

Mounting systems for solar technology



K2 SYSTEMS GMBH
CALCULATION BASIS

PROJECT:	Dale Halls
AUTHOR:	Hugo Silva
DATE:	19/07/2022

PROJECT DATA (ROOF 1)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	SolidRail
Customer	CorEnergy
Author	Hugo Silva

REMARKS

Best assumptions made for any missing information

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
Ground elevation	37.00 m
Roof type	Gable roof
Fastening method	Roof construction
Roof covering	Tile
Building height	10.80 m
Roof pitch	30 °
Min. roof edge distance	0.00 m
Rafter Spacing	0.400 m
Batten spacing	340.0 mm
Terrain category	Town Terrain

LOADS

Design method	BS EN	
Failure consequence class (CC)	CC1	Design working life 25 years

Terrain category	Town Terrain
distance to shoreline	46.48 km
distance inside town terrain	10.50 km
Peak velocity pressure	$q_{p,25} = 0.597 \text{ kN/m}^2$

Snow load zone	3
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$

MODULES

Manufacturer	Longi Solar	Quantity	66
Name	LR4-60HPH-375M	Total output power	24.750 kWp

Dimensions LxWxH	1755 x 1038 x 35.00 mm
Weight	19.5 kg
Output power	375 W



ASSEMBLY PLAN (ROOF 1)

Type	Whole Rails			Rail cutting		
	Total Rail Length / m	Quantity 4.40 m	Quantity 3.30 m	Part of Rail / m	Length / m	Rest / m
A	16.883	3		4.400	3.683	0.707
B	8.475	1		4.400	4.075	0.315
C	4.271			4.400	4.271	0.119
D	10.577	2		3.300	1.777	1.513

LEGEND

1.57



Distance to Roof Edge [m]

Fastener

Base rails

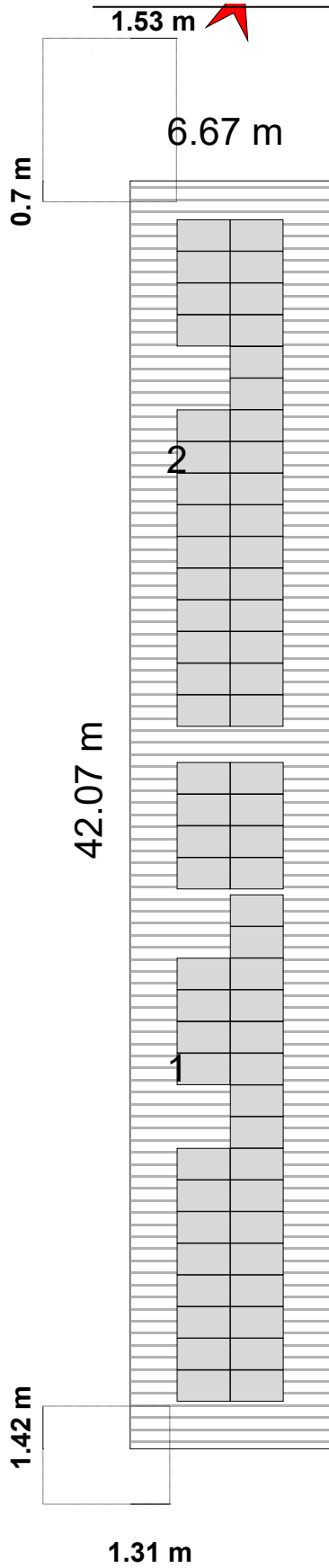
FASTENER SPACING

Module	Array	Distance
1	field area	0.80 m
1	ridge	0.80 m
1	corner region (eave)	0.40 m
1	eaves	0.40 m
2	field area	0.80 m
2	ridge	0.80 m
2	corner region (eave)	0.40 m
2	eaves	0.40 m

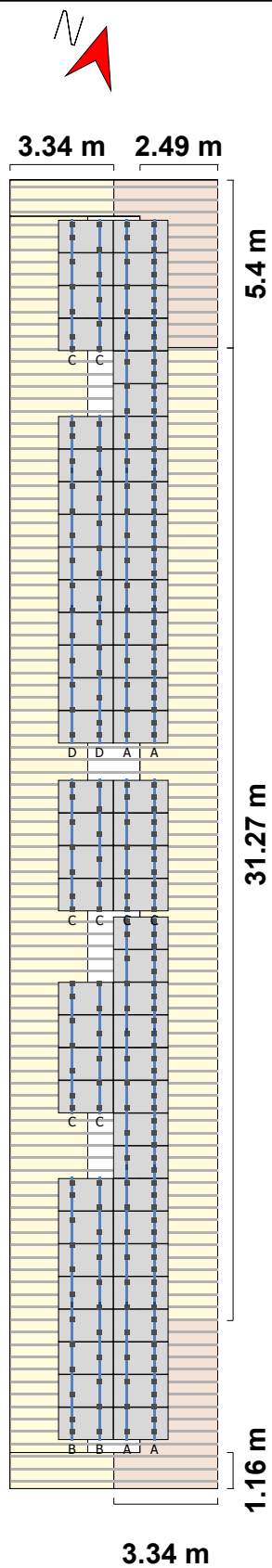
MODULE ARRAYS

Module array	Width [m]	Length [m]	Width in modules	Length in modules
1	21.19	3.52	20	2
2	16.80	3.52	16	2

ASSEMBLY PLAN - OVERVIEW (ROOF 1)



ASSEMBLY PLAN - BASE RAIL LAYER (ROOF 1)





RESULTS (ROOF 1)

COMPONENTS

Fastener	SolidHook Flat Tile H33/119 75x4
Base Rails	K2 SolidRail UltraLight 32

LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [Pa]				Serviceability [Pa]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
field area	1.82	840.3	379.7	-731.5	59.2	663.9	300.6	-551.6	59.2
ridge	1.82	840.3	379.7	-731.5	59.2	663.9	300.6	-551.6	59.2
corner region (eave)	1.82	977.3	379.7	-959.8	59.2	771.3	300.6	-730.7	59.2
eaves	1.82	977.3	379.7	-840.8	59.2	771.3	300.6	-637.4	59.2

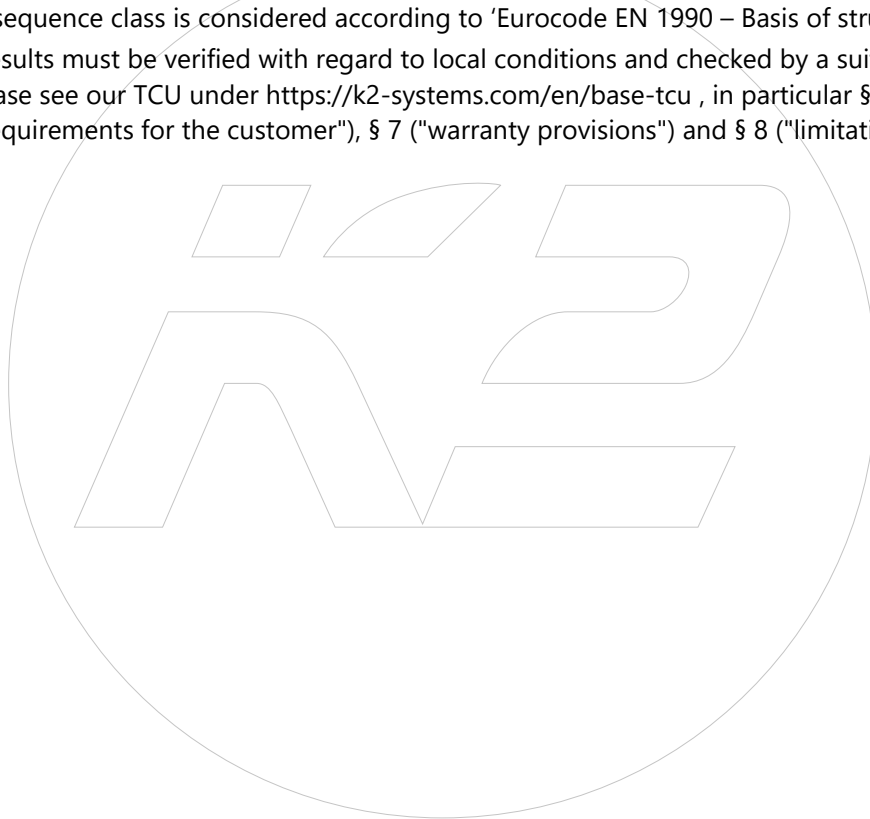
UTILISATION RESULT

No. Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		maximum values	
		Pr σ [%]	Cl σ [%]	Fst F [%]		Fst [m]	BR [m]	Cl Lmax[m]	Fst Dmax[m]
1	field area	20.7	14.7	88.9	11.4	0.800	---	0.513	0.900
1	ridge	20.7	14.7	88.9	11.4	0.800	---	0.513	0.900
1	corner region (eave)	5.8	16.6	51.7	1.7	0.400	---	0.400	0.774
1	eaves	5.8	6.0	51.7	1.7	0.400	---	0.400	0.774
2	field area	20.7	14.7	88.9	11.4	0.800	---	0.513	0.900
2	ridge	20.7	14.7	88.9	11.4	0.800	---	0.513	0.900
2	corner region (eave)	5.8	6.0	51.7	1.7	0.400	---	0.400	0.774
2	eaves	5.8	16.6	51.7	1.7	0.400	---	0.400	0.774

Pr	Profile
Fst	Fastener
σ	Tension
f	Deflection
F	Force
CL/Lmax [m]	maximum cantilever length
Fst Dmax [m]	maximum fastener spacing
BR	Base Rail
UR	Upper rail
Usab.	serviceability limit state
Cl	Cantilever

NOTES

- The dimensioning of the timber construction screws is not part of this structural analysis. The dimensioning and positioning of the timber construction screws to be used must be carried out in accordance with the respective applicable codes of practice.
- The structural design complies with BS EN 1990 - Basics 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	Dale Halls
Mounting System	SolidRail
Customer	CorEnergy
Author	Hugo Silva

LOCATION

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Min. roof edge distance	0.00 m
Rafter Spacing	0.400 m
Batten spacing	340.0 mm
Terrain category	Town Terrain

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years

WIND LOAD

Terrain category	Town Terrain
distance to shoreline	46.48 km
distance inside town terrain	10.50 km
Peak velocity pressure	$q_{p,50} = 0.648 \text{ kN/m}^2$
Adjustment factor for service life	$f_w = 0.921$
Peak velocity pressure	$q_{p,25} = 0.597 \text{ kN/m}^2$

ROOF AREAS

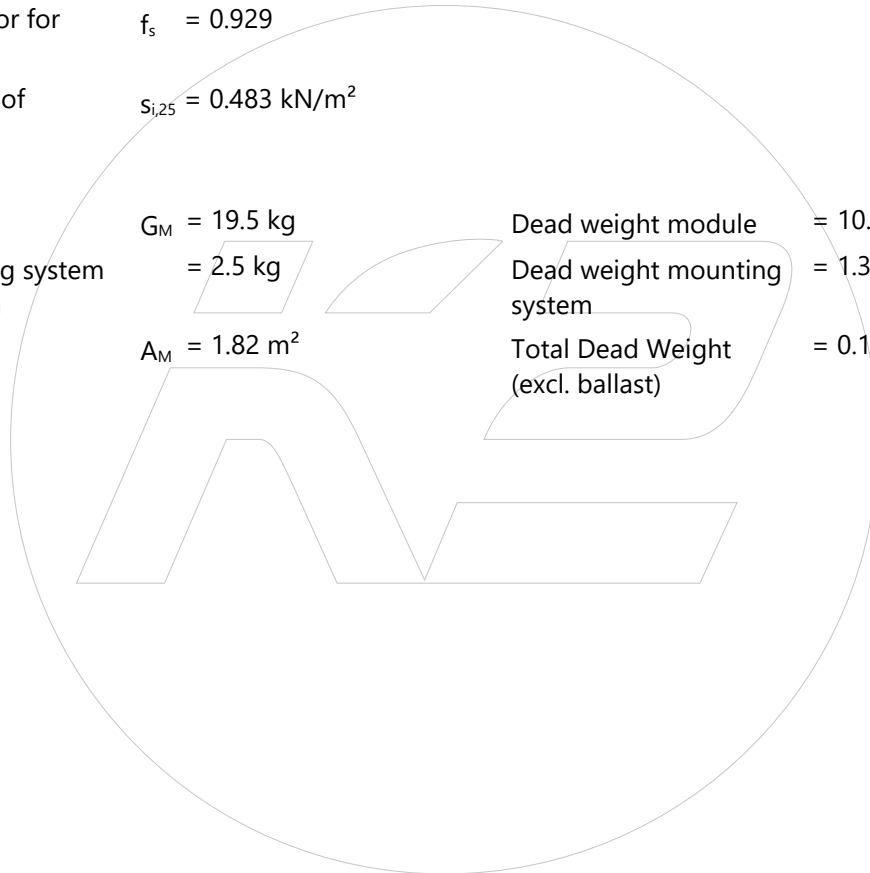
Array	load impact area [m ²]	maxCpe	minCpe	wind pressure [kN/m ²]	wind suction [kN/m ²]
field area	10.00	0.400	-0.800	0.239	-0.478
ridge	10.00	0.400	-0.800	0.239	-0.478
corner region (eave)	10.00	0.700	-1.100	0.418	-0.657
eaves	10.00	0.700	-0.800	0.418	-0.478

SNOW LOAD

Snow load zone	3
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$
Snow guard	No
Shape Coefficient for Snow	$\mu_i = 1.200$
Factor for roof pitch	$d_i = 0.866$
Snow load on roof	$s_{i,50} = 0.520 \text{ kN/m}^2$
Adjustment factor for service life	$f_s = 0.929$
Snow load on roof	$s_{i,25} = 0.483 \text{ kN/m}^2$

DEAD LOAD

Weight module	$G_M = 19.5 \text{ kg}$	Dead weight module	$= 10.70 \text{ kg/m}^2$
Weight mounting system per module area	$= 2.5 \text{ kg}$	Dead weight mounting system	$= 1.37 \text{ kg/m}^2$
Module area	$A_M = 1.82 \text{ m}^2$	Total Dead Weight (excl. ballast)	$= 0.12 \text{ kN/m}^2$



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 variable	$\kappa_{FI,Q}$	0.85
Characteristic dead weight	G_k	
Characteristic snow load on the roof	$S_{i,n}$	
Characteristic wind load	W_k	
Load case combination 00:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$	
Load case combination 02:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$	
Load case combination 03:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$	
Load case combination 04:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$	
Load case combination 05:		
Load case combination 06:	$E_d = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$	

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 00:		
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:	$E_d = G_k + W_{k,Suction}$	

MAXIMUM LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [kN/m ²]				Serviceability [kN/m ²]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
field area	10.00	0.840	0.380	-0.506	0.059	0.664	0.301	-0.375	0.059
ridge	10.00	0.840	0.380	-0.506	0.059	0.664	0.301	-0.375	0.059
corner region (eave)	10.00	0.977	0.380	-0.735	0.059	0.771	0.301	-0.554	0.059
eaves	10.00	0.977	0.380	-0.506	0.059	0.771	0.301	-0.375	0.059

MAX. LOAD ON FASTENER

Array	A-TrA [m ²]	ultimate state [kN]				Serviceability [kN]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
field area	10.00	0.649	0.293	-0.391	0.046	0.513	0.232	-0.290	0.046
ridge	10.00	0.649	0.293	-0.391	0.046	0.513	0.232	-0.290	0.046
corner region (eave)	10.00	0.377	0.147	-0.284	0.023	0.298	0.116	-0.214	0.023
eaves	10.00	0.377	0.147	-0.195	0.023	0.298	0.116	-0.145	0.023

RESISTANCE VALUES OF COMPONENTS

BASE RAILS

No. Module Array	Base Rails	A [cm ²]	I _y [cm ⁴]	I _z [cm ⁴]	W _y [cm ³]	W _z [cm ³]
1 - 2	K2 SolidRail UltraLight 32	2.610	2.59	5.54	1.57	2.84

FASTENER

No. Module Array	Fastener	R _{D,Suction, Perpendicular} [kN]	R _{D,Pressure, Perpendicular} [kN]	R _{D,Pressure, Parallel} [kN]
1 - 2	SolidHook Flat Tile H33/119 75x4	0.81	0.73	2.00

UTILISATION RESULT

Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		Cl Lmax[m]	Fst Fst Dmax[m]
		Pr σ [%]	Cl σ [%]	Fst F [%]		Fst [m]	BR [m]		
1	field area	20.7	14.7	88.9	11.4	0.800	---	0.513	0.900
1	ridge	20.7	14.7	88.9	11.4	0.800	---	0.513	0.900
1	corner region (eave)	5.8	16.6	51.7	1.7	0.400	---	0.400	0.774
1	eaves	5.8	6.0	51.7	1.7	0.400	---	0.400	0.774
2	field area	20.7	14.7	88.9	11.4	0.800	---	0.513	0.900
2	ridge	20.7	14.7	88.9	11.4	0.800	---	0.513	0.900
2	corner region (eave)	5.8	6.0	51.7	1.7	0.400	---	0.400	0.774
2	eaves	5.8	16.6	51.7	1.7	0.400	---	0.400	0.774

Pr	Profile
Fst	Fastener
σ	Tension
f	Deflection
F	Force
CL/Lmax [m]	maximum cantilever length
Fst Dmax [m]	maximum fastener spacing
BR	Base Rail
UR	Upper rail
Usab.	serviceability limit state

CI

Cantilever

THE SYSTEM HAS BEEN SUCCESSFULLY CALCULATED.



BILL OF MATERIALS (ROOF 1)

Position	Item no.	Item description	Quantity	Weight
1	2003073	SolidHook Flat Tile H33/119 75x4	236	235.3 kg
2	1000041	T-Bolt 28/15 M10x30	236	6.8 kg
3	1000042	Hexagon flange nut M10	236	2.6 kg
4	2004112	Heco-Topix Plus wood screw 8x100	472	12.7 kg
5	1005158	MiddleClamp XS Black Set 34-38	116	8.1 kg
6	1005268	EndClamp Black Set 34-36	32	2.4 kg
7	2002870	K2 Solar Cable Manager	66	0.2 kg
8	2003229	SolidRail UltraLight; 4.40 m	32	98.6 kg
9	2003228	SolidRail UltraLight; 3.30 m	2	4.6 kg
10	1004107	SolidRail UltraLight+Light RailConnector Set	18	4.1 kg
Total				375.3 kg



PROJECT DATA (ROOF 2)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	SolidRail
Customer	CorEnergy
Author	Hugo Silva

REMARKS

Best assumptions made for any missing information

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
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Batten spacing	340.0 mm
Terrain category	Town Terrain

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Failure consequence class (CC)	CC1	Design working life	25 years
Terrain category	Town Terrain		
distance to shoreline	46.48 km		
distance inside town terrain	10.50 km		
Peak velocity pressure	$q_{p,25} = 0.597 \text{ kN/m}^2$		
Snow load zone	3		
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$		

MODULES

Manufacturer	Longi Solar	Quantity	50
Name	LR4-60HPH-375M	Total output power	18.750 kWp

Dimensions LxWxH	1755 x 1038 x 35.00 mm
Weight	19.5 kg
Output power	375 W



ASSEMBLY PLAN (ROOF 2)

Type	Whole Rails		Rail cutting		
	Total Rail Length / m	Quantity 4.40 m	Part of Rail / m	Length / m	Rest / m
A	4.271		4.400	4.271	0.119
B	8.475	1	4.400	4.075	0.315
C	2.169		4.400	2.169	2.221
D	2.169		2.221	2.169	0.042
E	14.781	3	4.400	1.581	2.809
F	14.781	3	2.809	1.581	1.218
G	1.118		1.218	1.118	0.090
H	1.118		4.400	1.118	3.272
I	1.118		3.272	1.118	2.144

LEGEND

1.76



Distance to Roof Edge [m]

Fastener

Rail connector base rail

Base rails

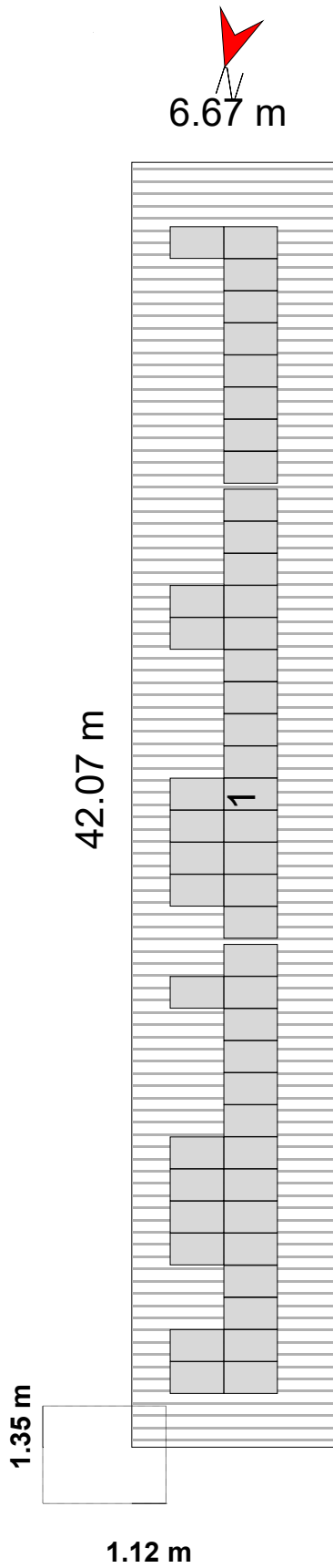
FASTENER SPACING

Module	Array	Distance
1	field area	0.80 m
1	ridge	0.80 m
1	corner region (eave)	0.40 m
1	eaves	0.40 m

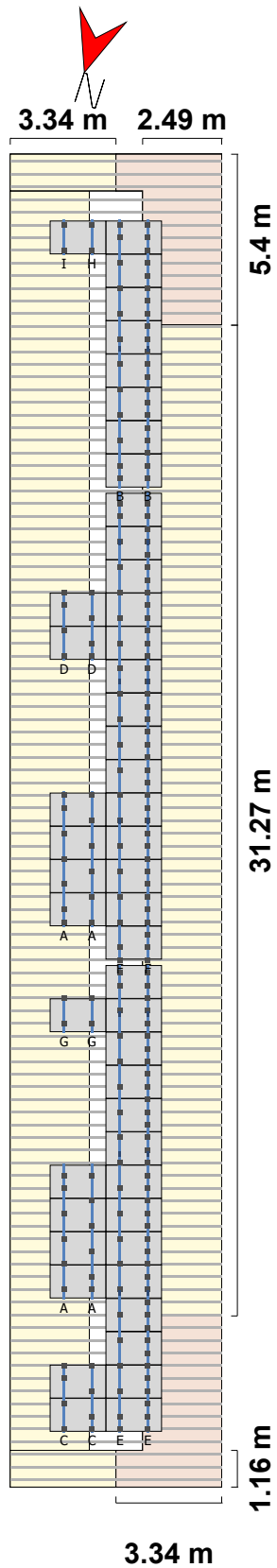
MODULE ARRAYS

Module array	Width [m]	Length [m]	Width in modules	Length in modules
1	38.20	3.52	36	2

ASSEMBLY PLAN - OVERVIEW (ROOF 2)



ASSEMBLY PLAN - BASE RAIL LAYER (ROOF 2)





RESULTS (ROOF 2)

COMPONENTS

Fastener	SolidHook Flat Tile H33/119 75x4
Base Rails	K2 SolidRail UltraLight 32

LOADS ON MODULES

Array	A-TrA [m²]	ultimate state [Pa]				Serviceability [Pa]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
field area	1.82	840.3	379.7	-731.5	59.2	663.9	300.6	-551.6	59.2
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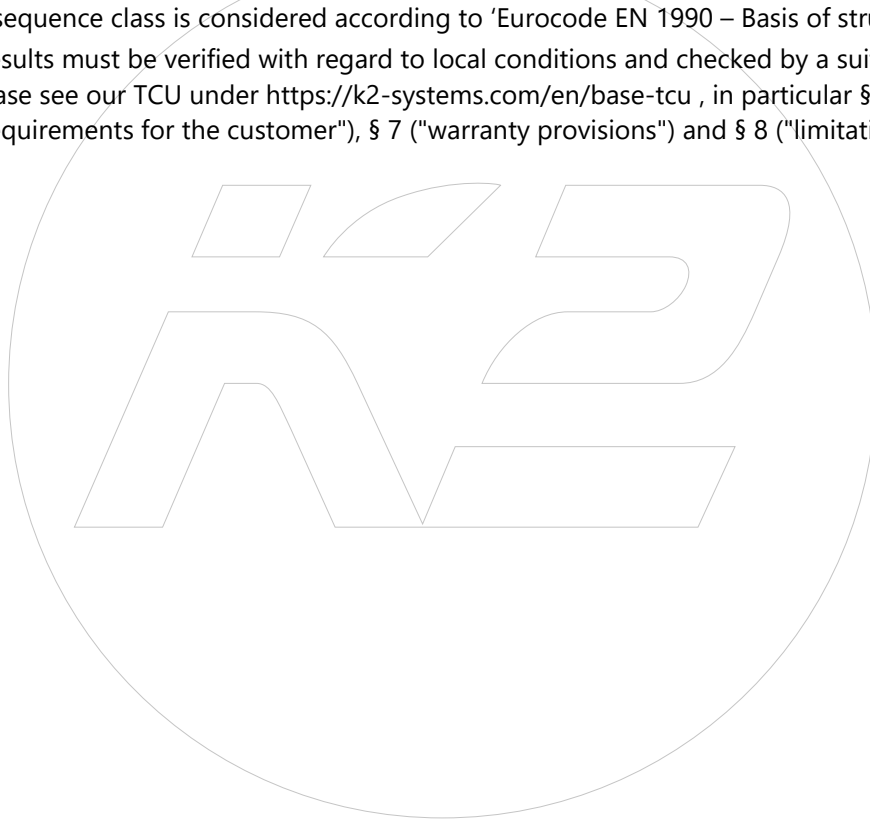
UTILISATION RESULT

No. Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		maximum values	
		Pr σ [%]	Cl σ [%]	Fst F [%]		Fst [m]	BR [m]	Cl Lmax[m]	Fst Dmax[m]
1	field area	20.7	22.2	88.9	11.4	0.800	---	0.513	0.900
1	ridge	20.7	21.3	88.9	11.4	0.800	---	0.513	0.900
1	corner region (eave)	5.8	5.0	51.7	1.7	0.400	---	0.400	0.774
1	eaves	5.8	25.1	51.7	1.7	0.400	---	0.400	0.774

Pr	Profile
Fst	Fastener
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F	Force
CL/Lmax [m]	maximum cantilever length
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 Author Hugo Silva

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 Batten spacing 340.0 mm
 Terrain category Town Terrain

LOADS

Design method BS EN
 Failure consequence class CC1
 Design working life 25 years
 (CC)

WIND LOAD

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 distance to shoreline 46.48 km
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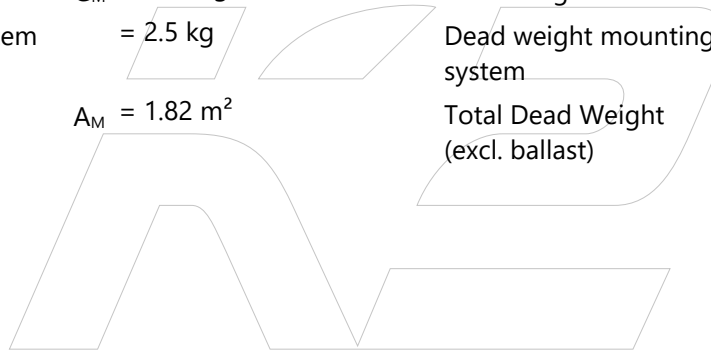
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SNOW LOAD

Snow load zone	3
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$
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Shape Coefficient for Snow	$\mu_i = 1.200$
Factor for roof pitch	$d_i = 0.866$
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Snow load on roof	$s_{i,25} = 0.483 \text{ kN/m}^2$

DEAD LOAD

Weight module	$G_M = 19.5 \text{ kg}$	Dead weight module	$= 10.70 \text{ kg/m}^2$
Weight mounting system per module area	$= 2.5 \text{ kg}$	Dead weight mounting system	$= 1.37 \text{ kg/m}^2$
Module area	$A_M = 1.82 \text{ m}^2$	Total Dead Weight (excl. ballast)	$= 0.12 \text{ kN/m}^2$



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 variable	$\kappa_{FI,Q}$	0.85
Characteristic dead weight	G_k	
Characteristic snow load on the roof	$S_{i,n}$	
Characteristic wind load	W_k	
Load case combination 00:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$	
Load case combination 02:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$	
Load case combination 03:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$	
Load case combination 04:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$	
Load case combination 05:		
Load case combination 06:	$E_d = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$	

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 00:		
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:	$E_d = G_k + W_{k,Suction}$	

MAXIMUM LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [kN/m ²]				Serviceability [kN/m ²]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
field area	10.00	0.840	0.380	-0.506	0.059	0.664	0.301	-0.375	0.059
ridge	10.00	0.840	0.380	-0.506	0.059	0.664	0.301	-0.375	0.059
corner region (eave)	10.00	0.977	0.380	-0.735	0.059	0.771	0.301	-0.554	0.059
eaves	10.00	0.977	0.380	-0.506	0.059	0.771	0.301	-0.375	0.059

MAX. LOAD ON FASTENER

Array	A-TrA [m ²]	ultimate state [kN]				Serviceability [kN]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
field area	10.00	0.649	0.293	-0.391	0.046	0.513	0.232	-0.290	0.046
ridge	10.00	0.649	0.293	-0.391	0.046	0.513	0.232	-0.290	0.046
corner region (eave)	10.00	0.377	0.147	-0.284	0.023	0.298	0.116	-0.214	0.023
eaves	10.00	0.377	0.147	-0.195	0.023	0.298	0.116	-0.145	0.023

RESISTANCE VALUES OF COMPONENTS

BASE RAILS

No. Module Array	Base Rails	A [cm ²]	I _y [cm ⁴]	I _z [cm ⁴]	W _y [cm ³]	W _z [cm ³]
1	K2 SolidRail UltraLight 32	2.610	2.59	5.54	1.57	2.84

FASTENER

No. Module Array	Fastener	R _{D,Suction,Perpendicular} [kN]	R _{D,Pressure,Perpendicular} [kN]	R _{D,Pressure,Parallel} [kN]
1	SolidHook Flat Tile H33/119 75x4	0.81	0.73	2.00

UTILISATION RESULT

Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		CL Lmax[m]	Fst Fst Dmax[m]
		Pr σ [%]	CL σ [%]	Fst F [%]		Fst [m]	BR [m]		
1	field area	20.7	22.2	88.9	11.4	0.800	---	0.513	0.900
1	ridge	20.7	21.3	88.9	11.4	0.800	---	0.513	0.900
1	corner region (eave)	5.8	5.0	51.7	1.7	0.400	---	0.400	0.774
1	eaves	5.8	25.1	51.7	1.7	0.400	---	0.400	0.774

Pr	Profile
Fst	Fastener
σ	Tension
f	Deflection
F	Force
CL/Lmax [m]	maximum cantilever length
Fst Dmax [m]	maximum fastener spacing
BR	Base Rail
UR	Upper rail
Usab.	serviceability limit state
CL	Cantilever

THE SYSTEM HAS BEEN SUCCESSFULLY CALCULATED.



BILL OF MATERIALS (ROOF 2)

Position	Item no.	Item description	Quantity	Weight
1	2003073	SolidHook Flat Tile H33/119 75x4	196	195.4 kg
2	1000041	T-Bolt 28/15 M10x30	196	5.7 kg
3	1000042	Hexagon flange nut M10	196	2.2 kg
4	2004112	Heco-Topix Plus wood screw 8x100	392	10.6 kg
5	1005158	MiddleClamp XS Black Set 34-38	82	5.7 kg
6	1005268	EndClamp Black Set 34-36	36	2.7 kg
7	2002870	K2 Solar Cable Manager	50	0.1 kg
8	2003229	SolidRail UltraLight; 4.40 m	25	77.1 kg
9	1004107	SolidRail UltraLight+Light RailConnector Set	14	3.2 kg
Total				302.6 kg



PROJECT DATA (ROOF 3)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	S-Dome 6.10 Classic
Customer	CorEnergy
Author	Hugo Silva

REMARKS

Best assumptions made for any missing information

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
Ground elevation	37.00 m
Roof type	Flat roof
Fastening method	with Ballast
Roof covering	Flat
Building height	10.80 m
Parapet wall height	0.10 m
Roof pitch	1 °
Min. roof edge distance	0.60 m
Material	Single ply membrane
Friction coefficient	0.50
Terrain category	Town Terrain

The friction coefficients given here must be checked onsite. If a lower value is found, this must be specified here for the ballast calculation!

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years
Terrain category	Town Terrain		
distance to shoreline	46.48 km		
distance inside town terrain	10.50 km		
Peak velocity pressure	$q_{p,25} = 0.597 \text{ kN/m}^2$		
Snow load zone	3		
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$		

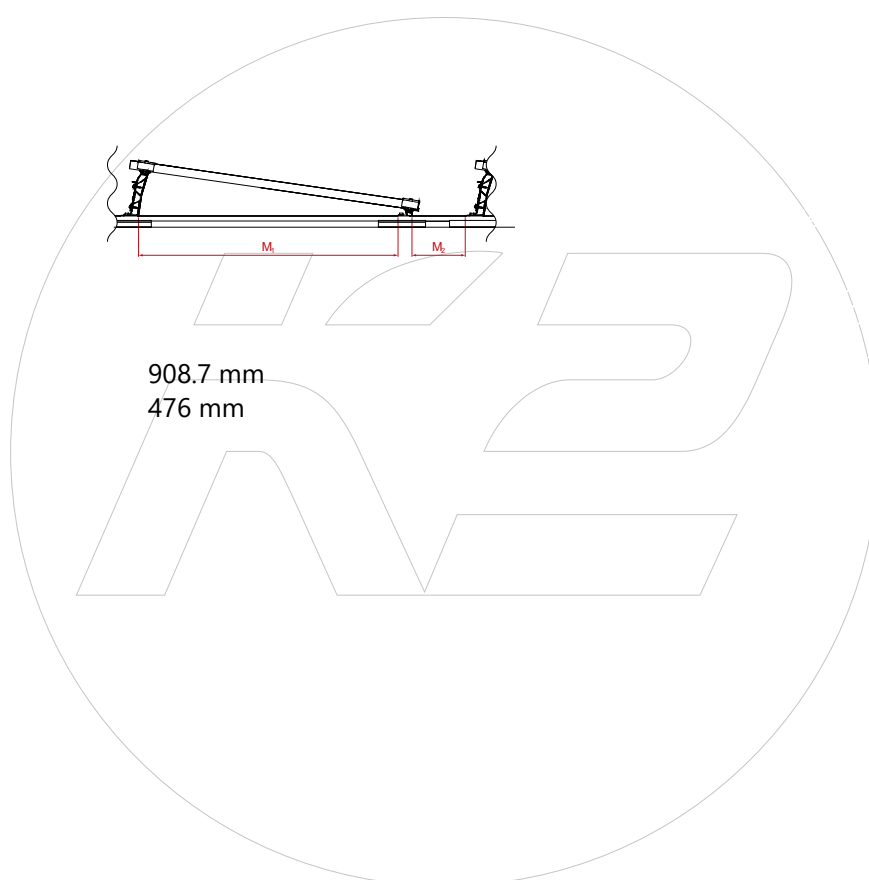
MODULES

Manufacturer	Longi Solar	Quantity	5
Name	LR4-60HPH-375M	Total output power	1.875 kWp
Dimensions LxWxH	1755 x 1038 x 35.00 mm	Panel Tilt	9.5 °
Weight	19.5 kg		
Output power	375 W		

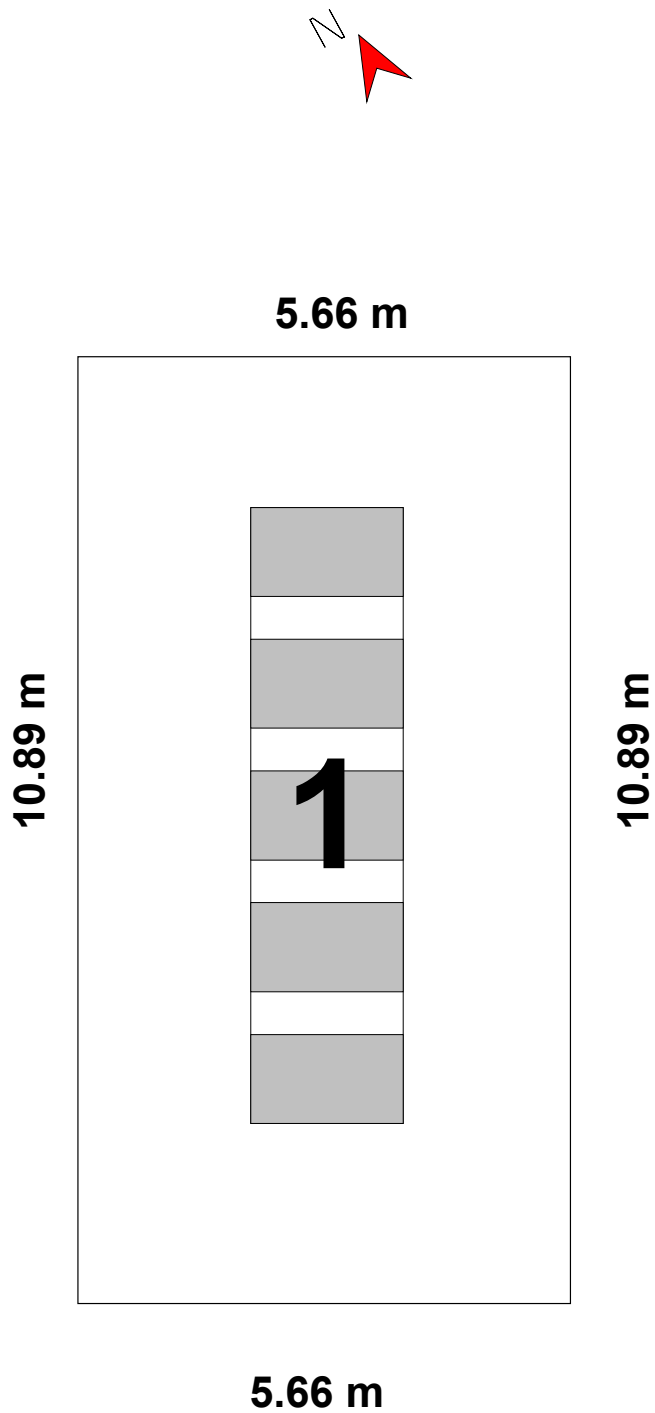
PRE-ASSEMBLY / ASSEMBLY INSTRUCTIONS (ROOF 3)

Module Array 1

M1
M2



ASSEMBLY PLAN (ROOF 3)



Dimensions in [m]

Whole Rails				Rail cutting		
Type	Total Rail / m	Quantity 4.40 m	Quantity 3.30 m	Part of / m	Length / m	Rest / m
A	7.560	1		3.300	3.160	0.130



LEGEND

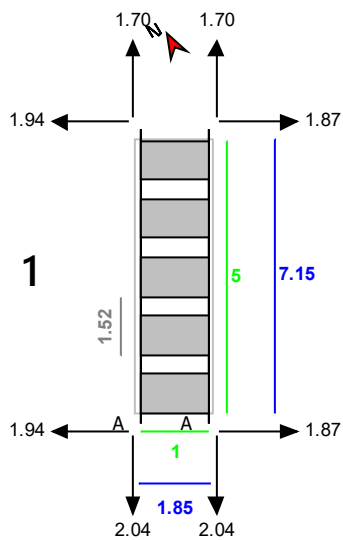
Distance to neighbouring module array [m]

Distance to roof edge [m]

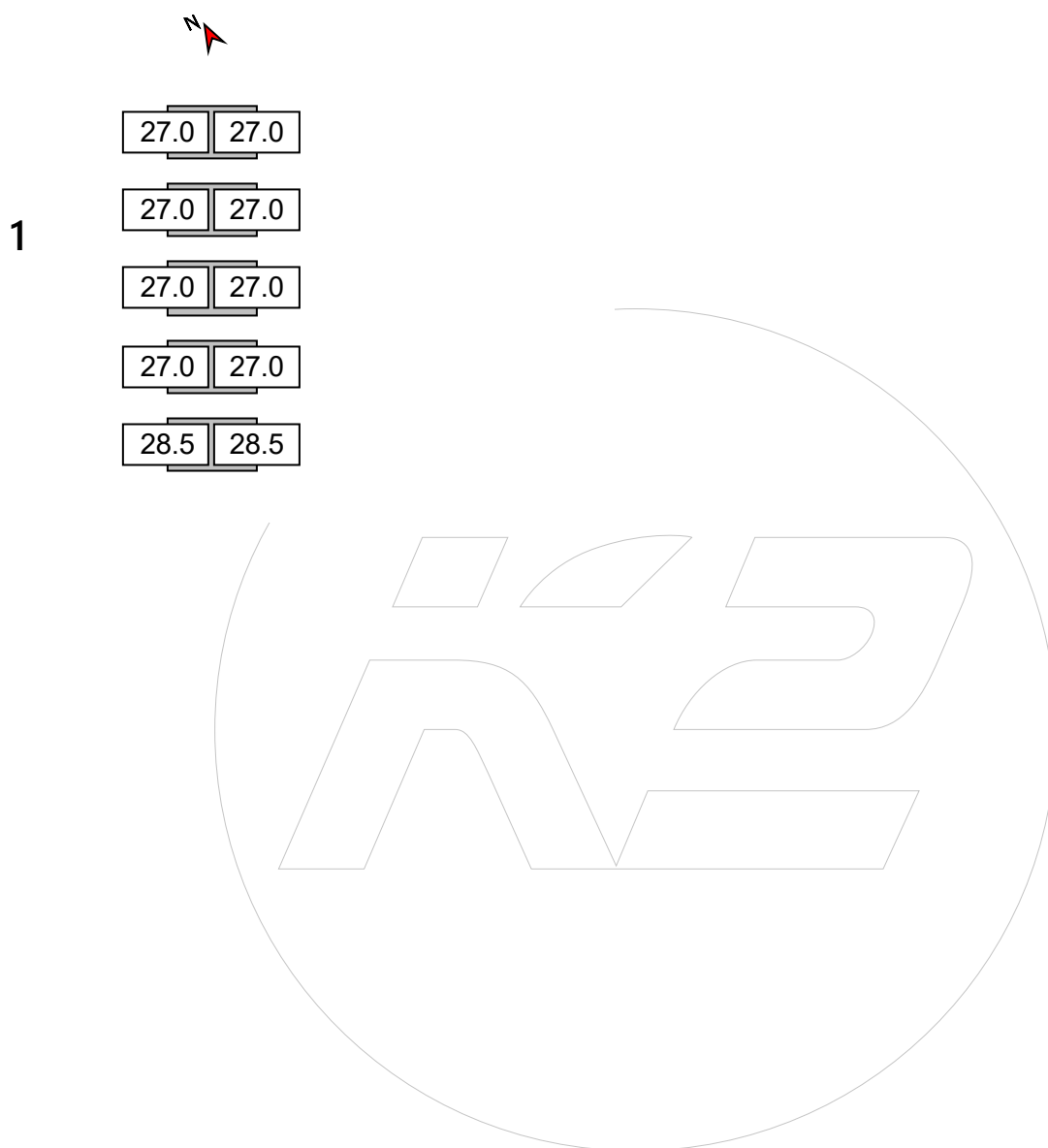
Number of modules

Length/width of module array [m]

Row distance [m]



BALLAST PLAN (ROOF 3)



RESULTS (ROOF 3)

BALLAST CAPACITY

Speed Porter	40.0 kg
Porter	108.0 kg
module clamp	MiniClamp MC Set 30-50
end clamp	MiniClamp EC Set 30-50

VERIFICATION SYSTEM UTILISATION

Verification system utilisation [%]	pressure	22.27
	suction	32.40
Loads on modules (ultimate state) [Pa]	pressure	1321
	suction	-842
Loads on modules (Serviceability) [Pa]	pressure	989
	suction	-589

SPECIFIC LOADS

Index (module block)	No. of modules (module block)	---	---	Ballast [kg] (module block)	Dead weight [kg] (module block)	Dead Load [kN/m ²] (module block)	Dead Load [kN/m ²] (roof surface area)	Own weight [kN/m ²]
module array 1	5	---	---	273.0	391.0	0.29	---	---
all Blocks	5	---	---	273.0	391.0	---	0.06	---

NOTES

- The proof of position safety and load capacity of the system are carried out by checking the load cases lifting and shifting by wind and by further static calculations. You will find a short version of the wind tunnel report and a certificate for the further static calculations on our homepage.
- The structural design complies with BS EN 1990 - Basics 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 3)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	S-Dome 6.10 Classic
Customer	CorEnergy
Author	Hugo Silva

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
Ground elevation	37.00 m
Roof type	Flat roof
Fastening method	with Ballast
Roof covering	Flat
Building height	10.80 m
Parapet wall height	0.10 m
Roof pitch	1 °
Min. roof edge distance	0.60 m
Material	Single ply membrane
Friction coefficient	0.50
Terrain category	Town Terrain



LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years

Terrain category Town Terrain

distance to shoreline 46.48 km

distance inside town terrain 10.50 km

Peak velocity pressure $q_{p,50} = 0.648 \text{ kN/m}^2$

Adjustment factor for service life $f_w = 0.921$

Peak velocity pressure $q_{p,25} = 0.597 \text{ kN/m}^2$

Snow load zone 3

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 $d_i = 0.000$

Snow load on roof $s_{i,50} = 0.000 \text{ kN/m}^2$

Adjustment factor for service life $f_s = 0.929$

Snow load on roof $s_{i,25} = 0.372 \text{ kN/m}^2$

DEAD LOAD

Weight module	$G_M = 19.5 \text{ kg}$	Dead weight module	$= 10.70 \text{ kg/m}^2$
Weight mounting system per module area	$= 4.1 \text{ kg}$	Dead weight mounting system	$= 2.25 \text{ kg/m}^2$
Module area	$A_M = 1.82 \text{ m}^2$	Total Dead Weight (excl. ballast)	$= 0.13 \text{ kN/m}^2$

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 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 variable	$\kappa_{FI,Q}$	0.85
Characteristic dead weight	G_k	
Characteristic snow load on the roof	$S_{i,n}$	
Characteristic wind load	W_k	
Load case combination 00:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$	
Load case combination 02:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$	
Load case combination 03:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$	
Load case combination 04:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$	
Load case combination 06:	$E_d = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$	
Uplift Verification:	$E_d = \gamma_{G,stab} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,n,Uplift}$	
Displacement verification:	$E_d = \gamma_{G,stab} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,n,Displacement}$	

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 00: $E_d = G_k$

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: $E_d = G_k + W_{k,Suction}$

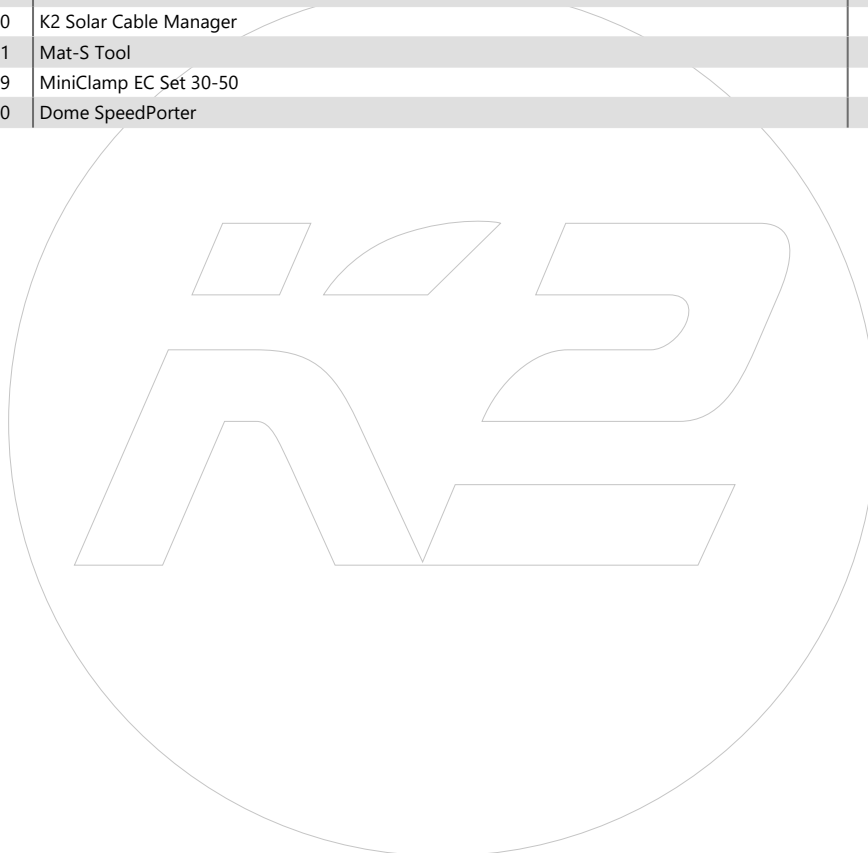
THE SYSTEM HAS BEEN SUCCESSFULLY CALCULATED.

BILL OF MATERIALS (ROOF 3)

Position	Item no.	Item description	Quantity	Weight
1	2004125	Dome 6.10 Peak	10	3.0 kg
2	1001643	MK2	20	0.4 kg
3	2001729	Socket Head Bolt serrated M8x20	20	0.3 kg
4	2003243	Dome 6.10 SD	10	3.0 kg
5	2003126	Dome Mat S 380	20	7.4 kg
6	2003249	S-Dome 6.10 Windbreaker short	5	9.0 kg
7	1005207	Thread-forming metal screw 6.0x25	20	0.1 kg
8	2003240	SpeedRail 22; 4.40 m	2	5.7 kg
9	2003239	SpeedRail 22; 3.30 m	2	4.2 kg
10	1006039	Dome FlatConnector Set	2	0.4 kg
11	2002870	K2 Solar Cable Manager	5	0.0 kg
12	2004141	Mat-S Tool	1	0.0 kg
13	2002559	MiniClamp EC Set 30-50	20	1.3 kg
14	2002300	Dome SpeedPorter	20	1.5 kg

Total

36.3 kg



PROJECT DATA (ROOF 4)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	S-Dome 6.10 Classic
Customer	CorEnergy
Author	Hugo Silva

REMARKS

Best assumptions made for any missing information

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
Ground elevation	37.00 m
Roof type	Flat roof
Fastening method	with Ballast
Roof covering	Flat
Building height	10.80 m
Parapet wall height	0.10 m
Roof pitch	1 °
Min. roof edge distance	0.60 m
Material	Single ply membrane
Friction coefficient	0.50
Terrain category	Town Terrain

The friction coefficients given here must be checked onsite. If a lower value is found, this must be specified here for the ballast calculation!

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years
Terrain category	Town Terrain		
distance to shoreline	46.48 km		
distance inside town terrain	10.50 km		
Peak velocity pressure	$q_{p,25} = 0.597 \text{ kN/m}^2$		
Snow load zone	3		
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$		

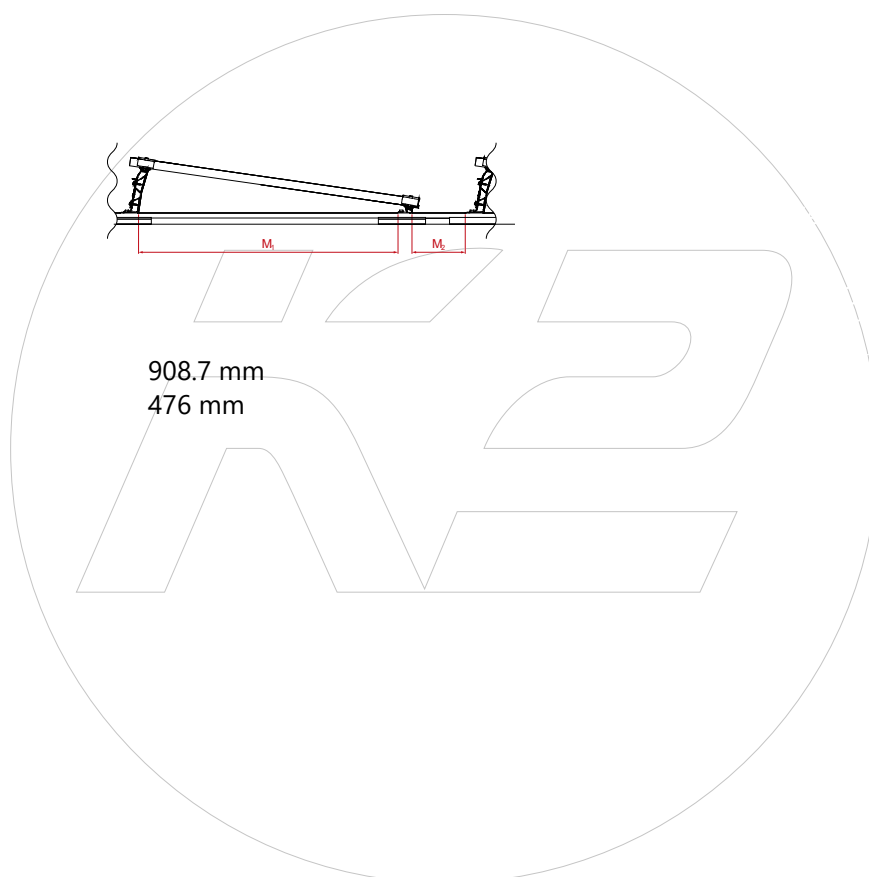
MODULES

Manufacturer	Longi Solar	Quantity	7
Name	LR4-60HPH-375M	Total output power	2.625 kWp
Dimensions LxWxH	1755 x 1038 x 35.00 mm	Panel Tilt	9.5 °
Weight	19.5 kg		
Output power	375 W		

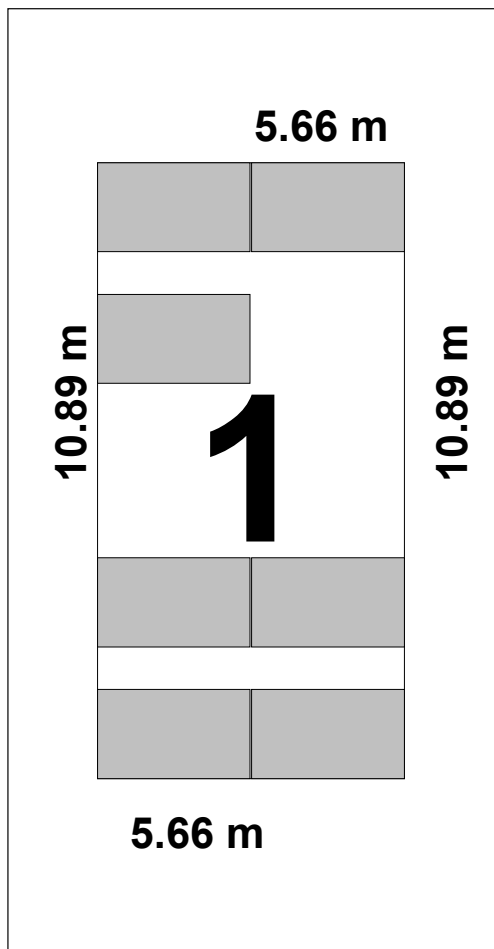
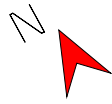
PRE-ASSEMBLY / ASSEMBLY INSTRUCTIONS (ROOF 4)

Module Array 1

M1
M2



ASSEMBLY PLAN (ROOF 4)

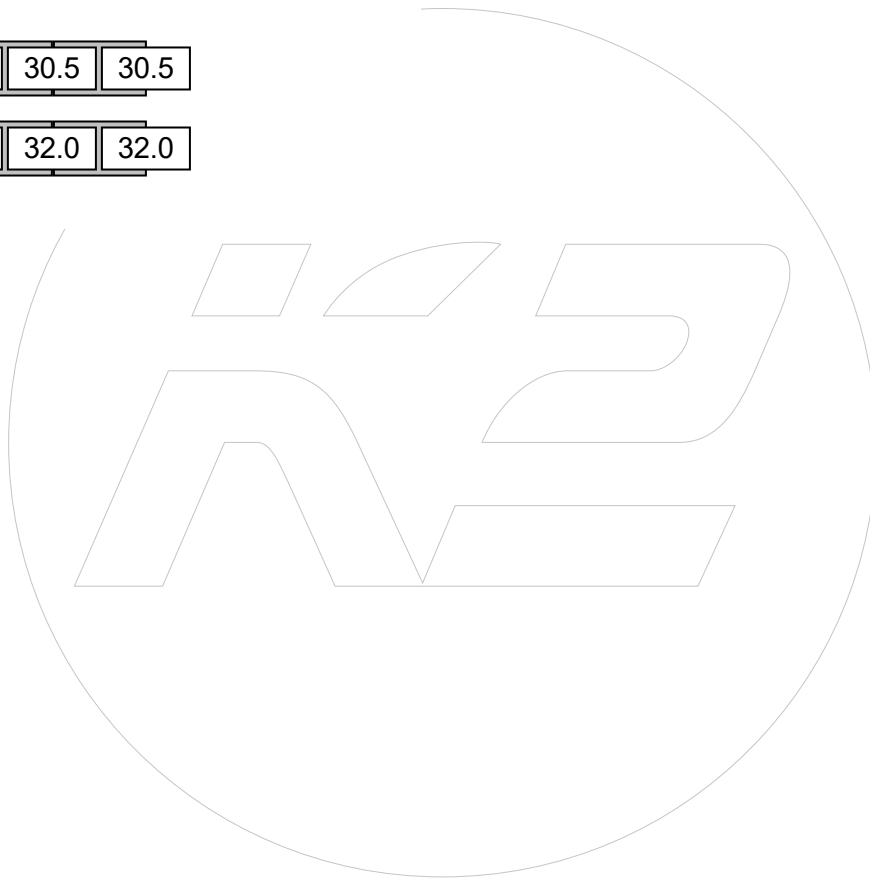
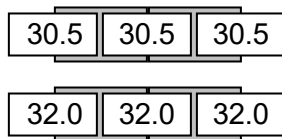
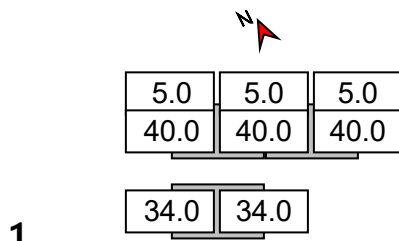


Dimensions in [m]

Type	Whole Rails			Rail cutting		
	Total Rail / m	Quantity 3.30 m	Quantity 4.40 m	Part of / m	Length / m	Rest / m
A	3.015			3.300	3.015	0.275
B	1.500			3.300	1.500	1.790



BALLAST PLAN (ROOF 4)



RESULTS (ROOF 4)

BALLAST CAPACITY

Speed Porter	40.0 kg
Porter	108.0 kg
module clamp	MiniClamp MC Set 30-50
end clamp	MiniClamp EC Set 30-50

VERIFICATION SYSTEM UTILISATION

Verification system utilisation [%]	pressure	35.16
	suction	32.40
Loads on modules (ultimate state) [Pa]	pressure	1321
	suction	-842
Loads on modules (Serviceability) [Pa]	pressure	989
	suction	-589

SPECIFIC LOADS

Index (module block)	No. of modules (module block)	---	---	Ballast [kg] (module block)	Dead weight [kg] (module block)	Dead Load [kN/m ²] (module block)	Dead Load [kN/m ²] (roof surface area)	Own weight [kN/m ²]
module array 1	7	---	---	390.5	555.7	0.34	---	---
all Blocks	7	---	---	390.5	555.7	---	0.09	---

NOTES

- The proof of position safety and load capacity of the system are carried out by checking the load cases lifting and shifting by wind and by further static calculations. You will find a short version of the wind tunnel report and a certificate for the further static calculations on our homepage.
- The structural design complies with BS EN 1990 - Basics 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 4)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	S-Dome 6.10 Classic
Customer	CorEnergy
Author	Hugo Silva

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
Ground elevation	37.00 m
Roof type	Flat roof
Fastening method	with Ballast
Roof covering	Flat
Building height	10.80 m
Parapet wall height	0.10 m
Roof pitch	1 °
Min. roof edge distance	0.60 m
Material	Single ply membrane
Friction coefficient	0.50
Terrain category	Town Terrain



LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years

Terrain category Town Terrain

distance to shoreline 46.48 km

distance inside town terrain 10.50 km

Peak velocity pressure $q_{p,50} = 0.648 \text{ kN/m}^2$

Adjustment factor for service life $f_w = 0.921$

Peak velocity pressure $q_{p,25} = 0.597 \text{ kN/m}^2$

Snow load zone 3

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 $d_i = 0.000$

Snow load on roof $s_{i,50} = 0.000 \text{ kN/m}^2$

Adjustment factor for service life $f_s = 0.929$

Snow load on roof $s_{i,25} = 0.372 \text{ kN/m}^2$

DEAD LOAD

Weight module	$G_M = 19.5 \text{ kg}$	Dead weight module	$= 10.70 \text{ kg/m}^2$
Weight mounting system per module area	$= 4.1 \text{ kg}$	Dead weight mounting system	$= 2.25 \text{ kg/m}^2$
Module area	$A_M = 1.82 \text{ m}^2$	Total Dead Weight (excl. ballast)	$= 0.13 \text{ kN/m}^2$

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 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 variable	$\kappa_{FI,Q}$	0.85
Characteristic dead weight	G_k	
Characteristic snow load on the roof	$S_{i,n}$	
Characteristic wind load	W_k	
Load case combination 00:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$	
Load case combination 02:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$	
Load case combination 03:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$	
Load case combination 04:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$	
Load case combination 06:	$E_d = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$	
Uplift Verification:	$E_d = \gamma_{G,stab} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,n,Uplift}$	
Displacement verification:	$E_d = \gamma_{G,stab} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,n,Displacement}$	

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 00: $E_d = G_k$

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: $E_d = G_k + W_{k,Pressure} + \psi_{0,S} * S_{i,n}$

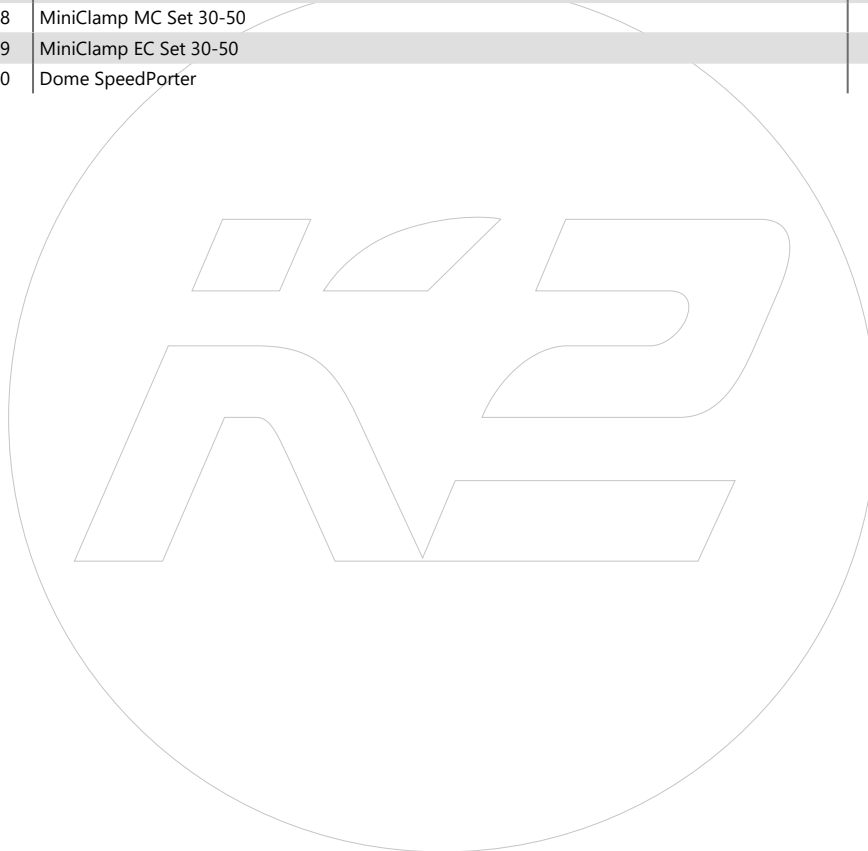
Load case combination 04: $E_d = G_k + S_{i,n} + \psi_{0,W} * W_{k,Pressure}$

Load case combination 06: $E_d = G_k + W_{k,Suction}$

THE SYSTEM HAS BEEN SUCCESSFULLY CALCULATED.

BILL OF MATERIALS (ROOF 4)

Position	Item no.	Item description	Quantity	Weight
1	2004125	Dome 6.10 Peak	11	3.3 kg
2	1001643	MK2	22	0.4 kg
3	2001729	Socket Head Bolt serrated M8x20	22	0.3 kg
4	2003243	Dome 6.10 SD	11	3.3 kg
5	2003126	Dome Mat S 380	22	8.1 kg
6	2003249	S-Dome 6.10 Windbreaker short	7	12.6 kg
7	1005207	Thread-forming metal screw 6.0x25	22	0.1 kg
8	2003239	SpeedRail 22; 3.30 m	6	12.7 kg
9	2002870	K2 Solar Cable Manager	7	0.0 kg
10	2004141	Mat-S Tool	1	0.0 kg
11	2002558	MiniClamp MC Set 30-50	6	0.3 kg
12	2002559	MiniClamp EC Set 30-50	16	1.1 kg
13	2002300	Dome SpeedPorter	28	2.1 kg
Total				44.3 kg



PROJECT DATA (ROOF 5)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	S-Dome 6.10 Classic
Customer	CorEnergy
Author	Hugo Silva

REMARKS

Best assumptions made for any missing information

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
Ground elevation	37.00 m
Roof type	Flat roof
Fastening method	with Ballast
Roof covering	Flat
Building height	10.80 m
Parapet wall height	0.10 m
Roof pitch	1 °
Min. roof edge distance	0.60 m
Material	Single ply membrane
Friction coefficient	0.50
Terrain category	Town Terrain

The friction coefficients given here must be checked onsite. If a lower value is found, this must be specified here for the ballast calculation!

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years
Terrain category	Town Terrain		
distance to shoreline	46.48 km		
distance inside town terrain	10.50 km		
Peak velocity pressure	$q_{p,25} = 0.597 \text{ kN/m}^2$		
Snow load zone	3		
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$		

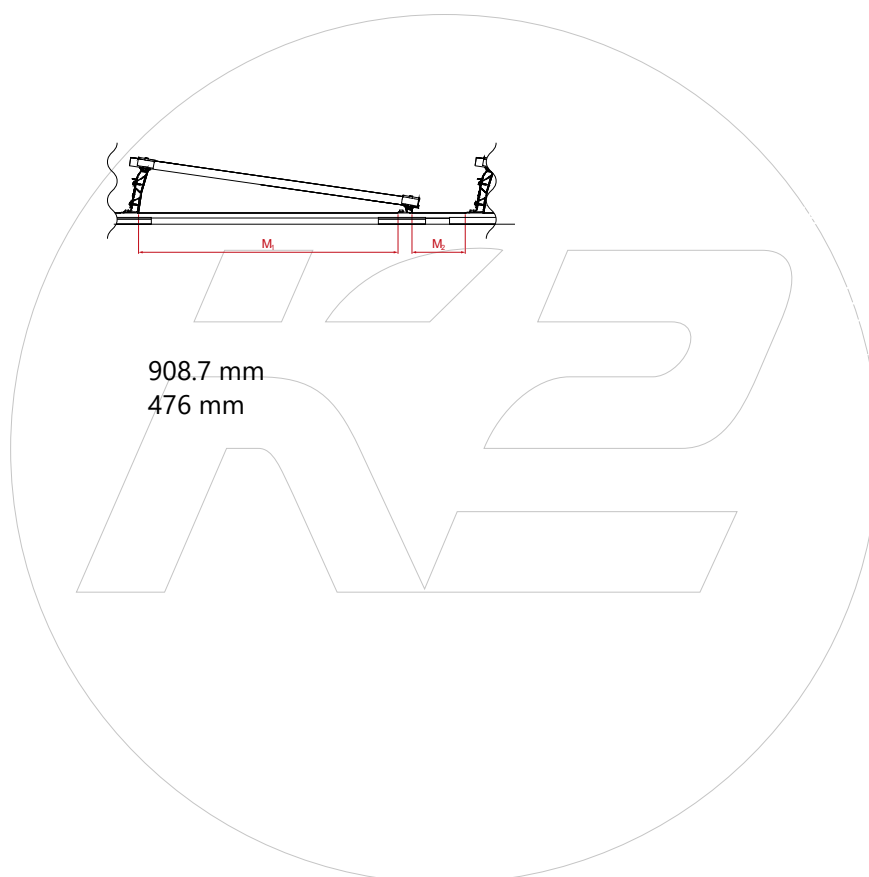
MODULES

Manufacturer	Longi Solar	Quantity	8
Name	LR4-60HPH-375M	Total output power	3.000 kWp
Dimensions LxWxH	1755 x 1038 x 35.00 mm	Panel Tilt	9.5 °
Weight	19.5 kg		
Output power	375 W		

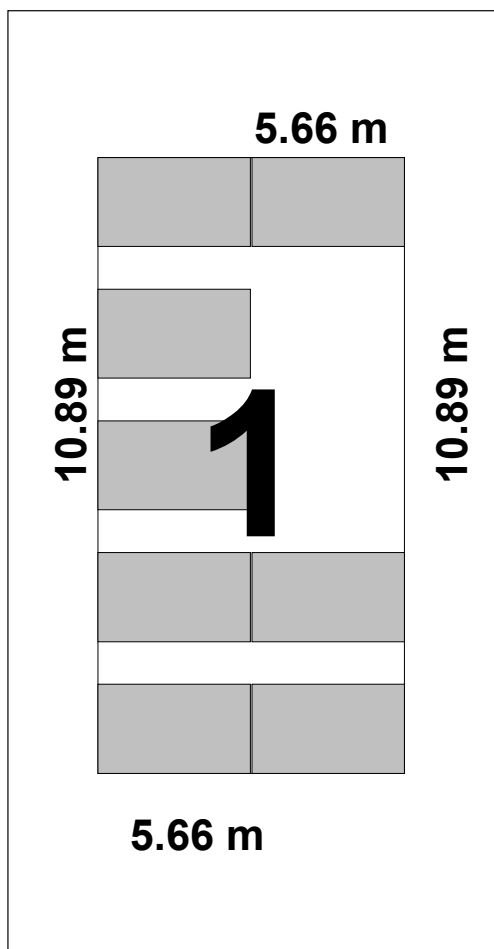
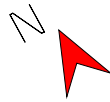
PRE-ASSEMBLY / ASSEMBLY INSTRUCTIONS (ROOF 5)

Module Array 1

M1
M2



ASSEMBLY PLAN (ROOF 5)



Dimensions in [m]

Type	Whole Rails			Rail cutting		
	Total Rail / m	Quantity 3.30 m	Quantity 4.40 m	Part of / m	Length / m	Rest / m
A	7.560		1	3.300	3.160	0.130
B	3.015			3.300	3.015	0.275
C	1.500			3.300	1.500	1.790



LEGEND

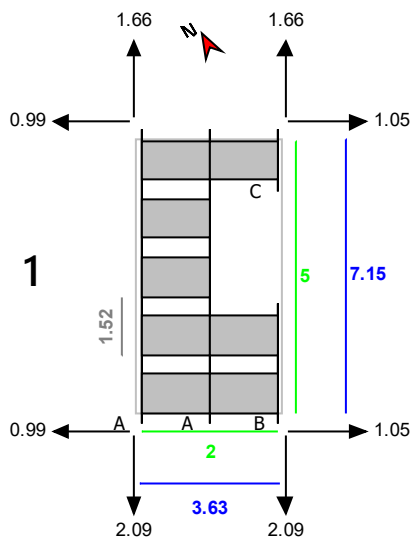
Distance to neighbouring module array [m]

Distance to roof edge [m]

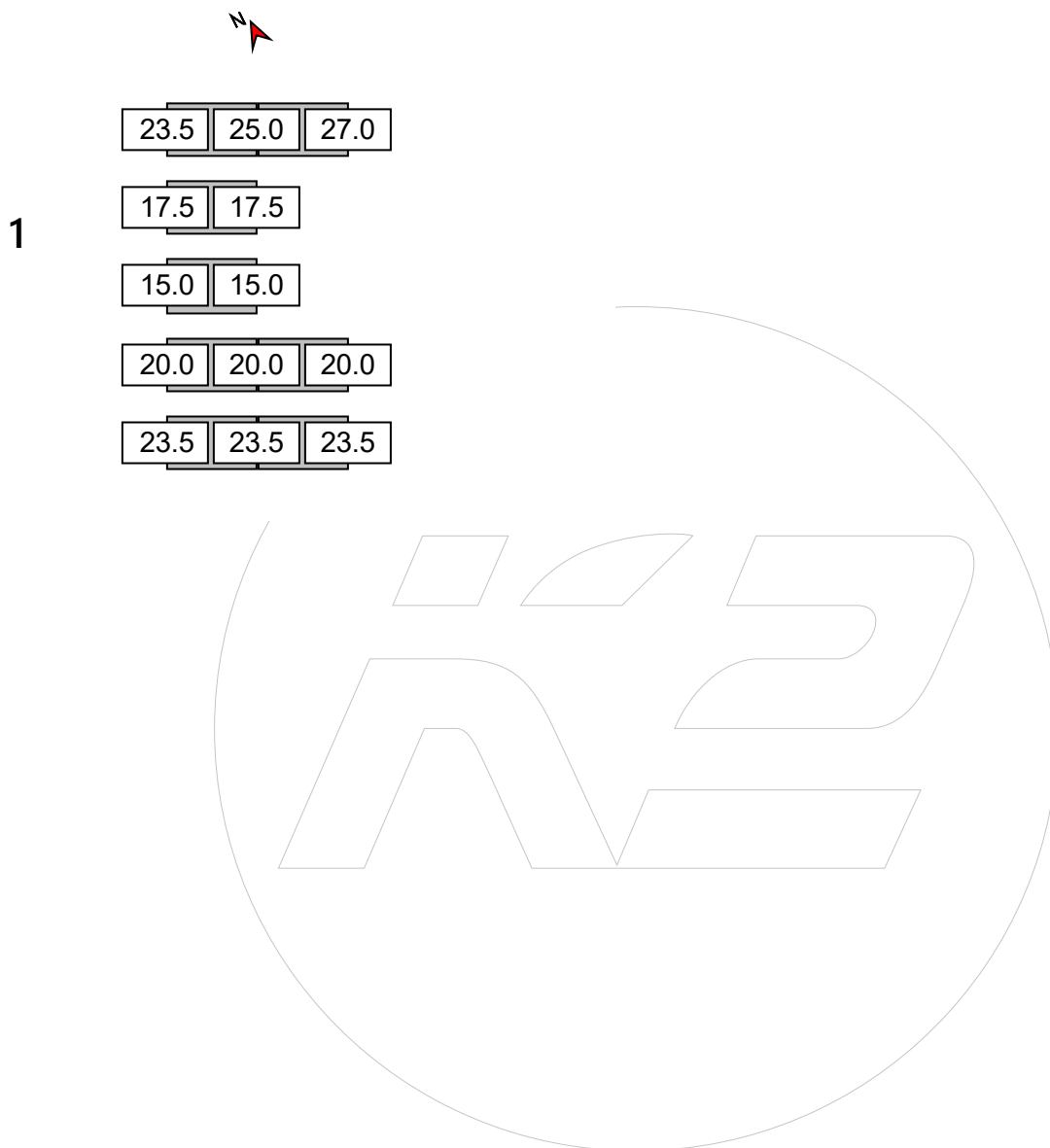
Number of modules

Length/width of module array [m]

Row distance [m]



BALLAST PLAN (ROOF 5)



RESULTS (ROOF 5)

BALLAST CAPACITY

Speed Porter	40.0 kg
Porter	108.0 kg
module clamp	MiniClamp MC Set 30-50
end clamp	MiniClamp EC Set 30-50

VERIFICATION SYSTEM UTILISATION

Verification system utilisation [%]	pressure	22.21
	suction	32.40
Loads on modules (ultimate state) [Pa]	pressure	1321
	suction	-842
Loads on modules (Serviceability) [Pa]	pressure	989
	suction	-589

SPECIFIC LOADS

Index (module block)	No. of modules (module block)	---	---	Ballast [kg] (module block)	Dead weight [kg] (module block)	Dead Load [kN/m ²] (module block)	Dead Load [kN/m ²] (roof surface area)	Own weight [kN/m ²]
module array 1	8	---	---	271.0	459.8	0.23	---	---
all Blocks	8	---	---	271.0	459.8	---	0.07	---

NOTES

- The proof of position safety and load capacity of the system are carried out by checking the load cases lifting and shifting by wind and by further static calculations. You will find a short version of the wind tunnel report and a certificate for the further static calculations on our homepage.
- The structural design complies with BS EN 1990 - Basics 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 5)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	S-Dome 6.10 Classic
Customer	CorEnergy
Author	Hugo Silva

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
Ground elevation	37.00 m
Roof type	Flat roof
Fastening method	with Ballast
Roof covering	Flat
Building height	10.80 m
Parapet wall height	0.10 m
Roof pitch	1 °
Min. roof edge distance	0.60 m
Material	Single ply membrane
Friction coefficient	0.50
Terrain category	Town Terrain

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years

Terrain category Town Terrain

distance to shoreline 46.48 km

distance inside town terrain 10.50 km

Peak velocity pressure $q_{p,50} = 0.648 \text{ kN/m}^2$

Adjustment factor for service life $f_w = 0.921$

Peak velocity pressure $q_{p,25} = 0.597 \text{ kN/m}^2$

Snow load zone 3

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 $d_i = 0.000$

Snow load on roof $s_{i,50} = 0.000 \text{ kN/m}^2$

Adjustment factor for service life $f_s = 0.929$

Snow load on roof $s_{i,25} = 0.372 \text{ kN/m}^2$

DEAD LOAD

Weight module	$G_M = 19.5 \text{ kg}$	Dead weight module	$= 10.70 \text{ kg/m}^2$
Weight mounting system per module area	$= 4.1 \text{ kg}$	Dead weight mounting system	$= 2.25 \text{ kg/m}^2$
Module area	$A_M = 1.82 \text{ m}^2$	Total Dead Weight (excl. ballast)	$= 0.13 \text{ kN/m}^2$

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 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 variable	$\kappa_{FI,Q}$	0.85
Characteristic dead weight	G_k	
Characteristic snow load on the roof	$S_{i,n}$	
Characteristic wind load	W_k	

Load case combination 00:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$
Load case combination 02:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$
Load case combination 03:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$
Load case combination 04:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$

Load case combination 06:	$E_d = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$
---------------------------	---

Uplift Verification:	$E_d = \gamma_{G,stab} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,n,Uplift}$
----------------------	---

Displacement verification:	$E_d = \gamma_{G,stab} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,n,Displacement}$
----------------------------	---

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 00: $E_d = G_k$

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: $E_d = G_k + W_{k,Pressure} + \psi_{0,S} * S_{i,n}$

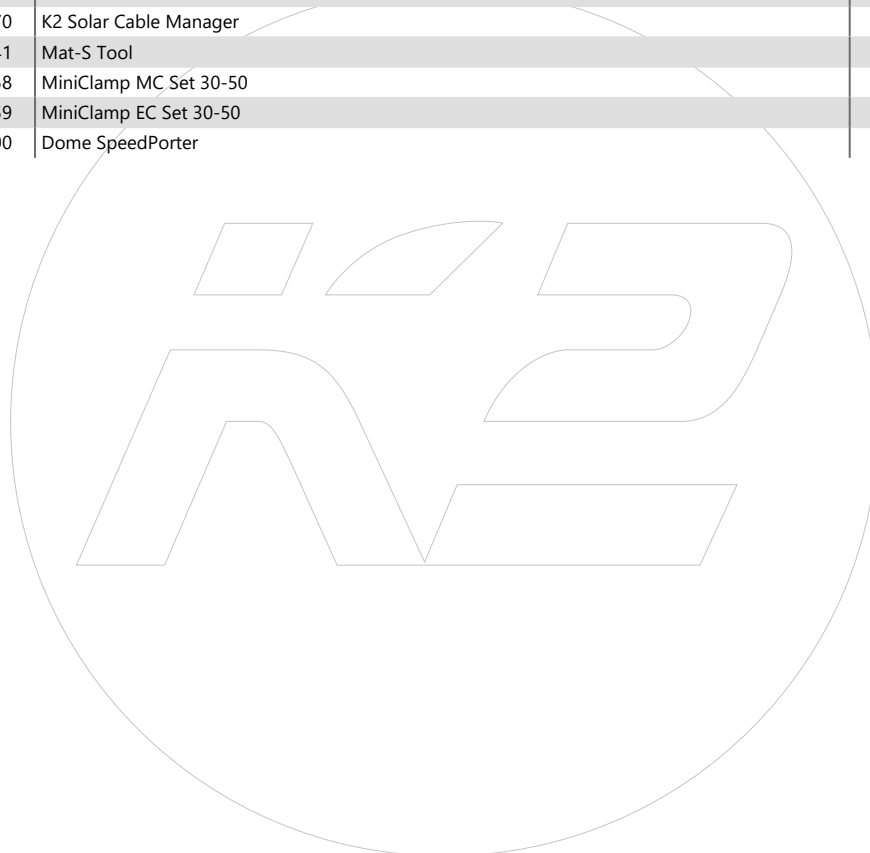
Load case combination 04: $E_d = G_k + S_{i,n} + \psi_{0,W} * W_{k,Pressure}$

Load case combination 06: $E_d = G_k + W_{k,Suction}$

THE SYSTEM HAS BEEN SUCCESSFULLY CALCULATED.

BILL OF MATERIALS (ROOF 5)

Position	Item no.	Item description	Quantity	Weight
1	2004125	Dome 6.10 Peak	13	3.9 kg
2	1001643	MK2	26	0.5 kg
3	2001729	Socket Head Bolt serrated M8x20	26	0.3 kg
4	2003243	Dome 6.10 SD	13	3.9 kg
5	2003126	Dome Mat S 380	26	9.6 kg
6	2003249	S-Dome 6.10 Windbreaker short	8	14.4 kg
7	1005207	Thread-forming metal screw 6.0x25	26	0.2 kg
8	2003239	SpeedRail 22; 3.30 m	4	8.5 kg
9	2003240	SpeedRail 22; 4.40 m	2	5.7 kg
10	1006039	Dome FlatConnector Set	2	0.4 kg
11	2002870	K2 Solar Cable Manager	8	0.0 kg
12	2004141	Mat-S Tool	1	0.0 kg
13	2002558	MiniClamp MC Set 30-50	6	0.3 kg
14	2002559	MiniClamp EC Set 30-50	20	1.3 kg
15	2002300	Dome SpeedPorter	26	2.0 kg
Total				51.0 kg



PROJECT DATA (ROOF 6)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	SolidRail
Customer	CorEnergy
Author	Hugo Silva

REMARKS

Best assumptions made for any missing information

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
Ground elevation	37.00 m
Roof type	Gable roof
Fastening method	Roof construction
Roof covering	Tile
Building height	10.80 m
Roof pitch	35 °
Min. roof edge distance	0.00 m
Rafter Spacing	0.400 m
Batten spacing	340.0 mm
Terrain category	Town Terrain

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years
Terrain category	Town Terrain		
distance to shoreline	46.48 km		
distance inside town terrain	10.50 km		
Peak velocity pressure	$q_{p,25} = 0.597 \text{ kN/m}^2$		
Snow load zone	3		
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$		

MODULES

Manufacturer	Longi Solar	Quantity	6
Name	LR4-60HPH-375M	Total output power	2.250 kWp

Dimensions LxWxH	1755 x 1038 x 35.00 mm
Weight	19.5 kg
Output power	375 W



ASSEMBLY PLAN (ROOF 6)

Type	Whole Rails		Rail cutting		
	Total Rail Length / m	Quantity 4.40 m	Part of Rail / m	Length / m	Rest / m
A	3.220		3.300	3.220	0.070

LEGEND

1.14	Distance to Roof Edge [m]
■	Fastener
■	Rail connector base rail
■	Base rails

FASTENER SPACING

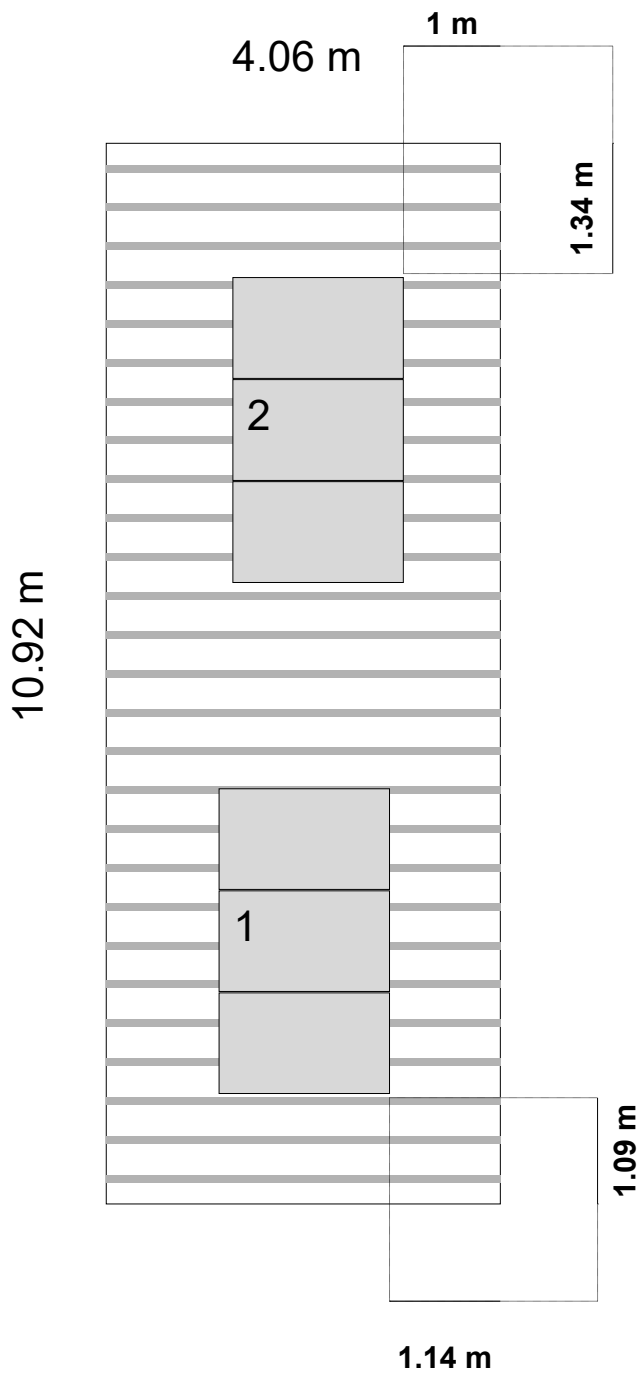
Module	Array	Distance
1	ridge	0.80 m
1	corner region (eave)	0.80 m
1	eaves	0.80 m
2	ridge	0.80 m
2	corner region (eave)	0.80 m
2	eaves	0.80 m

MODULE ARRAYS

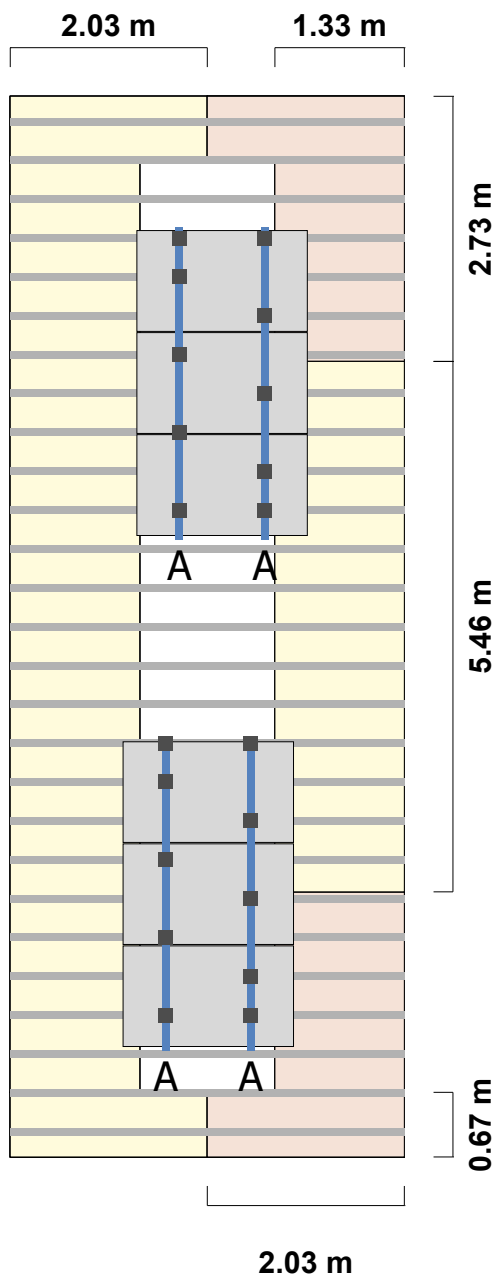
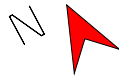
Module array	Width [m]	Length [m]	Width in modules	Length in modules
1	3.14	1.76	3	1
2	3.14	1.76	3	1



ASSEMBLY PLAN - OVERVIEW (ROOF 6)



ASSEMBLY PLAN - BASE RAIL LAYER (ROOF 6)





RESULTS (ROOF 6)

COMPONENTS

Fastener SolidHook Flat Tile H33/119 75x4

Base Rails K2 SolidRail UltraLight 32

LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [Pa]				Serviceability [Pa]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
ridge	1.82	728.4	360.8	-743.6	67.9	575.8	286.2	-562.3	67.9
corner region (eave)	1.82	849.3	360.8	-965.3	67.9	670.7	286.2	-736.2	67.9
eaves	1.82	849.3	360.8	-743.6	67.9	670.7	286.2	-562.3	67.9

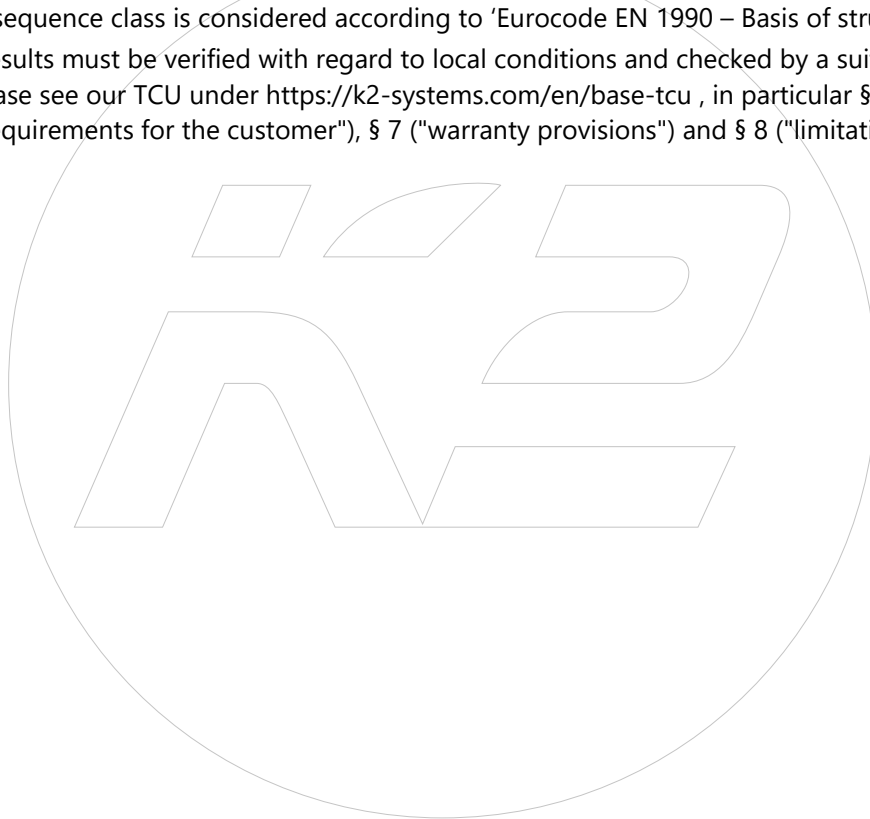
UTILISATION RESULT

No. Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		maximum values	
		Pr σ [%]	Cl σ [%]	Fst F [%]		Fst [m]	BR [m]	Cl Lmax[m]	Fst Dmax[m]
1	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
1	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
1	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
2	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890

Pr Profile
 Fst Fastener
 σ Tension
 f Deflection
 F Force
 CL/Lmax [m] maximum cantilever length
 Fst Dmax [m] maximum fastener spacing
 BR Base Rail
 UR Upper rail
 Usab. serviceability limit state
 Cl Cantilever

NOTES

- The dimensioning of the timber construction screws is not part of this structural analysis. The dimensioning and positioning of the timber construction screws to be used must be carried out in accordance with the respective applicable codes of practice.
- The structural design complies with BS EN 1990 - Basics 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 6)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	SolidRail
Customer	CorEnergy
Author	Hugo Silva

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
Ground elevation	37.00 m
Roof type	Gable roof
Fastening method	Roof construction
Roof covering	Tile
Building height	10.80 m
Roof pitch	35 °
Min. roof edge distance	0.00 m
Rafter Spacing	0.400 m
Batten spacing	340.0 mm
Terrain category	Town Terrain

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years

WIND LOAD

Terrain category	Town Terrain
distance to shoreline	46.48 km
distance inside town terrain	10.50 km
Peak velocity pressure	$q_{p,50} = 0.648 \text{ kN/m}^2$
Adjustment factor for service life	$f_w = 0.921$
Peak velocity pressure	$q_{p,25} = 0.597 \text{ kN/m}^2$

ROOF AREAS

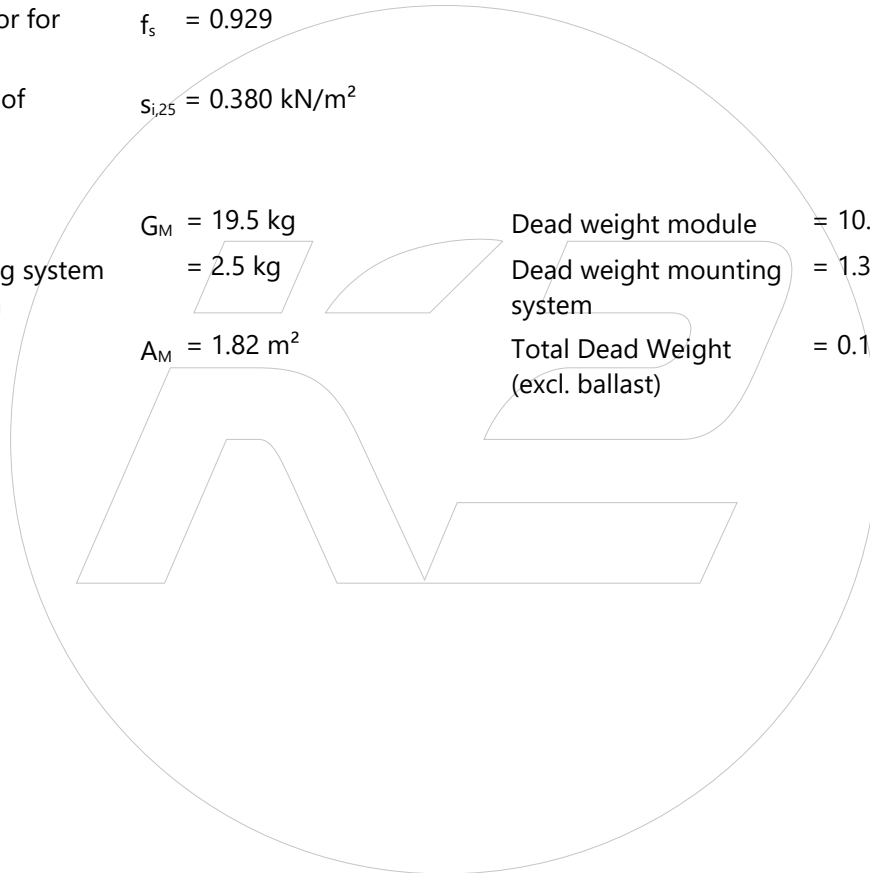
Array	load impact area [m ²]	maxCpe	minCpe	wind pressure [kN/m ²]	wind suction [kN/m ²]
ridge	10.00	0.467	-0.833	0.279	-0.497
corner region (eave)	10.00	0.700	-1.100	0.418	-0.657
eaves	10.00	0.700	-0.833	0.418	-0.497

SNOW LOAD

Snow load zone	3
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$
Snow guard	No
Shape Coefficient for Snow	$\mu_i = 1.000$
Factor for roof pitch	$d_i = 0.000$
Snow load on roof	$s_{i,50} = 0.000 \text{ kN/m}^2$
Adjustment factor for service life	$f_s = 0.929$
Snow load on roof	$s_{i,25} = 0.380 \text{ kN/m}^2$

DEAD LOAD

Weight module	$G_M = 19.5 \text{ kg}$	Dead weight module	$= 10.70 \text{ kg/m}^2$
Weight mounting system per module area	$= 2.5 \text{ kg}$	Dead weight mounting system	$= 1.37 \text{ kg/m}^2$
Module area	$A_M = 1.82 \text{ m}^2$	Total Dead Weight (excl. ballast)	$= 0.12 \text{ kN/m}^2$



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 variable	$\kappa_{FI,Q}$	0.85
Characteristic dead weight	G_k	
Characteristic snow load on the roof	$S_{i,n}$	
Characteristic wind load	W_k	
Load case combination 00:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$	
Load case combination 02:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$	
Load case combination 03:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$	
Load case combination 04:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$	
Load case combination 05:		
Load case combination 06:	$E_d = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$	

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 00:	$E_d = G_k$	
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:	$E_d = G_k + W_{k,Suction}$	

MAXIMUM LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [kN/m ²]				Serviceability [kN/m ²]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
ridge	10.00	0.728	0.361	-0.537	0.068	0.576	0.286	-0.400	0.068
corner region (eave)	10.00	0.849	0.361	-0.740	0.068	0.671	0.286	-0.560	0.068
eaves	10.00	0.849	0.361	-0.537	0.068	0.671	0.286	-0.400	0.068

MAX. LOAD ON FASTENER

Array	A-TrA [m ²]	ultimate state [kN]				Serviceability [kN]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
ridge	10.00	0.562	0.279	-0.415	0.052	0.445	0.221	-0.309	0.052
corner region (eave)	10.00	0.656	0.279	-0.572	0.052	0.518	0.221	-0.432	0.052
eaves	10.00	0.656	0.279	-0.415	0.052	0.518	0.221	-0.309	0.052

RESISTANCE VALUES OF COMPONENTS

BASE RAILS

No. Module Array	Base Rails	A [cm ²]	I _y [cm ⁴]	I _z [cm ⁴]	W _y [cm ³]	W _z [cm ³]
1 - 2	K2 SolidRail UltraLight 32	2.610	2.59	5.54	1.57	2.84

FASTENER

No. Module Array	Fastener	R _{D,Suction,Perpendicular} [kN]	R _{D,Pressure,Perpendicular} [kN]	R _{D,Pressure,Parallel} [kN]
1 - 2	SolidHook Flat Tile H33/119 75x4	0.81	0.73	2.00

UTILISATION RESULT

Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		CL Lmax[m]	Fst Fst Dmax[m]
		Pr σ [%]	CL σ [%]	Fst F [%]		Fst [m]	BR [m]		
1	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
1	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
1	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
2	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890

Pr	Profile
Fst	Fastener
σ	Tension
f	Deflection
F	Force
CL/Lmax [m]	maximum cantilever length
Fst Dmax [m]	maximum fastener spacing
BR	Base Rail
UR	Upper rail
Usab.	serviceability limit state
CL	Cantilever

THE SYSTEM HAS BEEN SUCCESSFULLY CALCULATED.



BILL OF MATERIALS (ROOF 6)

Position	Item no.	Item description	Quantity	Weight
1	2003073	SolidHook Flat Tile H33/119 75x4	20	19.9 kg
2	1000041	T-Bolt 28/15 M10x30	20	0.6 kg
3	1000042	Hexagon flange nut M10	20	0.2 kg
4	2004112	Heco-Topix Plus wood screw 8x100	40	1.1 kg
5	1005158	MiddleClamp XS Black Set 34-38	8	0.6 kg
6	1005268	EndClamp Black Set 34-36	8	0.6 kg
7	2002870	K2 Solar Cable Manager	6	0.0 kg
8	2003228	SolidRail UltraLight; 3.30 m	4	9.2 kg
Total				32.2 kg



PROJECT DATA (ROOF 7)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	SolidRail
Customer	CorEnergy
Author	Hugo Silva

REMARKS

Best assumptions made for any missing information

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
Ground elevation	37.00 m
Roof type	Gable roof
Fastening method	Roof construction
Roof covering	Tile
Building height	10.80 m
Roof pitch	35 °
Min. roof edge distance	0.00 m
Rafter Spacing	0.400 m
Batten spacing	340.0 mm
Terrain category	Town Terrain

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years
Terrain category	Town Terrain		
distance to shoreline	46.48 km		
distance inside town terrain	10.50 km		
Peak velocity pressure	$q_{p,25} = 0.597 \text{ kN/m}^2$		
Snow load zone	3		
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$		

MODULES

Manufacturer	Longi Solar	Quantity	6
Name	LR4-60HPH-375M	Total output power	2.250 kWp

Dimensions LxWxH	1755 x 1038 x 35.00 mm
Weight	19.5 kg
Output power	375 W



ASSEMBLY PLAN (ROOF 7)

Type	Whole Rails		Rail cutting		
	Total Rail Length / m	Quantity 4.40 m	Part of Rail / m	Length / m	Rest / m
A	3.220		3.300	3.220	0.070

LEGEND

1.14	Distance to Roof Edge [m]
■	Fastener
■	Rail connector base rail
■	Base rails

FASTENER SPACING

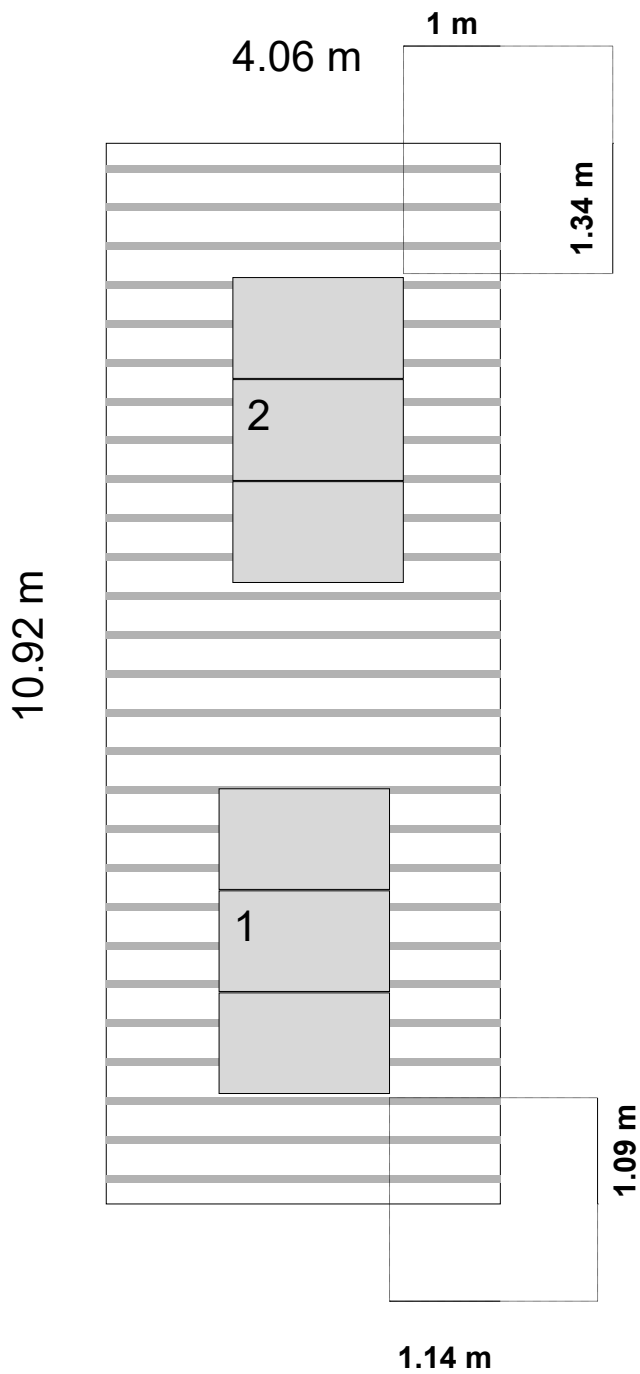
Module	Array	Distance
1	ridge	0.80 m
1	corner region (eave)	0.80 m
1	eaves	0.80 m
2	ridge	0.80 m
2	corner region (eave)	0.80 m
2	eaves	0.80 m

MODULE ARRAYS

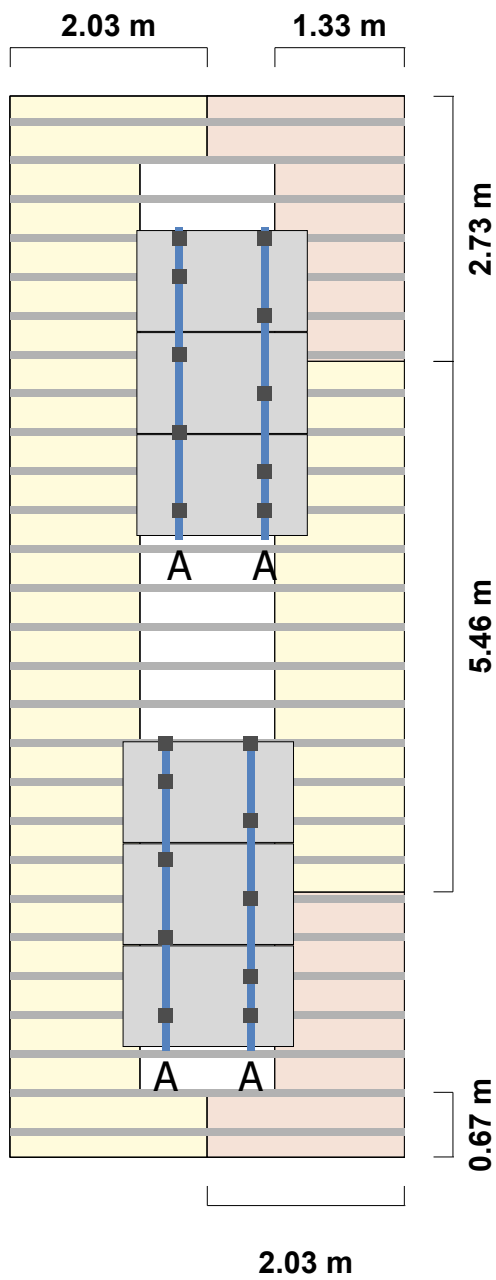
Module array	Width [m]	Length [m]	Width in modules	Length in modules
1	3.14	1.76	3	1
2	3.14	1.76	3	1



ASSEMBLY PLAN - OVERVIEW (ROOF 7)



ASSEMBLY PLAN - BASE RAIL LAYER (ROOF 7)





RESULTS (ROOF 7)

COMPONENTS

Fastener	SolidHook Flat Tile H33/119 75x4
Base Rails	K2 SolidRail UltraLight 32

LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [Pa]				Serviceability [Pa]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
ridge	1.82	728.4	360.8	-743.6	67.9	575.8	286.2	-562.3	67.9
corner region (eave)	1.82	849.3	360.8	-965.3	67.9	670.7	286.2	-736.2	67.9
eaves	1.82	849.3	360.8	-743.6	67.9	670.7	286.2	-562.3	67.9

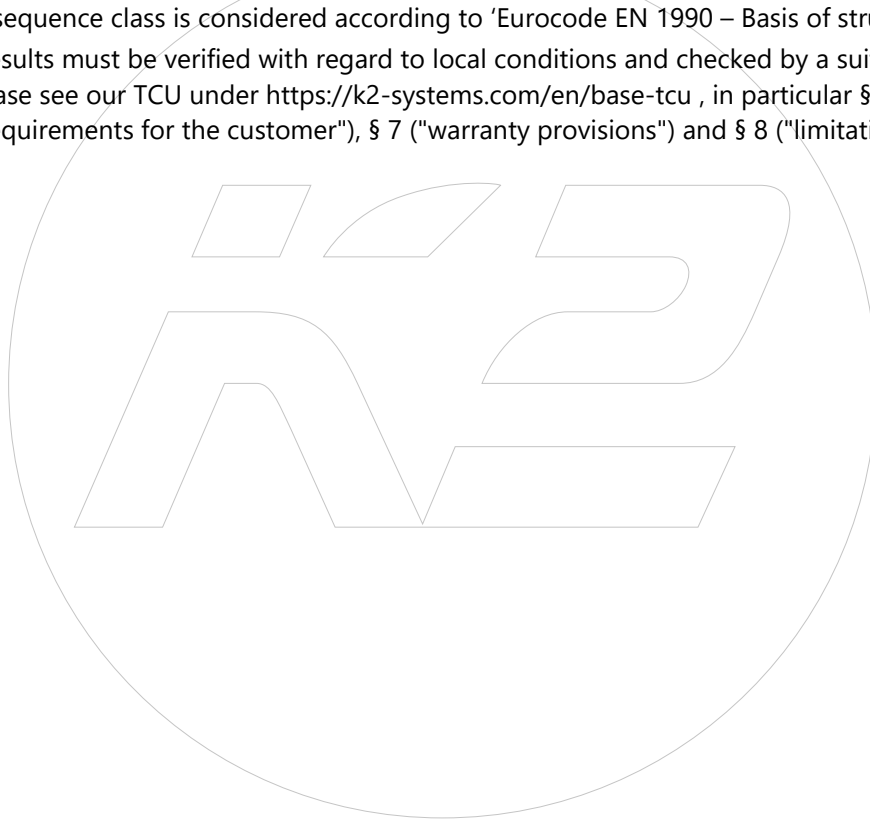
UTILISATION RESULT

No. Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		maximum values	
		Pr σ [%]	Cl σ [%]	Fst F [%]		Fst [m]	BR [m]	Cl Lmax[m]	Fst Dmax[m]
1	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
1	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
1	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
2	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890

Pr	Profile
Fst	Fastener
σ	Tension
f	Deflection
F	Force
CL/Lmax [m]	maximum cantilever length
Fst Dmax [m]	maximum fastener spacing
BR	Base Rail
UR	Upper rail
Usab.	serviceability limit state
Cl	Cantilever

NOTES

- The dimensioning of the timber construction screws is not part of this structural analysis. The dimensioning and positioning of the timber construction screws to be used must be carried out in accordance with the respective applicable codes of practice.
- The structural design complies with BS EN 1990 - Basics 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 7)

GENERAL INFORMATION

Name Dale Halls
 Mounting System SolidRail
 Customer CorEnergy
 Author Hugo Silva

LOCATION

Address 263 Stretford Rd, Hulme,
 Manchester M15 6GR, UK
 Ground elevation 37.00 m
 Roof type Gable roof
 Fastening method Roof construction
 Roof covering Tile
 Building height 10.80 m
 Roof pitch 35 °
 Min. roof edge distance 0.00 m
 Rafter Spacing 0.400 m
 Batten spacing 340.0 mm
 Terrain category Town Terrain

LOADS

Design method BS EN
 Failure consequence class CC1
 Design working life 25 years
 (CC)

WIND LOAD

Terrain category Town Terrain
 distance to shoreline 46.48 km
 distance inside town terrain 10.50 km
 Peak velocity pressure $q_{p,50} = 0.648 \text{ kN/m}^2$
 Adjustment factor for service life $f_w = 0.921$
 Peak velocity pressure $q_{p,25} = 0.597 \text{ kN/m}^2$

ROOF AREAS

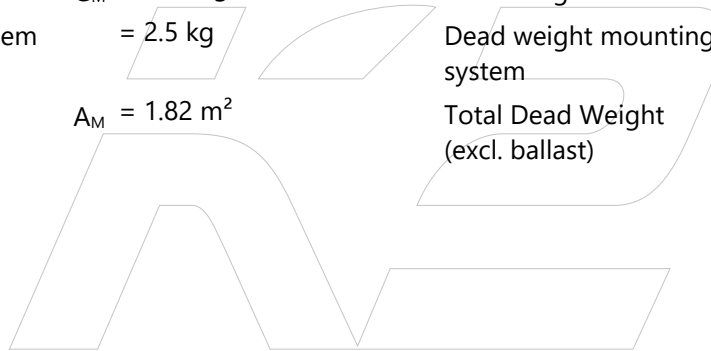
Array	load impact area [m ²]	maxCpe	minCpe	wind pressure [kN/m ²]	wind suction [kN/m ²]
ridge	10.00	0.467	-0.833	0.279	-0.497
corner region (eave)	10.00	0.700	-1.100	0.418	-0.657
eaves	10.00	0.700	-0.833	0.418	-0.497

SNOW LOAD

Snow load zone	3
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$
Snow guard	No
Shape Coefficient for Snow	$\mu_i = 1.000$
Factor for roof pitch	$d_i = 0.000$
Snow load on roof	$s_{i,50} = 0.000 \text{ kN/m}^2$
Adjustment factor for service life	$f_s = 0.929$
Snow load on roof	$s_{i,25} = 0.380 \text{ kN/m}^2$

DEAD LOAD

Weight module	$G_M = 19.5 \text{ kg}$	Dead weight module	$= 10.70 \text{ kg/m}^2$
Weight mounting system per module area	$= 2.5 \text{ kg}$	Dead weight mounting system	$= 1.37 \text{ kg/m}^2$
Module area	$A_M = 1.82 \text{ m}^2$	Total Dead Weight (excl. ballast)	$= 0.12 \text{ kN/m}^2$



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 variable	$\kappa_{FI,Q}$	0.85
Characteristic dead weight	G_k	
Characteristic snow load on the roof	$S_{i,n}$	
Characteristic wind load	W_k	
Load case combination 00:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$	
Load case combination 02:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$	
Load case combination 03:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$	
Load case combination 04:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$	
Load case combination 05:		
Load case combination 06:	$E_d = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$	

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 00:	$E_d = G_k$	
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:	$E_d = G_k + W_{k,Suction}$	

MAXIMUM LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [kN/m ²]				Serviceability [kN/m ²]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
ridge	10.00	0.728	0.361	-0.537	0.068	0.576	0.286	-0.400	0.068
corner region (eave)	10.00	0.849	0.361	-0.740	0.068	0.671	0.286	-0.560	0.068
eaves	10.00	0.849	0.361	-0.537	0.068	0.671	0.286	-0.400	0.068

MAX. LOAD ON FASTENER

Array	A-TrA [m ²]	ultimate state [kN]				Serviceability [kN]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
ridge	10.00	0.562	0.279	-0.415	0.052	0.445	0.221	-0.309	0.052
corner region (eave)	10.00	0.656	0.279	-0.572	0.052	0.518	0.221	-0.432	0.052
eaves	10.00	0.656	0.279	-0.415	0.052	0.518	0.221	-0.309	0.052

RESISTANCE VALUES OF COMPONENTS

BASE RAILS

No. Module Array	Base Rails	A [cm ²]	I _y [cm ⁴]	I _z [cm ⁴]	W _y [cm ³]	W _z [cm ³]
1 - 2	K2 SolidRail UltraLight 32	2.610	2.59	5.54	1.57	2.84

FASTENER

No. Module Array	Fastener	R _{D,Suction,Perpendicular} [kN]	R _{D,Pressure,Perpendicular} [kN]	R _{D,Pressure,Parallel} [kN]
1 - 2	SolidHook Flat Tile H33/119 75x4	0.81	0.73	2.00

UTILISATION RESULT

Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		CL Lmax[m]	Fst Fst Dmax[m]
		Pr σ [%]	CL σ [%]	Fst F [%]		Fst [m]	BR [m]		
1	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
1	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
1	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
2	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890

Pr	Profile
Fst	Fastener
σ	Tension
f	Deflection
F	Force
CL/Lmax [m]	maximum cantilever length
Fst Dmax [m]	maximum fastener spacing
BR	Base Rail
UR	Upper rail
Usab.	serviceability limit state
CL	Cantilever

THE SYSTEM HAS BEEN SUCCESSFULLY CALCULATED.



BILL OF MATERIALS (ROOF 7)

Position	Item no.	Item description	Quantity	Weight
1	2003073	SolidHook Flat Tile H33/119 75x4	20	19.9 kg
2	1000041	T-Bolt 28/15 M10x30	20	0.6 kg
3	1000042	Hexagon flange nut M10	20	0.2 kg
4	2004112	Heco-Topix Plus wood screw 8x100	40	1.1 kg
5	1005158	MiddleClamp XS Black Set 34-38	8	0.6 kg
6	1005268	EndClamp Black Set 34-36	8	0.6 kg
7	2002870	K2 Solar Cable Manager	6	0.0 kg
8	2003228	SolidRail UltraLight; 3.30 m	4	9.2 kg
Total				32.2 kg



PROJECT DATA (ROOF 8)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	S-Dome 6.10 Classic
Customer	CorEnergy
Author	Hugo Silva

REMARKS

Best assumptions made for any missing information

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
Ground elevation	37.00 m
Roof type	Flat roof
Fastening method	with Ballast
Roof covering	Flat
Building height	10.80 m
Parapet wall height	0.10 m
Roof pitch	1 °
Min. roof edge distance	0.60 m
Material	Single ply membrane
Friction coefficient	0.50
Terrain category	Town Terrain

The friction coefficients given here must be checked onsite. If a lower value is found, this must be specified here for the ballast calculation!

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years
Terrain category	Town Terrain		
distance to shoreline	46.48 km		
distance inside town terrain	10.50 km		
Peak velocity pressure	$q_{p,25} = 0.597 \text{ kN/m}^2$		
Snow load zone	3		
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$		

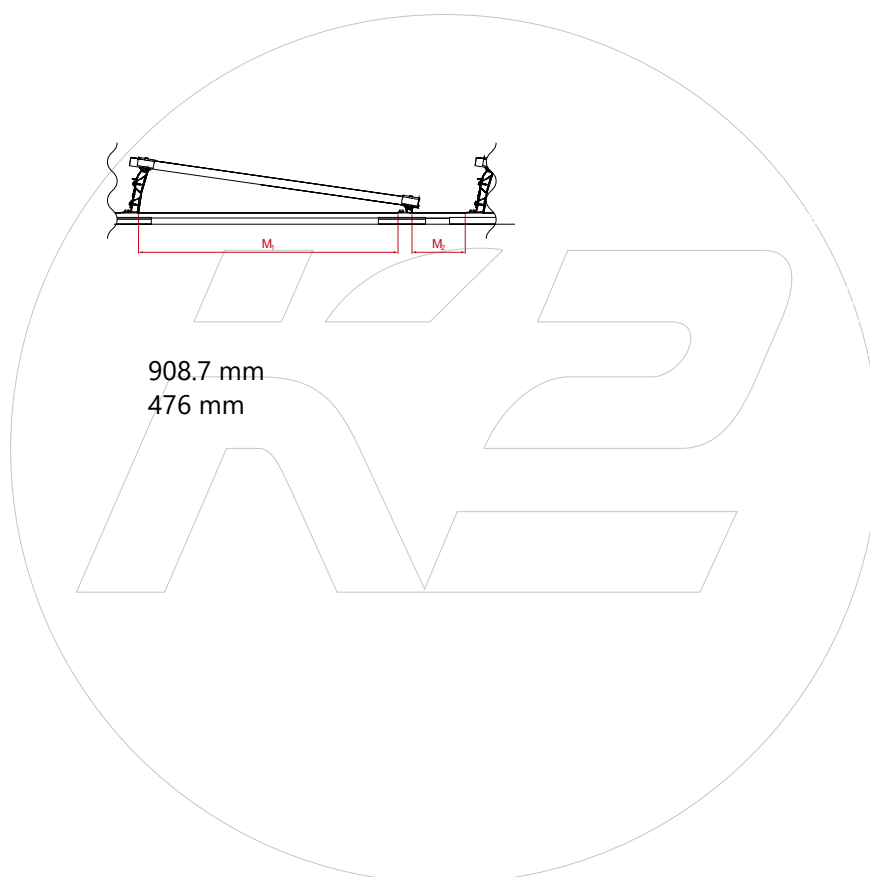
MODULES

Manufacturer	Longi Solar	Quantity	9
Name	LR4-60HPH-375M	Total output power	3.375 kWp
Dimensions LxWxH	1755 x 1038 x 35.00 mm	Panel Tilt	9.5 °
Weight	19.5 kg		
Output power	375 W		

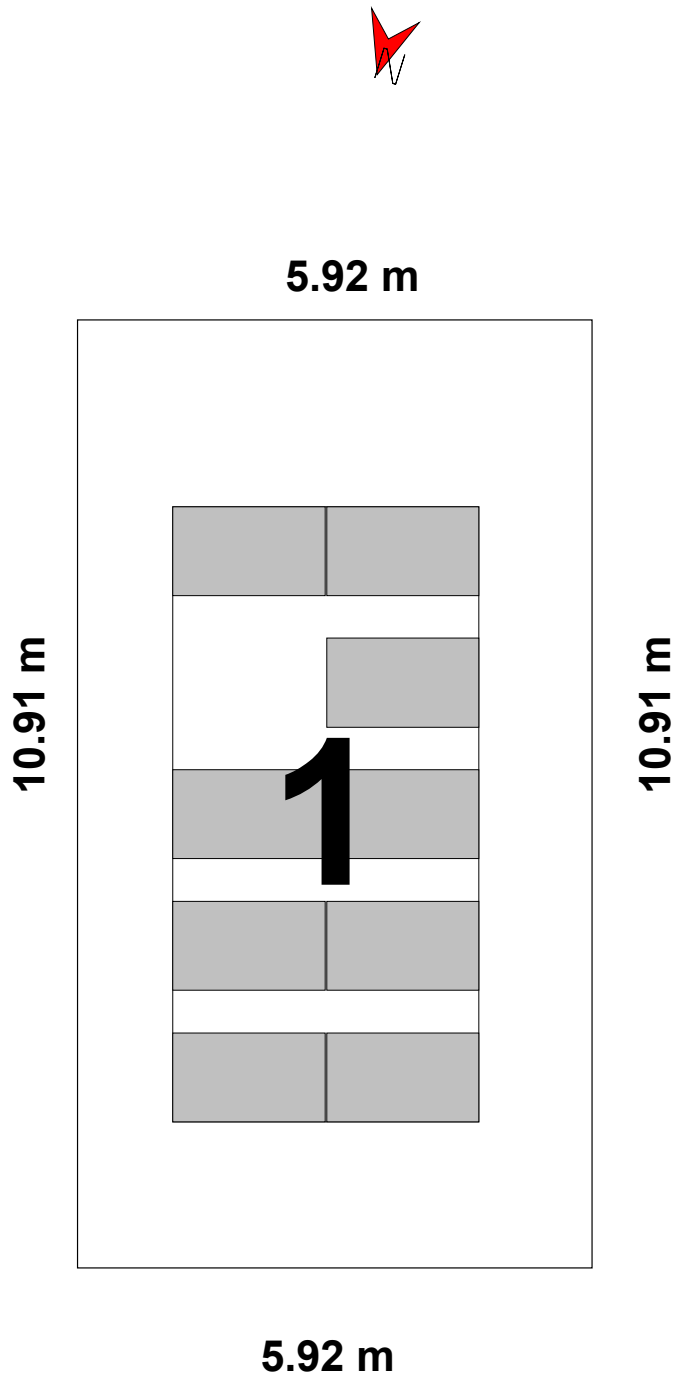
PRE-ASSEMBLY / ASSEMBLY INSTRUCTIONS (ROOF 8)

Module Array 1

M1
M2



ASSEMBLY PLAN (ROOF 8)



Dimensions in [m]

Type	Whole Rails			Rail cutting		
	Total Rail / m	Quantity 3.30 m	Quantity 4.40 m	Part of / m	Length / m	Rest / m
A	4.530	1		3.300	1.230	2.060
B	1.500			3.300	1.500	1.790
C	7.560		1	3.300	3.160	0.130



LEGEND

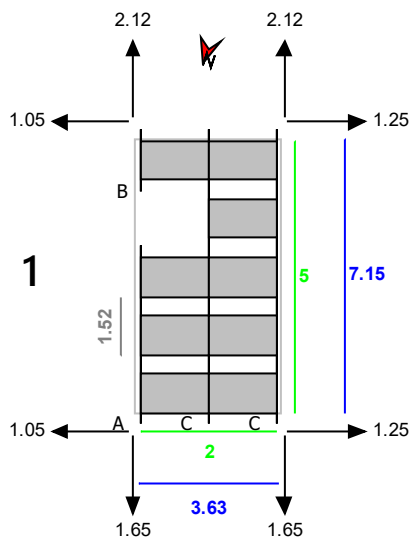
Distance to neighbouring module array [m]

Distance to roof edge [m]

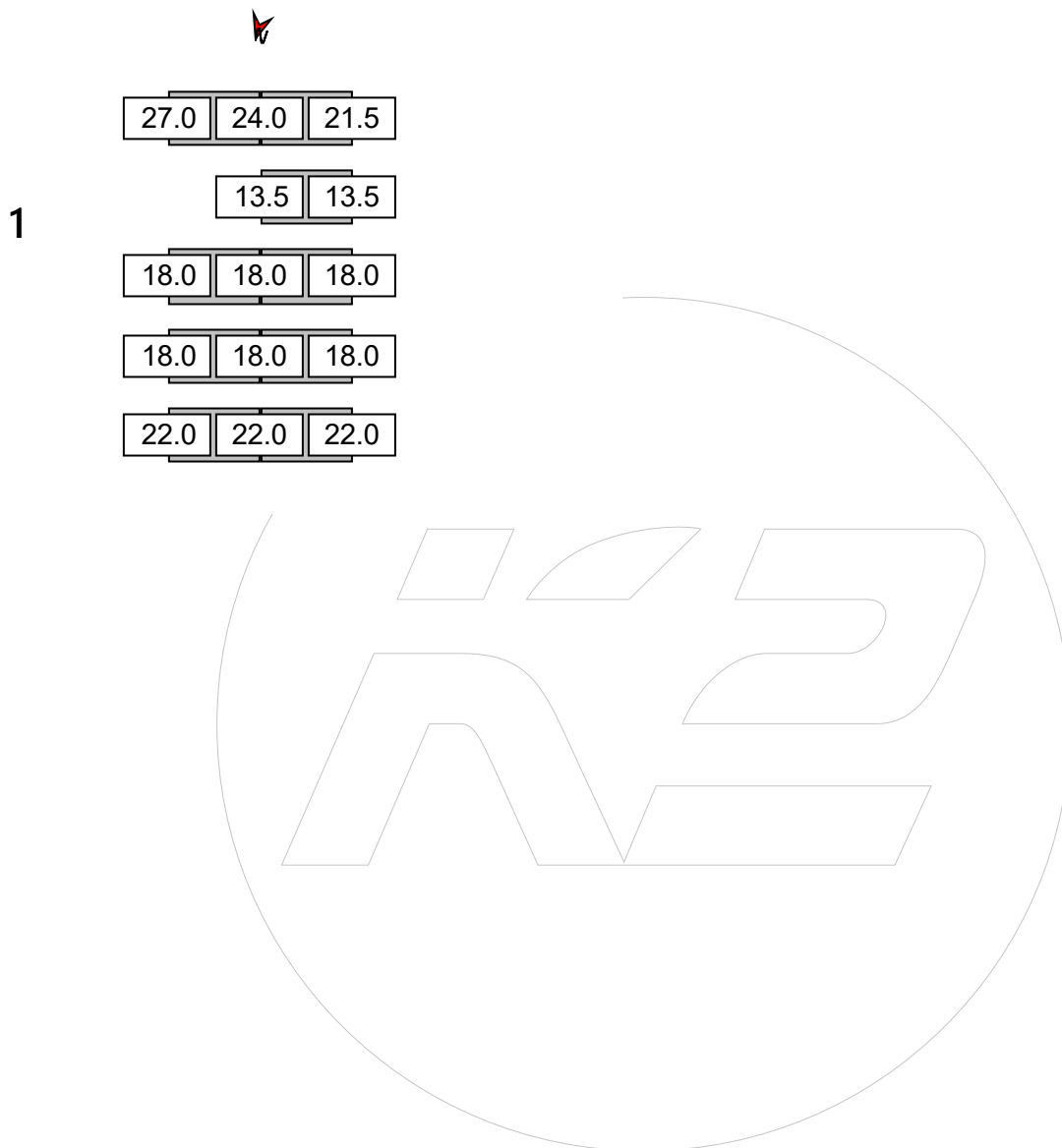
Number of modules

Length/width of module array [m]

Row distance [m]



BALLAST PLAN (ROOF 8)



RESULTS (ROOF 8)

BALLAST CAPACITY

Speed Porter	40.0 kg
Porter	108.0 kg
module clamp	MiniClamp MC Set 30-50
end clamp	MiniClamp EC Set 30-50

VERIFICATION SYSTEM UTILISATION

Verification system utilisation [%]	pressure	22.21
	suction	32.40
Loads on modules (ultimate state) [Pa]	pressure	1321
	suction	-842
Loads on modules (Serviceability) [Pa]	pressure	989
	suction	-589

SPECIFIC LOADS

Index (module block)	No. of modules (module block)	---	---	Ballast [kg] (module block)	Dead weight [kg] (module block)	Dead Load [kN/m ²] (module block)	Dead Load [kN/m ²] (roof surface area)	Own weight [kN/m ²]
module array 1	9	---	---	273.5	485.9	0.21	---	---
all Blocks	9	---	---	273.5	485.9	---	0.07	---

NOTES

- The proof of position safety and load capacity of the system are carried out by checking the load cases lifting and shifting by wind and by further static calculations. You will find a short version of the wind tunnel report and a certificate for the further static calculations on our homepage.
- The structural design complies with BS EN 1990 - Basics 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 8)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	S-Dome 6.10 Classic
Customer	CorEnergy
Author	Hugo Silva

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
Ground elevation	37.00 m
Roof type	Flat roof
Fastening method	with Ballast
Roof covering	Flat
Building height	10.80 m
Parapet wall height	0.10 m
Roof pitch	1 °
Min. roof edge distance	0.60 m
Material	Single ply membrane
Friction coefficient	0.50
Terrain category	Town Terrain



LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years

Terrain category Town Terrain

distance to shoreline 46.48 km

distance inside town terrain 10.50 km

Peak velocity pressure $q_{p,50} = 0.648 \text{ kN/m}^2$

Adjustment factor for service life $f_w = 0.921$

Peak velocity pressure $q_{p,25} = 0.597 \text{ kN/m}^2$

Snow load zone 3

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 $d_i = 0.000$

Snow load on roof $s_{i,50} = 0.000 \text{ kN/m}^2$

Adjustment factor for service life $f_s = 0.929$

Snow load on roof $s_{i,25} = 0.372 \text{ kN/m}^2$

DEAD LOAD

Weight module	$G_M = 19.5 \text{ kg}$	Dead weight module	$= 10.70 \text{ kg/m}^2$
Weight mounting system per module area	$= 4.1 \text{ kg}$	Dead weight mounting system	$= 2.25 \text{ kg/m}^2$
Module area	$A_M = 1.82 \text{ m}^2$	Total Dead Weight (excl. ballast)	$= 0.13 \text{ kN/m}^2$

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 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 variable	$\kappa_{FI,Q}$	0.85
Characteristic dead weight	G_k	
Characteristic snow load on the roof	$S_{i,n}$	
Characteristic wind load	W_k	

Load case combination 00:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$
Load case combination 02:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$
Load case combination 03:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$
Load case combination 04:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$

Load case combination 06:	$E_d = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$
---------------------------	---

Uplift Verification:	$E_d = \gamma_{G,stab} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,n,Uplift}$
----------------------	---

Displacement verification:	$E_d = \gamma_{G,stab} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,n,Displacement}$
----------------------------	---

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 00: $E_d = G_k$

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: $E_d = G_k + W_{k,Pressure} + \psi_{0,S} * S_{i,n}$

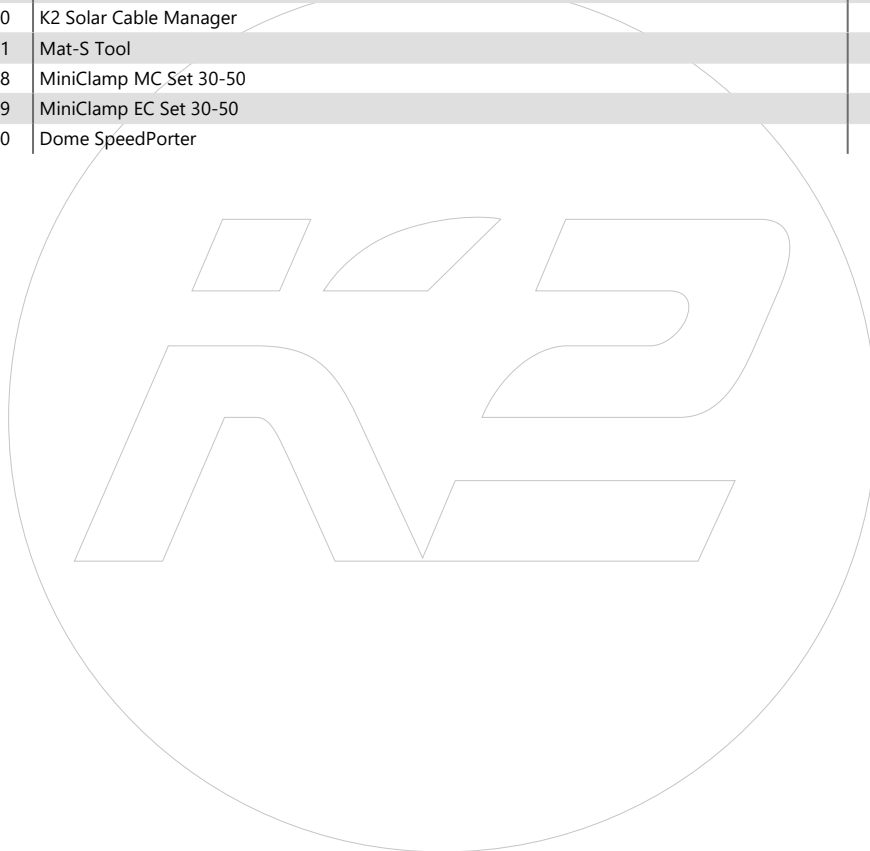
Load case combination 04: $E_d = G_k + S_{i,n} + \psi_{0,W} * W_{k,Pressure}$

Load case combination 06: $E_d = G_k + W_{k,Suction}$

THE SYSTEM HAS BEEN SUCCESSFULLY CALCULATED.

BILL OF MATERIALS (ROOF 8)

Position	Item no.	Item description	Quantity	Weight
1	2004125	Dome 6.10 Peak	14	4.2 kg
2	1001643	MK2	28	0.5 kg
3	2001729	Socket Head Bolt serrated M8x20	28	0.4 kg
4	2003243	Dome 6.10 SD	14	4.2 kg
5	2003126	Dome Mat S 380	28	10.3 kg
6	2003249	S-Dome 6.10 Windbreaker short	9	16.2 kg
7	1005207	Thread-forming metal screw 6.0x25	28	0.2 kg
8	2003239	SpeedRail 22; 3.30 m	5	10.6 kg
9	2003240	SpeedRail 22; 4.40 m	2	5.7 kg
10	1006039	Dome FlatConnector Set	3	0.6 kg
11	2002870	K2 Solar Cable Manager	9	0.0 kg
12	2004141	Mat-S Tool	1	0.0 kg
13	2002558	MiniClamp MC Set 30-50	8	0.5 kg
14	2002559	MiniClamp EC Set 30-50	20	1.3 kg
15	2002300	Dome SpeedPorter	28	2.1 kg
Total				56.8 kg



PROJECT DATA (ROOF 9)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	S-Dome 6.10 Classic
Customer	CorEnergy
Author	Hugo Silva

REMARKS

Best assumptions made for any missing information

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
Ground elevation	37.00 m
Roof type	Flat roof
Fastening method	with Ballast
Roof covering	Flat
Building height	10.80 m
Parapet wall height	0.10 m
Roof pitch	1 °
Min. roof edge distance	0.60 m
Material	Single ply membrane
Friction coefficient	0.50
Terrain category	Town Terrain

The friction coefficients given here must be checked onsite. If a lower value is found, this must be specified here for the ballast calculation!

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years
Terrain category	Town Terrain		
distance to shoreline	46.48 km		
distance inside town terrain	10.50 km		
Peak velocity pressure	$q_{p,25} = 0.597 \text{ kN/m}^2$		
Snow load zone	3		
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$		

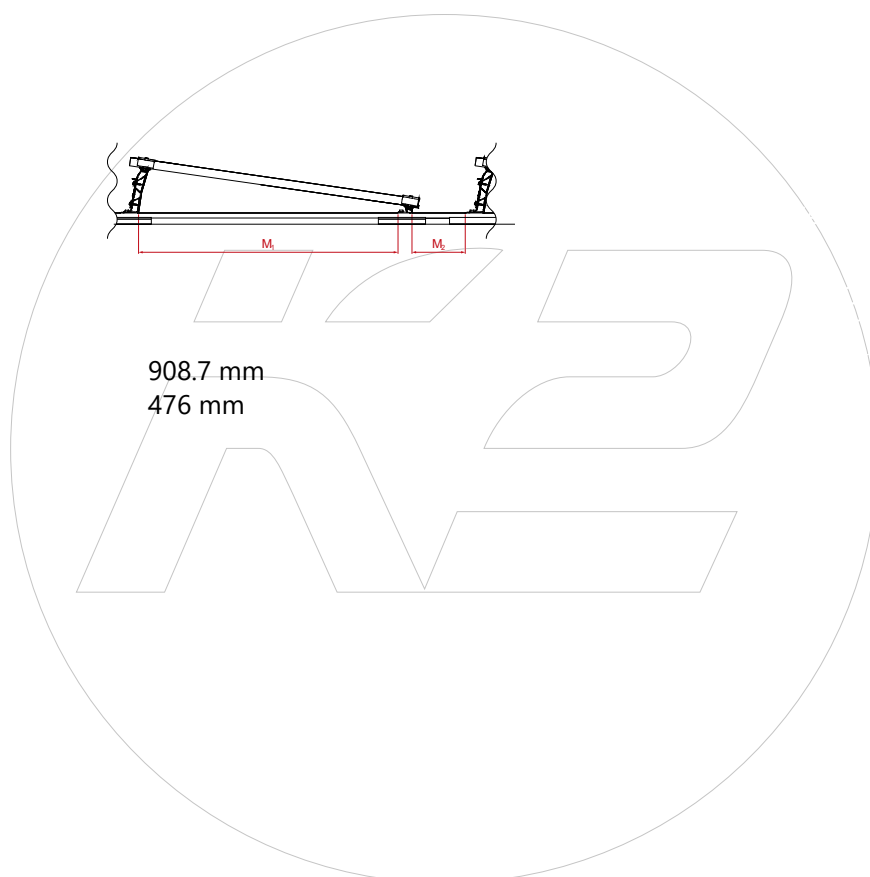
MODULES

Manufacturer	Longi Solar	Quantity	12
Name	LR4-60HPH-375M	Total output power	4.500 kWp
Dimensions LxWxH	1755 x 1038 x 35.00 mm	Panel Tilt	9.5 °
Weight	19.5 kg		
Output power	375 W		

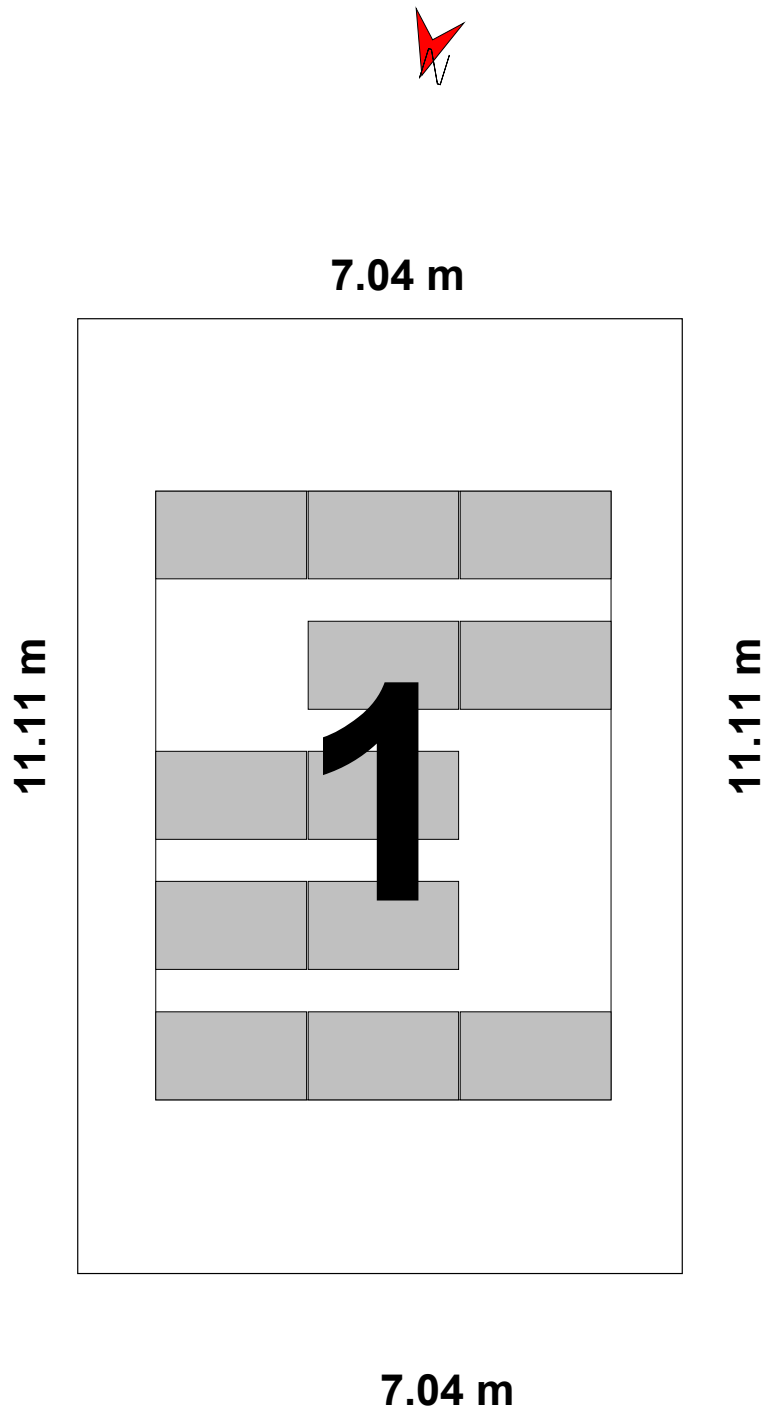
PRE-ASSEMBLY / ASSEMBLY INSTRUCTIONS (ROOF 9)

Module Array 1

M1
M2



ASSEMBLY PLAN (ROOF 9)



Dimensions in [m]

Type	Whole Rails			Rail cutting		
	Total Rail / m	Quantity 3.30 m	Quantity 4.40 m	Part of / m	Length / m	Rest / m
A	4.530	1		3.300	1.230	2.060
B	1.500			3.300	1.500	1.790
C	7.560		1	3.300	3.160	0.130
D	3.015			3.300	3.015	0.275



LEGEND

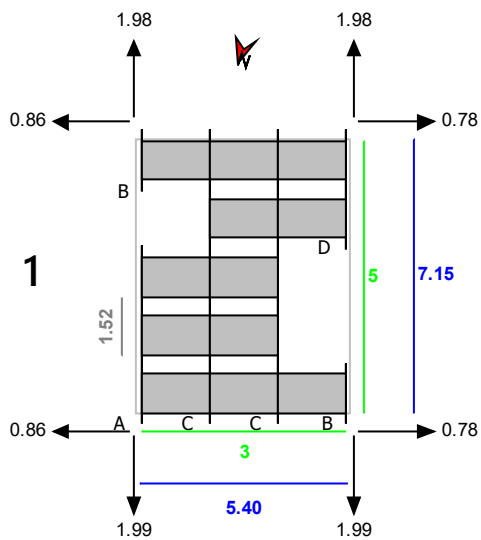
Distance to neighbouring module array [m]

Distance to roof edge [m]

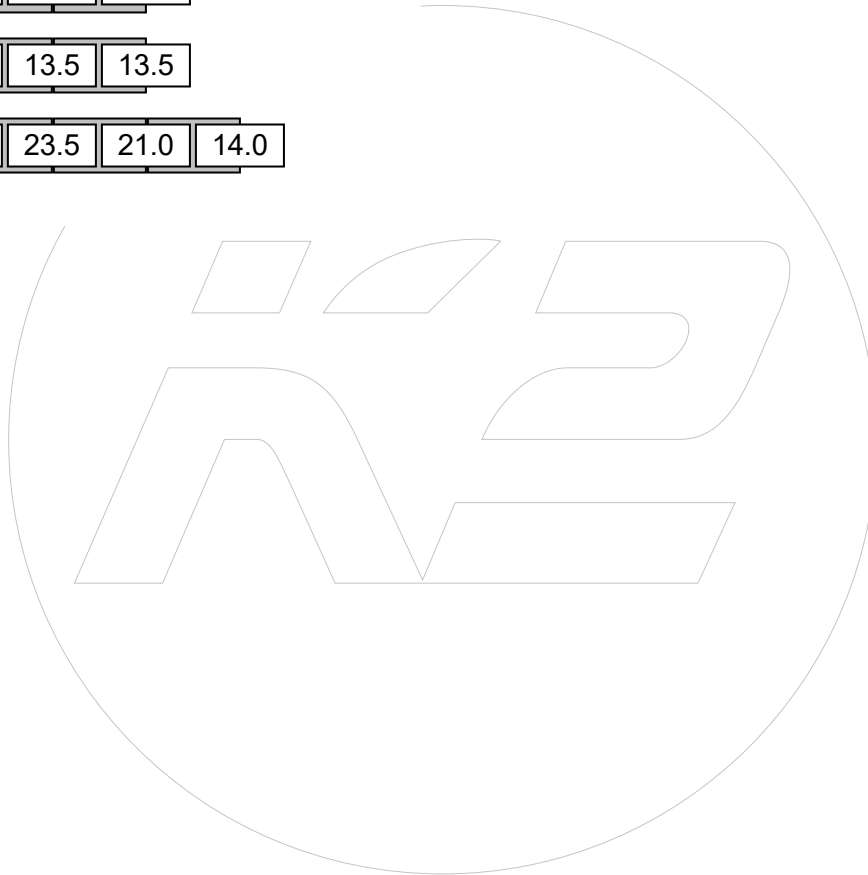
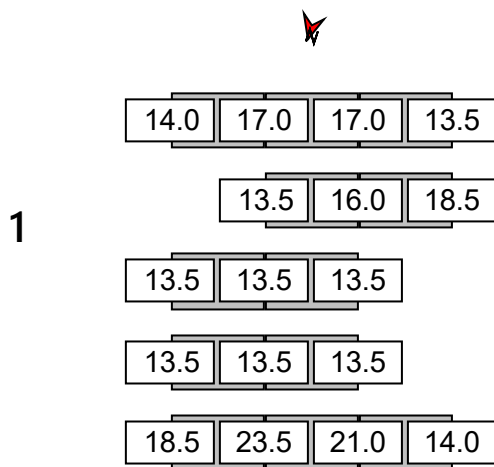
Number of modules

Length/width of module array [m]

Row distance [m]



BALLAST PLAN (ROOF 9)



RESULTS (ROOF 9)

BALLAST CAPACITY

Speed Porter	40.0 kg
Porter	108.0 kg
module clamp	MiniClamp MC Set 30-50
end clamp	MiniClamp EC Set 30-50

VERIFICATION SYSTEM UTILISATION

Verification system utilisation [%]	pressure	22.21
	suction	32.40
Loads on modules (ultimate state) [Pa]	pressure	1321
	suction	-842
Loads on modules (Serviceability) [Pa]	pressure	989
	suction	-589

SPECIFIC LOADS

Index (module block)	No. of modules (module block)	---	---	Ballast [kg] (module block)	Dead weight [kg] (module block)	Dead Load [kN/m ²] (module block)	Dead Load [kN/m ²] (roof surface area)	Own weight [kN/m ²]
module array 1	12	---	---	267.5	550.7	0.19	---	---
all Blocks	12	---	---	267.5	550.7	---	0.07	---

NOTES

- The proof of position safety and load capacity of the system are carried out by checking the load cases lifting and shifting by wind and by further static calculations. You will find a short version of the wind tunnel report and a certificate for the further static calculations on our homepage.
- The structural design complies with BS EN 1990 - Basics 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 9)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	S-Dome 6.10 Classic
Customer	CorEnergy
Author	Hugo Silva

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
Ground elevation	37.00 m
Roof type	Flat roof
Fastening method	with Ballast
Roof covering	Flat
Building height	10.80 m
Parapet wall height	0.10 m
Roof pitch	1 °
Min. roof edge distance	0.60 m
Material	Single ply membrane
Friction coefficient	0.50
Terrain category	Town Terrain



LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years

Terrain category Town Terrain

distance to shoreline 46.48 km

distance inside town terrain 10.50 km

Peak velocity pressure $q_{p,50} = 0.648 \text{ kN/m}^2$

Adjustment factor for service life $f_w = 0.921$

Peak velocity pressure $q_{p,25} = 0.597 \text{ kN/m}^2$

Snow load zone 3

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 $d_i = 0.000$

Snow load on roof $s_{i,50} = 0.000 \text{ kN/m}^2$

Adjustment factor for service life $f_s = 0.929$

Snow load on roof $s_{i,25} = 0.372 \text{ kN/m}^2$

DEAD LOAD

Weight module	$G_M = 19.5 \text{ kg}$	Dead weight module	$= 10.70 \text{ kg/m}^2$
Weight mounting system per module area	$= 4.1 \text{ kg}$	Dead weight mounting system	$= 2.25 \text{ kg/m}^2$
Module area	$A_M = 1.82 \text{ m}^2$	Total Dead Weight (excl. ballast)	$= 0.13 \text{ kN/m}^2$

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 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 variable	$\kappa_{FI,Q}$	0.85
Characteristic dead weight	G_k	
Characteristic snow load on the roof	$S_{i,n}$	
Characteristic wind load	W_k	

Load case combination 00:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$
Load case combination 02:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$
Load case combination 03:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$
Load case combination 04:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$

Load case combination 06:	$E_d = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$
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Uplift Verification:	$E_d = \gamma_{G,stab} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,n,Uplift}$
----------------------	---

Displacement verification:	$E_d = \gamma_{G,stab} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,n,Displacement}$
----------------------------	---

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 00: $E_d = G_k$

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: $E_d = G_k + W_{k,Pressure} + \psi_{0,S} * S_{i,n}$

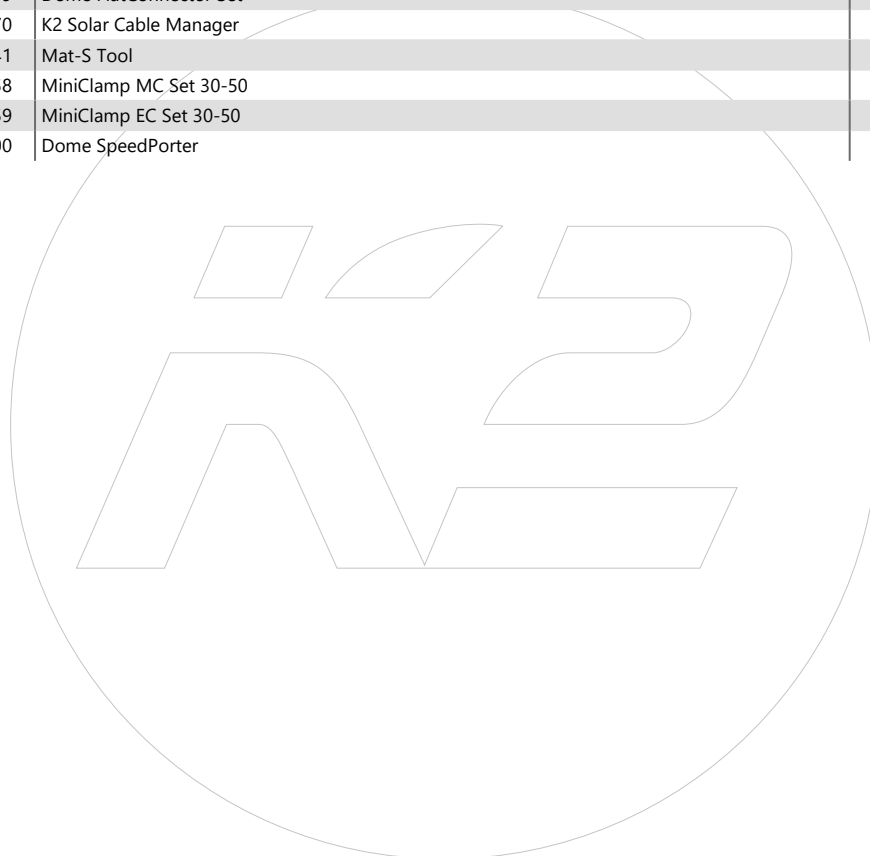
Load case combination 04: $E_d = G_k + S_{i,n} + \psi_{0,W} * W_{k,Pressure}$

Load case combination 06: $E_d = G_k + W_{k,Suction}$

THE SYSTEM HAS BEEN SUCCESSFULLY CALCULATED.

BILL OF MATERIALS (ROOF 9)

Position	Item no.	Item description	Quantity	Weight
1	2004125	Dome 6.10 Peak	17	5.1 kg
2	1001643	MK2	34	0.6 kg
3	2001729	Socket Head Bolt serrated M8x20	34	0.4 kg
4	2003243	Dome 6.10 SD	17	5.2 kg
5	2003126	Dome Mat S 380	34	12.5 kg
6	2003249	S-Dome 6.10 Windbreaker short	12	21.6 kg
7	1005207	Thread-forming metal screw 6.0x25	34	0.2 kg
8	2003239	SpeedRail 22; 3.30 m	7	14.9 kg
9	2003240	SpeedRail 22; 4.40 m	2	5.7 kg
10	1006039	Dome FlatConnector Set	3	0.6 kg
11	2002870	K2 Solar Cable Manager	12	0.0 kg
12	2004141	Mat-S Tool	1	0.0 kg
13	2002558	MiniClamp MC Set 30-50	14	0.8 kg
14	2002559	MiniClamp EC Set 30-50	20	1.3 kg
15	2002300	Dome SpeedPorter	34	2.6 kg
Total				71.5 kg



PROJECT DATA (ROOF 10)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	S-Dome 6.10 Classic
Customer	CorEnergy
Author	Hugo Silva

REMARKS

Best assumptions made for any missing information

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
Ground elevation	37.00 m
Roof type	Flat roof
Fastening method	with Ballast
Roof covering	Flat
Building height	10.80 m
Parapet wall height	0.10 m
Roof pitch	1 °
Min. roof edge distance	0.60 m
Material	Single ply membrane
Friction coefficient	0.50
Terrain category	Town Terrain

The friction coefficients given here must be checked onsite. If a lower value is found, this must be specified here for the ballast calculation!

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years
Terrain category	Town Terrain		
distance to shoreline	46.48 km		
distance inside town terrain	10.50 km		
Peak velocity pressure	$q_{p,25} = 0.597 \text{ kN/m}^2$		
Snow load zone	3		
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$		

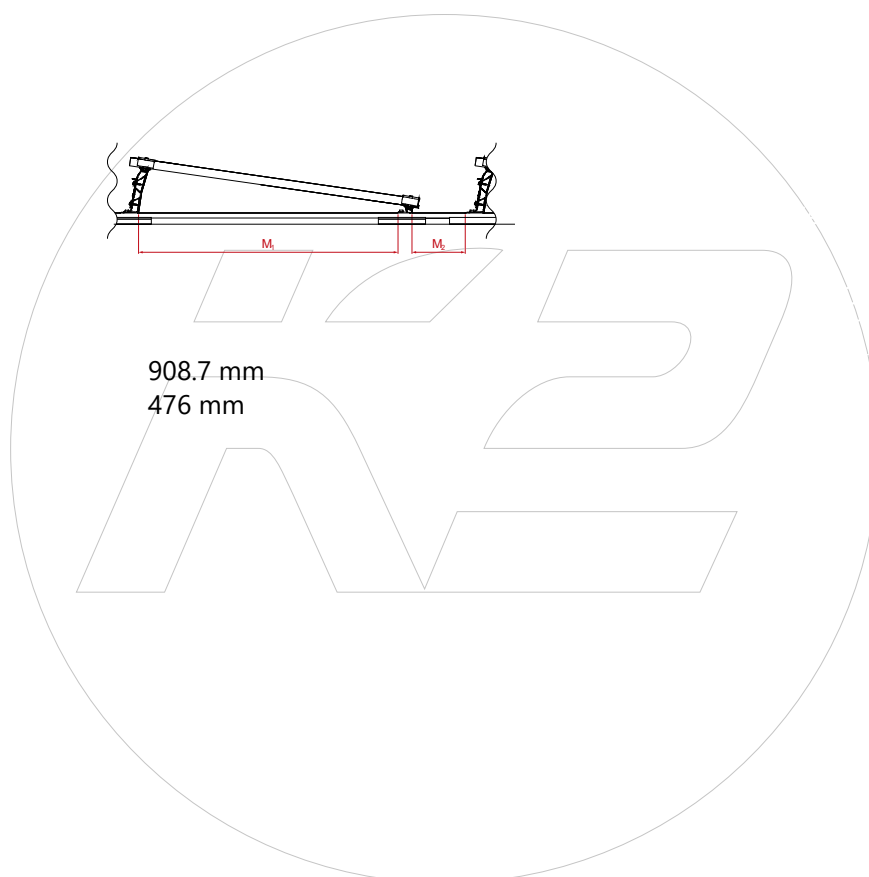
MODULES

Manufacturer	Longi Solar	Quantity	12
Name	LR4-60HPH-375M	Total output power	4.500 kWp
Dimensions LxWxH	1755 x 1038 x 35.00 mm	Panel Tilt	9.5 °
Weight	19.5 kg		
Output power	375 W		

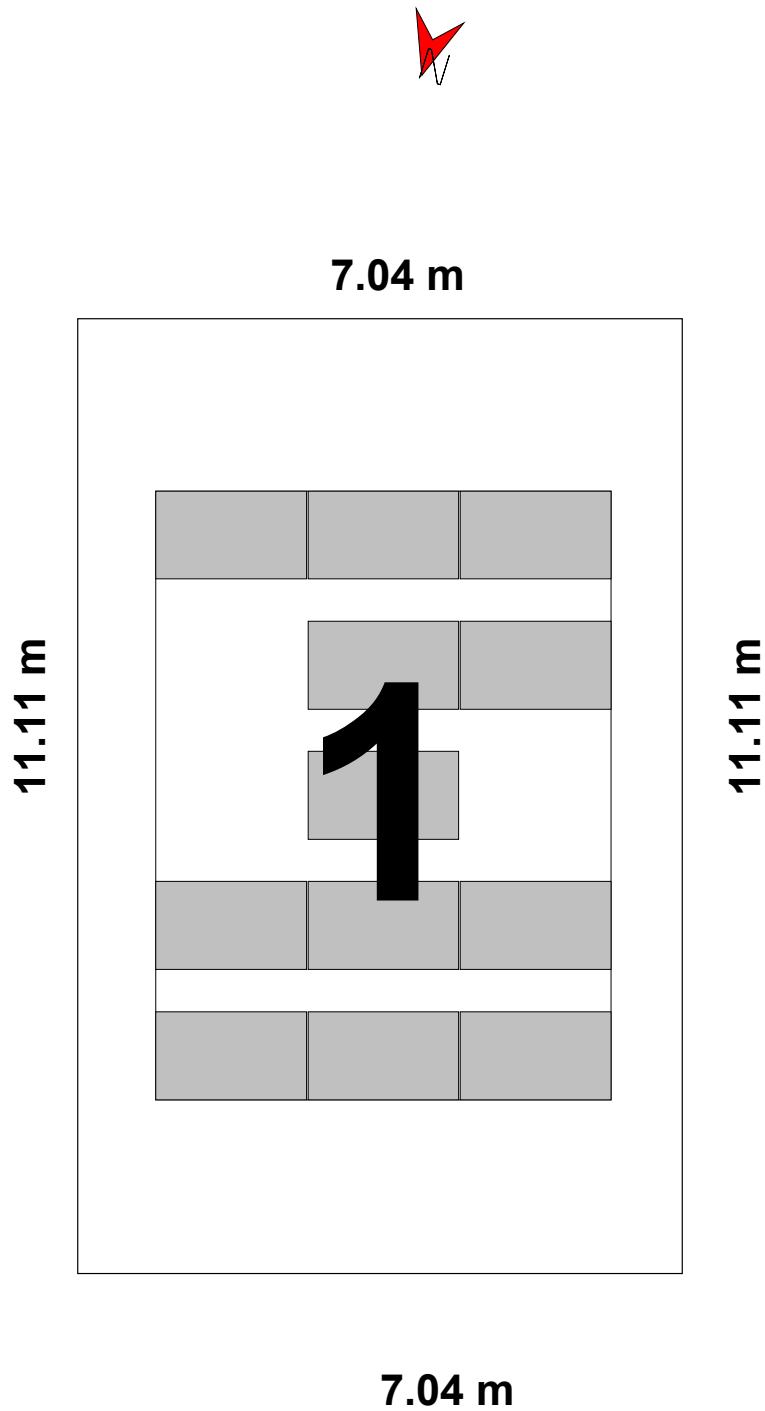
PRE-ASSEMBLY / ASSEMBLY INSTRUCTIONS (ROOF 10)

Module Array 1

M1
M2



ASSEMBLY PLAN (ROOF 10)



Dimensions in [m]

Type	Whole Rails			Rail cutting		
	Total Rail / m	Quantity 3.30 m	Quantity 4.40 m	Part of / m	Length / m	Rest / m
A	3.015			3.300	3.015	0.275
B	1.500			3.300	1.500	1.790
C	7.560		1	3.300	3.160	0.130



LEGEND

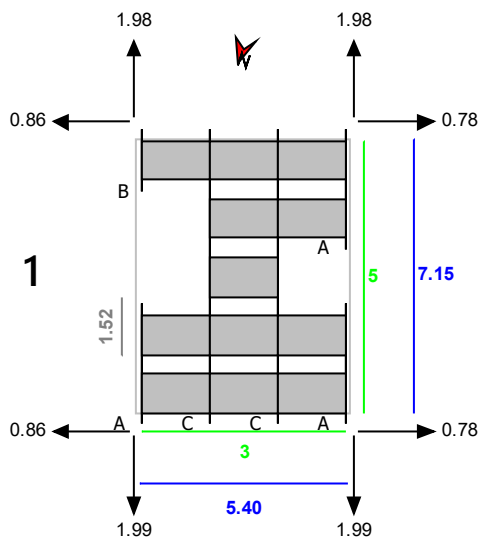
Distance to neighbouring module array [m]

Distance to roof edge [m]

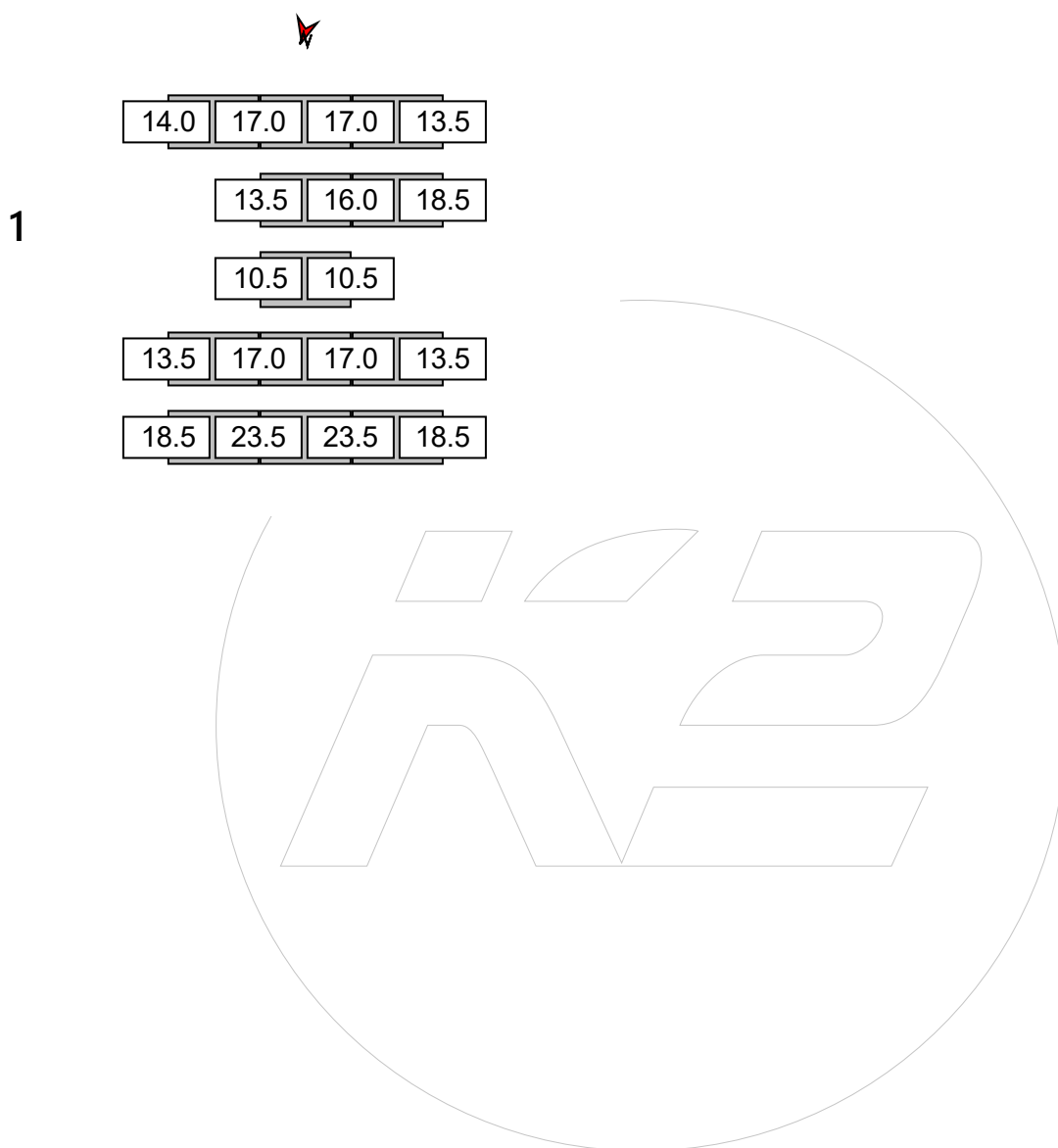
Number of modules

Length/width of module array [m]

Row distance [m]



BALLAST PLAN (ROOF 10)



RESULTS (ROOF 10)

BALLAST CAPACITY

Speed Porter	40.0 kg
Porter	108.0 kg
module clamp	MiniClamp MC Set 30-50
end clamp	MiniClamp EC Set 30-50

VERIFICATION SYSTEM UTILISATION

Verification system utilisation [%]	pressure	22.21
	suction	32.40
Loads on modules (ultimate state) [Pa]	pressure	1321
	suction	-842
Loads on modules (Serviceability) [Pa]	pressure	989
	suction	-589

SPECIFIC LOADS

Index (module block)	No. of modules (module block)	---	---	Ballast [kg] (module block)	Dead weight [kg] (module block)	Dead Load [kN/m ²] (module block)	Dead Load [kN/m ²] (roof surface area)	Own weight [kN/m ²]
module array 1	12	---	---	275.5	558.7	0.19	---	---
all Blocks	12	---	---	275.5	558.7	---	0.07	---

NOTES

- The proof of position safety and load capacity of the system are carried out by checking the load cases lifting and shifting by wind and by further static calculations. You will find a short version of the wind tunnel report and a certificate for the further static calculations on our homepage.
- The structural design complies with BS EN 1990 - Basics 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 10)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	S-Dome 6.10 Classic
Customer	CorEnergy
Author	Hugo Silva

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
Ground elevation	37.00 m
Roof type	Flat roof
Fastening method	with Ballast
Roof covering	Flat
Building height	10.80 m
Parapet wall height	0.10 m
Roof pitch	1 °
Min. roof edge distance	0.60 m
Material	Single ply membrane
Friction coefficient	0.50
Terrain category	Town Terrain



LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years

Terrain category Town Terrain

distance to shoreline 46.48 km

distance inside town terrain 10.50 km

Peak velocity pressure $q_{p,50} = 0.648 \text{ kN/m}^2$

Adjustment factor for service life $f_w = 0.921$

Peak velocity pressure $q_{p,25} = 0.597 \text{ kN/m}^2$

Snow load zone 3

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 $d_i = 0.000$

Snow load on roof $s_{i,50} = 0.000 \text{ kN/m}^2$

Adjustment factor for service life $f_s = 0.929$

Snow load on roof $s_{i,25} = 0.372 \text{ kN/m}^2$

DEAD LOAD

Weight module	$G_M = 19.5 \text{ kg}$	Dead weight module	$= 10.70 \text{ kg/m}^2$
Weight mounting system per module area	$= 4.1 \text{ kg}$	Dead weight mounting system	$= 2.25 \text{ kg/m}^2$
Module area	$A_M = 1.82 \text{ m}^2$	Total Dead Weight (excl. ballast)	$= 0.13 \text{ kN/m}^2$

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 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 variable	$\kappa_{FI,Q}$	0.85
Characteristic dead weight	G_k	
Characteristic snow load on the roof	$S_{i,n}$	
Characteristic wind load	W_k	

Load case combination 00:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$
Load case combination 02:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$
Load case combination 03:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$
Load case combination 04:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$

Load case combination 06:	$E_d = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$
---------------------------	---

Uplift Verification:	$E_d = \gamma_{G,stab} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,n,Uplift}$
----------------------	---

Displacement verification:	$E_d = \gamma_{G,stab} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,n,Displacement}$
----------------------------	---

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 00: $E_d = G_k$

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: $E_d = G_k + W_{k,Pressure} + \psi_{0,S} * S_{i,n}$

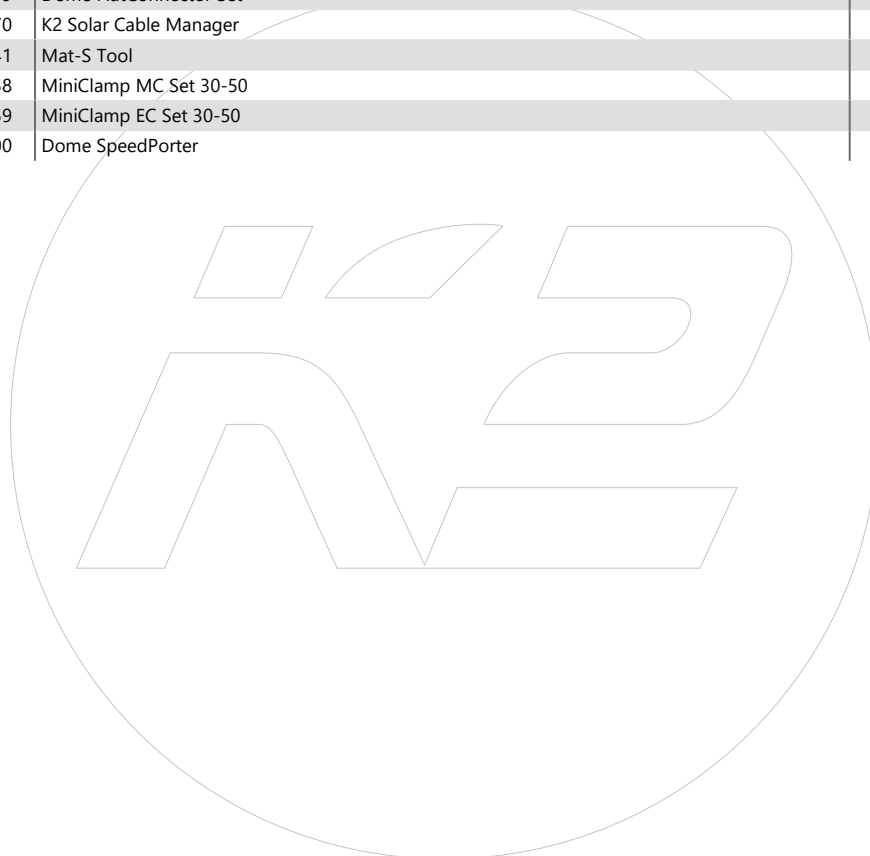
Load case combination 04: $E_d = G_k + S_{i,n} + \psi_{0,W} * W_{k,Pressure}$

Load case combination 06: $E_d = G_k + W_{k,Suction}$

THE SYSTEM HAS BEEN SUCCESSFULLY CALCULATED.

BILL OF MATERIALS (ROOF 10)

Position	Item no.	Item description	Quantity	Weight
1	2004125	Dome 6.10 Peak	17	5.1 kg
2	1001643	MK2	34	0.6 kg
3	2001729	Socket Head Bolt serrated M8x20	34	0.4 kg
4	2003243	Dome 6.10 SD	17	5.2 kg
5	2003126	Dome Mat S 380	34	12.5 kg
6	2003249	S-Dome 6.10 Windbreaker short	12	21.6 kg
7	1005207	Thread-forming metal screw 6.0x25	34	0.2 kg
8	2003239	SpeedRail 22; 3.30 m	6	12.7 kg
9	2003240	SpeedRail 22; 4.40 m	2	5.7 kg
10	1006039	Dome FlatConnector Set	2	0.4 kg
11	2002870	K2 Solar Cable Manager	12	0.0 kg
12	2004141	Mat-S Tool	1	0.0 kg
13	2002558	MiniClamp MC Set 30-50	14	0.8 kg
14	2002559	MiniClamp EC Set 30-50	20	1.3 kg
15	2002300	Dome SpeedPorter	34	2.6 kg
Total				69.1 kg



PROJECT DATA (ROOF 11)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	S-Dome 6.10 Classic
Customer	CorEnergy
Author	Hugo Silva

REMARKS

Best assumptions made for any missing information

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
Ground elevation	37.00 m
Roof type	Flat roof
Fastening method	with Ballast
Roof covering	Flat
Building height	10.80 m
Parapet wall height	0.10 m
Roof pitch	1 °
Min. roof edge distance	0.60 m
Material	Single ply membrane
Friction coefficient	0.50
Terrain category	Town Terrain

The friction coefficients given here must be checked onsite. If a lower value is found, this must be specified here for the ballast calculation!

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years
Terrain category	Town Terrain		
distance to shoreline	46.48 km		
distance inside town terrain	10.50 km		
Peak velocity pressure	$q_{p,25} = 0.597 \text{ kN/m}^2$		
Snow load zone	3		
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$		

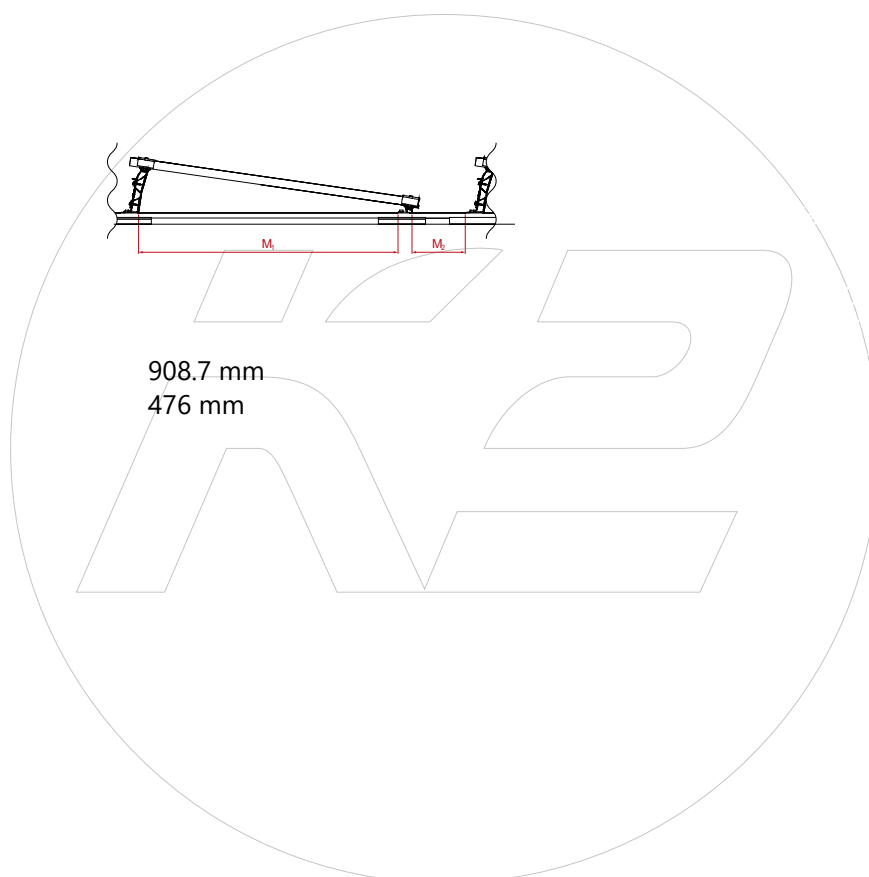
MODULES

Manufacturer	Longi Solar	Quantity	7
Name	LR4-60HPH-375M	Total output power	2.625 kWp
Dimensions LxWxH	1755 x 1038 x 35.00 mm	Panel Tilt	9.5 °
Weight	19.5 kg		
Output power	375 W		

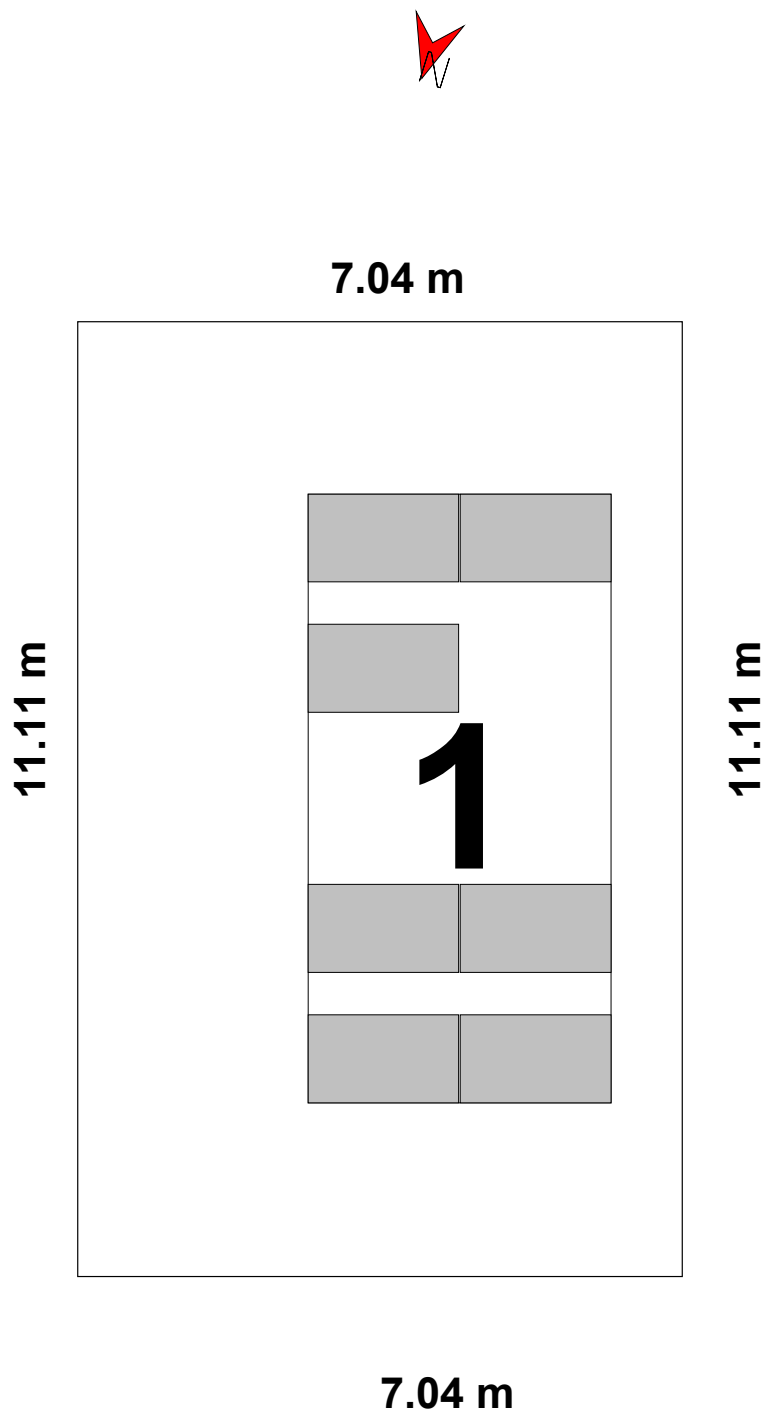
PRE-ASSEMBLY / ASSEMBLY INSTRUCTIONS (ROOF 11)

Module Array 1

M1
M2



ASSEMBLY PLAN (ROOF 11)



Dimensions in [m]

Type	Whole Rails			Rail cutting		
	Total Rail / m	Quantity 4.40 m	Quantity 3.30 m	Part of / m	Length / m	Rest / m
A	3.015			3.300	3.015	0.275
B	1.500			3.300	1.500	1.790



LEGEND

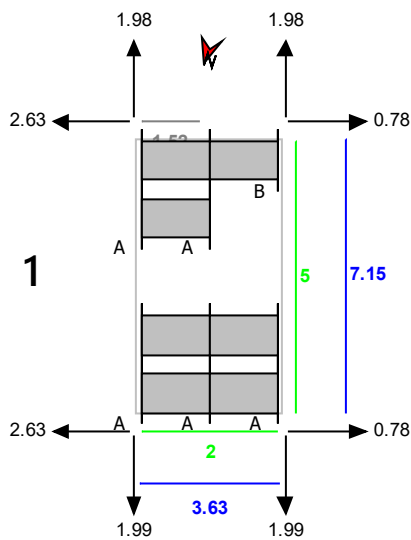
Distance to neighbouring module array [m]

Distance to roof edge [m]

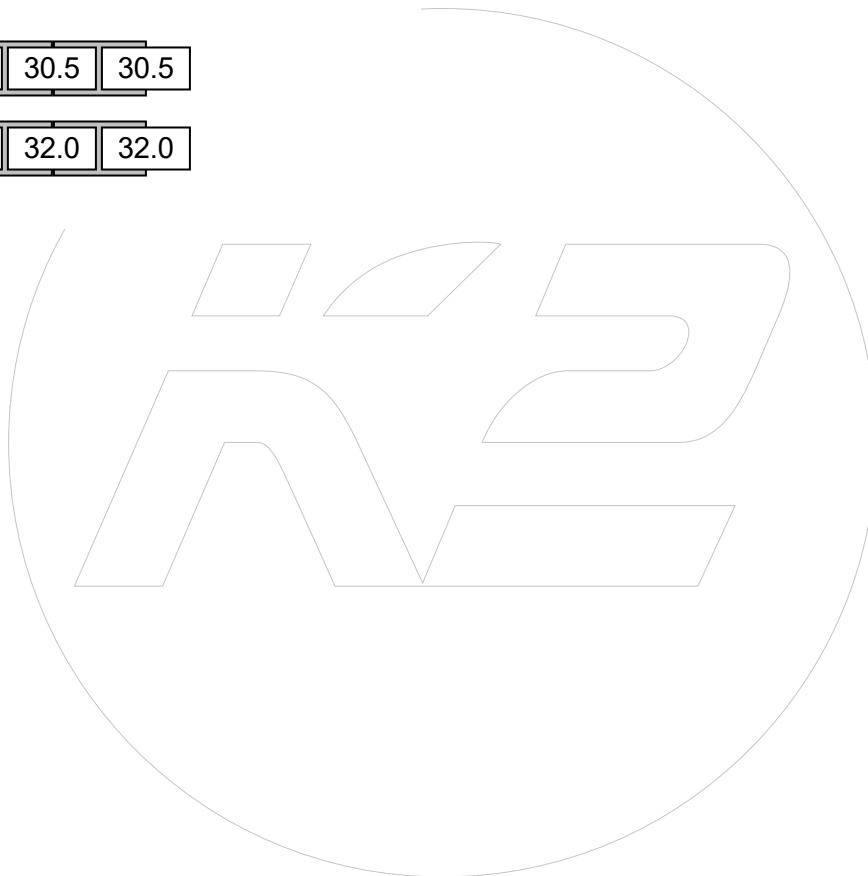
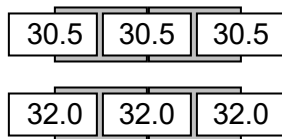
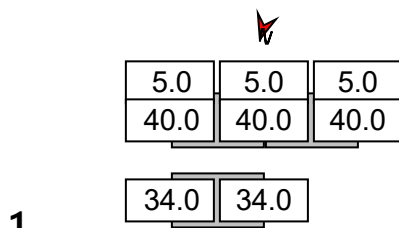
Number of modules

Length/width of module array [m]

Row distance [m]



BALLAST PLAN (ROOF 11)



RESULTS (ROOF 11)

BALLAST CAPACITY

Speed Porter	40.0 kg
Porter	108.0 kg
module clamp	MiniClamp MC Set 30-50
end clamp	MiniClamp EC Set 30-50

VERIFICATION SYSTEM UTILISATION

Verification system utilisation [%]	pressure	35.16
	suction	32.40
Loads on modules (ultimate state) [Pa]	pressure	1321
	suction	-842
Loads on modules (Serviceability) [Pa]	pressure	989
	suction	-589

SPECIFIC LOADS

Index (module block)	No. of modules (module block)	---	---	Ballast [kg] (module block)	Dead weight [kg] (module block)	Dead Load [kN/m ²] (module block)	Dead Load [kN/m ²] (roof surface area)	Own weight [kN/m ²]
module array 1	7	---	---	390.5	555.7	0.34	---	---
all Blocks	7	---	---	390.5	555.7	---	0.07	---

NOTES

- The proof of position safety and load capacity of the system are carried out by checking the load cases lifting and shifting by wind and by further static calculations. You will find a short version of the wind tunnel report and a certificate for the further static calculations on our homepage.
- The structural design complies with BS EN 1990 - Basics 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").

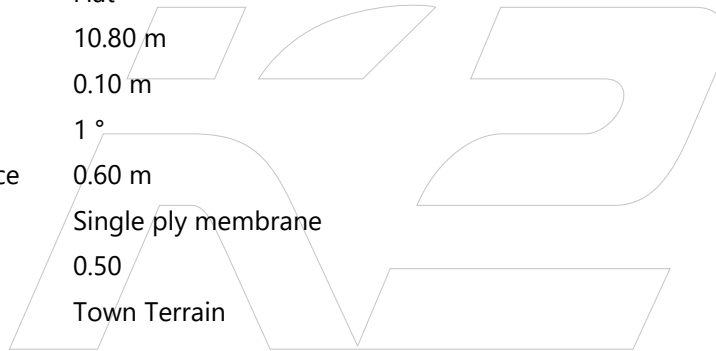
STRUCTURAL ANALYSIS REPORT (ROOF 11)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	S-Dome 6.10 Classic
Customer	CorEnergy
Author	Hugo Silva

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
Ground elevation	37.00 m
Roof type	Flat roof
Fastening method	with Ballast
Roof covering	Flat
Building height	10.80 m
Parapet wall height	0.10 m
Roof pitch	1 °
Min. roof edge distance	0.60 m
Material	Single ply membrane
Friction coefficient	0.50
Terrain category	Town Terrain



LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years

Terrain category Town Terrain

distance to shoreline 46.48 km

distance inside town terrain 10.50 km

Peak velocity pressure $q_{p,50} = 0.648 \text{ kN/m}^2$

Adjustment factor for service life $f_w = 0.921$

Peak velocity pressure $q_{p,25} = 0.597 \text{ kN/m}^2$

Snow load zone 3

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 $d_i = 0.000$

Snow load on roof $s_{i,50} = 0.000 \text{ kN/m}^2$

Adjustment factor for service life $f_s = 0.929$

Snow load on roof $s_{i,25} = 0.372 \text{ kN/m}^2$

DEAD LOAD

Weight module	$G_M = 19.5 \text{ kg}$	Dead weight module	$= 10.70 \text{ kg/m}^2$
Weight mounting system per module area	$= 4.1 \text{ kg}$	Dead weight mounting system	$= 2.25 \text{ kg/m}^2$
Module area	$A_M = 1.82 \text{ m}^2$	Total Dead Weight (excl. ballast)	$= 0.13 \text{ kN/m}^2$

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 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 variable	$\kappa_{FI,Q}$	0.85
Characteristic dead weight	G_k	
Characteristic snow load on the roof	$S_{i,n}$	
Characteristic wind load	W_k	

Load case combination 00:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$
Load case combination 02:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$
Load case combination 03:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$
Load case combination 04:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$

Load case combination 06:	$E_d = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$
---------------------------	---

Uplift Verification:	$E_d = \gamma_{G,stab} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,n,Uplift}$
----------------------	---

Displacement verification:	$E_d = \gamma_{G,stab} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,n,Displacement}$
----------------------------	---

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 00: $E_d = G_k$

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: $E_d = G_k + W_{k,Pressure} + \psi_{0,S} * S_{i,n}$

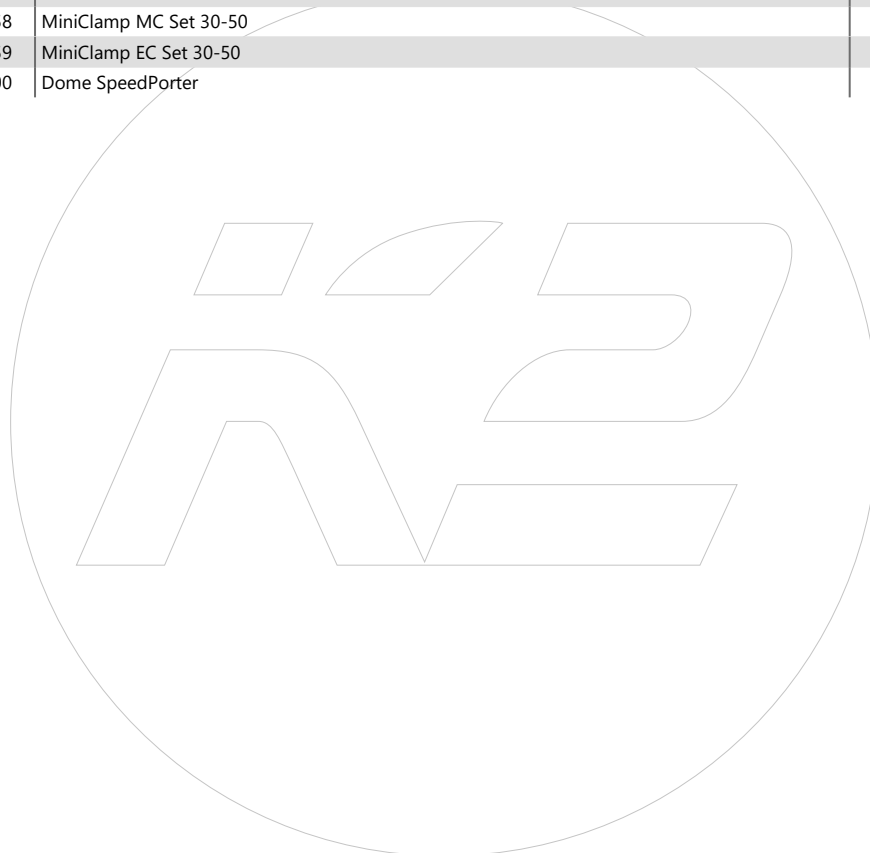
Load case combination 04: $E_d = G_k + S_{i,n} + \psi_{0,W} * W_{k,Pressure}$

Load case combination 06: $E_d = G_k + W_{k,Suction}$

THE SYSTEM HAS BEEN SUCCESSFULLY CALCULATED.

BILL OF MATERIALS (ROOF 11)

Position	Item no.	Item description	Quantity	Weight
1	2004125	Dome 6.10 Peak	11	3.3 kg
2	1001643	MK2	22	0.4 kg
3	2001729	Socket Head Bolt serrated M8x20	22	0.3 kg
4	2003243	Dome 6.10 SD	11	3.3 kg
5	2003126	Dome Mat S 380	22	8.1 kg
6	2003249	S-Dome 6.10 Windbreaker short	7	12.6 kg
7	1005207	Thread-forming metal screw 6.0x25	22	0.1 kg
8	2003239	SpeedRail 22; 3.30 m	6	12.7 kg
9	2002870	K2 Solar Cable Manager	7	0.0 kg
10	2004141	Mat-S Tool	1	0.0 kg
11	2002558	MiniClamp MC Set 30-50	6	0.3 kg
12	2002559	MiniClamp EC Set 30-50	16	1.1 kg
13	2002300	Dome SpeedPorter	28	2.1 kg
Total				44.3 kg



PROJECT DATA (ROOF 12)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	SolidRail
Customer	CorEnergy
Author	Hugo Silva

REMARKS

Best assumptions made for any missing information

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
Ground elevation	37.00 m
Roof type	Gable roof
Fastening method	Roof construction
Roof covering	Tile
Building height	10.80 m
Roof pitch	35 °
Min. roof edge distance	0.00 m
Rafter Spacing	0.400 m
Batten spacing	340.0 mm
Terrain category	Town Terrain

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years

Terrain category	Town Terrain
distance to shoreline	46.48 km
distance inside town terrain	10.50 km
Peak velocity pressure	$q_{p,25} = 0.597 \text{ kN/m}^2$

Snow load zone	3
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$

MODULES

Manufacturer	Longi Solar	Quantity	6
Name	LR4-60HPH-375M	Total output power	2.250 kWp

Dimensions LxWxH	1755 x 1038 x 35.00 mm
Weight	19.5 kg
Output power	375 W



ASSEMBLY PLAN (ROOF 12)

Type	Whole Rails		Rail cutting		
	Total Rail Length / m	Quantity 4.40 m	Part of Rail / m	Length / m	Rest / m
A	4.271		4.400	4.271	0.119
B	2.169		3.300	2.169	1.121

LEGEND

5.21	Distance to Roof Edge [m]
■	Fastener
■	Rail connector base rail
■	Base rails

FASTENER SPACING

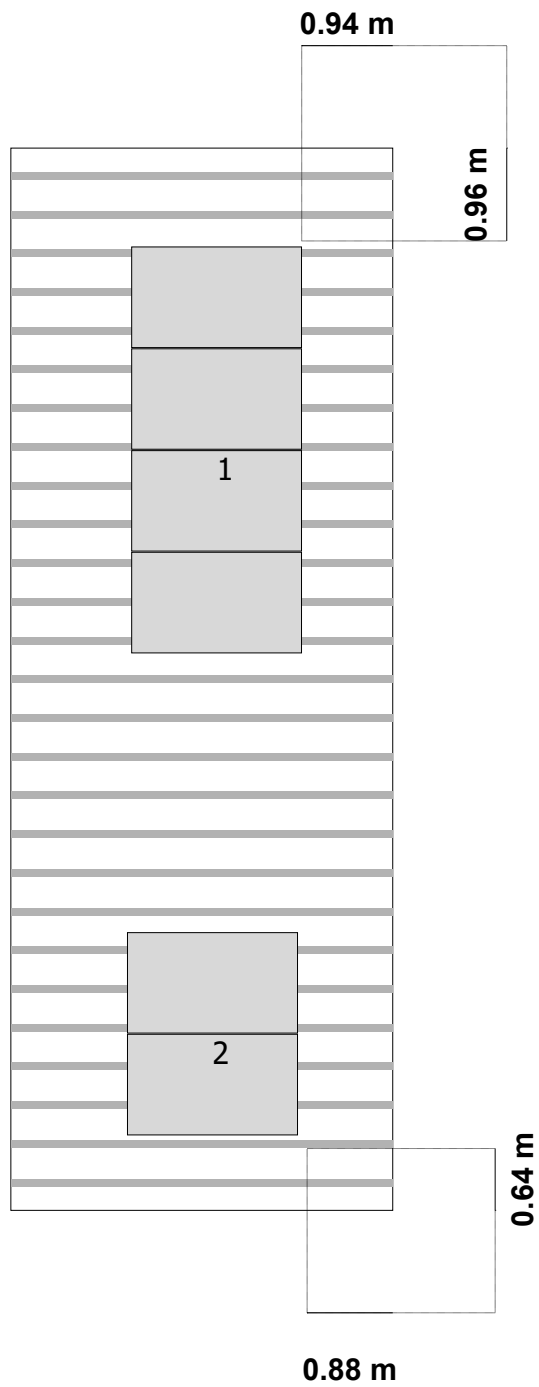
Module	Array	Distance
1	ridge	0.80 m
1	corner region (eave)	0.80 m
1	eaves	0.80 m
2	ridge	0.80 m
2	corner region (eave)	0.80 m
2	eaves	0.80 m

MODULE ARRAYS

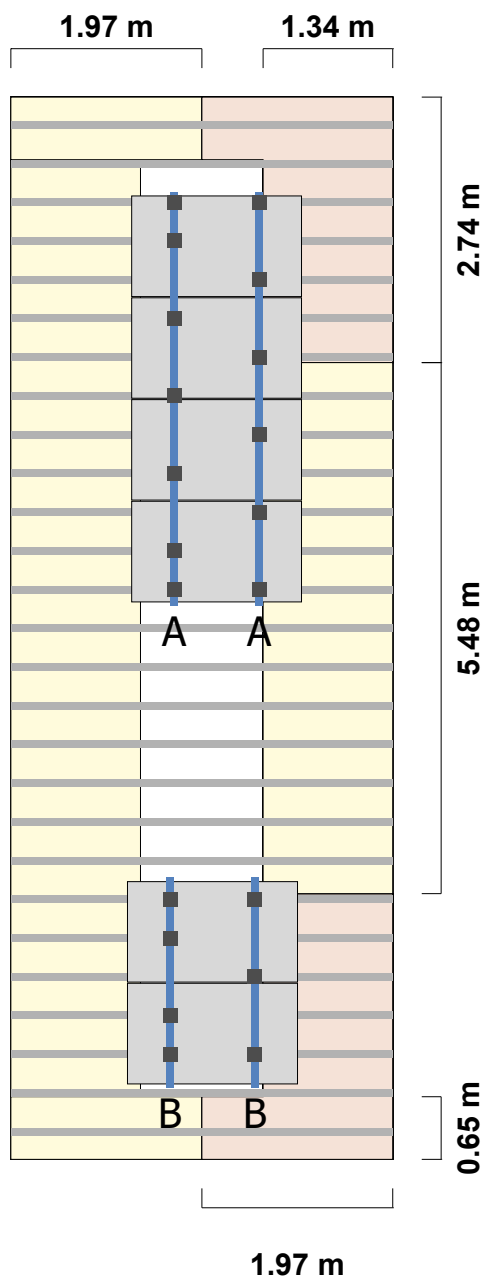
Module array	Width [m]	Length [m]	Width in modules	Length in modules
1	4.19	1.76	4	1
2	2.09	1.76	2	1



ASSEMBLY PLAN - OVERVIEW (ROOF 12)



ASSEMBLY PLAN - BASE RAIL LAYER (ROOF 12)





RESULTS (ROOF 12)

COMPONENTS

Fastener	SolidHook Flat Tile H33/119 75x4
Base Rails	K2 SolidRail UltraLight 32

LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [Pa]				Serviceability [Pa]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
ridge	1.82	728.4	360.8	-743.6	67.9	575.8	286.2	-562.3	67.9
corner region (eave)	1.82	849.3	360.8	-965.3	67.9	670.7	286.2	-736.2	67.9
eaves	1.82	849.3	360.8	-743.6	67.9	670.7	286.2	-562.3	67.9

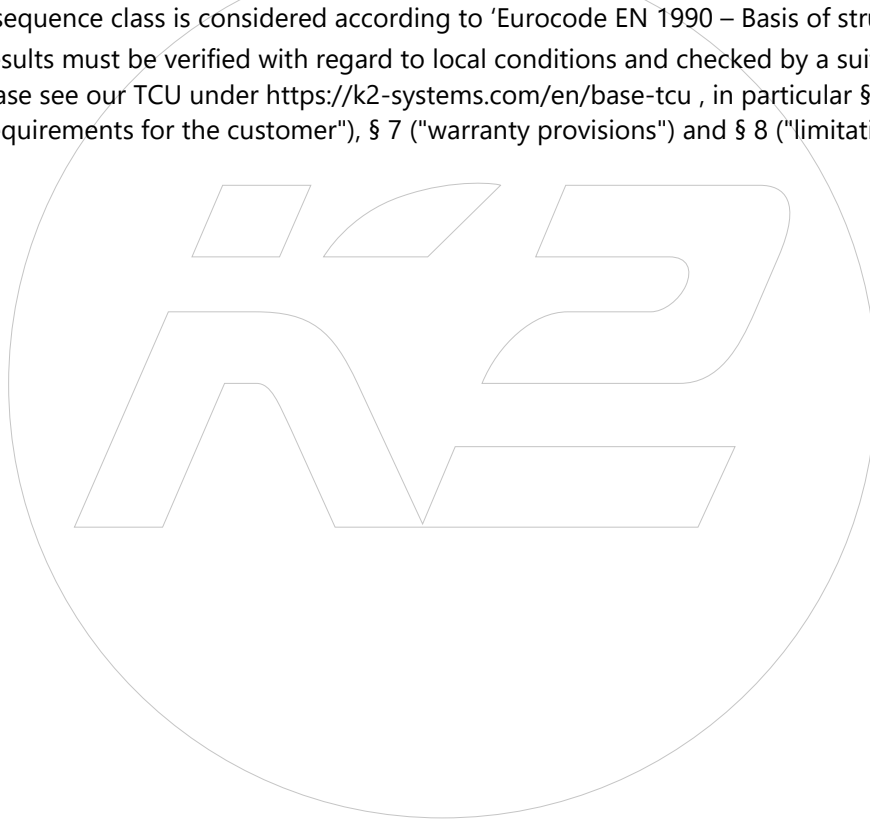
UTILISATION RESULT

No. Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		maximum values	
		Pr σ [%]	Cl σ [%]	Fst F [%]		Fst [m]	BR [m]	Cl Lmax[m]	Fst Dmax[m]
1	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
1	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
1	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
2	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890

Pr	Profile
Fst	Fastener
σ	Tension
f	Deflection
F	Force
CL/Lmax [m]	maximum cantilever length
Fst Dmax [m]	maximum fastener spacing
BR	Base Rail
UR	Upper rail
Usab.	serviceability limit state
Cl	Cantilever

NOTES

- The dimensioning of the timber construction screws is not part of this structural analysis. The dimensioning and positioning of the timber construction screws to be used must be carried out in accordance with the respective applicable codes of practice.
- The structural design complies with BS EN 1990 - Basics 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 12)

GENERAL INFORMATION

Name Dale Halls
 Mounting System SolidRail
 Customer CorEnergy
 Author Hugo Silva

LOCATION

Address 263 Stretford Rd, Hulme,
 Manchester M15 6GR, UK
 Ground elevation 37.00 m
 Roof type Gable roof
 Fastening method Roof construction
 Roof covering Tile
 Building height 10.80 m
 Roof pitch 35 °
 Min. roof edge distance 0.00 m
 Rafter Spacing 0.400 m
 Batten spacing 340.0 mm
 Terrain category Town Terrain

LOADS

Design method BS EN
 Failure consequence class CC1
 Design working life 25 years
 (CC)

WIND LOAD

Terrain category Town Terrain
 distance to shoreline 46.48 km
 distance inside town terrain 10.50 km
 Peak velocity pressure $q_{p,50} = 0.648 \text{ kN/m}^2$
 Adjustment factor for service life $f_w = 0.921$
 Peak velocity pressure $q_{p,25} = 0.597 \text{ kN/m}^2$

ROOF AREAS

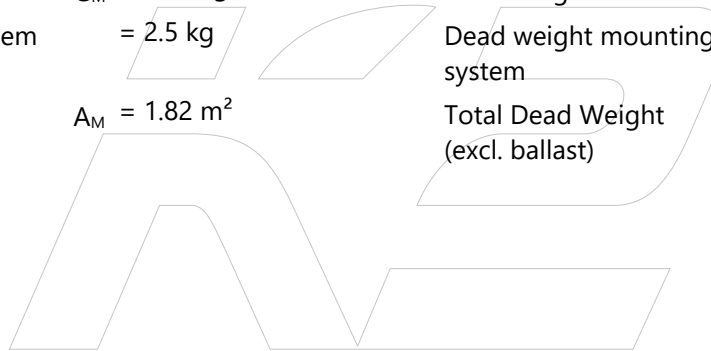
Array	load impact area [m ²]	maxCpe	minCpe	wind pressure [kN/m ²]	wind suction [kN/m ²]
ridge	10.00	0.467	-0.833	0.279	-0.497
corner region (eave)	10.00	0.700	-1.100	0.418	-0.657
eaves	10.00	0.700	-0.833	0.418	-0.497

SNOW LOAD

Snow load zone	3
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$
Snow guard	No
Shape Coefficient for Snow	$\mu_i = 1.000$
Factor for roof pitch	$d_i = 0.819$
Snow load on roof	$s_{i,50} = 0.410 \text{ kN/m}^2$
Adjustment factor for service life	$f_s = 0.929$
Snow load on roof	$s_{i,25} = 0.380 \text{ kN/m}^2$

DEAD LOAD

Weight module	$G_M = 19.5 \text{ kg}$	Dead weight module	$= 10.70 \text{ kg/m}^2$
Weight mounting system per module area	$= 2.5 \text{ kg}$	Dead weight mounting system	$= 1.37 \text{ kg/m}^2$
Module area	$A_M = 1.82 \text{ m}^2$	Total Dead Weight (excl. ballast)	$= 0.12 \text{ kN/m}^2$



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 variable	$\kappa_{FI,Q}$	0.85
Characteristic dead weight	G_k	
Characteristic snow load on the roof	$S_{i,n}$	
Characteristic wind load	W_k	
Load case combination 00:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$	
Load case combination 02:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$	
Load case combination 03:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$	
Load case combination 04:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$	
Load case combination 05:		
Load case combination 06:	$E_d = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$	

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 00:	$E_d = G_k$	
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:	$E_d = G_k + W_{k,Suction}$	

MAXIMUM LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [kN/m ²]				Serviceability [kN/m ²]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
ridge	10.00	0.728	0.361	-0.537	0.068	0.576	0.286	-0.400	0.068
corner region (eave)	10.00	0.849	0.361	-0.740	0.068	0.671	0.286	-0.560	0.068
eaves	10.00	0.849	0.361	-0.537	0.068	0.671	0.286	-0.400	0.068

MAX. LOAD ON FASTENER

Array	A-TrA [m ²]	ultimate state [kN]				Serviceability [kN]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
ridge	10.00	0.562	0.279	-0.415	0.052	0.445	0.221	-0.309	0.052
corner region (eave)	10.00	0.656	0.279	-0.572	0.052	0.518	0.221	-0.432	0.052
eaves	10.00	0.656	0.279	-0.415	0.052	0.518	0.221	-0.309	0.052

RESISTANCE VALUES OF COMPONENTS

BASE RAILS

No. Module Array	Base Rails	A [cm ²]	I _y [cm ⁴]	I _z [cm ⁴]	W _y [cm ³]	W _z [cm ³]
1 - 2	K2 SolidRail UltraLight 32	2.610	2.59	5.54	1.57	2.84

FASTENER

No. Module Array	Fastener	R _{D,Suction,Perpendicular} [kN]	R _{D,Pressure,Perpendicular} [kN]	R _{D,Pressure,Parallel} [kN]
1 - 2	SolidHook Flat Tile H33/119 75x4	0.81	0.73	2.00

UTILISATION RESULT

Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		CL Lmax[m]	Fst Fst Dmax[m]
		Pr σ [%]	CL σ [%]	Fst F [%]		Fst [m]	BR [m]		
1	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
1	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
1	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
2	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890

Pr	Profile
Fst	Fastener
σ	Tension
f	Deflection
F	Force
CL/Lmax [m]	maximum cantilever length
Fst Dmax [m]	maximum fastener spacing
BR	Base Rail
UR	Upper rail
Usab.	serviceability limit state
CL	Cantilever

THE SYSTEM HAS BEEN SUCCESSFULLY CALCULATED.



BILL OF MATERIALS (ROOF 12)

Position	Item no.	Item description	Quantity	Weight
1	2003073	SolidHook Flat Tile H33/119 75x4	20	19.9 kg
2	1000041	T-Bolt 28/15 M10x30	20	0.6 kg
3	1000042	Hexagon flange nut M10	20	0.2 kg
4	2004112	Heco-Topix Plus wood screw 8x100	40	1.1 kg
5	1005158	MiddleClamp XS Black Set 34-38	8	0.6 kg
6	1005268	EndClamp Black Set 34-36	8	0.6 kg
7	2002870	K2 Solar Cable Manager	6	0.0 kg
8	2003229	SolidRail UltraLight; 4.40 m	2	6.2 kg
9	2003228	SolidRail UltraLight; 3.30 m	2	4.6 kg
Total				33.8 kg



PROJECT DATA (ROOF 13)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	SolidRail
Customer	CorEnergy
Author	Hugo Silva

REMARKS

Best assumptions made for any missing information

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
Ground elevation	37.00 m
Roof type	Gable roof
Fastening method	Roof construction
Roof covering	Tile
Building height	10.80 m
Roof pitch	35 °
Min. roof edge distance	0.00 m
Rafter Spacing	0.400 m
Batten spacing	340.0 mm
Terrain category	Town Terrain

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years

Terrain category	Town Terrain
distance to shoreline	46.48 km
distance inside town terrain	10.50 km
Peak velocity pressure	$q_{p,25} = 0.597 \text{ kN/m}^2$

Snow load zone	3
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$

MODULES

Manufacturer	Longi Solar	Quantity	6
Name	LR4-60HPH-375M	Total output power	2.250 kWp

Mounting systems for solar technology



Dimensions LxWxH	1755 x 1038 x 35.00 mm
Weight	19.5 kg
Output power	375 W



ASSEMBLY PLAN (ROOF 13)

Type	Whole Rails		Rail cutting		
	Total Rail Length / m	Quantity 4.40 m	Part of Rail / m	Length / m	Rest / m
A	4.271		4.400	4.271	0.119
B	2.169		3.300	2.169	1.121

LEGEND

5.21	Distance to Roof Edge [m]
■	Fastener
■	Rail connector base rail
■	Base rails

FASTENER SPACING

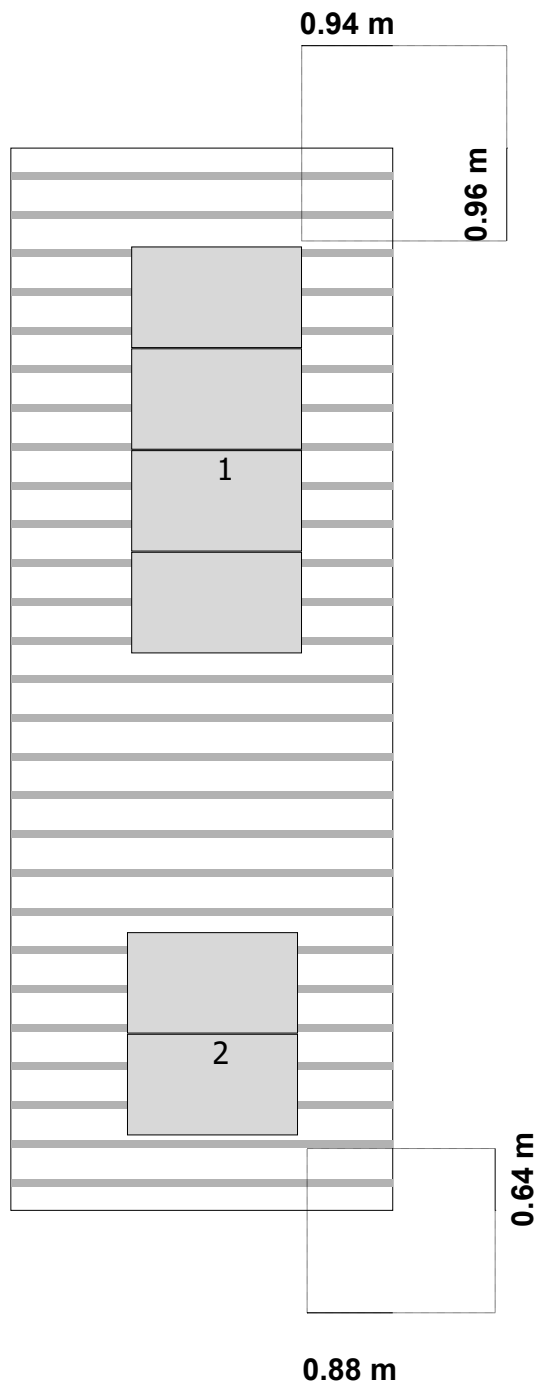
Module	Array	Distance
1	ridge	0.80 m
1	corner region (eave)	0.80 m
1	eaves	0.80 m
2	ridge	0.80 m
2	corner region (eave)	0.80 m
2	eaves	0.80 m

MODULE ARRAYS

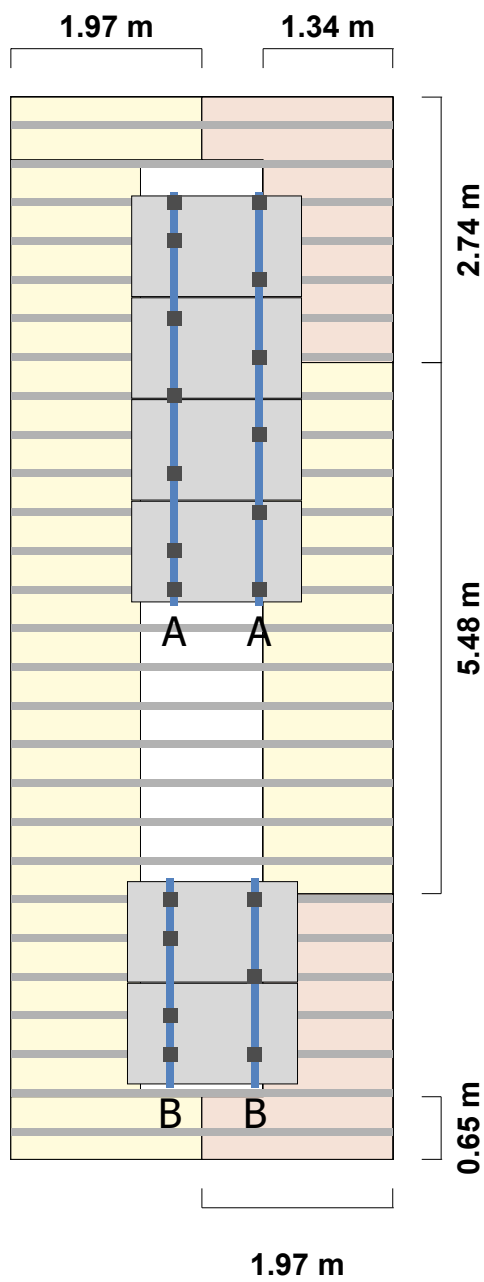
Module array	Width [m]	Length [m]	Width in modules	Length in modules
1	4.19	1.76	4	1
2	2.09	1.76	2	1



ASSEMBLY PLAN - OVERVIEW (ROOF 13)



ASSEMBLY PLAN - BASE RAIL LAYER (ROOF 13)





RESULTS (ROOF 13)

COMPONENTS

Fastener	SolidHook Flat Tile H33/119 75x4
Base Rails	K2 SolidRail UltraLight 32

LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [Pa]				Serviceability [Pa]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
ridge	1.82	728.4	360.8	-743.6	67.9	575.8	286.2	-562.3	67.9
corner region (eave)	1.82	849.3	360.8	-965.3	67.9	670.7	286.2	-736.2	67.9
eaves	1.82	849.3	360.8	-743.6	67.9	670.7	286.2	-562.3	67.9

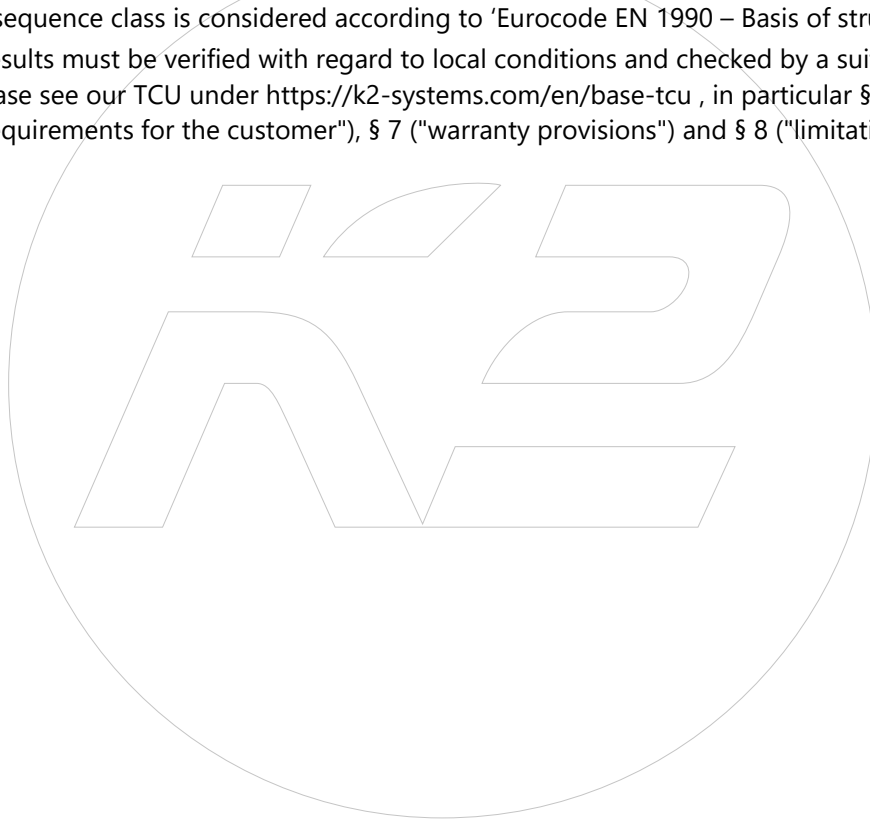
UTILISATION RESULT

No. Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		maximum values	
		Pr σ [%]	Cl σ [%]	Fst F [%]		Fst [m]	BR [m]	Cl Lmax[m]	Fst Dmax[m]
1	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
1	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
1	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
2	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890

Pr	Profile
Fst	Fastener
σ	Tension
f	Deflection
F	Force
CL/Lmax [m]	maximum cantilever length
Fst Dmax [m]	maximum fastener spacing
BR	Base Rail
UR	Upper rail
Usab.	serviceability limit state
Cl	Cantilever

NOTES

- The dimensioning of the timber construction screws is not part of this structural analysis. The dimensioning and positioning of the timber construction screws to be used must be carried out in accordance with the respective applicable codes of practice.
- The structural design complies with BS EN 1990 - Basics 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 13)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	SolidRail
Customer	CorEnergy
Author	Hugo Silva

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
Ground elevation	37.00 m
Roof type	Gable roof
Fastening method	Roof construction
Roof covering	Tile
Building height	10.80 m
Roof pitch	35 °
Min. roof edge distance	0.00 m
Rafter Spacing	0.400 m
Batten spacing	340.0 mm
Terrain category	Town Terrain

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years

WIND LOAD

Terrain category	Town Terrain
distance to shoreline	46.48 km
distance inside town terrain	10.50 km
Peak velocity pressure	$q_{p,50} = 0.648 \text{ kN/m}^2$
Adjustment factor for service life	$f_w = 0.921$
Peak velocity pressure	$q_{p,25} = 0.597 \text{ kN/m}^2$

ROOF AREAS

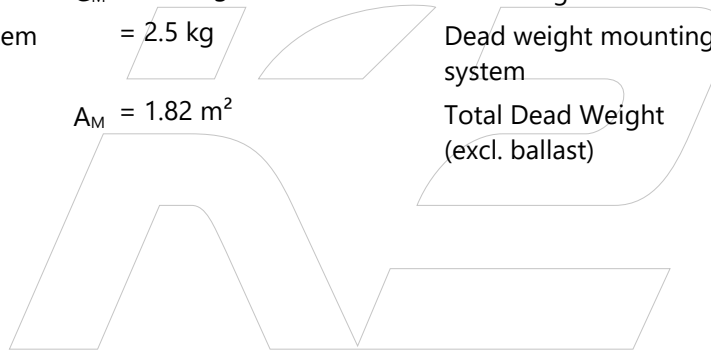
Array	load impact area [m ²]	maxCpe	minCpe	wind pressure [kN/m ²]	wind suction [kN/m ²]
ridge	10.00	0.467	-0.833	0.279	-0.497
corner region (eave)	10.00	0.700	-1.100	0.418	-0.657
eaves	10.00	0.700	-0.833	0.418	-0.497

SNOW LOAD

Snow load zone	3
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$
Snow guard	No
Shape Coefficient for Snow	$\mu_i = 1.000$
Factor for roof pitch	$d_i = 0.819$
Snow load on roof	$s_{i,50} = 0.410 \text{ kN/m}^2$
Adjustment factor for service life	$f_s = 0.929$
Snow load on roof	$s_{i,25} = 0.380 \text{ kN/m}^2$

DEAD LOAD

Weight module	$G_M = 19.5 \text{ kg}$	Dead weight module	$= 10.70 \text{ kg/m}^2$
Weight mounting system per module area	$= 2.5 \text{ kg}$	Dead weight mounting system	$= 1.37 \text{ kg/m}^2$
Module area	$A_M = 1.82 \text{ m}^2$	Total Dead Weight (excl. ballast)	$= 0.12 \text{ kN/m}^2$



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 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 variable	$\kappa_{FI,Q}$	0.85
Characteristic dead weight	G_k	
Characteristic snow load on the roof	$S_{i,n}$	
Characteristic wind load	W_k	
Load case combination 00:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$	
Load case combination 02:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$	
Load case combination 03:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$	
Load case combination 04:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$	
Load case combination 05:		
Load case combination 06:	$E_d = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$	

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 00:	$E_d = G_k$	
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:	$E_d = G_k + W_{k,Suction}$	

MAXIMUM LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [kN/m ²]				Serviceability [kN/m ²]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
ridge	10.00	0.728	0.361	-0.537	0.068	0.576	0.286	-0.400	0.068
corner region (eave)	10.00	0.849	0.361	-0.740	0.068	0.671	0.286	-0.560	0.068
eaves	10.00	0.849	0.361	-0.537	0.068	0.671	0.286	-0.400	0.068

MAX. LOAD ON FASTENER

Array	A-TrA [m ²]	ultimate state [kN]				Serviceability [kN]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
ridge	10.00	0.562	0.279	-0.415	0.052	0.445	0.221	-0.309	0.052
corner region (eave)	10.00	0.656	0.279	-0.572	0.052	0.518	0.221	-0.432	0.052
eaves	10.00	0.656	0.279	-0.415	0.052	0.518	0.221	-0.309	0.052

RESISTANCE VALUES OF COMPONENTS

BASE RAILS

No. Module Array	Base Rails	A [cm ²]	I _y [cm ⁴]	I _z [cm ⁴]	W _y [cm ³]	W _z [cm ³]
1 - 2	K2 SolidRail UltraLight 32	2.610	2.59	5.54	1.57	2.84

FASTENER

No. Module Array	Fastener	R _{D,Suction,Perpendicular} [kN]	R _{D,Pressure,Perpendicular} [kN]	R _{D,Pressure,Parallel} [kN]
1 - 2	SolidHook Flat Tile H33/119 75x4	0.81	0.73	2.00

UTILISATION RESULT

Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		CL Lmax[m]	Fst Fst Dmax[m]
		Pr σ [%]	CL σ [%]	Fst F [%]		Fst [m]	BR [m]		
1	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
1	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
1	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
2	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890

Pr	Profile
Fst	Fastener
σ	Tension
f	Deflection
F	Force
CL/Lmax [m]	maximum cantilever length
Fst Dmax [m]	maximum fastener spacing
BR	Base Rail
UR	Upper rail
Usab.	serviceability limit state
CL	Cantilever

THE SYSTEM HAS BEEN SUCCESSFULLY CALCULATED.



BILL OF MATERIALS (ROOF 13)

Position	Item no.	Item description	Quantity	Weight
1	2003073	SolidHook Flat Tile H33/119 75x4	20	19.9 kg
2	1000041	T-Bolt 28/15 M10x30	20	0.6 kg
3	1000042	Hexagon flange nut M10	20	0.2 kg
4	2004112	Heco-Topix Plus wood screw 8x100	40	1.1 kg
5	1005158	MiddleClamp XS Black Set 34-38	8	0.6 kg
6	1005268	EndClamp Black Set 34-36	8	0.6 kg
7	2002870	K2 Solar Cable Manager	6	0.0 kg
8	2003229	SolidRail UltraLight; 4.40 m	2	6.2 kg
9	2003228	SolidRail UltraLight; 3.30 m	2	4.6 kg
Total				33.8 kg



PROJECT DATA (ROOF 14)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	SolidRail
Customer	CorEnergy
Author	Hugo Silva

REMARKS

Best assumptions made for any missing information

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
Ground elevation	37.00 m
Roof type	Gable roof
Fastening method	Roof construction
Roof covering	Tile
Building height	10.80 m
Roof pitch	35 °
Min. roof edge distance	0.00 m
Rafter Spacing	0.400 m
Batten spacing	340.0 mm
Terrain category	Town Terrain

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years

Terrain category	Town Terrain
distance to shoreline	46.48 km
distance inside town terrain	10.50 km
Peak velocity pressure	$q_{p,25} = 0.597 \text{ kN/m}^2$

Snow load zone	3
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$

MODULES

Manufacturer	Longi Solar	Quantity	6
Name	LR4-60HPH-375M	Total output power	2.250 kWp

Dimensions LxWxH	1755 x 1038 x 35.00 mm
Weight	19.5 kg
Output power	375 W



ASSEMBLY PLAN (ROOF 14)

Type	Whole Rails		Rail cutting		
	Total Rail Length / m	Quantity 4.40 m	Part of Rail / m	Length / m	Rest / m
A	4.271		4.400	4.271	0.119
B	2.169		3.300	2.169	1.121

LEGEND

1.02	Distance to Roof Edge [m]
■	Fastener
■	Rail connector base rail
■	Base rails

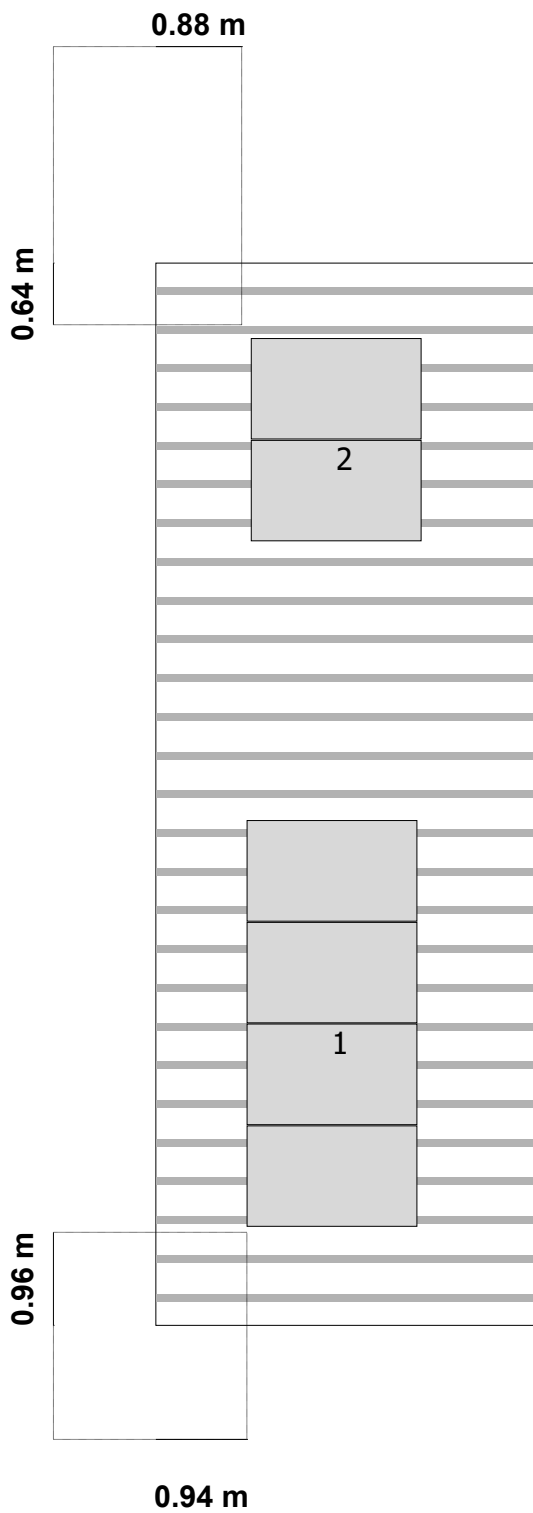
FASTENER SPACING

Module	Array	Distance
1	ridge	0.80 m
1	corner region (eave)	0.80 m
1	eaves	0.80 m
2	ridge	0.80 m
2	corner region (eave)	0.80 m
2	eaves	0.80 m

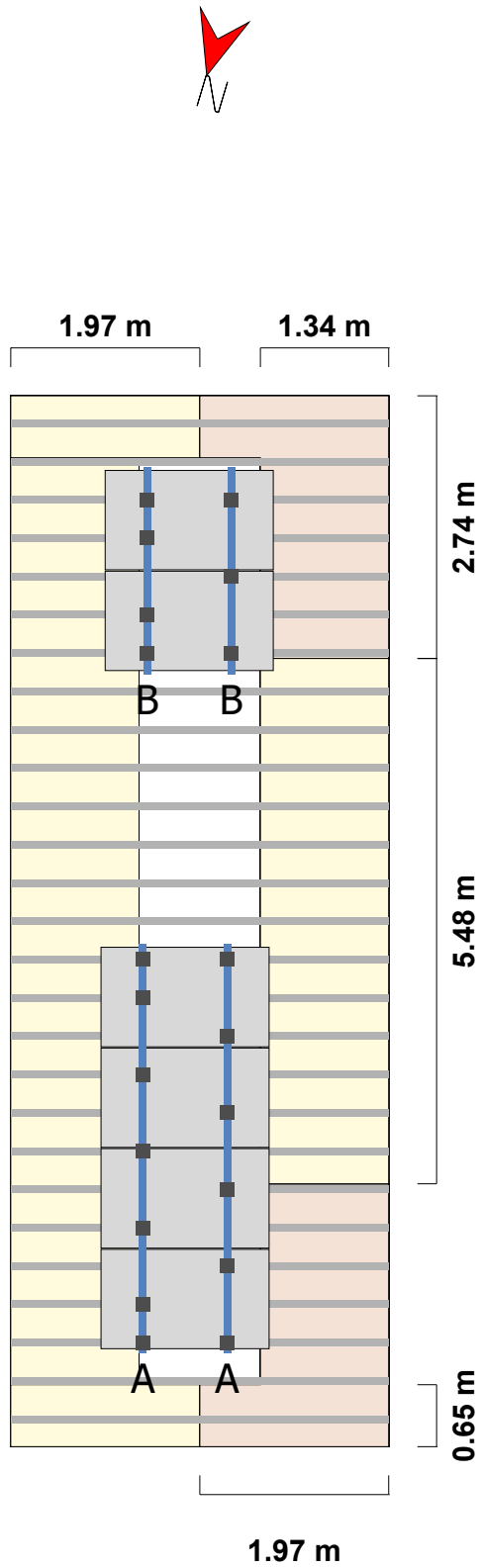
MODULE ARRAYS

Module array	Width [m]	Length [m]	Width in modules	Length in modules
1	4.19	1.76	4	1
2	2.09	1.76	2	1

ASSEMBLY PLAN - OVERVIEW (ROOF 14)



ASSEMBLY PLAN - BASE RAIL LAYER (ROOF 14)





RESULTS (ROOF 14)

COMPONENTS

Fastener SolidHook Flat Tile H33/119 75x4

Base Rails K2 SolidRail UltraLight 32

LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [Pa]				Serviceability [Pa]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
ridge	1.82	728.4	360.8	-743.6	67.9	575.8	286.2	-562.3	67.9
corner region (eave)	1.82	849.3	360.8	-965.3	67.9	670.7	286.2	-736.2	67.9
eaves	1.82	849.3	360.8	-743.6	67.9	670.7	286.2	-562.3	67.9

UTILISATION RESULT

No. Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		maximum values	
		Pr σ [%]	Cl σ [%]	Fst F [%]		Fst [m]	BR [m]	Cl Lmax[m]	Fst Dmax[m]
1	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
1	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
1	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
2	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890

Pr

Fst

σ

f

F

CL/Lmax [m]

Fst Dmax [m]

BR

UR

Usab.

Cl

Profile

Fastener

Tension

Deflection

Force

maximum cantilever length

maximum fastener spacing

Base Rail

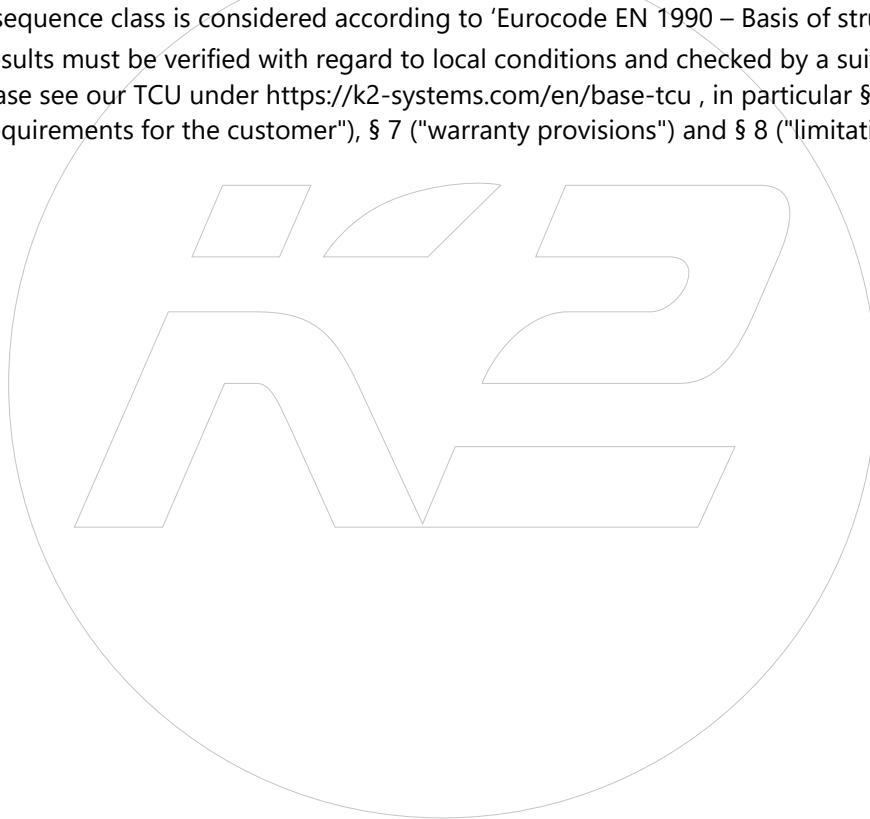
Upper rail

serviceability limit state

Cantilever

NOTES

- The dimensioning of the timber construction screws is not part of this structural analysis. The dimensioning and positioning of the timber construction screws to be used must be carried out in accordance with the respective applicable codes of practice.
- The structural design complies with BS EN 1990 - Basics 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'.
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STRUCTURAL ANALYSIS REPORT (ROOF 14)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	SolidRail
Customer	CorEnergy
Author	Hugo Silva

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
Ground elevation	37.00 m
Roof type	Gable roof
Fastening method	Roof construction
Roof covering	Tile
Building height	10.80 m
Roof pitch	35 °
Min. roof edge distance	0.00 m
Rafter Spacing	0.400 m
Batten spacing	340.0 mm
Terrain category	Town Terrain

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years

WIND LOAD

Terrain category	Town Terrain
distance to shoreline	46.48 km
distance inside town terrain	10.50 km
Peak velocity pressure	$q_{p,50} = 0.648 \text{ kN/m}^2$
Adjustment factor for service life	$f_w = 0.921$
Peak velocity pressure	$q_{p,25} = 0.597 \text{ kN/m}^2$

ROOF AREAS

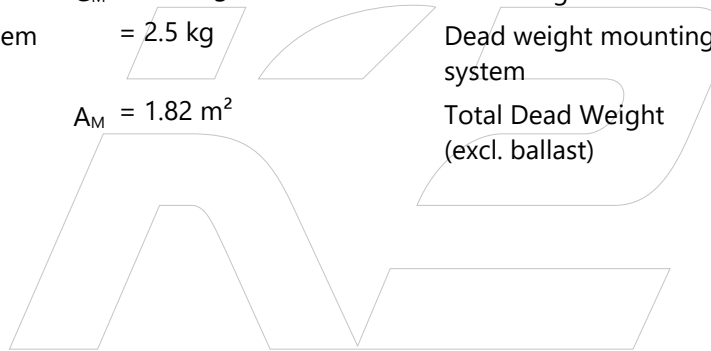
Array	load impact area [m ²]	maxCpe	minCpe	wind pressure [kN/m ²]	wind suction [kN/m ²]
ridge	10.00	0.467	-0.833	0.279	-0.497
corner region (eave)	10.00	0.700	-1.100	0.418	-0.657
eaves	10.00	0.700	-0.833	0.418	-0.497

SNOW LOAD

Snow load zone	3
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$
Snow guard	No
Shape Coefficient for Snow	$\mu_i = 1.000$
Factor for roof pitch	$d_i = 0.819$
Snow load on roof	$s_{i,50} = 0.410 \text{ kN/m}^2$
Adjustment factor for service life	$f_s = 0.929$
Snow load on roof	$s_{i,25} = 0.380 \text{ kN/m}^2$

DEAD LOAD

Weight module	$G_M = 19.5 \text{ kg}$	Dead weight module	$= 10.70 \text{ kg/m}^2$
Weight mounting system per module area	$= 2.5 \text{ kg}$	Dead weight mounting system	$= 1.37 \text{ kg/m}^2$
Module area	$A_M = 1.82 \text{ m}^2$	Total Dead Weight (excl. ballast)	$= 0.12 \text{ kN/m}^2$



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 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 variable	$\kappa_{FI,Q}$	0.85
Characteristic dead weight	G_k	
Characteristic snow load on the roof	$S_{i,n}$	
Characteristic wind load	W_k	
Load case combination 00:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$	
Load case combination 02:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$	
Load case combination 03:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$	
Load case combination 04:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$	
Load case combination 05:		
Load case combination 06:	$E_d = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$	

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 00:	$E_d = G_k$	
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:	$E_d = G_k + W_{k,Suction}$	

MAXIMUM LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [kN/m ²]				Serviceability [kN/m ²]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
ridge	10.00	0.728	0.361	-0.537	0.068	0.576	0.286	-0.400	0.068
corner region (eave)	10.00	0.849	0.361	-0.740	0.068	0.671	0.286	-0.560	0.068
eaves	10.00	0.849	0.361	-0.537	0.068	0.671	0.286	-0.400	0.068

MAX. LOAD ON FASTENER

Array	A-TrA [m ²]	ultimate state [kN]				Serviceability [kN]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
ridge	10.00	0.562	0.279	-0.415	0.052	0.445	0.221	-0.309	0.052
corner region (eave)	10.00	0.656	0.279	-0.572	0.052	0.518	0.221	-0.432	0.052
eaves	10.00	0.656	0.279	-0.415	0.052	0.518	0.221	-0.309	0.052

RESISTANCE VALUES OF COMPONENTS

BASE RAILS

No. Module Array	Base Rails	A [cm ²]	I _y [cm ⁴]	I _z [cm ⁴]	W _y [cm ³]	W _z [cm ³]
1 - 2	K2 SolidRail UltraLight 32	2.610	2.59	5.54	1.57	2.84

FASTENER

No. Module Array	Fastener	R _{D,Suction,Perpendicular} [kN]	R _{D,Pressure,Perpendicular} [kN]	R _{D,Pressure,Parallel} [kN]
1 - 2	SolidHook Flat Tile H33/119 75x4	0.81	0.73	2.00

UTILISATION RESULT

Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		CL Lmax[m]	Fst Fst Dmax[m]
		Pr σ [%]	CL σ [%]	Fst F [%]		Fst [m]	BR [m]		
1	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
1	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
1	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
2	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890

Pr	Profile
Fst	Fastener
σ	Tension
f	Deflection
F	Force
CL/Lmax [m]	maximum cantilever length
Fst Dmax [m]	maximum fastener spacing
BR	Base Rail
UR	Upper rail
Usab.	serviceability limit state
CL	Cantilever

THE SYSTEM HAS BEEN SUCCESSFULLY CALCULATED.



BILL OF MATERIALS (ROOF 14)

Position	Item no.	Item description	Quantity	Weight
1	2003073	SolidHook Flat Tile H33/119 75x4	20	19.9 kg
2	1000041	T-Bolt 28/15 M10x30	20	0.6 kg
3	1000042	Hexagon flange nut M10	20	0.2 kg
4	2004112	Heco-Topix Plus wood screw 8x100	40	1.1 kg
5	1005158	MiddleClamp XS Black Set 34-38	8	0.6 kg
6	1005268	EndClamp Black Set 34-36	8	0.6 kg
7	2002870	K2 Solar Cable Manager	6	0.0 kg
8	2003229	SolidRail UltraLight; 4.40 m	2	6.2 kg
9	2003228	SolidRail UltraLight; 3.30 m	2	4.6 kg
Total				33.8 kg



PROJECT DATA (ROOF 15)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	SolidRail
Customer	CorEnergy
Author	Hugo Silva

REMARKS

Best assumptions made for any missing information

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
Ground elevation	37.00 m
Roof type	Gable roof
Fastening method	Roof construction
Roof covering	Tile
Building height	10.80 m
Roof pitch	35 °
Min. roof edge distance	0.00 m
Rafter Spacing	0.400 m
Batten spacing	340.0 mm
Terrain category	Town Terrain

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years
Terrain category	Town Terrain		
distance to shoreline	46.48 km		
distance inside town terrain	10.50 km		
Peak velocity pressure	$q_{p,25} = 0.597 \text{ kN/m}^2$		
Snow load zone	3		
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$		

MODULES

Manufacturer	Longi Solar	Quantity	6
Name	LR4-60HPH-375M	Total output power	2.250 kWp

Dimensions LxWxH	1755 x 1038 x 35.00 mm
Weight	19.5 kg
Output power	375 W



ASSEMBLY PLAN (ROOF 15)

Type	Whole Rails		Rail cutting		
	Total Rail Length / m	Quantity 4.40 m	Part of Rail / m	Length / m	Rest / m
A	4.271		4.400	4.271	0.119
B	2.169		3.300	2.169	1.121

LEGEND

1.02	Distance to Roof Edge [m]
■	Fastener
■	Rail connector base rail
■	Base rails

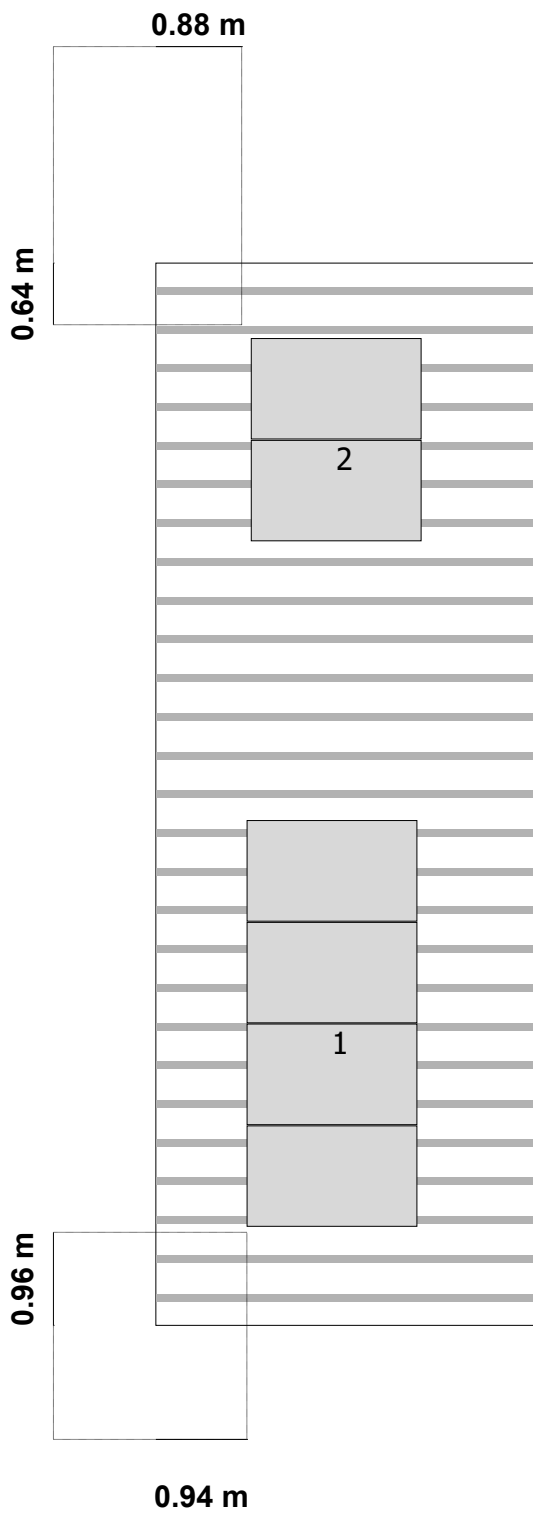
FASTENER SPACING

Module	Array	Distance
1	ridge	0.80 m
1	corner region (eave)	0.80 m
1	eaves	0.80 m
2	ridge	0.80 m
2	corner region (eave)	0.80 m
2	eaves	0.80 m

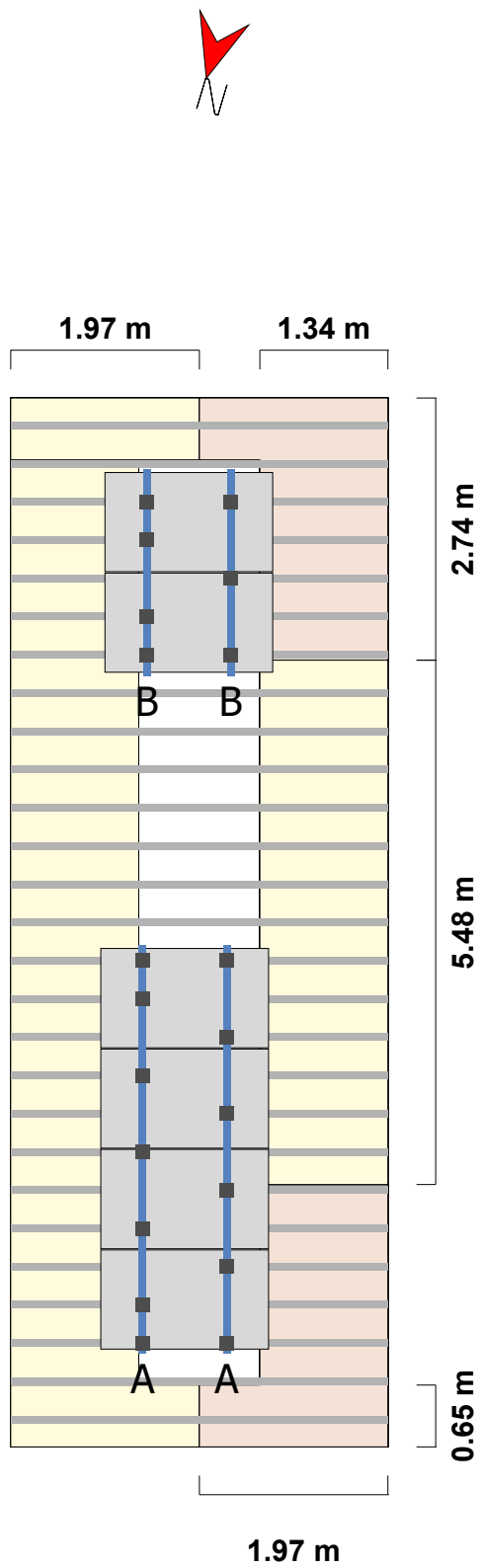
MODULE ARRAYS

Module array	Width [m]	Length [m]	Width in modules	Length in modules
1	4.19	1.76	4	1
2	2.09	1.76	2	1

ASSEMBLY PLAN - OVERVIEW (ROOF 15)



ASSEMBLY PLAN - BASE RAIL LAYER (ROOF 15)





RESULTS (ROOF 15)

COMPONENTS

Fastener	SolidHook Flat Tile H33/119 75x4
Base Rails	K2 SolidRail UltraLight 32

LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [Pa]				Serviceability [Pa]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
ridge	1.82	728.4	360.8	-743.6	67.9	575.8	286.2	-562.3	67.9
corner region (eave)	1.82	849.3	360.8	-965.3	67.9	670.7	286.2	-736.2	67.9
eaves	1.82	849.3	360.8	-743.6	67.9	670.7	286.2	-562.3	67.9

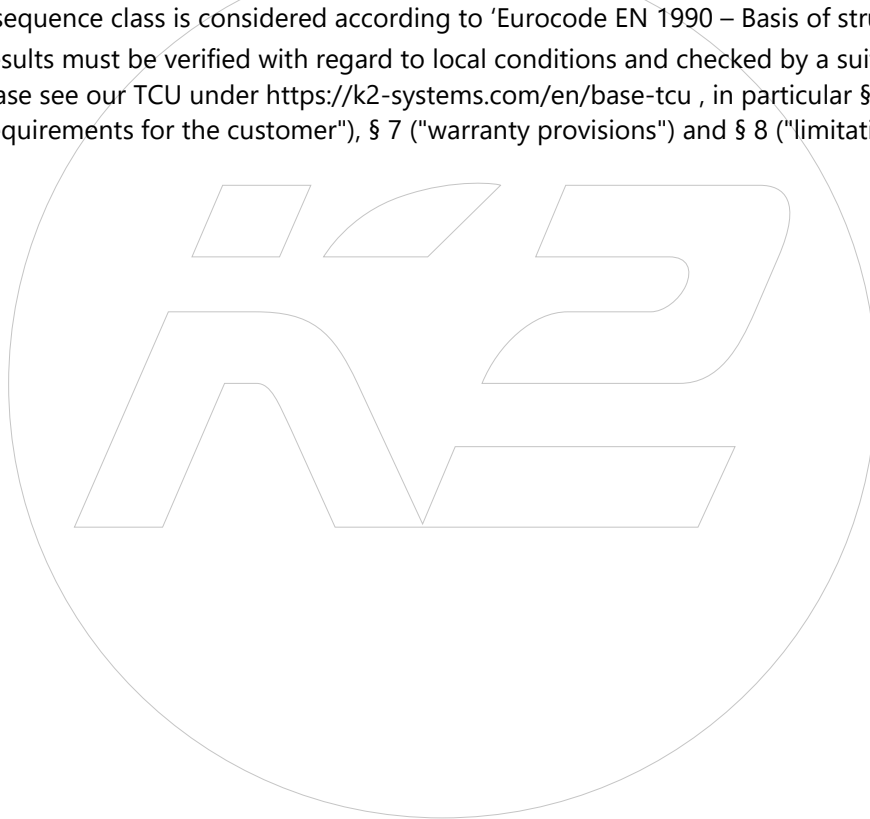
UTILISATION RESULT

No. Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		maximum values	
		Pr σ [%]	Cl σ [%]	Fst F [%]		Fst [m]	BR [m]	Cl Lmax[m]	Fst Dmax[m]
1	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
1	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
1	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
2	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890

Pr	Profile
Fst	Fastener
σ	Tension
f	Deflection
F	Force
CL/Lmax [m]	maximum cantilever length
Fst Dmax [m]	maximum fastener spacing
BR	Base Rail
UR	Upper rail
Usab.	serviceability limit state
Cl	Cantilever

NOTES

- The dimensioning of the timber construction screws is not part of this structural analysis. The dimensioning and positioning of the timber construction screws to be used must be carried out in accordance with the respective applicable codes of practice.
- The structural design complies with BS EN 1990 - Basics 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 15)

GENERAL INFORMATION

Name Dale Halls
 Mounting System SolidRail
 Customer CorEnergy
 Author Hugo Silva

LOCATION

Address 263 Stretford Rd, Hulme,
 Manchester M15 6GR, UK
 Ground elevation 37.00 m
 Roof type Gable roof
 Fastening method Roof construction
 Roof covering Tile
 Building height 10.80 m
 Roof pitch 35 °
 Min. roof edge distance 0.00 m
 Rafter Spacing 0.400 m
 Batten spacing 340.0 mm
 Terrain category Town Terrain

LOADS

Design method BS EN
 Failure consequence class CC1
 Design working life 25 years
 (CC)

WIND LOAD

Terrain category Town Terrain
 distance to shoreline 46.48 km
 distance inside town terrain 10.50 km
 Peak velocity pressure $q_{p,50} = 0.648 \text{ kN/m}^2$
 Adjustment factor for service life $f_w = 0.921$
 Peak velocity pressure $q_{p,25} = 0.597 \text{ kN/m}^2$

ROOF AREAS

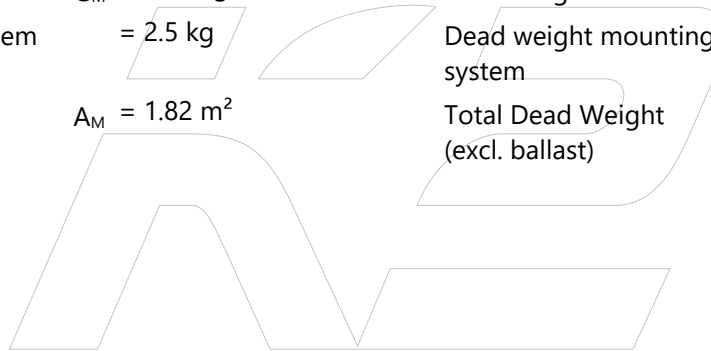
Array	load impact area [m ²]	maxCpe	minCpe	wind pressure [kN/m ²]	wind suction [kN/m ²]
ridge	10.00	0.467	-0.833	0.279	-0.497
corner region (eave)	10.00	0.700	-1.100	0.418	-0.657
eaves	10.00	0.700	-0.833	0.418	-0.497

SNOW LOAD

Snow load zone	3
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$
Snow guard	No
Shape Coefficient for Snow	$\mu_i = 1.000$
Factor for roof pitch	$d_i = 0.819$
Snow load on roof	$s_{i,50} = 0.410 \text{ kN/m}^2$
Adjustment factor for service life	$f_s = 0.929$
Snow load on roof	$s_{i,25} = 0.380 \text{ kN/m}^2$

DEAD LOAD

Weight module	$G_M = 19.5 \text{ kg}$	Dead weight module	$= 10.70 \text{ kg/m}^2$
Weight mounting system per module area	$= 2.5 \text{ kg}$	Dead weight mounting system	$= 1.37 \text{ kg/m}^2$
Module area	$A_M = 1.82 \text{ m}^2$	Total Dead Weight (excl. ballast)	$= 0.12 \text{ kN/m}^2$



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 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 variable	$\kappa_{FI,Q}$	0.85
Characteristic dead weight	G_k	
Characteristic snow load on the roof	$S_{i,n}$	
Characteristic wind load	W_k	
Load case combination 00:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$	
Load case combination 02:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$	
Load case combination 03:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$	
Load case combination 04:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$	
Load case combination 05:		
Load case combination 06:	$E_d = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$	

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 00:	$E_d = G_k$	
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:	$E_d = G_k + W_{k,Suction}$	

MAXIMUM LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [kN/m ²]				Serviceability [kN/m ²]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
ridge	10.00	0.728	0.361	-0.537	0.068	0.576	0.286	-0.400	0.068
corner region (eave)	10.00	0.849	0.361	-0.740	0.068	0.671	0.286	-0.560	0.068
eaves	10.00	0.849	0.361	-0.537	0.068	0.671	0.286	-0.400	0.068

MAX. LOAD ON FASTENER

Array	A-TrA [m ²]	ultimate state [kN]				Serviceability [kN]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
ridge	10.00	0.562	0.279	-0.415	0.052	0.445	0.221	-0.309	0.052
corner region (eave)	10.00	0.656	0.279	-0.572	0.052	0.518	0.221	-0.432	0.052
eaves	10.00	0.656	0.279	-0.415	0.052	0.518	0.221	-0.309	0.052

RESISTANCE VALUES OF COMPONENTS

BASE RAILS

No. Module Array	Base Rails	A [cm ²]	I _y [cm ⁴]	I _z [cm ⁴]	W _y [cm ³]	W _z [cm ³]
1 - 2	K2 SolidRail UltraLight 32	2.610	2.59	5.54	1.57	2.84

FASTENER

No. Module Array	Fastener	R _{D,Suction,Perpendicular} [kN]	R _{D,Pressure,Perpendicular} [kN]	R _{D,Pressure,Parallel} [kN]
1 - 2	SolidHook Flat Tile H33/119 75x4	0.81	0.73	2.00

UTILISATION RESULT

Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		CL Lmax[m]	Fst Fst Dmax[m]
		Pr σ [%]	CL σ [%]	Fst F [%]		Fst [m]	BR [m]		
1	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
1	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
1	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
2	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890

Pr	Profile
Fst	Fastener
σ	Tension
f	Deflection
F	Force
CL/Lmax [m]	maximum cantilever length
Fst Dmax [m]	maximum fastener spacing
BR	Base Rail
UR	Upper rail
Usab.	serviceability limit state
CL	Cantilever

THE SYSTEM HAS BEEN SUCCESSFULLY CALCULATED.



BILL OF MATERIALS (ROOF 15)

Position	Item no.	Item description	Quantity	Weight
1	2003073	SolidHook Flat Tile H33/119 75x4	20	19.9 kg
2	1000041	T-Bolt 28/15 M10x30	20	0.6 kg
3	1000042	Hexagon flange nut M10	20	0.2 kg
4	2004112	Heco-Topix Plus wood screw 8x100	40	1.1 kg
5	1005158	MiddleClamp XS Black Set 34-38	8	0.6 kg
6	1005268	EndClamp Black Set 34-36	8	0.6 kg
7	2002870	K2 Solar Cable Manager	6	0.0 kg
8	2003229	SolidRail UltraLight; 4.40 m	2	6.2 kg
9	2003228	SolidRail UltraLight; 3.30 m	2	4.6 kg
Total				33.8 kg



PROJECT DATA (ROOF 16)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	SolidRail
Customer	CorEnergy
Author	Hugo Silva

REMARKS

Best assumptions made for any missing information

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
Ground elevation	37.00 m
Roof type	Gable roof
Fastening method	Roof construction
Roof covering	Tile
Building height	10.80 m
Roof pitch	35 °
Min. roof edge distance	0.00 m
Rafter Spacing	0.400 m
Batten spacing	340.0 mm
Terrain category	Town Terrain

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years
Terrain category	Town Terrain		
distance to shoreline	46.48 km		
distance inside town terrain	10.50 km		
Peak velocity pressure	$q_{p,25} = 0.597 \text{ kN/m}^2$		
Snow load zone	3		
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$		

MODULES

Manufacturer	Longi Solar	Quantity	5
Name	LR4-60HPH-375M	Total output power	1.875 kWp

Dimensions LxWxH	1755 x 1038 x 35.00 mm
Weight	19.5 kg
Output power	375 W



ASSEMBLY PLAN (ROOF 16)

Type	Whole Rails		Rail cutting		
	Total Rail Length / m	Quantity 4.40 m	Part of Rail / m	Length / m	Rest / m
A	3.220		3.300	3.220	0.070
B	2.169		3.300	2.169	1.121

LEGEND

4.21	Distance to Roof Edge [m]
■	Fastener
■	Rail connector base rail
■	Base rails

FASTENER SPACING

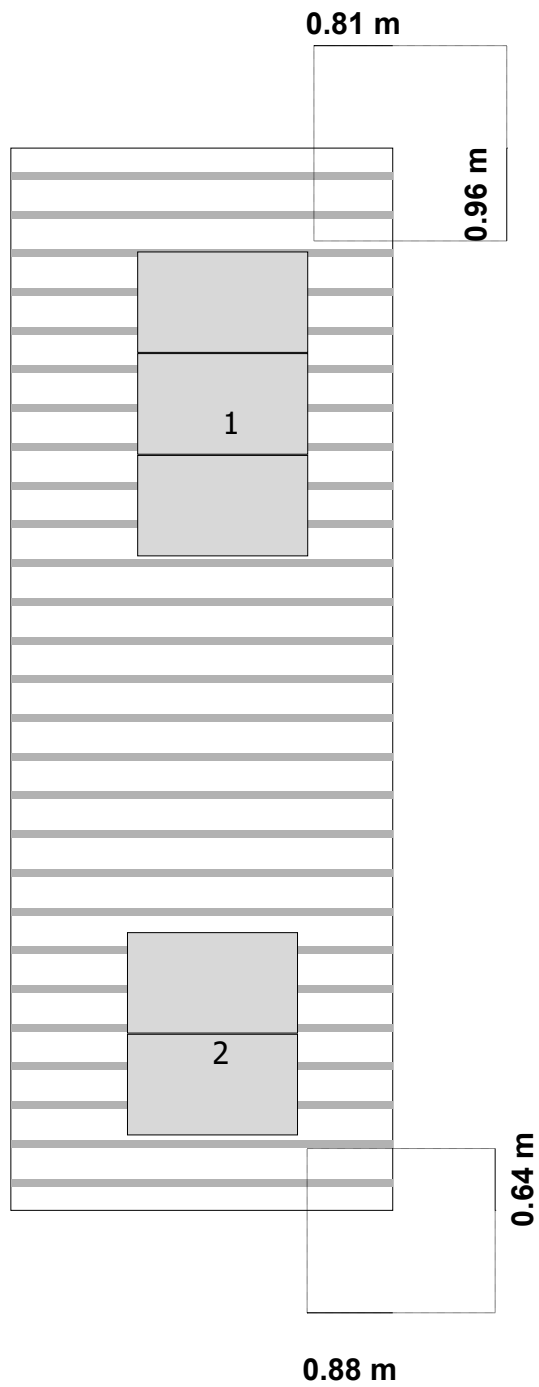
Module	Array	Distance
1	ridge	0.80 m
1	corner region (eave)	0.80 m
1	eaves	0.80 m
2	ridge	0.80 m
2	corner region (eave)	0.80 m
2	eaves	0.80 m

MODULE ARRAYS

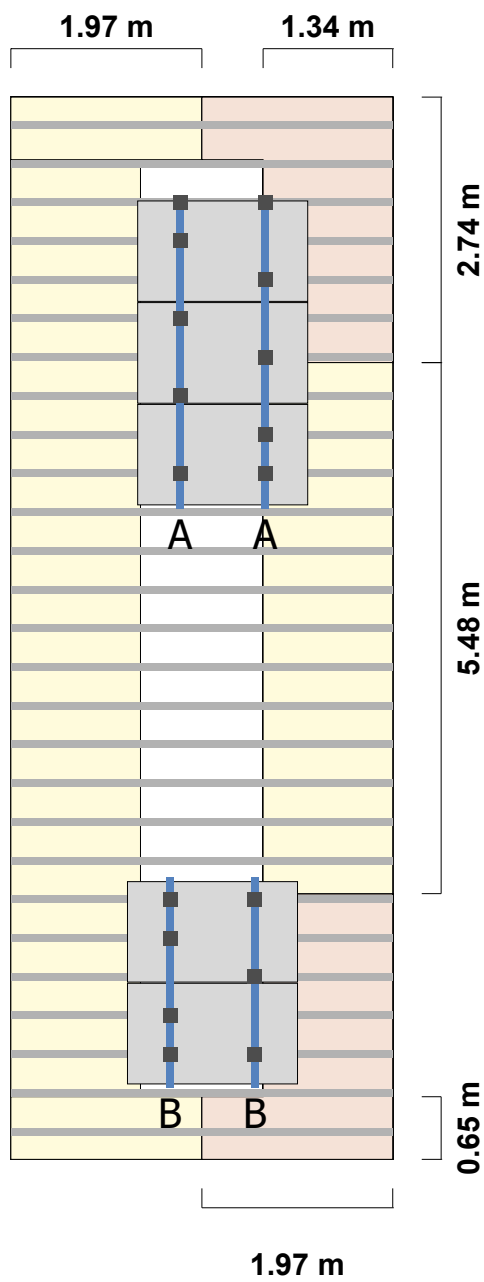
Module array	Width [m]	Length [m]	Width in modules	Length in modules
1	3.14	1.76	3	1
2	2.09	1.76	2	1



ASSEMBLY PLAN - OVERVIEW (ROOF 16)



ASSEMBLY PLAN - BASE RAIL LAYER (ROOF 16)





RESULTS (ROOF 16)

COMPONENTS

Fastener	SolidHook Flat Tile H33/119 75x4
Base Rails	K2 SolidRail UltraLight 32

LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [Pa]				Serviceability [Pa]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
ridge	1.82	728.4	360.8	-743.6	67.9	575.8	286.2	-562.3	67.9
corner region (eave)	1.82	849.3	360.8	-965.3	67.9	670.7	286.2	-736.2	67.9
eaves	1.82	849.3	360.8	-743.6	67.9	670.7	286.2	-562.3	67.9

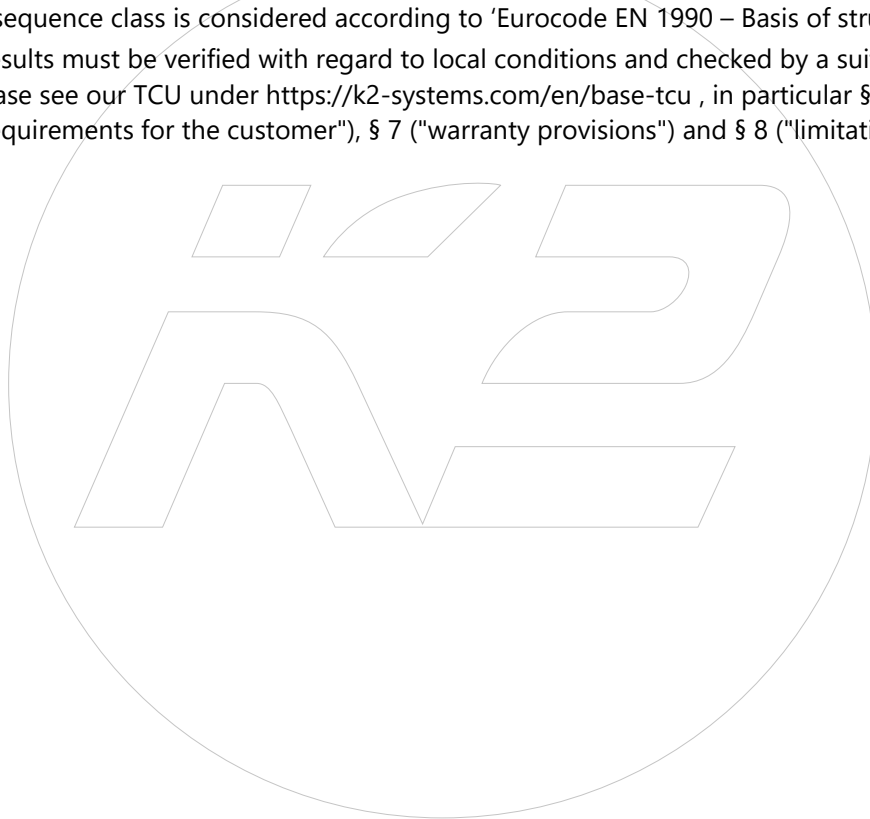
UTILISATION RESULT

No. Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		maximum values	
		Pr σ [%]	Cl σ [%]	Fst F [%]		Fst [m]	BR [m]	Cl Lmax[m]	Fst Dmax[m]
1	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
1	corner region (eave)	20.6	0.5	89.8	11.5	0.800	---	0.512	0.890
1	eaves	20.6	21.6	89.8	11.5	0.800	---	0.512	0.890
2	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
2	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890

Pr	Profile
Fst	Fastener
σ	Tension
f	Deflection
F	Force
CL/Lmax [m]	maximum cantilever length
Fst Dmax [m]	maximum fastener spacing
BR	Base Rail
UR	Upper rail
Usab.	serviceability limit state
Cl	Cantilever

NOTES

- The dimensioning of the timber construction screws is not part of this structural analysis. The dimensioning and positioning of the timber construction screws to be used must be carried out in accordance with the respective applicable codes of practice.
- The structural design complies with BS EN 1990 - Basics 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 16)

GENERAL INFORMATION

Name Dale Halls
 Mounting System SolidRail
 Customer CorEnergy
 Author Hugo Silva

LOCATION

Address 263 Stretford Rd, Hulme,
 Manchester M15 6GR, UK
 Ground elevation 37.00 m
 Roof type Gable roof
 Fastening method Roof construction
 Roof covering Tile
 Building height 10.80 m
 Roof pitch 35 °
 Min. roof edge distance 0.00 m
 Rafter Spacing 0.400 m
 Batten spacing 340.0 mm
 Terrain category Town Terrain

LOADS

Design method BS EN
 Failure consequence class CC1
 Design working life 25 years
 (CC)

WIND LOAD

Terrain category Town Terrain
 distance to shoreline 46.48 km
 distance inside town terrain 10.50 km
 Peak velocity pressure $q_{p,50} = 0.648 \text{ kN/m}^2$
 Adjustment factor for service life $f_w = 0.921$
 Peak velocity pressure $q_{p,25} = 0.597 \text{ kN/m}^2$

ROOF AREAS

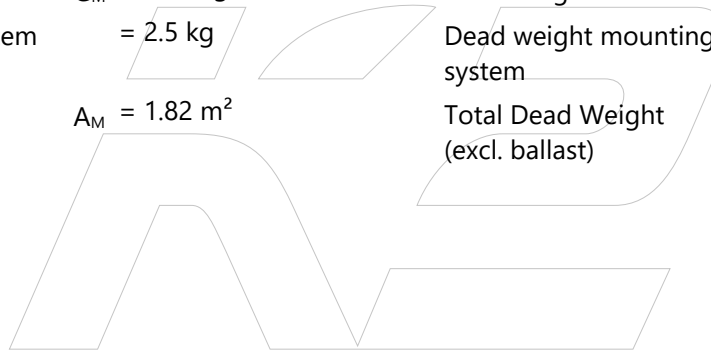
Array	load impact area [m ²]	maxCpe	minCpe	wind pressure [kN/m ²]	wind suction [kN/m ²]
ridge	10.00	0.467	-0.833	0.279	-0.497
corner region (eave)	10.00	0.700	-1.100	0.418	-0.657
eaves	10.00	0.700	-0.833	0.418	-0.497

SNOW LOAD

Snow load zone	3
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$
Snow guard	No
Shape Coefficient for Snow	$\mu_i = 1.000$
Factor for roof pitch	$d_i = 0.819$
Snow load on roof	$s_{i,50} = 0.410 \text{ kN/m}^2$
Adjustment factor for service life	$f_s = 0.929$
Snow load on roof	$s_{i,25} = 0.380 \text{ kN/m}^2$

DEAD LOAD

Weight module	$G_M = 19.5 \text{ kg}$	Dead weight module	$= 10.70 \text{ kg/m}^2$
Weight mounting system per module area	$= 2.5 \text{ kg}$	Dead weight mounting system	$= 1.37 \text{ kg/m}^2$
Module area	$A_M = 1.82 \text{ m}^2$	Total Dead Weight (excl. ballast)	$= 0.12 \text{ kN/m}^2$



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 variable	$\kappa_{FI,Q}$	0.85
Characteristic dead weight	G_k	
Characteristic snow load on the roof	$S_{i,n}$	
Characteristic wind load	W_k	
Load case combination 00:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$	
Load case combination 02:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$	
Load case combination 03:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$	
Load case combination 04:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$	
Load case combination 05:		
Load case combination 06:	$E_d = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$	

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 00:	$E_d = G_k$	
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:	$E_d = G_k + W_{k,Suction}$	

MAXIMUM LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [kN/m ²]				Serviceability [kN/m ²]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
ridge	10.00	0.728	0.361	-0.537	0.068	0.576	0.286	-0.400	0.068
corner region (eave)	10.00	0.849	0.361	-0.740	0.068	0.671	0.286	-0.560	0.068
eaves	10.00	0.849	0.361	-0.537	0.068	0.671	0.286	-0.400	0.068

MAX. LOAD ON FASTENER

Array	A-TrA [m ²]	ultimate state [kN]				Serviceability [kN]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
ridge	10.00	0.562	0.279	-0.415	0.052	0.445	0.221	-0.309	0.052
corner region (eave)	10.00	0.656	0.279	-0.572	0.052	0.518	0.221	-0.432	0.052
eaves	10.00	0.656	0.279	-0.415	0.052	0.518	0.221	-0.309	0.052

RESISTANCE VALUES OF COMPONENTS

BASE RAILS

No. Module Array	Base Rails	A [cm ²]	I _y [cm ⁴]	I _z [cm ⁴]	W _y [cm ³]	W _z [cm ³]
1 - 2	K2 SolidRail UltraLight 32	2.610	2.59	5.54	1.57	2.84

FASTENER

No. Module Array	Fastener	R _{D,Suction,Perpendicular} [kN]	R _{D,Pressure,Perpendicular} [kN]	R _{D,Pressure,Parallel} [kN]
1 - 2	SolidHook Flat Tile H33/119 75x4	0.81	0.73	2.00

UTILISATION RESULT

Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		CL Lmax[m]	Fst Fst Dmax[m]
		Pr σ [%]	CL σ [%]	Fst F [%]		Fst [m]	BR [m]		
1	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
1	corner region (eave)	20.6	0.5	89.8	11.5	0.800	---	0.512	0.890
1	eaves	20.6	21.6	89.8	11.5	0.800	---	0.512	0.890
2	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
2	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890

Pr	Profile
Fst	Fastener
σ	Tension
f	Deflection
F	Force
CL/Lmax [m]	maximum cantilever length
Fst Dmax [m]	maximum fastener spacing
BR	Base Rail
UR	Upper rail
Usab.	serviceability limit state
CL	Cantilever

THE SYSTEM HAS BEEN SUCCESSFULLY CALCULATED.



BILL OF MATERIALS (ROOF 16)

Position	Item no.	Item description	Quantity	Weight
1	2003073	SolidHook Flat Tile H33/119 75x4	17	16.9 kg
2	1000041	T-Bolt 28/15 M10x30	17	0.5 kg
3	1000042	Hexagon flange nut M10	17	0.2 kg
4	2004112	Heco-Topix Plus wood screw 8x100	34	0.9 kg
5	1005158	MiddleClamp XS Black Set 34-38	6	0.4 kg
6	1005268	EndClamp Black Set 34-36	8	0.6 kg
7	2002870	K2 Solar Cable Manager	5	0.0 kg
8	2003228	SolidRail UltraLight; 3.30 m	4	9.2 kg
Total				28.7 kg



PROJECT DATA (ROOF 17)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	SolidRail
Customer	CorEnergy
Author	Hugo Silva

REMARKS

Best assumptions made for any missing information

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
Ground elevation	37.00 m
Roof type	Gable roof
Fastening method	Roof construction
Roof covering	Tile
Building height	10.80 m
Roof pitch	35 °
Min. roof edge distance	0.00 m
Rafter Spacing	0.400 m
Batten spacing	340.0 mm
Terrain category	Town Terrain

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years
Terrain category	Town Terrain		
distance to shoreline	46.48 km		
distance inside town terrain	10.50 km		
Peak velocity pressure	$q_{p,25} = 0.597 \text{ kN/m}^2$		
Snow load zone	3		
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$		

MODULES

Manufacturer	Longi Solar	Quantity	5
Name	LR4-60HPH-375M	Total output power	1.875 kWp

Dimensions LxWxH	1755 x 1038 x 35.00 mm
Weight	19.5 kg
Output power	375 W



ASSEMBLY PLAN (ROOF 17)

Type	Whole Rails		Rail cutting		
	Total Rail Length / m	Quantity 4.40 m	Part of Rail / m	Length / m	Rest / m
A	3.220		3.300	3.220	0.070
B	2.169		3.300	2.169	1.121

LEGEND

1.07	Distance to Roof Edge [m]
■	Fastener
■	Rail connector base rail
■	Base rails

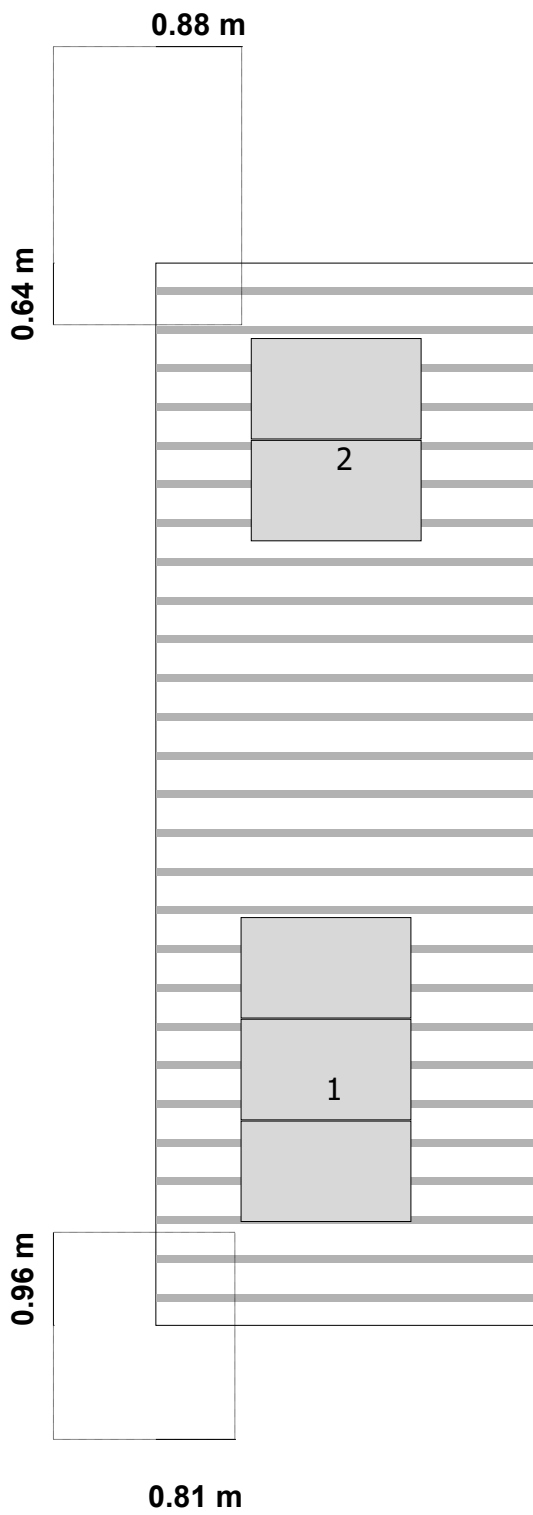
FASTENER SPACING

Module	Array	Distance
1	ridge	0.80 m
1	corner region (eave)	0.80 m
1	eaves	0.80 m
2	ridge	0.80 m
2	corner region (eave)	0.80 m
2	eaves	0.80 m

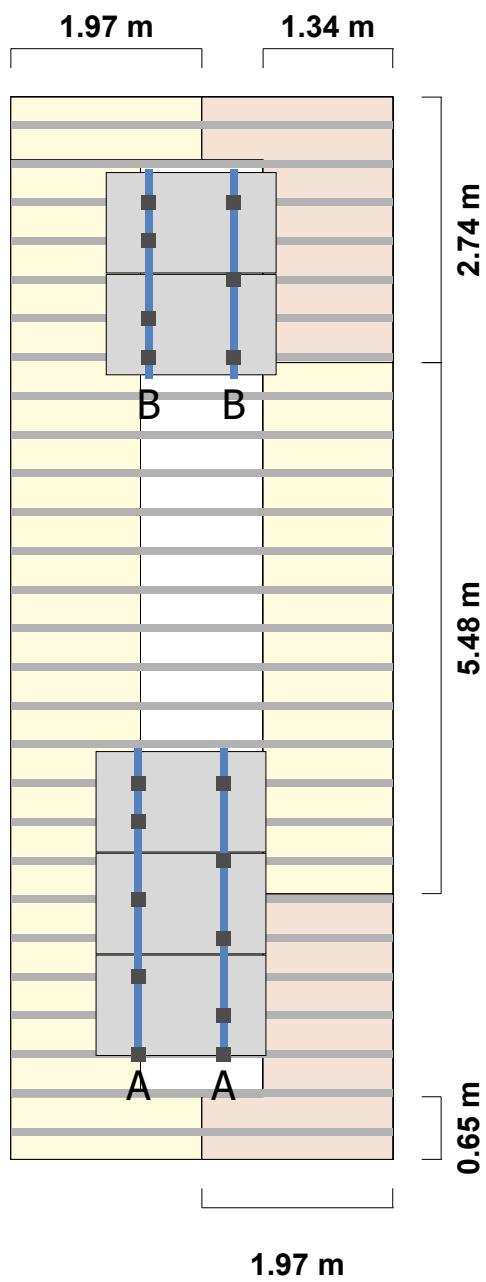
MODULE ARRAYS

Module array	Width [m]	Length [m]	Width in modules	Length in modules
1	3.14	1.76	3	1
2	2.09	1.76	2	1

ASSEMBLY PLAN - OVERVIEW (ROOF 17)



ASSEMBLY PLAN - BASE RAIL LAYER (ROOF 17)





RESULTS (ROOF 17)

COMPONENTS

Fastener	SolidHook Flat Tile H33/119 75x4
Base Rails	K2 SolidRail UltraLight 32

LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [Pa]				Serviceability [Pa]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
ridge	1.82	728.4	360.8	-743.6	67.9	575.8	286.2	-562.3	67.9
corner region (eave)	1.82	849.3	360.8	-965.3	67.9	670.7	286.2	-736.2	67.9
eaves	1.82	849.3	360.8	-743.6	67.9	670.7	286.2	-562.3	67.9

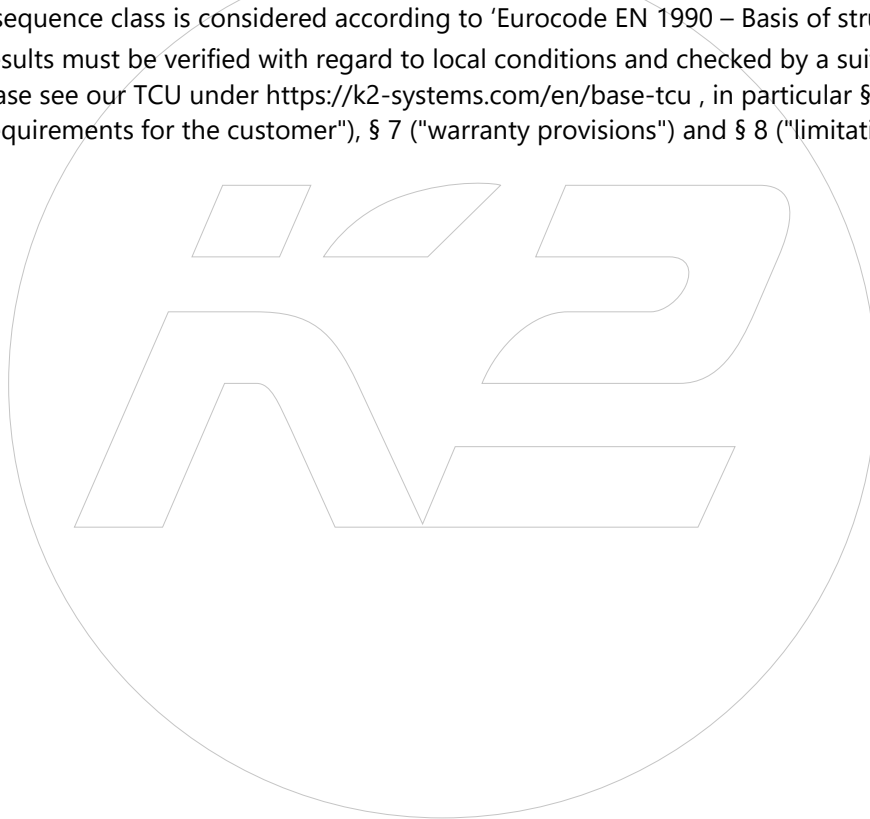
UTILISATION RESULT

No. Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		maximum values	
		Pr σ [%]	Cl σ [%]	Fst F [%]		Fst [m]	BR [m]	Cl Lmax[m]	Fst Dmax[m]
1	ridge	18.3	19.1	77.0	10.0	0.800	---	0.533	1.038
1	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
1	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
2	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890

Pr	Profile
Fst	Fastener
σ	Tension
f	Deflection
F	Force
CL/Lmax [m]	maximum cantilever length
Fst Dmax [m]	maximum fastener spacing
BR	Base Rail
UR	Upper rail
Usab.	serviceability limit state
Cl	Cantilever

NOTES

- The dimensioning of the timber construction screws is not part of this structural analysis. The dimensioning and positioning of the timber construction screws to be used must be carried out in accordance with the respective applicable codes of practice.
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- 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 17)

GENERAL INFORMATION

Name	Dale Halls
Mounting System	SolidRail
Customer	CorEnergy
Author	Hugo Silva

LOCATION

Address	263 Stretford Rd, Hulme, Manchester M15 6GR, UK
Ground elevation	37.00 m
Roof type	Gable roof
Fastening method	Roof construction
Roof covering	Tile
Building height	10.80 m
Roof pitch	35 °
Min. roof edge distance	0.00 m
Rafter Spacing	0.400 m
Batten spacing	340.0 mm
Terrain category	Town Terrain

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years

WIND LOAD

Terrain category	Town Terrain
distance to shoreline	46.48 km
distance inside town terrain	10.50 km
Peak velocity pressure	$q_{p,50} = 0.648 \text{ kN/m}^2$
Adjustment factor for service life	$f_w = 0.921$
Peak velocity pressure	$q_{p,25} = 0.597 \text{ kN/m}^2$

ROOF AREAS

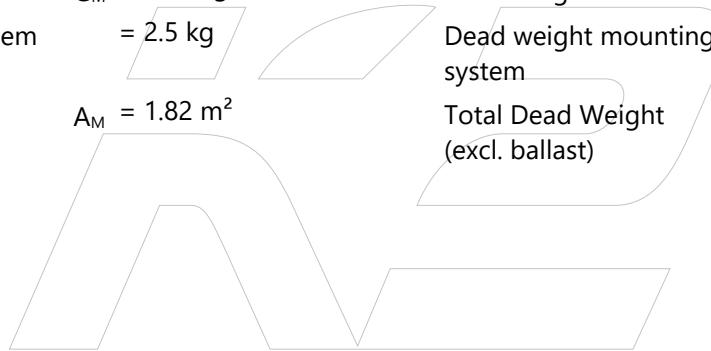
Array	load impact area [m ²]	maxCpe	minCpe	wind pressure [kN/m ²]	wind suction [kN/m ²]
ridge	10.00	0.467	-0.833	0.279	-0.497
corner region (eave)	10.00	0.700	-1.100	0.418	-0.657
eaves	10.00	0.700	-0.833	0.418	-0.497

SNOW LOAD

Snow load zone	3
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$
Snow guard	No
Shape Coefficient for Snow	$\mu_i = 1.000$
Factor for roof pitch	$d_i = 0.819$
Snow load on roof	$s_{i,50} = 0.410 \text{ kN/m}^2$
Adjustment factor for service life	$f_s = 0.929$
Snow load on roof	$s_{i,25} = 0.380 \text{ kN/m}^2$

DEAD LOAD

Weight module	$G_M = 19.5 \text{ kg}$	Dead weight module	$= 10.70 \text{ kg/m}^2$
Weight mounting system per module area	$= 2.5 \text{ kg}$	Dead weight mounting system	$= 1.37 \text{ kg/m}^2$
Module area	$A_M = 1.82 \text{ m}^2$	Total Dead Weight (excl. ballast)	$= 0.12 \text{ kN/m}^2$



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 variable	$\kappa_{FI,Q}$	0.85
Characteristic dead weight	G_k	
Characteristic snow load on the roof	$S_{i,n}$	
Characteristic wind load	W_k	
Load case combination 00:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$	
Load case combination 02:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$	
Load case combination 03:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$	
Load case combination 04:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$	
Load case combination 05:		
Load case combination 06:	$E_d = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$	

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 00:	$E_d = G_k$	
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:	$E_d = G_k + W_{k,Suction}$	

MAXIMUM LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [kN/m ²]				Serviceability [kN/m ²]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
ridge	10.00	0.728	0.361	-0.537	0.068	0.576	0.286	-0.400	0.068
corner region (eave)	10.00	0.849	0.361	-0.740	0.068	0.671	0.286	-0.560	0.068
eaves	10.00	0.849	0.361	-0.537	0.068	0.671	0.286	-0.400	0.068

MAX. LOAD ON FASTENER

Array	A-TrA [m ²]	ultimate state [kN]				Serviceability [kN]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
ridge	10.00	0.562	0.279	-0.415	0.052	0.445	0.221	-0.309	0.052
corner region (eave)	10.00	0.656	0.279	-0.572	0.052	0.518	0.221	-0.432	0.052
eaves	10.00	0.656	0.279	-0.415	0.052	0.518	0.221	-0.309	0.052

RESISTANCE VALUES OF COMPONENTS

BASE RAILS

No. Module Array	Base Rails	A [cm ²]	I _y [cm ⁴]	I _z [cm ⁴]	W _y [cm ³]	W _z [cm ³]
1 - 2	K2 SolidRail UltraLight 32	2.610	2.59	5.54	1.57	2.84

FASTENER

No. Module Array	Fastener	R _{D,Suction,Perpendicular} [kN]	R _{D,Pressure,Perpendicular} [kN]	R _{D,Pressure,Parallel} [kN]
1 - 2	SolidHook Flat Tile H33/119 75x4	0.81	0.73	2.00

UTILISATION RESULT

Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		Cl Lmax[m]	Fst Dmax[m]
		Pr σ [%]	Cl σ [%]	Fst F [%]		Fst [m]	BR [m]		
1	ridge	18.3	19.1	77.0	10.0	0.800	---	0.533	1.038
1	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
1	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	ridge	18.3	0.0	77.0	10.0	0.800	---	0.533	1.038
2	corner region (eave)	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890
2	eaves	20.6	0.0	89.8	11.5	0.800	---	0.512	0.890

Pr	Profile
Fst	Fastener
σ	Tension
f	Deflection
F	Force
CL/Lmax [m]	maximum cantilever length
Fst Dmax [m]	maximum fastener spacing
BR	Base Rail
UR	Upper rail
Usab.	serviceability limit state
Cl	Cantilever

THE SYSTEM HAS BEEN SUCCESSFULLY CALCULATED.



BILL OF MATERIALS (ROOF 17)

Position	Item no.	Item description	Quantity	Weight
1	2003073	SolidHook Flat Tile H33/119 75x4	17	16.9 kg
2	1000041	T-Bolt 28/15 M10x30	17	0.5 kg
3	1000042	Hexagon flange nut M10	17	0.2 kg
4	2004112	Heco-Topix Plus wood screw 8x100	34	0.9 kg
5	1005158	MiddleClamp XS Black Set 34-38	6	0.4 kg
6	1005268	EndClamp Black Set 34-36	8	0.6 kg
7	2002870	K2 Solar Cable Manager	5	0.0 kg
8	2003228	SolidRail UltraLight; 3.30 m	4	9.2 kg
Total				28.7 kg



TOTAL BILL OF MATERIALS (ALL ROOFS)

Position	Item no.	Item description	Quantity	Weight
1	2003073	SolidHook Flat Tile H33/119 75x4	586	584.2 kg
2	1000041	T-Bolt 28/15 M10x30	586	17.0 kg
3	1000042	Hexagon flange nut M10	586	6.4 kg
4	2004112	Heco-Topix Plus wood screw 8x100	1172	31.6 kg
5	1005158	MiddleClamp XS Black Set 34-38	258	18.1 kg
6	1005268	EndClamp Black Set 34-36	132	9.9 kg
7	2002870	K2 Solar Cable Manager	222	0.6 kg
8	2003229	SolidRail UltraLight; 4.40 m	65	200.3 kg
9	2003228	SolidRail UltraLight; 3.30 m	26	60.1 kg
10	1004107	SolidRail UltraLight+Light RailConnector Set	32	7.2 kg
11	2004125	Dome 6.10 Peak	93	27.9 kg
12	1001643	MK2	186	3.3 kg
13	2001729	Socket Head Bolt serrated M8x20	186	2.4 kg
14	2003243	Dome 6.10 SD	93	28.2 kg
15	2003126	Dome Mat S 380	186	68.4 kg
16	2003249	S-Dome 6.10 Windbreaker short	60	108.0 kg
17	1005207	Thread-forming metal screw 6.0x25	186	1.1 kg
18	2003240	SpeedRail 22; 4.40 m	10	28.3 kg
19	2003239	SpeedRail 22; 3.30 m	36	76.4 kg
20	1006039	Dome FlatConnector Set	12	2.3 kg
21	2004141	Mat-S Tool	7	0.2 kg
22	2002559	MiniClamp EC Set 30-50	132	8.7 kg
23	2002300	Dome SpeedPorter	198	15.0 kg
24	2002558	MiniClamp MC Set 30-50	54	3.1 kg
Total				1308.7 kg