SOLUTIONS website www.hd-hyundaies.co.kr regularly to obtain the latest version.

1.2 Installation Manual Disclaimer

Because the use of the manual and the conditions or methods of installation, operation, use and maintenance of photovoltaic (PV) product are beyond HD HYUNDAI's control, HD HYUNDAI does not accept responsibility and expressly disclaims liability for loss, damage, or expense arising out of or in any way connected with such installation, operation, use or maintenance.

No responsibility is assumed by HD HYUNDAI for any infringement of patents or other rights of third parties, which may result from use of the PV product. NO license is granted by implication or otherwise under any patent or patent rights.

The information in this manual is based on HD HYUNDAI's knowledge and experience and is believed to be reliable, but such information including product specification (without limitations) and suggestions do not constitute a warranty, expresses or implied. HD HYUNDAI reserve the right to change the manual, the PV produce, the specifications, or product information sheets without prior notice.

Modules qualified for safety through IEC 61730-1 and this part of IEC 61730 within this application class are considered to meet the requirements for safety class II.

1.3 Limitation of Liability

HD HYUNDAI is not responsible for any form of injury, including but not limited to module operation, system installation, and physical injury, injury and property damage caused by whether it is in accordance with the instructions in this manual.

1.4 Fire Safety

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 HD HYUNDAI modules is Class C (According to UL790).

The roof should be coated by a layer of fireproof materials with suitable fire protection rating for roofing installation and make sure that the back sheet and the mounting surface are fully ventilated. Different roof structures and installation modes will affect fireproof performance of buildings. Improper installation may lead to the risk of fire.

To guarantee roof fire rating, the distance between module frame and roof surface must be $\geq 10\text{cm}$.
(4in)

Adopt proper module accessories such as fuse, circuit breaker and grounding connector according to local regulations.

Please do not apply modules in where exposed inflammable gases are nearby.

2. Installation

2.1 Installation Safety

1. Always wear protective head gear, insulating gloves and safety shoes (with rubber soles).
2. Never disconnect electrical connections or unplug connectors while the circuit is under load.
3. Contact with electrically active parts of the modules, such as terminals, can result in burns, sparks and lethal shock whether or not the module is connected.
4. Do not touch the PV module unnecessarily during installation. The glass surface and the frame may be hot; there is a risk of burns and electric shock.
5. Do not work in the rain, snow or in windy conditions.
6. Avoid exposing cables and connectors to direct sunlight and scratches or cuts in order to prevent insulation degradation.
7. Use only insulated tools that are approved for working on electrical installations.
8. Keep children well away from the system while transporting and installing mechanical and electrical components.
9. Completely cover the module with an opaque material during installation to prevent electricity from being generated.
10. Do not wear metallic rings, watchbands, earrings, nose rings, lip rings or other metallic objects while installing or troubleshooting photovoltaic systems.
11. Follow the safety regulations (e.g., safety rules for working on electrical power plant stations) of your regions and for all other system components, including wires and cables, connectors, charging regulators, inverters, storage batteries, rechargeable batteries, etc.
12. 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 I_{sc} and V_{oc} marked on this module should be multiplied by a factor of 1.25 when determining component voltage ratings, conductor current ratings, minimum factor of fuse sizes, and size of controls connected to the PV output.

13. Only use same connectors to connect modules to form a string, or connect to another device.
Removing the connectors will void the warranty.

2.2 Installation Conditions

2.2.1 Climate Conditions

Please install the modules in the following conditions:

- a) Working environment: -40°C to +40°C
- b) Humidity: < 85RH%

* Note: The mechanical load bearing (include wind and snow loads) of the module is based on the installation method and installation location. When calculating the mechanical load, a professional installer must calculate it according to the design requirements of the system.

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

2.2.2 Site Selection

The modules should be facing south in northern latitudes and north in southern latitudes.

HD HYUNDAI recommends that the inclination angle of the installation modules should not be less than 10°, so that the dust is washed away by rain, and more effective light intensity and ventilation are obtained, because the hot air above and below the components can flow in one direction and the components are efficient at lower temperatures higher.

- For detailed information about the best installation angle, please refer to the standard solar photovoltaic installation guide or consult professional solar installers and system integrators.

- The modules should not be blocked by sunlight at any time.
- Do not use components near or in locations where flammable gas may be generated or collected.
- The modules cannot be directly irradiated by artificially concentrated sunlight.

2.3 Mechanical Installation Introduction

HJT PV modules usually can be installed in the following ways: Clamps and Bolts.

Note:

1) All installation methods herein are for reference only, and HD HYUNDAI is not responsible for providing related installation parts, design and installation of modules systems. Mechanical load and safety must be completed by a professional system installer or an experienced person.

2) Before installation, you need to confirm the following important items:

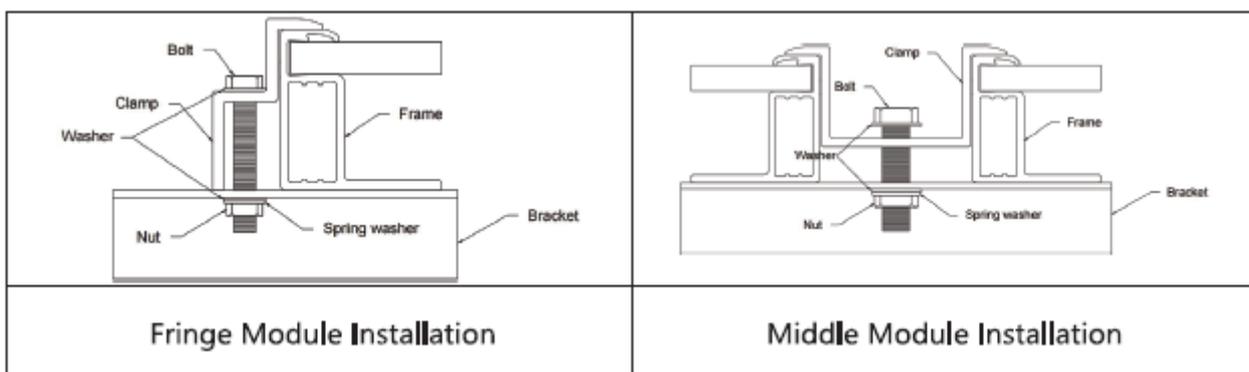
a) Visually check the module for any damage. Clean the module if any dirt or residue remains from shipping.

b) Check if the serial number of the module is correct.

3) The mechanical load of HD HYUNDAI HJT PV modules (framed module) was tested under 5400Pa on the front side (Designed 3600Pa, safety factor 1.5) and 2400Pa on the back side (Designed 1600Pa, safety factor 1.5). PV modules (frameless module) was tested under 3600Pa on the front side (Designed 2400Pa, safety factor 1.5) and 2400Pa on the back side (Designed 1600Pa, safety factor 1.5). If the installation environment of the module is snowy and strong wind, special protection should be adopted when the module is installed to meet the actual requirements.

2.3.1 Mounting with Clamps (framed module)

The modules should be installed using special clamps.



Under no circumstances should the clamps touch the glass or deform the frame of the module. The front contact surface between the clamp and the frame must be smooth, otherwise the frame may

be damaged and result in the damage of the module.

Always make sure the shadow of clamps should not come on the module front surface. The drain hole should not be blocked by clamps. For framed modules, ensure the clamps overlap the module frame by at least 8mm but not more than 11mm (cross section of clamps can be changed, on the condition that the modules may be installed securely). Suggested length of the clamp ≥ 60 mm, thickness ≥ 3 mm.

Module (framed) installation diagram and corresponding load When clamps installed on the short side, a slight deformation may occur to the center of the module, which is elastic deformation, due to a long distance of supporting points and under the self-weight or smaller load of modules.

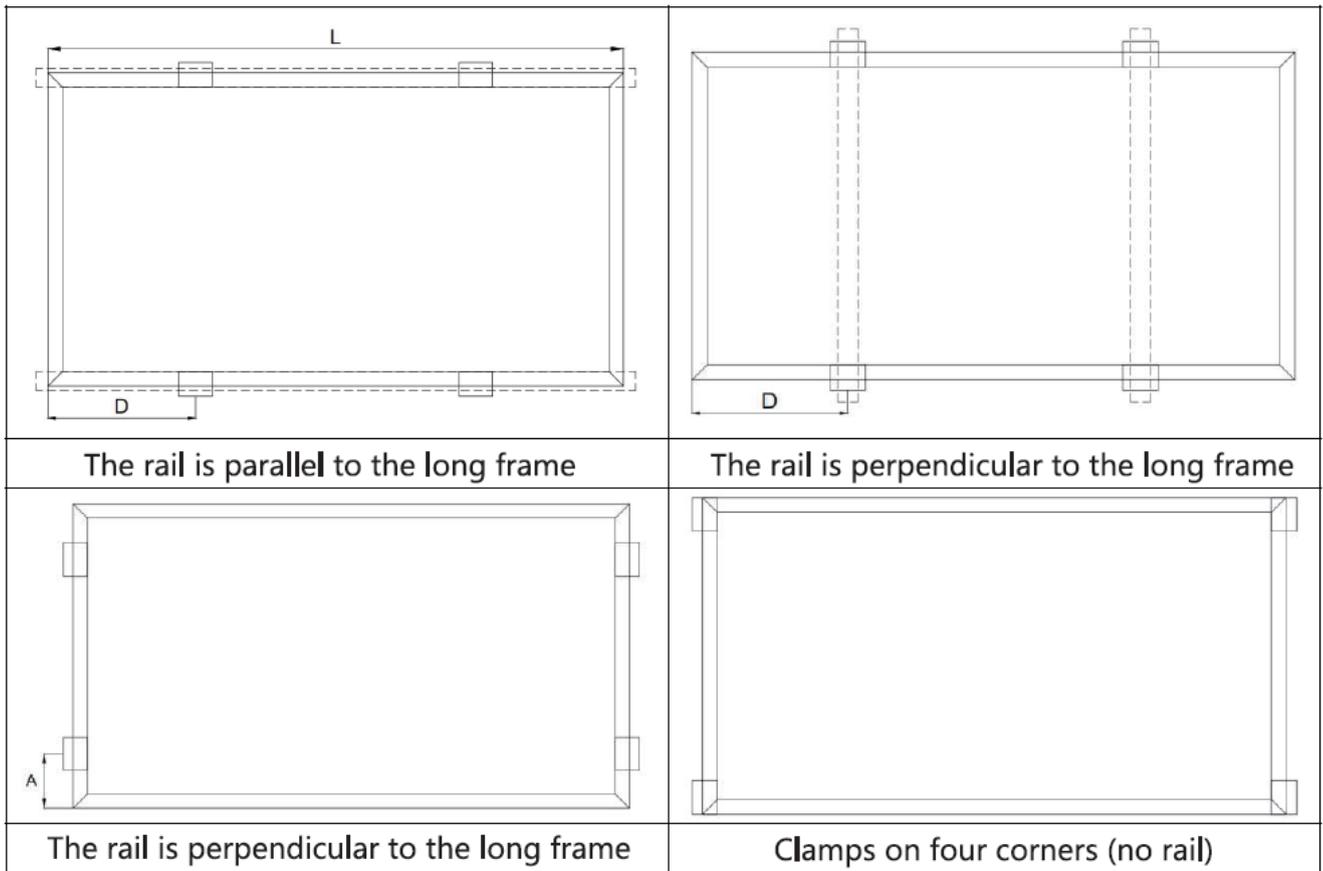
The deformation can be restored after taking down the module or removing the load, which will not result in micro-crack of cells and power degradation.

Module appearance may get affected under severe environment such as heavy snow, module will bear heavy snow load, a big shape change may occur to the center of the module. During the shape change of modules, the junction box or the glass may contact with the obstacle underneath, great stress may occur to the back glass and the modules are vulnerable to break. Hyundai requires that the distance between the obstacle underneath and the junction box or the glass shall ≥ 120 mm

When installing the clamps on the short side, the load should be calculated and the support structure designed by professional structural engineers, according to the project climate conditions. Any foreign matters should be avoided underneath the orthographic projection of the module glass.

Other appearance issues resulted from self-weight or other loads are not deemed as defects, and which will not be covered under warranty.

Clamps installation diagram



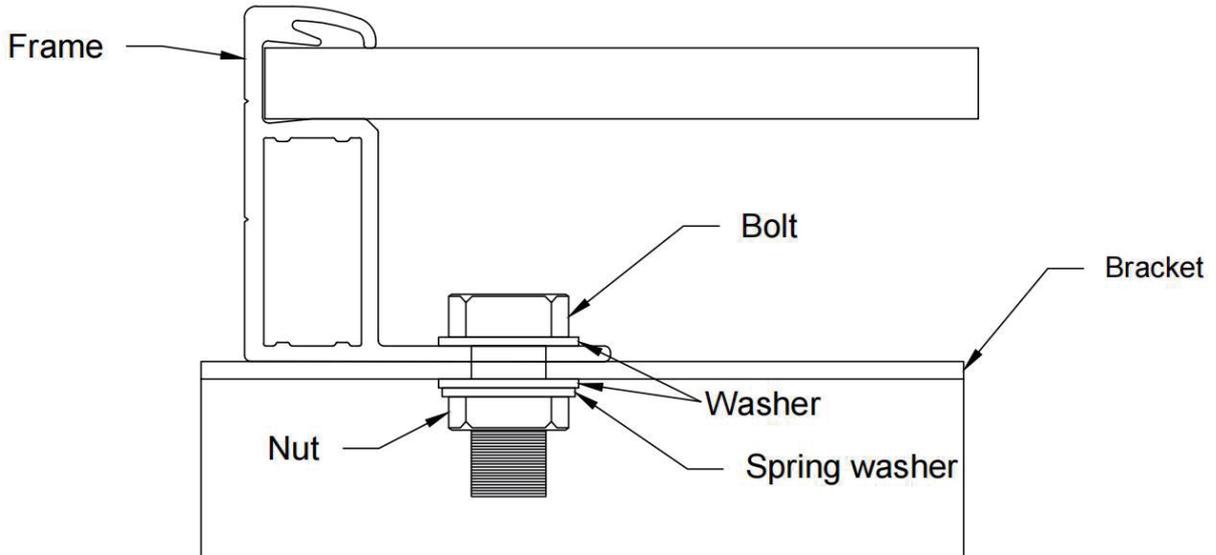
	The rail is perpendicular to the long frame							
	D=450±50mm	D=395±35mm	D=439±50mm	D=450±50mm	D=485±50mm	D=490±50mm	D=525±50mm	D=567±50mm
HiT-HxxxMF-FB	/	/	/	+5400 -2400	/	/	/	/
HiT-HxxxOF-BF	/	/	/	+5400 -2400	/	/	/	/
HiT-HxxxOF-BFT	/	/	/	+5400 -2400	/	/	/	/
HiT-HxxxOF-FB	/	/	/	+5400 -2400	/	/	/	/
HiT-HxxxOI	/	/	/	+5400 -2400	/	/	/	/
HiT-HxxxGM	/	/	/	/	/	+5400 -2400	/	/
HiT-HxxxGG	/	+5400 -2400	/	/	/	/	/	/
HiT-HxxxGH	/	/	/	/	/	+5400 -2400	/	/

Continue

Installation methods	Short side block		four corner block
	60≤A≤200mm	60≤A≤200mm	/
Module type			
HiT-HxxxMF-FB	±1800	±2000	±1600
HiT-HxxxOF-BF	±1800	±2000	±1600
HiT-HxxxOF-BFT	±1800	±2000	±1600
HiT-HxxxOF-FB	±1800	±2000	±1600

2.3.2 Mounting with Bolts (framed module)

Modules are bolted to the supporting structure through the mounting holes in the rear frame of modules.



Recommended accessories to be used are as follows

M8 bolts

Mounting fasteners	Model specifications	Material	Remarks
Bolts	M8 (full thread recommended)	Q235B/SUS304	Material for fasteners should be selected based on the local environment
Flat washer	2 * 8	Q235B/SUS304	
Spring washer	8	Q235B/SUS304	
Nut	M8	Q235B/SUS304	

M6 bolts

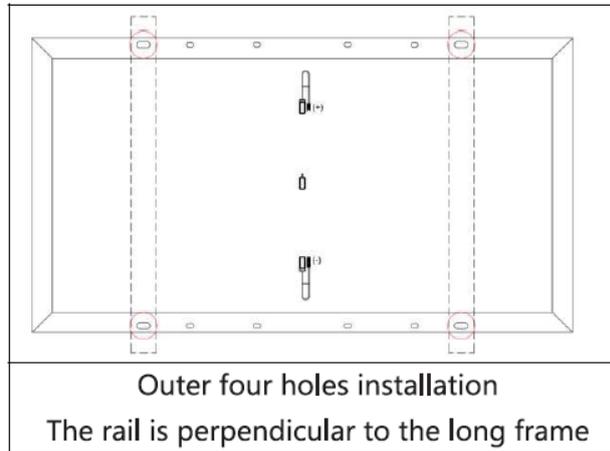
Mounting fasteners	Model specifications	Material	Remarks
Bolts	M6(full thread recommended)	Q235B/SUS304	Material for fasteners should be selected based on the local environment
Flat washer	2*6 (6.4*18-1.6 ISO 7093)	Q235B/SUS304	
Spring washer	6	Q235B/SUS304	
Nut	M6	Q235B/SUS304	

Suggestion: tightening torque for M8 bolts should be within 16 N · m-20N · m;

The torque for M6 bolts should be within 8N · m-12N · m.

Module mounting diagram and corresponding load (framed)

Schematic diagram of bolt type mounting



Corresponding load

Installation methods Module type	The rail is perpendicular to the long frame
	Outer four holes installation
HiT-HxxxOI	+5400 -2400
HiT-HxxxGM	+5400 -2400
HiT-HxxxGG	+5400 -2400
HiT-HxxxGH	+5400 -2400

3. Module Wiring

3.1 Correct Wiring Scheme

- ① Ensure that the wiring is correct before starting up the system. If the measured open circuit voltage (Voc) and short-circuit current (Isc) differ substantially from the specifications, this indicates that there is a wiring fault.
- ② Do not connect different connectors (brand and model) together.
- ③ Before the modules are connected to the grid, appropriate protective measures need to be taken to prevent water vapor and dust from penetrating into the connector.
- ④ The cable should be fixed on the module frame or mounting rail to avoid blocking the back of the module.
- ⑤ In order to meet the system wiring requirements, the distance between the two adjacent modules of the left and right must be within 50mm; for the adjacent two rows of modules, the distance between the modules must be within 25mm.

3.2 Correct Connection of Plug Connectors

- Make sure that all connections are safe and properly mated. The PV connectors should not be subjected to stress from the exterior. Connectors should only be used to connect the circuit. They should never be used to turn the circuit on and off.
- If the connector is not connected positively and negatively, the connector is not waterproof. After the modules are installed, they need to be connected as soon as possible or take appropriate measures (such as using connector end caps) to avoid infiltration of water vapor and dust.
- Do not clean or precondition the connectors using lubricants or any unauthorized chemical substances.

4. Electrical Specification

4.1 Test conditions

The module electrical rating are measured under two Standard Test Conditions, In some cases, the module may generate a voltage or current value higher or lower than the rated value. The maximum allowable reflected light intensity on the back is 300W/m².

For detailed electrical parameters under these two test conditions please refer to modules datasheet.

4.1.1 1000W/m² on front, irradiance with AM 1.5 spectrum and 25°C (77°F) ambient temperature, hereinafter referred to as STC.

4.2 Electrical Installation

The maximum allowed quantity of modules in string connection shall be calculated according to relative regulations. The open circuit voltage value under the expected lowest temperature shall not exceed the maximum system voltage value allowed by modules and other values required by DC electric parts.

Normally, the Voc factor can be calculated by the following formula. $C_{Voc} = 1 - \beta V_{oc} \times (25 - T)$

T: The expected lowest temperature of the installation site.

β : Voc temperature coefficient (%/°C) (Refer to modules datasheet)

Recommended maximum series is $[\text{Max System voltage } V / (1.25 * V_{oc})]$, parallel module configurations is $[\text{fuse rating} / 1.25 * I_{sc}]$

5. Grounding

(1) Module frame should be grounded to avoid lightning strikes and for electrical safety. It can be connected by using 4mm² copper core wire threaded through the adjacent ground hole on the module frame. If there is no ground hole, you can also use the unused mounting hole on frame for the grounding;

(2) When grounding, the screw must penetrate the anodized coating of the frame and it should be tightened to secure.

(3) The grounding conductor or grounding wire may be copper, copper alloy or any other material used as an electrical conductor that meets the requirements of the corresponding National Electrical Code, and the grounding conductor must be connected to the earth by a suitable grounding electrode;

(4) The following grounding methods are permitted:

① Use a grounding clamp for grounding

a. There is a Ø 5mm diameter ground hole in the middle near edge on the back frame of the module.

b. The grounding between the modules should be done by a qualified electrician and the grounding device must be made by a qualified electrical manufacturer. The recommended torque value is 2.3N•m. Use a 12AWG size copper core wire as grounding clamps. The copper wire should not be damaged by pressure during installation.

② Ground by unused mounting holes

Existing but unused mounting holes on the module can be used to install the grounding device.

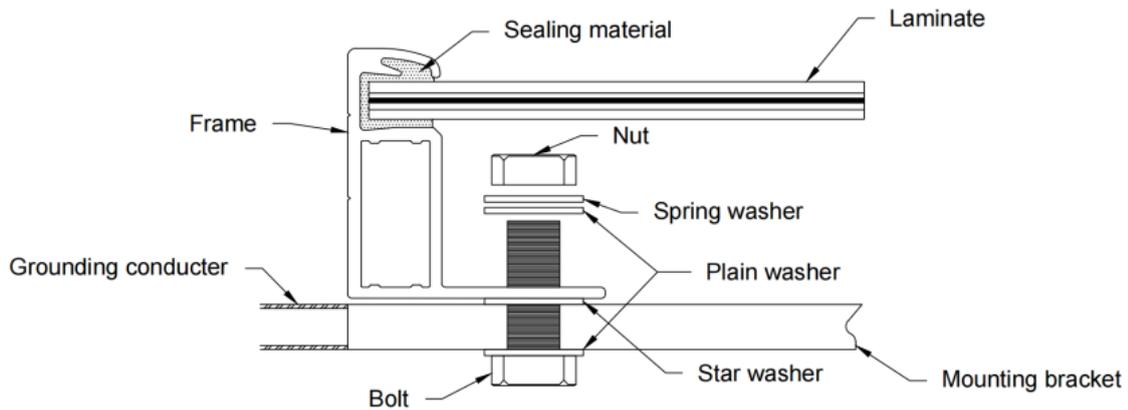
a. Align the grounding clip with the mounting hole of the frame. Use the grounding bolt to through the grounding clamp and frame;

b. Put the star washer on the other side and tighten the lock nut;

c. Pass the grounding wire through the grounding clip. The material and size of the grounding wire should meet the requirements of the relevant local national, regional and

local laws and regulations;

d. Tighten the fastening bolts of the grounding wire to complete the installation.



③ Other third party grounding devices

Modules may be grounded using a third party grounding device, but the grounding must be reliable and certified, and the grounding device is operated in accordance with the manufacturer's requirements.

6. Maintenance and Care

It is required to perform regular inspection and maintenance of the modules, especially during the warranty period. In order to ensure the best performance of the modules, HD HYUNDAI recommends the following maintenance measures:

6.1 Visual Inspection

Please carefully check the modules for appearance defects. Focus on the following points:

- a) If modules are observed having slight cell color differences at different angles, this is a normal phenomenon of modules with anti-reflection coating technology;
- b) Whether the glass is broken;
- c) Whether any sharp objects touch the surface of the module;
- d) Whether the module is blocked by obstacles or foreign objects; if there is snow, you can use a brush with soft bristles to clean the surface of the module;
- e) Whether there is corrosion near the grid line of the cell. This kind of corrosion is caused by the damage of the packaging material on the surface of the module during installation or transportation, which causes water vapor to penetrate into the module;
- f) Observe whether there are burn-through traces on the back plate of the module;
- g) Check whether the fixing screws between the modules and the bracket are loose or damaged, and adjust or repair them in time;
- h) The system should be checked regularly to ensure that the supporting structure of the junction box is intact;
- i) If you need inspection or maintenance of electrical or mechanical performance, it is recommended that the inspection or maintenance be carried out by certified and approved professionals to avoid electric shock or personal injury.

6.2 Module Cleaning

6.2.1 Safety Warning

- Cleaning will cause the risk of damage to modules and a series of parts, and also increase the risk of electric shock.
- Cracked or damaged modules will present a risk of electric shock due to leakage current, and wet modules will aggravate this risk of electric shock. Before cleaning, check the modules for cracks, damage, and loose joints.
- During the day, the voltage and current existing in the array are enough to cause fatal electric shock accidents.
- Since touching exposed parts of live parts can cause injury, make sure that the circuit is disconnected before cleaning.
- Before cleaning, make sure that the array and live parts (such as inverters and combiner boxes) are disconnected.
- Wear suitable protective clothing (clothes, insulating gloves, etc.).
- Do not immerse the modules partially or completely in water or any kind of washing liquid.

6.3 Inspection of Connector and Cable

The following preventive maintenance is recommended every six months:

- a) Check the sealing gels of the junction box for any damage.
- b) 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.