# Guide, Installation, InvisiMount® Residential Mounting System

Document Number: 508988 Rev F

**March 2016**

<table>
<thead>
<tr>
<th>REV.</th>
<th>DCN#</th>
<th>Description</th>
<th>Date</th>
<th>Author</th>
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<tr>
<td>A</td>
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<td>Initial Release</td>
<td>04/01/14</td>
<td>J. Lentz</td>
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<td>B</td>
<td>DCR-001081</td>
<td>Updates post beta installations.</td>
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<td>C</td>
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<tr>
<td>D</td>
<td>DCR-002158</td>
<td>Updates since limited launch, including end clamp grounding.</td>
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<td>E</td>
<td>DCR-002238</td>
<td>Updates including graphics, rail length optimization; UOM adjustments, remove array width limitation.</td>
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<td>Updates post beta and LA County feedback.</td>
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**SunPower Corporation**

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InvisiMount® Residential Mounting System

INSTALLATION GUIDE

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March 2016
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1.0 Overview and Scope

This guide describes how to install the SunPower InvisiMount® Residential Mounting System (“the system”) on a rooftop; and provides instructions for installing SunPower modules on the InvisiMount system. Do not attempt any aspect of the installation until you have thoroughly read this entire guide. Failure to follow these instructions can result in personal injury or equipment damage or failure, and may void the system warranty.

The system ships with the following standard components:

- rails
- splices
- end clamps
- mid clamps
- ground lug assemblies (rail nut, fender washer, ground lug, and M6 bolt)
- end caps

Depending on the roof type and attachment type, the following components are required and can be sourced from SunPower as well:

- L-feet
- flashings
- roof attachments:
  - composition shingle rafter
  - composition shingle decking
  - curved and flat tile

1.1 Safety and Warnings

IMPORTANT SAFETY INSTRUCTIONS – SAVE THESE INSTRUCTIONS!

All personnel must adhere to the following safety procedures when working on the system, including inspection, installation, operation, service work, repair, and testing. Failure to comply with these precautions or with specific warnings elsewhere in this guide may violate safety standards of design, warranty, manufacture, and intended use of the equipment. SunPower assumes no liability for failure to comply with these requirements.
Warning! The installation, adjustment, or repair of a solar system involves the risk of contact with potentially lethal voltages and currents.

Follow all applicable laws, including state and federal Occupational Safety and Health Administration (OSHA) standards when working on any construction project. Always reference the National Fire Protection Agency (NFPA) 70E, Handbook for Electrical Safety in the Workplace when performing electrical work.

Perform the installation in accordance with all applicable codes. In addition, reference NEC Articles 250 and 690—as well as applicable IEC standards—for proper compliance when wiring and grounding the system. All state and federal guidelines and regulations must be followed as well.

1.1.1 Site Safety

- These installation instructions are for use by qualified personnel only.
- System access is intended for authorized personnel only.
- Only authorized persons may shut down the system or open any system enclosure.
- To reduce the risk of fire, connect only to a circuit that has dedicated overcurrent protection not exceeding the maximum value stated in the product's Listing (20 A) in accordance with the NEC, ANSI/NFPA 70. **Maximum output (branch circuit) overcurrent protection: 20 A.**
- The metal components of the module can reach temperatures of approximately 80° C (176° F). Use appropriate safety procedures when handling modules.

1.1.2 General Warnings

- Do not attempt installation during conditions involving rain, snow, ice, or high winds.
- Do not attempt to install or service the system if you are not a qualified, trained electrician or technician familiar with power electronic equipment.
- Always wear rubber insulating gloves rated for the appropriate voltage level, and suitable eye and head protection when working near live electrical equipment.
- Always have a fully charged, operational cell phone available for calling emergency personnel.
- Never attempt to service any portion of the solar electric system.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

**Note.** Always perform all electrical installations in accordance with any local codes and the National Electrical Code (NEC).
1.2 Installer Responsibilities

**Warning!** If installing InvisiMount on a metal roof, you must first ensure that the InvisiMount system is bonded to the roof in compliance with grounding methods as required by the AHJ.

Installers are solely responsible for specific aspects of the system they are installing.

- Selection and verification of design parameters, including wind and snow load and all related aspects.
- Validation of third-party roof attachment design and interoperability, including any stipulations for rail overhang (cantilever) beyond the last roof attachment (standoff) at the end of a row. The online SunPower Design Tool limits overhang to a maximum of 1/3 the distance to the next adjacent standoff; for example, if the attachment spacing is 61 cm (24’’), a maximum 20.3 cm (8’’) overhang is permissible. Access the tool by logging into the Partner Portal and then clicking the *Design Tool* link.
- Code compliance and permitting.
- Vetting InvisiMount system compatibility with the installation site and structures.
- Verifying the roof integrity prior to installation.
- Selecting the correct attachment and flashing type for the particular roof.
- Care of the roof during the installation.

1.3 Tools and Materials

The following are required to install the system:

<table>
<thead>
<tr>
<th>Item</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cordless drive</td>
<td>Installing fasteners</td>
</tr>
<tr>
<td>Torque wrench</td>
<td>Verifying fastener torque</td>
</tr>
<tr>
<td>10 mm nut driver</td>
<td>Installing splice screws and tightening end clamp bolt</td>
</tr>
<tr>
<td>10 mm ratcheting wrench</td>
<td></td>
</tr>
<tr>
<td>10 mm open-end wrench</td>
<td>Attaching ground lug assembly</td>
</tr>
<tr>
<td>10 mm and 15 mm sockets</td>
<td>Attaching L-foot nut (for threaded end of bolt that fits into rail side channel)</td>
</tr>
<tr>
<td>Metal saw</td>
<td>Cutting rails</td>
</tr>
<tr>
<td>Rubber mallet</td>
<td>Fitting rail end caps</td>
</tr>
</tbody>
</table>

In addition, all applicable PPE (personal protective equipment) is always required.
### 1.4 Components and Key Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>array</td>
<td>One or more strings of photovoltaic modules connected together electrically and positioned as a discrete structure, with common support or mounting.</td>
</tr>
</tbody>
</table>
| **Best Practice** | A method of procedure that, while not mandatory, is recommended by SunPower.  
**Note.** SunPower implies no guarantee of benefit and reminds you to consider each of these recommendations in the context of your own installation experience and build strategy. |
<p>| EGC    | Equipment grounding conductor for row-to-row and system grounding.                                                                       |
| end cap| Fits into each end of each rail and provides a clean, professional look to the array.                                                      |</p>
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>end clamp</td>
<td>Module-to-rail fastener that fits over the end of a rail, clamps to secure each of the endmost modules in a given row, and bonds modules to the rail.</td>
</tr>
</tbody>
</table>
| flashing                 | Thin sections of material (typically sheet metal) that are installed between the roof substrate and any rooftop penetration in order to prevent water from penetrating the roof.  

**Note.** Shown with L-foot—a separate component. |
| ground lug assembly      | An assembly that fits securely into the top rail channel and accommodates the equipment grounding conductor (EGC). Its machined rail nut penetrates the rail anodization to provide a bond between components.  

**Note.** If you are installing SunPower AC Modules on the InvisiMount system no additional grounding hardware, lugs, or copper wire are required on the roof. |
<p>| J-box                    | Junction box. The small box on the back of a module from which the DC leads exit.                                                      |</p>
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-foot</td>
<td>L-shaped bracket that provides interface between the roof attachment and the rail; typically made of stainless steel or aluminum.</td>
</tr>
<tr>
<td>mid clamp</td>
<td>Module-to-rail fastener that attaches in the top rail channel; secures module frames; and bonds modules to the rail throughout a row.</td>
</tr>
<tr>
<td>rail</td>
<td>Extruded aluminum component that attaches to the L-feet and supports clamped modules. Each rail section is 3.28 m (129.13 in. or 10.76 ft.) in length.</td>
</tr>
<tr>
<td>rail splice</td>
<td>Extruded aluminum connector that, along with splice screws, joins two rails.</td>
</tr>
<tr>
<td>row</td>
<td>A horizontal line of adjacent modules (as opposed to a column, which is a vertical line of modules).</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| splice screw        | Black oxide coated stainless steel fastener that, in pairs and in conjunction with a rail splice, attaches two sections of rail together.  
**Note.** Splice screws are single-use components. |
| standalone module   | Any module that is installed in such a position as to not use mid clamps to secure it to the rails.                                                                                                          |
| transition box      | Also called junction box or J-box; is installed on the rooftop and enables the array wiring to transition to the building wiring.                                                                         |
2.0 Certifications and Listings

The SunPower InvisiMount Residential Mounting System is UL 2703 Listed. The InvisiMount Listing includes the following SunPower InvisiMount-compatible 96- and 72-cell modules (DC and AC), which are the only modules that are compatible with the InvisMount system:

<table>
<thead>
<tr>
<th>Module Model</th>
<th>Key</th>
<th>Example Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPR-$$XY$$-###</td>
<td>• YY = 18, 19, 20, or 21&lt;br&gt;• ### = 233–274; or 310–365</td>
<td>SPR-X21-345</td>
</tr>
<tr>
<td>SPR-$$EY$$-###</td>
<td>• YY = 18, 19, 20, or 21&lt;br&gt;• ### = 225–250; or 285–345</td>
<td>SPR-E20-327</td>
</tr>
<tr>
<td>SPR-$$X$$X$$-E$$/NE-WHT/BLK-U-$$YY$$ACPV</td>
<td>• XXX = 225–250&lt;br&gt;• YYY = 240 or 208/240</td>
<td>SPR-250NE-WHT-U-240 ACPV</td>
</tr>
<tr>
<td>SPR-$$V$$W$$-$$XX$$-$$Y$$-Z-G-AC</td>
<td>• V = E or X&lt;br&gt;• WW = 18, 19, 20, or 21&lt;br&gt;• XXX = 225–250 OR 320–360&lt;br&gt;• Y = COM or blank&lt;br&gt;• Z = BLK or blank&lt;br&gt;• G = A or B</td>
<td>SPR-X21-335-BLK-C-AC</td>
</tr>
</tbody>
</table>

The Listing also includes the following components, which have been evaluated for both mounting and bonding in accordance with UL 2703:

- end clamp
- mid clamp*
- rail
- rail splice and splice screw
- ground lug assembly
- L-foot

*UL 2703 Listing is also valid when a mid clamp is used as an end clamp (to secure the edge of a single module at the end of a row, for example).
SunPower InvisiMount® mounting system is compliant with UL 2703 requirements, and module-to-rail grounding is accomplished through both the mid clamp and end clamp.

### 2.1 Fire Classification

- The maximum distance between the roof deck and the bottom of the module frame is 7.6 cm (3").
- In order to maintain the system classification, this assembly must be mounted over a fire resistant roof covering for the application.
- The system achieves a Class A fire rating when installed with modules having a Type 2 fire classification (see Section 1.2).
- The system achieves a Class A fire rating when installed in the manner specified in these instructions.
- The system was evaluated for use on roofs having a pitch $\geq 2''/foot$ (greater than or equal to 2:12).

### 3.0 Torque Specifications

**Important!** SunPower requires that you use a torque wrench—*not an impact driver*—to enforce consistent fastener tightness and thereby ensure safe, high-quality installations.

According to the sequence described in the specific sections of this guide, tighten fasteners as follows:

<table>
<thead>
<tr>
<th>Fastener</th>
<th>Final Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>End clamp</td>
<td>9.6 N-m (85 +5/−0 in-lbs)</td>
</tr>
<tr>
<td>Mid clamp</td>
<td></td>
</tr>
<tr>
<td>Ground lug assembly</td>
<td>M6 bolt: 9.6 N-m (85 +5/−0 in-lbs)</td>
</tr>
<tr>
<td></td>
<td>(This torque value is achieved by 5/6 turn of the bolt after the bolt is finger tight and all play is eliminated. <strong>After tightening in this manner, verify the applied torque with a torque wrench.</strong>)</td>
</tr>
<tr>
<td>L-foot to rail nuts</td>
<td>Lug screw: 4 N-m (35 in-lbs)</td>
</tr>
<tr>
<td></td>
<td>42 +2/−0 N-m (375 +20/−0 in-lbs)</td>
</tr>
<tr>
<td>Fastener</td>
<td>Final Torque</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Rail splice screws</td>
<td>4.5 N-m (40 in-lbs) (This torque value is achieved by 1/3 turn of the screw after the screw face has contacted the rail face. After tightening in this manner, verify the applied torque with a torque wrench.)</td>
</tr>
<tr>
<td>L-foot to roof attachment</td>
<td>Refer to the roof attachment manufacturer's documentation (included in the roof attachment box). If using a roof attachment other than L-feet, refer to that attachment manufacturer’s included documentation.</td>
</tr>
</tbody>
</table>

4.0 Grounding

Ensure that you fully understand the grounding aspects in this section before proceeding.

**Important!** If installing InvisiMount on a metal roof, you must first ensure that the InvisiMount system is bonded to the roof in compliance with grounding methods as required by the AHJ.

This section is intended to provide a well-rounded understanding of all aspects of grounding for SunPower AC Modules when they are installed on the SunPower® InvisiMount™ Residential Mounting System; it contains excerpts from the SunPower 96-Cell AC Module Design and Installation Guide (#515791); and the SunPower AC Module Safety and Installation Instructions (#51744); as well as references to the applicable NEC Articles and UL Standards.

The InvisiMount system is Listed to UL 2703 for integrated grounding; SunPower AC Modules are a bonding component and are Listed to UL 1741. If you are installing SunPower AC Modules on the InvisiMount system (or any mounting system that is Listed to UL 2703 for bonding—not just for fire classification), **no additional grounding hardware, lugs, or copper wire are required on the roof.**

- The SunPower AC Module is one of the components that bonds all of the metallic non-current carrying components in the system, and is Listed to UL 1741.
- As part of UL 2703, only AC equipment grounding requirements apply—no DC system grounding requirements nor DC equipment grounding requirements apply.
- The equipment grounding conductor (EGC) that’s built into the AC Module cable system is sized appropriately and meets all of the AC equipment grounding requirements for the system.
- The AC dedicated branch circuit wiring from the readily accessible disconnect to the array must include an equipment grounding conductor (EGC) in the same raceway or cable as the AC circuit conductors. This EGC must be connected to the green conductor of the transition cable, which is part of the AC module cable system.
The AC Module cable system is “daisy-chained” and therefore if a module is removed from a circuit (for service or replacement, for example), you must first disconnect all power and then install a temporary EGC to bridge the gap by inserting an AC extension cable or other means, in order to maintain effective ground continuity to subsequent modules. Disconnecting a module from the circuit removes voltage and ground from the other downstream modules in the circuit. Extreme care should be taken to ensure that no other energized sources are adjacent to these ungrounded modules.

Because the DC power is internal to the module, a grounding electrode conductor (GEC) for the module or array is not required. The existing AC GEC at the utility service serves as the NEC-required GEC for the structure.

The AC cable grounding path has been tested by an NRTL, and its electrical continuity from the AC cable ground pin to the module frame has been certified.

The AC Module interconnecting cable system provides an internal EGC for grounding the AC Modules. It is the installer's responsibility to ground any metallic mounting structure according to local code—recall that if you are installing AC Modules, the system provides grounding of the InvisiMount mounting structure and thus no supplemental grounding is required.

Neither the AC Modules nor the array require a grounding electrode conductor (GEC). The AC Modules must be connected to a dedicated AC branch circuit with an appropriately sized equipment grounding conductor (EGC). The equipment grounding conductor must be connected to a grounding electrode using the existing premises wiring system, typically originating at the building service entrance or service panel.

There is no neutral conductor in the AC Modules. Each AC Module has been designed and is Listed to operate without a neutral conductor. The reference to ground in the AC Modules is through the equipment grounding conductor (EGC).

The AC interconnecting cable system attached to each module's microinverter is fully insulated and includes an internal EGC. The grounding pin is longer than the others in the plug, providing a “first to make, last to break” connection sequence.

The green conductor in the transition cable (“trans cable”) is connected to the EGC from the utility dedicated branch circuit (“house ground”).

The AC ground wire inside the microinverter terminates on the microinverter chassis with a bolted connection, and is environmentally sealed.

The microinverter chassis is bonded to the module frame with stainless steel hardware to provide ground continuity to the module frame.

Each receptacle has a ground pin that is longer than the circuit pins to ensure that the ground is the first to make contact when connecting a given plug–receptacle pair, and the last to break contact when disconnecting the pair.

Each SunPower AC Module includes a factory-integrated microinverter (MI) that does not require a neutral wire to be connected to it for operation or for compliance with IEEE 1547. Power produced is conducted on the L1–L2 240 VAC or 208 VAC grid connection. Utility interactive functions in the MI circuitry have been evaluated to IEEE 1547, and use the ground wire instead of the neutral to determine grid values. This functionality is part of its UL Listing.
This product must only be connected to a single-phase system (L–L) of a premises with the neutral (N) bonded to ground at the service entrance per code. (The MI does not reference the N to ground internally, therefore this reference must be accomplished only at the service entrance.) Ensure that the installation site has a high-quality N-to-ground reference at the service. The MI determines L–N voltages based on measuring internally from L to the MI chassis, which is connected to the EGC.

### 4.1 NEC Compliance and the Ground Path

The following are the grounding-related NEC Articles and applicability for SunPower AC Modules on rooftops, and are relevant when SunPower AC Modules are mounted on the InvisiMount system:

- 690.41 does not apply to AC modules.
- 690.42 does not apply to AC modules.
- 690.43 covers equipment grounding, which is the only required type of grounding for an AC module.
- 690.45 specifies that the EGC for PV Source and PV Output circuits be sized based on 250.122. Per 690.6, requirements in 690 pertaining to PV Source circuits shall not apply to AC modules because the circuits are internal to the Listed AC module. The AC module output is considered an inverter output. Requirements from 250 for equipment grounding are applied from the service to the junction box. The Listed AC Module interconnecting cable system uses the product safety listing standard which is based on section 250.122 and other sections in 250.
- 690.46 modifies 690.45 when the EGC is not protected within a raceway. This is not relevant to the AC Module system because the EGC is within the listed AC Module interconnecting cable system.
- 690.47 does not apply to AC modules:
  - 690.47(A) does not apply when installing an AC system. The AC “system” was already existing on the premises, and hence you are installing AC modules on the AC system.
  - 690.47(B) applies to DC systems; it does not apply to AC modules.
  - 690.47(C) does not apply (see 690.47(B)).
  - 690.47(D) only provides guidance for a “dc grounding electrode conductor.”
- 690.48 applies, but isn't relevant.
- 690.49 does not apply.
- 690.50 applies, but isn't relevant.

Note as well that Section 4.1 of the SunPower AC Module Safety and Installation Instructions (#51744) explains:

As a Listed product, “SunPower AC modules shall be installed and used in accordance with any instructions included in the listing or labeling” (110.3(B)). In addition, SunPower AC Modules “shall be grounded using the integrated equipment grounding conductor...no additional grounding conductor attachment to the AC module is required.”
4.2 System Ground Path

The system features:

- Integrated module-to-rail as well as adjacent-module bonding (achieved through the mid clamp and end clamp).
- Integrated rail-to-rail bonding (achieved through the self-drilling splice screws and the splice).
- System bonding is achieved through the ground lug assembly to the equipment ground conductor (EGC).

**Note.** The ground lug is only required when installing DC modules—*for arrays that feature AC Modules this system bonding is achieved solely through the system's components.*

The following two diagrams illustrate the key grounding and bonding aspects of the InvisiMount system—for AC and for DC module scenarios:

- the system ground path
- each component
- each bonding point
- the applicable NEC and UL references
### SunPower InvisiMount™ with AC Modules

1. **Building Grounding Electrode (GEC)**
2. **Service Panel to Rooftop Junction Box**
3. **Rooftop Junction Box to AC Cable**
4. **AC Cable to Microinverter**
5. **AC Module to AC Module Frame**
6. **AC Cable to AC Cable**
7. **AC Module Frame to Mid Clamp to Rail**
8. **AC Module Frame to End Clamp to Rail**
9. **Rail to Splice**

<table>
<thead>
<tr>
<th>Bonding Components</th>
<th>Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NEC</td>
</tr>
<tr>
<td>Grounding Electrode to Service Panel</td>
<td>690.47(A)</td>
</tr>
<tr>
<td></td>
<td>690.47(D)</td>
</tr>
<tr>
<td>Service Panel to Rooftop Junction Box</td>
<td>690.43</td>
</tr>
<tr>
<td>Rooftop Junction Box to AC Cable</td>
<td>690.43(A)</td>
</tr>
<tr>
<td></td>
<td>690.43(D)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>AC Cable to Microinverter</td>
<td>n/a (part of Listing)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Microinverter to AC Module Frame</td>
<td>n/a (part of Listing)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>AC Cable to AC Cable</td>
<td>690.43(A)</td>
</tr>
<tr>
<td></td>
<td>690.43(D)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>AC Module Frame to Mid Clamp to Rail</td>
<td>690.43(A)</td>
</tr>
<tr>
<td></td>
<td>690.43(C)</td>
</tr>
<tr>
<td></td>
<td>690.43(D)</td>
</tr>
<tr>
<td>AC Module Frame to End Clamp to Rail</td>
<td>690.43(A)</td>
</tr>
<tr>
<td></td>
<td>690.43(C)</td>
</tr>
<tr>
<td></td>
<td>690.43(D)</td>
</tr>
<tr>
<td>Rail to Splice</td>
<td>690.43(A)</td>
</tr>
<tr>
<td></td>
<td>690.43(C)</td>
</tr>
<tr>
<td></td>
<td>690.43(D)</td>
</tr>
</tbody>
</table>
SunPower InvisiMount™ with DC Modules

1. Building Grounding Electrode (GEC) to Service Panel
2. Service Panel to Rooftop Junction Box
3. Rooftop Junction Box to Ground Wire
4. Ground Wire to Ground Lug to Rail
5. Module Frame
6. Rail to Mid Clamp to Module Frame
7. Module Frame to End Clamp to Rail
8. Rail to Splice

<table>
<thead>
<tr>
<th>Bonding Components</th>
<th>Compliance</th>
<th>NEC</th>
<th>UL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Grounding Electrode to Service Panel</td>
<td>690.47(A)</td>
<td>690.47(D)</td>
<td>n/a</td>
</tr>
<tr>
<td>2. Service Panel to Rooftop Junction Box</td>
<td>690.43</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>3. Rooftop Junction Box to Ground Wire</td>
<td>690.43(C)</td>
<td>1741</td>
<td></td>
</tr>
<tr>
<td>4. Ground Wire to Ground Lug to Rail</td>
<td>690.43(C)</td>
<td>2703</td>
<td></td>
</tr>
<tr>
<td>5. Module Frame</td>
<td>n/a</td>
<td>1703</td>
<td></td>
</tr>
<tr>
<td>6. Rail to Mid Clamp to Module Frame</td>
<td>690.43(A)</td>
<td>690.43(D)</td>
<td>2703</td>
</tr>
<tr>
<td>7. Module Frame to End Clamp to Rail</td>
<td>690.43(A)</td>
<td>690.43(C)</td>
<td>2703</td>
</tr>
<tr>
<td>8. Rail to Splice</td>
<td>690.43(A)</td>
<td>690.43(C)</td>
<td>2703</td>
</tr>
</tbody>
</table>
5.0 Installation Outline

1. Mark the rooftop for penetrations.
2. Install flashings (if part of your chosen attachment solution) and roof attachments.
3. Join and install rails.
4. Attach ground wire.

**Note.** If you are installing SunPower AC Modules, a ground wire is not required.

5. Install modules.

5.1 Module Spacing

The spacing between the modules shall be as follows:

- Intra-row spacing (side to side; E–W in a typical row): spacing is governed and enforced when the mid clamps are installed, and is 20 mm (0.8”).
- Inter-row spacing (between an “upper” row and a “lower” row in a typical two-row array): minimum 6.5 mm (1/4”).

5.2 Attachment Span and Rail Cantilever

The maximum distance (span) between roof attachments (L-feet or other attachment type) is 1.8 m (6’).

The maximum rail overhang distance (cantilever) is 1/3 of the maximum span: 0.6 m (2’).

**Note.** A spliced rail does not require any special allowance for span nor cantilever.
6.0 Install System

These instructions describe attaching the rails parallel to the peak ("E–W")—the most common configuration. If you are installing SunPower modules, the rail length as shipped (3.28 m [129.13"] is optimized for both 96- and 72-cell SunPower module configurations:

<table>
<thead>
<tr>
<th>SunPower Module</th>
<th>Orientation</th>
<th>Number of Modules per Rail Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>96 cell</td>
<td>Portrait</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Landscape</td>
<td>2</td>
</tr>
<tr>
<td>72 cell</td>
<td>Portrait</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Landscape</td>
<td>2</td>
</tr>
</tbody>
</table>

Your array should be fully designed and all required permitting obtained before you begin. The SunPower Design Tool determines the actual span between attachments for a given system.

Designers can access the Tool by logging into the Partner Portal and then clicking the Design Tool link. The Tool yields all the racking–specific structural calculations that can then be provided to the AHJ and that are typically part of the permitting process.

It is acceptable to attach either to the rafters or to the roof deck. SunPower recommends the following attachments:

- For rafter attachment: SunModo K10068-BK8 (SunPower #508329)
- For deck attachment SunModo K10068-BK7 (SunPower #508330)

Instructions for installing the above attachments can be found here:


For curved and flat tile roofs, SunPower recommends Quick Mount PV QMHSS (SunPower #510083). Installation instructions can be found here:

www.quickmountpv.com/support/videos/qhk-quick-install.html
6.1 Join Rails

Depending on the roof slope and other factors, you may instead decide to join rails on the ground before transporting them to the rooftop. The rails and the splices have pre-drilled holes for the splice screws.

**Important!** The rail splice is an integral part of the ground path. There must be no interference between the splice screws and the L-feet. Therefore, ensure that the splice screws will not interfere with your eventual attachment of the rail to the L-feet.

1. Fit a splice halfway into a rail end, align the splice holes with the rail holes, secure the components so that they will not move, and then drive a splice screw through the aligned hole nearest the end of the rail ("1," Fig. 1), stopping 1/3 turn after the screw face has contacted the rail face (Fig. 2). This method provides 4.5 N-m (40 in-lbs) of torque. Drive another screw through the other hole pair in the same manner ("2," Fig. 1), and then use a torque wrench to verify and (if necessary) apply final torque to each screw.

Splice screws are single use. If a screw becomes dull or prevents smooth, consistent penetration of the splice, use a new screw in the original hole. If a screw breaks, drill a new 5 mm hole in the rail and splice no nearer than 1.3 cm (1/2″) from the original hole, and drive a new screw through the rail and into the splice—do not reuse the original hole. Ensure that you deburr the new hole.

2. Fit the second rail all the way onto the splice protruding from the first rail, and align the respective holes.

The rail holes and splice holes must be aligned; the rail ends are not required to be in contact with each other. The maximum distance between a spliced rail pair is 6.4 mm (1/4″).
3. With both rails still secured, through the two holes in the second rail, drive two of the screws in the same manner and sequence: the screw nearest the rail end goes in first, such that there are four screws per splice—two through each rail end (Fig. 1, second rail not shown).

### 6.2 Install Flashings, Roof Attachments, and Rails

1. Define the installation zone on the rooftop and mark it for penetrations as necessary.

2. **Referring both to the flashing (if appropriate for the roof type) and to the attachment manufacturer's documentation:**
   
   a. Install the flashings and the roof attachments (see Section 1.10).

   b. Attach an L-foot to each of the roof attachments according to the method described by the attachment manufacturer's documentation. *Leave the attaching hardware finger-tight for the moment.* (You will tighten it in Step 11.)

3. Position the rails on the roof, adjacent to the L-feet and such that the side channel of each rail is facing the roof peak (Fig. 3 and Fig. 5).

   **Important!** To ensure precise alignment with the finished array's footprint (perimeter), cut rails only after you have adjusted them to an even height and fully secured them to the attachments.

4. For each rail, determine the number of L-feet to which it will attach, and then slide that number of bolts into the rail's side channel (bolt heads fit into channel; Fig. 4).

   **Important!** For your roof attachment strategy, remember that a spliced rail is the same as a solid rail in that a **spliced rail does not require any special allowance in terms of overhang or attachments.**
5. Position the rail—with its side channel facing toward the peak—adjacent to and “below” (relative to the peak) the L-feet for the given row (Fig. 5).

   **Note.** L-feet must only “face” the peak (Fig. 5).

6. L-feet (or any other attachment type) must be positioned such that the L-foot-to-rail bolt is a minimum of 5 cm (2") from the end of a rail (Fig. 6); and a minimum of 5 cm (2") from any rail joint (Fig. 7).
7. Attach the rail to the L-feet by fitting the rail bolts through the slots on the L-feet and then temporarily finger-tightening an M10 nut on each of the bolts. (You apply torque to these nuts in Step 10.)

Position each bolt at the midpoint of the vertical slot in its L-foot (Fig. 8). This will provide the greatest vertical adjustment flexibility.

8. To ensure that the installed modules will appear as an even plane, SunPower recommends that you use a string line and level (or other method) to ensure that the top surface of the rails is even (Fig. 9).

9. After you are satisfied that the rails are level, tighten each L-foot nut to 42 +2/−0 N-m (375 +20/−0 in-lbs).

   **Note.** The L-feet should still be only loosely attached to the roof attachments.

10. Tighten all of the L-foot-to-roof-attachment hardware according to the attachment manufacturer's instructions. (If you are not using L-feet, tighten the attachment hardware according to the attachment manufacturer's instructions.)
6.3 Attach Ground Wire

Route and attach the row-to-row ground wire before installing any modules.

If you are installing SunPower AC Modules, this ground wire is not required.

Important! Ensure that the copper ground wire does not contact any aluminum! (Refer to Fig. 15.)

Install one ground lug assembly per row (Fig. 10), not per rail. If your array has a standalone module, you must install a ground lug assembly on one of its rails as well (refer to Section 1.12.5).

1. Slide the rail nut (Fig. 11) into the end of the top channel of a rail and position it where you want to attach the ground wire (you can disassemble the ground lug first if necessary).
2. Position the washer directly over the rail nut (Fig. 12), and then use the M6 bolt to attach the lug to the rail nut by first orienting the lug parallel to the array (Fig. 13), finger-tightening the bolt, and then using a 10 mm open-end wrench to apply an additional 5/6 of a turn only (Fig. 14). Doing so provides 9.6 N-m (85 +5/−0 in-lbs) of torque. After tightening in this manner, verify the value with a torque wrench.

3. Attach the copper ground wire to the lugs such that the rails are bonded together as per NEC. Tighten the lug screw to 4 N-m (35 in-lbs) (Fig. 12).

As you add modules, reposition the ground wire as necessary such that it will remain below the module frames but above the rails and will never contact the module frames or the rails!

Because it is possible that, over time, the ground wire may inadvertently come into contact with a rail or other system component, attach another ground lug assembly to the rail and route the ground wire through it, to act as a spacer/retainer and help ensure that the ground wire remains securely in the position in which you installed it.
4. Following standard construction practices and the NEC, connect the array ground wires to the building's ground.

**Warning!** The ground wires must never be any closer to any other metal than 0.6 cm (1/4”) (Fig. 15).

![Fig. 15](image-url)
6.4 Install Modules

This section describes installing SunPower modules on the InvisiMount system.

Rails may be positioned in the green (non-crosshatch) regions only, as follows:

<table>
<thead>
<tr>
<th>Module</th>
<th>Tolerances</th>
</tr>
</thead>
<tbody>
<tr>
<td>96 cell</td>
<td><strong>All sides</strong>: Minimum of 5 cm (2&quot;) but not more than 40.6 cm (16&quot;) from any module corner (Fig. 16 and Fig. 18).</td>
</tr>
</tbody>
</table>
| 72 cell | • **Short side**: Minimum of 5 cm (2") but not more than 25.3 cm (10") from any module corner (Fig. 17 and Fig. 19).  
• **Long side**: Minimum of 5 cm (2") but not more than 40.6 cm (16") from any module corner (Fig. 17 and Fig. 19). |

Fig. 16

Fig. 17
Tolerances are identical around each corner

Fig. 18

Tolerances are identical around each corner

Fig. 19
**Important!** If an L-foot in its final installed position extends above the top surface of the rail, you must ensure that the L-foot does not contact any part of the module or module frame (Fig. 20).

**Warning!** Do not step on, stand on, or walk on the modules or the module frames, and do not place anything whatsoever on them—even for a moment.

1. Slide an end clamp over the same end of each of the row’s two rails, such that the clamp opens away from the roof peak (Fig. 21). Position the clamp near the end of the rail.

2. Position the first module atop the rails.

   Always have two workers transport and position each module.

**Important!** If you are installing modules in landscape position, ensure that you review the rail positioning table at the beginning of this section.

3. Move the first module into position near the end of the rails, and then reach under the module and slide the end clamps toward the rail ends, ensuring that each clamp fits over the module frame edge as far as it will go (Fig. 22).

**Note.** Clearance between the roof surface and the modules is a function of the roof attachment method chosen.
4. Keeping the two end clamps in full engagement with the module frame, adjust the module so that the module edge is aligned with but covers up the ends of the rails (Fig. 23; the rails are hidden just beneath the module edge).

5. Tighten each of the two end clamps to 9.6 N-m (85 +5/−0 in-lbs).

6. Fit one mid clamp down into the top channel of each of the row’s two rails, rotate it 90° (Fig. 24), and slide it toward the first module. Leave the two mid clamps loose for now.

**Note.** Strategically position the mid clamps along the rails according to your chosen build strategy.

7. Position the second module next to the first module.

8. For each of the two mid clamps: fit one side (two teeth) of each clamp over the respective adjacent frame edge of each of the two modules (the first and second modules) (Fig. 25; second module not shown).
9. Tighten each of the two mid clamps to 9.6 N-m (85 +5/−0 in-lbs). (You tighten the mid clamps per module as you build the rows.)

**Important!** Each mid clamp's four teeth must solidly engage the module frames to ensure continuity of the module–rail ground path (Fig. 26).

10. Adding a pair of mid clamps per module, repeat Steps 6–9 until you have installed all except for the last module in the row.

**Note.** Pay close attention to the module-to-module alignment as you add modules.

11. Position the last module in the row at what will be its final installed location.

12. At the point where the outer (perimeter) edge of the module contacts the rails, mark each of the rails, and then remove the module.

**Note.** Alternatively, you can measure the distance (or use a jig you may have fabricated) instead of placing and removing the actual last module.

13. At the marks you made, cut each of the rails.

14. Reposition the last module and then repeat Steps 3–5 to secure it with end clamps.

15. Fit an end cap into each end of each rail, tapping it in fully with a rubber mallet (Fig. 27).
6.5 Standalone Modules

Any module in an array that will not include mid clamps as part of its mounting hardware is considered a “standalone module.” Typically a standalone module arises when an array has a module “missing” in order to accommodate a rooftop feature or obstruction, or when an array forms a “pyramid” shape and the topmost (or bottommost) row contains only a single module.

If you are not installing SunPower AC Modules, you must ground a standalone module as if it were its own row by attaching a ground lug assembly to one of its rails (Fig. 28 and Fig. 29), and routing the copper ground to it.

**Note.** If you are installing SunPower AC Modules in landscape position, any standalone module must instead have its rails perpendicular to the roof peak (Fig. 29).
Appendix A: Module Removal

Important! If you have to remove a module from an array, note that leaving any module in the array when it is physically secured only by two end clamps is expressly prohibited.

The AC Module cable system is “daisy-chained” and therefore when a module is removed from a circuit, you must first disconnect all power and then install a temporary EGC to bridge the gap by inserting an AC extension cable (or via other NEC-compliant means), in order to maintain effective ground continuity to subsequent modules.

To remove a module from an existing array:

1. Turn off the DC disconnect at the inverter.
2. Using a clamp-on multimeter, verify that current flow has stopped on all DC source circuit conductors. If fuses are installed at the combiner, remove the fuses to isolate the circuit with the target module from parallel-connected sources.
3. Using a clamp-on current meter, test each individual circuit conductor AND each equipment ground conductor on the rooftop before opening any module connectors (before disconnecting any module leads).
4. If the current is zero amps, it is safe to proceed to Step 8. If there is any current present (greater than 0 amps), double-check that the circuit is in fact disconnected from the inverter and proceed to Step 5.
5. If the circuit has been disconnected from the inverter and current is still present, DO NOT INTERRUPT THE CIRCUIT! (Do not unplug any module leads or open any breakers, for example.) It is likely that a short circuit or a ground fault is present—or both.
6. Troubleshoot and correct the short circuit, the ground fault, or both.
7. After verifying that the circuit is disconnected from the inverter and that there are no short circuits or ground faults present, use the clamp-on meter to retest each individual circuit conductor AND each equipment ground conductor. Verify that the current for each is zero before proceeding.
8. Disconnect (unplug) the target module's two electrical leads from the modules that are adjacent to the target module.
9. Remove the adjacent modules and mid clamps, ideally from the side of the row that contains fewer modules between the target module and the end of the row (Fig. A1 and Fig. A2). If there is any other grounding or wire management hardware present, remove it as well.
10. Remove the target module.
   • If the target module will be out of the array solely for the purposes of replacing it with another module immediately, ensure that you remain aware of the adjacent module's temporary partial securement, and execute the swap efficiently, reusing all of the mid clamps and end clamps.
   • If the target module will be out of the array for an extended period, carefully attach two mid clamps to the now-exposed edge of each adjacent module (Fig. A1, Fig. A2, and Fig. A3) according to Section 1.12.4 of this guide (note that two of the teeth on these mid clamps will instead directly engage the top of the rail—
11. After replacing or servicing the target module, reassemble the row according to the instructions in this guide. **Important!** When reinstalling a removed module, shift its original location slightly (min. 1.6 mm [1/16”]) relative to its original installed position and in the direction perpendicular to the rail before retightening the mid clamps and end clamps.

---

*Fig. A1*
Fig. A2

\[ X = \text{Module requiring removal (target module)} \]

\[ R = \text{Remove to access target module} \]

\[ \text{Add mid clamp} \]
Fig. A3

\[ X = \text{Module requiring removal (target module)} \]

\[ R = \text{Remove to access target module} \]

\[ \text{Add mid clamp} \]
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