TESLA

SOLAR ROOF

INSTALLATION MANUAL

DISCLAIMER OF LIABILITY

Tesla Incorporated (“Tesla”) and its subsidiaries are not liable for any damages caused by failure to follow the instructions and guidelines found in this manual, or from inappropriate use or maintenance of PV Modules. This includes, without limitation, any damages, losses, and expenses caused by non-observance of the instructions of this manual, as well as damages, losses, and expenses caused by, or in connection with, products of other manufacturers.

NOTICES

The information in this manual is believed to be reliable, but does not constitute an express or implied warranty. Tesla reserves the right to make changes to its PV Modules and other products, their specifications, or this manual without prior notice.

This manual applies to Solar Roof PV Modules, Roofing Tiles, Partial Tiles, the Prepared Roofing System elements which serve as their mounting system, and electrical wiring elements manufactured by Tesla. It is explicitly written for qualified professionals (“Installer” or “Installers”), including without limitation licensed electricians and NABCEP-Certified PV Installers.

CONTACT INFORMATION

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IMPORTANT SAFETY INSTRUCTIONS

SAVE THESE IMPORTANT SAFETY INSTRUCTIONS

All instructions must be read and understood before attempting to install, wire, operate, or maintain a PV system. Failure to read and comply with any of the limitations noted herein can result in property damage, serious bodily injury, or death.

The installer assumes the risk of all injury that might occur during installation, including, without limitation, the risk of electric shock.

Tesla Solar Roof is engineered to safely withstand applicable live loads required by building code for steep slope applications. However, to ensure safety and maintain maximum roof life, walking on a Solar Roof should be avoided except by trained Tesla Solar Roof installation professionals and first responders. This is a common recommendation for other high-end roof types, including slate, clay, concrete, and composite tile products.

- Use qualified personnel for installation. Installing a Solar Roof requires specialized skills and knowledge.
- Abide by local, regional, and national statutory regulations when installing the system, and obtain a building permit if necessary.
- Use equipment, connectors, and wiring suitable for solar electric systems.
- Work under dry conditions and use dry tools.
- Use fall protection when working from heights of 6 feet (183 cm) or above. Follow Occupational Safety and Health Act (OSHA) or local governing safety regulations regarding Fall Protection.
- Use insulated tools that are approved for working on electrical installations.
- Wear suitable personal protection equipment (PPE) to prevent the risk of personal injury, such as fall hazards or electrical hazards.
- Consult your local authority for guidelines and requirements for building or structural fire safety.

NOTE TO TRAINED PROFESSIONALS

⚠ DANGER: Tesla Solar Roof is slippery and is a fall hazard. Only access a Solar Roof with appropriate safety equipment and while wearing personal fall protection. An approved and safe walking platform should be used when accessing the roof to prevent falls, and damage to the roof. In addition, skylights, roof openings and light transfer panels must be covered with approved covering to prevent falls.

⚠ DANGER: In the event of a fire at the premises, rapid shutdown equipment in the array will reduce voltages and control the hazard for firefighter operations. Nevertheless the array wiring should be treated as potentially dangerous, especially if it is damaged by heat or flames. Inform the fire crew about the particular hazards from the PV system, and stay away from all elements of the PV system during and after a fire until the necessary steps have been taken to make the PV system safe.

ROOFING SPECIFICATIONS

SHEATHING REQUIREMENTS

Tesla Solar Roof is installed over bare solid or closely fitted sheathing, as follows:

- Exterior grade plywood: 15/32” nominal thickness or greater
- OSB: 7/16” nominal thickness or greater
- Solid sheathing boards: minimum of 1’x4’, closely fitted

Do not install Tesla Solar Roof over widely spaced sheathing boards (sometimes referred to as “skip sheathing”). Retrofitting the existing structure with solid sheathing would be necessary. Verify the capacity of the existing structure to carry this additional load. As this procedure is beyond the scope of this manual, contact Tesla for engineering support prior to such modification.

ROOF PITCH RANGE

2:12 - 20:12

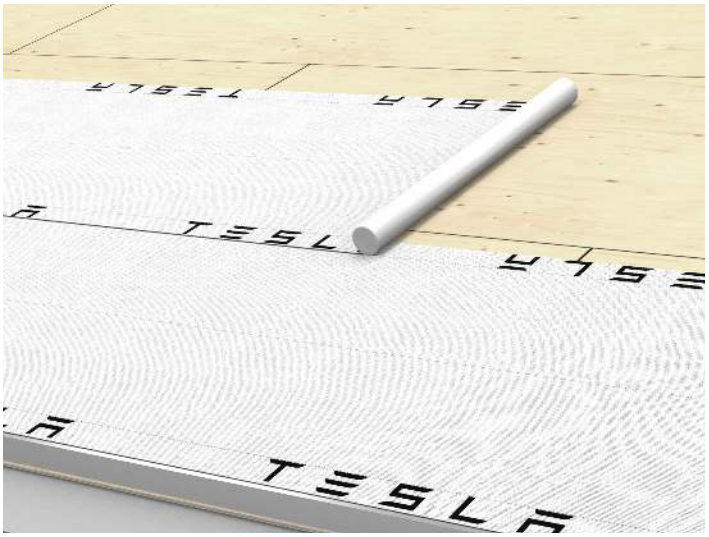
SINGLE COVERAGE UNDERLAYMENT

FT COBALT FR is a self-adhering peel and stick roofing underlayment designed for sloped roof applications to help protect against water infiltration from ice dams and wind-driven rain. It is installed with Solar Roof V3 as a single layer application.

PN:16113738-00-A

Full-Width roll: 38” with 3” Selvage Edge (Overlap Edge)
Detail roll: 12-11/16”

ASTM D1970/ICC AC48
ICC AC188
ASTM E108 Class -A



DECK PREPARATION

Cobalt FR should be installed over a clean, smooth, and dry deck. The deck should also not have any voids, protrusions, damaged or unsupported areas. For re-roofing projects, replace any water damaged sheathing and sweep roof deck thoroughly removing dust, dirt and loose nails. Do not install over old roof coverings.

APPLICATION

FT Cobalt FR maybe applied directly to plywood, OSB, fully cured concrete or masonry roof surfaces. Priming is not required for attaching Cobalt FR to dry wood, OSB or metal surfaces when the temperature is above -4˚F (-20˚C). Concrete and masonry decks should be primed with a solvent or a water based primer that meets ASTM D41 for self-adhesive membranes. Always work from the low point to the high point of the roof.

COLD WEATHER APPLICATION

Temperatures -4°F (-20°C) or below, a primer should be used and the upper most overlap edge blind nailed using 3/8” head roofing nails 1” or longer. Space nails at 12” intervals along upper side lap area 1” in from the edge using the guide marks. For best results, warm Cobalt FR to room temperature prior to application.

STEEP SLOPE APPLICATION

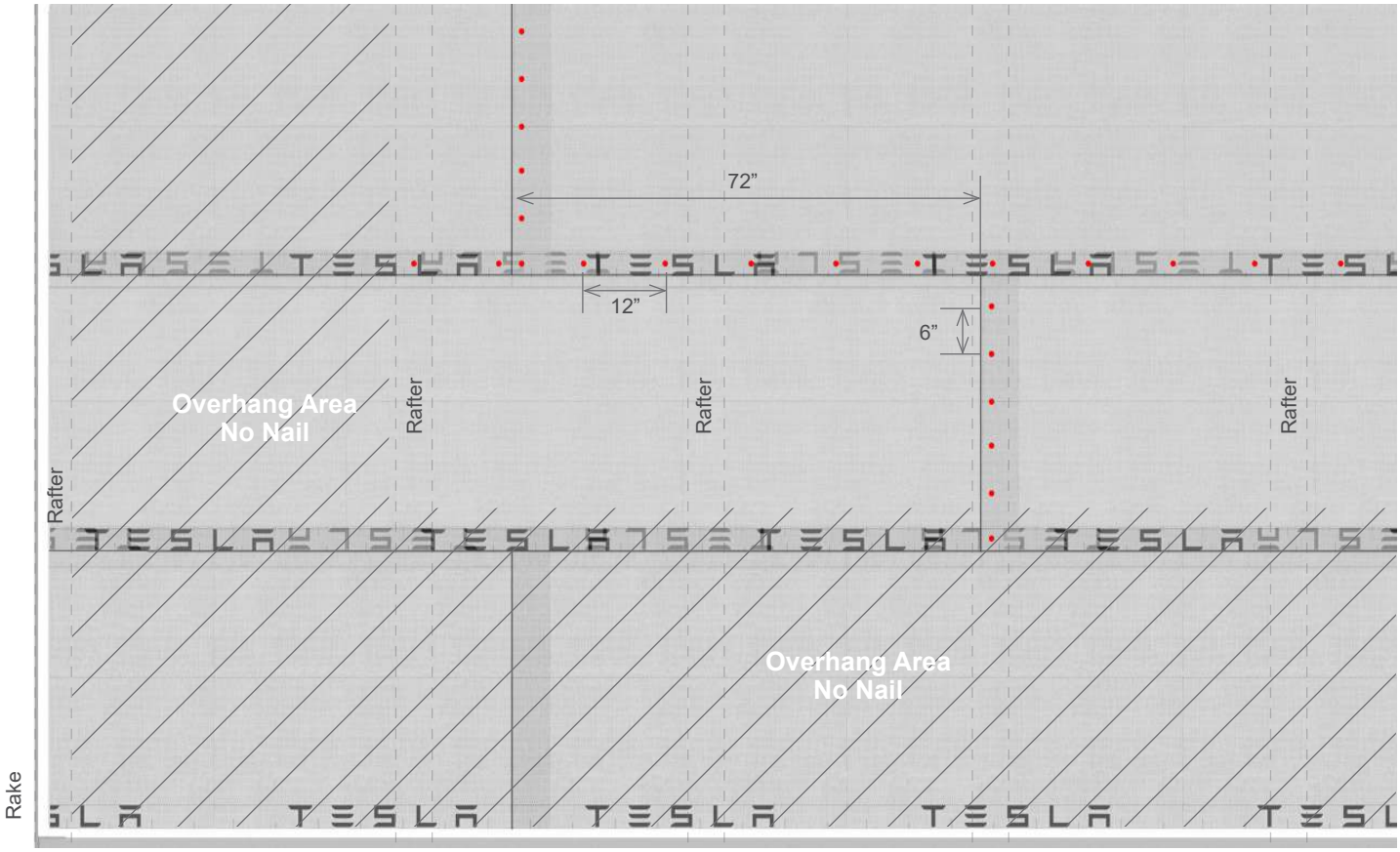
Steep slopes (5:12 or greater), high wind areas, or when installing at temperatures greater than 100°F (38°C), it is recommended to blind nail the selvage edge area as per above under cold weather application.

STORAGE

For best results store Cobalt FR upright in its original packaging in a well ventilated area at room temperature 40˚F (4.4˚ C) and 90˚F (32˚C). If product has been stored at a high temperature above 90˚F (32˚C) it may become difficult to remove the release liner backing. To correct this, move product to cooler location. Once cooled, the release liner can be easily removed.

ADDITIONAL NOTES

FT Cobalt FR is a moisture and vapor barrier and therefore must be installed above a properly ventilated space(s). Follow ALL building codes applicable to your geographical region and structure type. Cobalt FR is not designed for indefinite outdoor exposure. Final roofing should be installed within 180 days of underlayment installation.



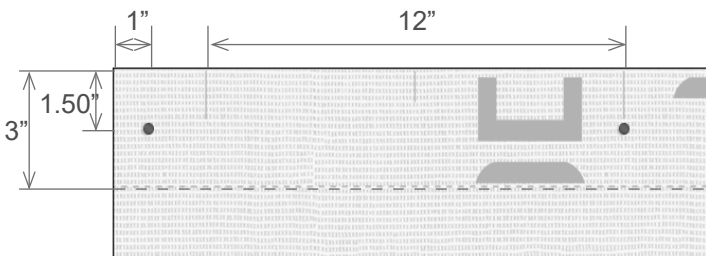
CONCEALED NAIL METHOD

FT Cobalt FR is to be laid out horizontally (parallel) to the eave with the printed side up. Apply underlayment over the Eave Flashing and offset the starter course 1/2” from the drip edge. Fasten each course at the up roof edge using nails every 12” on the guideline marks. At the eave drip edge, the underlayment will be fastened during the Starter Trim installation. On exposed overhangs, nail only on rafters unless the eave is soffited. Lap each succeeding course 3” over the preceding course, fully concealing the fasteners and the
upside-down Tesla logo. Use a roller along the entire face of the underlayment to ensure an adequate seal.

For end laps it is recommended to overlap a minimum of 6” and nail 1” in from the edges with 6” spacing between nails. End laps should be offset a minimum of 6’ on adjacent courses. **Note:** if underlayment will be left exposed for an extended period in high wind area it is also recommended to cap nail 1” in at 6” intervals along key exposed seams. This specifically includes along the outer edges of the roof along the rake or eave.

Horizontal laps

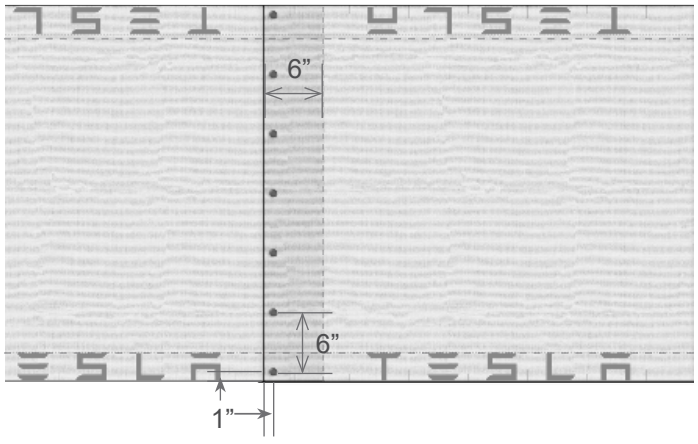
Lap 3” min. Fasten every 12” with nails.



Top Corner of Underlayment

End laps

Lap 6” min. Fasten every 6” with nails.



SOLAR ROOF MODULE INFORMATION

CERTIFICATIONS

UL Listed	ETL Listed
UL 61730	UL 790 Class A
UL 9703	TAS100
UL 1741	ASTM D3161 Class F

ELECTRICAL CHARACTERISTICS

Maximum open circuit voltage rating of connected branch circuits per diode (at STC): 13.34 V

Maximum series fuse rating: 10 A

Maximum system voltage: 1000 V (for installations above 2000 m but below 3000 m the system voltage is 877 V)

Temperature coefficient for voltage at open-circuit: -0.299 (%/°C)

Temperature coefficient for maximum power: -0.395 (%/°C)

Temperature coefficient for short-circuit current: 0.047 (%/°C)

Protection Class: II

Ambient temperature range: -40 °C to +40 °C

Wire: 12 AWG, PV wire, 90 °C wet or dry
Only PV connectors compatible with type PV-KST4/6II-UR or type PV-KST4-EVO2 (male), PV-KBT4/6II-UR or PV-KBT4-EVO2 (female) from Staubli may be used to connect to the PV module.

MODEL #SR60T1 14-CELL MODULE

Irradiance (W/m^2)	Temp. (Celsius)	Voc (V)	Vmp (V)	Isc (A)	Imp (A)	Pmax (W)
1000	25	13.34	10.99	5.65	5.32	58.47

These electrical characteristics are within ± 5% of the indicated values of Isc, Voc, and Pmax under standard test conditions (irradiance of 1000 W/m^2, AM 1.5 spectrum, and a cell temperature of 25 °C or 77 °F).

Dimensions	430 mm x 1140 mm Appx. 5 mm module thickness with 35.3 mm maximum height from deck
Principal Materials	Glass, Polymers, Fiberglass and Silicon
Installed System Weight	Textured Glass: 16.4 kg/m² or 3.4 psf Installed weights include all components of system above roof sheathing

PVRSA Model: Solarglass Roof Rapid Shutdown Array

Category QIJR, Report Date: 2020-05-01

TABLE OF ESSENTIAL ELEMENTS

Function	Manufacturer	Model No.	Firmware Versions and Checksums	Certification Standard
PVRSE Mid Circuit Interrupter (MCI)	Delta Electronics	GPI00010114 [2]	2.1.6	UL 1741 PVRSE
Inverter	Delta Electronics	M4, M5, M6, M8, M10	Sys: 2.2.11 Pwr: 1.4.9 Safety: 1.4.3	UL 1741
PV Module	Tesla	SR60T1	N/A	UL 61730
Diode Harness	Tesla	SRDTH	N/A	UL 9703
PV Wire Jumper(s)	Tesla	SR-BJ2X, SR-BJ3X, SR-BJ4X, SR-BJMini	N/A	UL 9703
Pass-Through Box	Tesla	SRPTB-4	N/A	UL 1741
PVRSA Initiator [1] (See installation req. below)	Non-Specific	N/A	N/A	N/A

1 Dedicated PV system AC circuit breaker or AC disconnect switch, labeled per NEC 690.12 requirements.

2 Applies to variations of this part number, e.g. suffixes.

Note: PVRSA installation requirements may reduce the effective equipment and component ratings below the individual equipment and component PVRSE ratings in order to achieve PVRSA shock hazard reduction requirements.

PVRSA INSTALLATION REQUIREMENTS

Max System Voltage	600 VDC
Max Array Internal Voltage After Actuation	165 VDC (cold weather open circuit)
Max Series-Connected Panels between MCI Output Connections:	10
Max Series-Connected Panels Connected to MCI Inputs:	5

OTHER INSTALLATION INSTRUCTIONS

1. MCIs shall be positioned at a slight angle during installation on roof deck to assist with water shedding.

2. An MCI must be connected to one end of each series string or mounting plane sub-array string.

3. Verification that MCIs are installed with 10 or fewer modules between MCI output connections shall be documented for inspection, by voltage measurement logs and/or as-built string layout diagrams.

4. The dedicated PV system AC circuit breaker or PV system AC disconnect switch shall serve as the PVRSA initiator and shall be sized and installed in accordance with NEC requirements. The specific part shall be identified on the as-built system drawings.

Certification Mark of UL on the installation instructions 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.

SOLAR ROOF SYSTEM OVERVIEW

A Solar Roof functions in fundamentally the same way as traditional roof-mounted PV systems. Sunlight is converted to DC electricity at each individual module. Individual modules are connected in series using diode harnesses to form a complete PV “string.” One or more strings connect in parallel at a typical string inverter to convert power to AC.

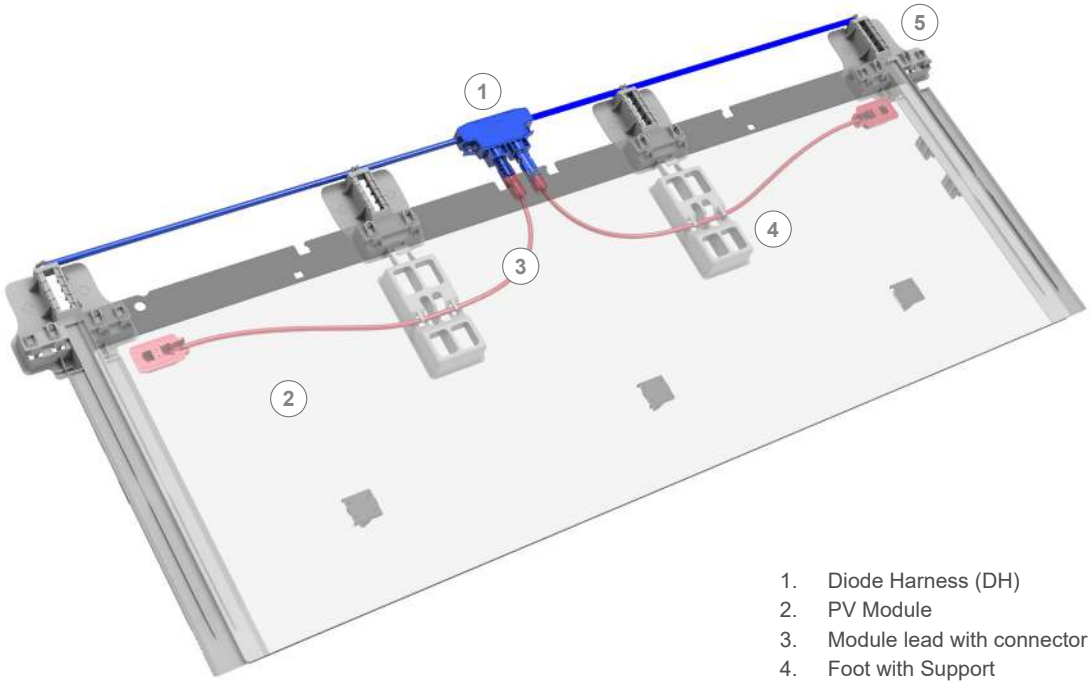
TRADITIONAL PV	TESLA SOLAR ROOF
DC modules	DC modules
Tempered glass	Tempered glass
Silicon cells	Silicon cells
Backsheet & encapsulant	Backsheet & encapsulant
Module J-boxes, PV wire and Listed connectors	Module J-boxes, pv wire and Listed connectors
Series strings below 600 V	Series strings below 600 V
DC - AC inverters	DC - AC inverters
Rapid shutdown (2014 or 2017)	Rapid shutdown (2014 or 2017)

TILE TYPES

- PV Modules
- Full and Partial Roofing Tiles
- Flashings

ELECTRICAL SYSTEM COMPONENTS

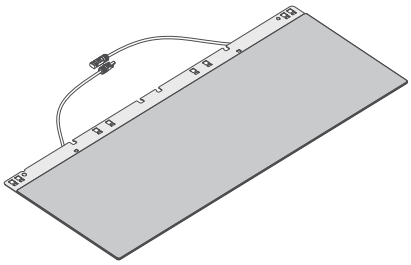
Evaluate preliminary PV layout prior to tear-off to verify that arrays will fit as designed. PV array layout must follow plan set when possible. Always communicate field changes with the installation hotline team. Field changes may cause BOM change (Diode Harness length and count, Jumper length and count, Partial Tile count).



1. Diode Harness (DH)
2. PV Module
3. Module lead with connector
4. Foot with Support
5. Footlap

PV MODULE

Model #SR60T1
Listed to UL 61730
UL 790 Class A
ASTM D3161 Class F
TAS100

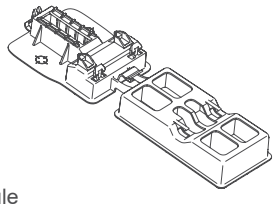


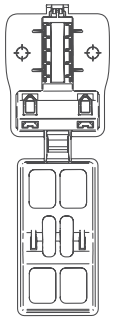
MCI RAPID SHUTDOWN

Model #EE-002605-003, Delta #GPI00010110
600V, 12A, NEMA 4X, MC4
Listed to UL 1741 PVRSE

FOOT WITH SUPPORT

Model #SR-FOOTSUP
Listed to UL 790 Class A
ASTM D3161 Class F
TAS100

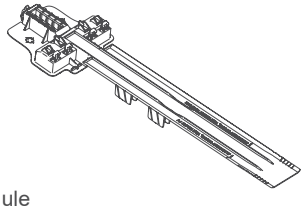




Center foot for PV module

FOOTLAP

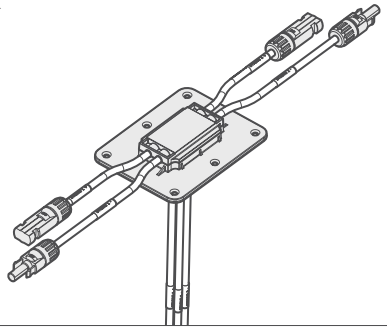
Model #SR-FOOTLAP
Listed to UL 790 Class A
ASTM D3161 Class F
TAS100



Edge foot for PV module

PASS THROUGH BOX

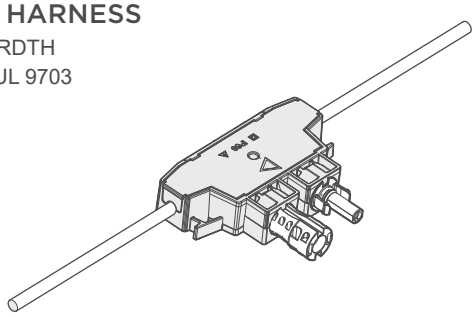
Model #SRPTB-4
Listed to UL 1741



Provides a method of transferring up to 2 PV source circuits through the roof decking to inverters or additional PV arrays.

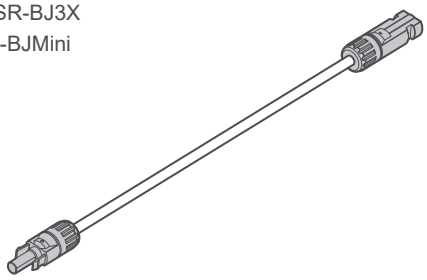
DIODE HARNESS

Model #SRDTH
Listed to UL 9703



JUMPER

Model #SR-BJ2X, #SR-BJ3X
#SR-BJ4X, and #SR-BJMini
Listed to UL 9703



BRANCH SOCKET, STAUBLI

Model #PV-AZB4
Listed to UL 6703

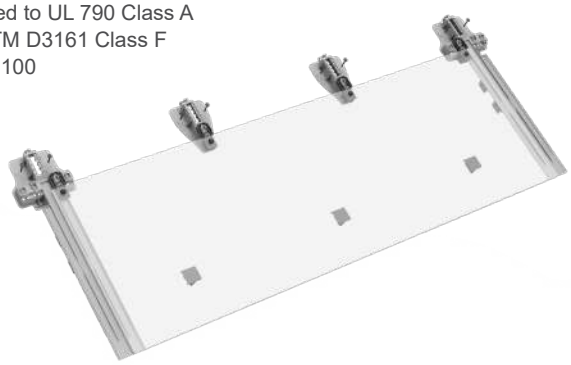
BRANCH PLUG, STAUBLI

Model #PV-AZS4
Listed to UL 6703

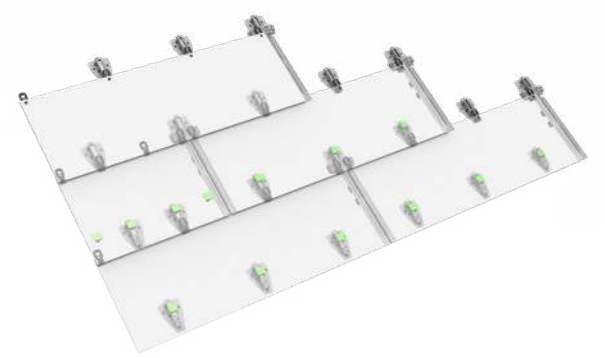
ROOFING TILES AND PARTIALS | STANDARD

ROOFING TILES, FULL AND PARTIALS

Listed to UL 61730
Listed to UL 790 Class A
ASTM D3161 Class F
TAS100

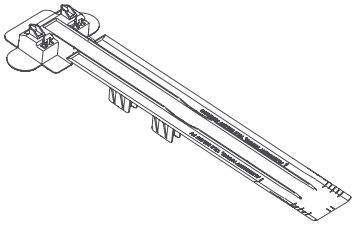


Roofing Tiles are non-electrical tiles buffering the solar array at all edge conditions. Roofing Tiles come in six different sizes to accommodate all areas of the mounting plane and are cross compatible with the PV Module hardware. The center foot is the Roofing Foot. The Reduced Footlap is used as an alternate edge foot.



REDUCED FOOTLAP

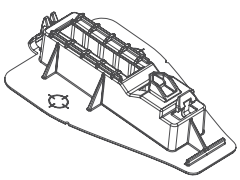
Model # SR-RFOOTLAP

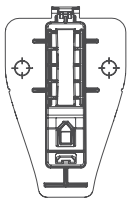


Alternate edge foot for Roofing Tile

ROOFING FOOT

Model #SR-FOOT

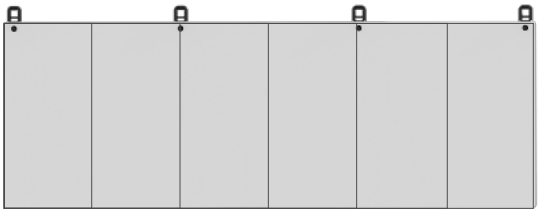




Center foot for Roofing Tile

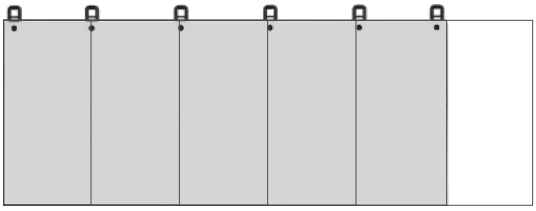
FULL TILE

Model #SRNFT1



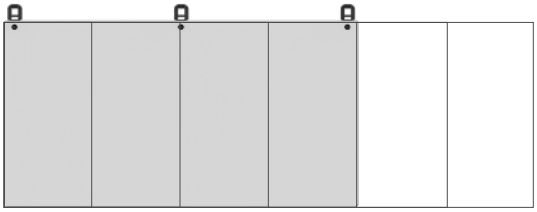
5/6 PARTIAL TILE

Model #SRNFT5/6



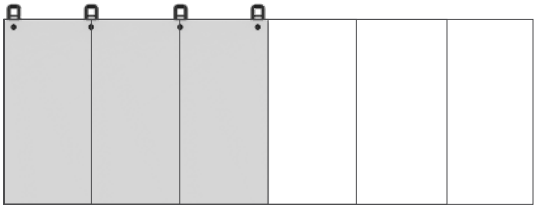
2/3 PARTIAL TILE

Model #SRNFT2/3



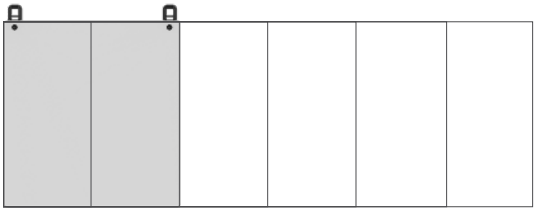
1/2 PARTIAL TILE

Model #SRNFT1/2



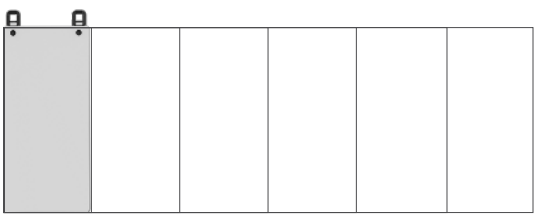
1/3 PARTIAL TILE

Model #SRNFT1/3



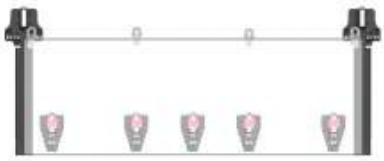
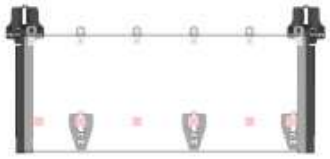
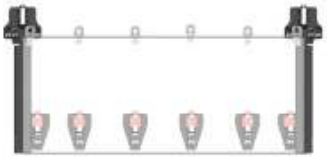
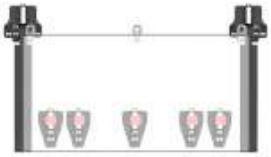
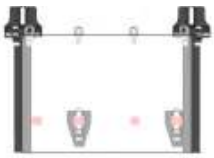
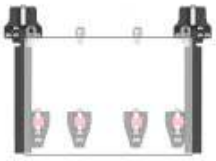
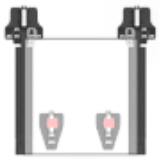
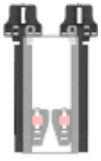
1/6 PARTIAL TILE

Model #SRNFT1/6



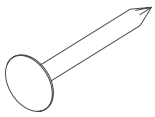
ROOFING TILES AND PARTIALS | HIGH WIND

A comparison of foot placement on starter course of High Wind installation versus standard installation is shown.
The Full Tile, 2/3 Tile, and 1/3 Tile are speciality High Wind Tiles.
The 5/6 tile, 1/2 Tile and 1/6 Tile use existing tiles with additional feet installed.

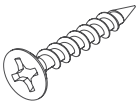
	STANDARD TILES	140-166 MPH WIND
FULL TILE	PN: 1523807-00-D	PN: 1558848-00-A
		
	3 FEET	5 FEET
5/6 TILE	PN: 1525181-00-B	PN: 1525181-00-B
		
	3 FEET	6 FEET
2/3 TILE	PN: 1525182-00-B	PN: 1558939-00-A
		
	2 FEET	5 FEET
1/2 TILE	PN: 1525183-00-B	PN: 1525183-00-B
		
	2 FEET	4 FEET
1/3 TILE	PN: 1525184-00-B	PN: 1558938-00-A
		
	1 FOOT	2 FEET
1/6 TILE	PN: 1525185-00-B	PN: 1525185-00-B
		
	1 FOOT	2 FEET

FASTENERS

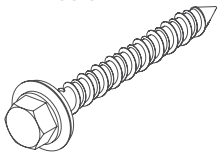
NAIL, RING SHANK ROOFING
.120" x 1.25", COLLATED, HDG



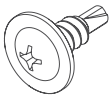
SCREW, PHILLIP BUGLEHEAD, DK
#8 X 1" COATED



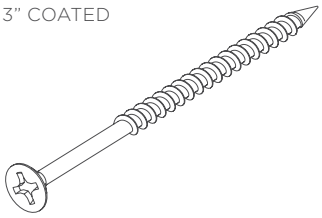
SCREW, CONCRETE
0.25" X 2.25", HEX WASHER
STAINLESS STEEL



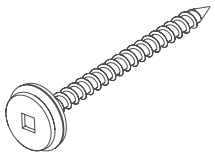
SCREW, PHILLIP, MODIFIED TRUSS
HEAD, SELF DRILLING
#8-18 x .5", STAINLESS STEEL



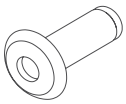
SCREW, PHILLIP BUGLEHEAD
#8 X 3" COATED



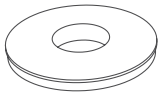
SCREW, SQUARE DRIVE CONCEALOR
BONDED WASHER
#10-13 x 2", GALVANIZED



RIVET, BLIND, DOMED
0.125" OD
0.125-0.187" MATERIAL THICKNESS



WASHER, BONDED SEALING,
0.25", STAINLESS STEEL



VENTILATION AT THE EAVE AND RIDGE

Ridge and eave flashing systems are designed to ensure that embers cannot enter into the building in the event of a wildland fire.

706A.2 REQUIREMENTS. *Ventilation openings for enclosed attics, enclosed eave soffit spaces, enclosed rafter spaces formed where ceilings are applied directly to the underside of roof rafters, and underfloor ventilation openings shall be fully covered with wire mesh, vents, other materials or other devices that meeting one of the following requirements :*

2. *Vents complying with all of the following:*

2.1 *The dimensions of the openings therein shall be a minimum of 1/16-inch (1.6 mm) and shall not exceed 1/8-inch (3.2 mm).*

2.2 *The materials used shall be noncombustible.*

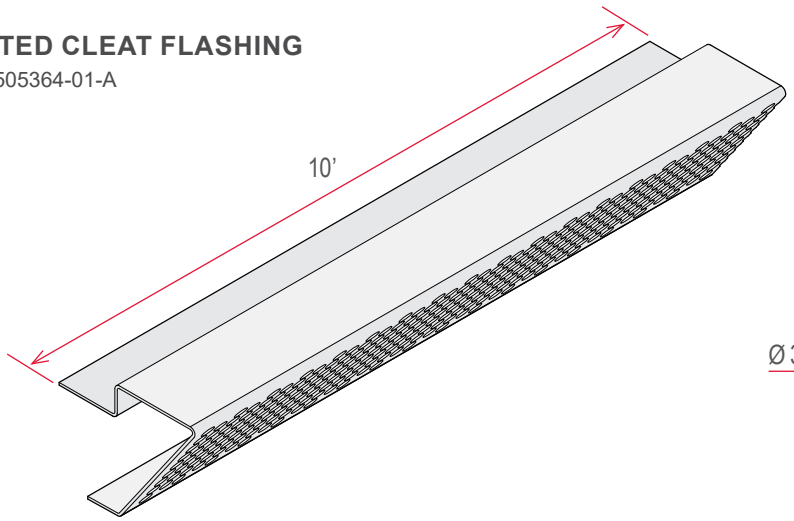
2.3 *The materials used shall be corrosion resistant.*

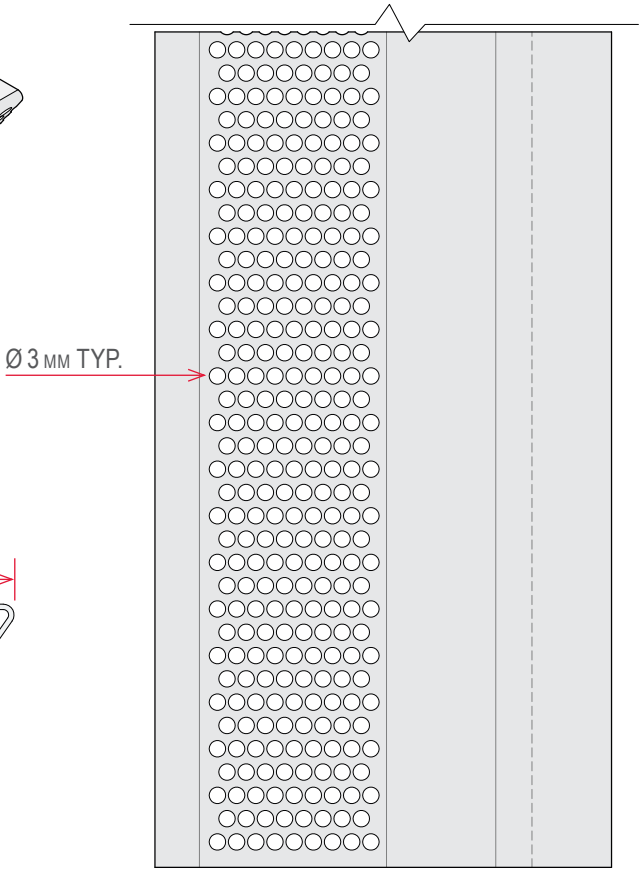
RIDGE VENTILATION

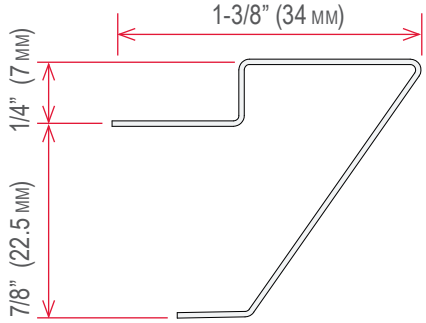
Solar Roof is vented using a ridge vent system. The ridge cap assembly consists of a Ridge Cap, Vented Cleat Flashing, and Ridge Bracket. The Vented Cleat has 3 millimeter round holes that are installed along the entire length of the ridge.

VENTED CLEAT FLASHING

PN: 1505364-01-A

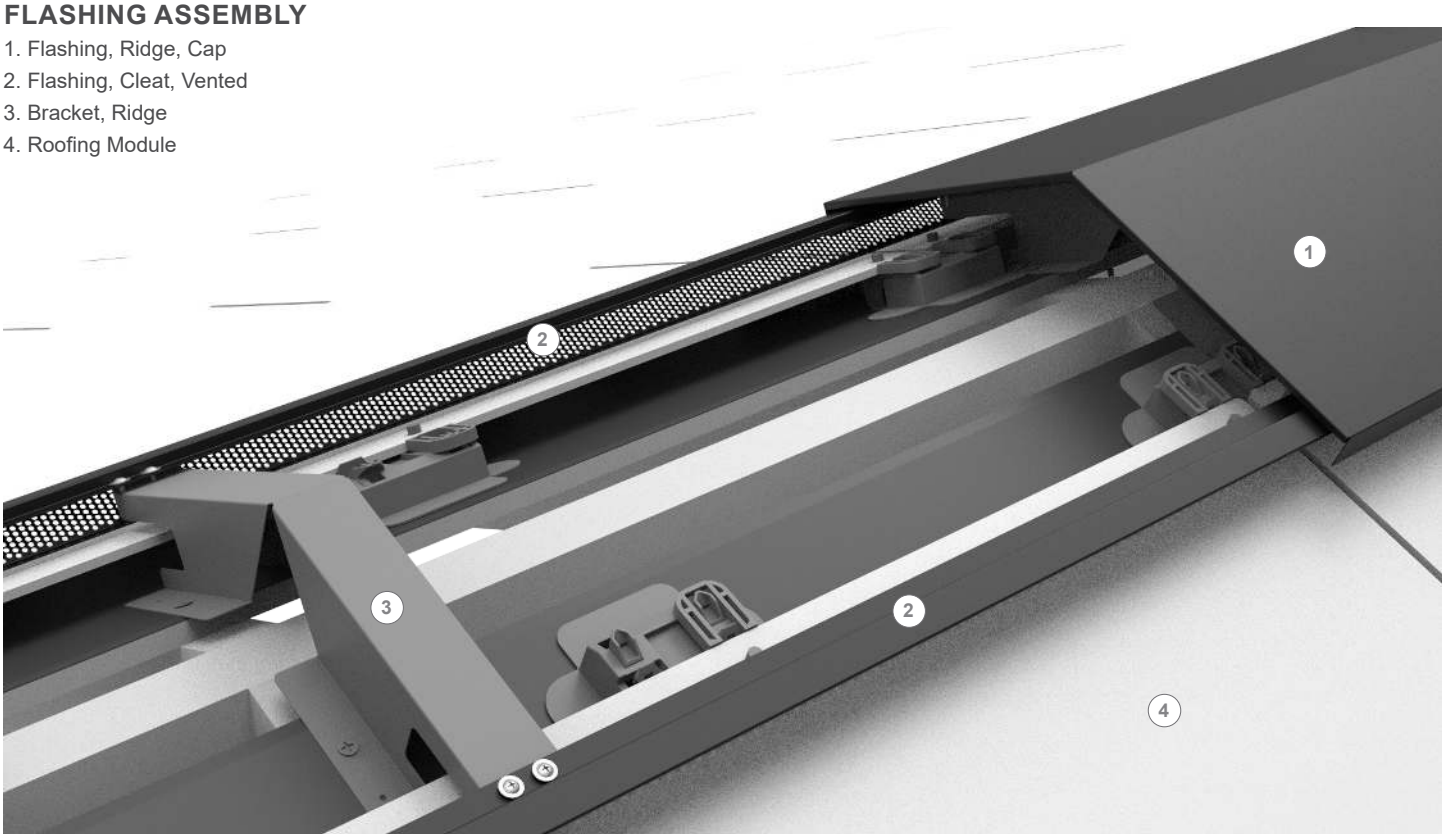






FLASHING ASSEMBLY

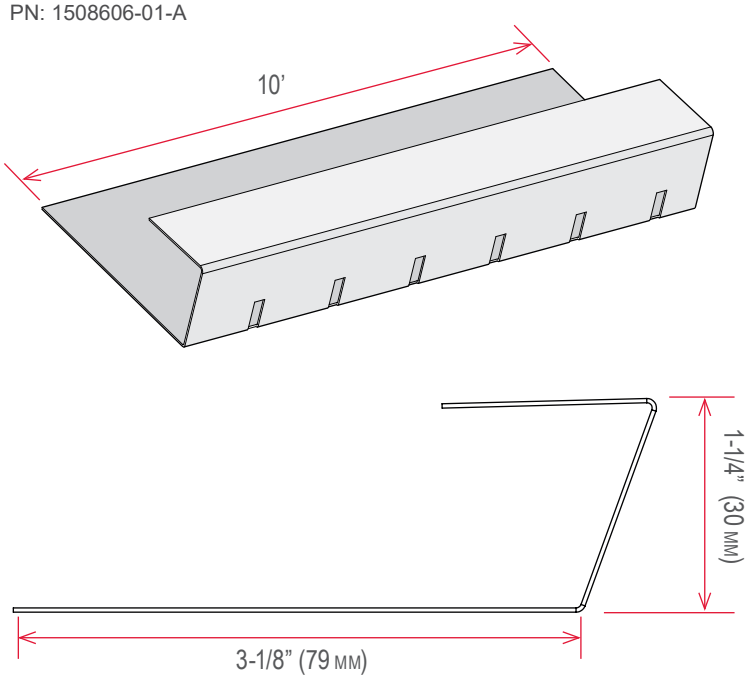
1. Flashing, Ridge, Cap
2. Flashing, Cleat, Vented
3. Bracket, Ridge
4. Roofing Module

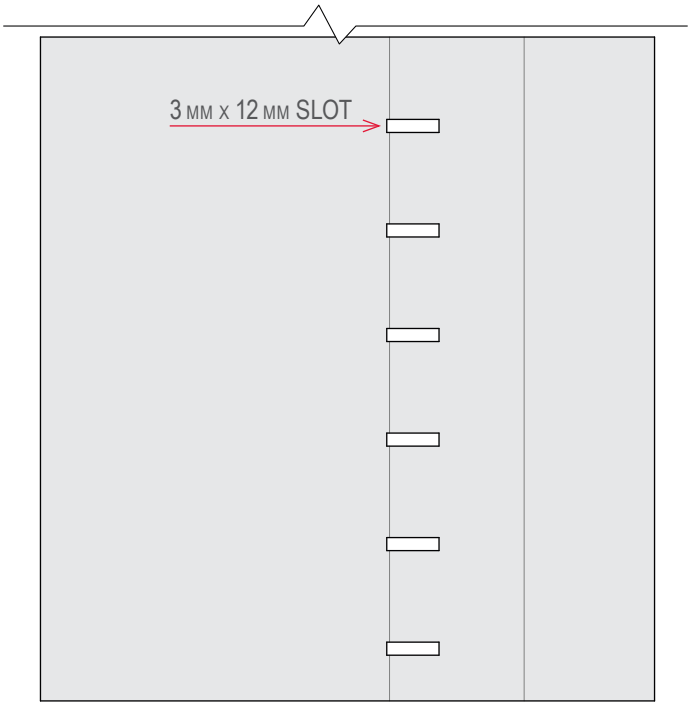


EAVE VENTILATION

Solar Roof is vented at the eave using the Starter Trim. The Starter Trim has 3 millimeter x 12 millimeter square slots and is installed along the entire length of the eave.

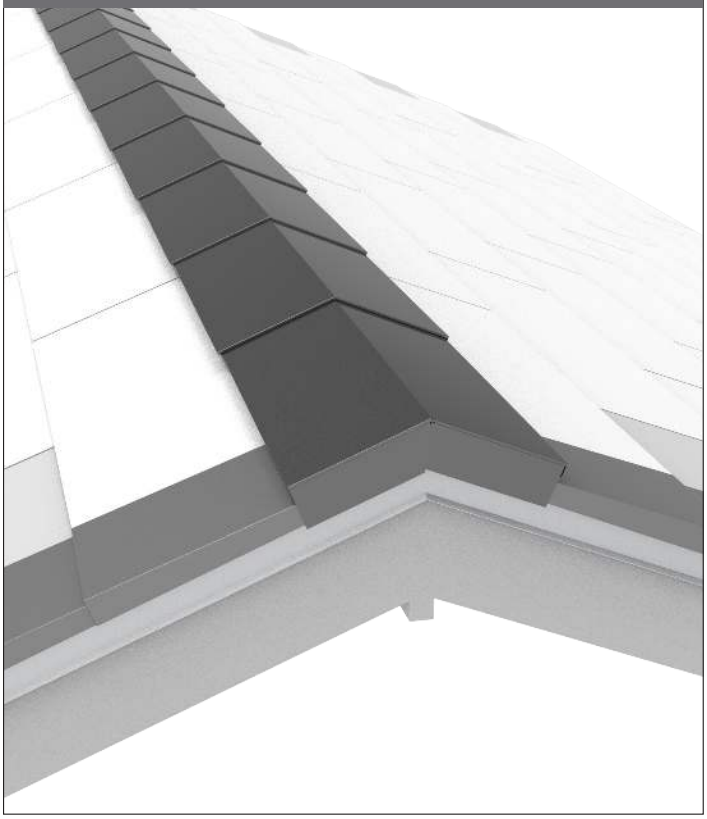
STARTER TRIM
PN: 1508606-01-A





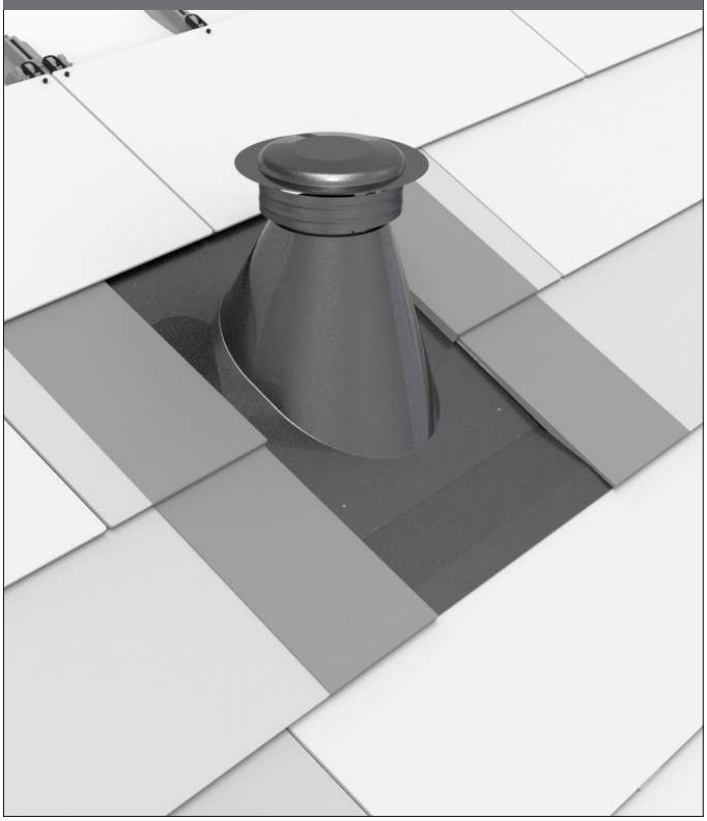
FLASHING COMPONENTS

STEPPED RIDGE DETAIL

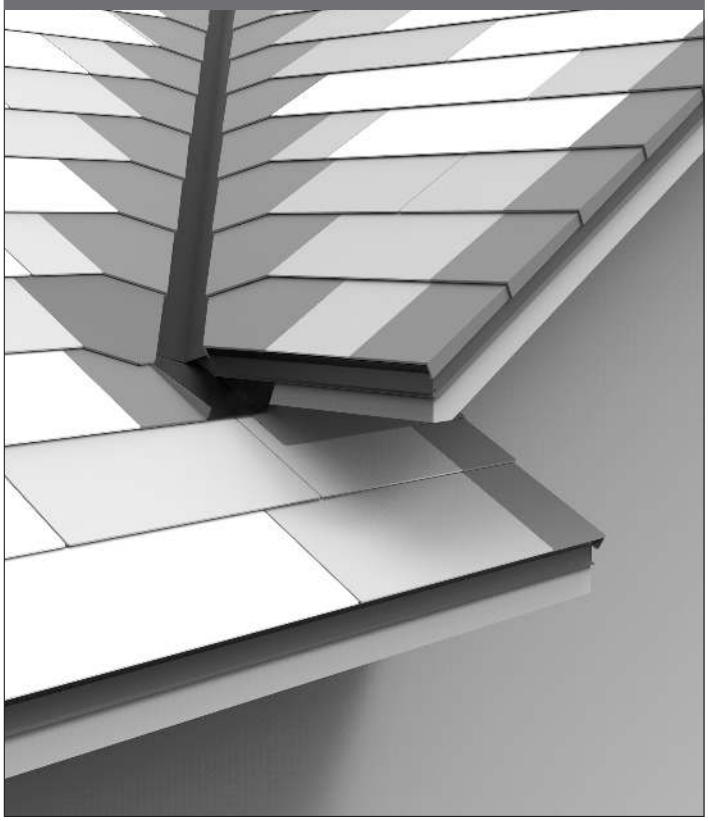


STEPPED HIP DETAIL

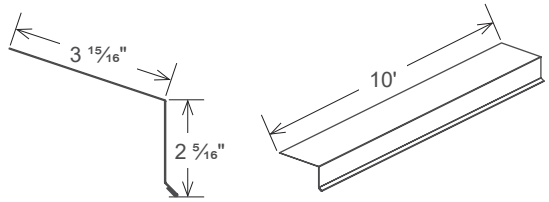
OBSTRUCTION DETAIL



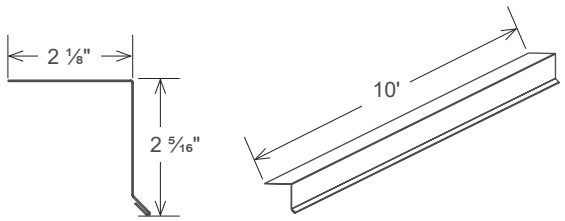
VALLEY DETAIL



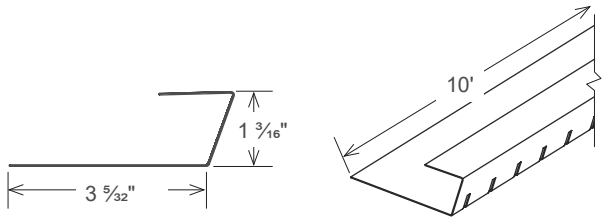
FLASHING, EAVE



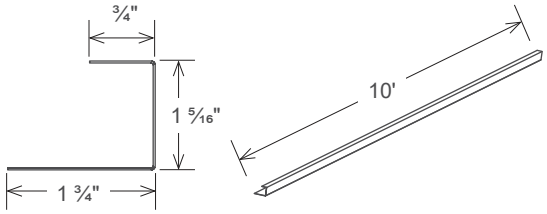
FLASHING, RAKE



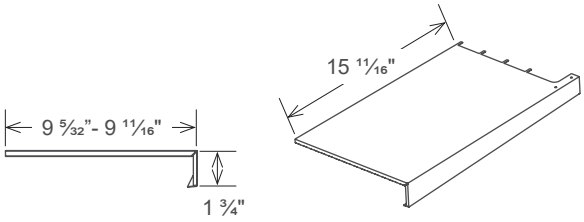
TRIM, STARTER



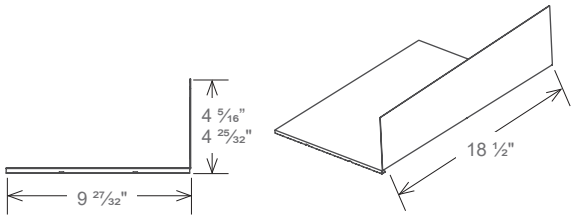
DECK, C CHANNEL



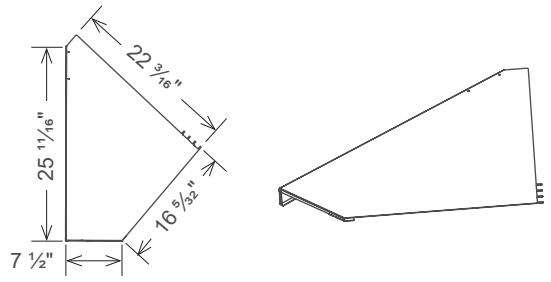
TRIM, RAKE



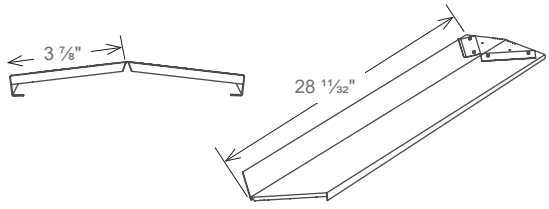
FLASHING, SIDEWALL STEP



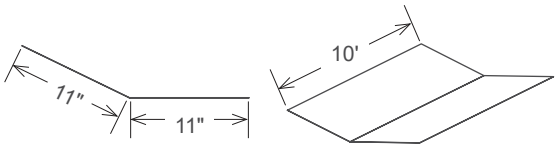
TRIM, VALLEY



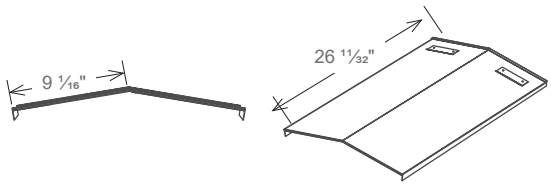
FLASHING, HIP CAP



FLASHING, VALLEY



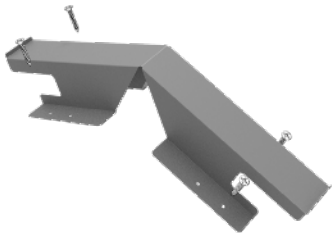
FLASHING, CAP, RIDGE

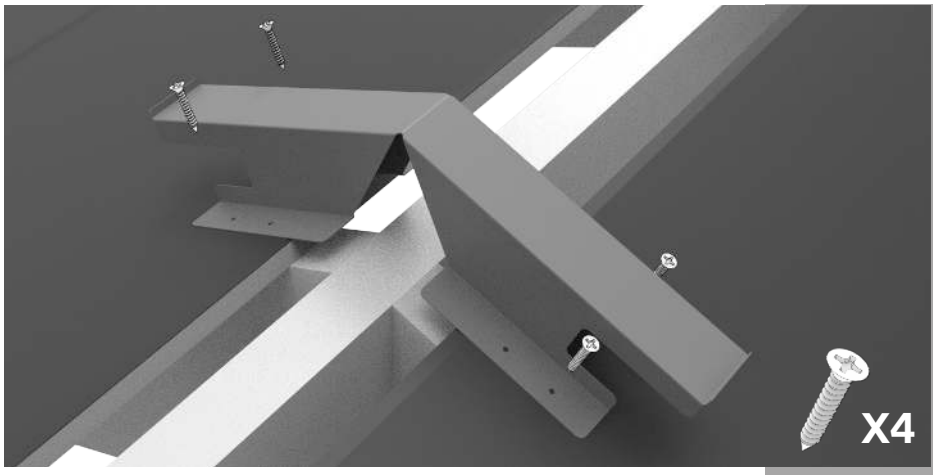


RIDGE FLASHING

RIDGE BRACKET

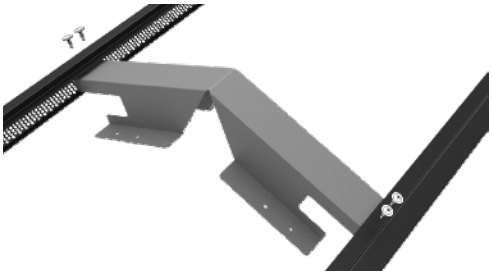
4 Self Tapping Screws, 2 per side.

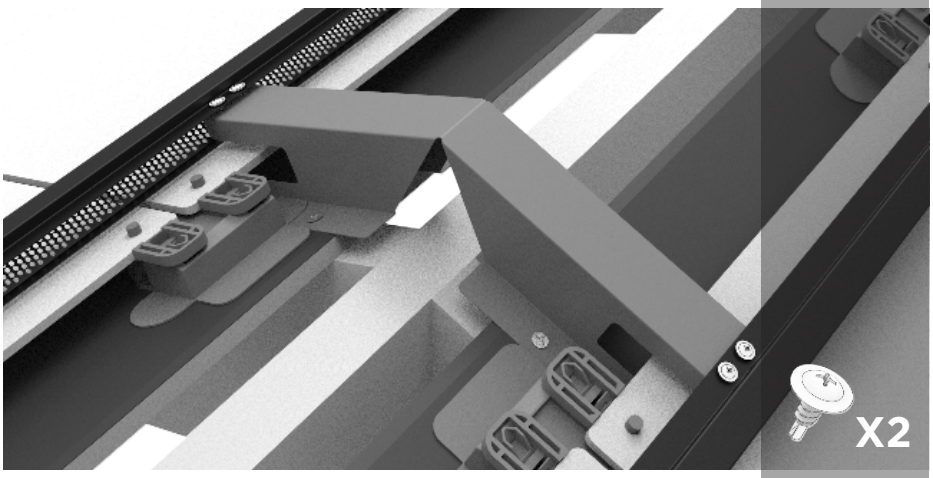




VENTED RIDGE FLASHING

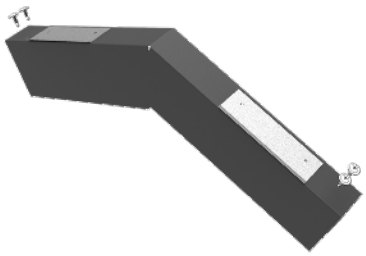
2 Self Tapping Screws per Vented rail.

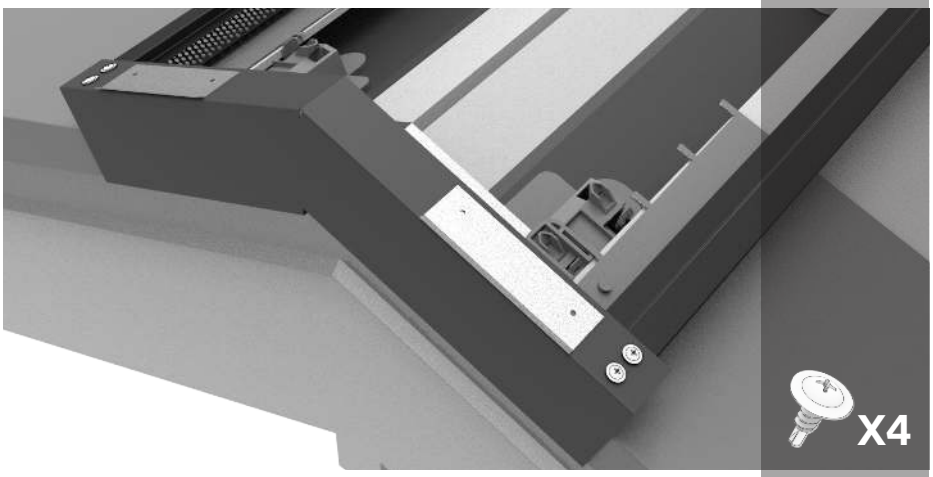




RIDGE END CAP TRIM

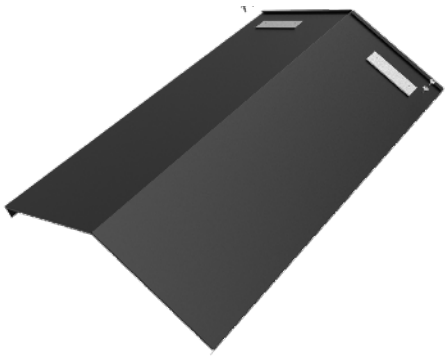
4 Self Tapping Screws per End Cap.





RIDGE CAP FLASHING

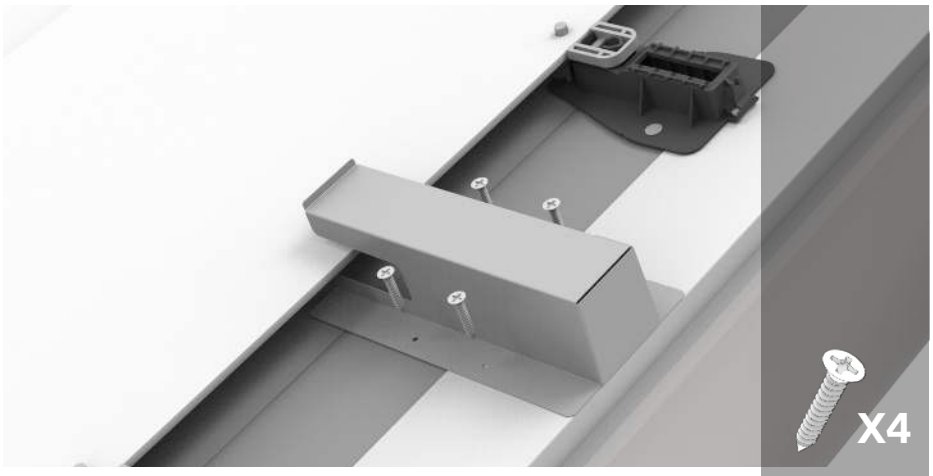
4 Self Tapping Screws per Ridge Cap.



PEAKWALL FLASHING

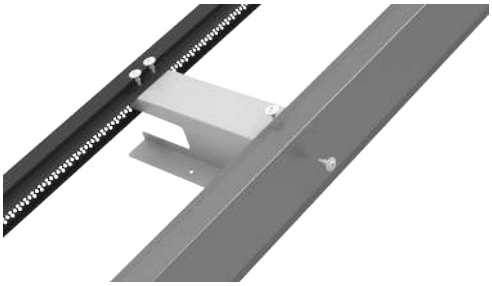
PEAKWALL BRACKET FLASHING

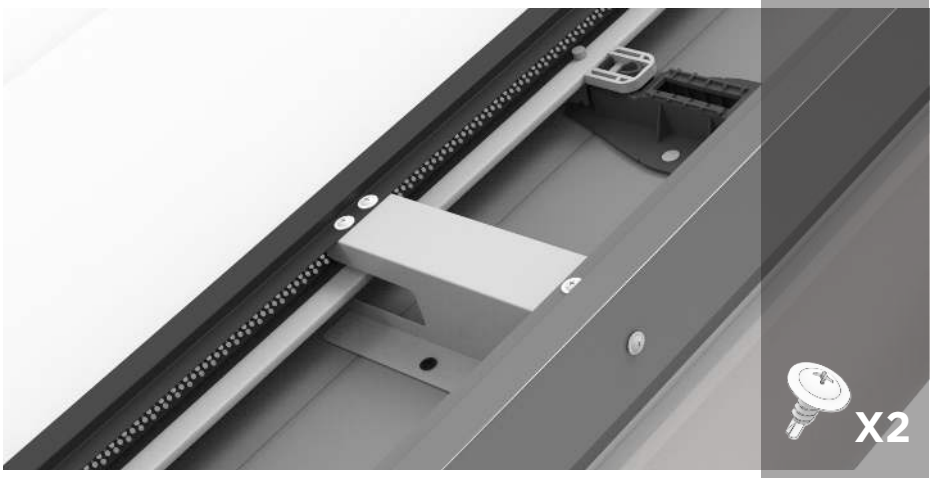
4 Fasteners per Peakwall Bracket Flashing.Installed every set of feet appx. 15" intervals in High Wind Areas.



VENTED RIDGE FLASHING
PEAKWALL SUPPORT RAIL

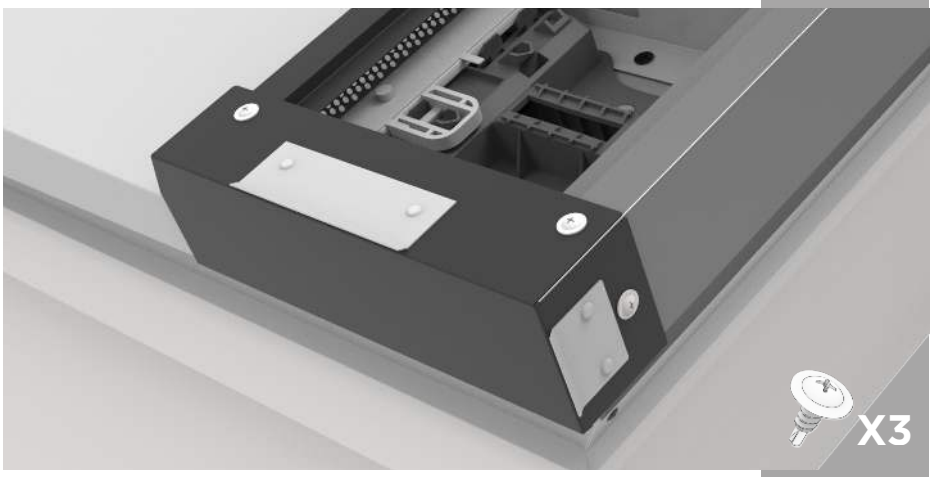
2 Self Tapping Screws per Vented rail.
2 Self Tapping Screws per Support rail.





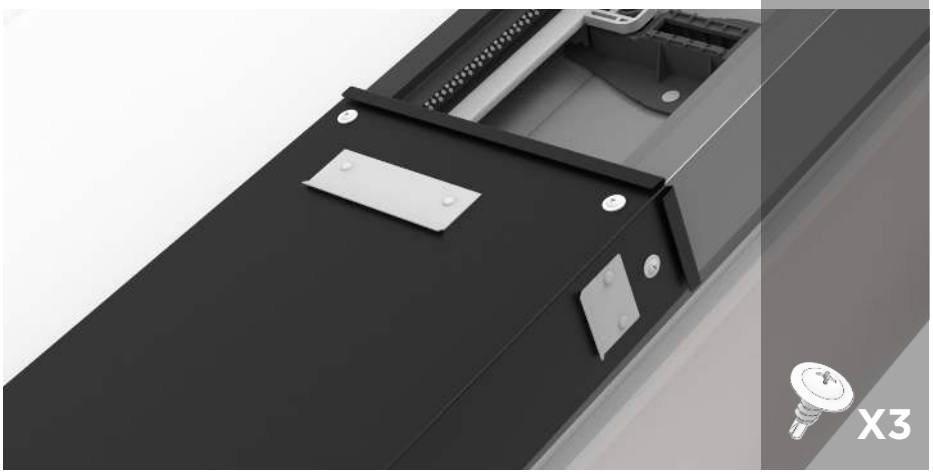
Peakwall end cap trim

3 Self Tapping Screws per End Cap.



PEAKWALL CAP FLASHING

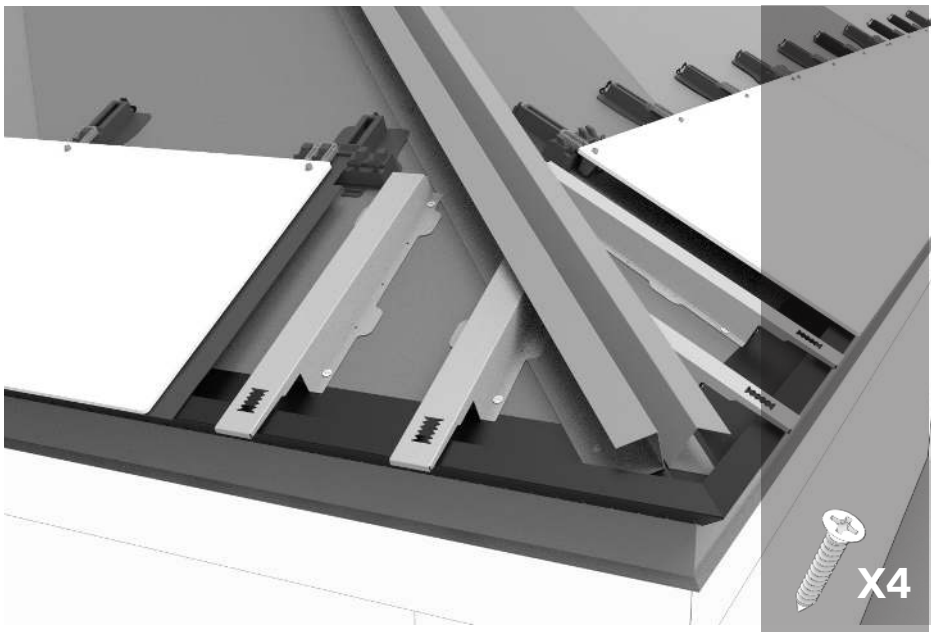
3 Self Tapping Screws per Peadkwall Cap.



HIP FLASHING

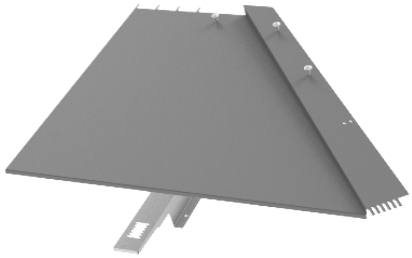
SUPPORT BRACKET

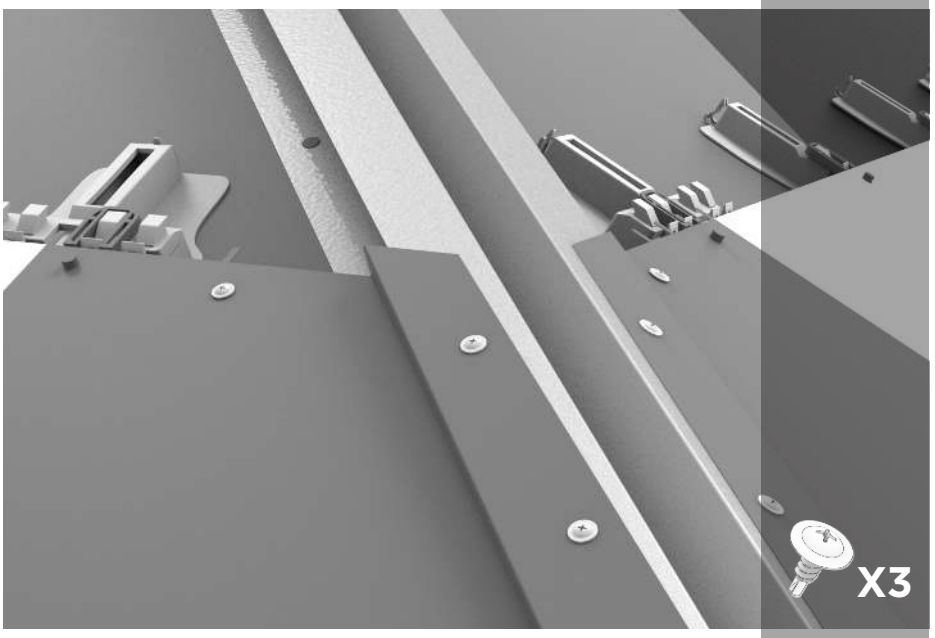
Fasten Support Bracket under Trim if it fits. In areas where the Support Bracket does not fit, no Brackets need to be installed. Fasten the Support Bracket to the deck using a minimum of 4 screws.



HIP TRIM

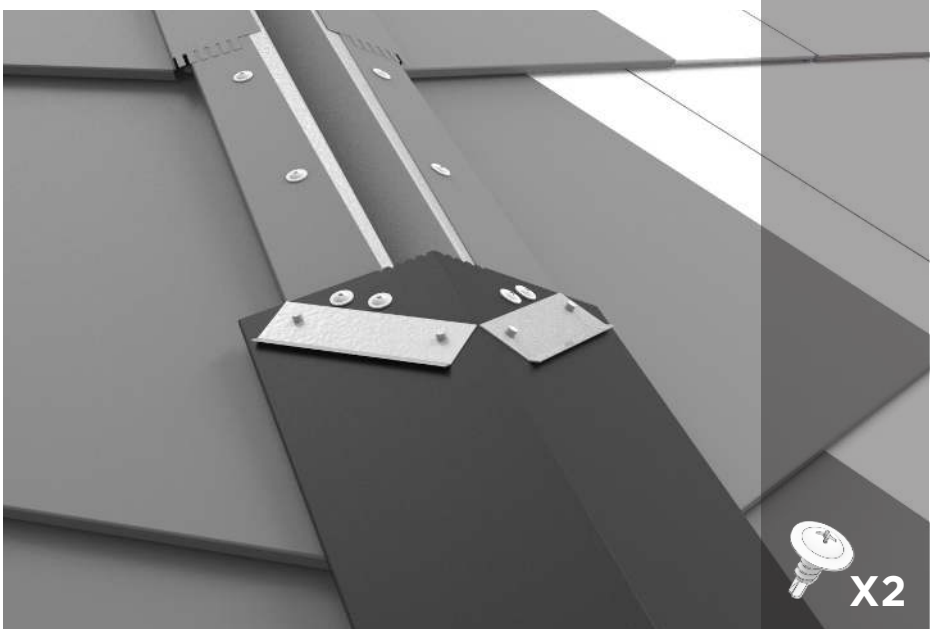
2 Self-Tappers through the C-Channel.
1 Self-Tapping screw through Support Bracket (if installed).





STARTER HIP CAP
HIP CAP

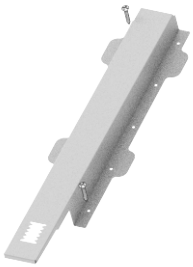
2 Self-Tapping screws per side to C-Channel.

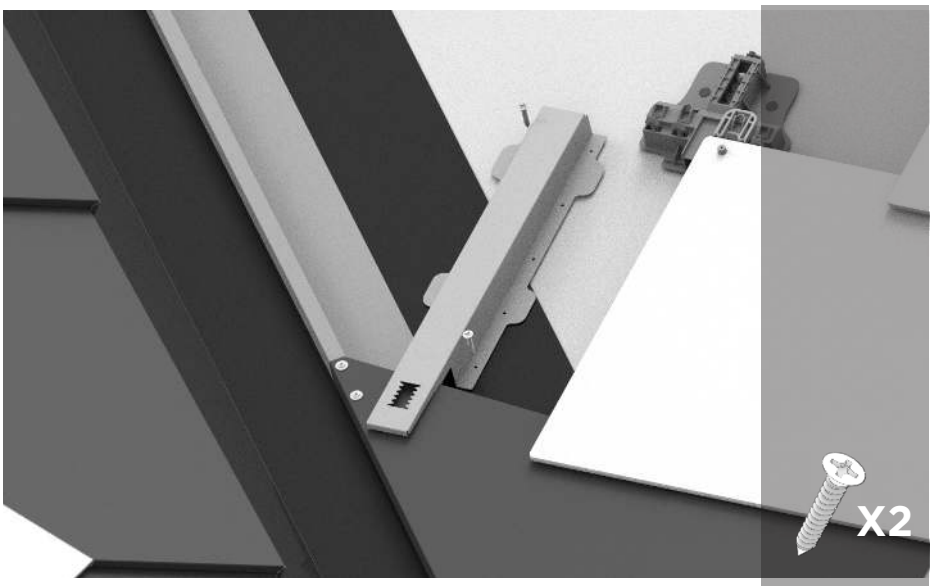


VALLEY FLASHING

SUPPORT BRACKET

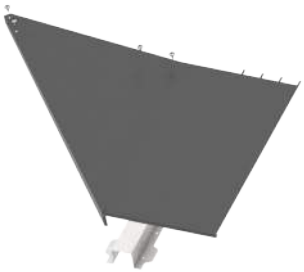
Install a minimum of 1 Support Bracket per Trim and every 7". Minimum of 2 Fasteners per Support Bracket.

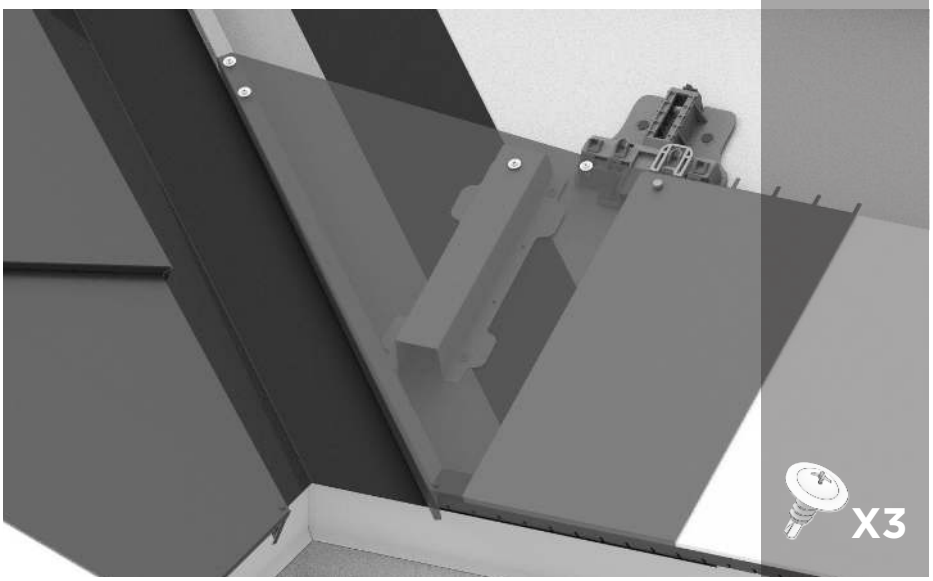




VALLEY TRIM

2 Self Tapping Screws fastened to C-Channel. 1 Self Tapping Screws fastened to Support Bracket. 1 Self Tapping Screw to lock Trim angle.





HEAT VENT FLASHING

Install Obstruction C-Channel (1) every 6".

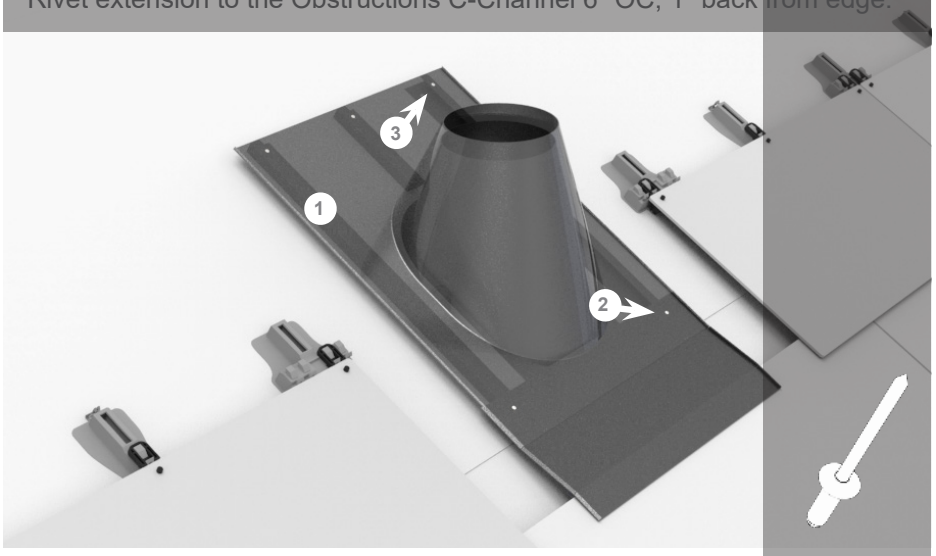
Trim and fasten the Lower Extension Flashing (2) to the rails 1" back from edge using rivets.

Lap the tile level Pipe Flashing over the Extension Flashing, and fasten with rivets uproof (3).

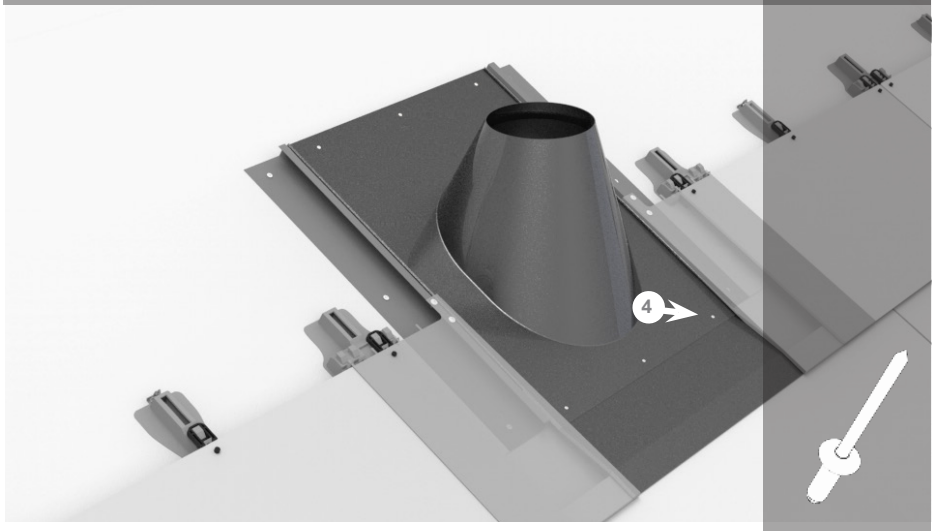
Fasten with rivets downroof through both flashings (4).

For larger Pipe Flashings, lap and rivet an Upper Extension Flashing (5) uproof.

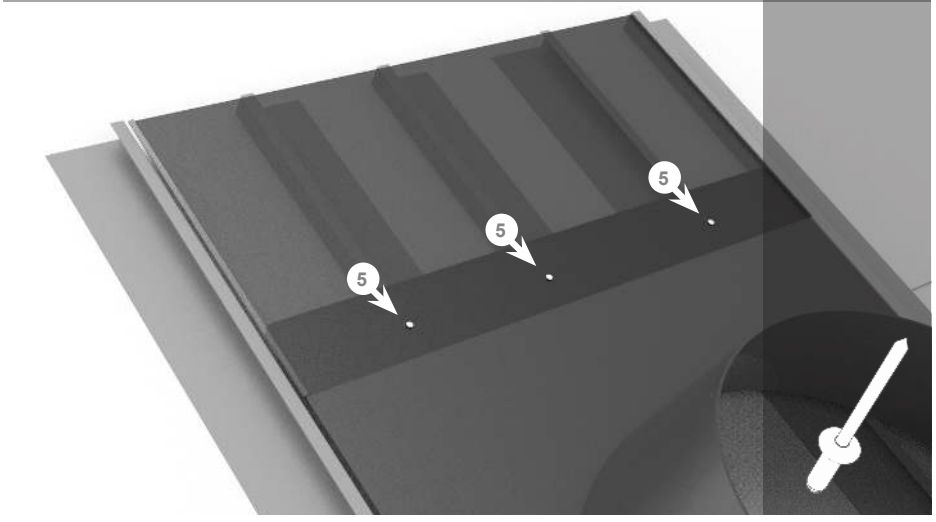
Rivet extension to the Obstructions C-Channel 6" OC, 1" back from edge.



Rivet through both flashings downroof and uproof 6" OC, 1" back from edge.



14" Pipe Flashing with Top Extension riveted to C-Channel.



ELECTRICAL SAFETY PRECAUTIONS

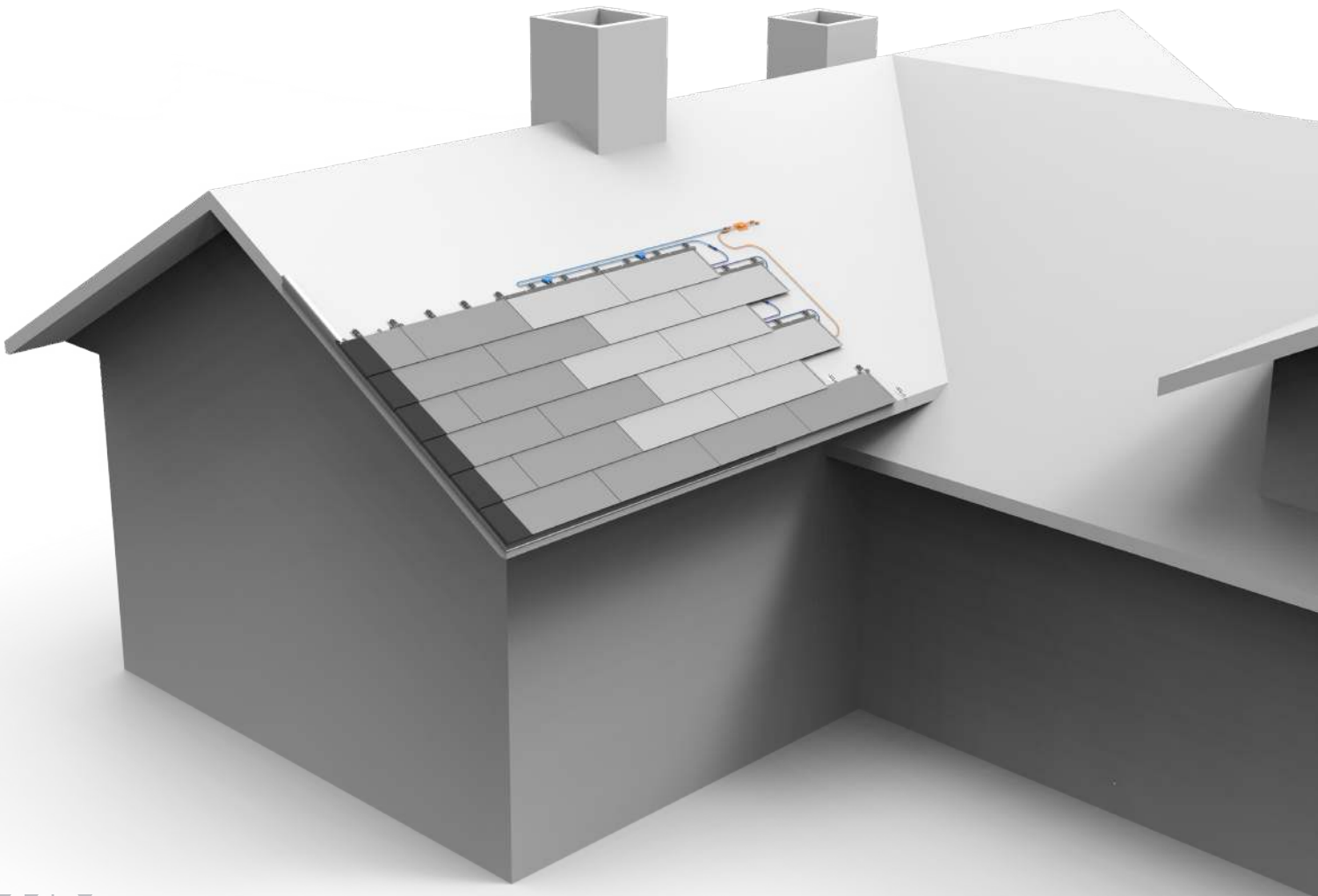
A PV Module may experience conditions that produce more current and/or voltage than reported at standard test conditions. Follow the requirements of the National Electrical Code (NEC) in Article 690 to address these increased outputs. In installations not under the requirements of the NEC, multiply the values of Isc and Voc marked on the Solar Roof PV Modules by a factor of 1.25 when determining component voltage ratings, conductor ampacities, overcurrent device ratings, and size of controls connected to the PV output.

PV MODULES AND WIRING CANNOT INTERACT WITH METAL FLASHINGS

Once energized, all components of the Solar Roof photovoltaic DC circuit, including the Diode Trunk Harness, all conductors, and the Pass Through Box must remain in isolation from metal flashings. The PV array must be buffered by non-energy generating Roofing tiles, which are designated in the project plan set.

Never locate PV Modules at true edge conditions, such as in first row at the eave or in the top two rows at the ridge.

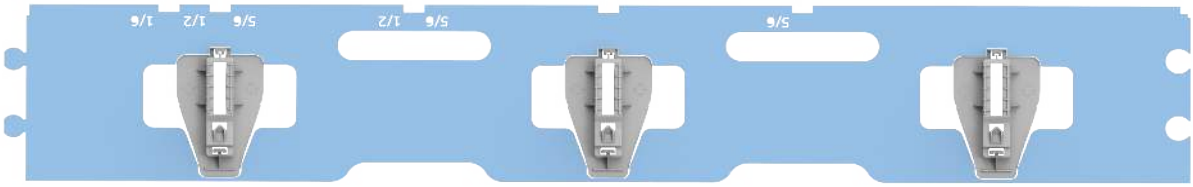
Never locate PV Modules on the mounting plane where they may contact transition, headwall, obstruction or valley flashings.



MATERIAL HANDLING

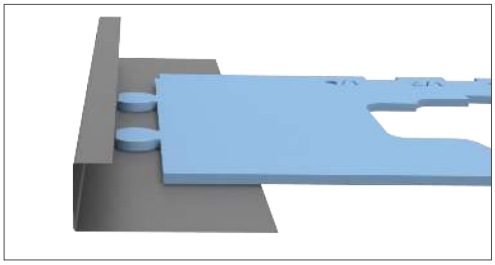
- Do not handle PV Modules under wet conditions unless wearing appropriate protective equipment.
- Do not attempt to make an electrical connection with wet, soiled, or otherwise faulty connectors.
- Do not wear metallic rings, watchbands, earrings, nose rings, lip rings, or other metallic objects while installing or troubleshooting PV systems.
- Do not use a PV Module with broken glass. A damaged PV Module cannot be repaired and must not be used.
- Do not open electrical connections or unplug connectors while the circuit is under load.
- Do not use PV Modules near equipment or in places where flammable liquid, gases, or other hazardous materials are located.
- Do not apply paint or adhesive to any module top surface or backsheet.
- Do not drop PV Modules or allow objects to fall on modules. Do not leave a module unsupported or unsecured.
- Do not disassemble or modify PV Modules in any way. Doing so may degrade performance or cause irreparable damage and will void any applicable warranties.
- Do not direct artificially concentrated sunlight onto the PV Module.
- Do not allow children or unauthorized persons near the installation site or storage site of modules.
- Wear non-slip gloves when carrying PV Modules. Exercise caution when transporting and installing PV Modules.
- Do not lift any module by the module’s junction box or electrical leads.

STARTER COURSE | FULL TILE

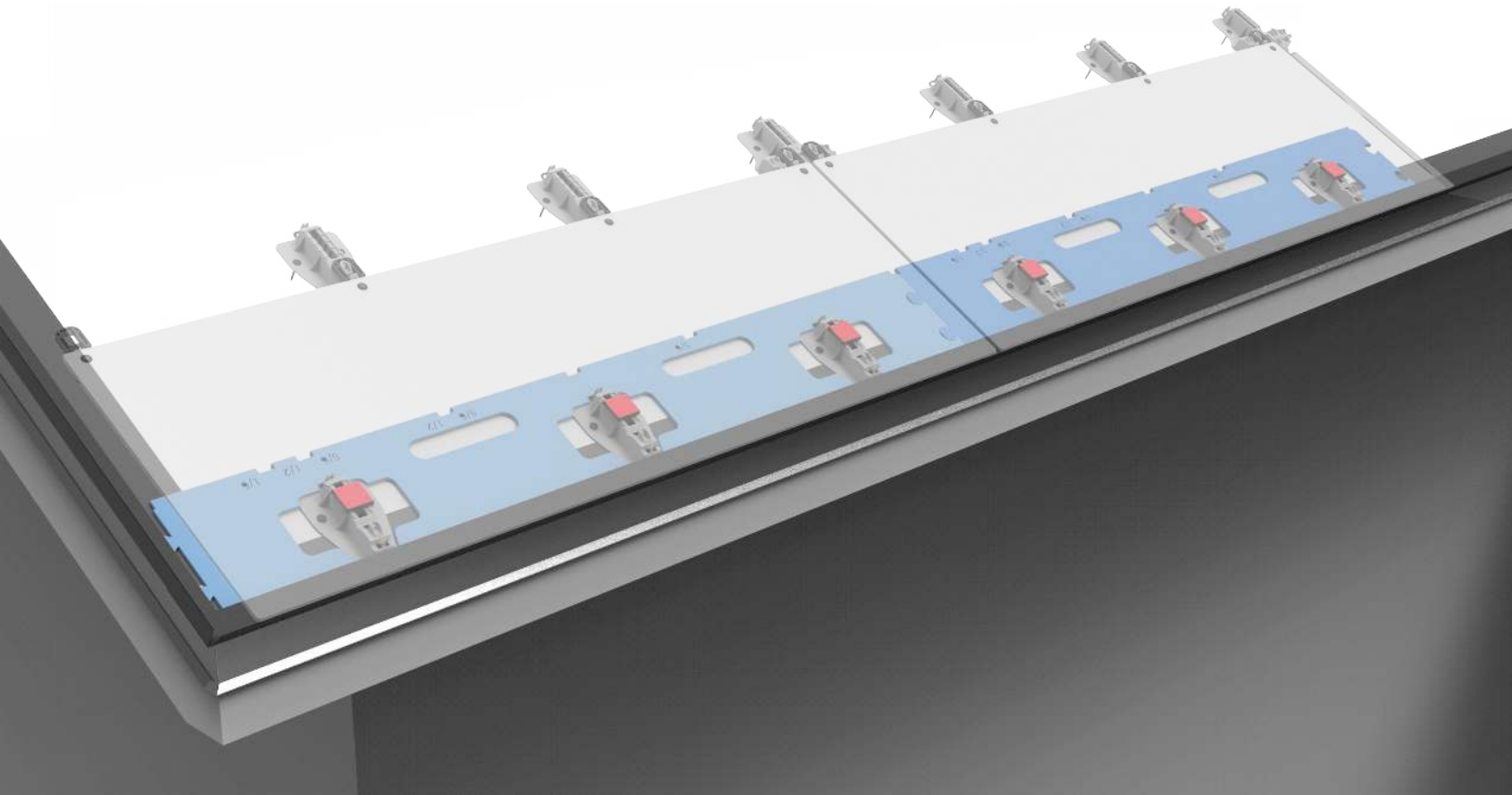


The start of the array is indicated in the project planset. If the first tile is a full tile, use the Starter Course Jig in the orientation shown above to position the first row of feet. Ensure that the inside edge of the Starter Trim is free of any debris that would push up the jig from its correct position.

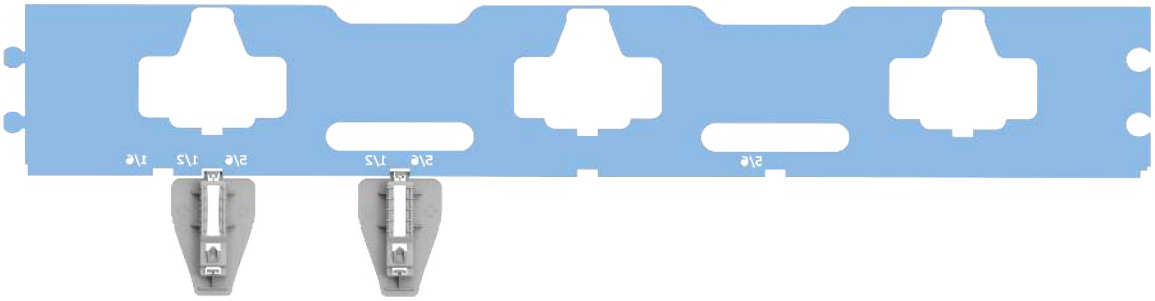
1. Abut the jig to the inside corner of the Starter Trim.
2. Align with the top edge of the Deck C-Channel to give the tile a 1” spacing the rake edge.



3. Fasten first row feet. Continue along the eave by snapping a second jig into the first jig.
4. Install the first tile by engaging the Uplift Clip into Foot slot then fastening the remaining feet.

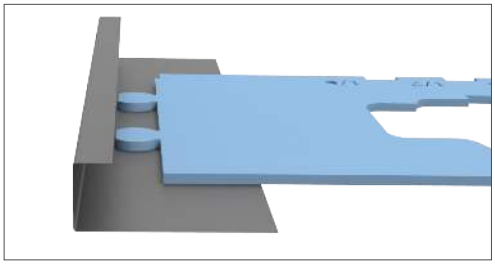


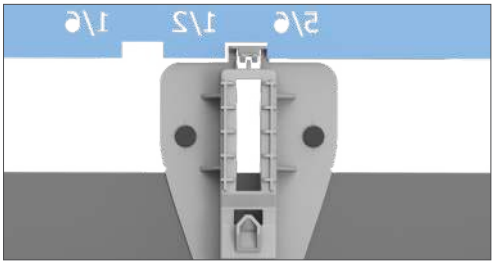
STARTER COURSE | PARTIAL TILE



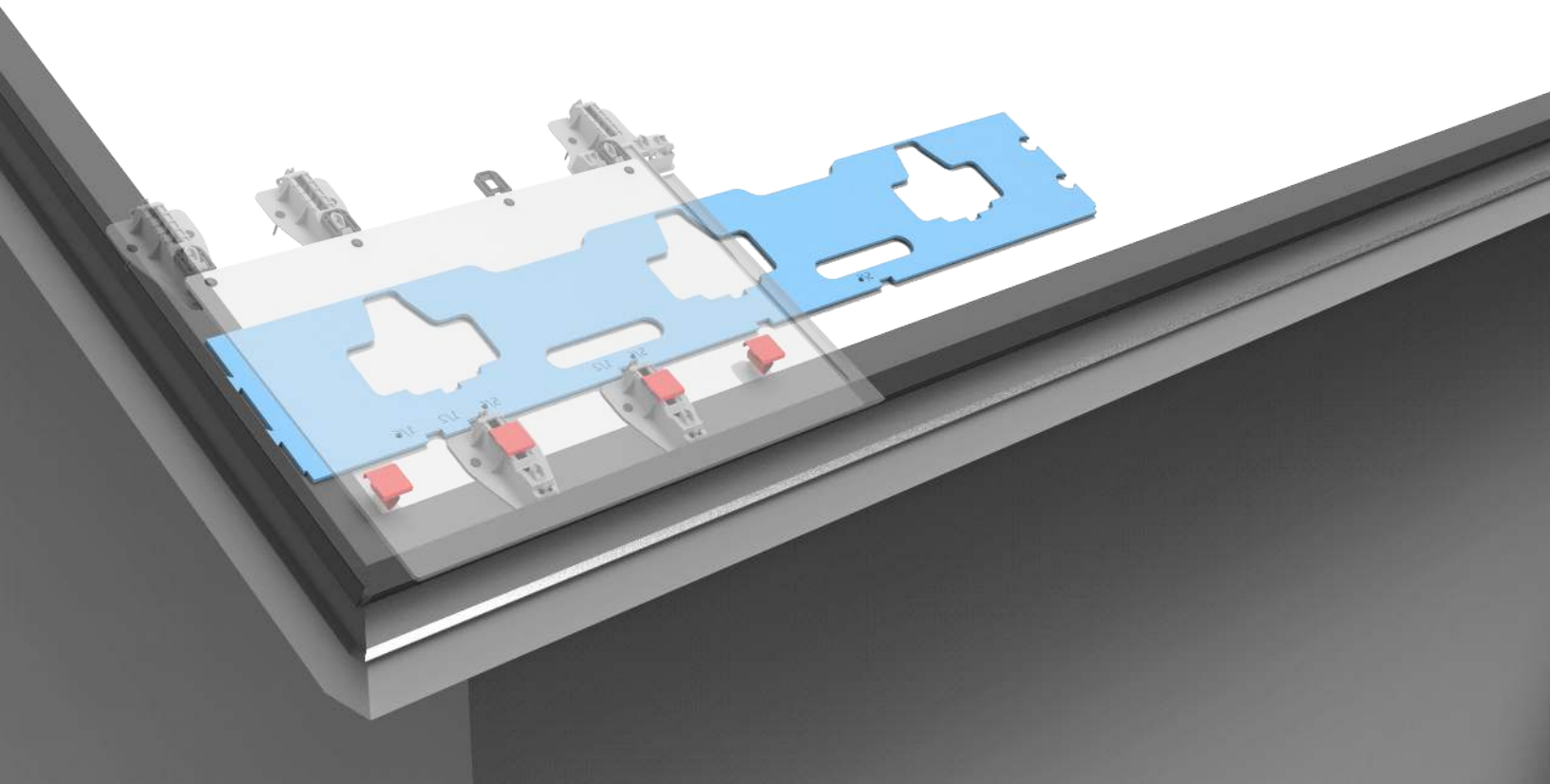
The start of the array is indicated in the project planset. If the first tile is a partial tile, use the Starter Course Jig in the orientation shown above to position the first row of feet.

1. Align the feet to the edge of the Starter Trim using the notches in the foot.
2. Align with the top edge of the Deck C Channel to give the tile a 1” spacing the rake edge.



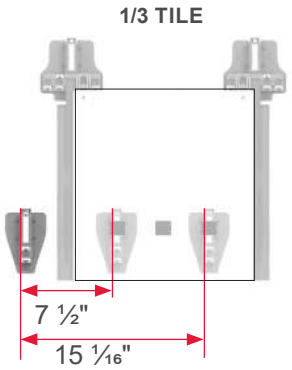


3. Fasten first row feet. Continue along the eave by snapping a second jig into the first jig.
4. Install the first tile by engaging the Uplift Clip into Foot slot then fastening the remaining feet.



STARTER COURSE FOR 140 TO 166 MPH WINDS

In high wind regions, additional feet are installed at the first row starter course to prevent tile uplift at the eave.

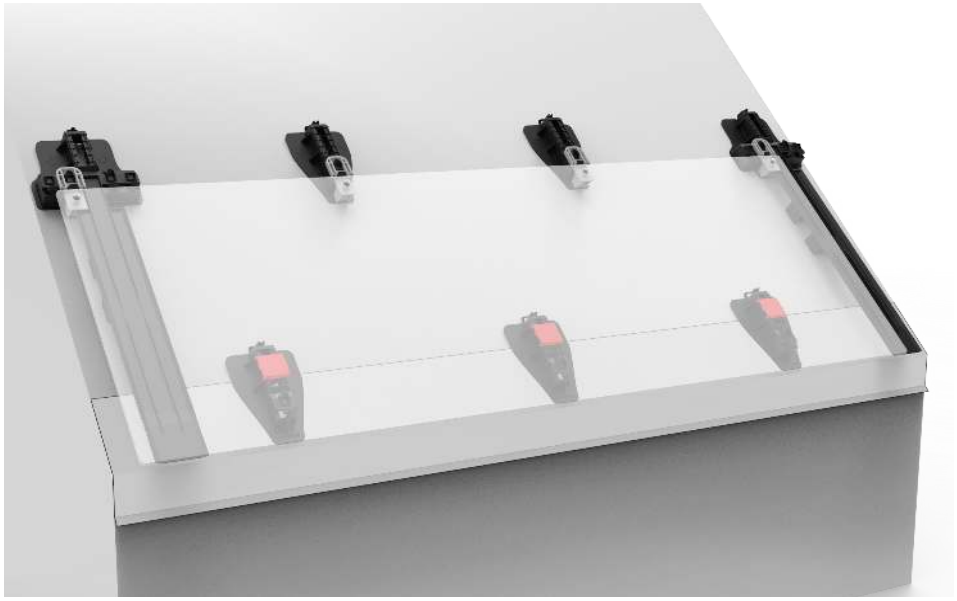


Example of Jig use with partial tile.

Dimensions from 1st Foot on Left (IN)						
Tile Size	**1**	**2**	**3**	**4**	**5**	**6**
1/6	5 ¾"	9 5⁄16"				
1/3	7 ½"	15 1⁄16"				
1/2	5 ¾"	11 ¼"	18 13⁄16"	24 ⅜"		
2/3	7 ½"	11 ¼"	18 13⁄16"	26 5⁄16"	30 1⁄16"	
5/6	5 ¾"	11 ¼"	18 13⁄16"	26 5⁄16"	33 13⁄16"	39 ⅜"
FULL						

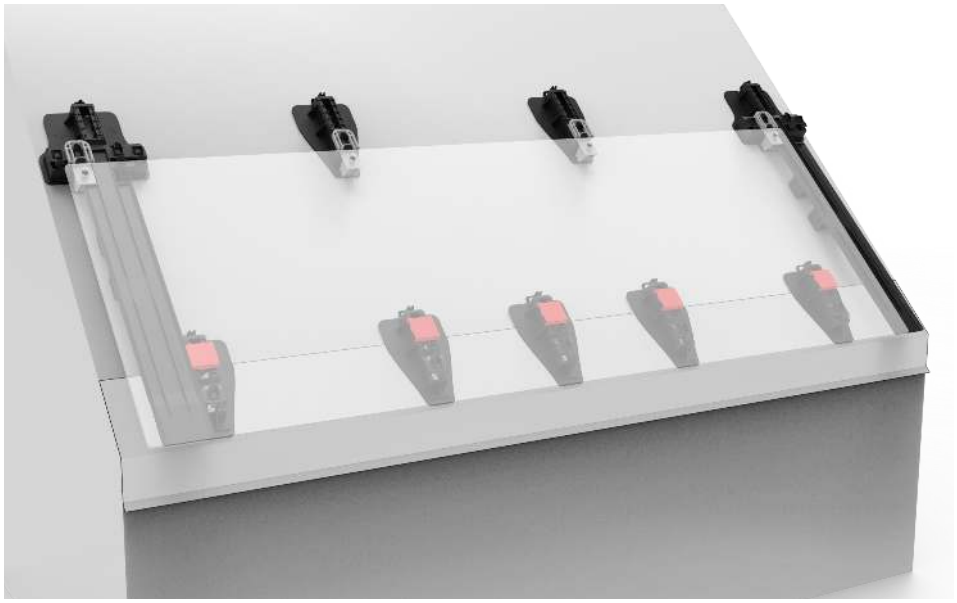
STANDARD INSTALLATION

A standard full tile starter course installation has three downroof feet.



HIGH WIND INSTALLATION

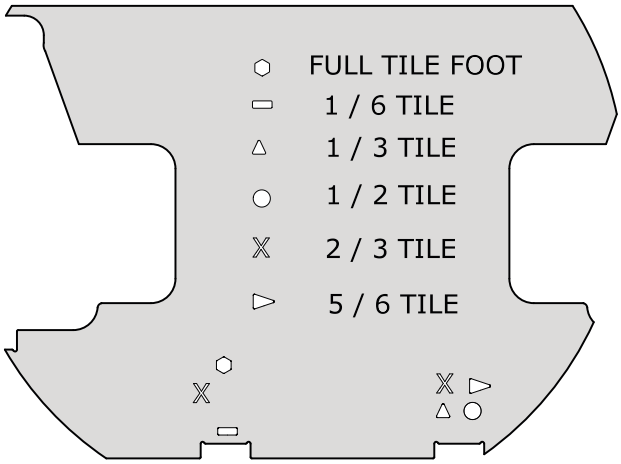
A high wind full tile starter course installatio has five downroof feet.



STARTER COURSE FOR 140 TO 166 MPH WINDS

STEP 1 IDENTIFY PARTIAL TILE SYMBOL

Identify partial tile size. Each partial tile is indicated by a unique symbol on the High Wind Jig.

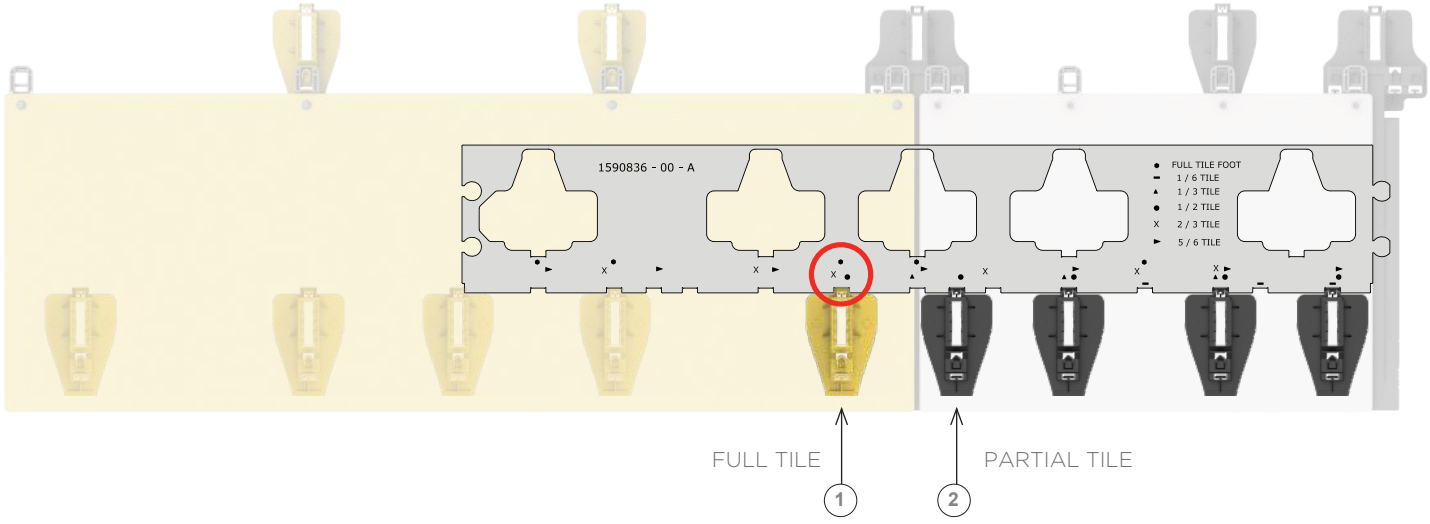


STEP 2 ENGAGE JIG ONTO FULL TILE

Locate the notch with the partial tile symbol at the left-most position that ALSO has the full tile symbol.

Position this notch over previously installed full tile right-most foot (1).

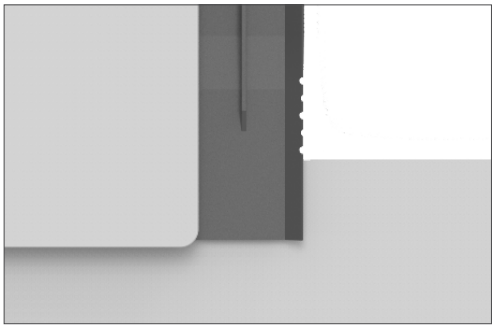
Install feet ifor partial tile in notches with symbol (2).

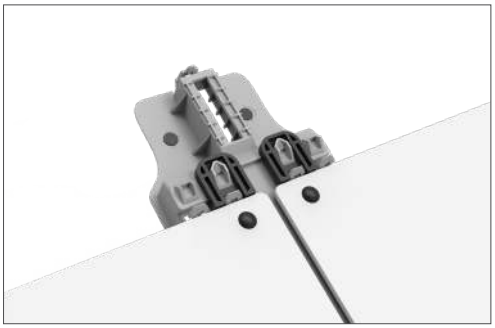


ARRAY LAYOUT & SECOND ROW

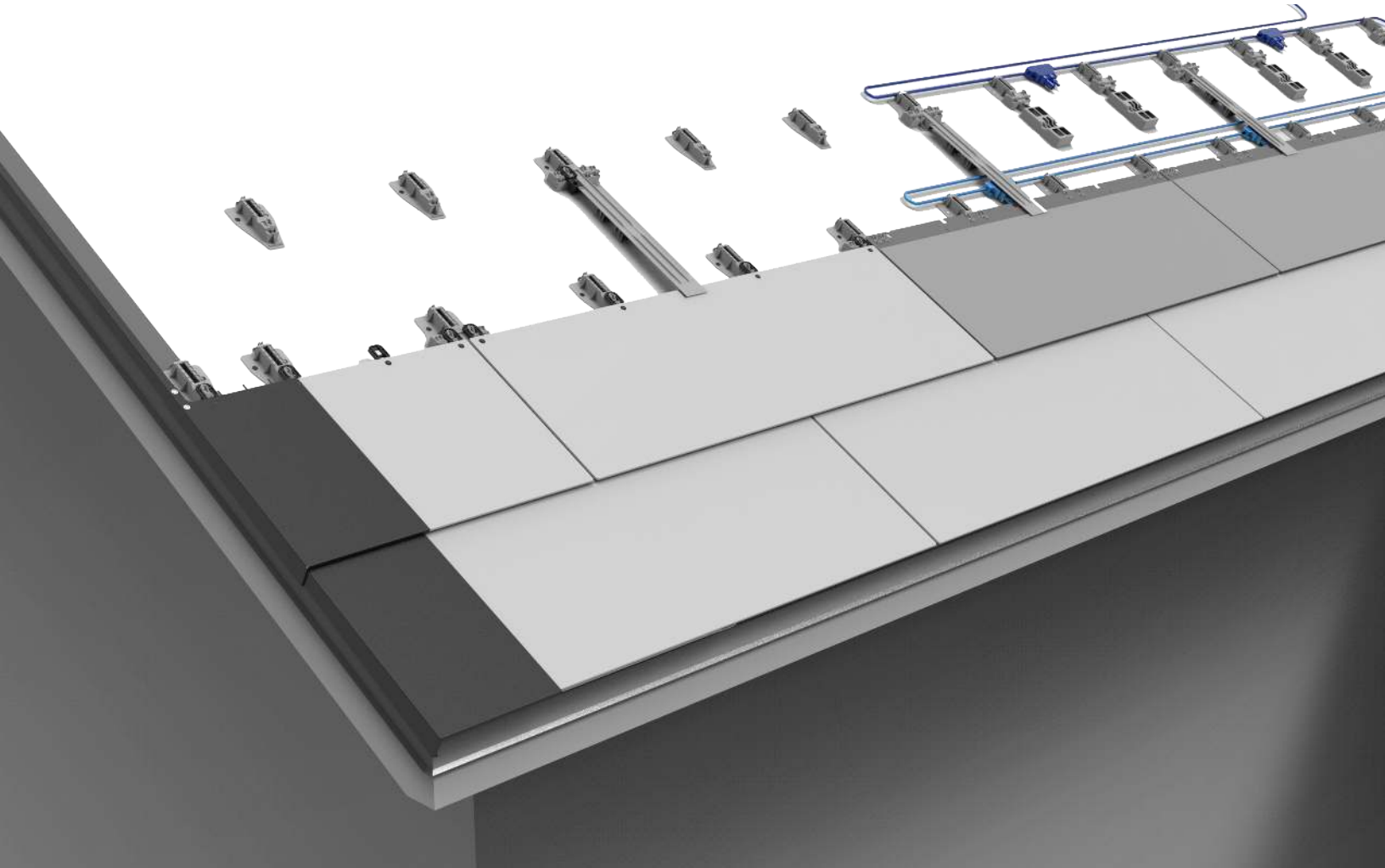
Continue the Roofing Tile and Partial Tile uproof row by row.

1. Position the row spacing (tile reveal) using the timing marks on the Footlap.
2. Adjacent Roofing Tiles will share a Footlap.

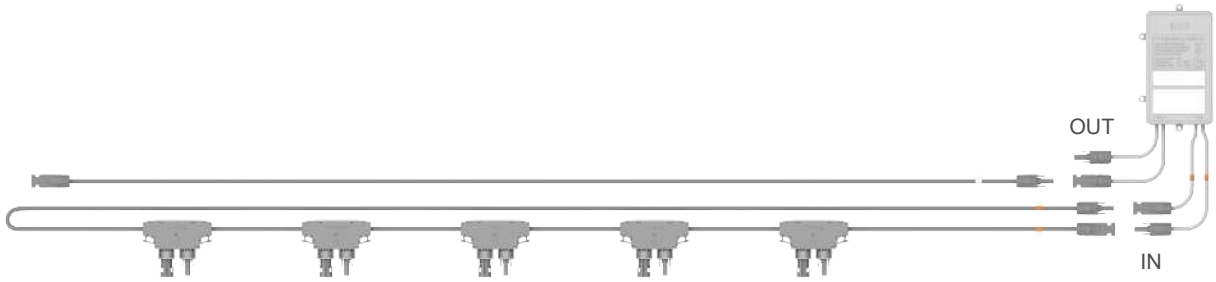




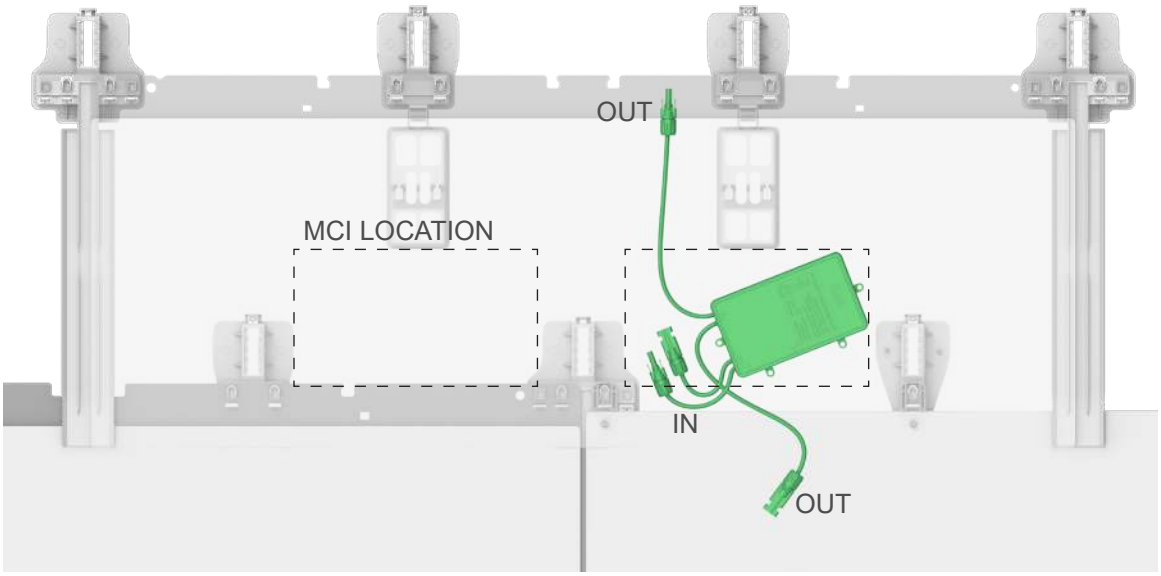
3. Engage the Uplift Clip(s) to a minimum of one foot downroof. Each tile needs to be anchored with at least three feet total.
4. Install the appropriate tile level flashings over the Roofing and Partial tiles at edge conditions.



MID-CIRCUIT INTERRUPTER



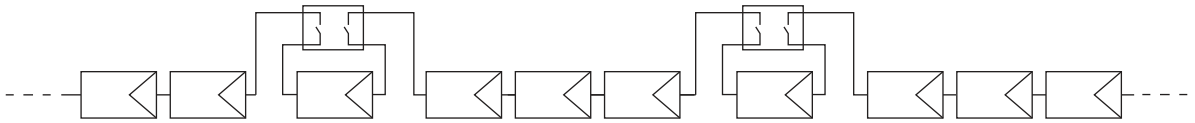
The Mid-Circuit Interrupter is installed directly above the row or sub-string of modules that connects to its input. Abide by all MCI Manufacturer instructions when installing the MCI. Fasten the MCI to the deck using standard fasteners. The input leads are shorter and connect to the positive and negative terminations of that Diode Harness sub-string. The output leads connect to the Diode Harness sub-strings above and below.



INSTALLATION BEST PRACTICES

- Position the MCI at a slight angle to assist with water shedding.
- Install the MCI between the module feet. The MCI cannot interfere with module supports.
- Do not install the MCI in a manner which would cause it to raise the PV Module above it. For example, directly underneath a Footlap.
- Provide enough clearance so the MCI does not directly contact the downroof module. The MCI cannot come in contact with the glass or backside of a module.
- For ease of installation, position the MCI to the right or left of the last PV Module.

POWER FLOW DIAGRAM

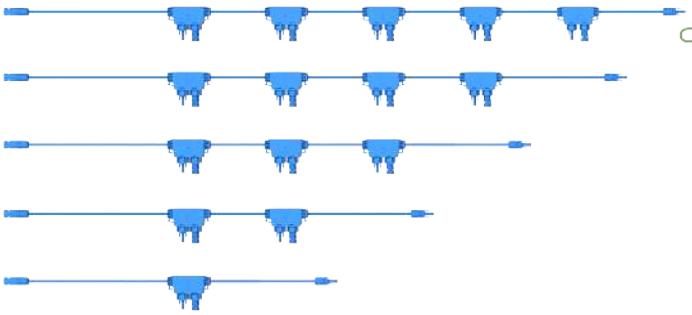


SERPENTINE WIRING SCHEMATIC

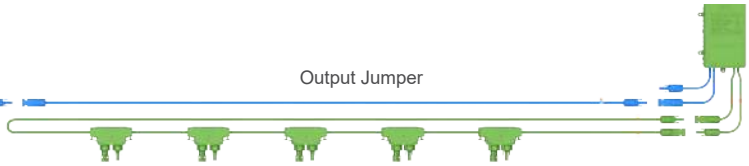
A serpentine wiring schematic weaves back and forth along the PV array. Connect the 5x Input Harness to the MCI input, then connect 10 or fewer Solar Roof PV Modules between MCI units.

- Do not swap input and output leads, this may overpower the MCI.
- Maximize the number of tiles per MCI (both input and output). To minimize hardware costs, avoid connecting MCI output directly to output of another MCI where feasible.
- An MCI must be connected to one end of a series string or sub-array string. It is not required on both ends. Whether the MCI is connected to the “first” or “last” module in a series string is not important.
- Use the wire management features on the module feet to hold up to 3 conductors. Tuck the Diode under the module.
- For areas with skipped PV Modules, such as at obstructions, install a Mini Jumper at the diode to close the circuit. Failing to do so will result in an open circuit and the entire string will not yield any energy.

Modified Cable Lengths on 1, 2, 3, 4 and 5x

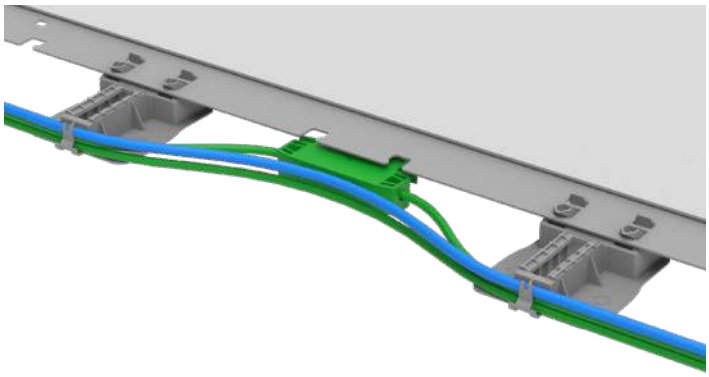


Output Jumper

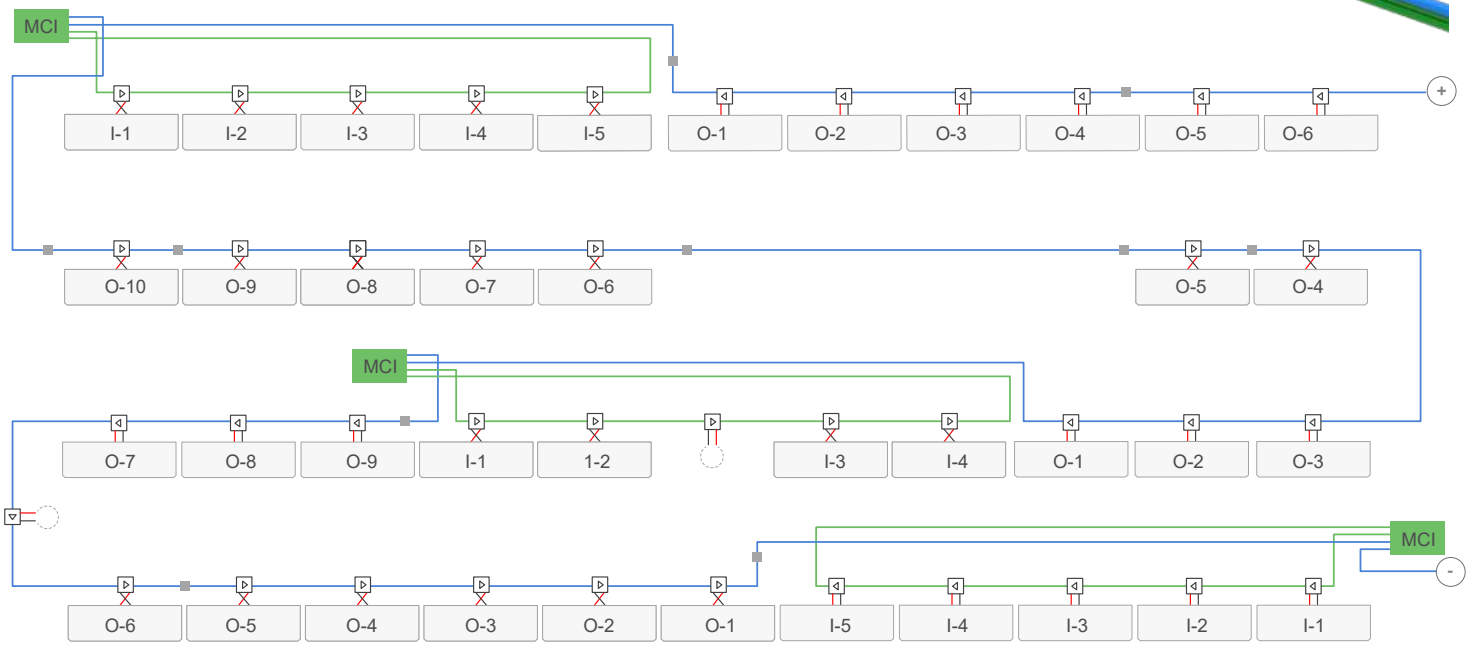


5x Input Harness

5x Input Harness with Output Jumper tucked into wire management feature.



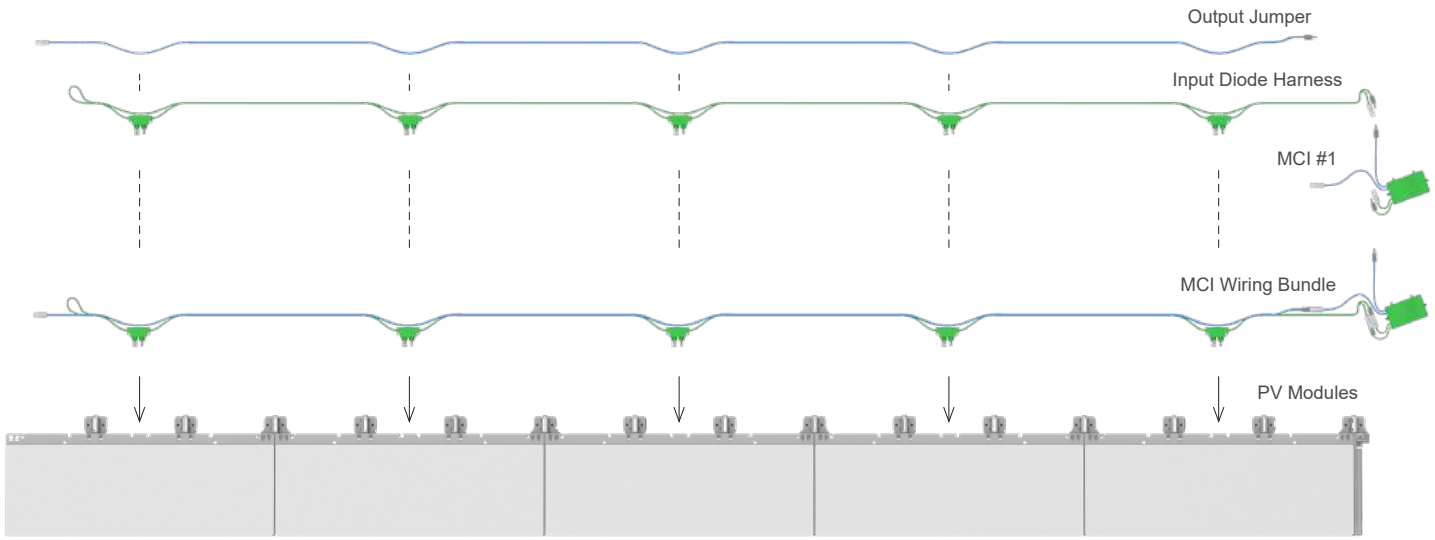
Example PV Array with 3 MCI Units

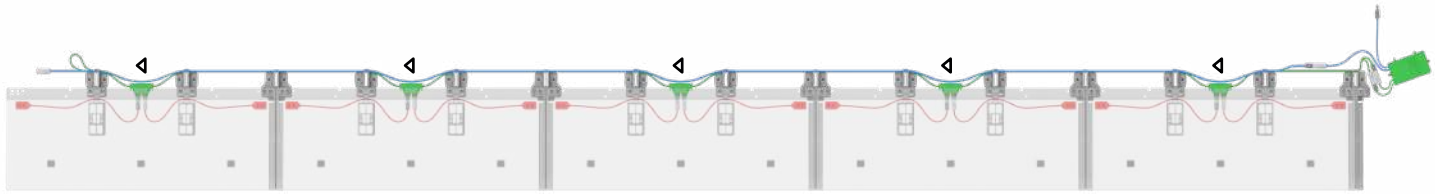


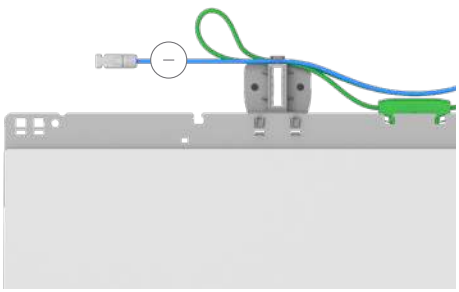
SERPENTINE WIRING SCHEMATIC

MCI INPUT ASSEMBLY

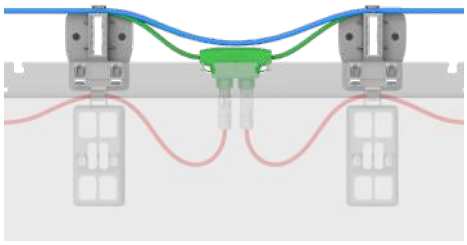
Connect 3 to 5 Solar Roof PV Modules to the MCI input (80V max). These modules will power the MCI. The wiring bundle contains the positive and negative input leads and a jumper to connect to the next (output) diode harness.



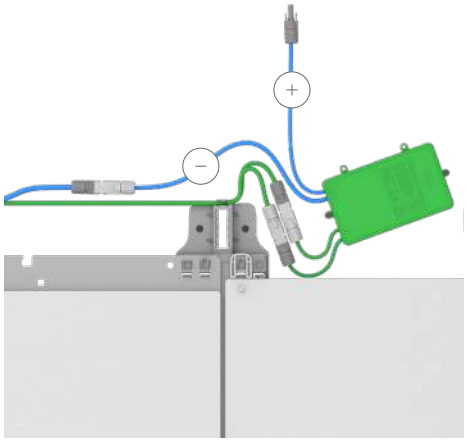




The input wire will wrap back to the MCI while the output wire extends to the next (output) 10x diode harness.



Plug the PV Module into the Diode and tuck the Diode under the PV Module.

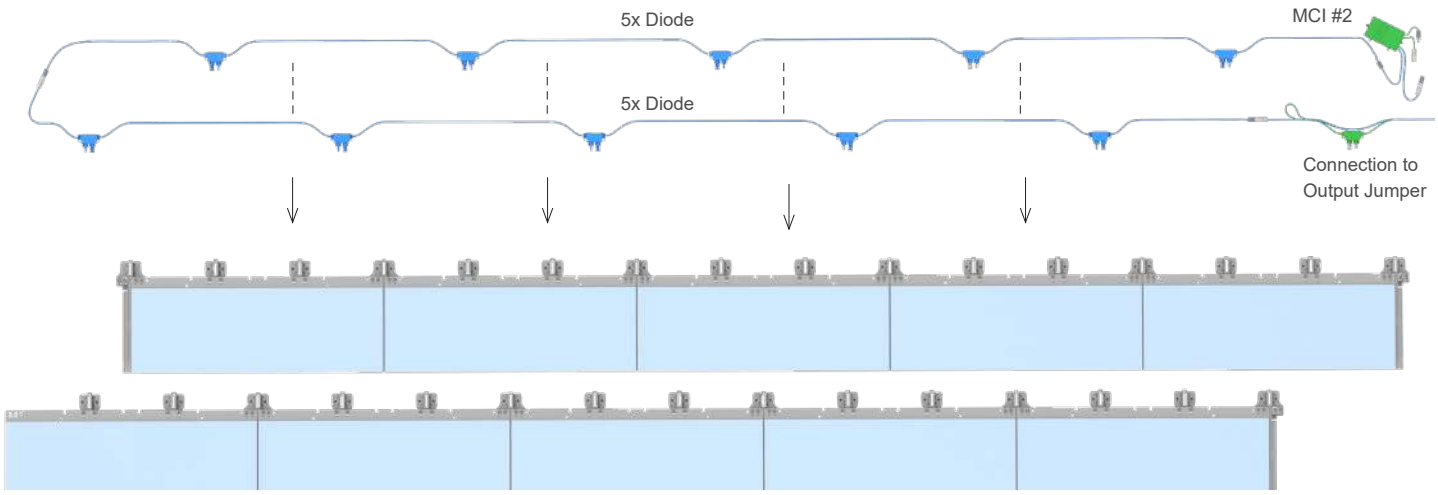


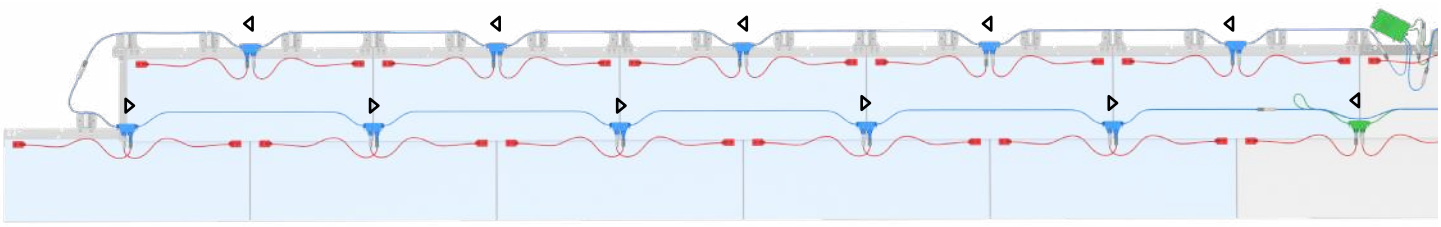
If not pre-assembled,connect the positive (female) and negative (male) input leads into the MCI. Connect the negative (female) output lead to the MCI.

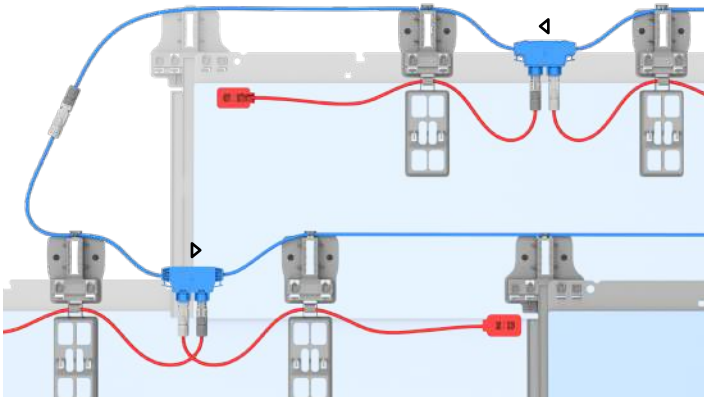
SERPENTINE WIRING SCHEMATIC

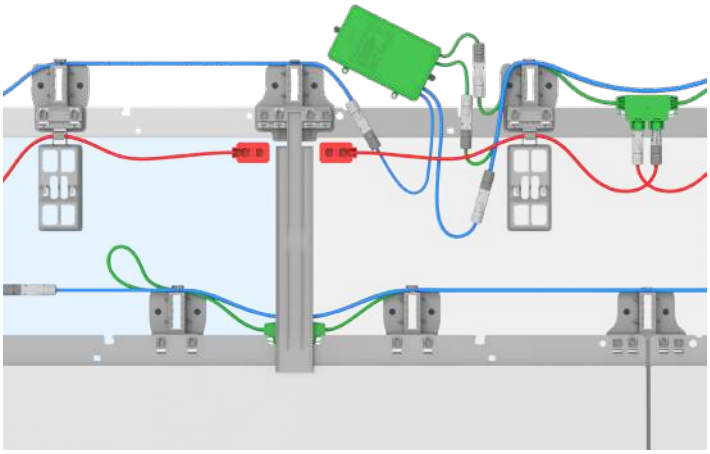
MCI OUTPUT ASSEMBLY

Connect 10 or fewer Solar Roof PV Modules between MCIs.









The output wire will wrap up to the next row. The module leads on the subsequent row will be reversed to connect to the Diode.

If not pre-assembled, connect the positive (female) and negative (male) input leads into the MCI. Connect the negative (female) output lead to the MCI.

STRING TESTING PROCEDURE

Solar Roof installation requires course by course testing and verification, of all strings, to ensure that all modules are connected properly and also that all modules are producing as designed. This testing is critical as any diagnostics and/or remediation of underperforming or miss-installed systems is challenging and time consuming.

- The data tested/collected is the Open Circuit Voltage (Voc) of the PV Modules when installed in series.
- When installed in series the Voc of these modules measure in a cumulative function.
- This number is representative of the nominal Voltage of the modules (13.34) multiplied by the number of modules.
- During the course of the installation ambient conditions may change depending on temperature and cloud cover being the biggest factors. Take a test reading from one PV module at beginning of population, after a break, or any big change in sunlight.

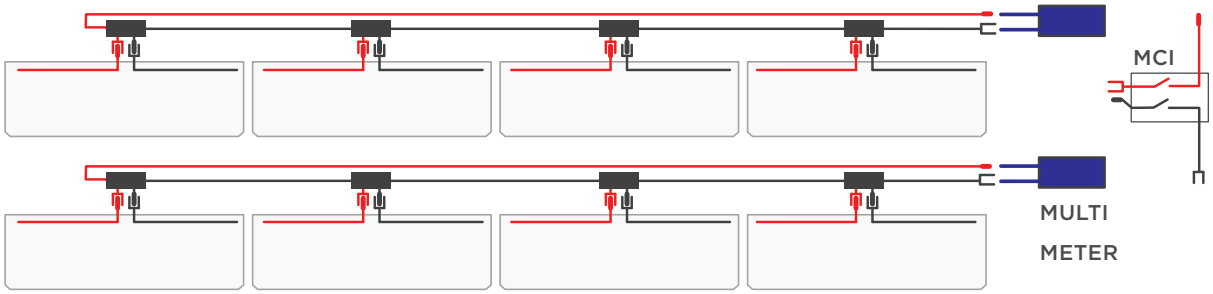
End of job verification requires submittal of the string level testing to the BOLT platform (JCO) to ensure this information is available through the lifetime of the system. Additionally, notations confirming that stringing as designed matches the string as installed are a requirements.

1. Voc is checked by plugging in to both ends of the circuit. *Note: This may be challenging due to split arrays.* Test each 10 x and MCI 5 x rows as you go. Typically, this happens at each completed diode section from the homerun or bypass section.
2. Verify that the Voc has jumped by the correct amount (# Modules x ~Voc).
   Voc should increase to the relative control value multiplied by the number of modules in the row.
3. Record values on Voc sheet for each string. Writing down the size of the row helps find inconsistencies or issues that might arise with the diodes or wiring.
4. Always get a picture of the final Voc for the string.
   This information is required as part of the job close out portion.

VOC TESTING

CURRENT PROCESS – NO MCI BYPASS UNIT

If no Bypass Unit is available the course by course testing is conducted just after the diodes are plugged into the modules, but BEFORE they are connected to the rest of the string. Utilize a multi-meter to determine output and record on the Voc Checklist. Extra care needs to be taken to ensure that connections made to the surrounding Diode Trunks are correct. This method generates a Voc count ONLY for the tiles in that subsection. This could read across mutiples courses of PV tiles.

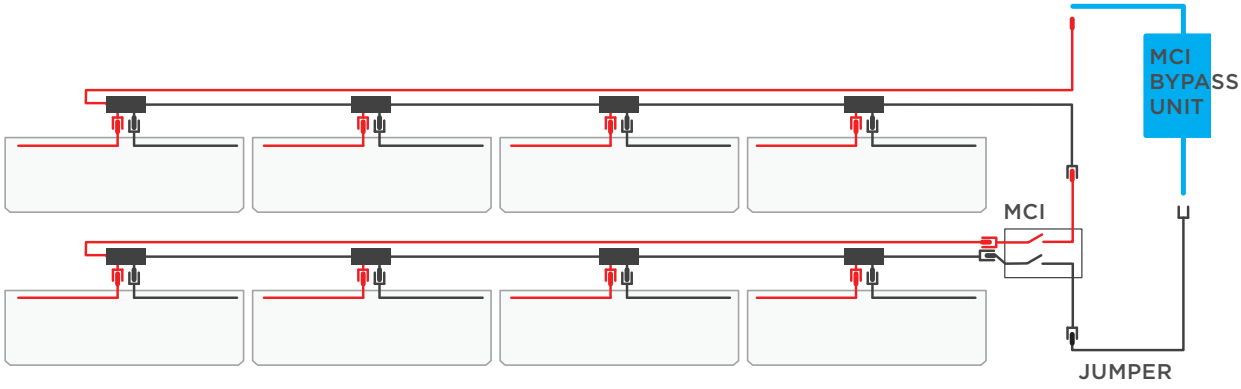


CURRENT PROCESS – MCI BYPASS UNIT

Mid-Circuit Interrupters effectively block the flow of energy when in shut-off mode preventing the capture of string level Voc. The MCI Bypass Unit solves this issue by sending enough power to the MCIs to activate them, allowing current to flow normally.

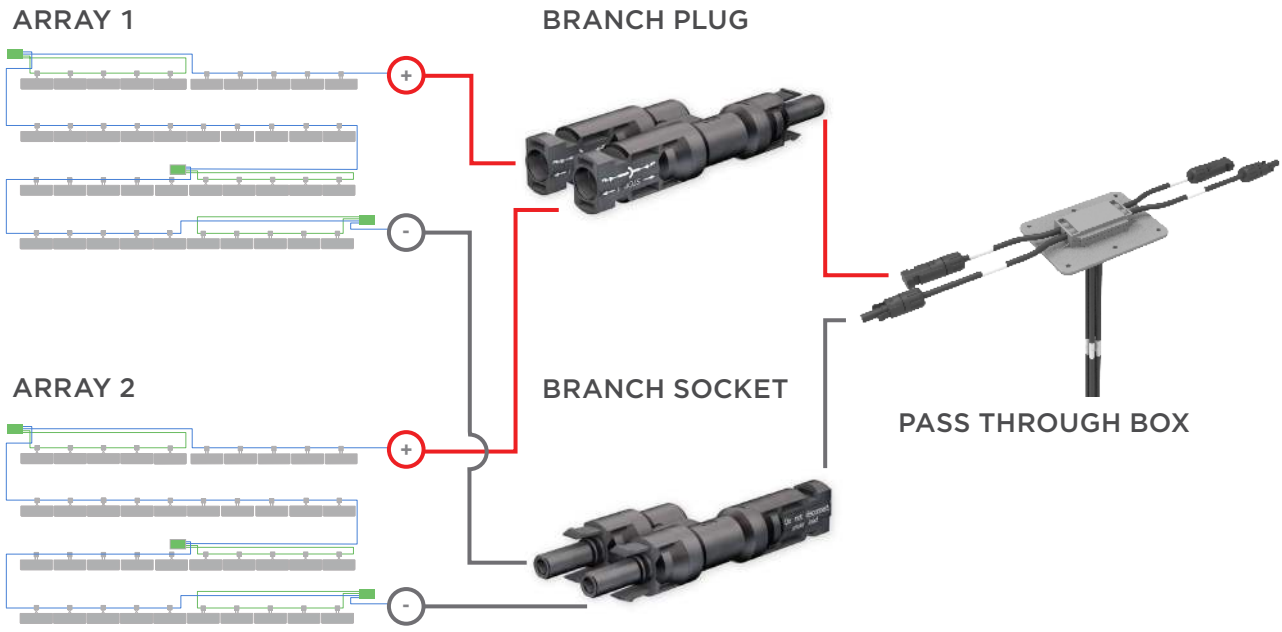
As the array is installed ensure that the low end jumper remains exposed and travels up the mounting plane along with the installation, this jumper will be used as one end of the circuit and will need to plug in to the MCI Bypass Unit.

Complete the circuit by connecting to the modules below and the bypass unit. As long as the unit power source is charged the string will now be powered. Utilize a multi-meter to determine output and record on the Voc Checklist. Also, ensure that the diodes have either a PV module or bypass jumper in them before testing a completed row.



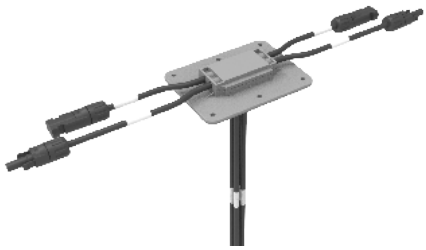
BRANCH SOCKET AND PLUG

Branch Sockets and Branch Plugs are used to make parallel connections between PV strings before entering a Pass Through Box. These connectors are installed on the roofing surface under the modules.



PASS THROUGH BOX

Verify transition location on plan set. Install Pass Through Box using wiring methods and materials that comply with Article 690 and Chapter 3 of the NEC and local regulations.



Disengage Uplift Clips in the tile by gently prying the tile up using a door lifter (tile removal tool). Push the tile uproof to disengage the uproof hooks from the feet, then slide the tile downroof and out of the array.