Guide

Recommendations for equipotential bonding and lightning protection

because you can build on us

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Inhalt

Information about this guide

This guide explains the theoretical principles and practical implementation of measures for equipotential bonding and lightning protection of PV systems in general – and of sflex mounting systems in particular – based on the relevant technical regulations.

The guide is largely based on the relevant sections of the German standards DIN VDE 0100, VDE 0185 (or the European equivalents DIN EN 62305 and DIN EN 62561) and IEC 61730.

The second part contains application examples for the S:FLEX frame systems. The installation and functionality of the earthing components from the sflex product range, which are used in the respective application examples, are described in the first part.

At this point, we would like to point out that the national standards and directives must be observed with regard to planning and execution. In addition, the respective recommendations and installation instructions issued by themodule and inverter manufacturer must be observed.

The planning and implementation of lightning protection measures and the entire wiring concept must always be carried out by lightning protection specialists and coordinated with a lightning protection planning office.

Equipotential bonding and earthing

Equipotential bonding ensures that all metallic parts in and on a building are brought to an almost equal potential by electrically connecting them. This prevents dangerous touch voltages between two metal parts and protects people from potential electric shock.

A PV system is also considered part of the building structure. According to DIN VDE 0100, all metallic components and rails of the mounting system must therefore be permanently conductively connected and integrated into the local equipotential bonding system to ensure electrical safety. In accordance with DIN VDE 0100, the minimum crosssections for protective equipotential bonding are 6 mm2 for copper cables or 16 mm2 for aluminium round wire.

Equipotential bonding is a prerequisite for earthing. In this process, all metallic structures that have been equalised in potential are connected to earth via an earthing conductor and the main earthing bar. Protective earthing can also serve as functional earthing, but not the other way around.

Unlike equipotential bonding or earthing for personal protection, functional earthing is a measure used for the regular operation of the PV system – for example, to safely discharge stray currents.

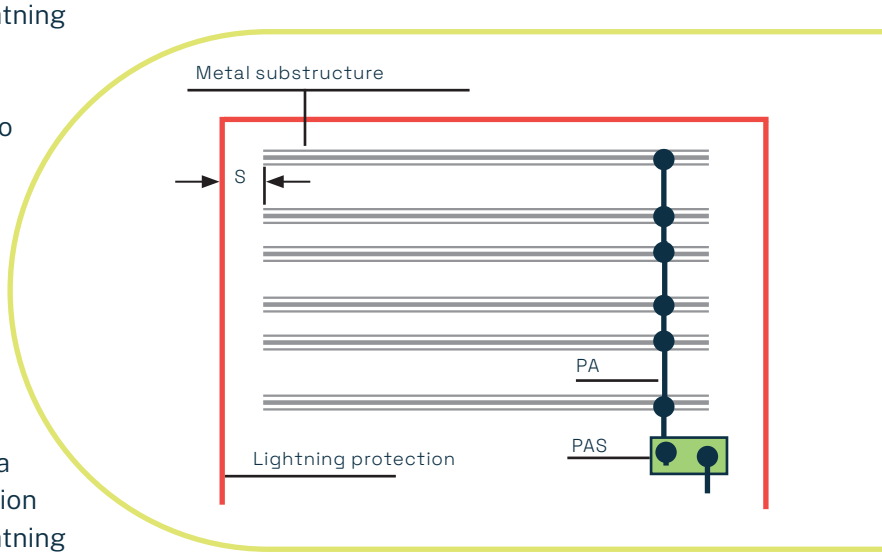
Lightning protection and lightning current carrying capacity

Due to the presence of high voltages and currents, PV systems are at risk from both direct and nearby lightning strikes, which can cause major damage and even fires. The lightning protection standard DIN EN 62305 (VDE 0185) forms the basis, among other things, for the protective measures required for PV systems in relation to external and internal lightning protection (including surge protection).

The purpose of external lightning protection is to intercept lightning strikes using air-termination rods and to safely conduct the lightning current to the ground via down conductors arranged in a mesh pattern along or within the building walls. However, external lightning protection cannot prevent damage to electrical equipment inside the building in the event of a lightning strike. Lightning can also penetrate the interior of buildings via electrical cables and cause further destruction internally. For PV systems, internal lightning protection serves to prevent dangerous sparking between the external lightning protection system and the PV power supply system. Sparking can occur, for example, if large potential differences arise between a conductor carrying lightning current (down conductor) and the PV system. For this reason, a lightning protection equipotential bonding system or functional earthing is required as the basis for internal lightning protection. When installing PV systems in accordance with VDE 0185, the following three scenarios must be distinguished:

1. The PV system is not in an exposed location and there is no external lightning protection system: In this case, the conductor cross-section for the functional earthing of the mounting system should not be less than 6 mm2 for copper or 16 mm2 for aluminium.

2. The PV system is located in the protected area of air-termination systems and the separation distance S calculated in accordance with EN 62305-3 (see figure below) is maintained: In this case, the conductor crosssection for the functional earthing of the mounting system should also be at least 6 mm2 for copper or 16m mm2 for aluminium. To maintain the prescribed separation distance, all parts of the PV system (modules, frame, lines, cable routes, etc.) must comply with this distance. In this case, lightning currents are discharged externally along the building. However, this may result in loss of usable roof space due to areas that cannot be utilised.



3. The PV system is located in the protected area of air-termination systems and the separation distance S cannot be maintained, e.g. because a large part of the roof area cannot be utilised as a result. It should be noted that lightning currents are channelled into the building and therefore protective measures are necessary inside the building. Two scenarios must be distinguished:

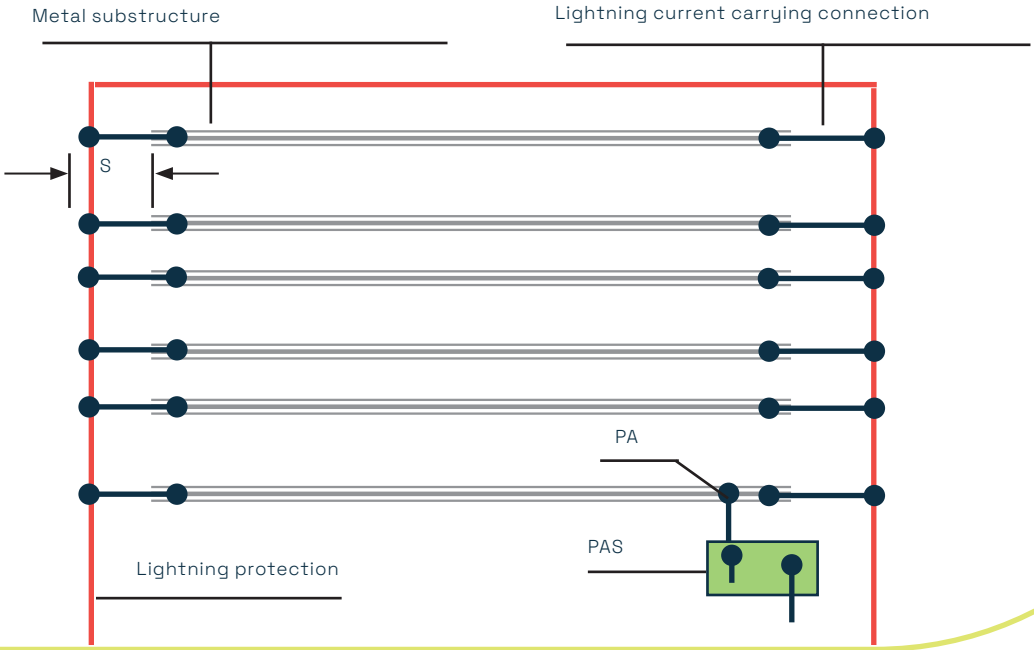
a. Lightning current carrying connections: In this case, the mounting system – which is already interconnected – must be connected to the external lightning protection system in accordance with the diagram below. The air-termination rods must be connected to the mounting structure at multiple points. These connections must be capable of carrying lightning current, and approved connection components must be used. The conductor cross-section should be at least 16 mm2 for copper or 25 mm2 for aluminium. In this case, too, the mounting frame does not serve as a lightning conductor, which is why it does not need to have its own lightning current carrying capacity. The planning for integrating

the system into the existing external lightning protection system, including the number of connections to the external lightning protection system, must be carried out by a lightning protection specialist.

b. Lightning current carrying capacity: If part of the external lightning protection is provided by the mounting system, the frame system must be planned and designed to withstand lightning currents. The connections between the individual components of the frame system must provide proof of lightning current carrying capacity in accordance with class H as per DIN EN 62561-1 (VDE 0185-561-1). It is also possible to design the substructure to withstand lightning currents if the lightning protection equipotential bonding is implemented with a conductor cross-section of 16 mm2 for copper or 25 mm2 for aluminium.

At this point it should be noted that, nowadays, when using an aluminium round wire, a conductor diameter of 8 mm or a conductor cross-section of 50 mm2 is commonly used for protective and lightning protection equipotential bonding – even though this is not strictly required.

For all of the above scenarios, it may also be necessary to install surge protective devices (SPDs) of Type 1 or Type 2 on both the DC and AC sides. The planning and implementation of lightning protection measures, as well as the entire wiring concept, must in every case be carried out by qualified lightning protection specialists and coordinated with a lightning protection design office.



Lightning current carrying capacity of sflex systems

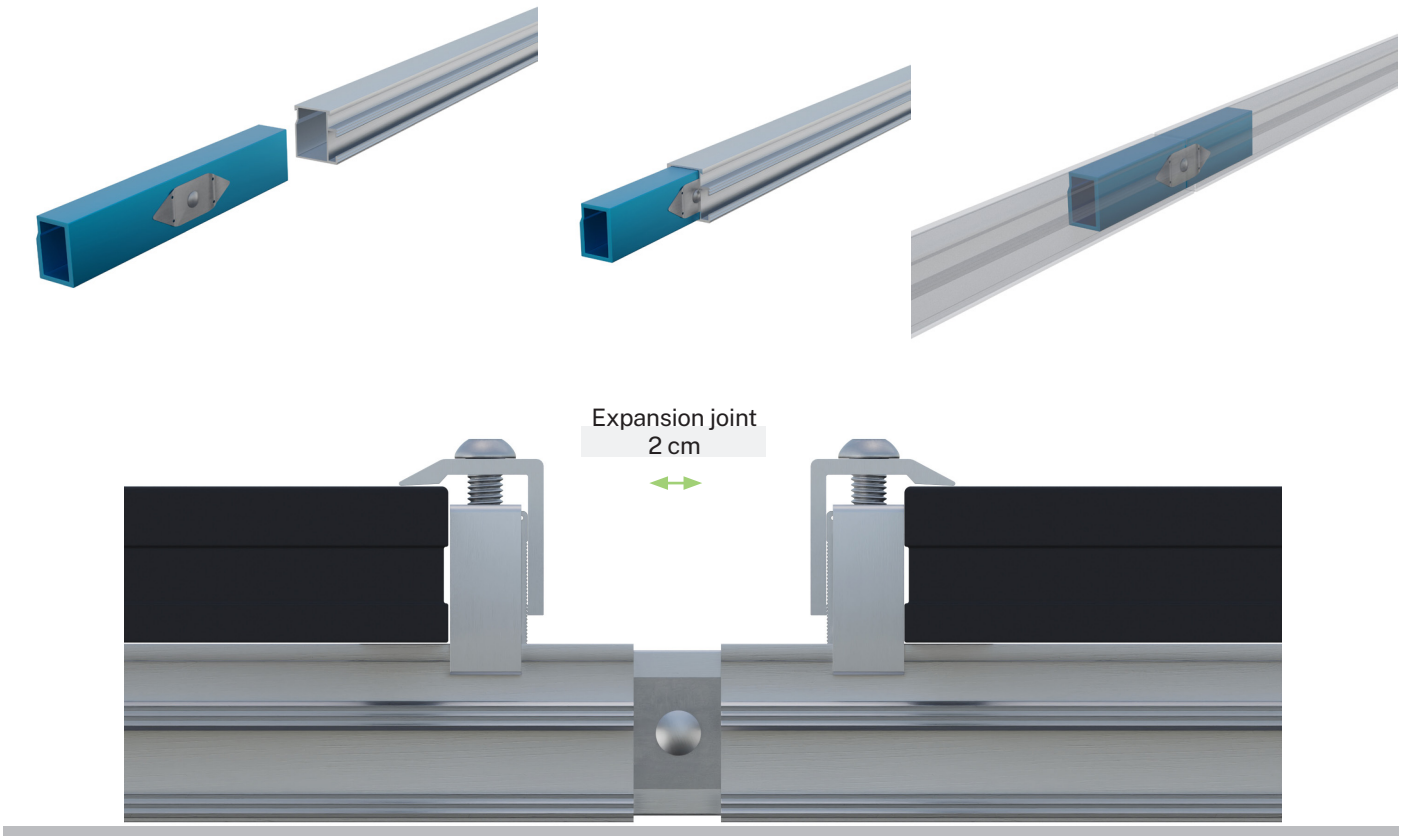
As part of the tests carried out, the lightning current carrying capacity of the S:FLEX LEICHTmount RAIL 2.1 system was verified in accordance with class H. The plug connections have fulfilled the requirements of test standard EN 62561-

1. This means that the mounting system can be used as a natural component of the down conductor of a lightning protection system, provided that the cross-bracing is continuously connected. These tests were also carried out for the Flat Direct system and the necessary evidence was provided.

Components for equipotential bonding

sflex offers various parts and components to implement equipotential bonding of the mounting system, depending on the specific requirements. System-specific features, such as the connector technology, can also be used for this purpose.

If mounting rails are used and arranged in series, the earth-conductive connection between the rails can be established using the appropriate connector together with a stainless steel earthing plate fitted with two “drill rings” on each side. As shown in the figure below, the mounting rails are pushed onto the connector and pressed together flush. The earth-conductive connection also works at expansion joints. The rail connectors with earthing plates are solely intended to provide standard-compliant equipotential bonding. Together with the rails, they do not meet the standards for lightning current carrying capacity – additional measures must be taken for this purpose.



Expansion joint, upper layer

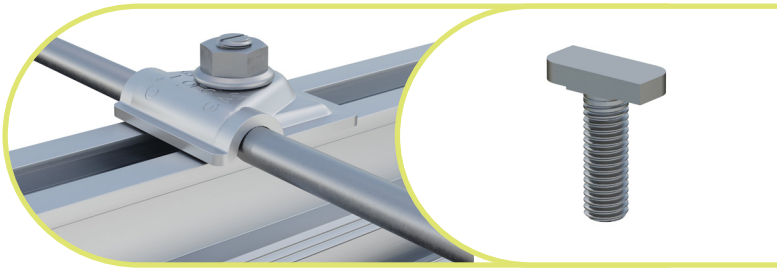
For single-layer installations, the mounting rails can be conductively connected to each other using the OBO equipotential bonding clamp and a round aluminium wire, or the sflex aluBar 3-27-1160.

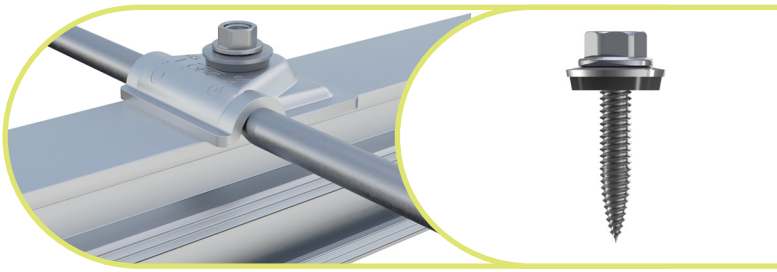
Variant 1

Equipotential bonding with aluminium round wire

The hammer-head bolt of the equipotential bonding clamp is slid into the upper hammer-head channel of the mounting rail and, after placing the aluminium round wire, is tightened by the serrated locking nut. Ensure the hammer-head bolt is correctly oriented in the channel of the mounting rail before tightening the nut.

For mounting rails without hammer-head channel on the top (e.g. ST-AK 5 40), the equipotential bonding clamp can be mounted directly to the top of the aluminium profile using a sheet-metal screw.





Variant 2

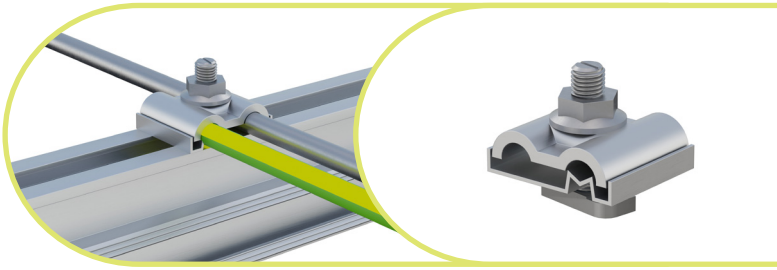
Equipotential bonding with sflex aluBar 3-27-1160

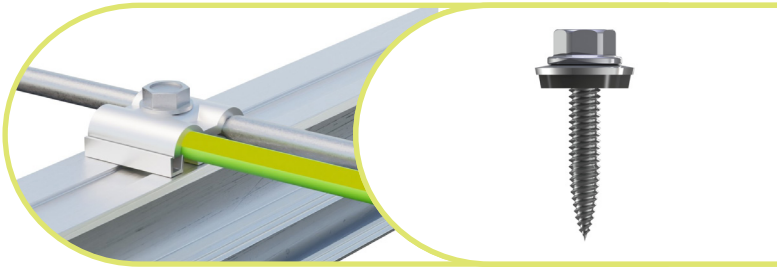
The sflex aluBar 3-27-1160 can be mounted directly on top of the aluminium profile using a sheet-metal screw, regardless of whether the profile has a top hammer-head channel.

The rails can also be electrically linked to each other with a copper conductor. Use stainless-steel cable lugs for this connection to prevent contact corrosion between aluminium and copper.

The grounding clamp DEHN UNI with hammer-head bolt and serrated locking nut integrates the already-connected mounting system into the building's equipotential network by providing an electrical link from the aluminium round wire, via an equipotential conductor, to the main grounding bus bar in the building. A stainless-steel intermediate element prevents contact corrosion between copper and aluminium.

The installation proceeds as described above, with the added step that, before tightening the serrated locking nut, the equipotential grounding conductor must be inserted alongside the aluminium round wire for grounding. The clamp's opening for the aluminium round wire accommodates diameters of 8–10 mm, while the clamp's opening for the single- or multi-wire connection accepts cross-sections of 4–50 mm^2.

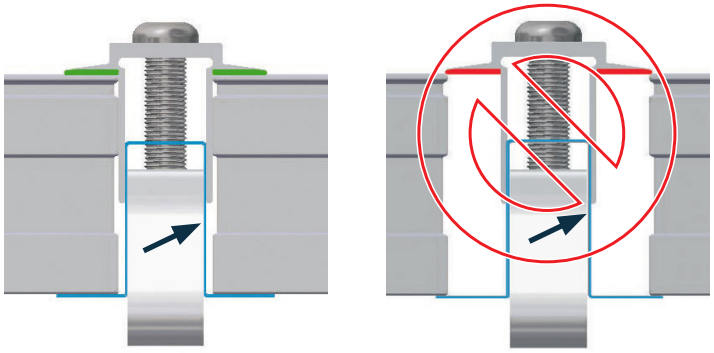




If necessary, the frames of the PV modules can also be included in the equipotential bonding system. For thispurpose, we recommend the sflex mid clamps and end clamps with the specially developed, optionally available earthing plates (see also the section “Earthing of Module Frames”). To do this, the earthing plates are inserted laterally between the clamp and cap in the module holder, as shown in the figure, so that the module is positioned between the plate and cap. The earthing plate has two "drill collars" on the top and bottom of the side wings, which are able to penetrate the thin anodised layer of the module frames during installation.

When the module clamp or end clamp screw is tightened, the earthing plate is pressed from the underside of the module frame against the mounting rail, creating a conductive connection between the frame and the substructure. This applies to the PV modules on both sides of the module clamp, which means that only one mid clamp with an earthing plate is needed for every two modules. In this context, it is important to ensure that the module clamp secures both module frames within the clamping area specified by the module manufacturer.

Installation with grounding plate



CORRECT
– defined clamping area –

INCORRECT

Earthing of module frames

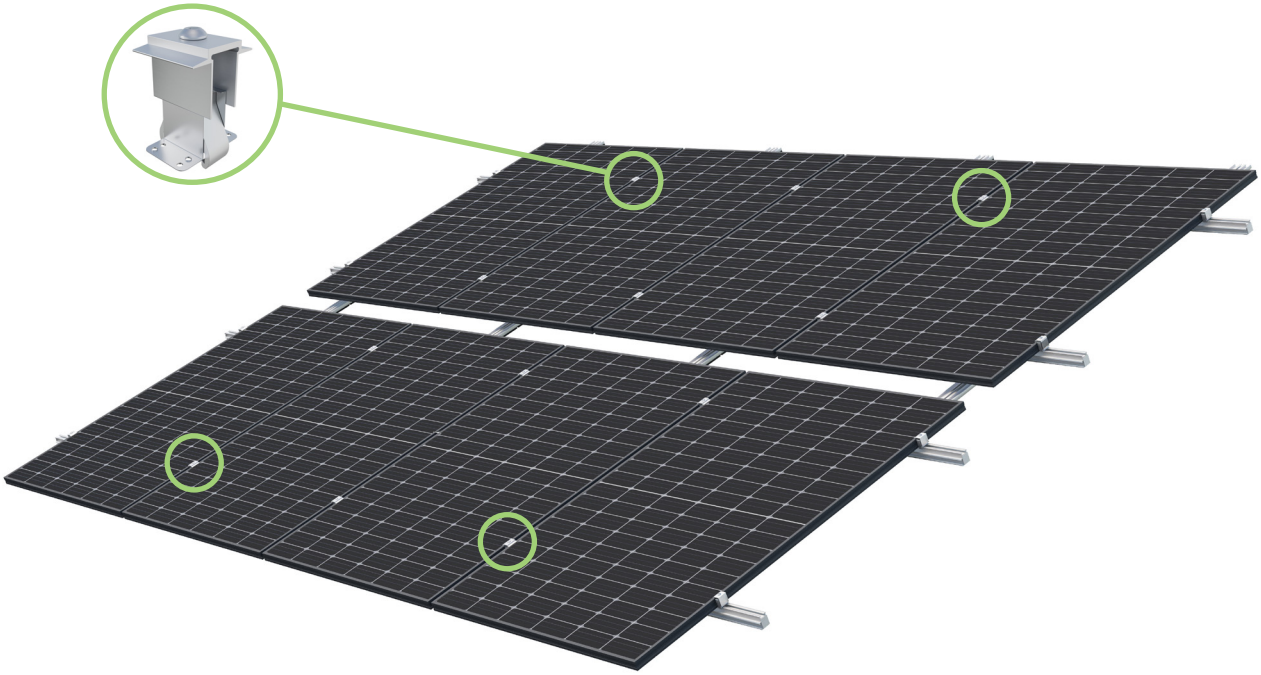
In the vast majority of cases, PV modules are designed in accordance with protection class II (SK-II). In order to be sold in the EU, all PV modules must bear the CE mark, which requires compliance with IEC 61730 and therefore SK-II. This protection class is indicated by the double square symbol on the junction box of the PV module, as shown below.

SK-II devices are electrical equipment with reinforced insulation in which the insulation between the circuit and the housing is so effective that there is no danger from the live parts. According to VDE 0100 or IEC 60364, earthing by means of a protective conductor is excluded in these cases for reasons of personal safety.

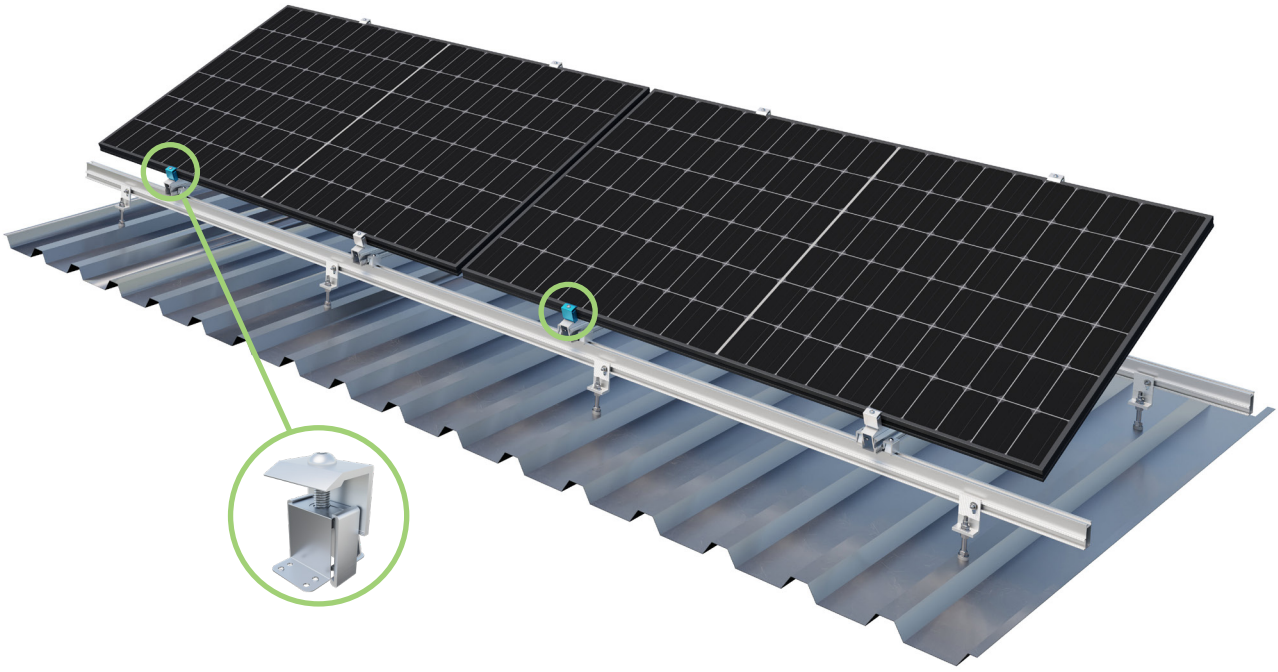
However, IEC 61730 also points out that the module frame is considered an auxiliary structure for mounting purposes –meaning that under this definition, the frame is no longer regarded as part of the SK-II equipment unit. Consequently, the module frame may be earthed in this context, which effectively means that the mounting system can be earthed via the module frame.

In addition, a growing number of module manufacturers specify or recommend frame earthing in their installation manuals. Some inverter manufacturers also recommend earthing the module frames. When deciding whether or not to earth the module frame, we recommend always following the installation instructions provided by the module and inverter manufacturers. There may also be country-specific regulations that must be observed.

If you wish to include the module frames in the local equipotential bonding of your PV system, we recommend doing so as shown in the figure below: one mid clamp with earthing plate is used for every two PV modules.



In the case of module arrays or PV module mounting systems and orientations where only end clamps are used, we recommend earthing according to the diagram in the figure below. One earthing plate (EH) should be used for each PV module.



Pitched roof

If multiple module arrays are installed on the roof, all arrays must be integrated into the equipotential bonding system and connected to the main earthing bar.

We recommend connecting the arrays to each other using round aluminium wire and equipotential bonding clamps. Thermal expansion can be compensated for, if necessary, by incorporating loops in the wire.

Alternatively, this can be done using a suitable copper cable with a stainless steel cable lug, which is connected to a suitable screw connection (e.g. to the hammerhead bolt of the roof hook arm). For this approach, we recommend using a protective conduit for the cable or routing it under the roof tiles in the case of a tiled roof.

For the minimum cross-sections of the connections, please refer to the sections “Equipotential bonding/ earthing” and “Lightning protection”.

The low-resistance connection from the outermost point to the main earthing busbar should be checked before commissioning.

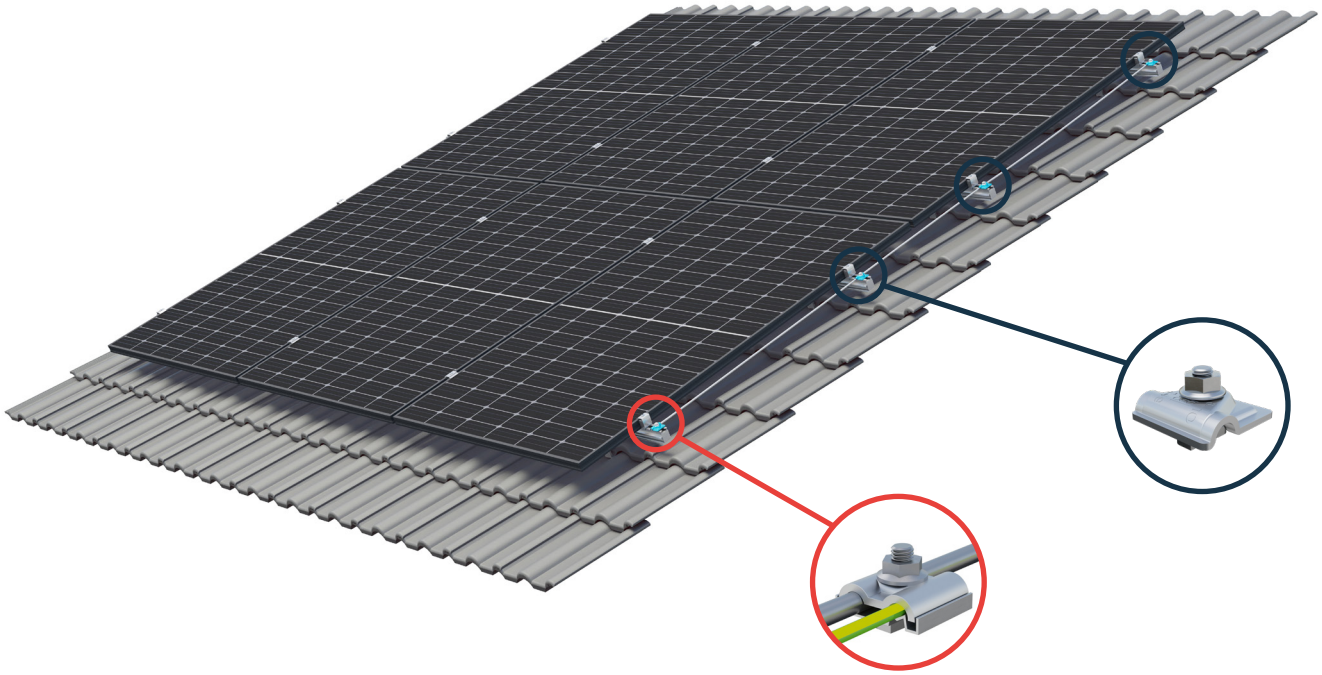
If the resistance between these two points is >1 ohm according to DIN VDE 0100, we recommend increasing the number of connections between the module arrays.

Single-layer installation with continuous mounting rails

sflex systems: Tiled Roof, bracket for sheet metal, hanger bolts & solar fasteners, triangle delta

Variant 1

Equipotential bonding with aluminium round wire and grounding clamp



In a single-layer construction with continuous system carriers, equipotential bonding along the rail direction is achieved by the rail itself and any necessary connectors.

Connections between individual module columns (for landscape mounting) or module rows (for portrait mounting) can be made with aluminium round wire and an equipotential bonding clamp.

The frame system can be linked to the main grounding bus bar using a grounding cable and the grounding clamp.

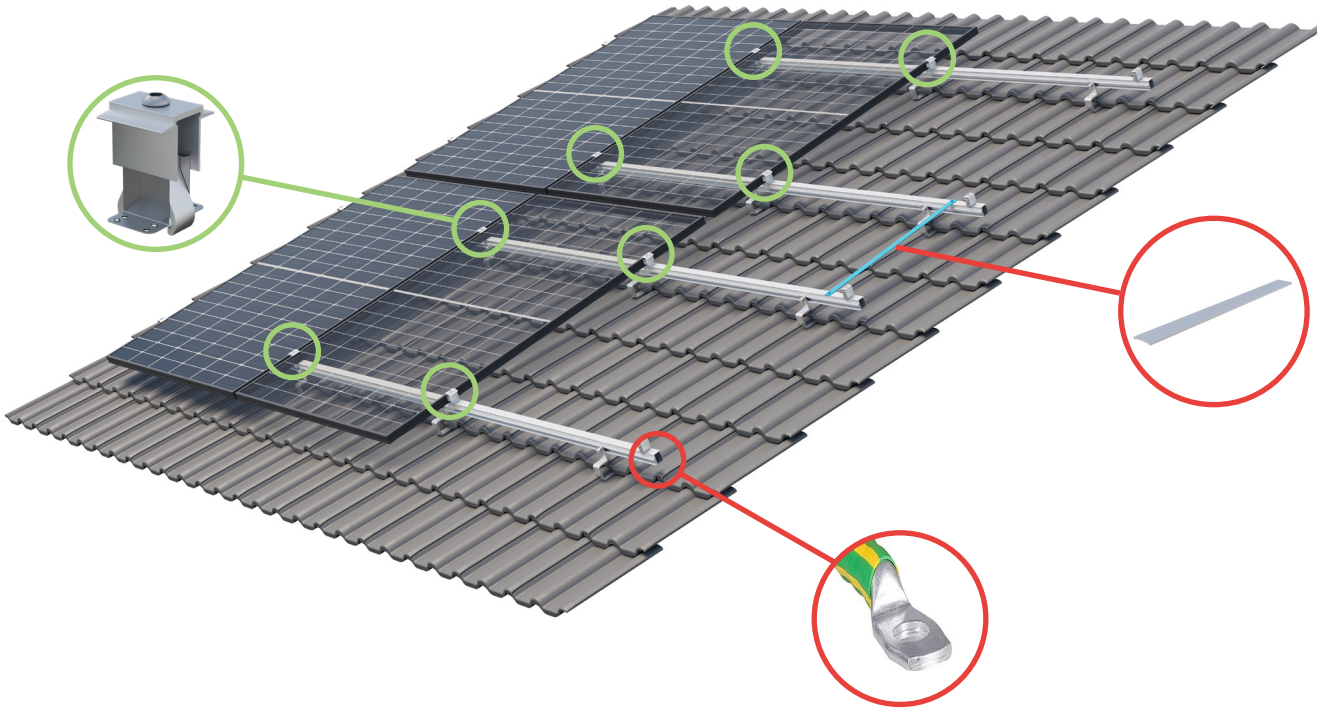
Alternatively, the grounding cable with a suitable cable lug may be placed between the hammer-head bolt and the serrated locking nut (e.g., on a roof hook).

Minimum conductor cross-sections for these connections are detailed in the sections “Equipotential earthing and grounding” and “Lightning protection and lightning current carrying capacity.”

For possible grounding of module frames, see the section “Earthing of module frames.”

Variant 2

Equipotential bonding with sflex aluBar 3-27-1160 mm and grounding cable



In a single-layer construction with continuous system carriers, equipotential bonding along the rail direction is provided by the rail itself and any necessary connectors.

The connection between individual module columns (for landscape mounting) or module rows (for portrait mounting) can be made with the sflex aluBar 3-27-1160 mm together with module brackets or end brackets
with grounding plates.

The frame system can be linked to the main grounding bus bar by fixing a grounding cable with a suitable cable lug to any rail of the installation.

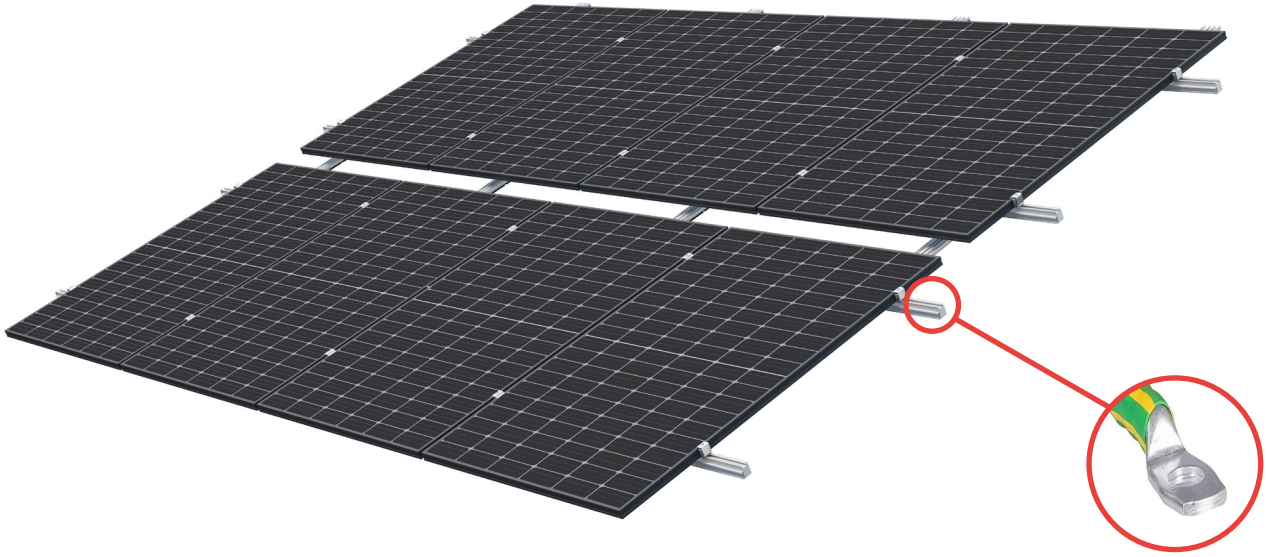
Alternatively, the grounding cable with a suitable cable lug may be placed between the hammer-head bolt and the serrated locking nut (e.g., on a roof hook).

Minimum conductor cross-sections for these connections are detailed in the sections “Equipotential earthing and grounding” and “Lightning protection and lightning current carrying capacity.”

For possible grounding of module frames, see the section “Earthing of module frames.”

Cross-bonding with continuous mounting rails

sflex systems: Cross-bonding with continuous mounting rails



In a cross-bonding arrangement with continuous mounting rails, equipotential bonding is already provided in both the ridge and verge directions by the rails and, if necessary, connectors.

If anodised rails are used, we recommend connecting both layers with round aluminium wire and equipotential bonding clamps, and additionally connecting them at one point using a copper cable and hammerhead bolts.

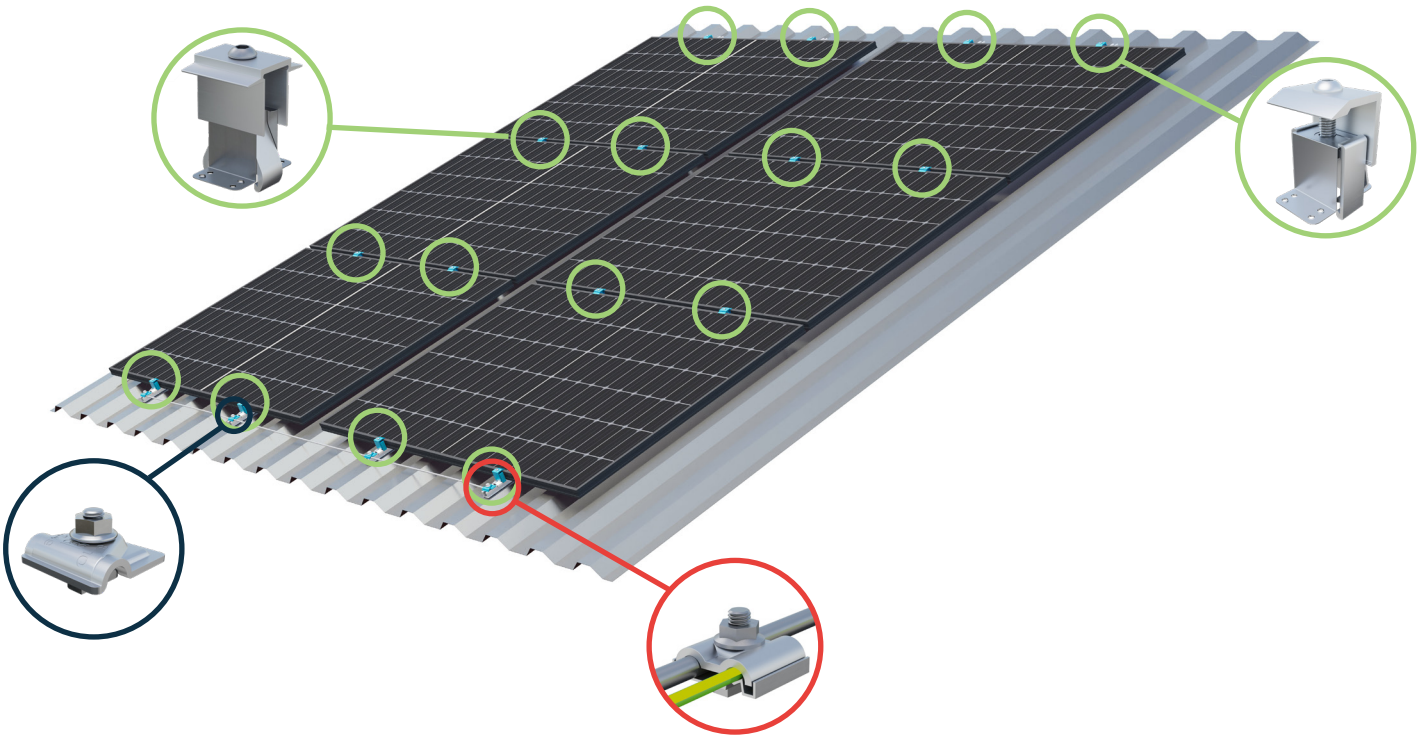
The frame system then only needs to be connected to the main earthing bar at one corner using an earthing cable.

For the minimum cross-sections of the connections, please refer to the sections “Equipotential bonding/ earthing” and “Lightning protection”.

For any module frame earthing, please refer to the section “Earthing of module frames”.

Direct installation – short rail systems: trapezoidal, corrugated and standing seam sheet metal

sflex systems: Direct mounting of HK 172/125, HK 125 XL, LIFT and VARIO systems, trapezoidal sheet metal rails, standing



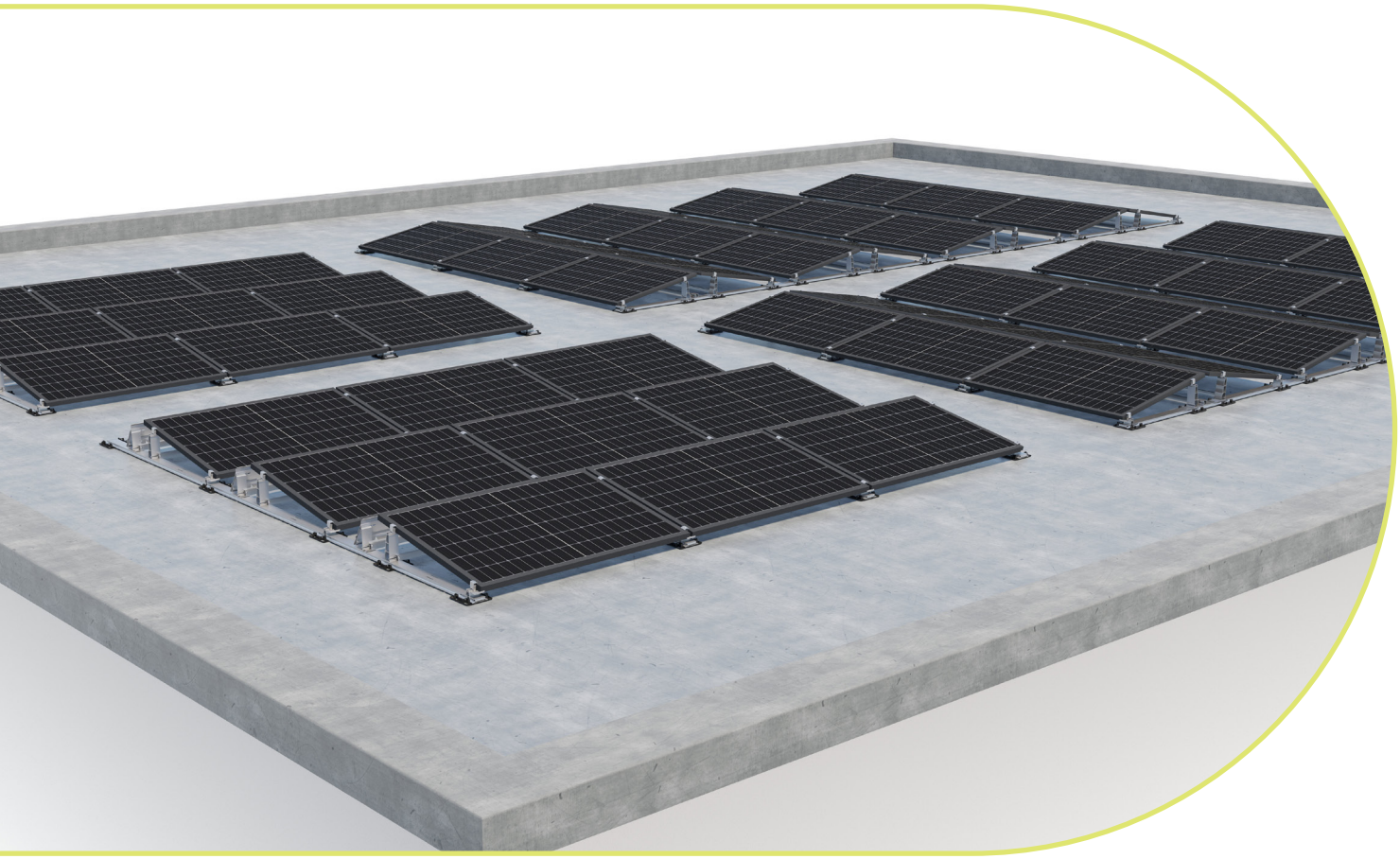
For direct installation of modules on our S:FLEX short rail systems and standing seam clamps, we recommend implementing equipotential bonding by including the module frames using mid clamps or end clamps with earthing plates.

Care must be taken to ensure that no gaps occur in the equipotential bonding system when modules are removed or due to an unusual module layout, which could result in isolated sections. Appropriate measures must be taken to prevent this.

The connection between individual module columns (landscape mounting) or rows (portrait mounting) can be made using round aluminium wire and equipotential bonding clamps.
The PV system can be connected to the main earthing bar using an earthing clamp and a copper cable with a stainless steel cable lug.
For the minimum cross-sections of the connections, please refer to the sections “Equipotential bonding/ earthing” and “Lightning protection”.

Flat roof systems

leichtmount rail 2.1



All module arrays must be integrated into the equipotential bonding system and connected to the main earthing busbar. We recommend doing this using aluminium round wire and equipotential bonding clamps, an earthing cable and earthing clamps. These can, for example, be attached to the screw channel of the cross-bracing or to the holes provided for the side plate using a suitable screw.

Alternatively, equipotential bonding can also be carried out using a copper cable and a suitable cable lug.

For the minimum cross-sections of the connections, please refer to the sections “Equipotential bonding/ earthing” and “Lightning protection”.

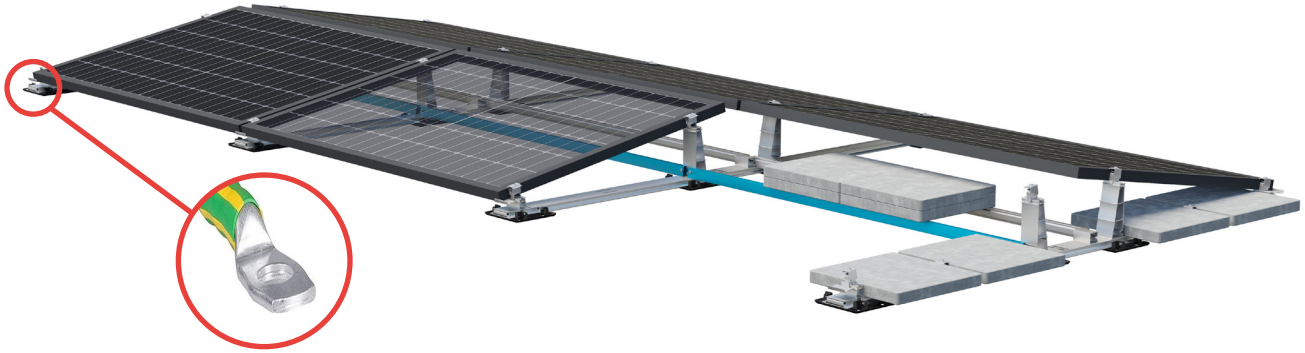
Due to its certified proven lightning current carrying capacity when installed with continuous cross-bracing, the LmR 2.1 can also form part of the external lightning protection system.

The low-resistance connection from the outermost point to the main earthing busbar should be checked before commissioning.

If the resistance between these two points is >1 ohm according to DIN VDE 0100, we recommend increasing the number of connections between the module arrays.

When removing modules, e.g. for maintenance work, care must be taken to ensure that the equipotential bonding of the mounting system is not interrupted, creating isolated sections. In such cases, appropriate measures must be taken in advance to maintain a continuous electrical connection.

leichtmount 2.1 rail east/west



Equipotential bonding is already provided in the east-west direction by the continuous ground rails.

If, according to the project design, there is a continuous cross-bracing connection in the north-south direction, equipotential bonding is also ensured in this direction. Gaps in the cross-bracing connections can alternatively be closed to provide equipotential bonding.

Otherwise, we recommend implementing equipotential bonding in the north-south direction using round aluminium wire and an equipotential bonding clamp. This can be attached directly at the guide for the crossbracing rails using a suitable screw.

A conductive connection using mid clamps and end clamps with earthing plates is also possible in the northsouth direction.

Alternatively, this can also be done with a copper cable and a suitable cable lug.

For the minimum cross-sections of the connections, please refer to the sections “Equipotential bonding/ earthing” and “Lightning protection”.

For any module frame earthing, please refer to the section “Earthing of module frames”.

leichtmount rail 2.1 south

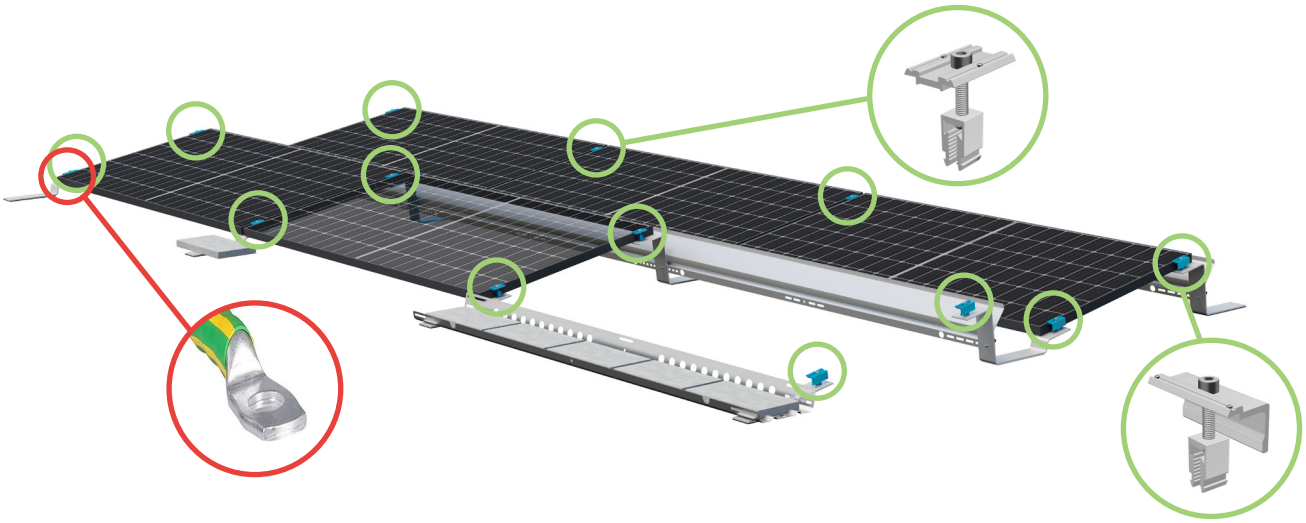
Equipotential bonding in the north-south direction is already provided by the continuous ground rails.

In the east-west direction, equipotential bonding is ensured by the wind deflectors.

For the minimum cross-sections of the connections, please refer to the sections “Equipotential bonding/ earthing” and “Lightning protection”.

For any module frame earthing, please refer to the section “Earthing of module frames”.

leichtmount cf



For the LEICHTmount CF South and East/West systems, equipotential bonding within a module array is achieved using the corresponding mid clamps and end clamps with integrated earthing pins. This means that the equipotential bonding of the mounting system within a module array is ensured by including the module frames.

The effectiveness of the conductive connection between the module frame and the substructure has been confirmed as part of the UL 2703 certification.

Care must be taken to ensure that no gaps occur in the equipotential bonding system when modules are removed or due to an unusual module layout, which could result i isolated sections. Appropriate measures must be taken to prevent this.

All module arrays must be integrated into the equipotential bonding system and connected to the main earthing busbar. We recommend using a copper cable with a stainless steel cable lug, which is attached through the round hole on a foot at the edge of a module array. For the South system, this is the same hole used to fasten the wind deflector.

For the minimum cross-sections of the connections, please refer to the sections “Equipotential bonding/ earthing” and “Lightning protection”.

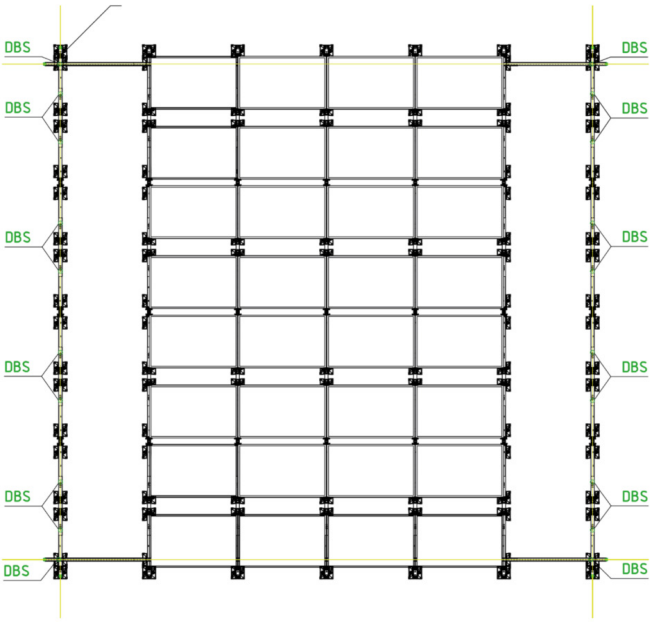
The low-resistance connection from the outermost point of the PV system to the main earthing busbar should be checked before commissioning.

If the resistance between these two points is >1 ohm according to DIN VDE 0100, we recommend increasing the number of connections between the module arrays.

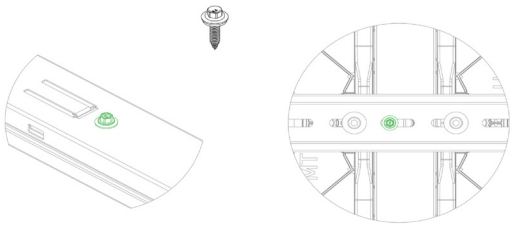
leichtmount snap edge clamping

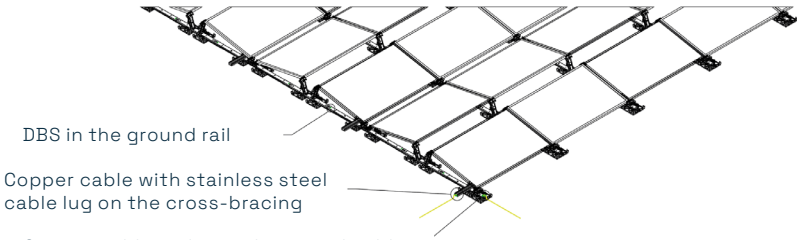
Our leichtmount snap system (lower grid with appropriate measures) is capable of carrying lightning current.
However, this does not automatically mean that the building's external lightning protection system can be integrated in accordance with Lightning Protection Class 3. The class specified by the lightning protection installer may require the construction of a mesh, which can be adapted in various ways.
With the corresponding specifications, sflex can determine and supply the necessary components. These specifications must come from the lightning protection installer. Integration can also be carried out on site, for example using round wire.

DBS in a cross-bonding arrangement

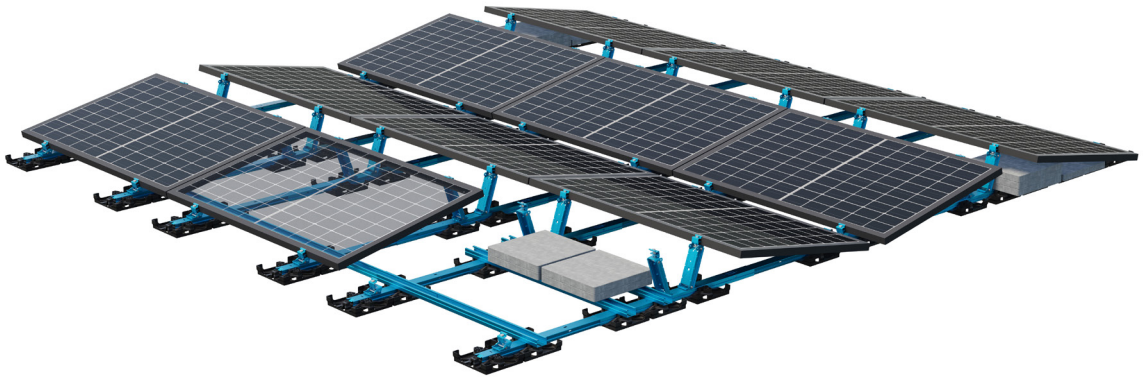


Sheet metal screw A2/bimetal



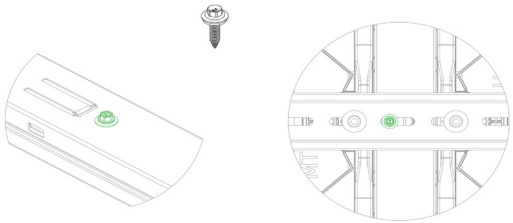


leichtmount snap quarter-point clamping

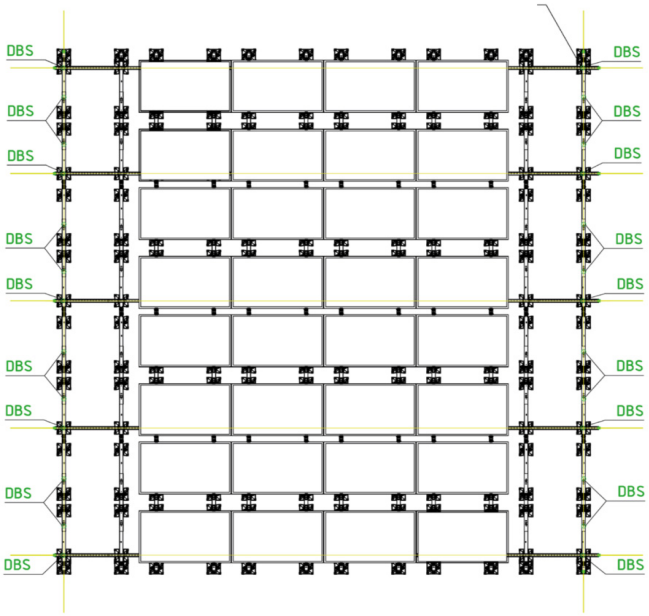


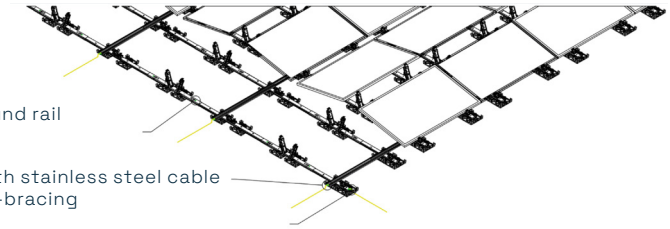
Our LEICHTmount SNAP system (lower grid with appropriate measures) is capable of carrying lightning current.
However, this does not automatically mean that the building's external lightning protection system can be integrated in accordance with Lightning Protection Class 3. The class specified by the lightning protection installer may require the construction of a mesh, which can be adapted in various ways. With the corresponding specifications, sflex can determine and supply the necessary components. These specifications must come from the lightning protection installer. Integration can also be carried out on site, for example using round wire.

Sheet metal screw A2/bimetal 6.0 x 25 E16



DBS in a cross-bonding arrangement





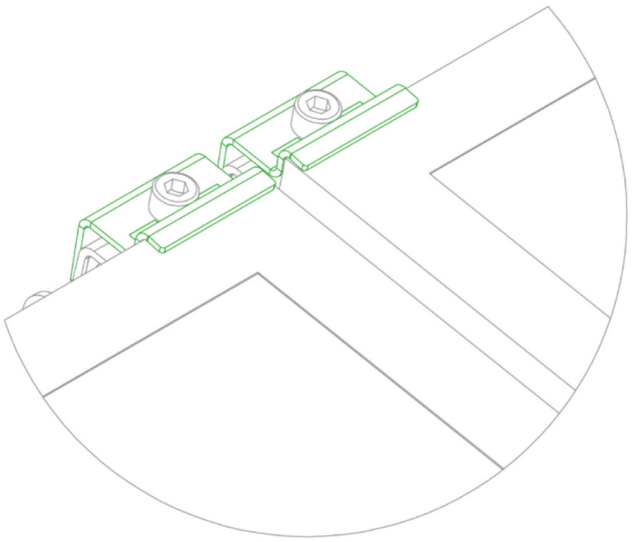
DBS in the ground rail

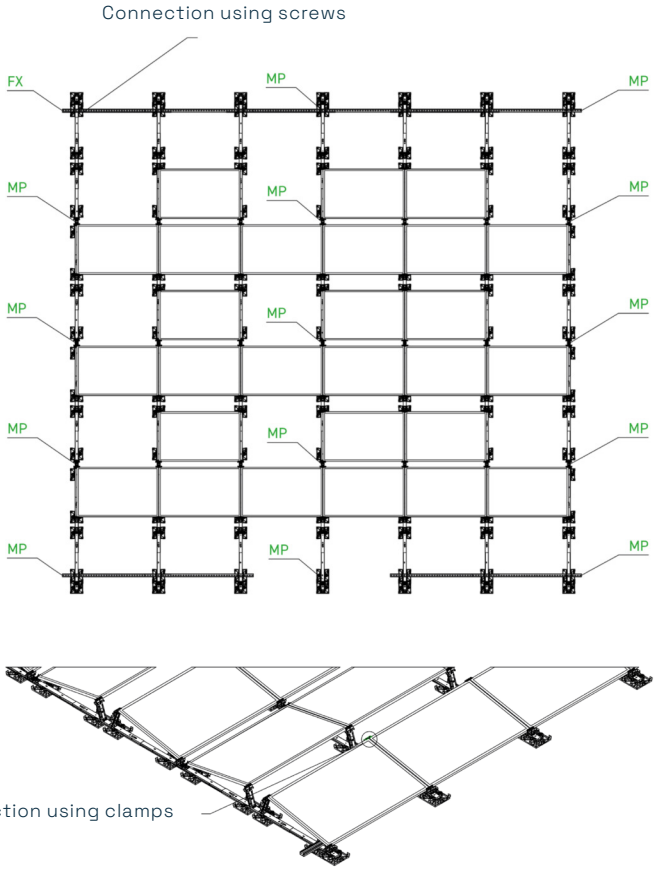
Copper cable with stainless steel cable lug on the cross-bracing

Copper cable with stainless steel cable lug on the ground rail

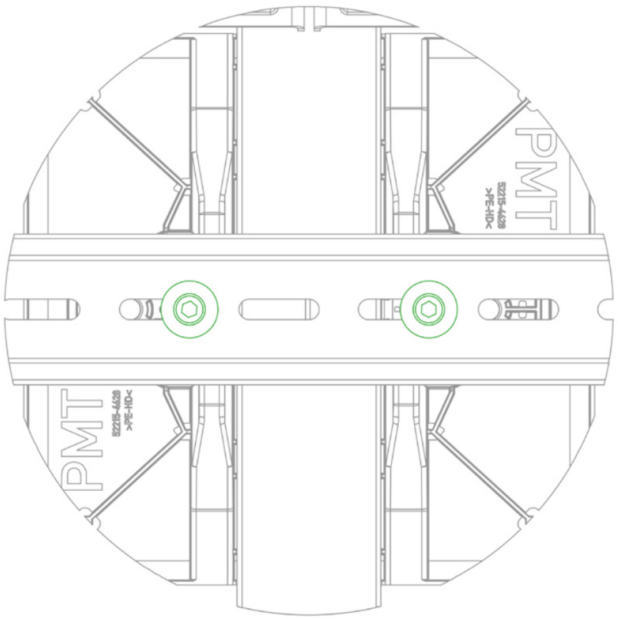
Low-resistance connection

After installation, the low-resistance connection to the module frame is ensured because the clamps on the base and tower penetrate the coating and establish conductivity with the aluminium surface.





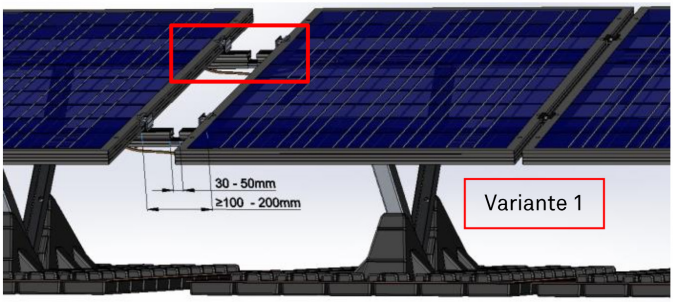
The screw connection in the cross-bonding arrangement ensures that the cross-bracing and cross-bracing connector fit tightly together, providing continuous contact and stable conductivity.

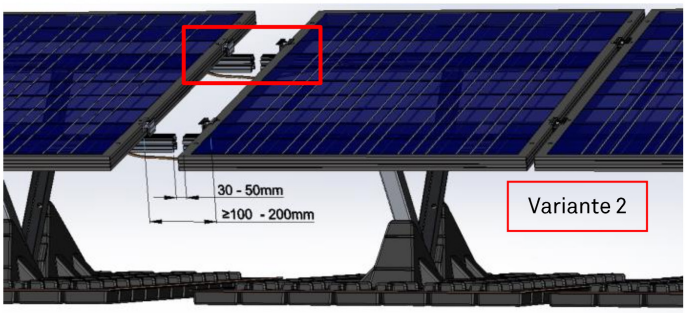


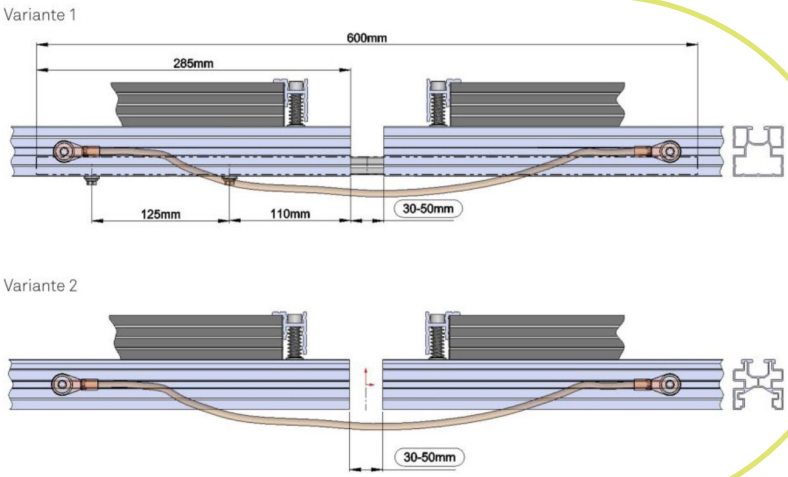
Green roof systems

greenlight und greenlight on top

Profile connector – thermal separation / profile rail interruption







Lightning protection must be ensured

Lightning protection must be ensured. For profile connectors screwed on one side only (Variant 1 or Variant 2), a lightning-current-carrying strap loop must be installed.

Installation instructions: Thermal separation / profile rail interruption

For continuous profile lengths over 24 m, the profiles must either be joined together in the middle (Variant 1) or an expansion joint must be integrated (Variant 2).

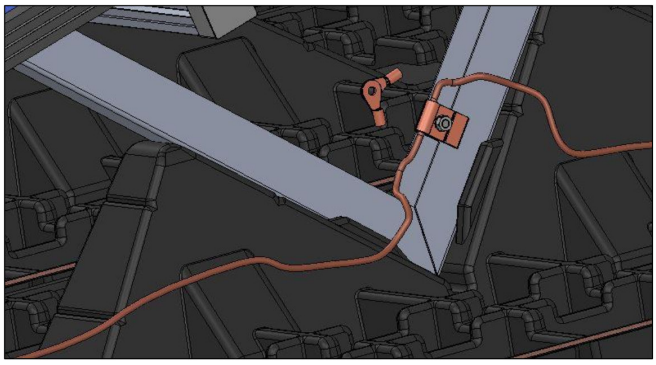
The connector is fixed on one side only using two 6.3 × 25 self-drilling screws. Important: lightning protection must be ensured.

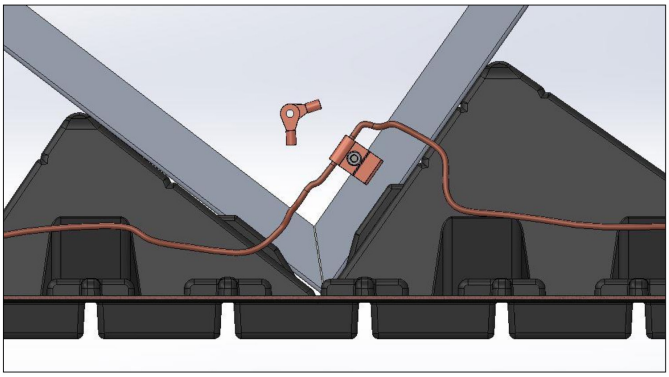
A gap of 3 - 5 cm must be left between the two profile rails.

The profile connector must be positioned so that it lies between two modules, which are each fastened with an end clamp.

Suggestion/examples for lightning protection installation

Routing the Lightning Protection via the Knickfix





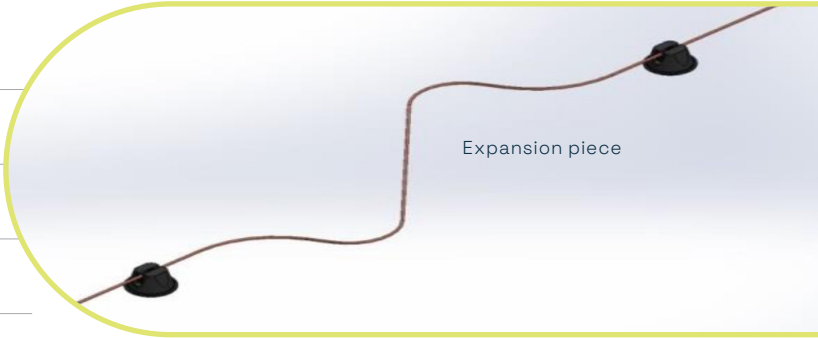
Lightning protection

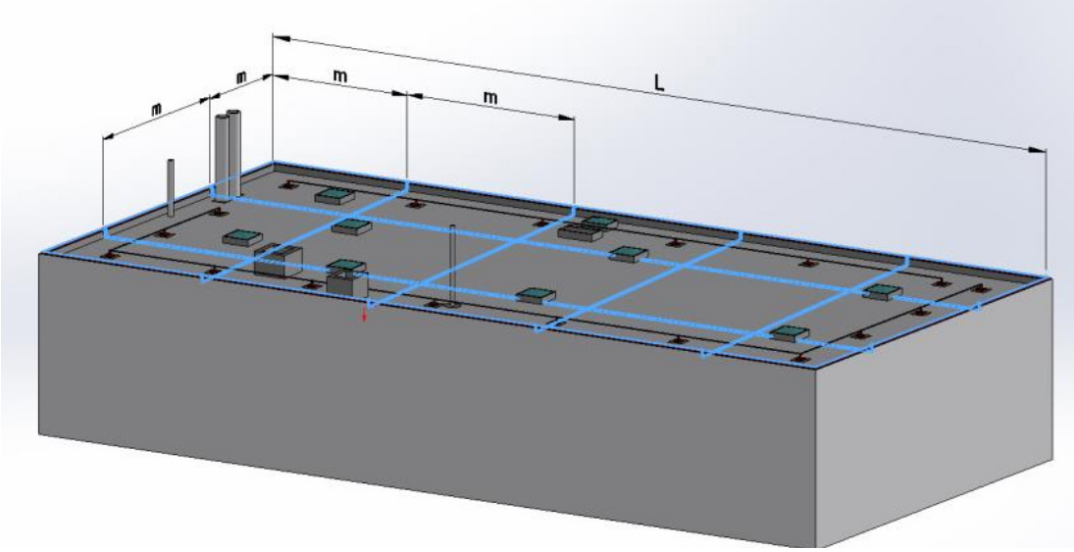
If a solar system is installed, no additional lightning protection system is required. However, if a lightning protection system is present, the solar installation must be integrated into the system.

Arrangement of conductor spacing / mesh size

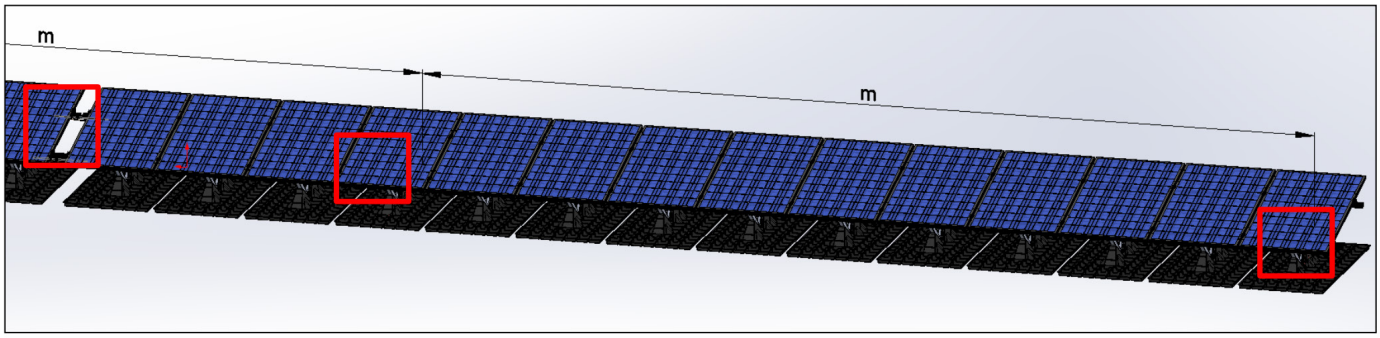
Depending on the lightning protection class of the building, different mesh sizes / conductor spacings apply. If the total length L is greater than 20 m, an additional expansion piece must be installed to compensate for length changes due to temperature variations.

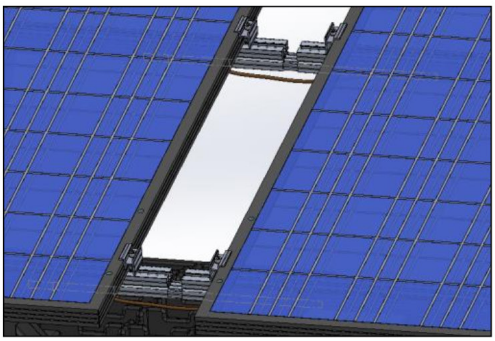
Lightning protection class	Conductor spacing / mesh size [m]
I	5x5 m
II	10x10 m
III	15x15 m
IV	20x20 m

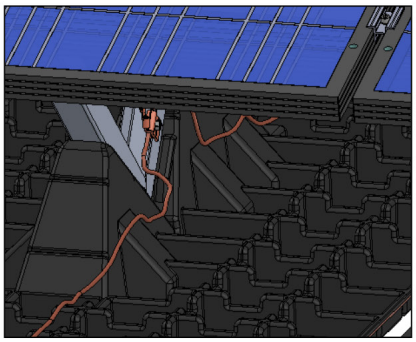


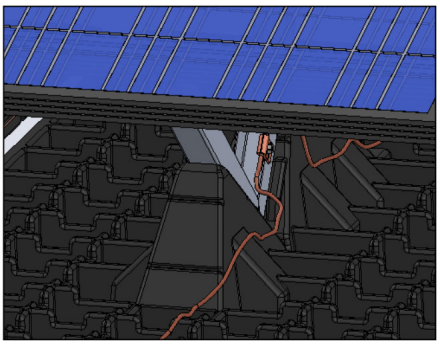


Application example – lightning protection

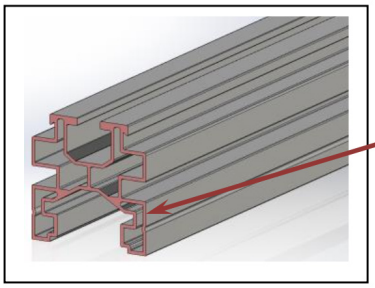








Conductivity: GreenLight profile



GreenLight Profile ST universal
Aluminium EN AW-6063 T66
Area A: 405.8 mm^2
Electrical conductivity: 36 m/ohm mm^2
Specific resistance: 1.88 Ohmxmm^2/m

The information provided is intended as recommendations for lightning protection with GreenLight.
The lightning protection systems must comply with the legal standards DIN EN 62305 and VDE 0185-305:2006. Final acceptance of the lightning protection system must be carried out by a qualified lightning protection officer or specialist.

sflex

Recommendations for equipotential bonding and lightning protection

Are you interested or do you have more questions about the product?

Build on our support!

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