



| Connecting Strength

K2 Base Report

MMU-Archway Halls

Project address	Bonsall St, Manchester M15 6DP, UK
Customer	Everwarm
Company	edge management
Author	claire fitzpatrick
Issue date & version	21/06/2024 K2 Base Version 3.1.133.5



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About us

K2 Systems. Innovative mounting system from a strong team.

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

A knowledgeable and friendly team

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

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

10 locations and worldwide sales network

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

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

Quality management and certificates

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

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



Product guarantee

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

In a nutshell

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

The static report is not including module and building verification.



Project overview

Roofs

Roof	System	Module	Height	Quantity	Total power
<u>MMU-Archway Hall</u>  Flat	<u>S-Dome 6.10 Classic</u>	TSM-440NEG9R.28 (Vertex S+) 1,762×1,134×30 mm 440 Wp	3.00 m	42	18.48 kWp
Total				42	18.48 kWp

Project information

Address	Bonsall St, Manchester M15 6DP, UK
Customer	Everwarm
Author	claire fitzpatrick

Load settings

Design method	BS EN
Failure consequence class (CC)	CC1
Design working life	25 years
Terrain category	Town Terrain
Basic wind speed	22.5 m/s
Distance to shoreline	52.00 km
Distance inside town terrain	1.00 km
Snow load zone	3
Snow load on ground level	0.50 kN/m ²

Material values

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

Elastic module	E = 70.000 N/mm ²
Shear module	G = 26.923 N/mm ²
Density	g = 2.700 kg/m ³
Thermal coefficient	α _T = 2.3e ⁻⁵
Yielding strength	f _{o,k} = 200 N/mm ²
Ultimate strength	f _{u,k} = 245 N/mm ²



THE PROJECT IS VERIFIED.

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

MMU-Archway Halls



Project information

Address	Bonsall St, Manchester M15 6DP, UK
Customer	Everwarm
Author	claire fitzpatrick

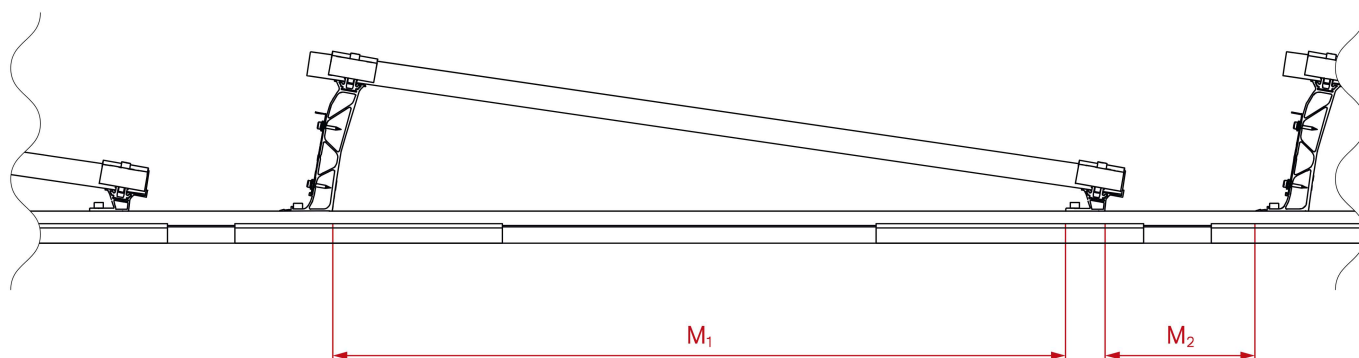


Roofs | MMU-Archway Hall



Roof	System	Module	Height	Quantity	Total power
MMU-Archway Hall  Flat	S-Dome 6.10 Classic	TSM-440NEG9R.28 (Vertex S+) 1,762×1,134×30 mm 440 Wp	3.00 m	42	18.48 kWp

Roofs | MMU-Archway Hall | Pre-assembly / assembly



Module Array 1

M1 1,005.96 mm

M2 484.80 mm

Roofs | MMU-Archway Hall | Assembly plan

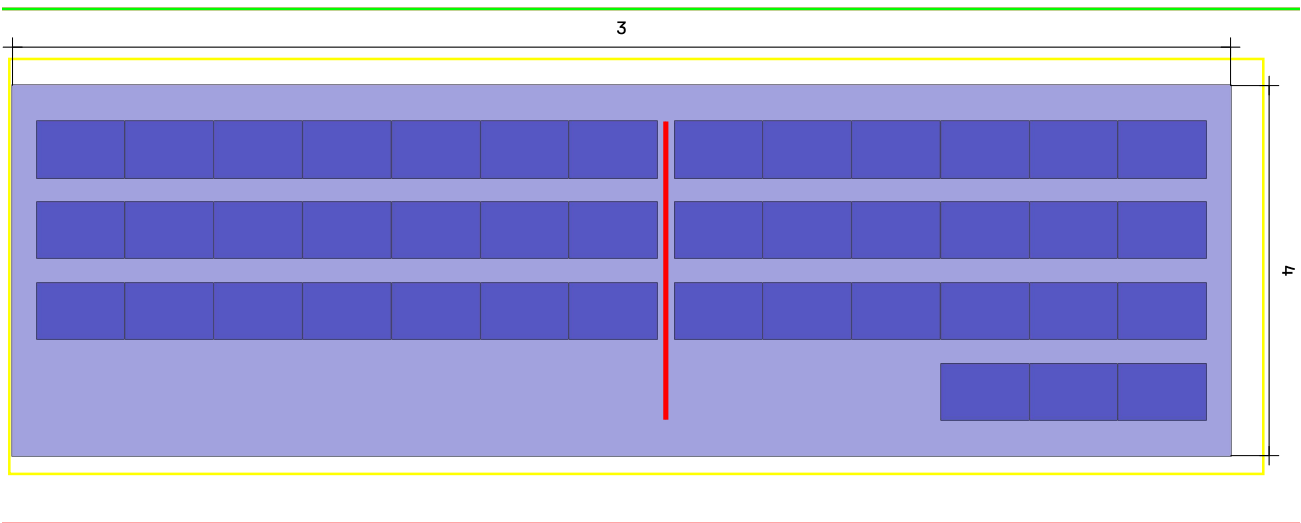
Base Rails

Type	Whole Rails		Rail cutting		
	Total Rail Length	Quantity 3.65 m	Part of Rail / Rest	Length	Rest
4*A	6.043 m	1*3.65 m	3.650	2.393 from 3.650	<u>1.247</u>
4*B	4.422 m	1*3.65 m	<u>1.247</u>	0.772 from 1.247	0.465
2*C	4.422 m	1*3.65 m	3.650	0.772 from 3.650	<u>2.868</u>
2*D	4.422 m	1*3.65 m	<u>2.868</u>	0.772 from 2.868	<u>2.086</u>
2*E	4.422 m	1*3.65 m	<u>2.086</u>	0.772 from 2.086	<u>1.305</u>
1*F	4.422 m	1*3.65 m	<u>1.305</u>	0.772 from 1.305	0.523

1 cm is viewed as lost for each cutting

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

Roofs | MMU-Archway Hall | Module array 1



Roof 1 Module array 1

Mounting System

Module

S-Dome 6.10 Classic

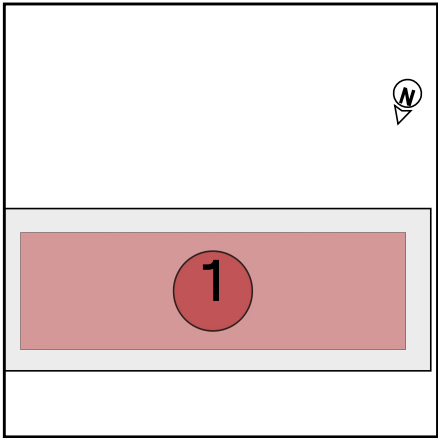
42(18.48 kWp) x
 TSM-440NEG9R.28 (Vertex
 S+)

Row spacing

1.62 m

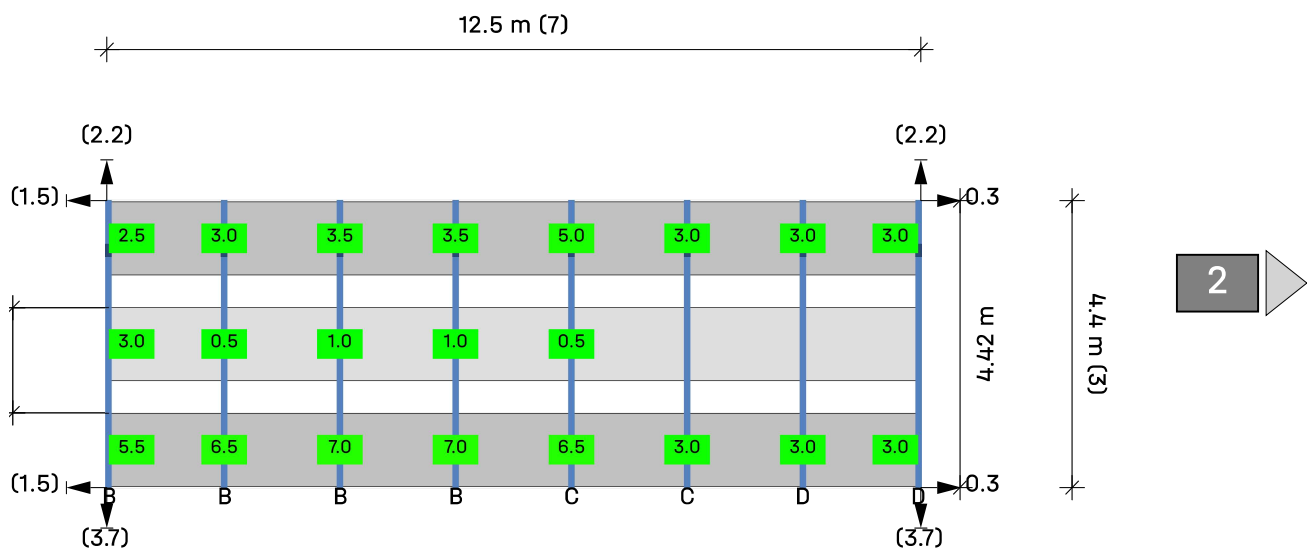
service corridor

0.50 m





Roofs | MMU-Archway Hall | Module array 1 | Module blocks



Roof ① Module array ① Module block 1

Modules $7 \times 3 = 21$

Legend

Next block indicator

Mounting rail

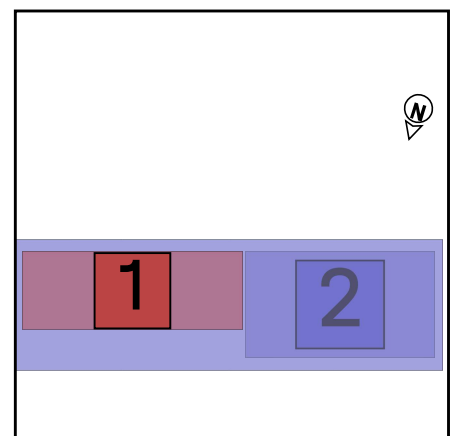
Row distance [m]

Distance to Roof Edge [m]

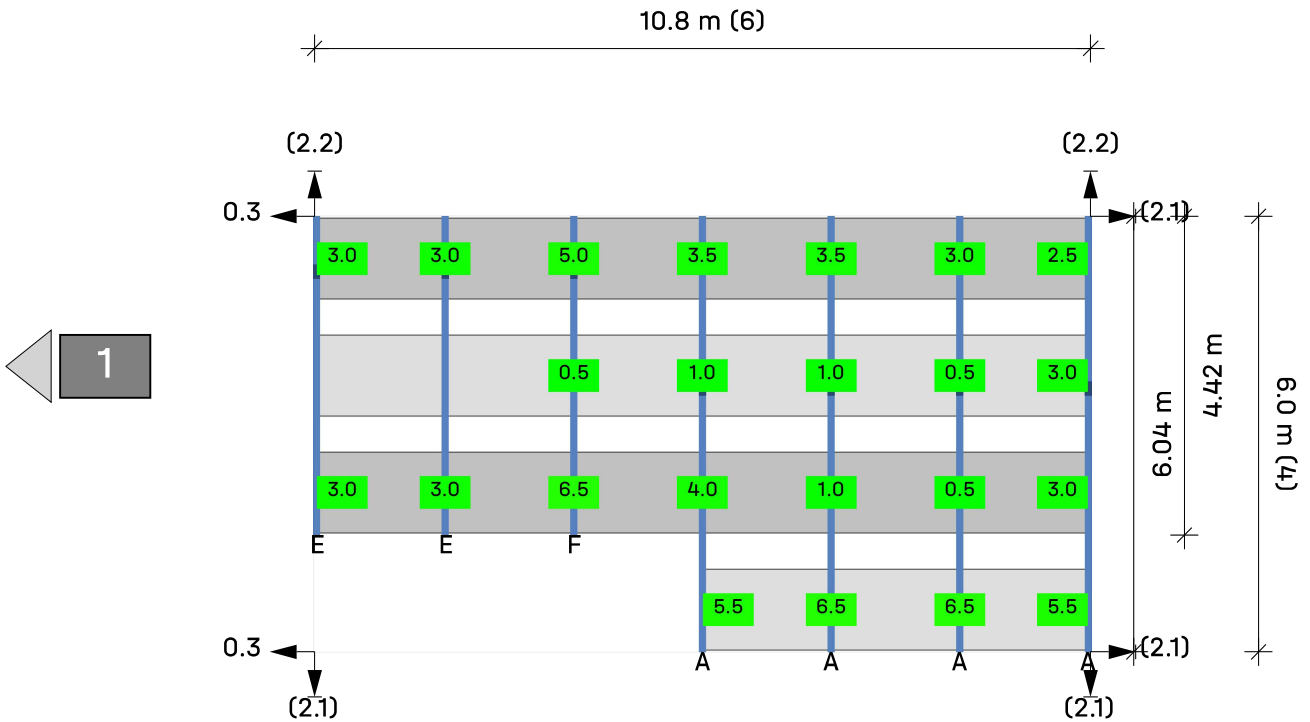
Dist. to neighbour module block/array [m]

Ballast in kilogram (kg)

Porter Ballast



Roofs | MMU-Archway Hall | Module array 1 | Module blocks

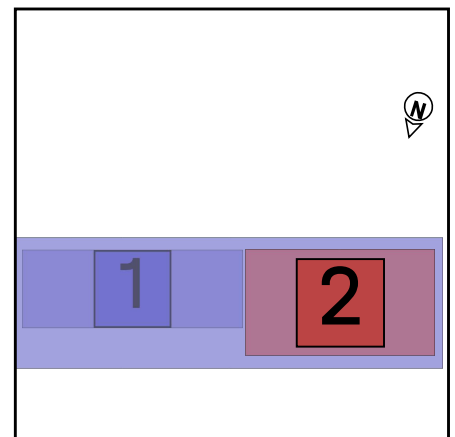


Roof ① Module array ① Module block 2

Modules (6 × 4) - 3 = 21

Legend

- Next block indicator
- Mounting rail
- Row distance [m]
- Distance to Roof Edge [m]
- Dist. to neighbour module block/array [m]
- Ballast in kilogram (kg)
- Porter Ballast





Results | MMU-Archway Hall

Roof	System	Module	Height	Quantity	Total power
<u>MMU-Archway Hall</u>  Flat	<u>S-Dome 6.10 Classic</u>	TSM-440NEG9R.28 (Vertex S+) 1,762×1,134×30 mm 440 Wp	3.00 m	42	18.48 kWp

Module

Name	TSM-440NEG9R.28 (Vertex S+)
Manufacturer	Trina Solar Energy
Output power	440 Wp
Dimensions	1,762×1,134×30 mm
Weight	21.0 kg
Panel Tilt	8.6 °

Module clamps

module clamp	DomeClamp Black MC Set 30-50
end clamp	DomeClamp Black EC Set 30-50

Ballast capacity

Speed Porter	40.0 kg
Porter	108.0 kg

Verification system utilisation

Type	pressure	suction
Verification system utilisation	18.51%	22.83%
Loads on modules (ultimate state)	1.00 kN/m ²	-0.54 kN/m ²
Loads on modules (Serviceability)	0.75 kN/m ²	-0.37 kN/m ²

Specific loads

Module block	No. of modules	Ballast [kg]	Dead weight [kg]	Module block area [m ²] (incl. service corridor)	Dead Load [kN/m ²]	Dead load (roof surface area) [kN/m ²]
Block 1	21	74.0	601.10	55.43	0.11	
Block 2	21	74.5	601.60	56.34	0.10	
Total	42	148.5	1,202.70			0.04

Results | MMU-Archway Hall

Notes

- The proof of static equilibrium and load capacity of the system are carried out by checking the load cases lifting and sliding 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 structure was statically verified in accordance with Eurocode 9: Design of aluminium structures (DIN EN 1999-1-1:2021) and offers sufficient load-bearing capacity and stability for the loads specified in the chapter 'Maximum actions on the components'.
- Adjustment factor for wind load regarding service life period, f_W , is according to DIN EN 1991-1-4/ NA, NDP for 4.2 (2P) note 5, table 3
- Adjustment factor for snow load regarding service life period, f_S , is according to DIN EN 1991-1-3/ annex D, table 4
- All resistance values of components are determined from an extern static engineering office.
- The structural design complies with BS EN 1990 - Basis of Structural Design.
- Snow loads are determined in accordance with National Annex BS NA EN 1991-1-3 (2018) - UK National Annex to EC1 - Action on structures - general actions - snow loads.
- Wind loads are determined in accordance with National Annex BS NA EN 1991-1-4 - UK National Annex to EC1 - Action on structures, general actions - wind actions.
- Service life is recognised according to 'Eurocode EN 1991 - Action on structures, Snow loads' and 'Eurocode EN 1991 - Actions on structures, Wind actions'. Subject to the Building Regulations and for security-relevant reasons the installation has to be dismantled at the end of its service life.
- Failure consequence class is considered according to 'Eurocode EN 1990 - Basis of structural design'.
- Data and results must be verified with regard to local conditions and checked by a suitably qualified person. Please see our TCU under <https://k2-systems.com/en/base-tcu> , in particular § 2 ("technical and specialist requirements for the customer"), § 7 ("warranty provisions") and § 8 ("limitation of liability").



Structural analysis report | MMU-Archway Hall

General information

Name	MMU-Archway Halls
Mounting System	S-Dome 6.10 Classic
Author	claire fitzpatrick

Location information

Address	Bonsall St, Manchester M15 6DP, UK
Ground elevation	36.01 m

Roof information

Building height	3.00 m
Roof type	Flat roof
Roof pitch	2°
Fastening method	with Ballast
Roof covering	Flat
Min. roof edge distance	1.00 m
Parapet wall height	0.01 m
Material	Gravel
Dumping height	0.050 m
Friction coefficient	0.6

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	52.00 km
Distance inside town terrain	1.00 km

Wind load

Velocity pressure, 50	$q_{p,50} = 0.418 \text{ kN/m}^2$
Adjustment factor for service life	$f_w = 0.921$
Velocity pressure, 25	$q_{p,25} = 0.385 \text{ kN/m}^2$

Structural analysis report | MMU-Archway Hall

Snow load

Snow load zone	3
Snow guard	No
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$
Shape Coefficient for Snow	$\mu_i = 0.800$
Factor for roof pitch	$d_i = 0.999$
Snow load on roof, 50	$s_{i,50} = 0.400 \text{ kN/m}^2$
Adjustment factor for service life	$f_s = 0.929$
Snow load on roof, 25	$s_{i,25} = 0.371 \text{ kN/m}^2$

Dead Load

Weight of module	$G_M = 21.0 \text{ kg}$
Weight of mounting system per module	$= 4.1 \text{ kg}$
Module area	$A_M = 2.00 \text{ m}^2$
Dead weight of module per m^2	$= 10.51 \text{ kg/m}^2$
Dead weight of mounting system per m^2	$= 2.05 \text{ kg/m}^2$
Total Dead Load (excl. ballast) per m^2	$= 0.12 \text{ kN/m}^2$

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 variable loads	$\gamma_Q = 1.50$
Combination coefficient with regards to wind	$\psi_{0,W} = 0.60$
Combination coefficient with regards to wind (additional varying influences)	$\psi_{1,W} = 0.20$
Combination coefficient with regards to Snow	$\psi_{0,S} = 0.50$
Importance factor permanent	$\kappa_{F1,G} = 0.90$
Importance factor variable	$\kappa_{F1,Q} = 0.85$
Characteristic dead weight	G_k
Characteristic snow load on the roof	$S_{i,n}$
Characteristic wind load	W_k
Load case combination 01	$LCC\ 01_{uls} = \gamma_{G,sup} * \kappa_{F1,G} * G_k + \gamma_Q * \kappa_{F1,Q} * S_{i,n}$
Load case combination 02	$LCC\ 02_{uls} = \gamma_{G,sup} * \kappa_{F1,G} * G_k + \gamma_Q * \kappa_{F1,Q} * W_{k,Pressure}$
Load case combination 03	$LCC\ 03_{uls} = \gamma_{G,sup} * \kappa_{F1,G} * G_k + \gamma_Q * \kappa_{F1,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$



Structural analysis report | MMU-Archway Hall

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

Static equilibrium

Uplift Verification	$LCC\ up = \gamma_{G,stab} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,n,Uplift}$
Displacement verification	$LCC\ displ = \gamma_{G,stab} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,n,Displacement}$

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

Max. Pressure on insulation

General information

dead load system	$g_{System} = 0.12\ kN/m^2$
aerodynamic coefficient	$c_{p,Pressure} = 0.20$

Load distribution underneath the building protection mat under Peak (45°)

Dimensions	$380.0 \times 75.3 \times 27.6\ mm$
	$A_{eff} = 28,614.00\ mm^2$
	$A_{load\ range\ area} = 1.00\ m^2$
maximum ballast	$G_{ballast\ required} = 4.6\ kg$

Load distribution underneath the building protection mat under SD (45°)

Dimensions	$380.0 \times 75.3 \times 27.6\ mm$
	$A_{eff} = 28,614.00\ mm^2$
	$A_{load\ range\ area} = 1.00\ m^2$
maximum ballast	$G_{ballast\ required} = 2.4\ kg$



Structural analysis report | MMU-Archway Hall

Load Combinations

	$\sigma_{Ek, \text{heat insulation, S6_10Eco}} [\text{Pa}]$	$\sigma_{Ek, \text{heat insulation, SD}} [\text{Pa}]$
Load case combination 00	5,885	5,117
Load case combination 01	18,711	17,944
Load case combination 02	8,572	7,804
Load case combination 03	14,985	14,217
Load case combination 04	20,324	19,556

Dead loads (PV system + ballast)

 $\sigma_{Ek, \text{heat insulation, S6_10Eco}}$

$$\sigma_{Ek} = 5,885 \text{ Pa}$$

 $\sigma_{Ek, \text{heat insulation, SD}}$

$$\sigma_{Ek} = 5,117 \text{ Pa}$$

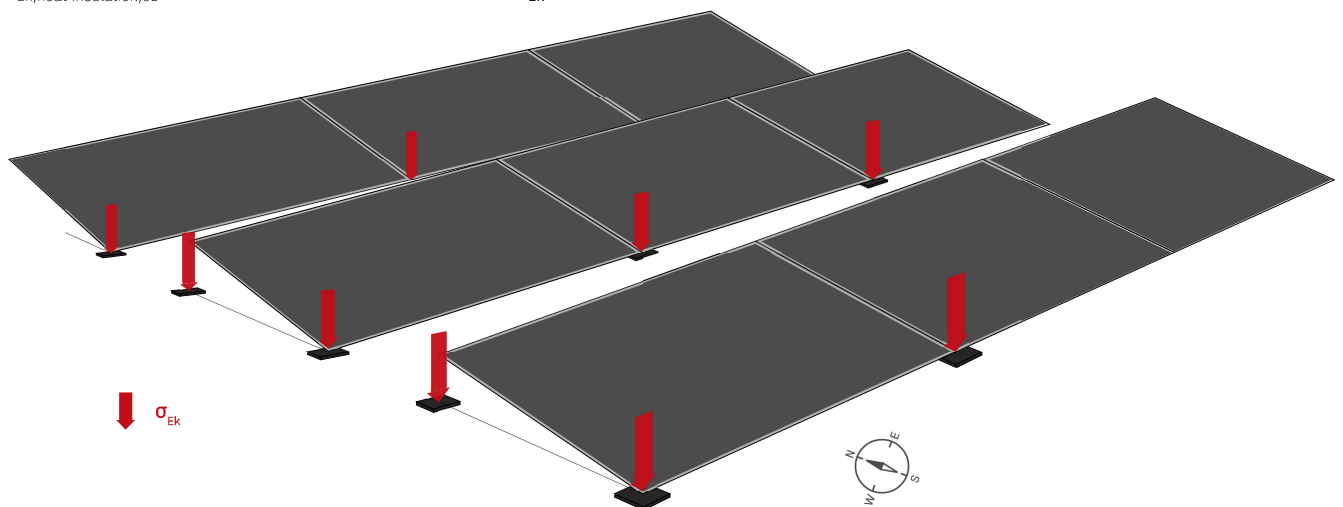
Maximum actions (sum of dead loads and the maximum variable actions from wind and snow)

 $\sigma_{Ek, \text{heat insulation, S6_10Eco}}$

$$\max \sigma_{Ek} = 20,324 \text{ Pa}$$

 $\sigma_{Ek, \text{heat insulation, SD}}$

$$\max \sigma_{Ek} = 19,556 \text{ Pa}$$



Structural analysis report | MMU-Archway Hall

H-V-loads

According to wind tunnel report by I.F.I. Institut für Industrieaerodynamik GmbH

General information

Total number of modules	42	
Roof areas covered with modules	A	= ca. 111.77 m ²
Dead Load	$g_{k, \text{System incl. ballast}}$	= 0.11 kN/m ²

Aerodynamic coefficients

	$C_{p, \text{Pressure}}$	= according to EN 1991-1-4
	$C_{F, x, \text{average}}$	= 0.01
	$C_{F, y, \text{averaged}}$	= -0.02
edge distance correction	$k_{s, xy}$	= 1.00
Parapet wall- correction coefficient	k_p	= 1.00
Factor building height		= 1.00

Horizontal pressure

$$W_{k, F, x} = 0.003 \text{ kN/m}^2$$

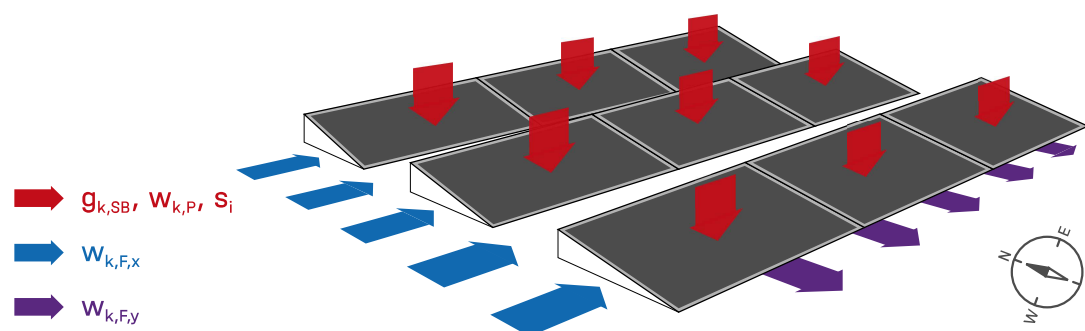
$$W_{k, F, y} = -0.007 \text{ kN/m}^2$$

Vertical pressure

$$g_{k, \text{System incl. ballast}} = 0.11 \text{ kN/m}^2$$

$$W_{k, \text{Pressure}} - \text{according to EN 1991-1-4}$$

$$S_i - \text{according to EN 1991-1-3}$$



Comment:

Flat roof vertical wind loads are essentially determined by its displacement effect and remain unchanged even with a flat pv structure. We advise using the aerodynamic coefficients according to DIN EN 1991-1-4 to calculate flat roofs.



Bill of material

Position	Item no.	Item description	Quantity	Weight
1	2004125	Dome 6.10 Peak	49	14.7 kg
2	1001643	MK2	98	1.7 kg
3	2001729	Socket Head Bolt serrated M8×20	98	1.3 kg
4	2003243	Dome 6.10 SD	49	14.8 kg
5	2003126	Dome Mat S 380	98	36.1 kg
6	2003249	S-Dome 6.10 Windbreaker short	42	75.6 kg
7	2002937	Thread-forming metal screw 6×25	98	0.7 kg
8	2004277	K2 BasicRail 22; 3.65 m	21	49.3 kg
9	1006039	Dome FlatConnector Set	15	2.9 kg
10	2002870	K2 Solar Cable Manager	42	0.1 kg
11	2004141	Mat-S Tool	1	0.0 kg
12	2002609	DomeClamp Black MC Set 30-50	70	4.1 kg
13	2002610	DomeClamp Black EC Set 30-50	28	1.8 kg
14	2002300	Dome SpeedPorter	88	6.7 kg
Total				209.8 kg



Thank you for choosing a K2 mounting system.

Systems from K2 Systems are quick and easy to install.

We hope these instructions have helped.

Please contact us with any questions or suggestions for improvement.

Our contact data:

k2-systems.com/en/contact

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

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