Installation Manual for Nahui Solar PV Modules

Regular Modules

Safety Notes

- *This manual elaborates on installation and safety use information for PV power generating modules (hereinafter referred to as module) of Qingdao Nahui Photovoltaic New Energy Co., Ltd. (hereinafter referred to as Nahui).*
  Please abide by all safety precautions in this guide and local regulations.
- *Installation of modules requires professional skills and knowledge and is to be carried out by qualified personnel. Please read this manual carefully before installing and using this module. Installation personnel shall get familiar with mechanical and electrical requirements of this system. Please keep this manual properly as reference for future maintenance or upkeep or for sales and treatment of modules.*
- *If you have any doubts, please contact Nahui global quality and customer service department for further interpretation.*

Contents

1 Introduction

This installation manual provides essential information on both the electrical and mechanical aspects of installing Nahui modules. It is imperative that this information be thoroughly understood prior to installation. Additionally, the manual includes important safety guidelines, with which you should familiarize yourself. All content contained herein is the intellectual property of Nahui, developed through years of technical innovation and experience.

Please note that this manual does not provide any explicit or implied warranty of quality, nor does it establish compensation schemes for any losses, damages to modules, or other costs arising from, or associated with, the installation, operation, usage, or maintenance of the modules. Nahui disclaims any responsibility for infringements of patent or third-party rights resulting from the use of these modules. Nahui reserves the right to amend this product or installation manual without prior notice.

Failure to install the modules in accordance with the requirements outlined in this manual will render the quality warranty, provided at the time of purchase, null and void. Furthermore, the recommendations provided in this manual are designed to enhance the safety of module installation, having been rigorously tested and validated through practical application. Please ensure that this manual is made available to users of the photovoltaic (PV) system, and advise them of the relevant safety, operational, and maintenance requirements and recommendations.

2 Laws and regulations

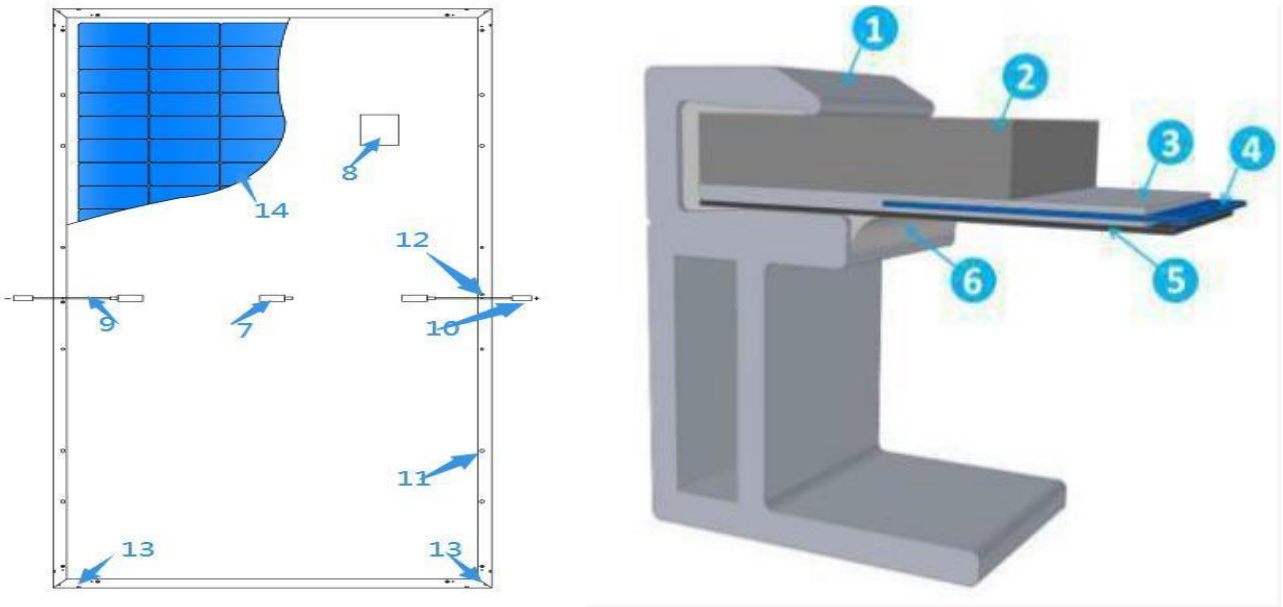
The mechanical and electrical installation of PV modules must adhere to applicable regulations, including electrical codes, building codes, and electrical connection standards. These regulations may vary depending on the installation site, such as rooftop installations or vehicle-mounted applications, and may also differ based on system voltage, whether DC or AC. It is essential to consult the specific guidelines issued by local authorities to ensure compliance with all relevant requirements.

3 General information

3.1 Module identification

Each module is pasted with 3 labels providing information below:

1. **Nameplate**: This label specifies key product details, including the product type, standard rated power, rated current, rated voltage, open-circuit voltage, short-circuit current under test conditions, certification mark, maximum system voltage, and other relevant information.
2. **Current Level Label**: This label categorizes modules based on their optimal operating current, with classifications of H, M, or L (H representing the highest current level). It is recommended to group modules with the same current level (e.g., H) within the same string during installation for optimal performance.
3. **Serial Number**: Each module is assigned a unique serial number, permanently embedded within the module and visible from the front top. The serial number is applied prior to the module's lamination process to ensure durability.



1. Aluminum alloy frame 2. PV tempered glass 3. Packaging EVA 4. Cells
5. Back plate 6. Silica gel 7. Connecting box 8. Nameplate
9. Cables 10. Connector 11. Mounting hole 12. Grounding hole
13. Leakage hole 14. Cell

Figure 1 Module Section Structure and Components

PV Modules with Half-cut 210mm Mono-crystalline Silicon Solar Cells:

132 cells: NHO132-xxxMN (xxx=670-700, in increment of 5)

PV Modules with Half-cut 182mm Mono-crystalline Silicon Solar Cells:

144 cells: NHO144-xxxMN (xxx=550-590, in increment of 5)

120 cells: NHO120-xxxMNB (xxx=460-490, in increment of 5)

108 cells: NHO108-xxxMN (xxx=410-440, in increment of 5)

108 cells: NHO108-xxxMNB (xxx=410-440, in increment of 5)

3.2 Regular safety

Nahui modules comply with IEC 61215 and IEC 61730 standards only when installed in accordance with the mounting instructions provided below.

When installing the module on a roof, it is essential to consider the overall fire rating of the completed structure as well as long-term maintenance requirements. The installation of a rooftop PV system must be carried out after an evaluation by qualified construction experts or engineers, supported by official structural analysis results. It must be verified that the structure can bear the additional pressure of the system brackets, including the weight of the PV modules.

For your safety, do not perform any work on the roof without implementing appropriate safety precautions. These measures include, but are not limited to, fall protection systems, ladders or stairways, and personal protective equipment.

Additionally, for safety reasons, avoid installing or handling modules in unfavorable conditions such as high winds, dampness, or on sandy roofs.

3.3 Electric performance safety

PV products generate direct current (DC) when exposed to sunlight and contact with metallic parts of the module's connecting lines can result in electric shock or burns. DC voltage of 30V or higher can be fatal. Even in the absence of connected loads or external circuits, PV modules may still produce voltage. Therefore, it is critical to use insulated tools and wear rubber gloves when handling modules in sunlight.

PV modules are not equipped with an on/off switch and can only cease operation when they are shielded from sunlight by cloth, hardboard, or other light-blocking materials, or when placed face-down on a smooth and flat surface.

To avoid the risk of electrical arcs or electric shock, do not disconnect electrical connections under load. Incorrect connections can also result in electrical arcing or shock. Ensure connectors are kept dry, clean, and in good working condition. Do not insert foreign metals into the connectors or make electrical connections through improper means.

Snow and water in the surrounding environment can intensify light reflection, leading to increased current and output power. Module voltage and power may also increase in low-temperature conditions. In the event of damage to the module's glass or packaging materials, wear appropriate personal protective equipment and isolate the module from the electrical circuit.

Work should only be conducted in dry conditions using dry tools. Do not handle modules when they are wet unless proper electric shock protection devices are worn. Follow the cleaning guidelines outlined in this manual when performing maintenance on the modules.

The safety protection of PV module models is class II.

3.4 Operation safety

- Do not open Nahui packages during transportation or storage until the modules have arrived at the installation site.
- Ensure the packaging remains intact and avoid dropping the pallet or causing packaged modules to fall. When stacking, do not exceed the maximum stacking limit indicated on the packaging carton. Before unpacking, store the cartons in ventilated, dry, and rainproof areas. Follow the specific unpacking instructions provided when opening Nahui's packaging.
- Under no circumstances should the junction box or wires be used to lift the entire module.
- Avoid standing or walking on the modules, and do not stack one module on top of another.
- To prevent damage to the glass, avoid placing heavy objects on the surface of the module.
- Exercise caution when placing modules on any surface, especially around corners.
- Do not attempt to unpack, alter, or remove the nameplate or any components of the modules.
- Avoid painting the surface of the modules or applying adhesives.
- Ensure the backsheet of the modules is not damaged, pulled, or scratched.
- Do not drill into the module frame, as this may weaken the load-bearing capacity or cause corrosion.
- The anodic coating of the aluminum alloy frame must not be scratched, except at the grounding connection point; scratches could lead to corrosion and reduce the frame's load-bearing capacity.
- Do not attempt to repair modules with damaged glass or backsheet on your own.

3.5 Fire safety

- Before installing the modules, please consult local laws and regulations, and ensure compliance with building fire protection requirements. Nahui modules are rated as Type-C according to IEC 61730 standards. For rooftop installations, the roof must be coated with fireproof materials of an equivalent rating, and proper ventilation between the backsheet of the module and the mounting surface must be ensured.
- Variations in roofing structures and installation methods can affect the building's fire resistance. Improper installation may increase the risk of fire hazards. To maintain the roof's fire rating, ensure that the module frame is installed at least 10 cm from the roof surface.
- Use appropriate module accessories, such as fuses, circuit breakers, and grounding connectors, in accordance with local regulations. The fire rating of this module is valid only when installed following the mechanical mounting instructions.
- Do not use the modules in environments where flammable gases are exposed.

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4 Installation conditions

4.1 Installation site and working environments

Nahui modules are designed for use on Earth and are not suitable for applications in outer space. Do not artificially concentrate sunlight onto the modules using mirrors or magnifying glasses.

Nahui modules must be installed on appropriate structures, such as buildings, rooftops, outer building walls, garages, ground installations, or photovoltaic (PV) tracking systems. Installation on mobile vehicles is not permitted. Additionally, modules should not be installed in locations that are prone to submersion.

Nahui recommends installing the modules in environments where the monthly average ambient temperature ranges from -20°C to 46°C. The extreme operating temperature range for the modules is -40°C to 85°C. Ensure that the modules are not subjected to wind or snow loads exceeding the maximum permissible limits.

Modules must be installed in areas free of shading throughout the year, ensuring that no obstacles block sunlight at any time. For installations in areas prone to frequent lightning and thunderstorms, appropriate lightning protection should be applied. Modules should not be installed in environments where flammable gases are present.

Avoid installing modules in environments with excessive hail, snow, smoke, air pollution, or soot. Likewise, refrain from installations in areas with highly corrosive substances, such as salt, salt mist, saline, active chemical vapours, acid rain, or other materials that may corrode the modules and impact their safety or performance.

In severe environmental conditions, such as heavy snow, extreme cold, strong winds, coastal areas with salt mist, or desert regions, take necessary protective measures to ensure the safe and reliable installation of the modules.

4.2 Selection of tilt angles

The tilt angle refers to the angle between the surface of the module and the horizontal plane. Maximum power output is achieved when the module is oriented directly towards the sunlight.

In the Northern Hemisphere, modules should ideally face south, while in the Southern Hemisphere, they should face north. The specific installation angle should be determined in accordance with the installation guide for standard modules or based on recommendations from a qualified PV module installer.

Nahui recommends that the tilt angle of the module installation be no less than 10°. This angle facilitates the natural cleaning of the module surface by rainfall, reducing the need for manual cleaning. It also helps to prevent water accumulation, which can leave watermarks on the glass and negatively affect both the appearance and performance of the modules over time.

5 Mechanical installation

5.1 Regular requirements

- Ensure that the module installation method and bracket system are robust enough to support the expected load. This is a critical assurance that must be provided by the bracket installer.
- The installation bracket system should be tested and inspected by a third-party testing institution with the capability for static mechanical analysis, in accordance with local, national, or international standards.
- The module brackets must be constructed from durable, corrosion-resistant, and ultraviolet-proof materials. Modules should be securely mounted onto the brackets. In areas prone to heavy snow accumulation, use elevated brackets to prevent the lowest point of the modules from being covered by snow for extended periods. Additionally, ensure the lowest point is sufficiently high to avoid obstruction by vegetation, as well as damage from flying sand or debris.
- When modules are installed on brackets parallel to the roof or wall, maintain a minimum gap of 10 cm between the module frame and the roof/wall to ensure proper air circulation and prevent damage to the module wiring. Do not drill holes in the glass or frame of the modules.
- Before installing modules on a roof, verify that the building is suitable for installation. Seal all permeable areas properly to prevent leakage. Since the module frame undergoes thermal expansion and contraction, ensure that the space between two adjoining modules is no less than 10 mm.
- Ensure that the backsheet of the modules does not come into contact with the bracket or building structures, particularly when the module surface is under pressure.
- Nahui Solar Modules are certified to withstand a maximum static load of up to 1600 Pa * 1.5 (wind load) on the back, and up to 3600 Pa * 1.5 (wind and snow load) on the front, depending on the clamp mounting (refer to the installation data for further information). This information is printed on the module label.
- The module installation method must not lead to electrochemical corrosion between the aluminum frame and other metals.
- The electrochemical potential difference between contacting metals should not exceed 0.6V, as recommended in IEC 61730 Appendix for Flat Plate Photovoltaic Modules and Panels.
- Modules can be installed either horizontally or vertically.

5.2 Way of installation

The connection between the module and bracket system may be achieved using either clamp or embedded systems. Installation must adhere to the guidelines and recommendations provided below. If an alternative installation method is proposed, please consult Nahui and obtain prior approval. Failure to do so may result in module damage and will void the quality warranty.

5.2.1 Use clamps to install modules

Use the special clamp to install modules. See Figure 3.

A. Fix modules on the bracket by metal clamp. The following clamps or those clamps recognized by module system installer are recommended.
Width: no less than 40mm； Thickness: no less than 3mm； Material: aluminum alloy； Bolt: M6.

B. Torque range for bolt fastening: 18N•m to 24N•m.

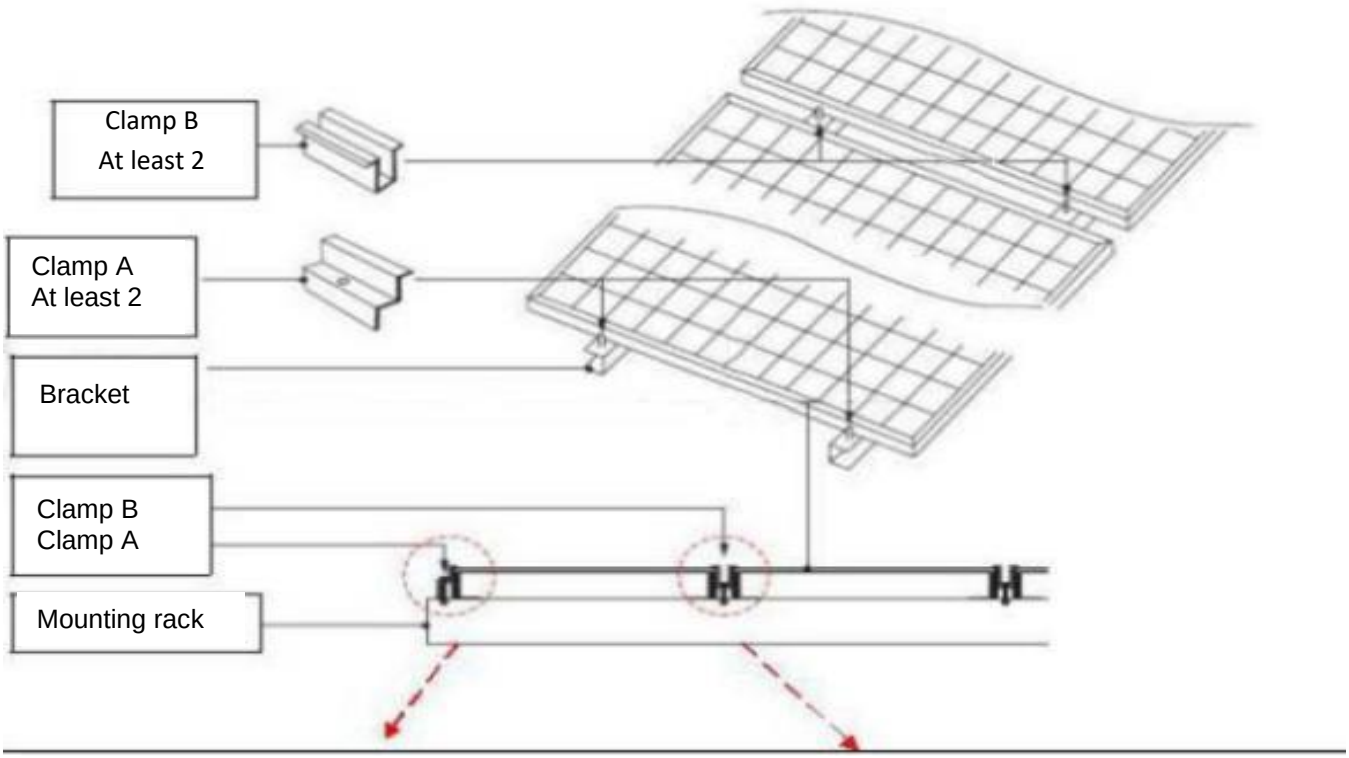
C. The clamp shall not contact glass or make module frame deformed in any case. The contacting surface of the clamp and frame front side shall be neat and smooth. Otherwise, frame and module may be damaged. Make sure that the clamp will not produce shading effect. Drain holes can not be sheltered by the clamp.

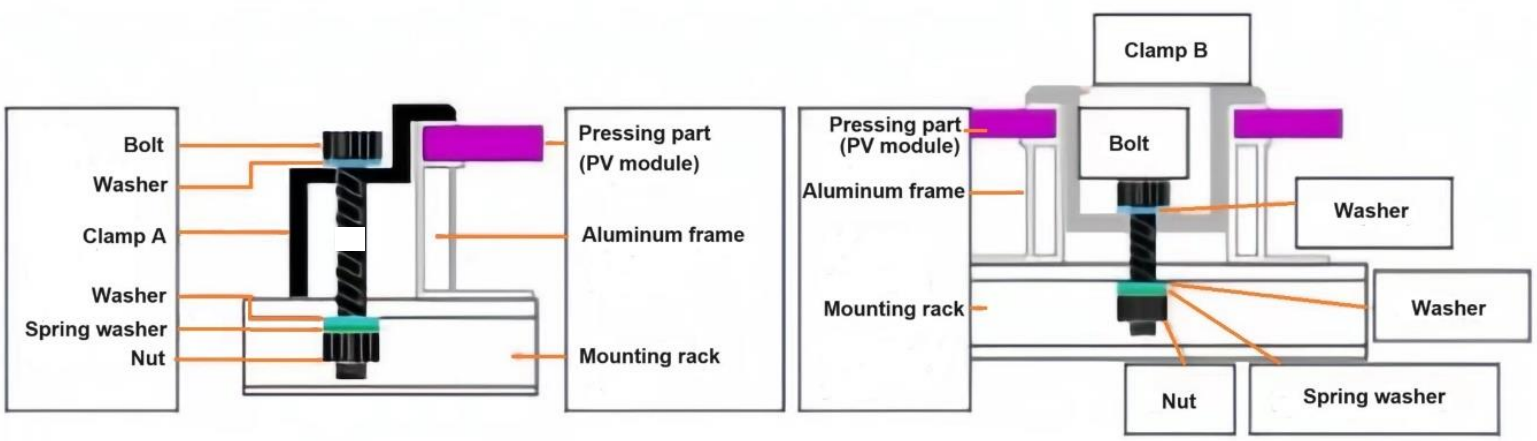
5.2.2 Handle the heavy or oversize PV modules to individual

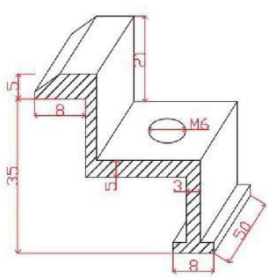
Considering the weight of modules, 2 persons are necessary to install them.
See the below table.

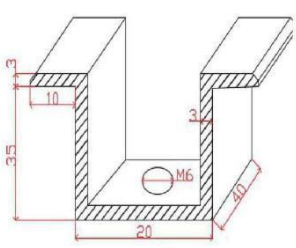
Module	Size/mm	Weight/kg	Staff
NHO108-XXXMN	1722*1134*30	21.5	2
NHO108-XXXMNB	1722*1134*30	21.5	2
NHO120-XXXMNB	1903*1134*30	23.8	2
NHO144-XXXMN	2278*1134*30	27.4	2
NHO132 – XXXMN	2384*1303*30	33.90	2

Figure 2









Clamp A for tail end module edge

Clamp B for middle modules

Figure 3 Clamp Illustration (unit: mm)

5.2.3 Position of installation connecting points

- **Low/Normal Load Conditions:** These conditions are suitable for most environments. The maximum static load for the backside of the module is 1600 Pa * 1.5 (equivalent to wind pressure). For the front side, the maximum static pressure is also 1600 Pa * 1.5, applicable when using four clamps (equivalent to both wind and snow pressure).

- **High Load Conditions:** These are applicable in severe environments, such as during windstorms or heavy snowfall. The maximum static load for the backside of the module is 1600 Pa * 1.5 (equivalent to wind pressure). For the front side, the maximum static pressure is 3600 Pa * 1.5, applicable when using six clamps (equivalent to both wind and snow pressure).

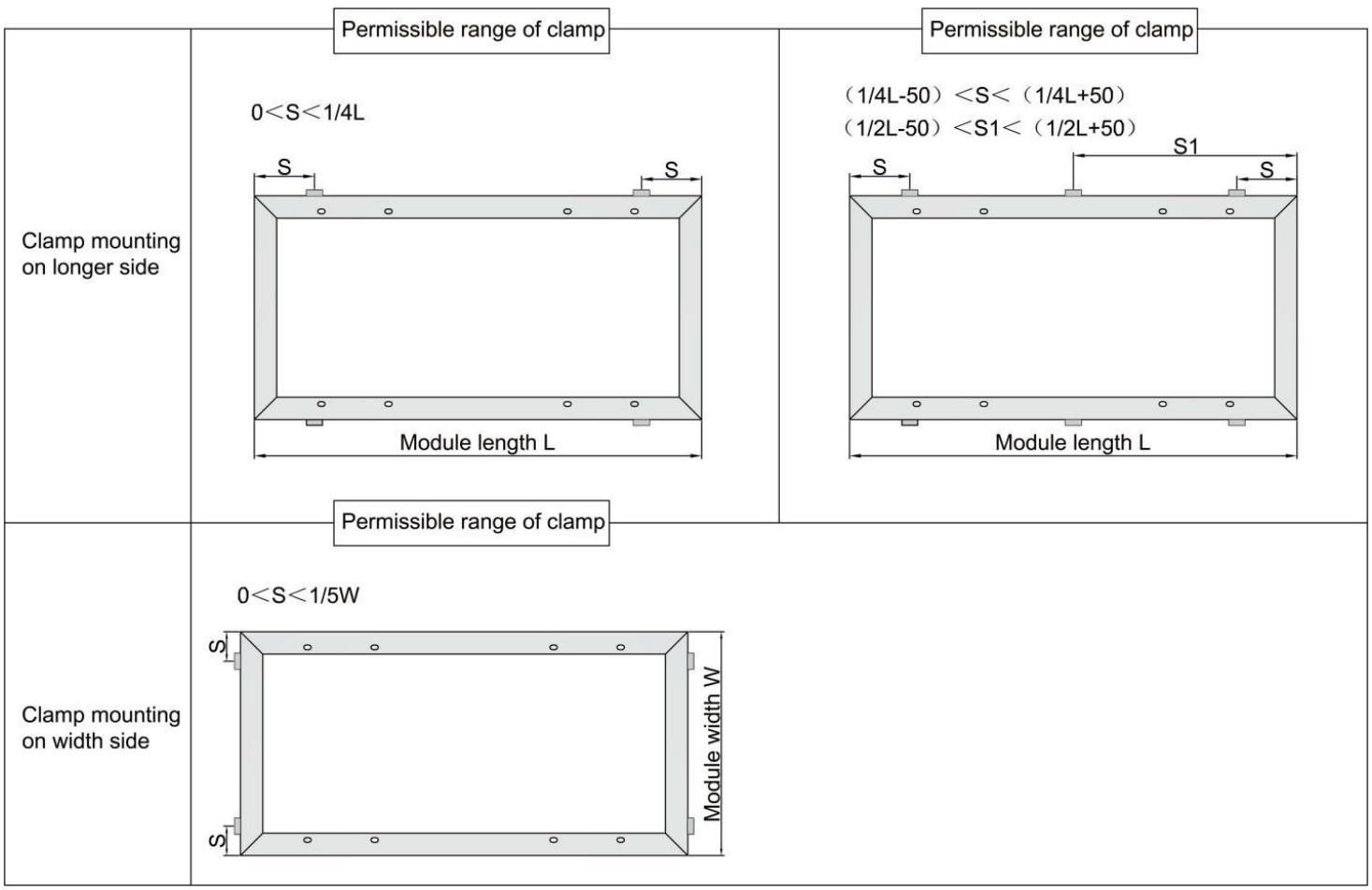


Figure 4 Position requirements of connecting points

6 Electrical installation

6.1 Electric performance

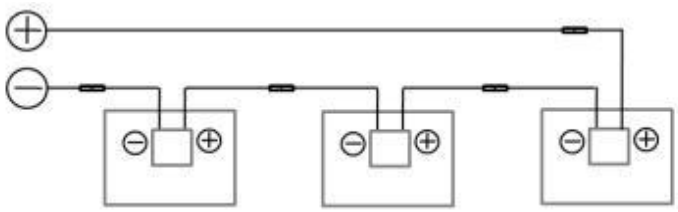
The electrical performance parameters of the module, including Isc (short-circuit current), Voc (open-circuit voltage), and Pmax (maximum power), may deviate by ±3% from their nominal values under standard testing conditions, which include an irradiance of 1000 W/m², a cell temperature of 25°C, and an air mass of AM1.5.

Under typical operating conditions, photovoltaic modules may produce higher currents and/or voltages than those measured under standard test conditions. To account for these increased outputs, the installation must comply with the requirements set forth in Article 690 of the Local Electrical Code. For installations not subject to the standards, the values of Isc and Voc indicated on this module should be multiplied by a factor of 1.25 when determining component voltage ratings, conductor ampacities, overcurrent protection ratings, and the sizing of controls connected to the PV output.

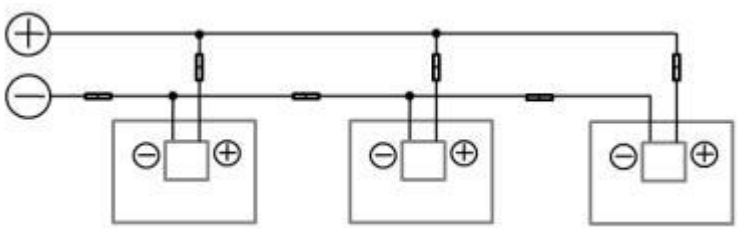
When modules are connected in series, the total voltage is the sum of the individual module voltages. When modules are connected in parallel, the total current is the sum of the individual module currents (refer to Figure 5 for reference).

Modules with different electrical performance characteristics should not be connected in the same series configuration, as this may result in performance inefficiencies or damage.

Series connection



Parallel connection



Parallel connection after series connection

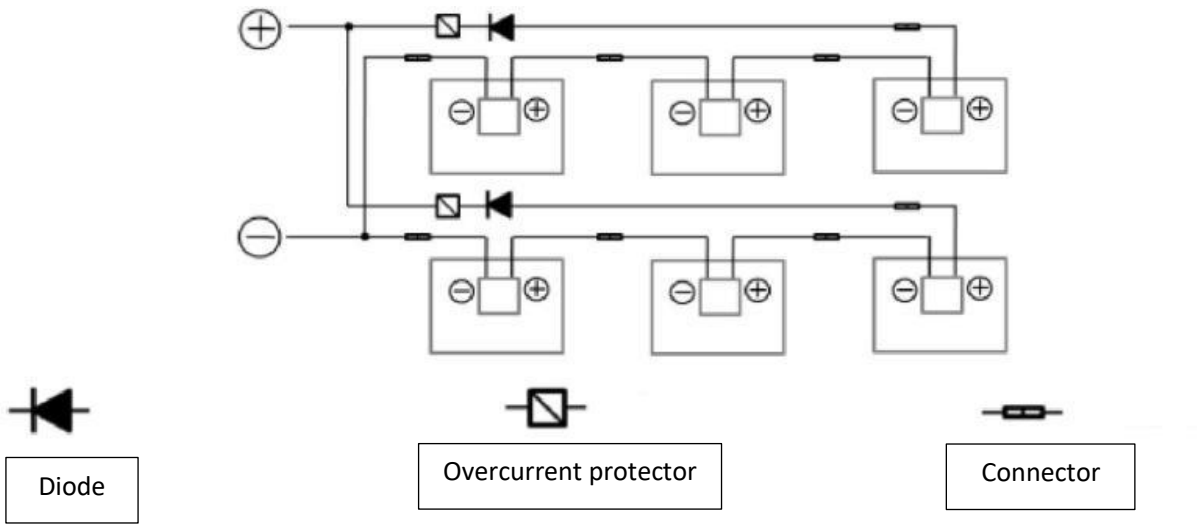


Figure 5: Series connection and parallel connection circuit diagram

- The number of modules connected in series within each string must be calculated in accordance with system requirements. The open-circuit voltage (Voc) at the expected lowest operating temperature must not exceed the maximum system voltage specified for the modules (for Nahui modules, the maximum system voltage is DC 1500V, as per IEC 61730) or the limits required by other DC electrical components.

When modules are connected in series, the total system voltage equals the sum of the individual module voltages. The recommended system voltage is provided below:

$$\text{Maximum system voltage} \geqslant N \times Voc \times [1+\beta^{*}(Tmin-25)]$$

Where:

N —— number of modules connected in series

Voc —— open circuit voltage of each module (refer to product nameplate or specification) [V]

β —— thermal coefficient of open circuit voltage for the module (refer to the specification) [°C-1]

Tmin —— lowest ambient temperature [°C]

Maximum series overcurrent protective device, where required.

If reverse current exceeding the module's maximum fuse current flows through the module, an overcurrent protection device with the appropriate specifications must be used to protect the module. In cases where more than two parallel-connected strings are present, an overcurrent protection device must be installed on each string. Refer to **Figure 5** for further details.

6.2 Cables and connecting lines

In module design, adopt enclosed connecting boxes with the protective level of IP68 for on-site connection to provide environmental influence protection for wires and connections and contacting protection for non-insulating electric parts. The connecting box has well connected cables and connectors with the protective level of IP68. These designs facilitate parallel connection of modules. Each module has two independent wires connecting the connecting box, one is negative pole and the other is positive pole. Two modules can be in parallel connection by inserting the positive pole at one end of wire of one module into the negative pole of the adjoining module.

Cables connecting modules shall satisfy the module maximum short circuit current. Adopt the special PV system sunlight resistant cables. The minimum standards of cables connecting modules are:

Compliance	Wire diameter	Temperature range	Voltage
Local Electrical Codes	4mm²	-40ºC to +85ºC	1500V

When fixing cables, avoid mechanical damage to cables or modules. Do not press cables by force. Adopt special designed UV resistant cabling and clamps to fix cables. Though cables are UV resistant and waterproof, it is still necessary to prevent cables from direct sun radiation and water immersion.

6.3 Connector

Ensure that all connectors are kept clean and dry. Verify that the connector nuts are properly tightened before making any connections. Do not connect damp, dirty, or otherwise compromised connectors.

Protect the connectors from direct sunlight, water immersion, or accidental falls onto the ground or roof. Improper connections can lead to electric arcs and electric shock. Therefore, ensure that all electrical connections are secure and reliable. Make certain that all connectors equipped with locking mechanisms are fully engaged and locked.

6.4 Bypass diode

The Nahui solar module junction box contains a bypass diode connected in parallel with the cell strings. In the event of a local hotspot on the module, the bypass diode will activate to prevent the main current from flowing through the affected cells, thereby reducing the risk of overheating and minimizing performance loss. However, it is important to note that the bypass diode does not function as an overcurrent protection device.
If the bypass diode is suspected to be malfunctioning, the installer or system maintenance provider must contact Nahui. Do not attempt to open the module junction box yourself.

7 Grounding

- The Nahui solar modules are designed with an anodized, corrosion-resistant aluminium alloy frame that provides structural support. To ensure safe operation and protect the modules from lightning and static electricity damage, the module frame must be properly grounded.
- The grounding device must make full contact with the inner side of the aluminium alloy and penetrate the oxide film on the surface of the frame. Drilling additional grounding holes on the module frame is strictly prohibited.
- Installation methods must prevent electrochemical corrosion between the module's aluminium frame and other metals. The electrochemical potential difference between contacting metals should not exceed 0.6V, as recommended by IEC61730.
- Pre-drilled holes on the frame, marked with grounding signs, are to be used exclusively for grounding purposes and not for module installation.
- Modules with exposed conductive parts meet the requirements of IEC61730 only when grounded in accordance with the following instructions and the applicable standards of the Local Electrical Code. If common grounding hardware such as nuts, bolts, star washers, split-ring lock washers, and flat washers are used to attach a listed grounding/bonding device, the attachment must comply with the grounding device manufacturer's instructions.
- Nahui emphasizes that the installation instructions must clearly detail the attachment methods for grounding.
- Common hardware items, including nuts, bolts, star washers, and lock washers, have not been evaluated for electrical conductivity or use as grounding devices. These items should only be used to maintain mechanical connections and hold grounding devices in the proper position for electrical conductivity. Where such devices are supplied with the module and evaluated under the IEC61730 requirements, they may be used for grounding in accordance with the provided instructions.

The following grounding methods are permissible:

7.1 Grounding by grounding clamp

- A grounding hole with a diameter of Ø4.2mm is provided at the edge of the module’s back frame. The centreline of the grounding symbol aligns with the centreline of the hole, following the frame’s lengthwise direction.
- Grounding connections between modules must be verified by certified electricians, and grounding devices must be sourced from qualified electrical manufacturers. The recommended torque for securing the grounding device is 2.3 N•m.
- A 12 AWG copper core wire is to be used for the grounding clamp. Care should be taken during installation to ensure that copper wires are neither compressed nor damaged.

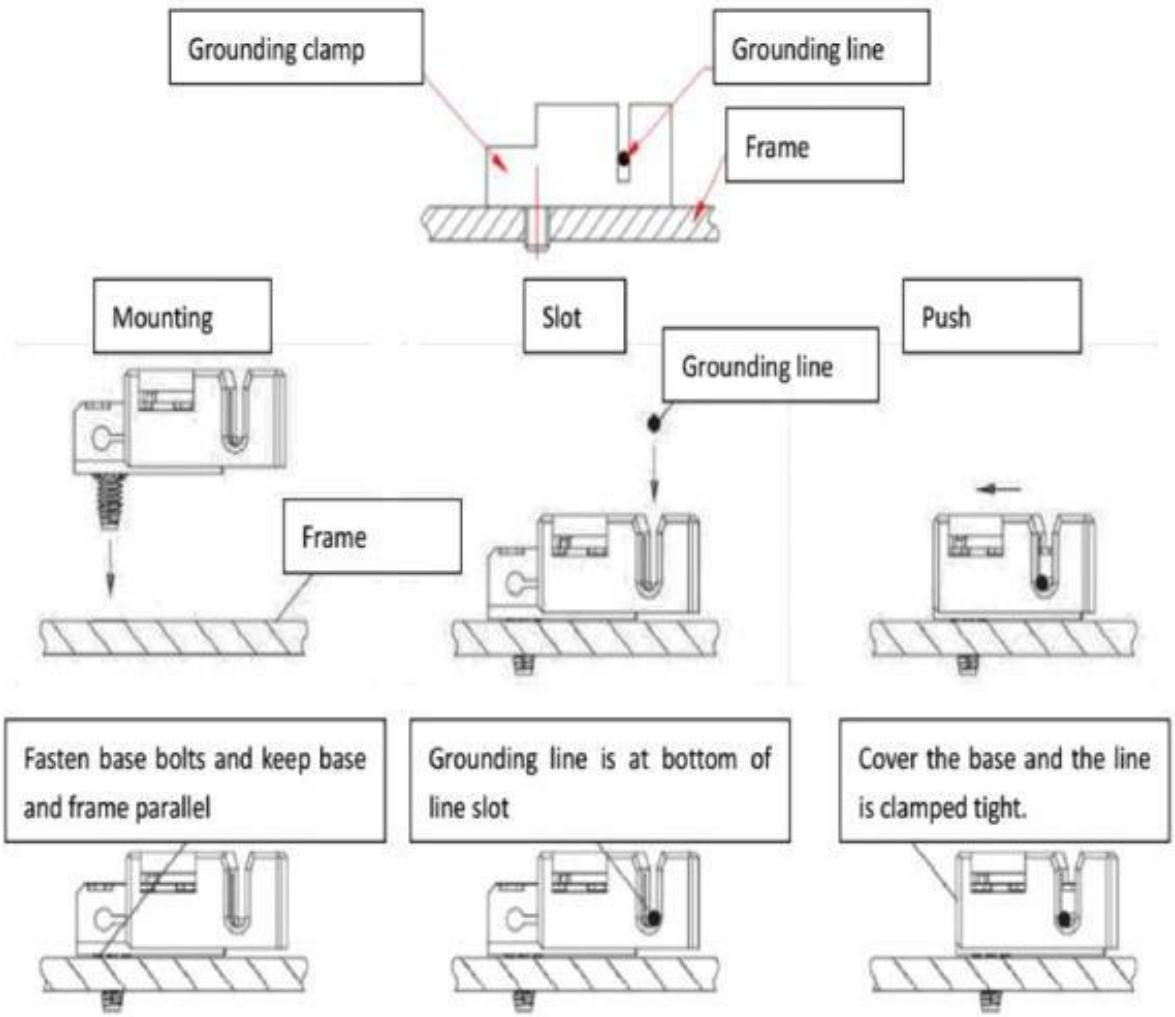


Figure 6 Grounding Clamp Installation

Note: TYCO. 1954381-1 (recommended) is used in figures above.

7.2 Grounding by unoccupied mounting holes

Unused mounting holes on the module frame may be utilized for the installation of grounding devices. Follow the steps below:

1. **Positioning the Grounding Clamp**: Align the grounding clamp with the mounting hole on the module frame. Insert a grounding bolt through the clamp and the frame. The recommended bolt size is M4.
2. **Fastening the Bolt and Washer**: Position the toothed side of the washer on the opposite side and tighten the nut securely. The recommended torque for fastening bolts and nuts is between 2.0 Nm and 2.2 Nm.
3. **Grounding Wire Installation**: Thread the grounding wire through the grounding clamp. The grounding wire material and dimensions must comply with local national and regional laws and regulations.
4. **Securing the Grounding Line**: Tighten the bolts of the grounding lines and the connection points to ensure secure installation.

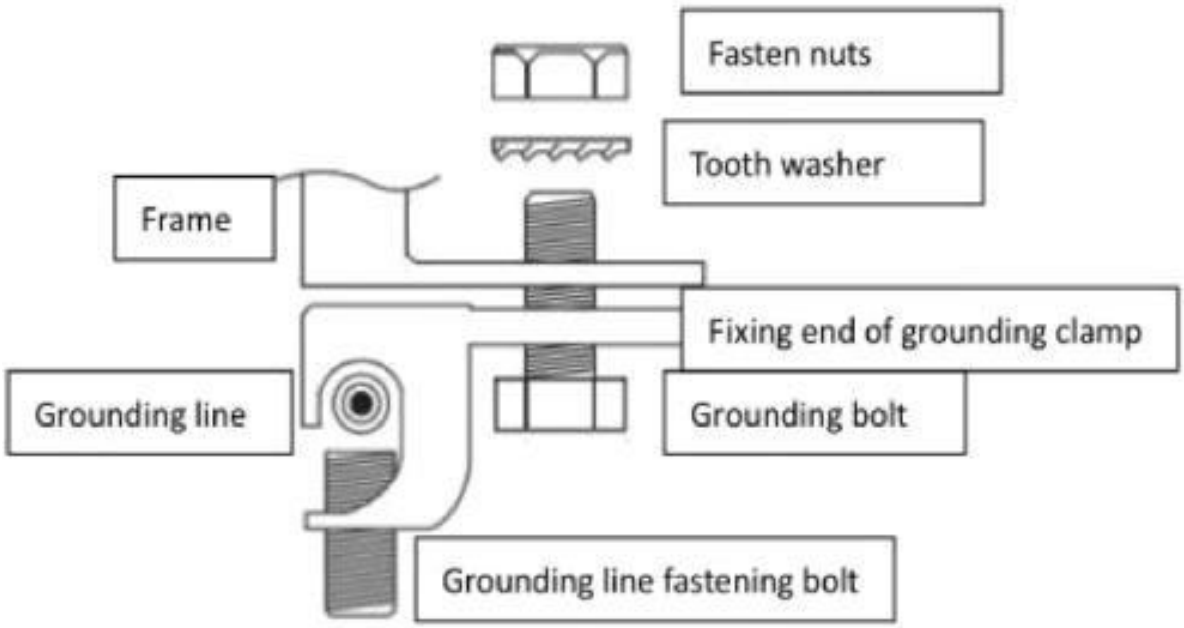


Figure 7 Way of Installation

7.3 The third party grounding devices

All module frames and mounting racks must be properly grounded in compliance with local and Local Electrical Codes. The equipment grounding conductor must be attached to the module frame using the designated hole and provided hardware. A stainless-steel star washer should be placed between the grounding wire and the module frame to prevent corrosion caused by dissimilar metals (see Figure 8 below). Ensure the screw is tightened securely. The recommended torque for fastening the M4 bolt and nut is between 2.0 Nm and 2.2 Nm.

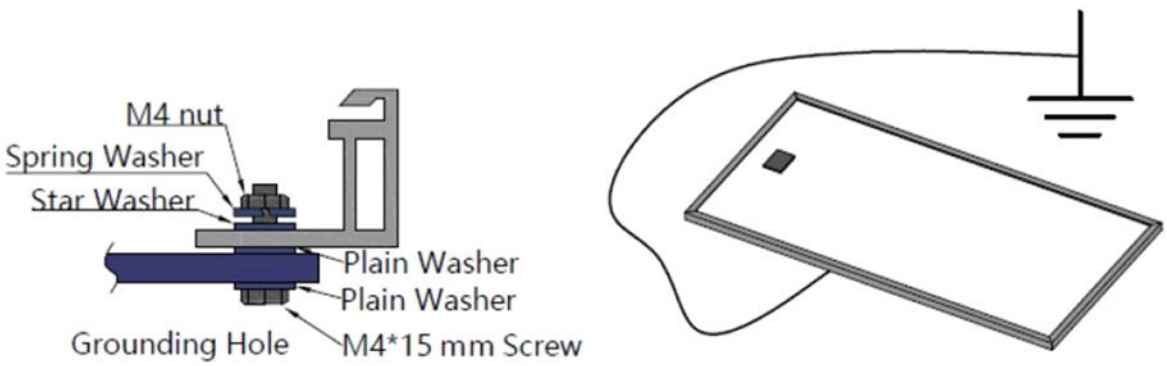


Figure 8 Ground installation of PV modules

8 Operation and maintenance

Regular inspection and maintenance of the modules are required, and it is the user's responsibility to perform these tasks within the quality warranty period. In the event of module damage, the supplier must be notified within two weeks of discovery.

8.1 Cleaning

Accumulated dust on the module surface glass can diminish power output and potentially create local heat spots, such as those caused by industrial wastewater or bird droppings. The impact of these factors is influenced by the transparency of the contaminants. While small amounts of dust may affect sunlight intensity and distribution, it generally does not significantly reduce power output.

Modules should be maintained in an environment free from obstructions or shading, including other modules, system brackets, birds, dust, soil, or vegetation. Such factors can impair output power. Nahui recommends ensuring that the module surface always remains unobstructed.

The frequency of cleaning should be based on the rate of dirt accumulation. In most cases, rainwater will naturally clean the module surface, reducing the need for frequent cleaning. It is advisable to use a damp sponge or soft cloth to wipe the glass surface. Avoid using acidic or alkaline detergents, as these can damage the modules.

8.2 Module appearance inspection

Visually inspect the modules for appearance defects, with particular attention to the following:

1. **Cracks in Module Glass**: Examine the module glass for any visible cracks.
2. **Corrosion at Cell Main Grid Welding Points**: Check for signs of corrosion at the welding parts of the cell main grid. Corrosion may result from moisture ingress due to damage to the surface packaging materials during installation or transportation.
3. **Burning Traces on the Module Back Plate:** Inspect the back plate of the module for any burning traces.

8.3 Inspection of connectors and cables

It is recommended to conduct a preventive inspection every six months, focusing on the following:

1. **Connector Sealing and Cable Connection**: Verify the integrity of connector seals and the firmness of cable connections.
2. **Terminal Box Sealant**: Inspect the sealant around the terminal box for any cracks or gaps.

9 The list of the modification

Date	Version	Contents	Remark

2021.1.30	1.0	1st edition	Updated parameters table

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