MONTGOMERY COUNTY HISTORIC PRESERVATION COMMISSION
STAFF REPORT

Address:	7124 Carroll Ave., Takoma Park	**Meeting Date:**	2/7/2024
Resource:	Outstanding Resource **Takoma Park Historic District**	**Report Date:**	1/31/2024
Applicant:	Walter Huaman (Agent)	**Public Notice:**	1/24/2024
Review:	HAWP	**Tax Credit:**	Partial
Case Number:	1053476	**Staff:**	Dan Bruechert
Proposal:	Solar Panel Installation and Roof Replacement		

RECOMMENDATION

Staff recommends the applicant make any revisions recommended by the HPC and return for a HAWP.

PROPERTY DESCRIPTION

SIGNIFICANCE: Outstanding Resource to the Takoma Park Historic District
STYLE: Craftsman
DATE: c.1925

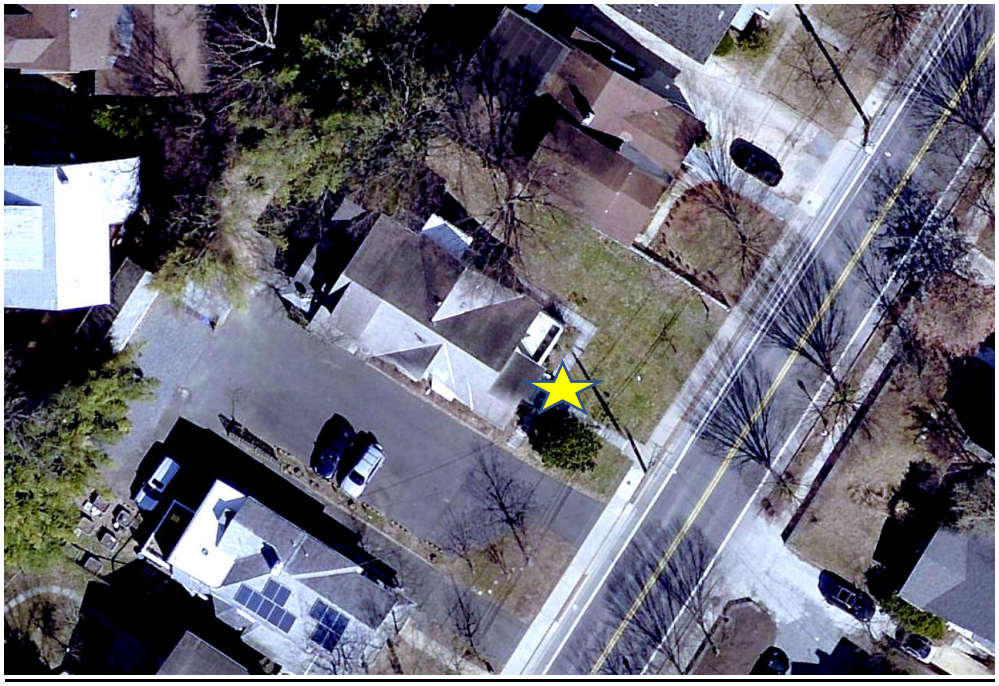


Figure 1: The subject property fronts Carroll Ave. and has a wide setback to the properties to the north and south.

PROPOSAL

The applicant proposes to replace the existing roof and replace with a GAF Timberline Solar roof and architectural shingles.

APPLICABLE GUIDELINES

The Historic Preservation Office and Historic Preservation Commission (HPC) consult several documents when reviewing alterations and new construction within the Takoma Park Historic District. These documents include the historic preservation review guidelines in the approved and adopted amendment for the *Takoma Park Historic District (Guidelines), Montgomery County Code Chapter 24A (Chapter 24A)*, and the *Secretary of the Interior's Standards for Rehabilitation (Standards)*, and the HPC's *Policy No. 20-01 ADDRESSING EMERGENCY CLIMATE MOBILIZATION THROUGH THE INSTALLATION OF ROOF-MOUNTED SOLAR PANELS*. The pertinent information in these four documents is outlined below.

Takoma Park Historic District Guidelines

There are two broad planning and design concepts which apply to all categories. These are:

- The design review emphasis will be restricted to changes that are all visible from the public right-of-way, irrespective of landscaping or vegetation (it is expected that the majority of new additions will be reviewed for their impact on the overall district), and

- The importance of assuring that additions and other changes to existing structures act to reinforce and continue existing streetscape, landscape, and building patterns rather than to impair the character of the historic district.

Outstanding Resources have the highest level of architectural and/or historical significance. While they will receive the most detailed level of design review, it is permissible to make sympathetic alterations, changes and additions. The guiding principles to be utilized by the Historic Preservation Commission are the *Secretary of the Interior's Standards for Rehabilitation*

Specifically, some of the factors to be considered in reviewing HAWPs on Outstanding Resources:

> Plans for all alterations should be compatible with the resource's original design; additions, specifically, should be sympathetic to existing architectural character, including massing, height, setback, and materials;
>
> Emphasize placement of major additions to the rear of existing structures so that they are less visible from the public right-of-way;
>
> While additions should be compatible, they are not required to be replicative of earlier architectural styles;
>
> Preservation of original and distinctive architectural features, such as porches, dormers, decorative details, shutters, etc. is encouraged;
>
> Preservation of original windows and doors, particularly those with specific architectural

importance, and of original size and shape of openings is encouraged;

Preservation of original building materials and use of appropriate, compatible new materials is encourages;

All changes and additions should respect existing environmental settings, landscaping, and patterns of open space.

Montgomery County Code, Chapter 24A-8

The following guidance which pertains to this project are as follows:

(b) The commission shall instruct the director to issue a permit, or issue a permit subject to such conditions as are found to be necessary to ensure conformity with the purposes and requirements of this chapter, if it finds that:

(1) The proposal will not substantially alter the exterior features of an historic site or historic resource within an historic district; or

(2) The proposal is compatible in character and nature with the historical, archeological, architectural or cultural features of the historic site or the historic district in which an historic resource is located and would not be detrimental thereto or to the achievement of the purposes of this chapter;

(d) In the case of an application for work on an historic resource located within an historic district, the commission shall be lenient in its judgment of plans for structures of little historical or design significance or for plans involving new construction, unless such plans would seriously impair the historic or architectural value of surrounding historic resources or would impair the character of the historic district. (Ord. No. 9-4, § 1; Ord. No. 11-59.)

Secretary of the Interior's Standards for Rehabilitation

The Secretary of the Interior defines rehabilitation as "the act or process of making possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features, which convey its historical, cultural, or architectural values." The applicable *Standards* are as follows:

2. The historic character of a property will be retained and preserved. The removal of distinctive materials or alteration of features, spaces and spatial relationships that characterize a property will be avoided.

9. New additions, exterior alterations, or related new construction shall not destroy historic materials that characterize the property. The new work shall be differentiated from the old and shall be compatible with the massing, size, scale, and architectural features to protect the historic integrity of the property and its environment.

10. New additions and adjacent or related new construction shall be undertaken in such a manner that if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

Historic Preservation Commission Policy No. 20-01: Addressing Emergency Climate Mobilization Through the Installation of Roof-Mounted Solar Panels

Now, THEREFORE:

WHEREAS, Historic Area Work Permit decisions are guided by the criteria in Section 24A, The Secretary of the Interior's Standards for Rehabilitation, and pertinent guidance from applicable master plan amendments and/or site or district-specific studies;

WHEREAS, The Secretary of the Interior's Standards for Rehabilitation as interpreted by the National Park Service limit the placement of rooftop solar panels under Standards 2, 9, and 10 to less conspicuous locations;

WHEREAS, the County Council has established a Climate Emergency;

WHEREAS, the Historic Preservation is a body established by the County Executive and County Council;

WHEREAS, Section 24-8(b)(6) states, "In balancing the interest of the public in preserving the historic site or historic resource located within an historic district, with the interests of the public from the use and benefit of the alternative proposal, the general public welfare is better served by granting the permit;"

WHEREAS, the widespread use of solar panels, both for hot water and for electricity production, will reduce greenhouse gases in the county, in accordance with the aims of the Emergency Climate Mobilization resolution (Resolution No.: 18-974), it shall be the policy of the Historic Preservation Commission that:

1. The preferred locations for solar panel installation(s) on a designated historic site or an historic resource located within an historic district is a) on the rear of the property, b) on non-historic building additions, c) on accessory structures, or d) in ground-mounted arrays;

2. If it is not feasible to install solar panels in one of the identified preferred locations due to resource orientation or other site limitations; and,

3. The roof is determined to be neither architecturally significant, nor a character-defining feature of the resource, nor is it a slate or tile roof, that unless it can be demonstrated that the solar array will be installed without damaging the historic character of the resource or historic fabric; then

4. The public welfare is better served by approving a Historic Area Work Permit for solar panels on all visible side or front roof slopes under Section 24A-8(b)(6).

A Historic Area Work Permit (HAWP) is required for all work referenced in this policy.

STAFF DISCUSSION

The subject property is a one-and-a-half-story tall stucco-sided Craftsman house with a three-tab shingle roof with a cross-gable roof form. The applicant proposes to remove the existing roof and replace it with an architectural shingle roof with three areas of GAF Timberline Solar shingles. Two of the three areas of the solar shingles will be visible from the public right-of-way, installed on the left roof slope near the front of the house. This is the first instance where the HPC has considered this solar shingle for work on a historic house.

The property at 7120 Carroll Ave. (a Contributing Resource to the Takoma Park Historic District) installed seven solar panels on its left roof slope. This HAWP, which was approved in 2014,[1] before the adoption of the HPC's solar policy, was approved because the panels had limited visibility due to their installation on a two-story tall building with a narrow side setback between 7120 and 7118 Carroll Ave.

Figure 2: The subject property (shown with a star) and adjacent Outstanding resources identified by a +.

Existing Roof Removal and Replacement

The existing three-tab shingle roof is not the original building materials and does not contribute to the historic character of the building. Staff finds the HPC should allow its removal as a matter of course. The HPC has consistently determined the proposed architectural shingles are an appropriate replacement for three-tab and Staff recommends the proposed roof replacement is compatible and would recommend the HPC approve the work for a HAWP. Were this proposal only for a roof replacement, it would fall under one of the categories of work that could be approved at the Staff-level.

Solar Panels

In considering any solar installation at the subject property, Staff is guided by the adopted HPC solar policy. Because of the proposed location for the solar shingles, two of the three solar arrays will be highly visible from the public right-of-way. In utilizing the guidance in the HPC policy, Staff first considers the identified preferred locations for solar panels. Staff finds the lot is too small to accommodate a ground-mounted array. The roof of the small accessory structure at the rear of the

[1] The March 26, 2014 HAWP and Staff Report for 7120 Carroll Ave. has not been connected to the County GIS system so Staff is unable to provide a link to the documents, but Staff can provide a copy if requested.

property is too covered by the tree canopy to be a viable location for solar collection. Staff further finds that the small rear addition is too small to accommodate the solar shingles and is on the north side of the house, making it an incompatible location for a solar array.

The second consideration is whether it is feasible to place the solar panels on a location that is not highly visible from the public right-of-way. The southeast facing orientation of the house means that the left roof slopes are likely the ones that will generate the most electricity; however, in a HAWP evaluation, the burden of persuasion is on the applicant. In past cases, applicants have been required to provide a roof heat map to demonstrate that front-facing or highly visible solar panels are necessary for the system to meet minimum efficiency. Staff recommends the HPC require a roof heat map to be submitted as part of the final HAWP application.

Third, Staff considers the architectural significance of the roof. Staff finds the complex roof form is one of the house's character defining features, but does not find that the installation of the solar shingles will damage any historic fabric. In fact, the material (discussed below) is likely the most reversible solar collection system the HPC has evaluated.

If the applicant can satisfy the second consideration outlined in the solar policy, Staff would support public-facing solar panels in the locations proposed.

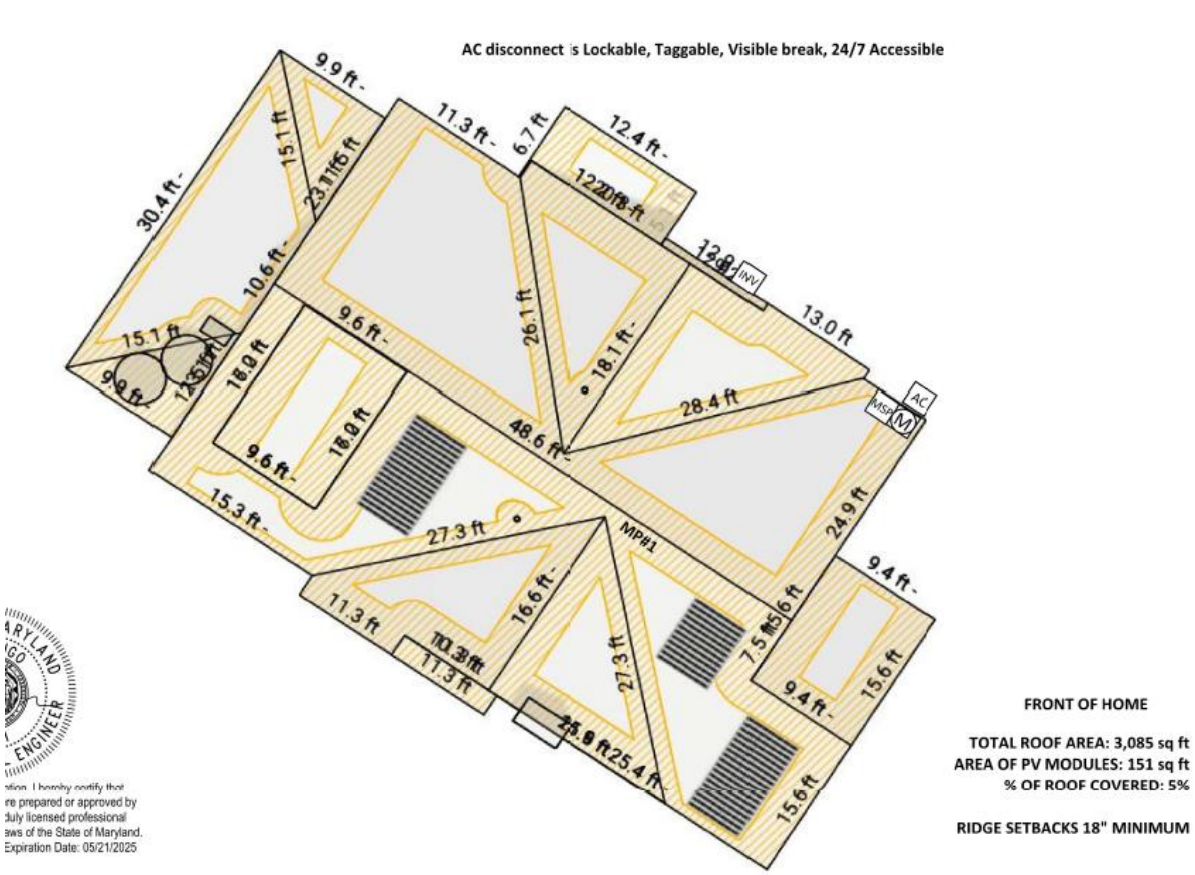


Figure 3: Proposed roof plan showing the locations of the proposed solar shingles.

Solar Shingle Roof

The next issue after location is the type, size, design, and configuration of the proposed panel. This is a separate, though related, consideration once the locations have been deemed acceptable by the HPC. The applicant proposes to install three sections of Timberline solar shingles (see the roof plan, above). The shingles are 65" (sixty-five inches wide) by 17 1/8" (seventeen and one-eighths inch high); with an exposure of 7 9/16" (seven and nine-sixteenth inches). The wiring harness for each shingle is located on the left side of the shingle unit. The applicant will bring a material sample to the hearing for the HPC to examine during the hearing. The HPC can also see the proposed shingles installed at the house at 1717 Noyes Ln., Silver Spring (Figure 4, below).

Figure 4: 1717 Noyes Ln., Silver Spring in the Woodside Locational Atlas District.

Unlike the other solar shingle products the HPC has evaluated, the Timberline shingles are installed the in the same manner as any other shingle roof: by nailing the shingle directly into the roof sheathing. The shingles are then wired to one another and covered with a piece that runs perpendicular to the roof eave (see the image in *Figure 6*, below).

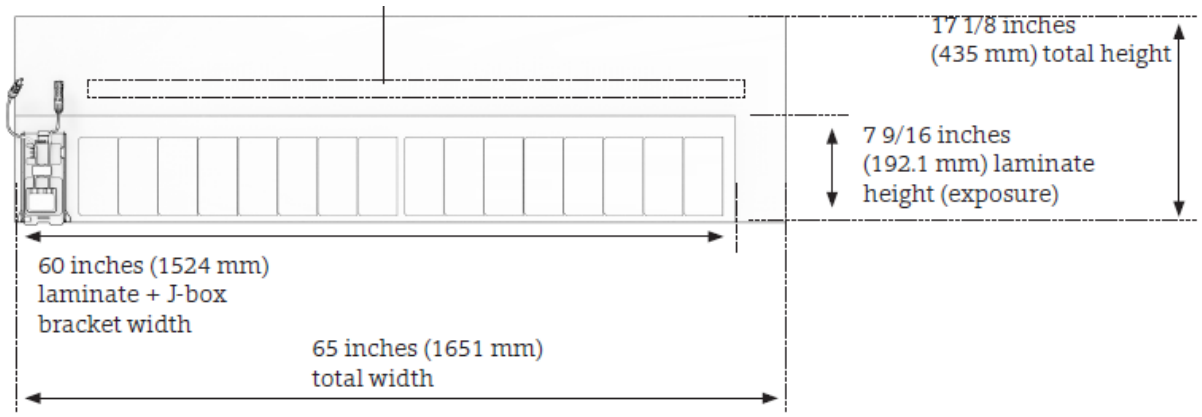


Figure 5: Detail of one solar shingle.

Figure 6: An installed Timberline solar shingle roof. Note: the vertical members cover the wiring to connect each shingle.

Staff finds the proposed Timberline shingles have several benefits compared to a typical photovoltaic solar panel or the Tesla shingles. First, the shingles are installed directly to the roof sheathing, so they have a very low profile that projects just above the architectural shingle surface. This is in contrast to solar panels that can project 4”-6” (four to six inches) above the roof surface. Second, the installation of the solar shingles can be completed with typical roofing materials. The shingles are installed by nailing the shingle into the sheathing like a typical shingle. This allows for quicker installation and piecemeal replacement if necessary. Third, Staff finds that the arrangement of the shingles creates a more uniform

appearance that will avoid the 'missing tooth' appearance that can occur when solar panels try to avoid roof vents.

Staff still has some reservations about the aesthetics of the proposed system. It may simply be that the proposed system has not been as widely adopted as typical solar panels, so it seems unusual. Or it may be that the textured roof and smooth shinier panels are installed in the same plane creates more visual dissonance, whereas the Tesla shingles create a uniform appearance over the entirety of the roof. Additionally, the width of the installation – which would dictate how many vertical wire covers are necessary – may significantly impact one's visual perception of the shingles. Based on the dimensions shown on the roof plan in *Figure 2*, it appears that the three areas where the shingles are proposed are only one shingle wide. This means that there would only be one vertical wire cover instead of the six perpendicular wire covers shown in *Figure 6*. The applicant should submit additional materials, potentially including renderings, to assist the HPC in determining the visual impact of this product.

Whatever reservations staff may have about the proposed material, it appears to satisfy all of the requirements in the adopted solar policy, can be easily reversed without damaging historic fabric (per Standard 10, and will preserve the historic roof form (per the *Design Guidelines*).

Requested feedback:

- Does the HPC concur with Staff's finding that the proposed solar locations are appropriate under the adopted solar policy?
    - Or is there some other consideration that should factor into the analysis for a HAWP application?
- Does the HPC concur with Staff's finding that the material is appropriate under the solar policy?
    - The Standards?
    - Chapter 24A?

Additional Requested Materials
Staff requested the applicant to provide a roof heat map to justify locating the solar panels in a location that is visible from the right of way, and other materials including a rendering or orthogonal drawing to show the actual application of the shingle on the roof plane as it will be seen from the right of way. Are there any other materials the HPC would like to have submitted with a final HAWP for the current proposal?

STAFF RECOMMENDATION

Staff requests the applicant make any revisions based on the feedback from the HPC and return for a HAWP.

FOR STAFF ONLY:
HAWP# 1053476
DATE ASSIGNED_____

APPLICATION FOR HISTORIC AREA WORK PERMIT

HISTORIC PRESERVATION COMMISSION
301.563.3400

APPLICANT:

Name: GAF Energy LLC E-mail: MDPermits@GAF.com

Address: 5981 Optical Court City: San Jose Zip: 95138

Daytime Phone: 240-409-9526 Tax Account No.: 01089894

AGENT/CONTACT (if applicable):

Name: Walter J Huaman E-mail: MDPermits@GAF.com

Address: 5981 Optical Court City: San Jose Zip: 95138

Daytime Phone: 240-306-7925 Contractor Registration No.: 144702

LOCATION OF BUILDING/PREMISE: MIHP # of Historic Property_____

Is the Property Located within an Historic District? X Yes/District Name Takoma Park
__No/Individual Site Name_____

Is there an Historic Preservation/Land Trust/Environmental Easement on the Property? If YES, include a map of the easement, and documentation from the Easement Holder supporting this application.

Are other Planning and/or Hearing Examiner Approvals /Reviews Required as part of this Application? (Conditional Use, Variance, Record Plat, etc.?) If YES, include information on these reviews as supplemental information.

Building Number: 7124 Street: Carroll Avenue

Town/City: Takoma Park Nearest Cross Street: Philadelphia Avenue

Lot: 5 Block: 2 Subdivision: 0025 Parcel: ____

TYPE OF WORK PROPOSED: See the checklist on Page 4 to verify that all supporting items for proposed work are submitted with this application. Incomplete Applications will not be accepted for review. Check all that apply:

- ☐ New Construction
- ☐ Addition
- ☐ Demolition
- ☐ Grading/Excavation
- ☐ Deck/Porch
- ☐ Fence
- ☐ Hardscape/Landscape
- ☑ Roof
- ☐ Shed/Garage/Accessory Structure
- ☑ Solar
- ☐ Tree removal/planting
- ☐ Window/Door
- ☐ Other:_____

I hereby certify that I have the authority to make the foregoing application, that the application is correct and accurate and that the construction will comply with plans reviewed and approved by all necessary agencies and hereby acknowledge and accept this to be a condition for the issuance of this permit.

Walter J. Huaman
Signature of owner or authorized agent

12/14/2023
Date

HAWP APPLICATION: MAILING ADDRESSES FOR NOTIFING [Owner, Owner's Agent, Adjacent and Confronting Property Owners]	
Owner's mailing address 7124 Carroll Avenue Takoma Park, MD 20912	**Owner's Agent's** mailing address 5981 Optical Court San Jose, CA 95138
Adjacent and confronting Property Owners mailing addresses	
7126 Carroll Avenue Takoma Park, MD 20912	7121 Carroll Avenue Takoma Park, MD 20912
7120 Carroll Avenue Takoma Park, MD 20912	

Description of Property: Please describe the building and surrounding environment. Include information on significant structures, landscape features, or other significant features of the property:

Residential 2-story home, gray shingle roof. Chimney on left side.
Paved walkway to front door. Multi-car parking lot on the left.
1 small tree on the left of home, 1 medium tree in front yard. Tall trees on rear and right side.
Front yard has white picket fence.

Description of Work Proposed: Please give an overview of the work to be undertaken:

Solar Shingles: Residential Roof-Integrated PV Installation/
System Size: 2.208kw/PV Shingle (48) GAF Energy Timberline Solar ES/
Inverter: (1) Delta M4-TL-US

This is a re-roof from shingles to shingles, with additional building-integrated photovoltaic shingles on the left sides of the roof(facing the parking lot). New shingles will be Weathered Wood Timberline HDZ shingles. PV shingles will be flush-mounted to the roof and in-line with the rest of the shingle courses. The electrical equipment will be installed on the side of the home per code; the inverter and a disconnect will be within the fence on the exterior right wall of the building.

No trees, landscaping, or other attributes of the home will be part of this scope of work.

Work Item 1: Re-roof

Description of Current Condition:	Proposed Work:
Roof is currently gray shingles	Roof will be new Weathered Wood shingles with photovoltaic shingles incorporated into the new courses

Work Item 2: Electrical (Side of Home)

Description of Current Condition:	Proposed Work:
Utility Meter is on interior right side wall of the basement	Add solar inverter + AC disconnect within fence on exterior right side wall for emergency services

Work Item 3: Electrical (Main Panel)

Description of Current Condition:	Proposed Work:
Main Service Panel is on interior right side wall of the basement next to Utility Meter	Install new 20A circuit breaker inside main panel

HISTORIC AREA WORK PERMIT
CHECKLIST OF
APPLICATION REQUIREMENTS

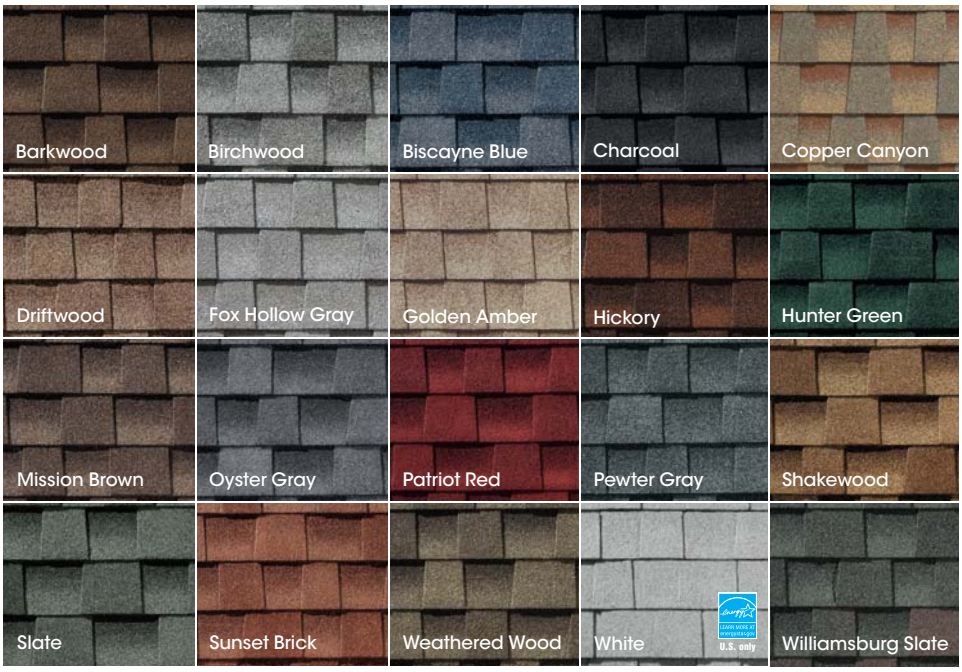
	Required Attachments						
Proposed Work	I. Written Description	2. Site Plan	3. Plans/ Elevations	4. Material Specifications	5. Photographs	6. Tree Survey	7. Property Owner Addresses
New Construction	*	*	*	*	*	*	*
Additions/ Alterations	*	*	*	*	*	*	*
Demolition	*	*	*		*		*
Deck/Porch	*	*	*	*	*	*	*
Fence/Wall	*	*	*	*	*	*	*
Driveway/ Parking Area	*	*		*	*	*	*
Grading/Excavation/Landscaing	*	*		*	*	*	*
Tree Removal	*	*		*	*	*	*
Siding/ Roof Changes	*	*	*	*	*		*
Window/ Door Changes	*	*	*	*	*		*
Masonry Repair/ Repoint	*	*	*	*	*		*
Signs	*	*	*	*	*		*

Timberline® SolarHD™ Shingles

Benefits:

- **WindProven™ Limited Wind Warranty** — When installed with the required combination of GAF Accessories, Timberline® HDZ™ Shingles are eligible for an industry first: a wind warranty with no maximum wind speed limitation.[2]
- Our legendary **Dura Grip™** sealant pairs with the smooth microgranule surface of the StrikeZone™ nailing area for fast tack. Then, an asphalt-to- asphalt monolithic bond cures for durability, strength, and exceptional wind uplift performance.
- **StainGuard® Algae Protection** — Helps protect the beauty of your roof against unsightly blue-green algae discoloration.[3]
- **High Performance** — Designed with Advanced Protection® Shingle Technology.
- **Seamless compatibility** — The new Timberline® HDZ™ Shingles are compatible with traditional Timberline HD® Shingles for the same look and feel homeowners and contractors rely on for beauty and endurance.[4]
- **Perfect Finishing Touch** — For the best look, use TimberTex® Premium Ridge Cap Shingles or TimberCrest™ Premium SBS-Modified Ridge Cap Shingles.

Colors & Availability:



Product details:

Product/System Specifics

- Fiberglass asphalt construction
- Dimensions (approx.): 13 ¼" x 39 ⅜" (337 x 1,000 mm)
- Exposure: 5 ⅝" (143 mm)
- Bundles/Square: 3
- Pieces/Square: 64
- StainGuard® Algae Protection[3]
- Hip/Ridge: TimberTex®; TimberCrest™; Seal-A-Ridge®; Z®Ridge; Ridglass®
- Starter: Pro-Start®; QuickStart®; WeatherBlocker™

Applicable Standards & Protocols:

- UL Listed to ANSI/UL 790 Class A
- State of Florida approved
- Classified by UL in accordance with ICC-ES AC438
- Meets ASTM D7158, Class H
- Meets ASTM D3161, Class F
- Meets ASTM D3018, Type 1
- Meets ASTM D3462[5]
- ICC-ES Evaluation Reports ESR-1475 and ESR-3267
- Meets Texas Department of Insurance Requirements
- ENERGY STAR® Certified (White Only) (U.S. Only); Rated by the CRRC; Can be used to comply with Title 24 cool roof requirements

[1] Results based on study conducted by Home Innovation Research Labs, an independent research lab, comparing installation of Timberline HD® Shingles to Timberline® HDZ™ Shingles on a 16-square roof deck using standard 4-nail nailing pattern under controlled laboratory conditions. Actual results may vary.

[2] 15-year WindProven™ limited wind warranty on Timberline® HDZ™ Shingles requires the use of GAF starter strips, roof deck protection, ridge cap shingles, and leak barrier or attic ventilation. See *GAF Roofing System Limited Warranty* for complete coverage and restrictions. Visit gaf.com/LRS for qualifying GAF products.

[3] StainGuard® algae protection is available only on shingles sold in packages bearing the StainGuard® logo. Products with StainGuard® algae protection are covered by a 10-year limited warranty against blue-green algae discoloration. See *GAF Shingle & Accessory Limited Warranty* for complete coverage and restrictions.

[4] To be mixed on one roof, Timberline® HDZ™ Shingles and Timberline HD® Shingles must have matching 6-digit codes found on the end of the bundle. When mixed, always use Timberline HD® installation instructions.

[5] Periodically tested by independent and internal labs to ensure compliance with ASTM D3462 at time of manufacture.

[6] Lifetime refers to the length of warranty coverage provided and means as long as the original individual owner(s) of a single-family detached residence [or eligible second owner(s)] owns the property where the qualifying GAF products are installed. For other owners/structures, Lifetime coverage is not applicable. Lifetime coverage on shingles requires use of GAF Lifetime shingles only. See *GAF Shingle & Accessory Limited Warranty* for complete coverage and restrictions. Lifetime coverage on shingles and accessories requires use of any GAF Lifetime Shingle and any 3 qualifying GAF accessories. See *GAF Roofing System Limited Warranty* for complete coverage and restrictions. Visit gaf.com/LRS for qualifying GAF products.

Note: It is difficult to reproduce the color clarity and actual color blends of these products. Before selecting your color, please ask to see several full-size shingles.

GAF Timberline HDZ® High Definition® Shingles

America's #1-selling shingle just got better — again

Now featuring a 25-Year Limited Warranty against blue-green algae discoloration*

Now with GAF Time-Release Algae-Fighting Technology and LayerLock™ Technology, Timberline HDZ® offers everything you can expect from an architectural shingle roof, and more.*

* See reverse for details

GAF

We protect what matters most™

Timberline HDZ® Shingles

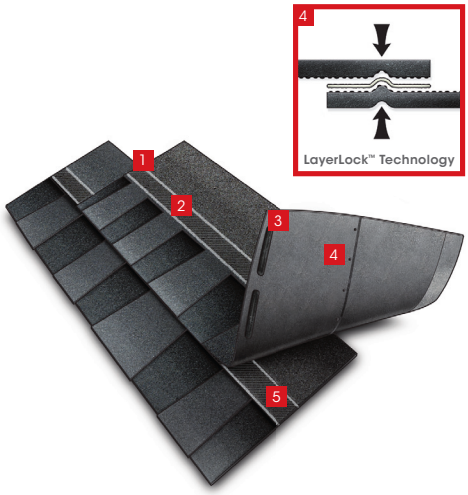
Benefits:

- **LayerLock™ Technology** mechanically fuses the common bond between overlapping shingle layers.
- The added strength at the common bond powers the **StrikeZone™** — The industry's widest nailing area.
- **Up to 99.9% nailing accuracy** — The StrikeZone™ nailing area is so easy to hit that a roofer placed 999 out of 1,000 nails correctly in our test.[3]
- **Up to 30% faster nail fastening** thanks to the industry's largest nail zone.[3]
- **Dura Grip™** sealant pairs with the smooth micrograniule surface of the StrikeZone™ nailing area for fast tack. Then, an asphalt-to asphalt monolithic bond cures for durability, strength, and exceptional wind uplift performance.
- **WindProven™ Limited Wind Warranty**[2] — When installed with the required combination of GAF Accessories, Timberline HDZ® Shingles are eligible for an industry first: a wind warranty with no maximum wind speed limitation.
- **25-year StainGuard Plus™ Algae Protection Limited Warranty** against blue-green algae discoloration.[1] Proprietary GAF Time-Release Algae-Fighting Technology helps protect shingles from unsightly stains.

Installation:

The StrikeZone™ Nailing Area
The industry's largest nailing area for up to 99.9% nail placement accuracy.[2]

LayerLock™ Technology
Proprietary technology mechanically fuses the common bond between overlapping shingle layers.



1. Alignment guide
2. StrikeZone™ Nailing Area
3. Dura Grip™ Adhesive
4. LayerLock™ Technology
5. Smooth micrograniule surface

Visit **gaf.com/TimberlineHDZ**

[1] 25-year StainGuard Plus™ Algae Protection Limited Warranty against blue-green algae discoloration is available only on products sold in packages bearing the StainGuard Plus™ logo. See *GAF Shingle & Accessory Limited Warranty* for complete coverage and restrictions.
[2] 15-year WindProven™ limited wind warranty on Timberline HDZ® Shingles requires the use of GAF starter strips, roof deck protection, ridge cap shingles, and leak barrier or attic ventilation. See *GAF Roofing System Limited Warranty* for complete coverage and restrictions. Visit gaf.com/LRS for qualifying GAF products.
[3] Results based on study conducted by Home Innovation Research Labs, an independent research lab, comparing installation of Timberline HD® Shingles to Timberline HDZ® Shingles on a 16-square roof deck using standard 4-nail nailing pattern under controlled laboratory conditions. Actual results may vary.

City of Takoma Park

Housing and Community Development Department

Main Office 301-891-7119
Fax 301-270-4568
www.takomaparkmd.gov

7500 Maple Avenue
Takoma Park, MD 20912

MUNICIPALITY LETTER

December 12, 2023

To: Russell Pittman
7124 Carroll Avenue, Takoma Park MD 20912
russellpittman3@gmail.com 202-476-0507

To: Department of Permitting Services
2425 Reedie Drive, 7th floor
Wheaton, Maryland 20902

From: Planning and Development Services Division

THIS IS NOT A PERMIT – For Informational Purposes Only

VALID FOR ONE YEAR FROM DATE OF ISSUE

The property owner is responsible for obtaining all required permits from Montgomery County and the City of Takoma Park. If this property is in the **Takoma Park Historic District,** it is subject to Montgomery County Historic Preservation requirements.

Representative Name: Walter J Huaman MDPermits@GAF.com 240-306-7925
Location of Project: 7124 Carroll Avenue, Takoma Park MD 20912
Proposed Scope of Work: Solar Shingles: Residential Roof-Integrated PV Installation/
System Size: 2.208kw/PV Shingle (48) GAF Energy Timberline Solar ES/
Inverter: (1) Delta M4-TL-US

The purpose of this municipality letter is to inform you that the City of Takoma Park has regulations and city permit requirements that may apply to your project. This municipality letter serves as notification that, in addition to all Montgomery County requirements, you are required to comply with all City permitting requirements, including:

- Tree Impact Assessment/Tree Protection Plan
- Stormwater management
- City Right of Way

Failure to comply with these requirements could result in the issuance of a Stop Work Order and other administrative actions within the provisions of the law. Details of Takoma Park's permit requirements are attached on page 2.

The issuance of this letter does not indicate approval of the project nor does it authorize the property owner to proceed with the project. The City retains the right to review and comment on project plans during the Montgomery County review process.

City Of Takoma Park

The City of Takoma Park permits for the following issues:

Tree Impact Assessment/Tree Protection Plan/Tree Removal Application:

Construction activities that occur within 50 feet of any urban forest tree (7 and 5/8" in trunk diameter or greater), located on the project property or on an adjacent property, may require a Tree Impact Assessment and possibly a Tree Protection Plan Permit. Make sure to submit a request for a Tree Impact Assessment and schedule a site visit with the City's Urban Forest Manager if any urban forest tree is in the vicinity of proposed construction activities. See the Tree Permits section of the City website for the specific conditions in which a Tree Impact Assessment is required. Depending on the Urban Forest Manager's conclusion following the Tree Impact Assessment, you may need to prepare a full Tree Protection Plan and apply for a Tree Protection Plan Permit as well. Separately, the removal of any urban forest tree will require a Tree Removal Permit application. The tree ordinance is detailed in the City Code, section 12.12. For permit information check: https://takomaparkmd.gov/services/permits/tree-permits. The City's Urban Forest Manager can be reached at 301-891-7612 or urbanforestmanager@takomaparkmd.gov.

Stormwater Management:

If you plan to develop or redevelop property, you may be required to provide appropriate stormwater management measures to control or manage runoff, as detailed in City Code section 16.04. All commercial or institutional development in the city must apply for a Stormwater Management Permit regardless of the size of the land disturbance. Additions or modifications to existing detached single-family residential properties do not require a Stormwater Management permit if the project does not disturb more than 5,000 square feet of land area. For more information visit: https://takomaparkmd.gov/government/public-works/stormwater-management-program/. The City Engineer should be contacted to determine if a City permit is required. The City Engineer can be reached at 301-891-7620.

City Right of Way:

- To place a **construction dumpster or storage container** temporarily on a City right of way (usually an adjacent road), you will need to obtain a permit. A permit is not required if the dumpster is placed in a privately-owned driveway or parking lot.
- If you plan to install a new **driveway apron**, or enlarge or replace an existing driveway apron, you need a Driveway Apron Permit.
- If you plan to construct a **fence** in the City right of way, you need to request a Fence Agreement. If approved, the Agreement will be recorded in the Land Records of Montgomery County.

For more information and applications for City permits, see: https://takomaparkmd.gov/services/permits/ or contact the Department of Public Works at 301-891-7633.

Failure to comply with the City's permitting requirements could result in the issuance of a Stop Work Order and other administrative actions within the provisions of the law.

eSigned via SeamlessDocs.com
Walter Junior Huaman
Key: 38bf2056622713c0bf979ea7ee94776a

Walter Junior Huaman 12-11-2023

eSigned via SeamlessDocs.com
Takoma Park Planning Division
Key: 19fe84f123e68a3ff457621905 9d5fbe

12-12-2023

GENERAL NOTES

1. INSTALLATION OF SOLAR PHOTOVOLTAIC SYSTEM SHALL BE IN ACCORDANCE WITH NEC ARTICLE 690, AND ALL OTHER APPLICABLE NEC CODES WHERE NOTED OR EXISTING.
2. PROPER ACCESS AND WORKING CLEARANCE AROUND EXISTING AND PROPOSED ELECTRICAL EQUIPMENT WILL COMPLY WITH NEC ARTICLE 110.
3. ALL WIRES, INCLUDING THE GROUNDING ELECTRODE CONDUCTOR SHALL BE PROTECTED FROM PHYSICAL DAMAGE IN ACCORDANCE WITH NEC ARTICLE 250
4. THE BIPV SHINGLES ARE CONSIDERED NON-COMBUSTIBLE; THIS SYSTEM IS UTILITY INTERACTIVE PER UL 1741 AND DOES NOT INCLUDE STORAGE BATTERIES OR OTHER ALTERNATIVE STORAGE SOURCES.
5. ALL DC WIRES SHALL BE SIZED ACCORDING TO [NEC 690.8]
6. DC CONDUCTORS SHALL BE WITHIN PROTECTED RACEWAYS IN ACCORDANCE WITH [NEC 690.31]
7. ALL SIGNAGE TO BE PLACED IN ACCORDANCE WITH LOCAL JURISDICTIONAL BUILDING CODE.

Professional Certification. I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Maryland. License No. 61131, Expiration Date: 05/21/2025

AERIAL VIEW

SHEET INDEX

Cutsheets

GAF ENERGY

APPLICABLE CODES:

2017 NATIONAL ELECTRICAL CODE (NEC)
2018 INTERNATIONAL BUILDING CODE (IBC)
2018 INTERNATIONAL FIRE CODE (IFC)
2018 INTERNATIONAL RESIDENTIAL CODE (IRC)

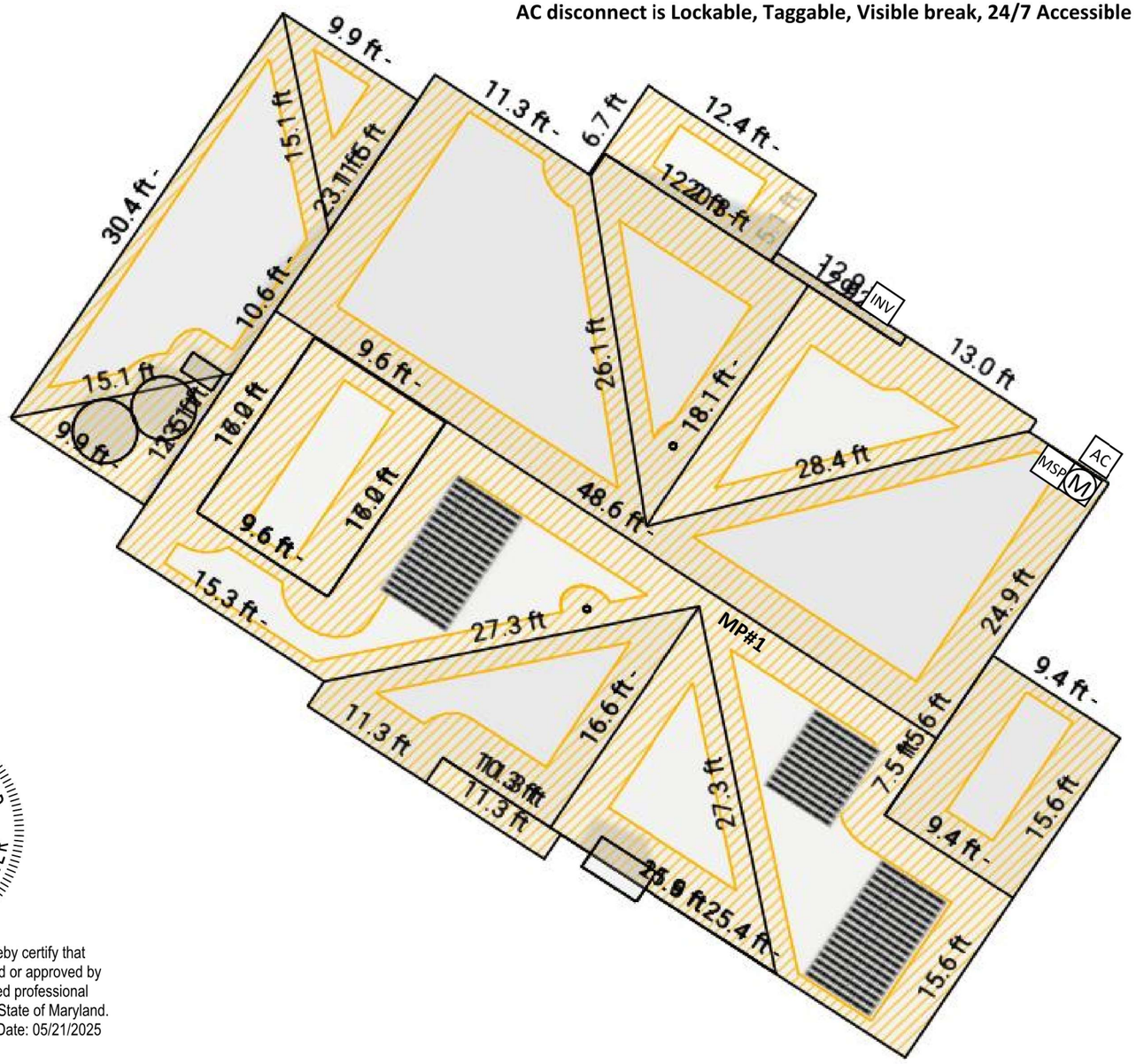
DESCRIPTION OF DESIGN:

INSTALLATION OF GRID TIED, UTILITY INTERACTIVE PHOTOVOLTAIC SYSTEM.

EQUIPMENT:	DC SYSTEM SIZE:	2.208	KW	(48)	BIPV Shingle:	GAF Energy TLS-1
	AC SYSTEM SIZE:	4	KW	(1)	Inverter:	Delta M4-TL-US

ADDRESS:	**CONTRACTOR:**	**EQUIPMENT:**	**DATE** 12/8/2023 **REV** 0
Russell Pittman	GAF Energy LLC (MD)	2.208 KW (DC) 4 KW (AC) (1) Delta M4-TL-US	PV1
7124 Carroll Avenue	973-628-3411 125 Mitchell Blvd, Suite D	(48) GAF Energy TLS-1	COVER PAGE
Takoma Park MD 20912	MHIC 144702, MD M.E. 15583 San Rafael CA 94903		**BY:** Aldortega

AC disconnect is Lockable, Taggable, Visible break, 24/7 Accessible



MP#1	Azimuth:	213	°	Pitch:	10	/12

Pass

N ↑ NORTH

EQUIPMENT LEGEND

M	UTILITY METER
MSP	MAIN SERVICE PANEL
LC	LOAD CENTER
AC	AC DISCONNECT
PV	METER SOCKET (FOR UTILITY PV METER)
INV	INVERTER
J-BOX	JUNCTION BOX
BAT	BATTERY(IES)
	FIRE ACCESS PATHWAY (3' TYP.)

FRONT OF HOME

TOTAL ROOF AREA: 3,085 sq ft
AREA OF PV MODULES: 151 sq ft
% OF ROOF COVERED: 5%

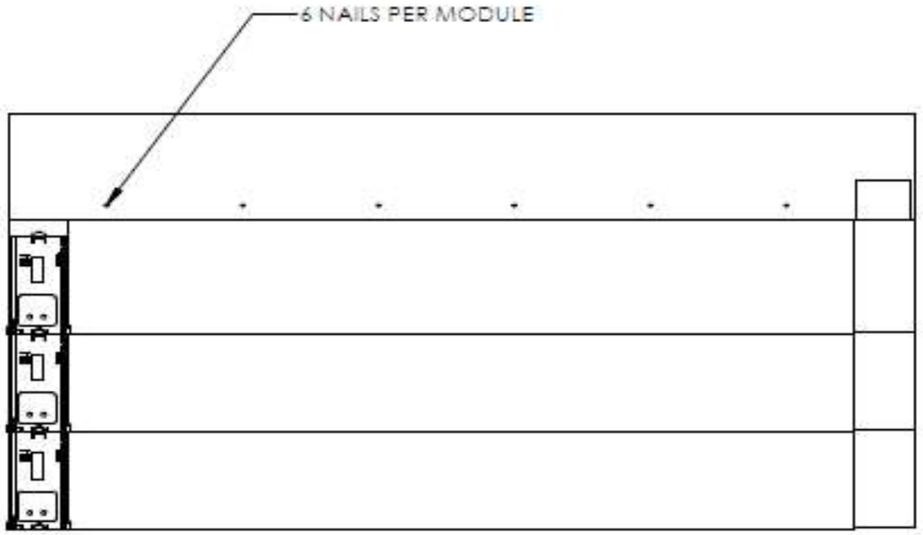
RIDGE SETBACKS 18" MINIMUM

STATE OF MARYLAND · RYAN NGO · 61131 · PROFESSIONAL ENGINEER

Professional Certification. I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Maryland. License No. 61131, Expiration Date: 05/21/2025

Energy Shingle Part Number: **GAF Energy TLS-1**

ADDRESS:			**CONTRACTOR:**				**EQUIPMENT:**					**DATE** 12/8/2023	**REV** 0
Russell Pittman			GAF Energy LLC (MD)				2.208	KW (DC)	4	KW (AC)	(1) Delta M4-TL-US	PV2	
7124 Carroll Avenue			973-628-3411	125 Mitchell Blvd, Suite D			(48)	GAF Energy TLS-1				SITE PLAN	
Takoma Park	MD	20912	MHIC 144702, MD M.E. 1558	San Rafael	CA	94903						**BY:** Aldortega	

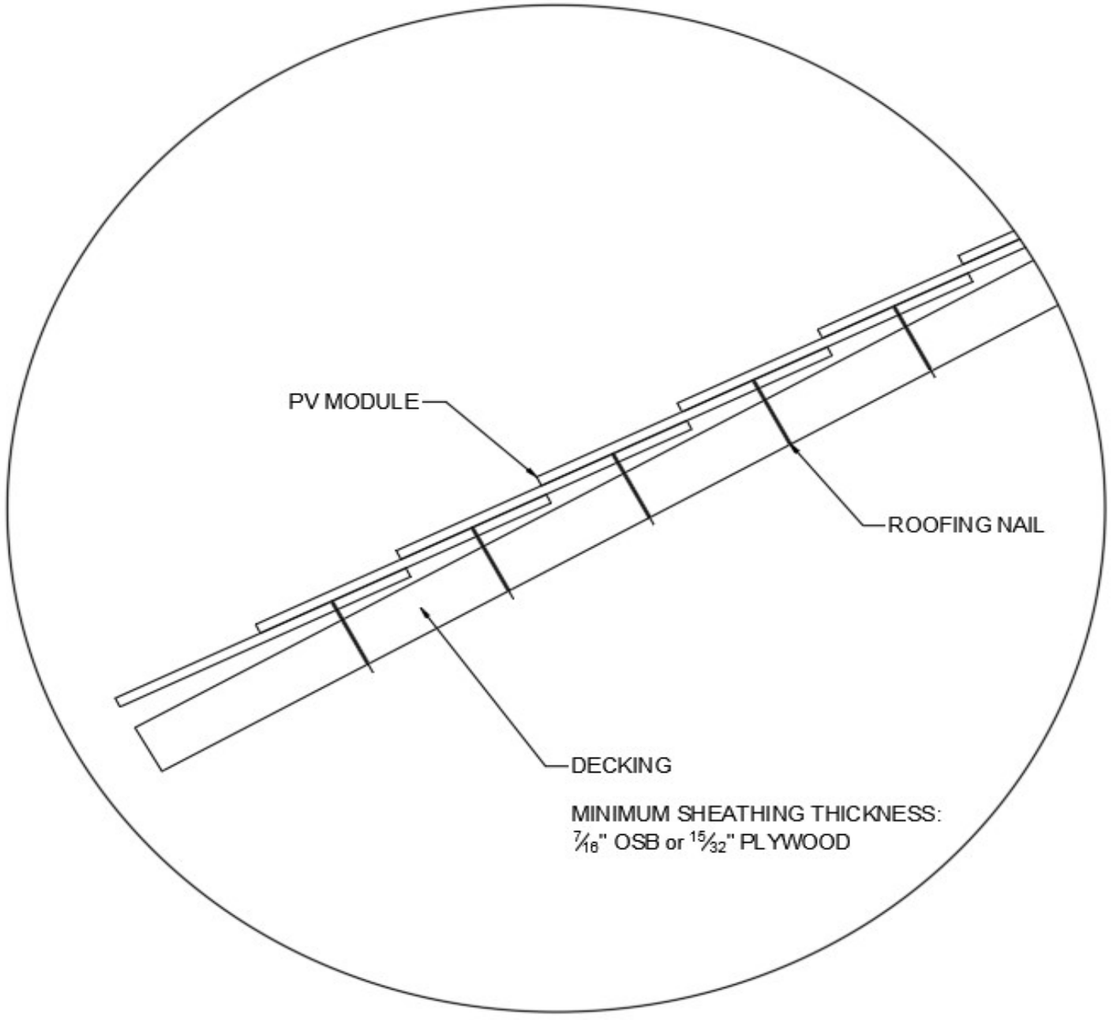


BIPV SHINGLES
TOP VIEW
(NOT TO SCALE)

INSTALLATION NOTES

MINIMUM SHEATHING THICKNESS: 7/16" OSB or 15/32" PLYWOOD.
FULL TEAR OFF REQUIRED PRIOR TO INSTALLATION TO VERIFY DECKING THICKNESS, CONDITION, AND CODE-COMPLIANT ATTACHMENT TO STRUCTURE.

PLEASE SEE ATTACHED STAMPED STRUCTURAL ENGINEERING LETTER FOR ADDITIONAL EXPLANATION REGARDING PE REVIEW/ REQUIREMENTS FOR THE TIMBERLINE SOLAR PRODUCT.



BIPV SHINGLES
SIDE VIEW
(NOT TO SCALE)

Professional Certification. I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Maryland. License No. 61131, Expiration Date: 05/21/2025

ADDRESS:			CONTRACTOR:			EQUIPMENT:					DATE 12/8/2023	REV 0
Russell Pittman			GAF Energy LLC (MD)			2.208 KW (DC)	4 KW (AC)	(1)	Delta M4-TL-US		PV3	
7124 Carroll Avenue			973-628-3411	125 Mitchell Blvd, Suite D		(48) GAF Energy TLS-1					MOUNTING DETAIL	
Takoma Park	MD	20912	MHIC 144702, MD M.E. 15583	San Rafael	CA 94903						BY: Aldortega	

Wire Schedule

REF	QTY	Wire Size / Type	QTY	Wire Size / Type	Conduit	Notes
1	(2)	#10 AWG PV WIRE, USE-2 COPPER			N/A	(OR CODE APPROVED EQUIVALENT)
2	(2)	#10 AWG THWN-2 (POS, NEG)	(1)	#10 AWG THWN-2 (GND)	3/4in EMT	(OR CODE APPROVED EQUIVALENT)
3A	(3)	#10 AWG THWN-2 (L1,L2,N)	(1)	#10 AWG THWN-2 (GND)	3/4in EMT	(OR CODE APPROVED EQUIVALENT)
3B						
3C						
4	(3)	#10 AWG THWN-2 (L1,L2,N)	(1)	#10 AWG THWN-2 (EGC)	3/4in EMT	(OR CODE APPROVED EQUIVALENT)
5						
6						
7						
8						

BIPV Shingle

QTY	Make/Model	Max output Power
(48)	GAF Energy TLS-1	46W

Rapid Shutdown Device

QTY	Make/Model	Max Output
(3)	Delta GPI00010105	20A

Inverter(s)

REF	Make/Model	AC Voltage	Ground	Rated Power	Max Output Current
INV1	Delta M4-TL-US	240V	No	4000W	16.0A
INV2					
INV3					

AC DISCONNECT

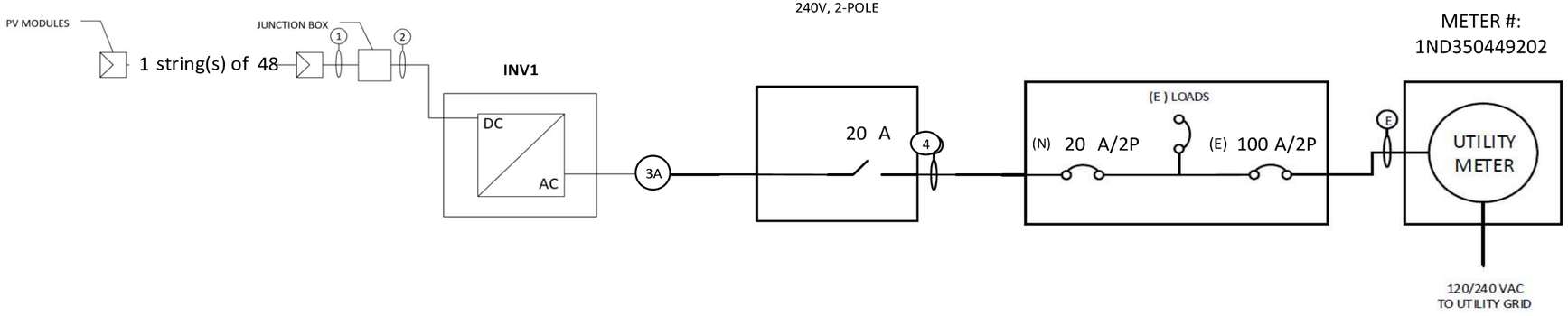
NON-FUSED, AIC 10kA VISIBLE,
LOCKABLE, LABELED, OPEN
30 A

240V, 2-POLE

MAIN SERVICE PANEL

(E) 100 A BUSBAR
(E) 100 A MAIN BREAKER

METER #:
1ND350449202



GROUNDING & GENERAL NOTES
TIMBERLINE SOLAR USES BIPV SHINGLES (PV MODULES) THAT ATTACH DIRECTLY TO THE ROOF DECKING LIKE ORDINARY ASPHALT SHINGLES. THE BIPV SHINGLES HAVE NO METAL FRAME AND ARE NOT RACK MOUNTED. THE SYSTEM HAS NO EXPOSED, CONDUCTIVE METAL AND REQUIRES NO EQUIPMENT GROUND CONDUCTOR (EGC) FOR THE BIPV SHINGLES, WIRE COVERS OR TRANSITION BOX. THE EGC PATH BEGINS AT THE CONNECTION OF THE CONDUIT (EMT OR FMC, TYPICALLY) AT THE TRANSITION BOX OR PASS THROUGH DEVICE AND TERMINATES AT THE MAIN SERVICE PANEL.

TIMBERLINE SOLAR AS A SYSTEM HAS BEEN LISTED TO MEET THE RAPID SHUTDOWN REQUIREMENTS OF ARTICLE 690.12 IN THE 2020, 2017 AND 2014 NEC (ANSI/NFPA 70). ANY LOSS OF CONNECTION TO THE UTILITY GRID WILL TRIGGER RAPID SHUTDOWN OF THE DELTA MCI AND/OR DELTA RSS PV RAPID SHUTDOWN EQUIPMENT (PVRSE) LISTED TO ANSI UL 1741 AND AS A PV HAZARD CONTROL SYSTEM (PVHCS) LISTED TO ANSI/CAN/UL 3741.

1.A SECOND FACILITY GROUNDING ELECTRODE IS NOT REQUIRED PER [NEC 690.47(C)(3)]
2.PV INVERTER IS UNGROUNDED, TRANSFORMER-LESS TYPE.
3.DC AND AC EGC TO REMAIN UNSPLICED, OR SPLICED TO EXISTING ELECTRODE
4.ANY EXISTING WIRING INVOLVED WITH PV SYSTEM CONNECTION THAT IS FOUND TO BE INADEQUATE PER CODE SHALL BE CORRECTED PRIOR TO FINAL INSPECTION.

GROUNDING & GENERAL NOTES (CONT'D)
5.TRANSITION BOX QUANTITIES, AND PLACEMENT SUBJECT TO CHANGE IN THE FIELD - TRANSITION BOXES DEPICTED ON ELECTRICAL DIAGRAM REPRESENT WIRE TYPE TRANSITIONS.
6.AC DISCONNECT NOTED IN EQUIPMENT SCHEDULE OPTIONAL IF OTHER AC DISCONNECTING MEANS IS LOCATED WITHIN 10' OF SERVICE DISCONNECT.
7.CONDUIT CARRYING THE DC WIRES ARE BONDED AT THE INVERTER.
8. INVERTERS ARE UL 1741 COMPLIANT.

INTERCONNECTION NOTES
1. GROUND FAULT PROTECTION IN ACCORDANCE WITH [NEC 215.9] & [NEC 230.95]
2. SUPPLY SIDE INTERCONNECTION ACCORDING TO[NEC 2014, 2017 - 705.12(A), NEC 2020, 2023 - 705.11] WITH SERVICE ENTRANCE CONDUCTORS IN ACCORDANCE WITH [NEC 240.21(B)]

DISCONNECT NOTES
1. DISCONNECTING SWITCHES SHALL BE WIRED SUCH THAT WHEN THE SWITCH IS OPENED THE CONDUCTORS REMAINING LIVE ARE CONNECTED TO THE TERMINALS MARKED "LINE SIDE" (TYPICALLY THE UPPER TERMINALS)
2. AC DISCONNECT MUST BE ACCESSIBLE TO QUALIFIED UTILITY PERSONNEL, BE LOCKABLE, AND BE A VISIBLE-BREAK SWITCH

Energy Shingle Part Number: **GAF Energy TLS-1**

ADDRESS:	CONTRACTOR:	EQUIPMENT:	DATE 12/8/2023 REV 0
Russell Pittman	GAF Energy LLC (MD)	2.208 KW (DC) 4 KW (AC) (1) Delta M4-TL-US	PV4
7124 Carroll Avenue	973-628-3411 125 Mitchell Blvd, Suite D	(48) GAF Energy TLS-1	ELECTRICAL DIAGRAM
Takoma Park MD 20912	MHIC 144702, MD M.E. 15583 San Rafael CA 94903		BY: Aldortega

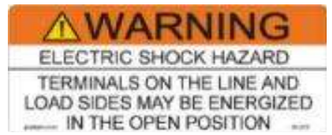
Max. Ambient Temperature (degF): 91.4 PV Module Power (W): 46

DC System Summary

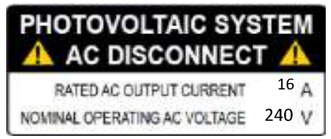
INVERTER	INV 1				INV 2				INV 3			
MPPT	1	2	3	4	1	2	3	4	1	2	3	4
QTY OF MODULES IN SERIES	48											
STRING VMP (V)	363.66											
STRING VOC (V)	576.25											
STRING IMP (A)	5.16											
STRING ISC (A)	5.40											
COMBINED STRING IMP (A)												
COMBINED STRING ISC (A)												
STRING REFERENCE LETTER	A1											

ADDRESS:			CONTRACTOR:				EQUIPMENT:						DATE 12/8/2023	REV 0
Russell Pittman			GAF Energy LLC (MD)				2.208	KW (DC)	4	KW (AC)	(1)	Delta M4-TL-US	PV5	
7124 Carroll Avenue			973-628-3411	125 Mitchell Blvd, Suite D			(48)	GAF Energy TLS-1					ELECTRICAL CALCS	
Takoma Park	MD	20912	MHIC 144702, MD M.E. 15583	San Rafael	CA	94903							BY: Aldortega	

LABEL 1
AT EACH JUNCTION BOX, COMBINER BOX, DISCONNECT, AND DEVICE WHERE ENERGIZED UNGROUNDED CONDUCTORS MAY BE EXPOSED DURING SERVICE. NEC. 690.35(F)



LABEL 2
FOR PV DISCONNECTING MEANS WHERE ALL TERMINALS OF THE DISCONNECTING MEANS MAY BE ENERGIZED IN THE OPEN POSITION.NEC 690.17(E), NEC 705.22



LABEL 3
AT POINT OF INTERCONNECTION, MARKED AT AC DISCONNECTING MEANS.NEC 690.54, NEC 690.13 (B)

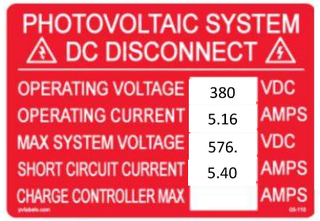
LABEL 4
AT POINT OF INTERCONNECTION FOR EQUIPMENT CONTAINING OVERCURRENT DEVICES IN CIRCUTS SUPPLYING POWER TO A BUSBAR OR CONDUCTOR SUPPLIED FROM MULTIPLE SOURCES, EACHSERVICE EQUIPMENT AND ALL ELECTRIC POWER PRODUCTION SOURCE LOCATIONS.NEC 705.12(D)(3

LABEL 5
AT DIRECT-CURRENT EXPOSED RACEWAYS, CABLE TRAYS, COVERS AND ENCLOSURES OF JUNCTION BOXES, AND OTHER WIRING METHODS; SPACED AT MAXIMUM 10FT SECTION OR WHERE SEPARATED BY ENCLOSURES, WALLS, PARTITIONS, CEILINGS, OR FLOORS.NEC 690.31(G)(3&4)

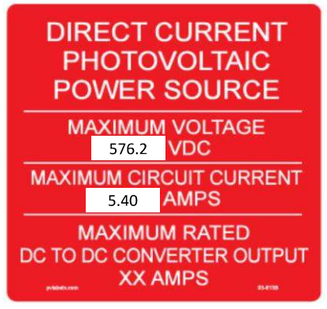
LABEL 6
PLACED ADJACENT TO THE BACK-FED BREAKER FROM THE INVERTER IF TIE IN CONSISTS OF LOAD SIDE CONNECTION TO BUSBAR.NEC 705.12(D)(2)(3)(B)

LABEL 7
SIGN LOCATED AT UTILITY SERVICE EQUIPMENT.NEC 690.56(C)

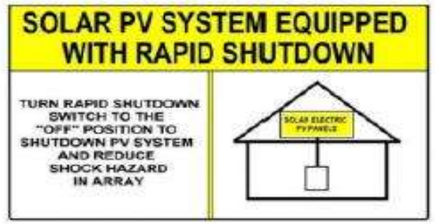
LABEL 8
SIGN LOCATED AT PV COMBINER PANEL. NEC 705.12(B)(2)(3)(C)



LABEL 9 - INVERTER
AT PV DISCONNECTING MEANS. TO BE USED IF NEC 2014 APPLIES. NEC 690.53



LABEL 10 - INVERTER 1
AT PV DISCONNECTING MEANS. TO BE USED IF NEC 2017 APPLIES. NEC 690.53

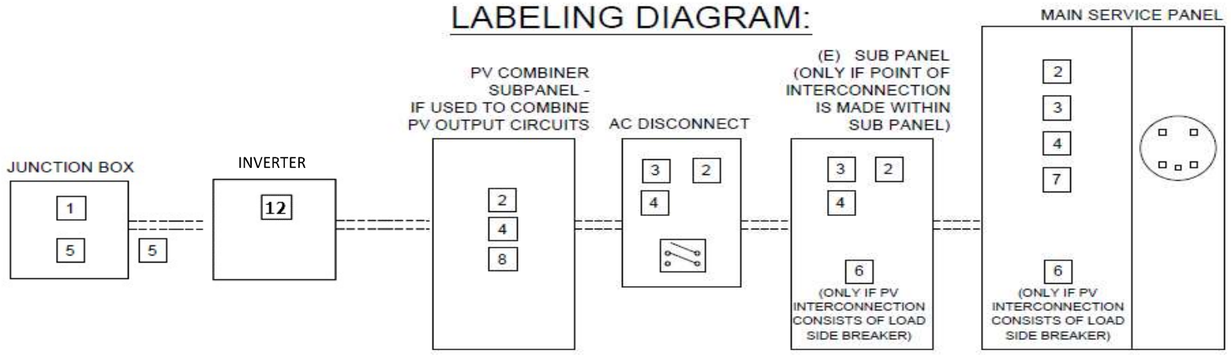


LABEL 11
FOR PV SYSTEMS THAT SHUT DOWN THE ARRAY AND CONDUCTORS LEAVING THE ARRAY NEC 690.56(C)(1). CEC 690.56(C)(1)(A)

LABEL 12
SIGN LOCATED AT INVERTER RAPID SHUTDOWN SWITCH. NEC 690.56(C)(2)

LABELING NOTES:
1. LABELS CALLED OUT ACCORDING TO ALL COMMON CONFIGURATIONS. ELECTRICIAN TO DETERMINE EXACT REQUIREMENTS IN THE FIELD PER CURRENT NEC AND LOCAL CODES AND MAKE APPROPRIATE ADJUSTMENTS.
2. LABELING REQUIREMENTS BASED ON THE (NFPA 70) 2017 National Electric Code
3. MATERIAL BASED ON THE REQUIREMENTS OF THE AUTHORITY HAVING JURISDICTION.
4. LABELS TO BE OF SUFFICIENT DURABILITY TO WITHSTAND THE ENVIRONMENT INVOLVED [NEC 110.21]
5. LABELS TO BE A MINIMUM LETTER HEIGHT OF 3/8", WHITE ON RED BACKGROUND; REFLECTIVE, AND PERMANENTLY AFFIXED [IFC 605.11.1.1]

LABELING DIAGRAM:



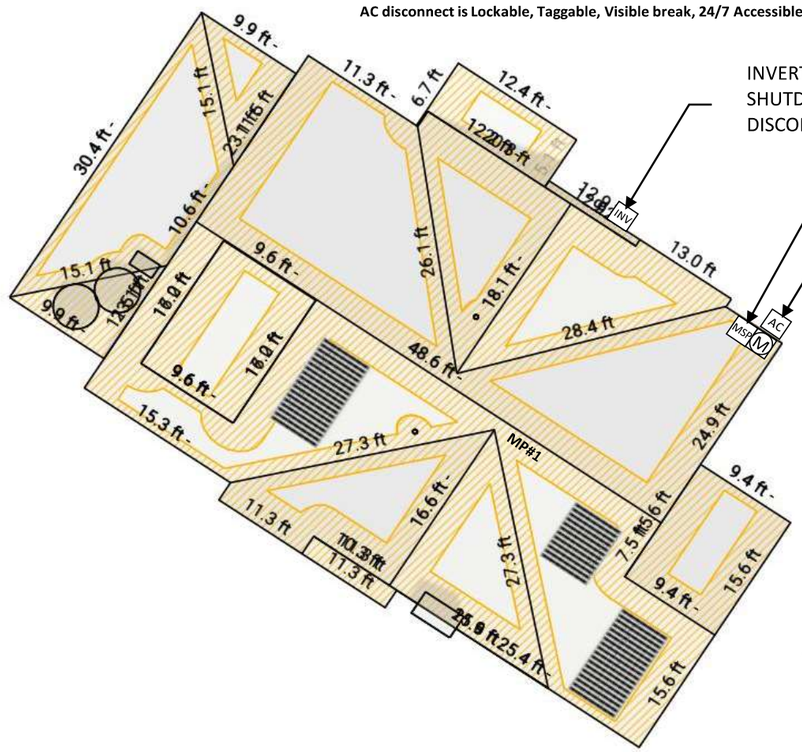
ELECTRICAL DIAGRAM SHOWN ABOVE IS FOR LABELING PURPOSES ONLY. NOT AN ACTUAL REPRESENATION OF EQUIPMENT AND CONNECTIONS TO BE INSTALLED. LABEL LOCATIONS PRESENTED MAY VERY DEPENDING ON TYPE OF INTERCONNECTION METHOD AND LOCATION PRESENTED ELECTRICAL DIAGRAM PAGE. **

ADDRESS:			CONTRACTOR:				EQUIPMENT:					DATE 12/8/2023	REV 0
Russell Pittman			GAF Energy LLC (MD)				2.208	KW (DC)	4	KW (AC)	(1) Delta M4-TL-US	PV6	
7124 Carroll Avenue			973-628-3411	125 Mitchell Blvd, Suite D			(48)	GAF Energy TLS-1				LABELS	
Takoma Park	MD	20912	MHIC 144702, MD M.E. 15583	San Rafael	CA	94903						BY: Aldortega	

CAUTION

POWER TO THIS BUILDING IS ALSO SUPPLIED FROM ROOF MOUNTED SOLAR ARRAYS WITH SAFETY DISCONNECTS SHOWN:

AC disconnect is Lockable, Taggable, Visible break, 24/7 Accessible



INVERTER & RAPID SHUTDOWN DC DISCONNECT SWITCH

MAIN DISTRIBUTION UTILITY DISCONNECT
AC DISCONNECT

FRONT OF HOME

TOTAL ROOF AREA: 3,085 sq ft
AREA OF PV MODULES: 151 sq ft
% OF ROOF COVERED: 5%

RIDGE SETBACKS 18" MINIMUM

7124 Carroll Avenue, Takoma Park MD 20912

ADDRESS:			**CONTRACTOR:**				**EQUIPMENT:**						**DATE** 12/8/2023	**REV** 0
Russell Pittman			GAF Energy LLC (MD)				2.208	KW (DC)	4	KW (AC)	(1)	Delta M4-TL-US	PV7	
7124 Carroll Avenue			973-628-3411	125 Mitchell Blvd, Suite D			(48)	GAF Energy TLS-1					PLACARD	
Takoma Park	MD	20912	MHIC 144702, MD M.E. 15583	San Rafael	CA	94903							**BY:** Aldortega	

Single Phase Solar Inverter for North America

M4-TL-US | M5-TL-US | M6-TL-US | M8-TL-US | M10-TL-US | M10-4-TL-US

Key Features:

- Smart inverter with BLE, optional WiFi, Ethernet, 3G / 4G cellular communication
- Optional revenue grade meter (compliant with ANSI C12.20, Class 0.5)
- Support bi-directional cloud communication
- Support remote diagnosis and OTA
- Type 4 protection
- Built-in AFCI & Rapid shutdown controller
- CEC efficiency 97.5%
- UL 1741 SB, HECO compliant
- CA Rule 21 Phase 1 & 2 & 3 compliant

C SP® US

Solar Inverter for North America

Model	M4-TL-US	M5-TL-US	M6-TL-US	M8-TL-US	M10-TL-US	M10-4-TL-US
INPUT (DC)						
Max. system voltage	600 V					
Nominal voltage	380 V					
Max. operating voltage	540 V					
Operating MPPT voltage range	50 V to 480 V					
Max. input current per MPPT	12 A	12 A	12 A	12 A	20 A	12 A
Max. short circuit current per MPPT	15 A	15 A	15 A	15 A	30 A	15 A
Max. DC/AC ratio [1]	1.35					
DC disconnect	Integrated					
MPP tracker	2	2	3	3	2	4
Input strings available	2 - 2	2 - 2	2 - 2 - 2	2 - 2 - 2	2 - 2	2 - 2 - 2 - 2
OUTPUT (AC)						
Nominal output power @ 240Vac	3840 W	4800 W	5760 W	7680 W	9600 W	9600 W
Max. output power @ 240Vac	4000 W	5000 W	6000 W	8000 W	10000 W	10000 W
Nominal output power @ 208Vac	3328 W	4160 W	4992 W	6656 W	8320 W	8320 W
Max. output power @ 208Vac	3648 W	4560 W	5472 W	7296 W	9120 W	9120 W
AC operating voltage range	183 Vac to 228 Vac @ 208 Vac 211 Vac to 264 Vac @ 240 Vac					
Max. continuous current	16 A	20 A	24 A	32 A	40 A	40 A
Nominal operating frequency	60 Hz					
Operating frequency range	59.3 Hz to 60.5 Hz					
Adjustable frequency range	50 Hz to 66 Hz					
Night consumption	< 1.5 W [2]					
THD @ nominal power	< 3 %					
Power factor @ nominal power	> 0.99					
Adjustable power factor range	0.85i to 0.85c					
GENERAL SPECIFICATION						
Max. efficiency	98%					
CEC efficiency	97.0 % @ 208 V 97.5 % @ 240 V	97.5 % @ 208 V 97.5 % @ 240 V	97.0 % @ 208 V 97.5 % @ 240 V	97.5 % @ 208 V 97.5 % @ 240 V	97.5 % @ 208 V 97.5 % @ 240 V	97.0 % @ 208 V 97.5 % @ 240 V
Operating temperature range	-22 °F to 149 °F (-30 °C to 65 °C) with derating above 113 °F (45 °C)					
Storage temperature range	-40 °F to 185 °F (-40 °C to 85 °C)					
Humidity	0% to 95%					
Max. operating altitude	9,843 ft (3,000 m)					
Acoustic noise	< 45 dB(A) @ 3 ft (1m)					

C SP® US

Model	M4-TL-US	M5-TL-US	M6-TL-US	M8-TL-US	M10-TL-US	M10-4-TL-US
MECHANICAL DESIGN						
Dimensions (W x H x D)	16.7 x 23.2 x 5.9 in (425 x 590 x 150 mm)					
Display	LED indicators					
Weight [3]	41.9 lbs (19.0 kg)	41.9 lbs (19.0 kg)	44.3 lbs (20.1 kg)	45.2 lbs (20.5 kg)	47.6 lbs (21.6 kg)	47.6 lbs (21.6 kg)
Cooling	Natural convection			Natural convection with internal fan		
DC connection	Spring contact type					
AC connection	Spring contact type					
Communication interface	BLE, optional WiFi, Ethernet, 3G / 4G cellular communication					
Remote diagnose/monitoring	Bi-direction via cloud					
Remote firmware update	Via cloud (optional)					
Enclosure material	Die-casting aluminum					
STANDARDS						
Enclosure protection rating	Type 4					
Safety	UL 1741, CSA-C22.2 No. 107.1-16					
Software approval	UL 1998					
Ground fault protection	UL 1741 CRD					
Anti-islanding protection	IEEE 1547-2018, IEEE 1547.1-2020					
EMC	FCC part 15 Class B					
AFCI	UL 1699B (Type 1), NEC 2020 Article 690.11					
Rapid shutdown protection	NEC 2020 690.12 [4]					
Rapid shutdown transmitter	Optional pre-installed [5]					
Integrated meter	ANSI C12.20, Class 0.5					
Grid support regulation	UL 1741 SB, California Rule 21 phase 1 & 2 & 3, HECO Compliant					
WARRANTY						
Standard warranty	10 years					

1) Please refer to technical note for detailed string configuration
2) Without consumption of communication card
3) Without weight of revenue grade meter
4) Compliant with APS rapid shutdown system or Tigo rapid shutdown system.
   Compliant with Delta MCI or Delta Smart RSS as part of listed
   or field labeled PV Hazard Control System/PV Rapid Shutdown Array.
5) Optional pre-installed with APS rapid shutdown transmitter or Tigo rapid shutdown transmitter

Delta Electronics (Americas), Ltd.
46101 Fremont Blvd, Fremont, CA 94538
Sales Email: Inverter.Sales@deltaww.com
Support Email: Inverter.Support@deltaww.com
Sales Hotline: +1-877-440-5851 or +1-626-369-8021
Support Hotline: +1-877-442-4832
Support (Intl.): +1-626-369-8019
Monday to Friday from 6am to 6pm PST (apart from Holidays)
www.Delta-Americas.com

Accessory: Rapid Shutdown System (RSS)

Features:

- With PLC, no additional wire needed for control
- Comply with NEC 2020, Article 690.12*
- String level rapid shutdown
- Type 4 protection
- Support rack mount or solar module mount
- Support series connection up to 2 sub strings
- With high voltage DC relay, high reliability

RATINGS	
Model Name	Smart RSS
Delta part number	GPI00010105
Maximum system voltage	600 Vdc
Maximum current on controlled conductor	25 A dc @70ºC, 18.7 A dc @80ºC
Rated input operating voltage	50 Vdc to 550 Vdc
Rated input operating current	20 A @ 70 °C 15 A @ 80 °C
Fuse Rating	NA
Self-power consumption	<4 W
GENERAL DATA	
Dimensions (W x H x D)	6.0 x 7.9 x 2.1 in (152 x 201 x 53 mm)
Weight	3.77 lbs (1.708 kg)
Cooling	Natural convection
DC input/output connectors	MC4 and H4
Enclosure material	Die cast aluminum
Operating temperature	-40 °F to 176 °F (-40 °C to 80 °C)
Humidity	0% to 95%
Maximum operating altitude	9,843 ft (3,000 m) above sea level
STANDARD COMPLIANCE	
Enclosure protection rating	Type 4
Safety	UL 1741, CSA C22.2 No. 330-17
Rapid shutdown	NEC 2020 Article 690.12*
EMC	FCC Part 15 Class B

*Installed with a listed or field labeled PV hazard control system

Timberline Solar™
Solar Roofing System

Trusted GAF products combined with advanced GAF Energy solar shingle technology

Timberline Solar™ is a comprehensive building-integrated photovoltaic roofing system that incorporates energy shingles and roofing shingles to generate solar energy from either new or replacement roofs. It complies with all applicable building codes and is listed by Intertek to all required safety standards.

Timberline Solar ES™
Nailable Energy Shingles

Electrical Characteristics[1]

P_{max} (±5%)	46 W
V_{oc} (±5%)	10.9 V
I_{sc} (±5%)	5.40 A
V_{mp} (±5%)	9.03 V
I_{mp} (±5%)	5.16 A
Max. System Voltage	600 V
Max. Series Fuse	15 A
Protection Class	Class II
Positive + Negative Load Rating	1600 Pa
Max. Modules in Series	48
Max. Parallel Strings	2
Cell Type	Monocrystalline PERC
Connector Type	Staubli EVO2: PV-KST4-EVO2/6II-UR
Connector Compatibility	All Staubli MC4: PV-KBT4/2 – PV-KBT4/10
Temp. Coeff. I_{sc}	+0.04%/°C
Temp. Coeff. V_{oc}	-0.26%/°C
Temp. Coeff. P_{max}	-0.35%/°C

Mechanical Characteristics

Energy Shingle Dimensions	64 1/4" x 17 1/8" x 1" (1,632 x 435 x 26 mm)
Active Exposure	60" x 7.56" (1,524 x 192 mm)
Energy Shingle Weight	10.1 lb. (4.58 kg)
Energy Shingle Coverage	Approximately 32 energy shingles per square (1.46 kW per square)
Installed System Weight	3.36 lb./sq. ft.
Allowed Roof Pitch	2:12 or greater
Sheathing Minimums	7/16" OSB or 15/32" plywood
Max. Installation Altitude	13,123 ft. (4,000 m)
Avg. Ambient Temp. Range	-40°F to 104°F (-40°C to 40°C)

Applies to Timberline Solar ES™ and Timberline Solar HDZ™

CCRR-0456

Approved for installation in Los Angeles County. See Research Bulletin 13 (RB13). Meets requirements of LAC 2023 Codes: Building, Residential, Electrical & Green Building Standards and 2022 Building Energy Efficiency Standards.

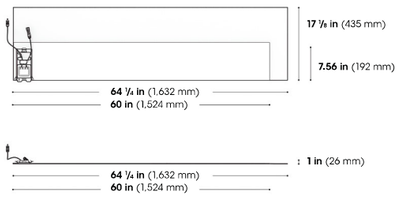
Approved for installation in High Velocity Hurricane Zones (HVHZ) per Florida Product Approval FL41599.

Meets requirements of the Texas Department of Insurance (TDI).

Certifications

Fire Certification[2]	UL 790 Class A
Wind Classification	ASTM D3161 Class F
Rapid Shutdown	Article 690.12 NEC UL 3741
Module Certifications[3]	UL 61730-1, -2 SECT 30 UL 1703
BIPV System Certification	UL 7103
Impact Resistance	UL 2218 Class 1

Model TLS-1, TLS-1.1
ETL Listed PV Hazard Control System UL 3741
Florida Product Approval FL41599



For more information, visit **gaf.energy/tls-info**

[1] All electrical data shown under Standard Test Conditions (STC) (1000 W/m², 25°C ±2°, 1.5 AM).
[2] See installation manual for requirements to achieve a System Fire Class Rating with this product.
[3] UL 61730-1 & UL 61730-2 superseded UL 1703 effective 12/4/19

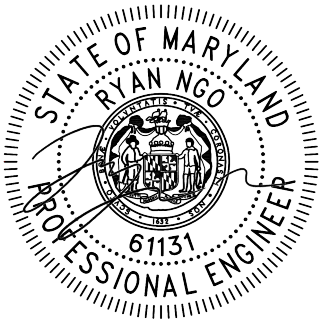
GAF ENERGY Energy from every roof®

BARUN CORP

December 8, 2023

RE: CERTIFICATION LETTER

Project Address: RUSSELL PITTMAN
7124 CARROLL AVENUE
TAKOMA PARK, MD 20912



Professional Certification. I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Maryland. License No. 61131, Expiration Date: 05/21/2025

Design Criteria:

- Applicable Codes = 2018 IEBC/IBC, 2018 IRC, ASCE 7-16 and 2018 NDS
- Risk Category = II
- Wind Speed = 115 mph, Exposure Category B, Partially/Fully Enclosed Method
- Ground Snow Load = 30 psf
- MP1 : Roof DL = 7 psf, Roof LL/SL = 22 psf (Non-ES), Roof LL/SL = 11.9 psf (ES)

To Whom It May Concern,

[√] I reviewed the design of the Timberline Energy Shingles, as designed by the manufacturer and the design criteria utilized for the mounting equipment and panel mounting assembly for the installation of (48) Timberline Energy Shingles, as shown on the drawings prepared for the above referenced address. I certify that the configurations and design criteria meet the standards and requirements of the International Residential Code (IRC) and International Existing Building Code (IEBC) adopted by Montgomery County in COMCOR 08.00.02.

[√] The attachment of the rack system to the building at the above address, including the location, number, and type of attachment points; the number of fasteners per attachment point; and the specific type of fasteners (size, diameter, length, minimum embedment into structural framing, etc.) meets the standards and requirements of the IRC and IEBC adopted by Montgomery County in COMCOR 08.00.02.

[√] I evaluated the existing roof structure of the building at the above address and analyzed its capacity to support the additional loads imposed by the Timberline Energy Shingles. I certify that no structural modifications of the existing roof structure are required. The existing roof structure meets the standards and requirements of the IRC and IEBC, adopted by Montgomery County in COMCOR 08.00.02, necessary to support the Timberline Energy Shingles.

[ ] I evaluated the existing roof structure of the building at the above address and analyzed its capacity to support the additional loads imposed by the Timberline Energy Shingles. Structural modifications of the existing roof structure are required. I certify that the roof structure, as modified on the drawings for this project, will support the additional loads imposed by the Timberline Energy Shingles. I further certify that design of the modified roof structure meets the standards and requirements of the IRC and IEBC, adopted by Montgomery County in COMCOR 08.00.02.

[√] I prepared or approved the construction documents for the mounting equipment, rack system, roof structure for this project.

Installer shall verify existing roof framing (including connection) is in suitable condition and does not exhibit any signs of structural damage or deficiency. Installer verification of the mounting planes noted above is required because some or all of the framing was not observed prior to the structural evaluation performed for this report.

Sincerely,

BARUN CORP	RESULTS SUMMARY
RUSSELL PITTMAN, 7124 CARROLL AVENUE, TAKOMA PARK, MD 20912	

MOUNTING PLANE STRUCTURAL EVALUATION			
MOUNTING PLANE	**ROOF PITCH**	**RESULT**	**GOVERNING ANALYSIS**
MP1	39°	OK	IEBC IMPACT CHECK

Limits of Scope of Work and Liability:

The existing structure has been reviewed based on the assumption that it has been originally designed and constructed per appropriate codes. The structural analysis of the subject property is based on the provided site survey data. The calculations produced for this structure's assessment are only for the roof framing supporting the proposed PV installation referenced in the stamped planset and were made according to generally recognized structural analysis standards and procedures. All PV modules, racking and attachment components shall be designed and installed per manufacturer's approved guidelines and specifications. These plans are not stamped for water leakage or existing damage to the structural component that was not accessed during the site survey. Prior to commencement of work, the PV system installer should verify that the existing roof and connections are in suitable condition and inspect framing noted on the certification letter and inform the Engineer of Record of any discrepancies prior to installation. The installer should also check for any damages such as water damage, cracked framing, etc. and inform the Engineer of Record of existing deficiencies which are unknown and/or were not observable during the time of survey and have not been included in this scope of work. Any change in the scope of the work shall not be accepted unless such change, addition, or deletion is approved in advance and in writing by the Engineer of Record.

BARUN CORP	LOAD CALCULATION
	MP1
RUSSELL PITTMAN, 7124 CARROLL AVENUE, TAKOMA PARK, MD 20912	

ENERGY SHINGLES DEAD LOAD (ES-DL)	
Energy Shingles Weight	= 2.50 psf
Hardware Assembly Weight	= 0.50 psf
Total Energy Shingles	**ES-DL = 3.00 psf**

ROOF DEAD LOAD (R-DL)			
Existing Roofing Material Weight	Composite Shingle Roof	1 Layer(s)	= 2.50 psf
Underlayment Weight			= 0.50 psf
Plywood/OSB Sheathing Weight			= 1.50 psf
Framing Weight			= 0.73 psf
No Vaulted Ceiling			= 0.00 psf
Miscellaneous			= 1.50 psf
Total Roof Dead Load			**R-DL = 6.70 psf**

REDUCED ROOF LIVE LOAD (Lr)	
Roof Live Load	Lo = 20.00 psf
Member Tributary Area	At < 200 ft^2
MP1 Pitch	39° or 10/12
Tributary Area Reduction Factor	R1 = 1.00
Roof Slope Reduction Factor	R2 = 0.73
Reduced Roof Live Load, Lr = Lo (R1) (R2)	**Lr = 14.50 psf**

SNOW LOAD	
Ground Snow Load	pg = 30.00 psf
Effective Roof Slope	39°
Snow Importance Factor	Is = 1.00
Snow Exposure Factor	Ce = 1.00
Snow Thermal Factor	Ct = 1.10
Minimum Flat Roof Snow Load	pf-min = 0.00 psf
Flat Roof Snow Load	**pf = 23.10 psf**

SLOPED ROOF SNOW LOAD ON ROOF (Non-Slippery Surfaces)	
Roof Slope Factor	Cs-roof = 0.95
Sloped Roof Snow Load on Roof	**ps-roof = 22.00 psf**

SLOPED ROOF SNOW LOAD ON ENERGY SHINGLES (Unobstructed Slippery Surfaces)	
Roof Slope Factor	Cs-ES = 0.52
Sloped Roof Snow Load on Energy Shingles	**ps-ES = 11.90 psf**

BARUN CORP

IEBC IMPACT CHECK

MP1

RUSSELL PITTMAN, 7124 CARROLL AVENUE, TAKOMA PARK, MD 20912

	EXISTING	WITH ENERGY SHINGLES	
Roof Dead Load (DL) =	6.70	9.70	psf
Roof Live Load (Lr) =	14.50	0.00	psf
Roof Snow Load (SL) =	22.00	11.90	psf

	EXISTING	WITH ENERGY SHINGLES	
(DL + Lr)/Cd =	16.96	10.78	psf
(DL + SL)/Cd =	24.96	18.78	psf
Maximum Gravity Load =	24.96	18.78	psf

Load Increase (%) = -24.74% **OK**

The requirements of section 806.2 of 2018 IEBC are met and the structure is permitted to remain unaltered.

BARUN CORP

WIND UPLIFT CALCULATION

MP1

RUSSELL PITTMAN, 7124 CARROLL AVENUE, TAKOMA PARK, MD 20912

SITE INFORMATION			
Ultimate Wind Speed =	115.00 mph	Roof Pitch =	39°
Risk Category =	II	Roof Type =	Gable
Exposure Category =	B	Velocity Pressure Exposure Coefficient, Kz =	0.57
Mean Roof Height =	10.00 ft	Topographic Factor, Kzt =	1.00
Solar Array Dead Load =	3.00 psf	Wind Directionality Factor, Kd =	0.85
a =	3.00 ft	Ground Elevation Factor, Ke =	1.00

DESIGN CALCULATIONS			
Wind Velocity Pressure, qh =		16.54 psf	(0.00256*Kz*Kzt*Kd*Ke*(V^2))
Solar Array Pressure Equalization Factor, γa =		0.60	
Hardware Type =			
Allowable Load =		86.50 lbs	OSB/Plywood, Timberline Solar Roofing System Nails
Array Edge Factor, γE =		1.50	Exposed Condition
Max. X - Spacing (Zone 1 - 2r) =		0.89 ft	Effective Wind Area
Max. Y - Spacing (Zone 1 - 2r) =		1.43 ft	1.27 ft²
Max. X - Spacing (Zone 2n & 3r) =		0.89 ft	Effective Wind Area
Max. Y - Spacing (Zone 2n & 3r) =		1.43 ft	1.27 ft²
Max. X - Spacing (Zone 3e) =		0.89 ft	Effective Wind Area
Max. Y - Spacing (Zone 3e) =		1.43 ft	1.27 ft²
ROOF ZONE	**GCp (-) UPLIFT**	**UPLIFT PRESSURE**	**PULLOUT FORCE**
1 - 2r	3.00	28.19 psf	-35.81 lbs
2n & 3r	-2.00	-16.46 psf	20.91 lbs
3e	-3.20	-27.18 psf	34.52 lbs

NOTE:

• Wind calculation is based on ASCE 7-16, 29.4 - C&C, LC #7: 0.6DL + 0.6WL is used.

Installation Instructions

GAF ENERGY

Timberline Solar™

Solar Roofing System

Integrated rooftop solar for composition shingle steep sloped roofs

GAF Energy LLC
Document Version: Rev. 1.7
Date Last Exported: March 22, 2022

Notices

Copyright

Trademark

The name GAF Energy and the GAF Energy logo are all trademarks of GAF Energy LLC.

Warranty

Warranty is void unless product is installed and used in accordance with all written instructions.

Disclaimer

This manual is intended to be a guideline for the installation and use for the product lines manufactured by GAF Energy LLC. The installer is responsible for complying with all applicable regulations.

As the manufacturer, GAF Energy LLC has designed the Timberline Solar™ system to work in a typical installation as described herein, but cannot guarantee that a typical installation will meet every customer's individual needs.

Homeowners and other building owners should refer to a professional contractor who is trained and authorized by GAF Energy for all installation details.

Contents

Table of Contents, continued

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.

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. Please 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

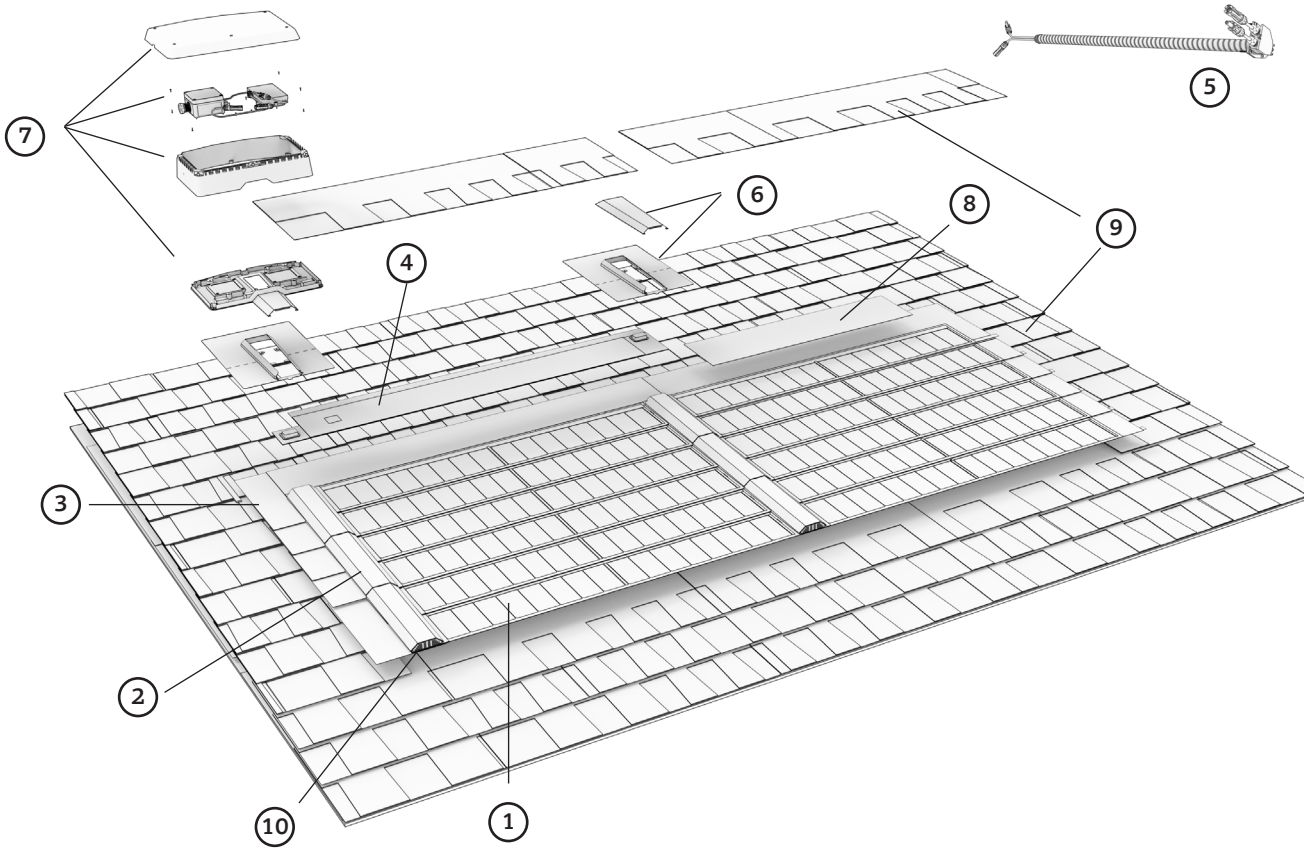
- **Inspect for damage.** Do not use Timberline Solar™ components if there are visible signs of damage from transport or handling.
- **Working Safely with PV systems.** Be aware of the hazards at the jobsite as well as the hazards of working on PV systems. Be alert at all times. Never work alone on roofs 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 NEC (National Electrical Code) 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, etc.) 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



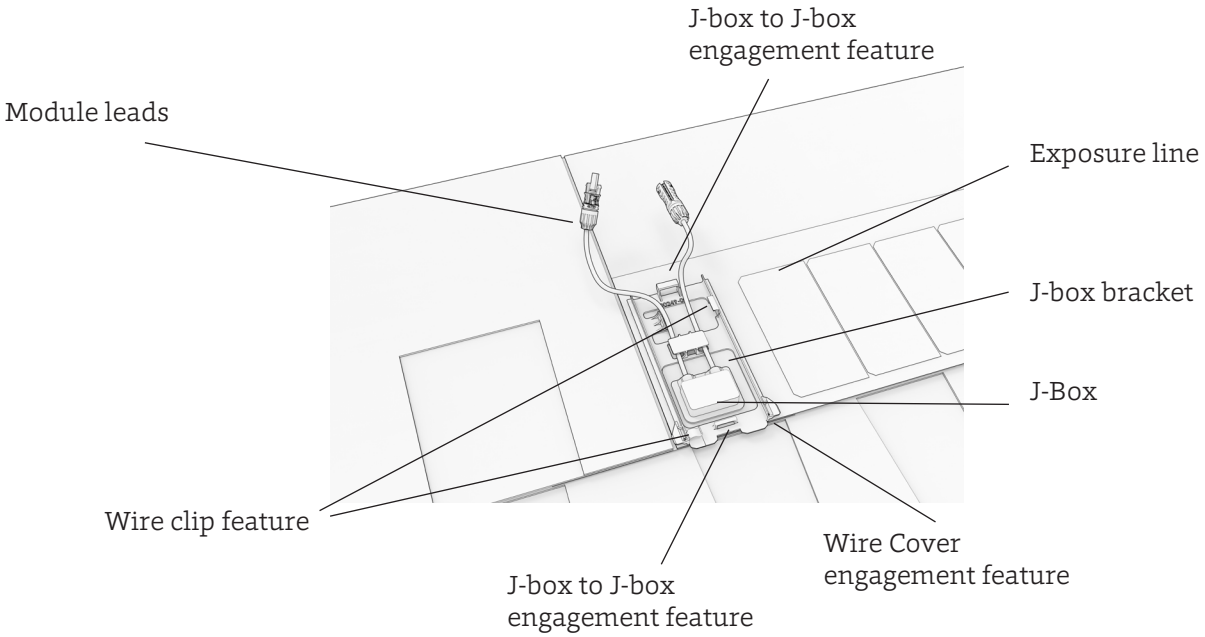
1. Solar Shingle
2. Wire Cover
3. Step Flap
4. Jumper Module
5. Option 1: Pass Through Device for in-attic wiring
6. Top Flashing
7. Option 2: Transition Box for wiring on the exterior of the home
8. GAF QuickStart® Peel & Stick Starter Roll
9. Roofing shingles
10. Bottom Cap

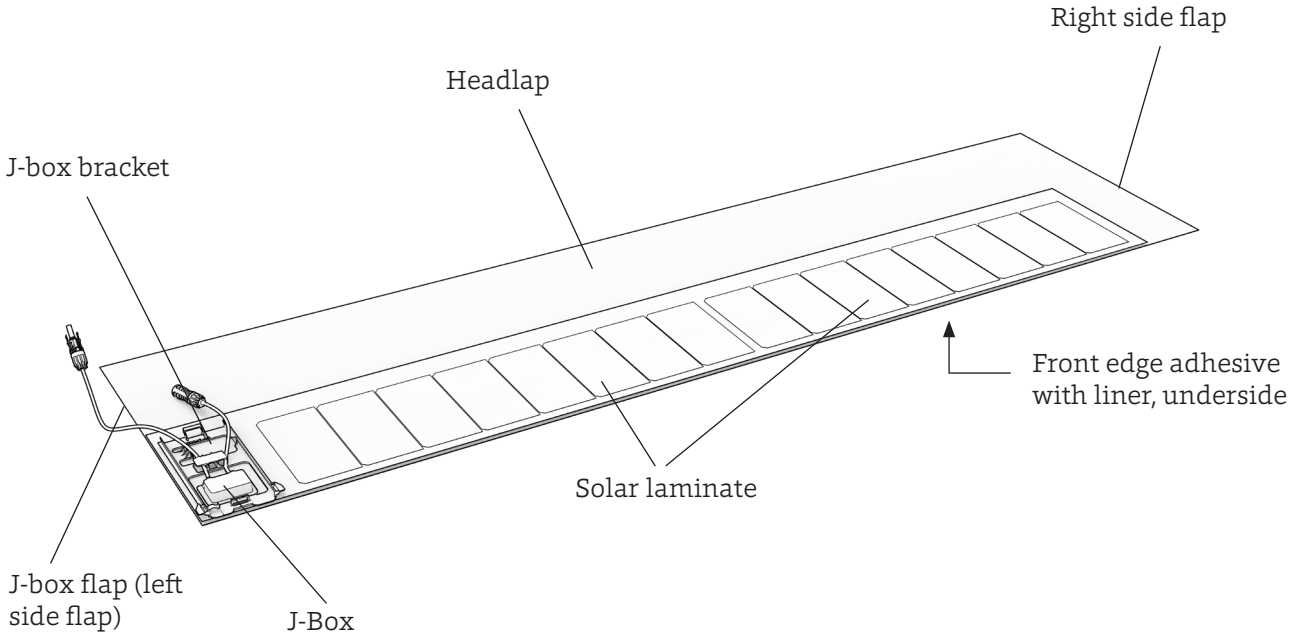
Figure 2. Timberline Solar™ Hardware Components

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

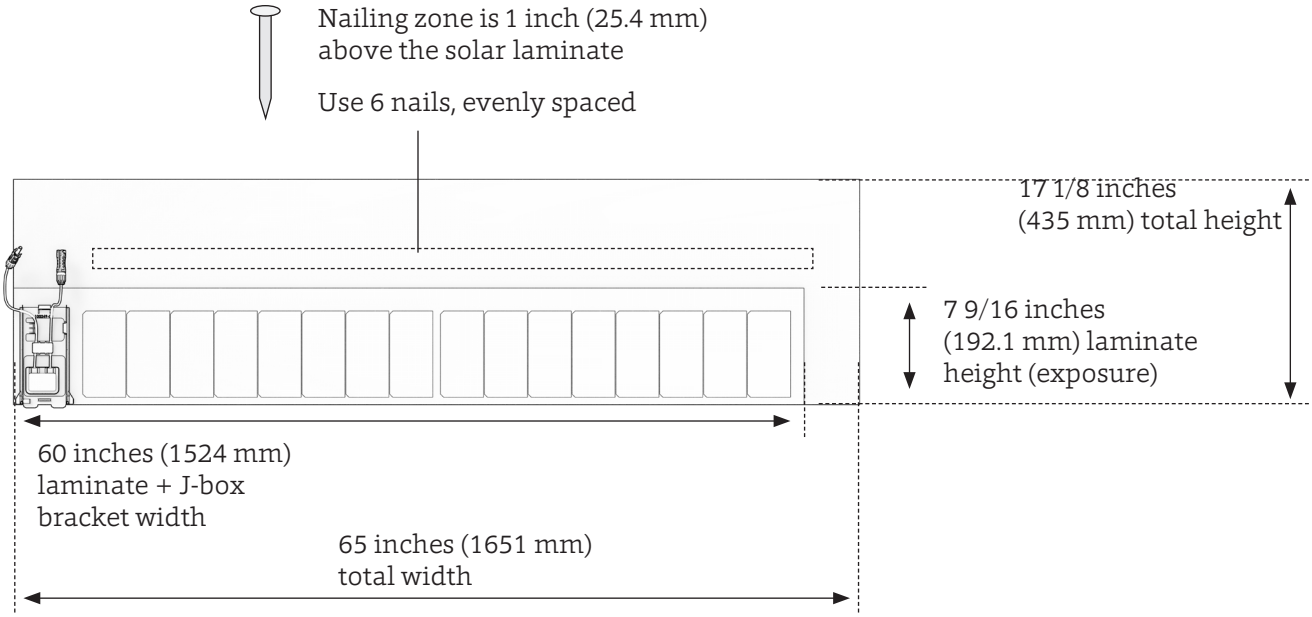
Component Details

Solar Shingle features



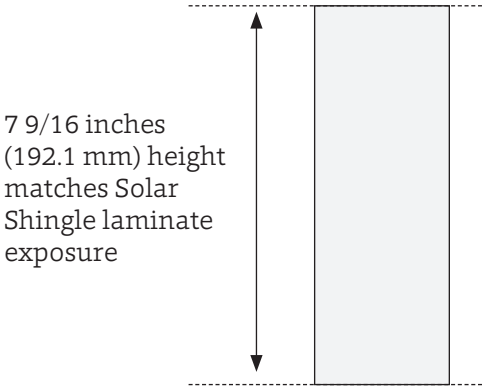


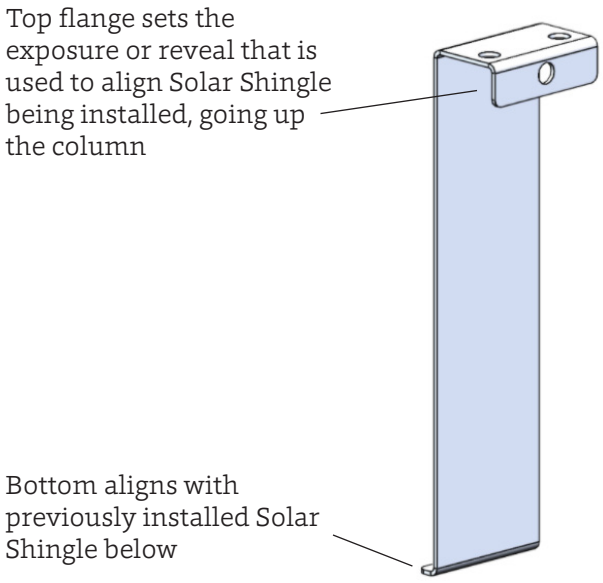
Solar Shingle dimensions



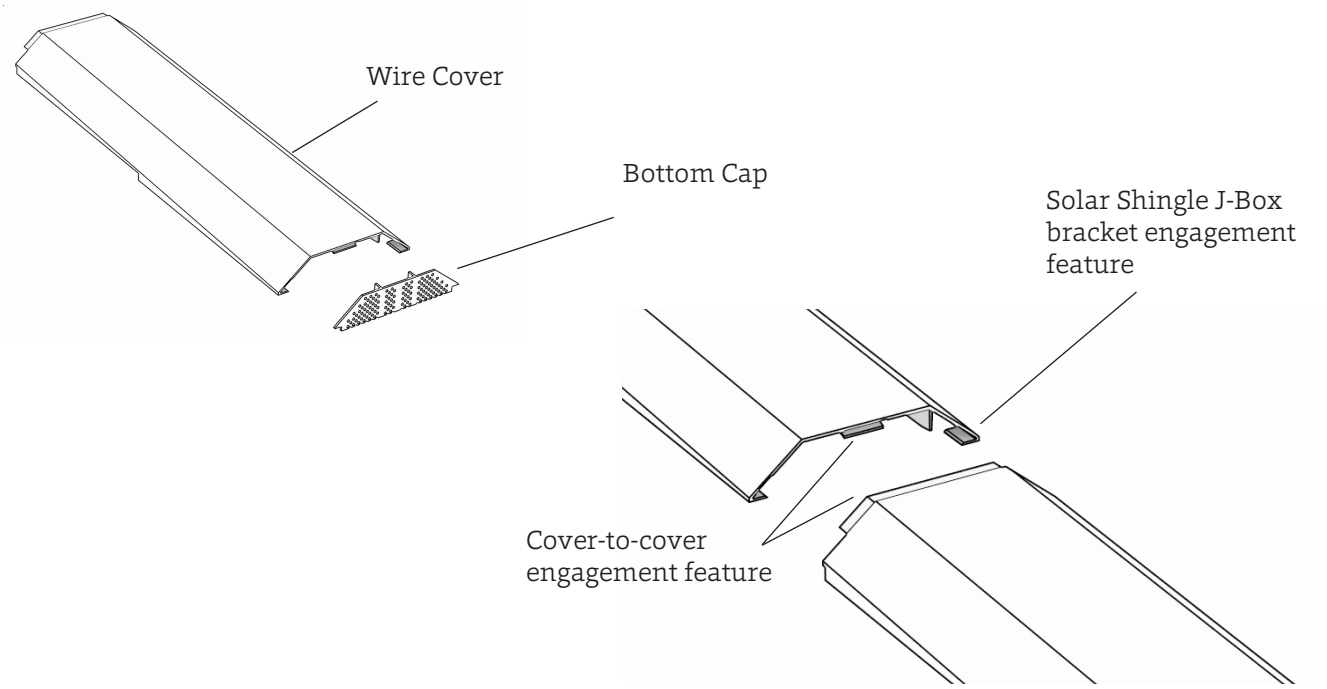
Alignment Jig dimensions

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

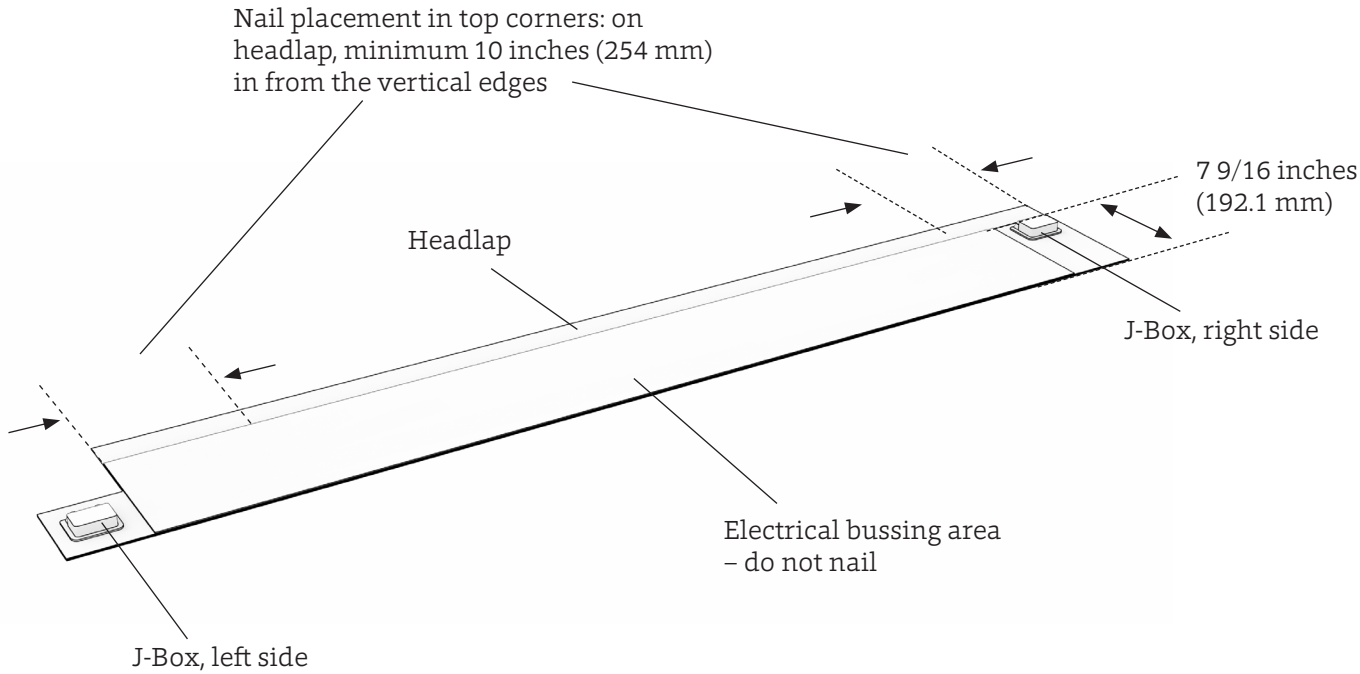




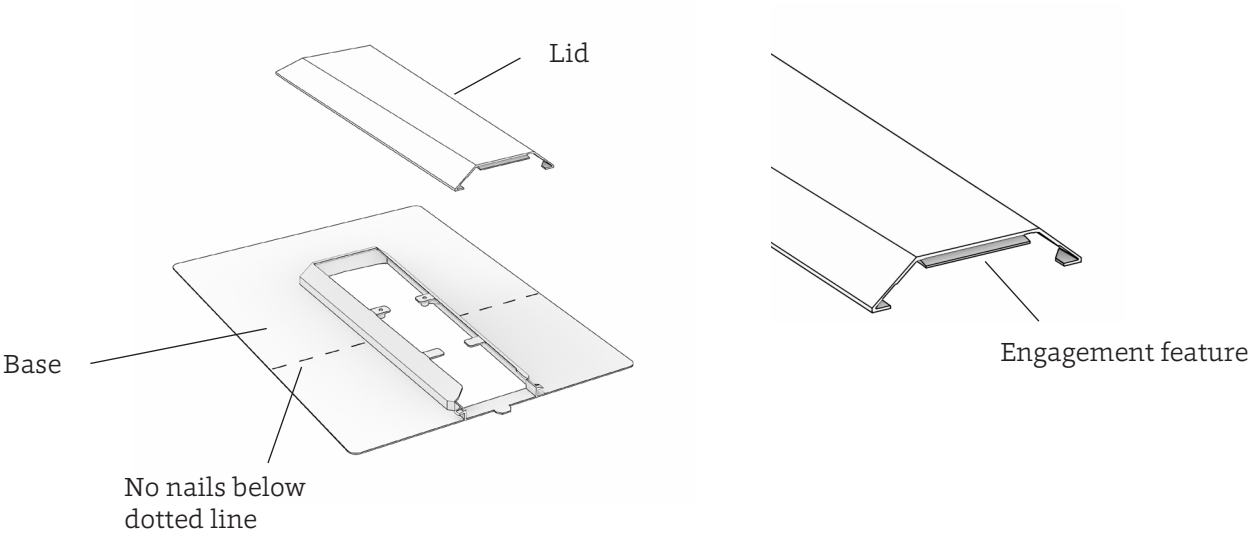
Wire Cover and Bottom Cap



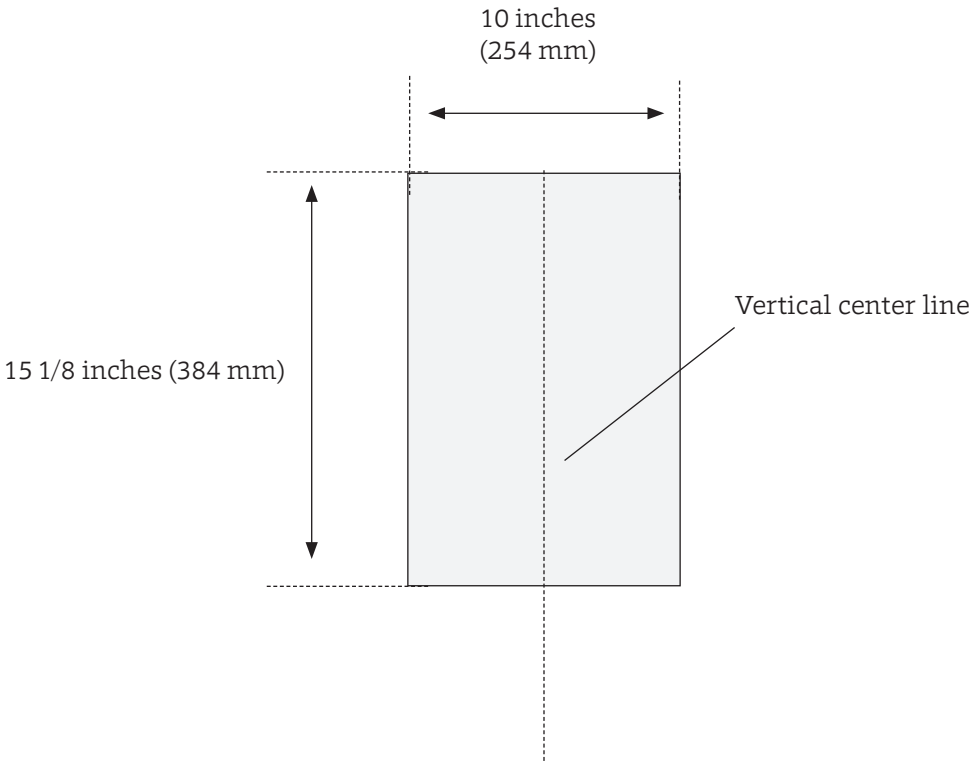
Jumper Module



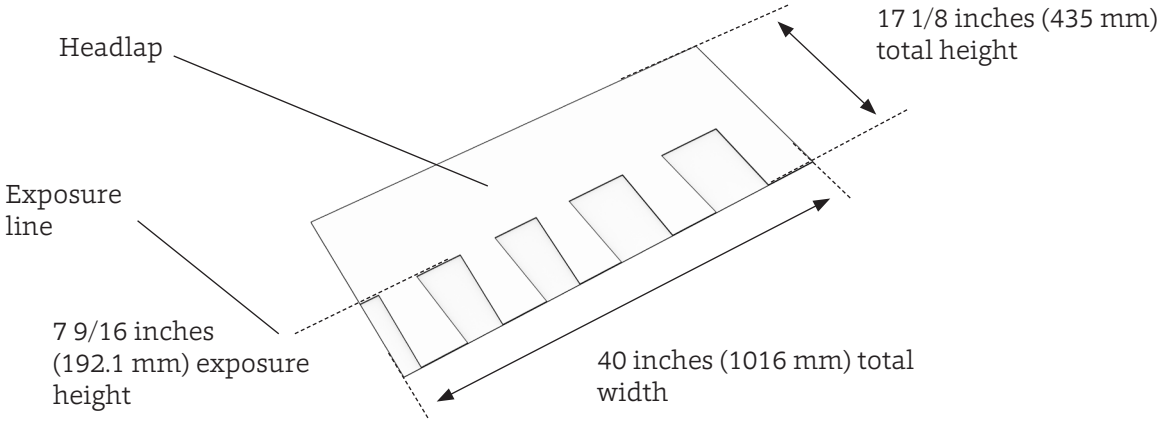
Top Flashing



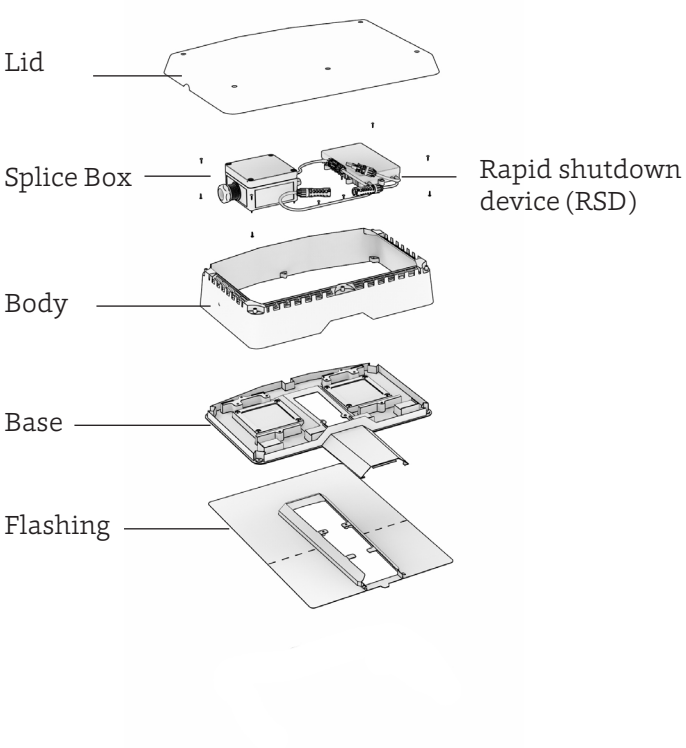
Step Flap



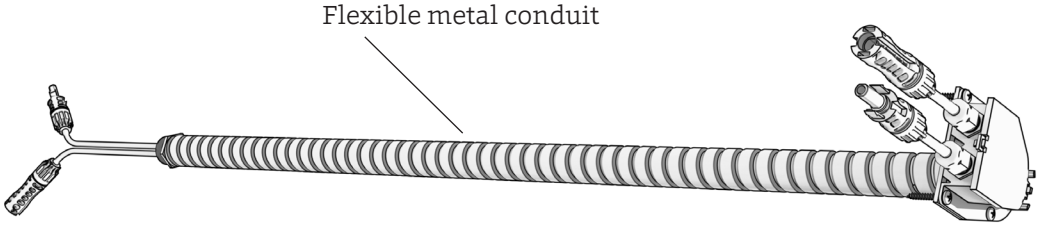
Roofing Shingle (uncut)



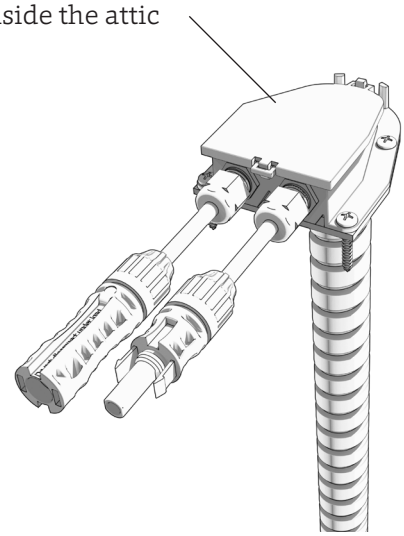
Transition Box

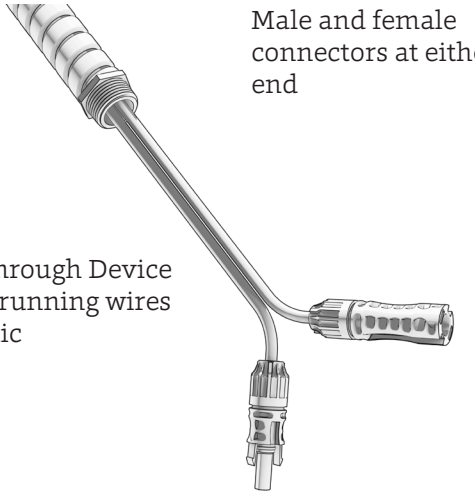


Pass Through Device

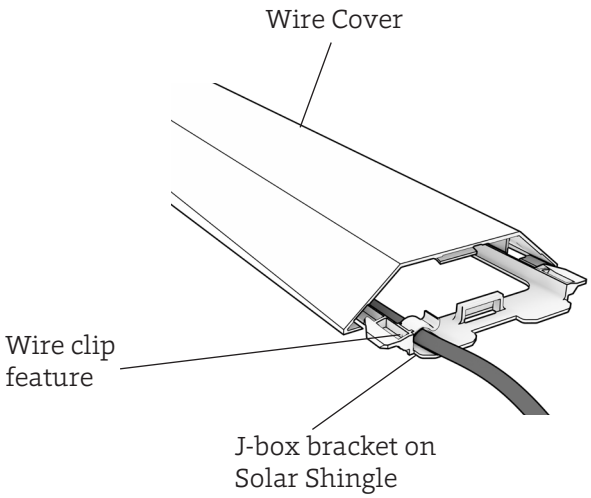


The body portion sits on the roof, the remainder of the device is inside the attic

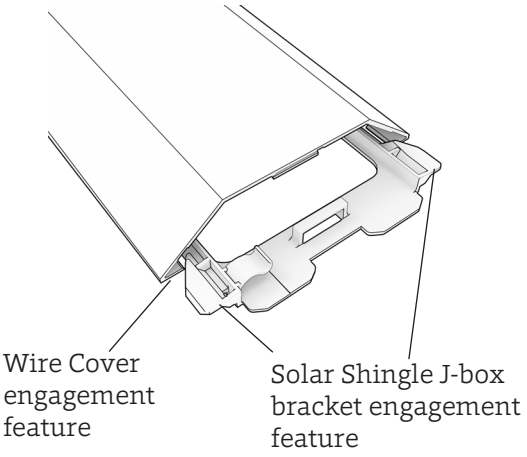




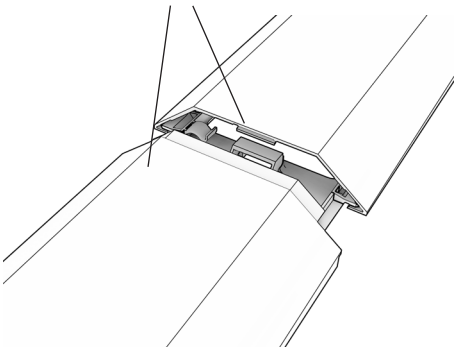
Alignment and Engagement Features, Fitting

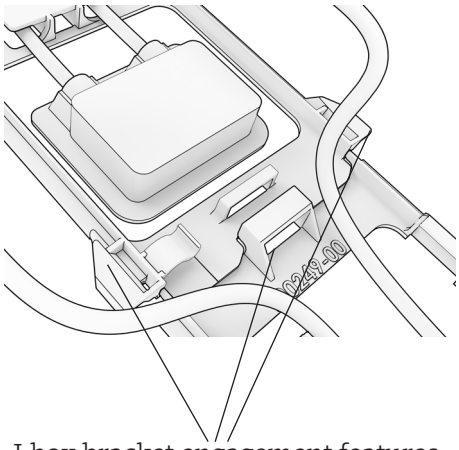


Wire Cover engaging with Solar Shingle J-box bracket



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	294000328 TLS-1*
Wire Cover	294000204
Bottom Cap	294000120
Top Flashing Assembly	294000300
Step Flap	294000241
Jumper Module	294000215 294000417** 294000456**
Transition Box	294000257
Pass Through Device	294000200
QuickStart® Peel & Stick Starter Roll *	1122000ST
Timberline Solar™ HD Shingle	0497###MV
Staubli EVO2 Disconnect Tool	294000437
Module Alignment Jig	294000280
Flex Seal Caulk Grade	8962920WP
* TLS-1 model number applies only to Intertek-certified Solar Shingle. ** Intertek-certified component.	

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
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

Table 4. PVRSA/PVHCS Components

Component	Manufacturer	Provided By
Mid Circuit Interrupters (MCI) GPI00010110 - GPI00010119 *	Delta Electronics	GAF Energy
Smart Rapid Shutdown System (Smart RSS) GPI00010105 *	Delta Electronics	GAF Energy
M4-TL-US, M5-TL-US, M6-TL-US, M8-TL-US, M10-4-TL-US *	Delta Electronics	GAF Energy
Solar Shingle 294000328 TLS-1	GAF Energy	GAF Energy
Wire Cover 294000204	GAF Energy	GAF Energy
Top Flashing Assembly 294000300	GAF Energy	GAF Energy
Transition Box 294000257	GAF Energy	GAF Energy
Pass Through Device 294000200	GAF Energy	GAF Energy
* 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.		

Balance of System Components

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

- 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.
- **Deck thickness and fastening:** 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.
- **Landscape orientation:** The Timberline Solar™ Solar 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. Please 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 and impacts the GAF Energy warranty.

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 Class C 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:** For jurisdictions that adopt ice damming requirements prescriptively, follow requirements outlined by jurisdictions.
- **Shingle mismatch:** When installing a Timberline Solar™ system on an existing roof, all the shingles in the plane of the roof with the solar array must be removed and replaced with GAF-approved roofing shingles.
- **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. Use only shingle products that have been approved by GAF Energy. Special attention is needed when stripping the shingles, installing underlayment, and trim around the Timberline Solar™ system.
- **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

- **Water damage:** Replace water-damaged sheathing (if any) and fasten in compliance with applicable building codes.
- **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, 25C +/-2C, 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 Electric 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 2020, 2017, and 2014 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:
  - » PV Hazard Control System (2020 NEC 690.12(B)(2)(1))
  - » PV Rapid Shutdown Array (2017 NEC 690.12(B)(2)(1))
  - » PV Rapid Shutdown System (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 5. System Electrical Characteristics*

Isc:	5.31A +/- 5%	Ipmax:	5.04A +/- 5%
Voc:	10.9V +/- 5%	Vpmax:	9.03V +/- 5%
Pmax:	45W +/- 5%	Equipment Class:	III
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)
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 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 Steep Slope Pro Field Guide*, version 2.0, September 2020.

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.

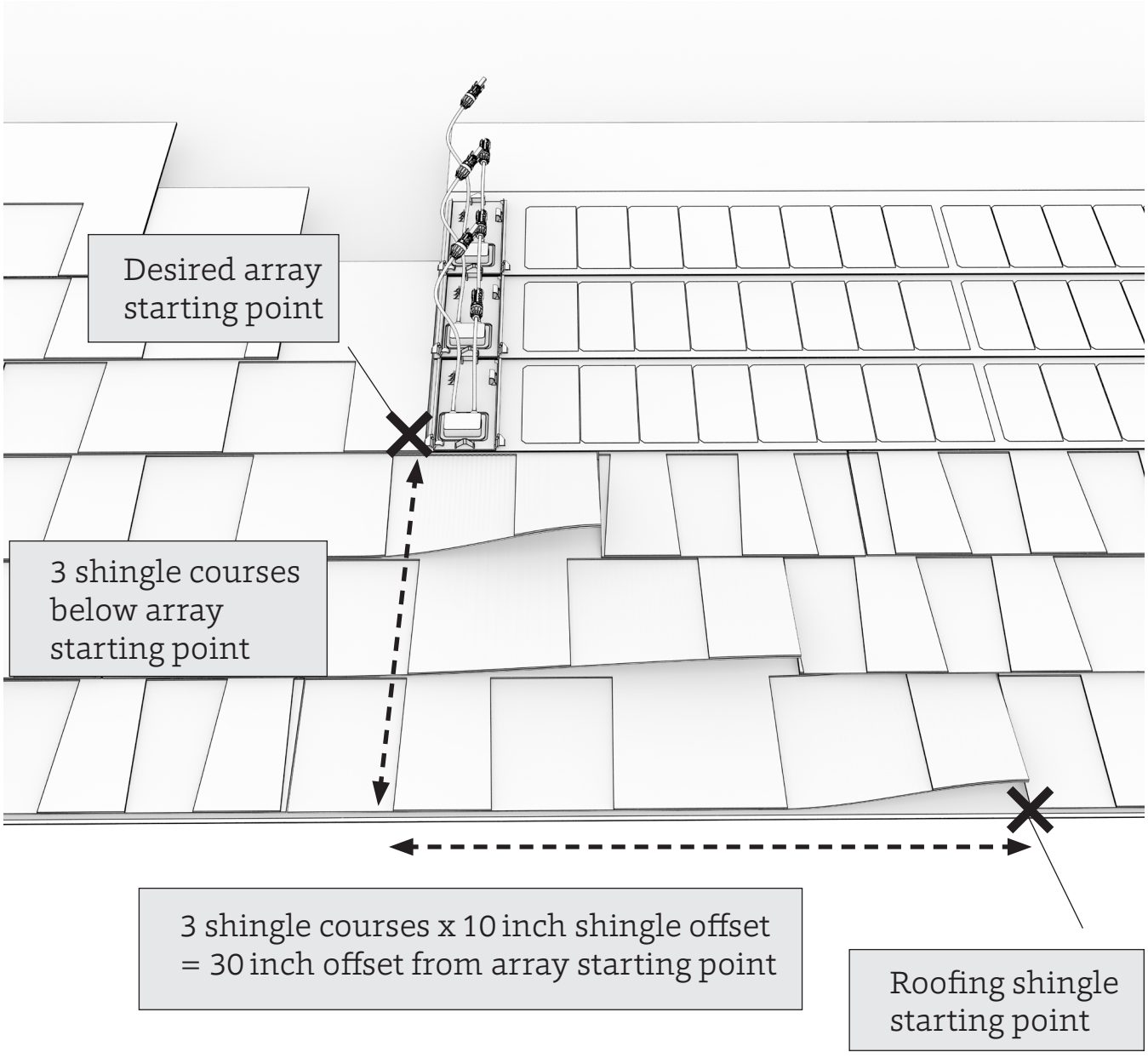


Figure 5. Array starting point, example with three shingle courses

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. Add a hand sealing bead for the first Solar Shingle.

e. 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.

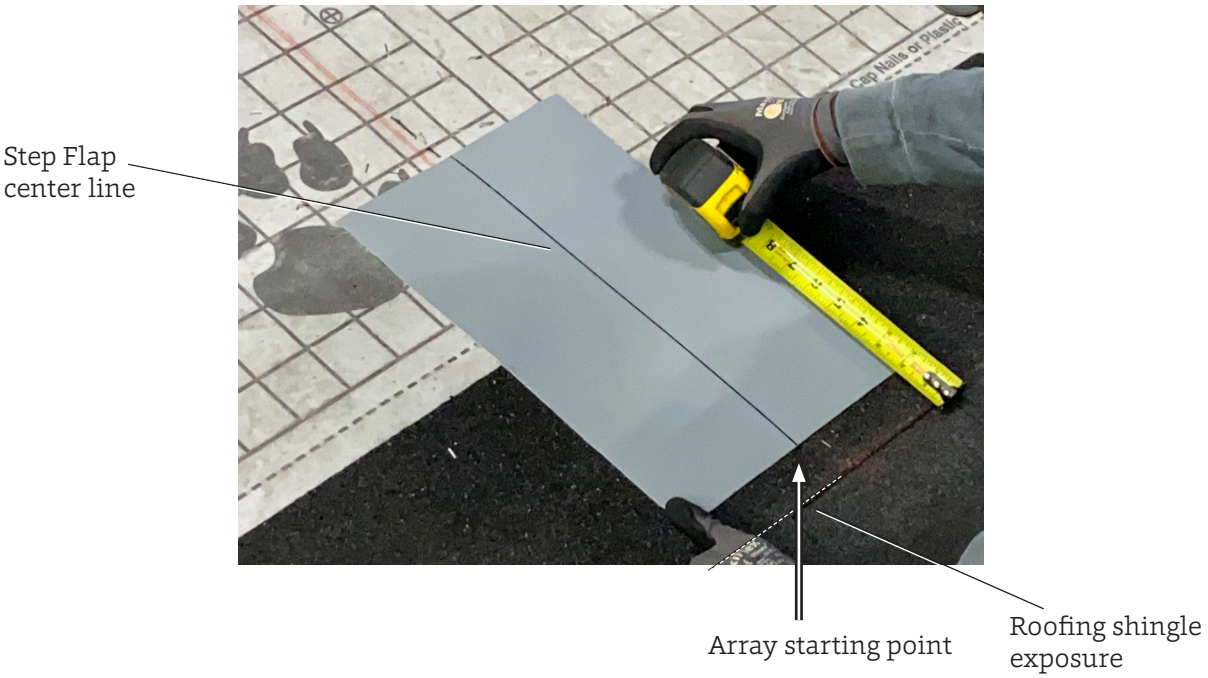


Figure 9. Position the Step Flap

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.

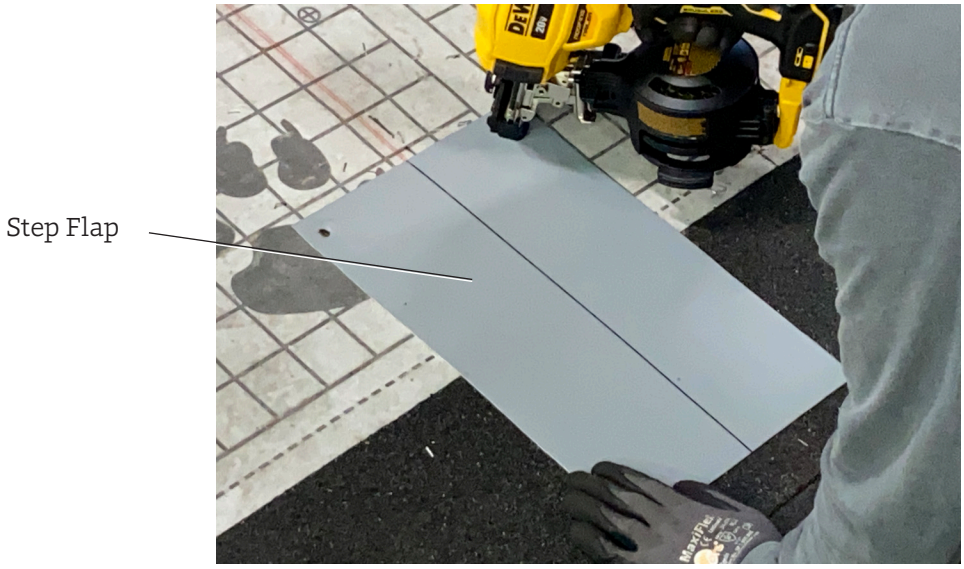


Figure 10. Nail Step Flap in place

Step 2d. Apply a bead of approved sealant.

- Flip the Solar Shingle over and remove the release liner from the underside. Apply 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.

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 as described in Step 2d, above.

Step 2. First Solar Shingle, continued

Step 2e. 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.
- Once Solar Shingles are installed, adjoining roofing shingles can be installed.

Figure 11. Install first Solar Shingle

Step 3. Bottom Row

Summary:

a. Install the next Solar Shingle, adding hand sealant on the first row..

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

Step 3a. Install the next Solar Shingle.

» Flip the Solar Shingle over and remove the release liner from the underside. Apply 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.

» 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 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.

- Proceed as for the first two Solar Shingles, applying hand sealant under each Solar Shingle prior to positioning. Sealant is only needed on the bottom row of the array.
- Complete the bottom row of the array.
- Align 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. Once Solar Shingles are installed, adjoining roofing shingles can be installed.

Step 5. Remaining Columns

Summary:

a. Interweave all Solar Shingle flaps correctly.

b. Once 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.

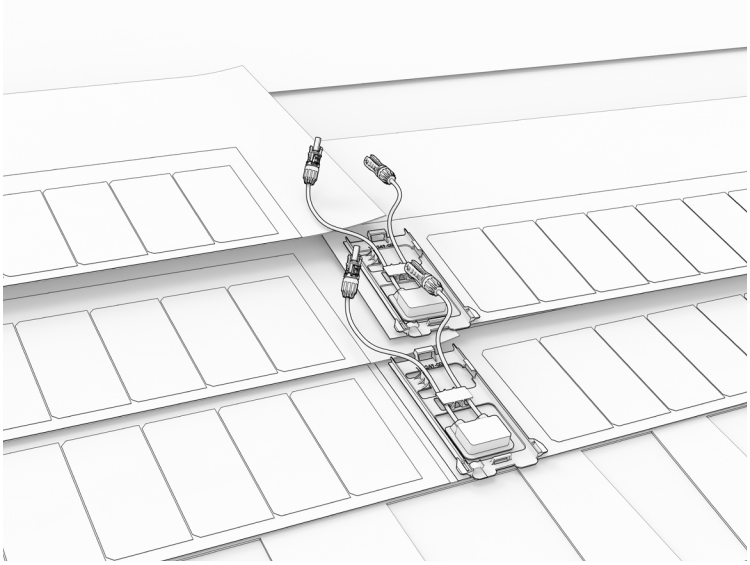


Figure 16. Interweave Solar Shingles up each column and across columns

Step 5. Remaining Columns, continued

Step 5b. **Once 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.

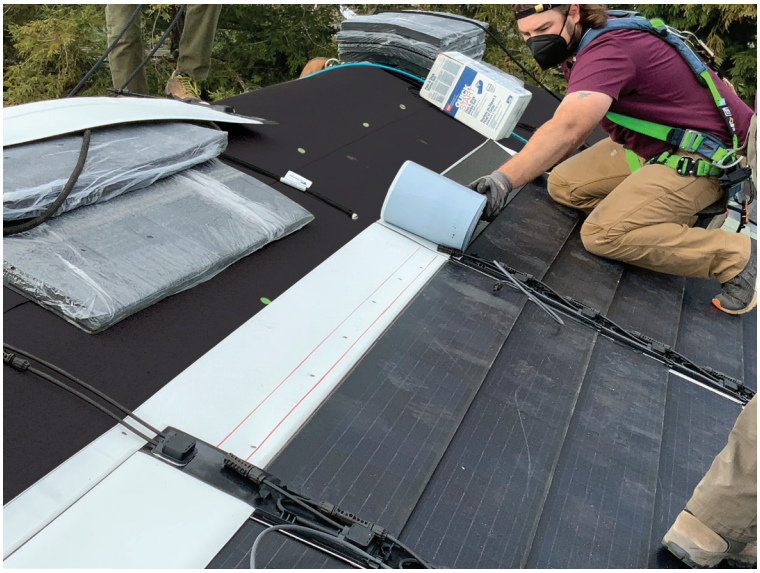


Figure 19. Use QuickStart® on columns without Jumper Modules

Step 7. Top Flashings

Summary:

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

b. Align Top Flashing.

c. Apply hand sealant.

d. 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 7c. Apply the hand sealant.

- » Prior to fastening the Top Flashing, apply a 1/4 inch bead of sealant horizontally on each side of the front edge, on the underside of the flashing, and approximately 1 inch up from the bottom edge.

Step 7. Top Flashings, continued

Step 7d. Nail the Top Flashing in place.

- Once 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.

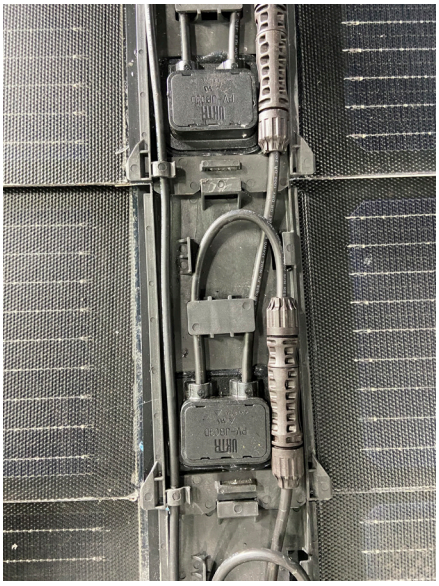
» Routed from bottom home run up to the Top Flashing.

» 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.



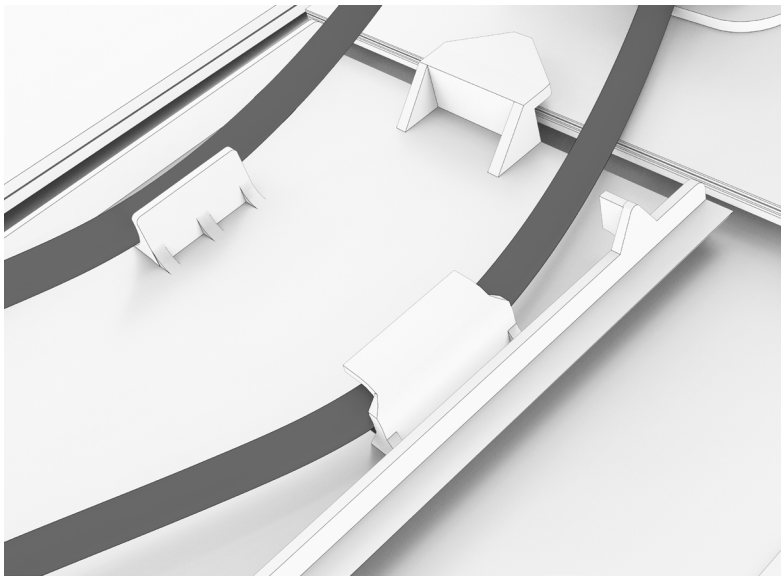


Figure 24. Use built-in wire clip features to secure wires

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.

» Once 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.

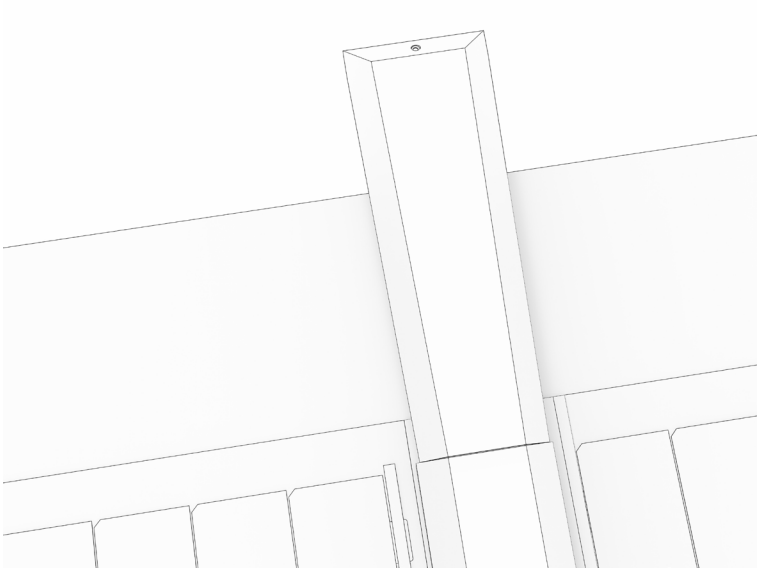


Figure 26. Attach Top Flashing lids

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.

f. Apply approved sealant between Jumper Modules and roofing shingles.

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.

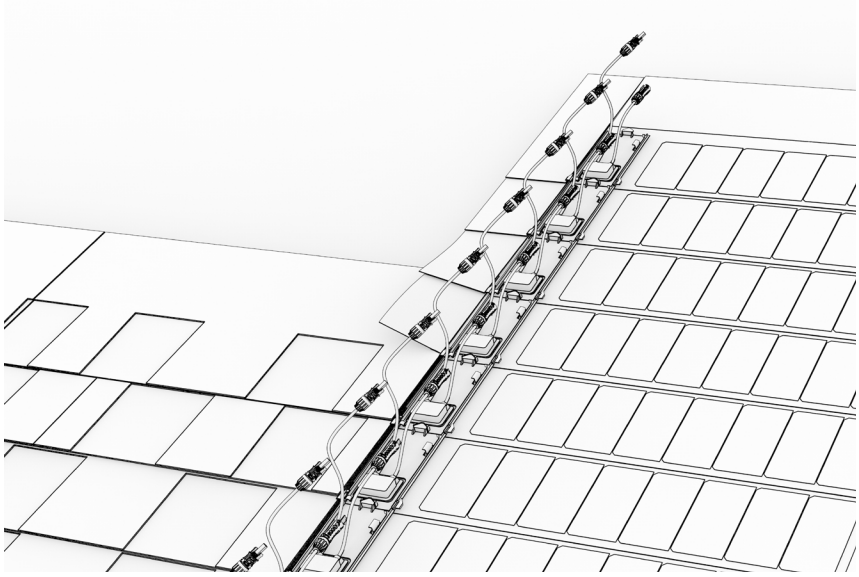


Figure 27. Shingles on array left side

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 a10 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.
- As the roofing shingles are installed going up the right side of the array, start at the bottom row and apply a 1/4 inch horizontal bead of sealant across the bottom of the right side flap, starting 1 inch over from the edge of the laminate and 1 inch up from the bottom edge of the side flap.
- Install the adjacent roofing shingle over the lowest exposed Solar Shingle right side flap with the sealant, while tucking under the right side flap immediately above.
- On the following row, lift the Solar Shingle right side flap and apply a 1 inch bead of sealant underneath the flap, directly onto the roofing shingle headlap below it.
- On top of that right side flap, apply the vertical bead of sealant in the same fashion as before and install the adjacent roofing shingle.
- 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.

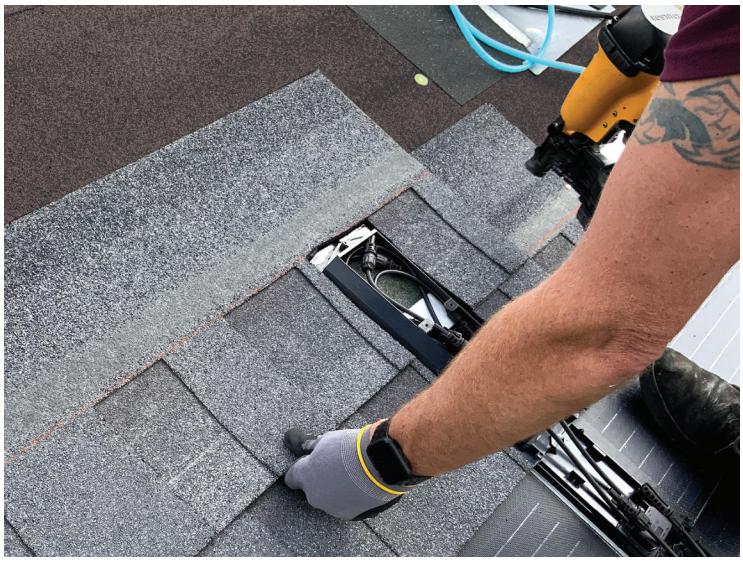


Figure 29. Cutting shingles around Top Flashing

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. Apply approved sealant between the Jumper Module and roofing shingle.

- Prior to hand sealing, ensure that all Jumper Modules are installed and that Quickstart is installed where no Jumper Module is needed.
- Starting from the leftmost Jumper Module, flip the first roofing shingle that will be installed and apply a 1/4 inch bead of GAF Energy-approved sealant directly above the adhesive on the underside of the roofing shingle, following the length and gaps of each bead of adhesive.
- Do not apply sealant within 1 inch from either side of the roofing shingle, or where a shingle butt joint is located (water egress).
- Carefully flip the roofing shingle and align it over top of the Jumper Module.
- 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.

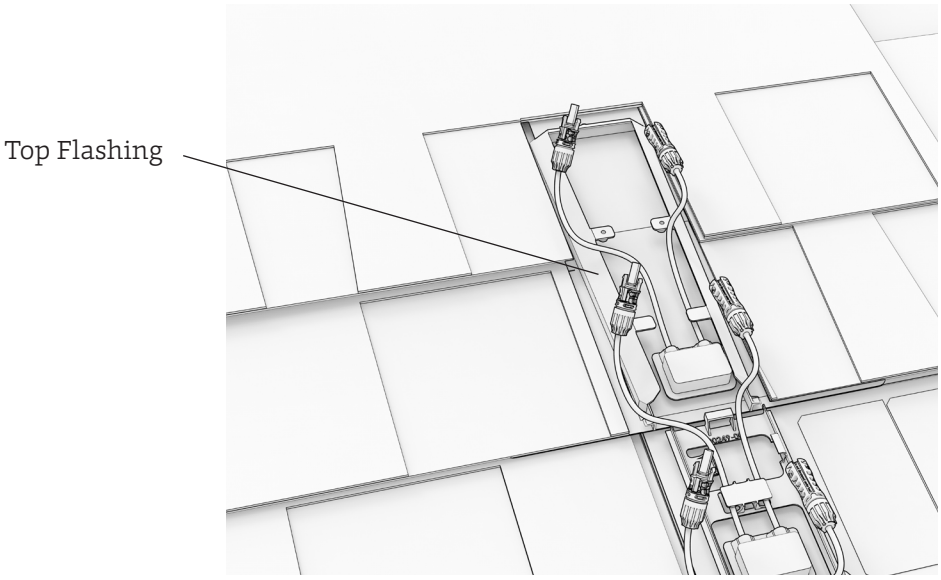
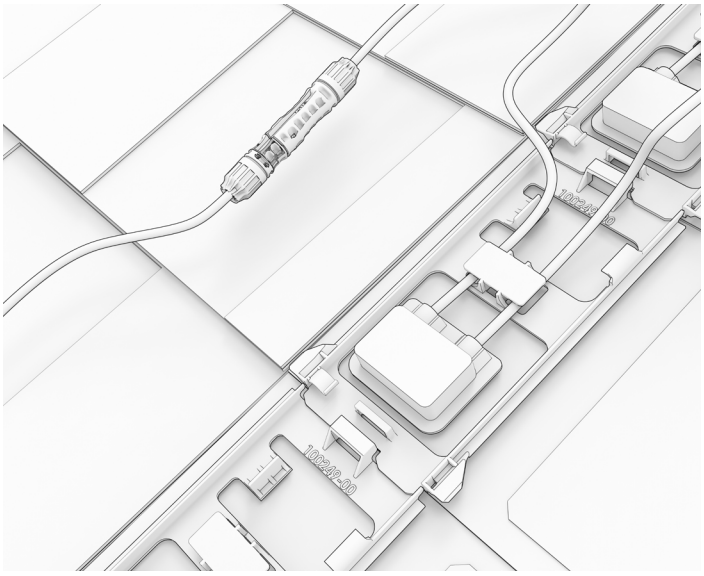


Figure 31. Remove Top Flashing lid

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

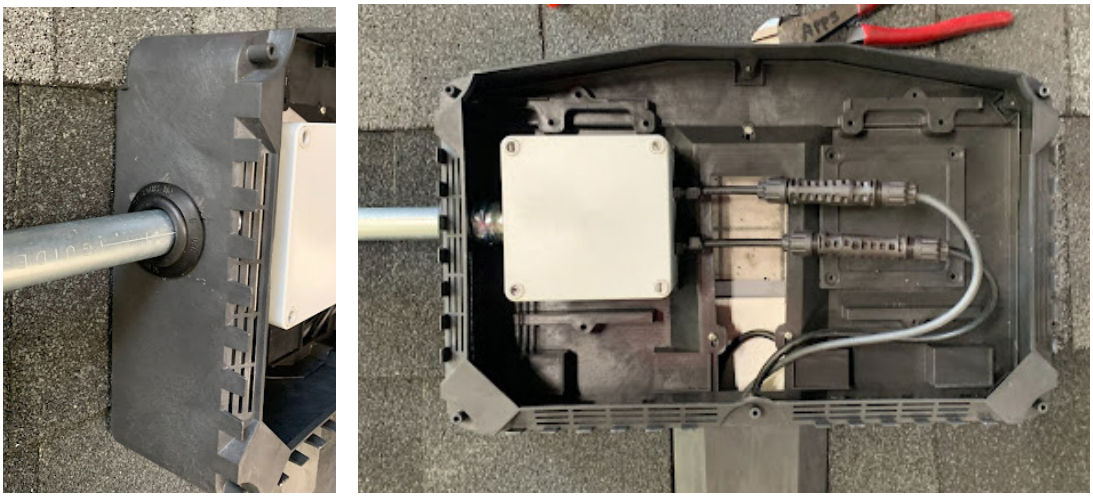
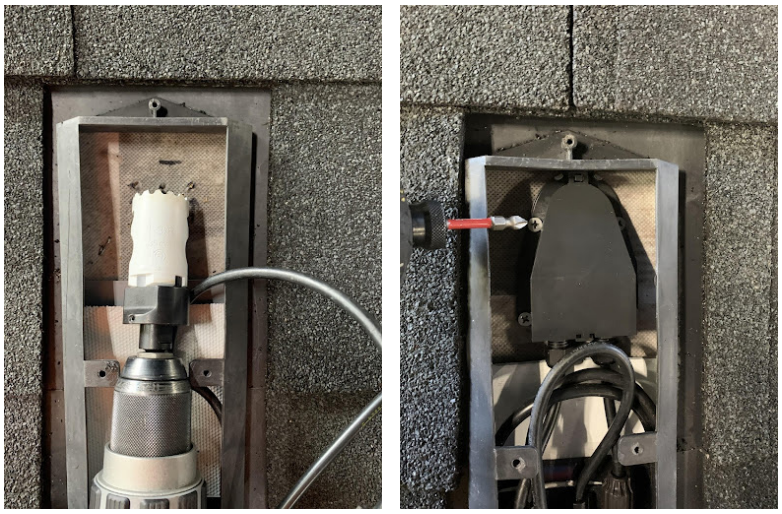


Figure 33. Transition Box and Splice Box with Conduit

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

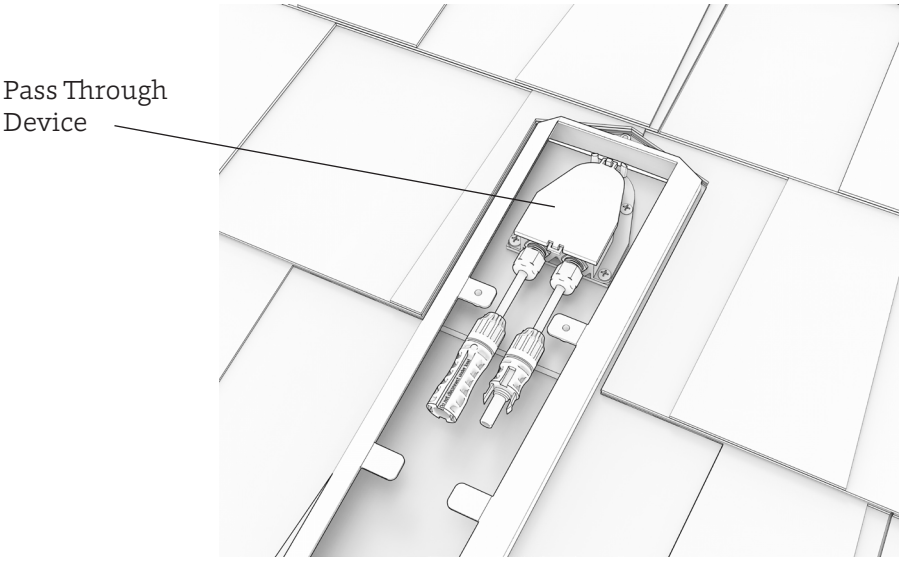


Figure 36. Pass Through Device sits over Top Flashing base

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.

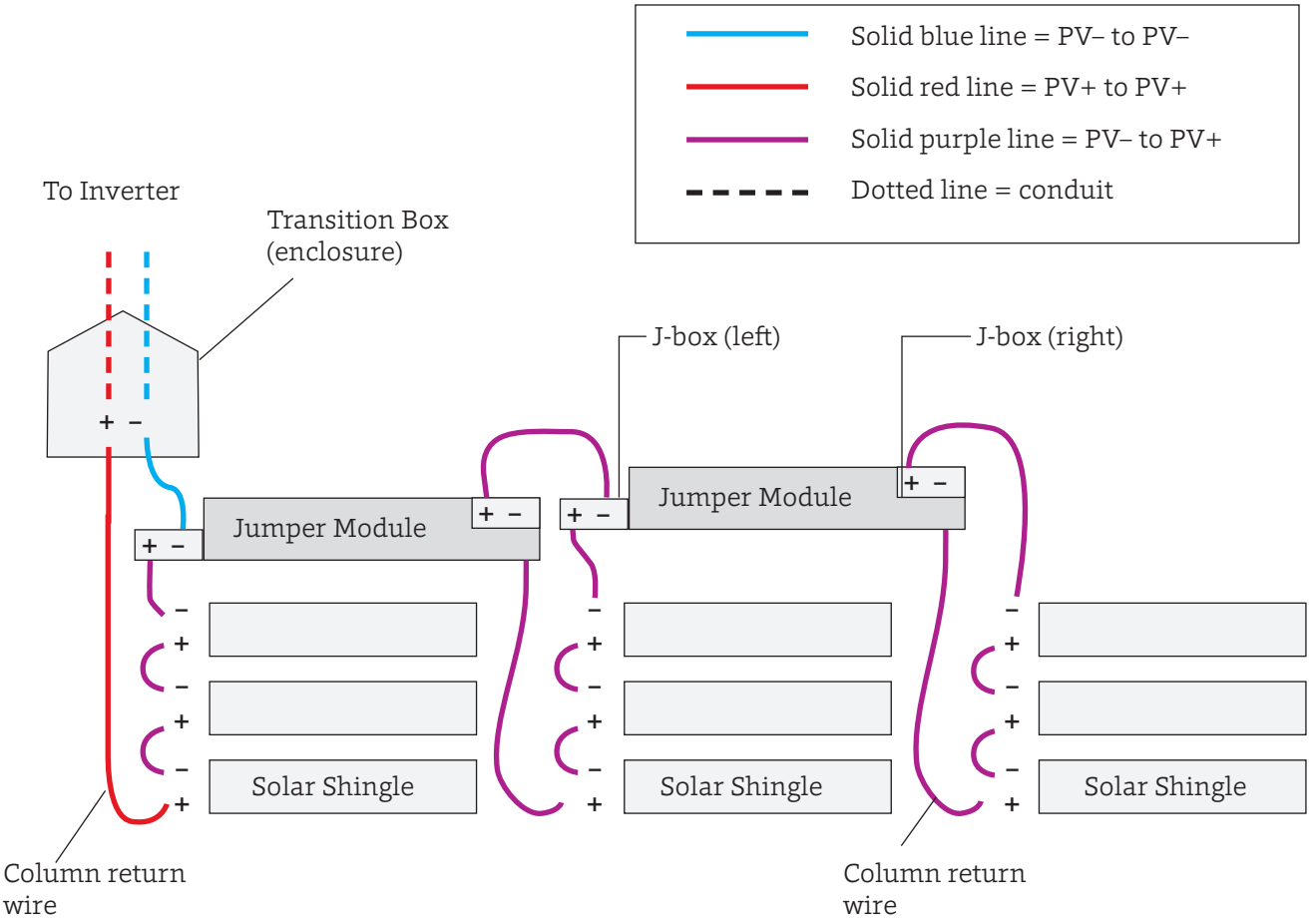
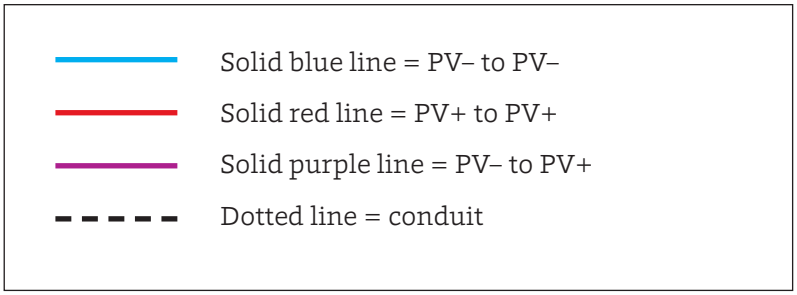


Figure 38. Array wiring

Array Wiring, continued



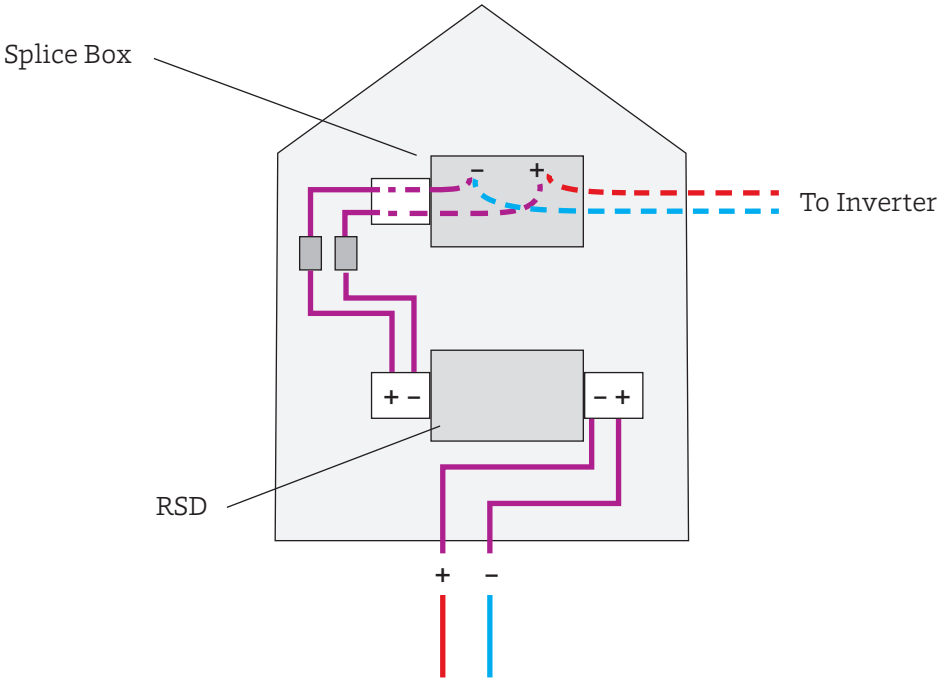


Figure 39. Array wiring inside the Transition Box

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

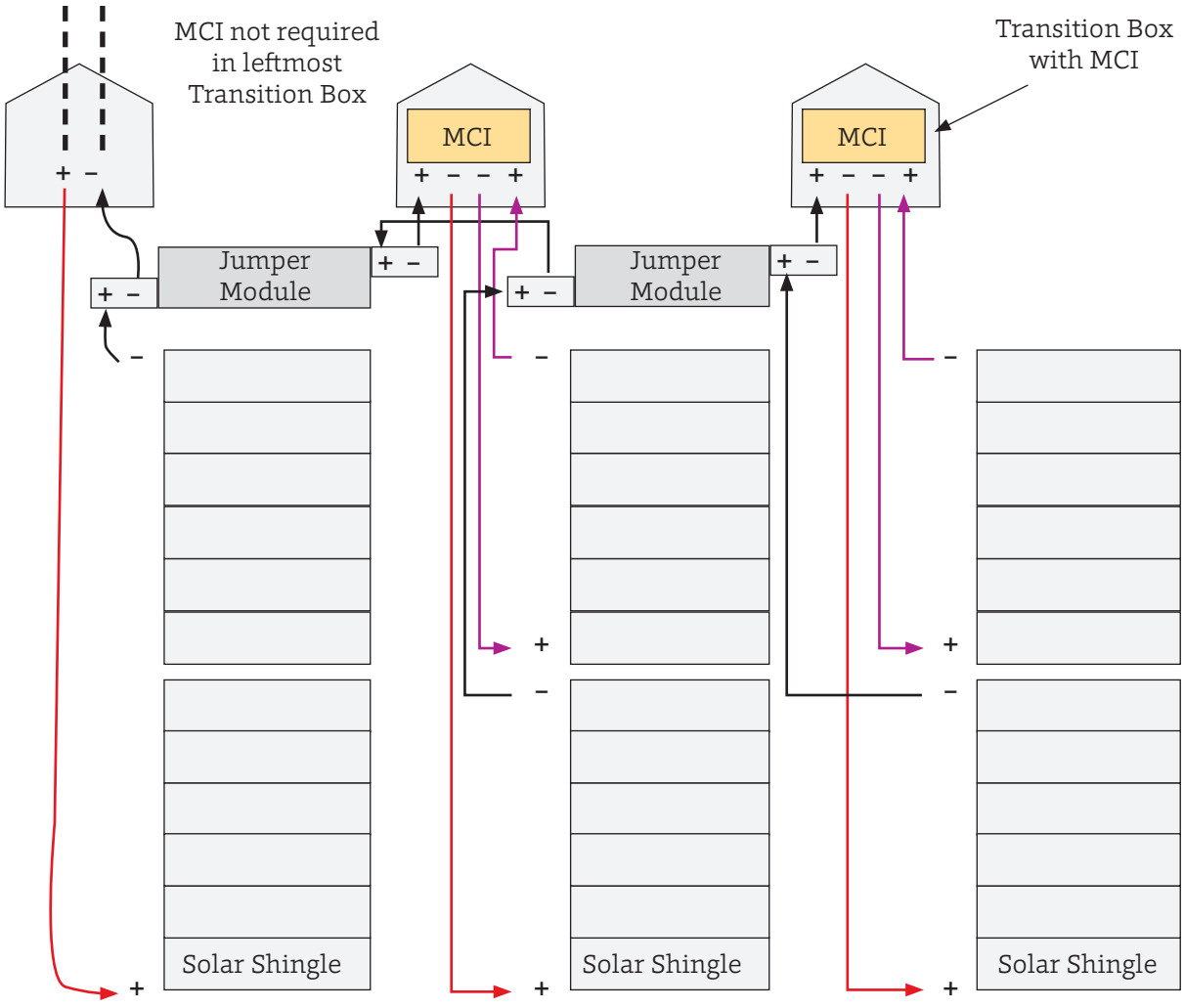


Figure 40. MCI wiring

Array Wiring, continued

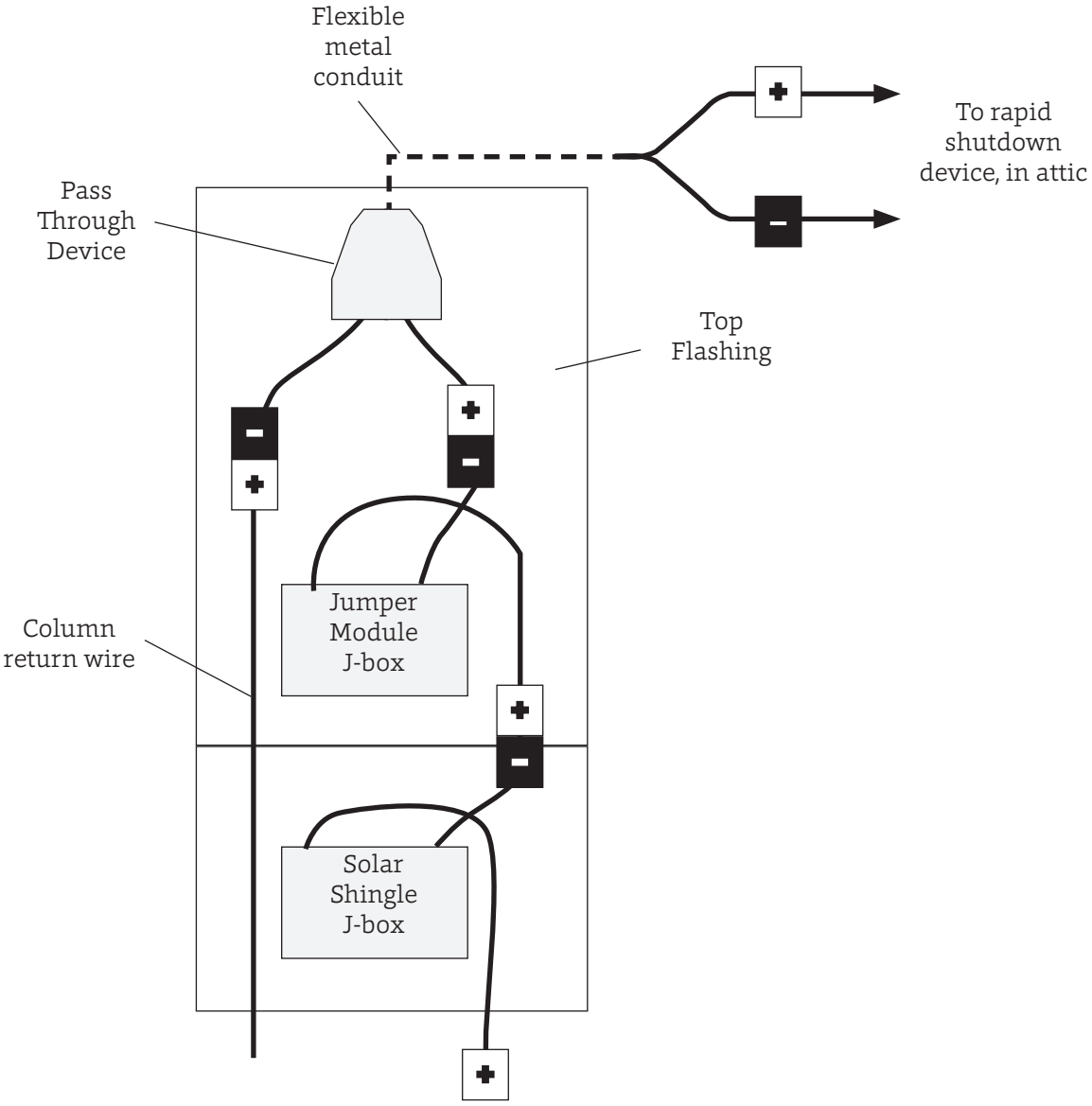


Figure 41. Array wiring for Pass Through Device

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 and void the warranty.
- 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

GAF ENERGY

Timberline Solar™

Solar Roofing System

gaf.energy