



| Connecting Strength

K2 Base Report

GORTON MARKET

Planned installation date	31/03/2025
Project address	Manchester M18 8LD, UK
Customer	Warden Construction
Company	Evolution Construction Group
Author	JJ Fitzgerald
Issue date & version	04/02/2025 K2 Base Version 3.2.24.2

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About us

K2 Systems. Innovative mounting system from a strong team.

Since 2004 we have been developing pioneering and highly functional mounting system solutions for photovoltaic installations around the world. Our systems are designed in our own product development department where we continually optimize and adapt mounting systems to the ever-changing market.

A knowledgeable and friendly team

Just like a mountain climbing team, K2 Systems is built on mutual trust. This applies to our customer service as well as within the company itself, because we believe a trusting partnership leads to successful photovoltaic projects.

Our employees place total focus on the needs and wishes of our customer. This is true in all company departments.

10 locations and worldwide sales network

In our international team, everyone works together to provide customers with competent, comprehensive and entirely personalized service.

This is especially true in the constant training our employees undergo with regards to product optimization, quality assurance, or innovations in construction techniques.

Quality management and certificates

K2 Systems stands for Connecting Strength, the highest quality, and precision-crafted and customized components. Our customers and business partners deeply appreciate all of these factors. Three independent authorities have tested, confirmed, and certified our skills and components. External authorities are not the only ones to have put K2 Systems to the test. Our internal quality control ensures that all our products are subject to a constant review process.

These measures all ensure the outstanding quality standards that exemplify products from K2 Systems, and which we maintain through largely exclusive "Made in Germany" or "Made in Europe" practices.



Product guarantee

K2 Systems offers a 12-year product warranty on all products in its integrated range. The use of high quality materials and a three-level quality inspection ensure these standards.

In a nutshell

As roof-top specialists, we offer effective and economical solutions for roofs all around the world and provide professional, fast and reliable support for our customers in the solar industry.

The static report is not including module and building verification.



Project overview

Roofs

Roof	System	Module	Height	Quantity	Total power
West 1  Trapezoidal	K2 BasicRail	JAM54D40-430/LB 1,762×1,134×30 mm 430 Wp	15.00 m	51	21.93 kWp
West 2  Trapezoidal	K2 BasicRail	JAM54D40-430/LB 1,762×1,134×30 mm 430 Wp	15.00 m	57	24.51 kWp
West 3  Trapezoidal	K2 BasicRail	JAM54D40-430/LB 1,762×1,134×30 mm 430 Wp	15.00 m	63	27.09 kWp
West 4  Trapezoidal	K2 BasicRail	JAM54D40-430/LB 1,762×1,134×30 mm 430 Wp	15.00 m	73	31.39 kWp
East 1  Trapezoidal	K2 BasicRail	JAM54D40-430/LB 1,762×1,134×30 mm 430 Wp	15.00 m	64	27.52 kWp
East 2  Trapezoidal	K2 BasicRail	JAM54D40-430/LB 1,762×1,134×30 mm 430 Wp	15.00 m	81	34.83 kWp
East 3  Trapezoidal	K2 BasicRail	JAM54D40-430/LB 1,762×1,134×30 mm 430 Wp	15.00 m	81	34.83 kWp
East 4  Trapezoidal	K2 BasicRail	JAM54D40-430/LB 1,762×1,134×30 mm 430 Wp	15.00 m	81	34.83 kWp
Total				551	236.93 kWp

Project information

Address	Manchester M18 8LD, UK
Planned installation date	31/03/2025
Customer	Warden Construction
Contact person	Warden Construction
Author	JJ Fitzgerald



Project overview

Load settings

Design method	BS EN
Failure consequence class (CC)	CC3
Design working life	25 years
Terrain category	Town Terrain
Basic wind speed	22.5 m/s
Distance to shoreline	50.00 km
Distance inside town terrain	25.00 km
Snow load zone	3
Snow load on ground level	0.50 kN/m ²

Material values

Aluminium EM-AW 6063 (EP, ET, ER/B) T66

Elastic module	E = 70.000 N/mm ²
Shear module	G = 26.923 N/mm ²
Density	g = 2.700 kg/m ³
Thermal coefficient	$\alpha_T = 2.3e^{-5}$
Yielding strength	$f_{o,k} = 200 \text{ N/mm}^2$
Ultimate strength	$f_{u,k} = 245 \text{ N/mm}^2$



THE PROJECT IS VERIFIED.

The selected mounting system can be installed as planned
Thank you for choosing a K2 mounting system.

GORTON MARKET

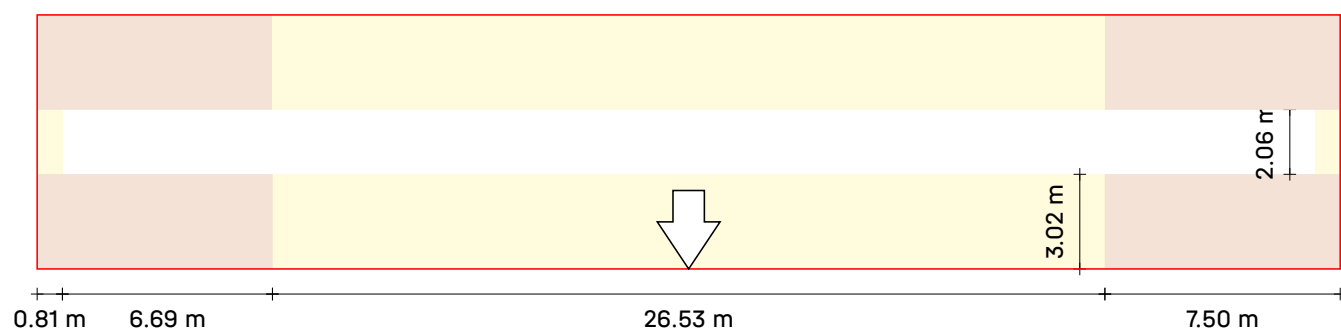


Project information

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Customer	Warden Construction
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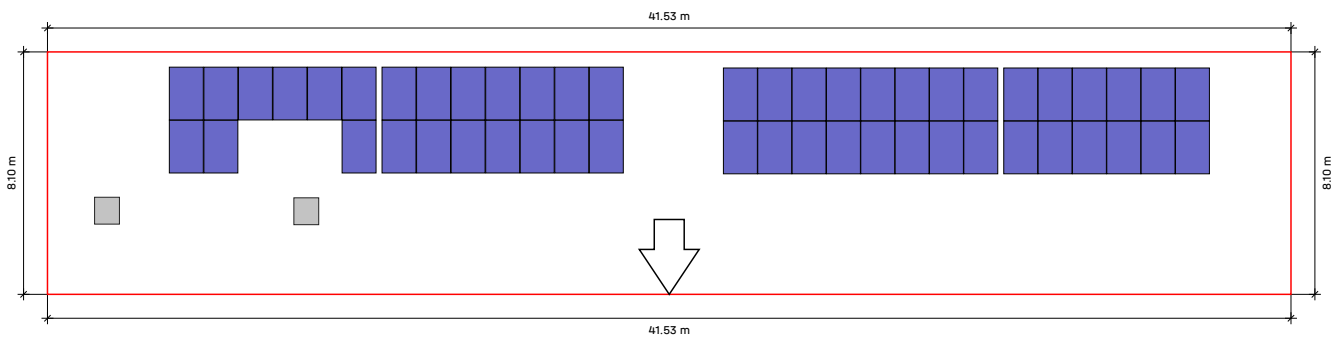


Roofs | West 1





Roofs | West 1



Roof	System	Module	Height	Quantity	Total power
<u>West 1</u>  Trapezoidal	<u>K2 BasicRail</u>	JAM54D40-430/LB 1,762×1,134×30 mm 430 Wp	15.00 m	51	21.93 kWp

Roofs | West 1 | Assembly plan

Base Rails

Type	Whole Rails		Rail cutting		
	Total Rail Length	Quantity 3.65 m	Part of Rail / Rest	Length	Rest
13*A	3.534 m		3.650	3.534 from 3.650	0.106
4*B	6.949 m	1*3.65 m	3.650	3.299 from 3.650	0.341
4*C	9.243 m	2*3.65 m	3.650	1.943 from 3.650	1.697
1*D	1.762 m		3.650	1.762 from 3.650	<u>1.878</u>
1*E	1.762 m		<u>1.878</u>	1.762 from 1.878	0.106

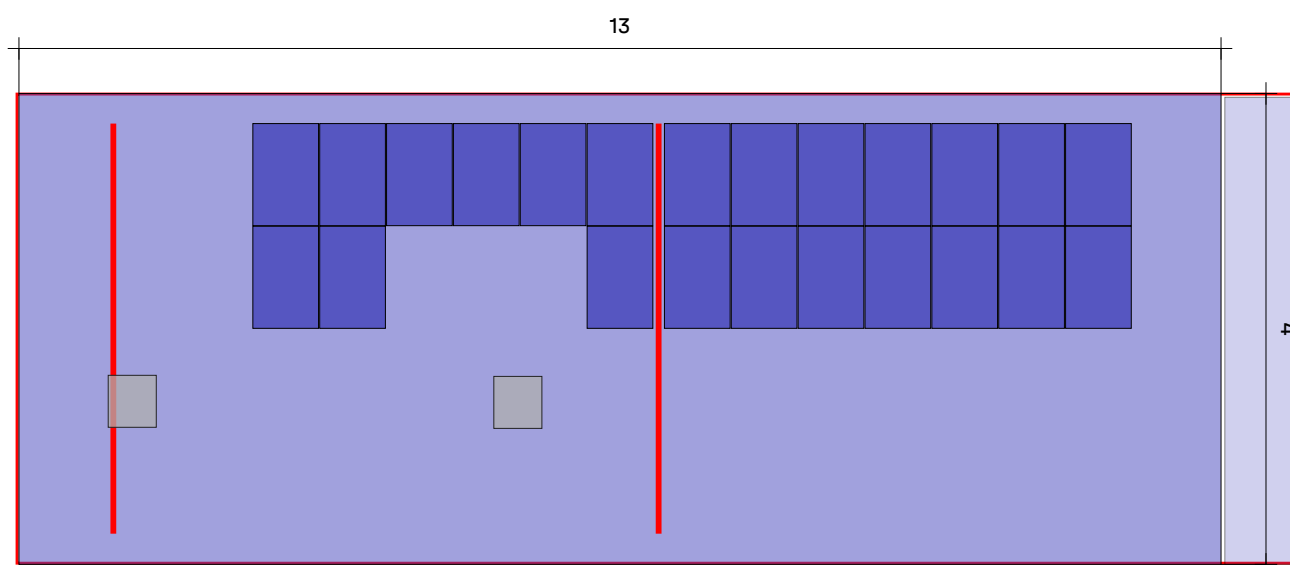
1 cm is viewed as lost for each cutting

Red numbers are leftover rails which will not be used any longer

Module arrays

Module array	Width[m]	Length[m]	Width in modules	Length in modules
1	19.96	7.08	13	2
2	19.86	7.08	14	2

Roofs | West 1 | Module array 1



Roof ① Module array ①

Mounting System

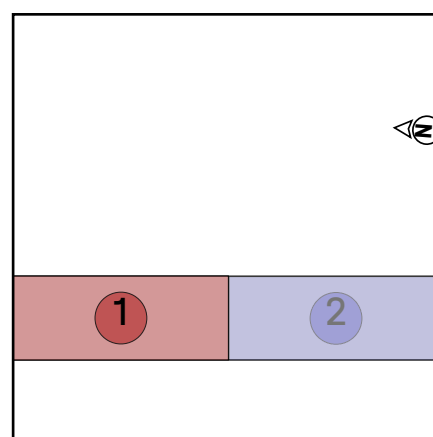
[K2 BasicRail](#)

Module

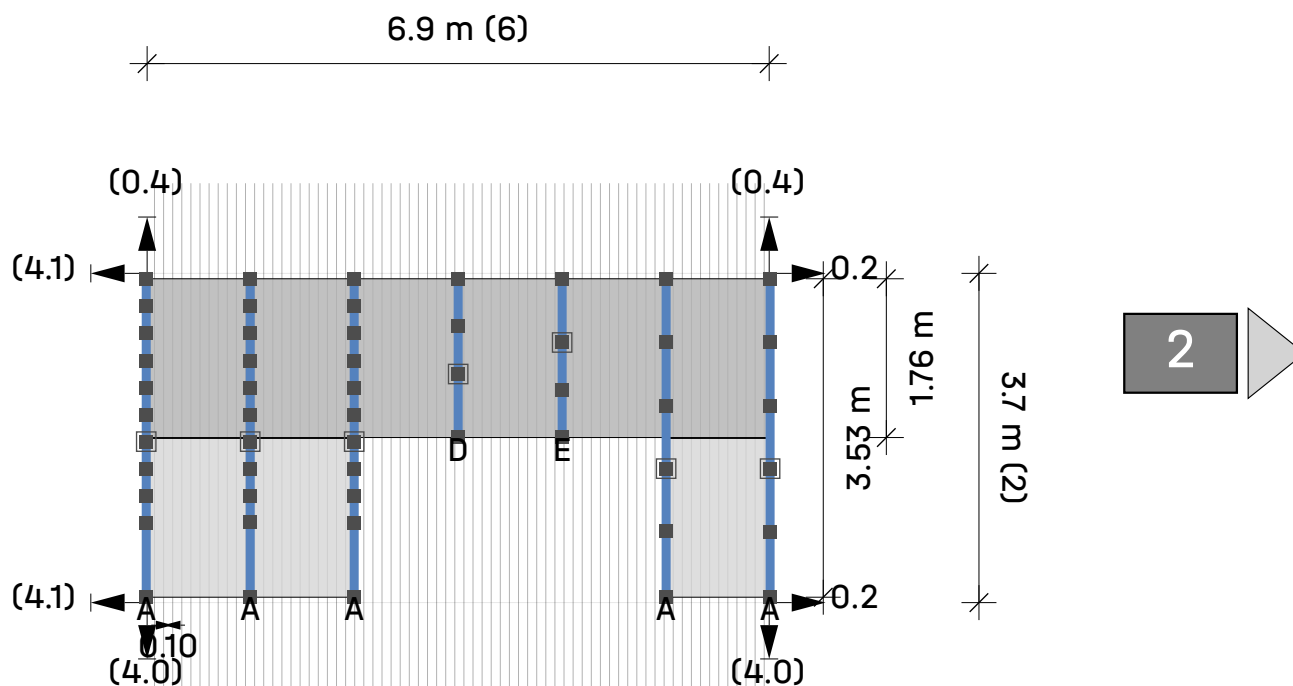
23(9.89 kWp) x
JAM54D40-430/LB

Row spacing

1.14 m



Roofs | West 1 | Module array 1 | Module blocks

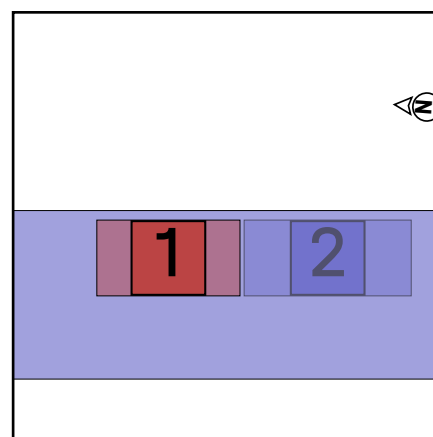


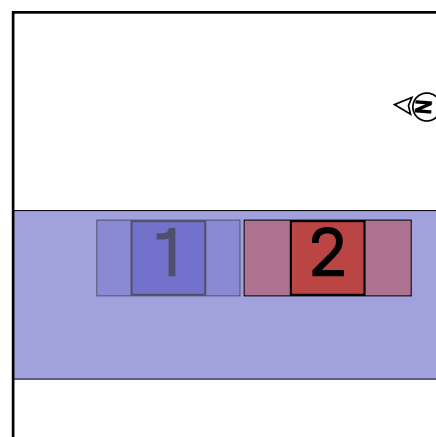
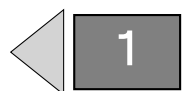
Roof ① Module array ① Module block 1

Modules (6 × 2) - 3 = 9

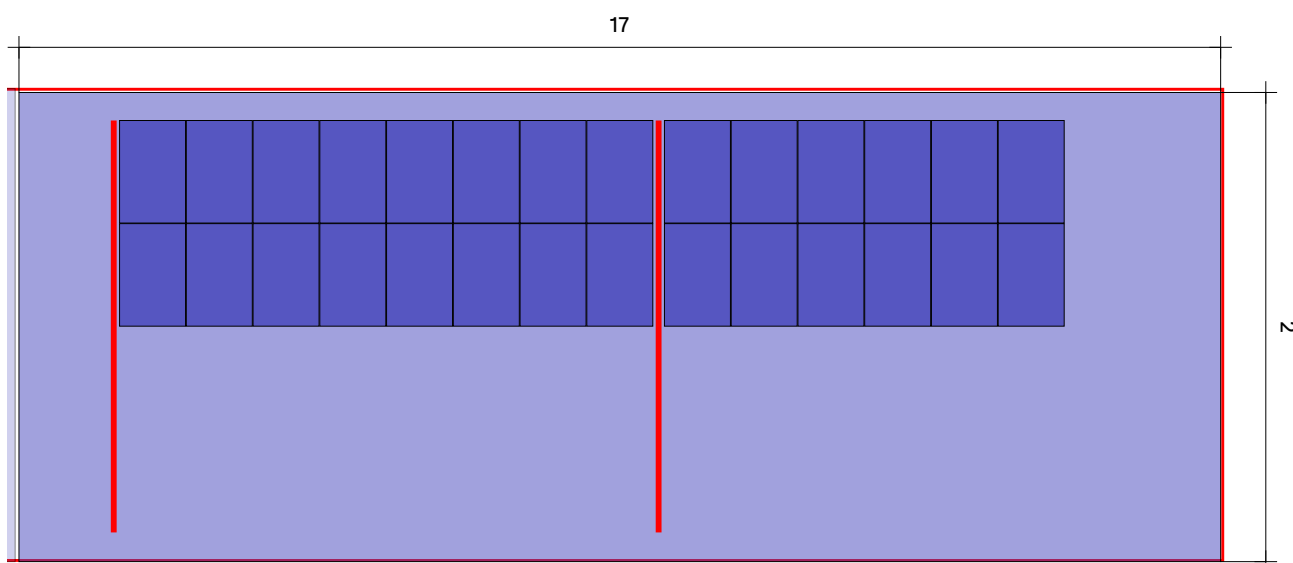
Legend

- Next block indicator
- Fastener
- BasicLocks
- Mounting rail: K2 BasicRail 22
- Distance to Roof Edge [m]
- Dist. to neighbour module block/array [m]
- Dc Distance for clamping between modules
- Dm Distance between modules





Roofs | West 1 | Module array 2



Roof ① Module array ②

Mounting System

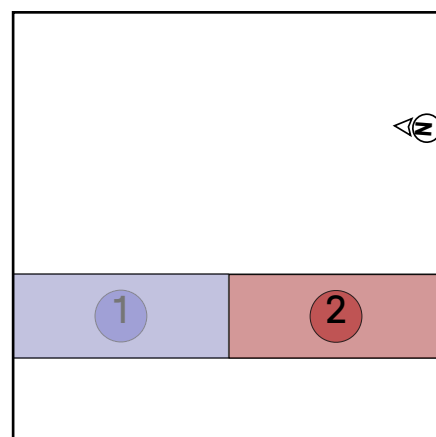
[K2 BasicRail](#)

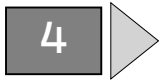
Module

28(12.04 kWp) x
JAM54D40-430/LB

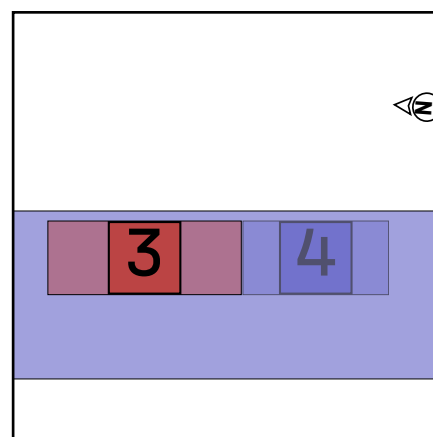
Row spacing

1.77 m



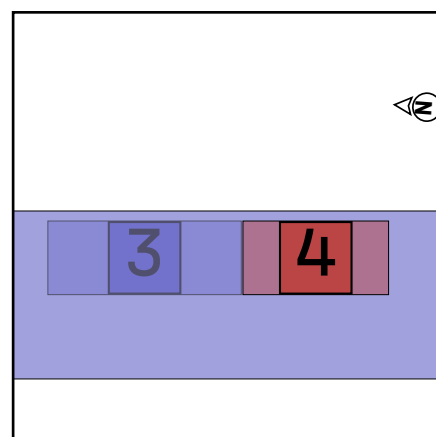


D_m Distance between modules





D_m Distance between modules



Results | West 1

Roof	System	Module	Height	Quantity	Total power
<u>West 1</u>  Trapezoidal	<u>K2 BasicRail</u>	JAM54D40-430/LB 1,762×1,134×30 mm 430 Wp	15.00 m	51	21.93 kWp

Module

Name	JAM54D40-430/LB
Manufacturer	Shanghai JA Solar Technology Co. Ltd.
Output power	430 Wp
Dimensions	1,762×1,134×30 mm
Weight	22.0 kg

Components

Fastener	K2 BasicClip
Base rails	K2 BasicRail 22
Metal screw	Thread-forming metal screw 6.0×38

Loads on modules (module dimensioning)

Array	A-TrA [m²]	ultimate state [Pa]				Serviceability [Pa]			
		Pressure ⊥	Pressure 	Uplift ⊥	Uplift 	Pressure ⊥	Pressure 	Uplift ⊥	Uplift
field area	2.00	794.1	82.0	-806.8	12.3	493.0	50.9	-442.9	12.3
corner region (ridge)	2.00	794.1	82.0	-2,643.4	12.3	493.0	50.9	-1,555.9	12.3
ridge	2.00	794.1	82.0	-1,126.3	12.3	493.0	50.9	-636.4	12.3
field area	2.00	794.1	82.0	-806.8	12.3	493.0	50.9	-442.9	12.3
corner region (ridge)	2.00	794.1	82.0	-2,643.4	12.3	493.0	50.9	-1,555.9	12.3
ridge	2.00	794.1	82.0	-1,126.3	12.3	493.0	50.9	-636.4	12.3

Results | West 1

Utilisation result

No. Module Array	roof areas	ultimate limit state			Usab.	Distances		maximum values	
		Pr σ [%]	CL σ [%]	Fst F[%]	Pr f[%]	Fst [m]	BR [m]	CL L_{max} [m]	Fst D _{max} [m]
1	field area	34.3	0.0	86.5	47.4	0.850	---	0.444	0.850
1	corner region (ridge)	14.0	0.0	98.9	3.1	0.300	---	0.300	0.303
1	ridge	32.5	0.0	99.0	28.2	0.700	---	0.430	0.707
2	field area	24.3	1.8	62.8	29.6	0.808	---	0.483	0.850
2	corner region (ridge)	10.9	1.7	76.3	2.4	0.303	---	0.303	0.397
2	ridge	33.1	2.5	87.2	38.2	0.808	---	0.450	0.850

Pr	Profile	Fst D _{max}	maximum fastener spacing
Fst	Fastener	BR	Base Rail
σ	Stress	Usab.	serviceability limit state
f	Deflection	CL	Cantilever
F	Force		
CL/ L_{max}	maximum cantilever length		



Results | West 1

Important Information

- The quantity for K2 BasicRail BasicClips is calculated in such a way, that - according to the Assembly Instructions - a BasicClip can be installed on the crest to the left and right of a Rail Connector Set.
- The structure was statically verified in accordance with Eurocode 9: Design of aluminium structures (DIN EN 1999-1-1:2021) and offers sufficient load-bearing capacity and stability for the loads specified in the chapter 'Maximum actions on the components'.
- Adjustment factor for wind load regarding service life period, f_W , is according to DIN EN 1991-1-4/ NA, NDP for 4.2 (2P) note 5, table 3
- Adjustment factor for snow load regarding service life period, f_S , is according to DIN EN 1991-1-3/ annex D, table 4
- The structural design complies with BS EN 1990 - Basis of Structural Design.
- Snow loads are determined in accordance with National Annex BS NA EN 1991-1-3 (2018) - UK National Annex to EC1 - Action on structures - general actions - snow loads.
- Wind loads are determined in accordance with National Annex BS NA EN 1991-1-4 - UK National Annex to EC1 - Action on structures, general actions - wind actions.
- Service life is recognised according to 'Eurocode EN 1991 - Action on structures, Snow loads' and 'Eurocode EN 1991 - Actions on structures, Wind actions'. Subject to the Building Regulations and for security-relevant reasons the installation has to be dismantled at the end of its service life.
- Failure consequence class is considered according to 'Eurocode EN 1990 - Basis of structural design'.
- The person responsible for the execution of the work must check the load assumptions made with the conditions on site. If deviations are found, the person who prepared the static calculation must be consulted immediately. , in particular § 2 ("technical and specialist requirements for the customer"), § 7 ("warranty provisions") and § 8 ("limitation of liability").



Structural analysis report | West 1

General information

Name	GORTON MARKET
Mounting System	K2 BasicRail
Author	JJ Fitzgerald

Location information

Address	Manchester M18 8LD, UK
Ground elevation	70.03 m

Roof information

Building height	15.00 m
Roof type	Monopitch roof
Roof pitch	6°
Roof covering	Trapezoidal
Min. roof edge distance	0.00 m
Crest distance	101.0 mm
Crest width	22.0 mm
Crest height	40.0 mm
Roof material	Steel
Sheet quality	S235
Sheet thickness	0.500 mm

Loads

Design method	BS EN
Failure consequence class (CC)	CC3
Design working life	25 years
Terrain category	Town Terrain
Distance to shoreline	50.00 km
Distance inside town terrain	25.00 km

Wind load

Velocity pressure, 50 years	$q_{p,50} = 0.751 \text{ kN/m}^2$
Adjustment factor for service life	$f_w = 1.000$
Velocity pressure, 25 years	$q_{p,25} = 0.691 \text{ kN/m}^2$



Structural analysis report | West 1

Roof areas

Array	load impact area [m ²]	maxCpe ₁₀	minCpe ₁₀	wind pressure [kN/m ²]	wind suction [kN/m ²]
field area	10.00	0.020	-0.810	0.014	-0.560
corner region (ridge)	10.00	0.020	-2.420	0.014	-1.673
ridge	10.00	0.020	-1.090	0.014	-0.754
field area	10.00	0.020	-0.810	0.014	-0.560
corner region (ridge)	10.00	0.020	-2.420	0.014	-1.673
ridge	10.00	0.020	-1.090	0.014	-0.754

Snow load

Snow load zone	3
Snow guard	No
Snow load on ground level	s_k = 0.500 kN/m²
Shape Coefficient for Snow	μ_i = 0.800
Factor for roof pitch	d_i = 0.995
Snow load on roof, 50 year	s_{i,50} = 0.398 kN/m²
Adjustment factor for service life	f_s = 1.000
Snow load on roof, 25 years	s_{i,25} = 0.370 kN/m²

Dead Load

Weight of module	G_M = 22.0 kg
Weight of mounting system per module	= 2.0 kg
Module area	A_M = 2.00 m²
Dead weight of module per m ²	= 11.01 kg/m²
Dead weight of mounting system per m ²	= 1.00 kg/m²
Total Dead Load (excl. ballast) per m ²	= 0.12 kN/m²



Structural analysis report | West 1

Load Combinations

Ultimate limit state

Partial safety factor unfavourable permanent load	$\gamma_{G,sup} = 1.35$
Partial safety factor favourable permanent load	$\gamma_{G,inf} = 1.00$
Partial safety factor destabilising permanent load	$\gamma_{G,dst} = 1.10$
Partial safety factor stabilising permanent load	$\gamma_{G,stab} = 0.90$
Partial safety factor variable loads	$\gamma_Q = 1.50$
Combination coefficient with regards to wind	$\psi_{0,W} = 0.60$
Combination coefficient with regards to wind (additional varying influences)	$\psi_{1,W} = 0.20$
Combination coefficient with regards to Snow	$\psi_{0,S} = 0.50$
Importance factor permanent	$\kappa_{FI,G} = 1.10$
Importance factor variable	$\kappa_{FI,Q} = 1.10$
Characteristic dead weight	G_k
Characteristic snow load on the roof	$S_{i,n}$
Characteristic wind load	W_k

Load case combination 01	$LCC\ 01_{uls} = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$
Load case combination 02	$LCC\ 02_{uls} = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$
Load case combination 03	$LCC\ 03_{uls} = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$
Load case combination 04	$LCC\ 04_{uls} = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$
Load case combination 06	$LCC\ 06_{uls} = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$

Serviceability limit state

Combination coefficient with regards to wind	$\psi_{0,W} = 0.60$
Combination coefficient with regards to Snow	$\psi_{0,S} = 0.50$

Load case combination 01	$LCC\ 01_{sls} = G_k + S_{i,n}$
Load case combination 02	$LCC\ 02_{sls} = G_k + W_{k,Pressure}$
Load case combination 03	$LCC\ 03_{sls} = G_k + W_{k,Pressure} + \psi_{0,S} * S_{i,n}$
Load case combination 04	$LCC\ 04_{sls} = G_k + S_{i,n} + \psi_{0,W} * W_{k,Pressure}$
Load case combination 06	$LCC\ 06_{sls} = G_k + W_{k,Suction}$

Structural analysis report | West 1

Maximum load on modules (Mounting system dimensioning)

Array	A-TrA [m ²]	ultimate state [kN/m ²]				Serviceability [kN/m ²]			
		Pressure ⊥	Pressure 	Uplift ⊥	Uplift	Pressure ⊥	Pressure 	Uplift ⊥	Uplift
field area	10.00	0.794	0.082	-0.807	0.012	0.493	0.051	-0.443	0.012
corner region (ridge)	10.00	0.794	0.082	-2.643	0.012	0.493	0.051	-1.556	0.012
ridge	10.00	0.794	0.082	-1.126	0.012	0.493	0.051	-0.636	0.012
field area	10.00	0.794	0.082	-0.807	0.012	0.493	0.051	-0.443	0.012
corner region (ridge)	10.00	0.794	0.082	-2.643	0.012	0.493	0.051	-1.556	0.012
ridge	10.00	0.794	0.082	-1.126	0.012	0.493	0.051	-0.636	0.012

Max. load on fastener

Array	A-TrA [m ²]	ultimate state [kN]				Serviceability [kN]			
		Pressure ⊥	Pressure 	Uplift ⊥	Uplift	Pressure ⊥	Pressure 	Uplift ⊥	Uplift
field area	10.00	0.857	0.089	-0.871	0.013	0.532	0.055	-0.478	0.013
corner region (ridge)	10.00	0.302	0.031	-1.007	0.005	0.188	0.019	-0.593	0.005
ridge	10.00	0.706	0.073	-1.001	0.011	0.438	0.045	-0.566	0.011
field area	10.00	0.622	0.064	-0.632	0.010	0.386	0.040	-0.347	0.010
corner region (ridge)	10.00	0.233	0.024	-0.776	0.004	0.145	0.015	-0.457	0.004
ridge	10.00	0.622	0.064	-0.882	0.010	0.386	0.040	-0.498	0.010

Resistance Values of Components

Base Rails

Base Rails	A [cm ²]	I _y [cm ⁴]	I _z [cm ⁴]	W _y [cm ³]	W _z [cm ³]
K2 BasicRail 22	2.380	1.52	7.74	1.08	2.46

Fastener

Fastener	R _{D,Uplift,Perpendicular} [kN]	R _{D,Pressure,Perpendicular} [kN]	R _{D,Pressure,Parallel} [kN]
K2 BasicClip	1.02	-	0.96
Thread-forming metal screw 6.0×38	0.65	-	0.62



Structural analysis report | West 1

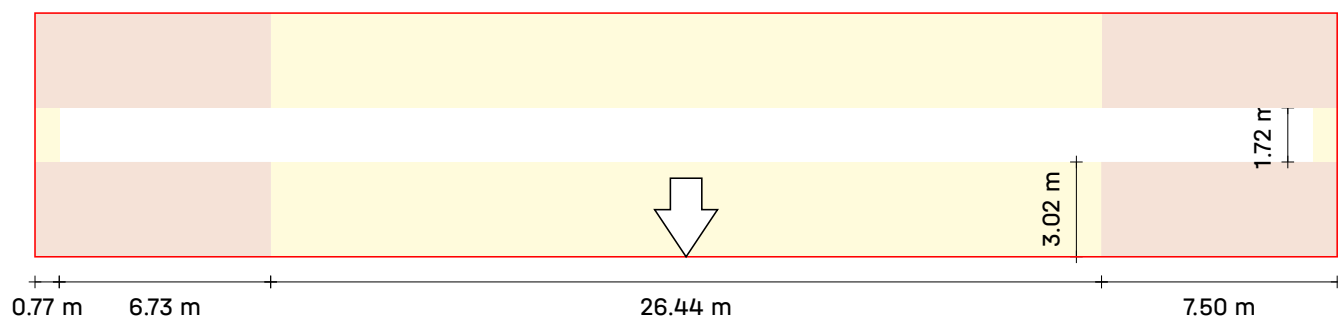
Utilisation result

No.	Module Array	roof areas	ultimate limit state			Usab.	Distances		maximum values	
			Pr σ [%]	CL σ [%]	Fst F[%]	Pr f[%]	Fst [m]	BR [m]	CL L_{max} [m]	Fst D _{max} [m]
1		field area	34.3	0.0	86.5	47.4	0.850	---	0.444	0.850
1		corner region (ridge)	14.0	0.0	98.9	3.1	0.300	---	0.300	0.303
1		ridge	32.5	0.0	99.0	28.2	0.700	---	0.430	0.707
2		field area	24.3	1.8	62.8	29.6	0.808	---	0.483	0.850
2		corner region (ridge)	10.9	1.7	76.3	2.4	0.303	---	0.303	0.397
2		ridge	33.1	2.5	87.2	38.2	0.808	---	0.450	0.850

Pr	Profile	Fst D _{max}	maximum fastener spacing
Fst	Fastener	BR	Base Rail
σ	Stress	Usab.	serviceability limit state
f	Deflection	CL	Cantilever
F	Force		
CL/L _{max}	maximum cantilever length		

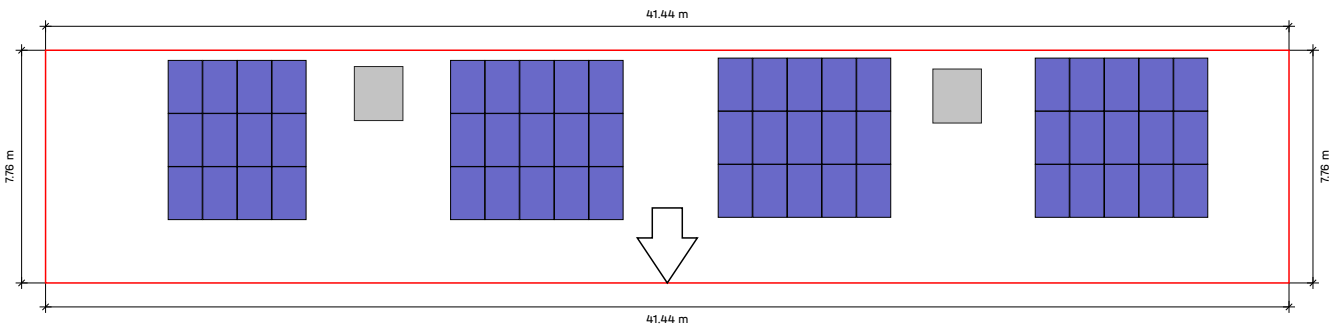


Roofs | West 2





Roofs | West 2



Roof	System	Module	Height	Quantity	Total power
<u>West 2</u>  Trapezoidal	<u>K2 BasicRail</u>	JAM54D40-430/LB 1,762×1,134×30 mm 430 Wp	15.00 m	57	24.51 kWp



Roofs | West 2 | Assembly plan

Base Rails

Type	Whole Rails		Rail cutting		
	Total Rail Length	Quantity 3.65 m	Part of Rail / Rest	Length	Rest
18*A	5.870 m	1*3.65 m	3.650	2.220 from 3.650	<u>1.420</u>
6*B	4.716 m	1*3.65 m	<u>1.420</u>	1.066 from 1.420	0.344

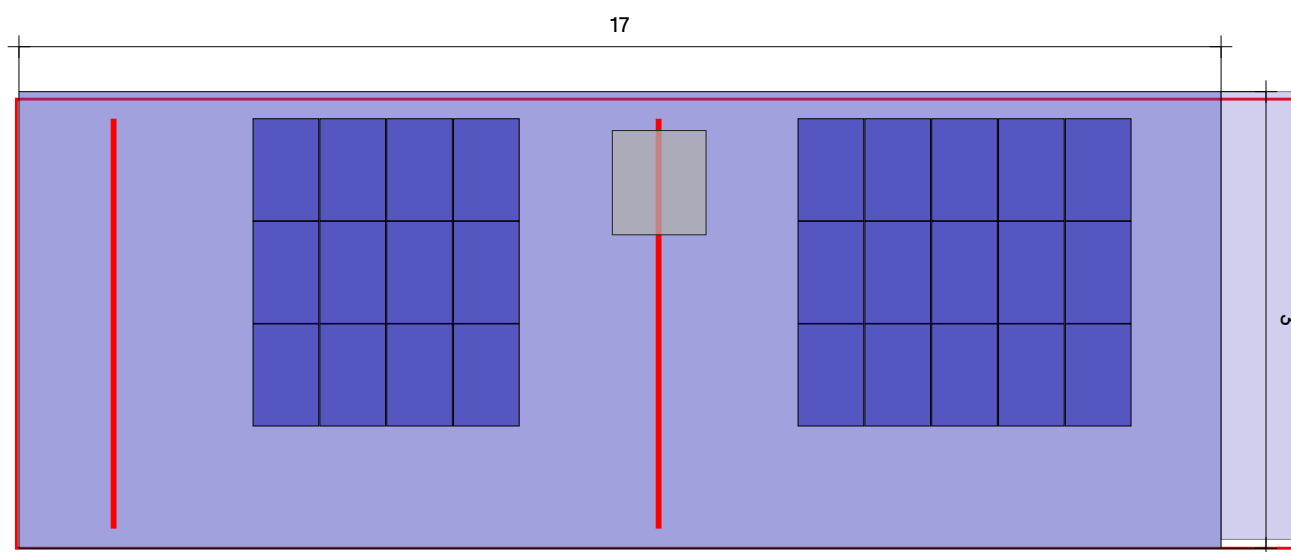
1 cm is viewed as lost for each cutting

Red numbers are leftover rails which will not be used any longer

Module arrays

Module array	Width[m]	Length[m]	Width in modules	Length in modules
1	19.96	7.08	13	3
2	19.96	7.08	14	3

Roofs | West 2 | Module array 1



Roof ② Module array ①

Mounting System

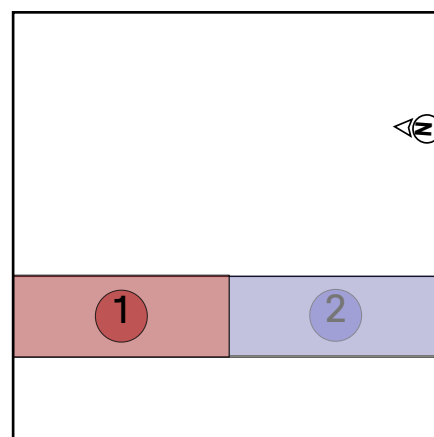
[K2 BasicRail](#)

Module

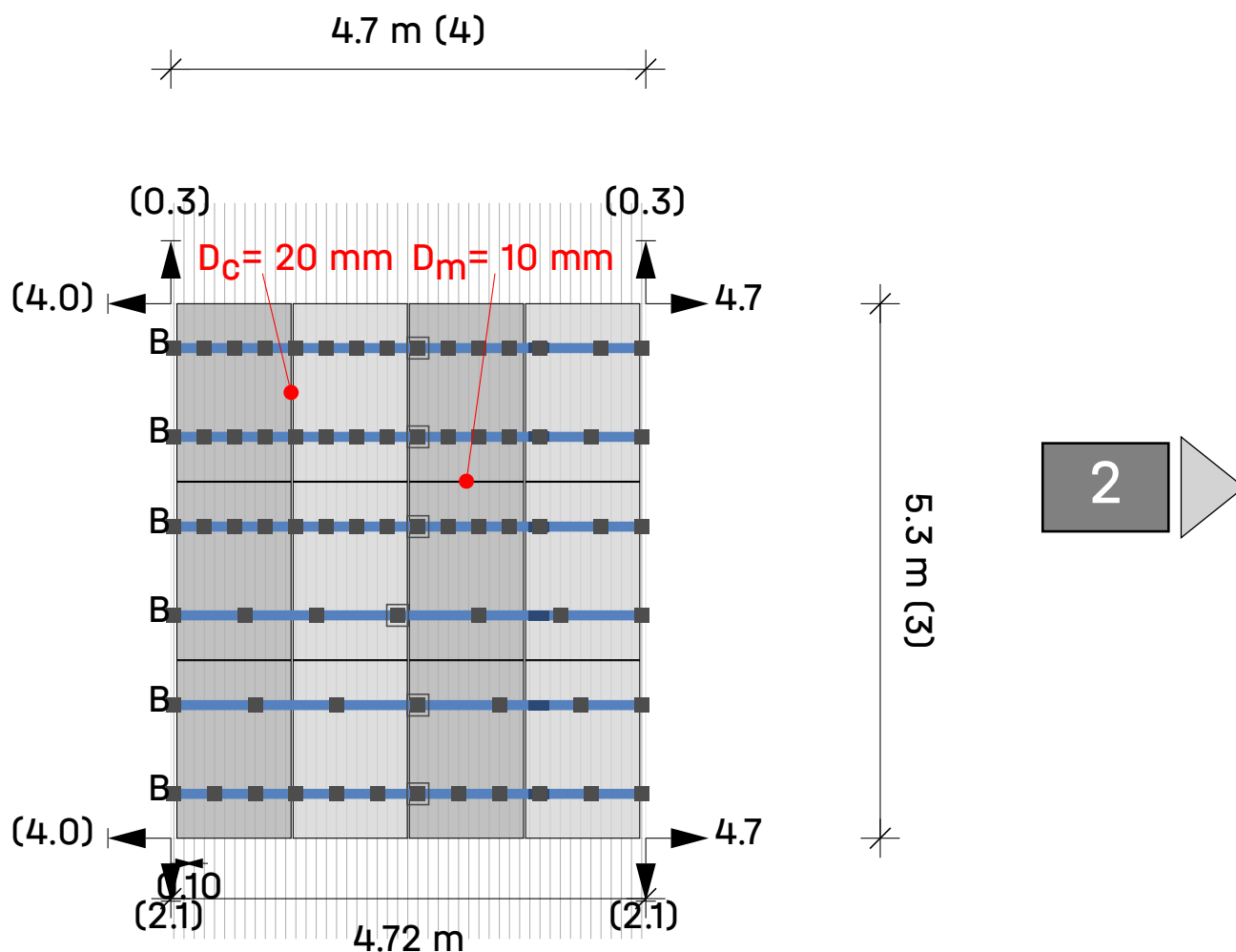
27(11.61 kWp) x
JAM54D40-430/LB

Row spacing

1.77 m



Roofs | West 2 | Module array 1 | Module blocks

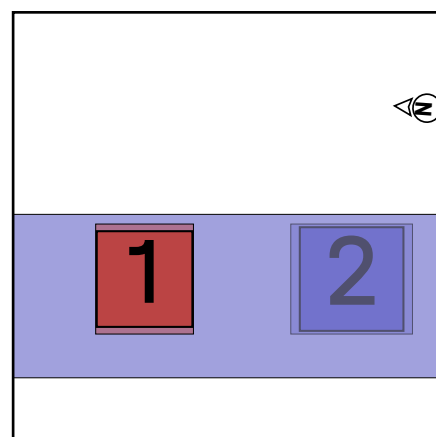


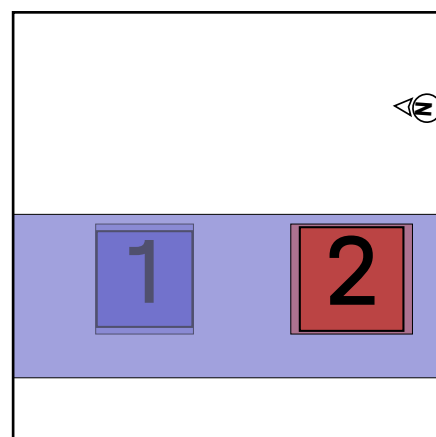
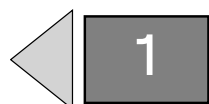
Roof ② Module array ① Module block 1

Modules $4 \times 3 = 12$

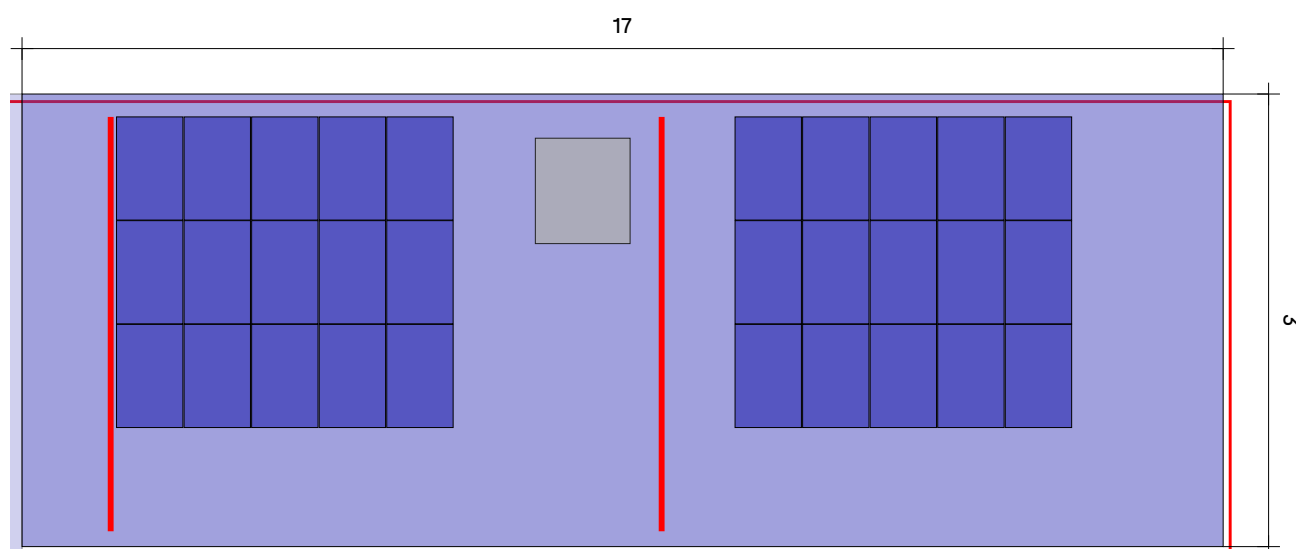
Legend

- Next block indicator
- Fastener
- BasicLocks
- Mounting rail: K2 BasicRail 22
- Distance to Roof Edge [m]
- Dist. to neighbour module block/array [m]
- D_c Distance for clamping between modules
- D_m Distance between modules





Roofs | West 2 | Module array 2



Roof ② Module array ②

Mounting System

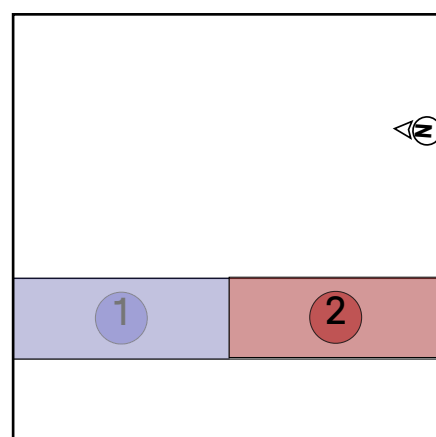
[K2 BasicRail](#)

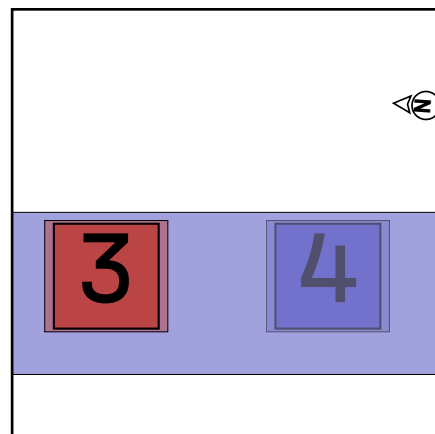
Module

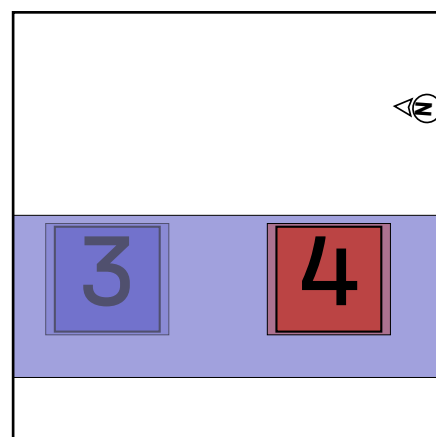
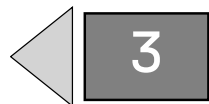
30(12.9 kWp) x
JAM54D40-430/LB

Row spacing

1.77 m







Results | West 2

Roof	System	Module	Height	Quantity	Total power
<u>West 2</u>	<u>K2 BasicRail</u>	JAM54D40-430/LB 1,762×1,134×30 mm 430 Wp	15.00 m	57	24.51 kWp
 Trapezoidal					

Module

Name	JAM54D40-430/LB
Manufacturer	Shanghai JA Solar Technology Co. Ltd.
Output power	430 Wp
Dimensions	1,762×1,134×30 mm
Weight	22.0 kg

Components

Fastener	K2 BasicClip
Base rails	K2 BasicRail 22
Metal screw	Thread-forming metal screw 6.0×38

Loads on modules (module dimensioning)

Array	A-TrA [m²]	ultimate state [Pa]				Serviceability [Pa]			
		Pressure ⊥	Pressure 	Uplift ⊥	Uplift 	Pressure ⊥	Pressure 	Uplift ⊥	Uplift
field area	2.00	794.1	82.0	-806.8	12.3	493.0	50.9	-442.9	12.3
eaves	2.00	794.1	82.0	-1,206.1	12.3	493.0	50.9	-684.8	12.3
corner region (eave)	2.00	794.1	82.0	-2,221.4	12.3	493.0	50.9	-1,300.1	12.3
corner region (ridge)	2.00	794.1	82.0	-2,643.4	12.3	493.0	50.9	-1,555.9	12.3
ridge	2.00	794.1	82.0	-1,126.3	12.3	493.0	50.9	-636.4	12.3
field area	2.00	794.1	82.0	-806.8	12.3	493.0	50.9	-442.9	12.3
eaves	2.00	794.1	82.0	-1,206.1	12.3	493.0	50.9	-684.8	12.3
corner region (eave)	2.00	794.1	82.0	-2,221.4	12.3	493.0	50.9	-1,300.1	12.3
corner region (ridge)	2.00	794.1	82.0	-2,643.4	12.3	493.0	50.9	-1,555.9	12.3
ridge	2.00	794.1	82.0	-1,126.3	12.3	493.0	50.9	-636.4	12.3



Results | West 2

Utilisation result

No.	Module Array	roof areas	ultimate limit state			Usab.	Distances		maximum values	
			Pr σ [%]	CL σ [%]	Fst F[%]	Pr f[%]	Fst [m]	BR [m]	CL $L_{\max}$ [m]	Fst D _{max} [m]
1		field area	24.3	0.0	62.8	29.6	0.808	---	0.483	0.850
1		eaves	35.5	0.0	93.4	41.1	0.808	---	0.441	0.850
1		corner region (eave)	16.3	0.0	85.6	4.9	0.404	---	0.404	0.472
1		corner region (ridge)	10.9	0.0	76.3	2.4	0.303	---	0.303	0.397
1		ridge	33.1	0.0	87.2	38.2	0.808	---	0.450	0.850
2		field area	24.3	1.7	62.8	29.6	0.808	---	0.483	0.850
2		eaves	35.5	1.7	93.4	41.1	0.808	---	0.441	0.850
2		corner region (eave)	16.3	4.5	85.6	4.9	0.404	---	0.404	0.472
2		corner region (ridge)	10.9	5.4	76.3	2.4	0.303	---	0.303	0.397
2		ridge	33.1	1.6	87.2	38.2	0.808	---	0.450	0.850

Pr **Profile**Fst **Fastener** σ **Stress**f **Deflection**F **Force**CL/ $L_{\max}$ **maximum cantilever length**Fst D_{max} **maximum fastener spacing**BR **Base Rail**Usab. **serviceability limit state**CL **Cantilever**



Results | West 2

Important Information

- The quantity for K2 BasicRail BasicClips is calculated in such a way, that - according to the Assembly Instructions - a BasicClip can be installed on the crest to the left and right of a Rail Connector Set.
- The structure was statically verified in accordance with Eurocode 9: Design of aluminium structures (DIN EN 1999-1-1:2021) and offers sufficient load-bearing capacity and stability for the loads specified in the chapter 'Maximum actions on the components'.
- Adjustment factor for wind load regarding service life period, f_W , is according to DIN EN 1991-1-4/ NA, NDP for 4.2 (2P) note 5, table 3
- Adjustment factor for snow load regarding service life period, f_S , is according to DIN EN 1991-1-3/ annex D, table 4
- The structural design complies with BS EN 1990 - Basis of Structural Design.
- Snow loads are determined in accordance with National Annex BS NA EN 1991-1-3 (2018) - UK National Annex to EC1 - Action on structures - general actions - snow loads.
- Wind loads are determined in accordance with National Annex BS NA EN 1991-1-4 - UK National Annex to EC1 - Action on structures, general actions - wind actions.
- Service life is recognised according to 'Eurocode EN 1991 - Action on structures, Snow loads' and 'Eurocode EN 1991 - Actions on structures, Wind actions'. Subject to the Building Regulations and for security-relevant reasons the installation has to be dismantled at the end of its service life.
- Failure consequence class is considered according to 'Eurocode EN 1990 - Basis of structural design'.
- The person responsible for the execution of the work must check the load assumptions made with the conditions on site. If deviations are found, the person who prepared the static calculation must be consulted immediately. , in particular § 2 ("technical and specialist requirements for the customer"), § 7 ("warranty provisions") and § 8 ("limitation of liability").

Structural analysis report | West 2

General information

Name	GORTON MARKET
Mounting System	K2 BasicRail
Author	JJ Fitzgerald

Location information

Address	Manchester M18 8LD, UK
Ground elevation	70.03 m

Roof information

Building height	15.00 m
Roof type	Monopitch roof
Roof pitch	6°
Roof covering	Trapezoidal
Min. roof edge distance	0.00 m
Crest distance	101.0 mm
Crest width	22.0 mm
Crest height	40.0 mm
Roof material	Steel
Sheet quality	S235
Sheet thickness	0.500 mm

Loads

Design method	BS EN
Failure consequence class (CC)	CC3
Design working life	25 years
Terrain category	Town Terrain
Distance to shoreline	50.00 km
Distance inside town terrain	25.00 km

Wind load

Velocity pressure, 50 years	$q_{p,50} = 0.751 \text{ kN/m}^2$
Adjustment factor for service life	$f_w = 1.000$
Velocity pressure, 25 years	$q_{p,25} = 0.691 \text{ kN/m}^2$

Structural analysis report | West 2

Roof areas

Array	load impact area [m ²]	maxCpe ₁₀	minCpe ₁₀	wind pressure [kN/m ²]	wind suction [kN/m ²]
field area	10.00	0.020	-0.810	0.014	-0.560
eaves	10.00	0.020	-1.160	0.014	-0.802
corner region (eave)	10.00	0.020	-2.050	0.014	-1.417
corner region (ridge)	10.00	0.020	-2.420	0.014	-1.673
ridge	10.00	0.020	-1.090	0.014	-0.754
field area	10.00	0.020	-0.810	0.014	-0.560
eaves	10.00	0.020	-1.160	0.014	-0.802
corner region (eave)	10.00	0.020	-2.050	0.014	-1.417
corner region (ridge)	10.00	0.020	-2.420	0.014	-1.673
ridge	10.00	0.020	-1.090	0.014	-0.754

Snow load

Snow load zone	3
Snow guard	No
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$
Shape Coefficient for Snow	$\mu_i = 0.800$
Factor for roof pitch	$d_i = 0.995$
Snow load on roof, 50 year	$s_{i,50} = 0.398 \text{ kN/m}^2$
Adjustment factor for service life	$f_s = 1.000$
Snow load on roof, 25 years	$s_{i,25} = 0.370 \text{ kN/m}^2$

Dead Load

Weight of module	$G_M = 22.0 \text{ kg}$
Weight of mounting system per module	$= 2.0 \text{ kg}$
Module area	$A_M = 2.00 \text{ m}^2$
Dead weight of module per m ²	$= 11.01 \text{ kg/m}^2$
Dead weight of mounting system per m ²	$= 1.00 \text{ kg/m}^2$
Total Dead Load (excl. ballast) per m ²	$= 0.12 \text{ kN/m}^2$



Structural analysis report | West 2

Load Combinations

Ultimate limit state

Partial safety factor unfavourable permanent load	$\gamma_{G,sup} = 1.35$
Partial safety factor favourable permanent load	$\gamma_{G,inf} = 1.00$
Partial safety factor destabilising permanent load	$\gamma_{G,dst} = 1.10$
Partial safety factor stabilising permanent load	$\gamma_{G,stab} = 0.90$
Partial safety factor variable loads	$\gamma_Q = 1.50$
Combination coefficient with regards to wind	$\psi_{0,W} = 0.60$
Combination coefficient with regards to wind (additional varying influences)	$\psi_{1,W} = 0.20$
Combination coefficient with regards to Snow	$\psi_{0,S} = 0.50$
Importance factor permanent	$\kappa_{FI,G} = 1.10$
Importance factor variable	$\kappa_{FI,Q} = 1.10$
Characteristic dead weight	G_k
Characteristic snow load on the roof	$S_{i,n}$
Characteristic wind load	W_k

Load case combination 01	$LCC\ 01_{uls} = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$
Load case combination 02	$LCC\ 02_{uls} = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$
Load case combination 03	$LCC\ 03_{uls} = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$
Load case combination 04	$LCC\ 04_{uls} = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$
Load case combination 06	$LCC\ 06_{uls} = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$

Serviceability limit state

Combination coefficient with regards to wind	$\psi_{0,W} = 0.60$
Combination coefficient with regards to Snow	$\psi_{0,S} = 0.50$

Load case combination 01	$LCC\ 01_{sls} = G_k + S_{i,n}$
Load case combination 02	$LCC\ 02_{sls} = G_k + W_{k,Pressure}$
Load case combination 03	$LCC\ 03_{sls} = G_k + W_{k,Pressure} + \psi_{0,S} * S_{i,n}$
Load case combination 04	$LCC\ 04_{sls} = G_k + S_{i,n} + \psi_{0,W} * W_{k,Pressure}$
Load case combination 06	$LCC\ 06_{sls} = G_k + W_{k,Suction}$

Structural analysis report | West 2

Maximum load on modules (Mounting system dimensioning)

Array	A-TrA [m ²]	ultimate state [kN/m ²]				Serviceability [kN/m ²]			
		Pressure ⊥	Pressure 	Uplift ⊥	Uplift	Pressure ⊥	Pressure 	Uplift ⊥	Uplift
field area	10.00	0.794	0.082	-0.807	0.012	0.493	0.051	-0.443	0.012
eaves	10.00	0.794	0.082	-1.206	0.012	0.493	0.051	-0.685	0.012
corner region (eave)	10.00	0.794	0.082	-2.221	0.012	0.493	0.051	-1.300	0.012
corner region (ridge)	10.00	0.794	0.082	-2.643	0.012	0.493	0.051	-1.556	0.012
ridge	10.00	0.794	0.082	-1.126	0.012	0.493	0.051	-0.636	0.012
field area	10.00	0.794	0.082	-0.807	0.012	0.493	0.051	-0.443	0.012
eaves	10.00	0.794	0.082	-1.206	0.012	0.493	0.051	-0.685	0.012
corner region (eave)	10.00	0.794	0.082	-2.221	0.012	0.493	0.051	-1.300	0.012
corner region (ridge)	10.00	0.794	0.082	-2.643	0.012	0.493	0.051	-1.556	0.012
ridge	10.00	0.794	0.082	-1.126	0.012	0.493	0.051	-0.636	0.012

Max. load on fastener

Array	A-TrA [m ²]	ultimate state [kN]				Serviceability [kN]			
		Pressure ⊥	Pressure 	Uplift ⊥	Uplift	Pressure ⊥	Pressure 	Uplift ⊥	Uplift
field area	10.00	0.622	0.064	-0.632	0.010	0.386	0.040	-0.347	0.010
eaves	10.00	0.622	0.064	-0.944	0.010	0.386	0.040	-0.536	0.010
corner region (eave)	10.00	0.311	0.032	-0.870	0.005	0.193	0.020	-0.509	0.005
corner region (ridge)	10.00	0.233	0.024	-0.776	0.004	0.145	0.015	-0.457	0.004
ridge	10.00	0.622	0.064	-0.882	0.010	0.386	0.040	-0.498	0.010
field area	10.00	0.622	0.064	-0.632	0.010	0.386	0.040	-0.347	0.010
eaves	10.00	0.622	0.064	-0.944	0.010	0.386	0.040	-0.536	0.010
corner region (eave)	10.00	0.311	0.032	-0.870	0.005	0.193	0.020	-0.509	0.005
corner region (ridge)	10.00	0.233	0.024	-0.776	0.004	0.145	0.015	-0.457	0.004
ridge	10.00	0.622	0.064	-0.882	0.010	0.386	0.040	-0.498	0.010

Resistance Values of Components

Base Rails



Structural analysis report | West 2

Base Rails	A [cm ²]	I _y [cm ⁴]	I _z [cm ⁴]	W _y [cm ³]	W _z [cm ³]
K2 BasicRail 22	2.380	1.52	7.74	1.08	2.46

Fastener

Fastener	R _{D,Uplift,Perpendicular} [kN]	R _{D,Pressure,Perpendicular} [kN]	R _{D,Pressure,Parallel} [kN]
K2 BasicClip	1.02	-	0.96
Thread-forming metal screw 6.0×38	0.65	-	0.62

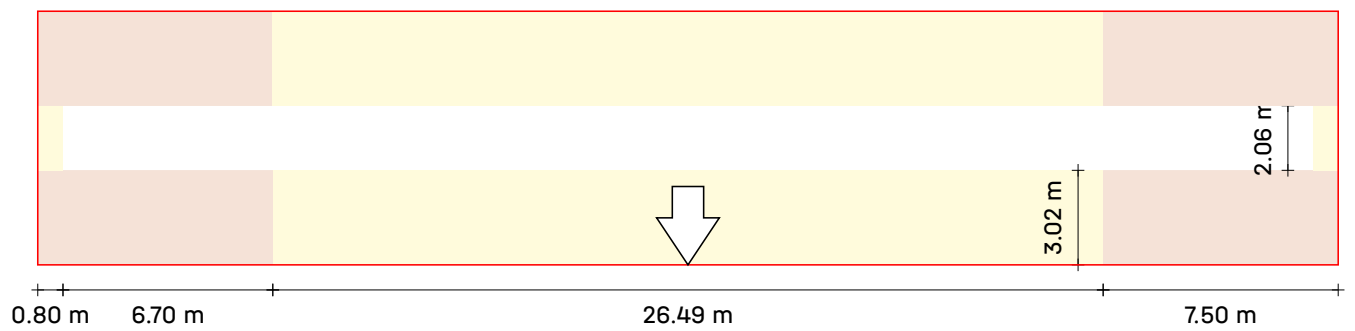
Utilisation result

No.	roof areas	ultimate limit state			Usab.	Distances		maximum values	
		Pr σ[%]	CL σ[%]	Fst F[%]	Pr f[%]	Fst [m]	BR [m]	CL L _{max} [m]	Fst D _{max} [m]
Module Array									
1	field area	24.3	0.0	62.8	29.6	0.808	---	0.483	0.850
1	eaves	35.5	0.0	93.4	41.1	0.808	---	0.441	0.850
1	corner region (eave)	16.3	0.0	85.6	4.9	0.404	---	0.404	0.472
1	corner region (ridge)	10.9	0.0	76.3	2.4	0.303	---	0.303	0.397
1	ridge	33.1	0.0	87.2	38.2	0.808	---	0.450	0.850
2	field area	24.3	1.7	62.8	29.6	0.808	---	0.483	0.850
2	eaves	35.5	1.7	93.4	41.1	0.808	---	0.441	0.850
2	corner region (eave)	16.3	4.5	85.6	4.9	0.404	---	0.404	0.472
2	corner region (ridge)	10.9	5.4	76.3	2.4	0.303	---	0.303	0.397
2	ridge	33.1	1.6	87.2	38.2	0.808	---	0.450	0.850

Pr	Profile	Fst D _{max}	maximum fastener spacing
Fst	Fastener	BR	Base Rail
σ	Stress	Usab.	serviceability limit state
f	Deflection	CL	Cantilever
F	Force		
CL/L _{max}	maximum cantilever length		

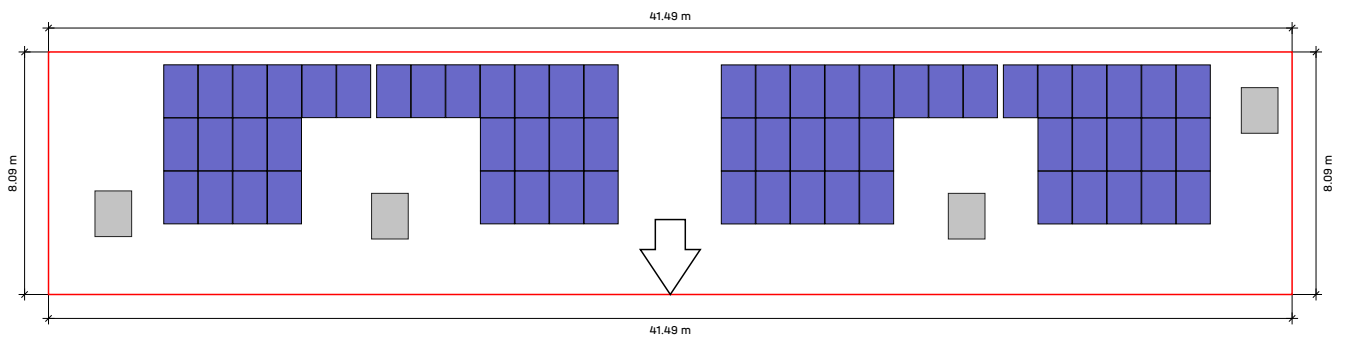


Roofs | West 3





Roofs | West 3



Roof	System	Module	Height	Quantity	Total power
<u>West 3</u>  Trapezoidal	<u>K2 BasicRail</u>	JAM54D40-430/LB 1,762×1,134×30 mm 430 Wp	15.00 m	63	27.09 kWp



Roofs | West 3 | Assembly plan

Base Rails

Type	Whole Rails		Rail cutting			
	Total Rail Length	Quantity 3.65 m	Part of Rail / Rest	Length	Rest	
4*A	7.024 m	1*3.65 m	3.650	3.374 from 3.650	0.266	
8*B	5.870 m	1*3.65 m	3.650	2.220 from 3.650	1.420	
8*C	4.716 m	1*3.65 m	1.420	1.066 from 1.420	0.344	
2*D	9.332 m	2*3.65 m	3.650	2.032 from 3.650	1.608	
2*E	8.178 m	2*3.65 m	1.608	0.878 from 1.608	0.720	

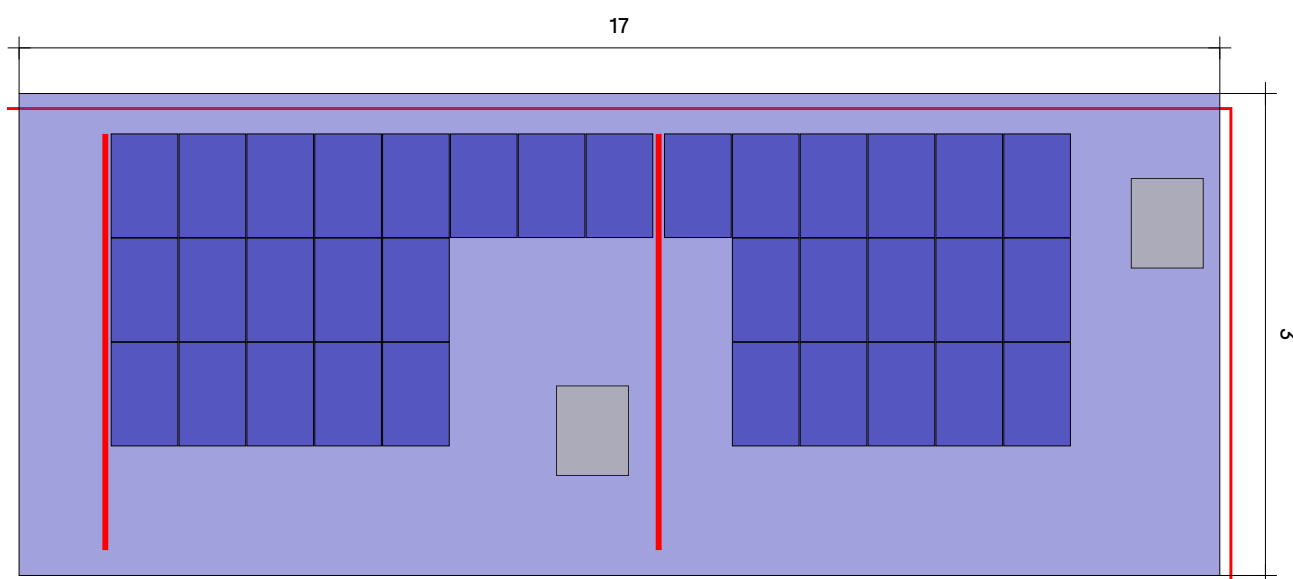
1 cm is viewed as lost for each cutting

Red numbers are leftover rails which will not be used any longer

Module arrays

Module array	Width[m]	Length[m]	Width in modules	Length in modules
1	19.96	7.08	14	3
2	19.96	7.08	13	3

Roofs | West 3 | Module array 1



Roof ③ Module array ①

Mounting System

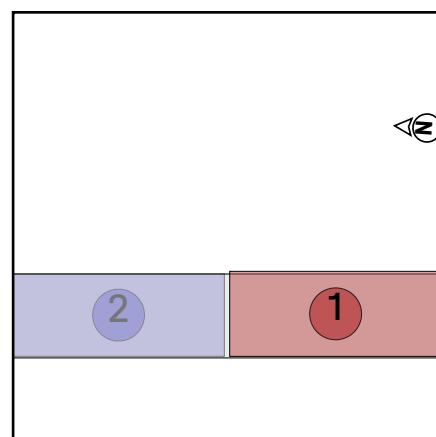
[K2 BasicRail](#)

Module

34(14.62 kWp) x
JAM54D40-430/LB

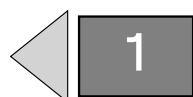
Row spacing

1.77 m

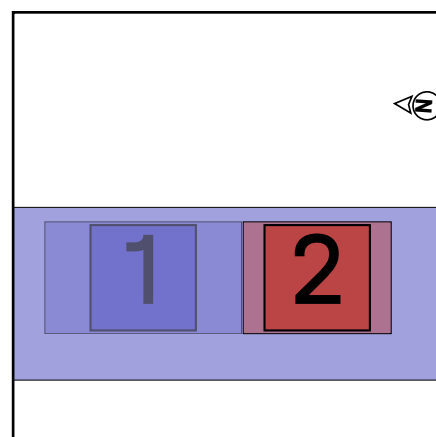




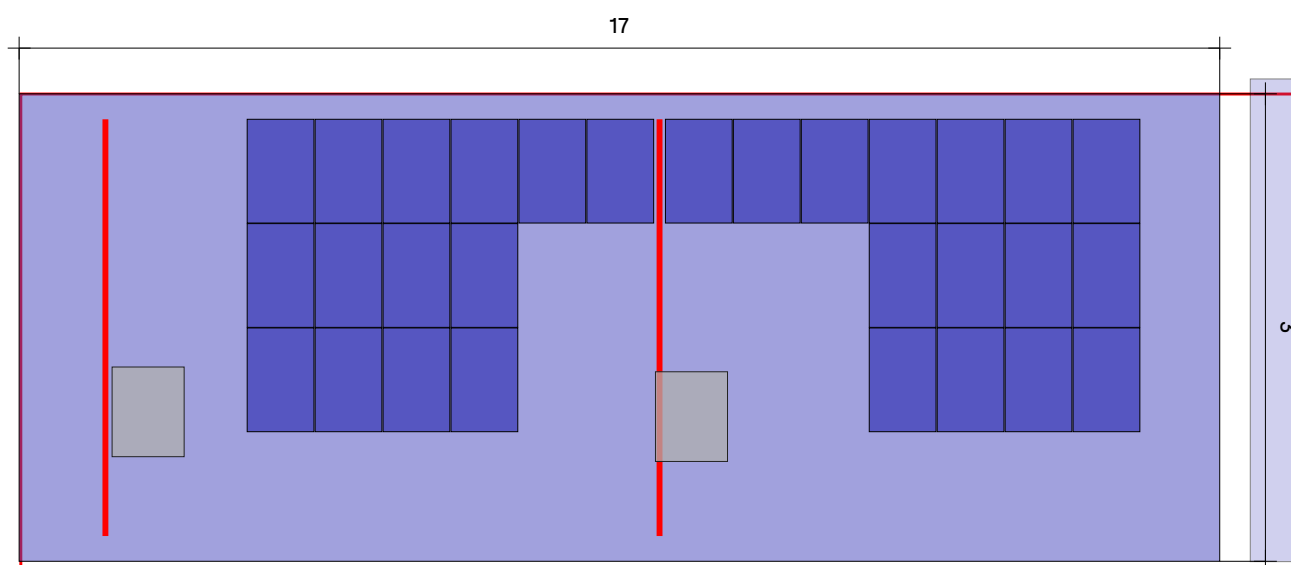
A diagram illustrating a two-stage process flow. A light blue horizontal bar contains two boxes: a red box labeled '1' and a blue box labeled '2'. A north arrow is in the top right corner.



D_m Distance between modules



Roofs | West 3 | Module array 2



Roof ③ Module array ②

Mounting System

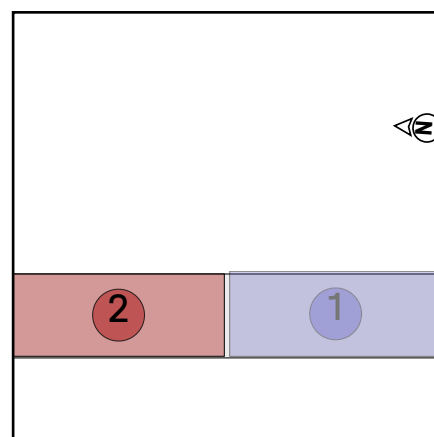
[K2 BasicRail](#)

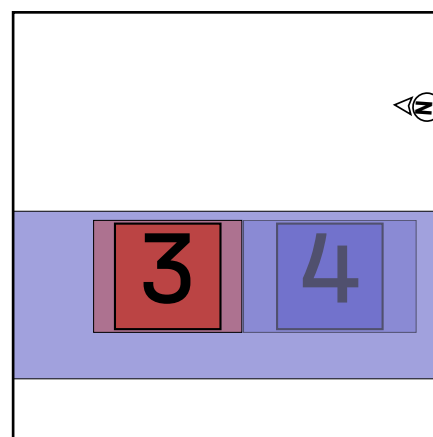
Module

29(12.47 kWp) x
JAM54D40-430/LB

Row spacing

1.77 m





Results | West 3

Roof	System	Module	Height	Quantity	Total power
<u>West 3</u>	<u>K2 BasicRail</u>	JAM54D40-430/LB 1,762×1,134×30 mm 430 Wp	15.00 m	63	27.09 kWp
 Trapezoidal					

Module

Name	JAM54D40-430/LB
Manufacturer	Shanghai JA Solar Technology Co. Ltd.
Output power	430 Wp
Dimensions	1,762×1,134×30 mm
Weight	22.0 kg

Components

Fastener	K2 BasicClip
Base rails	K2 BasicRail 22
Metal screw	Thread-forming metal screw 6.0×38

Loads on modules (module dimensioning)

Array	A-TrA [m²]	ultimate state [Pa]				Serviceability [Pa]			
		Pressure ⊥	Pressure 	Uplift ⊥	Uplift 	Pressure ⊥	Pressure 	Uplift ⊥	Uplift
field area	2.00	794.1	82.0	-806.8	12.3	493.0	50.9	-442.9	12.3
eaves	2.00	794.1	82.0	-1,206.1	12.3	493.0	50.9	-684.8	12.3
corner region (eave)	2.00	794.1	82.0	-2,221.4	12.3	493.0	50.9	-1,300.1	12.3
corner region (ridge)	2.00	794.1	82.0	-2,643.4	12.3	493.0	50.9	-1,555.9	12.3
ridge	2.00	794.1	82.0	-1,126.3	12.3	493.0	50.9	-636.4	12.3
field area	2.00	794.1	82.0	-806.8	12.3	493.0	50.9	-442.9	12.3
eaves	2.00	794.1	82.0	-1,206.1	12.3	493.0	50.9	-684.8	12.3
corner region (eave)	2.00	794.1	82.0	-2,221.4	12.3	493.0	50.9	-1,300.1	12.3
corner region (ridge)	2.00	794.1	82.0	-2,643.4	12.3	493.0	50.9	-1,555.9	12.3
ridge	2.00	794.1	82.0	-1,126.3	12.3	493.0	50.9	-636.4	12.3



Results | West 3

Utilisation result

No.	Module Array	roof areas	ultimate limit state			Usab.	Distances		maximum values	
			Pr σ [%]	CL σ [%]	Fst F[%]	Pr f[%]	Fst [m]	BR [m]	CL $L_{\max}$ [m]	Fst D _{max} [m]
1		field area	24.3	1.9	62.8	29.6	0.808	---	0.483	0.850
1		eaves	35.5	1.5	93.4	41.1	0.808	---	0.441	0.850
1		corner region (eave)	16.3	5.0	85.6	4.9	0.404	---	0.404	0.472
1		corner region (ridge)	10.9	5.9	76.3	2.4	0.303	---	0.303	0.397
1		ridge	33.1	1.4	87.2	38.2	0.808	---	0.450	0.850
2		field area	24.3	1.7	62.8	29.6	0.808	---	0.483	0.850
2		eaves	35.5	1.5	93.4	41.1	0.808	---	0.441	0.850
2		corner region (eave)	16.3	4.6	85.6	4.9	0.404	---	0.404	0.472
2		corner region (ridge)	10.9	5.4	76.3	2.4	0.303	---	0.303	0.397
2		ridge	33.1	1.4	87.2	38.2	0.808	---	0.450	0.850

Pr **Profile**Fst **Fastener** σ **Stress**f **Deflection**F **Force**CL/ $L_{\max}$ **maximum cantilever length**Fst D_{max} **maximum fastener spacing**BR **Base Rail**Usab. **serviceability limit state**CL **Cantilever**



Results | West 3

Important Information

- The quantity for K2 BasicRail BasicClips is calculated in such a way, that - according to the Assembly Instructions - a BasicClip can be installed on the crest to the left and right of a Rail Connector Set.
- The structure was statically verified in accordance with Eurocode 9: Design of aluminium structures (DIN EN 1999-1-1:2021) and offers sufficient load-bearing capacity and stability for the loads specified in the chapter 'Maximum actions on the components'.
- Adjustment factor for wind load regarding service life period, f_W , is according to DIN EN 1991-1-4/ NA, NDP for 4.2 (2P) note 5, table 3
- Adjustment factor for snow load regarding service life period, f_S , is according to DIN EN 1991-1-3/ annex D, table 4
- The structural design complies with BS EN 1990 - Basis of Structural Design.
- Snow loads are determined in accordance with National Annex BS NA EN 1991-1-3 (2018) - UK National Annex to EC1 - Action on structures - general actions - snow loads.
- Wind loads are determined in accordance with National Annex BS NA EN 1991-1-4 - UK National Annex to EC1 - Action on structures, general actions - wind actions.
- Service life is recognised according to 'Eurocode EN 1991 - Action on structures, Snow loads' and 'Eurocode EN 1991 - Actions on structures, Wind actions'. Subject to the Building Regulations and for security-relevant reasons the installation has to be dismantled at the end of its service life.
- Failure consequence class is considered according to 'Eurocode EN 1990 - Basis of structural design'.
- The person responsible for the execution of the work must check the load assumptions made with the conditions on site. If deviations are found, the person who prepared the static calculation must be consulted immediately. , in particular § 2 ("technical and specialist requirements for the customer"), § 7 ("warranty provisions") and § 8 ("limitation of liability").



Structural analysis report | West 3

General information

Name	GORTON MARKET
Mounting System	K2 BasicRail
Author	JJ Fitzgerald

Location information

Address	Manchester M18 8LD, UK
Ground elevation	70.03 m

Roof information

Building height	15.00 m
Roof type	Monopitch roof
Roof pitch	6°
Roof covering	Trapezoidal
Min. roof edge distance	0.00 m
Crest distance	101.0 mm
Crest width	22.0 mm
Crest height	40.0 mm
Roof material	Steel
Sheet quality	S235
Sheet thickness	0.500 mm

Loads

Design method	BS EN
Failure consequence class (CC)	CC3
Design working life	25 years
Terrain category	Town Terrain
Distance to shoreline	50.00 km
Distance inside town terrain	25.00 km

Wind load

Velocity pressure, 50 years	$q_{p,50} = 0.751 \text{ kN/m}^2$
Adjustment factor for service life	$f_w = 1.000$
Velocity pressure, 25 years	$q_{p,25} = 0.691 \text{ kN/m}^2$

Structural analysis report | West 3

Roof areas

Array	load impact area [m ²]	maxCpe ₁₀	minCpe ₁₀	wind pressure [kN/m ²]	wind suction [kN/m ²]
field area	10.00	0.020	-0.810	0.014	-0.560
eaves	10.00	0.020	-1.160	0.014	-0.802
corner region (eave)	10.00	0.020	-2.050	0.014	-1.417
corner region (ridge)	10.00	0.020	-2.420	0.014	-1.673
ridge	10.00	0.020	-1.090	0.014	-0.754
field area	10.00	0.020	-0.810	0.014	-0.560
eaves	10.00	0.020	-1.160	0.014	-0.802
corner region (eave)	10.00	0.020	-2.050	0.014	-1.417
corner region (ridge)	10.00	0.020	-2.420	0.014	-1.673
ridge	10.00	0.020	-1.090	0.014	-0.754

Snow load

Snow load zone	3
Snow guard	No
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$
Shape Coefficient for Snow	$\mu_i = 0.800$
Factor for roof pitch	$d_i = 0.995$
Snow load on roof, 50 year	$s_{i,50} = 0.398 \text{ kN/m}^2$
Adjustment factor for service life	$f_s = 1.000$
Snow load on roof, 25 years	$s_{i,25} = 0.370 \text{ kN/m}^2$

Dead Load

Weight of module	$G_M = 22.0 \text{ kg}$
Weight of mounting system per module	$= 2.0 \text{ kg}$
Module area	$A_M = 2.00 \text{ m}^2$
Dead weight of module per m ²	$= 11.01 \text{ kg/m}^2$
Dead weight of mounting system per m ²	$= 1.00 \text{ kg/m}^2$
Total Dead Load (excl. ballast) per m ²	$= 0.12 \text{ kN/m}^2$



Structural analysis report | West 3

Load Combinations

Ultimate limit state

Partial safety factor unfavourable permanent load	$\gamma_{G,sup} = 1.35$
Partial safety factor favourable permanent load	$\gamma_{G,inf} = 1.00$
Partial safety factor destabilising permanent load	$\gamma_{G,dst} = 1.10$
Partial safety factor stabilising permanent load	$\gamma_{G,stab} = 0.90$
Partial safety factor variable loads	$\gamma_Q = 1.50$
Combination coefficient with regards to wind	$\psi_{0,W} = 0.60$
Combination coefficient with regards to wind (additional varying influences)	$\psi_{1,W} = 0.20$
Combination coefficient with regards to Snow	$\psi_{0,S} = 0.50$
Importance factor permanent	$\kappa_{FI,G} = 1.10$
Importance factor variable	$\kappa_{FI,Q} = 1.10$
Characteristic dead weight	G_k
Characteristic snow load on the roof	$S_{i,n}$
Characteristic wind load	W_k

Load case combination 01	$LCC\ 01_{uls} = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$
Load case combination 02	$LCC\ 02_{uls} = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$
Load case combination 03	$LCC\ 03_{uls} = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$
Load case combination 04	$LCC\ 04_{uls} = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$
Load case combination 06	$LCC\ 06_{uls} = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$

Serviceability limit state

Combination coefficient with regards to wind	$\psi_{0,W} = 0.60$
Combination coefficient with regards to Snow	$\psi_{0,S} = 0.50$

Load case combination 01	$LCC\ 01_{sls} = G_k + S_{i,n}$
Load case combination 02	$LCC\ 02_{sls} = G_k + W_{k,Pressure}$
Load case combination 03	$LCC\ 03_{sls} = G_k + W_{k,Pressure} + \psi_{0,S} * S_{i,n}$
Load case combination 04	$LCC\ 04_{sls} = G_k + S_{i,n} + \psi_{0,W} * W_{k,Pressure}$
Load case combination 06	$LCC\ 06_{sls} = G_k + W_{k,Suction}$

Structural analysis report | West 3

Maximum load on modules (Mounting system dimensioning)

Array	A-TrA [m ²]	ultimate state [kN/m ²]				Serviceability [kN/m ²]			
		Pressure ⊥	Pressure 	Uplift ⊥	Uplift 	Pressure ⊥	Pressure 	Uplift ⊥	Uplift
field area	10.00	0.794	0.082	-0.807	0.012	0.493	0.051	-0.443	0.012
eaves	10.00	0.794	0.082	-1.206	0.012	0.493	0.051	-0.685	0.012
corner region (eave)	10.00	0.794	0.082	-2.221	0.012	0.493	0.051	-1.300	0.012
corner region (ridge)	10.00	0.794	0.082	-2.643	0.012	0.493	0.051	-1.556	0.012
ridge	10.00	0.794	0.082	-1.126	0.012	0.493	0.051	-0.636	0.012
field area	10.00	0.794	0.082	-0.807	0.012	0.493	0.051	-0.443	0.012
eaves	10.00	0.794	0.082	-1.206	0.012	0.493	0.051	-0.685	0.012
corner region (eave)	10.00	0.794	0.082	-2.221	0.012	0.493	0.051	-1.300	0.012
corner region (ridge)	10.00	0.794	0.082	-2.643	0.012	0.493	0.051	-1.556	0.012
ridge	10.00	0.794	0.082	-1.126	0.012	0.493	0.051	-0.636	0.012

Max. load on fastener

Array	A-TrA [m ²]	ultimate state [kN]				Serviceability [kN]			
		Pressure ⊥	Pressure 	Uplift ⊥	Uplift	Pressure ⊥	Pressure 	Uplift ⊥	Uplift
field area	10.00	0.622	0.064	-0.632	0.010	0.386	0.040	-0.347	0.010
eaves	10.00	0.622	0.064	-0.944	0.010	0.386	0.040	-0.536	0.010
corner region (eave)	10.00	0.311	0.032	-0.870	0.005	0.193	0.020	-0.509	0.005
corner region (ridge)	10.00	0.233	0.024	-0.776	0.004	0.145	0.015	-0.457	0.004
ridge	10.00	0.622	0.064	-0.882	0.010	0.386	0.040	-0.498	0.010
field area	10.00	0.622	0.064	-0.632	0.010	0.386	0.040	-0.347	0.010
eaves	10.00	0.622	0.064	-0.944	0.010	0.386	0.040	-0.536	0.010
corner region (eave)	10.00	0.311	0.032	-0.870	0.005	0.193	0.020	-0.509	0.005
corner region (ridge)	10.00	0.233	0.024	-0.776	0.004	0.145	0.015	-0.457	0.004
ridge	10.00	0.622	0.064	-0.882	0.010	0.386	0.040	-0.498	0.010

Resistance Values of Components

Base Rails



Structural analysis report | West 3

Base Rails	A [cm ²]	I _y [cm ⁴]	I _z [cm ⁴]	W _y [cm ³]	W _z [cm ³]
K2 BasicRail 22	2.380	1.52	7.74	1.08	2.46

Fastener

Fastener	R _{D,Uplift,Perpendicular} [kN]	R _{D,Pressure,Perpendicular} [kN]	R _{D,Pressure,Parallel} [kN]
K2 BasicClip	1.02	-	0.96
Thread-forming metal screw 6.0×38	0.65	-	0.62

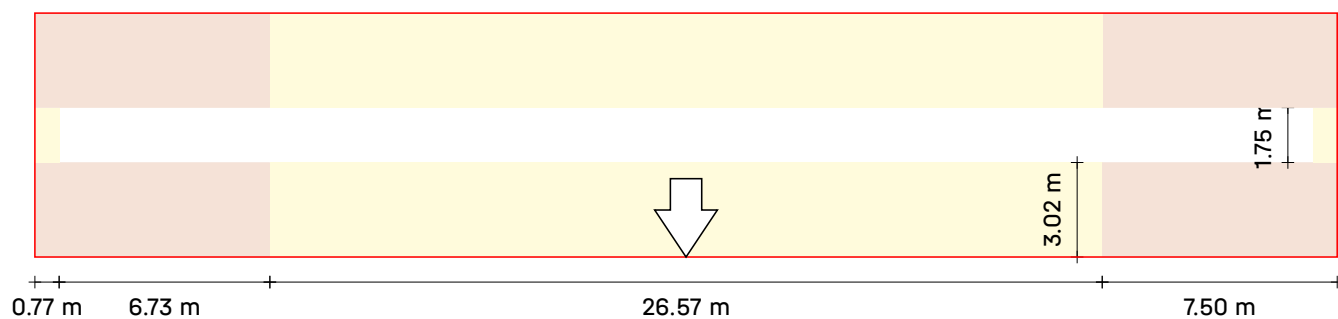
Utilisation result

No.	roof areas	ultimate limit state			Usab.	Distances		maximum values	
		Pr σ[%]	CL σ[%]	Fst F[%]	Pr f[%]	Fst [m]	BR [m]	CL L _{max} [m]	Fst D _{max} [m]
1	field area	24.3	1.9	62.8	29.6	0.808	---	0.483	0.850
1	eaves	35.5	1.5	93.4	41.1	0.808	---	0.441	0.850
1	corner region (eave)	16.3	5.0	85.6	4.9	0.404	---	0.404	0.472
1	corner region (ridge)	10.9	5.9	76.3	2.4	0.303	---	0.303	0.397
1	ridge	33.1	1.4	87.2	38.2	0.808	---	0.450	0.850
2	field area	24.3	1.7	62.8	29.6	0.808	---	0.483	0.850
2	eaves	35.5	1.5	93.4	41.1	0.808	---	0.441	0.850
2	corner region (eave)	16.3	4.6	85.6	4.9	0.404	---	0.404	0.472
2	corner region (ridge)	10.9	5.4	76.3	2.4	0.303	---	0.303	0.397
2	ridge	33.1	1.4	87.2	38.2	0.808	---	0.450	0.850

Pr	Profile	Fst D _{max}	maximum fastener spacing
Fst	Fastener	BR	Base Rail
σ	Stress	Usab.	serviceability limit state
f	Deflection	CL	Cantilever
F	Force		
CL/L _{max}	maximum cantilever length		

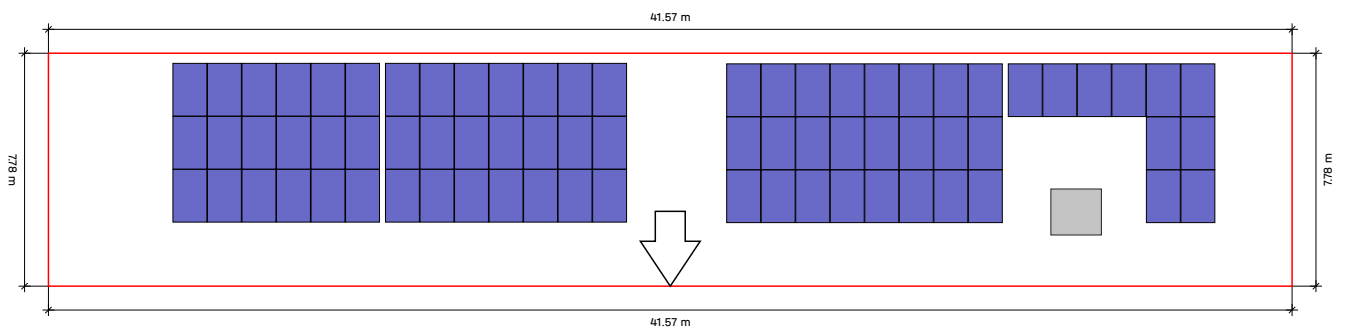


Roofs | West 4





Roofs | West 4



Roof	System	Module	Height	Quantity	Total power
<u>West 4</u>  Trapezoidal	<u>K2 BasicRail</u>	JAM54D40-430/LB 1,762×1,134×30 mm 430 Wp	15.00 m	73	31.39 kWp

Roofs | West 4 | Assembly plan

Base Rails

Type	Whole Rails		Rail cutting			
	Total Rail Length	Quantity 3.65 m	Part of Rail / Rest	Length	Rest	
8*A	7.024 m	1*3.65 m	3.650	3.374 from 3.650	0.266	
4*B	2.408 m		3.650	2.408 from 3.650	1.232	
4*C	8.178 m	2*3.65 m	1.232	0.878 from 1.232	0.344	
6*D	9.332 m	2*3.65 m	3.650	2.032 from 3.650	1.608	
2*E	8.178 m	2*3.65 m	1.608	0.878 from 1.608	0.720	

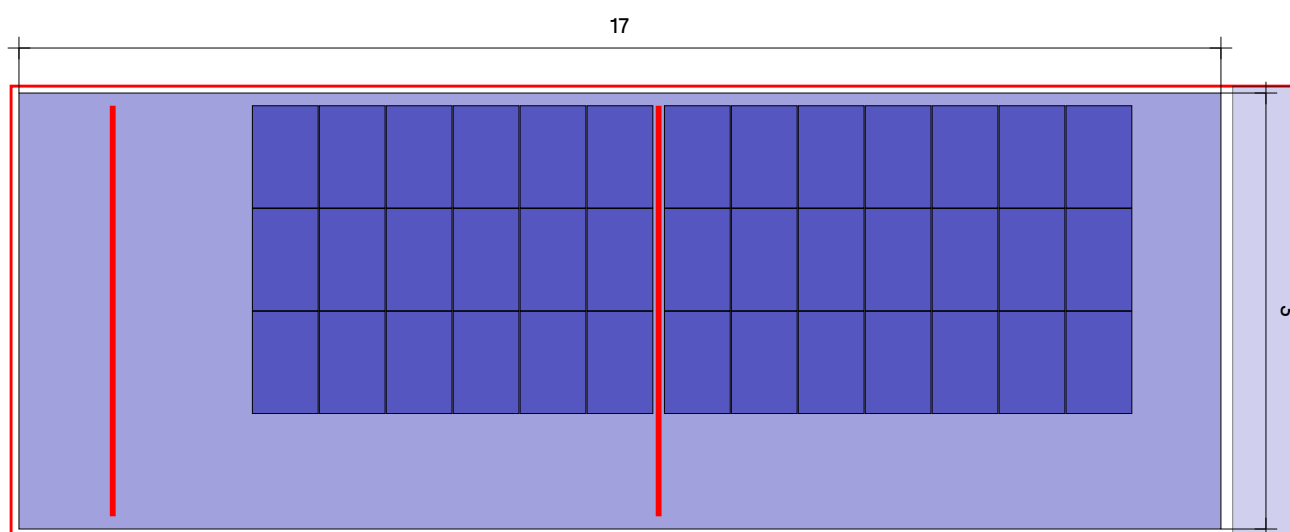
1 cm is viewed as lost for each cutting

Red numbers are leftover rails which will not be used any longer

Module arrays

Module array	Width[m]	Length[m]	Width in modules	Length in modules
1	19.96	7.08	13	3
2	19.96	7.08	14	3

Roofs | West 4 | Module array 1



Roof ④ Module array ①

Mounting System

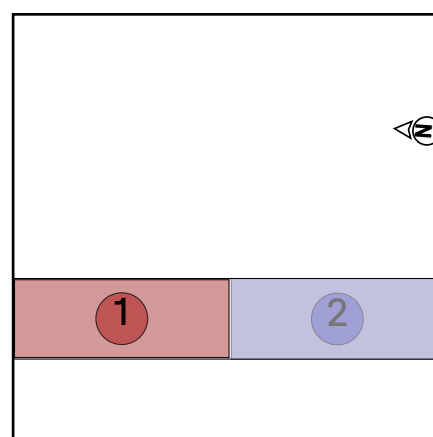
[K2 BasicRail](#)

Module

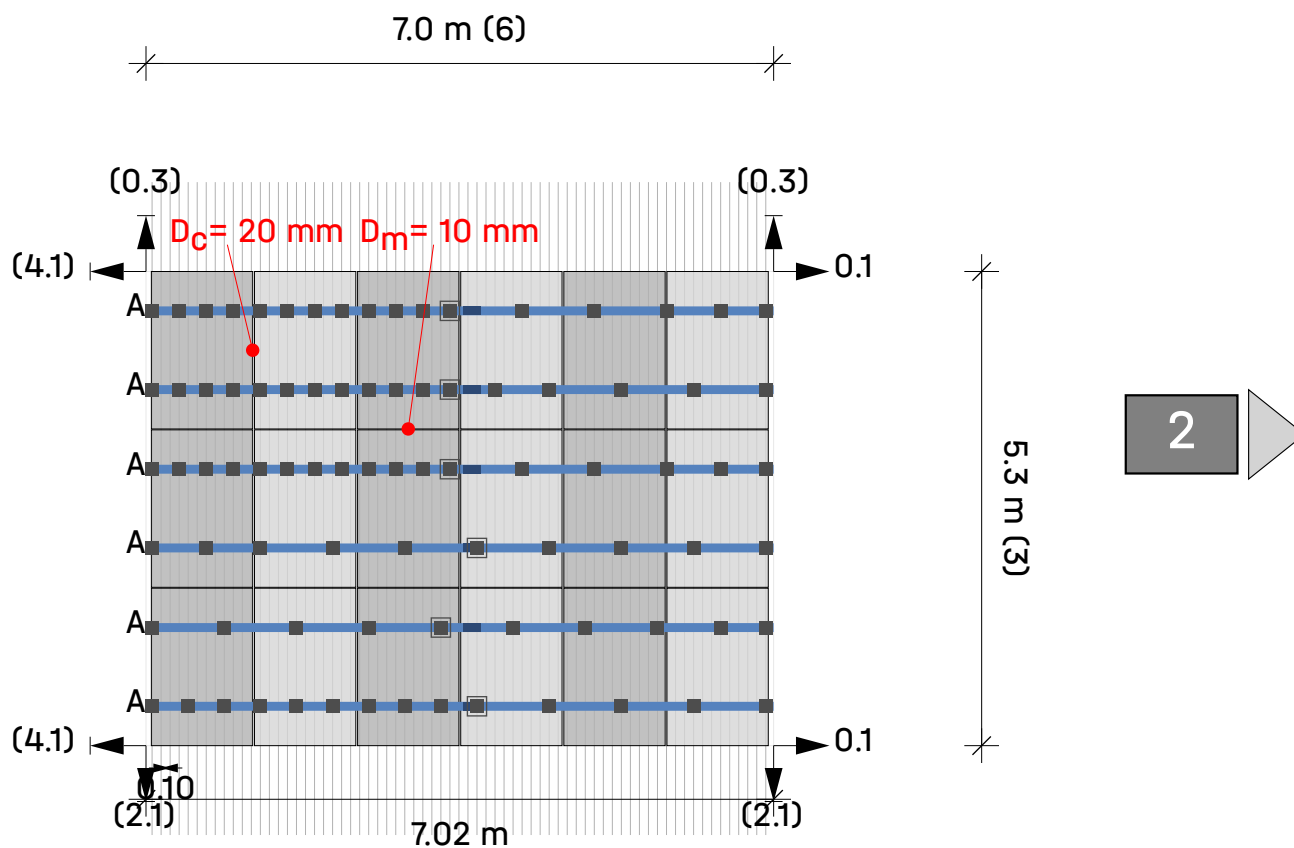
39(16.77 kWp) x
JAM54D40-430/LB

Row spacing

1.77 m



Roofs | West 4 | Module array 1 | Module blocks

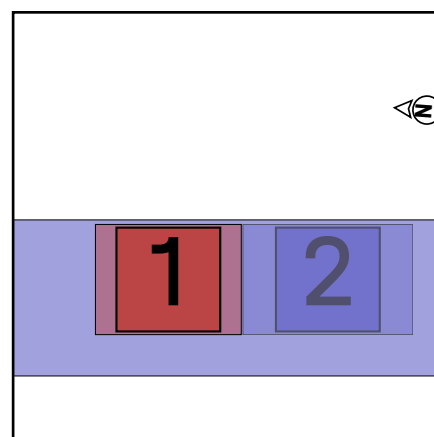


Roof ④ Module array ① Module block 1

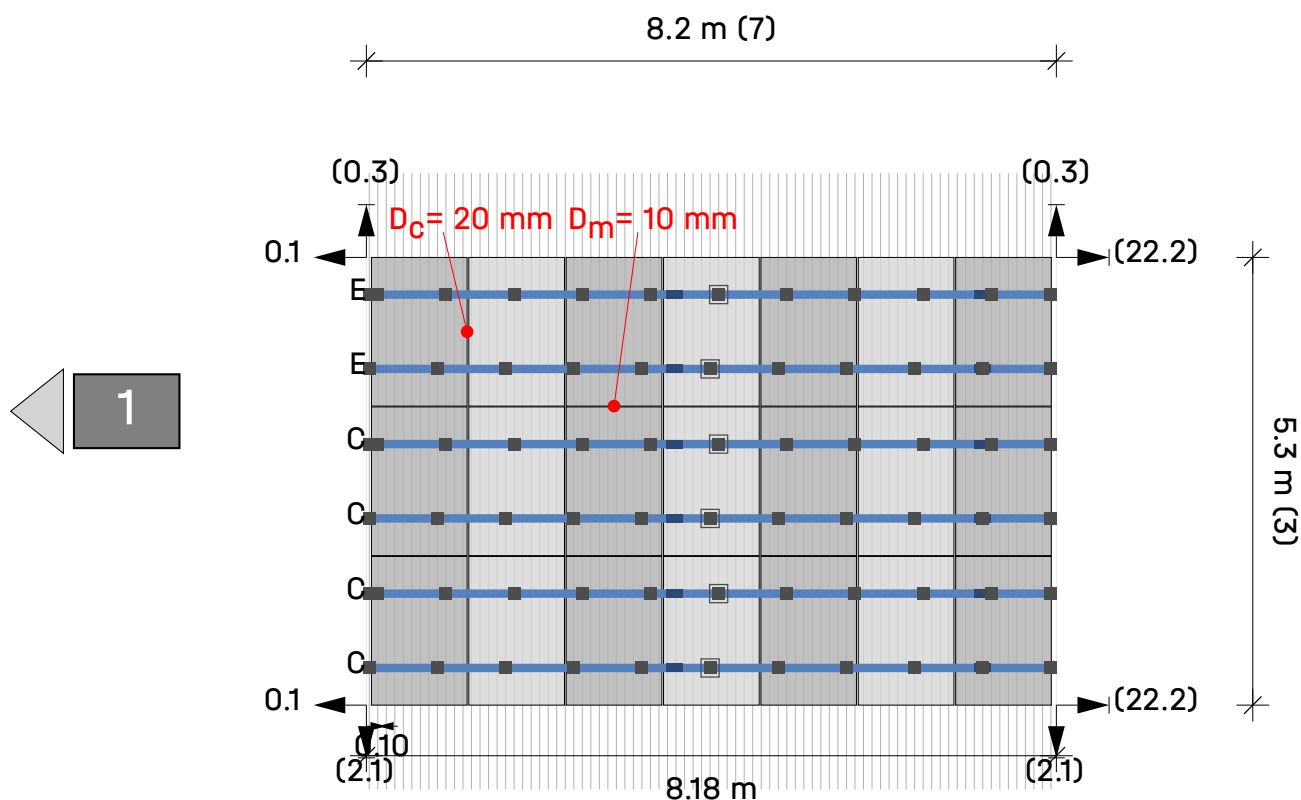
Modules $6 \times 3 = 18$

Legend

- Next block indicator
- Fastener
- BasicLocks
- Mounting rail: K2 BasicRail 22
- Distance to Roof Edge [m]
- Dist. to neighbour module block/array [m]
- D_c Distance for clamping between modules
- D_m Distance between modules



Roofs | West 4 | Module array 1 | Module blocks

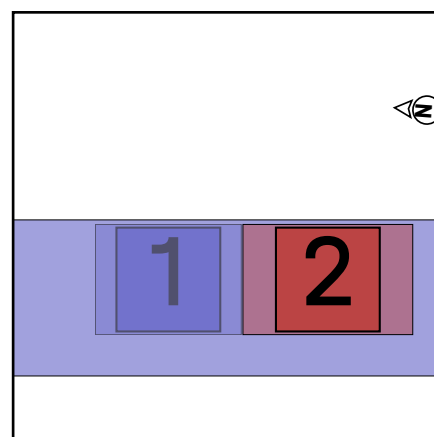


Roof ④ Module array ① Module block ②

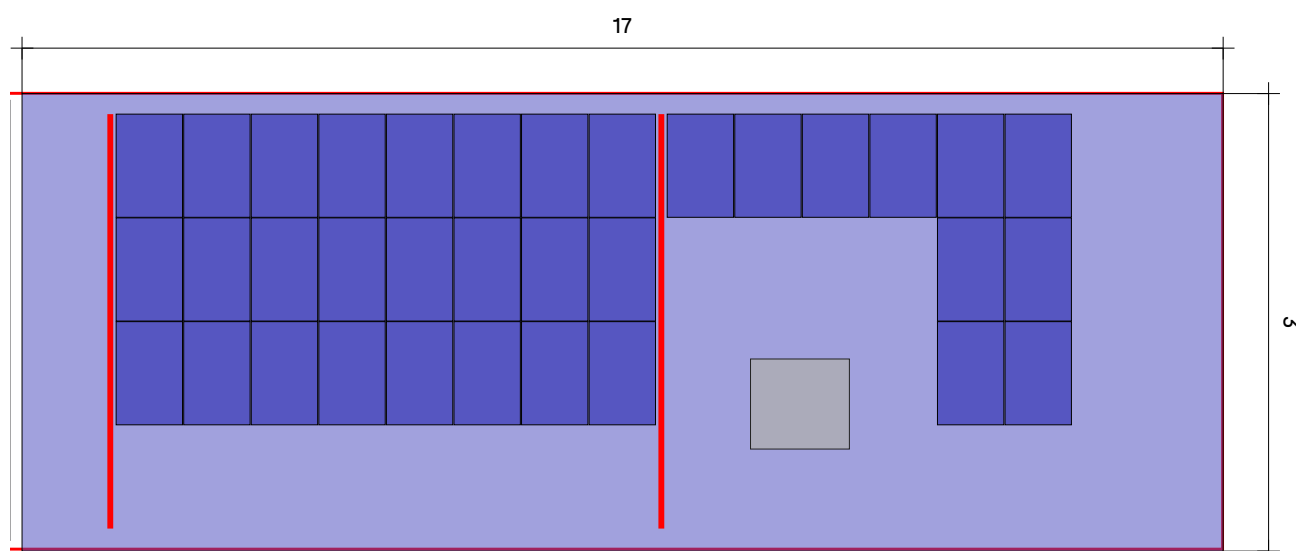
Modules $7 \times 3 = 21$

Legend

- Next block indicator
- Fastener
- BasicLocks
- Mounting rail: K2 BasicRail 22
- Distance to Roof Edge [m]
- Dist. to neighbour module block/array [m]
- D_c Distance for clamping between modules
- D_m Distance between modules



Roofs | West 4 | Module array 2



Roof ④ Module array ②

Mounting System

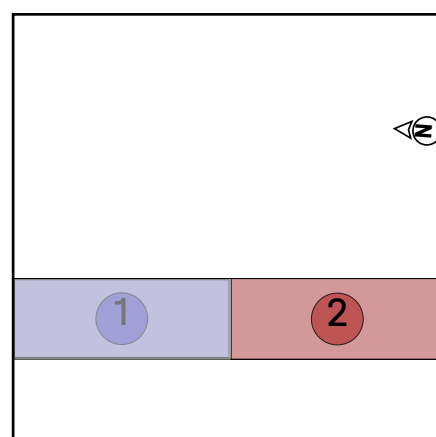
[K2 BasicRail](#)

Module

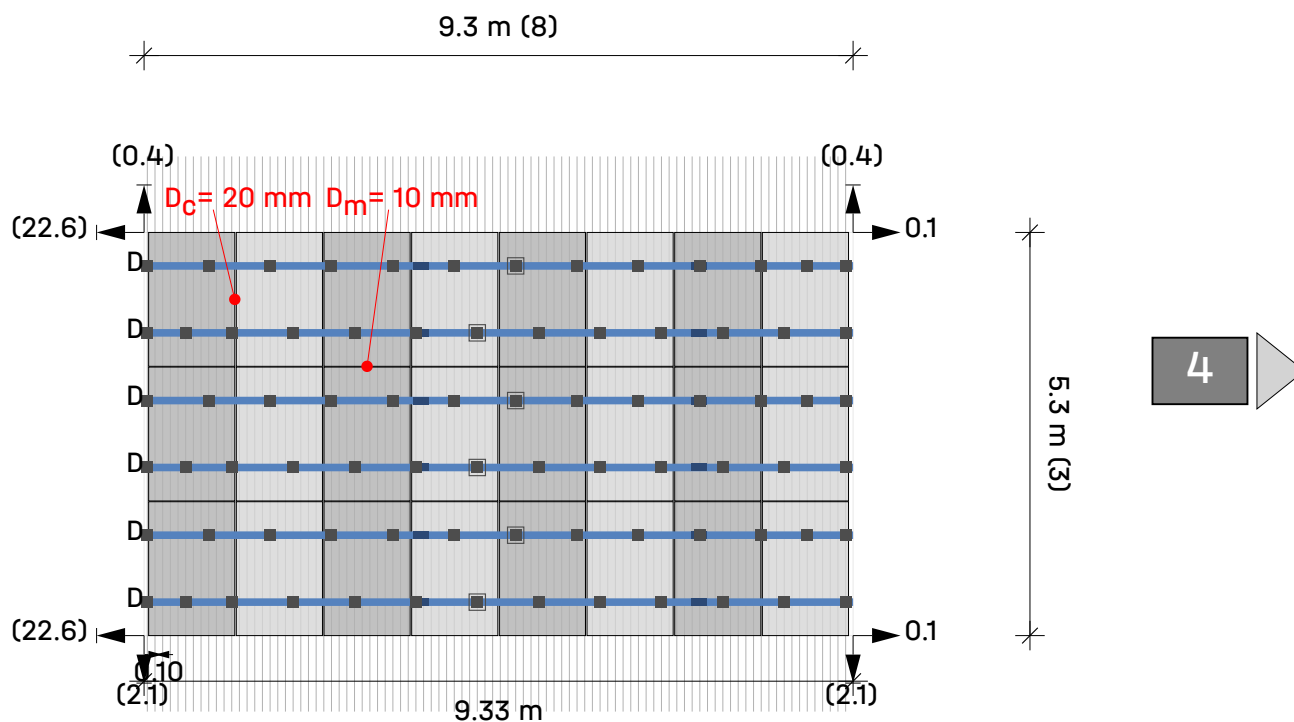
34(14.62 kWp) x
JAM54D40-430/LB

Row spacing

1.77 m



Roofs | West 4 | Module array 2 | Module blocks

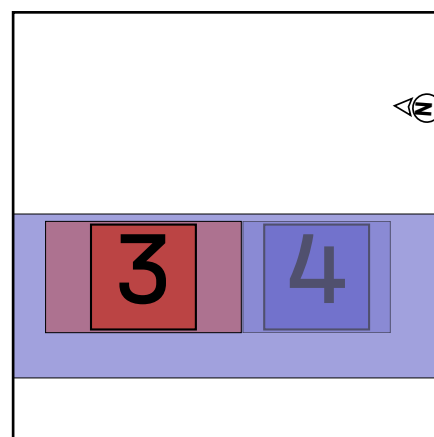


Roof ④ Module array ② Module block ③

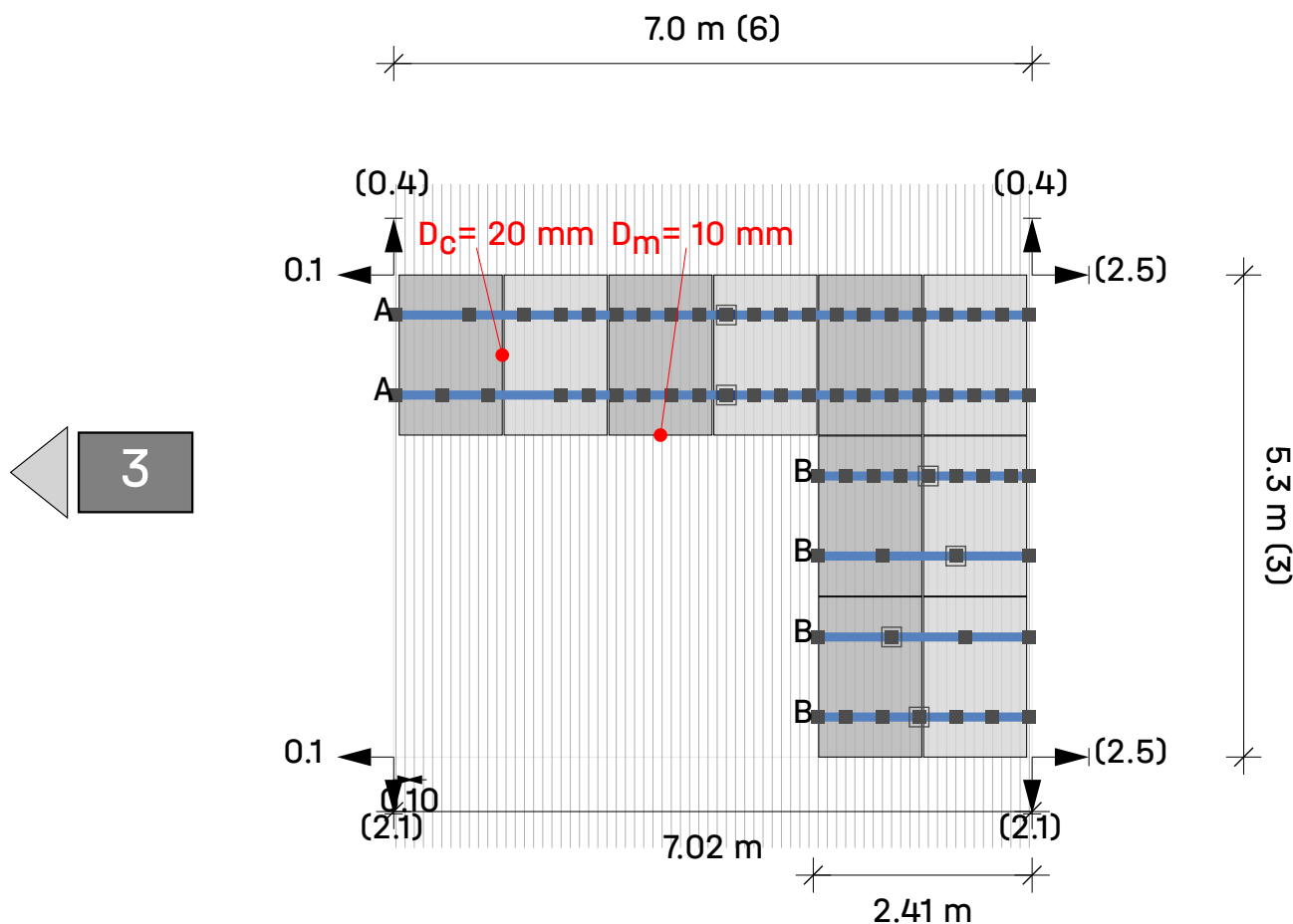
Modules $8 \times 3 = 24$

Legend

- Next block indicator
- Fastener
- BasicLocks
- Mounting rail: K2 BasicRail 22
- Distance to Roof Edge [m]
- Dist. to neighbour module block/array [m]
- D_c Distance for clamping between modules
- D_m Distance between modules



Roofs | West 4 | Module array 2 | Module blocks

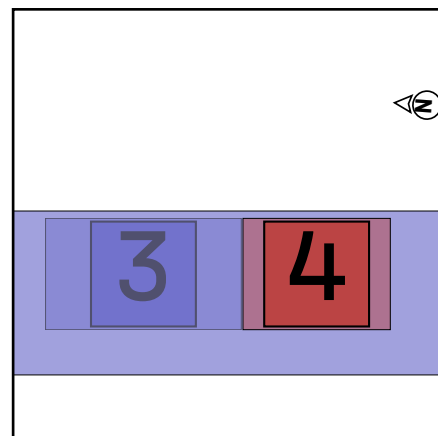


Roof ④ Module array ② Module block ④

Modules (6 × 3) - 8 = 10

Legend

- Next block indicator
- Fastener
- BasicLocks
- Mounting rail: K2 BasicRail 22
- Distance to Roof Edge [m]
- Dist. to neighbour module block/array [m]
- D_c Distance for clamping between modules
- D_m Distance between modules



Results | West 4

Roof	System	Module	Height	Quantity	Total power
<u>West 4</u> Trapezoidal	<u>K2 BasicRail</u>	JAM54D40-430/LB 1,762×1,134×30 mm 430 Wp	15.00 m	73	31.39 kWp

Module

Name	JAM54D40-430/LB
Manufacturer	Shanghai JA Solar Technology Co. Ltd.
Output power	430 Wp
Dimensions	1,762×1,134×30 mm
Weight	22.0 kg

Components

Fastener	K2 BasicClip
Base rails	K2 BasicRail 22
Metal screw	Thread-forming metal screw 6.0×38

Loads on modules (module dimensioning)

Array	A-TrA [m²]	ultimate state [Pa]				Serviceability [Pa]			
		Pressure ⊥	Pressure 	Uplift ⊥	Uplift 	Pressure ⊥	Pressure 	Uplift ⊥	Uplift
field area	2.00	794.1	82.0	-806.8	12.3	493.0	50.9	-442.9	12.3
eaves	2.00	794.1	82.0	-1,206.1	12.3	493.0	50.9	-684.8	12.3
corner region (eave)	2.00	794.1	82.0	-2,221.4	12.3	493.0	50.9	-1,300.1	12.3
corner region (ridge)	2.00	794.1	82.0	-2,643.4	12.3	493.0	50.9	-1,555.9	12.3
ridge	2.00	794.1	82.0	-1,126.3	12.3	493.0	50.9	-636.4	12.3
field area	2.00	794.1	82.0	-806.8	12.3	493.0	50.9	-442.9	12.3
eaves	2.00	794.1	82.0	-1,206.1	12.3	493.0	50.9	-684.8	12.3
corner region (eave)	2.00	794.1	82.0	-2,221.4	12.3	493.0	50.9	-1,300.1	12.3
corner region (ridge)	2.00	794.1	82.0	-2,643.4	12.3	493.0	50.9	-1,555.9	12.3
ridge	2.00	794.1	82.0	-1,126.3	12.3	493.0	50.9	-636.4	12.3



Results | West 4

Utilisation result

No.	Module Array	roof areas	ultimate limit state			Usab.	Distances		maximum values	
			Pr σ [%]	CL σ [%]	Fst F[%]	Pr f[%]	Fst [m]	BR [m]	CL $L_{\max}$ [m]	Fst D _{max} [m]
1		field area	24.3	1.4	62.8	29.6	0.808	---	0.483	0.850
1		eaves	35.5	2.1	93.4	41.1	0.808	---	0.441	0.850
1		corner region (eave)	16.3	2.3	85.6	4.9	0.404	---	0.404	0.472
1		corner region (ridge)	10.9	2.8	76.3	2.4	0.303	---	0.303	0.397
1		ridge	33.1	2.0	87.2	38.2	0.808	---	0.450	0.850
2		field area	24.3	1.8	62.8	29.6	0.808	---	0.483	0.850
2		eaves	35.5	2.6	93.4	41.1	0.808	---	0.441	0.850
2		corner region (eave)	16.3	1.4	85.6	4.9	0.404	---	0.404	0.472
2		corner region (ridge)	10.9	1.7	76.3	2.4	0.303	---	0.303	0.397
2		ridge	33.1	2.4	87.2	38.2	0.808	---	0.450	0.850

Pr **Profile**Fst **Fastener** σ **Stress**f **Deflection**F **Force**CL/ $L_{\max}$ **maximum cantilever length**Fst D_{max} **maximum fastener spacing**BR **Base Rail**Usab. **serviceability limit state**CL **Cantilever**



Results | West 4

Important Information

- The quantity for K2 BasicRail BasicClips is calculated in such a way, that - according to the Assembly Instructions - a BasicClip can be installed on the crest to the left and right of a Rail Connector Set.
- The structure was statically verified in accordance with Eurocode 9: Design of aluminium structures (DIN EN 1999-1-1:2021) and offers sufficient load-bearing capacity and stability for the loads specified in the chapter 'Maximum actions on the components'.
- Adjustment factor for wind load regarding service life period, f_W , is according to DIN EN 1991-1-4/ NA, NDP for 4.2 (2P) note 5, table 3
- Adjustment factor for snow load regarding service life period, f_S , is according to DIN EN 1991-1-3/ annex D, table 4
- The structural design complies with BS EN 1990 - Basis of Structural Design.
- Snow loads are determined in accordance with National Annex BS NA EN 1991-1-3 (2018) - UK National Annex to EC1 - Action on structures - general actions - snow loads.
- Wind loads are determined in accordance with National Annex BS NA EN 1991-1-4 - UK National Annex to EC1 - Action on structures, general actions - wind actions.
- Service life is recognised according to 'Eurocode EN 1991 - Action on structures, Snow loads' and 'Eurocode EN 1991 - Actions on structures, Wind actions'. Subject to the Building Regulations and for security-relevant reasons the installation has to be dismantled at the end of its service life.
- Failure consequence class is considered according to 'Eurocode EN 1990 - Basis of structural design'.
- The person responsible for the execution of the work must check the load assumptions made with the conditions on site. If deviations are found, the person who prepared the static calculation must be consulted immediately. , in particular § 2 ("technical and specialist requirements for the customer"), § 7 ("warranty provisions") and § 8 ("limitation of liability").



Structural analysis report | West 4

General information

Name	GORTON MARKET
Mounting System	K2 BasicRail
Author	JJ Fitzgerald

Location information

Address	Manchester M18 8LD, UK
Ground elevation	70.03 m

Roof information

Building height	15.00 m
Roof type	Monopitch roof
Roof pitch	6°
Roof covering	Trapezoidal
Min. roof edge distance	0.00 m
Crest distance	101.0 mm
Crest width	22.0 mm
Crest height	40.0 mm
Roof material	Steel
Sheet quality	S235
Sheet thickness	0.500 mm

Loads

Design method	BS EN
Failure consequence class (CC)	CC3
Design working life	25 years
Terrain category	Town Terrain
Distance to shoreline	50.00 km
Distance inside town terrain	25.00 km

Wind load

Velocity pressure, 50 years	$q_{p,50} = 0.751 \text{ kN/m}^2$
Adjustment factor for service life	$f_w = 1.000$
Velocity pressure, 25 years	$q_{p,25} = 0.691 \text{ kN/m}^2$

Structural analysis report | West 4

Roof areas

Array	load impact area [m ²]	maxCpe ₁₀	minCpe ₁₀	wind pressure [kN/m ²]	wind suction [kN/m ²]
field area	10.00	0.020	-0.810	0.014	-0.560
eaves	10.00	0.020	-1.160	0.014	-0.802
corner region (eave)	10.00	0.020	-2.050	0.014	-1.417
corner region (ridge)	10.00	0.020	-2.420	0.014	-1.673
ridge	10.00	0.020	-1.090	0.014	-0.754
field area	10.00	0.020	-0.810	0.014	-0.560
eaves	10.00	0.020	-1.160	0.014	-0.802
corner region (eave)	10.00	0.020	-2.050	0.014	-1.417
corner region (ridge)	10.00	0.020	-2.420	0.014	-1.673
ridge	10.00	0.020	-1.090	0.014	-0.754

Snow load

Snow load zone	3
Snow guard	No
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$
Shape Coefficient for Snow	$\mu_i = 0.800$
Factor for roof pitch	$d_i = 0.995$
Snow load on roof, 50 year	$s_{i,50} = 0.398 \text{ kN/m}^2$
Adjustment factor for service life	$f_s = 1.000$
Snow load on roof, 25 years	$s_{i,25} = 0.370 \text{ kN/m}^2$

Dead Load

Weight of module	$G_M = 22.0 \text{ kg}$
Weight of mounting system per module	$= 2.0 \text{ kg}$
Module area	$A_M = 2.00 \text{ m}^2$
Dead weight of module per m ²	$= 11.01 \text{ kg/m}^2$
Dead weight of mounting system per m ²	$= 1.00 \text{ kg/m}^2$
Total Dead Load (excl. ballast) per m ²	$= 0.12 \text{ kN/m}^2$



Structural analysis report | West 4

Load Combinations

Ultimate limit state

Partial safety factor unfavourable permanent load	$\gamma_{G,sup} = 1.35$
Partial safety factor favourable permanent load	$\gamma_{G,inf} = 1.00$
Partial safety factor destabilising permanent load	$\gamma_{G,dst} = 1.10$
Partial safety factor stabilising permanent load	$\gamma_{G,stab} = 0.90$
Partial safety factor variable loads	$\gamma_Q = 1.50$
Combination coefficient with regards to wind	$\psi_{0,W} = 0.60$
Combination coefficient with regards to wind (additional varying influences)	$\psi_{1,W} = 0.20$
Combination coefficient with regards to Snow	$\psi_{0,S} = 0.50$
Importance factor permanent	$\kappa_{FI,G} = 1.10$
Importance factor variable	$\kappa_{FI,Q} = 1.10$
Characteristic dead weight	G_k
Characteristic snow load on the roof	$S_{i,n}$
Characteristic wind load	W_k

Load case combination 01	$LCC\ 01_{uls} = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$
Load case combination 02	$LCC\ 02_{uls} = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$
Load case combination 03	$LCC\ 03_{uls} = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$
Load case combination 04	$LCC\ 04_{uls} = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$
Load case combination 06	$LCC\ 06_{uls} = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$

Serviceability limit state

Combination coefficient with regards to wind	$\psi_{0,W} = 0.60$
Combination coefficient with regards to Snow	$\psi_{0,S} = 0.50$

Load case combination 01	$LCC\ 01_{sls} = G_k + S_{i,n}$
Load case combination 02	$LCC\ 02_{sls} = G_k + W_{k,Pressure}$
Load case combination 03	$LCC\ 03_{sls} = G_k + W_{k,Pressure} + \psi_{0,S} * S_{i,n}$
Load case combination 04	$LCC\ 04_{sls} = G_k + S_{i,n} + \psi_{0,W} * W_{k,Pressure}$
Load case combination 06	$LCC\ 06_{sls} = G_k + W_{k,Suction}$

Structural analysis report | West 4

Maximum load on modules (Mounting system dimensioning)

Array	A-TrA [m ²]	ultimate state [kN/m ²]				Serviceability [kN/m ²]			
		Pressure ⊥	Pressure 	Uplift ⊥	Uplift 	Pressure ⊥	Pressure 	Uplift ⊥	Uplift
field area	10.00	0.794	0.082	-0.807	0.012	0.493	0.051	-0.443	0.012
eaves	10.00	0.794	0.082	-1.206	0.012	0.493	0.051	-0.685	0.012
corner region (eave)	10.00	0.794	0.082	-2.221	0.012	0.493	0.051	-1.300	0.012
corner region (ridge)	10.00	0.794	0.082	-2.643	0.012	0.493	0.051	-1.556	0.012
ridge	10.00	0.794	0.082	-1.126	0.012	0.493	0.051	-0.636	0.012
field area	10.00	0.794	0.082	-0.807	0.012	0.493	0.051	-0.443	0.012
eaves	10.00	0.794	0.082	-1.206	0.012	0.493	0.051	-0.685	0.012
corner region (eave)	10.00	0.794	0.082	-2.221	0.012	0.493	0.051	-1.300	0.012
corner region (ridge)	10.00	0.794	0.082	-2.643	0.012	0.493	0.051	-1.556	0.012
ridge	10.00	0.794	0.082	-1.126	0.012	0.493	0.051	-0.636	0.012

Max. load on fastener

Array	A-TrA [m ²]	ultimate state [kN]				Serviceability [kN]			
		Pressure ⊥	Pressure 	Uplift ⊥	Uplift	Pressure ⊥	Pressure 	Uplift ⊥	Uplift
field area	10.00	0.622	0.064	-0.632	0.010	0.386	0.040	-0.347	0.010
eaves	10.00	0.622	0.064	-0.944	0.010	0.386	0.040	-0.536	0.010
corner region (eave)	10.00	0.311	0.032	-0.870	0.005	0.193	0.020	-0.509	0.005
corner region (ridge)	10.00	0.233	0.024	-0.776	0.004	0.145	0.015	-0.457	0.004
ridge	10.00	0.622	0.064	-0.882	0.010	0.386	0.040	-0.498	0.010
field area	10.00	0.622	0.064	-0.632	0.010	0.386	0.040	-0.347	0.010
eaves	10.00	0.622	0.064	-0.944	0.010	0.386	0.040	-0.536	0.010
corner region (eave)	10.00	0.311	0.032	-0.870	0.005	0.193	0.020	-0.509	0.005
corner region (ridge)	10.00	0.233	0.024	-0.776	0.004	0.145	0.015	-0.457	0.004
ridge	10.00	0.622	0.064	-0.882	0.010	0.386	0.040	-0.498	0.010

Resistance Values of Components

Base Rails



Structural analysis report | West 4

Base Rails	A [cm ²]	I _y [cm ⁴]	I _z [cm ⁴]	W _y [cm ³]	W _z [cm ³]
K2 BasicRail 22	2.380	1.52	7.74	1.08	2.46

Fastener

Fastener	R _{D,Uplift,Perpendicular} [kN]	R _{D,Pressure,Perpendicular} [kN]	R _{D,Pressure,Parallel} [kN]
K2 BasicClip	1.02	-	0.96
Thread-forming metal screw 6.0×38	0.65	-	0.62

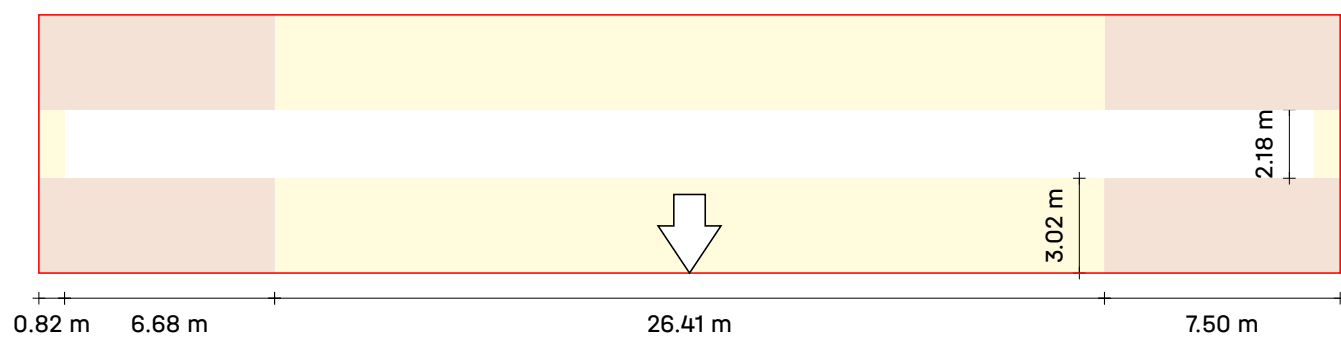
Utilisation result

No. Module Array	roof areas	ultimate limit state			Usab.	Distances		maximum values	
		Pr σ[%]	CL σ[%]	Fst F[%]	Pr f[%]	Fst [m]	BR [m]	CL L _{max} [m]	Fst D _{max} [m]
1	field area	24.3	1.4	62.8	29.6	0.808	---	0.483	0.850
1	eaves	35.5	2.1	93.4	41.1	0.808	---	0.441	0.850
1	corner region (eave)	16.3	2.3	85.6	4.9	0.404	---	0.404	0.472
1	corner region (ridge)	10.9	2.8	76.3	2.4	0.303	---	0.303	0.397
1	ridge	33.1	2.0	87.2	38.2	0.808	---	0.450	0.850
2	field area	24.3	1.8	62.8	29.6	0.808	---	0.483	0.850
2	eaves	35.5	2.6	93.4	41.1	0.808	---	0.441	0.850
2	corner region (eave)	16.3	1.4	85.6	4.9	0.404	---	0.404	0.472
2	corner region (ridge)	10.9	1.7	76.3	2.4	0.303	---	0.303	0.397
2	ridge	33.1	2.4	87.2	38.2	0.808	---	0.450	0.850

Pr	Profile	Fst D _{max}	maximum fastener spacing
Fst	Fastener	BR	Base Rail
σ	Stress	Usab.	serviceability limit state
f	Deflection	CL	Cantilever
F	Force		
CL/L _{max}	maximum cantilever length		

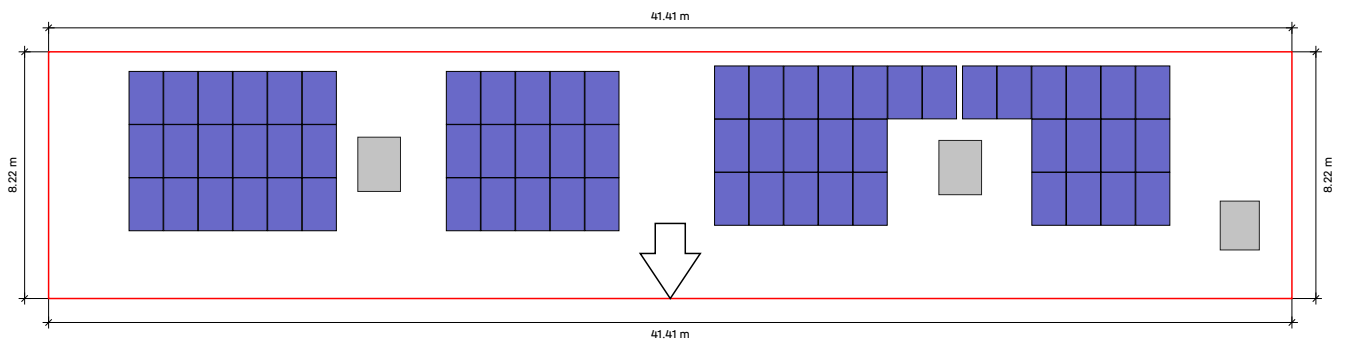


Roofs | East 1





Roofs | East 1



Roof	System	Module	Height	Quantity	Total power
<u>East 1</u>  Trapezoidal	<u>K2 BasicRail</u>	JAM54D40-430/LB 1,762×1,134×30 mm 430 Wp	15.00 m	64	27.52 kWp

Roofs | East 1 | Assembly plan

Base Rails

Type	Whole Rails		Rail cutting		
	Total Rail Length	Quantity 3.65 m	Part of Rail / Rest	Length	Rest
8*A	7.024 m	1*3.65 m	3.650	3.374 from 3.650	0.266
10*B	5.870 m	1*3.65 m	3.650	2.220 from 3.650	<u>1.420</u>
4*C	4.716 m	1*3.65 m	<u>1.420</u>	1.066 from 1.420	0.344
2*D	8.178 m	2*3.65 m	1.420	0.878 from 1.420	0.532

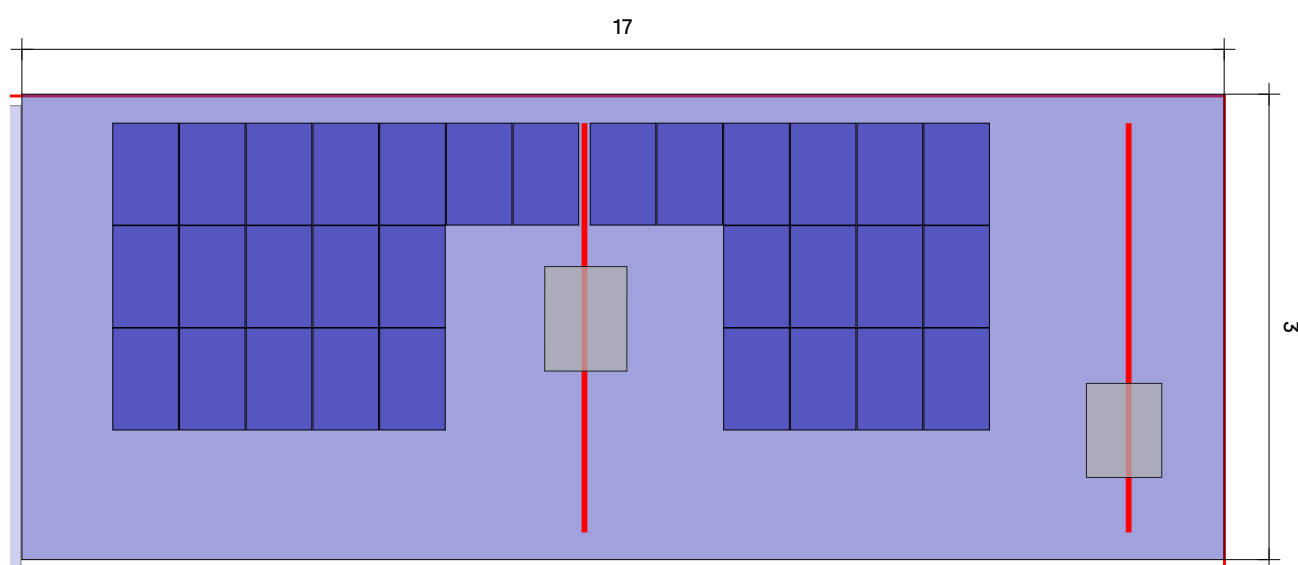
1 cm is viewed as lost for each cutting

Red numbers are leftover rails which will not be used any longer

Module arrays

Module array	Width[m]	Length[m]	Width in modules	Length in modules
1	19.96	7.08	13	3
2	19.96	7.08	14	3

Roofs | East 1 | Module array 1



Roof ⑤ Module array ①

Mounting System

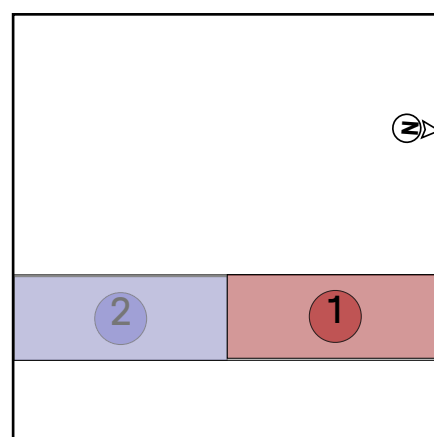
[K2 BasicRail](#)

Module

31(13.33 kWp) x
JAM54D40-430/LB

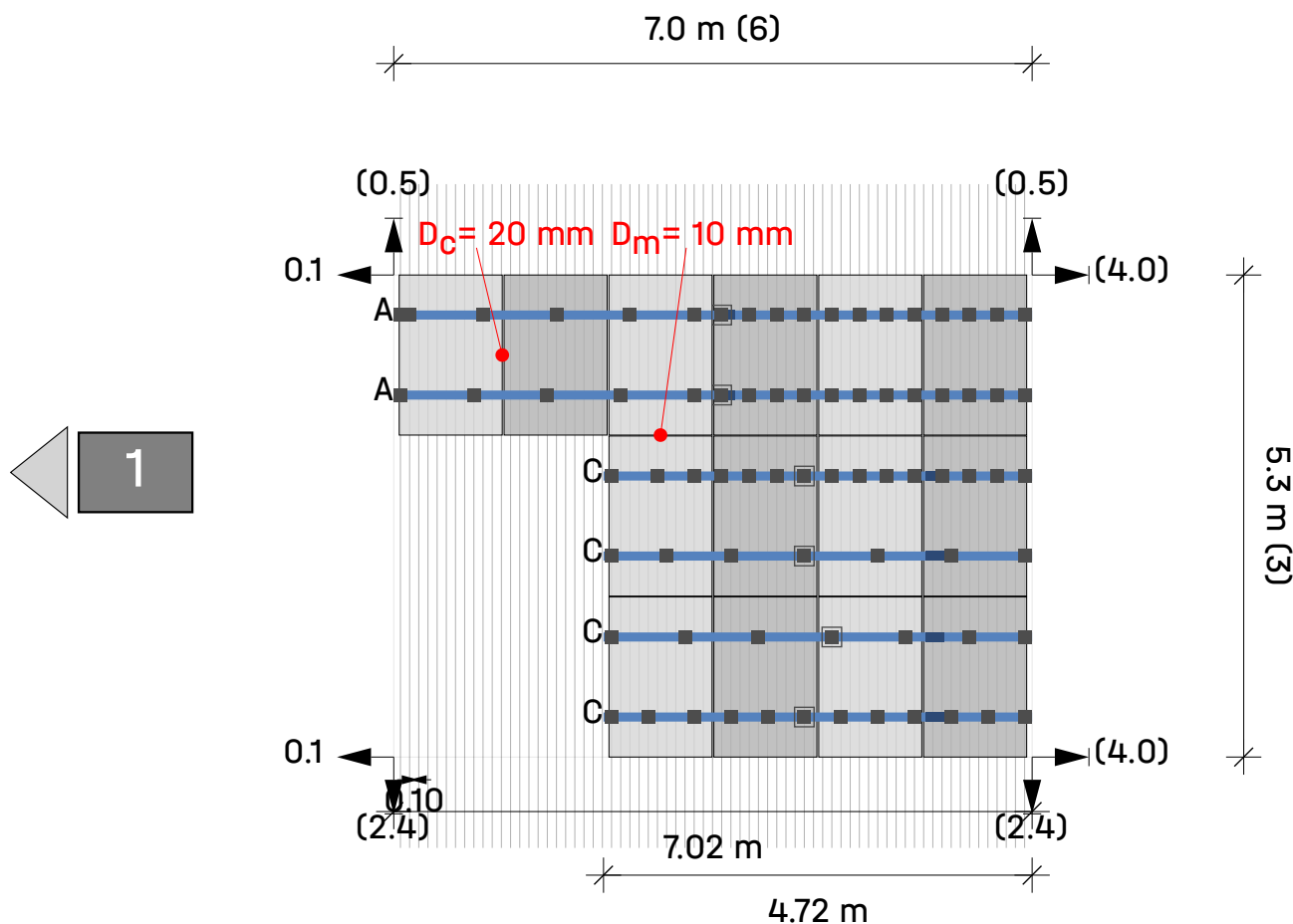
Row spacing

1.77 m





Roofs | East 1 | Module array 1 | Module blocks



Roof ⑤ Module array ① Module block 2

Modules $(6 \times 3) - 4 = 14$

Legend

Next block indicator

Fastener

BasicLocks

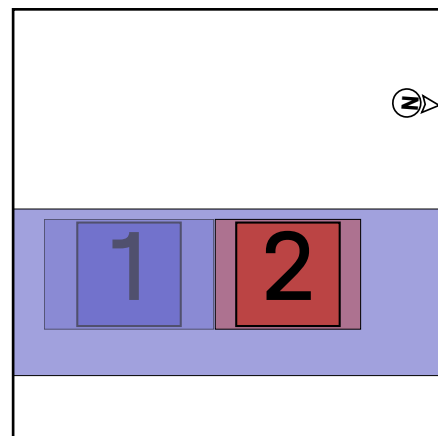
Mounting rail: K2 BasicRail 22

Distance to Roof Edge [m]

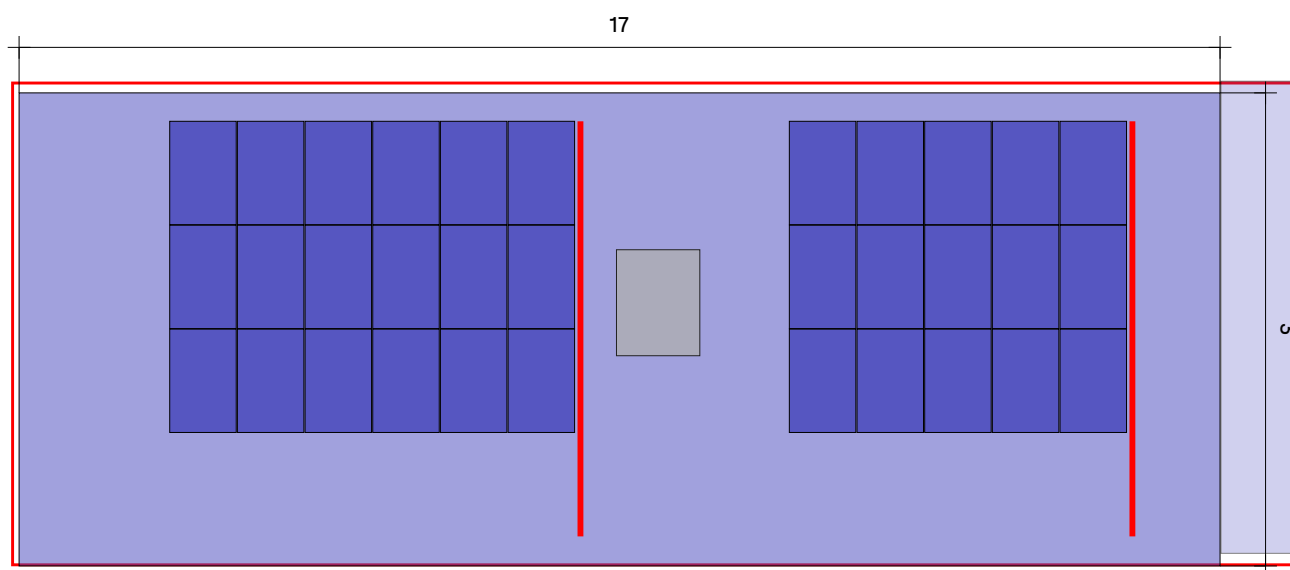
Dist. to neighbour module block/array [m]

D_c Distance for clamping between modules

D_m Distance between modules



Roofs | East 1 | Module array 2



Roof ⑤ Module array ②

Mounting System

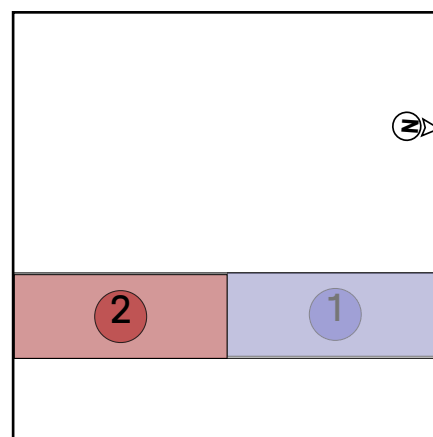
[K2 BasicRail](#)

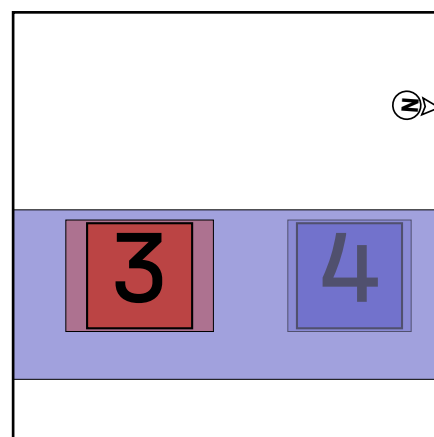
Module

33(14.19 kWp) x
JAM54D40-430/LB

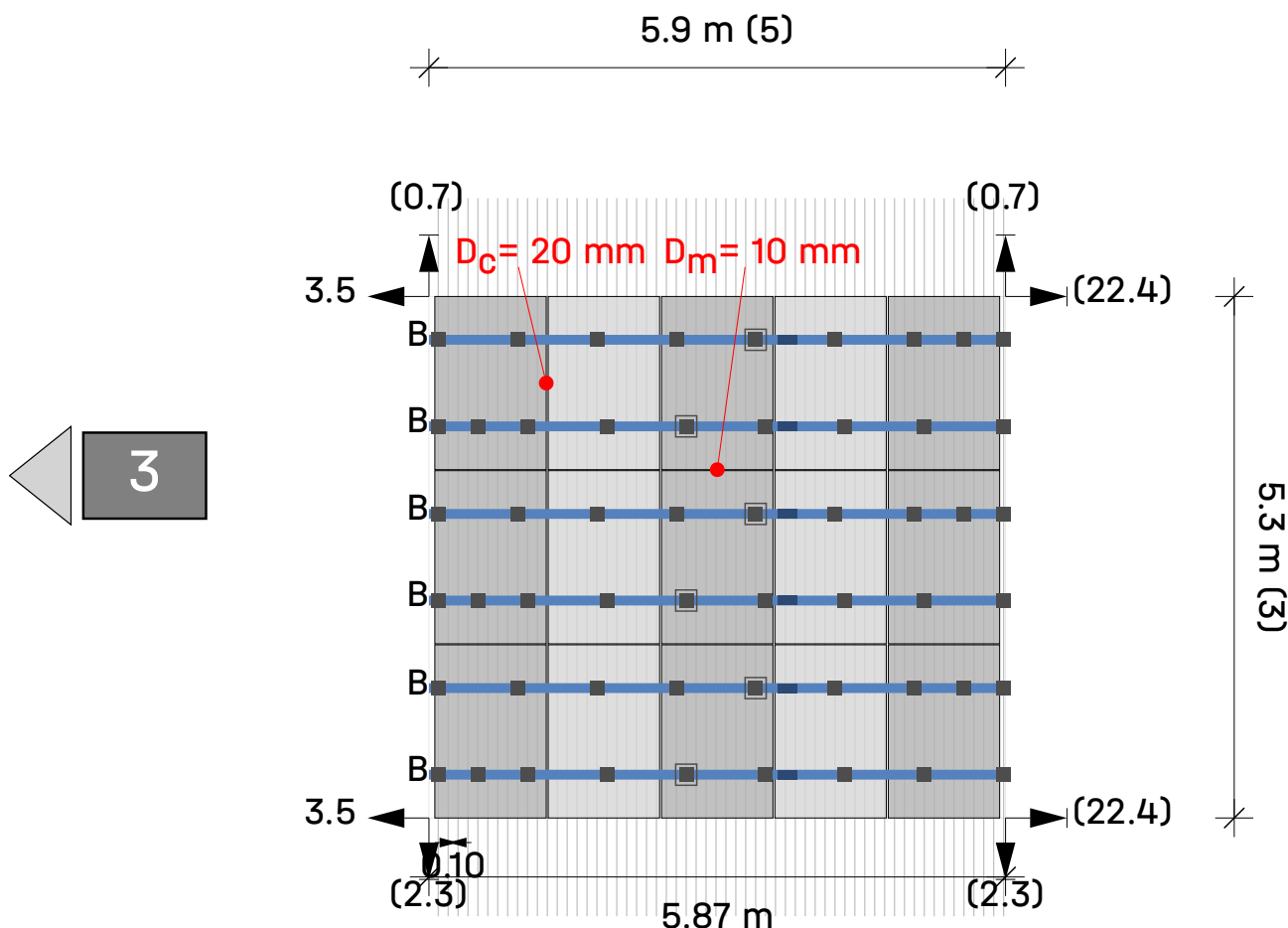
Row spacing

1.77 m





Roofs | East 1 | Module array 2 | Module blocks

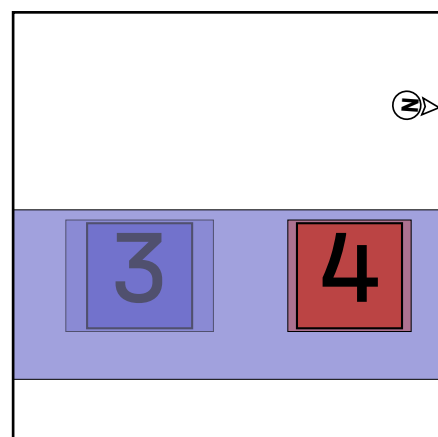


Roof (5) Module array (2) Module block (4)

Modules 5 × 3 = 15

Legend

- Next block indicator
- Fastener
- BasicLocks
- Mounting rail: K2 BasicRail 22
- Distance to Roof Edge [m]
- Dist. to neighbour module block/array [m]
- D_c Distance for clamping between modules
- D_m Distance between modules



Results | East 1

Roof	System	Module	Height	Quantity	Total power
<u>East 1</u>	<u>K2 BasicRail</u>	JAM54D40-430/LB 1,762×1,134×30 mm 430 Wp	15.00 m	64	27.52 kWp
 Trapezoidal					

Module

Name	JAM54D40-430/LB
Manufacturer	Shanghai JA Solar Technology Co. Ltd.
Output power	430 Wp
Dimensions	1,762×1,134×30 mm
Weight	22.0 kg

Components

Fastener	K2 BasicClip
Base rails	K2 BasicRail 22
Metal screw	Thread-forming metal screw 6.0×38

Loads on modules (module dimensioning)

Array	A-TrA [m²]	ultimate state [Pa]				Serviceability [Pa]			
		Pressure ⊥	Pressure 	Uplift ⊥	Uplift 	Pressure ⊥	Pressure 	Uplift ⊥	Uplift
field area	2.00	794.1	82.0	-806.8	12.3	493.0	50.9	-442.9	12.3
eaves	2.00	794.1	82.0	-1,206.1	12.3	493.0	50.9	-684.8	12.3
corner region (eave)	2.00	794.1	82.0	-2,221.4	12.3	493.0	50.9	-1,300.1	12.3
corner region (ridge)	2.00	794.1	82.0	-2,643.4	12.3	493.0	50.9	-1,555.9	12.3
ridge	2.00	794.1	82.0	-1,126.3	12.3	493.0	50.9	-636.4	12.3
field area	2.00	794.1	82.0	-806.8	12.3	493.0	50.9	-442.9	12.3
eaves	2.00	794.1	82.0	-1,206.1	12.3	493.0	50.9	-684.8	12.3
corner region (eave)	2.00	794.1	82.0	-2,221.4	12.3	493.0	50.9	-1,300.1	12.3
corner region (ridge)	2.00	794.1	82.0	-2,643.4	12.3	493.0	50.9	-1,555.9	12.3
ridge	2.00	794.1	82.0	-1,126.3	12.3	493.0	50.9	-636.4	12.3



Results | East 1

Utilisation result

No.	Module Array	roof areas	ultimate limit state			Usab.	Distances		maximum values	
			Pr σ [%]	CL σ [%]	Fst F[%]	Pr f[%]	Fst [m]	BR [m]	CL $L_{\max}$ [m]	Fst D _{max} [m]
1		field area	24.3	1.5	62.8	29.6	0.808	---	0.483	0.850
1		eaves	35.5	2.1	93.4	41.1	0.808	---	0.441	0.850
1		corner region (eave)	16.3	3.4	85.6	4.9	0.404	---	0.404	0.472
1		corner region (ridge)	10.9	4.1	76.3	2.4	0.303	---	0.303	0.397
1		ridge	33.1	2.0	87.2	38.2	0.808	---	0.450	0.850
2		field area	24.3	1.6	62.8	29.6	0.808	---	0.483	0.850
2		eaves	35.5	2.4	93.4	41.1	0.808	---	0.441	0.850
2		corner region (eave)	16.3	1.5	85.6	4.9	0.404	---	0.404	0.472
2		corner region (ridge)	10.9	1.8	76.3	2.4	0.303	---	0.303	0.397
2		ridge	33.1	2.2	87.2	38.2	0.808	---	0.450	0.850

Pr	Profile	Fst D _{max}	maximum fastener spacing
Fst	Fastener	BR	Base Rail
σ	Stress	Usab.	serviceability limit state
f	Deflection	CL	Cantilever
F	Force		
CL/ $L_{\max}$	maximum cantilever length		



Results | East 1

Important Information

- The quantity for K2 BasicRail BasicClips is calculated in such a way, that - according to the Assembly Instructions - a BasicClip can be installed on the crest to the left and right of a Rail Connector Set.
- The structure was statically verified in accordance with Eurocode 9: Design of aluminium structures (DIN EN 1999-1-1:2021) and offers sufficient load-bearing capacity and stability for the loads specified in the chapter 'Maximum actions on the components'.
- Adjustment factor for wind load regarding service life period, f_W , is according to DIN EN 1991-1-4/ NA, NDP for 4.2 (2P) note 5, table 3
- Adjustment factor for snow load regarding service life period, f_S , is according to DIN EN 1991-1-3/ annex D, table 4
- The structural design complies with BS EN 1990 - Basis of Structural Design.
- Snow loads are determined in accordance with National Annex BS NA EN 1991-1-3 (2018) - UK National Annex to EC1 - Action on structures - general actions - snow loads.
- Wind loads are determined in accordance with National Annex BS NA EN 1991-1-4 - UK National Annex to EC1 - Action on structures, general actions - wind actions.
- Service life is recognised according to 'Eurocode EN 1991 - Action on structures, Snow loads' and 'Eurocode EN 1991 - Actions on structures, Wind actions'. Subject to the Building Regulations and for security-relevant reasons the installation has to be dismantled at the end of its service life.
- Failure consequence class is considered according to 'Eurocode EN 1990 - Basis of structural design'.
- The person responsible for the execution of the work must check the load assumptions made with the conditions on site. If deviations are found, the person who prepared the static calculation must be consulted immediately. , in particular § 2 ("technical and specialist requirements for the customer"), § 7 ("warranty provisions") and § 8 ("limitation of liability").



Structural analysis report | East 1

General information

Name	GORTON MARKET
Mounting System	K2 BasicRail
Author	JJ Fitzgerald

Location information

Address	Manchester M18 8LD, UK
Ground elevation	70.03 m

Roof information

Building height	15.00 m
Roof type	Monopitch roof
Roof pitch	6°
Roof covering	Trapezoidal
Min. roof edge distance	0.00 m
Crest distance	101.0 mm
Crest width	22.0 mm
Crest height	40.0 mm
Roof material	Steel
Sheet quality	S235
Sheet thickness	0.500 mm

Loads

Design method	BS EN
Failure consequence class (CC)	CC3
Design working life	25 years
Terrain category	Town Terrain
Distance to shoreline	50.00 km
Distance inside town terrain	25.00 km

Wind load

Velocity pressure, 50 years	$q_{p,50} = 0.751 \text{ kN/m}^2$
Adjustment factor for service life	$f_w = 1.000$
Velocity pressure, 25 years	$q_{p,25} = 0.691 \text{ kN/m}^2$

Structural analysis report | East 1

Roof areas

Array	load impact area [m ²]	maxCpe ₁₀	minCpe ₁₀	wind pressure [kN/m ²]	wind suction [kN/m ²]
field area	10.00	0.020	-0.810	0.014	-0.560
eaves	10.00	0.020	-1.160	0.014	-0.802
corner region (eave)	10.00	0.020	-2.050	0.014	-1.417
corner region (ridge)	10.00	0.020	-2.420	0.014	-1.673
ridge	10.00	0.020	-1.090	0.014	-0.754
field area	10.00	0.020	-0.810	0.014	-0.560
eaves	10.00	0.020	-1.160	0.014	-0.802
corner region (eave)	10.00	0.020	-2.050	0.014	-1.417
corner region (ridge)	10.00	0.020	-2.420	0.014	-1.673
ridge	10.00	0.020	-1.090	0.014	-0.754

Snow load

Snow load zone	3
Snow guard	No
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$
Shape Coefficient for Snow	$\mu_i = 0.800$
Factor for roof pitch	$d_i = 0.995$
Snow load on roof, 50 year	$s_{i,50} = 0.398 \text{ kN/m}^2$
Adjustment factor for service life	$f_s = 1.000$
Snow load on roof, 25 years	$s_{i,25} = 0.370 \text{ kN/m}^2$

Dead Load

Weight of module	$G_M = 22.0 \text{ kg}$
Weight of mounting system per module	$= 2.0 \text{ kg}$
Module area	$A_M = 2.00 \text{ m}^2$
Dead weight of module per m ²	$= 11.01 \text{ kg/m}^2$
Dead weight of mounting system per m ²	$= 1.00 \text{ kg/m}^2$
Total Dead Load (excl. ballast) per m ²	$= 0.12 \text{ kN/m}^2$



Structural analysis report | East 1

Load Combinations

Ultimate limit state

Partial safety factor unfavourable permanent load	$\gamma_{G,sup} = 1.35$
Partial safety factor favourable permanent load	$\gamma_{G,inf} = 1.00$
Partial safety factor destabilising permanent load	$\gamma_{G,dst} = 1.10$
Partial safety factor stabilising permanent load	$\gamma_{G,stab} = 0.90$
Partial safety factor variable loads	$\gamma_Q = 1.50$
Combination coefficient with regards to wind	$\psi_{0,W} = 0.60$
Combination coefficient with regards to wind (additional varying influences)	$\psi_{1,W} = 0.20$
Combination coefficient with regards to Snow	$\psi_{0,S} = 0.50$
Importance factor permanent	$\kappa_{FI,G} = 1.10$
Importance factor variable	$\kappa_{FI,Q} = 1.10$
Characteristic dead weight	G_k
Characteristic snow load on the roof	$S_{i,n}$
Characteristic wind load	W_k

Load case combination 01	$LCC\ 01_{uls} = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$
Load case combination 02	$LCC\ 02_{uls} = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$
Load case combination 03	$LCC\ 03_{uls} = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$
Load case combination 04	$LCC\ 04_{uls} = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$
Load case combination 06	$LCC\ 06_{uls} = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$

Serviceability limit state

Combination coefficient with regards to wind	$\psi_{0,W} = 0.60$
Combination coefficient with regards to Snow	$\psi_{0,S} = 0.50$

Load case combination 01	$LCC\ 01_{sls} = G_k + S_{i,n}$
Load case combination 02	$LCC\ 02_{sls} = G_k + W_{k,Pressure}$
Load case combination 03	$LCC\ 03_{sls} = G_k + W_{k,Pressure} + \psi_{0,S} * S_{i,n}$
Load case combination 04	$LCC\ 04_{sls} = G_k + S_{i,n} + \psi_{0,W} * W_{k,Pressure}$
Load case combination 06	$LCC\ 06_{sls} = G_k + W_{k,Suction}$

Structural analysis report | East 1

Maximum load on modules (Mounting system dimensioning)

Array	A-TrA [m ²]	ultimate state [kN/m ²]				Serviceability [kN/m ²]			
		Pressure ⊥	Pressure 	Uplift ⊥	Uplift 	Pressure ⊥	Pressure 	Uplift ⊥	Uplift
field area	10.00	0.794	0.082	-0.807	0.012	0.493	0.051	-0.443	0.012
eaves	10.00	0.794	0.082	-1.206	0.012	0.493	0.051	-0.685	0.012
corner region (eave)	10.00	0.794	0.082	-2.221	0.012	0.493	0.051	-1.300	0.012
corner region (ridge)	10.00	0.794	0.082	-2.643	0.012	0.493	0.051	-1.556	0.012
ridge	10.00	0.794	0.082	-1.126	0.012	0.493	0.051	-0.636	0.012
field area	10.00	0.794	0.082	-0.807	0.012	0.493	0.051	-0.443	0.012
eaves	10.00	0.794	0.082	-1.206	0.012	0.493	0.051	-0.685	0.012
corner region (eave)	10.00	0.794	0.082	-2.221	0.012	0.493	0.051	-1.300	0.012
corner region (ridge)	10.00	0.794	0.082	-2.643	0.012	0.493	0.051	-1.556	0.012
ridge	10.00	0.794	0.082	-1.126	0.012	0.493	0.051	-0.636	0.012

Max. load on fastener

Array	A-TrA [m ²]	ultimate state [kN]				Serviceability [kN]			
		Pressure ⊥	Pressure 	Uplift ⊥	Uplift	Pressure ⊥	Pressure 	Uplift ⊥	Uplift
field area	10.00	0.622	0.064	-0.632	0.010	0.386	0.040	-0.347	0.010
eaves	10.00	0.622	0.064	-0.944	0.010	0.386	0.040	-0.536	0.010
corner region (eave)	10.00	0.311	0.032	-0.870	0.005	0.193	0.020	-0.509	0.005
corner region (ridge)	10.00	0.233	0.024	-0.776	0.004	0.145	0.015	-0.457	0.004
ridge	10.00	0.622	0.064	-0.882	0.010	0.386	0.040	-0.498	0.010
field area	10.00	0.622	0.064	-0.632	0.010	0.386	0.040	-0.347	0.010
eaves	10.00	0.622	0.064	-0.944	0.010	0.386	0.040	-0.536	0.010
corner region (eave)	10.00	0.311	0.032	-0.870	0.005	0.193	0.020	-0.509	0.005
corner region (ridge)	10.00	0.233	0.024	-0.776	0.004	0.145	0.015	-0.457	0.004
ridge	10.00	0.622	0.064	-0.882	0.010	0.386	0.040	-0.498	0.010

Resistance Values of Components

Base Rails



Structural analysis report | East 1

Base Rails	A [cm ²]	I _y [cm ⁴]	I _z [cm ⁴]	W _y [cm ³]	W _z [cm ³]
K2 BasicRail 22	2.380	1.52	7.74	1.08	2.46

Fastener

Fastener	R _{D,Uplift,Perpendicular} [kN]	R _{D,Pressure,Perpendicular} [kN]	R _{D,Pressure,Parallel} [kN]
K2 BasicClip	1.02	-	0.96
Thread-forming metal screw 6.0×38	0.65	-	0.62

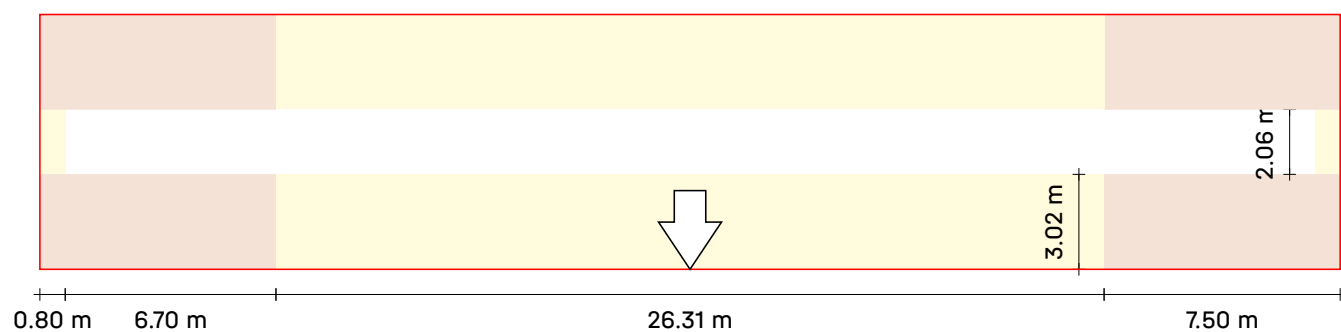
Utilisation result

No. Module Array	roof areas	ultimate limit state			Usab.	Distances		maximum values	
		Pr σ[%]	CL σ[%]	Fst F[%]	Pr f[%]	Fst [m]	BR [m]	CL L _{max} [m]	Fst D _{max} [m]
1	field area	24.3	1.5	62.8	29.6	0.808	---	0.483	0.850
1	eaves	35.5	2.1	93.4	41.1	0.808	---	0.441	0.850
1	corner region (eave)	16.3	3.4	85.6	4.9	0.404	---	0.404	0.472
1	corner region (ridge)	10.9	4.1	76.3	2.4	0.303	---	0.303	0.397
1	ridge	33.1	2.0	87.2	38.2	0.808	---	0.450	0.850
2	field area	24.3	1.6	62.8	29.6	0.808	---	0.483	0.850
2	eaves	35.5	2.4	93.4	41.1	0.808	---	0.441	0.850
2	corner region (eave)	16.3	1.5	85.6	4.9	0.404	---	0.404	0.472
2	corner region (ridge)	10.9	1.8	76.3	2.4	0.303	---	0.303	0.397
2	ridge	33.1	2.2	87.2	38.2	0.808	---	0.450	0.850

Pr	Profile	Fst D _{max}	maximum fastener spacing
Fst	Fastener	BR	Base Rail
σ	Stress	Usab.	serviceability limit state
f	Deflection	CL	Cantilever
F	Force		
CL/L _{max}	maximum cantilever length		

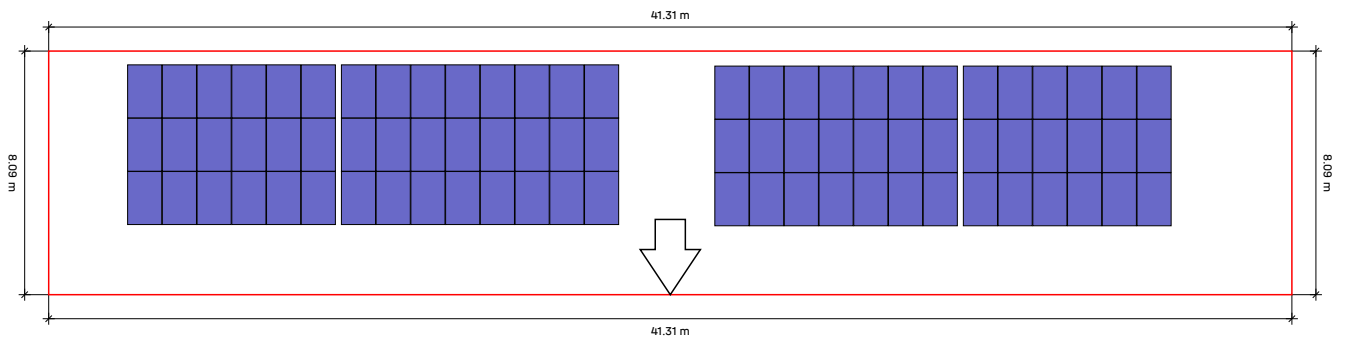


Roofs | East 2





Roofs | East 2



Roof	System	Module	Height	Quantity	Total power
<u>East 2</u>  Trapezoidal	<u>K2 BasicRail</u>	JAM54D40-430/LB 1,762×1,134×30 mm 430 Wp	15.00 m	81	34.83 kWp

Roofs | East 2 | Assembly plan

Base Rails

Type	Whole Rails		Rail cutting		
	Total Rail Length	Quantity 3.65 m	Part of Rail / Rest	Length	Rest
12*A	7.024 m	1*3.65 m	3.650	3.374 from 3.650	0.266
6*B	9.332 m	2*3.65 m	3.650	2.032 from 3.650	1.608
6*C	8.178 m	2*3.65 m	1.608	0.878 from 1.608	0.720

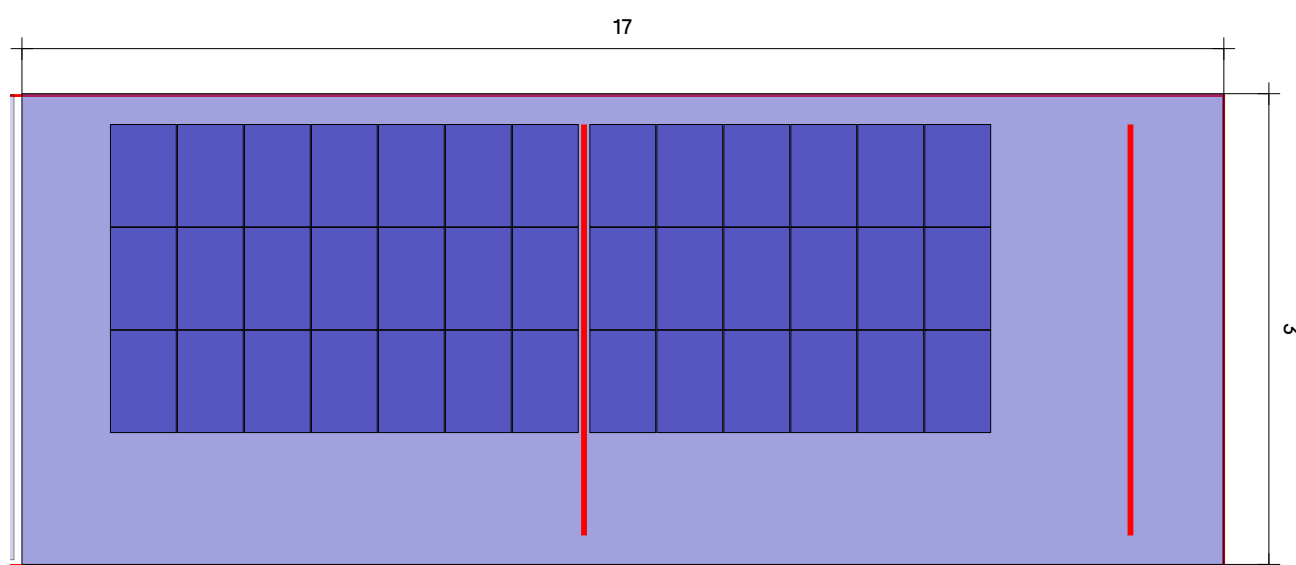
1 cm is viewed as lost for each cutting

Red numbers are leftover rails which will not be used any longer

Module arrays

Module array	Width[m]	Length[m]	Width in modules	Length in modules
1	19.96	7.08	13	3
2	19.96	7.08	14	3

Roofs | East 2 | Module array 1



Roof ⑥ Module array ①

Mounting System

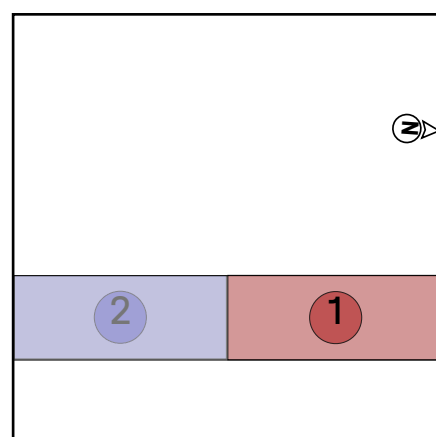
[K2 BasicRail](#)

Module

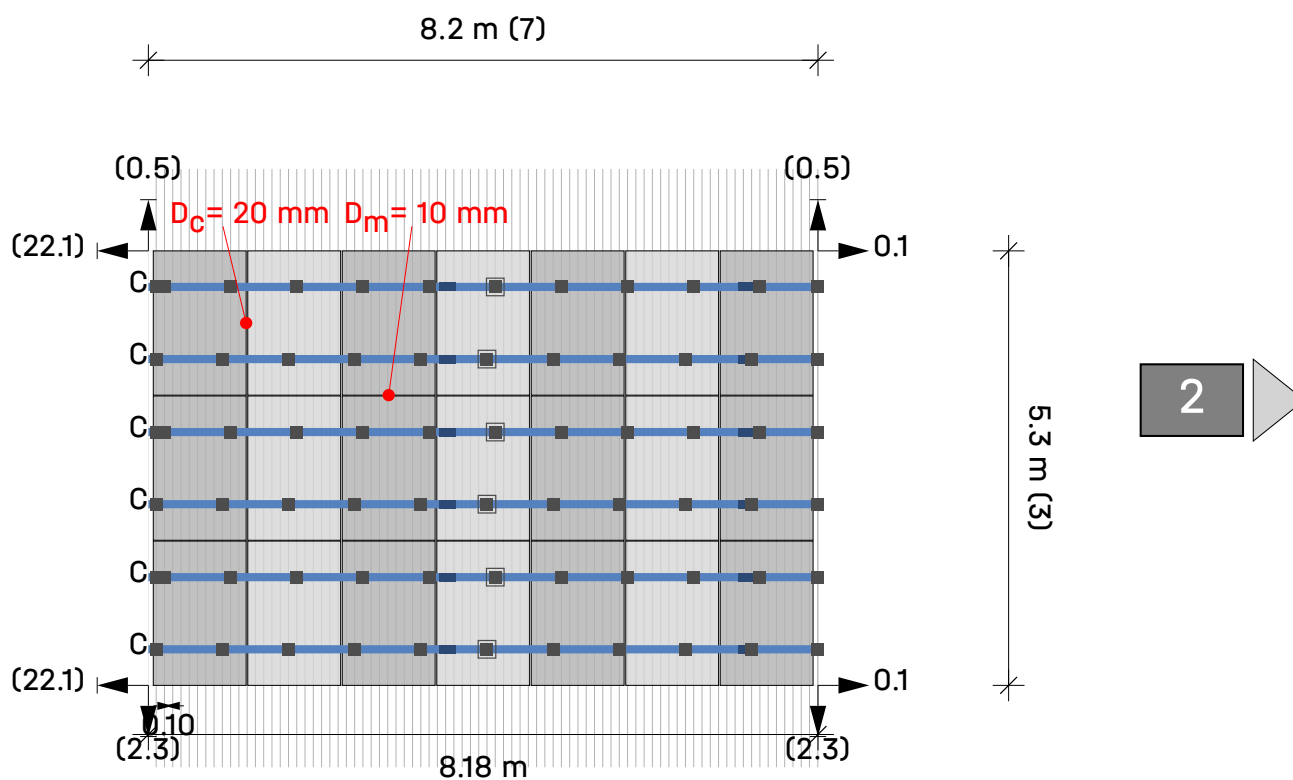
39(16.77 kWp) x
JAM54D40-430/LB

Row spacing

1.77 m



Roofs | East 2 | Module array 1 | Module blocks

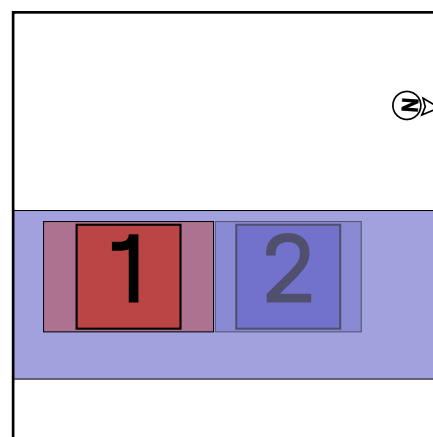


Roof ⑥ Module array ① Module block 1

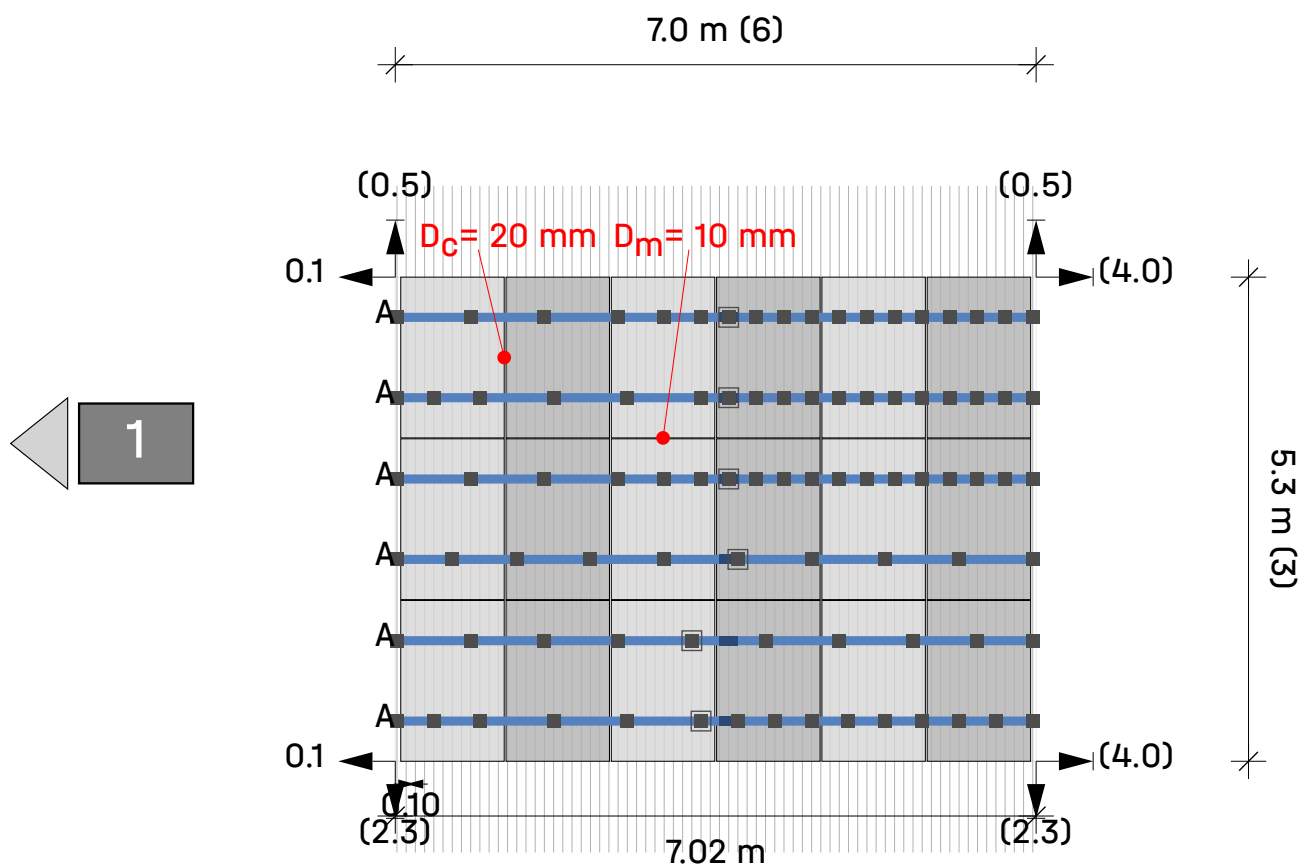
Modules $7 \times 3 = 21$

Legend

- Next block indicator
- Fastener
- BasicLocks
- Mounting rail: K2 BasicRail 22
- Distance to Roof Edge [m]
- Dist. to neighbour module block/array [m]
- D_c Distance for clamping between modules
- D_m Distance between modules



Roofs | East 2 | Module array 1 | Module blocks

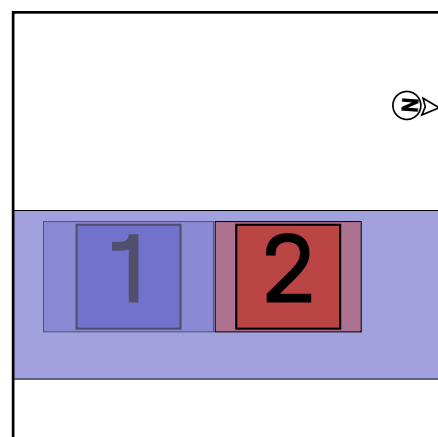


Roof ⑥ Module array ① Module block ②

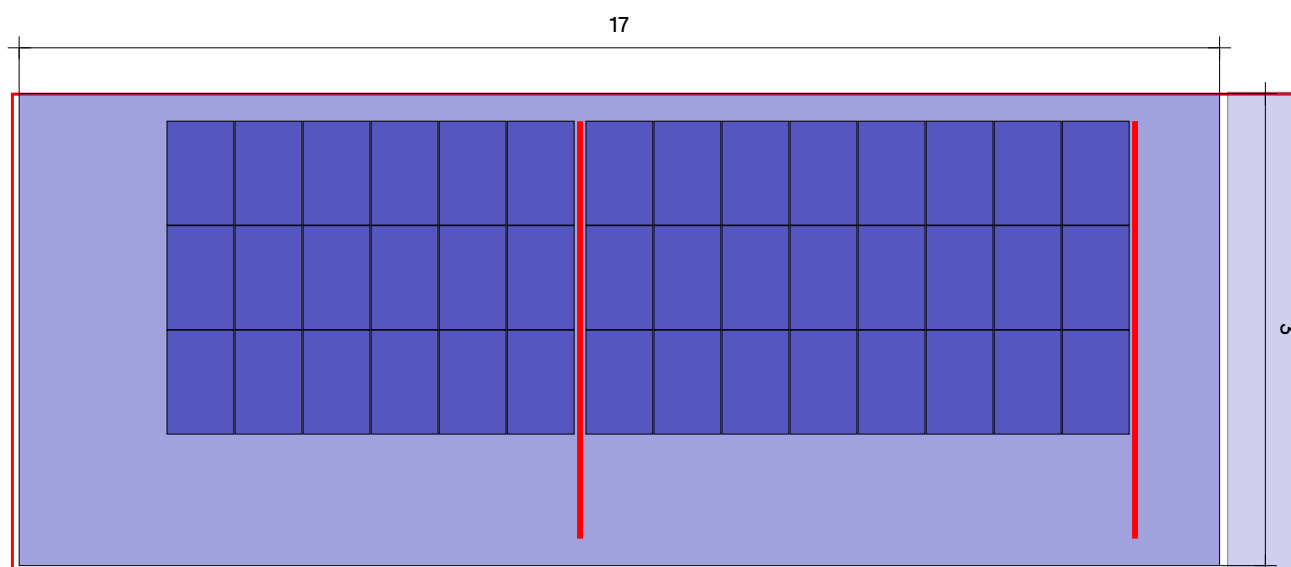
Modules $6 \times 3 = 18$

Legend

- Next block indicator
- Fastener
- BasicLocks
- Mounting rail: K2 BasicRail 22
- Distance to Roof Edge [m]
- Dist. to neighbour module block/array [m]
- D_c Distance for clamping between modules
- D_m Distance between modules



Roofs | East 2 | Module array 2



Roof ⑥ Module array ②

Mounting System

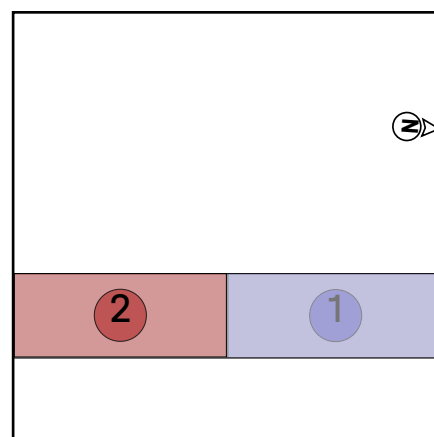
[K2 BasicRail](#)

Module

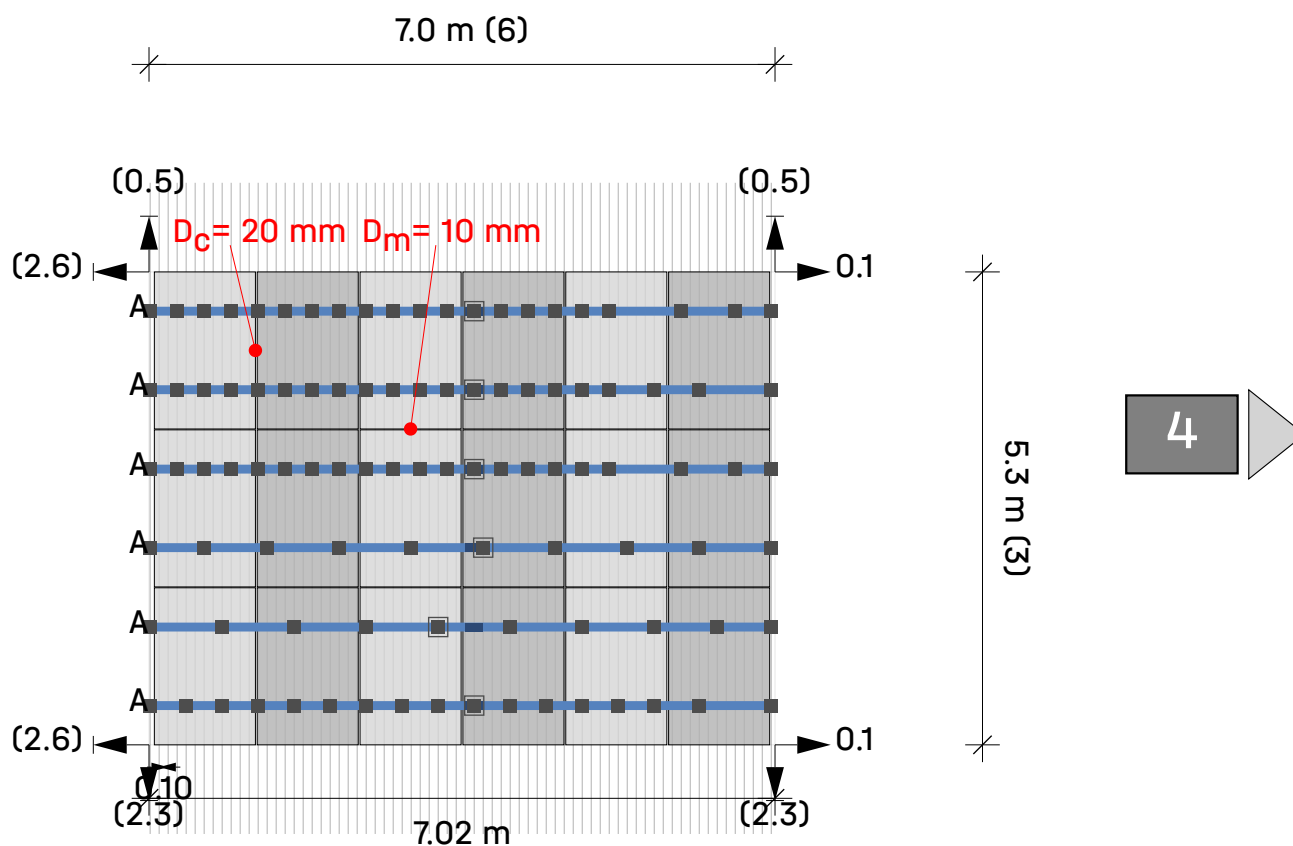
42(18.06 kWp) x
JAM54D40-430/LB

Row spacing

1.77 m



Roofs | East 2 | Module array 2 | Module blocks

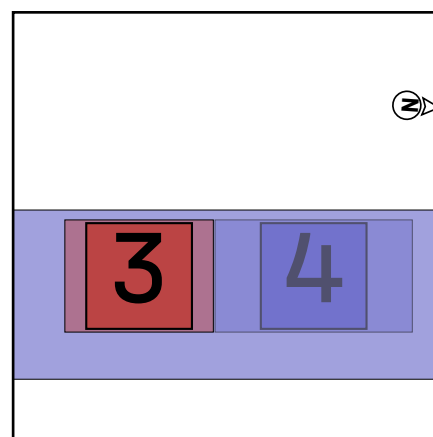


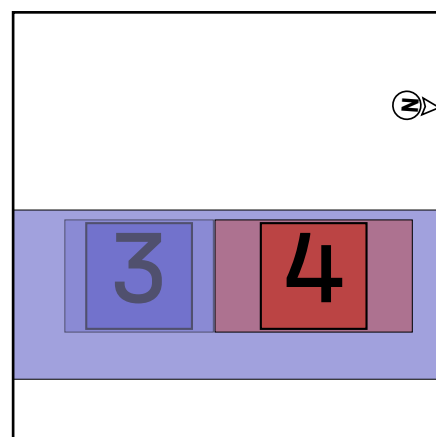
Roof ⑥ Module array ② Module block ③

Modules $6 \times 3 = 18$

Legend

- Next block indicator
- Fastener
- BasicLocks
- Mounting rail: K2 BasicRail 22
- Distance to Roof Edge [m]
- Dist. to neighbour module block/array [m]
- D_c Distance for clamping between modules
- D_m Distance between modules





Results | East 2

Roof	System	Module	Height	Quantity	Total power
<u>East 2</u>	<u>K2 BasicRail</u>	JAM54D40-430/LB 1,762×1,134×30 mm 430 Wp	15.00 m	81	34.83 kWp
 Trapezoidal					

Module

Name	JAM54D40-430/LB
Manufacturer	Shanghai JA Solar Technology Co. Ltd.
Output power	430 Wp
Dimensions	1,762×1,134×30 mm
Weight	22.0 kg

Components

Fastener	K2 BasicClip
Base rails	K2 BasicRail 22
Metal screw	Thread-forming metal screw 6.0×38

Loads on modules (module dimensioning)

Array	A-TrA [m²]	ultimate state [Pa]				Serviceability [Pa]			
		Pressure ⊥	Pressure 	Uplift ⊥	Uplift 	Pressure ⊥	Pressure 	Uplift ⊥	Uplift
field area	2.00	794.1	82.0	-806.8	12.3	493.0	50.9	-442.9	12.3
eaves	2.00	794.1	82.0	-1,206.1	12.3	493.0	50.9	-684.8	12.3
corner region (eave)	2.00	794.1	82.0	-2,221.4	12.3	493.0	50.9	-1,300.1	12.3
corner region (ridge)	2.00	794.1	82.0	-2,643.4	12.3	493.0	50.9	-1,555.9	12.3
ridge	2.00	794.1	82.0	-1,126.3	12.3	493.0	50.9	-636.4	12.3
field area	2.00	794.1	82.0	-806.8	12.3	493.0	50.9	-442.9	12.3
eaves	2.00	794.1	82.0	-1,206.1	12.3	493.0	50.9	-684.8	12.3
corner region (eave)	2.00	794.1	82.0	-2,221.4	12.3	493.0	50.9	-1,300.1	12.3
corner region (ridge)	2.00	794.1	82.0	-2,643.4	12.3	493.0	50.9	-1,555.9	12.3
ridge	2.00	794.1	82.0	-1,126.3	12.3	493.0	50.9	-636.4	12.3



Results | East 2

Utilisation result

No.	Module Array	roof areas	ultimate limit state			Usab.	Distances		maximum values	
			Pr σ [%]	CL σ [%]	Fst F[%]	Pr f[%]	Fst [m]	BR [m]	CL L_{max} [m]	Fst Fst D_{max} [m]
1		field area	24.3	1.7	62.8	29.6	0.808	---	0.483	0.850
1		eaves	35.5	2.5	93.4	41.1	0.808	---	0.441	0.850
1		corner region (eave)	16.3	0.0	85.6	4.9	0.404	---	0.404	0.472
1		corner region (ridge)	10.9	0.0	76.3	2.4	0.303	---	0.303	0.397
1		ridge	33.1	2.3	87.2	38.2	0.808	---	0.450	0.850
2		field area	24.3	1.2	62.8	29.6	0.808	---	0.483	0.850
2		eaves	35.5	1.7	93.4	41.1	0.808	---	0.441	0.850
2		corner region (eave)	16.3	0.0	85.6	4.9	0.404	---	0.404	0.472
2		corner region (ridge)	10.9	0.0	76.3	2.4	0.303	---	0.303	0.397
2		ridge	33.1	1.6	87.2	38.2	0.808	---	0.450	0.850

Pr	Profile	Fst D_{max}	maximum fastener spacing
Fst	Fastener	BR	Base Rail
σ	Stress	Usab.	serviceability limit state
f	Deflection	CL	Cantilever
F	Force		
CL/ L_{max}	maximum cantilever length		



Results | East 2

Important Information

- The quantity for K2 BasicRail BasicClips is calculated in such a way, that - according to the Assembly Instructions - a BasicClip can be installed on the crest to the left and right of a Rail Connector Set.
- The structure was statically verified in accordance with Eurocode 9: Design of aluminium structures (DIN EN 1999-1-1:2021) and offers sufficient load-bearing capacity and stability for the loads specified in the chapter 'Maximum actions on the components'.
- Adjustment factor for wind load regarding service life period, f_W , is according to DIN EN 1991-1-4/ NA, NDP for 4.2 (2P) note 5, table 3
- Adjustment factor for snow load regarding service life period, f_S , is according to DIN EN 1991-1-3/ annex D, table 4
- The structural design complies with BS EN 1990 - Basis of Structural Design.
- Snow loads are determined in accordance with National Annex BS NA EN 1991-1-3 (2018) - UK National Annex to EC1 - Action on structures - general actions - snow loads.
- Wind loads are determined in accordance with National Annex BS NA EN 1991-1-4 - UK National Annex to EC1 - Action on structures, general actions - wind actions.
- Service life is recognised according to 'Eurocode EN 1991 - Action on structures, Snow loads' and 'Eurocode EN 1991 - Actions on structures, Wind actions'. Subject to the Building Regulations and for security-relevant reasons the installation has to be dismantled at the end of its service life.
- Failure consequence class is considered according to 'Eurocode EN 1990 - Basis of structural design'.
- The person responsible for the execution of the work must check the load assumptions made with the conditions on site. If deviations are found, the person who prepared the static calculation must be consulted immediately. , in particular § 2 ("technical and specialist requirements for the customer"), § 7 ("warranty provisions") and § 8 ("limitation of liability").



Structural analysis report | East 2

General information

Name	GORTON MARKET
Mounting System	K2 BasicRail
Author	JJ Fitzgerald

Location information

Address	Manchester M18 8LD, UK
Ground elevation	70.03 m

Roof information

Building height	15.00 m
Roof type	Monopitch roof
Roof pitch	6°
Roof covering	Trapezoidal
Min. roof edge distance	0.00 m
Crest distance	101.0 mm
Crest width	22.0 mm
Crest height	40.0 mm
Roof material	Steel
Sheet quality	S235
Sheet thickness	0.500 mm

Loads

Design method	BS EN
Failure consequence class (CC)	CC3
Design working life	25 years
Terrain category	Town Terrain
Distance to shoreline	50.00 km
Distance inside town terrain	25.00 km

Wind load

Velocity pressure, 50 years	$q_{p,50} = 0.751 \text{ kN/m}^2$
Adjustment factor for service life	$f_w = 0.921$
Velocity pressure, 25 years	$q_{p,25} = 0.691 \text{ kN/m}^2$

Structural analysis report | East 2

Roof areas

Array	load impact area [m ²]	maxCpe ₁₀	minCpe ₁₀	wind pressure [kN/m ²]	wind suction [kN/m ²]
field area	10.00	0.020	-0.810	0.014	-0.560
eaves	10.00	0.020	-1.160	0.014	-0.802
corner region (eave)	10.00	0.020	-2.050	0.014	-1.417
corner region (ridge)	10.00	0.020	-2.420	0.014	-1.673
ridge	10.00	0.020	-1.090	0.014	-0.754
field area	10.00	0.020	-0.810	0.014	-0.560
eaves	10.00	0.020	-1.160	0.014	-0.802
corner region (eave)	10.00	0.020	-2.050	0.014	-1.417
corner region (ridge)	10.00	0.020	-2.420	0.014	-1.673
ridge	10.00	0.020	-1.090	0.014	-0.754

Snow load

Snow load zone	3
Snow guard	No
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$
Shape Coefficient for Snow	$\mu_i = 0.800$
Factor for roof pitch	$d_i = 0.995$
Snow load on roof, 50 year	$s_{i,50} = 0.398 \text{ kN/m}^2$
Adjustment factor for service life	$f_s = 0.929$
Snow load on roof, 25 years	$s_{i,25} = 0.370 \text{ kN/m}^2$

Dead Load

Weight of module	$G_M = 22.0 \text{ kg}$
Weight of mounting system per module	$= 2.0 \text{ kg}$
Module area	$A_M = 2.00 \text{ m}^2$
Dead weight of module per m ²	$= 11.01 \text{ kg/m}^2$
Dead weight of mounting system per m ²	$= 1.00 \text{ kg/m}^2$
Total Dead Load (excl. ballast) per m ²	$= 0.12 \text{ kN/m}^2$

Structural analysis report | East 2

Load Combinations

Ultimate limit state

Partial safety factor unfavourable permanent load	$\gamma_{G,sup}$	= 1.35
Partial safety factor favourable permanent load	$\gamma_{G,inf}$	= 1.00
Partial safety factor destabilising permanent load	$\gamma_{G,dst}$	= 1.10
Partial safety factor stabilising permanent load	$\gamma_{G,stab}$	= 0.90
Partial safety factor variable loads	γ_Q	= 1.50
Combination coefficient with regards to wind	$\psi_{0,W}$	= 0.60
Combination coefficient with regards to wind (additional varying influences)	$\psi_{1,W}$	= 0.20
Combination coefficient with regards to Snow	$\psi_{0,S}$	= 0.50
Importance factor permanent	$\kappa_{FI,G}$	= 1.10
Importance factor variable	$\kappa_{FI,Q}$	= 1.10
Characteristic dead weight	G_k	
Characteristic snow load on the roof	$S_{i,n}$	
Characteristic wind load	W_k	
Load case combination 01	$LCC\ 01_{uls}$	= $\gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$
Load case combination 02	$LCC\ 02_{uls}$	= $\gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$
Load case combination 03	$LCC\ 03_{uls}$	= $\gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$
Load case combination 04	$LCC\ 04_{uls}$	= $\gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$
Load case combination 06	$LCC\ 06_{uls}$	= $\gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$

Serviceability limit state

Combination coefficient with regards to wind	$\psi_{0,W}$	= 0.60
Combination coefficient with regards to Snow	$\psi_{0,S}$	= 0.50
Load case combination 01	$LCC\ 01_{sls}$	= $G_k + S_{i,n}$
Load case combination 02	$LCC\ 02_{sls}$	= $G_k + W_{k,Pressure}$
Load case combination 03	$LCC\ 03_{sls}$	= $G_k + W_{k,Pressure} + \psi_{0,S} * S_{i,n}$
Load case combination 04	$LCC\ 04_{sls}$	= $G_k + S_{i,n} + \psi_{0,W} * W_{k,Pressure}$
Load case combination 06	$LCC\ 06_{sls}$	= $G_k + W_{k,Suction}$

Structural analysis report | East 2

Maximum load on modules (Mounting system dimensioning)

Array	A-TrA [m ²]	ultimate state [kN/m ²]				Serviceability [kN/m ²]			
		Pressure ⊥	Pressure 	Uplift ⊥	Uplift 	Pressure ⊥	Pressure 	Uplift ⊥	Uplift
field area	10.00	0.794	0.082	-0.807	0.012	0.493	0.051	-0.443	0.012
eaves	10.00	0.794	0.082	-1.206	0.012	0.493	0.051	-0.685	0.012
corner region (eave)	10.00	0.794	0.082	-2.221	0.012	0.493	0.051	-1.300	0.012
corner region (ridge)	10.00	0.794	0.082	-2.643	0.012	0.493	0.051	-1.556	0.012
ridge	10.00	0.794	0.082	-1.126	0.012	0.493	0.051	-0.636	0.012
field area	10.00	0.794	0.082	-0.807	0.012	0.493	0.051	-0.443	0.012
eaves	10.00	0.794	0.082	-1.206	0.012	0.493	0.051	-0.685	0.012
corner region (eave)	10.00	0.794	0.082	-2.221	0.012	0.493	0.051	-1.300	0.012
corner region (ridge)	10.00	0.794	0.082	-2.643	0.012	0.493	0.051	-1.556	0.012
ridge	10.00	0.794	0.082	-1.126	0.012	0.493	0.051	-0.636	0.012

Max. load on fastener

Array	A-TrA [m ²]	ultimate state [kN]				Serviceability [kN]			
		Pressure ⊥	Pressure 	Uplift ⊥	Uplift	Pressure ⊥	Pressure 	Uplift ⊥	Uplift
field area	10.00	0.622	0.064	-0.632	0.010	0.386	0.040	-0.347	0.010
eaves	10.00	0.622	0.064	-0.944	0.010	0.386	0.040	-0.536	0.010
corner region (eave)	10.00	0.311	0.032	-0.870	0.005	0.193	0.020	-0.509	0.005
corner region (ridge)	10.00	0.233	0.024	-0.776	0.004	0.145	0.015	-0.457	0.004
ridge	10.00	0.622	0.064	-0.882	0.010	0.386	0.040	-0.498	0.010
field area	10.00	0.622	0.064	-0.632	0.010	0.386	0.040	-0.347	0.010
eaves	10.00	0.622	0.064	-0.944	0.010	0.386	0.040	-0.536	0.010
corner region (eave)	10.00	0.311	0.032	-0.870	0.005	0.193	0.020	-0.509	0.005
corner region (ridge)	10.00	0.233	0.024	-0.776	0.004	0.145	0.015	-0.457	0.004
ridge	10.00	0.622	0.064	-0.882	0.010	0.386	0.040	-0.498	0.010

Resistance Values of Components

Base Rails



Structural analysis report | East 2

Base Rails	A [cm ²]	I _y [cm ⁴]	I _z [cm ⁴]	W _y [cm ³]	W _z [cm ³]
K2 BasicRail 22	2.380	1.52	7.74	1.08	2.46

Fastener

Fastener	R _{D,Uplift,Perpendicular} [kN]	R _{D,Pressure,Perpendicular} [kN]	R _{D,Pressure,Parallel} [kN]
K2 BasicClip	1.02	-	0.96
Thread-forming metal screw 6.0×38	0.65	-	0.62

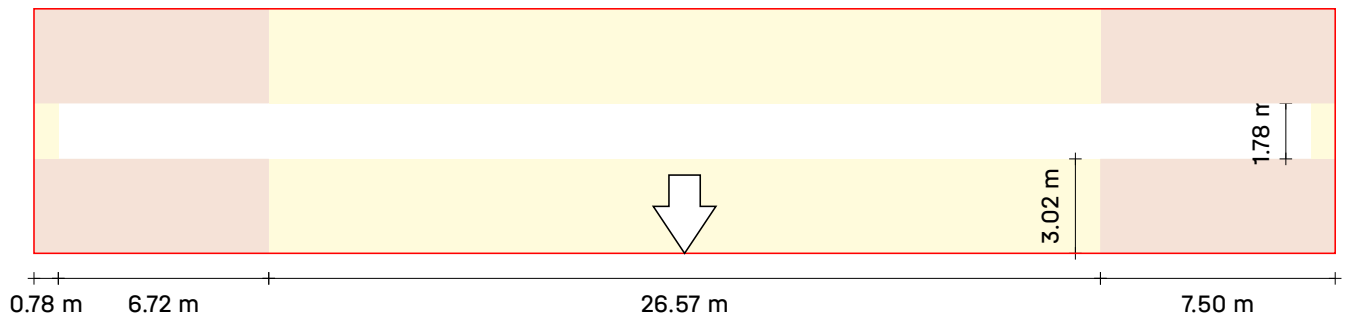
Utilisation result

No.	roof areas	ultimate limit state			Usab.	Distances		maximum values	
		Pr σ[%]	CL σ[%]	Fst F[%]	Pr f[%]	Fst [m]	BR [m]	CL L _{max} [m]	Fst D _{max} [m]
1	field area	24.3	1.7	62.8	29.6	0.808	---	0.483	0.850
1	eaves	35.5	2.5	93.4	41.1	0.808	---	0.441	0.850
1	corner region (eave)	16.3	0.0	85.6	4.9	0.404	---	0.404	0.472
1	corner region (ridge)	10.9	0.0	76.3	2.4	0.303	---	0.303	0.397
1	ridge	33.1	2.3	87.2	38.2	0.808	---	0.450	0.850
2	field area	24.3	1.2	62.8	29.6	0.808	---	0.483	0.850
2	eaves	35.5	1.7	93.4	41.1	0.808	---	0.441	0.850
2	corner region (eave)	16.3	0.0	85.6	4.9	0.404	---	0.404	0.472
2	corner region (ridge)	10.9	0.0	76.3	2.4	0.303	---	0.303	0.397
2	ridge	33.1	1.6	87.2	38.2	0.808	---	0.450	0.850

Pr	Profile	Fst D _{max}	maximum fastener spacing
Fst	Fastener	BR	Base Rail
σ	Stress	Usab.	serviceability limit state
f	Deflection	CL	Cantilever
F	Force		
CL/L _{max}	maximum cantilever length		

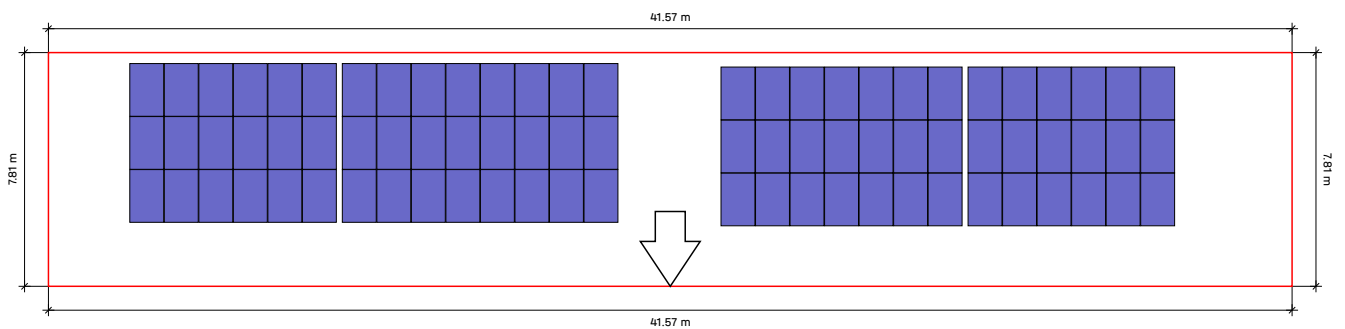


Roofs | East 3





Roofs | East 3



Roof	System	Module	Height	Quantity	Total power
<u>East 3</u>  Trapezoidal	<u>K2 BasicRail</u>	JAM54D40-430/LB 1,762×1,134×30 mm 430 Wp	15.00 m	81	34.83 kWp



Roofs | East 3 | Assembly plan

Base Rails

Type	Whole Rails		Rail cutting		
	Total Rail Length	Quantity 3.65 m	Part of Rail / Rest	Length	Rest
12*A	7.024 m	1*3.65 m	3.650	3.374 from 3.650	0.266
6*B	9.332 m	2*3.65 m	3.650	2.032 from 3.650	1.608
6*C	8.178 m	2*3.65 m	1.608	0.878 from 1.608	0.720

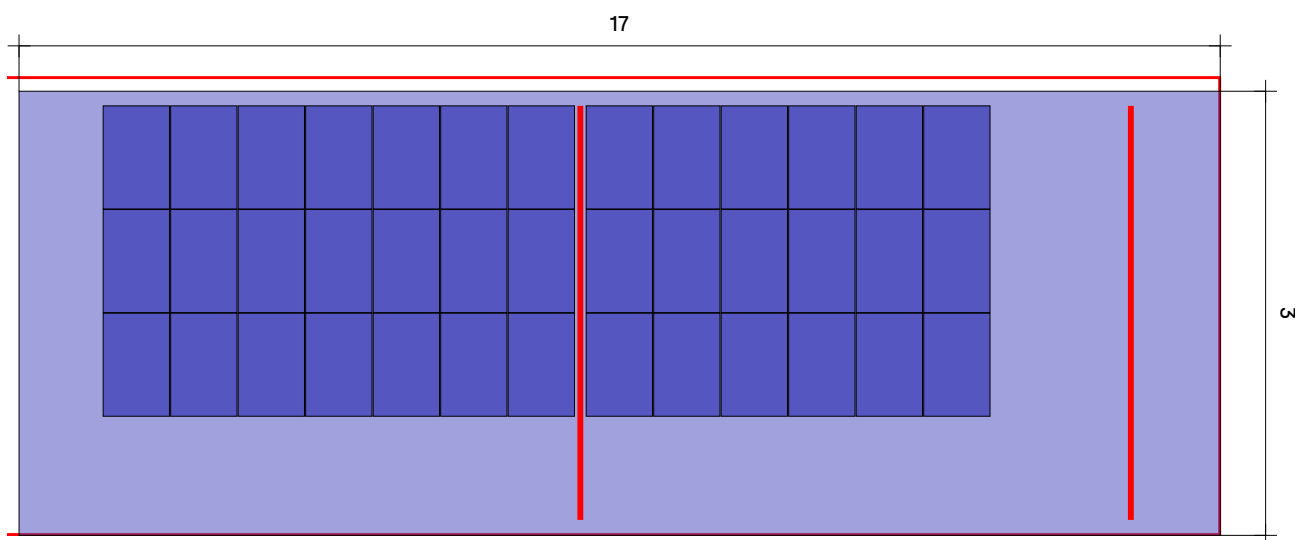
1 cm is viewed as lost for each cutting

Red numbers are leftover rails which will not be used any longer

Module arrays

Module array	Width[m]	Length[m]	Width in modules	Length in modules
1	19.96	7.08	13	3
2	19.96	7.08	14	3

Roofs | East 3 | Module array 1



Roof ⑦ Module array ①

Mounting System

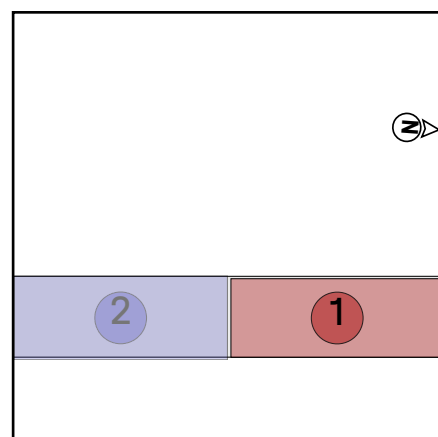
[K2 BasicRail](#)

Module

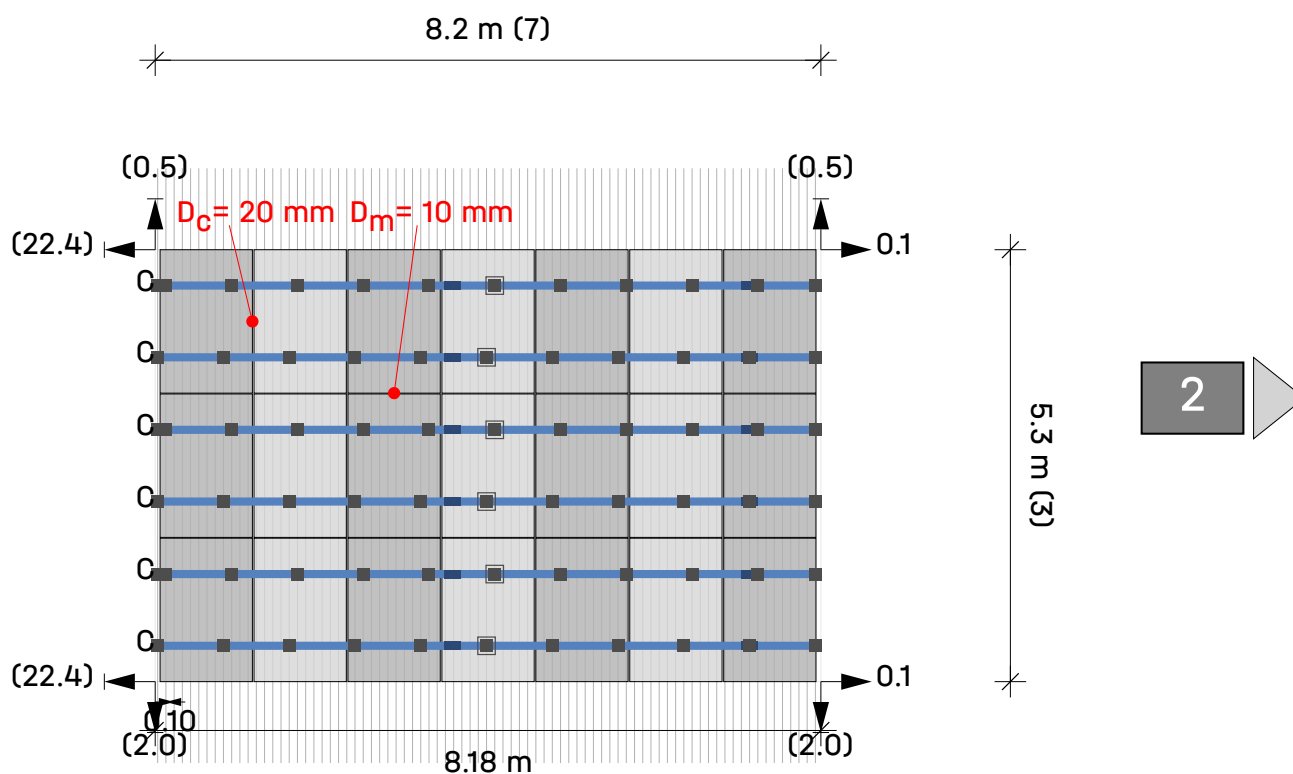
39(16.77 kWp) x
JAM54D40-430/LB

Row spacing

1.77 m



Roofs | East 3 | Module array 1 | Module blocks

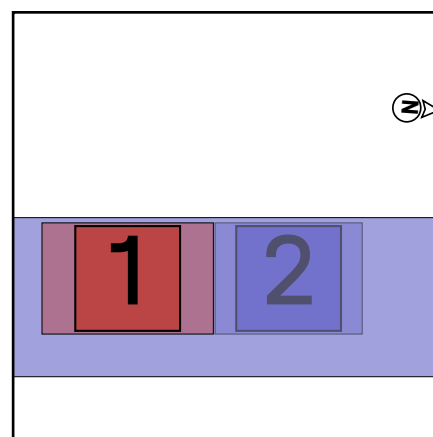


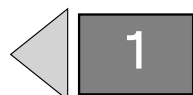
Roof ⑦ Module array ① Module block 1

Modules $7 \times 3 = 21$

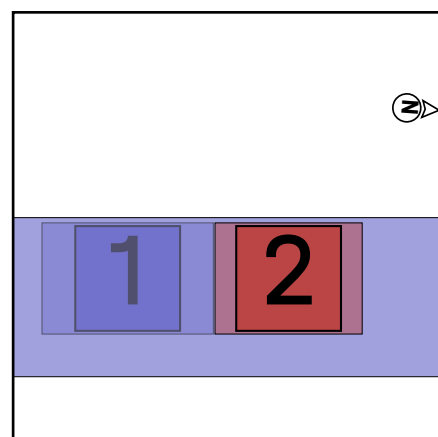
Legend

- ◀■ Next block indicator
- Fastener
- BasicLocks
- Mounting rail: K2 BasicRail 22
- Distance to Roof Edge [m]
- Dist. to neighbour module block/array [m]
- Dc Distance for clamping between modules
- Dm Distance between modules

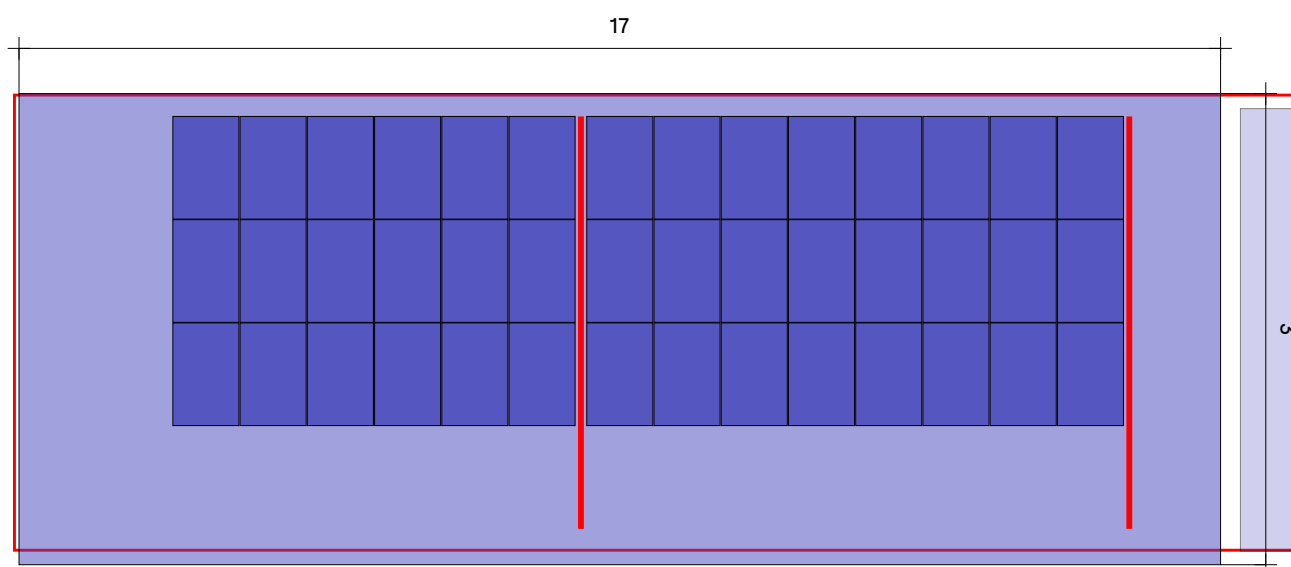




D_m Distance between modules



Roofs | East 3 | Module array 2



Roof ⑦ Module array ②

Mounting System

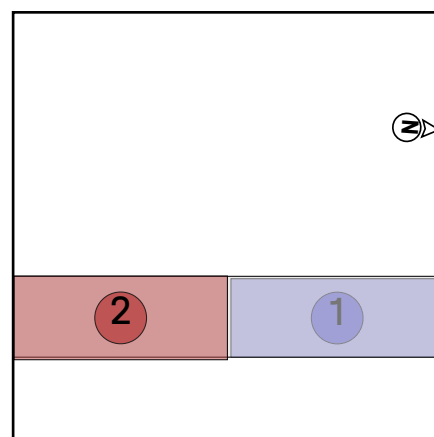
[K2 BasicRail](#)

Module

42(18.06 kWp) x
JAM54D40-430/LB

Row spacing

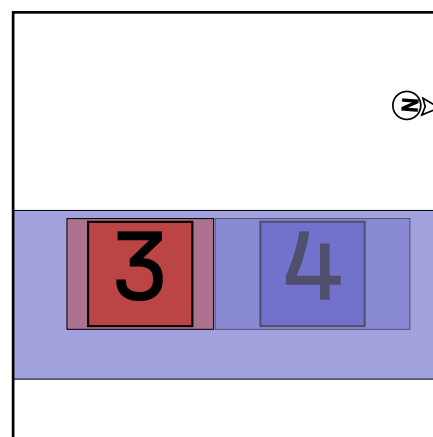
1.77 m



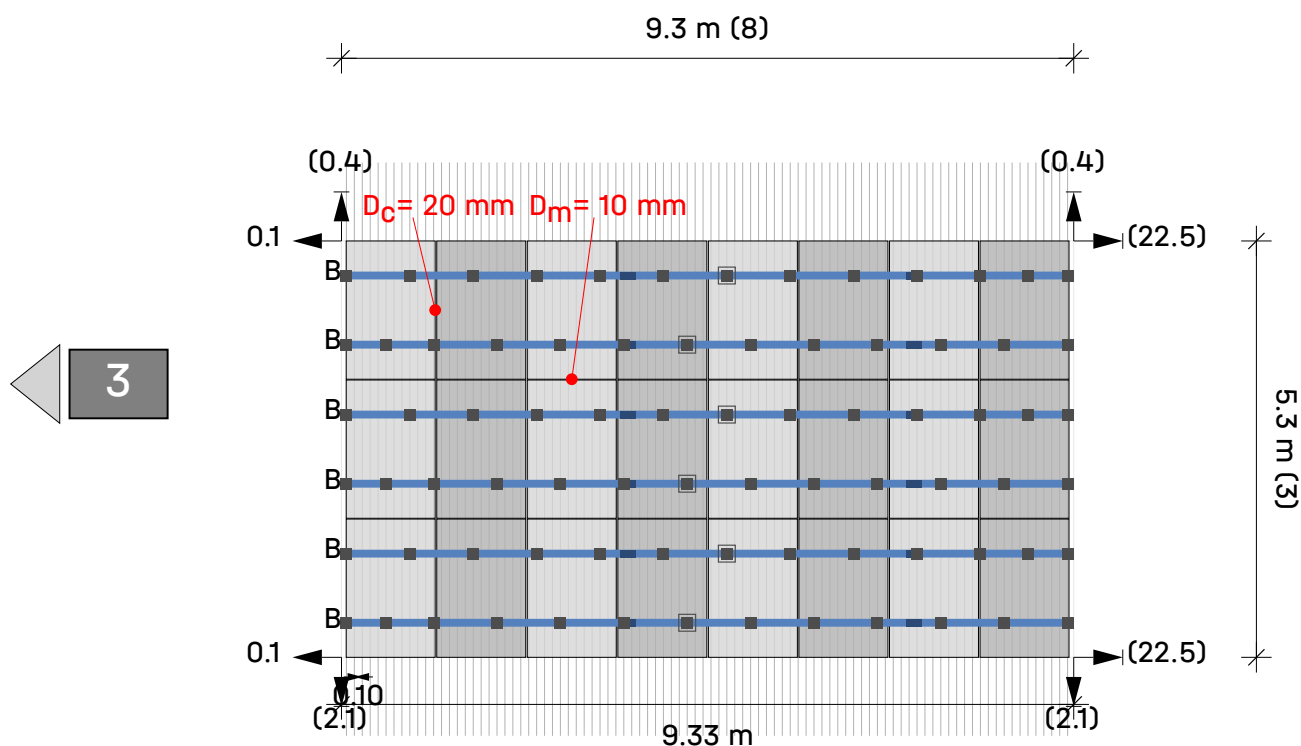

$$6 \times 3 = 18$$

◀ 1 Next block indicator

- Fastener
- BasicLocks
- Mounting rail: K2 BasicRail 22
- Distance to Roof Edge [m]
- Dist. to neighbour module block/array [m]
- Dc Distance for clamping between modules
- Dm Distance between modules



Roofs | East 3 | Module array 2 | Module blocks

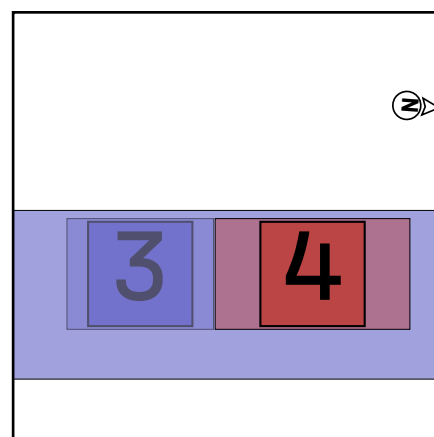


Roof **7** Module array **2** Module block **4**

Modules $8 \times 3 = 24$

Legend

- Next block indicator
- Fastener
- BasicLocks
- Mounting rail: K2 BasicRail 22
- Distance to Roof Edge [m]
- Dist. to neighbour module block/array [m]
- D_c Distance for clamping between modules
- D_m Distance between modules



Results | East 3

Roof	System	Module	Height	Quantity	Total power
<u>East 3</u>  Trapezoidal	<u>K2 BasicRail</u>	JAM54D40-430/LB 1,762×1,134×30 mm 430 Wp	15.00 m	81	34.83 kWp

Module

Name	JAM54D40-430/LB
Manufacturer	Shanghai JA Solar Technology Co. Ltd.
Output power	430 Wp
Dimensions	1,762×1,134×30 mm
Weight	22.0 kg

Components

Fastener	K2 BasicClip
Base rails	K2 BasicRail 22
Metal screw	Thread-forming metal screw 6.0×38

Loads on modules (module dimensioning)

Array	A-TrA [m²]	ultimate state [Pa]				Serviceability [Pa]			
		Pressure ⊥	Pressure 	Uplift ⊥	Uplift 	Pressure ⊥	Pressure 	Uplift ⊥	Uplift
field area	2.00	794.1	82.0	-806.8	12.3	493.0	50.9	-442.9	12.3
eaves	2.00	794.1	82.0	-1,206.1	12.3	493.0	50.9	-684.8	12.3
corner region (eave)	2.00	794.1	82.0	-2,221.4	12.3	493.0	50.9	-1,300.1	12.3
corner region (ridge)	2.00	794.1	82.0	-2,643.4	12.3	493.0	50.9	-1,555.9	12.3
ridge	2.00	794.1	82.0	-1,126.3	12.3	493.0	50.9	-636.4	12.3
field area	2.00	794.1	82.0	-806.8	12.3	493.0	50.9	-442.9	12.3
eaves	2.00	794.1	82.0	-1,206.1	12.3	493.0	50.9	-684.8	12.3
corner region (eave)	2.00	794.1	82.0	-2,221.4	12.3	493.0	50.9	-1,300.1	12.3
corner region (ridge)	2.00	794.1	82.0	-2,643.4	12.3	493.0	50.9	-1,555.9	12.3
ridge	2.00	794.1	82.0	-1,126.3	12.3	493.0	50.9	-636.4	12.3



Results | East 3

Utilisation result

No.	Module Array	roof areas	ultimate limit state			Usab.	Distances		maximum values	
			Pr σ [%]	CL σ [%]	Fst F[%]	Pr f[%]	Fst [m]	BR [m]	CL $L_{\max}$ [m]	Fst D _{max} [m]
1		field area	24.3	0.8	62.8	29.6	0.808	---	0.483	0.850
1		eaves	35.5	1.2	93.4	41.1	0.808	---	0.441	0.850
1		corner region (eave)	16.3	0.0	85.6	4.9	0.404	---	0.404	0.472
1		corner region (ridge)	10.9	0.0	76.3	2.4	0.303	---	0.303	0.397
1		ridge	33.1	1.2	87.2	38.2	0.808	---	0.450	0.850
2		field area	24.3	1.7	62.8	29.6	0.808	---	0.483	0.850
2		eaves	35.5	1.7	93.4	41.1	0.808	---	0.441	0.850
2		corner region (eave)	16.3	4.7	85.6	4.9	0.404	---	0.404	0.472
2		corner region (ridge)	10.9	5.6	76.3	2.4	0.303	---	0.303	0.397
2		ridge	33.1	1.5	87.2	38.2	0.808	---	0.450	0.850

Pr **Profile**Fst **Fastener** σ **Stress**f **Deflection**F **Force**CL/ $L_{\max}$ **maximum cantilever length**Fst D_{max} **maximum fastener spacing**BR **Base Rail**Usab. **serviceability limit state**CL **Cantilever**



Results | East 3

Important Information

- The quantity for K2 BasicRail BasicClips is calculated in such a way, that - according to the Assembly Instructions - a BasicClip can be installed on the crest to the left and right of a Rail Connector Set.
- The structure was statically verified in accordance with Eurocode 9: Design of aluminium structures (DIN EN 1999-1-1:2021) and offers sufficient load-bearing capacity and stability for the loads specified in the chapter 'Maximum actions on the components'.
- Adjustment factor for wind load regarding service life period, f_W , is according to DIN EN 1991-1-4/ NA, NDP for 4.2 (2P) note 5, table 3
- Adjustment factor for snow load regarding service life period, f_S , is according to DIN EN 1991-1-3/ annex D, table 4
- The structural design complies with BS EN 1990 - Basis of Structural Design.
- Snow loads are determined in accordance with National Annex BS NA EN 1991-1-3 (2018) - UK National Annex to EC1 - Action on structures - general actions - snow loads.
- Wind loads are determined in accordance with National Annex BS NA EN 1991-1-4 - UK National Annex to EC1 - Action on structures, general actions - wind actions.
- Service life is recognised according to 'Eurocode EN 1991 - Action on structures, Snow loads' and 'Eurocode EN 1991 - Actions on structures, Wind actions'. Subject to the Building Regulations and for security-relevant reasons the installation has to be dismantled at the end of its service life.
- Failure consequence class is considered according to 'Eurocode EN 1990 - Basis of structural design'.
- The person responsible for the execution of the work must check the load assumptions made with the conditions on site. If deviations are found, the person who prepared the static calculation must be consulted immediately. , in particular § 2 ("technical and specialist requirements for the customer"), § 7 ("warranty provisions") and § 8 ("limitation of liability").



Structural analysis report | East 3

General information

Name	GORTON MARKET
Mounting System	K2 BasicRail
Author	JJ Fitzgerald

Location information

Address	Manchester M18 8LD, UK
Ground elevation	70.03 m

Roof information

Building height	15.00 m
Roof type	Monopitch roof
Roof pitch	6°
Roof covering	Trapezoidal
Min. roof edge distance	0.00 m
Crest distance	101.0 mm
Crest width	22.0 mm
Crest height	40.0 mm
Roof material	Steel
Sheet quality	S235
Sheet thickness	0.500 mm

Loads

Design method	BS EN
Failure consequence class (CC)	CC3
Design working life	25 years
Terrain category	Town Terrain
Distance to shoreline	50.00 km
Distance inside town terrain	25.00 km

Wind load

Velocity pressure, 50 years	$q_{p,50} = 0.751 \text{ kN/m}^2$
Adjustment factor for service life	$f_w = 1.000$
Velocity pressure, 25 years	$q_{p,25} = 0.691 \text{ kN/m}^2$

Structural analysis report | East 3

Roof areas

Array	load impact area [m ²]	maxCpe ₁₀	minCpe ₁₀	wind pressure [kN/m ²]	wind suction [kN/m ²]
field area	10.00	0.020	-0.810	0.014	-0.560
eaves	10.00	0.020	-1.160	0.014	-0.802
corner region (eave)	10.00	0.020	-2.050	0.014	-1.417
corner region (ridge)	10.00	0.020	-2.420	0.014	-1.673
ridge	10.00	0.020	-1.090	0.014	-0.754
field area	10.00	0.020	-0.810	0.014	-0.560
eaves	10.00	0.020	-1.160	0.014	-0.802
corner region (eave)	10.00	0.020	-2.050	0.014	-1.417
corner region (ridge)	10.00	0.020	-2.420	0.014	-1.673
ridge	10.00	0.020	-1.090	0.014	-0.754

Snow load

Snow load zone	3
Snow guard	No
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$
Shape Coefficient for Snow	$\mu_i = 0.800$
Factor for roof pitch	$d_i = 0.995$
Snow load on roof, 50 year	$s_{i,50} = 0.398 \text{ kN/m}^2$
Adjustment factor for service life	$f_s = 1.000$
Snow load on roof, 25 years	$s_{i,25} = 0.370 \text{ kN/m}^2$

Dead Load

Weight of module	$G_M = 22.0 \text{ kg}$
Weight of mounting system per module	$= 2.0 \text{ kg}$
Module area	$A_M = 2.00 \text{ m}^2$
Dead weight of module per m ²	$= 11.01 \text{ kg/m}^2$
Dead weight of mounting system per m ²	$= 1.00 \text{ kg/m}^2$
Total Dead Load (excl. ballast) per m ²	$= 0.12 \text{ kN/m}^2$



Structural analysis report | East 3

Load Combinations

Ultimate limit state

Partial safety factor unfavourable permanent load	$\gamma_{G,sup} = 1.35$
Partial safety factor favourable permanent load	$\gamma_{G,inf} = 1.00$
Partial safety factor destabilising permanent load	$\gamma_{G,dst} = 1.10$
Partial safety factor stabilising permanent load	$\gamma_{G,stab} = 0.90$
Partial safety factor variable loads	$\gamma_Q = 1.50$
Combination coefficient with regards to wind	$\psi_{0,W} = 0.60$
Combination coefficient with regards to wind (additional varying influences)	$\psi_{1,W} = 0.20$
Combination coefficient with regards to Snow	$\psi_{0,S} = 0.50$
Importance factor permanent	$\kappa_{FI,G} = 1.10$
Importance factor variable	$\kappa_{FI,Q} = 1.10$
Characteristic dead weight	G_k
Characteristic snow load on the roof	$S_{i,n}$
Characteristic wind load	W_k

Load case combination 01	$LCC\ 01_{uls} = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$
Load case combination 02	$LCC\ 02_{uls} = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$
Load case combination 03	$LCC\ 03_{uls} = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$
Load case combination 04	$LCC\ 04_{uls} = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$
Load case combination 06	$LCC\ 06_{uls} = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$

Serviceability limit state

Combination coefficient with regards to wind	$\psi_{0,W} = 0.60$
Combination coefficient with regards to Snow	$\psi_{0,S} = 0.50$

Load case combination 01	$LCC\ 01_{sls} = G_k + S_{i,n}$
Load case combination 02	$LCC\ 02_{sls} = G_k + W_{k,Pressure}$
Load case combination 03	$LCC\ 03_{sls} = G_k + W_{k,Pressure} + \psi_{0,S} * S_{i,n}$
Load case combination 04	$LCC\ 04_{sls} = G_k + S_{i,n} + \psi_{0,W} * W_{k,Pressure}$
Load case combination 06	$LCC\ 06_{sls} = G_k + W_{k,Suction}$

Structural analysis report | East 3

Maximum load on modules (Mounting system dimensioning)

Array	A-TrA [m ²]	ultimate state [kN/m ²]				Serviceability [kN/m ²]			
		Pressure ⊥	Pressure 	Uplift ⊥	Uplift 	Pressure ⊥	Pressure 	Uplift ⊥	Uplift
field area	10.00	0.794	0.082	-0.807	0.012	0.493	0.051	-0.443	0.012
eaves	10.00	0.794	0.082	-1.206	0.012	0.493	0.051	-0.685	0.012
corner region (eave)	10.00	0.794	0.082	-2.221	0.012	0.493	0.051	-1.300	0.012
corner region (ridge)	10.00	0.794	0.082	-2.643	0.012	0.493	0.051	-1.556	0.012
ridge	10.00	0.794	0.082	-1.126	0.012	0.493	0.051	-0.636	0.012
field area	10.00	0.794	0.082	-0.807	0.012	0.493	0.051	-0.443	0.012
eaves	10.00	0.794	0.082	-1.206	0.012	0.493	0.051	-0.685	0.012
corner region (eave)	10.00	0.794	0.082	-2.221	0.012	0.493	0.051	-1.300	0.012
corner region (ridge)	10.00	0.794	0.082	-2.643	0.012	0.493	0.051	-1.556	0.012
ridge	10.00	0.794	0.082	-1.126	0.012	0.493	0.051	-0.636	0.012

Max. load on fastener

Array	A-TrA [m ²]	ultimate state [kN]				Serviceability [kN]			
		Pressure ⊥	Pressure 	Uplift ⊥	Uplift	Pressure ⊥	Pressure 	Uplift ⊥	Uplift
field area	10.00	0.622	0.064	-0.632	0.010	0.386	0.040	-0.347	0.010
eaves	10.00	0.622	0.064	-0.944	0.010	0.386	0.040	-0.536	0.010
corner region (eave)	10.00	0.311	0.032	-0.870	0.005	0.193	0.020	-0.509	0.005
corner region (ridge)	10.00	0.233	0.024	-0.776	0.004	0.145	0.015	-0.457	0.004
ridge	10.00	0.622	0.064	-0.882	0.010	0.386	0.040	-0.498	0.010
field area	10.00	0.622	0.064	-0.632	0.010	0.386	0.040	-0.347	0.010
eaves	10.00	0.622	0.064	-0.944	0.010	0.386	0.040	-0.536	0.010
corner region (eave)	10.00	0.311	0.032	-0.870	0.005	0.193	0.020	-0.509	0.005
corner region (ridge)	10.00	0.233	0.024	-0.776	0.004	0.145	0.015	-0.457	0.004
ridge	10.00	0.622	0.064	-0.882	0.010	0.386	0.040	-0.498	0.010

Resistance Values of Components

Base Rails



Structural analysis report | East 3

Base Rails	A [cm ²]	I _y [cm ⁴]	I _z [cm ⁴]	W _y [cm ³]	W _z [cm ³]
K2 BasicRail 22	2.380	1.52	7.74	1.08	2.46

Fastener

Fastener	R _{D,Uplift,Perpendicular} [kN]	R _{D,Pressure,Perpendicular} [kN]	R _{D,Pressure,Parallel} [kN]
K2 BasicClip	1.02	-	0.96
Thread-forming metal screw 6.0×38	0.65	-	0.62

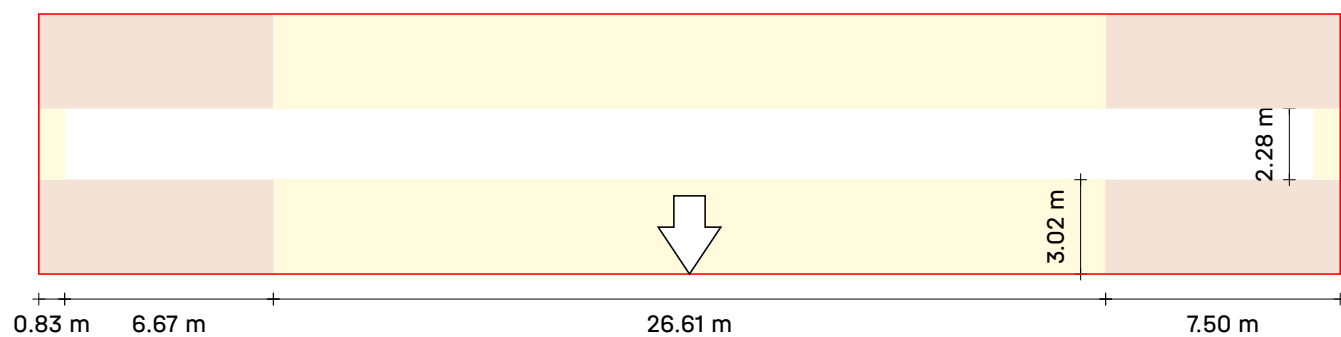
Utilisation result

No.	roof areas	ultimate limit state			Usab.	Distances		maximum values	
		Pr σ[%]	CL σ[%]	Fst F[%]	Pr f[%]	Fst [m]	BR [m]	CL L _{max} [m]	Fst D _{max} [m]
1	field area	24.3	0.8	62.8	29.6	0.808	---	0.483	0.850
1	eaves	35.5	1.2	93.4	41.1	0.808	---	0.441	0.850
1	corner region (eave)	16.3	0.0	85.6	4.9	0.404	---	0.404	0.472
1	corner region (ridge)	10.9	0.0	76.3	2.4	0.303	---	0.303	0.397
1	ridge	33.1	1.2	87.2	38.2	0.808	---	0.450	0.850
2	field area	24.3	1.7	62.8	29.6	0.808	---	0.483	0.850
2	eaves	35.5	1.7	93.4	41.1	0.808	---	0.441	0.850
2	corner region (eave)	16.3	4.7	85.6	4.9	0.404	---	0.404	0.472
2	corner region (ridge)	10.9	5.6	76.3	2.4	0.303	---	0.303	0.397
2	ridge	33.1	1.5	87.2	38.2	0.808	---	0.450	0.850

Pr	Profile	Fst D _{max}	maximum fastener spacing
Fst	Fastener	BR	Base Rail
σ	Stress	Usab.	serviceability limit state
f	Deflection	CL	Cantilever
F	Force		
CL/L _{max}	maximum cantilever length		

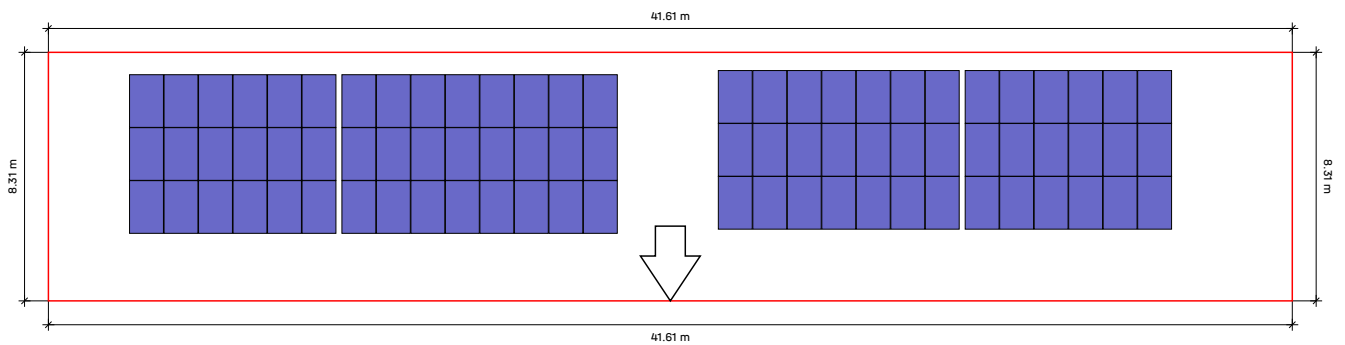


Roofs | East 4





Roofs | East 4



Roof	System	Module	Height	Quantity	Total power
<u>East 4</u>  Trapezoidal	<u>K2 BasicRail</u>	JAM54D40-430/LB 1,762×1,134×30 mm 430 Wp	15.00 m	81	34.83 kWp



Roofs | East 4 | Assembly plan

Base Rails

Type	Whole Rails		Rail cutting		
	Total Rail Length	Quantity 3.65 m	Part of Rail / Rest	Length	Rest
12*A	7.024 m	1*3.65 m	3.650	3.374 from 3.650	0.266
6*B	9.332 m	2*3.65 m	3.650	2.032 from 3.650	1.608
6*C	8.178 m	2*3.65 m	1.608	0.878 from 1.608	0.720

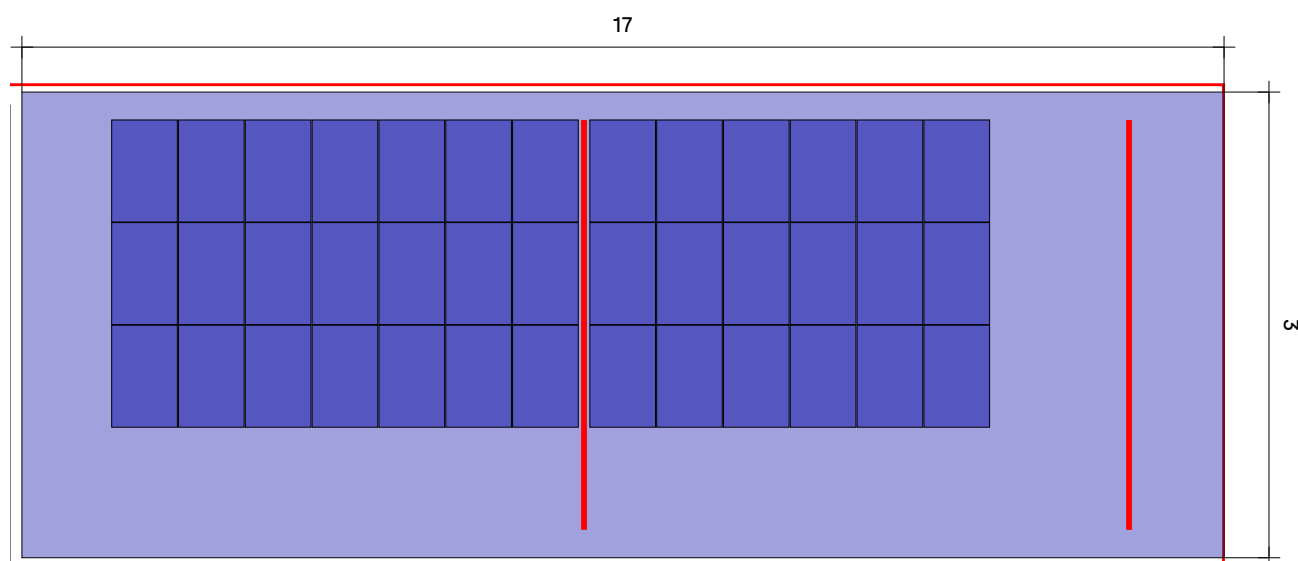
1 cm is viewed as lost for each cutting

Red numbers are leftover rails which will not be used any longer

Module arrays

Module array	Width[m]	Length[m]	Width in modules	Length in modules
1	19.96	7.08	13	3
2	19.96	7.08	14	3

Roofs | East 4 | Module array 1



Roof ⑧ Module array ①

Mounting System

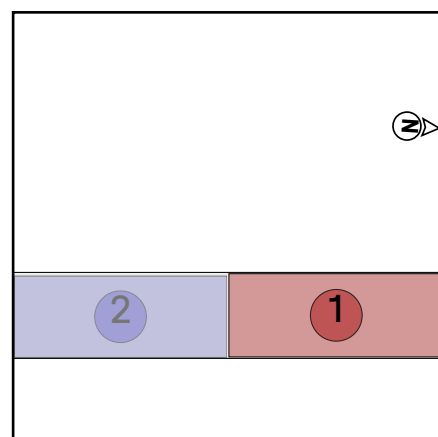
[K2 BasicRail](#)

Module

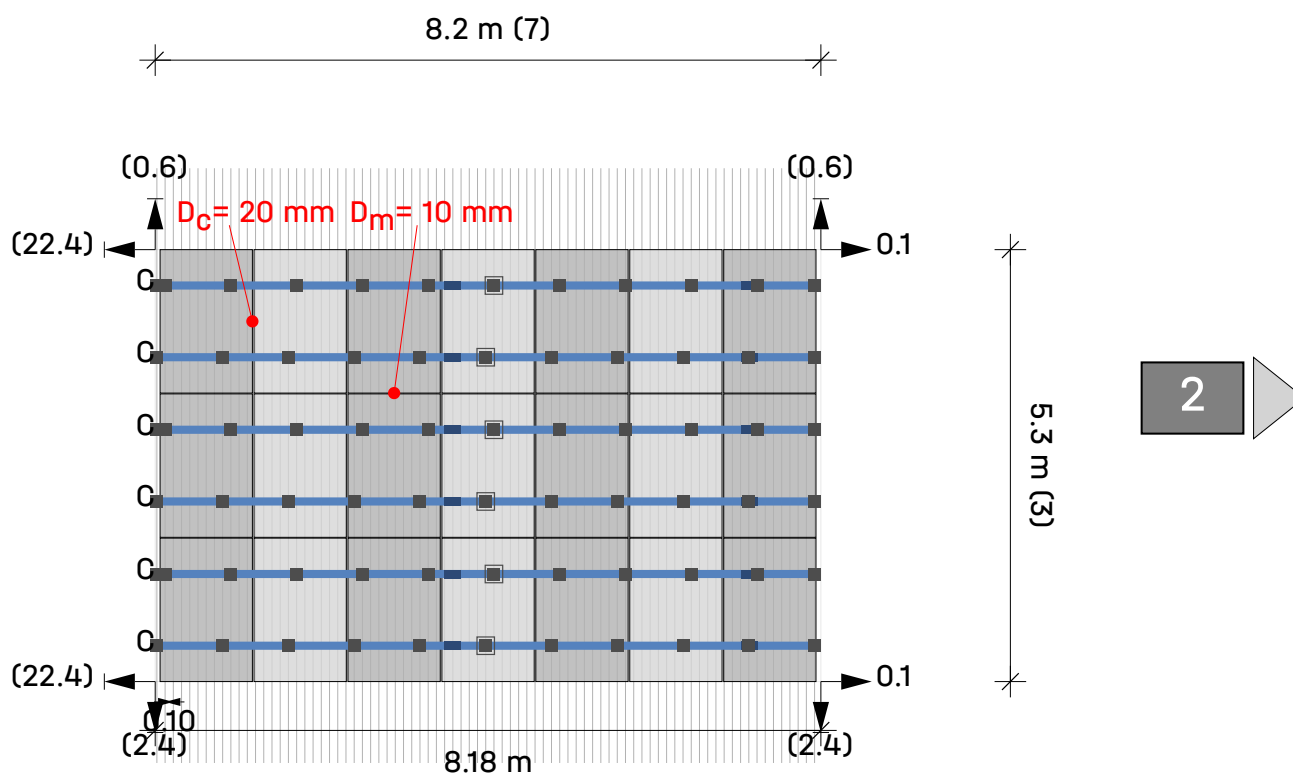
39(16.77 kWp) x
JAM54D40-430/LB

Row spacing

1.77 m



Roofs | East 4 | Module array 1 | Module blocks

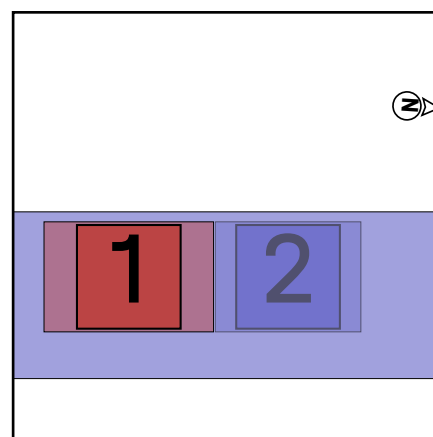


Roof ⑧ Module array ① Module block 1

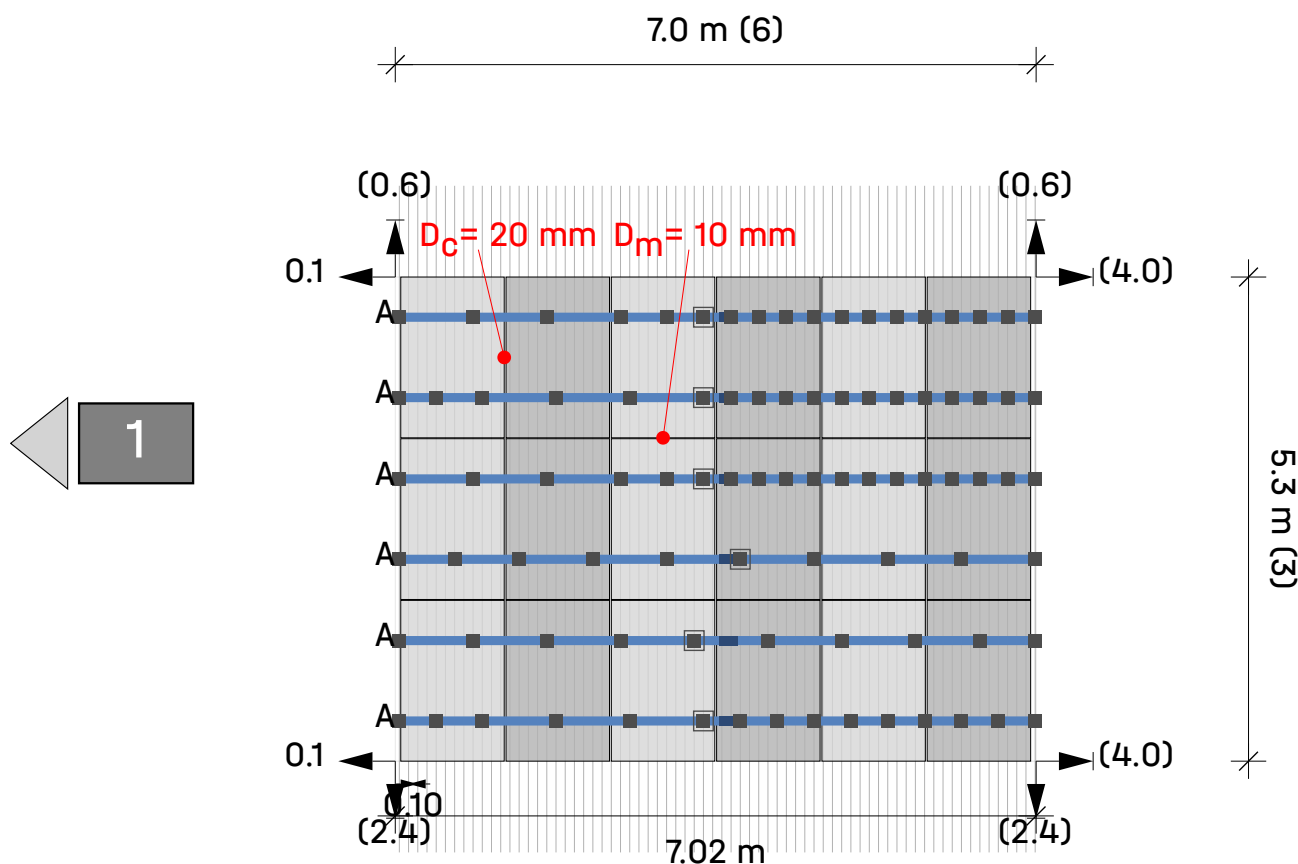
Modules $7 \times 3 = 21$

Legend

- Next block indicator
- Fastener
- BasicLocks
- Mounting rail: K2 BasicRail 22
- Distance to Roof Edge [m]
- Dist. to neighbour module block/array [m]
- D_c Distance for clamping between modules
- D_m Distance between modules



Roofs | East 4 | Module array 1 | Module blocks

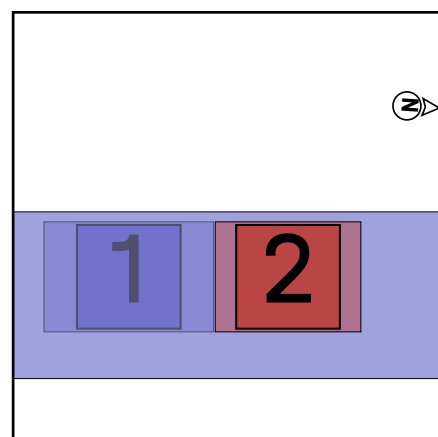


Roof ⑧ Module array ① Module block ②

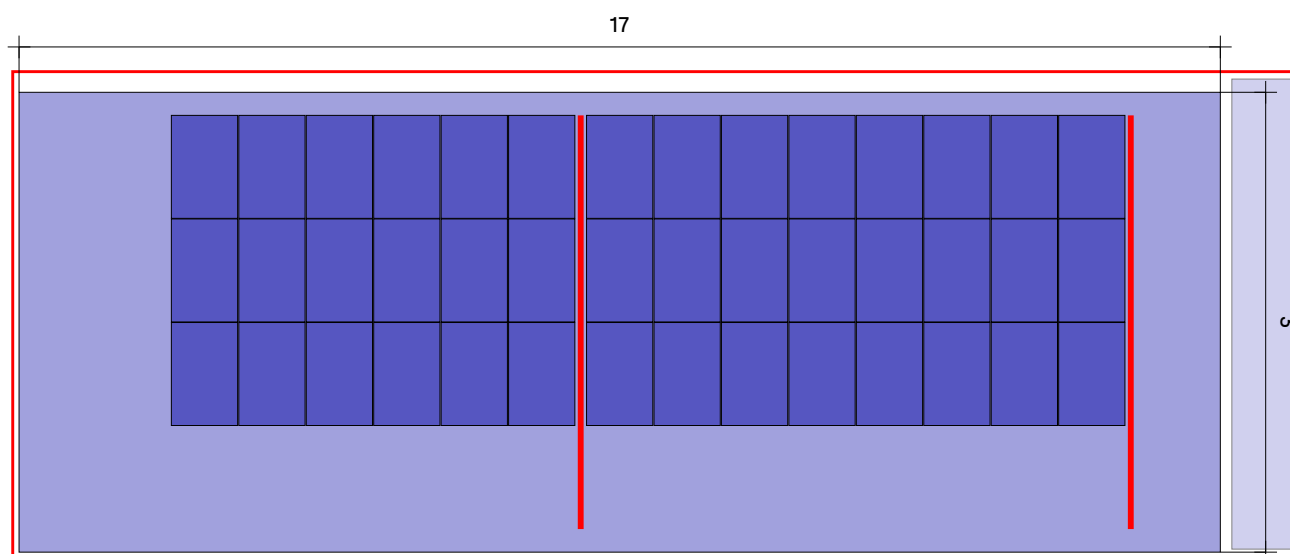
Modules $6 \times 3 = 18$

Legend

- ◀ Next block indicator
- Fastener
- BasicLocks
- Mounting rail: K2 BasicRail 22
- Distance to Roof Edge [m]
- Dist. to neighbour module block/array [m]
- D_c Distance for clamping between modules
- D_m Distance between modules



Roofs | East 4 | Module array 2



Roof ⑧ Module array ②

Mounting System

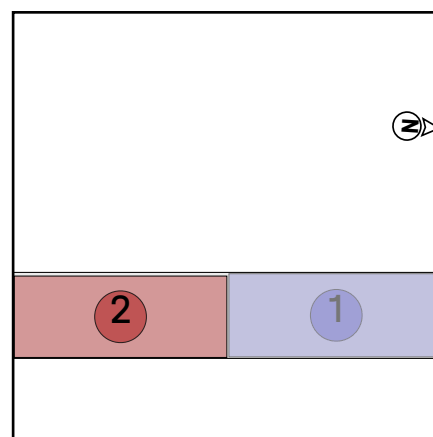
[K2 BasicRail](#)

Module

42(18.06 kWp) x
JAM54D40-430/LB

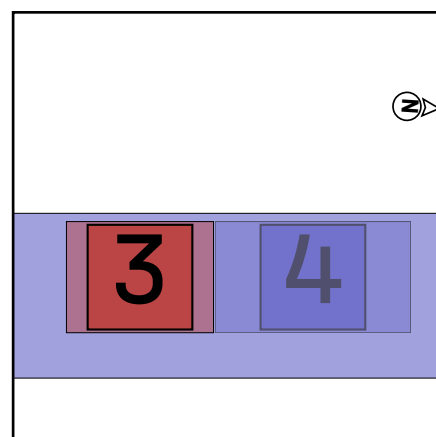
Row spacing

1.77 m

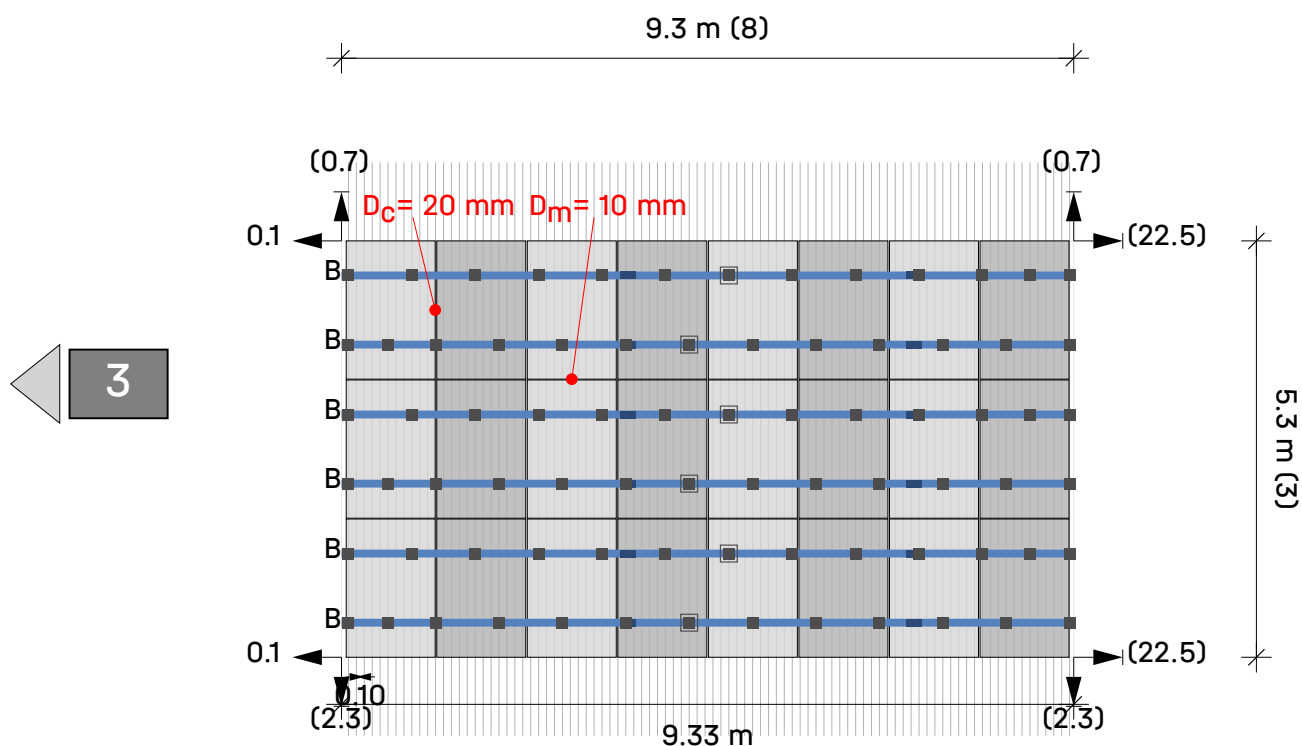



$$6 \times 3 = 18$$

D_m Distance between modules



Roofs | East 4 | Module array 2 | Module blocks

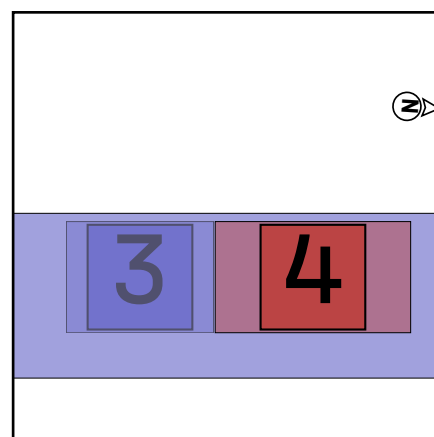


Roof ⑧ Module array ② Module block ④

Modules $8 \times 3 = 24$

Legend

- Next block indicator
- Fastener
- BasicLocks
- Mounting rail: K2 BasicRail 22
- Distance to Roof Edge [m]
- Dist. to neighbour module block/array [m]
- D_c Distance for clamping between modules
- D_m Distance between modules



Results | East 4

Roof	System	Module	Height	Quantity	Total power
<u>East 4</u>  Trapezoidal	<u>K2 BasicRail</u>	JAM54D40-430/LB 1,762×1,134×30 mm 430 Wp	15.00 m	81	34.83 kWp

Module

Name	JAM54D40-430/LB
Manufacturer	Shanghai JA Solar Technology Co. Ltd.
Output power	430 Wp
Dimensions	1,762×1,134×30 mm
Weight	22.0 kg

Components

Fastener	K2 BasicClip
Base rails	K2 BasicRail 22
Metal screw	Thread-forming metal screw 6.0×38

Loads on modules (module dimensioning)

Array	A-TrA [m²]	ultimate state [Pa]				Serviceability [Pa]			
		Pressure ⊥	Pressure 	Uplift ⊥	Uplift 	Pressure ⊥	Pressure 	Uplift ⊥	Uplift
field area	2.00	794.1	82.0	-806.8	12.3	493.0	50.9	-442.9	12.3
eaves	2.00	794.1	82.0	-1,206.1	12.3	493.0	50.9	-684.8	12.3
corner region (eave)	2.00	794.1	82.0	-2,221.4	12.3	493.0	50.9	-1,300.1	12.3
corner region (ridge)	2.00	794.1	82.0	-2,643.4	12.3	493.0	50.9	-1,555.9	12.3
ridge	2.00	794.1	82.0	-1,126.3	12.3	493.0	50.9	-636.4	12.3
field area	2.00	794.1	82.0	-806.8	12.3	493.0	50.9	-442.9	12.3
eaves	2.00	794.1	82.0	-1,206.1	12.3	493.0	50.9	-684.8	12.3
corner region (eave)	2.00	794.1	82.0	-2,221.4	12.3	493.0	50.9	-1,300.1	12.3
corner region (ridge)	2.00	794.1	82.0	-2,643.4	12.3	493.0	50.9	-1,555.9	12.3
ridge	2.00	794.1	82.0	-1,126.3	12.3	493.0	50.9	-636.4	12.3



Results | East 4

Utilisation result

No.	Module Array	roof areas	ultimate limit state			Usab.	Distances		maximum values	
			Pr σ [%]	CL σ [%]	Fst F[%]	Pr f[%]	Fst [m]	BR [m]	CL $L_{\max}$ [m]	Fst D _{max} [m]
1		field area	24.3	1.1	62.8	29.6	0.808	---	0.483	0.850
1		eaves	35.5	1.6	93.4	41.1	0.808	---	0.441	0.850
1		corner region (eave)	16.3	0.0	85.6	4.9	0.404	---	0.404	0.472
1		corner region (ridge)	10.9	0.0	76.3	2.4	0.303	---	0.303	0.397
1		ridge	33.1	1.5	87.2	38.2	0.808	---	0.450	0.850
2		field area	24.3	1.5	62.8	29.6	0.808	---	0.483	0.850
2		eaves	35.5	2.1	93.4	41.1	0.808	---	0.441	0.850
2		corner region (eave)	16.3	0.0	85.6	4.9	0.404	---	0.404	0.472
2		corner region (ridge)	10.9	0.0	76.3	2.4	0.303	---	0.303	0.397
2		ridge	33.1	2.0	87.2	38.2	0.808	---	0.450	0.850

Pr **Profile**Fst **Fastener** σ **Stress**f **Deflection**F **Force**CL/ $L_{\max}$ **maximum cantilever length**Fst D_{max} **maximum fastener spacing**BR **Base Rail**Usab. **serviceability limit state**CL **Cantilever**



Results | East 4

Important Information

- The quantity for K2 BasicRail BasicClips is calculated in such a way, that - according to the Assembly Instructions - a BasicClip can be installed on the crest to the left and right of a Rail Connector Set.
- The structure was statically verified in accordance with Eurocode 9: Design of aluminium structures (DIN EN 1999-1-1:2021) and offers sufficient load-bearing capacity and stability for the loads specified in the chapter 'Maximum actions on the components'.
- Adjustment factor for wind load regarding service life period, f_W , is according to DIN EN 1991-1-4/ NA, NDP for 4.2 (2P) note 5, table 3
- Adjustment factor for snow load regarding service life period, f_S , is according to DIN EN 1991-1-3/ annex D, table 4
- The structural design complies with BS EN 1990 - Basis of Structural Design.
- Snow loads are determined in accordance with National Annex BS NA EN 1991-1-3 (2018) - UK National Annex to EC1 - Action on structures - general actions - snow loads.
- Wind loads are determined in accordance with National Annex BS NA EN 1991-1-4 - UK National Annex to EC1 - Action on structures, general actions - wind actions.
- Service life is recognised according to 'Eurocode EN 1991 - Action on structures, Snow loads' and 'Eurocode EN 1991 - Actions on structures, Wind actions'. Subject to the Building Regulations and for security-relevant reasons the installation has to be dismantled at the end of its service life.
- Failure consequence class is considered according to 'Eurocode EN 1990 - Basis of structural design'.
- The person responsible for the execution of the work must check the load assumptions made with the conditions on site. If deviations are found, the person who prepared the static calculation must be consulted immediately. , in particular § 2 ("technical and specialist requirements for the customer"), § 7 ("warranty provisions") and § 8 ("limitation of liability").



Structural analysis report | East 4

General information

Name	GORTON MARKET
Mounting System	K2 BasicRail
Author	JJ Fitzgerald

Location information

Address	Manchester M18 8LD, UK
Ground elevation	70.03 m

Roof information

Building height	15.00 m
Roof type	Monopitch roof
Roof pitch	6°
Roof covering	Trapezoidal
Min. roof edge distance	0.00 m
Crest distance	101.0 mm
Crest width	22.0 mm
Crest height	40.0 mm
Roof material	Steel
Sheet quality	S235
Sheet thickness	0.500 mm

Loads

Design method	BS EN
Failure consequence class (CC)	CC3
Design working life	25 years
Terrain category	Town Terrain
Distance to shoreline	50.00 km
Distance inside town terrain	25.00 km

Wind load

Velocity pressure, 50 years	$q_{p,50} = 0.751 \text{ kN/m}^2$
Adjustment factor for service life	$f_w = 0.921$
Velocity pressure, 25 years	$q_{p,25} = 0.691 \text{ kN/m}^2$

Structural analysis report | East 4

Roof areas

Array	load impact area [m ²]	maxCpe ₁₀	minCpe ₁₀	wind pressure [kN/m ²]	wind suction [kN/m ²]
field area	10.00	0.020	-0.810	0.014	-0.560
eaves	10.00	0.020	-1.160	0.014	-0.802
corner region (eave)	10.00	0.020	-2.050	0.014	-1.417
corner region (ridge)	10.00	0.020	-2.420	0.014	-1.673
ridge	10.00	0.020	-1.090	0.014	-0.754
field area	10.00	0.020	-0.810	0.014	-0.560
eaves	10.00	0.020	-1.160	0.014	-0.802
corner region (eave)	10.00	0.020	-2.050	0.014	-1.417
corner region (ridge)	10.00	0.020	-2.420	0.014	-1.673
ridge	10.00	0.020	-1.090	0.014	-0.754

Snow load

Snow load zone	3
Snow guard	No
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$
Shape Coefficient for Snow	$\mu_i = 0.800$
Factor for roof pitch	$d_i = 0.995$
Snow load on roof, 50 year	$s_{i,50} = 0.398 \text{ kN/m}^2$
Adjustment factor for service life	$f_s = 0.929$
Snow load on roof, 25 years	$s_{i,25} = 0.370 \text{ kN/m}^2$

Dead Load

Weight of module	$G_M = 22.0 \text{ kg}$
Weight of mounting system per module	$= 2.0 \text{ kg}$
Module area	$A_M = 2.00 \text{ m}^2$
Dead weight of module per m ²	$= 11.01 \text{ kg/m}^2$
Dead weight of mounting system per m ²	$= 1.00 \text{ kg/m}^2$
Total Dead Load (excl. ballast) per m ²	$= 0.12 \text{ kN/m}^2$



Structural analysis report | East 4

Load Combinations

Ultimate limit state

Partial safety factor unfavourable permanent load	$\gamma_{G,sup} = 1.35$
Partial safety factor favourable permanent load	$\gamma_{G,inf} = 1.00$
Partial safety factor destabilising permanent load	$\gamma_{G,dst} = 1.10$
Partial safety factor stabilising permanent load	$\gamma_{G,stab} = 0.90$
Partial safety factor variable loads	$\gamma_Q = 1.50$
Combination coefficient with regards to wind	$\psi_{0,W} = 0.60$
Combination coefficient with regards to wind (additional varying influences)	$\psi_{1,W} = 0.20$
Combination coefficient with regards to Snow	$\psi_{0,S} = 0.50$
Importance factor permanent	$\kappa_{F1,G} = 1.10$
Importance factor variable	$\kappa_{F1,Q} = 1.10$
Characteristic dead weight	G_k
Characteristic snow load on the roof	$S_{i,n}$
Characteristic wind load	W_k

Load case combination 01	$LCC\ 01_{uls} = \gamma_{G,sup} * \kappa_{F1,G} * G_k + \gamma_Q * \kappa_{F1,Q} * S_{i,n}$
Load case combination 02	$LCC\ 02_{uls} = \gamma_{G,sup} * \kappa_{F1,G} * G_k + \gamma_Q * \kappa_{F1,Q} * W_{k,Pressure}$
Load case combination 03	$LCC\ 03_{uls} = \gamma_{G,sup} * \kappa_{F1,G} * G_k + \gamma_Q * \kappa_{F1,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$
Load case combination 04	$LCC\ 04_{uls} = \gamma_{G,sup} * \kappa_{F1,G} * G_k + \gamma_Q * \kappa_{F1,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$
Load case combination 06	$LCC\ 06_{uls} = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{F1,Q} * W_{k,Suction}$

Serviceability limit state

Combination coefficient with regards to wind	$\psi_{0,W} = 0.60$
Combination coefficient with regards to Snow	$\psi_{0,S} = 0.50$

Load case combination 01	$LCC\ 01_{sls} = G_k + S_{i,n}$
Load case combination 02	$LCC\ 02_{sls} = G_k + W_{k,Pressure}$
Load case combination 03	$LCC\ 03_{sls} = G_k + W_{k,Pressure} + \psi_{0,S} * S_{i,n}$
Load case combination 04	$LCC\ 04_{sls} = G_k + S_{i,n} + \psi_{0,W} * W_{k,Pressure}$
Load case combination 06	$LCC\ 06_{sls} = G_k + W_{k,Suction}$

Structural analysis report | East 4

Maximum load on modules (Mounting system dimensioning)

Array	A-TrA [m ²]	ultimate state [kN/m ²]				Serviceability [kN/m ²]			
		Pressure ⊥	Pressure 	Uplift ⊥	Uplift 	Pressure ⊥	Pressure 	Uplift ⊥	Uplift
field area	10.00	0.794	0.082	-0.807	0.012	0.493	0.051	-0.443	0.012
eaves	10.00	0.794	0.082	-1.206	0.012	0.493	0.051	-0.685	0.012
corner region (eave)	10.00	0.794	0.082	-2.221	0.012	0.493	0.051	-1.300	0.012
corner region (ridge)	10.00	0.794	0.082	-2.643	0.012	0.493	0.051	-1.556	0.012
ridge	10.00	0.794	0.082	-1.126	0.012	0.493	0.051	-0.636	0.012
field area	10.00	0.794	0.082	-0.807	0.012	0.493	0.051	-0.443	0.012
eaves	10.00	0.794	0.082	-1.206	0.012	0.493	0.051	-0.685	0.012
corner region (eave)	10.00	0.794	0.082	-2.221	0.012	0.493	0.051	-1.300	0.012
corner region (ridge)	10.00	0.794	0.082	-2.643	0.012	0.493	0.051	-1.556	0.012
ridge	10.00	0.794	0.082	-1.126	0.012	0.493	0.051	-0.636	0.012

Max. load on fastener

Array	A-TrA [m ²]	ultimate state [kN]				Serviceability [kN]			
		Pressure ⊥	Pressure 	Uplift ⊥	Uplift	Pressure ⊥	Pressure 	Uplift ⊥	Uplift
field area	10.00	0.622	0.064	-0.632	0.010	0.386	0.040	-0.347	0.010
eaves	10.00	0.622	0.064	-0.944	0.010	0.386	0.040	-0.536	0.010
corner region (eave)	10.00	0.311	0.032	-0.870	0.005	0.193	0.020	-0.509	0.005
corner region (ridge)	10.00	0.233	0.024	-0.776	0.004	0.145	0.015	-0.457	0.004
ridge	10.00	0.622	0.064	-0.882	0.010	0.386	0.040	-0.498	0.010
field area	10.00	0.622	0.064	-0.632	0.010	0.386	0.040	-0.347	0.010
eaves	10.00	0.622	0.064	-0.944	0.010	0.386	0.040	-0.536	0.010
corner region (eave)	10.00	0.311	0.032	-0.870	0.005	0.193	0.020	-0.509	0.005
corner region (ridge)	10.00	0.233	0.024	-0.776	0.004	0.145	0.015	-0.457	0.004
ridge	10.00	0.622	0.064	-0.882	0.010	0.386	0.040	-0.498	0.010

Resistance Values of Components

Base Rails



Structural analysis report | East 4

Base Rails	A [cm ²]	I _y [cm ⁴]	I _z [cm ⁴]	W _y [cm ³]	W _z [cm ³]
K2 BasicRail 22	2.380	1.52	7.74	1.08	2.46

Fastener

Fastener	R _{D,Uplift,Perpendicular} [kN]	R _{D,Pressure,Perpendicular} [kN]	R _{D,Pressure,Parallel} [kN]
K2 BasicClip	1.02	-	0.96
Thread-forming metal screw 6.0×38	0.65	-	0.62

Utilisation result

No. Module Array	roof areas	ultimate limit state			Usab.	Distances		maximum values	
		Pr σ[%]	CL σ[%]	Fst F[%]	Pr f[%]	Fst [m]	BR [m]	CL L _{max} [m]	Fst D _{max} [m]
1	field area	24.3	1.1	62.8	29.6	0.808	---	0.483	0.850
1	eaves	35.5	1.6	93.4	41.1	0.808	---	0.441	0.850
1	corner region (eave)	16.3	0.0	85.6	4.9	0.404	---	0.404	0.472
1	corner region (ridge)	10.9	0.0	76.3	2.4	0.303	---	0.303	0.397
1	ridge	33.1	1.5	87.2	38.2	0.808	---	0.450	0.850
2	field area	24.3	1.5	62.8	29.6	0.808	---	0.483	0.850
2	eaves	35.5	2.1	93.4	41.1	0.808	---	0.441	0.850
2	corner region (eave)	16.3	0.0	85.6	4.9	0.404	---	0.404	0.472
2	corner region (ridge)	10.9	0.0	76.3	2.4	0.303	---	0.303	0.397
2	ridge	33.1	2.0	87.2	38.2	0.808	---	0.450	0.850

Pr	Profile	Fst D _{max}	maximum fastener spacing
Fst	Fastener	BR	Base Rail
σ	Stress	Usab.	serviceability limit state
f	Deflection	CL	Cantilever
F	Force		
CL/L _{max}	maximum cantilever length		



Thank you for choosing a K2 mounting system.

Systems from K2 Systems are quick and easy to install.

We hope these instructions have helped.

Please contact us with any questions or suggestions for improvement.

Our contact data:

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Our General Terms of Business apply. Please refer to k2-systems.com

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