

Roofit.solar

ClicSeam™

Safety and Installation Manual



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» Acronyms

| | |
|-----------------|---|
| AM1.5 | Air Mass 1.5 |
| BIPV | Building Integrated Photovoltaics (i.e. metal integrated photovoltaics) |
| DC | Direct Current |
| I_{max} | Current at maximum power |
| I_{sc} | Short Circuit Current |
| JB | Junction box |
| m.a.s.l. | Meters above sea level |
| PV | Photovoltaic |
| P_{max} | Maximum power |
| STC | Standard Test Conditions (T= 25°C, Solar Irradiance = 1000 W/m ² , AM = 1.5) |
| V_{max} | Voltage at maximum power |
| V_{oc} | Open Circuit Voltage |

» Definitions

| | |
|------------------------|---|
| Buyer | A person or party that purchases the Product/s from the Roofit Solar Energy OÜ. |
| Product/s | Roofit Solar Energy OÜ BIPV (i.e. metal integrated photovoltaics) |
| Warranty Period | The period beginning on the date of purchase of Product/s by the Buyer |
| PV layer | The Photovoltaic part of the Roofit.solar Product |
| PV system | System composed of two or more Roofit.solar Products combined with an inverter and other electrical accessories. |

» Introduction

This manual contains essential information about electrical and mechanical installation that must be followed before handling, installing and maintaining our Product. In addition, this manual contains safety information one needs to be familiar with.

» Disclaimer of Liability

All the information contained in this manual is the intellectual property of the Roofit Solar Energy OÜ and is based on the technologies and experience acquired and accumulated by the company. This manual does not constitute a warranty, either explicit or implicit. Roofit Solar Energy OÜ does not assume responsibility and expressly disclaims liability for any loss, damage, or expenses arising from or in any way related to the installation, operation, use or maintenance of our Product. Roofit Solar Energy OÜ assumes no responsibility for any infringements of patents or other rights of third parties that may result from the use of our Product.

Roofit Solar Energy OÜ reserves the right to make changes to the Product, the specifications, or the installation manual without prior notice. Failure to comply with the requirements listed in this manual will void the warranty provided by the Roofit Solar Energy OÜ.

The mechanical and electrical installation of PV systems must be carried out with all applicable codes, including electrical codes, building codes and electric utility interconnection requirements. These requirements may vary from country to country. Contact local authorities for applicable regulations. The product must be installed by a qualified person. The electrical connection must be made by a certified electrician. Planning the location of the product on the roof should be carried out by a competent professional with experience in planning PV systems.

» Safety

General Considerations

The distributor of our Products is required to provide this manual to the PV system owners.

The Product is designed to meet the requirements of the IEC 61215 and IEC 61730 standards.

Perform structural analysis of the roof before installing **Roofit.solar** Products.

Observe all relevant laws, regulations, guidelines, and safety measures when handling solar modules.

For your safety, do not attempt to work on a rooftop until the necessary safety precautions have been identified and taken. Sufficient protective equipment (e.g., harnesses, insulated rubber gloves and tools, etc.) is required throughout the installation process.

Roofit.solar Products can be combined with other components to form a photovoltaic system. In this case, installation and operating instructions issued for these additional components must be also followed.

NB! PV system generates DC electricity when exposed to light and therefore can cause an electrical shock or burn if not handled properly. PV modules are running on voltage higher than 30VDC and currents exceeding 30mA, thus all contacts with bare wires without proper safety measures can be dangerous for health. The danger increases when multiple Products are connected to provide higher system voltage or current levels. Dangerous voltages can also occur at night or even when the modules are not connected to an electrical circuit or load.

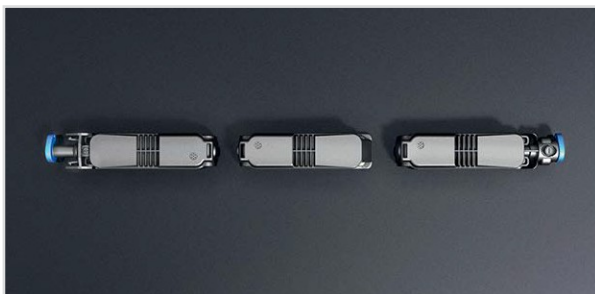
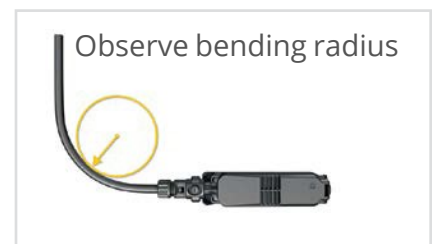
The Products can only be rendered inoperative by removing them from sunlight, or by fully covering their front side with a fabric, cardboard, or other completely opaque material, or by working with Products face down on a smooth, flat surface.

A PV system can produce a higher output than the rated specifications. Industry standard ratings are made at STC. Reflection from snow or water can increase sunlight, therefore boosting current performance and power. In addition, colder temperatures can substantially increase voltage and power. This must be taken into consideration during the system design done by a competent person experienced in PV system planning (for more information see the section Electrical Installation).

Main Precautions

Always follow the safety precautions listed below when dealing with Roofit.solar Product:

- Do not keep the Product packages open outdoors until they are ready to be installed.
- Transport and store the Products in appropriate packaging in a ventilated, rainproof, and dry location.
- Always use electrically insulated tools and gloves while working on the electrical connection of the Product.
- Be careful with the sharp edges and corners of the Product.
- DO NOT disconnect/connect electrical connections under load.
- DO NOT install the Product in adverse conditions (rain, strong or gusty winds, wet or frosted roof surfaces, etc.).
- DO NOT use mirrors or other magnifiers to concentrate sunlight onto the Product.
- DO NOT overbend or apply stress to the cables. Observe the recommended cable bend radius following the supplier's data sheet.
- Ensure that all electrical connections are properly secured and protected from unwanted interference.
- Before installation, make sure that all the PV4 connectors have blue dust caps on. Remove the dust caps only prior making electrical connections.

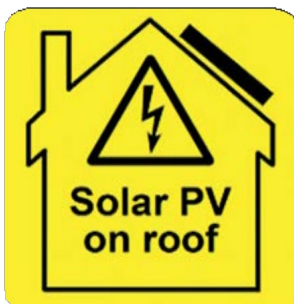


- DO NOT lift the Product by grasping junction boxes.
- DO NOT drop the Product or drag it over any surface.
- DO NOT attempt to install or service the PV system unless you are qualified to do so.
- DO NOT attempt to open the junction box, repair, modify or disassemble the Product.

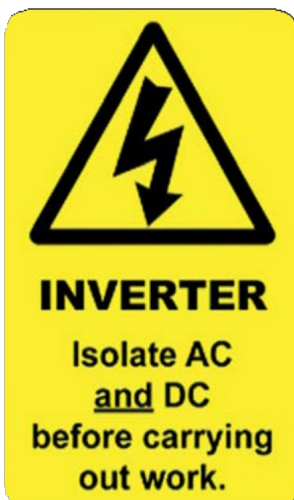
- DO NOT leave the Product unsecured. If it falls, the glass layer could break. The Product with a broken glass layer cannot be repaired and must not be installed.
- DO NOT apply paint or adhesive to the Product surface or attempt to remove any markings, labels or parts attached to the Product by the manufacturer.
- DO NOT drill holes in the PV layer of the Product.
- Always mount the Product so that the junction box is unobstructed and does not carry any of the weight of the Product.
- Avoid stepping or placing heavy load on the modules during the installation. Doing so may cause microcracks/cracks that are invisible to human eye.

Fire Safety

Consult your local authority for guidelines and requirements for building or structural fire safety. **Roofit.solar** Products have been tested according to the Fire Test in IEC 61730 Part 2 and classified as Class A. Also, **Roofit.solar** Products have been tested according to CEN/TS 1187 and labelled as Broof (t2) in accordance with EN 13501-5:2016. In addition, the metal sheet has been tested according to the EN 14782:2006 Self-supporting metal sheet for roofing, external cladding, and internal lining. Roof constructions and installations may affect the fire safety of buildings. Improper installation may lead to hazards in the event of a fire. Use appropriate components such as fuses and grounding connectors as required by the local authorities.



Inform firefighters about the existence of a photo-voltaic system in the building.



In case of fire, stay away from all elements of the PV system, until the area is safe.

Fire safety switch combiner box

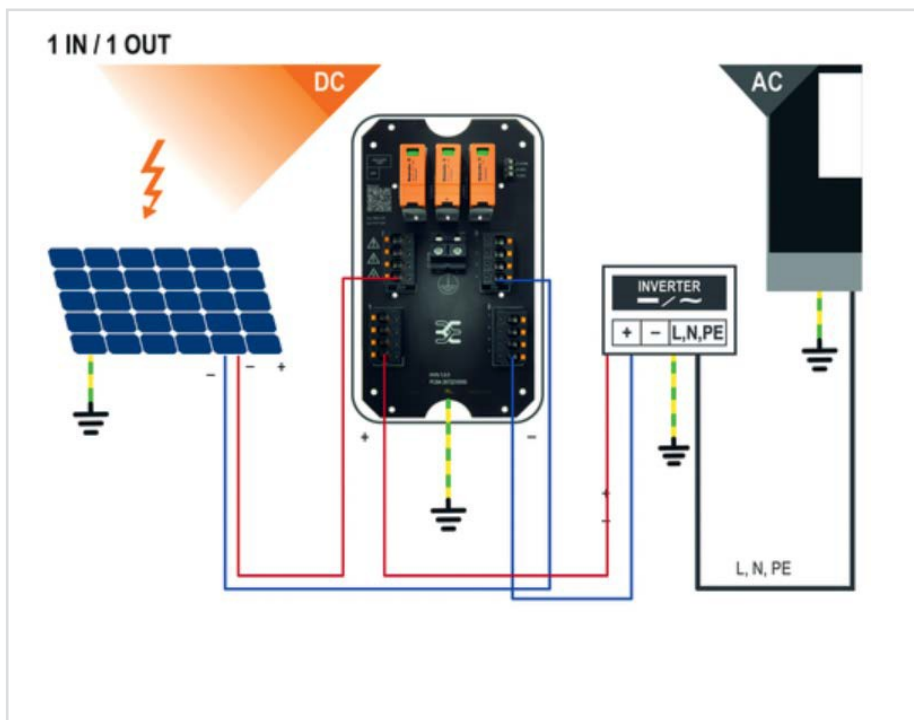
A Combiner Box is recommended by **Roofit.solar** for the buildings with PV systems in order to secure the house and the inverter(s) from unexpected overvoltage.



The Combiner Box is equipped with an emergency disconnect mechanism that shuts down the PV system and protects it from overvoltage caused by the lightning strikes. Depending on the roof specifications, the Combiner Box is available in different sizes for up to 3MPPTs per box.

The Combiner Box includes fireman's switch, which disconnects the DC power lines between the solar modules and the inverter(s). The device can be triggered remotely, as it is installed inside the building with an easy access that can be activated in case of a fire.

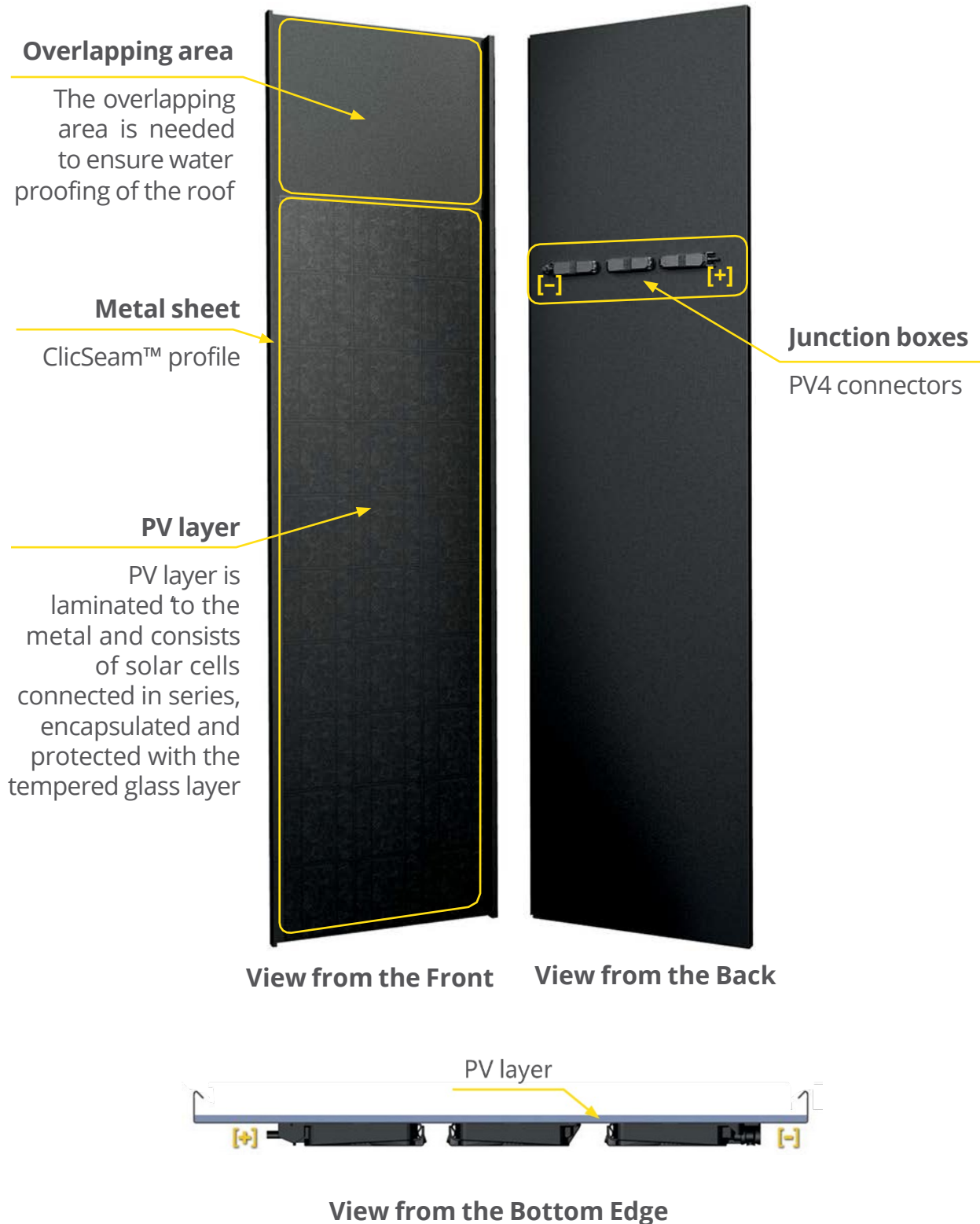
The maximum distance between the Combiner box and PV modules must not exceed 10 meters of cable length. Otherwise, an additional Combiner Box is required to be installed.



» Roofit.solar Product Information

The **Roofit.solar** Product is a building integrated photovoltaic (PV) product used as a construction material placed on a roof or the facade of a building.

Illustration of the Product



Connectors

The **Roofit**.solar Product has three JBs containing positive and negative PV4 terminals. The junction boxes have been designed to be electrically interconnected in series with IP67 protection grade.

| Manufacturer | Type | Ambient temperature (°C) | Degree of protection | Rated voltage (V, DC) | Rated current (I, A) |
|-----------------|--------------------|--------------------------|----------------------|-----------------------|-------------------------|
| TE Connectivity | PV4-S/S1 Connector | -40 to +85 °C | IP67 | 1000 V | UL 20A DC TUV 40A DC |

Bypass diodes

Each junction box contains a bypass diode wired in parallel with the PV cell strings. In case of partial shading, the diodes bypass the current generated by the unshaded cells, thereby limiting the Product heating and performance losses. Bypass diodes are not overcurrent protection devices. In the event of a known or suspected diode failure, installers or main-tenance providers should contact the supplier.

Specifications of the bypass diode

| Type | Rated bypass current | Rated reverse current | Rated voltage | Operating temperature |
|--------------|----------------------|-----------------------|---------------|-----------------------|
| TE 2213713-1 | 15 A | 15 A | 1000 VDC | -40 to 115 °C |

» Product environment

Product location

Proper measures must be taken to ensure the performance and safety of the Product when installed or operated in areas with heavy snow, extreme cold, strong wind, near coastal areas or deserts where salt fog may manifest. The operating temperature range of the product is between -40°C and 85°C .

The maximum altitude for the installation of a 1000 V Roofit.solar Product is 2000 m.a.s.l. For altitudes between 2001 and 3000 m.a.s.l., the system voltage must be decreased to 600 V. Ensure the Product is not subject to wind or snow exceeding the maximum permissible load. The maximum permissible load has been defined as 1600 Pa with an extra safety factor of 1.5 according to Swedish test institute RISE.

Roofit.solar is not responsible or liable for Products damaged during lightning. Therefore, surge protection is recommended for Products to be installed in locations with high probability of lightning strikes.

The Product should not be installed in locations where any type of corrosive agents and/or flammable gases may be generated or collected.

Roof Support Structure

Ensure the installation method and supporting system of the roofing materials are strong and durable enough to install the Product and meet its load conditions. The supporting system must be installed according to local, national, or international standards.



Any penetration (e.g. chimney, pipes etc.) to the **Roofit.solar** Product must be properly sealed to prevent leaks. Always keep the back of the Product free of foreign objects which are not part of the support structure.



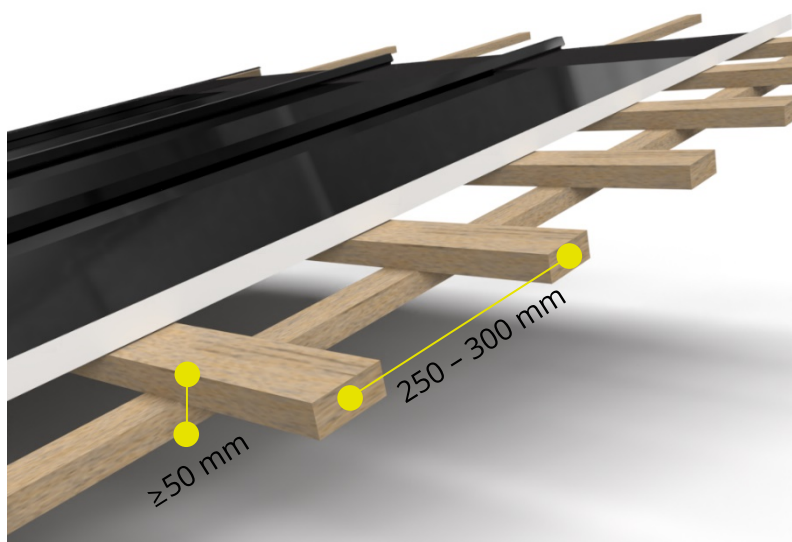
Roof Slope

For the purposes of waterproofing as well as maintenance, it is strongly recommended the roof is at slope of more than 10 degrees.

Location of battens

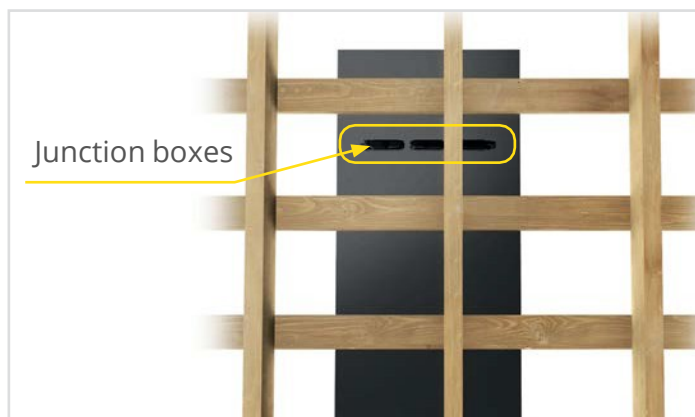
Battens serve as a support for the Product, and therefore, must be installed on the same level and form an even surface to eliminate the possibility of damage to the glass layer during the installation.

Roofit.solar recommends 250-300 mm gap between the horizontal battens. Ventilation gap between the Product and the moisture barrier should be at least 50 mm.



Ensure the installation method and supporting system of the roofing materials are strong and durable enough to install the Product and meet its load conditions. The supporting system must be installed according to local, national, or international standards.

Special attention must be paid to the positioning of the battens in respect to the installation of the Product. Each Product has junction boxes that must be placed in between the battens to guarantee safe installation.

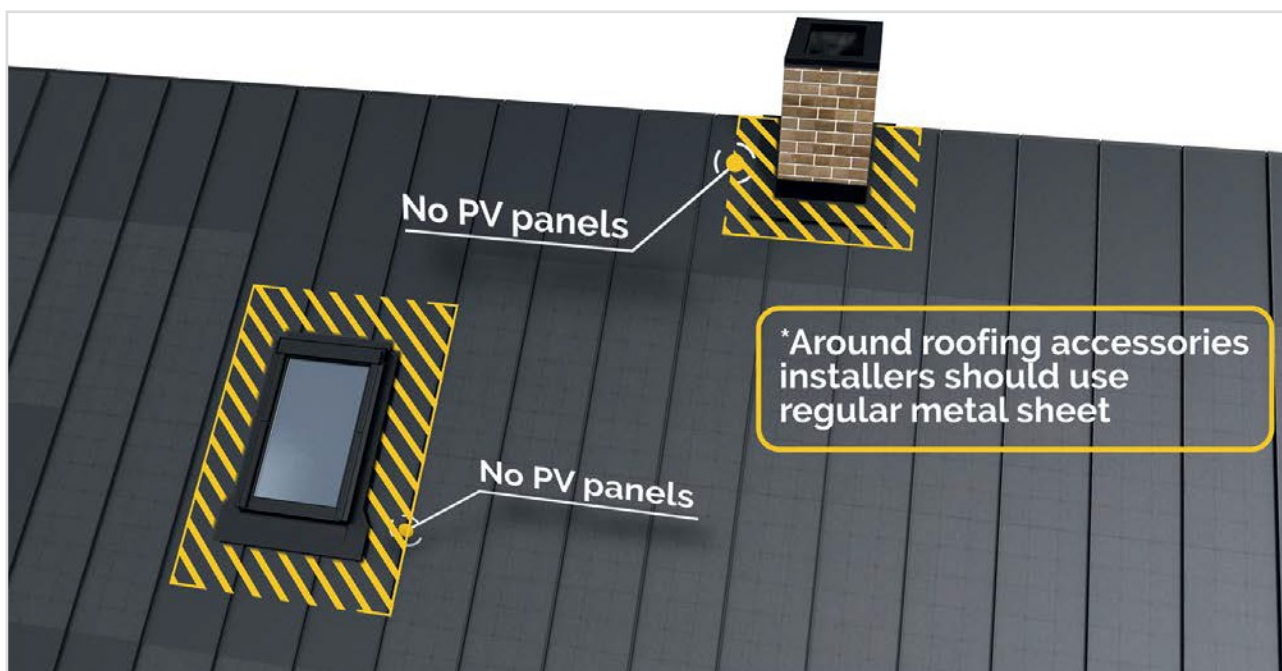


Roofit.solar PV system planning

The PV layer of the **Roofit.solar** Product must not be cut or bent.



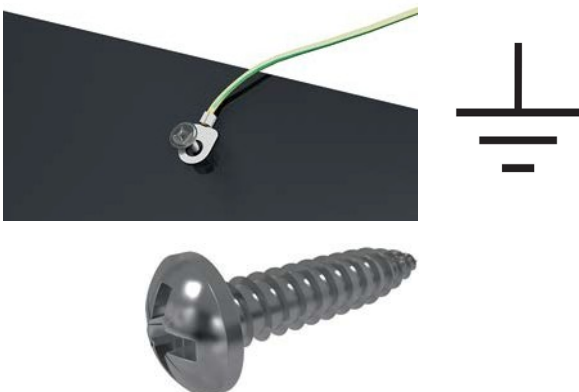

Depending on the roof design, **Roofit.solar** Products can cover the whole roof or be combined with regular metal roofing materials. However, all penetrating roof elements should be surrounded by standard metal sheets.

In the case of complex geometry, shadow analysis is needed to determine the appropriate area for the installation of the Products.



» Electrical interconnection

Electrical connection accessories

| | |
|---|--|
| <p>Jumper/Extension cable</p>  <p>Jumper cable (1 m)</p> <p>Jumper cable connects Products electrically with each other.</p> <p>Extension cable (> 1 m)</p> <p>Customized length. Extension cables are needed if the connection distance between the modules is more than 1 m.</p> | <p>DC cable with PV4 male/female connectors</p>  <p>DC cables are used to connect Roofit.solar DC Strings with the inverter.</p> |
| <p>Grounding cable</p>  <p></p> | <p>Spanner</p>  <p>Spanner is used for the disassembly of connectors.</p> |

Wiring Considerations

Roofit Solar Energy OÜ recommends that all wiring is double insulated with a minimum temperature rating of 110°C. All wiring should use flexible copper (Cu) conductors. The minimum wiring sizes are determined by the applicable codes. Roofit Solar Energy OÜ recommends a size not less than 4 mm².

The insulation should be suitable for the type of installation method used and must meet SKII (Safety Class II) and IEC 61730 requirements. The polarities of cables and terminals must be matched when making the connections, failure to do so may result in damage to the Product and to person. Ensure that all electrical connections are secure and tight.

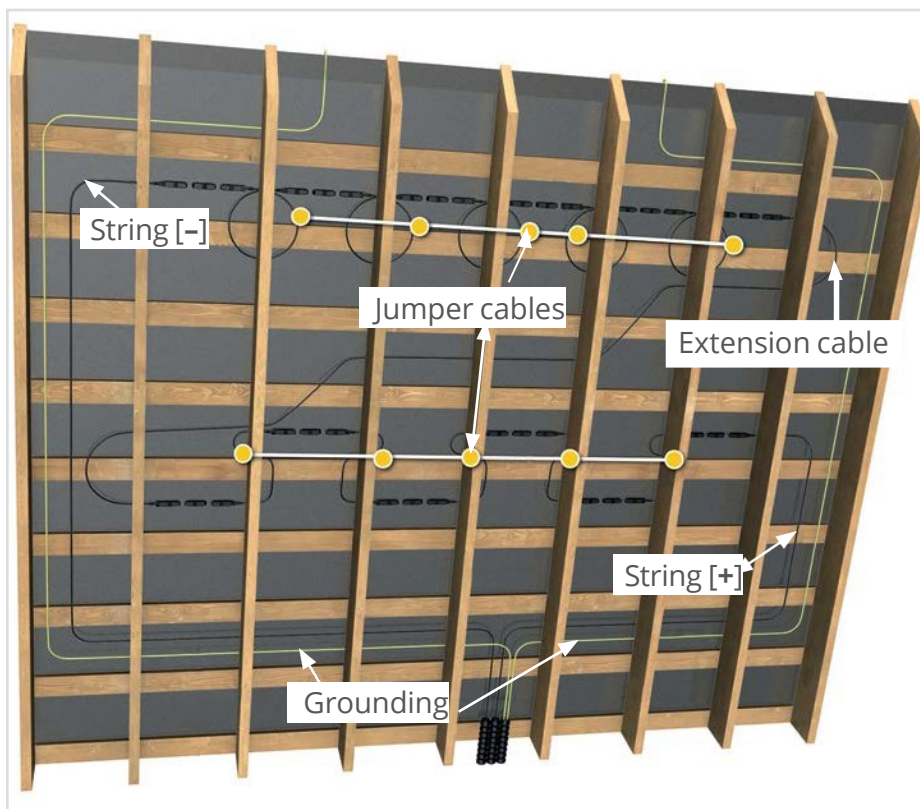
Series and Parallel Wiring

Voltages are additive when Products are connected directly in series, and currents are additive when the Products are connected directly in parallel. PV circuits should be designed according to the best practice guidelines of the respective country. The maximum number of Products that can be connected in series string must be calculated in accordance with applicable regulations so that the specified maximum system voltage of the Products and all other electrical DC components are not exceeded in open-circuit operation at the lowest temperature expected at the PV system location. In addition, the maximum number of strings that can be connected in parallel cannot exceed 2 without proper protection. An overcurrent protection device is required for each series string if more than two series strings are connected in parallel. The maximum system voltage of the **Roofit.solar** Product is DC 1000V according to the safety assessments of the IEC61730. The correction factor for the open-circuit voltage can be calculated based on the following formula:

$$C_{V_{oc}} = 1 - \beta * (25^{\circ}\text{C} - T_{min}),$$

T_{min} , °C is the lowest expected ambient temperature at the system site. β , %/°C is the temperature coefficient of the selected Product V_{oc} (See Appendix 1). A properly rated overcurrent protection device must be used when the reverse current could exceed the

maximum fuse rating of the Product.

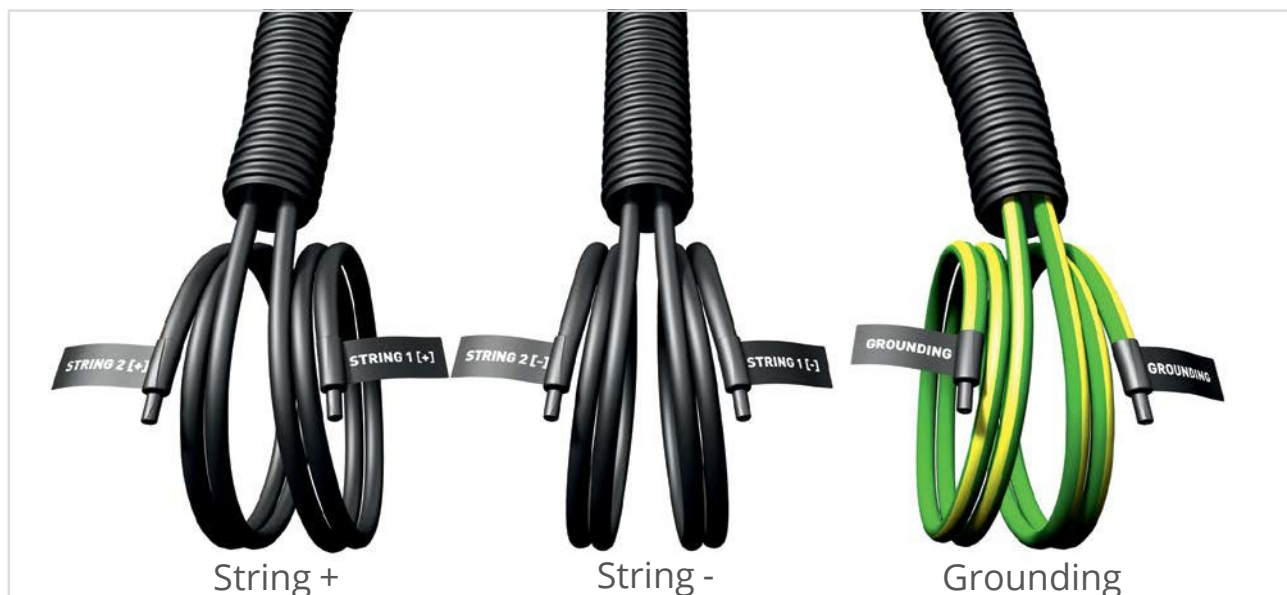


The inverter (String [-], String [+]), the grounding and extension cables connecting the Roofit.solar Products should be positioned on site (i.e. between battens) before the installation. Loose cables should be fixed to the wooden structure with the help of cable holder clips.

DO NOT group together positive, negative, and grounding cables to avoid ground fault and short-circuit. Insulate bare DC cables and mark them accordingly for the time between PV system and inverter installation.

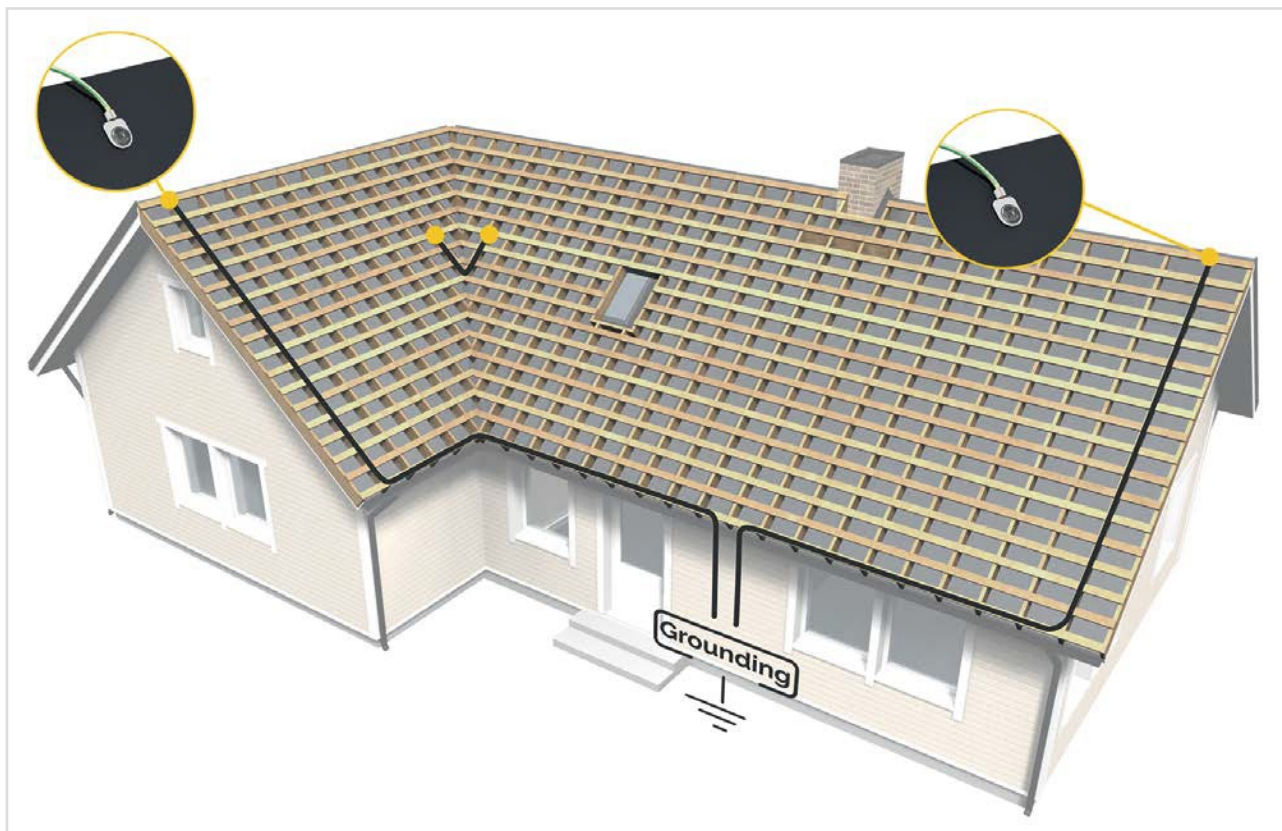
Each type of the cables should be separately routed to the protective tubes and taken to the technical room where they will later be connected to the inverter.

An example of 2 strings



NB. Roofit.solar PV system must be equipped with DC arc-fault circuit protection. DC arc-fault circuit protection provides supplementary protection against fires that may arise because of arcing faults in PV system components or wiring. Therefore, inverters with arc fault circuit interrupter shall be used for the **Roofit.solar** PV system installation.

Grounding






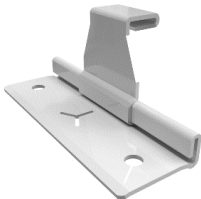




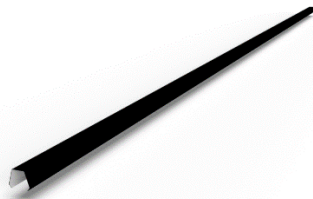
Each PV system must be connected to the grounding cable to ensure electrical safety. All **Roofit.solar** products that are assembled with each-other are galvanically connected through the combination of the fastening clip and screw. **Roofit.solar** recommends 2 grounding cables per roof, to provide the possibility to measure ground connection quality.

If the building has more than one type of active surface on the roof (i.e., **Roofit.solar** Products covering different sides of the roof), they can be connected in one grounding circuit to minimize the number of grounding cables as shown in the picture. Double grounding of the PV system is recommended even when applicable regulations, code requirements and standards do not require any safety-related grounding.

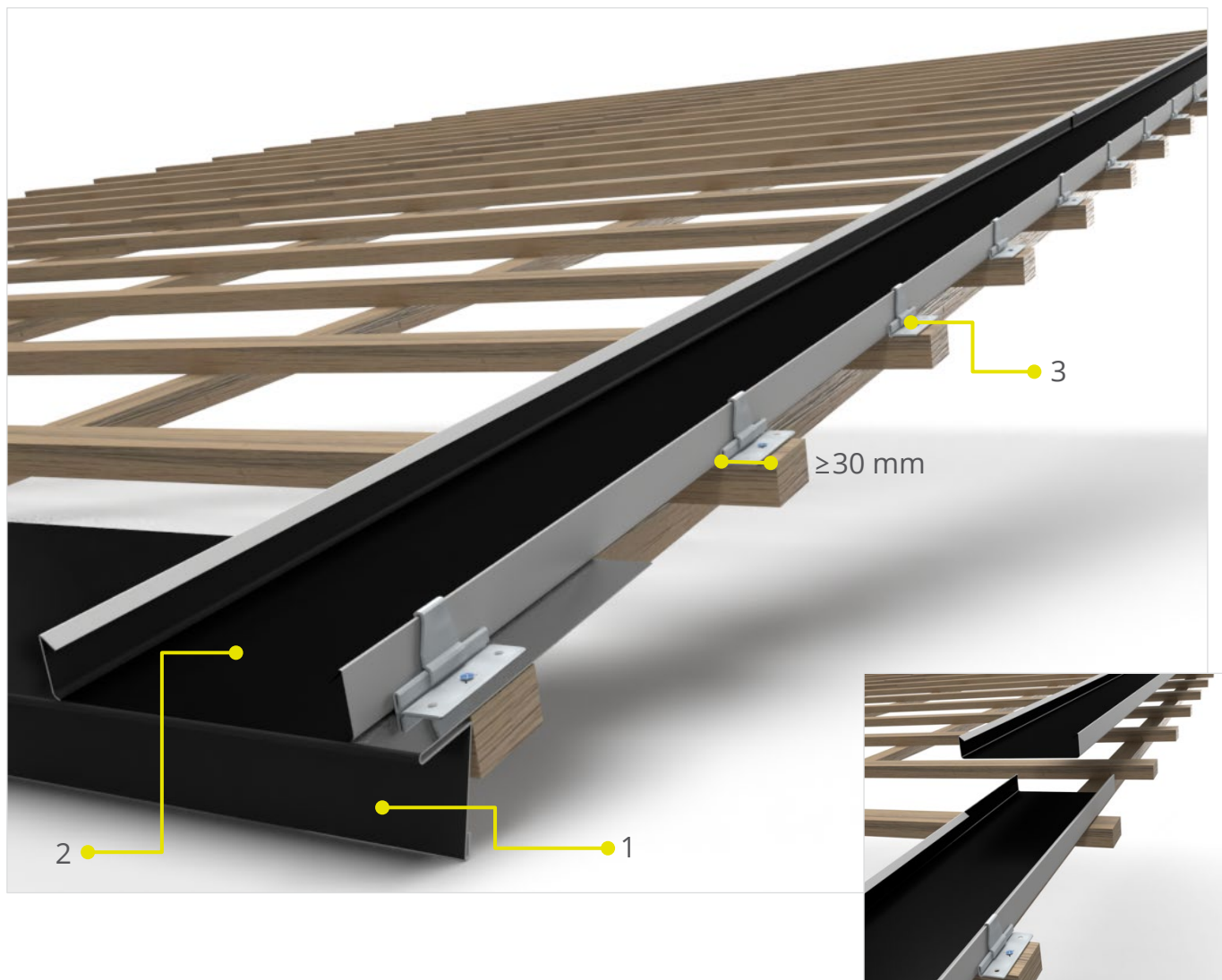
The grounding should be initialized by screwing a self-tapping A2 or A4 stainless steel screw, ST 4.8 according to DIN 7981C with a length between 10 mm and 16 mm. The screw is connected to the grounding conductor on the uppermost metal sheet of the roof under the ridge cap. The grounding is finalized by connecting the grounding conductors to the equipotential grounding.

» Mechanical Installation

Accessories for installation

| | | |
|--|---|---|
| <p>ClicSeam™ fastening clip</p>  <p>Used for fixating rows of panels to each-other, every 300 mm</p> | <p>Screw 5x70 C4 WAF</p>  <p>For fixation of ClicSeam™ fastening clip</p> | <p>Cable fastening clip</p>  <p>Used for fixing loose cables to the battens</p> |
| <p>Fastening clip edge with screw</p>  <p>Used for fixing the products to the battens, screws included in package</p> | <p>Silicone sealant</p>  <p>Silicone type ABRA M82 or equal</p> <p>Supports waterproofing of seams in all overlapping areas</p> | <p>Expanding sealant tape 15 / 1-4</p>  <p>For waterproofing under ClicSeam™ top profile</p> <p>Attached inside each top profile before installation</p> |
| <p>ClicSeam™ Edge panel</p>  <p>150 mm wide end-bent Edge panel, standard length 2000 mm</p> | <p>ClicSeam™ installation plate</p>  <p>A start profile that is used when the first panel-row requires regular metal, standard length 900 mm</p> | <p>ClicSeam™ top profile</p>  <p>A top profile is pressed over and used for covering fastening clips, standard length 2000 mm</p> |

ClicSeam™ Edge panel installation



1. ClicSeam™ Eaves flashing
2. ClicSeam™ Edge panel - Standard 150 mm / Available custom made
3. Fastening clip edge

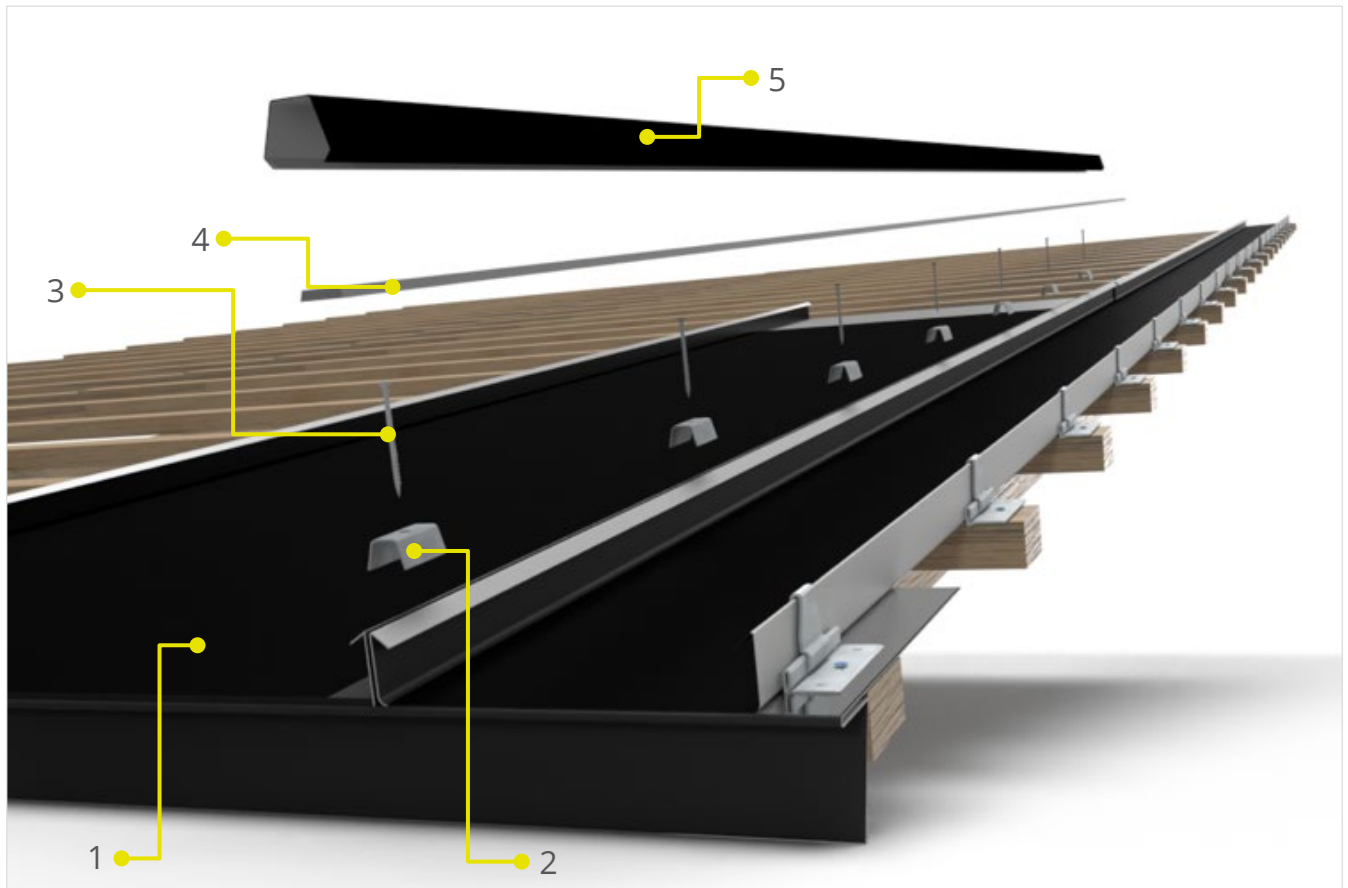
Edge panel is installed a minimum of 30 mm from the batten edge by sliding the end-bent side under the eaves flashing. Note that fastening clips are to be mounted in each batten with a minimum of 1 screw per clip.

When the second edge panel is installed, ensure a minimum of 150 mm overlap. Cut the seam of the first edge panel in the overlapping area using a metal cutter. Add silicone sealant in the overlapping area and press the second edge panel over the first one.

Metal worker completes the connection between the edge panel and gable board / other type of steel-plate installation.

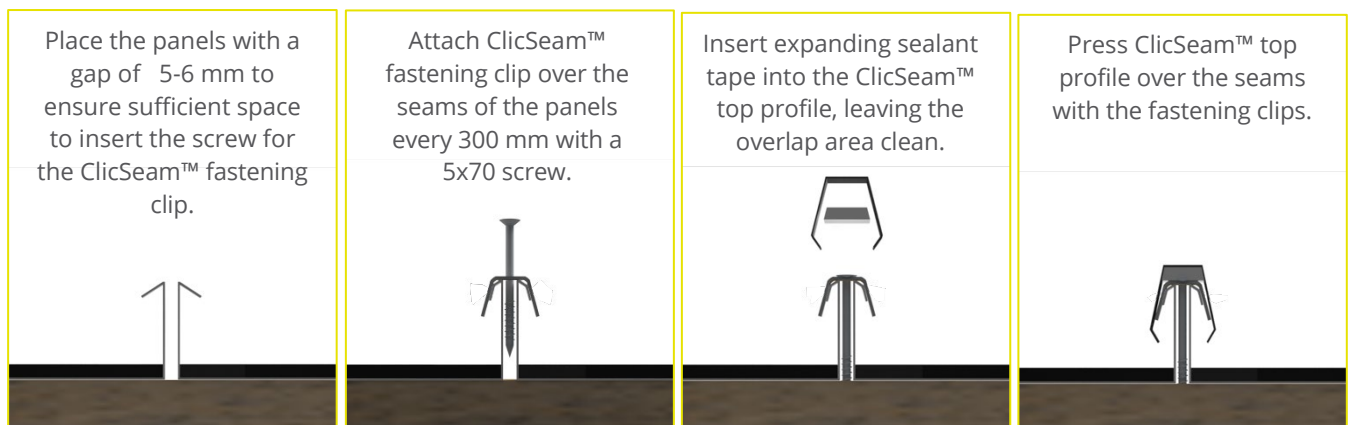
Basic installation of ClicSeam™ PV-panel and/or regular metal

The first panel row is aligned with the eave's edge, with a minimum of 150 mm overlap over the eaves flashing.



ClicSeam™ panel connection

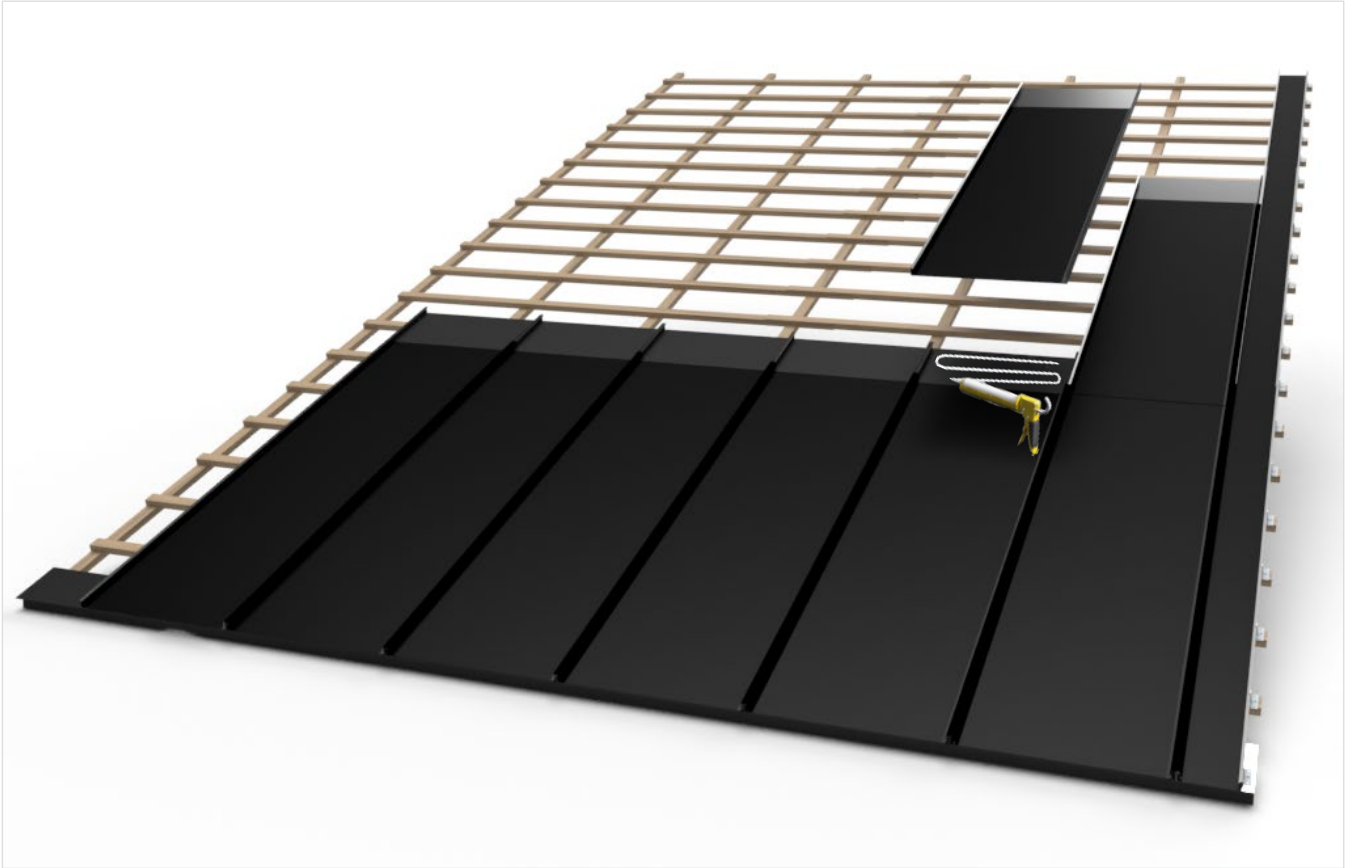
1. ClicSeam™ PV-panel
2. ClicSeam™ fastening clip
3. Screw for fastening clip
4. Expanding sealant tape 15 / 1-4
5. ClicSeam™ top profile, minimum 100 mm overlap



Step-by-step view of panel connection

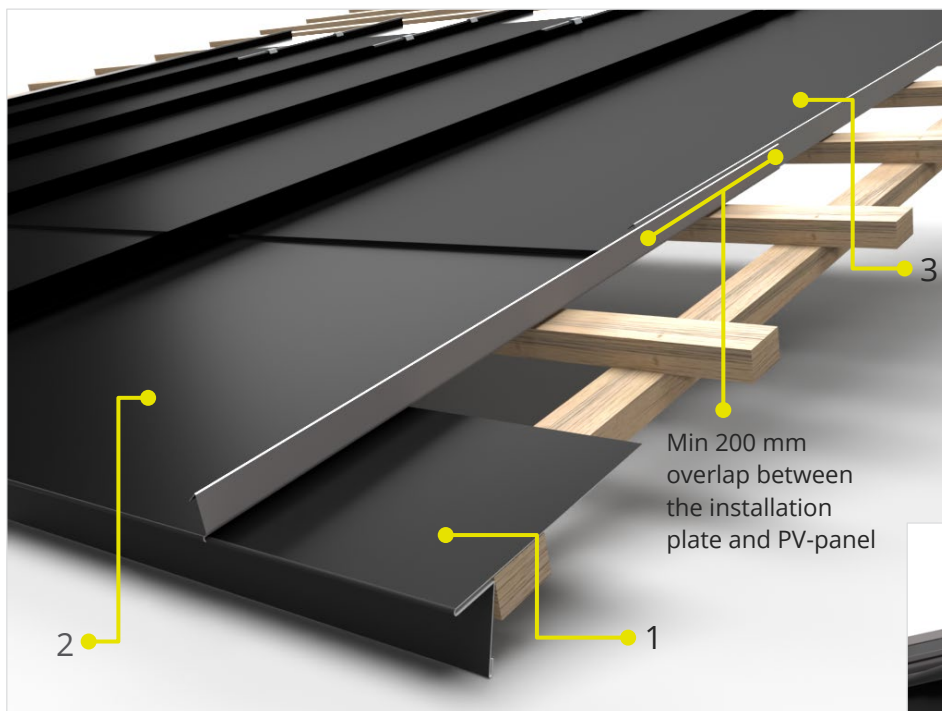
It is recommended to install ClicSeam™ panels in rows, starting with the edge panel. Apply silicone sealant in the overlapping areas. The next module is placed according to the system plan with a minimum overlap of 200 mm.

When applying expanding sealant tape inside the top profile, make sure to leave the overlapping area free to ensure a complete connection between the overlapping top profiles.



ClicSeam™ panel connection using installation plate

Installation plate is needed when according to the roof plan the column should start from regular metal



1. ClicSeam™ Eaves flashing
2. ClicSeam™ Installation plate 700 mm, end-bent
3. ClicSeam™ PV-panel

Cross-section showing Installation plate and PV-panel with Edge panel removed

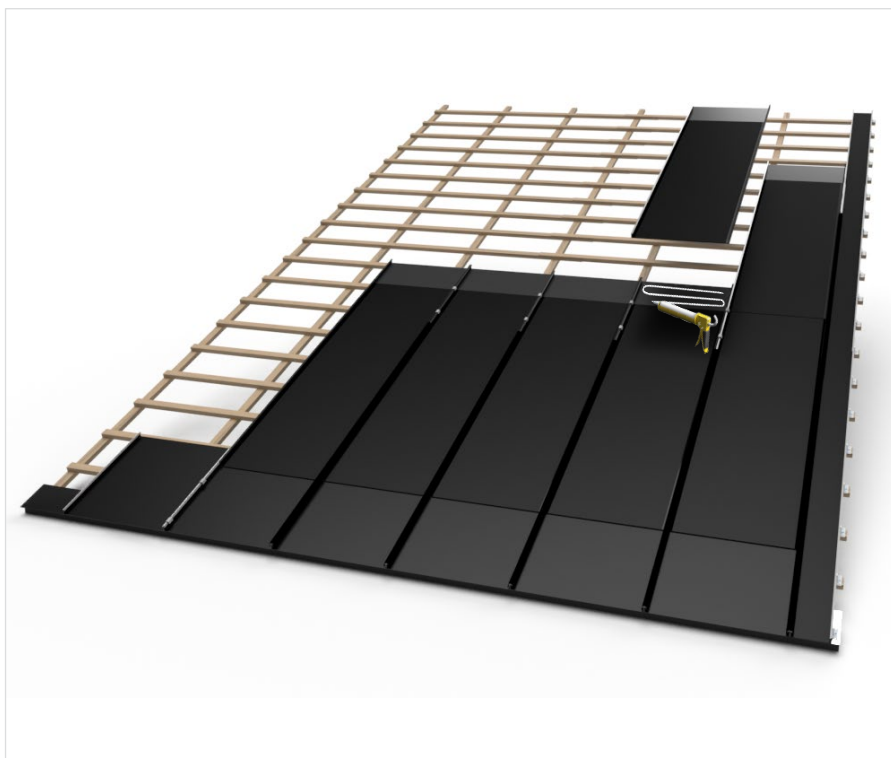


ClicSeam™ installation plates are installed in rows according to the system plan, starting with the edge panel.

Note that fastening clips are to be mounted in each batten and that screws and ClicSeam™ top profile have to be installed according to ClicSeam™ panel connection.

The installation plates are installed by sliding the end-bent side under the eaves flashing.

The connection between the installation plate and eaves flashing does not require silicone sealant.



» Maintenance

Regular inspection and maintenance of the Products is necessary, especially within the Warranty Period. It is the user's responsibility to report any damages to the supplier within 4 weeks after the Product delivery.

Cleaning

Dust accumulation on the glass may reduce power output and even cause regional hot-spot effects. Industrial emissions or bird droppings may also affect, and the degree of severity depends on the transparency of the foreign objects. Usually, the accumulated dust does not reduce the transparency much, as light intensity is still homogeneous and the reduction in power output is typically not visible.

Negative environmental effects, such as foreign objects casting shadows or laying directly on the roof, may adversely affect the power output of the Product. **Roofit.solar** advises that the PV part of the system should not be obstructed at any time. The Product cleaning frequency depends on the environmental factors. In many cases the glass is sufficiently cleaned by naturally occurring rain and the necessity to explicitly clean it is reduced.

When cleaning the Product, it is recommended to wipe the glass surface with a damp sponge or soft cloth – without touching any electrical connections. Do not clean the glass with an acidic or alkaline cleaning agent.

Visual inspection

Inspect the Products visually to detect any possible defects such as glass breakage.

It is recommended to implement the following preventive maintenance every 12 months (if accessible):

Check if the connectors are intact and encapsulated (i.e., the cables are not exposed).

Check the sealing gel of the junction box to locate any possible cracks or crevices.

Decommissioning and Disposal

Roofit.solar is strongly committed to protecting the environment. The Products are durable for decades and built of non-hazardous materials. When the Products have reached the end of their life cycle, they should be disposed in accordance with local recycling regulations.

» Customer Support

Technical support shall be provided to the owner of the **Roofit.solar** system by the Buyer

For more information, please visit **Roofit.solar** website www.roofitsolar.com.

» Appendix 1

Electrical, Mechanical and Thermal Characteristics

**Standard Test Conditions (irradiance 1000 W/m²,
cell temperature 25 °C, spectrum AM1.5)**

| Acronym | Unit | 3x8/110W/ RR33/B/DS | 3x10/135W/ RR33/B/DS | 3x12/160W/ RR33/B/DS |
|-----------------------|---------------|------------------------|-------------------------|-------------------------|
| Nominal Power | P_{max} (W) | 110 | 135 | 160 |
| Power Tolerance | 0...+5 W | | | |
| MPP Voltage | V_{max} (V) | 12.8 | 15.8 | 19.0 |
| MPP Current | I_{max} (A) | 8.57 | 8.54 | 8.44 |
| Open Circuit Voltage | V_{oc} (V) | 15.9 | 19.9 | 23.9 |
| Short Circuit Current | I_{sc} (A) | 9.11 | 9.04 | 9.00 |

**Normal Operating Conditions (irradiance 800 W/m²,
cell temperature 20 °C, spectrum AM1.5)**

| | | | | |
|-----------------------|---------------|------|------|-------|
| Nominal Power | P_{max} (W) | 80.8 | 99.2 | 116.8 |
| MPP Voltage | V_{mpp} (V) | 11.9 | 14.7 | 17.41 |
| MPP Current | I_{max} (A) | 6.78 | 6.75 | 6.71 |
| Open Circuit Voltage | V_{oc} (V) | 14.7 | 18.4 | 21.87 |
| Short Circuit Current | I_{sc} (A) | 7.24 | 7.19 | 7.20 |

Current and voltage tolerances $\pm 3\%$

Mechanical Characteristics

| | |
|---|-----------|
| Design load front (Pa) and safety factor for mechanical load ym | 1600; 1.5 |
| Design load back (Pa) and safety factor for mechanical load ym | 1600; 1.5 |
| Material Group (MG) 1,2 according to IEC 60664-1 | 3 |
| Pollution Degree (PD) according to IEC 60664-1 | 2 |

Thermal Characteristics

| | | |
|--------------------------------------|----------|-------------|
| Normal Operating Cell Temperature | NOCT | 42.1± 4.0°C |
| Temperature Coefficient of P_{mpp} | γ | -0.363 %/K |
| Temperature Coefficient of V_{oc} | β | -0.276 %/K |
| Temperature Coefficient of I_{sc} | α | 0.043 %/K |