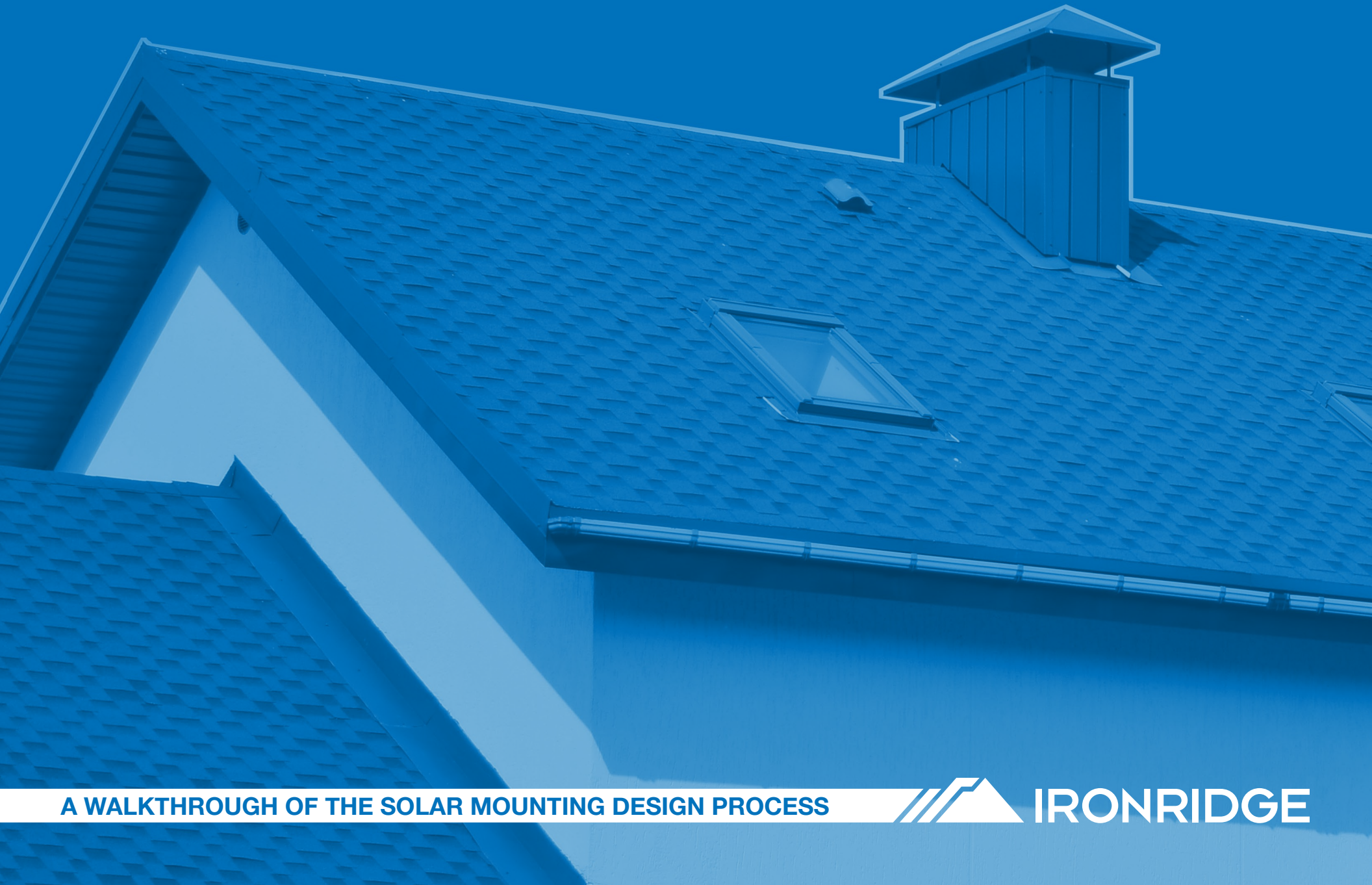


# PITCHED ROOF DESIGN GUIDE



A WALKTHROUGH OF THE SOLAR MOUNTING DESIGN PROCESS



**IRONRIDGE**

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# BEFORE YOU BEGIN

## Introduction

This guide walks you through the process of completing a Flush Mount System design.

In addition to this document, IronRidge provides a [free online design tool](#), [installation manuals](#), [pre-stamped engineering letters](#), [cut sheets](#), and [more](#).

To get started, sign up for [Design Assistant](#). As you follow the steps in this guide, Design Assistant will help you to design and price a fully engineered system.

Upon completion, you will walk away with:

- Basic project design
- Complete bill of materials
- Documents for inclusion in a permit package

Please note that more complex or unusual pitched roof designs may not be covered by IronRidge's pre-stamped engineering letters. If you run into this, [contact IronRidge](#) for additional engineering support.

## IronRidge Flush Mount System

The IronRidge Flush Mount System is an all-in-one mounting solution for residential and commercial pitched roofs – including composition shingle, tile, and metal roofs. All products are engineered to withstand extreme weather conditions and come with an industry-leading 20 year warranty.

Product Type	IronRidge Component
Rail	<a href="#">XR10</a> , <a href="#">XR100</a> , <a href="#">XR1000</a>
Splice	<a href="#">Bonded Splice</a>
Attachment	<a href="#">FlashFoot2</a> , <a href="#">Slotted L-Foot</a> , and <a href="#">Flush Standoff</a>
Mid Clamp	<a href="#">UFO (Universal Fastening Object)</a>
End Clamp	<a href="#">UFO</a> and <a href="#">Stopper Sleeve</a>
Grounding Hardware	<a href="#">Grounding Lug</a> and <a href="#">Expansion Joint</a>
Accessory	<a href="#">Microinverter Kit</a> , End Cap, and Wire Clip

## ASCE and IBC Compliant

The IronRidge Flush Mount System is designed and certified for compliance with International Building Code and ASCE/SEI-7.

## UL 2703 Listing

The IronRidge Flush Mount System is listed to the UL 2703 standard by Intertek Group plc. UL 2703 is the standard for evaluating and testing solar mounting systems. It ensures they will maintain strong electrical and mechanical connections over an extended period of time in extreme outdoor environments.

## Class A Fire Rating

The IronRidge Flush Mount System has a Class A Fire Rating on any roof slope with Module Types 1, 2, and 3. This rating permits any module-to-roof gap, with no perimeter guarding required. It is also applicable with any third-party attachment. Class A rated PV systems can be installed on Class A, B, and C roofs without impacting the roof's fire rating.

# 1. DEFINE SITE CONDITIONS

## Environmental Considerations

First, identify where you want to install PV and the specific conditions associated with this site. These conditions impact the usable space, attachment choice, and layout of your system.

### Wind/Snow Loads

Because PV is installed outdoors, your system will need to withstand regional wind and snow loads.

When you enter your zip code into Design Assistant, the tool automatically provides the typical wind speed and snow load values for the location. Be sure to also confirm these values by contacting your local building authority.

The screenshot shows a web form titled 'Design Assistant' with three main sections: 'Project Info', 'Building', and 'Module'.  
- **Project Info:** Includes fields for 'PROJECT NAME' (IronRidge), 'ZIP CODE' (94544), 'CITY, STATE' (Hayward, CA), 'WIND SPEED (ASCE 7-10)' (100 MPH), and 'GROUND SNOW LOAD' (0 PSF).  
- **Building:** Includes 'ROOF SLOPE' (0 DEG), 'BUILDING HEIGHT' (30 FT), 'WIND EXPOSURE' (radio buttons for B, C, D, with B selected), and 'RISK CATEGORY' (radio buttons for I, II, with I selected).  
- **Module:** Includes 'MANUFACTURER' (dropdown with 'Pick a manufacturer'), 'MODEL' (dropdown with 'Pick a model'), and 'COLOR' (color swatches).  
A large grey arrow button with a right-pointing chevron is at the bottom center.

## Exposure Category

Exposure category refers to the way obstacles protect buildings and the structures on top of them from the force of wind storms.

Therefore, based on your setting (urban, rural, or on flat unobstructed terrain), you will design to one of the following Exposure Categories:

Wind Exposure Category	Surface Roughness
Exposure B	Urban and suburban areas, wooded areas, or other terrain with numerous closely spaced obstructions having the size of single-family dwellings.
Exposure C	Open terrain with scattered obstructions having heights generally less than 30 feet. This category includes flat open country and grass-lands.
Exposure D	Flat, unobstructed areas and water surfaces. This category includes smooth mud flats, salt flats, and unbroken ice.

## Risk Category

Risk Category refers to the level of “hazard to human life in the event of a failure.”

Because solar arrays are placed on top of an existing structure, they are considered Risk Category I. This means the structural failure of a solar array will have a low hazard to human life.

Using Risk Category II to design your project requires obtaining approval from a licensed PE. Contact [support@ironridge.com](mailto:support@ironridge.com) if you need additional engineering support.



# 1. DEFINE SITE CONDITIONS

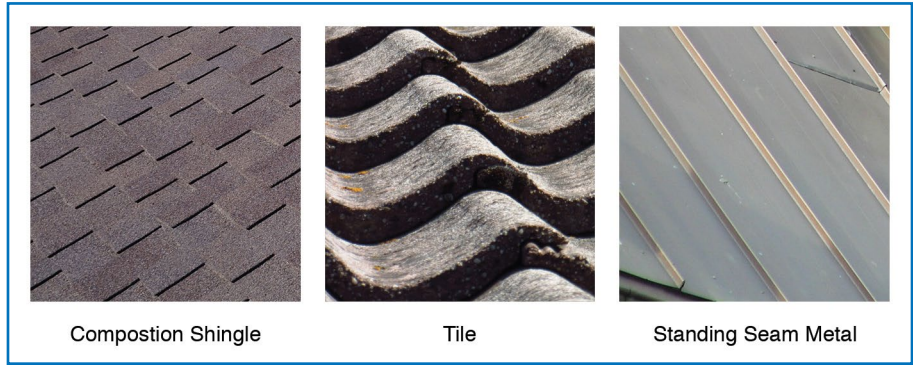
## Building Considerations

Now that you have the environmental details, you will need to consider the building/roof where you want to install PV. The IronRidge Flush Mount System’s pre-stamped certification applies to buildings with a roof slope of up to 45 degrees (12:12 roof pitch), and buildings with a mean height of up to 30 ft.

Design Assistant allows you to create projects for buildings that go up to 60 ft. However, if your building exceeds 30 ft. in height, this requires obtaining approval from a licensed PE. Contact [support@ironridge.com](mailto:support@ironridge.com) if you need additional engineering support.

## Roof Type

Roofing systems will function in different ways, which is why they require attachments that are built to integrate with them. Composition shingle and tile are most commonly used on residential roofs. You may also encounter metal roofing – such as standing seam or corrugated/trapezoidal. In the “Choosing Attachments” section of this guide, we will walk you through the options for these different roof types.



## Site Conditions Worksheet

Before moving onto the next section of this guide, make sure that you have collected all the relevant site details in the table below:

Fill In Site Conditions For Your Project	
Location	
Wind Speed	
Ground Snow Load	
Roof Slope	
Buidling Height	
Wind Exposure Category	
Risk Category	
Roof Type	

## 2. MEASURE USABLE SPACE

### Roof Area

Next, you will determine the amount of space on the roof that can be dedicated to your PV system.

Begin with the total south or partially south-facing – which is where modules will be exposed to sun for more hours per day.

### Setbacks

Fire setbacks are areas of the roof that need to remain unobstructed, so that they can be used as a pathway for firefighters to access and vent the roof in the event of an emergency. Setbacks also facilitate safer installation, provide access for future maintenance, and allow for water/snow runoff.

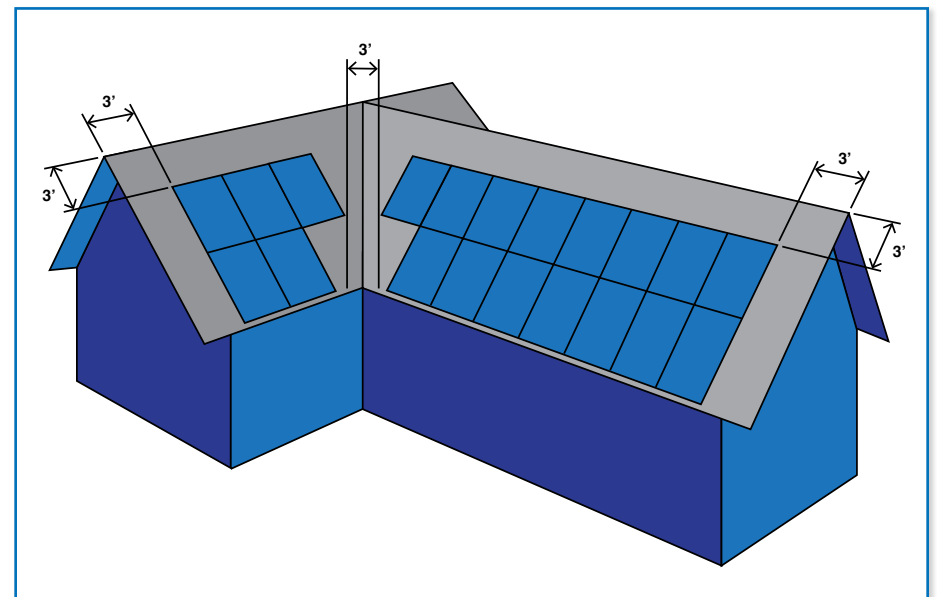
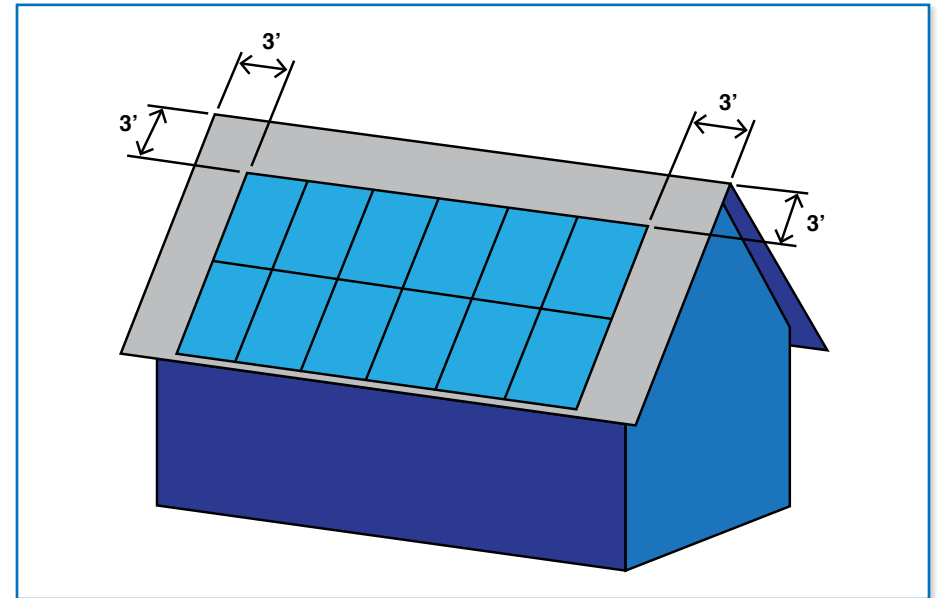
Always check with your local AHJ and fire department on what setbacks are required in your jurisdiction.

### Calculating Setback Areas

The following rules are considered best practice when factoring setbacks into your system design. However, always verify that the design meets your local jurisdiction's requirements.

On a pitched roof, the system design should feature:

- A 3-ft-wide pathway from eave to ridge, and 3-ft-wide setback from the ridge.
- An additional 18-inch setback on either side of a roof hip or valley (if applicable). This adds up to a 3-ft wide pathway.



## 2. MEASURE USABLE SPACE

### Shade and Obstructions

If you have objects shading and obstructing the roof, this will further limit the area where you can place modules. Parts of the roof that are shaded by trees, tall buildings, or other objects will greatly reduce the PV output.

To assess shading on the roof, check out these resources:

- [solarpathfinder.com](http://solarpathfinder.com)
- [solmetric.com](http://solmetric.com)

Other obstructions, such as vents, chimneys, satellite dishes, skylights, and other roof-mounted equipment will both limit your usable space and require special design considerations.

By taking note of setbacks, shading, and obstructions on the roof, you can estimate the number of modules that will fit.

Take the total square footage of the roof area and subtract the square footage for setbacks, shading, and obstructions. Then divide that number by the square footage of the module being used (17 is the approximate square footage of a standard 60-cell module). This will give you a rough estimate of how many standard sized modules can fit onto the roof.

For example, if you have 300 square feet of south or partially south-facing roof area, but 75 square feet are not usable due to setbacks/shading/obstructions, you can fit 13 modules.

#### Module Number Estimate:

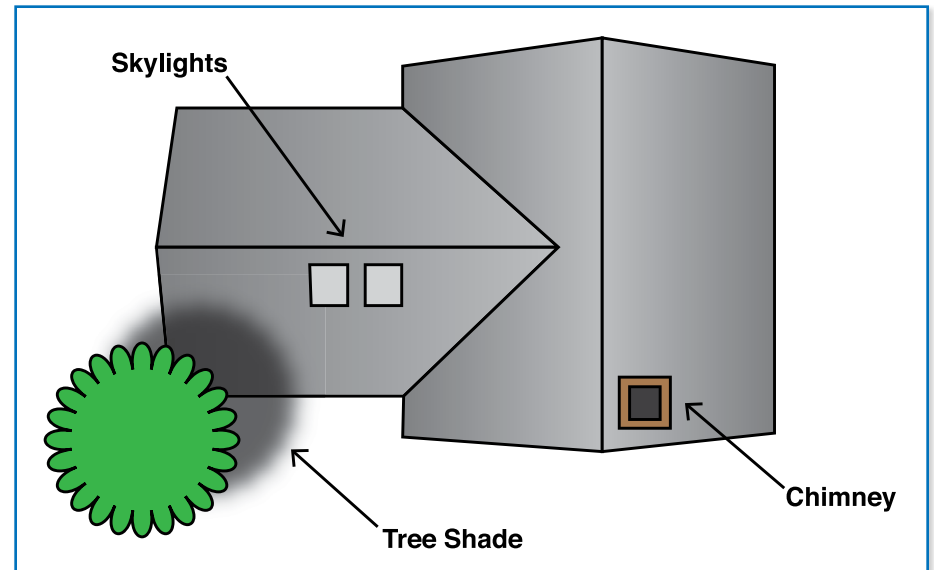
$$(\text{Roof Sq Ft} - \text{Setback Sq Ft} - \text{Shading \& Obstructions Sq Ft}) / 17$$

\*Be sure to round down to the nearest whole number.

### Verify Rafter Spacing

Verify the rafter spacing on the roof. This number impacts where you can place attachments as you lay out your system.

Measure from one rafter to the next (center-to-center), then use the spacing to plan out your attachment locations. The most common rafter spacing for residential homes is 16" or 24".



# 3. DESIGN ARRAY LAYOUT

Now that you know your site conditions and how much roof space is available for PV, you can move onto project layout and design. This also involves selecting the mounting products that will best support your project – such as rails and attachments.

Design Assistant will automatically calculate and display the number of parts and cost at the top of the screen. As you change various factors in the system, you can see it's effect on the total system cost.

## Design Your Array

After entering site information, click “Next” or go to the “Design” tab, which will bring up the Array Editor. Click the “+ Array” icon and hover over the number of modules (columns) and rows for your array. Click the selection to create the array. Click the “+ Array” icon again to add more arrays to your design.

As you build out your array in Design Assistant, the tool will automatically calculate the required amount of several key components. This can be found at the top of the page.

The Dimensions feature in the upper right of the page lets you see how much roof space your array will require. Check these dimensions against the usable space available.

Pitched Roof

SITE

DESIGN

QUOTE

PROJECT NAME  
IronRidge

LOCATION  
Hayward, CA

MSRP (-0%)  
\$ 2,816

WATTS  
9,000

\$/WATTS  
\$0.31

MODULES  
36

ATTACHMENTS  
66

SPLICES  
6

+

ARRAY

ORIENT

SAVE

DELETE

DIMENSIONS ON

26' 4.5"

13' 3"

16' 4.3"

16' 4.3"

A

B

+

-

...

ARRAYS ^

Attachments

ATTACHMENTS

FlashFoot2

RAIL ATTACHMENT HARDWARE

☒ Square Bolt

☐ T-Bolt (limited availability)

Rails

ATTACHMENT SPAN 4 FT

VALUES FOR PORTRAIT/LANDSCAPE

RAIL		XR10	XR100	XR1000
MAX SPAN	Zone 1	6' 11"	10' 6"	13' 11"
	Zone 2	6' 2"	9' 2"	12' 1"
	Zone 3	4' 11"	7' 3"	9' 7"
MAX CANTILEVER	Zone 1	2' 9"	4' 2"	5' 7"
	Zone 2	2' 6"	3' 8"	4' 10"
	Zone 3	2'	2' 11"	3' 10"

REACTION FORCES

	DOWN	UPLIFT	LATERAL
Zone 1	142.00 LBS	-88.00 LBS	0.00 LBS
Zone 2	142.00 LBS	-165.00 LBS	0.00 LBS
Zone 3	142.00 LBS	-268.00 LBS	0.00 LBS

WEIGHT

TOTAL SYSTEM WEIGHT	1871 LBS	WEIGHT/ATTACHMENT	28.4 LBS
RACKING WEIGHT	204.8 LBS	DISTRIBUTED WEIGHT	2.9 PSF

Array Details

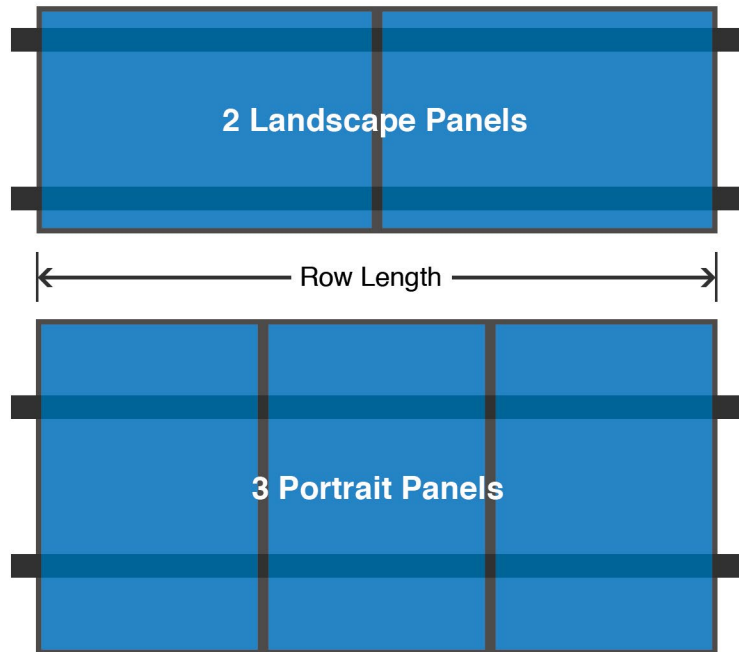


# 3. DESIGN ARRAY LAYOUT

Module orientation will impact how many solar panels can fit into a single continuous row. Modules are most commonly installed in portrait orientation as it allows more modules to be placed in a single row which helps save on material costs.

In some cases, having modules in landscape orientation could allow you to maximize the solar on the roof. However, this will likely require more rails and attachments.

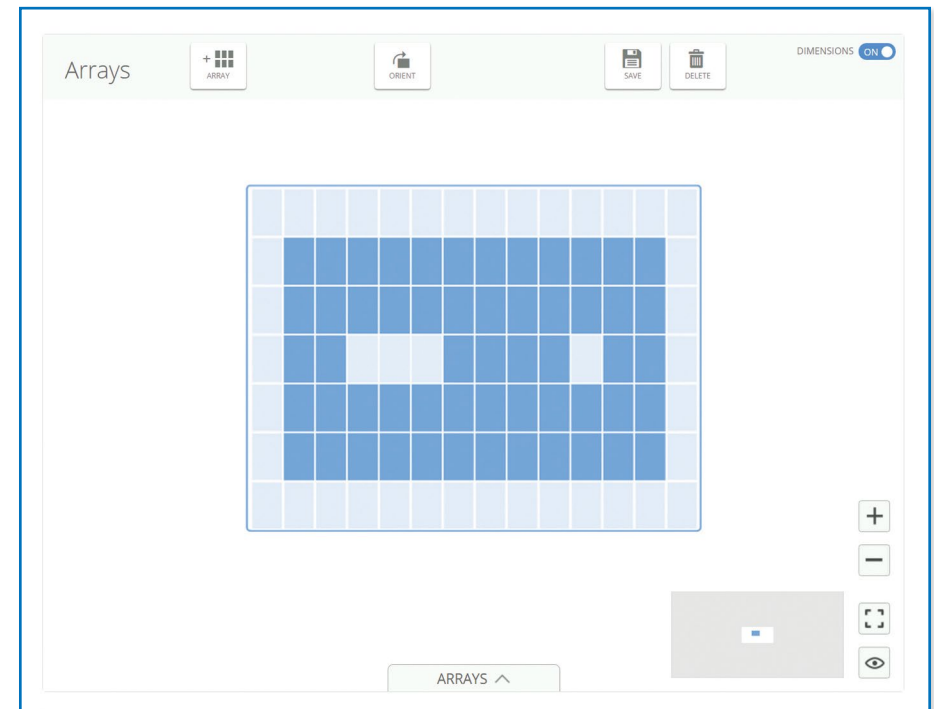
Design Assistant allows you to create projects with rails running East-West. If you plan to run rails North-South, design your project with modules in landscape orientation. Turn the array 90° counterclockwise and invert the dimensions to see your project with rails running North-South.



## Breaks in a Row

If you encounter obstructions like chimneys, skylights, or satellite dishes, it is best to break up a row and start a new one on the other side of the obstruction.

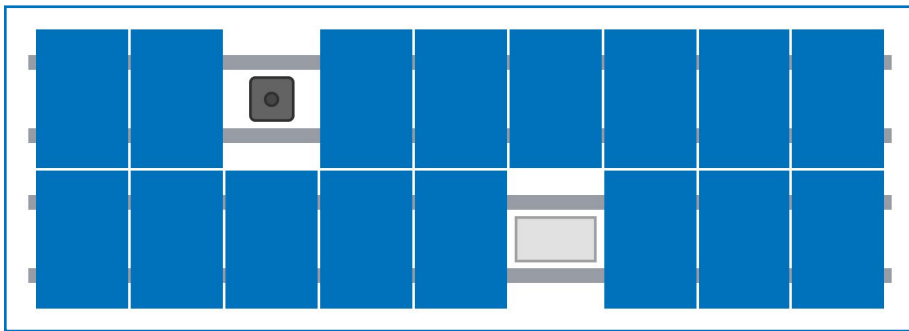
In Design Assistant, highlight an array and click on the modules that you want to remove. The tool will automatically re-calculate the amount of materials needed in the array.



# 3. DESIGN ARRAY LAYOUT

## Spanning Over Obstructions

If you have low-profile obstacles on your roof – such as vents – it is best to span over them instead of breaking up a row. In this case, leave a gap in the row over the obstacle, and install the next module on the other side of the obstruction.



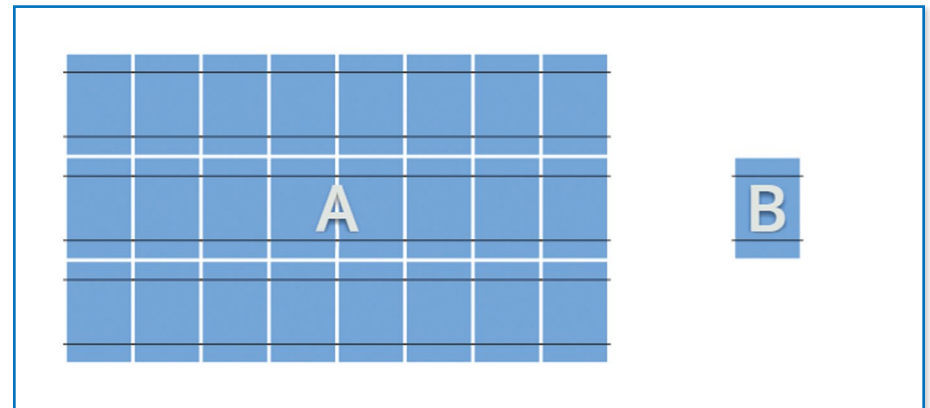
In this scenario, you will not want to remove modules from the Array Editor. Instead, you should design the project as though the modules will remain – which will ensure that you have enough rail. When you complete your project design and move onto the “Quote” tab, you can manually add one kit of Stopper Sleeves (to transform the UFO into an end clamp) for each obstruction spanned over.

GROUP	COLOR	PART	DESCRIPTION	QTY	PRICE/EA	PRICE
ATTACHMENTS		FM-FF1-002	Kit, 6pcs, FlashFoot, Mill	4	\$132.00	\$528.00
CLAMPS & GROUNDING		UFO-CL-001	Kit, 4pcs, Universal Module Clamp	14	\$14.00	\$196.00
		GD-LUG-003	Kit, 2pcs, Grounding Lug, Low Profile	2	\$14.00	\$28.00
		UFO-STP-46MM	Kit, 4pcs, Stopper Sleeve, 46MM, Clear	5	\$2.00	\$10.00
RAILS		XR-100-168A	XR100, Rail 168" (14	12	\$66.42	\$797.04

## Standalone Modules

If roof space is limited, you may need to add a standalone module to meet the desired energy output requirements. Design Assistant will automatically calculate the amount of materials required.

Use the Array Editor to add a single-module array to your system design. Under “Array Details,” Design Assistant will automatically add the four Stopper Sleeves and UFOs required to support the “single” module. Design Assistant will add two 11’ rails to the BOM for a single module. You can cut one rail in half to mount the module, however. So remember to reduce the quantity of 11’ rails by one in the “Quote” tab.





## Choose Attachments

After creating arrays, select the appropriate attachment for your project. IronRidge offers several attachment options that can accommodate various roof types. Reaction Force numbers will turn red to let you know if the engineering values for FlashFoot2 or Flush Standoffs have been exceeded.

# 3. DESIGN ARRAY LAYOUT

## IronRidge Flush Mount System Attachments

Attachment	Roof Type	Description	Image
FlashFoot2	Composition Shingle	Mill or Black Aluminum Flashing with Lag Bolt	
Flush Standoff	Composition Shingle	Mill Aluminum with 5/16" SS Hardware	

## Third-Party Attachments

The IronRidge Flush Mount System has also been tested/evaluated with the third party attachments listed in the Flush Mount Installation Manual:

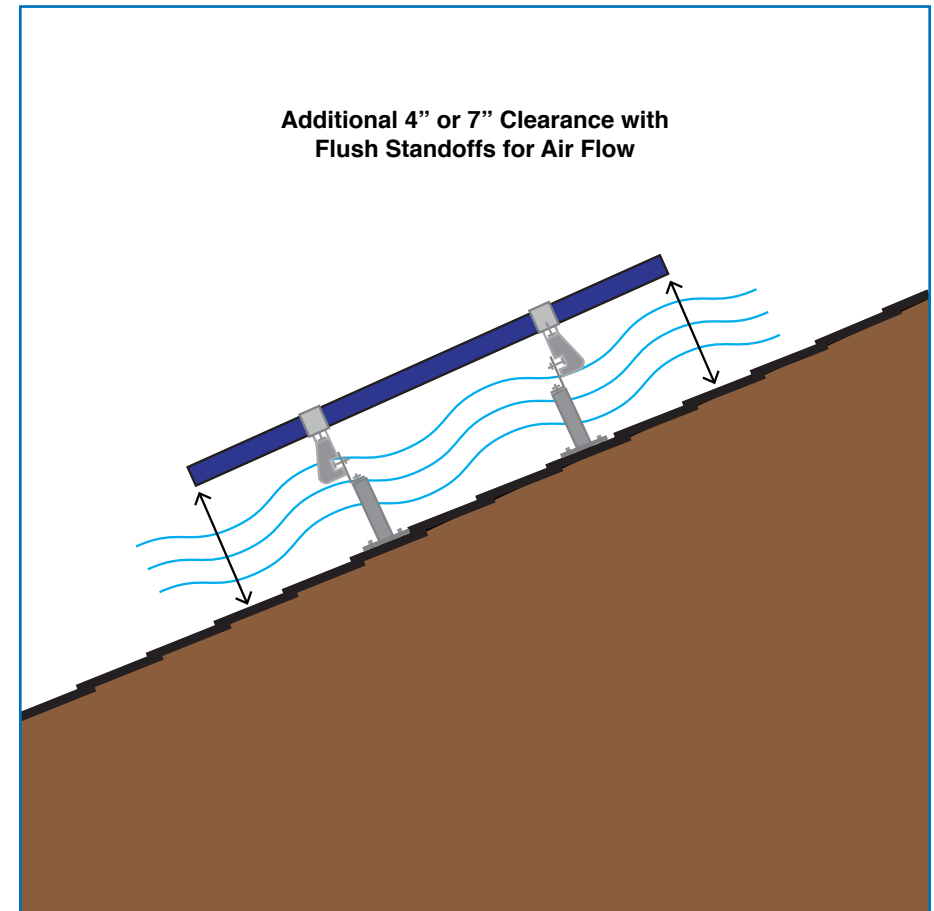
- Anchor Products - U-Anchor
- S-5! Standing Seam Metal Roof Clamps
- EcoFasten Green Fasten GF-1 Anchors
- QuickMount PV Roof Mounts and Tile Hooks
- Quickscrews Solar Roof Hooks
- Ejot Aluminum Roof Hooks
- Unirac Creotecc Tile Hooks

When selecting a third-party attachment, check its capacity against the reaction forces provided in Design Assistant. You can find this information by checking the manufacturer website or contacting them directly.

## Design for Added Air Flow

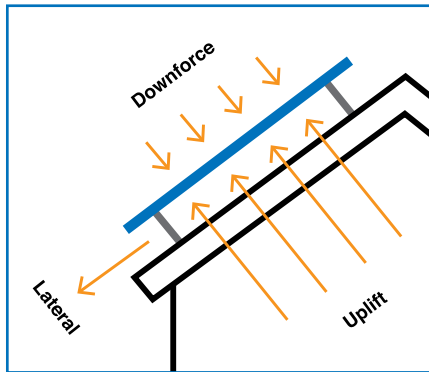
In hot climates, increasing the clearance between the roof and modules can improve air flow which helps cool the modules and increase module efficiency. It is also popular to do so on tile roofs, which heat up more quickly than other roofing materials.

To achieve the additional clearance, you can use IronRidge Flush Standoffs which come in 4" and 7" lengths.



# 3. DESIGN ARRAY LAYOUT

## Reaction Forces



VALUES FOR PORTRAIT/LANDSCAPE			
REACTION FORCES			
	DOWN ①	UPLIFT ①	LATERAL ①
Zone 1	142.00 LBS	-88.00 LBS	0.00 LBS
Zone 2	142.00 LBS	-165.00 LBS	0.00 LBS
Zone 3	142.00 LBS	-268.00 LBS	0.00 LBS
WEIGHT			
TOTAL SYSTEM WEIGHT	WEIGHT/ATTACHMENT		
3229 LBS	32.3 LBS		
RACKING WEIGHT	DISTRIBUTED WEIGHT		
450.5 LBS	3.0 PSF		

## Downforce

This represents the maximum compression, perpendicular to a roof slope, acting on the roof at each attachment due to snow load, wind load, and system weight.

## Uplift

This represents the maximum tension, perpendicular to the roof slope, acting on the roof at each attachment due to wind load and system weight.

## Lateral Loads

This represents the average force, parallel to the roof slope, acting on the roof attachment due to a combination of snow load and system weight.

Make sure reaction forces in the DA project do not exceed what the selected attachment can support. This may require making changes—such as adjusting rail span to reduce these numbers.

## Choose a Rail

The IronRidge XR Rail Family features our unique curved rail profile, which increases strength and resists bending, buckling, and twisting. XR Rails come in three targeted sizes: XR10, XR100, and XR1000. Each size is tailored to support different design loads while minimizing material costs.

XR10 Rail	XR100 Rail	XR1000 Rail
		
<p>A low-profile mounting rail for regions with light snow.</p> <ul style="list-style-type: none"><li>• 6' spanning capability</li><li>• Moderate load capability</li><li>• Clear &amp; black anod. finish</li></ul>	<p>The ultimate residential solar mounting rail.</p> <ul style="list-style-type: none"><li>• 8' spanning capability</li><li>• Heavy load capability</li><li>• Clear &amp; black anod. finish</li></ul>	<p>A heavyweight mounting rail for commercial projects.</p> <ul style="list-style-type: none"><li>• 12' spanning capability</li><li>• Extreme load capability</li><li>• Clear anodized finish</li></ul>

## Attachment Spacing

Design Assistant conveniently displays the maximum allowable attachment spacing based on site/loading conditions. If you exceed the allowable attachment spacing, the value(s) will be highlighted in red.

It is best to select attachment spacing that is a multiple of your rafter spacing. Reducing the attachment spacing (for example, using 4-ft spans) will allow you to use a lighter and less expensive rail.

However, doing so also increases the number of attachments required for the system. Maximizing the attachment spacing will reduce the number of required attachments, but may necessitate the use of a more robust and expensive rail.

### 3. DESIGN ARRAY LAYOUT

Rails <sup>①</sup>		ATTACHMENT SPAN <sup>①</sup>		8		FT	
						VALUES FOR PORTRAIT	
RAIL							
		XR10		XR100		XR1000	
MAX SPAN <sup>①</sup>		Zone 1 <sup>①</sup>		6' 11"		10' 6"	
		Zone 2		6' 2"		9' 2"	
		Zone 3		4' 11"		7' 3"	
MAX CANTILEVER <sup>①</sup>		Zone 1		2' 9"		4' 2"	
		Zone 2		2' 6"		3' 8"	
		Zone 3		2'		2' 11"	
						REACTION FORCES	
						DOWN <sup>①</sup>	
		Zone 1		283.00		LBS	
		Zone 2		284.00		LBS	
		Zone 3		257.00		LBS	
						WEIGHT	
				TOTAL SYSTEM WEIGHT		1268 LBS	

In the example above, attachment spacing is set at 8 ft. Several maximum rail span values are below the desired amount and highlighted red. Determining which rail to select depends on which roof zones the array will be installed in. If the array will not extend into Roof Zone 3 (which will have the highest wind loads), you can select the XR100 rail to minimize rail cost. If the array extends into Roof Zone 3, you will either need to select the XR1000 rail or add attachments to the BOM knowing that spacing will need to be reduced in Roof Zone 3.

#### Attachment Spacing Considerations

You have chosen your rail, attachment type, and desired spans to create a project in Design Assistant. Now you will want to think about where to place the attachments on the roof in order to reduce point loading on rafters.

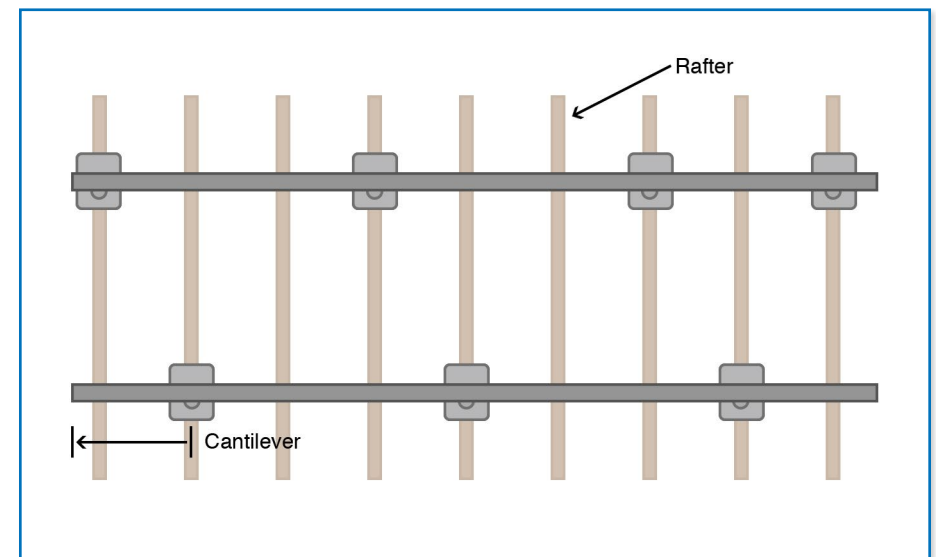
Design Assistant has simple rules for planning attachments. It starts with attachments on the left of the array and calculates

using the spacing you selected. The tool will apply cantilever only on the right side of the array in order to ensure that you always have enough attachments in your Bill of Materials.

#### Stagger Attachments

One option to reduce the point loading on a single rafter is to stagger attachments. This reduces the stress on each individual rafter by distributing weight more evenly across the roof.

Utilizing the cantilever strength (the amount of rail that can extend beyond the last attachment in a row) of XR Rails also reduces the overall number of attachments needed in a system. Design Assistant automatically calculates the allowable cantilever under the "Rails" section. You can use this number to determine how much rail can extend past the last attachment point in a given row. See image of example below.



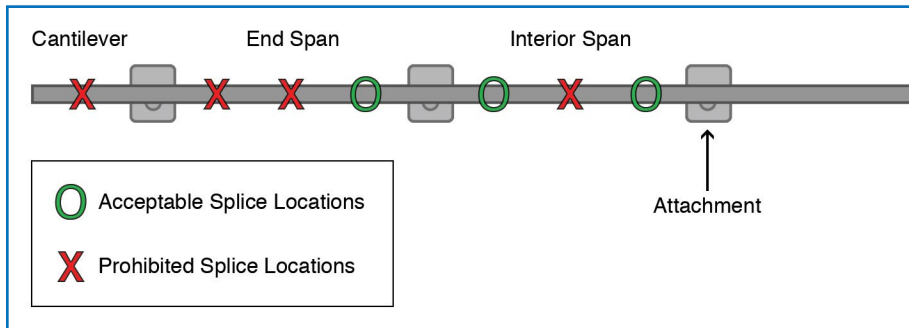


# 3. DESIGN ARRAY LAYOUT

## Plan Splice Locations

If you plan to have rows exceeding standard rail lengths (11', 14', and 17') you will need to splice rail (join two rails together). This enables you to extend the size of your overall array and the number of modules that fit in a single row without any gaps or breaks.

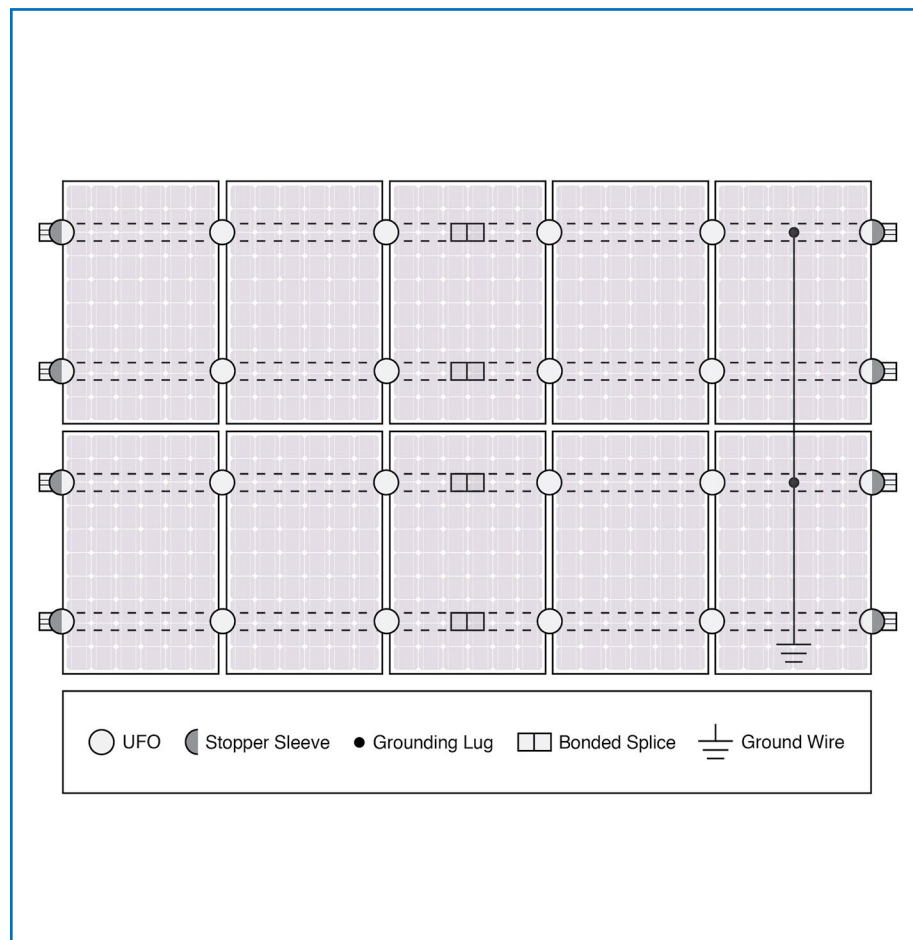
You will need to plan out the splice locations as the internal splices cannot be installed in the outer 2/3 of an end span, or in the middle 1/3 of an interior span (see diagram below).



## 4. GROUND THE SYSTEM

Building authorities require proper grounding in order to mitigate the risk of accidental shocks and system fires.

IronRidge's UL 2703 Listed Flush Mount System effectively bonds modules directly to XR Rails, which eliminates the need for separate grounding hardware. System grounding can be achieved with one ground lug per row of modules connected to a code compliant ground conductor.



### Microinverter and Power Optimizer Compatibility

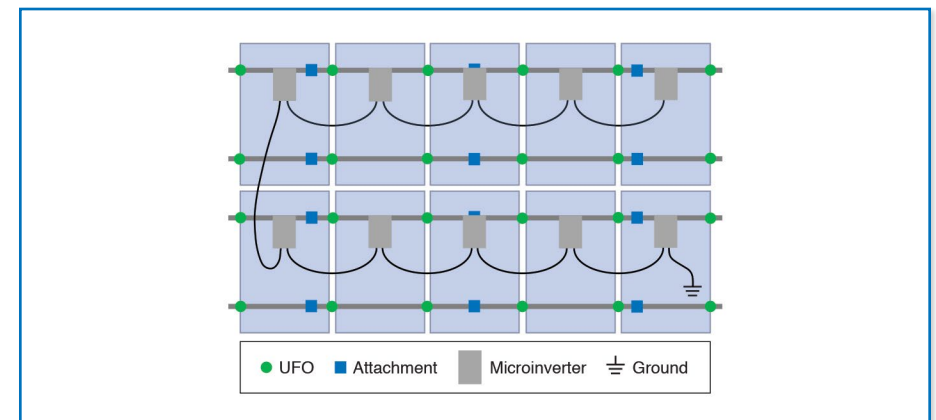
If you are using microinverters or power optimizers in your system, select the Microinverter Kit in the “Accessories” section in Design Assistant. The following devices have been tested and/or evaluated to bond to IronRidge XR Rails:

- Enphase - M250-72, M250-60, M215-60, C250-72, S230, S280
- Darfon - MIG240, MIG300, G320, G640
- SolarEdge - P300, P320, P400, P405, P600, P700, P730, P800p, P800s

### Enphase Microinverters

Using approved Enphase microinverters (M- and C-Series) that have an internal ground provides equipment grounding for the IronRidge Flush Mount System. This eliminates the need for grounding lugs and field-installed equipment grounding conductors.

If you are using such Enphase microinverters to ground your system, you will need to remove Grounding Lugs from your project's Bill of Materials in Design Assistant.



# 5. FINALIZE PROJECT PLAN

## Bill of Materials

Once you've finished configuring the system in the "Design" tab, you can click the "Quote" tab to review your bill of materials. As you've created your project, Design Assistant has been automatically calculating all the components needed in your system.

Review your selections and make changes in the Bill of Materials – whether you need different hardware color, or a larger quantity of parts. You can also add optional accessories to your final Bill of Materials to help with wire management, End Caps, or securing microinverters or power optimizers.

GROUP	COLOR	PART	DESCRIPTION	QTY	PRICE/EA	TOTAL PRICE
RAILS & SPLICES		XR-100-168A	XR100, Rail 168" (14 Feet) Clear	18	\$66.42	\$1,195.56
		XR-100-SPLC-BD	Kit, XR100 Bonded Splice	6	\$8.00	\$48.00
CLAMPS & GROUNDING		UFO-CL-001	Kit, 4pcs, Universal Module Clamp	21	\$14.00	\$294.00
		GD-LUG-003	Kit, 2pcs, Grounding Lug, Low Profile	3	\$14.00	\$42.00
		UFO-STP-46MM	Kit, 4pcs, Stopper Sleeve, 46MM, Clear	6	\$2.00	\$12.00
ATTACHMENTS		FM-FF2-001	Kit, 4pcs, FlashFoot 2 (Mill)	17	\$64.00	\$1,088.00
		FM-SQ-BHW	Kit, 4pcs, Square-Bolt Bonding Attachment Hardware	17	\$8.00	\$136.00
					MSRP	\$2,815.56
					Discount	0 % (\$0.00)
					Total Price	\$2,815.56
					\$/Watt	\$0.31
					Weight	204.8 lbs

## Request a Quote

The "Request Quote" button gives you an easy way to forward project details to a local IronRidge distributor. Search for your current distributor, or select from a list of those nearby.

## Download Project Report

Design Assistant provides a Project Report that is designed to aid in permitting, procurement, and installation. The PDF document includes installation drawings, array details, and the maximum spans and cantilevers for the project.

## Email Team Members

Design Assistant makes it easy to email your Project Report or Bill of Materials to a team member. Click the envelope button and enter in the recipient's email address. They do not need to be a registered user in order to receive the project documents.

## Invite Collaborators

Click the "Invite" button and enter an email address to give someone else access to view and edit your project. They will only be able to access the shared project, and will not have access to the rest of your projects.

## View Relevant Documents

Documents relevant to your project are automatically populated by Design Assistant and listed under "Certification," "Installation," and "Design." These documents can be downloaded or printed for inclusion in your permit package.

## Additional Permitting Resources

You can use the National Solar Permitting Database ([solarpermit.org](https://solarpermit.org)) for details on your local jurisdiction's solar permitting requirements. Click on your state and search by city or county.



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