



# LIGHTWEIGHT FLEXIBLE MODULES

# INSTALLATION MANUAL

Version: SYSCOM\_2025B

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# Chapter 1 General Description

This Installation Manual applies only to lightweight flexible photovoltaic modules ("Modules") supplied by SISTEMAS Y SERVICIOS DE COMUNICACION, S.A. DE C.V. ("Syscom"). The installation of PV module systems requires professional skills and knowledge. Only qualified professionals or personnel who have received proper training and certification are permitted to carry out this work.

Please read and fully understand this installation manual before installing, operating, or maintaining the modules. This manual must also be provided to the PV system owner as a reference, together with all relevant safety instructions, operational guidelines, maintenance requirements, and recommendations.

## 1.1 Disclaimer

- 1.1.1 Failure by the customer to follow the installation requirements specified in this manual will result in the invalidity of the limited module warranty provided to the customer.
- 1.1.2 Syscom reserves the right to change this manual without prior notice.
- 1.1.3 This manual has different language versions, such as conflicts between versions, the specific interpretation of the Spanish version shall prevail.

## 1.2 The Scope of Responsibility

This manual does not constitute a warranty of any kind. Module installation must be carried out in strict accordance with the requirements of this manual and with all applicable regulations, standards, and specifications.

Regardless of whether installation is performed in accordance with this manual, Fortunes Solar shall not be held liable for any incidental, indirect, economic, or legal consequences, including but not limited to personal injury, property damage, or other losses arising from the installation process.

The mechanical and electrical installation of PV modules must comply with the relevant European standards (e.g., IEC/EN standards) as well as applicable international regulations and local building codes.

For specific terms, conditions, and regulatory requirements, installers must refer to the rules and standards of the project location and obtain the necessary installation permits from the relevant local authorities.

## 1.3 Module Specification


- 1.3.1 Syscom modules represent the following models

Due to the renewal of product development, product specifications and models will be increased or updated without prior notice. "xxx" represents the nominal power of the module nameplate, every 5 W a grade.

Product Specification	Power Output	Module Size (L*W*H) mm
EPL52072M10	510-530	2246*1185*2.5
EPL43060M10	420-450	1923*1142*2.5
EPL40054M10	380-410	1737*1142*2.5

- 1.3.2 Module nameplate information

This describes the product type, maximum power, optimum working voltage, optimum working current, open-circuit voltage, short-circuit current, and maximum system voltage under standard test conditions, certification, and other information. Taking EPL52072M10 as an example:

Potencia Máxima(Pmax)	520W	<b>epcom</b> Modelos POWER LINE EPL52072M10	Selección de Potencia	0-+5W			
Tensión máxima de funcionamiento(Vmp)	42.34V		Tolerancia de Potencia	±3%			
Corriente máxima de funcionamiento(Imp)	12.30A	STC AM1.5 E=1000W/m² Tc=25°C	Tolerancia de Tensión en circuito abierto	±3%			
Tensión en circuito abierto(Voc)	50.20V		Tolerancia de Corriente de cortocircuito	±4%			
Corriente de cortocircuito(Isc)	13.24A	Dimensión	2246*1185*2.5mm				
Tensión máxima del sistema	DC1500V						
Clasificación máxima del fusible en serie	20A	Hecho en China					
Clase de Aplicación	Class A						
<b>Módulo Solar</b>							

# Chapter 2 Safety Information

Read and understand all safety rules before installing, wiring, operating, or maintaining the modules.

## 2.1 General Safety

- 2.1.1 Do not install or operate the modules in rain, snow, strong winds, dewy mornings, or at night.
- 2.1.2 Do not wear metal ornaments or place heavy or sharp objects on the module during its installation. This may damage the module surface, create a risk of electric shock, and compromise system safety.
- 2.1.3 When the battery side of the module is directly exposed to sunlight or other light sources, direct current (DC) is generated, and direct contact with the electrically charged parts of the module, such as the connector, may result in injury or death. Therefore, regardless of whether the modules are connected to the system, appropriate protective measures should be used when contacting the modules, such as insulated tools, safety helmets, insulated gloves, and safety insulated shoes.
- 2.1.4 When you need to install, grounding, wiring, cleaning and other operations on the modules, please be sure to use appropriate electrical safety protection tools to avoid direct contact with the modules, resulting in electric shock or cuts.
- 2.1.5 Do not stand, step on, sit or lie on, walk, or jump on the packaging or module directly.
- 2.1.6 Do not drop the module or let the objects hit the module directly or drop the objects directly on the module.
- 2.1.7 Do not carry the modules in an incorrect way, such as over the head, over the shoulder, tied with a rope, or on the back.
- 2.1.8 The modules should not be lifted by lifting and pulling the junction box or connecting wires directly.
- 2.1.9 Pulling, scratching, or forcefully bending the connecting wires is prohibited.
- 2.1.10 The modules should not be damaged or scratched. Do not use the modules if you find any scratches or cuts or abrasions.
- 2.1.11 Do not disassemble or move any part of the module; there are no usable components inside the module.
- 2.1.12 Do not insert any conductive material into the connectors.
- 2.1.13 Do not intentionally focus light on the module.
- 2.1.14 Do not use water to extinguish the fire without disconnecting the power supply.
- 2.1.15 The cover of the junction box should remain closed at all times.
- 2.1.16 The junction box and connectors must not come into contact with oily substances, organic solvents, corrosive materials, or any other substances that may cause functional failures. If contamination occurs, the junction box or connectors should not be used.
- 2.1.17 The junction box and connector should avoid immersion in water.
- 2.1.18 PV array connectors should be matched with the PV module connectors.
- 2.1.19 Wiring cables shall comply with the cable design standards for photovoltaic systems.
- 2.1.20 The actual open-circuit voltage (Voc) and short-circuit current (Isc) of the module may be higher than the values measured under standard test conditions (STC). Follow relevant European and international standards (such as IEC 60364, IEC 61730, and IEC 62446) during system design and installation, as well as any additional standards applicable in the country of installation.
- 2.1.21 If a module is installed under non-standard conditions, multiply the labeled Voc and Isc values by a safety factor of 1.25 when determining the module rated voltage, conductor current, fuses, and other connected devices. For bifacial modules, ground or roof reflectivity, row spacing, and mounting height should be considered. Therefore, when determining the rated voltage and current of the modules connected to the PV output, the labeled Voc and Isc values (for bifacial modules, Isc-aBSI) should be multiplied by a safety factor of 1.25.

## 2.2 Fire Safety

- 2.2.1 Before installing the modules, please consult the laws and regulations of the project site and the relevant departments, and comply with the requirements for building fire safety. It should be noted that the module is power generation equipment, this may affect the fire safety of buildings.
- 2.2.2 The modules should not be installed in areas where flammable liquids, gases, or hazardous materials are present in the vicinity. If flammable gas is exposed in the vicinity after the module is installed, please suspend the use of the module.
- 2.2.3 The modules may arc during operation due to incorrect installation methods or defective parts, resulting in an accidental risk of fire. Use appropriate system accessories such as fuses, circuit breakers, and grounding connectors in accordance with local codes.
- 2.2.4 If the roof is not fire-protected, add a suitable fireproof layer before installing modules. Ensure proper ventilation between the modules and the roof surface.
- 2.2.5 During a fire event, the module may continue to generate hazardous DC voltages even if the module and inverter are disconnected, the module is partially or complete destroyed, or the system cables are broken or even destroyed.
- 2.2.6 In the event of a fire, firefighters should be informed of the special hazards of the modules and should stay away from the PV system until measures have been taken to ensure the safety of the PV system prior to approaching it.
- 2.2.7 The fire rating of the modules is valid only if this manual is fully complied with.

# Chapter 3 Installation Conditions

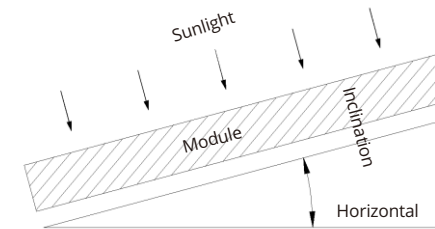
## 3.1 Installation Environment

- 3.1.1 It is recommended that the module be installed in an environment where the ambient temperature is  $-40^{\circ}\text{C}\sim 70^{\circ}\text{C}$ .
- 3.1.2 As stated in IEC TS 63126, according to the geographic area, installation conditions, and system design and installation factors, the annual operating temperature of the modules are ranked from low to high, and in the 98% of the expected location, where the ambient temperature remains lower than 70, the rated operating altitude of the modules and all the equipment shall not be higher than 2,000 m above sea level.
- 3.1.3 When used in areas of high wind pressure and high snow pressure, the support and fixing structure design shall be carried out in strict accordance with the design specifications of the photovoltaic power station at the project site, to ensure that the external load does not exceed the mechanical strength limit of the module.
- 3.1.4 In areas with frequent lightning activities, lightning protection devices must be installed for the PV system, as the high voltage generated by an induced lightning strike may damage the module units in the PV system.
- 3.1.5 Modules must not be installed in a strong corrosive substances, such as active chemical vapors, acid rain or other corrosive substances, and can not be installed and used in hail, snow, sand, smoke, air pollution, soot, seawater next to excessive impact on the safety of the modules or the performance of the environment. The modules shall not be installed in the location within 500 meters from the coastline, and when installing in the location 500~1000 meters from the coastline, all system modules that meet the requirements of anti-salt spray shall be used.
- 3.1.6 The module should not be installed in a location where it may be flooded or continuously exposed to sprinklers or fountains.
- 3.1.7 The modules must be installed in an area that is free of shadows throughout the year. This is because system performance is significantly reduced when one or more modules are partially or fully shaded, and there is a risk of hot spots, resulting in high-module surface temperatures, which affect the optimal

performance and operational safety of the modules.

- 3.1.8 When the modules are installed on the roof, a safe working area must be maintained between the roof edge and the outer edge of the PV module array.

## 3.2 Tilt Angle and Orientation



- 3.2.1 The tilt angle of the module refers to the angle between the module and the horizontal ground, as shown in the figure on the right. Different projects need to choose different installation tilt angles according to the local conditions, and the recommended tilt angle of the modules is not less than  $5^{\circ}$ , so that when it rains, the dust on the surface of the modules can be easily taken away by the rain, thus reducing the number of times the modules are cleaned. It also avoids the long-term accumulation of large amounts of water on the front membrane of the module and leave marks. This, in turn, affects the appearance and performance of the module. The specific inclination angle can be selected according to the local design procedures, codes, regulations or follow the recommendations of the module installer.
- 3.2.2 In the northern hemisphere, the module is usually installed facing south; in the southern hemisphere, the module is usually installed facing north.

# Chapter 4 Unloading of Modules

## 4.1 General Requirements

- 4.1.1 The unloading area must be clearly marked with warning signs, guardrails, or barriers to prevent accidents.
- 4.1.2 The unloading site must be level and stable, without tilt. Do not store modules near corrosive chemicals.
- 4.1.3 Upon Vehicle arrival:
  - 4.1.3.1 Inspect all packaging for any damage or impact marks.
  - 4.1.3.2 Collect the delivery note, certificate of conformity, and factory inspection report
  - 4.1.3.3 Verify quantity and model against the delivery note.
  - 4.1.3.4 If abnormalities exist: mark with a marker and date, take photos, and immediately inform the supplier.
  - 4.1.3.5 If no inspection is done at unloading, any packaging damage discovered later will be the responsibility of the installer.
- 4.1.4 Modules of the same specification should be placed together.
- 4.1.5 Packing boxes must be neatly arranged, with a minimum safety distance of 30 cm between stacks.
- 4.1.6 Modules packed on stacked pallets must not be stacked on top of each other. Modules packed on single pallets must not be stacked more than two layers high.
- 4.1.7 Do not throw or drop modules under any circumstances.
- 4.1.8 After unloading, modules should be handled in an organized manner to avoid collisions.

## 4.2 Unloading Methods



### 4.2.1 Crane Unloading

- 4.2.1.1 Use dedicated lifting tools suitable for module weight and size. Adjust sling positions to keep balance; place a wooden board/hard panel across carton tops to avoid strap compression damage.
- 4.2.1.2 Qualified personnel must direct the lift; operate smoothly at slow speed; gently guide the modules onto a flat, stable surface.
- 4.2.1.3 Don't lift/unpack modules (special cases only under technical supervision).
- 4.2.1.4 Don't perform lifting operations under adverse weather conditions such as wind speeds above Beaufort 6, heavy rain, or snow.

### 4.2.2 Forklift Unloading

- 4.2.2.1 Loading dock should be level with truck bed.
  - 4.2.2.2 Maintain safe distance; no personnel standing near forklift sides.
  - 4.2.2.3 Drive slowly:  $\leq 5$  km/h straight,  $\leq 3$  km/h turning. Avoid sudden stops/starts.
  - 4.2.2.4 If view is blocked, drive in reverse with spotter guidance.
  - 4.2.2.5 Place on flat, solid ground.
- ### 4.2.3 Warehouse Forklift Handling
- 4.2.3.1 Select forklift with adequate load rating.
  - 4.2.3.2 Fork insertion  $\geq \frac{3}{4}$  pallet depth.
  - 4.2.3.3 Adjust fork spacing to max for stability.
  - 4.2.3.4 Add cushioning on forklift rack to avoid carton/module damage.
  - 4.2.3.5 Operate slowly, never bump pallets/cartons.

## Chapter 5 Unpacking, Secondary Transport, and Storage of Modules

### 5.1 Module Unpacking

- 5.1.1 Preparation
  - 5.1.1.1 Tools and equipment: utility knife, gloves, helmet, protective clothing, forklift.
  - 5.1.1.2 Personnel: at least 3 people.
  - 5.1.1.3 Handling tools: pallets, transfer racks, or other suitable equipment.
- 5.1.2 Unloading Stacked Pallets
  - 5.1.2.1 Dismantle stacked pallet packaging before unloading.

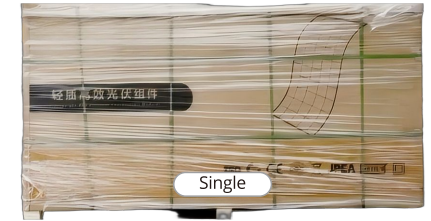
- 5.1.2.2 Cut the fixing straps of the upper pallet, then use a forklift to lower the upper pallet carefully, preventing tilt.
- 5.1.2.3 If a crane is used, do not cut the straps connecting the upper and lower pallets until each pallet is lifted separately.



### 5.1.3 Syscom Standard Packing Box Unpacking



5.1.3.1 Before unpacking, ensure the carton is intact and undamaged.



5.1.3.2 Remove the wrapping film and packing tape carefully. Do not use excessive force to avoid module damage.



5.1.3.3 Retain labels and documentation for records.



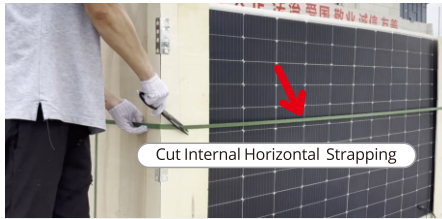
5.1.3.4 Remove the top cover and protective foam. Inspect modules and take photos of any abnormalities.



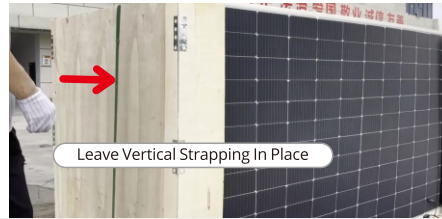
5.1.3.5 Count and confirm the number of modules.



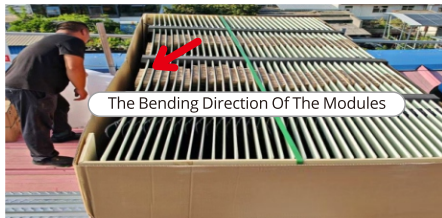
5.1.3.6 Two people must lift and remove the outer carton together.



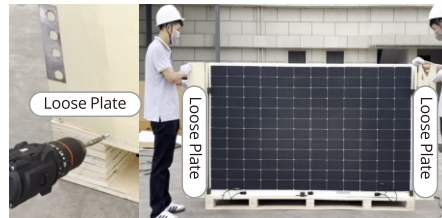
5.1.3.7 Cut internal horizontal strapping but leave vertical strapping in place.



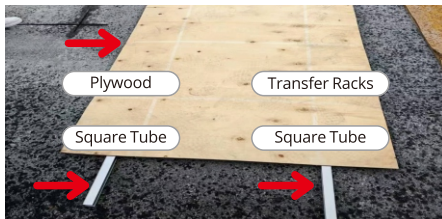
5.1.3.8 Identify the bending direction of the modules.



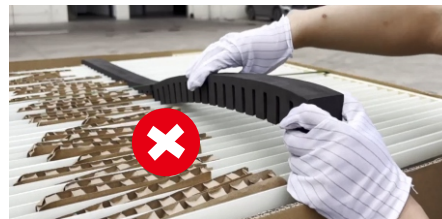
5.1.3.9 Open the recessed side panels for access.



5.1.3.10 Prepare pallets or transfer racks for modules.



5.1.3.11 Take modules one at a time. Do not remove EVA clamps unless the corresponding module is being taken out.



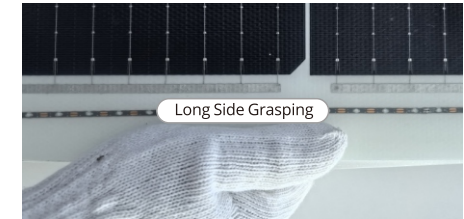
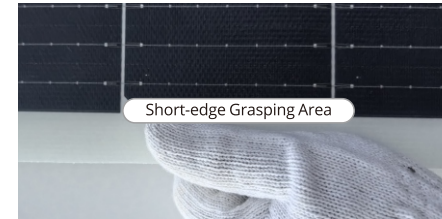
5.1.3.12 Two operators should carefully lift modules from the carton, holding the frame edges only. Do not press on the cell area.



5.1.3.13 After removing the module, slowly turn it to horizontal position and placed it on transport racks. When stacking, ensure junction boxes and connectors are staggered and never stack more than four modules.



5.1.4 Precautions



- 5.1.4.1 Follow this unpacking procedure strictly; do not use customized methods.
- 5.1.4.2 Do not unpack outdoors during rain, snow, or strong winds.
- 5.1.4.3 Verify model, power grade, and serial numbers before unpacking. Retain all labels.
- 5.1.4.4 Check module quantity and condition immediately after opening. Report any issues with photos to the manufacturer.
- 5.1.4.5 Prevent tipping by securing cartons before removing internal straps.
- 5.1.4.6 Always use insulated, non-slip gloves. At least two people must handle modules.
- 5.1.4.7 Do not pull cables or junction boxes when lifting modules.
- 5.1.4.8 Do not lean modules against posts or unstable surfaces.
- 5.1.4.9 If modules are not fully removed from the pallet, re-pack the remaining modules securely.
- 5.1.4.10 If modules are not installed immediately, store them flat, or re-pack the remaining modules in their packaging.

## 5.2 Secondary transportation

- 5.2.1 Intact packages may be transported by land, sea, or air. Always secure cartons to prevent tipping or shifting.
- 5.2.2 If unpacked modules must be re-transported, re-pack them following the original pallet and strapping method.
- 5.2.3 During transportation, partially filled module pallets shall not be placed on the lower layer of stacked cargo pallets.
- 5.2.4 Pallets must not extend beyond the transport vehicle platform. Use appropriate vehicles.
- 5.2.5 For small trucks, only single-layer placement is allowed. Secure cartons with ropes, and place protective padding between ropes and cartons. Drive at safe speeds adapted to road conditions.
- 5.2.6 During transport in box or flatbed trucks, pallets must be placed tightly without gaps. Reinforce empty spaces to prevent movement. For non-box trucks, each pallet must be secured with ropes.

## 5.3 Storage

- 5.3.1 Store modules in conditions with humidity below 85% and temperatures between -40°C and +50°C.
- 5.3.2 Storage areas must be secure, and unauthorized access is prohibited.
- 5.3.3 Do not stack more than two layers. If stacking two layers, protect the lower carton with plywood.
- 5.3.4 At project sites, store on firm, level ground with proper drainage. Do not store on soft or uneven ground. Protect with waterproof covers during rain but remove covers promptly during dry or sunny conditions to prevent moisture damage. Do not allow pallets to sit in water.
- 5.3.5 For long-term storage, keep modules in their original packaging with intact wrapping film and cartons. Ensure shelves or racks can support the weight. Perform regular inspections to check stability and reinforce if necessary.

# Chapter 6 Installation Safety Requirements and Instructions

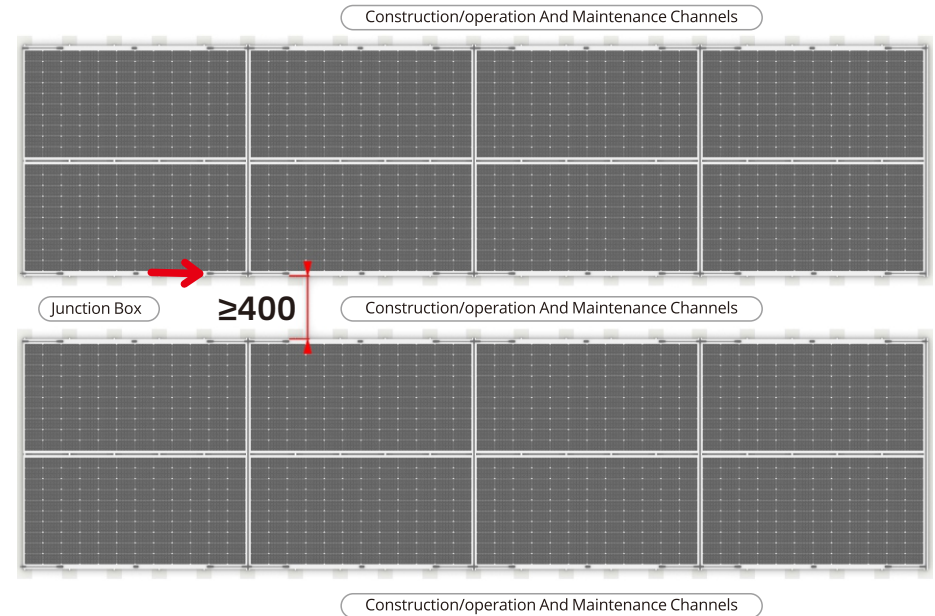
## 6.1 Installation Safety

- 6.1.1 PV module installation must be carried out only by trained and qualified personnel with professional experience in PV systems. A minimum of two installers is required; single-person operations are strictly prohibited.
- 6.1.2 All installation activities must comply with local laws, building codes, and electrical standards. Unauthorized people are not allowed in the installation area.
- 6.1.3 Installation or handling of modules is strictly prohibited during rain, snow, or strong wind. If modules must be handled in damp conditions (e.g. after rain or in dewy mornings), ensure connectors remain dry and free from water ingress.
- 6.1.4 Avoid dropping tools or objects onto the front or back of the module to prevent damage or risk of electric shock.
- 6.1.5 Keep modules in their original packaging until immediately before installation.
- 6.1.6 Do not stand on the lower side of a tilted module during installation to avoid slipping hazards. When using scaffolding, ensure it is stable and equipped with anti-tipping protection. Installers must use appropriate fall protection (e.g. safety harnesses) in compliance with local building regulations.
- 6.1.7 Mixing modules of different power ratings or models in the same array is prohibited.
- 6.1.8 Before installation, check that all modules are clean, dry, and free of defects, such as cracks, scratches, damaged junction boxes, missing labels, or broken connectors/cables. Defective modules must not be used.
- 6.1.9 The cable length of the junction box should be selected according to the installation method. During wiring, remove the cable ties used for securing the cables. Place the cables inside plastic conduits with anti-aging properties, and use anti-aging cable ties or clips to secure the cables to the mounting system (frame, bracket, or rail). This prevents exposure to direct sunlight or immersion in water, which may accelerate cable aging, cause leakage, or even lead to fire hazards.
- 6.1.10 In open areas, minimize potential arc sources and ensure proper shielding and grounding to reduce lightning risks.
- 6.1.11 Do not stand, sit, or place weight on modules.
- 6.1.12 Never unplug connectors while the system is under load.

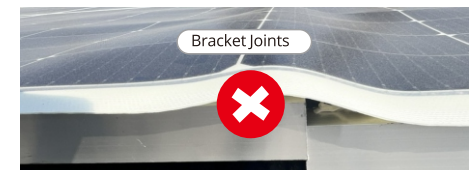
## 6.2 Installation Instructions

- 6.2.1 Modules must be installed according to this manual. If alternative installation methods are required, prior written approval from Fortunes Solar is necessary; otherwise, the warranty will be void.
- 6.2.2 When calculating maximum permissible design load, apply a safety factor as required by local regulations. Final requirements must be verified by project designers based on site-specific engineering reviews.
- 6.2.3 Roof mounted modules must undergo pull tests to verify adhesive or clamp strength before final installation. See Annex A for test methods.
- 6.2.4 Stop installation immediately if sudden wind gusts occur. Modules blown over during installation must be inspected using EL testing. Modules that fail must not be used.
- 6.2.5 Leave a minimum 20 mm gap between module and roof for ventilation and drainage.
- 6.2.6 Maintain a minimum 20 mm gap between adjacent modules to allow for thermal expansion.

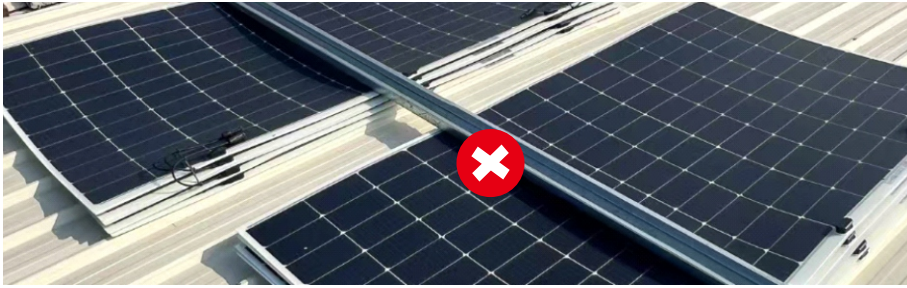
- 6.2.7 Leave at least 400 mm between module arrays to create safe access channels for construction, operation, and maintenance (see Fig.).



- 6.2.8 Do not install modules across areas subject to relative displacement (e.g. roof expansion joints, bracket joints). Movement can cause wrinkles or cracks in the modules.



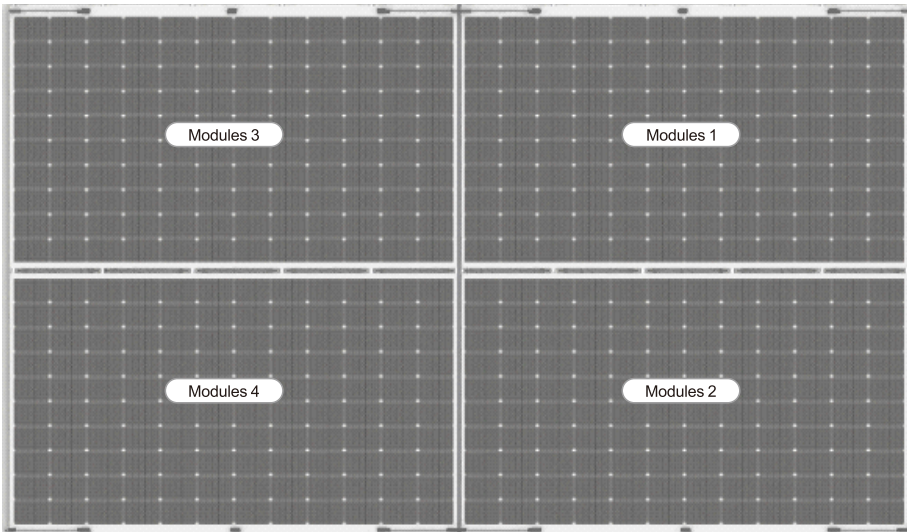
- 6.2.9 For adhesive mounting,
  - 6.2.9.1 Apply only at 5–40°C and 40–80% relative humidity.
  - 6.2.9.2 Bonding surfaces must be flat, dry, clean, and free of dust, oil, or rust.
  - 6.2.9.3 The adhesive area must be ≥10 mm wide.
  - 6.2.9.4 Installation must be completed within 5 minutes of adhesive application.
  - 6.2.9.5 Modules must not be repositioned once adhesive is applied.
  - 6.2.9.6 See Annex B for detailed procedures.
- 6.2.10 The mounting structure must be made of durable, corrosion-resistant, and UV-stable materials.
- 6.2.11 Do not drill holes, dismantle, or modify the modules.
- 6.2.12 Final wiring (positive/negative connectors) must only be carried out after module installation and acceptance. Ensure all wiring is well insulated and mechanically protected.
- 6.2.13 Do not apply paint, labels, or adhesives on the module's active cell area.
- 6.2.14 Install modules immediately after unpacking. If installation is delayed, return modules to their packaging for protection.
- 6.2.15 Do not stack more than 4 modules. When stacking, stagger junction boxes and connectors to avoid damage. Do not place heavy objects on modules.



6.2.16 The Limited Warranty will be void if module failure is caused by improper accessories or incorrect installation.

## Chapter 7 Mounting of Modules at Corners and Edge

The following example shows a 4-module installation.



Tips1: Modules 1, 2, and 3 can be installed normally, as at least three sides are accessible.

Tips2: Module 4 has only two accessible sides, so special handling is required.

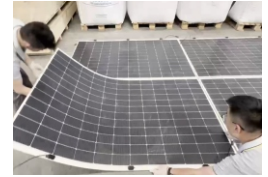
### 7.1 Method 1: Long-Side Alignment Installation

- 7.1.1 Two installers carefully position module 4 so that its long side rests above the long side of module 3, leaving a 20 mm expansion gap.
- 7.1.2 One installer holds module 4 steady while the other lowers it slowly into position.
- 7.1.3 Once module 4 is correctly aligned and bonded with structural adhesive, further movement is prohibited.



### 7.2 Method 2: Short-Side Alignment Installation

- 7.2.1 Two installers carefully position module 4 so that its short side rests above the short side of module 2, leaving a 20 mm expansion gap.
- 7.2.2 One installer holds module 4 steady while the other lowers it slowly into position.
- 7.2.3 Once module 4 is correctly aligned and bonded with structural adhesive, further movement is prohibited.



## Chapter 8 Roof-Specific Installation Examples

Note: The following installation examples illustrate common methods for roof-mounted PV modules. They are provided for reference only. Always follow manufacturer instructions, structural adhesive specifications, and local building codes.

### 8.1 Example 1: Trapezoidal Metal Roof (Direct Bonding)

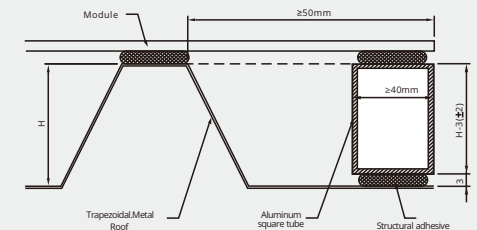
#### 8.1.1 Required Materials and Tools

- 8.1.1.1 EPL series PV modules
- 8.1.1.2 Structural adhesive
- 8.1.1.3 Aluminum profile (height = crest height of color steel tile - 3 mm)
- 8.1.1.4 Butyl double-sided adhesive (for auxiliary fixation if needed)
- 8.1.1.5 Electric glue gun
- 8.1.1.6 Utility knife
- 8.1.1.7 Wool roller
- 8.1.1.8 Tape measure
- 8.1.1.9 Marking and cleaning tools

#### 8.1.2 Installation Steps

##### Step1 Aluminum Profile Preparation

Step1.1 Install tubes if module overhang  $\geq 50\text{mm}$ .



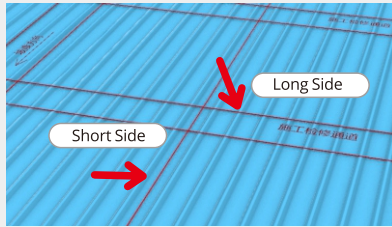
Step2 Roof Cleaning

- Step2.1 Ensure surface is dry, free of dust, oil, and debris.
- Step2.2 Treat rust spots before installation.



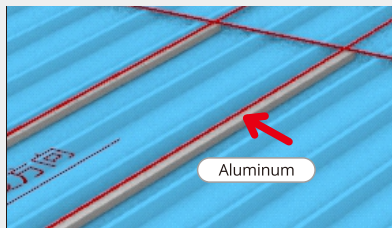
Step3 Positioning

- Step3.1 Mark installation positions of modules and aluminum tubes according to design drawings.



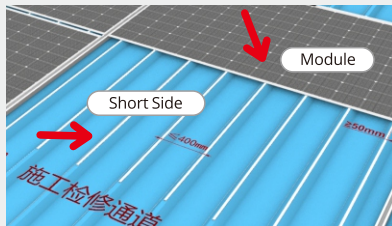
Step4 Aluminum Tube Installation

- Step4.1 Clean the tube surface (dry, no dust or oil).
- Step4.2 Apply structural adhesive in triangular cross-section (▲):
  - Step4.2.1 Width  $\geq 8$  mm
  - Step4.2.2 Height  $\geq 8$  mm
  - Step4.2.3 Continuous along the tube length
- Step4.3 Position the tube and wait for adhesive to fully cure.



Step5 Module Installation

- Step5.1 Clean module back (dry, no dust or oil).
- Step5.2 Apply structural adhesive to
  - Step5.2.1 Color steel tile crest
  - Step5.2.2 Aluminum tube surface
  - Step5.2.3 Spacing  $\leq 400$  mm
- Step5.3 Place module along the positioning line.
- Step5.4 Use wool roller to press gently; adhesive should overflow slightly.
  - Step5.4.1 Final adhesive thickness  $\geq 3$  mm
  - Step5.4.2 Complete installation within 5 minutes after adhesive application
- Step5.5 Once placed and bonded, do not move the module.



8.1.3 Additional Notes

- 8.1.3.1 Follow adhesive manufacturer's instructions for specific operations.
- 8.1.3.2 On steep roofs or walls, use butyl double-sided adhesive for temporary support before structural adhesive cures.

## 8.2 Example 2: Standing Seam Metal Roof (Aluminum profile)

8.2.1 Required Materials and Tools

- 8.2.1.1 EPL Series PV modules
- 8.2.1.2 Structural adhesive
- 8.2.1.3 Aluminum profile (height = color steel tile crest + 10 mm)
- 8.2.1.4 Butyl double-sided adhesive (optional)
- 8.2.1.5 Electric glue gun
- 8.2.1.6 Utility knife
- 8.2.1.7 Wool roller
- 8.2.1.8 Tape measure, line tools, cleaning tools

8.2.2 Installation Steps

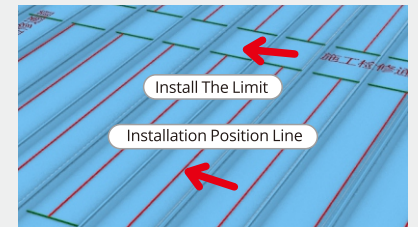
Step1 Roof Cleaning

- Step1.1 Ensure surface is dry, dust-free, and oil-free. Treat rust spots before installation.

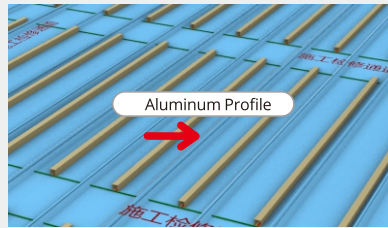


Step2 Aluminum Profile Positioning

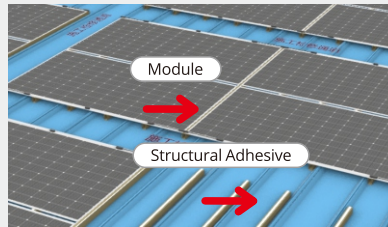
- Step2.1 Mark the location of aluminum profiles according to design drawings. Spacing  $\leq 400$  mm between adjacent tubes.



- Step3 Aluminum Profile Installation
- Step3.1 Clean the tube surface.
- Step3.2 Apply structural adhesive in a triangular cross-section (▲):
- Step3.2.1 Width  $\geq 8$  mm
- Step3.2.2 Height  $\geq 8$  mm
- Step3.2.3 Continuous along the tube length
- Step3.3 Proceed to the next step only after the structural adhesive has fully cured. The height of the cured adhesive shall not be less than 3mm.



- Step4 Module Installation
- Step4.1 Clean the module back and aluminum tube surface.
- Step4.2 Apply structural adhesive in triangular cross-section (▲) on aluminum tube surface:
- Step4.2.1 Width  $\geq 8$  mm module
- Step4.2.2 Height  $\geq 8$  mm
- Step4.2.3 Continuous along module length
- Step4.3 Place modules carefully.
- Step4.4 Press gently with a wool roller; final adhesive thickness  $\geq 3$  mm.
- Step4.5 Complete installation within 5 minutes of adhesive application.
- Step4.6 Do not move modules after adhesive placement.



- 8.2.3 Additional Notes
- 8.2.3.1 Follow structural adhesive manufacturer's guidance.
- 8.2.3.2 On steep roofs, use butyl double-sided adhesive to prevent shifting before structural adhesive cures.

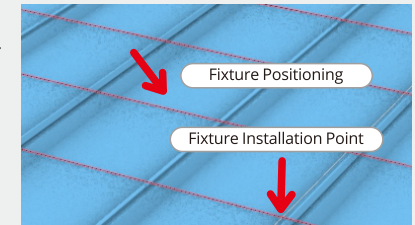
### 8.3 Example 3: Standing Seam Metal Roof (Clamp and Rail)

- 8.3.1 Required Materials and Tools
- 8.3.1.1 EPL Series PV modules
- 8.3.1.2 Fixtures (adapted to the roof tile type, typically including bolt, nut, flat washers, spring washer, clamp)
- 8.3.1.3 Rails
- 8.3.1.4 Structural adhesive
- 8.3.1.5 Wrenches
- 8.3.1.6 Butyl double-sided adhesive (optional)
- 8.3.1.7 Electric glue gun, utility knife, wool roller, tape measure, line tools, cleaning tools

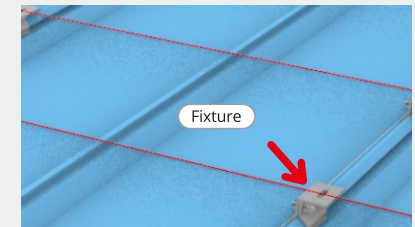
- 8.3.2 Installation Steps
- Step1 Roof Cleaning
- Step1.1 Ensure surface is dry, dust-free, and rust-treated.



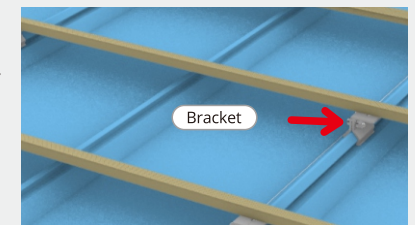
- Step2 Fixture Positioning
- step2.1 Mark fixture locations according to design drawings.
- Step2.2 Spacing  $\leq 400$  mm between adjacent brackets.



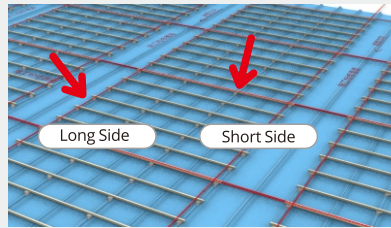
- Step3 Fixture Installation
- Step3.1 Secure fixtures to color steel tile using M8×25mm hex bolts.
- Step3.2 Perform on-site pull test to verify stability.



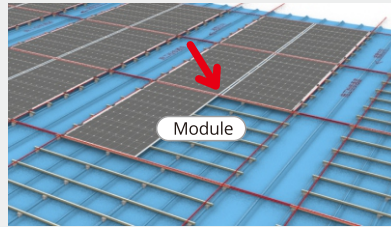
- Step4 Rail Installation
- Step4.1 Attach rails to fixtures using M8×25 mm hex bolts.



- Step5 Module Positioning  
 Step5.1 Mark module locations after rail installation.



- Step6 Module Installation  
 Step6.1 Clean module back and rail surface.  
 Step6.2 Apply structural adhesive in triangular cross-section (▲):  
 Step6.2.1 Width  $\geq 8$  mm  
 Step6.2.2 Height  $\geq 8$  mm  
 Step6.2.3 Continuous along module length  
 Step6.2.4 Place modules carefully; press gently with wool roller.  
 Step6.2.5 Adhesive height after pressing  $\geq 3$  mm.  
 Step6.2.6 Complete installation within 5 minutes; do not move modules after placement.



- 8.3.3 Additional Notes  
 8.3.3.1 Structural adhesive instructions are for reference only; follow the adhesive manufacturer's guidelines.  
 8.3.3.2 Use butyl double-sided adhesive on steep roofs for temporary support.

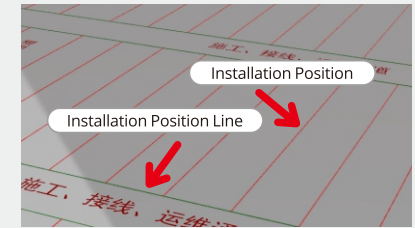
## 8.4 Example 4: Flat Roof(PVC Profile)

- 8.4.1 Required Materials and Tools  
 8.4.1.1 EPL Series PV modules  
 8.4.1.2 Aluminum Profile  
 8.4.1.3 Structural adhesive  
 8.4.1.4 Butyl double-sided adhesive (optional)  
 8.4.1.5 Electric glue gun, utility knife, wool roller, tape measure, alignment and cleaning tools.

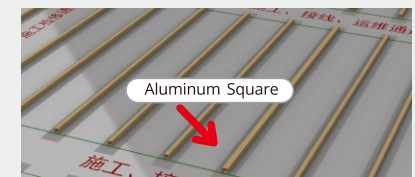
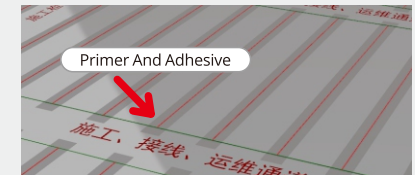
- 8.4.2 Installation Steps  
 Step1 Roof Cleaning  
 Step1.1 Ensure surface is dry, clean, and repaired.



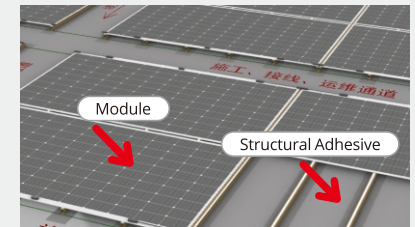
- Step2 PVC Tube Positioning  
 Step2.1 Mark installation positions according to drawings. Spacing  $\leq 400$  mm between adjacent tubes.



- Step3 Primer and Adhesive Application  
 Step3.1 Ensure the bonding surface is dry, free of dust, and free of oil  
 Step3.2 Apply primer if required.  
 Step3.3 Apply structural adhesive to PVC tube in triangular cross-section (▲):  
 Step3.3.1 Width  $\geq 8$  mm  
 Step3.3.2 Height  $\geq 8$  mm  
 Step3.3.3 Continuous along tube length  
 Step3.4 Bond tubes to the roof; press gently with wool roller. Allow adhesive to fully cure.



- Step4 Module Installation  
 Step4.1 Clean module back and tube surface.  
 Step4.2 Apply structural adhesive (triangular, same specifications as above).  
 Step4.3 Place modules; press gently with wool roller.  
 Step4.4 Adhesive height  $\geq 3$  mm; complete within 5 minutes.  
 Step4.5 Do not move modules after placement.

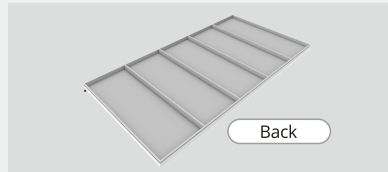
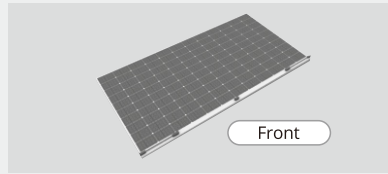


- 8.4.3 Additional Notes  
 8.4.3.1 Structural adhesive instructions are for reference only; follow the adhesive manufacturer's guidelines.  
 8.4.3.2 Use butyl double-sided adhesive on steep roofs or walls as temporary support.

## 8.5 Example 5: Metal Roof(Detachable)

### 8.5.1 Required Materials and Tools

- 8.5.1.1 EPY Series PV modules
- 8.5.1.2 Fixtures (adapted to the roof tile type, typically including M8 bolt, nut, flat washers, spring washer)
- 8.5.1.3 Blocks
- 8.5.1.4 Wrenches, tape measure, line tools, cleaning tools



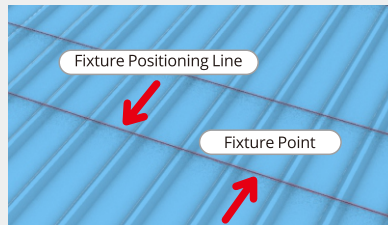
### 8.5.2 Installation Steps

#### Step1 Roof Cleaning

Step1.1 Ensure surface is dry, dust-free, and rust-treated.

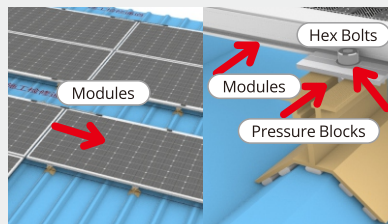
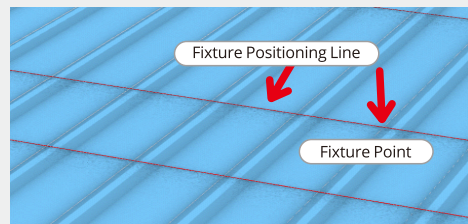
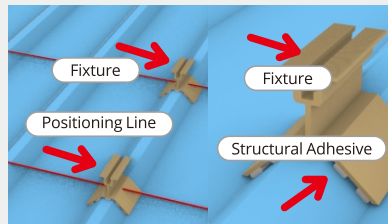
#### Step2 Fixture Positioning

Step2.1 Mark fixture locations according to drawings. Ensure that each long side of the module has no less than three fixing points, and that the spacing between adjacent fixture is controlled within 700 – 800 mm.



#### Step3 Fixture Installation

Step3.1 Secure fixture to tile using M8×25 mm hex bolts (2 sets per fixture: 1 bolt, 1 nut, 2 flat washers, 1 spring washer).



#### Step4 Module Installation

Step4.1 Install modules onto fixtures using blocks and M8×25 mm hex bolts.

Step4.2 After installation, verify all fasteners, types, and quantities to ensure system reliability.

### 8.5.3 Additional Notes

8.5.3.1 Blocks between adjacent modules require additional bridge support; do not step on modules.

8.5.3.2 An engineering check should be conducted on the mounting structure before installation to ensure system stability.

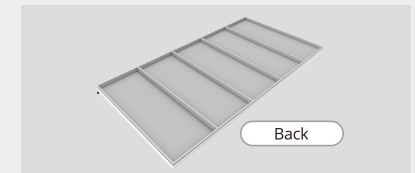
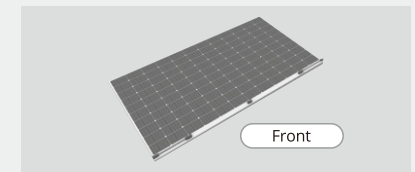
8.5.3.3 After installation, verify all bolts and nuts for correct type, quantity, and tightness to ensure system reliability.

8.5.3.4 Structural adhesive instructions are for reference only; follow the adhesive manufacturer's guidelines.

## 8.6 Example 6: Flat Roof (Detachable)

### 8.6.1 Required Materials and Tools

- 8.6.1.1 EPLY series PV modules
- 8.6.1.2 C-beam
- 8.6.1.3 Structural adhesive
- 8.6.1.4 Electric glue gun
- 8.6.1.5 Blocks
- 8.6.1.6 M8 bolts
- 8.6.1.7 Wrenches
- 8.6.1.8 Utility knife
- 8.6.1.9 Tape measure, alignment tools, cleaning tools



### 8.6.2 Installation Steps

#### Step1 Roof Cleaning

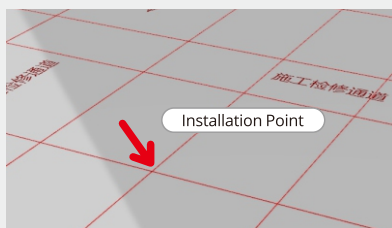
Step1.1 Clean the roof thoroughly, remove dust, particles, and debris.

Step1.2 Repair any leaks or defects before proceeding.



## Step2 C-Beam Positioning

Step2.1 Mark the C-beam positions according to design drawings. Ensure that each long side of the module has no less than three fixing points, and that the spacing between adjacent fixture is controlled within 700–800mm.



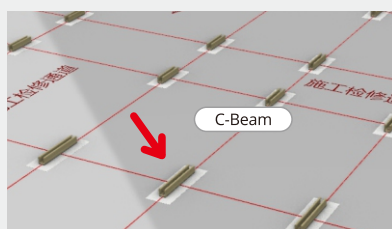
## Step3 C-Beam Positioning

Step3.1 Apply primer at the marked positions as per the primer manufacturer's instructions.  
Step3.2 Ensure the primer is fully dry before proceeding.



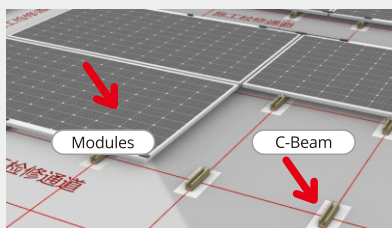
## Step4 C-Beam Installation

Step4.1 Clean the bottom surface of each C-beam. Ensure it is dry, dust-free, and oil-free.  
Step4.2 Apply two parallel strips of structural adhesive along the length of the C-beam.  
Step4.2.1 C-Beam Triangular cross-section (▲)  
Step4.2.2 Width  $\geq 8$  mm  
Step4.2.3 Height  $\geq 8$  mm  
Step4.2.4 Length = length of the C-beam  
Step4.3 Place the C-beam on the marked position.  
Step4.4 Wait until the adhesive is fully cured before installing modules.



## Step5 Module Installation

Step5.1 Position modules according to the layout lines.  
Step5.2 Use blocks, M8×25 mm hex bolts, and M8 plastic wing nuts to secure modules onto the C-beam.



# Chapter 9 Dismantling of Modules

EPL series modules installed using bonding methods cannot be reused after disassembly. EPY series modules are designed for disassembly using their specific installation method. Proper disassembly ensures the modules remain in good condition for a second installation while following strict safety and electrical regulations. Disassembly must never be performed in rainy, windy, or other adverse weather conditions.

## 9.1 Preparation Before Disassembly

- 9.1.1 Safety Protection
  - 9.1.1.1 All personnel must wear insulated gloves, helmets, non-slip shoes, and other protective equipment.
- 9.1.2 Tool Check
  - 9.1.2.1 Ensure MC4 unlocking pliers, cable cutting pliers, insulated wrenches, screwdrivers, and other tools are intact and ready.
- 9.1.3 Power Shutdown
  - 9.1.3.1 Disconnect the DC and AC sides of the PV system.
  - 9.1.3.2 Ensure inverters, combiner boxes, and other devices are fully disconnected from the power supply.
  - 9.1.3.3 If necessary, hang "Do Not Operate" or equivalent warning signs.
- 9.1.4 Site Assessment
  - 9.1.4.1 Check modules for visible damage or cable aging.
  - 9.1.4.2 Prepare a flat, shaded, and dry area for module stacking.

## 9.2 Module Disassembly Steps

- 9.2.1 Remove Connection Cables
  - 9.2.1.1 First, disconnect the serial cables (MC4 connectors) between modules, observing correct polarity to prevent short circuits.
  - 9.2.1.2 If a combiner box is present, disconnect cables connected to it first and insulate exposed wires.
- 9.2.2 Disassemble Fixing Components
  - 9.2.2.1 Two people should work together.
  - 9.2.2.2 Loosen the block bolts in a diagonal sequence using the correct wrench.
  - 9.2.2.3 Rotate the bolts counterclockwise to remove them manually, then carefully remove the block to avoid sudden drops or damage.
- 9.2.3 Remove the Modules
  - 9.2.3.1 Two people gently lift and pan the modules onto prepared buffer pads (e.g., foam, wooden boards) to prevent collision or scratches.
- 9.2.4 Module Placement
  - 9.2.4.1 Place Y series modules centrally with the short side vertical to prevent junction box compression.
  - 9.2.4.2 Separate modules using soft materials to avoid contact damage.
- 9.2.5 Transfer and Inspection
  - 9.2.5.1 Move modules to a safe storage area.
  - 9.2.5.2 Check each module for electrical performance and visual condition, recording inspection results.
- 9.2.6 Classification and Storage
  - 9.2.6.1 Sort modules according to inspection results.
  - 9.2.6.2 Use protective boxes for storage.
  - 9.2.6.3 Record serial numbers and relevant details for traceability.
  - 9.2.6.4 Do not store modules in open areas.

## 9.3 Follow-Up Processing

- 9.3.1 Site Cleanup
  - 9.3.1.1 Recover all cables, screws, and accessories.
  - 9.3.1.2 Categorize and store tools and components properly.
- 9.3.2 Module Handling
  - 9.3.2.1 Decide on secondary installation or disposal based on module condition and inspection results.

# Chapter 10 Electrical Installation

## 10.1 Electrical Safety Precautions

- 10.1.1 All wiring must be carried out by qualified electricians in accordance with local electrical construction codes, regulations, standards, and the manufacturer's manual.
- 10.1.2 Modules must use dedicated PV cables with a cross-sectional area  $\geq 4 \text{ mm}^2$  and UV resistance. All other DC connection cables shall have equivalent or higher specifications. Cables must be routed in suitable conduits or cable trays and kept away from areas prone to waterlogging.
- 10.1.3 Electrical performance parameters of modules ( $I_{sc}$ ,  $V_{oc}$ ,  $P_{max}$ ) deviate from Standard Test Conditions (STC:  $1000 \text{ W/m}^2$  irradiance,  $25^\circ\text{C}$  cell temperature, AM1.5 spectrum).  
**Current** For conductor rating, fuses, and controller selection, calculate the design short-circuit current as  $I_{sc} \times 1.25$ , adjusted for maximum ambient temperature and temperature coefficient.  
**Voltage** Based on the lowest ambient temperature at the installation site, and considering the voltage temperature coefficient provided in the technical datasheet, calculate the expected open-circuit voltage ( $V_{oc}$ ). Modules with different electrical characteristics must not be connected in series or parallel to avoid mismatch losses. For modules connected in series, the voltages shall be added. For modules connected in parallel, the currents shall be added.
- 10.1.4 For series connection, insert the positive connector of one module into the negative connector of the next. Ensure all connectors are clean, dry, and corrosion-free before making connections.
- 10.1.5 Incorrect polarity (e.g., connecting arrays with opposite polarity) can cause irreparable damage. Always measure voltage and polarity before parallel connection.
- 10.1.6 Strings with different quantities of modules must not be connected to the same MPPT.
- 10.1.7 Modules generate DC electricity whenever illuminated, even without load. DC voltages  $\geq 30 \text{ V}$  may be hazardous or fatal. Always use insulated tools and wear insulated gloves when working under sunlight.
- 10.1.8 Modules cannot be switched off. To stop generation, cover them with an opaque material or remove them from sunlight.
- 10.1.9 To avoid the risk of arcing and electric shock, do not disconnect circuit connections under load.
- 10.1.10 Incorrect connections can cause arcing and electric shock.
  - 10.1.11 Keep connectors dry, clean, and protected from moisture. Never immerse connectors in water.
  - 10.1.12 Do not insert metal objects into connectors or attempt non-standard electrical connections.
  - 10.1.13 Do not touch or operate damaged modules (e.g., cracked frontsheet, broken junction box) unless fully disconnected and only with appropriate insulated protective equipment.
  - 10.1.14 Never touch wet modules or connectors without insulated gloves.

## 10.2 Electrical Connection Methods

- 10.2.1 The maximum number of modules per string must be determined by a qualified designer in compliance with local PV system design standards. The calculated maximum string open-circuit voltage at the minimum site temperature must not exceed the module's rated maximum system voltage (DC 1500 V according to IEC 61730 certification).
- 10.2.2 The open-circuit voltage at temperature T can be calculated:  
 $V_{oc}(T) = V_{oc}(25^\circ\text{C}) \times [1 - \beta \times (25 - T)]$  where  $\beta$  ( $\%/^\circ\text{C}$ ) is the  $V_{oc}$  temperature coefficient (see datasheet).
- 10.2.3 If reverse current may exceed the module's maximum fuse rating, overcurrent protection must be provided for each string. For  $\geq 2$  parallel strings, each must be protected by a fuse or equivalent device.
- 10.2.4 Sealed junction boxes of protection class IP 68 shall be used for the field connection of the modules to provide protection against environmental influences for the conductors and their corresponding connections, and to provide accessible protection against uninsulated energized parts.
- 10.2.5 The junction box has a connected cable and protection class IP 68 connector for series connection between modules; each component has two separate wires connected to the junction box (one positive, one negative), correctly locked with an audible click. Use an appropriate PV wrench to ensure proper tightening.
- 10.2.6 Make sure the connector is tight and properly connected. Use a special wrench to tighten the connector nut, tightening torque must be matched with the use of photovoltaic cable.
- 10.2.7 The root of the connector cable should be retained at least 20mm above the unbent length, so as not to cause deformation of the connector seal due to the external forces generated by the bending of the cable.
- 10.2.8 The connector shall not be subjected to external pressure.
- 10.2.9 The connector can only be used for circuit connection function, shall not be used to open and close the circuit.
- 10.2.10 The junction box and connector shall not be used in the environment containing hydrocarbons, phenols, ketones, ammonia compounds and other corrosive substances. Ensure that the parts can not be in contact with acid, alkali, gas, acetone or any other chemical substances that affect the use of materials. During installation, it is prohibited to add or apply any grease and lubricant in the connector. If the junction box and connector are contaminated, it is prohibited to continue using them.

## 10.3 Wiring

- 10.3.1 Observe correct polarity when connecting modules and loads (e.g., inverters, batteries). Incorrect polarity may damage bypass diodes.
- 10.3.2 Ensure connectors are compatible with the design requirements; otherwise Fortunes Solar assumes no liability.
- 10.3.3 Use diagonal cutters to cut the cable ties, taking care not to damage the cables. Connect the positive and negative connectors between the modules in sequence according to the electrical requirements. Make sure you hear a "click" sound, which indicates that the connection is properly in place. Otherwise, during module operation, a loose connection may cause arcing and burn the connector. Before commissioning, test open-circuit voltage and polarity of each string and verify against acceptance criteria.
- 10.3.4 Field wiring must use PV cables rated for  $\geq 90^\circ\text{C}$ , UV resistance, and  $\geq 4 \text{ mm}^2$  cross-section.
- 10.3.5 On-site crimping or assembly of connectors must follow the connector installation manual and warranty requirements.
- 10.3.6 The number of modules in series/parallel must be designed according to system configuration.

## 10.4 Cables

- 10.4.1 All cables must be rated above the maximum module short-circuit current, UV-resistant, and mechanically robust.
- 10.4.2 Fix the cable to the bracket, ensuring that no mechanical damage occurs to the cable or the modules.
- 10.4.3 Do not apply force or pressure to the cable.
- 10.4.4 Do not place the cable directly on the surface of the module. Use UV- and ageing-resistant cable ties to secure the cable to the mounting system.
- 10.4.5 Take appropriate measures to protect exposed cables from damage (e.g. by placing them in a plastic sleeve with anti-aging properties).
- 10.4.6 Prevent immersion of cables in water.

## 10.5 Connectors

- 10.5.1 Keep connectors dry and clean. Do not connect when wet or dirty.
- 10.5.2 Avoid direct sunlight or water immersion of connectors.
- 10.5.3 Lock connectors fully until an audible click is heard. Verify that all connections are secure.
- 10.5.4 Incorrect connections may cause arcing or electric shock. Check the firmness of all electrical connections and make sure that all connectors are fully locked in place.

## 10.6 Bypass diode

- 10.6.1 Bypass diode is not an overcurrent protection device.
- 10.6.2 If a diode failure is known or suspected, do not attempt repairs yourself. Contact the installer or system maintenance contractor, who should then coordinate with Polyshine Solar.
- 10.6.3 Bypass diode is built into the junction box, do not try to open the junction box of the component.

## 10.7 On-site connector assembly

- 10.7.1 Connector selection: The connector type must match the connector model used on the PV module.
- 10.7.2 Required tools:
  - 10.7.2.1 wire stripper (with length positioning function)
  - 10.7.2.2 crimping pliers
  - 10.7.2.3 Wrench
  - 10.7.2.4 Torque wrench (torque adjustable).
- 10.7.3 Connector assembly process
  - 10.7.3.1 Strip the cable insulation to a length L of 7 ~ 9mm (See Fig.1).
  - 10.7.3.2 Insert the stripped conductor into the pin terminal. use crimping pliers to crimp the pin firmly onto the conductor (See Fig.2).
  - 10.7.3.3 Assemble the negative (or positive) connector according to the illustration below. The parts from left to right are: negative connector body, sealing insert, collet, and locking nut (see Fig.3).
  - 10.7.3.4 Tighten the locking nut clockwise. Ensure that the gap between the locking nut and the connector body is controlled within 1.0–1.7 mm (see Fig.4).
  - 10.7.3.5 Insert the crimped pin (or socket) into the negative (or positive) connector housing until an audible click is heard. Pull gently on the cable to confirm it is locked in place and cannot be removed (see Fig.5).
  - 10.7.3.6 To disconnect the connectors, insert the appropriate tool into the connector latch. Pull the connectors apart with both hands to separate the positive and negative connectors (see Fig. 6).



## 10.8 Grounding

- 10.8.1 Syscom modules have no metal parts, so we do not provide grounding devices or materials.
- 10.8.2 If installed with metal mounting rails, please ensure proper grounding in accordance with the applicable electrical design and construction codes, procedures, regulations, and other grounding requirements.
- 10.8.3 For E P L Y series product, in order to avoid lightning strikes and electrical safety, the aluminum bottom frame of the module and the mounting bracket must be reliably grounded if required by local regulations.

# Chapter 11 Operation and Maintenance

Photovoltaic (PV) systems must be regularly maintained by the installer or other qualified personnel. Improper maintenance or incorrect operation that results in module damage will void the product warranty. Depending on local pollution levels, the module surfaces should be cleaned. Dirt or deposits on module surfaces may reduce system power output.

## 11.1 System Inspection

- 11.1.1 Preventive inspections should be carried out once per month. If electrical or mechanical performance checks or maintenance are required, only qualified professionals should perform these tasks to avoid the risk of electric shock or injury.
- 11.1.2 Before inspection, disconnect the circuit breaker. Do not touch live parts of cables or connectors.
- 11.1.3 Check whether modules are shaded or blocked by obstacles such as newly grown trees or newly installed poles or wires.
- 11.1.4 Inspect module surfaces for scratches, corrosion, or other visible damage.
- 11.1.5 Verify that all connection points are securely fastened and that structural adhesive has not loosened or detached.
- 11.1.6 Check for cracks or gaps in the sealing compound of the junction box.
- 11.1.7 Inspect all connectors to confirm secure connections and check for signs of corrosion.
- 11.1.8 Ensure cables are not exposed to direct sunlight for long periods and keep them away from areas where water may accumulate.

## 11.2 Module Cleaning

The power output of PV modules is directly related to solar irradiance reaching the surface. Dust or dirt buildup reduces light transmission and decreases energy production, so regular cleaning is essential. Modules should generally be cleaned at least once per month. In harsh environmental conditions, the cleaning frequency should be increased. For modules installed parallel to the ground, cleaning should be performed more frequently, as they lack the “self-cleaning” effect of modules installed at a steep tilt angle.

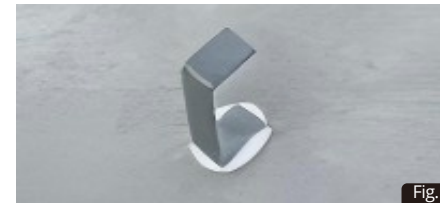
### 11.2.1 Cleaning Precautions

- 11.2.1.1 It is strictly forbidden to clean modules during strong winds (> Beaufort scale 4), heavy rain, or snowstorms.
  - 11.2.1.2 Avoid cleaning during high temperatures (> 40 °C) or very low temperatures (< 0 °C) to prevent thermal stress damage. Cleaning should preferably be done in the early morning or evening to minimize temperature differences.
  - 11.2.1.3 Personnel must follow local building regulations and wear appropriate protective equipment before cleaning, such as insulated gloves, safety glasses, helmets, and protective footwear.
  - 11.2.1.4 Ensure the PV system is powered down before cleaning.
  - 11.2.1.5 Do not walk, stand, or sit on modules during cleaning.
  - 11.2.1.6 Do not use high-pressure washers directly on the modules; standard low-pressure water jets are acceptable.
  - 11.2.1.7 Do not use acidic or alkaline detergents. Use only neutral (pH 6–8), non-abrasive cleaning agents for stubborn dirt.
  - 11.2.1.8 Use damp sponges, soft cloths, or soft-bristle brushes for wiping. Do not apply excessive force on the module surface.
  - 11.2.1.9 Do not use hard tools to remove light snow or dirt. Soft brushes may be used gently for snow removal.
  - 11.2.1.10 Do not attempt to remove frozen snow or ice adhered to the module surface.
- ### 11.2.2 Cleaning Procedure
- 11.2.2.1 Dry Pre-Cleaning: Remove loose dust, leaves, and other debris using an air blower or soft-bristled brush.
  - 11.2.2.2 Wet Cleaning:
    - Gently wipe the module surface with a sponge or non-woven cloth.
    - For heavy stains, soak to soften before wiping.
    - For oil or stubborn stains, use a neutral cleaning agent (e.g., 3% isopropanol solution).
    - Rinse immediately with clean water to avoid residue.
  - 11.2.2.3 Drying:
    - Dry with a microfiber cloth or allow to air dry naturally.
    - Avoid rapid drying under direct sunlight to prevent water stains.

## Appendix A Roof Pull Test

### Appendix A.1 Pull Test Procedure

- 1.1 Clean the test area thoroughly.
- 1.2 For roofs requiring high-adhesion waterproof primer, apply the primer first. Allow it to dry completely before proceeding with the test.
- 1.3 Apply structural adhesive to a small metal test block and press it firmly onto the prepared test area (see Fig.1).
- 1.4 After the adhesive has fully cured, use a force gauge or digital hanging scale to apply a vertical upward pull to the test block. Record the pull-out force data (see Fig.2).



### Appendix A.2 Calculation

- 2.1 The vertical pull-out force is calculated using the formula:  
$$F = M \times g$$
where:  
 $M$  = measured pull-out weight (kg)  
 $g$  = gravitational acceleration = 9.8 N/kg
- 2.2 Example (using JY 72-cell module):  
Standard module area:  
 $S = 1.185 \times 2.246 = 2.662\text{m}^2$   
Short side adhesive lines: 6 lines, each 1 cm wide  
Total adhesive bonding area during installation:  
 $S_1 = 6 \times 1.185 \times 0.01 = 0.071\text{m}^2$
- 2.3 Adhesive bonding area of the test block =  $S_2$ .  
Unit bonding strength:  
 $\sigma = (M \times g) / S_2 \text{ (N/m}^2\text{)}$
- 2.4 Module pull resistance:  $F_1 = \sigma \times S_1$   
Corresponding pull resistance  $q_1 \text{ (kN/m}^2\text{)}$ :  
 $q_1 = F_1 / (S \times 1000)$

### Appendix A.3 Wind Load Assessment for PV Modules

The design wind pressure for the installation site shall be determined in accordance with Eurocode 1: Actions on structures Part 1-4: Wind actions (EN 1991-1-4) and any applicable National Annex. The Eurocode procedure accounts for terrain category, reference wind speed, height above ground, topography, shielding effects, directionality and gust factors. This manual does not reproduce the full EN 1991-1-4 calculation procedure; designers and engineers shall use the Eurocode method (or a recognised wind-loading tool compliant with EN 1991-1-4) to obtain the site design wind pressure  $q_d$  (Pa or  $\text{kN/m}^2$ ).

### 3.1 Comparison with pull-test result

Let:

$q_1$  = module pull resistance obtained from the pull test (kN/m<sup>2</sup>), as calculated in Section 2;

$q_d$  = design wind pressure for the site obtained per EN 1991-1-4 (kN/m<sup>2</sup>).

Prior to installation, verify the following condition is met:

$$q_1 \geq \gamma_s \times q_d$$

where  $\gamma_s$  is a safety factor to cover test uncertainty, material variation, extreme events and ageing.

Always check and apply any nationally mandated partial factors in the EN 1991-1-4 National Annex for the country of installation.

### 3.2 Wind pressure from wind speed is calculated as:

$$b = 0.5 \times 1.25 \times v_b^2$$

where:

$q_b$  = basic velocity pressure (in Pa)

$v_b$  = wind speed (m/s)

## Appendix A.4 Additional considerations

- 4.1 The pull test shall be performed representative of the final installation (same substrate, primer and adhesive, same curing conditions). Record adhesive batch, primer, ambient temperature, cure time and test date. If the adhesive supplier provides certified joint resistance values, use them for calculations and follow the supplier's instructions.
- 4.2 Edge and corner modules are more susceptible to uplift; when assessing these positions apply the same verification and consider local amplification factors.
- 4.3 For conservative design, account for seasonal extremes and rare events (return periods) per national rules rather than only mean/annual values.
- 4.4 Where doubt remains, consult a structural engineer experienced with EN 1991-1-4.

Beaufort Scale	Description	Wind Speed		Basic Velocity Pressure $q_b$ (Pa)
		km/h	m/s	
0	Calm	<1	0-0.2	0-0.03
1	Light Air	1-5	0.3-1.5	0.06-1.41
2	Light Breeze	6-11	1.6-3.3	1.60-6.81
3	Gentle Breeze	12-19	3.3-5.5	6.81-18.91
4	Moderate Breeze	20-28	5.5-8	18.91-40
5	Fresh Breeze	29-38	8.0-10.8	40-72.90
6	Strong Breeze	39-49	10.8-13.9	72.90-120.76
7	Near Gale	50-61	13.9-17.2	120.76-184.90
8	Gale	62-74	17.2-20.7	184.90-267.81
9	Severe Gale	75-88	20.7-24.5	267.81-375.16
10	Storm	89-102	24.5-28.4	375.16-504.10
11	Violent Storm	103-117	28.4-32.6	504.10-664.23
12	Hurricane	>117	32.6-37	664.23-855.63
13	☐	☐	37.0-41.4	855.63-1071.23
14	☐	☐	41.5-46.1	1076.41-1328.26
15	☐	☐	46.2-50.9	1334.03-1619.26
16	☐	☐	51.0-56.0	1625.63-1960
17	☐	☐	56.1-61.2	1967.01-2340.90

## Appendix B Structural Adhesive Application Guidelines

During PV module installation, the use of structural adhesive must strictly follow standardized procedures to ensure bonding strength and safety. The following guidelines are provided for reference only. Always follow manufacturer instructions.

### Appendix B.1 Preparation Before Application

#### 1.1 Surface Treatment

Clean the substrate with alcohol, acetone, or a dedicated cleaner to remove oil, dust, moisture, and release agents (residues will reduce adhesion). Both the substrate and the bonding surface of the module must be cleaned thoroughly to ensure no foreign matter compromises bonding strength.

#### 1.2 Adhesive Selection

Use structural adhesives designed for photovoltaic applications. Reputable, first-line brand products are recommended. The use of uncertified or untraceable adhesives is strictly prohibited.

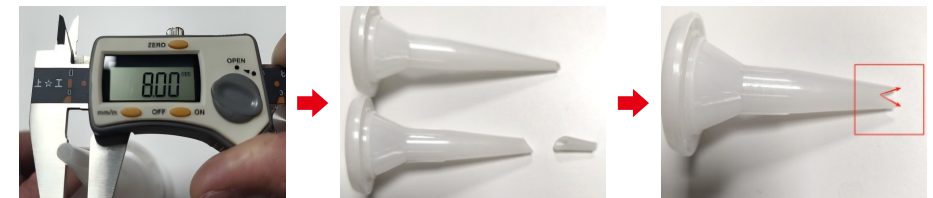
#### 1.3 Tool Preparation

Caulking gun (an electric caulking gun is recommended for consistent dispensing)  
Nozzle  
Utility knife

### Appendix B.2 Application Procedure

#### 2.1 Nozzle Cutting

Cut off the tip of the nozzle using a utility knife or similar cutting tool. The nozzle opening should be approximately 8 mm in diameter. Then cut a V-shaped notch on one side of the nozzle (see illustration).



## 2.2 Caulking Gun Adjustment

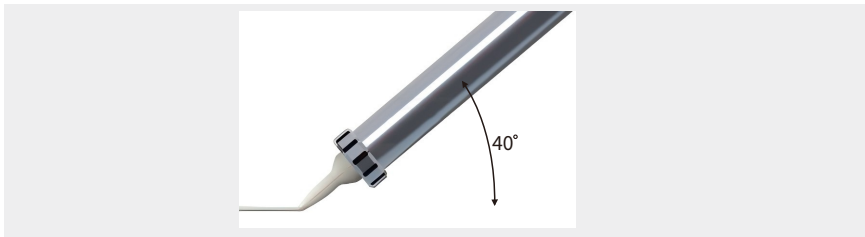
Adjust the dispensing speed of the caulking gun. The standard speed corresponds to rotating the adjustment knob by half a turn (see illustration).



## 2.3 Adhesive Application

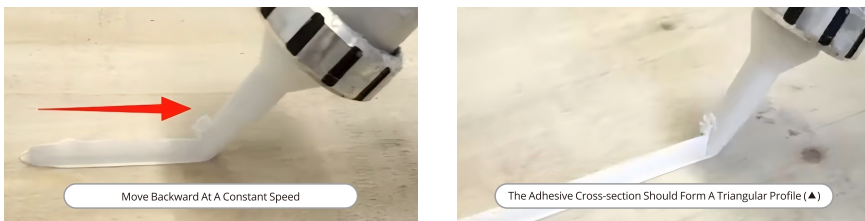
Speed: approximately 10 cm/s

Angle: hold the caulking gun at about 40° to the ground (see illustration).



### Bead Shape

The adhesive cross-section should form a triangular profile (▲). The bead width should be  $\geq 8$  mm, and the bead height should be  $\geq 8$  mm. Position the pre-cut V-shaped nozzle upward to dispense a uniform triangular adhesive bead along the bonding surface (see illustration).



## 2.4 Bonding

When modules are pressed into place after adhesive application, the triangular bead ensures uniform contact with the bonding surface and adequate adhesive thickness. This method helps prevent common application errors such as insufficient adhesive, missed areas, or uneven bead thickness (too thin or too thick). See the comparison illustration of adhesive before and after bonding.