



# SnapNrack™

Solar Mounting Solutions

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## Series 100

Residential Roof Mount System  
Installation Manual

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[snapnrack.com](https://snapnrack.com)



2703 Listed — PV Mounting System

# An Intro to SnapNrack Series 100

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SnapNrack Series 100 PV Mounting System offers a low profile, visually appealing, photovoltaic (PV) module installation system. This innovative system simplifies the process of installing solar PV modules, shortens installation times, and lowers installation costs.

SnapNrack systems, when installed in accordance with this manual, will be structurally adequate for the specific installation site and will meet the local and International Building Code. Systems will also be bonded to ground, under SnapNrack's UL 2703 Listing.

The SnapNrack installation system is a set of engineered components that can be assembled into a wide variety of solar mounting structures. It is designed to be installed by qualified solar installation technicians. With SnapNrack you will be able to solve virtually any PV module mounting challenge.

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# Certification Details

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SnapNrack Series 100 system has been evaluated by Underwriters Laboratories (UL) and Listed to UL/ANSI Standard 2703 for Grounding/Bonding, Fire Classification and Mechanical Loading.

## Grounding/Bonding

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The Series 100 system has been designed in compliance with UL Standard 2703 Section 9.1 Exception, which permits accessible components that are **not part** of the fault current ground path to **not be electrically bonded** to the mounting system (e.g. roof attachments, array skirt, etc.). The UL Listing covers bonding for a load rating up to 45 psf. For more details on the integrated grounding functionality see the [Grounding Specifications](#) section.

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. See the [Grounding Specifications](#) for the list of modules tested with the Series 100 system for integrated grounding.

Ground Lug has been evaluated to both UL 467 and UL 2703 Listing requirements.

Series 100 has been listed with the following Enphase microinverter models for grounding/bonding: M215, M250 and C250. The Enphase microinverters are certified to be mounted to SnapNrack rail with the MLPE Attachment or to the module frame with the Enphase Frame Mount. When installing the Enphase microinverters per the specifications in the MLPE Installation section of this manual, the total roof-mounted PV system is bonded (modules, racking and microinverters) and grounded through the Enphase ground circuit when the Enphase units are properly grounded through to the service entrance. Therefore, no ground lugs or equipment grounding conductor (EGC) are required on the SnapNrack systems.

Series 100 has been Listed with the following SolarEdge optimizer models for grounding/bonding: P300-5NC4ARS and P320-5NC4ARS. The SolarEdge optimizers are certified to be mounted to SnapNrack rail with the MLPE Attachment or to the module frame with the SolarEdge Power Optimizer Frame-Mounted Module Add-On. When installing the SolarEdge optimizers per the specifications in the MLPE Installation section of this manual, the total roof-mounted PV system is bonded to the optimizer backing plate (modules, racking and optimizers) and grounded through the ground lugs installed on the SnapNrack rail. Therefore, it is not necessary to run an EGC to each SolarEdge optimizer. **Note: Frame-Mounted Module Add-On has been evaluated for all modules except Suniva modules.**

Series 100 has been Listed with the following Ginlong Rapid Shutdown Units for grounding/bonding: Solis-RSD-1G 1:1 and Solis-RSD-1G 2:2. The Ginlong Rapid Shutdown Units are certified to be mounted to SnapNrack rail with the MLPE Attachment.

The mounting system Bonding Listing is only valid when installed with a Non-Separately Derived PV system. The PV system is required to have a direct electrical connection to another source, such as connecting to the grid via a grid interactive inverter.

SnapNrack recommends that bare copper never come into contact with aluminum.

## Mechanical Loading

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The Series 100 system is Listed for mechanical loading for different load ratings depending on the mounting configuration and PV module installed. For more details on the mechanical loading details see the [Mechanical Loading Specifications](#) section.

SnapNrack engineered systems should only be used with SnapNrack components and hardware. Any application outside of those specified in this Installation Manual and the Structural Engineering Report may void the warranty and structural certification could become invalid.

The following components have only been evaluated for mechanical loading: Flashed L Foot (90 & 92 Deg), Standard Standoff\*, Four Hole Standoff\*, Heavy Duty Standoff\*\*, Hanger Bolt Clamp, Corrugated Block, Standard Seam Clamp, Wide Seam Clamp, Rail Splice, Universal Tile Hook, Flat Tile Hook, Mid Clamp, Adjustable End Clamp, and Universal End Clamp.

\*Maximum standoff height of 10"

\*\*Maximum standoff height of 12"

If the module clamps have been engaged and need to be loosened and reengaged, SnapNrack recommends moving the module frame 3mm to engage the bonding pin in a new location *if required by the AHJ*.

The UL Listing covers mechanical load ratings for the various span lengths, module orientations and positive, negative, and side load ratings. These values can be found in the [Mechanical Loading Specifications](#).

SnapNrack recommends a periodic re-inspection of the completed installation for loose components, loose fasteners, and any corrosion, such that if found, the affected components are to be immediately replaced.

# Certification Details

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## Fire

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The Series 100 system has been evaluated for a Class A System Fire Classification for a Steep-Sloped Roof using Type 1 and Type 2 modules. In order to maintain the System Classification, modules are clamped to the mounting rails between 0 and 12 inches from the top and bottom edges of the module.

The Series 100 System has been evaluated for a Class A System Fire Classification for a Low-Sloped Roof using Type 1 and Type 2 modules. In order to maintain the System Classification, modules are clamped to the mounting rails between 0 and 16.3 inches from the top and bottom edges of the module.

The optional Array Skirt accessory has also been evaluated and the Series 100 system will maintain the Class A System Fire Classification detailed above if installed with the Skirt.

Because the system was tested at 5 inches above the test roof fixture Series 100 can be installed without any height restrictions and will maintain the Class A System Fire Classification. See [Rail Installation](#) Section for potential module-specific height restrictions due to module temperature.

## Structural Components



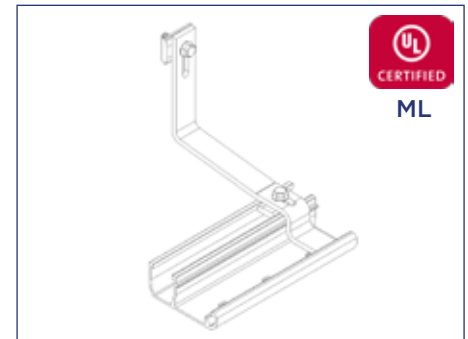
### Composition Roof Attachment

Roof attachment kit for composition shingle roofs including L foot, base, flashing, and hardware



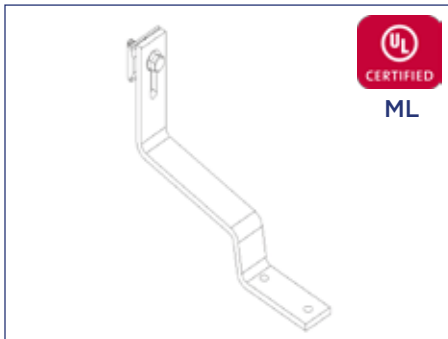
### Standoff Roof Attachment

Roof attachment kit for all roof types including standoff shaft, base, and hardware



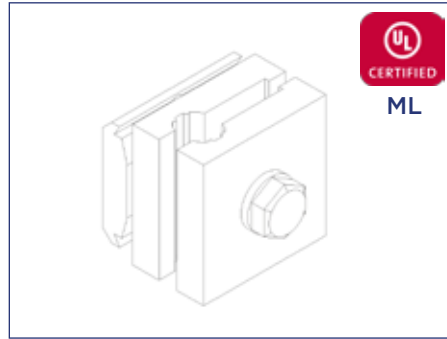
### Universal Tile Roof Attachment

Roof attachment kit for any tile roofs including tile hook, base, and hardware



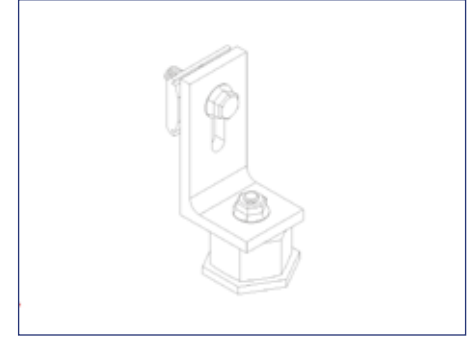
### Flat Tile Roof Attachment

Roof attachment kit for flat tile roofs including tile hook and hardware



### Hanger Bolt Roof Attachment

Roof attachment kit for all roof types including hanger bolt clamp and hardware



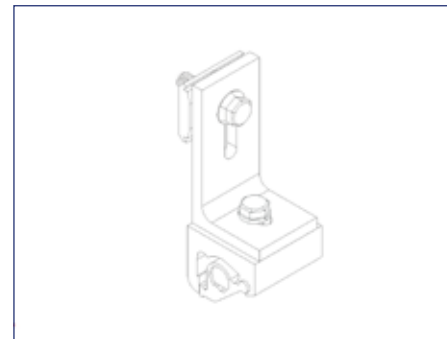
### Metal Roof Base Attachment

Roof attachment kit for flat metal roofs including metal roof base, L foot, and hardware



### Corrugated Roof Block Attachment

Roof attachment for sinusoidal corrugated metal roofs including roof block, L foot, and hardware



### Seam Clamp Roof Attachment

Roof attachment for standing seam metal roofs including seam clamp, L foot, and hardware



### Standard Rail

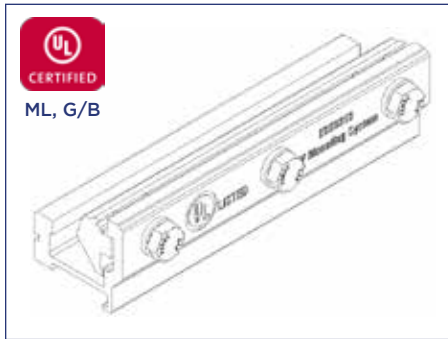
Rail for Series 100 roof mount racking system

#### UL Listing Legend:

ML - Evaluated for Mechanical Loading  
G/B - Evaluated for Grounding/Bonding



## Structural Components



ML, G/B

### Standard Rail Splice

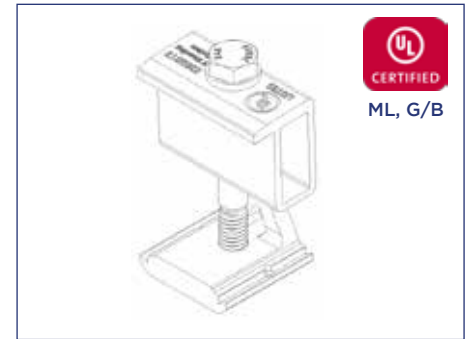
Rail splice component including base, insert, and hardware



ML, G/B

### Mid Clamp

Top-down module mid clamp including clamp and hardware



ML, G/B

### Adjustable End Clamp

Top-down module end clamp including clamp and hardware



ML

### Universal End Clamp

Bottom-mount module end clamp including clamp and hardware

## Wire Management/Grounding Components

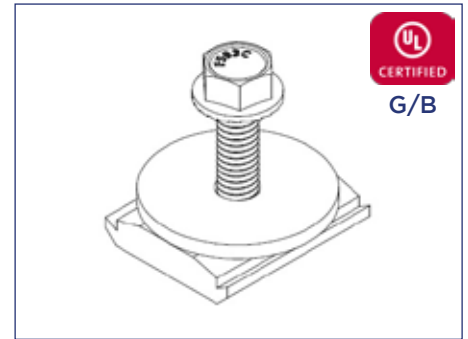


### Trunk Cable Clamp

Wire Clamp (Trunk Cable Clamp shown)



### Wire Clip



G/B

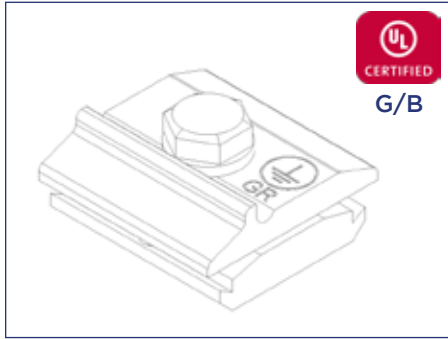
### MLPE Attachment Kit

Rail attachment for module level power electronics like microinverters and optimizers

### UL Listing Legend:

ML - Evaluated for Mechanical Loading  
G/B - Evaluated for Grounding/Bonding

## Wire Management/Grounding Components

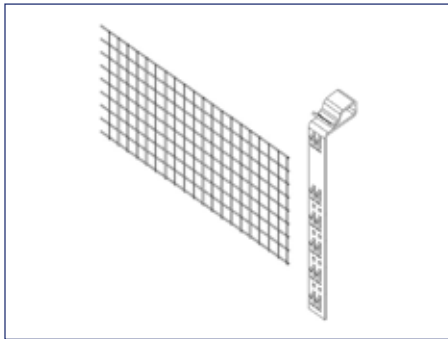


SnapNrack Ground Lug



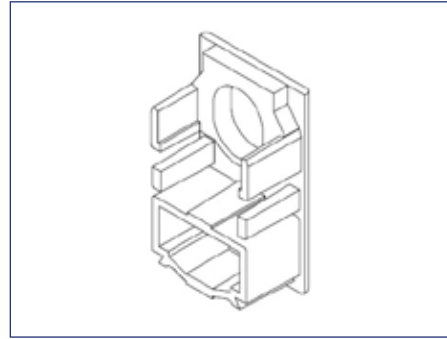
IlSCO Lay-In Lug - GBL-4DBT

## Aesthetic Components



Array Edge Screen

Array edge screen kit including mesh edge screen and clips



Standard Rail End Cap

Rubber end cap for Standard Rail

 UL Listing Legend:  
ML - Evaluated for Mechanical Loading  
G/B - Evaluated for Grounding/Bonding

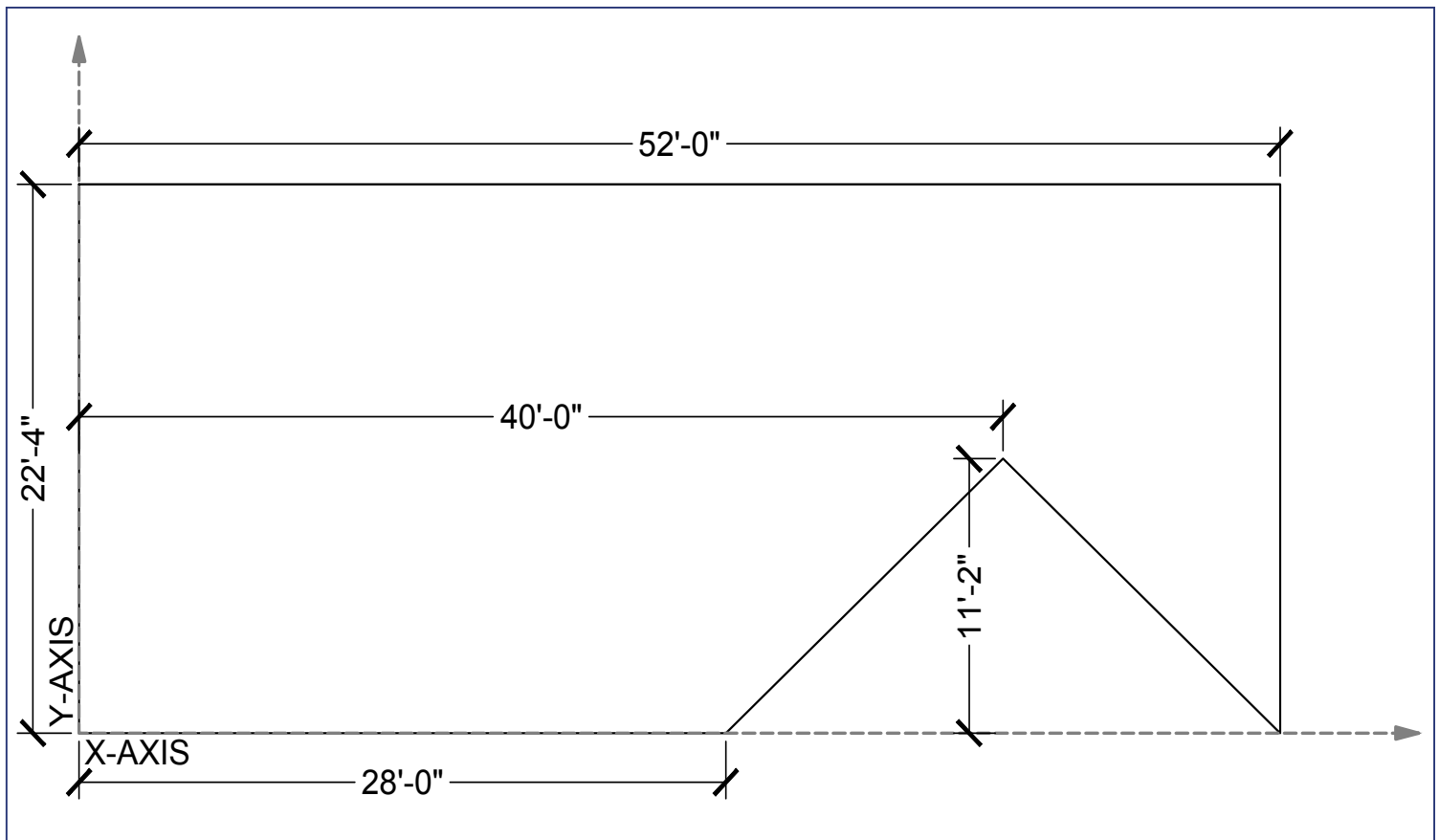


## Hardware Torque Specifications

Hardware Description	Torque Specification
Grounding Electrode Conductor to SnapNrack Ground Lug (6-12 AWG Solid Copper)	16 ft-lbs (192 in-lbs)
IlSCO Lay-in Lug GBL-4DBT to Rail	5 ft-lbs (60 in-lbs)
Grounding Electrode Conductor to IlSCO Lay-in Lug GBL-4DBT (10-14 AWG Solid Copper)	1.67 ft-lbs (20 in-lbs)
Grounding Electrode Conductor to IlSCO Lay-in Lug GBL-4DBT (8 AWG Stranded Copper)	1.04 ft-lbs (25 in-lbs)
Grounding Electrode Conductor to IlSCO Lay-in Lug GBL-4DBT (4-6 AWG Stranded Copper)	1.46 ft-lbs (35 in-lbs)
Adjustable End Clamp, Mid Clamp, Universal End Clamp, Corrugated Roof Block, Hanger Bolt Clamp, Tilt Mount Clamps, Standoff Clamp, Rail Splice	10+ ft-lbs (120-192 in-lbs)
L Foot to Rail, Universal Tile Hook to Rail, Flat Tile Hook to Rail	12 ft-lbs (144 in-lbs)
Adjustable End Clamp to Module, Standoff Clamp, Rail Splice (Black Fasteners)	8-10 ft-lbs (96-120 in-lbs)
Standard Base Seam Clamp, Wide Base Seam Clamp	16.7 ft-lbs (200 in-lbs)
SolarEdge Frame Mounted Bracket to Module Frame	7 ft-lbs (84 in-lbs)
MLPE Attachment Kit (Rail Mounted Bracket to Rail)	10 ft-lbs (120 in-lbs)
Enphase Frame Mounted Bracket to Module Frame	13 ft-lbs (156 in-lbs)

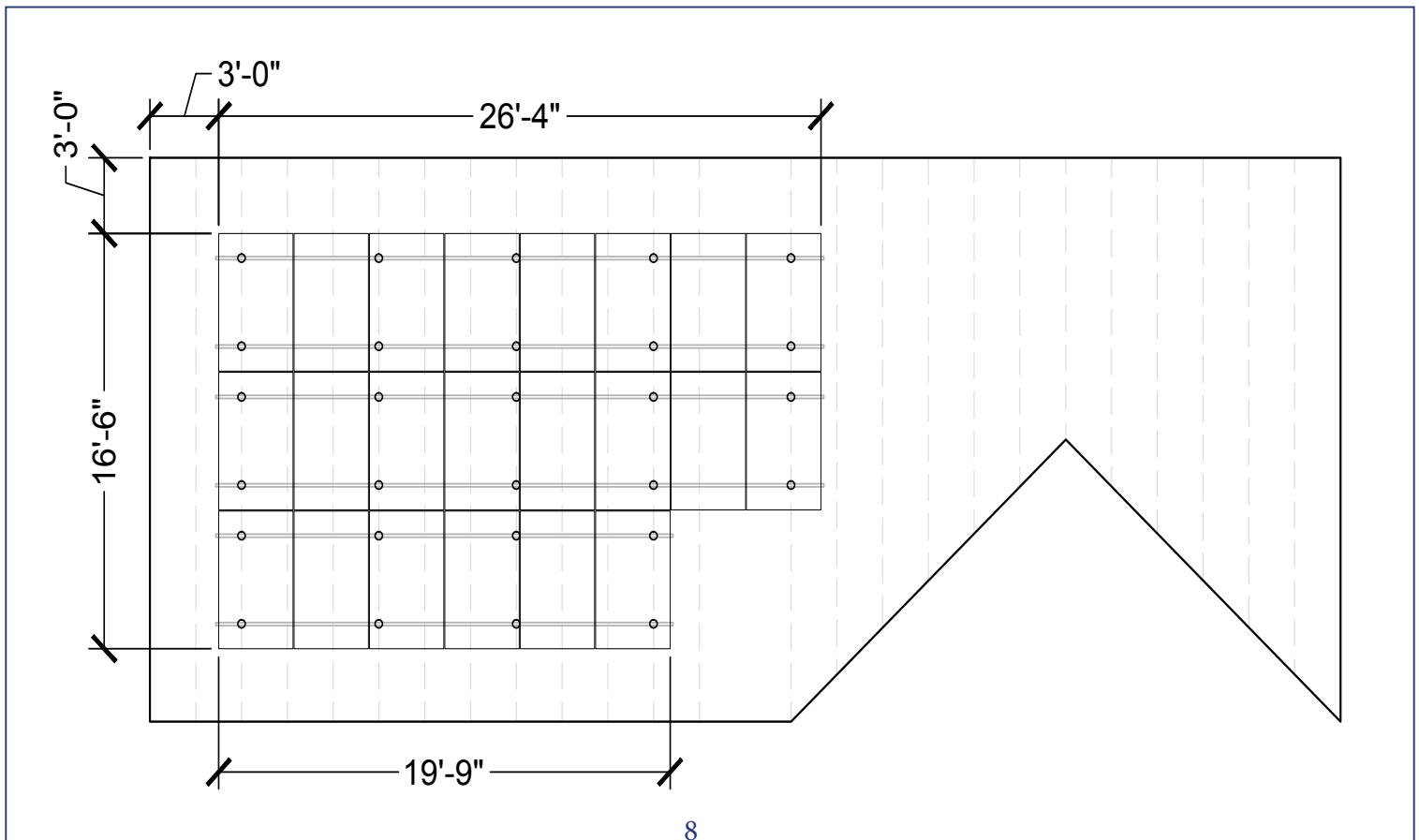
## Site Survey

- Measure the roof surfaces and develop an accurate drawing, including any obstacles such as chimneys and roof vents.
- If plans are available, check to make sure that the plans match the final structure.
- Identify any roof access areas or keep-out areas as required by the local AHJ (i.e. fire lanes).
- Identify any construction issues that may complicate the process of locating roof framing members from the roof surface.
- If you find structural problems such as termite damage or cracked roof framing members that may compromise the structure's integrity, consult a structural engineer.



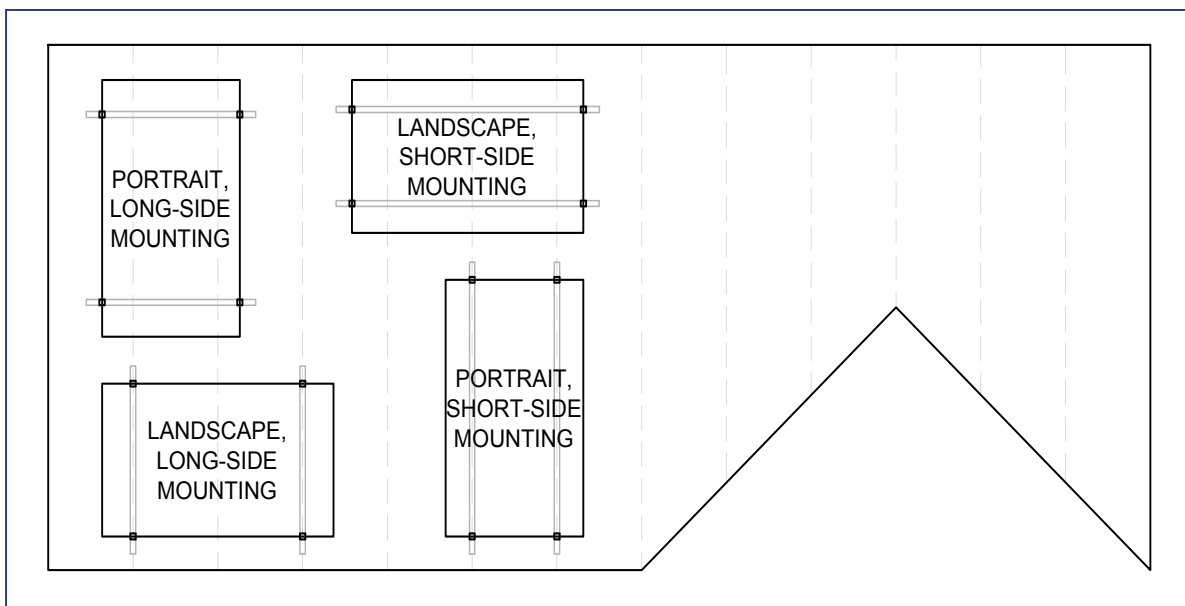
## Design Guidance

- 1) Layout the modules in the available roof area. Adjacent modules in the same row are spaced 1/2" apart. Adjustable End Clamps require an additional 1.5" of rail extending past module frame, while Universal End Clamps require no extra rail. When installing multiple rows of modules, a minimum spacing gap of 1/8" should be used between rows.
- 2) Draw the roof framing member location on the layout to identify where roof attachments can be installed.
- 3) Determine site conditions for calculating the engineering values, confirm site conditions and code versions comply with local AHJ requirements.
- 4) Reference site conditions and system specifications in Series 100 Structural Engineering Report to determine maximum attachment spacing and cantilever values.
- 5) Draw roof attachment locations on layout based on maximum attachment spacing and cantilever values.
- 6) Confirm design complies with UL 2703 Listing for Mechanical Loading. For more details on the mechanical loading details see the [Mechanical Loading Specifications](#) section.
- 7) To simplify the design process and automatically generate a bill of materials for the mounting system, use the Series 100 Configuration Tool located on the SnapNrack website. Always refer to Approved Module Lists in Installation Manuals to ensure installation complies with UL 2703 Listing.
- 8) Mark distance from array edge to identifiable roof feature in x and y axes.
- 9) Insert SnapNrack installation details in to design set specific to the project requirements.



## Design Note:

Series 100 allows for multiple mounting configurations. Modules can be mounted in portrait (long side of module perpendicular to ridge) or landscape (long side of module parallel to ridge) orientations. In addition, modules can also be short side-mounted (module clamps on short side) or long side-mounted (module clamps on long side). Long-side mounting is recommended for maximum material efficiency. Most residential structures utilize roof framing members that run in-slope with the roof, so a portrait orientation with long-side mounting is typically the most efficient use of materials.



## Safety Guidance

- Always wear appropriate OSHA approved safety equipment when at active construction site
- Appropriate fall protection or prevention gear should be used. Always use extreme caution when near the edge of a roof
- Use appropriate ladder safety equipment when accessing the roof from ground level
- Safety equipment should be checked periodically for wear and quality issues
- Always wear proper eye protection

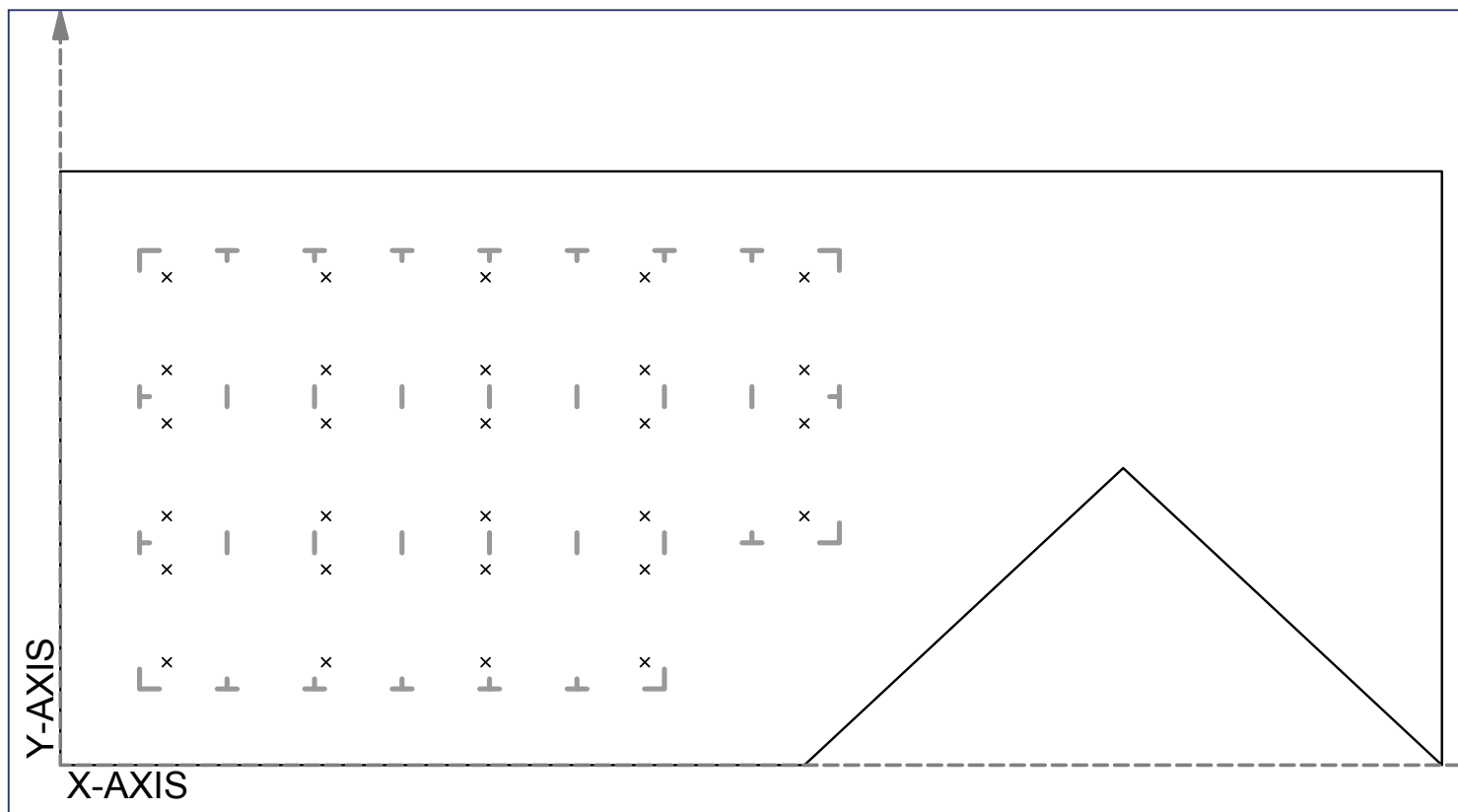
## System Layout

- 1) Transfer the array layout to the roof using a roof marking crayon to mark the inside and outside corners of the array.
- 2) Locate the estimated roof framing member positions and mark them in the array area with a roof marking crayon.
- 3) Transfer rail locations using a chalk line.
- 4) Mark roof attachment locations on the roof, noting that attachments will be located at intersections of rails and roof framing members. Layout rails such that module frames do not overhang mounting rails more than specified by module manufacturer, more than 30% of total module length, or more than required by the Class A Fire Certification (see Certification Details section).



### Layout Note:

Ensure final roof attachment locations do not exceed the maximum attachment spacing and cantilever specified in the design.

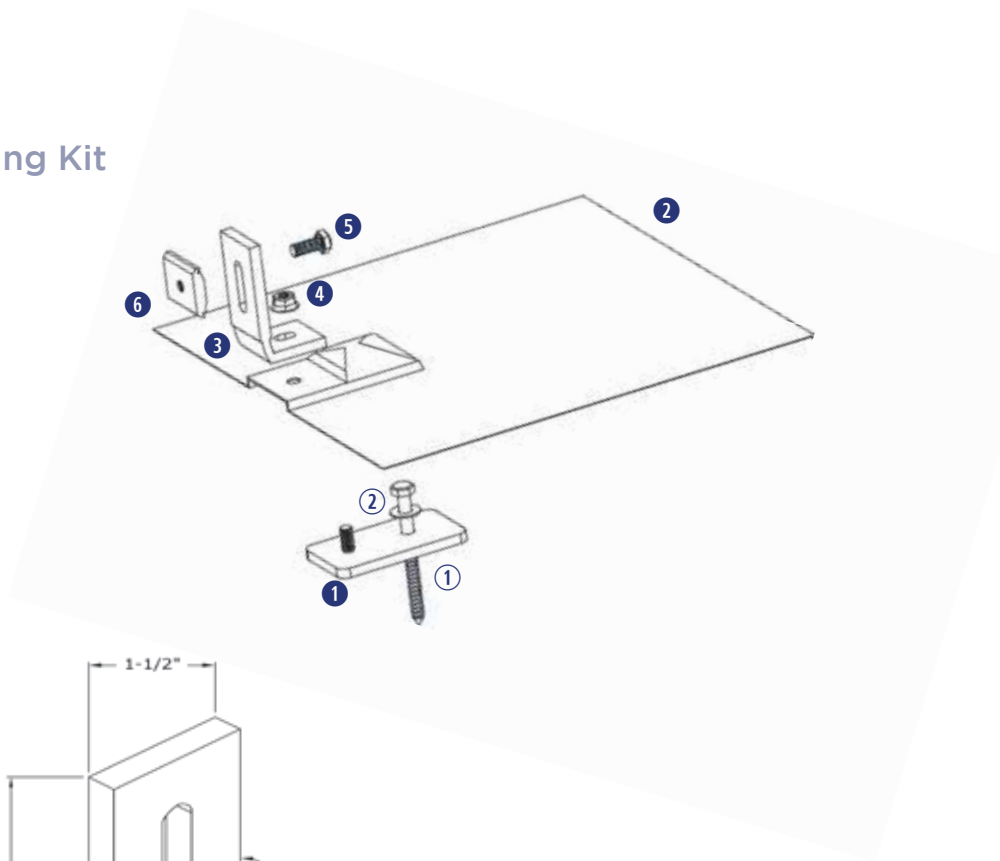


## Required Tools

- Hammer or Stud Finder
- Roof Marking Crayon
- Drill with 3/16" Pilot Drill Bit
- Roof Sealant
- Torque Wrench
- Socket Wrench
- 1/2" Socket

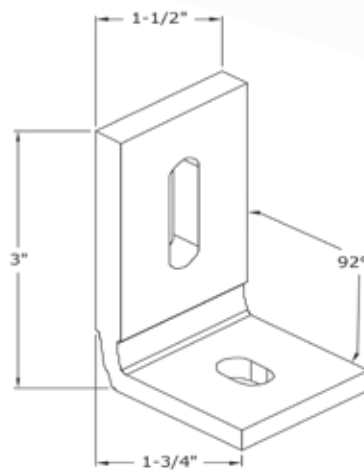
## Materials Included - L Foot Flashing Kit

- ① (1) SnapNrack L Foot Base
- ② (1) SnapNrack L Foot Flashing
- ③ (1) SnapNrack Composition L Foot
- ④ (1) 5/16"-18 SS Flange Hex Nut
- ⑤ (1) 5/16"-18 X 1-1/4" SS Flange Bolt
- ⑥ (1) SnapNrack Channel Nut

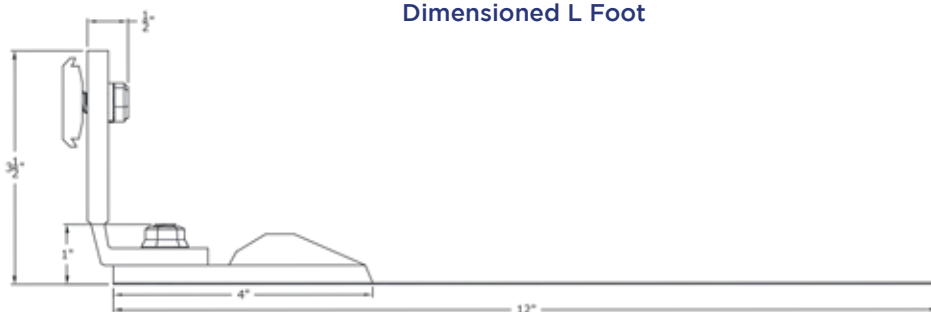


## Other Materials Required

- ① (1) 5/16" Lag Screw
- ② (1) 5/16" Washer



Dimensioned L Foot



Dimensioned L Foot Assembly

**Application Note:**  
Install on composition shingle roofs.

## INSTALLATION INSTRUCTIONS



1) Using roof attachment locations drawn during system layout, drill a pilot hole through the roofing material into the roof framing member.

### Install Note:

Ensure the lag screws will be installed in a solid portion of the roof framing member.

If the roof framing member is not found then seal the pilot hole immediately with roofing sealant.



2) Apply roofing sealant to the bottom of the base and directly onto the lag screw to ensure a water tight seal.



3) Attach the L Foot Base with a 5/16" lag screw, drive lag screw for minimum 2.5" embedment into the roof framing member.

### Best Practice:

If using an impact driver, finish tightening lag screw with a hand wrench to prevent L Foot Base from rotating.



4) Pry up shingles with a breaker bar and install flashing underneath shingle course above installed base, position flashing so base stud extends through hole in bottom edge of flashing.

### Install Note:

Ensure flashing extends minimum (2) courses above base, and does not overhang bottom edge of shingle course.

Apply a horseshoe of sealant under flashing to direct water away from penetration.



5) Place the L Foot on the base stud over the flashing and tighten the flange nut over the L Foot, torque to 10+ ft-lbs.

### Install Note:

The L Foot can be attached in any orientation.



6) If necessary, adjust the vertical face of the L Foot with the "live hinge" feature and adjust angle of L Foot so that the vertical face is perpendicular to the roof surface.

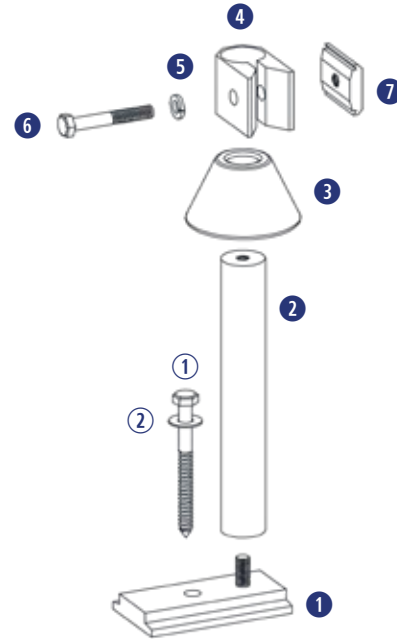


## Required Tools

- Hammer or Stud Finder
- Roof Marking Crayon
- Drill with 3/16" Pilot Drill Bit
- Roof Sealant
- Torque Wrench
- Socket Wrench
- 1/2" Socket

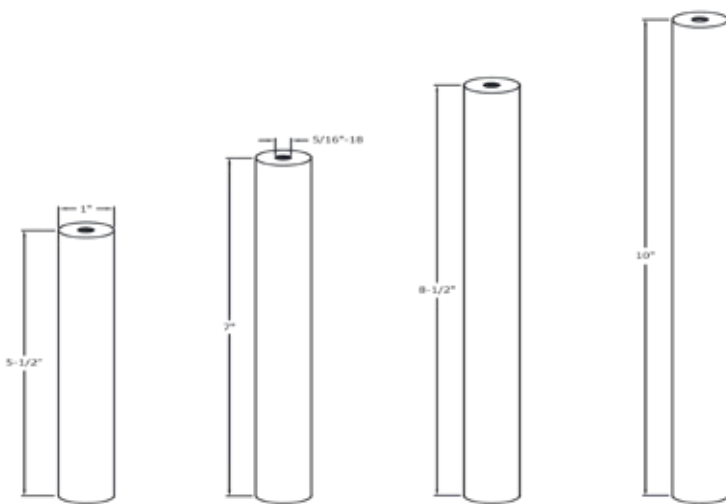
## Materials Included - Standoff Kit

- ① (1) SnapNrack Standoff Base, 1-Hole
- ② (1) SnapNrack Standoff Shaft
- ③ (1) SnapNrack Rubber Rain Collar
- ④ (1) SnapNrack Standoff Clamp
- ⑤ (1) 5/16" SS Split Lock Washer
- ⑥ (1) 5/16"-18 X 2" SS HCS Bolt
- ⑦ (1) SnapNrack Channel Nut

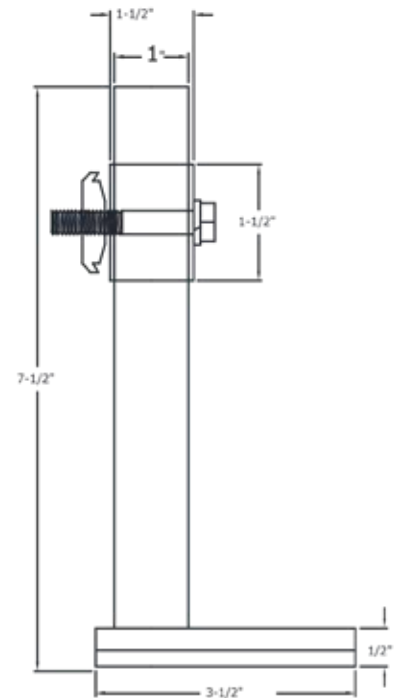


## Other Materials Required

- ① (1) 5/16" Lag Screw
- ② (1) 5/16" Washer
- ③ Conical Flashing (Not Shown)



Dimensioned Standoff Shaft



Dimensioned Standoff Assembly

**Application Note:**  
Install on concrete or clay tile roofs.

## INSTALLATION INSTRUCTIONS



1) Using roof attachment locations drawn during system layout, remove roof tile where the roof attachment will be installed and drill a pilot hole through the roofing material into the roof framing member.



2) Apply roofing sealant and attach the base with a 5/16" lag screw, drive lag screw for minimum 2.5" embedment into the roof framing member.



3) Set the flashing by sliding the flashing underneath the row of tiles directly above the installed base, with the hole in the flashing directly above the base stud.

### Install Note:

Ensure the lag screws will be installed in a solid portion of the roof framing member.

If the roof framing member is not found then seal the pilot hole immediately with roofing sealant.

### Best Practice:

If using an impact driver, finish tightening lag screw with a hand wrench to prevent 1-Hole Base from rotating.



4) Attach the standoff shaft by sliding it through the hole in the flashing and tighten it onto the base stud with channel locks.



5) Cut the tile to fit around the flashing, replace the tile, then attach the standoff clamp by first sliding the rubber rain collar over the standoff shaft then the standoff clamp with bolt, washer and channel nut.



### Install Note:

As an alternative, the post may be installed prior to the flashing if there is adequate clearance for the flashing to be slid over the post and under the tile simultaneously.

## Materials Included – Standoff Kit (Steel Structural Member)

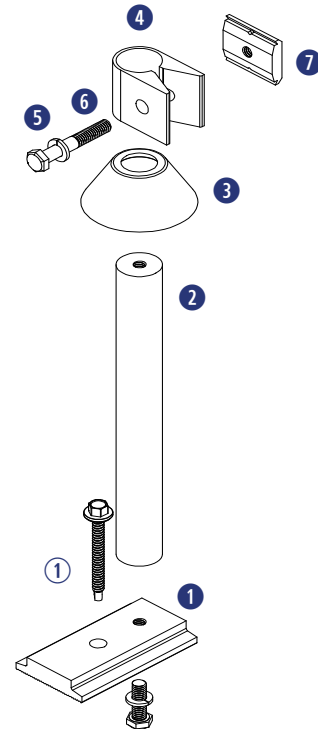
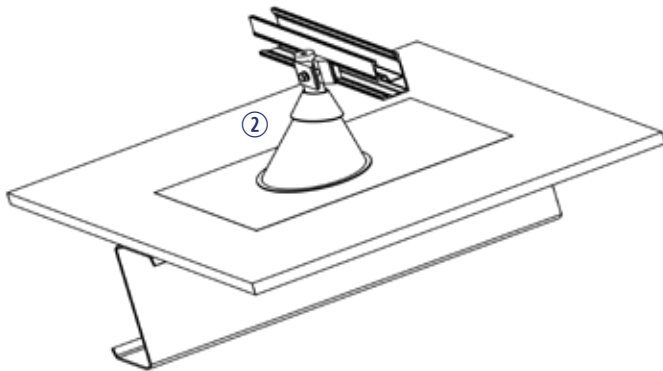
- ① (1) SnapNrack Standoff Base, 1-Hole
- ② (1) SnapNrack Standoff Shaft
- ③ (1) SnapNrack Rubber Rain Collar
- ④ (1) SnapNrack Standoff Clamp
- ⑤ (1) 5/16" SS Split Lock Washer
- ⑥ (1) 5/16"-18 X 2" SS HCS Bolt
- ⑦ (1) SnapNrack Channel Nut



Standoff Base, 1-Hole

## Other Materials Required

- ① (1) 1/4" Self-drilling Screw
- ② (1) Conical Flashing



 **Application Note:**  
Install on roofs with steel structural member configurations.

## Materials Included - 4-Hole Standoff Kit

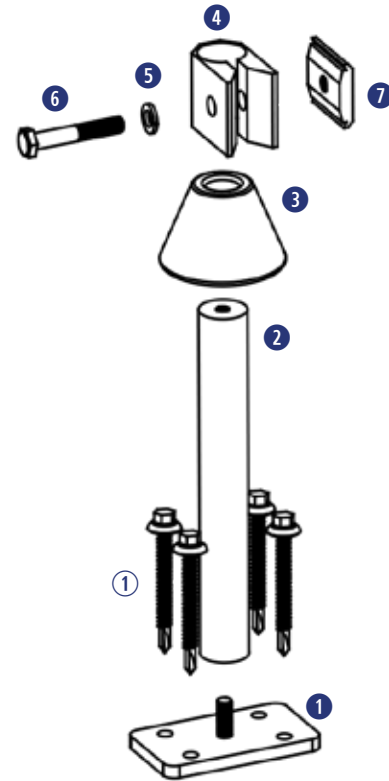
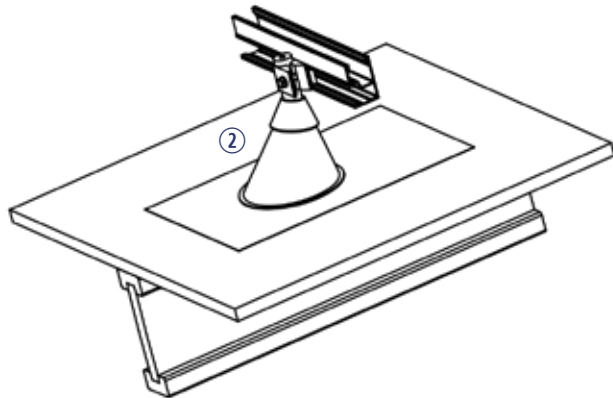
- ① (1) SnapNrack Standoff Base, 4-Hole
- ② (1) SnapNrack Standoff Shaft
- ③ (1) SnapNrack Rubber Rain Collar
- ④ (1) SnapNrack Standoff Clamp
- ⑤ (1) 5/16" SS Split Lock Washer
- ⑥ (1) 5/16"-18 X 2" SS HCS Bolt
- ⑦ (1) SnapNrack Channel Nut



Standoff Base, 4-Hole

## Other Materials Required

- ① (2-4) 1/4" Wood Screws
- ② (1) Conical Flashing



### Application Note:

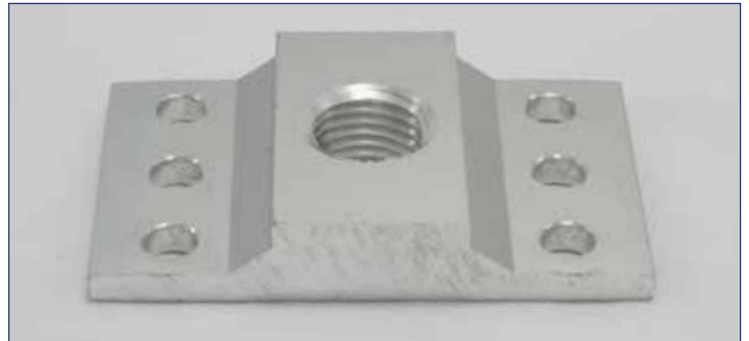
Install on roofs with composite wood I-joists, unless fastening to top flange is prohibited by I-joist manufacturer.

## Materials Included – HD Standoff Kit

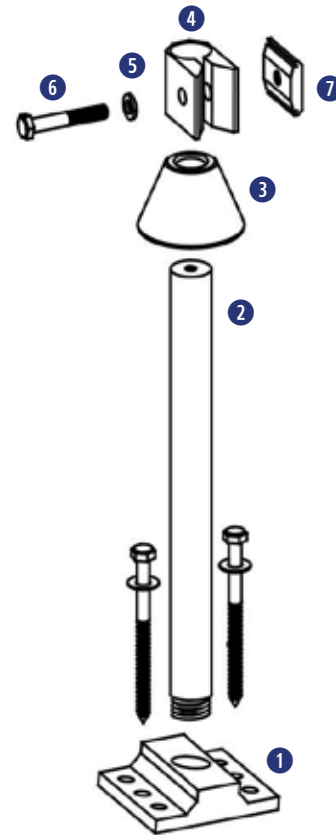
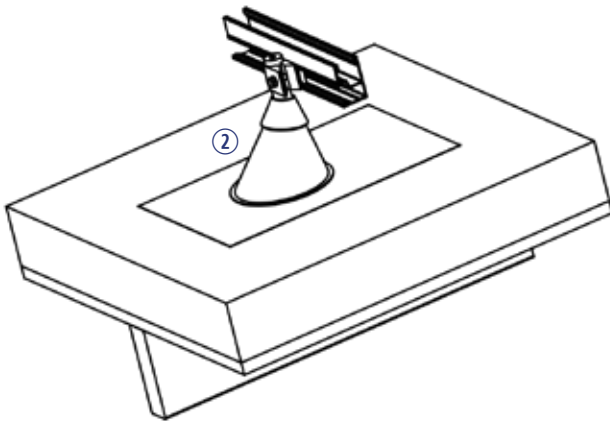
- ① (1) SnapNrack HD Standoff Base, 6-Hole
- ② (1) SnapNrack HD Standoff Shaft
- ③ (1) SnapNrack Rubber Rain Collar
- ④ (1) SnapNrack Standoff Clamp
- ⑤ (1) 5/16" SS Split Lock Washer
- ⑥ (1) 5/16"-18 X 2" SS HCS Bolt
- ⑦ (1) SnapNrack Channel Nut


## Other Materials Required

- ① (2) 5/16" Lag Screw (minimum)
- ② (1) Conical Flashing



HD Standoff Base, 6-Hole



 Application Note:  
Install on foam or other built-up roofs.

## INSTALLATION INSTRUCTIONS

### Steel Structural Member Installation

1) Follow the instruction exactly as the SnapNrack Standoff Mounts, substituting the 1/4" self-drilling screw for the 5/16" lag screw.

### 4-Hole Base Installation

1) Follow the instruction exactly as the SnapNrack Standoff Mounts, substituting the 1-Hole Base for the 4-Hole Base and 1/4" wood screws (with 1.25" minimum embedment) for the 5/16" lag screw.

### HD Base Installation

- 1) Remove the foam roofing above the roof framing member to be installed on.
- 2) Attach the base with (2) 5/16" lag screws minimum in center holes, or (4) 5/16" lag screws in corner holes. Drive lag screws for minimum 2.5" embedment into the roof framing member.
- 3) Attach the standoff shaft by tightening it onto the base with channel locks.
- 4) Replace the foam roofing or roofing membrane that was removed.
- 5) Set the flashing by sliding the cone flashing over the exposed standoff and heat weld the rubber membrane around the flashing for a water tight seal.
- 6) Attach the standoff clamp by first sliding the rubber rain collar over the standoff shaft then the standoff clamp with bolt, washer and channel nut.

## Required Tools

- Hammer or Stud Finder
- Roof Marking Crayon
- Drill with 3/16" Pilot Drill Bit
- Roof Sealant
- Torque Wrench
- Socket Wrench
- 1/2" Socket
- Flat Pry Bar

## Materials Included - Universal Tile Hook

- ① (1) SnapNrack Universal Tile Hook Base
- ② (1) SnapNrack Universal Tile Hook Arm
- ③ (2) 5/16"-18 X 1-1/4" SS Flange Bolt
- ④ (2) SnapNrack Channel Nut

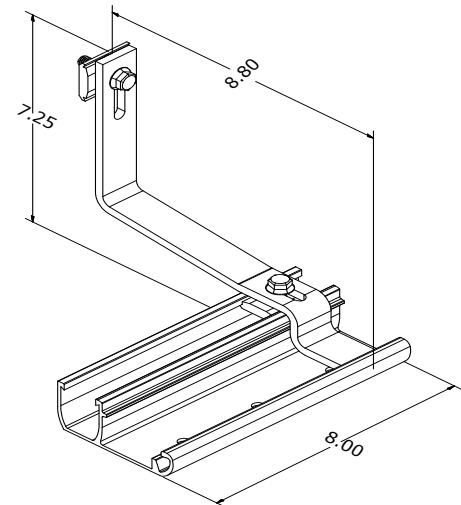
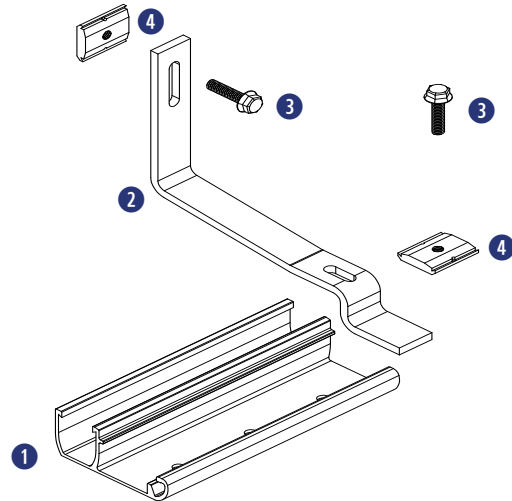
## Other Materials Required (Not Shown)

- ① (2) 5/16" Lag Screw
- ② (2) 5/16" Washer
- ③ Flexible Flashing  
(when required for deck-level flashing)

### ⚙️ Note:

Tile Roof Hooks are limited to areas with design wind speeds of 120 mph or less.

Roof attachment spacing with Tile Roof Hooks is limited to 6 ft (maximum).



Dimensioned Universal Tile Hook Assembly

### ⚙️ Application Note:

Install on flat, W and S style concrete tile roofs.



## INSTALLATION INSTRUCTIONS



1) Using roof attachment locations drawn during system layout, remove roof tile where the roof attachment will be installed and drill two pilot holes through the roofing material into the roof framing member.



2) Apply roofing sealant and attach the base with (2) 5/16" lag screws, drive lag screws for minimum 2.5" embedment into the roof framing member.



3) Insert the top end of the arm into the groove at the top of the base and slide the arm to position it over the valley of the tile below, then lower the arm down.

### Install Note:

Align the base over the roof framing member so the hook can enter at the valley of a tile and not extend beyond the edge of the base.

Ensure the lag screws will be installed in a solid portion of the roof framing member.

If the roof framing member is not found then seal the pilot hole immediately with roofing sealant.



### Best Practice:

If using an impact driver, finish tightening lag screw with a hand wrench.



4) Work the channel nut into the lower groove of the base as you lower the arm, without removing the channel nut.



5) Once hook arm position is set, tighten the bolt in the channel nut and ensure the arm fully seats to the base.



6) If deck-level flashing is required, integrate roof felt or a flexible flashing with the existing underlayment and over the Tile Hook.



7) Replace the roof tiles and install SnapNrack Standard Rail directly to the available channel nut on the hook arm.

## INSTALLATION INSTRUCTIONS



1) Prepare the underlayment surface for adhesion.



2) Peel off the backings from two 4"x8" strips of flexible flashing.



3) Apply the strips along the side edges of the synthetic underlayment flashing with 2" laps at the top and side edges.

### Best Practice:

The surface should be dry, clean and free of any dirt, dust or foreign matter that may prevent adhesion. Clean the surface around the Tile Hook with a brush of medium-stiff bristles. If necessary, prime the surface with compatible spray or paint primer.



4) Apply the synthetic underlayment flashing centered over the tile hook and abutted to the lower row of tile.



5) Press and smooth out any creases or air bubbles with a roller to maximize contact of the adhesive to 100% of the flashing and deck-level surface.

### Install Note:

Removal of an additional tile may be necessary.



6) Peel off the backing from a 4"x19" strip of flexible flashing.



7) Apply the strip along the top edge of the flashing with 2" laps at the top and side edges, then roll out any creases or air bubbles between the strip, the flashing, and the deck-level surface.



8) Peel off the backing and apply the second 4"x19" strip of flexible flashing along the top edge of the first strip with a 2" lap at the top edge, then roll out any creases between the strip and the deck-level surface.

## INSTALLATION INSTRUCTIONS

### Install Note:

SnapNrack recommends testing underlayment surfaces for adhesion. If adhesion is found to be marginal, then an adhesive primer is recommended to ensure optimal adhesion.

See instructions below:

- 1) Ensure surface is dry, clean, and free of anything that may prevent adhesion
- 2) Shake can of adhesive before use
- 3) Apply a uniform coat of adhesive to surface being treated
- 4) Allow surface to dry for 2 minutes (no more than 10 minutes) before applying flashing
- 5) Never cover wet adhesive

SnapNrack recommends using Protecto Wrap Protecto Seal 45 waterproofing membrane, or equivalent, as the flexible flashing and lap material.



## Required Tools

- Hammer or Stud Finder
- Roof Marking Crayon
- Drill with 3/16" Pilot Drill Bit
- Roof Sealant
- Torque Wrench
- Socket Wrench
- 1/2" Socket
- Flat Pry Bar

## Materials Included - Universal Tile Hook

- ① (1) SnapNrack Flat Tile Hook
- ② (1) 5/16"-18 X 1-1/4" SS Flange Bolt
- ③ (1) SnapNrack Channel Nut

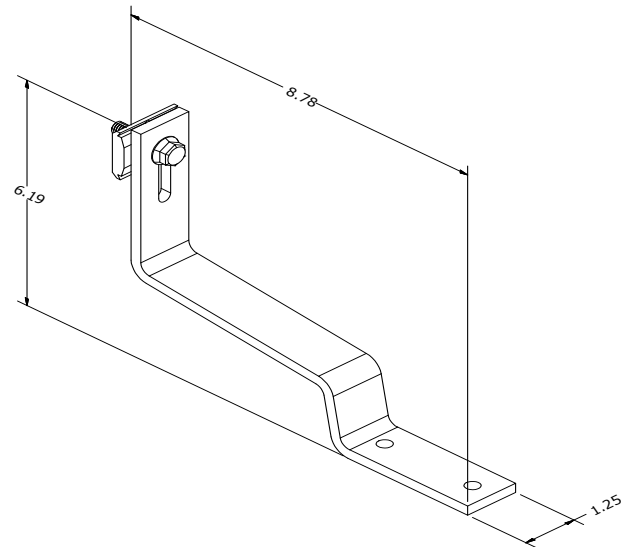
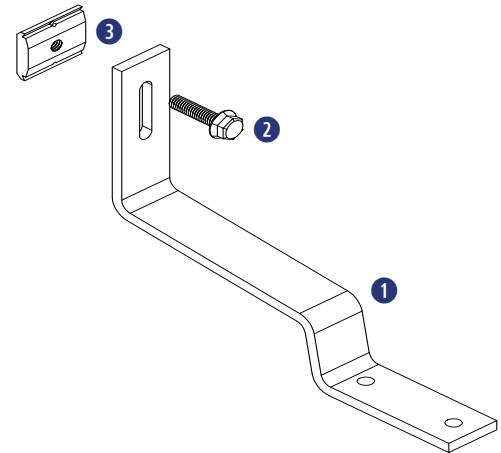
## Other Materials Required (Not Shown)

- ① (2) 5/16" Lag Screw
- ② (2) 5/16" Washer
- ③ Flexible Flashing  
(when required for deck-level flashing)

### Note:

Tile Roof Hooks are limited to areas with design wind speeds of 120 mph or less.

Roof attachment spacing with Tile Roof Hooks is limited to 6 ft (maximum).



Dimensioned Flat Tile Hook Assembly

### Application Note:

Install on flat concrete tile roofs.



## INSTALLATION INSTRUCTIONS



1) Using roof attachment locations drawn during system layout, remove roof tile where the roof attachment will be installed and drill two pilot holes through the roofing material into the roof framing member.



### Install Note:

Ensure the lag screws will be installed in a solid portion of the roof framing member.

If the roof framing member is not found then seal the pilot hole immediately with roofing sealant.

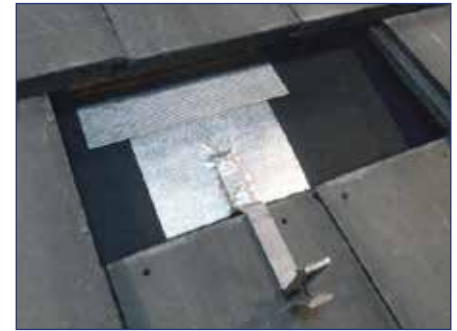


2) Apply roofing sealant and attach the base with (2) 5/16" lag screws, drive lag screws for minimum 2.5" embedment into the roof framing member.



### Best Practice:

If using an impact driver, finish tightening lag screw with a hand wrench.



3) If deck-level flashing is required, integrate roof felt or a flexible flashing with the existing underlayment and over the Tile Hook.



4) Replace the roof tiles and install SnapNrack Standard Rail directly to the available channel nut on the hook arm.

## INSTALLATION INSTRUCTIONS



1) Prepare the underlayment surface for adhesion.



2) Peel off the backing from a 9" square of flexible flashing.



3) Apply flexible flashing centered laterally over tile hook and abutted to the tile hook arm.

### Best Practice:

The surface should be dry, clean and free of any dirt, dust or foreign matter that may prevent adhesion. Clean the surface around the Tile Hook with a brush of medium-stiff bristles. If necessary, prime the surface with compatible spray or paint primer.

### Install Note:

Ensure tape adheres to the corners between the edges of the Tile Hook and the underlayment as well as over the lag screw heads and tile hook surface.



4) Press and smooth out any creases or air bubbles with a roller to maximize contact of the flashing adhesive to 100% of the surface and Tile Hook.



5) Peel off the backing from a 4" by 13" strip of flexible flashing.



6) Apply the strip with 2" laps at the top and side edges of the square flashing. Roll out any creases or air bubbles between the strip, the flashing and the underlayment surface.

### Install Note:

SnapNrack recommends testing underlayment surfaces for adhesion. If adhesion is found to be marginal, then a primer is recommended to ensure optimal adhesion.

See instructions below:

- 1) Ensure surface is dry, clean, and free of anything that may prevent adhesion
- 2) Shake can of adhesive before use
- 3) Apply a uniform coat of adhesive to surface being treated
- 4) Allow surface to dry for 2 minutes (no more than 10 minutes) before applying flashing
- 5) Never cover wet adhesive

SnapNrack recommends using Protecto Wrap Protecto Seal 45 waterproofing membrane, or equivalent, as the flexible flashing and lap material.

## Required Tools

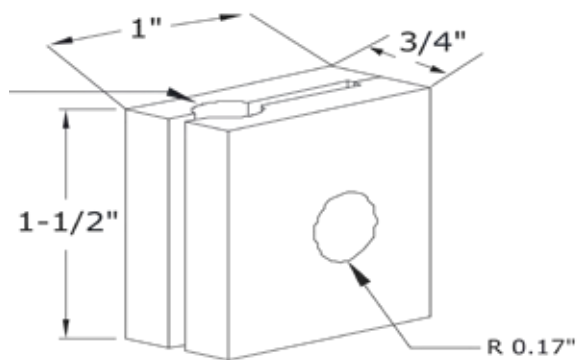
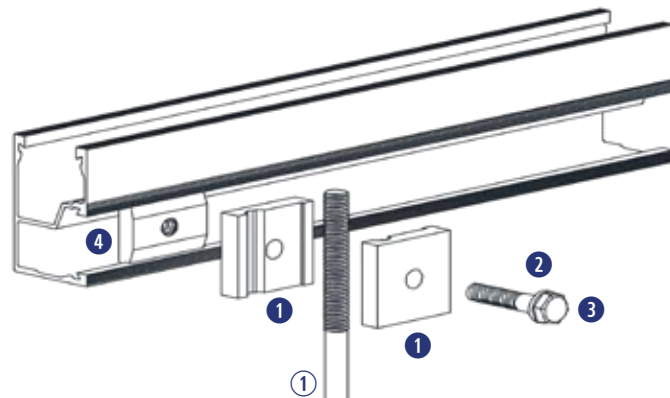
- Hammer or Stud Finder
- Roof Marking Crayon
- Drill with 3/16" Pilot Drill Bit
- Roof Sealant
- Threaded Bit Adapter
- Torque Wrench
- Socket Wrench
- 1/2" Socket

## Materials Included - Hanger Bolt Kit

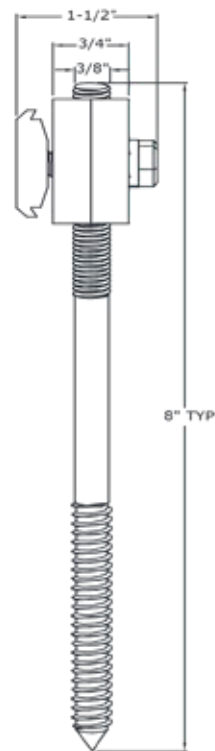
- ① (2) SnapNrack Hanger Bolt Clamp
- ② (1) 5/16" SS Split Lock Washer
- ③ (1) 5/16"-18 X 1-1/2" SS HCS Bolt
- ④ (1) SnapNrack Channel Nut

## Other Materials Required

- ① (1) 3/8" Stainless Steel Hanger Bolt



Dimensioned Hanger Bolt Clamp



Dimensioned Hanger Bolt Clamp Assembly

### Application Note:

Install on roofs where practical flashing solutions are not available, such as sinusoidal style corrugated roofs.

### Install Note:

Grounding and bonding of mounting system to metal roof panels shall meet local AHJ requirements.



## INSTALLATION INSTRUCTIONS



1) Using roof attachment locations drawn during system layout, drill a pilot hole through the roofing material into the roof framing member.



2) Apply roofing sealant directly onto the pilot hole and the hanger bolt to ensure a water tight seal.



3) Attach the hanger bolt using the threaded bit adapter, drive hanger bolt for minimum 2.5" embedment of lag shank into the roof framing member.

### Install Note:

Ensure the lag screws will be installed in a solid portion of the roof framing member.

If the roof framing member is not found then seal the pilot hole immediately with roofing sealant.

### Best Practice:

If using an impact driver, finish tightening hanger bolt with a hand wrench.



4) Attach the channel nut of the hanger bolt assembly into side channel of rail.



5) Attach the hanger bolt clamp by setting it around the threaded portion of the hanger bolt to the desired height and tighten to 10+ ft-lbs.

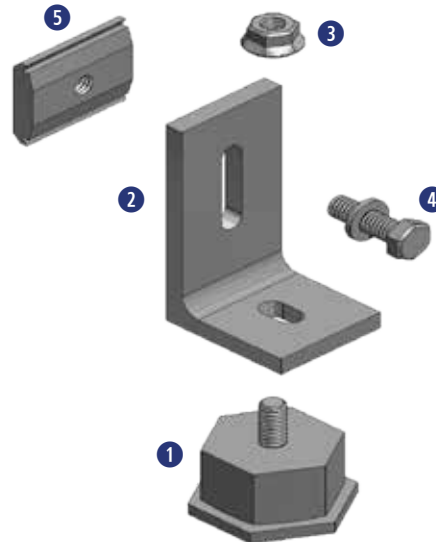


## Required Tools

- Hammer or Stud Finder
- Roof Marking Crayon
- Drill with 3/16" Pilot Drill Bit
- Torque Wrench
- Socket Wrench
- 1/2" Socket

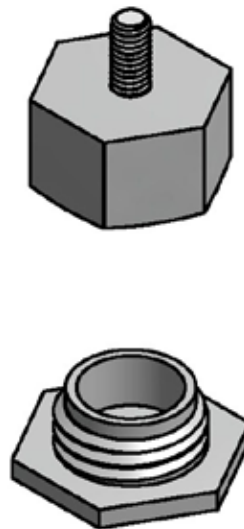
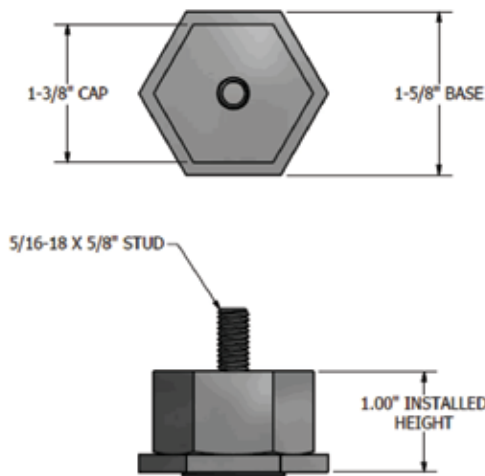
## Materials Included - Metal Roof Base

- ① (1) SnapNrack Metal Roof Base
- ② (1) SnapNrack All Purpose L Foot
- ③ (1) 5/16"-18 SS Flange Nut
- ④ (1) 5/16"-18 X 1-1/4" SS Flange Bolt
- ⑤ (1) SnapNrack Channel Nut



## Other Materials Required

- ① (1) 5/16" Lag Screw or 1/4" Self-drilling Screw (Not Shown)



Dimensioned Metal Roof Base Assembly

### Application Note:

Install on metal roof profiles with flat surface large enough to accommodate 1-5/8" wide base.

### Install Note:

Grounding and bonding of mounting system to metal roof panels shall meet local AHJ requirements.

## INSTALLATION INSTRUCTIONS



1) Using roof attachment locations drawn during system layout, drill a pilot hole through the roofing material into the roof framing member.



2) Attach the base with 5/16" lag screw (or 1/4" self-drilling screw), drive lag screw for minimum 2.5" embedment into the roof framing member.



3) Thread Metal Roof Base cap onto Metal Roof Base bottom, ensuring cap is fully seated to base.

### Install Note:

Ensure the lag or self-drilling screws will be installed in a solid portion of the roof framing member.

If the roof framing member is not found then seal the pilot hole immediately with roofing sealant.

### Install Note:

Ensure area is free from metal shavings and debris before installing Metal Roof Base. Metal roofs with excessive debris, corrosion, or non-factory coating should be evaluated for adequate sealing surface.

Additional roof sealant not required but can be applied after tightening the Metal Roof Base to roof, if desired.

### Install Note:

Take care to ensure the base does not twist when cap is tightened.



4) Attach L Foot to stud in Metal Roof Base cap and tighten hardware to 10+ ft-lbs.

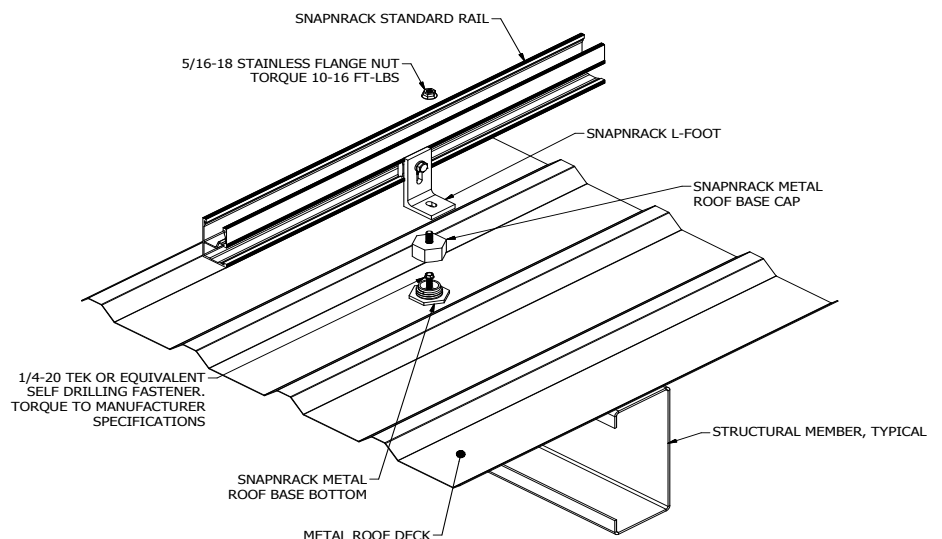
### Best Practice:

If using an impact driver, finish tightening lag screw with a hand wrench.



### Best Practice:

Finish tightening hardware with a hand wrench to prevent L Foot from rotating.



## Required Tools

- Hammer or Stud Finder
- Drill with 3/16" Pilot Drill Bit
- Socket Wrench
- 1/2" Socket

- Roof Sealant
- Torque Wrench

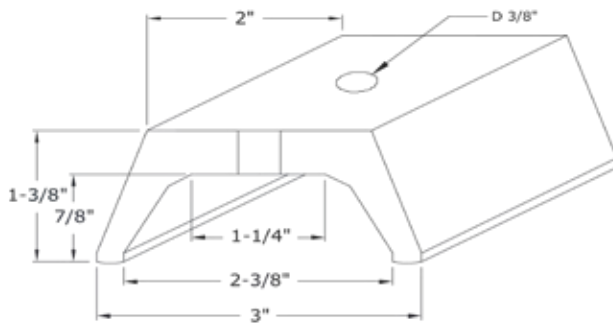
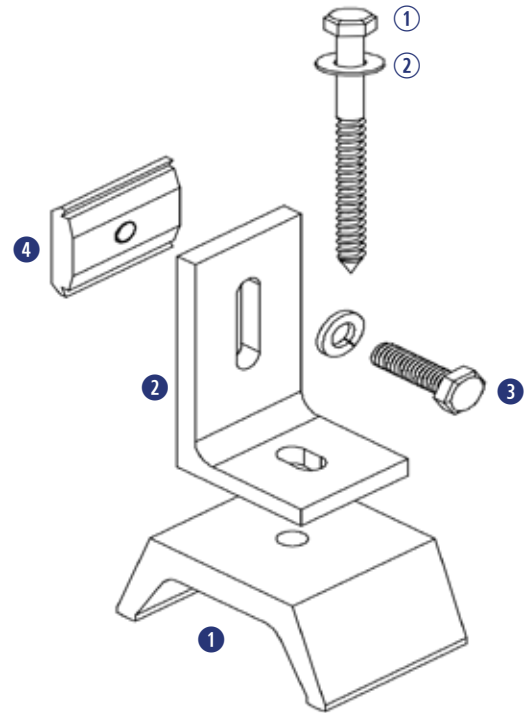
## Materials Included - Corrugated Straddle Block

- ① (1) SnapNrack Corrugated Straddle Block
- ② (1) SnapNrack All Purpose L Foot
- ③ (1) 5/16"-18 X 1-1/4" SS Flange Bolt
- ④ (1) SnapNrack Channel Nut

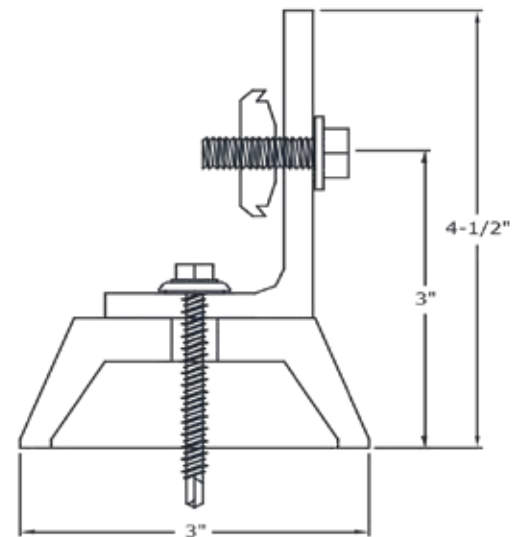
## Other Materials Required

- ① (1) 5/16" Lag Screw or 1/4" Self-drilling Screw
- ② (1) Washer

**Note:**  
Self-drilling screw for steel roofing members, lag screw for wooden roof framing members.



Dimensioned Corrugated Straddle Block



Dimensioned Corrugated Straddle Block Assembly

**Application Note:**  
Install on sinusoidal style corrugated metal roofs.

**Install Note:**  
Grounding and bonding of mounting system to metal roof panels shall meet local AHJ requirements.

## INSTALLATION INSTRUCTIONS



1) Using roof attachment locations drawn during system layout, drill a pilot hole through the roofing material into the roof framing member.



2) Apply roofing sealant directly onto the pilot hole and the lag to ensure a water tight seal.



3) Attach the Straddle Block and L Foot with 5/16" lag screw, drive lag screw for minimum 2.5" embedment into the roof framing member.

### Install Note:

Ensure the lag or self-drilling screws will be installed in a solid portion of the roof framing member.

If the roof framing member is not found then seal the pilot hole immediately with roofing sealant.

### Best Practice:

If using an impact driver, finish tightening lag screw with a hand wrench to prevent L Foot from rotating.



4) Install SnapNrack standard rail directly onto channel nut and tighten L Foot assembly silver hardware to 12 ft-lb.

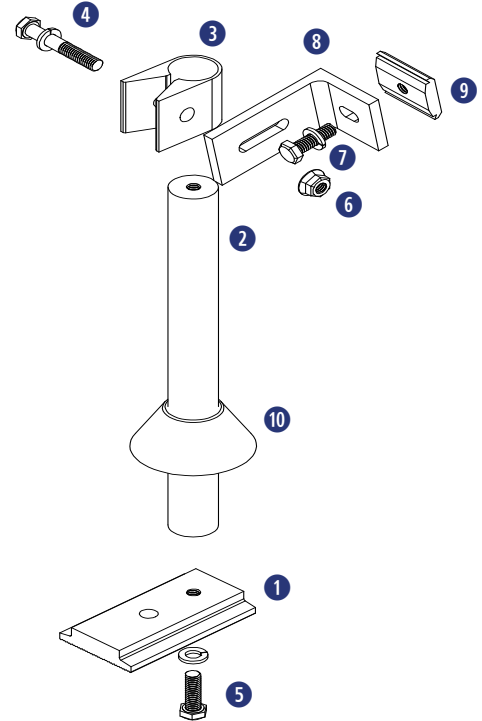


## Required Tools

- Hammer or Stud Finder
- Roof Marking Crayon
- Drill with 3/16" Pilot Drill Bit
- Roof Sealant
- Torque Wrench
- Socket Wrench
- 1/2" Socket

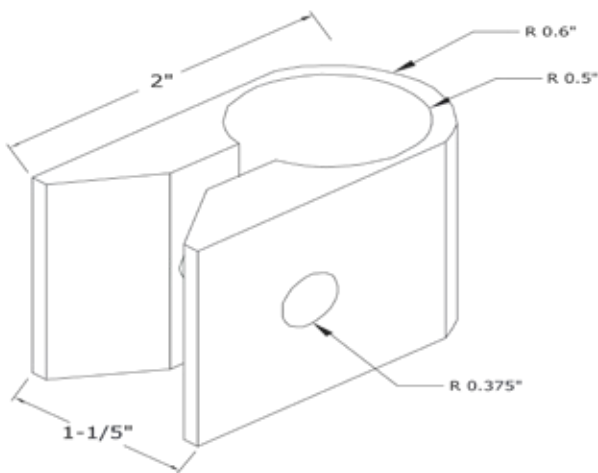
## Materials Included - 5°-15° Tilt Kit

- ① (2) SnapNrack Standoff Base, 1-Hole
- ② (2) SnapNrack Standoff Shaft
- ③ (2) SnapNrack Standoff Clamp
- ④ (2) 5/16" SS Split Lock Washer
- ⑤ (2) 5/16"-18 X 2" SS HCS Bolt
- ⑥ (2) 5/16"-18 SS Flange Nut
- ⑦ (2) 5/16"-18 X 1-1/4" SS Flange Bolt
- ⑧ (2) SnapNrack All Purpose L Foot
- ⑨ (2) SnapNrack Channel Nut
- ⑩ (2) SnapNrack Rubber Rain Collar

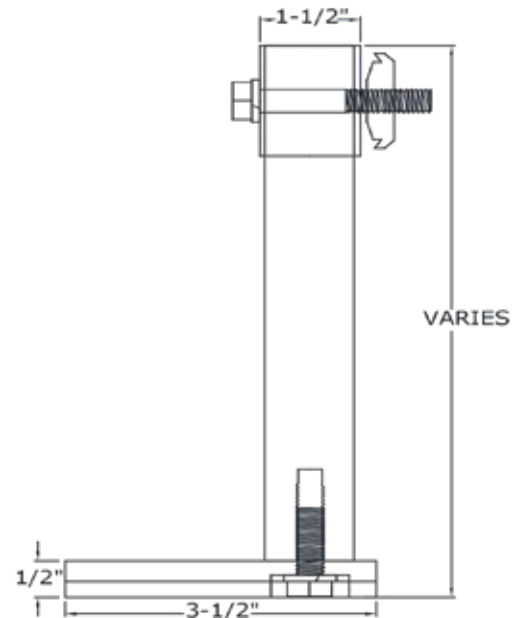


## Other Materials Required (Not Shown)

- ① (2) 5/16" Lag Screw
- ② (2) Washer
- ③ (2) Conical Flashings



Dimensioned Standoff Clamp



Dimensioned Standoff Assembly



### Application Note:

Install when additional tilt of solar array is required.



## Required Tools

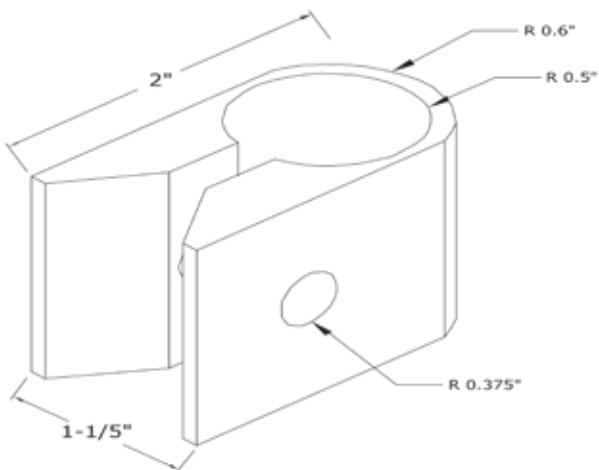
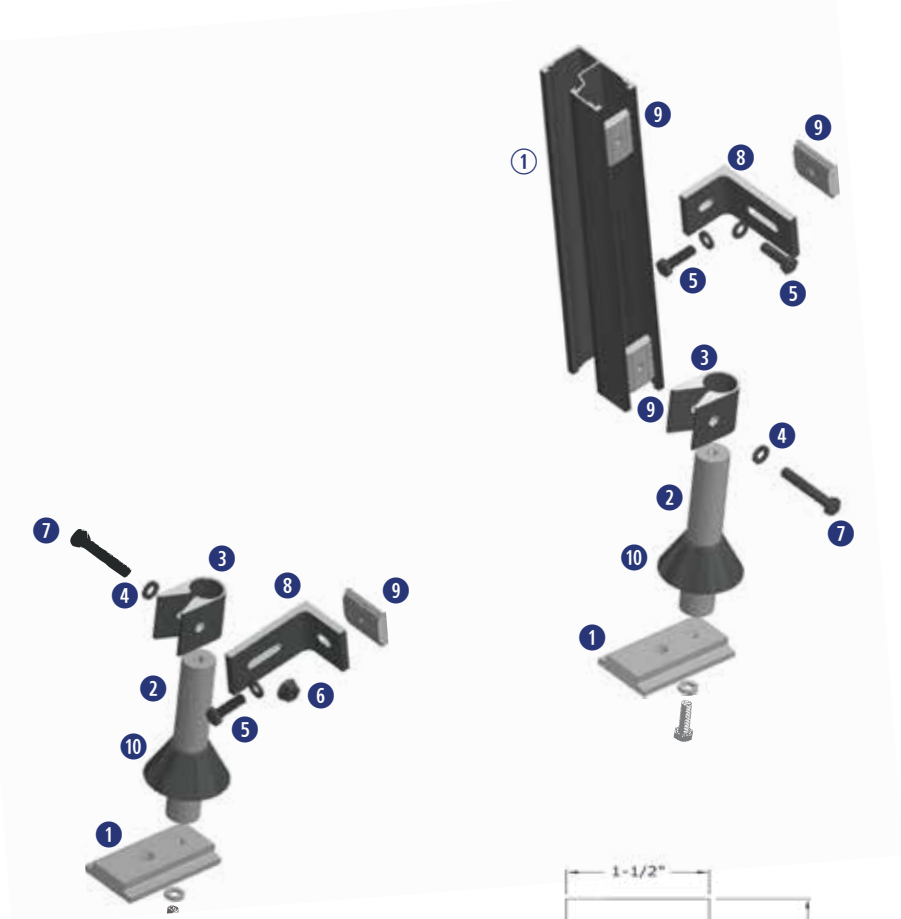
- Hammer or Stud Finder
- Roof Marking Crayon
- Drill with 3/16" Pilot Drill Bit
- Roof Sealant
- Torque Wrench
- Socket Wrench
- 1/2" Socket
- SnapNrack High Tilt

## Materials Included - 10°-45° Tilt Kit

- ① (2) SnapNrack Standoff Base
- ② (2) SnapNrack Standoff Shaft
- ③ (2) SnapNrack Standoff Clamp
- ④ (2) 5/16" SS Split Lock Washer
- ⑤ (3) 5/16"-18 X 1-1/4" SS Flange Bolt
- ⑥ (1) 5/16"-18 SS Flange Nut
- ⑦ (2) 5/16"-18 X 2" SS HCS Bolt
- ⑧ (2) SnapNrack All Purpose L Foot
- ⑨ (4) SnapNrack Channel Nut
- ⑩ (2) Rubber Rain Collar

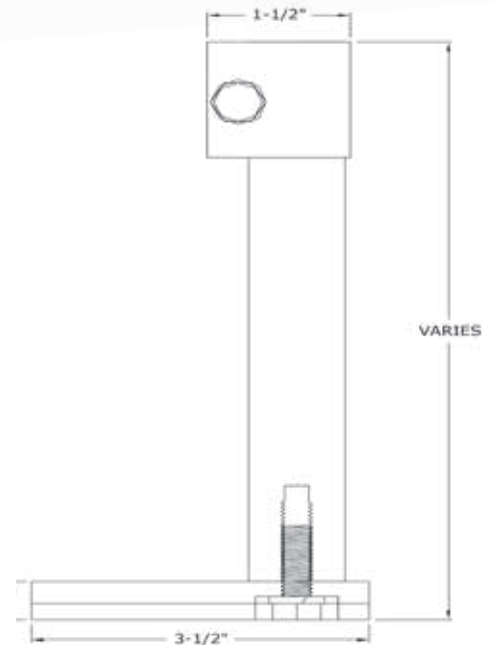
## Other Materials Required

- ① (1) Cut-to-Length Standard Rail (Rear Tilt Leg)
- ② (2) 5/16" Lag Screw (Not Shown)
- ③ (2) 5/16" Washer (Not Shown)
- ④ (2) Roof Cone Flashings (Not Shown)



Dimensioned Standoff Clamp

**Application Note:**  
Install when additional tilt of solar array is required.



Dimensioned Standoff Assembly



## INSTALLATION INSTRUCTIONS



1) Using roof attachment locations drawn during system layout, drill a pilot hole through the roofing material into the roof framing member.



2) Apply roofing sealant directly onto the pilot hole and the lag to ensure a water tight seal.



3) Attach the base with a 5/16" lag screw, drive lag screw for minimum 2.5" embedment into the roof framing member.

### Install Note:

Ensure the lag or self-drilling screws will be installed in a solid portion of the roof framing member.

If the roof framing member is not found then seal the pilot hole immediately with roofing sealant

### Best Practice:

If using an impact driver, finish tightening lag screw with a hand wrench to prevent 1-Hole Base from rotating.



4) Attach the standoff shaft and tighten it onto the base stud with channel locks. Set the flashing by sliding it over the standoff and directly applying it to the roof surface, using all necessary sealants and attachment methods for flashing. Slide Rubber Rain Collar over the standoff shaft to cover top of flashing.



5) Slide the standoff clamp and L Foot onto the standoff shaft, adjust it to the desired height, and tighten hardware to 10+ ft-lbs.



## INSTALLATION INSTRUCTIONS



6) For tilts greater than 15 degrees, cut length of rail to use as rear tilt leg and attach to rear standoff using L Feet hardware.



7) Set array tilt and tighten hardware to 10+ ft-lbs.



### Best Practice:

High Tilt Tool may be constructed to help set array tilt and support the top rail while installing first modules (see below).

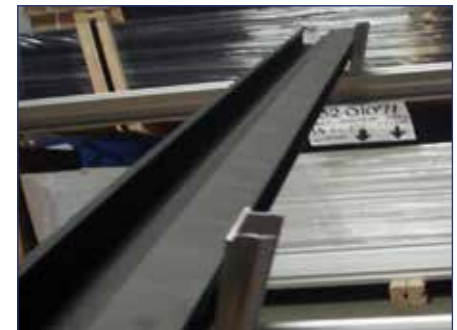
## HIGH TILT TOOL INSTRUCTIONS



1) Construct High Tilt Tool using a length of SnapNrack rail cut to the dimensions of the module(s) being installed, two 4" lengths of Rail Cover with 3/8" holes drilled in the center of each, two channel nuts, and two 5/16" bolts.



2) Assemble bolts and channel nuts in rail covers through the pre-drilled holes with channel nut on flat side of rail cover, then slide or snap channel nuts into top channel of rail.



3) Adjust the rail covers to the correct positions, spaced at the same distance as that between the lower rail and top rail of tilted array.



4) Tighten hardware.



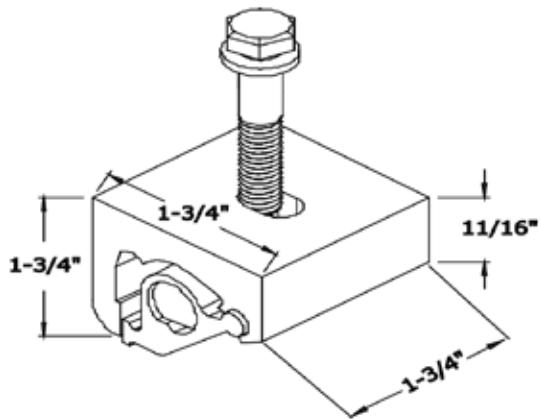
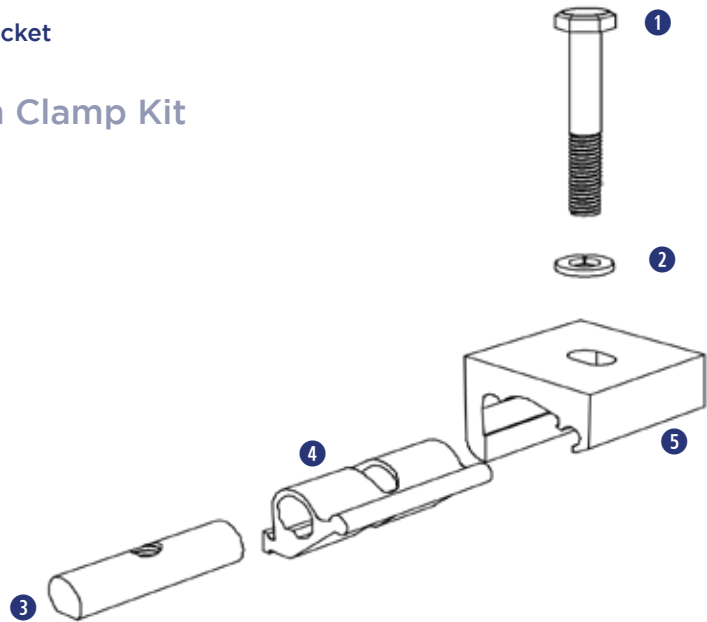
Assembled High Tilt Tool

## Required Tools

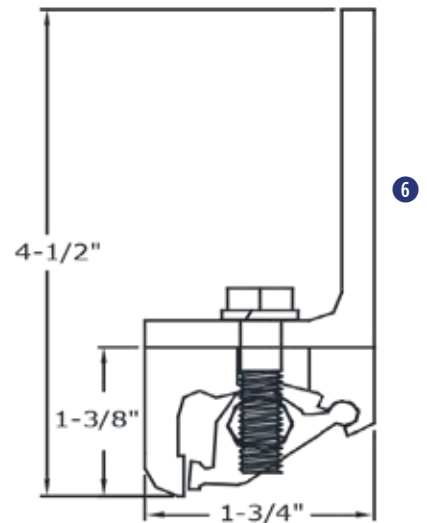
- Torque Wrench
- Socket Wrench
- 1/2" Socket

## Materials Included - Standard Base Seam Clamp Kit

- ① (1) 5/16"-18 X 1-1/2" SS HCS Bolt (Black)
- ② (1) 5/16" SS Split Lock Washer
- ③ (1) SnapNrack Seam Clamp Insert
- ④ (1) SnapNrack Seam Clamp Cam
- ⑤ (1) SnapNrack Seam Clamp Standard Base
- ⑥ (1) SnapNrack All Purpose L Foot
- ⑦ (1) 5/16"-18 X 1-1/4" SS Flange Bolt (Not Shown)
- ⑧ (1) SnapNrack Channel Nut (Not Shown)



Dimensioned Standard Base Seam Clamp



Dimensioned Standard Base Seam Clamp Assembly

**Application Note:**  
Install on standing metal seam roofs.

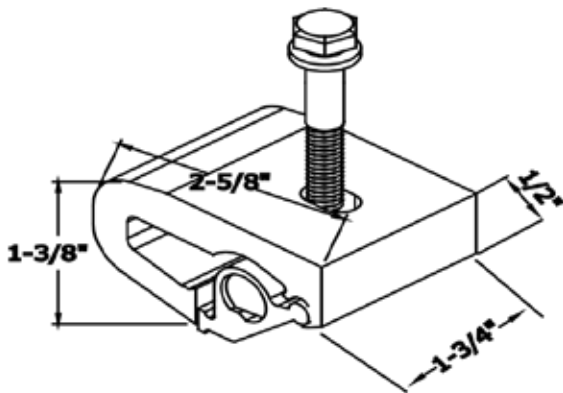
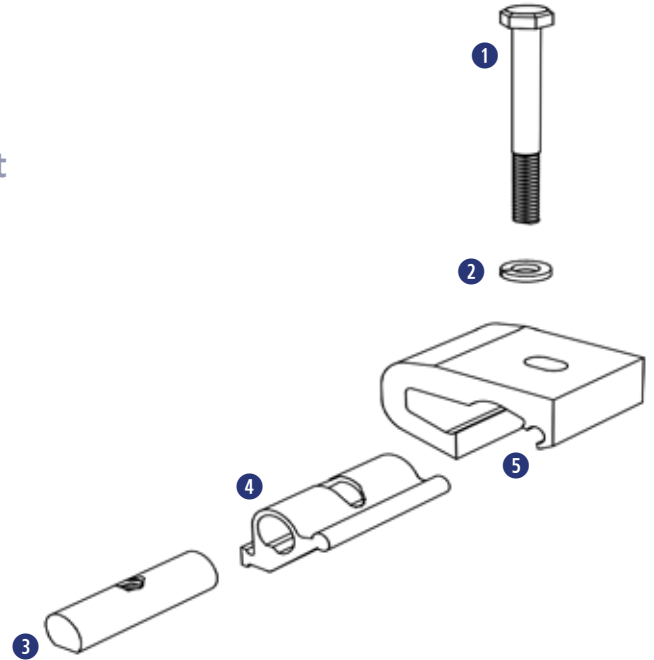
**Install Note:**  
Grounding and bonding of mounting system to metal roof panels shall meet local AHJ requirements.

## Required Tools

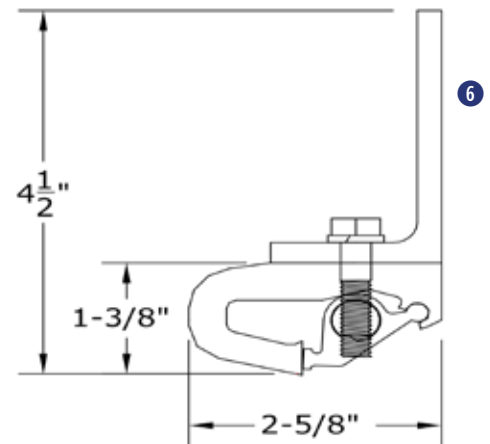
- Torque Wrench
- Socket Wrench
- 1/2" Socket

## Materials Included - Wide Base Seam Clamp Kit

- ① (1) 5/16"-18 X 1-1/2" SS HCS Bolt (Black)
- ② (1) 5/16" SS Split Lock Washer
- ③ (1) SnapNrack Seam Clamp Insert
- ④ (1) SnapNrack Seam Clamp Cam
- ⑤ (1) SnapNrack Seam Clamp Wide Base
- ⑥ (1) SnapNrack All Purpose L Foot
- ⑦ (1) 5/16"-18 X 1-1/4" SS Flange Bolt (Not Shown)
- ⑧ (1) SnapNrack Channel Nut (Not Shown)



Dimensioned Wide Base  
Seam Clamp



Dimensioned Wide Base  
Seam Clamp Assembly

**Application Note:**  
Install on standing metal seam roofs.

**Install Note:**  
Grounding and bonding of mounting system to metal roof panels shall meet local AHJ requirements.

## INSTALLATION INSTRUCTIONS



1) Loosen seam clamp hardware and use roof attachment locations to lay out seam clamps on roof.



2) Attach the seam clamp to the standing metal seam by opening the seam clamp cam and placing the clamp over the top of the standing metal seam.



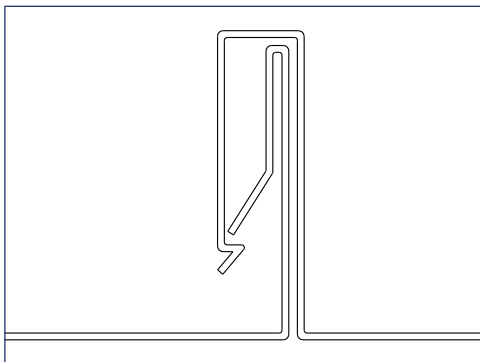
3) Torque black seam clamp bolt to 200 in-lbs (16.7 ft-lbs).



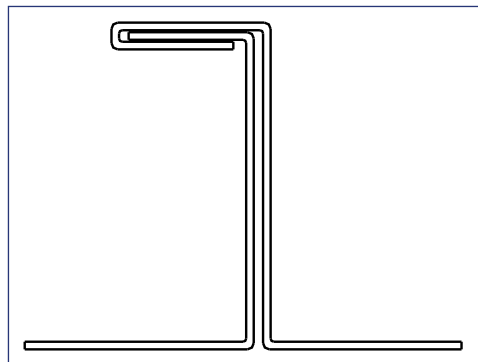
### Install Note:

Seam clamps should never be installed using an impact driver.

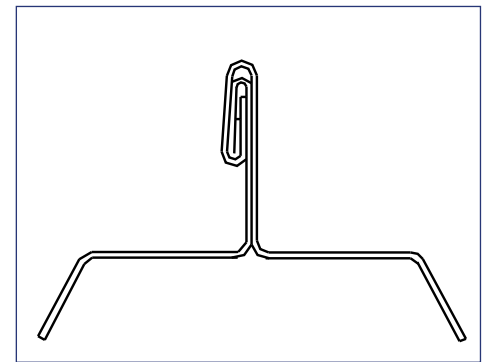
SnapNrack Seam Clamps have been designed to work with a variety of standing seam metal roofs, the most common seam types are:



Snap Lock



Single Lock



Double Lock



### Design Note:

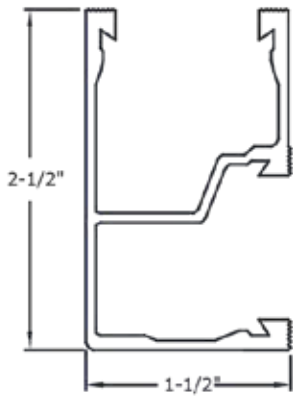
If a specific roof seam is not found on list, contact SnapNrack prior to installation.

## Required Tools

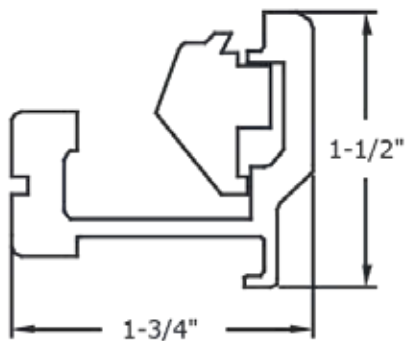
- Level
- String Line or Spare Rail
- Pitch Meter
- 5/32" Allen Key
- Torque Wrench
- Socket Wrench
- 1/2" Socket

## Materials Included - Install and Level Rails

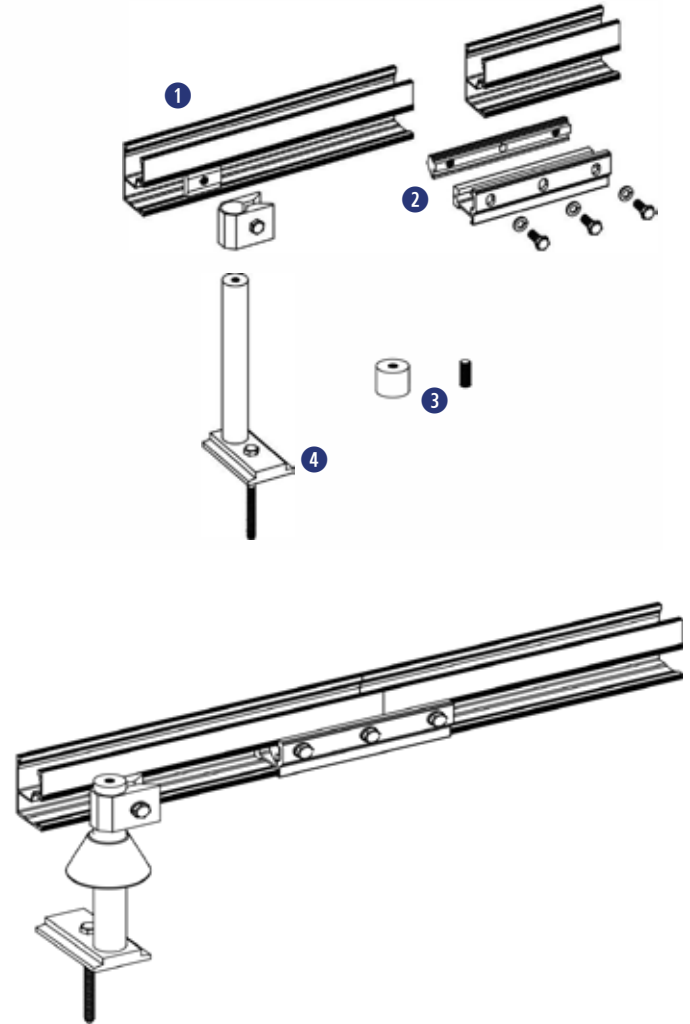
- ① SnapNrack Standard Rail
- ② SnapNrack Standard Rail Splice
- ③ SnapNrack 1" Standoff Spacer with Set Screw
- ④ Pre-Installed SnapNrack Roof Attachments (L Foot, Standoff)



Standard Rail Profile



Rail Splice Profile





## INSTALLATION INSTRUCTIONS



1) Set rails into the attachments by snapping channel nuts into the side channel of the rail. Connect multiple lengths of rail end to end using the SnapNrack rail splice.



2) Level the bottom rail of the array to the roof and tighten attachment points, to the following torque specifications: L Feet and Tile Hooks to Rail - 12 ft-lbs, Standoff Clamps to Rail - 10+ ft-lbs, Black Fasteners - 8 ft-lbs



3) Run a string line or spare rail from the bottom rail to the top rail and set desired pitch of the array by adjusting the top rail, add leveling spacers if needed.



### Best Practice:

Set attachments in the middle of available leveling range to start.



4) Level the top rail by moving the string line down the length of the rail, matching pitch over the entire length of the array.



5) Level the remaining rails to the string line by working out from the middle rail, add leveling spacers if needed.



6) Tighten all racking hardware.



### Note:

The minimum standoff height between the modules and roof is as follows:

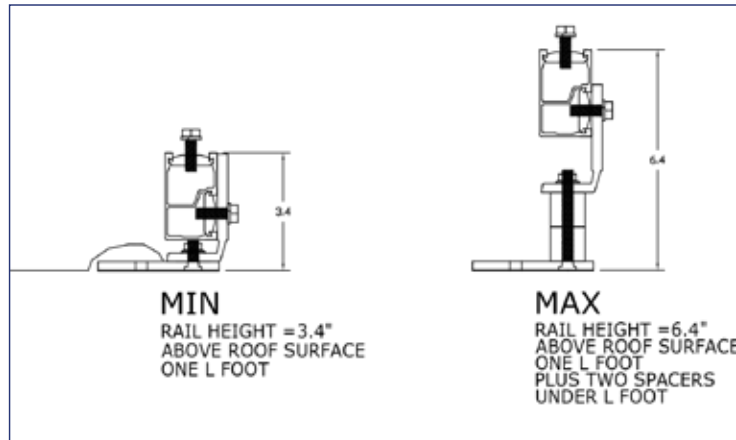
- REC Solar, Yingli, and Suniva modules: 4.00"
- ReneSola modules: 3.93" (100 mm)
- Trina Solar modules: 4.53" (115 mm)



## INSTALLATION INSTRUCTIONS

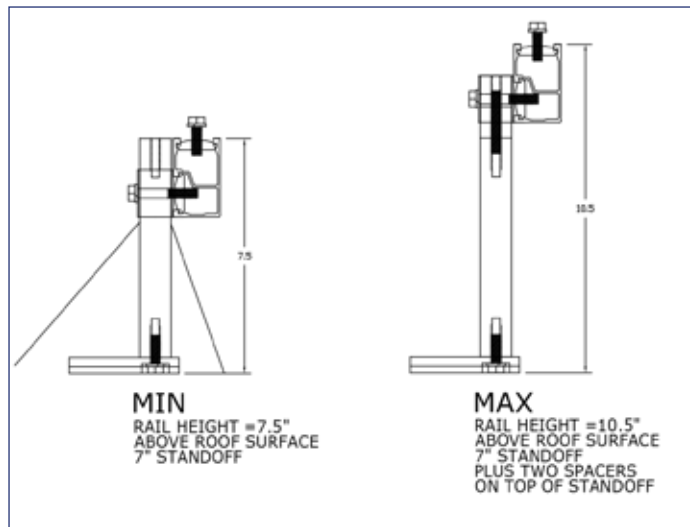
- Use a single level spacer on no more than 30% of attachment points.
- Use a double level spacer on no more than 10% of attachment points.

### L Foot



\*Up To 3" Leveling

### Standoff



\*Up To 3" Leveling

## INSTALLATION INSTRUCTIONS



1) Align sections of rail so that ends butt up to each other.



### Install Note:

Leave approximately 1/8" gap between rails to allow for thermal expansion of rail.



2) Set rail splice assembly in to the side channel of rail, making sure the base is seated all the way into the channel and that the splice is centered.



### Best Practice:

Loosening splice bolts will allow for play with the insert and ease installation.



3) Lift up on splice insert to engage the upper lip of rail channel and tighten bolts by hand to secure insert in rails.



### Best Practice:

Push up on bolts or use fingers on both sides of insert to ensure proper engagement.



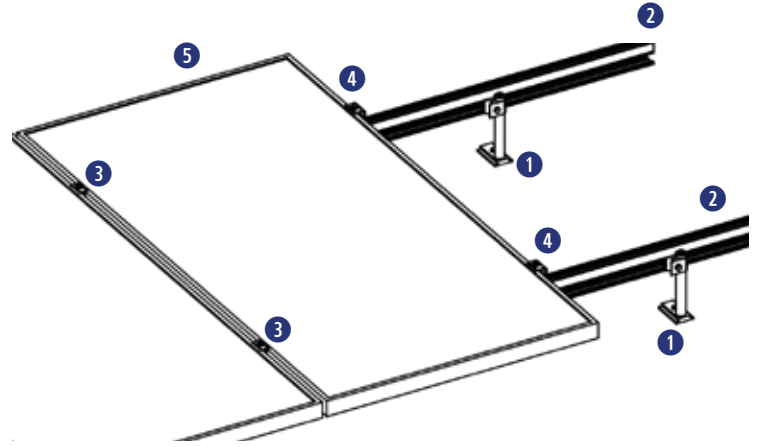
4) Use a socket wrench to tighten splice bolts, torque silver hardware to 10+ ft-lbs and black hardware to 8 ft-lbs.

## Required Tools

- Torque Wrench
- Socket Wrench
- 1/2" Socket

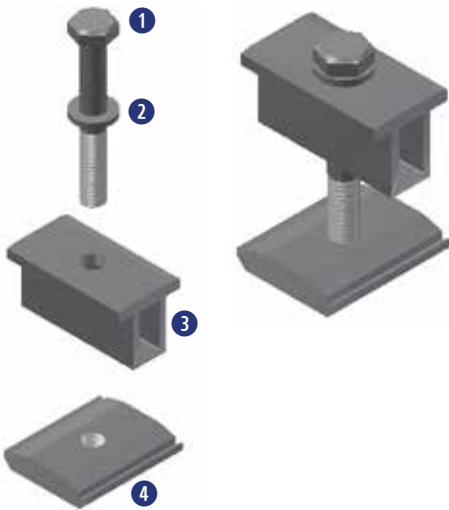
## Materials Needed - Module Installation

- ① Pre-Installed SnapNrack Roof Attachments
- ② Pre-Installed SnapNrack Rails
- ③ SnapNrack Mid Clamp Assemblies
- ④ SnapNrack End Clamp Assemblies
- ⑤ PV Modules



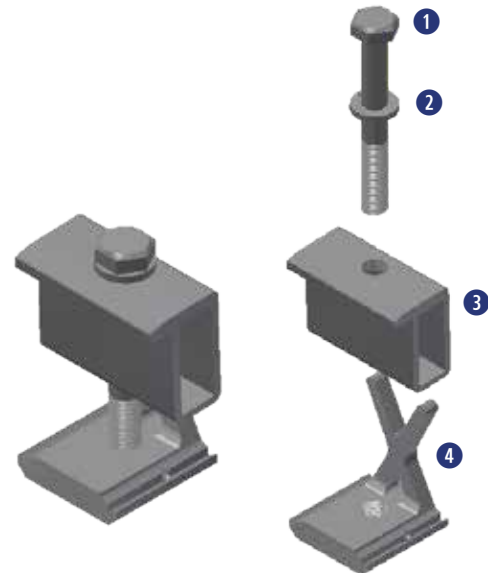
## Mid Clamp Assembly

- ① (1) 5/16"-18 SS HCS Bolt
- ② (1) 5/16" SS Split Lock Washer
- ③ (1) SnapNrack Mid Clamp
- ④ (1) 5/16"-18 SnapNrack Channel Nut



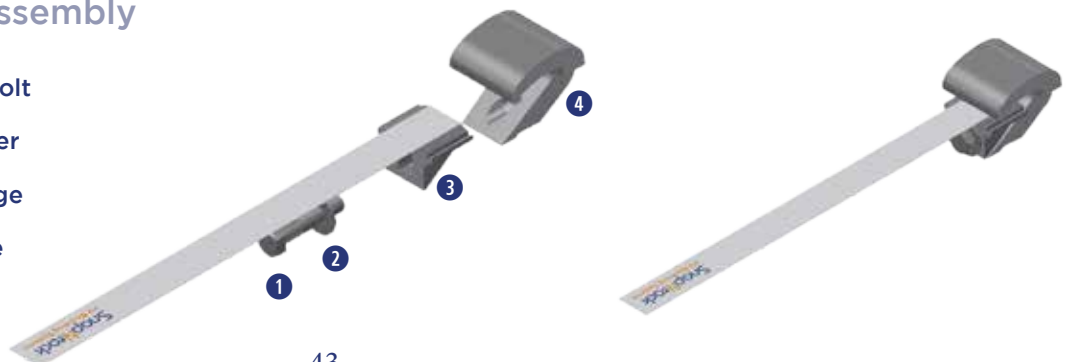
## Adjustable End Clamp Assembly

- ① (1) 5/16"-18 SS HCS Bolt
- ② (1) 5/16" SS Split Lock Washer
- ③ (1) SnapNrack Adjustable End Clamp Top
- ④ (1) SnapNrack Adjustable End Clamp Bottom



## Universal End Clamp Assembly

- ① (1) 5/16"-18 X 1-1/2" SS HCS Bolt
- ② (1) 5/16" X 3/4" SS Flat Washer
- ③ (1) SnapNrack Universal Wedge
- ④ (1) SnapNrack Universal Wave



## INSTALLATION INSTRUCTIONS

### SnapNrack Mid Clamp



1) Snap the channel nut into the top channel of the rail.



2) Slide the clamp flush to the module with the top lip of the mid clamp over the top edge of the module frame.



#### Install Note:

Take care to avoid having wires pinched between modules and rails, as this can lead to system failure and be dangerous.



3) Place the next module flush to the other side of the mid clamp.



#### Install Note:

Mid clamps create 1/2" gap between modules.



4) Tighten hardware, torque silver hardware to 10+ ft-lbs and black hardware to 8 ft-lbs.



#### Install Note:

Mid clamps are Listed with and without springs.

## INSTALLATION INSTRUCTIONS

### SnapNrack Adjustable End Clamp



1) Snap the channel nut into the top channel of the rail.



2) Slide the clamp flush to the module with the top lip of the end clamp over the top edge of the module frame.



3) Tighten hardware, torque silver hardware to 10+ ft-lbs and black hardware to 8 ft-lbs.

#### Install Note:

Adjustable End Clamps require 1.5" of extra rail to extend past the end of the module frame.

#### Install Note:

Take care to avoid having wires pinched between modules and rails, as this can lead to system failure and be dangerous.



4) Install rubber end cap to finish.

## INSTALLATION INSTRUCTIONS

### SnapNrack Universal End Clamp



1) Slide the preassembled Universal End Clamp (UEC) into the end of the rail.



2) Lift the module and slide the clamp far enough under the module to pass the lip of the bottom edge of the module frame.



3) Use the pull tab to hold the UEC taut towards the end of the rail and tighten hardware to 10+ ft-lbs.



#### Install Note:

Take care to avoid having wires pinched between modules and rails, as this can lead to system failure and be dangerous.



#### Install Note:

UEC hardware must be tightened to 12 ft-lbs when installed with the following Hanwha modules:

- Q.BASE-GY XXX
- Q.PRO-GY XXX
- Q.PLUS-GY XXX
- Q.PRO BFR-GY XXX
- Q.PRO BLK-GY XXX
- Q.PRO-GY/SC XXX

Rail can be flush to the module using the UEC Rail Cutting Tool.



4) Install rubber end cap to finish.



#### Install Note:

Modules need to be grounded separately when Universal End Clamps are the only type of clamp attaching a module.

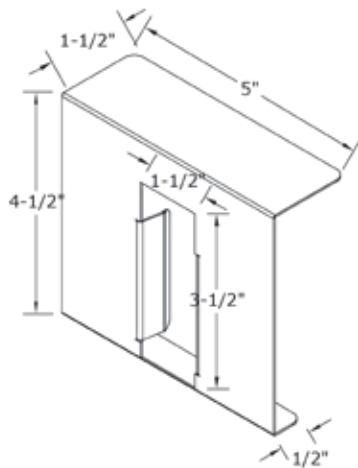
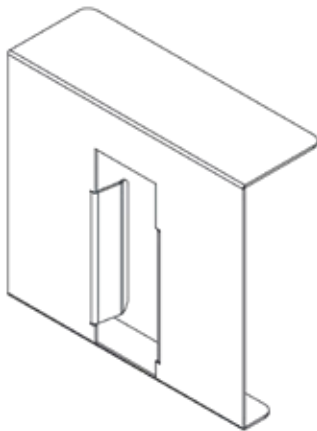


## Required Tools

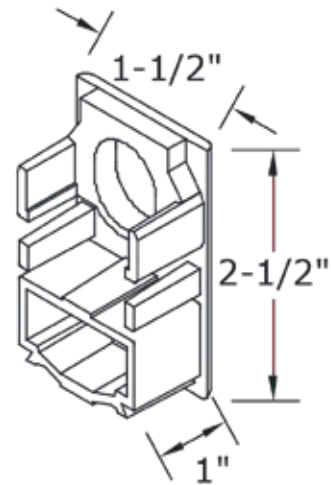
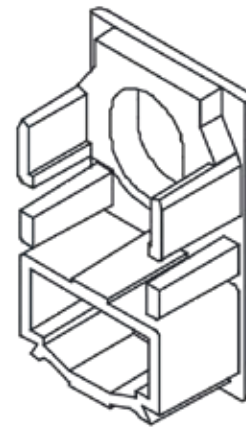
- Reciprocating Saw or Portable Band Saw

## Materials Included - Rail Cutting Tool and Rail End Cap

- ① (1) SnapNrack Rail Cutting Tool
- ② (1) SnapNrack Rail End Cap



Dimensioned Rail Cutting Tool



Dimensioned Rail End Cap

 **Application Note:**  
Use to cut rail flush to module frame when using Universal End Clamps (UEC).



## INSTALLATION INSTRUCTIONS



1) Slide the Rail Cutting Tool over the end of the rail and place it so that the upper lip is safely covering the edge of the module.



2) Use the reciprocating saw or band saw to cut off the end of the rail.



3) Remove the Cutting Tool from the rail.



4) Insert SnapNrack Rail End Cap into the cut end of the rail to create a flush finish to the array.



Edge of array with end caps in rails

## Required Tools

- Wire Cutters
- Pliers



### Note:

Series 100 Edge Screen is NOT UL Listed.

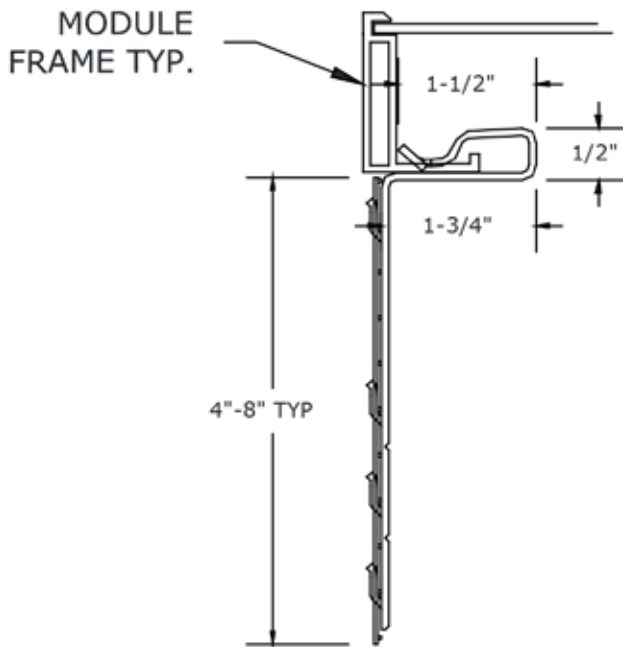
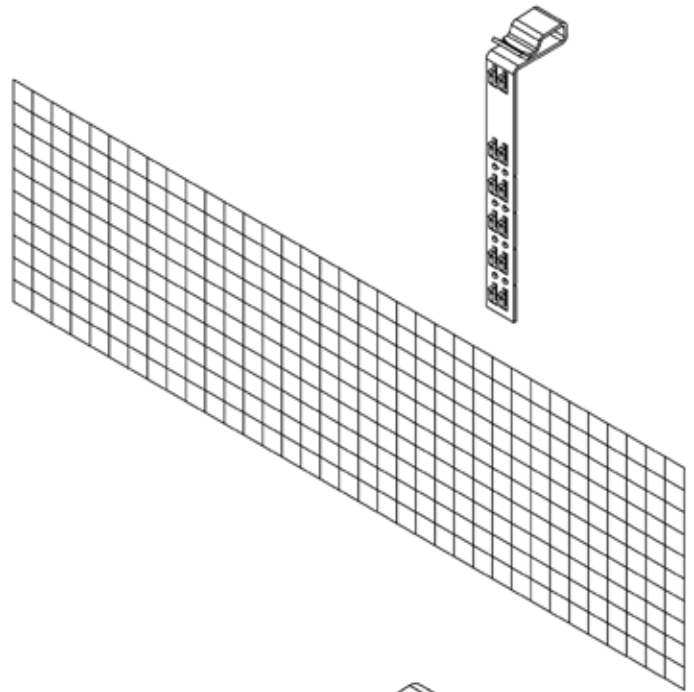
## Materials Included - Array Edge Screen

- 1) SnapNrack Array Edge Screen Clip
- 2) 1) SnapNrack Array Edge Screen

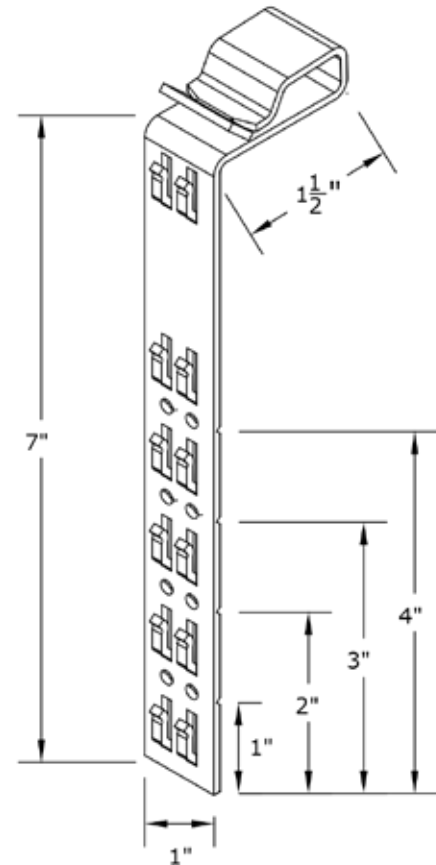


### Application Note:

Install to prevent animals from getting under the array and causing problems such as chewing on wires, or prevent leaves and other debris from collecting.



Dimensioned Array Edge Screen Assembly



Dimensioned Array Edge Screen Clip (8" Clip Shown)

## INSTALLATION INSTRUCTIONS



1) Measure required height of Array Edge Screen to determine which notch the clip will need to be broken off at.



2) Use pliers to break the Array Edge Screen Clip at the appropriate length.



3) Clip the Array Edge Screen Clip to the lip on the underside of the modules around the area that the edge screen will be installed.

### Install Note:

Screen designed to extend below bottom edge of clip.

### Install Note:

Recommended spacing of clips is 3'-0" on center and within 6" from the corners of the array.



4) Slide the Array Edge Screen into the hooks on the Edge Screen Clips and repeat for all locations around the array.

### Install Note:

If necessary, trim Array Edge Screen to desired height using wire cutters.



### Note:

Add-A-Lip Box Frame Adapters are available from SnapNrack for modules with frames that do not have a lip on the underside to receive clip.

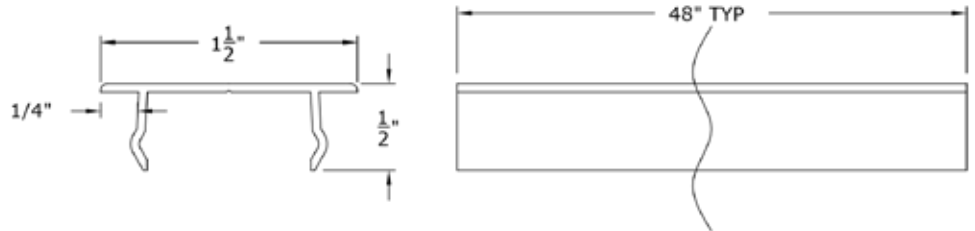
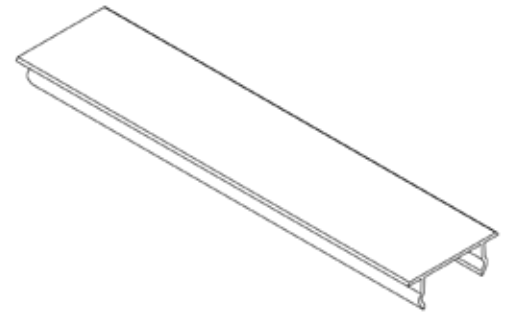
## Required Tools

- Reciprocating Saw or Chop Saw

## Materials Included - Rail Cover

- ① (1) SnapNrack 48" Rail Cover

**Application Note:**  
Install to protect any conductors that are exposed to sunlight that are not approved for use in UV light.



Dimensioned 48" Rail Cover

## Materials Included - Wire Retention Clip

- ① SnapNrack Wire Retention Clip



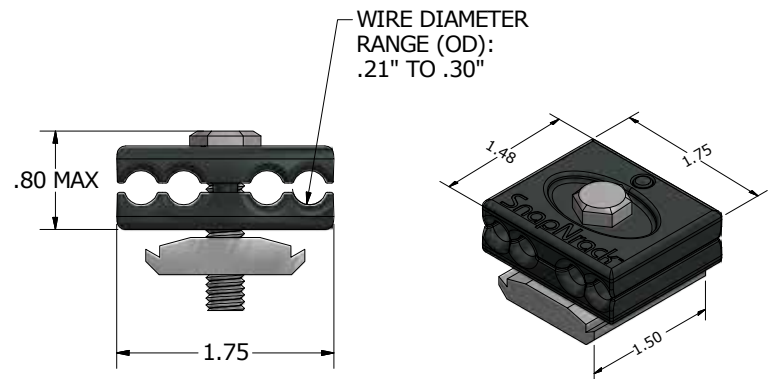
Dimensioned Wire Retention Clip

**Application Note:**  
Install as necessary to manage and safely retain conductors within SnapNrack rails.

## Materials Included - Wire Clamp

- ① (1) SnapNrack 4-Wire Clamp or Trunk Cable Clamp

**Application Note:**  
Install as necessary to secure cables and conductors running from rail to rail, or transitioning out/in from a rail channel

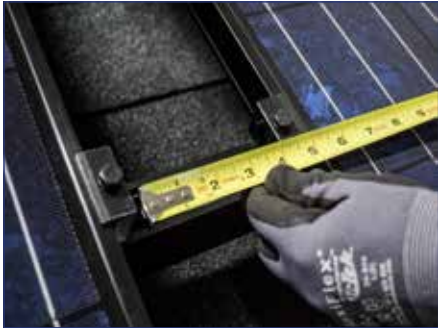


Dimensioned 4-Wire Clamp Assembly



## INSTALLATION INSTRUCTIONS

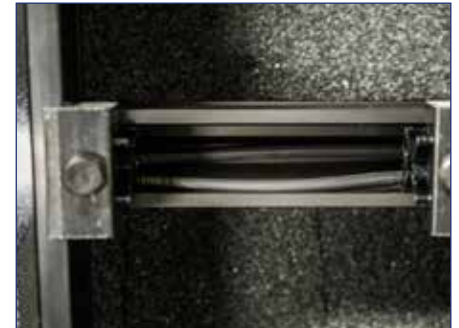
### SnapNrack 48" Rail Cover



1) Measure the length of the SnapNrack 48" Rail Cover that is needed.



2) Cut the rail cover to length.



3) Place all electrical conductors in the bottom of the rail channel.



4) Snap Rail Cover into place, enclosing all conductors inside of rail channel.

#### Install Note:

SnapNrack Rail Cover is designed to stay in place once installed, use a flat blade screw driver if it needs to be relocated or removed.

## INSTALLATION INSTRUCTIONS

### SnapNrack Wire Retention Clip



1) Place all electrical conductors in the bottom of the rail channel.



2) Install the Wire Retention Clip by snapping it into place on the rail.

### SnapNrack 4-Wire or Trunk Cable Clamp



1) Snap Clamp into top or side rail channel.



2) With Wire Clamp loose, place conductors or cables in slots.



3) Tighten Wire Clamp with 1/2" socket, ensure cables and conductors are aligned in the clamp slots.



Install Note:

Clamps can be rotated and oriented in any direction.



4) 4-Wire Clamp intended for PV Wire conductors, Trunk Cable Clamp intended for trunk cable.



## Required Tools

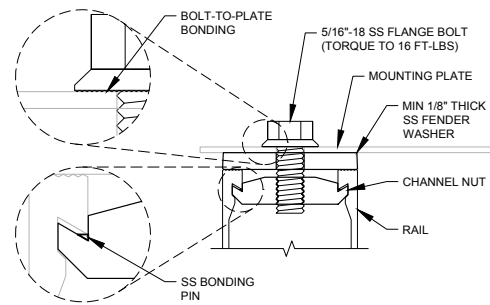
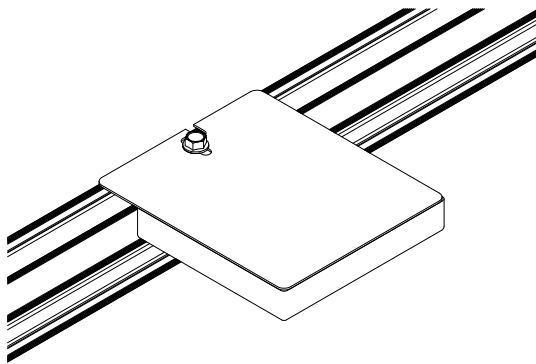
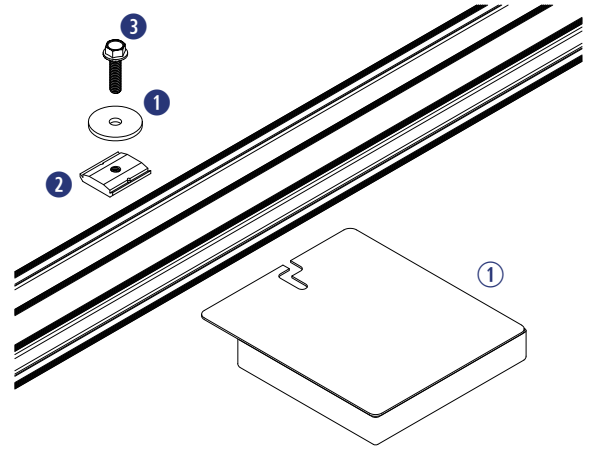
- Torque Wrench
- Socket Wrench
- 1/2" Socket

## Materials Included - MLPE Rail Attachment Kit

- ① (1) 5/16" X 1-1/2" X 0.125" SS Fender Washer
- ② (1) SnapNrack Channel Nut
- ③ (1) 5/16"-18 X 1-1/4" SS Flange Bolt

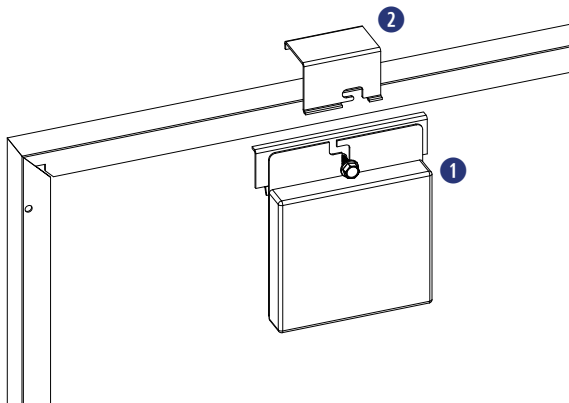
## Other Materials Required

- ① (1) MLPE Unit



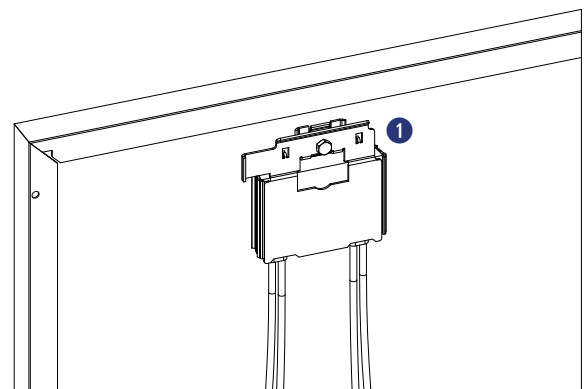
## Materials Needed - Enphase Frame Mount

- ① (1) Enphase Microinverter
- ② (1) Enphase Frame Mount



## Materials Needed - SolarEdge Frame Mount

- ① (1) SolarEdge Optimizer w/ Frame-Mounted Module Add-On



## INSTALLATION INSTRUCTIONS - MLPE RAIL ATTACHMENT



1) Snap the SnapRack MLPE Rail Attachment Kit channel nut into the desired location on the rail where the microinverter will be installed.



2) Install the microinverter mounting plate onto the bolt of the MLPE Rail Attachment Kit, ensuring that the large fender washer is between the rail and mounting plate.

### Install Note:

Bolt and washers may need to be removed and then replaced.



3) Tighten hardware to 10 ft-lbs.

### Install Note:

MLPE Attachment Kits are approved for bolt lengths between 1" and 1-1/2" long.

## INSTALLATION INSTRUCTIONS - SOLAREGE FRAME MOUNT



1) Locate the SolarEdge optimizer with Frame-Mounted Module Add-On at a location on the module frame that will not interfere with the SnapRack rail.



2) Install the optimizer mounting plate onto the module frame and tighten hardware to 7 ft-lbs.



3) Connect the module leads to the input connectors on the optimizer.

### Install Note:

Refer to the SolarEdge optimizer Frame-Mounted Module Add-On installation guide for additional instructions.

## INSTALLATION INSTRUCTIONS - ENPHASE FRAME MOUNT



1) Locate the Enphase Frame Mount bracket clamp at a location on the module frame that will not interfere with the SnapNrack rail.



2) Slide the microinverter unit onto the bracket clamp, then move it slightly to the left.



3) Tighten hardware to 13 ft-lbs



### Install Note:

The microinverter mounting flange should be on the outside of the module frame.



4) Connect the module leads to the microinverter DC connectors.

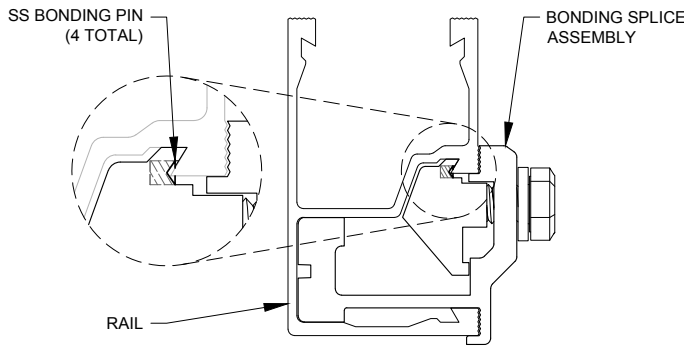
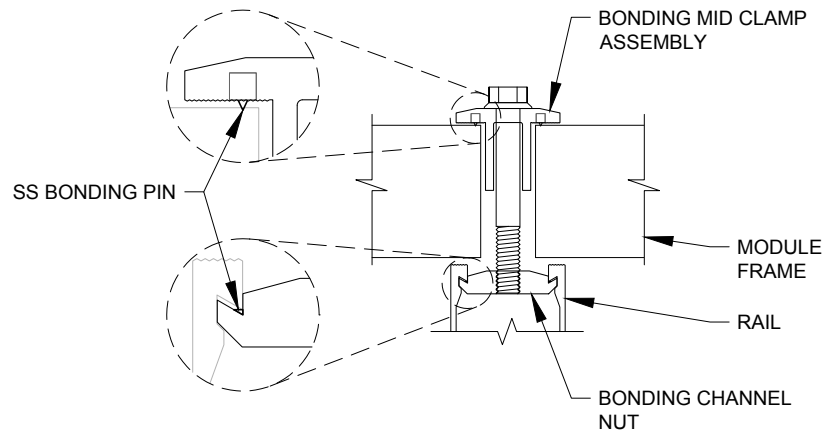


### Install Note:

Refer to the Enphase Frame Mount installation guide for additional instructions.

## System Bonding Methods

- 1 SnapNrack Mid Clamp
- 2 SnapNrack Adjustable End Clamp
- 3 SnapNrack Standard Rail Splice



Note:

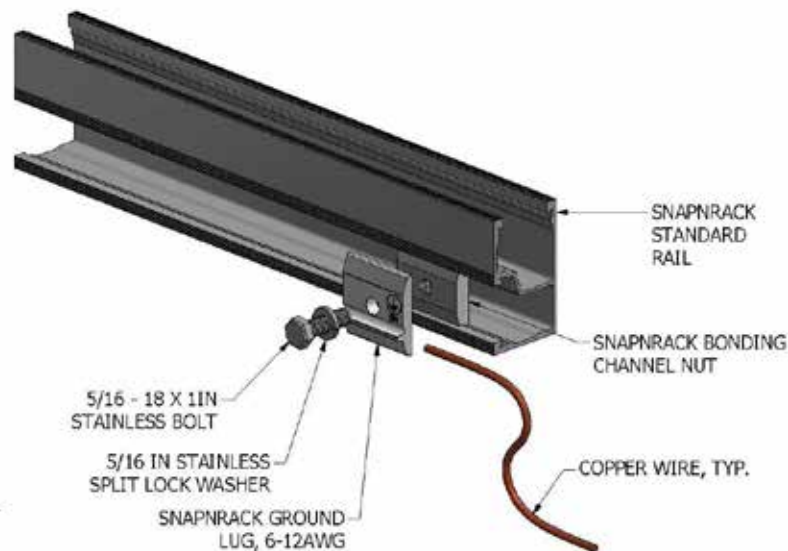
SnapNrack module clamps contain a SnapNrack Channel Nut with integral bonding pins in assembly to properly bond the system (except Universal End Clamps).



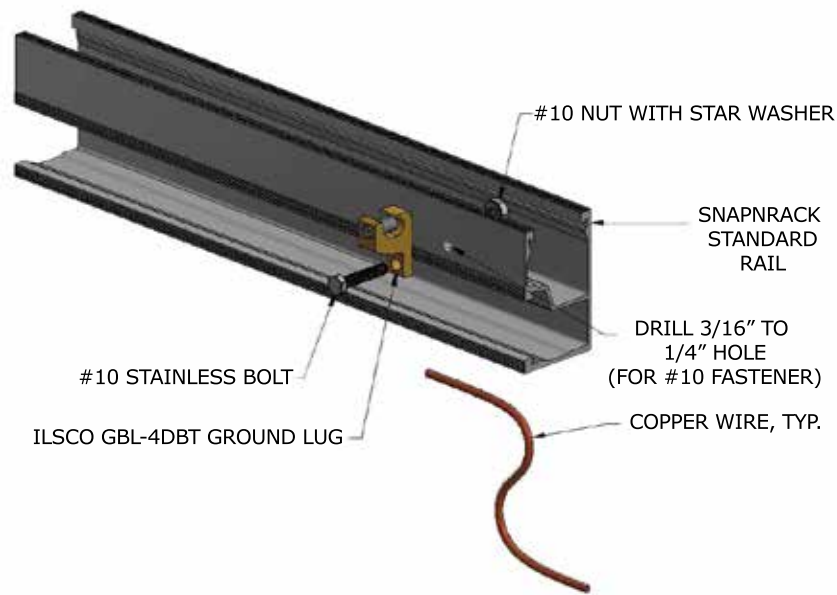
Note:

SnapNrack rail splices contain an insert with integral bonding pins in assembly to properly bond the system.

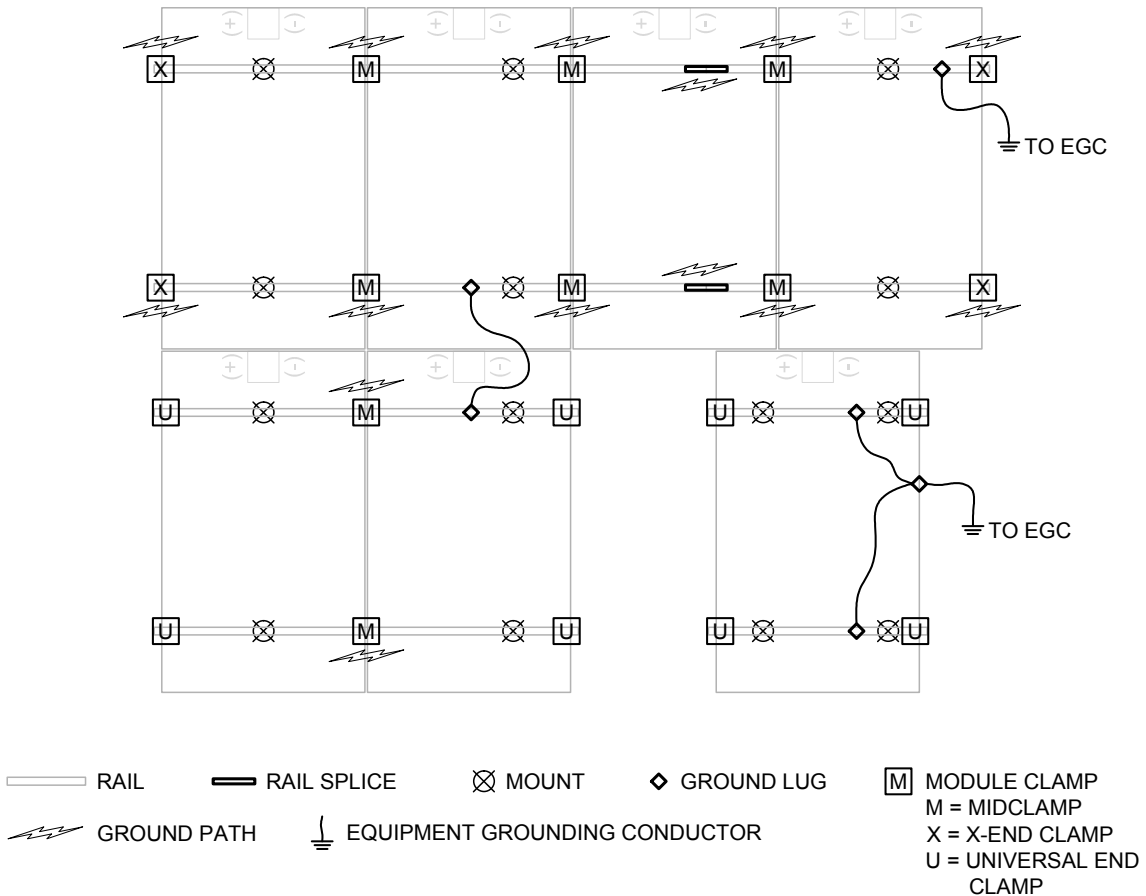
## SnapNrack Ground Lug Assembly



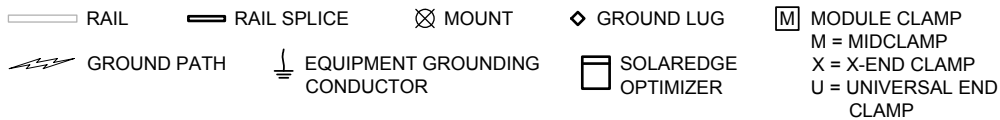
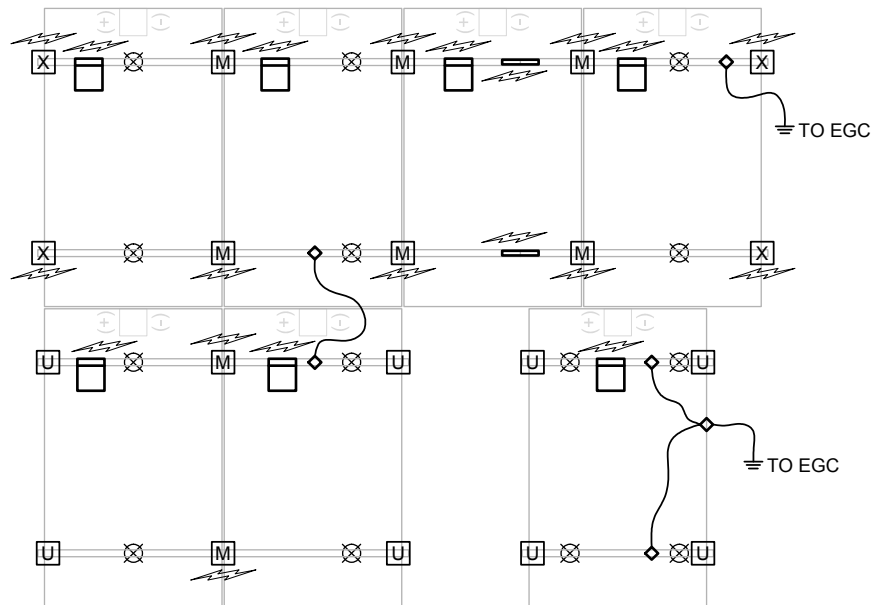
## IlSCO Lay-in Lug Assembly



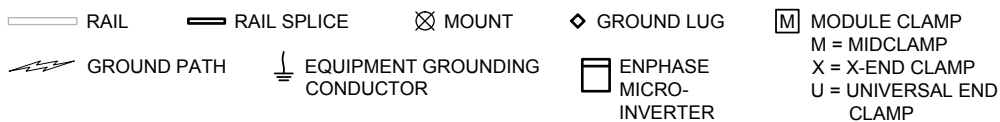
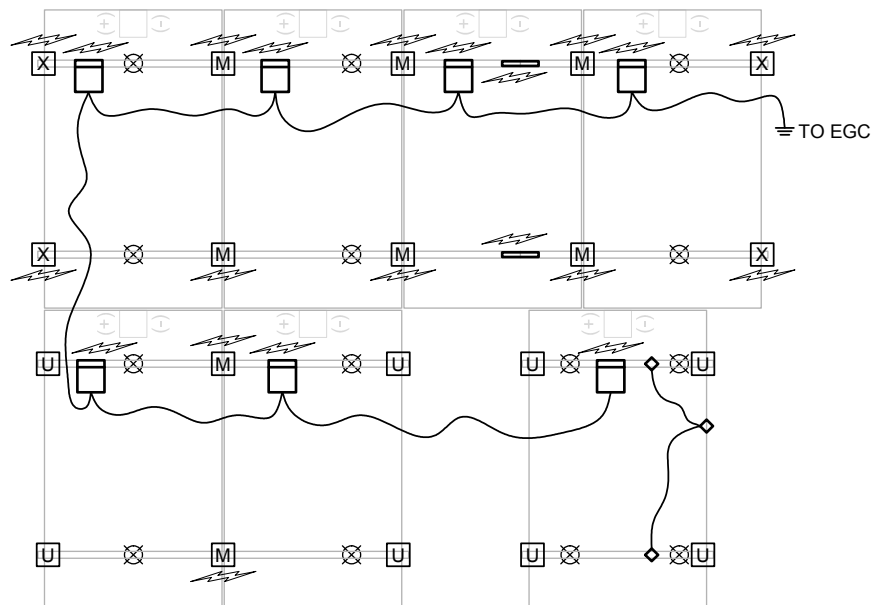
## Ground Path Details



## Ground Path Details - SolarEdge



## Ground Path Details - Enphase





## INSTALLATION INSTRUCTIONS

### SnapNrack Ground Lug



1) Snap the SnapNrack Ground Lug into the rail channel on one rail per module row.



2) Place grounding conductor into slot underneath split ring washer.



3) Tighten all hardware to a minimum of 16 ft-lbs.



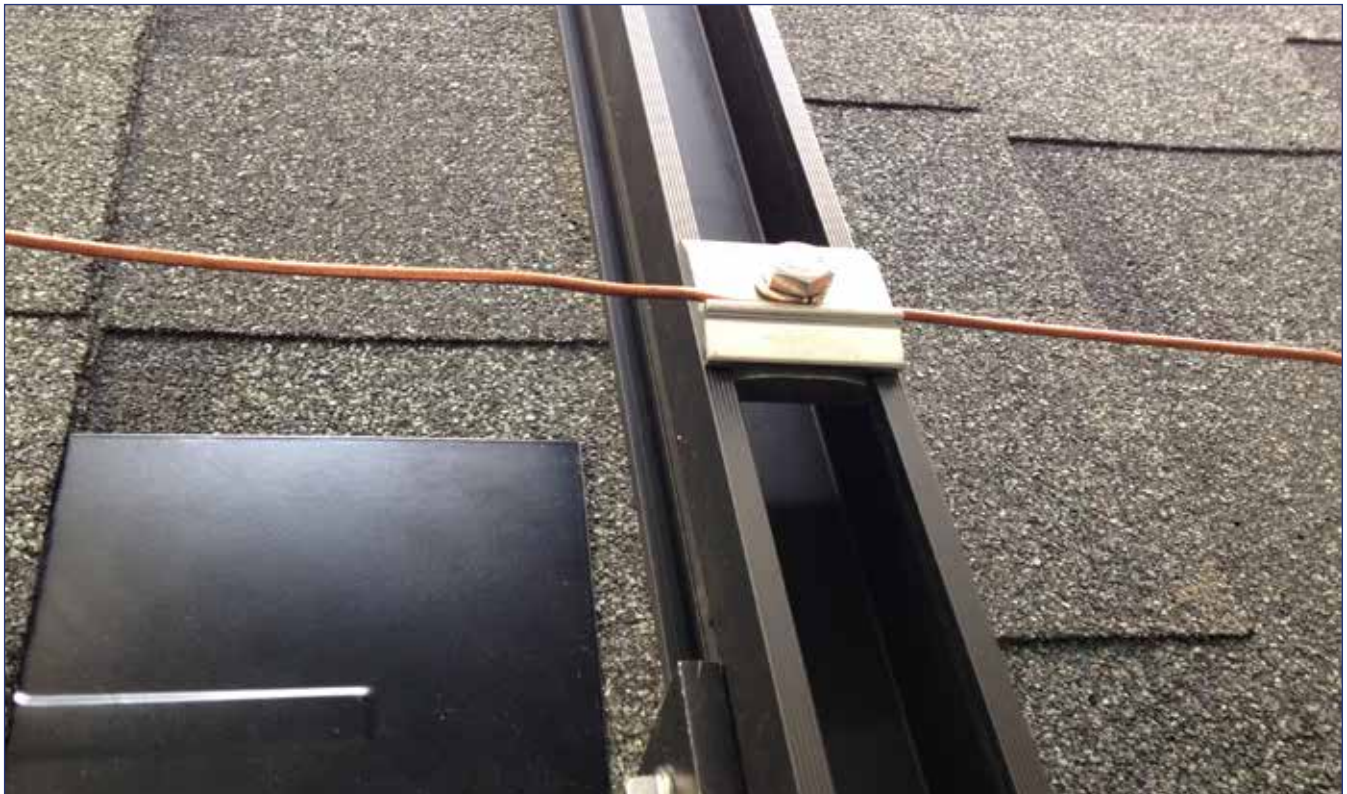
#### Install Note:

SnapNrack Ground Lug may be used in side or top channel, and may be rotated 90 degrees relative to slot to facilitate running copper across top of rails.



#### Install Note:

SnapNrack Ground Lug only Listed for use with 6-12 AWG solid copper conductor.



## INSTALLATION INSTRUCTIONS

### IlSCO Lay-In Lug



1) Drill and deburr a 1/4" hole in the back side of the rail for the IlSCO lug to attach to, place the bolt through the hole, and attach the lug assembly on one rail per module row.



#### Install Note:

Torque rail connection to 5 ft-lbs.



2) Place grounding conductor into slot.



3) Tighten set screw per IlSCO's recommendation (see below).



#### Install Note:

Torque set screw to 20 in-lbs for #10-#14 solid and stranded copper, 25 in-lbs for #8 stranded copper, and 35 in-lbs for #4-#6 stranded copper.



#### Note:

- System has been evaluated to a maximum overcurrent device (OCD) protection level of 20 Amps.
- Universal End Clamp (UEC) does not bond module to rail. Be sure to separately ground any modules that are only secured by UECs, especially during servicing.
- SnapNrack recommends that bare copper never come into contact with aluminum.
- SnapNrack Ground Lug: torque bolt to 16 ft-lbs. The Ground Lug may be used in side or top channel. It may be rotated 90 degrees relative to slot to facilitate running copper across top of rails.
- Grounding with a standard IlSCO GBL-4DBT Lug is a listed alternate and requires drilling of a hole in the rail.
- Hardware connection to rail: 5 ft-lbs. Torque for lug set screw: #10-#14 solid and stranded copper- 20 in-lbs, #8 stranded copper- 25 in-lbs, #4-#6 stranded copper- 35 in-lbs.

**Series 100 has been tested with the following UL Listed modules:**

The Series 100 System employs top-down clamps which have been evaluated for frame-to-system bonding, at specific mounting torques and with the specific modules listed below. The system has been assessed to a maximum Over-Current Device (OCD) protection level of 20 amps. The UL file number is included in parentheses below.

Hyundai Heavy Industries Co Ltd (E325005): HiS-MXXXRG Series where XXX is 235 to 275; HiS-SXXXRG where XXX is 245 to 295; HiS-SXXXRW where XXX is 250 to 265; HiS-MXXXMG where XXX is 210 to 270; HiS-SXXXMG where XXX is 220 to 275. All may be followed by the suffix BK or blank.

Jinko Solar (E362479): Models JKMXXXP-60 where XXX is 200 to 275; JKMXXXP-72 where XXX is 250 to 330; JKMXXXM-60 where XXX is 200 to 280; JKMXXXM-72 where XXX is 250 to 320; JKMXXXPP-60 where XXX is 200 to 275; JKMXXXPP-72 where XXX is 250 to 330; JKMXXXP-60-V where XXX is 200 to 265; JKMXXXP-72-V where XXX is 250 to 325; JKMXXXPP-60-V where XXX is 200 to 275; JKMXXXPP-72-V where XXX is 250 to 330; JKMSXXXP-72 where XXX is 250 to 320; JKMXXXP-60-J4 where XXX is 200 to 275; JKMXXXP-60B-J4 where XXX is 200 to 275.

Kyocera (E467150): KU-60 1000 V Series - KUXXX, where XXX is 250 to 275, followed -6BCA, -6BFA, -6BPA, -6DCA, -6DFA, -6DPA, -6MCA, -6MPA, -6XCA, -6XPA, -6ZCA, -6ZPA, -6ZPB, -6ZCB, -6ZPC, -6ZCC, -6ZPD, -6ZCD, -6ZPE, 6ZCE, -6MPC, -6MCC, -6MPB or -6MCB; KU-80 1000 V Series - KUXXX, where XXX is 315 to 335, followed by -8BCA, -8BFA or -8BPA.

REC Solar AS (E308147): RECXXX, where XXX is 214 to 270, all may be followed by PE, PE(BLK), PE-US, PE-US(BLK), PEQ2 or PEQ3.

Renesola Jiangsu Ltd (E312637): JCXXM-24/Bb Series where XXX is 200 to 270; JCXXM-24/BBh Series where XXX is 235 to 270.

Suniva Inc (E333709): MVX-XXX-60-5-YYY where XXX is 235 to 265 and YYY is 701 or 7B1; OPT-XXX-60-4-YYY where XXX is 250 to 275 and YYY is 800 or 8B0.

Sunpower (E246423): Gen 3 or Gen 5 frame models SPR-YY-### where YY represents numbers 18, 19, 20 or 21, and ### represents any number from 365 to 310 and 274 to 233; Gen 3 or Gen 5 frame models SPR-EYY-### where YY represents numbers 18, 19, 20 or 21, and ### represents any number from 345 to 285 and 250 to 225.

Talesun Solar (E359349) - TP660P-XXX where XXX is 235 to 285; TP660M-XXX where XXX is 240 to 300; TP672P-XXX where XXX is 280 to 345; TP672M-XXX where XXX is 290 to 360.

Talesun Solar (E349638) - TP660P-XXX where XXX is 210 to 255; TP660M-XXX where XXX is 215 to 260; TP672P-XXX where XXX is 260 to 300; TP672M-XXX where XXX is 270 to 310; all may be followed by "B".

Trina Solar Ltd (E306515) - TSM-XXXPA05 where XXX is 215 to 260; TSM-XXXPA05.05 where XXX is 215 to 260; TSM-XXXPA05.08 where XXX is 215 to 260; TSM-XXXPD05 where XXX is 240 to 280; TSM-XXXPD05.05 where XXX is 240 to 280; TSM-XXXPD05.08 where XXX is 240 to 280. All may be followed by Black or White.

Yingli Energy (China) Co Ltd (E320066) - YLXXXP-29b where XXX is 215 to 260; YLXXXA-29b where XXX is 220 to 255.

## NRTL Listed PV Modules:

Canadian Solar: Models CS6P-XXX-P where XXX is 200 to 285; CS6P-XXX-M where XXX is 200 to 290; CS6P-XXX-P-SD where XXX is 240 to 285; CS6K-XXX-M where XXX is 240 to 305; CS6K-XXX-M-SD where XXX is 240 to 305; CS6K-XXX-P where XXX is 220 to 285; CS6K-XXX-P-SD where 220 to 285; CS6X-XXX-P where XXX is 250 to 345; CS6V-XXX-M where XXX is 215 to 225; CS6V-XXX-P where XXX is 250 to 255.

ET Solar: ET-P660XXXBB where XXX is 200 to 265; ET-P660XXXWB where XXX is 200 to 265; ET-P660XXXWW where XXX is 200 to 265; ET-P660XXXWWG where XXX is 235 to 265; P660XXXWB/WW where XXX is 200 to 265 and may be followed by WB or WW; P660XXXWWG where XXX is 240 to 250; M660XXXBB where XXX is 250 to 265; M660XXXWW where XXX is 200 to 270.

Hanwha Q Cells: Q.Pro BFR-G4-XXX where XXX is 205 to 295. Q.Pro BFR-G4.1-XXX where XXX is 245 to 295. Q.Plus BFG-G4-XXX where XXX is 255 to 280. Q.Plus BFG-G4.1-XXX where XXX is 270-280. Models Q.BASE-GY XXX, Q.PRO-GY XXX, Q.PLUS-GY XXX, Q.PRO BFR-GY XXX, Q.PLUS BFR-GY XXX, Q.PRO BLK-GY XXX, Q.PRO-GY/SC XXX, where Y is the generation number between 1.x and 9.x, where XXX is 205 to 295.

Hanwha SolarOne: Models HSL60P6-PB-X-YYYQ where X is 2 or 4, and YYY is 230 to 270, may be followed by additional suffixes.

JA Solar: Models JAP6-60-XXX/3BB where XXX is 235 to 265; JAM6-60-XXX/SI where XXX is 250 to 270.

LG Electronics Inc.: Models LGXXS1C-G4 where XXX is 250 to 300; LGXXN1K-G4 where XXX is 280 to 300; LGxxxN1C-G4 where XXX is 280 to 340; LGXXN2C-G4, LGXXN2W-G4, where XXX is 360 to 395; LGXXN2K-G4, where XXX is 360 to 385; LGXXS2C-G4, LGXXS2W-G4, where XXX is 300 to 360; LGXXN2C-B3, LGXXN2W-B3, where XXX is 330 to 400.

REC Solar PTE. LTD.: Models RECXXXPE Series where the XXX is 214 to 280; RECXXTP Series where XXX is 260 to 280; All may be followed by BLK; RECXXTP72, where XXX is 330 to 345; RECXXX, where XXX is 285 to 325, followed by PE72, PE72BLK, PE72 Q2 or PE72 Q3; RECXXXPE72XV, where XXX is 295 to 325, followed by PE72 XV, PE72 XV Q2 or PE72 XV Q3.

Silfab: SLAXXX-M, where XXX is 280 to 300; SLGXXX-M, where XXX is 335 to 360; SLAXXX-P, where XXX is 250 to 265; SLGXXX-P, where XXX is 300 to 315; SSAXXX-M, where XXX is 280 to 300; SSGXXX-M, where XXX is 335 to 360; SSAXXX-P, where XXX is 250 to 260; SSGXXX-P, where XXX is 300 to 315.

Solar World: Models SWXXX-Mono where XXX is 200 to 300; SWXXX-Mono XL where XXX is 320 to 350. All may be followed by Black.

Suniva Inc: OPTXXX-60-4-YYY where XXX is 240 to 300 and YYY is 100; OPTXXX-60-4-YYY where XXX is 235 to 300 and YYY is 1B0.

Trina Solar Ltd: Models TSM-XXXPD05.002 or TSM-XXXPD05.082 where XXX is 245 to 310; may be followed by Black.



# Mechanical Loading Specifications

The UL Listing covers mechanical load ratings for the following span lengths, module orientations and downforce, uplift, and down-slope ratings.

Mechanical Load Rating if system is using the following components:

Component	Span	Orientation	Direction	Load Rating (lb/ft <sup>2</sup> )	
Flashed L Foot (90 and 92 Deg)	4 feet	Long Side Mounting	Downforce	36.7	
			Uplift	35.4	
	Corrugated Roof Block	Short Side Mounting	Downforce	55.0	
			Uplift	32.5	
Metal Roof Base (with L Foot)	6 feet	Long Side Mounting	Downforce	25.0	
			Uplift	23.9	
Standard Seam Clamp	6 feet	Short Side Mounting	Downforce	30.0	
			Uplift	26.8	
Wide Seam Clamp	8 feet	Long Side Mounting	Downforce	20.0	
			Uplift	17.1	
	Wide Seam Clamp	8 feet	Short Side Mounting	Downforce	23.3
				Uplift	19.2
L Feet, Corrugated Roof Block, Metal Roof Base (L Foot)			Down-Slope	20.3	
Standard Seam Clamp, Wide Seam Clamp			Down-Slope	10.5	
Universal Tile Hook	4 feet	Long Side Mounting	Downforce	36.7	
			Uplift	22.2	
	Flat Tile Hook	6 feet	Short Side Mounting	Downforce	36.7
				Uplift	22.6
Flat Tile Hook	6 feet	Long Side Mounting	Downforce	20.0	
			Uplift	18.2	
	Flat Tile Hook	6 feet	Short Side Mounting	Downforce	26.7
				Uplift	17.1
			Down-Slope	18.5	
Standard Standoff, max 10" height	4 feet	Long Side Mounting	Downforce	53.3	
			Uplift	42.1	
	Four Hole Standoff, max 10" height	6 feet	Short Side Mounting	Downforce	60.0
				Uplift	32.5
Hanger Bolt Clamp	6 feet	Long Side Mounting	Downforce	40.0	
			Uplift	32.2	
Metal Roof Base (with Standoff)	6 feet	Short Side Mounting	Downforce	33.3	
			Uplift	29.5	
Heavy Duty Standoff, max 12" height	8 feet	Long Side Mounting	Downforce	26.7	
			Uplift	22.1	
	Heavy Duty Standoff, max 12" height	8 feet	Short Side Mounting	Downforce	30.0
				Uplift	24.2

Component	Span	Orientation	Direction	Load Rating (lb/ft <sup>2</sup> )
Standard Standoff, Hanger Bolt Clamp, Heavy Duty Standoff			Down-Slope	13
Four Hole Standoff, Metal Roof Base (Standoff)			Down-Slope	10.5

The following modules have been tested with Series 100 components, and may be used with all roof attachments in the following orientations up to the module load ratings or the system load rating, whichever is less:

Module Manufacturer	Rails Tested	Load Direction	Design Load (lb/ft <sup>2</sup> )
Hyundai Heavy Industries	Long Side Mounting	Downforce	75.5
		Uplift	53.3
	Short Side Mounting	Downforce	40.3
		Uplift	40.3
JA Solar	Long Side Mounting	Downforce	45.5
		Uplift	45.5
	Short Side Mounting	Downforce	40.3
		Uplift	40.3
Jinko Solar	Long Side Mounting	Downforce	75.5
		Uplift	53.3
	Short Side Mounting	Downforce	40.3
		Uplift	40.3
Renesola	Long Side Mounting	Downforce	75.4
		Uplift	53.7
	Short Side Mounting	Downforce	40.5
		Uplift	40.5
Trina Solar	Long Side Mounting	Downforce	75.5
		Uplift	53.3
	Short Side Mounting	Downforce	40.3
		Uplift	40.3
Yingli Solar	Long Side Mounting	Downforce	75.5
		Uplift	53.8
	Short Side Mounting	Downforce	40.0
		Uplift	40.0
Canadian Solar - CS6P Series	Long Side Mounting	Downforce	75.1
		Uplift	53.7
	Short Side Mounting	Downforce	40.4
		Uplift	40.4
Canadian Solar - CS6K Series	Long Side Mounting	Downforce	75.5
		Uplift	53.3
	Short Side Mounting	Downforce	40.3
		Uplift	40.3
ET Solar	Long Side Mounting	Downforce	75.4
		Uplift	53.7
	Short Side Mounting	Downforce	40.5
		Uplift	40.5



Module Manufacturer	Rails Tested	Load Direction	Load Rating (lb/ft <sup>2</sup> )
Hanwha Q-Cells	Long Side Mounting	Downforce	75.1
		Uplift	53.4
	Short Side Mounting	Downforce	40.0
		Uplift	40.0
LG Solar	Long Side Mounting	Downforce	75.4
		Uplift	53.8
	Short Side Mounting	Downforce	40.2
		Uplift	40.2
Solarworld	Long Side Mounting	Downforce	75.3
		Uplift	32.1
	Short Side Mounting	Downforce	40.4
		Uplift	22.2
REC Solar	Long Side Mounting	Downforce	75.5
		Uplift	53.5
	Short Side Mounting	Downforce	33.8
		Uplift	33.8
Talesun	Long Side Mounting	Downforce	75.5
		Uplift	50.3
	Short Side Mounting	Downforce	40.0
		Uplift	40.0

## Series 100 has been tested with the following UL Listed modules:

The Series 100 System has been evaluated for mechanical loading for its top-down clamps with the specific modules listed below. The UL file number is included in parentheses below. *(The following modules were also evaluated for bonding. Please see Grounding Specifications section.)*

Hyundai Heavy Industries Co Ltd (E325005): HiS-MxxxRG Series where xxx is 235 to 275; HiS-SXXXXRG where XXX is 245 to 295; HiS-SXXXXRW where XXX is 250 to 265.

JA Solar (E328263): Models JAP6-60-XXX/3BB where XXX is 235 to 250.

Jinko Solar (E362479): Models JKMXXXXP-60 where XXX is 200 to 265; JKMXXXXM-60 where XXX is 200 to 265; JKMXXXXPP-60 where XXX is 200 to 265; JKMXXXXP-60-J4 where XXX is 200 to 265; JKMXXXXP-60B-J4 where XXX is 200 to 265.

ReneSola (E312637): Models JCXXXXM-24/Bbh where XXX is 235 to 270.

Trina Solar (E306515): Models TSM-XXXXPD05, TSM-XXXXPD05.05 and TSM-XXXXPD05.08, where XXX 240 to 280.

Yingli Solar (E357540): Models YLXXXXP-29b where XXX is 215 to 265.

## NRTL Listed PV Modules:

Canadian Solar: Models CS6P-XXXXP where XXX is 200 to 285; CS6P-XXX-P-SD where XXX is 240 to 285; CS6P-XXX-M where XXX is 200 to 290; CS6K-XXX-M where XXX is 240 to 305; CS6K-XXX-M-SD where XXX is 240 to 305; CS6K-XXX-P where XXX is 220 to 285; CS6K-XXX-P-SD where 220 to 285.

ET Solar: Models ET-P660XXXBB where XXX is 200 to 265; ET-P660XXXWB where XXX is 200 to 265; ET-P660XXXWW where XXX is 200 to 265; ET-P660XXXWWG where XXX is 235 to 265.

Hanwah Q Cells: Q.Pro BFR-G4-XXX where XXX is 205 to 295. Q.Pro BFR-G4.1-XXX where XXX is 245 to 295. Q.Plus BFR-G4-XXX where XXX is 255-265. Q.Plus BFR-G4.1-XXX where XXX is 270 to 280.

LG Electronics: Models LGxxxN1C-G4 where xxx is 280 to 340; LGXXXS1C-G4 where XXX is 250 to 300; LGXXXN1K-G4 where XXX is 280 to 330.

REC Solar PTE, LTD: Models RECxxxPE or RECXXXPE-BLK Series where XXX is 214 to 270; RECxxxTP RECXXXTTP-BLK Series, where the xxx is 260 to 290.

SolarWorld: Models SW XXX mono where XXX is 200 to 300, may additionally be followed by “black”.

Talesun: Models TP660P-XXX where XXX is 215 to 285; TP660M-XXX where XXX is 210 to 300.