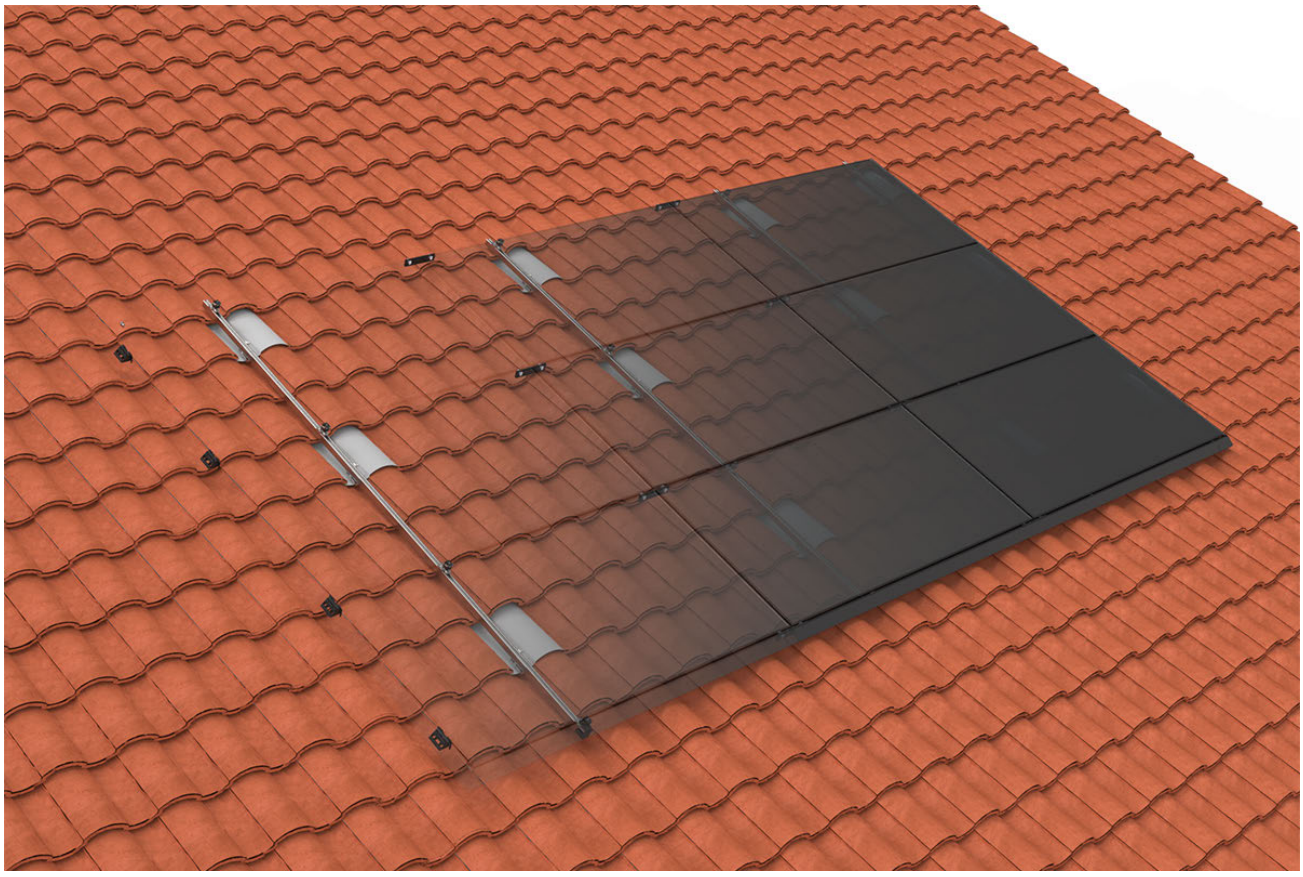
TESLA PANEL MOUNT – TILE

INSTALLATION MANUAL



April 30, 2026

NOTICES

- Initial publication.

This manual contains safety, installation, configuration, and troubleshooting instructions for Tesla Solar products. Tesla recommends that you save this manual in a readily accessible location should any questions arise.

Tesla Panel Mount - Tile Mounting System is UL 2703 Listed for Bonding.

Tesla Panel Mount - Tile Mounting System has an UL 2703 Class "A" Fire Rating when installed on steep slope roofs using modules from any manufacturer certified as "Type 1" or "Type 2" to UL 61730.

Tesla Panel Mount - Tile Mounting System is to be mounted over a fire-resistant roof covering rated for the application.

This system should be periodically re-inspected by qualified service technicians. In the event any components or fasteners are found to be loose, they should be re-tightened to the manufacturer's specifications. Any components showing signs of corrosion that compromise safety or function shall be replaced immediately.

Tesla Panel Mount - Tile Mounting System may only be used to bond and mount compatible modules.

All Tesla Panel Mount - Tile compatible modules comply with IEC/UL 61730 and have been evaluated for grounding and mounting in compliance with the included instructions.

Tesla Panel Mount - Tile components are only suitable for PV modules with a series fuse rating of 25 Amps or less.

To communicate feedback about this document, please reach out to your Tesla Representative.

IMPORTANT SAFETY INSTRUCTIONS

WARNING: Read and understand all instructions before you install, wire, operate, or maintain a PV system. Failure to read and comply with any of the limitations noted herein can result in property damage, serious bodily injury, or death. The installer assumes the risk of all injury that might occur during installation, including, without limitation, the risk of electric shock.

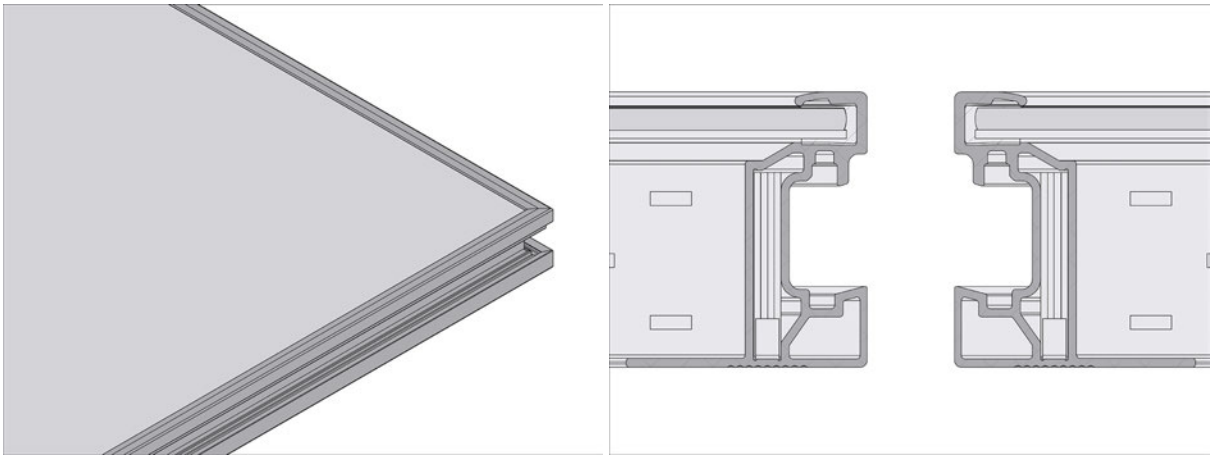
- Always use qualified personnel for installation.
- Always follow PV module manufacturer safety precautions, installation instructions, and operating guidelines.
- Always abide by local, regional, and national statutory regulations when installing the system, and obtain a building permit when required.
- Always use equipment, connectors, and wiring suitable for solar electric systems.
- Always use fall protection when working from heights of 6 feet (183 cm) or above. Follow Occupational Safety and Health Act (OSHA) or local governing safety regulations regarding fall protection.
- Always use insulated tools that are approved for working on electrical installations.
- Always wear suitable personal protective equipment (PPE) to prevent the risk of personal injury, such as fall hazards or electrical hazards.
- Always exercise caution when transporting and installing PV modules.
- Do not walk on the PV modules.
- Always wear non-slip gloves when carrying PV modules.
- DO NOT wear metallic rings, watchbands, earrings, facial jewelry or piercings, or other metallic objects while installing or troubleshooting PV systems.
- DO NOT contact or touch electrically-charged, accessible live parts of PV modules, such as terminals.
- DO NOT touch the PV module unnecessarily during installation.
- DO NOT attempt to make an electrical connection with wet, soiled, or otherwise faulty connectors.
- DO NOT use a PV module with broken glass or torn backsheet.
- DO NOT open electrical connections or unplug connectors while the circuit is under load.
- DO NOT allow children or unauthorized persons near the installation.

INTRODUCTION TO TESLA PANEL MOUNT - TILE MOUNTING SYSTEM

The Tesla Panel Mount - Tile system is designed for use with PV modules manufactured with Tesla's proprietary frame groove. The PV module frames are mechanically connected by Interlocks, creating continuous beams for a simultaneous structural and electrical bond. The system is installed with simple tools and requires no additional electrical bonding steps, enabling fast and easy installation.

Tesla Solar Compatible

Tesla Solar mounting solutions are based on the Tesla Groove, a patented module frame profile designed to mate easily and precisely with Tesla Solar components, creating a simultaneous structural and electrical bond with a simple drop-in motion.



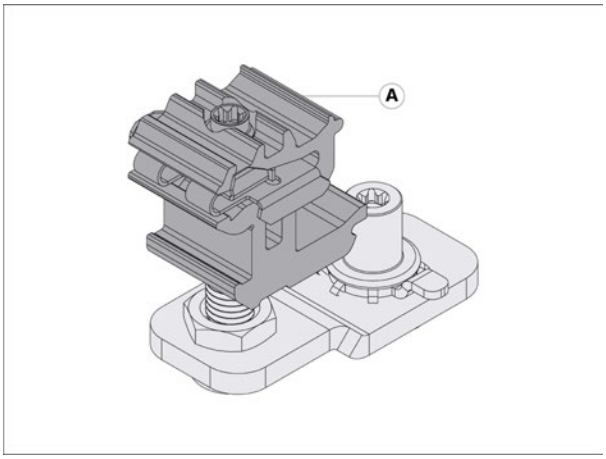
- *PV module frame with Tesla Groove*

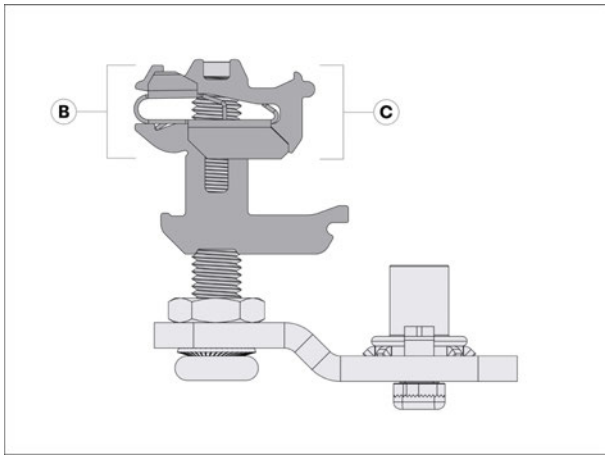
INTRODUCTION TO TESLA PANEL MOUNT - TILE MOUNTING SYSTEM

The Key and Tongue Concept

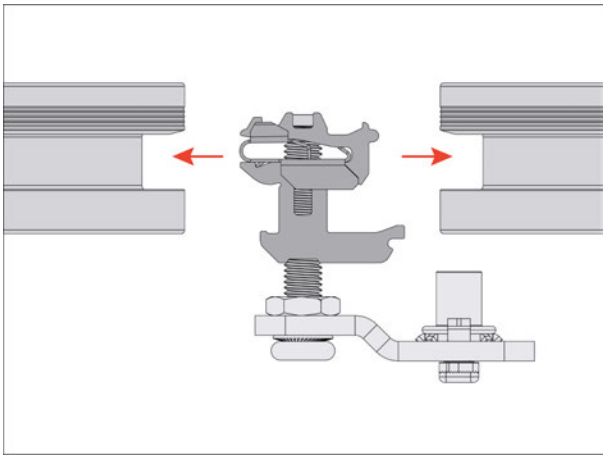
The Key and Tongue concept informs all Tesla Solar Compatible designs. The Key side inserts into the Tesla Groove, similar to inserting a key into a lock. On the other side, the Tesla Groove allows PV modules to drop in easily onto the Tongue. This Key and Tongue system creates automatic structural connection and electrical bonding as the modules are dropped in to the components below.

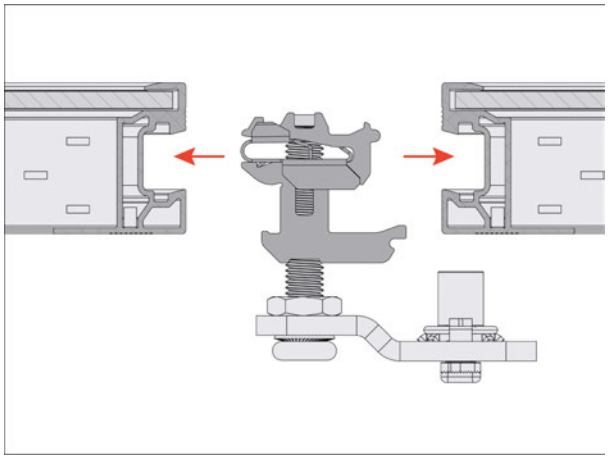
For example, the Rockit is a component in the Leveling Foot that is used to connect PV modules together and to the mounts attached to the roof. The Rockit fits into the Tesla Groove on both sides: The Key side inserts, while the Tongue side receives.



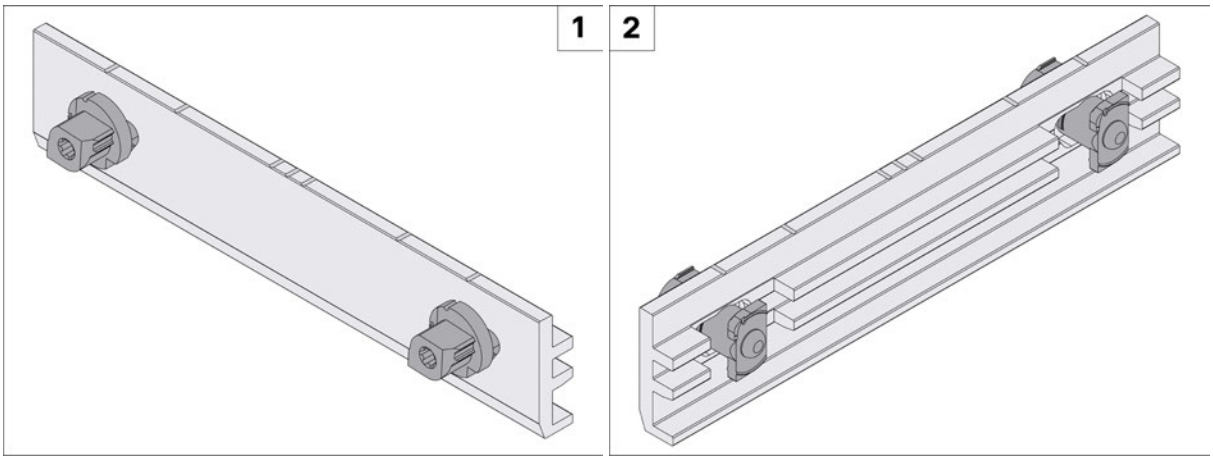


- *A - Rockit*
- *B - Key side*
- *C - Tongue side*

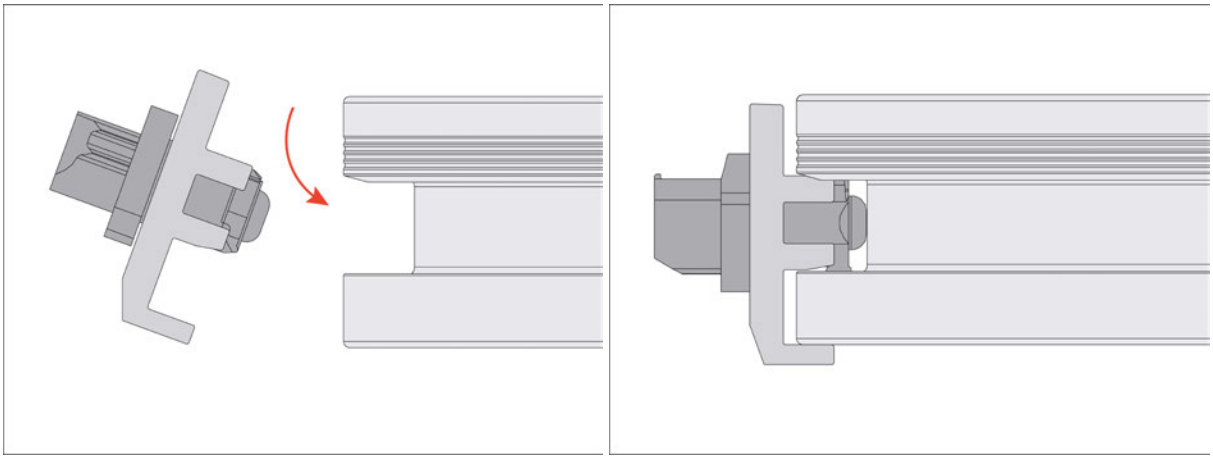




The Key and Tongue design is also used with the Interlock, a component that mechanically connects and bonds two modules together. Here, the Key and Tongue are differently shaped, but they fit into the Tesla Groove in a similar manner to the Rockit.



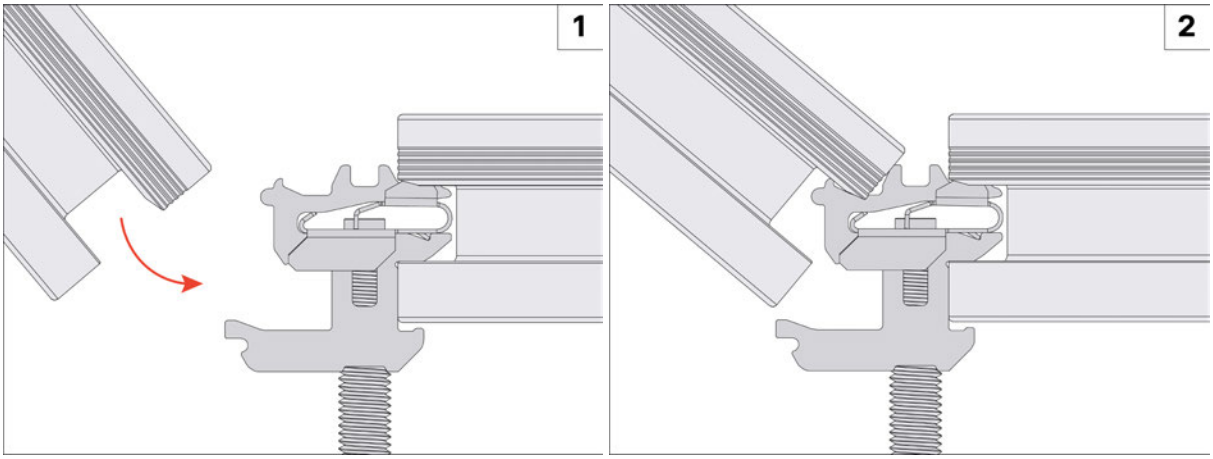
- *(1) - Interlock front is the Tongue side*
- *(2) - Interlock back is the Key side*



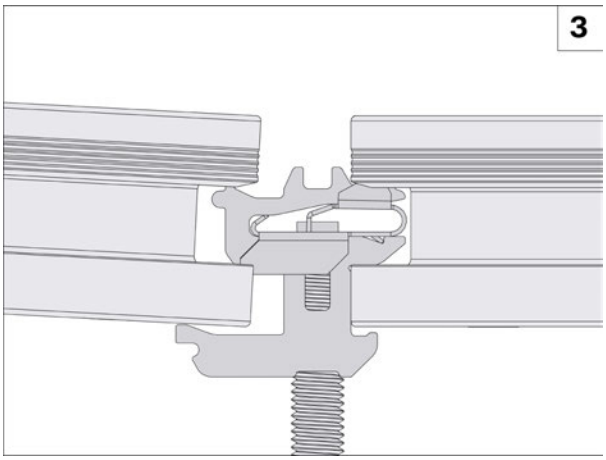
- *Interlock inserting into the Tesla Groove*

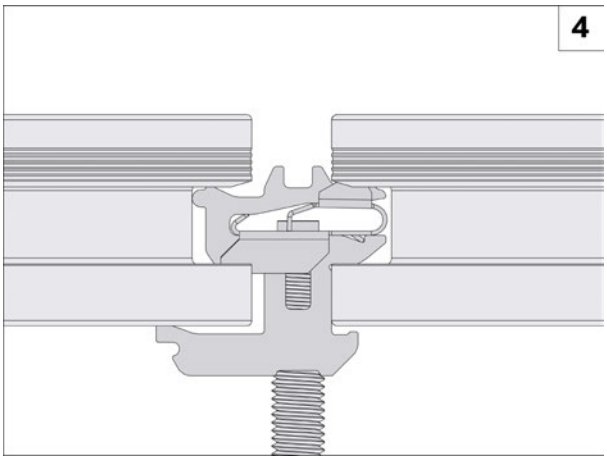
Module Drop-In

Tesla Solar Compatible modules are dropped in to the Rockit with a downward motion as shown (1). The module's downward motion creates forced interference with the Tesla Groove of the module frame (2), cutting through the frame coating (3) to create an electrical bond and structural connection (4).



INTRODUCTION TO TESLA PANEL MOUNT - TILE MOUNTING SYSTEM

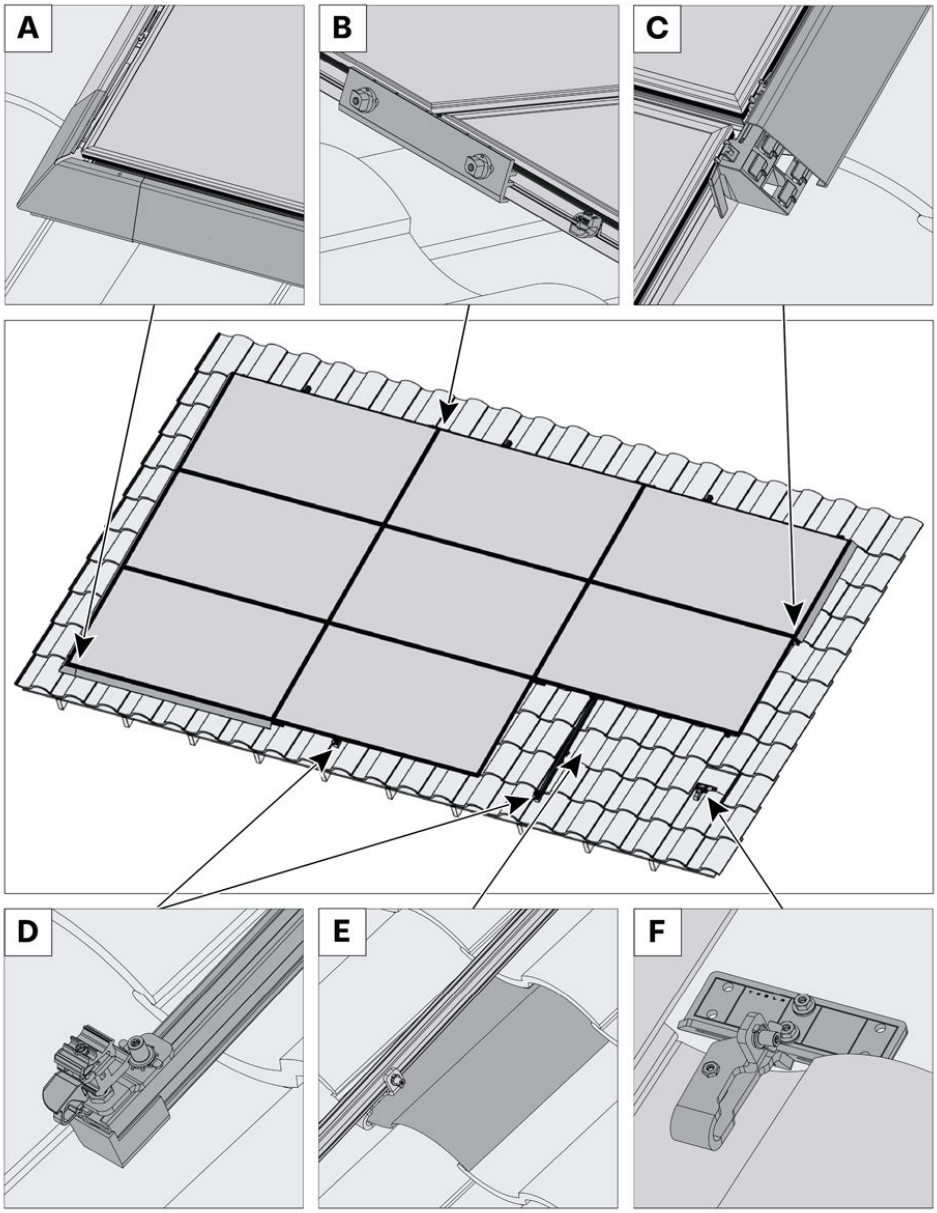




TESLA PANEL MOUNT - TILE SYSTEM COMPONENTS

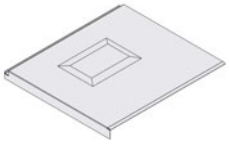
- Updated Spanner Bar part numbers.

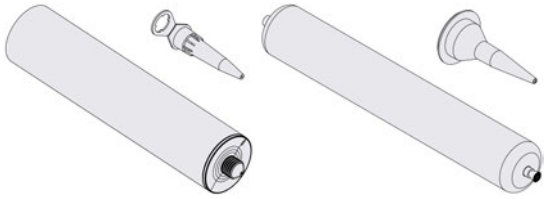
System Components



- (A) - Corner Cap and Front Skirt
- (B) - Interlock and Ground Lockit
- (C) - Side Skirt and Side Skirt Bracket
- (D) - Spanner Bar, Spanner Bar Cap, Front Skirt Grip, and Leveling Foot
- (E) - Replacement Flashing
- (F) - Tile Hook and Lag Screws

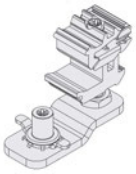
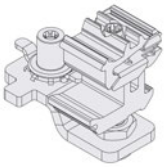
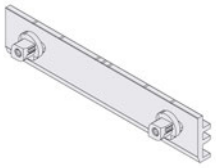
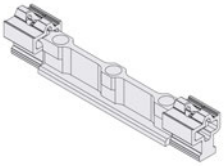
Mounting Components

Part	Description	Part Number
Tile Hook 	Provides a roof mounting attachment point for the array. Listed to UL 2703	2262305-00-X
Securing Bolt 	Secures the Replacement Flashing in place.	2127987-00-X
Lag Screw 	Attaches the Tile Hook to the roof rafter.	2131805-00-X (4 in.) 2044245-00-X (4 ¾ in.)[1] [1]Verify that the correct length lag is being used to achieve 2 ½ in. threaded embedment.
S-Tile Replacement Flashing 	Matches the shape of removed tiles and covers attachment points to preserve water shed.	1615280-00-X
W-Tile Replacement Flashing 	Matches the shape of removed tiles and covers attachment points to preserve water shed.	1615279-00-X
Flat Tile Replacement Flashing 	Matches the shape of removed tiles and covers attachment points to preserve water shed.	1615277-00-X

Part	Description	Part Number
Sealant Cartridge with Nozzle or Sealant Sausage Pack with Nozzle 	Tonsan MS-1937 Sealant Cartridge, 10.5 oz or Tonsan MS-1937 Sealant Sausage Pack, 600 ml Seals roof penetrations for waterproofing.	1679265-00-X or 1576600-00-X

Fasteners shall be clean and free of damage or signs of corrosion during installation.

Structural and Bonding Components

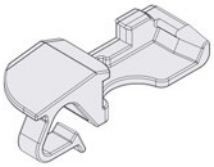
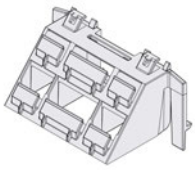
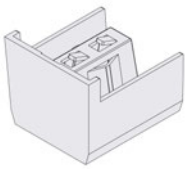
Part	Description	Part Number
Leveling Foot (Round Tile) 	Secures PV modules to the Spanner Bar, bonds connected modules, and enables array leveling. Used for S- and W- Tile roofs. Listed to UL 2703	2133094-00-X
Leveling Foot (Flat Tile) 	Secures PV modules to the Spanner Bar, bonds connected modules, and enables array leveling. Used for Flat Tile roofs. Listed to UL 2703	2177129-00-X
Spanner Bar 	Provides an attachment point between the Leveling Foot and Tile Hook.	Refer to **Spanner Bar Lengths** table below.
Spanner Splice 	Provides connection between adjacent Spanner Bar lengths.	2129977-00-X
Interlock 	Provides structural and electrical bonding between PV modules within each subarray. Listed to UL 2703	1576999-00-X
Hybrid Interlock 	Combines the functions of an Interlock and Leveling Foot for attachment points where space is restricted. Only to be used with Round Tile Leveling Feet.	1578969-00-X
Ground Lockit	Provides a single point for grounding a PV array.	1578119-00-X

Part	Description	Part Number
	Listed to UL 467 and UL 2703	

Spanner Bar Lengths

Model	Dimensions	Part Number
Spanner Bar for Tesla Solar Panel	1267 mm (49.9 inch), 1x	2129978-10-X
	2420 mm (95.3 inch), 2x	2129978-11-X
	3573 mm (139.3 inch), 3x	2129978-12-X
Spanner Bar for QCells	1178 mm (46.4 inch), 1x	2129978-07-X
	2242 mm (88.5 inch) 2x	2129978-08-X
	3306 mm (130.2 inch), 3x	2129978-09-X

Array Skirt Components

Part	Description	Part Number
Front Skirt 	Serves as a structural and aesthetic feature for the array and helps establish a straight line to build from. Listed to UL 2703	Refer to **Front Skirt Sections** table below.
Side Skirt 	Covers the edges of the array to create a clean aesthetic.	Refer to **Side Skirt Sections** table below.
Front Skirt Grip 	Provides structural support to the Front Skirt, connecting it to the Leveling Foot. Listed to UL 2703	2088697-00-X
Corner Cap 	Conceals hardware and creates a clean aesthetic on the corners of the array.	2049667-00-X (Inside) 2049666-00-X (Outside)
Side Skirt Bracket 	Provides an attachment point for the Side Skirt, connecting it to the Tesla Groove.	2022523-00-X
Spanner Bar Cap 	Conceals the down-roof end of the Spanner Bar.	2167701-00-X

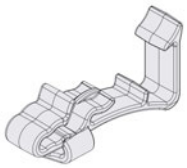
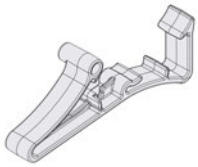
Front Skirt Sections

Model	Dimensions	Part Number
Front Skirt for Tesla Solar Panel	1818 mm (71.6 inch), landscape, 1x	2047098-23-X
	2296 mm (90.4 inch), portrait, 2x	2047098-24-X
Front Skirt for QCells	1903 mm (74.9 inch), landscape, 1x	2047098-21-X
	2118 mm (83.4 inch), portrait, 2x	2047098-22-X

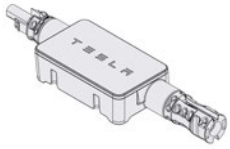
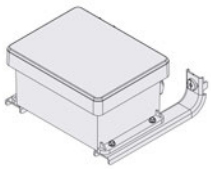
Side Skirt Sections

Model	Dimensions	Part Number
Side Skirt for Tesla Solar Panel	2296 mm (90.4 inch), landscape, 2x	1993354-05-X
	1148 mm (45.2 inch), landscape, 1x	1993354-06-X
	1818 mm (71.6 inch), portrait, 1x	1993354-07-X
Side Skirt for QCells	2118 mm (83.4 inch), landscape, 2x	1993354-01-X
	1059 mm (41.7 inch), landscape, 1x	1993354-02-X
	1903 mm (74.9 inch), portrait, 1x	1993354-04-X

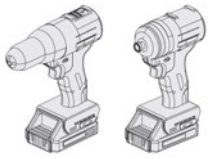
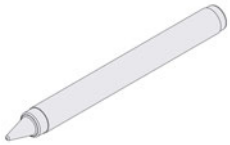
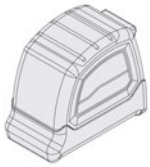
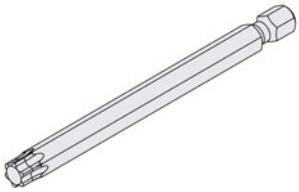
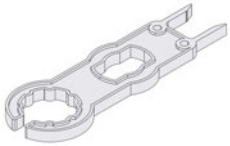
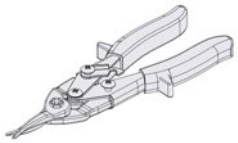
Wire Management Components

Part	Description	Part Number
DC Wire Clip 	Secures up to 3 conductors underneath a PV module by attaching to the Tesla Groove. Listed to UL 1565	1578249-00-X
Home Run Wire Clip 	Secures up to 6 conductors underneath a PV module by attaching to the Tesla Groove. Listed to UL 1565	1578389-00-X

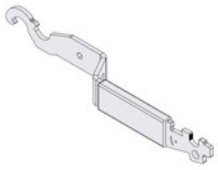
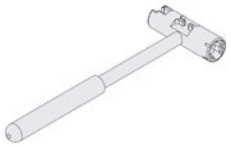
Electrical Accessories

Part	Description	Part Number
MCI-2 (Mid-Circuit Interrupter) 	Tesla's rapid shutdown solution, which is compatible with Tesla power electronics. Listed to UL 1741	1879359-00-X
Combiner Box 	Provides terminal blocks to make parallel connections and transition wire. Connects directly to the Tesla Groove. Listed to UL 1741	1571739-00-X
Conduit Support 	Conduit support for use with the Tesla Panel Mount - Tile system.	1577457-00-X

Required Tools

Drill and Impact Driver 	**3/16 in. or 7/32 in. Drill Bit** 	**Roof Crayon or Chalk** 
Tape Measure 	**String Line** 	**#40 Torx Bit Socket and Ratchet Wrench** 
#40 Torx Bit 	**Slotted Screwdriver** 	**MC4 Disconnect Tool** 
Tin Snips 	**Caulking Gun** 	**Hammer** 

Recommended Tools

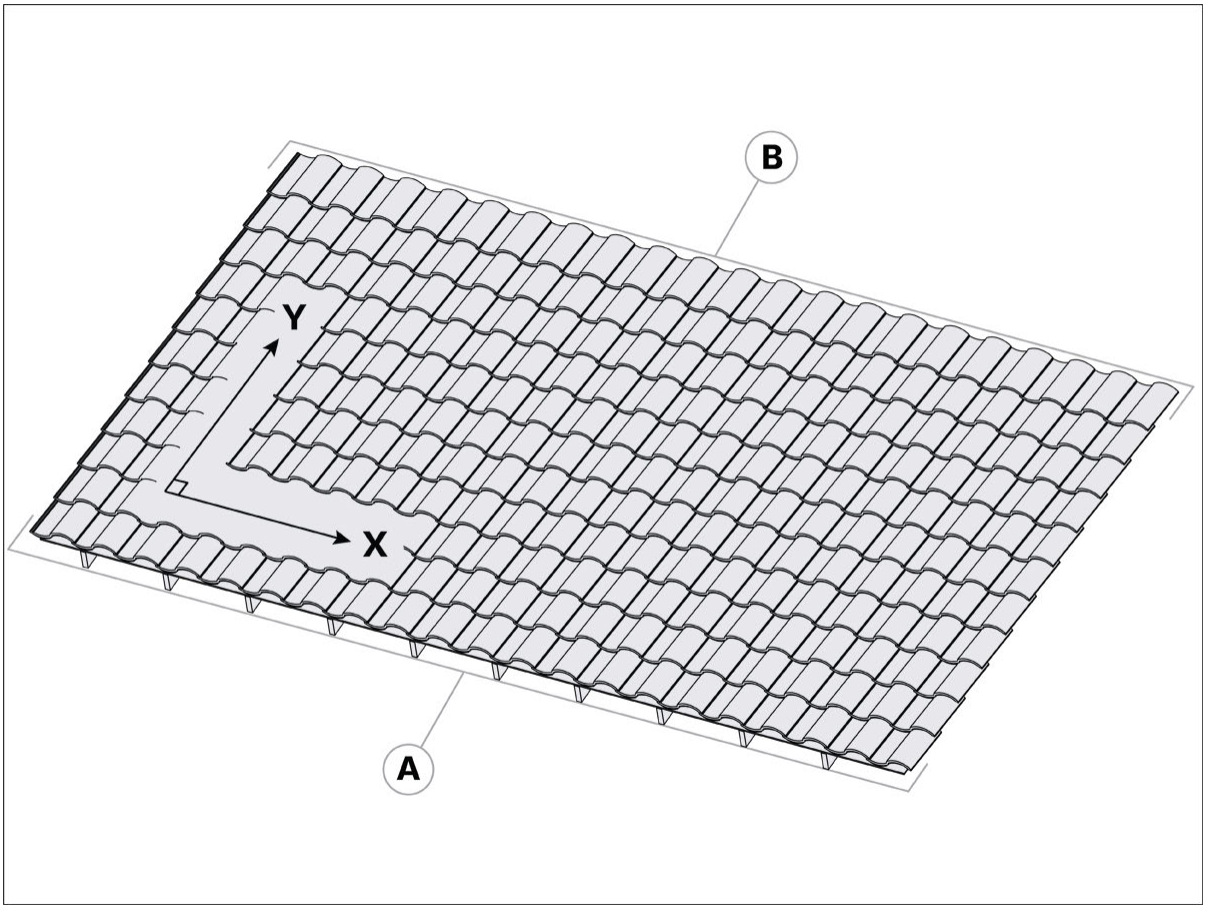
Part	Description	Part Number
Tesla Solar Wrench 	A multifunctional tool for Tesla Solar installation. Includes every feature needed for speedy installation, removal, and service of installed systems.	2066971-00-X
Tesla Installation Tool 	Provides the optimal ergonomics and speed for installing/adjusting Interlocks, Ground Lockits, and spacing modules.	1578989-00-X
Ladder Hoist 	Tesla's module lifting solution. Attaches to a standard extension ladder and is capable of lifting two modules, three skirt boxes, or multiple work bags. Can be set up and removed in less than 5 minutes.	2135588-00-X

DESIGN AND LAYOUT RULES

- Updated thermal expansion rules.

The rules and guidelines described in this section, together with the individual component ratings, are important factors in array design and must be considered when adjusting or customizing array layout. Installers must be aware of these rules when making field adjustments during installation.

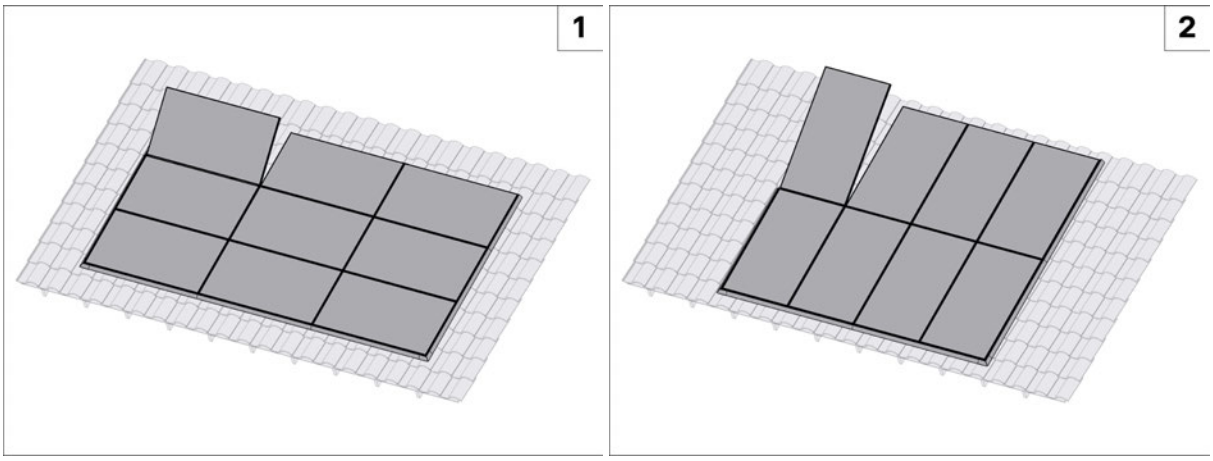
NOTE: This document refers to directions on the roof in relation to the X and Y direction. The Y direction is up- and down-roof, typically parallel to the rafters. The X direction is horizontal, typically called left and right relative to up-roof direction. These directions hold true regardless of the presence or lack of a ridge/eave.



- *(A) - Down-Roof*
- *(B) - Up-Roof*

Drop-In Direction

The PV module drop-in process is specific to Tesla Panel Mount designs. Roof attachments connect to the rafters which run in the Y direction. Modules are dropped in row by row going up-roof beginning at the Front Skirt, which is nearest to the eave. The Front Skirt must always be installed along the X-axis. Modules must never be installed at an angle relative to the rafters.



- *(1) - 3 x 3 array in landscape orientation*
- *(2) - 4 x 2 array in portrait orientation*

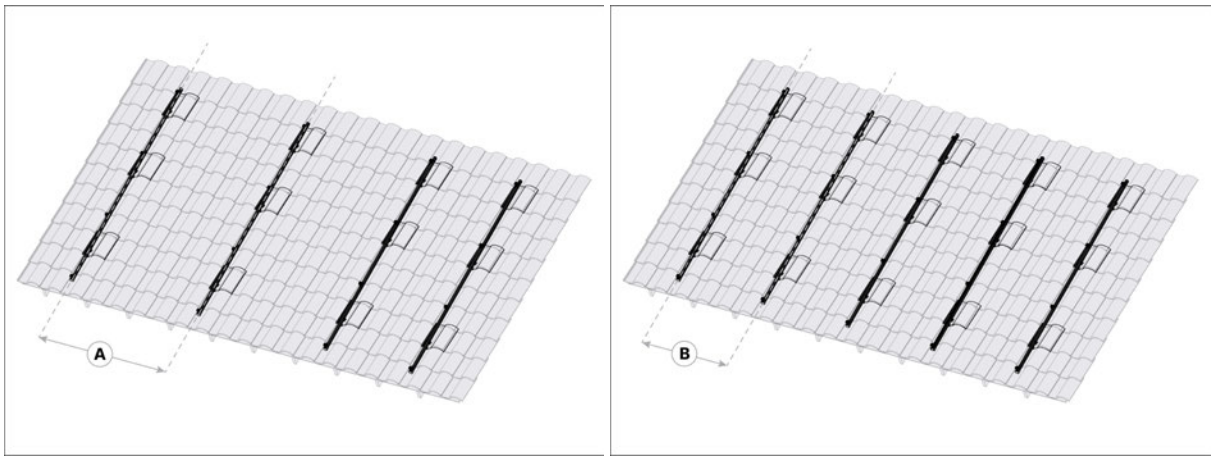
Minimum Pitch

The minimum roof pitch for installation of Tesla Panel Mount - Tile systems is 2:12, or 9.46°.

Span and Distance

Maximum Allowable X Span:

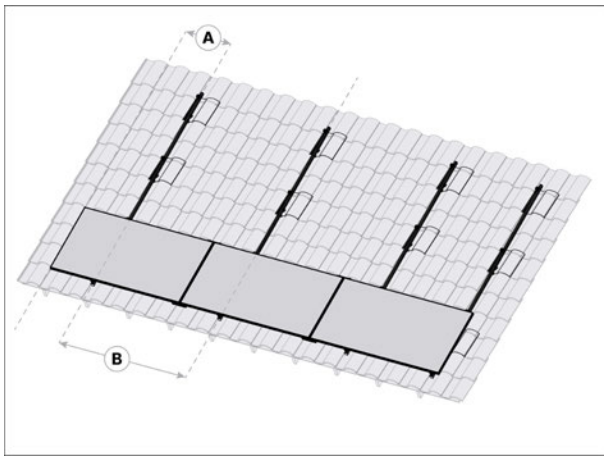
- The maximum allowable X span between the roof attachment points is determined by various site-specific and building inputs, which are calculated using the individual component ratings.

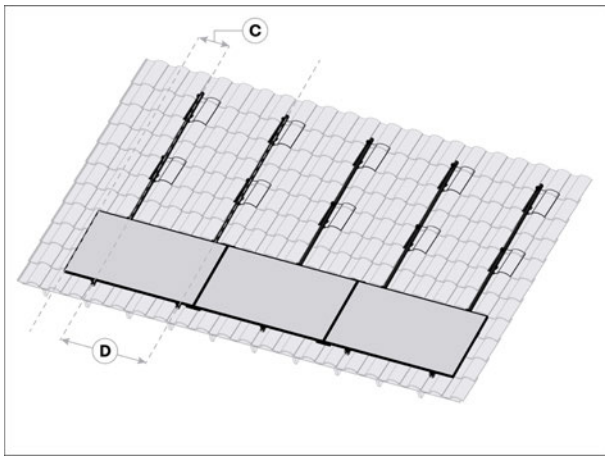


  - *(A) - 72 in. span*
  - *(B) - 48 in. span*

Maximum X Cantilever:

- The maximum module X cantilever distance varies with span and pressure, refer to *Appendix C: Allowable Mounting System Loading on page 119* for more information.

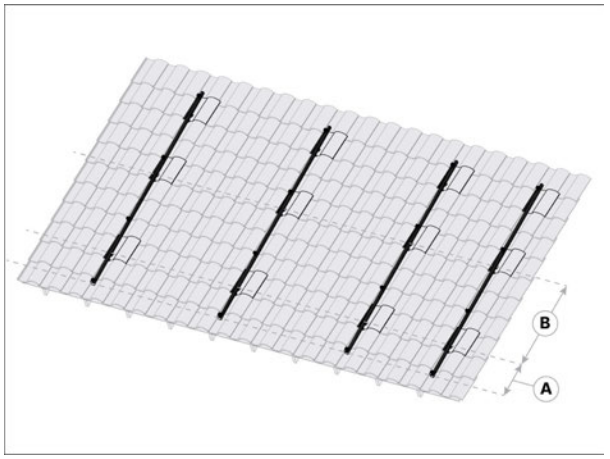


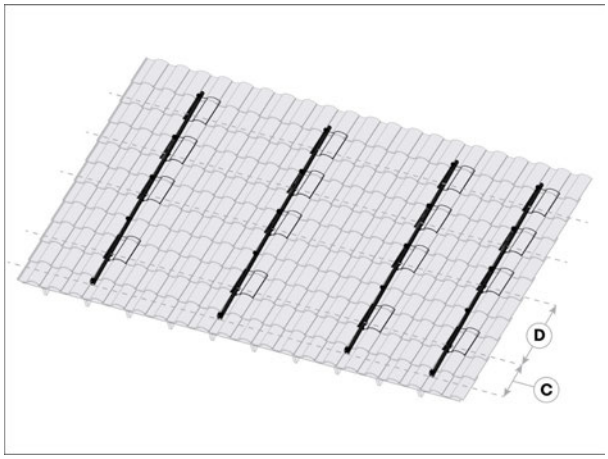


- *(A) - 24 in. max cantilever on (B) 72 in. span*
- *(C) - 16 in. max cantilever on (D) 48 in. span*

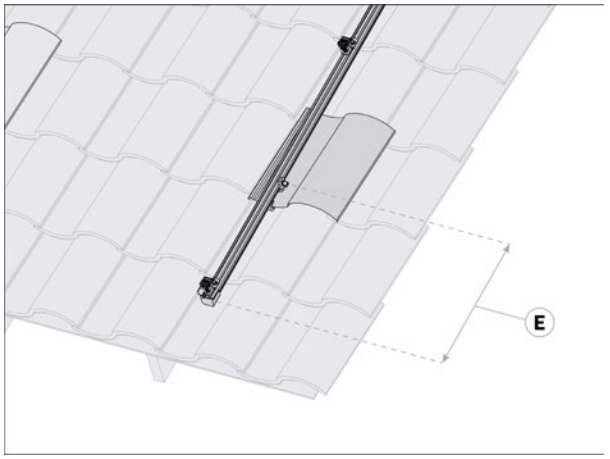
Maximum Y Cantilever:

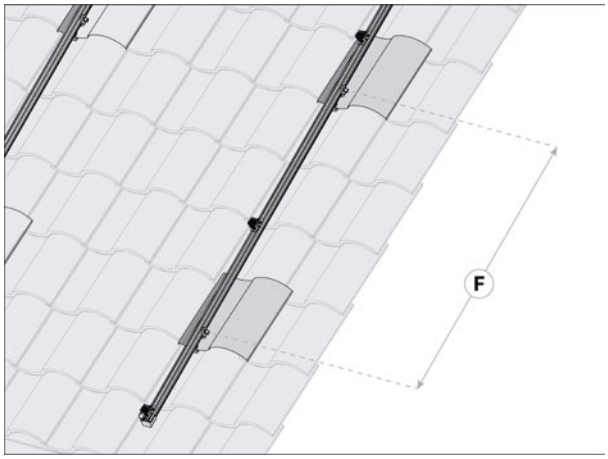
- The maximum module Y cantilever distance is always 1/2 of the maximum allowable Y span.





- *(A) - 26 in. max cantilever on (B) 52 in. span*
- *(C) - 20 in. max cantilever on (D) 39 in. span*

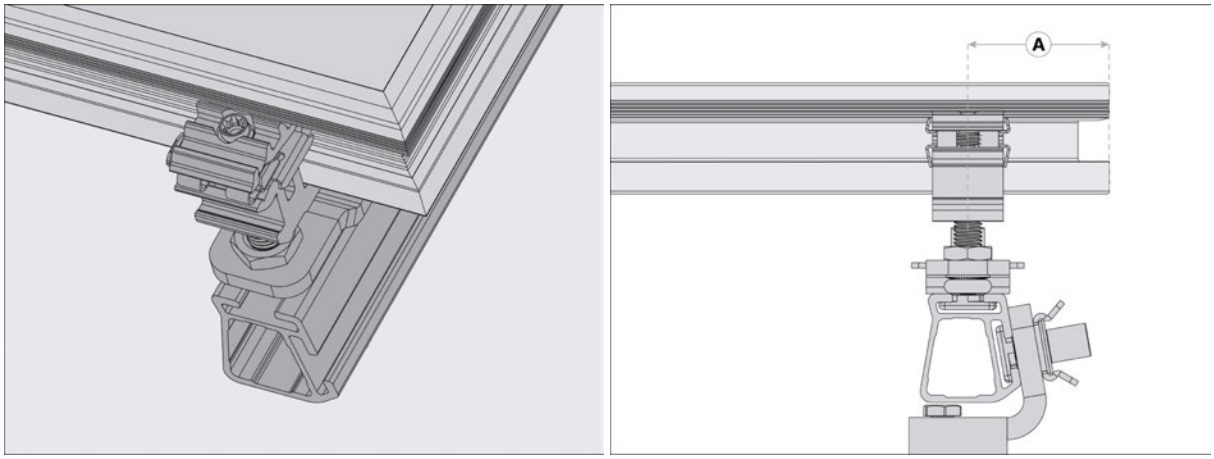




- *(E) - Y cantilever, measured from end of Spanner Bar to T-Bolt connection*
- *(F) - Y span, measured from T-Bolt to T-Bolt*

Module Corner Minimum Distance:

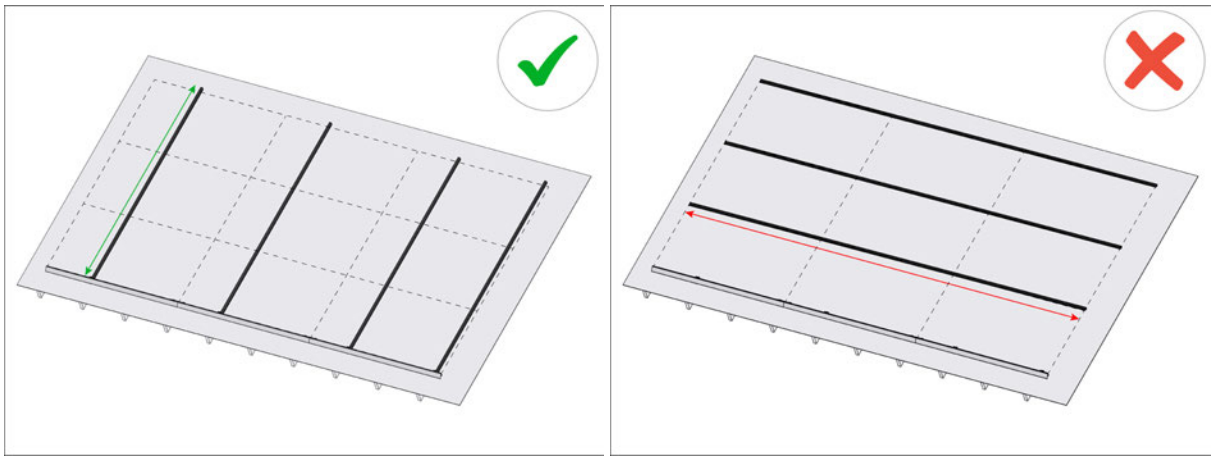
- Rockits and Ground Lockits must be installed a minimum distance of 2 in. (50 mm) from module corners, measured from the center of the Rockit or Ground Lockit. This minimum distance does not apply to Interlock Lockits. Other distances will be called out in the process of this document.



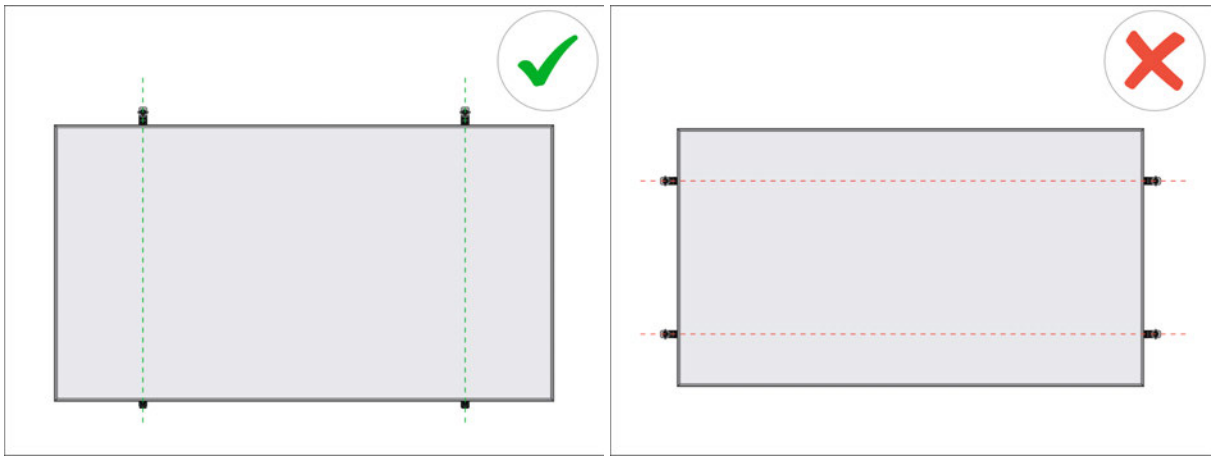
  - *(A) - 2 in. (50 mm) distance from module corner to center of Rockit*

Component Installation Direction

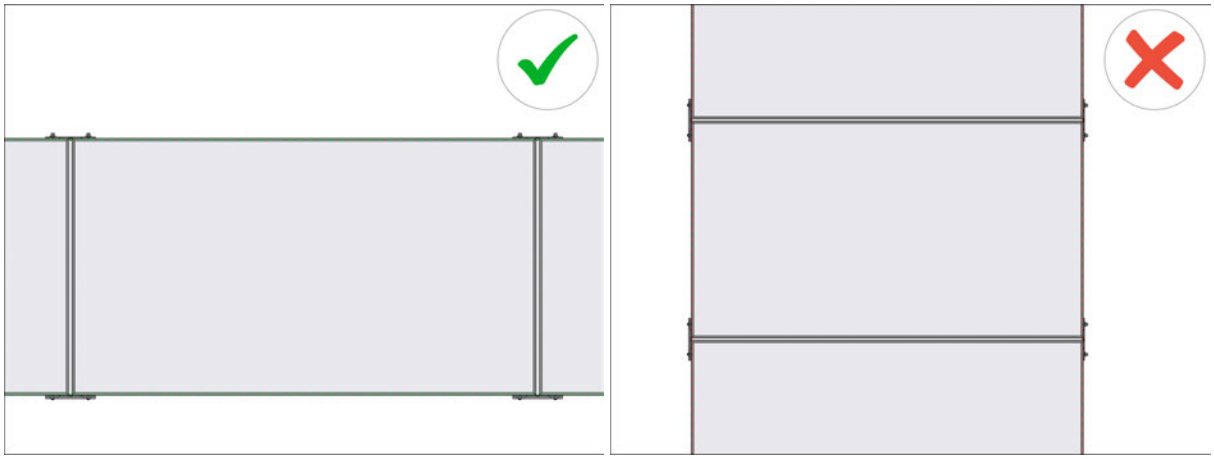
1. **Spanner Bars must be installed along the Y-axis:** Spanner Bars must be installed in the up-roof/down-roof direction, with Spanner Splices connecting adjacent ends.



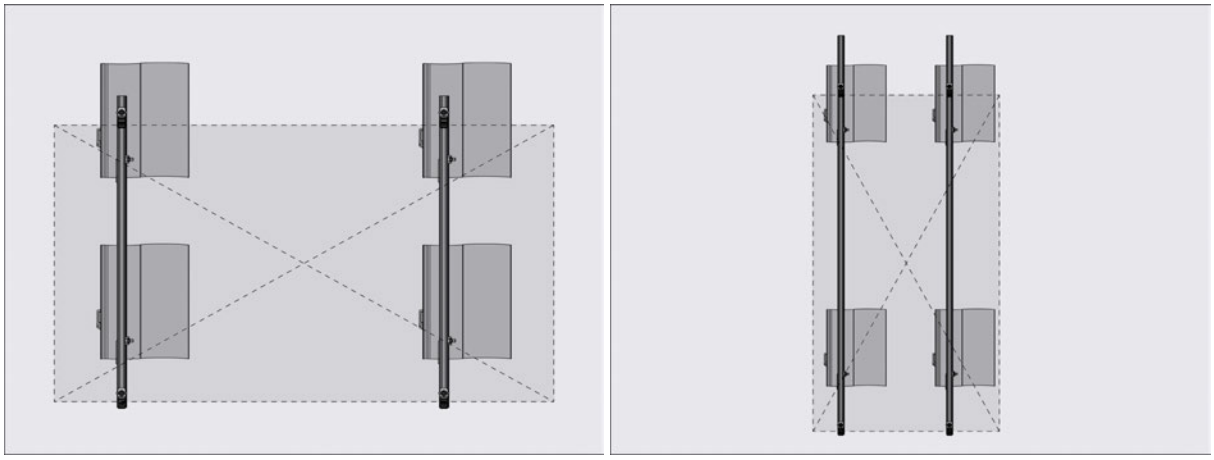
2. **Leveling Feet attach on opposing sides of the module:** Leveling Feet should always be installed on the up-roof and down-roof edges of the module, e.g. the long edges in landscape orientation, and the short edges in portrait orientation.



3. **Interlocks must be parallel with Front Skirt:** Interlocks should be attached along the upper edge of each module row, parallel with the Front Skirt and the X-axis.

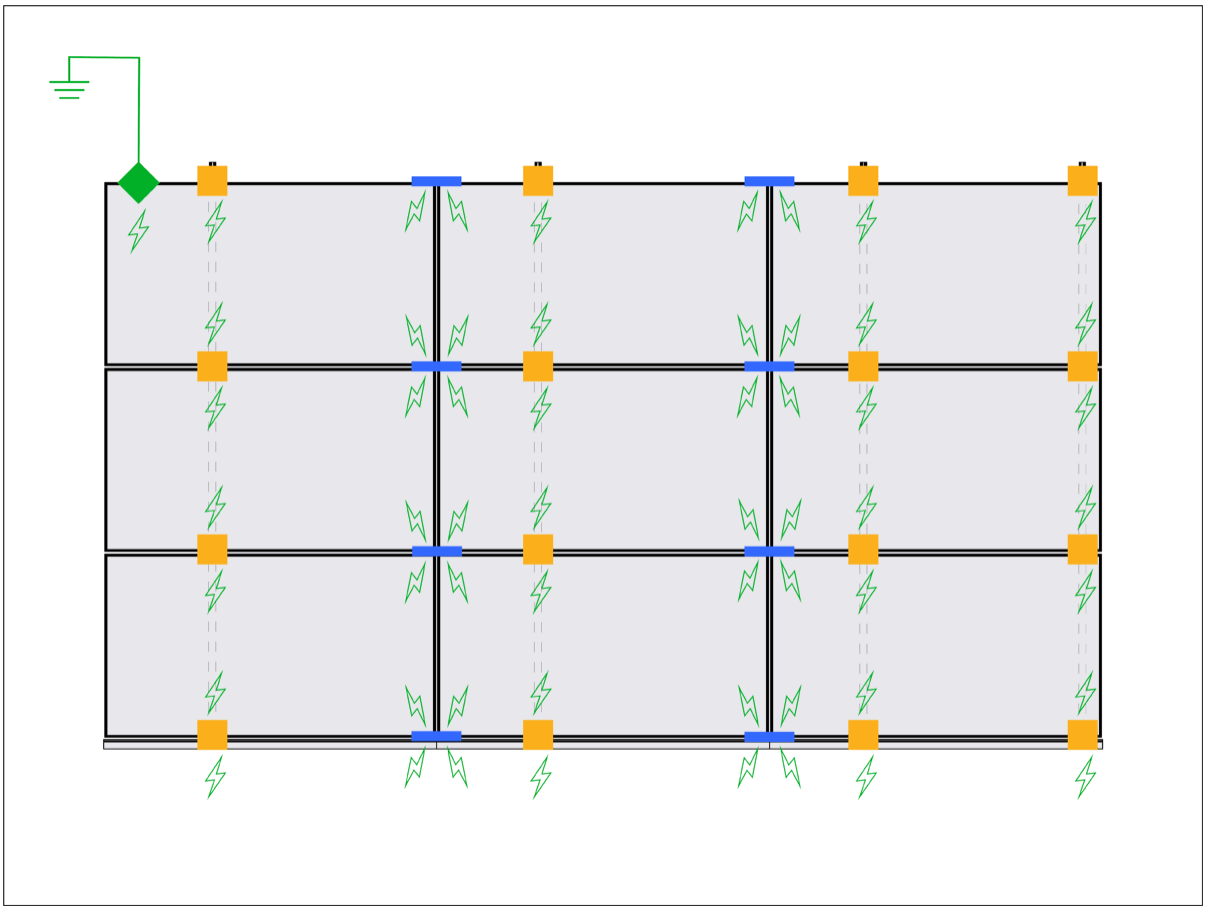


4. **Single Module Installation:** A standalone module requires two Leveling Feet on each side, for a total of four Leveling Feet. This remains true regardless of module orientation.



Grounding/Earthing

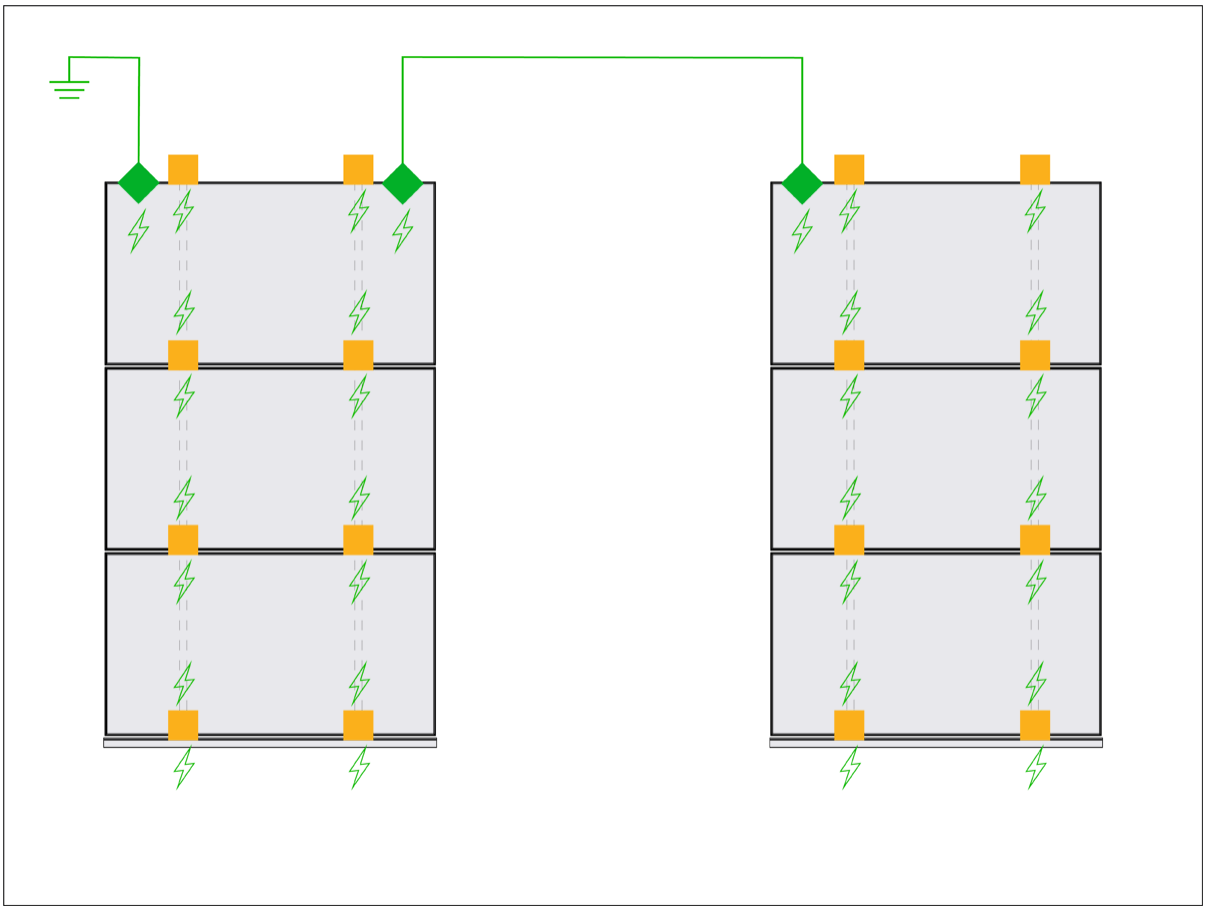
The Tesla Solar Compatible design concept allows the installer to build a redundantly-bonded array with a single ground bond connection. In this system, every module and Spanner Bar is structurally and electrically bonded to the surrounding modules on all sides. This eliminates the need for jumper wires between mounting rails or modules.



- *Bond path*
- *Ground Lockit*
- *Equipment grounding conductor (EGC)*
- *Interlock*
- *Earth ground*
- *Rockit*

Interlocks bond modules connected at all four corners; the two modules below, and the two modules above. Rockits bond modules directly above and below the Rockit. The Front Skirt is bonded in an identical way with both Interlocks and Rockits. For details on how this bonding occurs, refer to *Appendix A: Grounding and Bonding on page 107*.

Additional bond connections between modules will be required any time a physical gap exists. This includes sub-arrays on the same mounting plane and arrays on different parts of the roof. The Ground Lockit is used to bond the isolated array back to the array which is connected to the grounding electrode conductor (GEC).



- *Bond path*
- *Ground Lockit*
- *Equipment grounding conductor (EGC)*
- Interlock
- *Earth ground*
- *Rockit*

Ground Lockit Module Limit:

A single Ground Lockit can ground up to 72 Modules.

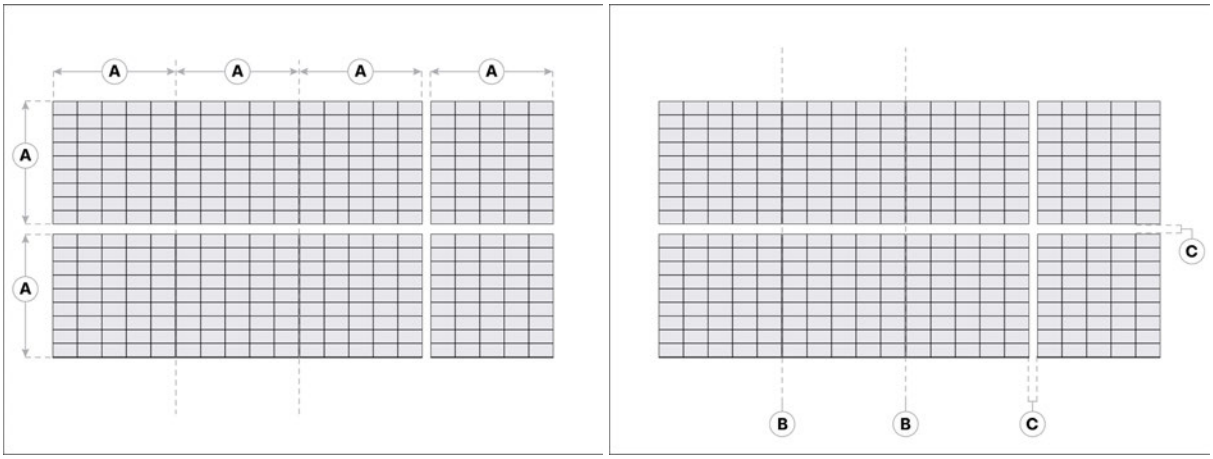
Thermal Expansion

There are two methods to address thermal expansion and contraction within very large arrays: thermal expansion joints and physical gaps between sub-arrays.

When Are Thermal Expansion Joints Needed?

Thermal expansion must be addressed when array sizes are larger than 33 ft (10 m) in either direction. For typical modules, this is every five module lengths or nine module widths.

- In the Y direction, a physical gap is required every 33 ft (10 m).
- In the X direction, Interlocks can be used to create thermal expansion joints every 33 ft (10 m). After 98 ft (30 m) a physical gap is required.



- *(A) - 33 ft (10 m) in X or Y direction*
- *(B) - Thermal expansion joints*
- *(C) - Physical gaps*

For more information on thermal expansion, refer to *Appendix B: Thermal Expansion on page 114*.

ARRAY DESIGN

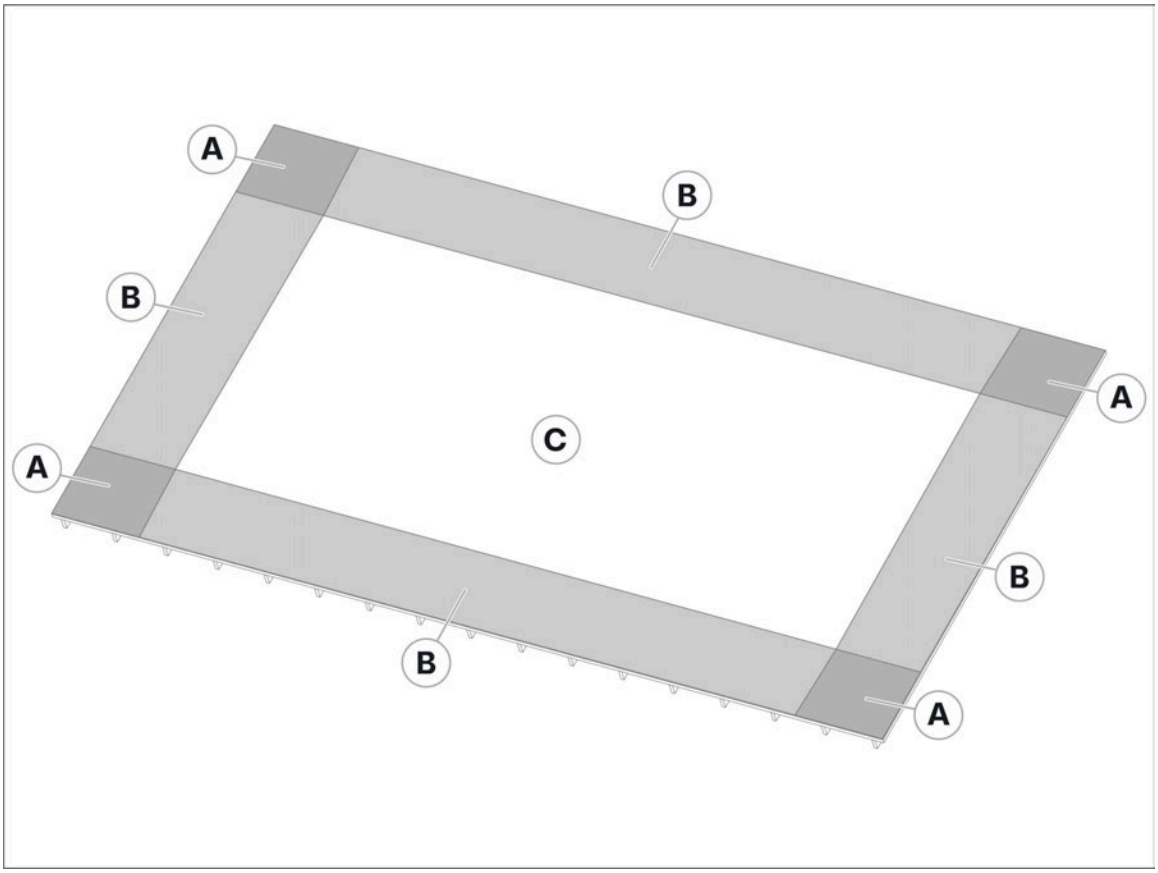
Gather Project Data

Array design begins with identifying specific information that applies to the project, including:

- Site information such as wind speed/zones, snow load, and terrain characteristics.
- Building characteristics such as rafter/truss spacing, roof pitch, sheathing type and condition, and number of shingle layers.
- Authority Having Jurisdiction (AHJ)-specific information on fire setbacks, access/egress requirements, and obstruction clearances.
- PV array details such as PV module manufacturer, mounting area size, and desired orientation.

Roof Zones

Roof zones identify the regions of a roof plane subject to low, medium, and high wind pressures. This is to account for varying wind pressure as wind passes over different areas of the roof. The maximum allowable Leveling Foot spacing and cantilever may be smaller in medium and high pressure zones. Roof zones are determined in accordance with ASCE 7 as prescribed by the AHJ. Wind zones A, B, and C below are an example; different ASCE 7 editions define and group them in different ways. Be sure to follow ASCE 7 definitions when planning the standoff placement.



- *(A) - Corner zone*
- *(B) - Edge zone*
- *(C) - Interior zone*

Calculate Span and Cantilever Allowances

Once project data has been gathered, the allowable capacities of the system must be compared to the site-specific loading. These calculations should account for any applicable design loads (e.g., dead, wind, and snow loading) defined within International Building Code, International Residential Code, and ASCE 7.

Individual component ratings have been tested as follows:

Table 1. Tesla Panel Mount - Tile Component Allowable Forces

Component	Uplift	Downforce	Shear
Leveling Foot Assembly	440 lbf (1959 N)	817 lbf (3636 N)	389.7 lbf (1733 N)
Tile Hook Assembly	544 lbf (2420 N)	544 lbf (2420 N)	339.9 lbf (1512 N)
Spanner Bar	8380 in*lbf (947 Nm)	8380 in*lbf (947 Nm)	-

A safety factor of 2 was applied to the uplift and 1.67 to the downforce and lateral loads.

Refer to *Appendix C: Allowable Mounting System Loading on page 119* for maximum pressure capacities (UL 2703 testing).

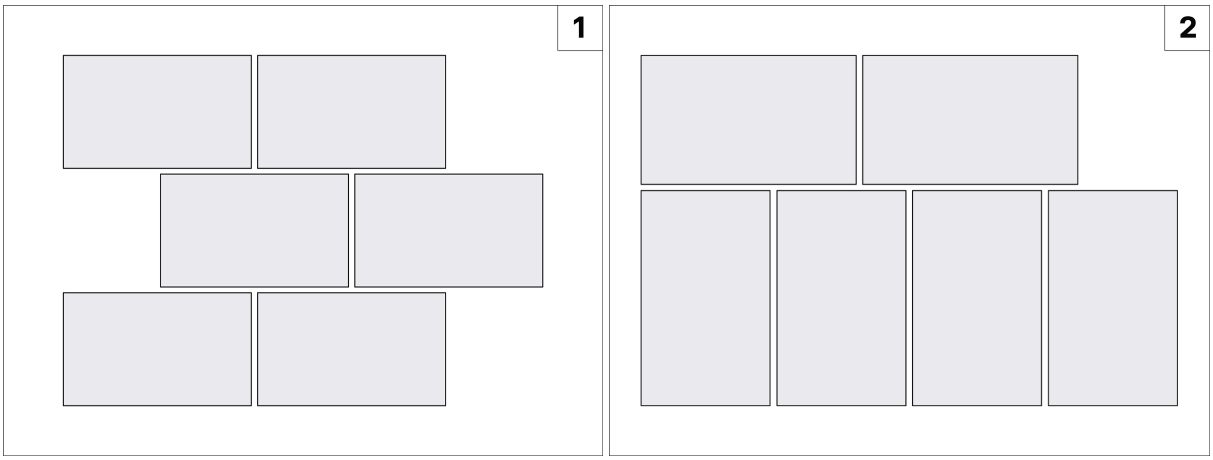
Determine Hardware Attachment Placement

Mark the array boundaries for the PV modules on the roof section in the desired location. Plan Spanner Bar placement to maximize X spacing. Locate the hardware attachment points on the rafters based on the calculated span. Be sure to abide by the span and cantilever rules from the previous steps. Only attach the system within wind pressure zones that have a site-specific loading below the system capacity.

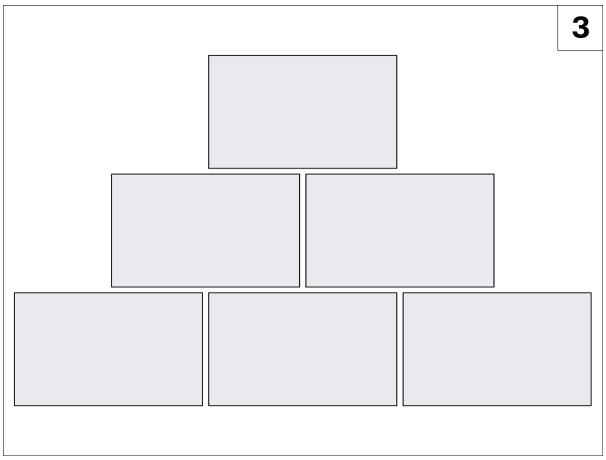
NOTE: Install modules with a ½ in. gap (+/- ¼ in.) in both X and Y directions.

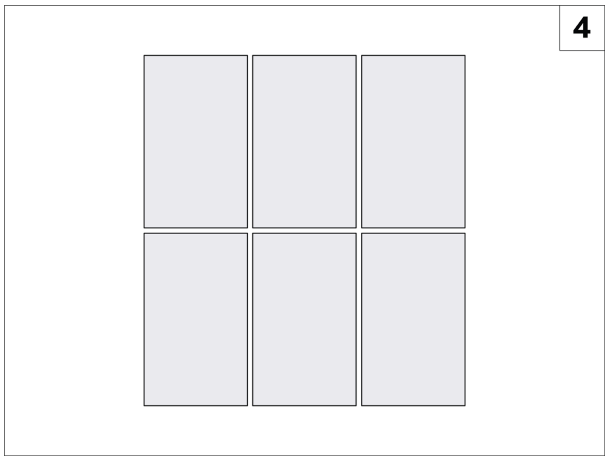
Alternative Layout Possibilities

The layouts shown thus far have been simple examples for the purposes of illustration. Site-specific conditions such as roof obstacles, shading, and multiple roof planes may require an adaptive approach. The following examples show a few of the array designs that are possible with the Tesla Panel Mount - Tile System.

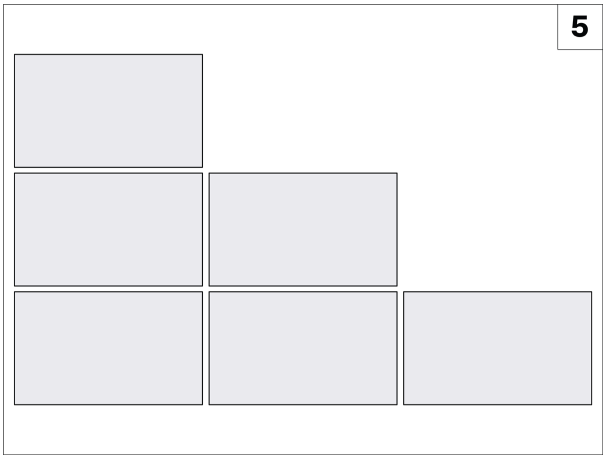


- *(1) - Staggered Modules*
- *(2) - Hybrid Orientation*





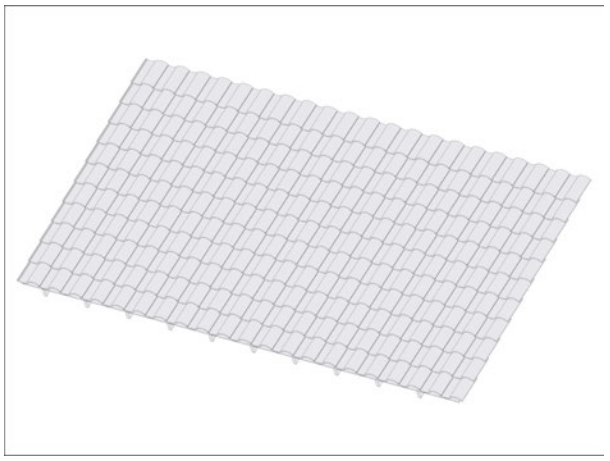
- *(3) - Pyramid Array*
- *(4) - Portrait Array*

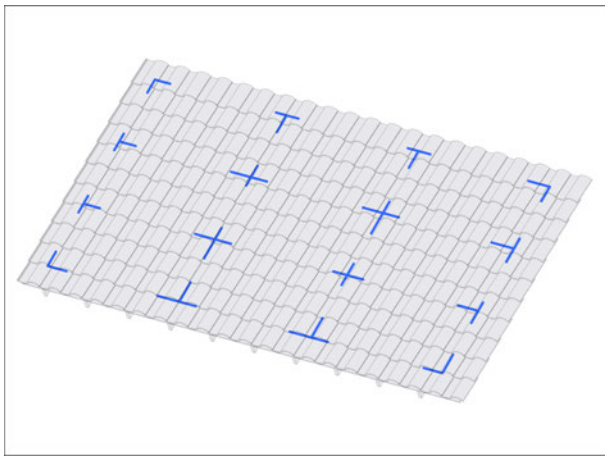


- *(5) - Stair Step Array*

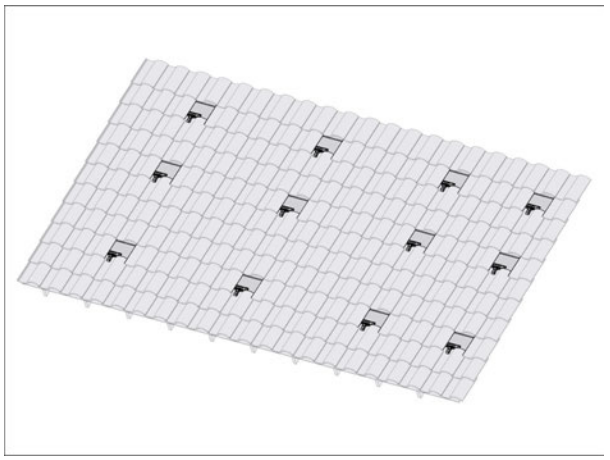
INSTALLATION OVERVIEW

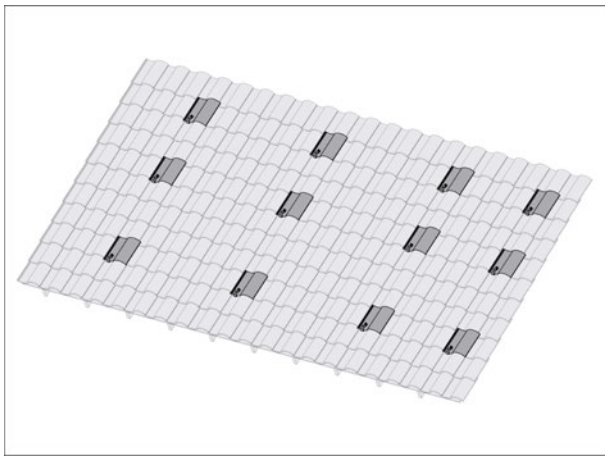
1. Check planset and mark out the perimeter of the array.



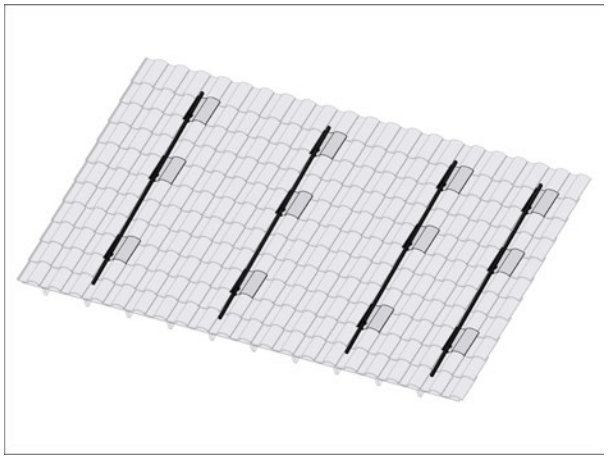


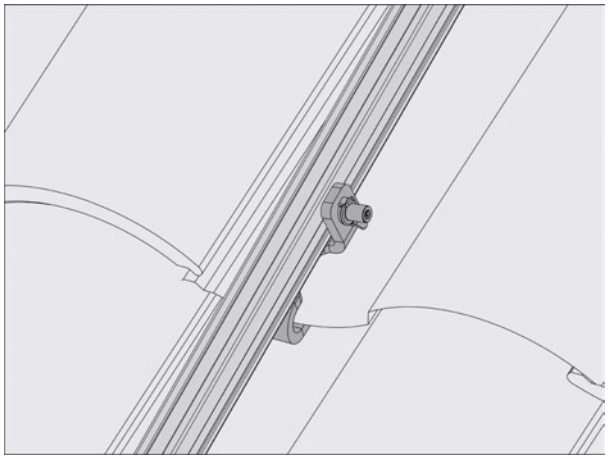
2. Install Tile Hooks and Replacement Flashings.





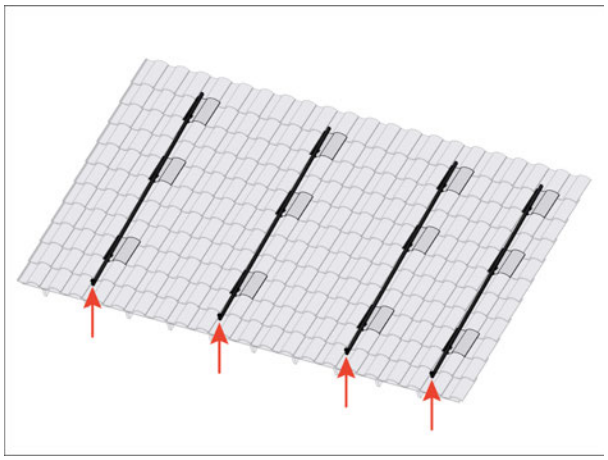
3. Install Spanner Bars.

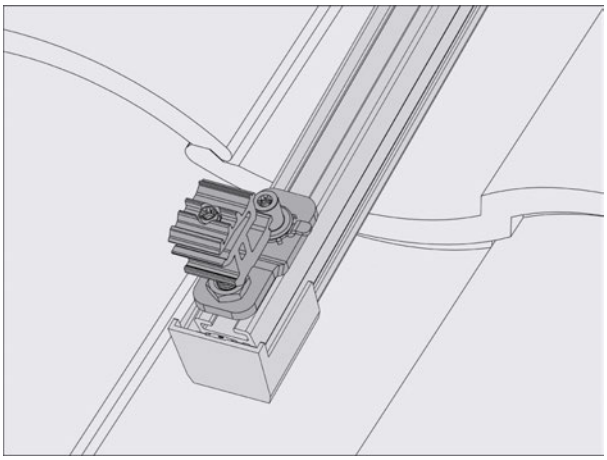




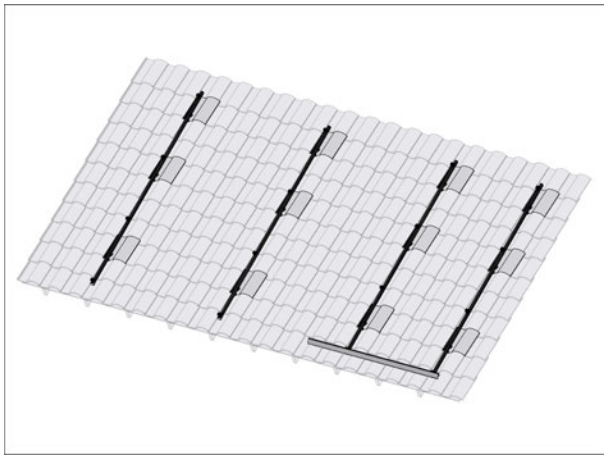
4. Install first row Leveling Feet.

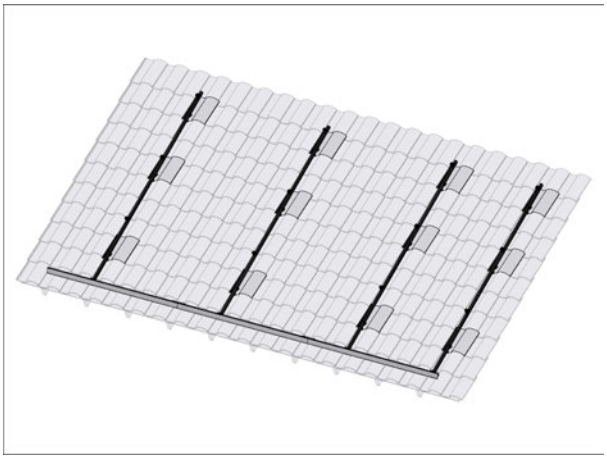
INSTALLATION OVERVIEW





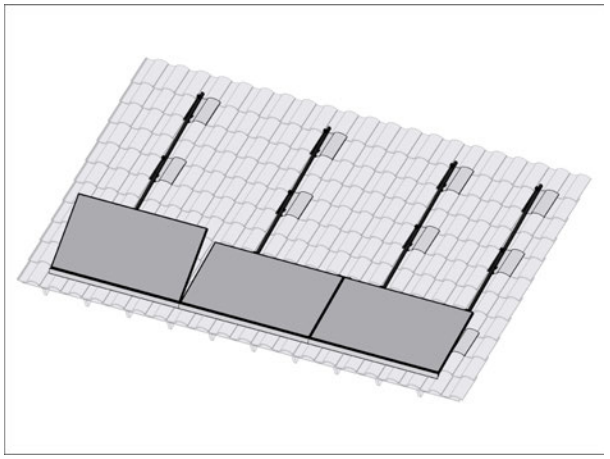
5. Install the Front Skirt.

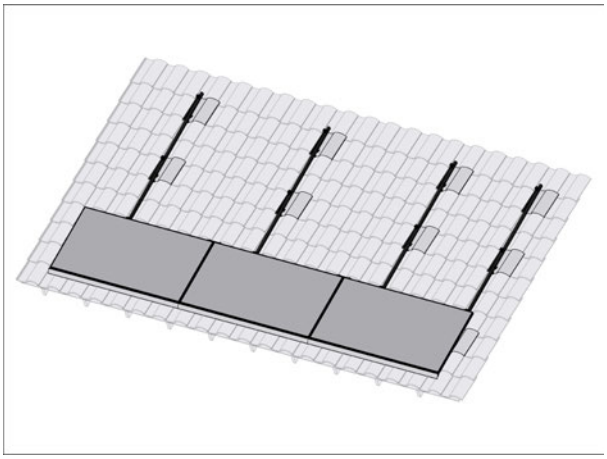




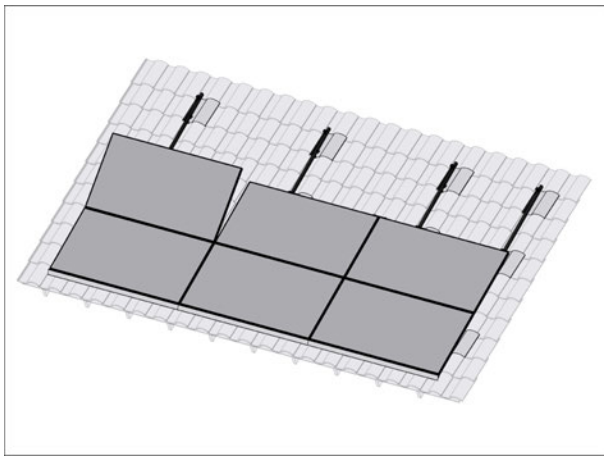
6. Install first module row - **SMILES**
    - **S**et
    - **M**anage
    - **I**nterlock
    - **L**evel
    - **E**valuate
    - **S**ecure

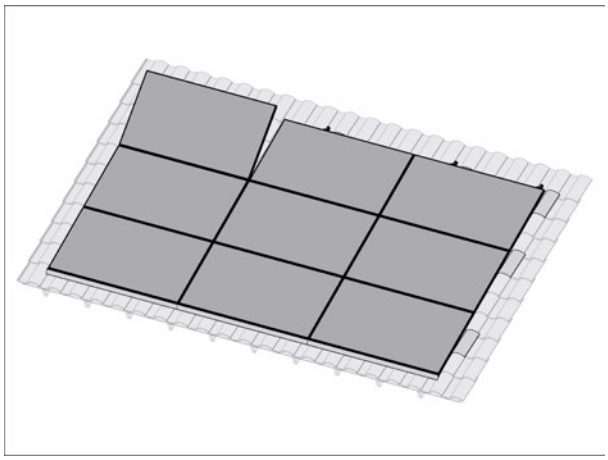
.



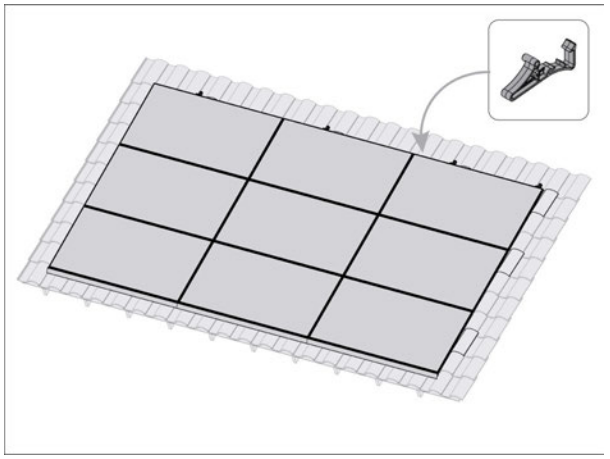


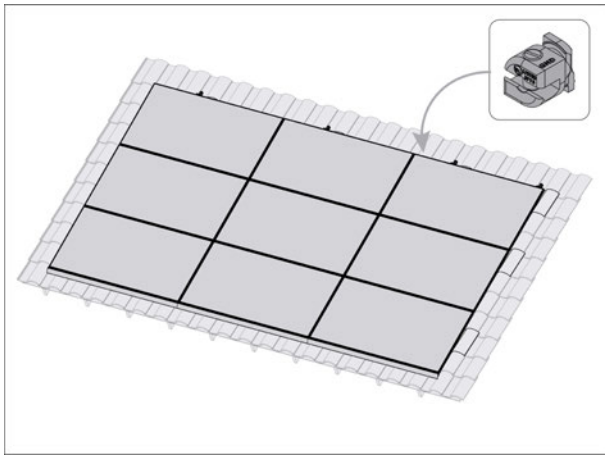
Repeat **SMILES** steps for each module row.



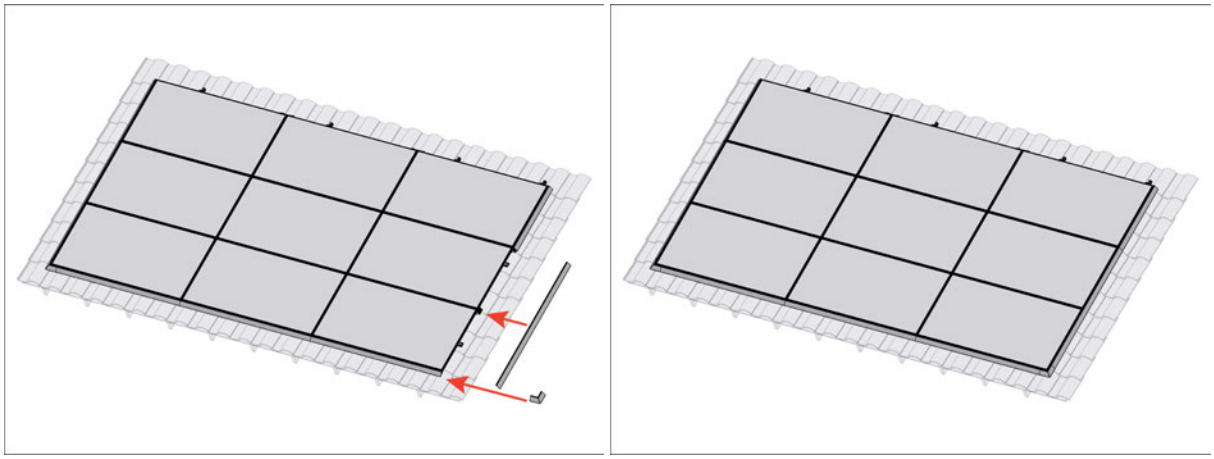


7. Complete the wire management and bonding.





8. Install the Side Skirts and Corner Caps.



INSTALLATION PROCESS

Step 1: Array Layout

Overview

Prepare for installation by marking out array boundaries, module locations, and hardware attachment points.

Prerequisites

Refer to the planset and project information specified in *Array Design on page 26* when preparing the array layout.

Hazards

Figure 1. Fall from Height

Safety and PPE

- Safety glasses (ANSI Z87.1 or EN 166)
- Cut-resistant gloves (ANSI Cut Level 3 or EN 388 Level C)
- Closed-toed shoes
- Fall protection equipment (full-body harness with lanyard) for working at height

General Equipment

- Extension ladder, fiberglass (ANSI/ASC Type IA, 300 lb/135 kg rating)

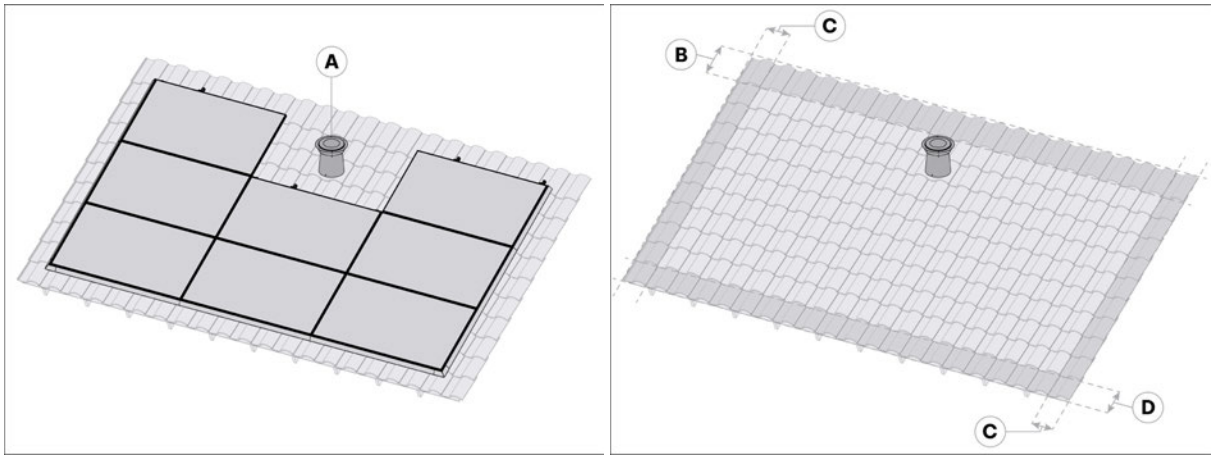
Required Parts and Tools

- Tape measure
- Roof crayon or chalk

Layout

1. Inspect and put on fall protection before performing roof work. Ensure that your fall harness is connected to a certified anchor point and maintain 6 ft (2 m) clearance from the roof edge unless guarded.
2. Put on cut-resistant gloves and safety glasses.
3. Check planset and lay out the array.

a. Note ASCE 7 wind and code-prescribed fire setbacks on the roof as defined in previous steps. Be aware of roof obstructions when marking out the array. Refer to *Array Design on page 26*.



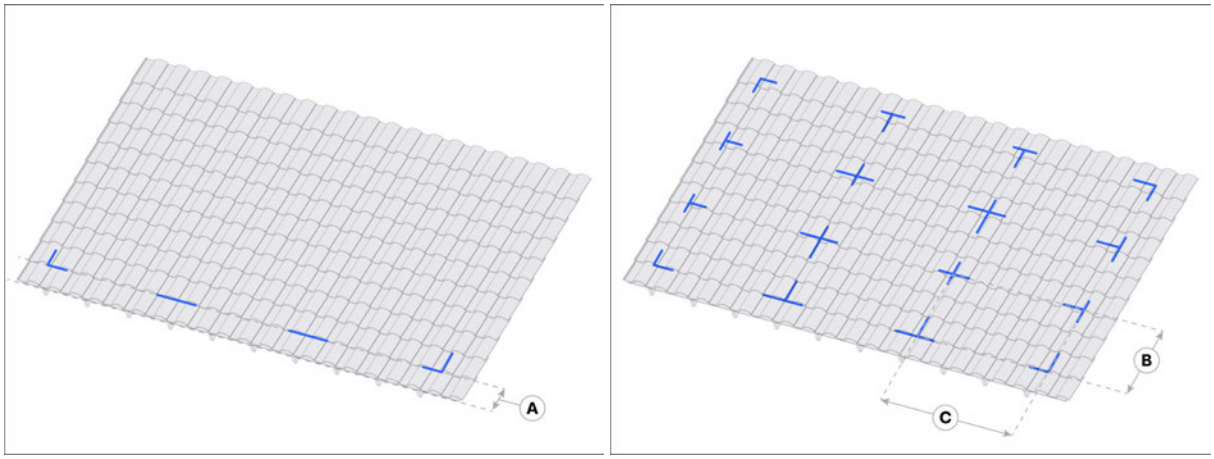
- *(A) - Obstruction*
- *(B) - Ridge setback*
- *(C) - Gable setback*
- *(D) - Eave setback*

b. Obstructions may include passive vents, vent pipes, skylights, chimneys, etc. AHJs may allow or prohibit spanning over some obstructions. Take care to minimize array shading from obstructions.

4. Mark out the perimeter of the array and module locations, ensuring that the boundaries are not within any setbacks or blocked by roof obstructions. Include a ½ in. gap between modules in both X and Y directions.

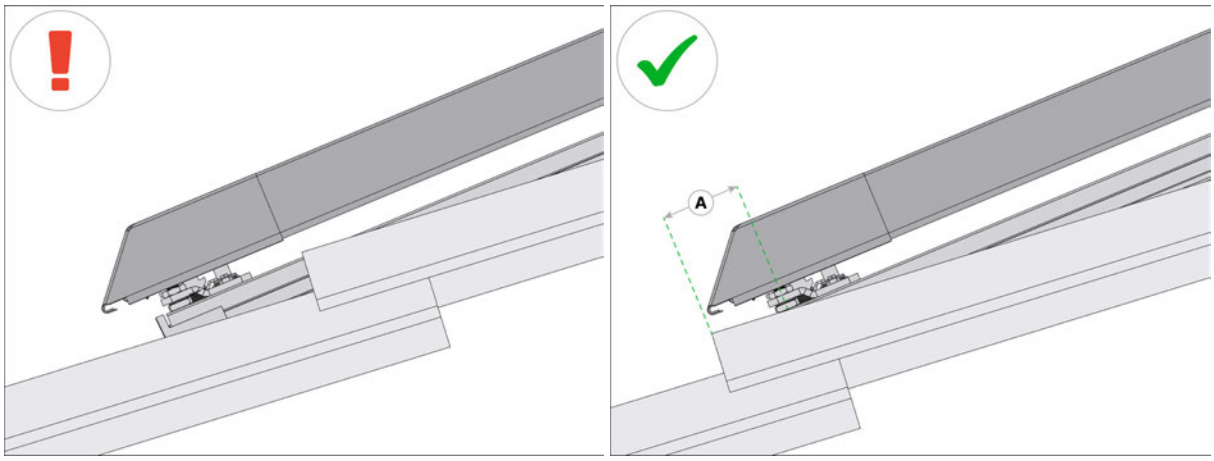
NOTE: Marking Interlock locations and up-roof attachment points for other hooks is recommended.

5. Adjust front row marks to a square reference, typically the eave. Ensure that the outside corners of the array on the first row are the same distance from the eave or square reference.



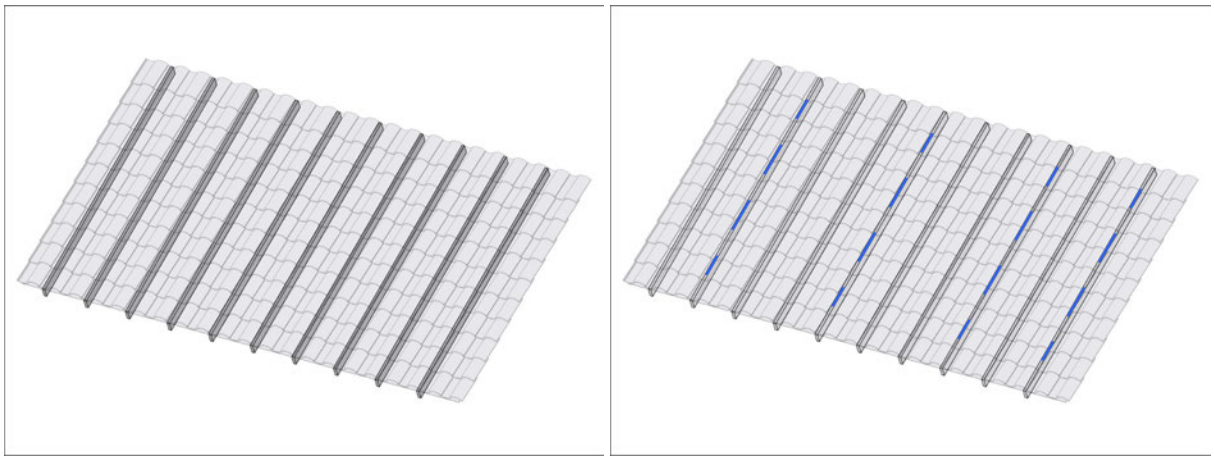
- *(A) - Square reference from eave*
- *(B) - Module Y dimension + ½ in.*
- *(C) - Module X dimension + ½ in.*

NOTE: For ideal aesthetics, the down-roof edge of the Front Skirt should align with the overlap in a tile course. To achieve this, lay out the PV modules with the down-roof edge 3 in. above the lip of a tile course so that the Front Skirt is correctly aligned once installed. Modules should always be installed in this manner when allowed by space limitations.



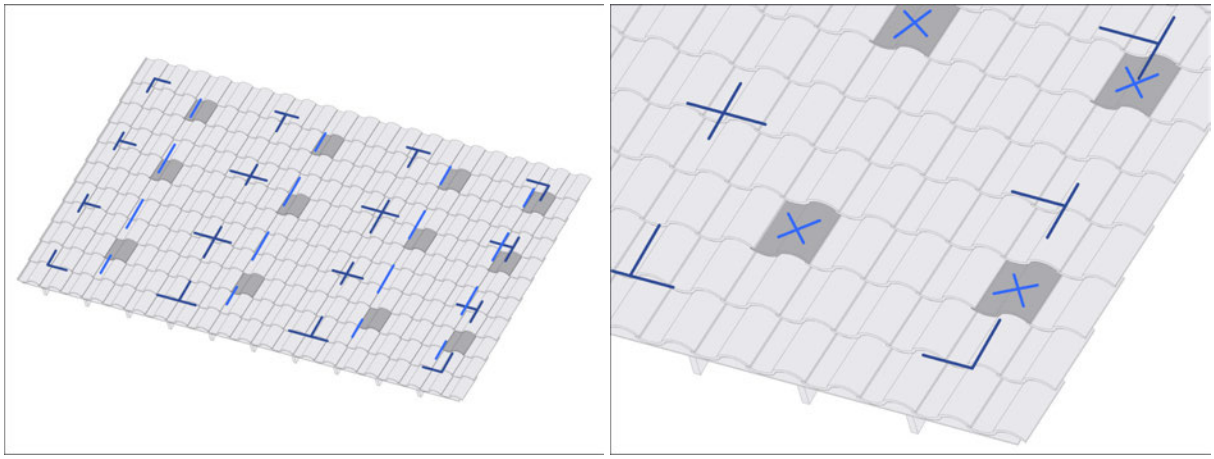
- *(A) - 3 in. from the lip of the tile course*

6. Ensure that modules are not installed in the wind setback zone as defined by ASCE 7.
7. **Identify the attachment locations.**
   a. Locate the rafters that fall within the array perimeter.



   b. Starting with the first rafter inside the perimeter of the array, select a tile over the rafter to remove for placement of the first Tile Hook. Observe setback, spacing, and cantilever rules when selecting the tile.

8. Locate the tiles to remove for all attachment points in both the X and Y directions.



Related tasks

- Step 2: Install Tile Hooks on page 37

Related information

- Installation Overview on page 29

Step 2: Install Tile Hooks

Overview

Contains steps for installing Tile Hooks and sealing missed roof penetrations when locating rafters.

Prerequisites

Requires removal of specific roof tiles over the rafters identified in *Step 1: Array Layout on page 34*.

Hazards

Figure 2. Fall from Height

Safety and PPE

- Safety glasses (ANSI Z87.1 or EN 166)
- Cut-resistant gloves (ANSI Cut Level 3 or EN 388 Level C)
- Closed-toed shoes
- Fall protection equipment (full-body harness with lanyard) for working at height

General Equipment

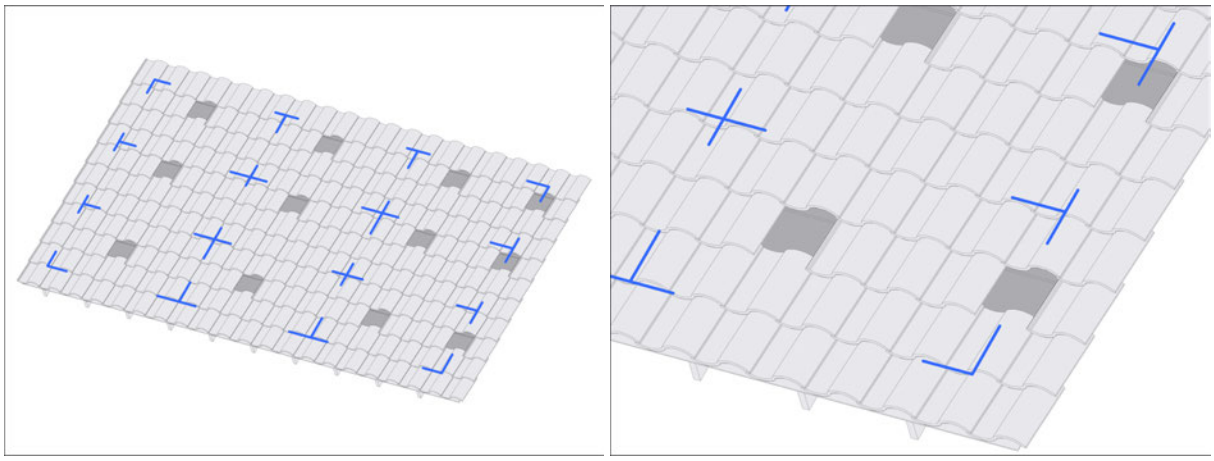
- Extension ladder, fiberglass (ANSI/ASC Type IA, 300 lb/135 kg rating)

Required Parts and Tools

- Impact driver
- T40 Torx bit
- Drill and 3/16 in. or 7/32 in. drill bit
- ½ in. socket or T40 Torx bit

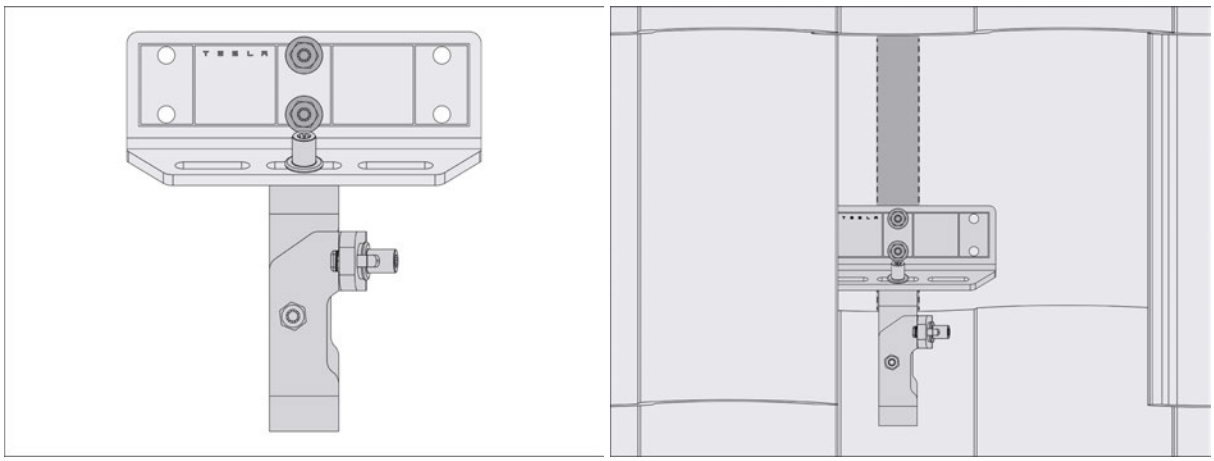
Install

1. Inspect and put on fall protection before performing roof work. Ensure that your fall harness is connected to a certified anchor point and maintain 6 ft (2 m) clearance from the roof edge unless guarded.
2. Put on cut-resistant gloves and safety glasses.
3. **Remove marked roof tiles from the previous step.** (*Step 1: Array Layout on page 34*)
   a. Removing a tile should uncover the roof deck above a rafter in a location that follows all setback, spacing, and cantilever rules. Preserve removed tiles for use as spares.



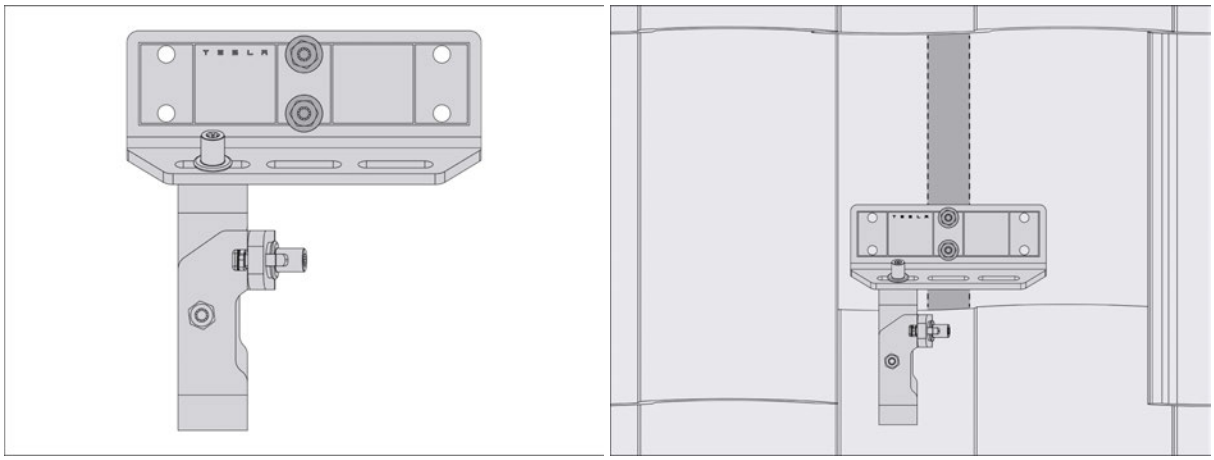
4. **Set up Tile Hook base.**

   The ideal configuration of the hook and base is the nominal position where both the lag screws and the hook are in the center holes on the base.

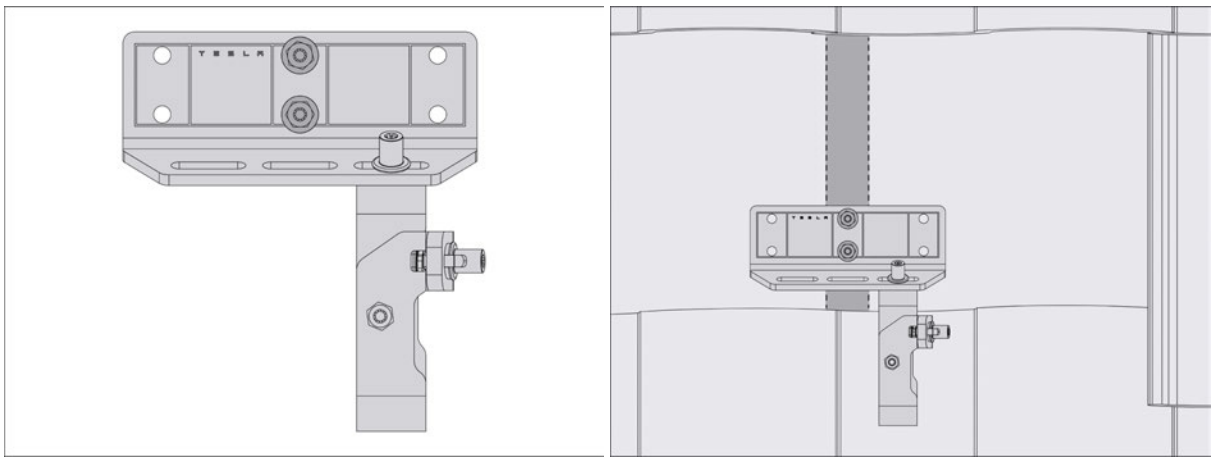


   Flat tile will typically use the nominal position.

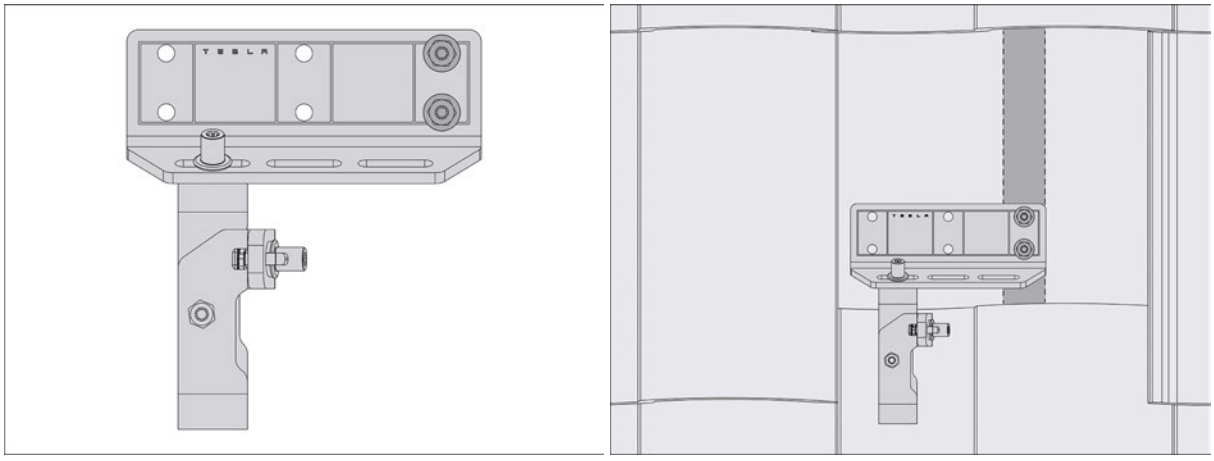
   Round tile may require an offset of the base and/or the hook to align the lag screws vertically with the rafter. The hook should always be positioned in the lowest part of the tile trough.



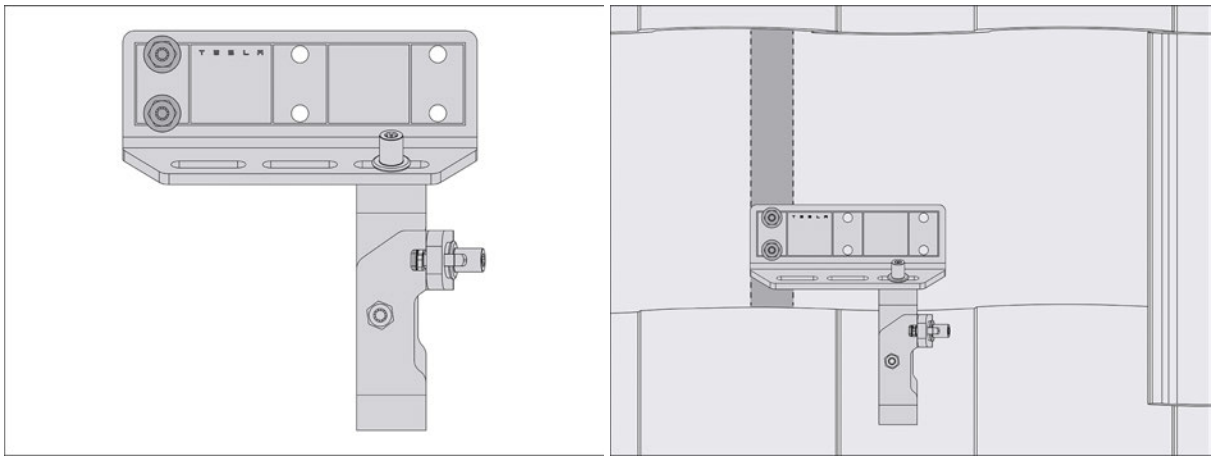
- *Centered lag screws, hook offset to the left*



- *Centered lag screws, hook offset to the right*

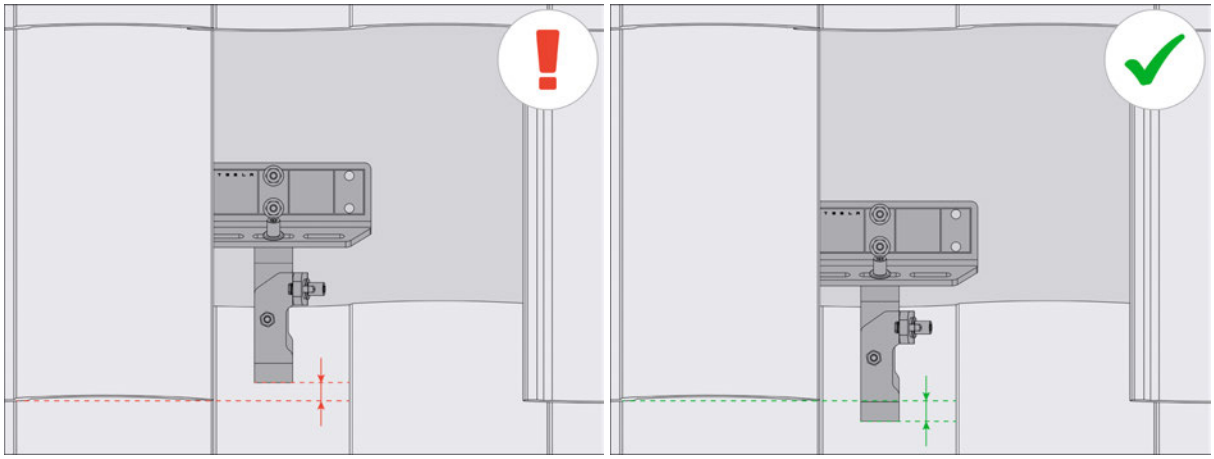


- *Offset lag screws, hook offset to the left*



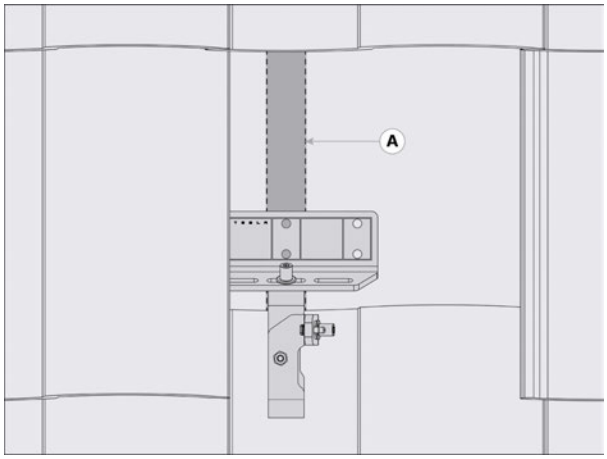
- *Offset lag screws, hook offset to the right*

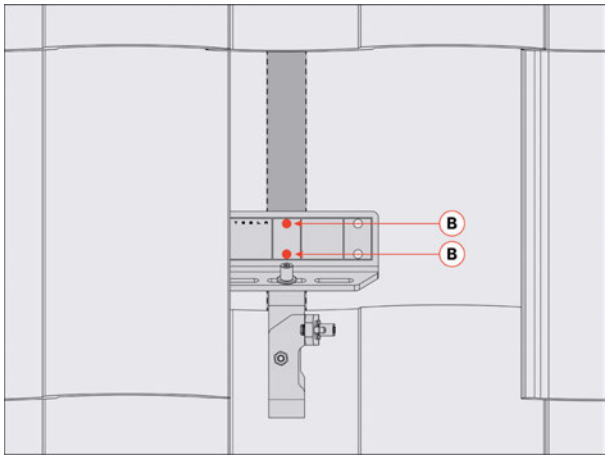
The down-roof edge of the hook should align with or be just below the edge of the tile course above it.



5. **Drill pilot holes for the lag screws.**
    a. Select the correct drill bit for the lumber type:
        - Soft woods will require a 3/16 in. drill bit.
        - Hard woods may require a 7/32 in. drill bit.

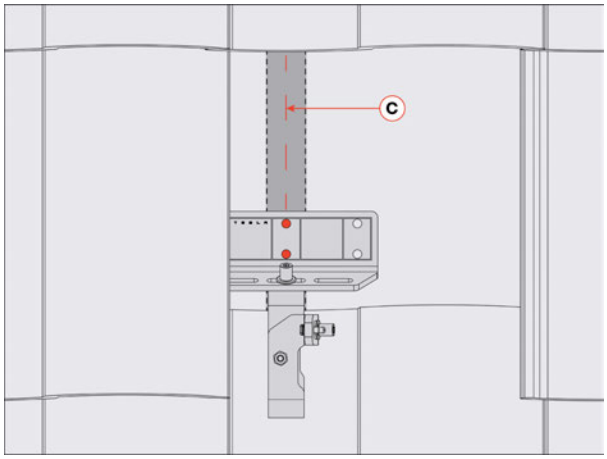
b. Place the Tile Hook base over the center of the rafter and drill two pilot holes.

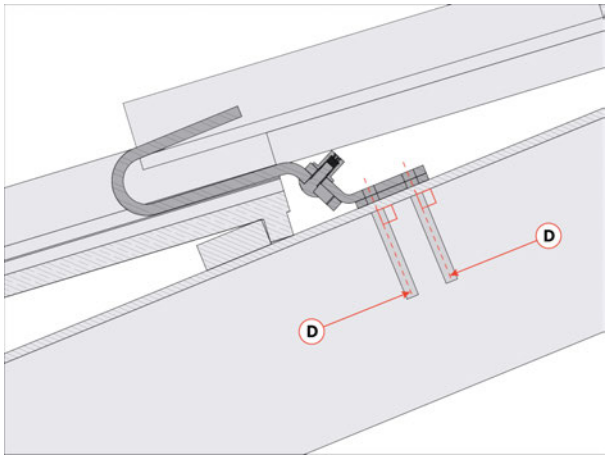




- *(A) - Rafter location*
- *(B) - Location of pilot holes*

c. Ensure that the holes are drilled perpendicular to the roof surface and centered on the rafter width. The holes must be deep enough to achieve a minimum of 2 1/2 in. of threaded embedment.

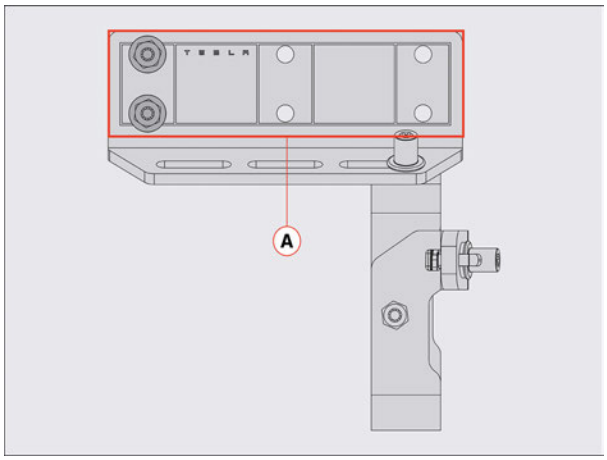




- *(C) - Rafter center line*
- *(D) - Holes perpendicular to roof surface*

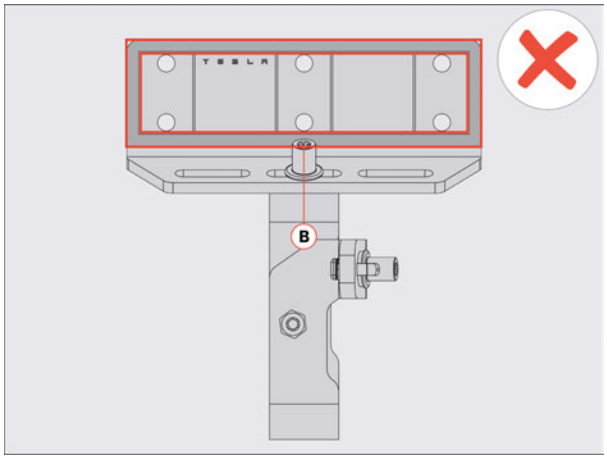
6. **Seal any missed penetrations.**
   No Miss Zones

   When the hook and lag screws are in the fully offset configuration, all missed penetrations must be sealed with Eternabond or liquid sealant using the steps in the next section.

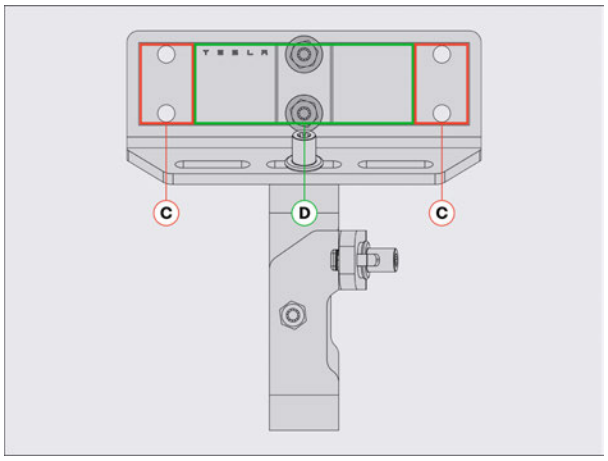


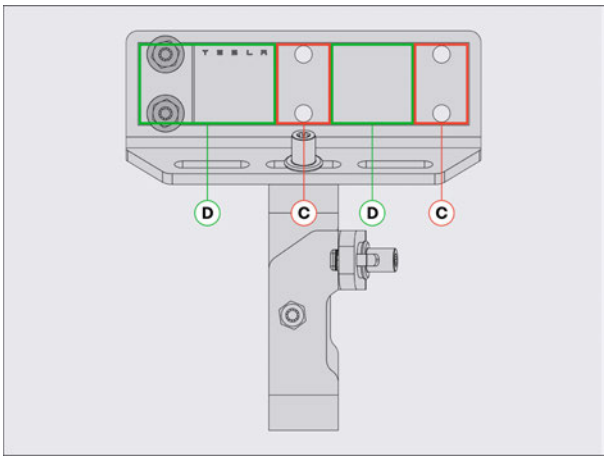
- *(A) - No miss zone. All misses must be sealed with Eternabond or liquid sealant before installing the base in this configuration.*

For all other configurations of the hook and base, follow the rules below:



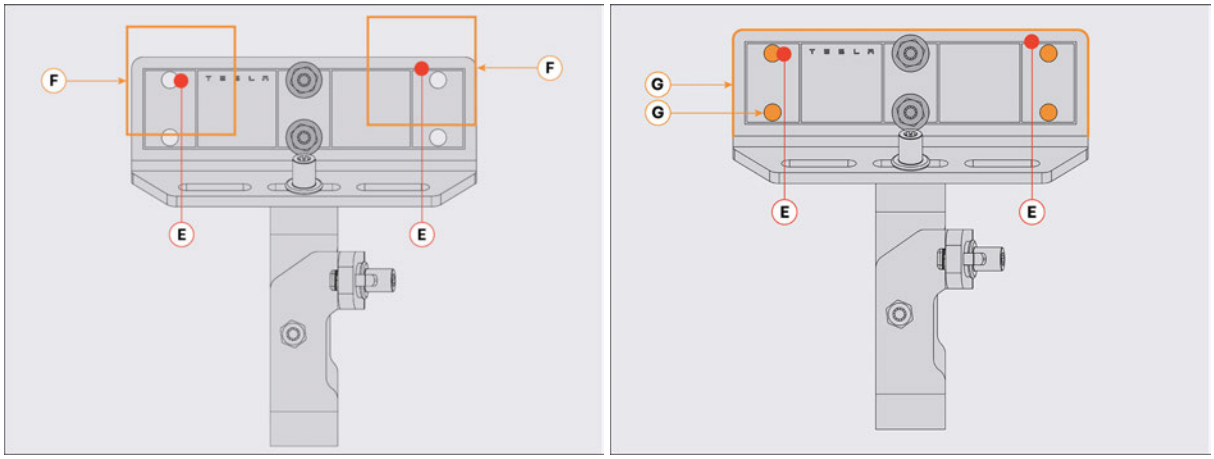
- *(B) - No miss zone, no misses allowed ¼ in. from the perimeter*





- *(C) - No missed penetrations are allowed in the areas around open mounting holes*
- *(D) - Missed penetrations are allowed in this area*

a. To repair missed penetrations outside of the allowable miss zone:



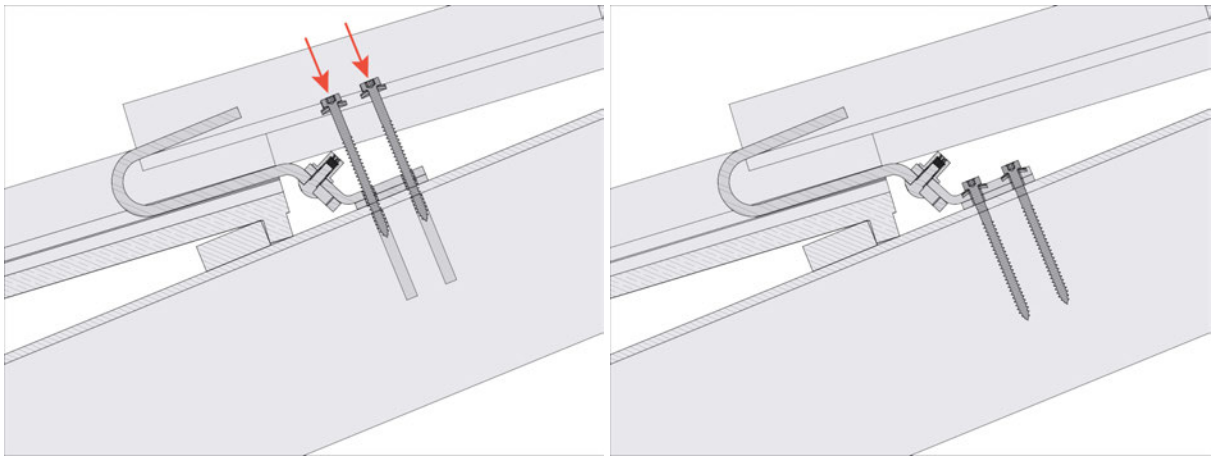
- *(E) - Missed penetration*
- *(F) - Eternabond (1 in. around missed penetration)*
- *(G) - Liquid sealant (around entire base)*

b. Repairing missed penetrations using Eternabond:
   - Clean off any debris.
   - Cut Eternabond to size so that the missed penetration is covered by at least 1 in. on either side.
   - Remove backing and attach to install location.
   - Place Tile Hook base on top of Eternabond and install lag screws.

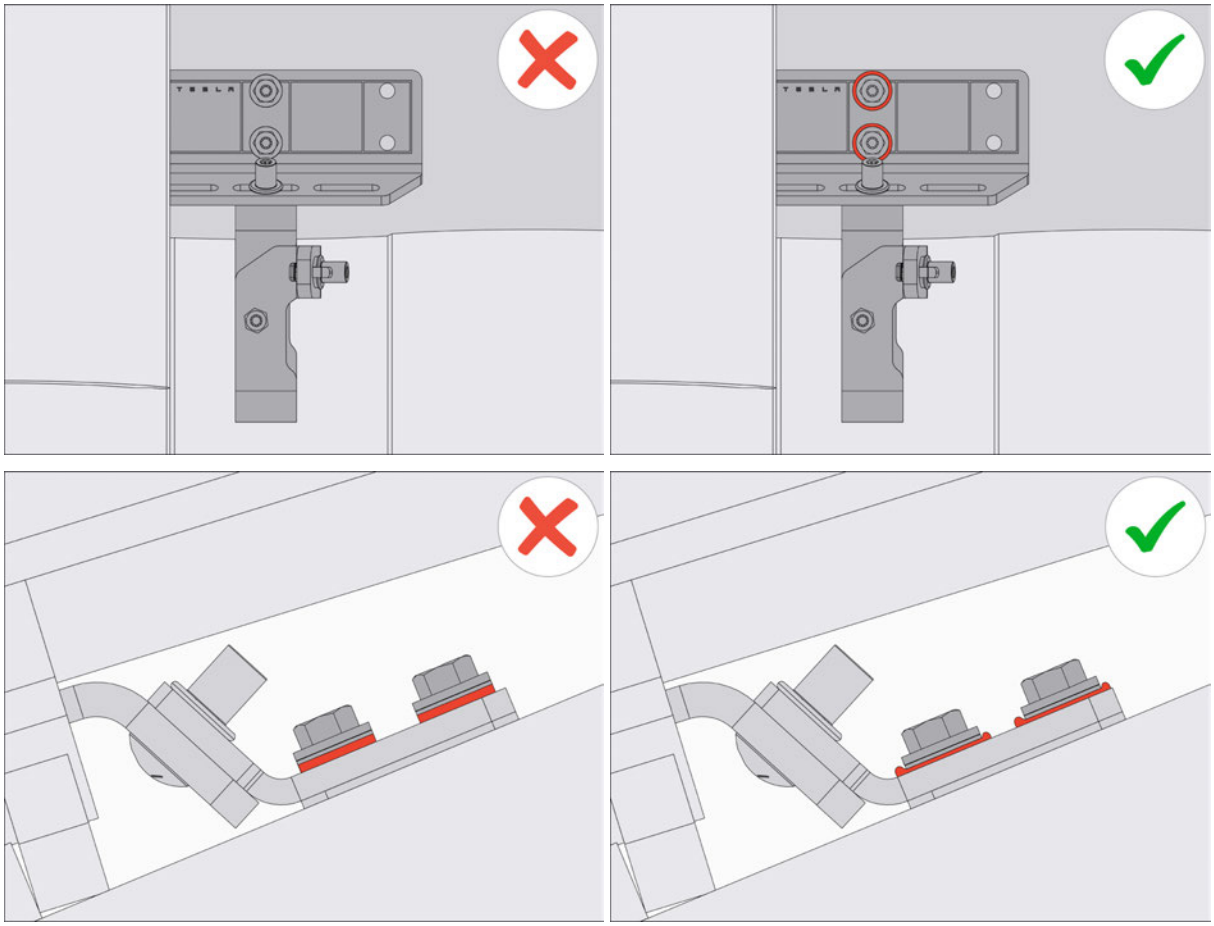
c. Repairing missed penetrations using liquid sealant:
   - Clean off any debris.
   - Fill missed holes with sealant.
   - Line the perimeter of the Tile Hook base with sealant.
   - Install Tile Hook base.
   - Fill open holes with sealant.

7. **Install the Tile Hook.**

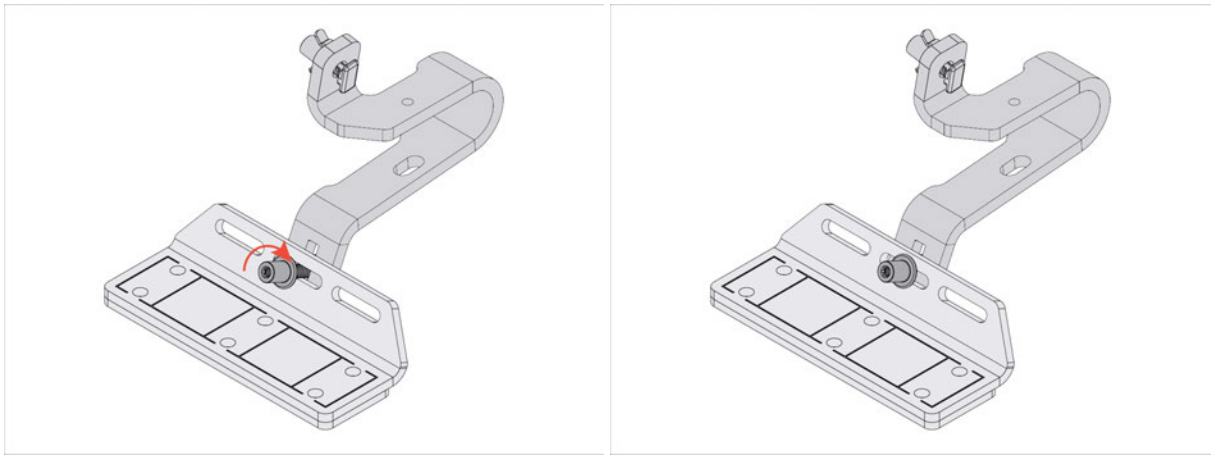
a. Fasten the Tile Hook base with Lag Screws in the pre-drilled holes before tightening the carriage bolt on the hook.



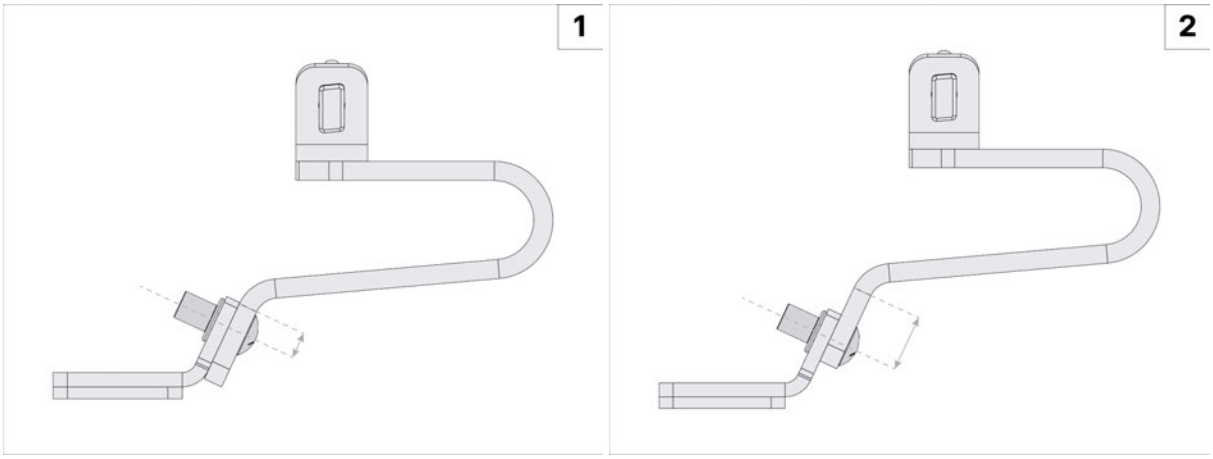
b. Check the gaskets for adequate compression. The gasket under the washer is visible once adequately compressed.



c. Tighten the carriage bolt to secure the hook to the base.



d. Adjust the hook height to accommodate the tile profile.



- *(1) - Minimum hook height*
- *(2) - Maximum hook height*

Related tasks

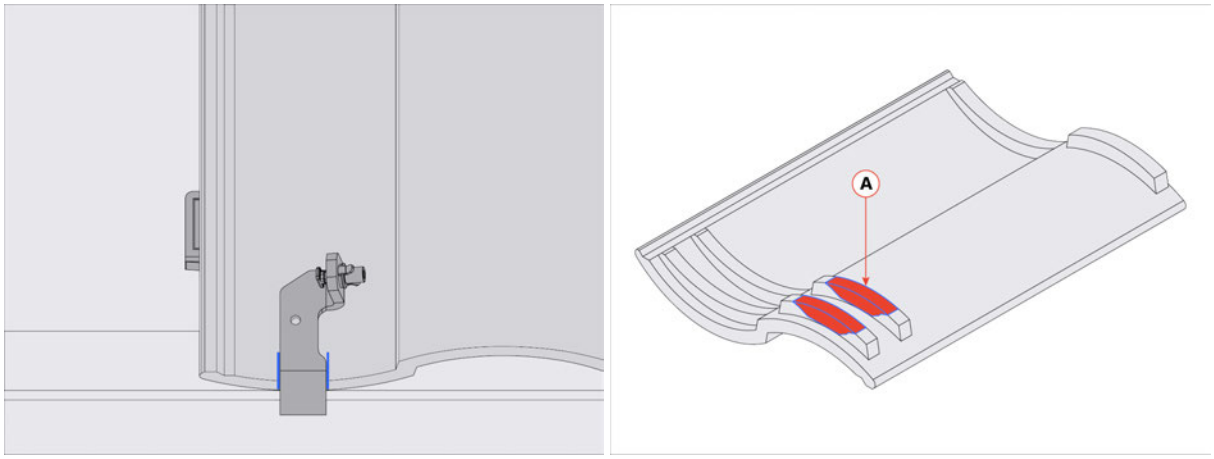
- Tile Chipping on page 45
- Install Replacement Flashing on page 47
- Step 3: Install Spanner Bars on page 51

Related information

- Installation Overview on page 29

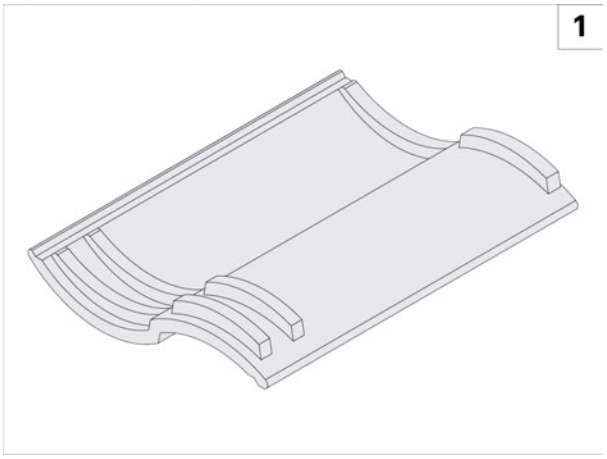
Tile Chipping

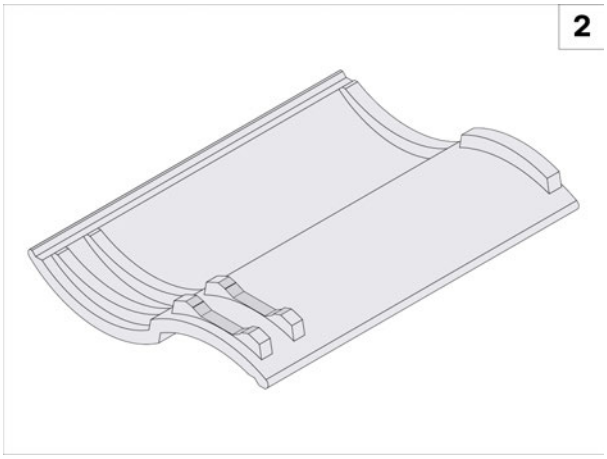
1. After securing the Tile Hooks, set the removed tiles in position and mark the edge of the tile where it interferes with a Tile Hook.



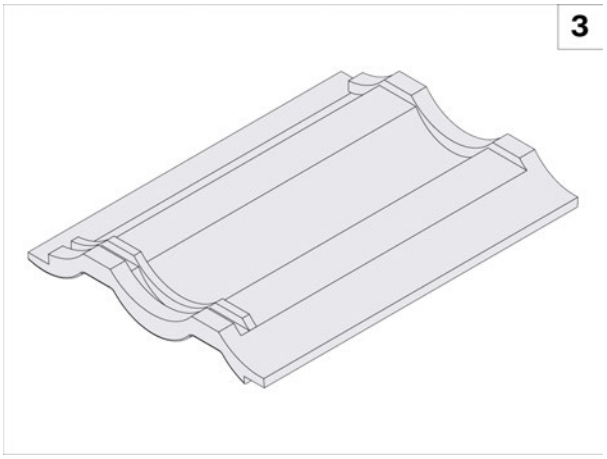
- *(A) - Interference with Tile Hook*

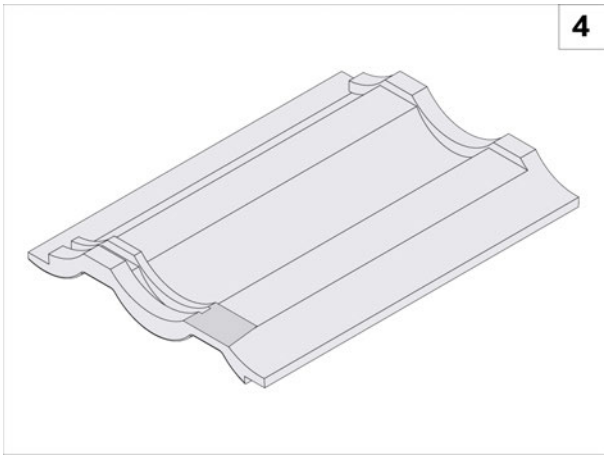
2. Use a hammer or grinder to carefully remove the section of tile that interferes with the Tile Hook.



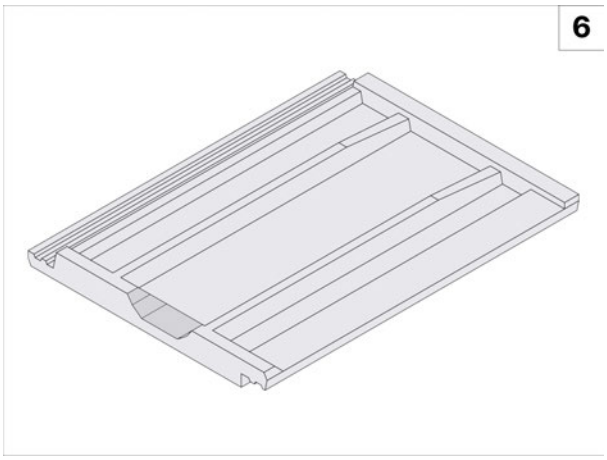


- *(1) - Unchipped S-Tile*
- *(2) - Chipped S-Tile*



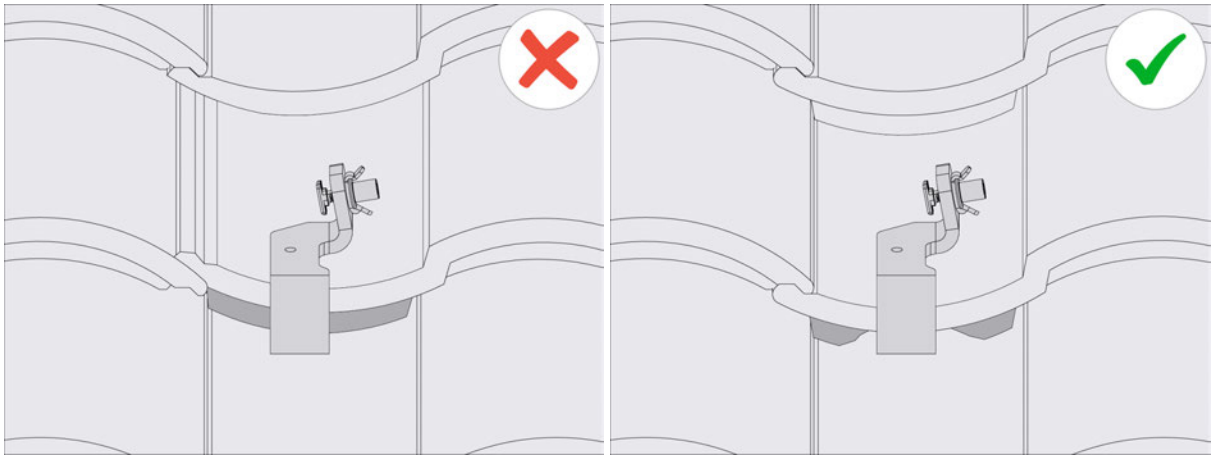


- *(3) - Unchipped W-Tile*
- *(4) - Chipped W-Tile*



- *(5) - Unchipped Flat Tile*
- *(6) - Chipped Flat Tile*

3. Install the modified tile so that it aligns and interfaces properly with the adjacent tiles and fits into the Tile Hook.



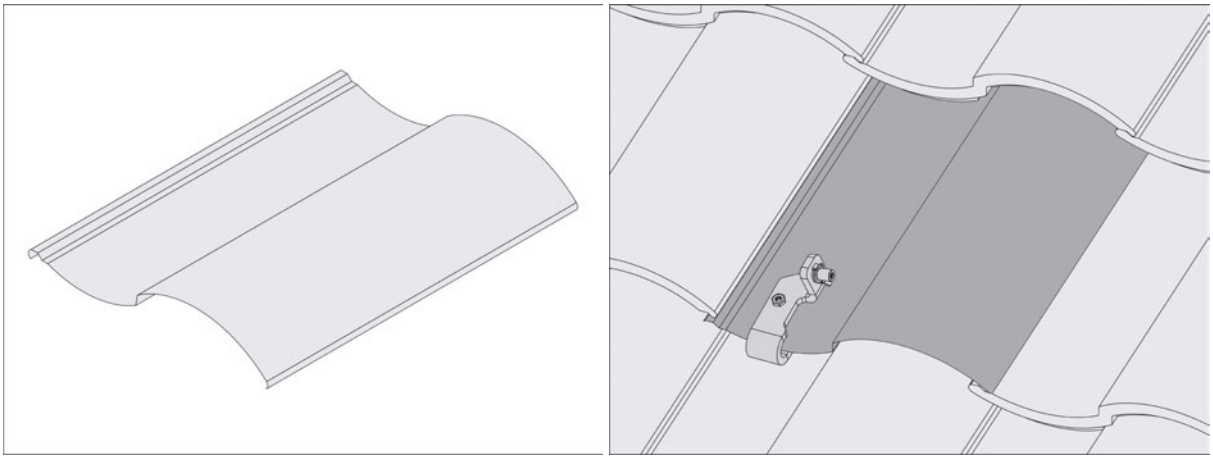
If a tile breaks during the modification or installation, replace it with a Replacement Flashing. Refer to *Install Replacement Flashing on page 47*.

Install Replacement Flashing

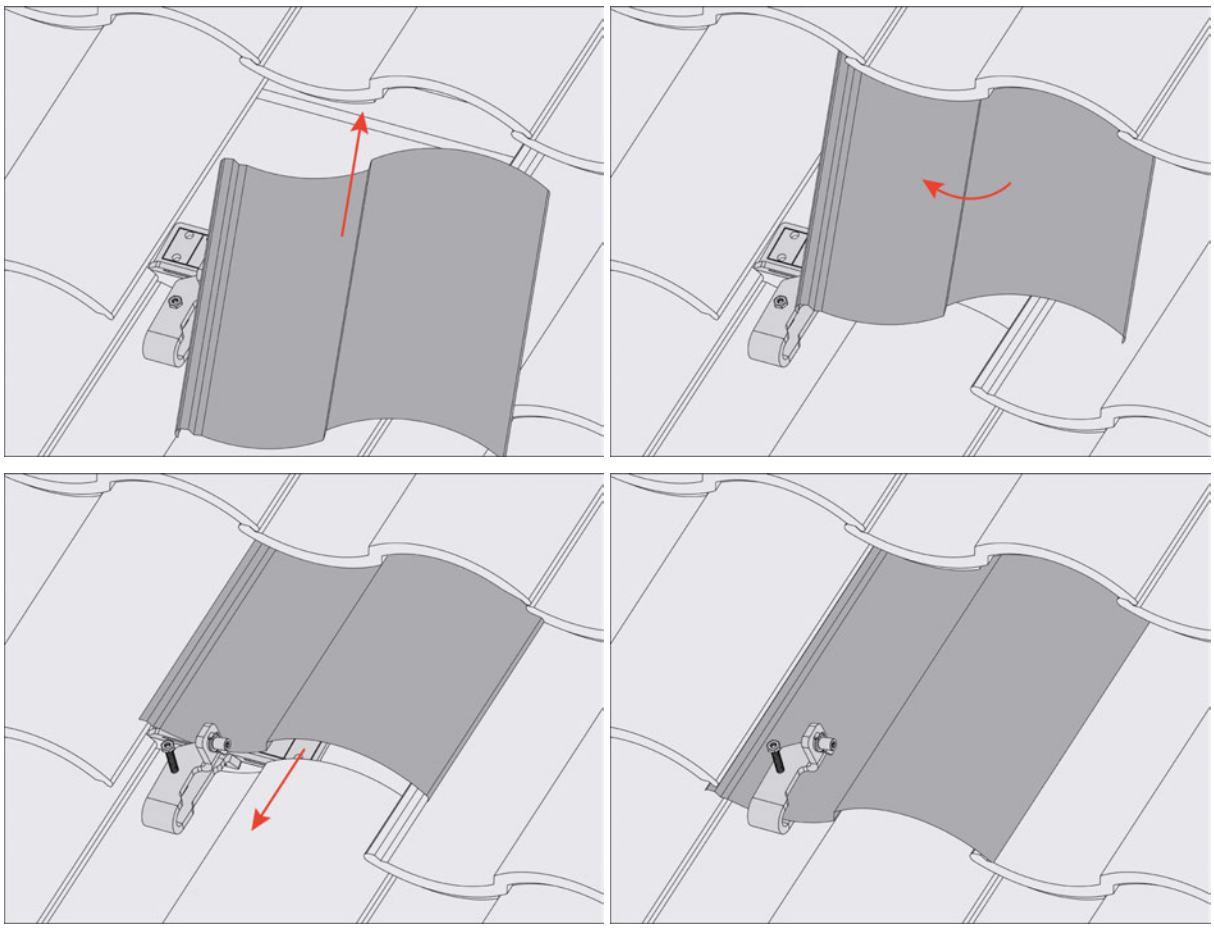
The Replacement Flashing matches the shape of the removed tile and laps with adjacent tiles to preserve water shed.

NOTE: With correct module placement, the Replacement Flashing is hidden by the array skirts once completed.

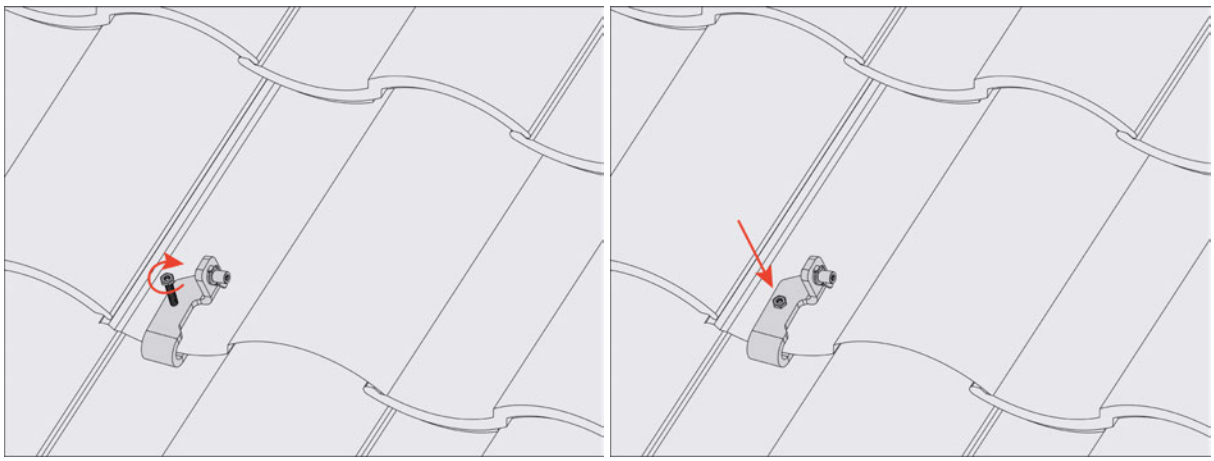
S-Tile Replacement Flashing



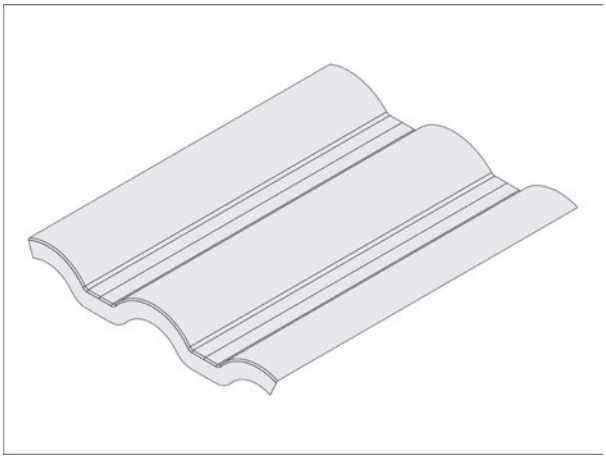
1. After securing the Tile Hooks, insert the S-Tile Replacement Flashing in place of the removed tiles.

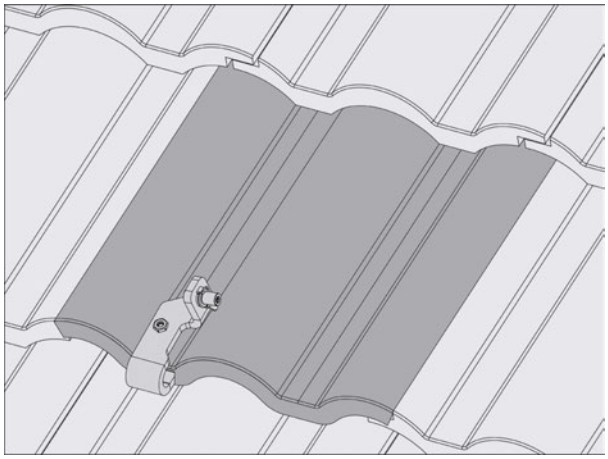


2. Drive the flashing securing bolt through the Replacement Flashing until the fastener head is flush with the hook to secure the Replacement Flashing in place.

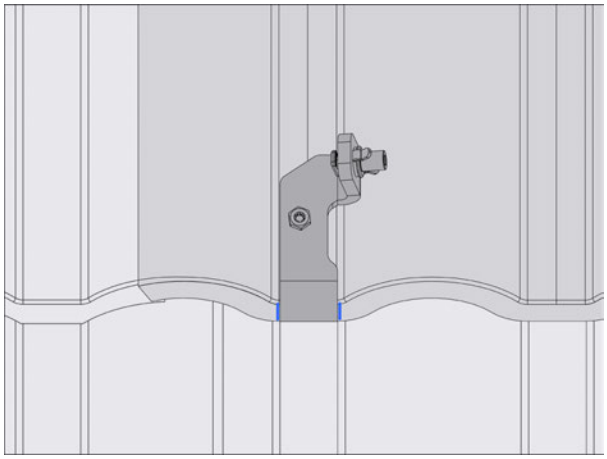


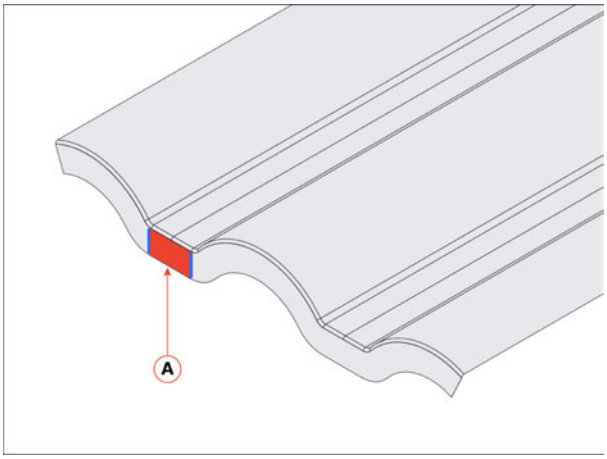
W-Tile Replacement Flashing





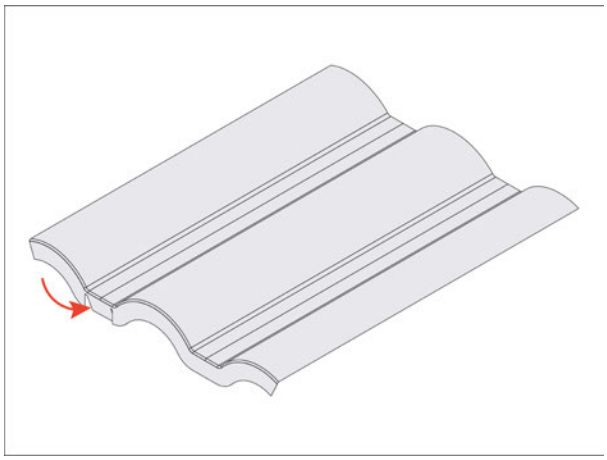
1. Place the W-Tile Replacement Flashing in the location of the removed tile, mark the edge of the flashing where it interferes with the Tile Hook and cut it with tin snips.

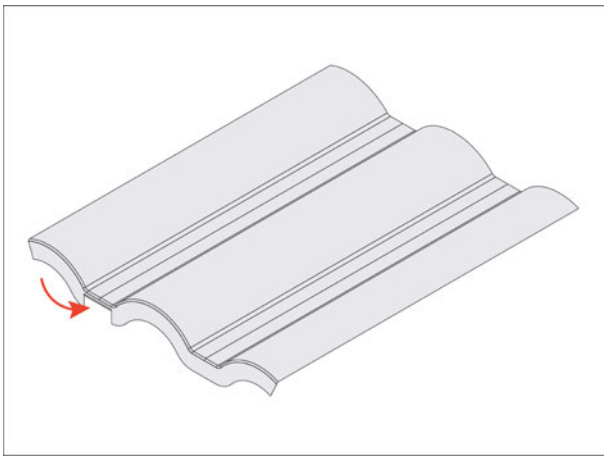




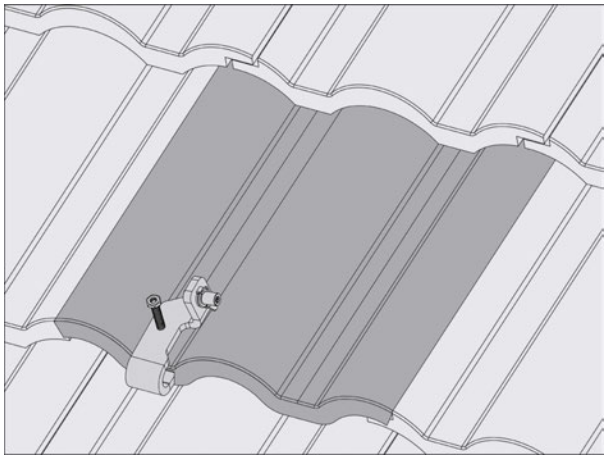
   - *(A) - Marked interference area to be cut out*

2. Bend the cut tab under the flashing so that it sits against the Tile Hook without interference.

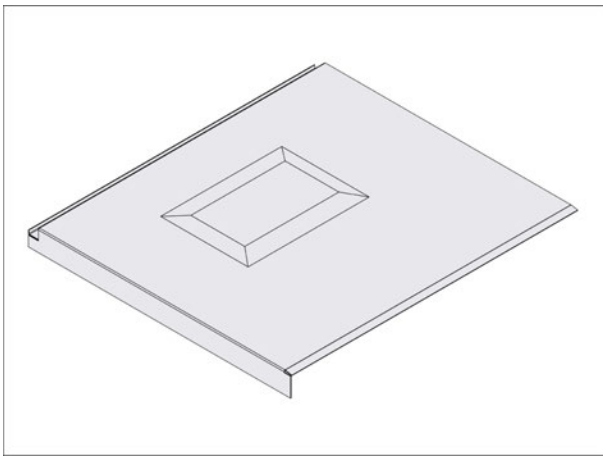


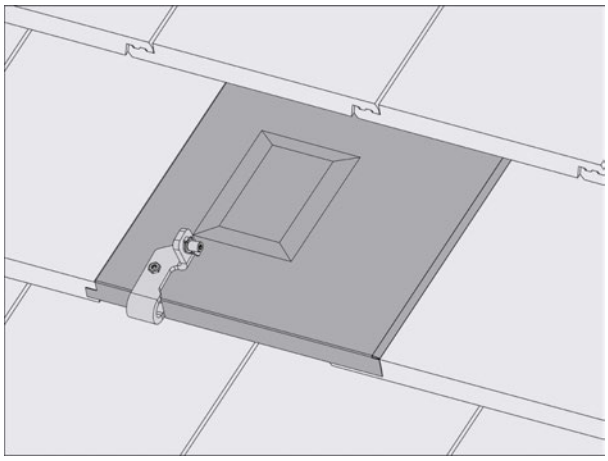


3. Drive the flashing securing bolt through the Replacement Flashing until the fastener head is flush with the hook to secure the Replacement Flashing in place.

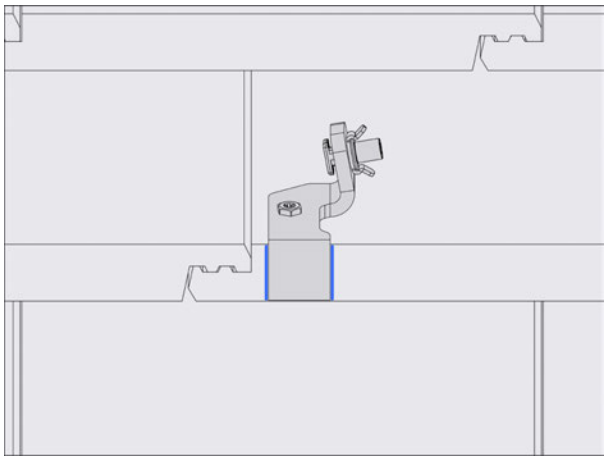


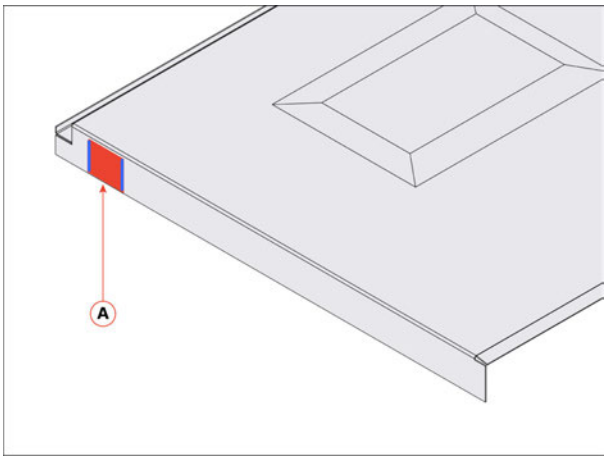
Flat Tile Replacement Flashing





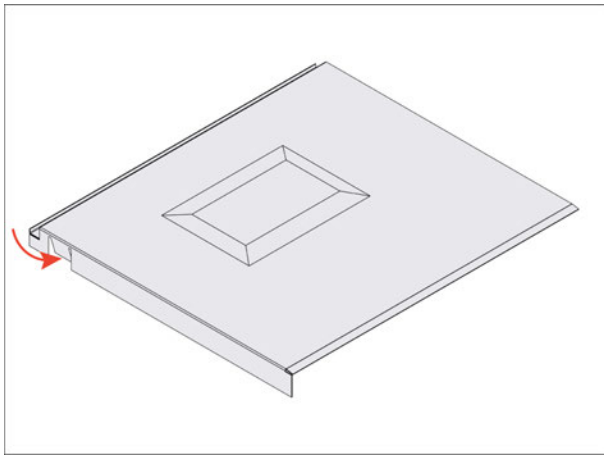
1. Place the Flat Tile Replacement Flashing in the location of the removed tile, mark the edge of the flashing where it interferes with the Tile Hook and cut it with tin snips.

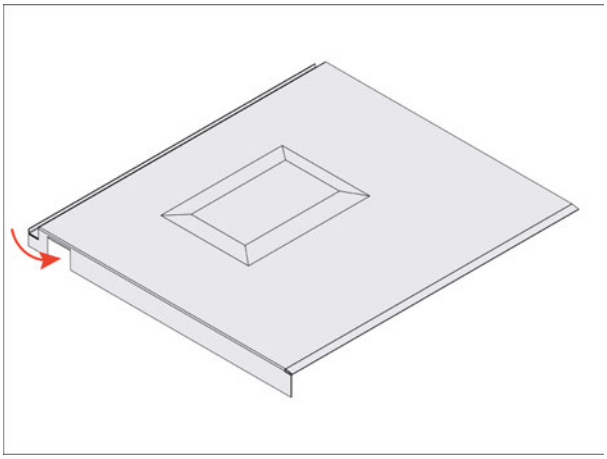




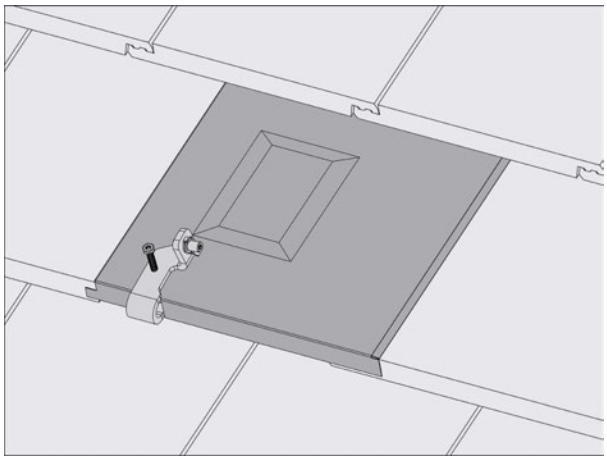
- *(A) - Marked interference area to be cut out*

2. Bend the cut tab under the flashing so that it sits against the Tile Hook without interference.





3. Drive the flashing securing bolt through the Replacement Flashing until the fastener head is flush with the hook to secure the Replacement Flashing in place.



Step 3: Install Spanner Bars

Overview

Install the Spanner Bars on the vertical supports to interface with the mounting hardware. Spanner Bars are installed in the Y direction and are secured to the Tile Hook by T-bolts.

Prerequisites

Requires installation of Tile Hooks in the marked locations along the rafters. (*Step 2: Install Tile Hooks on page 37*)

Hazards

Figure 3. Fall from Height

Safety and PPE

- Safety glasses (ANSI Z87.1 or EN 166)
- Cut-resistant gloves (ANSI Cut Level 3 or EN 388 Level C)
- Closed-toed shoes
- Fall protection equipment (full-body harness with lanyard) for working at height

General Equipment

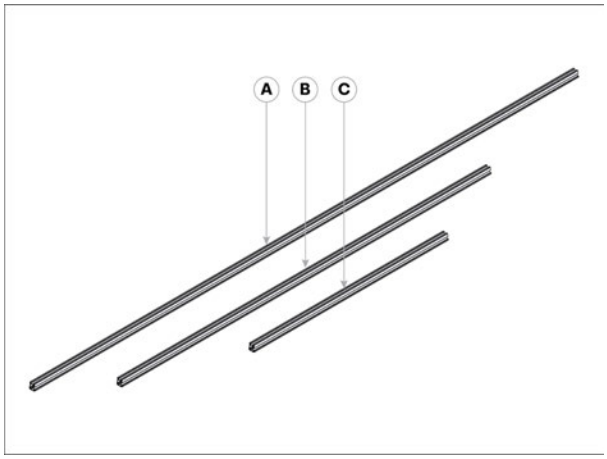
- Extension ladder, fiberglass (ANSI/ASC Type IA, 300 lb/135 kg rating)

Required Parts and Tools

- Spanner Bars
- Spanner Splices
- Spanner Bar Caps
- Impact driver
- Torque wrench
- T40 Torx bit

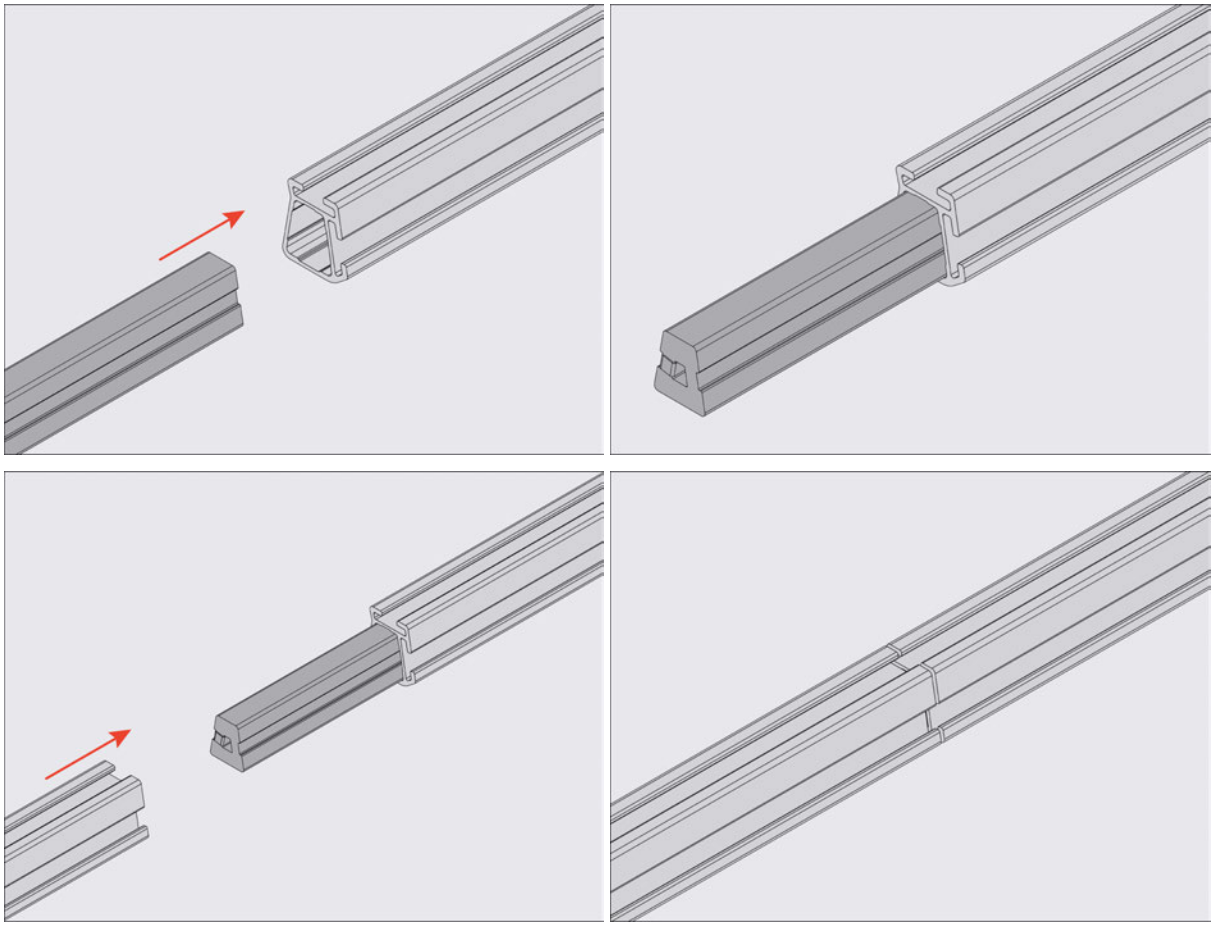
Install

1. Put on cut-resistant gloves and safety glasses.
2. **Determine Spanner Bar lengths.**
    a. Spanner Bars are available in 1x, 2x, and 3x lengths. Select the correct pre-cut lengths and assemble them based on the up-roof dimension of the array design. When Spanner Bar ends meet in the Y direction, install a Spanner Splice to connect them structurally.

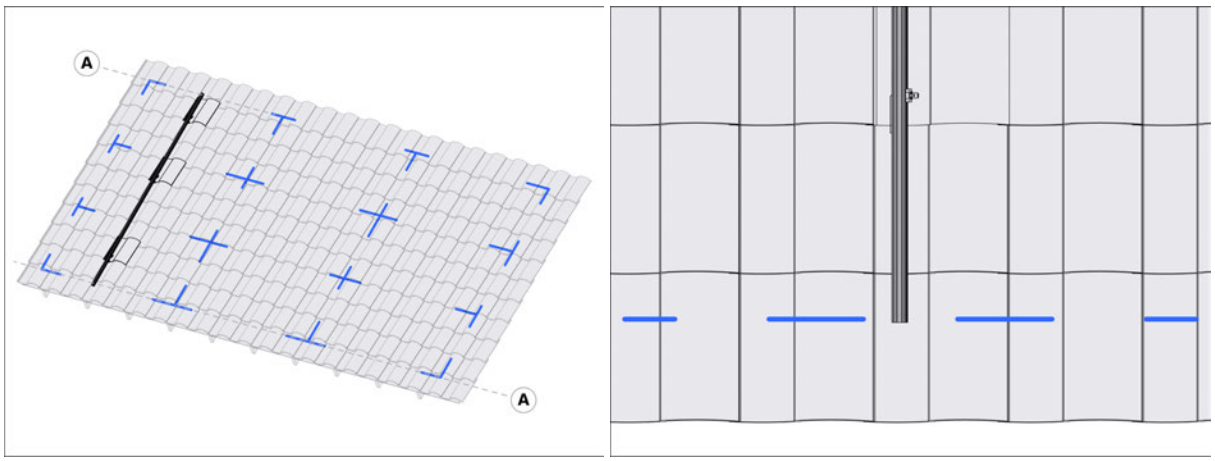


- *(A) - 3x Spanner Bar length*
- *(B) - 2x Spanner Bar length*
- *(C) - 1x Spanner Bar length*

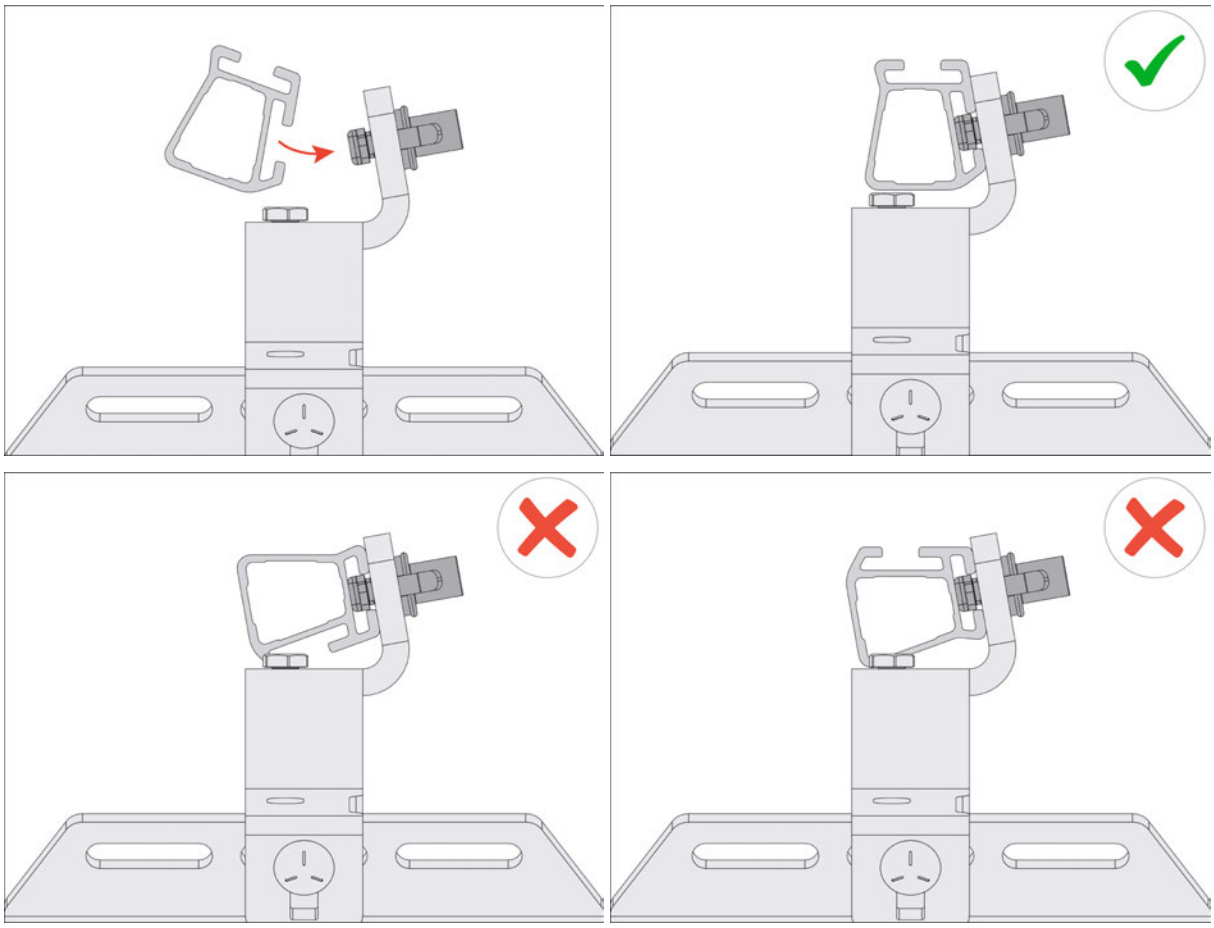
b. To install a Spanner Splice, insert it into the channel on the Spanner Bars by hand and slide it in until it stops. The Spanner Bar ends should meet in the middle of the Spanner Splice when it is fully inserted, and a small gap between the Spanner Splice ends is expected due to the geometry of the splice spring.



3. **Install Spanner Bars at the outside ends of the first row.**
   a. Align the down-roof end of the Spanner Bar with the marked module edge with the tapered side up.

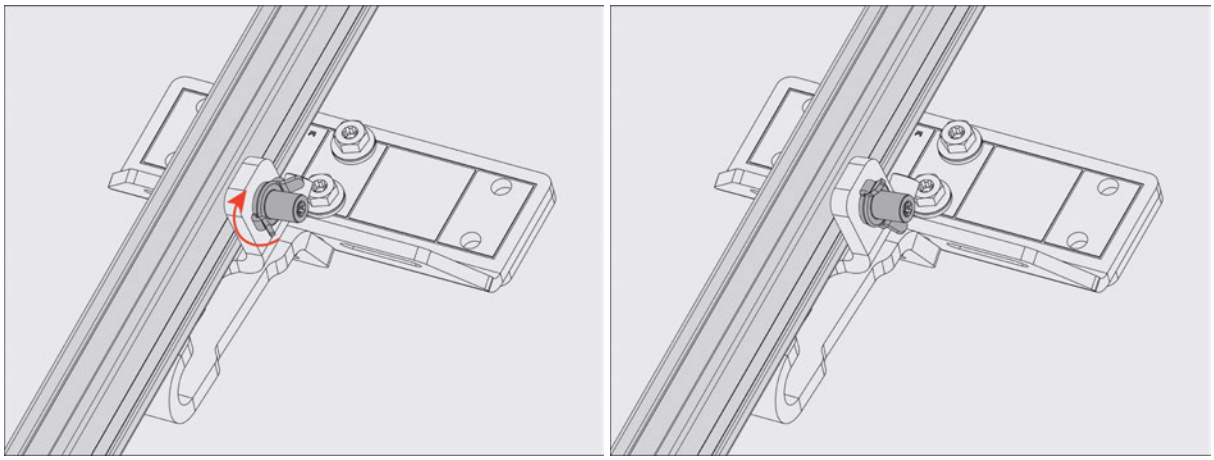


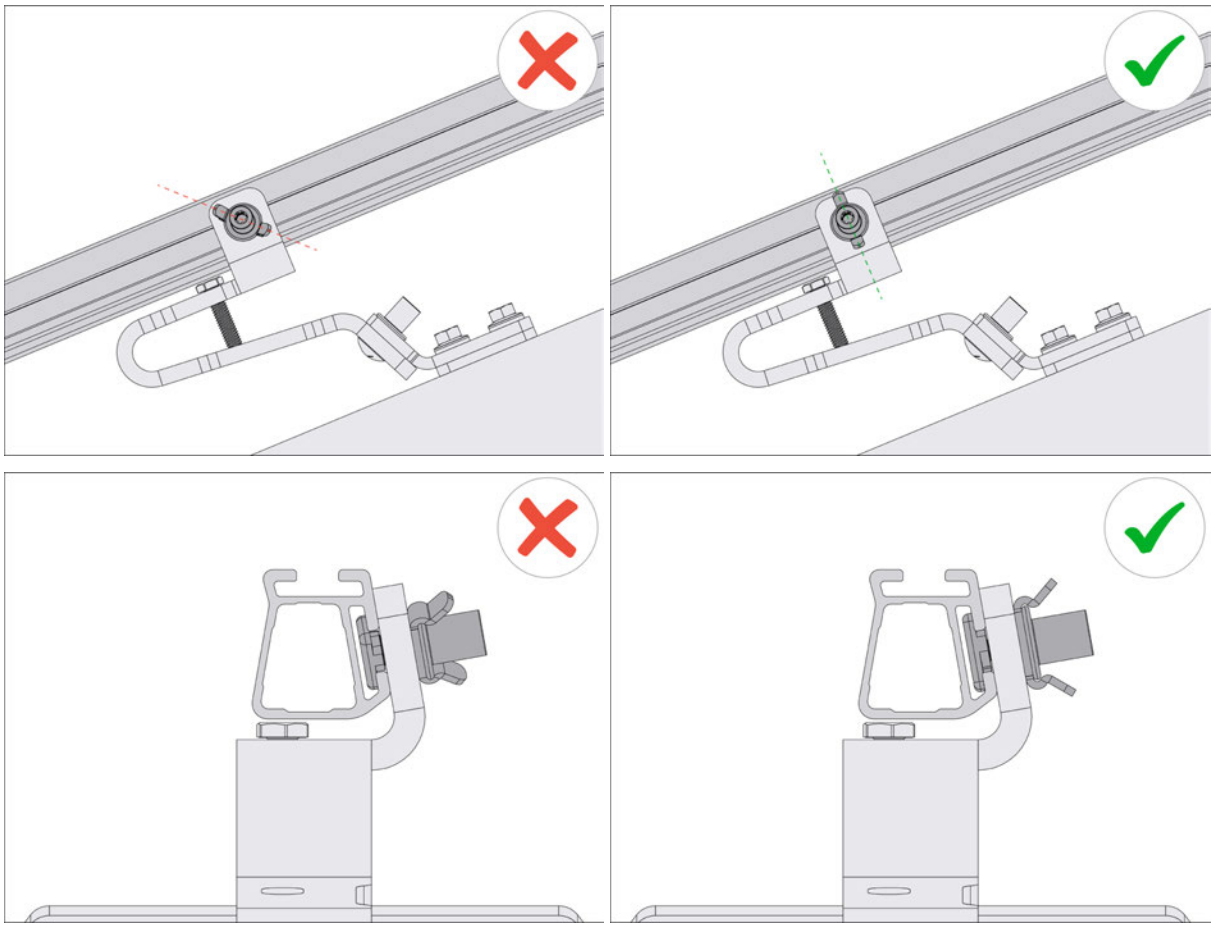
- *(A) - Spanner Bar in line with marked module edges*



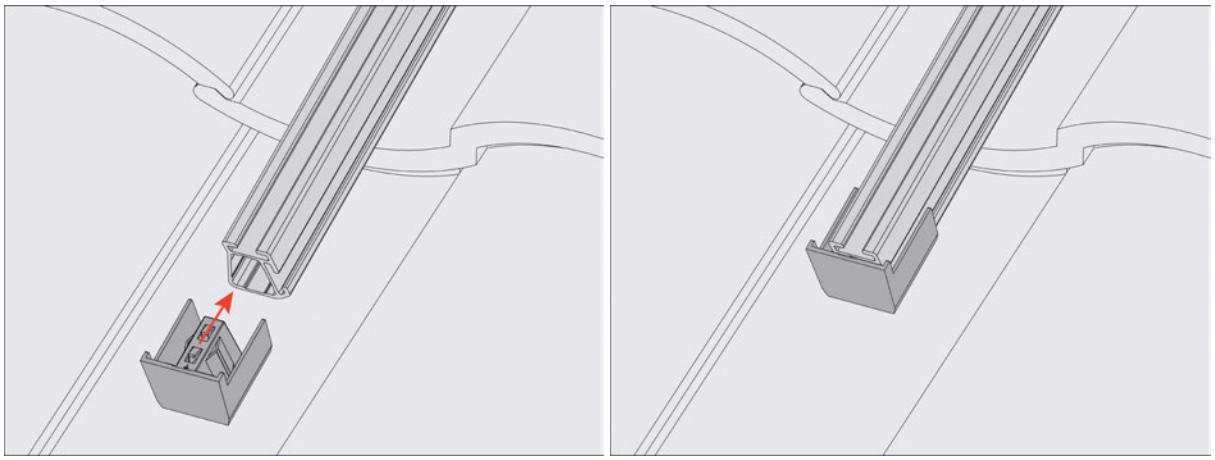
4. **Fasten the up-roof and down-roof ends of the outside Spanner Bars.**
    a. Insert the T-Bolt into the channel on the Spanner Bar and fasten it with the impact driver. When the T-Bolt rotates 90° clockwise and is fully fastened, the Spanner Bar will lock into place and the bolt will prevent it from sliding along the channel.

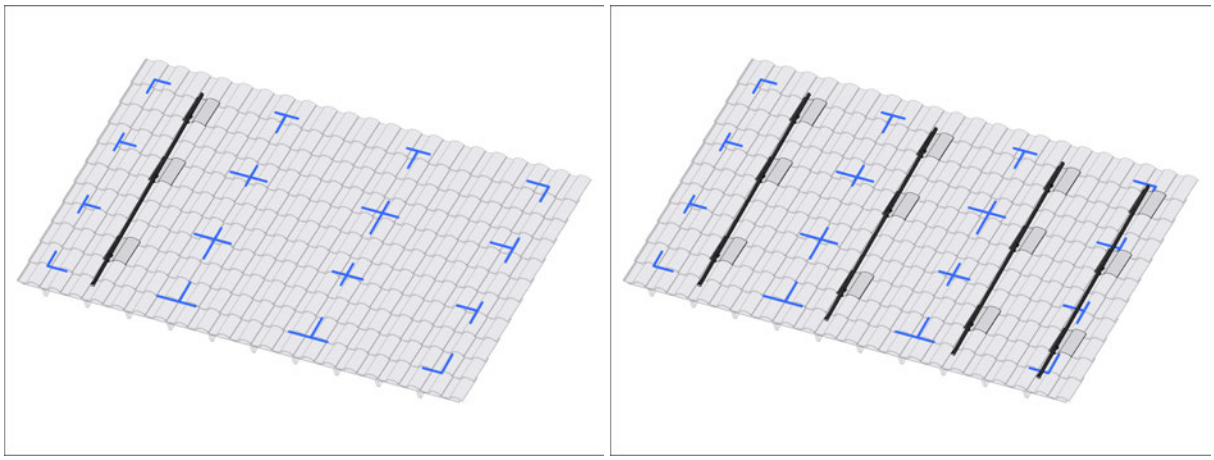
> **NOTE:** When fully engaged with the channel, the indicator tabs on the T-Bolt will rotate 90° and be perpendicular to the Spanner Bar. Failure to rotate the T-Bolt fully will result in an insufficient structural connection.





5. **Install Spanner Bar Caps.**
    a. To complete the aesthetic design of the array, insert Spanner Bar Caps into the Spanner Bars at the down-roof end with the tapered side up.





Related tasks

- Step 4: Install the Front Row Leveling Feet on page 56

Related information

- Installation Overview on page 29

Step 4: Install the Front Row Leveling Feet

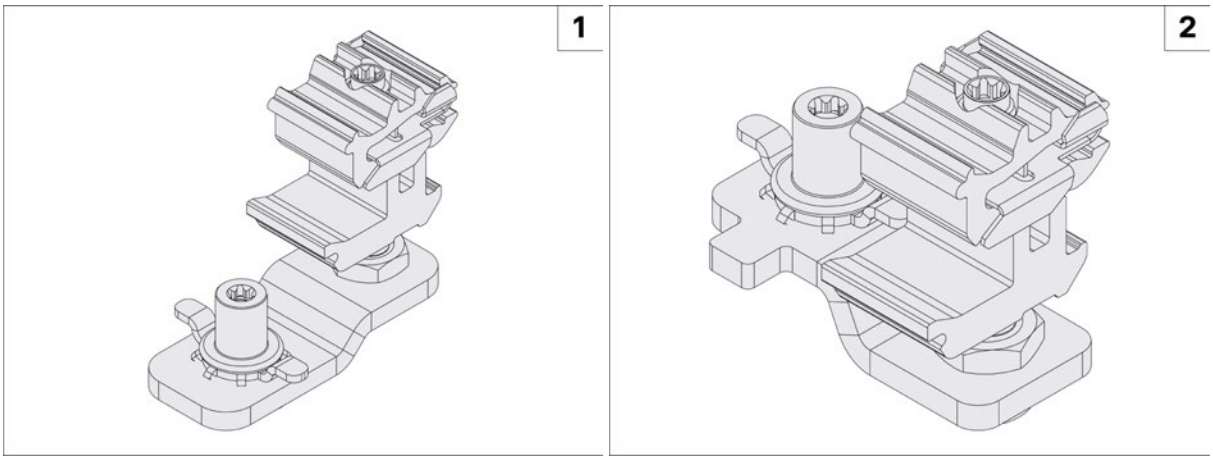
Overview

Install the Leveling Feet on the Spanner Bars.

Prerequisites

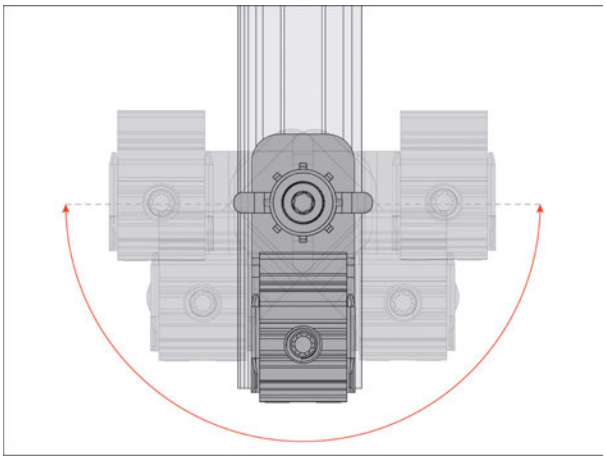
Perform this procedure after installing the Spanner Bars. (*Step 3: Install Spanner Bars on page 51*)

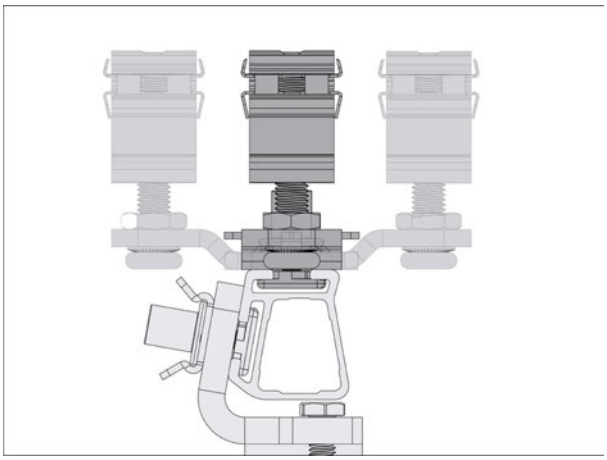
Select the correct Leveling Feet for the type of tile.



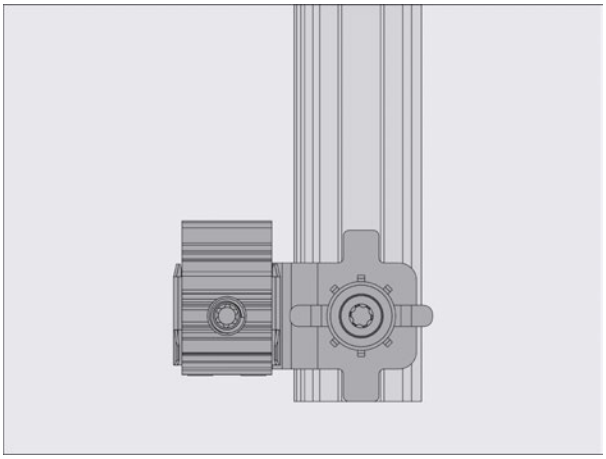
- *(1) - Leveling Foot for Round Tile*
- *(2) - Leveling Foot for Flat Tile*

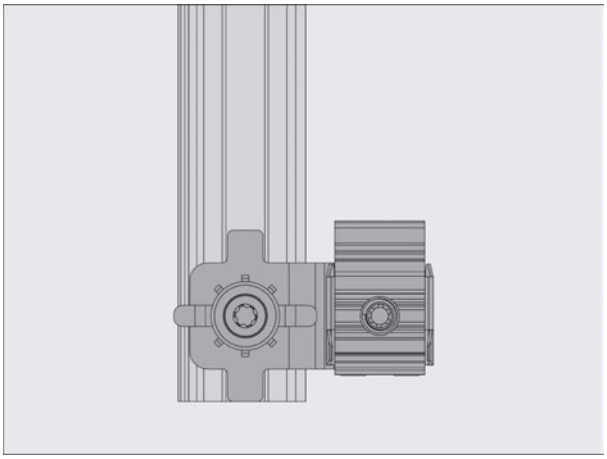
Round tile uses a Leveling Foot assembly that can swivel to either side of the Spanner Bar for module alignment.

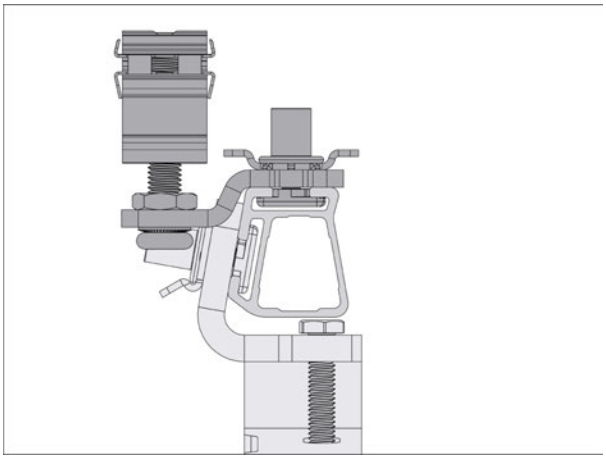


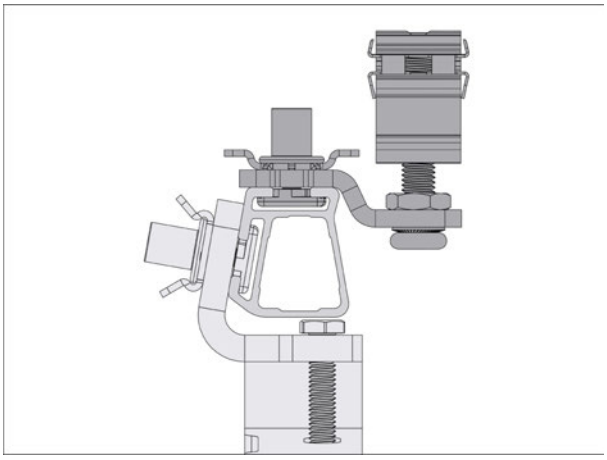


Flat Tile uses a Leveling Foot assembly that does not swivel but can be installed on either side of the Spanner Bar and sits lower to reduce the gap between the PV modules and the tile.









Hazards

Figure 4. Fall from Height

Safety and PPE

- Safety glasses (ANSI Z87.1 or EN 166)
- Cut-resistant gloves (ANSI Cut Level 3 or EN 388 Level C)
- Closed-toed shoes
- Fall protection equipment (full-body harness with lanyard) for working at height

General Equipment

- Extension ladder, fiberglass (ANSI/ASC Type IA, 300 lb/135 kg rating)

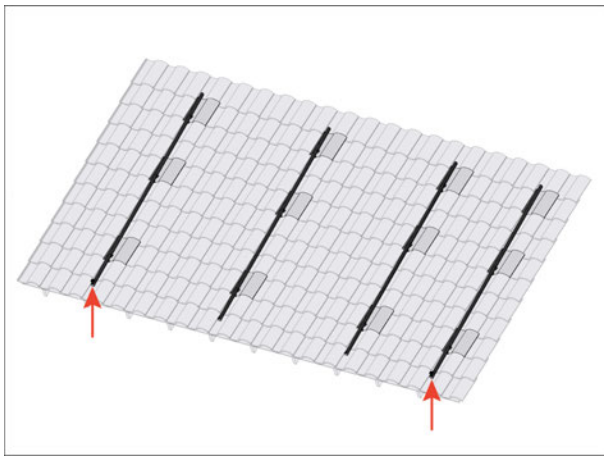
Required Parts and Tools

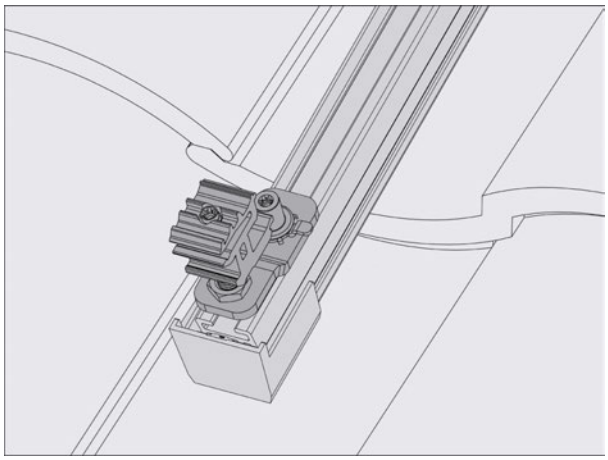
Tools listed are in addition to *#unique_49 on page* .

- Impact driver
- ½ in. socket or T40 Torx bit

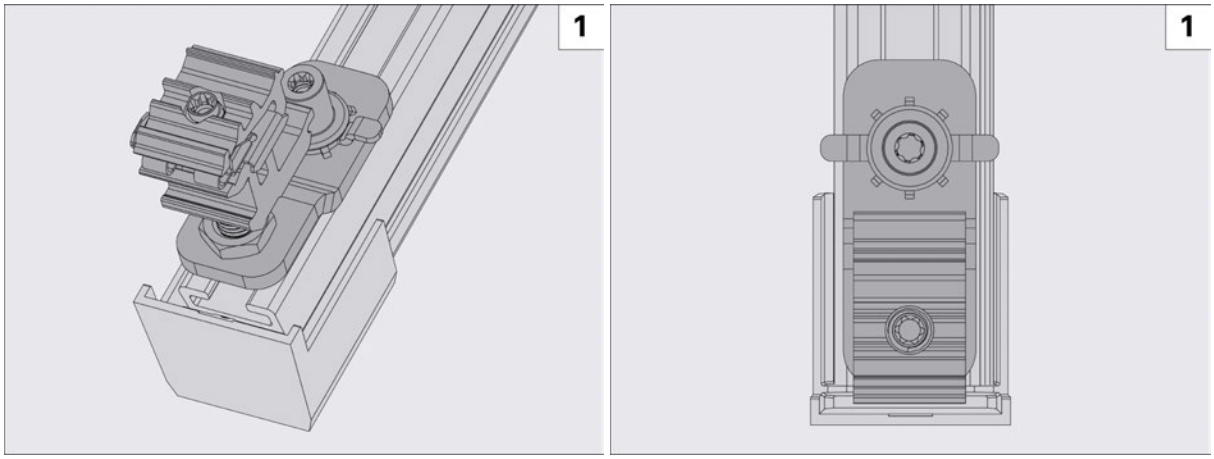
Install Leveling Feet

1. Put on cut-resistant gloves and safety glasses.
2. **Install the Leveling Feet at the corners of the first row.**
    a. Set the Leveling Feet in the nominal position by aligning them flush with the down-roof ends of the Spanner Bars.

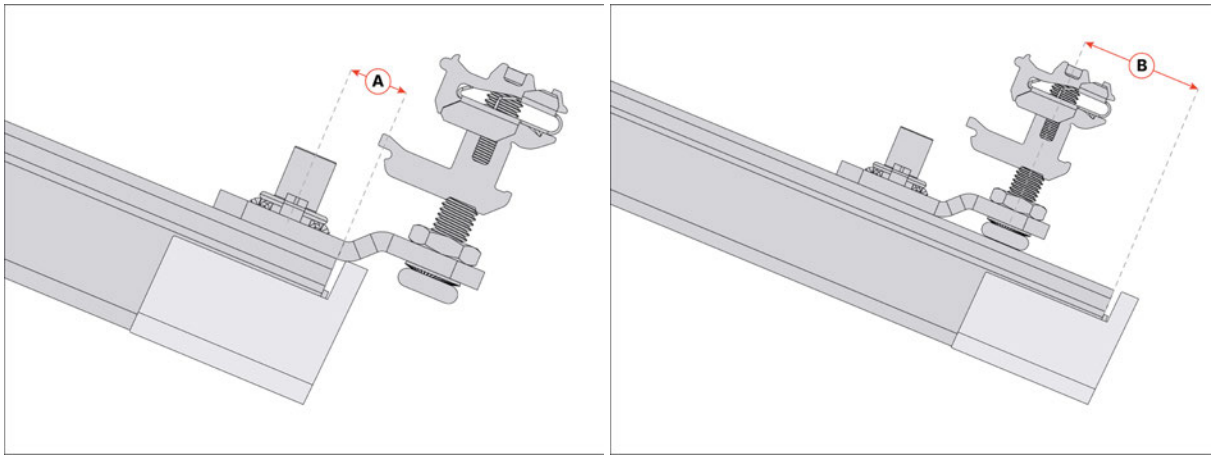




b. Face the Key side of the Rockit down-roof, with the Tongue side facing up-roof.



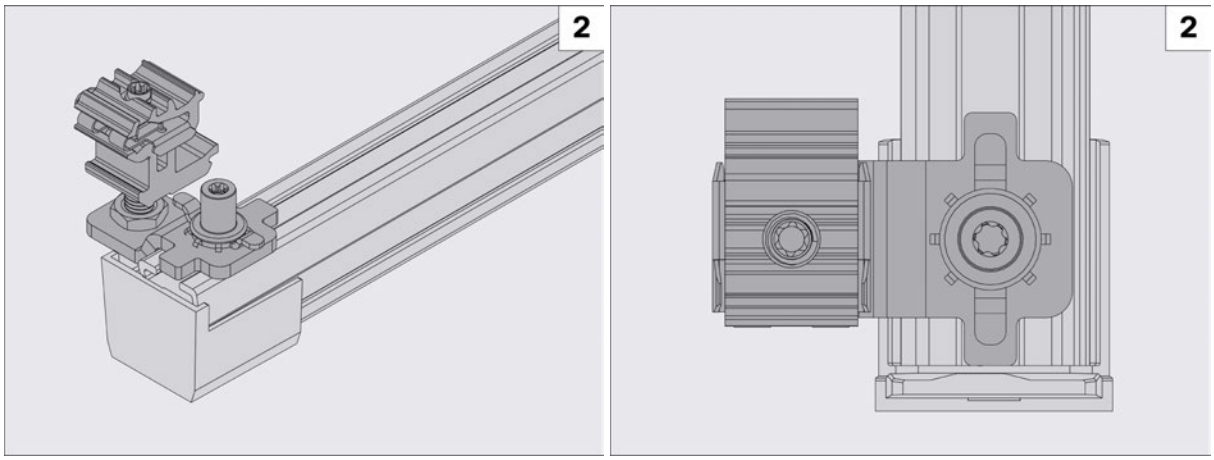
- *(1) - Round Tile Leveling Foot, nominal position on Spanner Bar*



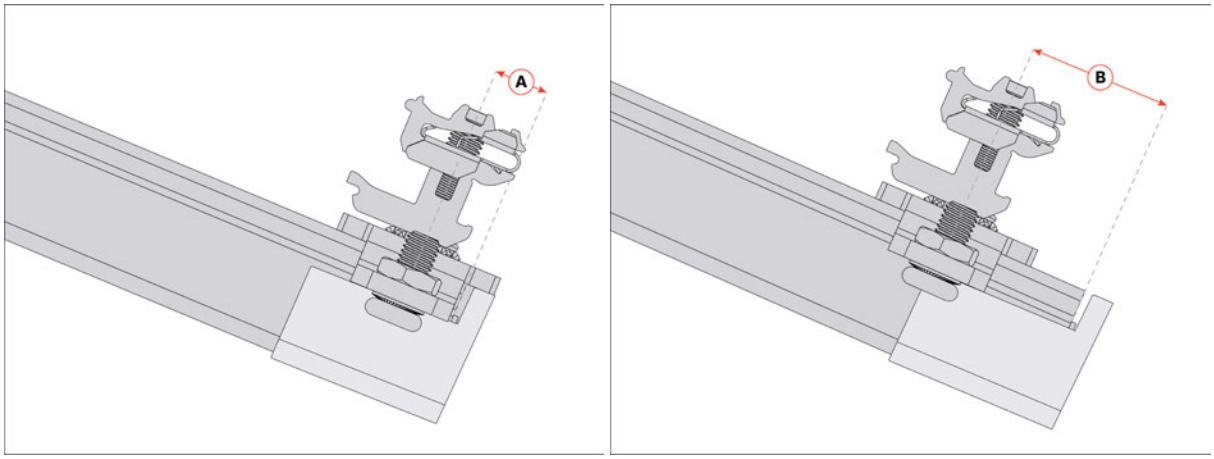
- *(A) - Minimum distance between Round Tile Leveling Foot T-Bolt and front of Spanner Bar (5/8 in)*
- *(B) - Maximum distance between Round Tile Leveling Foot stud and front of Spanner Bar (1 5/8 in)*

NOTE: Leveling Feet for Flat Tile should be installed on the right side of the Spanner Bar when looking down-roof to avoid interference with the Front Skirt Grips.

If a Leveling Foot needs to be installed on the left side of the Spanner Bar to meet cantilever rules, raise the Rockit to install the Front Skirt and Front Skirt Grip, then lower the Rockit until level with the others in the row.



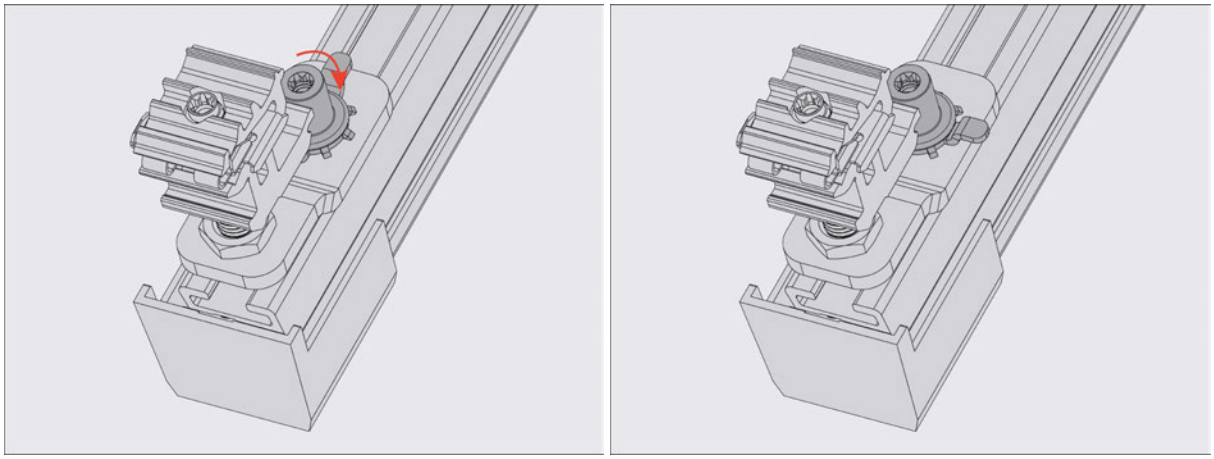
- *(2) - Flat Tile Leveling Foot, nominal position on Spanner Bar*

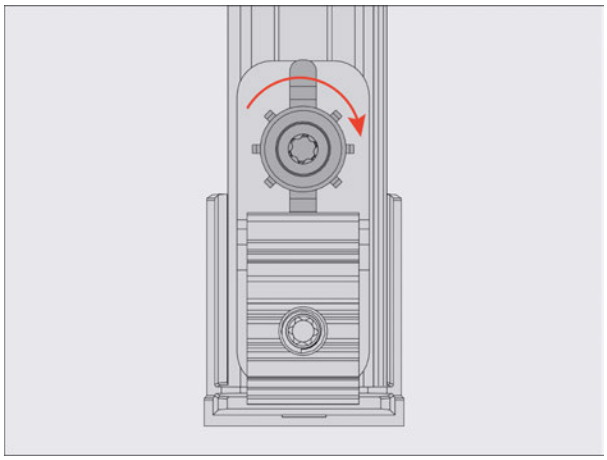


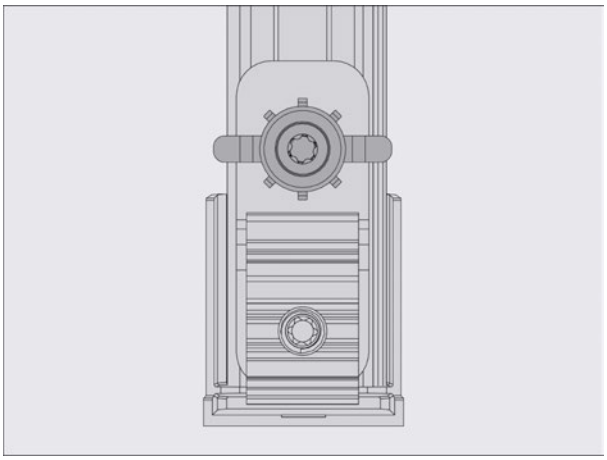
- *(A) - Minimum distance between Flat Tile Leveling Foot T-Bolt and front of Spanner Bar (5/8 in)*
- *(B) - Maximum distance between Flat Tile Leveling Foot stud and front of Spanner Bar (1 5/8 in)*

c. Secure the Leveling Feet to the Spanner Bar using the included T-Bolt.

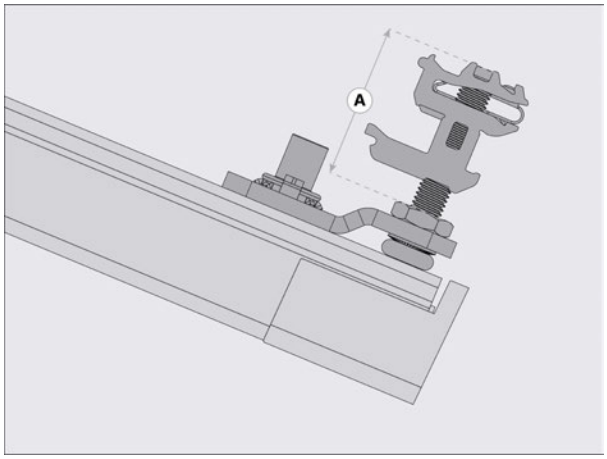
NOTE: When fully engaged with the channel, the indicator tabs on the T-Bolt will rotate 90° and be perpendicular to the Spanner Bar. Failure to rotate the T-Bolt fully will result in an insufficient structural connection.





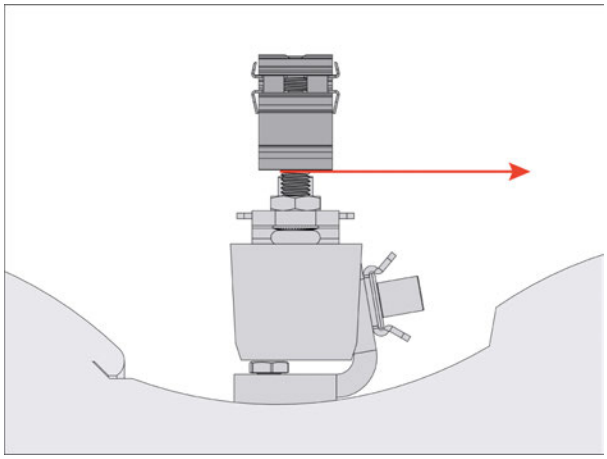


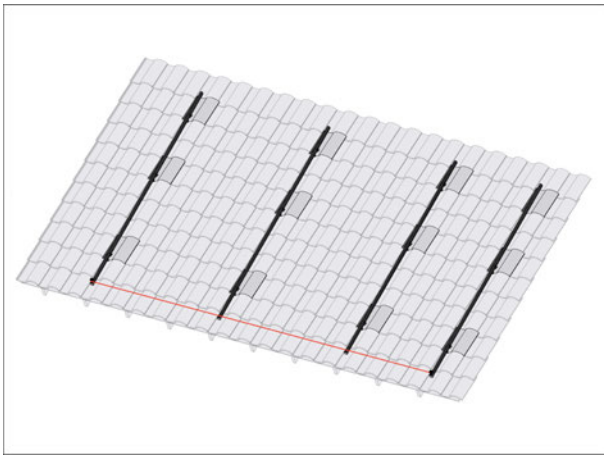
3. **Anchor a string line between the outside Leveling Feet.**
    a. Ensure that the Rockit is at nominal height on its stud to provide maximum flexibility on consecutive rows. The Rockit is in the nominal height when the top of the stud is flush with the top of the Rockit.

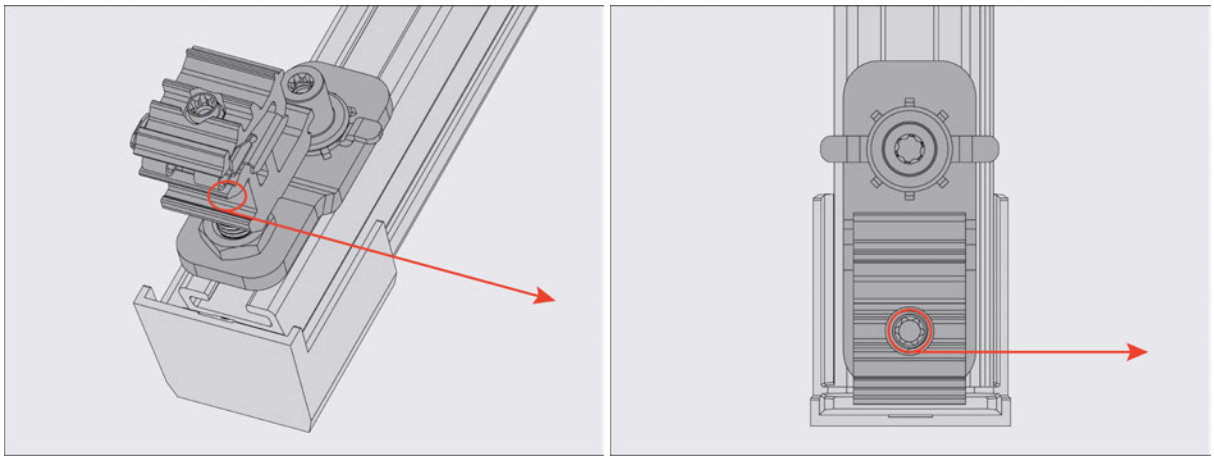


- *(A) - Nominal Rockit height on Round Tile Leveling Foot, Rockit at same height as bolt on Leveling Foot*

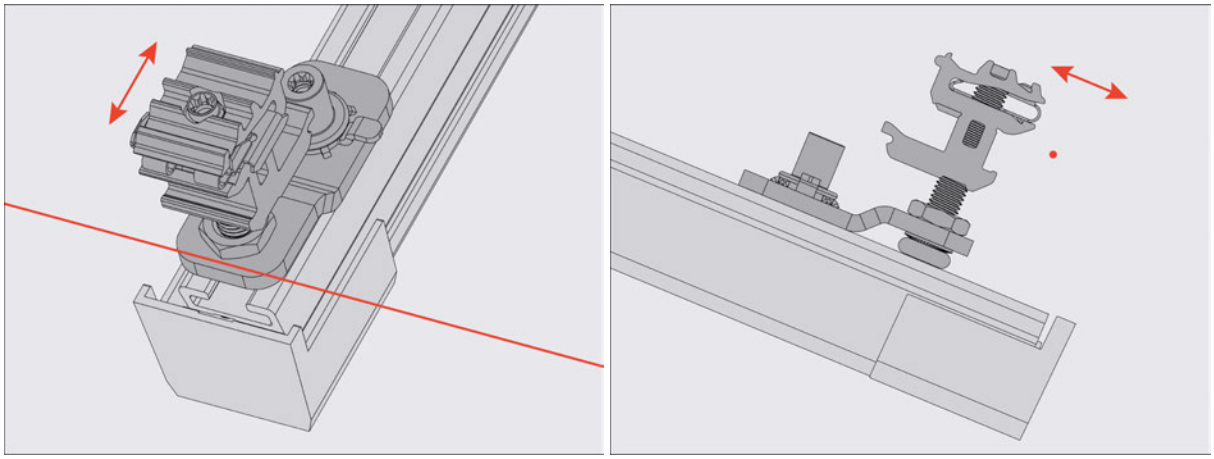
    b. Run a string line between the two corner Leveling Feet. The string line should be pulled across the front of the stud and flush with the bottom of the Rockit.



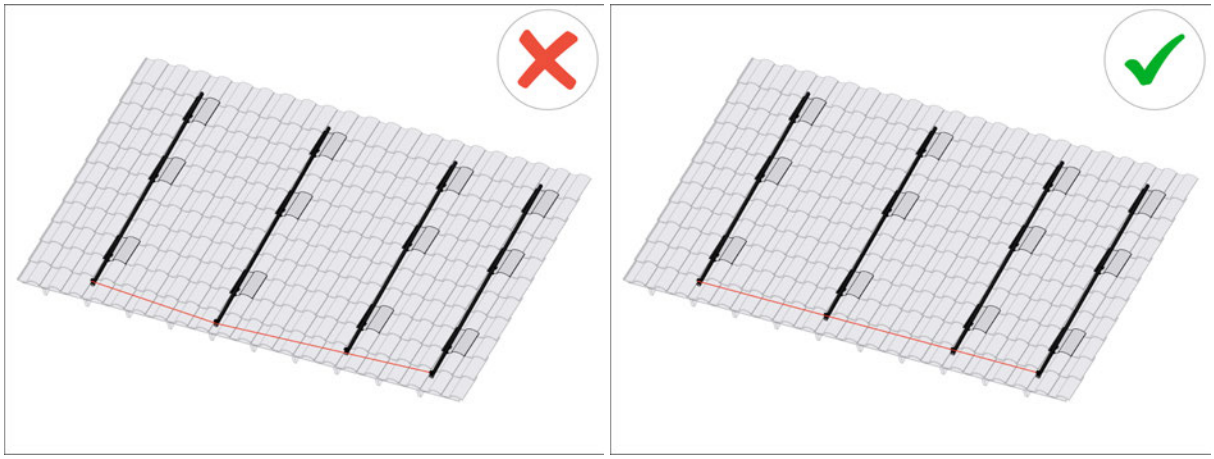




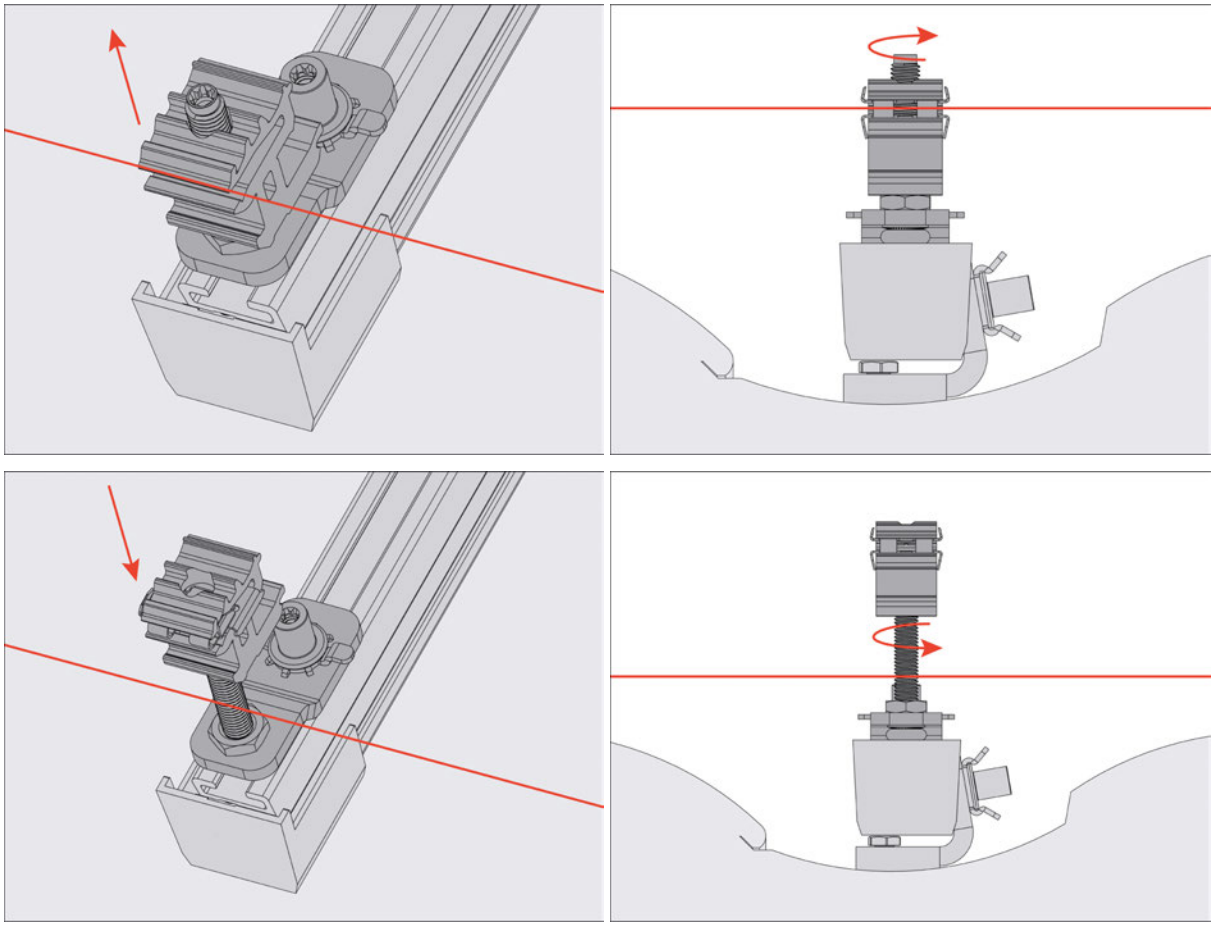
4. **Align the remaining first row Leveling Feet to the string line.**
    a. Set the inner Leveling Feet in the nominal position, and align the Leveling Feet with the string line before tightening the T-Bolts.



    b. Install the remaining Leveling Feet in the first row and adjust them so that the Leveling Foot stud is as close to the string line as possible without pushing on the string line.



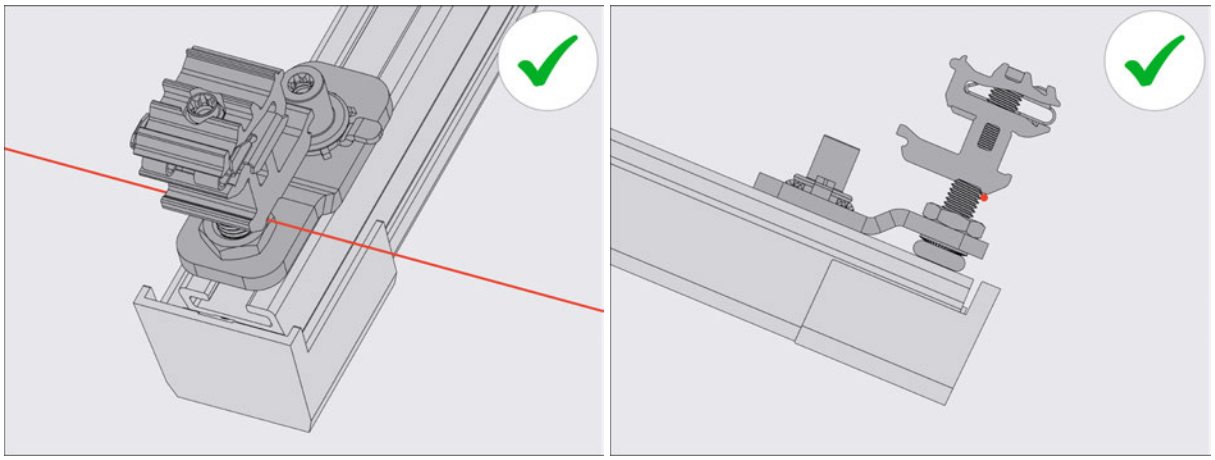
c. To accommodate for sags or humps in the roof surface, adjust the Rockits up or down by 3/8 in.

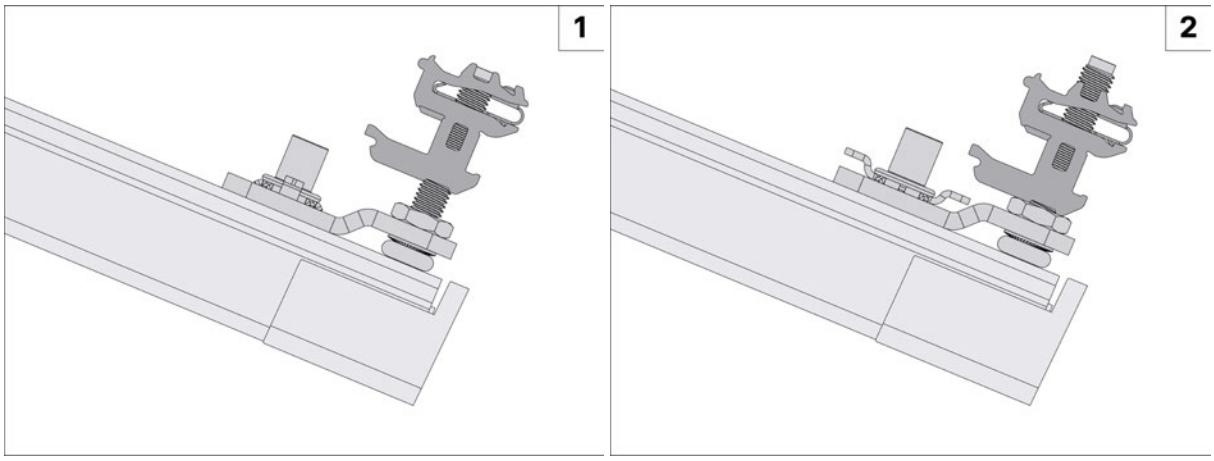


- In the lowest position, the Rockit will be touching the nut.
- In the highest position, the stud will be flush with the bottom of the window of the Rockit.

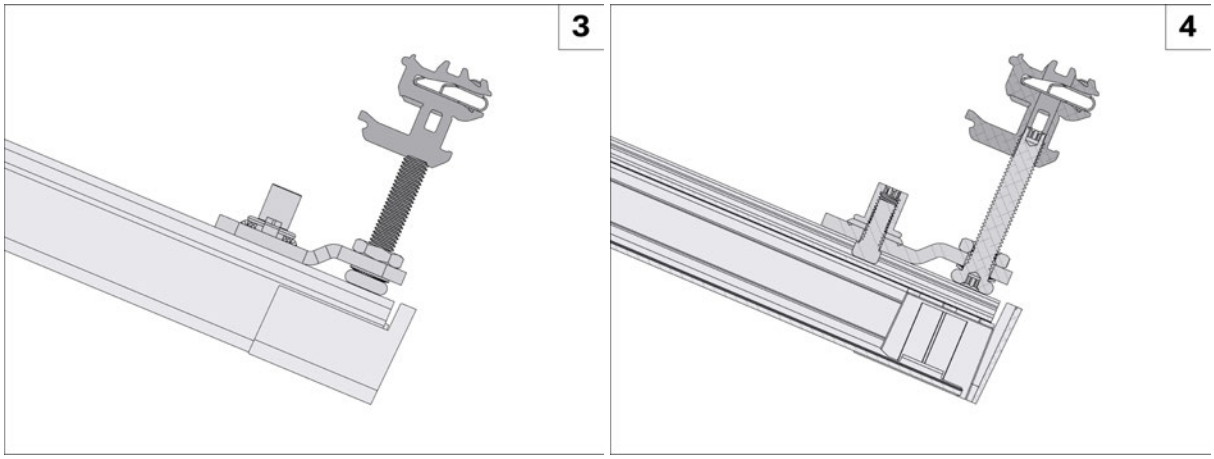
d. Rotate and level all first row Rockits to just above the string line, with the Key side of the Rockits pointing down-roof.

Round Tile Leveling Feet



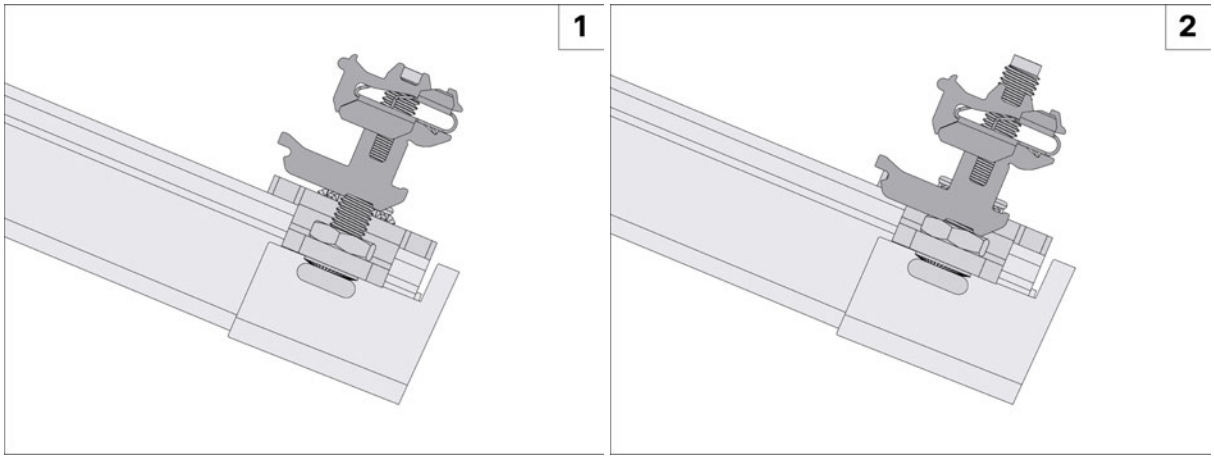


- *(1) - Nominal height*
- *(2) - Minimum height*

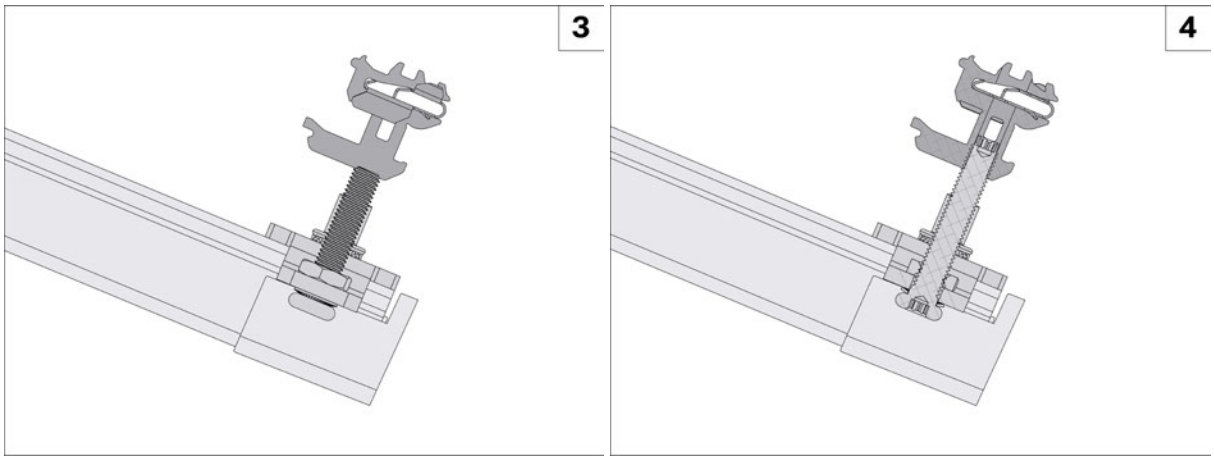


- *(3) - Maximum height (stud flush with bottom of window)*
- *(4) - Maximum height (cross section)*

Flat Tile Leveling Feet



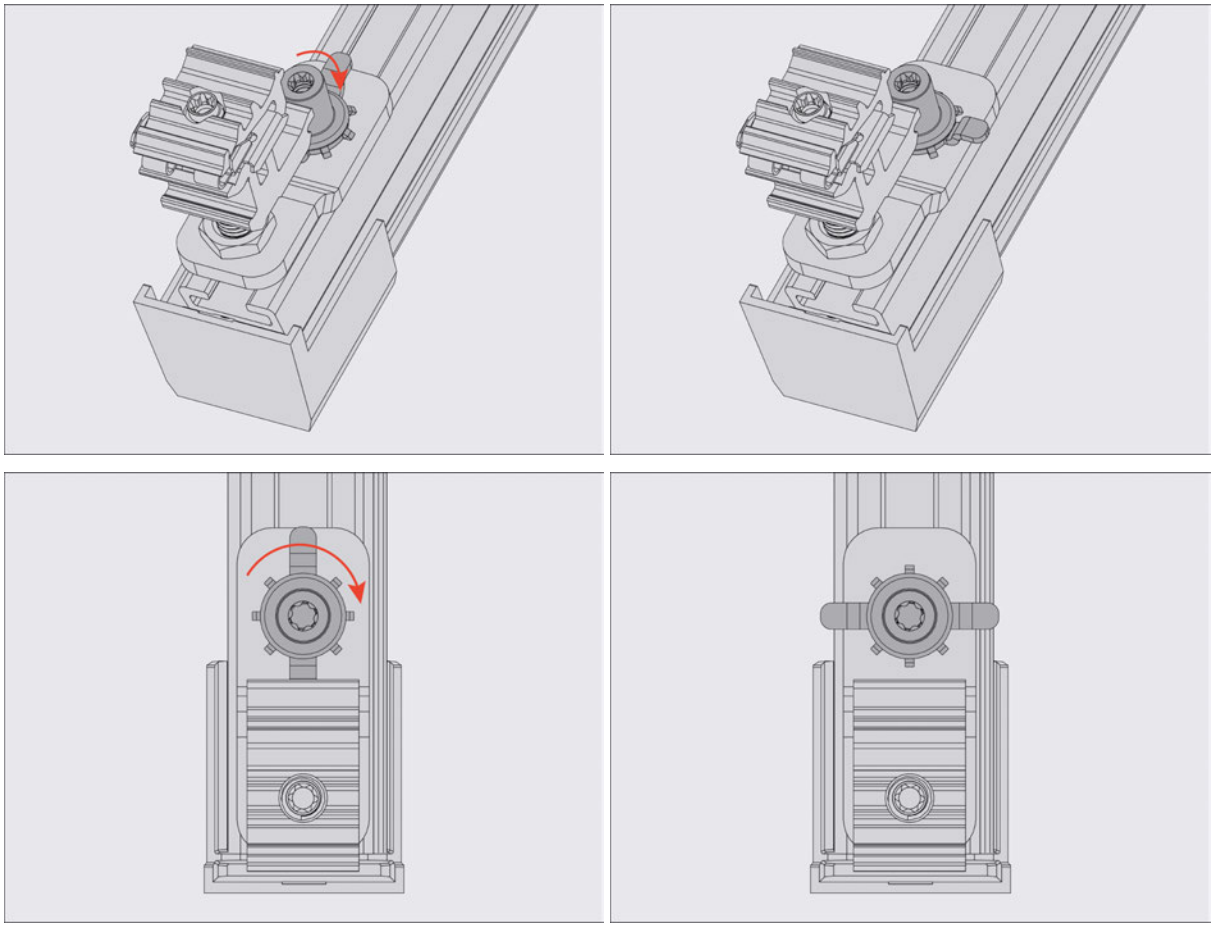
- *(1) - Nominal height*
- *(2) - Minimum height*



- *(3) - Maximum height*
- *(4) - Maximum height (cross section)*

5. **Tighten the Leveling Foot T-Bolts.**
   a. Fasten the Leveling Feet in place once the Rockits are aligned with the string line.

> **NOTE:** When fully engaged with the channel, the indicator tabs on the T-Bolt will rotate 90° and be perpendicular to the Spanner Bar. Failure to rotate the T-Bolt fully will result in an insufficient structural connection.



Related tasks

- Step 5: Install the Front Skirt on page 67

Related information

- Installation Overview on page 29

Step 5: Install the Front Skirt

Overview

The Front Skirt establishes structural support for the first row of PV modules and conceals the mounting hardware underneath.

Prerequisites

Requires installation of the first row of mounting hardware. (*Step 4: Install the Front Row Leveling Feet on page 56*)

Hazards

Figure 5. Fall from Height

Safety and PPE

- Safety glasses (ANSI Z87.1 or EN 166)
- Cut-resistant gloves (ANSI Cut Level 3 or EN 388 Level C)
- Closed-toed shoes
- Fall protection equipment (full-body harness with lanyard) for working at height

General Equipment

- Extension ladder, fiberglass (ANSI/ASC Type IA, 300 lb/135 kg rating)

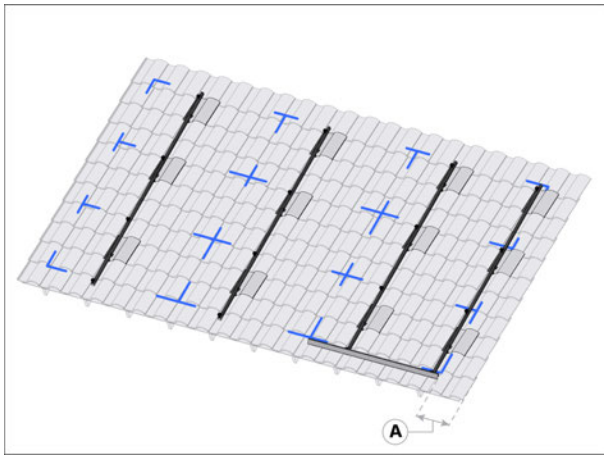
Required Parts and Tools

- Tesla Installation Tool **or** Tesla Solar Wrench
- String line

Install Front Skirt

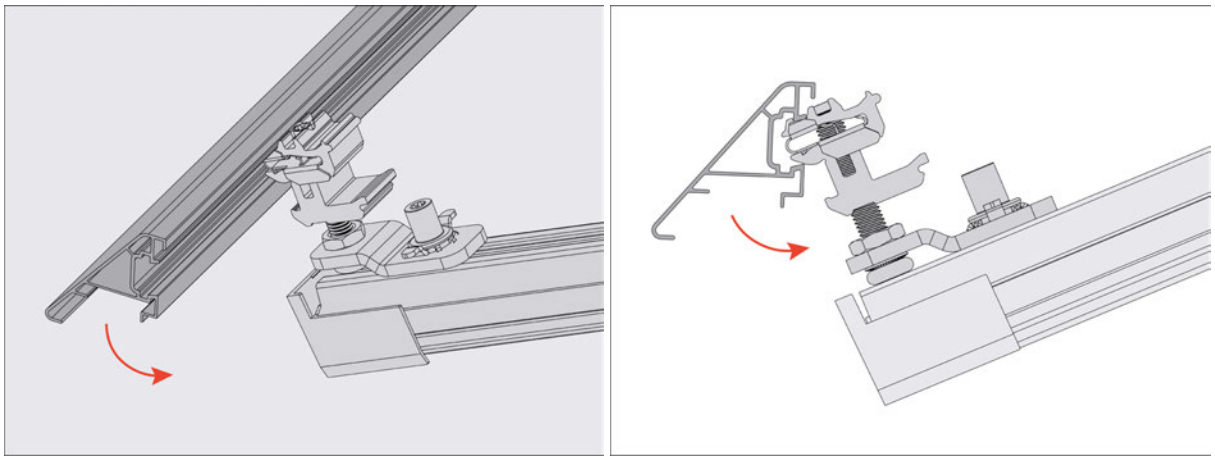
1. Put on cut-resistant gloves and safety glasses.
2. Inspect and put on fall protection before performing roof work. Ensure that your fall harness is connected to a certified anchor point and maintain 6 ft (2 m) clearance from the roof edge unless guarded.

3. Rock in the Front Skirt.

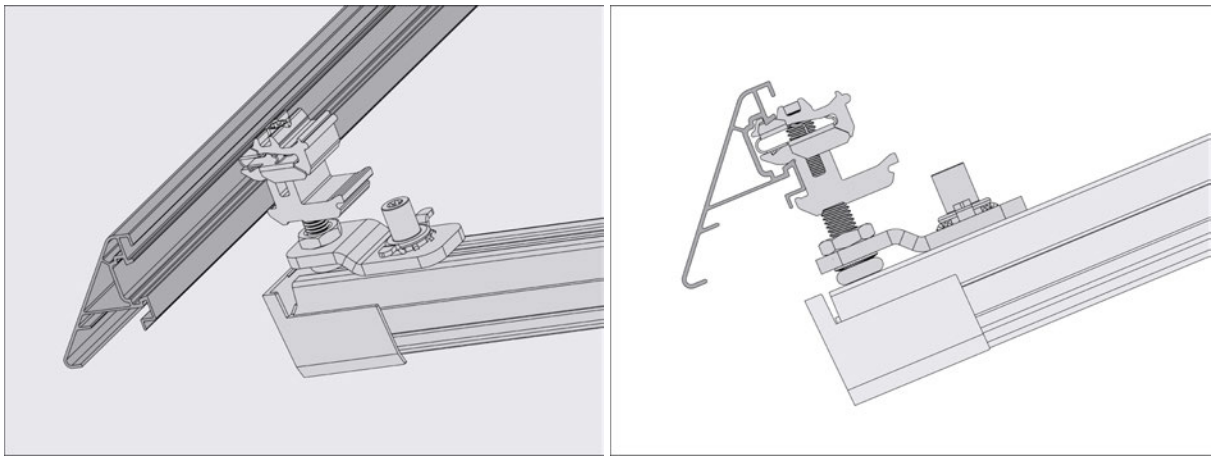


   - *(A) - Front Skirt aligned with module layout marks*

   a. Install the first Front Skirt starting at the corner of the array. If either corner has two Leveling Feet spaced closer together, start with this corner. Align the edge of the skirt with the module layout marks, ensuring the skirt end stays within the allowed cantilever distance from the center of the Rockit.

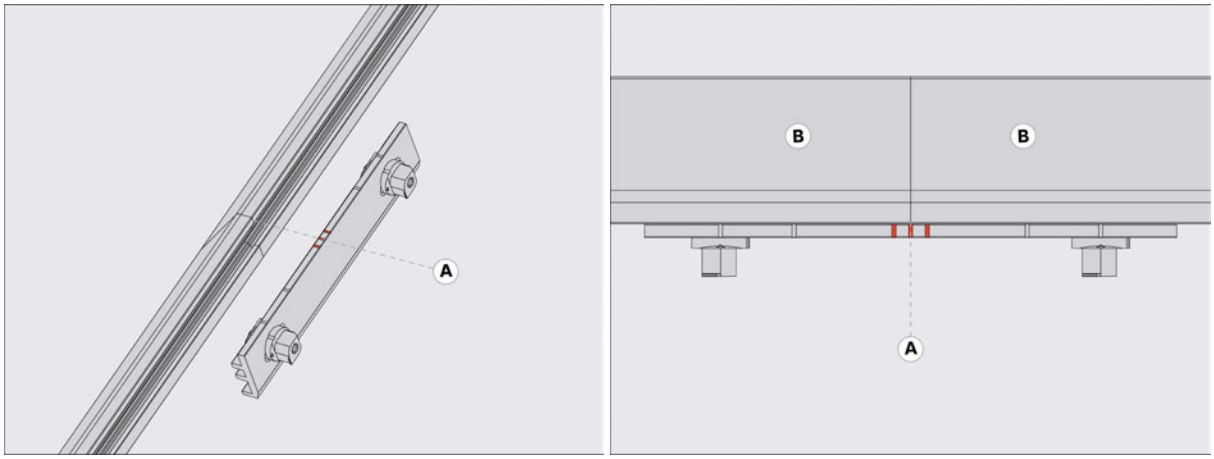


   b. Set the Front Skirt on the Rockits and rock it down, making sure to fully engage with the Key side of the Rockit. The Front Skirt should press flush against the Rockit.

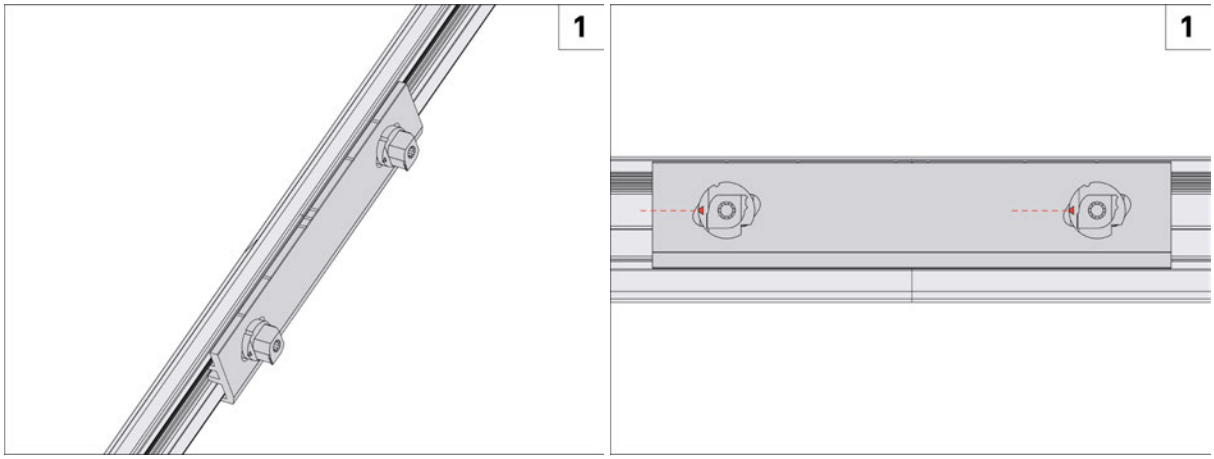


4. Install the Interlock.

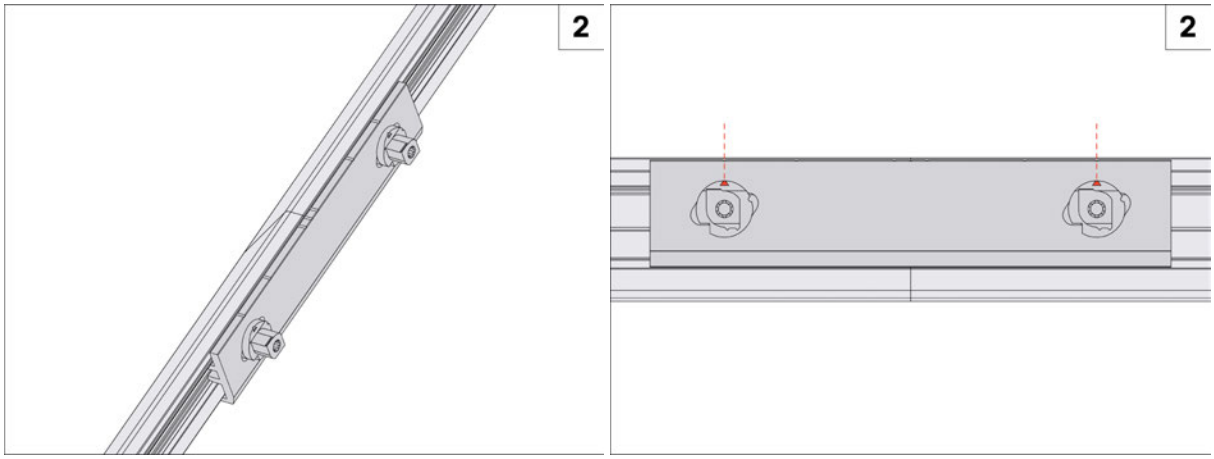
a. Install the next Front Skirt, ensuring that the edge sits flush against the first with no gap. Place and center an Interlock over the seam of the two Front Skirts, using timing marks as shown. Rotate the Interlock Keys from Position 1 to Position 3. This bonds the two skirt sections both structurally and electrically.



- *(A) - Seam*
- *(B) - Front Skirt*



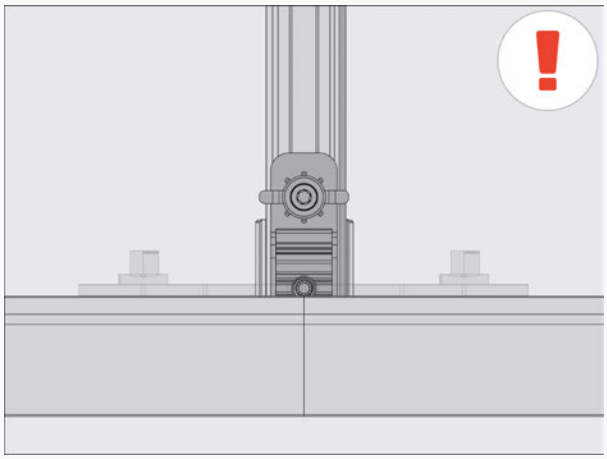
- *(1) - Interlock in open position*



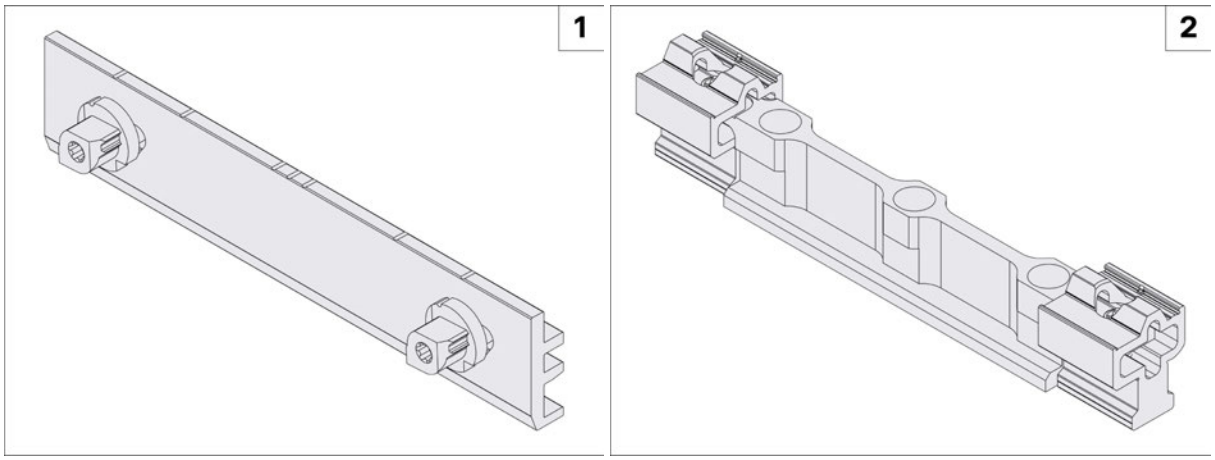
- *(2) - Interlock in locked position*

b. Complete the Front Skirt by installing additional Front Skirts with Interlocks for the length of the array.

NOTE: If the position of the Front Skirt seams requires an Interlock where it conflicts with the position of a Rockit, use a Hybrid Interlock instead. The Hybrid Interlock has three mounting holes for centered or offset installation.



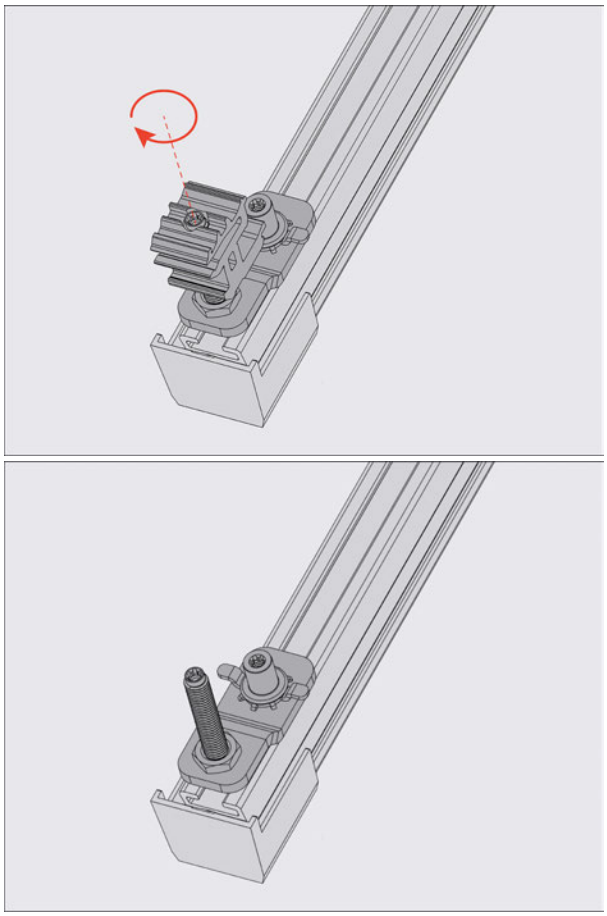
Hybrid Interlock



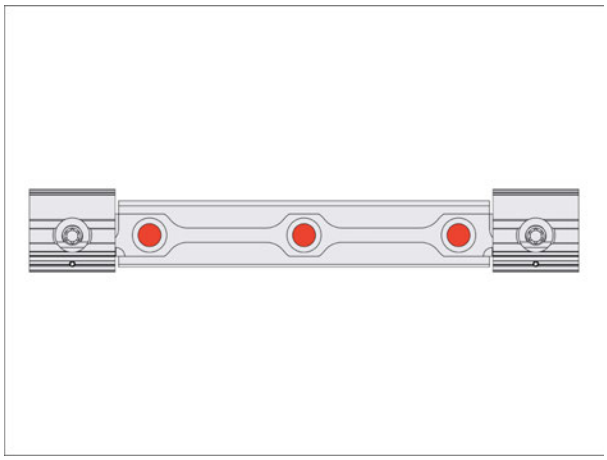
- *(1) - Interlock*
- *(2) - Hybrid Interlock*

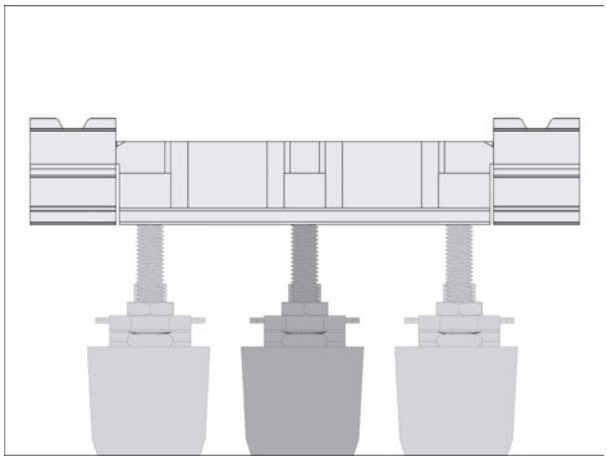
To install a Hybrid Interlock:

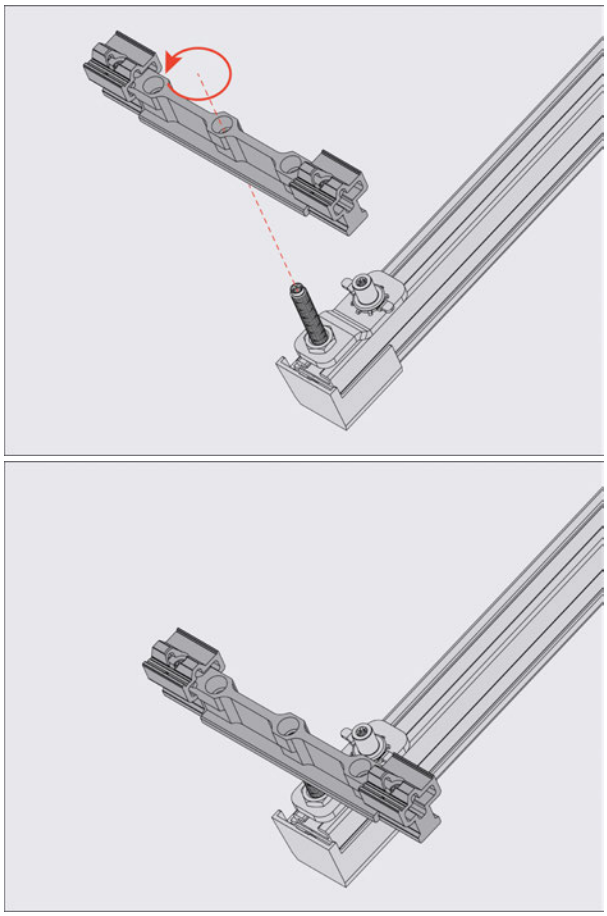
i. Rotate the Rockit clockwise to remove it from the Leveling Foot stud.



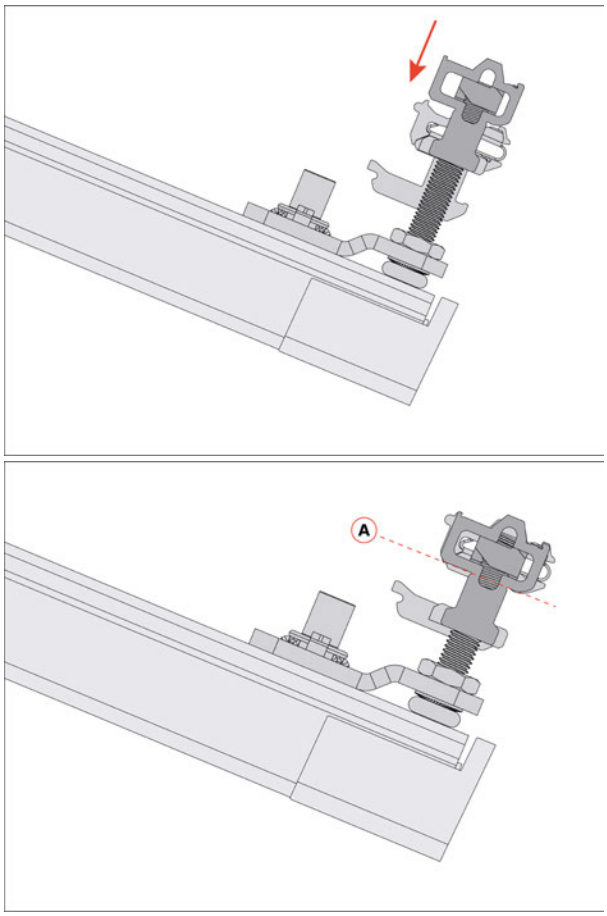
ii. Install the Hybrid Interlock onto the Leveling Foot stud using one of the three mounting holes on the Hybrid Interlock.



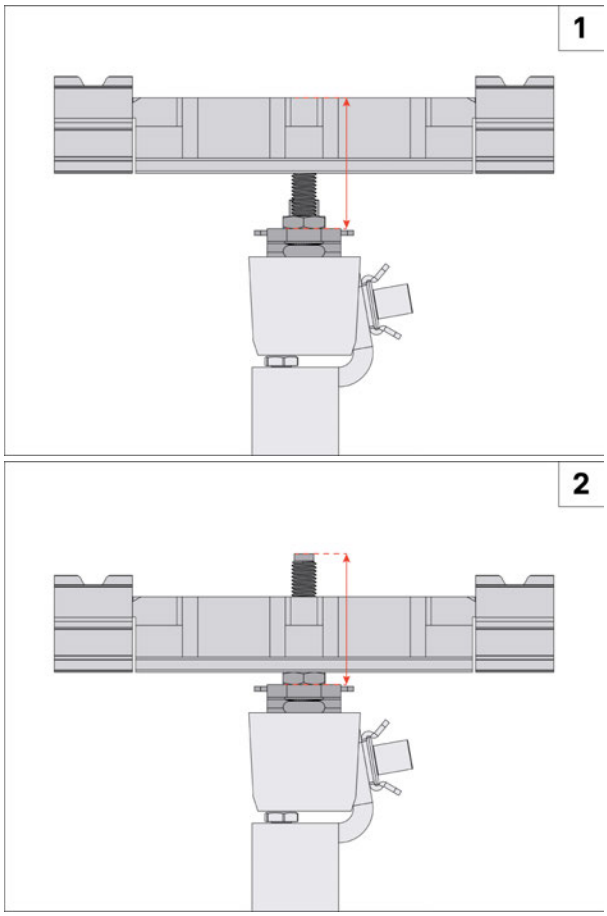




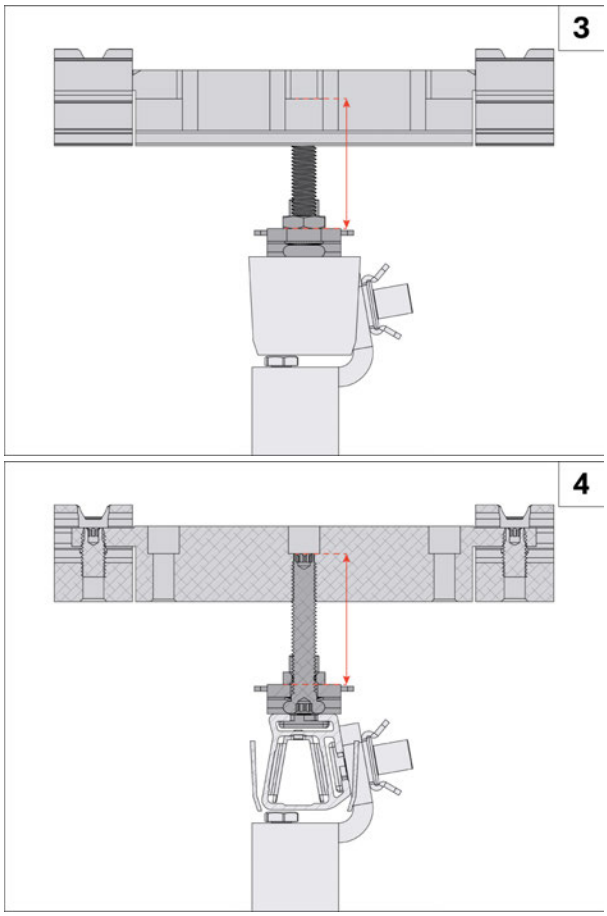
iii. Use a string line to correctly align the Hybrid Interlock with the rest of the Rockits in the front row.



- *(A) - Align Hybrid Interlock with Rockits here.*

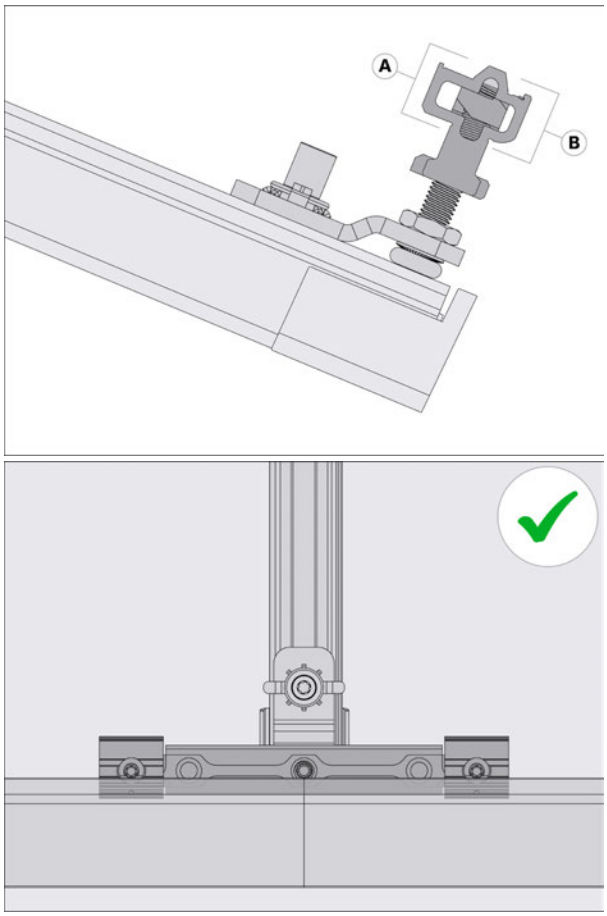


- *(1) - Nominal height*
- *(2) - Minimum height*

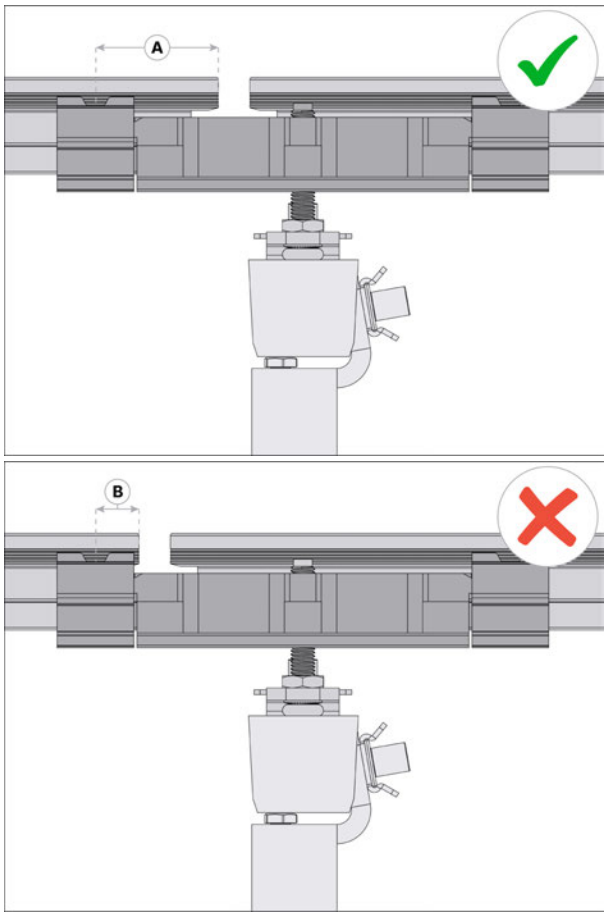


- *(3) - Maximum height*
- *(4) - Maximum height (cross section)*

iv. Observe span and cantilever as defined in previous steps and align the Front Skirt seam with the Hybrid Interlock.

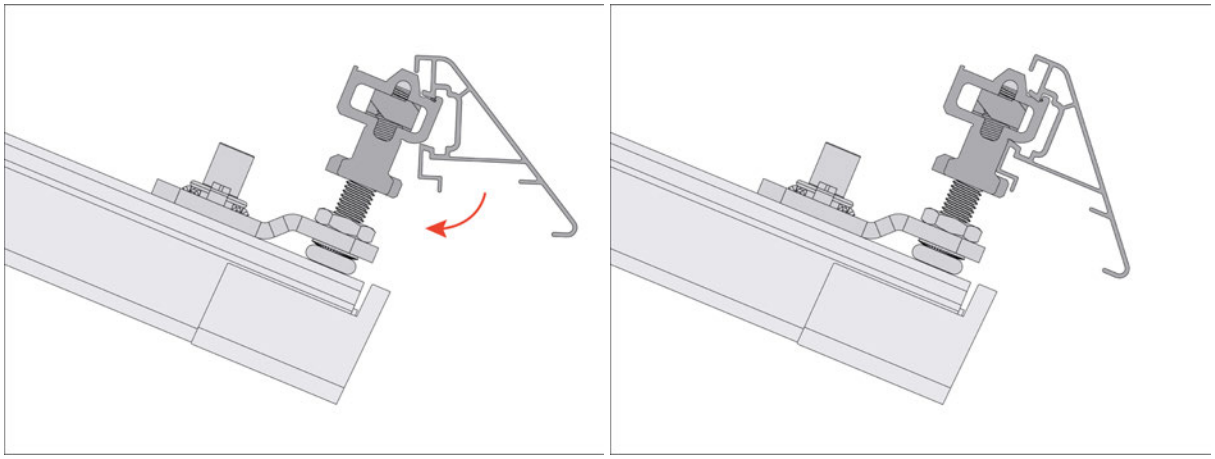


- *(A) - Tongue side*
- *(B) - Key side*

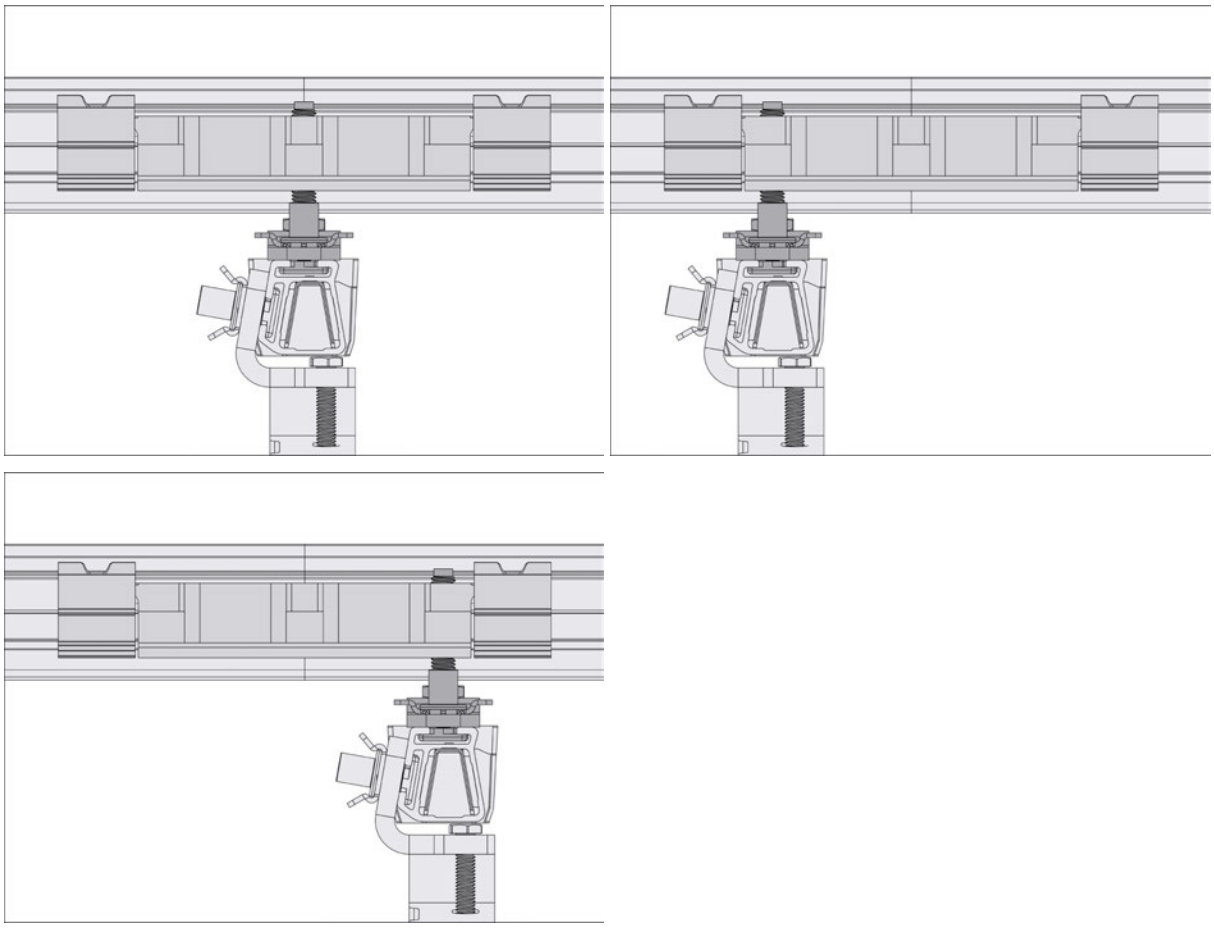


- *(A) - The minimum distance between the center of the Rockit on the Hybrid Interlock and the corner of the PV module or Front Skirt seam is 2 in.*
- *(B) - Insufficient distance from the corner of the PV module*

v. Set the Front Skirt on the Rockits of the Hybrid Interlock and rock it down, making sure to fully engage with the Key side of the Rockits. The Front Skirt should press flush against the Rockits.



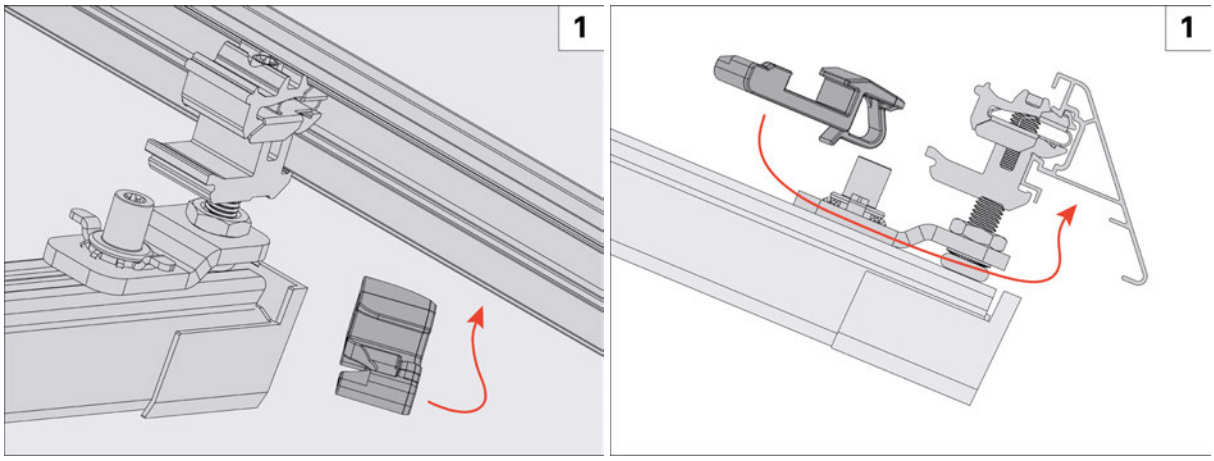
NOTE: When a Hybrid Interlock is required in the first row, all Interlocks in the same column will need to be replaced with Hybrid Interlocks in the same configuration.



- *Correctly installed Hybrid Interlocks using different mounting holes.*

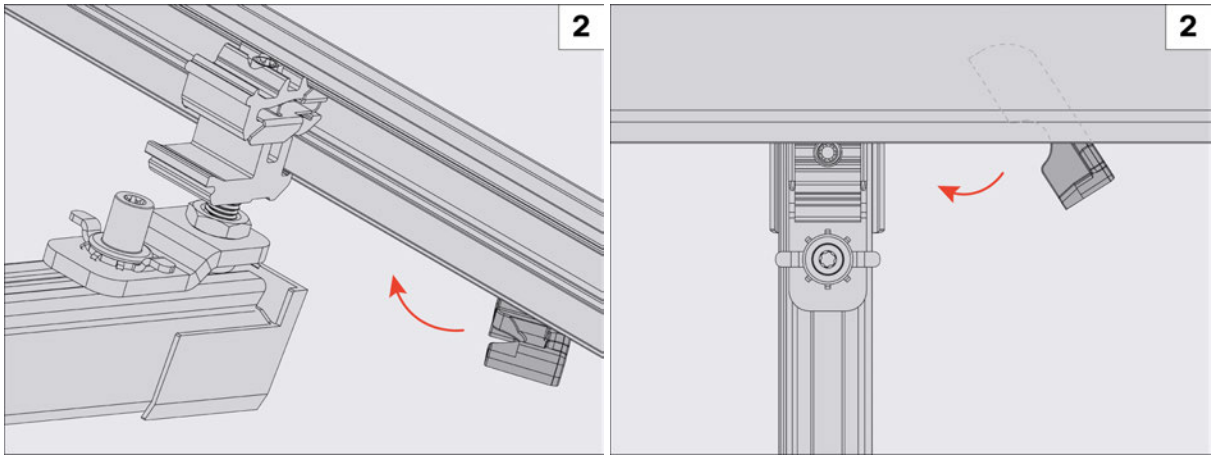
5. Install Front Skirt Grips to secure the Front Skirt to the Rockits.
   a. Insert a Front Skirt Grip into the slot on the underside of the Front Skirt.

> **NOTE:** Front Skirt Grips are installed to the right of the Rockit (when looking down-roof as shown in the image).



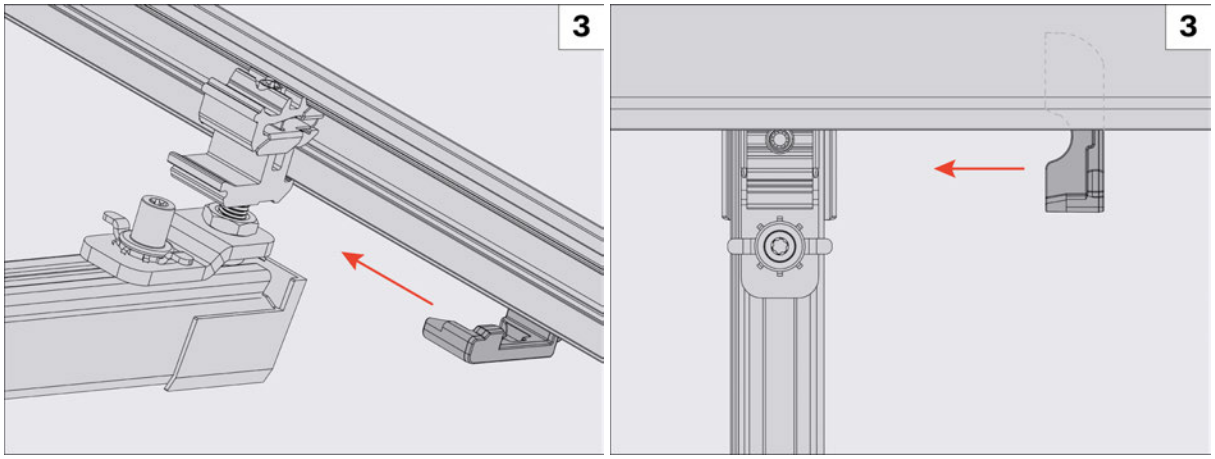
- *(1) - Front Skirt Grip and Grip slot of the Front Skirt*

b. Rotate the Front Skirt Grip parallel with the Rockit until it clicks into the grip slot.

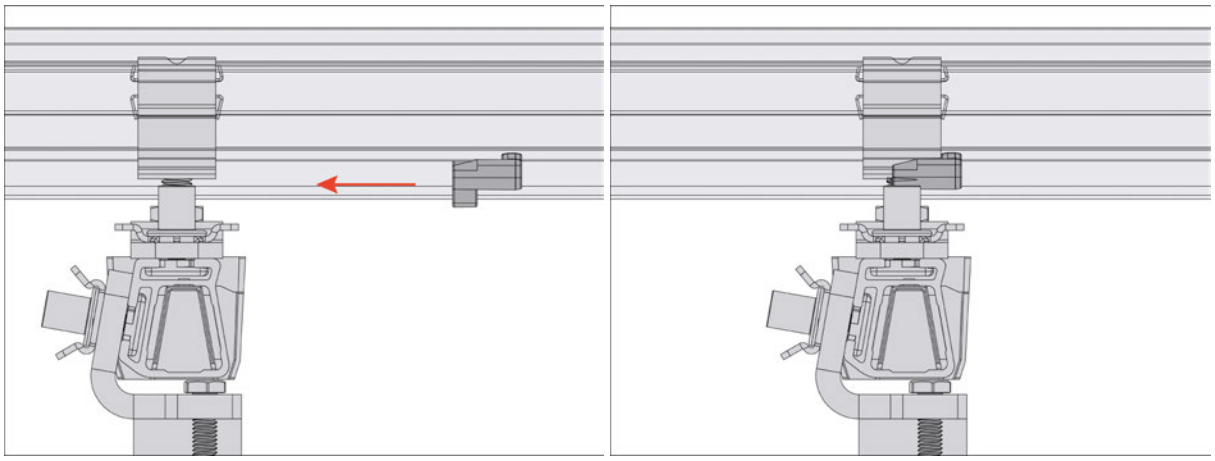


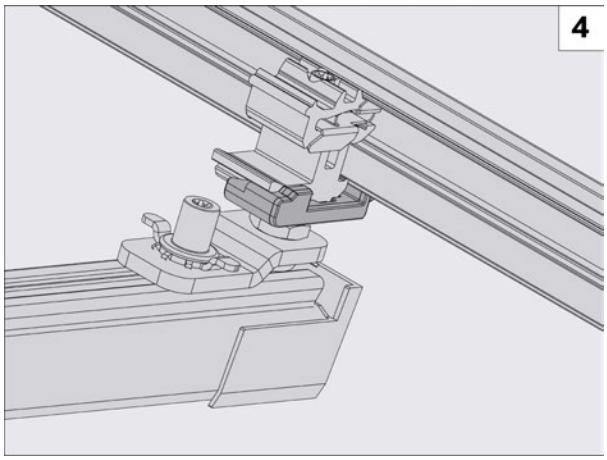
- *(2) - Rotating the Front Skirt Grip into the Grip slot*

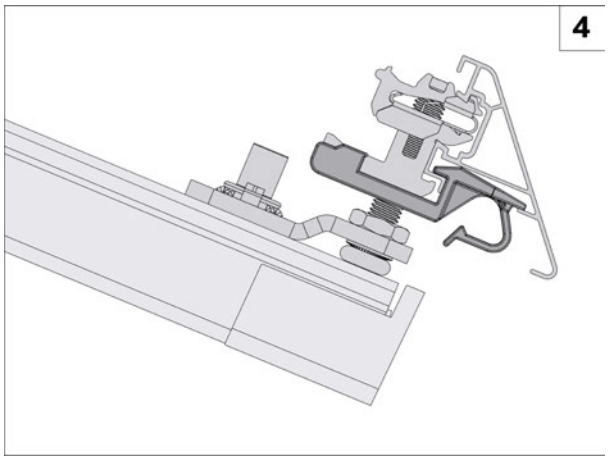
c. Slide the Front Skirt Grip over the Rockit until it is flush.



- *(3) - Front Skirt Grip slides into position under the Rockit*







- (4) - Front Skirt Grip fully installed

Related tasks

- Step 6: Install the PV Modules (SMILES) on page 82

Related information

- Installation Overview on page 29

Step 6: Install the PV Modules (SMILES)

- Updated order of operations.

Overview

Module drop-in is the same for portrait orientation as for landscape. To remember the installation order, think "SMILES":

- **S**et the Module
- **M**anage the Wires
- **I**nterlock
- **L**evel
- **E**valuate
- **S**ecure

Prerequisites

Install PV modules after installing the mounting hardware and Front Skirt. (*Step 5: Install the Front Skirt on page 67*)

Hazards

Figure 6. Fall from Height

Safety and PPE

- Safety glasses (ANSI Z87.1 or EN 166)
- Cut-resistant gloves (ANSI Cut Level 3 or EN 388 Level C)
- Closed-toed shoes
- Fall protection equipment (full-body harness with lanyard) for working at height

General Equipment

- Extension ladder, fiberglass (ANSI/ASC Type IA, 300 lb/135 kg rating)

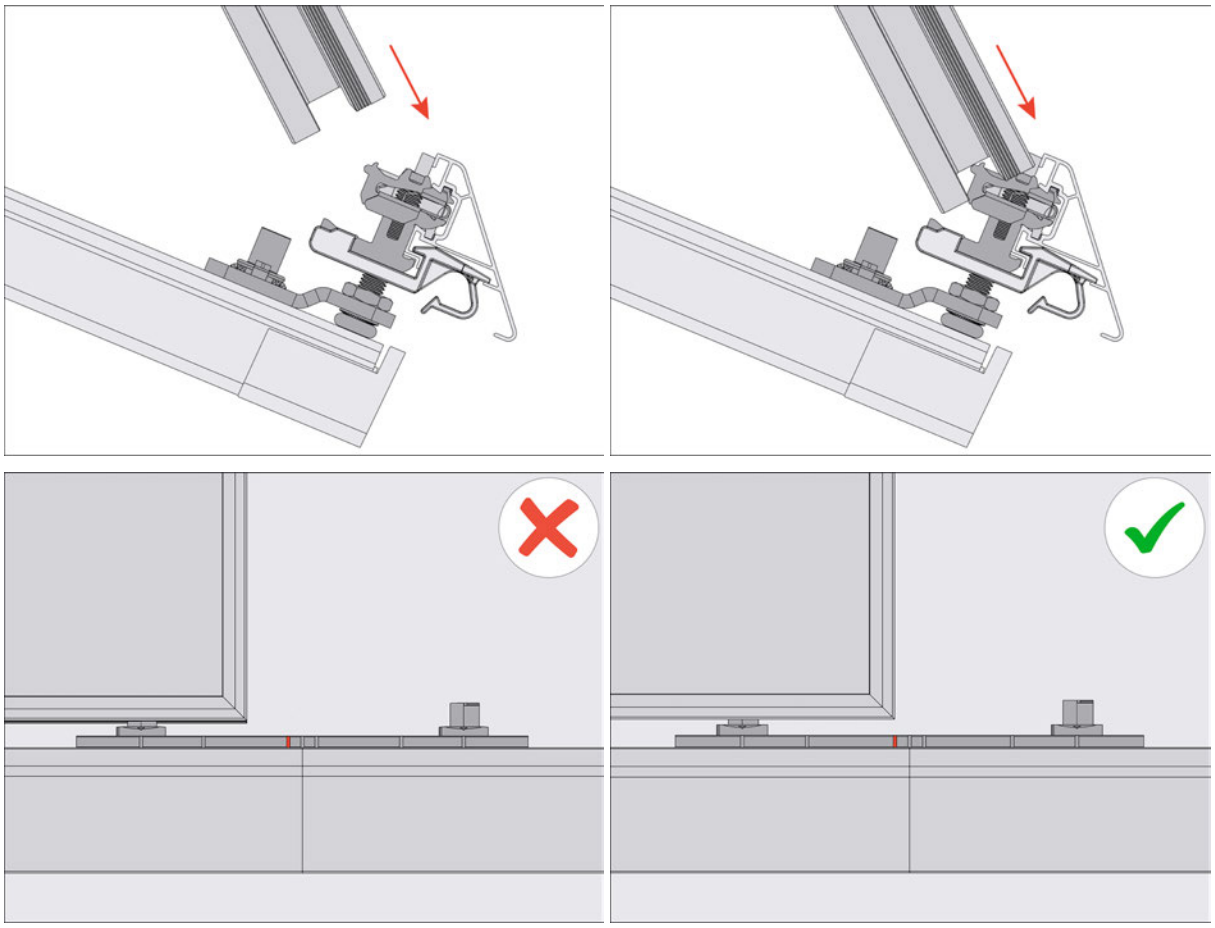
Required Parts and Tools

Tools listed are in addition to *#unique_49 on page* .

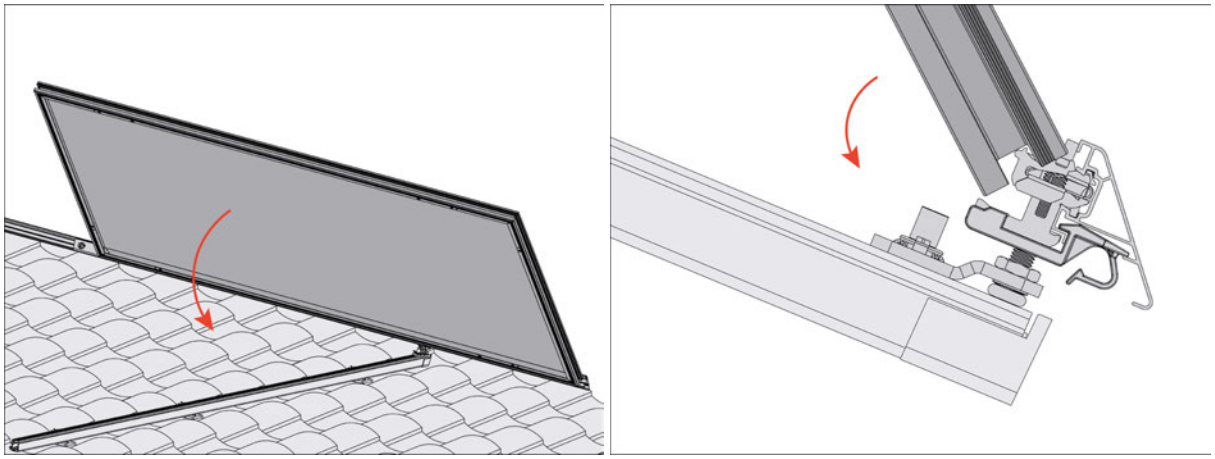
- Tesla Installation Tool **or** Tesla Solar Wrench
- DC Wire Clips
- Impact driver
- Torque wrench
- T40 Torx bit

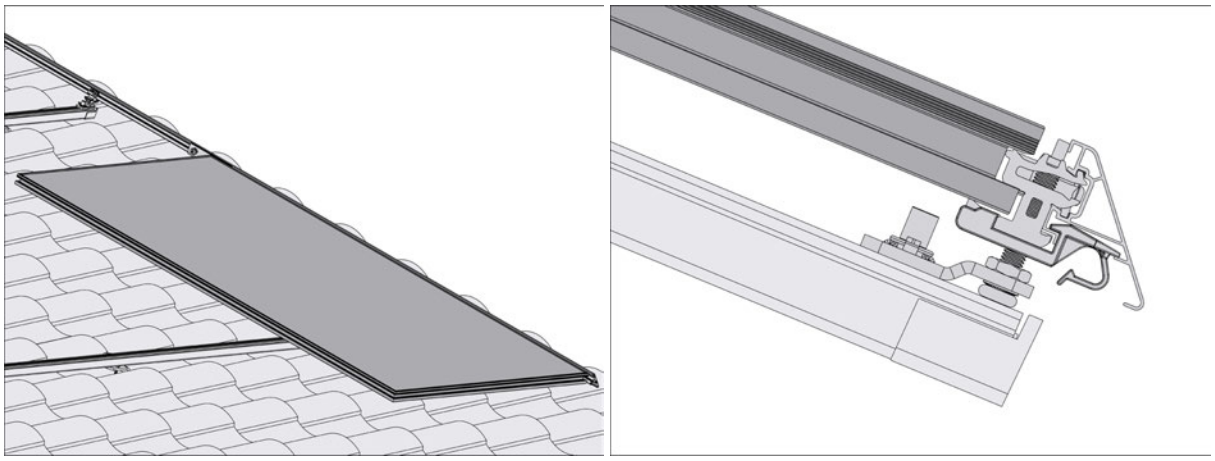
Install PV Modules

1. Inspect and put on fall protection before performing roof work. Ensure that your fall harness is connected to a certified anchor point and maintain 6 ft (2 m) clearance from the roof edge unless guarded.
2. Put on cut-resistant gloves and safety glasses.
3. **Set the module (SMILES).**
    a. Position the first module on the Tongue side of the Rockits at a steep angle. Align the module edges to the 3rd and 5th Interlock timing marks.

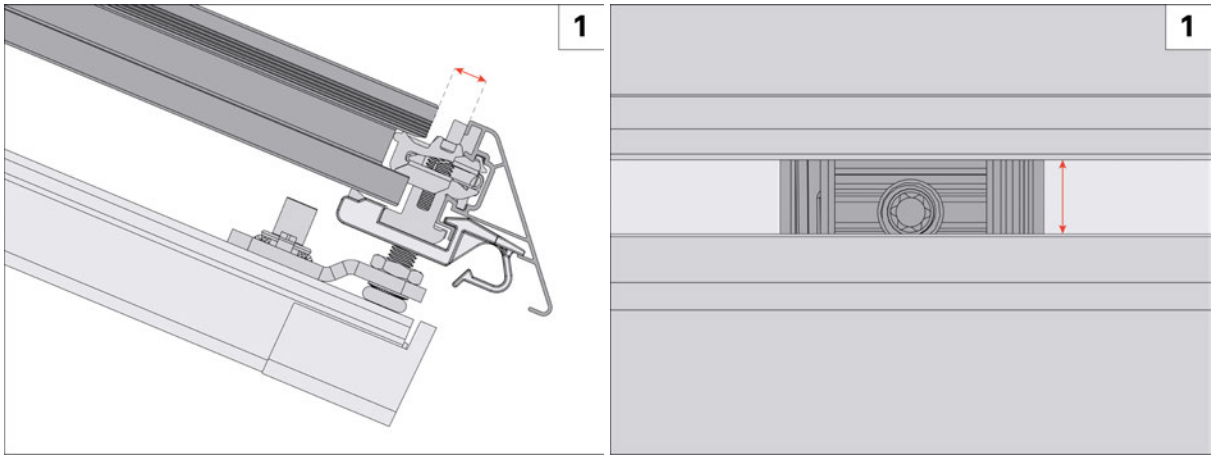


    b. Rock the module down almost flat, while pushing the module onto the Tongues of the Rockits. The bonding tabs on the Rockit will engage with the module frame once the module reaches 15° and you may feel some resistance. An audible grinding sound while rocking the module in indicates that the bond is being made.

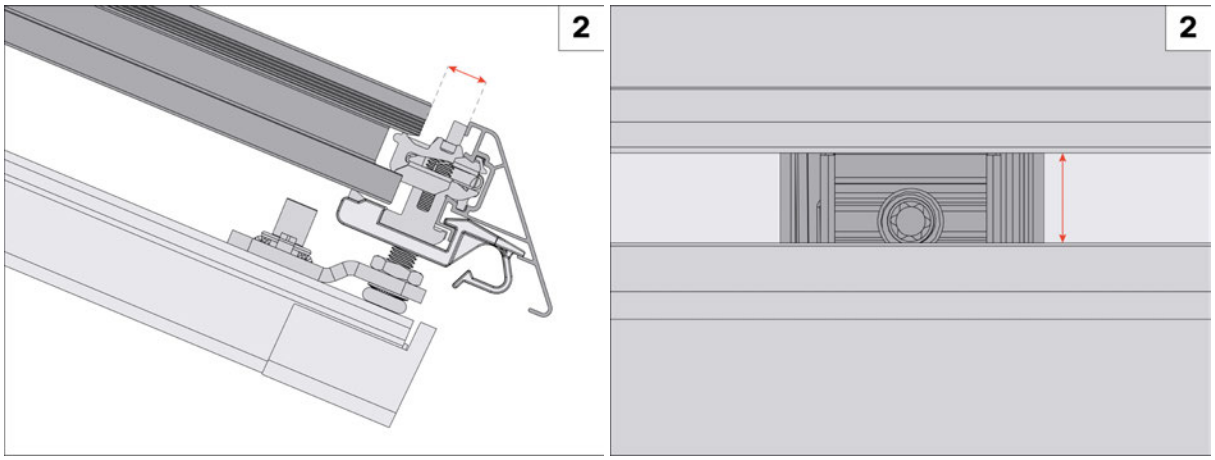




c. The Tongue side of the Rockit has approximately 1/8 in. of adjustment in the Y direction. Adjust the module within this range to ensure that all modules in the row are straight. If adjustments are needed, lift the module just above the 15° angle before adjusting it.

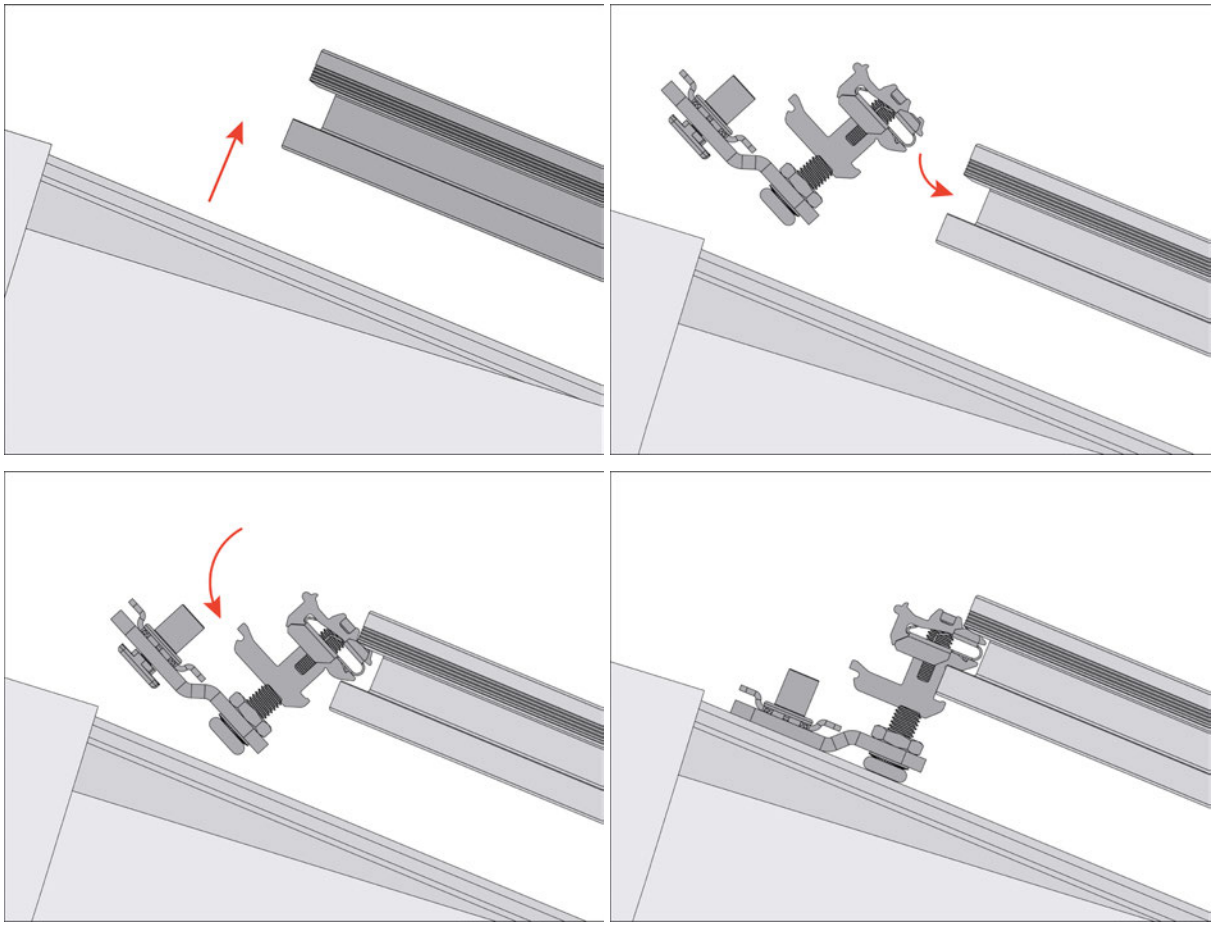


- *(1) - Minimum distance between PV module and Front Skirt*



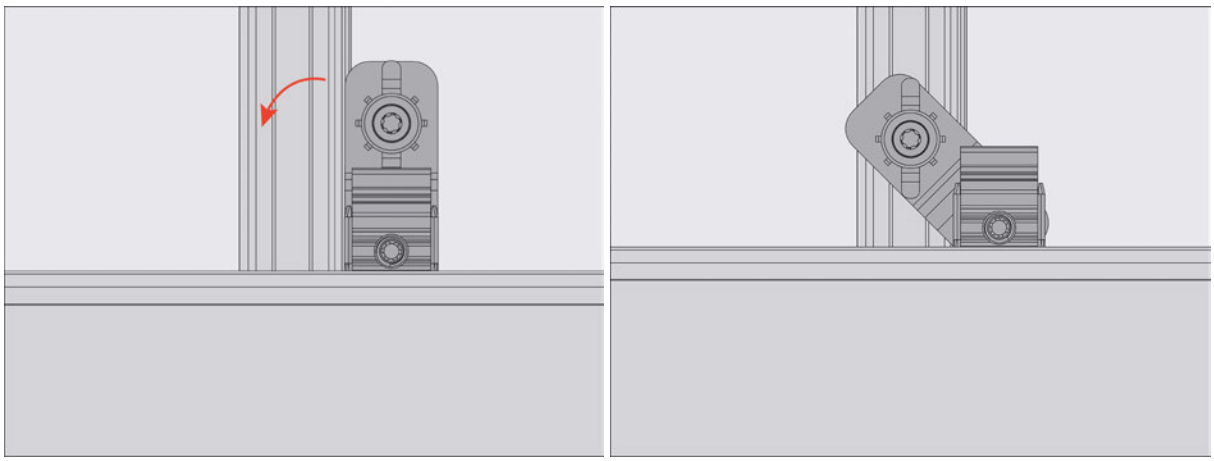
- *(2) - Maximum distance between PV module and Front Skirt*

d. Lift the up-roof side of the PV module and attach the Leveling Foot into the PV module frame.



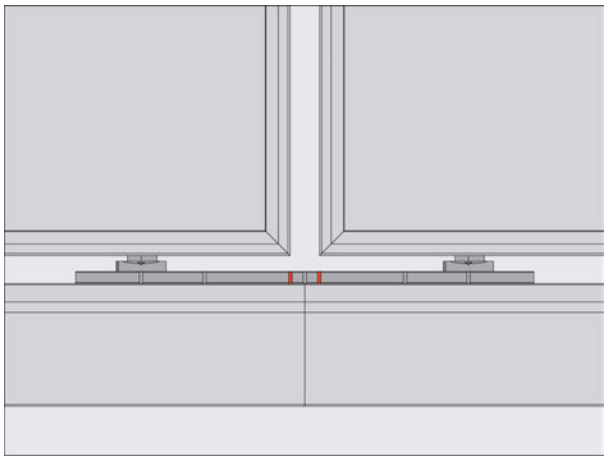
e. Swivel the Leveling Foot and insert the T-bolt into the top channel on the Spanner Bar.

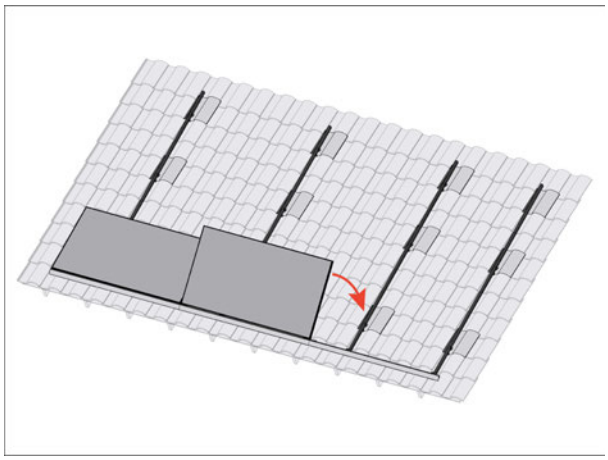
NOTE: Do not tighten the T-bolt during this step.



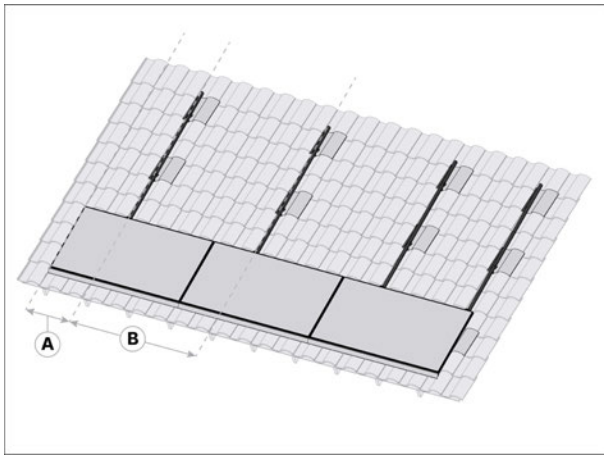
f. Set the next module in the row, using the center ½ in. timing marks on the Interlock to create a ½ in. gap between modules.

NOTE: The system allows for ±¼ in. of adjustability in the module gap.



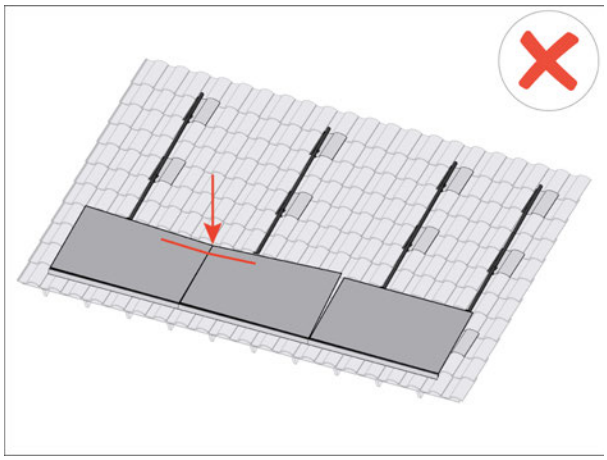


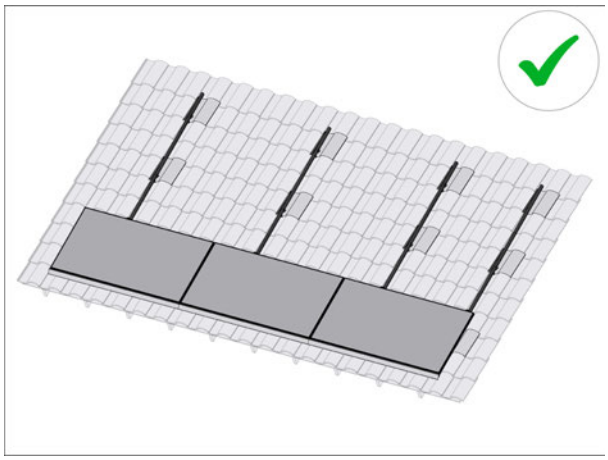
g. Repeat these steps to install the full row of modules, ensuring that the locations of the Rockits comply with cantilever and X span.



- *(A) - X cantilever*
- *(B) - X Span*

If a module does not sit parallel with the adjacent module, this indicates that the skirt was not installed straight. Use the Y adjustability of the Rockit to re-establish a straight line along the up-roof edge of the modules. If this is insufficient to establish a straight line, remove the modules and adjust the skirt.

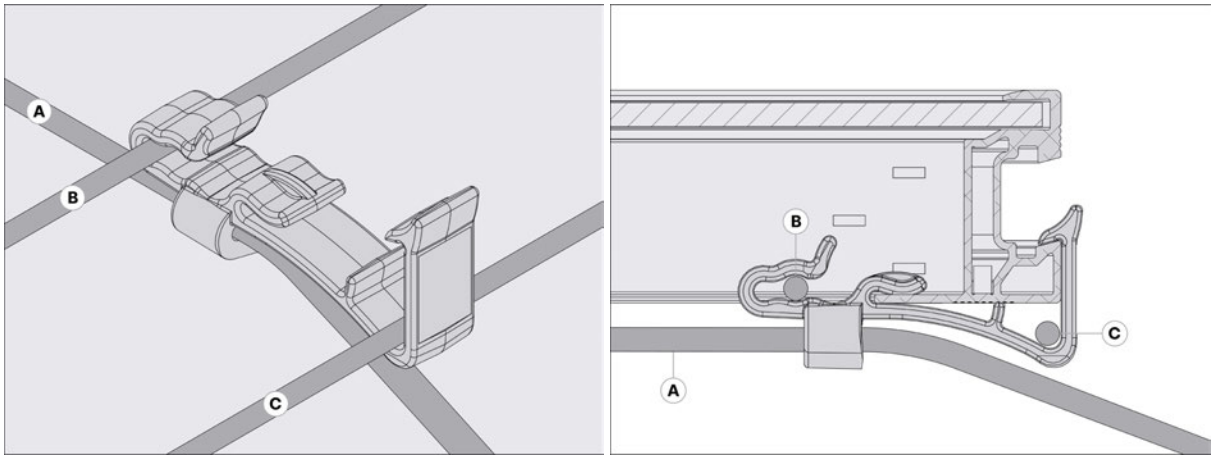




4. **Manage the wires (SMILES).**

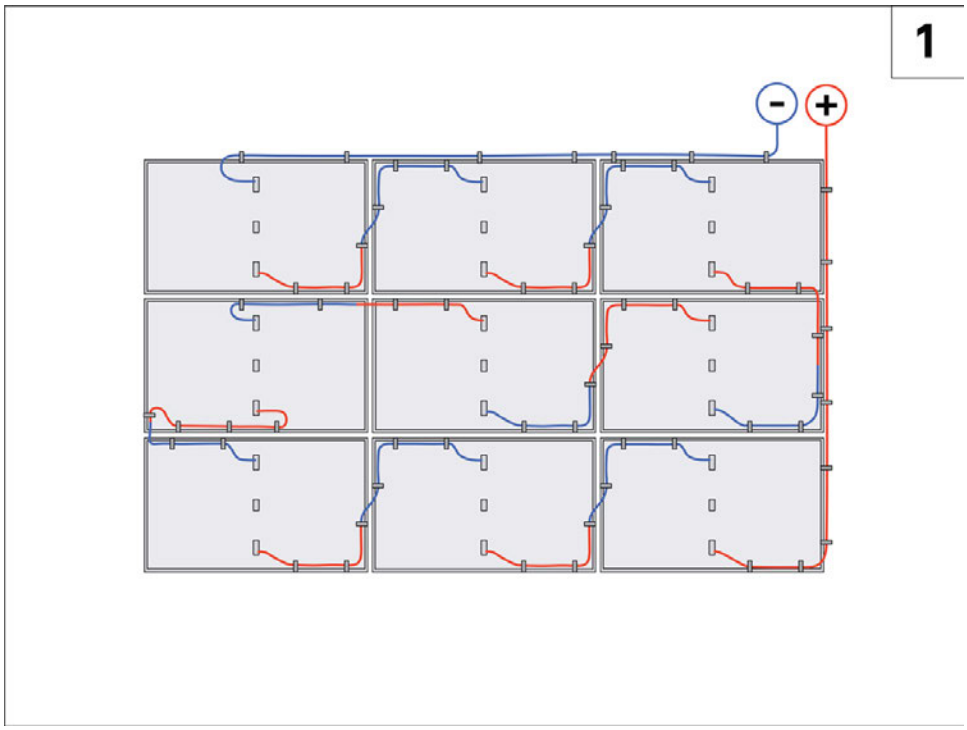
a. Perform wire management as appropriate for the array. Refer to the example below for a standard 3x3 module array.

The DC Wire Clip is UL listed to UL 1565 as a "wire positioning device." The DC Wire Clip accommodates up to three wires.

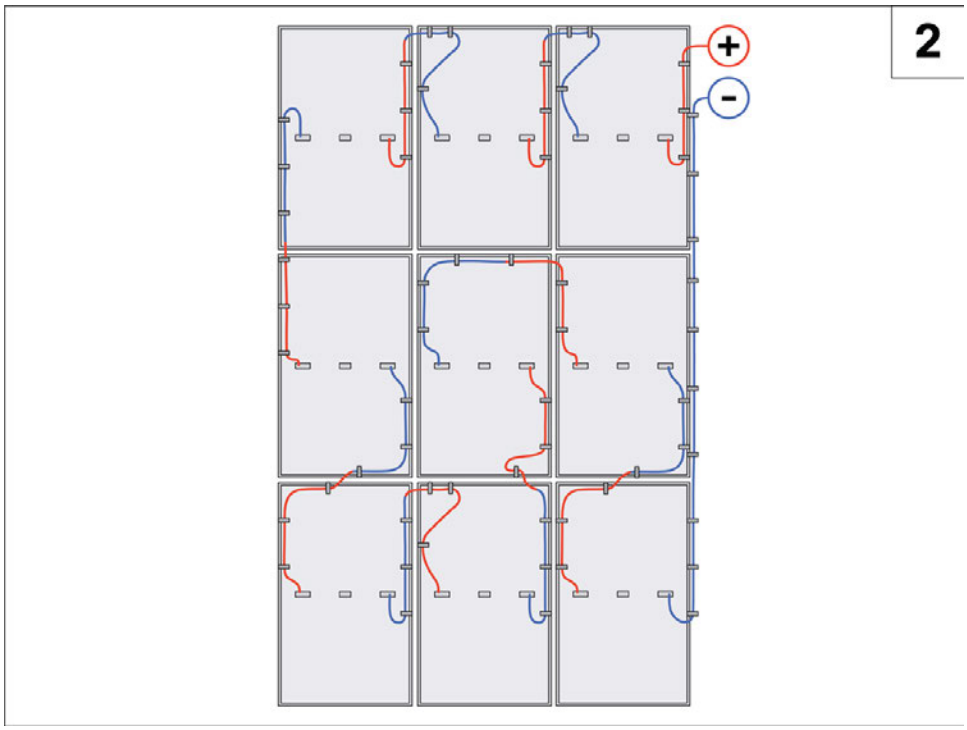


- *(A) - Wire 1*
- *(B) - Wire 2*
- *(C) - Wire 3*

Example Array Wiring:

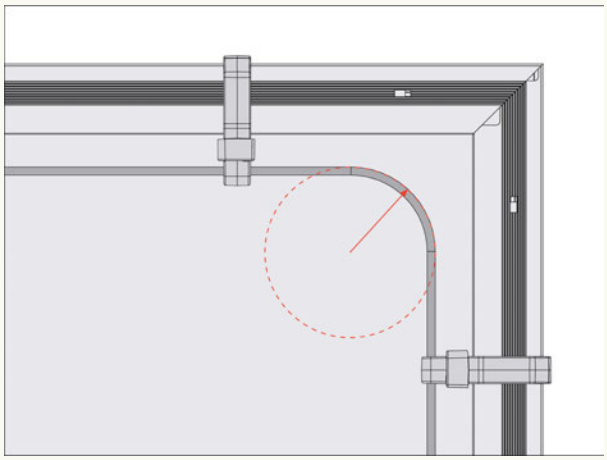


- *(1) - Landscape orientation*



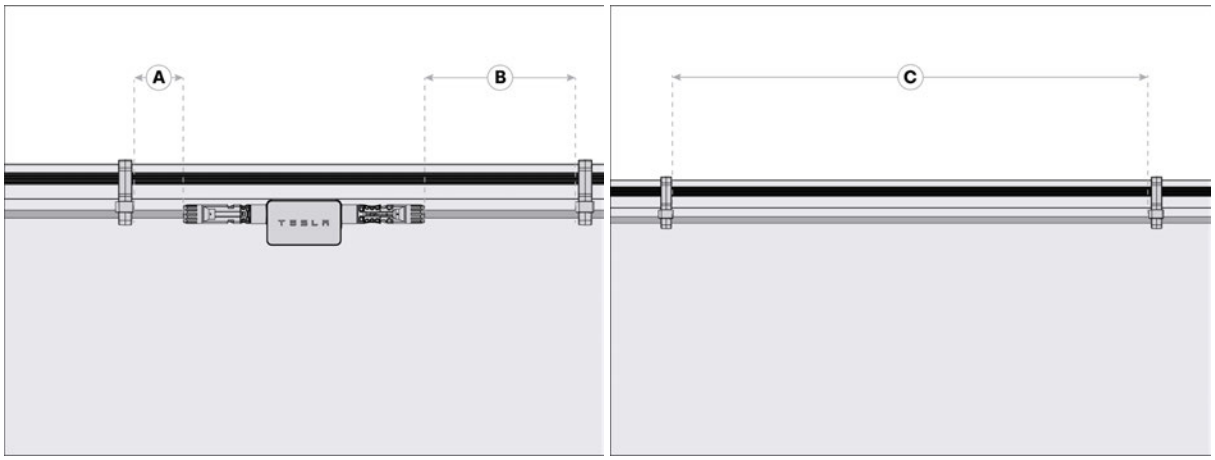
- *(2) - Portrait orientation*

CAUTION: Ensure that the wires are not under mechanical stress. Minimum bending radius is 5x the wire diameter, generally ≥ 1 ¼ in. (30 mm).



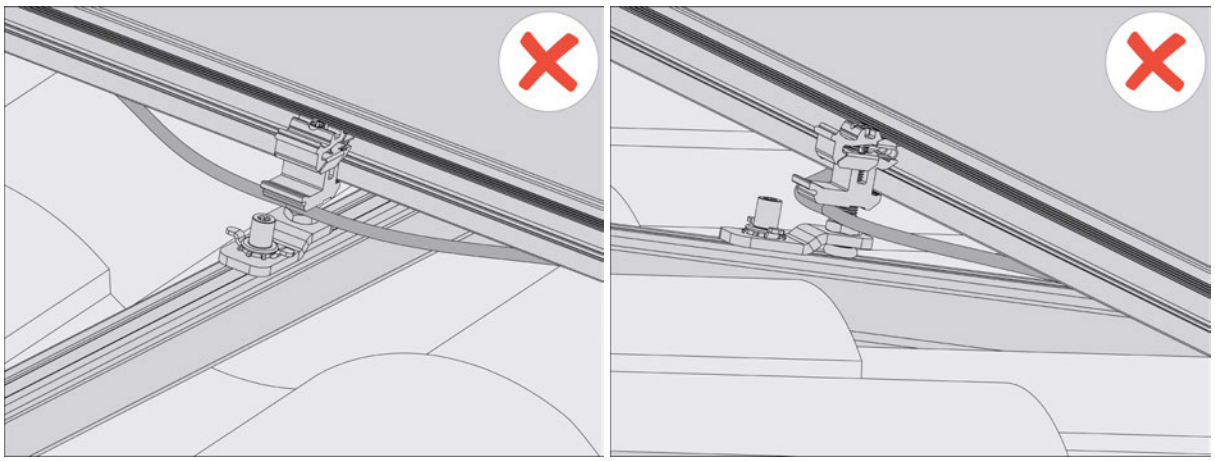
NEC 690.31(C)(1)(b) specifies that there must be a wire clip every 24 in. (600 mm).

Wire clips should be at least 2 in. (50 mm) but not more than 6 in. (150 mm) from the connectors.



- *(A) - Minimum distance between DC Wire Clip and connector (2 in.)*
- *(B) - Maximum distance between DC Wire Clip and connector (6 in.)*
- *(C) - Maximum distance between DC Wire Clips (24 in.)*

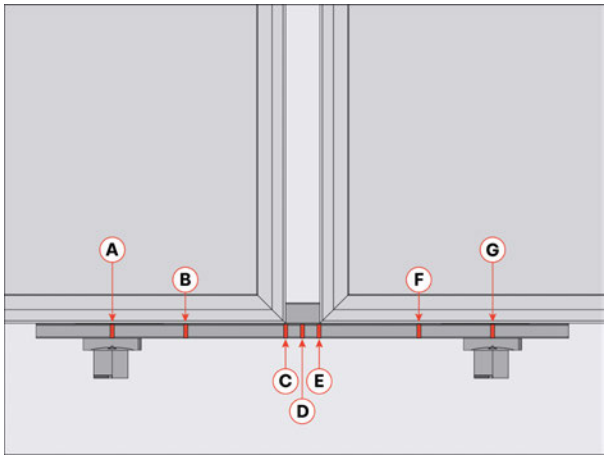
Ensure that the wires do not run around any mounting components as this can lead to abrasion or wire pinches.



Refer to *Appendix D: Wire Management Recommendations on page 121* for more information on wire management of Tesla MCI systems.

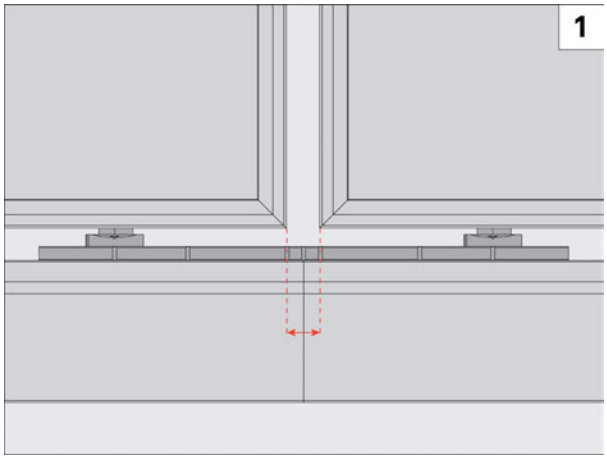
5. **Install Interlocks (SMILES).**

a. Once you install a full row of modules and manage the wires, use Interlocks to secure the modules together. Interlocks feature timing marks that help with module spacing.

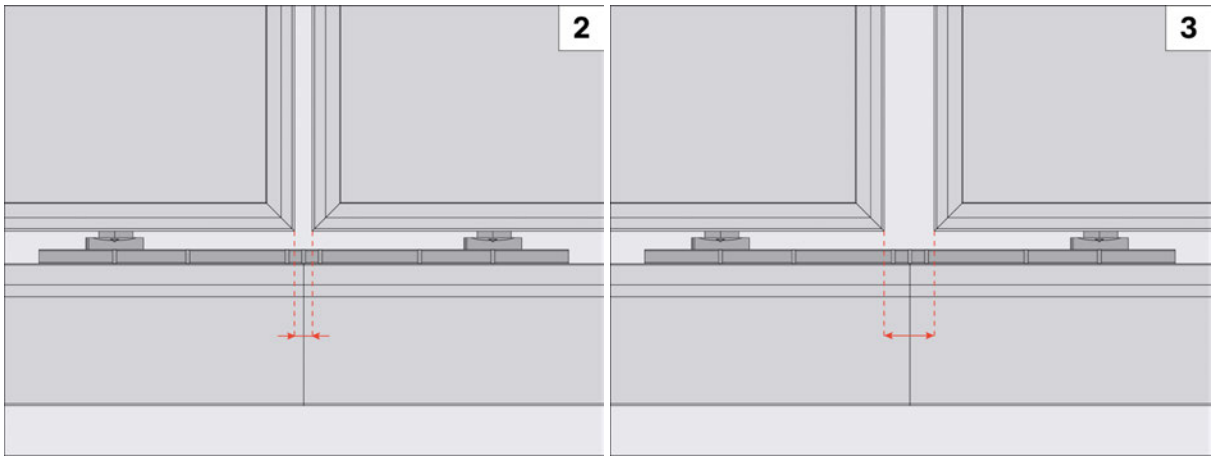


- *(A) - 1st timing mark, used to verify alignment when tightening the Interlock Lockit*
- *(B) - 2nd timing mark, indicates maximum allowable range of module edge when sliding the Interlock*
- *(C) - 3rd timing mark, used to align module edges and ensure consistent spacing (¼ in from center line)*
- *(D) - 4th timing mark, used to center the Interlock on the skirt or PV modules (center line of the Interlock)*
- *(E) - 5th timing mark, used to align module edges and ensure consistent spacing (¼ in from center line)*
- *(F) - 6th timing mark, indicates maximum allowable range of module edge when sliding the Interlock*
- *(G) - 7th timing mark, used to verify alignment when tightening the Interlock Lockit*

b. Adjust modules if necessary to ensure alignment at the up-roof edge of the module. The X gap between module corners should be ½ in. with ±¼ in. of tolerance.

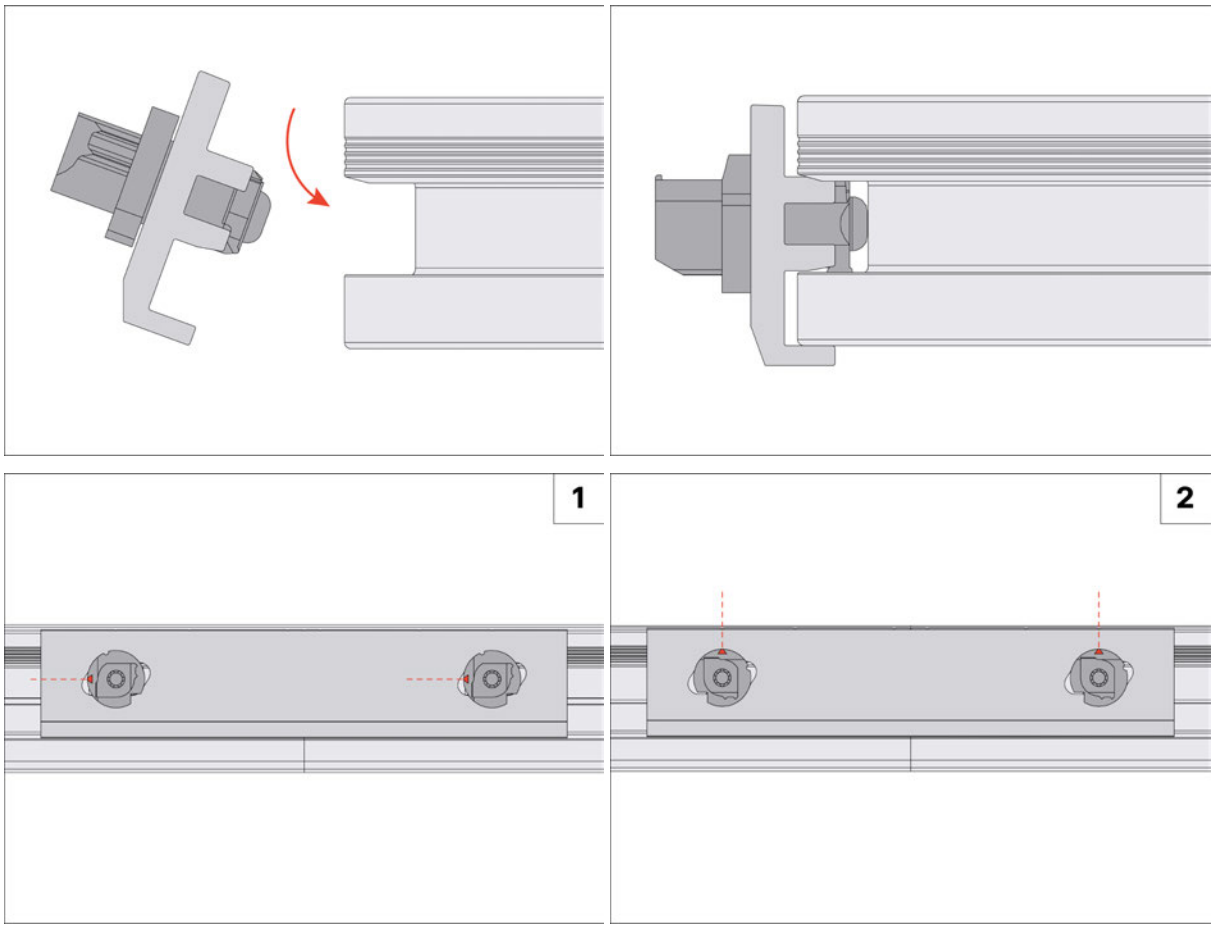


- *(1) - Ideal distance between modules (½ in.)*



- *(2) - Minimum distance between modules (¼ in.)*
- *(3) - Maximum distance between modules (¾ in.)*

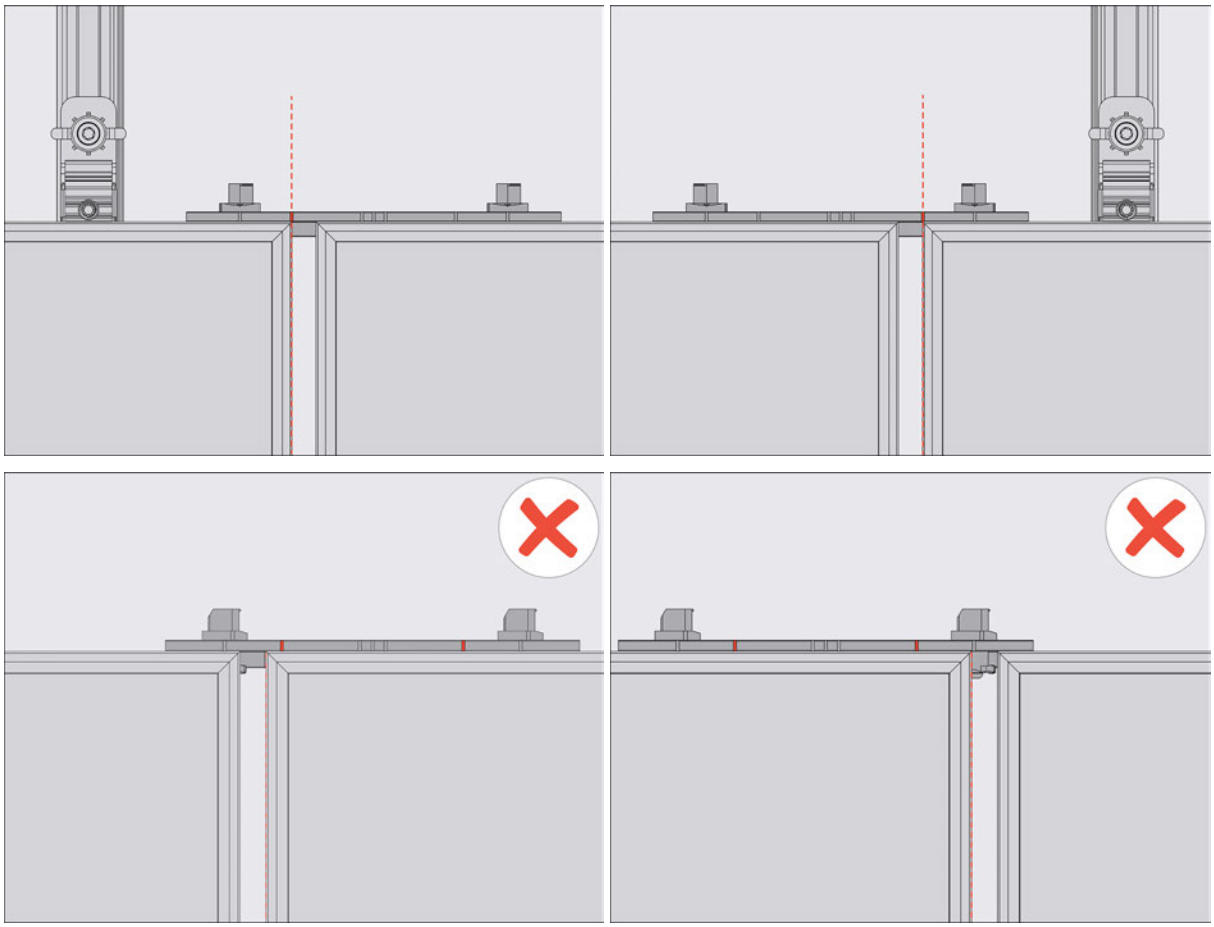
c. Insert an Interlock into the Tesla Groove between two modules and use the timing marks to create a ½ in. gap between modules. This ensures the timing marks can be used as reference for the next row.



- *(1) - Position 1: open Interlock*
- *(2) - Position 3: locked Interlock*

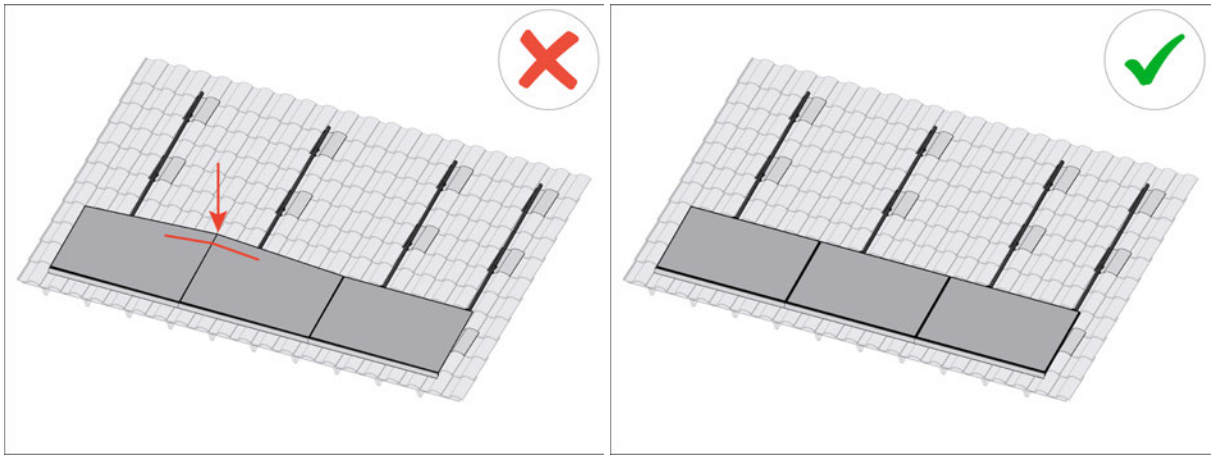
d. The Interlock may not fully seat into the Tesla Groove with hand pressure only. Rotate both Keys to Position 3 to form a structural and electrical bond with the modules. This motion will pull the Interlock into the module frame and an audible grinding sound indicates that the bond forms.

e. In certain cantilever and span conditions, a Rockit may land close to the corner of a module. When this Rockit lands within the space that an Interlock would normally occupy, this is called an interference. When an interference occurs, adjust the Interlock in the X direction up to the point that the 2nd or 6th timing mark aligns with the module corner. In this case, the timing marks will not align with module corners for subsequent rows and the same process must be repeated to align gaps between the rows.



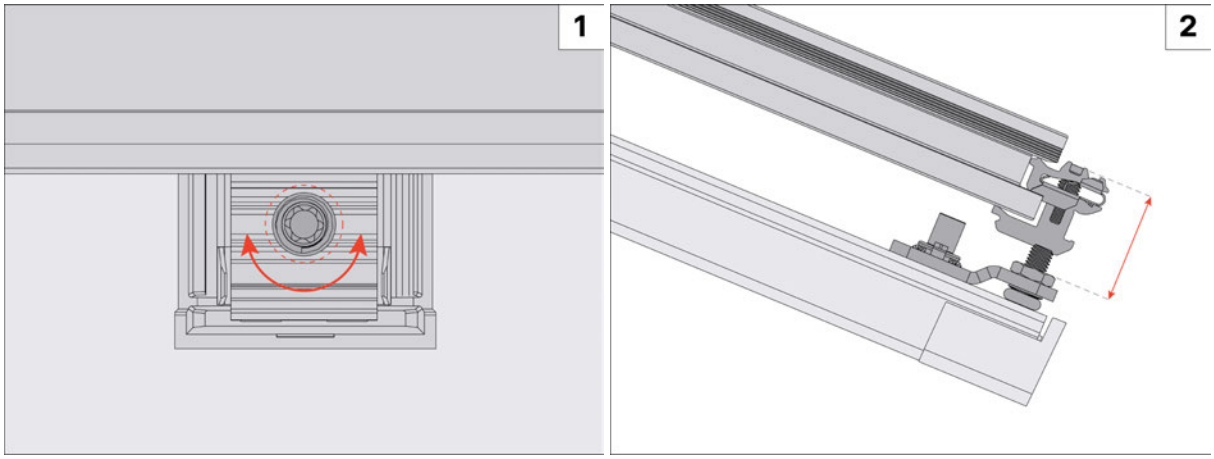
If adjusting the X position of the Interlock is insufficient to remove the interference with the Rockit, use a Hybrid Interlock instead.

6. **Level the modules (SMILES).**
   a. From the top corner of the row, look in the X direction and Y direction to check edges for irregularities in height. Modules must be straight and parallel to the roof deck.
   b. Uneven leveling is visually apparent and aesthetically undesirable. Level all the modules so that the array appears to be perfectly flat regardless of roof irregularities underneath.



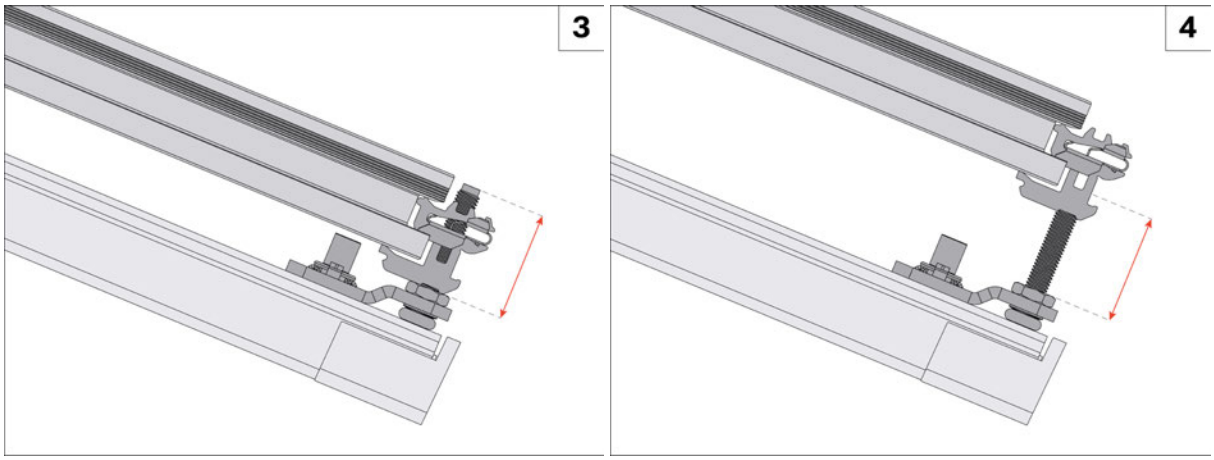
- *(1) - Uneven leveling*
- *(2) - Even leveling*

   c. Rotate the threaded stud on the Leveling Foot using a T40 Torx bit to raise or lower the Rockit in relation to the foot. The stud is reverse-threaded so turning the stud clockwise will lower the module and turning it counterclockwise will raise the module.



- *(1) - Threaded stud on the Leveling Foot for Rockit height adjustment*
- *(2) - Nominal Rockit height, stud flush with top of the Rockit*

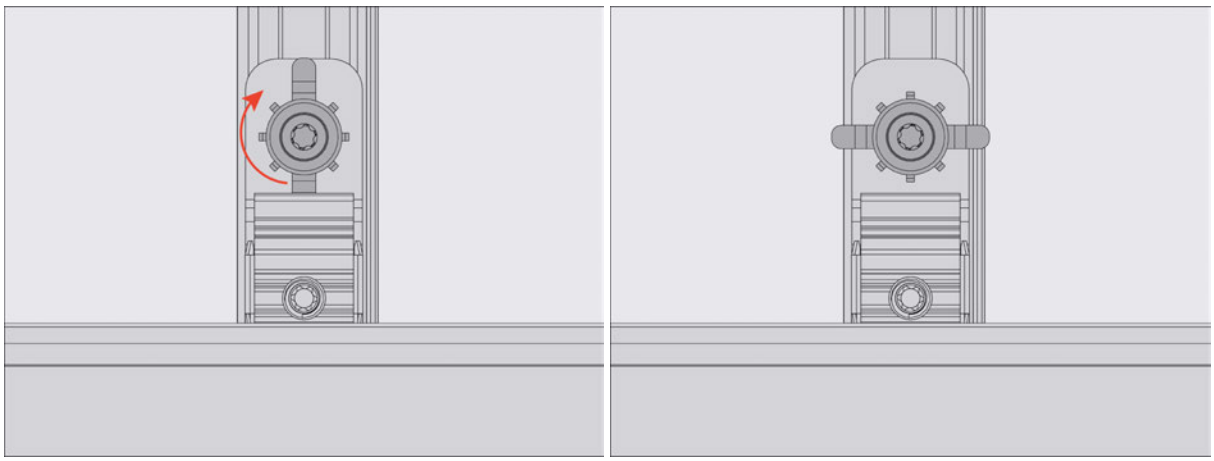
Do not raise the Rockit 1 ¼ in. above the Leveling Foot nut. The stud will be flush with the bottom of the window of the Rockit at maximum height.



- *(3) - Minimum Rockit height*
- *(4) - Maximum Rockit height*

7. **Evaluate (SMILES).**
   a. At this point, pause and evaluate the work you have done so far. Check that all wire management is proper and there are no hanging wires present, there are no missed connections, or any wires touching the roof. Check that all Replacement Flashings are secured.

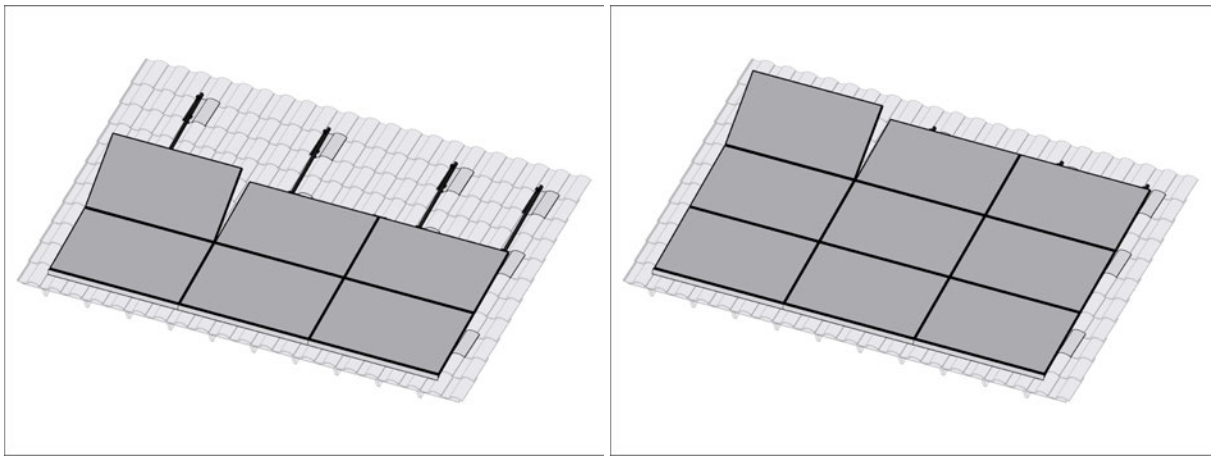
8. **Secure (SMILES).**
   a. Secure the up-roof Leveling Feet by fastening the T-bolt on the Leveling Foot into the Spanner Bar.



NOTE: Torque to a range of 13 – 20 ft-lbs. Make sure that the Leveling Foot cannot be moved by hand.

   b. Check the indicator tabs on the T-Bolts to ensure that they are perpendicular to the Spanner Bars.

9. **Repeat SMILES to install the remaining rows of PV modules.**
    a. Continue to install the modules, Leveling Feet, and Interlocks until the array is complete. Complete all steps of "SMILES" for each row.



Related tasks

- Step 7: Complete Wire Management and Bonding on page 95

Related information

- Installation Overview on page 29

Step 7: Complete Wire Management and Bonding

- Added Front Skirt Grip as a UL listed wire positioning device.

Overview

Wire management for DC home runs and equipment grounding conductor (EGC) installation.

Prerequisites

Perform after installing PV modules on mounting hardware. (*Step 6: Install the PV Modules (SMILES) on page 82*)

Hazards

Figure 7. Fall from Height

Safety and PPE

- Safety glasses (ANSI Z87.1 or EN 166)
- Cut-resistant gloves (ANSI Cut Level 3 or EN 388 Level C)
- Closed-toed shoes
- Fall protection equipment (full-body harness with lanyard) for working at height

General Equipment

- Extension ladder, fiberglass (ANSI/ASC Type IA, 300 lb/135 kg rating)

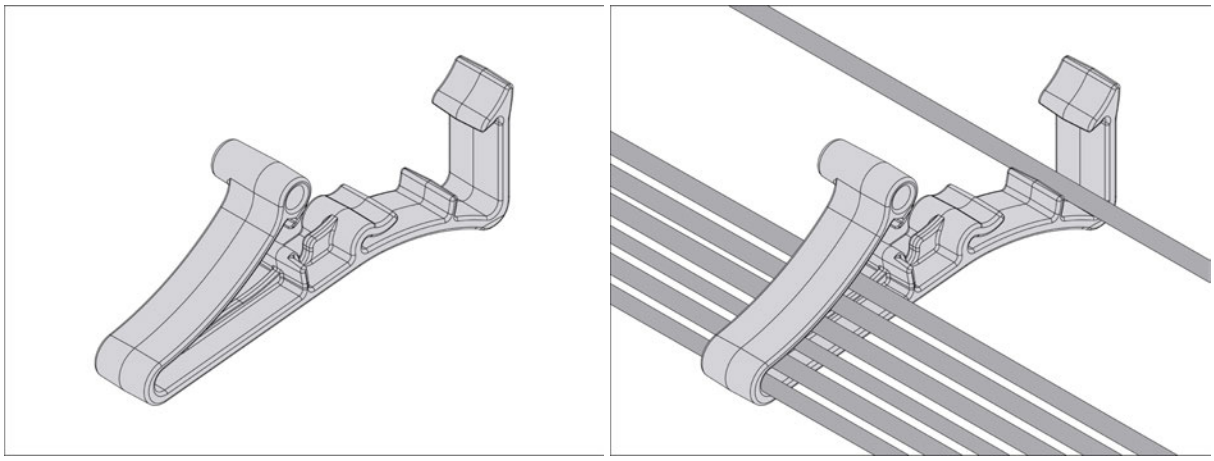
Required Parts and Tools

Tools listed are in addition to *#unique_49 on page* .

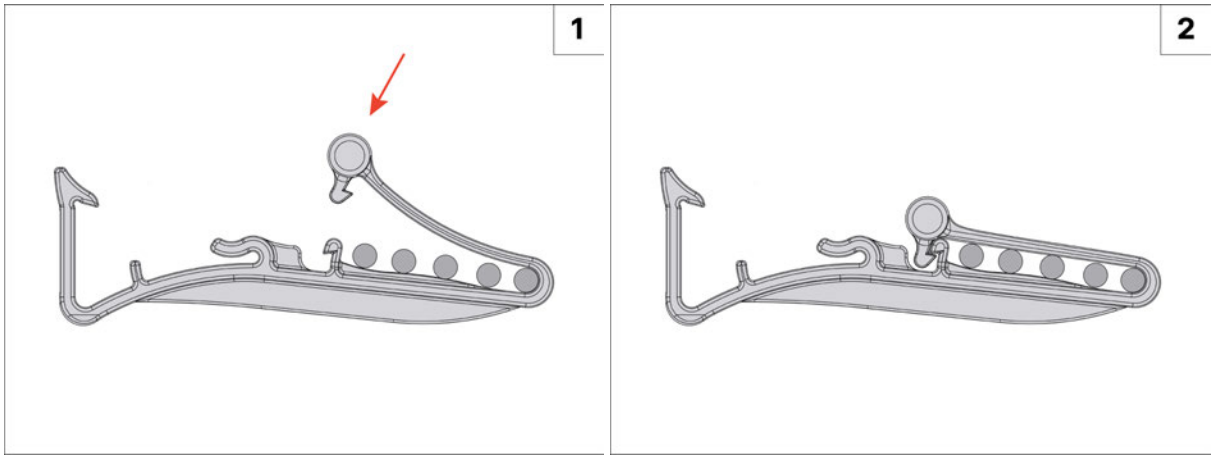
- Home Run Wire Clips
- Ground Lockits
- Torque screwdriver

Install Home Run Wire Clips and Ground Lockits

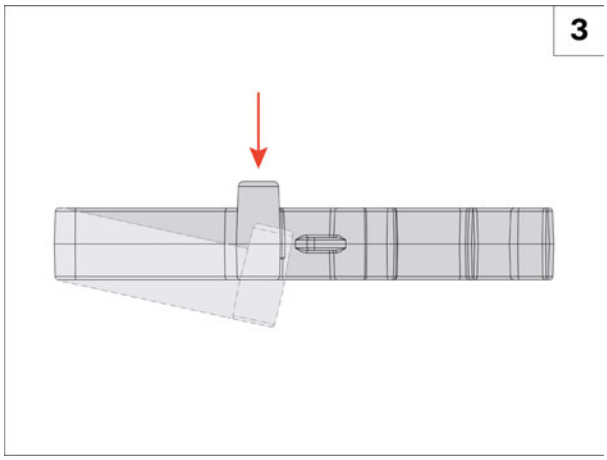
1. Put on cut-resistant gloves and safety glasses.
2. Install Home Run Wire Clips.
   a. Complete wire management as necessary for the array. Use a Home Run Wire Clip to secure wires if more than two wires need to travel along any edge of a module. It holds 6x 10 AWG wires or 4x 8 AWG wires and installs in a similar fashion to the DC Wire Clip.



   b. Close the Home Run Wire Clip by snapping the clip together. To open the clip, push the tab to the side.

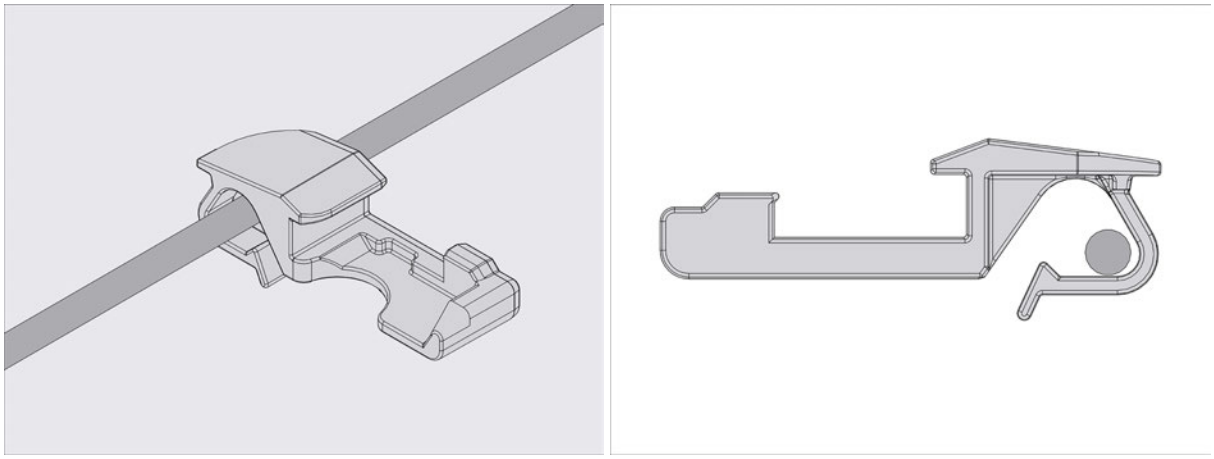


- *(1) - Close the Home Run Wire Clip by snapping the clip together*
- *(2) - Closed Home Run Wire Clip*



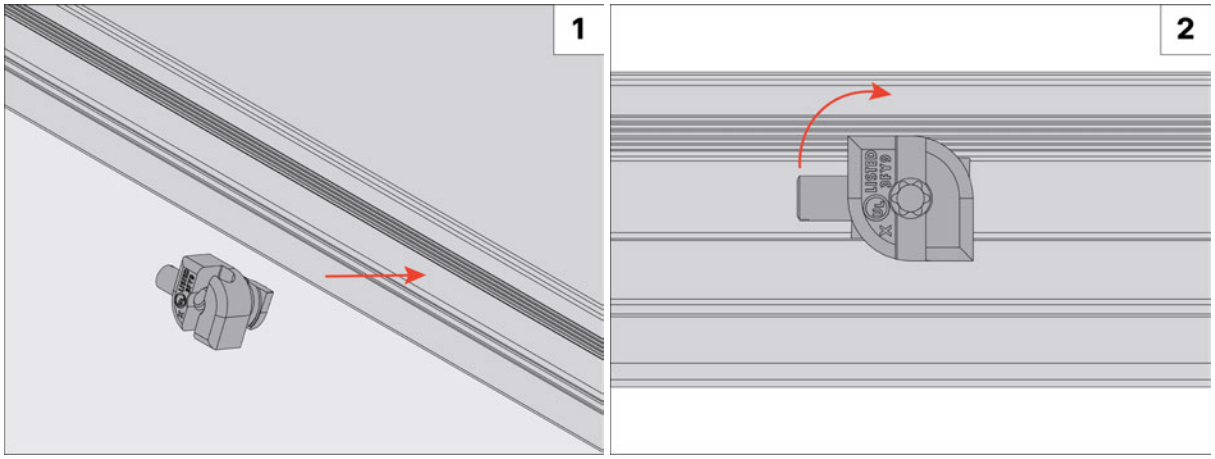
- *(3) - To open the clip, push the tab to the side*

3. To route a PV wire along the front of the array, use the Front Skirt Grip as a wire holder. The Front Skirt Grip can hold 1x 10 AWG or 12 AWG wire. This Front Skirt Grip (2088697-00-X) is a UL 2239 listed wire positioning device.

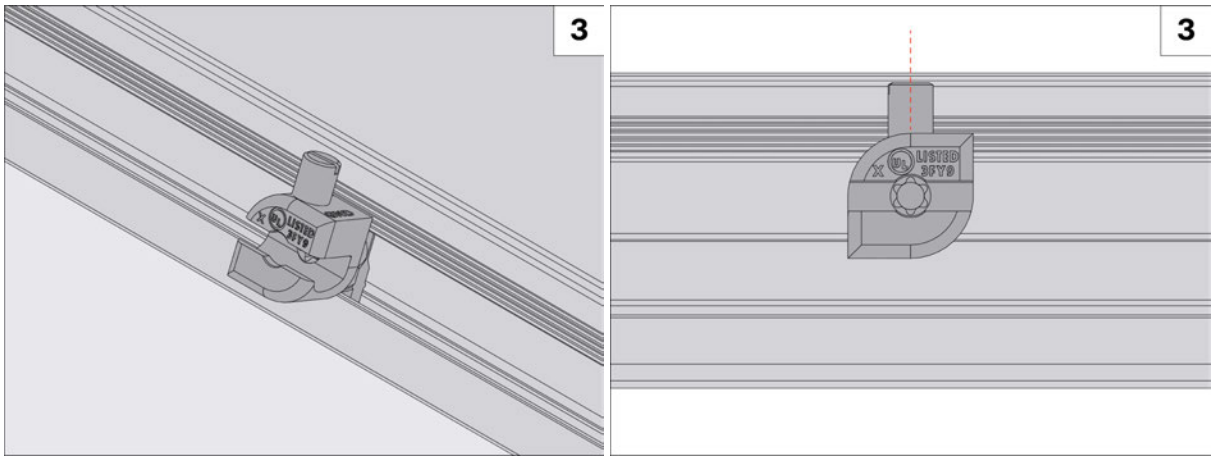


4. Install the Ground Lockit.
    a. The Ground Lockit provides a single point of connection for the equipment grounding conductor (EGC) from the array to the grounding electrode conductor (GEC). Place the Ground Lockit on the module frame where the DC wiring meets the array. Place a Ground Lockit for each sub-array.

b. Insert a Ground Lockit into the Tesla Groove with the set screw pointing left. Rotate the Ground Lockit into place with a 90° clockwise turn with the set screw pointing up.



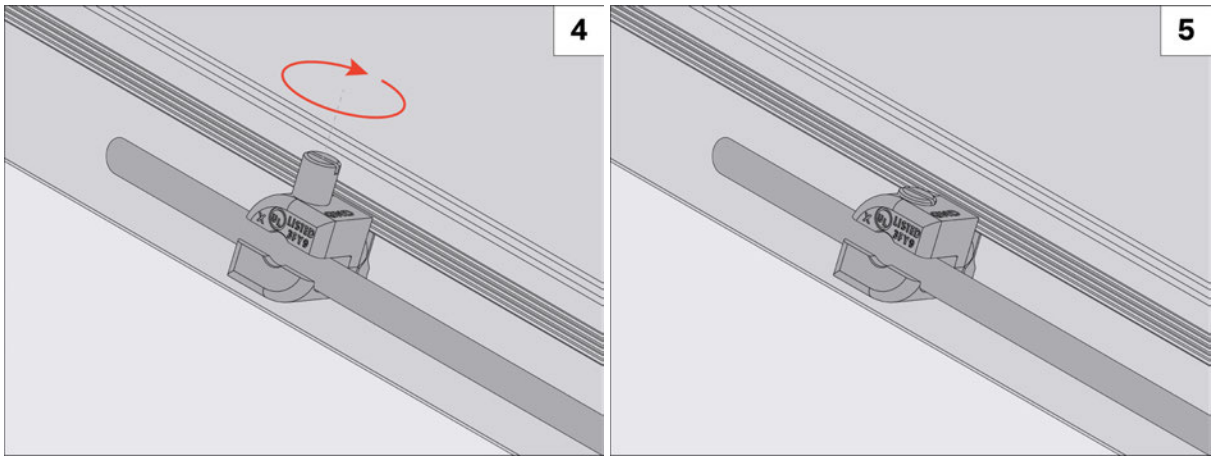
- *(1) - Ground Lockit with the set screw pointing left*
- *(2) - Ground Lockit in the groove of the PV module*



- *(3) - Installed and rotated Ground Lockit*

5. **Insert the Ground Wire.**
   a. Insert the ground wire into the ground wire retention slot. Ensure that excess ground wire is not sticking out of the Ground Lockit.
   b. Torque the set screw based on the ground wire size:

Cat. No.	Conductor Material	Conductor Size	Tightening Torque
850-1511	Copper, solid	14 – 10 AWG	40 in-lbf
		8 AWG	45 in-lbf
		6 AWG	50 in-lbf
		4 AWG	55 in-lbf



- *(4) - Tighten the set screw on the ground wire*
- *(5) - Fully installed Ground Lockit*

Refer to *Appendix D: Wire Management Recommendations on page 121* for additional information on wire management.

Related tasks

- Step 8: Install the Side Skirts and Corner Caps on page 100

Related information

- Installation Overview on page 29

Step 8: Install the Side Skirts and Corner Caps

Overview

Contains steps to complete the array by installing the rest of the cosmetic skirt.

Prerequisites

Complete PV module installation, wire management, and grounding before installing Side Skirts. (*Step 7: Complete Wire Management and Bonding on page 95*)

Hazards

Figure 8. Fall from Height

Figure 9. Cut Hazard

Safety and PPE

- Safety glasses (ANSI Z87.1 or EN 166)
- Cut-resistant gloves (ANSI Cut Level 3 or EN 388 Level C)
- Closed-toed shoes
- Fall protection equipment (full-body harness with lanyard) for working at height

General Equipment

- Extension ladder, fiberglass (ANSI/ASC Type IA, 300 lb/135 kg rating)

Required Parts and Tools

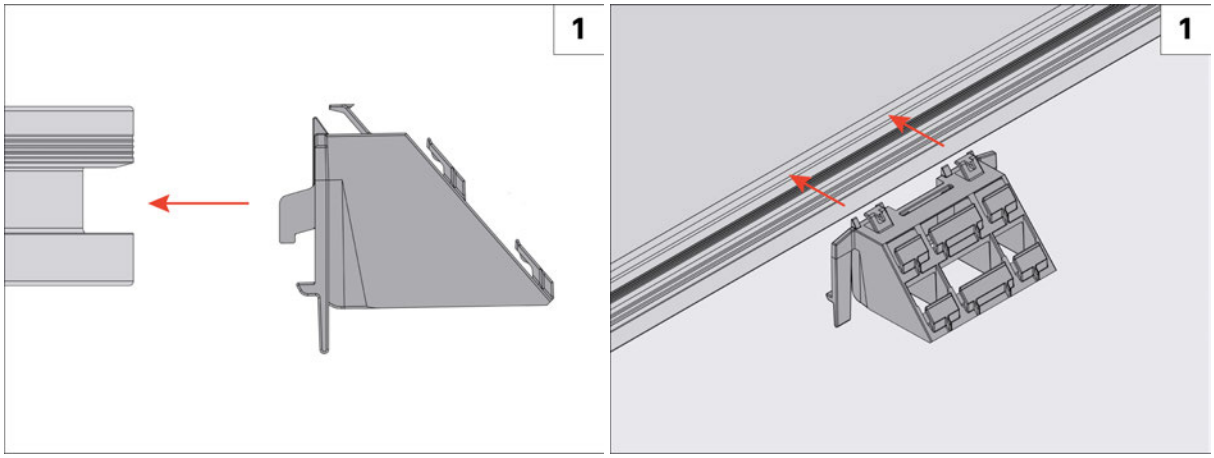
Refer to *Tesla Panel Mount - Tile System Components on page 8* for available lengths of Side Skirt sections.

- Side Skirt Brackets
- Side Skirt sections
- Inner or outer Corner Caps

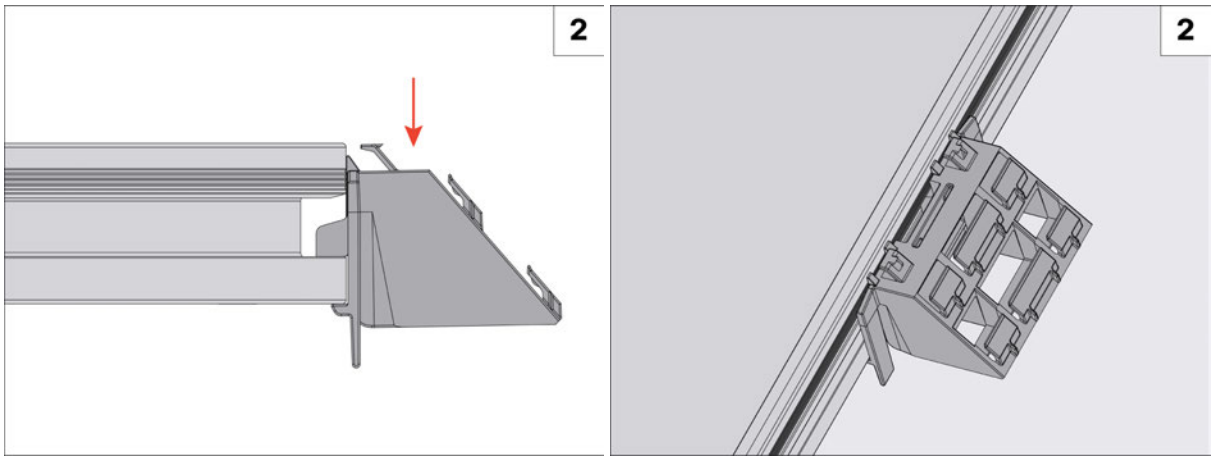
Install Side Skirt Brackets

1. Put on cut-resistant gloves and safety glasses.

2. Inspect and put on fall protection before performing roof work. Ensure that your fall harness is connected to a certified anchor point and maintain 6 ft (2 m) clearance from the roof edge unless guarded.
3. Install the Side Skirt Brackets into the Tesla Groove by hand with an inward motion then by pressing downward. A click indicates that the brackets are correctly installed.



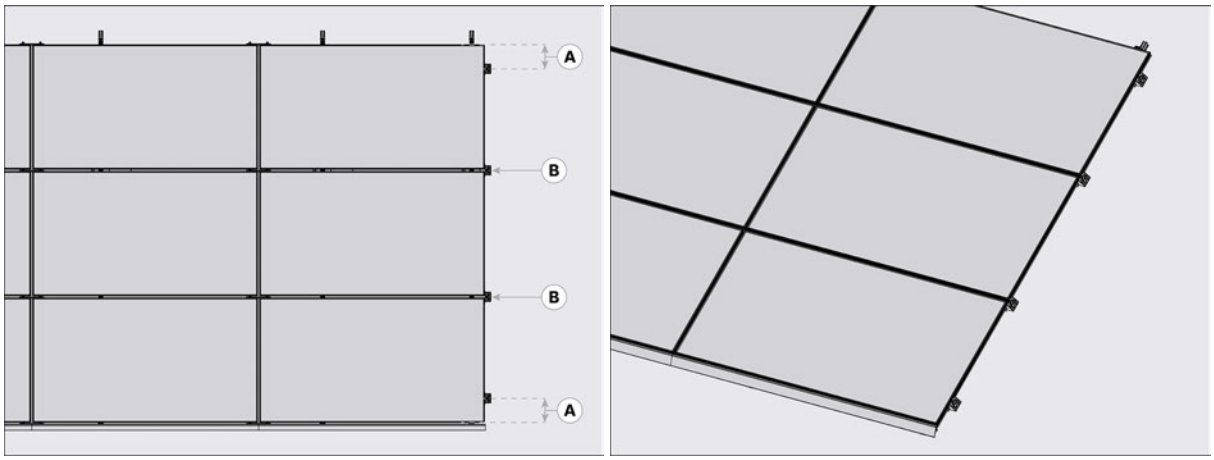
- *(1) - Inserting Side Skirt Bracket into Tesla Groove*



- *(2) - Side Skirt Bracket clicks into place when pressed down*

4. Install the Side Skirt Brackets 8 in. from an inside, outside, or top corner of the array and at every module junction.

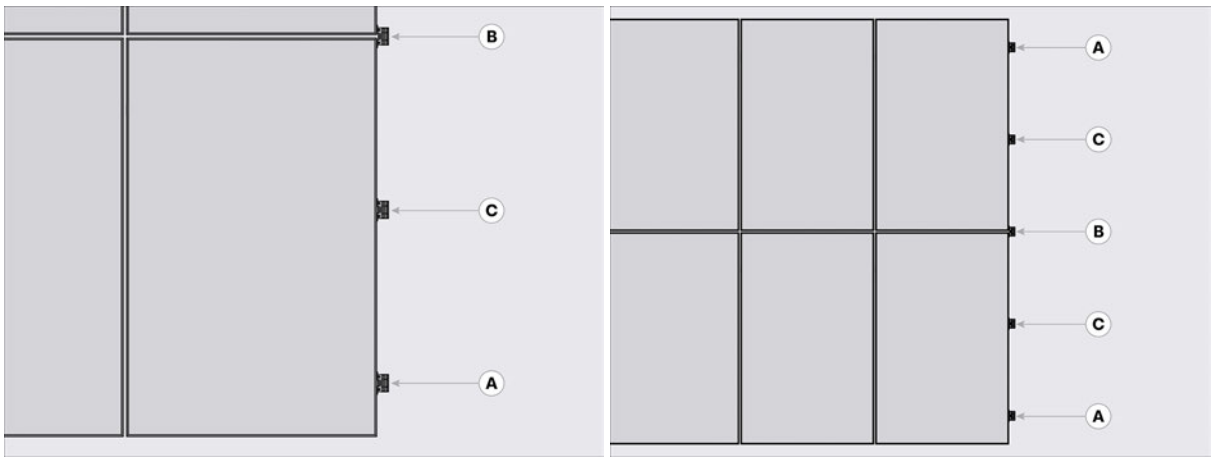
   Landscape orientation:



   - *(A) - 8 in. spacing from corner of array*
   - *(B) - Module junctions*

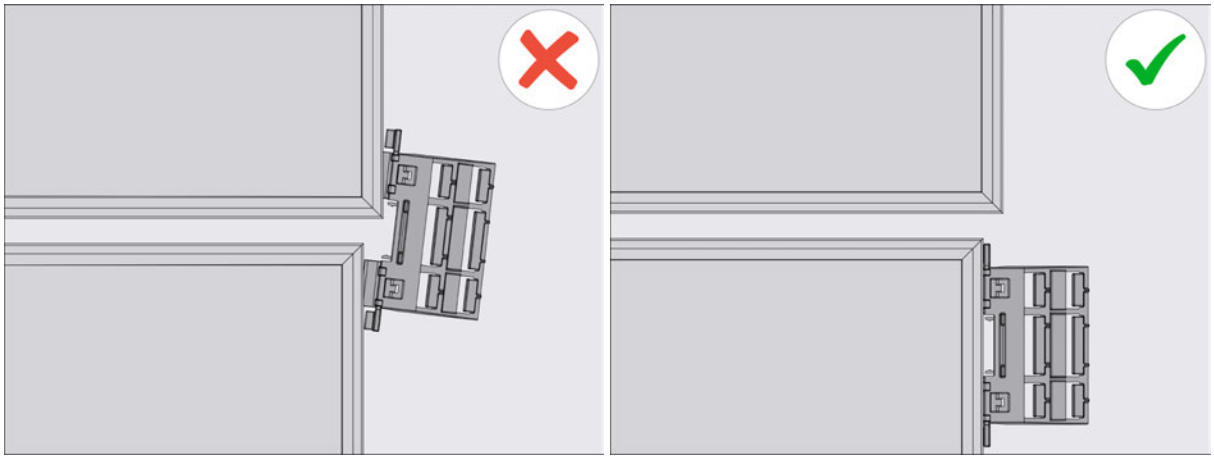
   Portrait orientation:

   In portrait orientation, install an additional Side Skirt Bracket in the middle of the long side of the PV module.

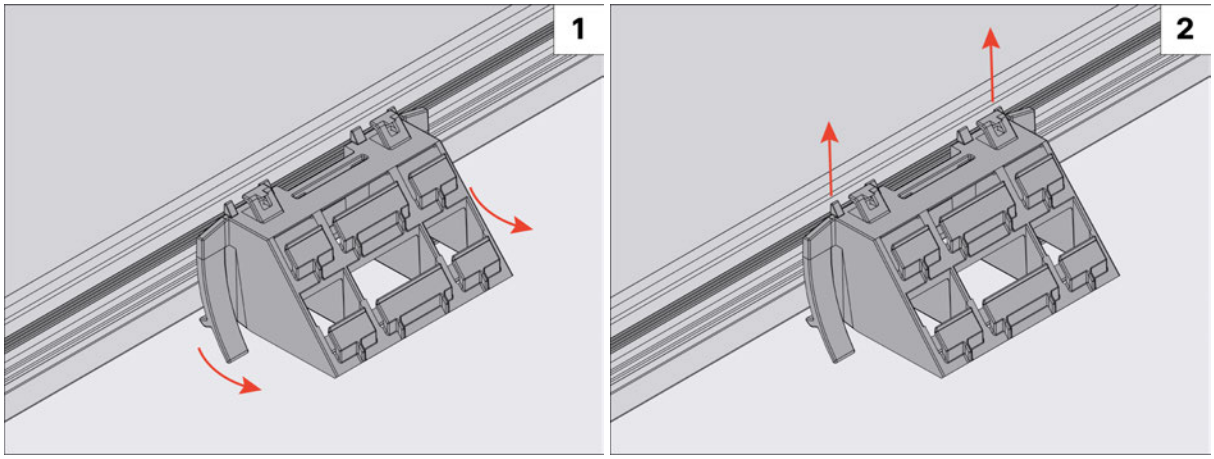


   - *(A) - Side Skirt Bracket 8 in. from corner of array*
   - *(B) - Module junctions*
   - *(C) - Additional Side Skirt Bracket in center of module*

5. If misalignment exists, the Side Skirt Brackets may not install correctly at module junctions. Either adjust X location of the modules if possible or install the bracket fully on one module.



6. To reposition a Side Skirt Bracket remove it from the module frame and adjust the location. Do so by pulling back on the tabs at the bottom of the bracket then lifting straight up on the bracket.

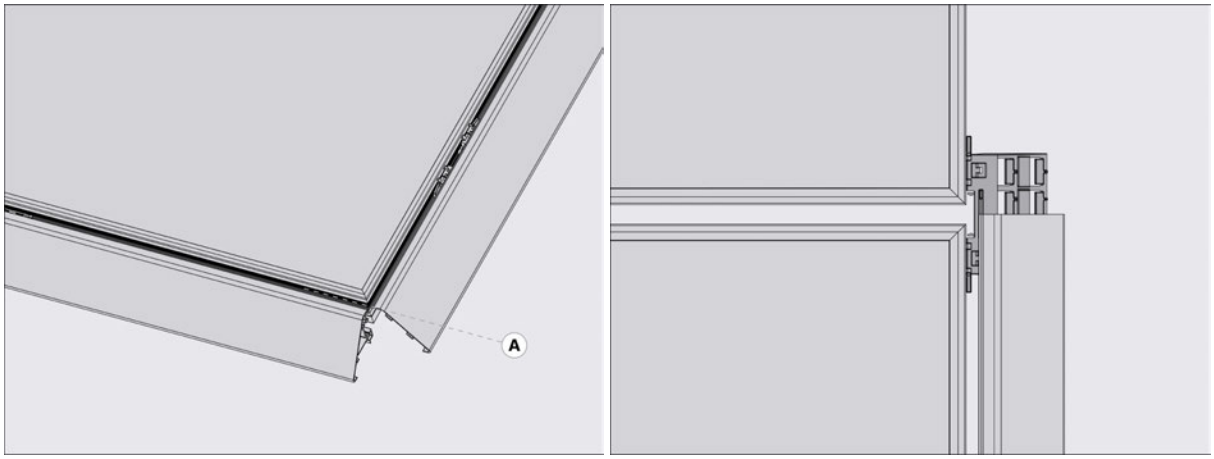


   - *(1) - Pull tabs away from module.*
   - *(2) - Lift up to remove Side Skirt Bracket.*

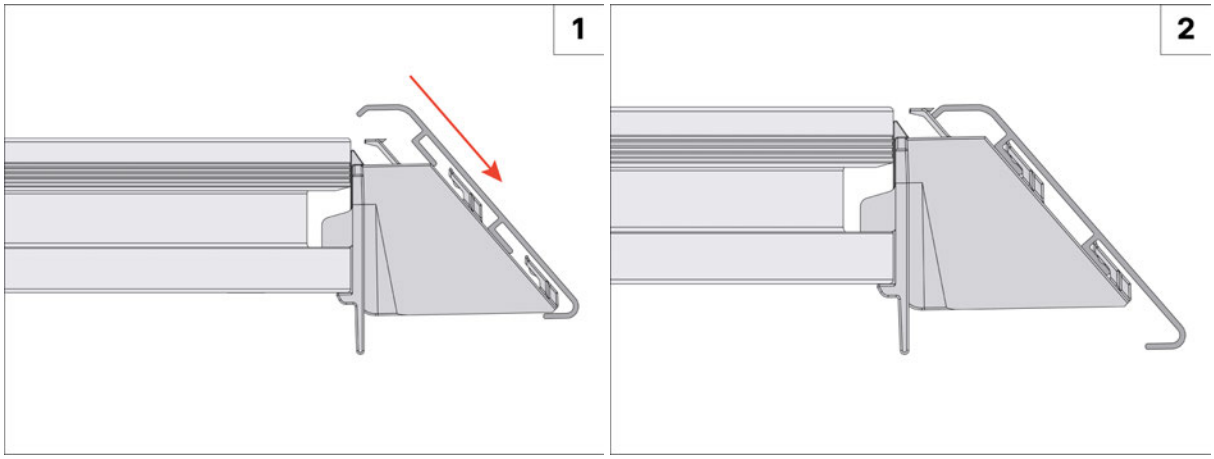
Install Side Skirts

1. Wear cut-resistant gloves and exercise caution when handling cut ends of Side Skirt sections.

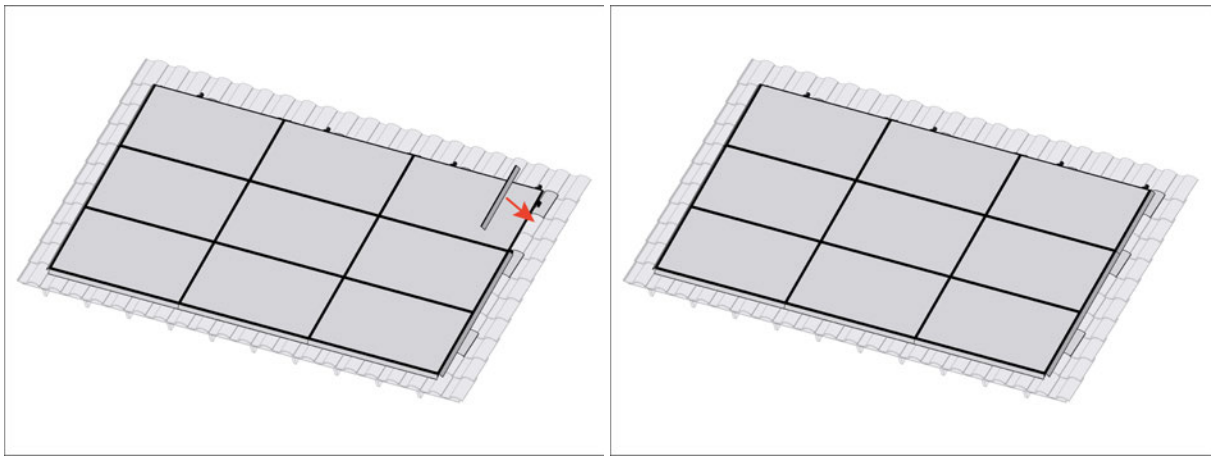
2. Starting at the bottom corner, align the Side Skirt with the corner of the module (A) and snap it into the Side Skirt Bracket. Adjacent Side Skirts will share a Side Skirt Bracket where the edges meet.



3. Push down until a clicking sound indicates that the Side Skirt is in place. The tabs at the top of the Side Skirt Bracket will wrap around the upper lip of the Side Skirt when fully seated.



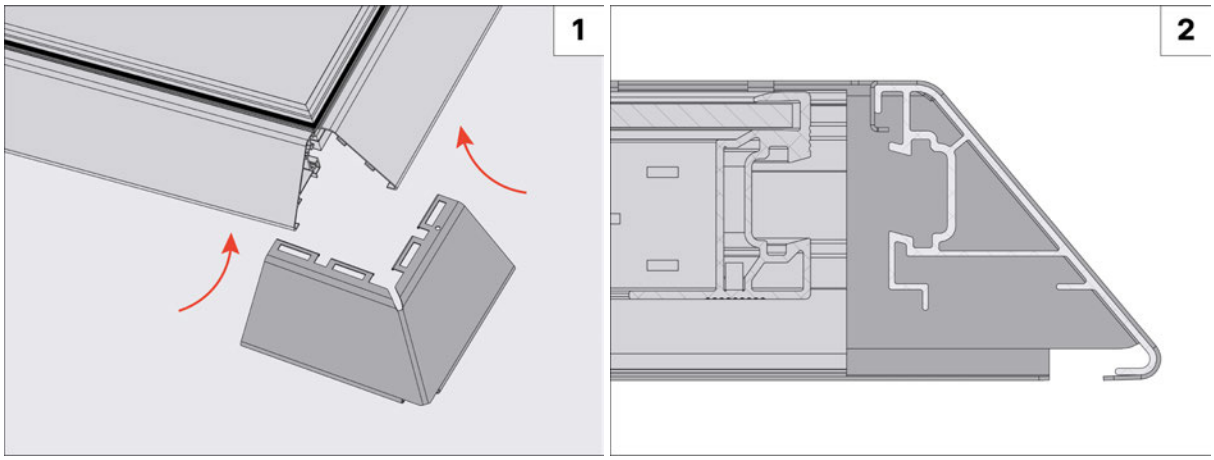
- *(1) - Installing Side Skirt onto Side Skirt Bracket*
- *(2) - Side Skirt clicks into place when fully seated*



NOTE: Side Skirt Brackets can be pre-installed on the Side Skirt before attachment to the modules. Always comply with spacing requirements and avoid placing brackets on top of wire clips.

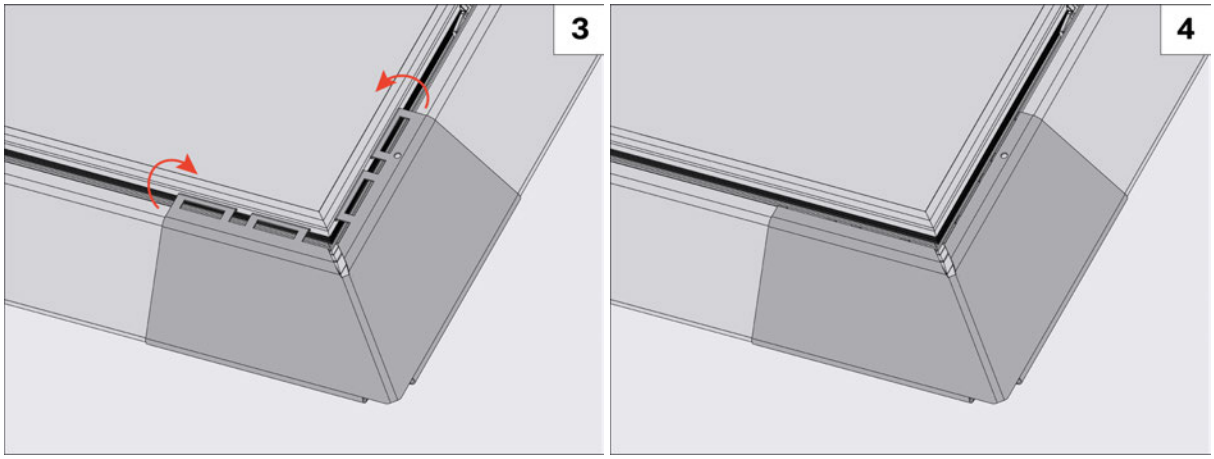
Install Corner Caps

1. Install a Corner Cap at the junction between the Front Skirt and Side Skirt. Ensure that the lower flange on the Corner Cap wraps around the bottom edge of the skirts.



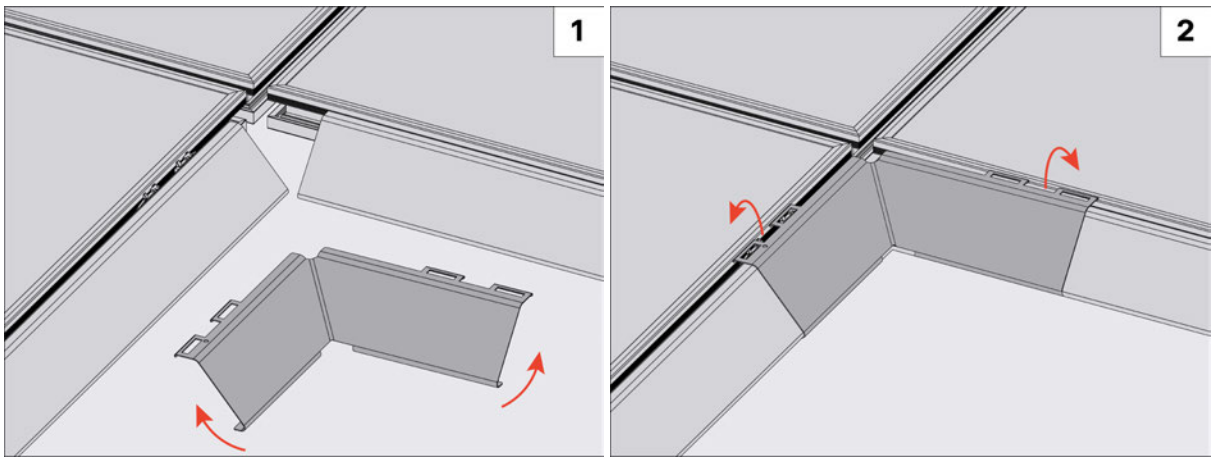
   - *(1) - Installing Corner Cap at the junction between Front Skirt and Side Skirt*
   - *(2) - Lower flange wraps around bottom edge*

2. Fold the Corner Cap tabs down around the back of the Front Skirt and Side Skirt. Place the back of a slotted screwdriver between the module frame and the Corner Cap and twist gently to fully engage the tab.

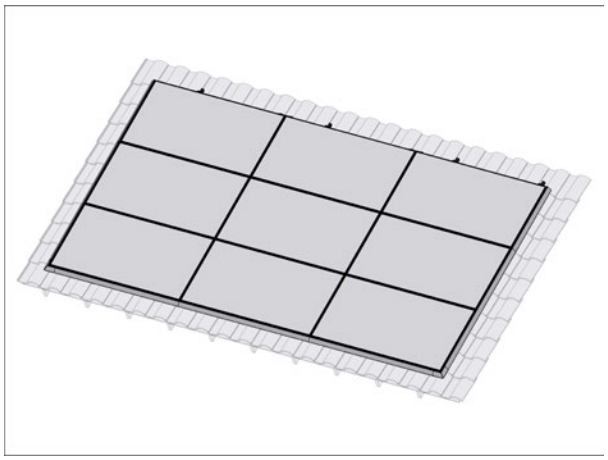


   - *(3) - Corner Cap tabs fold over the Front Skirt and Side Skirt*
   - *(4) - Fully installed Corner Cap*

3. Install inside Corner Caps in the same manner where skirt sections meet at a corner to complete the array.



   - *(1) - Placement of inside Corner Cap*
   - *(2) - Corner Cap tabs fold over the Front Skirt and Side Skirt*



   - *Completed array*

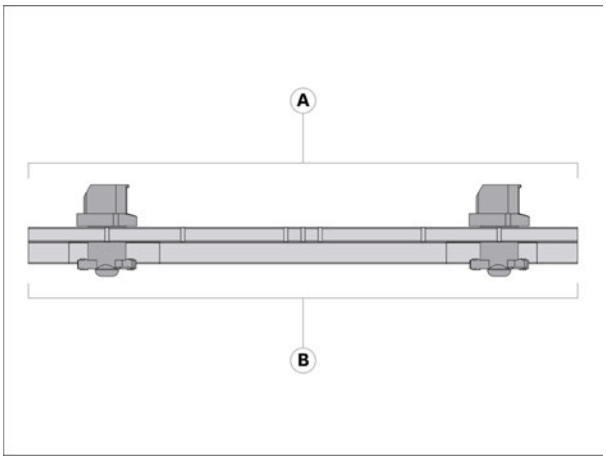
Related information

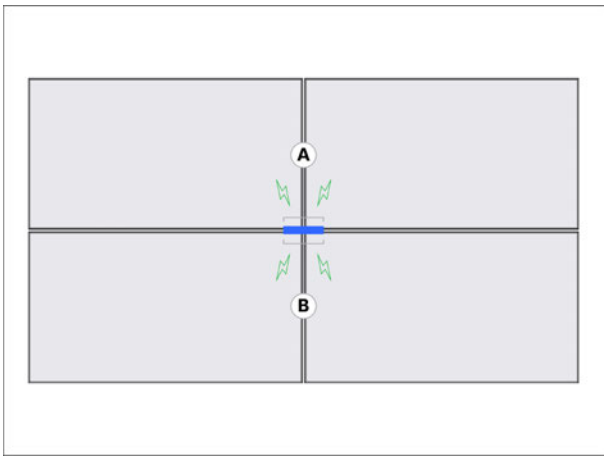
- Installation Overview on page 29

APPENDIX A: GROUNDING AND BONDING

Interlock Bonding

The Interlock bonds modules on all four sides and across the Interlock plate to create a redundantly-bonded array where every module is structurally and electrically bonded to the surrounding modules.

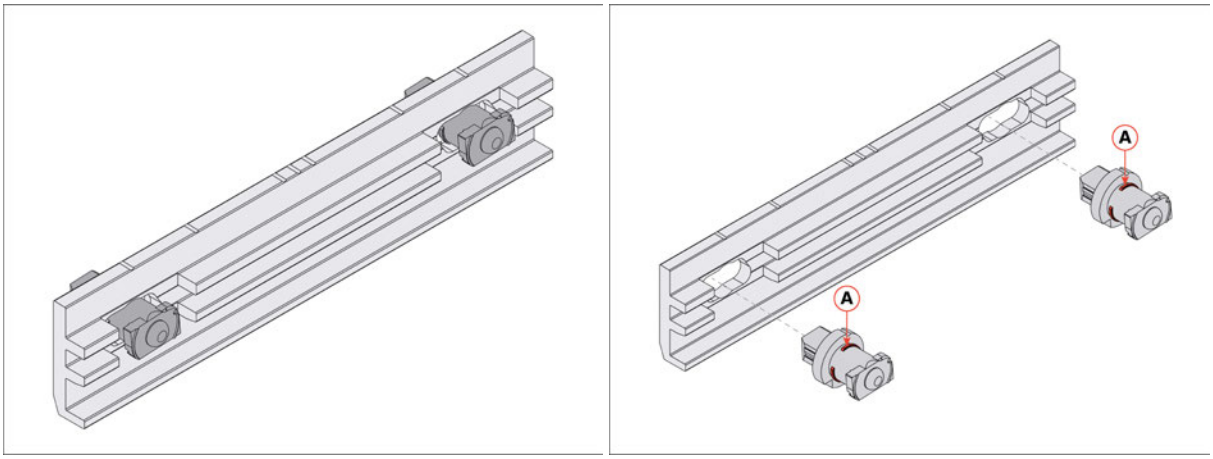




- *(A) - Tongue side of the Interlock*
- *(B) - Key side of the Interlock*
- *Bond path*
- *Interlock*

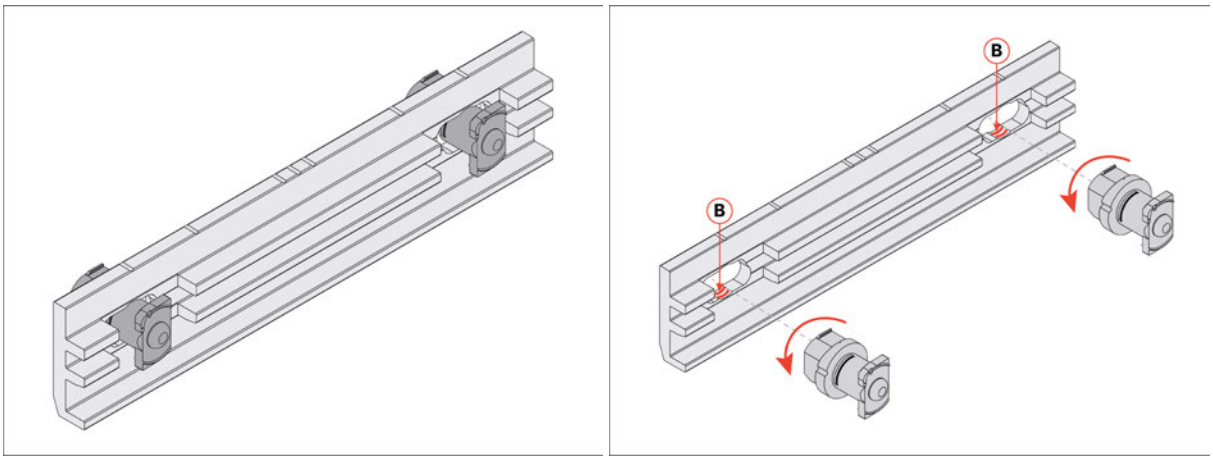
Interlock Lockit to Interlock Bonding

The rotating fastener attached to the Interlock plate, called the Lockit or Interlock Lockit, has two cutting teeth on the shaft that cut into the Interlock plate when the Lockit is tightened during normal installation, resulting in a robust and UL-certified bonding path. The Interlock may be re-installed up to 15 times.



- *Lockit (A) in open position:*

Lockit in locked position cuts into Interlock plate:

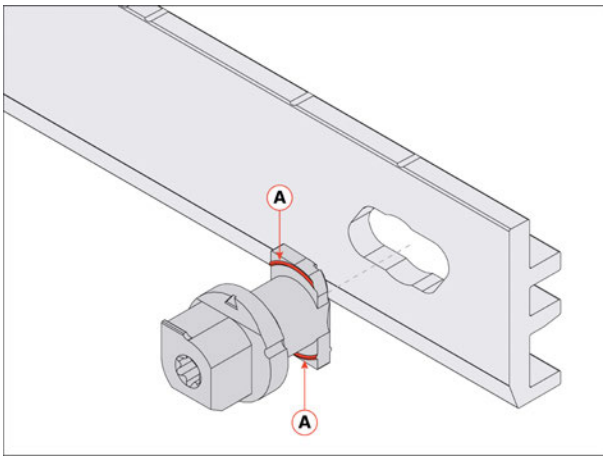


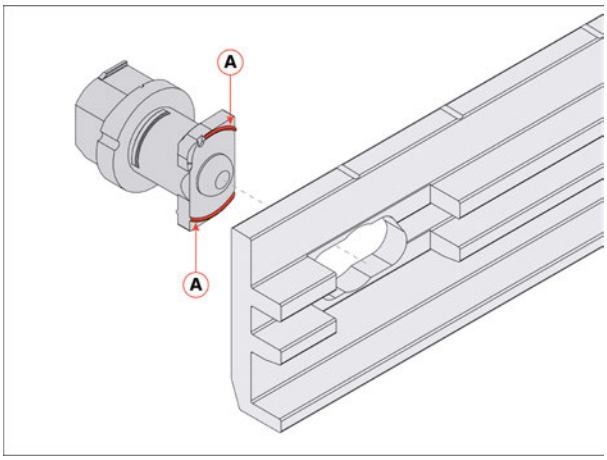
- *Lockit in locked position cuts into Interlock plate (B)*

Interlock Bonding to Module Frame

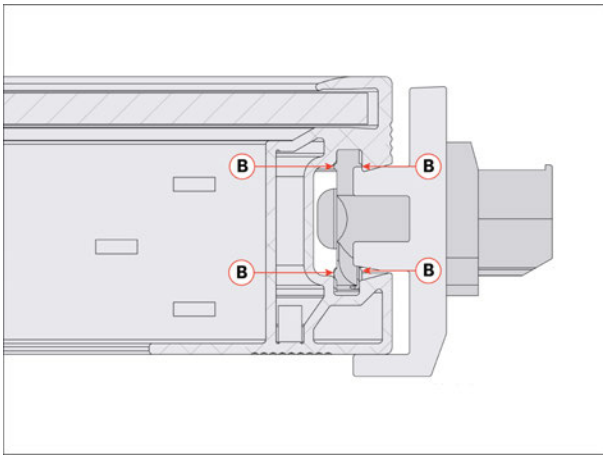
Forced interference during the rotation of the Interlock Lockit causes the teeth to cut through the coating on the module frame, resulting in a robust and UL-certified bonding path. The Key side of the Interlock Lockit bonds the down-roof edge of modules, as shown below:

APPENDIX A: GROUNDING AND BONDING



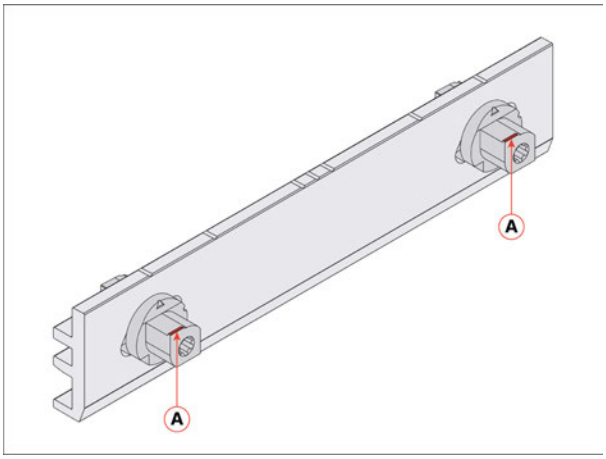


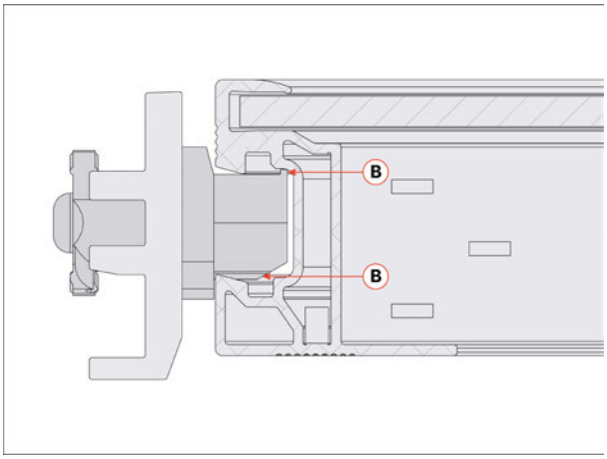
- *(A) - Teeth on Interlock Lockit*



- *(B) - Forced interference bonding with module frame*

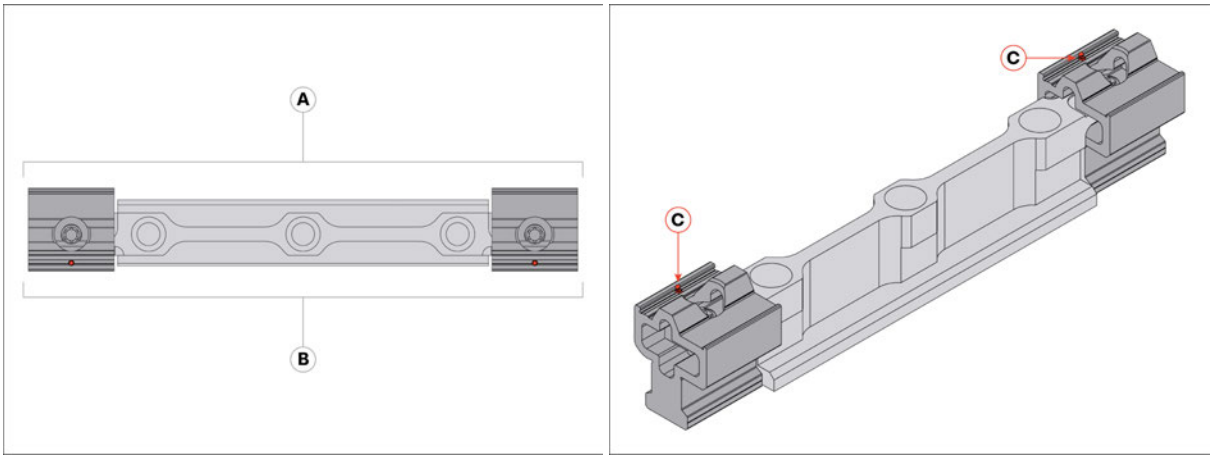
The Tongue side of the Interlock Lockit bonds modules on the up-roof side in a similar manner, as shown below:



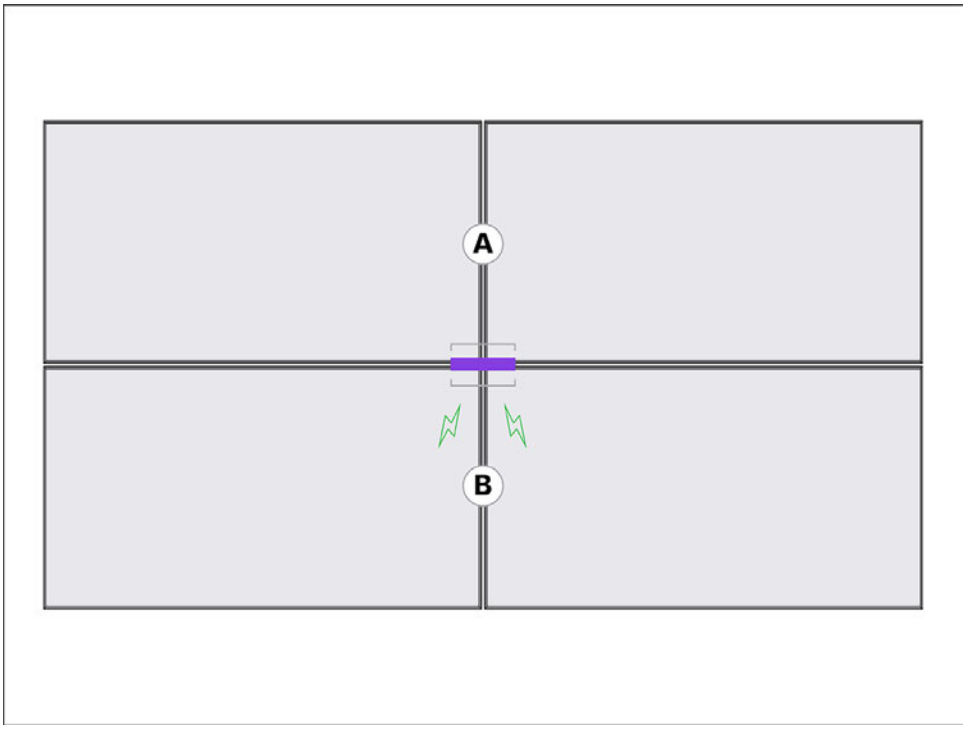


- *(A) - Teeth on Interlock Lockit*
- *(B) - Forced interference bonding with module frame*

Hybrid Interlock Bonding



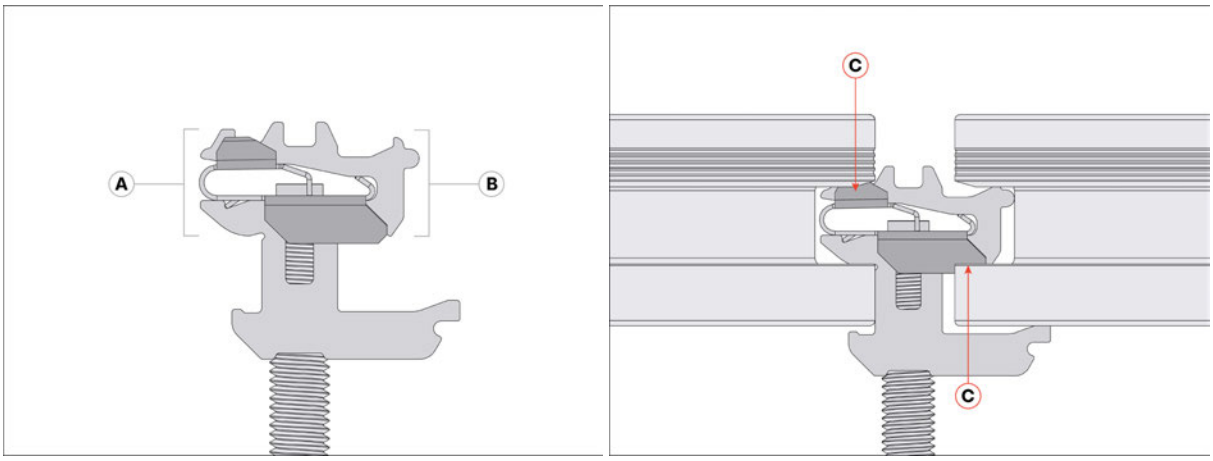
- *(A) - Tongue side of the Hybrid Interlock*
- *(B) - Key side of the Hybrid Interlock*
- *(C) - Bonding pins*



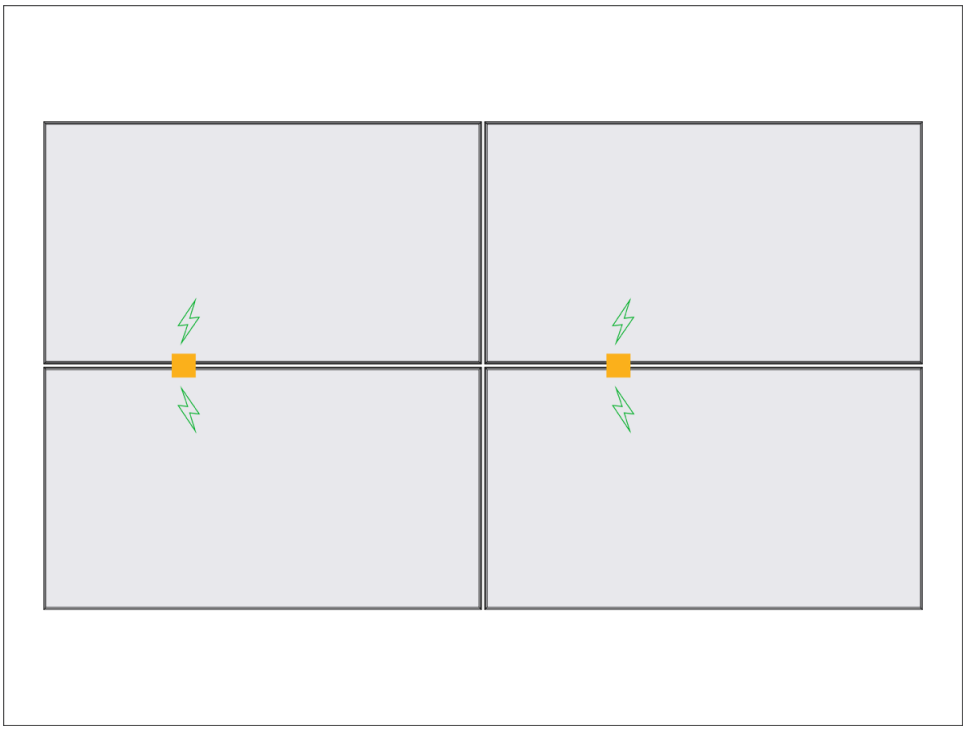
Hybrid Interlocks only bond the two down-roof modules.

Key & Tongue Side Bonding of the Rockit

The Rockit has a stainless-steel spring clip that bonds to the adjacent module frame on both Key and Tongue sides. A module can be pulled out to the edge of the lip and still be correctly installed, allowing for small variations in module sizes or module alignment.



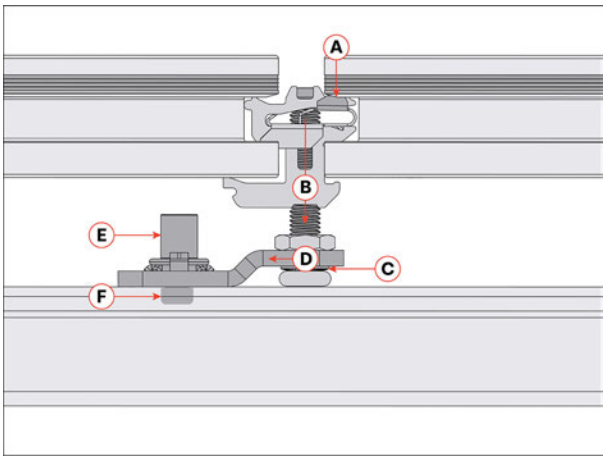
- *(A) - Key side of Rockit*
- *(B) - Tongue side of Rockit*
- *(C)- Bond location*

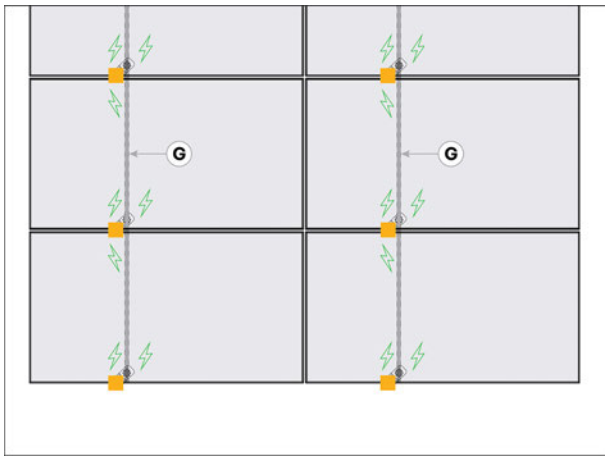


- *Bond path*
- *Rockit*

Leveling Foot to Spanner Bar Bonding

In the Tesla Panel Mount - Tile system, the Spanner Bars are also electrically bonded to the EGC through the leveling foot. Both Round Tile Leveling Feet and Flat Tile Leveling Feet complete this bonding in a similar manner.

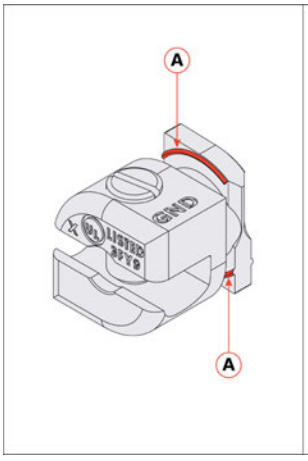


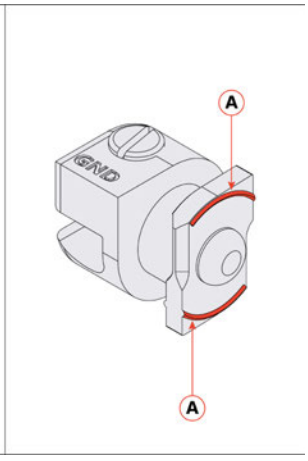


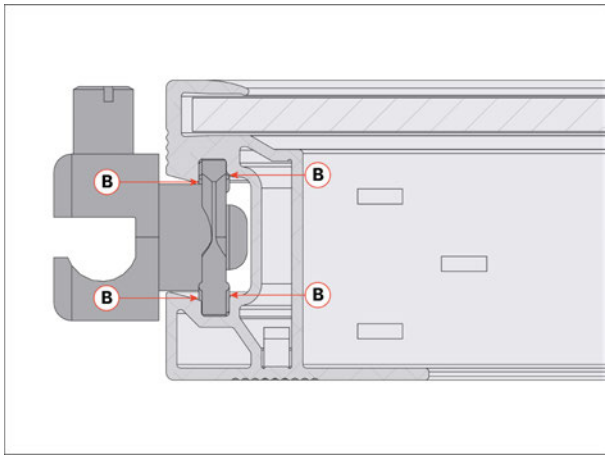
- *(A) - Stainless steel spring in the Rockit cuts through the coating on the module frame*
- *(B) - Rockit connects to the stud at the threaded connection*
- *(C) - Stud head connects to the serrated washer*
- *(D) - Serrated washer connects to the Leveling Foot bracket*
- *(E) - Winged washer connects the Leveling Foot bracket to the T-Bolt assembly*
- *(F) - T-Bolt connects to the Spanner Bar with serrated teeth*
- *(G) - Spanner Bar*

Ground Lockit

The Ground Lockit bonds to the modules in the same way as the Interlock with biting teeth that cause forced interference during rotation. The teeth cut through the coating on the module frame, resulting in a robust and UL-certified bonding path.

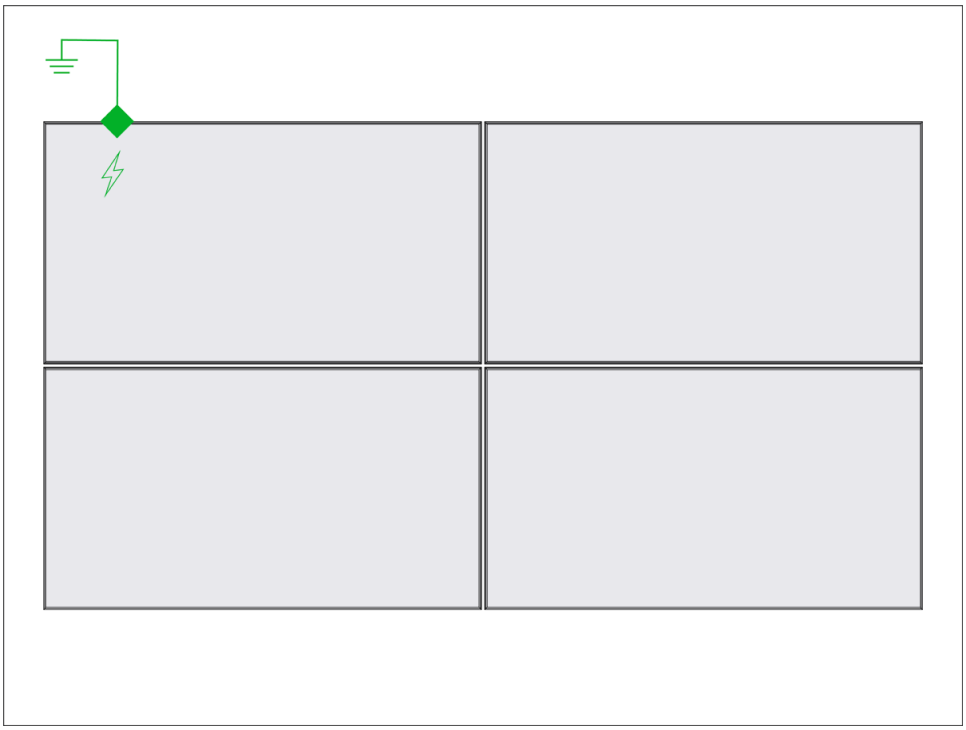






- *(A) - Teeth on Ground Lockit*
- *(B) - Forced interference bonding with module frame*

APPENDIX A: GROUNDING AND BONDING



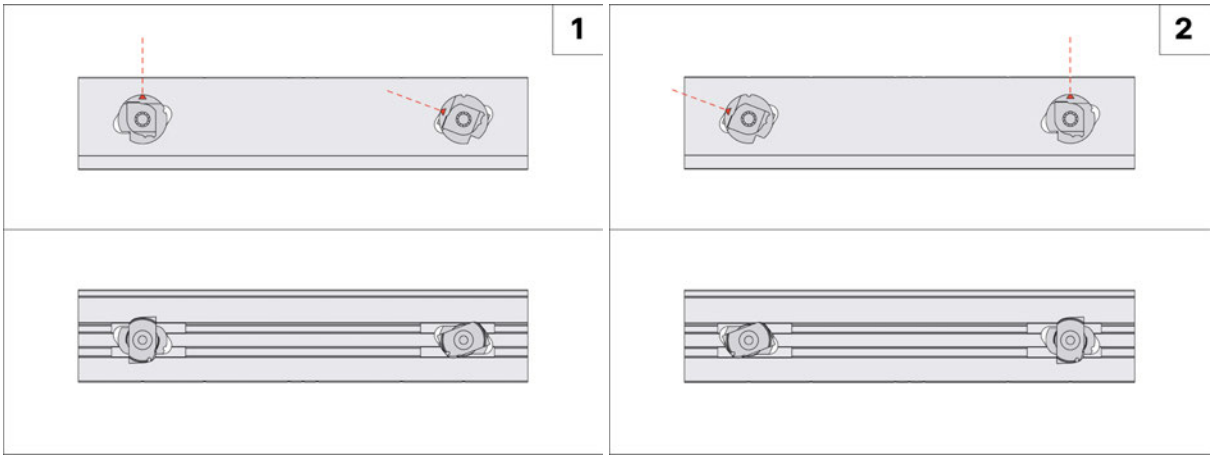
- *Bond path*
- *Ground Lockit*
- *Equipment grounding conductor (EGC)*
- *Earth ground*

APPENDIX B: THERMAL EXPANSION

Installing Thermal Expansion Joints

Thermal expansion joints consist of Interlocks that are installed in a manner allowing modules a small amount of lateral movement for thermal expansion in response to daily temperature swings on the roof. In the up-roof/down-roof direction, a physical gap is required to allow for thermal expansion of the modules. A gap of at least 12 in. between sub-arrays is recommended, both for thermal expansion and to allow access by work crews for module servicing.

Rotate the Interlock Lockit on one side to Position 3 (locked position). Rotate the Interlock Key on the other side to Position 2. Position 2 provides a structural connection but does not establish an electrical bond.



- *(1) - Thermal break right (Positions 3 and 2)*
- *(2) - Thermal break left (Positions 2 and 3)*

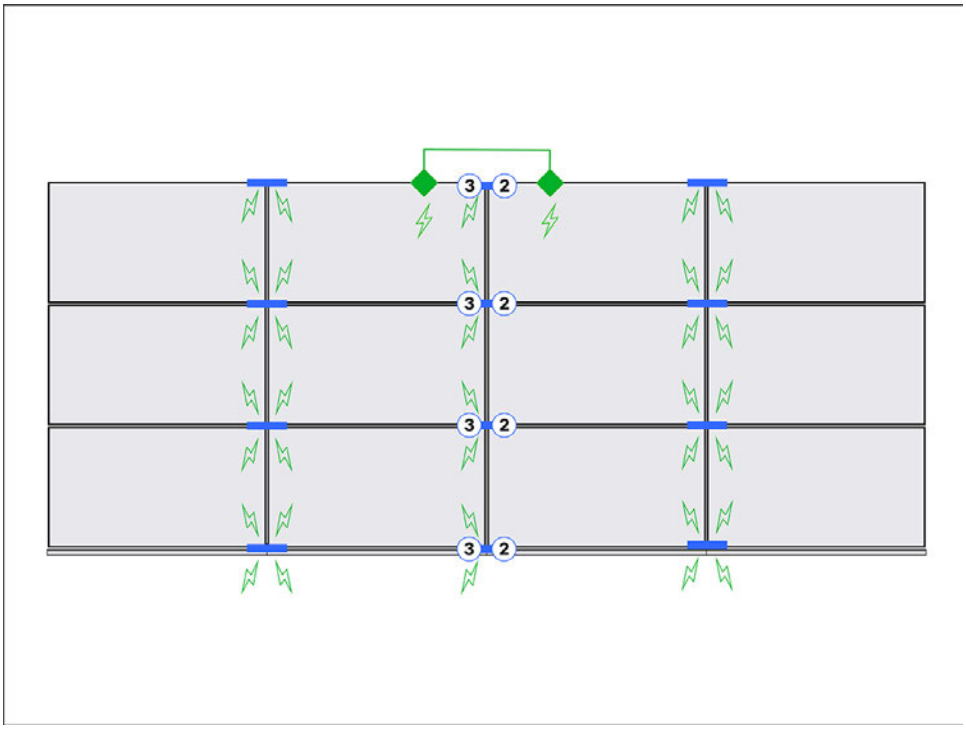
NOTE: Marking thermal breaks on the roof during array layout can help ensure they are completed as required.

Thermal expansion joints require that a Ground Lockit be installed on both sides of the break.

Thermal Expansion Joints and Module Columns

When there is a continuous column of Interlocks all serving as a thermal expansion joint, all Interlocks must be set to Position 3 on the same side. This is because the Interlock also electrically bonds the up-roof module when turned to Position 3. Thermal expansion joints should also be included at the array skirt.

NOTE: Hybrid Interlocks may not be used in thermal expansion joints.



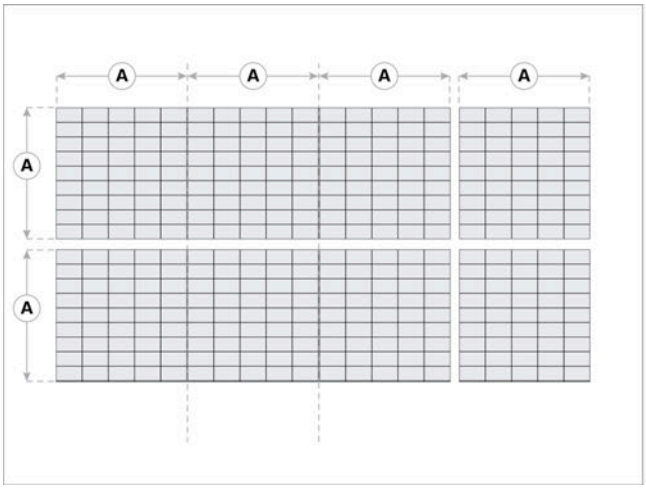
- *Bond path*
- *Ground Lockit*
- *Equipment grounding conductor (EGC)*
- *Interlock*

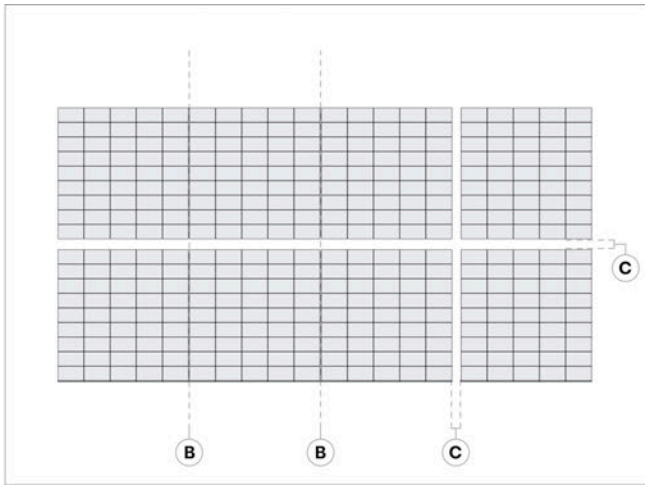
APPENDIX B: THERMAL EXPANSION

Physical Gaps between Sub-Arrays

For arrays spanning more than 98 ft (30 m) in the X direction or 33 ft (10 m) in the Y direction, create a physical gap to allow thermal expansion. The minimum gap between sub-arrays should be 4 in. (100 mm), but a gap of 12 in. (300 mm) is recommended for ease of servicing.

For typical modules, this is every five module lengths or nine module widths.



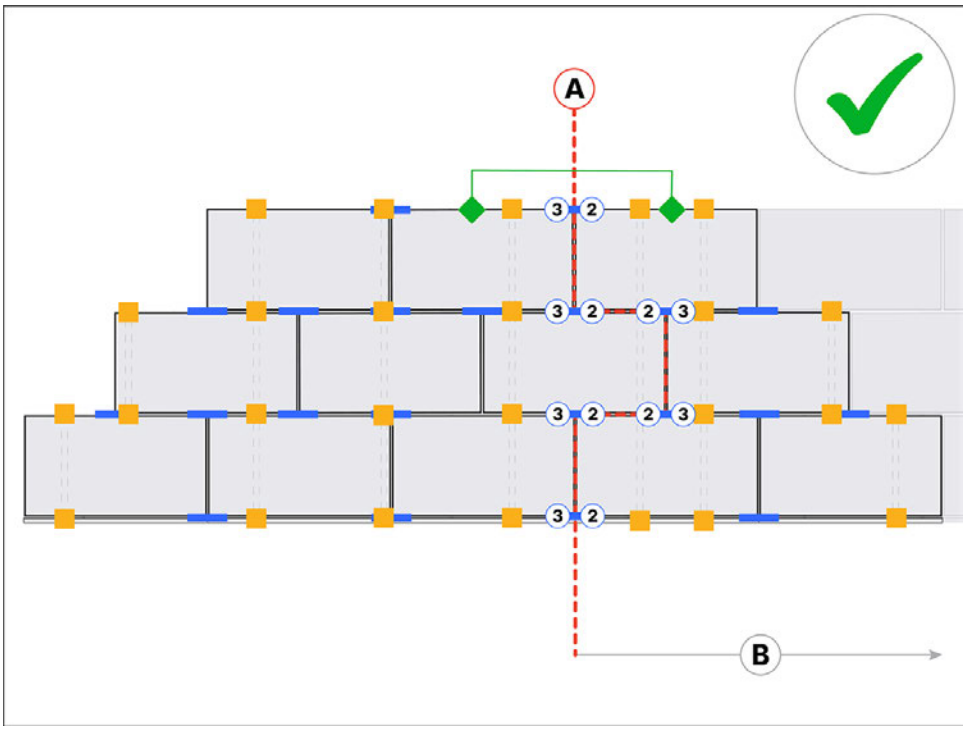


- *(A) - 33 ft (10 m) in X or Y direction*
- *(B) - Thermal expansion joints*
- *(C) - Physical gaps*

Thermal Expansion Joints in Staggered Arrays

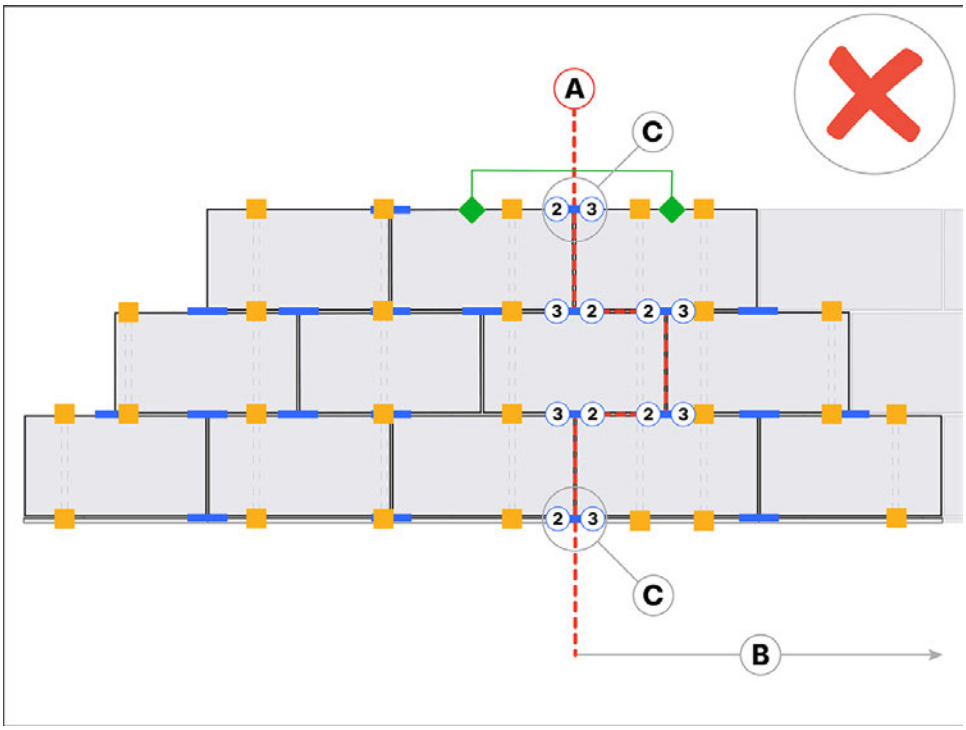
When module rows are offset from one another, creating a thermal expansion joint is more complex, requiring additional Interlocks in a continuous path with no Rockits between them.

Thermal expansion joints on staggered arrays require Interlocks at each juncture where the array is intended to expand. Each Interlock Lockit is turned to Position 2 (the middle position- marked by a notch) on one side (allows thermal expansion) and Position 3 (fully locked - marked by an arrow) on the other, such that there is an unbroken line between the Lockits in Position 2. The installer must not place any Leveling Feet between these points as the Rockits do not allow any lateral movement.

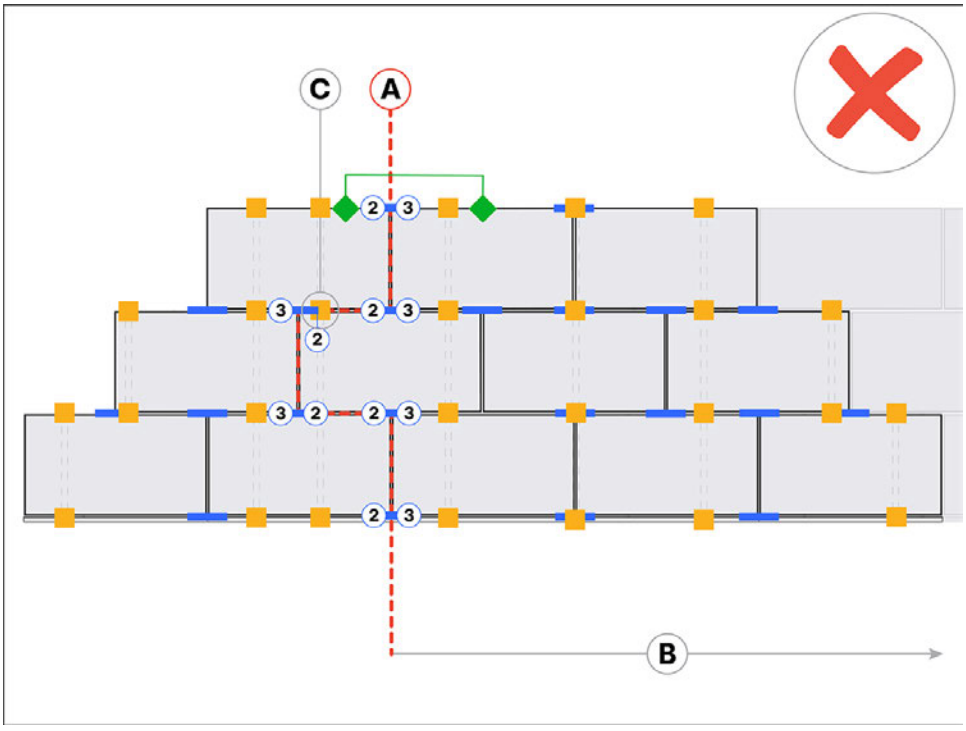


- *(A) - Thermal expansion joint*
- *(B) - No more than 10 m to the edge of the array or next thermal expansion joint*

APPENDIX B: THERMAL EXPANSION



- *(A) - Thermal expansion joint*
- *(B) - No more than 10 m to the edge of the array or next thermal expansion joint*
- *(C) - Incorrect Interlock Lockit positions*



- *(A) - Thermal expansion joint*
- *(B) - No more than 10 m to the edge of the array or next thermal expansion joint*
- *(C) - Rockit interfering with thermal expansion path*

APPENDIX C: ALLOWABLE MOUNTING SYSTEM LOADING

- Updated pressure tables.
- Updated pressure tables.

Tesla Compatible modules have been evaluated for design loads on the back surface (e.g., wind load) and on the front surface (e.g., wind and snow load.)

UL 2703 Requirements:

PV modules were evaluated at the following attachment spans in order for Tesla Solar hardware to obtain load ratings using specified test procedures:

Tesla Solar Panels

Tesla Panel Mount - Tile - Tesla Solar Panels - TSP-4XX System Allowable Pressures							
	Spans						
	Vertical Span (MH Y Spacing)	**Horizontal Span (Rail X Spacing)**	**Allowable Panel X Cantilever**	**Allowable Spanner Bar Y Cantilever**	**Uplift**	**Downforce**	**Shear**
	in.	in.	in.	in.	psf	psf	psf
Landscape (4 Tiles)	52	72	24	26	19.7	20.9	13.1
	52	64	22	26	22.2	23.5	14.7
	52	48	16	26	29.6	31.4	19.6
	52	32	11	26	44.4	47.1	29.4
	52	24	14	26	54.6	57.9	36.2
	52	24	12	26	59.1	60	39.2
	52[1]	16	6	26	60.0	60.0	58.8
Portrait (4 Tiles)	52	48	16	26	18.6	27.2	16.5
	52	32	11	26	27.0	28.8	24.7
	52[1]	24	8	26	27.0	28.8	32.9

[1] Indicated value evaluated as part of UL 2703 Listing with standard UL 2703 test method and acceptance criteria.

Hanwha Qcells

Tesla Panel Mount - Tile - Hanwha Q-Cells: Q.PEAK DUO BLK ML-G10+/TS & Q.PEAK DUO BLK ML-G10.a+/TS System Allowable Pressures							
	Spans						
	Vertical Span (MH Y Spacing)	Horizontal Span (Rail X Spacing)	Allowable Panel X Cantilever	Allowable Spanner Bar Y Cantilever	Uplift	Downforce	Shear
	in.	in.	in.	in.	psf	psf	psf
Landscape (4 Tiles)	52	72	24	26	20.9	20.9	13.1
	52	64	22	26	23.5	23.5	14.7
	52	48	16	26	31.4	31.4	19.6
	52	32	11	26	47.1	47.1	29.4
	52	24	8	26	62.8	62.8	39.2
	52[1]	16	6	26	85.0	85.0	58.8
Portrait (4 Tiles)	52	48	16	26	17.8	20.0	15.7
	52	32	11	26	26.6	30.0	23.6
	52[1]	24	8	26	35.5	42.0	31.4

[1] Indicated value evaluated as part of UL 2703 Listing with standard UL 2703 test method and acceptance criteria.

Mounting system Model No.	Investigated for Bonding	Investigated for Mechanical Loading	System Fire Classification (A, B, or C)	Tested in Combination With
Tesla Panel Mount - Tile	Yes	Yes	A	NRTL Listed: Hanwha -Q.CELLS GmbH: Q.PEAK DUO BLK ML-G10+/TS XXX, where XXX is 395 to 415Q.PEAK DUO BLK ML-G10.a+/TS, where XXX is 370 to 425 Tesla -TSP-XXX, where XXX is 405 to 430

As specified in UL 61730-1 5.2.3DV, PV modules are considered to be in compliance with the mechanical loading and bonding and grounding requirements of UL 61730-1 when mounted, bonded, and grounded in the manner specified by either the PV module mounting instructions, or the mounting system manufacturer's instructions when the mounting, bonding, and grounding means have been evaluated with the PV module to UL 2703.

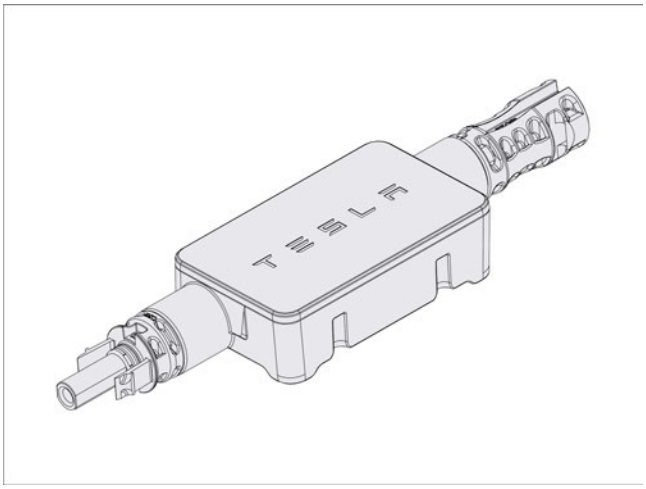
To be used only in combination with modules that include this specific rack system in the module manufacturer's installation manual.

APPENDIX D: WIRE MANAGEMENT RECOMMENDATIONS

Installing Mid-Circuit Interrupters (MCIs) in PV Arrays

The Tesla Mid-Circuit Interrupter (MCI) is used within PV strings and arrays to meet the rapid shutdown requirements of NEC Article 690.12.

MCI-2



MCI Locations

The quantity and placement of MCIs necessary to meet rapid shutdown requirements in NEC Article 690.12 (B) is governed by the UL 3741 (PV Hazard Control System or PVHCS) listing applicable to various array types. Always refer to the applicable PVHCS datasheets and references included in the addendum for detailed instructions to ensure adequate compliance and safe operation.

WARNING: It is critical that the minimum number of required MCIs is installed. Without the appropriate number of MCIs, the MCIs may not function as intended, which could lead to equipment damage and risk of electrical shock.

NOTE: MCIs are not required if the system does not need to comply with rapid shutdown requirements (NEC 690.12).

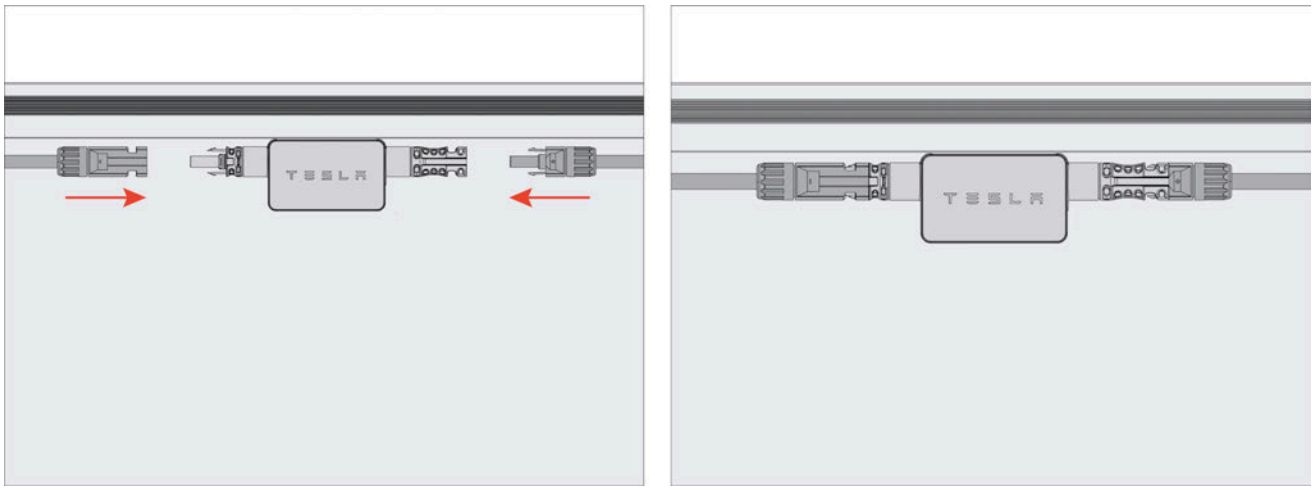
Installation Best Practices

- Do not store MCIs are not stored in environments with moisture or dirt prior to installation. Improper storage can lead to corrosion on the connector pins.
- Install the Tesla MCI in line with the PV modules using standard Staubli MC4 connectors. Incompatible connectors can lead to system failures.
- Ensure that the MCI is a minimum of ½ in. from the glass or backside of a PV module. This prevents overheating of the power electronics.
- Always secure the MCI with wire clips as specified. NEC 690.31(C)(1)(b) specifies that there must be a wire clip every 24 in. (600 mm). Wire clips must be at least 2 in. (50 mm) but not more than 6 in. (150 mm) from the connectors.
- Ensure that no more than 5 MCIs are connected per PV string.

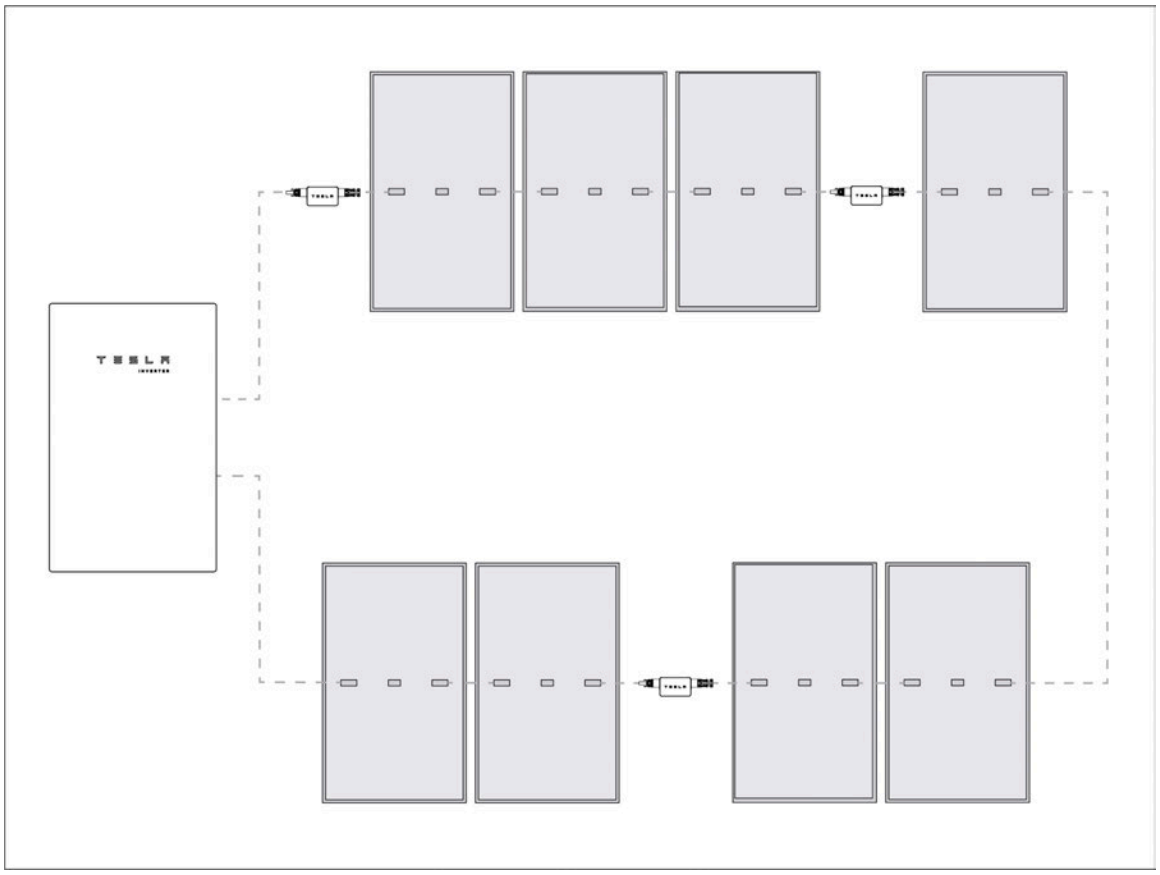
- Ensure that the total DC circuit length, from (+) MPPT terminal to (-) MPPT terminal (including module wire leads, jumper wires, and all wiring within the array boundary for any individual string) does not exceed 525 ft (160 m) for single strings or 394 ft (120 m) for parallel strings.
    - The total DC circuit length refers to the entire round trip wire length from the inverter to the roof, then back to the inverter.
    - Ensure that the parallel strings are the same length or as close in length as possible. If the parallel strings are different lengths, it is likely that the MCIs will not function properly. This likelihood increases with greater difference in parallel string lengths.
- Keep a completed string diagram indicating the layout of the array and the placement of each MCI (either a paper copy, electronic copy available in the field, or both).

Installing MCIs

1. Connect the positive and negative leads of the MCI to the corresponding positive / negative MC4 terminals of the PV modules.

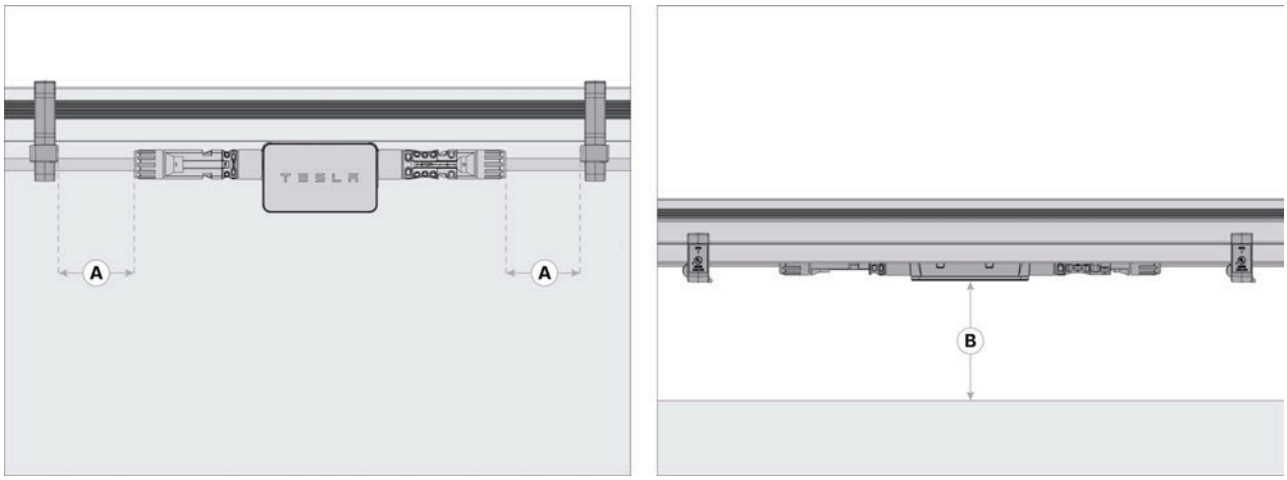


MCIs Installed in Line with PV Modules



2. Attach the MCI under the module frame.
    - To attach the MCI using DC Wire Clips or Home Run Wire Clips, install two clips to the module frame and clip both ends of the MCI leads, then slot the MCI underneath the metal frame.

MCI-2 Attached with Wire Clips



- *(A) - Minimum distance from clips*
- *(B) - Minimum distance from roof*

> ⚠ **CAUTION: Do not twist the MC4 connectors on MCI-2**. Twisting the connectors damages the electrical contacts inside, likely resulting in MCI failure.

APPENDIX D: WIRE MANAGEMENT RECOMMENDATIONS

NOTE: For MCI-2, place the wire clips at least 2 in. (50 mm) but not more than 6 in. (150 mm) from the connectors.

APPENDIX E: MODULE SERVICING

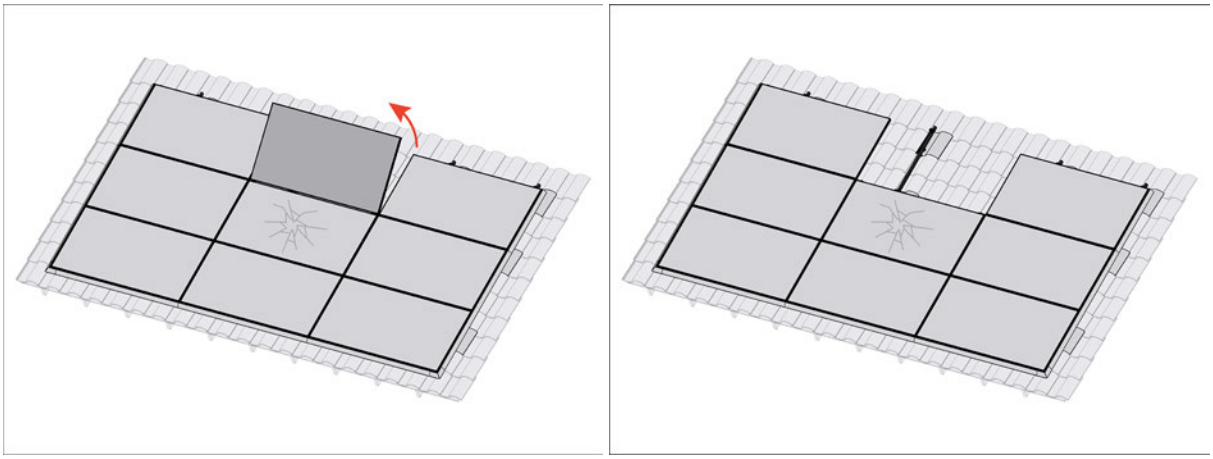
Overview

Removal and replacement instructions for PV modules installed with Tesla Panel Mount - Tile.

Prerequisites

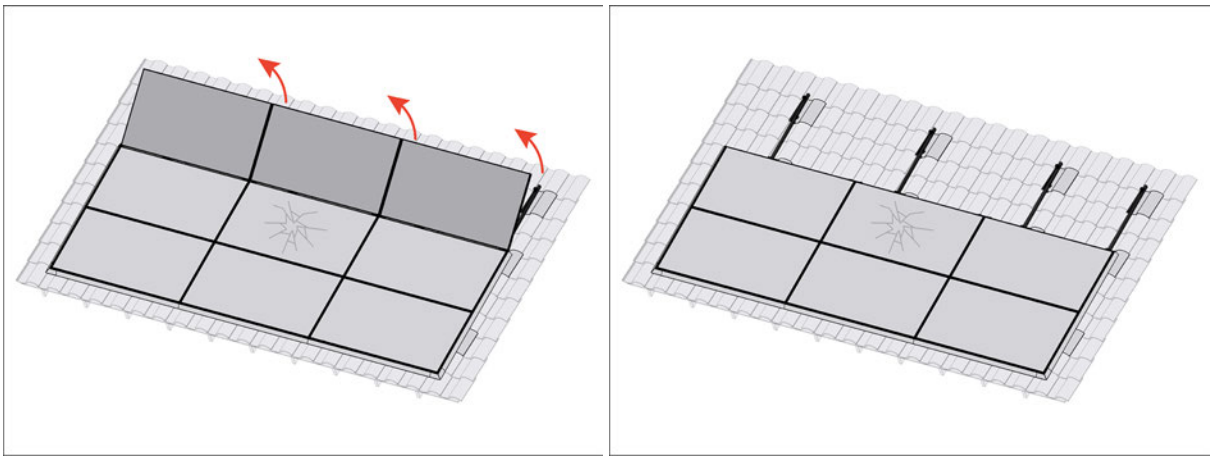
All individuals that will be working on the PV system must apply a Lock and Tag. When more than one individual is working on the PV system, each individual must also sign on and off when applying and removing their lock. Use the LOTOV Form linked here: (*LOTOV Form*)

To service installed modules, the hardware can be removed in the reverse operation from which it was installed, from the top of the array down. The Tesla Solar Wrench is a custom tool designed to aid in the servicing of Tesla Panel Mount systems. With this tool, a centrally-located module can be removed by first removing the modules in the column above it.



- *Top row module removal with Tesla Solar Wrench*

If using a T40 tool instead of the Tesla Solar Wrench, entire rows must be removed down to the level of the suspect module.



- *Top row removal is required if using T40 tool*

Hazards

Figure 10. Shock

Figure 11. Arc Flash

Figure 12. Fall from Height

Safety and PPE

- Closed-toe shoes (leather upper)
- HRC2/CAT 2 arc-rated, long-sleeved shirt (tucked in) and arc-rated pants or coveralls
- Safety glasses (ANSI Z87.1 or EN 166)
- Class 0 insulated electrical gloves with leather protectors (ANSI A4 cut-resistant, ANSI A3 abrasion-resistant, ASTM CAT2)
- Cut-resistant gloves (ANSI Cut Level 3 or EN 388 Level C)
- Full-body harness with lanyard (when working at height)

General Equipment

- Extension ladder, fiberglass (ANSI/ASC Type IA, 300 lb [135 kg] rating)

Required Parts and Tools

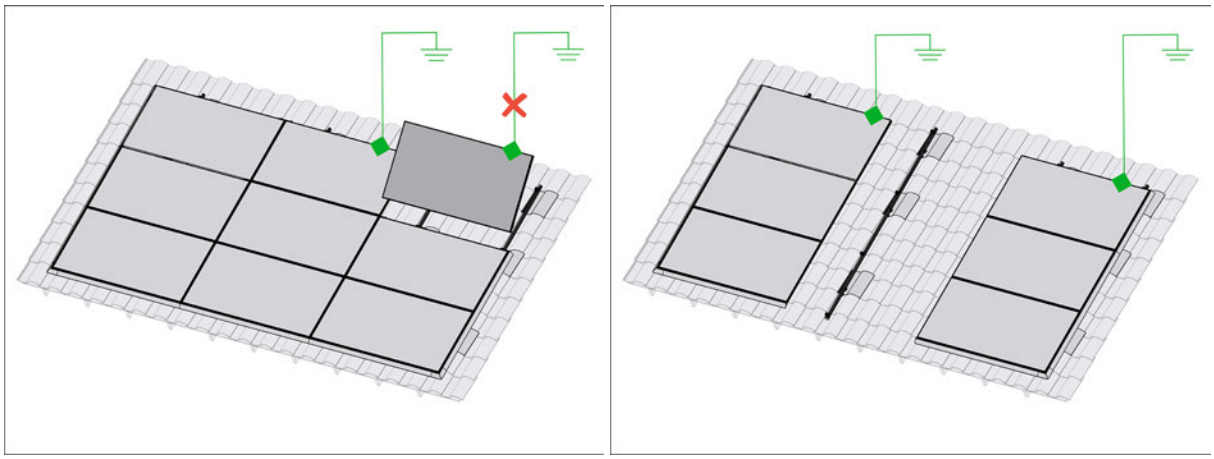
- Tesla Solar Wrench **or** T40 Torx
- MC4 disconnect tool
- Slotted screwdriver

Remove

1. De-energize the PV system. Refer to *PV Inverter - LOTOV on page 135*.
2. Verify that a Ground Lockit or equivalent equipment grounding conductor (EGC) is installed to safely dissipate residual voltage. Maintain EGC continuity throughout the PV array.
3. Use a multimeter rated for equipment voltage to test DC voltage.

a. Set the multimeter and proving unit to DC and verify operation of the multimeter.
b. Test between DC+ and ground and confirm that voltage is ≤ 20 V. Verify the multimeter on the proving unit.
c. Test between DC- and ground and confirm that voltage is ≤ 20 V. Verify the multimeter on the proving unit.
d. Test between DC+ and DC- and confirm that voltage is ≤ 20 V. Verify the multimeter on the proving unit.
e. If measured voltage is > 20 V, re-isolate and investigate. Do not proceed with work until DC voltage is ≤ 20 V.

4. Wait 5 minutes to allow capacitive discharge of components. Do not bypass or touch conductors during this time.
5. Inspect and put on fall protection before performing roof work. Ensure that your fall harness is connected to a certified anchor point and maintain 6 ft (2 m) clearance from the roof edge unless guarded.
6. Maintain ground path for module servicing.
   a. Put on Class 0 insulated electrical gloves with leather protectors or equivalent protectors.
   b. If a module with a Ground Lockit must be removed for servicing, use additional Ground Lockits as needed to ensure the ground path is maintained.
   c. If a group of modules is entirely disconnected from the module with the Ground Lockit, an additional Ground Lockit must be added to the isolated modules to ensure the ground path is maintained.



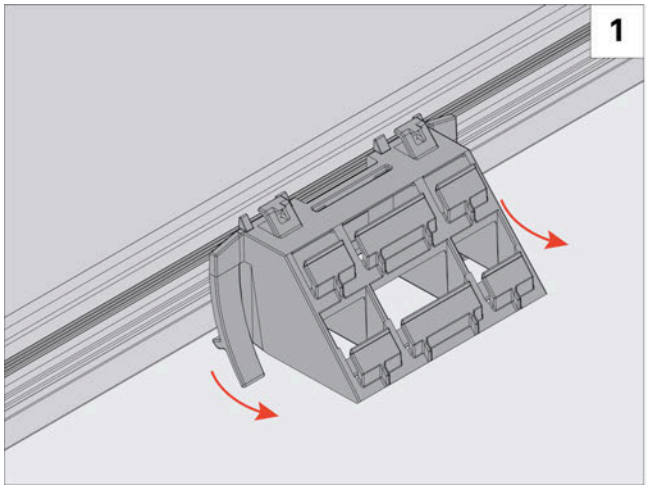
- *Ground Lockit*
- *Equipment grounding conductor (EGC)*
- *Earth ground*

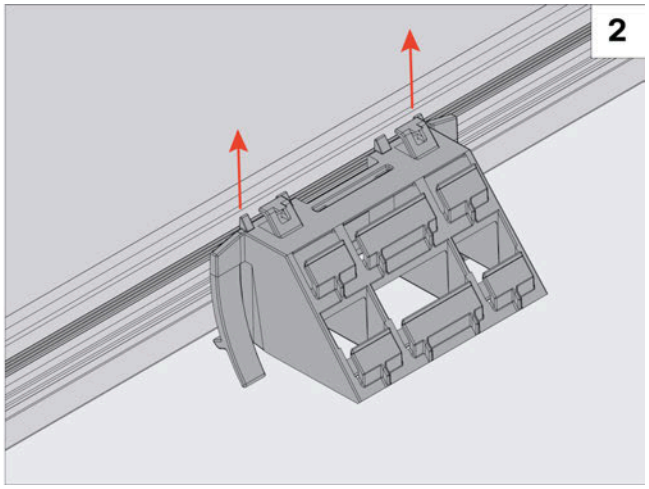
   d. Torque the Ground Lockit set screw based on the ground wire size:

Cat. No.	Conductor Material	Conductor Size	Tightening Torque
850-1511	Copper, solid	14 - 10 AWG	40 in-lbf
		8 AWG	45 in-lbf
		6 AWG	50 in-lbf
		4 AWG	55 in-lbf

7. Remove Class 0 insulated electrical gloves and put on cut-resistant gloves.

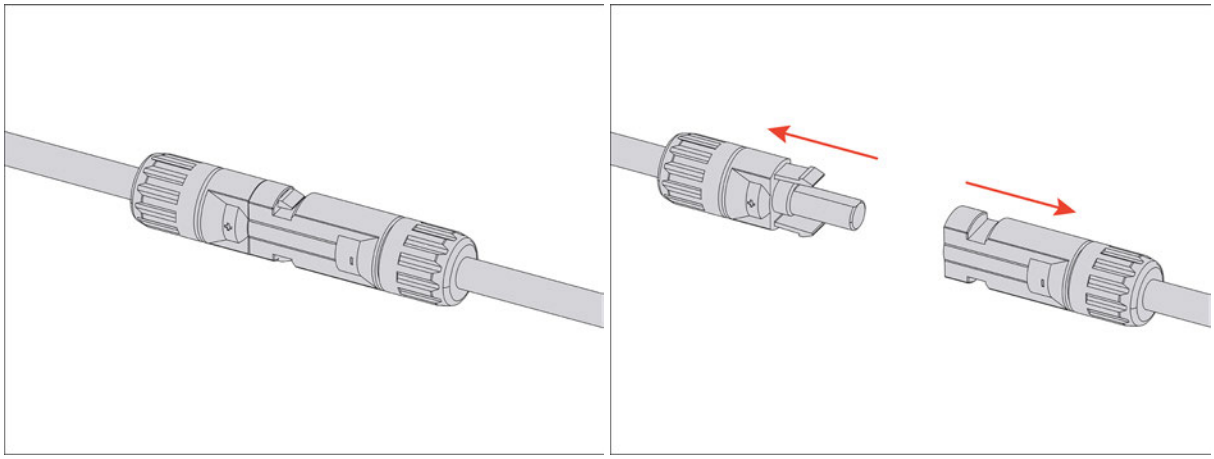
8. Detach Corner Caps, Side Skirts, and Side Skirt Brackets connected to any PV modules that must be removed for service.
    a. Place the back of a slotted screwdriver between the module frame and the Corner Cap and gently release the tabs folded over the Front Skirt and Side Skirt sections.
    b. To remove a Side Skirt Bracket, pull back on the tabs at the bottom of the bracket and lift straight up on the bracket.



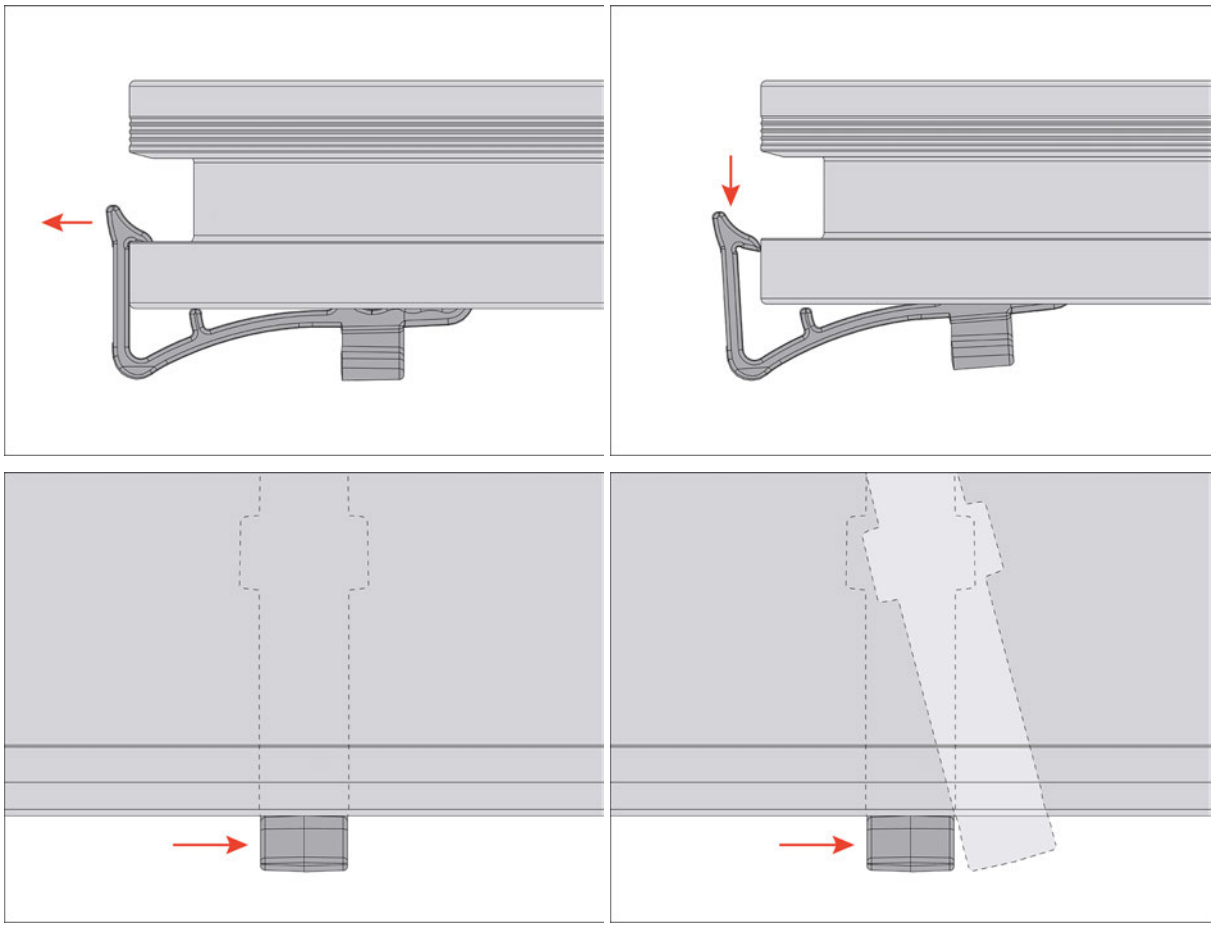


- *(1) - Pull tabs away from module.*
- *(2) - Lift up to remove Side Skirt Bracket.*

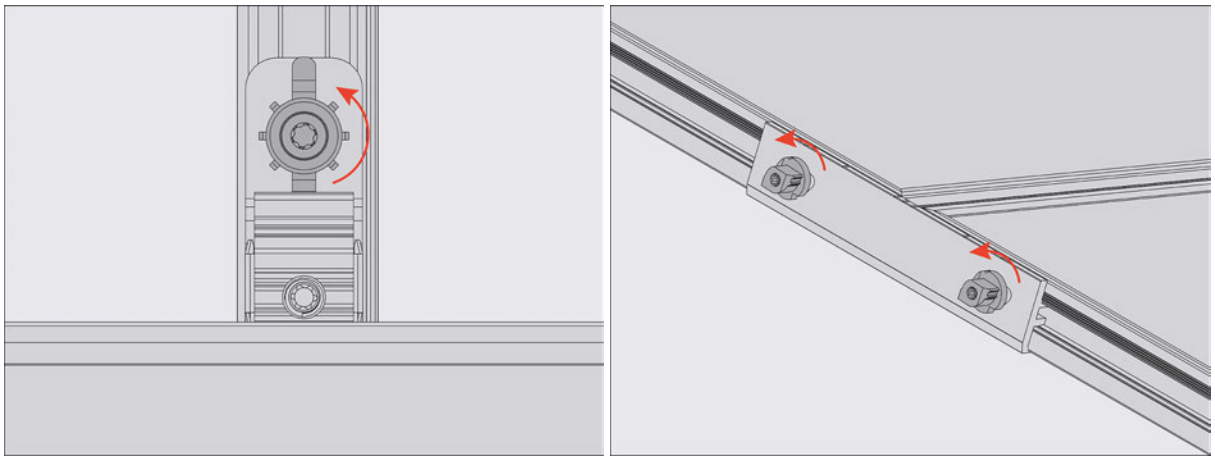
9. Disconnect the module wires, Wire Clips, and jumpers.



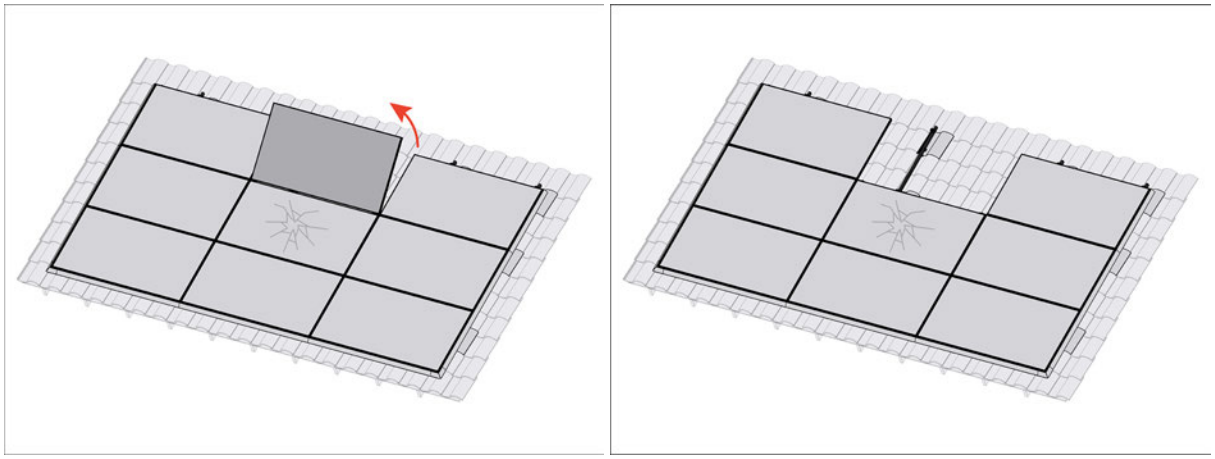
NOTE: Use an MC4 disconnect tool to release the connectors.



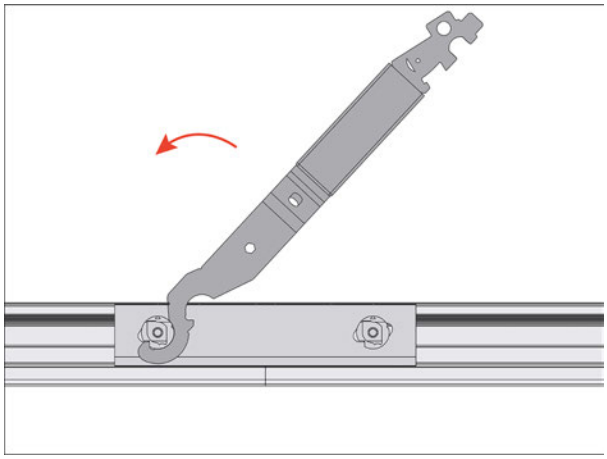
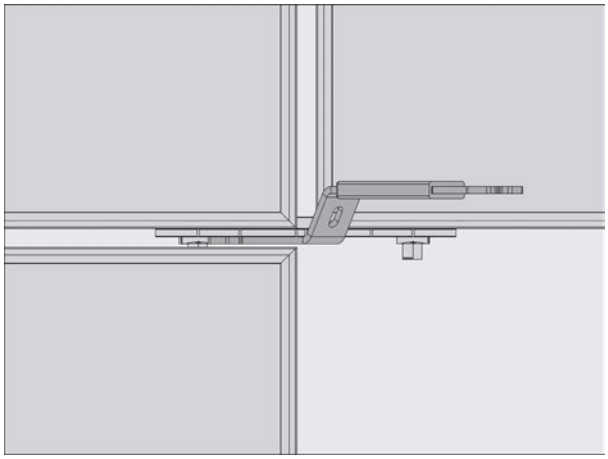
10. Release the up-roof modules.
    a. Remove all the Interlocks at the top of the column containing the module needing replacement and unbolt the Leveling Feet attached to the module.



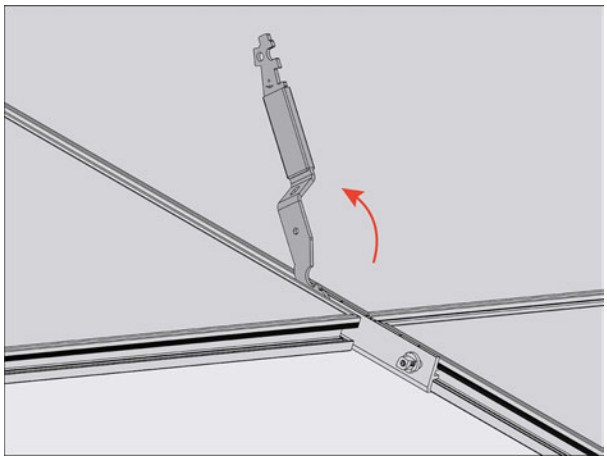
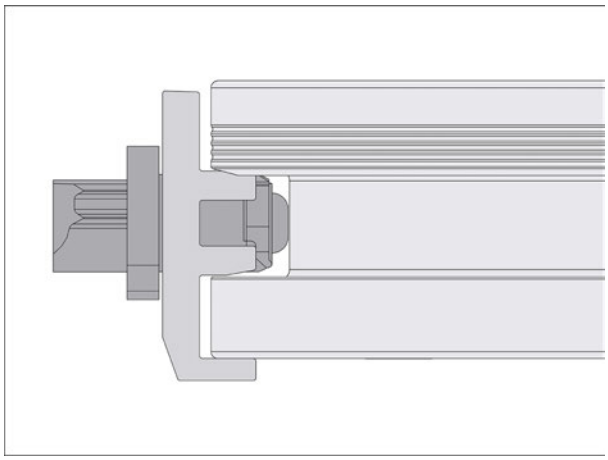
b. Remove the first module by lifting it above a 15° angle and pulling it off the front Leveling Feet and Interlocks.



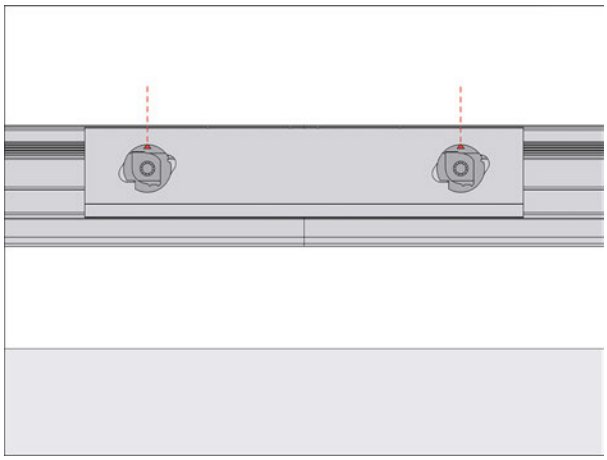
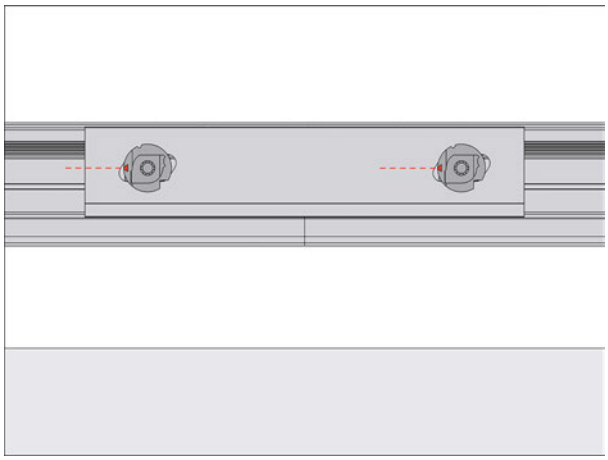
11. Release the mid-array modules.
    a. Use the Tesla Solar Wrench to unlock the mid-array Interlocks and release the modules.

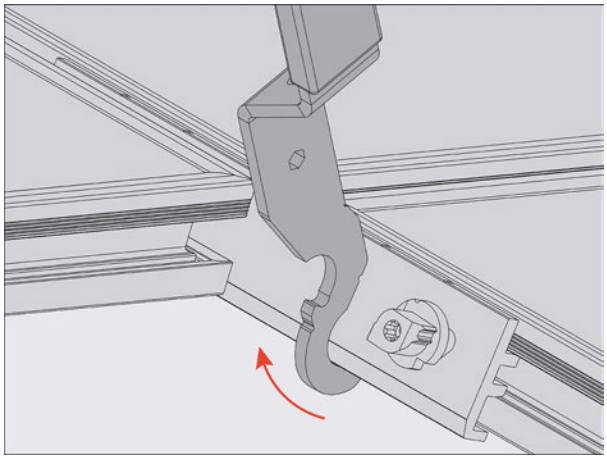
    b. Rotate both Lockits to Position 1.

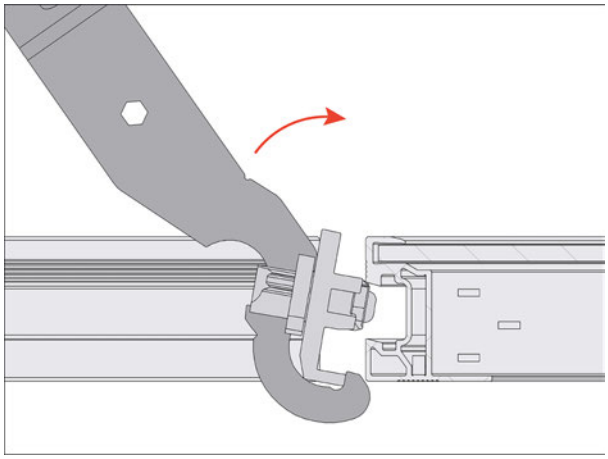



> **NOTE:** Position 1 is indicated by the timing mark on the Tesla Solar Wrench.

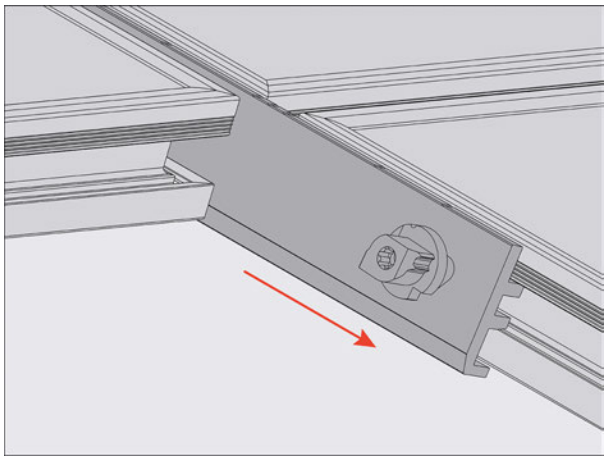



c. Use the hook on the Tesla Solar Wrench to release the Interlock from the module frame.

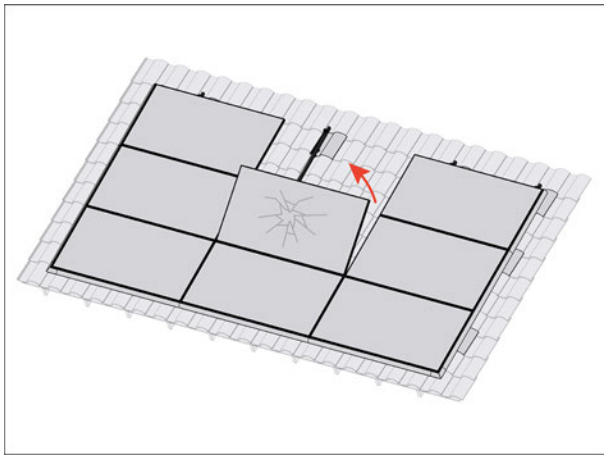


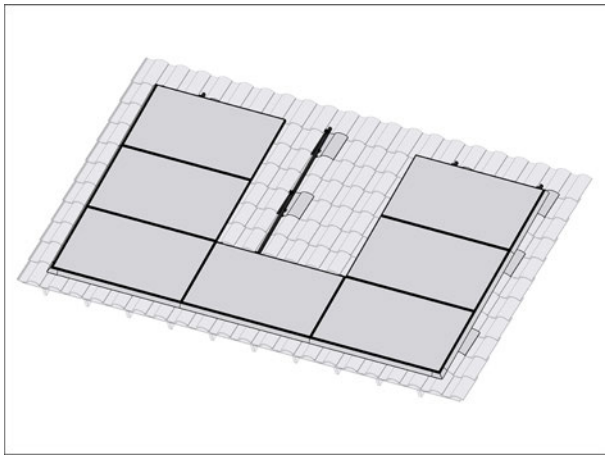


d. Slide the Interlock towards the opening to remove it fully.



e. Unbolt the Leveling Feet and remove the module from the array.

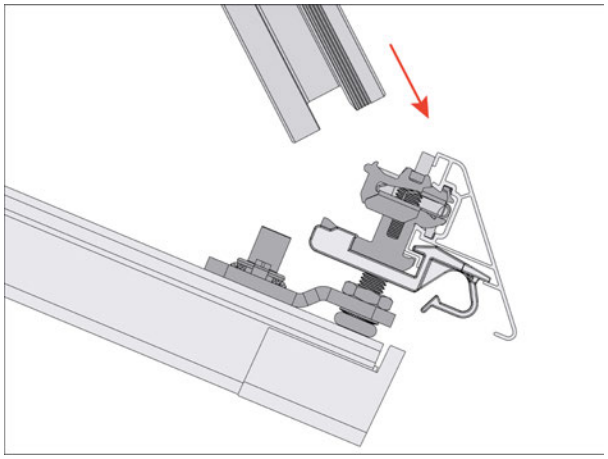
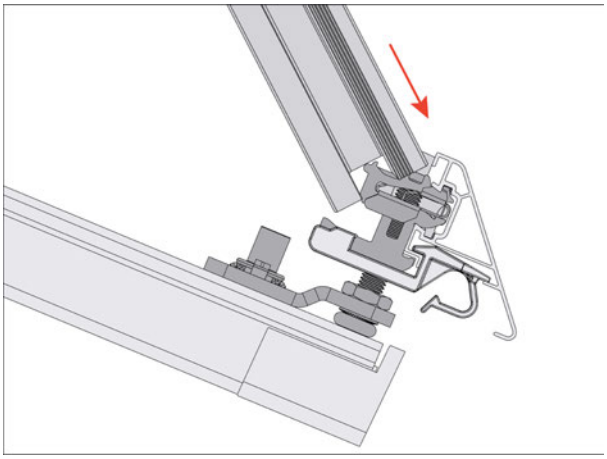




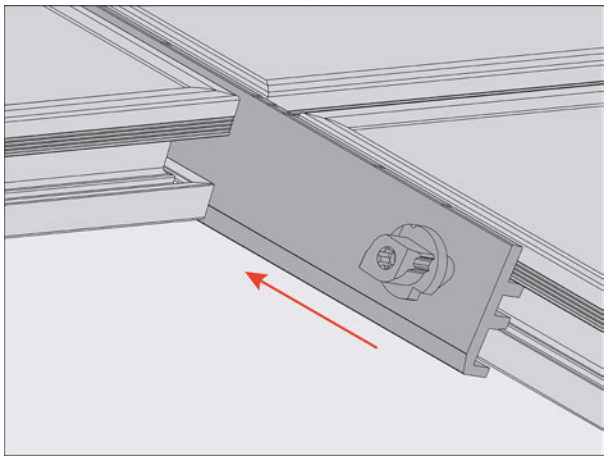
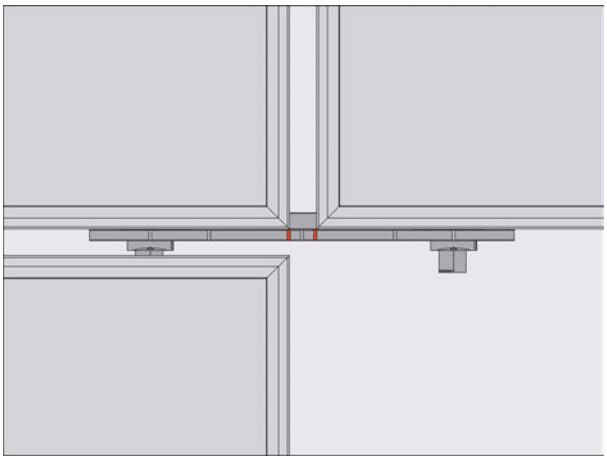
Install

To reassemble the array, replace the modules, Interlocks, and Leveling Feet row-by-row until the array is complete. Use the Tesla Solar Wrench to fasten mid-array Interlocks.

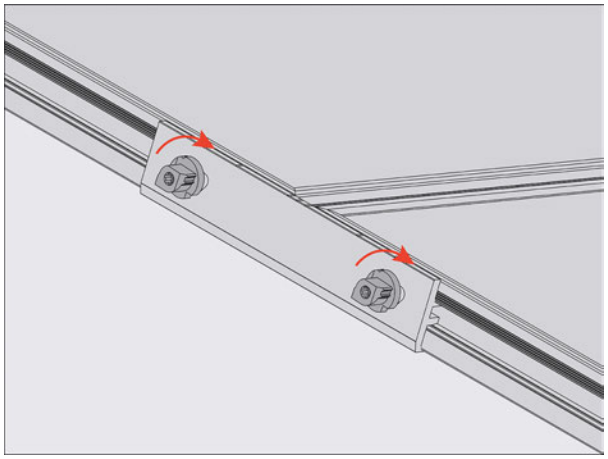
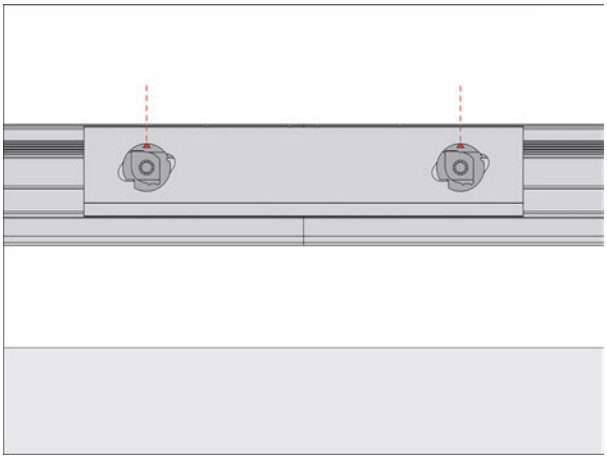
1. Place the module and manage the wires.

2. Slide the Interlock into place between the modules and align the timing marks.

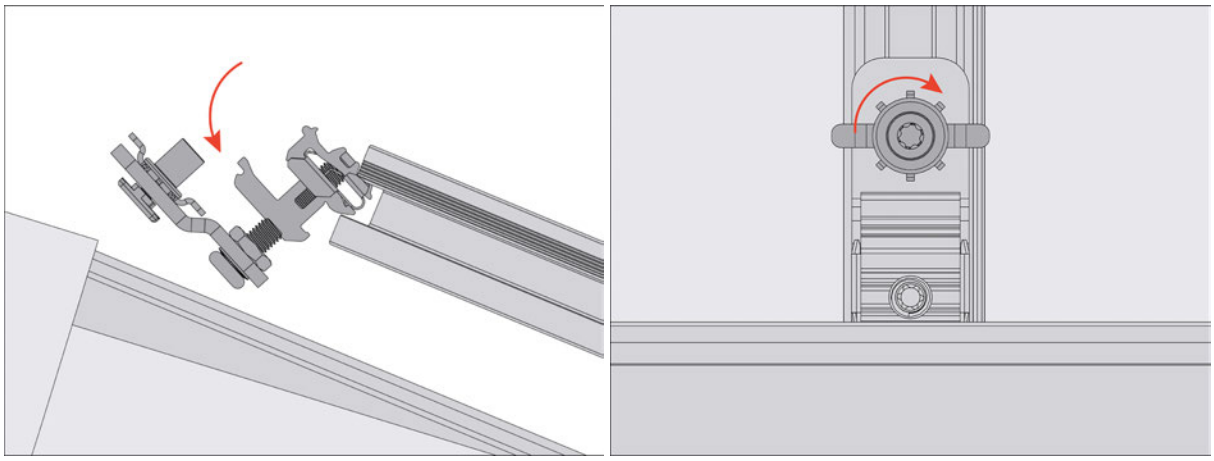



3. Rotate both Interlock Lockits to Position 3 to create a structural and electrical bond, or Position 2 to create a thermal break. Refer to *Appendix B: Thermal Expansion on page 114*

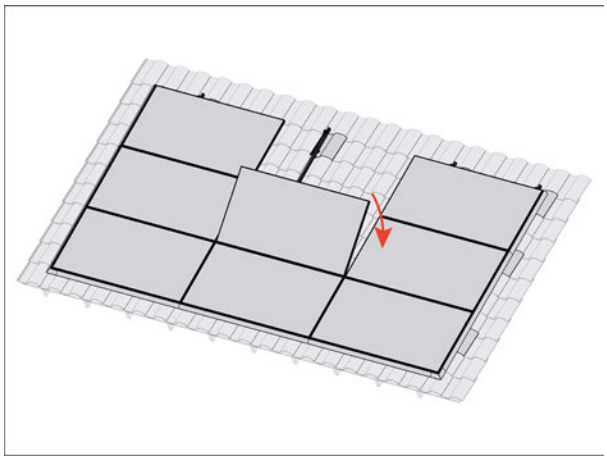



4. Reinstall the Leveling Feet on the Spanner Bars and torque the bolts to the required specification.

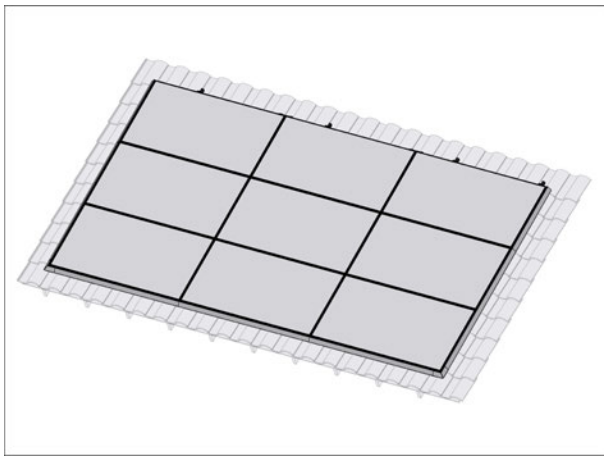
> **NOTE:** When fully engaged with the channel, the indicator tabs on the T-Bolt will rotate 90° and be perpendicular to the Spanner Bar. Failure to rotate the T-Bolt fully will result in an insufficient structural connection.



5. Reinstall the module by placing it on the Interlocks and rocking it down into position.



6. Repeat Steps *1 on page 133* – *5 on page 134* for each module in the column above.



7. Reinstall any Side Skirts, Corner Caps, and Side Skirt Brackets that were removed to service the modules. Refer to Installation *Step 8: Install the Side Skirts and Corner Caps on page 100*.
8. Evaluate the work performed:
    a. From the top corner of the row, look in the X direction and Y direction to check edges for irregularities in height. Modules must be straight and parallel to the roof deck.

> **NOTE:** To adjust module height, use a T40 bit to rotate the threaded stud on a Leveling Foot to raise or lower the Rockit.

   b. Check that all wire management is proper and there are no hanging wires present, there are no missed connections, or any wires that are touching the roof.
   c. Verify that the ground path was maintained. Refer to *Appendix A: Grounding and Bonding on page 107*.

9. Remove all LOTOV tags and locks, making sure that each person who installed a lock and tag is present to complete this step.
10. Put on required PPE: arc-flash-rated clothing with shirt tucked in, ear protection, arc-rated balaclava, arc-rated face shield and hard hat, voltage-rated gloves with leather protectors, and eye protection.
11. Close the DC disconnect.
12. Close the AC disconnect.
13. Verify that the PV inverter starts up and resumes normal operation.

Related tasks

- Step 6: Install the PV Modules (SMILES) on page 82
- Step 7: Complete Wire Management and Bonding on page 95
- Step 8: Install the Side Skirts and Corner Caps on page 100

PV Inverter - LOTOV

Overview

General steps for making a solar PV inverter electrically safe. Refer to manufacturer's documentation for more specific instructions.

Prerequisites

Residential systems have many variations so de-energization procedures may differ from site to site depending on the equipment present. Ensure that the site architecture and de-energization procedures are understood by all individuals performing service on-site and perform all applicable steps.

- This procedure requires Group Lockout/Tagout (LOTOV) when more than one worker is involved. Each worker must apply their own lock and tag or use a group lockbox system in accordance with site procedures. Each worker is responsible for removing their own lock and tag upon completion of work.
- Take a photo of the signed LOTOV form used by the site operator at the end of service. Each worker must sign on and sign off on this form. If there is no LOTOV form, use the digital LOTOV form included in the Pre-Task Plan for this procedure.
- Review arc-flash labels affixed to the equipment and follow all PPE and boundary requirements.
- Only trained and authorized personnel are permitted to perform this procedure.

Hazards

Figure 13. Shock

Figure 14. Arc Flash

Safety and PPE

- Closed-toe shoes (leather upper)
- HRC2/CAT 2 arc-rated, long-sleeved shirt (tucked in) and arc-rated pants or coveralls
- HRC2/CAT 2 arc-rated face shield and Class E hard hat
- Safety glasses (ANSI Z87.1 or EN 166)
- Class 0 insulated electrical gloves with leather protectors (ANSI A4 cut-resistant, ANSI A3 abrasion-resistant, ASTM CAT2)
- Cut-resistant gloves (ANSI Cut Level 3 or EN 388 Level C)
- Proving unit (Fluke PRV240 or equivalent)
- Insulated multimeter (Fluke 1587 FC or equivalent; rated for equipment voltage)
- Lockout/Tagout kit (locks, tags, hasps, lock box)
- Safety cones (minimum 28 inches / 71 cm)
- Barricade tape or plastic chains
- HRC2/CAT 2 arc-rated face shield and Class E hard hat

General Equipment

- N/A

Required Parts and Tools

Tools listed are in addition to *#unique_49 on page* .

- N/A

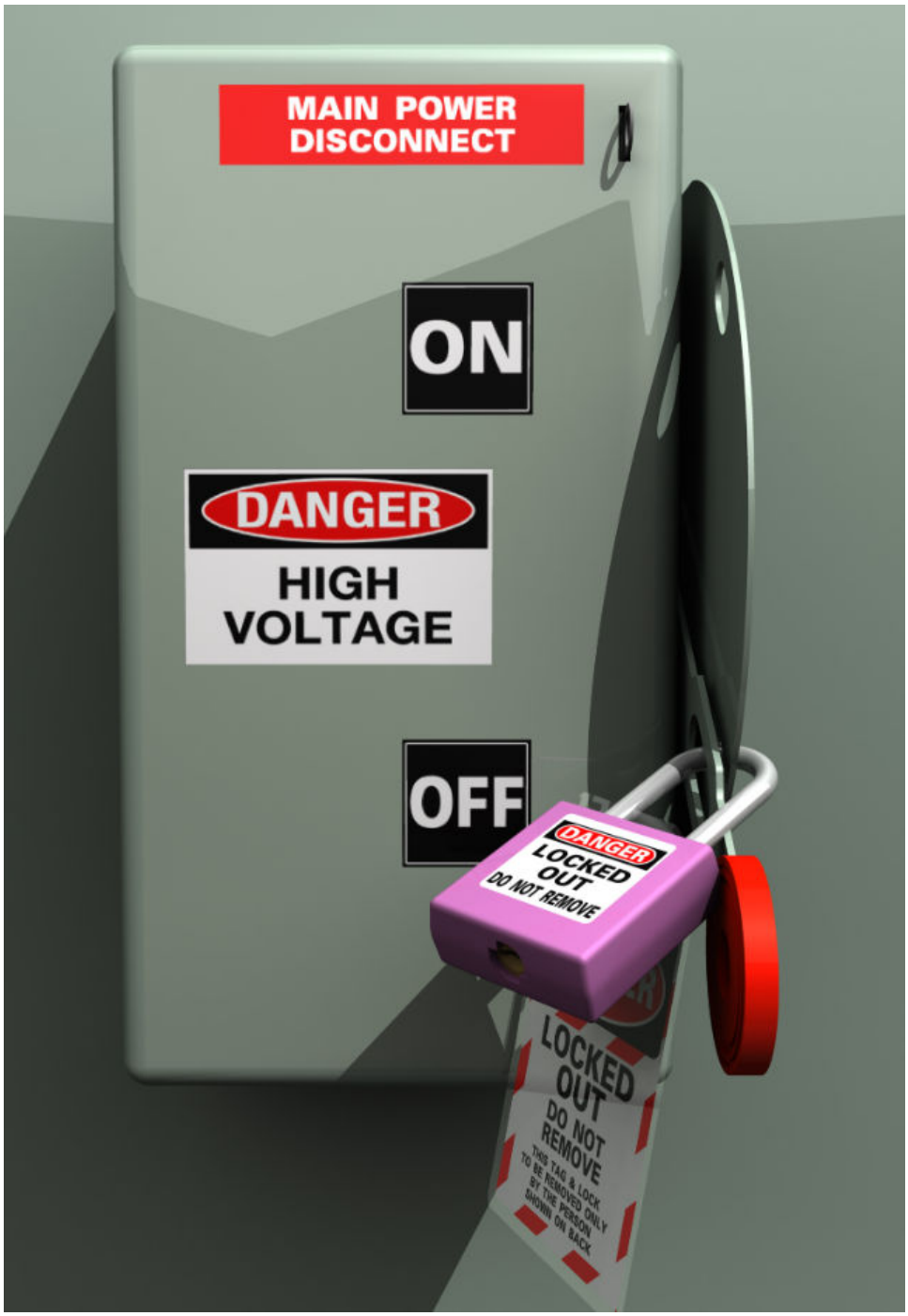
Lock Out, Tag Out

1. Survey the site and understand the PV system layout. Identify locations of disconnects and electrical connections. Look for placards near the main panel or electric meter.

2. Put on required PPE: arc-flash-rated clothing with shirt tucked in, voltage-rated gloves with leather protectors, and eye protection.
3. Set up a limited approach boundary at 1 m (42 inches) radially from the inverter to prevent unauthorized persons from entering into the shock and arc flash zone.
4. To isolate the inverter from the grid, switch off the circuit breaker associated with the inverter in the electrical panel and apply a breaker lockout clamp with a lock and tag. If there is a lever AC disconnect, switch it off and apply a lock and tag.

> **WARNING:** All individuals who are working on the Solar Inverter system must apply a Lock and Tag. When more than one individual is working on the Solar Inverter system, all individuals must also sign on and off when applying and removing their lock. Use the LOTOV Form linked here: (*LOTOV Form*.)

APPENDIX E: MODULE SERVICING



5. To isolate the inverter from the PV array, switch off the DC disconnect and apply a lock and tag. If there is a lever disconnect, switch it off and apply a lock and tag.

   WARNING: All individuals who are working on the Solar Inverter system must apply a Lock and Tag. When more than one individual is working on the Solar Inverter system, all individuals must also sign on and off when applying and removing their lock. Use the LOTOV Form linked here: (*LOTOV Form*.)

6. Capacitance is present in all inverters and the discharge time will be indicated on the regulatory label. If no label is present, wait 5 minutes before interacting with the inverter.

Check for Dead

1. Locate the AC and DC terminal blocks inside the inverter.
2. Put on Class 0 gloves and leather protectors or equivalent protectors.
3. Set the multimeter to measure AC voltage and verify the meter on a proving unit. If the multimeter does not read the correct value, replace it with a different meter and repeat the test.

4. Perform the following tests for voltage on the AC terminal block of the inverter:
    a. **L1** to **L2**
    b. **L1** to **Neutral**
    c. **L2** to **Neutral**
    d. **L1** to **Ground**
    e. **L2** to **Ground**
    f. **Neutral** to **Ground**

g. Re-verify the multimeter on the proving unit.
h. If any voltage measurements are greater than 5 V, stop work and determine the source of the voltage.

5. Perform the following tests for AC voltage on the DC terminal block:
   a. **String +** to **String -**
   b. **String +** to **Ground**
   c. **String -** to **Ground**
   d. Re-verify the multimeter on the proving unit.
   e. If any voltage measurements are greater than 5 V, stop work and determine the source of the voltage.

6. Set the multimeter to measure DC voltage and verify the meter on a proving unit. If the multimeter does not read the correct value, replace it with a different meter and repeat the test.

7. Perform the following tests for DC voltage on the AC terminals:

a. **L1** to **L2**
b. **L1** to **Neutral**
c. **L2** to **Neutral**
d. **L1** to **Ground**
e. **L2** to **Ground**
f. **Neutral** to **Ground**
g. Re-verify the multimeter on the proving unit.
h. If any voltage measurements are greater than 5 V, stop work and determine the source of the voltage.

8. Perform the following tests for DC voltage on the DC terminals:

> **NOTE:** Measured values will vary due to the equipment present in the PV system, e.g. rapid shutdown devices (RSD). Refer to manufacturer's documentation for expected measurements.

a. **String +** to **String -**
b. **String +** to **Ground**
c. **String -** to **Ground**
d. Re-verify the multimeter on the proving unit.
e. Use the measured values to determine PPE and safety precautions while working on the inverter.