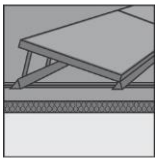
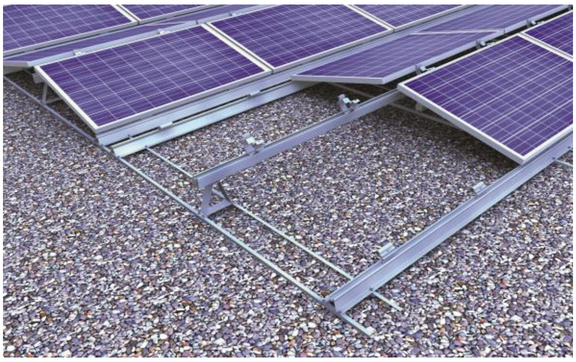
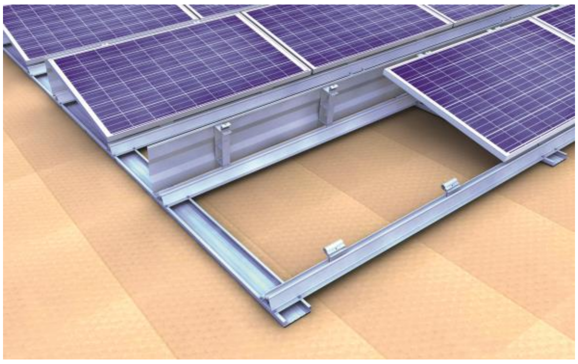
Mounting instructions

novotegra for Flat Roofs







CONTENTS

1 General information

Check for completeness
On receipt of the goods, check that your order is complete on delivery based on the enclosed delivery slip. BayWa r.e. Solar Energy Systems GmbH assumes no costs or guarantee for any subsequent express deliveries if it only becomes apparent that materials are missing during installation.

Solar modules
The data relating to the permitted pressure and suction loads for the modules and permitted mounting areas is included in the datasheets or installation instructions provided by the solar module manufacturer. In individual cases, check that the mounting system is suitable for the used modules.

Mounting system
All mounting systems described in these installation instructions are designed for erection on flat roofs with pitches ranging from 0 to 5 degrees. Before installing the system, read the installation instructions and observe the information, specifications etc.

Roof characteristics
In individual cases, you should make sure that the roof covering is suitable for the mounting system. The system must meet the requirements of the mounting system with regard to load-bearing capacity, support structure and condition. Due to the variety of different materials used for cladding flat roofs it might be necessary to select an appropriate separating layer between the roof cladding and the mounting system, depending on the compatibility and durability of the existing roof cladding. This decision must be made by the installer of the PV system in direct collaboration with the customer and an appropriate specialist roof sealing company.

Structural analysis
BayWa r.e. Solar Energy Systems GmbH performs the static loading calculations and detailed of the system.

novotegra has been tested and certified by TÜV Rheinland:

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2 novotegra: mounting system planning

2.1 Structural design and planning of flat roof systems with novotegra

2.1.1 General information

The design of the mounting system must be performed by BayWa r.e. Solar Energy Systems GmbH.

The loading capacity of the mounting system components and the necessary ballast are determined according to the system planning (arrangement of the modules on the roof). On-site deviations from the planning can lead to different results. Load transfer within the building is not taken into account (structural analysis of the building).

The dimensioning is performed using the current load assumptions specified in the Eurocodes under consideration of the framework conditions and specifications resulting from wind tunnel tests.

The PV system must have a minimum clearance of 500 mm to the parapet wall, or to the edge of the roof in the case of roofs without a parapet wall.

If the building is in an exposed location, e.g. at the edge of a slope, please contact BayWa r.e. Solar Energy Systems GmbH sales team.

2.1.2 Cost estimate and detailed planning

The data collection form provided must be filled out by the installer in order to plan the flat roof system and provide a quote. The following information is also required:

- A plan and cross-section of the roof with all relevant dimensions.
- Information on roof structures, penetrations, drainage etc.
- The permitted load on the roof.

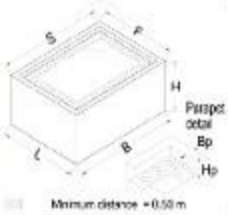
Planning of the flat roof system cannot be carried out with incomplete information.

The installer receives a cost estimate based on the documents provided (Figure 1). This contains the most important project data (building, site and system data), the type of flat roof variant (close, open or east-west), a cost estimate (+/-10%) and estimation of the roof loads.

Novotegra for flat roofs
Project Flat roof system, Anlage Kyo 245 Wp
Novotegra-Planner version 2.2.8.29, Data base version 2.38

General	Project	Flat roof system	**Cost estimate** Novotegra for flat roofs
	Customer	dulasMHH	
	System	Kyo 245 Wp	
	Date	13.12.2012	

Building	Roof type		Flat roof
	Building width (B)		8,60 m
	Building height (H)		14,00 m
	Building length (L)		7,70 m
	Roof surface length (F)		7,70 m
	Roof surface width (S)		8,60 m
	Roof angle | Height parapet	0 °	0,1 m



Environment	Terrain category	individual load determination
	Altitude	individual load determination
	Peak velocity pressure [kN/m²]	1,03
	Ground snow load [kN/m²]	0,34

System Layout	12 Modules	Kyocera KD245GH-2YB			245Wp	Module dimensions		990 x 1662 x 46 mm	
	Module orientation				Landscape	Output		2,94 kWp	
	Type of roof sealant							Foil or Bitumen sealing	
	Distance from roof edge (min 50cm)	South	75 cm	West	75 cm	North	75 cm	East	75 cm
	Mounting frame	Degree of angle			13 °	Sun angle			10 °
	Distance between rows				2,29 m	Degree of module			13 °

Information / Estimation	Type of mounting system	Flat roof East-West			Ballast weight estimation only. Accurate ballast calculations are performed in the detail planning.			
	Cosst assessment Rails with underlay without synthetic fibre	**167 EUR / kW**	= 40,9 EUR/Modul		+/- 10%, Estimation without detail planning; Tax and margin excluded!			
	Ballast weight estimation (max-value) excluding dead load	Middle area	0,0	Border area	13,1	Changeover Middle-Border	5,2	kg/m² roof area,
	Entire roof burden (max-value) Testing roof statics by the building contractor	Middle area	12,6	Border area	25,7	Changeover Middle-Border	17,8	kg/m² roof area including dead load
	Safety instructions* *All the safety information and warnings, along with the installation instructions, can be found in the manual!	Minimum distance between roof edge/parapet and array: 0.5m. Maximum roof angle: 5 degrees. Maximum distance from the end of the base trough to the parapet: 0.1m. Due to safety reasons, the parapet needs to prevent the base trough slipping. Assumed coefficient of friction to prevent sliding: 0.5. This must be verified on site. The determined coefficient of friction has to be transmitted on site to MHH for further verifications. The installer must verify the quality of the roof. The installer must verify the suitability of the base trough/protection layers for the roofing membrane used to ensure the durability of the waterproof seal. **We assume no liability for the correctness of the specifications. Technical changes and errors reserved. This is not an order confirmation.**						
	Weight mounting system ca. 77 kg							

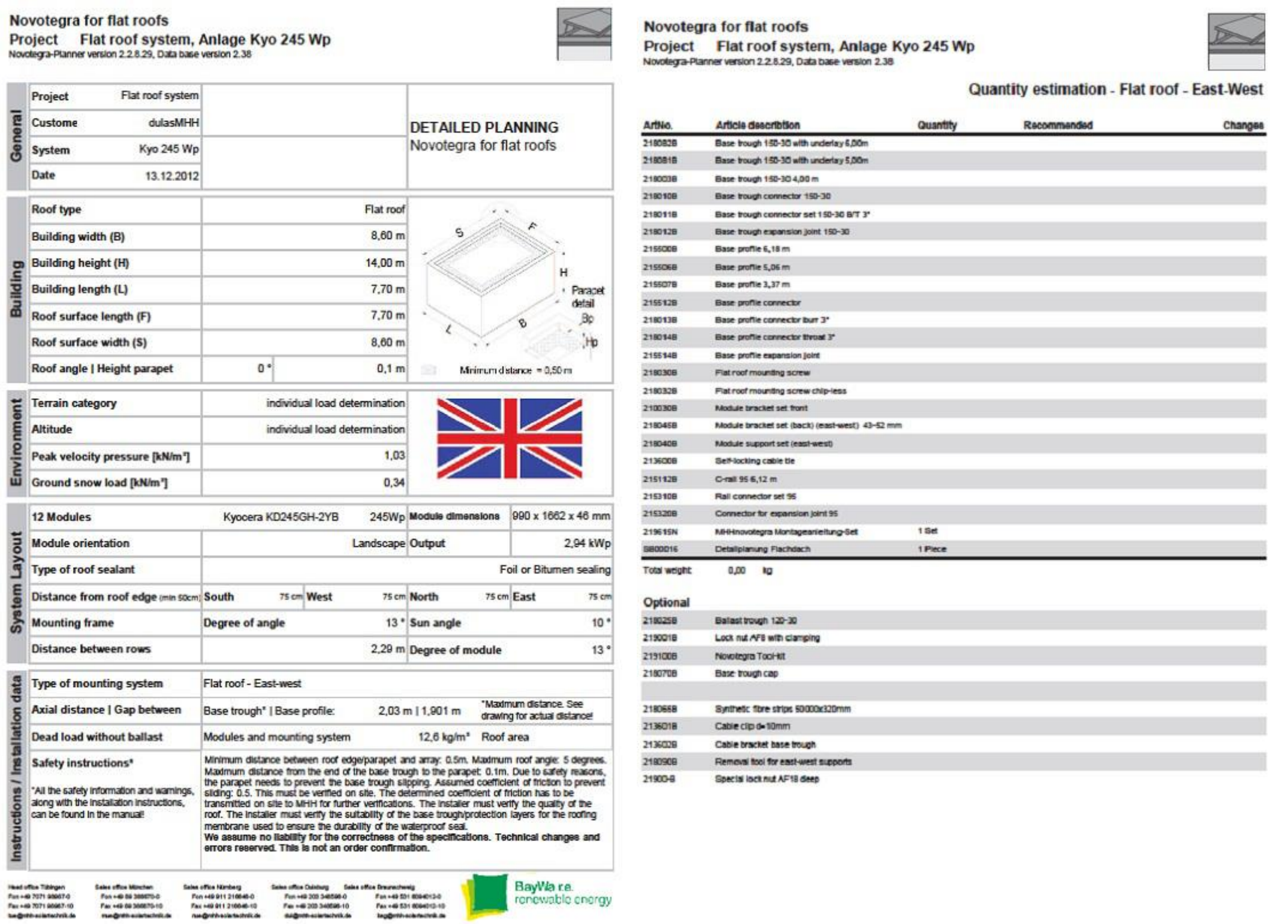
BayWa r.e. renewable energy

Figure 1 Cost estimate

On completion of the detailed planning the installer receives the following documents:

- A project description with quantity estimates: This contains the most important general project data such as (e.g.) the modules used, the wind and snow load zones, the building data used for the planning, the characteristic snow and wind loads and the quantities of mounting system components determined for this project
- Installation plan for base troughs
- Installation plan for base profiles
- Ballast plan
- System plan.

The installer receives pdf-documents via email as well as a print-document about system components.



Novotegra for flat roofs
Project Flat roof system, Anlage Kyo 245 Wp
Novotegra-Planner version 2.2.8.29, Data base version 2.38

DETAILED PLANNING
Novotegra for flat roofs

General	Project	Flat roof system			
	Custome	dulasMHH			
	System	Kyo 245 Wp			
	Date	13.12.2012			
Building	Roof type		Flat roof		
	Building width (B)		8,60 m		
	Building height (H)		14,00 m		
	Building length (L)		7,70 m		
	Roof surface length (F)		7,70 m		
	Roof surface width (S)		8,60 m		
	Roof angle | Height parapet	0 °	0,1 m		
Environment	Terrain category		individual load determination		
	Altitude		individual load determination		
	Peak velocity pressure [kN/m²]		1,03		
	Ground snow load [kN/m²]		0,34		
System Layout	12 Modules	Kyocera KD245GH-2YB	245Wp	Module dimensions	990 x 1662 x 46 mm
	Module orientation		Landscape	Output	2,94 kWp
	Type of roof sealant				Foil or Bitumen sealing
	Distance from roof edge (min 50cm)	South 75 cm	West 75 cm	North 75 cm	East 75 cm
	Mounting frame	Degree of angle	13 °	Sun angle	10 °
	Distance between rows		2,29 m	Degree of module	13 °
Instructions / Installation data	Type of mounting system	Flat roof - East-west			
	Axial distance | Gap between	Base trough* | Base profile:	2,03 m | 1,901 m	*Maximum distance. See drawing for actual distance!	
	Dead load without ballast	Modules and mounting system	12,6 kg/m²	Roof area	
	Safety instructions* *All the safety information and warnings, along with the installation instructions, can be found in the manual!	Minimum distance between roof edge/parapet and array: 0.5m. Maximum roof angle: 5 degrees. Maximum distance from the end of the base trough to the parapet: 0.1m. Due to safety reasons, the parapet needs to prevent the base trough slipping. Assumed coefficient of friction to prevent sliding: 0.5. This must be verified on site. The determined coefficient of friction has to be transmitted on site to MHH for further verifications. The installer must verify the quality of the roof. The installer must verify the suitability of the base trough/protection layers for the roofing membrane used to ensure the durability of the waterproof seal. **We assume no liability for the correctness of the specifications. Technical changes and errors reserved. This is not an order confirmation.**			

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Quantity estimation - Flat roof - East-West

ArtNo.	Article describtion	Quantity	Recommended	Changes
218082B	Base trough 150-30 with underlay 6,00m			
218081B	Base trough 150-30 with underlay 5,00m			
218003B	Base trough 150-30 4,00 m			
218010B	Base trough connector 150-30			
218011B	Base trough connector set 150-30 B/T 3"			
218012B	Base trough expansion joint 150-30			
215500B	Base profile 6,18 m			
215506B	Base profile 5,06 m			
215507B	Base profile 3,37 m			
215512B	Base profile connector			
218013B	Base profile connector burr 3"			
218014B	Base profile connector throat 3"			
215514B	Base profile expansion joint			
218030B	Flat roof mounting screw			
218032B	Flat roof mounting screw chip-less			
210030B	Module bracket set front			
218045B	Module bracket set (back) (east-west) 43-52 mm			
218040B	Module support set (east-west)			
213600B	Self-locking cable tie			
215112B	C-rail 95 6,12 m			
215310B	Rail connector set 95			
215320B	Connector for expansion joint 95			
219615N	MHHnovotegra Montageanleitung-Set	1 Set		
S800016	Detailplanung Flachdach	1 Piece		

Total weight: 0,00 kg

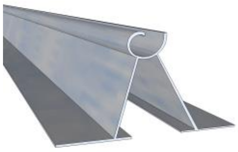
Optional

218025B	Ballast trough 120-30			
219001B	Lock nut AF8 with clamping			
219100B	Novotegra Tool-kit			
218070B	Base trough cap			
218066B	Synthetic fibre strips 50000x320mm			
213601B	Cable clip d=10mm			
213602B	Cable bracket base trough			
218090B	Removal tool for east-west supports			
21900-B	Special lock nut AF18 deep			

Figure 2 Project description with quantity estimates

The individual planning documents contain all relevant information required for each installation step. The following symbols are used to provide a clear distinction between the plans:

Base trough



Base profile

Ballast plan

System plan

Figure 3 Symbols for distinguishing between the planning documents

2.1.3 Installation plan for base troughs

The installation plan contains a plan of the building showing the arrangement of the base troughs on the roof surface. The position of the base troughs with respect to the parapet wall, or the edge of the roof in the case of roofs without a parapet wall – i.e. the usable roof area – is clearly defined by the clearance dimensions between the base troughs and the parapet wall or edge of the roof.

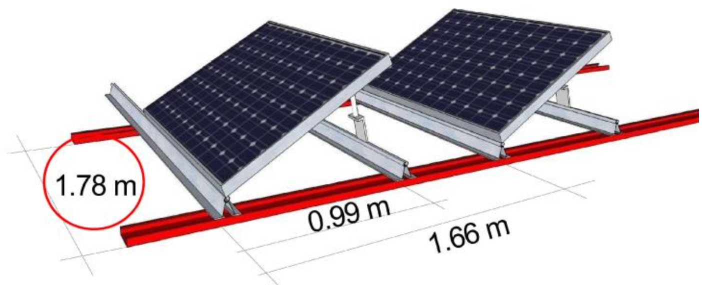


Figure 4 Specification of the distance between base troughs

The distance between the base troughs is shown in the perspective drawing for the elevated mounting frame variant (red circle), as illustrated in Figure 4, and is also on the drawing. In some cases the distance between the base troughs may vary in different places in the array.

The length of the base trough needed varies. The different lengths have different colours on the plan, see Figure 5. Orange denotes a length other than 4m, 5m or 6 m.

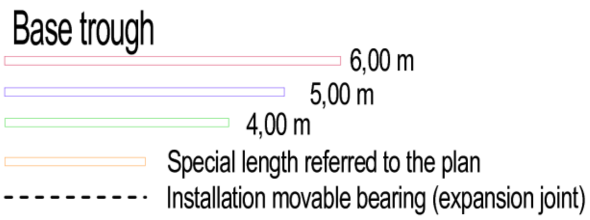


Figure 5 Legend for base troughs

If requested by the customer, the system can be planned using the standard base trough length to minimise cutting as far as possible.

2.1.4 Installation plan for base profile

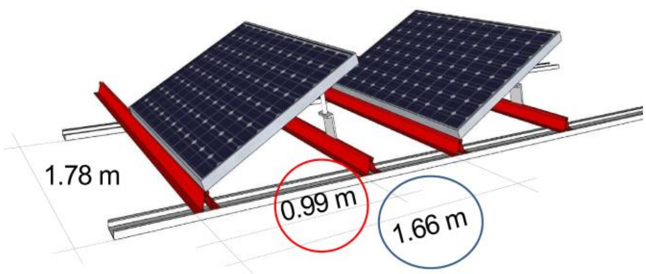


Figure 6 Axial clearance dimensions for base profiles in a row and for the subsequent row

The base profiles are installed after the base troughs have been installed. The installation plan specifies the distance between the base profiles at the front and the back of each panel, and the distance between the front of the panel and the front of the next (see the red rails in Figure 6). As with the base troughs, the distances between base profiles may not be all identical in a single system.

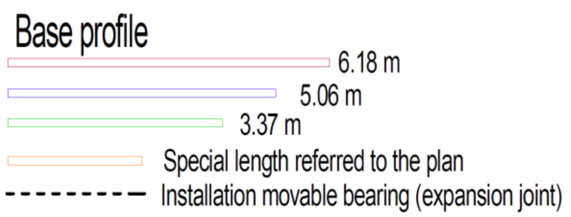


Figure 7 Legend for base profiles

See Figure 7 for standard rail sizes.
If requested by the customer, the system can be planned using the standard base profile lengths to minimise cutting as far as possible.

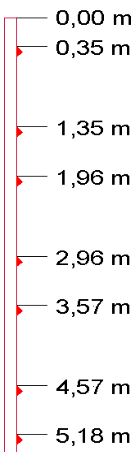


Figure 8 Positioning the base profiles

A layout plan of how to position the base profiles onto the base troughs is provided (Figure 8).

2.1.5 Ballast plan

The next step is to lay the necessary ballast on the base troughs. The ballast plan specifies how many kilograms of ballast per base trough and module row must be laid on the base troughs. To provide a clear illustration of the assignment of the ballast to each module row and base trough, the base troughs and base profiles are illustrated in a single colour (grey) in this plan. The ballast can then be distributed underneath and behind the modules on the base troughs of each module row. The ballast plan shows a sample perspective view with the numerical values of the ballast. This drawing shows a weight as a symbolic representation of the ballast (Figure 9).

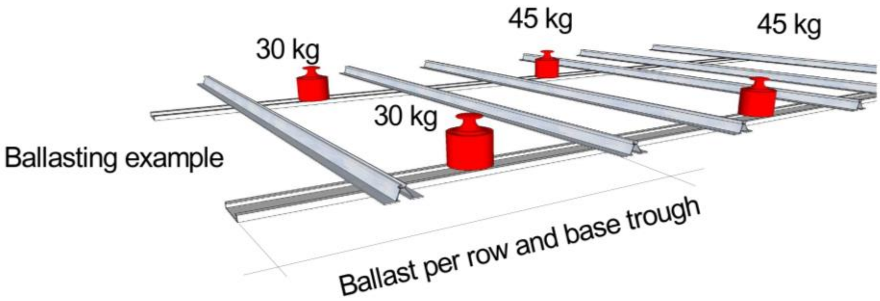


Figure 9 Ballasting example showing the ballast per module row and base trough

In addition to the ballast specifications the ballast plan shows the points on the roof where the largest and smallest additional loads per m² of roof area, due to the own weight of the system and the necessary ballast, exist. The numerical values with the ballast specifications in kilograms are shown in green as standard on the plan drawing. The numerical ballast values are coloured red in the areas where the largest surface loads due to the ballast are present. The areas with the smallest surface loads are indicated by blue ballast values.

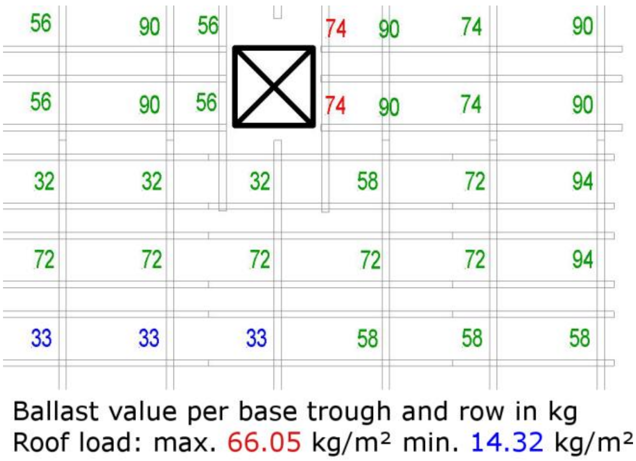


Figure 10 Labelling of the roof areas with the largest and smallest area loads using open elevated mounting frames as an example

The surface load per m² of roof area resulting from the required ballast and the own weight of the system is calculated across the loaded area and specified on the ballast plan, as illustrated in Figure 10.

2.1.6 System plan

The system plan shows the arrangement of the modules. As shown in Figure 11 the perspective view in the module plan provides information on the module inclination and the angle of the sun (shadowing angle) for each mounting frame variant.

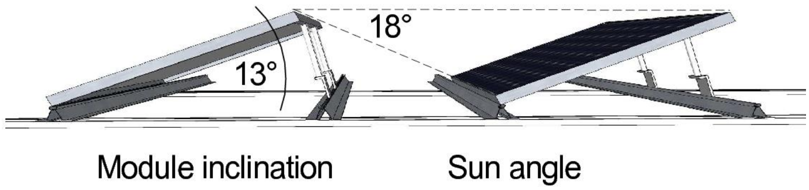
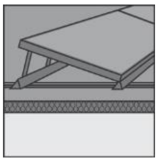


Figure 11 Representation of module and shadowing angles in system plan



3 novotegra for flat roofs

3.1 General information

This chapter describes the installation of the novotegra mounting system for flat roofs. In principle, the mounting system can be used on flat roofs sealed with foil or bitumen sealing sheets. The need for a separating layer between the mounting system and the roof sealing, and the type of separating layer to be used must be evaluated on-site depending on the compatibility and durability of the existing roof sealing. This installer is to check these aspects of the roof structure on-site, with the assistance of a technical specialist if necessary.

A coefficient of friction of □ = 0.5 is used for calculating the verification of slip safety. This coefficient of friction is to be checked on-site and can be adjusted to suit the actual on-site conditions if requested by the installer. The installer must then provide the new coefficient of friction determined on-site to BayWa r.e. Solar Energy Systems GmbH sales team in advance. For roofs with parapet walls the base profiles are to be laid to approx. 100 mm from the parapet wall. For safety reasons the design of the parapet wall must prevent any possible slipping of the system.

The installer is responsible for checking the permissible load of the roof. BayWa r.e. Solar Energy Systems GmbH can only provide the ballast plan.

The system must be secured on site to prevent it from "creeping" due to expansion caused by temperature. This can be achieved by installing suitable stop points on the roof surface or by anchoring to the parapet, for example. The connection points on the building and building parts must be able to bear the forces exerted.

The novotegra flat roof mounting system has been tested in a wind tunnel under the following conditions:

- Minimum roof parapet height: from 0 mm
- Minimum clearance between roof parapet and modules: 500 mm
- Roof pitch: max. 5 degrees
- Module width: approx. 1,000 mm [+/- 25 mm] (closed mounting frame and east-west)
- Module width: approx. 800 – 1,000 mm [+/- 25 mm] (open mounting frame only)

Three novotegra flat roof variants are available, where the correct variant to be used depends on the roof static loading requirements and the desired layout on the roof:

- Open elevated mounting frame – module angle freely selectable from 13°[15°] - 25° (module width 1,000 [800] mm)
- Closed elevated mounting frame – module angle fixed at 13°
- East-west mounting frame - module angle fixed at 13°

The following tools are required for installing the novotegra flat roof mounting system:

Tool	Mounting system component
Electric screwdriver	
Torque wrench	
Socket bit for hex-head self-tapping screws, AF8	Module fastener set, module support set and fastening screws
Special deep socket, AF18	Locking nuts

The special deep sockets (AF15) are only required for installing the east-west mounting frames.

3.2 Rail extension and expansion joints

3.2.1 General information

The rails are extended using base trough connectors or base profile connectors. Due to temperature-related length expansions, certain limits regarding the rail lengths must be observed, and expansion joints must be created. The expansion joints can be created using two methods. The following descriptions relating to extending the base troughs and base profiles and the design of expansion joints for base troughs and base profiles apply to all three variants of the novotegra flat roof mounting system.

The base trough 230 – 90 can be used for "open elevated mounting frames" and "closed elevated mounting frames" on flat roofs with a gravel surface. With this base trough the existing gravel can be filled into the rail and used as ballast. The base trough 230 – 90 cannot be used with the east-west system!

The east-west system uses the C-rail 71 in addition to the base troughs and base profiles. Details on extending the rails/profiles and implementation of expansion joints are provided in chapter 3.5.9.

3.2.2 Rail extension

Base trough 150-30 and base profile:

Two different connectors are available for extending the base troughs and the base profiles.
The installation and fastening principle is the same. The connectors are designed as inserts that are slid halfway into each of the adjacent rails and then fastened with two self-drilling screws, as shown in Figure 12.

Since the planning process attempts to avoid on-site cutting of the rails by using base troughs and base profiles of different lengths, you can install the neighbouring rail segments with extra clearance at the connectors. This provides additional length to allow compensation for missing smaller residual segments. The gap between neighbouring rails – base troughs and base profiles – must not exceed 100mm.

Figure 12 Installed base trough connector and profile connector

Base trough 230-90:

The cross-section of this trough makes it suitable for filling with gravel ballast. The troughs are extended without the use of connector pieces by plugging adjacent profiles together. To allow this, one end of these troughs is expanded at the sides. The length of this expansion is 250 mm. The adjacent troughs are to be inserted into each other by at least 200 mm. This leaves 50 mm for final adjustment of the trough lengths.

The joined base troughs are to be fastened using two fastening screws on each side (Figure 13).

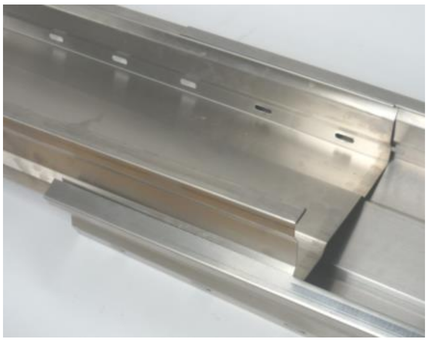


Figure 13 Extending and screwing the base trough 230 - 90

3.2.3 Separating module arrays to allow for expansion

The rails in the mounting system must be a maximum of 50 m in order to allow for expansion. This includes the base profiles, base troughs and wind deflector spans. There must be a complete break in the array after this distance. Ballast is important in these edge areas.

3.2.4 Designing expansion joints using movable bearings – Base trough/ base profile

In addition to the separating the modules fields after 50 m, there must also be an expansion joint after 25 m (Figure 14). The expansion joints are slid into the rails and fastened as shown using screws.

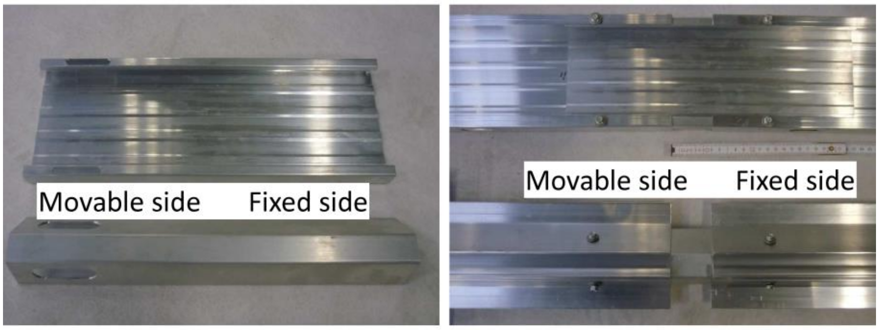


Figure 14 Expansion Joints

The expansion joint should be positioned as centrally as possible on the base profile or trough, i.e. as far away from any fixings to the rail as possible.
An expansion joint must be installed between the modules and not underneath them. The wind deflector must not be screwed across the joint.

The clearance between adjancent base trough/profiles is approximately 50 mm. At the fixed side of the expansion joint the joint is fixed to the base trough/profile with one screw on each side. At the movable side of the joint, a single screw is screwed through the elongated hole into the base trough/profile.

3.2.5 Designing expansion joints with base trough 230-90

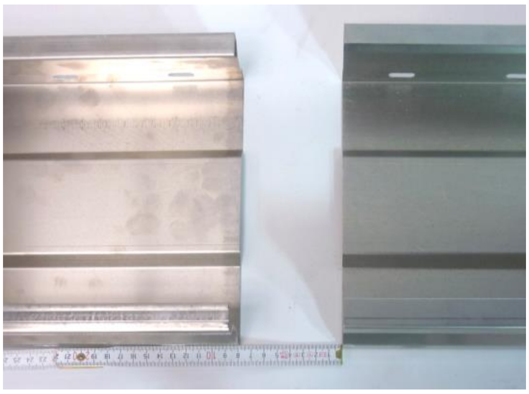


Figure 15 Expansion joint design for base trough 230 – 90; clearance 50 – 100 mm

When using base trough 230-90, there must be a complete break in the base trough after 25m. An expansion joint is not sufficient in the case of this larger trough (Figure 15).

The specifications provided in chapters 3.2.3**Fehler! Verweisquelle konnte nicht gefunden werden.** and 3.2.4 also apply to the design of the base profile expansion joints.

3.2.6 Designing expansion joints for C-rail 71

This requires the expansion joint set 71, which consists of two uncoated saucer head screws, two coated saucer head screws and four locking nuts. The rails are joined to the rail connector with two screws on each side. The screw connections on the fixed side are to be tightened to a torque of 50 Nm. The screws to be used on the movable side have a red coating on the threads. These screws must also first be tightened to 50 Nm and then loosened by approximately a half-turn. The distance between adjacent C-rails must be approx. 40 – 50 mm and the clearance between the screws and the edge of the elongated hole must be approx. 20 – 25mm (Figure 16). A movable bearing must not be installed below a module. As with the other rail types, a complete new array field must be made after a maximum distance of 50m.

Figure 16 Movable bearing set 71 – Components (above) and installed (below)

3.3 Open elevated mounting frames

3.3.1 General information

This chapter describes the installation of the open elevated mounting frame variant of the novotegra mounting system for flat roofs. The open elevated mounting frame variant is a reduced ballast system due to the interconnection of multiple rails and panels, spreading out the load. The mounting system consists of components from the elevated mounting frame solution in the novotegra family of mounting systems. The mounting structure is designed as a cross rail assembly (CRA) with a lower rail (base trough) and a module support rail (base profile) mounted on top of this. The modules must be horizontally mounted. This elevated mounting frame allows a freely selectable module angle ranging from 13° to 25°. BayWa r.e. Solar Energy Systems GmbH calculates the load of the mounting structure and the ballast arrangement.

3.3.2 Roof division

For connected module arrays, the roof is divided into four areas (Figure 17).

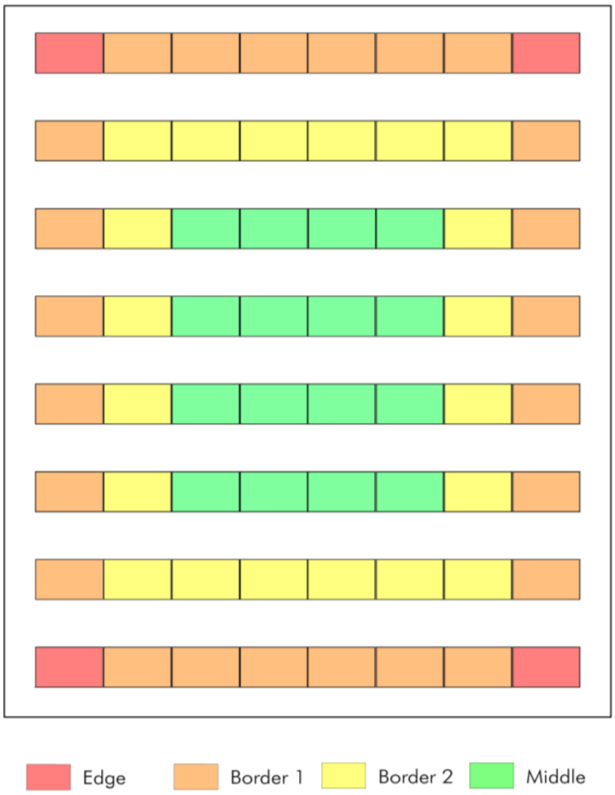


Figure 17 Schematic diagram of roof division

3.3.3 Module arrangement

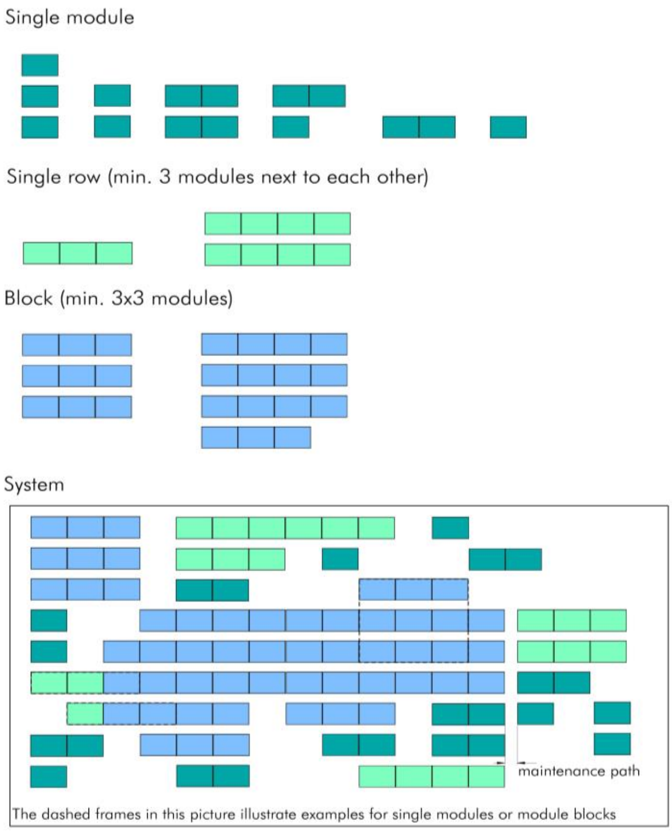


Figure 18 Examples of single modules, module rows and module blocks – light blue modules require the least ballast, then light green, with the dark green requiring the most ballast

The standard layout arranges the modules in blocks of at least 3 modules next to each other (rows) and 3 modules behind each other (columns). If this arrangement is not used, e.g. with single rows or single modules due to roof structures, then significantly more ballast is required to ensure positional stability. This also applies to (e.g.) single modules projecting out of a block. Examples of this are illustrated in Figure 18.

The decisive factor for calculating ballast needed is how many modules are connected to each other via the base troughs and base profiles. Module blocks of 4x6, 6x6 and 10x10 are preferred.

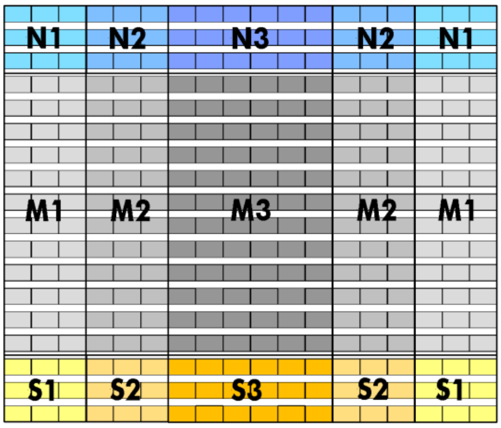


Figure 19 Block designations

The blocks are designated as "S" for south, "M" for middle and "N" for north for the north-south direction. In the east-west direction the blocks are designated as "1" for the edge, "2" for the edge-middle transition and "3" for the middle. The block designations are illustrated in Figure 19.

3.3.4 Arrangement of base troughs

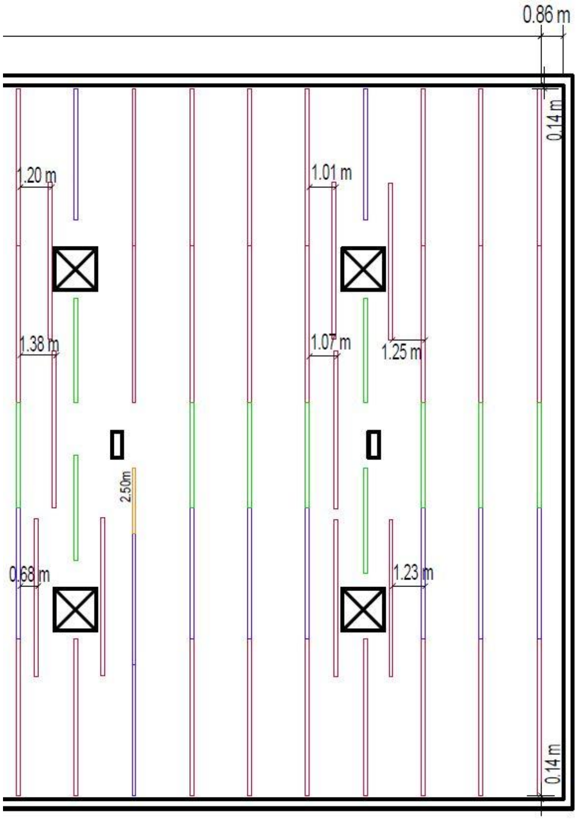


Figure 20 Sample installation plan for base troughs

The base troughs are to be laid out according to the installation plan, observing the clearance specified. The installation plan uses colour coding to specify the various different base trough lengths required. The base troughs are to be joined together using the appropriate connectors, with expansion joints to be provided as specified.

Refer to chapter 2.1.3 "Installation plan for base troughs" regarding the contents of the installation plan for base troughs.

3.3.5 Arranging the base profiles

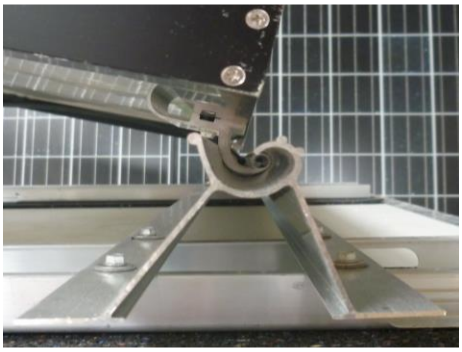


Figure 21 Spiral of the base profile pointing south (right)

The base profiles form the module support rail. They lie on the base profiles and run parallel to the module rows. A front and rear base profile run under the modules rows and these must be installed with the spiral shape facing south (the platform of the spiral faces north (Figure 21).

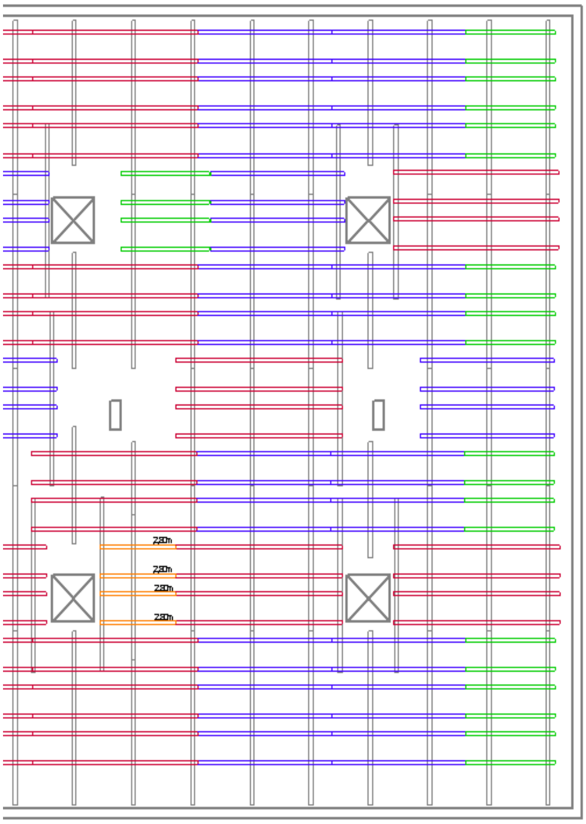


Figure 22 Sample installation plan for base profiles

The installation shows the clearances required, along with the base profile length and where connectors and expantions joints are required.

Refer to chapter 2.1.4 "Installation plan for base profiles" regarding the contents of the installation plan for base profiles.

3.3.6 Fastening the base profiles

Figure 23 Flat roof mounting screw

Figure 24 Flat roof mounting screw (chipless)

<u>General information on fastening</u>

The base profile is fastened to the underlying base troughs using either flat roof mounting screws (Figure 24) or flat roof mounting screws (chipless) (Figure 23). The choice of mounting screws is left to the customer. The base profiles are fastened at both sides through the base profile platforms into the base trough flange, without pre-drilling the base troughs (Figure 25). The self-tapping screws must not be overtightened or they will lose their fastening effectiveness.

<u>Fastening to the base trough 150 - 30</u>

At the intersection points in the edge rows and edge columns of the individual module arrays, the base profile is to be screwed to the base trough using four self-tapping screws (Figure 25 left) and at the intersection points in the middle of the module arrays the base profile is to be screwed to the base trough using two self-tapping screws (Figure 25 middle).

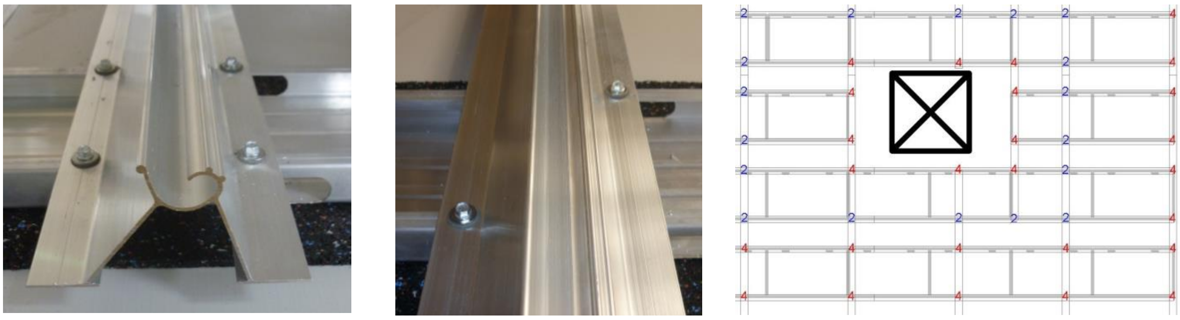


Figure 25 Fastening the base profiles to the base troughs

Modules installed next to roof penetrations, such as (e.g.) light domes or similar are also classified as modules in edge rows or edge columns. This designation does not relate to modules near to the edge of the roof but rather to modules at the edges of the PV system.

If the required ballast is greater than 100 kg per base trough and row then all base profile/ base trough intersections are to be fastened with 4 screws, regardless of their positions on the roof.

<u>Fastening to the base trough 230 - 90</u>

If the base profiles are fastened to gravel roof base troughs then the base profiles are to be fastened with four screws at each intersection point.

3.3.7 Ballasting the base troughs

Ballasting the base trough 150 – 30

The necessary ballast in kilograms per base profile and row is specified in the ballast plan. This is the minimum amount of ballast required in order to secure the system against lifting or sliding. The base troughs must be weighted by choosing a suitable type of ballast (e.g. different stone formats). If the stone format and weight are known at the start of planning then the planning can be performed based on the actual ballast used. It must be ensured on-site that the ballast used remains permanently on or in the troughs. Frost-proof material must be used for ballasting.
For roofs with low loading reserves, or where the loading reserve is already exhausted by the required ballast, care must be taken to install exactly the correct amount of ballast specified, otherwise the little remaining load reserve of the building may be exceed when too much ballast is installed.

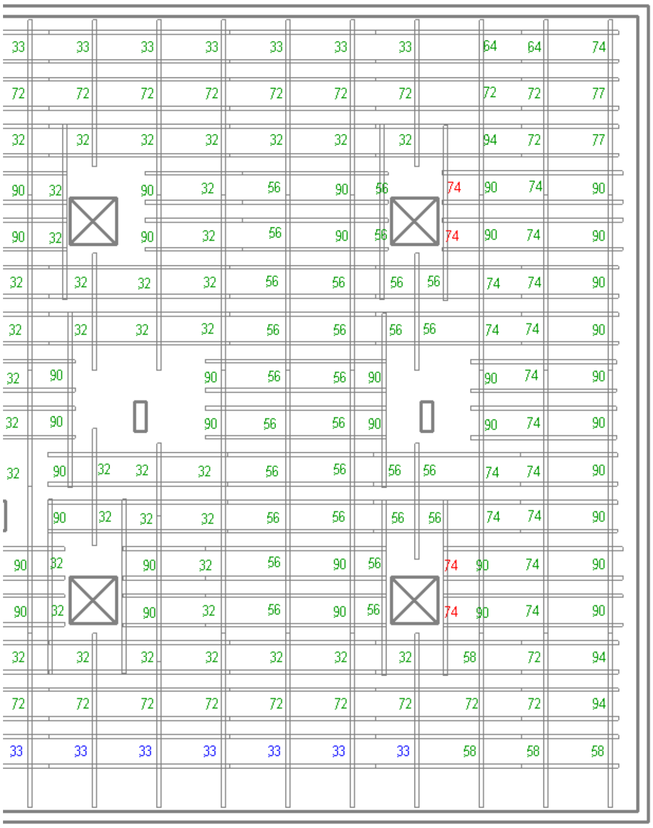


Figure 26 Sample ballast plan

Ballast example
Ballast specification =74 kg
Ballast = 50 x 50 x 5 cm stones
Stone weight = 25.0 kg
Required number of stones = 3pieces

This ballast is to be laid on the base trough under the module. If lighter stones are used then more than 3 pieces are required. These can also be laid directly behind the rear base profile – in the shadow clearance area (Figure 27). Alternatively, a ballast trough can be used for laying the ballast, as described below.

Figure 27 Ballast distribution: on base toughs (left) or via the ballast trough (right)

The ballast is preferably laid under the module. If there is insufficient space then additional ballast can be applied using a ballast tray (Figure 27). The ballast tray is hung in the base trough at the sides and can be laid at both sides. This then also provides a safe location for large-format stones.

Ballasting the base trough 230 – 90

The height of the base troughs for gravel roof allows gravel from the roof to be laid in these troughs as ballast (Figure 28). The maximum filling height is approx. 9 cm. The ballast plan provided with the detailed planning specifies how many cm of gravel must be filled into the trough.

Figure 28 Gravel ballast in the base trough 230 - 90

If the existing filling volume of gravel ballast is not sufficient then additional ballast in the form of stones may need to be added. In this case, the ballast plan specifies the numerical value of the amount of additional ballast required, in the same way as previously described for the base trough 150 – 30.

3.3.8 Module fastening and position securing

Mounting system components	Pieces / module
Front module bracket set	2
Rear module bracket set	2
Module support set	2

For each module, two front module bracket sets and rear module bracket sets must be screwed through the mounting holes in the module so that they cannot be moved to a tightening torque of 12-14 Nm (Figure 29).

Figure 29 Installation of the Module bracket set at the rear (left) and front (right)

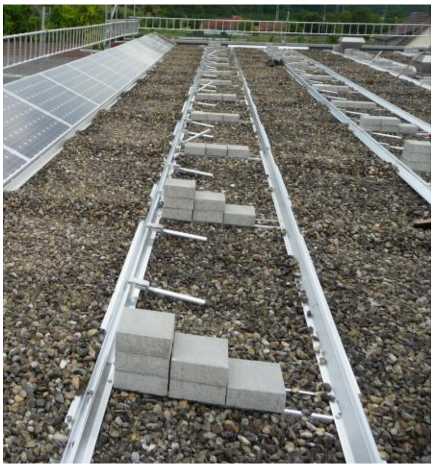


Figure 30 Inserted module support set

At the same time, the module support sets can be inserted into the rear base profiles (Figure 30). The module is then inserted into the base profiles with the front module bracket set, and lowered at the back onto the module support sets. Every module is mounted consecutively in this way. There must be a clearance of at least 10 mm between the modules in a row.

Figure 31 Height adjustable module support

The thread on the module supports allows the module to be adjusted to the desired angle of elevation (Figure 31). The module supports can be finally fixed in position via the locking screw on the rear module bracket set once the module has been correctly aligned.

To secure the position of the modules, secure them to the front module bracket set using a self-tapping screw (Figure 32). The outer module brackets must be secured at the front for all modules at column edges (roof edges, maintenance paths, expansion joints with module array interruptions).

The previously mentioned self-tapping screws are used to secure the position of the modules. To secure the module the non-chipping flat roof fastening screw is positioned in the guide slot of the mounting spiral and screwed in at the outer side next to the module bracket set. When using the flat roof fastening screw the self-tapping screw can also be screwed into the module bracket through the base profile.

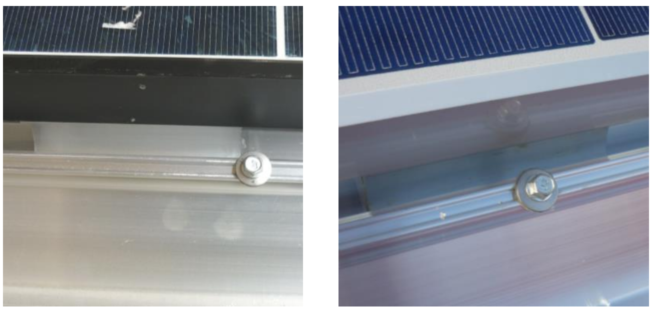


Figure 32 Securing of modules at the Front module bracket set adjacent to or through the module bracket

The module cables are attached to the module frames using self-locking cable ties. Per module, 2 – 3 cable ties are required depending on the cable length. If the module cables are too short, they must be extended accordingly using extension cable and affixed to the module frame.

3.4 Closed elevated mounting frame

3.4.1 General information

This chapter describes the installation of the closed elevated mounting frame variant of the novotegra mounting system for flat roofs. The closed elevated mounting frame variant is a low ballast system due to the interconnection of multiple rails and panels, spreading out the load. The mounting system largely consists of components from the elevated mounting frame solution in the novotegra family of mounting systems. The substructure is designed as a cross rail assembly (CRA) with a lower rail (base profile) and a module support rail (base profile) mounted on top of this. The modules must be horizontally mounted. With this elevated mounting frame variant, the module angle is fixed at 13°. BayWa r.e. Solar Energy Systems GmbH calculates the load of the mounting structure and the ballast arrangement.

3.4.2 Roof division

For connected module arrays, the roof is divided into four areas (Figure 33).

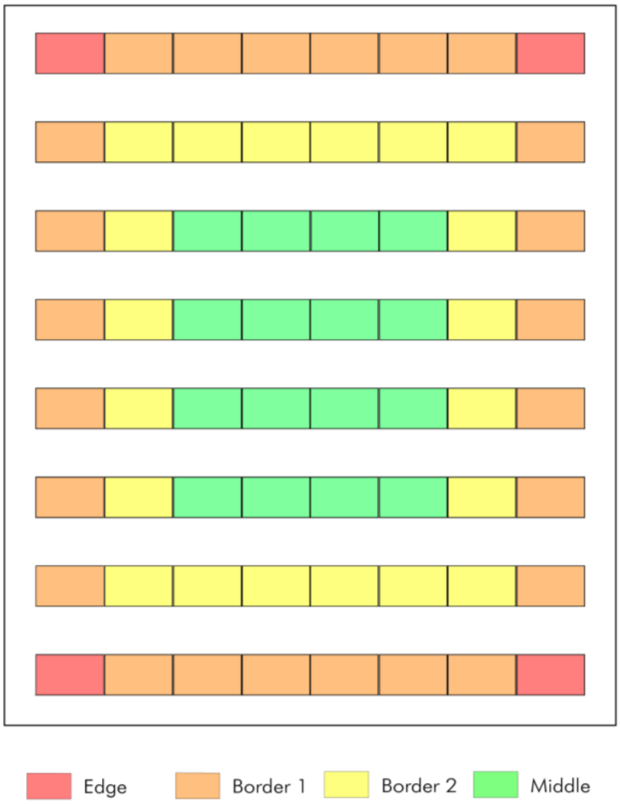


Figure 33 Schematic drawing roof division

3.4.3 Module arrangement

The standard layout arranges the modules in blocks of at least 3 modules next to each other (rows) and 3 modules behind each other (columns). If this arrangement is not used, e.g. single rows or single modules due to roof structures, then significantly more ballast is required to ensure positional stability. This also applies to (e.g.) single modules projecting out of a block. Examples of this are illustrated in Figure 34.

The decisive factor for calculating ballast needed is how many modules are connected to each other via the base troughs and base profiles. Module blocks of 4x6, 6x6 and 10x10 are preferred.

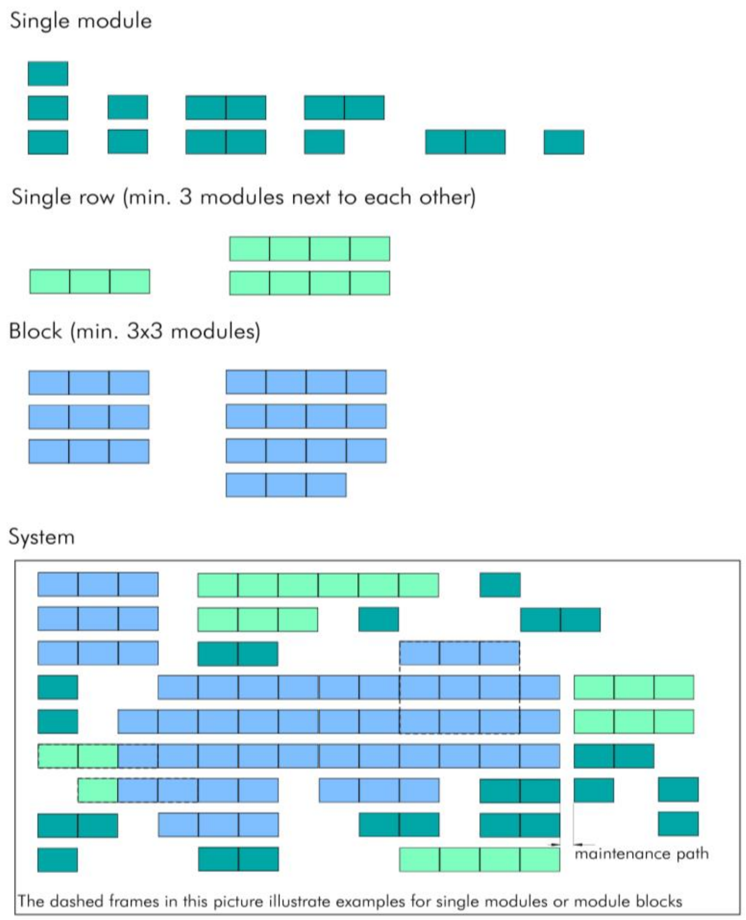


Figure 34 Examples of single modules, module rows and module blocks – light blue modules require the least ballast, then bright green, with the dark green requiring the most ballast

The blocks are designated as "S" for south, "M" for middle and "N" for north for the north-south direction. In the east-west direction the blocks are designated as "1" for the edge, "2" for the edge-middle transition and "3" for the middle. The block designations are illustrated in Figure 35.

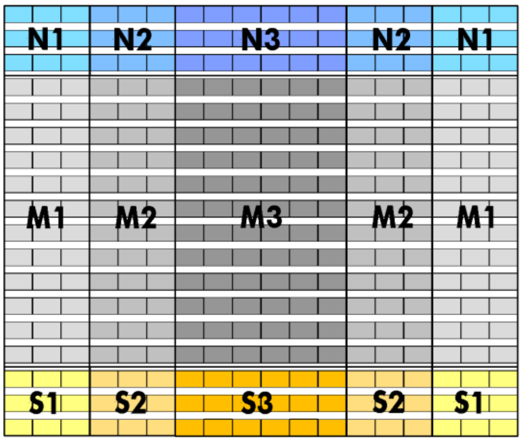


Figure 35 Block designations

3.4.4 Arrangement of the base troughs

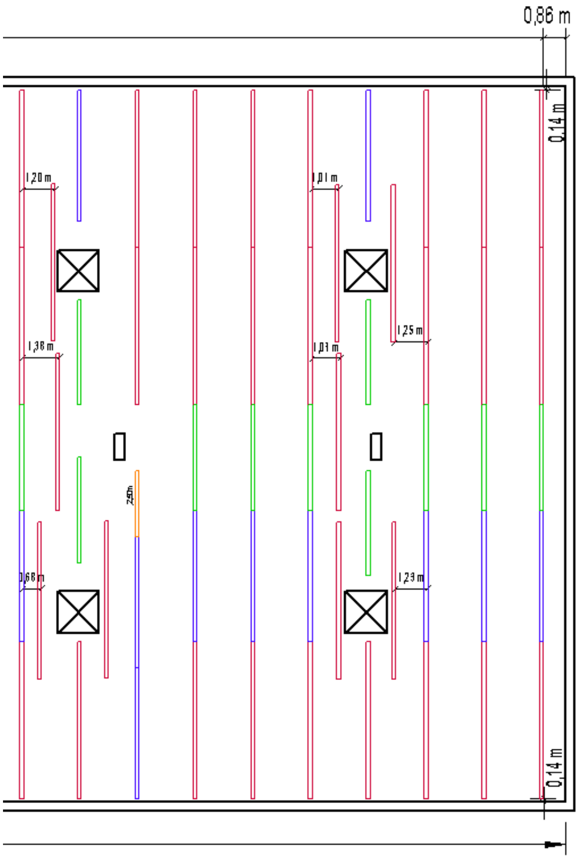


Figure 36 Sample installation plan for base troughs

The base troughs are to be laid out according to the installation plan, observing the clearances specified. The installation plan uses colour coding to specify the various different base trough lengths required. The base troughs are to be joined together using the appropriate connectors, with expansion joints to be provided as specified.

Refer to chapter 2.1.3 "Installation plan for base troughs" regarding the contents of the installation plan for base troughs.

3.4.5 Arranging the base profiles

The base profiles form the module support rail. They lie on the base troughs and run parallel to the module rows.

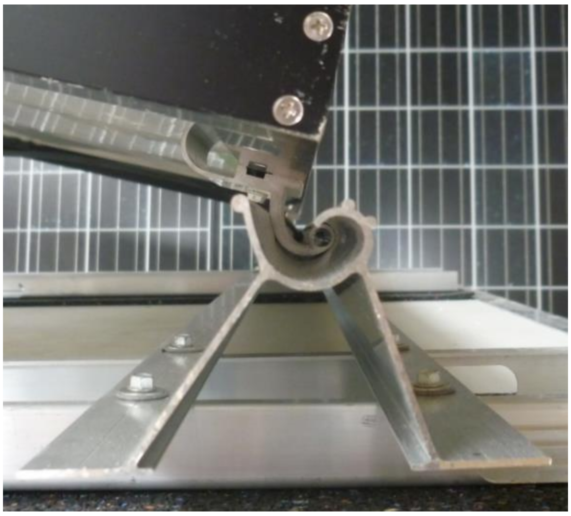


Figure 37 Spiral of the base profile pointing south (right)

A front and rear base profile run under the modules rows and these must be installed with the spiral shape facing south (the platform of the spiral faces north Figure 37).

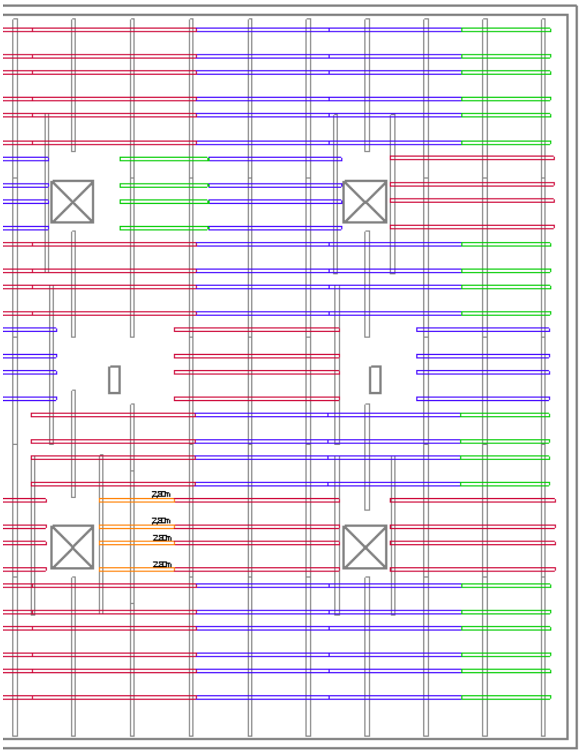


Figure 38 Sample installation plan for base profiles

The installation shows the clearance required, along with the base profile lengths and where connectors and expansion joints are required.

Refer to chapter 2.1.4 "Installation plan for base profiles" regarding the contents of the installation plan for base profiles.

3.4.6 Fastening the base profiles

Figure 39 Sample installation plan for base profiles

Figure 40 Flat roof mounting screws (chipless)

General information on fastening

The base profile is fastened to the underlying base troughs using either flat roof mounting screws (Figure 39) or flat roof mounting screws (chipless) (Figure 40). The choice of mounting screws is left to the customer. The base profiles are fastened at both sides through the base profile platforms into the base trough flange, without pre-drilling the base troughs (Figure 41). The self-tapping screws must not be overtightened or they will lose their fastening effectiveness.

Fastening to the base trough 150 - 30

At the intersection points in the edge rows and edge columns of the individual module arrays, the base profile is to be screwed to the base trough using four self-tapping screws (Figure 41 left) and at the intersection points in the middle of the module arrays the base profile is to be screwed to the base trough using two self-tapping screws (Figure 41 middle).

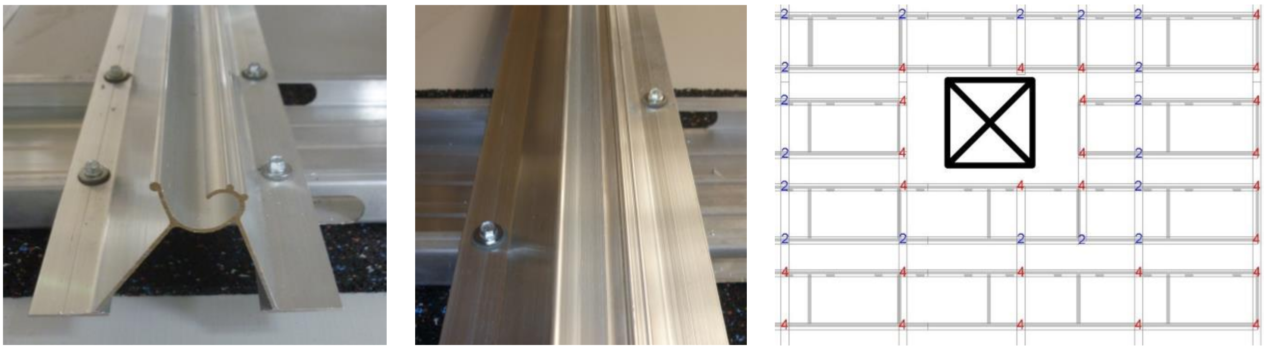


Figure 41 Fastening the base profiles to the base profiles

Modules installed next to roof penetrations, such as (e.g.) light domes or similar are also classified as modules in edge rows or edge columns. This designation does not relate to modules near to the edge of the roof but rather to modules at the edges of the PV system.

If the required ballast is greater than 100 kg per base trough and row then all base profile/ base trough intersections are to be fastened with 4 screws, regardless of their positions on the roof.

Fastening to the base trough 230 - 90

If the base profiles are fastened to gravel roof base troughs then the base profiles are to be fastened with four screws at each intersection point.

3.4.7 Ballasting the base troughs

Ballasting the base trough 150 – 30

The necessary ballast in kilograms per base trough and row is specified in the ballast plan. This is the minimum amount of ballast required in order to secure the system against lifting or sliding. The base troughs must be weighted by choosing a suitable type of ballast (e.g. different stone formats). If the stone format and weight are known at the start of planning then the planning can be performed based on the actual ballast used. It must be ensured on-site that the ballast used remains permanently on or in the troughs. Frost-proof material must be used for ballasting.

For roofs with low loading reserves, or where the loading reserve is already exhausted by the required ballast, care must be taken to install exactly the correct amount of ballast specified, otherwise the little remaining load reserve of the building may be exceed when too much ballast is installed.

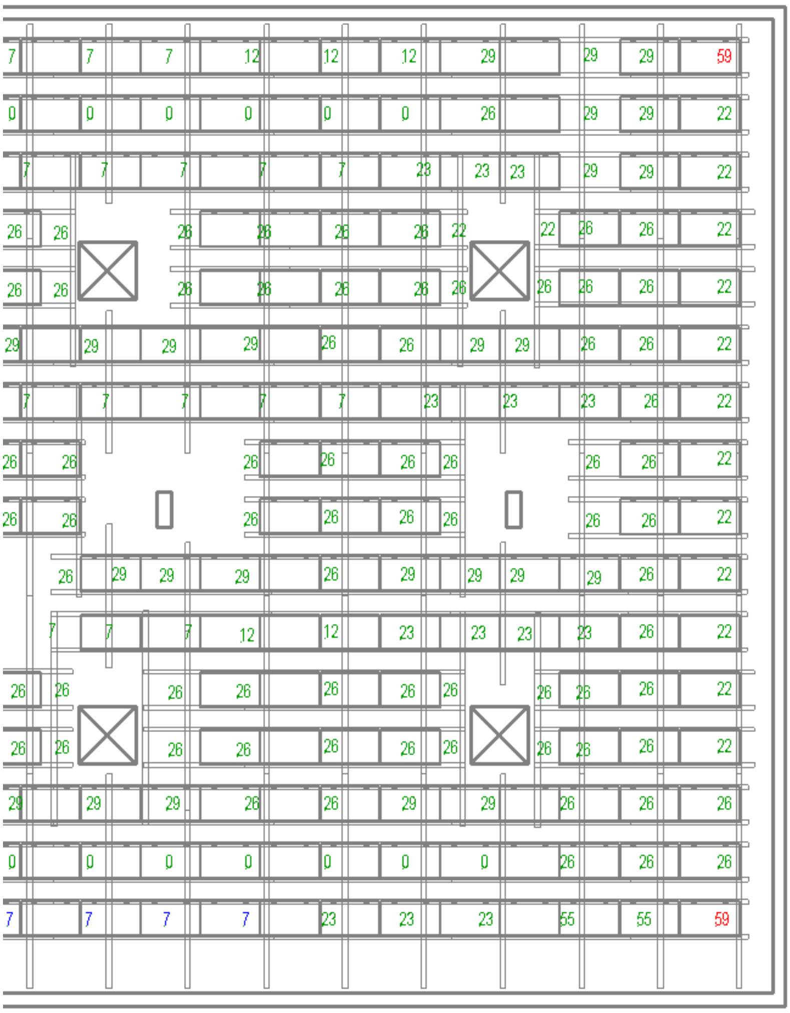


Figure 42 Sample Ballast Plan

Ballast example
Ballast specification in plan = 22kg
Ballast = 28 x 21 x 6.5 cm stones
Stone weight = 8.0kg
Required number of stones = 3 pieces

This ballast is to be laid on the base trough under the module. If lighter stones are used then, in this example, more than 3 pieces are required. These can also be laid directly behind the rear base profile – in the shadow clearance area. Alternatively, a ballast through can be used for laying the ballast, as described below. However, due to the low ballast requirements of the closed elevated mounting frame system, this is only required in special cases.

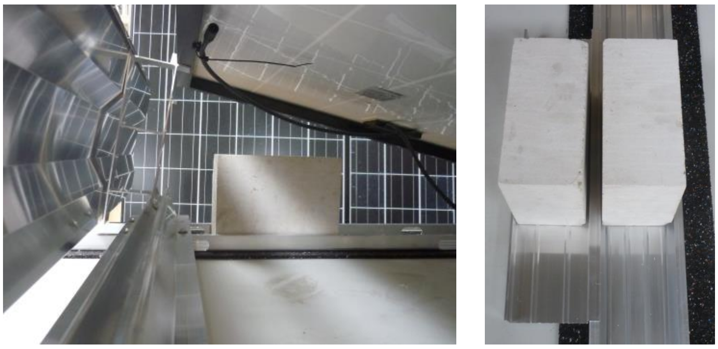


Figure 43 Ballast distribution on base troughs (left) or via ballast trough (right)

The ballast is preferably laid under the module. If there is insufficient space then additional ballast can be applied using a ballast trough (Figure 43). The ballast trough is hung in the base trough at the sides and can be laid at both sides. This then also provides a safe location for large-format stones.

Ballasting the base trough 230 – 90:

The height of the base troughs for gravel roofs allows gravel from the roof to be laid in these troughs as ballast (Figure 44). The maximum filling height is approx. 9 cm. The ballast plan provided with the detailed planning specifies how many cm of gravel must be filled into the trough.

Figure 44 Gravel ballast in the base trough 230 - 90

If the existing filling volume of gravel ballast is not sufficient then additional ballast in the form of stones may need to be added. In this case, the ballast plan specifies the numerical value of the amount of additional ballast required, in the same way as previously described for the base trough 150 – 30.

3.4.8 Securing the position of the modules and wind deflector

Mounting system components	Units/ module
Module bracket set (front)	2
Module support set 13°	2


Figure 45 Installation of module bracket set (front)

Two module bracket sets (front) are to be screwed to each module through the module fastening holes so that they cannot slip – tightening torque 12-14 Nm (Figure 45).

At the same time, the module support sets can be inserted into the rear base profiles (Figure 46). The module is then inserted into the base profiles with the module bracket set (front), and lowered at the back onto the module support sets. Every module is mounted consecutively in this way. There must be a clearance of at least 10 mm between the modules in a row.


Figure 46 Inserted module support set

The modules are held in place via the clamp by tightening the screw on the "module support set 13°". The module support is to be pressed against the module when tightening the screw. The tightening torque is 8 – 10 Nm.

After installing the modules the wind deflectors are to be hung in the module support set (Figure 47 left and middle) and then fastened to the module supports at the lower leg of each support. The previously mentioned mounting screws can also be used for this.

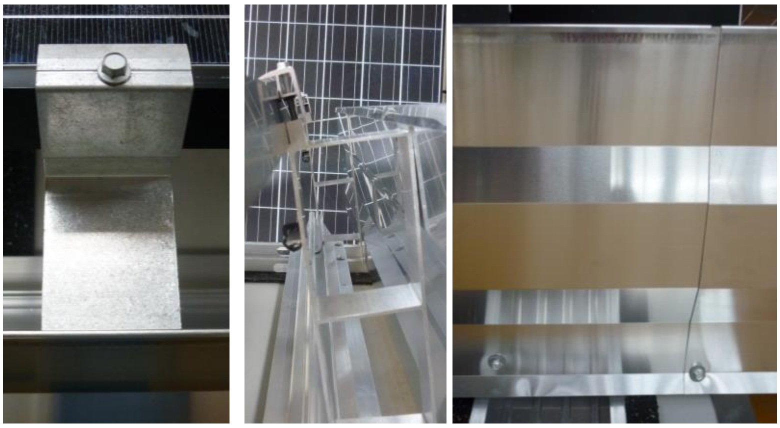


Figure 47 Installation of the wind deflector

One wind deflector is required for each module. Each wind deflector is to be screwed to both module supports. In the region of the neighbouring module the wind deflectors are also to be fastened at the bottom with a screw (Figure 47 right). In order to accommodate temperature-dependent changes in length, the wind deflectors must not be screwed together across any expansions joints.

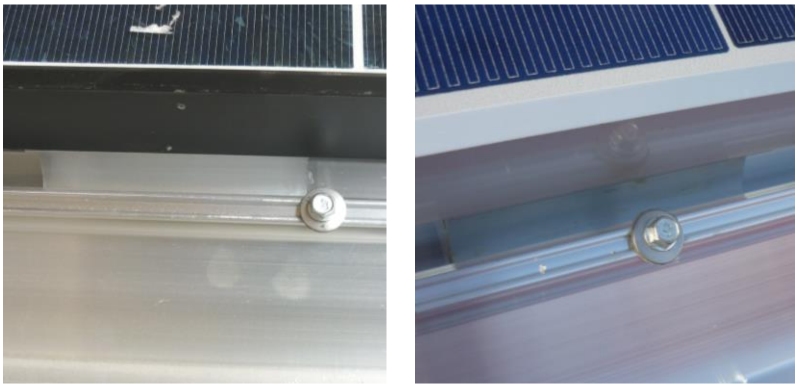


Figure 48 Securing of the module at the module bracket set (front) adjacent to or through the module bracket

To secure the position of the modules, secure them to the module bracket set (front) using a self-tapping-screw (Figure 48). The outer module brackets must be secured at the front for all modules at column edges.

The previously mentioned self-tapping screws are used to secure the position of the modules. To secure the module the non-chipping flat roof mounting screw is positioned in the guide slot of the mounting spiral and screwed in at the outer side next to the module bracket set. When using the flat roof mounting screw the self-tapping screw can also be screwed into the module bracket through the base profile.

A cable clip for holding the module cable is mounted on the module support and the module cable is pressed into this clip. If the module cables are too short, they must be extended accordingly using extension cable and affixed to the module frame.

3.5 East-west system

3.5.1 General information

This chapter describes the installation of the east-west elevated mounting frame variant of the novotegra mounting system for flat roofs. The east-west system is a low ballast system that uses the available roof area optimally. The mounting system largely consists of components from the elevated mounting frame solution in the novotegra family of mounting systems. The substructure is designed as a cross rail assembly (CRA) with a lower rail (base trough) and a module support rail (base profile) mounted on top of this. A rail (C-rail 71) is mounted on supports which then support the top of the panels. The modules must be mounted in landscape at 13°. BayWa r.e. Solar Energy Systems GmbH calculates the load of the mounting structure and the ballast arrangement.

3.5.2 Roof division

For connected module arrays, the roof is divided into four areas (Figure 49).

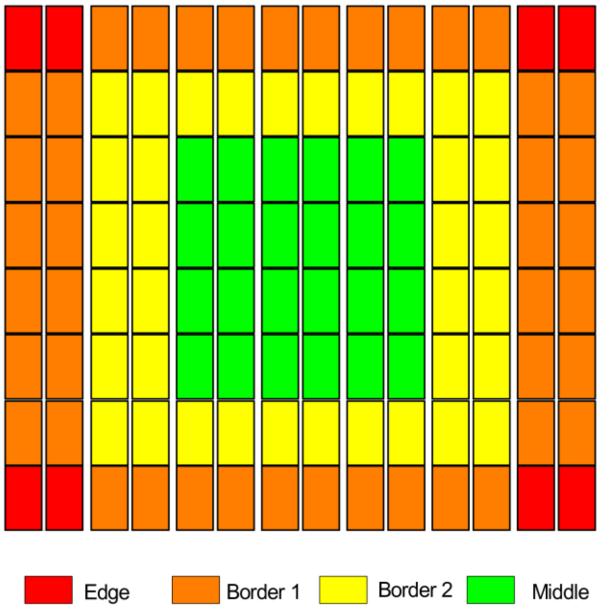


Figure 49 Schematic digram roof division

3.5.3 Module arrangement

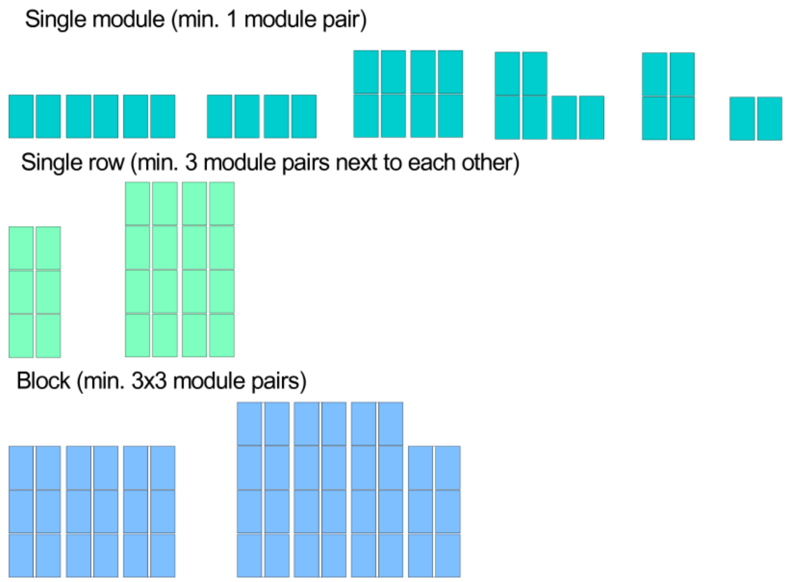


Figure 50 Examples of single modules, module rows and module blocks

The standard layout arranges the modules in blocks of at least 3 modules next to each other (rows) and 3 module pairs behind each other (columns). If this arrangement is not used, e.g. with single rows or single module pairs due to roof structures then significantly more ballast is required to ensure positional stability. This also applies to (e.g.) single modules projecting out of a block. Examples of this are illustrated in Figure 50.

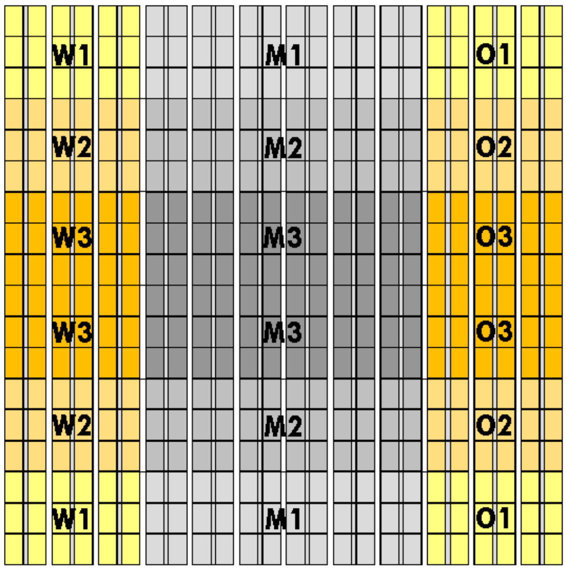


Figure 51 Block designations

The decisive factor for calculating ballast needed is how many modules are connected to each other via the base troughs and base profiles. Module blocks of 4x6, 6x6 and 10x10 are preferred.

The blocks are designated as "O" for east ("Ost"), "M" for middle and "W" for west for the east-west direction. In the east-west direction the blocks are designated as "1" for the edge, "2" for the edge-middle transition and "3" for the middle. The block designations are illustrated in Figure 51.

3.5.4 Arrangement of the base troughs

The base troughs are to be laid out according to the installation plan, observing the clearances specified. The installation plan uses colour coding to specify the various different base trough lengths required. The base troughs are to be joined together using the appropriate connectors, with expansion joints to be provided as specified.

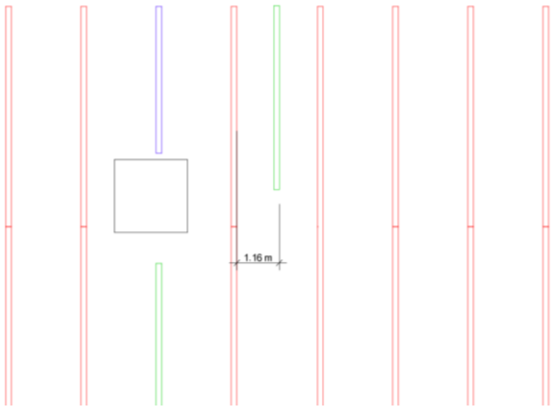


Figure 52 Sample base through layout plan

Refer to chapter 2.1.3 "Installation plan for base troughs" regarding the contents of the installation plan for base troughs.

3.5.5 Arrangement of the base profiles

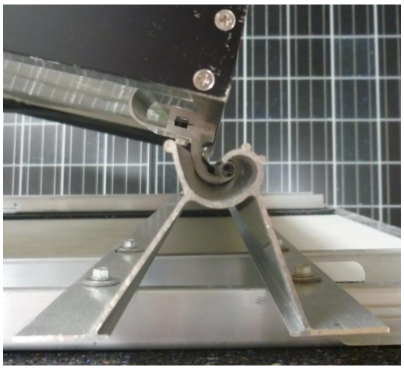


Figure 53 Mounting spiral pointing outwards

The base profiles form the module support rail. They lie on the base profiles and run parallel to the module rows.

The module rows consist of module pairs, one facing east and one west. The spirals connected to the front of the modules must face outwards (Figure 53).

The installation shows the clearance required, along with the base profile lengths and where connectors and expansion joints are required

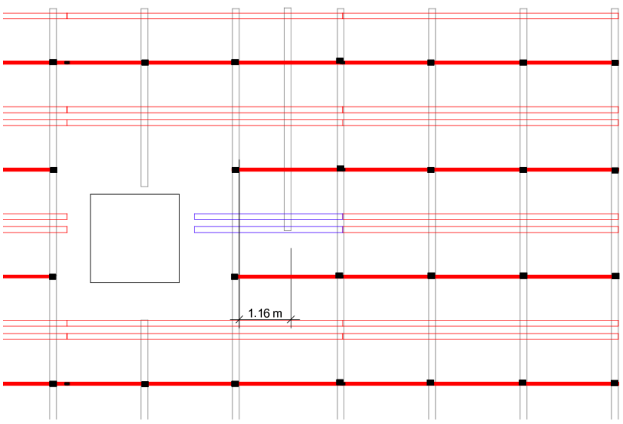


Figure 54 Installation plan for base profiles (sample excerpt)

Refer to chapter 2.1.4 "Installation plan for base profiles" regarding the contents of the installation plan for base profiles.

3.5.6 Fastening the base profiles

Figure 55 Flat roof mounting screw

Figure 56 Flat roof mounting screw (chipless)

The base profile is fastened to the underlying base troughs using either "flat roof mounting screws" (Figure 55) or "flat roof mounting screws (chipless)" (Figure 56). The base profiles are fastened at both sides through the base profile platforms into the base trough flange, without pre-drilling the base troughs (Figure 57). The self-tapping screws must not be overtightened or they will lose their fastening effectiveness. At the intersection points in the edge rows and edge columns of the individual module arrays, the base profile is to be screwed to the base trough using four self-tapping screws (Figure 57 left) and at the intersection points in the middle of the module arrays the base profile is to be screwed to the base trough using two self-tapping screws (Figure 57 middle).

If the required ballast is greater than 100 kg per base trough and row then all base profile/ base trough intersections are to be fastened with 4 screws, regardless of their positions on the roof.

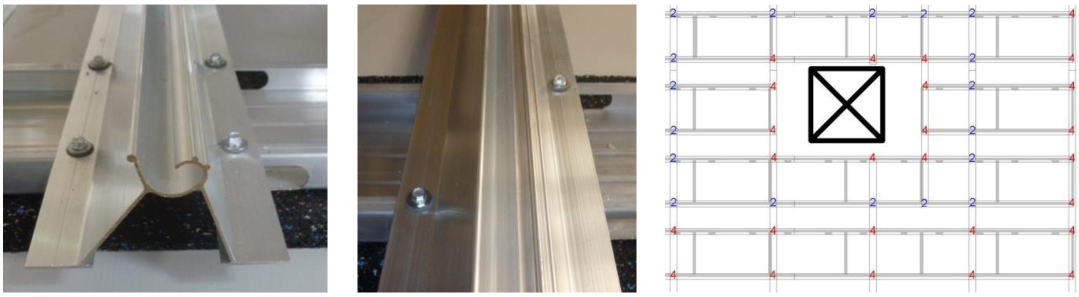


Figure 57 Fastening the base profiles to the base troughs

3.5.7 Arrangement of the module supports

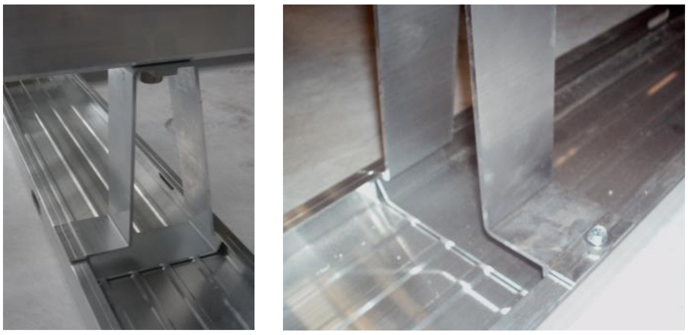


Figure 58 Support set in base trough

The module supports provide support for the C-rails. These are clicked into the base troughs in the middle between the base profiles of a module row (Figure 58). The support sets are preconfigured with M12 screws for mounting the C-rail 71 segments. When the ballast to the left or the right of the support is greater than 20 kg, the support must be secured with a fastening screw (Figure 58 right).

3.5.8 Ballasting the base profiles

The ballast plan provided must be followed to prevent lifting/sliding. Frost proof material must be used for ballasting and must not be able t move once placed.

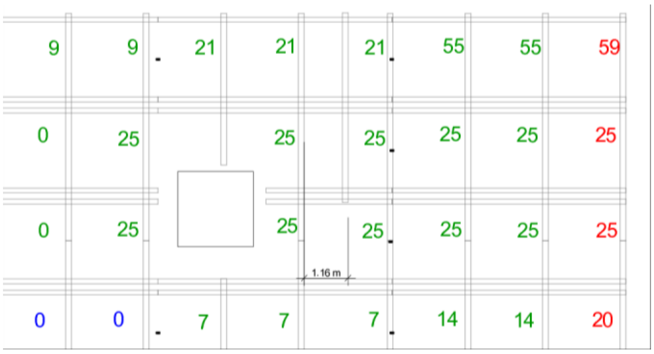


Figure 59 Sample Ballast Plan

Care must be taken to keep within the permitted load of the roof.

<u>Ballast example:</u>
Ballast specification in plan = 14 kg
Ballast = 40 x 20 x 8 cm stones
Stone weight = 14.7 kg
Required number of stones = 1 piece

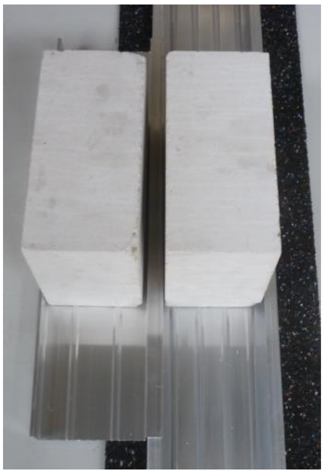
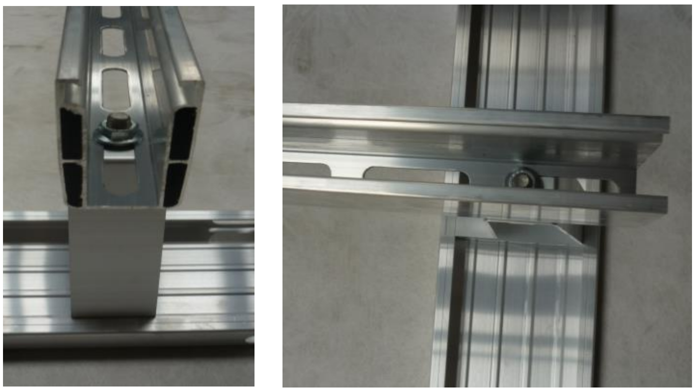


Figure 60 Ballast on base trough and ballast trough

This ballast is to be laid on the base trough under the module pair.
If there is insufficient space for ballast in the base trough then additional ballast can be applied using a ballast trough (Figure 60). However, due to the low ballast requirements of the east-west elevated mounting frame system, this is only required in special cases.

3.5.9 Installation of the C-rail 71



The C-rails are laid on the support sets. These are fastened through the elongated holes in the rails using the pre-configured M12 screws on the support set and locking nuts (Figure 61). The tightening torque for the locking nuts is 50 Nm.

Figure 61 C-rail 71 on east-west support set

<u>Rail extension:</u>

Components of the rail connector set 71	Units
Aluminium profile	1
Saucer head screw M12	4
Locking nuts M12	4

The rails are extended using the rail connector set 71. The rails are joined to the rail connector using four saucer head screws with locking nuts (Figure 62). The tightening torque is 50 Nm.

Figure 62 Rail connector set 71 – Components (above) and installed (below)

The gap between neighbouring rails must not exceed 10 cm. This provides some additional length for configuring rows.

3.5.10 Module fastening and position securing

Mounting system components	Units / module
Front module bracket set	2
East-west module bracket set (back)	1

Figure 63 Installation of front module bracket set

Two front module bracket sets are to be screwed to each module through the module fastening holes so that they cannot slip – tightening torque 12-14 Nm (Figure 63).
The east-west module bracket set (back) can also be clicked into the C-rails at this time (Figure 64). After this, the module with the front module bracket set is laid in the base profile and then laid with the rear on the east-west module support set (back). Every module is mounted consecutively in this way. There must be a clearance of at least 10 mm between the modules in a row.

Figure 64 ast-west module bracket set (back)

The modules are held in place via the clamp by tightening the screw on the east-west module bracket set (back). The clamp is positioned on the pre-configured screw and pressed against the module. The tightening torque is 8 – 10 Nm.

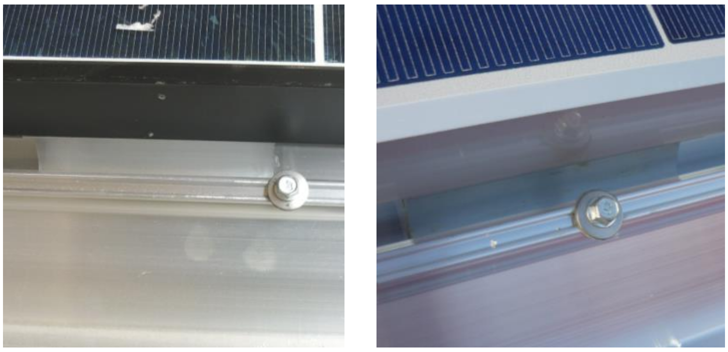


Figure 65 Securing the module at the front module bracket set adjacent to or through the module bracket

To secure the modules, secure the front module bracket to the base profile using self-tapping screws (Figure 65). The module brackets nearest to the edge of the array must be secured in this way.

Alternatively, to secure the module using the non-cutting flat roof fastening screw, the screws must be positioned in the guide slot of the mounting spiral and screwed in at the outer side next to the module bracket set, rather than through it.

The module cables are attached to the module frames using self-locking cable ties. Per module, 2 – 3 cable ties are required depending on the cable length. If the module cables are too short, they must be extended accordingly using extension cable and affixed to the module frame.

4 Earthing the mounting system/ electrical installation

Please use the country-specific requirements for earthing the mounting system and the lightning protection. In the following an example of requirements for GB is listed.

4.1 Earthing the mounting system

In the UK, please consult the DTI Guide “Photovoltaics in Buildings – Guide to the Installation of PV Systems”, and/or BS 7430, BS 6651 and BS 7671 to determine earthing/bonding requirements for your array. Please also refer the DTI guide for details of lightning protection measures, along with BS 6651.

Earthing via the roofing sheet may be possible, as the mounting system is fastened directly to this with self-tapping screws.

Earthing via the rails can be achieved using the novotegra earth connectors (Figure 66). Separate sections of panels must be connected together via the rail. These points must then be connected to each other and then to the earthing terminal/spike.

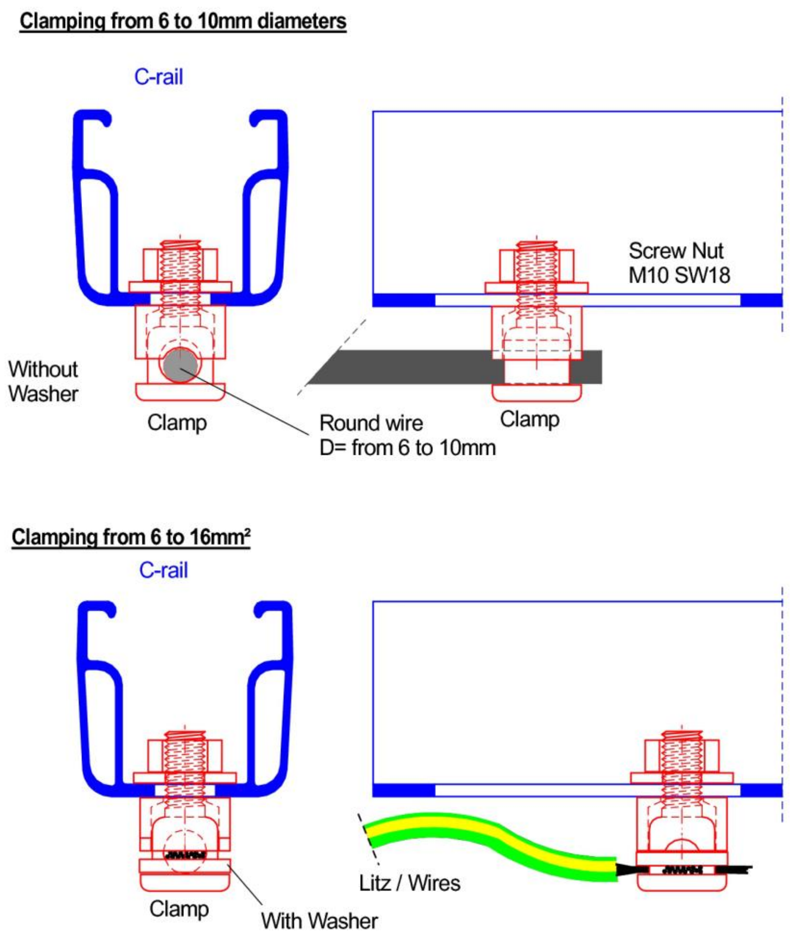


Figure 66: Using the Earthing Connectors

4.2 Laying the main DC cables

To prevent contact with dangerous DC voltage on subsequent electrical connection of the modules, lay the main DC wire from the roof to the DC isolator and DC load circuit breaker or other approved load separators first. When passing the cables through the roof, ensure that the cable insulation is not damaged and the cable does not rub or kink in the penetration.

5 Safety instructions and warnings

Safety regulations

When performing any work, please observe the relevant safety standards, including those regarding working on site, working on electrical systems and working at height, along with the specifications and instructions provided by the module, inverter and cable manufacturers. The installation of solar photovoltaic panels should only be carried out by qualified personnel.

The structural design of the mounting system takes the following standards into account:

Design loads	Content
EN 1991-1-3	Snow loads (Eurocode 1)
EN 1991-1-4	Wind loads (Eurocode 1)
DIN V ENV 1999-1-1	EC 9: Dimensioning and design of aluminium structures, Part 1-1 General dimensioning rules; dimensioning rules for building construction
DIN V ENV 1993-1-1	EC 3: Dimensioning and design of steel structures; Part 1-1: General dimensioning rules; dimensioning rules for building construction
EN 10088	Stainless steels

Guarantee/ product liability (exclusion)

In addition to the abovementioned regulations and safety instructions, the valid technical regulations and rules must be observed by the specialist installers.
The installer is responsible for dimensioning the novotegra mounting system
The installer is responsible for connecting the interfaces between the mounting system and building. That also includes ensuring that the building envelope is sealed.
For flat roofs, the roof seal must be evaluated with regard to the material of the seal strip, resistance, aging, compatibility with other materials, overall condition of the roof seal, requirement of a separating system between the roof seal and mounting system on-site by the installer under their own responsibility. The required and necessary measures or precautions to protect the roof seal for mounting the substructure of a PV system must be performed by the installer with the assistance of a technical specialist if necessary. BayWa r.e. Solar Energy Systems GmbH shall not accept liability for incorrect or insufficient measures and precautions for protecting the roof seal!
The installer must verify the coefficients of friction applied in the calculation for proving the anti-slip properties of PV systems on flat roofs on-site. Coefficients of friction calculated on-site can be incorporated and must be provided to BayWa r.e. Solar Energy Systems GmbH for calculation. BayWa r.e. Solar Energy Systems GmbH shall not accept liability for the correctness of the assumed values or for damage due to the use of incorrect values.
The tightening torques specified must be observed.
No components may be omitted or own components added.
All specifications and statistics refer to installation of the mounting system in Germany – unless explicitly stated otherwise. Other regulations may apply in other countries. As a result, no liability can be accepted for installation of the mounting system outside Germany – without the approval of BayWa r.e. Solar Energy Systems GmbH.
The specifications of the module, cable and inverter manufacturers must be adhered to. If they contradict these installation instructions, please consult your BayWa r.e. Solar Energy

Systems GmbH sales team, or the manufacturer in question for components not delivered by BayWa r.e. Solar Energy Systems GmbH, before installing the novotegra mounting system.

When our sales staff draws up quotations for novotegra systems, they are not always sufficiently aware of the local conditions, and as a result, the quoted quantities may change during installation. These changes largely concern the number of fastening material to the building envelope (e.g. roof hooks). If this is the case, the additional components required per the dimensioning absolutely must be installed.

BayWa r.e. Solar Energy Systems GmbH accepts no liability for damage resulting from incorrect handling of the installed components.

BayWa r.e. Solar Energy Systems GmbH is not liable for incorrectly or incompletely filled in data entry forms. Accurate and completely filled-in data entry forms are essential for correct dimensioning.

The mounting instructions, guarantee conditions and liability exclusion information must be observed.

The listed standards and guidelines are specified for Germany. The latest versions must be observed. Outside Germany, the corresponding national standards and guidelines must be applied.

The corresponding accident prevention guidelines must be observed.

Internal tests were also carried out to guarantee load-bearing capacities. Please note that the technical approvals and Z-9.1-453 and Z-9.1-652 must be complied with for screw fastening of roof hooks to rafters.

Local construction and safety regulations must also be adhered to.

Notes:

Notes:

Notes:

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