ZKFN Solar Lightweight PV System Design Guide

Shandong ZKFN Solar Technology Co., Ltd.

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Chapter 1 General Provisions

1.1 Scope of Application

This document applies to the system scheme design phase of SolarVela series, SolarNoah series, and SolarPega series PV modules manufactured by Shandong ZKFN Solar Technology Co., Ltd. (hereinafter referred to as "ZKFN Solar") for use in industrial and commercial rooftops, public building rooftops, special-structure rooftops, and BIPV/BAPV projects.

1.2 Purpose of Compilation

To standardize the design process for light-flexible PV module systems, unify technical design requirements, guide design units in scheme development, product selection, layout planning, and electrical configuration, and mitigate risks such as insufficient rooftop load-bearing capacity, mismatched module selection, shading, electrical parameter mismatch, and improper installation practices, thereby ensuring safe, reliable, cost-effective, and compliant project implementation.

1.3 Document Positioning

This general specification serves as a guiding technical document for the design phase and does not replace mandatory national or industry standards. Engineering design shall concurrently comply with current standards including GB 50797, GB 50009, GB 50016, GB 50205, NB/T 10394, GB/T 38946, IEC 61215, IEC 61730, IEC 61701, IEC 62109, as well as ZKFN Solar product installation work instructions and limited warranty documents.

1.4 Four Fundamental Design Principles

Principles	Meaning
Safety First	The PV module, support system, and electrical system shall meet structural safety, electrical safety, and fire safety requirements within the 25/30-year design service life.
Structural Compatibility	The module installation method shall be compatible with the roof base material, structural strength, and waterproofing configuration.
Environmental Adaptability	Environmental conditions such as wind, snow, salt spray, temperature variation, and corrosion shall be fully considered to ensure the system meets extreme operating condition requirements.
Maintenance Convenience	Inspection access routes, operation and maintenance interfaces, and non-destructive disassembly space shall be reasonably arranged to ensure system maintainability.

1.5 Reference Values for Applicable Environmental Conditions

Item	Reference Value

Item	Reference Value
Basic Wind Speed	Based on 50-year return period data at the project location, or higher requirements specified by the owner
Snow Load	Based on the local basic snow pressure for a 50-year return period
Module operating temperature	–40℃ ~ +85℃
Long-term ambient relative humidity	≤ 85% RH
Installation altitude	≤ 2000 m (special assessment required for high altitude)
Distance from coastline	≥ 500 m (offshore projects require written confirmation from ZKFN Solar)

1.6 Risk Warnings

This general specification is a reference document for the design phase. The final scheme must be reviewed by structural and electrical professionals and approved by relevant review authorities. Failure to adequately assess rooftop structure, environmental conditions, and electrical compatibility may result in module failure, power generation degradation, warranty invalidation, or structural safety incidents.

Chapter 2 Terminology

1. SolarVela Series: Light-Flexible Crack-Free Crystalline Silicon PV Module (Light-flexible PV Module without Frame), featuring thinness, lightness, and bendability with a minimum bending radius of 0.3 m. Suitable for low-load-bearing rooftops and irregular-shaped rooftops, installed directly using structural adhesive. Includes SolarVela, SolarVela Pro, and SolarVela Max.
2. SolarNoah Series: Light-Flexible PV Module with Frame, equipped with a 20 mm composite material back frame, installed using Quick-Clamp fixtures for non-destructive removal. Includes SolarNoah, SolarNoah Pro, and SolarNoah Max.
3. SolarPega Series: Light-Rigid, Walkable PV Module — Encapsulated with 1.1 mm or 1.6 mm ultra-thin tempered glass, combined with ZKFN Solar's proprietary TSR-Armor™ Technology, featuring walkability, dust-shedding, and crack-free performance. Includes four models: SolarPega / SolarPegaL / SolarPegaF / SolarPegaFL.
4. PV Array / Power Generation Unit / Peak Sun Hours / Installed Capacity: Refer to GB/T 12936 and GB 50797-2012.
5. Structural Adhesive: The preferred model for ZKFN Solar products is Guangzhou Baiyun SMG533 PV-specific structural adhesive, with a 25-year warranty. It is the core **bonding**

material for direct structural adhesive bonding installation.

6. BIPV / BAPV: Building Integrated Photovoltaics / Building Attached Photovoltaics.
7. Direct Structural Adhesive Bonding: An installation method that uses only structural adhesive (without mechanical fastening) to fix the module (or TPO/UPVC square tube) to the roof substrate.
8. TPO / UPVC Square Tube Leveling Support: A leveling-type auxiliary support used on trapezoidal, standing seam, and other profiled steel sheet roofs lacking continuous bonding surfaces, helping light-flexible modules form a stable adhesive base.
9. Flat Roof / Sloped Roof / Irregular Roof:
   (1) Flat Roof: Roof tilt angle close to 0°;
   (2) Sloped Roof: Roof slope ≥5°;
   (3) Irregular Roof: Curved, circular, or other non-flat, non-sloped roofs.
10. Hot Spot Effect: Caused by partial shading, dust accumulation, or cell mismatch, leading to reverse bias and heating of certain cells, which can result in permanent module damage in severe cases.
11. MPPT: Maximum Power Point Tracking.
12. DC/AC Ratio: Ratio of total DC power of the PV array to the AC rated power of the inverter.
13. Pull-out Force: The ability of the fixing system to resist external forces perpendicular to the roof surface, a key acceptance criterion for structural adhesive bonding solutions.
14. TSR-Armor™ Technology: ZKFN Solar's proprietary crack-free encapsulation technology, enabling light-flexible modules to pass Ø25 mm, 23 m/s hail impact tests with zero micro-cracks and zero power degradation, and light-rigid modules to remain crack-free with zero power degradation after walking.
15. Other terms shall be in accordance with GB/T 12936-2007 "Terminology for Solar Thermal Utilization". The right of final interpretation belongs to ZKFN Solar.

Chapter 3 Referenced Standards and Reference Documents

3.1 National and Industry Standards

- GB 50009-2012 "Load Code for the Design of Building Structures"
- GB 50797-2012 (2024 Edition) "Code for Design of Photovoltaic Power Stations"
- GB 55037-2022 "Code for Fire Protection in Building Design"
- GB 50205-2020 "Standard for Acceptance of Construction Quality of Steel Structures"
- GB 50033-2013 "Standard for Daylighting Design of Buildings"
- NB/T 10394-2020 "Specification for Performance of Photovoltaic Power Systems"
- GB/T 38946-2020 "Code for Operation and Maintenance of Photovoltaic Power Stations"

- IEC 61215, IEC 61730, IEC 61701, IEC 62109

3.2 Enterprise Technical Documents

- SolarVela / SolarNoah / SolarPega Series Installation Work Instructions (Latest Version)
- SolarVela / SolarNoah / SolarPega Series TDS Specifications
- SolarVela/Noah Series Limited Warranty (12-Year Product + 25-Year Power)
- SolarPega Series Limited Warranty (15-Year Product + 30-Year Power)

3.3 ⚠ Two Mandatory Preconditions

① Overseas Project Module Model Restrictions

- ✅ Available for overseas (global regions outside China): SolarVela Max, SolarNoah Max (six-compartment junction box)
- ❌ Sales/use limited to China only: SolarVela, SolarVela Pro, SolarNoah, SolarNoah Pro (three-compartment junction box); warranty automatically voided for overseas use.
- SolarPega full series applies to markets as per contract terms.

② **Full Series Long-Term Shadow Obstruction Prohibition:** Modules must not be installed in areas with permanent shadow obstructions (buildings, structures, trees, rooftop equipment, etc.). Hot spot damage caused by long-term external fixed shadows is not covered under warranty.

Chapter 4 Product Introduction and Selection Overview

4.1 Product Series Overview

Series	Typical Model	Power (W) (W)	Weight (kg) (kg)	Weight (kg/m²) (kg/m²)	Recommended Application	Installation Method	Warranty (Product/Power) (产品/功率)
SolarVela	ZKFN B1 000A-510~520	510–520	7.6	2.9	Low-load-bearing roofs, irregular-shaped roofs, sloped roofs, within China	Direct bonding with Structural Adhesive	12 years / 25 years
SolarVela Pro	ZKFN B1 010A-550~560	550–560	7.6	2.9	High-efficiency flexible projects, irregular roofs, sloped roofs, within China	Direct structural adhesive bonding	12 years / 25 years
SolarVela Max	ZKFN B1 010A-550~560	550–560	7.6	2.9	Flat roof 0° installation, overseas projects, high-pollution areas, high-dust accumulation areas	Direct structural adhesive bonding	12 years / 25 years
SolarNoah	ZKFN B1 000A-510~520	510–520	10.2	3.8	Roofs requiring future maintenance / detachable roofs, within China	Quick-Clamp Fixture	12 years / 25 years

SolarNoah Pro	ZKFN B1 012B-550~560	550–560	10.2	3.8	High-efficiency detachable project, within China	Quick-Clamp Fixture	12 years / 25 years
SolarNoah Max	ZKFN B1 012B-550~560	550–560	10.2	3.8	Flat roof 0°, overseas projects, high-pollution areas, high-dust accumulation areas	Quick-Clamp Clamp	12 years / 25 years
SolarPegaL	ZKFN-G2-120B 500~510	500–510	10.0	4.5	Light-load flat roofs, medium-load roofs	Direct bonding with structural adhesive / TPO or UPVC square tube	15 years / 30 years
SolarPega	ZKFN-G2-220B 510~520	510–520	13.0	5.9	Light-Rigid Walkable Project	Structural Adhesive Direct Bonding / TPO or UPVC Square Tube	15 Years / 30 Years
SolarPegaFL	ZKFN-G2-122B 500~510	500–510	13.0	5.9	Light-Load Project Requiring Clamp Fixation	Clamp + Pressure Block / Rail	15 Years / 30 Years
SolarPegaF	ZKFN-G2-222B 510–520	510–520	16.2	7.3	Light-Rigid Walkable + Clamp Fixing	Clamp + Pressure Block / Rail	15 Years / 30 Years

4.2 Full-Scenario Selection Decision Flowchart

Step 1: Does the rooftop have long-term fixed shadows?

└ Yes → Installation prohibited, relocate site

└ No → Proceed to Step 2

Step 2: Evaluate available residual load capacity of the rooftop (conventional glass PV system ≥20 kg/㎡ is completely unusable)

└ <8 kg/㎡ (conventional glass: ❌ Unusable) → Only compatible with: SolarVela series (2.9 kg/㎡), the only installable flexible module

└ 8-15 kg/m² (Standard Glass: ❌ Prohibited / High Risk) → Priority: SolarNoah/SolarPegaL (3.8-4.5 kg/m²) Optimal Lightweight Flexible Solution for Low-Load Roofs

└ 15-25 kg/m² (Standard Glass: ❌ Not Recommended / Insufficient Margin) → Optional: SolarPega/PegaF (5.9-7.3 kg/m²) Upper Limit for Light-Rigid Modules

Step 3: Roof Slope?

└ ≥5° Sloped Roof → Compatible: Vela/Vela Pro/Noah/Noah Pro (Both Flexible and Light-Rigid Options Available)

└ <5° Flat Roof → Mandatory: Max Series/Pega Series Dedicated Flexible Solution for Flat Roofs

Step 4: Overseas Project?

└ Yes → Restricted to: Max Series/Pega Series Overseas-Compliant Flexible Modules

└ No → Retain Current Selection

Step 5: Removable O&M Required?

└ Yes → Priority: SolarNoah/SolarPegaF/SolarPegaFL Removable Flexible Modules

└ No → Continue with Current Selection

Step 6: Roof Substrate Matching Installation Method

└ Trapezoidal/Corrugated Steel Tile → Direct Bonding Dedicated Flexible Process

└ Standing Seam/Clip-Fixed → TPO/UPVC Leveling Dedicated Flexible Support Solution

└ Concrete/Waterproof Membrane → Structural Adhesive Base Low-Load Roof-Specific Fixation

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Chapter 5 Design Principles

5.1 Safety First

- Modules, connectors, supports, and anchors must meet structural and electrical safety requirements throughout the 25/30-year full lifecycle.
- All solutions must pass triple verification for wind load, snow load, and seismic load.
- Safety factor for anchor pull-out force ≥ 2.5.

5.2 Structural Compatibility

- Structural adhesive solution: The substrate must meet minimum bonding area and pull-out force requirements;
- Clamp solution: Clamp dimensions must match the tile profile, with clamp length ≥ 54 mm and pull-out force > 100 kg after clamping;
- Base solution: Single-point pull-out force ≥ 40 kg after base structural adhesive application.

5.3 Environmental Adaptability

- For salt spray environments (within 500 m from coastline), written confirmation from ZKFN Solar is required;
- Areas with corrosive gases, acid rain, high dust, or industrial fumes should be used with caution or avoided;
- In cold regions, the minimum curing temperature of structural adhesive (≥ 0℃) and snow load must be considered.

5.4 Maintenance Convenience

- Maintenance access walkways between arrays: 400 mm (minimum);
- Reserve disassembly space for modules. If disassembly is required, prioritize the use of SolarNoah and SolarPegaF series for non-destructive disassembly solutions.

Chapter 6 Load Calculation Basis

6.1 Quick Reference Table for Module Self-Weight Load

Module Model	Weight (kg/m²)	Self-Weight Load (kN/m²)
SolarVela / SolarVela Pro / SolarVela Max	2.9	0.0274
SolarNoah / SolarNoah Pro / SolarNoah Max	3.8	0.0372
SolarPegaL	4.5	0.0441
SolarPega	5.9	0.0549
SolarPegaFL	5.9	0.0574
SolarPegaF	7.3	0.0716

6.2 Wind Load Calculation (GB 50009)

$$W=\mu s \cdot \omega \cdot \beta z$$

- W: Design wind load (kN/m²)
- μs: Wind load shape coefficient (related to roof shape; for flat roofs, take –1.3; for parapet corner zones, take –2.0)
- ω: Basic wind pressure (50-year return period)
- βz: Height coefficient

Refer to the national standard for details.

Design values of static load for modules (measured capability per series TDS):

- SolarVela/Pro/Max, SolarNoah/Pro/Max: Front 5400 Pa, Back 2400 Pa
- SolarPega / PegaF: Front 3600 Pa, Back 2400 Pa
- SolarPegaL / PegaFL: Front 2400 Pa, Back 2400 Pa
- All series: Wind resistance rating of 17, passed Ø25 mm / 23 m/s hail test

6.3 Snow Load Calculation (GB 50009)

$$S = \mu s \cdot S0$$

6.4 Seismic Action (GB 50011)

For regions with seismic fortification intensity ≥ 7:

$$FEk = \alpha max \cdot Geq$$

Seismic Fortification Intensity	6 Degrees	7 Degrees	8 Degrees

α_max	0.04	0.08 (0.10)	0.16 (0.20)

Maximum horizontal seismic influence coefficient α_max:

6.5 Load Combinations

- Dead Load + 1.4 × Wind Load (Suction)
- Dead Load + 1.4 × Snow Load
- Dead Load + 1.4 × 0.7 × Wind Load + 1.4 × 0.7 × Snow Load
- Dead Load + 1.3 × Seismic Action

Control Values:

- Total load on PV module and mounting system ≤ Roof allowable load capacity × 0.8
- **Single-point anchor pull-out force ≥ Design load × Safety factor ≥ 2.5**

Chapter 7 PV Module Layout Design

7.1 Layout Principles

Economical, reliable, rational, and aesthetically pleasing — while meeting product application specifications and maximizing power generation, ensure construction feasibility and ease of operation and maintenance.

7.2 Typical Layout Parameters for Each Series

Series	Module Orientation	Module Spacing	Array Spacing (Maintenance Access)	String Direction
SolarVela / Pro / Max	Landscape (Long Side Perpendicular to Corrugation)	≥20 mm	≥400 mm	Left-Right Series Connection
SolarNoah / Pro / Max	Horizontal	≥20 mm	≥400 mm	Left-Right Series Connection
SolarPega / L	Horizontal or Vertical (Both Acceptable)	≥20 mm	≥400 mm	Left-Right Series Connection
TPO or UPVC Square Tube Solution (Angle-Ridge / Standing Seam Roof)	Horizontal	≥20 mm	≥400 mm	Left-Right Series Connection
SolarPegaF / FL	Horizontal or Vertical Orientation Both Acceptable	≥20 mm	≥400 mm	Left-Right Series Connection

Strictly Prohibited (for all series):

- Installation of a single module spanning roof pipes (drainage pipes, gutters);
- Presence of splicing seams beneath a single module (including color steel tile seams, support member seams);
- Installation of a single module spanning building expansion joints;

- Module installation in the skylight area of color steel tile roofs;
- Module installation in areas near sewage outlets, exhaust vents, or locations prone to dust accumulation/chemical vapor.

7.3 Shading and Shadow Design

7.3.1 Design Prohibitions

- Permanent fixed shadows: Strictly prohibited (all series);
- Temporary/non-fixed shadows: Strictly avoided (heavy pollution, excessive dust accumulation, temporary obstructions).
- Design Exemption Note: The Max series (Vela Max / Noah Max) features a six-diode junction box, offering greater tolerance to temporary/non-fixed shadows, but must not be placed under permanent shading.

7.3.2 Shading Safety Distance

Obstruction Type	Minimum Safe Distance
Parapet Wall, Roof Equipment	≥ 2.5 H (H = Height of Obstruction)
Skylight, Daylight Panel	≥ 2 H
Adjacent Building	No Shading from 9:00 to 15:00 on Winter Solstice

7.3.3 Formula for North-South Array Row Spacing (GB 50797-2012)

$$D=H/\tan\theta min$$

- D: Array row spacing (m)
- H: Height difference between the highest point of the front row and the lowest point of the rear row (m)
- θmin: Solar altitude angle at local solar noon on the winter solstice

7.3.4 Critical Power Generation Period and Evaluation

- Critical power generation period: No direct light obstruction between 9:00 AM and 3:00 PM on the winter solstice;
- Annual effective irradiance loss rate: ≤ 3%;
- Evaluation tools: PVsyst, Helioscope, SketchUp + drone aerial photography.

7.3.5 Special Requirements for Irregular/Roofs and Curved Roofs

- Avoid installation in areas with abrupt curvature changes;
- Mandatory MPPT grouping for curved roofs: The tilt angle deviation of modules within the same MPPT circuit must be controlled within ±5°, otherwise, they shall be divided into independent string control zones;
- Minimum bending radius for curved modules (Flexible Vela series) ≥ 0.3 m.

7.4 Electrical Layout Safety Design

7.4.1 Junction Box and Cables

- Junction Box Protection Rating: IP68 (Standard for All Series)
- DC Cable Specification: ≥ 1×4.0 mm², Double-Layer Insulation
- Temperature Range: –40°C to +90°C
- Cable Routing: Cable Tray / Conduit Protection Required; Direct Contact with Metal Roof Prohibited
- Voltage Drop Requirement: DC Side ≤ 2%, AC Side ≤ 1%
- Minimum Bending Radius: R = 10 × Cable Outer Diameter

7.4.2 Over-current Protection

- Each String Configured with DC Fuse or Circuit Breaker
- Maximum Fuse Rated Current: 25 A (Unified Across All Series)
- Fuse Rated Current: Ir = 1.25 × Isc
- Combiner Box Must Be Equipped with SPD (Class II) and Disconnect Switch

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Chapter 8 Module Installation Design

8.1 Substrate (Roof) Suitability Assessment

8.1.1 Profiled Steel Sheet Roof

Project	Qualification Conditions	Prohibited Conditions
Corrugation Peak Spacing	≤ 350 mm	> 350 mm (Direct bonding prohibited)
Surface Coating	Intact, rust area ≤ 5%	Large-area paint peeling, exposed metal
Peak Integrity	No perforations, no protruding rivets	Rivets, perforations, or other fasteners interfering with the peak
Contamination Condition	No oil, moss, or dust	Oil, moss, or chemical contamination not removed
Structure (Single Layer)	No high-temperature workshop below	High-temperature workshop below single-layer tiles

Roof Rust Treatment: Refurbishment shall be performed using specialized paint for profiled steel sheet roof refurbishment under the guidance of a professional manufacturer (cycle of 3–5 years). Pull-out force must be re-verified after refurbishment.

8.1.2 Concrete Roofs

Item	Acceptance Criteria
Concrete Strength Grade	≥ C25
Surface Flatness	≤ 3 mm / 2 m
Waterproofing Layer	Intact, no cracks, no blistering
Fine Aggregate Mortar Protective Layer	Must be ground or covered with waterproof latex, and pass pull-out test

Treatment of fine aggregate mortar concrete roofs: The surface contains numerous loose particles and is exposed, which affects the adhesion of structural adhesive. Treatment method: Grind the protective layer with an angle grinder → Apply specialized waterproof latex coating → Perform pull-out force test (single point ≥ 40 kg, sampling rate > 1% of total mounting base quantity).

8.1.3 Waterproof Membrane Roofs

Item	Acceptance Criteria
Membrane Surface	No debris, no protrusions
Membrane condition	No aging, no delamination
Bottom adhesion	Firmly bonded to the substrate, no blistering
Substrate structure	Reinforced concrete / Double-T precast slab / Light steel composite panel

Blister treatment: Direct installation over blistered areas is strictly prohibited. The membrane manufacturer must repair or replace the affected section → Installation may proceed only after the pull-out force test (single point ≥ 40 kg, sampling rate > 1% of total mounting base quantity) meets the required standard.

8.2 Mandatory Requirements for Module Installation Tilt Angle

Series	Minimum tilt angle	Maximum tilt angle	Remarks
SolarVela / SolarVela Pro	≥ 5°	90°	⚠ 0° horizontal installation strictly prohibited
SolarVela Max	Unrestricted (0°–90°)	90°	The only flexible model that allows horizontal installation on flat roofs

SolarNoah / SolarNoah Pro	≥ 5°	90°	Strictly prohibited from 0° or horizontal installation
SolarNoah Max	Unrestricted (0°–90°)	90°	Preferred framed removable solution for flat roofs
SolarPega / PegaL / PegaF / PegaFL	Recommended ≥ 5°	90°	If installed at 0° tilt, cleaning frequency must be increased.

Design basis for tilt angle ≥ 5°: Ensures self-cleaning by rainwater, prevents dust accumulation and water ponding at the lower edge, and mitigates the long-term hot spot effect risks caused by such conditions.

8.3 Structural Adhesive Application Process

8.3.1 Product Specification

- Model: Guangzhou Baiyun SMG533 PV-specific Structural Adhesive
- Specification: 590 mL/cartridge
- Color: White
- Warranty: 25 years

8.3.2 Performance Parameters

Parameter	Value
Tensile Strength (after curing)	≥ 1.5 MPa
Elongation at Break	≥ 250%
Minimum Ambient Temperature for Adhesive Application	≥ 0℃
Recommended Application Temperature	4.4℃ ~ 35℃
Curing Time	24 h @ 25℃ (longer at lower temperatures)

8.3.3 Adhesive Application Process Requirements

Requirement	Value
Adhesive Nozzle Cutting Method	Angled Cut
Adhesive Bead Cross-Section	Cylindrical
Adhesive Bead Width	Approx. 10 mm

Adhesive Bead Height	Approx. 8 mm
Application Speed	Approx. 10 cm/s, constant speed
Adhesive Bead Continuity	Must be continuous and uniform; spot or segmented application is strictly prohibited
Air Bubbles / Breaks	Not permitted

8.3.4 Critical Time Points (Must Be Followed)

- "Golden 5 Minutes": Module placement must be completed within 5 minutes after adhesive application;
- Do not lift and reposition the module after placement (secondary adhesion is strictly prohibited);
- During the curing period (24 h @ 25°C), the module must not be disturbed.

8.3.5 Construction Weather Requirements

- Construction is prohibited under rainy, snowy, or strong wind (≥ Level 4) conditions;
- The substrate must be dry and clean (wipe with specified cleaning agent);
- Sunny, windless, or light breeze conditions are recommended.

8.4 Detailed Installation Solutions for Each Series

8.4.1 SolarVela / SolarVela Pro / SolarVela Max: Direct Adhesion with Structural Adhesive

[Applicable Scenarios] Profiled steel sheet (T-type, corrugated), flat roof, curved roof, irregular roof, roof with insufficient load-bearing capacity, BIPV projects.

[Preconditions for Direct Adhesion]

- The spacing between corrugation peaks of the profiled steel sheet ≤ 350 mm;
- No rivets on the corrugation peaks of the profiled steel sheet;
- The profiled steel sheet is free from overall corrosion, with no local damage or deformation;
- No high-temperature heat-generating equipment beneath single-layer profiled steel sheets.
- Tilt Angle: Vela/Vela Pro ≥ 5°, Vela Max no restriction.

[Key Design Parameters]

Parameters	Numerical Values
Minimum Bonding Area per Module	≥ 800 cm^2
Corresponding Typical Design Pull-out Force	≈ 17.4 kN (1771 kg)

Pull-out Force Requirement for Single-Point TPO or UPVC Square Tube	> 40 kg (tested after curing)
Module Overhang Limitation	Overhang on both sides < 5 cm; if overhang ≥ 5 cm, leveling with square tube is required
Array Spacing	≥ 400 mm
Module Spacing	≥ 20 mm

8.4.2 SolarVela Pro/Max on Sloped Roofs (Slope > 5°, for slopes < 5° use Max series): TPO or UPVC square tube bonding solution

[Applicable Scenarios] All Light-Flexible Modules on sloped roofs, waterproof membrane roofs, trapezoidal-profile metal roofing, and standing-seam metal roofing.

[TPO or UPVC Square Tube Specifications]

Parameters	Requirements
Material	TPO or UPVC, UV-resistant and weather-resistant
Height H_1	= (Measured crest height of profiled steel sheet H − 6 mm) ± 2 mm
Width B (shared by two modules)	≥ 40 mm and ≥ ½ H_1
Width B (single module support)	≥ 30 mm and ≥ ½ H_1
Number of rails per module	≥ 6, evenly distributed along the module length direction
Joint position	Must be placed between modules; a single module is strictly prohibited from spanning across a joint

8.4.3 **Special Warning:** Direct bonding on trapezoidal-profile / standing-seam metal roofing is strictly prohibited!

Reason: Trapezoidal-profile roofing has wave crest height deviations and insufficient effective bonding width; standing-seam roofing features a vertical interlocking structure with no continuous large-area bonding surface on the panel. Neither can meet the load requirements for wind loads and thermal stress. Direct bonding poses significant safety risks of detachment and wind uplift.

Recommended Solutions:

- Prioritize the SolarNoah series + Quick-Clamp clamps;
- If the roof has no renovation or repair plan within 25 years, the SolarVela/Pro (tilt

angle ≥ 5°) or SolarVela Max (any tilt angle) + TPO or UPVC square tube leveling support solution may be adopted.

8.4.4 SolarNoah / SolarNoah Pro / SolarNoah Max: Quick-Clamp clamp solution

[Metal Roofing] Clamps + dedicated pressing blocks

Roof sheet profile	Compatible clamp	Long-side direction
T-Type	T-Type Special Clamp	Vertical Corrugation
Angle-Running Type	Angle-Running Special Clamp	Vertical Corrugation
Vertical Standing Seam Type	Standing Seam Special Clamp	Vertical Corrugation
Wave Type	Wave Type Special Clamp	Vertical Corrugation

[Clamp Technical Requirements]

- Aluminum alloy material, must comply with national standards, anodized film thickness ≥ 15 μm;
- Connection bolts: 304-2 stainless steel;
- Clamp length ≥ 54 mm;
- Pull-out force after clamping > 100 kg;
- Bolt torque: 15-20 N·m (Grade 8.8 bolts, per GB 50205-2020);
- Recommended maximum pressure: 20 MPa.

[BOM for Every 2 Modules (Typical Values)]

No.	Name	Specification	Quantity
1	SolarNoah Module	SET	2
2	Edge Clamp	Universal Clamp 04	6
3	Mid Clamp	Universal Clamp 01	3

[Flat Roof Solution] Base + Structural Adhesive + Clamp Block

- Use high-low base to form a tilt angle ≥ 5°;
- Single-point pull-out force after base bonding with structural adhesive ≥ 40 kg;
- BOM for every 2 modules: Edge clamp base assembly ×6, Mid-clip base assembly ×3, SMG533 structural adhesive ×1 cartridge.

8.4.5 SolarPega / SolarPegaL: Frameless Light-Rigid Module

[Flat Roof Waterproof Membrane Installation]

- Clean the substrate → Bond the square tube → Apply adhesive on the top surface of the square tube;
- Adhesive bead with cylindrical cross-section (10 mm × 8 mm), applied at a constant speed of 10 cm/s;
- Bonding area per module ≥ 800 cm² (corresponding tensile resistance ≈ 17.4 kN);
- After installation, compact using a soft pressure roller. Do not press on the solar cells by hand.

【Color Steel Roof Installation Method Compatibility Table】

Tile Type	Adhesive Application Method	Module Long Side Direction
T-Shape	Direct Bonding + TPO or UPVC Square Tube	Vertical Corrugation
Wave Shape	Direct Bonding	Vertical Corrugation
Angle-Running Shape	TPO or UPVC Square Tube Bonding	Vertical Corrugation
Standing Seam Shape	TPO or UPVC Square Tube Bonding	Vertical Corrugation

【TPO or UPVC Square Tube Layout】

- Square tube spacing: < 350 mm (centered between corrugation peaks);
- Square tubes are bonded between corrugation peaks and at the center of corrugation valleys.

8.4.6 SolarPegaF / SolarPegaFL: Light-Rigid Framed Module (Clamp Solution)

Method	Number of Clamps (Per Module)	Clamping Block Positions
① Six clamping blocks along the long side of the rail	6	Evenly distributed along the long side
② Six clamping blocks perpendicular to the long side of the rail	6	Evenly distributed perpendicular to the long side

【Rail/Clamp Installation Solution】

【Clamp Technical Requirements】

- Width a ≥ 40 mm, hole diameter Ø 8.5 mm, thickness ≥ 3 mm;
- Overlap with module frame: 8–11 mm;

- Drainage holes must not be obstructed by clamps;
- Clamps must not directly press against the glass;
- Bolt torque: 15-20 N·m (Grade 8.8);
- Installation sequence: flat washer → spring washer → nut.

【Flat Roof Installation with Light-Steel Back-Frame Module】

- Dedicated support bracket + structural adhesive / chemical anchor bolts fixed to the roof.
- Concrete roof chemical bolt anchoring: Bolt exposed length ≥ 55 mm, pull-out test shall be performed only after 24 h of curing.
- Pull-out force of a single chemical bolt ≥ 20–25 kN.
- Waterproof membrane roof: Bolt fixing + waterproof membrane patch (lap width ≥ 100 mm, laid in square shape, welded with same material).

8.5 Walkability Design Requirements for Modules (Pega Series)

 The SolarPega / PegaF series are nominally rated as "walkable," but the following restrictions must be clearly defined in the design scheme:

Pre-installation conditions:

- SolarPega / SolarPegaL must be supported by 8 UPVC square tubes evenly spaced along the long side direction of the module. Each square tube length shall match the short side dimension of the module, with both ends extending 5–8 mm beyond the module width. The short side edges shall cover 1/2 to 2/3 of the outermost square tube width.
- SolarPegaF / SolarPegaFL must be provided with 8 evenly distributed support fixing points, symmetrically arranged along the two long sides of the module (4 points per side). The center of the outermost clamp shall be 8–10 cm from the short side edge, and the clearance distance below the module shall be > 50 mm. The installation base surface must be flat and stable, with a flatness tolerance of ≤ ±2 mm/m.

Item	Limitation
Personnel Body Weight	< 80 kg
Footwear	Rubber-soled protective shoes or soft-soled safety shoes
Prohibited Footwear	High heels, hard-soled leather shoes, shoes with nails
Allowed Area	Module Center Area
Prohibited Area	Peripheral Edges, Clamping Support Positions, Module Joints

Permitted Actions	Walking, Standing Still
Prohibited Actions	Jumping, Stomping, Forceful Stepping, Running
Maximum Persons per Module	1 Person Only
Weather Restrictions	Stepping is strictly prohibited during rain, snow, or when the surface is wet

SolarVela / SolarNoah series are prohibited from being walked on. Operation and maintenance shall be performed via designated inspection walkways.

8.6 Coastline & Special Environment Design

- Salt spray environment: Module distance from coastline ≥ 500 m; for near-shore installation (< 500 m), written confirmation from ZKFN Solar is required.
- High altitude: ≤ 2000 m; for altitudes exceeding this, a special assessment is required.
- Lightning protection: In areas with frequent lightning activity, independent lightning protection devices shall be installed.
- Corrosive environment: Installation is prohibited in areas prone to salt accumulation, active chemical vapors, or acid rain.

Chapter 9 Inverter Selection

9.1 DC/AC Ratio Reference (NB/T 10394-2020)

Annual Horizontal Irradiance (kWh/m²·year) (kWh/m²·年)	Typical Regions	Temperature Factor	Recommended DC/AC Ratio	Notes
< 1200 (Low Irradiance Zone)	Harbin, Shenyang, Urumqi	Colder Climate	1.15–1.25	Low irradiance; oversizing improves inverter utilization
1200–1400 (Moderate Irradiance Zone)	Jining, Jinan, Shanghai, Chengdu	Temperate Climate	1.10–1.15	No overload during most operating hours
1400–1700 (Higher Irradiance Zone)	Xi'an, Hohhot, Lanzhou	Hot Summers and Cold Winters	1.05–1.10	Avoid summer power curtailment
> 1700 (High Irradiance Zone)	Gonghe, Qinghai;	Hot Plateau	1.00–1.05	Oversizing easily leads to

	Dunhuang, Gansu; Hami, Xinjiang			significant curtailment losses

9.2 Voltage Matching Design

- **Under High Temperature:** Ensure Vmp (Module Maximum Power Voltage) ≥ MPPT Lower Limit
- **Under Low Temperature:** Ensure Voc (Total Open-Circuit Voltage in Series) ≤ Inverter Maximum DC Input Voltage (1000 V or 1500 V)

9.2.1 Open-Circuit Voltage Low-Temperature Correction Coefficient Table

For rooftop distributed projects, a coefficient of 1.05–1.10 is recommended (to avoid summer overload).

Expected Minimum Ambient Temperature (°C)	Correction Factor
24 ~ 20	1.02
19 ~ 15	1.04
14 ~ 10	1.06
9 ~ 5	1.08
4 ~ 0	1.10
–1 ~ –5	1.12
–6 ~ –10	1.14
–11 ~ –15	1.16
–16 ~ –20	1.18
–21 ~ –25	1.20
–26 ~ –30	1.21
–31 ~ –35	1.23
–36 ~ –40	1.25

9.2.2 Precise Calculation Formula

(1)

$$N \leq \frac{V_{dc\,max}}{V_{oc} \times [1 + (t - 25) \times K_v]}$$

(2)

$$\frac{V_{mppt\,min}}{V_{pm} \times [1 + (t' - 25) \times K_v']} \leq N \leq \frac{V_{mppt\,max}}{V_{pm} \times [1 + (t - 25) \times K_v']}$$

Symbol	Definition	Parameter Source
Kv	Temperature coefficient of PV module open-circuit voltage	Module datasheet
Kv'	Temperature coefficient of PV module operating voltage	Module datasheet
Voc	Open-Circuit Voltage of PV Module (V)	Module Datasheet
Vpm	Operating Voltage of PV Module (V)	Module Datasheet
Vdcmax	Maximum DC Input Voltage Allowed by Inverter (V)	Inverter Datasheet
Vmpptmax	Maximum Voltage at Full Load for Inverter MPPT (V)	Inverter Datasheet
Vmpptmin	Minimum Voltage at Full Load for Inverter MPPT (V)	Inverter Datasheet
t	Extreme Low Temperature Under PV Module Operating Conditions (℃)	Local Weather
t'	Extreme High Temperature Under PV Module Operating Conditions (℃)	Local Weather

Note:

- For building-integrated PV systems, the maximum number of modules per string is often not adopted. The integer range of module count per string shall be determined by combining the two formulas. Then, factors such as module layout, DC combiner arrangement, and construction conditions shall be considered for a techno-economic comparison to rationally design the string configuration.
- If Kv' is difficult to obtain, the module Kv value may be used as a substitute.
- If module temperature rise data is unavailable for t and t', ambient temperature may be used as a substitute.
- To optimize power generation, Vmpptmax and Vmpptmin shall be taken as the full-load MPPT voltage range of the inverter.

9.2.4 Maximum String Current Design

Conductor/Fuse Current Rating Calculation:

$$I_{fu} \geq 1.56 \times I_{sc}$$

Maximum series fuse rating for the full product range = 25 A.

9.3 MPPT Channel Design

- When the roof has different orientations, tilts, or shading, inverters with multiple MPPT channels should be selected.
- String inverters are preferred for distributed projects.
- The tilt angle deviation of modules within the same MPPT channel must be ≤ ±5°.
- Curved roof: Divide into independent MPPT control zones based on ±5° increments.
- Different orientations must not share the same MPPT channel.

9.4 Grid-Connection Requirements

- The output voltage level must match the grid connection point (380 V low voltage or stepped up to 10 kV medium voltage).
- Must include overvoltage, undervoltage, overfrequency, underfrequency, and anti-islanding protection.
- Harmonics, voltage fluctuations, and power factor must comply with grid connection standards (power factor ≥ 0.9 lagging to 0.9 leading).

9.5 Protection and Environmental Adaptation

- Protection rating: ≥ IP65 (outdoor)
- Operating temperature: –25°C to +55°C
- Salt spray environment: Compliant with GB/T 10125
- Must have remote monitoring and data recording functions.
- The inverter must be equipped with AFCI (Arc Fault Circuit Interrupter) function.

9.6 Safety and Protection

- DC side: Reverse polarity protection, overvoltage protection, SPD (Class II), AFCI
- AC side: Overcurrent, short-circuit, and surge protection
- Grounding: Compliant with TN-S or TT system
- Compliant with IEC 62109 safety standard

9.7 Mandatory MC4 Connector Consistency Requirements

- MC4 connectors must be compatible with the PV module, using connectors of the same manufacturer, same model, and same specification.
- Mixing connectors from different brands or series is strictly prohibited, as it may lead to poor contact, overheating, or even fire risk, and will automatically void the warranty.

- Recommended connector models for ZKFN Solar modules: PV-BN101B BONENG, RHC2 RENHE, EVO2 Stäubli.

Chapter 10 Operation and Maintenance Design

10.1 Water Flushing System Design

10.1.1 Piping Layout

- Uniformly arranged along the rooftop array, ensuring full coverage;
- Main pipe DN25–DN50, branch pipe DN15–DN20;
- Material: Stainless steel or UV-resistant PPR;
- The piping must be UV-resistant, low-temperature-resistant, and corrosion-resistant.

10.1.2 Water Source and Water Pressure

- Water source: Municipal supply or purified rainwater;
- Water pressure: 0.1–0.2 MPa (High-pressure impact is strictly prohibited; excessive water pressure can easily cause micro-cracks);
- Insufficient water pressure (< 0.1 MPa) results in poor cleaning performance, while excessive water pressure (> 0.2 MPa) can easily cause micro-cracks in the PV modules.

10.1.3 Cleaning Device

- The spray nozzle must cover the entire surface of the module with no blind spots;
- Equipped with zoned electric or manual valves;
- The spray angle must match the module tilt angle.

10.1.4 Drainage and Freeze Protection

- Wastewater shall be directed to the rainwater pipeline or a dedicated drainage channel;
- In northern regions, insulation layers or antifreeze circulation (or seasonal shutdown and drainage) shall be provided.

10.1.5 Recommended Cleaning Frequency (GB/T 38946-2020)

Environmental Conditions	Recommended Frequency	Remarks
General Urban and Suburban Areas	Recommended once per month	Can be reduced in winter
Areas with High Dust Levels	At least once per month	Clean immediately after sandstorms

Heavy Industrial Pollution	1–2 times per month	Monitor soiling and power generation degradation
Coastal salt-spray regions	At least once per month	Concurrent corrosion inspection
Rainy regions	≥ 1 time per quarter	Rainwater-assisted cleaning
After unexpected events	Immediate cleaning	Prevent hot spot effect

10.1.6 Cleaning Precautions

- Perform cleaning in the early morning or evening (to avoid micro-cracks caused by sudden cooling of modules at high temperatures);
- Do not use strong acids, strong alkalis, or high-salinity water;
- For recommended cleaning agents for different roof substrates, refer to Appendix 1 of the Installation Work Instruction;
- Record the cleaning date, method, and water consumption, and monitor changes in power generation.

10.2 Lightning Protection and Grounding

All ZKFN Solar series modules do not require frame grounding.

Reason: Non-conductive bonding processes or composite material back frames are used, making the frames non-conductive.

The design only requires:

1. Grounding of metal components such as mounting structures and bases in accordance with the TN-S / TT system;
2. Grounding of inverters and combiner boxes in compliance with inverter manufacturer requirements and local regulations;
3. Installation of independent lightning protection devices (lightning strips/rods) in areas with frequent lightning strikes.

10.3 Design Requirements for Routine Inspection

During the design phase, provisions shall be made for:

- Inspection walkways (> 400 mm);
- Safety harness anchor points and lifeline anchorage points (for areas with working heights > 2 m);
- Maintenance tool room or equipment room (for centralized storage of cleaning and electrical inspection tools);
- Power generation monitoring and alarm system (string-level accuracy, fault

localization to the module string).

10.4 Design Provisions for Periodic Electrical System Maintenance

- Combiner box and inverter maintenance clearance ≥ 800 mm;
- DC circuit breakers and SPDs shall be independently arranged to facilitate hot-swap operation;
- Module junction boxes shall be oriented toward the maintenance access side to enable infrared inspection and replacement;
- At least 0.5% of the total module quantity shall be reserved as spare parts during the design phase (subject to contract terms).

Chapter 11 Warranty Scope and Disclaimer

11.1 Warranty Period Quick Reference Table

Series	Product Warranty 质保	Power Warranty 质保	Power Degradation (Year 1) (首年)	Power Degradation (Years 2–25/30) (2–25/30 年)	End of Year 25/30 Power Output 功率
SolarVela (PERC)	12 Years	25 Years	≤ 2%	≤ 0.55% / Year	≥ 84.8%
SolarVela Pro/Max (TOPCON)	12 Years	25 Years	≤ 1%	≤ 0.4% / Year	≥ 89.4%
SolarNoah (PERC)	12 years	25 years	≤ 2%	≤ 0.55% / year	≥ 84.8%
SolarNoah Pro/Max (TOPCON)	12 years	25 years	≤ 1%	≤ 0.4% / year	≥ 89.4%
SolarPega / PegaL / PegaF / PegaFL (TOPCON)	15 years	30 years	≤ 1%	≤ 0.4% / year	≥ 87.4%

11.2 Warranty Market Limitations

Junction Box Type	Typical Model	Target Market
6-Partition Junction Box	SolarVela Max, SolarNoah Max	Global Sales, Global Warranty
3-Partition Junction Box	SolarVela, SolarVela Pro, SolarNoah, SolarNoah Pro	China Domestic Only; Overseas Sales Void Warranty
SolarPega Series	As Per Contract Agreement	As Per Contract Agreement

11.3 Typical Scenarios of Warranty Voidance

The following scenarios will directly result in full warranty voidance and must be strictly avoided during the design phase:

- Shading: Areas subject to permanent fixed shading (from buildings, structures, trees, etc.);
- Tilt Angle Violation: SolarVela/Pro and SolarNoah/Pro installed at < 5° or horizontally;
- Model Misuse: SolarVela/Vela Pro/Noah/Noah Pro used in overseas projects;
- Violation of installation instructions;
- Electrical violations;
- Non-static scenarios: vibration, jolting, folding, buckle fastening, frequent handling (warranty period only 3 years);
- Natural forces or force majeure: lightning, hail, frost, snow, storms (exceeding design load), fire, explosion, etc.;
- Unauthorized modifications: any form of modification, drilling, or disassembly of the module without written consent;
- Serial number damaged or illegible.

11.4 Design Institute Notification Obligations

The design institute shall clearly indicate the following items in the design drawings and design specifications, and provide a briefing to the owner:

- Module model and market restrictions for sale;
- Minimum tilt angle requirements for the module;
- Shading prohibition and operation & maintenance requirements;
- Specified model and parameters of the structural adhesive/clamp/clamping block used;
- Walkability restrictions (Pega series) and prohibition of walking (Vela/Noah series);
- Water pressure and frequency limits for water rinsing;
- Warranty period and transfer rules.

Chapter 12 Design Deliverables Checklist

Before finalizing the design plan, the design institute shall complete the following deliverables in accordance with the requirements of this general specification:

12.1 Basic Information

- Roof structure review report (load-bearing capacity, substrate type, flatness, waterproofing condition)
- Project site meteorological data (basic wind pressure, snow pressure, minimum/maximum temperature, annual irradiation)

- Project site salt spray/corrosion/seismic resistance classification data
- Shading analysis report (critical periods throughout the year, PVsyst/Helioscope report)

12.2 Design Documents

- PV module selection report (including market suitability verification)
- Roof layout plan (including array spacing, maintenance walkways, string orientation, MPPT grouping)
- Load verification calculation (wind, snow, seismic combinations, anchor pull-out force)
- Electrical design drawings (string voltage calculation, fuse selection, MPPT matching, cable voltage drop)
- Structural adhesive/clamp/base accessory BOM list (designated products must be used)
- Lightning protection and grounding system diagram
- Operation and maintenance system diagram (water flushing pipeline, cleaning frequency, emergency access routes)

12.3 Design Review

- Structural Discipline Review and Signature
- Electrical Discipline Review and Signature
- ZKFN Solar Technical Team Scheme Confirmation (Mandatory for overseas projects, offshore projects, irregular roofs, and special models)
- Project Review Authority Approval

Chapter 13 Common Design Errors and Avoidance

No.	Common Mistakes	Correct Practices	Reference Section
1	Selecting SolarVela Pro for roofs with a slope < 5°	SolarVela Max should be selected instead	8.2
2	Directly bonding Light-Flexible Modules onto angle-purlin profiled steel sheets	Must level the surface with TPO or UPVC square tubes, or switch to SolarNoah with mounting clamps	8.4.3
3	Connecting modules with a tilt angle difference > 5° to the same MPPT	Divide into independent MPPT zones based on a ±5° tilt angle range	9.3
4	For overseas projects, use SolarVela Pro (three-part junction	The Max series must be selected	11.2

	box)		
5	A single module spanning a roof joint or expansion joint	Place the joint between modules	7.2
6	Adhesive installation on single-layer color steel tile roof with a high-temperature workshop below	Prohibited; switch to a clamp-based solution or replace the module	8.1.1
7	Use of inferior structural adhesive	Use designated SMG533	8.3.1
8	Mixing MC4 Connectors from Different Brands	Must Use the Same Manufacturer/Model	9.7
9	Direct Bonding on Fine Aggregate Mortar Concrete Roof	Grinding + Waterproof Emulsion + Pull-out Test	8.1.2
10	Water Rinse Pressure > 0.2 MPa	Control Within 0.1–0.2 MPa	10.1.2
11	Open-Circuit Voltage Low-Temperature Correction Not Considered	Use the Cvoc formula or correction factor table	9.2
12	Inverter not equipped with AFCI	Mandatory requirement: inverter with AFCI	9.5
13	Array spacing only 200 mm	≥400 mm	7.2
14	Modules installed near skylight without reserving 2H distance	Distance from skylight ≥ 2H	7.3.2
15	On-site drilling or modification of PV modules is strictly prohibited.	Failure to comply will void the warranty.	11.3

Chapter 14 Appendices

Appendix A: Specified Structural Adhesive Parameters (Guangzhou Baiyun SMG533)

Project	Parameter
Model	SMG533 Structural Adhesive for PV Applications
Manufacturer	Guangzhou Baiyun Technology Co., Ltd.
Specification	590 mL per cartridge

Color	White
Tensile Strength	≥ 1.5 MPa (after curing)
Elongation at Break	≥ 250%
Minimum Application Temperature	≥ 0°C
Recommended Application Temperature	4.4–35°C
Curing Time	24 h @ 25°C
Warranty Period	25 Years

Appendix B: Profiled Steel Sheet Roof Type and Installation Method Compatibility Table

Roof Tile Type	SolarVela – Direct Bonding	SolarVela + Square Tube	SolarNoah – Clamp Mounting	SolarPega – Direct Bonding	Pega+ Square Tube	PegaF Clamp
T-Type	✅	✅	✅	✅	✅	✅
Wavy Type	✅	–	✅	✅	–	
Angle-Batten Type	❌	✅	✅	❌	✅	✅
Standing Seam Type	❌	✅	✅	❌	✅	✅
Vertical Standing Seam Round Type	❌	✅	✅	❌	✅	✅

Appendix C: Temperature Coefficient Quick Reference Table (TDS Data)

Series	α_Voc (%/°C)	β_Pmpp (%/°C)	δ_Isc (%/°C)	NOCT (°C)
SolarVela (PERC)	–0.28	–0.34	+0.05	45±2
SolarVela Pro / Max (TOPCON)	–0.26	–0.29	+0.045	45±2
SolarNoah (PERC)	–0.28	–0.34	+0.05	45±2
SolarNoah Pro / Max (TOPCON)	–0.26	–0.29	+0.045	45±2

Appendix D: List of Items Corrosive to PV Connectors

During the design phase, avoid arranging modules in areas where the following chemicals may come into contact:

Category	Substance
Acids & Alkalis	Sodium chloride, Sodium bicarbonate, Hydrogen peroxide, Calcium chloride, Sodium hydroxide, Ammonia water, Borax, Calcium carbonate, Alum
Oxidizing Agents	Hydrogen peroxide, Sodium hypochlorite bleach, Potassium permanganate, Chlorine, Ozone, Swimming pool disinfectant, Industrial oxidizing agents
Organic Solvents	Acetone, Toluene, Xylene, Benzene, Carbon tetrachloride, Dichloromethane, Paint thinner, Nail polish remover, High-concentration ethanol/isopropanol, Turpentine, Tetrahydrofuran

Appendix E: Abnormal Installation Surfaces and Treatment Methods

Abnormal Condition	Treatment Method	Follow-up Requirement
Corroded Color Steel Tile	Repaint with professional refinishing paint (3–5 year cycle)	Recheck pull-out force after renovation
Fine-aggregate mortar concrete roof	Angle grinder polishing + waterproof latex coating	Single-point pull-out force ≥ 40 kg, sampling rate > 1%
Waterproof membrane blistering	Manufacturer treatment/renovation	Single-point pull-out force ≥ 40 kg, sampling rate > 1%
Corrugation rivet interference	Adjust square tube position or remove rivets	Do not compromise waterproofing
Ridge-to-eave seam	Place seams between modules	Single module shall not cover seams

Appendix F: SolarVela/Noah Module String Electrical Parameters (Typical Values)

Parameters	SolarVela	SolarVela Pro/Max	SolarNoah	SolarNoah Pro/Max
STC Pmax (W)	510–520	550–560	510–520	550–560
Vmp (V)	41.43–42.04	45.19–45.29	41.43–42.04	45.19–45.29
Voc (V)	49.76–49.9	52.96–53.05	49.76–49.9	52.96–53.05
Imp (A)	12.31–12.37	12.18–12.37	12.31–12.37	12.18–12.37

Isc (A)	12.74–13.09	12.92–12.96	12.74–13.09	12.92–12.96

Appendix G: SolarPega Module String Electrical Parameters (Typical Values)

Parameter	SolarPegaL / PegaFL	SolarPega / PegaF
STC Pmax (W)	500–510	510–520
Vmp (V)	33.76–33.91	33.58–33.79
Voc (V)	39.72–40.03	39.46–39.78
Imp (A)	14.83–15.06	15.19–15.40
Isc (A)	15.36–15.45	15.78–15.84

Appendix H: Reference Terminology and Abbreviations

Abbreviation	Full Name	Chinese
STC	Standard Test Conditions	Standard Test Conditions (1000 W/m², 25°C, AM 1.5)
NMOT	Nominal Module Operating Temperature	Nominal Module Operating Temperature (800 W/m², 20°C, 1 m/s)
MPPT	Maximum Power Point Tracking	Maximum Power Point Tracking
AFCI	Arc-Fault Circuit Interrupter	Arc Fault Circuit Interrupter (AFCI)
SPD	Surge Protective Device	Surge Protective Device
TDS	Technical Data Sheet	Technical Data Sheet
BIPV / BAPV	Building Integrated / Attached PV	Building Integrated PV / Building Attached PV

Chapter 15: Technical Support and Contact Information

For special scenarios, specific models, or custom requirements not explicitly covered in this General Specification, design institutes and engineers must proactively contact the ZKFN Solar technical team for specialized technical support before finalizing the design plan:

Shandong ZKFN Solar Technology Co., Ltd.

- Address: Building 1, Xinshenglin, Lvhaihui Intelligent Manufacturing Industrial Park, Jining Economic Development Zone, Jining City, Shandong Province
- Service Hotline: 400 6768 100

- Technical Support Email: tech-support@zkfnsolar.com
- Official Website: www.zkfnsolar.com

Project Types Requiring Mandatory Coordination with ZKFN Solar

- Overseas projects (including but not limited to Europe, Southeast Asia, the Middle East, North America, Africa, and South America);
- Nearshore projects (distance from coastline < 500 m);
- Irregular/curved/arched roof projects;
- High-altitude projects (> 2000 m);
- High seismic intensity projects (≥ 8 degrees);
- BIPV projects with special customization (color, pattern, size, power rating);
- Design for large-scale O&M involving walkable areas of SolarPega.
- Non-stationary application scenarios (e.g., carports, foldable power stations).

Document Description

- This General Guideline is the 2026 edition, compiled based on ZKFN Solar's product specification sheets, the "SolarVela & SolarNoah Series Installation Work Instructions," the "SolarPega / PegaF Series Installation Guide Manual," and the "Limited Warranty."
- Should product specifications be upgraded, the latest TDS and installation work instructions published on ZKFN Solar's official website shall prevail.
- In the event of any conflict between this Design Guide and the terms of ZKFN Solar's official installation work instructions or limited warranty, the installation work instructions and limited warranty shall take precedence.
- The final right of interpretation is vested in Shandong ZKFN Solar Technology Co., Ltd.