

# clawFR 10 Degree Installation Manual

## Table of Contents

Introduction & Safety Overview	2
System Components	3
Tools, Torque, Construction Aid & Accessories	4
Construction Aid Setup	5
Build Assemblies	6
Build North Array Row	7
Build Racking	8
Place Ballast	9
Install Module Low Side	10
Install Module High Side	11
Install Deflectors	13
Electrical Grounding	14
Appendix A-F	15-23

## Introduction

The clawFR 10 Degree flat roof mounting system is comprised of four major components that intuitively assemble into a support structure for photovoltaic (PV) modules.

This installation manual explains how to build a PV array using clawFR 10 Degree.

## Mechanical Attachments

THIS INSTALLATION MANUAL DOES NOT COVER THE SELECTION OR INSTALLATION OF MECHANICAL ATTACHMENTS INCLUDING MATERIALS AND FASTENERS USED TO SECURE AND/OR SEAL MECHANICAL ATTACHMENTS TO THE ROOF. PLEASE SEE OEM PROVIDER INSTALLATION MANUALS AND RELATED LITERATURE. A LIST OF OEM PROVIDERS IS SHOWN BELOW.

OEM MECHANICAL ATTACHMENT PROVIDERS:

- Anchor Products: [www.anchorp.com](http://www.anchorp.com)
- OMG Roofing Products: [www.omgroofing.com](http://www.omgroofing.com)
- Facet: [www.sustainabletechnologiesllc.com](http://www.sustainabletechnologiesllc.com)

## Safety Overview

Safety is an essential part of every PV installation and every construction site. It is imperative to plan ahead for any safety concerns and hazards to promote safe work practices during installation. This section does not claim to address or support all safety concerns that may arise during the installation of PanelClaw mounting systems or any other aspect of the work being performed. Before beginning work, installers should refer to all local and federal safety, health, and regulatory requirements to assure compliance. Refer to OSHA Part 1926 and its related Subparts for federal construction related regulations and standards.

Appendix A: Safety outlines some of the major hazards to be aware of during the installation of PanelClaw products.

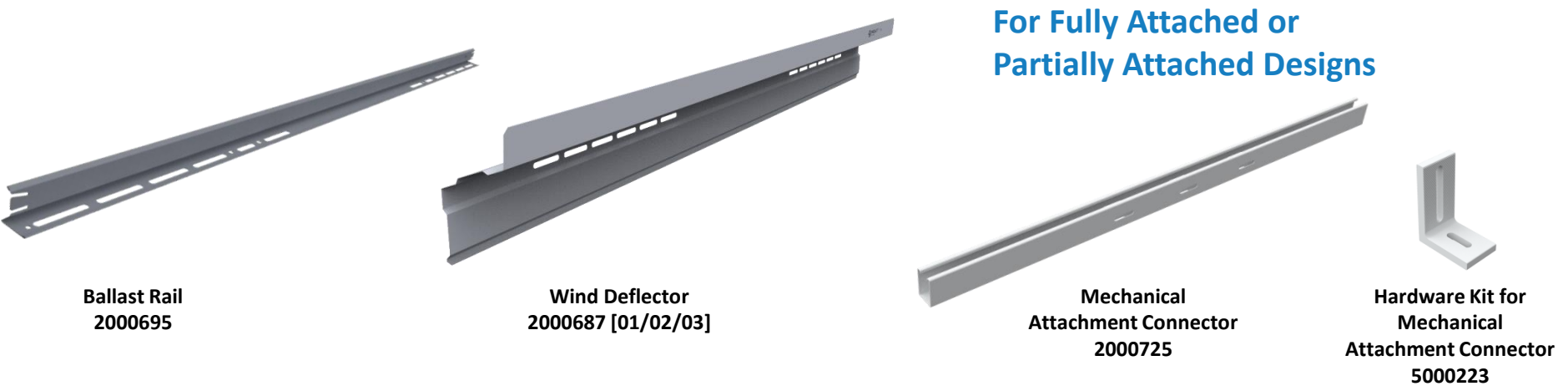
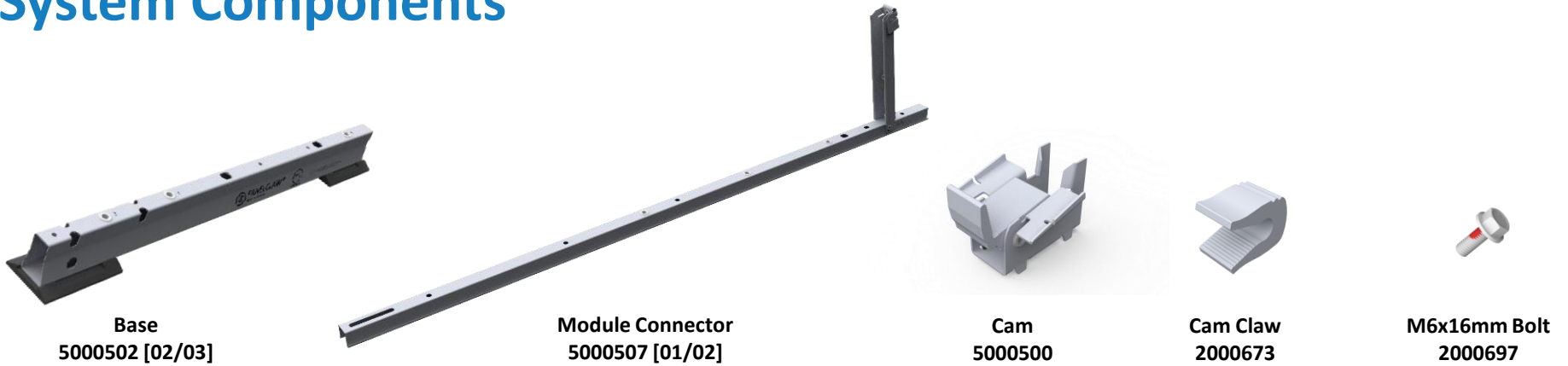


PRIOR TO INSTALLATION, READ THE SAFETY PROVISIONS ATTACHED IN [Appendix A: Safety](#) AND REVIEW THIS INSTALLATION MANUAL IN ITS ENTIRETY.



A CORROSION INSPECTION ONE YEAR AFTER INSTALLATION AND ONCE EVERY THREE YEARS THEREAFTER IS REQUIRED TO MAINTAIN THE PRODUCT WARRANTY. VISIBLE SURFACE RED RUST ON ZAM COATED STEEL COMPONENTS MUST BE LOCALLY COATED WITH A COMMERCIALY AVAILABLE GALVANIZED PAINT OR COATING TO MAINTAIN PRODUCT WARRANTY.

# System Components

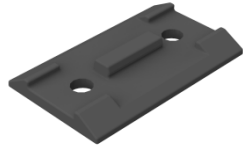


**Ballast Block:** Solid cap concrete roof paver, conforms to ASTM C1491-03 standard and manufactured for freeze-thaw resistance where applicable. See Appendix F for more details

## Optional Accessories



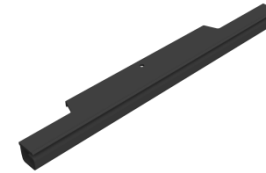
Optimizer Attachment  
5000509



Base Pad  
2000678



Shim Pad  
5000228



Wire Router  
5000225 [01/02]



Wire Clip  
5000226

**Note:** Use of non-UL listed accessories, including these non-metallic components, **does not** affect the system ANSI/UL 2703 certification.

## Construction Aids



Spacer Stick



Cam Spacer / Lock Claw Insertion Depth Gauge

Spacer Stick and Cam Spacer Kit  
5000510

## Tools

Drill with torque limiter or Torque Wrench

10 mm Magnetic Socket

**NO IMPACT DRIVERS**

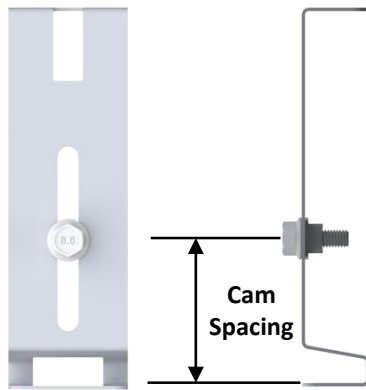
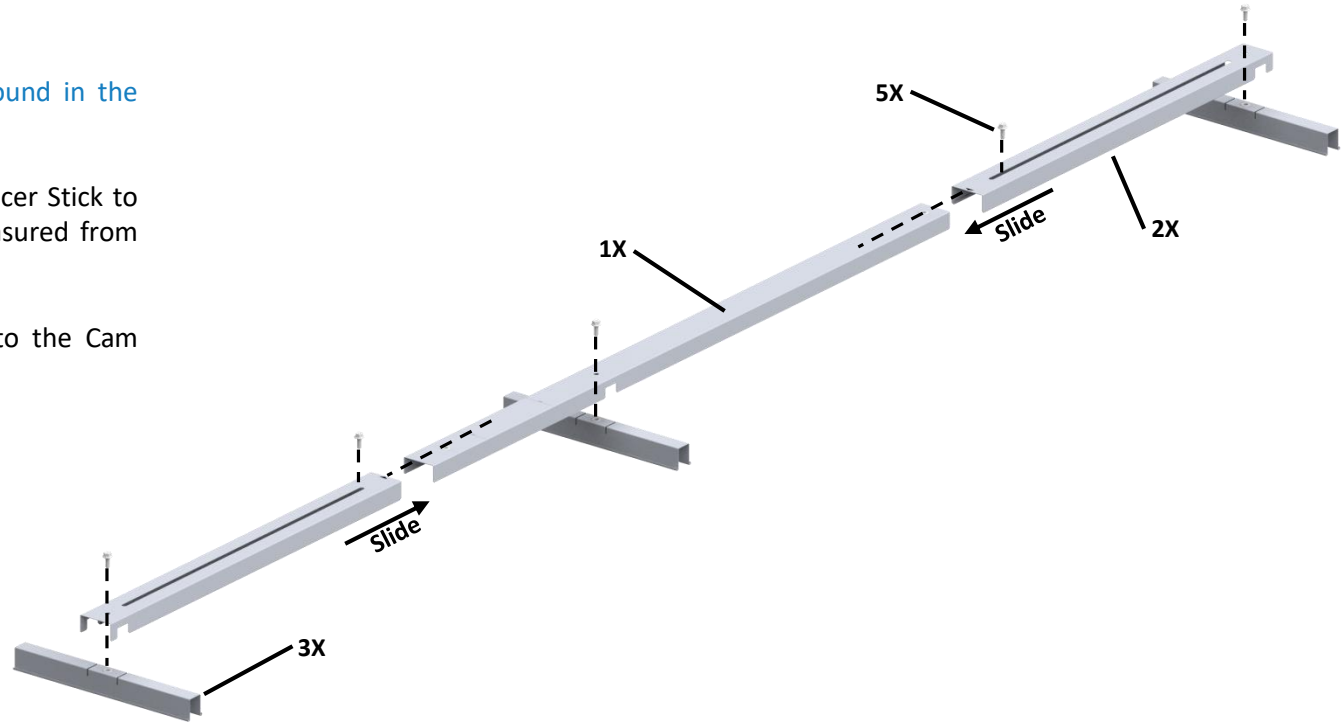
Torque Setting*	Fastening Operation
8 ft-lb (10.8 Nm)	All System connections except South Row Ballast Rail
4 ft-lb (5.4 Nm)	South Row Ballast Rail (includes interior south edges)

\* +/-4% allowable during installation

# 1. Construction Aid Setup

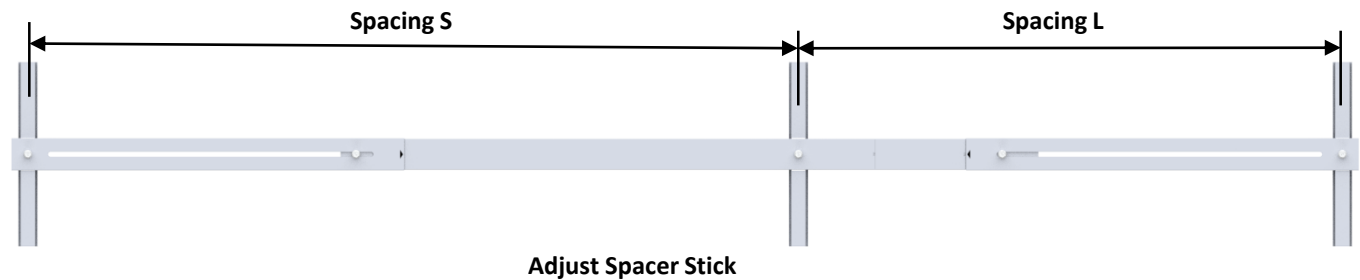
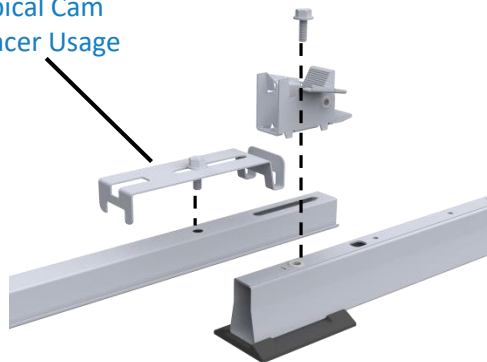
**Tip:** L, S, and Cam Spacer dimensions are found in the Racking Construction Set

- 1.1 Assemble the Spacer Stick and Adjust the Spacer Stick to the L & S dimension. All dimensions are measured from the Base centerlines.
- 1.2 Insert the bolt and adjust the Cam Spacer to the Cam Spacing dimension.



Cam Spacer / Lock Claw Insertion Depth Gauge

Typical Cam Spacer Usage



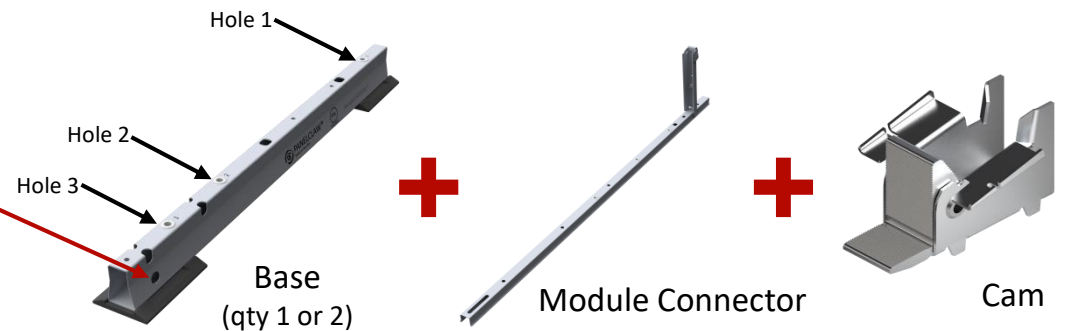
## 2. Build Assemblies

2.1 Position components as required per assembly type and loosely assemble the Cam, Module Connector and Base.

**ALERT:** Note location of orientation marker on Base “●”

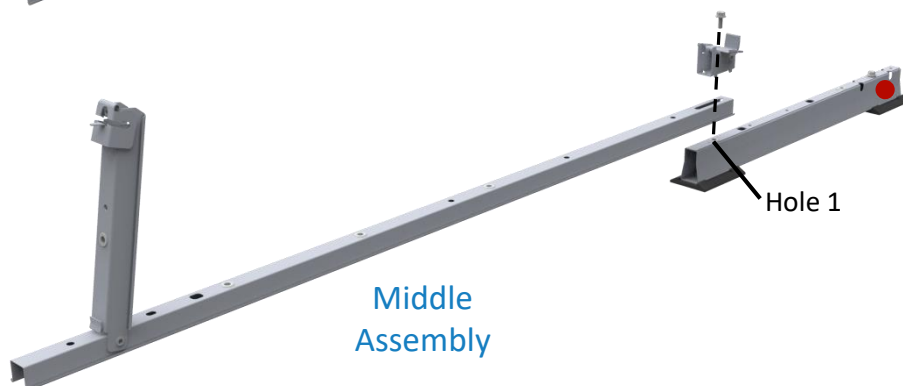
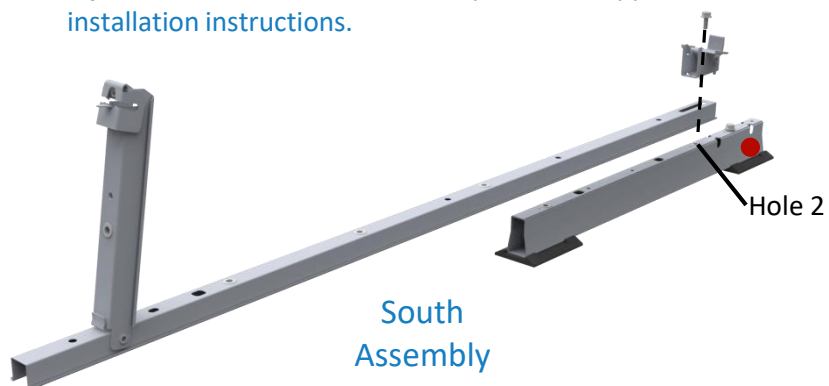
**Tip:** Base length may vary depending on the row spacing option.

**Tip:** Immediately tighten to **8 ft-lb** bolts located just in front of Tilt Arm (no Cam).



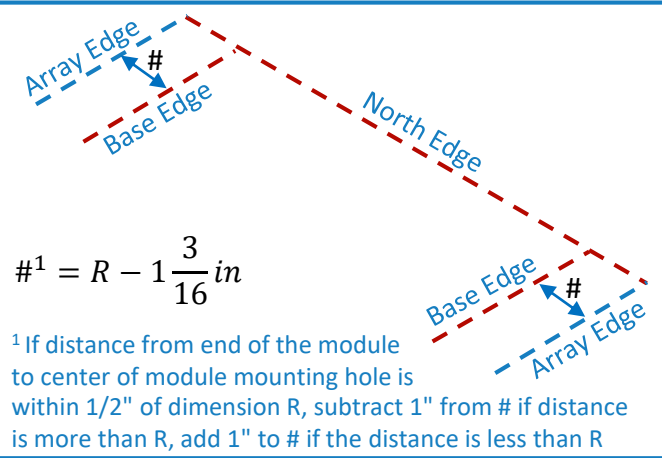
2.2 Use the Cam Spacer tool to correctly locate the module connector. Tighten bolt to **8 ft-lb**.

**Tip:** If additional Base Pads are required, see appendix for installation instructions.



# 3. Build North Row

3.1

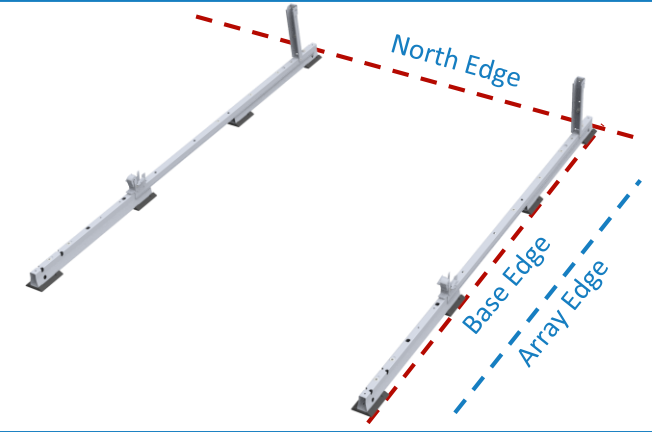


$$\#1 = R - 1\frac{3}{16}in$$

<sup>1</sup> If distance from end of the module to center of module mounting hole is within 1/2" of dimension R, subtract 1" from # if distance is more than R, add 1" to # if the distance is less than R

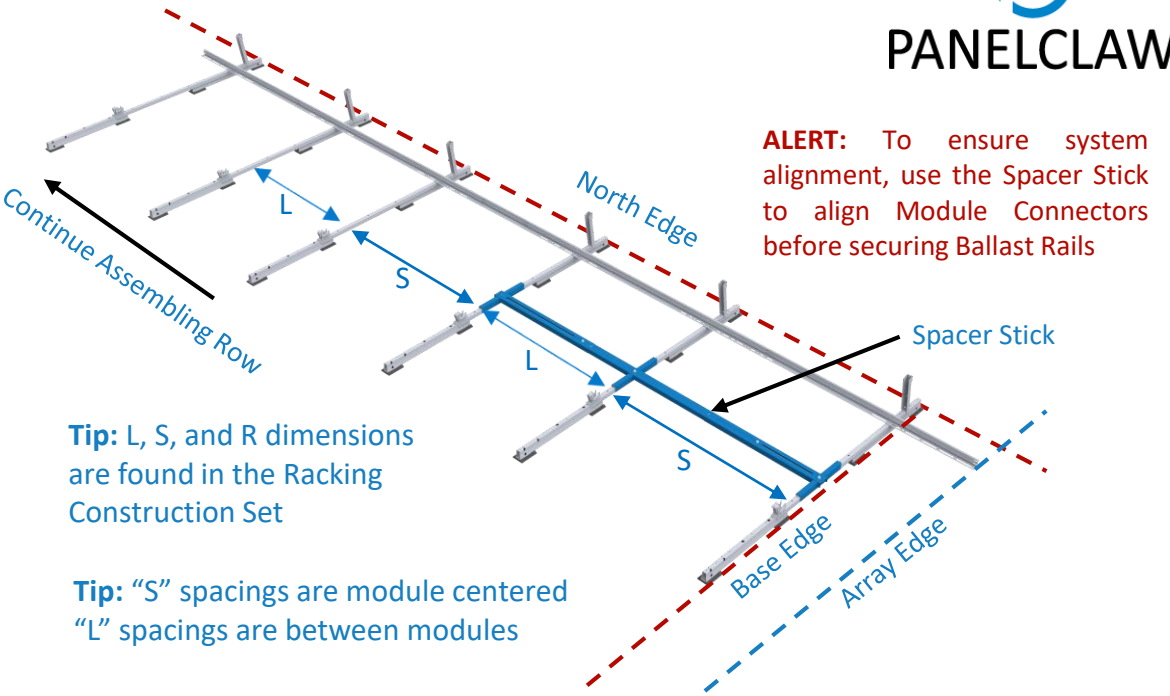
Snap North Edge, Base Edge, and Array Edge lines  
**Tip:** Snap Base and Array Edge lines on either side of the array to ensure the array construction is square

3.2



Place North Assemblies with the Base Pads along the North Edge line. The first and last North Assemblies should be placed with the edge of the Base Pads on the Base Edge line.

**Tip:** Raise tilt arms after securement of assembly.

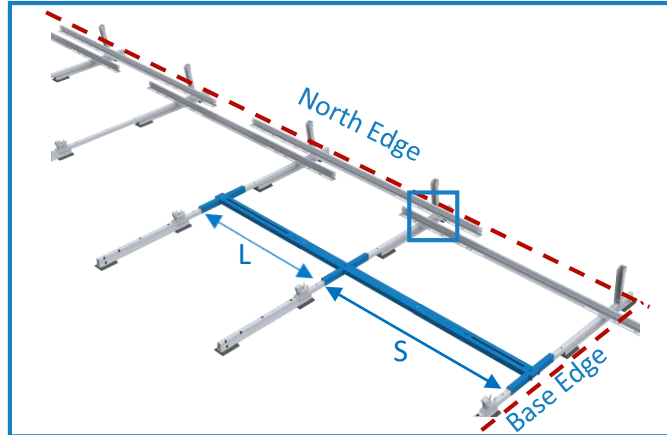


**ALERT:** To ensure system alignment, use the Spacer Stick to align Module Connectors before securing Ballast Rails

**Tip:** L, S, and R dimensions are found in the Racking Construction Set

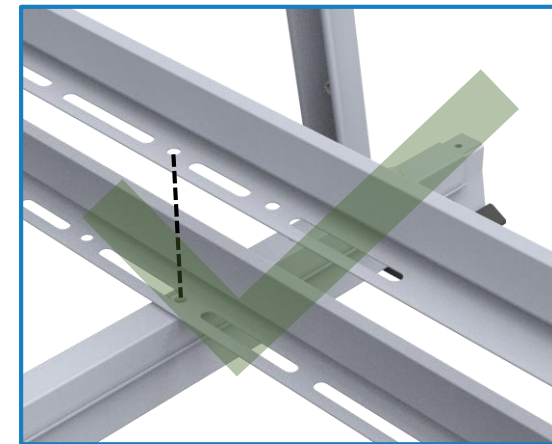
**Tip:** "S" spacings are module centered  
 "L" spacings are between modules

3.3



Place a Ballast Rail on all "S" spacings (module centered). Ballast Rails at ends of rows must be flush with array edge.

Place a Ballast Rail on all "L" spacings (between modules) on top of and overlapping the Ballast Rails on the S spacing. Install bolt and tighten to **8 ft-lb**

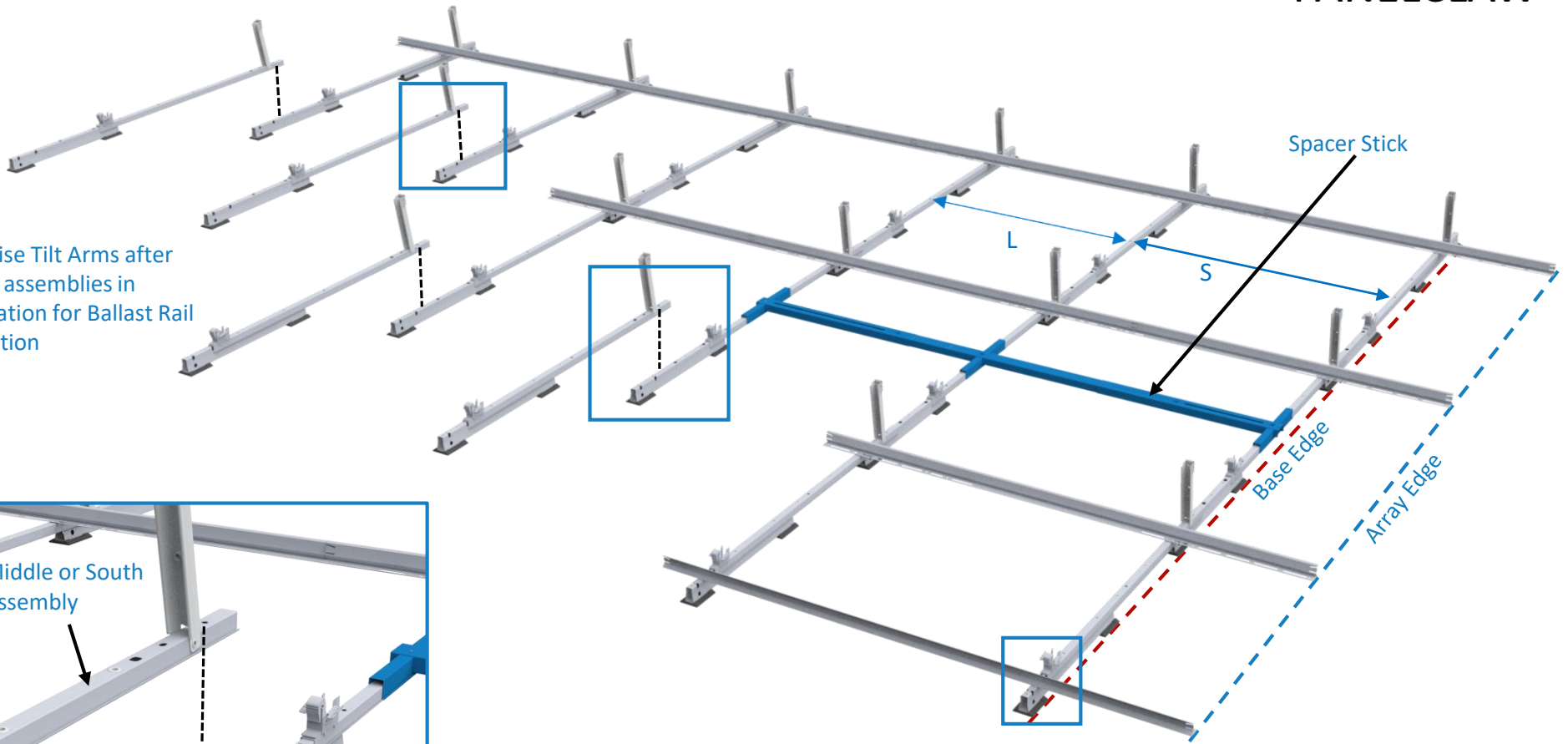


**Tip:** Ballast Rail on "L" Spacing is ALWAYS on top of the Ballast Rail on "S" Spacing

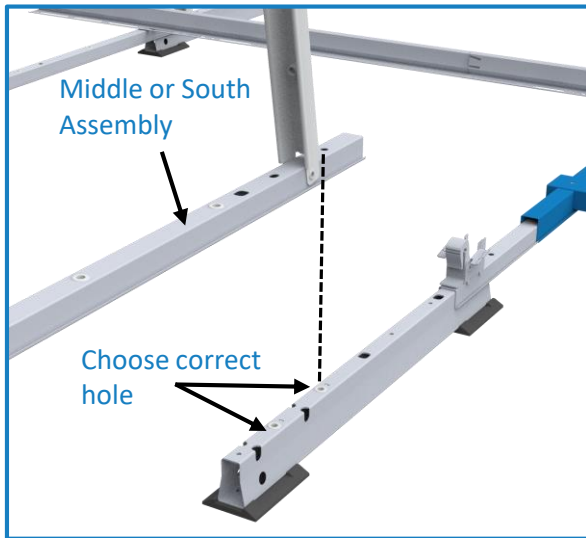
**Tip:** Ballast Rail has two holes. Consult the Racking Construction Set for appropriate hole use.

# 4. Build Racking

**Tip:** Raise Tilt Arms after bolting assemblies in preparation for Ballast Rail installation



4.1

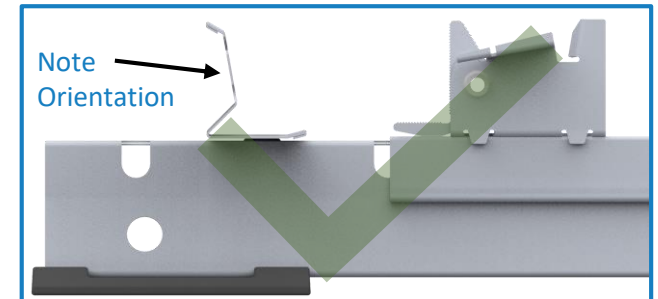


Place Middle or South assemblies onto Assemblies from previous row and bolt to **8 ft-lb**

**Tip:** Racking Construction Set clearly indicates hole selection. Using the wrong hole will result in an array which does not match site plan.

4.2 Install Ballast Rails throughout the array using the same steps described on the previous page. Alternating between "S" and "L" Spacings. Install bolt and tighten to **8 ft-lb**.

**ALERT:** To ensure system alignment, use the spacer stick to align Module Connectors before securing Ballast Rails



**ALERT:** Southern Edge and Interior Corner Ballast Rails face the opposite direction; bolts securing these rails are tightened to **4 ft-lb**



# 5. Place Ballast

**Tip:** The Racking Construction Set identifies where Ballast is to be installed. Mark the roof with chalk to speed up installation.

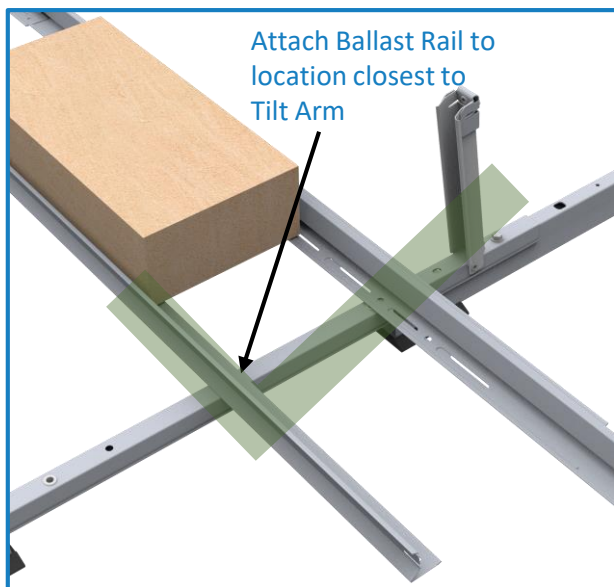
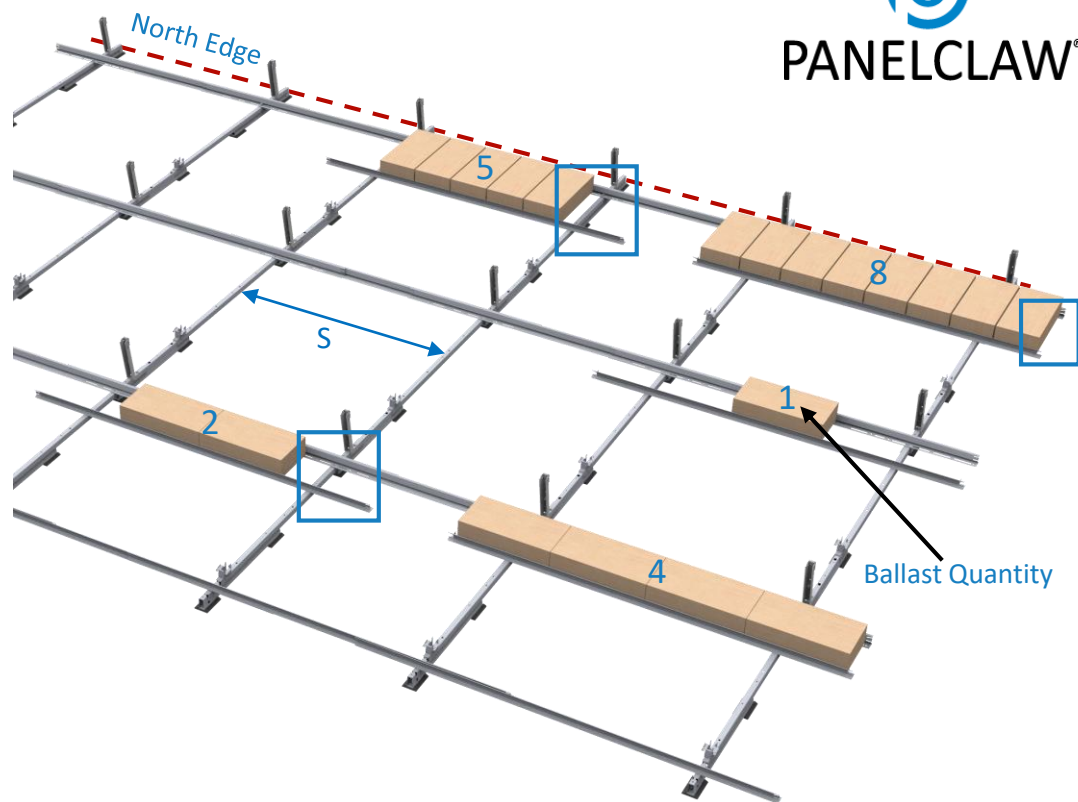
5.1 Install a Ballast Rail onto array in locations where Ballast is required. Bolt to both Module Connectors and tighten to **8 ft-lb**

**ALERT:** Every Ballast Rail must be fastened to two Module Connector assemblies.

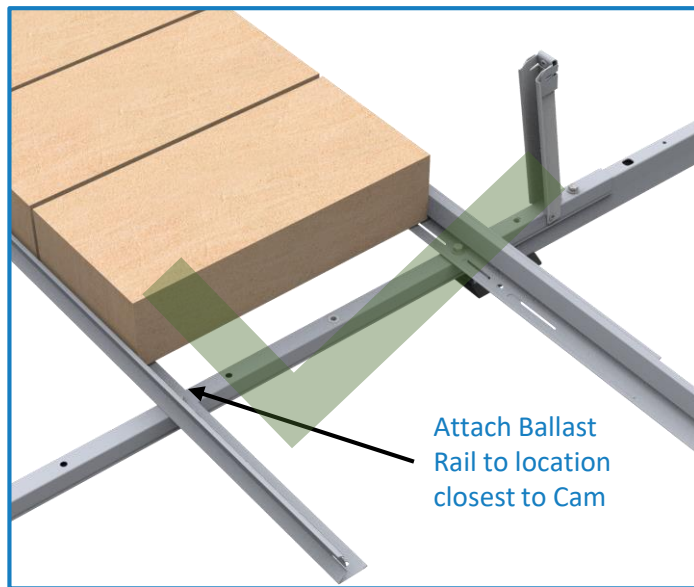
**Tip:** Ballast and Ballast Rails are only placed on “S” spacings. Center them on the “S” spacing for equal ballast distribution.

5.2 Place Ballast onto Ballast rails. If rapid cyclic movement of system is expected e.g. due to seismic activity or building vibration from activities within or nearby the structure, bend the Ballast Rail tabs to secure Ballast.

**Tip:** Installing the north row ballast blocks helps keep the racking structure from moving as the rest of the array is built.



Ballast Rail Position for 1-4 Ballasts

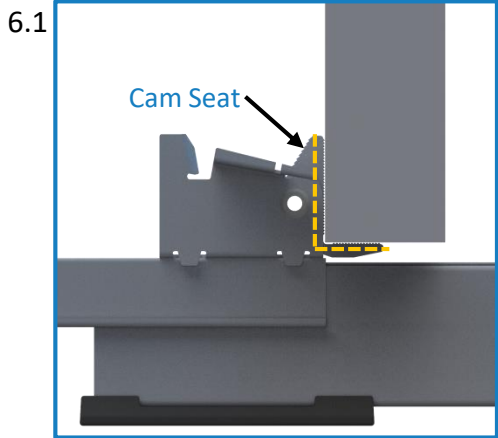


Ballast Rail Position for 5-8 Ballasts



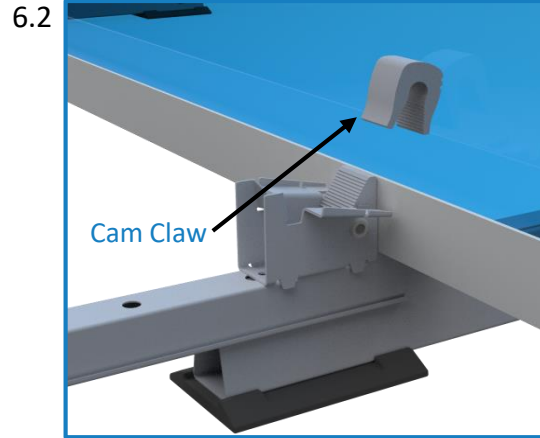
Bend tabs at ends of Ballast Rail (See 5.2 to determine if required)

# 6. Install Module Low Side



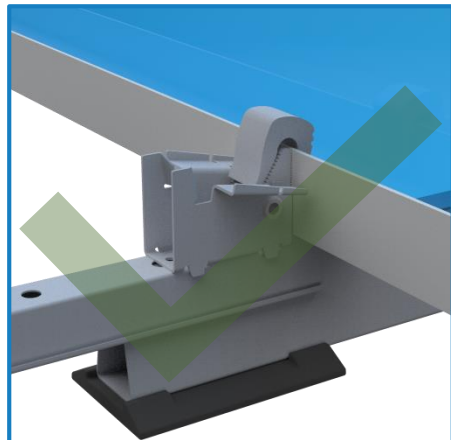
Place module on Cam Seat and align with Array Edge

**Tip:** Ensure the module is vertical and flush with Seat

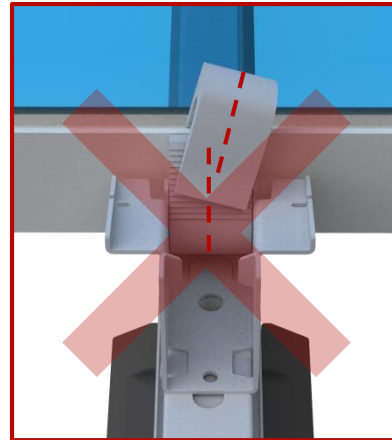


Place Cam Claw over module flange

Apply a small downward force to make sure it is properly seated

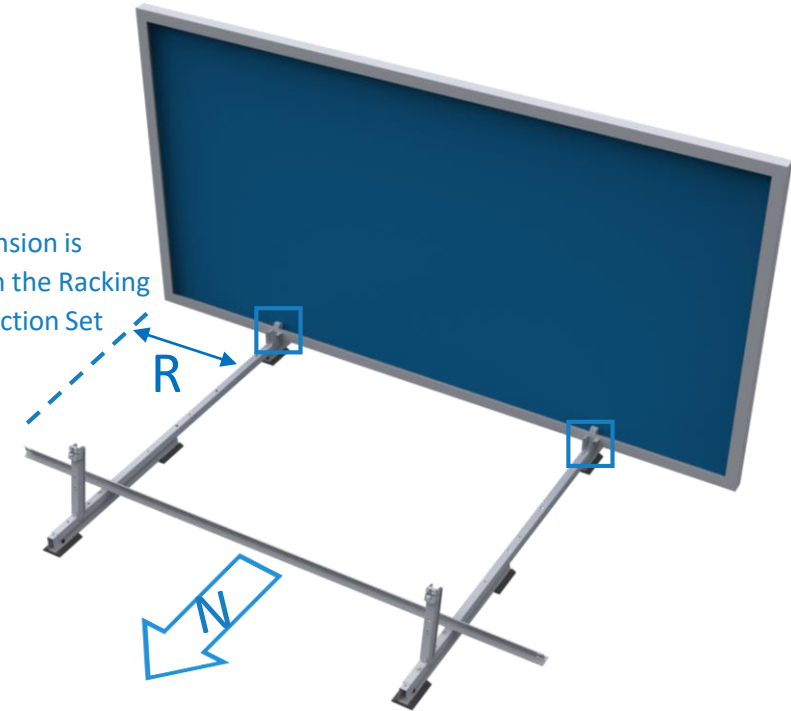


Cam Claw aligned



**ALERT:** CAM CLAW IS MISALIGNED

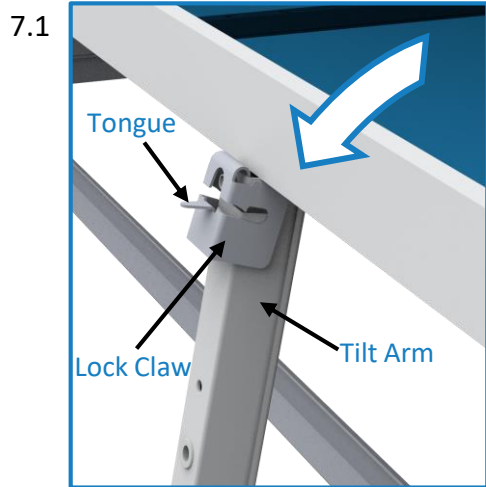
**Tip:** R dimension is found in the Racking Construction Set



**Tip:** Installing modules starting at the south array edge provides more working room and speeds installation

**ALERT:** Do not leave modules in vertical position, go immediately to next installation step (high side install).

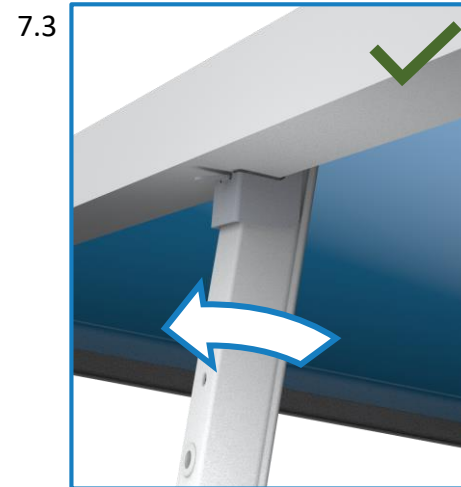
# 7. Install Module High Side



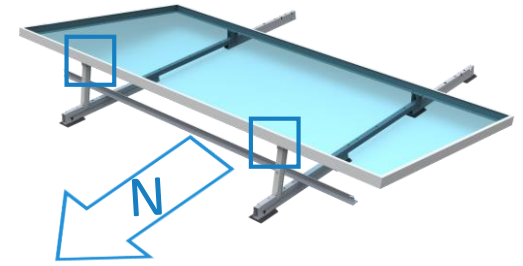
Rotate module down and rest the module frame on the top of the Tilt Arms  
**Tip:** Make sure the Tilt Arms are fully raised



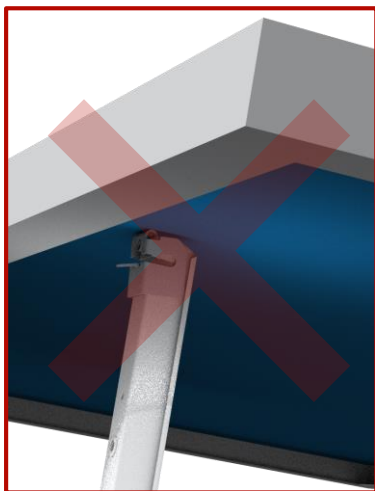
Support module while carefully rotating the Tilt Arm just enough to rest the module frame on the Lock Claw tongue



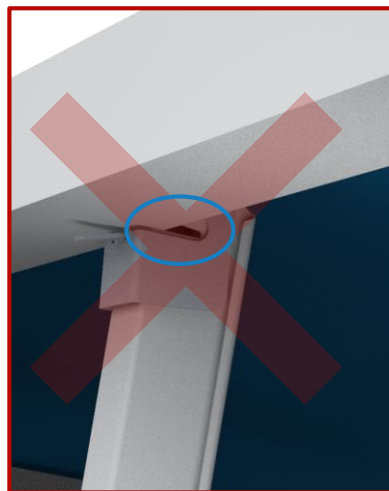
Pull the Tilt Arm forward until the Lock Claw is fully engaged onto the module frame flange



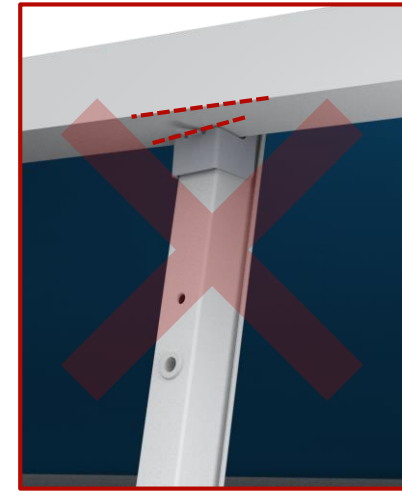
**Tip:** Use two hands when engaging Lock Claw to ensure correct installation



**DO NOT REST MODULE BACKSHEET ON TILT ARM**

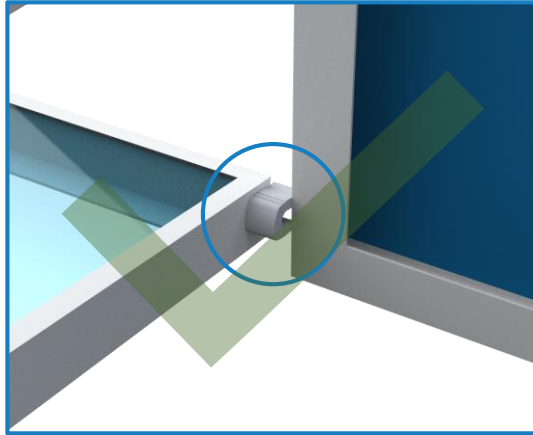


**LOCK CLAW NOT FULLY ENGAGED**

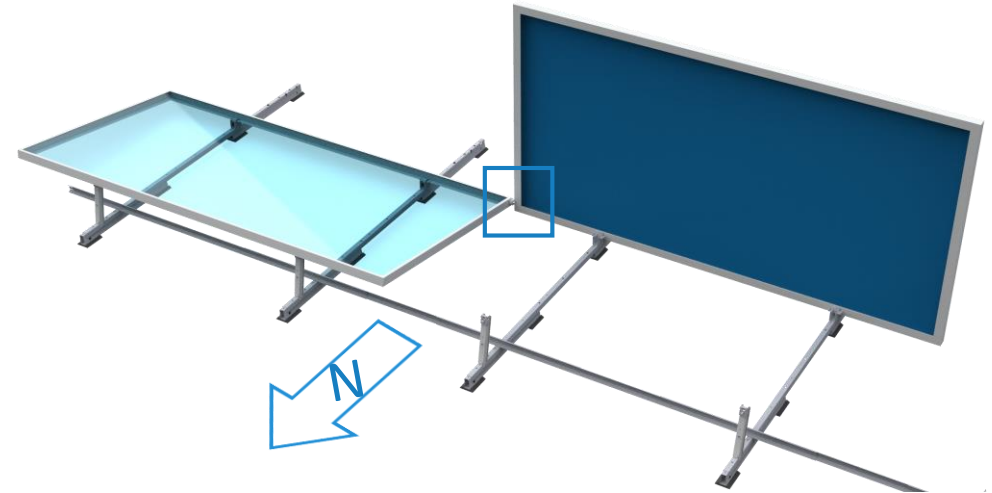


**LOCK CLAW UNEVENLY ENGAGED**

## 7. (Contd.)



Use Cam Claw as spacer to set spacing between adjacent modules



### Lock Claw Insertion Gauge configuration and use

Select a Lock Claw which has been confirmed to be installed correctly through visual inspection.

The Tilt Arm and Lock Claw should be aligned with the module frame and the Lock Claw fully engaged on the frame.



Place gauge against Lock Claw and underside of module



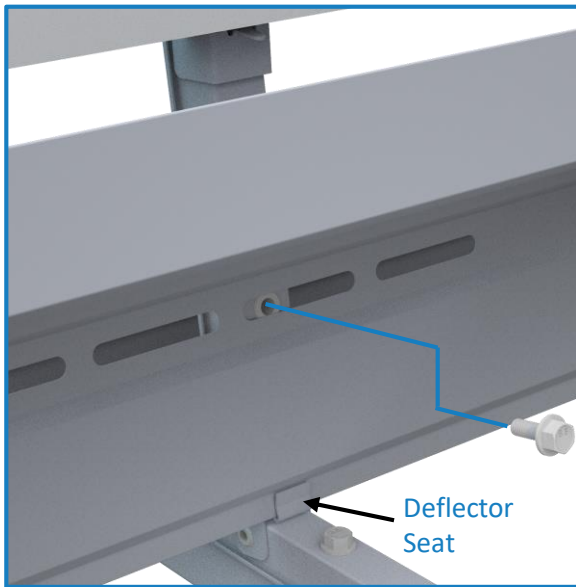
Mark line on gauge to finish setup

Use gauge to confirm full Lock Claw engagement – line must be visible

# 8. Install Deflectors

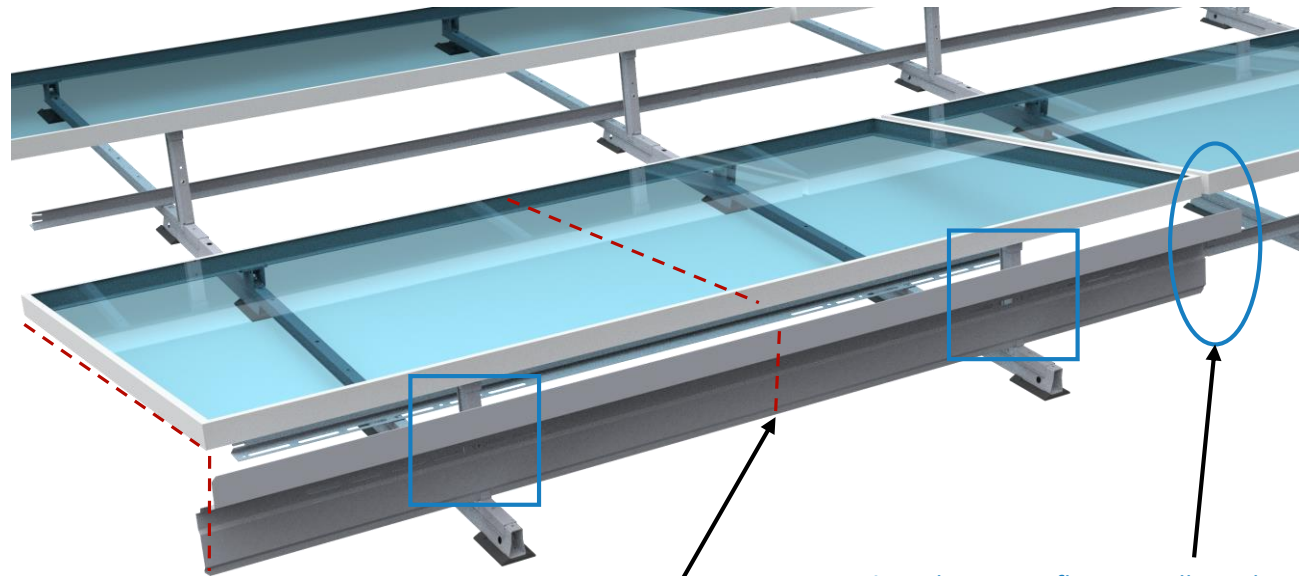
**Tip:** Complete system wiring before installing deflectors.

8.1



Deflector Seat

Place the bottom edge of the Deflector in the Deflector Seat near the bottom of the Tilt Arm. Fasten to Tilt Arm with bolt and tighten to **8 ft-lb.**



Center Deflector on module for all non edge modules

**Tip:** Adjacent Deflectors will overlap (adjacent deflector not shown)

**Tip:** On array edge Deflectors can be installed flush to module/array edge

# Electrical Grounding



Please consult with national and local building code(s) for complete grounding requirements for your installation. The clawFR grounding method conforms to ANSI/UL 2703 and is certified by SolarPTL for use with approved photovoltaic modules listed under ANSI/UL 1703 and/or ANSI/UL 61730. Installers can quickly and easily establish ANSI/UL 2703 certified electric bonds between all connected array components, including modules and mounting system components, without the use of additional grounding devices, e.g. ground lugs and copper wire. At least one ground lug must be used to ground all strings within a physical sub-array provided the fuse rating for each string does not exceed 30 amps. Installers may opt to use multiple lugs per sub-array for redundancy. When grounding devices are installed according with the approved methodology and capacity below, the connections described above meet all the requirements outlined in NEC 690.43.

## Grounding Instructions

For modules that have been evaluated for use with clawFR 10 Degree, please follow the instructions below in [Appendix B: UL 2703 Grounding](#). Additional information regarding ANSI/UL 2703 and the specific list of evaluated modules included in PanelClaw's UL listing can be found in the "clawFR UL Overview and Module Listing" document (available at [www.panelclaw.com](http://www.panelclaw.com)).

For modules that have not been evaluated for use with clawFR, please follow the instructions below in [Appendix D: Electrical Grounding \(Non 2703 PV Module\)](#).

**ALERT:** During grounding and bonding ensure there is separation between bare copper and aluminum or ZAM coated steel components.

# Appendix A: Safety



The subsections below outline some of the obvious / major hazards that could exist during the installation of PanelClaw products and are divided to bring a level of clarity to such hazards. Some sections do not apply to all PanelClaw product lines and such exclusions are noted within each section.

**Electrical Hazards:** PanelClaw products are purely mechanical and do not contain any electrically live parts. When a photovoltaic module is exposed to sunlight it is electrically live and cannot be turned off. As soon as modules are installed using a PanelClaw system, an electrical shock hazard is present. All personnel on site should coordinate to ensure that such electrical hazards are clearly communicated. It is advised, at a minimum, that all personnel utilize caution and proper Personal Protective Equipment as outlined in that section. Only electrically qualified personnel should perform PV module installation. Refer to OSHA Part 1926 Subpart K – Electrical and NFPA 70E for additional information.

**Fall Hazards:** This section only applies to clawFR® products installed on locations six feet or higher above grade. Proper fall protection should be in place at all work sites. There are many fall protection solutions readily available to help reduce exposure to fall hazards. These may include personal fall arrest systems, safety nets, guardrails, and flagged setbacks from all roof edges as outlined in OSHA Part 1926 Subpart M – Fall Protection.

**Trip Hazards:** All PanelClaw arrays have elevated components that are installed above grade or above a roof surface. Such hazards should be identified and caution should be taken to avoid tripping over such components. Refer to the Fall Hazards section specifically if working with the clawFR product line. Make sure to pick up and not drag your feet when working on site, and always pay attention to your path of movement to note any obstructions that could create a trip hazard.

**Lifting Hazards:** The PanelClaw installation process involves lifting of heavy items that could lead to personal injury and damage to property. All personnel should be trained in the proper procedures for manually lifting. Evaluate an object's size and weight prior to lifting, and follow these general guidelines for lifting:

1. Assess the lift and know the object weight.
2. Bend at the knees and get a good grip.
3. Keep back straight and lift straight up with legs without twisting. It is important to lift with the legs and not the back.
4. If an object is too large or heavy, ask for help and do not attempt to lift by yourself. In the case that mechanical assistance (e.g. crane, forklift, etc.) is required to complete the lifting operations, all machine operators of such devices should be licensed and trained.

# Appendix A: Safety (Contd.)



**Material Handling:** All PanelClaw parts and components are made of aluminum and steel alloys and utilize stainless steel assembly hardware. These materials are considered non-toxic and require no special handling procedures. Metal components may have sharp edges, so be sure to handle with care and utilize proper personal protection equipment, especially gloves, during handling. Refer to OSHA Part 1926 Subpart H – Materials Handling, Storage, Use, and Disposal for additional information.

**Personal Protective Equipment (PPE):** All personnel should utilize and implement proper PPE per OSHA requirements. Refer to OSHA requirements for proper use and implementation of PPE. The following items are suggested as a minimum to avoid injury based on the installation procedure outlined in this manual:

1. Appropriate work clothing
2. Electrically insulated hard hat
3. Protective eyewear
4. EH rated safety boots
5. Gloves
6. High-visibility safety vest
7. Hearing protection

If any PPE appears to be defective, stop the use of such equipment immediately, and ensure it is replaced before work continues. Refer to OSHA Part 1926 Subpart E – Personal Protective and Life Saving Equipment for additional information.

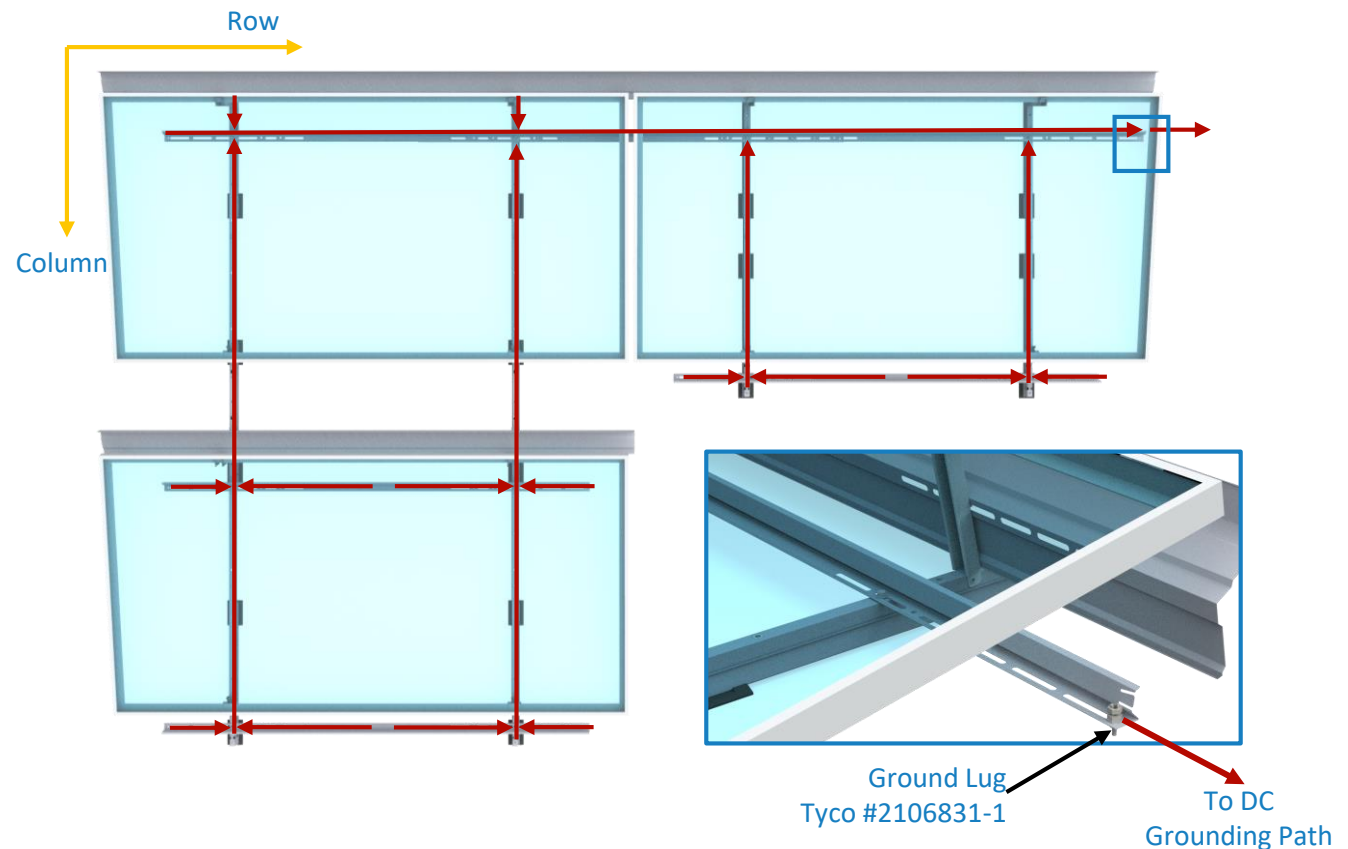
**Hand and Power Tools:** Access to all hand and power tools should be regulated and controlled at all times on site to prevent improper use and related injuries. When not in use, all equipment should be stored in a secured location. Only personnel who have been properly trained in the safe operation of any potentially dangerous tool should be allowed access. All required tools to perform the installation of PanelClaw racking are outlined in the installation procedure. All tools should be inspected daily and before use by the operator. If any tool appears to be defective, stop the use of such equipment immediately, and ensure it is replaced before work continues. Electrical power tools should follow proper lock-out tag-out procedures per OSHA requirements. Refer to OSHA Part 1926 Subpart I – Tools – Hand and Power for additional information.



# Appendix B: UL 2703 Grounding

The clawFR 10 Degree flat roof system may be used to ground and/or mount a PV module complying with ANSI/UL 1703 or ANSI/UL 61730 only when the specific module has been evaluated for grounding and/or mounting in compliance with the included instructions. For a list of modules which have been evaluated see PanelClaw's "clawFR UL Overview and Module Listing" (see [www.panelclaw.com](http://www.panelclaw.com)).

A periodic re-inspection of the system shall be performed for loose components, loose fasteners, and any corrosion. If found, they should be immediately replaced or remedied in accordance with the system installation instructions.



## System Ground Path

The system ground path "grid" is established throughout the array by the interconnection of system components. Specifically, in the column direction via the Base and Module Connector connections and in the row direction via the Ballast Rail connections. A Tyco lug connected to the Ballast Rail establishes a point of connection for the EGC at one location with a contiguous array. All modules are grounded to the system through their Cam to Module connection.

**Note:** The presence of a PV module does not affect the bonding ability of the clawFR system components. More precisely, the grid provides a means to ground PV Modules which have been evaluated for ANSI/UL 2703 grounding with clawFR.

# Appendix B: UL 2703 Grounding (Contd.)

## Grounding Instructions:

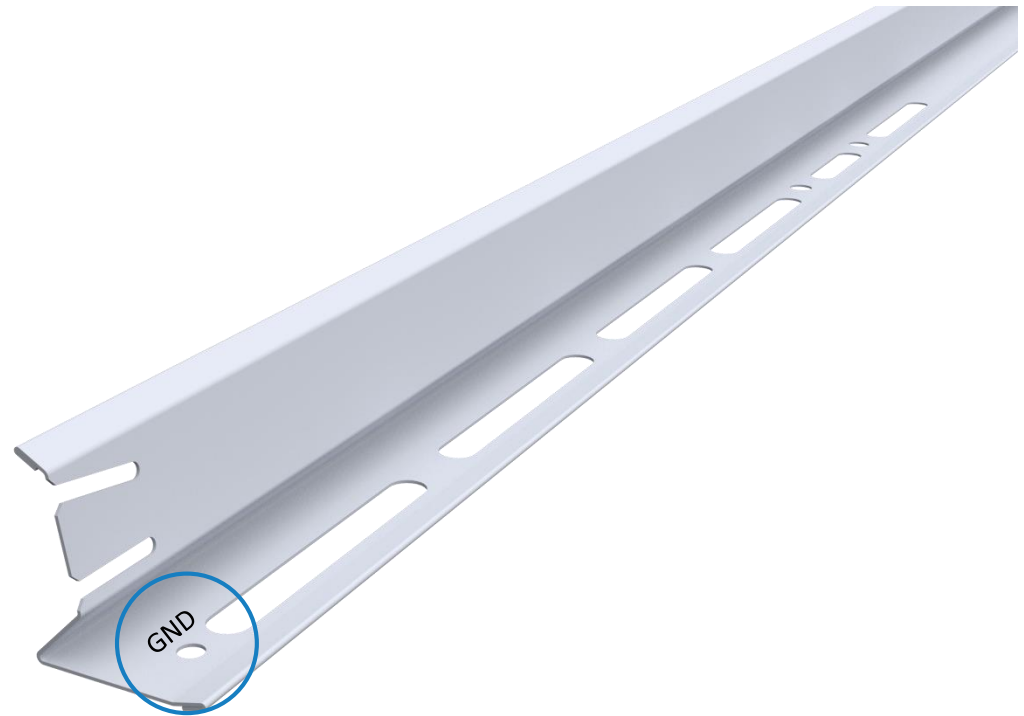
PanelClaw components within the array are required to be electrically bonded to other DC grounding paths via the use of appropriately sized Cu wire and a UL 467 listed Tyco Solarlok grounding assembly, part number **2106831-1**, manufactured by Tyco Electronics Corporation. The conductor size should be selected in accordance with NEC 690.45 and NEC 250.122.1.

To ground the array, first determine the groupings of strings whose power output wiring is grounded together at an equipotential grounding conductor location. This could be all the strings within a physical sub-array, or all the strings grouped by a single combiner box. Once the groupings of strings at equipotential have been determined, a Tyco solid wire grounding assembly must be attached to one Ballast Rail within each group of strings. PanelClaw's clawFR Ballast Rails have a hole to which this grounding device/lug can be attached. In an array that requires multiple bonding jumpers to satisfy the equipotential requirements, each bonding jumper should be located and installed on a Ballast Rail within the group of strings which will be grounded by that jumper.

**ALERT:** Every sub-array must include at least one grounding device/lug.

## Tyco Grounding lug attachment:

To attach the Tyco grounding device/lug to the Ballast Rail, the mounting hex washer and threaded post end should be installed to the specified hole in the Ballast Rail and torqued to **2.08 ft-lb (25 in-lb)**. Once the grounding device/lug has been attached to the Ballast Rail, a copper bonding jumper from an acceptable DC grounded location outside of the array must be installed to the wire slot end and torqued to **3.75 ft-lb (45 in-lb)**. For additional instruction regarding the installation of the Tyco solid wire grounding assembly, please refer to the Tyco Electronics instructions sheet (document number 408-10262) via their website [www.te.com](http://www.te.com).



# Appendix C: UL 2703 Fire Classification



The system has a Fire Class A rating for low slope roofs with Type I modules when the following requirements are met:

- System is installed over a fire resistant roof covering rated for the application (UL2703, 26.3B)
- Roof slope is less than 2" per ft

The system has a Fire Class A rating for low slope roofs with Type II modules when the following requirements are met:

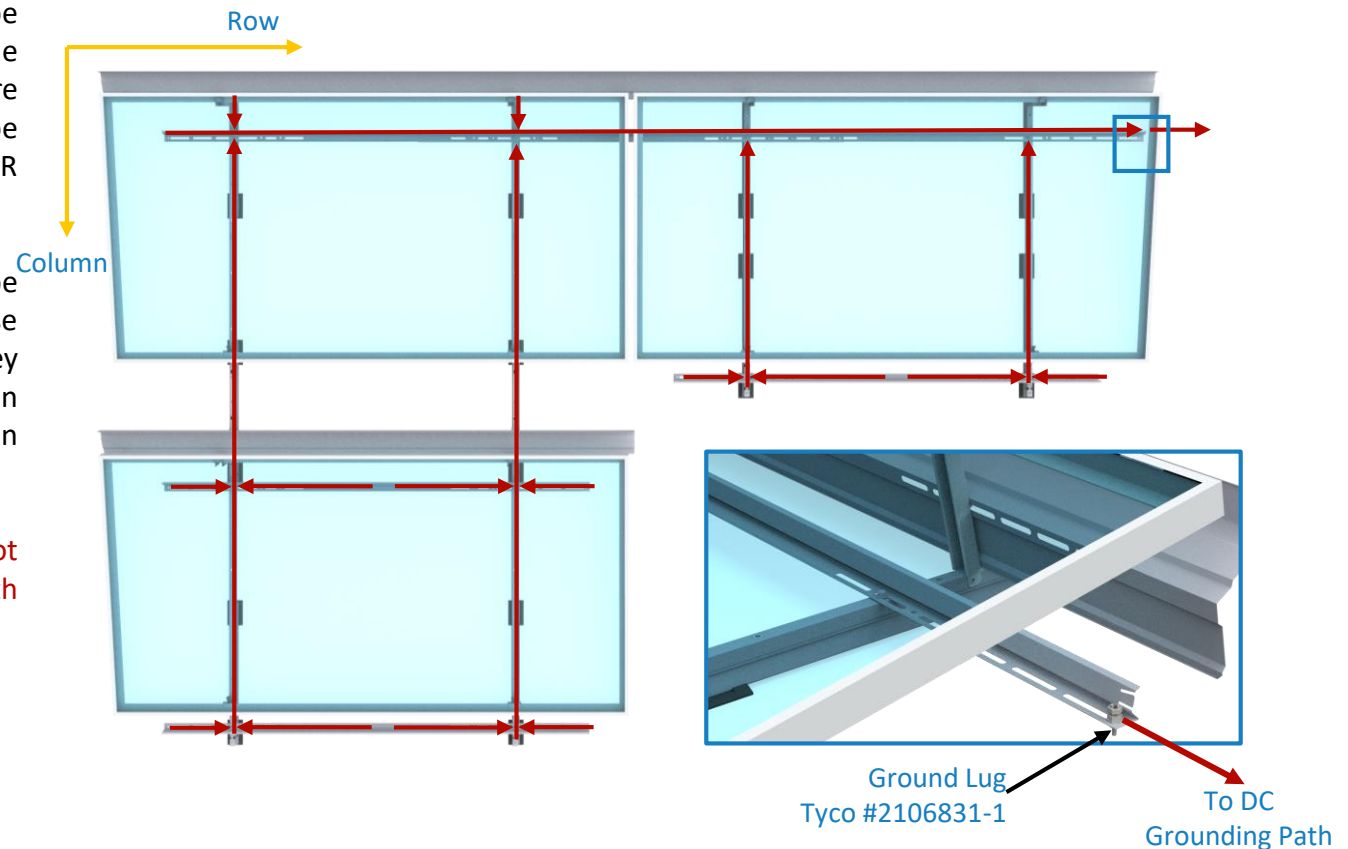
- System is installed over a fire resistant roof covering rated for the application (UL2703, 26.3B)
- Roof slope is less than 2" per ft
- The Ballast Rail nearest the Tilt Arm is installed such that its edge is flush/near flush with the edge of the module nearest the perimeter of the array.

# Appendix D: Electrical Grounding (Non 2703 PV Module)

The clawFR 10 Degree flat roof system may be used to ground a PV module only when the specific module grounding instructions are followed. A separate bonding jumper must be used between the PV Module and the clawFR 10D system.

A periodic re-inspection of the system shall be performed for loose components, loose fasteners, and any corrosion. If found, they should be immediately replaced or remedied in accordance with the system installation instructions.

**ALERT:** PV Module connection to Cam has not been evaluated to be in compliance with ANSI/UL 2703



## System Ground Path

The system ground path “grid” is established throughout the array by the interconnection of system components. Specifically, in the column direction via the Base and Module Connector connections and in the row direction via the Ballast Rail connections. A Tyco lug connected to the Ballast Rail establishes a point of connection for the EGC at one location with a contiguous array. PV modules will require a jumper to be connected between modules and the “grid”.

**Note:** The presence of a PV module does not affect the bonding ability of the clawFR system components.

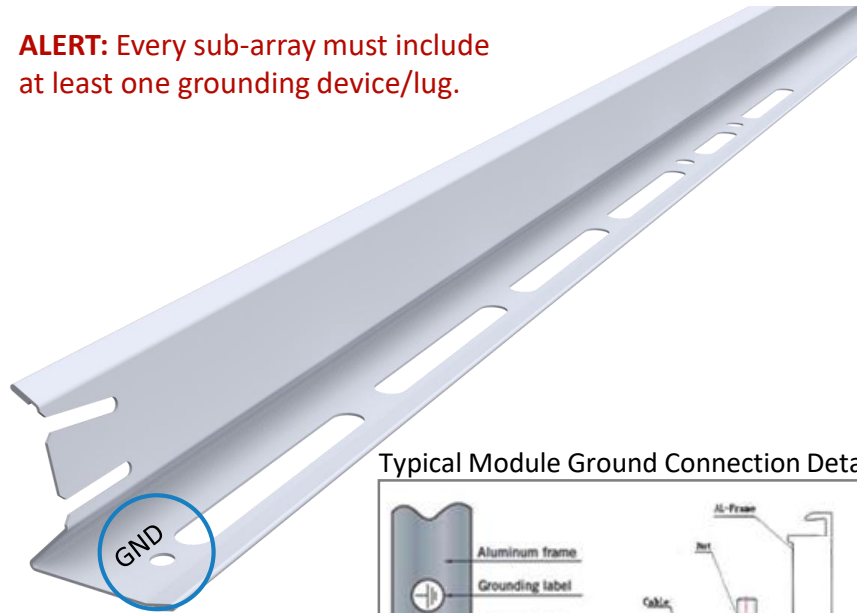
# Appendix D: Electrical Grounding (ANSI/UL 2703 Not Applicable) (Contd.)

## Grounding Instructions:

PanelClaw components within the array are required to be electrically bonded to other DC grounding paths via the use of appropriately sized Cu wire and a UL 467 listed Tyco Solarlok grounding assembly, part number **2106831-1**, manufactured by Tyco Electronics Corporation. The conductor size should be selected in accordance with NEC 690.45 and NEC 250.122.1.

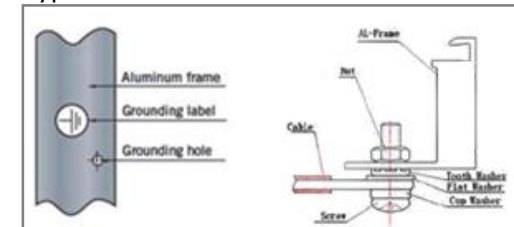
To ground the grid, first determine the groupings of strings whose power output wiring is grounded together at an equipotential grounding conductor location. This could be all the strings within a physical sub-array, or all the strings grouped by a single combiner box. Once the groupings of strings at equipotential have been determined, a Tyco solid wire grounding assembly must be attached to one Ballast Rail within each group of strings. PanelClaw's clawFR Ballast Rails have a hole to which this grounding device/lug can be attached. In an array that requires multiple bonding jumpers to satisfy the equipotential requirements, each bonding jumper should be located and installed on a Ballast Rail within the group of strings which will be grounded by that jumper.

Follow PV Module manufacturer instructions to establish an approved ground connection between the module and an appropriately sized bonding jumper. The bonding Jumper can then be connected to a UL 467 listed Tyco Solarlok grounding assembly, part number **2106831-1**, manufactured by Tyco Electronics Corporation, which may be installed on a Ballast Rail to establish the ground connection to the "grid".



**ALERT:** Every sub-array must include at least one grounding device/lug.

Typical Module Ground Connection Detail



## Tyco Grounding lug attachment:

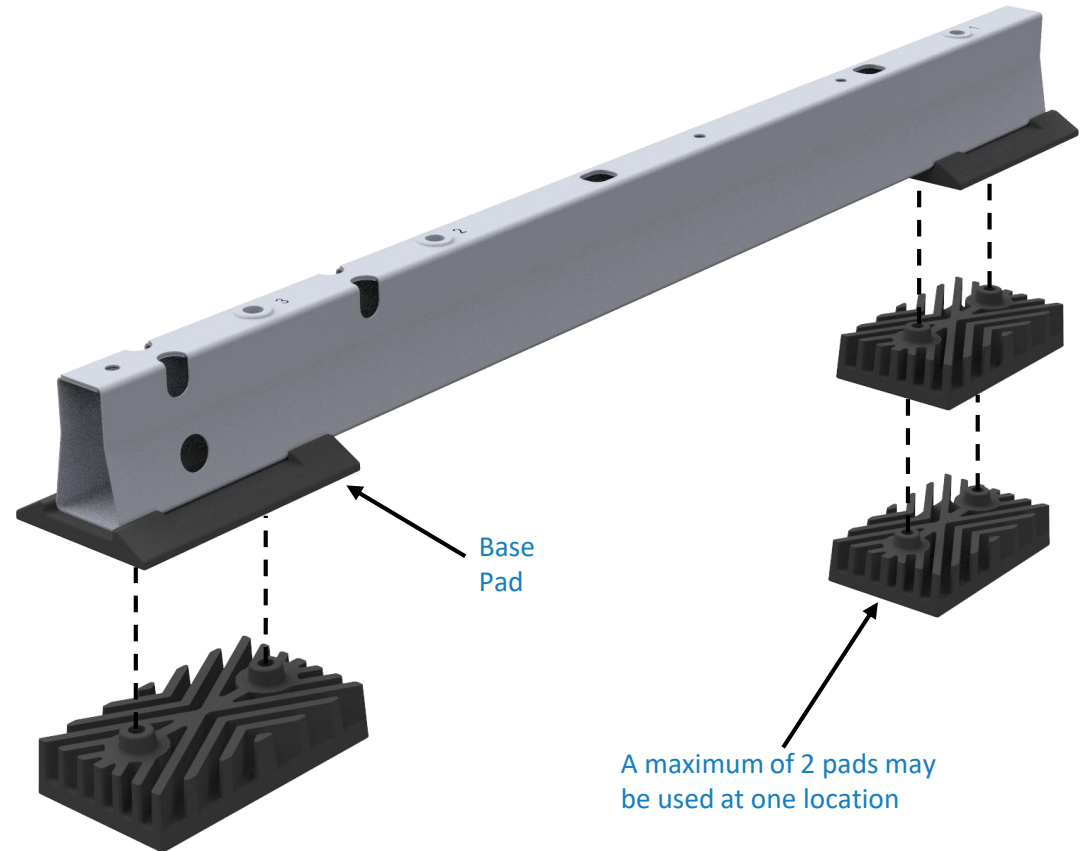
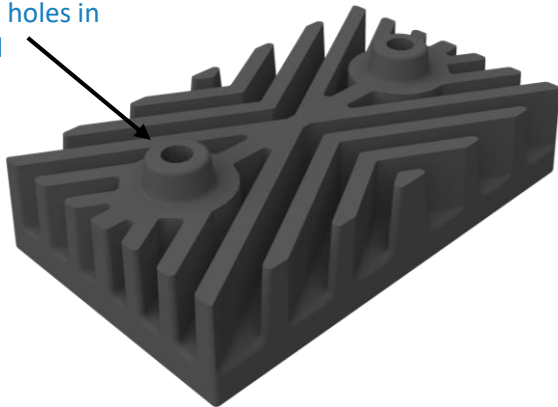
To attach the Tyco grounding device/lug to the Ballast Rail, the mounting hex washer and threaded post end should be installed to the specified hole in the Ballast Rail and torqued to **2.08 ft-lb (25 in-lb)**. Once the grounding device/lug has been attached to the Ballast Rail, a copper bonding jumper from an acceptable DC grounded location outside of the array must be installed to the wire slot end and torqued to **3.75 ft-lb (45 in-lb)**. For additional instruction regarding the installation of the Tyco solid wire grounding assembly, please refer to the Tyco Electronics instructions sheet (document number 408-10262) via their website [www.te.com](http://www.te.com).

# Appendix E: Shim Pad Installation

E.1 Place the Shim Pads underneath the Base Pads and compress firmly.

E.2 Stack the Shim Pads as needed to get the suitable height.

Embossments nest into holes in base pad



**Tip:** Shim Pad installation is not required on all pads, select the appropriate locations and stack up to two Shim Pads to ensure each Base is in contact with the roof at all base contact points.

# Appendix F: Ballast Blocks

PanelClaw does not provide the ballast blocks required to construct the system in accordance with PanelClaw's Racking Construction Set drawings. However, PanelClaw maintains a list of potential block suppliers across the country and this list is available upon request.

BALLAST BLOCKS FOR **ANY** BALLASTED ROOFTOP SYSTEM MUST BE MANUFACTURED TO RESIST FREEZE-THAW AS REQUIRED BY LOCAL CONDITIONS **AND** TO MAINTAIN THEIR WEIGHT OVER THE LIFE OF THE SYSTEM. IT IS STRONGLY RECOMMENDED THAT INSTALLERS WEIGH SEVERAL BLOCKS ON-SITE TO ENSURE BLOCK WEIGHTS MATCH THE WEIGHT OF THE BLOCKS SPECIFIED IN PANELCLAW'S RACKING CONSTRUCTION SET DRAWINGS. BLOCK WEIGHT VARIANCES LISTED IN THE CHART BELOW ARE ACCEPTABLE.



<b>Ballast Block Description</b>	<b>Nominal Weight kg [lb]</b>	<b>Allowable Weight Variance (+ or -) Kg [lb]</b>
BLOCK, CONCRETE, 2"X 8"X 16"	6.6 [14.6]	0.45 [1.00]
BLOCK, CONCRETE, 3"X 8"X 16"	10.7 [23.6]	0.57 [1.25]
BLOCK, CONCRETE, 4"X 8"X 16"	14.8 [32.6]	0.68 [1.50]

BLOCKS WITH A WEIGHT VARIANCE GREATER THAN WHAT IS SHOWN IN THE CHART ABOVE MUST NOT BE USED. FAILURE TO FOLLOW THESE PRACTICES MAY RESULT IN SYSTEM PERFORMANCE BELOW DESIGN CRITERIA AND/OR MAY CAUSE STRUCTURAL DAMAGE TO THE BUILDING AND/OR ARRAY.

PanelClaw®'s clawFR products have been tested in accordance with the *ANSI/UL 2703-2015 Standard for Mounting Systems, Mounting Devices, Clamping/Retention Devices, and Ground Lugs for Use with Flat-Plate Photovoltaic Modules and Panels*. The test program includes temperature and humidity cycling; electrical resistance and conductance testing; fire performance; manufacturing and operational quality reviews; and module-specific mechanical load testing and review. The ANSI/UL 2703 mechanical strength, electric bonding and grounding, and fire performance requirements closely mirror ANSI/UL 1703, the standard for flat-plate PV modules. **Appendix A: Bonding Testing, Mechanical Load Testing and Fire Testing**, provides some details regarding the testing performed.



PanelClaw's clawFR systems are listed for their mechanical strength, ability to electrically bond and ground modules and for fire performance. Each PanelClaw product installation manual contains instructions for bonding and grounding listed modules and fire performance requirements.

PV system installers using clawFR can quickly and easily establish ANSI/UL 2703 certified electric bonds between all connected array components, including modules and mounting system components, without the use of dedicated grounding devices, e.g. ground lugs and copper wire. Multiple strings within an array having a fuse rating of up to 30 amps can be grounded via a single properly sized ground lug acting as a Grounding Electrode Conductor (GEC).

All clawFR module connections are certified as recognized components under ANSI/UL 2703 for module-to-module and module-to-mounting system electric bonding. For projects using modules not currently included in PanelClaw's UL Listing, additional approvals from the module manufacturer and the relevant permitting authority may be necessary to utilize the ANSI/UL 2703 electric bonding and grounding method described in the clawFR installation manual.

## PanelClaw's SolarPTL Partner Lab Test Program

In 2012, PanelClaw opened the mounting system industry's first Intertek® Satellite Test Laboratory in order to accelerate the company's product innovation cycle and develop close partnerships with Nationally Recognized Test Laboratories (NRTL's) in the United States. PanelClaw transitioned to Underwriters Laboratories under its *UL Client Test Data Program* (CTDP) in 2016. The company's commitment to the development of codes and standards for mounting systems, product testing and certification is unwavering, and our engineers have been active in the UL 2703 Technical Standards Committee since its inception.

Starting with clawFR, PanelClaw's innovation lab transitioned its certification to SolarPTL (formerly TUV Rheinland) under its Partner Lab Program (PLP).





## Adding Modules to PanelClaw Product Listings

We regularly add new modules to the clawFR ANSI/UL 2703 listing. If you have specified or plan to specify a module not listed on this document, we can quickly and efficiently add it. We work closely with all module manufacturers in the industry and have developed a standard process for evaluating and adding new modules to our listing leveraging our Testing and Innovation Lab and its PLP designation. We can test modules within 24 hours of receiving them and can typically have them added to our listing within 2 weeks. We offer the most robust and expeditious process for addition of modules to a flat roof racking platform in the industry.

## Helpful Links and Phone Numbers

UL provides a summary of requirements for the ANSI/UL2703 specification. This summary can be found by visiting the UL 2703 Guide Information web page. An excerpt can be found in Appendix B: UL 2703 of this document.

See [Appendix C: Module Listing](#) of this document for a list of photovoltaic modules which have been listed, as of the release of this document, for use with the clawFR mounting systems.

For additional information regarding PanelClaw's ANSI/UL 2703 listings, please contact Applications Engineering at +1 (978) 688-4900.



## Appendix A: Bonding Testing, Mechanical Load Testing and Fire Testing

### Bonding Testing

Bonding testing has been performed on all connections within the clawFR system. Samples were assembled representing system connections and bonding path resistance testing was performed on non-conditioned and conditioned samples. ANSI/UL 2703 requires the following conditioning to be performed on the samples:

- Bonding Conductor 135%
- Bonding Conductor 200%
- Bonding Conductor Limited Short Circuit
- Thermal Cycling test, 200 cycles
- Humidity Cycling test, 10 cycles

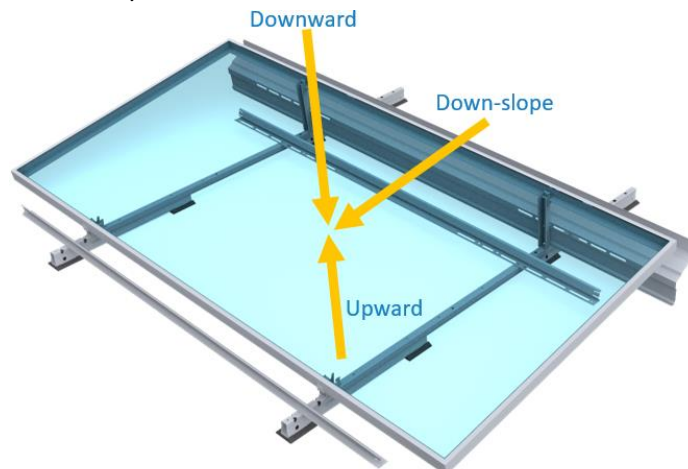
Bonding Path Resistance testing was performed on these samples after conditioning to ensure that the fidelity of the connection is within allowable safe limits established by the ANSI/UL 2703 safety standard.

### Mechanical Load Testing

Mechanical load testing has been performed on production grade components paired with UL 1703 listed modules. Mechanical test loads, per the ANSI/UL 2703 standard, are applied at 1.5 times the desired design load. The load was uniformly applied until test load was achieved and allowed to stand for a minimum of 30 minutes. The load was then removed, and the module and components were inspected for permanent deformation which would adversely affect system safety or compliance.

The following load directions and ANSI/UL 2703 minimum design load ratings are:

- Downward pressure: 10lb/ft<sup>2</sup>
- Upward pressure: 5lb/ft<sup>2</sup>
- Down-slope Pressure: 5lb/ft<sup>2</sup>





PanelClaw has determined these minimum load ratings often do not satisfy the various environmental conditions in regions of clawFR deployment. The ratings listed in [Appendix C: Module Listing](#) supersede the minimums. [Appendix C: Module Listing](#) contains the design load ratings resulting from actual Mechanical Load Tests performed on the modules listed therein.

### Fire Testing

Full scale fire testing has been performed on clawFR systems. System installation must be in accordance with the product installation manuals to achieve a Class A fire rating for low slope roofs with Type I and Type II modules.

Please consult the ANSI/UL 2703 safety standard for additional details related to the testing performed.



## Appendix B: UL 2703

ANSI/UL 2703 Guide Information – QIMS Guide Information: The data below is taken from UL's website and represents the most current information as of January 18, 2019.



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### QIMS.GuideInfo

#### Mounting Systems, Mounting Devices, Clamping Devices and Ground Lugs for Use with Photovoltaic Modules and Panels

[View Listings](#)

[Page Bottom](#)

#### [Distributed Generation Power Systems Equipment] Mounting Systems, Mounting Devices, Clamping Devices and Ground Lugs for Use with Photovoltaic Modules and Panels

[See General Information for Distributed Generation Power Systems Equipment](#)

#### USE AND INSTALLATION

This category covers photovoltaic (PV) mounting systems, mounting devices, clamping devices (which may be for bonding and/or mechanical loading) and ground lugs tested in combination with specific PV modules and panels and specified module frames and mounting structures as identified in the individual certifications. These systems and devices are investigated for one of two installation types: (1) ground mounted, or (2) intended to serve as part of a nonstructural component of a building, such as a stand-alone system on a building, curtain wall, facade, atrium, skylight, etc., which is applied extant to the primary building structure. Both mounting systems and clamping devices may be investigated for mechanical mounting alone, or mechanical mounting and ground bonding as identified in the individual certifications. Ground lugs may be tested in combination with specific PV modules, specific PV module frames, or specific mounting-system rails as identified in the individual certifications.

Only those features noted in the individual certifications and/or the Reports for specific products have been investigated by UL.

The installation of these mounting systems, clamping devices or bonding devices is intended to be in accordance with ANSI/NFPA 70, "National Electrical Code," in addition to any applicable building codes.

Authorities Having Jurisdiction should be consulted as to conformance with applicable building codes, including the class of roof covering, and any additional safety investigations that may be required.

#### FLAME CLASSES

When applicable, PV mounting systems are marked "Class A," "Class B" or "Class C" to denote their resistance to external fire exposure when installed in combination with specific PV modules and according to the PV mounting system installation instructions.

#### PRODUCT IDENTITY

One of the following product identities appears on the product:

Photovoltaic Bonding Device

Photovoltaic Ground Lug

Photovoltaic Module Clamping Device

Photovoltaic Mounting and Bonding Device

Photovoltaic Mounting Device

Photovoltaic Mounting System

The word "Photovoltaic" may be abbreviated "PV."

#### RELATED PRODUCTS

PV modules and panels are covered under Photovoltaic Modules and Panels ([QIGU](#)).

Low-concentration flat-plate modules are covered under Flat-plate, Low-concentration Photovoltaic Modules and Panels ([QHZU](#)).

PV concentrators are covered under Concentrator Photovoltaic Modules and Assemblies ([QICP](#)).

AC modules are covered under AC Modules and Photovoltaic Modules with Integrated Electronics ([QHYZ](#)).



**ADDITIONAL INFORMATION**

For additional information, see Electrical Equipment for Use in Ordinary Locations ([AALZ](#)).

**REQUIREMENTS**

The basic standard used to investigate products in this category is [ANSI/UL 2703](#), "Mounting Systems, Mounting Devices, Clamping/Retention Devices, and Ground Lugs for Use with Flat-Plate Photovoltaic Modules and Panels."

The System Fire Test Requirement in [ANSI/UL 1703](#), "Flat-Plate Photovoltaic Modules and Panels," or in [ANSI/UL 61730-1](#), "Photovoltaic (PV) Module Safety Qualification - Part 1: Requirements for Construction," and [ANSI/UL 61730-2](#), "Photovoltaic (PV) Module Safety Qualification - Part 2: Requirements for Testing," may be utilized in lieu of the [ANSI/UL 2703](#) Fire Test.

Ground lugs are additionally investigated to [ANSI/UL 467](#), "Grounding and Bonding Equipment."

Constructions that penetrate roofing may be investigated utilizing the Wind-Driven Rain Test in [UL 2582](#), "Outline of Investigation for Hip and Ridge Vents."

**UL MARK**

The Certification Mark of UL on the product or on the smallest unit container in which the product is packaged is the only method provided by UL to identify products manufactured under its Certification and Follow-Up Service. The [Certification Mark](#) for these products includes the UL symbol, the words "CERTIFIED" and "SAFETY," the geographic identifier(s), and a file number.

**Alternate UL Mark**

The Listing Mark of UL on the product or on the smallest unit container in which the product is packaged is the only method provided by UL to identify products manufactured under its Listing and Follow-Up Service. The Listing Mark for these products includes the UL symbol (as illustrated in the Introduction of this Directory) together with the word "LISTED," a control number, and one of the following product names: "Photovoltaic Mounting System," "Photovoltaic Module Clamping Device," "Photovoltaic Mounting Device," "Photovoltaic Bonding Device," "Photovoltaic Mounting and Bonding Device" or "Photovoltaic Ground Lug." The word "Photovoltaic" may be abbreviated "PV."

For PV mounting systems additionally investigated for resistance to external fire exposure, the Listing Mark includes the words **CLASS A**, **CLASS B** or **CLASS C**, as appropriate.

\*\*\*\*\*

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[Last Updated](#) on 2018-01-26

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## Appendix C: Module Listing

The following tables define the listed modules and their respective load ratings which can be used with the clawFR mounting system. All modules listed have been evaluated for mechanical loading and grounding and bonding.

Table 1: Modules Qualified for use with ClawFR				
Module Manufacturer	Model Type	Downward Pressure Design Load (psf)	Upward Pressure Design Load (psf)	Down-slope Design Load (psf)
REC	RECXXTP2	60	50	10
	RECXXTP2S	60	30	10
	RECXXNP	60	30	10
Silfab	SLA-M	60	50	10
	SLG-M	60	50	10
	SLG-X	60	50	10
	SLA-X	60	50	10
Talesun	TP672P	60	50	10
	TP672M	60	50	10
	HIPRO II TP672M	60	50	10
LG	LGXXXQ1C-A5	60	50	10
	LGXXN1C-A5	60	50	10
	LGXXN2W-A5	60	50	10
	LGXXN1C-G4	60	50	10
	LGXXN2W-G4	60	50	10
JA Solar	JAM60S01/PR	60	50	10
	JAM72S01/PR	60	50	10
	JAP60S01/SC	60	50	10
	JAP72S01/SC	60	50	10
Jinko	JKMxxxP-72	60	50	10
	JKMxxxPP-72	60	50	10
	JKMxxxPP-72-V	60	50	10
	JKMxxxM-72	60	50	10
	JKMxxxM-72-V	60	50	10
Q Cells (Hanwha)	Q.PEAK DUO-G5 (315-330)	60	50	10
	Q.PEAK DUO BLK-G5 (305-320)	60	50	10
	Q.PEAK-G4.1 (290-305)	60	50	10
	Q.PEAK BLK G4.1 (290-305)	60	50	10
	Q.PEAK-G4.1/TAA	60	50	10
	Q.PEAK BLK G4.1/TAA	60	50	10



**Table 1: Modules Qualified for use with ClawFR**

Module Manufacturer	Model Type	Downward Pressure Design Load (psf)	Upward Pressure Design Load (psf)	Down-slope Design Load (psf)
Q Cells (Hanwha)	Q.PEAK-G4.1/MAX	60	50	10
	Q.PLUS G4 (270-280)	60	50	10
	Q.PLUS BFR G4.1 (270-280)	60	50	10
	Q.PLUS BFR G4.1/TAA	60	50	10
	B.LINE PLUS BFR G4.1 (265-285)	60	50	10
	B.LINE PRO BFR G4.1 (245-265)	60	50	10
	Q.PRO EC-G4.4 (260-265)	60	50	10
	Q.PRO BFR G4 (255-265)	60	50	10
	Q.PRO BFR G4.1 (260-270)	60	50	10
	Q.PRO BFR G4.3 (260-265)	60	50	10
	Q.PRO G4 (255-265)	60	50	10
	Q.PEAK DUO L-G5.2 (380-395)	60	50	10
	Q.PEAK DUO L-G5.3 (380-395)	60	50	10
	Q.PEAK L G4.2 (365-370)	60	50	10
	Q.PEAK L G4.1 (365-370)	60	50	10
	Q.PLUS L G4.2 (325-355)	60	50	10
	Q.PLUS L G4.1 (330-340)	60	50	10
	Q.PLUS L G4 (320-340)	60	50	10
	Q.PRO L G4 (310-320)	60	50	10
	Q.PRO L G4.1 (310-320)	60	50	10
	Q.PRO L G4.2 (310-320)	60	50	10
	B.LINE PLUS L G4.2 (310-345)	60	50	10
	B.LINE PRO L G4.1 (300-337)	60	50	10
B.LINE PRO L G4.2 (307-337)	60	50	10	
Q.PLUS L-G4.2/TAA	60	50	10	
Sunpower	SPR-E19-XXX-COM	60	50	10
	SPR-E22-XXX-COM	60	50	10
	SPR-E19-XXX-COM	60	30	10
	SPR-X21-XXX-COM	60	30	10

Note that the **Applied Test Load** exceeds the minimum test loading required for UL 2703 compliance. **Design Load Ratings** in each direction are determined by calculating a safety factor, where: **DesignLoadRating = AppliedTestLoad/1.5**.