



SnapNrack™

PV MOUNTING SYSTEM
ROOF MOUNT



CODE COMPLIANT
INSTALLATION
MANUAL | 2010-11

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1. Introduction

1.1 Overview of the SnapNrack System

SnapNrack PV Mounting System offers a low profile, visually appealing, photovoltaic (PV) module installation system called SnapNrack. This innovative system simplifies the process of installing solar PV modules, shortens install 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 building code and the International Building Code.

The SnapNrack installation system is a set of engineered components that can be assembled into a wide variety of PV 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.



1.2 Overview of this Manual

This manual describes the installation procedures for standard roof mounting for common photovoltaic (PV) arrays. It guides you through the correct procedures for mounting the SnapNrack PV module racking system on the major types of roof structures and materials. It also provides layout and installation tips and directions.

Review this entire manual before installing the SnapNrack system.

Throughout this manual you will see highlighted notes which will provide you with different types of information:

 **NOTICES** indicate important information to help with the installation or to avoid potential damage to the structure or components.

 **CAUTIONS** indicate a potential for property damage, personal injury, or death.

For help with your installation, call SnapNrack technical support. Visit www.snapnrack.com and click Contact in the top menu bar.

For information on Ground Mount installation procedures, refer to SnapNrack Ground Mount Installation Manual. It can be downloaded from www.snapnrack.com

1.3 Your responsibility as installer

Comply with all applicable local or national building codes, including any that may supersede this manual.

- Make sure that the SnapNrack components and other products are appropriate for the particular installation and the installation environment.
- Make sure that the roof, its rafters, connections, and other structural members can support the array in compliance with all applicable code requirements.
- Use only SnapNrack parts and components.
- Make sure that lag screws or roof attachment fasteners are properly and securely attached to the roof rafters or structural members and that roof members are structurally sound.

- Maintain the waterproof integrity of the roof, including the proper use of roofing sealant and selection of appropriate flashings for post type installations (see section 4 for flush-mount installations using standoffs and section 5.4 for tilted installations using standoffs).



Note: L-foot type mounting assembly includes flashing material.

-
- Ensure safe installation of all electrical aspects of the PV array.



All installers working on any roof surface must always follow necessary and applicable precautions for working in a rooftop environment including maintaining a secure attachment to a regulation fall protection safety harness that conforms to OSHA standards.



If it is raining, or if you anticipate any potentially dangerous conditions, do not proceed with the installation.



All tools and equipment used on the roof should be secured to avoid falling object hazards.



All equipment should be properly maintained and inspected prior to use.



Any exposed studs should be protectively capped to help avoid injury.

1.4 Support

For help with your installation, call technical support. Visit www.snapnrack.com and click Contact in the top menu bar.

2. Prepare for the installation

2.1 Identify type of roof

Roofs on residential buildings are constructed primarily of three types of material: asphalt shingles (commonly known as composition shingles), tile or slate (which we will refer to as tile), and wood or shake shingles (which we will refer to as shake).

PV array installations on composition roof surfaces using the SnapNrack flashed L-foot components as described in section 3, offers the quickest and easiest SnapNrack installation solution.

Installations on tile or shake roofs, or thicker composition roofs that exceed a typical 1/8-inch material thickness (often called presidential composition), should not use SnapNrack L-feet and should instead use standoffs as described in section 4.

Installation of PV arrays tilted at an angle to the roof surface is described in section 5.

✓ **Sometimes stainless steel hardware has a tendency to seize up when it is exposed to sunlight and gets hot. To reduce the possibility of seizing, apply lubricant to bolts, shade the hardware prior to installation, and avoid spinning on nuts at high speed.**

2.2 Identify SnapNrack components

Make sure you have all the necessary SnapNrack system components — shown below — needed to complete the installation.



Snap-in channel nut



Rails - black or silver



Rail splice assembly - snap-in insert and top piece



L-foot assembly —base, L-foot, stamped steel flashing



Standoff assembly —base and standoffshaft (various lengths)



Leveling spacer — 1 inch



Universal end clamp (UEC)



Module mid clamp assembly



Standard module end clamp assembly

2.3 Obtain installer supplied tools and materials

Make sure you have all the necessary additional hardware components, tools, and other material that are needed to complete the installation. These include:

- Appropriate roof flashings for standoff installations
- Lag bolts and washers for roof attachments
- Waterproof roofing sealant (such as Rainbuster) in a color to match the color of the roof
- ½-inch box / open end wrench
- 3/8-inch ratchet wrench with ½-inch socket and short extension
- 3/8-inch torque wrench
- Power drill with 3/16-inch x 6-inch and 12-inch drill bits for lag bolt pilot holes
- 5/32-inch Allen key for leveling spacers on standoffs
- Tools for attaching grounding hardware
- Reciprocating saw (such as a Sawzall or miter box) with correct blade for trimming non-ferrous metal rails
- Metal file for finishing trimmed rails
- Chalk line and grease pens (in two or three different colors) for marking mounting locations on the roof material
- Tape measure
- Flat pry bar
- Structural plans for the building when available

2.4 Survey the site

- Measure the roof surfaces and develop an accurate drawing of the roof and any obstacles such as chimneys and roof vents.
- If plans are available, check to make sure that the plans match the final structure.
- Review the shading pattern across the roof surface from the residence itself, from adjacent structures, and from other nearby features such as trees.
- Identify any roof access areas or keep-out areas as required by the local jurisdiction.
- Confirm roof construction, type, and condition.
- Assess roof rafter size, material, and span to confirm that the structure is sound and can support the additional load of the array.
- Identify any construction anomalies that may complicate the process of locating rafters from the roof surface.
- Measure the spacing between the rafters.
- If you find structural problems such as termite damage or cracked rafters that may compromise the structure's integrity, consult a structural engineer.

Determine the design wind speed and site specific conditions for the site and reference the structural engineering tables (see section 11: Appendix) to determine the maximum allowable rail span for this site.

If you are unsure about the local design wind speed, consult with the local building jurisdiction.

2.5 Lay out system on the roof

Using the information collected in the site survey, complete a system layout showing array location and distances from key roof features. Include any information necessary for the permitting process.

The following definitions are used to describe array layout designs:

- Module length—the measurement along the longest side of the module frame
- Module width—the measurement along the shorter side of the module frame
- Module thickness—the measurement of the thickness of the module

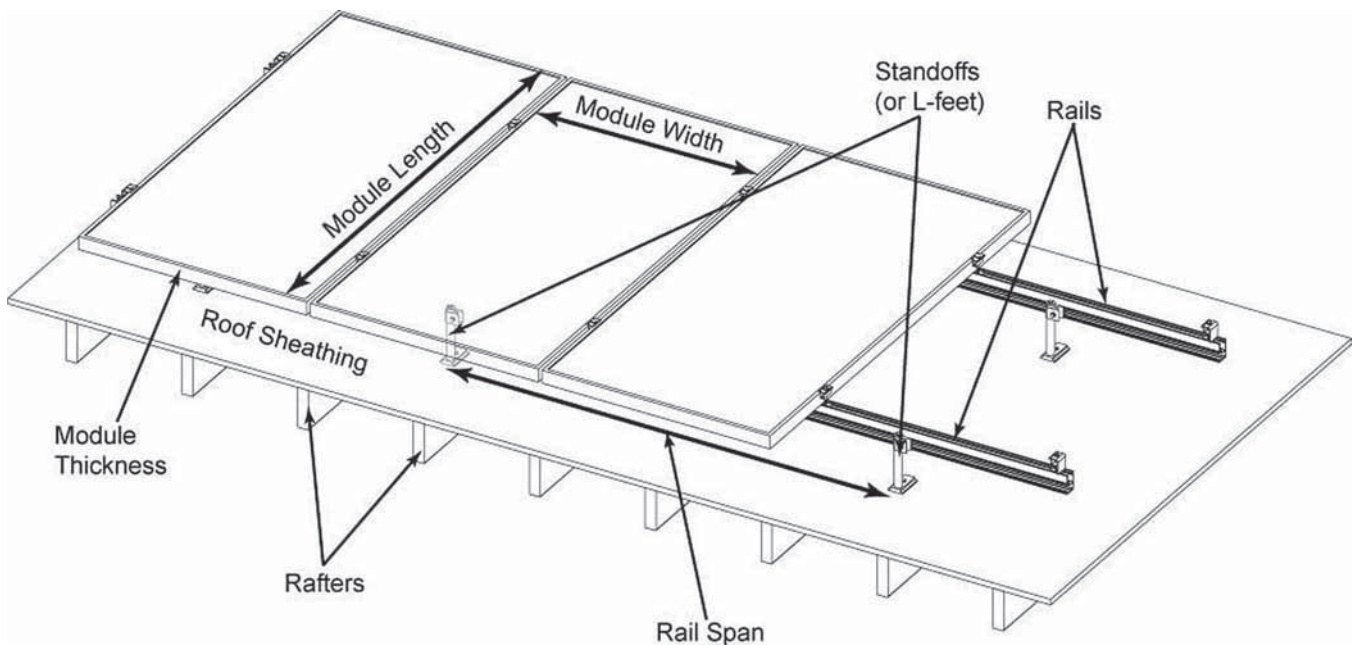


DIAGRAM 1: Layout of PV modules showing rail span

Typically, PV modules are installed in portrait mode, with the long side of the module running up the roof slope and the rails running horizontally across the roof perpendicular to the roof rafters, which commonly run down slope.

Arrays can also be installed in landscape

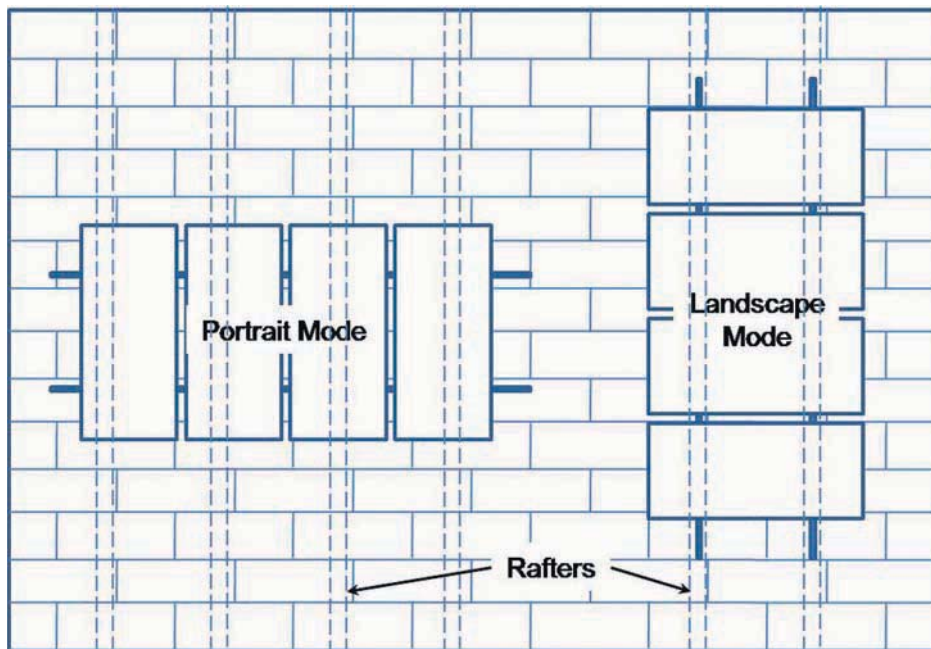
Module mid clamps (see photo on page 7) are installed between modules in a row and require a half inch of space between the modules.

Standard module end clamps (see photo on page 7) require 1½ inches of extra rail to extend past the end of the module

frame. If using the UEC (universal end clamp) this does not apply.

The space between rows of modules is not critical, but it is common for rows of modules to be installed so that the modules are flush with each other.

Submit array plans to local permitting



mode, with the modules oriented so that their long edge runs horizontally across the roof and the rails run up the roof slope.

Landscape mode is typically used in cases where the roof has been constructed with structural elements running horizontally across the roof, but can also be used on standard residential buildings for a variety of reasons including to facilitate a convenient layout.

When laying out the array, be sure to leave space for the module clamps on the rails.

jurisdiction and proceed with the roof layout only when all permits for the project have been granted by the authority having jurisdiction.



CAUTION: If possible leave at least 3 to 4 feet around the outside edges of the array to enable safe access during the installation and during maintenance and cleaning.

Transfer the array layout to the roof using grease pens to mark the inside and outside corners of the array.

Locate estimated rafter positions and mark them in the array area with a different color grease pen.

✓ **Common techniques for locating rafters include looking under the eaves, measuring from the ends of the roof, using attic access, and using electronic stud and rafter finders.**

Transfer rail and estimated attachment locations to the roof, noting that attachments will be located at intersections of rails and rafters.

Layout rails such that module frame ends do not overhang mounting rails by more than 25% of total module frame length.

Verify that mounting rail spans are in accordance with the rail span tables in the Appendix at the back of this manual (section 11).

Verify that rail ends do not overhang by a distance greater than 30% of the acceptable rail span specified in the same table.

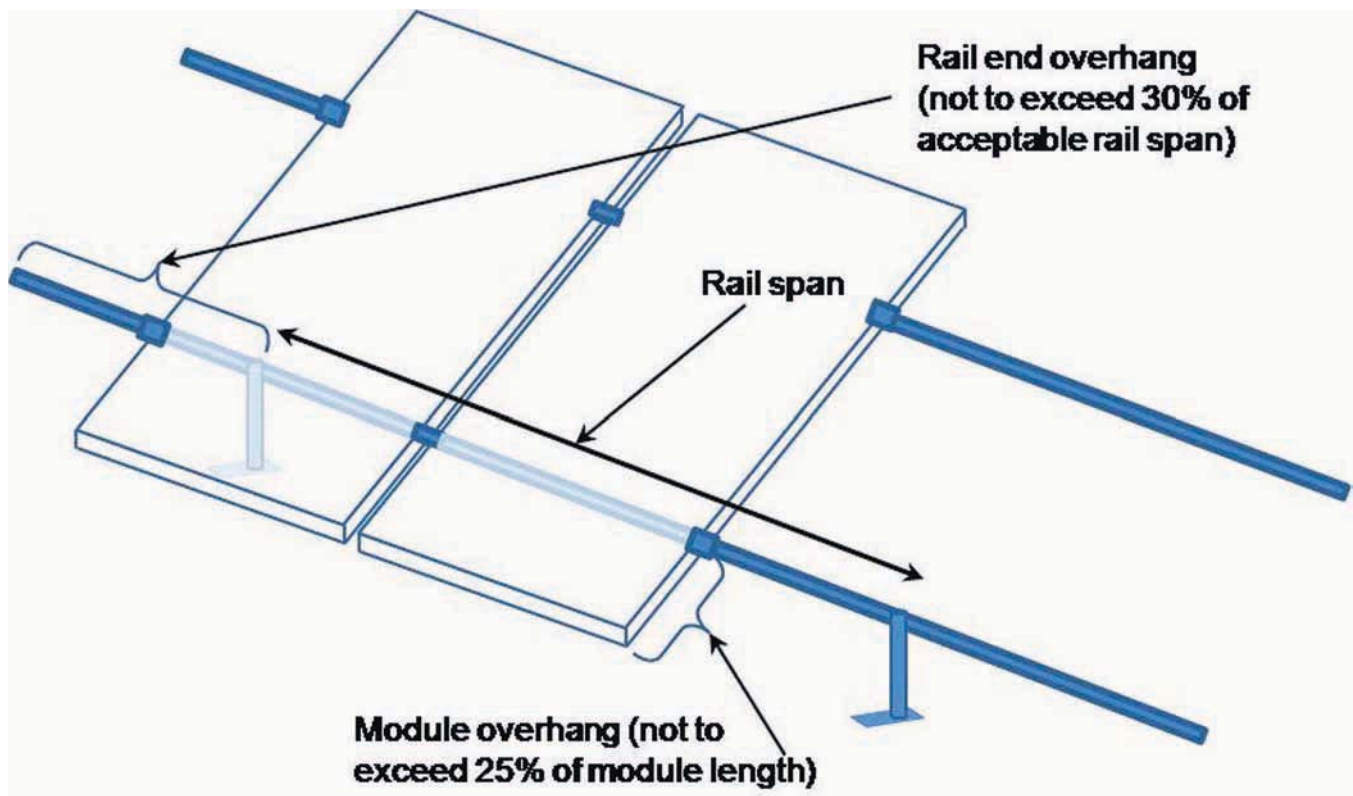


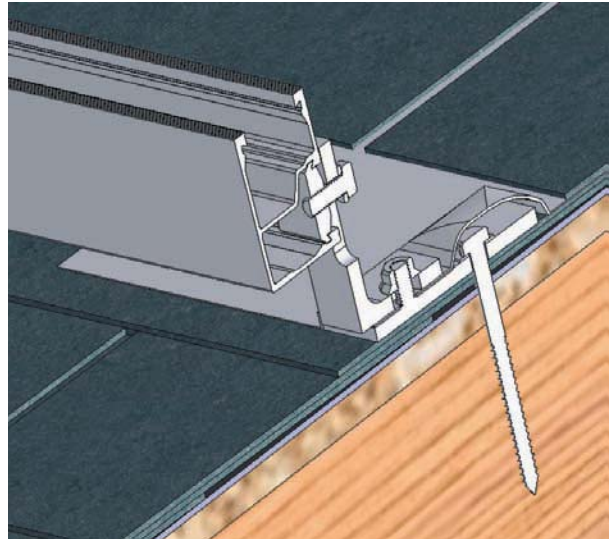
DIAGRAM 2: Location of rail end overhang and module overhang

3. Flush mount on composition roofs (using L-feet)

3.1 Introduction

Typically, using flashed L-feet to mount PV modules enables a faster and simpler installation than using standoffs, but the L-foot type of mount can only be used on composition roofs. Installations on shake and tile roof surfaces, as well as thicker composition roofs (that is, thicker than 1/8 inch), require the use of standoffs and standard flashings.

For installations using standoffs, see section 4. For installations where the PV modules will be installed tilted at an angle to the roof surface, see section 5.



Flashed L-foot section view

3.2 Locate attachment points

The location of the attachment points for L-foot mounts depends on the orientation of the modules relative to the rafters as shown in this diagram.

Using the array layout plans and the estimated rafter locations, as described in the previous section 2.5. Determine location of all attachment points and mark the holes for each L-foot base.

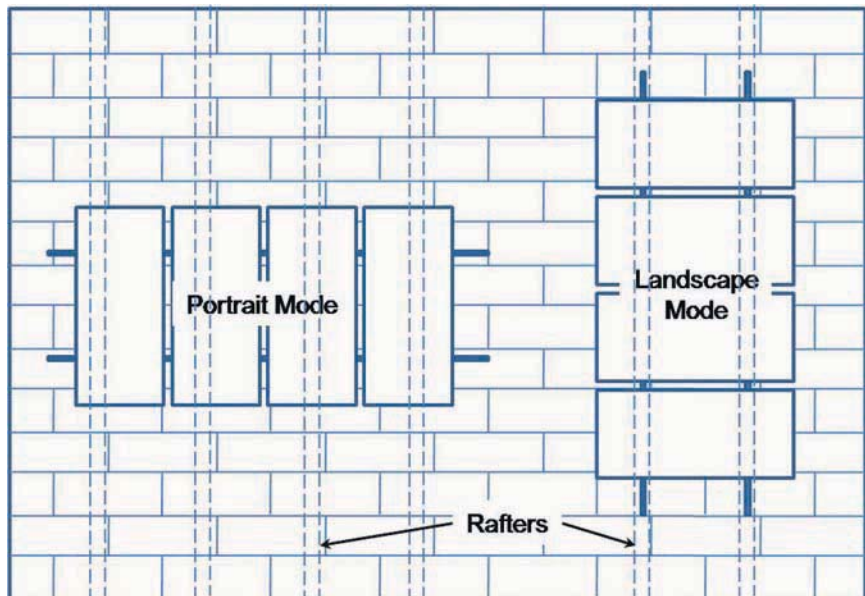


DIAGRAM 3: PV module orientation relative to rafters

3.3 Drill pilot holes

Confirm the location of the rafters by drilling pilot holes into the roof at each of the identified attachment points with a 3/16-inch pilot drill.

Be sure to drill the hole deep enough to penetrate the roof decking and enter the rafter by 1 to 1½ inches. If the *drill pushes through* at this point, you have likely missed the rafter and should move ½ inch laterally toward where you estimate the rafter to be and try again.

See diagram 4 for L-foot mount assembly details.



Drill pilot holes

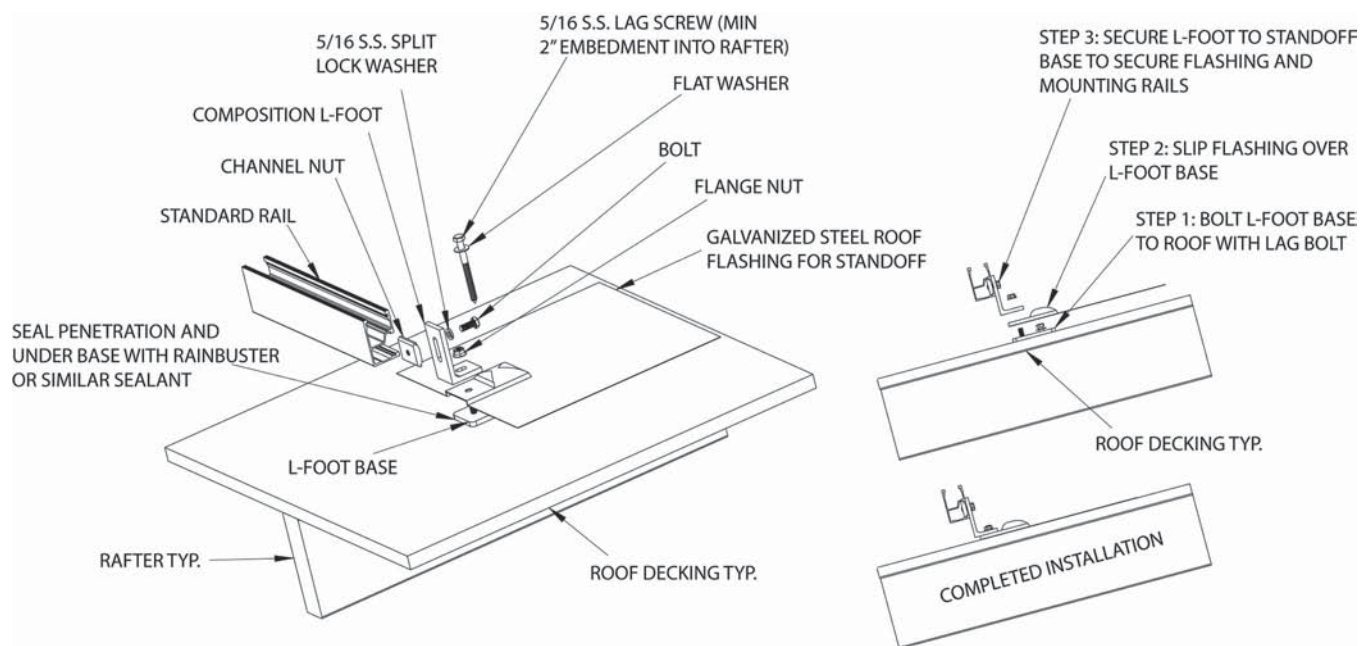


DIAGRAM 4: L-foot mount assembly

3.4 Secure base

Apply a bead of sealant to the underside of the L-foot base and into pilot hole.

Screw 5/16-inch lag bolts with lag bolt washers into the pilot holes and tighten with a ½-inch socket. Using a socket adapter bit in a power driver is a common method.

Make sure the lag bolts used are long enough to embed a minimum of 2 inches into the rafter to secure the L-foot base to the roof. Refer to the lag bolt pullout chart for appropriate embedment.



The required lag bolt length is based on the roof thickness as measured during the site evaluation.



Check that the lag bolts are secure with a socket and ratchet wrench.

If the bolt spins out, you didn't hit a rafter. Move ½ inch laterally towards where you estimate the rafter to be and try again starting with a new pilot hole.



L-foot base



Apply sealant and secure base to rafter

3.5 Install flashing

Insert the stamped-steel roof flashing over the L-foot base and underneath the upslope shingle.

-
- ✓ **Note:** the L-foot base is different from the standoff base described in section 4 of this manual. Make sure you are using the correct part for the type of roof on which you are installing the array. See photos of each type on page 7.
-

3.6 Attach L-foot

Using the provided 5/16" serrated flange nut to attach L-foot to L-foot base, securing the entire assembly to a rafter. Repeat this procedure for each L-foot base.

-
- ✓ The orientation of the L-foot on top of the L-foot base is not critical and can be varied based on installer preference.
-
- ✓ Check all bolt torques to ensure that all 5/16-inch hardware is tightened to 12 ft-lbs.
-

After installing all L-feet, go to section 6.



Install flashing



Secure L-foot to base



Installed L-foot assembly

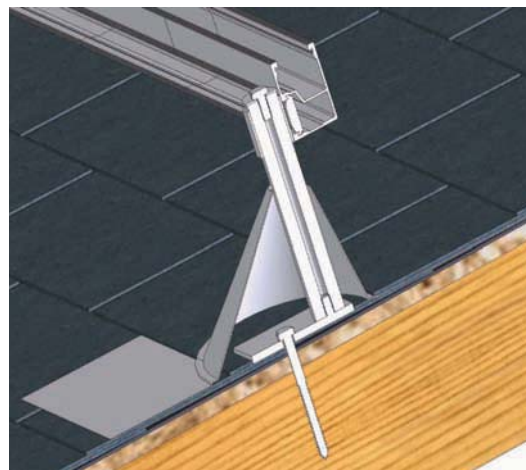
4. Flush mount on other roof types (using standoffs)

4.1 Introduction

Typically, standoffs are used for installations on tile, shake, or special thick composition roof types.

For installations on standard composition roofs, use flashed L-feet as described in section 3. For installations where the PV modules will be installed tilted at an angle to the roof surface, see section 5.

Diagram below shows standoff mount assembly details.



Standoff section view

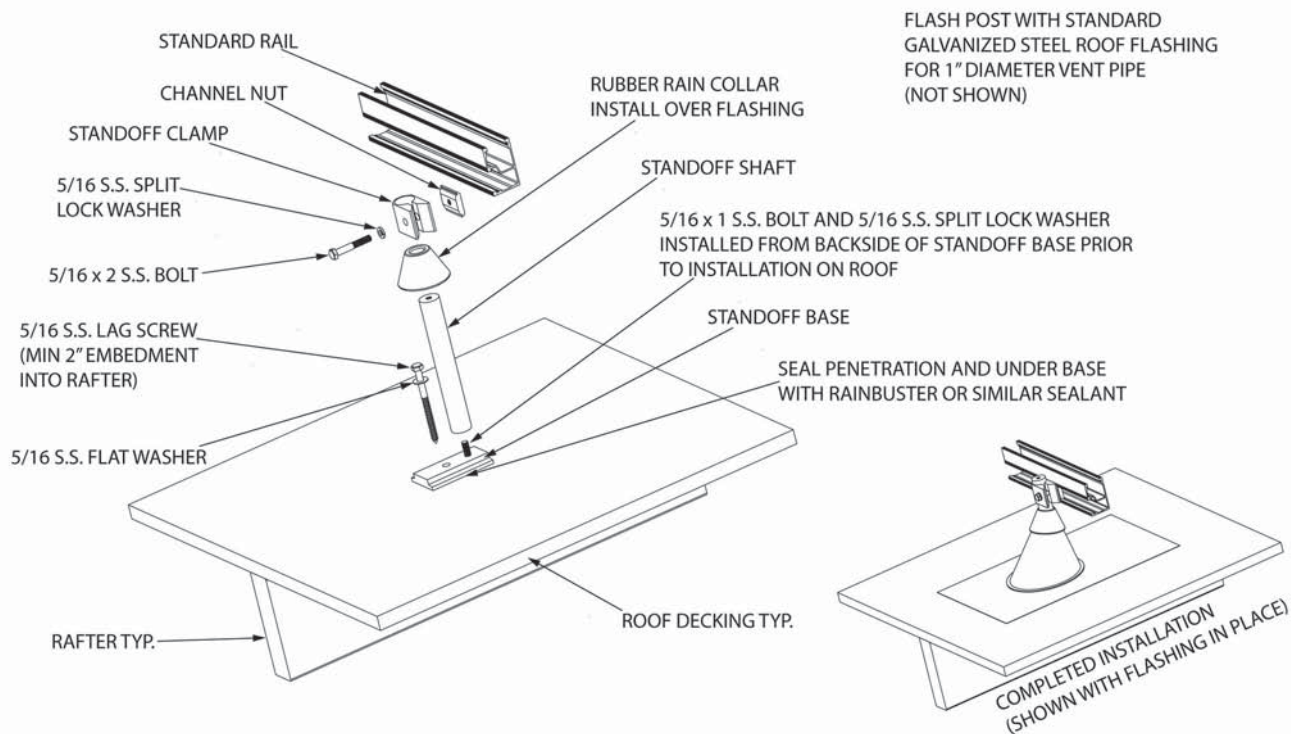


DIAGRAM 5: Standoff mount assembly

4.2 Determine type and size of attachment and flashing

Based on the construction type, style of the roof, and type of flashings to be used, determine the size of standoffs needed.

As a general rule, standoffs should be approximately 2½ inches taller than the cone of the flashing selected for the roof type.

Some typical roof flashing heights are shown in the list at the beginning of this section:



Standoff installation using Oatey flashing

Roof Type	Flashing Type	Flashing Height	Standoff Height
Composition	Low profile Oatey	3 inches	5½ inches
Shake, Wood	Standard Galvanized Steel	4½ inches	7 inches
Flat Tile, Slate	Deadpan soft aluminum	6 inches	8½ inches
S or Mission Tile	Deadpan soft aluminum (Same as above except lifted off roof)	7 inches	10 inches

4.3 Locate attachment points

The location of attachment points for standoff mounts depends on the orientation of the modules relative to the rafters as shown in diagram 3.

Using the array layout plans and the estimated rafter locations, determine the location of all attachment points and mark the holes for each standoff base.

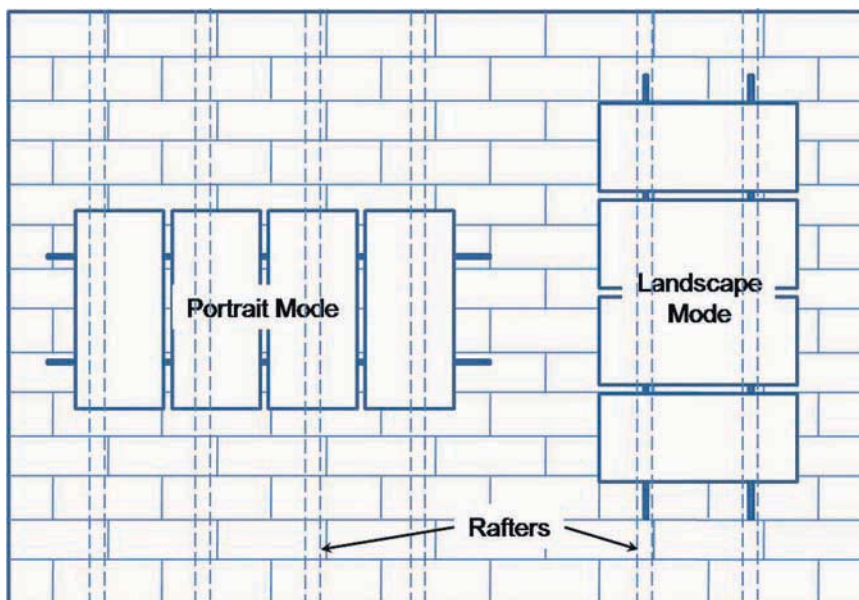


DIAGRAM 3: PV module orientation relative to rafters

4.4 Mark attachment points

Remove the tile or shake underneath each standoff location, exposing the roofing underlayment. Transcribe the location marks from the roofing material to the roofing underlayment. Ensure that the standoff base lies flat on the underlayment, but remove no more material than required for the flashing to be installed properly.

Use the standoff base as a template to mark lag-bolt hole locations on underlayment above the center of the rafters.



Remove roofing material to expose roof underlayment



Transcribe layout lines from roofing material to underlayment

4.5 Drill pilot holes

Confirm the location of the rafters by drilling pilot holes into the roof at each of the identified attachment points with a 3/16-inch pilot drill.

Be sure to drill the hole deep enough to penetrate the roof decking and enter the rafter by 1 inch to 1½ inch. If the drill pushes through at this point, you have likely missed a rafter and should move ½ inch laterally toward where you estimate the rafter to be and try again.



Drill pilot holes

4.6 Secure the base

Prior to securing the base to the roof, insert the 5/16-inch x 1-inch bolt and lock washer through the tapped hole in the standoff base and tighten.



Standoff base with bolt inserted

✓ This piece can be preassembled and taken out to the job site as one part.

✓ Note: the standoff base is different from the L-foot base described in section 3 of this manual. Make sure you are using the correct base.



Apply sealant

Make certain you use the correct part for the type of roof on which you are installing the array. See photos of each type on page 7.

Apply a bead of sealant to the underside of the standoff base and into the pilot hole.

Secure base to the roof by screwing 5/16-inch lag bolts with lag bolt washers into the pilot holes and tightening with a ½-inch socket and socket adapter bit in a power driver.

Make sure the lag bolts used are long enough to embed a minimum of 2 inches into the rafter to secure the standoff base to the roof.

-
- ✓ **The required lag bolt length is based on the roof thickness as measured during the site evaluation.**
-

-
- ✓ **Check that the lag bolts are secure with a socket and ratchet wrench.**
-

If the bolt *spins out*, you didn't hit a rafter. Move ½ inch laterally toward where you estimate the rafter to be and try again starting with a new pilot hole. Most wooden rafters are only 1.625 inches thick, so you should always attempt to hit a wooden rafter in the center if possible.



Secure standoff base to rafter



Typical standoff base installation

4.7 Attach standoff and install flashing

Screw standoff shaft onto the base and tighten. Install flashing over the standoff shaft and base using standard building practices.

Apply a bead of sealant to seal the top of the flashing around the standoff shaft.

Slide rubber rain collar over the standoff and press down to cover the sealant at the top of the flashing.

Every standoff must be firmly secured to a rafter to ensure system integrity. Make sure that all lag screws are securely tightened into roof rafters and are structurally sound.

Repeat this procedure for each array attachment point. After installing all standoffs, go to section 6.



Screw standoff onto base



Install flashing using appropriate methods for roof type.
Slide rain collar over flashing.



Slide standoff clamp and hardware onto shaft over rain collar

5. Tilt mount (using standoffs and extensions)

5.1 Introduction

Installations that require the arrays to be tilted relative to the roof surface can be installed on either standoffs or L-feet as described in sections 3 and 4, but standoffs are the most common and are the only solution for flat roof surfaces where full flashings will be required.



PV modules installed at shallow angle

For flush mounted (not tilted) installations on standard composition roofs, use flashed L-feet as described in section 3. For flush mounted arrays on thicker composition, shake, or tile roof types, use standoffs as described in section 4.

5.2 Determine type of tilt assembly

There are two types of tilt assemblies for SnapNrack installations depending on the amount of tilt required: shallow tilt assemblies for arrays installed at angles less than 15 degrees and full tilt assemblies for arrays installed at angles greater than 15 degrees (up to 60 degrees).

5.3 Shallow tilt kits

Tilt angles from 0 to 15 degrees can be configured as shown in the following diagram. This configuration uses a standard length standoff for the lower rail and a longer standoff for the upper rail.

Calculate the length of the upper rail standoff to provide the desired module tilt angle. If the length of the standoff needs to exceed 9 inches, please contact SnapNrack tech support for recommendations.

For this type of installation, complete the layout and installation of standoffs as described in section 4.

Attach a standoff clamp and L-foot to each standoff, such that the rail can be bolted to the L-foot at the appropriate angle for the two rails to provide a flush mounting surface for the modules at the desired tilt angle.

Proceed with mounting rails and modules as described in section 6.

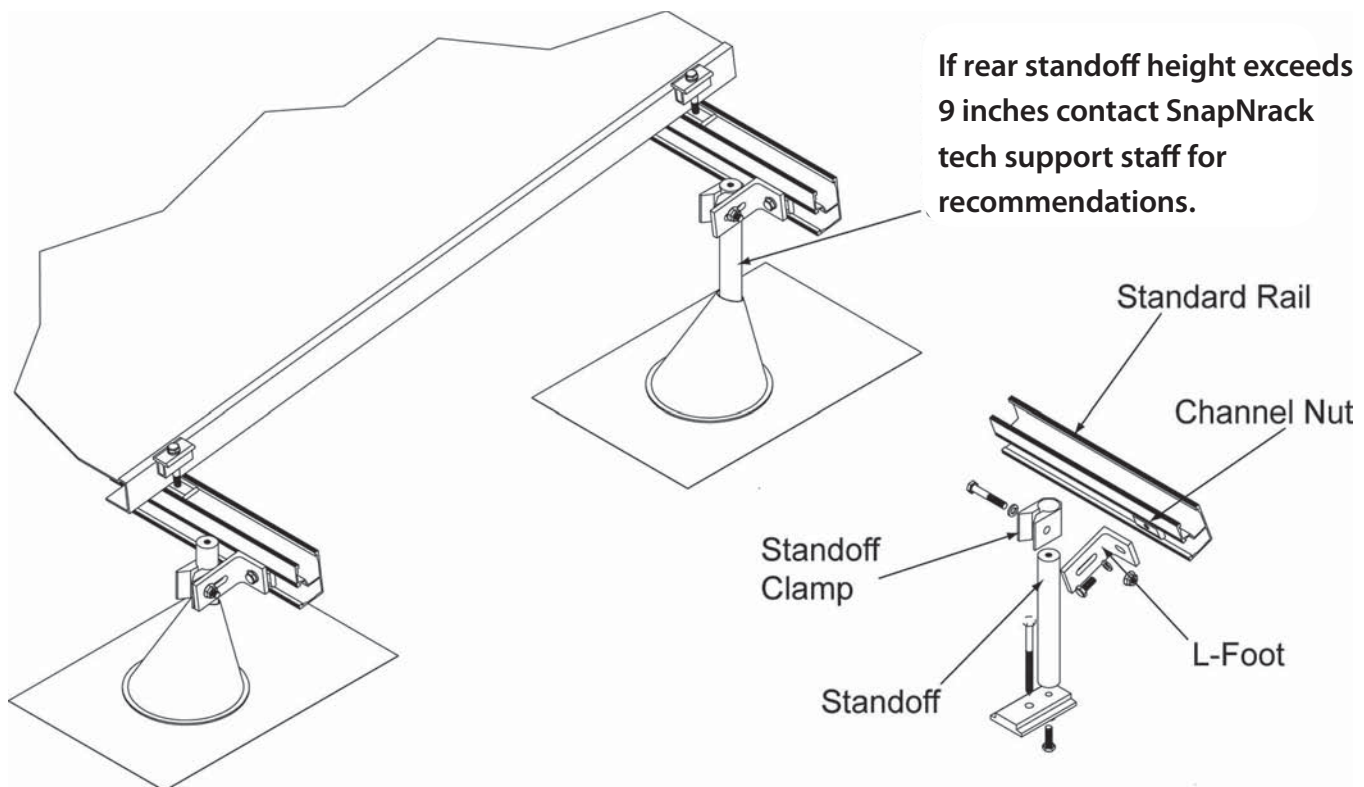


DIAGRAM 6: Tilt assembly for angles less than 15 degrees

5.4 Full tilt kits

Tilt angles from 10 to 60 degrees can be configured as shown in the diagram on this page. This configuration uses a standard length standoff for both upper and lower rails and adds an extension to the standoff supporting the upper rail using a section of rail cut to the appropriate length and drilled with two holes.

Calculate the length of the upper rail standoff extension to provide the desired module tilt angle. If the length of the cut rail exceeds 4 feet, consult a structural engineer before proceeding.

Tilt leg rails can be cut and drilled ahead of time to save time on the job site. A simple drill guide will help with locating the holes in the tilt leg.

For this type of installation, complete the layout and installation of standoffs as shown in Section 4. Attach the lower or front rail mounting hardware as described in section 5.3 *Shallow Tilt Kits*.

Bolt the pre-drilled tilt leg rail to the standoff clamp on the back row of standoffs by passing a bolt through one of the holes in the rail and into a channel nut as shown in the drawing.

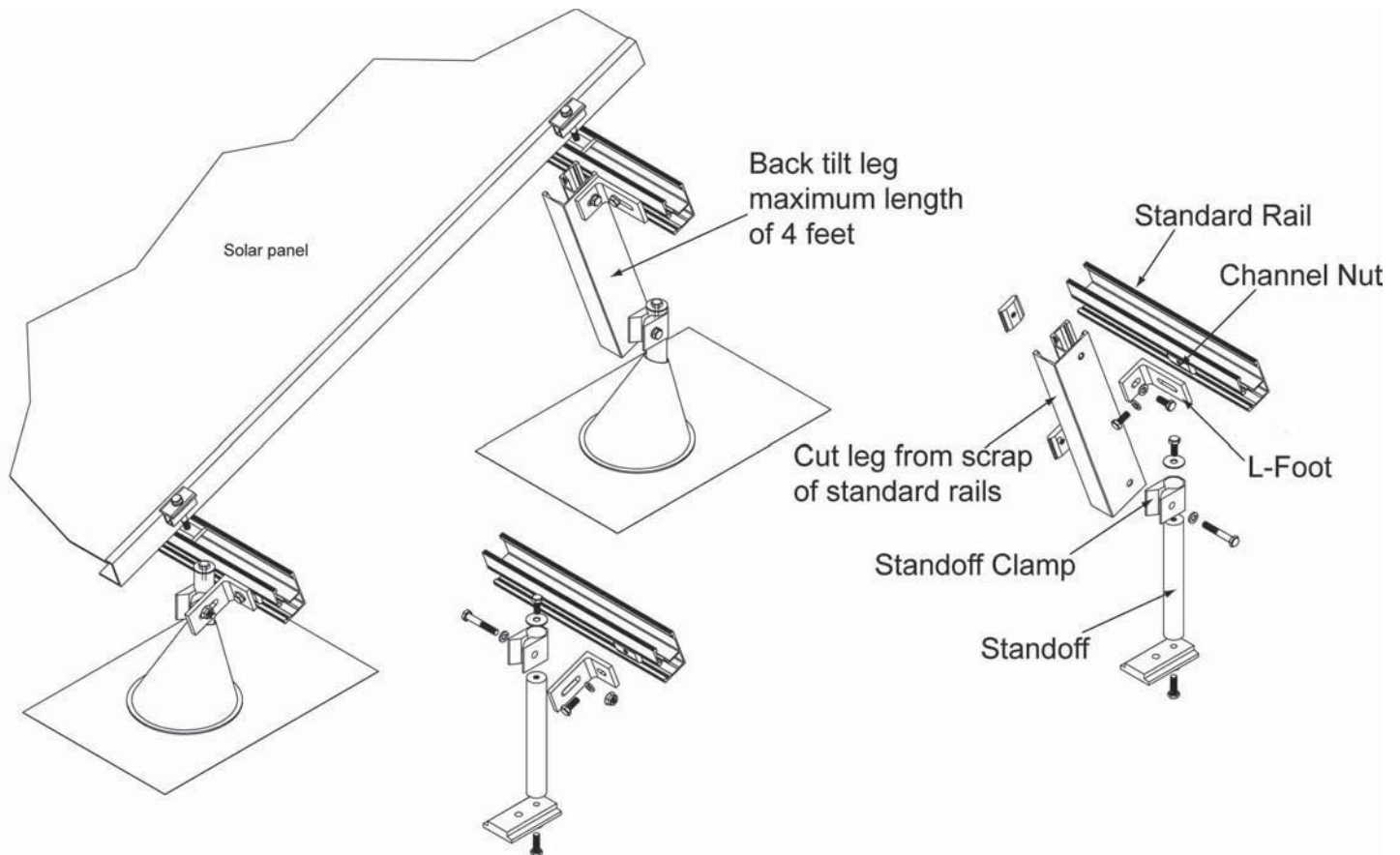


DIAGRAM 7: Tilt assembly for angles greater than 15 degrees

Similarly, bolt an L-foot to the upper end of the tilt leg rail and attach the upper rail to the L-foot.

Tighten all hardware at the appropriate angle for the two rails to provide a flush mounting surface for the modules at the desired module tilt angle.

✓ **Note that when tall tilt angles are used, the upper rail may seem a bit precarious until the first two or three modules are installed.**

Take care that you don't put excessive force on the rear leg standoffs such as to compromise their integrity over the duration of the installation.

Proceed with installing mounting rails and modules in Section 6.

5.5 Installing on L-feet

In some cases it may be desirable to install tilt kits on L-feet. Often, this is done when a row of modules along the top of a north facing roof slope is "tilted back" to match the south facing roof slope on the other side of the ridge line, and the building has a basic composition roof.

In these cases, proceed with installation as described in section 5.4 *Full Tilt Kits* substituting L-feet for the standoff/standoff clamp assemblies.

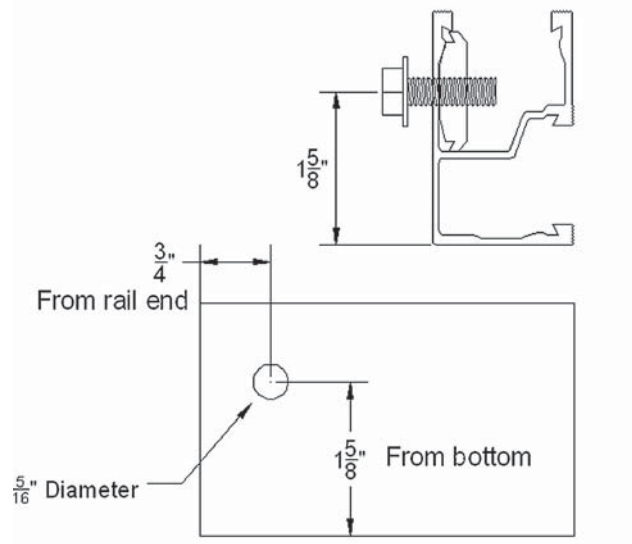


DIAGRAM 8: Tilt leg rail section drilling location

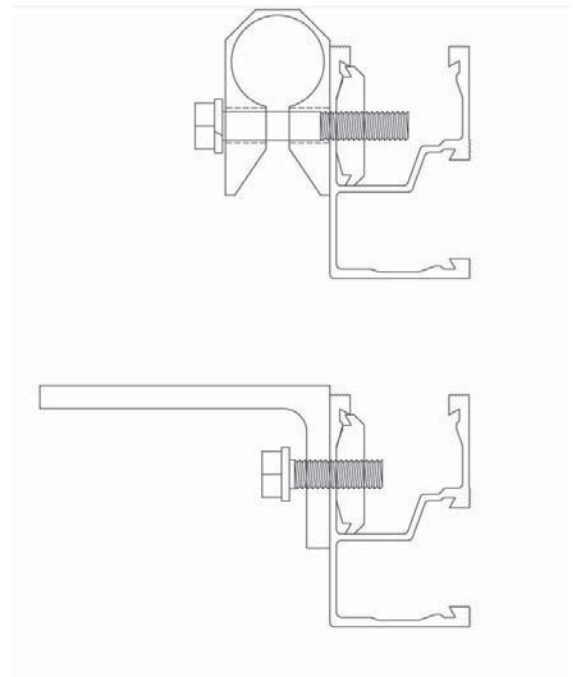


DIAGRAM 9: Rear tilt leg attachment configuration with L-feet

Note: requires drilling two holes in each rear tilt leg

6. Install rails

6.1 Snap in channel nuts

Snap in channel nuts and attach rails to mounting hardware using 5/16-inch bolts as shown in the photo.

Channel nuts are designed to snap in and out of rail channels. This enables you to quickly assemble systems without having to slide nuts from the end of a rail.

Rails can be mounted to either side of the L-feet or standoffs, upslope or downslope, as seen in the photos.

-
- ✓ **The rail nearest the low edge of the roof should be mounted in such a way that it presents an even, clean face as seen from the ground.**
-

Leave bolts finger tight to facilitate rail leveling in the next section.



Snap in channel nut



Standard rail mounting configuration



Down slope mounted rail

7. Install rail splices

7.1 Snap in splice insert

At every junction of two rails, snap or slide in a rail splice insert and attach a rail splice top using the provided 5/16-inch bolts and lock washers.

On combined single row rail length longer than 35 feet a thermal expansion joint is required. A gap in the rails of 1/4 inch is recommended.

Check all bolt torques to ensure that all 5/16-inch hardware is tightened to 12 ft-lbs.



Snap in channel nut



Tighten bolts on splice

8. Level rails

8.1 Overview

Rails can be leveled by raising or lowering the points where they attach to the L-foot or standoff assembly.

Up to 1 inch of adjustment is achieved with the basic sliding features built into both L-foot and standoff clamp components.

Use a spare rail or a string line to level the rails and make sure the tops of all of the rails are in the same plane.

8.2 Additional leveling for L-foot mounted rails

An additional 1 or 2 inches of height can be added by installing one or two 1-inch standoff spacers between the L-foot and its base. When necessary, use spacers as follows:

- Remove L-foot.
- Thread 1-inch standoff onto standoff bases threaded stud.
- Screw 1-inch set screw into 1-inch standoff with 5/32-inch Allen wrench.
- Reinstall L-foot as before by tightening the original nut and lock washer onto the threads of the set screw.
- Repeat process to add a second 1-inch spacer if needed.



Check all bolt torques to ensure that all 5/16-hardware is tightened to 12 ft-lbs.

8.3 Additional leveling for standoff mounted rails

An additional 1 inch or 2 inches of height can be added by installing one or two 1-inch standoff spacers to the top of the standoff shaft. When it is necessary to use spacers, adjust the level as follows:

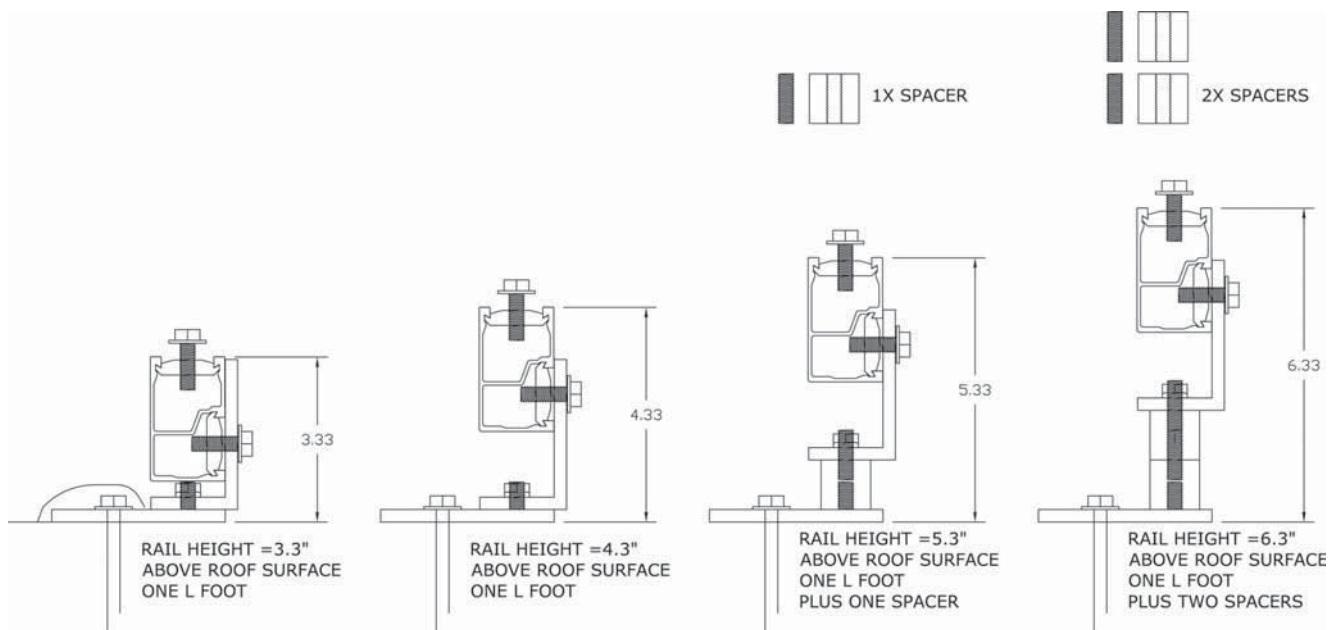


DIAGRAM 10: Up to three inches of leveling capability for L-foot mounts

- Remove standoff clamp or simply slide down standoff shaft.
- Screw 1-inch threaded stud into top of standoff so that half the threads are into the standoff.
- Thread 1-inch spacer onto set screw using 5/32-inch Allen key to hold set screw still and ensure even thread engagement into both shafts.
- Reinstall standoff clamp as before.
- Repeat process to add a second 1-inch spacer if needed.

✓ If the standoff clamp extends above the top surface of the standoff, spacers need to be added.

✓ Never use more than two spacers. If more height is required, use a taller standoff.

✓ Check all bolt torques to ensure that all 5/16-inch hardware is tightened to 12 ft-lbs.

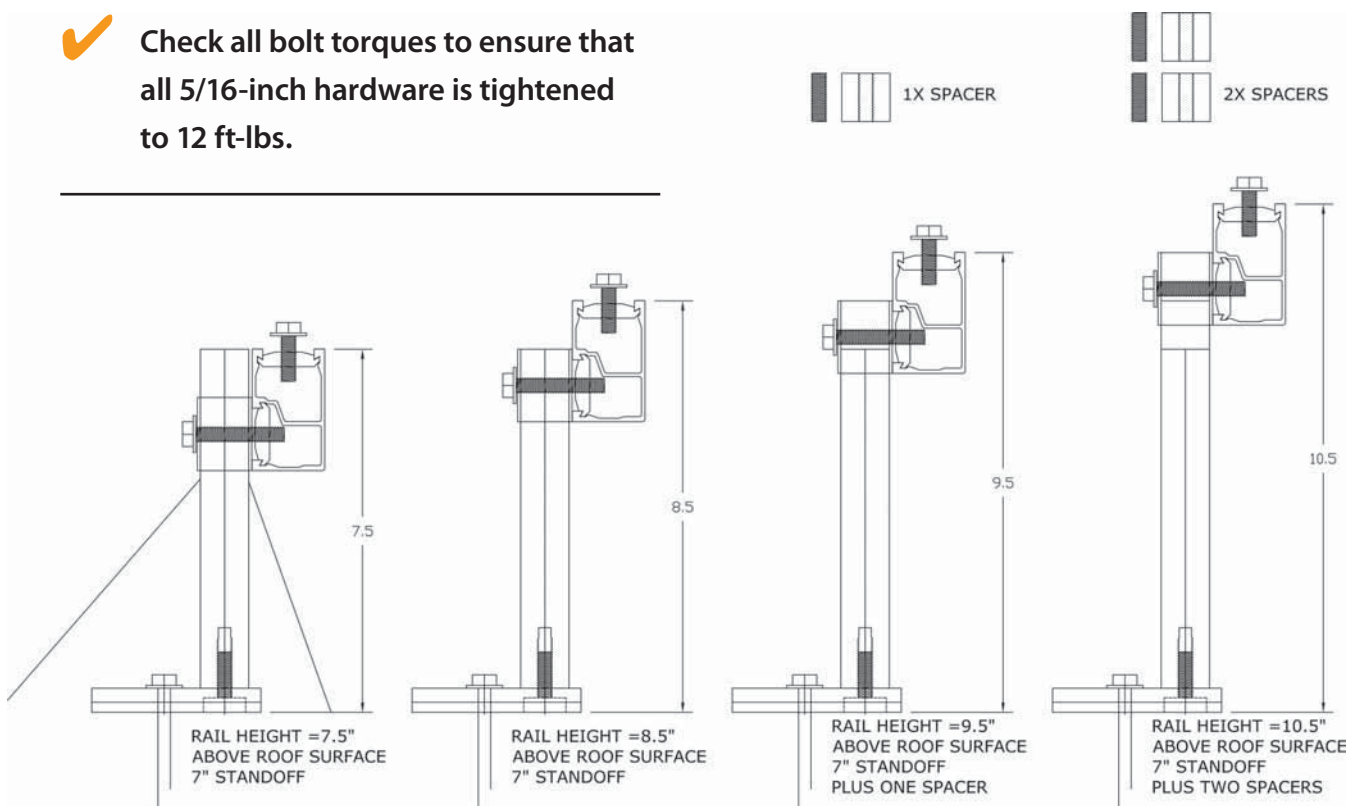


DIAGRAM 11: Up to three inches of leveling capability for standoff mounts

9. Install modules on rails

9.1 Prepare clamping hardware

Preassemble module clamping hardware. Each clamp assembly consists of a module clamp, a channel nut, and a 5/16-inch bolt and split lock washer.

When using standard end clamps the end clamp size and bolt length are specific to the thickness of the module. Make sure you have the right size for the modules being installed.

If using the universal end clamp (UEC) make certain it is slid all the way up on the module frame lip before tightening the clamp.

To speed the installation, measure out the location of mid-clamps and end clamps on rails with a tape measure.

Snap in clamps on all the rails so the clamps will be ready when you place the modules.

9.2 Set first module

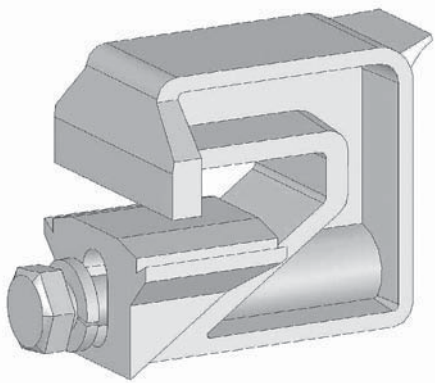
Place the first module, taking care to line the module up to the rails and roof edges.

✓ The rest of the installation will go more smoothly if you take the time to get the first module lined up properly.

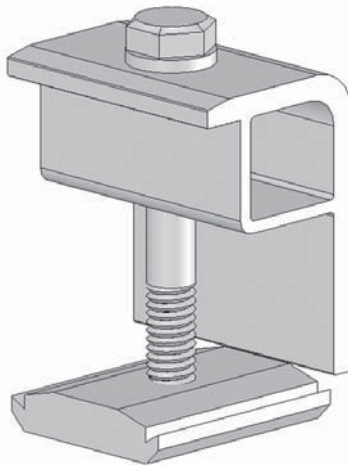
Tighten the two end clamps on the first module and snap in the next two clamps, which will typically be mid clamps, to prepare to receive the next module.



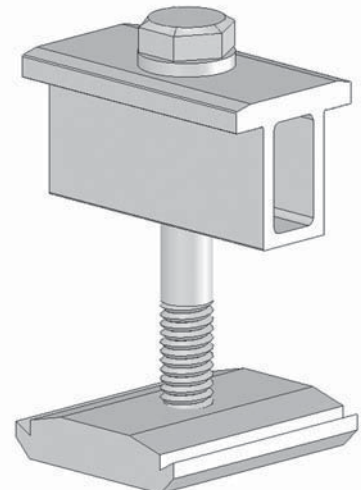
Snap module clamp assemblies into rail



Universal End Clamp



Standard end clamp



Mid clamp

Proceed down the row placing one module at a time and tightening clamps as you go.

When you place the last module in the row, secure it with end clamps to finish the row and repeat the process for the next row of modules.

9.3 Connect wiring

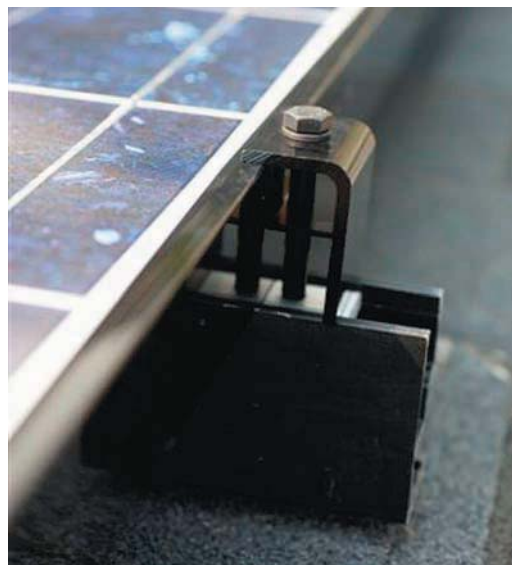
Connect module leads and train the wires into the rail channels as the modules are being installed. This will ensure a clean, robust electrical installation with no dangling wires. Use module lead clips as necessary to insure that module leads are secured to module frames until they drop into the rail channel. SnapNrack rail cover can be used to help retain the wire in the channel.

9.4 Connect grounding

Install grounding hardware per PV module manufacturer's specifications.

The Wiley Electronics WEEB is an acceptable grounding device for use with the SnapNrack rails. For installation instruction download the WEEB installation guide from www.snapnrack.com

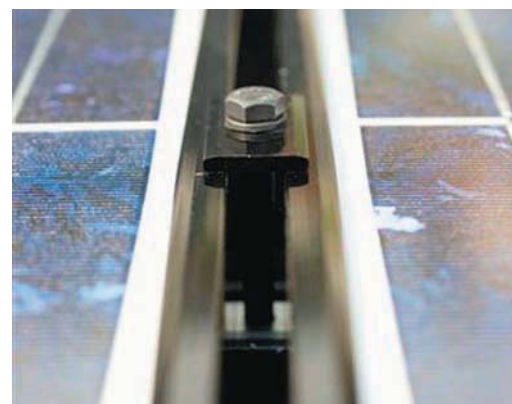
It is often convenient to install grounding hardware as modules are being installed but this will vary with the type of PV modules used.



Installed end clamp



Installed
Universal End Clamp



Installed Mid Clamp

9.5 Trim rails

Trim rail ends to leave about ½-inch of rail extending past the end of all module end clamps when the standard end clamps are used. If the UEC is used then the rails can be trimmed flush with the module frames.

Take care not to cut into the roof surface with the saw while trimming rails.

File off rail ends with a hand file and vacuum up metal shavings.

Careful planning will enable you to cut rails before they are installed on the roof.



Connect wiring



Teamwork makes the job easier



Trim rails



Channel cover

10. Final check

10.1 Check tightness of all bolts

Check all bolt torques to ensure that all 5/16-inch hardware is tightened to 12 ft-lbs.

10.2 Check wires and grounding

Check under the array to ensure all wires are tucked up with module clips along the module frames and trained into the cable channels of the rails. The SnapNrack channel cover can be used to retain the wires in the channels. It can be cut to short sections with a saw and snapped on to the channel as needed. Make certain you file down any sharp edges before installing it.

10.3 End caps

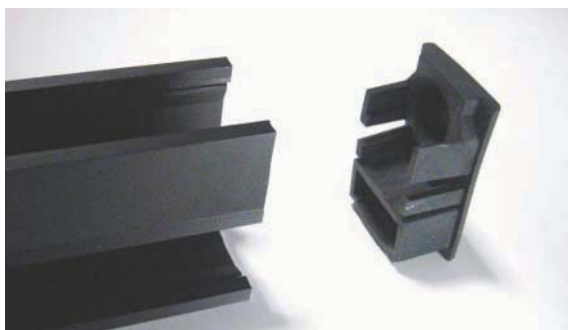
The SnapNrack black rubber end caps should be installed now. They are simply pressed on to the end of the rail or if needed a rubber mallet can be used to tap them in place.



Check all bolts



Check under the array for dangling wires



Rubber end cap



Rubber end cap installed

11. Appendix

11.1 Engineering Certification Letter



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STRUCTURAL CALCULATIONS

PREPARED FOR:

SYSTEM:

SnapNrack Roof Mount Racking System

DESIGNER OF RECORD:

SnapNrack
775 Fiero Lane Suite 200
San Luis Obispo, CA 93401

PROJECT ENGINEERS:

Matthew Gilliss, LEED AP
Nathan B. White, S.E., LEED AP



**Valid Through December 31, 2010
Subject to Annual Review & Reissuance**

Job No. 8445
January 28, 2010

We also have letters with engineering seals for other states. All engineering is done to IBC2006.



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SnapNrack Roof Mount Racking System

Date: January 28, 2010

To: Tim Vaughn
SnapNrack

From: Matthew Gilliss
Taylor & Syfan Consulting Engineers

Project: SnapNrack Roof Mount Racking System

T&S Job No.: 8445

Subject: Summary Letter for SnapNrack

INTRODUCTION

This Project Summary Letter is in reference to the Structural Calculation Packet for the SnapNrack Solar Racking System, dated December 2009. The calculations have been performed in accordance with the 2007 California Building Code (CBC), the governing structural code in California, which is based on the 2006 International Building Code (IBC). Several factors contained within this code govern the overall design of the racking system. The racking system has been designed to withstand code-prescribed forces due to the racking system's own weight, the weight of the solar panels, snow loads, and wind forces.

RAIL SPANS

In terms of variable conditions for the racking system, the main rails which support the solar panels (referred to as the "standard rails") have an adjustable length, which is the distance between their attachments to the roof (called standoffs). For the purpose of the calculation packet, that length was taken to be 8'-0", 6'-0", 4'-0", or 2'-0".

Due to the many variables that are required to be taken into account during a wind analysis, we have determined multiple cases that we feel are the most common. These cases are based upon several factors which include building height, pitch of the panels, wind exposure region, wind speed, snow loads, and topographic factors.

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SnapNrack Roof Mount Racking System

SITE-SPECIFIC ANALYSIS

We have determined that the rails are able to span a maximum of 8'-0" for many of the common cases, but that there are certain cases which will require shorter spans and/or a location-sensitive analysis to be performed on a case-by-case basis. A site-specific analysis may be required if it is found that the location of the solar panel install corresponds to any of the following criteria:

- The total pitch of the solar panel (solar panel pitch & roof pitch) is greater than 60 degrees above the horizontal.
- A topographic factor applies to the location. Topographic factors apply, for general purposes, when the structure is on a hill, mesa or bluff, or is adjacent to a large body of water. For complete descriptions of topographic factors, please refer to ASCE 7-05 Section 6.5.7.
- The roof of the structure that the solar panels will be installed on is greater than 50 ft. above grade.
- A combination of loads and/or site conditions applies that is not addressed in the attached rail span charts.

If one of more of these factors applies to the project location, please contact Taylor & Syfan, and we will be able to analyze the site conditions and recommend a standoff spacing for each specific site.

RAIL TESTING

Due to the possibility of structural failure of the rails due to their non-symmetrical shape, testing was conducted per the standards set forth by the 2006 IBC Section 1714: Preconstruction Load Tests. The results of this testing procedure were used in comparison with the calculated values to help establish the maximum load allowed by the rails. The full procedure and results of these tests can be found in this packet.

RACKING CONNECTIONS TO THE EXISTING ROOF

Also contained within the calculation packet are calculations for the connection of the rails to the roof framing. Using the sizes provided by SnapNrack, we have calculated the maximum



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forces that will be resisted based on the withdrawal value of the lag screws, and the strength of the aluminum components which are involved in transferring these forces from the rail to the roof framing. These components consist of the L-foot (SnapNrack Drawing ATCH-D01), the Standoff (ATCH-D02), the Hybrid (ATCH-D05), and the Hanger Bolt (ATCH-D06 - which is discussed below). All (4) options are acceptable under the parameters shown in SnapNrack's plans. The results from our analysis have been integrated into the summary charts.

SUMMARY CHARTS AND TOPGRAPHIC FACTORS

The attached pages of this summary contain what we feel are some of the most common building configurations with varying wind speeds. These charts can be used as a quick reference for looking up maximum rail span lengths based on the building and site conditions, but it must be noted that for any building where a topographic factor is to be applied (e.g. hills, mesas, seashore) the rail span lengths given may exceed what is allowed for the given site condition. A registered structural engineer should evaluate the exact topographic conditions for this specific site prior to construction.

UNIVERSAL END CLAMP

SnapNrack has also developed a "Universal End Clamp" which is used to connect individual solar panels to the rails (see SnapNrack's drawing "UEC INSTALL"). These have been developed and tested by SnapNrack, and they are adequate to resist the maximum uplift and shear forces generated by code prescribed wind forces when installed as specified. The testing results may be submitted upon request.

HANGER BOLT OPTION

The Hanger Bolt consists of a 3/8" diameter bolt that is used in place of the typical standoff connection to connect the racking components to the existing roof framing. Because the connection between the hanger bolt and the racking consists of a clamp that relies on friction, extensive testing has been done and a factor of safety over 4 has been applied to the ultimate loads that the assembly safely carried. With the factor of safety, the hanger bolt was able to resist the same loads required of the other standoff options. Please see



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SnapNrack Roof Mount Racking System

SnapNrack's plans for limits on the bolt parameters, including minimum required installation torque. The testing results may be submitted upon request.

EXISTING BUILDING LIMITATIONS

This summary letter discusses the structural adequacy of the solar racking system itself only and does not investigate or validate the adequacy of the structure that the racking system is being placed upon. It does not address the ability of the existing roofing or roof framing to support the new loads imposed upon them by the new system nor does it address the new localized forces between the roofing and the roof framing that may be imposed by the new standoff connections. It also does not address the additional lateral forces that will be imposed upon the building due to the seismic mass the new system adds to the existing roof. These various building-specific issues need to be evaluated by the appropriate registered professional(s) prior to the addition of the photovoltaic and racking systems. Taylor & Syfan may be consulted for building-specific structural evaluation. Taylor and Syfan assumes that systems are installed to the specifications presented here and using good structural judgment by the installer. Additionally, as an optional service, we recommend the performance of structural observations of the installation, as a best practice service, by Taylor & Syfan.

Please note that all sizes, material specifications, and weights have been provided by SnapNrack. All waterproofing, roofing, and drainage issues are the responsibility of SnapNrack's customer otherwise known as the contractor or professional solar installer.

Please let us know if you have any questions or comments. Thank you.

Sincerely,

Matthew B. Gilliss
 Project Engineer
 Taylor & Syfan Consulting Engineers

11.2 Rail span tables

For Tilts of 19 Degrees or Less

MAXIMUM RAIL SPANS BETWEEN STANDOFFS (FT.)

Conditions		Windspeed (Nominal 3-sec. Gust in mph)				
		90	105	120	135	150
Building Ht. is 30 ft. or Less	0 to 19 Degree Pitch 0 psf Ground Snow Load	8*	8	6	6	6
	0 to 19 Degree Pitch 0 – 10 psf Ground Snow Load	6	6	6	4	4
	0 to 19 Degree Pitch 11 – 20 psf Ground Snow Load	6	4	4	4	2
	0 to 19 Degree Pitch 21 – 30 psf Ground Snow Load	4	4	4	2	2
	0 to 19 Degree Pitch 31 – 40 psf Ground Snow Load	4	4	2	2	2
	0 to 19 Degree Pitch 41 – 60 psf Ground Snow Load	2	2	2	2	2
	0 to 19 Degree Pitch 61 – 80 psf Ground Snow Load	2	2	2	2	2
	0 to 19 Degree Pitch 81 – 100 psf Ground Snow Load	2	2	NG	NG	NG
Building Ht. is 31 ft. to 50 ft.	0 to 19 Degree Pitch 0 psf Ground Snow Load	8	6	6	6	4
	0 to 19 Degree Pitch 0 – 10 psf Ground Snow Load	6	6	4	4	4
	0 to 19 Degree Pitch 11 – 20 psf Ground Snow Load	4	4	4	4	2
	0 to 19 Degree Pitch 21 – 30 psf Ground Snow Load	4	4	4	2	2
	0 to 19 Degree Pitch 31 – 40 psf Ground Snow Load	4	2	2	2	2
	0 to 19 Degree Pitch 41 – 60 psf Ground Snow Load	2	2	2	2	2
	0 to 19 Degree Pitch 61 – 80 psf Ground Snow Load	2	2	2	2	2
	0 to 19 Degree Pitch 81 – 100 psf Ground Snow Load	2	2	NG	NG	NG

* For 90 MPH Wind Speed, Building Ht. up to 30 ft., and 0 psf Snow Load, an 8 ft. span may be used up to 28 deg. pitch

Note: For Solar Installations 50 ft. Above Ground Level or Less. If Location of Solar Installation Is Higher than 50 ft. Above Ground Level, Please Contact Taylor & Syfan.

For Tilts of 20 – 30 Degrees

MAXIMUM RAIL SPANS BETWEEN STANDOFFS (FT.)

		Windspeed (Nominal 3-sec. Gust in mph)				
		90	105	120	135	150
Building Ht. is 30 ft. or Less	20 to 30 Degree Pitch 0 psf Ground Snow Load	6*	6	6	4	4
	20 to 30 Degree Pitch 0 – 10 psf Ground Snow Load	6	6	4	4	2
	20 to 30 Degree Pitch 11 – 20 psf Ground Snow Load	4	4	4	2	2
	20 to 30 Degree Pitch 21 – 30 psf Ground Snow Load	4	4	4	2	2
	20 to 30 Degree Pitch 31 – 40 psf Ground Snow Load	4	4	2	2	2
	20 to 30 Degree Pitch 41 – 60 psf Ground Snow Load	2	2	2	2	2
	20 to 30 Degree Pitch 61 – 80 psf Ground Snow Load	2	2	2	2	2
	20 to 30 Degree Pitch 81 – 100 psf Ground Snow Load	2	2	NG	NG	NG
Building Ht. is 31 ft. to 50 ft.	20 to 30 Degree Pitch 0 psf Ground Snow Load	6	6	6	4	4
	20 to 30 Degree Pitch 0 – 10 psf Ground Snow Load	6	4	4	4	2
	20 to 30 Degree Pitch 11 – 20 psf Ground Snow Load	4	4	2	2	2
	20 to 30 Degree Pitch 21 – 30 psf Ground Snow Load	4	4	2	2	2
	20 to 30 Degree Pitch 31 – 40 psf Ground Snow Load	4	2	2	2	2
	20 to 30 Degree Pitch 41 – 60 psf Ground Snow Load	2	2	2	2	2
	20 to 30 Degree Pitch 61 – 80 psf Ground Snow Load	2	2	2	2	2
	20 to 30 Degree Pitch 81 – 100 psf Ground Snow Load	2	2	NG	NG	NG

* For 90 MPH Wind Speed, Building Ht. up to 30 ft., and 0 psf Snow Load, an 8 ft. span may be used up to 28 deg. pitch

Note: For Solar Installations 50 ft. Above Ground Level or Less. If Location of Solar Installation Is Higher than 50 ft. Above Ground Level, Please Contact Taylor & Syfan.

For Tilts of 31 - 45 Degrees

MAXIMUM RAIL SPANS BETWEEN STANDOFFS (FT.)

Conditions		Windspeed (Nominal 3-sec. Gust in mph)				
		90	105	120	135	150
Building Ht. is 30 ft. or Less	31 to 45 Degree Pitch 0 psf Ground Snow Load	6	6	4	4	2
	31 to 45 Degree Pitch 0 – 10 psf Ground Snow Load	6	4	4	2	2
	31 to 45 Degree Pitch 11 – 20 psf Ground Snow Load	4	4	2	2	2
	31 to 45 Degree Pitch 21 – 30 psf Ground Snow Load	4	4	2	2	2
	31 to 45 Degree Pitch 31 – 40 psf Ground Snow Load	4	4	2	2	2
	31 to 45 Degree Pitch 41 – 60 psf Ground Snow Load	4	4	2	2	2
	31 to 45 Degree Pitch 61 – 80 psf Ground Snow Load	4	4	2	2	2
	31 to 45 Degree Pitch 81 – 100 psf Ground Snow Load	4	2	2	2	2
Building Ht. is 31 ft. to 50 ft.	31 to 45 Degree Pitch 0 psf Ground Snow Load	6	6	4	4	2
	31 to 45 Degree Pitch 0 – 10 psf Ground Snow Load	6	4	4	2	2
	31 to 45 Degree Pitch 11 – 20 psf Ground Snow Load	4	4	2	2	2
	31 to 45 Degree Pitch 21 – 30 psf Ground Snow Load	4	4	2	2	2
	31 to 45 Degree Pitch 31 – 40 psf Ground Snow Load	4	4	2	2	2
	31 to 45 Degree Pitch 41 – 60 psf Ground Snow Load	4	4	2	2	2
	31 to 45 Degree Pitch 61 – 80 psf Ground Snow Load	4	4	2	2	2
	31 to 45 Degree Pitch 81 – 100 psf Ground Snow Load	4	2	2	2	2

Note: For Solar Installations 50 ft. Above Ground Level or Less. If Location of Solar Installation Is Higher than 50 ft. Above Ground Level, Please Contact Taylor & Syfan.

For Tilts of 46 - 60 Degrees**MAXIMUM RAIL SPANS BETWEEN STANDOFFS (FT.)**

		Windspeed (Nominal 3-sec. Gust in mph)				
Conditions		90	105	120	135	150
Building Ht. is 30 ft. or Less	46 to 60 Degree Pitch 0 psf Ground Snow Load	6	6	6	4	4
	46 to 60 Degree Pitch 0 – 10 psf Ground Snow Load	6	6	4	4	2
	46 to 60 Degree Pitch 11 – 20 psf Ground Snow Load	4	4	4	2	2
	46 to 60 Degree Pitch 21 – 30 psf Ground Snow Load	4	4	4	2	2
	46 to 60 Degree Pitch 31 – 40 psf Ground Snow Load	4	4	4	2	2
	46 to 60 Degree Pitch 41 – 60 psf Ground Snow Load	4	4	4	2	2
	46 to 60 Degree Pitch 61 – 80 psf Ground Snow Load	4	4	4	2	2
	46 to 60 Degree Pitch 81 – 100 psf Ground Snow Load	4	4	4	2	2
Building Ht. is 31 ft. to 50 ft.	46 to 60 Degree Pitch 0 psf Ground Snow Load	6	6	6	4	4
	46 to 60 Degree Pitch 0 – 10 psf Ground Snow Load	6	4	4	2	2
	46 to 60 Degree Pitch 11 – 20 psf Ground Snow Load	4	4	2	2	2
	46 to 60 Degree Pitch 21 – 30 psf Ground Snow Load	4	4	2	2	2
	46 to 60 Degree Pitch 31 – 40 psf Ground Snow Load	4	4	2	2	2
	46 to 60 Degree Pitch 41 – 60 psf Ground Snow Load	4	4	2	2	2
	46 to 60 Degree Pitch 61 – 80 psf Ground Snow Load	4	4	2	2	2
	46 to 60 Degree Pitch 81 – 100 psf Ground Snow Load	4	4	2	2	2

* For 90 MPH Wind Speed, Building Ht. up to 30 ft., and 0 psf Snow Load, an 8 ft. span may be used up to 28 deg. pitch

Note: For Solar Installations 50 ft. Above Ground Level or Less. If Location of Solar Installation Is Higher than 50 ft. Above Ground Level, Please Contact Taylor & Syfan.

MAXIMUM RAIL SPANS BETWEEN STANDOFFS (FT.) (Topographic Effects)

Conditions	Windspeed (Nominal 3-sec. Gust in mph)				
	90	105	120	135	150
0 to 15 Degree Pitch Building Ht. up to 30 ft. Top Of Hill	8	6	6	4	4
0 to 15 Degree Pitch Building Ht. up to 30 ft. Coastal Condition	6	6	4	4	2
0 to 15 Degree Pitch Building Ht. up to 30 ft. Mesa Condition	6	6	4	4	2
16 to 30 Degree Pitch Building Ht. up to 30 ft. Top Of Hill	6	6	4	4	2
16 to 30 Degree Pitch Building Ht. up to 30 ft. Coastal Condition	6	4	4	2	2
16 to 30 Degree Pitch Building Ht. up to 30 ft. Mesa Condition	6	4	4	2	2
31 to 45 Degree Pitch Building Ht. up to 30 ft. Top Of Hill	6	4	4	2	2
31 to 45 Degree Pitch Building Ht. up to 30 ft. Coastal Condition	6	4	2	2	2
31 to 45 Degree Pitch Building Ht. up to 30 ft. Mesa Condition	6	4	2	2	2
46 to 60 Degree Pitch Building Ht. up to 30 ft. Top Of Hill	6	6	4	4	2
46 to 60 Degree Pitch Building Ht. up to 30 ft. Coastal Condition	6	4	4	2	2
46 to 60 Degree Pitch Building Ht. up to 30 ft. Mesa Condition	6	4	4	2	2

***No Snow Load Taken Into Account With Topographic Effects. If Site Has Snow Loads AND Topographic Effects, Please Contact Taylor & Syfan.**

THIS CHART IS FOR ESTIMATION PURPOSES ONLY. SITES WITH TOPOGRAPHIC FACTORS SHOULD HAVE A STRUCTURAL ENGINEER CALCULATE THE EXACT FACTOR PRIOR TO CONSTRUCTION

SnapNrack™

10 year Limited Product Warranty and 5 year Limited Finish Warranty

Limited Warranties: SnapNrack, Inc., ("SnapNrack") warrants to the original end-user of the Product ("Purchaser") at the original installation site ("Site") that the SnapNrack™ PV module mounting system (the "Product") shall be free from defects in materials and workmanship for a period of **ten (10) years** (the "Limited Product Warranty"), and the Product's anodized finish shall be free from visible peeling, cracking or chalking under normal atmospheric conditions for a period of **five (5) years** (the "Limited Finish Warranty") (collectively, the "Limited Warranties"). The Limited Warranties shall commence on the earlier of (a) the date the installation of the Product as part of the original solar electric system (the "System") is complete, or (b) thirty (30) days after SnapNrack ships the Product to the authorized distributor or retailer. If, within the warranty period the Product is determined by SnapNrack to be defective, based on reasonable evidence of a defect provided by Purchaser, SnapNrack will, at its sole option, (a) repair the Product or replace it with an equivalent product, or (b) take back the Product and refund the purchase price to the Purchaser.

Conditions, Limitations and Exclusions: SnapNrack is not responsible for, and Purchaser hereby agrees to bear, the costs of any on-site labor and any costs associated with the installation, removal, reinstallation, shipping or transportation of the Product or any components thereof for replacement or service. (Note: the foregoing may not be applicable to consumer sales in certain jurisdictions.) SnapNrack may, at its sole discretion, use new, remanufactured or refurbished parts or products when repairing or replacing your Product under this warranty. Any exchanged or replaced parts or products will become the property of SnapNrack. This warranty is extended only to the original end-user purchaser and is not transferable, provided that as long as the System has not been physically moved or altered, any subsequent owner of the System shall have the same Limited Warranty rights as the original Purchaser.

The Limited Warranties do not apply to Products installed (a) outside the U.S.A. or Canada, or (b) in corrosive atmospheric conditions, including, but not limited to chemical fumes, salt spray, acidic rain or surface temperatures which exceed 200 degrees Fahrenheit. The Limited Warranties do not cover damage to the Product's anodized finish caused by moisture, condensation, or other contamination resulting from improper storage, packing or handling. The Limited Warranties do not cover damage to the Product that occurs during shipment or prior to or during installation. The Limited Warranties shall be void if the Product is not installed in accordance with SnapNrack's written installation instructions for the Product, or if the Product has been modified, repaired, or reworked in a manner not previously authorized by SnapNrack in writing, or if the Product is installed in an

environment for which it was not designed. As used herein, the term "chalking" refers to the powdery residue formed by the breakdown of the anodized finish, and excludes any foreign residue deposited on the finish by the surrounding atmosphere, including, but not limited to soot, dust, plaster, cement, etc. The Limited Finish Warranty is void if normal maintenance and cleaning practices are not followed by Purchaser as specified by AAMA 609 & 610-02 entitled "Cleaning and Maintenance for Architecturally Finished Aluminum," a copy of which is available from SnapNrack or from www.aamanet.org.

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