Code-Compliant Installation Manual

MAGERACK

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Chapter 1 Overview

Magerack solar mounting system is designed to support solar photovoltaic modules on pitched roof tops. The system is designed to ensure it withstands severe weather conditions and meet the local and international building codes, and yet enables solar contractors to install solar PV systems easily, and reduce installation time and overall installation cost.

The system is designed to simplify the installation process with fewer part and easy access, and helps reduce installation time.

1.1 Magerack Mounting System and Components

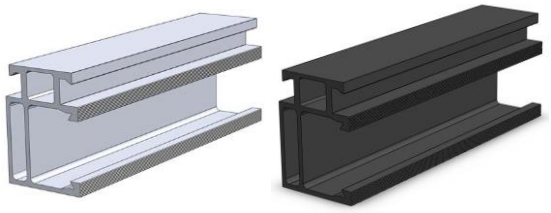
A mounting system mainly consists of three parts, attachments that secure the mounting system to the roof, rails that support PV module and clamps that secure module to the rails. Except lag screws or through bolts that secure attachment to the roof, all parts come with all necessary bolts and nuts. All major components are made with 6061-T6 structural aluminum alloy in clear and black anodized finish unless noted. All bolts, washers and nuts are made with 304 stainless steel. L-foot flashing is made with aluminum 1060 in mill or black anodized finish.

The components are listed as follows,

Rails

Magerack provides rails in five lengths,

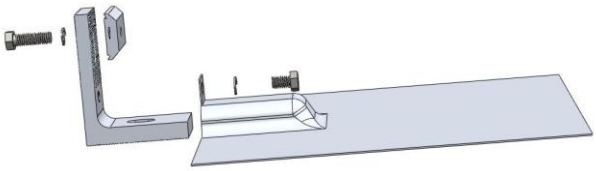
126” (10’6”)
144” (12’)
168” (14’)
204” (17’)
240” (20’)

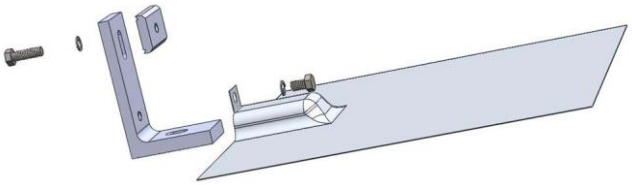


Roof Attachments

L-foot with flashing and Tall L-foot with flashing

One (1) L-foot (or Tall L-foot)
One (1) rail nut
One (1) 5/16 X 1-1/4” stainless steel bolt/washer
One (1) 5/16 X 3/4” stainless steel bolt/washer
One (1) L-foot flashing (9”x12” or 12”x12”)

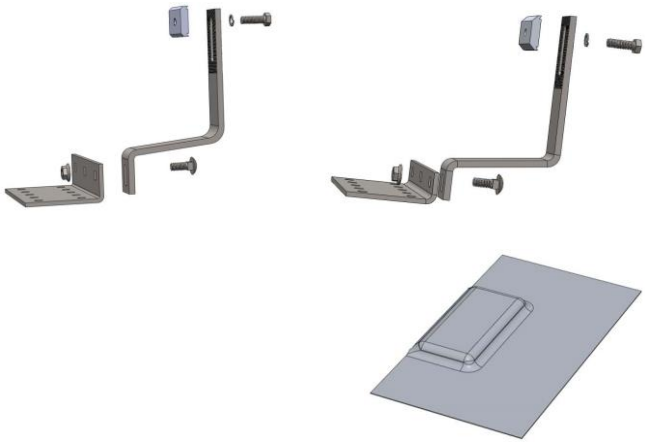




Standoff

One (1) standoff (3”, 4”, 6” or 7” tall)
One (1) standoff L-foot
One (1) rail nut
Two (2) 5/16 X 1” stainless steel bolts/washers

Tile hook and Low Tile hook with optional flashing



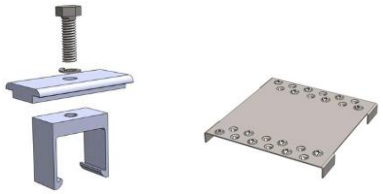
One (1) stainless tile hook top (or low tile hook top)
One (1) stainless tile hook base (or low tile hook base)
One (1) rail nut
One (1) 5/16 X 1-1/4” stainless steel bolt/washer
One (1) 5/16 X 3/4” stainless steel carriage bolt
One (1) 5/16 stainless steel flange nut
One (1) optional tile hook flashing

Tile hook for stone-coated steel roof

One (1) stainless tile hook
One (1) rail nut
One (1) 5/16 X 1-1/4” stainless steel bolt/washer

Mounting Components

Mid clamp



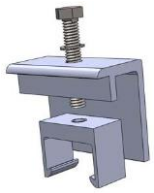
One (1) mid clamp top
One (1) mid clamp bottom
One (1) 5/16 X 1-1/4” or 5/16 X 1-1/2” stainless steel bolt/washer
One (1) optional bonding clip

Mid clamp with Integrated Bonding

One (1) mid clamp top
One (1) mid clamp bottom
One (1) 5/16 X 1-5/8” stainless steel bolt/washers

End clamp

One (1) end clamp top (various heights)
One (1) end clamp bottom
One (1) 5/16 X 1-1/4” (or 5/16 X 1-1/2, 5/16 X 1-3/4, 5/15 X 2) stainless steel bolt/washer

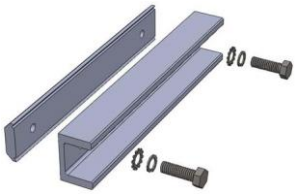


Universal End clamp with Integrated Bonding

One (1) end clamp top
One (1) end clamp bottom
One (1) 5/16 X 1-5/8” (or 5/16 X 2”) stainless steel bolt/washers

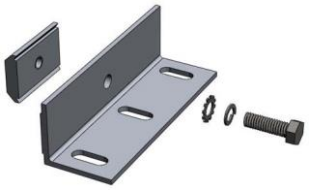
Rail Splice with Integrated Bonding

One (1) rail splice
One (1) rail splice plate
Two (2) 5/16 X 1-1/4” stainless steel bolts/washers



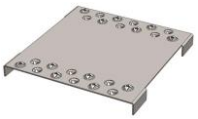
Microinverter mounting kit with Integrated Bonding

One (1) microinverter mounting plate
One (1) rail nuts
One (1) 5/16 X 1-1/4” stainless steel bolt/washer



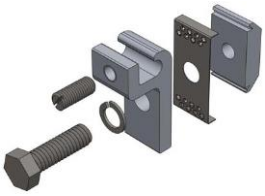
Bonding Clip for Rail and PV Module

One (1) bonding clip for rail and PV module



Ground Lug

One (1) ground conductor
One (1) rail nut
One (1) bonding clip
One (1) 5/16 X 1-1/4” stainless steel bolt/washer
One (1) 1/4 X 5/8” stainless steel set screw



Cable Clip

One (1) cable clip 

1.2 Installer Responsibility

Installer will be responsible to

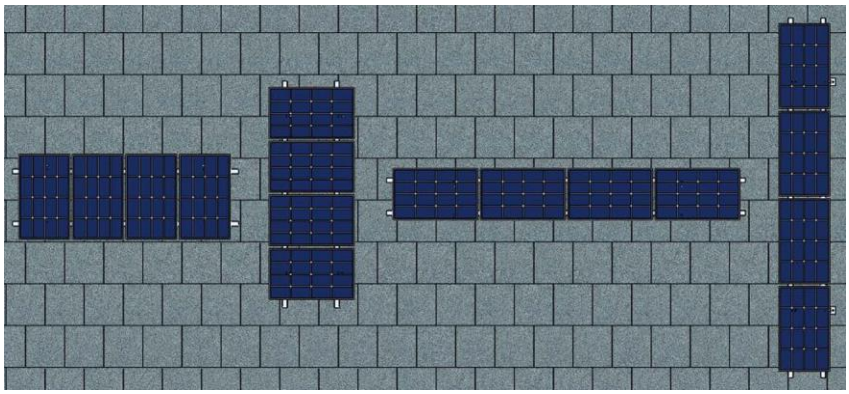
- Comply with all local or national building codes; including any requirements may supersede this installation instruction.
- Ensure Magerack Solar PV Mounting System and other items of solar PV system are appropriate for this particular installation, environment and structural load conditions.
- Make sure the installation meets all local and national code requirements and the system doesn't exceed the design parameters.
- Use only Magerack parts and installer-supplied parts.
- Make sure the lag screws or through bolts are to adequately secure attachments to the roof rafters or structural members.
- Ensure appropriate waterproofing.

Chapter 2 Preparation of Installation

Installer designs the solar system. With the design and selected solar panel, installer will decide what type of attachment will be used based on roof type, determine rail span and calculate rails and components needed.

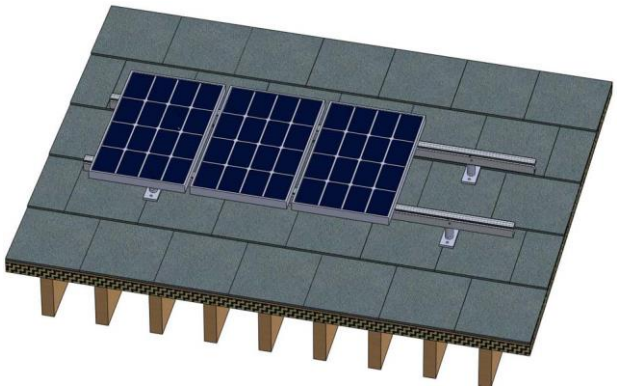
2.1 Layout Design and Planning

Solar PV modules are supported by two rails in parallel. Rails can be laid out horizontally or vertically depending on the layout of solar modules. Solar module can also be installed in portrait or landscape layout. See illustration.



Determine Rail Span

The tables from the Engineering Certification Letter in Appendix illustrate the maximum rail span (spacing between attachments) under different conditions. When you design the rail span, make sure to consider wind speed, snow load, topographic factors and other factors and your design should be adequate to withstand the weather conditions in the area.



2.2 Select Roof Attachment Type

Roof Type and Roof Attachment Selection

Appropriate attachment should be used based on roof type. For composition shingles or shake roof, **L-foot** is the best choice. It is easy and quick to install. For flat or curved tile roof, **tile hook** can be used. For stone-coated steel roof, **tile hook for stone-coated steel roof** can be used. For other roof type or new roof, **standoff** may be the best choice.

2.3 Calculate Total Mounting Components Needed

Portrait Layout

The following table shows number of rails and components needed per row, the table is based on the portrait layout and the width of the PV module is up to 40”.

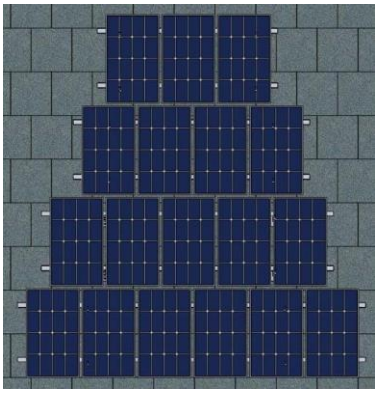


Chart to calculate rails and components needed per row

Module per Row	Rail – 10.5’ (126”)	Rail – 12’ (144”)	Rail – 14’ (168”)	Rail – 17’ (204”)	Rail – 20’ (240”)	Mid clamps	End clamps	Rail Splice
2			1*			2	4	
3	2					4	4	
4			2			6	4	
5				2		8	4	
6	4					10	4	2
7	2		2			12	4	2
8			4			14	4	2
9	2				2	16	4	2
10				4		18	4	2
11	4				2	20	4	4
12	2	2			2	22	4	4

* The rail needs to be cut in half.

Landscape Layout

The following table shows number of rails and components needed per row, the table is based on the landscape layout and the width of the PV module is up to 65.5”.

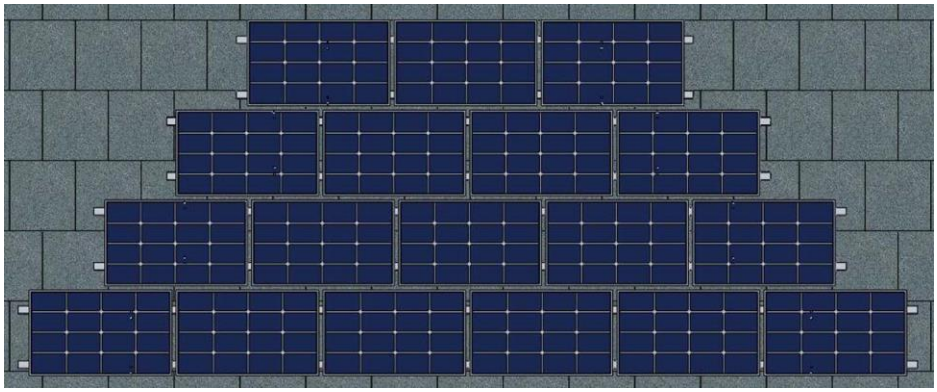
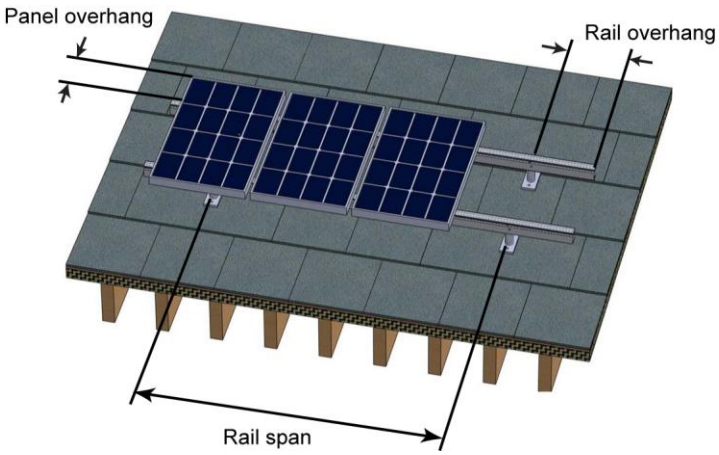


Chart to calculate rails and components needed per row

Module per Row	Rail – 10.5’ (126”)	Rail – 12’ (144”)	Rail – 14’ (168”)	Rail – 17’ (204”)	Rail – 20’ (240”)	Mid clamps	End clamps	Rail Splice
2		2				2	4	
3				2		4	4	
4	2	2				6	4	2
5		2		2		8	4	2
6				4		10	4	2
7	2	2		2		12	4	4
8	2			4		14	4	4
9	2			4		16	4	4
10				2	4	18	4	4

Determine Number of Attachments

The module frame ends shall not overhang mounting rails by more than 25%. The rail end cantilever length shall not exceed 30% of allowable rail span.



Based on the number of modules, calculate the total length of each row. Remember to add the space for mid and clamps. Add 0.79” for each mid clamp and 0.87” for each end clamp. The total length will be as follows,

Length of row *= module width * no. of modules + 0.79 * (no. of modules - 1) + 0.87 * 2*

E.g., if a row has 6 modules and the module width is 65”, the total length will be as follows,

Length of row *= 65 * 6 + 0.79 * 5 + 0.87 * 2* = 395.69”

The number of attachment per row is as follows,

No. of attachment *= round (length of row / span – 0.67)*

If the maximum rail span is 6 feet (72”), the number of attachment per row is as follows,

No. of attachment *= round (395.69 / 72 – 0.67) = round (4.83) = 5*

5 attachments will be needed for each row.

Chapter 3 Install Roof Attachments

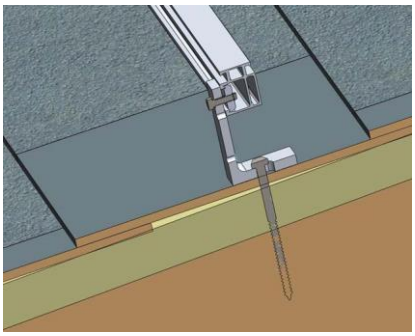
Due to variety of roof types and conditions, all Magerack roof attachments do not come with roof fasteners. Installer needs to check the roof condition and building codes requirement to decide the appropriate lag screws or roof fasteners to make sure the lag screws or roof fasteners are adequate to secure the attachment to roof structural elements. Please refer to the engineer letter in the Appendix about depth of penetration or consult with structural engineer or local building code for proper lag screw that should be used for L-foot, standoff and tile hook.

3.1 L-foot

For composition shingle roofs, L-foot is the choice for simple, easy and quick installation of roof attachment. When install L-foot, make sure L-foot is secured to the rafter with adequate lag screws or through bolts. 5/16 screws or through bolts should be used.

Installer should decide what lag screws should be used to secure L-foot to the rafter. Make sure the lag screw is penetrated into the rafter deep enough. See Appendix for minimum depth of penetration or consult with structural engineer or local building code for proper lag screw that should be used. When install L-foot to the roof, follow building code requirement to apply roofing sealant to the underside of L-foot base and into bolt holes.

Locate L-foot Attachment Position



L-foot must be secured to roof rafter. Please use appropriate lag screw or through bolts to secure L-foot to the raft. 5/16 lag screw or through bolt should be used.

Drill pilot holes to locate rafter and avoid rafter split.

Secure L-foot

When securing L-foot to rafter, roofing sealant may be applied to the backside of L-foot for additional waterproofing. After L-foot is secured with lag screw through the slot hole, do not tighten the lag screw so you can adjust the L-foot position by moving L-foot vertically. Install all L-feet on the same row.

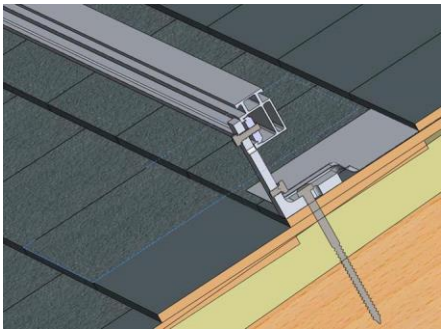
After all the L-feet on the same row are secured to the roof, adjust them to make sure all L-feet are properly aligned. After adjustment is completed, tighten the lag screws.

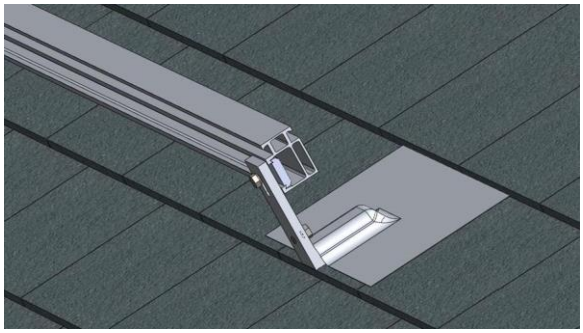
L-foot Flashing

For water proofing, the L-foot flashing must be installed. Slide the top of flashing under the upper roofing material and move flashing all the way up until the bottom of flashing is right above L-foot base. Make adjustment so that the flashing is centered horizontally above L-foot.

Make sure the roofing material must be overlapping over the flashing top. Secure flashing to L-foot with provided 5/16 bolt.

When it is necessary, flashing can be further secured to the roof with roofing nails. Lift or remove upper roofing materials, nail flashing to the roof on the top portion of the flashing and then return upper roofing materials to the original position and cover the top of flashing.



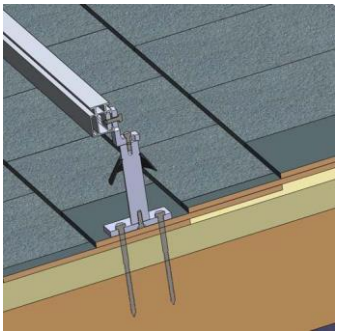


3.2 Standoff

For roofs other than composition shingle, tile or stone-coated steel roof or new roofs, or if solar panels need to be installed higher, standoff can be used as attachment. When install standoff base, make sure the standoff base is secured to the rafter with adequate lag screws or through bolts. 5/16 lag screws or through bolts should be used.

Installer should decide what lag screws should be used to secure standoff base to the rafter. Make sure the lag screw is penetrated into the rafter deep enough. Consult with structural engineer or local building code for the proper lag screw or roof fastener that should be used. Consult with structural engineer or local building codes for proper lag screw that should be used. When secure standoff to the roof, follow building code requirement to apply roofing sealant to the underside of standoff base and into bolt holes.

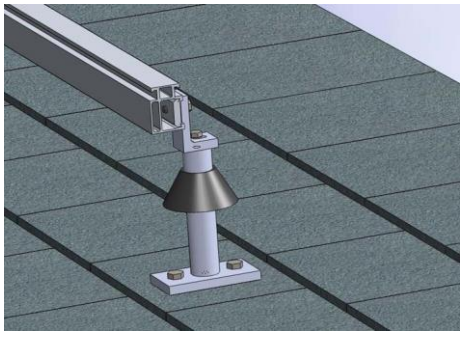
Locate Standoff Attachment Position



Standoff must be secured to roof rafter. Please use appropriate lag screw to secure standoff base to the raft. 5/16 lag screws or through bolts should be used.

Drill pilot holes to locate rafter and avoid rafter split.

Secure Standoff



When securing standoff to rafter, roofing sealant must be applied to the backside of standoff base. Install all standoff on the same row and make sure they are properly aligned horizontally, and then tighten all standoff bases on the same row.

Install the small L-foot for standoff with provided 5/16 bolt. The slot hole is attached to the top of the standoff shaft. You can make adjust by moving the L-foot vertically to ensure all the standoffs in a row are aligned properly. Tighten all bolts to 12 lbs-ft.

Flashing

Use traditional cone-shaped flashing such as Oatey flashing and follow manufacturer's instruction to install cone-shaped flashing properly. Secure flashing to the roof with fasteners or adhesive in compliance with local or international building code, or instruction from roofing material manufacturer. Slide rubber rain collar through standoff shaft.

3.3 Tile Hook

For various tile roofs, tile hook can be used as attachment. When install tile hook base, make sure the tile hook base is secured to the rafter with adequate lag screws or through bolts. 5/16 lag screws or through bolts should be used.

Two 5/16 lag screws or through bolts should be used to secure tile hook base to the roof and they should be used through any two vertically aligned holes on the tile hook base. It is optional to use only one lag screw or through bolt to secure tile hook base to the roof, but the lag screw or through bolt must be through the inner hole of any two vertically aligned holes on the tile hook base and the lag screw's pull-out strength must exceed the maximum allowable load of the system.

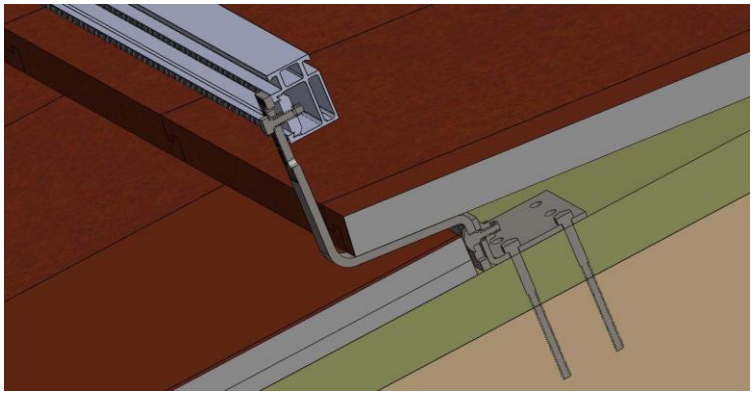
Tile hook and tile hook base are attached with provided 5/16 bolt and nut with lock washer. Tile hook can be mounted to any two adjacent holes on tile hook base, so there are three choices.

Installer should decide what lag screws should be used to secure tile hook base to the rafter. Make sure the lag screw is penetrated into the rafter deep enough. Consult with structural engineer or local building codes for the proper lag screw or roof fastener that should be used. When secure the tile hook base to the roof, follow local building code requirement to apply roofing sealant to the underside of tile hook base and into bolt holes.

Locate Tile Hook Attachment Position

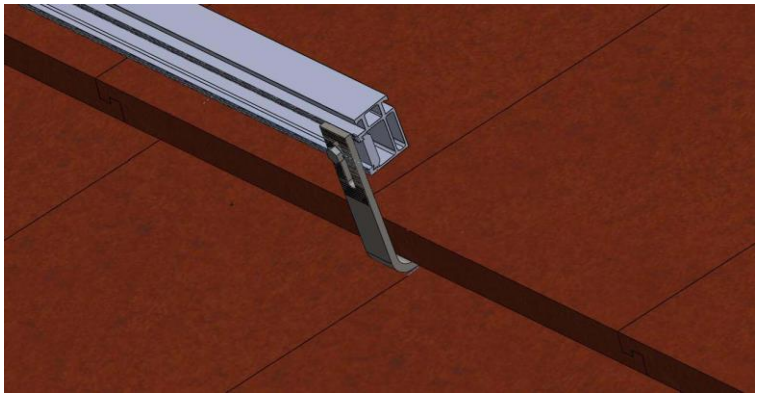
Tile hook must be secured to roof rafter. Please use appropriate lag screw to secure tile hook base to the raft. 5/16 lag screws or through bolts should be used.

Remove tiles where tile hook base will be attached. Try tile hook and tile hook base at different positions and find out the best location so that the tile hook can be secured to rafter and tile hook is above the middle valley of underlying tile.



Secure Tile Hook Base

When securing tile hook to rafter, roofing sealant must be applied to the backside of tile hook base. Install all tile hooks on the same row and make sure they are properly aligned horizontally. Do not tighten the lag screw yet so you can adjust the tile hook position by moving tile hook base vertically.



The tile hook and tile hook base are connected with provided 5/16 carriage bolt and flange nut. The height of tile hook can be adjusted by moving tile hook up and down through the slot where carriage bolt is located. After positions for tile hook and tile hook base are

determined, tighten the carriage bolt to 12 lbs-ft.

After all the tile hooks on the same row are secured to the roof, adjust them to make sure all tile hooks are properly aligned. After adjustment is completed, tighten all fasteners.

Flashing

Move the tiles back to the original location. If necessary, installer may need to grind the tiles to fix around tile hooks.

If double flashing is required, the optional tile hook flashing may be used to cover the tile hook base after it is secured to roof rafter.

3.4 Tile Hook for Stone-Coated Steel Roof

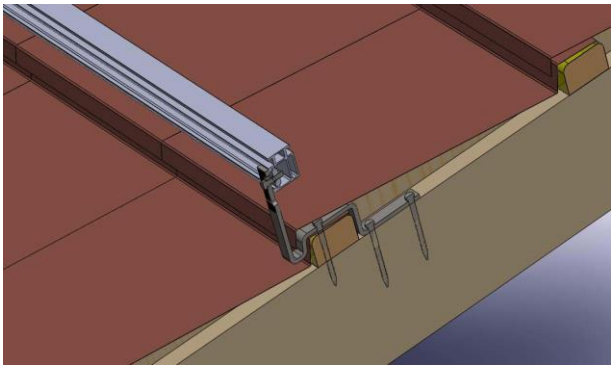
For stone-coated residential metal roof, tile hook for stone-coated steel roof can be used as attachment. When install the tile hook, make sure the tile hook is secured to the rafter with adequate lag screws or through bolts. 5/16 lag screws or through bolts should be used.

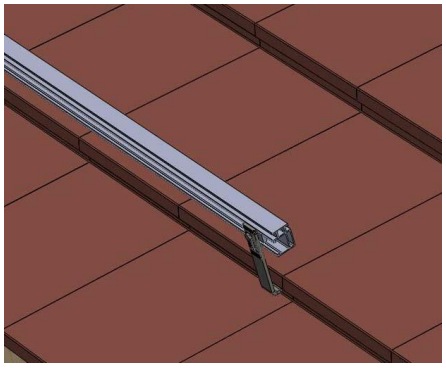
Two 5/16 lag screws or through bolts should be used to secure tile hook base to the roof through the two holes on the tile hook base. If batten is installed with the steel roof, an optional lag screw or nail can be used through the third hole at the middle of the tile hook to further secure the tile hook.

Locate Tile Hook Attachment Position

Tile hook must be secured to roof rafter. Please use appropriate lag screw to secure tile hook base to the raft. Two 5/16 lag screws or through bolts should be used. An optional third lag screw or nail may be used to secure the tile hook to batten.

Remove steel tiles where tile hook will be attached. Find out the best location so that the tile hook can be secured to rafter.





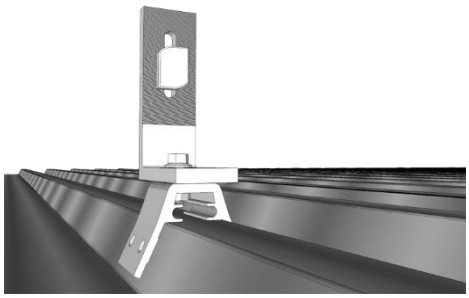
Secure Tile Hook

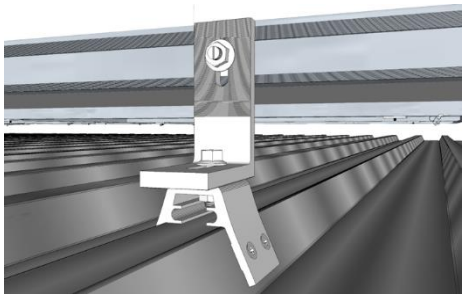
When securing tile hook to rafter, roofing sealant may be applied to the backside of tile hook base. Install all tile hooks on the same row and make sure they are properly aligned horizontally.

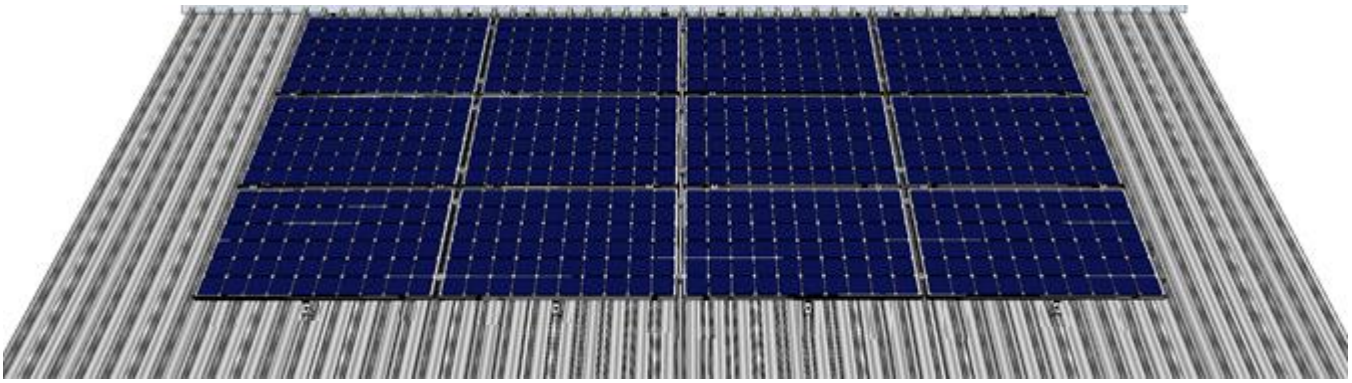
After all the tile hooks on the same row are secured to the roof, adjust them to make sure all tile hooks are properly aligned. After adjustment is completed, tighten all fasteners. Move back the upper steel roof and secure them.

3.5 Install Roof Attachment on Metal Roof and Other Types of Roofs

Magerack Solar Mounting System can also be used on other types of roofs or structures, such as metal roof as long as the L-foot can be attached to a roof attachment. For example, for standing seam metal roof, you can use Magerack metal roof clamps or clamps from other manufacturers and install them on the metal roof. Magerack L-feet can be secured to the metal clamps and rails can be attached to L-feet. The installation steps are similar to installing L-foot on composition shingle roof. Follow the steps of 3.1 to finish the installation. Tighten the 5/16” bolts attaching to the rail and the clamp to 12 lbs-ft.



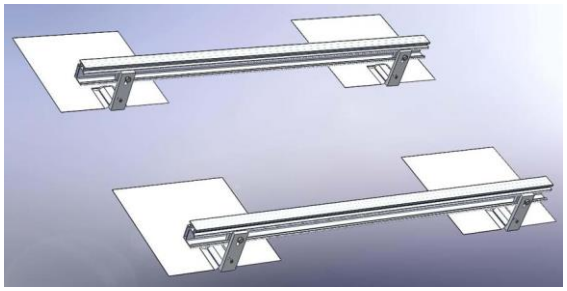




Chapter 4 Install Rail and Rail Connector

4.1 Install Rail

Rail is mounted to the attachment through L-foot, the small L-foot on top of the standoff or tile hook. For L-foot, rail can be mounted on either side of the L-foot depending on your preference or convenience. For the small L-foot on top of the standoff or tile hook, rail should be mounted as shown.

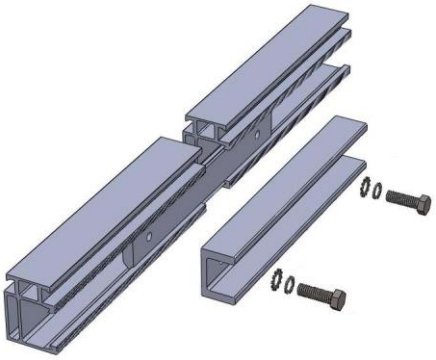


Rail is installed to roof attachments through rail nut. Slide rail nut into rail channel from either end of the rail or push rail nut inside the rail channel. Mount rail to attachment with 5/16” bolt provided. Don’t tighten the bolt yet. Install all rails along one row.

4.2 Install Rail Splice

To connect two rails, insert the rail splice plate into the rails and mount the rail splice with the rail splice plate using provided 5/16” bolt. For consideration of thermal expansion, leave a 1/4 " gap between rails. Tighten all 5/16 bolts to 12 lbs-ft.

The rail splice is designed to bond connecting rails once it is tightened. The rail splice plate has teeth along the groves on the two edges and the teeth are pierced into the two connecting rails and create bonding between the two connecting rails and the rail splice plate. The bolts bond rail splice with the rail splice plate. Therefore, the two connecting rails and rail splice are all bonded. Tighten the 5/16” bolts to 12 lbs-ft.



4.3 Level and Tighten Rail

Before tightening all bolts to the attachment, adjust the rail up and down by moving rails vertically along the attachment slots. Make sure all rails in two rows where solar panel will be mounted are leveled and the top of rails are in the same surface. Tighten all bolts to 12 lbs-ft.

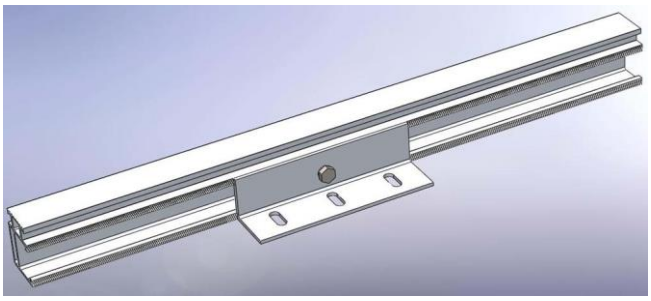
Chapter 5 Install Wiring, Grounding and Accessories

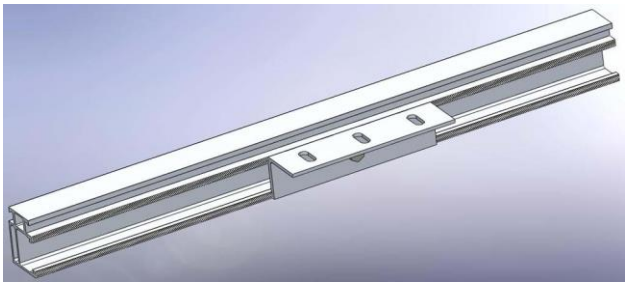
After rails are installed, depending on the design, wiring and ground lugs may need to be prewired before installing solar modules. In addition, other elements of the solar system such as junction box or microinverters may need to be preinstalled as well.

Follow the design and make sure all elements under the solar modules are positioned or preinstalled.

5.1 Install Microinverter Mounting Kit

For the convenience of installing ground wire or microinverter, optional microinverter mounting kit can be installed. The mounting kit can be installed anywhere along the rail. The mounting platform can be installed either way as shown.

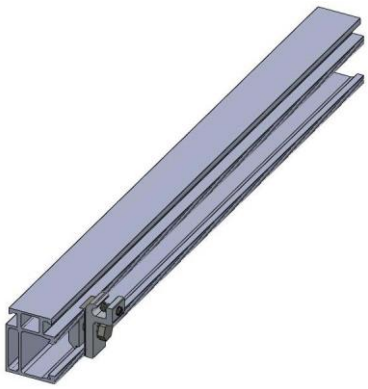




The microinverter mounting kit is designed to bond itself with the rail once it is tightened. The rail nut has teeth along the groves on the two edges and the teeth are pierced into the rail and create bonding between rail and the rail nut. The bolt bonds the microinverter mounting plate with the rail nut. Therefore, the microinverter mounting plate and rail are bonded. Tighten the 5/16” bolt to 12 lbs-ft.

5.2 Install Ground Lug

The ground lug is designed to attach ground lug to the rail without drilling rail. The ground lug is attached to rail with bolt and rail nut. The bonding clip has sharp pins that are pierced into rail and ground lug once the ground lug is tightened to the rail and creates bonding between ground lug and rail. Tighten 5/16” bolt to 8 lbs-ft.



The ground lug must be installed to the rail using the provided rail nut and bonding clip. It can be attached to the rail at any location but it is usually installed at the end of each row of the rails.

The equipment ground conductor wire size, type and set screw torque are as follows,

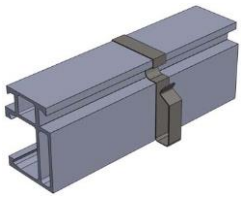
Wire Range, AWG	Wire Type	Torque in-lbs
10-14	Solid	20

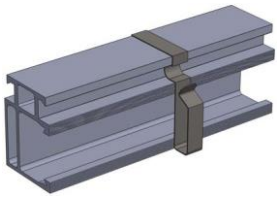
5.3 Install Wiring and Accessories

Before mounting solar modules, it may be convenient to install all the wiring, bonding, ground lugs or other solar system elements. Please refer to the corresponding installation instructions to install wiring, bonding, ground and accessories.

Cable Clip

Cable clip can be used to manage wires and can be installed either way as shown.





Chapter 6 Install Solar Module

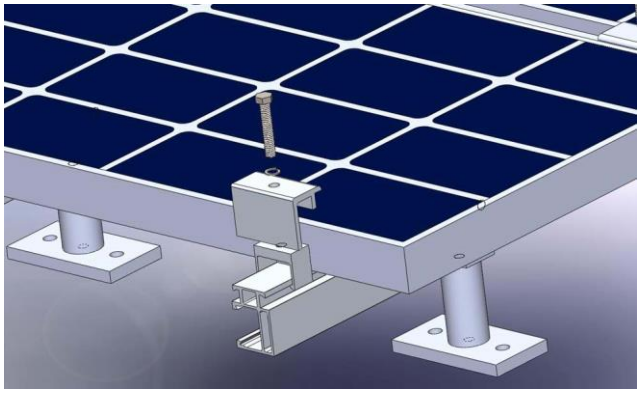
The solar module should be installed from one end to the other on each row.

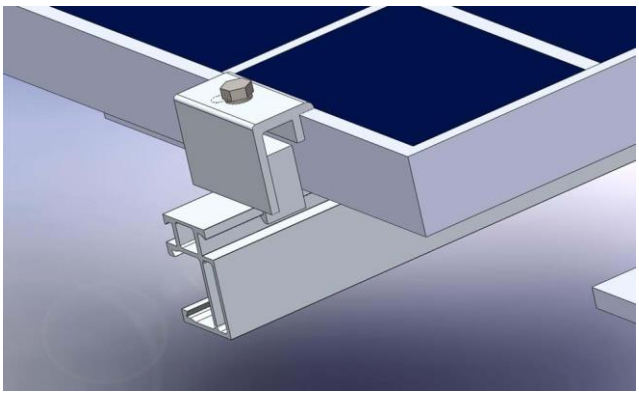
For each solar module there should be four clamps. If the module is the first or last module in a row, it is secured with two mid clamps and two end clamps. If the module is in the middle of a row, it is secured with four mid clamps. Each mid clamp secures two modules, one on each side. Each end clamp secures one module only.

6.1 Set up End Clamps

End Clamp

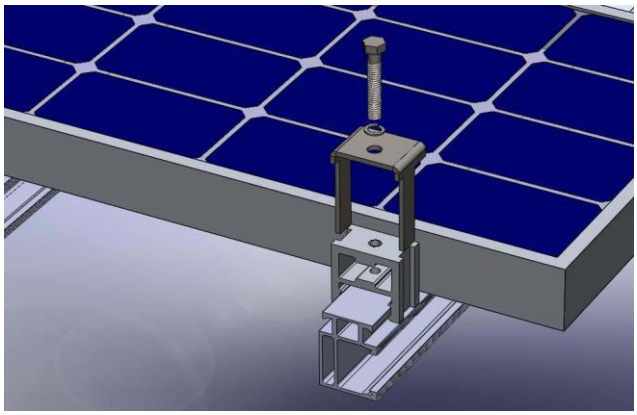
Before installing solar panel, slide in the end clamps. Make sure the end clamp size matches the solar panel thickness.

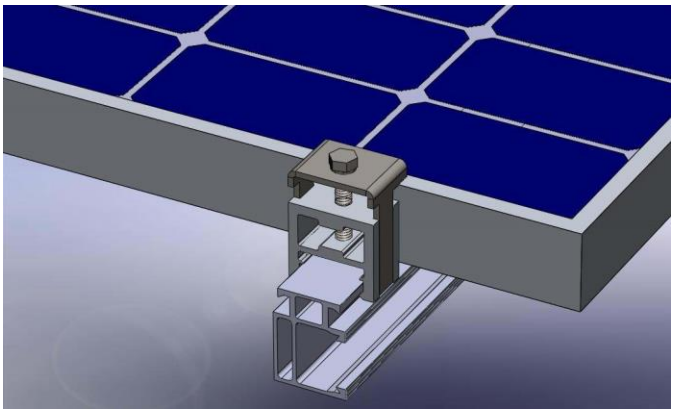




Universal End Clamp with Integrated Bonding

The universal end clamp is designed to bond rail and PV module once it is tightened. The teeth on the top part of the end clamp are pierced into the PV module frame and create bonding between PV module and end clamp. The teeth on the bottom part of mid clamp are pierced into rail and create bonding between rail and end clamp. The bolt bonds the top and bottom parts of the end clamp. Therefore, the rail, PV module and end clamp are all bonded. Tighten the 5/16” bolt to 12 lbs-ft. Please note that the black universal end clamp doesn’t have integrated bonding capability.

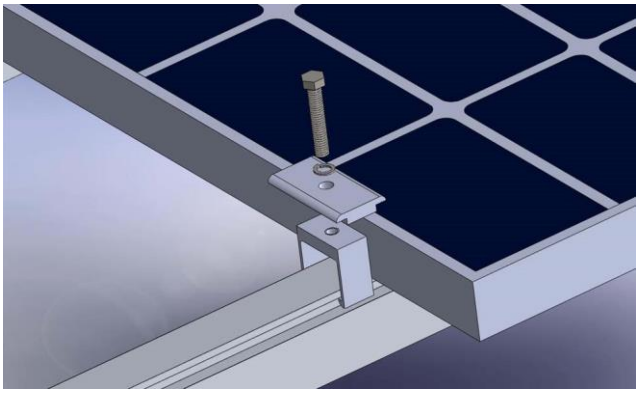




6.2 Set up Mid Clamps

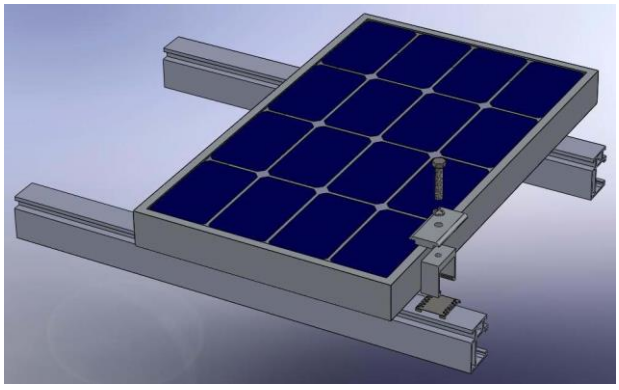
Mid Clamp

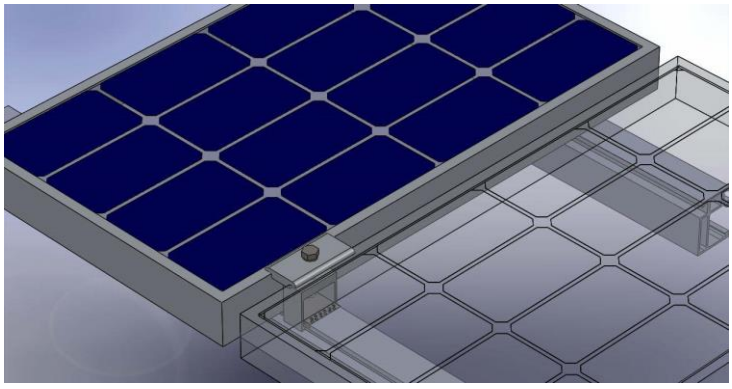
Before installing solar panel, slide the mid clamps to the appropriate location. The mid clamp can also be pressed into the top of the rail, which is convenient when installer forgets to slide the mid clamp in the rail before they install solar panels.



Mid Clamp with Optional Bonding Clip

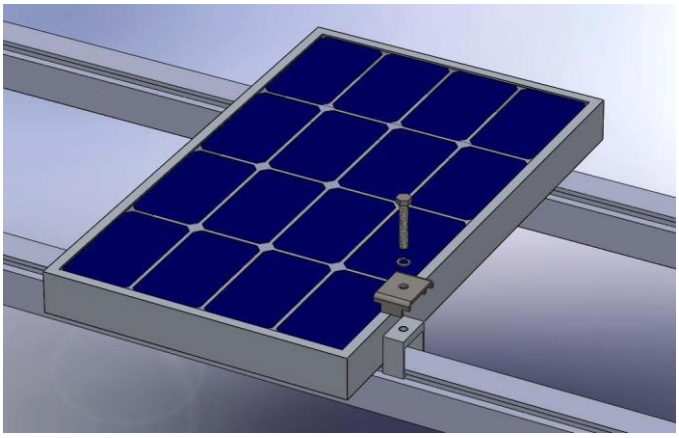
To bond solar panel with rail, the optional bonding clips can be used. The bonding clip should be installed between panel and rail and secured with mid clamp. Tighten all 5/16” bolt to 12 lbs-ft.

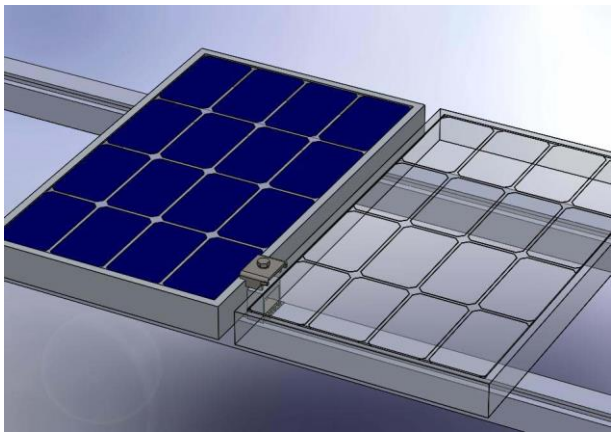




Mid Clamp with Integrated Bonding

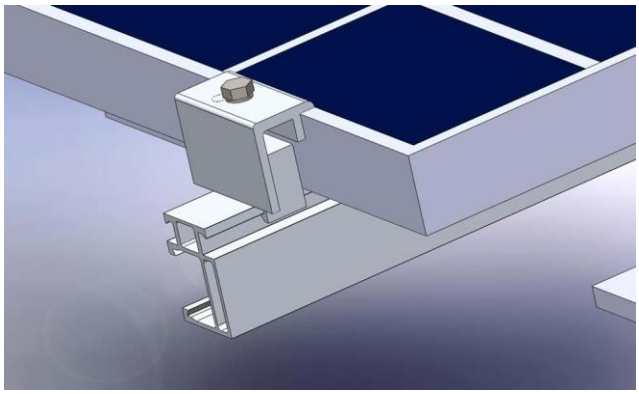
The mid clamp with integrated bonding is designed to bond rail and PV module once it is tightened. The teeth on the top part of the mid clamp are pierced into the PV module frame and create bonding between PV module and mid clamp. The teeth on the bottom part of mid clamp are pierced into rail and create bonding between rail and mid clamp. The bolt bonds the top and bottom parts of the mid clamp. Therefore, the rail, PV module and mid clamp are all bonded. Tighten the 5/16” bolt to 12 lbs-ft.

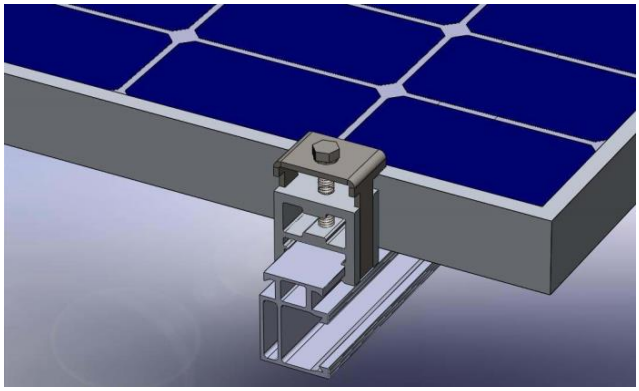




6.3 Mount Solar Modules

After positioning the first solar module on the rails, line up the position and then secure it with two end clamps. After that, position the second module and secure the first and second module with mid clamps. Continue to install all the models until the last module is positioned, which will be secured with two mid clamps on one side and two end clamps on the other side. After one row of solar modules is installed, tighten all the bolts to 12 lbs-ft.





6.4 Connect Wiring and Grounding

Connect wiring, grounding and other accessories per solar module manufacturer’s specifications.

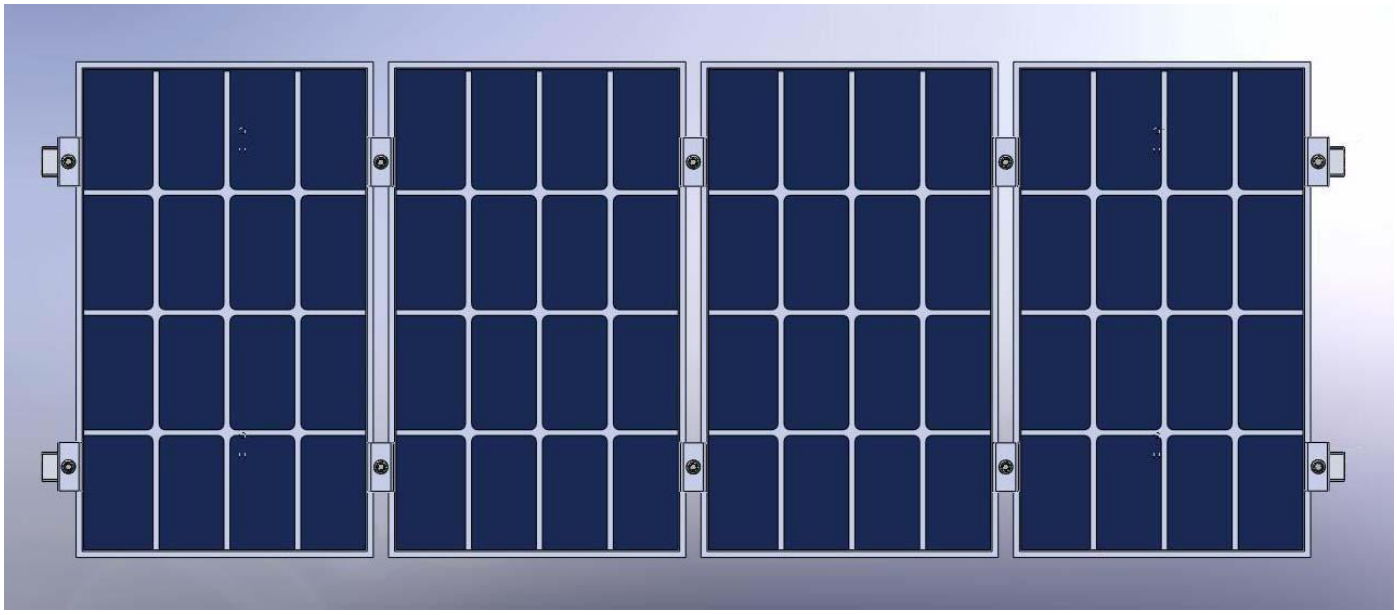
Chapter 7 Finish Installation

7.1 Trim Rail

Trim excessive rail on both end. Make sure to leave half inch of rail space beyond end clamps.

7.2 Check All Bolts

Check and tighten all 5/16 bolts to 12 lbs-ft.



Appendix

Limited Warranty

20 Year Limited Product Warranty

Magerack warrants to the original end-user ("Purchaser") of Magerack Solar Mounting System that Magerack manufactures ("Product") at the original installation site that the Product shall be free from defects in material and workmanship for a period of twenty (20) years from the date the installation of the Product is completed or 30 days after the purchase of the Product by the original Purchaser, whichever comes earlier.

This Warranty does not cover damage to the Product that occurs during its shipment, storage, or installation. This Warranty does not apply to installation that is not performed in accordance with Magerack's written installation instructions and design specifications, or installation of which the Product has been altered, modified or repaired in a manner not authorized by Magerack in writing, or installation that the Product is installed in an environment for which it was not designed. The Warranty does not apply to any installations in corrosive atmospheric conditions.

Under no circumstances shall Magerack be liable for consequential, contingent, incidental or punitive damages arising due to the use of the Product by Purchaser under any circumstances. When the Product is determined to be defective within Warranty period, Magerack shall repair or replace the defective Product under Limited Warranty in Magerack's sole discretion and Magerack shall not be responsible for the cost of any labor and any cost associated with the repair, removal, installation and shipping or transportation of the Product. Such repair or replacement shall discharge all of Magerack's liability with respect to this limited Warranty completely. Magerack's maximum liability is limited to the original purchase price of the Product due to any manufacturing or design defects or under any theory of liability, whether expressed, implied or statutory.

For other components of the solar PV system, such as solar panels, inverters, electrical components and flashings, respective Manufacturers may provide written warranties of their own. Magerack's Limited Warranty covers only its Product, and is not responsible for any other components of the solar PV system.