SolarVela & SolarNoah

Series PV Module Installation Manual

Shandong ZKFN Solar Technology Co., Ltd.

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1. Manual Overview and Responsibility Statement

1.1 Scope of Manual

This Installation Guide (hereinafter referred to as "this document") is issued by Shandong ZKFN Solar Technology Co., Ltd. (hereinafter referred to as "ZKFN Solar") and applies to all operational procedures of the SolarVela and SolarNoah series light-flexible PV modules (hereinafter collectively referred to as "modules") from delivery to grid connection and full lifecycle O&M, covering: product selection, logistics unloading, warehouse management, unpacking, mechanical installation, electrical connection, system commissioning, and maintenance.

This document is intended for qualified system integrators, EPC contractors, installation contractors, and O&M units. The aforementioned units and their personnel have the obligation to thoroughly read, fully understand, and strictly comply with all terms of this document before operations, and shall provide written safety and maintenance briefings to end customers.

1.2 Disclaimer

1. ZKFN Solar reserves the right to modify this manual without prior notice due to product technology upgrades, process improvements, or standard updates. The latest version will be published on the ZKFN Solar official website download center. Customers and installers are responsible for proactively ensuring use of the latest version. Any operational deviations resulting from use of outdated versions shall be borne by the user.
2. Failure to follow the requirements specified in the installation manual (including changes published on ZKFN Solar's official website at the time of installation) during module installation will void the limited product warranty provided to the customer.
3. ZKFN Solar makes no warranties, express or implied, regarding any information contained in this manual. Users and installers must complete a site technical survey to ensure the provided installation methods comply with local laws and building standards.

1.3 Scope of Liability

1. Regardless of whether module installation follows the installation manual (including changes published on ZKFN Solar's official website), ZKFN Solar shall not be held legally liable for any damages arising during installation, including but not limited to module handling, personal injury, or property loss resulting from system installation.
2. In case of inconsistencies between different language versions of this manual, the Chinese version shall prevail.
3. This manual is provided for installation guidance only and does not constitute any warranty, whether express or implied.

1.4 Warranty Warning Terms

1. ZKFN Solar provides a 12-year product warranty and 25-year linear power output guarantee for all SolarVela and SolarNoah series products. Specific warranty scope, claims procedures, and exceptions shall be governed by the official warranty documents accompanying the product at the time of purchase.

2. Key auxiliary materials used with the modules, including clamps, structural adhesive, and connectors, must be models recommended or certified by ZKFN Solar to ensure system compatibility, reliability, and safety. Damage to products or systems caused by the use of non-certified hardware is not covered under warranty.

1.5 Technical Support Information

For more detailed technical support documents, project-specific solution consultation, or recommendations for abnormal installation surfaces, please contact ZKFN Solar through the following official channels:

- Service Hotline: (+86) 400 6768 100 (Office Hours: 8:30-17:30, Beijing Time)
- Technical Support Email: tech-support@zkfnsolar.com
- Official Website: www.zkfnsolar.com
- Manufacturing Base: Building 1, Xinshenglin, Lvhaihui Intelligent Manufacturing Industrial Park, Jining Economic Development Zone, Jining City, Shandong Province

2. Safety Operation Specifications

2.1 General Safety Warnings

1. All installation work must comply fully with local regulations and applicable national or international electrical standards.
2. Electric Shock and Burn Risk: PV modules are DC power generation equipment. When exposed to light, even without circuit connection, DC voltage is present at the positive and negative terminals and connectors. Multiple modules connected in series form a PV array whose voltage can reach levels hazardous to personal safety. Personnel without professional training or authorization are prohibited from touching module terminals, connectors, or exposed live parts in any manner. Contact with live parts may cause severe burns or fatal electric shock.
3. No Live-Load Operation: Before any module installation, replacement, wiring, or system modification, the DC and AC sides must be completely de-energized, with strict anti-reclosure and de-energization verification measures. Under no circumstances shall connectors or electrical connections be disconnected under load, as this produces hazardous and destructive DC arcs that may cause fire, equipment damage, and serious personal injury.
4. Damaged Module Handling: Do not use modules with visible damage, including but not limited to surface penetration, cracking, backsheet scratches or penetration, junction box cracking, or internal water ingress. Damaged modules cannot be repaired and present extremely high electric shock and leakage risks with completely compromised insulation. Do not disassemble modules, remove component parts, or modify bypass diode wiring for any reason. Module junction box covers must remain closed at all times.
5. Short-Circuit Risk of Positive and Negative Poles: Do not directly connect the positive and negative connectors of a single module, as this will cause a short circuit. Before installation, inspect and ensure all connector insulating caps or sealing rings are intact and properly installed to prevent short circuits caused by insulation failure, which could lead to fire or electric shock.
6. Environmental and Electrical Parameter Limits: The module's designed stable operating ambient temperature range is -40°C to +85°C. The maximum system open-

circuit voltage must not exceed the maximum system voltage of DC 1500V indicated on the module label under any expected minimum ambient temperature. Operation beyond rated parameters is prohibited.

7. Fire Safety: In the event of a fire at the installation or O&M site, and where conditions permit without personal danger, the entire PV system power (including DC and AC sides) must be disconnected first, then extinguish using dry powder, CO_2, or other non-conductive fire extinguishing media according to electrical fire safety regulations. Do not use water or foam to directly flush modules or electrical systems before disconnecting power.
8. Application Class and Warning: This series of modules is Application Class A (equivalent to IEC 61730-1 Safety Class II), suitable for systems accessible to the public. When the system open-circuit voltage exceeds 50V, prominent "Electric Shock Hazard" warning signs must be installed near string connection devices, inverters, and other easily accessible locations according to safety regulations.

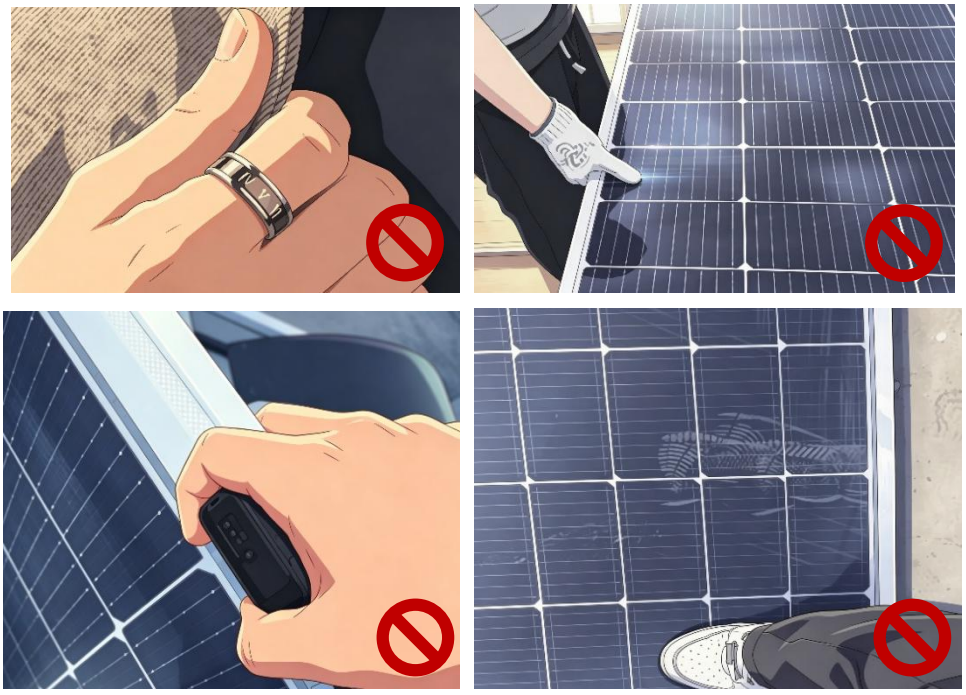
2.2 General Personnel Safety Requirements

1. Qualification Requirements: All personnel responsible for PV system installation, wiring, commissioning, and maintenance must complete professional PV system installation training, hold relevant valid qualification certificates, and be fully familiar with all safety regulations in this manual and relevant local government regulations.
2. Two-Person Work System: To minimize the risks of single-person operations (such as accidental electric shock, falls from height, etc.), all on-site installation, handling, and wiring operations must be carried out by at least two persons working together. High-risk operations by a single person are prohibited.
3. Personal Protective Equipment (PPE): Personnel must properly wear certified personal protective equipment during operations, including but not limited to: anti-slip protective gloves, long-sleeve insulated work clothing, anti-impact insulated shoes. When working on roof edges or any area with fall risk (height difference exceeding 2 meters), a double-hook shock-absorbing safety harness must be worn at all times and securely attached to an independently installed lifeline or anchor point, with fall protection barriers or safety nets installed below the work area.
4. Tools and Jewelry: Only tools meeting safety standards with intact insulation shall be used. Wearing any metal jewelry such as watches, rings, necklaces, bracelets, etc., is prohibited during work, as such items may cause unintended current conduction leading to short-circuit risk, or scratch the module surface during handling.
5. Adverse Weather: Outdoor installation, hoisting, or wiring operations are prohibited in rain, snow, fog, thunderstorms, or when instantaneous wind speed reaches or exceeds Level 4 (wind speed approximately 7.9 m/s). Humid environments significantly increase electric shock risk. Installers must ensure all modules, tools, and electrical connection points are clean and dry before proceeding.
6. Area Control: The construction site and temporary module storage area must be clearly marked with warning signs and barriers. Unauthorized personnel, children, or other unrelated persons are prohibited from entering to prevent accidents.
7. Light Exposure Protection: At any time, even when modules are not connected to a complete system, they constitute a power source when exposed to light. Do not directly touch junction boxes, cable ends, or metal contacts inside connectors with bare hands without protection.

2.3 General Prohibited Operations

To ensure module performance, personnel safety, and warranty validity, the following are prohibited:

1. Physical Damage and Coating: Do not scratch, strike, bend, or impact the front or back of modules with sharp objects. Do not apply paint, adhesives, tape, or any form of coating on any area of the module surface. Do not drill, cut, or grind any part of the module.
2. Cable and Connector Damage: Do not scratch, cut, squeeze, or pull the module's cables and connectors in any manner. Do not expose cables and connectors to direct sunlight or water for extended periods without proper protection (such as conduit).
3. Handling and Pressure: Do not press on the cell area when handling. Do not lift, carry, or drag modules by grasping the junction box, lead wires, or connectors. Do not press, stand, walk, climb, or jump on the module surface. Do not allow modules to collide, rub, or impact with any hard or sharp objects.



4. Artificial Light Concentration: Do not use mirrors, lenses, or other optical devices to concentrate additional sunlight or artificial light onto the module surface.

5. Water Immersion and Stacking: Do not place modules in areas prone to water accumulation or continuous humidity for extended or permanent periods. During all storage, handling, and installation stages, do not place modules with back facing upward, stack, or compress modules.
6. Surface Contamination and Shading: Do not apply structural adhesive, sealant, or any foreign matter to the effective light-receiving area of cells during installation. After installation, ensure all output cables and jumpers are routed clearly and securely fastened. Do not allow wires, clamps, or other objects to shade the effective light-receiving area of cells.
7. Pollution Sources and Fire Hazards: Do not install modules near vents or exhaust outlets that continuously emit oil fumes, dust, or chemically corrosive gases. Do not install modules near open flames or flammable/explosive materials.
8. Disturbance After Installation: Modules installed with structural adhesive must not be disturbed within 24 hours after bonding, including but not limited to moving modules, connecting cables, applying external force, or standing on modules for other operations. Do not lift and re-adhere modules after adhesive curing.
9. Improper Loading: After module installation and testing, do not place any heavy objects, tools, or objects with sharp fulcrums on the module surface to avoid long-term pressure damage.
10. Lightning Protection: To reduce the risk of indirect lightning strikes, avoid creating loops in the system design.
11. Prevent Loosening: Modules must be securely fixed to withstand all possible loads, including wind and snow loads. Module loosening pulling on connection cables leading to insulation failure, leakage, and arcing are significant risks in distributed PV systems.
12. No Single Module Across Joints: During installation, a single module must not span across joints where the contacting materials may shift. Otherwise, there may be risks of module deformation, micro-cracks, or even failure.

3. Product Specifications and Core Performance Parameters

3.1 Product Series and Model Description

This manual comprehensively covers ZKFN Solar's two core light-flexible module product lines: the SolarVela and SolarNoah series, comprising six main products, all equipped with

proprietary TSR-Armor™ anti-crack technology. The characteristics and internal model definitions of each series are as follows:

Product Series	Internal Model Code	Cell Technology	Power Range
SolarVela	ZKFN B1 000A-520	182 PERC	510W - 520W
SolarVela Pro	ZKFN B1 010A-560	182 TOPCON	550W - 560W
SolarVela Max	ZKFN B1 010A-560	182 TOPCON	550W - 560W
SolarNoah	ZKFN B1 002A-520	182 PERC	510W - 520W
SolarNoah Pro	ZKFN B1 012B-560	182 TOPCON	550W - 560W
SolarNoah Max	ZKFN B1 012B-560	182 TOPCON	550W - 560W

The SolarVela series features flexible form-fitting, direct structural adhesive bonding installation; the SolarNoah series features a rigid back frame, Quick-Clamp fixture quick installation, supporting non-destructive disassembly.

3.2 Core Electrical Performance Parameters

3.2.1 SolarVela Series Electrical Parameters (STC Standard Test Conditions)

Parameter Item	SolarVela (510-520W)	SolarVela Pro/Max (550-560W)
Peak Power Range (Pmax)	510~520W	550~560W
Module Efficiency	19.3%	21.0%
Power Tolerance	0 ~ +5 W	0 ~ +5 W
First Year Power Degradation	≤ 2.0%	≤ 1.0%
Annual Power Degradation (Year 2-25)	≤ 0.55%	≤ 0.4%
25-Year End Power Guarantee	≥ 84.8%	≥ 89.4%
Peak Power Temperature Coefficient (γ)	-0.34% / °C	-0.29% / °C
Open-Circuit Voltage Temperature Coefficient (α)	-0.28% / °C	-0.26% / °C
Short-Circuit Current Temperature Coefficient (β)	+0.05% / °C	+0.045% / °C
Nominal Operating Cell Temperature (NOCT)	45 ± 2 °C	45 ± 2 °C
Maximum System Voltage	DC 1500 V	DC 1500 V

Parameter Item	SolarVela (510-520W)	SolarVela Pro/Max (550-560W)
Maximum Series Fuse Rating	25 A	25 A

(STC Conditions: Irradiance 1000W/m², Air Mass AM 1.5, Cell Temperature 25°C, Test Tolerance ±3%)

> Supplementary Note: Due to normal operating conditions such as specific low temperatures and high irradiance, the actual output open-circuit voltage and short-circuit current of modules may be significantly higher than STC nominal values. Therefore, in electrical system design, the nominal Isc and Voc values must be multiplied by a factor of 1.25 for engineering design.

3.2.2 SolarNoah Series Electrical Parameters (STC Standard Test Conditions)

Parameter Item	SolarNoah (510-520W)	SolarNoah Pro/Max (550-560W)
Peak Power Range (Pmax)	510~520W	550~560W
Module Efficiency	19.3%	21.0%
Power Tolerance	0 ~ +5 W	0 ~ +5 W
First Year Power Degradation	≤ 2.0%	≤ 1.0%
Annual Power Degradation (Year 2-25)	≤ 0.55%	≤ 0.4%
25-Year End Power Guarantee	≥ 84.8%	≥ 89.4%
Peak Power Temperature Coefficient (γ)	-0.34% / °C	-0.29% / °C
Open-Circuit Voltage Temperature Coefficient (α)	-0.28% / °C	-0.26% / °C
Short-Circuit Current Temperature Coefficient (β)	+0.05% / °C	+0.045% / °C
Nominal Operating Cell Temperature (NOCT)	45 ± 2 °C	45 ± 2 °C
Maximum System Voltage	DC 1500 V	DC 1500 V
Maximum Series Fuse Rating	25 A	25 A

3.3 Core Mechanical Performance Parameters

The following table summarizes the key structural and physical characteristics of each series, which are the basis for on-site handling, installation decisions, and mechanical load assessment.

Parameter Item	SolarVela/Pro	SolarVela Max	SolarNoah/Pro	SolarNoah Max
Module Dimensions	2250×1200×1.8mm	2250×1200×1.8mm	2250×1200×25mm	2250×1200×25mm
Module Weight	Approx. 7.6 kg	Approx. 7.6 kg	Approx. 10.2 kg	Approx. 10.2 kg
Weight per Unit Area	2.9 kg/m²	2.9 kg/m²	3.8 kg/m²	3.8 kg/m²
Structure Characteristic	Flexible form-fitting R≥0.3m	Flexible form-fitting R≥0.3m	Rigid back frame	Rigid back frame
Junction Box Specification	3-part, IP68	6-part, IP68	3-part, IP68	6-part, IP68
Output Cable	4mm², length 400mm, customizable			
Connector	MC4 Compatible			
Static Mechanical Load	Front 5400Pa, Back 2400Pa			
Wind Resistance Level	Level 17			
Hail Test	Diameter 25mm, Impact speed 23m/s			
Core Performance Features	Flexible, adhesive installation	Flexible, adhesive installation, 6-bypass anti-hot-spot	Back frame, quick-install, easy removal	Back frame, quick-install, easy removal, 6-bypass anti-hot-spot

3.4 Installation Tilt Angle and Site Selection Specifications

1. Installation Site Requirements
    - ZKFN Solar recommends installing modules in an operating ambient temperature range of -40°C to +40°C, suitable for modules operating under these conditions, where 98% of module operating temperatures do not exceed 70°C.
    - Modules should be installed in areas without year-round shadow shading. Although modules are equipped with bypass diodes, shadow shading will still

affect optimal performance and operational safety, potentially causing encapsulation material aging and continuous diode heating, significantly shortening module service life and voiding the limited warranty.

- Do not install modules in locations that may be submerged or continuously exposed to sprinklers, fountains, etc.
- When installing solar modules on a roof, a safe working area must be maintained between the roof edge and the outer edge of the PV module array.
- When modules are loaded on the roof, load verification must be performed on the roof, and a construction organization plan compliant with specifications must be developed.

2. SolarVela Series Tilt Requirements
    - SolarVela and SolarVela Pro models: In all application scenarios and installation methods, the horizontal tilt angle after installation must be ≥ 5°. This minimum tilt is designed to ensure gravity-assisted self-cleaning of the module surface, preventing bottom dust accumulation forming hot spots, and ensuring effective rainwater flushing and drainage. These two models are prohibited from being installed at an angle less than 5° or horizontally (0°).
    - SolarVela Max model: As an enhanced product, there is no minimum installation tilt restriction in any application scenario, allowing 0° horizontal installation while being fully compatible with any tilt angle greater than 0°.
3. SolarNoah Series Tilt Requirements
    - SolarNoah and SolarNoah Pro models: In all application scenarios and installation methods, the horizontal tilt angle after installation must be ≥ 5°. This requirement is likewise based on ensuring optimal drainage and preventing long-term reliability issues from bottom dust accumulation and water ponding. These two models are prohibited from being installed at an angle less than 5° or horizontally.
    - SolarNoah Max model: As an enhanced product, there is no minimum installation tilt restriction in any application scenario, allowing 0° horizontal installation while being fully compatible with tilted clamp or base installation solutions.
4. Installation angle selection should also consider natural conditions such as local wind load, snow load, and air pollution levels. Module surfaces should avoid water accumulation, dust buildup, and snow coverage. It is recommended that the module installation angle be no less than 10°, facilitating dust removal by rainwater and snow sliding off, and preventing surface marks from long-term deposits that could affect the module's appearance and performance.

4. Unloading, Transportation, and Storage Specifications

4.1 General Protection Requirements

1. Original Packaging Protection: All modules must be kept in ZKFN Solar's original cardboard or wooden packaging boxes until officially installed on the support structure. All necessary measures must be taken to ensure the packaging boxes are protected from external force damage, impact, or tipping during transportation, handling, and storage.

2. Safe Operation and Load Limits: Stepping, standing, climbing, jumping, or placing heavy objects on packaging boxes or modules is prohibited. Colliding or squeezing packaging boxes in any manner is prohibited. Packaging boxes must not be placed or transported in a non-vertical (tilted or sideways) orientation. Any improper transportation or installation behavior may cause internal micro-cracks in modules, leading to warranty voidance.

No impact on the container　　No tilting / Keep upright

3. Moisture Protection and Ventilation: Modules must be kept in a dry, well-ventilated environment throughout the entire process from factory to installation. Modules and their packaging must not be exposed to rain or moisture. If temporary outdoor storage is required due to construction needs, the storage area must be well-drained, and the packaging must be tightly covered and reinforced with waterproof tarpaulin to prevent wind or moisture ingress.
4. Correct Manual Handling Posture: Handling modules requires teamwork and must be completed by 2 or more persons working together. Single-person operation is prohibited. When handling, both hands must steadily grip the long-side frame of the module or the white non-power-generation area of the module body. Prohibited handling methods include: gripping only the junction box, grabbing lead wires, or holding the module by the short side with one hand to lift, support, or drag the module.
5. Stacking Restrictions: When manually handling exposed modules, no more than 1 piece at a time. When temporary stacking of modules awaiting installation is necessary at the work area, the total stack height must not exceed 5 pieces, with proper anti-tipping and anti-scratch measures in place.

4.2 Packaging Label Descriptions

All operation diagrams and warning signs printed on the outer packaging are mandatory safety instructions. Installers have the obligation to read, understand, and strictly comply before operation. The main label meanings are explained below:

1. Environmental Label ( ): Product complies with all WEEE Directive requirements of 28 EU member states. Do not discard modules carelessly; they must be specially recycled.
2. Fragile Item ( ): Handle with care using proper methods; do not drop from height or handle roughly to prevent micro-cracks or direct damage from strong vibration.

3. This Side Up (): During transportation, handling, and storage, packaging boxes must always be kept upright as shown. Inverting or laying on the side is prohibited to prevent excessive deformation and edge stress on modules.

4. Keep Dry (): Packaging and modules must be protected in a dry environment at all times. Direct exposure to rain, snow, or excessive humidity is prohibited to prevent cardboard softening and connector corrosion from moisture.

5. No Stepping (): Applying any concentrated load (such as stepping, standing, or placing heavy objects) on packaging boxes or unpacked modules will cause permanent product damage.

6. Stacking Layer Limit (): Indicates the maximum stacking layers allowed for packaging boxes under static storage conditions. In warehouses or environments without vibration sources, the static stacking limit for this series of lightweight module packaging boxes is a maximum of 2 layers.

4.3 Unloading Operation Specifications

4.3.1 Crane Unloading Specifications

1. Safe Lifting Gear: When using a crane for unloading, specialized lifting tools confirmed by ZKFN Solar technical staff or flexible grid lifting slings with equivalent moment arms must be used. Before lifting, select lifting ropes or slings with sufficient safety factor based on total cargo weight and inspect their integrity.
2. Lifting Rules: Adjust the sling position on the pallet to ensure balanced center of gravity during lifting. The lifting arm must be raised, lowered, and rotated slowly and uniformly. When the packaging box approaches the ground, two persons at each end must steady the box for precise, gentle placement on a leveled, firm, hard ground surface.
3. Environmental Limits: Hoisting operations are prohibited under severe weather conditions including instantaneous wind speed exceeding Level 6 (>13.8 m/s), moderate rain or above, and heavy snow.

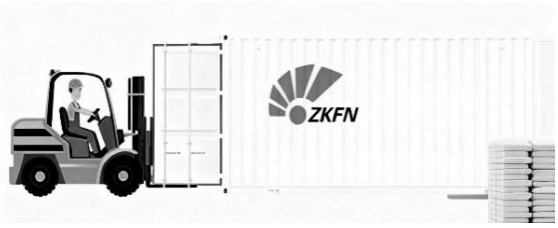
4.3.2 Forklift Unloading Specifications

1. Equipment Selection: Select a forklift with sufficient load capacity and mast/forks in good condition based on the weight and size of module packaging boxes. To accommodate standard pallets, forklift forks should have adjustable spacing function. Adjust spacing before operation to be as close as possible to the reinforced corner posts on both sides of the pallet.

2. Precise Operation: When forking, ensure forks are fully horizontally inserted under the pallet to a depth of at least three-quarters of the pallet depth. The front of the forklift mast or contact surface with packaging must be pre-installed or lined with EPE (expanded polyethylene) or thick rubber pads. Direct contact between the forklift's metal mast or forks and the module packaging box is prohibited to avoid forklift damage to modules.
3. Visibility and Safety: If the module pallet packaging blocks the forklift driver's forward view during transport, the forklift must be driven in reverse at low speed with a signal person directing. All persons must maintain a safe distance from the forklift and cargo.

4.3.3 Container Unloading Special Responsibilities

1. Operator Qualifications and Discipline: Forklift operators entering containers must have verified container operation experience and professional qualifications. Operations must be conducted with high concentration, strictly following the principle of slow and steady approach.



2. Cargo Fixing and Center of Gravity Control: Before forking out a packaging box, verify it is securely placed on the forks. When transporting to the stacking area over bumpy roads, ensure cargo has no risk of sliding, tilting, or falling.
3. Space Planning and Safety Limits: Before entering a container, the operator must pre-calculate the layout of remaining cargo inside and the turning radius of the equipment. Any operation that may scrape or impact container walls, roof panels, or other cargo is prohibited.

4.4 Secondary Transport Requirements

1. Original Packaging Principle: Original factory packaging must be retained and used for any form of long-distance secondary transport or outdoor storage exceeding one week. For land transport, after loading, use ropes or straps of sufficient strength to secure the bottom layer packaging to the truck bed. For standard flatbed transport, the maximum stacking height is two layers of standard pallets. Cutting original factory strapping bands for any reason is prohibited.
2. On-Site Transfer Prohibitions: For short-distance transfer from on-site warehouse to installation location, removing original packaging is also prohibited, and single-layer transport only is permitted. Use of electric tricycles or other unstable vehicles for module transfer is prohibited. Simply bundling modules with rope, single-person carrying on back or shoulder, or dragging modules by pulling output cables or junction boxes is prohibited.

4.5 Storage Specifications

1. Storage Environment Requirements: Warehouses must meet basic requirements of ventilation, dryness, and freedom from corrosive industrial gases. Recommended storage environment: relative humidity below 70%, temperature maintained in a moderate range (-20°C to +50°C), avoiding condensation from extreme temperature differences.

2. Stacking Restrictions: In warehouses with hard flooring, lightweight module packaging boxes are specified for static stacking only, with a maximum of 2 pallet layers. Any form of excessive stacking, packaging box compression, or elevated equipment impact on packaging is prohibited.

3. Outdoor Temporary Storage Precautions: When temporary outdoor storage without cover is unavoidable due to construction scheduling, the storage period shall not exceed 7 days. All module packaging boxes must be placed on elevated, well-drained, flat ground without water accumulation risk, completely covered with waterproof tarpaulin of adequate size and secured with heavy objects.

5. Unpacking Operation Guide

5.1 Unpacking Safety Requirements

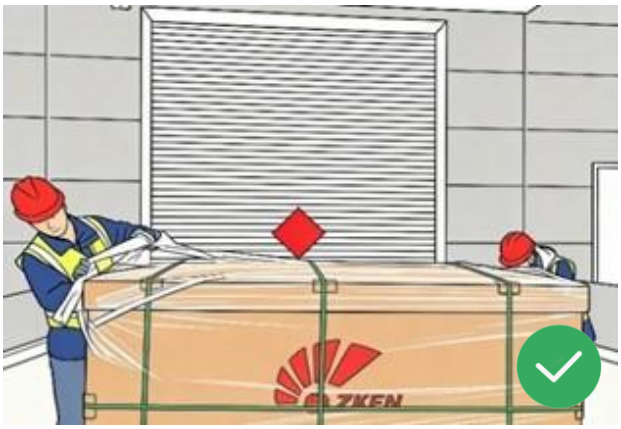
> Warning - Unpacking Weather Threshold: Outdoor unpacking is prohibited in rain, snow, or fog conditions. Moisture will rapidly soften cardboard boxes and cause loss of structural strength, potentially leading to module sliding damage or personnel injury. When instantaneous wind speed reaches or exceeds Level 4 (>7.9 m/s), all unpacking and module handling operations must cease immediately.

1. Unpacking Space Conditions: Select a completely level and firm ground area as the unpacking zone. Ensure the packaging box is stable on all four corners without tipping risk. When removing packaging panels, use appropriate pry bar tools rather than pulling by hand.
2. Hand Protection and Clean Operations: All personnel must wear cut-resistant, anti-slip work gloves when unpacking and handling modules. This protects workers from cuts by packaging panels and strapping bands, and prevents oil and sweat from hands from contaminating the white backsheet (affecting bonding performance) or leaving fingerprints on the front sheet.
3. Document and Information Preservation: Logistics and product information labels are often attached to outer packaging boxes. Record or photograph this information before unpacking. After opening, locate and safekeep the packing list, certificate of quality, and serial number corresponding table inside the box until all modules are successfully installed and connected to the grid.

5.2 Standard Unpacking Procedure

5.2.1 SolarVela Series Unpacking Procedure

1. Remove Outer Packaging: Use tools to cut and remove all longitudinal and transverse strapping bands from the outside of the packaging box, then cut and peel off the stretch film from top to bottom.



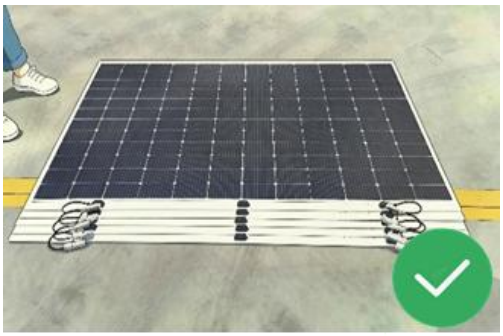
2. Information Verification: Before unpacking, verify the packing list against external label information to confirm model, power rating, quantity, and batch consistency.

3. Open Box and Remove Cover: Open the packaging box top seal, lift the entire box cover structure vertically upward, and remove the internal anti-vibration top plate placed above the modules, placing them aside.

4. Remove Side Panels and Fillers: Remove the front packaging panel facing the modules, then remove filler materials such as EVA buffer strips placed above the modules.

5. Remove Modules Individually: Working in pairs, stand on the same side or opposite sides of the box, firmly grip the long-side white area of the top module, apply even force, and pull it vertically upward from the box smoothly, then transfer directly to the designated EPE or wooden pallet in the construction stacking area.

6. Temporary Stacking: Stack modules sequentially in a safe location adjacent to the installation point. Align junction boxes pointing to the same side, stagger junction box ends in an orderly manner. In any case, the stacking height must not exceed 5 pieces.



5.2.2 SolarNoah Series Unpacking Procedure

The SolarNoah series, due to its integrated back frame, has greater overall thickness and structural rigidity. The unpacking procedure is basically the same as the SolarVela series, with the specific steps as follows:

<table>
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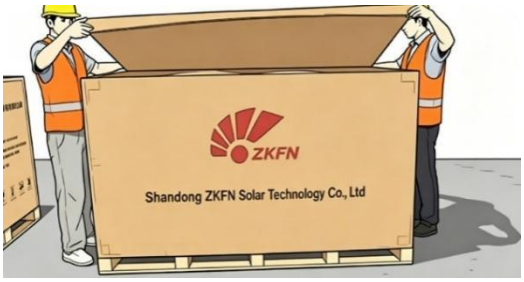
Remove outer strapping bands from packaging box</td>
<td> 

Lift packaging box cover from top</td>
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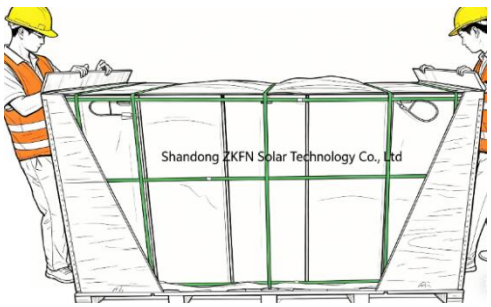
Remove front packaging panel</td>
<td> 

Remove internal top plate from packaging box</td>
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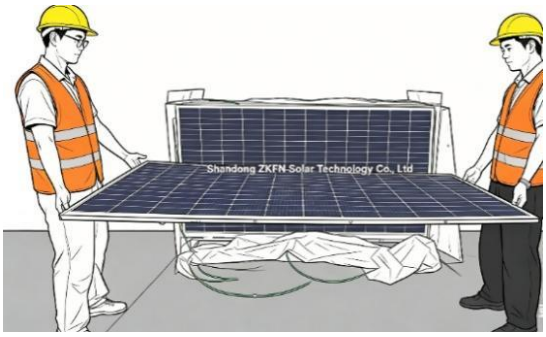
<td> 
Place anti-tip fixture on one side of box, remove module securing straps</td>
<td> 

Remove modules sequentially from top, stack according to specifications</td>
</tr>
</table>

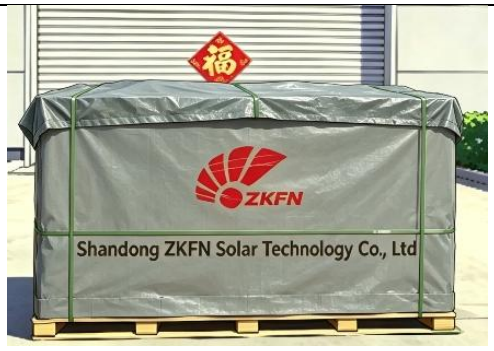
Points requiring special emphasis are:

1. When grasping, two persons must cooperate to hold the long-side vertical edge of the module's back frame, which ensures stability and prevents torsional stress on the cells.
2. Modules with back frames weigh 10.2 kg. Two-person handling requires extra attention to coordination and stability.
3. When temporarily stacking, ensure the back frame's contact points are on non-cell areas. Direct point contact of the back frame on the cell area of the module below is prohibited. Single stack height shall not exceed 5 pieces.

5.3 Remaining Module Repacking Procedure

If the entire box of modules cannot be fully used on the same day due to construction plan changes, they must be repacked into the original packaging box following the standard procedure below. Discarding or leaving them scattered is prohibited.

The specific steps for repacking SolarVela series modules are as follows:

	
Place modules back in box, junction boxes one up one down, backsheets facing each other	Place upper EVA strips on modules, one gap holds two modules per EVA strip
	
Install outer packaging	Install cover plate
	
Install box top cover	Re-bandage with strapping bands
	
Cover outermost layer with rain cover	Clearly mark "Opened - Not Fully Packed" status

The SolarNoah series, with its composite material back frame, has greater overall thickness (25 mm) and structural rigidity, and the weight per unit (10.2 kg) is slightly higher than the SolarVela series, making repacking more convenient. The operation procedure is essentially the same as above.

Note: 1. Strapping band tension should not be excessive: When re-bandaging with a strapping tool, maintain moderate tension sufficient to securely fix the box and cover without movement. Do not over-tighten strapping bands to avoid pressure transfer through the cover to the top layer module cells, causing micro-cracks. 2. If storage exceeds 3 days, the packaging box must be moved to a dry, rain-protected indoor environment.

6. Application Scenario Selection and Module Installation Solutions

6.1 General Installation Requirements

1. Installation Preparation and Site Environment: The installation area must be dry, safe, and free of obstacles. For unopened module boxes, packaging must remain sealed and not removed. Once modules are removed from the box, standardized installation should proceed immediately — "open and install."
2. Clean Dry Operation: Installation must be scheduled during consecutive clear, sunny daytime hours. Throughout the operation, do not handle modules or make electrical connections in rain, fog, or high-humidity condensing environments. Keep all tools, especially torque wrenches and wire strippers, with dry insulated handles.
3. Installation Surface Pre-treatment: 85% of the success rate and long-term life of structural adhesive bonding installation depends on surface pre-treatment. Installers must thoroughly verify roof substrate integrity (no aging, rust, powdering, peeling, blistering), and use the cleaner specified in Annex 1 for thorough degreasing and decontamination to prevent module detachment due to substrate failure.
4. Module Spacing and O&M Access: To effectively resist wind uplift and provide conditions for daily inspection, two spaces must be reserved in the installation design:
    - Module Spacing: The distance between the short sides of adjacent modules should be 20 mm to accommodate slight thermal expansion/contraction and installation tolerances.
    - Array Access (Maintenance Corridor):

      (1) One maintenance corridor must be reserved for every two rows of modules. When designing the module array, a continuous, uninterrupted dedicated maintenance corridor running across the entire roof must be planned and reserved for every two rows of modules. This ensures O&M personnel can access deeper modules without having to step over or assume dangerous postures. The minimum clear width of this maintenance corridor should be 400 mm - 600 mm.

      (2) Junction boxes must be on the maintenance corridor side. All modules must be installed in a uniform orientation, ensuring each module's junction box (i.e., cable exit end) faces and is adjacent to the nearest maintenance corridor. In other words, two adjacent rows of modules should have their junction boxes arranged in a "back-to-back" or "facing the corridor" mirrored layout, allowing installation and O&M personnel to safely and directly inspect, connect, and service junction boxes, connectors, and cables from within the

corridor. Do not orient junction box ends toward the array interior away from the corridor.

5. Load Calculation Disclaimer: The loads mentioned in this manual correspond to test loads. For installation methods compliant with local laws and regulations, a safety factor of 1.5 must be considered when calculating the permissible maximum design load (Mechanical Load = Design Load × 1.5 Safety Factor). The project design load depends on structure, application standards, installation location, and local climate. The design load shall be determined by a professional supplier or professional engineer. For details, follow local building codes or contact a professional structural engineer.

6.2 Full-Scenario Product Selection Guide

Correct product selection is the foundation of project success. Please follow the preferred product type selection based on scenario characteristics:

1. Scenarios Preferring SolarVela Series (Bonding Solution)

   When the following conditions are simultaneously met, the SolarVela series structural adhesive direct bonding solution is the most economical and efficient choice:

   - The roof substrate is T-type or corrugated steel tile with corrugation pitch ≤ 350 mm, smooth surface, no rivet protrusions on crests, and protrusions in valleys (if any) are more than 20 mm below the crest level, with no irreparable corrosion pits.
   - The minimum roof installation slope meets the mandatory ≥5° requirement (or directly select the tilt-unrestricted SolarVela Max).

2. Scenarios Preferring SolarNoah Series (Clamp/Quick-Install Solution)

   When any of the following situations occur, the SolarNoah series with back frame + clamp installation is the preferred solution:

   - The roof is of standing seam, angle-ridge type, or other profiles that can accommodate clamps but cannot provide a continuous flat surface for structural adhesive bonding.
   - The minimum roof installation slope meets the mandatory ≥5° requirement (or directly select the tilt-unrestricted SolarNoah Max).

3. Scenarios for Selecting Max Enhanced Models

   SolarVela Max or SolarNoah Max models, in addition to their respective series' basic features, offer core advantages of "zero tilt restriction" and "six-bypass anti-hot-spot" design. They are the preferred choice when:

   - Flat roof (concrete, waterproof membrane) engineering design specifies 0° horizontal installation.
   - The project is located in a high-dust, high-pollution area, or the layout design cannot fully avoid temporary, non-fixed shading due to objective factors, requiring greater shading tolerance and anti-hot-spot capability.

6.3 Installation Precautions

This section supplements key operation points not fully covered in the general installation requirements above, and provides a pre-installation checklist for steel tile roof scenarios. The

installation supervisor must check each item before work begins; only proceed when all items pass.

1. Module Installation Orientation: ZKFN Solar SolarVela and SolarNoah modules allow horizontal or vertical installation. Obstacles around the installation surface (such as parapet walls, vents, monitor roofs, pipes, equipment rooms, etc.) must not cast shadow shading on the module surface.
2. Metal Jewelry Prohibited: All personnel are prohibited from wearing metal rings, watches, necklaces, or other conductive jewelry when installing or maintaining PV systems, to prevent accidental short circuits or scratches on module surfaces.
3. Two-Person Teamwork: Single-person independent operation is prohibited throughout the module installation process. Operations must always be performed by a team of 2 or more persons working together.
4. Cable Fixing and Anti-Aging: After module installation, all output cables and jumpers must be securely fastened with dedicated cable clips or UV-resistant cable ties. Wires must not shade the effective light-receiving area of cells. Cables must not sag, accumulate water, or be exposed to direct sunlight for extended periods to prevent accelerated aging, leakage, or fire.
5. Rain and Strong Wind Prohibition: When the installation area is wet or wind speed reaches a level affecting safe operation, module installation or electrical operations are prohibited. For modules installed with structural adhesive, ensure the adhesive application and module placement processes are completed entirely in clear weather.
6. Drainage Hole Protection: During installation, cleaning, or O&M, roof drainage holes must not be blocked by structural adhesive, foreign objects, or installation materials under any circumstances, ensuring smooth rainwater drainage.
7. Wind Uplift Zone Avoidance: Installation positions must be planned according to professional design, actively avoiding areas with significant wind uplift effects such as roof corners, eaves edges, and skylight peripheries, to prevent modules from bearing negative wind pressure exceeding design values under extreme weather.
8. Anti-Loosening Measures and Conductor Protection

- Surface friction alone (such as simple spring washer pressure) must not be relied upon as the sole measure to prevent loosening of electrical or mechanical connections.
- Terminal areas must be kept clean and free of foreign matter to prevent mechanical wear or stress on conductor insulation.

9. Cable Protection and Jumper Fastening

- Module terminal cables and added jumpers must be mechanically protected with flexible conduit or UV-resistant PVC tubing.
- When connecting jumpers, use dedicated crimping tools for fastening. Connections must be fully and securely mated. Loose or poor connections that may cause leakage, personal injury, or module damage are prohibited.

10. Connector Specification Matching: Field extension cables or patch cables connected to module cables must use connectors of the same manufacturer, same model, and equivalent specification as the module connector. Mixing different brands or series is prohibited.

6.4 SolarVela Series Module Installation Solutions

The core installation method for the SolarVela series is direct structural adhesive bonding without the need for a mounting frame. It is compatible with T-type steel tiles, corrugated steel tiles, curved roofs, and the SolarVela Max model is also suitable for flat roof scenarios. Direct bonding installation on standing seam or angle-ridge steel tiles without a specific engineered solution is prohibited. The following is the detailed installation guide for the SolarVela series structural adhesive bonding solution.

6.4.1 Pre-Installation Preparation

1. Consumables and tool preparation: Structural adhesive, glue gun, lint-free cloth, specified substrate cleaner, ink line, construction alignment line, plastic roller, square tube (for overhang scenarios), insulated tools, safety protective equipment.

 Electric glue gun	 Structural adhesive
 Ink line	 Lint-free cloth
 Roller	 Padded square tube

2. Roof Substrate Treatment: Thoroughly clean the roof bonding area using the specified cleaner, removing dust, oil, rust, and debris. Ensure the bonding surface is dry, clean, and flat. Steel tiles with rust must be derusted and refinished first. Roofs with peeling, softened, or sunken paint surfaces are prohibited from installation.

6.4.2 T-Type Steel Tile Roof Installation Solution

(1) Pre-Installation Conditions

Before proceeding with structural adhesive direct bonding installation on T-type steel tile roofs, the installation supervisor must verify all of the following conditions. Work must not commence if any condition is not met:

1. Tile Type and Roof Condition Requirements

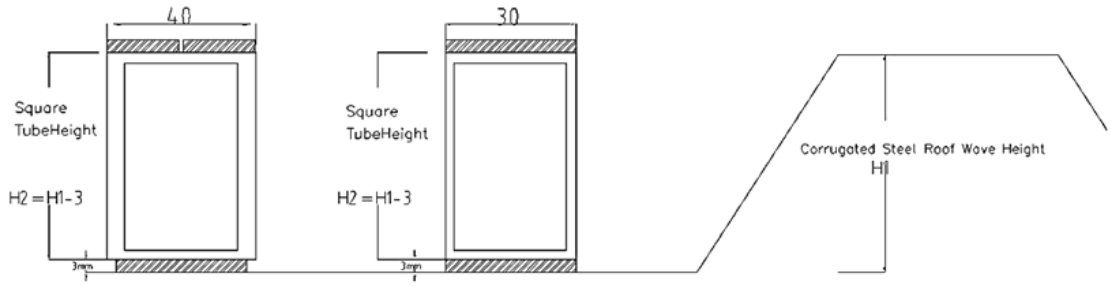
- The steel tile type is confirmed as T-type, with corrugation pitch ≤ 350 mm.
- Corrugations are straight, with no rivet protrusions on crests. Rivet protrusions in valleys (if any) are more than 20 mm below the crest level. Existing rivets on corrugations must be avoided during installation; otherwise, they must be ground down or removed first. Direct adhesive application on corrugation crests with rivets is prohibited.

- Steel tiles have no severe overall rust, localized damage, deformation, or paint peeling. Any rust must be thoroughly removed with anti-corrosion refinishing to ensure structural adhesive bond strength.
- Steel tile substrate is firm without softening. No significant depression or elastic deformation should occur when stepped on. Roofs with softened or depressed areas are prohibited from direct installation.
- When the roof structure is single-layer steel tile, there must be no high-temperature heat-emitting equipment or objects below the module installation area.
- Module installation on roof skylights is prohibited.

2. Applicable Models and Mandatory Tilt Requirements

- SolarVela / SolarVela Pro: Installation tilt angle must be ≥ 5°. Horizontal or less than 5° installation is prohibited.
- SolarVela Max: No minimum tilt restriction, allowing 0° to 90° installation at any angle.

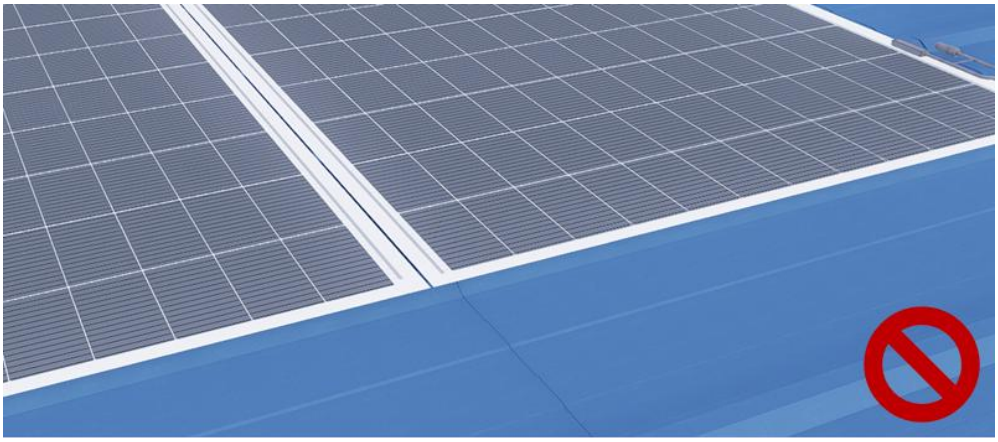
3. Square Tube Dimension Determination

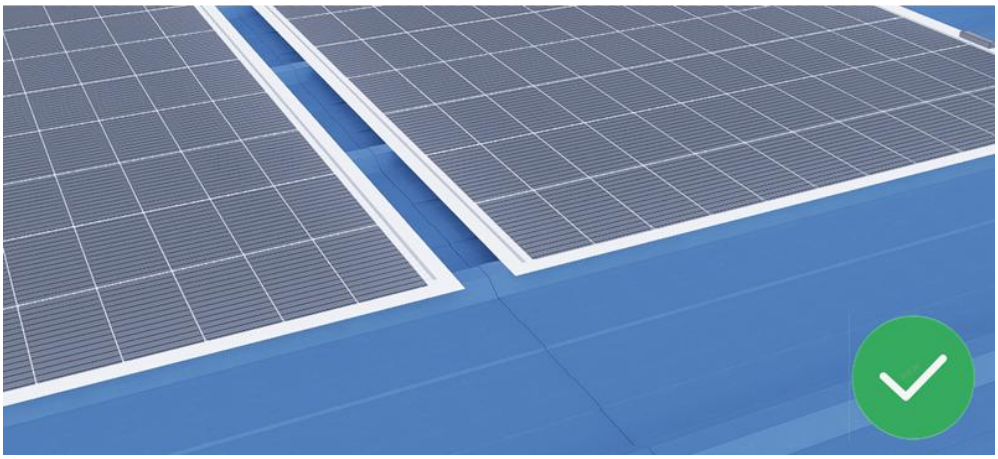


Dimensions Above: B = 30mm, H2 = (H1 - 3mm) ± 2mm

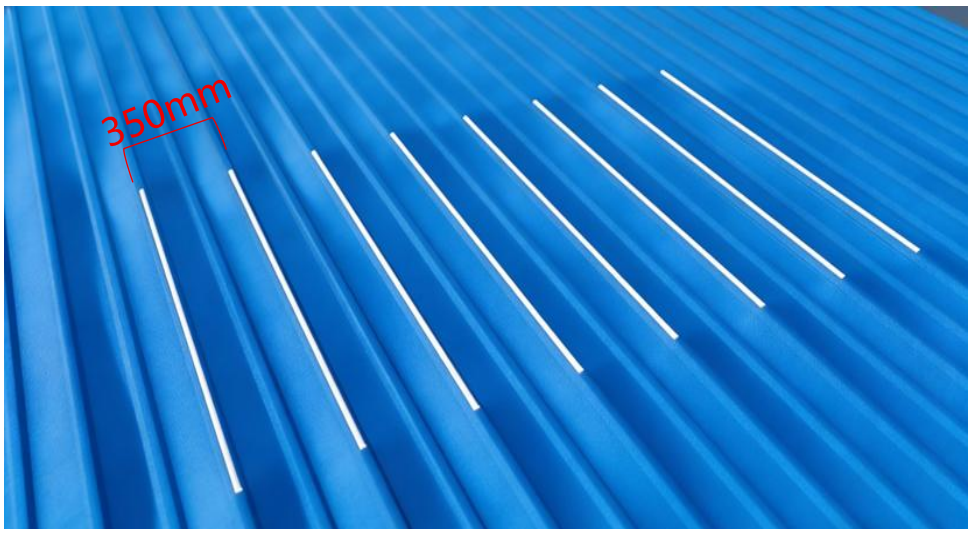
(2) Horizontal Installation Procedure (Module Long Side Perpendicular to Corrugation Direction)

1. Positioning and Layout: (a) According to layout drawings, use an ink line to mark horizontal reference lines parallel to the roof ridge on the roof. Then, combining module width and corrugation pitch, mark the installation frame for each module one by one. During positioning, avoid shadow areas based on site conditions. (b) If there are seams from ridge to eave, the seam must be between modules. A single module must not span across a seam.



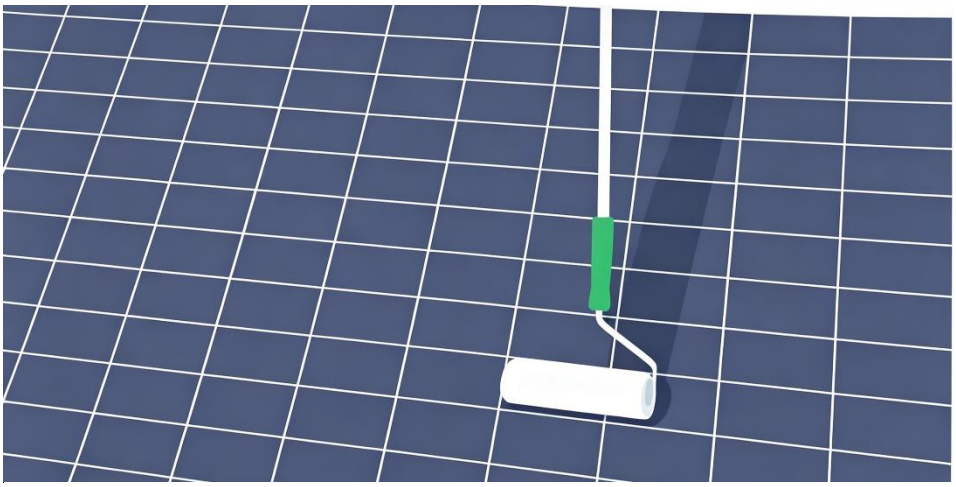


2. Apply Structural Adhesive: Apply 7 strips of structural adhesive on the marked T-type tile corrugations. Adhesive length L2 = module width (1200 mm), width 8~10 mm, height 5~8 mm.



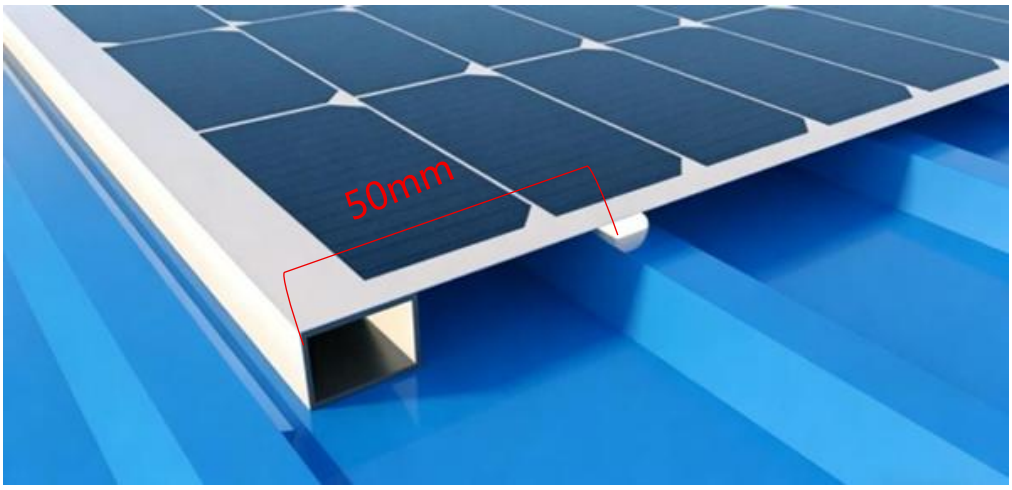
3. Golden 5 Minutes and Positioning: Module placement must be completed within 5 minutes after adhesive application. Two installers face each other, grasp the white edges of the module with both hands, lower center of gravity, and precisely place the module into the adhesive area using a "position the reference edge first, then slowly lower flat" method. Ensure it is perfectly horizontal and level. Do not lift and reposition after placement.

4. Flexible Rolling: Immediately after module placement, use a clean soft roller starting from the module centerline, rolling unidirectionally toward both sides. Apply uniform rolling pressure to the module surface at the adhesive positions to expel air from the adhesive strips and ensure full wetting of the module backsheet by the adhesive.



5. O&M Orientation and Cable Management: Every two rows of modules must have a maintenance corridor of at least 400 mm, with junction box ends oriented toward the designated maintenance corridor direction.

6. Overhang Treatment Standard (≥5 cm): When corrugation pitch cannot be evenly divided, resulting in module long-side overhang ≥ 50 mm, a Square tube must be bonded underneath the overhang as support. Tube height H = actual measured corrugation crest height - 3 mm (average compressed structural adhesive thickness).



7. Curing Protection: As the curing depth and time of structural adhesive vary under different environments, monitor weather conditions after installation and check for module detachment or corner lifting. Address any issues appropriately.

(3) Vertical Installation Procedure (Module Long Side Parallel to Corrugation Direction)

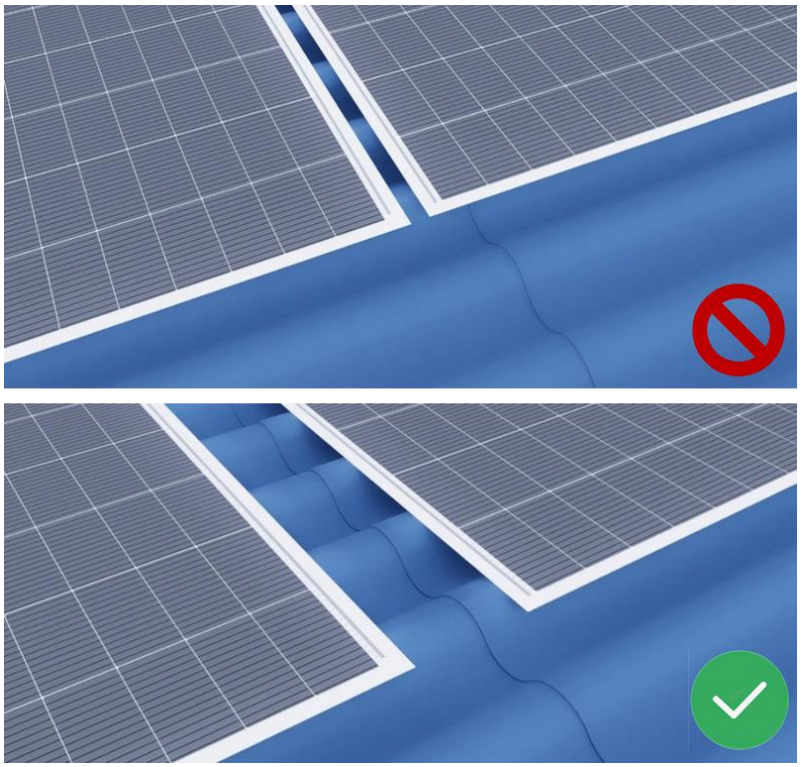
1. Highly similar to the horizontal installation solution. The difference is the adhesive application changes to: apply 4 strips of structural adhesive on steel tile corrugations. Adhesive length L3 = module length (2250 mm), width 8~10 mm, height 5~8 mm. The subsequent steps (handling, bonding, rolling, curing protection) are identical to horizontal installation.
2. The same risks need attention. During positioning, avoid shadow areas and roof seam joints. Seams must be between modules. A single module must not span across a seam.

6.4.3 Corrugated Steel Tile Roof Installation Solution

(1) This solution is highly similar to T-type tile installation. However, note that due to the curved surface of corrugated tiles, the structural adhesive should be applied at the highest point line of each corrugation crest.

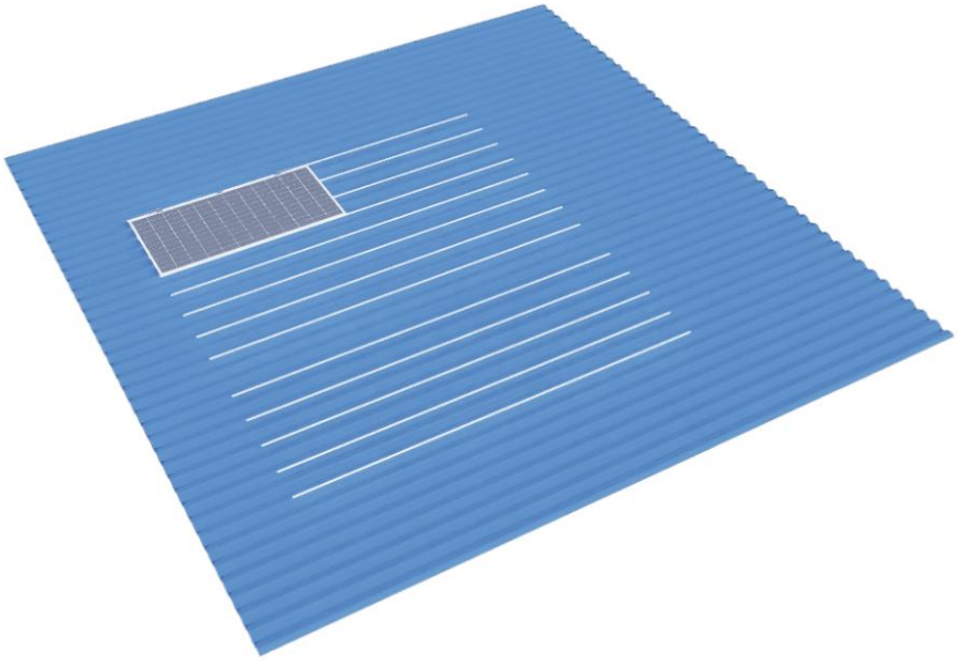
(2) The same risks need attention and avoidance.

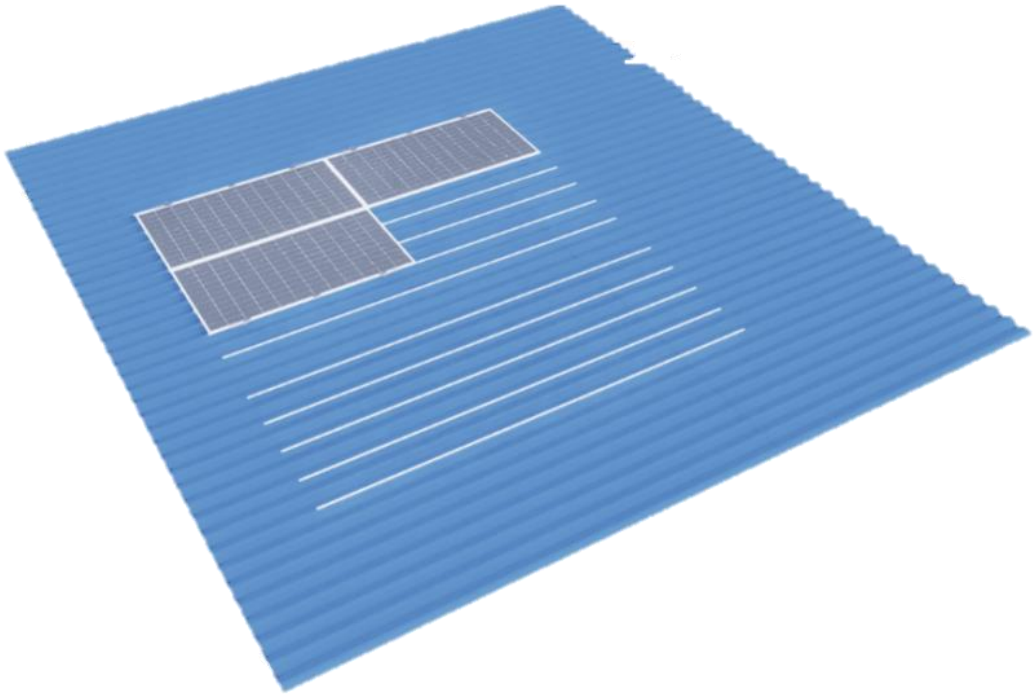
1. During positioning, avoid shadow areas and roof seam joints. Seams must be between modules. A single module must not span across a seam.
2. Corrugations are straight with no rivet protrusions on crests. Existing rivets must be avoided; otherwise, grinding or removal is required. Direct adhesive application on crests with rivets is prohibited.

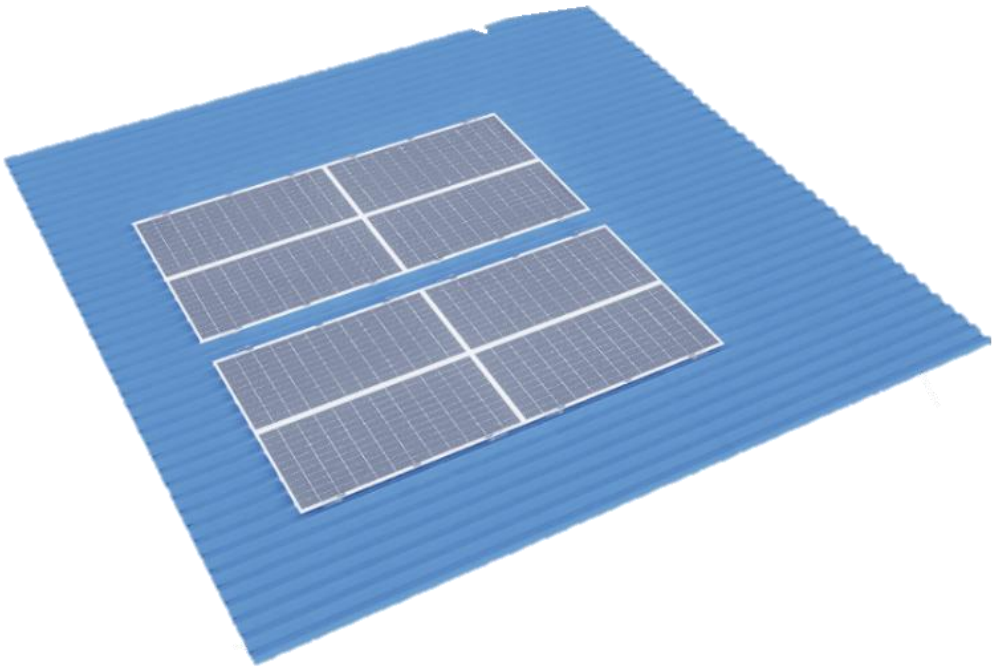


(3) The specific installation solution is as follows.

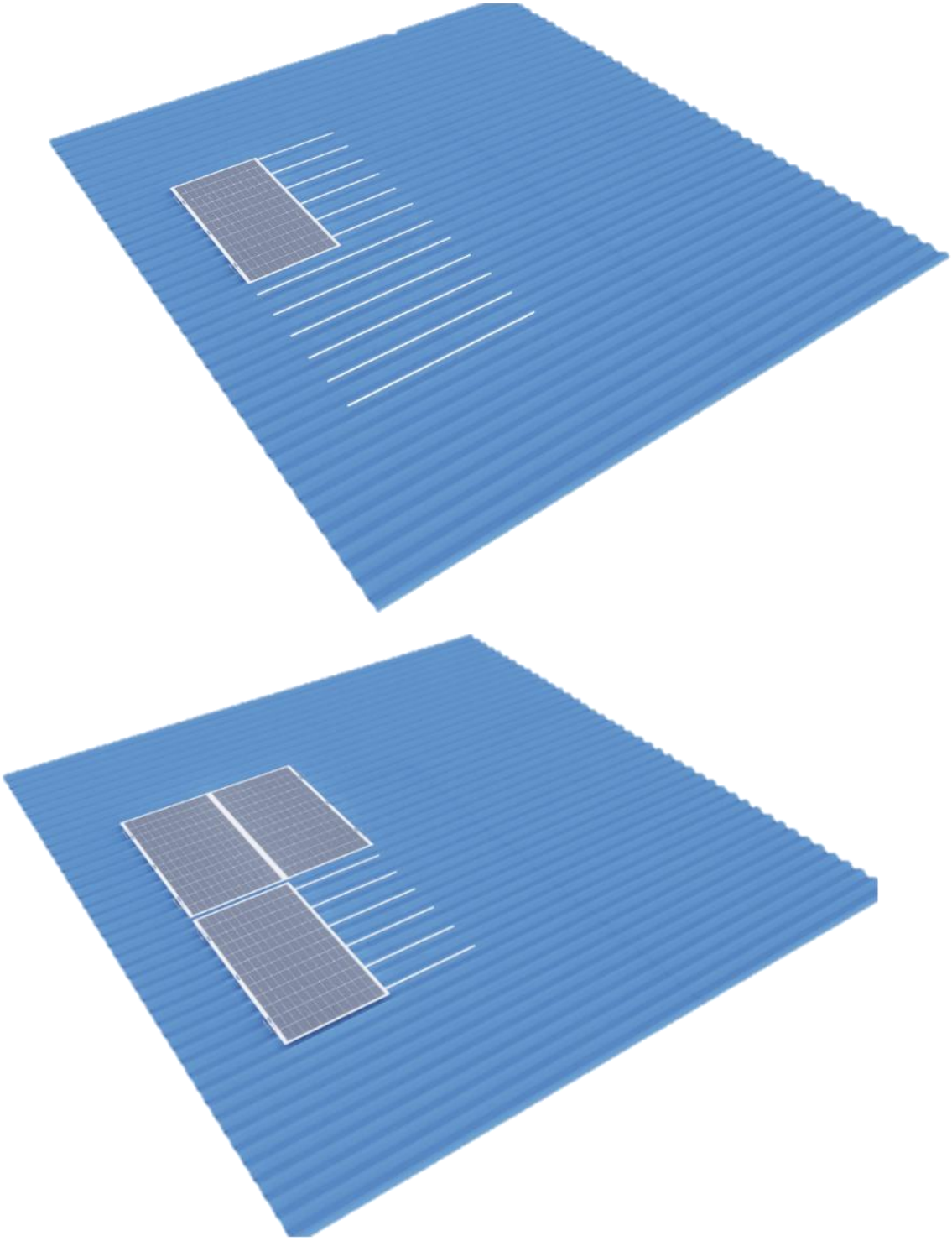
1. The adhesive application method is the same as T-type tile installation. Ensure the total bonding area is greater than 800 cm².
2. The subsequent steps (cleaning, handling, bonding, rolling, curing protection) are identical to T-type steel tile installation.
3. Horizontal installation is possible (module long side perpendicular to corrugation direction).

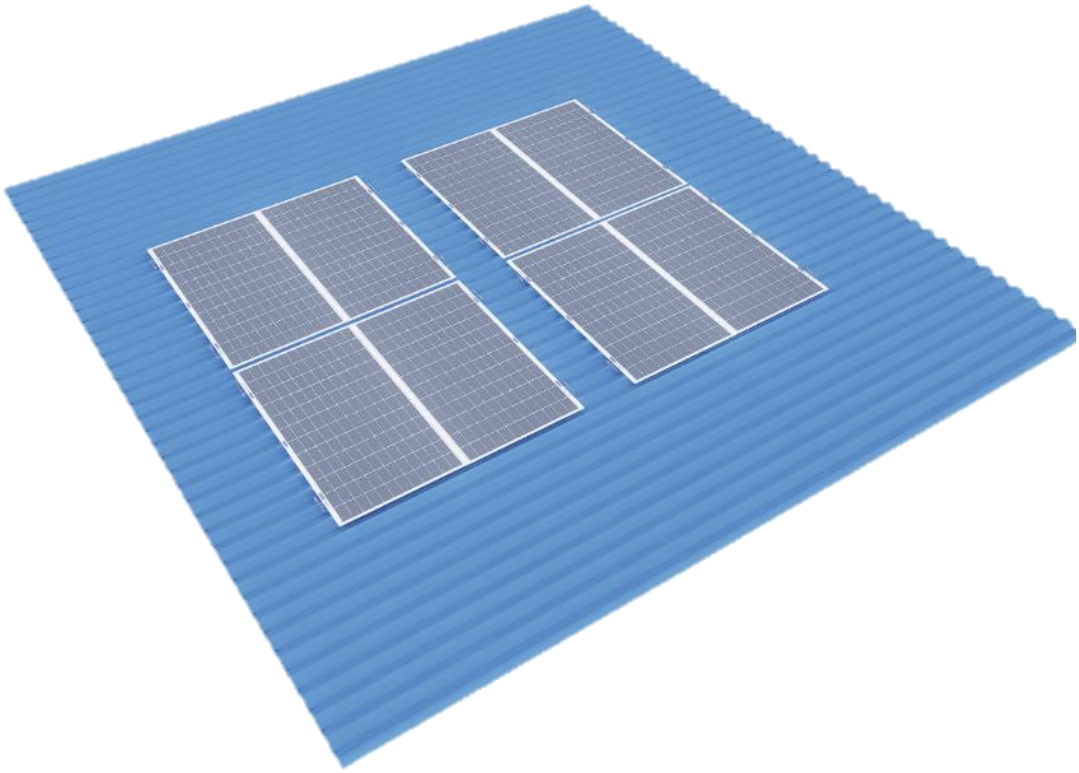






4. Vertical installation is also possible (module long side parallel to corrugation direction).





Note: Every two rows of modules must have a maintenance corridor of at least 400 mm. Junction boxes must be on the maintenance corridor side.

6.4.4 Angle-Ridge and Standing Seam Steel Tile Roof Installation Solution

Warning - Important Notice: Angle-ridge steel tiles have inherent defects of crest height deviation and insufficient effective bonding width. Standing seam steel tiles have an interlocking seam structure with no continuous flat large-area bonding surface on the tile surface. Neither tile type can meet the minimum contact area and long-term wind load/temperature stress requirements for direct flexible module bonding. Direct bonding poses extremely high risks of module detachment and wind uplift safety hazards. Therefore, direct bonding installation on these two tile types is prohibited.

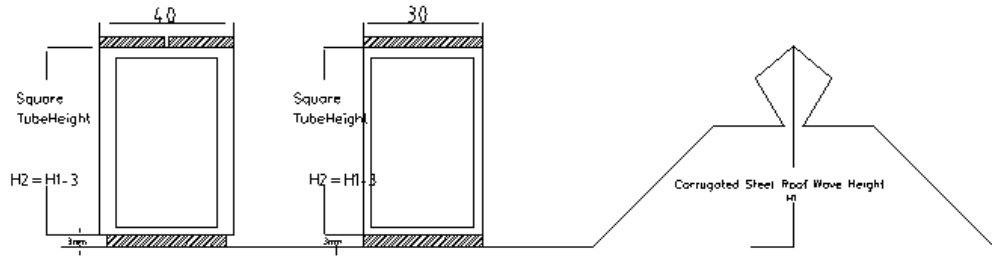
Note: SolarVela series is not recommended for these two tile types. The SolarNoah series with clamp installation is recommended. If no future renovation or repair of these steel tiles is planned, installation using SolarVela/SolarVela Pro modules (steel tile tilt ≥5°) or SolarVela Max (any steel tile tilt angle) + Square tube leveling support bonding solution is also possible. The specific installation solution is as follows:

1. Consumables and tool preparation: Structural adhesive, glue gun, lint-free cloth, specified substrate cleaner, ink line, construction alignment line, plastic roller, Square tube (for overhang scenarios), insulated tools, safety protective equipment.

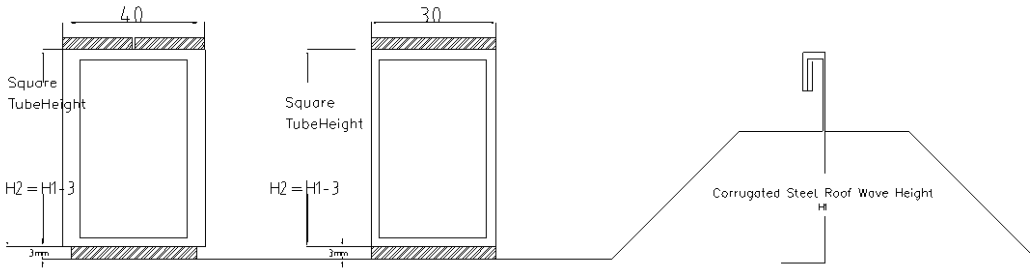
 Electric glue gun	 Structural adhesive
 Ink line	 Lint-free cloth
 Roller	 Leveling Square tube

2. Roof Substrate Treatment: Thoroughly clean the roof bonding area using the specified cleaner, removing dust, oil, rust, and debris. Ensure the bonding surface is dry, clean, and flat. Steel tiles with rust must be derusted and refinished first. Roofs with peeling, softened, or sunken paint are prohibited from installation.
3. Site Survey and Shadow Assessment: Thoroughly assess all shading sources including parapet walls, protrusions, equipment, surrounding trees, etc. Use sunlight simulation to confirm the module installation area has no year-round permanent shading. Module placement in shaded areas is prohibited.
4. Applicable Models and Mandatory Tilt Requirements
    - SolarVela / SolarVela Pro: Installation tilt angle must be ≥ 5°. Horizontal or less than 5° installation is prohibited.
    - SolarVela Max: No minimum tilt restriction, allowing 0° to 90° installation at any angle.

5. Leveling Square Tube Dimension Determination



Dimensions Above: B = 30mm, H2 = (H1 - 3mm) ± 2mm



Dimensions Above: B = 30mm, H2 = (H1 - 3mm) ± 2mm

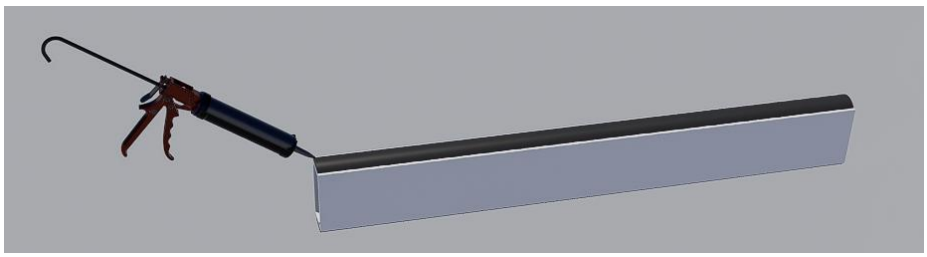
Material: Square tube. Dimensions: Tube height H1 = (H-6 mm) ± 2 mm. For tubes shared by two modules, tube width B ≥ 40 mm and B ≥ H1. For other tubes, tube width B ≥ 30 mm and B ≥ H1.$\frac{1}{2}\frac{1}{2}$

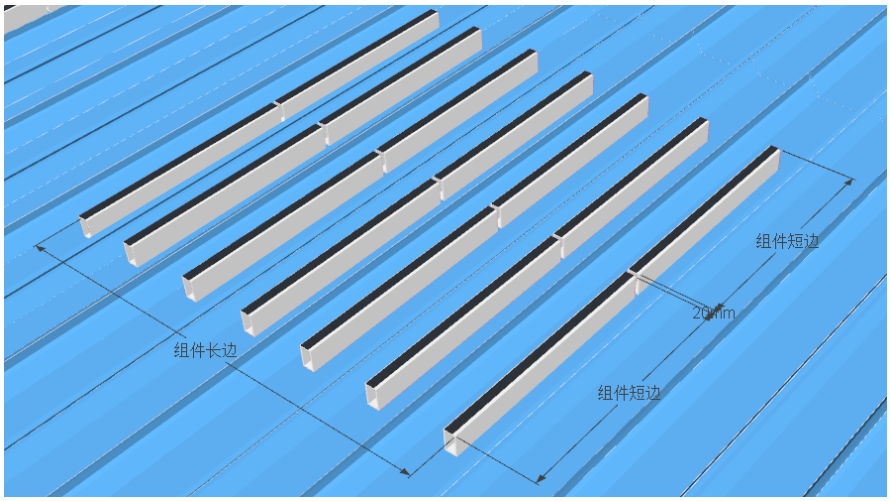
6. Specific Installation Steps:

(a) Layout Positioning: Based on design drawings and on-site shadow verification results, position the Square tube bonding reference lines on the steel tiles, ensuring parallel placement and uniform spacing on the same roof. The top surfaces of all installed tubes must be on the same horizontal plane. (i) For vertical installation, each module uses no fewer than 4 Square tube supports, evenly distributed across the module width. For horizontal installation, each module uses no fewer than 7 Square tube supports, evenly distributed across the module length. (ii) When tube positions interfere with corrugation crests, tube positions may be adjusted appropriately. (iii) If there are seams from ridge to eave, the seam must be between modules. A single module must not span across a seam.

(b) Bond Square tubes: (i) Apply adhesive continuously and evenly on the steel tile valleys. Spot bonding or segmented bonding is prohibited. (ii) For tubes shared by two modules, use tubes with width ≥ 40 mm. For other positions, use tubes with width ≥ 30 mm. (iii) Structural adhesive length L2 equals

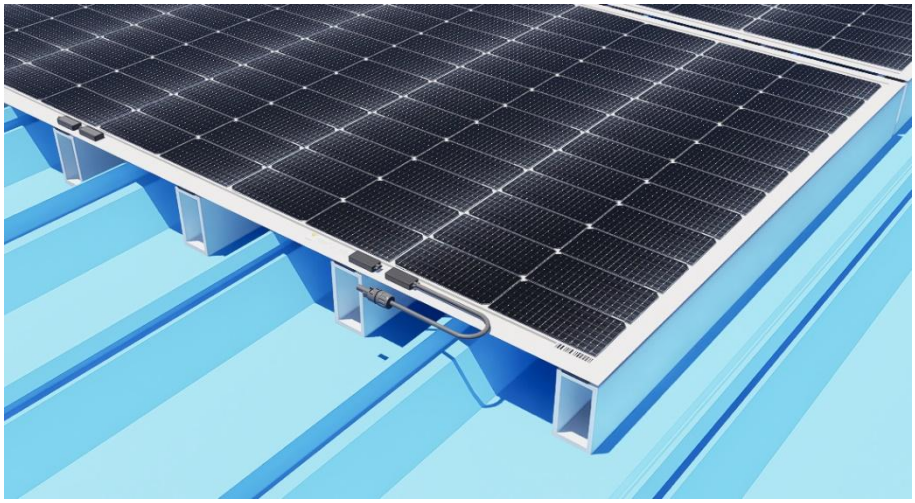
module width, L3 equals module length. (iv) Apply adhesive evenly on the top surface of the tubes.





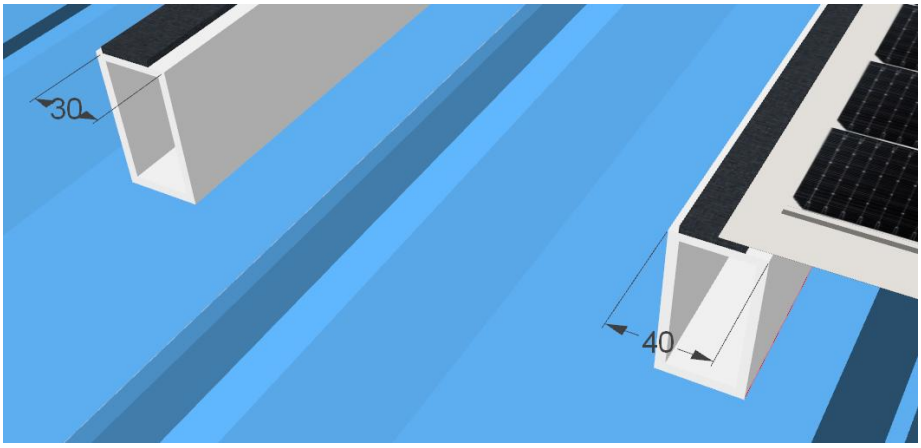
(c) Module Bonding:

(i) Do not excessively twist modules during installation. Two persons must grasp the white edges of the module and slowly place it into the adhesive-applied area. Modules must be placed horizontally and vertically level. Do not reapply after initial placement.



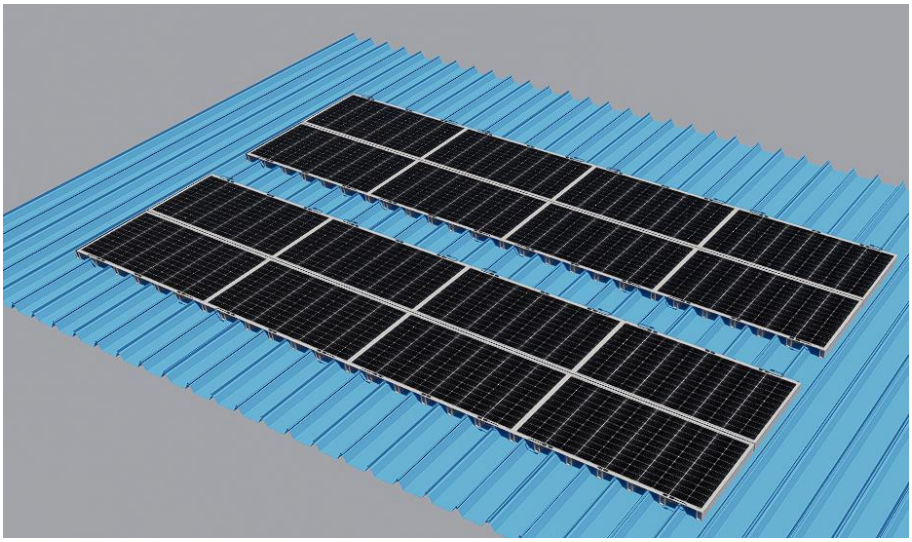
(ii) For vertical installation, the module long side must be parallel to the Square tubes. For horizontal installation, the module short side must be parallel to the Square tubes.

(iii) After the module is leveled, do not press on cells by hand. Use a soft roller for rolling. (iv) Minimum distance between modules is 20 mm. The maintenance corridor between arrays is no less than 400 mm (for reference only).

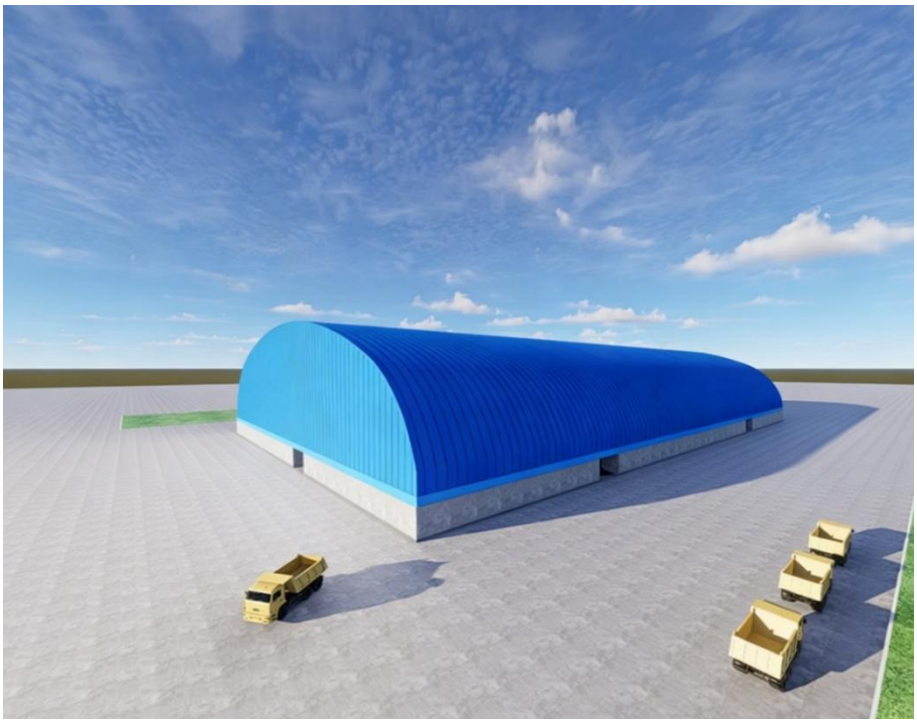


(v) Adjacent modules share leveling tubes.

(vi) Place junction boxes on the maintenance corridor side to facilitate string connection and inspection.



6.4.5 Curved Roof Installation Solution



This solution is specifically designed for irregular metal roofs with continuous curved surfaces.

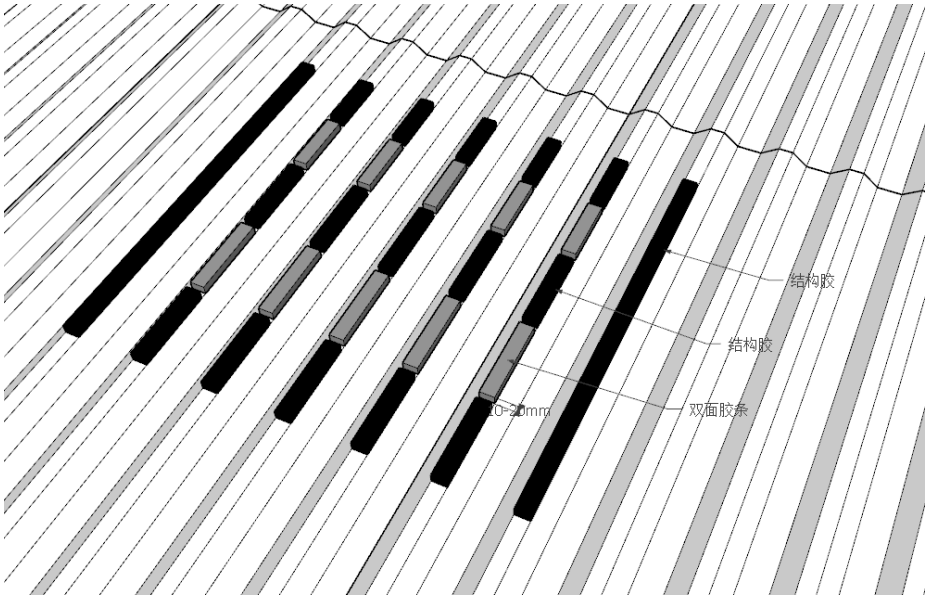
(1) Pre-Installation Conditions

- Roof tile type must be T-type or corrugated with corrugation pitch ≤ 350 mm.
- A complete height safety system must be in place: independent lifelines installed, fall protection barriers installed and inspected.
- Applicable Models and Tilt: SolarVela, SolarVela Pro (tilt ≥5° required); SolarVela Max (tilt unlimited).

(2) Installation Procedure

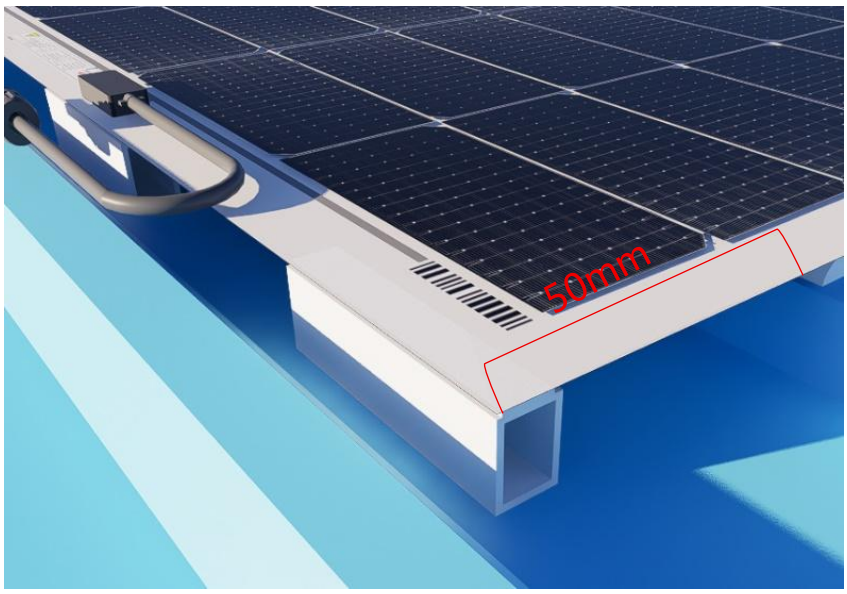
1. Zoning and Consistency Principle: Divide the installation area into control zones based on the degree of roof curvature variation. Use an electronic angle meter for precise measurement. Areas within ±5° angle deviation are classified as one string control zone, ensuring all modules in the MPPT circuit receive consistent light reception angles.

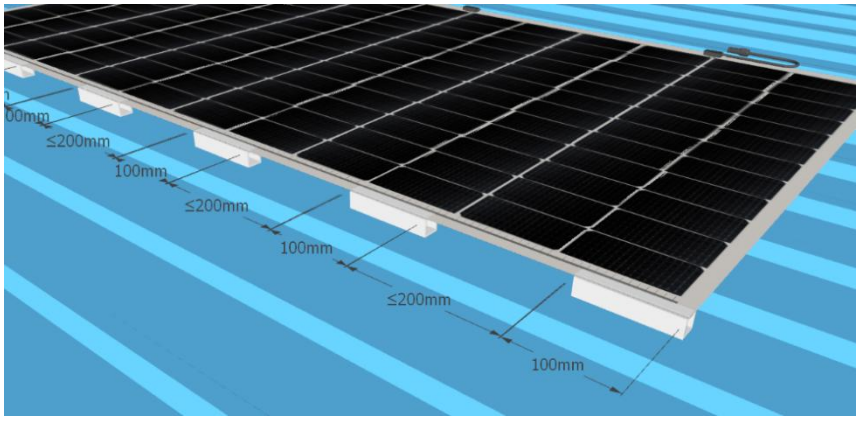
2. Composite Adhesive Method: Use a combination of "structural adhesive + double-sided foam tape." Along the long and short edges of each module, continuous structural adhesive must be applied at the edge positions. In internal load-bearing areas, structural adhesive and double-sided foam tape are applied alternately in equal-length sections. Recommended adhesive and tape lengths: 200-300 mm. Adhesive width must reach 15 mm or more (ensuring total bonding area per module > 800 cm²).



3. Overhang Treatment Standard (≥5 cm): When corrugation pitch cannot be evenly divided, resulting in module long-side overhang ≥ 50 mm, Square tube sections must be bonded underneath the overhang as support. Tube section length is approximately 100 mm (after conforming to the curved surface, the height difference between tube ends must not exceed 2 mm). Spacing between tube sections ≤ 200 mm. Tube height

H = actual measured corrugation crest height - 3 mm (average compressed structural adhesive thickness).



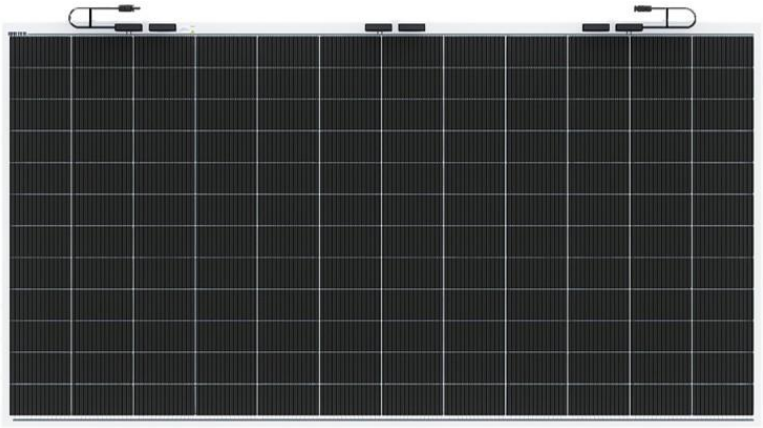


4. Installation Sequence: Strictly follow the logic of installing from the low side to the high side of the roof to prevent workers stepping on or tools falling onto already-installed lower modules during installation of upper modules.
5. Rolling and Curing: Use a soft roller, rolling back and forth along the module surface curvature to ensure each strip of structural adhesive is properly compressed.

6.4.6 Flat Roof Installation Solution (SolarVela Max Only)

(1) Pre-Installation Conditions

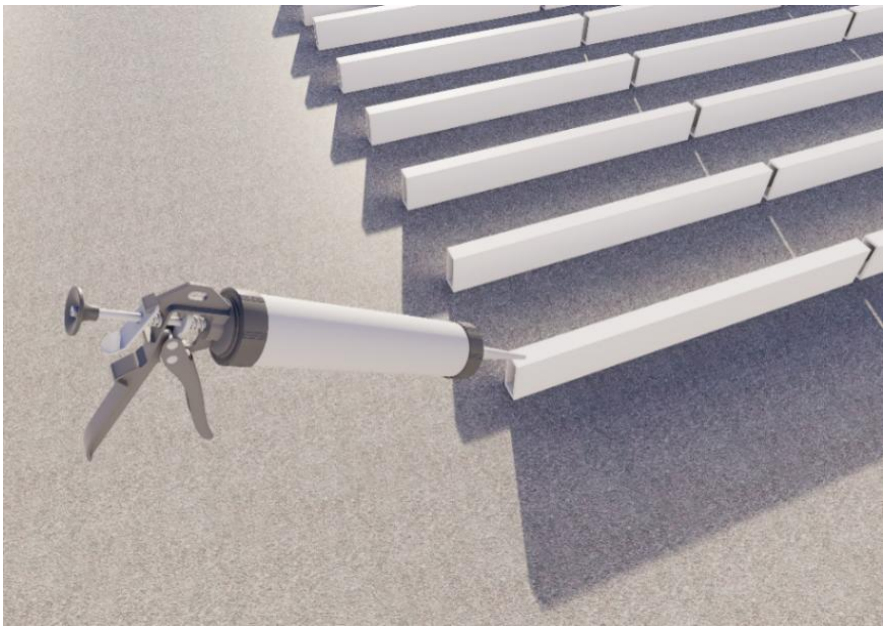
- This solution is clearly applicable only to SolarVela Max models. SolarVela Max features a 6-bypass architecture, providing superior current 分流 capability under shadow shading and current mismatch conditions, thus offering the advantages of 0° horizontal installation and immunity to dust accumulation hot spots.



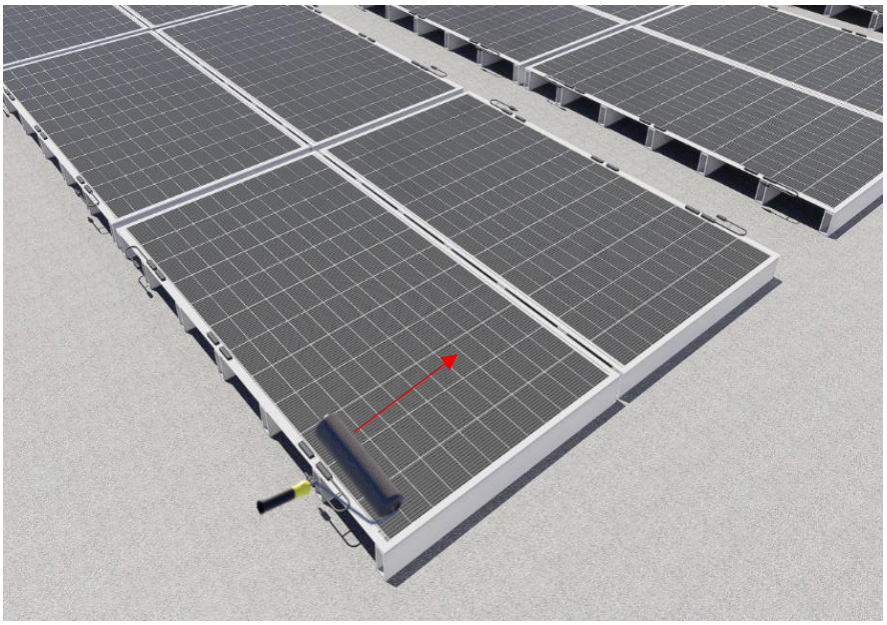
- Roof waterproof membrane has no aging, debonding, peeling, or blistering. Substrate is flat. Single-point adhesion to base ≥ 40 kg (single-point area 4×4 cm^2).
- Installation area has no permanent shading from parapet walls, equipment rooms, surrounding buildings, etc.
- Installation surface must be kept dry and free of foreign matter. Module installation must be completed within 5 minutes after adhesive application.
- Recommended module bonding area: ≥ 800 cm^2. Under satisfied bonding area conditions, the typical maximum design pull-out resistance per module is 1771 kg (17.4 kN).

(2) Installation Procedure

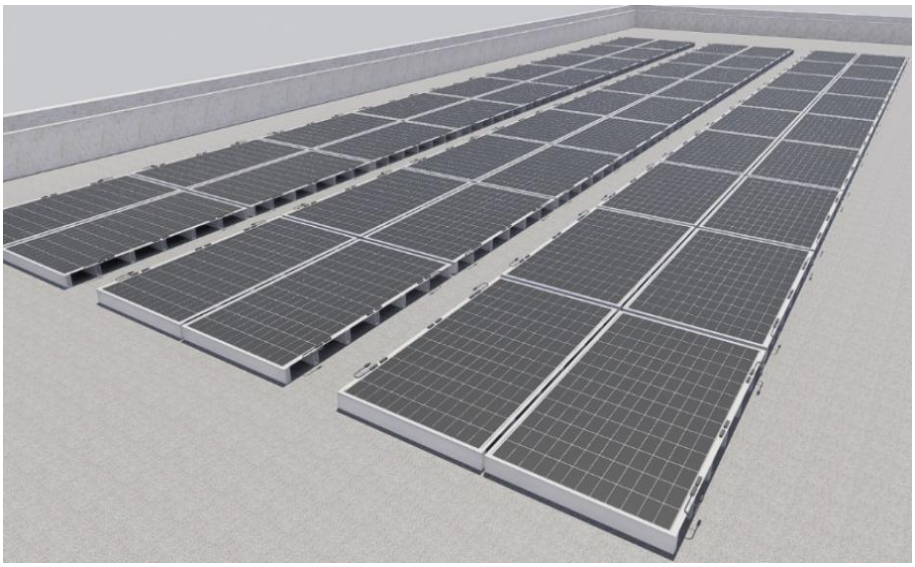
1. Positioning and Layout: After verification according to design drawings and on-site shadow assessment, position the module installation area and draw the Square tube bonding positions.
2. Bond Square tubes: (a) Wipe the Square tubes and roof with a lint-free cloth dampened with cleaner. (b) Cut the glue nozzle at an angle, apply adhesive along the tube bonding positions on the roof, extruding a triangular adhesive strip (approx. 10 mm wide, 8 mm high). (c) Press the Square tube firmly onto the adhesive strip.



3. Apply Adhesive and Bond Module: Apply continuous triangular adhesive strips (approx. 10 mm wide, 8 mm high) at a uniform speed of about 10 cm/s on top of the installed Square tubes. Place the SolarVela Max module flat on the adhesive-coated tubes and compact with a roller.



4. O&M Orientation and Cable Management: Every two rows of modules must have a maintenance corridor of at least 400 mm, with junction box ends oriented toward the designated maintenance corridor direction.

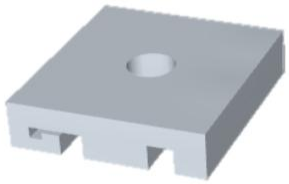


6.5 SolarNoah Series Module Installation Solutions

The core installation method for the SolarNoah series is the back frame + Quick-clamp fast installation, requiring no rails, enabling non-destructive quick removal of modules. It is compatible with all steel tile roof and flat roof tile type scenarios, and is the preferred solution for detachable requirements, complex steel tile roofs, and scenarios requiring flexible layout due to partial shading.

6.5.1 Pre-Installation Preparation

1. Roof Substrate Inspection: Check steel tile/flat roof substrate condition. Steel tiles must have no softening, depression, or severe corrosion. Roof must be level without height differences. Module installation on skylights is prohibited.
2. Site Survey and Shadow Assessment: Thoroughly assess all shading sources including parapet walls, vents, monitor roofs, camera poles, equipment, etc. Use sunlight simulation to confirm the module installation area has no year-round permanent shading. Module placement in shaded areas is prohibited.
3. Clamp and Roof Compatibility Verification: Ensure the model of aluminum clamps to be used matches the on-site steel tile profile. Refer to Annex 4.
4. Tool Calibration: A calibrated digital torque wrench within its validity period must be used. For M8 bolts used for clamp fastening, the final tightening torque must be strictly set to 15~20 N·m. Insufficient torque leads to fixing failure; excessive torque may crush or damage the module's composite back frame.
5. Positioning and Layout: According to design drawings, use an ink line to mark positions for clamps and bases, ensuring even division, horizontal and vertical alignment, avoiding all fixed shading sources.
6. Installation Tools and Consumables: Quick-clamp fixtures (double-horn middle clamp + edge clamp), roof-matching clamps, installation/maintenance bridge deck, ink line, electric wrench, etc.

 Edge clamp	 Middle clamp
 Steel tile clamp	 Electric wrench
 Ink line	

6.5.2 Steel Tile Roof Installation Solution (Suitable for All Tile Types)

(1) Pre-Installation Conditions

- Applicable Models and Tilt: SolarNoah, SolarNoah Pro (tilt ≥5° required); SolarNoah Max (tilt 0-90° acceptable).
- Installation environment is clean, free of debris affecting clamp stability.

(2) Installation Procedure

1. Clamp Positioning and Installation: Position and install dedicated clamps according to the layout on the design drawings. For T-type and corrugated tiles, use self-tapping screws or structural adhesive for auxiliary fixing. For angle-ridge and standing seam types, use locking bolts to clamp the tile ribs.
2. Install Middle Clamps: Install the interconnecting middle clamps between modules onto the clamps.

3. Module Placement: Two persons handle the SolarNoah module, align the C-slot of its back frame with the slot of the middle clamp, slowly lower, and after the inner slot of the middle clamp is engaged, slowly level the module.
4. Install Edge Clamps: Place edge clamps at the outermost edges of the module array, tighten bolts with standard torque of 15~20 N·m.
5. The clamps and clamps at both ends of each module must be kept 10~15 cm from the short side edge of the module.

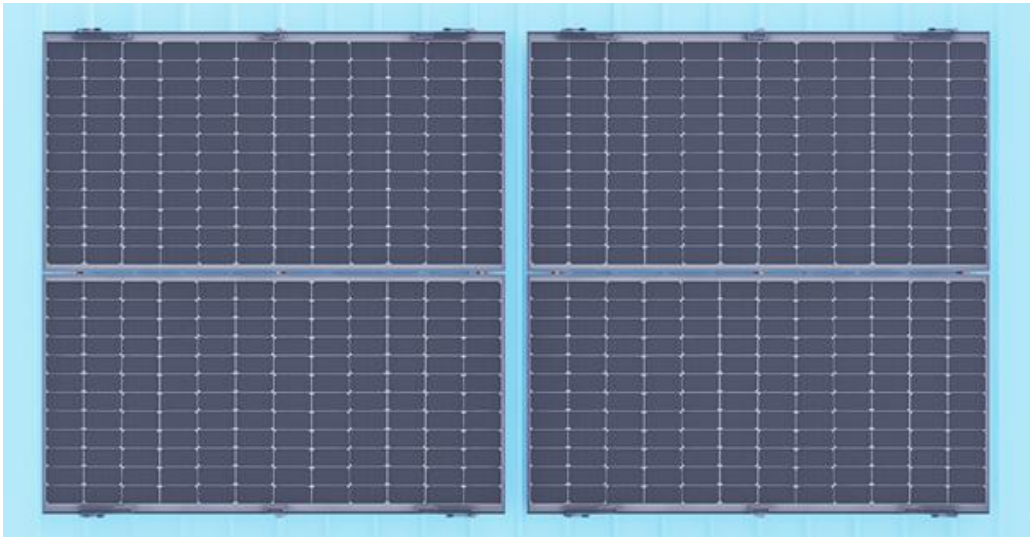
Fix clamps to steel tiles according to drawings

Fix middle clamps

Handle and clip modules into middle clamp slots

Install edge clamps

(3) Installation Complete



(4) Installation Key Points

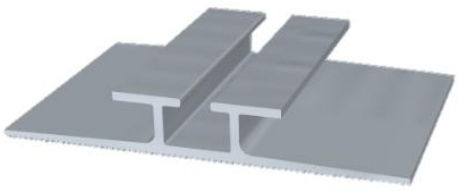
1. Fix middle clamps to corresponding clamp positions, ensuring accurate installation positioning.
2. Two persons coordinate module handling, place smoothly onto middle clamps. Do not grasp junction boxes or cables for handling. Do not impact or drop modules.
3. When installing clamps, use a torque wrench to tighten bolts. Bolt tightening torque standard is 15~20 N·m. Over-tightening or under-tightening is prohibited.
4. Module installation must be horizontal and vertical. Module spacing follows design drawings, standard spacing ≥20 mm. Ensure clamps can properly press the module back frame while avoiding roof fixed shading sources.
5. Every two rows of modules require a maintenance corridor of no less than 400 mm. Junction boxes remain on the maintenance corridor side for subsequent wiring and O&M.
6. After single module installation, check clamp and clamp tightening status to ensure no looseness or misalignment.

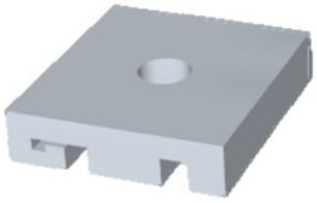
6.5.3 Flat Roof Tilt Installation Solution

(1) Pre-Installation Conditions

- Roof waterproof membrane has no aging, debonding, peeling, or blistering. Substrate is flat. Single-point adhesion to base ≥ 40 kg (single-point area 4×4 cm²).
- Complete roof substrate treatment in advance. Fine stone mortar concrete roofs must first be ground, coated with curing agent, waterproofed, and pass a pull-out test before installation.
- Installation area has no permanent shading from parapet walls, equipment, surrounding buildings, etc.

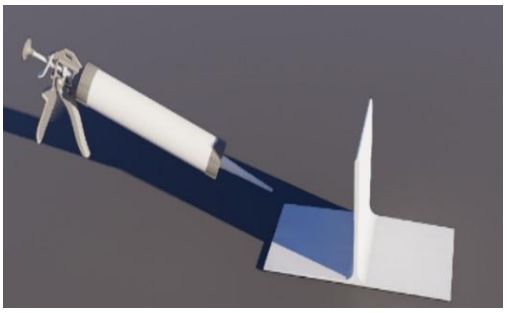
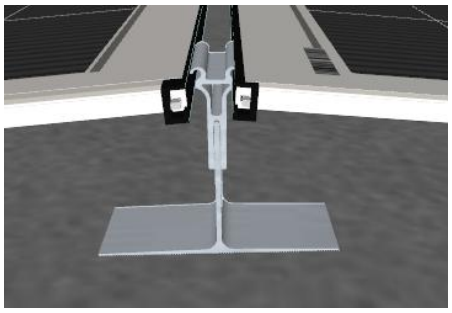
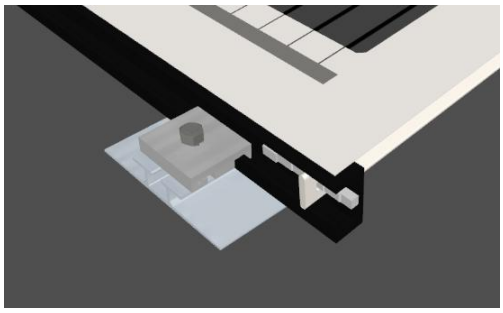
(2) Installation Preparation:

 Edge clamp base	 Middle clamp bracket

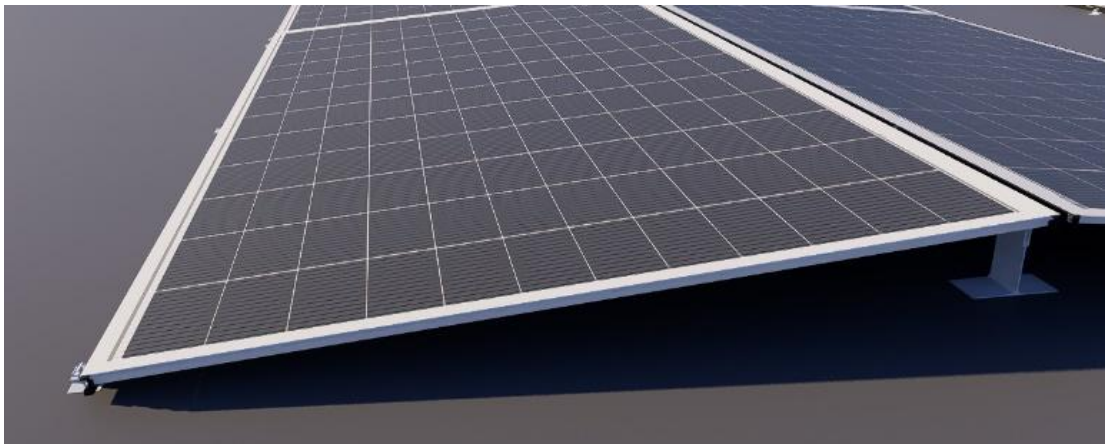
 Edge clamp	 Structural adhesive
 Electric wrench	 Ink line
 Electric glue gun	

(3) Installation Procedure

1. Base Positioning and Fixing: Mark base centers on the roof according to drawings. Perform pull-out tests on the marked point areas. After test approval, bond bases onto the roof ensuring firm adhesion and levelness. Do not disturb before full structural adhesive curing. For SolarNoah and SolarNoah Pro, bases with ≥5° tilt must be used.
2. Module Installation: After base adhesive curing, two persons coordinate handling the module above the bases. Align the C-slot of the module back frame on the junction box side with the middle clamp and slowly lower. Connect connectors with the adjacent module. Gently push the module so the back frame C-slot is close to the middle clamp's inner slot, then slowly level the module. Ensure precise positioning without offset.
3. Clamp Fixing: Install edge clamps. Use a torque wrench to tighten bolts (torque standard 15~20 N·m). Ensure modules are firmly fixed without looseness.
4. Tightness Check: After installation, check all bases and clamp tightening status to ensure installation requirements are met.
5. Reserve Access: Every two rows of modules reserve a maintenance corridor of no less than 400 mm.

 Base positioning installation	 Fix base on roof with structural adhesive
 Install module	 Fix clamps

(4) Installation Complete



7. Connection and Cabling Work Specifications

7.1 Cable Routing and Fixing Requirements

1. System Cable Specifications: Except for module output cables, all on-site DC main cables must be TÜV or equivalent authority certified 1500V PV-specific cables, with copper conductor cross-section no less than 4 mm², temperature rating no less than 90 °C, and excellent UV resistance and anti-aging properties.
2. Anti-Shading Routing Principle: All cable routing paths should be precisely planned and securely fixed using dedicated PV cable clips on module back frames, module edges, or cable fixing channels. Cables must not be suspended, swinging, or directly placed on the roof forming water accumulation bends under any working condition.
3. Connector Protection:

- Keep connectors dry and clean. Ensure connector nuts are tightened before connection.
- Prevent moisture, dust, organisms, and other foreign matter from entering connectors. Foreign matter ingress may cause connector malfunction or damage.
- Do not connect if the connector is wet. Do not connect if the connector is contaminated. (iv) Connectors do not have waterproof function without being mated.
- Modules should be connected promptly after installation. Connected connectors must meet IP68 (IEC 60529) requirements. If connectors cannot be promptly connected or the installation area has frequent rainy/foggy weather, it is recommended to add connector protective caps.
- Avoid direct sunlight exposure and water immersion of connectors. Avoid connectors resting on the roof surface.
- Incorrect connection may produce arcing and electric shock. Ensure all electrical connections are secure. Ensure all locking connectors are fully engaged.
- Do not connect different connector models together.

4. Minimum Bend Radius: When routing cables around corners, the minimum bend radius requirement must be strictly observed. Typically, this value is 10 to 12 times the cable outer diameter (OD). Excessive bending may damage the internal copper conductor, increasing resistance and creating potential hot spots.

7.2 Grounding Specifications

1. Module Grounding Exemption: Given that the design of all SolarVela and SolarNoah series modules does not employ any non-insulated external metal frame (border), the modules themselves constitute a complete Class II insulation structure. Therefore, no explicit grounding treatment is required for any part of the module body.
2. System Grounding Design: This exemption does not alter the lightning protection grounding requirements of the PV system.

All exposed conductive parts such as aluminum alloy rails, metal clamps, and PV cable metal conduits must form a complete and electrically continuous equipotential bonding network according to national standards and be connected to the building's existing lightning protection grounding grid at appropriate locations. The electrical grounding reference point for the entire array should be set within the inverter or combiner box.

8. Electrical Installation Work Instructions

8.1 General Electrical Installation Requirements

1. Certified Personnel and De-energized Operation: Electrical installation and wiring work is limited to authorized personnel with electrician certification. Before work, ensure all DC and AC switches are in the OFF position, implement an effective LOTO (Lockout/Tagout) procedure, and verify no voltage with a multimeter before proceeding.
2. Application of Design Correction Factor 1.25: A safety design factor must be used when configuring system circuit breakers, fuses, cable ampacity, and inverter maximum input voltage. All calculations should be based on the limit values of module specification sheet Voc × 1.25 and Isc × 1.25.

3. Arc Fault Protection (AFCI): To address potential DC arc and fire risks, the inverter or multi-function shutoff device selected for the power station should have and activate an available AFCI (Arc Fault Circuit Interrupter) function.

8.2 Module Series/Parallel Connection Specifications

1. String Homogeneity Principle: In one MPPT tracking channel, only modules of the same specification may be connected: same model (or manufacturer-approved substitute model), same installation tilt and orientation. Violation of this principle will result in internal mismatch losses due to operating point mismatch.
2. Extreme Voltage Calculation: When connecting modules in series, the open-circuit voltage must be corrected using the historically lowest temperature recorded by the local meteorological bureau. Ensure the total open-circuit voltage of the string at any possible minimum temperature is less than the inverter's maximum DC input voltage.
3. Reverse Polarity Hazard Warning: If two parallel strings are connected with reverse polarity (positive to negative), a massive forced circulation current is immediately generated, which can irreversibly burn out the module's bypass diodes and junction box within milliseconds.

8.3 Fuse Selection and Installation Requirements

1. Overcurrent Protection Limits: Module technical data indicates the maximum series fuse rating is 25A. As this is a limit value for flexible modules, in any scenario with more than 2 strings in parallel, each individual string must be series-connected with a DC-specific PV fuse rated at 25A.
2. Independent Polarity Protection: Fuse holders must be configured on both positive and negative wires. A solution using a single common fuse after multi-circuit busbar connection is not recommended.

8.4 Connector Use and Protection Specifications

1. Prohibition on Mixing Different Manufacturers and Models:

> Warning - Important Notice: Throughout the DC side of the PV system, from module output cables, field-made jumpers (string extension cables), to combiner box and inverter inputs, any location requiring connection must ensure male and female connectors come from the same manufacturer and belong to the same product model series. Connectors from different manufacturers (including so-called "MC4 compatible" brands), and even different product lines within the same manufacturer (e.g., standard vs. dual-certified), differ in insulation material formulation, metal contact pin precision outer diameter tolerance, plating process, spring clamping force, and sealing ring material. Mixing connectors of different manufacturers or models is a highly dangerous non-standard practice, resulting in the following consequences:

i. Incomplete Engagement: Male and female tolerance mismatch prevents complete mechanical locking and sealing, leaving microscopic gaps.

ii. Moisture Ingress and Electrochemical Corrosion: Microscopic gaps in outdoor high-humidity, rain, and condensation environments create a "capillary effect" drawing in moisture, causing galvanic reactions at the contact surfaces of different metals, accelerating contact corrosion.

iii. Abnormal Contact Resistance Increase: Corrosion and insufficient contact stress cause contact resistance to multiply by several times or even tens of times,

resulting in abnormal heating at the connection point. Heat further accelerates material aging, creating a vicious cycle.

iv. DC Arc and Fire: Ultimately, severely degraded or near-loosened connection points, under high-voltage DC current, will sustain continuous arcing. The high temperature is sufficient to melt the connector housing, ignite surrounding combustibles, directly causing catastrophic electrical fire.

2. No Substitutes: Using electrical tape, wire caps, or connectors of different series or brands for so-called "connection" or "repair" of any connector in this system is prohibited during construction.

3. Final Engagement Check: When engaging connectors, a distinct "click" sound must be heard to ensure proper engagement.

9. Operation and Maintenance Specifications

Modules require regular inspection and maintenance, especially during the warranty period. To ensure optimal module performance, ZKFN Solar recommends the following maintenance measures. Refer to the "ZKFN Solar Light-Flexible Module SolarVela & SolarNoah Series O&M Manual" for details.

9.1 Routine Inspection

1. Module Visual Inspection: (i) Check for module damage. (ii) Check for sharp objects contacting the module surface.

2. Shadow Check: Check if modules are shaded by obstacles or foreign objects. Avoid shading from newly grown trees, newly erected poles, etc.

3. Structural Integrity Check: Check if the special adhesive between modules and the roof has debonded, and if clamp/fastening screws are loose. Adjust or repair promptly.

9.2 Module Cleaning Specifications

1. Regular Cleaning: Dust or dirt accumulation on module surfaces reduces power output. Clean regularly to maintain surface cleanliness. Generally, clean at least once a month, increasing frequency under harsh environmental conditions.

2. Safe Timing and Water Volume: First rinse with clean water, then dry with a soft cloth. Do not use corrosive solvents or hard objects to clean PV modules. Clean PV modules under irradiance below 200 W/m². Do not clean PV modules under wind conditions above Level 4, heavy rain, or heavy snow.

   Warning - Important: Do not walk, stand, or sit on modules during cleaning.

3. Water Prohibition Areas: Do not use high-pressure water jets to directly flush junction box seams and connectors at close range at any time.

9.3 Electrical System Periodic Inspection Requirements

1. Module Connector and Cable Inspection: (i) Special inspection recommended every six months. (ii) Check PV wiring for signs of aging, including possible rodent damage, weather aging, and whether all connectors are tightly connected and corrosion-free. (iii) Pay special attention to connector thermal infrared temperature. If one connector in a pair is a few degrees hotter than the other or than the circuit conductor, this is a sign of increased contact resistance. Power off, open and check if spring contacts have

lost elasticity or become oxidized. Faulty connector pairs must be cut off and replaced entirely.

10. Annexes

Annex 1: Recommended Cleaners for Different Roof Substrates

Roof Type	Recommended Cleaner Name
UPVC, PVC, Asphalt, EPDM and other plastic flexible roofs	China: RA-1033 Professional Plastic Cleaner; Overseas: Use non-corrosive cleaner recommended by roofing material manufacturer
Steel tile, glass roof, metal roof	90% Isopropyl Alcohol + 10% Deionized Water, mix well before use. Do not use solvents containing ketones or aromatic hydrocarbons

Use the above cleaners or cleaners recommended by the roofing material supplier.

Annex 2: Structural Adhesive Construction Specifications

Nozzle Trimming Standard: Standard angle-cut nozzle. At an extrusion speed of 10 cm/s, it should form a full standard strip of 10 mm width and 8 mm height.

Adhesive Application Prohibitions: Except for continuous operation, segmented, spot, or zigzag adhesive application within a bonding area is prohibited. Adhesive application speed must be uniform with the glue gun trigger pull.

Curing and Load Relationship: The following data serve as the basis for construction organization design. When ambient temperature is below 5°C, the surface drying time and final strength establishment time of structural adhesive will increase exponentially. Typically, at least 48 hours of undisturbed curing is required.

Ambient Temperature Range	Recommended Minimum Curing Time (Undisturbed)
25°C - 40°C	24 hours
10°C - 25°C	48 hours
0°C - 10°C	72 hours
Below 0°C	Installation not recommended

Rolling Operation Correct vs. Incorrect Comparison:

Comparison Item	Correct Operation	Incorrect Operation
Adhesive Strip Height	Height > 8mm (Correct)	Height < 5mm (Poor adhesive wetting)
Rolling Method	Use plastic roller for uniform rolling	Excessive rolling / No rolling / Twisting module after rolling
Pressing Method	Roll non-cell area of module	Press on cells directly by hand for stabilization

Annex 3: List of Items Corrosive/Damaging to PV Connectors

Strictly manage the chemical safety data sheets (MSDS) of all installation auxiliary materials. Before using any non-listed chemical near connectors, complete chemical compatibility testing in a laboratory.

Chemical Category	Common construction items prohibited near connectors
Acid/Alkaline Substances	Salt (salt spray), baking soda, caustic soda solution, ammonia, concrete curing agent (containing mineral salts)
Oxidizing Agents	Hydrogen peroxide (H_2O_2), sodium hypochlorite (bleach), potassium permanganate disinfectant tablets
Organic Solvents	Acetone, toluene, xylene, banana oil (paint thinner), high-concentration isopropanol (>90%), nail polish remover, turpentine

Annex 4: Steel Tile Profile and Compatible Clamp Type Reference

Steel Tile Classification	Compatible Clamp Type	Recommended Installation Solution
T-type Steel Tile	T-type dedicated clamp	SolarVela series adhesive installation / SolarNoah series clamp installation
Standing Seam Type	Standing seam dedicated clamp	Prefer SolarNoah series clamp installation / Some cases allow SolarVela+tube adhesive installation
Angle-Ridge Steel Tile	Angle-ridge dedicated clamp	Prefer SolarNoah series clamp installation / Some cases allow SolarVela+tube adhesive installation
Corrugated Steel Tile	Corrugated dedicated clamp	SolarVela series adhesive installation / SolarNoah series clamp installation
Round Standing Seam Type	Round dedicated clamp	Prefer SolarNoah series clamp installation / Some cases allow SolarVela+tube adhesive installation

The above tile profiles and clamps do not specify specific models or specifications and are for reference only. For specific clamp model types and other parameters, contact ZKFN Solar for technical support.

Annex 5: Abnormal Installation Surface Conditions and Treatment Methods

Abnormal Condition	Detailed Description and Risk	Mandatory Treatment and Acceptance Criteria
Severe Steel Tile Corrosion	Surface paint film extensively burst, base steel plate showing layered rust spalling	Direct installation prohibited. Roof must be fully refurbished (spray rust-converting anti-corrosion primer + topcoat) or replace steel tiles
Fine Concrete Dusting	Extremely low surface strength, disintegrates when rubbed with foot. Adhesive will peel off with loose cement layer	Direct installation prohibited. Grind off loose surface layer, clean dust, apply high-permeability moisture-proof primer, allow 24 hours curing before construction
Waterproof Membrane Blistering	Membrane has detached from structural layer. Additional weight and wind suction will accelerate large-area tearing	Direct installation prohibited. Notify membrane manufacturer to cut open and re-weld blister areas. Re-perform pull-out test on repaired areas

> Warning - Important Note: The above methods should be performed under the professional guidance of other manufacturers. The treatment methods here are for reference only.

Annex 6: Summary Table of Module Selection and Installation Methods for Different Roofs

Roof Type	Tile Subtype	Recommended Product Series	Core Installation Requirements
Steel Tile	T-type, Corrugated	SolarVela Full Series / SolarNoah Full Series	Vela/Noah Pro ≥5° tilt required, Max unlimited; Corrugation pitch ≤350mm, crest width ≥1cm; Bonding area ≥800cm²
Steel Tile	Standing Seam, Angle-Ridge	Prefer SolarNoah Full Series	Vela/Noah Pro ≥5° tilt required, Max unlimited; Non-destructive removal achievable
Steel Tile	Curved Roof	SolarVela Full Series / SolarNoah Full Series	Vela/Noah Pro ≥5° tilt required, Max unlimited

Roof Type	Tile Subtype	Recommended Product Series	Core Installation Requirements
Flat Roof	Waterproof Membrane, Concrete	SolarVela Max / SolarNoah Full Series	Noah series use 5° tilt bracket; Max model can be 0° horizontal; Roof tilt >5° can use SolarVela+leveling tube; Substrate pull-out single-point ≥40kg (4×4 cm²)

This table is a simplified quick reference guide. Detailed requirements are given in the main body of this manual.

Annex 7: Electrical Parameter Description

No.	Parameter Item	Parameter Value
1	Open-Circuit Voltage Temp. Coeff. α / Max Power Temp. Coeff. β / Short-Circuit Current Temp. Coeff. δ	α = -0.28 %/°C, β = -0.34 %/°C, δ = +0.05 %/°C
2	Nominal Operating Cell Temperature (NOCT)	45 ± 2 °C
3	Minimum Cable Cross-Section for PV Module Field Wiring	1 × 4.0 mm²
4	Connector Mating Requirements	Must use connectors of same brand and model as module connectors. Socket must be kept clean, free of moisture or mud before connection
5	Connector Dimensions, Type, Material, and Temperature Rating	PV-BN101B, IP68, -40°C ~ +85°C RHC2, IP68, -40°C ~ +85°C EVO2, IP68, -40°C ~ +85°C
6	Terminal Type for Field Wiring	Crimping terminal
7	Recommended Connector Model and Manufacturer	PV-BN101B BONENG RHC2 RENHE EVO2 Stäubli
8	Connection Method	A: Structural adhesive bonding B: Clamp
9	Bypass Diode Type	GF5045 BONENG MK4045 RENHE
10	Installation Temperature Range and Slope Requirements	Installation temperature 5°C to 35°C; When slope >25°, use double-sided tape to assist adhesive positioning and anti-slip

No.	Parameter Item	Parameter Value
11	Minimum Mechanical Fixing Method	Use M8 bolts, tightening torque 15~20 N·m
12	Fire Rating	Class C (UL790 standard)
13	Design Mechanical Load and Safety Factor	Adhesive installation: Positive 3600Pa/1.5, Negative 2400Pa/1.5; Clamp installation: Positive 3600Pa/1.5, Negative 2400Pa/1.5
14	Spotlight Statement	This module does not allow external spotlight illumination on the front or back of the module. Module anomalies or damage caused by light concentration are not covered under warranty

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