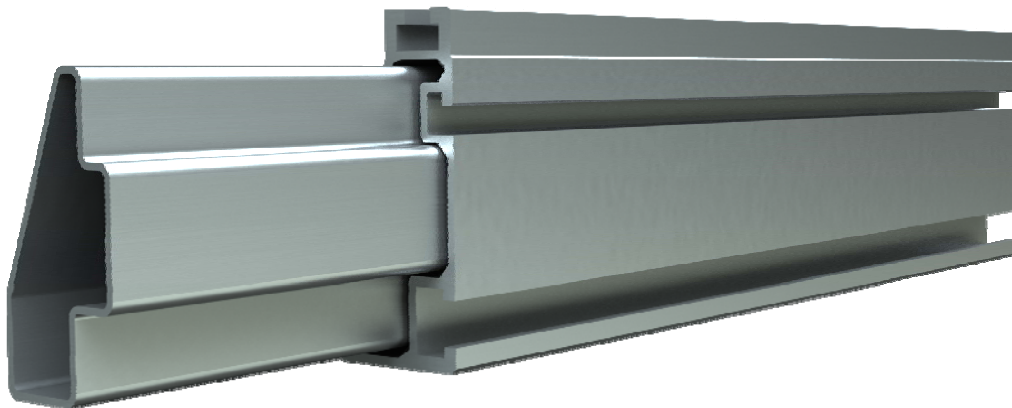


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# XRS Splice Installation Guide Addendum



XRS Splice bars are structural elements that may be used to join two or more of the IronRidge XRS rails together to create a single, longer rail. Although the splice is structural, the installer must note that the joint will not be as strong as the rail itself.

## Component List

The component list is indicated here for a single splice kit:

- Splice Bar (1), 51-7000-000
- 10-16x1/2", Self-drilling/tapping screws (4), 48-1016-500



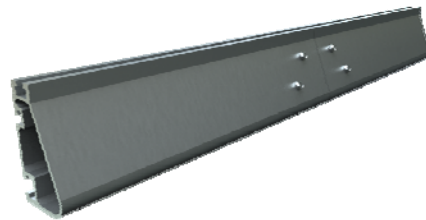
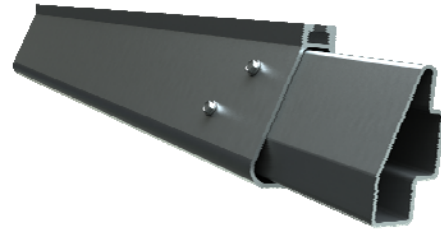
## Tools Required

The following tools are required to install the XRS splice correctly:

- Screw gun (cordless drill); 5/16 socket
- Tape measure (or Ruler)

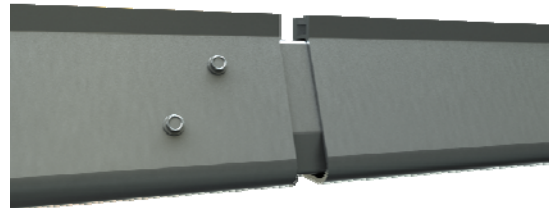
## Installation Instructions

- 1) Slide the internal splice halfway into the internal cavity of the rail. It should extend approximately six (6) inches into the cavity of the XRS rail.
- 2) Using two of the self-drilling, self-tapping screws, secure the internal splice into the rail utilizing the screw pattern shown on the right.
- 3) The screws will drill through both the XRS rail and the splice into the cavity of the internal splice. In the cross-section diagram on the right, you'll notice how the screws pierce both the wall of the rail and the splice, securing the splice to the rail.
- 4) Slip the second rail over the internal splice until the two XRS rails are butting tightly and evenly together.
- 5) Drive two self-tapping screws through the second rail utilizing the same pattern from the first rail.
- 6) Repeat this procedure for any remaining splices.



## Expansion Joints

For rows of panels exceeding 50 feet of rail, IronRidge recommends the utilization of expansion joints. Expansion joints prevent the potential buckling of rails due to thermal expansion. To create a thermal expansion joint, secure the splice bar into one of the rails as described above. Then slide the other rail over the splice bar, and leave the splice bar secured on one side only. Leave a ½" gap between the ends of the rails to allow for thermal expansion.



## Installation Notes

- 1) Take care to make sure the splice does not occur in the middle 1/3 of the span between attachments. In situations where the actual span is less than the maximum allowable span, there may be more flexibility with the location of the splice bar. Please contact your local distributor for more information.
- 2) No splices are permitted in the end spans of a row. In other words, splices must be placed on the inside of the 2<sup>nd</sup> attachment (see diagram below).
- 3) Thermal expansion joints are not structural connections and should not be treated as such. It is recommended that modules not span over a thermal expansion joint. Panels should have end clamps on each side of the expansion joint. In addition, an extra attachment will need to be added to the long portion of the rail created by the break. This layout will allow for maximum density while allowing for thermal expansion.

# XRS Rail for Flush Mount

## SPAN CHART & ENGINEERING GUIDE

### XRS Maximum Spans (feet)

Exposure	Wind Speed (mph)	0 psf Snow			10 psf Snow			20 psf Snow			30 psf Snow			40 psf Snow		
		Zone 1	Zone 2	Zone 3	Zone 1	Zone 2	Zone 3	Zone 1	Zone 2	Zone 3	Zone 1	Zone 2	Zone 3	Zone 1	Zone 2	Zone 3
Category B	90 mph	13.5	13.5	10.5	12.5	12.5	10.5	10.5	10.5	10.5	10.0	10.0	10.0	9.0	9.0	9.0
	100 mph	13.5	12.0	9.5	12.5	12.0	9.5	10.5	10.5	9.5	10.0	10.0	9.5	9.0	9.0	9.0
	110 mph	13.5	11.5	9.0	12.5	11.5	9.0	10.5	10.5	9.0	10.0	10.0	9.0	9.0	9.0	9.0
	120 mph	13.5	10.5	8.5	12.5	10.5	8.5	10.5	10.5	8.5	10.0	10.0	8.5	9.0	9.0	8.5
	130 mph	13.5	9.5	7.5	12.5	9.5	7.5	10.5	9.5	7.5	10.0	9.5	7.5	9.0	9.0	7.5
	140 mph	12.5	9.0	7.0	12.5	9.0	7.0	10.5	9.0	7.0	10.0	9.0	7.0	9.0	9.0	7.0
	150 mph	11.5	8.5	6.5	11.5	8.5	6.5	9.5	9.5	9.5	10.0	8.5	6.5	9.0	8.5	6.5
Category C	90 mph	13.5	11.0	8.5	12.5	11.0	8.5	10.5	10.5	10.5	10.0	10.0	8.5	9.0	9.0	8.5
	100 mph	13.5	9.5	8.0	12.5	9.5	8.0	10.5	9.5	8.0	10.0	9.5	8.0	9.0	9.0	8.0
	110 mph	13.0	9.5	7.5	12.5	9.5	7.5	10.5	9.5	7.5	10.0	9.5	7.5	9.0	9.0	7.5
	120 mph	12.0	8.5	7.0	12.0	8.5	7.0	10.5	8.5	7.0	10.0	8.5	7.0	9.0	8.5	7.0
	130 mph	11.0	8.0	6.5	11.0	8.0	6.5	10.5	8.0	6.5	9.5	8.0	6.5	9.0	8.0	6.5
	140 mph	10.0	7.5	6.0	10.0	7.5	6.0	10.0	7.5	6.0	9.5	7.5	6.0	8.5	7.5	6.0
	150 mph	9.5	7.0	5.5	9.5	7.0	5.5	9.5	7.0	5.5	9.0	7.0	5.5	8.5	7.0	5.5

### LOAD CONDITION ASSUMPTIONS

- ◆ Flush roof mounting installations only
- ◆ Roof pitch must be 27 degrees or less
- ◆ Module length is 67.5" or less
- ◆ Building height must be less than or equal to 15 feet
- ◆ Clearance between roof and rail is at least 2 inches
- ◆ End cantilever span not to exceed 40% of the adjacent interior span
- ◆ No rail splice permitted within the middle ½ of the span

For installations that do not conform to the load condition assumptions, please contact your local distributor or refer to [www.ironridge.com](http://www.ironridge.com) for a more complete engineering analysis.





# XRS Rail for Tilt Mount

## SPAN CHART & ENGINEERING GUIDE

### XRS Maximum Spans (feet)

Exposure	Wind Speed (mph)	0 psf Snow			10 psf Snow			20 psf Snow			30 psf Snow			40 psf Snow		
		10°	20°	30°	10°	20°	30°	10°	20°	30°	10°	20°	30°	10°	20°	30°
Category B	90 mph	13.0	12.0	10.5	12.0	11.0	10.5	10.5	10.0	9.5	9.5	9.5	9.0	9.0	8.5	8.0
	100 mph	12.0	11.0	9.5	11.5	10.5	9.5	10.0	9.5	9.0	9.5	9.0	8.5	8.5	8.0	8.0
	110 mph	11.5	10.5	9.5	11.0	10.5	9.5	9.5	9.0	8.5	9.0	8.5	8.0	8.5	8.0	7.5
	120 mph	11.0	9.5	8.5	10.5	9.5	8.5	9.5	9.0	8.0	9.0	8.5	8.0	8.0	8.0	7.5
	130 mph	10.0	9.0	8.0	10.0	9.0	8.0	9.0	8.5	8.0	8.5	8.0	7.5	8.0	7.5	7.0
	140 mph	9.5	8.5	7.5	9.5	8.5	7.5	8.5	8.0	7.5	8.0	7.5	7.0	7.5	7.0	7.0
	150 mph	9.0	8.0	7.0	9.0	8.0	7.0	8.0	7.5	7.0	8.0	7.5	7.0	7.5	7.0	6.5
Category C	90 mph	11.0	10.0	9.0	10.5	10.0	9.0	9.5	9.0	8.5	9.0	8.5	8.0	8.5	8.0	7.5
	100 mph	10.0	9.0	8.0	10.0	9.0	8.0	9.0	8.5	8.0	8.5	8.0	7.5	8.0	7.5	7.0
	110 mph	10.0	9.0	8.0	10.0	9.0	8.0	9.0	8.5	7.5	8.5	8.0	7.5	8.0	7.5	7.0
	120 mph	9.0	8.0	7.5	9.0	8.0	7.5	8.5	8.0	7.0	8.0	7.5	7.0	7.5	7.0	6.5
	130 mph	8.5	7.5	7.0	8.5	7.5	7.0	8.0	7.5	7.0	7.5	7.0	6.5	7.5	7.0	6.5
	140 mph	8.0	7.0	6.5	8.0	7.0	6.5	7.5	7.0	6.5	7.5	7.0	6.5	7.0	6.5	6.0
	150 mph	7.5	6.5	6.0	7.5	6.5	6.0	7.5	6.5	6.0	7.0	6.5	6.0	6.5	6.0	5.5

### LOAD CONDITION ASSUMPTIONS

- ◆ Roof pitch must be 25 degrees or less
- ◆ Module length is 67.5" or less
- ◆ Building height must be less than or equal to 15 feet
- ◆ Clearance between roof and rail is at least 2 inches
- ◆ End cantilever span not to exceed 40% of the adjacent interior span
- ◆ No rail splice permitted within the middle ½ of the span

For installations that do not conform to the load condition assumptions, please contact your local distributor or refer to [www.ironridge.com](http://www.ironridge.com) for a more complete engineering analysis.

# IronRidge Roof Mount Products

## ATTACHMENT DIMENSIONS

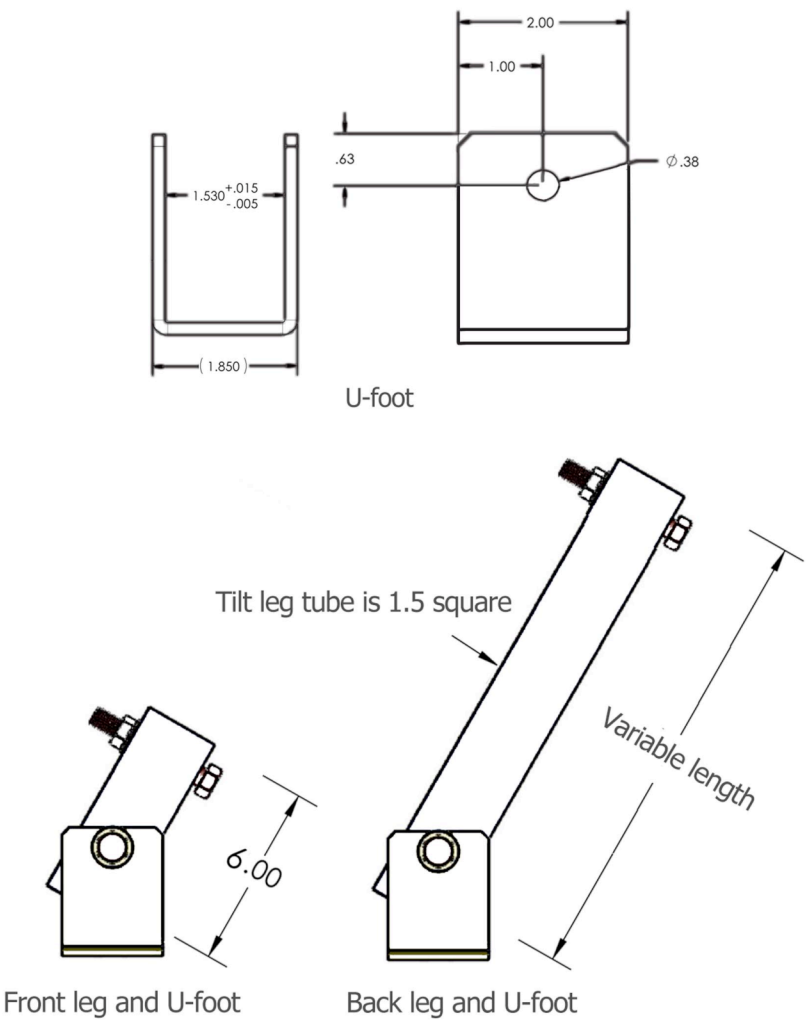
### Flush Standoffs

Part Numbers	Diagram
29-6003-500 (3") 29-6004-500 (4") 29-6006-500 (6") 29-6007-500 (7")	<p>Height depends on model selected.</p> <p>Standoff</p> <p>Base</p>
<b>Notes:</b> Flush mount standoffs come in four heights: 3", 4", 6", and 7"	

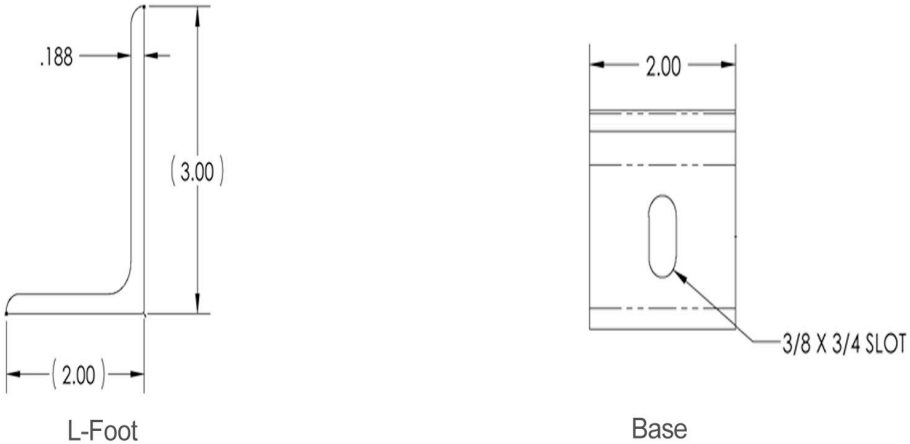
### Tilt Standoffs

Part Numbers	Diagram
51-4004-00T (4") 51-4006-00T (6") 51-4009-00T (9")	<p>U-foot for reference only (sold separately in Tilt Leg Kit)</p> <p>Height depends on model selected.</p> <p>Standoff</p> <p>Base</p>
<b>Notes:</b> Tilt mount standoffs come in three heights: 4", 6", and 9"	

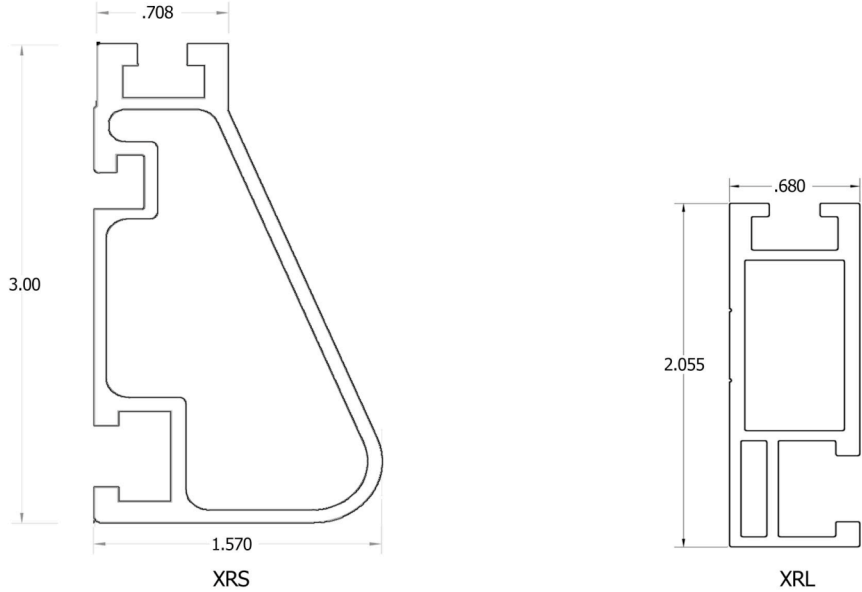
## Tilt Leg Kits

Part Numbers	Diagram
<p>29-7210-010 (10")  29-7215-015 (15")  29-7220-020 (20")  29-7225-025 (25")  29-7230-030 (30")  29-7240-040 (40")</p>	 <p>The diagram illustrates the components and dimensions of the Tilt Leg Kits. It includes three main views:</p> <ul style="list-style-type: none"> <li><b>U-foot:</b> A side view of the U-foot component showing a width of 1.850 and a height of 1.530 with a tolerance of <math>+0.015</math> to <math>-0.005</math>. A top view shows a width of 2.00, a height of 1.00, and a central hole with a diameter of <math>\phi .38</math>. A dimension of .63 is also indicated for the top flange.</li> <li><b>Front leg and U-foot:</b> A side view showing the front leg assembly with a fixed length of 6.00.</li> <li><b>Back leg and U-foot:</b> A side view showing the back leg assembly with a variable length, indicated by a dimension line labeled "Variable length".</li> </ul> <p>A note specifies: "Tilt leg tube is 1.5 square".</p>
<p><b>Notes:</b> Tilt legs are 1.5" square tubing. The front leg is always 6" in length, but the back leg is variable as shown below, based on the model.</p>	

## L-feet

Part Numbers	Diagram
29-7000-017	 <p>L-Foot</p> <p>Base</p>
<b>Notes:</b> IronRidge L-feet are adjustable in height using the vertical slot in the diagram above.	

## Rails

Part Numbers	Diagram
XRS 51-7000-XXX XRL 51-6000-XXX	 <p>XRS</p> <p>XRL</p>



# Installation Manual

## Tilt Leg



**Solar Mounting Solutions**

## Introduction

The Tilt Leg is a flexible and straightforward roof mounting attachment usable in conjunction with the IronRidge XR rail systems (both XRS and XRL rails). Due to its modular design, it can easily be used in any size installation.

## 1. Installer Responsibility

The installer is solely responsible for:

- ◆ Conforming to the Installer Responsibility section of the respective XR Solar Rail System Installation Guides: The XR rail assembly is assembled first, and this guide functions as an addendum to connect that assembly to IronRidge Tilt Legs.
- ◆ Confirming the provided Tilt Leg allows mounting modules at the desired tilt angle

## 2. Customer Support

IronRidge makes every effort to ensure your Tilt Leg is easy to install. If you need assistance at any point with your installation or have suggestions on how we can improve your experience, call IronRidge customer support: (707) 459-9523

## 3. Tools Required For Assembly

The following tools are required to assemble the Tilt Leg:

Tool	Use for
Wrenches  Open-end wrench, Box-end wrench, or socket drive with sockets to support the following size hex heads:  ◆ 3/8"	◆ 3/8 flange nuts, 3/8 bolts

## 4. Torque Values For Bolts

Use the following torque values in this assembly.

Bolt Size	Required Torque Value
◆ 3/8-16	180 in-lbs.

### Note:

Once the desired angle is achieved for the tilt array, tighten all bolts in the assembly to 180 inch-lbs.

### Caution:

Stainless steel hardware can seize up in a process known as galling. To significantly reduce the likelihood of galling, apply a small drop of anti-seize lubricant to the threads of all stainless steel bolts before installation.

## 5. Component List

Component List	Qty	Part Number
Tilt Leg Kit	1	51-7206-000
Long Leg	1	51-7200-xxx
Short Leg	1	51-7200-006
U-Foot	2	51-7100-001
3/8-16 x 2.5" SS Hex Head Bolt	4	23-3716-250
3/8" SS Flat Washer	2	25-3702-000
3/8-16 SS Serrated Flange Nut	4	25-2501-016

## 6. Assembly

1. Mount all U-Feet to the roof in the desired locations. Please note the orientation of both U-Feet in Figure 1.

**Note:** Determine the maximum distance between U-feet according to engineering specifications. In addition, please be aware that the placement of the XR rails vary by module manufacturer. Set your XR rail spacing (North to South). The maximum distance the XR rails can be placed from the edge of the module is 15% of the module's length, as shown in Figure 2. On the South side, the rail might require placement near the edge of the module to avoid the module 'crashing' into the roof as you tilt the assembly.

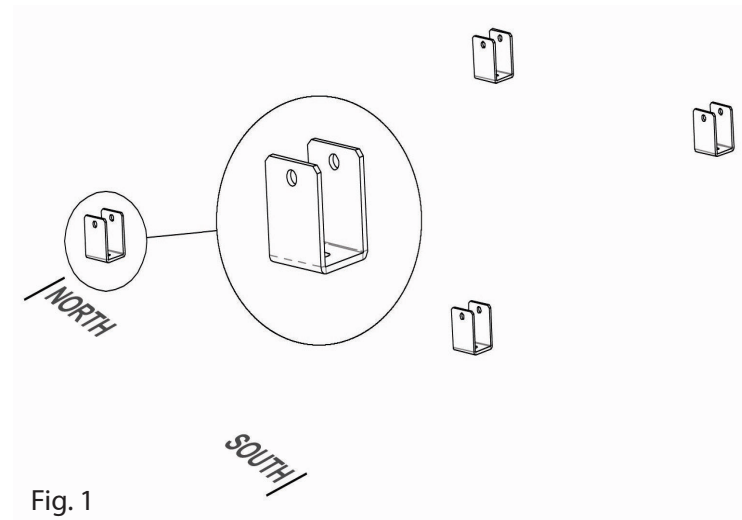


Fig. 1

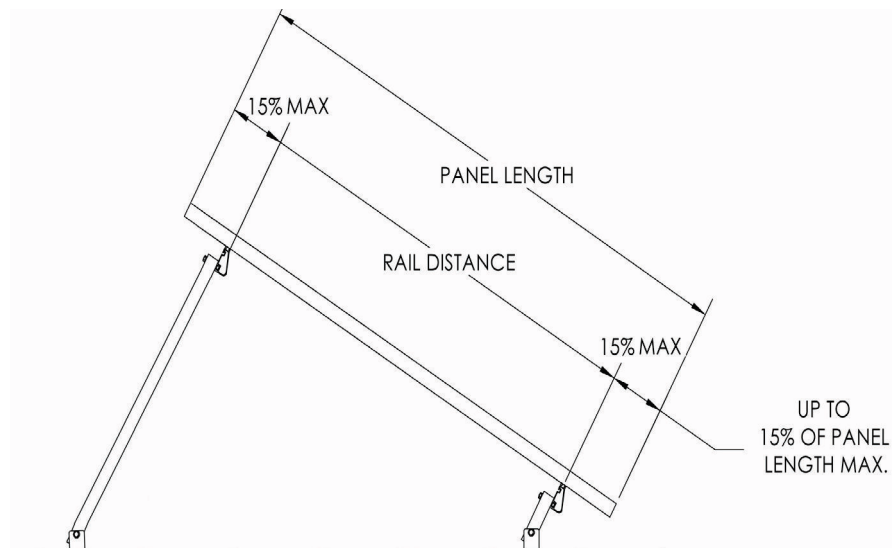


Fig. 2



2. Place the Long Leg in the center of the U-Foot. Align the slot of the Long Leg with the hole in the U-Foot. Insert a 3/8-16 x 2.5" hex head bolt with washer into the hole and loosely attach a 3/8" flange nut. Do not tighten completely. Pivot the Long Leg onto the roof north of the array.

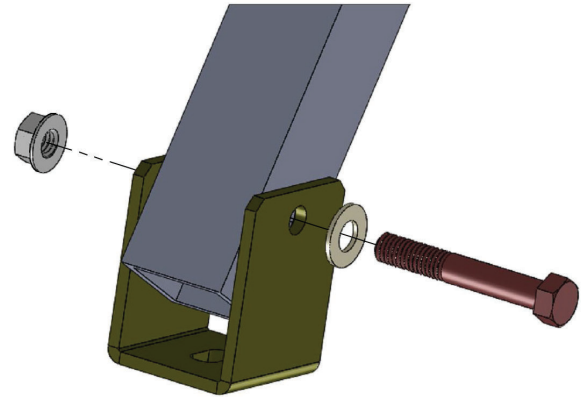


Fig. 3

3. Attach the Short Leg to the front XR rail in your XR assembly (created according to the XR Solar Rail System Installation Manuals) using the normal method of sliding bolts into the 3/8" channel (shown in same Installation Manual). Leave nut finger tight to assist in aligning with U-foot previously attached on roof.

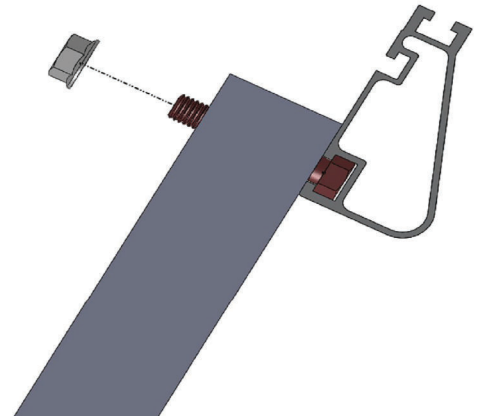


Fig. 4

4. Attach the Short Leg to the U-foot by aligning the hole in U-foot with the slot in Short Leg and inserting a 3/8-16 x 2.5" hex head bolt and washer. Loosely attach 3/8" flange nut as shown in Figure 5.

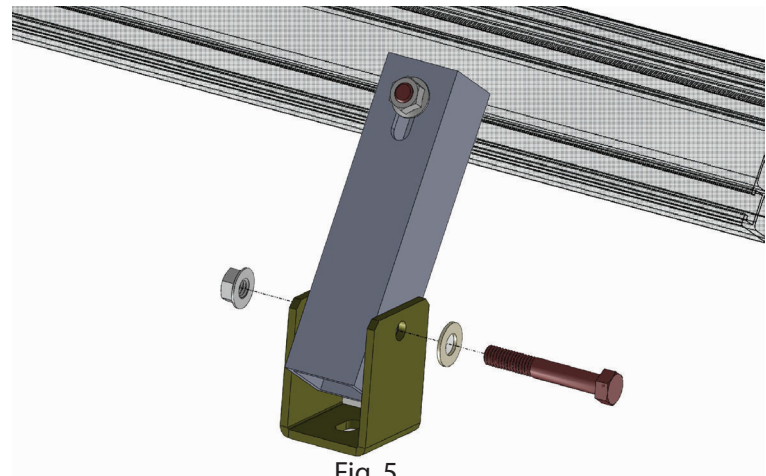


Fig. 5

5. For the final Long Leg connections, tilt the Long Leg of the XR assembly up and align the Long Leg slot with the 3/8-16 x 2.5" hex head bolt in the XR track as shown in Figure 6.
6. Once the desired angle is achieved, tighten all bolts in the assembly to 180 inch-lbs.

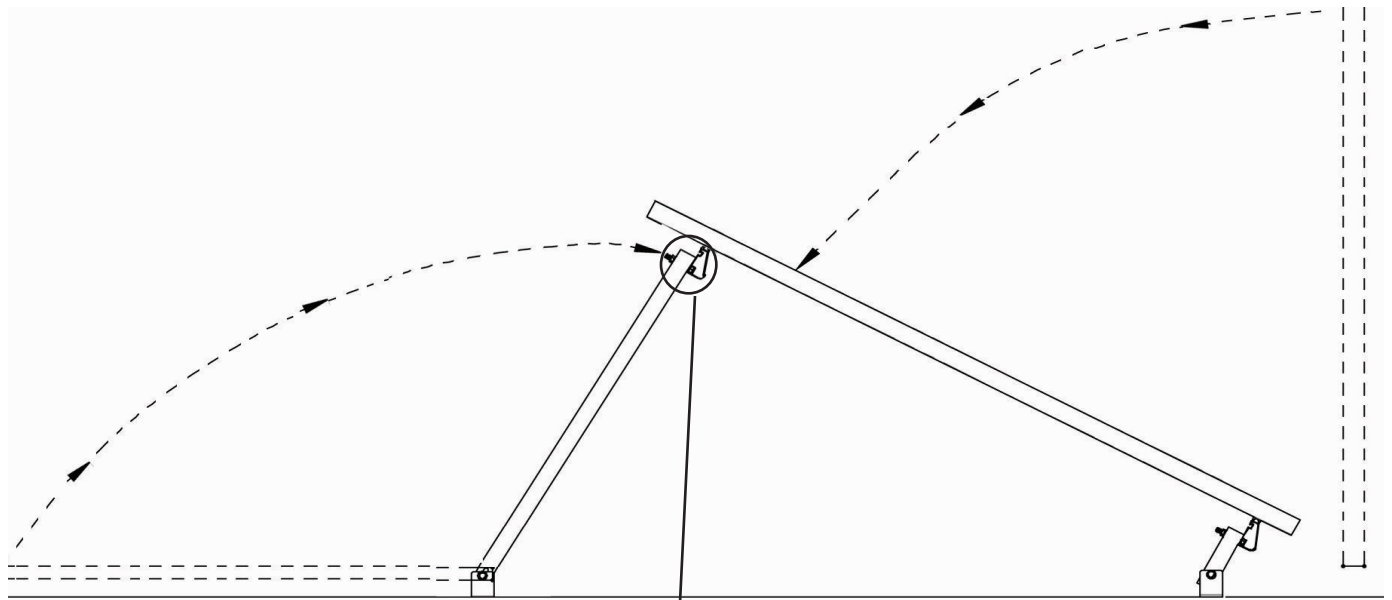
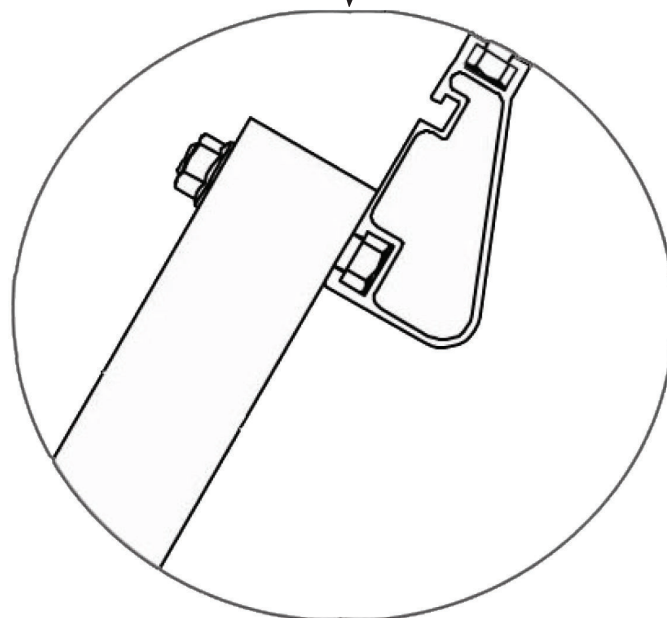


Fig. 6



## IronRidge 10-Year Warranty

### Terms and Conditions

IronRidge warrants each Mounting Structure to be free from defects in materials and workmanship for ten (10) years from the date of first purchase ("Warranty Period"), when installed properly and used for the purpose for which it is designed, except for the finish, which shall be free from visible peeling, or cracking or chalking under normal atmospheric conditions for a period of three (3) years, from the earlier of 1) the date the installation of the Product is completed, or 2) 30 days after the purchase of the Product by the original Purchaser ("Finish Warranty"). The Finish Warranty does not apply to any foreign residue deposited on the finish. All installations in corrosive atmospheric conditions are excluded. The Finish Warranty is VOID if the practices specified by AAMA 609 & 610-02 – "Cleaning and Maintenance for Architecturally Finished Aluminum" ([www.aamanet.org](http://www.aamanet.org)) are not followed by Purchaser for IronRidge's aluminum based products.

The warranty covers the replacement cost of parts to repair the product to proper working condition. Transportation and incidental costs associated with warranty items are not reimbursable. The warranty does not cover normal wear, or damage resulting from misuse, abuse, improper installation, negligence, or accident. The warranty does not cover any defect that has not been reported in writing to IronRidge within ten (10) days after discovery of such defect. Furthermore, it does not cover units that have been altered, modified or repaired without written authorization from the manufacturer or its authorized representative, or units used in a manner or for a purpose other than that specified by the manufacturer. IronRidge's entire liability and Purchaser exclusive remedy, whether in contract, tort or otherwise, for any claim related to or arising out of breach of the warranty covering the Mounting Structures shall be correction of defects by repair, replacement, or credit, at IronRidge's discretion. Refurbished Mounting Structures may be used to repair or replace the Mounting Structures.

IronRidge shall have no liability for any injuries or damages to persons or property resulting from any cause, whatsoever, or any claims or demands brought against IronRidge by Purchaser, any employee of Purchaser, client of Purchaser, end-user of the Product or other party, even if IronRidge has been advised of the possibility of such claims or demands (collectively, "Third Party Claims"). This limitation applies to all materials provided by IronRidge during and after the Warranty Period.



# Adjustable Tilt Leg Kit

## Installation Guide Addendum

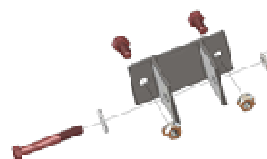
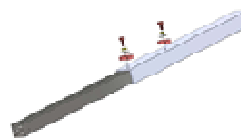
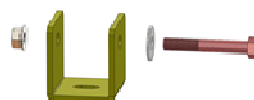
The Adjustable Tilt Leg is a flexible and straightforward roof mounting attachment usable in conjunction with the IronRidge XRS or XRL rail system. Due to its modular design, it can easily be used in any size installation.



### Component List

The component list is indicated here for a single splice kit:

- **U-feet and Hardware** (2 per kit)  
Attaches tilt legs to the roof. A U-foot is necessary for each leg. Each U-foot comes with a 3/8<sup>th</sup> bolt and matching flange nut.
- **Short Leg** (1 per kit)  
A fixed length leg that attaches to the front rail of the array. Comes with 3/8<sup>th</sup> bolt and flange nut.
- **Adjustable Leg Assembly** (1 per kit)  
Adjustable length leg that attaches via the Pivot Bracket to the back rail and provides support for the PV modules.
- **Pivot Bracket** (1 per kit)  
Attaches to the back XR rail via two 3/8<sup>th</sup> bolts. Connects to Adjustable Leg Assembly with single 3/8<sup>th</sup> bolt.



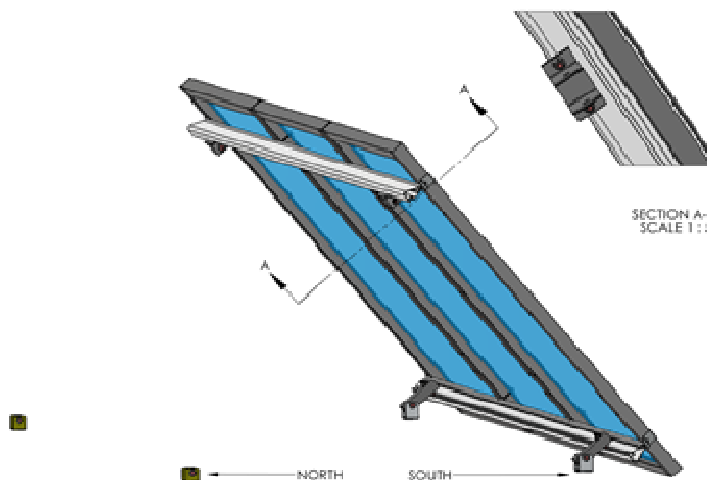
### Tools Required

The following tools are required to install the Adjustable Tilt Leg Kit

- 3/8 socket, or wrench
- Tape measure

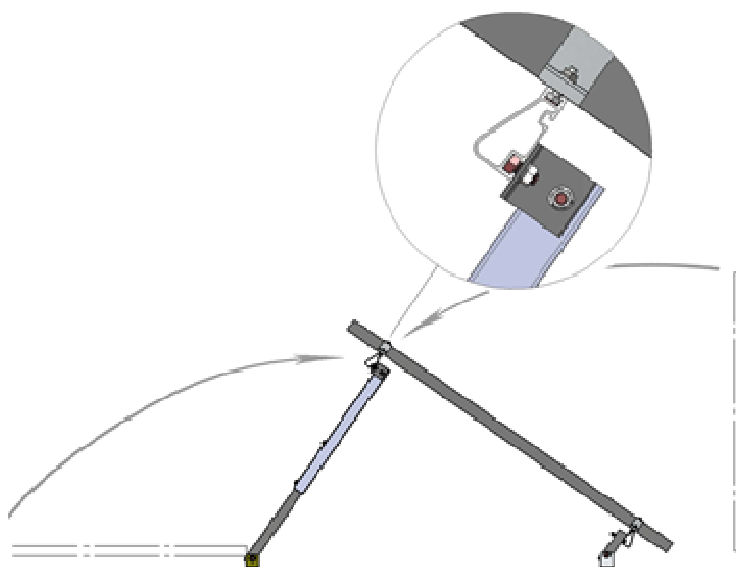
## Installation Instructions

- 1) Mount all of the U-feet to the roof or ground in the desired locations. Attach the Short Leg to the front XR rail in your XR assembly (created according to the XR Rail System Installation Guide) using the normal method of inserting bolts into the 3/8th channel per the guide.
- 2) Attach the Pivot Bracket to the north rail of the XR assembly in each approximate position where the Adjustable Leg Assembly will connect. Allow module row to rest on roof surface.



**Note:** Determine the maximum distance between U-feet according to engineering specifications.

- 3) Adjust the lengths of the Adjustable Leg Assembly to roughly match the required length for your installation parameters.
- 4) Attach the Adjustable Leg Assembly to the north (back) U-foot with 3/8th bolt and flange nut. Hand tighten.
- 5) Tilt the row of modules off of the roof surface and hold at the desired installation angle. Swing the Adjustable Leg Assembly to meet the module row, attaching with a single 3/8th bolt to the Pivot Bracket as shown on left. Repeat until all tilt legs are attached.
- 6) Adjust all attachments as required, and tighten all 3/8th hardware to 180in-lbs.



For Warranty information please refer to the XR Rail System Installation Guide that this addendum is amending.

## Introduction

Stand-offs are used whenever flashed installations or increased airflow is desired. Our seamless hardware-based aluminum stand-offs allow precise placement of flashing over a secured base. IronRidge offers two styles of stand-offs: L-foot attachment stand-offs and Tilt Leg attachment stand-offs. Please note Tilt Leg attachment stand-offs are currently for 1-10 degree tilt only. Both styles are covered in the instructions below.

## Stand-off, L-Foot Attachment

### 1. Component List

Parts Required	Qty	Part Number
Base Plate, 4"	1	51-6000-501
5/16" EPDM Backed Washer	1	25-3102-006
5/16" - 18 x 3/4" Hex Head Thread Forming Bolt	1	23-31HH-TR1
1/4" - 20 x 1" Flat Head Thread Forming Bolt	2	23-25FH-TR1
Extrusion, Stand-off post (3", 4", 6" or 7" length )	1	51-60X0-500
L-foot (not included)	1	51-6000-015

### 2. Assembly

1. Begin by creating threads in stand-off post. Select a Phillips tip for the screw gun that fits the 1/4" - 20 x 1" Flat Head Thread Forming Bolt snugly.
2. Clamp standoff post securely in a vise.
3. Align screw straight with the hole and drive the screw  $\frac{3}{4}$  of the way in. Note: often a drop of oil will assist in the threading process.
4. Repeat for all holes required.
5. Remove the screws and install the base plate, reinserting and tightening the screws to 74 inch-lbs.
6. Place the 5/16" EPDM backed washer rubber side down on the top of the stand-off post, aligning the hole in the washer with the hole in the top of the stand-off post.
7. Position your L-foot on top of the washer, aligning the L-foot obround with the hole in the top of the stand-off and washer as shown in Figure 1.
8. Insert a 5/16" - 18 x 3/4" Hex Head Thread Forming Bolt into the obround in the base of the L-foot, and thread into the top of the stand-off post. Make sure that the EPDM washer stays properly seated on the stand-off to ensure a good seal as you torque the bolt. Tighten to 139 in-lbs.

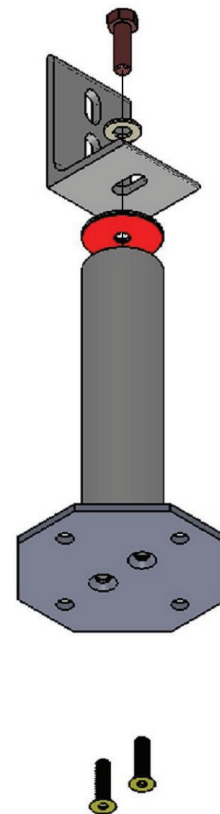


Fig. 1

## Stand-off, Tilt Leg Attachment

### 1. Component List

Parts Required	Qty	Part Number
Base Plate, 4"	1	51-6000-501
Washer, Flat 1/4" SS	2	25-2502-000
1/4" -20 x 1" Flat Head Thread Forming Bolt	2	23-25FH-TR1
1/4" -20 x 1" Hex Head Thread Forming Bolt	2	23-25HH-TR1
Extrusion, Stand-off post (3", 4", 6" or 7" length )	1	51-60X0-500
Tilt Leg U-foot Bracket (not included)	1	51-7100-001

**Note:** Stand-off, Tilt Leg Attachment is designed for 1-10 degree tilt only.

### 2. Assembly

1. Begin by creating threads in stand-off post. Select a Phillips tip for the screw gun that fits the 1/4" - 20 x 1" Flat Head Thread Forming Bolt snugly.
2. Clamp standoff post securely in a vise.
3. Align screw straight with the hole and drive the screw  $\frac{3}{4}$  of the way in. Note: often a drop of oil will assist in the threading process.
4. Repeat for all holes required.
5. Remove the screws and install the base plate, reinserting and tightening the screws to 74 inch-lbs.
6. Position your Tilt Leg U-foot Bracket on top of the stand-off as shown in Figure 2.
7. Insert two 1/4" -20 x 1" Hex Head Thread Forming Bolts through the two flat washers and into the obrounds in the base of the Tilt Leg U-foot Bracket and thread into pair of outer holes on the top of the stand-off post as shown in Figure 2. Tighten to 139 in-lbs.

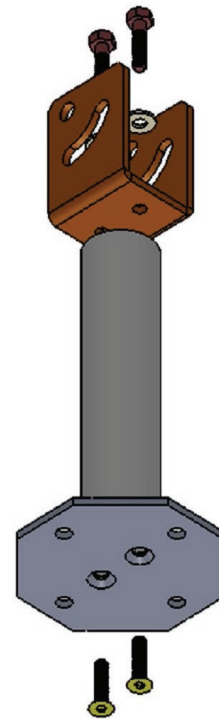
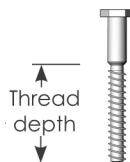


Fig. 2



# Lag pull-out (withdrawal) capacities (lbs) in typical roof lumber(ASD)

	Specific gravity	Lag screw specifications
		$\frac{5}{16}$ " shaft,* per inch thread depth
<b>Douglas Fir, Larch</b>	<b>0.50</b>	<b>266</b>
<b>Douglas Fir, South</b>	<b>0.46</b>	<b>235</b>
<b>Engelmann Spruce, Lodgepole Pine (MSR 1650 f &amp; higher)</b>	<b>0.46</b>	<b>235</b>
<b>Hem, Fir, Redwood (close grain)</b>	<b>0.43</b>	<b>212</b>
<b>Hem, Fir (North)</b>	<b>0.46</b>	<b>235</b>
<b>Southern Pine</b>	<b>0.55</b>	<b>307</b>
<b>Spruce, Pine, Fir</b>	<b>0.42</b>	<b>205</b>
<b>Spruce, Pine, Fir (E of 2 million psi and higher grades of MSR and MEL)</b>	<b>0.50</b>	<b>266</b>



Sources: American Wood Council, NDS 2005, Table 11.2A, 11.3.2A.

Notes: (1) Thread must be embedded in the side grain of a rafter or other structural member integral with the building structure.

(2) Lag bolts must be located in the middle third of the structural member.

(3) These values are not valid for wet service.

(4) This table does not include shear capacities. If necessary, contact a local engineer to specify lag bolt size with regard to shear forces.

(5) Install lag bolts with head and washer flush to surface (no gap). Do not over-torque.

(6) Withdrawal design values for lag screw connections shall be multiplied by applicable adjustment factors if necessary. See Table 10.3.1 in the American Wood Council NDS for Wood Construction.

\*Use flat washers with lag screws.



**Starling Madison Lofquist, Inc.**  
*Consulting Structural and Forensic Engineers*

**5224 South 39<sup>th</sup> Street, Phoenix, Arizona 85040**  
**tel: (602) 438-2500 fax: (602) 438-2505 [www.smleng.com](http://www.smleng.com)**

IronRidge  
1435 Baechtel Rd.  
Willits, CA 95490

June 3, 2011

page 1 of 2

Attn: Mr. William Kim, Chief Executive Officer

Subject: IronRidge Roof Flush Mount System – Quick Mount PV Anchors

Dear Sir:

This letter is a supplement to the standard letter for the IronRidge Rail, Roof Flush Mount System to address the requirements for use with Quick Mount PV Anchors. This supplement supersedes the previous version dated July 6, 2010.

We have reviewed the Test Report for the QMPV anchor prepared by Applied Materials & Engineering, Inc. (AME) dated October 28, 2008. We have reviewed loading and anchorage requirements for the IronRidge Roof Flush Mount System for both the XRS and XRL rails and determined that, subject to the limitations outlined below, the QMPV is a suitable anchorage system for the IronRidge Roof Flush Mount System.

The structural element of the QMPV anchor is a standard 5/16" dia. lag screw with a threaded top for (2) 5/16" hex nuts. The AME report indicates the failure mode is the pullout of the anchor from the wood framing.

Approved allowable values for pullout of lag screws are obtained from the 2005 National Design Specifications for Wood Construction (ANSI/AF&PA NDS-2005). The basic value for a 5/16" dia. lag screw installed in DFL#2 timber ( $G=0.50$ ) is 266 lbs per inch of thread penetration. The QMPV lag screw has an effective threaded length of 2.7" and a Duration of Load factor of 1.6 is permitted for wind loads.

Therefore, the allowable wind uplift load =  $266 \times 2.7 \times 1.6 = 1150$  lbs.

The loading and anchorage requirements for the IronRidge Roof Flush Mount System shows that the allowable load is adequate for the conditions shown in the tables below. The tables are based on the rails being installed at their maximum allowable spans. For rail spans less than maximum, the requirements can be revised. Contact IronRidge for more information.

MAX ROOF HEIGHTS (ft)			
XRS Rail	Exposure B		
V (mph)	Roof Zone		
	1	2	3
90	60	60	60
100	60	60	60
110	60	60	60
120	60	60	60
130	60	60	60
140	60	60	45

MAX ROOF HEIGHTS (ft)			
XRS Rail	Exposure C		
V (mph)	Roof Zone		
	1	2	3
90	60	60	60
100	60	60	60
110	60	60	60
120	60	60	45
130	60	60	15
140	60	60	-

The **XRL Rail** may be installed in any roof zone at a maximum height of 60 ft for winds speed up to 140 mph.

Please feel free to contact me at your convenience if you have any questions.

Respectfully yours,

Bruce Swanney, P.E.  
Special Projects Engineer





**Starling Madison Lofquist, Inc.**  
*Consulting Structural and Forensic Engineers*

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IronRidge  
1435 Baechtel Rd.  
Willits, CA 95490

June 3, 2011

page 1 of 3

Attn: Mr. William Kim, Chief Executive Officer

Subject: IronRidge Roof Flush Mount System  
Green Fasten GF-1 Anchors by EcoFasten Solar

Dear Sir:

This letter is a supplement to the standard letter for the IronRidge Rail, Roof Flush Mount System to address the requirements for use with Green Fasten GF-1 Anchors.

We have reviewed the Test Report for the GF-1 anchor prepared by Smith Emery Laboratories (SEL), dated April 5, 2011 and the subsequent IAPMO ES Evaluation Report No.0216 dated 04/2011. We have also reviewed loading and anchorage requirements for the IronRidge Roof Flush Mount System for both the XRS and XRL rails and determined that, subject to the limitations outlined below, the GF-1 is a suitable anchorage system for the IronRidge Roof Flush Mount System.

The anchorage of the GF-1 is provided by a 5/16" dia. lag screw with a threaded length of 2-1/2". The SEL report indicates the failure mode is the pullout of the anchor from the wood framing and the bending of the attached aluminum L bracket.

The test determined the allowable values for pullout for two values of specific gravity (G) and moisture content (M/C) of the timber framing supporting the panels as follows:

1. 741 lbs when installed in DFL#2 timber with G=0.52 and 20% M/C
2. 653 lbs when installed in DFL#2 timber with G=0.42 and 16% M/C

Per the IAPMO Report, these values include a Duration of Load Factor for Wind Loads and no further increase is permitted.



The loading and anchorage requirements for the IronRidge Roof Flush Mount System shows that the allowable loads are adequate for the conditions shown in the tables below. The tables are based on the rails being installed at their maximum allowable spans. For rail spans less than maximum, the requirements can be revised. Contact IronRidge for more information.

MAX ROOF HEIGHTS (ft)			
XRS Rail	Exposure B, G=0.52, M/C=20%		
V (mph)	Roof Zone		
	1	2	3
90	60	60	30
100	60	60	15
110	60	60	15
120	60	30	-
130	60	15	-
140	60	-	-

MAX ROOF HEIGHTS (ft)			
XRS Rail	Exposure C, G=0.52, M/C=20%		
V (mph)	Roof Zone		
	1	2	3
90	60	60	-
100	60	15	-
110	60	15	-
120	60	-	-
130	30	-	-
140	15	-	-

MAX ROOF HEIGHTS (ft)			
XRS Rail	Exposure B, G=0.42, M/C=16%		
V (mph)	Roof Zone		
	1	2	3
90	60	60	15
100	60	30	-
110	60	30	-
120	60	15	-
130	45	-	-
140	30	-	-

MAX ROOF HEIGHTS (ft)			
XRS Rail	Exposure C, G=0.42, M/C=16%		
V (mph)	Roof Zone		
	1	2	3
90	60	15	-
100	60	-	-
110	60	-	-
120	15	-	-
130	-	-	-
140	-	-	-

IronRidge  
Mr. William Kim  
IronRidge Roof Flush Mount System – GF-1 Anchors

June 3, 2011

page 3 of 3

MAX ROOF HEIGHTS (ft)			
XRL Rail	Exposure B, G=0.52, M/C=20%		
V (mph)	Roof Zone		
	1	2	3
90	60	60	60
100	60	60	60
110	60	60	60
120	60	60	60
130	60	60	60
140	60	60	45

MAX ROOF HEIGHTS (ft)			
XRL Rail	Exposure C, G=0.52, M/C=20%		
V (mph)	Roof Zone		
	1	2	3
90	60	60	60
100	60	60	60
110	60	60	60
120	60	60	60
130	60	60	30
140	60	60	15

MAX ROOF HEIGHTS (ft)			
XRL Rail	Exposure B, G=0.42, M/C=16%		
V (mph)	Roof Zone		
	1	2	3
90	60	60	30
100	60	60	15
110	60	60	15
120	60	30	-
130	60	15	-
140	60	-	-

MAX ROOF HEIGHTS (ft)			
XRL Rail	Exposure C, G=0.42, M/C=16%		
V (mph)	Roof Zone		
	1	2	3
90	60	60	-
100	60	15	-
110	60	15	-
120	60	-	-
130	30	-	-
140	15	-	-

Please feel free to contact me at your convenience if you have any questions.

Respectfully yours,

Bruce Swanney, P.E.  
Special Projects Engineer



## Compatible Racking Makes/Models for Mounting Enphase Microinverters

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### Purpose

This document is not intended to be an exclusive list of racking manufacturers. It lists products that have been verified either through field installations or the evaluation of actual racking samples in the Enphase mechanical lab. Section 1 lists products that work without modification, using the racking manufacturer's standard hardware. Section 2 includes products that are known to work after modification or by adding a custom adapter. Section 3 lists manufacturers that are shipping the Enphase Microinverter as part of a factory assembled proprietary racking/module solution.

### Grounding Options

The ground clamp provided on the mounting flange of the Enphase Microinverter accepts #10 through #6 AWG grounding electrode conductors. As an alternative to installing a continuous grounding electrode conductor connected to each Microinverter chassis, a grounding washer may be used to ground the Microinverter to grounded racking. CSA recently completed the evaluation and approval of the Wiley Electronics "WEEB" grounding washers for use with the Enphase Microinverter. Where the compatible racking models have listed grounding washers available, the Wiley Electronics part numbers have been included in the tables below.

### Section 1 - No Modification Required

#### AEE

Module Rail	Fastener Information	Grounding Washer
SnapNRack	Slide nut with 5/16 hex head bolt	WEEB-PMC

#### Conergy

Module Rail	Fastener Information	Grounding Washer
Suntop	Quickstone slide nut with M8 socket head cap screw	WEEB-CMC

#### Direct Power and Water

Module Rail	Fastener Information	Grounding Washer
Power Rail	¼" hex head bolt, washer, nut, for top rail mount	WEEB-DMC



### IronRidge

Module Rail	Fastener Information	Grounding Washer
Light Rail XRL	¼" hex head bolt, washer, nut, for top rail mount	WEEB-DMC
Standard Rail XRS	¼" hex head bolt, washer, nut, for top rail mount	WEEB-DMC

### Krannich Solar

Module Rail	Fastener Information	Grounding Washer
K2 Systems	Slide nut with M8 socket head cap screw	WEEB-KMC

### mounts4solar

Module Rail	Fastener Information	Grounding Washer
Rail 6.0	M8 SS Hammer Head Bolt	

### NCP Solar

Module Rail	Fastener Information	Grounding Washer
	Slide nut with 5/16" socket head cap screw	WEEB-11.5

### ProSolar

Module Rail	Fastener Information	Grounding Washer
Rooftrac	Slide nut with 5/16" hex head bolt	WEEB-PMC

### Schuco

Module Rail	Fastener Information	Grounding Washer
SolarEZ	ezUniversal Screws (M8x14) ezAnchor Blocks	WEEB-SMC

## Sollega

Module Rail	Fastener Information	Grounding Washer
InstaRack	Top Spring Nut with 5/16" hex head bolt	WEEB-DMC

## Unistrut

Module Rail	Fastener Information	Grounding Washer
1-5/8", 1-1/4", 13/16", metal framing system	Channel nut with either 1/4" or 5/16" hex head bolt	

## Unirac

Module Rail	Fastener Information	Grounding Washer
Solarmount Light	1/4" hex head bolt, washer, nut, for top rail mount	WEEB-DMC
Solarmount Standard	1/4" hex head bolt, washer, nut, for top rail mount	WEEB-DMC
Solarmount HD	1/4" hex head bolt, washer, nut, for top rail mount	WEEB-DMC
Clicksys	Enphase mounting kit – 008010M-0024	

## Section 2 – Modification or Custom Adapter Required

### Unirac Sunframe

The Unirac Sunframe racking system secures the PV modules with a cap strip along the entire top edge of the racking instead of a typical bolt and clamp bracket arrangement. The Enphase Microinverters can be attached to the racking flange that supports the underside of the PV module by adding mounting holes and a flat adapter plate for the microinverter to attach to.

### Sunlink

When ordering a Sunlink Tilt Access™ system, specify that it is for an Enphase Microinverter installation. Sunlink will add microinverter mounting holes to the "Spar" extrusion. The mounting holes would be located at per module spacing for the M190, M210 microinverters, or at every other module spacing for the D380.

## **Section 3 – Factory Installed Assemblies**

### **Akeena Andalay**

The Akeena Andalay system makes use of a proprietary PV module frame that allows the PV modules to be assembled to each other without the use of standard module racking. The Enphase Microinverter is factory mounted directly to the underside of the PV module frame and shipped as a one PV module, one Microinverter assembly.

### **Ready Solar**

The Ready Solar “Solar in a Box” system makes use of a proprietary PV module frame weldment that supports 3 PV modules per frame. The Enphase Microinverters are factory installed to a rail behind the modules and shipped as part of a complete 3 PV module, frame, Microinverter assembly.

### **Solar Red**

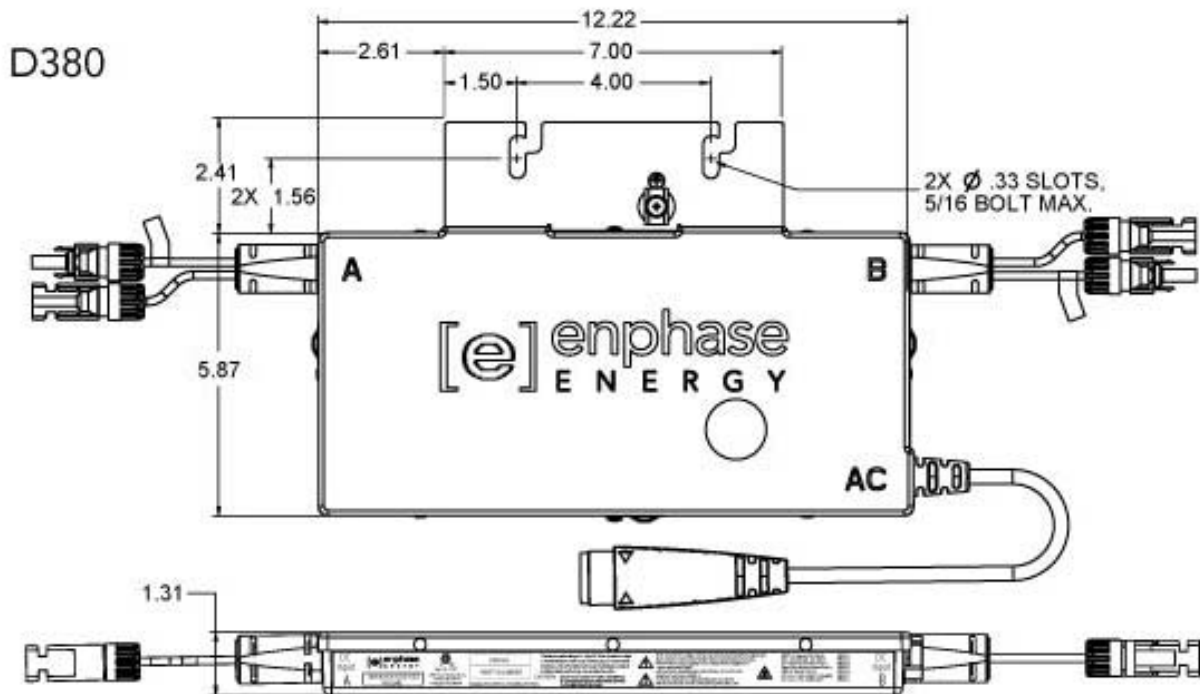
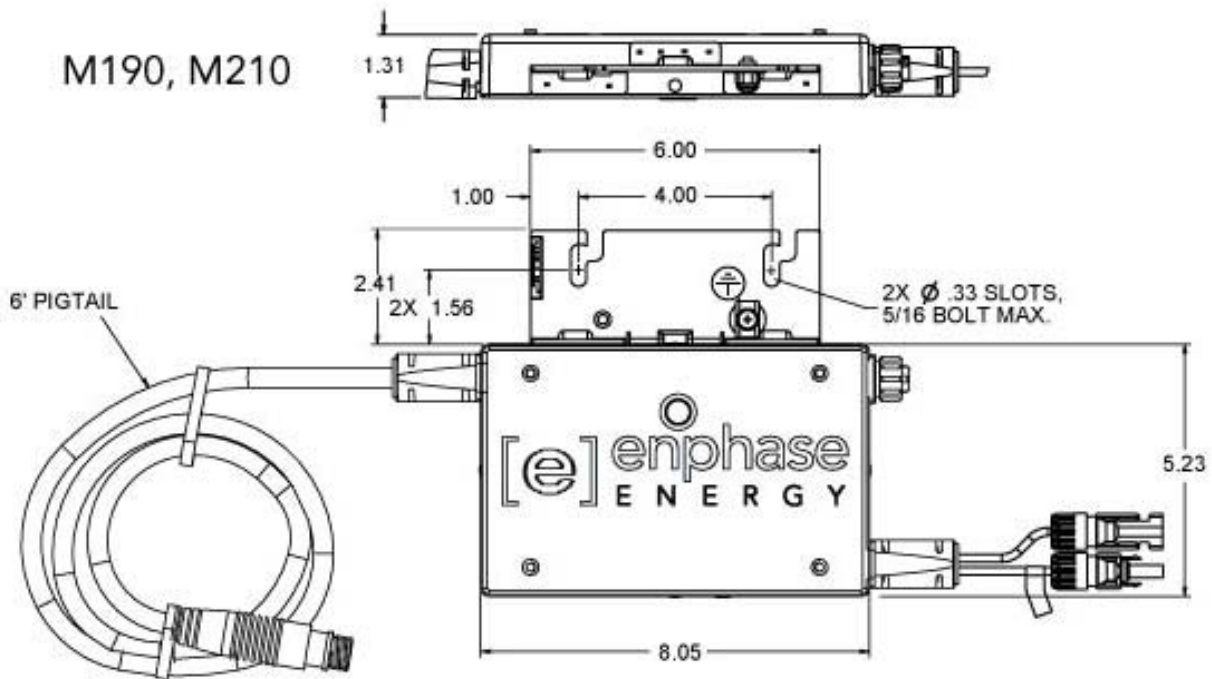
The Solar Red PV module mounting system makes use of proprietary brackets that are factory mounted to standard PV module frames and mate to a proprietary roof bracket. The Enphase Microinverter is factory mounted to the “Panel Lower Mount” and ships as part of a PV module, panel lower mount, panel locking mechanism assembly.

### **Zep Solar**

The Zep Solar system makes use of a proprietary PV module frame that allows the PV modules to be assembled to each other without the use of standard module racking. The Enphase Microinverter is factory mounted directly to the underside of the PV module frame and shipped as a one PV module, one Microinverter assembly.

## M190, M210, D380 Dimensions

If a specific racking model is not listed in this document, the drawing below can be used to verify compatibility.



We continue to evaluate racking models for compatibility. Please check the Enphase Energy website for product updates and announcements or contact Customer Service regarding a specific racking compatibility:

Enphase Energy website: <http://www.enphaseenergy.com>

Enphase Customer Service:  
<http://www.enphaseenergy.com/support/technicalsupport.cfm>

Enphase Energy Inc.  
201 1<sup>st</sup> Street, Suite 300  
Petaluma, CA 94952  
Phone: 707-763-4784  
TOLL FREE: 877-797-4743  
Fax: 707-763-0784  
[www.enphaseenergy.com](http://www.enphaseenergy.com)  
[info@enphaseenergy.com](mailto:info@enphaseenergy.com)



*Experience. Technology. Answers.™*

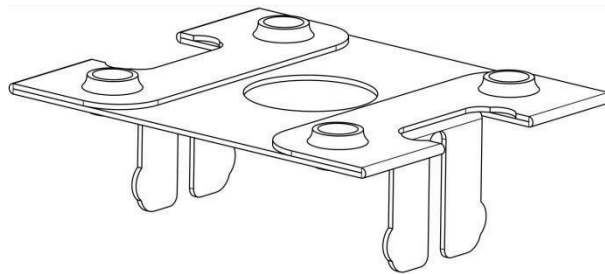
## Washer, Electrical Equipment Bond **WEEB**

### INSTALLATION INSTRUCTIONS

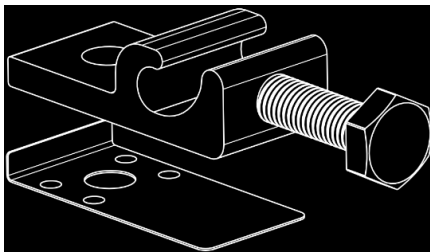
***For IronRidge Light & Standard Series Rails Only***

Please read carefully before installing.

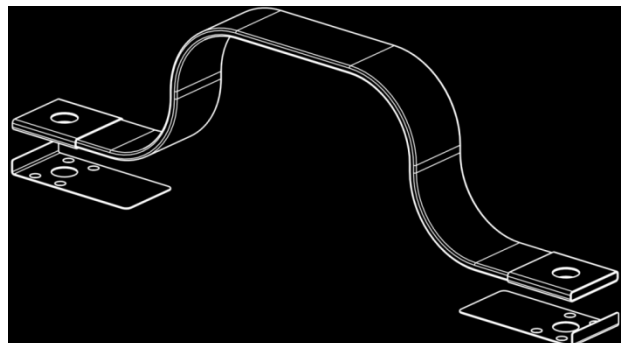
Burndy recommends that the sufficient details of the installation be submitted to the AHJ for approval before any work is started.



**WEEB-DMC**



**WEEBLug-6.7**



**WEEB Bonding Jumper-6.7**

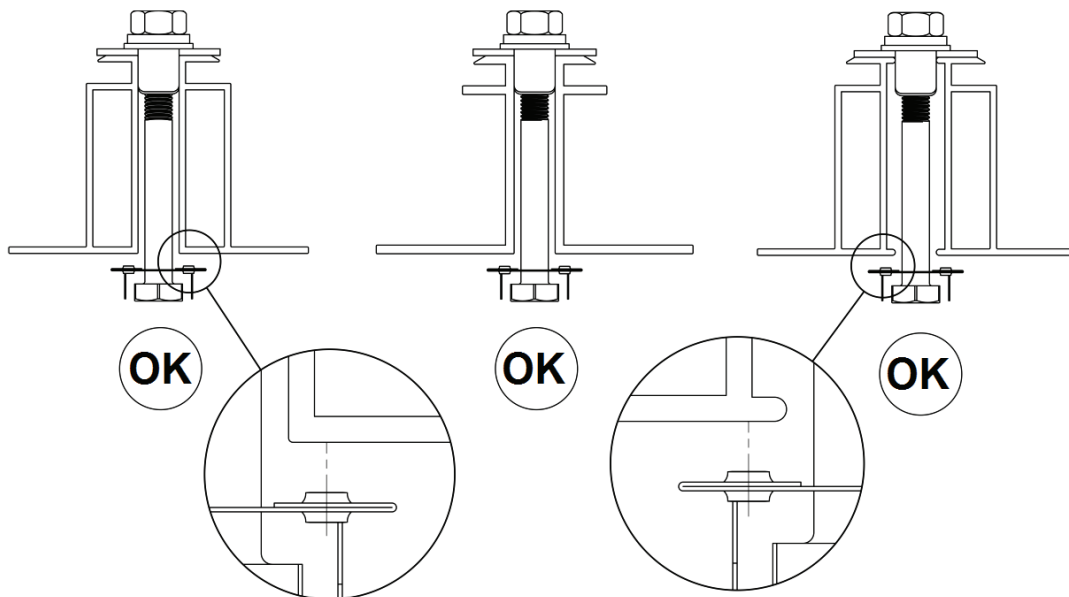
Products are tested to UL 467, CAN/CSA-C22.2 No. 41 US/ Canadian standards for safety grounding and bonding equipment.

# WEEB COMPATIBILITY

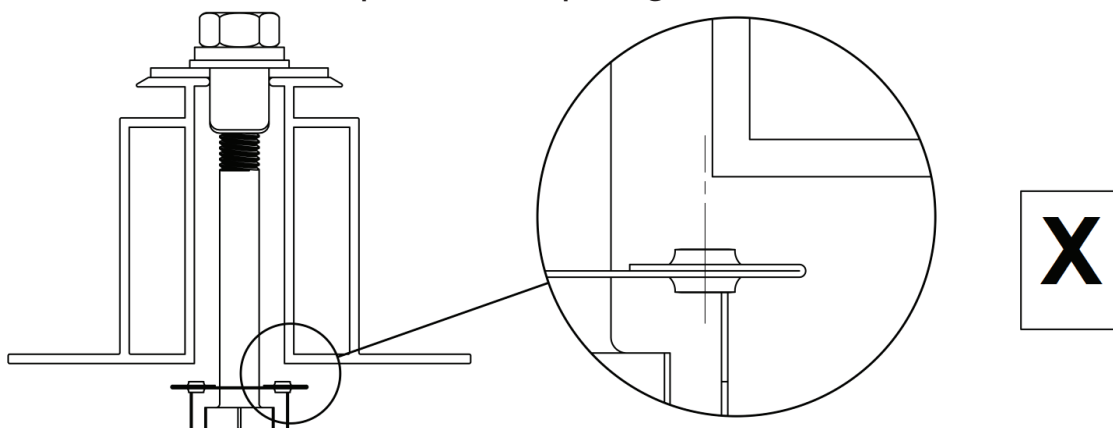
The WEEB family of products can be used to bond anodized aluminium, galvanized steel, steel and other electrically conductive metal structures. All installations shall be in accordance with NEC requirements in the USA and with CSA C22.1 in Canada. The WEEBs are for use with modules that have a maximum series fuse rating of less than 25A.

## Standard Top Down Clamps

The WEEBs used for bonding the PV modules to the mounting rails are compatible with various cross-sections of module frames. The following are examples of module frames that are compatible. Notice that the WEEB teeth are positioned completely under the edge of the module frame.



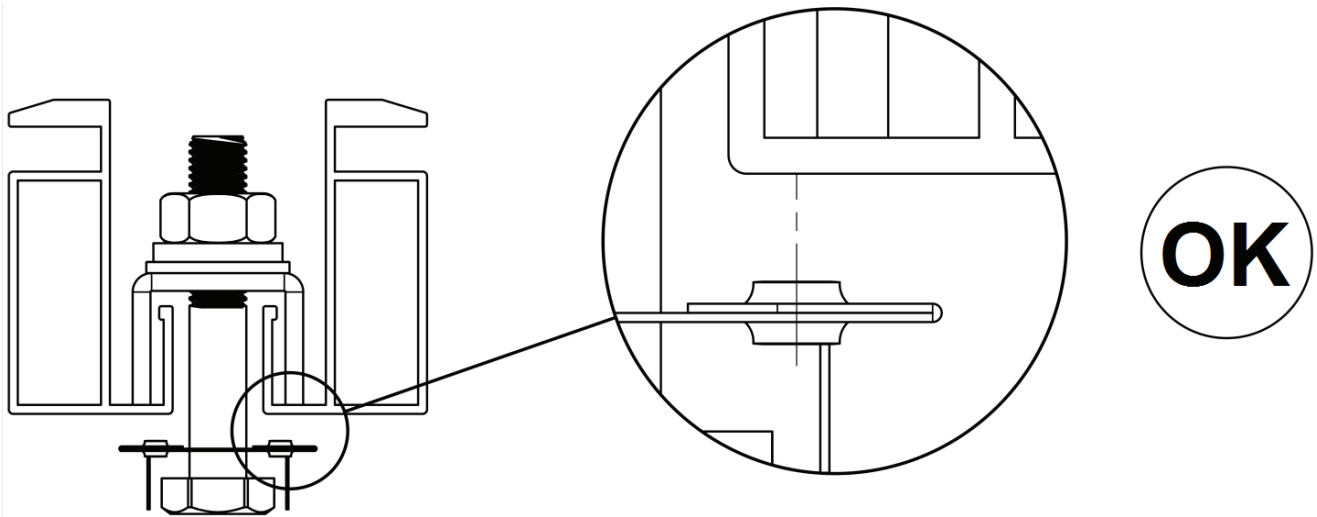
The following is an example of a module frame that is incompatible with the WEEB. The WEEB teeth are positioned only partially under the edge of the module due to the lip on the top edge of the module.





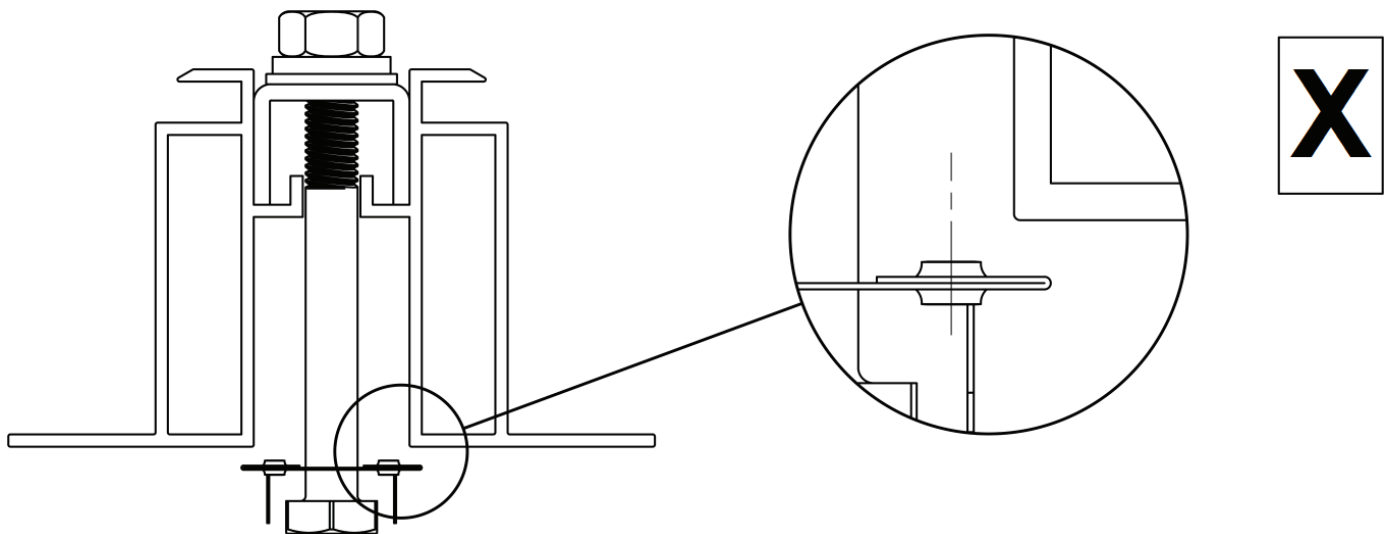
## Top Down Clamps for Lipped Modules

The following are a few variations of lipped solar modules mounted with inverted U-shaped clamps. Notice that the force which the inverted U-shaped clamp exerts is in line with the WEEB teeth.



## Low-Lipped Module

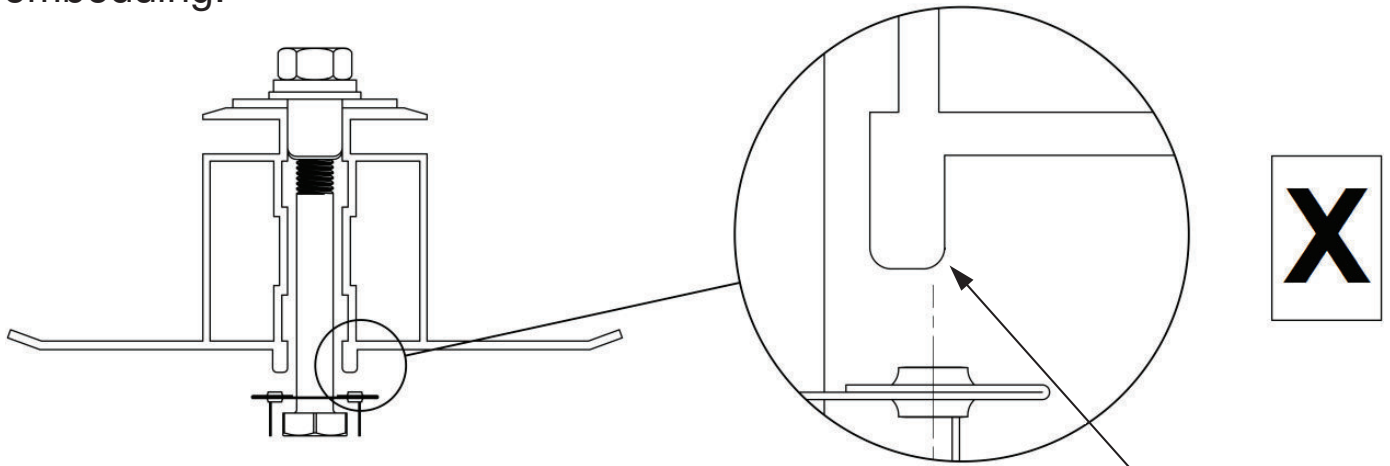
The WEEB-DMC is not compatible with high lipped modules. The WEEB teeth do not intersect with the solar module frame.



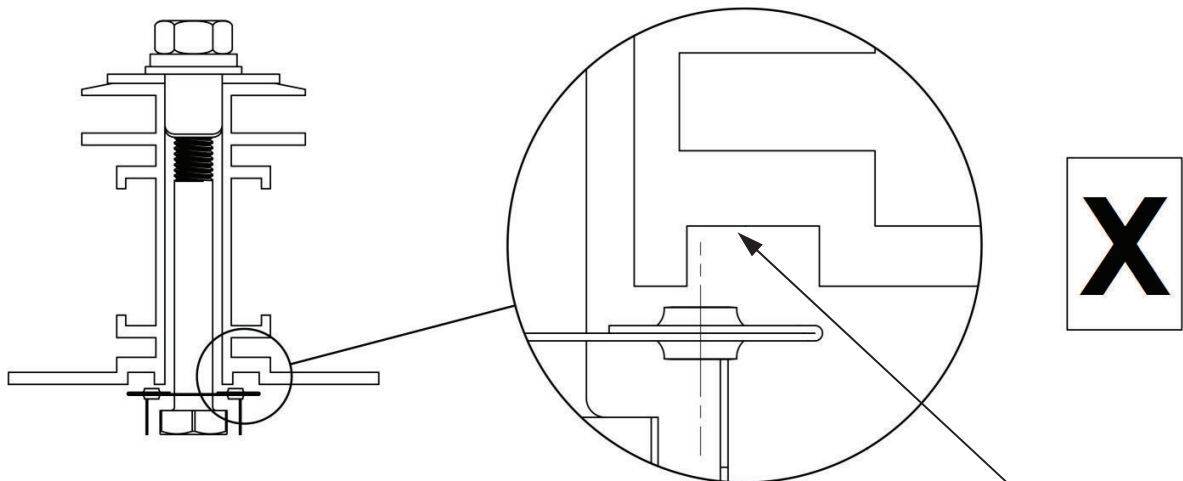
## High-Lipped Module

# WEEB COMPATIBILITY

Module frames like those shown here may have a ridge or lip on the bottom edge of the frame that would prevent the WEEB teeth from fully embedding.



Shown here is an example of a lip that will prevent the WEEB teeth from properly penetrating the module frame. This type of frame is not compatible with the WEEB.



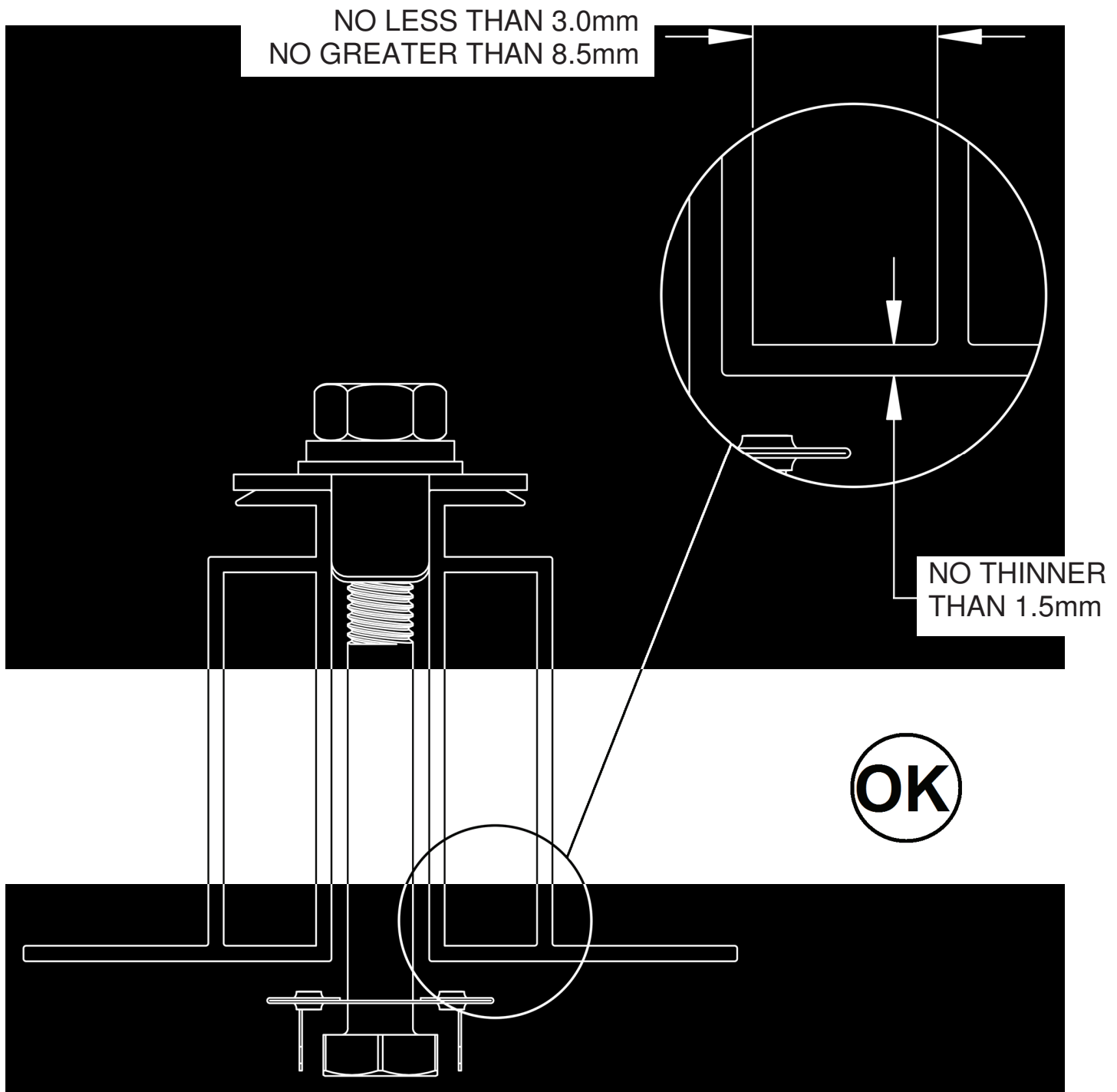
Shown here is an example of a groove that will prevent the WEEB teeth from properly penetrating the module frame. This type of frame is not compatible with the WEEB.

## Important Note:

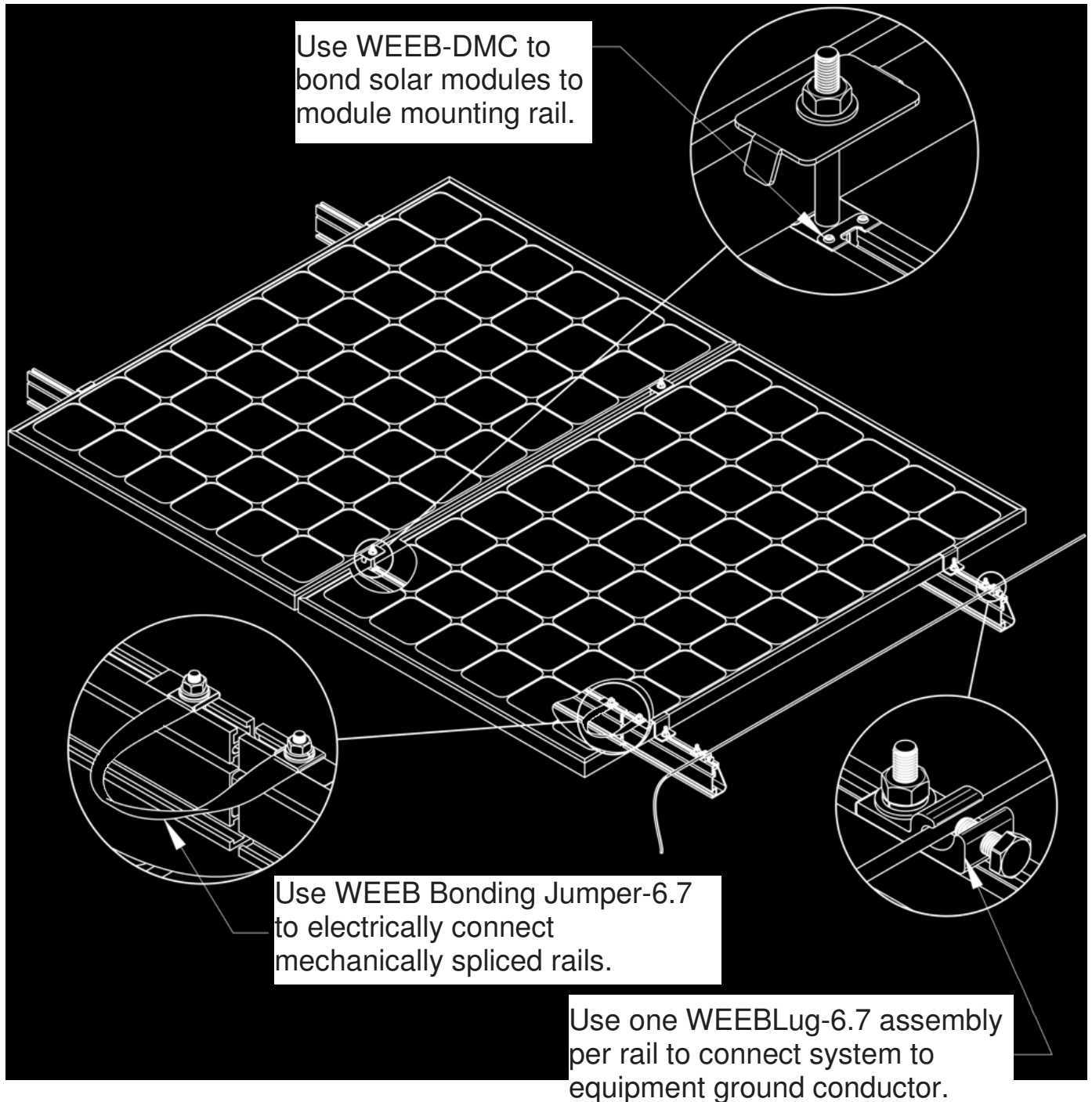
**Inspect each module frame used with a WEEB to ensure that the bottom mounting face of the frame is flat, and that there are no hindrances to embedding WEEB teeth. Do not use a module with a frame that prevents the WEEB teeth from embedding fully.**

# WEEB-DMC on Boxed Module Frames

Certain module frames do not have enough structural strength to withstand the force required to embed a WEEB. These frames will deform and therefore not allow sufficient penetration of the WEEB teeth. The general requirements for minimum module frame thickness of "boxed" type module frames are illustrated below.



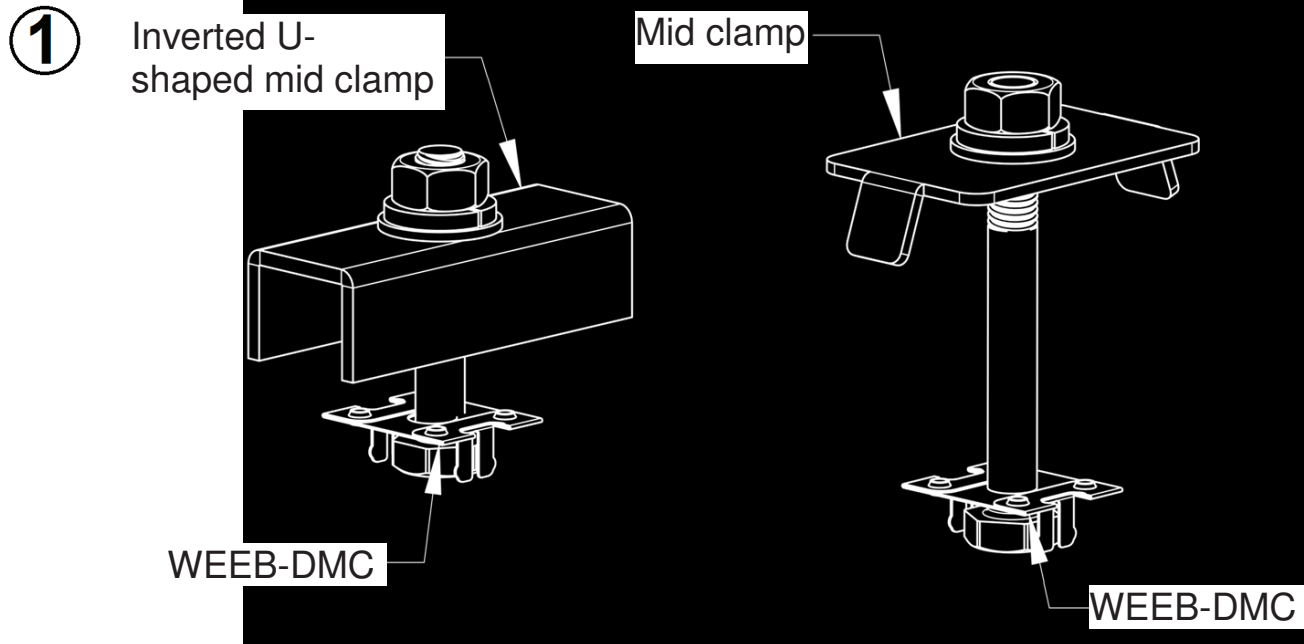
# SYSTEM OVERVIEW



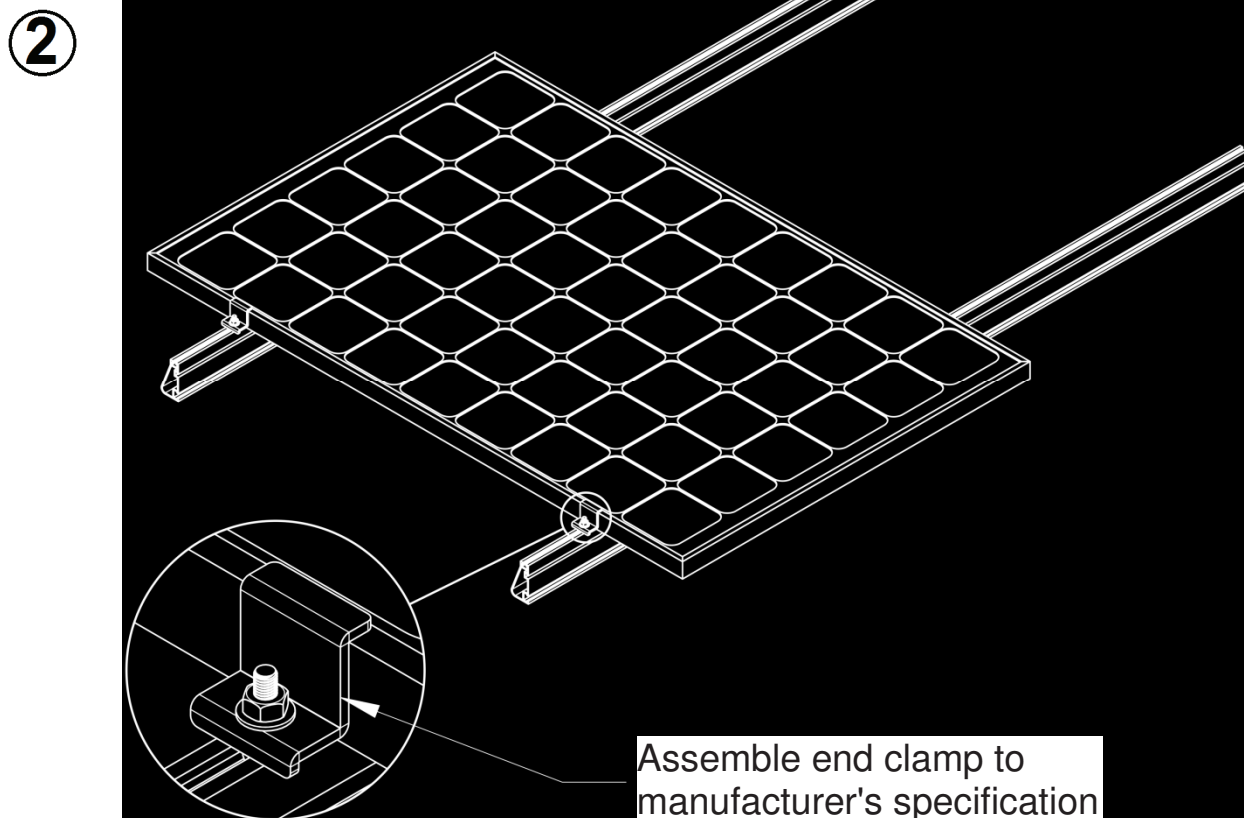
## Important notes

1. Use general purpose anti-seize compound on fastener threads when installing WEEBs.
2. The NEC section 690.43 states, "Exposed non-current carrying metal parts of module frames, equipment, and conductor enclosures shall be grounded in accordance with 250.134 or 250.136(A) regardless of voltage."
3. WEEBs are intended for **SINGLE USE ONLY**. Functionality will not be guaranteed if reused.

# WEEB-DMC ASSEMBLY

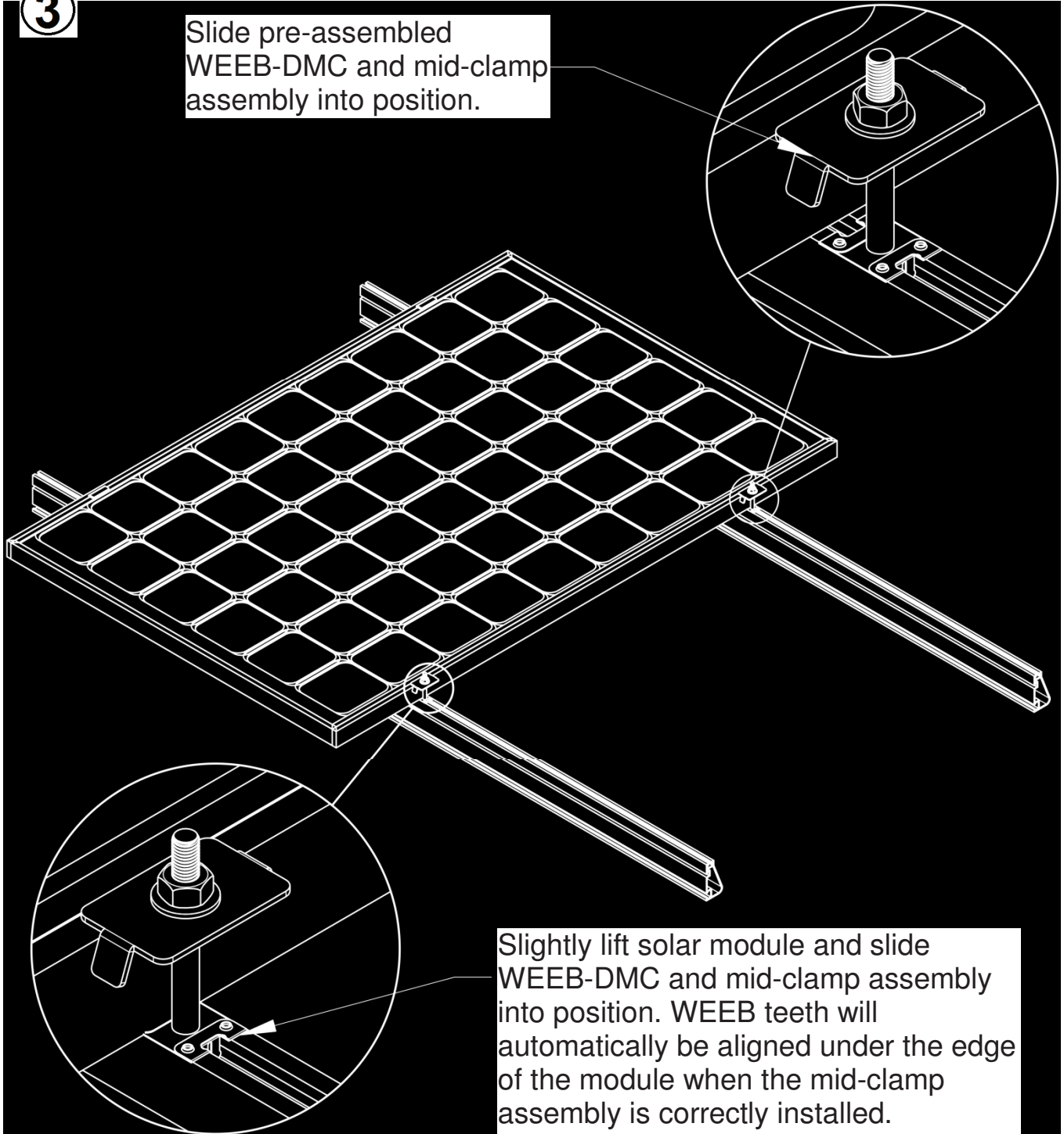


Pre-assemble WEEB-DMC to mid-clamp assembly as shown. Pre-assembling WEEB-DMC to mid-clamp assembly will contain the small individual parts, reducing the possibility of losing parts during installation.



3

Slide pre-assembled WEEB-DMC and mid-clamp assembly into position.



### Important note:

To correctly install mid clamp assembly, ensure that the bolt is perpendicular to the mounting rail. To correctly install WEEB-DMC, ensure that both sides of the solar modules are completely positioned against the mid-clamp. Refer to WEEB compatibility page for illustrations. Visually check that WEEBs are properly positioned.

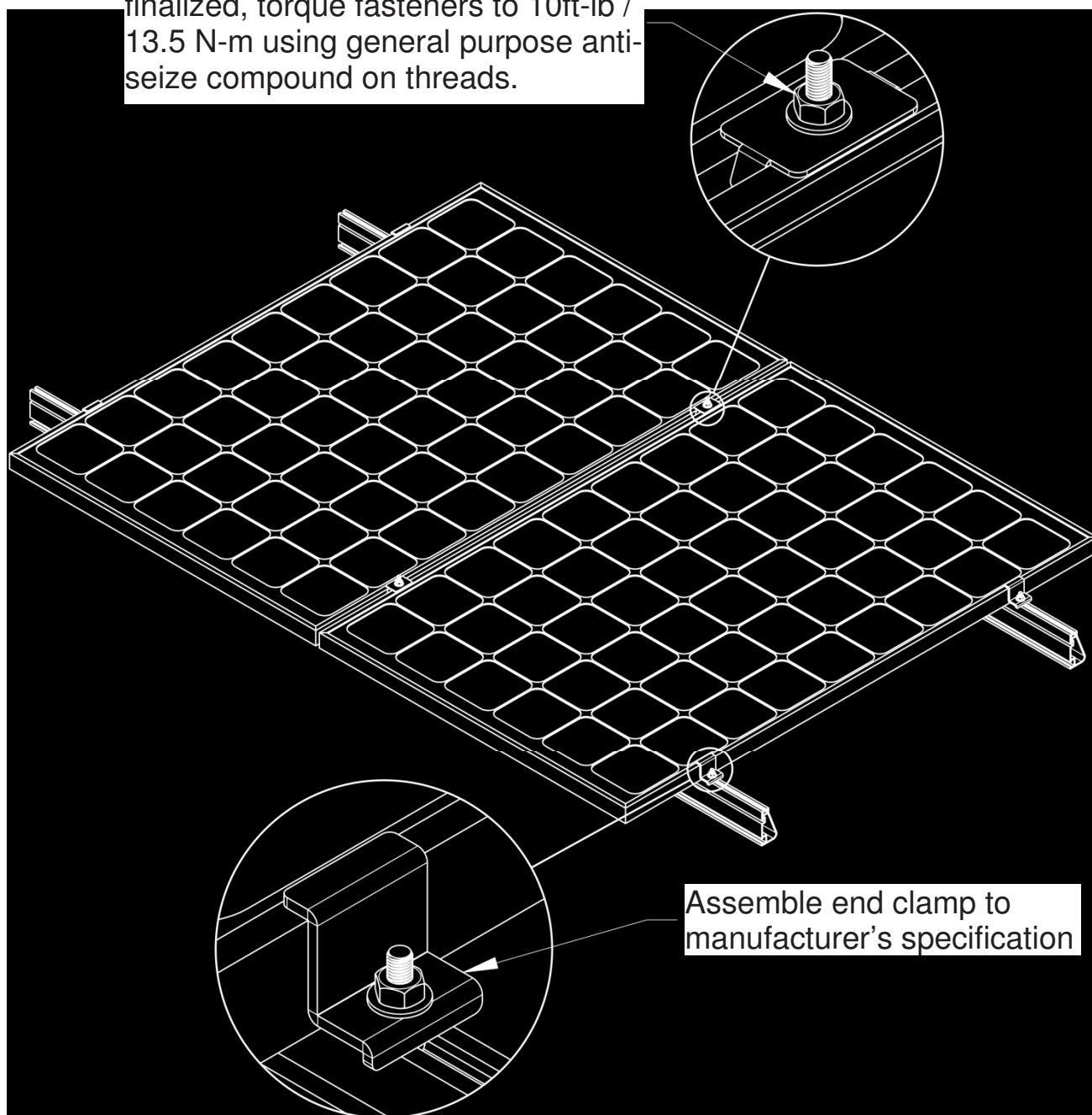


## Important note:

**WEEBs are for SINGLE USE ONLY! Do not torque fasteners down if position of solar modules is not finalized. Only slightly tighten fasteners to keep modules in place.**

④

When position of solar modules is finalized, torque fasteners to 10ft-lb / 13.5 N-m using general purpose anti-seize compound on threads.

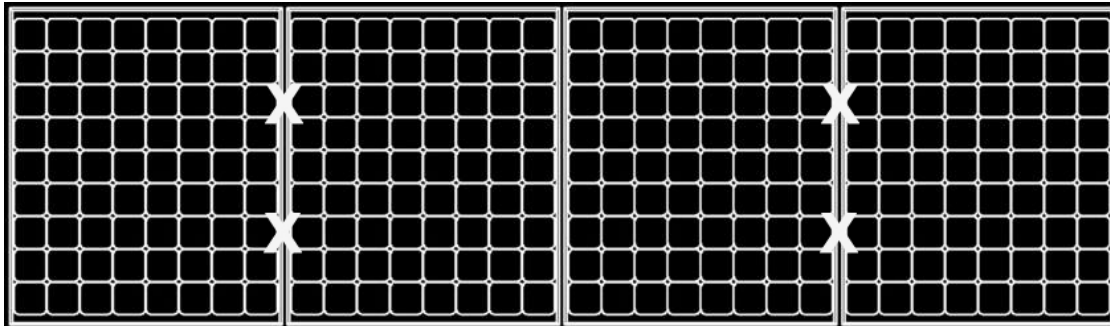




⑤

# WEEB-DMC LAYOUT

## EVEN NUMBER OF MODULES IN ROW

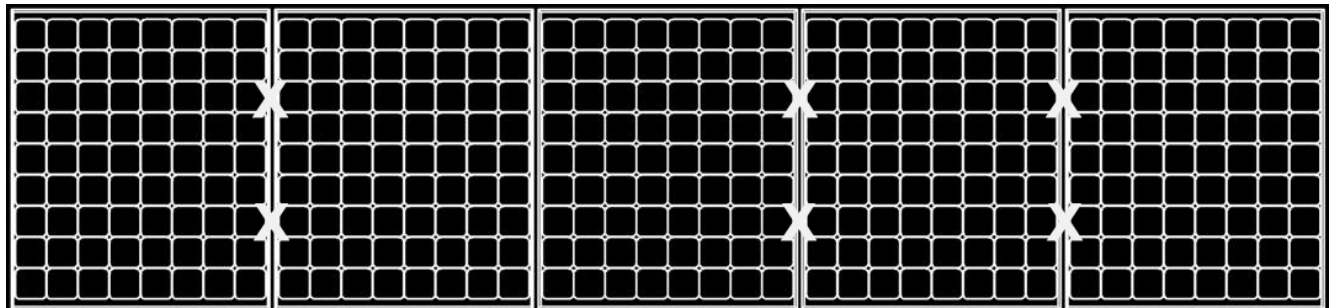


X DENOTES PLACES TO INSTALL WEEB-DMC

$$C \times R = 4 \times 1$$

$$\text{WEEB-DMC NEEDED} = C \times R = 4 \times 1 = 4$$

## ODD NUMBER OF MODULES IN ROW



X DENOTES PLACES TO INSTALL WEEB-DMC

$$C \times R = 5 \times 1$$

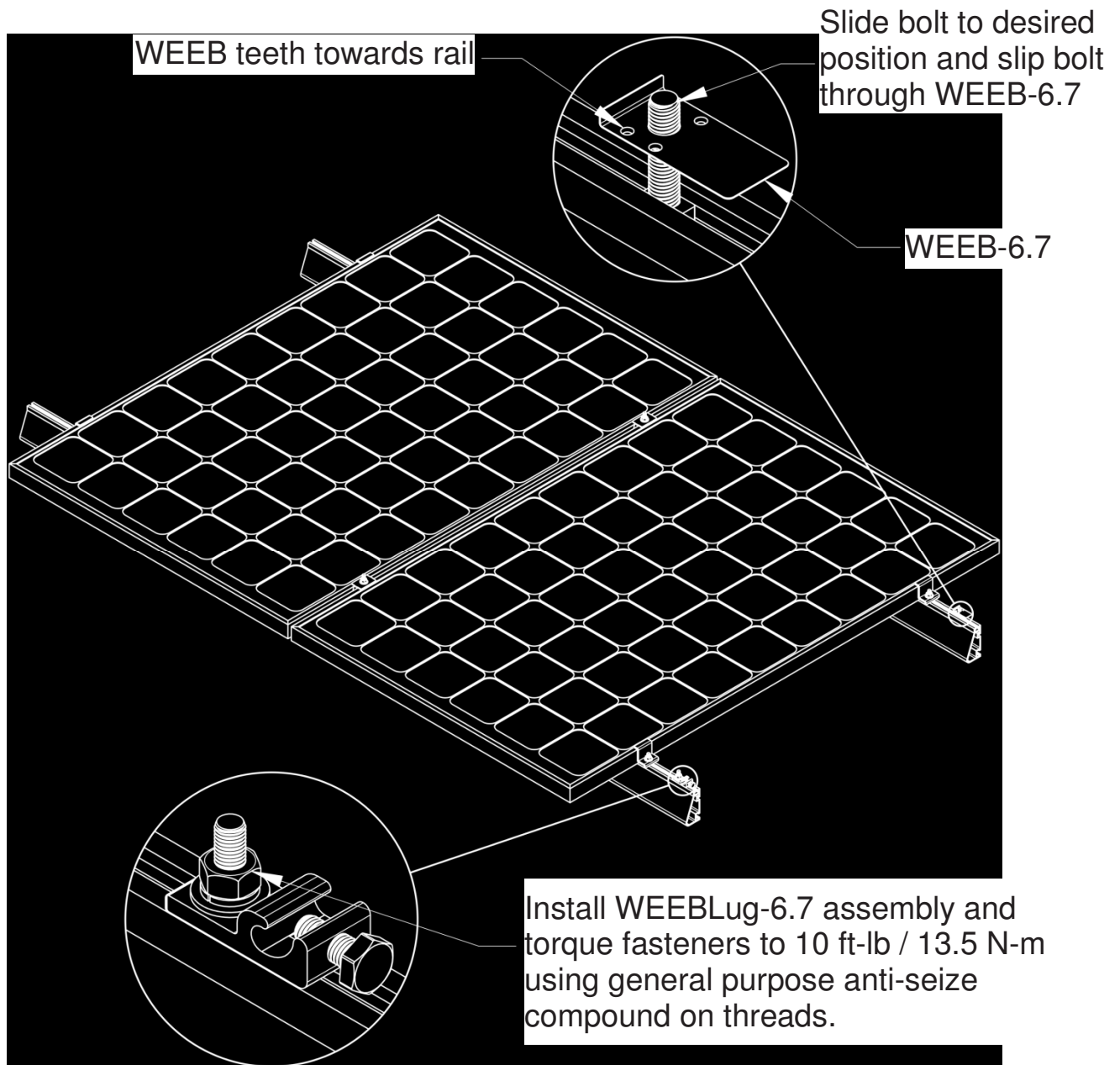
$$\text{WEEB-DMC NEEDED} = [C+1] \times R = [5+1] \times 1 = 6$$

### Note:

When replacing a single faulty module, also remove the adjacent module which contacts the same WEEBs as the faulty module. This will ensure that there are never ungrounded modules in the array.

# WEEBLUG ASSEMBLY

⑥

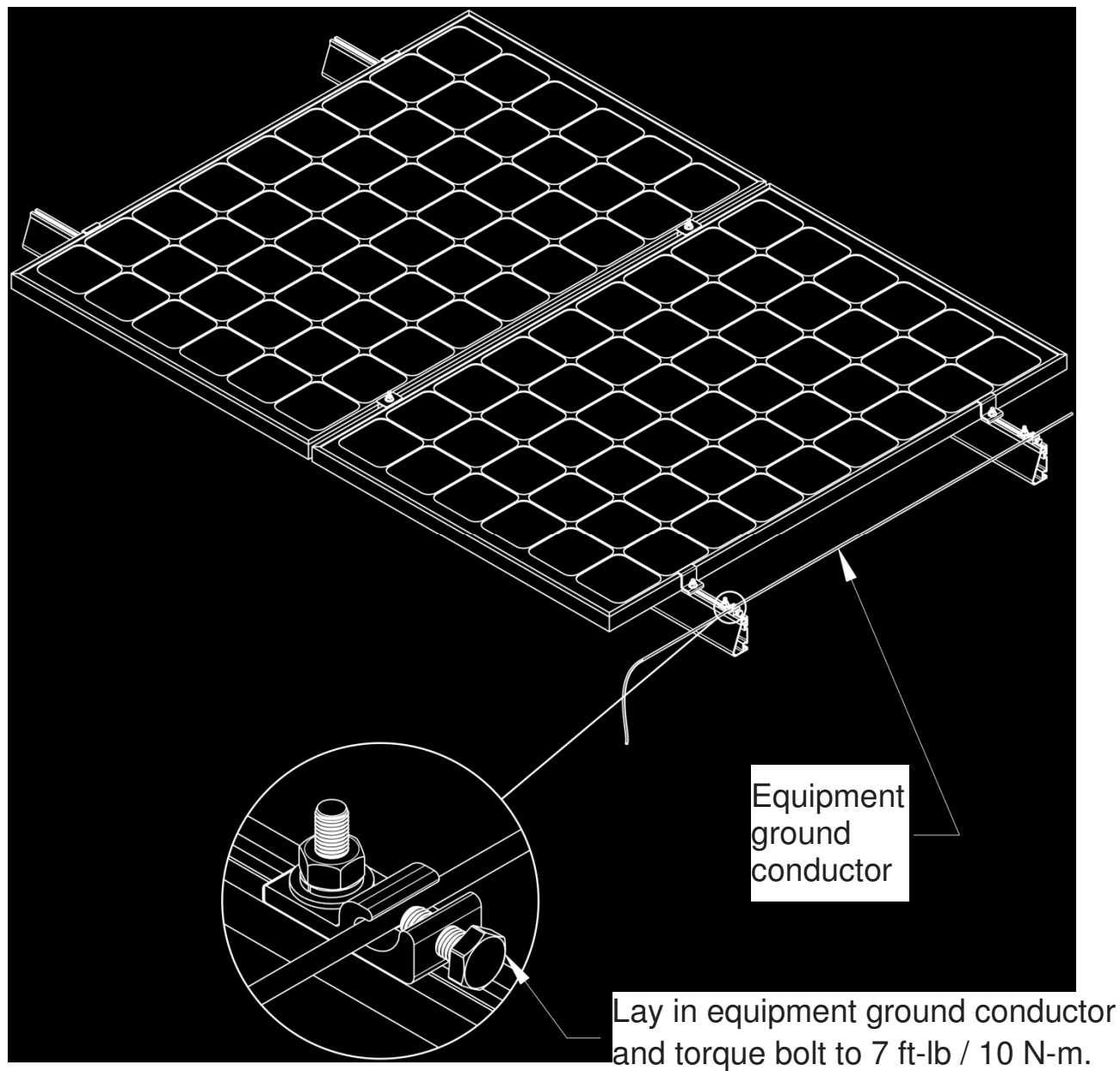


## Important note:

1. WEEB-6.7 that sits under the WEEBLug is for **SINGLE USE ONLY!** Ensure position is correct before tightening.
2. The WEEBLug-6.7 may be used with a maximum equipment ground wire of 6 AWG.

# GROUND CONDUCTOR ASSEMBLY

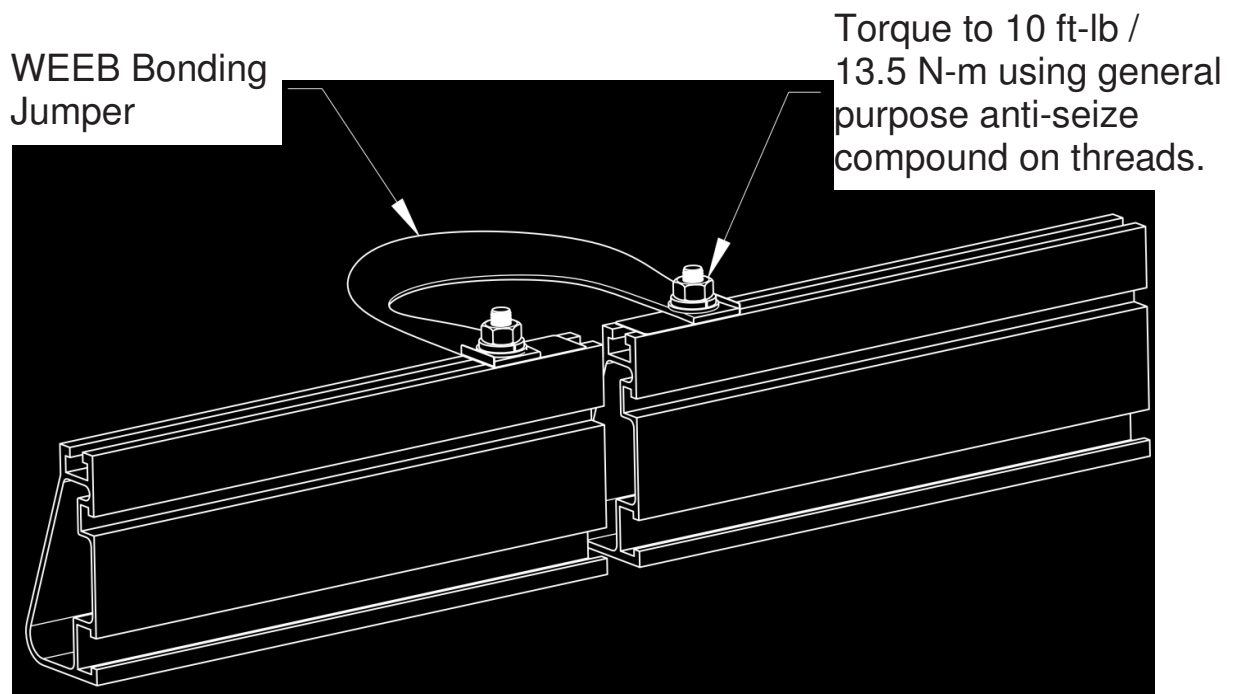
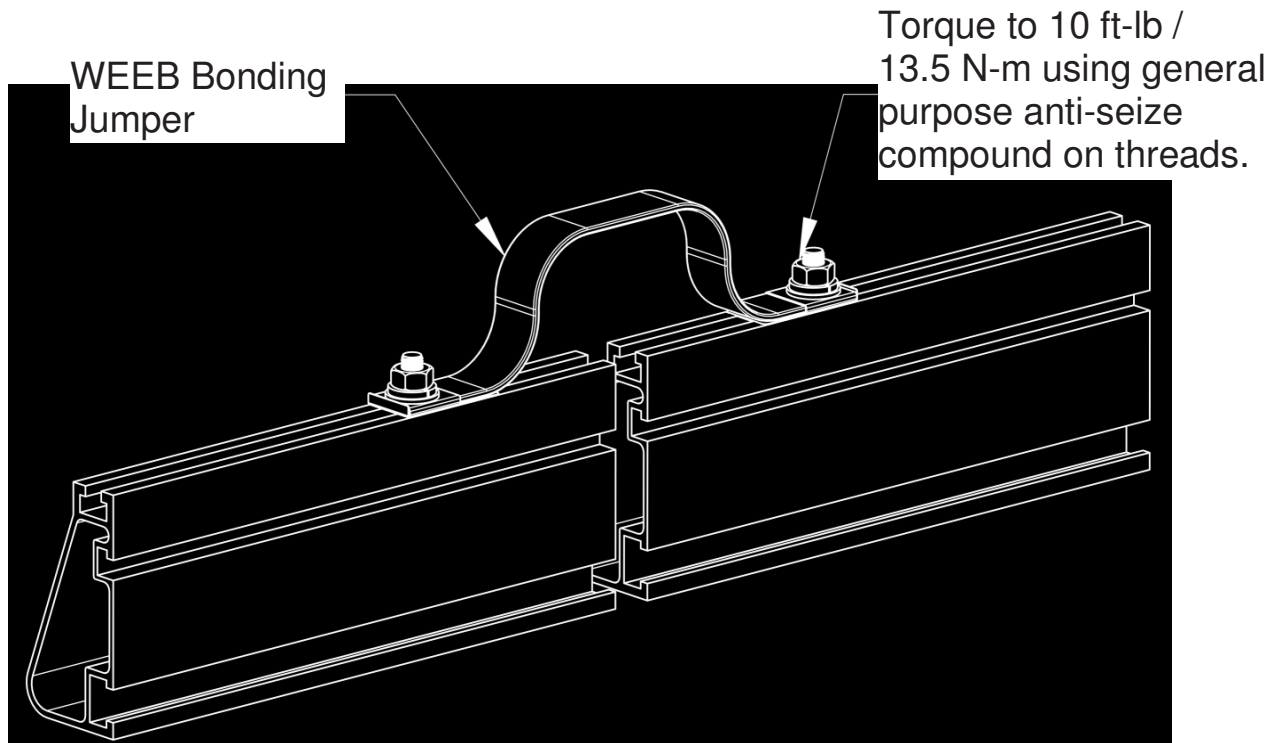
7



# WEEB BONDING JUMPER-6.7 ASSEMBLY

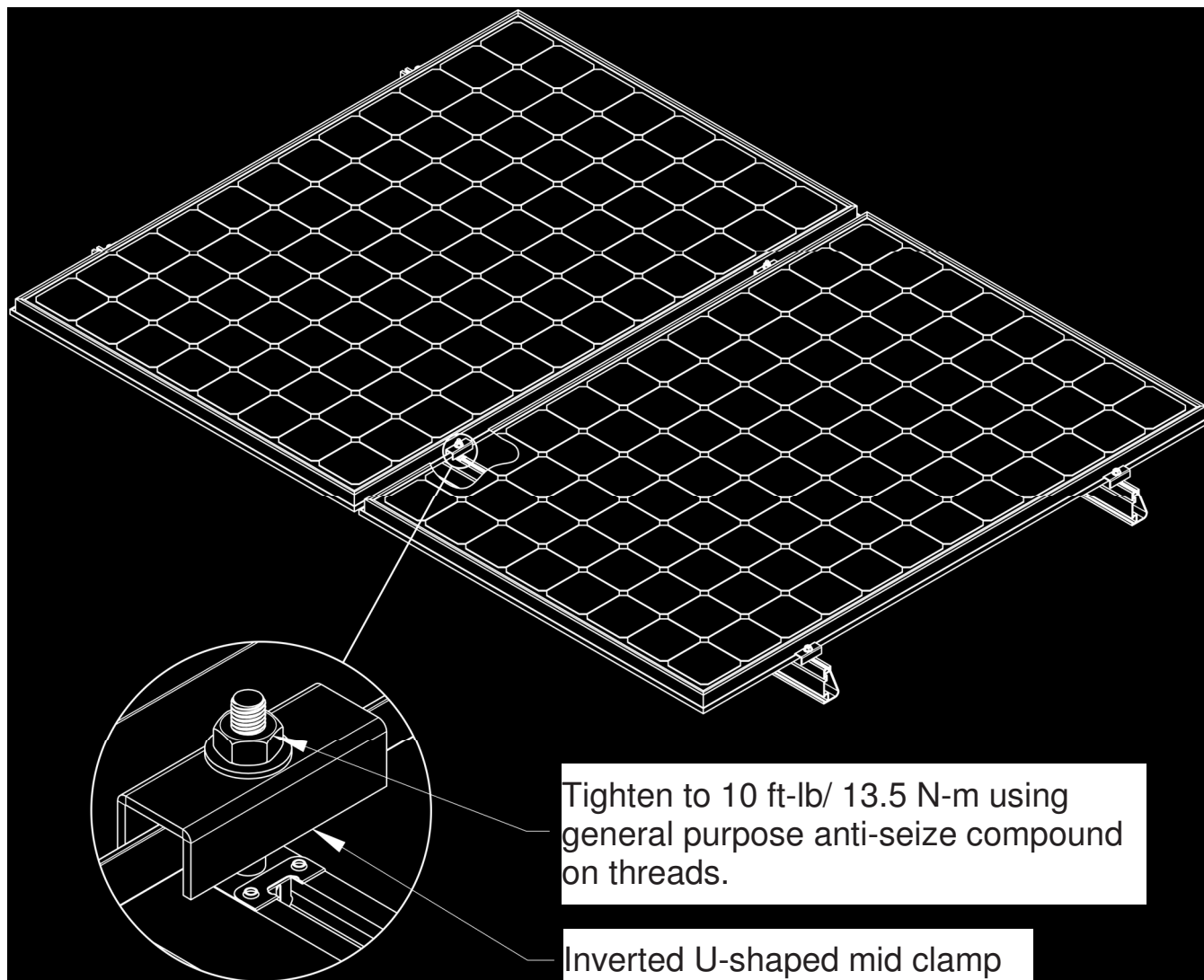
⑧

The flexible WEEB Bonding Jumper can be mounted on all rail splices including expansion joints in different ways shown below.



Route WEEB Bonding Jumper as shown above if the edge of solar module lands between two splice rails.

# LOW LIPPED MODULE INSTALLATION



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## Frequently Asked Inspection Questions

### What is a WEEB?

The WEEB (Washer, Electrical Equipment Bond) is the first production part specifically intended for use in grounding photovoltaic systems. There is a family of WEEB parts, one for each kind of photovoltaic mounting system. The WEEBs are used to bond photovoltaic modules to the mounting structure. A ground is connected to the resulting composite structure so that the photovoltaic modules are also grounded. This is more technically described in NEC sections 250.136 and 250.134 and discussed at the company website, [http://www.we-llc.com/WEEB\\_nec.html](http://www.we-llc.com/WEEB_nec.html).

### Are WEEBs listed?

Yes, all WEEBS meet ANSI/UL 467, standard for grounding and bonding equipment. Testing was performed by Intertek ETL. The WEEB are listed to US and Canadian standards. A copy of the certificate is available online at [http://www.we-llc.com/PDF/ETL mark.pdf](http://www.we-llc.com/PDF/ETL_mark.pdf)

### Why UL 467 and not UL 1703, standard for photovoltaic modules?

ANSI/UL 1703 only covers photovoltaic modules. Since the WEEB parts involve both module and mounting system, the more general standard, ANSI/UL 467 is required. Also, since ANSI/UL 467 was written with AC systems in mind it is a much more severe specification. All WEEBs are tested to carry a current of 1530 Amperes for 6 seconds. This is much more than any photovoltaic module can source and is why the WEEBs offer better lightning protection than previous grounding methods.

### Why not just use the commonly available grounding lugs?

The lugs are not listed for use in the manner they are commonly installed.

One popular method of grounding photovoltaic modules is to attach a lug to each module, then run a ground conductor between all the lugs. IlSCO and Burndy make a direct burial rated lug, listed to ANSI/UL 467 which is often used. In testing to ANSI/UL 467 for these lugs, the lugs are bolted to a steel plate. The majority of conduction is through the lug and not through the mounting bolt. Some installers instead use a #8 stainless steel screw to mount the lugs and rely on the screw to conduct current from the top of the lug, through the screw, into the module. The NEC does not permit a conductor to be other than copper or aluminum. One might consider the lug/screw combination to be one part; however, the screw is not provided by the lug manufacturer but by third party suppliers who have not had the lug/screw combination part listed.

Testing at Wiley Electronics LLC shows that if the third part suppliers were to have the lug/screw combination parts tested to ANSI/UL 467, they would only be rated for use with a 10 AWG wire maximum. This limitation is due to the high resistance of the stainless steel screw.



### **How can an installation using WEEBs be verified?**

We suggest measuring electrical resistance. This directly verifies the ground connection without the need for visual inspection. We recommend using an ohm-meter set to its lowest scale. Safety pins are a convenient extension to the ohm-meter leads. The sharp points can penetrate non-conductive aluminum oxide layers and be easily stored.

#### **1. Verify module frames are connected**

- a) Select two modules at random.
- b) Verify that the ohm-meter and probes are functioning.

Scratch through the anodized layer of the first module frame at two points and verify that continuity exists between the two points. Repeat for a second module frame.

- c) Verify continuity between the scratched points of the two module frames.
- d) Repeat steps (a) – (d) for a statistically significant number of other pairs of modules.

#### **2. Verify modules are connected to mounting rails**

- a) Select a module and mounting rail at random.
- b) Verify that the ohm-meter and probes are functioning.

Scratch through the anodized layer of the module at two points and verify that continuity exists between the two points. Repeat for the mounting rail.

- c) Verify continuity between the scratched points on the module and mounting rail.
- d) Repeat steps (a) – (c) for a statistically significant number of other modules and mounting rails.

#### **3. Verify mounting rail is grounded**

- a) Select a rail at random.
- b) Verify that the ohm-meter and probes are functioning.

Scratch through the anodized layer of the mounting rail at two points and verify that continuity exists between the two points.

- c) Verify continuity between one of the scratched points and the equipment ground conductor.
- d) Repeat steps (a) – (c) for a statistically significant number of other mounting rails.





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## **Servicing a grounded array**

Section 60.48 of the National Electric Code states that

“Where the removal of equipment disconnects the bonding connection between the grounding electrode conductor and exposed conducting surfaces in the photovoltaic source or output circuit equipment, a bonding jumper shall be installed while the equipment is removed.”

In rail mounted systems, each WEEB connects to two modules as is shown in figure 1. If the two WEEBs between the modules are removed in order to remove one of the modules, then the ground to the other module would be disturbed. To prevent this from happening, before a module is serviced, a new WEEB should be added at the far end of the module which is not being removed. This is shown as a circle in the figure. The additional WEEB connection will ensure that ground is present during the service operation.