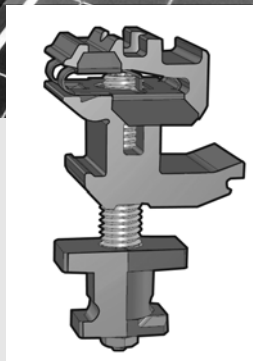
Zep Solar



ZS Span™

Installation Manual for Rail-Based Applications - U.S.

Document #800-0329-001 Rev F

File Generated July 3, 2013

Notices

This manual contains safety, installation, configuration and troubleshooting instructions for ZS Span. Zep Solar, Inc. recommends that you save this manual in a readily accessible location, should any questions arise regarding ZS Span.

Copyright and Trademark Information

Warranty Notice

Warranty void if hardware not certified by Zep Solar, Inc. is attached to the Zep Groove of a Zep Compatible PV module frame.

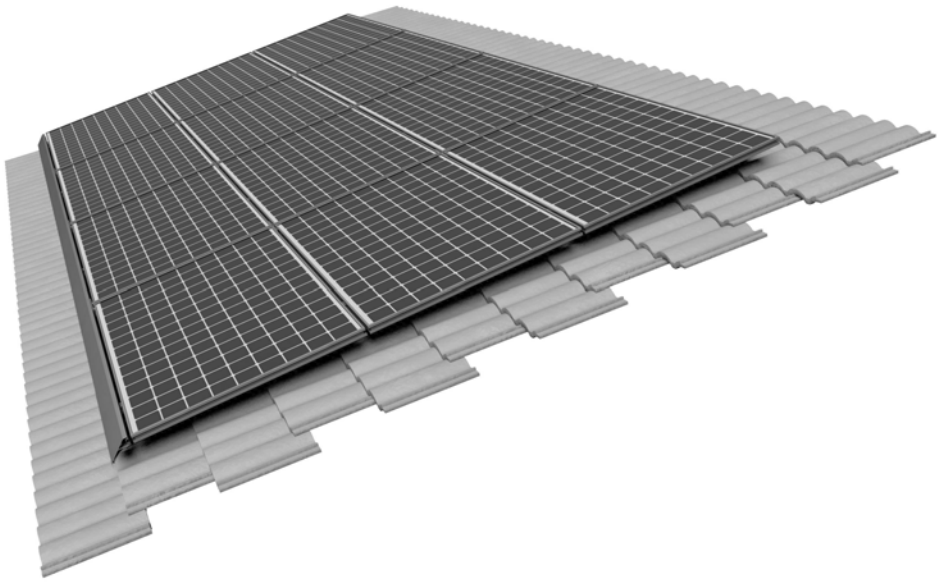
Contents

1 Introduction

ZS Span™, from Zep Solar, Inc., is an integrated roof mounting solution for installing PV arrays on tile roofs. ZS Span offers the following benefits: rapid installation, reduced roof penetrations, reduced parts count, low system weight, precision alignment, enhanced aesthetics, resistance to theft, redundant auto-grounding hardware, portrait and landscape options, and an easy-to-use design tool with array-level BOM calculations.

1.1 ZS Span Overview

Figure 1.1 ZS Span for Tile Roofs



1.2 General Safety Precautions

Follow all instructions in this manual and the PV module installation manual. The installer is ultimately responsible for ensuring that all installations are performed in compliance with applicable codes and standards, as well as industry best practices.

1.2.1 Installation Safety

- The installation process requires working on sloped and elevated building surfaces, in outdoor weather conditions, using tools and heavy components designed for the generation of electricity.
  - Use properly anchored fall protection equipment.
  - Use caution to prevent objects from falling or dropping off the roof area.
  - Cordon off ground areas directly beneath the roof work area when possible.
- Always use personal protection equipment such as safety glasses, gloves, etc. as necessary.
- Do not perform installations in excessively wet, windy, or inclement weather conditions.
- When working in hot weather, work crews should take care to prevent symptoms of overheating or deyhdration.
- Use proper lifting and carrying techniques when handling heavy components at the job site. If conditions are challenging for moving PV modules to the roof area, use a mechanical lift.
- Follow best practices when working around high-voltage electrical equipment.
- Do not anchor fall protection equipment to roof mounts, or any other inappropriate roof structure.
- Ensure that Zep Solar components are properly engaged with the PV modules.
- Do not subject the PV modules to excessive loads or deformation such as twisting or bending.
- The installer is responsible for:
  - Following all applicable regional and local codes, standards, and regulations
  - Ensuring that all personnel are properly trained, equipped, and licensed
  - Obtaining all required permits and inspections
  - Verifying that the roof structure can support the array under live load conditions.
  - Verifying that the system is installed over a properly rated fire-resistant roof covering

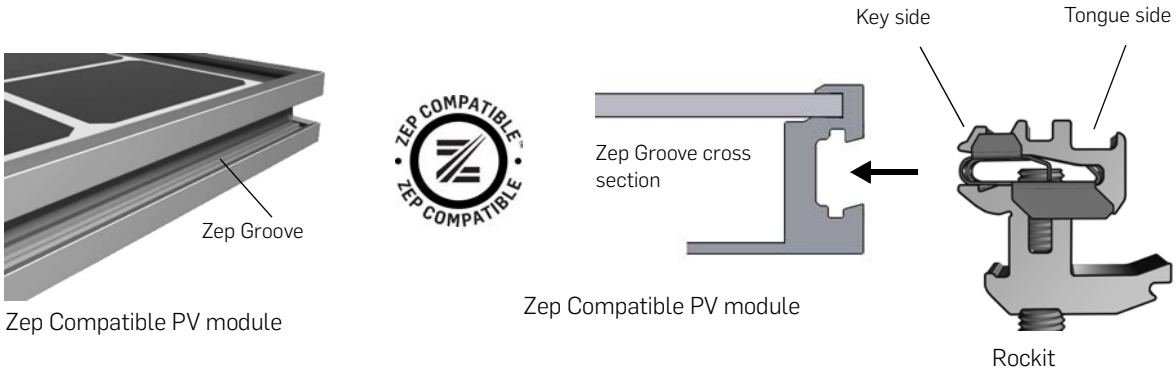
1.2.2 Electrical Specifications

- These instructions describe the correct installation of the Interlock, the Ground Zep, and other listed components into a PV module that has a Zep Compatible frame.
- Product listing information is shown for each component in the Components chapter and in the Requirements chapter. For the most up-to-date listing information, please refer to the product datasheets on the Zep Solar web site.
- Zep Solar components are only suitable for PV modules with a series fuse rating of 15 Amps or less.
- Each array of PV modules must be earthed with a solid copper wire that is connected between the Ground Zep and a suitable earth ground. The ground wire and torque specs are identified in "Ground the Array" on page 58.

1.3 Zep Compatible™

Zep Solar mounting solutions are based on the Zep Groove, a patented module frame profile designed to mate easily and precisely with Zep components. Module frames with the Zep Groove are considered "Zep Compatible", and are offered by PV module manufacturers who have established a licensing agreement with Zep Solar, Inc. Please visit **www.zepsolar.com** for an updated list of Zep Compatible partners.

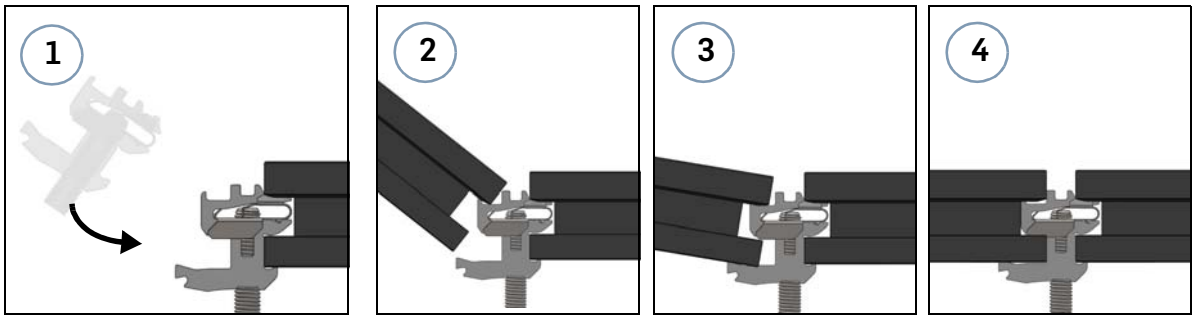
Figure 1.2 Zep Groove and Rockit



For example, the “Rockit” is a hardware feature used to secure PV modules to the roof attachments. The Rockit fits into the Zep Groove on both sides: The Key side inserts, while the Tongue side receives.

Key and Tongue. The Key and Tongue concept informs all Zep Compatible designs. The Key side inserts into the Zep Groove, similar to inserting a key into a lock. On the other side, the Zep Groove allows PV modules to “drop in” easily onto the Tongue of the Rockit.

Figure 1.3 Module Drop-In Example



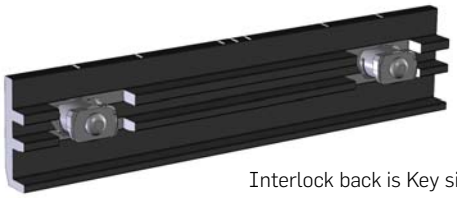
First, the Key side of the Rockit is inserted into the Zep Groove.

In the next row, modules are “dropped in” on the Tongue side (the receiving side). Each Tongue provides an in/out adjustability with the Zep Groove, allowing for optimized placement of each module.

Another example of the use of Key and Tongue in a Zep Compatible design is seen with the Interlock, a component that couples and bonds two modules together. Here, the Key and Tongue are differently shaped, but they still fit into the Zep Groove in the same manner as the Rockit.

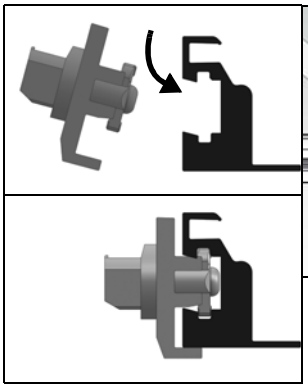
Figure 1.4 Zep Groove and Interlock

Interlock front is Tongue side

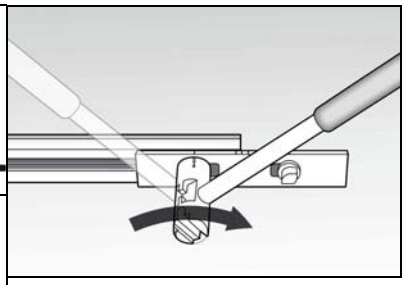


Interlock back is Key side

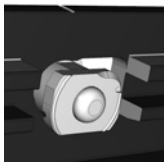
Other Zep Solar components such as the Interlock also use the Key and Tongue concept.



Key side is inserted into Zep Groove



The fasteners on the Interlock (the "Interlock Zeps") are tightened one-quarter turn to lock securely into the Zep Groove.



Open

Closed

Rotation seen from Key side

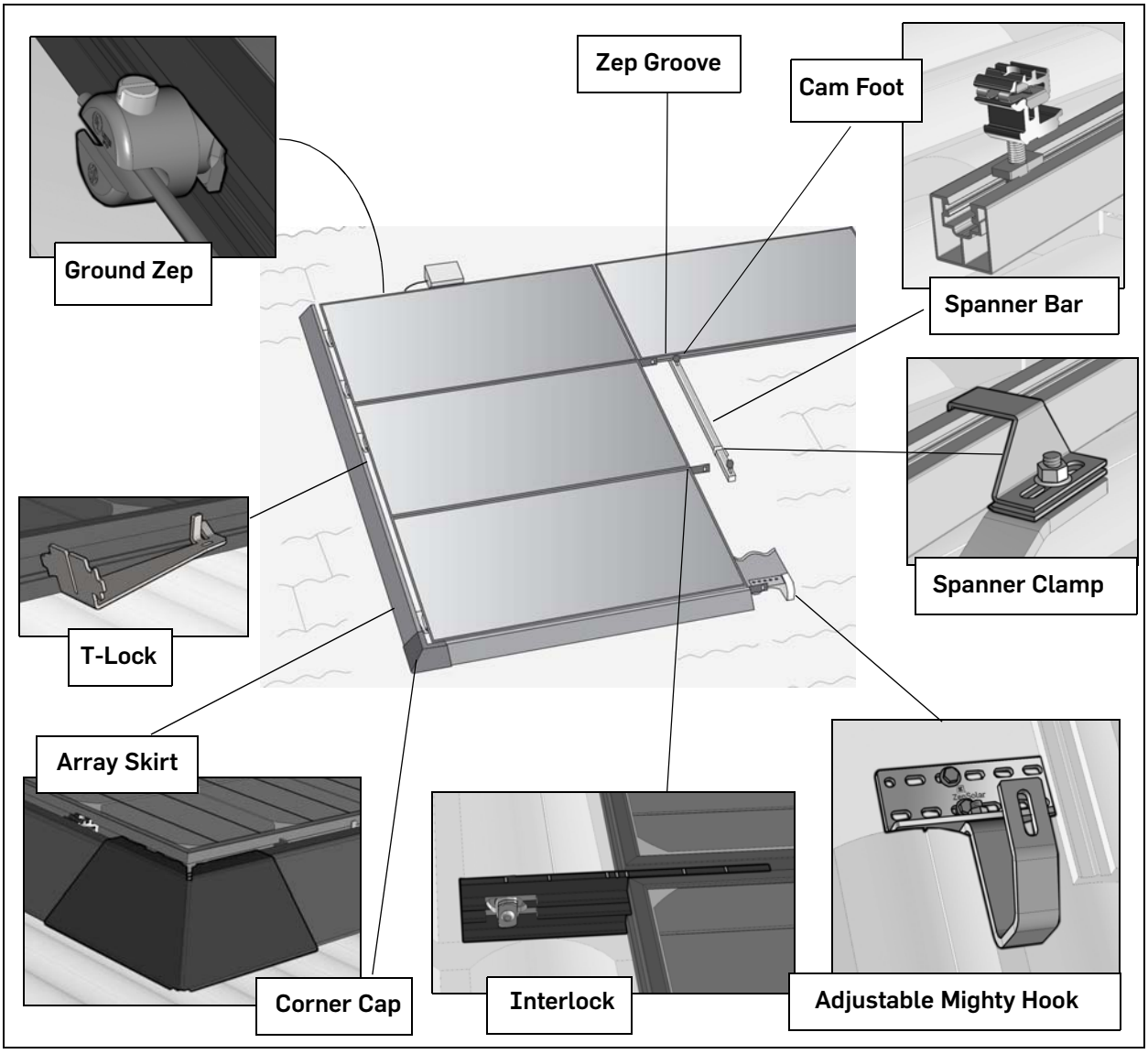
See "Interlocks" on page 53 for more information on the Interlock.

Auto Grounding. The Key and Tongue sides of Rockits and Interlocks establish an electrical bonding connection between both modules and other Zep Solar components such as the Array Skirt. The rotation of the Key side into the Zep Groove, and the rotation of the next row of PV modules onto the Tongue side, acts to establish an equipotential bond for all UL listed components by cutting through the surface coating (tested for both anodized and painted coatings) on the Zep Groove.

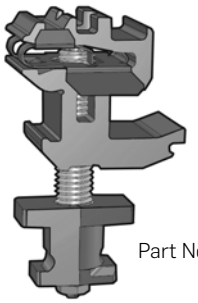
Note: All components shown as UL Listed to UL 2703 are listed for bonding.

2 ZS Span Components

2.1 ZS Span Cutaway View



2.2 ZS Span Core Components

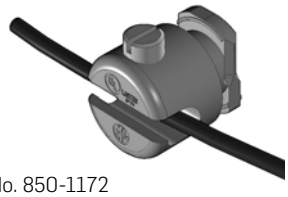


Part No. 850-1413

Cam Foot

Secures PV Modules to the Spanner Bar, and enables fine-tuned leveling. Create an electrical bond between modules on both Key and Tongue sides. Also creates bond with Spanner Bar.

Listed by UL to UL 2703.



Part No. 850-1172

Ground Zep

Provides a single point for grounding/earthing the PV Array. One Ground Zep can ground an array up to 33 x 33 feet.

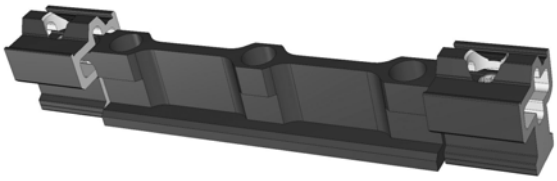
Listed by UL to UL 467 and UL 2703. ETL listing conforms to UL STD 467.

Part No. 850-1388

Interlock

Provides a structural and electrical bond between modules. See "Backwards Compatibility" on page 73 for additional information regarding Interlock versions.

Listed by UL to UL 2703.



Part No. 850-1281

Hybrid Interlock

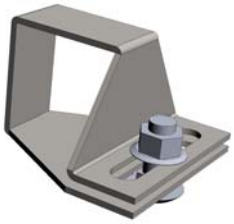
Used on Cam Foot base where the Cam Foot location conflicts with the installation of an Interlock. Creates electrical bond between modules on both Key and Tongue sides.

Listed by UL to UL 2703.

ZS Span Core Components, Continued

Part No. 850-1396

Part No. 850-1403



Part No. 850-1194

Adjustable Mighty Hook

Provides a roof mounting attachment point for the array. Shown above are 2-piece and 3-piece product versions.

Spanner Clamp

Attaches Spanner Bar to Adjustable Mighty Hook or other roof attachment.

Listed by UL to UL 2703.

Part No. 850-1400 - 4x
Part No. 850-1399 - 3x
Part No. 850-1398 - 1x

1x 3x 4x Spanner Bar

Attaches to Adjustable Mighty Hook or other roof attachment to provide a mounting channel for the Cam Feet. Pre-cut lengths dimensioned by module width for 1, 3, or 4 modules.

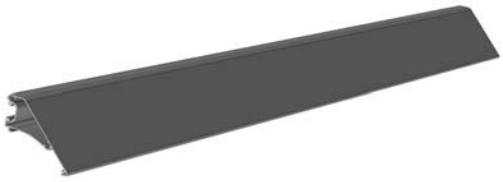
Note: Some regions may continue to stock the previous version of the 1x for all Spanner Bar needs. See "Backwards Compatibility" on page 73 for more information.

Part No. 850-1401

Splice Kit

Splices lengths of Spanner Bar together for use in large arrays. Creates electrical bond between Spanner Bars when fully spliced together. Two Splices per join.

2.3 ZS Span Accessory Components



Array Skirt profile view

Part No. 850-1421

Array Skirt

Conceals hardware for an aesthetic appearance on all sides of the array, and also serves as a jig during installation to keep the first row of modules straight. Also serves as a structural component when attached to modules via the Key side of a Cam Foot Rockit with Interlocks connectiong sections of Array Skirt.

Listed by UL to UL 2703.

Grip

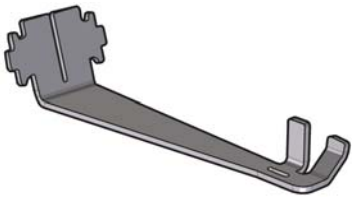
Used to secure Array Skirt after attaching the Array Skirt to the first row of Cam Feet.

Listed by UL to UL 2703.

End Cap

Used to cover the ends of the Array Skirt on the front row of modules for a more aesthetic appearance.

Listed by UL to UL 2703.



T-Lock

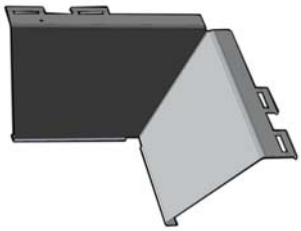
Attaches the Array Skirt to the module frame along the non-leading edges of the array. Creates an electrical bond between Array Skirt and module.

Listed by UL to UL 2703.

Outside Corner Cap

Used to bridge the corners when Array Skirt is applied all around the perimeter of the array, for a more aesthetic appearance.

Listed by UL to UL 2703.

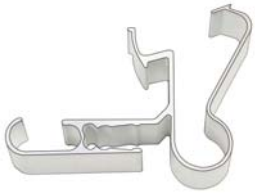


Inside Corner Cap

Used to bridge inside corners when Array Skirt is applied all around the perimeter of the array, for a more aesthetic appearance.

DC Wire Clip

Snaps into the Zep Groove to secure array wiring, and to adjust wire tension, with parallel and 90 degree clips. Fits wires 5.2mm-7.6mm in diameter.

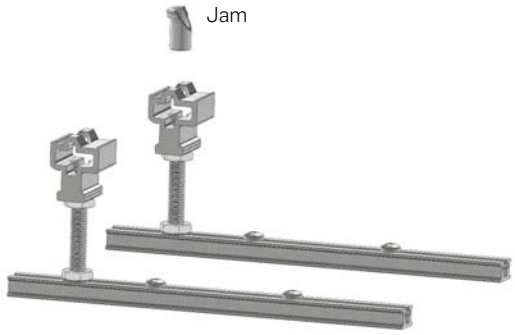


AC/DC Cable Clip

Snaps into the Zep Groove to secure array wiring, and to adjust wire tension. Fits a variety of cable sizes.

* When properly installed, these Accessory Hardware Components are capable of creating an electrical bond with adjacent Zep Solar hardware components. See "Installation Process" on page 33 for details.

ZS Span Accessory Components, Continued



Universal Box Bracket

Allows attachment of electrical boxes to Zep Compatible PV module frame, thereby eliminating additional roof penetrations.

Groove Adapter Bracket

Mounts to selected microinverters and provides an electrical bond and a mechanical connection to a Zep Compatible PV module frame.

UL Listed to UL 2703.

Part No. 850-1258

Jam

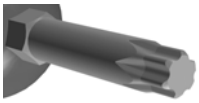
Secures the Universal Box Bracket to the module frame.

2.4 ZS Span Tools

Zep Tool

The Zep Tool performs the following functions:

- Install and remove Interlock
- Install and remove Ground Zep
- Adjust height of Cam Feet using #30 Torx Bit attachment



#30 Torx Bit Attachment

Inserts into top of Rockit for the Cam Foot and the Hybrid Interlock, for raising and lowering of the array at the attachment points. Base attaches to the handle end of the Zep Tool.

850-1412

Flat Tool

The Flat Tool does everything that the Zep Tool can do, except for adjusting the Cam Foot height. In addition, the Flat tool performs these additional functions:

- Secure Cam Foot base in Spanner Bar groove
- Remove Interlock from between two modules

3 Array Design

Zep Solar, Inc. seeks to encourage efficient design of PV arrays by providing tools and resources necessary for installers and integrators to successfully design system that meet local structural codes. The Zepulator online design tool and Span Tables are available on the Zep Solar web site to enable custom array designs. Additional information on fine-tuning array designs can be found in training videos, also available on the Zep Solar web site.

Step 1: Gather Project Data

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

- Site information such as wind speed and terrain characteristics
- Building characteristics such as purlin/battenspacing, roof pitch, and roof type
- PV array details such as PV module manufacturer, mounting area, and desired orientation

Within each specified roof type, users can select a preferred Zep Solar approved roof attachment when using the Zepulator. The Span Tables and Certification Letters are only valid for hardware specifically tested and approved by Zep Solar, Inc. for use within each country.

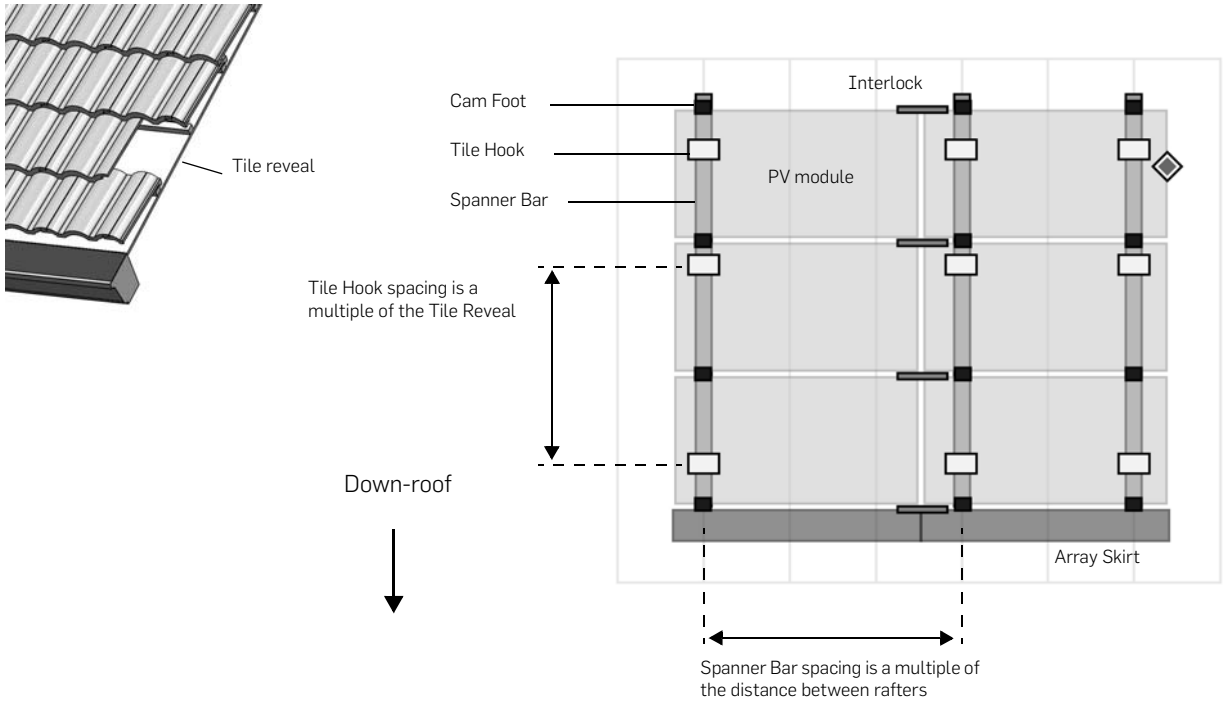
NOTE: Input variables may vary from one country to the next. To see variables for other countries supported in the Zepulator, select another country for the project on the Project page.

Step 2: Obtain Spacing and Cantilever Allowances

After gathering the project data, the designer can either look up the allowances in the Span Tables, or s/he can enter the project information into the Zepulator in order to obtain the maximum allowable spacing and cantilever distances. (The terms “spacing” and “span” are interchangeable.)

Figure 3.1 Spacing and Tile Reveal

Showing Spanner Bars Running North-South

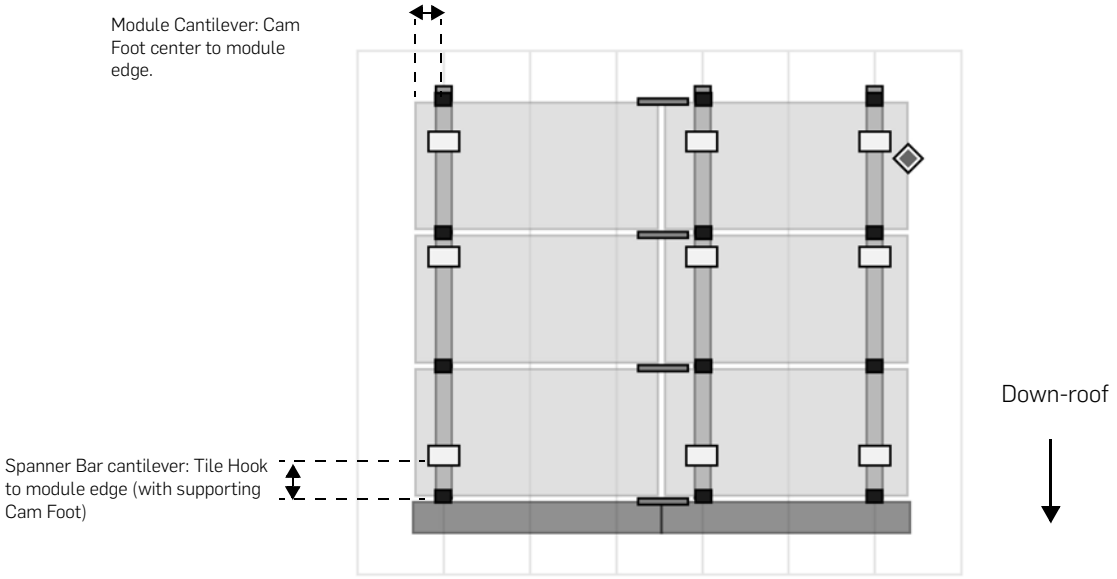


Spacing terminology is dependent on Spanner Bar direction. Most of the examples in this manual show Spanner Bars running North-South. However, if the Spanner Bars run East-West, then the Tile Hook spacing will refer to the the dimension that is a multiple of the spacing between rafters, and the Spanner Bar spacing will be a multiple of the Tile Reveal. See “Engineering Rules” on page 20 for more details.

Maximum achievable vs. maximum allowable spacing. The maximum allowable spacing is an absolute maximum based on Zep Solar’s engineering values. The maximum spacing achievable in practice is a mulitple of either rafters or tile sizes, and may be smaller than the maximum allowable spacing. Cantilever allowances are based on the maximum allowable spacing, not the maximum achievable spacing.

NOTE: It is strongly recommended that both and designers and installer crews attend hands-on training classes with Zep Solar, Inc., and also view the online videos available on the Zep Solar web site at **www.zepsolar.com**.

Figure 3.2 Cantilever



Spans are site and project-specific. Field installers should keep the span allowances in mind for each job, as they may need to re-configure an array due to unexpected conditions at the job site.

Cantilever is also site and project-specific. Cantilever refers to the amount of overhang that a module or Spanner Bar can have beyond its last support point. Please refer to "Engineering Rules" on page 20 for more information on cantilever rules for ZS Span.

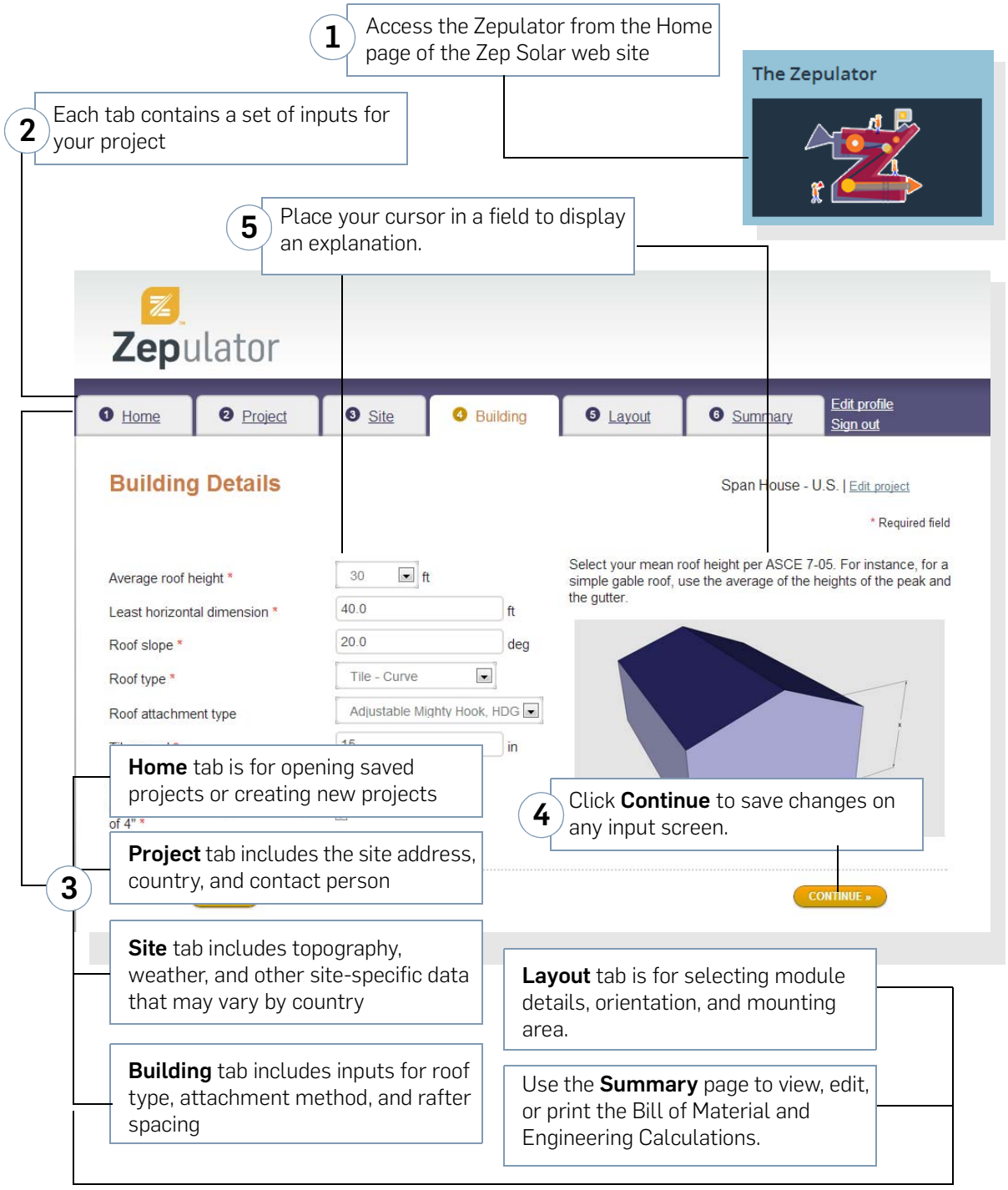
Step 3: Create Array Layout and Bill of Material

Array Layouts and a Bill of Material can be created using the Zepulator online design tool or using a CAD program. The designer may also choose to generate an initial layout in the Zepulator and then further refine the design using another program. Zep Solar, Inc. provides downloadable CAD blocks on the Zep Solar web site for Zep Solar components. Note that the Bill of Material created by the Zepulator does not include hardware pricing, since that may depend on the distribution channel and other factors.

3.1 Using the Zepulator Online Design Tool

The Zepulator online design tool is available from the Zep Solar web site, or directly at **www.zepulator.com**.

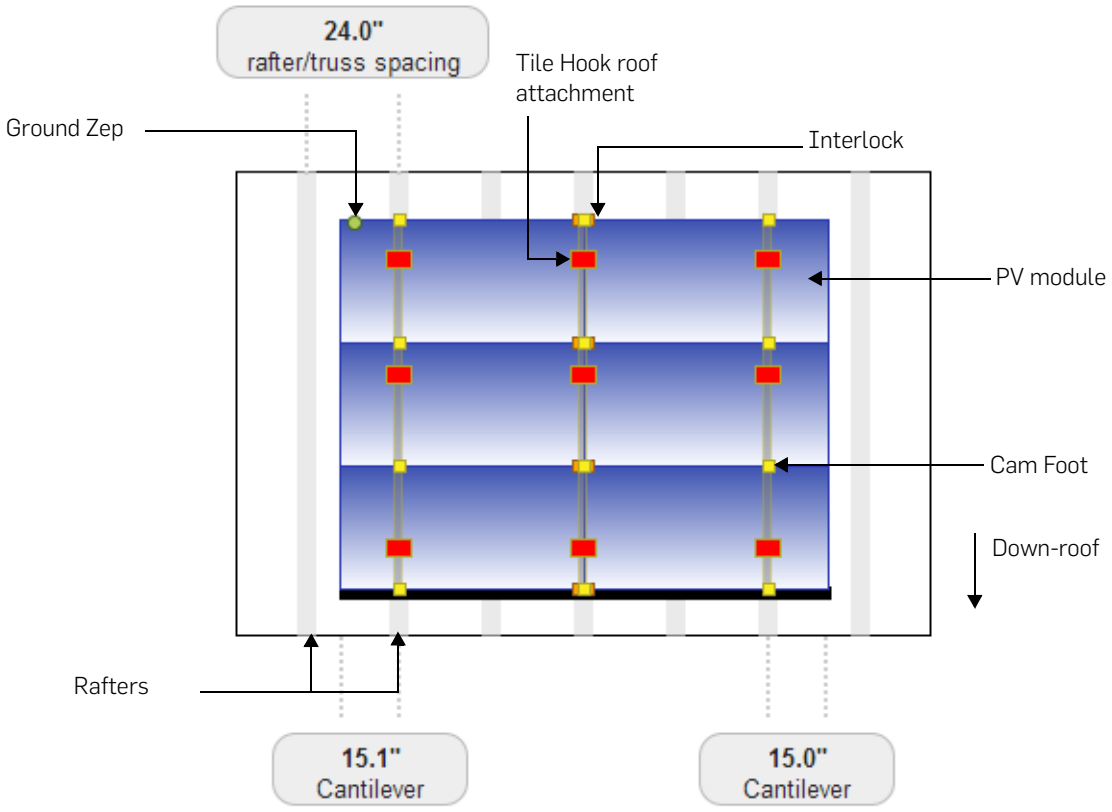
Figure 3.3 Zepulator Online Design Tool



3.1.1 Zepulator Layout Example

After all information is entered or selected, click the **Update** button on the **Layout** tab to see a suggested layout similar to the one shown below. Note that the Zepulator optimizes the layout to minimize the number of roof penetrations.

Figure 3.4 Example Zepulator Array Layout (ZS Span, US)



The Zepulator centers the array in the specified roof mounting area.

The array layout accounts for each ZS Span component listed on the Bill of Material.

NOTE: In cases where a Cam Foot coincides with an Interlock location, you may need to substitute a Hybrid Interlock. However, shifting the array slightly left or right (in the direction perperpendicular to the Spanner Bar direction) can sometimes eliminate the need for Hybrid Interlocks altogether.

The Zepulator does not show Hybrid Interlocks on the layout, although it will include Hybrid Interlocks in Additional Truck Stock to ensure adequate hardware supply if needed.

3.2 Using the Span Tables

In addition to the Zepulator online design tool, Zep Solar, Inc. provides complete Span Tables that are included with the Engineering Certification Letters for each country. These tables represent tested structural values for every combination of hardware that is approved for use with Zep Compatible roof mounted PV arrays. The Engineering Certification Letter may also be provided to building officials when submitting for a permit, or for use by independent engineering consultants.

Figure 3.5 Span Table Example (ZS Span - US)

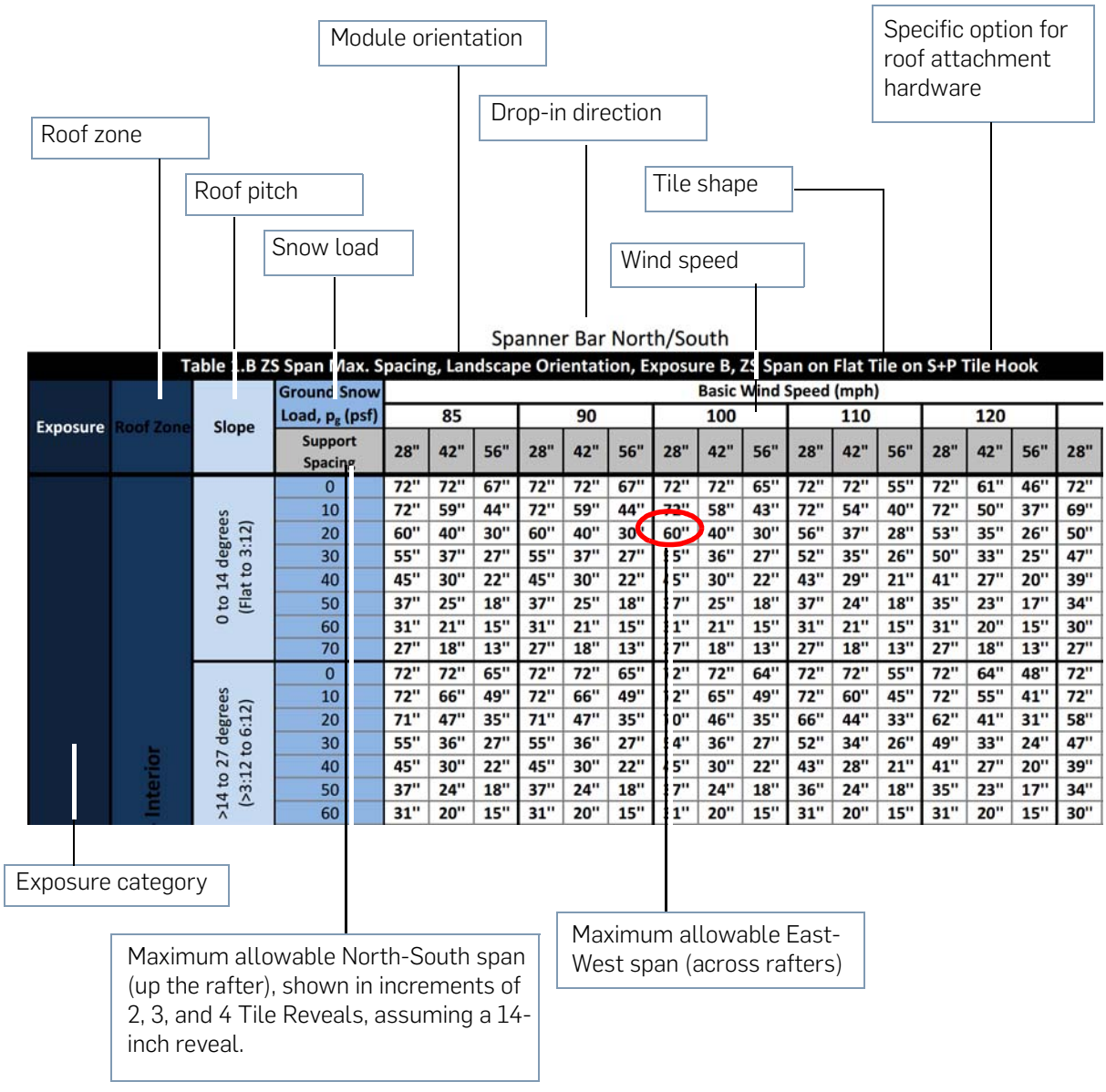


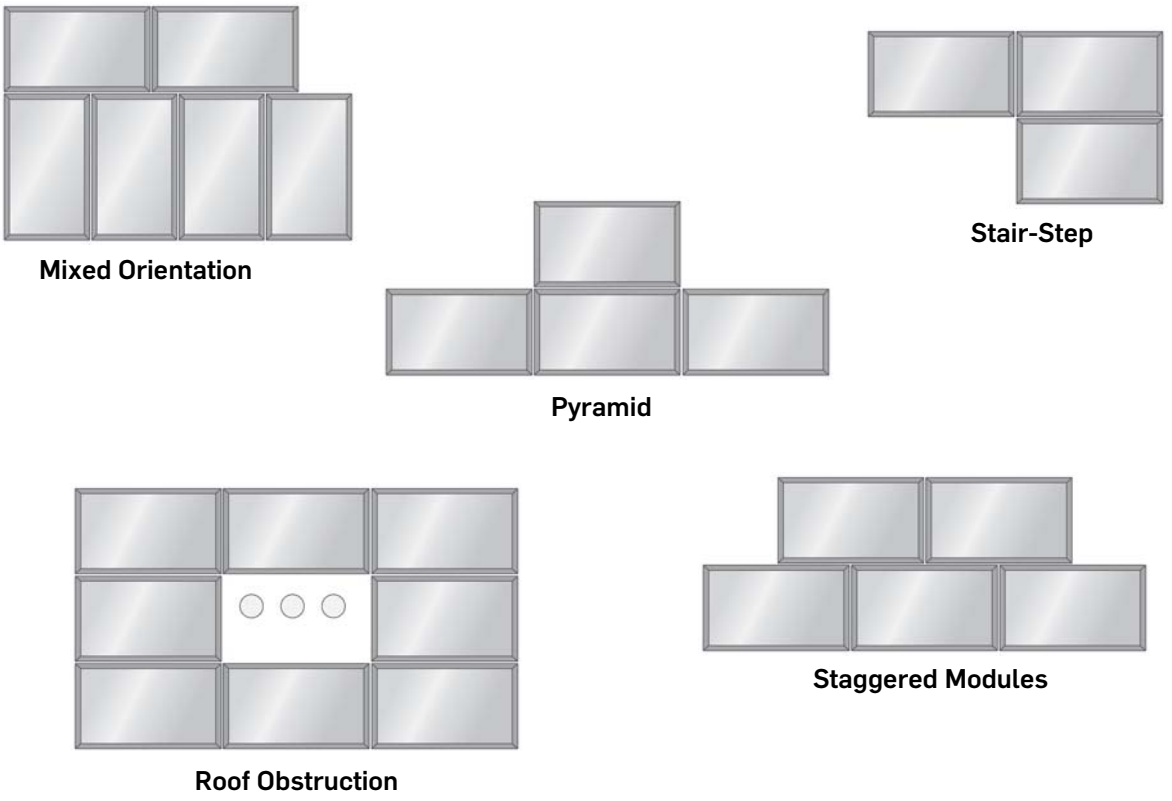
Table 1.B ZS Span Max. Spacing, Landscape Orientation, Exposure B, ZS Span on Flat Tile on S+P Tile Hook

Exposure	Roof Zone	Slope	Ground Snow Load, p_g (psf)	Basic Wind Speed (mph)															
				85			90			100			110			120			
			Support Spacing	28"	42"	56"	28"	42"	56"	28"	42"	56"	28"	42"	56"	28"	42"	56"	28"
	Interior	0 to 14 degrees (Flat to 3:12)	0	72"	72"	67"	72"	72"	67"	72"	72"	65"	72"	72"	55"	72"	61"	46"	72"
			10	72"	59"	44"	72"	59"	44"	73"	58"	43"	72"	54"	40"	72"	50"	37"	69"
			20	60"	40"	30"	60"	40"	30"	60"	40"	30"	56"	37"	28"	53"	35"	26"	50"
			30	55"	37"	27"	55"	37"	27"	55"	36"	27"	52"	35"	26"	50"	33"	25"	47"
			40	45"	30"	22"	45"	30"	22"	45"	30"	22"	43"	29"	21"	41"	27"	20"	39"
			50	37"	25"	18"	37"	25"	18"	37"	25"	18"	37"	24"	18"	35"	23"	17"	34"
			60	31"	21"	15"	31"	21"	15"	31"	21"	15"	31"	21"	15"	31"	20"	15"	30"
			70	27"	18"	13"	27"	18"	13"	27"	18"	13"	27"	18"	13"	27"	18"	13"	27"
		>14 to 27 degrees (>3:12 to 6:12)	0	72"	72"	65"	72"	72"	65"	72"	72"	64"	72"	72"	55"	72"	64"	48"	72"
			10	72"	66"	49"	72"	66"	49"	72"	65"	49"	72"	60"	45"	72"	55"	41"	72"
			20	71"	47"	35"	71"	47"	35"	70"	46"	35"	66"	44"	33"	62"	41"	31"	58"
			30	55"	36"	27"	55"	36"	27"	54"	36"	27"	52"	34"	26"	49"	33"	24"	47"
			40	45"	30"	22"	45"	30"	22"	45"	30"	22"	43"	28"	21"	41"	27"	20"	39"
			50	37"	24"	18"	37"	24"	18"	37"	24"	18"	36"	24"	18"	35"	23"	17"	34"
			60	31"	20"	15"	31"	20"	15"	31"	20"	15"	31"	20"	15"	31"	20"	15"	30"

3.3 Alternative Layout Possibilities

The layouts shown thus far have been simple examples for the purposes of illustration. In the real world, things are rarely as straightforward: maximizing the number of modules on the available roof space while avoiding roof obstacles may require an adaptive approach. The following examples show a few of the array designs that are possible with ZS Span.

Figure 3.6 Alternative Layouts Possible in ZS Span



3.3.1 Special Design Assistance

The above “advanced” layout examples are governed by additional layout rules not described in this manual. Installers who need additional support are encouraged to contact Zep Solar Support for design assistance.

4 Layout Concepts

This chapter contains important information on the rules governing Zep Compatible array layouts.

4.1 Drop-In Direction

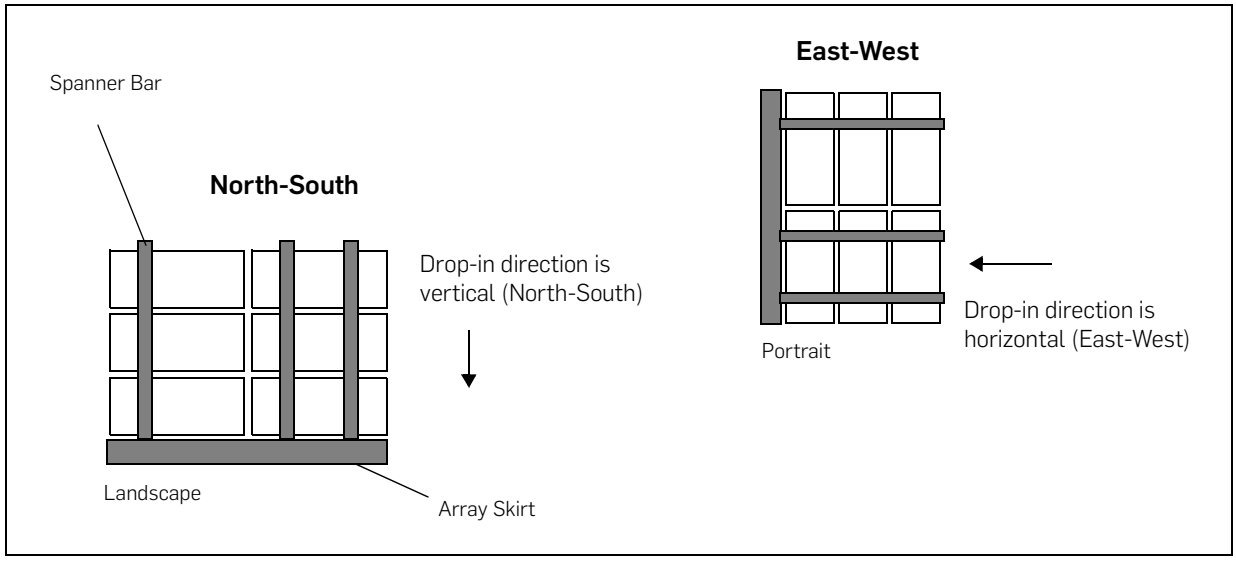
The PV module drop-in process is specific to Zep Solar hardware designs. **For ZS Span, drop-in direction is the same as the Spanner Bar direction.**

North-South. Spanner Bars run vertically. Modules are "dropped in" one row at a time, starting at the Array Skirt and working upwards. Complete each row before proceeding to the next.

East-West. Spanner Bars run horizontally. Modules are "dropped in" one column at a time, starting at one side and working towards the other. Each column is completed, working from bottom to top, before going on to the next. (The Array Skirt is typically used on the first column to keep the modules aligned during installation.)

Is There a Preferred Module Orientation? For ZS Span, Landscape orientation is supported for North-South Spanner Bar/drop-in direction, and Portrait is supported for East-West.

Figure 4.1 Drop-In and Orientation Supported for ZS Span



4.2 Engineering Rules

The engineering rules and Span Tables are important factors to consider when customizing array designs. Installers must be fully aware of these rules when making field adjustments.

4.2.1 Spacing Rules

Cantilever allowances are dependent on the maximum allowable spacing and the drop-in direction. There are two cantilever numbers for ZS Span: module cantilever (Cam Foot to module edge) and Spanner Bar cantilever (Tile Hook to Spanner Bar end).

Maximum Allowable Spacing. The maximum allowable spacing between roof attachment points is determined by various site-specific and building inputs, which are captured in the Zepulator and/or the Span Tables. There are two spacing numbers for ZS Span:

- **Spanner Bar spacing**, which is the distance between Spanner Bars. Typically this is the East-West spacing shown in the Span Tables.
- **Tile Hook spacing**, which is the distance between Tile Hooks running along the same Spanner Bar. Typically this is the Tile Reveal shown in the Span Tables.

Achievable Spacing Increments. The maximum allowable spacing is not necessarily achievable on a project, because the actual spacing is limited by two increments:

- **Rafter spacing**, which is a horizontal dimension. Typically this will be the Spanner Bar spacing, assumings the Spanner Bars are running North-South down a rafter.
- **Tile Reveal**, which is a vertical dimension. Typically, this will be the Tile Hook spacing.

Inverse Relationship Between Maximum Spans. The larger the spacing in one direction, the smaller the spacing in the other. For example, the Zepulator online design tool allows the user to select the desired number of tiles based on the specified vertical Tile Reveal. Choosing a smaller number of tiles can allow for a creater span in the East-West direction, while choosing a larger number of tiles will result in a smaller horizontal span.

4.2.2 Cantilever Rules

Spanner Bar Cantilever. For ZS Span, the maximum Spanner Bar cantilever distance is dependent on the direction in which the Spanner Bars are running.

- **North-South drop-in.** For Spanner Bars running North-South, the maximum Spanner Bar cantilever is 1/2 of the maximum allowable North-South Tile Hook spacing, not to exceed 24 inches.
- **East-West drop-in.** For Spanner Bars running East-West, the maximum Spanner Bar cantilever is 1/2 of the maximum allowable East-West Tile Hook spacing, not to exceed 24 inches.

Module Cantilever. For ZS Span, the maximum module cantilever distance is also dependent on the direction in which the Spanner Bars are running.

- **North-South drop-in.** For Spanner Bars running North-South, the maximum module cantilever is 1/3 of the maximum allowable East-West Spanner Bar spacing.
- **East-West drop-in.** For Spanner Bars running East-West, the maximum module cantilever is 1/3 of the maximum allowable North-South Spanner Bar spacing.

Figure 4.2 Spacing and Cantilever I

North-South Drop-in, Rafters Running North-South

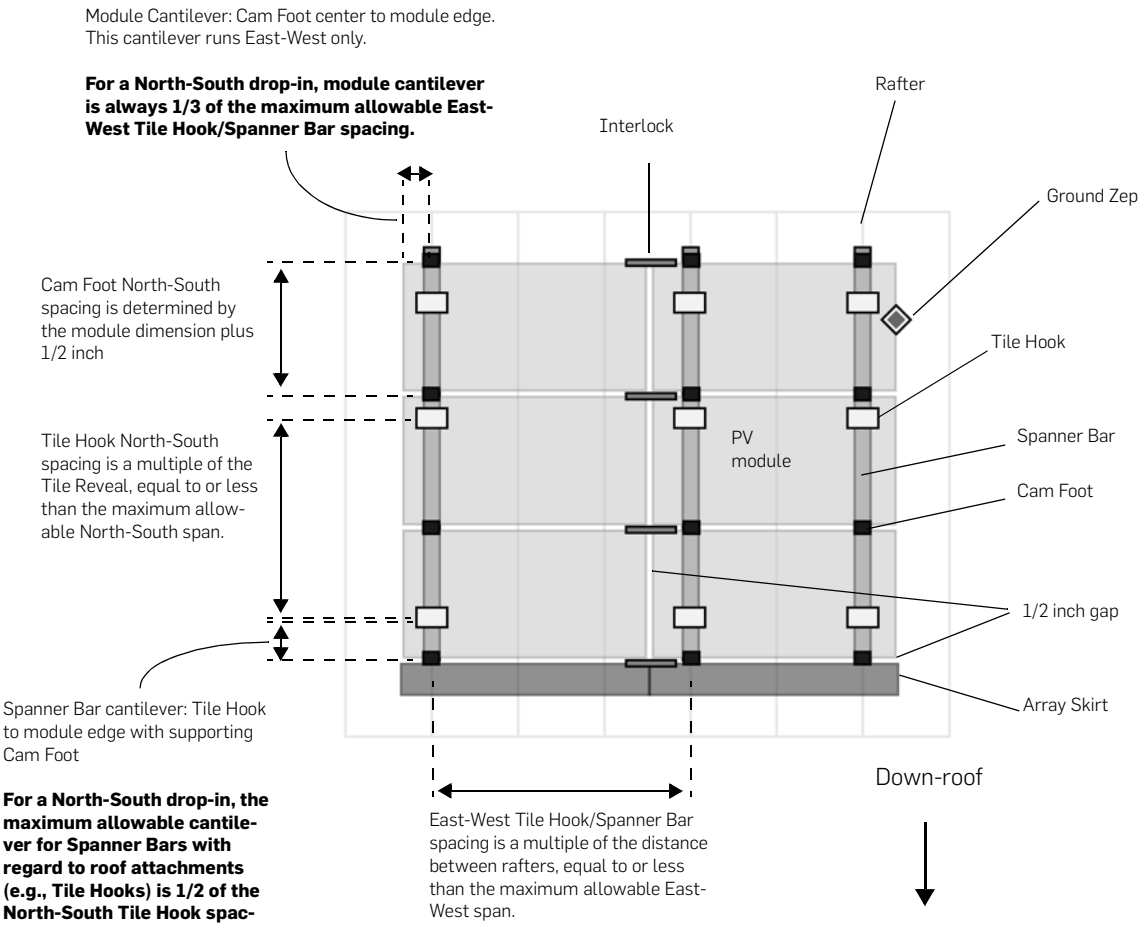
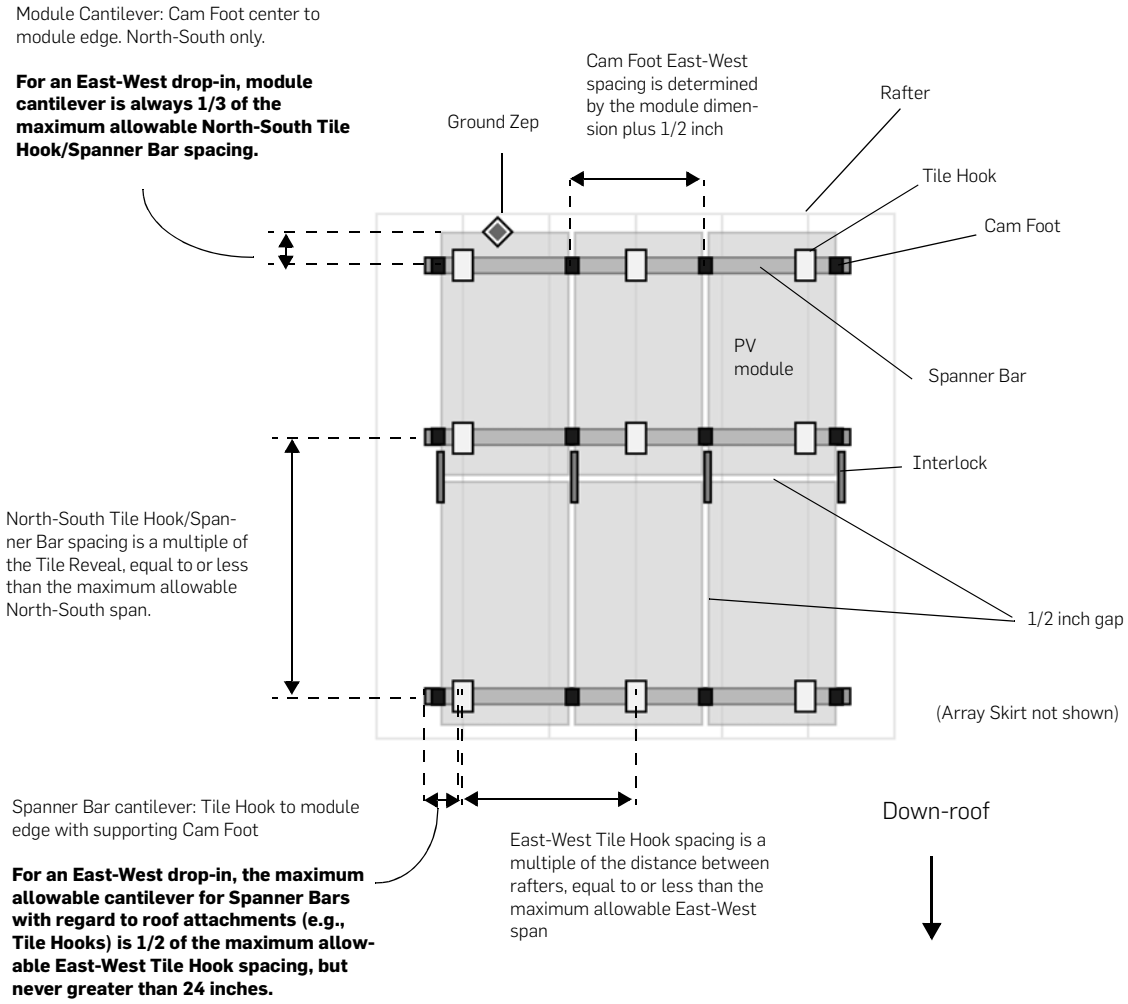


Figure 4.3 Spacing and Cantilever II

East-West Drop-in, Rafters Running North-South

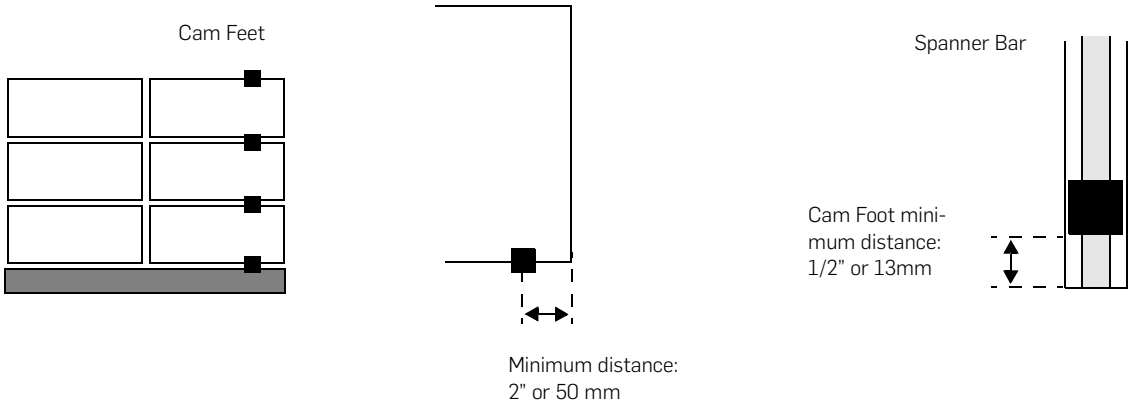


4.2.3 Distance Rules

Cam Feet and Spanner Bar Ends. Cam Feet must be a minimum 1/2" from a Spanner Bar end, measured from the center of the Cam Foot threaded stud.

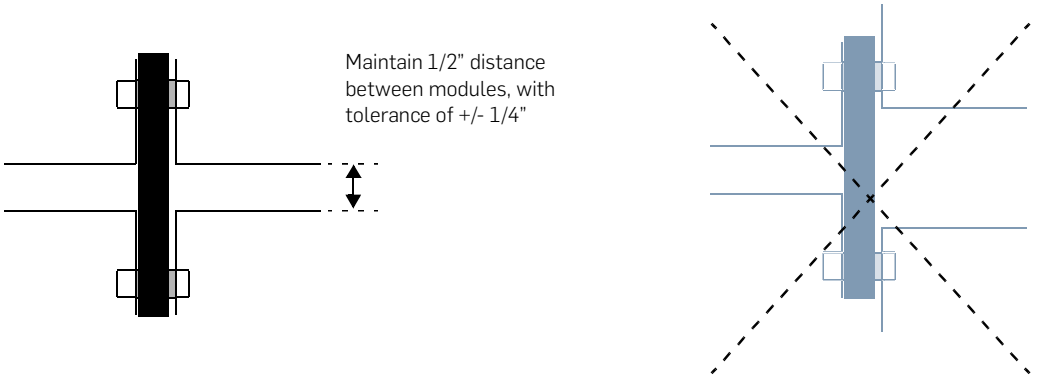
Module Corner Minimum Distance. Zep Solar hardware such as Cam Feet and Ground Zeps must be installed a minimum distance of 2 inches from module corners, measured from the center of the Cam Foot Rockit.

Figure 4.4 Minimum Corner Distance and Spanner Bar End Distance



Spacing Between Modules. Any two modules bonded by the same Interlock should always be spaced 1/2 inch apart, with a tolerance of +/- 1/4 inch.

Figure 4.5 Allowable Module Spacing

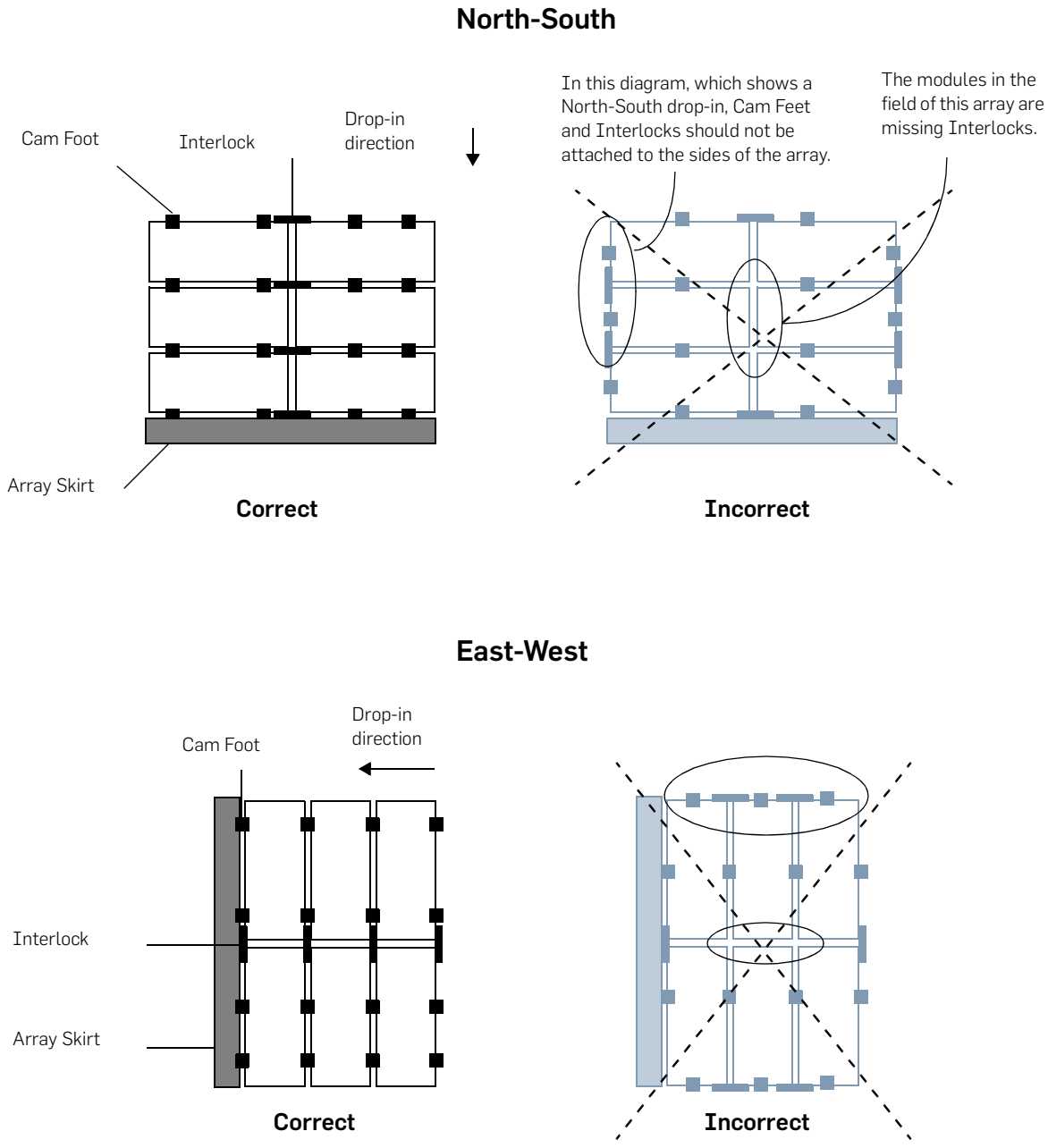


4.2.4 Law of Perpendicularity

Interlocks Must be Perpendicular to Drop-In Direction. For ZS Span, module drop-in direction parallels Spanner Bar direction, which can run either North-South or East-West. Interlocks always run perpendicular to the module drop-in direction.

Feet Attach on Opposing Sides of Module. Cam Feet must always attach on opposite sides of the module, with the Tongue and Groove facing along the drop-in direction. Cam Feet should never be installed along the drop-in direction.

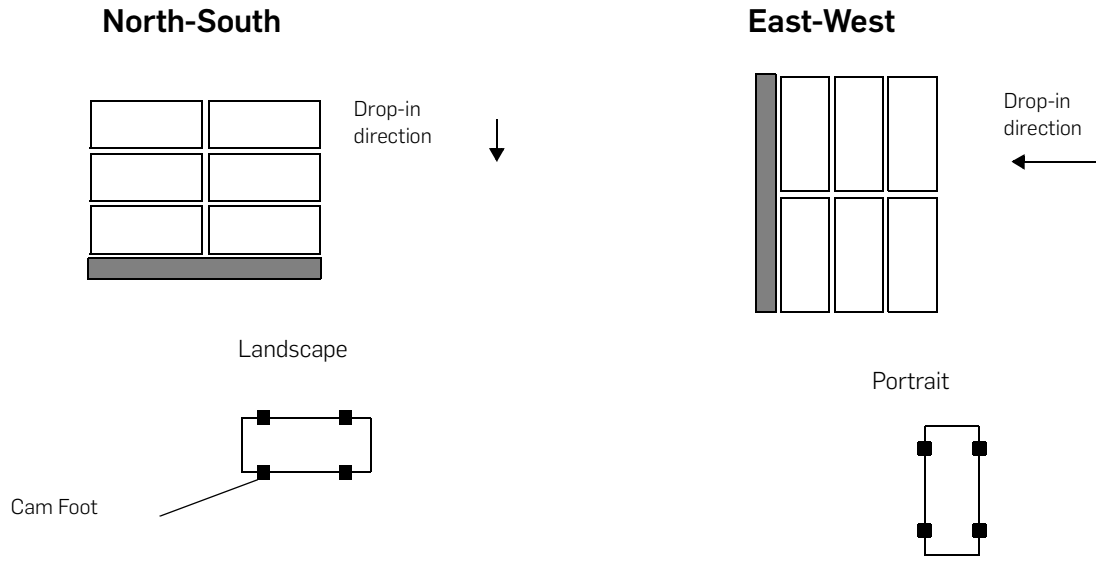
Figure 4.6 Law of Perpendicularity



4.2.5 Single Module Installation

A standalone module requires two Cam Feet per supporting frame side, for a total of 4 Cam Feet. This remains true regardless of module orientation or drop-in direction.

Figure 4.7 Standalone Module Installation



4.3 Grounding/Earthing

The Zep Compatible design concept allows the installer to build a hyper-bonded array up to a specified size with a single ground bond connection (an Equipment Grounding Conductor). In a hyper-bonded array, every module is structurally and electrically bonded to the surrounding modules, on all sides. The rotation of the Key side into the Zep Groove, and the dropping in of the next row of PV modules onto the Tongue side, acts to establish an electrical bond for all UL listed components by cutting through the anodization on the Zep Groove. This eliminates the need for extensive lengths of copper wire run to every module in order to ground the array.

In some situations, portions of the array may require additional bonding connections. The illustrations on the following pages show when additional Equipment Ground Conductors or jumpers are required.

4.3.1 Bonding Path Examples

The following examples show how a Zep Compatible PV array is hyper-bonded using Interlocks.

Figure 4.8 Bonding Path - Simple Array

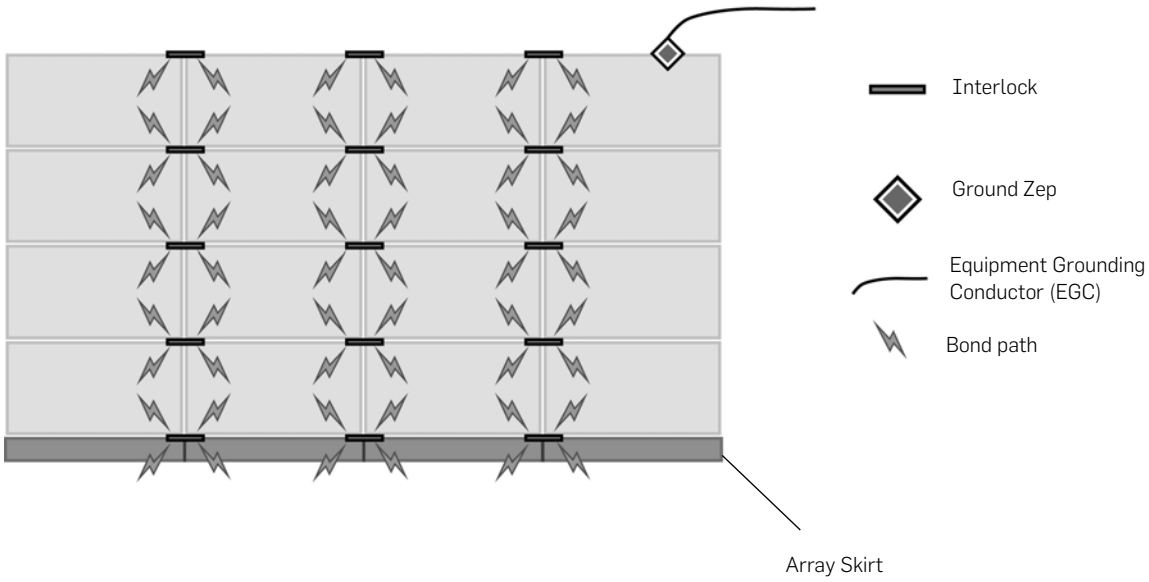
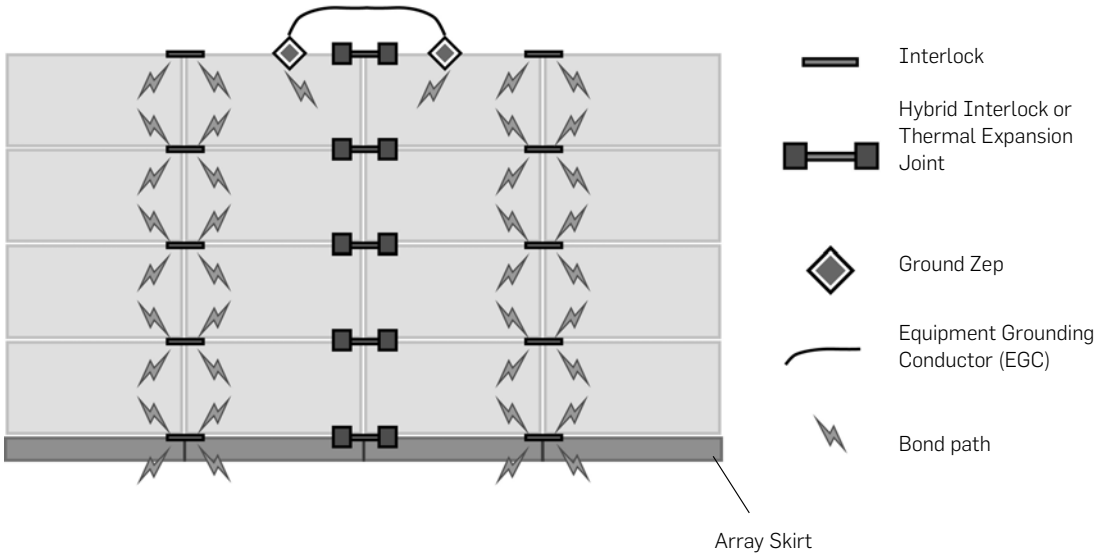


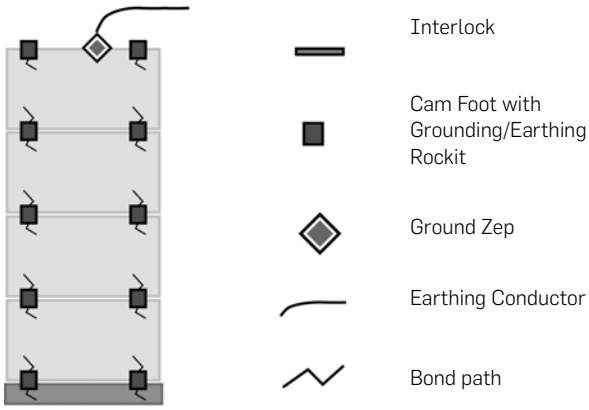
Figure 4.9 Bonding Path - Hybrid Interlocks or Thermal Expansion Joints



An array with a continuous column of Hybrid Interlocks (or a Thermal Expansion Joint) must be installed with a Ground Zep on either side of the column and a copper conductor wire between the two, in order to bond the two electrically isolated sub-arrays.

Selected versions of the Cam Foot also create an electrical bond as well.

Figure 4.10 Bonding Path - Rockit



4.3.2 Special Bonding Component Options

Hybrid Interlocks and Grounding. Zep Solar, Inc. offers both bonding and non-bonding versions of the Hybrid Interlock. National code requirements determine which component is available within each country. If an installed layout has a continuous column of Hybrid Interlocks, and the bonding version is not available, a Ground Zep must be installed on either side of that column.

Cam Feet and Grounding. Bonding versions of the Cam Foot also create an electrical bond with modules on both Key and Tongue sides of the Cam Foot Rockit. The Cam Foot creates an electrical bond with the Spanner Bar as well.

Spanner Bar Splicing and Grounding. The Splice Kit creates an electrical bond between two sections of Spanner Bar when they are fully spliced together.

Ground Zep Module Limit. A single Ground Zep can be used as a connection point to ground an array up to 33 x 33 feet.

4.4 Thermal Expansion

There are two methods to address thermal expansion and contraction within Zep Compatible arrays: Thermal Expansion Joints and physical gaps or breaks between sub-arrays.

Thermal Expansion Joints consist of Interlocks that are installed in a manner that allows modules to slide back and forth as they expand and contract in response to daily temperature swings on the roof. This allows the modules some added flexibility to expand in the direction that the Interlocks are running. In the other direction, a physical gap is required to allow for thermal expansion of the modules. Generally, a gap of at least 12" between sub-arrays is recommended, both for thermal expansion and to allow access by work crews for module servicing.

4.4.1 When Are Thermal Expansion Joints Needed?

Thermal expansion must be addressed under the following conditions:

- Array sizes larger than approximately 33 feet in either direction.
- After two consecutive Thermal Expansion Joints, a physical gap is required.

NOTE: For example, a typical 60-cell polycrystalline module would require thermal expansion every 6 module lengths or 10 module widths, or approximately every 60 modules assuming a square array.

4.4.2 Installing Thermal Expansion Joints

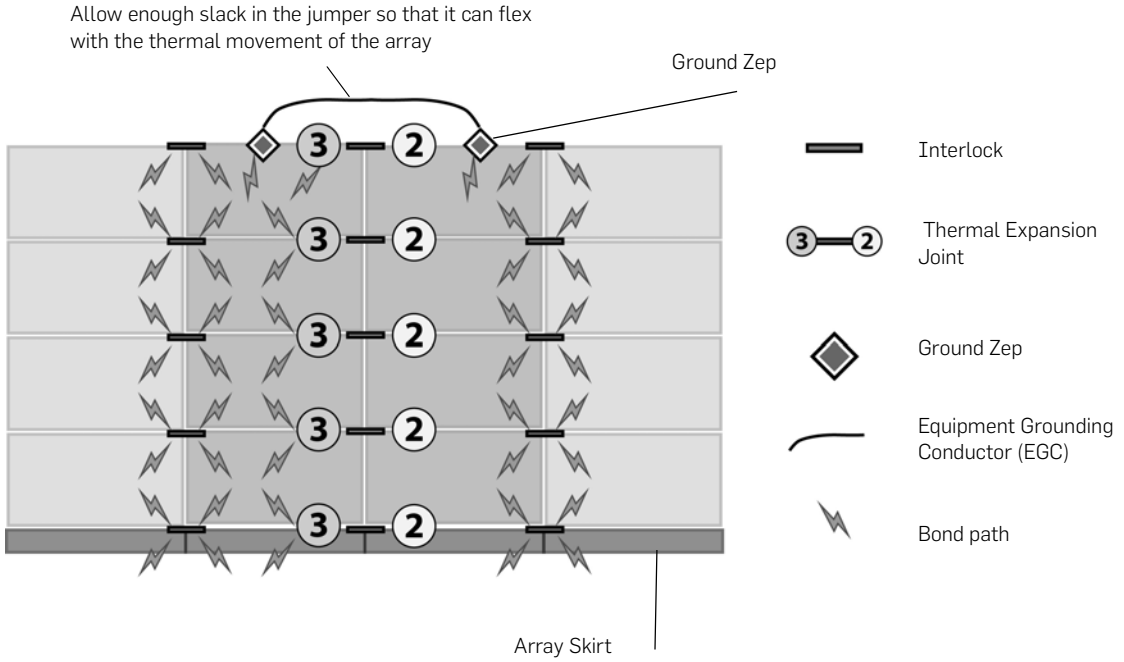
Thermal Expansion Joints use the Interlock component, which is used to connect and bond two modules together. To create a Thermal Expansion Joint between two modules, rotate the Interlock Zep on one side to Position 3 (locked position) using the Zep Tool. Rotate the Interlock Zep on the other side to just past Position 2. Position 2 provides a structural connection, but does not establish an electrical bond.This allows the module on the side of just past Position 2 to slide back and forth as the modules expand and contract in changing temperatures.

NOTE: Thermal Expansion Joints require that a Ground Zep be installed on both sides of the break.

4.4.3 Thermal Expansion Joints and Module Rows or Columns

When there is a continuous row or column of Interlocks all serving as a thermal expansion joint, **all Interlocks must be tightened consistently going across the entire row or column**. In most cases, one side of the Interlock is turned to Position 3, and the other side to just past Position 2, the exception being a staggered array. Interlock Position 3 creates an electrical bond with modules on both Key and Tongue sides.

Figure 4.11 Thermal Expansion Joint: Interlock Tightening Positions, North-South Drop-In



4.4.4 Physical Gaps Between Sub-Arrays

Thermal Expansion Joints only work along the axis of the Interlock. Thermal expansions running along the other axis (parallel to the module drop-in direction) require a physical break between the sub-arrays.

At a minimum, the gap should be at least 4 inches. However, a gap of 12 inches is recommended for ease of servicing.

Figure 4.12 North South Drop-In, Thermal Expansion Gap

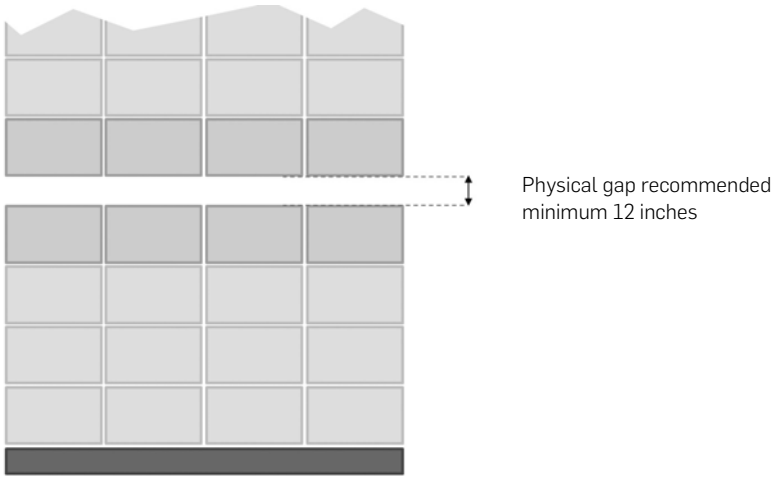
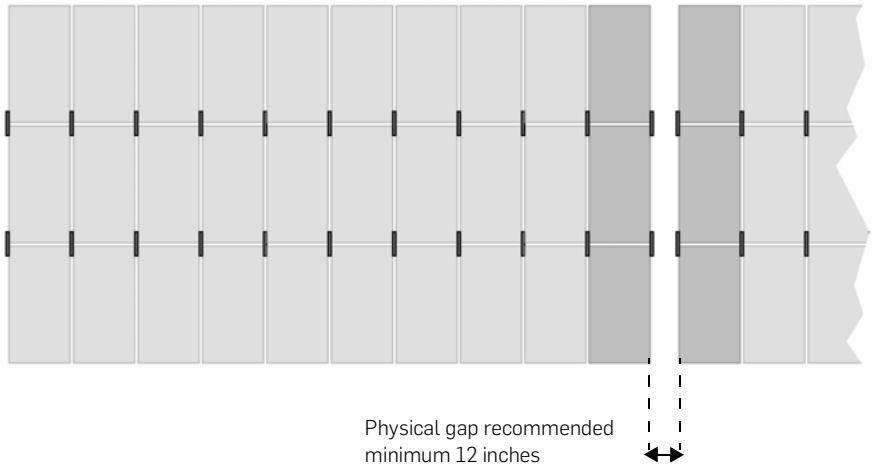
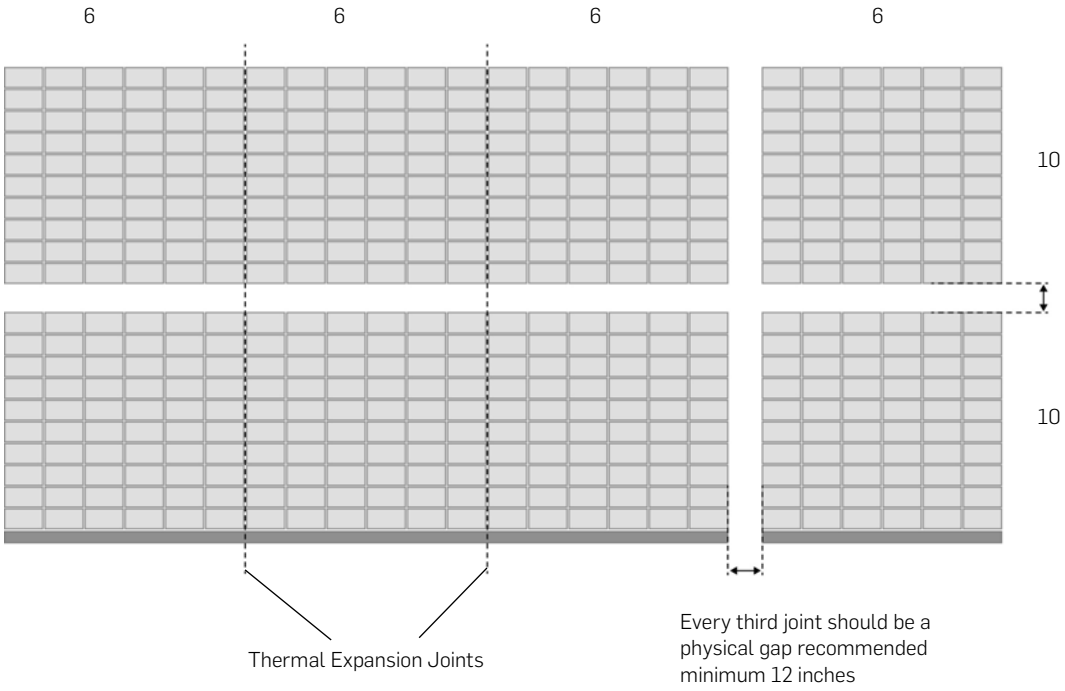


Figure 4.13 East-West Drop-In, Thermal Expansion Gap



Along the axis of the Interlock, large arrays also need a physical gap after two Thermal Expansion Joints. For example, a North-South drop-in, Landscape orientation, might require a physical gap approximately every 100 feet. This would be approximately every 18 module lengths, depending on the module.

Figure 4.14 Large Array, North Drop-In, Thermal Expansion Gap

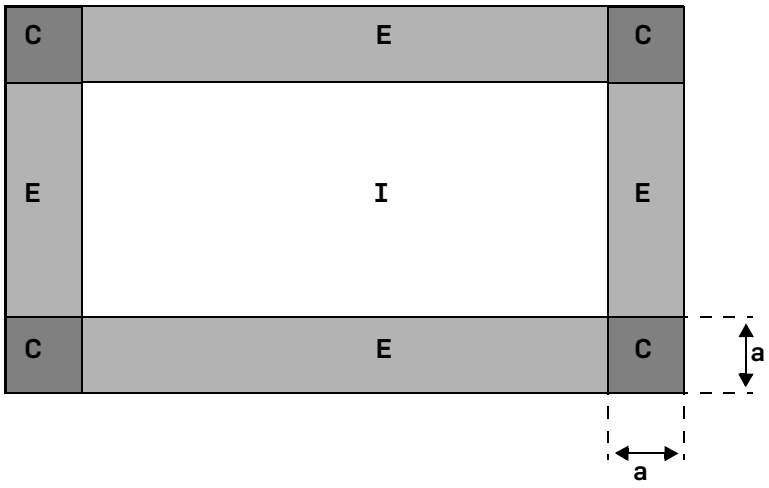


4.5 Roof Zones

Roof zones identify the interior, edge and corner regions of each designated roof plane. This is to take into account varying wind pressures as the wind passes over different areas of the roof. The maximum allowable Cam Foot spacing may be smaller in edge and corner roof zones.

Note: The examples shown in this document are for illustration purposes only and are subject to change in accordance with any modifications to regional engineering and structural requirements.

Figure 4.15 Roof Zone Example (U.S.)



I Interior zone

E Edge zone

C Corner zone

a The determination of the edge and corner zone dimensions is country-specific, as described in the Engineering Certification Letters for each country.

When generating array layouts, the Zepulator assumes that the entire mounting area is within an Interior roof zone. For detailed examples showing applications of array layouts within edge and corner roof zones, and how to determine the dimensions of these zones, please refer to the Engineering Certification Letter and Span Tables document that is appropriate for the project location. This document is available on the Zep Solar web site.

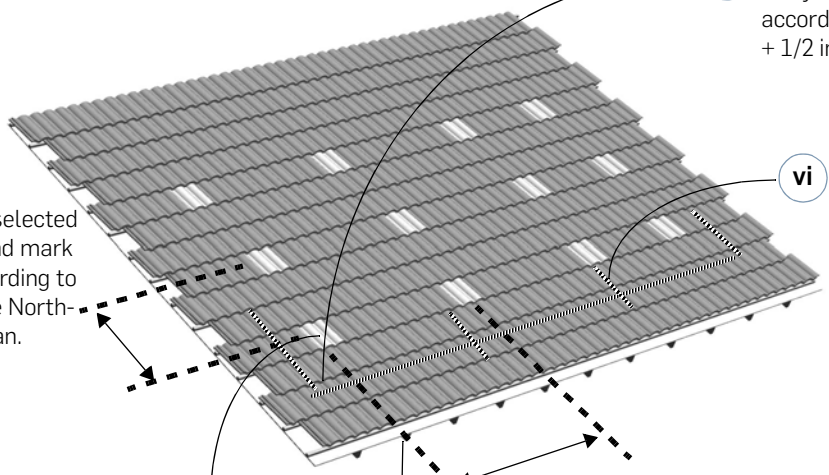
5 Installation Process

ZS Span for Tile Roofs

Mounting Solution for Solar Arrays

Step 1: Mark Out Array Layout on Roof

1a Mark Attachment Locations



i Locate the outside edges of the array. Mark array perimeter according to module dimension + 1/2 inch.

v Work up selected rafters and mark tiles according to allowable North-South span.

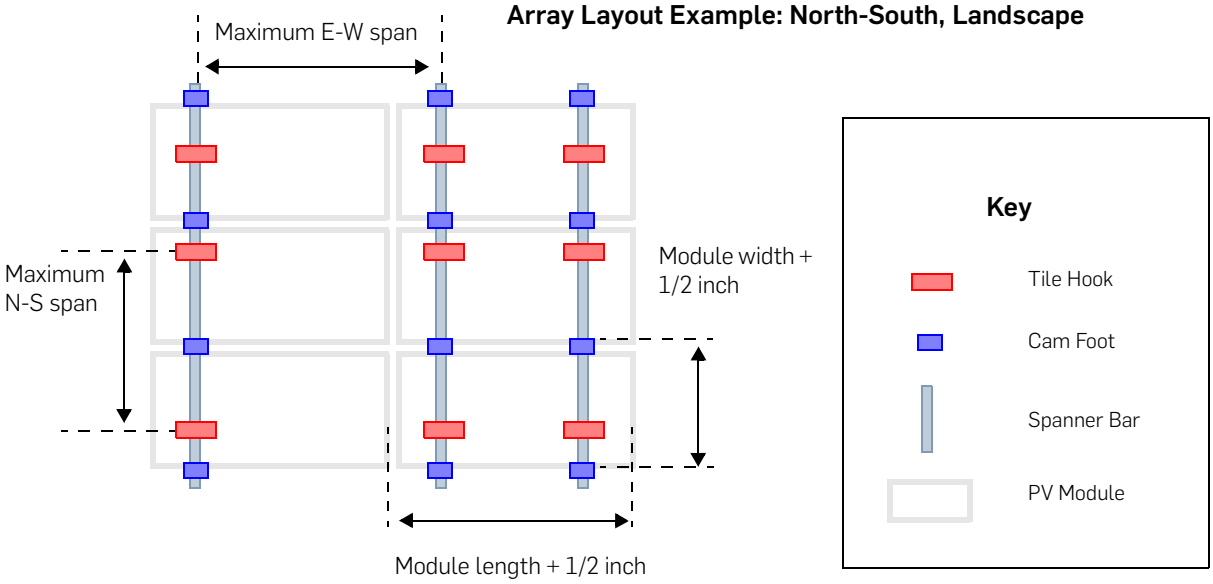
vi Mark intervals for Array Skirt sections (custom matched for each module type and orientation) to identify Cam Foot/Inter-lock conflicts and lay out module gaps. Array can shift over attachment points if needed. **Do not exceed cantilever allowance.**

iii Working up the rafter, choose and mark the first tile to be removed. It is best not to select a tile at the very edge of the array, and to fully utilize allowable Spanner Bar cantilever.

iv Work across to select rafters based on allowable East-West span. Mark corresponding tiles above.

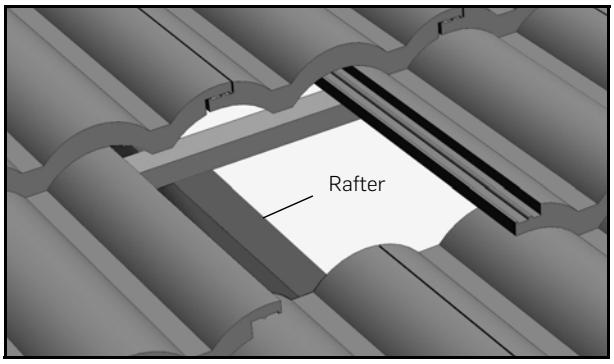
ii To mark roof attachment points, start by finding the first available rafter within the mounting area.

Array Layout Example: North-South, Landscape



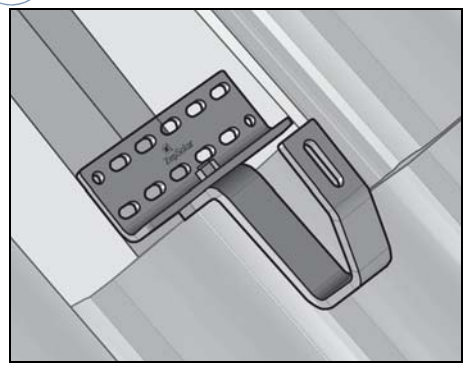
Step 2: Install Roof Attachments

2a Remove Identified Roof Tiles



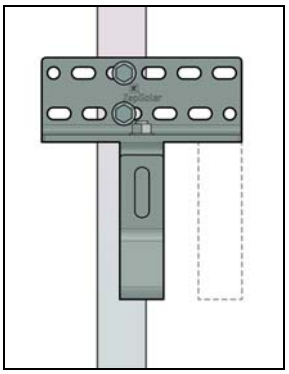
Preserve tiles for later re-installation. (Roof sheathing not shown)

2b Install Attachment

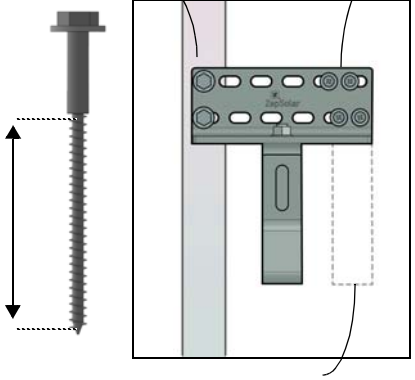


Follow manufacturer's instructions for Zep Solar-approved Tile Hooks or standoffs.

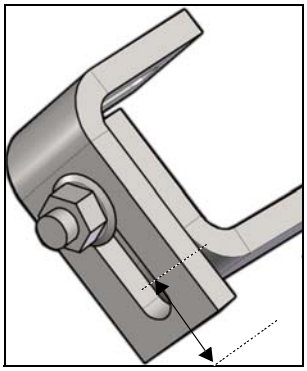
Tile Hook Placement



The Adjustable Mighty Hook from Zep Solar, Inc. can be shifted off-center.

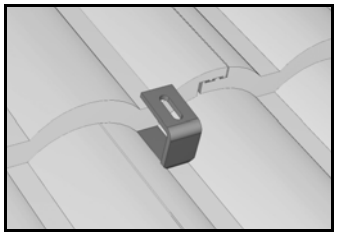


The hook portion of the Adjustable Mighty Hook can be shifted as well.



Some Tile Hooks allow adjustment of the hook depth.

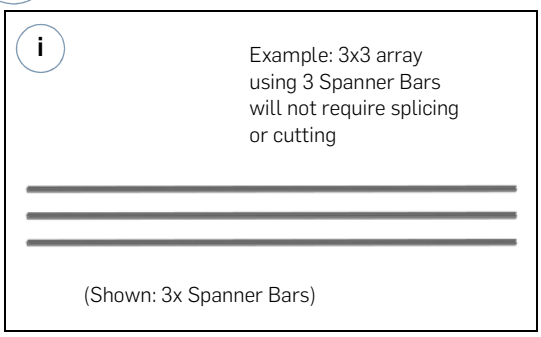
2c Replace Roof Tiles



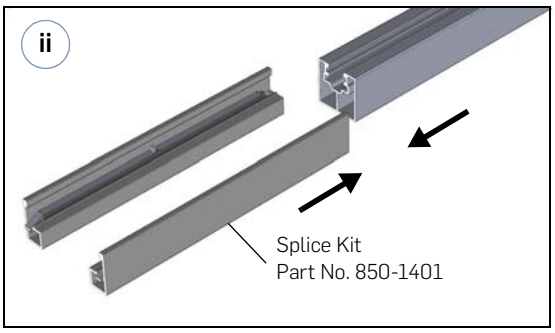
Tiles may require grinding in order to fit flush.

Step 3: Ground Prep

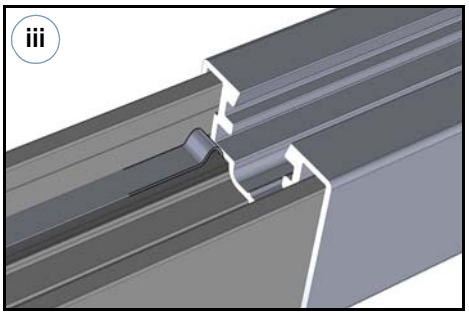
3a Assemble Spanner Bar Lengths



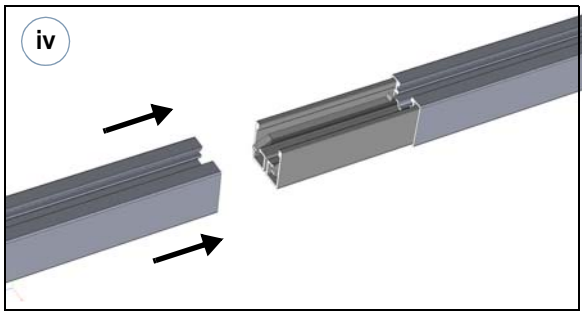
Assemble Spanner Bars into the final lengths required for the array design. See "Spanner Bar 1x 3x 4x Lengths" on page 39 for guidance on splicing pre-cut lengths for larger arrays.



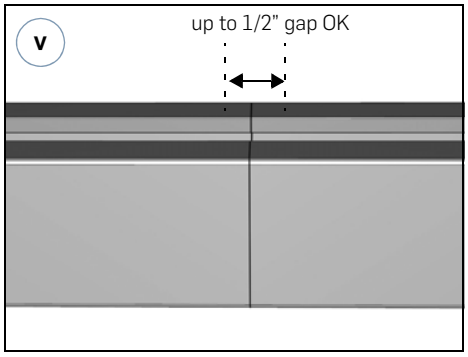
Use a Splice Kit to splice two Spanner Bars together if needed.



Slide the Splice Kit into the first Spanner Bar until the ridge in the Splice Kit meets the Spanner Bar edge as shown.



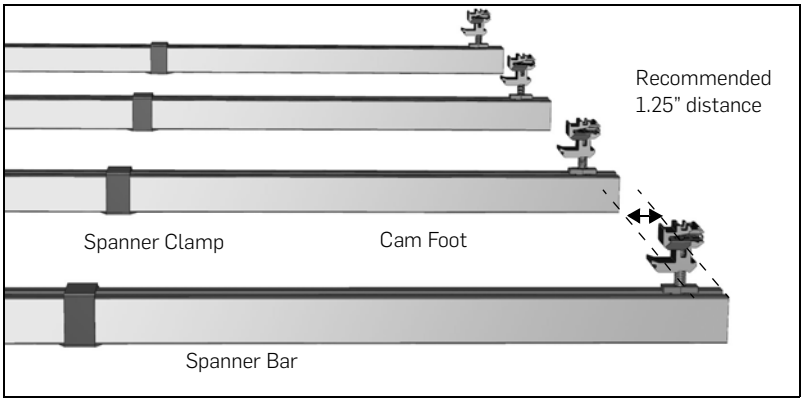
Insert the second Spanner Bar over the Splice Kit until the two Spanner Bar ends meet.

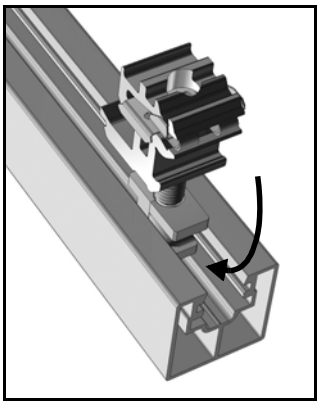


Spanner Bars should be flush when fully spliced, tolerance of +/- 1/4".

Ground Prep, Continued

3b Place First Row of Cam Feet into Spanner Bars



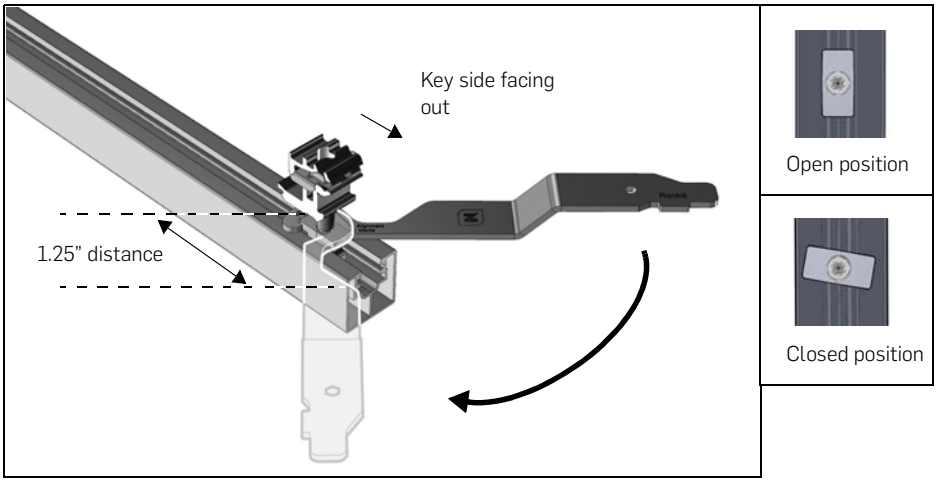


Attach first row of Cam Feet 1.25 inches from Spanner Bar ends, measuring to the center of the Cam Foot threaded stud. (Minimum distance is 1/2")

The Key side of the Cam Foot Rockit should face outwards, towards the perimeter of the array. Tongue side of Rockit should face inwards, towards the field of the array.

Insert Cam Foot base into Spanner Bar channel.

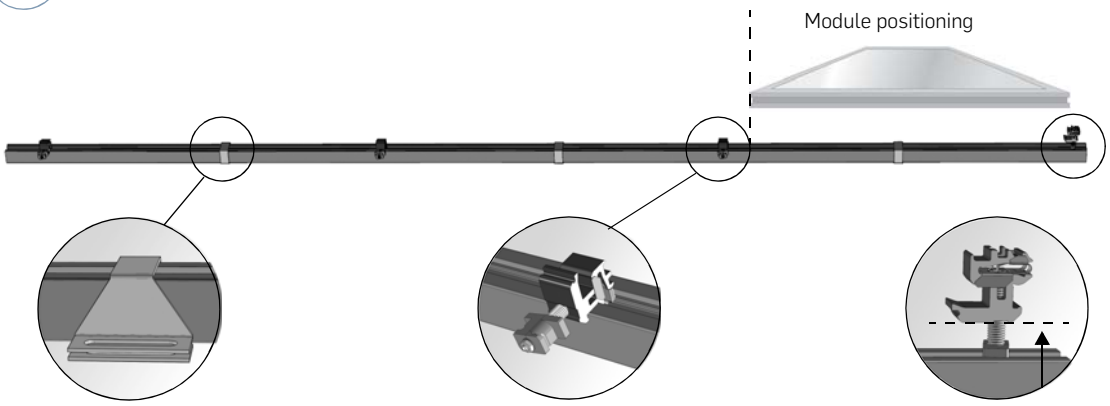
3c Secure Cam Feet Using Flat Tool



Tighten Cam Foot base 100 degrees, using Flat Tool.

Ground Prep, Continued

3d Spanner Bar Staging

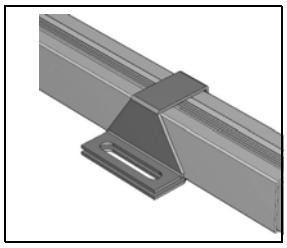


Slide Spanner Clamps onto Spanner Bars. All Spanner Clamps should face the same way.

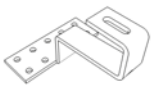
Stage the Cam Feet between Spanner Clamps, just past where module edge will fall.

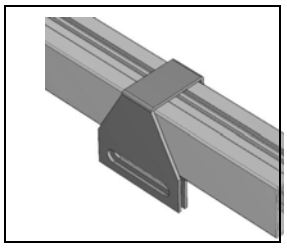
First-row Cam Feet Rockits should be positioned half-way up the threaded stud.

3e Spanner Clamp Position Matches Tile Hook Type



Top Mount Tile Hook

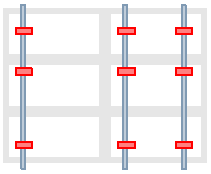




Side Mount Tile Hook

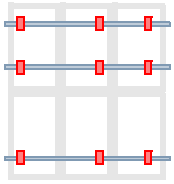
3f Use Correct Tile Hook Type for Spanner Bar Direction

North-South drop-in



Top Mount or Side Mount Tile Hook

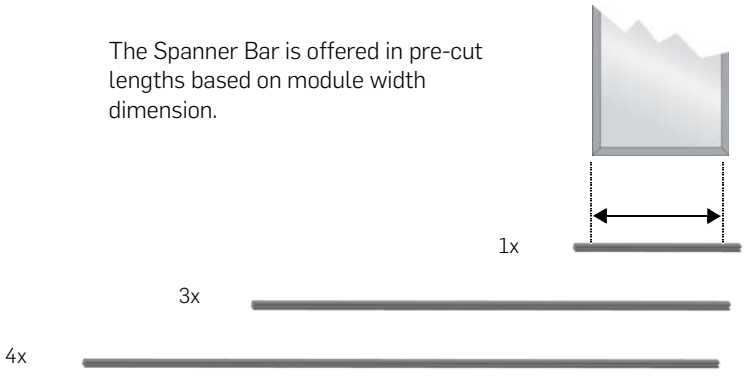
East-West drop-in

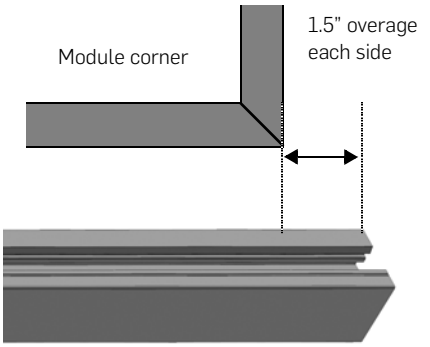


Top Mount Tile Hook only

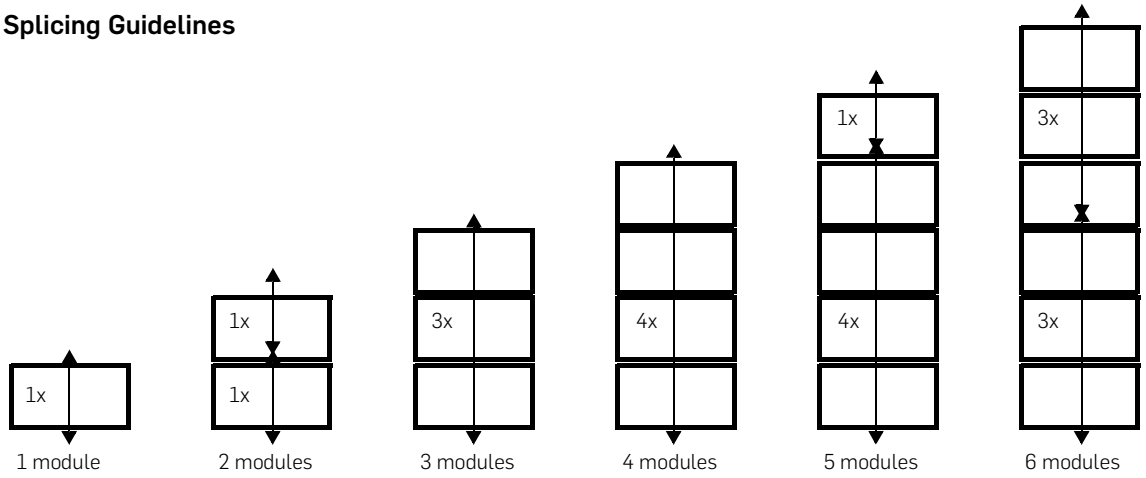
Special Inset: Spanner Bar 1x 3x 4x Lengths

The Spanner Bar is offered in pre-cut lengths based on module width dimension.

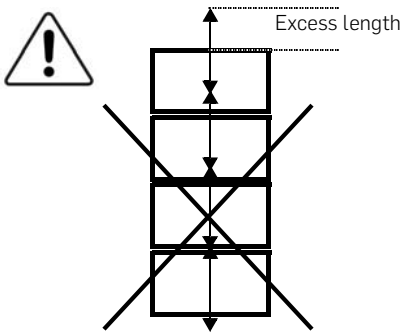




Splicing Guidelines

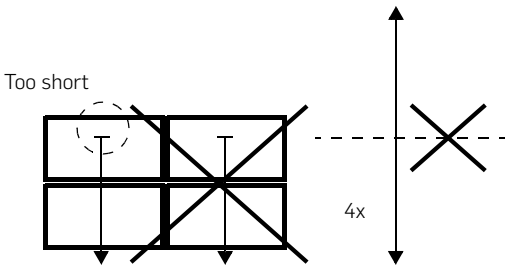


Minimize Splices



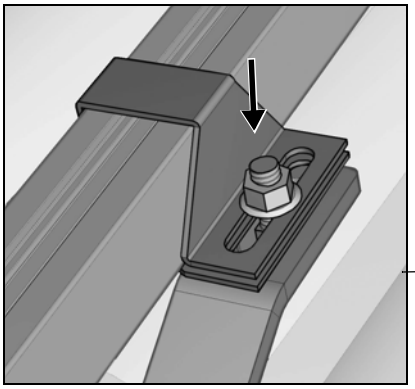
Do Not Cut Spanner Bars in Half

Cutting a 4x Spanner Bar in half will result in two lengths that do not quite span 2 module widths.

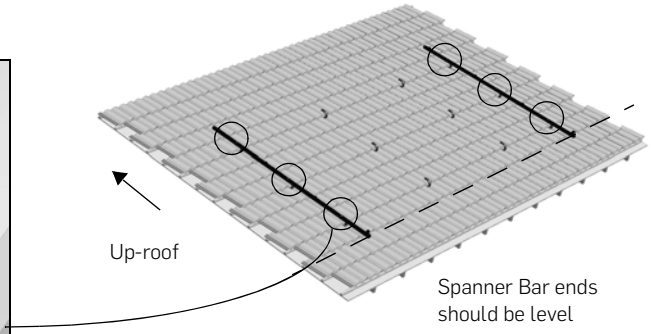


Step 4: Attach Spanner Bars

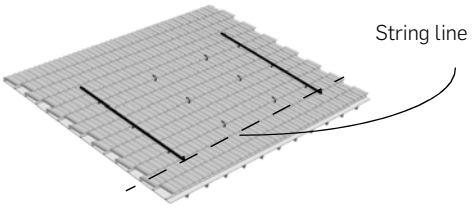
4a Mount Outer Spanner Bar Sections on Roof Attachments

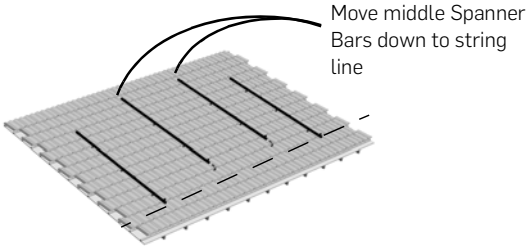


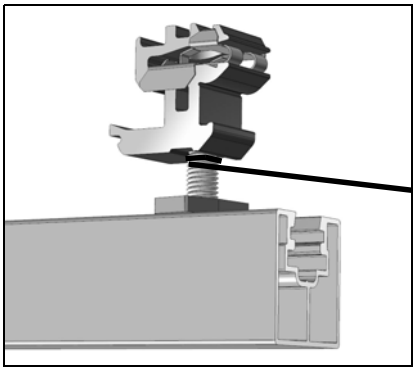
Torque the carriage bolt on Spanner Clamps going up the column.



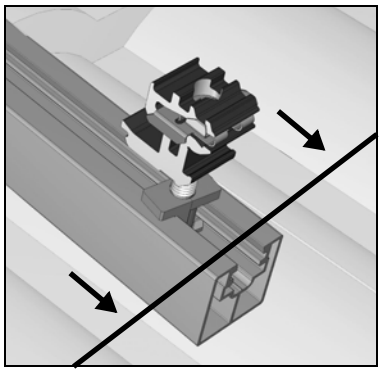
4b Use String Line to Align Middle Spanner Bars and Cam Feet







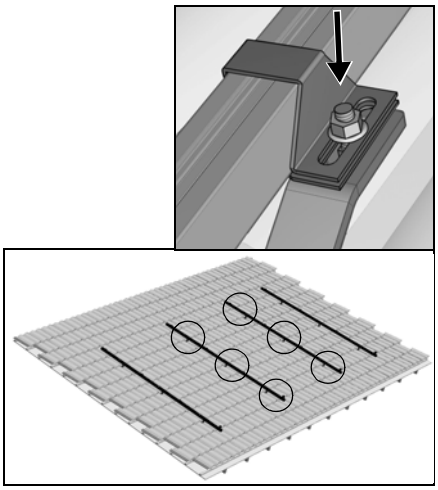
Place string line on front side, just below the Rockit, on the two outermost Cam Feet.



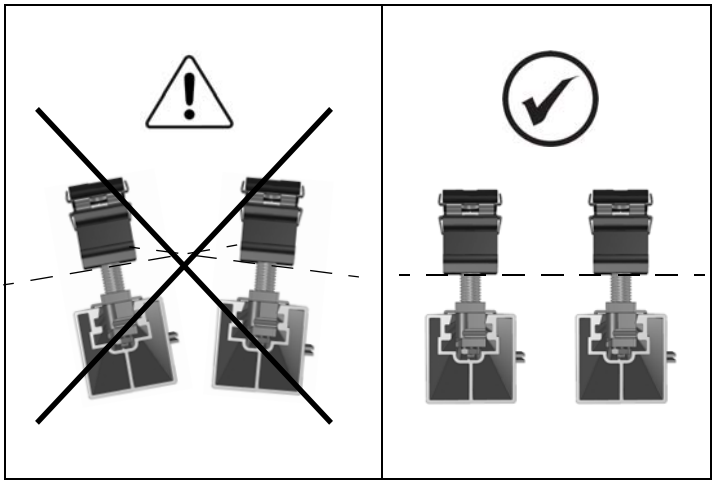
Slide middle Spanner Bars into position until Cam Feet threaded studs meet string line.

Attach Spanner Bars, Continued

4c Secure Middle Spanner Bars and Align Cam Feet

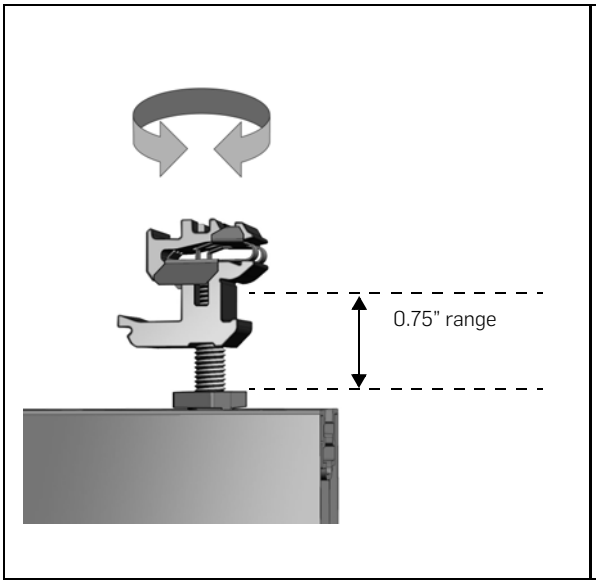


Secure Spanner Clamps going up each middle Spanner Bar.



Visually check that Spanner Bars are level, and not tilted.

4d Level Cam Feet Rockits to String Line

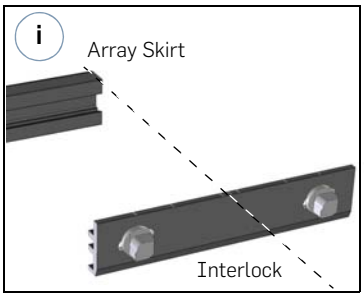


Spin the Rockit to adjust Cam Foot height up or down within the allowable range.

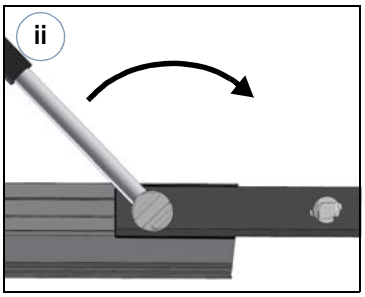
Allowable range is as shown.

Step 5: Install Array Skirt

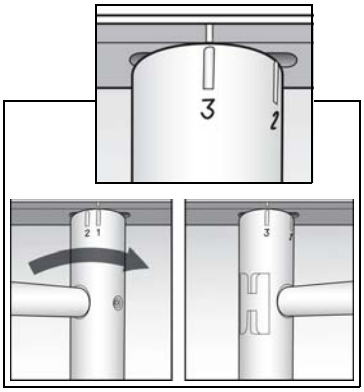
5a Connect First Two Array Skirt Sections Together



Position an Interlock with the Key side towards the Array Skirt, aligning the end of the Array Skirt with the center mark on the Interlock.



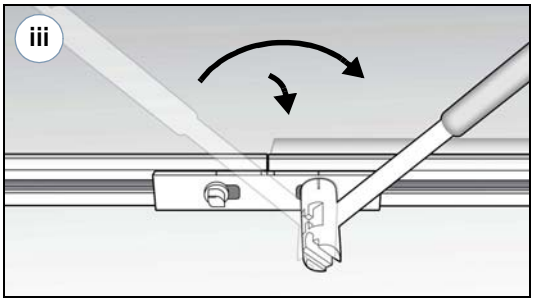
Use the Zep Tool to secure the Interlock on one side.



Rotate the Zep Tool from Position 1 to Position 3.

Do not over-turn.

Note: Pre-assemble the first two Array Skirt sections if the Cam Foot spacing up the roof is greater than the length of a single Array Skirt.

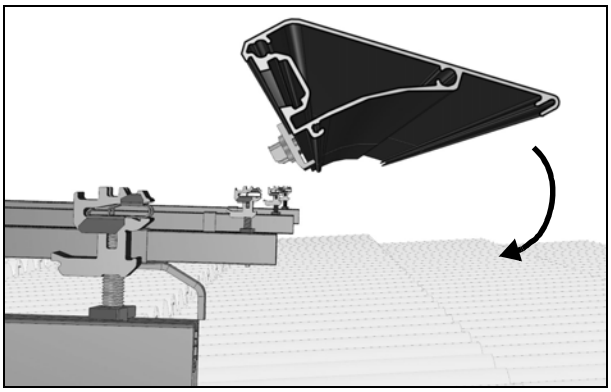


Attach the second Array Skirt section, and tighten the Interlock on the second side. **Skirt will not be flush at the bottom until Zep Tool is fully turned to Position 3.**

NOTE: The Interlock includes built-in alignment marks along its top edge. See "Interlocks" on page 53 for more information.

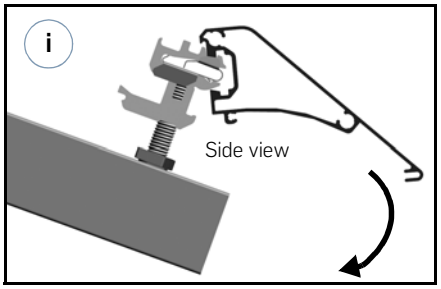
Array Skirt, Continued

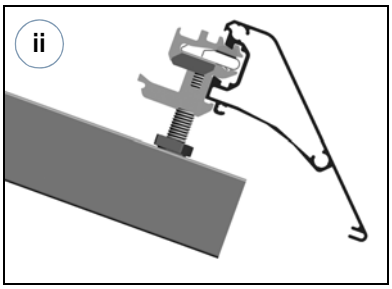
5b Rotate First Array Skirt Sections Onto Key Side of Cam Feet

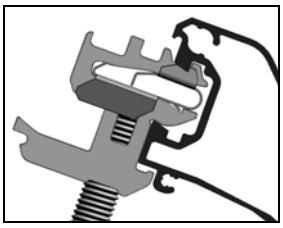


Array Skirt can be shifted to avoid conflicts between Interlocks and Cam Feet. Be sure to stay within module cantilever allowances as described in "Spacing Rules" on page 20.

If a conflict between an Interlock and a Cam Foot cannot be avoided by repositioning the Array Skirt, see "Interlocks" on page 53 and "Hybrid Interlocks" on page 71 for additional solutions.

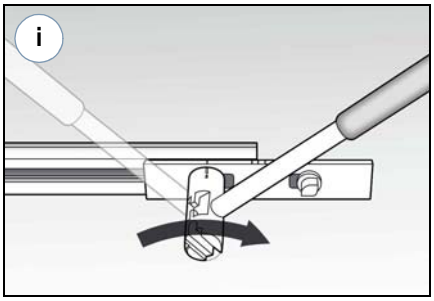




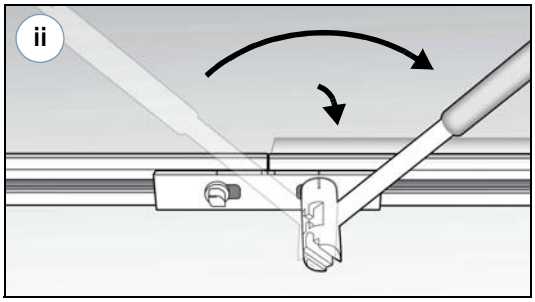


Bottom edge of Array Skirt should be flush against Cam Foot Rockit.

5c Install Remaining Sections of Array Skirt



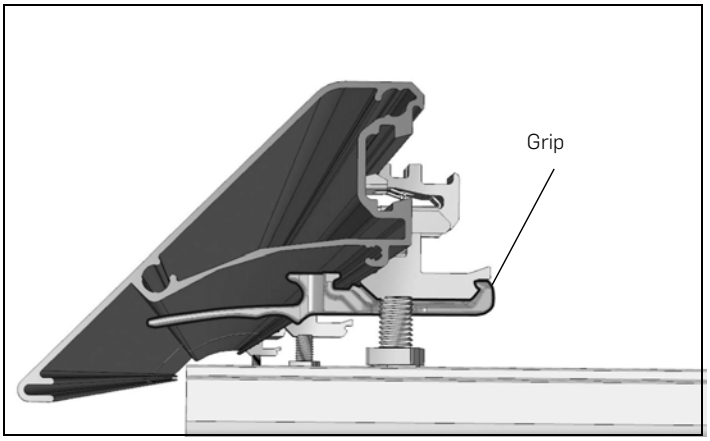
Install next Interlock.



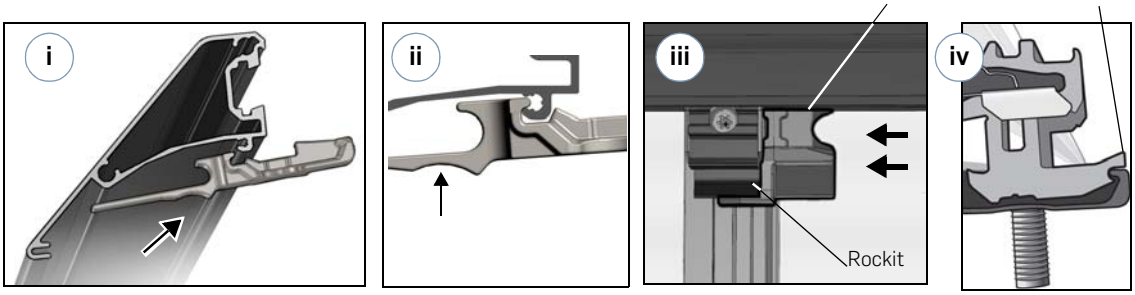
Simultaneously tighten Interlock to Position 3 (closed) while rotating next section of Array Skirt into place on the first-column Cam Feet.

Array Skirt, Continued

5d Slide Grips Onto Cam Feet



To fully secure the Array Skirt, a Grip is fitted around the Rockit of **every** first-row Cam Foot.



The Grip fits underneath the Array Skirt. Press upwards and pull towards you **(i)** to engage the Grip with the Array Skirt **(ii)**. Slide the Grip snugly around the right side* of the threaded stud **(iii)**. Make sure the Grip notch also fits into the corresponding notch in the Rockit (**iv**).

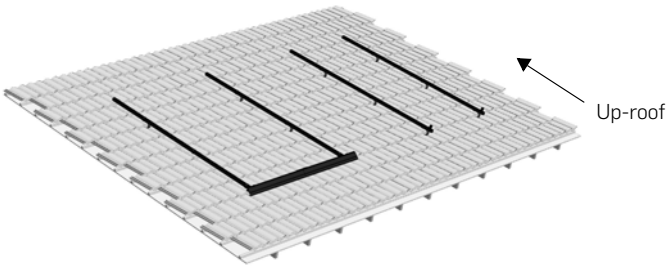
Notch must insert into Rockit base as shown.

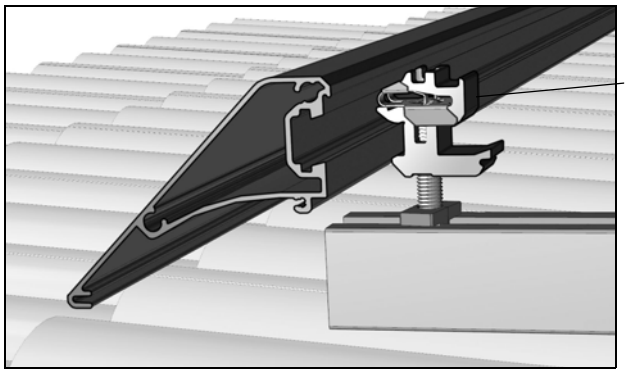
*For previous Cam Foot version, Part No. 850-1284, use the left side of the Rockit. Please see "Grip Installation" on page 46 for additional installation notes.

Array Skirt, Continued

CHECKPOINT: Array Skirt

North-South drop-in





Array Skirt Notes

The first-row Array Skirt serves multiple functions:

- As a templating tool, the Array Skirt is used to mark the outside edges of the array, verify or establish cantilevers, identify potential Interlock and Cam Foot conflicts, and ensure that the first row or column of modules is straight and level.
- As an aesthetic feature, the Array Skirt conceals module hardware for a more finished appearance.

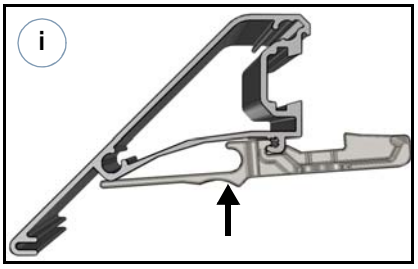
If desired, the Array Skirt can be removed after installation is complete - or, alternatively, the installer can add finishing touches including End Caps or Corner Caps. See "Array Skirt Options" on page 65 for more information.

Special Inset: Grip Installation

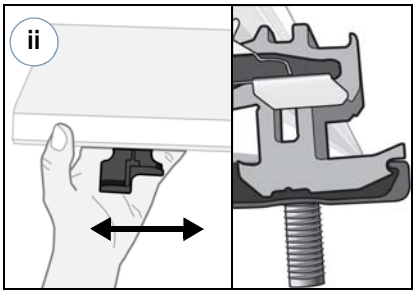
Notch clips onto Array Skirt

Indented notch fits over Cam Foot threaded stud

Top notch slides onto Rockit

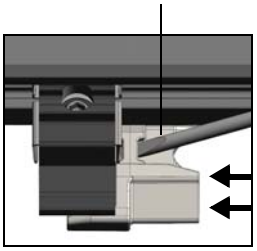


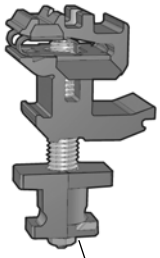
The Grip fits beneath the Array Skirt, securing the Array Skirt to the first column of Cam Feet.



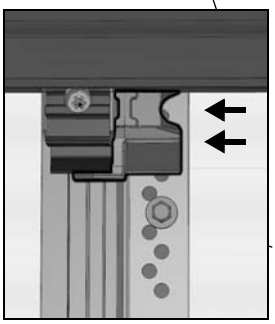
Slide the Grip into position around the Rockit and threaded stud of the Cam Foot. Be sure to hook the top notch into the corresponding notch on the Rockit as shown.

Use a screwdriver to push the Grip into position

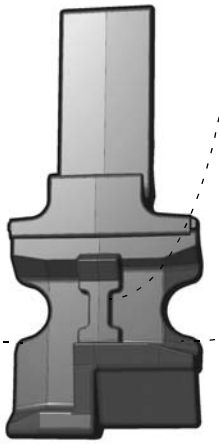




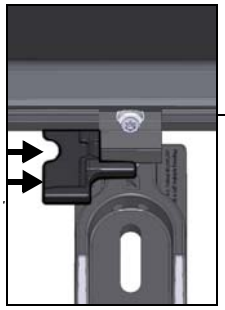
Part No. 850-1413



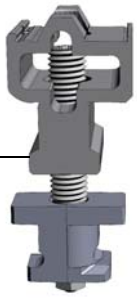
Slide in from the right



Part No. 850-1421



Slide in from the left

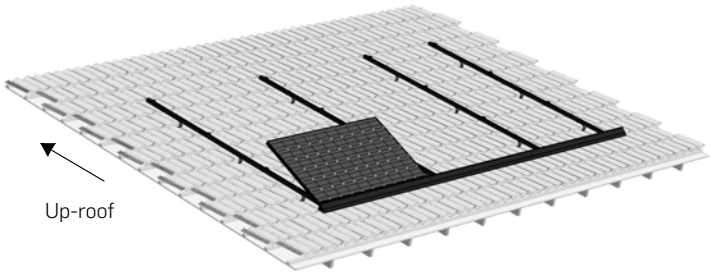


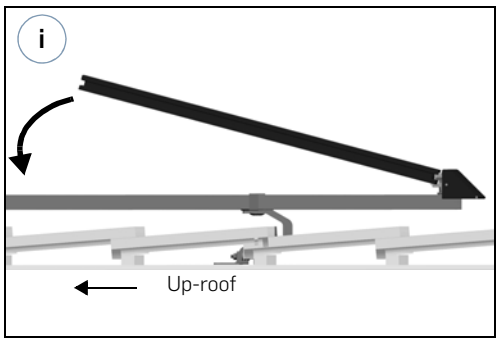
Part No. 850-1284

Step 6: Install First Row of Modules

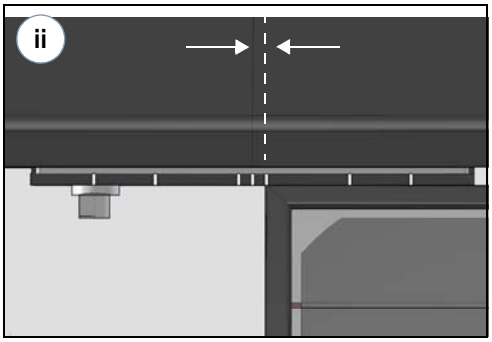
6a Drop In First Module

North-South drop-in

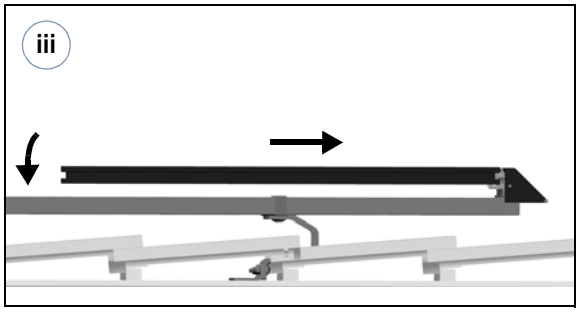




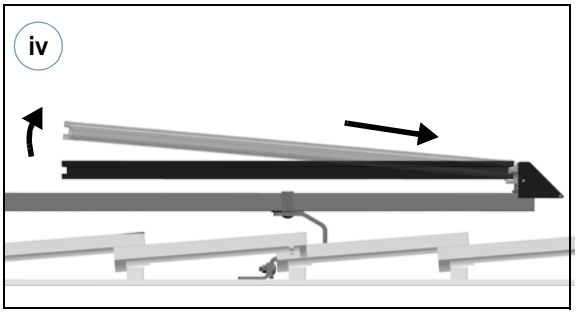
Place first module on Tongue side of Cam Feet and Interlocks at a steep angle.



Adjust module edge alignment using Interlock timing marks. (If Interlock is offset to avoid Cam Foot conflict, align module using Array Skirt.)



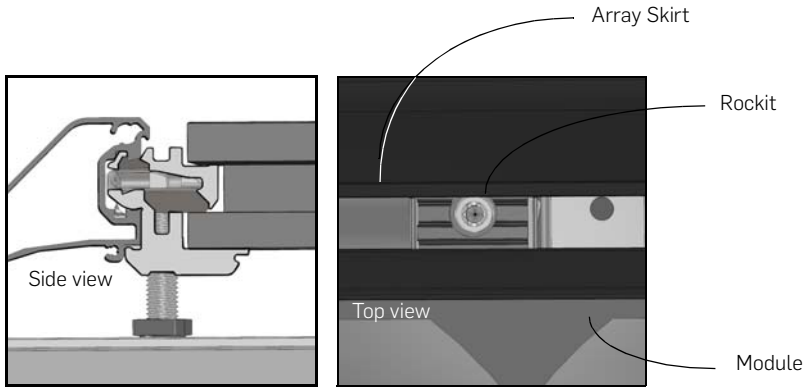
Rotate module downward almost flat, while pushing module onto tongues of Cam Feet and Interlocks. Frame engages at 15 degrees.



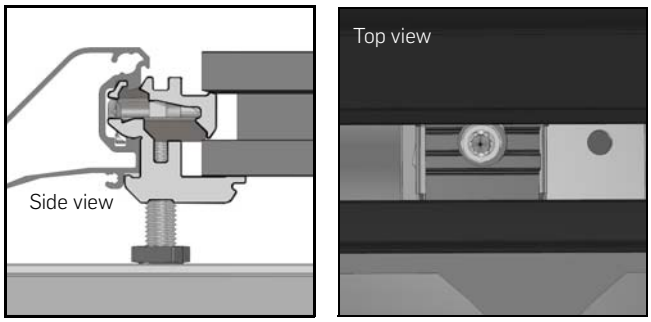
If needed, lift module up slightly, and apply force towards Cam Feet to seat the module completely.

First Module Row, Continued

6b Adjust First Module on Tongues

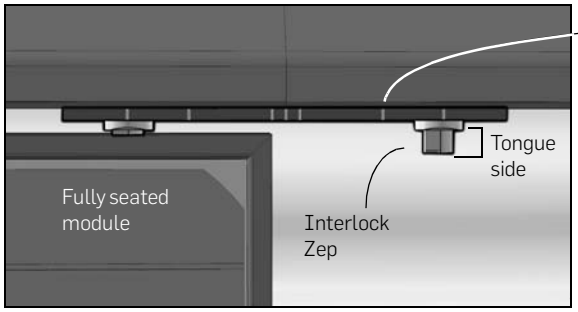


Fully Seated (Optimal)



Acceptable

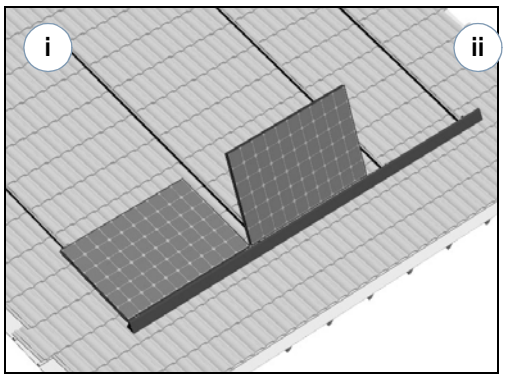
Visually check that first module is aligned and straight. Ideally, Rockit block of Cam Foot should be flush with module edge. Remove module and re-seat if needed.



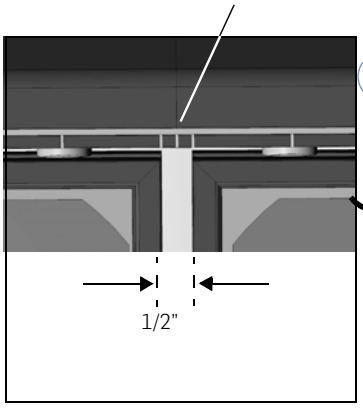
When module is fully seated, tongue side of Interlock Zep is concealed within the Zep Groove of the module frame.

First Module Row, Continued

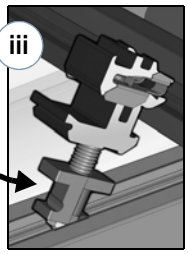
6c Drop In Remaining Modules In First Row



Place the second module on Tongue side of first-column Cam Feet and Interlocks.

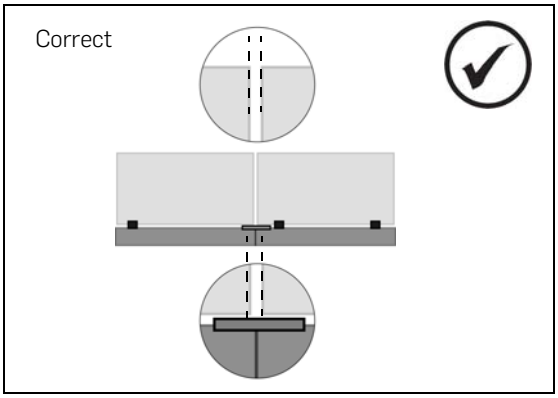


Align module with Interlock timing marks. Allow 1/2" gap between modules.

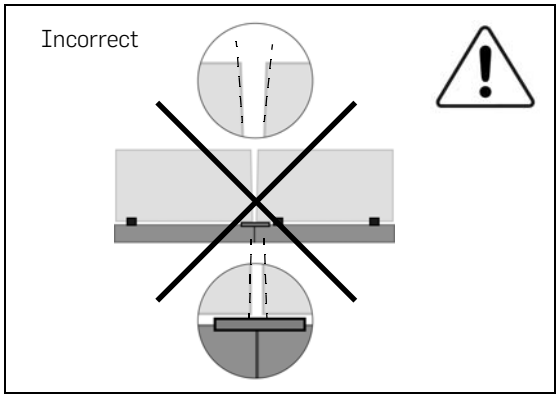


Insert Cam Feet at rear of remaining first-row modules.

6d Ensure Gaps Between Modules Are Consistent on Both Sides



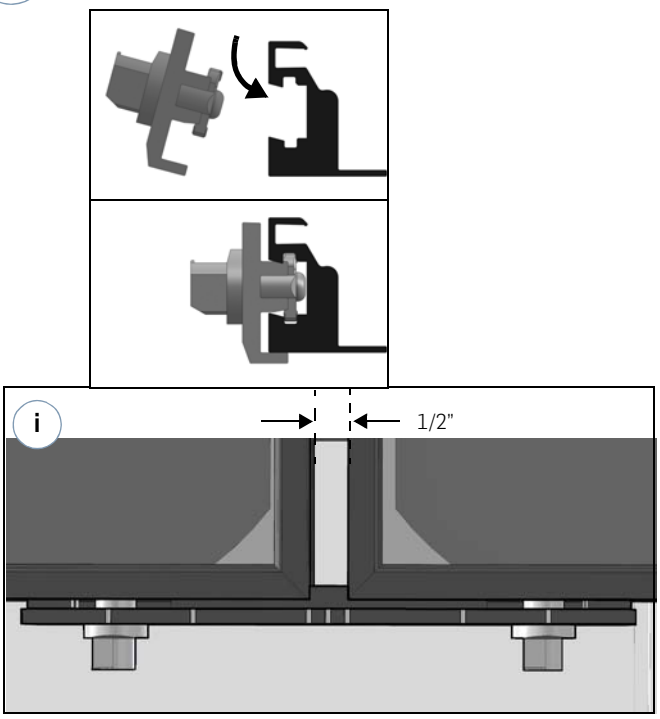
Gap between modules should be consistent at the upper and lower edge of each module.



If module gap is not even, detach Cam Foot base and and re-seat modules until row is straight.

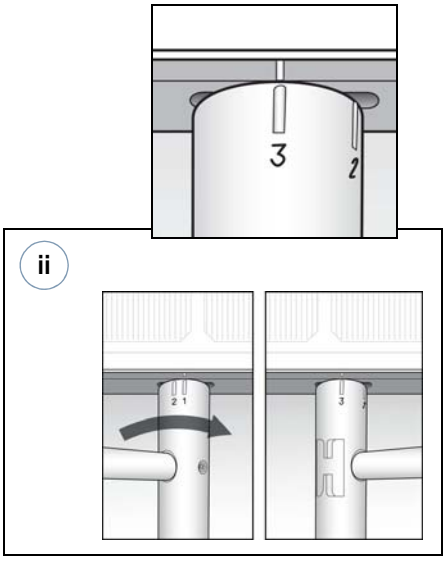
First Module Row, Continued

6e Attach Interlocks to Rear Edge of Modules



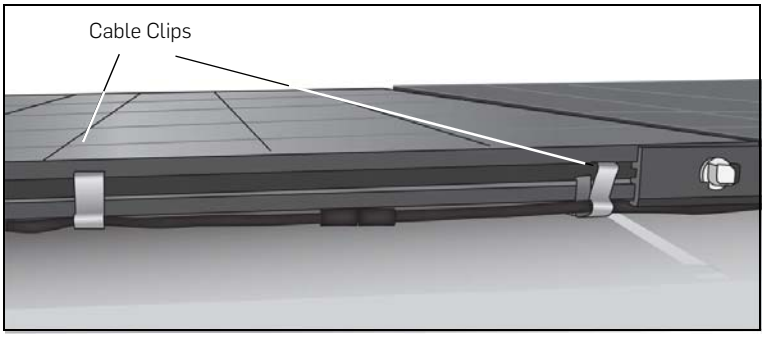
Align Interlocks with module corners using timing marks.

The Interlock can slide to one side if needed, to avoid conflicting with a nearby Cam Foot. See "Interlocks" on page 53.



Rotate the Zep Tool from Position 1 to Position 3. **Do not over-turn.** Over-turning may prevent next row of modules from seating properly.

6f Manage Wires

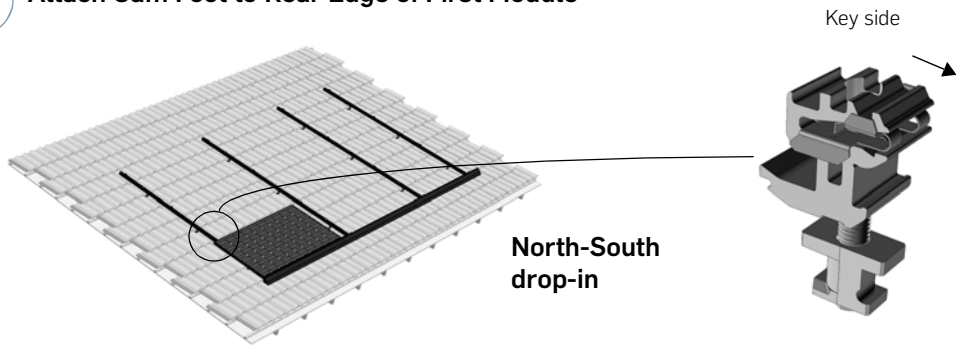


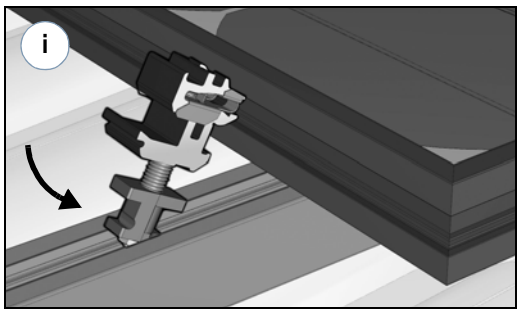
Connect DC leads and clip wires to module frame using the AC/DC Cable Clip, the DC Wire Clip, or other Zep Solar-approved solution.

See "Wire Management" on page 55.

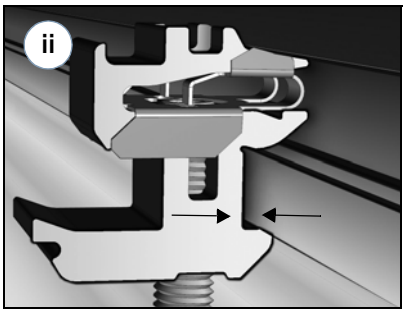
First Module Row, Continued

6g Attach Cam Foot to Rear Edge of First Module





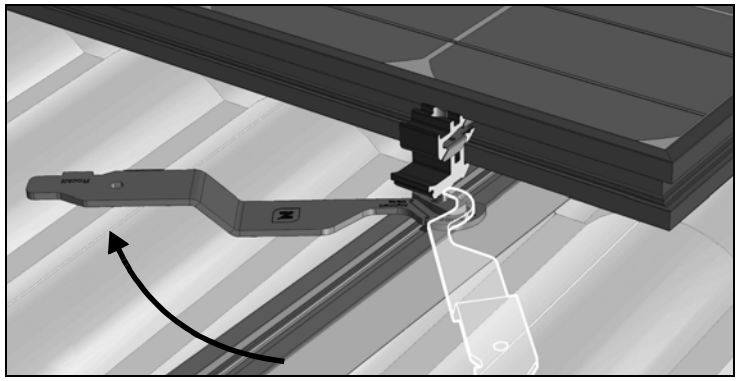
Manually insert the Key side of the Cam Foot into Zep Groove while aligning Cam Foot base with Spanner Bar channel.



Flat face of Rockit should be flush with module frame.

Do not secure the Cam Foot base in the Spanner Bar yet.

6h Secure Cam Foot Base



Tighten Cam Foot base 100 degrees using Flat Tool.

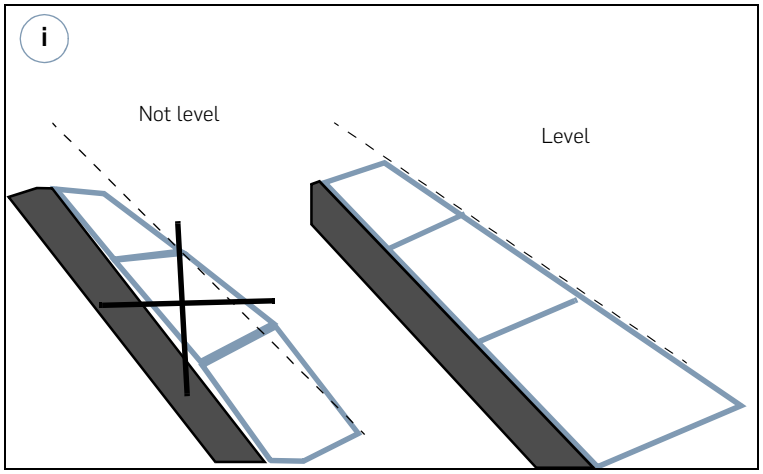
Open position

Closed position

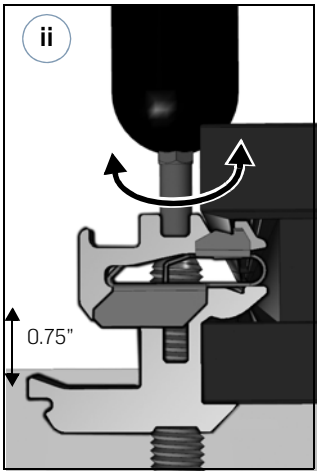
Note positioning of correctly tightened Cam Foot base.

First Module Row, Continued

6i Adjust Cam Foot Height



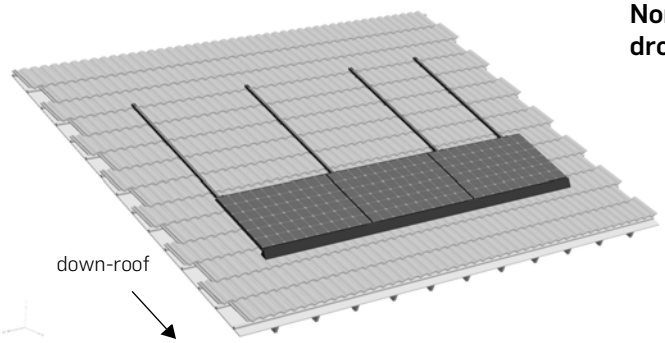
Ensure that all modules in first column are level. This will aid in keeping the rest of the array true.

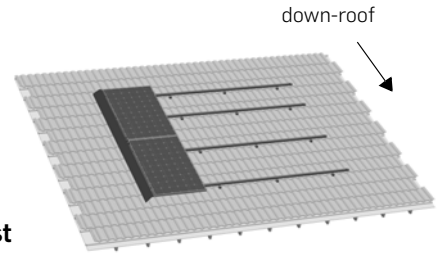


Use the Zep Tool with #30 torx bit to raise or lower the Cam Feet as needed.

CHECKPOINT: First Module Row

North-South drop-in





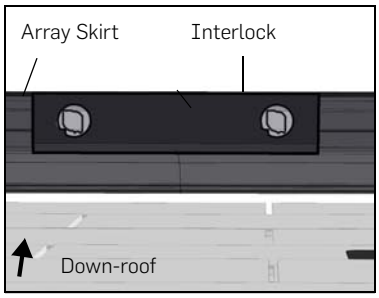
East-West drop-in

If an Array Skirt is not desired on the finished array, the installer may choose to remove it at this point. See “Array Skirt Options” on page 65 for more information.

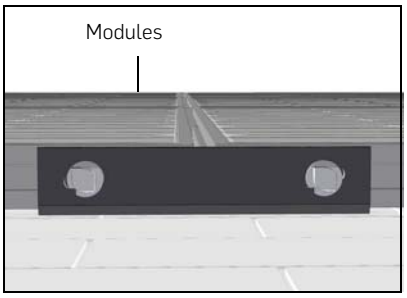
Special Inset: Interlocks

How Interlocks Are Used

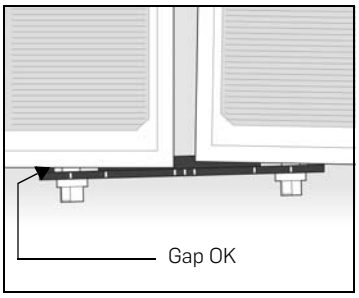
The Interlock creates a simultaneous structural and electrical bond on both Key and Tongue sides.



Connect Array Skirt

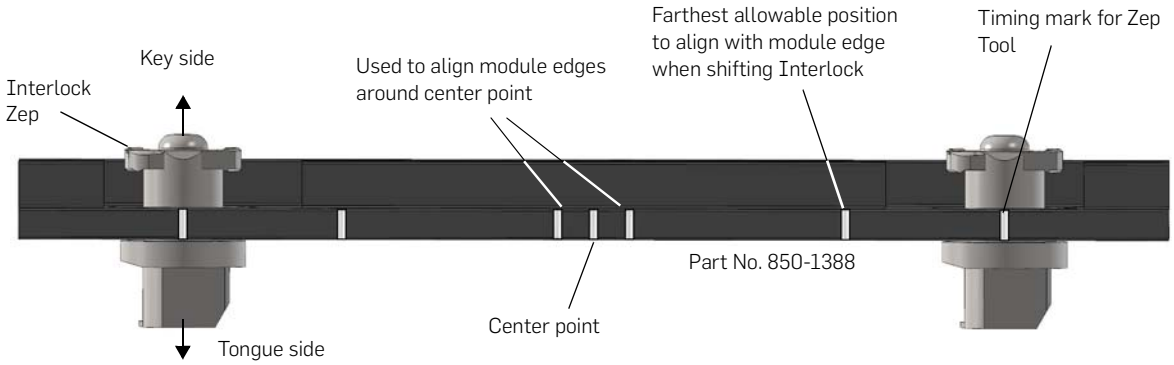


Connect PV modules

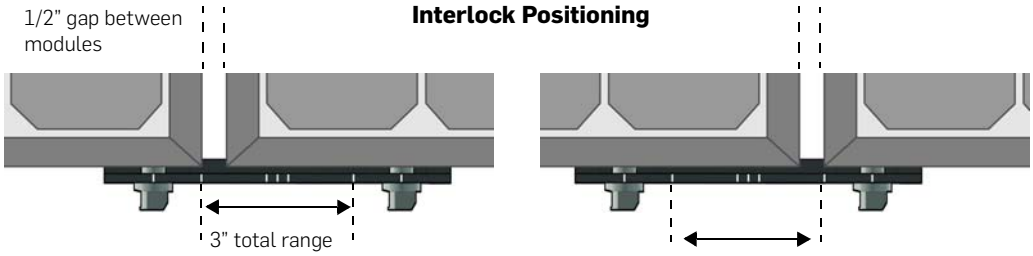


Built-in tolerance for module size variations and adjustability

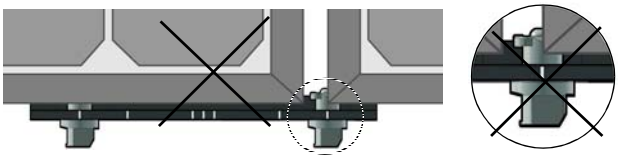
Interlock Timing and Alignment Marks



Interlock Positioning

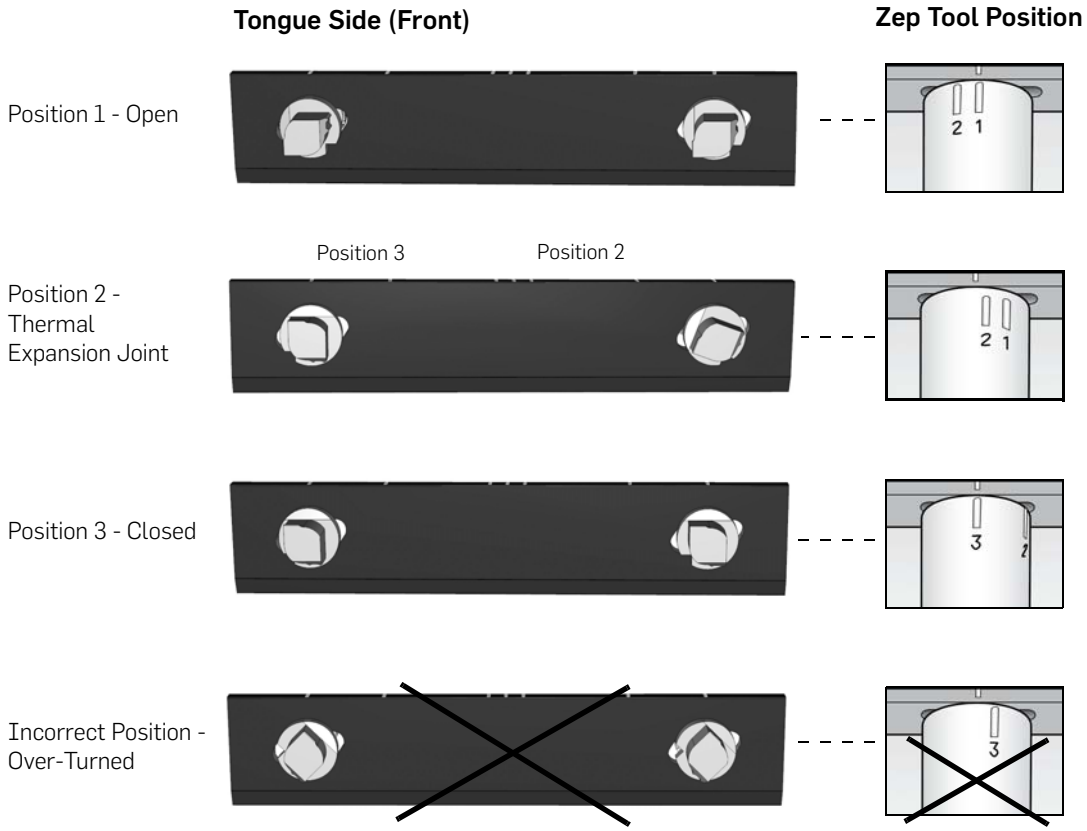


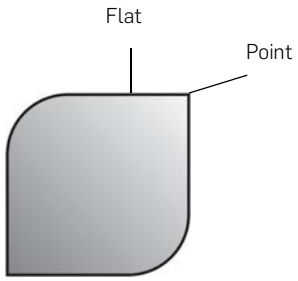
Note: If the Key side of an Interlock Zep is visible, the Interlock is positioned too far to one side.



Interlocks, Continued

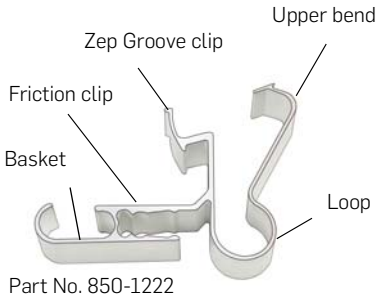
Closed and Open Positions





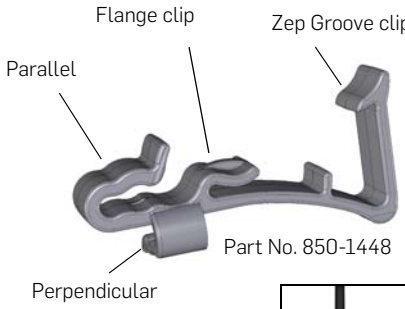
NOTE: An over-turned Interlock Zep will interfere with the drop-in of the next row of modules. Flats should be facing up, not the points.

Special Inset: Wire Management

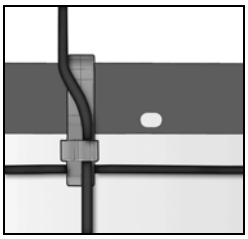


Part No. 850-1222

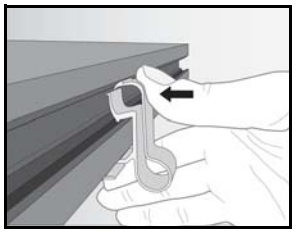
The **AC/DC Cable Clip** fits both DC and AC cable sizes.



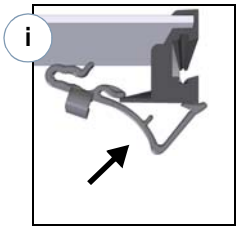
The **DC Wire Clip** fits wire diameters 5.2mm-7.6mm and attaches wires in two directions.

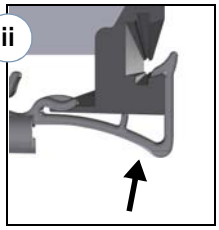


Attach to Zep Groove



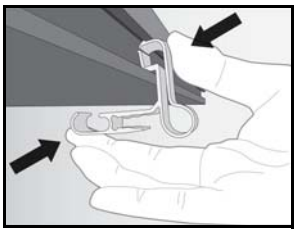
AC/DC Cable Clip



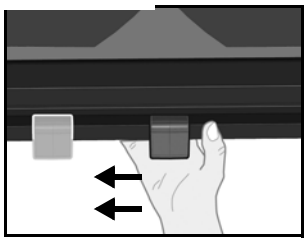


DC Wire Clip

Adjust Wire Tension

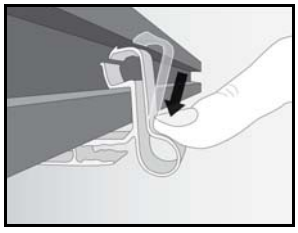


AC/DC Cable Clip



DC Wire Clip

Release

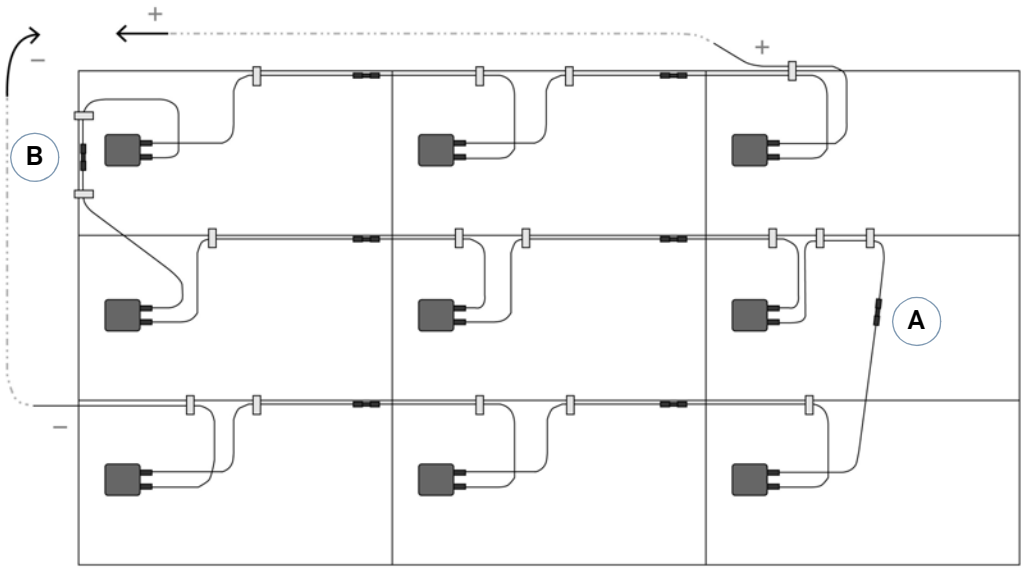


AC/DC Cable Clip

DC Wire Clip

Wire Management, Continued

Example: Array Wiring Using 2 Clips Per Module



Down-roof

North-South drop-in

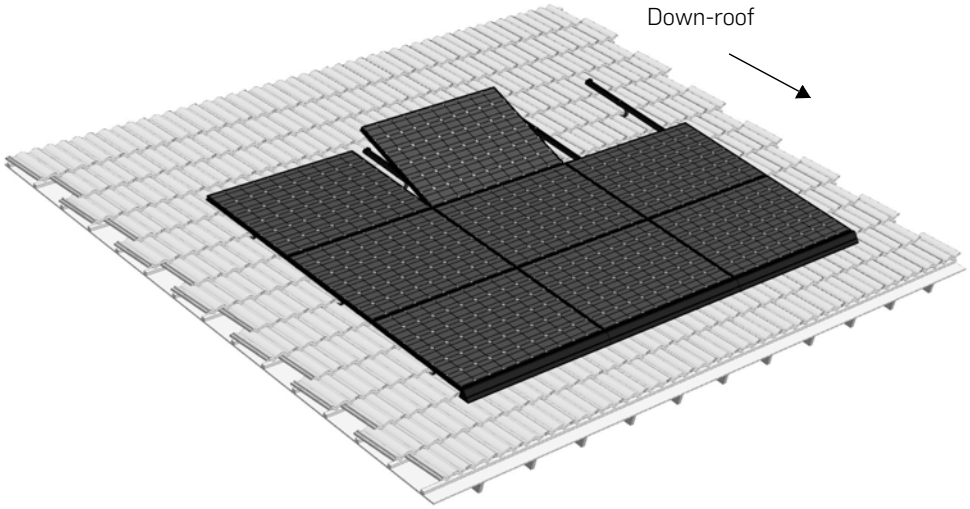
Wires are shown stylized to make the diagram more readable. In practice, wires should not have slack between clipping points.

NOTE: Two variants for row-to-row wire management are shown. Method A is to clip wires to the far edge of the module as shown on lower right, rather than clipping along the top side as shown in Method B.

NOTE: Please contact Zep Solar Support for more information on wire management solutions and approaches.

Step 7: Complete the Array

7a Install Remaining Modules



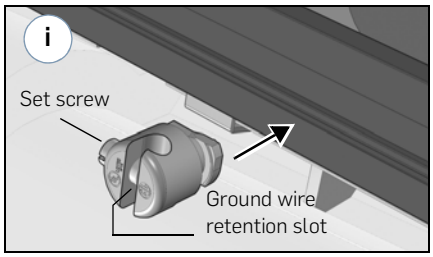
Install remaining modules, row by row. True and level the array as you go. Attach Interlocks and Cam Feet as before. Clip and secure wires for each row before moving on to the next row.

Note: For large arrays, the installer must address thermal expansion. "Thermal Expansion" on page 27 describes when Thermal Expansion Joints are needed, and "Interlocks" on page 53 contains installation details.

Note: Additional aesthetic options are available for a more finished appearance of the array. "Array Skirt Options" on page 65 describes the various configurations that are available, and "Installing Side Skirt and Corner Caps" on page 59 contains installation details.

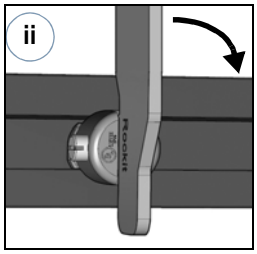
Step 8: Ground the Array

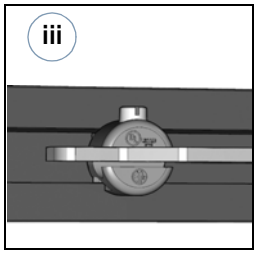
7a Insert a Ground Zep Into Module



Insert a Ground Zep in the Zep Groove of any module around the array perimeter.

Start with the set screw at 9 o'clock position (pointing left).

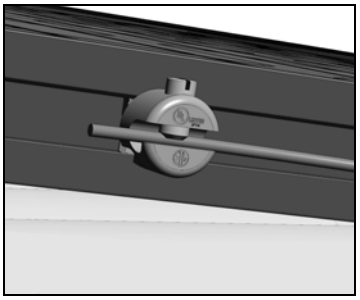




Using either the Zep Tool or the Flat Tool (shown), lock the Ground Zep into place by turning 1/4 turn clockwise. After the Ground Zep is turned 90 degrees, the set screw should be pointing straight up.

This locks the Ground Zep into the Zep Groove and creates a solid ground bond with the module frame.

7b Connect Ground Zep to Building Ground

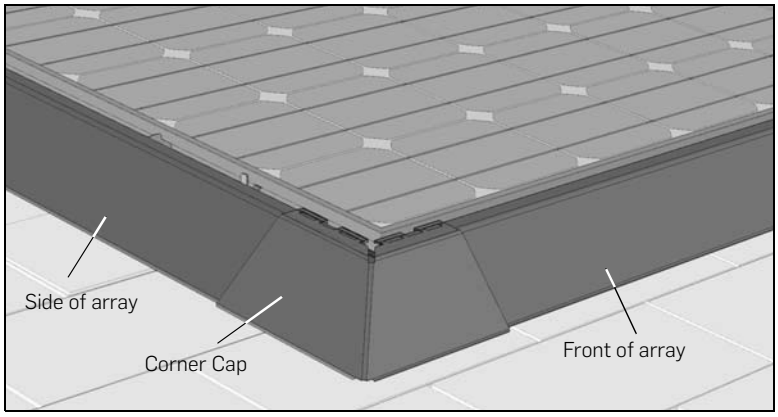


Insert solid copper ground wire into the ground wire retention slot and turn the set screw wtih a flat-bladed screwdriver until the ground wire is captured by the set screw. Torque the set screw as follows:

- 14-10 AWG: 40 inch-lbs.
- 8 AWG: 45 inch-lbs.
- 6 AWG: 50 inch-lbs.

NOTE: If the array contains an unbroken row of non-bonding Hybrid Interlocks or Thermal Expansion Joints, an additional Ground Zep is required, one on either side of the break. See "Grounding/Earthing" on page 25 and "Thermal Expansion" on page 27 for more information.

Special Inset: Installing Side Skirt and Corner Caps



Installers have the option of attaching the Array Skirt and Corner Caps to the sides of a completed array for an enhanced visual appearance.

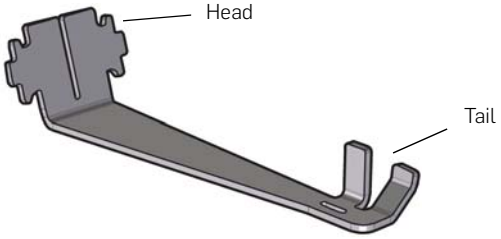
See "Array Skirt Options" on page 65 for information on various configurations achievable with ZS Span.

Notes:

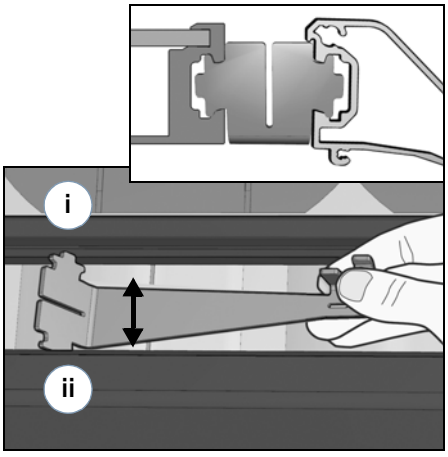
Use two T-Locks per Array Skirt section.

If using a Universal Box Bracket or other PV electronic device that attaches directly to a module's Zep Groove, omit one section of perimeter Array Skirt or cut Array Skirt as needed.

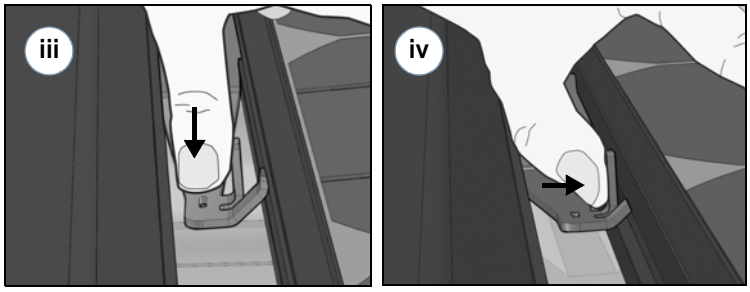
T-Lock



Installing the Side Skirt Using the T-Lock



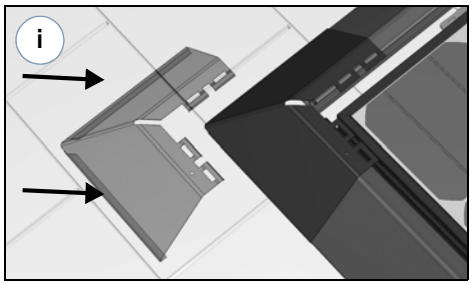
Engage one side of the T-Lock head with the Zep Groove (**i**). Then snap the Array Skirt onto the T-Lock from the other side (**ii**).



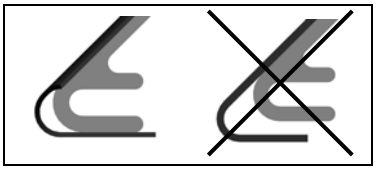
Press down (**iii**) and then inwards (**iv**) on the tail of the T-Lock to fully secure the Array Skirt.

Installing Side Skirt and Corner Caps, continued

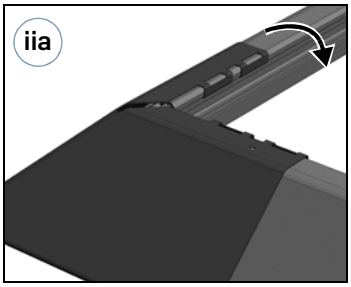
Installing the Outside Corner Cap



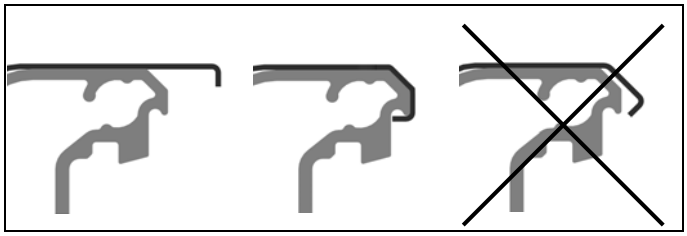
Place the Corner Cap so that the bottom fits snugly against the bottom of both Array Skirt corner sections.



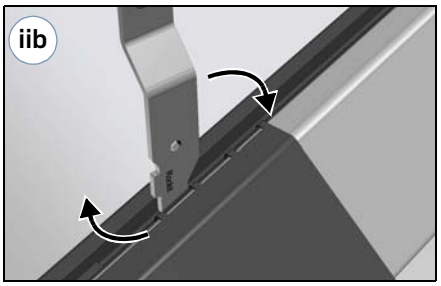
No gap at bottom



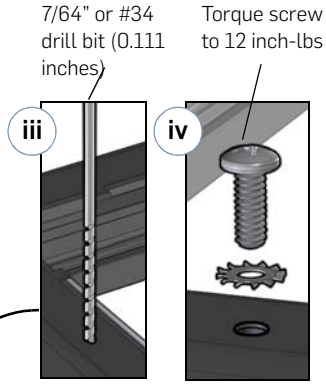
Fold the Corner Cap tabs down to wrap over the top of the Array Skirt.



Tabs should bend tightly around the top of the Array Skirt. Use the Flat Tool to bend the tabs if needed.



Hold Corner Cap against bottom edge of Array Skirt, and use Flat Tool to crimp the tab completely flush.



6-32 x3/8" thread-cutting screw, 18-8 SS

#6 external-tooth lock washer, 18-8 SS

Drill through the pre-drilled hole into the Array Skirt. To ensure proper electrical bonding, secure using thread-cutting screw and tooth washer provided.

Drill hole must be perpendicular to Array Skirt

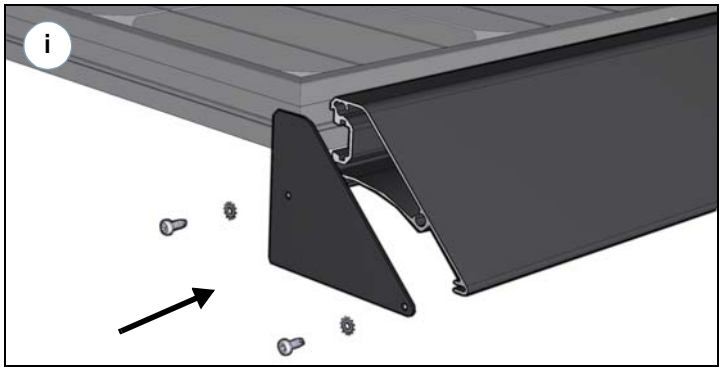
Note: The same fastener specifications apply to the Inside Corner Cap, Outside Corner Cap, and End Cap.

Installing Side Skirt and Corner Caps, continued

Installing the Inside Corner Cap

The Inside Corner Cap installation is similar to that for the Outside Corner Cap.

Installing Array Skirt End Caps



End Caps are used with bottom-only Array Skirt for a more finished appearance. See "Bottom Skirt Option" on page 67 for more information.

Special Inset: Universal Box Brackets and Other Accessories

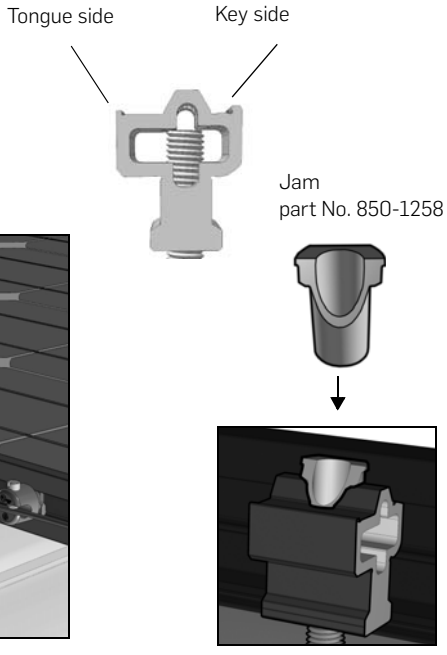
Zep Solar, Inc. offers accessories for installing third-party products:

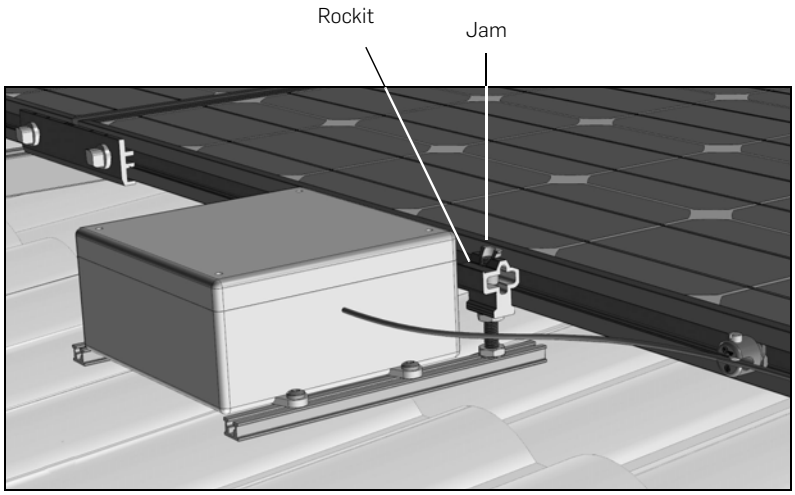
- The **Groove Adapter Bracket** works with selected third-party microinverters to provide a earth bond path as well as a mechanical connection to the PV module frame.
- The **Universal Box Bracket** is for PV electronic devices such as rooftop isolators or combiner boxes that are typically bottom mounted and attached on the perimeter of the array.

Each of the above components includes installation details on the Component Level Instruction sheets that are shipped with the component. For some third-party Zep Compatible items, additional manual supplements are available. Contact Zep Solar Support for more information.

Groove Adapter Bracket (example)

Note: Some accessories such as the Universal Box Bracket use the version of the Rockit shown below. When accessory is attached to the Zep Groove of a module frame on the perimeter of an array, a Jam is required to secure it in place.





Universal Box Bracket (example)

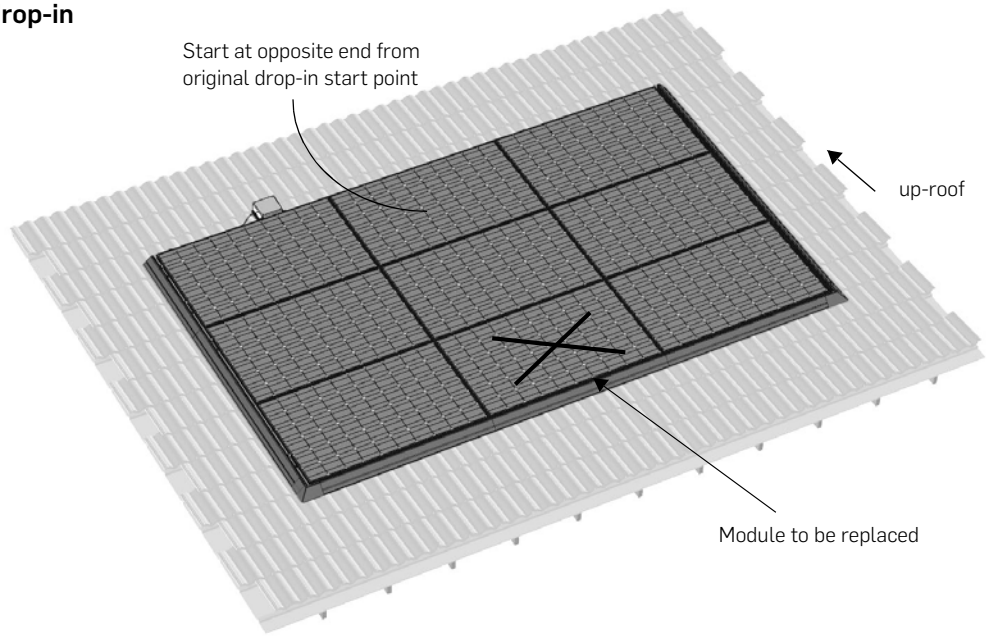
6 Installation Supplement

6.1 Servicing an Array

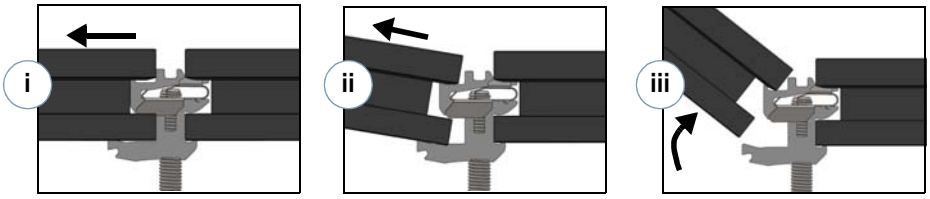
To access a module within the field of an array, follow the procedure below.

1. **Start at the opposide end of the row with the module to be removed.**

North-South drop-in

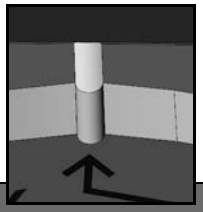


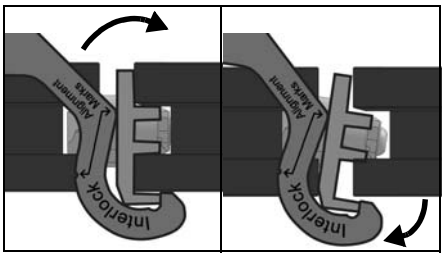
2. **Disconnect wires from first module to be removed.**
3. **Remove the first Interlocks.**
   Remove the two Interlocks on either side of the module column to be removed using the Zep Tool, turning the Interlock Zeps from Position 3 to Position 1.
4. **Detach Cam Foot base and remove Cam Foot from module frame.**
5. **Remove the first module.**

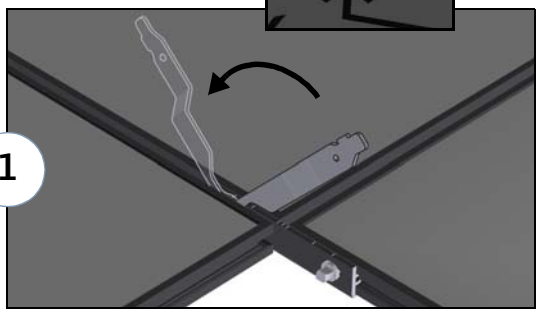


6. Remove mid-array Interlocks from next row of modules, using Flat Tool.

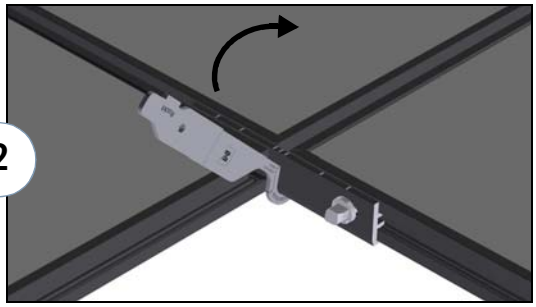
Line up alignment mark on Flat Tool with mark on Interlock.



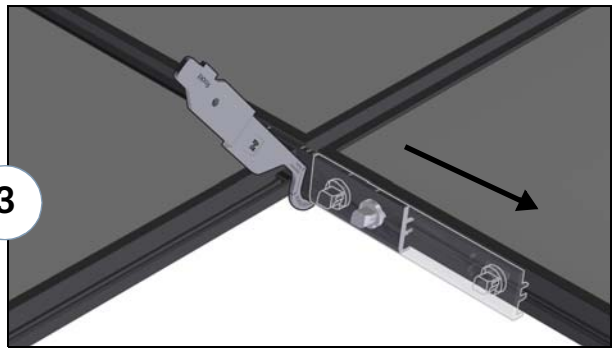




Rotate Flat Tool from Position 3 to Position 1 to open both Interlock Zeps. Note that Flat Tool is reversed.



Use the Flat Tool to rotate the Interlock out of the Zep Groove.



Slide the Interlock out from between modules. Tap gently with the Flat Tool if needed. For easier Interlock removal, hold modules up to keep them from sagging.

For a Hybrid Interlock, remove the exposed Rockit using #30 Torx Bit. Leave the rest of the Hybrid Interlock in place.

7. **Remove remaining mid-array modules.**
8. **Replace module needing service.**
9. **Re-connect wires.**
10. **Replace and secure mid-array Interlocks using Flat Tool.**
11. **Replace remaining modules in column.**

NOTE: It is important to maintain a complete bonding path to earth at all times while servicing modules. When removing an entire module column or row, or otherwise isolating modules, use additional Ground Zeps and jumpers during maintenance work.

6.2 Array Skirt Options

The Array Skirt is an optional accessory. Its purpose is to aesthetically finish the array, conceal wires and hardware, and also to serve as an installation jig for the first column of modules.

6.2.1 Array Skirt Attachment Methods

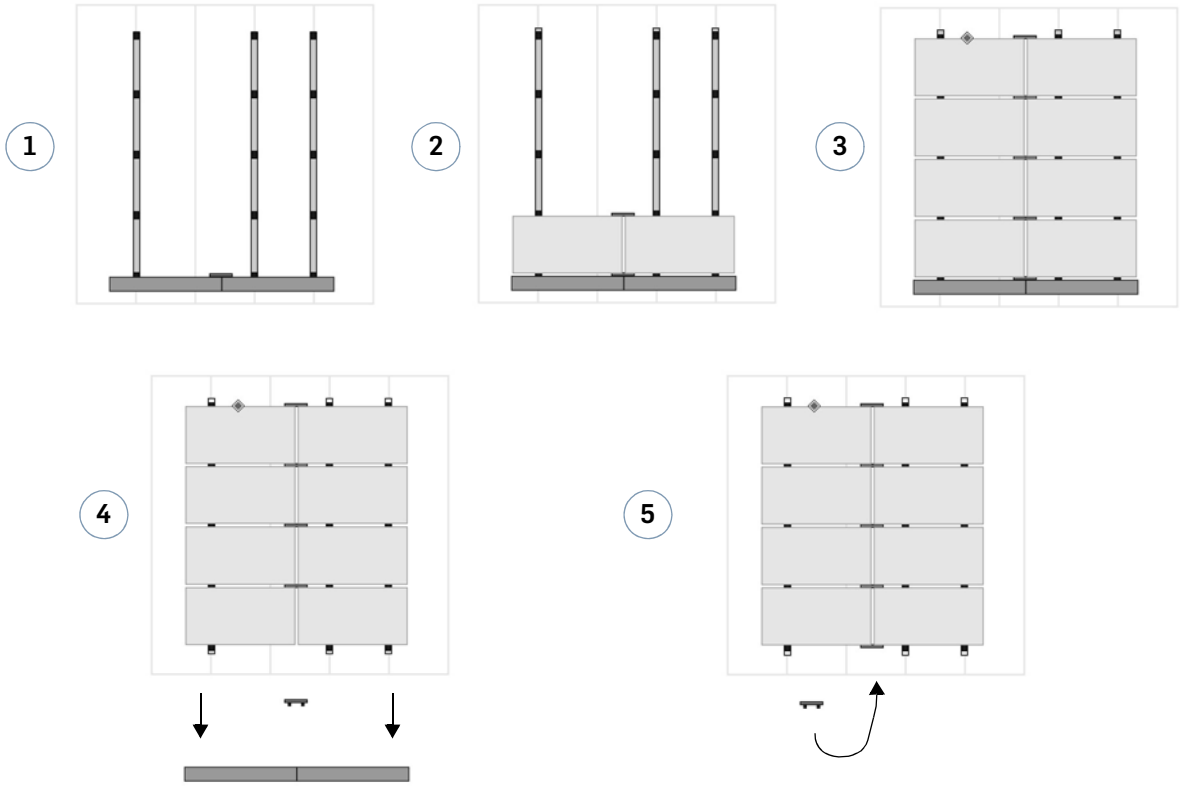
If the Array Skirt is used as a jig during initial installation, it is attached to the Key side of the first column of Cam Feet, and is further secured to the Cam Feet using Grips. The resulting gap is around 1/2" .

NOTE: A previous version of the Array Skirt required an additional component called a Spacer when used with the Interlock - but only when used as an installation jig and then left as a permanent part of the array.

If a more finished appearance is desired, the installer can install the Array Skirt around the array perimeter using 2 T-Locks per Array Skirt section. When attaching Array Skirt using a T-Lock, a slightly larger visual gap between the module frame and Array Skirt is produced, approximately 1.25" .

6.2.2 Using Array Skirt as Jig During Installation

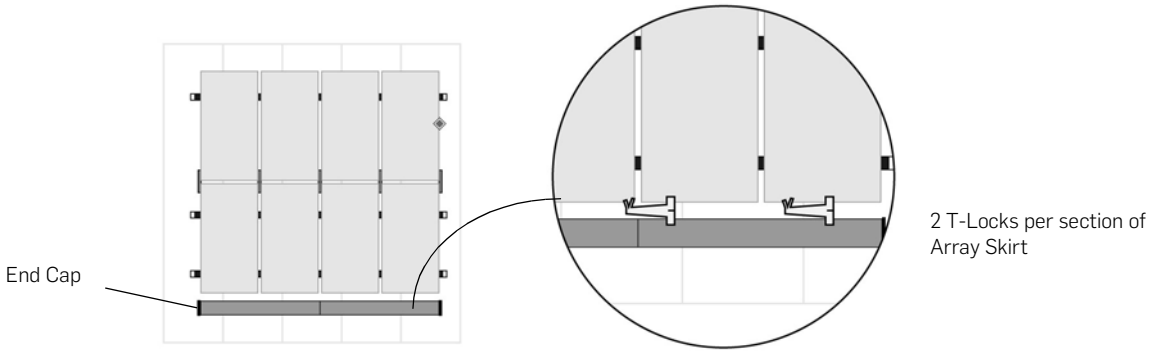
After the first column of modules is fully secured, leveled, and aligned, the installer may choose to remove the Array Skirt subsequent to completing the installation.



6.2.3 Bottom Skirt Option

If desired, the Array Skirt can be attached at the bottom of the completed array using T-Locks, and attach End Caps on either end of the Array Skirt to conceal the extrusion profile.

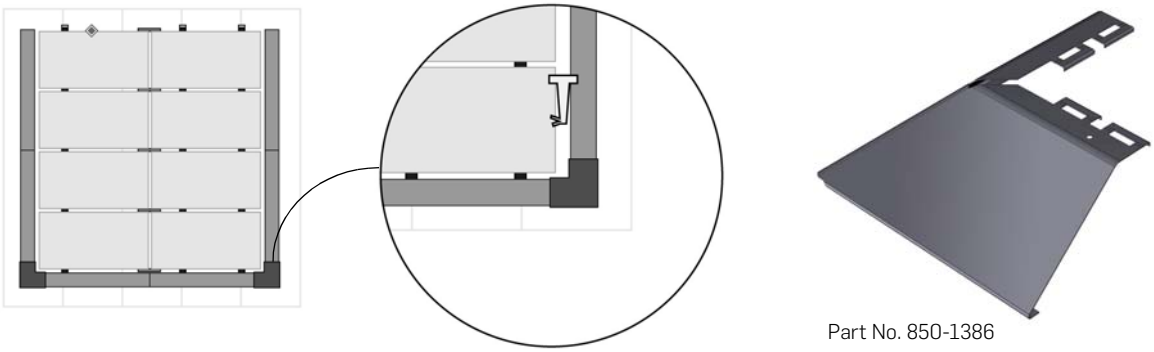
Bottom Skirt Option



6.2.4 Side Skirt and Corner Cap Options

If the Array Skirt is attached all around the array perimeter on front, sides, and back, Corner Caps can provide additional finishing touch. **Outside Corner Caps** connect the Array Skirt at the outside corners of a array. **Inside Corner Caps** connect Array Skirt sections at the inside corners in arrays containing stair-stepped or omitted modules. See "Installing Side Skirt and Corner Caps" on page 59 for installation details.

Outside Corner Cap



Part No. 850-1386

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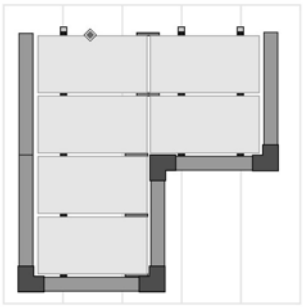
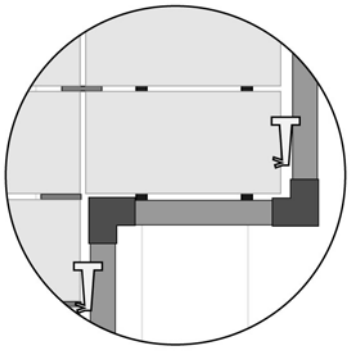
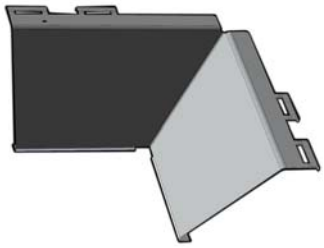
Inside Corner Cap







Part No. 850-1425

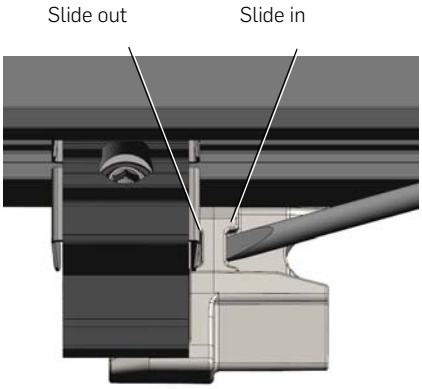
6.2.5 Pest and Debris Control

In regions where nesting animals and birds are a concern, additional mesh can be attached either to the Array Skirt or directly to the Zep Groove of the module frames. Mesh can also be used as a screen to prevent rooftop debris from collecting underneath the array. Contact Zep Solar Support for more information.

6.3 Removing the First-Row Array Skirt

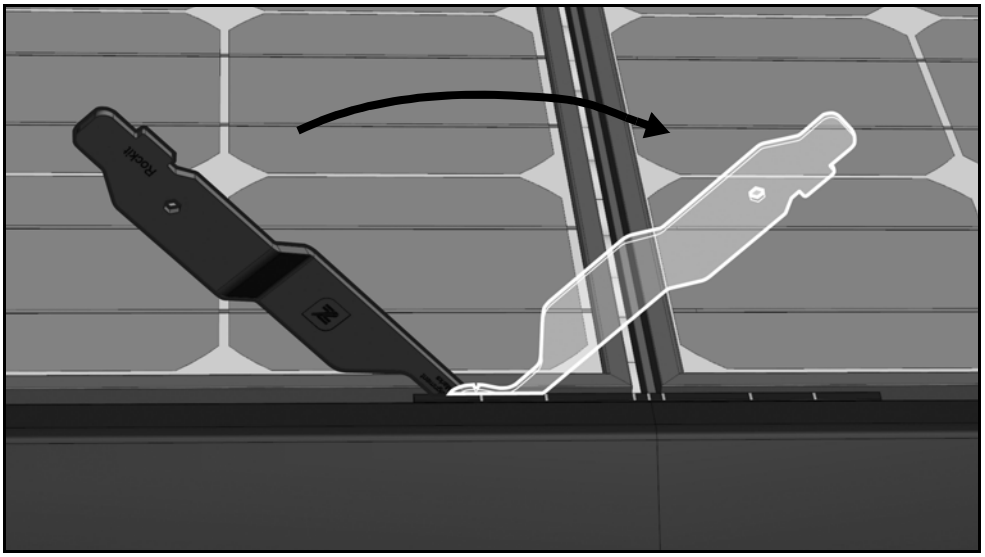
Follow these steps to remove the Array Skirt subsequent to module installation.

1. **Slide Grips off the first-row Cam Feet using a flat screwdriver.**

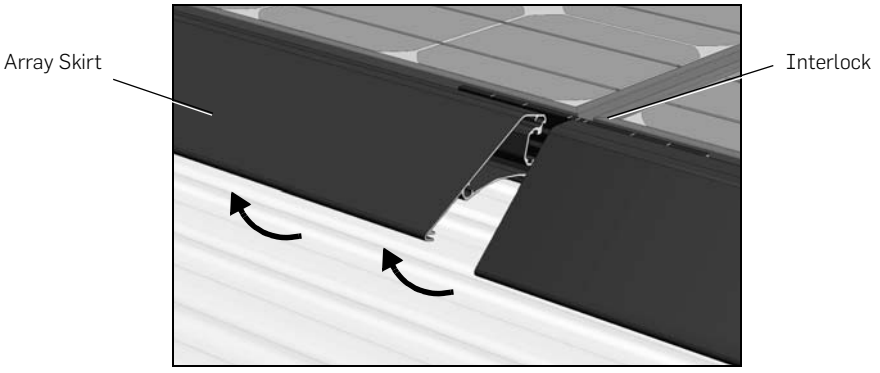


Apply screwdriver to one side of position notch for leverage.

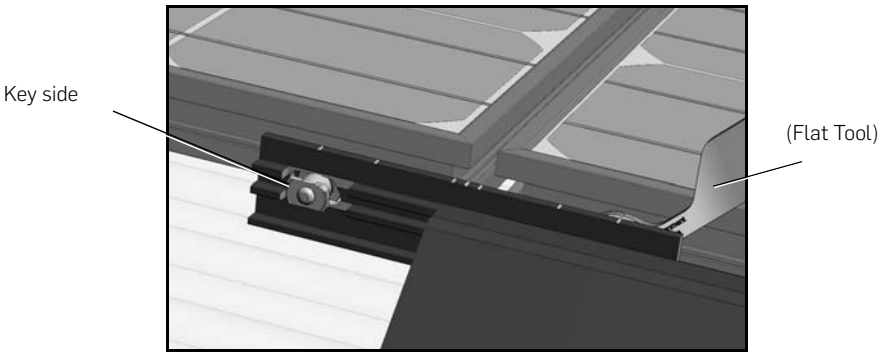
2. **Use the Flat Tool to open Interlock Zeps on Array Skirt from Position 3 to Position 1.**



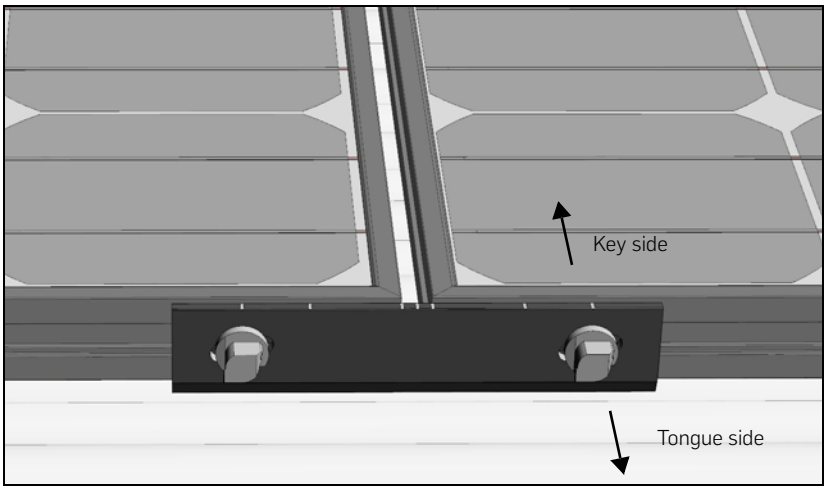
3. **Remove Array Skirt sections by rotating them up and off the first-column Cam Feet.**



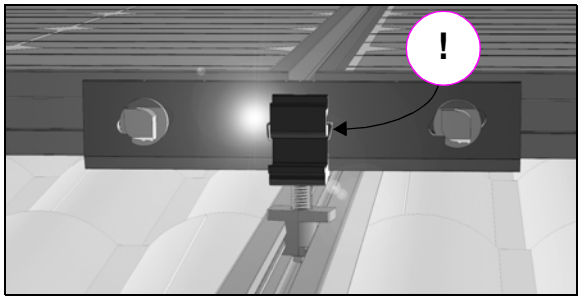
4. **The Interlocks are revealed with the Key side showing.**



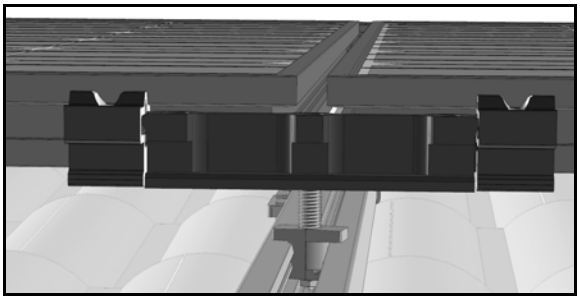
5. **After all sections of Array Skirt are removed, the Interlocks will be loose for removal. (Hybrid Interlocks can remain, and do not need to be removed.)**
6. **Re-install and secure the Interlock with the Key side facing inwards.**



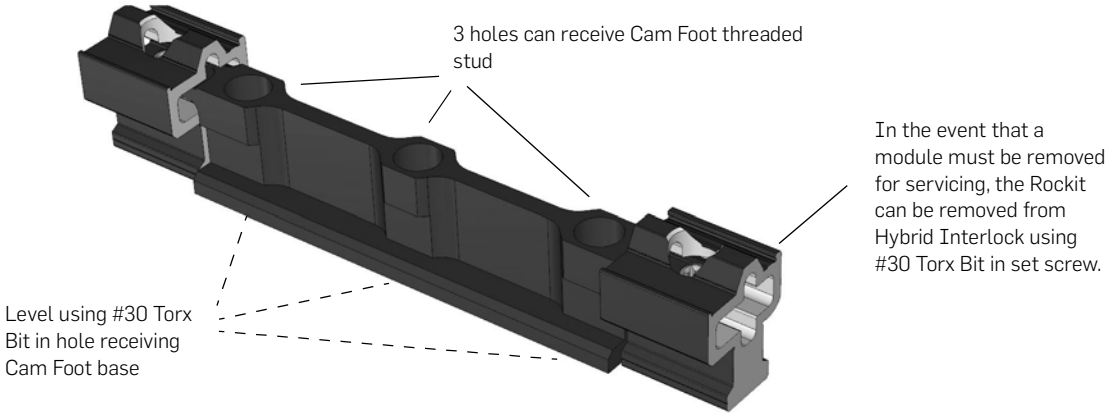
6.4 Hybrid Interlocks



A Cam Foot-Interlock conflict occurs when the location of a Cam Foot coincides with the location of an Interlock.



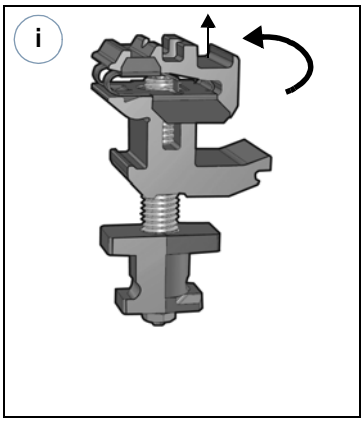
The Hybrid Interlock has a dual function: attachment to the Comp Mount and structural connection between modules.



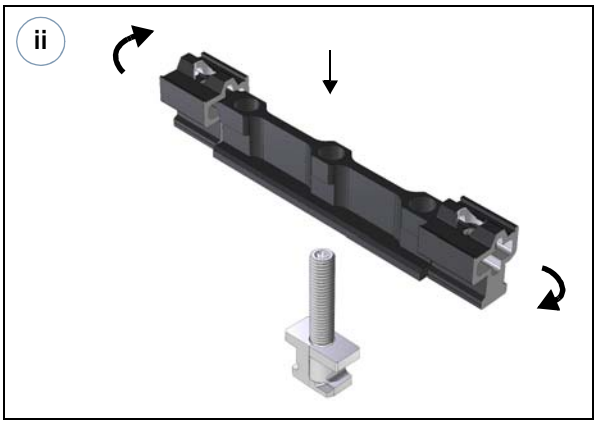
NOTE: The non-bonding Hybrid Interlock does not create a bonding path across modules. An array containing an unbroken row or column of Hybrid Interlocks requires a Ground Zep on both sides of the break. (A bonding version of the Hybrid Interlock is available in selected regions, and the bonding Hybrid Interlock does create a bonding path across modules.)

Hybrid Interlocks, Continued

Connecting the Hybrid Interlock to the Cam Foot Base

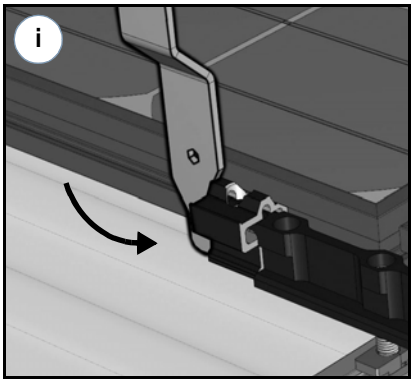


Spin the Rockit to remove it from the threaded stud and the Cam Foot base.

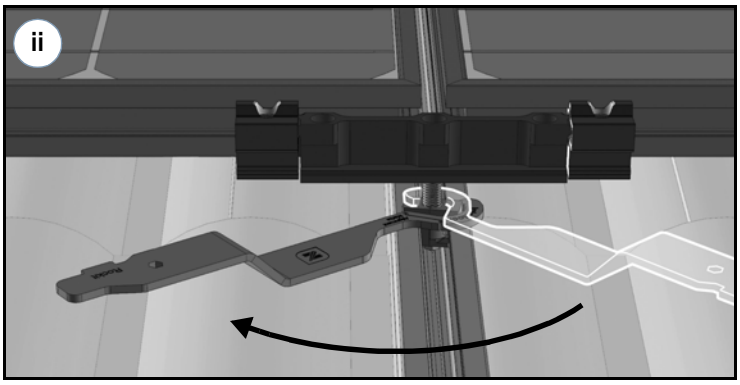


Insert the Cam Foot stud into one of the holes on the Hybrid Interlock, and spin the Hybrid Interlock to attach it.

Installing the Hybrid Interlock



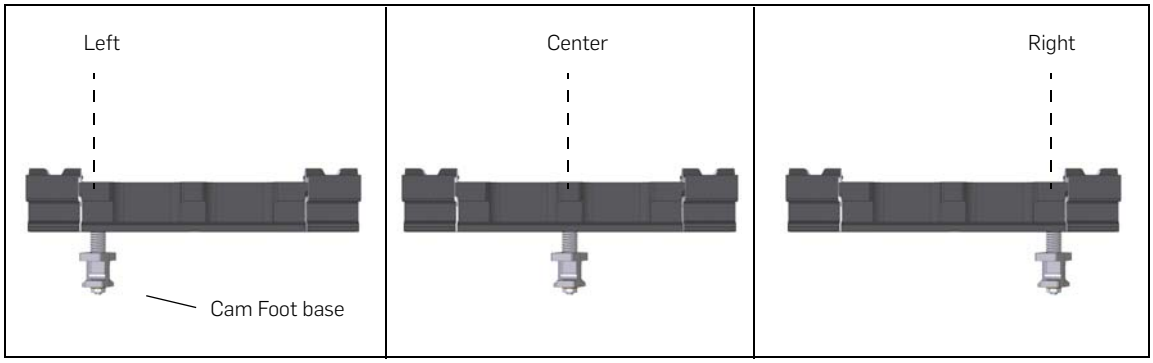
Using the Zep Tool or Flat Tool to provide leverage as needed, attach the Hybrid Interlock to the PV module frame or Array Skirt.



Secure Cam Foot base to Big Foot using Flat Tool, turning 100 degrees. Keep the center of each Rockit minimum 2 inches from module corner.

Hybrid Interlocks, Continued

Centering the Hybrid Interlock



When threading the Cam Foot base for a Hybrid Interlock, choose the hole that best centers the Hybrid Interlock between Array Skirt sections or modules. For Interlocks connect PV modules within the field of the array, only the center hole may be used.

6.5 Backwards Compatibility

Zep Solar, Inc. is constantly working to improve and innovate its system designs. Many of the components shown in this manual are versions scheduled for 2013 release. In most cases, previous and current generations are fully compatible with one another. However, the installer should be aware of specific part versions in order to ensure compatibility in the field. This section contains important information regarding inter-operability among components.

Special Inset: Component Versioning

This section shows which part designs have been recently updated.

Cam Foot

Part No. 850-1242

Part No. 850-1413

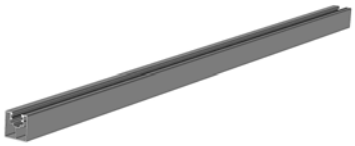
Interlock

Part No. 850-1178

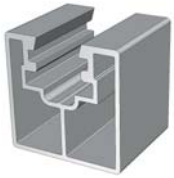
Part No. 850-1388

Spanner Bar Assembly

Part No. 850-1192
(Splice is included)



Three Spanner Bar lengths:
1x - Part No. 850-1398
3x - Part No. 850-1399
4x - Part No. 850-1400



Part No. 850-1143
(Bar Sleeve)

Part No. 850-1401
(Splice Kit now separate)

Component Versioning, Continued

Array Skirt

Frofile No. 500-0104 *

Profile No. 500-0113 *

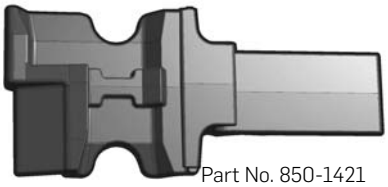
End Caps

Part No. 850-1215

Part No. 850-1405

Grip

Part No. 850-1258



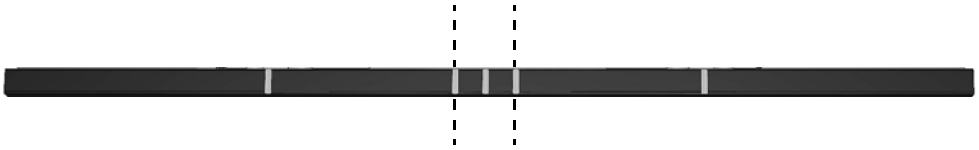
Part No. 850-1421

* Please contact Zep Solar Support for a complete list of associated SKUS for each Array Skirt profile.

Special Inset: Interlock Versions and Alignment Marks

Previous Version

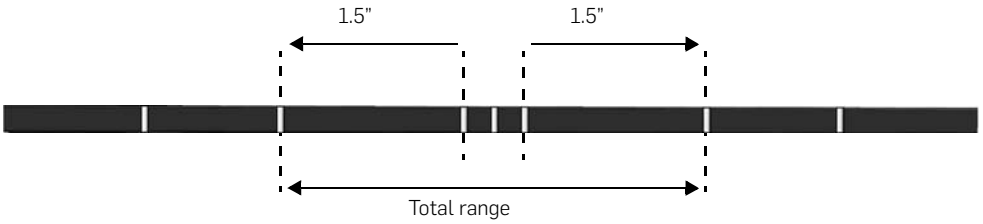
Part No. 850-1178



The Interlock with 5 timing marks must be centered with 1/2" gap between the PV modules using the three center marks.

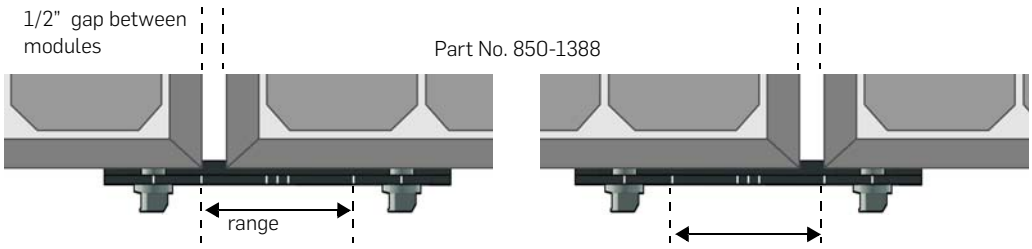
Current Version

Part No. 850-1388



The Interlock with 7 timing marks can be 1.5" off-center between the PV modules, up to marks as shown. Maintain the same 1/2" gap between modules.

Current Version



Special Inset: Array Skirt Version Compatibility

Current Version

Array Skirt
Profile No. 500-0113 *

uses either

Cam Foot
Part No. 850-1413

- or -

Cam Foot
Part No. 850-1284

with

Grip
Part No. 850-1421

uses either

Interlock
Part No. 850-1388

- or -

Interlock
Part No. 850-1178

Previous Version

Array Skirt
Frofile No. 500-0104 *

uses

Cam Foot
Part No. 850-1284

with

Jam
Part No. 850-1258

only

uses either

Interlock
Part No. 850-1388

- or -

Interlock
Part No. 850-1178

with

Spacer **
Part No. 850-1402

with either

Spacer **
Part No. 850-1402

- or -

Spacer **
Part No. 850-1296

* Please contact Zep Solar Support for a complete list of SKUS for each Array Skirt profile.

** The Spacer is only needed with the previous version of the Array Skirt, and is applied between the Interlock and the Array Skirt when connecting Array Skirt sections together.

Special Inset: Array Skirts and Caps

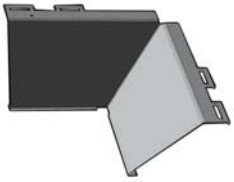
Current Version

Array Skirt
Profile No. 500-0113 *

fits

End Caps
Part No. 850-1405

Outside Corner Cap
Part No. 850-1386



Inside Corner Cap
Part No. 850-1425

Previous Version

Array Skirt
Frofile No. 500-0104 *

fits

End Caps
Part No. 850-1215

only

* Please contact Zep Solar Support for a complete list of SKUS for each Array Skirt profile.

7 Regulatory Information

The following electrical, waterproofing, and safety information regarding Zep Solar hardware products is for use by building inspectors having jurisdiction as well as national listing agencies. Additional specifications may be provided for use by both regulatory agencies and field installers.

NOTE: Structural testing and related requirements are contained within the Engineering Certification Letters, available on the Zep Solar web site.

7.1 UL and ETL Listings

Selected Zep Solar products have been tested for electrical bonding functionality, and have been approved by the following testing agencies:

- **Underwriters Laboratories, Inc. (UL)** - These listings appear as "Listed by UL to..." followed by the UL standard.
- **Intertek Testing Services (ETL)** - These listings appear as "ETL listing conforms to..." followed by the UL standard.
- **Canadian Standards Association (CSA)** - These items appear as "Certified to ULC ORD STD..." or "Certified to CSA STD..."

Table 7.1 Zep Solar Product Listing and Torque Specifications

Product Name and Number *	UL and ETL Listings	Listing Notification, Full Text Version	Additional Specifications
Adjustable Mighty Hook, HDG 850-1396			Attaches to rafter to provide attachment point for Spanner Bar, using Spanner Clamp. Hot-dipped galvanized coating.
Adjustable Mighty Hook, SS 850-1403			Attaches to rafter to provide attachment point for Spanner Bar, using Spanner Clamp. Stainless steel, recommended for coastal areas.
Array Skirt Profile 500-0113	UL Listings: • UL 2703	Listed by UL to UL 2703.	The Array Skirt contains the Zep Groove geometry and can receive the same Zep Solar components as a Zep Compatible PV module frame. Sections of Array Skirt are joined together using Interlocks tightened in a precise quarter-turn connection using the Zep Tool. When installing onto a front-row Cam Foot, a Grip is required.
Bar Sleeve 850-1143	UL Listings: • UL 2703	Listed by UL to UL 2703.	Slides onto far end of Spanner Bar 850-1192 to provide additional space for Cam Foot installation.
Cam Foot 850-1413	UL Listings: • 2703	Listed by UL to UL 2703.	Insertion of Cam Foot Rockit into Zep Groove is self-grounding. Installing the Cam Foot base into the Big Foot uses the Flat Tool with a defined 100 degree turn. See the Installation chapter for details. Creates an electrical bond between modules and with Spanner Bar.
Cam Foot 850-1284	UL Listings: • 2703	Listed by UL to UL 2703.	Insertion of Cam Foot Rockit into Zep Groove is self-grounding. Installing the Cam Foot base into the Big Foot uses the Flat Tool with a defined 100 degree turn. See the Installation chapter for details.
End Cap 850-1405	UL Listings: • 2703	Listed by UL to UL 2703.	End Cap mechanical and electrical bond is accomplished by inserting a screw and tooth washer into extruded holes in the Array Skirt profile, and torquing to 26 inch-lbs.
Grip 850-1421	UL Listings: • 2703	Listed by UL to UL 2703.	Grip is of non-conducting material. Mechanical installation is accomplished by inserting the Grip onto a notch on the Array Skirt, and then sliding the Grip around the base of the Cam Foot to engage a locking notch on the Grip.

* Part numbers beginning with 850 refer to top-level SKUs as shown on shipping labels and sales catalogs. Part numbers beginning with 301 or other numbers refer to common parts or profiles that may have many top-level SKUs. Items shown in this table by profile number also display this number on shipping labels, and for listed parts, the listings explicitly reference the profile number rather than the top-level SKU.

Table 7.1 Zep Solar Product Listing and Torque Specifications

Product Name and Number *	UL and ETL Listings	Listing Notification, Full Text Version	Additional Specifications
Ground Zep 850-1172	UL Listings: • UL 2703 • UL 467 ETL Listings: • UL 467 • CSA STD C22.2 NO 41	Listed by UL to UL 467 and UL 2703. ETL listing conforms to UL STD 467. Certified to CSA STD C22.2 NO 41.	Installation of Ground Zep into Zep Groove requires precise quarter-turn connections using the Zep Tool or the Flat Tool. See Installation chapter for further details. US torque specifications and ground wire gauges: • 14-10 AWG: 40 inch-lbs. • 8 AWG: 45 inch-lbs. • 6 AWG: 50 inch-lbs.
Hybrid Interlock 850-1281	UL Listings: • 2703	Listed by UL to UL 2703.	Installation of bonding version of Hybrid Interlock Rockits into Zep Groove is self-grounding. See Installation chapter for details.
Inside Corner Cap 850-1425			Inside Corner Cap is first mechanically installed, then electrically bonded. Once the Corner Cap is in position, a pilot hole is drilled into the Array Skirt. Then a thread-cutting screw and tooth washer are inserted and torqued to 1.4 N-m. See Installation chapter for details and fastener specifications.
Interlock 850-1178	UL Listings: • 2703 ETL Listings: • UL 1703 • ULC ORD STD C1703	Listed by UL to UL 2703. ETL listing conforms to UL STD 1703. Certified to ULC ORD STD C1703.	Installation requires precise quarter-turn connections according to alignment marks provided, using the Zep Tool or Flat Tool. See the Installation chapter for further details.
Interlock 850-1388	UL Listings: • 2703	Listed by UL to UL 2703.	Installation requires precise quarter-turn connections according to alignment marks provided, using the Zep Tool or Flat Tool. See the Installation chapter for further details.
Outside Corner Cap 850-1386	UL Listings: • UL 2703	Listed by UL to UL 2703.	Outside Corner Cap is first mechanically installed, then electrically bonded. Once the Corner Cap is in position, a pilot hole is drilled into the Array Skirt. Then a thread-cutting screw and tooth washer are inserted and torqued to 1.4 N-m. See Installation chapter for details and fastener specifications.
Spanner Bar 850-1192	UL Listings: • UL 2703	Listed by UL to UL 2703.	Spanner Bar attaches to Adjustable Mighty Hook or other roof attachment via the Spanner Clamp. Built-in splice allows multiple Spanner Bar lengths to be connected. Requires Bar Sleeve at end to secure the last Cam Foot in the column. Spliced sections are electrically bonded.

* Part numbers beginning with 850 refer to top-level SKUs as shown on shipping labels and sales catalogs. Part numbers beginning with 301 or other numbers refer to common parts or profiles that may have many top-level SKUs. Items shown in this table by profile number also display this number on shipping labels, and for listed parts, the listings explicitly reference the profile number rather than the top-level SKU.

Table 7.1 Zep Solar Product Listing and Torque Specifications

Product Name and Number *	UL and ETL Listings	Listing Notification, Full Text Version	Additional Specifications
Spanner Bar 850-1398 - 1x 850-1399 - 3x 850-1400 - 4x			Spanner Bar attaches to Adjustable Mighty Hook or other roof attachment via the Spanner Clamp. Multiple lengths can be connected using the Splice Kit. Spliced sections are electrically bonded.
Spanner Clamp 850-1194	UL Listings: • UL 2703	Listed by UL to UL 2703.	Spanner Clamp attaches Spanner Bar to roof attachment using carriage bolt and washer provided. Recommended torque value is 31 ft-lbs.
Splice Kit 850-1401			Used to splice multiple lengths of Spanner Bar together. Built-in tab indicates when splice is fully completed.
T-Lock 850-1409	UL Listings: • 2703	Listed by UL to UL 2703.	T-Lock flanges are inserted into Zep Groove in the module frame and the Array Skirt to secure the Array Skirt to the perimeter of the array.

* Part numbers beginning with 850 refer to top-level SKUs as shown on shipping labels and sales catalogs. Part numbers beginning with 301 or other numbers refer to common parts or profiles that may have many top-level SKUs. Items shown in this table by profile number also display this number on shipping labels, and for listed parts, the listings explicitly reference the profile number rather than the top-level SKU.

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