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systems**

## **Alpha+ On-Roof System Installation Manual**





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*Alpha+ – Sometimes, things just click.*

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# 1. Introduction

## 1.1 Short Description

The Alpha+ PV mounting system is a strong, versatile system for mounting PV modules on pitched roofs. The system consists of aluminum module support rails and includes all necessary components in order to attach the rails to each other (splice), to attach the rails to the roof, and to attach the modules to the rails; it also includes other various accessories, such as microinverters. The system allows modules to be mounted in portrait or landscape and can be configured for shared rails in either orientation. It accommodates both framed and unframed modules. The Alpha+ system is fully, integrally bonded.

## 1.2 About This Manual

This manual describes the installation of the Alpha+ mounting system and provides necessary information regarding components, system planning, and important safety warnings. Sections 1, 2, and 3 provide an overview as well as detailed information about the Alpha+ system and components. Section 4 provides basic module layout and planning information. Sections 5 and 6 provide detailed system assembly and installation instructions. Section 7 provides maintenance requirements, and the last remaining section provides detailed information on evaluated and approved modules.

## Applicable Documents

This document provides general information for Mounting Systems' products regarding standardization, safety, transport, maintenance, disassembly, and disposal. Both this manual and the "Installation Instructions for PV Mounting Systems: General Information"<sup>1</sup> are an integral part of the Alpha+ system and must be adhered to for each installation.

**It is important that you carefully read these Instructions as well as all applicable documents prior to carrying out any installation, maintenance, or disassembly work. These instructions provide you with the information required for the safe and complete installation, maintenance, and disassembly. Should you have any questions, please contact Mounting Systems, Inc.**

## Pictograms



This symbol indicates important information and useful tips.



This symbol indicates tips and tricks to make the installation process easier.

<sup>1</sup> "Installation Instructions for PV Mounting Systems: General Information" can be found on Mounting Systems' website: <http://www.mounting-systems.us/downloads-technical-docs-warranty/>

### 1.3 Warnings

The following warnings are used in these Installation Instructions to indicate safety-related information. They include:

- Warning symbols (pictograms)
- Signal words which identify the hazard level
- Information about the type and source of the hazard
- Information about the potential consequences in case of the hazard being disregarded
- Measures for the prevention of hazards and the prevention of injuries or damage to property.

The signal words of the warnings respectively indicate one of the following hazard levels:

 <b>DANGER</b>	<p><b>Indicates a potentially mortal danger, disregard for which may result in serious injury or death.</b></p>
 <b>WARNING</b>	<p><b>Indicates a potentially dangerous situation which may result in serious injury or damage to property.</b></p>
 <b>CAUTION</b>	<p><b>Indicates a potentially dangerous situation which may result in minor injuries or damage to the property if ignored.</b></p>
 <b>ATTENTION</b>	<p><b>Indicates potential danger which can result in damage to the property.</b></p>

### Installation Personnel

The Alpha+ system and these instructions are intended for use by qualified personnel. Qualified personnel are those who have skills, knowledge, and training in the installation of photovoltaic mounting systems necessary to follow these instructions in order to safely use the required tools and to carry out the required procedures.

### Intended Use

The Alpha+ system is intended for use only as a mounting system for photovoltaic panels and certain associated hardware and components. Any other usage or usage outside the intent or scope of these instructions is considered not as intended and may result in forfeiture of the system warranty. Please contact Mounting Systems, Inc. with any questions regarding these requirements.

## General Safety Warnings



**DANGER**

**Risk of fatal injury due to falling.** Falling from the roof can result in serious injuries or death.

- Please wear and use proper protective equipment
- Secure yourself against falling
- Do not perform any work in strong winds



**DANGER**

**Risk of fatal injury from falling objects.** Parts falling from the roof can result in serious injuries or death.

- Before beginning the installation, please ensure that proper safety precautions are observed, only authorized personnel are permitted in and around the construction area and proper protective clothing and equipment are worn.



**DANGER**

**Risk of injury from damage to roof excessive loads can severely damage the roof and cause injury.**

- Before mounting and installation, please make sure that the buildings and especially the roof cladding meet the increased structural requirements of the PV system and the installation operations.



**CAUTION**

**Material damage due to incorrect installation.** Incorrectly mounted Clickstones can slip out. PV modules can fall and be damaged.

- Mount all Clickstone connections in accordance with the instructions.

## 1.4 Regulatory Information

### ANSI / UL 2703

The Alpha+ system is ETL listed to UL Subject 2703, Ed. 2. Listing documents are available from the Mounting Systems, Inc. website: [www.mounting-systems.us](http://www.mounting-systems.us). For additional information, contact Mounting Systems, Inc.



UL 2703 requires that listed PV systems be labeled to indicate their compliance with UL 2703. The Alpha+ system includes labels affixed to the Clickstone on each module end clamp as shown in image 1.4.1.



Image 1.4.1 **UL 2703 system label and location**

### Fire Class Resistance Rating (ANSI / UL 1703)

The Alpha+ system is intended for roof mounting over a fire-resistant roof covering rated for the application. The Alpha+ fire rating is valid for roofs with slopes greater than 2:12 (9.5°).

- Class A for Steep Slope Applications when using Type 1 or Type 2, Listed Photovoltaic Modules.
- Class A for Steep Slope Applications when using Array Skirt and Type 1 or Type 2, Listed Photovoltaic Modules.

This fire class rating requires installation procedures, which are in compliance with the included instructions. The Alpha+ system is intended for roof mounting over a fire-resistant roof covering rated for the application. The Alpha+ fire rating is valid for roofs with slopes greater than 9.5° (2:12). The fire class rating is valid for systems installed at any height above the roof deck. It is also valid with and without the addition of the optional array skirt.

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.

ANSI/UL 1703 and/or ANSI/UL 2703 require the presence of a label indicating the system Fire Class Rating or information directing the user to the appropriate information. The Alpha+ Fire Class Rating label is located on each end clamp Clickstone as shown in Image 1.4.2.

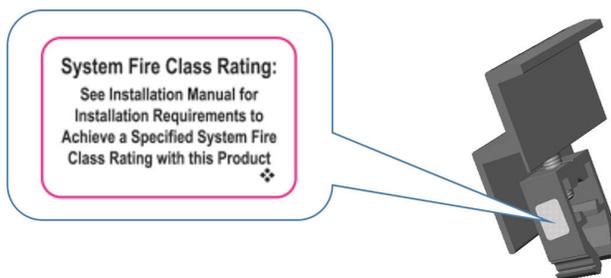


Image 1.4.2 Alpha+ Fire Class Rating label and location

### Mechanical Load Rating (ANSI / UL 1703)

The Alpha+ system has been mechanically tested according to UL 2703 Edition 1 to the following load ratings:

- Downward Pressure: 10 PSF
- Upward Pressure: 5 PSF
- Down-Slope Load: 5 PSF

### 1.5 Safety

All generally applicable safety regulations for Mounting Systems, Inc. products can be viewed in the document "Installation Instructions for PV mounting Systems: General Information". Please read this document carefully and adhere to the instructions and procedures therein – use the system only for its intended purpose and follow both the general and specific safety instructions. In addition, please observe the specific safety instructions which precede the process steps in the present product-specific Mounting Instructions.

### Safety Ratings:

- Maximum 300 modules per ground lug
- Maximum size of modules: 1970mm x 1000mm x 50mm
- Maximum system voltage is 1000 VDC

## 2. Technical Description

### 2.1 System Overview

The following is an overview of the major Alpha+ system components as shown in Image 2.1.1.

Note that the actual configuration of each individual system can vary depending on:

- Type of roof (substructure and roof cladding)
- Type of module
- Number of modules and configuration
- Local conditions

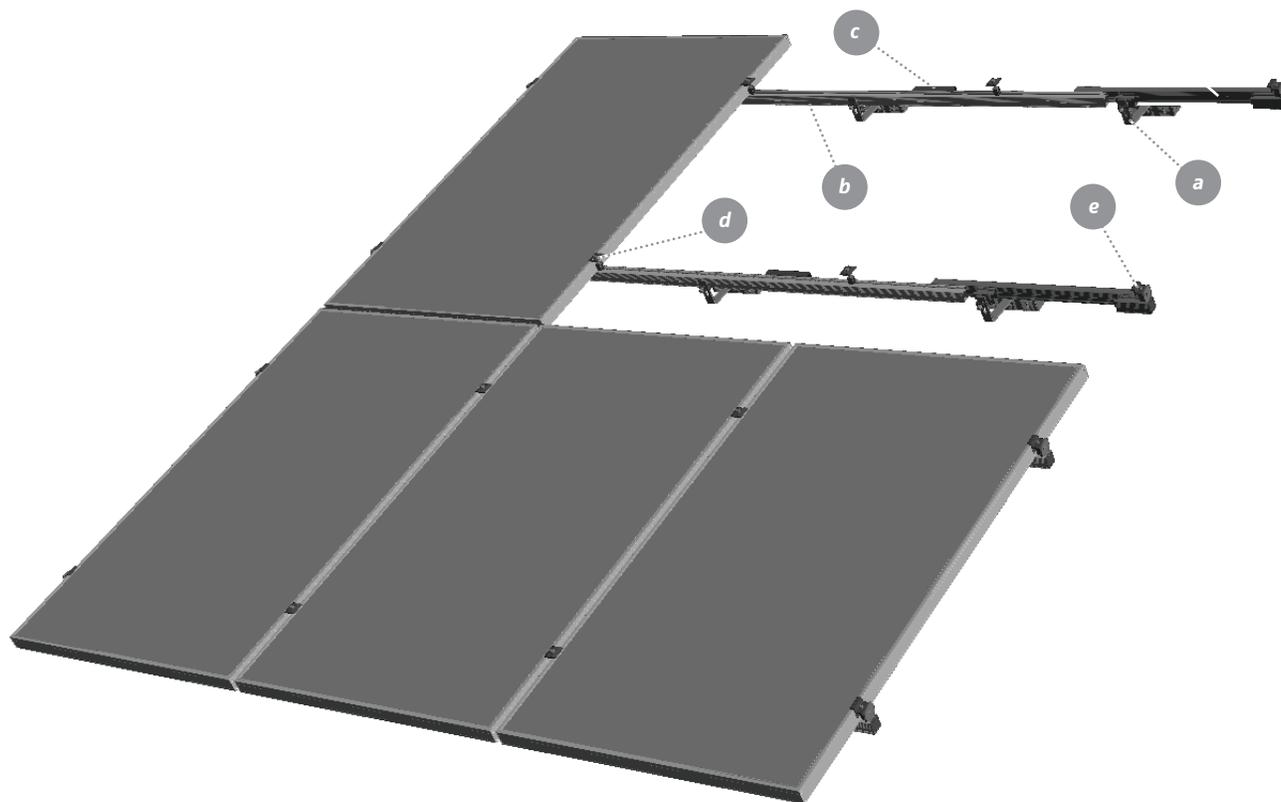


Image 2.1.1

- a** Roof hook
- b** Base rail
- c** Splice
- d** Module mid clamp
- e** Module end clamp

## 2.2 Alpha+ Components

<i>Components</i>	<i>Product Rendering</i>	<i>Torque Value</i>
<p><b>a</b> Alpha+ base rail (BR) options:</p> <ul style="list-style-type: none"> <li>• BR 10/48 in various lengths</li> <li>• BR 13/52 in various lengths</li> </ul>		
<p><b>b</b> Alpha+ rail splice:</p> <ul style="list-style-type: none"> <li>• Rail splices, 10/48 or 13/52 rail sizes</li> </ul>		<p>15 ft-lbf / 20 N-m</p>
<p><b>c</b> Standard module end clamps:</p> <ul style="list-style-type: none"> <li>• Discrete sizes for modules from 31 to 50mm thick</li> <li>• Available with optional WEEB-BMC module bonding clip</li> <li>• Mill or black finished</li> </ul>		<p>8 ft-lbf / 11 N-m</p>
<p><b>d</b> Variable module end clamps:</p> <ul style="list-style-type: none"> <li>• Three clamp ranges for module thicknesses from 31 to 50 mm</li> <li>• Available with optional WEEB-BMC module bonding clip</li> <li>• Mill or black finished</li> </ul>		<p>8 ft-lbf / 11 N-m (Standard) 12 ft-lbf / 16 N-m (WEEB - BMC)</p>
<p><b>e</b> Bonding module mid clamps:</p> <ul style="list-style-type: none"> <li>• Sizes for module thicknesses 28–40 mm, 33–45 mm, or 38–50 mm</li> <li>• Mill or black finished</li> </ul>		<p>12 ft-lbf / 16 N-m</p>
<p><b>f</b> Roof attachment options:</p> <ul style="list-style-type: none"> <li>• Roof hooks in various designs (example shown here: standard roof hook)</li> <li>• Hanger bolts in various designs (example shown here: hanger bolt with rubber seal)</li> <li>• Flashing options for standard and shared rail configurations</li> </ul>		

2.2 Components	Product Rendering	Torque Value
<p><b>g</b> Small parts for connecting the roof attachments to the base rail options:</p> <ul style="list-style-type: none"> <li>• L-bracket + small parts (required for some roof hook flashings, hanger bolts and sheet-metal clamps)</li> <li>• T-head bolt and serrated lock nut (supplied loose)</li> </ul>		<p>15 ft-lbf / 20 N-m</p>
<p><b>h</b> End caps options:</p> <ul style="list-style-type: none"> <li>• For BR 10/48 and BR 13/52</li> <li>• Gray or black</li> </ul>		

### 2.3 Technical Data

<b>Application</b>	<i>Pitched roof – on-roof</i>
<b>Roof cladding</b>	<i>Suitable for most types of roof cladding</i>
<b>Roof slope</b>	<i>Up to 60°<sup>1</sup></i>
<b>Building height</b>	<i>Up to 65 ft / 20 m<sup>1</sup></i>
<b>PV modules</b>	<i>Framed or frameless</i>
<b>Module orientation</b>	<i>Landscape, portrait</i>
<b>Size of module array</b>	<i>Any size possible<sup>2</sup></i>
<b>Position of the module array</b>	<i>No special requirements</i>
<b>Distance between roof attachment points</b>	<i>Up to 10 ft / 3 m<sup>1</sup></i>
<b>Maximum Rail Cantilever</b>	<i>16 in / 40 cm<sup>2</sup></i>
<b>Standards</b>	<i>IBC 2009 IBC 2012 ASCE 7-05 ASCE 7-10 CBC 2013 ANSI/UL 2703 Ed. 1 UL 1703 ANSI / AISC 360-05 ACI 318-08 Aluminum Design Manual 2010 Eurocode 1-DIN EN 191-1-1 – Actions on structures Eurocode 9 – Design of aluminum structures</i>
<b>Supporting profiles</b>	<i>Extruded Aluminium (EN AW 6063 T66)</i>
<b>Hooks, small parts</b>	<i>Stainless steel (V2A)</i>
<b>Color</b>	<i>Mill finish, black (option)</i>
<b>Warranty</b>	<i>10 Years<sup>3</sup></i>

<sup>1</sup> Different maximum values may apply, depending on site, building, choice of roof attachment and module type.

<sup>2</sup> The Mounting Systems QuickConfigurator can be used to verify the structural adequacy of each specific project quickly and easily.

<sup>3</sup> To allow for thermal expansion, MSI recommends a maximum continuous rail length of 40' (12 m)

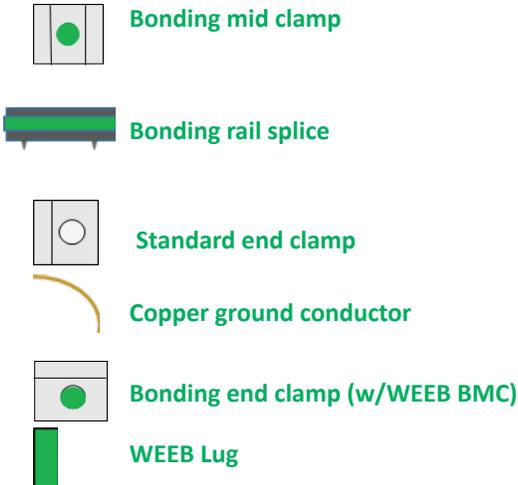


Image 2.4.1 Icons

## 2.4 System Electrical Bonding

The Alpha+ system, when properly assembled and installed, provides an integrated electrical bonding path, ensuring that all exposed metal parts and the PV module frames are electrically connected. The Alpha+ employs a number of features to ensure reliable electrical connectivity.

### Bonding and Fault Path

Images 2.4.2 and 2.4.3 show the available current path(s) in the Alpha+ system for standard and shared rail configurations, respectively.

Images 2.4.4 through 2.4.14 provide detail drawings of the labeled connection points.

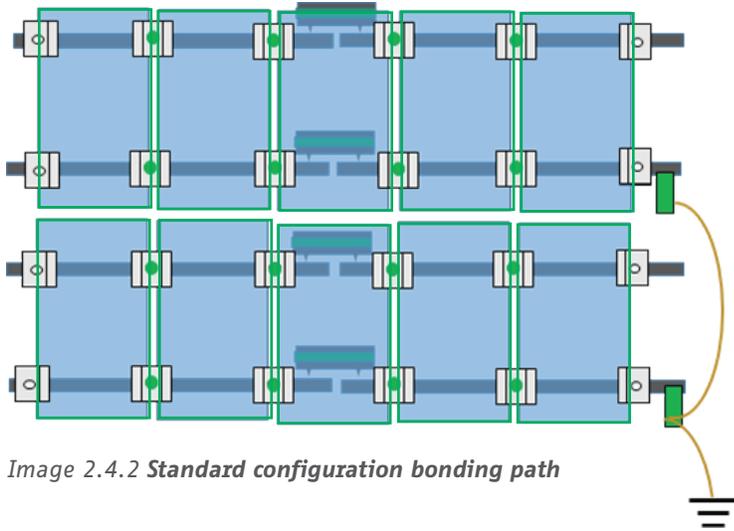


Image 2.4.2 Standard configuration bonding path

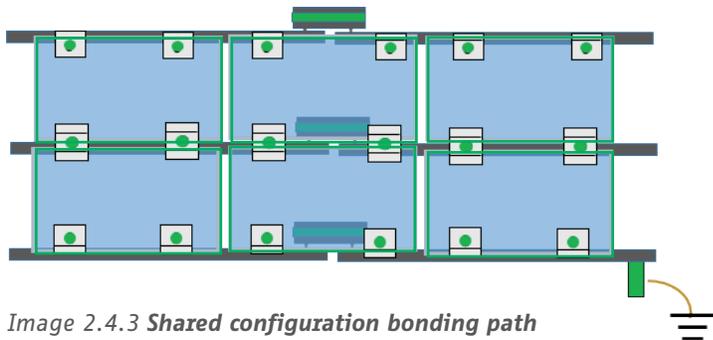


Image 2.4.3 Shared configuration bonding path

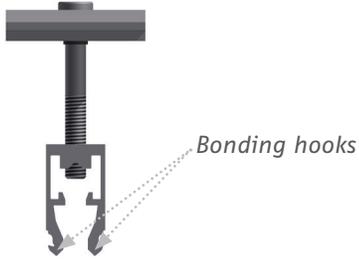


Image 2.4.4 Clickstone bonding hooks



**NOTE!**

The installer is responsible for and shall provide an appropriate method of direct-to-earth grounding according to the latest edition of the National Electrical Code, including NEC 250: Grounding and Bonding and NEC 690: Solar Photovoltaic Systems.

**Clickstone Bonding**

As shown in Image 2.4.4 and 2.4.5, the Alpha+ Clickstones and rails are designed with complementary, sharp bonding hooks. When the Clickstone clamp is installed in the Alpha+ rail and the bolt is tightened, the bolt forces the hooks into the rail. Then, as the clamp engages the module and the bolt is tightened to the recommended torque specification [12 ft-lbf (16 N-m)], these hooks are pulled tightly together and penetrate the aluminum oxide or painted coating on the rail and electrically connect the rail, Clickstone, and Clickstone bolt. A star washer under the bolt head serves to connect the Clickstone bolt to the body of the mid or end clamp, thus forming a secure, high-ampacity electrical bonding path as shown in Image 2.4.6.



Image 2.4.5 Clickstone rail bonding hooks



Image 2.4.6 Clickstone bonding path



Image 2.4.7  
**Bonding plate mid clamp**



Image 2.4.8  
**Standard end clamp**



Image 2.4.9  
**Variable end clamp**



Image 2.4.10  
**Universal end clamp**

## PV Module Bonding

PV module frames are electrically bonded to the Alpha+ system by the bonding mid clamps. Bonding plate mid clamps are preassembled with a stainless steel plate below the clamp head. The stainless steel bonding plate is formed with sharp points that pierce the oxide or anodized coating of the clamp head and the PV module, forming an electrical bond between the module, the clamp head, and thus to the rest of the Alpha+ system. Bonding plate mid clamps are available in mill finish and black anodized versions.

Both standard, discrete module height end clamps and variable height end clamps are available with optional WEEB-BMC bonding clips. Bonding versions of the end clamps are useful when mounting a single row of modules where bonding mid clamps are not utilized. The WEEB-BMC works in the same way as the bonding plate and set screws.

## Rail Bonding

Alpha+ rails can be spliced into a longer unit by means of the Alpha+ Bonding Splice, (Image 2.4.10). The bonding splice joins the two rail segments mechanically and electrically. The splice uses two stainless steel bolts – one for each rail – which, when tightened to the specified torque of 15 ft-lbf (20 N-m), pierce any painted coating or aluminum oxide layer on the rails and embed in the rails being joined. This forms a conductive path from the rails through the bolt shafts, captive square nuts, and star washers into the splice body, which then acts as a high-ampacity conductor between the two rail segments to the rails, modules, and clamps.

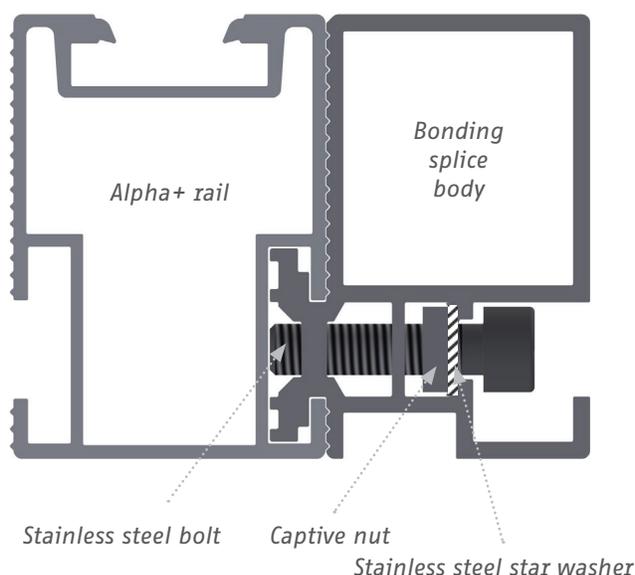


Image 2.4.10 **Alpha+ bonding splice**



Image 2.4.11 Hammerhead bolt and flange nut



Image 2.4.12 Hammerhead bolt in rail

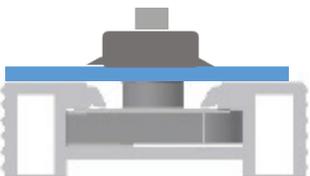


Image 2.4.13 Hammerhead bolt in rail

### Roof Attachment Bonding

The Alpha+ rail is attached to the roof by one of three methods: a) roof hooks, b) flashings and L-feet or c) hanger bolts.

In each case, the connection from the attachment device to the rail is made via a stainless steel hammerhead bolt and a stainless steel, serrated flange nut (Image 2.4.11).

### Microinverter, Accessory Bonding

The Alpha+ rail is attached to a micro-inverter with the same stainless steel hammerhead bolt and a stainless steel, serrated flange nut. (Image 2.4.11).

When secured to the rail [15 ft-lbf (20 N-m)], the hammerhead bolt crushes and pierces the oxide or anodized layer on the rail and forms an electrical bond. The serrated flange of the nut then connects the bolt to the stainless steel body of the roof hook or the aluminum body of the L-foot thereby bonding the roof attachment and micro-inverter to the rails, modules, and clamps.

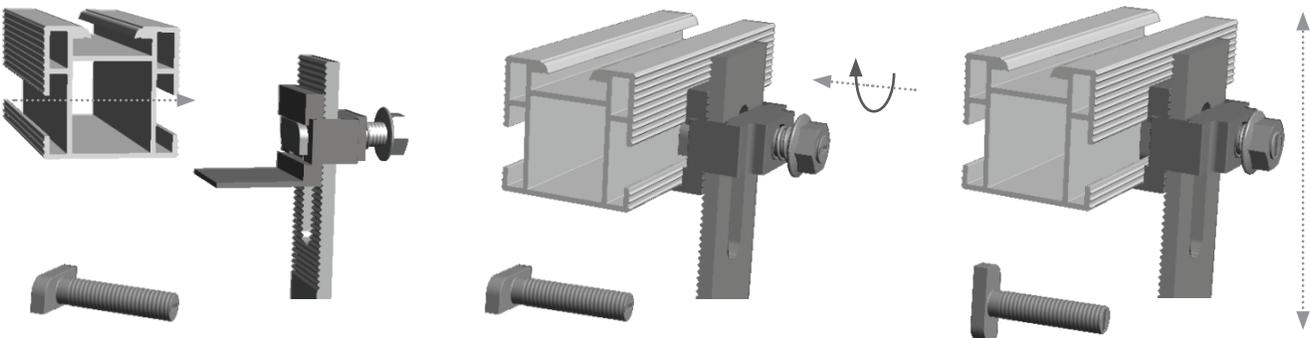


Image 2.4.14 Roof attachment connection



Image 2.5.1 WEEB-Lug 8.2

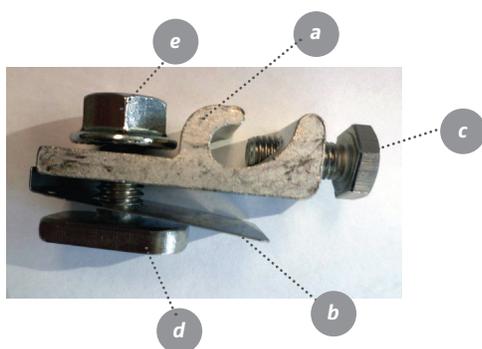


Image 2.5.2 Bonding variable end clamp with WEEB BMC

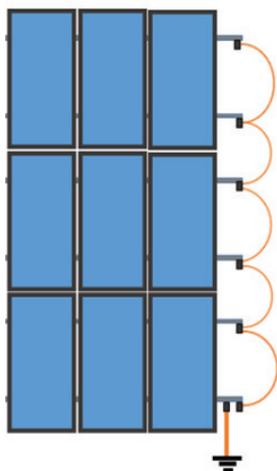


Image 2.5.3 Array bonding connections



**NOTE!**

Because the Alpha+ rail splices are ETL listed to UL 467, a spliced rail can be treated as a single, solid rail. Additional WEEB-Lugs or bonding jumpers are not required for spliced rails.

## 2.5 System Electrical Grounding

### Array Grounding Lug

The Alpha+ system is listed to UL 2703 with the Burndy/Wiley WEEB-Lug 8.2 as the means to connect the Alpha+ array to the system ground electrode. It is the system installer's responsibility to determine the appropriate wire size for grounding the array.

To ease and facilitate the process of bonding and grounding the array, it is recommended that these steps are accomplished after the roof attachments and rails are in place prior to module installation. The Burndy WEEB-Lug 8.2 is a special, preassembled lay-in lug designed specifically for use in bonding the array segments (module rows) electrically and for connecting the bonded array to ground. The WEEB-Lug 8.2 is shown in Image 2.5.2:

- a Lug
- b WEEB 8.2
- c Wire capture bolt
- d M8x25 T-head bolt
- e M8 serrated flange nut

When the PV modules are properly installed, the Alpha+ Clickstone bonding clamps ensure that all the exposed metal parts and the module frames in each module row or array segment are integrally electrically connected (bonded) with a high-ampacity bond. Each module row must also be connected to ground through the system ground electrode. This is accomplished by using WEEB-Lugs to bond each of the array segments or module rows together and for connecting the entire array to the ground electrode.

Because of the integral bonding provided by the Alpha+ system, it is, therefore, necessary to use only one WEEB-Lug per array segment to connect the array segment to ground. However, many AHJs and building inspectors require that a WEEB-Lug be used to connect each rail in the array. This arrangement is shown in Image 2.5.3.

It is the installer's responsibility to determine the correct wire type, size, and temperature rating for the particular array. The wire sizes and capacities, which can be accommodated by the WEEB-Lug 8.2, are shown in Table 2.5.1 on the next page.

AWG Wire Size	WEEB-Lug 8.2 Capacity
14-6	1 wire
10	2 wires
12	2 wires

Table 2.5.1 WEEB Lug 8.2 wire capacity



Image 2.5.4 WEEB-Lug 8.2 installed



Image 2.5.5. WEEB-Lug 8.2 incorrectly installed

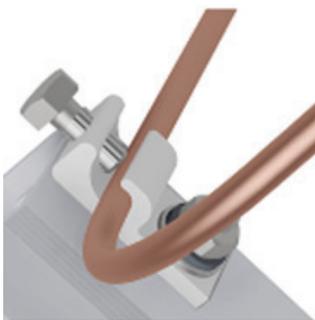


Image 2.5.6 Copper wire in WEEB-Lug

### WEEB-Lug Installation

The Alpha+ WEEB-Lug 8.2 is preassembled with an M-8 T-head bolt, M8 nut, and a WEEB bonding washer. Depending on layout and accessibility, the lug may be installed in either side channel of the Alpha+ rail.

- Select appropriate Alpha+ rail channel and insert T-head bolt head into channel.
- Ensure WEEB washer is aligned with lug body and that lug body makes full contact with rail. Tighten nut finger tight to hold lug and WEEB in place.
- Tighten M8 nut to 15 ft-lbf (20 N-m).

Using the above procedure, install a WEEB-Lug in each rail in the array. Once all the WEEB-Lugs are installed, use a continuous length of wire to connect each rail by laying wire in the lug wire channel and secure with the wire capture bolt. Torque to 7 ft-lbf (10 N-m).

### Array Grounding

The bonded array must be connected to the system ground electrode. This can be done by continuing to run the same wire connecting the module rows to the ground electrode, securing it to the electrode by appropriate means. It may be easier or more convenient, however, to use a separate WEEB-Lug 8.2 to connect to the ground electrode that terminates at one of the module rails as shown in Image 2.5.6.

Installation and connection of the lug is the same as described above.

### Galvanic Reaction

When dissimilar metals come into contact, it is possible that they will react with each other and cause corrosion in one or both of the metal surfaces. Aluminum and copper are particularly reactive with each other; care must be taken to prevent any contact between aluminum components and bare copper wire (Image 2.5.6).



**NOTE!**

The WEEB Lug 8.2 can only be reused five times. When uninstalled and reinstalled, it must be moved to a new location.

### 3. Important Installation Information

#### 3.1 Conditions of Use

The Alpha+ on-roof system is available with different rail and roof attachment types designed in accordance to and/or compliance with the following codes and standards:

- International Building Code 2012
- California Building Code 2013
- ASCE 7-05
- ASCE / SEI 7-10
- ANSI / AISC 360-05
- ACI 318-08
- UL 2703
- UL 1703 (Enhanced)
- Aluminum Design Manual 2010
- Eurocode 1-DIN EN 1991-1-1



#### Risk of injury from damage to roof

Excessive loads can severely damage the roof and cause injury.

- Before mounting and installation, please make sure that the building and especially the roof cladding meet the increased structural requirements of the PV system and the installation operations.



#### Risk of fatal injury from falling objects

Parts falling from the roof can result in serious injuries or death.

- Before beginning the installation, please ensure that proper safety precautions are observed, that only authorized personnel are permitted in and around the construction area, and that proper protective clothing and equipment are worn.

The design of each system should be verified, e.g. by means of the Alpha+ QuickConfigurator or an independent Professional Engineer. Please observe the constraints listed in Chapter 2.3, "Technical Data."

#### 3.2 Mounting Preparation

Mounting Systems, Inc. recommends you ascertain the local conditions and requirements before ordering the Alpha+. In particular, acquaint yourself with:

- The roof structure and any irregularities
- Dimensions, material, quality, and spacing of the rafters and purlins
- Type, quality, and attachment method of the roof tiles/ cladding.

#### 3.3 Mounting Aids and Required Tools

In addition to standard hand tools, you will need the following tools:

- 5 mm Allen key / 5 mm Allen key power driver
- 13 mm hex socket / 13 mm box or open-end wrench
- Drill driver
- Metric socket set
- Torque wrench
- Angle grinder with
  - Metal cutting disc
  - Stone disc (if necessary for tile installations)
- Chalk line
- Spirit level
- Tape measure

**Please adhere to the mounting steps listed and be sure to follow the safety instructions.**

#### 3.4 Fastener Torque Settings

Proper torque is important to a safe and secure installation. Please refer to Section 2.2 Alpha+ Components for recommended torque values for the various fasteners in the Alpha+ system. Unless specifically directed otherwise, these values should be used for all metal-to-metal attachments.

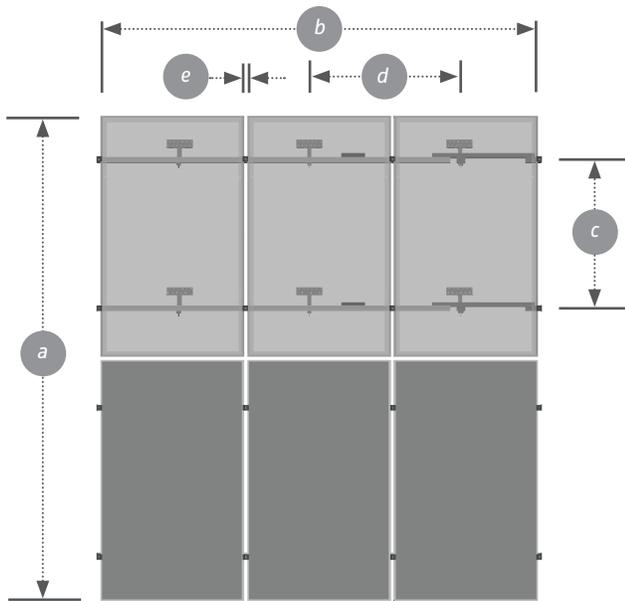


Image 4.1 Module area

- a** Height of the module field: Number of modules vertically x module length (+ any clearances)
- b** Width of the module field: Number of modules horizontally x (module width + 0.75 in. / 19 mm) + 1.6 in. / 41 mm.
- c** Vertical spacing of the base rails: Approximately the module quarter points =  $1/2 \times$  module length (adjusted for tile considerations and actual recommended module mounting point locations).
- d** Horizontal attachment point spacing: Dependent upon roof attachment method and site-specific parameters.<sup>2</sup>
- e** Distance between the modules = 0.67 – 0.75 in. / 17 – 19 mm.

<sup>2</sup> Spacing can be determined and verified to IBC 2009 or IBC 2012 with the Mounting Systems QuickConfigurator.

## 4. Planning the Module Area

For installation, the base rails are fastened to the rafters or purlins (for metal roofs) of the building with roof attachments (e.g. roof hooks). The roof fasteners must be mounted at defined distances, depending on the spacing of the rafters/ purlins, the position on the roof, and the site conditions. The layout should be verified using the Mounting Systems QuickConfigurator tool or a project-related structural analysis by a licensed engineer.



### Risk of fatal injury due to falling

Falling from the roof can result in serious injuries or death.

- Please wear and use proper protective equipment.
- Secure yourself against falling.
- Do not perform any work in strong winds.



### Risk of fatal injury from falling objects

Parts falling from the roof can result in serious injuries or death.

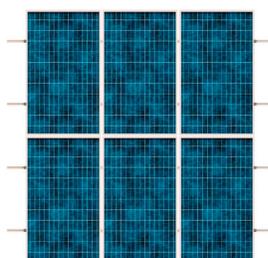
- Block off the hazard area on the ground prior to beginning work to prevent falling objects injuring persons.
- Ensure that no parts can fall off the roof.
- Please wear required protective equipment.
- Do not linger in the hazard area.
- After completion of the installation, re-check area for loose objects and re-check for proper attachment of racking and modules.

**NOTE!**

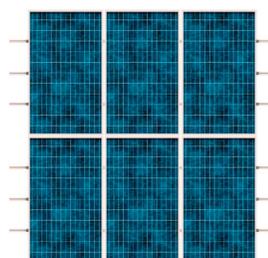
Portrait-oriented shared rail systems can be used only for modules approved or granted a waiver by the module manufacturer for mounting on the short side. In most cases, the wind and snow load bearing capacities of modules mounted at these locations is significantly reduced. Ensure that the environmental conditions at the installation site do not exceed these reduced capacities.

**NOTE!**

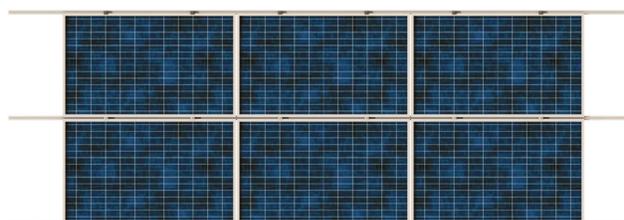
Precise rail positioning and alignment is critical when installing shared rail systems. Roof attachments which are adjustable in the N-S direction should be used when installing shared rail systems.



*Image 5.1.1*  
**Standard rail configuration**



*Image 5.1.2*  
**Three-rail configuration**



*Image 5.1.3*  
**Shared rail configuration**

## 5. Installation of Roof Attachments and Rails

The roof fasteners are attached to the roof structure and support the base rails. The permissible distance between the roof fasteners depends on several factors and must be calculated specifically for each project, e.g. with the Mounting Systems QuickConfigurator tool. Roof attachments are available for a wide variety of roof types and cladding. In many cases, additional items may be required to accomplish flashing or other weather sealing. Suitable products are available from a number of sources. It is the responsibility of the installer to select the appropriate products, if required, and to install them correctly.

### 5.1 Select Base Rail Configuration

#### Standard Rail

Image 5.1.1 shows a typical standard rail configuration. In this configuration, a row of modules is supported by two rails under each row of modules. In areas with exceptionally high snow loads it may be necessary to support the modules with three rails as shown in Image 5.1.2. The Mounting Systems Quick Configurator tool can be used to plan and lay out both 2- and 3-rail configurations.

#### Shared Rails

The rail design of the Alpha+ system allows the use of shared rails. In this configuration, a single rail supports two rows of modules as shown in Image 5.1.3. Shared rails may be used for both landscape and portrait array configurations.

Standard Alpha+ end and mid clamps are also used in shared rail configurations.

The Mounting Systems Quick Configurator tool can be used to plan and layout shared rail systems.

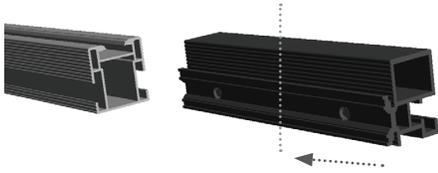


Image 5.2.1

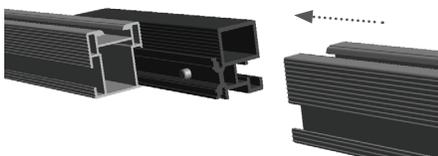


Image 5.2.2



Image 5.2.3

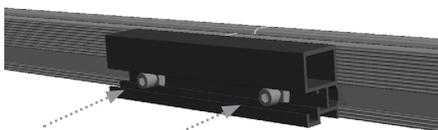


Image 5.2.4



Image 5.2.5

## 5.2 Base Rail Preparation

### Rail Splicing

The Alpha+ splice is used to join two rail sections to provide a single rail section of a desired length. The splice is preassembled with bolts, nuts, and bonding star washers.

#### Installation steps:

- To join the rail sections, slide the splice onto the end of the rail, leaving half the length of the splice protruding from the end of the rail.
- Tighten the splice bolt onto the rail end. Tighten to 15 ft-lbf (20 N-m).
- Slide the other rail onto the splice and tighten the splice bolt to 15 ft-lbf (20 N-m).



#### NOTE!

The Alpha+ splice is a "full-strength" splice. Once it is installed and tightened to the recommended torque specification, it forms an essentially unbroken rail.

It may speed installation to splice rails on the ground and transport them to the roof in one piece for installation on the roof attachments.



#### NOTE!

To allow for thermal expansion/contraction, spliced rail lengths should not exceed 40 feet (12 m) without a thermal break of approximately 2 in. (5 cm). Do not install modules over this thermal break.



#### NOTE!

The maximum cantilever (the length of rail extending beyond the last roof attachment) for standard Alpha+ rail is 16 in. (40 cm). Do not exceed this limit.

### 5.3 Installation on Composition Shingle Roofs

In general, the Mounting Systems, Inc. L-feet will be used to install the base rails on composition shingle roofs. Installation of the Alpha+ system on composition shingle roofs requires that any penetrations of the roof surface be flashed in accordance with the appropriate local codes. Mounting Systems recommends the use of the Flashmount flashings for standard rail installations or the Flashmount SR flashings for shared rail installations.



Image 5.3.1 L-foot on flashing



**NOTE!**

Where site conditions and safety considerations allow, it may speed and simplify the installation to splice rails on the ground then transport them to the roof.



**NOTE!**

If rails are to be spliced, the splice should be installed prior to installing the rails onto the L-feet or other roof attachments. See Section 5.2 for rail splicing instructions.

It does not matter whether the first rail is installed at the upper or lower side of the array. If the array will be installed with reference to a particular point on the roof, the first rail should be installed with respect to that reference point.

#### **Installing Standard Rail Configuration**

##### **Installation Steps:**

- After determining the location of the array on the roof, mark the rail locations with chalk lines or other suitable method.
- Determine the rafter or purlin locations and mark them on the E-W chalk lines.
- For standard 2- or 3-rail installations, if you are using Mounting Systems, Inc. Flashmount flashings, install them at the above marked locations per the instructions in Appendix B, "Flashmount Installation Instructions," which can be found on Mounting Systems' website.<sup>2</sup> For other mounting/flushing products, install per the manufacturer's installation instructions.
- Install the mounting/flashings along the chalk line per the manufacturer's instructions taking care to align the L-foot mounting point (flashing bolt) as closely as possible to the intersection of the rafter or purlin and the chalk line.
- Loosely install the Alpha+ L-feet on the mounting/flashings with the preassembled T-head bolts facing the ridge of the roof. The L-feet may be aligned with the base of the "L" facing north or south (it may be necessary to disassemble and reassemble the T-bolts and nuts as appropriate).

<sup>2</sup> "Flashmount Installation Instructions" can be found on Mounting Systems' website: <http://www.mounting-systems.us/downloads-technical-docs-warranty/>

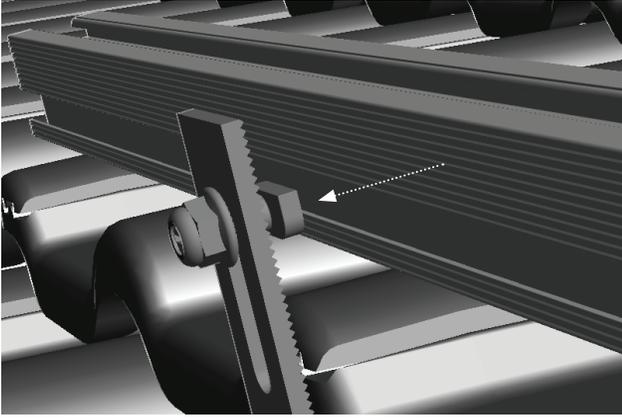


Image 5.3.2 T-head bolt correctly positioned

- Position the rail in place E-W and hold each end of the rail against the end L-feet. Insert the preassembled T-head rail fasteners in the end L-feet into the slot on the side of the Alpha+ rail. Using a spirit level or other suitable device, set and hold the rail level at the desired height by moving the T-head bolt up or down in the L-foot.
- Using a 13 mm socket, tighten the rail fastener nuts to 15 ft-lbf (20 N-m). (Be sure to allow the bolt head to rotate as far as possible in the T-head channel to ensure full engagement of the bolt head with the sides of the channel).
- Proceed along the line of L-feet, inserting the T-head bolts and tightening as above.
- Position the rail and L-feet N-S and secure the L-feet to the mounting/flashing according to the instructions for the mounting/flashing.
- Repeat the above steps for each rail in the array.

### Installing Shared Rail Configuration

#### Installation Steps:

##### Optional gauge fabrication

- Fabricate an installation gauge by laying two rails on a flat surface. Lay one of the modules on the rails as shown. Be sure the rails are parallel with the edges of the module and with each other.
- Carefully measure distance "A" as shown in Image 5.5.3. This is the critical N-S distance between L-foot rail attachment points for shared rails.

Carefully cut a dowel, PVC pipe, or other rigid length of material to distance "A."

#### Array Installation

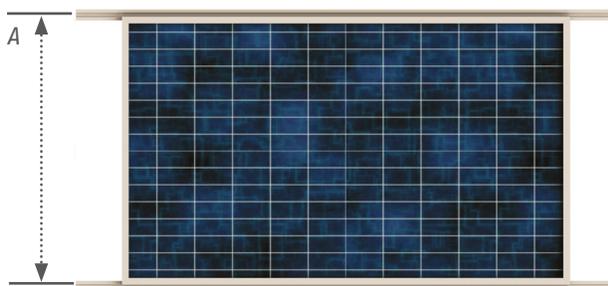
- After determining the location of the array on the roof, mark the location of the lower rail with a chalk line or other suitable method.
- Determine the rafter or purlin locations and mark them on the E-W chalk lines.

#### NOTE!



- The use of shared rails requires precise positioning of the base rails. Mounting Systems, Inc. strongly recommends the use of roof attachments with adequate adjustability.
- Mounting Systems recommends fabrication and use of a gauge such as a length of dowel or PVC pipe to be used to precisely position and maintain the distance between roof attachments in the N-S direction.

- For shared rail installations, if you are using Mounting Systems, Inc. Flashmount SR flashings, install them at the above marked locations per the instructions in Appendix B, “Flashmount Installation Instructions” at the back of this manual. For other mounting/flushing products, install per the manufacturer’s installation instructions at the locations determined above.
- Install the mounting/ flashings along the chalk line per the manufacturers’ instructions taking care to align the L-foot mounting point (flashing bolt) as closely as possible to the intersection of the rafter or purlin and the chalk line.
- Install and tighten the L-feet on the two end mounting/ flashings taking care to place the upright stays of the L-feet as closely aligned with the marked line as possible with the faces of the stays as closely parallel to the line as possible.



*Image 5.3.3 Shared rail distance gauge*

- Stretch a reference string between the end L-feet and attach the remaining L-feet with the upright stays just touching the reference string and secure them in position.
- Using the gauge fabricated earlier or using a measuring tape or other suitable method, locate and mark the positions of the remaining rows of the array.
- Install the remaining mounting/ flashings and L-feet and check frequently to ensure proper N-S spacing of the upright surfaces of the L-feet stays with the distance gauge.
- Position the rail in place E-W and hold each end of the rail against the end L-feet. Insert the preassembled T-head rail fasteners in the end L-feet into the slot on the side of the Alpha+ rail. Using a spirit level or other suitable device, set and hold the rail level at the desired height by moving the T-head bolt up or down in the L-foot.
- Using a 13 mm socket, tighten the rail fastener nuts to 15 ft-lbf (20 N-m). (Be sure to allow the bolt head to rotate as far as possible in the T-head channel to ensure full engagement of the bolt head with the sides of the channel).
- With each end of the rail secured and the rail level, proceed along the line of L-feet, inserting the T-head bolts into the rail side channel and tightening as above.
- At this point, it is recommended to install the rail at the opposite side of the array and level it at both ends with respect to the first rail. That is, if the lower-most rail was installed first, the uppermost rail should be installed second and leveled N-S with the first rail and E-W.
- Stretch strings from each corner of the upper and lower rails.
- Position the next rail and attach it as described above, leveling it both E-W and N-S using the strings installed above as reference.
- Repeat the above steps for each rail in the array

## 5.4 Installation on Tile Roofs

In North America, the tile on tile roofs is virtually always a decorative cladding; it is not structural nor is it the primary weather seal. There is also a wide variety of tile types and designs. As such, installation and flashing requirements vary widely by roof and tile type as well as by local jurisdiction.

Mounting Systems, Inc. tile roof hooks are designed so that in most applications, additional flashing is not required.



Image 5.4.1 High Lift Roof Hook

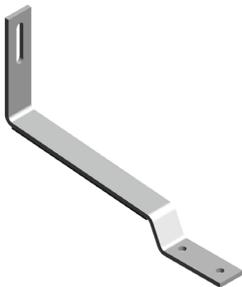


Image 5.4.2 Direct Attach Roof Hook

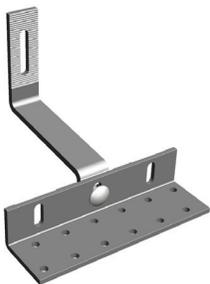


Image 5.4.3 Universal Roof Hook

If flashing is required for a particular application or jurisdiction, flashings and flashing materials may be procured from a number of sources. Contact Mounting Systems, Inc. for more information and recommendations. The following instructions provide basic installation procedures for each Mounting Systems, Inc. roof hook type.

### Flat Tiles

Mounting Systems provides two types of roof hooks for flat tiles: a standard roof hook and an adjustable roof hook. The standard roof hook is available in a Direct Attach version and a High Lift version. Both versions are primarily intended for use with 1-inch thick concrete roof tiles.

An adjustable, "universal" roof hook is available for use with both 1-inch and 1<sup>1</sup>/<sub>4</sub>-inch concrete tiles. (The universal roof hook is also usable for curved tiles).

### Installing Standard Rail Configuration

#### Installation Steps:

- After determining the location of the array on the roof, mark the rail locations with chalk lines or other suitable method.
- Determine the rafter or purlin locations and mark them on the E-W chalk lines.
- For standard 2- or 3-rail installations, if you are using Mounting Systems, Inc. Alpha+ Self-Sealing Roof Hooks, install them at the above marked locations per the instructions in Appendix C, "Alpha+ Self-Sealing Roof Hooks Installation Instructions," which can be found on Mounting Systems' website.<sup>3</sup> For other mounting/ flashing products, install per the manufacturer's installation instructions at the locations determined above. If you are using Mounting Systems, Inc. standard roof hooks, install them at the above marked locations per the instructions in Appendix D, "Alpha+ Standard Roof Hook Installation Instructions" at the back of this manual.

<sup>3</sup> "Alpha+ Self-Sealing Roof Hooks Installation Instructions" can be found on Mounting Systems' website: <http://www.mounting-systems.us/downloads-technical-docs-warranty/>

- Carefully remove the tiles from the attachment locations. It may be necessary to remove one or more tiles above the desired roof attachment location.
- For High Lift and Direct Attach roof hooks, center the roof hooks on the rafters and note the fit of the horizontal "arm" of the roof hook over the tile. If necessary, place a suitably sized shim under the roof hook and, using appropriately sized lag screws, secure the roof hook to the rafter or purlin, taking care to align the rail attachment points with the chalk line for the desired rail position.
- For Universal roof hooks, the upright stay should be attached in the center hole of the mounting plate, adjusted vertically for best fit over the tile and secured. Tighten the bolt and nut to 15 ft-lbf (20 N-m). Align the mounting plate so that one set of holes is centered over the rafter or purlin and secure with appropriate lag screws as in the previous step.
- Position the rail in place E-W and hold each end of the rail against the end roof hooks. Insert the preassembled T-head rail fasteners in the end roof hooks into the slot on the side of the Alpha+ rail. Using a spirit level or other suitable device, set and hold the rail level at the desired height by moving the T-head bolt up or down in the vertical slot in the roof hook.
- Using a 13 mm socket, tighten the rail fastener nuts to 15 ft-lbf (20 N-m). (Be sure to allow the bolt head to rotate as far as possible in the T-head channel to ensure full engagement of the bolt head with the sides of the channel.)
- Proceed along the line of roof hooks, inserting the T-head bolts and tightening as above.
- Repeat the above steps for each rail in the array.

**NOTE!**

If it is necessary to shim the roof hook, the lag screws used to secure the roof hook to the rafter, truss, or purlin must be long enough that the threaded depth of the lag screw in the rafter, truss, or purlin provides adequate *pull out strength*. This value can be determined with the Mounting Systems QuickConfigurator and called out as, "**F suction, orthogonal [lbf]**" in the "Statics Attachment" section of the QuickConfigurator printout.

*Pull out values*

Pull out values per inch of thread embedded in the rafter, truss, or purlin for various lag screw diameters for typical pine dimensional lumber is shown in the table below.

Lag screw shaft diameter	Pull out value (lbf / inch)
3/16" (5 mm)	64.3
1/4" (6 mm)	85.7
5/16" (8 mm)	107.2
3/8" *	128.6 *

\* The use of lag screw shaft diameters larger than 5/16" in the narrow (1-1/2") width of standard 2x dimensional lumber is strongly discouraged.

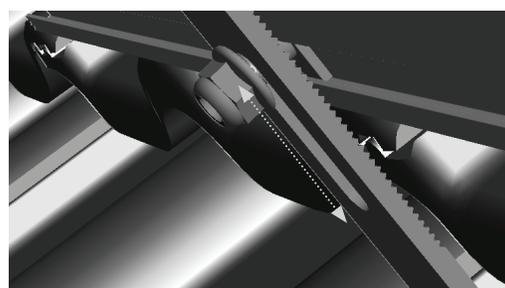


Image 5.4.4 Roof hook vertical adjustment

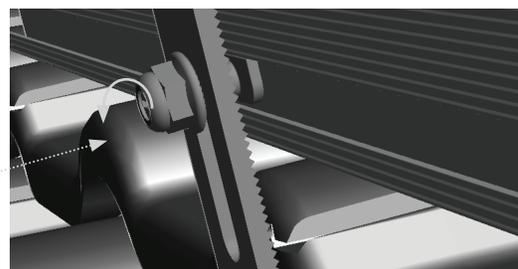


Image 5.4.5 T-head bolt correctly positioned



**NOTE!**

- The use of shared rails requires precise positioning of the base rails. Mounting Systems strongly recommends the use of appropriate tile roof attachments with adequate adjustability.
- Mounting Systems recommends fabrication and use of a gauge, such as a length of dowel or PVC pipe, to be used to precisely position and maintain the distance between roof attachments in the N-S direction.

**Installing Shared Rail Configuration**

**Installation Steps:**

Optional gauge fabrication

- Fabricate an installation gauge by laying two rails on a flat surface. Lay one of the modules on the rails as shown. Be sure the rails are parallel with the edges of the module and with each other.
- Carefully measure distance "A" as shown in Image 5.4.6. This is the critical N-S spacing between the roof hook rail attachment points for shared rails.
- Carefully cut a dowel, PVC pipe, or other rigid length of material to distance "A."

**Array Installation**

- After determining the location of the array on the roof, mark the location of the lower rail with a chalk line or other suitable method.
- Determine the rafter or purlin locations and mark them on the E-W chalk lines.
- Remove tiles as necessary and install the tile roof attachments along the chalk line taking care to align the roof hook rail mounting as closely as possible to the intersection of the rafter or purlin and the chalk line.
- Install and tighten the roof hooks on the two end roof hooks, taking care to place the upright stays of the roof hooks as closely aligned with the marked line as possible with the faces of the stays as closely parallel to the line as possible.
- Stretch a reference string between the end roof hooks and attach the remaining roof hooks with the upright stays just touching the reference string and secure them in position.
- Using the gauge fabricated earlier or using a measuring tape or other suitable method, locate and mark the positions of the remaining rows of the array.

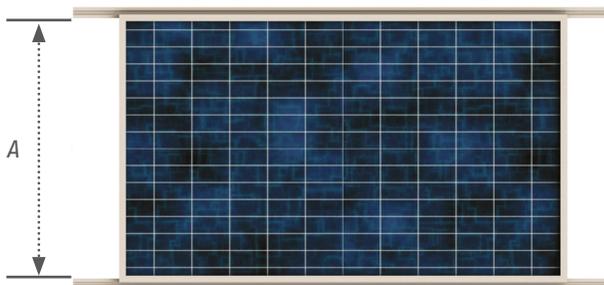


Image 5.4.6 Shared rail distance gauge

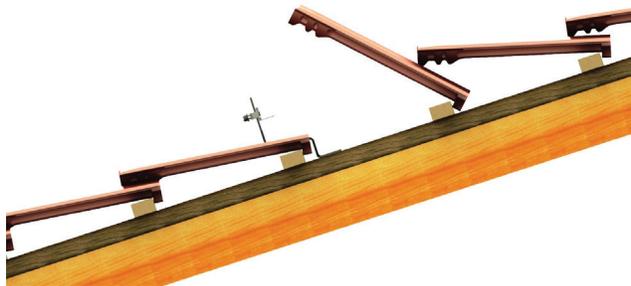
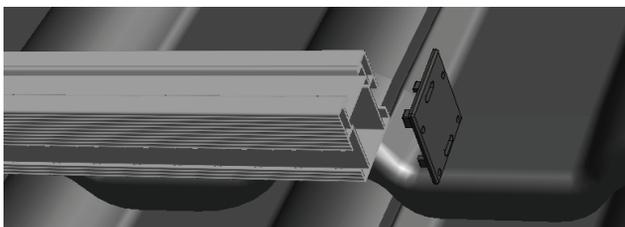
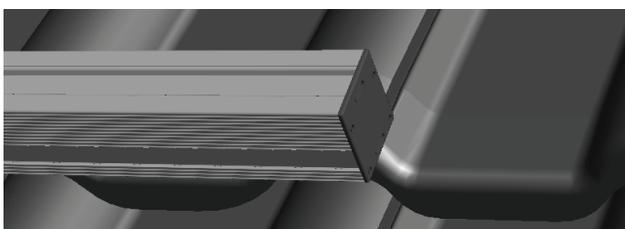


Image 5.4.7 Mounting the roof hooks

- Install the remaining roof hooks, checking frequently to ensure proper N-S spacing with the distance gauge.
- Position the rail in place E-W and hold each end of the rail against the end roof hooks. Insert the preassembled T-head rail fasteners in the end roof hooks into the slot on the side of the Alpha+ rail. Using a spirit level or other suitable device, set and hold the rail level at the desired height by moving the T-head bolt up or down in the vertical slot of the roof hook.
- Using a 13 mm socket, tighten the rail fastener nuts to 15 ft-lbf (20 N-m). (Be sure to allow the bolt head to rotate as far as possible in the T-head channel to ensure full engagement of the bolt head with the sides of the channel).
- With each end of the rail secured and the rail level, proceed along the line of L-feet, inserting the T-head bolts into the rail side channel and tightening as above.
- At this point it is recommended to install the rail at the opposite side of the array and level it at both ends with respect to the first rail. That is, if the lower-most rail was installed first, the uppermost rail should be installed second and leveled N-S with the first rail.
- Stretch strings from each corner of the upper and lower rails as shown in Image 5.3.4.
- Position the next rail and attach it as described above, leveling it both E-W and N-S using the strings installed above as reference.
- Repeat the above steps for each rail in the array.



1



2

Image 5.6.1 End cap installation

## 5.6 End Caps

Depending on the type of end cap supplied, they are installed either by simply inserting them into the ends of the rails or by sliding them over the ends of the rails and securing them with the supplied self-drilling/ self-tapping screws.

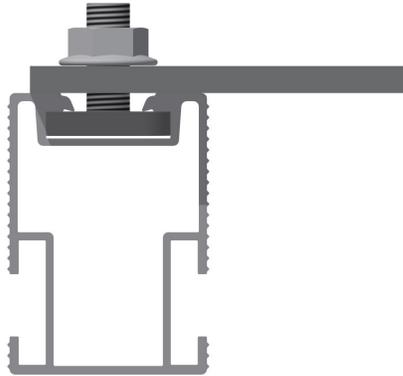


Image 6.1.1 Microinverter

## 6. Module Installation

### 6.1 Microinverter / Optimizer Installation

If microinverters or optimizers are to be used with the array and mounted on the rails, they should be installed prior to installing the PV modules. The Mounting Systems, Inc. "Rail / Microinverter Attachment," Part Number 712-0147, is an M8 x 20mm T-bolt and a serrated, flanged nut. It is intended to be used with the mounting flanges supplied with the microinverters or optimizers to hold the microinverter or optimizer device mounting flange to the top of the Alpha+ rail.

- Loosely assemble the T-bolt and flanged nut through the mounting flange of the device to be mounted to the Alpha+ rail with the T-head below the mounting flange.
- Insert T-head into the top channel of the Alpha+ rail and, using a 13 mm wrench or socket, tighten the flanged nut to secure the device mounting flange to the top of the rail. Torque the nut to 15 ft-lbf (20 N-m).

### 6.2 Installing Clickstones

Mounting Systems' patented Clickstone is a special clip with which the module clamps are fastened in the base rail. You need only a 5mm Allen key for the installation. The Clickstone is inserted from above into the top channel of the base rail.

#### Installation Steps:

- Insert the Clickstone at a slight angle into the rail channel.
- While holding it firmly in place, rock the Clickstone upright until it clicks into place.

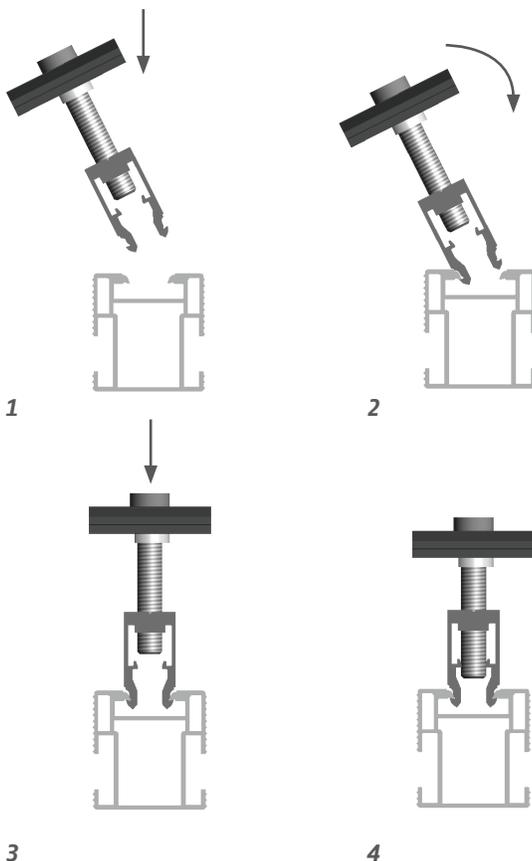


Image 6.2.1 Mounting steps from top left to bottom right

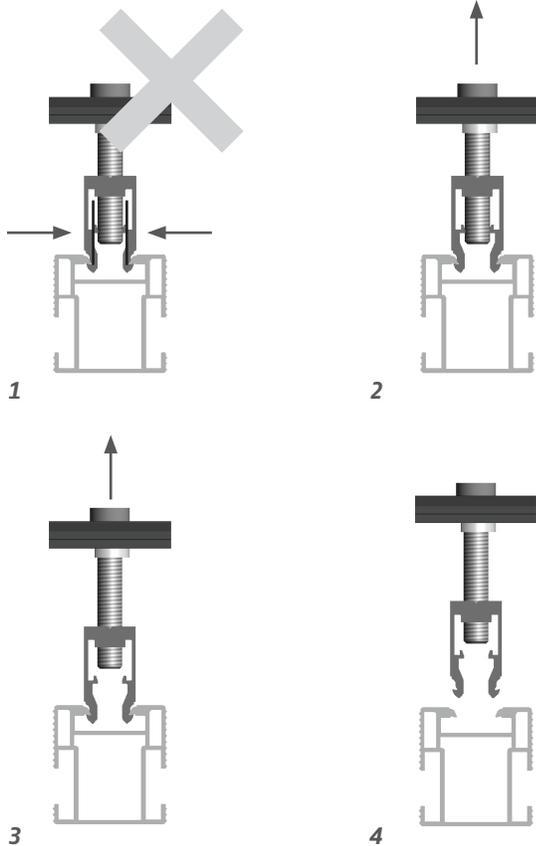


Image 6.2.2 Removing the Clickstone



**NOTE!**

The shape of the Clickstone corresponds exactly to the profile of the rail channel. It has been deliberately designed not to slide easily in order to prevent unintentional slipping in vertical rail installations. To move the Clickstone, loosen the bolt so that it is not contacting the spreaders in the Clickstone body. Then, while pressing lightly on the bolt, squeeze the Clickstone legs together and slide the Clickstone along the channel.



**NOTE!**

Spreaders on the inside of the Clickstones are designed so that once the bolt has been tightened, the Clickstone cannot unlatch from the rail. To remove a Clickstone, first unscrew the bolt so that it is clear of the spreaders then, with pressure on the Clickstone "legs," rock the Clickstone to unlatch it from the rail and lift it out.



**CAUTION**

**Material damage due to incorrect installation**

Incorrectly mounted Clickstones can slip out. PV modules can fall and be damaged.

- Mount all Clickstone connections in accordance with the instructions.



**CAUTION**

**Material damage caused by deformed Clickstones**

If clearly deformed Clickstones are used, the safety of the module attachment is not assured. PV modules can fall and be damaged.

- Use only Clickstones where the lugs are parallel to each other and you can clearly hear them clicking into the rail channel.
- Replace deformed Clickstones prior to installation.

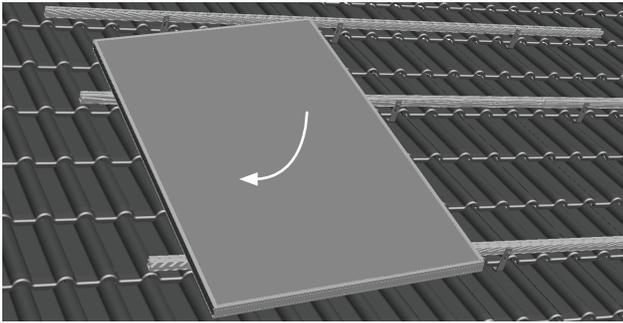


Image 6.3.1

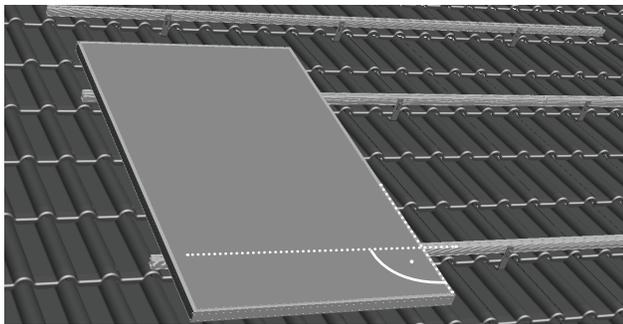


Image 6.3.2

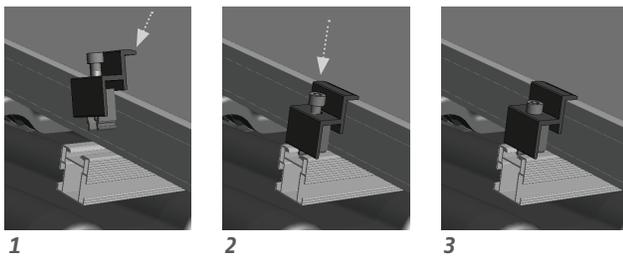


Image 6.3.3 End clamp

### 6.3 Installing the End Modules

The end modules of the PV system are fastened on the outer side with two module end clamps each. Two types of module end clamps are available from Mounting Systems, Inc. Standard end clamps are sized to fit a particular module thickness and will not work on modules of other thicknesses. Variable end clamps are designed to fit three ranges of module thicknesses. Variable end clamps are available in the following size ranges:

- 31–40 mm
- 33–45 mm
- 38–50 mm

#### Installation Steps:

- Place and align an outside module. The base rail must extend beyond the module frame by 1.2 in. (30 mm).
- Insert the Clickstone of the module end clamp into the channel of the base rail.
- Push the module end clamp flush to the module frame.
- Tighten the bolt to 6 ft-Lb (8 Nm), thus clamping the module.

#### Mounting steps, variable end clamps:

- Place and align an outside module. The base rail must extend beyond the module frame by 1.2 in. (30 mm).
- Insert the Clickstone of the end clamp flush against the module frame. The lip of the upper clamp body should be flush against the edge of the module.
- Ensure that the lower section of the clamp body sits squarely on the top of the rail.
- While holding the upper clamp body against the module and the lower clamp body, tighten the clamp bolt to 8 ft-lbf (11 N-m).
- For variable end clamps with bonding, tighten the clamp bolt to 12 ft-lbf (16 N-m)



**CAUTION**

**Material damage due to incorrect mounting**

Incorrectly mounted modules can fall and become damaged.

- Make sure the Clickstones are installed correctly.
- Ensure the module is installed flush and tight against the side of the end clamp.
- Ensure proper torque of the end clamp mounting bolt (6 ft-lbf / 8 N-m), 12 ft-lbf (16 N-m) for end clamps with bonding.

**6.4 Installing the Inner Modules**

Inner modules of the array are secured with mid clamps. All mid clamps are provided with integral bonding plates. Mid clamps are designed to fit modules within a particular range. Mid clamps are available in either mill finish or black anodized in the following size ranges:

<i>Part Number</i>	<i>Finish</i>	<i>Clamping Range (mm)</i>	<i>Clamping Range (inches)</i>
700-0102	Mill	30 – 40	1.10 – 1.58
700-0103	Black	30 – 40	1.10 – 1.58
700-0104	Mill	33 – 45	1.30 – 1.77
700-0105	Black	33 – 45	1.30 – 1.77
700-0106	Mill	38 – 50	1.50 – 1.97
700-0107	Black	38 – 50	1.50 – 1.97

*Table 6.4.1 Mid clamps part number, finish, and range*

**Mounting Steps:**

- Insert the Clickstone of the mid clamp into the Clickstone channel of the rail. The flat sides of the Clickstone make it possible to install the Clickstone flush against the module side.
- Slide the module clamp flush against the side of the module by squeezing the Clickstone legs and pushing the clamp against the side of the module. Ensure the bonding plate is above the module frame.
- Slide the next module under the clamp head and flush against the Clickstone body.
- Using a 5 mm Allen key, tighten the clamp bolt onto the modules. Tighten the clamp bolt to 12 ft-lbf (16 N-m).

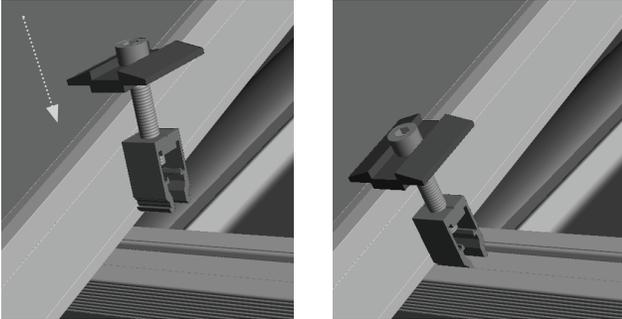


Image 6.4.1 Inner module installation

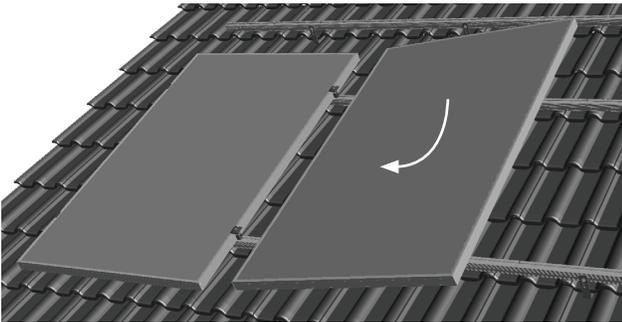


Image 6.4.2 Inner module installation 2

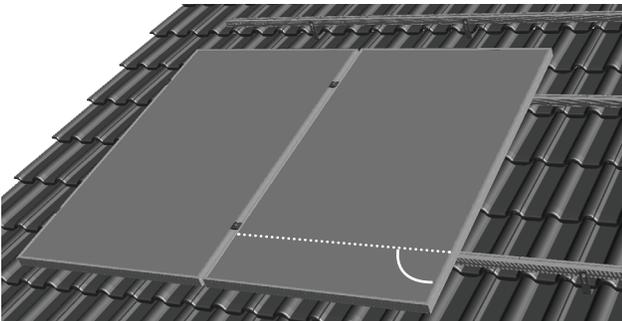


Image 6.4.3 Inner module installation 3

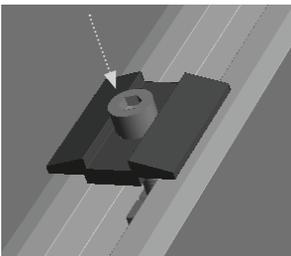


Image 6.4.4

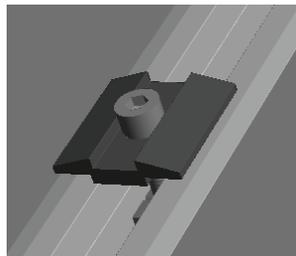


Image 6.4.5



**NOTE!**

- The bonding mid clamps with bonding plates are supplied with the bonding plates preassembled under the clamp head
- If not already so positioned, slide the bonding plate and clamp head to the bolt head. This will hold the clamp plate above the module frames until you are ready to tighten the clamp into place.



**CAUTION**

**Material damage due to incorrect mounting**

Incorrectly fastened modules can fall and become damaged.

- Ensure the Clickstones click in securely.
- Ensure the modules are flush against both sides of the clamp.
- Observe and adhere to the recommended torque specifications.

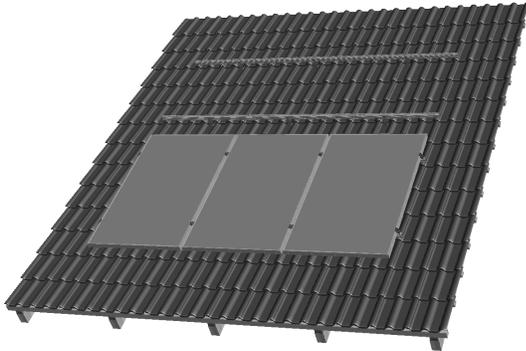


Image 6.5.1 Spare Clickstone used as spacer

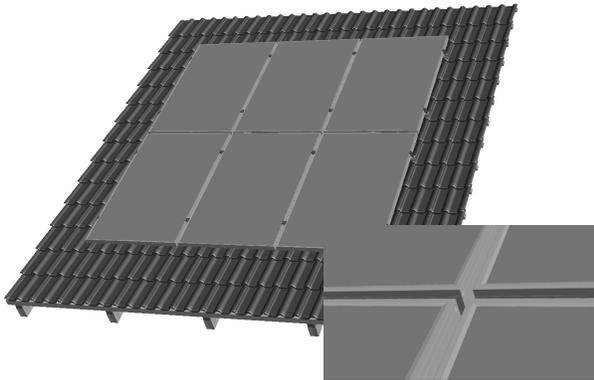
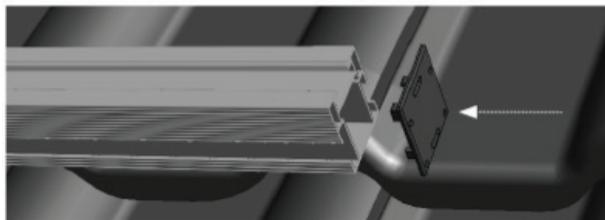
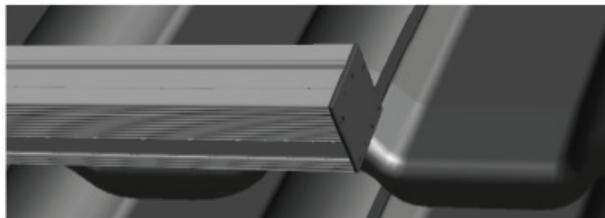


Image 6.5.2 Spare Clickstone used as spacer close-up



1



2

Image 6.5.3 Rail End Caps

## 6.5 Installing Additional Module Rows

### Mounting steps:

- Additional module rows are installed in the same way as described above.



#### NOTE!

Use of a spare module clamp Clickstone or other item as a spacing gauge between the top of one row of modules and the bottom of another can help provide a neat, aesthetically pleasing array.

## 7. Maintenance

When properly assembled, the Alpha+ is a reliable and trouble-free system and should require little in the way of ongoing maintenance or repair. Nevertheless, Mounting Systems recommends maintaining a regular inspection and maintenance schedule. Such a program can detect and address potential problems before they become serious and help ensure the system's excellent long-term durability and reliability.

The following procedure pertains only to the Alpha+ mounting system structure. Maintenance and repair of other PV system components should be carried out in accordance with the respective manufacturers' recommendations.

### 7.1 Inspection

The system should be visually inspected periodically for loose components, loose fasteners, and any corrosion. If any of these conditions are found, the affected components should be immediately adjusted, repaired, or replaced.

### 7.2 Testing

After one year in service, it is a good practice to check the torque settings of a representative sample of system connections, including module clamps and rail clamps. Do not exceed the recommended torque settings. If a disproportionate number of loose connections (more than 10% of connections) are found, it may be an indication of improper assembly and it may be necessary to take comprehensive corrective action.

A smaller sampling of connections can be tested annually thereafter. Mounting Systems recommends keeping records of the connections sampled each year and testing and, if necessary, adjusting previously untested connections in succeeding years. After all connections have been tested, sample sizes and test frequency can be reduced.

## 8 List of Evaluated and Approved Modules<sup>6</sup>

Manufacturer	Model
Canadian Solar	CS6P-XXX
Conergy	PowerPlus XXX
Hanwha Q Cells	Q Pro XXX
Jinko	60 cell modules model: JKMXXXP-60
Jinko	72 cell modules model: JKMXXXP-72
SolarWorld	Sunmodule Plus SWXXX
Suniva	OPTXXX-60-4-1B0
SunPower	SPR-X21-XXX
SunPower	SPR-E20-XXX
Trina	60 cell modules model: TSM-PD05.08-XXX
Trina	72 cell modules model: TSM-PD14-XXX
Yingli	72 cell modules model: YL-XXX-35B
Yingli	60 cell modules model: YL-XXX-29B.

Note: XXX refers to the power class in watts (W) of the module.

<sup>6</sup> The Alpha+ system is to be used only with modules on this list or with those which include the Alpha+ system in their respective installation manuals.



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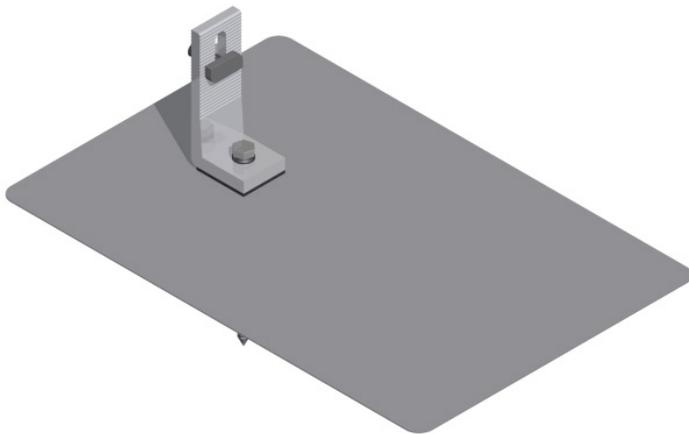
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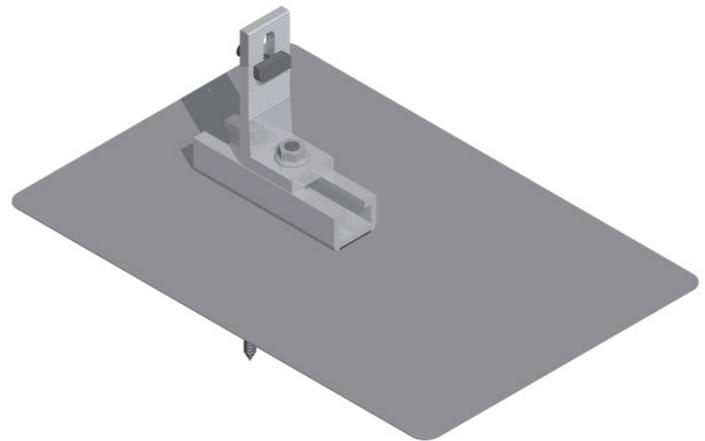
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## **Alpha+ On-Roof System** Flashmount Installation Manual

### Appendix B



Flashmount



Flashmount SR



*Alpha+ – Sometimes, things just click.*

## Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
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5.2	Installing the Flashmount	5
5.3	Installing the Flashmount SR	6

## 1. Introduction

Mounting Systems, Inc. provides two types of flashings for composition shingle roofs: the Flashmount for standard portrait installations and the Flashmount SR for shared rail configurations. Both types are available in black or mill finish.

The Flashmount is supplied with the Mounting Systems Flashmount L-foot, secured with the included 5/16" x 4" lag screw and EPDM bonded washer. The Flashmount SR includes the same flashing, lag screw, and EPDM bonded washer as the Flashmount, but it includes the Flashmount SR L-foot and a Rail Position Slider as well. An M8 x 25 T-head bolt and M8 flanged washer are also included for securing the L-foot to the slider.

These instructions assume that the PV array layout has been properly planned and the rafter positions and roof attachment points have been marked on the roof. If this has not been done, the Mounting Systems QuickConfigurator may be used to plan the layout, calculate loads, and generate construction diagrams and a Bill of Materials. There are two versions of the QuickConfigurator, one to download to your computer and the other for use online or with tablets and smartphones. Both versions can be found at the following web page: <http://www.quickconfigurator.com/>

## 2. Safety

All generally applicable safety regulations for Mounting Systems products can be viewed in the document "Installation Instructions for PV Mounting Systems: General Information."<sup>1</sup> Please read this document carefully and adhere to the instructions and procedures.

Use the products only for their intended purpose and follow both the general and specific safety instructions. In addition, please observe the specific safety instructions which precede the process steps in these product-specific installation instructions.

### 2.1 Warnings

The following warnings are used in these Installation Instructions to indicate safety-related information. They include:

- Warning symbols (pictograms)
- Signal words which identify the hazard level
- Information about the type and source of the hazard
- Information about the potential consequences in case of the hazard being disregarded
- Measures for the prevention of hazards and the prevention of injuries or damage to property.

The signal words of the warnings respectively indicate one of the following hazard levels:



**DANGER**

Indicates a potentially mortal danger, disregard for which may result in death or serious injury.



**WARNING**

Indicates a potentially dangerous situation which may result in serious injury or damage to property.



**CAUTION**

Indicates a potentially dangerous situation which may result in minor injuries or damage to the property if ignored.



**ATTENTION**

Indicates potential danger which can result in damage to the property.

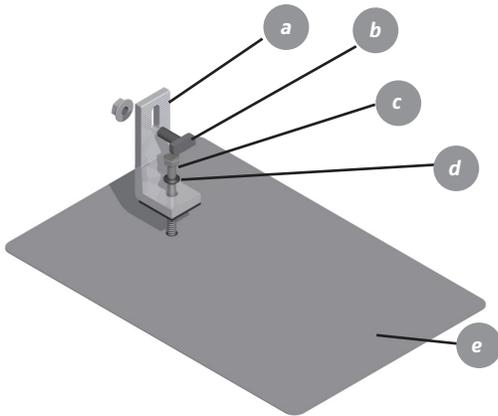
<sup>1</sup>"Installation Instructions for PV Mounting Systems: General Information" can be found on Mounting Systems' website: <http://www.mounting-systems.us/downloads-technical-docs-warranty/>

### 3. Required Tools

To install the Flashmount you will need:

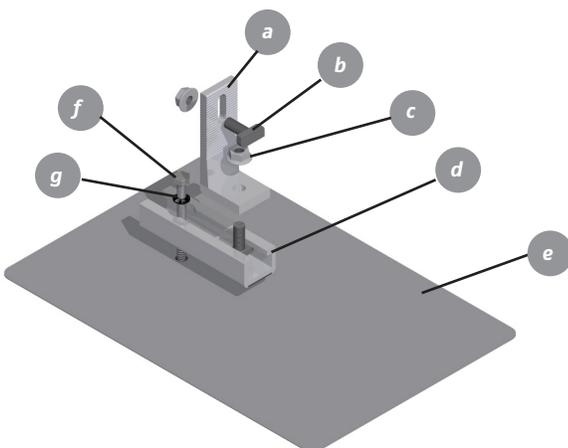
- Measuring tape
- Chalk line
- Power drill / driver
- 1/2" socket
- 3/16" drill bit
- Stud finder (optional)
- Torque wrench

### 4. Product Overview



*Image 4.1.1 Flashmount*

- a** Flashmount L-foot
- b** M8 x 25mm T-bolt and M8 nut (pre-assembled)
- c** 5/16" x 4" Lag screw
- d** EPDM Bonded washer
- e** Flashmount Flashing



*Image 4.1.2 Flashmount SR*

- a** Flashmount SR L-foot
- b** M8 x 25mm T-bolt and M8 nut (pre-assembled)
- c** M8 x 25mm T-bolt and M8 nut (pre-assembled)
- d** Flashmount SR Slide
- e** Flashmount Flashing
- f** 5/16" x 4" Lag screw
- g** EPDM Bonded washer

#### 4.2 Technical Data

<b>Application</b>	<i>Composition shingle roofs</i>
<b>Roof attachment</b>	<i>5/16" x 411 hex lag screw</i>
<b>Raile attachment</b>	<i>Alpha+ L-foot with M8 T-bolt, serrated flange nut</i>
<b>Sealing</b>	<i>Neoprene Rubber/ EPDM bonded washer</i>
<b>Flashing dimensions</b>	<i>12 x 8 x 0.040 in. / 305 x 203 x 1 mm</i>
<b>Flashmount SR adjustment range</b>	<i>± 3 in. / 44 mm</i>
<b>Flashing material</b>	<i>6050 Aluminum</i>
<b>Hardware</b>	<i>300-Series stainless steel</i>
<b>Flashing Finish</b>	<i>Mill or black anodized</i>
<b>Architectual Testing</b>	<i>ASTM E 2140-01 Certified</i>
<b>Warranty</b>	<i>10 Years <sup>2</sup></i>

<sup>2</sup> For details, please consult Mounting Systems, Inc. full warranty document, available upon request.

## 5. Installation

The Flashmount is intended to be installed in rafters. Before beginning the installation, determine the position of the array and locate the rafters. Using a chalk line, mark their positions horizontally and vertically. Mark the positions of the rail attachment points along the chalk lines.

### 5.1 Installing the Flashing

1. The Flashmount flashing is provided with a rubber sealing pad on the bottom of the flashing at the bolt hole. Use a sharp scribe or a small drill to make a small hole through the sealing pad in the center of the bolt hole to facilitate marking the bolt hole position on the roof surface
2. Slide the end of the flashing furthest from the bolt hole in the flashing under the shingle above the marked location of the Flashmount flashing. Position the flashing so that the hole in the flashing is directly over the marked location for the lag screw. Mark the location of the hole on the roof surface
3. Remove the flashing and drill a 3/16" pilot hole at the marked location. Fill the pilot hole with a roof sealant compatible with the composite shingles such as Henry Wet Patch, Sikaflex 11FC, or ChemLink M-1.
4. Reposition the flashing with the hole in the flashing lined up with the pilot hole. Note: the rubber should be on the underside of the flashing against the roof surface.

Option: For additional security, it may be desirable to add a U-shaped bead of sealant around the bolt hole on the underside of the flashing. The bottom of the "U" must be toward the roof ridge with the opening of the "U" toward the eaves. Do NOT fully surround the bolt hole with a sealant bead

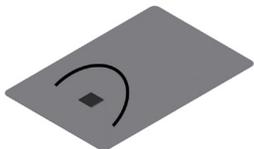


Image 5.1.3 Flashing with U-shaped sealant



Always drill correctly sized pilot holes for the lag screws. Attempting to fasten lag screws without first drilling pilot holes or drilling incorrectly sized pilot holes can cause splitting of the roof rafter or truss or insufficient pull-out strength.

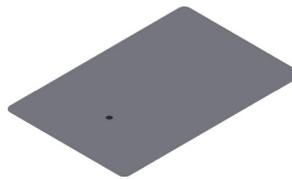


Image 5.1.1a Flashing top view

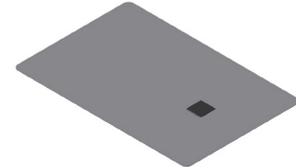


Image 5.1.1b Flashing bottom view



If a roofing nail obstructs the location of the flashing, it will be necessary to notch the flashing so that the lag screw hole can be properly positioned at the desired location. Do NOT shorten the flashing by trimming material from the end.

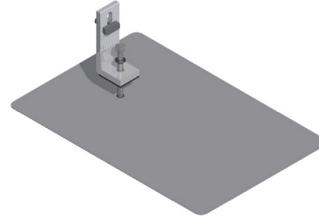


Image 5.1.2 Position flashing under shingles

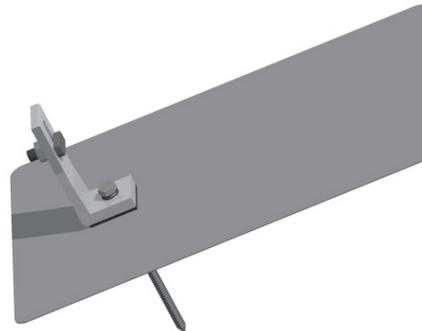
**For Flashmount instructions, proceed to Section 5.2.  
For Flashmount SR instructions, proceed to Section 5.3.**

## 5.2 Installing the Flashmount

1. Drill a small hole through the rubber underneath the L-foot in order to line it up correctly with the flashing.
2. Insert the 5/16" x 4" lag screw through the base of the L-foot and into the pilot hole and, holding the L-foot in position, tighten the screw until the EPDM pad on the base of the L-foot just begins to bow out from compression.
3. Flashmount installation is now complete. Refer to the Alpha+ Installation Manual for installation instructions for the remainder of the Alpha+ system



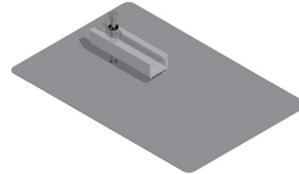
*Image 5.2.1 Install lag screw*



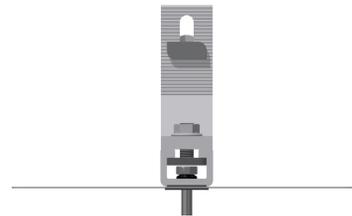
*Image 5.2.2 Flashmount*

### 5.3 Installing the Flashmount SR

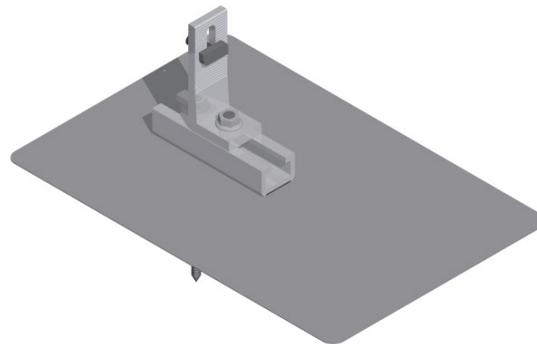
1. Line up the hole in the base of the slider with the hole in the flashing. Orient slider to North or South as appropriate.
2. Insert the 5/16" x 4" lag screw through the hole in the base of the slider, then through the flashing and into the pilot hole. Hold the slider so that the channel runs North-South and tighten the lag screw until the slider is secured firmly to the flashing.
3. Insert the M8 x 25 T-head bolt in the base of the L-foot into the Rail Position slider channel and turn the T-bolt as shown in Image 5.3 - 2. Tighten the flange nut finger tight, just enough to hold the L-foot in position on the slider.
4. Using the M8 x 25 T-head bolts and flange nuts preassembled in the L-foot slot, attach the Alpha+ rail to the L-feet.
5. After aligning the rails as described in Section 5 of the Alpha+ Installation Manual, tighten the flange nuts holding the L-feet to the Rail Position Sliders. Tighten the nuts to 15 ft-lbf (20 N-m).
6. Refer to the Alpha+ Installation Manual for installation instructions for the remainder of the Alpha+ system.



*Image 5.3.1 Install lag screw*



*Image 5.3.2 L-foot t-bolt engaged in slider*



*Image 5.3.3 Flashmount SR*



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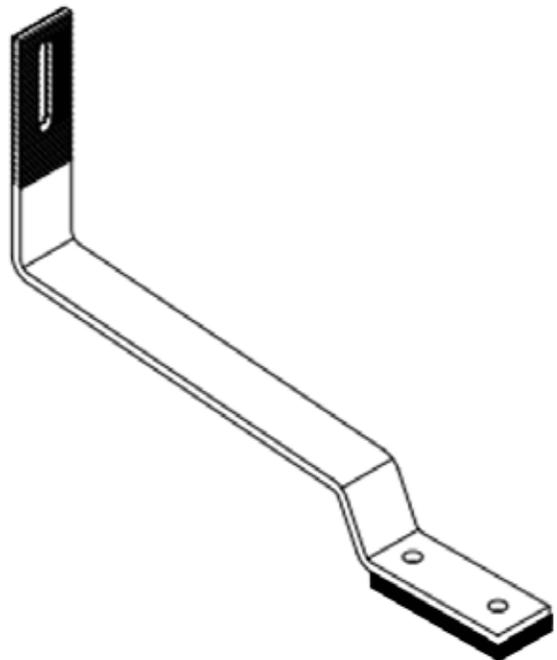
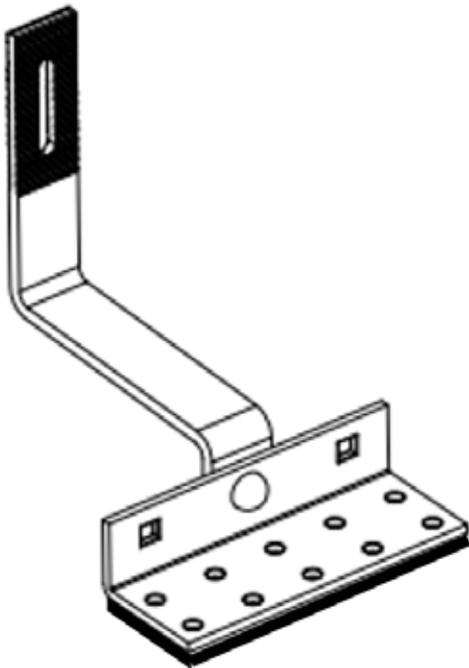
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# Alpha+ On-Roof System

## Self-Sealing Roof Hooks Installation Manual

### Appendix C





*Alpha+ – Sometimes, things just click.*

## Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
<b>2</b>	<b>Installation</b>	<b>2</b>
2.1	Curved Tile Installation	2
2.2	Flat Tile Installation	3

## 1. Introduction

Mounting Systems, Inc. provides two types of self-sealing roof hooks. Roof hook, part number 707-0071, is a Universal Roof Hook that can be used for both curved tile and flat tile roofs. It includes provisions for selecting three different rail attachment locations and the ability to accommodate both 1" and 1-1/4" flat tiles. The Flat Tile Roof Hook, part number 707-0070, is designed expressly for standard, 1" flat tiles.

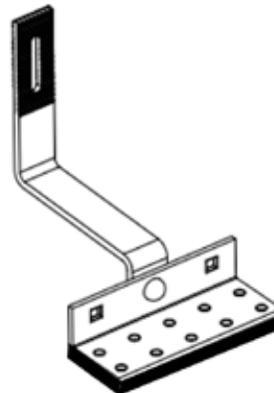
Both roof hooks are supplied with an EPDM rubber sealing pad adhered to their respective bases. The sealing pad is designed to allow the roof hooks to be mounted under the tiles, directly to the roof decking, on top of the felt weatherproofing layer. No additional flashing is required.

Both roof hooks are designed to be installed with two lag screws and EPDM bonded washers anchored in the roof rafters. These instructions assume that the array layout has been planned and marked on the roof and that the rafters to which the roof hooks will be attached have been identified.

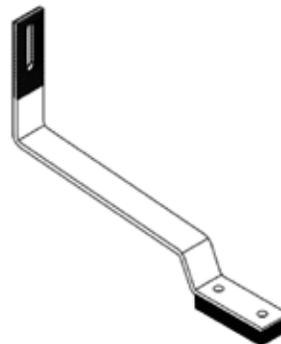


### ATTENTION

Always drill correctly sized pilot holes for the roof hook lag screws. Attempting to fasten lag screws without first drilling pilot holes or drilling incorrectly sized pilot holes can cause splitting of the roof rafter or truss or insufficient pull-out strength.



707-0071 Universal Roof Hook



707-0070 Flat Tile Roof Hook

"Installation Instructions for PV Mounting Systems: General Information" can be found on Mounting Systems' website: <http://www.mounting-systems.us/downloads-technical-docs-warranty/>



**ATTENTION**

If it is necessary to shim the roof hook, the lag screws used to secure the roof hook to the rafter, truss, or purlin must be long enough that the threaded depth of the lag screw in the rafter, truss, or purlin provides adequate *pull-out strength*. This value can be determined with the Mounting Systems QuickConfigurator and called out as, "**F suction, orthogonal [lbf]**" in the "Statics Attachment" section of the QuickConfigurator printout.

*Pull-Out values*

Pull-out values per inch of thread embedded in the rafter, truss, or purlin for various lag screw diameters for typical pine dimensional lumber is shown in the table below.

Lag Screw shaft diameter	Pull-out value (lbf / inch)
3/16" (5 mm)	64.3
1/4" (6 mm)	85.7
5/16" (8 mm)	107.2
3/8" *	128.6*

*\* The use of lag screw shaft diameters larger than 5/16" in the narrow (1- 1/2") width of standard 2x dimensional lumber is strongly discouraged*

## 2. Installation

### 2.1 Curved Tile Installation

1. Remove the tile(s) above rafter to which the roof hook is to be attached. Mark the rafter line on the roof surface
2. The rail attachment arm may be attached to the base plate at one of three locations by removing the carriage bolt and re-installing the arm at one of the other attachment arm mounting positions. Adjust the positions of the Curved Tile Roof Hook base plate and the rail attachment arm so that when the rail attachment arm is located in the valley of the tile, two of the holes in the roof hook base plate are centered over the rafter line. Note the location of these holes as shown in Image 2.1.
3. Tighten the bolt and nut holding the rail attachment arm to 15 ft-lbf (20 N-m).
4. Drill a 5/32" (#22) hole through the EPDM pad at the holes in the base plate identified in step 2.
5. Center the holes in the base plate over the rafter line and mark the locations of the two holes on the roof surface. Drill a 5/32" (#22) pilot hole in each location.
6. Fill the pilot holes in the roof with a sealant compatible with the roofing felt such as Henry Wet Patch, Sikaflex 11FC, or ChemLink M-1.
7. Insert the supplied 1/4" x 4" lag screws with EPDM bonded washers through the holes in the base plate and tighten the lag screws until the EPDM pad on the base plate can just be seen to compress. Note that an exact torque specification cannot be provided due to the variations in rafter/ truss composition, age, etc.
8. Replace and secure the tile(s). (It may be necessary to remove the "lip" from the bottom of the tile where it crosses the roof hook rail attachment arm).

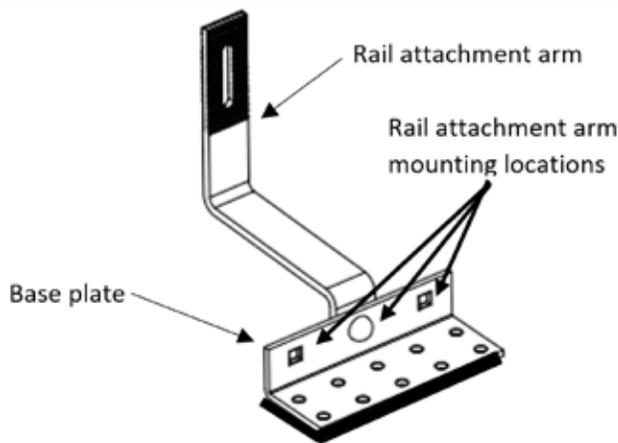


Image 2.1 Curved Tile Roof Hook

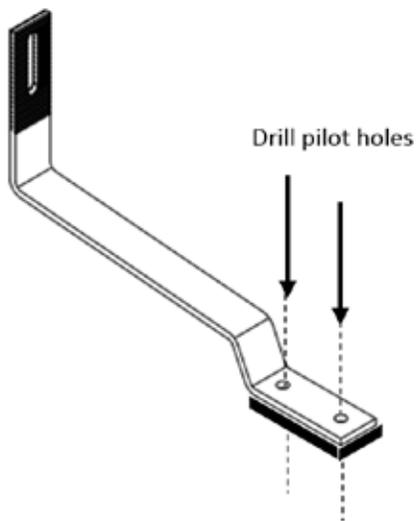


Image 2.2 Flat Tile Roof Hook

## 2.2 Flat Tile Installation

1. Remove the tile(s) above rafter to which the roof hook is to be attached. Mark the rafter line on the roof surface.
2. Drill 5/32" (#22) pilot holes through the EPDM pad as shown in Image 2.2.
3. Center the roof hook along the rafter line with the vertical rail attachment surface positioned on the rail line. Mark the position of the holes on the rafter line.
4. Drill 5/32" (#22) pilot holes at the marked locations on the rafter line.
5. Fill the pilot holes with a sealant compatible with the roofing felt. For asphalt-impregnated felt, Mounting Systems, Inc. recommends the use of Henry Wet Patch, Sikaflex 11FC, or ChemLink M-1.
6. Insert the supplied 1/4" x 4" lag screws with EPDM bonded washers through the holes in the roof hook base and tighten the lag screws until the EPDM pad can just be seen to compress. Note that an exact torque specification cannot be provided due to the variations in rafter/ truss composition, age, etc.
7. Replace and secure the tile(s) (It may be necessary to remove the "lip" from the bottom of the tile where it crosses the roof hook rail attachment arm).



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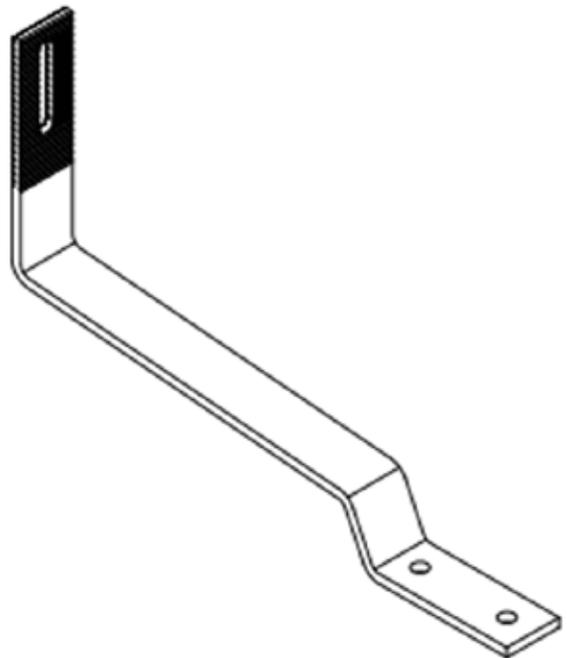
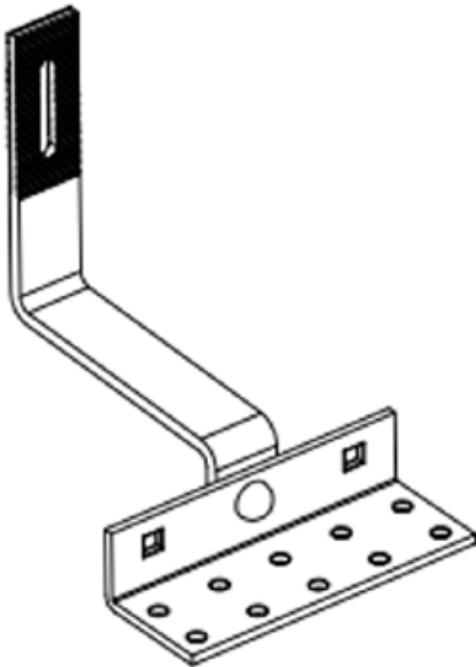
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# Alpha+ On-Roof System

## Standard Roof Hooks Installation Manual

### Appendix D





*Alpha+ – Sometimes, things just click.*

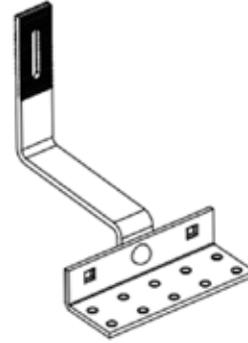
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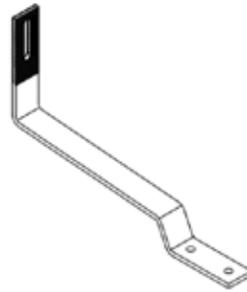
## 1. Introduction

Mounting Systems, Inc. provides two types of standard roof hooks. Roof hook, part number 805-0072, is a Universal Roof Hook that can be used for both curved tile and flat tile roofs. It includes provisions for selecting three different rail attachment locations and the ability to accommodate both 1" and 1-1/4" flat tiles. The Flat Tile Roof Hook, part number 805-0052, is designed expressly for standard, 1" flat tiles.

Both roof hooks are designed to be installed with two lag screws and EPDM bonded washers anchored in the roof rafters. These instructions assume that the array layout has been planned and marked on the roof and that the rafters to which the roof hooks will be attached have been identified.



805-0072 Universal Roof Hook



805-0052 Flat Tile Roof Hook



### ATTENTION

Always drill correctly sized pilot holes for the roof hook lag screws. Attempting to fasten lag screws without first drilling pilot holes or drilling incorrectly sized pilot holes can cause splitting of the roof rafter or truss or insufficient pull-out strength.

"Installation Instructions for PV Mounting Systems: General Information" can be found on Mounting Systems' website:  
<http://www.mounting-systems.us/downloads-technical-docs-warranty/>



**ATTENTION**

If it is necessary to shim the roof hook, the lag screws used to secure the roof hook to the rafter, truss, or purlin must be long enough that the threaded depth of the lag screw in the rafter, truss or purlin provides adequate *pull-out strength*. This value can be determined with the Mounting Systems QuickConfigurator and called out as, "**F suction, orthogonal [lbf]**" in the "Statics Attachment" section of the QuickConfigurator printout.

*Pull-Out values*

Pull-out values per inch of thread embedded in the rafter, truss, or purlin for various lag screw diameters for typical pine dimensional lumber is shown in the table below.

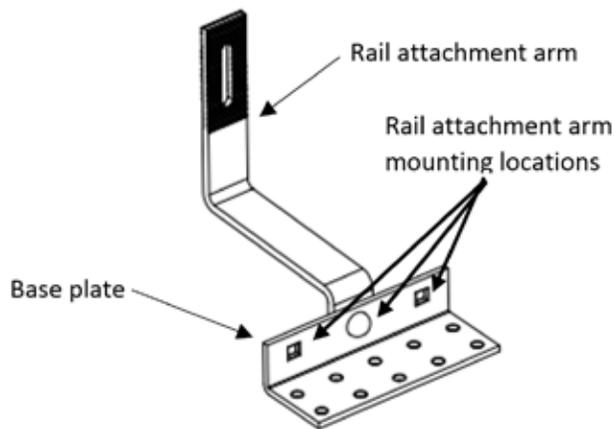
Lag Screw shaft diameter	Pull-out value (lbf / inch)
3/16" (5 mm)	64.3
1/4" (6 mm)	85.7
5/16" (8 mm)	107.2
3/8" *	128.6*

*\* The use of lag screw shaft diameters larger than 5/16" in the narrow (1- 1/2") width of standard 2x dimensional lumber is strongly discouraged*

## 2. Installation

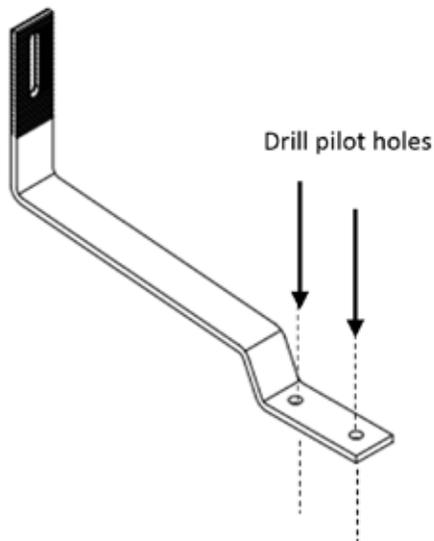
### 2.1 Curved Tile Installation

1. Remove the tile(s) above rafter to which the roof hook is to be attached. Mark the rafter line on the roof surface.
2. The rail attachment arm may be attached to the base plate at one of three locations by removing the carriage bolt and re-installing the arm at one of the other attachment arm mounting positions. Adjust the positions of the Curved Tile Roof Hook base plate and the rail attachment arm so that when the rail attachment arm is located in the valley of the tile, two of the holes in the roof hook base plate are centered over the rafter line. Note the location of these holes as shown in Image 2.1.
3. Tighten the bolt and nut holding the rail attachment arm to 15 ft-lbf (20 N-m).
4. Center the holes in the base plate over the rafter line and mark the locations of the two holes on the roof surface. Drill a 5/32" (#22) pilot hole in each location.
5. Fill the pilot holes in the roof with a sealant compatible with the roofing felt such as Henry Wet Patch, Sikaflex 11FC, or ChemLink M-1. (An optional, 1/8" U-shaped bead of sealant may be applied around the pilot holes with the base of the "U" toward the peak of the roof and the opening of the "U" toward the eaves. DO NOT enclose the pilot holes with a sealant bead.)
6. Insert the supplied 1/4" x 4" lag screws with EPDM bonded washers through the holes in the base plate and tighten the lag screws. Note that an exact torque specification cannot be provided due to the variations in rafter/ truss composition, age, etc.
7. Replace and secure the tile(s). (It may be necessary to remove the "lip" from the bottom of the tile where it crosses the roof hook rail attachment arm).



805-0072 Universal Roof Hook

Image 2.1 Universal Roof Hook



805-0052 Flat Tile Roof Hook

Image 2.2 Flat Tile Roof Hook

## 2.2 Flat Tile Installation

1. Remove the tile(s) above rafter to which the roof hook is to be attached. Mark the rafter line on the roof surface.
2. Center the roof hook along the rafter line with the vertical rail attachment surface positioned on the rail line. Mark the position of the holes on the rafter line.
3. Drill 5/32" (#22) pilot holes at the marked locations on the rafter line as shown in Image 2.2.
4. Fill the pilot holes with a sealant compatible with the roofing felt. For asphalt-impregnated felt, Mounting Systems, Inc. recommends the use of Henry Wet Patch, Sikaflex 11FC, or ChemLink M-1. (An optional, 1'8" U-shaped bead of sealant may be run around the pilot holes with the base of the "U" toward the peak of the roof and the opening of the "U" toward the eaves. DO NOT enclose the pilot holes with a sealant bead.)
5. Insert the supplied 1/4" x 4" lag screws with EPDM bonded washers through the holes in the roof hook base and tighten the lag screws. Note that an exact torque specification cannot be provided due to the variations in rafter/ truss composition, age, etc.
6. Replace and secure the tile(s) (It may be necessary to remove the "lip" from the bottom of the tile where it crosses the roof hook rail attachment arm).



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