Appendix 1

AluGrid

The flat roof system with optimized superimposed load

- quick, simple and mainly tool-free mounting
- reduced number of components
- economically efficient
- system structural analysis based on the latest research on wind dynamics

On many flat roofs, the area that can be used for photovoltaic installations can be enlarged by using load-optimized systems. Besides the systems that have been proven for years like CompactVario, SolRack, Windsafe, SolTube, etc., the **AluLight** system is a further system that can be used for the fastening of modules on flat roofs with minimum superimposed loads in completely closed rows and a fixed elevation angle of 15 degrees.

The components are connected using our well-proven Klick-system. The modules are mounted using screw-less module clamps (spring clamps) that are fastened to the substructure.

The loading can be optimized according to the structural requirements.

By using approved aluminum materials, both a virtually unlimited duration even with high UV-irradiation and certain acceptance in structural expertises is safeguarded.

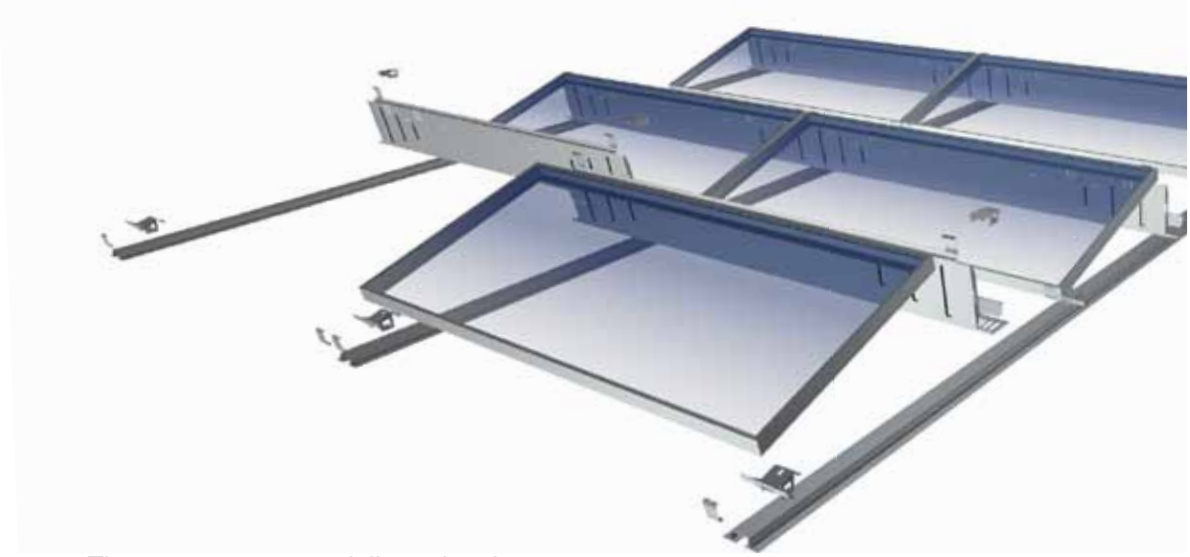
Loading: Concrete stones (for example curb stones, paving stones), gravel etc.
A special structural analysis regarding the superimposed load has to be carried out in order to determine the required loading. This structural analysis is available on our website or in combination with a shade distance calculation within the framework of the offer calculation.

Module clamping: Module spring clamps are available for module heights from 30-51 mm. There is a range of Windsafe metal sheets that can be chosen from for all module sizes that are available on the market. The modules are clamped in the edge areas of the longitudinal sides. The customer has to check whether the clamping area determined by the module producer is maintained. A pair of special pliers is required for the mounting of the modules. Please find more information about this matter in the AluGrid mounting instruction.

In order to avoid any damaging of the flat roof membrane, EPDM form rubber parts can be ordered as complete rolls that are cut to size, accordingly. When rubber parts with a length of 300 mm and distances of maximally 100 mm are installed, water can drain off parallel to the continuous beam. The amount of water draining off depends on the amount of precipitation on location and the shape of the roof. The drain-off section required has to be checked by the customer.

Dimensioning: User-friendly dimensioning with our auto-calculator (Schletter creates a structural analysis regarding the superimposed loads).

Components	
166501-006	Continuous beam 6m
166501-004	Continuous beam 4m
166501-001	Continuous beam customized cut
169005-001	Interior connector kit
166003-001	Support rubber for continuous beam 6 mm, rolled material
169007-116	Windsafe W940-1019 L1300-1360
169007-146	Windsafe W940-1019 L1440-1500
169007-164	Windsafe W780-859 L1560-1620
169007-174	Windsafe W780-859 L1621-1680
169007-176	Windsafe W940-1019 L1621-1680
169007-186	Windsafe W940-1019 L1681-1740
169007-236	Windsafe W940-1019 L1940-2000
169007-001	End cap for Windsafe, module width W790-859
169007-002	End cap for Windsafe, module width W940-1019
166002-001	Fastening clamp
166002-002	Lower module support
166001-030	Module clamps for module thickness 30/31mm
166001-032	Module clamps for module thickness 32/33mm
166001-034	Module clamps for module thickness 34/35mm
166001-036	Module clamps for module thickness 36/37mm
166001-038	Module clamps for module thickness 38/39mm
166001-040	Module clamps for module thickness 40/41mm
166001-042	Module clamps for module thickness 42/43mm
166001-044	Module clamps for module thickness 44/45mm
166001-046	Module clamps for module thickness 46/47mm
166001-048	Module clamps for module thickness 48/49mm
166001-050	Module clamps for module thickness 50/51mm



Setting up: The components are delivered to the site as single parts and are assembled on location in just a few simple work steps.

© Schletter GmbH · Gewerbegebiet an der B15 · Alustraße 1 · 83527 Kirchdorf/Haag i. OB · Germany · Phone: +49 8072 9191-200
Fax: +49 8072 9191-9200 · E-mail: solar@schletter.eu · www.schletter.eu · updated 10/2011 · subject to change without notice
Your contact in the UK: Schletter UK Limited, Phone: +44 1296 461 800, Fax: +44 1296 461 801, E-mail: info@schletter.co.uk

Support rubber: We recommend to install the support rubber (6 mm rolled material 166003-001) as a building protection element between the AluGrid continuous beam and the roof cladding of the flat roof. We recommend to lay the rubber without interruptions. The rubber can be attached to the profiles. A drainage system on the roof has to be provided, too. The ideal flow direction is parallel to the continuous beams. If the flow direction is not parallel, the rubber can be interrupted. We recommend a support length of 300 mm and gaps of 100 mm. The openings that are created like that allow a draining off of the water horizontally to the cross beams. The customer has to check, if the quantity of the water that can drain off is sufficient.

The support rubber is made of high-value EPDM material. Damage to the EPDM-profile by direct contact between materials that are used on the roof can largely be ruled out. The compatibility with Bitumen roofing membranes is excellent and all plastic roofing membranes we know do not harm the EPDM-profile in any way. Some manufacturers gave us their approval for the application of the EPDM-profile on their roofing membranes. As there are so many different roofing membranes on the market, it is not possible to get an approval for this kind of application for all types of roofing membranes. With roofing membranes by other manufacturers, the customer has to check the compatibility of material with the manufacturer. A potential incompatibility of materials with PVC roofing membrane due to plasticizer migration is a well-known fact.

Compatibility of AluGrid support rubbers with roofing membranes.

Manufacturer	Product information	Feedback	Material compatibility
Alwitra	Evalon white	yes	conditional approval*
	Evalon grey		conditional approval*
	Evalon colored		conditional approval*
	Evalastic „R“ grey		conditional approval*
Hirler	VAEplan white	yes	approval granted
	VAEplan grey		approval granted
	VAEplan colored		approval granted
Polyfin	Polyfin 1020 light grey	yes	no objections
	O.C.-Plan 3020 black		no objections
Sika	Sikaplan S15 light grey	yes	not compatible**
	Sikaplan S15 anthracite		not compatible**
	Sikaplan SgmA 15 beige		not compatible**
	Sika Sarnafil T66-15 D beige		not compatible**

* In the course of time, discolorizations and/or other imprints in the roof membrane surface may occur. But according to our long-term practical experience, this does not lead to any deterioration.

** application is only possible with special safety measures, for example separation layers according to manufacturer´s instructions

Potential connection: All connections within the AluGrid system are conductive and designed with cross sections that are sufficient for an electrical grounding according to the accordant technical standards. Thus, the internal potential connection of the rack is fully safeguarded. In contrast to other systems with common middle clamps, the module frame is also conductively integrated into the rack by the utilization of toothed high-grade steel clamps. This results in a complete potential connection within the system. Thus, it is sufficient for the integration of the rack into the potential equalization to connect the rack at one point with an earthing conductor that has a sufficient cross section and to connect this grounding conductor to the main electrical grounding terminal of the building.

Lightning ampacity: The lightning protection of a solar plant respectively the building below the solar plant generally has to be planned by the system supplier. The expression “lightning ampacity” is used for connections, clamps etc. that actively have to deduct lightning current within the framework of the lightning protection system. Each of these components has to be tested and certified within the framework of a special test.

The **lightning ampacity of a rack system** is usually not relevant for this problem, as the load-bearing system is not used as a conductor or as a lightning rod as part of the external lightning protection. The lightning protection usually has to be planned completely independent from the solar plant.
Usually, a defined separation distance between the solar plant and the lightning protection plant has to be maintained.

In certain cases, it is also admissible to connect the rack system to the lightning protection system, but in this case the coupling of partial lightning currents has to be reckoned with. In this case, it is important that the internal connections of the rack are connected with an accordant low impedance and at the same time with a sufficient cross section. Both is safeguarded with the AluGrid system.

Technical data

Material	Windsafe metal sheet and end cap: AlMg3; continuous beam: Alu ENAW6063; profile rubber: EPDM; Lower module support 1.4301; Fastening clamps and module clamps: 1.4310
Structural analysis	Structural analysis according to the current specific national standards (in Germany DIN1055 and EC1). Structural analysis attachment on the dimensioning of the number of the required fastening spots, By all means, consider the information on structural safety!

Get all our system prices fast and easily with our auto-calculator!
Further information and declaration of warranty at www.schletter.eu

© Schletter GmbH · Gewerbegebiet an der B15 · Alustraße 1 · 83527 Kirchdorf/Haag i. OB · Germany · Phone: +49 8072 9191-200
Fax: +49 8072 9191-9200 · E-mail: solar@schletter.eu · www.schletter.eu · updated 10/2011 · subject to change without notice
Your contact in the UK: Schletter UK Limited, Phone: +44 1296 461 800, Fax: +44 1296 461 801, E-mail: info@schletter.co.uk

Schletter UK Limited

Unit 4 Premus, Brunel Park Coldharbour Way
Aylesbury, HP19 8AP

Phone: +44 1296 461 800
Fax: +44 1296 461 801

info@schletter.co.uk

http://www.schletter.co.uk/

Planning documentation for the bearing system AluGrid for solar modules

Project: Parker Tower

Module type: 270w 1640 x 992 mm

By order

Engie

March 2017

System dimensioning

Preliminary remarks

The following design calculations apply for multi-span mounting systems in midland areas with regular conditions. In coastal areas and exposed locations (with special terrain formation), the consideration of higher wind loads is required. In these cases,

---

Customer	Engie
Project	Parker Tower

Construction site

Street	Parker Street
Postal code - Town/City	WC2B London
Country	United Kingdom
Geographic coordinates	51.5084° North 0.1255° West
Height above sea level	25 m

Solar module

Height / Width / Thickness	1640 / 992 / 40 mm
Module peak power	270 Wp
Weight	18.0 kg

Building

Length in east-west direction	23 m
Length in north-south direction	27 m
Height above ground	50 m
Roof parapet height	0 cm

Load assumptions acc. to BS EN 1991-1

Module weight g 0.11 kN/m²

Wind load

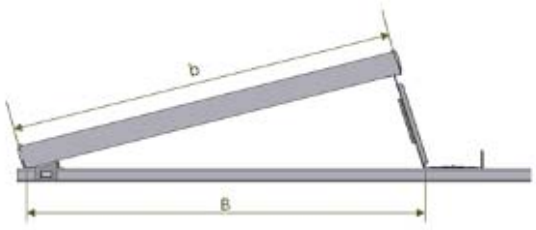
Standard	BS EN 1991-1-4:2004
Wind zone	21,4 m/s
Terrain formation	Flat/plane
Terrain category	IV I V
Peak velocity pressure $q_{(z)}$	0.70 kN/m²

Snow load

Standard	BS EN 1991-1-3:2003/NA
Snow load zone	3
Ground snow load s_k	0.3 kN/m²
Shape factor μ_1	0.8
Snow load s	0.27 kN/m²

Configuration

System selection	AluGrid
Tilt angle	10°
Roof pitch	0°
Module orientation	Horizontal
Number of modules	30



Shading distance

S = 1.58 m

S_0 = 1.65 m Shading distance according to Erfurt und Bahner

Required loading

kg

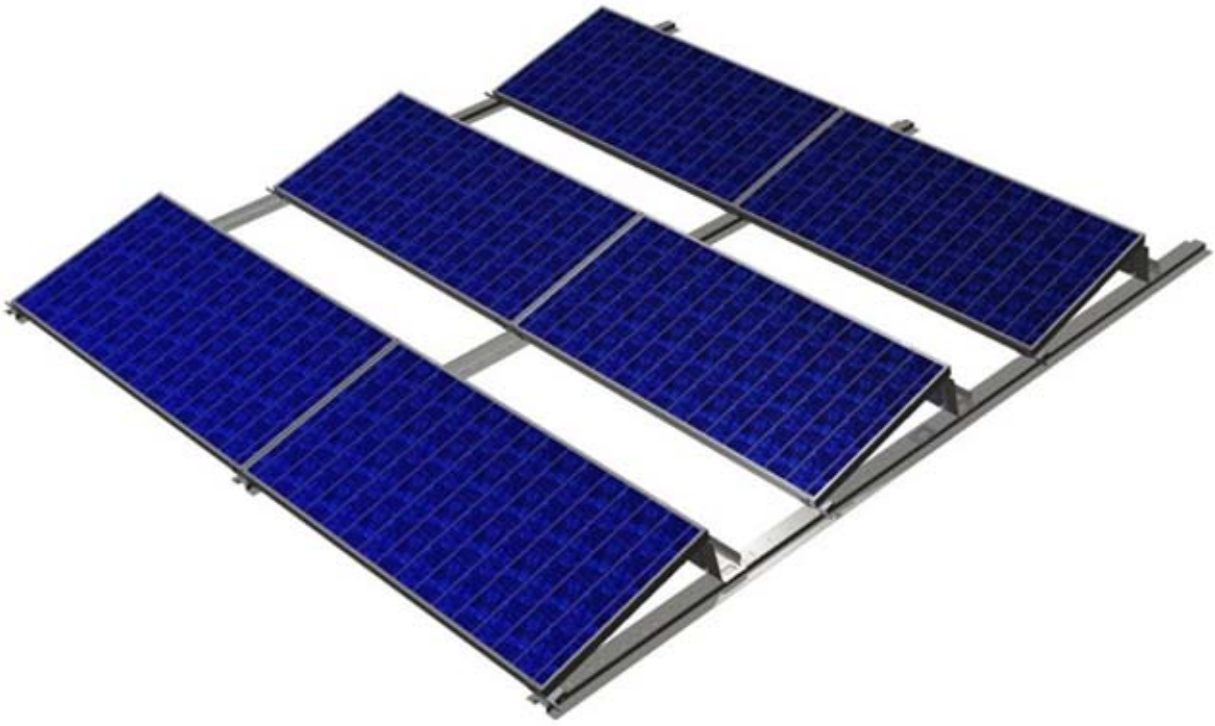
Sliding friction coefficient 0.51

	Verification against sliding	Uplift safety
Zone a	47.7	64.7
Zone b	36.8	38.7
Zone c	22.9	14.8
Zone d	1.8	0.1

Equivalent substitute loads

	q_k kN/m²	q_d kN/m²
Zone a	0.32	0.44
Zone b	0.22	0.30
Zone c	0.16	0.22
Zone d	0.08	0.11

Includes the following loads:
- Module weight
- Weight of the mounting rack
- Weight of the ballasting



Verification of position permanence for ballast installations on flat roofs

Module tilt	α	10	°
Roof pitch		0	°
Snow load	s	0.27	kN/m²
Height above ground	z	50.00	m
Module height	h	1.64	m
Module width	b	0.99	m
Module weight	g	0.11	kN/m²

sin = 0.174	cos = 0.985
Peak velocity pressure 0.70 kN/m²	

Overview load per m² Module surface

Dead load

g = 0.11 · 1.00 · 1.00 = 0.11 kN/m²

Snow load

s = 0.27 · 1.00 · 0.985 = 0.26 kN/m²

Partial safety factors and combination coefficients

γ_g = 1.35 γ_g = 0.90 For favourable action

γ_q = 1.50

$\Psi_{0,w}$ = 0.60

$\Psi_{0,s}$ = 0.50

Load combinations

LC 1: $\gamma_g \cdot g + \gamma_q \cdot s + \Psi_{0,w} \cdot \gamma_q \cdot W_{1,j}$

LC 2: $\gamma_g \cdot g + \Psi_{0,s} \cdot \gamma_q \cdot s + \gamma_q \cdot W_{1,j}$

LC 3: $0.9 \cdot g + \gamma_q \cdot W_{2,j}$ Uplifting

Distribution in various roof areas

Due to the low module tilt of 10° and due to the closed structure of the aluminium tray, the ballasting is calculated following the rules for flat roofs. The ballasting depends on where it is to be located on the roof.

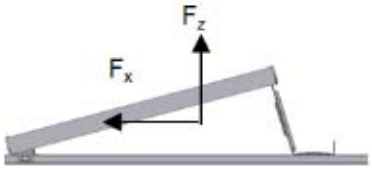
Zone	Modules	Per Module	Total
a	10	64.7 kg	647.0 kg
b	6	38.7 kg	232.2 kg
c	14	22.9 kg	320.6 kg
d	0	1.8 kg	0.0 kg
	30		1,199.8 kg

Pressure coefficients

North wind

South wind

Alternative: Uplifting and sliding



Total tensile force related to one module $F_z = \sum q_p (c_{p,res,i} \cdot A_i \cdot \cos \alpha_i)$
Total shear force related to one module $F_x = \sum q_p (c_{p,res,i} \cdot A_i \cdot \sin \alpha_i)$

Pressure coefficients for the determination of the uplifting loads Module surface = 1.63 m²

The self-weight of the construction is g = 19.21 kg Base width B = 0.98 m Height H = 0.2 m

	Uplifting loads				Horizontal thrust			
	$c_{p,vi}$	**$c_{p,vs}$**	**F_zkN**	**req g/Module**	**$c_{p,hi}$**	**$c_{p,hs}$**	**F_xkN**	**req g/Module**
Zone a	-0.57	-0.44	-0.49	64.7 kg	1.26	0.95	0.19	47.7 kg
Zone b	-0.57	-0.30	-0.34	38.7 kg	1.26	0.74	0.14	36.8 kg
Zone c	-0.40	-0.17	-0.19	14.8 kg	0.92	0.46	0.09	22.9 kg
Zone d	-0.30	-0.09	-0.10	0.1 kg	0.68	0.32	0.01	1.8 kg

A corner block / curbstone of the size 100 x 25 x 6 cm weighs 36 kg

Shading distance S = 1.58 m S_0 = 1.65 m Shading distance according to Erfurt und Bahner

Equivalent substitute loads, Pressure on insulation

Zone	q_k	q_d	σ
a	0.32 kN/m²	0.44 kN/m²	19.80 kN/m²
b	0.22 kN/m²	0.30 kN/m²	15.86 kN/m²
c	0.16 kN/m²	0.22 kN/m²	13.47 kN/m²
d	0.08 kN/m²	0.11 kN/m²	10.27 kN/m²
Maximum	0.32 kN/m²	0.44 kN/m²	

q_k Characteristic equivalent load
q_d Load chart per m² of roof area
σ Pressure on insulation

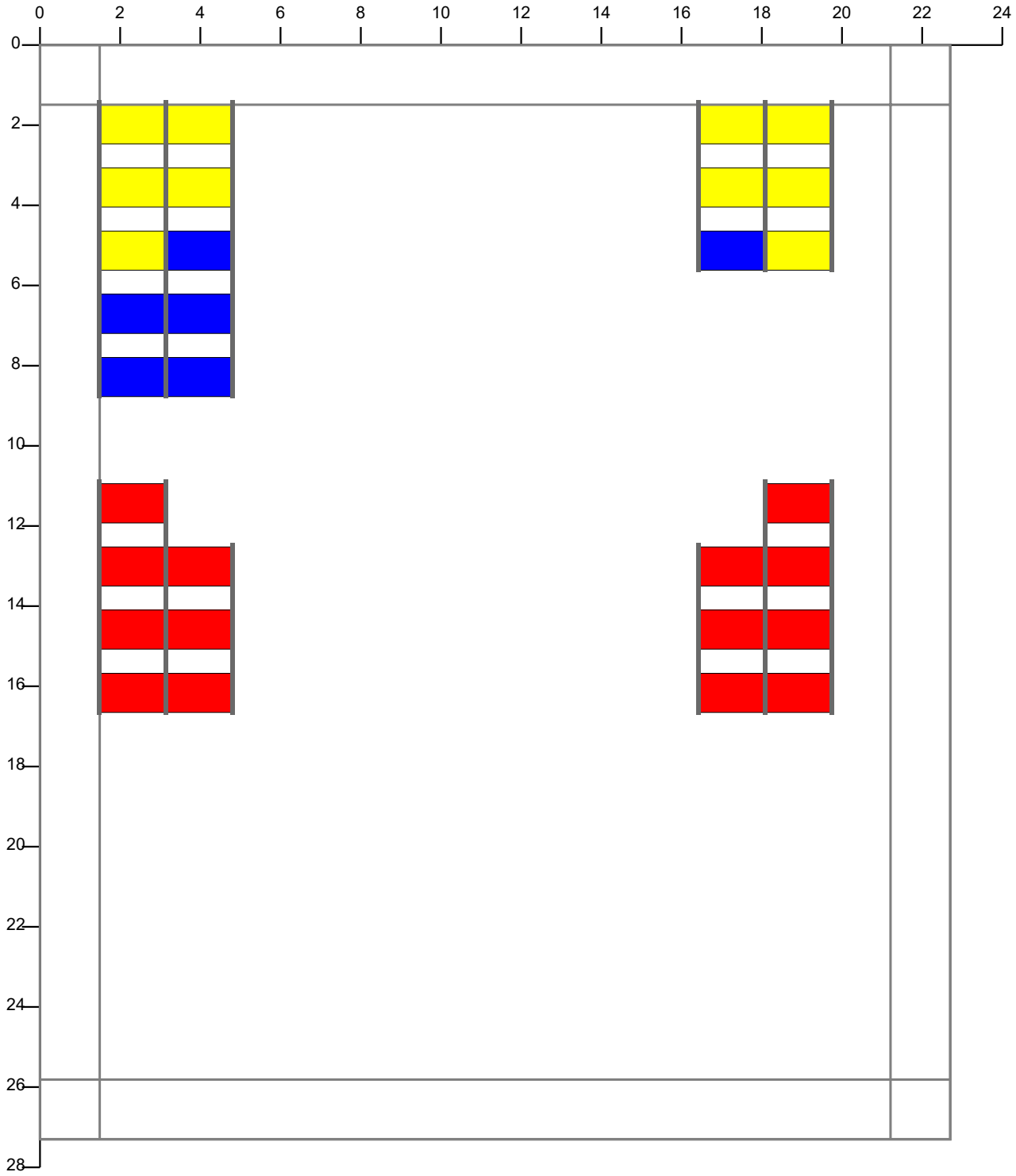
The global horizontal forces for the building are calculated with friction coefficients, multiplied by the roof area in main and transversal direction. An additional reduction may be made in case of larger building widths.

$F_x = c_{fx} \cdot A_{PV}\ q_b \cdot F_G = 0.024 \cdot 426 \cdot 0.70 \cdot 0.9 = 6.3$ kN
$F_y = c_{fy} \cdot A_{PV}\ q_b \cdot F_G = 0.013 \cdot 426 \cdot 0.70 \cdot 0.9 = 3.3$ kN

With: c_{fx} = 0.024 c_{fy} = 0.013 F_G = 0.9

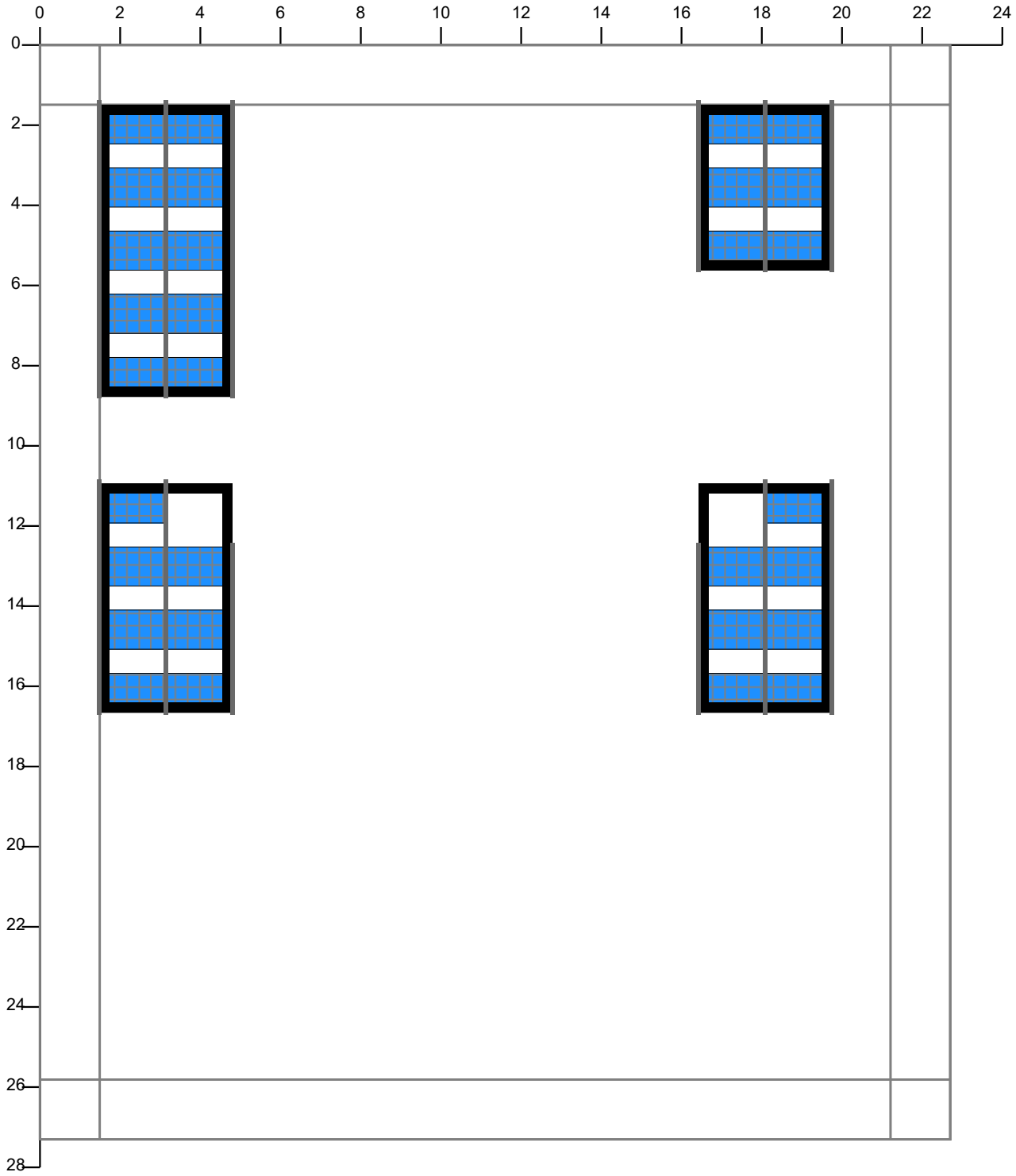
N

Schematic roof layout plan

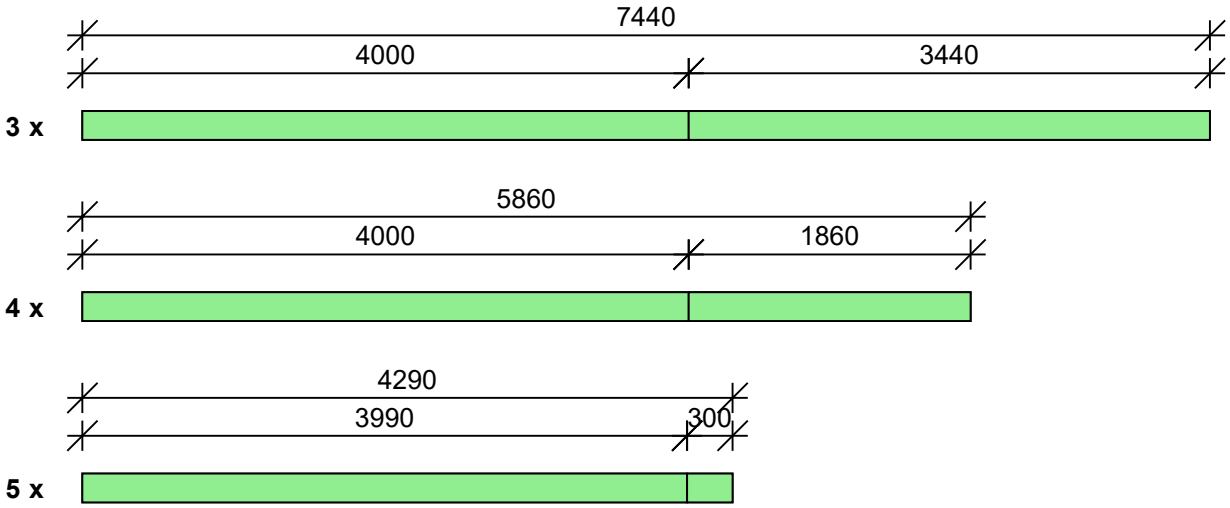


Border zones:	West side	a = 1.49 m
	East side	a = 1.49 m
	North side	a = 1.49 m
	South side	a = 1.49 m

Schematic view: thermal separation



Required base rail lengths



All dimensions in mm

ELDORA

HIGH EFFICIENCY SOLAR PV MODULES

vikramsolar

ELDORA VSP.60.AAA.03 | POLYCRYSTALLINE SOLAR PV MODULES | 60 CELLS | 240-265 WATT

ELDORA ULTIMA

SILVER SERIES

Designed for very **HIGH AREA EFFICIENCY** ideally suited for roof-top and ground-mounted applications

Up to +5 Wp **POSITIVE POWER OUTPUT TOLERANCE GUARANTEED** ensuring faster ROI

Extremely **RELIABLE PRODUCT** suiting all environment conditions

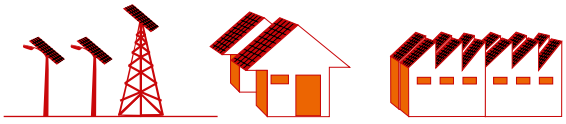
Engineered to provide **EXCELLENT LOW LIGHT RESPONSE**

QUALITY AND SAFETY

- 27 years of linear power output warranty **
- Rigorous quality control meeting the highest international standards
- 100% EL tested to ensure micro crack free modules
- Certified for PID resistance
- Certified for salt mist corrosion resistance – severity VI
- Certified for ammonia resistance
- Compatible with K2, HILTI & Schletter structures for short and long side clamping
- 3rd Party PAN file validated by PVEL
- Approved by OST energy

APPLICATIONS

- On-grid large scale utility systems
- On-grid rooftop residential and commercial systems
- Off-grid residential systems



TECHNICAL DATA

ELDORA ULTIMA SILVER SERIES

vikramsolar

THIS DATASHEET IS APPLICABLE FOR: **ELDORA VSP.60.AAA.03 (AAA=240-265)**

Electrical Data[1]

All Data refers to STC (AM 1.5, 1000 W/m², 25 °C)

Peak Power (0-4.99Wp) P_{max} (Wp)	240	245	250	255	260	265
Maximum Voltage V_{mpp} (V)	30.18	30.38	30.58	30.78	30.98	31.18
Maximum Current I_{mpp} (A)	7.97	8.08	8.18	8.29	8.40	8.50
Open Circuit Voltage V_{oc} (V)	37.15	37.30	37.45	37.60	37.75	37.99
Short Circuit Current I_{sc} (A)	8.50	8.60	8.70	8.82	8.95	9.00
Module Efficiency (%)	14.75	15.06	15.37	15.67	15.98	16.29

1) STC: 1000 W/m² irradiance, 25°C cell temperature, AM 1.5g spectrum according to EN 60904-3.
Average relative efficiency reduction of 5% at 200 W/m² according to EN 60904-1.

Electrical Parameters at NOCT[2]

Power (W)	180.24	183.09	185.97	189.29	192.84	196.16
V@P_{max} (V)	27.49	27.60	27.72	27.83	27.94	28.01
I@P_{max} (A)	6.56	6.63	6.71	6.80	6.90	7.00
V_{oc} (V)	34.80	34.94	35.08	35.22	35.36	35.46
I_{sc} (A)	6.88	6.96	7.04	7.14	7.24	7.35

2) NOCT irradiance 800 W/m², ambient temperature 20°C, wind speed 1 m/sec

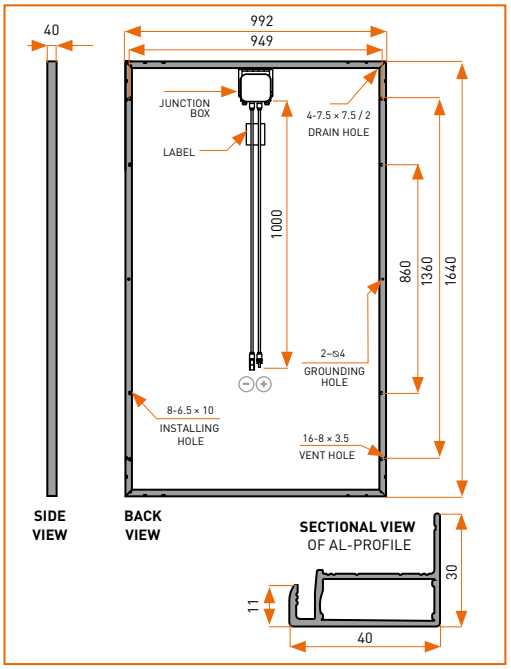
Temperature Coefficients (Tc) permissible operating conditions

Tc of Open Circuit Voltage (β)	-0.31%/°C
Tc of Short Circuit Current (α)	0.057%/°C
Tc of Power (γ)	-0.41%/°C
Maximum System Voltage	1000 V
NOCT	45°C ± 2°C
Temperature Range	-40°C to + 85°C

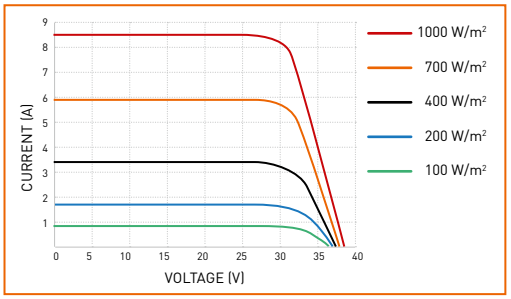
Mechanical Data

Length × Width × Height	1640 mm × 992 mm × 40 mm
Weight	18.50 kg
Junction Box	IP67, 3 bypass diodes
Cable & Connectors	1000 mm length cables, SOLARLOK PV4 connectors (MC4 compatible)
Application Class	Class A (Safety class II)
Superstrate	High transmission low iron tempered glass, AR coated
Cells	60 polycrystalline solar cells, 3 bus bars
Cell Encapsulant	EVA (Ethylene Vinyl Acetate)
Back Sheet	Composite film
Frame	Anodized aluminium frame with twin wall profile
Mechanical Load Test	5400 Pa
Maximum Series Fuse Rating	15 A

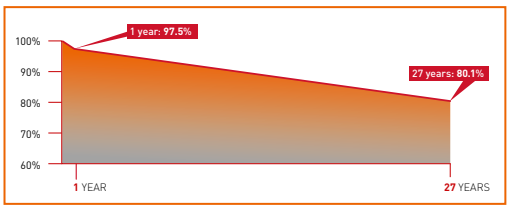
Dimensions in mm



IV Curves



Performance Warranty



Warranty and Certifications

Product Warranty**	12 years
Performance Warranty**	Linear power warranty for 27 years with 2.5% for 1st year degradation and 0.67% from year 2 to year 27
Approvals and Certificates	IEC 61215 Ed2, IEC 61730, IEC 61701, IEC 62716, UL1703, CE, MCS, CEC, PV Cycle, IEC 62804, CAN/CAS 61730, CEC (Australia), JET

Packaging Information

Container	20'GP	40'GP	40'HC
Pallets/Container	10	28	28
Pieces/Container	250	700	700

* All (*) certifications under progress.
** Refer to Vikram Solar's warranty document for terms and conditions.

sales@vikramsolar.com www.vikramsolar.com