Valin RailBase™

Technical White Paper

The Technical Guide to Non-Penetrating Solar Mounting
on TPO/PVC/EVA/EPDM Membrane Roofs

Valin New Energy Co., Ltd.

Version 1.0 — May 2026

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Executive Summary

The global commercial roofing market is undergoing a profound transformation. With over 4 billion square meters of low-slope membrane roofs (TPO, PVC, EVA, EPDM) installed across industrial and commercial buildings worldwide, the opportunity for rooftop solar integration is immense — yet fraught with technical complexity.

The central challenge is clear: **how do you install solar on a single-ply membrane roof without compromising its waterproof integrity?**

Traditional penetration-based mounting methods puncture the membrane, creating leak paths that can void roof warranties, shorten roof lifespan, and introduce costly remediation risks. Ballasted systems, while non-penetrating, add thousands of kilograms of dead load — often exceeding structural capacity, especially on retrofitted industrial roofs.

Valin RailBase™ offers a fundamentally different approach: a hot-air welded, non-penetrating integrated membrane-rail base built on two core engineering differentiators:

1. **No Perforation** — The RailBase™ is hot-air welded directly to the membrane, forming a homogeneous molecular bond. Zero roof penetrations means zero leak paths, full preservation of the membrane warranty, and 100% waterproof integrity.

2. **Wide-Base + Long Rail Design — Linear Load Distribution** — Unlike competing systems that use discrete point supports (creating concentrated stress on the membrane), RailBase™ features a wide bottom flange (70mm) combined with continuous long-rail profiles (R250/R500/R1000/R1840). This design distributes the PV array load linearly across the membrane surface, eliminating localized stress points. The result: no panel sagging, superior snow load performance, and uniform load transfer to the roof structure.

Additional system benefits:

- **High wind uplift resistance — 4,000 N certified** (SGS-tested), enabled by the welded bond and wide-base geometry
- **40% faster installation** vs. traditional multi-component bracket assembly
- **20+ GW annual production capacity** across 5 manufacturing bases
- **Compatibility with 99% of roof membrane suppliers**

This white paper provides engineers, EPC contractors, building owners, and solar developers with a comprehensive technical reference for membrane roof solar mounting, covering product design, engineering validation, comparative analysis, and installation best practices.

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The Membrane Roof Solar Market: Opportunity and Challenge

Market Context

The global low-slope roofing market is dominated by single-ply membranes, with TPO (Thermoplastic Polyolefin) representing the fastest-growing segment due to its energy-reflective properties and durability. According to industry data:

- **TPO** accounts for ~40% of the U.S. low-slope roofing market
- **PVC** holds ~25%, with strong presence in Europe

- **EPDM** represents ~20%, primarily in retrofit applications

- **EVA** is emerging in Asia-Pacific markets

These roofs cover the vast majority of modern industrial parks, logistics centers, big-box retail, and commercial buildings — making them prime candidates for solar installation.

The Membrane Roof Paradox

Membrane roofs are ideal for solar because they are:

- Large, unobstructed surfaces with optimal sun exposure

- Typically newer or recently retrofitted, with decades of remaining service life

- Located on buildings with high daytime energy consumption

Yet they are uniquely vulnerable to penetration. A single screw or fastener through a TPO/PVC membrane creates a leak path that:

1. Voids the roof membrane manufacturer's warranty

2. Requires ongoing maintenance of sealants and flashings

3. Increases long-term risk of water intrusion and structural damage

4. Complicates insurance and building owner liability

Industry Responses and Their Limitations

Approach	Limitation
Penetration mounting	High leak risk; voids membrane warranty; ongoing maintenance burden
Full ballast systems	Heavy (15–25 psf); requires structural reinforcement; costly logistics
Adhered/glue-based	Questionable long-term bond durability; UV degradation; not reworkable
Hybrid ballast+penetration	Compromises both approaches; complex engineering

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The RailBase™ Innovation: Integrated Membrane-Rail Design

Design Philosophy

Valin RailBase™ reimagines the solar mounting base as an integrated component of the roof membrane. Rather than attaching a separate bracket and rail assembly to the roof, RailBase™ combines the membrane attachment base and the solar rail into a single extruded profile.

The core engineering insight: In single-ply membrane roofs, the greatest vulnerability is not wind uplift — it is concentrated point loading. Competing systems use discrete L-feet, pucks, or adhesive pads that concentrate the entire panel load into small membrane areas. Over thermal cycles and snow loads, these point stresses can cause membrane creep, dimpling, weld fatigue, and micro-tears around adhesive bonds.

RailBase™ solves this with a **wide-base, long-rail architecture** that converts point loads into linear distributed loads.

The Wide-Base Principle

The RailBase™ bottom flange spans **70 mm in width** — significantly wider than industry-standard point-support bases (typically 20–25 mm). This wide base:

- **Spreads load over a larger membrane area**, reducing localized stress by 50–60% vs. point supports
- **Eliminates membrane dimpling** common with discrete L-foot systems
- **Provides a stable welding platform** for homogeneous fusion with the membrane
- **Resists peel forces** from wind uplift by distributing tension across the full weld width

Long Rail — Linear Load Distribution

Unlike conventional systems that mount panels on discrete support points, RailBase™ uses continuous aluminum rail profiles (R250, R500, R1000, R1840) that serve as both the membrane-attached base and the panel-supporting rail:

Model	Length (mm)	Application	Load Distribution
R250	250	Short support / clamp base	Linear across 250 mm
R500	500	Mid-span panel support	Linear across 500 mm
R1000	1,000	Standard panel support	Linear across 1,000 mm
R1840	1,840	Full-length panel support	Linear across full panel length

The mechanical advantage:

- **Point-support systems:** Load concentrates at 4–6 discrete points per panel → membrane stress peaks at each contact point → risk of creep and fatigue over time
- **RailBase™ linear distribution:** Load spreads continuously along the entire panel length → no stress peaks → no sagging → superior snow load capacity

This is especially critical for **snow load performance**: RailBase™'s continuous support prevents the panel from sagging between supports, eliminating the risk of snow accumulation pockets and cell microcracking that plague discrete-support systems in heavy snow regions.

Key Design Features

3.4.1 Integrated Base-Rail Profile

The RailBase™ series consists of extruded aluminum profiles that serve dual functions:

- **Base function:** The wide bottom flange is hot-air welded directly to the TPO/PVC/EVA/EPDM membrane, forming a homogeneous bond with the roof
- **Rail function:** The top channel accepts PV panel clamps and tilt supports without additional bracket components

3.4.2 Material Specification

- **Material:** 6063-T5 aluminum alloy
- **Coating:** Anodized (min. 15μm)
- **Thermal compatibility:** Coefficient of thermal expansion matched to PV module frames
- **Weight:** Standard 1.8kg/m (custom models vary by profile)
- **Temperature range:** -40°C to +90°C

3.4.3 Homogeneous Welding Technology

The RailBase™ uses the same hot-air welding process used in original roof membrane installation:

- Welding temperature: 500–620°C (adjustable per membrane type)
- Weld width: ≥ 40 mm
- Peel strength: > 120 N/50mm (TPO), > 100 N/50mm (PVC)
- The weld creates a molecular bond — the base becomes part of the membrane

3.4.4 Wind Load Performance

SGS testing confirms RailBase™ achieves **4,000 N wind uplift resistance** — exceeding the requirements of most building codes for non-penetrating systems.

Table: RailBase™ Model Specifications

Model	Length (mm)	Profile Height (mm)	Panel Positions	Weight (kg)	Load Capacity (N)
R250	250	80	4 panel supports	0.9	2,000
R500	500	80	4 panel supports	1.8	3,000
R1000	1,000	80	4 panel supports	3.6	4,000
R1840	1,840	80	3 full-rail length	7.7	6,000

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No-Perforation Solution Product Portfolio

V-NP-F — Flat Installation Bracket

The V-NP-F is the foundational no-perforation solution for membrane roofs. Solar panels are mounted directly to the RailBase™ with a 0° tilt (parallel to roof surface).

Technical Specifications:

- **Panel orientation:** 0° flat (horizontal)
- **Wind resistance:** ≥ 4,000 N (SGS tested)
- **Inter-row spacing:** Not required (flat mounting)
- **Ideal for:** Flexible panels, bifacial panels, low-angle installations
- **Standard panel sizes:** All standard commercial panels (1,500–2,500 mm)
- **Material:** Aluminum 6063-T5 + Aluminum 6063-T5 clamps + SS304 bolts
- **Installation rate:** 300–400 panels/day per crew

Key Advantages:

- Lowest profile (minimal wind exposure)
- Maximum panel density per roof area
- No inter-row shading
- Simplest installation sequence

V-NP-S — South-Facing Tilted Installation Bracket

The V-NP-S adds adjustable front/rear support columns to the RailBase™ base, orienting panels at a 10° south-facing tilt.

Technical Specifications:

- **Panel orientation:** 10° south-facing tilt
- **Wind resistance:** ≥ 3,500 N (SGS tested)
- **Tilt angle:** 10° standard (5°–15° customizable)
- **Ideal for:** Maximizing energy yield in higher latitudes
- **Self-cleaning:** 10° tilt reduces dust accumulation vs. flat mounting
- **Standard panel sizes:** All standard commercial panels

Key Advantages:

- 10–18% higher annual energy yield vs. flat mounting (depending on latitude)
- Reduced soiling and self-cleaning via rainwater runoff
- Compatible with both glass-glass and glass-backsheet modules

V-NP-EW — East-West Installation Bracket

The V-NP-EW creates an east-west-facing "butterfly" configuration, with panels tilted 10° in opposing directions along the same base row.

Technical Specifications:

- **Panel orientation:** ±10° east-west (alternating)
- **Wind resistance:** ≥ 3,500 N — enhanced aerodynamic profile
- **Tilt angle:** 10° standard (adjustable)
- **Ideal for:** Low latitude regions, large roof areas, windy environments
- **Standard panel sizes:** All standard commercial panels

Key Advantages:

- Superior wind performance (aerodynamic profile)
- More uniform daily generation curve (peak clipping)
- Higher roof coverage ratio vs. south-facing tilted
- No inter-row spacing required within EW pairs
- Compatible with string inverter and microinverter topologies

V-NP-FP — Flexible Panel Bracket

The V-NP-FP is specifically optimized for lightweight flexible PV panels, addressing the unique challenge of panel sagging that causes microcracking in thin-film and lightweight modules.

Technical Specifications:

- **Panel length support:** 1,000–2,500 mm
- **Support base spacing:** Adjustable per panel stiffness
- **Patent-pending extended base design:** Continuous bottom support eliminates sagging
- **Ideal for:** CIGS thin-film, lightweight glass-free modules, adhesive-backed flexible panels

Key Advantages:

- Eliminates cell microcrack risk from panel sagging
- Full-length bottom support for flexible modules

- Ultra-light system weight (as low as 3.5 kg/m²)
- Compatible with adhesive or clamp mounting

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Ballasted Solution Portfolio

For roof structures with adequate load-bearing capacity, Valin offers ballasted mounting solutions using concrete blocks or paver stones instead of welding to the membrane.

V-B-EW — East-West Ballasted System

- **Materials:** Aluminum 6063-T5 + Aluminum 6063-T5 clamps + SS304 bolts + Magnelis®-coated steel
- **Panel orientation:** East-west ballasted configuration
- **Ballast type:** Concrete blocks / paver stones (site-sourced or precast)
- **Corrosion protection:** Magnelis® coating (Zn-Al-Mg alloy) for extended service life
- **Modular expansion:** Easily expandable for phased installations

V-B-S — South-Facing Tilted Ballasted System

- **Materials:** Aluminum 6063-T5 + Aluminum 6063-T5 clamps + SS304 bolts + Magnelis®-coated steel
- **Panel orientation:** South-facing tilted ballasted configuration
- **Load distribution:** Optimized frame design minimizes point loads on roof membrane
- **Anti-slip protection:** Integrated rubber padding under all contact points

Ballasted vs. No-Perforation: Selection Guide

Factor	No-Perforation (NP)	Ballasted (B)
Roof load	Minimal (~2–5 kg/m²)	High (~15–30 kg/m²)
Wind uplift	4,000 N (welded)	Dependent on ballast weight
Roof structural capacity	No constraint	Must verify
Membrane warranty	Compatible (welded)	Compatible (no penetration)
Installation speed	Fast (welding + mounting)	Slower (ballast placement)
Retrofit access	Good	Requires ballast material logistics

Best for	Lightweight roofs, new builds	Strong concrete decks, retrofit

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Engineering Validation: SGS Wind Uplift Testing

Test Overview

In 2024, Valin commissioned **SGS** (Société Générale de Surveillance) — the world's leading testing, inspection, and certification company — to conduct rigorous wind uplift testing on the RailBase™ integrated membrane-rail system.

Test Methodology

- **Test standard:** Based on ASTM E1592 / European EN 1991-1-4 wind loading protocols
- **Test specimen:** RailBase™ R1000 hot-air welded to 1.5 mm TPO membrane (Firestone UltraPly TPO)
- **Test fixture:** Full-scale roof assembly on insulated deck
- **Loading protocol:** Cyclic pressure loading at incremental steps until failure

Test Results

Parameter	Value
Maximum uplift resistance	4,000 N
Failure mode	Membrane delamination from substrate (not weld failure)
Weld integrity	100% intact at maximum load
Safety factor (typical design)	2.0–2.5 (using 1,600–2,000 N design wind load)

Interpretation

The 4,000 N result means that under the most common design wind speeds (110–140 km/h, corresponding to ASCE 7-16 Exposure C), the RailBase™ system operates at **less than 50% of its certified capacity**, providing substantial safety margin.

For project-specific wind load calculations, Valin's engineering team provides custom structural analysis using ANSYS and PKPM software, incorporating local building codes, roof height, exposure category, and topographic factors.

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Comparative Analysis: Valin vs. Competing Solutions

Competitive Landscape Overview

The membrane roof solar mounting market includes several established competitors. The following analysis compares Valin RailBase™ against the leading solutions.

Criterion	**Valin RailBase™**	Esdec SolarDock	Schletter FS Eco	K2 Dome 6	EcoFasten SolarSeal
Mounting principle	Hot-air welded integrated base	Adhesive/mechanical base + separate rail	Aluminum rail + ballast tray	Ballast block + rail	Adhesive flashing + L-foot
Penetration required	No	No (adhesive) / Yes (mechanical)	No	No (ballast)	Yes (flashing)
Wind uplift (SGS)	4,000 N	~2,500 N (adhesive reported)	N/A (ballast-dependent)	N/A (ballast-dependent)	~2,000 N
Integrated rail-base	Yes — single profile	No — separate components	No — separate components	No — separate components	No — separate components
Installation speed	+40% faster(pre-assembled)	Standard	Standard	Standard	Standard
Membrane compatibility	TPO/PVC/EVA/EPDM	TPO/PVC	All (ballast)	All (ballast)	TPO/PVC
Panel compatibility	All types incl. flexible	Standard framed	Standard framed	Standard framed	Standard framed
Weight on roof	Minimal (3–5 kg/m²)	Low	Moderate (ballast)	High (ballast)	Low
Factory pre-assembly	Yes — RailBase arrives ready	No	No	No	No
Minimum order (containers)	Flexible	Standard MOQ	Standard MOQ	Standard MOQ	Standard MOQ
Price positioning	Competitive	Premium	Premium	Premium	Mid-range
20+ GW capacity	Yes	No	No	No	No
Global logistics	5 manufacturing bases	Limited	Regional	Regional	Regional

Analysis of Key Differentiators

RailBase™ Advantages:

1. **Hot-air welded molecular bond vs. adhesive:** Adhesive-based systems (e.g., Esdec SolarDock adhesive variant) rely on acrylic or butyl adhesives whose bond strength degrades over time with UV exposure, thermal

cycling, and moisture intrusion. RailBase™ homogeneous welding creates a permanent molecular bond identical to the membrane seams.

2. **Integrated profile vs. multi-component:** Competitors typically require 3–5 separate components (base plate, bracket, rail, clamps, fasteners). RailBase™ combines base and rail into a single profile with pre-assembled delivery — reducing installation time by ~40%.

3. **Flexible panel support:** No competitor offers a dedicated solution for lightweight flexible panels with full-length bottom support, which is critical for preventing microcracks.

4. **Manufacturing scale:** Valin's 20 GW annual production capacity across 5 bases provides unmatched supply chain reliability vs. regional competitors.

Engineering Services Comparison

Service	Valin	Esdec	Schletter	K2
Custom wind/snow load calc	✓ (ANSYS, PKPM, SAP)	✓	✓	✓
On-site engineering support	✓	Limited	Limited	Limited
Structural analysis report	✓	✓	✓	✓
Installation training	✓	✗	✗	✗
Geological survey	✓	✗	✗	✗

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Installation Methodology & Quality Control

Installation Sequence (No-Perforation NP Series)

Step 1 — Roof Survey & Layout

- Verify membrane type (TPO/PVC/EVA/EPDM) and thickness
- Confirm roof structural capacity
- Mark panel layout per engineering drawings
- Temperature check: installation recommended at 10°C–35°C

Step 2 — RailBase™ Layout & Positioning

- Position RailBase™ units per layout plan
- Maintain consistent row spacing (typically 1,000–1,800 mm depending on panel)
- Clean membrane surface with isopropyl alcohol at welding zone

Step 3 — Hot-Air Welding

- Preheat hot-air welder to 500–620°C (depending on membrane material and thickness)
- Weld speed: ~0.5–1.5 m/min (adjust for ambient temperature)
- Weld pressure: apply consistent downward pressure to ensure full contact
- Visual inspection: weld bead should be visible along full length

Step 4 — Weld Quality Inspection

- Peel test: ≥ 120 N/50mm for TPO, ≥ 100 N/50mm for PVC
- Visual check for voids, discoloration, or incomplete fusion
- Spark testing for pinhole detection (optional)

Step 5 — Panel Mounting

- Attach support columns or clamps to RailBase™ top channel
- Place PV modules on supports
- Secure with stainless steel clamps at specified torque
- Wire management: route cables through integrated cable clips

Step 6 — Electrical & System Commissioning

- Connect string wiring
- Verify grounding/bonding per local code
- Perform I-V curve test
- Commission monitoring system

Quality Assurance

Checkpoint	Method	Frequency
Raw material (aluminum)	Spectrometer analysis, tensile test	Per batch
RailBase™ dimensional tolerance	CMM (Coordinate Measuring Machine)	Every 100 units
Anodizing thickness	Eddy current gauge	Per batch
Weld peel strength	Portable peel tester	Every row
Wind uplift (witness test)	SGS-scale test	Per project (≥ 1 MW)
Final inspection	Visual, torque check	100%

ISO-Certified Manufacturing

Valin operates under ISO 9001:2015 (Quality Management), ISO 14001:2015 (Environmental Management), and ISO 45001:2018 (Occupational Health & Safety) certified processes, with 7S management on all production floors.

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Global Project References

Selected Membrane Roof Projects

Project	Location	Capacity	Product	Year
SVOLT	Zhejiang, China	35 MW	V-NP-F	2023
JAHWA	Shanghai, China	4 MW	V-NP-F	2023
Hörmann	Jiangsu, China	0.9 MW	V-NP-F	2023
Vaillant	Jiangsu, China	2 MW	V-NP-F	2024
Vandewiele	Jiangsu, China	4.5 MW	V-NP-F	2023
Boysen	Tianjin, China	2 MW	V-NP-S	2025
Boysen	Liaoning, China	0.85 MW	V-NP-S	2023
Naumburg	Saxony, Germany	0.3 MW	V-NP-EW (PVC)	2023
Ilfov	Ilfov, Romania	2 MW	V-NP-F	2025
Ilfov - Flexible	Ilfov, Romania	1 MW	V-NP-FP	2023

Notable highlights:

- **SVOLT 35 MW** — the largest single membrane roof solar installation in China using non-penetrating technology
- **JAHWA 4 MW** — successfully withstood Typhoon-level winds (Category 13 equivalent) in Shanghai
- **Ilfov, Romania 2 MW** — European flagship demonstrating RailBase™ on European TPO membrane systems

Total Deployment

Metric	Value
Total supplied since 2021	3 GW+(all mounting types)
Membrane roof projects	25+ projects across 8 countries
Largest single membrane roof	35 MW (SVOLT)
Geographic coverage	Asia, Europe, Australia

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Certifications, Patents & Quality Assurance

Certifications

- **ISO 9001:2015** — Quality Management System
- **ISO 14001:2015** — Environmental Management System
- **ISO 45001:2018** — Occupational Health & Safety
- **CE (EN 1090-1:2009+A1:2011)** — European Structural Component Certification
- **SGS** — Third-party wind uplift testing
- **Production capacity:** 20 GW/year across 5 manufacturing bases

Intellectual Property

Valin New Energy holds multiple invention patents and utility model patents covering:

- Novel photovoltaic bracket installation structures
- Membrane roof photovoltaic mounting systems (RailBase™ family)
- Modular quick-installation photovoltaic carports
- Distributed solar trackers
- Lightweight concrete roof brackets
- Flexible panel mounting apparatus (patent pending)

Manufacturing Infrastructure

Base	Location	Specialty	Capacity (GW)
Base 1	Changzhou, Jiangsu	Membrane roof systems	10
Base 2	Northern China	Ground-mount / steel	4
Base 3	Southern China	Pitched roof / aluminum	3
Base 4	Central China	Ballasted systems	2
Base 5	Eastern China	BIPV / specialty	1

Strategic proximity to Shanghai Port (300 km) ensures efficient global logistics.

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Conclusion & Outlook

Summary

The Valin RailBase™ system represents a fundamental rethinking of how solar panels should be mounted on membrane roofs. By eliminating the artificial distinction between "base" and "rail," the integrated profile approach delivers:

- **Superior waterproof protection** through homogeneous membrane welding
- **Faster installation** through factory pre-assembly and reduced part count
- **Proven wind resistance** validated through SGS third-party testing
- **Scalable manufacturing** with 20 GW annual capacity
- **Comprehensive engineering support** from site survey to commissioning

Future Development Roadmap

Valin continues to invest in membrane roof mounting technology, with active R&D programs in:

1. **Next-generation RailBase™ profiles:** Lower weight, higher load capacity
2. **Integrated cable management:** AI-assisted layout optimization for wire routing
3. **Monitoring integration:** Temperature and strain sensors embedded in RailBase™ bases
4. **Circular economy:** Recyclable aluminum profiles with take-back program
5. **BIPV integration:** Direct membrane roof integration of building-integrated PV modules

Call to Action

For technical inquiries, project-specific engineering support, or to request a sample:

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