Installation Instructions

GAF ENERGY

Timberline Solar™

Solar Roofing System

Integrated rooftop solar for composition shingle steep-sloped roofs

GAF Energy LLC
Document Version: Rev. 2.5
Date Last Exported: January 30, 2024

Notices

Copyright

Trademark

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All other trademarks are the property of their respective owners.

Warranty and Disclaimer

All Timberline Solar Roofing System Products are covered the by Timberline Solar Shingle & Accessory Limited Warranty. Any deviation from the installation methods recommended in this manual may result in denial of a homeowner's warranty claim.

When GAF Certified Contractors install a qualifying GAF roofing system at the same time as the GAF Energy Timberline Solar Roofing System, the installation may be eligible for one or more enhanced warranties backed by GAF.

For complete details on eligibility, see www.gaf.energy/warranty and for questions relating to the installation of the GAF roofing system, refer to the most current version of the *GAF Pro Field Guide for Steep-Slope Roofs*.

Always follow local building codes. State and local building codes vary from region to region. It is the responsibility of every quality installer to KNOW and FOLLOW local building codes for roof and solar installation.

The Timberline Solar Roofing System is designed to be installed with GAF Roofing products. No testing has been done to ensure compatibility with other manufacturers' roofing materials. Accordingly, use of such other manufacturers' roofing materials may significantly diminish GAF Energy's and GAF's warranty coverage.

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1. Introduction

The Timberline Solar™ system is designed by GAF Energy. GAF Energy is a sister company to GAF, North America's largest roofing manufacturer. Timberline Solar was developed with roofing best practices, simplicity of installation, performance, safety, and aesthetics in mind. This Manual contains safety and installation instructions for the Timberline Solar system.

For purposes of this Manual only, "Timberline Solar system" refers to Timberline Solar Energy Shingles and the hardware components listed in "2. Timberline Solar Overview" on page 9.

Installation instructions covering Timberline Solar HD shingles and other GAF shingles can be found at **www.gaf.com**. It is also recommended that installers consult the *GAF Pro Field Guide for Steep-Slope Roofs,* version 2.0, September 2020.

WARNING: Read these instructions entirely and thoroughly to reduce the risk of injury and to ensure a problem-free installation.

Save this Manual for future reference. As part of its continuing efforts to improve the performance of its products, GAF Energy periodically makes changes to its products. GAF Energy reserves the right to change or modify any of the information, requirements, specifications, or policies contained herein. Be sure to check **www.gaf.energy** for the most up-to-date version of this Manual or any technical bulletins for this product.

Symbol List

CAUTION: Use caution and fully understand the instructions before proceeding.

DANGER: Indicates a hazardous situation. Failure to follow these instructions could lead to serious injury or death.

NOTE: Follow these instructions closely for optimal system operations and best installation practices.

DON'T: An X symbol illustrates an incorrect practice or installation technique.

DO: A check mark illustrates the correct or preferred method of installation.

General Safety Precautions

- **Must be installed by a qualified person.** The Timberline Solar system must be installed by a PROPERLY TRAINED and QUALIFIED INSTALLER. It is the responsibility of every installer to know and follow local code requirements.
- **Follow OSHA.** GAF Energy recommends compliance with OSHA guidelines for Residential Fall Protection.
- **Wear Personal Protective Equipment (PPE).** Use proper PPE and follow safety policies and procedures. Proper PPE when dealing with rooftop solar systems includes, but is not limited to, the following:
  - » **Hard hats.** For falling objects, as well as risk of contact with energized conductors. An ANSI Z89 Class A helmet satisfies this OSHA requirement.
  - » **Work gloves.** For slip, abrasion, and thermal resistance. Solar modules tend to get very hot when exposed directly to the sun.
  - » **Electrically insulated gloves.** When working on energized circuits.
  - » **Appropriate footwear.** Footwear with extra traction and/or heat-resistant soles.
  - » **Personal fall arrest system (PFAS).** Consists of an OSHA-approved anchor point, a full-body harness approved for electrical workers, rope or cable, and specific connecting hardware.
  - » **Eye protection.** For site-specific hazards.

Figure 1. Personal Protective Equipment (PPE)

- **Work only in dry conditions.** Use dry equipment and dry tools. Protect all electrical equipment against weather elements.
- **Eliminate trip and fall hazards.** Keep work areas on the roof and ground staging areas organized and clean.

General Safety Precautions, continued

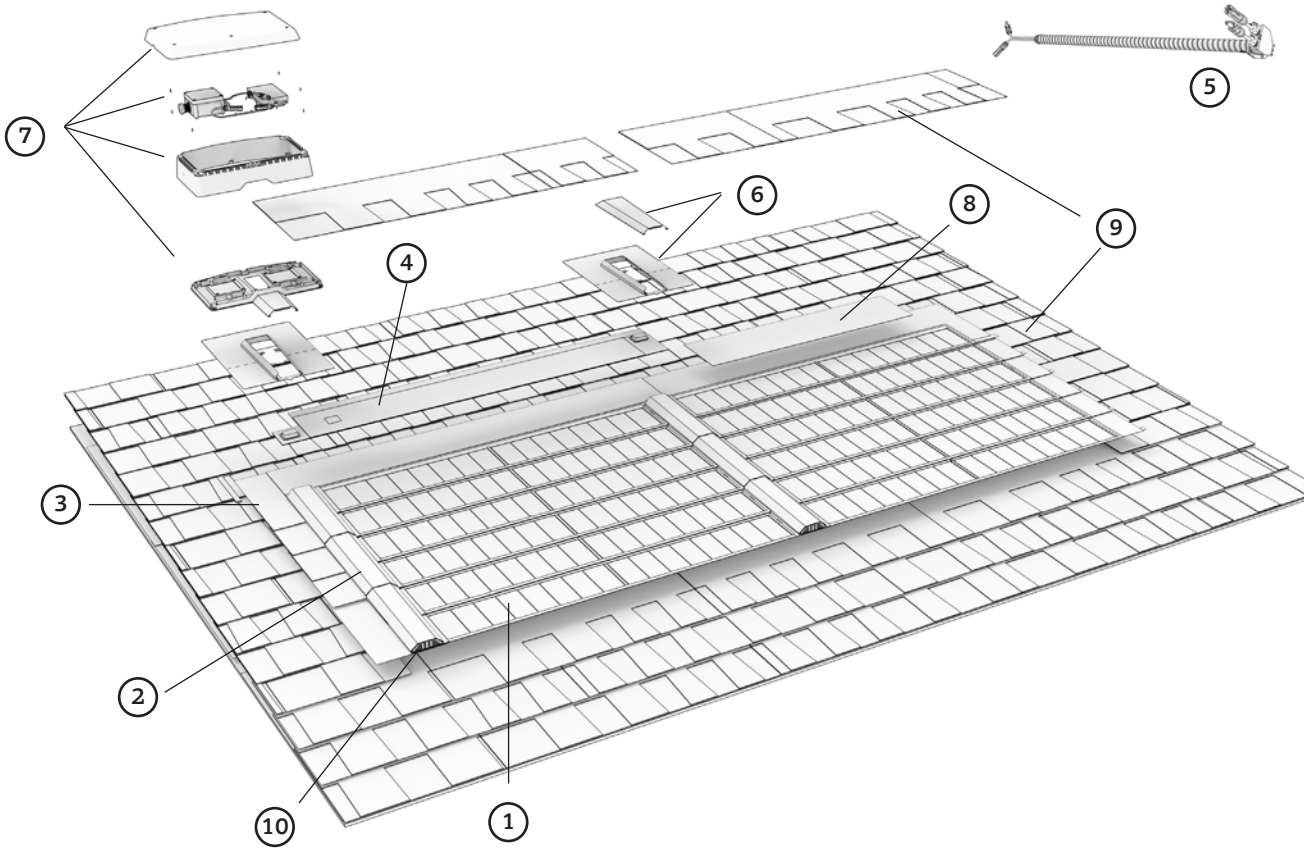
- **Inspect for damage.** Do not use Timberline Solar components if there are visible signs of damage from transport or handling.
- **Working Safely with PV systems.** Be aware of the hazards at the jobsite as well as the hazards of working on PV systems. Be alert at all times. Never work alone on roofs or PV systems. Always have at least two people installing solar systems on the roof.

Electrical Safety Precautions

- **Must be competent with electrical safety work practices.** Timberline Solar is an electric power generation system. The installer must be qualified according to state and local requirements.
- **De-energize.** All work must be performed on circuits that have been de-energized. Timberline Solar modules produce current whenever exposed to light. Installers should assume wiring on the roof is likely to be energized and to follow safe electrical practices at all times.
- **Use proper wire management techniques.** Ensure that none of the AC or DC wires are pinched or damaged during installation. Do not exceed the bend radius of the cables.
- **Do not modify factory-applied connectors, terminals, or jumper cables.** Do not customize or modify the provided DC or AC cables or connectors in the field, except as specified in this manual.
- **Do not repair.** Timberline Solar does not contain any user-serviceable parts. Replacement products should be obtained through GAF Energy and must be installed by qualified persons approved by GAF Energy. Tampering with the Timberline Solar system voids the warranty.
- **Thermal hazard.** Certain parts of the Timberline Solar system may become extremely hot due to continued exposure to the sun. The installer should take care to avoid incidental contact with bare skin.
- **Follow codes.** Perform all installations in accordance with all applicable building codes, ordinances, and the National Electrical Code (NEC) ANSI/NFPA 70 for U.S. installations.
- **Re-inspection.** The Timberline Solar system should be periodically re-inspected for any signs of damage. This is important especially after storms and in areas prone to hail and high winds. Any damaged parts should be replaced immediately by a qualified person.
- **Qualified person.** Installing AC or DC circuits, disconnects, tie-in to the PV point of connection, OCPDs, and initial startup of the PV system must be performed by a qualified person. Make all electrical connections (e.g., conductor termination, fuses, potential earth connection) in accordance with the electrical standards prescribed by the applicable NEC wiring methods and in compliance with local regulations and codes.

2. Timberline Solar Overview

System Hardware Components



1. Solar Shingle
2. Wire Cover
3. Step Flap
4. Jumper Module
5. Option 1: Pass Through Device for in-attic wiring
6. Top Flashing
7. Option 2: Transition Box for wiring on the exterior of the home
8. GAF QuickStart® Peel & Stick Starter Roll
9. Roofing shingles
10. Bottom Cap

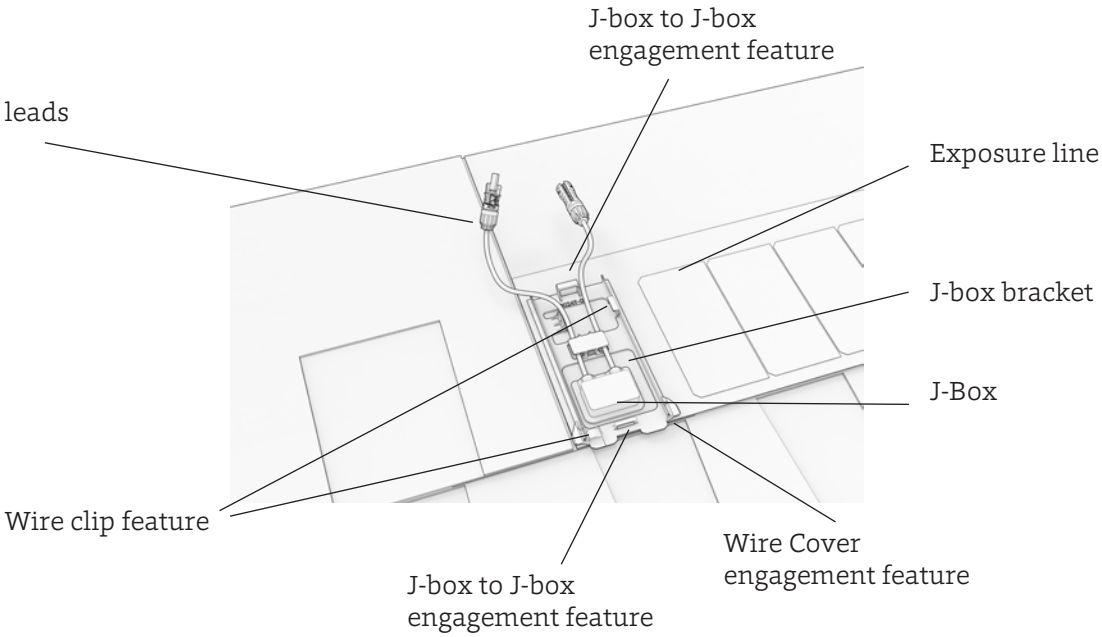
Figure 2. Timberline Solar Hardware Components

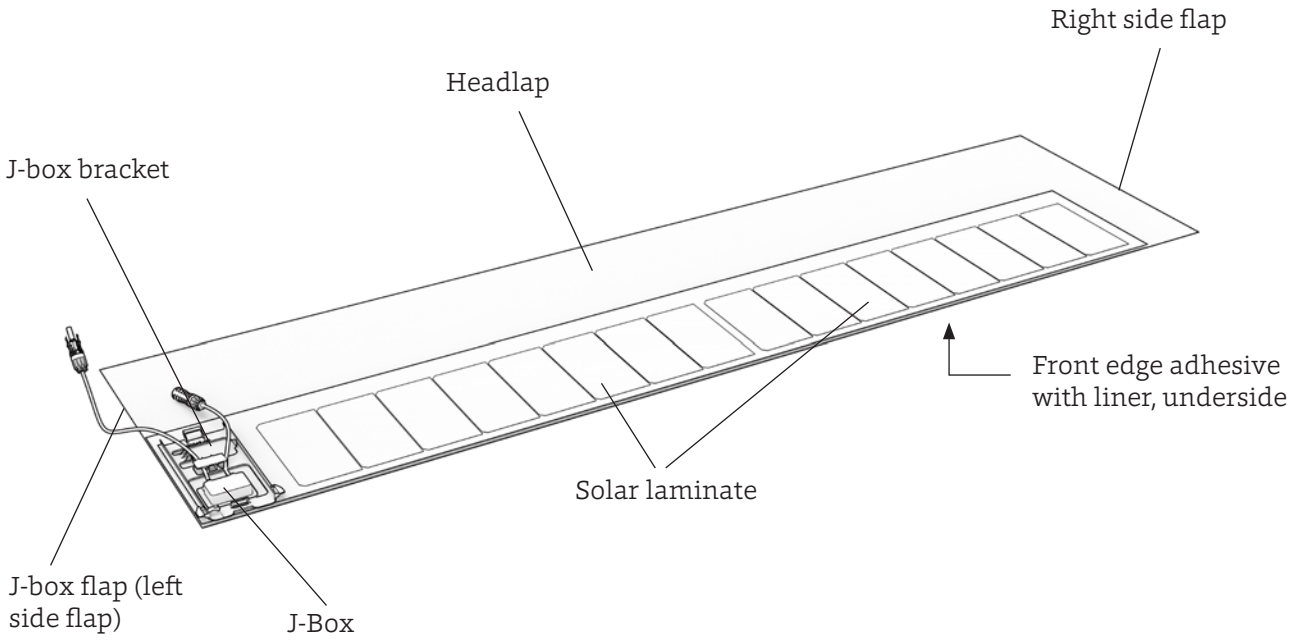
The Balance Of System (BoS) components that make up the remainder of the solar installation are outside the scope of this manual.

Component Details

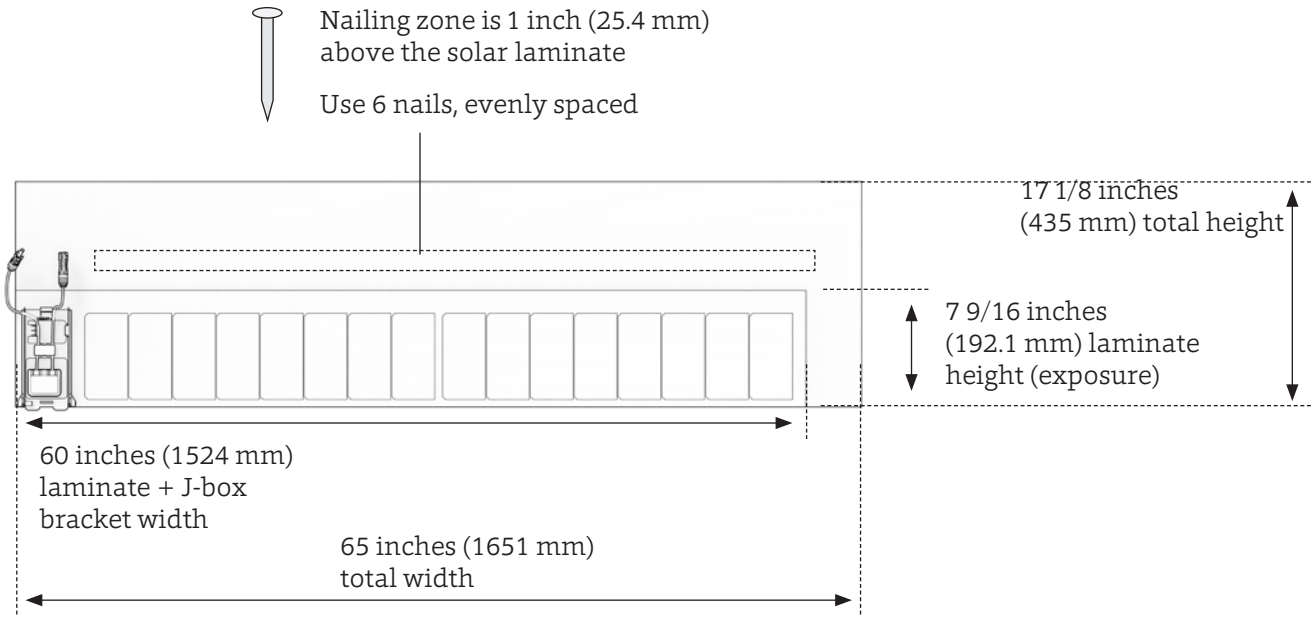
Solar Shingle features

As used in this Manual, "Solar Shingle" refers to the Timberline Solar Energy Shingle (ES).



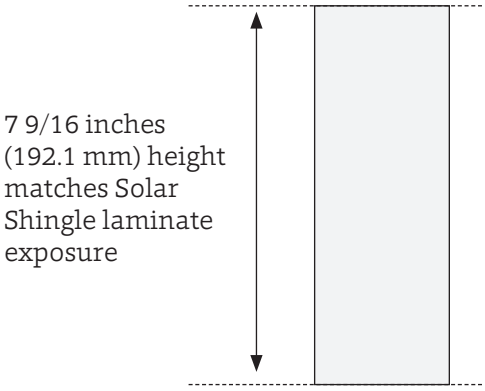


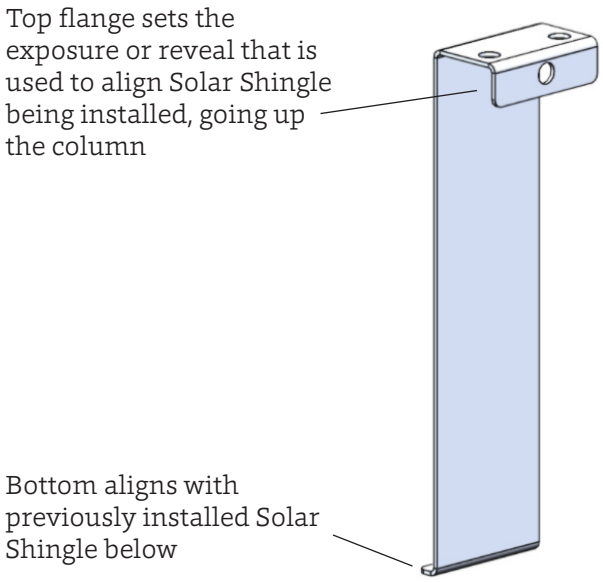
Solar Shingle dimensions



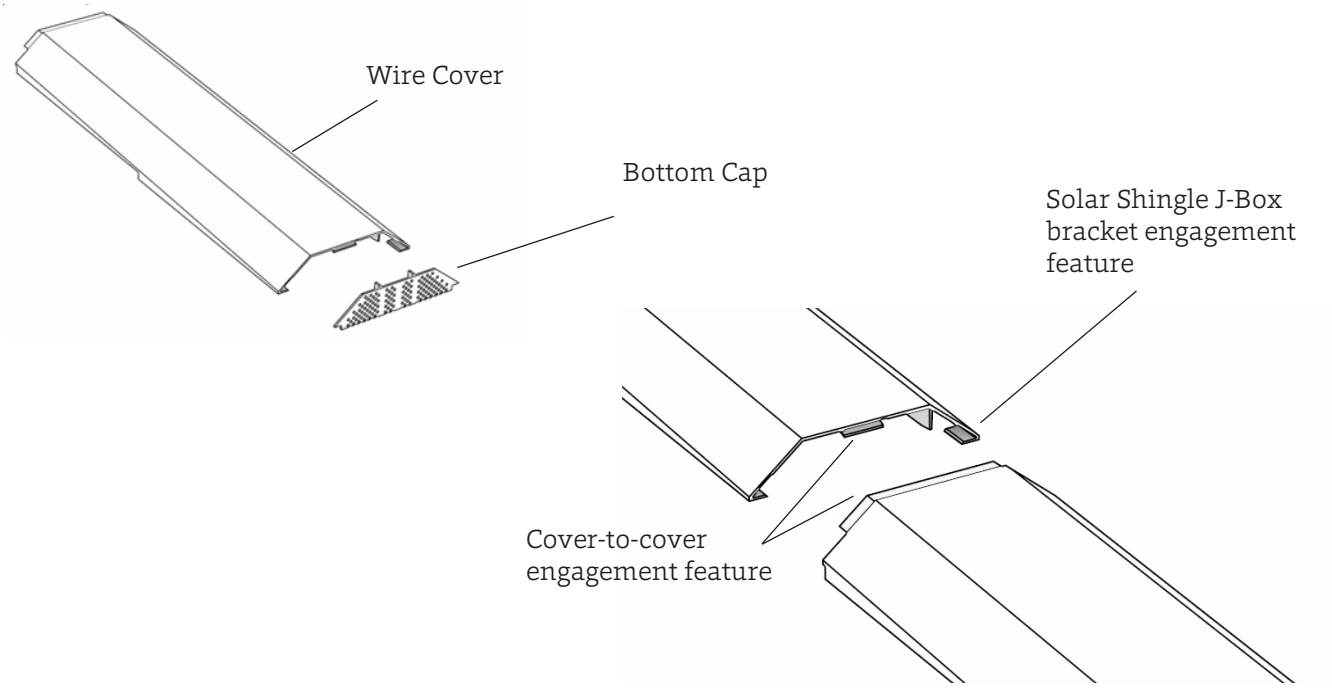
Alignment Jig dimensions

The alignment jig is a tool that helps with alignment on the right side, for use when vertically aligning a column of Solar Shingles

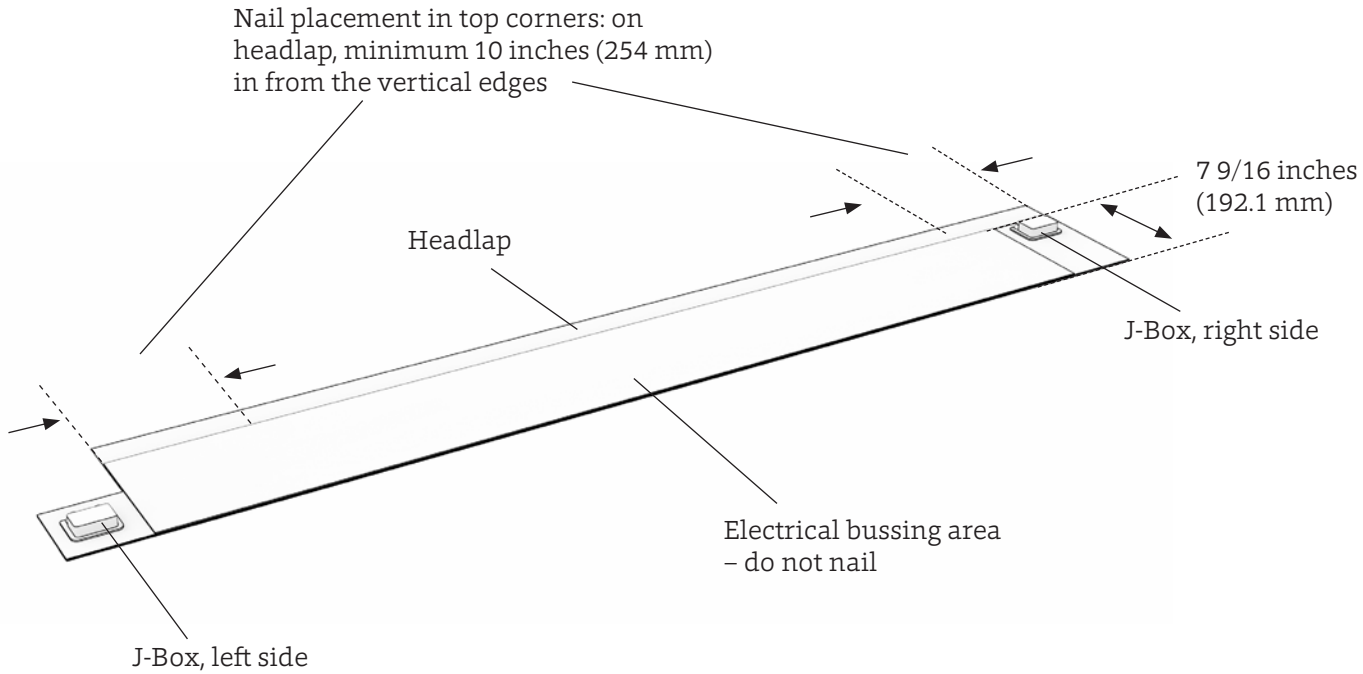




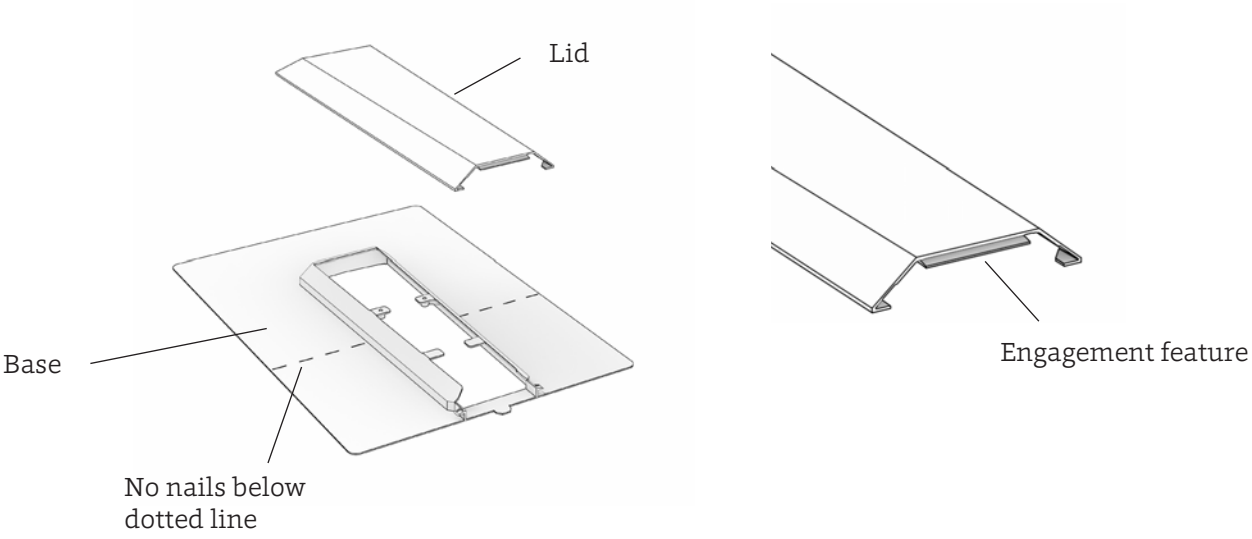
Wire Cover and Bottom Cap



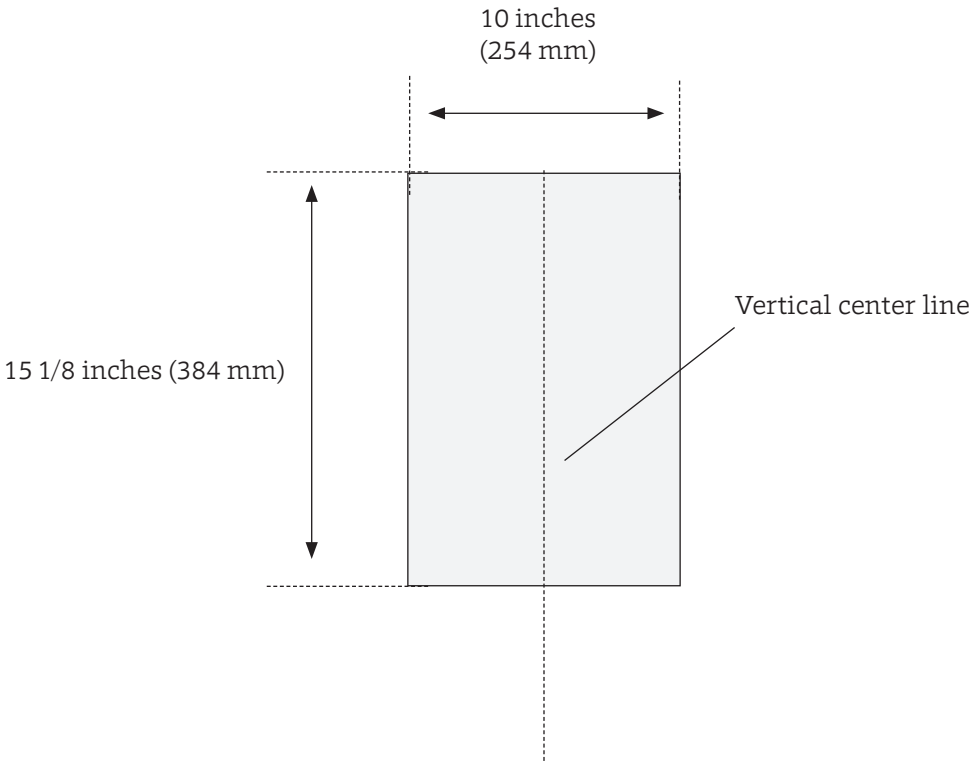
Jumper Module



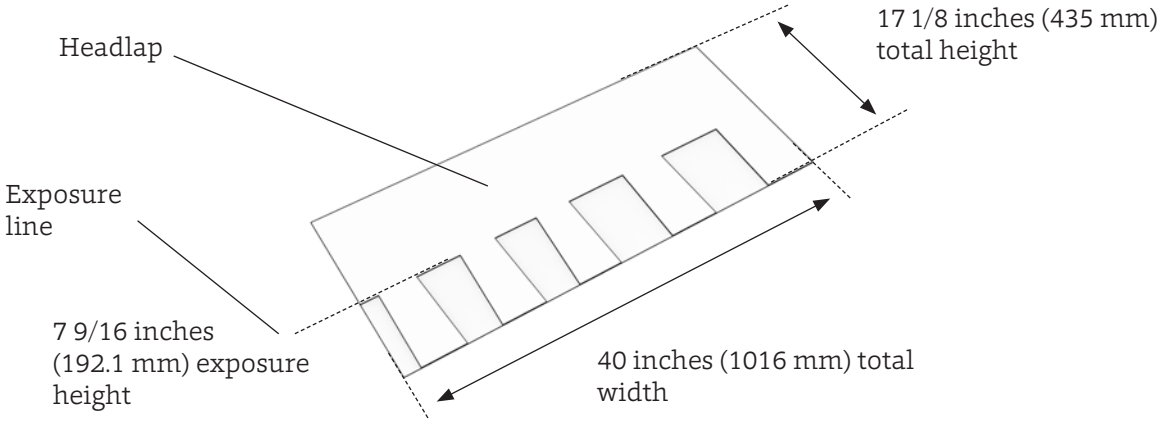
Top Flashing



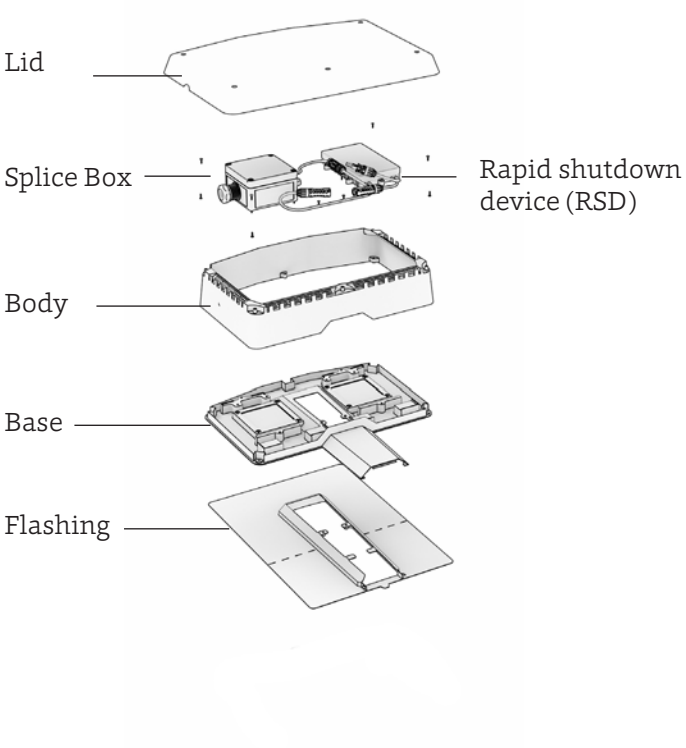
Step Flap



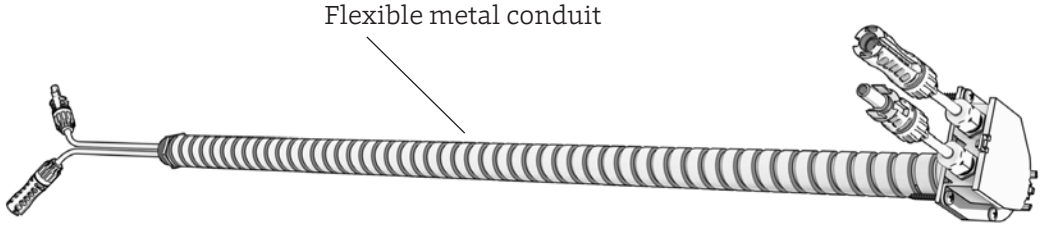
Roofing Shingle (uncut)



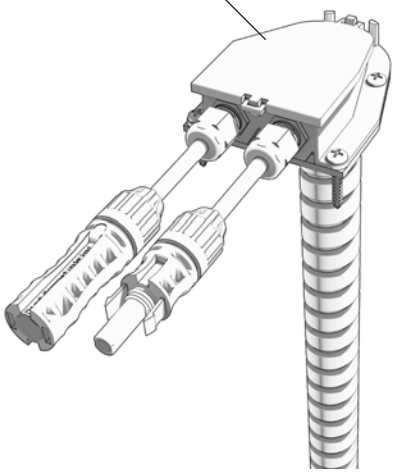
Transition Box

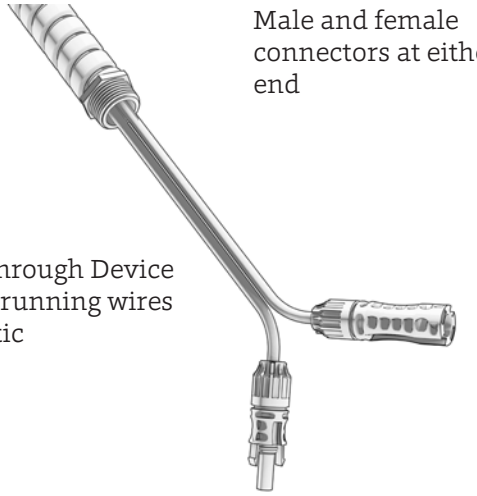


Pass Through Device

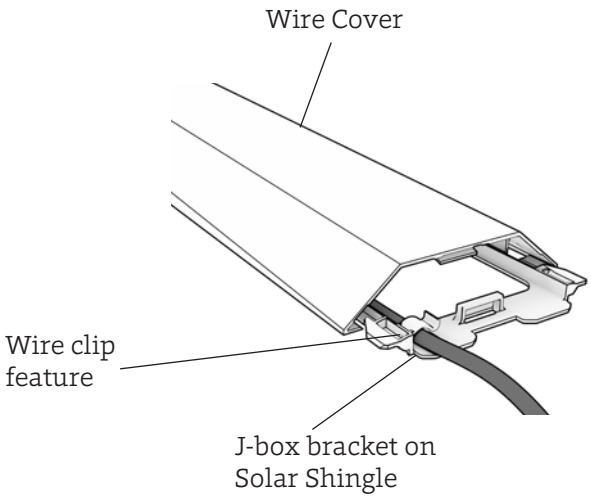


The body portion sits on the roof, the remainder of the device is inside the attic

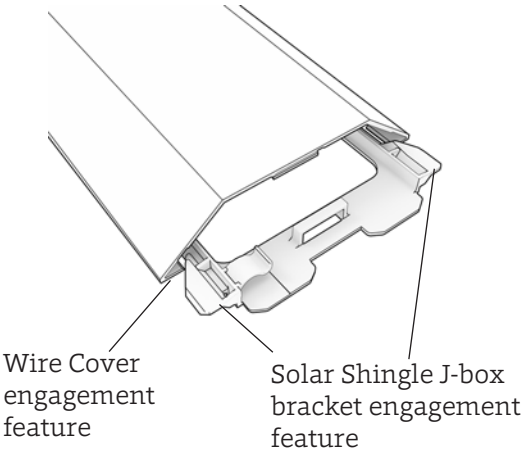




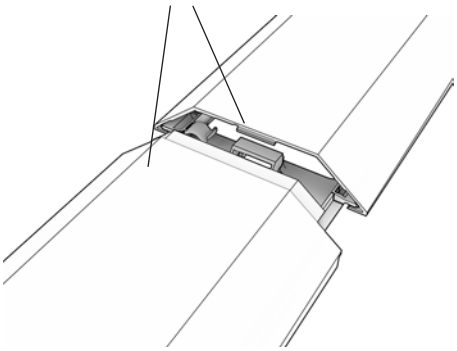
Alignment and Engagement Features, Fitting

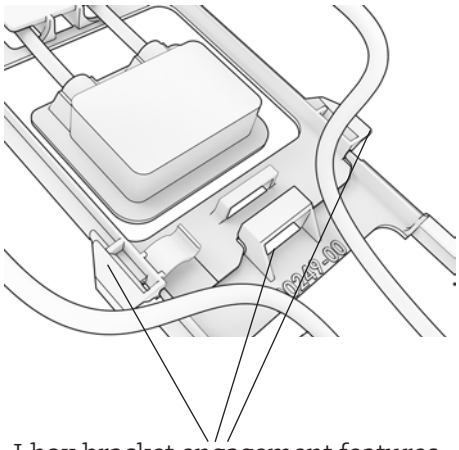


Wire Cover engaging with Solar Shingle J-box bracket



Cover-to-cover engagement





J-box bracket engagement features, showing two Solar Shingles

Module and Component SKUs

- Separate tables show SKUs for parts made by GAF Energy, third-party components, and fasteners.
- See Appendix A for alternative SKUs.

Table 1. GAF Energy SKU Numbers for Solar Array

Component	GAF Energy SKU #
Solar Shingle	TLS-1 TLS-1.1 TLS-1.2 TLS-1.3
Wire Cover	294000204
Bottom Cap	294000278
Top Flashing Assembly	294000300
Step Flap	294000241
Jumper Module	294000215 294000417 294000456 294000589 294000590
Transition Box	294000257
Pass Through Device	294000200 294000563
QuickStart® Peel & Stick Starter Roll	1122000ST
Timberline Solar HD or HDZ Shingle	0491###MV 0492###MV
Staubli Evo2 Disconnect Tool	294000437
Module Alignment Jig	294000280
Flex Seal Caulk Grade*	8962920WP
* GAF Energy-approved sealant. Any sealant complying with ASTM D4586 may be used as an alternative to Flex Seal.	

Table 2. Third-Party Components

Component	Manufacturer	Provided By
Spelsburg TK PC 1111-7-o (Splice Box) *	Spelsburg	GAF Energy
Buchanan 2006S & 2007 copper crimp connector and cap (Wire splice), used with crimp tool model C-24	Ideal Industries Inc.	GAF Energy
Staubli Evo2 (Column Return Wire)	Staubli	GAF Energy
Staubli MC4 (Column Return Wire)	Staubli	GAF Energy
UKT PV-CO02 (Column Return Wire)	UKT	GAF Energy
Staubli Evo2 (MCI Return Wire)	Staubli	GAF Energy
Staubli MC4 (MCI Return Wire)	Staubli	GAF Energy
UKT PV-CO02 (MCI Return Wire)	UKT	GAF Energy
Lay-in ground lug	Various	GAF Energy
M4 10 mm bolt	Various	GAF Energy
* Included in Transition Box		

Table 3. Fastener Specifications

Fastener Type	Where Used	Provided By
Cap nails	Roofing underlayment	Installer
Roofing nails	Attaching array components to roof deck	Installer

RSD/PVRSA/PVHCS Components and Requirements

Timberline Solar, in combination with the Delta Electronics components listed in the table below, has been evaluated as a system to the requirements in ANSI/CAN UL 3741 Photovoltaic Hazard Control. When installed in accordance with these instructions, this system meets the requirements of Article 690.12 of the National Electrical Code for 2014, 2017, 2020, and 2023.

The terms to describe this function vary slightly in each code cycle:

- **2014: Rapid Shutdown (RSD):** Conductors leaving the array must drop to 30V or less within 10 seconds of rapid shutdown initiation. Equipment must be listed, but standards are not specified. *2014 NEC 690.12(2)and (5).*
- **2017: PV Rapid Shutdown Array (PVRSA):** A listed assembly or system designed to "*reduce but not eliminate risk of electric shock hazard within a damaged PV array during fire-fighting procedures.*" *2017 NEC 690.12(B)(2)(1).*
- **2020 and 2023: PV Hazard Control System (PVHCS):** Equipment or multiple pieces of equipment listed to UL 3741 "*to reduce the risk of electric shock hazard within a damaged PV array for fire fighters.*" *2020 and 2023 NEC 690.12(B)(2)(1).*

Table 4. RSD/PVRSA/PVHCS Components & Requirements

Component and Function	Manufacturer	Model No.	Certification Standards	Years of Compliance to 690.12
Mid Circuit Interrupters (MCI)	Delta Electronics *	GPI00010117 GPI00010119	UL 1741 PVRSE	2014, 2017, 2020, 2023
Smart Rapid Shutdown System (Smart RSS)	Delta Electronics	GPI00010105	UL 1741 PVRSE	2014, 2017, 2020, 2023
Inverters	Delta Electronics	M4-TL-US M5-TL-US M6-TL-US M8-TL-US M10-TL-US M10-4-TL-US	UL 1741	2014, 2017, 2020, 2023
Solar Shingle	GAF Energy	294000328 TLS-1 TLS-1.1 TLS-1.2 TLS-1.3	UL 61730 UL 7103	2014, 2017, 2020, 2023
Wire Cover	GAF Energy	294000204	Tested in end-product to UL 3741 & UL 7103	2014, 2017, 2020, 2023

Component and Function	Manufacturer	Model No.	Certification Standards	Years of Compliance to 690.12
Top Flashing Assembly	GAF Energy	294000300	Tested in end-product to UL 3741 & UL 7103	2014, 2017, 2020, 2023
Transition Box	GAF Energy	294000257	Tested in end-product to UL 3741 & UL 7103	2014, 2017, 2020, 2023
Pass Through Device	GAF Energy	294000200	Tested in end-product to UL 3741 & UL 7103	2014, 2017, 2020, 2023
Jumper Module	GAF Energy	294000215 294000417 294000456	UL 7103 and evaluated in end-product to UL 3741	2014, 2017, 2020, 2023
* For the most current specifications, instructions and limitations on the use of Delta Electronics components, please refer to their website at https://www.deltaww.com/en-US/index.				

Table 5. Installation Requirements

Requirement	Specification
Max System Voltage	600V_{DC}
Max Array Internal Voltage After Actuation	600V_{DC} (cold weather V^{OC})
MCI/RSS Voltage Output after Actuation	≤30V_{DC}
Voltage Bleed-Down Interval.	≤30 secs.
Max Series-Connected Solar Shingles per 1 MCI or 1 RSS	48

Other Installation Instructions

- MCI or RSS shall be secured inside the enclosure (Transition Box, Hoffman Box, or other listed enclosure) using provided fasteners.
- One MCI or RSS must be connected to each series string (48 solar shingles max.) or separate mounting plane subarray string. MCI and RSS may be installed on subarrays smaller than 48 series-connected solar shingles.
- To operate, the MCI requires an input operating voltage of 6–80V_{DC} and a startup voltage of 22V_{DC}. The Solar Shingles have a V_{OC} of 10.9 V_{DC}. Minimum recommended number of Solar Shingles to the input of each MCI is 6 Solar Shingles.
- Verification that each MCI or RSS is installed with 48 or fewer modules shall be documented for inspection by as-built string diagrams and/or voltage measurement logs. Voltage output per string not to exceed 600V.
- The RSS has a metal enclosure and shall be bonded to the EGC using the lay-in lug and M4 bolt provided, or by equivalent means approved in the NEC.
- A designated PV system disconnect shall serve as the RSD/PVRSA/PVHCS initiator and shall be sized, installed and labeled in accordance with NEC requirements. The specific part shall be identified on the as-built system drawings.

Balance of System Components

The roofing and solar system installer provides the remaining typical Balance of System items, including:

- Roofing materials
  - » Roofing underlayment (GAF Tiger Paw™ or underlayment certified to ASTM D226, D4869, D1970, or D6757)
  - » Roofing adhesive
  - » Drip edge
  - » Starter strip
  - » Ridge cap
  - » Flashings
  - » Roofing Fasteners
  - » Cap nails/staples

A qualified person must perform final electrical tie-in. Depending on the site-specific array design, they might provide the following additional items:

- Listed raintight conduit fittings
- Electrical conduit
- Inverter
- AC/DC disconnect
- Back fed breaker (OCPD)
- Meter

3. System Considerations and Installation Requirements

System Design Considerations

- **Slope limitations:** The Timberline Solar system (Solar Array) is intended for use on roofs having a slope of 2:12 or greater.
- **Deck mounting:** The Timberline Solar system must be deck-mounted with prescribed underlayment. Timberline Solar shingles are to be installed only on a clean deck. All debris should be removed and old nails should be removed or pounded flush with the deck surface.
- **Deck requirements:** The roof deck must be a minimum of 15/32 inch (11.9 mm) thick plywood or 7/16 inch (11.1 mm) OSB decking as recommended by APA – The Engineered Wood Association. Wood plank decking must be well-seasoned and supported, having a maximum 1/8 inch (3 mm) spacing between boards with a minimum nominal thickness of 1 inch (25 mm) x maximum 6 inch (152 mm) lumber. Installers should ensure that the deck is properly fastened per local building code requirements. If any damaged sheathing is discovered during tear-off, replace and fasten in compliance with applicable codes and these instructions. Refer to the *GAF Pro Field Guide for Steep-Slope Roofs*.
- **Landscape orientation:** The Timberline Solar Energy Shingles are designed for landscape orientation only.
- **Solar Array wiring:** Refer to the Permit Design Drawings for the system wiring details. The system electrical design is outside the scope of this manual.
- **Operating temperature:** The Timberline Solar system is intended for an environmental ambient temperature range of -40°C to + 50°C (-40°F to 122°F) on average, as measured and documented by meteorological services for the intended installation's geographic location.
- **DC electrical output:** Under certain environmental conditions, the Timberline Solar system may produce more current and/or voltage than reported at standard test conditions (irradiance of 1000 W/m^2, AM 1.5 spectrum, and a cell temperature of 25°C [77°F]). The solar designer should account for these conditions when designing the solar array.
- **Suitable ambient conditions:** Artificially concentrated sunlight shall not be directed on the Timberline Solar system The modules must neither be immersed in water nor be exposed to continuous wetting (e.g., by fountains). Exposure to salt or sulfur (sulfur sources, volcanoes) increases a risk of corrosion of exposed metal components (e.g., EMT). The system must not be used on boats or vehicles. The system must not be exposed to extraordinary chemical loads (e.g., emissions from manufacturing plants). The GAF Energy Timberline Solar™ should not be installed on stables.
- **Paint:** Do not apply unapproved paint to any part of the Timberline Solar system.
- **Roof Setbacks:** The Timberline Solar system requires the installation of a minimum of one full row of shingles at the eave and the ridge. Refer to the local building and fire codes for additional setback and pathway requirements.
- **Mounting hardware:** Timberline Solar is intended to be mounted to a roof using only the specified hardware. Using other unapproved means is a violation of the product's certification.

System Design Considerations, continued

- **Fire classification:** Timberline Solar has been rated as Class A for resistance to external fire exposure per UL 790 when installed with GAF Tiger Paw™ Premium Roof Deck Protection or with underlayment certified to ASTM D226, D4869, D1970, or D6757.
- **Nonstructural component:** These products have been evaluated for serving as a nonstructural component of a building only.
- **Wind resistance and load ratings:**
  - » Solar Shingle wind uplift classification: ASTM D3161 Class F.
  - » Solar Shingle has a positive and negative design load rating of 1600 Pa with a safety factor of 2400 Pa (1.5X design load rating).
  - » Each Solar Shingle weighs 10.1 lb. (4.58 kg.).
  - » The installed system weight, including all components and underlayment, imposes a dead load of 3.36 pounds per square foot.
- **Impact resistance:** Timberline Solar has achieved a Class 1 rating under UL 2218 *Impact Resistance of Prepared Roof Covering Materials*.
- **Roof obstructions:** Do not install any portion of the solar system over any roof obstructions, plumbing, or attic vents. Do not attempt to cut or modify the Solar Shingles to accommodate any roof projections. Roof obstructions must be removed or relocated.
- **Ice dams:** Refer to the *GAF Pro Field Guide for Steep-Slope Roofs* for installing leak barriers.
- **Approved shingles:** Timberline Solar is a system that combines photovoltaic shingles (aka Energy Shingles or Solar Shingles) and asphalt shingles engineered to pair with the photovoltaic shingles. The only asphalt shingles approved for use in this system are GAF Timberline Solar HD or HDZ.
- **Safety first:** Follow all of the General Safety Precautions outlined in this manual.
- **Follow roofing best practices:** Follow all related shingle application instructions and industry best practices. Special attention is needed when stripping the shingles, installing underlayment, and trim around the Timberline Solar system. Refer to the *GAF Pro Field Guide for Steep-Slope Roofs* for best practices, including tearing off existing roofs and installing leak barriers.
- **Obtain permits:** The installer must comply with local, regional, and state building codes and obtain necessary permits and approvals from the local jurisdiction prior to installing the Timberline Solar system.
- **Contact local utility:** Contact your local power provider for grid connection requirements prior to the system design and installation.
- **Deck-height variations:** Repair roof if deck-height variation (either a peak or valley) is greater than 1 inch (25.4 mm) over a 32 inch span or if there are any steps in decking 1/4 inch or greater.

System Design Considerations, continued

- **Electrical classification:** The Timberline Solar system has been listed to UL 7103 *Building Integrated Photovoltaic Roof Coverings*, which includes listing to UL 61730-1 and UL 61730-2 as a Class II Building-Integrated Photovoltaic module. The module electrical characteristics shown in Table 5, below, are under Standard Test Conditions (STC: 1000 W/m^2, 25°C +/-2°C, AM 1.5 according to IEC 60904-3).

  Under real world conditions, PV modules may produce more current or voltage than reported at STC. System designer shall apply any correction factors required by the National Electrical Code (ANSI/NFPA 70) to account for irradiance above STC and/or temperature below STC.

  NOTE: UL 61730-1 and 61730-2 supersede UL 1703 as of 12/4/19. All PV modules certified in the U.S. after this date, including Timberline Solar, are certified to UL 61730-1 and UL 61730-2.

- The Timberline Solar system is listed to UL 3741 *Photovoltaic Hazard Control* and complies with the rapid shutdown requirements of Article 690.12 in the 2014, 2017, 2020, and 2023 NEC (ANSI/NFPA 70). Delta Electronics manufactures additional listed PV Rapid Shutdown Equipment (PVRSE) required to complete a Timberline Solar installation that meets the following requirements:

  » Listed PV Hazard Control System (2020 and 2023 NEC 690.12(B)(2)(1))

  » Listed Rapid Shutdown PV Array (2017 NEC 690.12(B)(2)(1))

  » Listed PV Rapid Shutdown Equipment (2014 NEC 690.12 (1) - (5))

  See Table 4 on page 18 for a complete list of required GAF Energy and Delta Electronics components.

- **WARNING:** To reduce the risk of injury, read all instructions.

Table 6. System Electrical Characteristics*

Isc +/- 5%	5.40A (TLS-1, TLS-1.1, TLS-1.2) 5.44A (TLS-1.3)	Ipmax +/- 5%	5.16A
Voc +/- 5%	10.9V	Vpmax +/- 5%	9.03V (TLS-1, TLS-1.1) 9.12V (TLS-1.2) 9.30V (TLS-1.3)
Pmax +/- 5%	46W (TLS-1, TLS-1.1) 47W (TLS-1.2) 48W (TLS-1.3)	Equipment class	II
Temp coefficient Isc	+0.06%/C	Max recommended modules in series	48
Temp coefficient Voc	-0.30%/C	Max recommended parallel strings	2
Temp coefficient Pmax	-0.39%/C	Diode	Schottky 12A 45V, Diodes Inc. #SBR12U45LH1-13
Vsys	600V	Connector	**Staubli PV-KST4-EVO2/6II-UR (F) PV-KBT4-EVO2/6II-UR (M) PV-KST4/6X-UR (F) PV-KST4/6X-UR (M) UKT PV-CO02 (F) PV-CO02 (M)
Max installation altitude	4000m/13,100 ft.	Max series fuse rating	15A

* All electrical ratings shown are within tolerance both initial and stabilized conditions.

**All Staubli EVO2-series connectors are fully compatible with all Staubli MC4-series connectors.

Recommended Tools for Installation

The following tools are recommended to properly install a Timberline Solar system. This list is representative only; additional tools may be required depending on the installation.

- Nail gun
- Unibit or graduating drill bit
- Hole saw or paddle bit
- Channel locks
- Chalk line
- Multimeter
- Phillips tip screwdriver
- Caulking gun
- Drill
- Alignment jig for use with Solar Shingles

Pre-Installation Checklist

The following should be completed prior to the installation of the Timberline Solar system:

- **Review documentation:** Review the installation instructions, Permit Drawings, and other site-specific drawings thoroughly.
- **Ensure materials are onsite:** Ensure that all the correct materials in the appropriate quantities are present onsite.
- **Display permits:** Ensure all building/electrical permits are posted in a visible location onsite.
- **Discuss with the building owner:** Confirm access roads, material staging area, and ladder access area (as shown in the Permit Design Drawings). Also discuss work hours, installation noise, and electrical panel shutdown timing with the building owner.
- **Review site:** Review site conditions prior to installation. If the installer notices any abnormalities, do **NOT** proceed with the installation until the matter is resolved with the building owner and with GAF Energy. Typical abnormalities could include:
  - » Conditions do not match planned design
  - » Roof obstructions
  - » Excessive deck-height variations

4. Installation Procedure

The following steps outline the procedure to install the Timberline Solar system:

Step 1	Array Layout
Step 2	First Solar Shingle
Step 3	Bottom Row
Step 4	First Column
Step 5	Remaining Columns
Step 6	Jumper Modules
Step 7	Top Flashings
Step 8	Column Wires and Voltage Testing
Step 9	Install Wire Covers
Step 10	Finish Installing Roof Shingles
Step 11	Connect Array Wiring
Step 12	Final Check

Conventions for These Instructions

The installation instructions sometimes refer to “up”, “down”, “previous”, “next” when referring to positions of Solar Shingles and roofing shingles. Sometimes components are layered one on top of the other, and sometimes components are positioned or aligned to be touching but not covering one another.

Refer to the following conventions when reading through the instructions, and consult the illustrations for clarification.

- Above = up-roof, towards the peak
- Below = down-roof, towards the eave
- Adjacent = usually horizontal, but can mean touching in any direction
- Previous = left side, usually
- Next = right side, usually
- On top of or covering = layered
- Beneath = layered underneath
- Vertical = up-roof or down-roof
- Horizontal = right or left on the roof
- Left = on the left side of the roofing plane, facing uproof
- Right = on the right side of the roofing plane, facing uproof
- Top = farthest point up-roof
- Bottom = farthest point down-roof

Step 1. Array Layout

Summary:

a. Prep roof deck and install necessary roofing components, including underlayment.

b. Compute array dimensions.

c. Locate bottom left corner of the array.

d. Install roofing shingles below the array.

Step 1a. Prep the roof deck and install underlayment.

» **Ensure that roof substrate is free from debris, with all existing fasteners either removed or hammered flush to the deck surface.**

» Confirm that roof sheathing meets product minimum requirements, and is secured in accordance with applicable building codes and manufacturer's instructions. Make any necessary repairs before proceeding. Refer to GAF product installation instructions and the ***GAF Pro Field Guide for Steep-Slope Roofs*** for roofing shingles, roofing underlayment, and other roofing products.

» Install approved starter strips and first course of shingles in accordance with the instructions in the *GAF Pro Field Guide for Steep-Slope Roofs*.

Figure 3. Install roofing underlayment

Step 1. Array layout, continued

Step 1b. Compute the array dimensions.

- Width is the total number of columns x 60 inches, + 5 inches for the right side flap of the rightmost Solar Shingle (#columns x 1524 mm, + 127 mm).
- Height is the number of Solar Shingle exposures x 7 9/16 inches, + 19 1/8 inches for the Top Flashing (#exposures x 192.1 mm, + 486 mm).

Figure 4. Compute array dimensions

Step 1c. Locate the bottom left corner of the array.

- Some jurisdictions require access pathways for rooftop fire operations. These may be at the rake, ridge or valleys. Refer to your permitted plans and do not place the array in fire access pathways.
- Check for roof obstructions.
- Measure from the eave up to the bottom start of the array in order to determine the number of courses required.
- Count the number of roofing shingle courses under the array. Multiply the number of courses by 10 inches (254 mm). Measure this distance inward from the starting point of the array. This is your starting point for the roofing shingle butt joint at the eave.
- Based on all these considerations, choose an optimal starting point at the bottom left corner of the array.

Step 1. Array layout, continued

Locating the Array Starting Point

The figure below illustrates an example with 3 courses of shingles below the array. Actual installations may vary in the number of shingle courses.

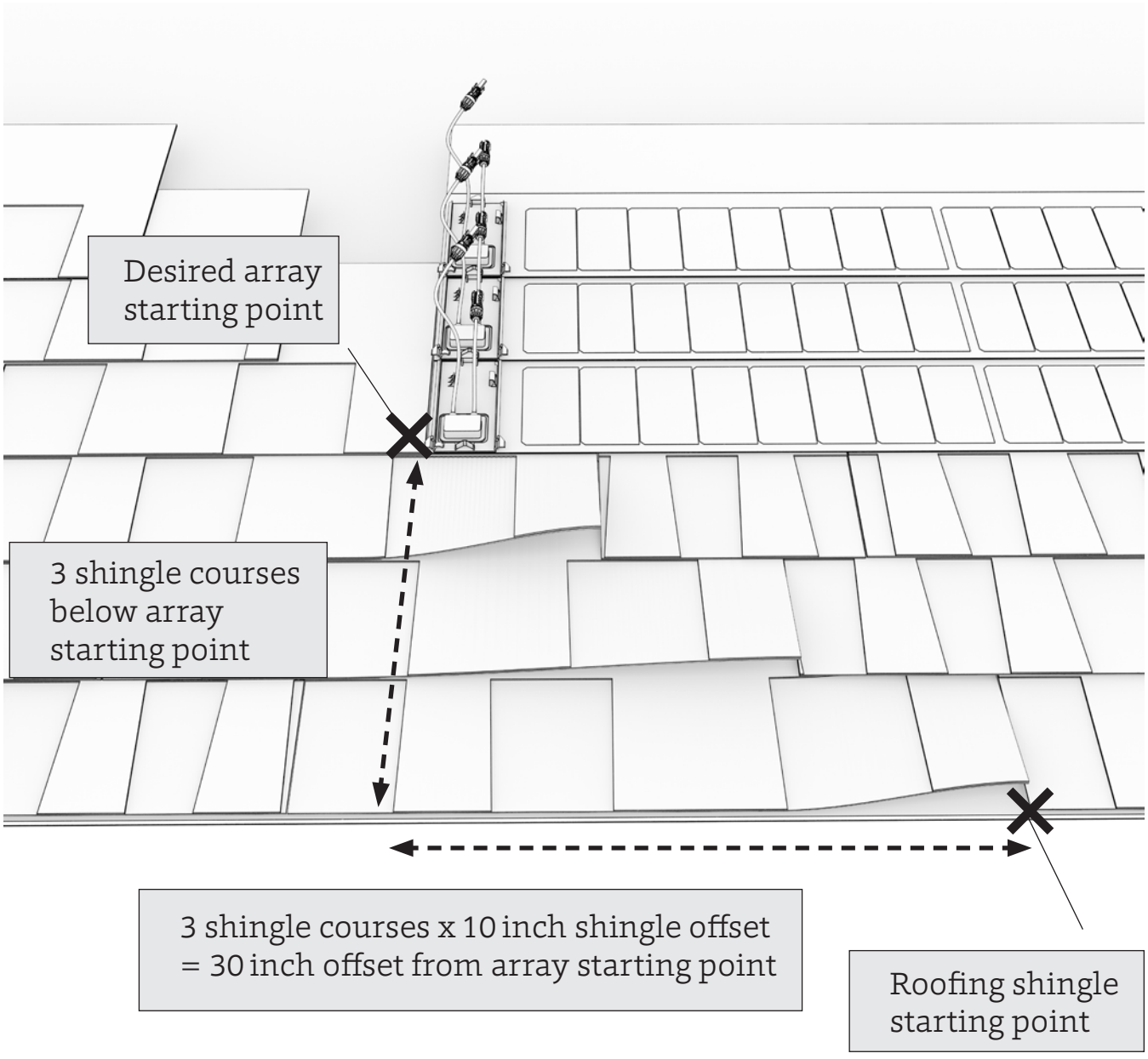


Figure 5. Array starting point, example with three shingle courses

Step 1. Array layout, continued

Figure 6. Locate array starting point

Step 1d. Install roofing shingle courses up to the array starting point.

- Install starter strip and roofing shingles, referring to GAF application instructions for the roofing products being used.
- Maintain a 10 inch (254 mm) horizontal shingle offset from the bottom left array corner.
- Roofing shingles installed directly under the array should be offset to the right by 10 inches (254 mm) from the array starting point, which is the lower left corner.
- Any roofing shingle that is overlapped by a Solar Shingle requires an additional 4 nails at the top of each headlap.

Figure 7. Bottom course of roofing shingles

Step 2. First Solar Shingle

Summary:

a. Snap horizontal chalk line along array bottom edge.

b. Position the Step Flap.

c. Nail Step Flap in place.

d. Install first Solar Shingle.

Step 2a. Snap horizontal chalk line along array bottom edge.

» Match to roofing shingle exposure line.

» This is where the first row of Solar Shingles will be installed.

Figure 8. Snap horizontal chalk line along array bottom edge

Step 2. First Solar Shingle, continued

Step 2b. Position the Step Flap.

- Position the Step Flap center line at the array starting point.
- Align bottom of Step Flap 2 inches (51 mm) above roofing shingle exposure.

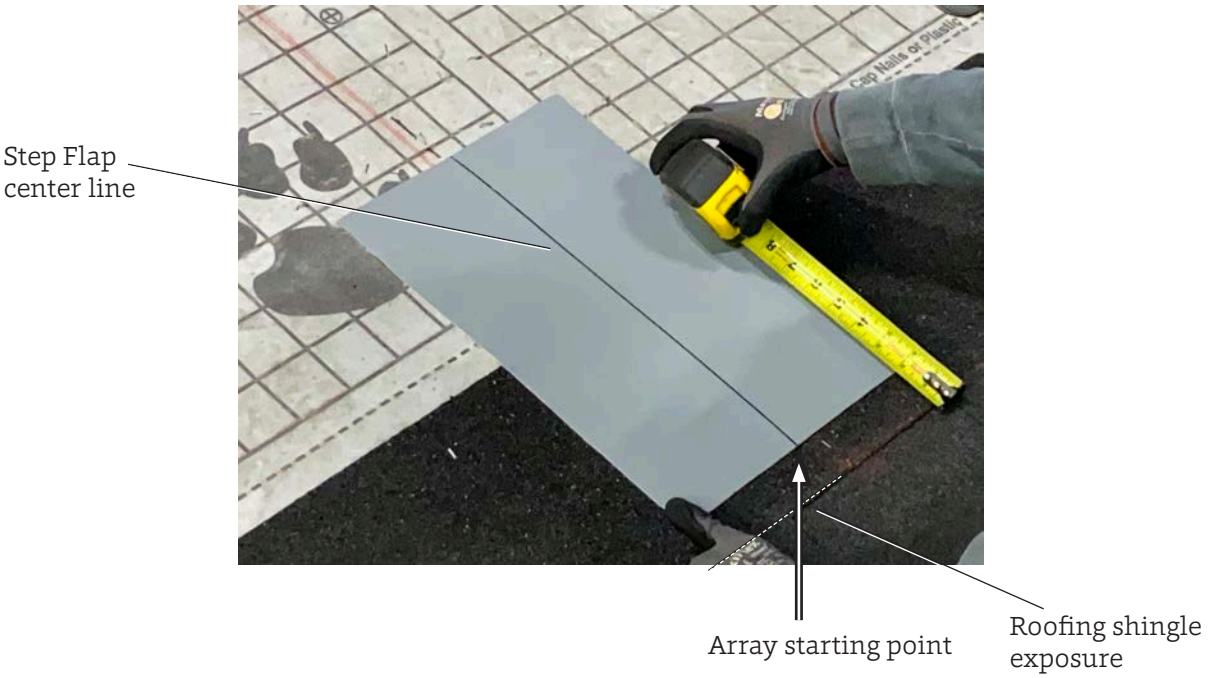


Figure 9. Position the Step Flap

Step 2. First Solar Shingle, continued

Step 2c. Nail Step Flap in place.

- Nail the top right and left corners of the Step Flap.
- Later on, the roofing shingle will be nailed in place over the left side of the Step Flap.

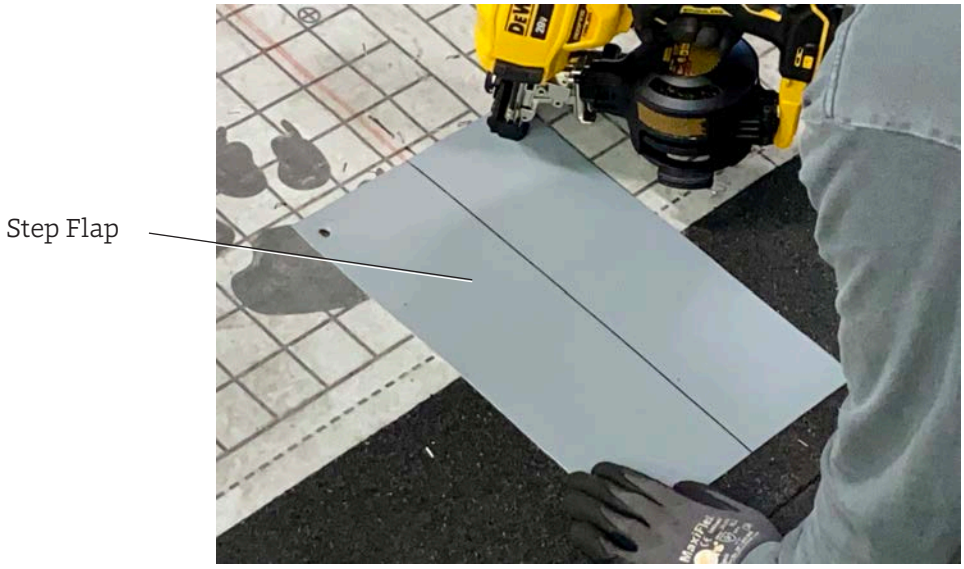


Figure 10. Nail Step Flap in place

NOTE ON WIND RESISTANCE AND HAND SEALING: The Solar Shingles have a special thermal sealant that bonds the shingles together after installation when exposed to sun and warm temperatures. If the Solar Shingles are damaged by winds before sealing or are not exposed to adequate surface temperatures, or if the self-sealant gets dirty, the shingles may never seal. Failure to seal under these circumstances results from the nature of self-sealing shingles, and is not a manufacturing defect. If shingles are to be applied during PROLONGED COLD (below 40°F for three or more days) or in areas where airborne dust or sand can be expected before sealing occurs, all Solar Shingles MUST be hand sealed by applying a 1/4 inch bead of GAF Energy-approved sealant directly above the front edge butyl on the Solar Shingle, following the length and gaps of each bead of butyl.

Step 2. First Solar Shingle, continued

Step 2d. Install the first Solar Shingle.

- Carefully flip the Solar Shingle back over and position it on the roof, lining up the front edge of the Solar Shingle with the chalk line.
- Place first Solar Shingle's J-box flap over the top of the Step Flap.
- The Solar Shingle J-box flap left edge should align with the center line of the Step Flap.
- The Step Flap is not visible after the array is complete.
- Secure the Solar Shingle using 6 evenly spaced nails, in the outlined nailing zone above the active area of the Solar Shingle only. Do not nail above the Jbox or right side flaps. Nails must be driven fully and flat to the headlap. Use the same proper nailing practices as used with the asphalt shingles and as described in the *GAF Pro Field Guide for Steep-Slope Roofs*.
- When Solar Shingles are installed, adjoining roofing shingles can be installed.

Figure 11. Install first Solar Shingle

Step 3. Bottom Row

Summary:

a. Continue installing Solar Shingles across the first row, going from left to right.

Step 3a. Install the next Solar Shingle.

- Line up the front edge of the Solar Shingle with the chalk line along roofing shingle exposure line.
- The J-box flap on the next Solar Shingle should cover the previous Solar Shingle's right side flap.
- The J-box flap on the next Solar Shingle should touch the edge of the previous Solar Shingle's laminate area, but should not overlap it. When placed, it should measure 60 inches (1524 mm) horizontally from one J-box bracket to the next.
- Secure the Solar Shingle using six evenly spaced nails, in the outlined nailing zone above the active area of the Solar Shingle only. Do not nail above the Jbox or right side flaps.

Figure 12. Install next Solar Shingle

Step 3. Bottom Row, continued

Step 3b. Continue installing Solar Shingles across the first row.

- Align each Solar Shingle front edge with the horizontal chalk line.
- Measure 60 inches (1524 mm) from each J-box bracket to the J-box bracket of the Solar Shingle next to it.
- No Step Flap is needed on the right side of the array.

Figure 13. Complete the first row

Step 4. First Column

Summary:

a. Position a Step Flap below the J-box flap of each Solar Shingle in the first column.

b. Align next Solar Shingle up the column.

c. Install adjoining roofing shingles.

Step 4a. Position a Step Flap below the J-box flap of each Solar Shingle in the first column.

- Use a Step Flap under every roofing shingle/Solar Shingle butt joint, on the left edge of the array only.
- Align Step Flap bottom edge to the top of the lower J-box bracket of the previous Solar Shingle in the column, but without covering the bracket.
- Align the Step Flap center line with the vertical butt joint between the roofing shingle and the Solar Shingle.
- Align the bottom of the Step Flap 2 inches (51 mm) above the shingle exposure line.
- Nail the Step Flap on the top right and left corners.

Figure 14. Step Flaps going up the column

Step 4. First Column, continued

Step 4b. Align the next Solar Shingle up the column.

- Position the next Solar Shingle, aligning left edge of J-box flap with Step Flap center line.
- Use the Alignment Jig to align the bottom edge of the Solar Shingle correctly with the Solar Shingle below.
- The J-box flap should cover the right half of the Step Flap.
- Use the alignment feature on the Solar Shingle's J-box bracket to align with the corresponding bracket on the Solar Shingle below.
- Visually check to ensure that the alignment brackets are fully engaged.
- Secure the Solar Shingle using 6 evenly spaced nails, in the outlined nailing zone above the active area of the Solar Shingle only. Do not nail above the Jbox or right side flaps.

Figure 15. Next Solar Shingle going up the column

Step 4c. When Solar Shingles are installed, adjoining roofing shingles can be installed.

Step 5. Remaining Columns

Summary:

a. Interweave all Solar Shingle flaps in accordance with Step 3a, above.

b. When installed, all flaps should lay flat.

c. Ensure that vertical wire channels are straight.

Step 5a. Interweave the Solar Shingle flaps as you go.

» Interweaving the flaps is essential to ensure proper water-shedding integrity of the array.

» J-box flap on next Solar Shingle covers right side flap of Solar Shingle from previous column.

» The top portion of the J-box flap of next Solar Shingle will be underneath the right side flap of the Solar Shingle above it and to the left, in the previous column. The J-box bracket should not be covered.

» Engage the J-box bracket alignment feature.

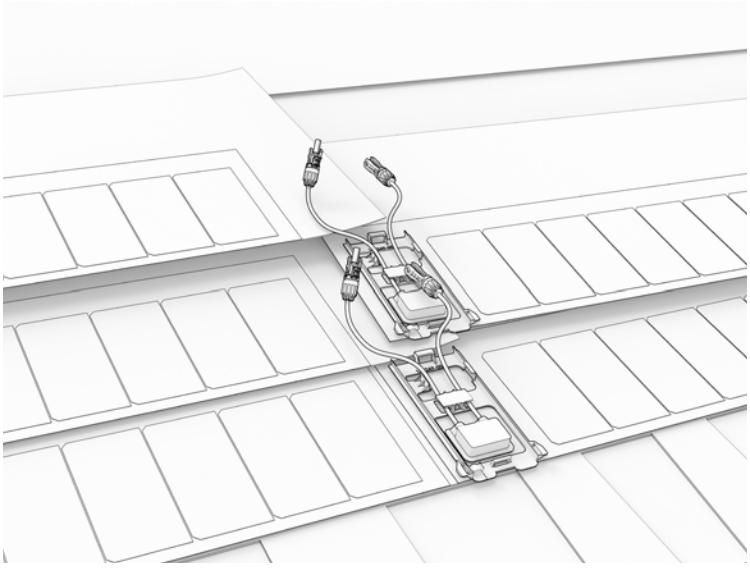


Figure 16. Interweave Solar Shingles up each column and across columns

Step 5. Remaining Columns, continued

Step 5b. **When installed, make sure that all flaps lay flat, and are in the correct overlapping order.**

- For each Solar Shingle, its J-box bracket and J-Box flap is on top of the right side flap of the previous Solar Shingle.
- J-box flap is under the flap from the Solar Shingle above it, but the J-Box bracket is still exposed.
- Outside edge of J-box flap aligns with the edge of the laminate area of the previous Solar Shingle, and should measure 60 inches (1524 mm) from J-box bracket to J-box bracket.

Step 5c. **Ensure that the vertical wire channels are straight going up the roof**.

- The J-box bracket alignment features should be fully engaged.

Figure 17. Ensure that vertical wire channels are straight

Step 5d. **Place a step flap at the top of every vertical wireway.**

- Measure up 5 inches from last J-box bracket and place a mark.
- Take the step flap and align the bottom edge at the previous mark.
- Center the step flap l/r in the wireway column.
- Nail the step flap at the top corners.

Step 6. Jumper Modules

Summary:

a. Locate the Jumper Module positions from the plan set.

b. Position a Jumper Module at the top of each column that requires it.

c. Apply QuickStart® on top of columns without Jumper Modules.

Step 6a. Locate the Jumper Module positions from the plan set.

» The plan set for the site installation shows where to locate the Jumper Modules.

» For example, in an array with 3 columns, 2 of those columns require Jumper Modules, but the last rightmost column does not.

Step 6b. Position a Jumper Module at the top of each column that requires it.

» Position Jumper Module at the top of the column.

» Bottom edge of Jumper Module aligns with the top edge of the J-box brackets of the Solar Shingles below, covering the Solar Shingle headlap.

» Ensure that all J-boxes are aligned going all the way up the column.

» Nail the top corners of the Jumper Modules to secure it in place.

Figure 18. Position a Jumper Module at top of columns, per plan set

Step 6. Jumper Modules, continued

Step 6c. Apply QuickStart® on top of any columns without Jumper Modules.

- Cut a 55 3/4 inch (1416 mm) piece of QuickStart® and run across the headlap of the Solar Shingle directly above the solar laminate.
- Align the QuickStart® strip with the laminate below at the exposure line, using the Alignment Jig for reference.
- Remove the release liner from the QuickStart® and apply pressure to stick it in place.
- Nail the QuickStart® in place with 6 evenly spaced nails along the nail strip of the Solar Shingle below.

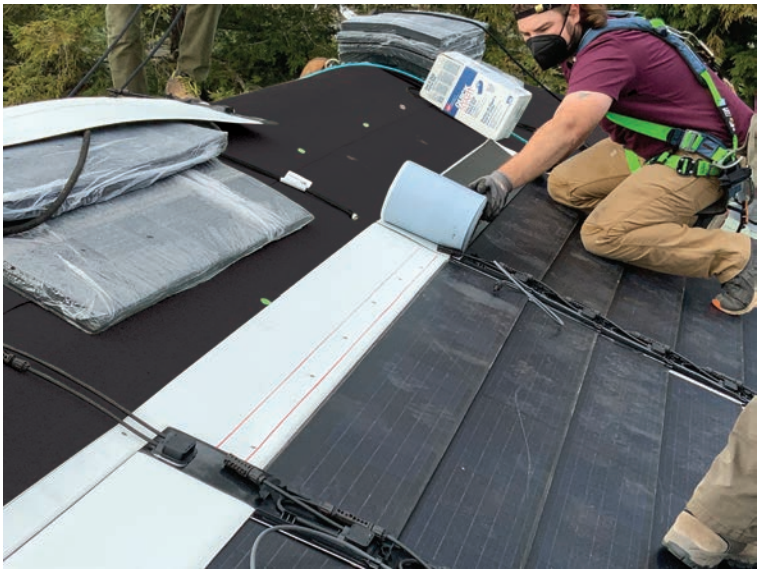


Figure 19. Use QuickStart® on columns without Jumper Modules

Step 7. Top Flashings

Summary:

a. Position Top Flashings at the top of every column over the J-boxes.

b. Align Top Flashing.

c. Nail Top Flashing in place.

Step 7a. Position the Top Flashings at the top of every column.

» The Top Flashing sits at the top of each column of J-boxes.

» It sits over top of the Jumper Module's J-box.

» Before installing the leftmost Top Flashing, roofing shingles must be installed up the entire left side of the array.

Figure 20. Position Top Flashing

Step 7. Top Flashings, continued

Step 7b. Align the Top Flashing.

- Uproof from vertical wireway.
- Use alignment features from Solar Shingle below.
- Do not pinch wires.
- Ensure that Top Flashing and J-box bracket below are fully engaged, using the engagement features.

Figure 21. Align Top Flashing

Step 7. Top Flashings, continued

Step 7c. Nail the Top Flashing in place.

» When the Top Flashing is aligned, secure it using 4 nails: two at the top corners, and two on either side, aligned with the Jumper Modules' nail targets.

» Make sure to only nail in the targets of the Top Flashing.

Figure 22. Nail Top Flashing

Step 8. Column Wires and Voltage Testing

Summary:

a. Connect module leads going up each column.

b. Connect a column return wire for each column.

c. Secure wires using Solar Shingle J-Box wire clip feature.

d. Confirm column Voc.

Step 8a. Connect the module leads going up each column.

» Each Solar Shingle plugs into the Solar Shingle above it. When the connectors are plugged together, you should hear and feel a positive mechanical "click." To confirm the connectors are fully seated, gently try to pull them apart.

Figure 23. Connect Solar Shingles

Step 8b. Connect the column return wires for each column.

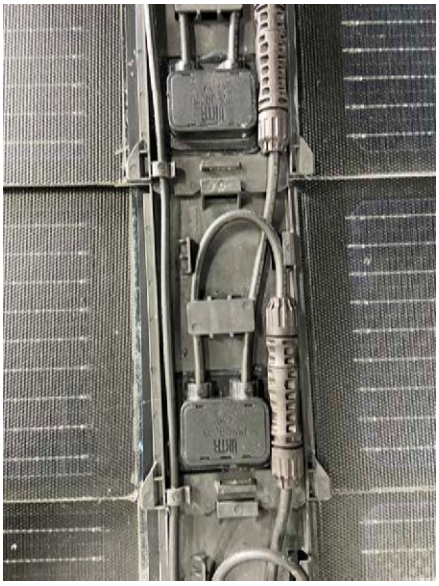
» Routed from bottom home run up to the Top Flashing.

» One male and one female connector are left open at the top.

Step 8. Column Wires and Voltage Testing, continued

Step 8c. Secure the wires using Solar Shingle J-box wire clip features.

» Connect and place the wires into the built-in clips as you go.



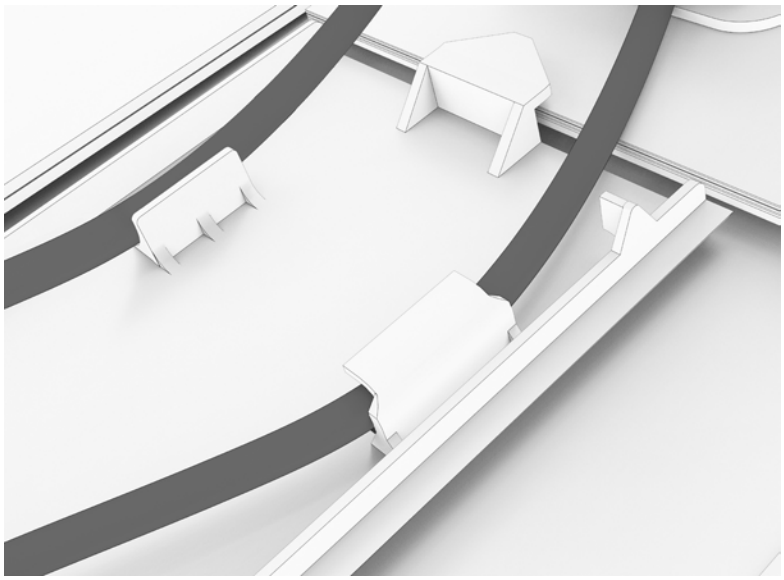


Figure 24. Use built-in wire clip features to secure wires

Step 8d. Confirm the column Voc.

» Confirm correct column voltage using this equation:

Column Voc = # Solar Shingles in column x Solar Shingle Voc

» For example, consider a 1-column array with 10 Solar Shingles, and an estimated Solar Shingle Voc of approximately 10 volts. This column would have an open circuit voltage equal to 10 Solar Shingles X 10 volts/Solar Shingle or about 100 volts.

NOTES:

- Refer to the section in this document titled "Array Wiring" for more information.

Step 9. Install Wire Covers

Summary:

a. Attach Wire Covers going up each column.

b. Attach the lids onto the Top Flashings at the top of each column.

Step 9a. Attach Wire Covers going up each column.

» Use the Wire Cover engagement feature to hook the Wire Covers together.

Figure 25. Use built-in wire clip features to secure wires

Step 9. Install Wire Covers, continued

Step 9b. Attach lids onto the Top Flashings at the top of each column.

- Place the Top Flashing lid onto the Top Flashing by engaging it with the Wire Cover from the row below.
- When properly engaged and placed, secure the Top Flashing lid to the Top Flashing, using screws provided and a Phillips head screwdriver. Do not use an impactor or electric screwdriver to prevent stripping the screw base.

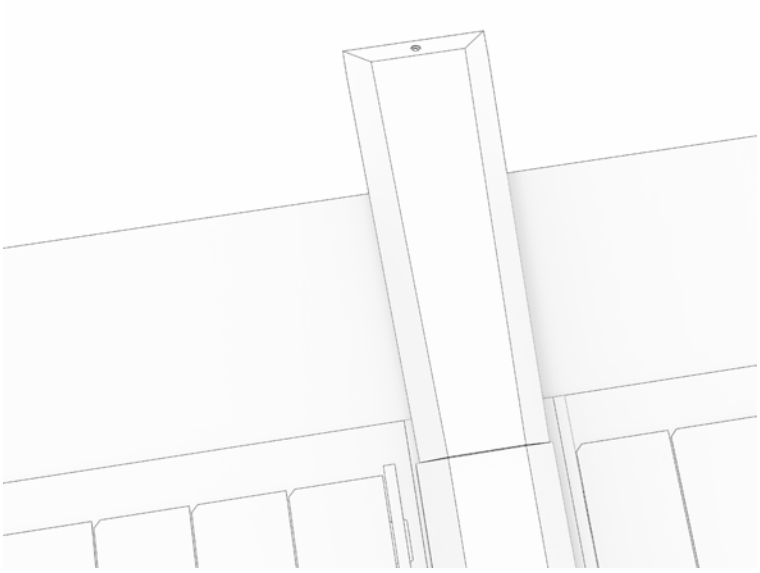


Figure 26. Attach Top Flashing lids

Step 10. Finish Installing Roof Shingles

Summary:

a. Install roofing shingles on the left side of array.

b. Install roofing shingles along array right edge.

c. Maintain required horizontal shingle offset and vertical exposure.

d. Cut shingles across the top of the array to fit around the Top Flashings and across the roof.

e. Apply approved sealant to the top side of the Top Flashing.

Step 10a. Install roofing shingles on the left side of array.

» Install roofing shingles on the left any time after the first column of Solar Shingles with Step Flaps has been installed.

» Trim roofing shingles flush to edge of the J-box bracket, covering the topmost Step Flap. The roofing shingle is placed on top of that course's Step Flap, and under the Step Flap above. Lift the Step Flap above to place the right most nail roughly 3 inches up above the nail line and under the Step Flap.

» Continue installing roofing shingles uproof on the left side of the array, stopping at the last Solar Shingle.

» Follow roofing best practices for roofing shingle offsets. Maintain a 10 inch (254 mm) offset, and follow the instructions in the GAF product manual for roofing shingles.

» Be sure to install left side roofing shingles before installing the leftmost Top Flashing.

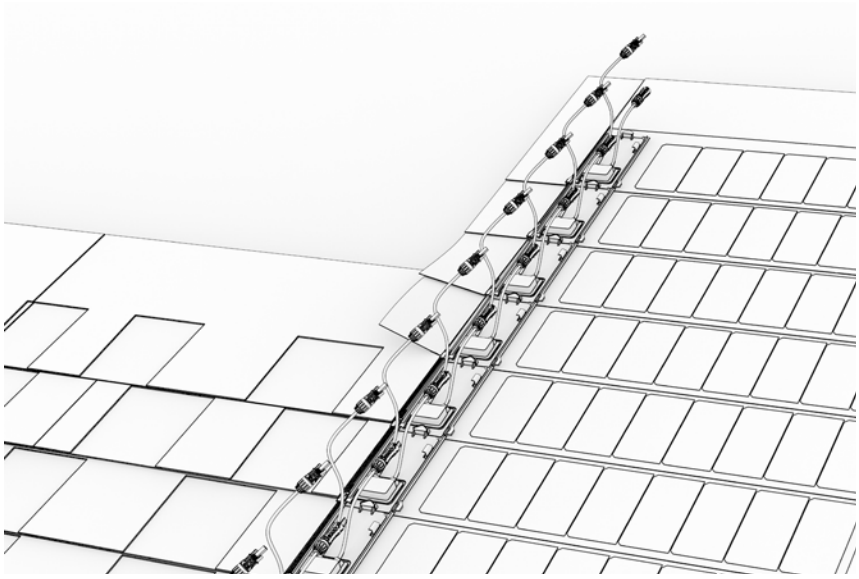


Figure 27. Shingles on array left side

Step 10. Finish Roof Shingles, continued

Step 10b. Install roofing shingles along array right edge.

- Install remainder of roofing shingles on the right side of the array, after all columns of Solar Shingles are installed, and maintaining a 10 inch (254 mm) shingle offset.
- No Step Flap is needed on the right side of the array.
- Roofing shingle is placed on top of the adjacent Solar Shingle's side flap, but under the side flap above.
- Install the adjacent roofing shingle over the lowest exposed Solar Shingle right side flap, while tucking under the right side flap immediately above.
- Continue this process up the entire last column.
- When nailing the roofing shingle, lift the Solar Shingle's side flap and nail the roofing shingle below.
- For arrays with an even number of columns, the array lands 10 inches (254 mm) short of the roofing shingle butt joint. This represents the shingle offset.
- For arrays with an odd number of columns, the array lands 10 inches (254 mm) past the roofing shingle butt joint.

Figure 28. Shingle offsets on right edge of array

Step 10. Finish Roof Shingles, continued

Step 10c. Maintain the required horizontal shingle offset and vertical exposure.

- 10 inch (254 mm) shingle offset
- 7 9/16 inch exposure (192.1 mm)
- Shingle booking will meet up with the right side roofing shingles, if solar array is started on an offset.

Step 10d. Cut the shingles to fit around the Top Flashings and across the top of the array.

- Leave a 1/2 inch (13 mm) water channel along the edge of the Top Flashing.
- Cut top ear of roofing shingle to prevent water from traveling across the top of the shingle. This is also referred to as dog earing a shingle.
- Be sure to maintain the same shingle offset at the top of the array.

Figure 29. Cutting shingles around Top Flashing

Step 10e. Apply approved sealant to the top side of the Top Flashing base.

- Use a continuous bead of sealant in an upside down U shape.
- Apply the sealant inside of the Top Flashing nail zone. Make sure all nails are located outside of the bead of sealant.

Step 10. Finish Roof Shingles, continued

Figure 30. Apply sealant to Top Flashing base

Step 10f. Install roofing shingles over the top of the array.

- Ensure that all Jumper Modules are installed and that Quickstart is installed where no Jumper Module is needed.
- Align the roofing shingle over the top of the Jumper Module using the Alignment Jig.
- Nail the roofing shingle in place.
- Repeat this process across the top of the array.

Step 11. Connect Array Wiring

Summary:

a. Identify column(s) where Transition Box or Pass Through Device is to be installed.
b. Remove Top Flashing lid.
c. Connect column home runs to Jumper Modules and verify string voltage.
d. Install Pass Through Device or Transition Box, as required.
e. Connect string home runs to Smart RSS device and Pass Through Device (if used).
f. Bond the Smart RSS with the equipment grounding conductor.
g. Install Wire Cover and Transition Box lids.

Step 11a. Identify the columns where Transition Box or Pass Through Device is to be installed.

» Refer to the plan set if more than one location is required. If there is only one location, it is more likely on the side of the array that is closest to the inverter and main panel.

» Use a Pass Through Device for an attic, and Transition Box for a rooftop.

Step 11b. Remove the Top Flashing lid.

» Every column has a Top Flashing. Remove the lid of the Top Flashing at the top of the column where the Transition Box or Pass Through Device will be located.

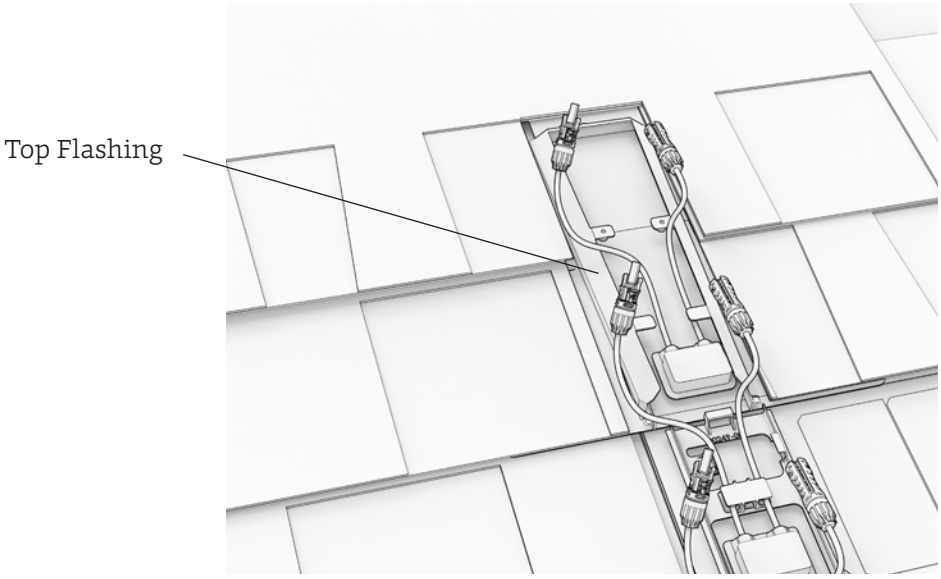
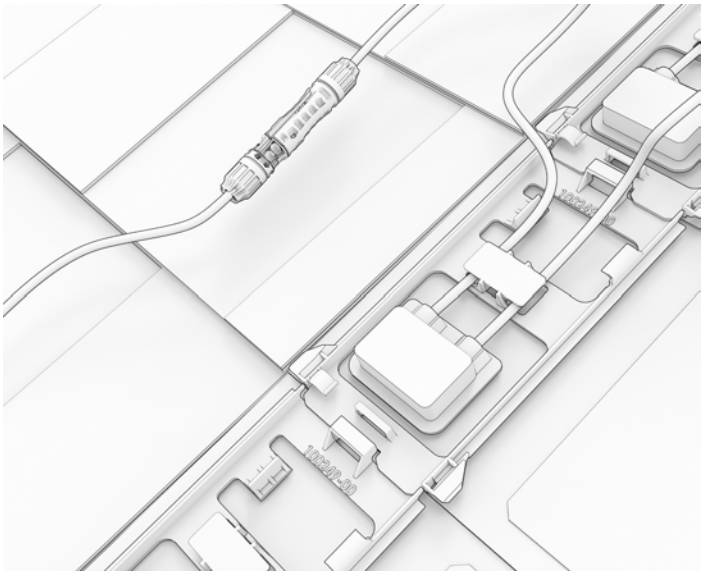


Figure 31. Remove Top Flashing lid

Step 11. Connect Array Wiring, continued

Step 11c. Connect the column home runs to the Jumper Modules and verify the string voltage.



Verify string voltage before connecting array to rapid shutdown device (RSD)

Figure 32. Connect column home runs to Jumper Modules

Step 11d. Install the Pass Through Device or Transition Box, as required.

- Use either a Transition Box or a Pass Through Device, but not both. Refer to the plan set.
- When using a Pass Through Device, be careful not to drill into any structural members.

If using a Transition Box:

- Fasten the Splice Box to the Transition Box base with provided screws on the side that the rooftop conduit will enter (left or right side). Install the Splice Box so the side of PV wire faces toward the inside of the Transition Box.
- Drill a 1-3/4 inch hole in the side of the Transition Box that conduit will enter. Use the dimple on the Transition Box wall as a guide.
- Install the conduit gasket in the new hole.
- Install a certified 3/4 inch conduit connector on the side of the splice box facing the gasket.
- Route conduit to Splice Box inside of Transition Box, pull wire from inverter to Splice Box and splice home run wires using Buchanan copper crimp connector and cap or equivalent.

Step 11. Connect Array Wiring, continued

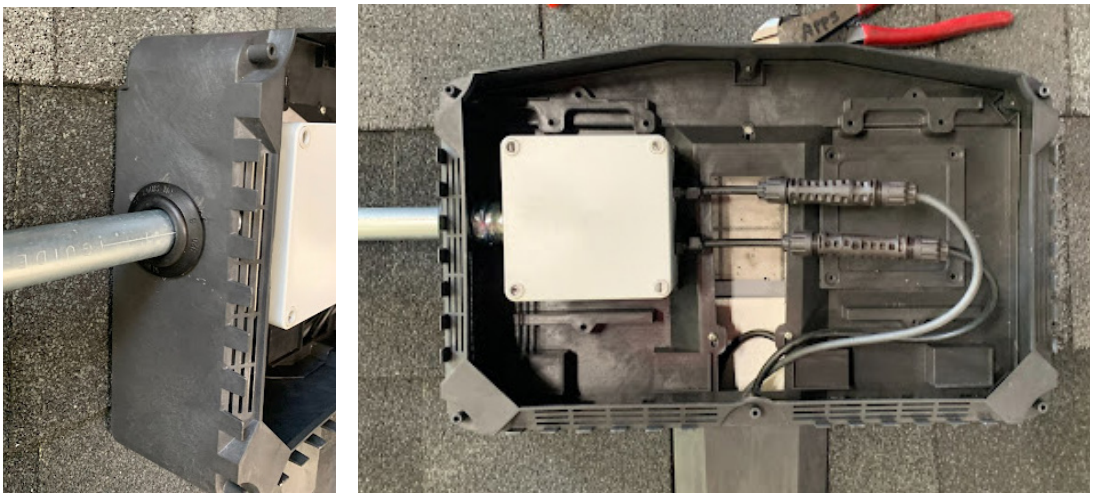
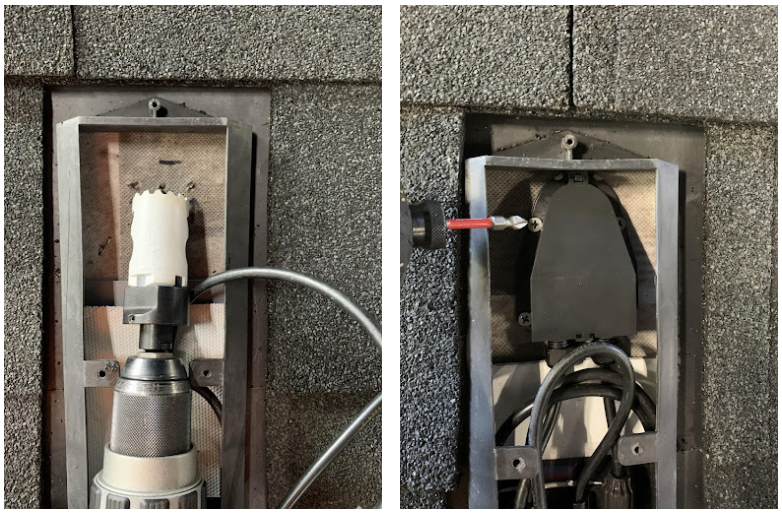


Figure 33. Transition Box and Splice Box with Conduit

If using a Pass Through Device:

- When routing conduit through the attic, the Pass Through Device is installed inside the Top Flashing. Wiring from the Pass Through Device is then connected to an enclosure inside the attic. Conduit routes array wiring to the inverter from the attic enclosure.
- Drill a 1-3/8 inch hole inside the Top Flashing, centered, and 1/2 inch down from the top wall of the Top Flashing.
- Do NOT drill through any structural members, such as rafters.
- Pass the conduit end of the Pass Through Device into the attic.
- Fasten the Pass Through Device to the roof deck using the screws provided.

Pass conduit end of Pass Through Device into attic



Fasten Pass Through Device to roof deck

Figure 34. Installing Pass Through Device

Step 11. Connect Array Wiring, continued

- Make wiring connections on the roof and reinstall the Top Flashing lid.
- From inside the attic, mount the attic enclosure close enough to connect to the Pass Through Device's flexible metallic conduit. The length of the conduit is 30 inches (762 mm).
- Connect the FMC to the attic enclosure to transition from PV to indoor wiring.
- Route conduit to attic enclosure, pull wire from inverter and splice home runs using Buchanan copper crimp connector and cap or NEC-approved equivalent.
- Ensure that the metallic conduit end of the Pass Through Device is grounded and bonded to the metallic attic enclosure using the lockring on the interior end.
- Ensure that the metallic attic enclosure is properly grounded and bonded by installing a lay-in ground lug inside and landing an equipment grounding conductor on it.

Figure 35. Conduit to Attic Enclosure

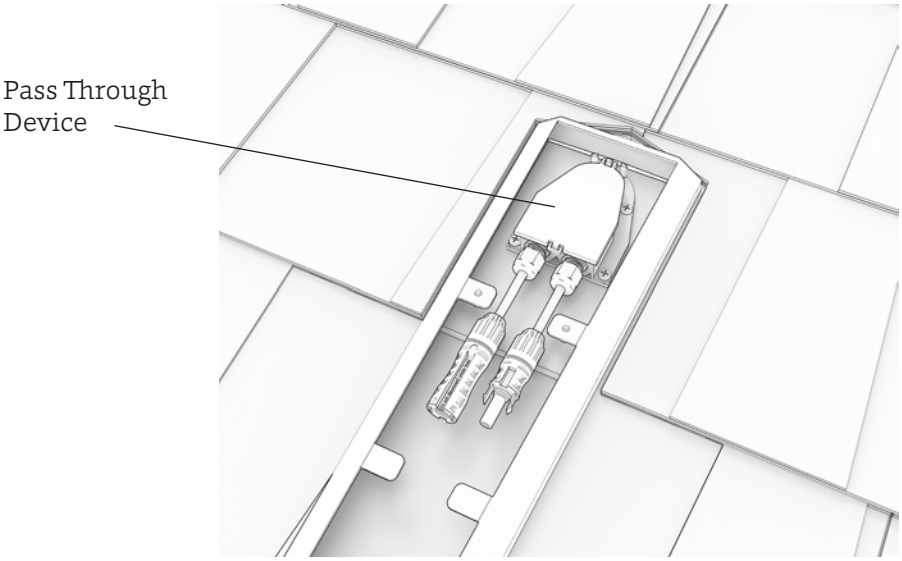


Figure 36. Pass Through Device sits over Top Flashing base

Step 11e. Connect the string home runs to the shutdown device and Pass Through Device (if used).

Step 11f. Bond the Smart RSS with the equipment grounding conductor.

- » Fasten the lay-in ground lug on the Smart RSS grounding port with the M4 bolt.
- » Land the equipment grounding conductor on the lay-in ground lug.

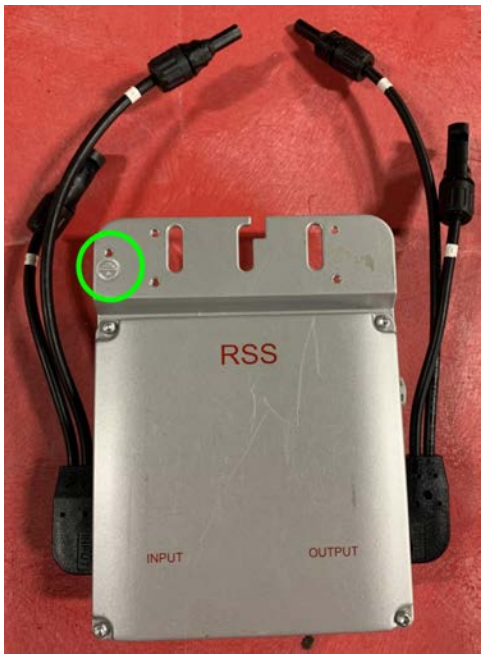


Figure 37. Smart RSS device showing M4 bolt

Step 11g. Install the Wire Cover and/or Transition Box lid.

» Place the Transition Box lid on the Transition Box.

» Secure the Transition Box lid using screws provided and a Phillips head screwdriver. Do not use an impactor or electric screwdriver to prevent stripping the screw base.

NOTES:

- Refer to the section in this document titled "Array Wiring" for more information.

Step 12. Final Check

Final system commissioning and tie-in must be performed by a qualified person. Prior to handoff, perform a final array inspection to ensure that:

» All column voltages and the array voltage are correct.

» Solar Shingles are properly aligned and in good condition.

» All Wire Covers and Top Flashing lids are properly installed.

» Ensure that all front-edge adhesive release liners have been removed from the Solar Shingles.

» Remove all protective film on the front of the solar laminate on the Solar Shingles.

Array Wiring

The wiring diagrams below provide guidance on connecting column wires, Jumper Modules, and home run jumpers through the Transition Box or Pass Through Device.

- Wire management is vertical going up the array, across Jumper Modules, through the Transition Box or Pass Through Device, and then off the roof.
- Wires are managed in series, with Jumper Modules between all columns except for the rightmost column. For the leftmost column, the home run jumpers terminate either inside the Transition Box, at the rapid shutdown device (RSD), or the Pass Through Device and off the roof to an RSD.
- Wiring from the Transition Box to the inverter is performed by a qualified person.
- Visually confirm all metallic components are grounded and bonded in accordance with the NEC.
  - » Smart RSS has a lay-in ground lug bonded to the EGC.
  - » Conduit end of Pass Through Device is bonded to metallic attic enclosure with lockring.
  - » Metallic attic enclosure is bonded with lay-in ground lug or other NEC-approved method.
  - » All metallic conduit is bonded in accordance with NEC requirements.

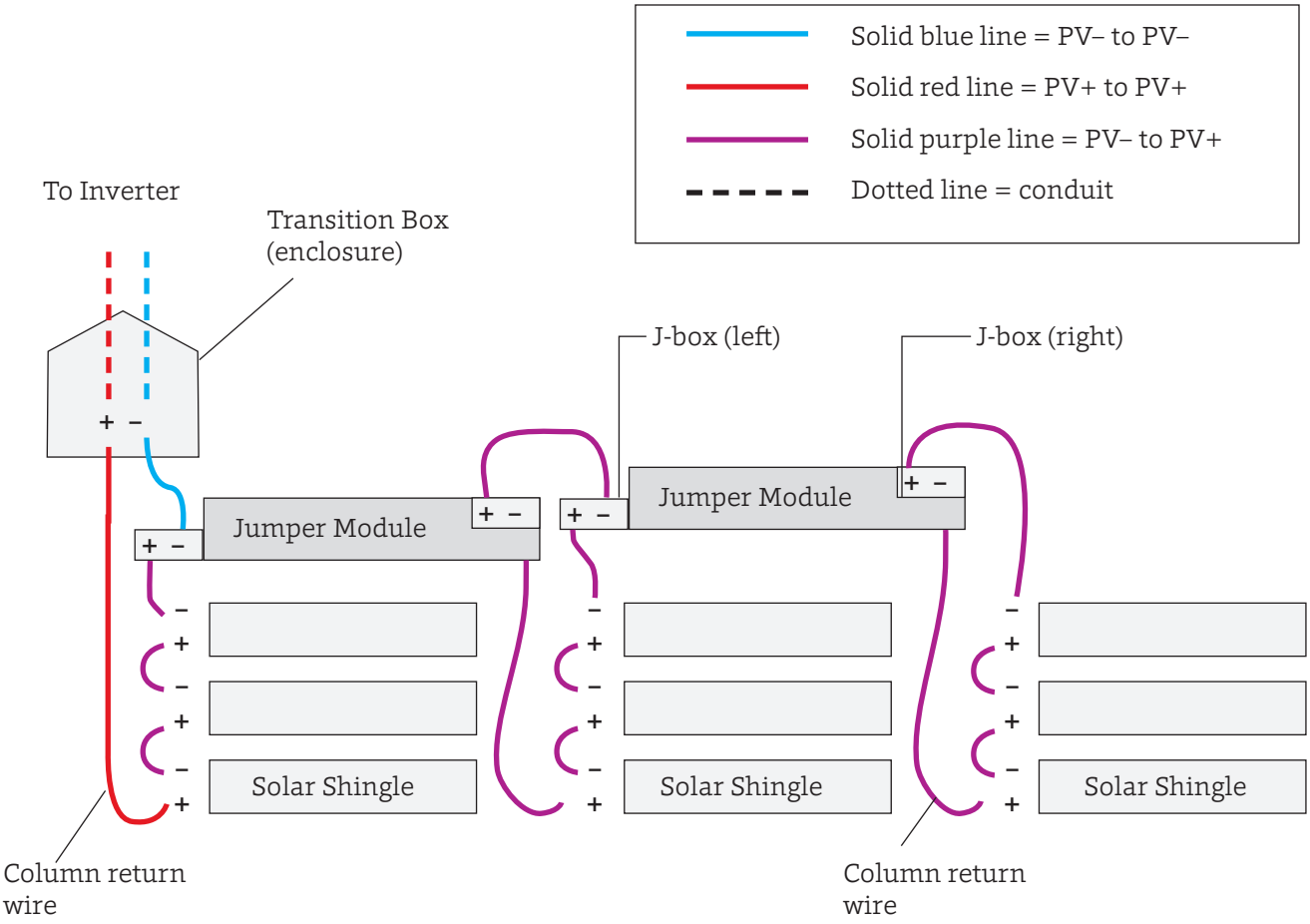
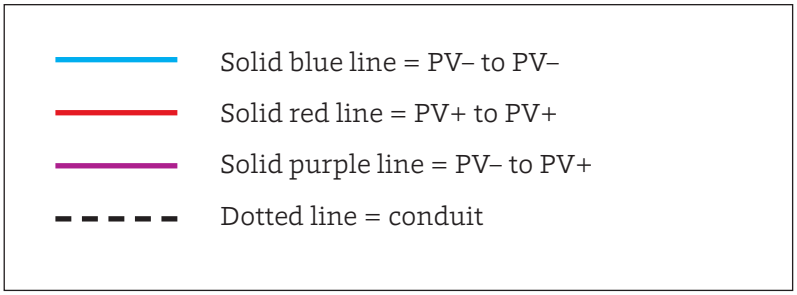


Figure 38. Array wiring

Array Wiring, continued



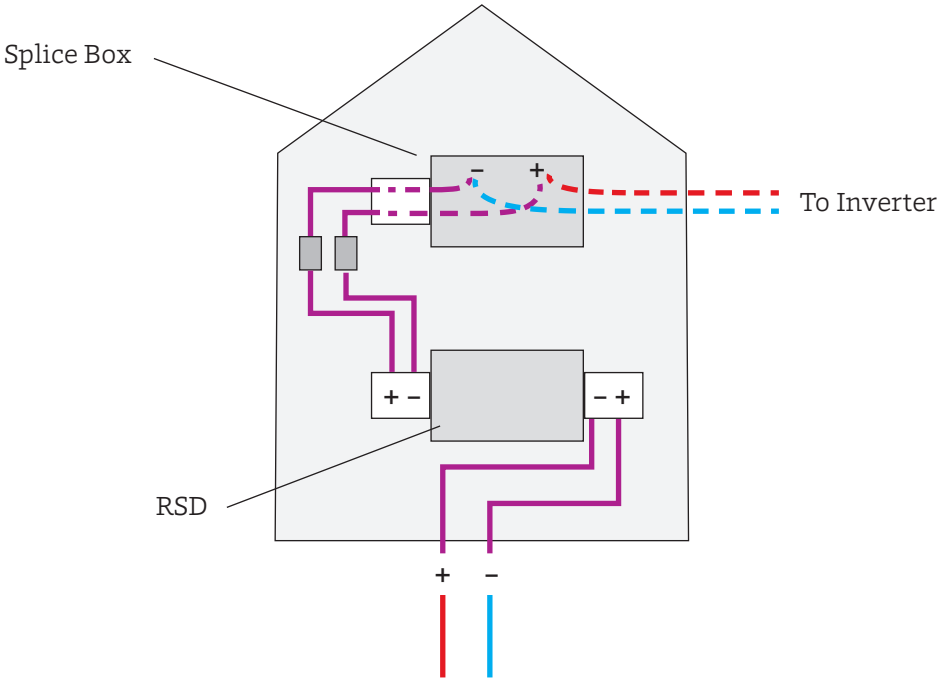


Figure 39. Array wiring inside the Transition Box

Array Wiring, continued

The figure below shows an example that uses Mid-Circuit Interruptors (MCIs) being used as PV Rapid Shutdown Equipment (PVRSE) in a 3-column array. MCIs are installed at the top of columns where a voltage break is required.

This example shows a 3-column array with 12 Solar Shingles in each column. In this example:

- A Transition Box is used at the top of each column. The middle and last Transition Boxes contain MCIs that allow array shutdown as part of a rapid shutdown system. The first Transition Box leads to the inverter, and contains a Splice Box for connecting the array wiring to the inverter wiring.
- Jumper Modules are at the top of the first and middle columns, but not the last column.
- The columns with MCIs are disconnected between the 6th and 7th Solar Shingle. Solar Shingles 1 and 6 are plugged into input side of the MCI.

To Inverter

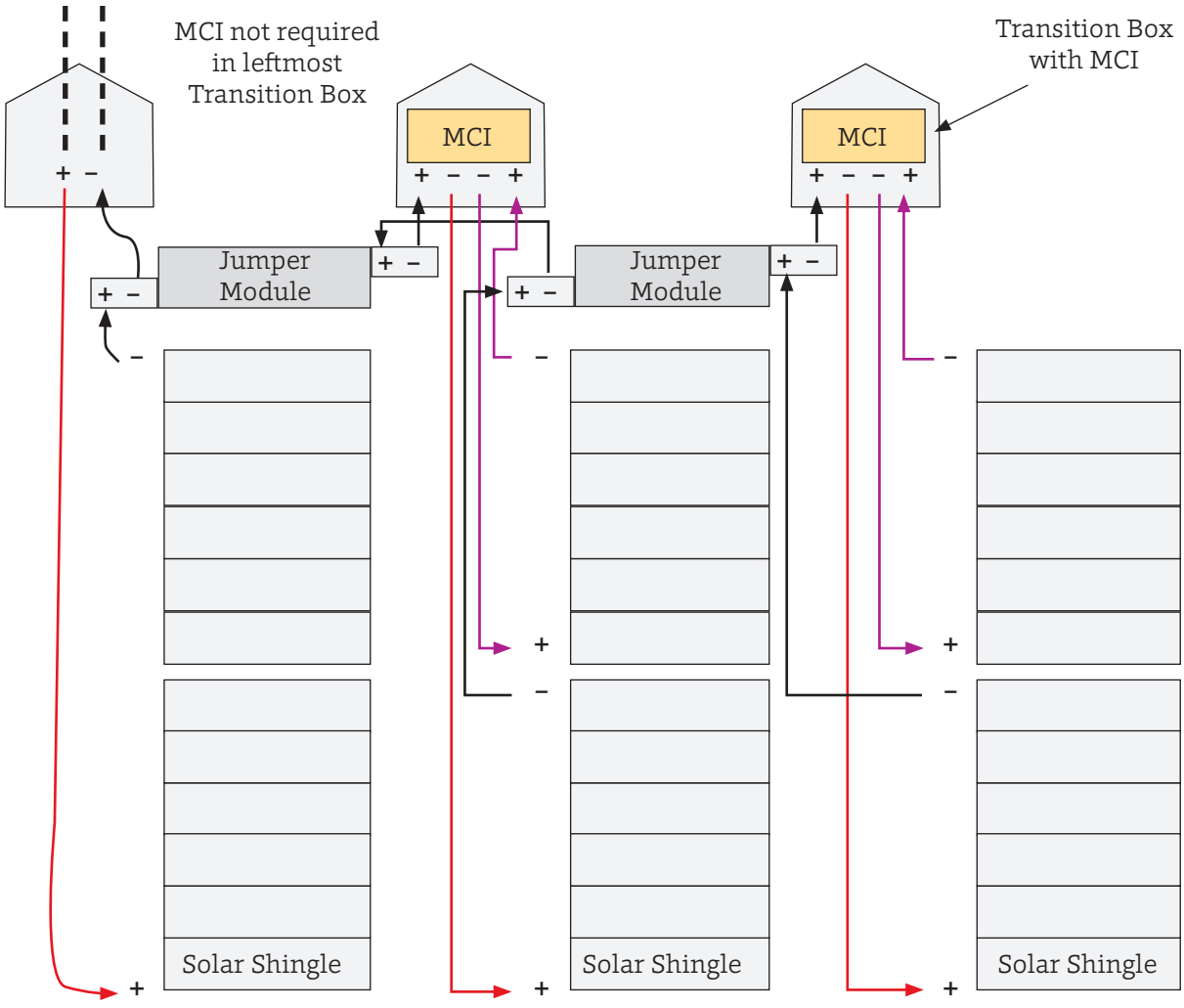


Figure 40. MCI wiring

Array Wiring, continued

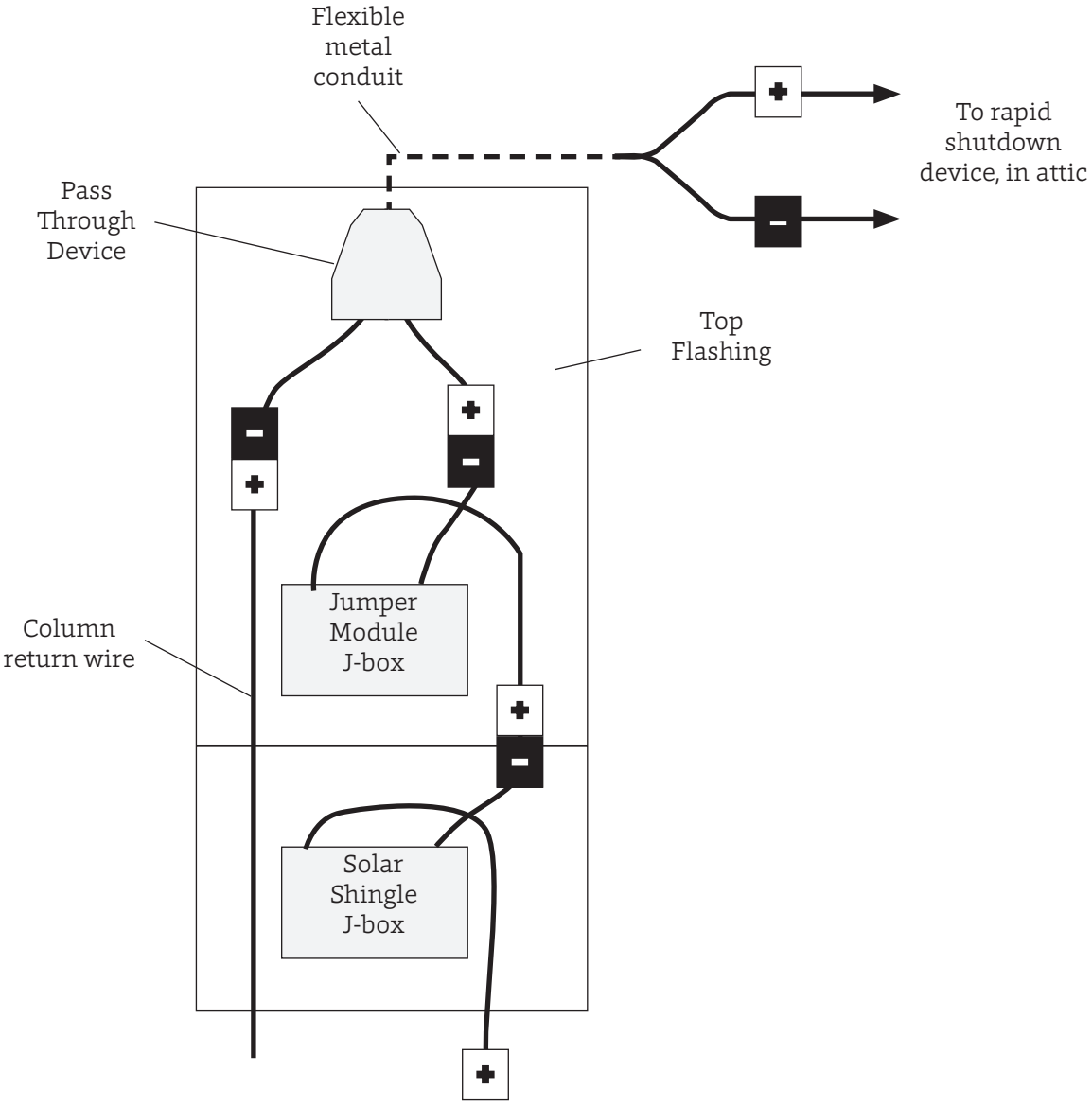


Figure 41. Array wiring for Pass Through Device

NOTE:

- Initiation of the PV Hazard Control System (PVHCS) is triggered by any interruption of connection to the grid. Any method of disconnecting means allowed by the NEC may be used to initiate the shutdown, including but not limited to disconnects, breakers, OCPD, etc. The disconnecting means used to initiate the PVHCS shall be installed in an accessible location on the exterior of the building and shall be clearly marked in accordance with the NEC.

System Maintenance

- **WARNING:** The Timberline Solar system has no user-serviceable parts and requires no routine maintenance. However, the system should be periodically re-inspected for any signs of damage. This is important especially after storms and in areas prone to hail and high winds. Any damaged parts should be replaced immediately with parts provided by GAF Energy, by qualified persons approved by GAF Energy.
- Do NOT attempt to dismantle the equipment or make any internal repairs. Any attempt to open the equipment could compromise the integrity of the system.
- Do not attempt to clean soiled Solar Shingles with a high-pressure washer, as this may damage the system. The Solar Shingle is naturally cleaned by seasonal rains. In the event that a more intensive cleaning is required, contact your installer for assistance.
- Direct all inquiries to GAF Energy Technical Support at 1-877-GAF-ROOF.
- For more information on GAF Energy solar products and services for solar applications, visit **www.gaf.energy**.

Document Version Control

Document Revision Number	Date	Notes
0.1	September 2020	First manual version
0.2	December 2020	Revised Jumper Module
1.0	April 2021	Pre-certification release version of the product
1.1	June 2021	Image adjustments, new SKUs
1.2	August 2021	Updated part numbers; additional Step Flap instructions, finalized part numbers
1.3	September 2021	Added new front and back covers, minor updates
1.4	October 2021	Minor updates for release
1.5	January 2022	Added TLS-1 and RSS grounding/bonding
1.6	February 2022	Updated product certifications
1.7	March 2022	Additional part numbers certified
1.8	April 2022	Included references to Pro Field Guide
1.9	May 2022	Additional part numbers certified
2.0	July 2022	Additional part numbers and module power rating
2.1	September 2022	Added RSD/PVRSA/PVHCS info
2.2	January 2023	Minor edits
2.3	June 2023	Minor edits
2.4	September 2023	Minor edits
2.5	January 2024	Add TLS-1.3 and compliance to 2023 NEC 690.12

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