| Connecting Strength

K2 Base Report

shed 4 DR Collin

Project address	39 Coldingham Rd, Eyemouth TD14 5AR, UK
Company	Maden Eco
Author	Conor Maden
Issue date & version	27/11/2023 | K2 Base Version 3.1.106.0

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.

Contents

Project overview

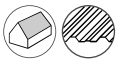
Project information

Name	**shed 4 DR Collin**
Address	**39 Coldingham Rd, Eyemouth TD14 5AR, UK**
Ground elevation	**35.92 m**
Author	**Conor Maden**

Load settings

Design method	**BS EN**
Failure consequence class (CC)	**CC1**
Design working life	**25 years**
Terrain category	**Sea**
Environment	**Normal area**
Basic wind speed	**24.5 m/s**
Snow load zone	**3**
Snow load on ground level	**0.50 kN/m²**

Roofs

Roof	System	Module	Power	Quantity	Total power
Roof 1 	K2 BasicRail	TSM-440NEG9R.28 (Vertex S+)	440 Wp	124	54.56 kWp
Roof 2 	K2 BasicRail	TSM-440NEG9R.28 (Vertex S+)	440 Wp	124	54.56 kWp
Total				**248**	**109.12 kWp**

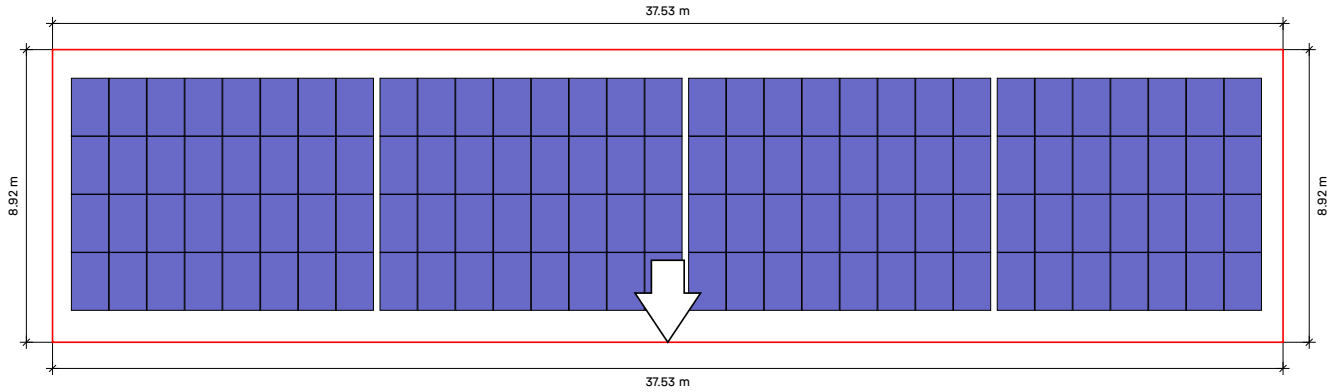
THE PROJECT IS VERIFIED.
The selected mounting system can be installed as planned
Thank you for choosing a K2 mounting system.

Roofs

Project information

Name	**shed 4 DR Collin**
Address	**39 Coldingham Rd, Eyemouth TD14 5AR, UK**
Ground elevation	**35.92 m**
Author	**Conor Maden**

Roofs | Roof 1



Roof	System	Module	Power	Quantity	Total power
Roof 1	K2 BasicRail	TSM-440NEG9R.28 (Vertex S+)	440 Wp	124	54.56 kWp

Roofs | Roof 1 | Assembly plan

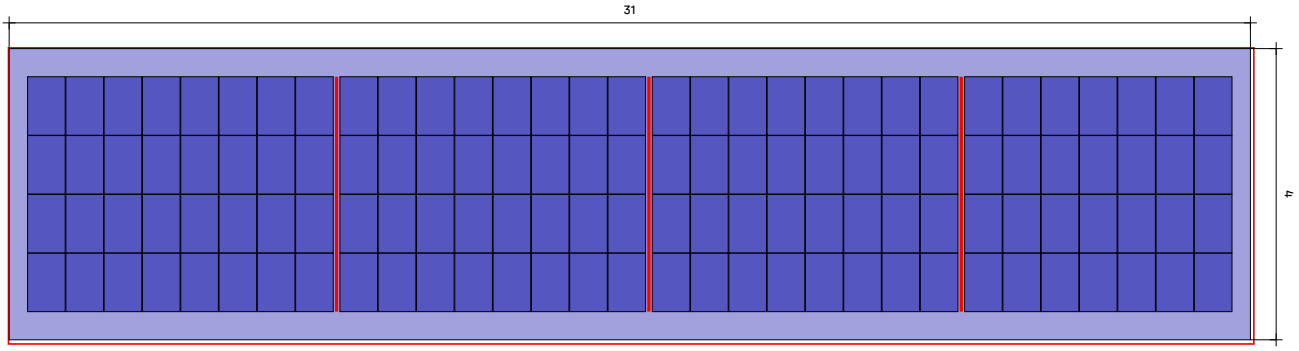
Base Rails

	Whole Rails		Rail cutting		
Type	Total Rail Length	Quantity 4.40 m	Part of Rail	Length	Rest
A	8.178	1	4.400	3.778	0.612
B	9.332	2	4.400	0.700	3.690
C	9.332	2	3.690	0.700	2.980
D	9.332	2	2.980	0.700	2.270
E	9.332	2	2.270	0.700	1.560
F	9.332	2	1.560	0.700	0.850
G	9.332	2	0.850	0.700	0.140

Module arrays

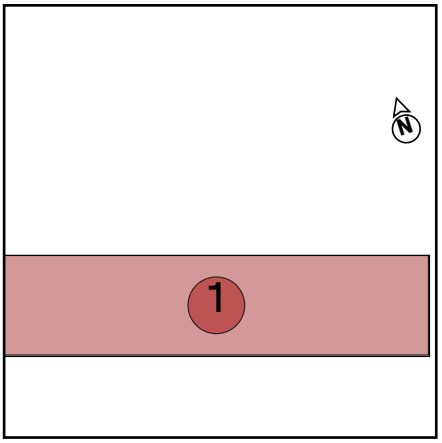
Module array	Width[m]	Length[m]	Width in modules	Length in modules
1	36.29	7.08	31	4

Roofs | Roof 1 | Module array 1

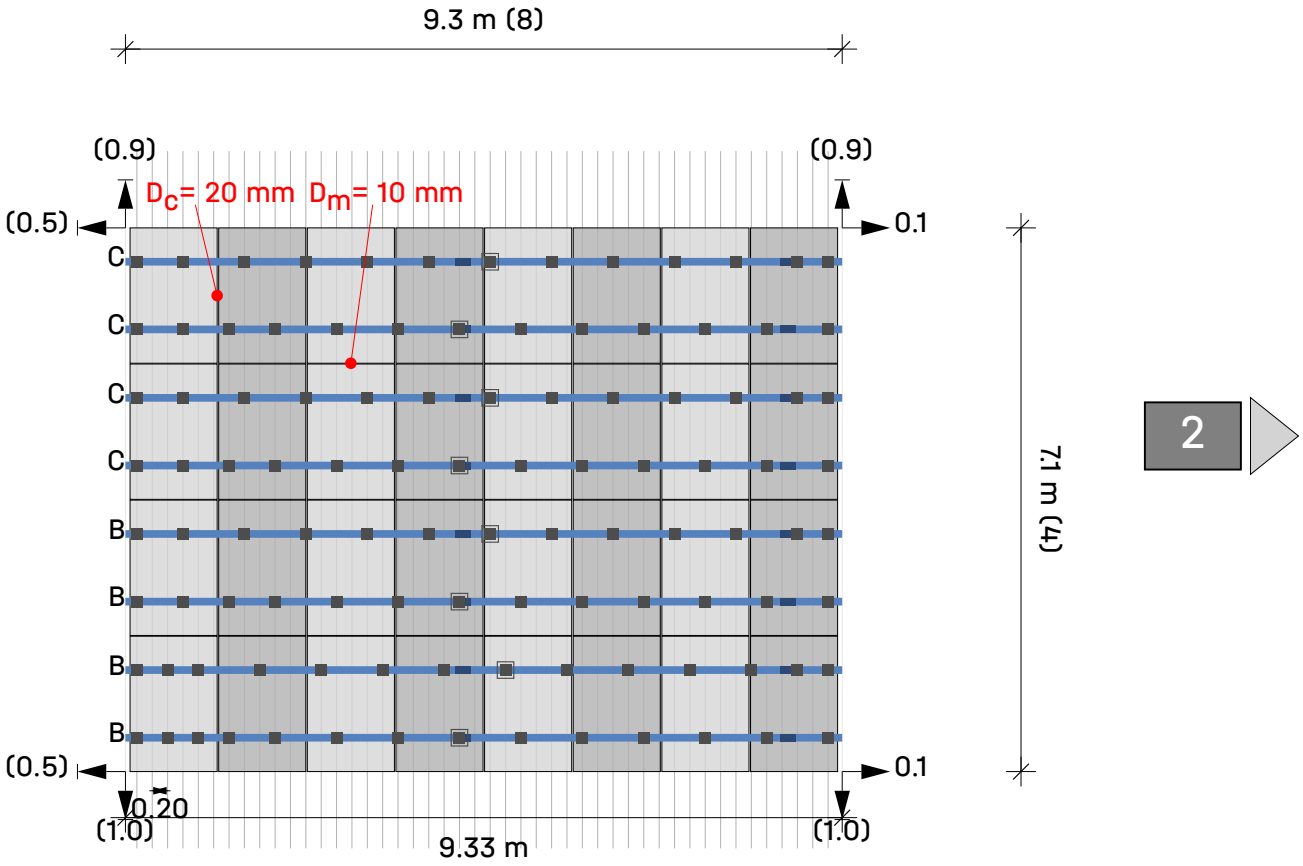


Roof 1 Module array 1

Mounting System	K2 BasicRail
Module	124(54.56 kWp) x TSM-440NEG9R.28 (Vertex S+)
Row spacing	1.77 m



Roofs | Roof 1 | Module array 1 | Module blocks

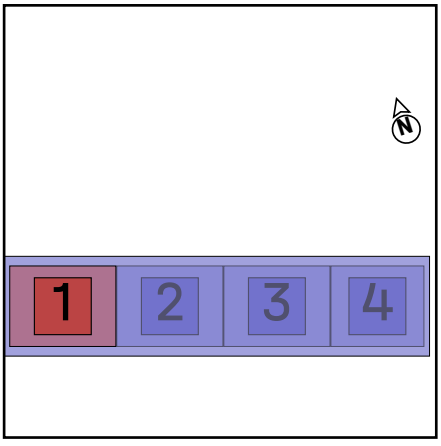


Roof (1) Module array 1 Module block 1

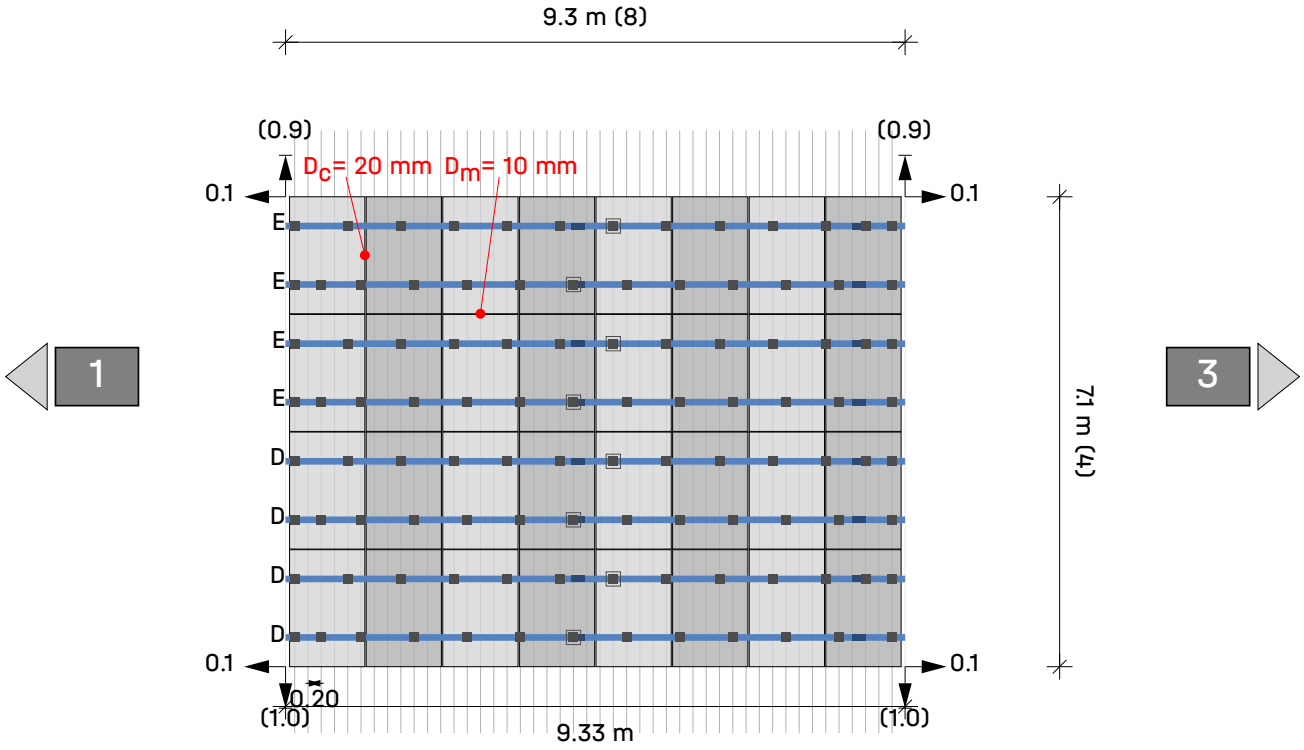
Modules 8 × 4 = **32**

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 | Roof 1 | Module array 1 | Module blocks

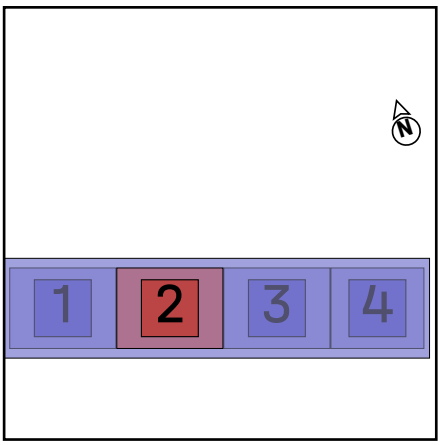


Roof (1) Module array 1 Module block 2

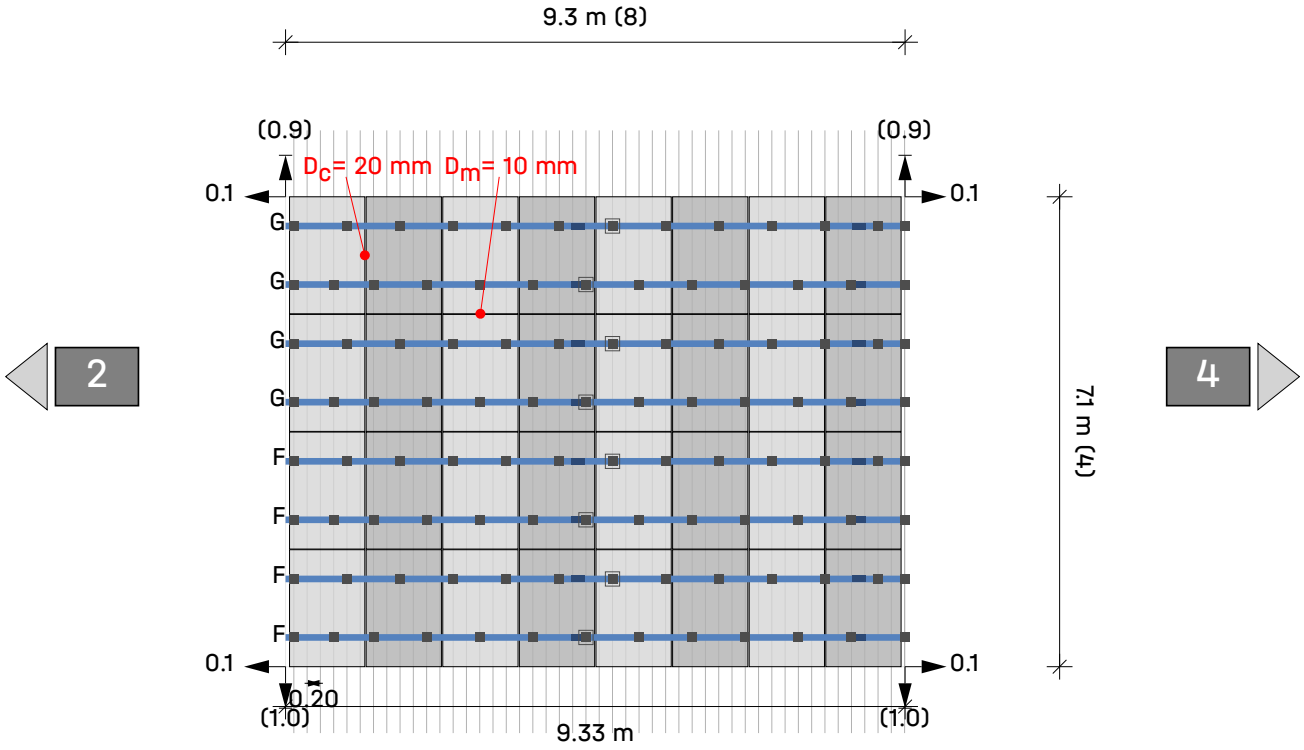
Modules 8 × 4 = **32**

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 | Roof 1 | Module array 1 | Module blocks

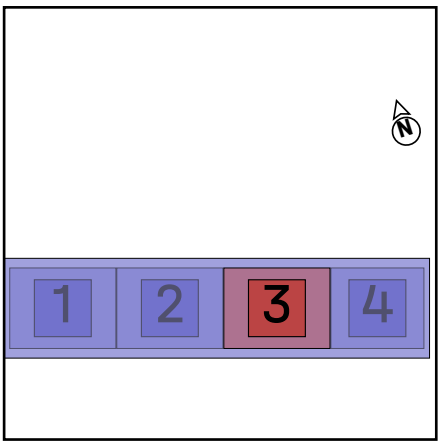


Roof (1) Module array 1 Module block 3

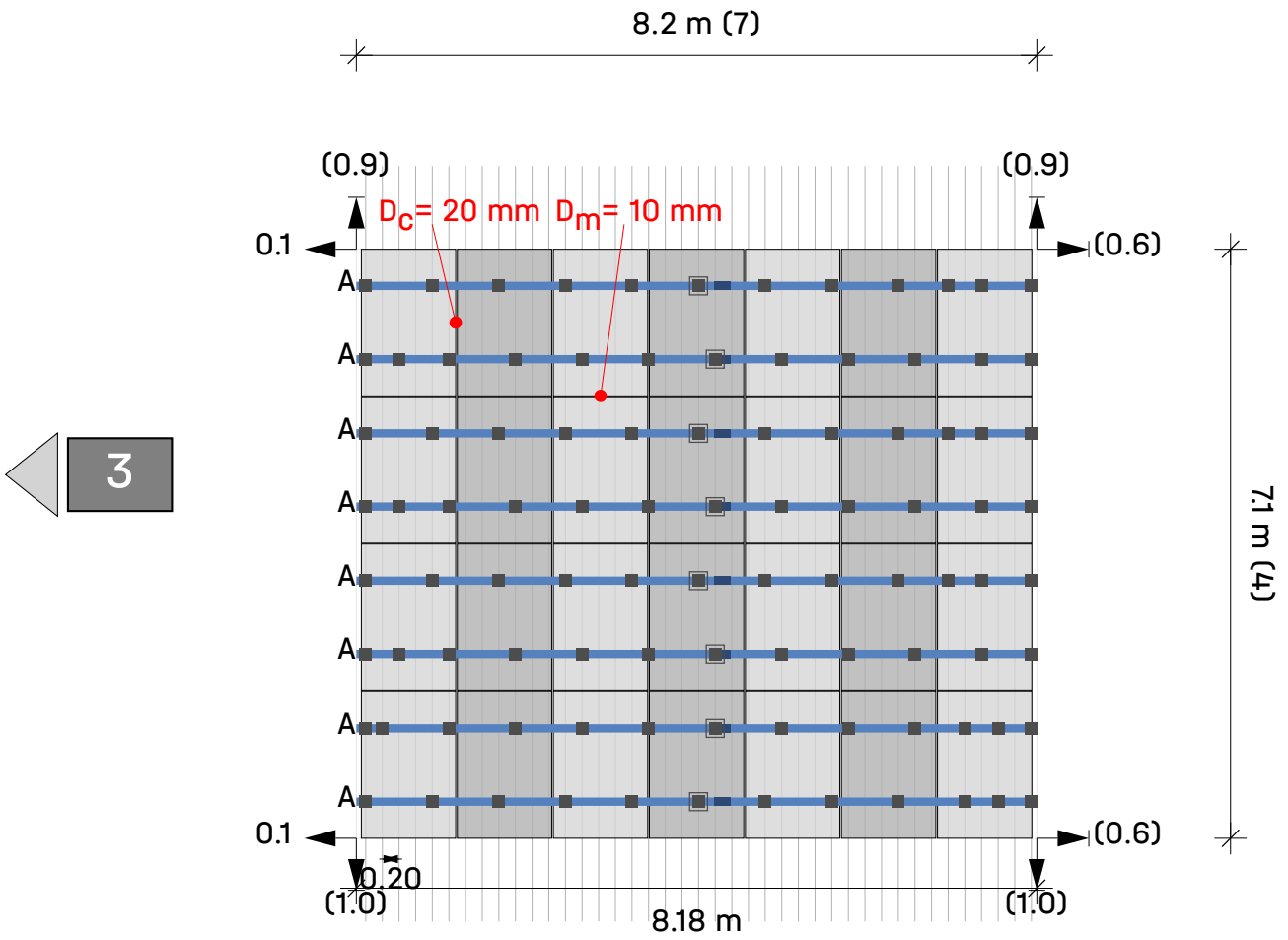
Modules 8 × 4 = **32**

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 | Roof 1 | Module array 1 | Module blocks

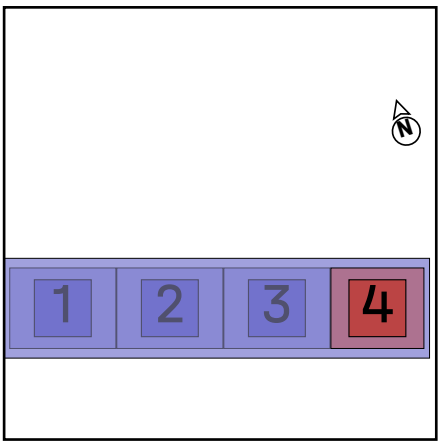


Roof (1) Module array 1 Module block 4

Modules 7 × 4 = **28**

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 | Roof 1

Roof	System	Module	Power	Quantity	Total power
Roof 1 	K2 BasicRail	TSM-440NEG9R.28 (Vertex S+)	440 Wp	124	54.56 kWp

Module

Name	TSM-440NEG9R.28 (Vertex S+)
Manufacturer	Trina Solar Energy
Output power	440 Wp
Dimensions	1,762×1,134×30 mm
Weight	21.1 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	713.1	153.3	-597.2	28.7	564.3	121.6	-445.3	28.7
ridge	2.00	713.1	153.3	-1,418.9	28.7	564.3	121.6	-1,089.8	28.7
gableboard	2.00	713.1	153.3	-1,653.7	28.7	564.3	121.6	-1,273.9	28.7
corner region (eave)	2.00	713.1	153.3	-1,771.1	28.7	564.3	121.6	-1,366.0	28.7
eaves	2.00	713.1	153.3	-832.0	28.7	564.3	121.6	-629.4	28.7

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	22.4	6.7	47.6	32.6	0.800	---	0.466	0.850
1	ridge	23.1	0.0	82.4	19.9	0.600	---	0.411	0.728
1	gableboard	26.9	8.3	95.8	23.2	0.600	---	0.394	0.627
1	corner region (eave)	12.8	8.9	68.3	4.9	0.400	---	0.400	0.586
1	eaves	24.3	0.0	65.4	36.3	0.800	---	0.452	0.850

Results | Roof 1

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 | Roof 1

Notes

- 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 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'.
- Data and results must be verified with regard to local conditions and checked by a suitably qualified person. Please see our TCU under https://k2-systems.com/en/base-tcu , in particular § 2 (''technical and specialist requirements for the customer''), § 7 (''warranty provisions'') and § 8 (''limitation of liability'').

Structural analysis report | Roof 1

General information

Name	shed 4 DR Collin
Mounting System	K2 BasicRail
Author	Conor Maden

Location information

Address	39 Coldingham Rd, Eyemouth TD14 5AR, UK
Ground elevation	35.92 m

Roof information

Building height	6.00 m
Roof type	Gable roof
Roof pitch	15°
Fastening method	Roof cover
Roof covering	Trapezoidal
Min. roof edge distance	0.00 m
Crest distance	200.0 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)	CC1
Design working life	25 years
Terrain category	Sea

Wind load

Velocity pressure	$q_{p,50}$ = 1.000 kN/m²
Adjustment factor for service life	f_w = 1.000
Velocity pressure	$q_{p,25}$ = 0.921 kN/m²

Structural analysis report | Roof 1

Roof areas

Array	load impact area [m²]	maxCpe_{10}	minCpe_{10}	wind pressure [kN/m²]	wind suction [kN/m²]
field area	10.00	0.200	-0.600	0.184	-0.552
ridge	10.00	0.200	-1.300	0.184	-1.197
gableboard	10.00	0.200	-1.500	0.184	-1.381
corner region (eave)	10.00	0.200	-1.600	0.184	-1.473
eaves	10.00	0.200	-0.800	0.184	-0.737

Snow load

Snow load zone		3
Environment		Normal terrain
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	= 0.966
Snow load on roof	$s_{i,50}$	= 0.386 kN/m²
Adjustment factor for service life	f_s	= 1.000
Snow load on roof	$s_{i,25}$	= 0.359 kN/m²

Dead Load

Weight of module	G_M	= 21.1 kg
Weight of mounting system per module		= 1.5 kg
Module area	A_M	= 2.00 m²
Dead weight of module per m²		= 10.56 kg/m²
Dead weight of mounting system per m²		= 0.75 kg/m²
Total Dead Load (excl. ballast) per m²		= 0.11 kN/m²

Structural analysis report | Roof 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	$\gamma_{G,stb}$ = 0.90
Partial safety factor first variable load	γ_{Q} = 1.50
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	$\kappa_{Fl,G}$ = 0.90
Importance factor variable	$\kappa_{Fl,Q}$ = 0.85
Characteristic dead weight	G_k
Characteristic snow load on the roof	$S_{i,n}$
Characteristic wind load	W_k

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

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	$E_d = G_k + S_{i,n}$
Load case combination 02	$E_d = G_k + W_{k,Pressure}$
Load case combination 03	$E_d = G_k + W_{k,Pressure} + \psi_{0,S} * S_{i,n}$
Load case combination 04	$E_d = G_k + S_{i,n} + \psi_{0,W} * W_{k,Pressure}$
Load case combination 06	$E_d = G_k + W_{k,Uplift}$

Structural analysis report | Roof 1

Maximum load on modules (Mounting system dimensioning)

Array	A-TrA [m²]	ultimate state [kN/m²]				Serviceability [kN/m²]			
		Pressure ⊥	Pressure ∥	Uplift ⊥	Uplift ∥	Pressure ⊥	Pressure ∥	Uplift ⊥	Uplift ∥
field area	10.00	0.713	0.153	-0.597	0.029	0.564	0.122	-0.445	0.029
ridge	10.00	0.713	0.153	-1.419	0.029	0.564	0.122	-1.090	0.029
gableboard	10.00	0.713	0.153	-1.654	0.029	0.564	0.122	-1.274	0.029
corner region (eave)	10.00	0.713	0.153	-1.771	0.029	0.564	0.122	-1.366	0.029
eaves	10.00	0.713	0.153	-0.832	0.029	0.564	0.122	-0.629	0.029

Max. load on fastener

Array	A-TrA [m²]	ultimate state [kN]				Serviceability [kN]			
		Pressure ⊥	Pressure ∥	Uplift ⊥	Uplift ∥	Pressure ⊥	Pressure ∥	Uplift ⊥	Uplift ∥
field area	10.00	0.553	0.119	-0.463	0.022	0.438	0.094	-0.345	0.022
ridge	10.00	0.415	0.089	-0.825	0.017	0.328	0.071	-0.634	0.017
gableboard	10.00	0.415	0.089	-0.962	0.017	0.328	0.071	-0.741	0.017
corner region (eave)	10.00	0.276	0.059	-0.687	0.011	0.219	0.047	-0.530	0.011
eaves	10.00	0.553	0.119	-0.645	0.022	0.438	0.094	-0.488	0.022

Resistance Values of Components

Base Rails

Base Rails	A [cm²]	I_y [cm^4]	I_z [cm^4]	W_y [cm³]	W_z [cm³]
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 | Roof 1

Utilisation result

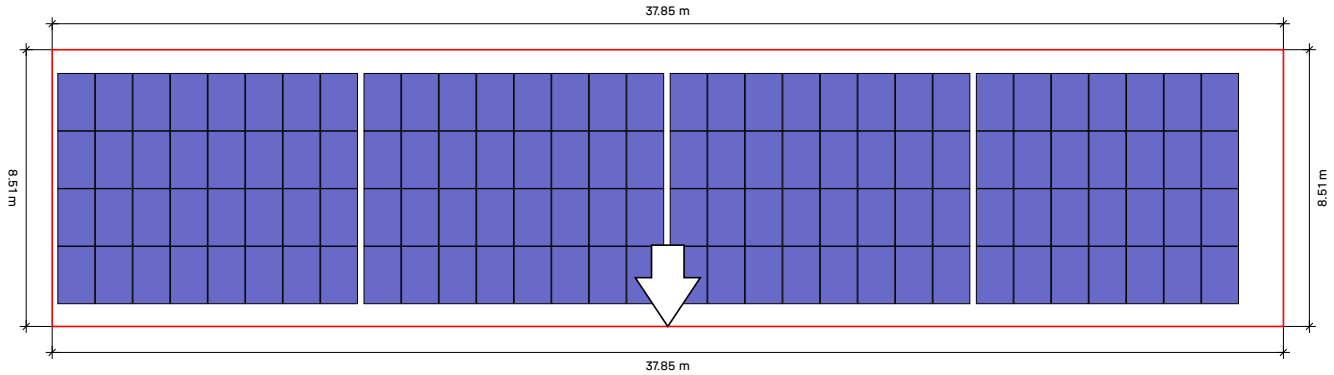
No. Module Array	roof areas	ultimate limit state Pr σ[%]	ultimate limit state CL σ[%]	ultimate limit state Fst F[%]	Usab. Pr f[%]	Distances Fst [m]	Distances BR [m]	maximum values CL L_{max}[m]	maximum values Fst Fst D_{max}[m]
1	field area	22.4	6.7	47.6	32.6	0.800	---	0.466	0.850
1	ridge	23.1	0.0	82.4	19.9	0.600	---	0.411	0.728
1	gableboard	26.9	8.3	95.8	23.2	0.600	---	0.394	0.627
1	corner region (eave)	12.8	8.9	68.3	4.9	0.400	---	0.400	0.586
1	eaves	24.3	0.0	65.4	36.3	0.800	---	0.452	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 | Roof 1 | Bill of material

Position	Item no.	Item description	Quantity	Weight
1	1001164	K2 BasicClip	467	14.0 kg
2	1005193	Thread-forming metal screw 6.0×38	934	6.5 kg
3	2003072	OneMid Black Set 30-42	216	17.1 kg
4	2002589	OneEnd Black Set 30-42	64	5.6 kg
5	2003240	K2 BasicRail 22; 4.40m	68	192.4 kg
6	1003571	K2 BasicRail BasicConnector Set	56	2.7 kg
7	1003558	K2 BasicRail BasicLock 22 Set	32	1.6 kg
Total				**239.9 kg**

Roofs | Roof 2



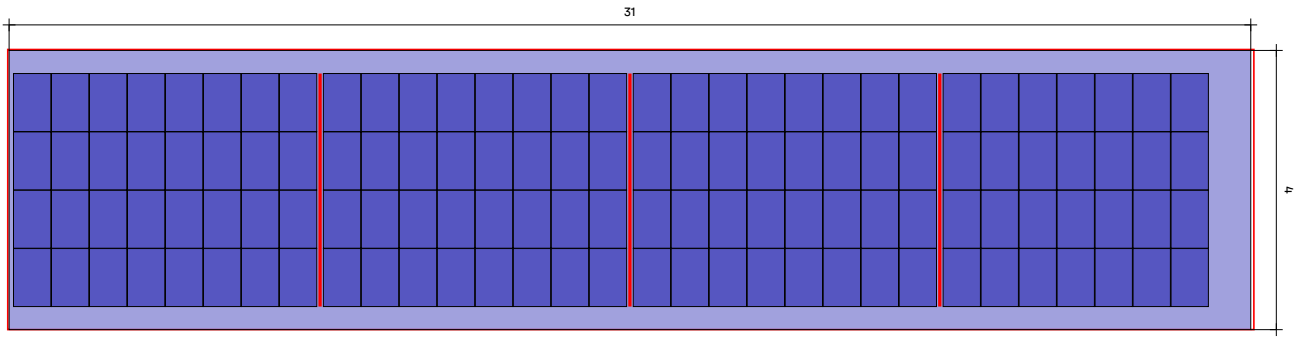
Roof	System	Module	Power	Quantity	Total power
Roof 2	K2 BasicRail	TSM-440NEG9R.28 (Vertex S+)	440 Wp	124	54.56 kWp

Roofs | Roof 2 | Assembly plan

Module arrays

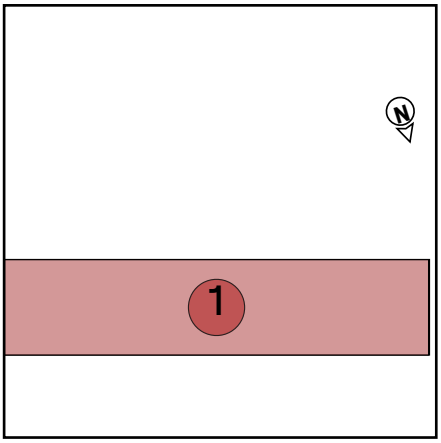
Module array	Width[m]	Length[m]	Width in modules	Length in modules
1	37.45	7.08	31	4

Roofs | Roof 2 | Module array 1

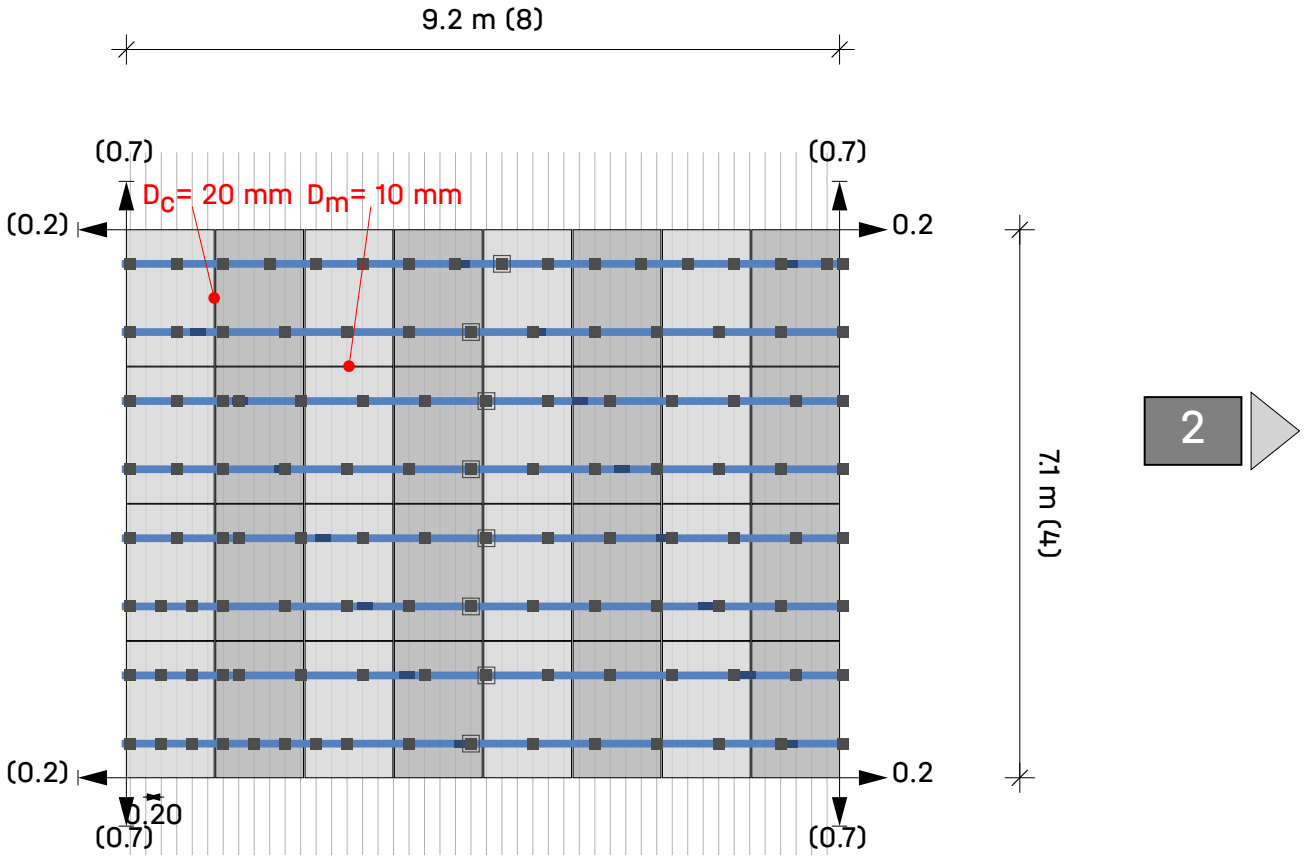


Roof (2) Module array (1)

Mounting System	K2 BasicRail
Module	124(54.56 kWp) x TSM-440NEG9R.28 (Vertex S+)
Row spacing	1.77 m



Roofs | Roof 2 | Module array 1 | Module blocks

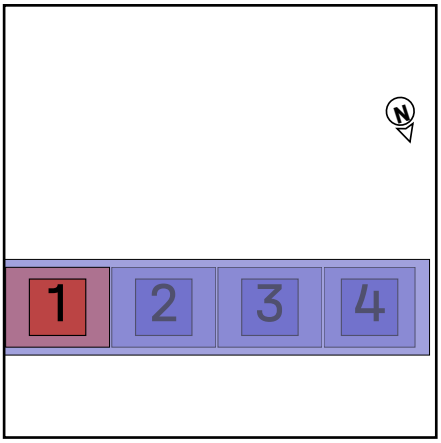


Roof (2) Module array (1) Module block 1

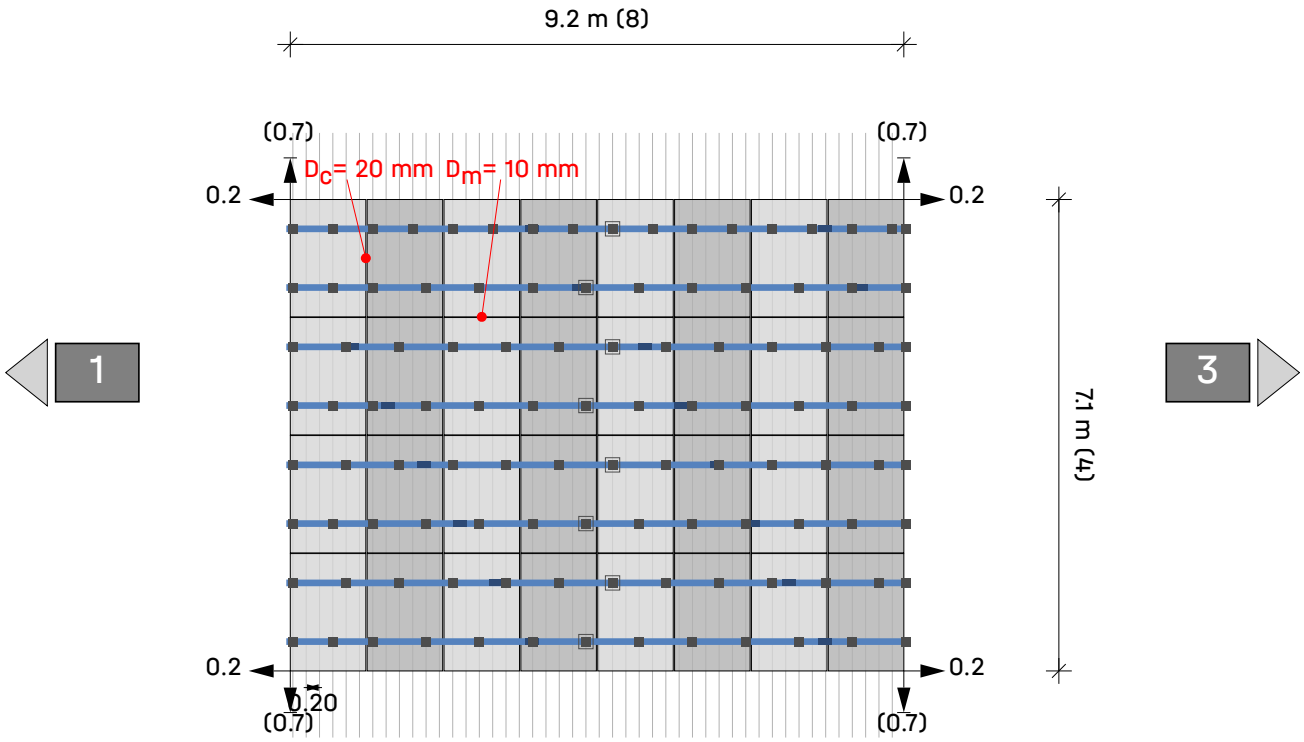
Modules 8 × 4 = **32**

Legend

- Next block indicator
- Fastener
- BasicLocks
- 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 | Roof 2 | Module array 1 | Module blocks

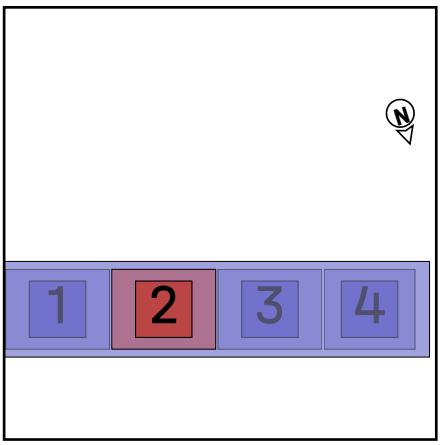


Roof (2) Module array (1) Module block 2

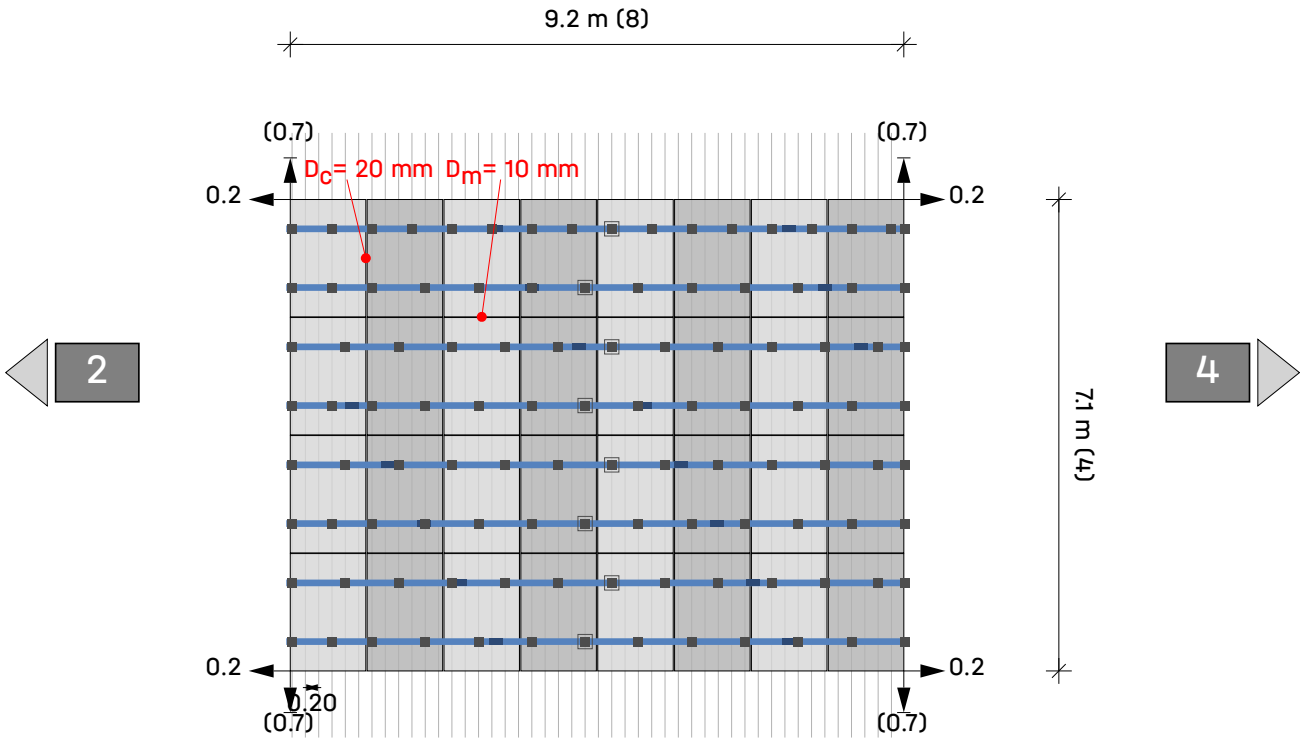
Modules 8 × 4 = **32**

Legend

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



Roofs | Roof 2 | Module array 1 | Module blocks

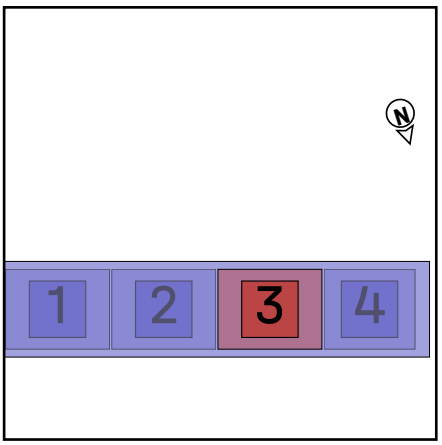


Roof (2) Module array (1) Module block 3

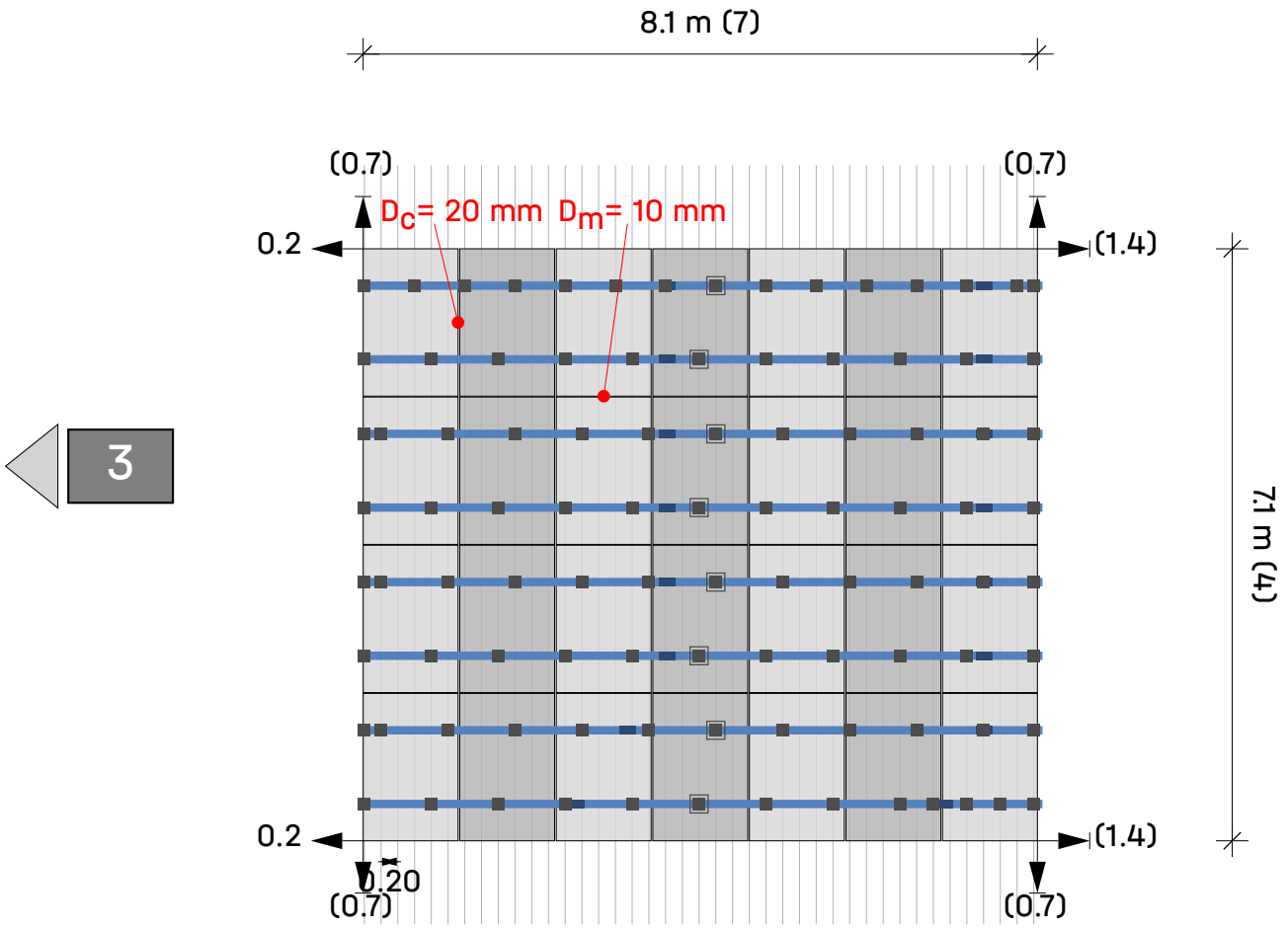
Modules 8 × 4 = **32**

Legend

- Next block indicator
- Fastener
- BasicLocks
- 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 | Roof 2 | Module array 1 | Module blocks

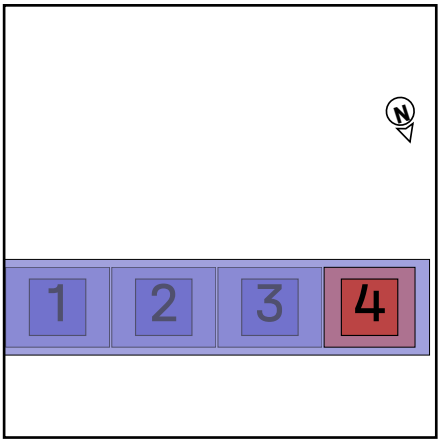


Roof (2) Module array (1) Module block 4

Modules 7 × 4 = **28**

Legend

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



Results | Roof 2

Roof	System	Module	Power	Quantity	Total power
Roof 2 	K2 BasicRail	TSM-440NEG9R.28 (Vertex S+)	440 Wp	124	54.56 kWp

Module

Name	TSM-440NEG9R.28 (Vertex S+)
Manufacturer	Trina Solar Energy
Output power	440 Wp
Dimensions	1,762×1,134×30 mm
Weight	21.1 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	713.1	153.3	-597.2	28.7	564.3	121.6	-445.3	28.7
ridge	2.00	713.1	153.3	-1,418.9	28.7	564.3	121.6	-1,089.8	28.7
gableboard	2.00	713.1	153.3	-1,653.7	28.7	564.3	121.6	-1,273.9	28.7
corner region (eave)	2.00	713.1	153.3	-1,771.1	28.7	564.3	121.6	-1,366.0	28.7
eaves	2.00	713.1	153.3	-832.0	28.7	564.3	121.6	-629.4	28.7

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	22.4	1.9	47.6	32.6	0.800	---	0.466	0.850
1	ridge	23.1	3.4	82.4	19.9	0.600	---	0.411	0.728
1	gableboard	26.9	4.6	95.8	23.2	0.600	---	0.394	0.627
1	corner region (eave)	12.8	4.9	68.3	4.9	0.400	---	0.400	0.586
1	eaves	24.3	1.8	65.4	36.3	0.800	---	0.452	0.850

Results | Roof 2

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 | Roof 2

Notes

- 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 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'.
- Data and results must be verified with regard to local conditions and checked by a suitably qualified person. Please see our TCU under https://k2-systems.com/en/base-tcu , in particular § 2 (''technical and specialist requirements for the customer''), § 7 (''warranty provisions'') and § 8 (''limitation of liability'').

Structural analysis report | Roof 2

General information

Name	shed 4 DR Collin
Mounting System	K2 BasicRail
Author	Conor Maden

Location information

Address	39 Coldingham Rd, Eyemouth TD14 5AR, UK
Ground elevation	35.92 m

Roof information

Building height	6.00 m
Roof type	Gable roof
Roof pitch	15°
Fastening method	Roof cover
Roof covering	Trapezoidal
Min. roof edge distance	0.00 m
Crest distance	200.0 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)	CC1
Design working life	25 years
Terrain category	Sea

Wind load

Velocity pressure	$q_{p,50}$ = 1.000 kN/m²
Adjustment factor for service life	f_w = 0.921
Velocity pressure	$q_{p,25}$ = 0.921 kN/m²

Structural analysis report | Roof 2

Roof areas

Array	load impact area [m²]	maxCpe_{10}	minCpe_{10}	wind pressure [kN/m²]	wind suction [kN/m²]
field area	10.00	0.200	-0.600	0.184	-0.552
ridge	10.00	0.200	-1.300	0.184	-1.197
gableboard	10.00	0.200	-1.500	0.184	-1.381
corner region (eave)	10.00	0.200	-1.600	0.184	-1.473
eaves	10.00	0.200	-0.800	0.184	-0.737

Snow load

Snow load zone		3
Environment		Normal terrain
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	= 0.966
Snow load on roof	$s_{i,50}$	= 0.386 kN/m²
Adjustment factor for service life	f_s	= 0.929
Snow load on roof	$s_{i,25}$	= 0.359 kN/m²

Dead Load

Weight of module	G_M	= 21.1 kg
Weight of mounting system per module		= 1.5 kg
Module area	A_M	= 2.00 m²
Dead weight of module per m²		= 10.56 kg/m²
Dead weight of mounting system per m²		= 0.75 kg/m²
Total Dead Load (excl. ballast) per m²		= 0.11 kN/m²

Structural analysis report | Roof 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	$\gamma_{G,stb}$ = 0.90
Partial safety factor first variable load	γ_{Q} = 1.50
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	$\kappa_{Fl,G}$ = 0.90
Importance factor variable	$\kappa_{Fl,Q}$ = 0.85
Characteristic dead weight	G_k
Characteristic snow load on the roof	$S_{i,n}$
Characteristic wind load	W_k

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

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	$E_d = G_k + S_{i,n}$
Load case combination 02	$E_d = G_k + W_{k,Pressure}$
Load case combination 03	$E_d = G_k + W_{k,Pressure} + \psi_{0,S} * S_{i,n}$
Load case combination 04	$E_d = G_k + S_{i,n} + \psi_{0,W} * W_{k,Pressure}$
Load case combination 06	$E_d = G_k + W_{k,Uplift}$

Structural analysis report | Roof 2

Maximum load on modules (Mounting system dimensioning)

Array	A-TrA [m²]	ultimate state [kN/m²]				Serviceability [kN/m²]			
		Pressure ⊥	Pressure ∥	Uplift ⊥	Uplift ∥	Pressure ⊥	Pressure ∥	Uplift ⊥	Uplift ∥
field area	10.00	0.713	0.153	-0.597	0.029	0.564	0.122	-0.445	0.029
ridge	10.00	0.713	0.153	-1.419	0.029	0.564	0.122	-1.090	0.029
gableboard	10.00	0.713	0.153	-1.654	0.029	0.564	0.122	-1.274	0.029
corner region (eave)	10.00	0.713	0.153	-1.771	0.029	0.564	0.122	-1.366	0.029
eaves	10.00	0.713	0.153	-0.832	0.029	0.564	0.122	-0.629	0.029

Max. load on fastener

Array	A-TrA [m²]	ultimate state [kN]				Serviceability [kN]			
		Pressure ⊥	Pressure ∥	Uplift ⊥	Uplift ∥	Pressure ⊥	Pressure ∥	Uplift ⊥	Uplift ∥
field area	10.00	0.553	0.119	-0.463	0.022	0.438	0.094	-0.345	0.022
ridge	10.00	0.415	0.089	-0.825	0.017	0.328	0.071	-0.634	0.017
gableboard	10.00	0.415	0.089	-0.962	0.017	0.328	0.071	-0.741	0.017
corner region (eave)	10.00	0.276	0.059	-0.687	0.011	0.219	0.047	-0.530	0.011
eaves	10.00	0.553	0.119	-0.645	0.022	0.438	0.094	-0.488	0.022

Resistance Values of Components

Base Rails

Base Rails	A [cm²]	I_y [cm^4]	I_z [cm^4]	W_y [cm³]	W_z [cm³]
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 | Roof 2

Utilisation result

No. Module Array	roof areas	ultimate limit state Pr σ[%]	ultimate limit state CL σ[%]	ultimate limit state Fst F[%]	Usab. Pr f[%]	Distances Fst [m]	Distances BR [m]	maximum values CL L_{max}[m]	maximum values Fst D_{max}[m]
1	field area	22.4	1.9	47.6	32.6	0.800	---	0.466	0.850
1	ridge	23.1	3.4	82.4	19.9	0.600	---	0.411	0.728
1	gableboard	26.9	4.6	95.8	23.2	0.600	---	0.394	0.627
1	corner region (eave)	12.8	4.9	68.3	4.9	0.400	---	0.400	0.586
1	eaves	24.3	1.8	65.4	36.3	0.800	---	0.452	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**

Roofs | Roof 2 | Bill of material

Position	Item no.	Item description	Quantity	Weight
1	1001164	K2 BasicClip	493	14.8 kg
2	1005193	Thread-forming metal screw 6.0×38	986	6.9 kg
3	2003072	OneMid Black Set 30-42	216	17.1 kg
4	2002589	OneEnd Black Set 30-42	64	5.6 kg
5	2003240	K2 BasicRail 22; 4.40m	68	192.4 kg
6	1003571	K2 BasicRail BasicConnector Set	64	3.1 kg
7	1003558	K2 BasicRail BasicLock 22 Set	32	1.6 kg
Total				**241.4 kg**

Bill of material

Position	Item no.	Item description	Quantity	Weight
1	1001164	K2 BasicClip	960	28.8 kg
2	1005193	Thread-forming metal screw 6.0×38	1,920	13.4 kg
3	2003072	OneMid Black Set 30-42	432	34.1 kg
4	2002589	OneEnd Black Set 30-42	128	11.1 kg
5	2003240	K2 BasicRail 22; 4.40m	136	384.7 kg
6	1003571	K2 BasicRail BasicConnector Set	120	5.9 kg
7	1003558	K2 BasicRail BasicLock 22 Set	64	3.2 kg
Total				**481.3 kg**

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:

k2-systems.com/en/contact

Service Hotline: +44 1189 701280

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

K2 Solar Mounting Solutions Ltd
Unit 46 Easter Park
Benyon Road
Aldermaston, RG7 2PQ
Great Britain
+44 1189 701280
info@k2-systems.uk.com
k2-systems.com/en