

January 11, 2019

Everest Solar Systems, LLC
3809 Ocean Ranch Blvd, Suite 111
Oceanside, CA 92056
Attn: Andy Neshat



RE: *CrossRail 48-X Connector Evaluation*

To whom it may concern:

Per your request, Moment Engineering + Design has performed a comprehensive structural review of the Everest CrossRail 48-X Splice Connector. When installed per the conditions and design criteria described herein, the Splice Connector specified is compliant with the applicable sections of the design reference documents noted below.

Design Reference Documents

- ASCE/SEI 7-10 & 7-05 – *Minimum Design Loads for Buildings and Other Structures*
- ADM1 - *2010 Aluminum Design Manual*, by the Aluminum Association
- AAMA TIR A9-91 – *Metal Curtain Wall Fasteners*

Overview

The proposed connector secures two shorter pieces of rail together to form a longer rail section with a channel nut located each side of the splice (on one side) and a continuous interlocking T-Groove connection on the opposite side as shown in product literature (attached). The connected pieces of rail are then used in a similar application as an un-spliced rail transferring loads from connected PV panels thru the rail system to support brackets providing points of attachment to an existing roof structure.

Note that connections to an existing structure are not included in this analysis and should be analyzed by a registered design professional where required by the authority having jurisdiction. Designer should note eccentricity of applied loads in anchorage consideration.

Methods & Design Parameters

Calculated allowable loads were based on the following data:

- *Section and materials data provided by K2 Systems GmbH*
- *Load/deflection test data provided by K2 Systems GmbH*
- *Calculation model of bending stresses based on applied loads*

Technical Data

Material selection for CrossRail 48-X connector is region-dependent and may be any of the following. Analysis of connector is based on least values for material yield and ultimate stresses. Refer to attached product data sheets for supplementary technical data.

<u>Material</u>	<u>Fy</u>	<u>Fu</u>	
EN AW 6063-T66	29	35.5	ksi
6005A-T5	31	38	ksi

6005A-T61	35	38	ksi
6061-T6	35	38	ksi

Section Properties

Tested assembly was based the following:

<u>Property</u>	<u>CrossRail 48-X</u>	<u>Connector</u>
Sx (horizontal axis)	0.199 in ³	0.241 in ³
Sy (vertical axis)	0.153 in ³	0.351 in ³
A (x-Section)	0.467 in ²	0.688 in ²

Installation Notes

The following guidelines apply to all installations using the CrossRail 48-X Connector:

- Connector shall be used for the sole purpose of connecting two pieces of CrossRail 48-X as part of a complete rail system in accordance with manufacturer’s installation instructions.
- Adjoining pieces of rail should be assembled in the connector prior to installation and attachment to the mounting brackets. Do not place gaps (including thermal expansion gaps) between rails in the connector
- Only manufacturer supplied parts equivalent to those in the tested assembly should be used to connect the rails and secure the connector (including M10x25 T-bolts & M10 serrated flange nuts)
- Ensure location of connector does not land at mounting bracket locations as it will prevent the mounting bracket from securing to the rail.
- For proper performance of the connector, t-bolts must be tightened to the specified torque.

Summary

When the CrossRail 48-X connector is installed in accordance with the parameters noted it will not adversely affect the load carrying capacity of the CrossRail 48-X rail system in accordance with previously established span charts.

Maximum Loading Parameters

ASCE 7-10 – 60 cell modules

- Ultimate 3-second gust wind speed (V): 170mph
- Max ground snow load: 50psf
- Max down force: 605#
- Max shear force: 370#
- Max uplift force: 675#

ASCE 7-05 – 60 cell modules

- Ultimate 3-second gust wind speed (V): 140mph
- Max ground snow load: 30psf
- Max down force: 605#
- Max shear force: 370#
- Max uplift force: 675#

ASCE 7-10 – 72 cell modules

- Ultimate 3-second gust wind speed (V): 150mph
- Max ground snow load: 50psf
- Max down force: 605#
- Max shear force: 370#
- Max uplift force: 675#

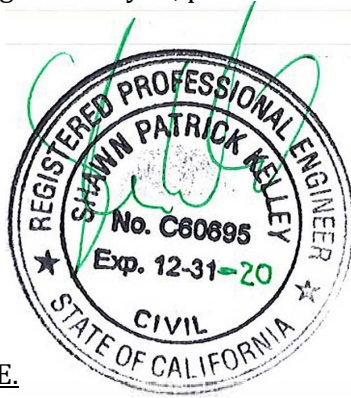
ASCE 7-05 – 72 cell modules

- Ultimate 3-second gust wind speed (V): 120mph
- Max ground snow load: 40psf
- Max down force: 605#
- Max shear force: 370#
- Max uplift force: 675#

For all other configurations exceeding the abovementioned loading parameters, refer to Everest Solar Systems for further engineering support. This evaluation report does not provide analysis of any existing structures, as may be required by the local authority having jurisdiction.

We appreciate the opportunity to have assisted you with this project. Should you have any further questions regarding this analysis, please feel free to contact us by phone or email.

Best Regards,



Shawn P. Kelley, P.E.

Principal

moment ENGINEERING + DESIGN

spkelley@msegllc.com

Attachments:

1. CrossRail 48-X Technical Data Sheet
2. Assembly instructions for Residential Roof Solutions - CrossRail system

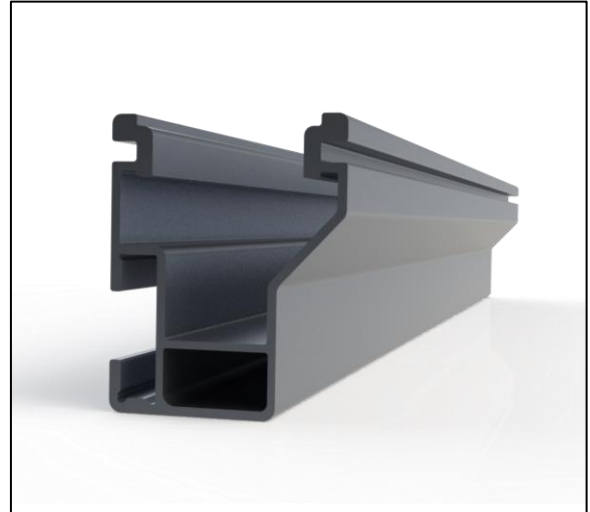


CrossRail 48-X Technical Data Sheet

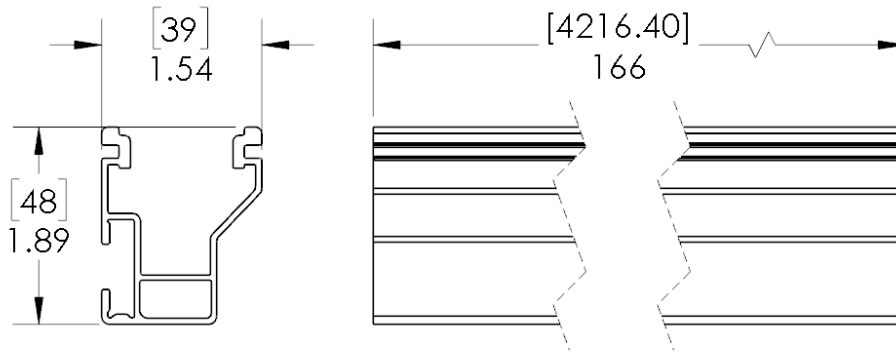
Overview:

MECHANICAL PROPERTIES	
Material:	6000 Series Aluminum
Ultimate Tensile Strength:	37.7 ksi (260 MPa)
Yield Strength:	34.8 ksi (240 MPa)
Weight:	0.56 lbs./ft. (0.833 kg/m)
Finish:	Mill or Dark Anodized

SECTION PROPERTIES	
Sx:	0.199 in ³ (3.261 cm ³)
Sy:	0.153 in ³ (2.507 cm ³)
A (X-Section):	0.467 in ² (3.013 cm ²)



General Dimensions:



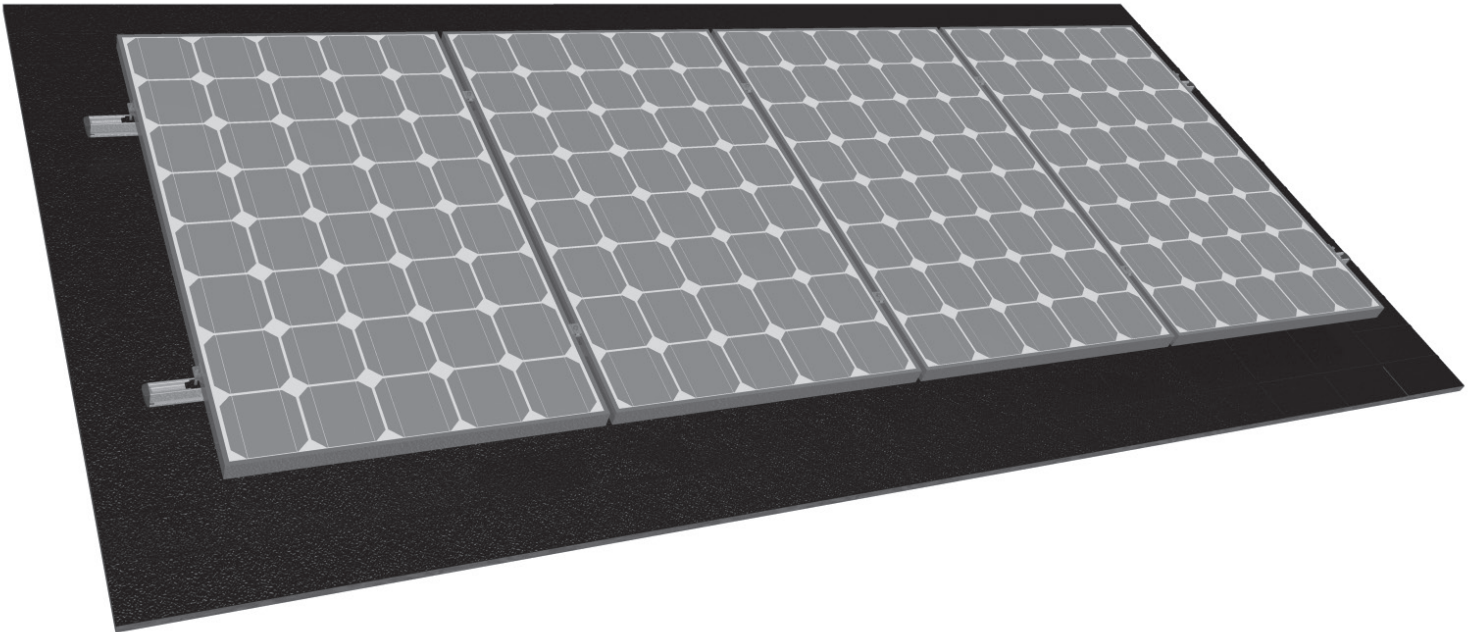
Dimensions in [mm] Inches

Notes:

- ▶ Structural values and span charts determined in accordance with Aluminum Design Manual and ASCE 7-10
- ▶ UL2703 Listed System for Fire and Bonding



Mounting systems for solar technology



ASSEMBLY INSTRUCTIONS
RESIDENTIAL ROOF SOLUTIONS
CROSSRAIL SYSTEM



UL 2703 Listed System

USA

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ENGINEERING STRENGTH IS AT OUR CORE

With sophisticated product innovations and a deep customer focus, Everest Solar is the engineering leader for all your mounting system needs. We are the US division of K2 Systems, one of Europe's market leaders with more than 3.0 GW installed.

We offer proven product solutions and innovative designs. Wind tunnel testing along with advanced structural and electrical validation to facilitate permitting, design and installation. Our designs result in cost competitive racking systems with dedicated support that will position you to win more projects.

We partner with our customers and suppliers for the long-term. High quality materials and cutting edge designs provide a durable, yet functional system. Our product line is comprised of a few, coordinated components that lower the cost of materials, and simplify installation, saving you time and money. All backed by German engineering, a long track record of quality and a company that is here to stay.

Thank you for choosing Everest Solar Systems for your Solar PV Project.

GENERAL SAFETY INSTRUCTIONS

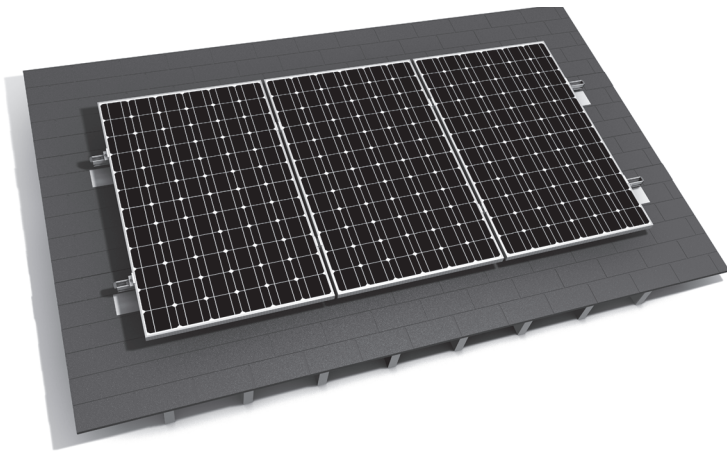
Everest Solar Systems' General Assembly Instructions must be followed to maintain the exclusive, limited product warranty. You can access these instructions at Everest Technical Info Page

<http://www.everest-solarsystems.com/us/downloads/technical-information.html> or by contacting us directly.

In general, the following applies:

- Systems should be installed by experienced contractors licensed and qualified to perform the work with professional workmanship and quality.
- Before installation, Contractor must verify that the system meets all applicable laws, regulations, ordinances, and codes. Contractor shall verify that the roof or other structures to which the system is being attached are capable of carrying the system loads.
- Contractor is solely responsible for work safety and accident prevention regulations and corresponding standards and regulations of the applicable occupational safety and health agency are followed, including:
 - Safety clothing is worn such as safety helmets, work shoes, and gloves.
 - Where required, the contractor should use fall protection, scaffolding with arrestor equipment and other approved methods for worker safety.
- Contractor shall verify that it is using the most current instructions by downloading the latest version from our website or contacting our office directly.
- Module manufacturer installation guides must be followed. Please use approved electrical bonding and grounding components that are required by the local or national codes and AHJ.
- A copy of these instructions must be on site, and read and understood by all workers during installation.
- In the event our general installation and assembly instructions are not followed, or that not all system components and assemblies are used according to these instructions, or that components are used which were not obtained from us, Everest Solar Systems is not liable for any resulting defects and damages, and the exclusive, limited warranty will be void.
- The exclusive, limited product warranty shall apply only if all instructions are strictly adhered to and the system is correctly installed. Everest Solar Systems disclaims any and all warranties, express or implied, including without limitation any warranties of merchantability and fitness for a particular purpose other than as set forth in the exclusive, limited warranty in the terms and conditions of sale, which can be viewed under on our website: <http://www.everest-solarsystems.com/us/downloads/technical-information.html>
- The dismantling of the system should be in reverse order of these assembly instructions.

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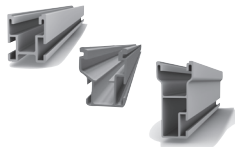


CrossRail for Pitched Roof:

- High quality, German engineering
- UL 2703 Listed for bonding and fire
- Fast, simple installation
 - No drilling, no bonding jumpers
 - Pre-assembled clamps with integrated bonding
 - Robust bonding rail splices
 - Low part count

UL 2703 LISTED COMPONENTS

All components evaluated under UL 2703 and encompassed within Everest Solar System's UL 2703 Listing shown below



CrossRail 48/48-S/80

Material: aluminum
Finish: mill, dark anodized
Standard length: 164", custom



Burndy WEEB Lug 8.0 + Hardware

Weeb Lug 8.0 Material: tin plated copper
Hardware: stainless steel



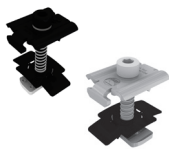
Rail Connector Set¹

Material: aluminum
Finish: mill, dark anodized
Hardware: stainless steel



L-Foot w / Hardware⁴

Material: aluminum
Finish: mill, dark anodized
Hardware: stainless steel



Bonding Mid Clamp Set¹

Material: stainless steel
Finish: silver, dark



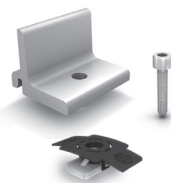
Optional: Micro Inverter Mounting Kit^{1,3}

Material: stainless steel



Bonding End Clamp Set¹

Material: stainless steel
Finish: silver, dark



Optional: Climber Set²

Material: aluminum
Finish: mill, dark anodized
Hardware: stainless steel

¹ Dark anodized rail must use Bonding T-Bolt and Bonding MK3 hardware.

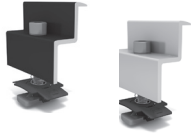
² Slotted version may only be used on arrays with a tilt angle less than 45 degrees, relative to ground.

³ The inverter hardware kit is not intended to replace the micro inverter ground and has only been evaluated to attach to the rail.

⁴ Use standard L-Foot with 3rd party roof attachments and EverFlash L-Foot with EverFlash Comp Flashing.

NON-UL LISTED COMPONENTS

Components in this section were not evaluated by UL for bonding



Module End Clamp Set

Material: aluminum
Finish: mill, dark anodized
Hardware: stainless steel



Module Middle Clamp Set

Material: aluminum
Finish: mill, dark anodized
Hardware: stainless steel



Optional: End Cap for CrossRail 48/80

Material: glass fibre reinforced polyimide



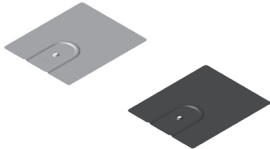
Optional: External Omega cable clip

Material: polyamid, black



Optional: HEYClip SunRunner Cable Clip SS, S6404

Material: stainless steel



EverFlash Comp Kit

Material: aluminum
Finish: mill, dark anodized
Hardware: lag bolt (not included)

TOOLS REQUIRED

- Torque wrench (0 – 50 lb-ft)
- Cordless Drill (non-impact)
- 13mm Deep Socket
- 15mm Deep Socket
- HW 6
- ½" Socket (for lag bolt)
- Measuring Tape
- String Line

TORQUE SPECIFICATIONS

- M10 T-Bolts: 25.8 lb-ft (35 Nm)
- M8 T-Bolts: 10 lb-ft (13.5 Nm)
- M8 Allen Bolts: 10.3 lb-ft (14 Nm)

Tools and materials for the installation of third party items such as roof attachment products, roof covering and sealing products or items used for bonding and grounding are not listed here. Please refer to the instructions of those third party products.

BONDING AND GROUNDING:

Appropriate means of bonding and grounding are required by regulation. The information provided in this manual shall always be verified with local and national building codes.

Everest Solar Systems has obtained a UL 2703 system listing from Underwriter's Laboratories (UL).

A sample bonding path diagram is shown in Figure 1 below. Your specific installation may vary, based upon site conditions and your AHJ's requirements.

Each electrical connection has been evaluated to a maximum fuse rating of 30A. At least one ground lug must be used to ground all strings within each sub-array, although additional may be used for redundancy. When installed per these installation instructions, all connections meet the requirements of NEC 690.43.

Everest CrossRail system was tested with the SolarWorld, Sunmodule family of modules.

- PlusSW200-300Mono (including black)
- PlusSW200-280Poly (including black)

This racking system may be used to ground and/or mount a PV module complying with UL 1703 only when the specific module has been evaluated for grounding and/or mounting in compliance with the included instructions.

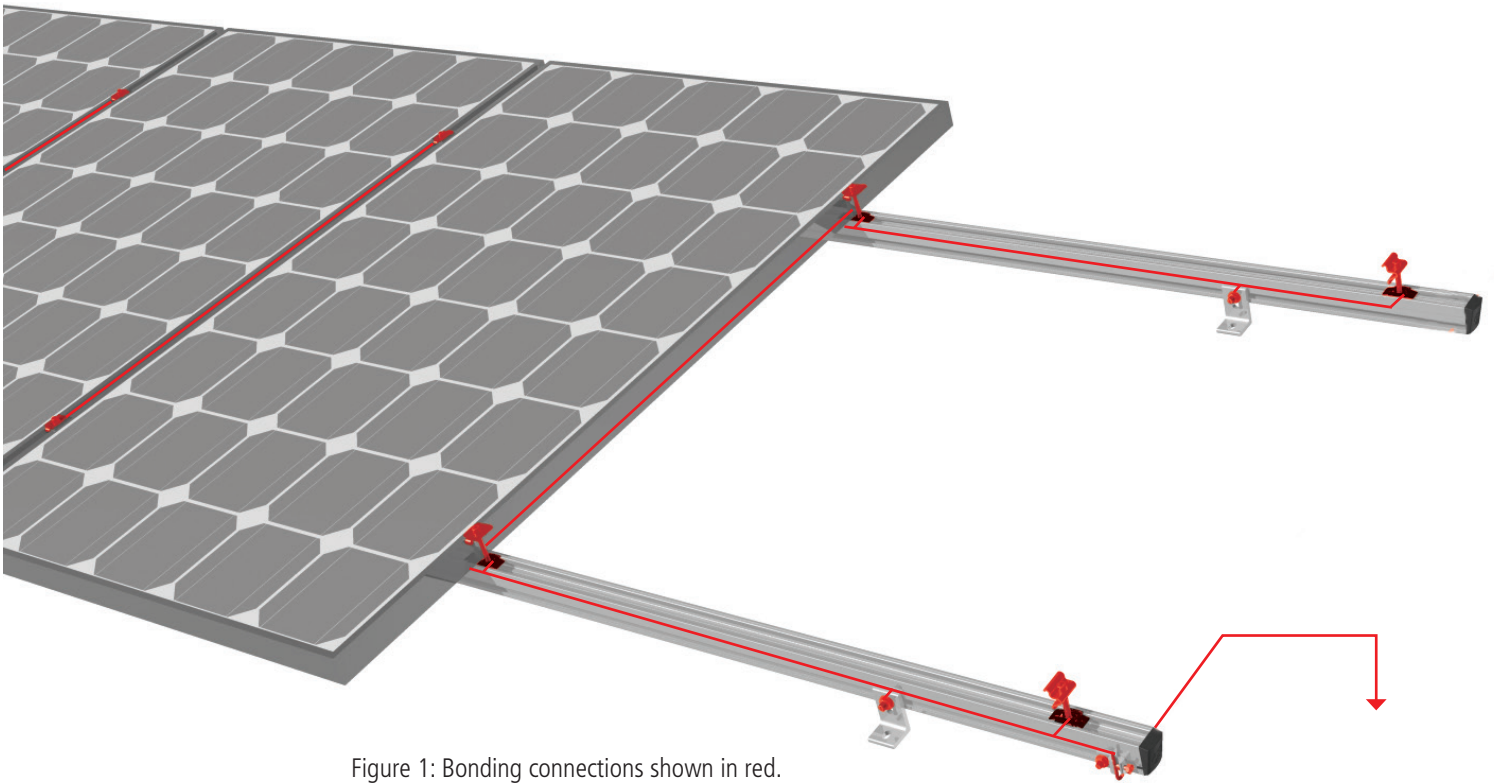


Figure 1: Bonding connections shown in red.

CROSSRAIL FIRE RATING:

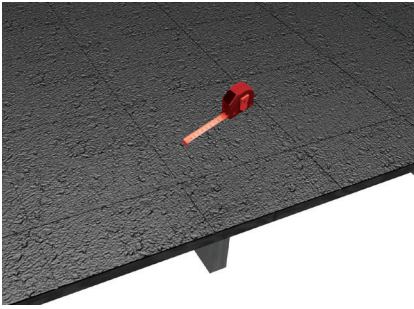
The CrossRail 48/48-S system has undergone fire performance testing per UL 1703 Section 16, Fire Performance.

A System Class A fire rating is achieved when using CrossRail 48/48-S under the following conditions:

- Roof slope of 2/12 inch rise per linear foot or greater.
- Used in combination with a UL 1703 Listed module with a fire performance rating of Type 1 or Type 2. Consult the module manufacturer for specific fire performance rating information.
- CrossRail may be mounted using any stand-off height to maintain the Class A fire rating. Always consult the module manufacturer's installation instructions to ensure your installation is in compliance with their UL 1703 Listing.
- The results of the racking system do not improve a roof covering Class rating.

All documentation can be found on UL's Online Database as well as Everest Solar System's website.

ASSEMBLY: STEP BY STEP



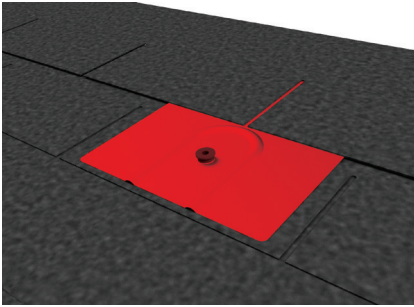
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PREP ROOF FOR EVERFLASH COMP SHINGLE FLASHING

Locate the rafters and snap horizontal and vertical lines to mark the installation position for each EverFlash flashing. Drill a pilot hole (1/4" diameter) for the lag bolt. Backfill with appropriate sealant. Always consult a professional roofer to ensure integrity is maintained.

Materials required: Tape measure, string line, drill.



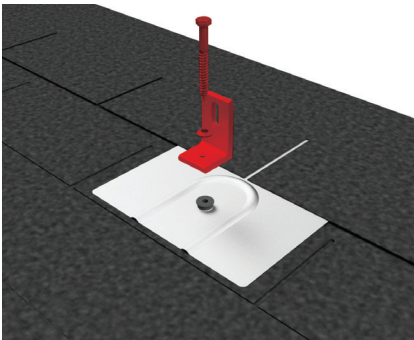
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INSERT EVERFLASH FLASHING

Insert the flashing so the top part is under the next row of shingles and pushed far enough up slope to prevent water infiltration through vertical joint in shingles. The leading edge of flashing must butt against upper row of nails to prevent turning when torqued.

Materials required: EverFlash flashing.



3

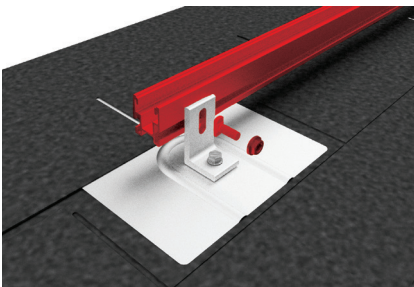
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ATTACH EVERFLASH L-FOOT

Line up pilot hole with the EverFlash flashing hole. Insert the lag bolt through the EPDM bonded washer, the L-Foot, the gasketed hole in the flashing and into the rafter.

Torque: The range is between 8.3 - 11.6 lb-ft depending on the type of wood and time of year. The visual indicator for proper torque is when the EPDM on the underside of the bonded washer begins to push out the sides as the washer compresses. If using an impact wrench to install the fasteners be careful not to over torque the fastener. You may need to stop and use a ratchet to finish the install.

Materials required: Bolt, EverFlash L-Foot and hardware, torque wrench with 1/2" socket.



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INSTALL CROSSRAIL

Insert the T-Bolt through the L-Foot slot and into the side channel of CrossRail. Turn the T-Bolt clockwise ensuring that the mark at the end of the shaft is vertical, indicating proper alignment. Attach the M10 Serrated Hex Nut and tighten to 25.8 lb-ft (35 Nm). Make sure that the top of the CrossRail is located above the top of the L-Foot. Double check that the alignment marking on the end of the T-Bolt shaft is vertical, to ensure it is properly engaged.

Due to thermal expansion, we recommend placing a gap of 1.25" - 2.00" (3 - 5 cm) every 65 ft (20 m) between rails. Maximum allowable spacing between thermal expansion gaps shall not exceed 80 ft (24.4 m).

Materials required: CrossRail, M10 T-Bolt (use Bonding T-Bolt with dark rail), M10 serrated hex nut.

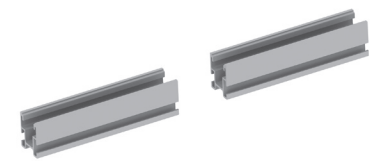
RAIL CONNECTOR INSTALLATION

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ALIGN RAILS

Align the two rail ends next to each other.

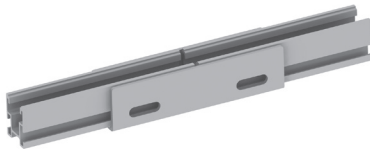


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SLIDE RAIL CONNECTOR

Slide the rail connector from below the rails, centering the connector between the two rail ends. Ensure the rail connector does not interfere with an L-Foot or roof attachment.



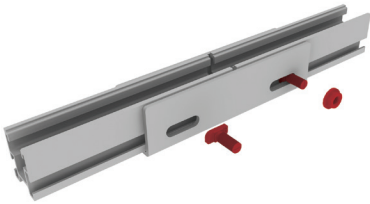
Note: the rail connector for CrossRail 48-S contains mating features, thus must be inserted prior to aligning rails together (Step 5 above).

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CONNECT RAILS

Attach the rail connector using two M10 t-bolts (use bonding t-bolts with dark rail) and hex nuts per side (4 total). Ensure that the slot on the bottom of the t-bolt is vertical, indicating that the t-bolt head is properly engaged in the rail channel.



Torque M10 serrated hex nuts to 25.8 lb-ft (35 Nm).

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OPTIONAL: ATTACH MICRO INVERTERS OR POWER OPTIMIZERS

Using the Micro Inverter Mounting Kit Hardware from Everest Solar Systems, attach your chosen device to the top channel of CrossRail. Torque M8 Allen Bolt to 10.3 lb-ft (14 Nm).



Tightening torque: 10.3 lb-ft (14 Nm).

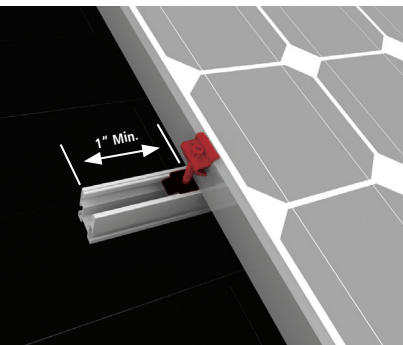
Materials required: Micro Inverter Mounting Kit includes: M8x20mm Allen Bolt, M8 lock washer, M8 flat washer, MK2 (MK3 if using dark rails)

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ATTACH END CLAMPS

Insert the MK2 slot nut of the pre-assembled end clamps into the top channel on CrossRail. While slightly lifting the plastic tabs, rotate 90 degrees clockwise to engage the MK2 into the channel.



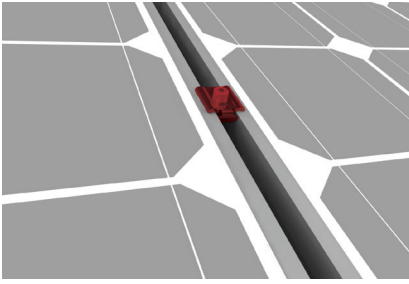
Attach the end clamps to the module at the specified locations per the PV module manufacturer's installation instructions. Torque the M8 bolt to 10.3 lb-ft. Ensure the clamp sits flush against the frame of the PV module, the M8.

Never mount end clamps directly over a rail connector or at the end of the rail. Ensure a minimum gap of 1" (20mm) exists from the end of the rail to the clamp.

Tightening torque 10.3 lb-ft (14 Nm).

Important: Verify module manufacturers recommended torque specification to ensure clamps are compatible.

Materials required: End Clamp Set



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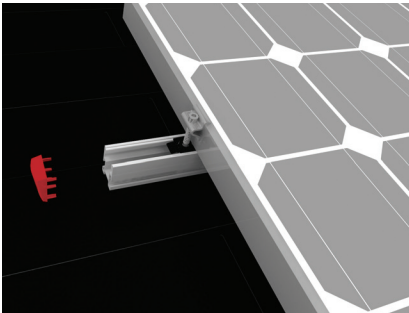
ATTACH MID CLAMPS

Insert the MK2 slot nut of the pre-assembled mid clamps into the top channel on CrossRail. While slightly lifting the plastic tabs, rotate 90 degrees clockwise to engage the MK2 into the channel.

Attach the mid clamps to the module at the specified locations per the PV module manufacturer's installation instructions. Torque the M8 bolt to 10.3 lb-ft. Ensure the modules are flush against the clamp, and torque.

Important: Verify module manufacturers recommended torque specification to ensure clamps are compatible.

Materials required: Mid Clamp Set

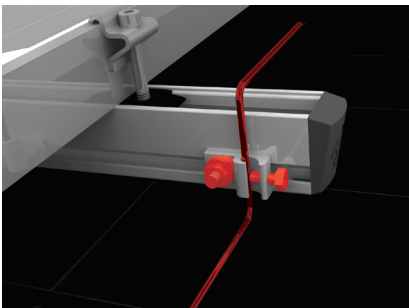


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OPTIONAL: ATTACH END CAPS

Push the pins of the appropriate end cap into end of the rail.

Materials required: End cap



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SYSTEM GROUNDING

CrossRail components are required to be electrically bonded to ground via Burndy's WEEB Lug 8.0 Assembly (Burndy P/N 781810537572) and the use of either #6 or #8 AWG solid copper wire.

A minimum of one WEEB Lug 8.0 is required per each independent row of modules. The lug must be attached to the side channel of CrossRail, as shown.

To attach the WEEB Lug 8.0, insert the M8 T-Bolt into the side slot on CrossRail and rotate clockwise 90 degrees. Attach the remaining components, as shown, tightening the M8 serrated hex nut to 10 lb-ft (13.5 N-m).

Once the lug has been installed, a #6 or #8 AWG solid copper wire from a DC ground location external to the array must be inserted in the equipment ground conductor location on the lug. Torque the bolt to 5 lb-ft (6.7 N-m).

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Ready!

THANK YOU FOR CHOOSING AN EVEREST SOLAR SYSTEMS MOUNTING SYSTEM.

Systems from Everest Solar Systems are fast and simple to install. Please contact us if you have any questions or suggestions for improvements. We are looking forward to receive your call on our

Service-Hotline +1 760.301.5300

TERMS AND CONDITIONS

Product images are for illustrative purposes only. Specifications are subject to change without notice. All sales of our products shall be subject to Everest Solar Systems terms and conditions, including the exclusive limited warranty set forth therein. The terms and conditions can be found at <http://www.everest-solarsystems.com/us/downloads/technical-information.html>

Everest Solar Systems, LLC
3809 Ocean Ranch Blvd.
Suite 111
Oceanside, CA 92056
Tel. +1.760.301.5300
info@everest-solarsystems.com
www.everest-solarsystems.com

K2 Systems International:
World headquarters
K2 Systems GmbH, Germany
K2 Systems SARL, France
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Montageanleitung Quickmount - CrossRail | US7 | 0715
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