

MONTGOMERY COUNTY HISTORIC PRESERVATION COMMISSION
STAFF REPORT

| | | | |
|--------------------|---|-----------------------|---------------|
| Address: | 12 Montgomery Ave., Takoma Park | Meeting Date: | 3/2/2022 |
| Resource: | Contributing Resource Takoma Park Historic District | Report Date: | 2/23/2022 |
| Applicant: | Paul Miller | Public Notice: | 2/16/2022 |
| Review: | HAWP | Tax Credit: | n/a |
| Permit No.: | 979264 | Staff: | Dan Bruechert |
| Proposal: | Solar Panel Installation and Roof Replacement | | |

STAFF RECOMMENDATION

Staff recommends the HPC **approve** the HAWP.

ARCHITECTURAL DESCRIPTION

SIGNIFICANCE: Contributing Resource to the Takoma Park Historic District
STYLE: Colonial Revival
DATE: 1913



Figure 1: 12 Montgomery Ave. is located mid-block, oriented toward the south.

PROPOSAL

The applicant proposes to install 16 roof-mounted solar panels on two arrays.

APPLICABLE GUIDELINES

When reviewing alterations and new construction within the Takoma Park Historic District several documents are to be utilized as guidelines to assist the Commission in developing their decision. 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)*, Historic Preservation Commission Policy No. 20-01: ADDRESSING EMERGENCY CLIMATE MOBILIZATION THROUGH THE INSTALLATION OF ROOF-MOUNTED SOLAR PANELS, and *the Secretary of the Interior's Standards for Rehabilitation (Standards)*. The pertinent information in these documents is outlined below.

Takoma Park Historic District Guidelines

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

The design review emphasis will be restricted to changes that are at 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 district.

Contributing Resources should receive a more lenient review than those structures that have been classified as Outstanding. This design review should emphasize the importance of the resource to the overall streetscape and its compatibility with existing patterns rather than focusing on a close scrutiny of architectural detailing. In general, however, changes to Contributing Resources should respect the predominant architectural style of the resource. As stated above, the design review emphasis will be restricted to changes that are *at all visible from the public right-of-way*, irrespective of landscaping or vegetation.

Some of the factors to be considered in reviewing HAWPs on Contributing Resources include:

All exterior alterations, including those to architectural features and details, should be generally consistent with the predominant architectural style and period of the resource and should preserve the predominant architectural features of the resource; exact replication of existing details and features is, however, not required

Alterations to features that are not visible from the public right-of-way should be allowed as a matter of course

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

Montgomery County Code; Chapter 24A-8

- (a) 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; or

Secretary of the Interior's Standards for Rehabilitation:

2. The historic character of a property shall be retained and preserved. The removal of historic materials or alteration of features and spaces that characterize a property shall be avoided.
9. New additions, exterior alterations, or related new construction will not destroy historic materials, features, and spatial relationships that characterize the property. The new work shall be differentiated from the old and will be compatible with the historic materials, features, size, scale and proportions, and massing to protect the integrity of the property and its environment.
10. New additions and adjacent or related new construction will 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).
5. A Historic Area Work Permit (HAWP) is required for all work referenced in this policy.

STAFF DISCUSSION

The subject property is a two-story, stucco-clad, Colonial Revival house with a side gable roof and a non-historic rear addition with a rear gable roof. Due to the change in grade along Montgomery Ave., the subject property is several feet higher than street level.

The applicant proposes to install a total of 16 (sixteen) solar panels in two arrays, 12 (twelve) panels will be installed on the south (front-facing) roof slope, and the remaining 4 (four) will be installed on the right (east) roof slope on the non-historic addition. Additionally, the applicant proposes to re-shingle the roof; replacing the asphalt 3-tab shingles with architectural shingles. Staff finds the proposed work complies with the requisite guidance and recommends the HPC approve the HAWP application.

Roof Replacement

In the Takoma Park Historic District, the HPC has consistently determined that replacing 3-tab with architectural shingle roofs is an appropriate treatment for ‘Contributing’ resources because the architectural shingles maintain the general appearance and profile of the 3-tab shingles. Staff finds this is the case with the subject property and recommends the HPC approve the roof replacement under 24A-8(1) and (2) and the *Design Guidelines*. If it were considered on its own, this alteration would qualify for staff approval of the HAWP under the HPC’s updated Bylaws.

Solar Panel Installation

The larger proposed alteration in this HAWP application is for the installation a total of 16 (sixteen) solar panels on two roof slopes.

On the right rear (east) facing roof slope, the applicant proposes to install four solar panels. Staff finds these panels will not be visible from the public right-of-way and are one of the preferred locations for solar panels on buildings in historic districts. Therefore, Staff recommends the HPC approve these four panels under the *Design Guidelines* and the adopted solar policy.

The applicant proposes to install 12 (twelve) solar panels on the front (south) facing roof slope in a 2 × 6 configuration. Installing solar panels on the front roof slopes is generally a disfavored location unless the applicant can demonstrate that no other location is sufficient. Staff finds that a ground-mounted array is not feasible, because of the size of the subject property and the trees in the rear of the property.

Additionally, those trees keep the detached garage in shade, which makes a roof installation unacceptable in that location. The next preferred locations are the rear or on non-historic additions. The rear of the subject property is a non-historic rear addition with a rear-facing gable roof with slopes that face east (right) and west (left). The applicant created a shade report in the accompanying application materials (see below) to demonstrate the areas of the roof that receive sufficient amounts of direct sunlight. The western roof slope is largely in the shade of mature trees in the rear yard, which makes it an infeasible location. The eastern roof slope receives a moderate amount of sun. The front roof slope, oriented toward the south, receives a significant amount of sunlight.

Annual irradiance

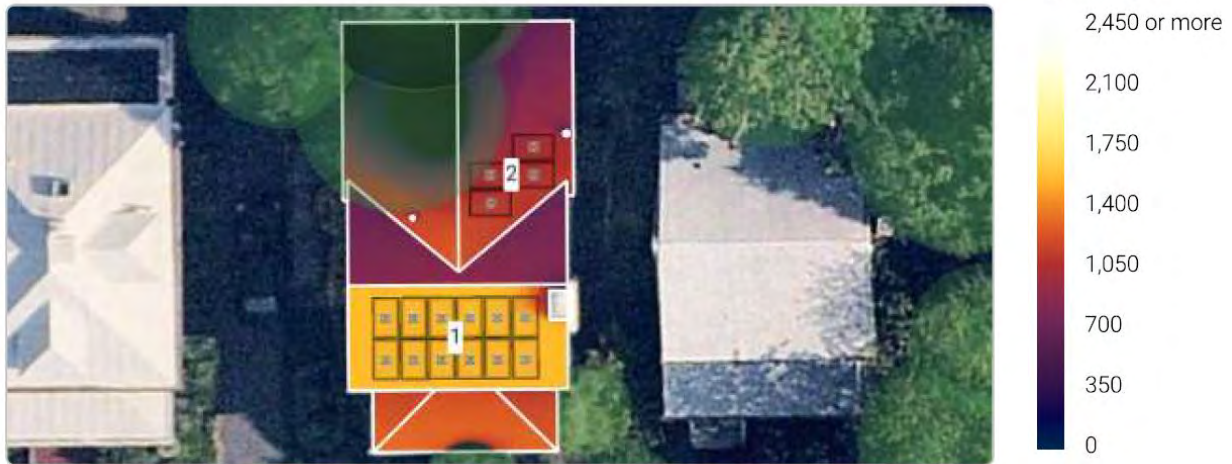


Figure 2: Shade report for the subject property.

The calculations provided by the applicant show that the proposed configuration would offset 97% (ninety-seven percent) of the household's energy use.

In response to questions from Staff, the applicant produced an alternative array that eliminates any front-facing panels. None of the panels in this configuration would be visible from the public right-of-way. The alternate configuration has the same number of panes, 16 (sixteen), as the proposed array but would only offset 43% (forty-three percent) of the household's energy usage. The payback period for this configuration is nearly four times longer than the proposed array.

Annual irradiance

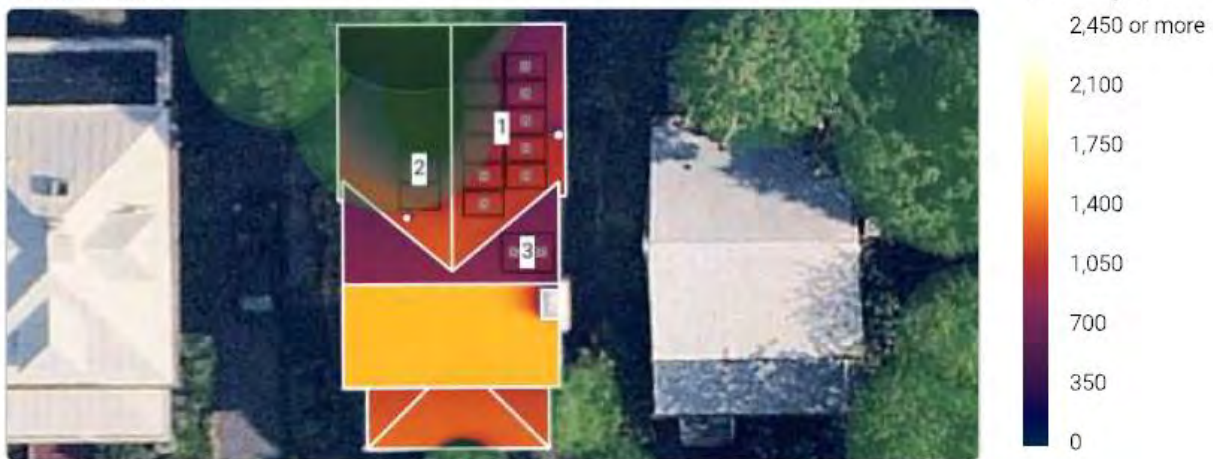


Figure 3: Alternative array configuration without front-facing panels.

Staff finds that the all-rear configuration presented demonstrates that, due to the resource's orientation, front-facing panels are necessary for adequate solar collection. Staff further finds that the side gable roof, which lacks dormers or an interior chimney, is not architecturally significant; and that the proposal will not impact any historic fabric. Based on these findings, Staff recommends the HPC approve the proposed solar installation under 24A-8(b)(6).

There are two 'Outstanding' resources further down the block across the street at 17 and 19 Montgomery Ave., but most of the other buildings on the block are categorized as either 'Contributing' or 'Non-Contributing.' Additionally, several other houses on this side of the street have front-facing solar including, 6 Montgomery Ave., 18 Montgomery Ave., and 20 Montgomery Ave.

STAFF RECOMMENDATION

Staff recommends that the Commission **approve** the HAWP application; under the Criteria for Issuance in Chapter 24A-8(b)(6) and the *Takoma Park Historic District Guidelines*, and the *Historic Preservation Commission Policy No. 20-01: ADDRESSING EMERGENCY CLIMATE MOBILIZATION THROUGH THE INSTALLATION OF ROOF-MOUNTED SOLAR PANELS*; having found that the proposal will not substantially alter the exterior features of the historic resource and is compatible in character with the district and the purposes of Chapter 24A;

and with the *Secretary of the Interior's Standards for Rehabilitation* #2, 9, and 10;

and with the general condition that the applicant shall present an electronic set of drawings, if applicable, to Historic Preservation Commission (HPC) staff for review and stamping prior to submission for the Montgomery County Department of Permitting Services (DPS) building permits;

and with the general condition that final project design details, not specifically delineated by the Commission, shall be approved by HPC staff or brought back to the Commission as a revised HAWP application at staff's discretion;

and with the general condition that the applicant shall notify the Historic Preservation Staff if they propose to make **any alterations** to the approved plans. Once the work is completed the applicant will contact the staff person assigned to this application at 301-563-3400 or dan.bruechert@montgomeryplanning.org to schedule a follow-up site visit.



FOR STAFF ONLY:
HAWP# 979264
DATE ASSIGNED _____

**APPLICATION FOR
HISTORIC AREA WORK PERMIT**
HISTORIC PRESERVATION COMMISSION
301.563.3400

APPLICANT:

Name: Paul Miller

E-mail: prmiiii2003@yahoo.com

Address: 12 Montgomery Ave

City: Takoma Park Zip: 20912

Daytime Phone: 2406642818

Tax Account No.: 01072985

AGENT/CONTACT (if applicable):

Name: Ola Carew

E-mail: ocarew@luminasolar.com

Address: 3600 Commerce Drive Ste 601

City: Baltimore Zip: 21227

Daytime Phone: 443-425-3023

Contractor Registration No.: MHIC 30991

LOCATION OF BUILDING/PREMISE: MIHP # of Historic Property _____

Is the Property Located within an Historic District? ☒ 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: _____ Street: _____

Town/City: _____ Nearest Cross Street: _____

Lot: _____ Block: _____ Subdivision: _____ 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:

- | | | |
|---|--|--|
| <input type="checkbox"/> New Construction | <input type="checkbox"/> Deck/Porch | <input type="checkbox"/> Shed/Garage/Accessory Structure |
| <input type="checkbox"/> Addition | <input type="checkbox"/> Fence | <input checked="" type="checkbox"/> Solar |
| <input type="checkbox"/> Demolition | <input type="checkbox"/> Hardscape/Landscape | <input type="checkbox"/> Tree removal/planting |
| <input type="checkbox"/> Grading/Excavation | <input type="checkbox"/> Roof | <input type="checkbox"/> Window/Door |
| | | <input type="checkbox"/> 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.

Ola Carew

01/05/2022

Signature of owner or authorized agent

Date

HAWP APPLICATION: MAILING ADDRESSES FOR NOTIFYING
[Owner, Owner's Agent, Adjacent and Confronting Property Owners]

| | |
|--|--|
| Owner's mailing address 12 Montgomery Ave Takoma Park MD 20912 | Owner's Agent's mailing address 3600 Commerce Drive Ste 601 Halethroe MD 21227 |
| Adjacent and confronting Property Owners mailing addresses | |
| 10 Montgomery Ave Philip Schuler & Rachel Schmidt | 11 Montgomery Ave Marianna Diggs |
| 13 Montgomery Ave James Ogorzalek | 14 Montgomery Ave William Huang |
| 13 Columbia Avenue | |

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

Home is in great shape however, roof has to be replaced prior to solar panel installation.

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

Installing 16 Roof Mounted Solar Panels on Front Face Roof and Right Rear Roof

| | |
|--|---|
| Work Item 1: _____ | |
| Description of Current Condition: <div>Good Condition</div> | Proposed Work: <div>Install 16 Roof Mounted Solar Panels on Front Facing Roof and Rear Right Roof.</div> |

| | |
|-----------------------------------|----------------|
| Work Item 2: _____ | |
| Description of Current Condition: | Proposed Work: |

| | |
|-----------------------------------|----------------|
| Work Item 3: _____ | |
| Description of Current Condition: | Proposed Work: |

Desired design= 12 street-facing panels located on the southern slope and 4 panels located in the best location on the rear east sloping roof. The total yield or number of sun hours between both southern and eastern slopes is 1,176 kWh/kWp. This indicates the total number of expected sun hours hitting these two roof surfaces after all derating factors to include but not limited to, shade, azimuth, roof pitch, weather, soiling and line loss.

This design would produce 6,963 kWh annually. Generating a year 1 electricity savings of \$974.82. An ROI of 2.5 years.

All Rear Design= 16 panels on the rear roof with 2 panels on the northern slope, 11 on the eastern slope and 3 on the western slope produces a yield of just 515 kWh/kWp since the majority of the panels are under the tree that covers the majority of the rear of the home.

This design would produce just 3,050 kWh annually. Generating a year 1 savings of \$427 in year 1. Extending the ROI from 2.5 years to 8 years.

Takoma Park being a forward thinking region within Montgomery county, contains residents that are in tune with and dedicated to reducing their carbon footprint. These residents such as the 4 other families on Montgomery Ave that Lumina has worked with in the past (2 of which have street facing panels) want to do their part to reduce their greenhouse gas emissions. This is honorable and something that should be supported to further add to Takoma Park's great reputation. Given that other families on this street have gone solar and some of which with street facing panels we believe that the same approval should be provided to Mr. Miller and his families such as to reward them for doing their part and to also not deter others from deciding to do the same.

A consideration should also be placed on the fact that Mr. Miller stands to save quite a bit of money on his electric bill over the course of the systems life. Placing panels on the rear greatly reduces this savings while the cost remains the same, greatly reducing the economic and environmental benefit.

We appreciate the need to preserve the historic nature of the home and area and understand the need for historic review. We do hope that Mr. Miller gets approved as his neighbors did so that he can proceed forward with his goal of doing his part and joining his neighbors in the fight to slow climate change."



AOstructures Inc.
PO Box 413
Carnelian Bay, CA 96140
916.541.8586
www.AOstructures.com

December 8, 2021

TO: Lumina Solar

SUBJECT: Roof-top Solar PV Addition - Miller Residence
12 Montgomery Ave., Takoma Park, MD. 20912

SCOPE OF WORK:

AOstructures, Inc. was asked to provide a structural review for the project at the above subject location. The scope of this report is strictly limited to the items listed below and based on the design criteria listed below. See additional limitations in Appendix B.

- Analyze the existing structure(s) to see if it is/they are suitable to support the additional weight of the proposed roof mounted solar PV system.
- Evaluate the connection capacity of the proposed racking system to the existing roof structure.

PROVIDED INFORMATION:

As-built plans were not provided for our review. The findings of this report are based upon a jobsite evaluation of the existing condition of the existing framing system collected by Lumina Solar as requested by AOstructures, Inc.. All attached structural calculations are based on the provided information and are only deemed valid if the provided information is true and accurate.

OBSERVED CONDITIONS:

The observed roof framing is described below. If field conditions differ, the contractor shall notify the engineer prior to starting construction.

The roof structure of (Roof A) consists of composition shingle on 1x decking that is supported by 2x6 rafters @ 24"o.c. with ceiling joists acting as rafter ties. The rafters have a max projected horizontal span of 12'-0", with a slope of 27 degrees. The rafters are connected at the ridge to a ridge board and are supported at the eave by a load bearing wall.

The roof structure of (Roof B) consists of composition shingle on roof plywood that is supported by nominal 2x8 rafters @ 16"o.c. with ceiling joists acting as rafter ties. The rafters have a max projected horizontal span of 13'-0", with a slope of 22 degrees. The rafters are connected at the ridge to a ridge board and are supported at the eave by a load bearing wall.

CONCLUSIONS:

The existing roof framing members of (Roof A) are judged to be inadequate to withstand the loading imposed by the installation of the solar panels. Structural reinforcement is required. Sister upgrade is required for all rafters with PV standoffs attaching to them on (Roof A). Stitch new 12'-0" long 2x6 SPF#2 or DF#2 (min) to existing member with Simpson SDW 22300 screws @ 16"o.c. or 10d nails @ 6"o.c.. Lap as needed with 4'-0" minimum lap. See attached detail for reference.

The existing roof framing members of (Roof B) are judged to be adequate to withstand the loading imposed by the installation of the solar panels. No The spacing of the solar standoffs shall not exceed 48" o.c. and be staggered. All racking hardware shall be installed per manufacturer specifications and utilized within the manufacturers design limitations based on the design criteria of this report. AOstructures, Inc. assumes no responsibility for hardware installed outside the design & install specifications of the manufacturer. All waterproofing shall be provided by the contractor.

DESIGN CRITERIA:

- Applicable Codes = 2018 IBC/IRC, ASCE 7-16
- 60 cell solar PV modules w/ a flush mounted rail based racking system
- Roof Dead Load = 11 psf (Roof A) -- 10 psf (Roof B)
- Roof Live Load = 20 psf
- Wind Speed = 115 mph, Exposure C, Risk Category II
- Ground Snow Load = 30 psf - Roof Snow Load = 21 psf
- Per IBC 1613.1; Seismic check is not required

Please contact me with any further questions or concerns regarding this project.

Sincerely,
Andrew Oesterreicher, P.E.



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. 49910 Expires: 9/15/22

Miller, Paul, Takoma Park, MD 20912



AOstructures Inc.
PO Box 413
Carnelian Bay, CA 96140
916.541.8586
www.AOstructures.com

Address: 12 Montgomery Ave., Takoma Park, MD. 20912

Wind Design

Exposure: C
Wind Speed: 115 mph
Risk Category: II

Aerial Image





Wind Calculations

Per ASCE 7-16 § 29.4.4 - Components and Cladding - Solar Specific

Input Variables

| | | | |
|-------------------|---------|---------------------|--------------------------|
| Wind Speed | 115 mph | Roof Slope | 22 deg |
| Exposure Category | C | Mean Roof Height | 30 ft |
| Roof Shape | Gable | Effective Wind Area | 11.0 sft (standoff area) |

Design Wind Pressure Calculations

| | | |
|--|---------|-----------------------|
| Wind Pressure $P = qh (GCp) (\gamma_e) (\gamma_a)$ | | (Eq. 29.4-7) |
| $qh = 0.00256 * Kz * Kzt * Kd * Ke * V^2$ | | (Eq. 26.10-1) |
| Kz (Exposure Coefficient) = | 0.98 | (Table 26.10-1) |
| Kzt (topographic factor) = | 1 | (Fig. 26.8-1) |
| Kd (Wind Directionality Factor) = | 0.85 | (Table 26.6-1) |
| Ke (Ground Elevation Factor) = | 1 | (Table 26.9-1) |
| V (Design Wind Speed) = | 115 mph | (Fig. 26.5-1) |
| Risk Category = | II | (Table 1.5-1) |
| (γ_e) Array Edge Factor = | 1.00 | 29.4.4 |
| (γ_a) Solar Panel Pressure Equalization = | 0.80 | (Figure 29.4-8) |
| $qh (\gamma_e) (\gamma_a) =$ | 22.56 | Ultimate Design Level |
| $0.6 * qh (\gamma_e) (\gamma_a) =$ | 13.54 | ASD Design Level |

Standoff Uplift Calculations (ASD Level)

| | | | | |
|------------------------------|---------------|---------------|---------------|---------------------|
| Zone(s) = | 3r | 2n, 2r, 3e | 1, 2e | (+) |
| $GCp =$ | -2.66 | -2.46 | -1.50 | 0.50 (Fig. 30.3-2C) |
| ASD Uplift Pressure (psf) = | -36.03 | -33.32 | -20.31 | 10.00 |
| X Tributary Width (ft) = | 2.67 | 4.00 | 4.00 | |
| Y Tributary Width (ft) = | 2.74 | 2.74 | 2.74 | |
| Tributary Area (sf) = | 7.31 | 10.97 | 10.97 | |
| Footing Uplift (lb) = | -263.4 | -365.4 | -222.7 | |

Standoff Uplift Check

| | |
|---------------------------------|---------------|
| Maximum Design Uplift = | -365 lb |
| Standoff Uplift Capacity = | 400 lb |
| 400 lb capacity > 365 lb demand | Therefore, OK |

Fastener Uplift Capacity Check

| | |
|---------------------------------|------------------|
| Fastener = | 5/16"Ø Lag Screw |
| Number of Fasteners = | 1 |
| Embedment Depth = | 2.0 in |
| Pullout Capacity Per Inch = | 205 lb (per NDS) |
| Fastener Capacity = | 410 lb |
| w/ Cd of 1.6 = | 656 lb |
| 656 lb capacity > 365 lb demand | Therefore, OK |



GRAVITY LOADS

Roof Snow Load Calculations

| | | |
|---|-----------------|---------------------|
| Unobstructed, Slippery Roof Surface? | no | |
| Roof Slope | 22 degrees | |
| p_g = Ground Snow Load = | 30.0 psf | |
| $p_f = 0.7 C_e C_t I p_g$ | | (ASCE7 - Eq 7-1) |
| C_e = Exposure Factor = | 1.0 | (ASCE7 - Table 7-2) |
| C_t = Thermal Factor = | 1.0 | (ASCE7 - Table 7-3) |
| I = Importance Factor = | 1.0 | (ASCE7 - 7.3.3) |
| p_f = Flat Roof Snow Load = | 21.0 psf | |
| $p_s = C_s p_f$ | | (ASCE7 - Eq 7-2) |
| C_s = Slope Factor = | 1.00 | (ASCE7 - Fig. 7-2) |
| p_s = Sloped Roof Snow Load = | 21.0 psf | |

PV Dead Load = 3 psf (Per Lumina Solar)

Roof Dead Load (Roof A)

| | |
|--------------------------------|----------------------------|
| Composition Shingle | 4.00 psf |
| 1x Decking | 3.00 |
| Double 2x6 Rafters @ 24"o.c. | 2.30 |
| Vaulted Ceiling | 0.00 (Ceiling Not Vaulted) |
| Miscellaneous | 1.70 |
| Total Roof DL (Roof A) | 11.0 psf |
| DL Adjusted to 27 Degree Slope | 12.3 psf |

Roof Dead Load (Roof B)

| | |
|--------------------------------|----------------------------|
| Composition Shingle | 4.00 psf |
| Roof Plywood | 2.00 |
| 2x8 Rafters @ 16"o.c. | 2.27 |
| Vaulted Ceiling | 0.00 (Ceiling Not Vaulted) |
| Miscellaneous | 1.73 |
| Total Roof DL (Roof B) | 10.0 psf |
| DL Adjusted to 22 Degree Slope | 10.8 psf |



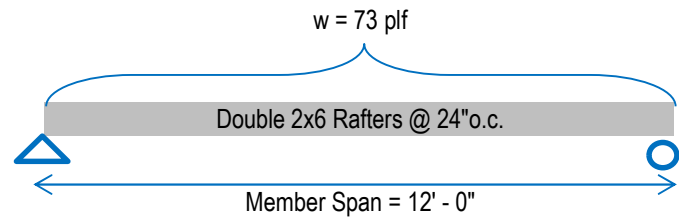
FRAMING CHECK

(Roof A)

PASS - With Framing Upgrades

Dead Load 12.3 psf
PV Load 3.0 psf
Snow Load 21.0 psf

Governing Load Combo = DL + SL
Total Load 36.3 psf



Member Properties - Based on Upgraded Section

| Member Size | S (in ³) | I (in ⁴) | Lumber Sp/Gr | Member Spacing |
|-------------|----------------------|----------------------|--------------|----------------|
| Double 2x6 | 15.13 | 41.59 | SPF#2 | @ 24"o.c. |

Check Bending Stress

| | | | | | | | | |
|------------|----------------|---|----------------|---|----------------|---|----------------|-------------------|
| Fb (psi) = | f _b | x | C _d | x | C _f | x | C _r | (NDS Table 4.3.1) |
| | 875 | x | 1.15 | x | 1.3 | x | 1.15 | |

Allowed Bending Stress = 1504.3 psi

Maximum Moment = $(wL^2) / 8$
= 1308.441 ft#
= 15701.29 in#

Actual Bending Stress = (Maximum Moment) / S
= 1038.2 psi

Allowed > Actual -- 69.1% Stressed -- Therefore, OK

Check Deflection

Allowed Deflection (Total Load) = $L/180$ (E = 1400000 psi Per NDS)
= 0.8 in

Deflection Criteria Based on = Simple Span
Actual Deflection (Total Load) = $(5 * w * L^4) / (384 * E * I)$
= 0.583 in
= L/247 > L/180 **Therefore OK**

Allowed Deflection (Live Load) = $L/240$
= 0.6 in

Actual Deflection (Live Load) = $(5 * w * L^4) / (384 * E * I)$
= 0.337 in
L/428 > L/240 **Therefore OK**

Check Shear

Member Area = 16.5 in² F_v (psi) = 135 psi (NDS Table 4A)
Allowed Shear = F_v * A = 2228 lb Max Shear (V) = w * L / 2 = 436 lb

Allowed > Actual -- 19.6% Stressed -- Therefore, OK

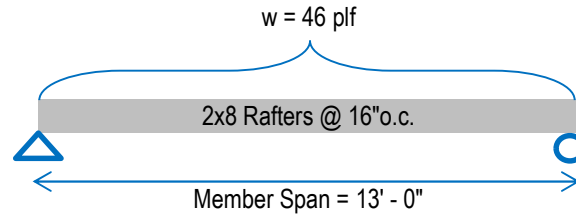
Framing Check

(Roof B)

PASS

Dead Load 10.8 psf
PV Load 3.0 psf
Snow Load 21.0 psf

Governing Load Combo = DL + SL
Total Load 34.8 psf



| Member Properties | | | | |
|-------------------|----------------------|----------------------|--------------|----------------|
| Member Size | S (in ³) | I (in ⁴) | Lumber Sp/Gr | Member Spacing |
| 2x8 | 13.14 | 47.63 | SPF#2 | @ 16" o.c. |

| Check Bending Stress | | | | | | | |
|-------------------------------------|-----|---|------|---|-----|---|------|
| Fb (psi) = | f'b | x | Cd | x | Cf | x | Cr |
| | 875 | x | 1.15 | x | 1.2 | x | 1.15 |
| Allowed Bending Stress = 1388.6 psi | | | | | | | |

Maximum Moment = $(wL^2) / 8$
 $= 979.787 \text{ ft}\#$
 $= 11757.4 \text{ in}\#$
 Actual Bending Stress = (Maximum Moment) / S
 $= 894.8 \text{ psi}$

Allowed > Actual - 64.5% Stressed -- Therefore, OK

| Check Deflection | |
|-----------------------------------|---|
| Allowed Deflection (Total Load) = | $L/180$ (E = 1400000 psi Per NDS) |
| | = 0.866 in |
| Deflection Criteria Based on = | Simple Span |
| Actual Deflection (Total Load) = | $(5 \cdot w \cdot L^4) / (384 \cdot E \cdot I)$ |
| | = 0.447 in |
| | = L/349 > L/180 Therefore OK |

| | |
|----------------------------------|---|
| Allowed Deflection (Live Load) = | $L/240$ |
| | 0.65 in |
| Actual Deflection (Live Load) = | $(5 \cdot w \cdot L^4) / (384 \cdot E \cdot I)$ |
| | 0.270 in |
| | L/578 > L/240 Therefore OK |

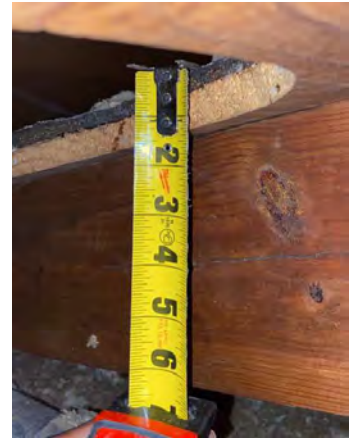
| Check Shear | |
|------------------------------------|------------------------------------|
| Member Area = 10.9 in ² | Fv (psi) = 135 psi (NDS Table 4A) |
| Allowed Shear = Fv * A = 1468 lb | Max Shear (V) = w * L / 2 = 301 lb |

Allowed > Actual -- 20.6% Stressed -- Therefore, OK



AOstructures Inc.
PO Box 413
Carnelian Bay, CA 96140
916.541.8586
www.AOstructures.com

Appendix A: Framing Information & Site Specific Pictures



(Roof A)



(Roof B)



AOstructures Inc.
PO Box 413
Carnelian Bay, CA 96140
916.541.8586
www.AOstructures.com

Appendix B: General Notes

GENERAL

- The contractor shall verify all dimensions, property setbacks, AHJ/HOA CC&R's, elevations and site conditions before starting work and shall notify AOstructure, Inc, (AOstructures) of any discrepancies.
- All report conclusions represent AOstructures, Inc.'s best professional judgment based upon industry standards.
- Resolve any conflicts on the drawings with AOstructures, Inc before proceeding with construction.
- The design criteria used for this project & listed on the first page of the report is based on the engineers best judgement and/or provided by the ATC council. AHJ specific requests may differ. Please contact our team if the design criteria needs to be modified.
- A site visit was not physically conducted by AOstructures. The accompanying calculations and certification are provided with the understanding that the site building and construction standards meet an acceptable level of industry standards. It shall be the contractors responsibility to identify any irregularities such as inconsistent framing conditions, water damage, fire damage, cracked, split or noticeably deflecting framing members.
- AOstructures is not responsible for enforcing safety measures or regulations. The contractor shall design, construct, and maintain all safety devices including shoring and bracing, and shall be solely responsible for conforming to all local, state and federal safety and health standards, laws and regulations. The contractor shall take necessary precautions to maintain and insure the integrity of the structure during construction. If a lawsuit is filed by one of the contractor's or subcontractor's employees, or any one else, the contractor will indemnify, defend and hold the owner and aostructures, inc harmless of any and all such claims.
- Any and all waterproofing shall be provided by the contractor. AOstructures is not responsible for waterproofing.
- All hardware shall be installed per manufacturer specifications and within specified design limitations. AOstructures, Inc. assumes no responsibility for incorrectly installed hardware or hardware installed outside of the manufacturer specifications.

USER RELIANCE

- AOstructures was engaged by Lumina Solar (Client) to perform this assessment. This report and the information therein, are for the exclusive use of the Client. This report has no other purpose and shall not be relied upon, or used, by any other person or entity without the written consent of AOstructures. Third parties that obtain this report, or the information within shall have no rights of recourse or recovery against AOstructures, it's officers or employees.

ROOF MOUNTED ARRAY'S

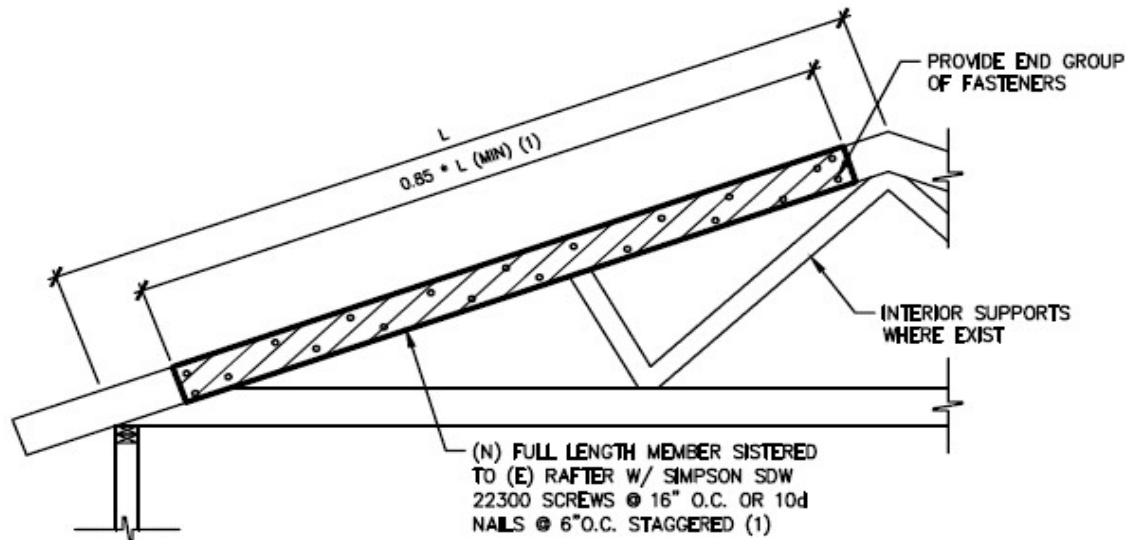
- If an analysis of a supporting structure is included in our scope of work, the structural assessment only applies to the section of the roof that is directly supporting the proposed solar PV system.
- No structural members can be cut for conduit, etc., unless specifically shown. Obtain prior written approval for installation of any additional conduit, etc.
- It is assumed that a standard quality of construction care was used to construct the original building. It shall be the contractors responsibility to field verify any and all framing member supporting the proposed PV array are in adequate condition. The contractor shall field inspect for sub-standard construction means, signs of dryrot, mold, fire damage, etc. and notify engineer if any compromised material is found on site prior to starting construction.
- It is assumed that there have been no additional loads (HVAC or MEP equipment, additional layers of roofing, etc) added to the building over the course of the structures history. The contractor and/or client shall verify this with the property owner and notify AOstructures, Inc. if additional load has been added to the structure already.
- Flexible utility connections must be used at any building seismic joint.
- Care should be taken to ensure that PV arrays do not preclude drainage of rain water.
- Unless otherwise noted, construction material shall be evenly distributed if placed on framed floors or roofs. Loads shall not exceed the allowable loading for the supporting members and their connections.
- All lags or wood screws at the roof shall be stainless steel and installed withing the middle 1/3 of the dimensional width of the framing members.
- Unless otherwise noted, all lags installed in underlying roof framing members shall be embedded (threaded embed) a minimum of 2.5" into the underlying framing.



Structural Upgrade Details (Sister Upgrade)

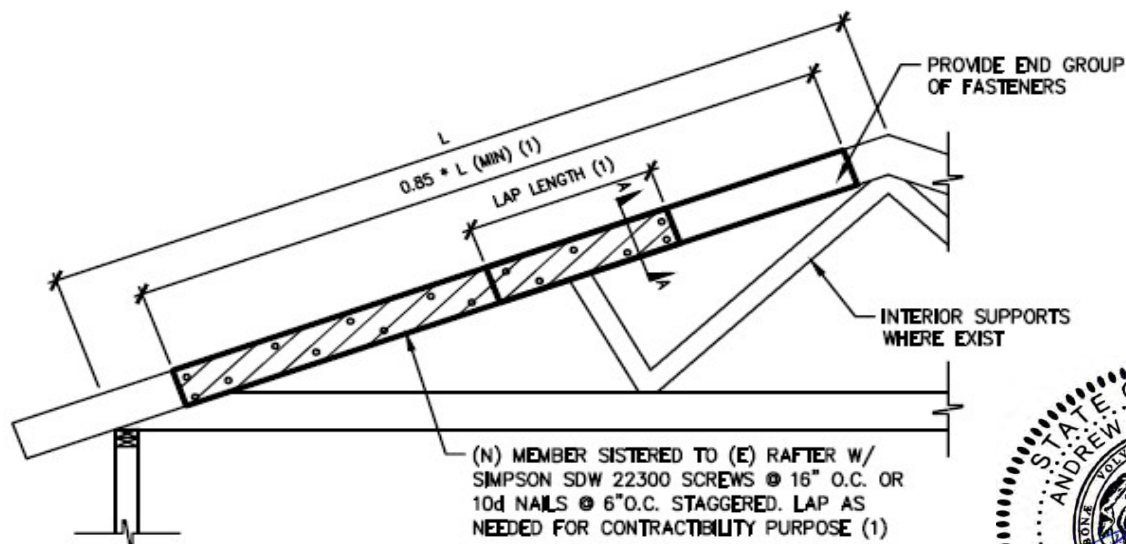
AOstructures Inc.
PO Box 413
Carnelian Bay, CA 96140
916.541.8586
www.AOstructures.com

Roof-top Solar PV Addition - Miller Residence
12 Montgomery Ave., Takoma Park, MD. 20912



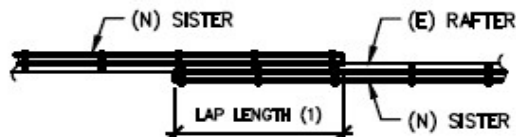
OPTION 1 - FULL LENGTH SISTER

NOTE: (1) SEE STRUCTURAL LETTER FOR ANY ADDITIONAL SPECIFICATIONS



OPTION 2 - LAPPED SISTER

NOTE: (1) SEE STRUCTURAL LETTER FOR ANY ADDITIONAL SPECIFICATIONS



SECTION A-A

NOTE: (1) SEE STRUCTURAL LETTER FOR ANY ADDITIONAL SPECIFICATIONS



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. 49910 Expires: 9/15/22

S1

Enphase IQ 7 and IQ 7+ Microinverters

The high-powered smart grid-ready **Enphase IQ 7 Micro™** and **Enphase IQ 7+ Micro™** dramatically simplify the installation process while achieving the highest system efficiency.

Part of the Enphase IQ System, the IQ 7 and IQ 7+ Microinverters integrate with the Enphase IQ Envoy™, Enphase IQ Battery™, and the Enphase Enlighten™ monitoring and analysis software.

IQ Series Microinverters extend the reliability standards set forth by previous generations and undergo over a million hours of power-on testing, enabling Enphase to provide an industry-leading warranty of up to 25 years.



Easy to Install

- Lightweight and simple
- Faster installation with improved, lighter two-wire cabling
- Built-in rapid shutdown compliant (NEC 2014 & 2017)

Productive and Reliable

- Optimized for high powered 60-cell and 72-cell* modules
- More than a million hours of testing
- Class II double-insulated enclosure
- UL listed

Smart Grid Ready

- Complies with advanced grid support, voltage and frequency ride-through requirements
- Remotely updates to respond to changing grid requirements
- Configurable for varying grid profiles
- Meets CA Rule 21 (UL 1741-SA)

* The IQ 7+ Micro is required to support 72-cell modules.



To learn more about Enphase offerings, visit enphase.com

Enphase IQ 7 and IQ 7+ Microinverters

| INPUT DATA (DC) | IQ7-60-2-US / IQ7-60-B-US | | IQ7PLUS-72-2-US / IQ7PLUS-72-B-US | |
|--|---|----------------------|-----------------------------------|----------------------|
| Commonly used module pairings ¹ | 235 W - 350 W + | | 235 W - 440 W + | |
| Module compatibility | 60-cell PV modules only | | 60-cell and 72-cell PV modules | |
| Maximum input DC voltage | 48 V | | 60 V | |
| Peak power tracking voltage | 27 V - 37 V | | 27 V - 45 V | |
| Operating range | 16 V - 48 V | | 16 V - 60 V | |
| Min/Max start voltage | 22 V / 48 V | | 22 V / 60 V | |
| Max DC short circuit current (module Isc) | 15 A | | 15 A | |
| Overvoltage class DC port | II | | II | |
| DC port backfeed current | 0 A | | 0 A | |
| PV array configuration | 1 x 1 ungrounded array; No additional DC side protection required; AC side protection requires max 20A per branch circuit | | | |
| OUTPUT DATA (AC) | IQ 7 Microinverter | | IQ 7+ Microinverter | |
| Peak output power | 250 VA | | 295 VA | |
| Maximum continuous output power | 240 VA | | 290 VA | |
| Nominal (L-L) voltage/range ² | 240 V / 211-264 V | 208 V / 183-229 V | 240 V / 211-264 V | 208 V / 183-229 V |
| Maximum continuous output current | 1.0 A (240 V) | 1.15 A (208 V) | 1.21 A (240 V) | 1.39 A (208 V) |
| Nominal frequency | 60 Hz | | 60 Hz | |
| Extended frequency range | 47 - 68 Hz | | 47 - 68 Hz | |
| AC short circuit fault current over 3 cycles | 5.8 Arms | | 5.8 Arms | |
| Maximum units per 20 A (L-L) branch circuit ³ | 16 (240 VAC) | 13 (208 VAC) | 13 (240 VAC) | 11 (208 VAC) |
| Overvoltage class AC port | III | | III | |
| AC port backfeed current | 0 A | | 0 A | |
| Power factor setting | 1.0 | | 1.0 | |
| Power factor (adjustable) | 0.85 leading ... 0.85 lagging | | 0.85 leading ... 0.85 lagging | |
| EFFICIENCY | @240 V | @208 V | @240 V | @208 V |
| Peak efficiency | 97.6 % | 97.6 % | 97.5 % | 97.3 % |
| CEC weighted efficiency | 97.0 % | 97.0 % | 97.0 % | 97.0 % |
| MECHANICAL DATA | | | | |
| Ambient temperature range | -40°C to +65°C | | | |
| Relative humidity range | 4% to 100% (condensing) | | | |
| Connector type (IQ7-60-2-US & IQ7PLUS-72-2-US) | MC4 (or Amphenol H4 UTX with additional Q-DCC-5 adapter) | | | |
| Connector type (IQ7-60-B-US & IQ7PLUS-72-B-US) | Friends PV2 (MC4 intermateable). Adaptors for modules with MC4 or UTX connectors: - PV2 to MC4: order ECA-S20-S22 - PV2 to UTX: order ECA-S20-S25 | | | |
| Dimensions (WxHxD) | 212 mm x 175 mm x 30.2 mm (without bracket) | | | |
| Weight | 1.08 kg (2.38 lbs) | | | |
| Cooling | Natural convection - No fans | | | |
| Approved for wet locations | Yes | | | |
| Pollution degree | PD3 | | | |
| Enclosure | Class II double-insulated, corrosion resistant polymeric enclosure | | | |
| Environmental category / UV exposure rating | NEMA Type 6 / outdoor | | | |
| FEATURES | | | | |
| Communication | Power Line Communication (PLC) | | | |
| Monitoring | Enlighten Manager and MyEnlighten monitoring options. Both options require installation of an Enphase IQ Envoy. | | | |
| Disconnecting means | The AC and DC connectors have been evaluated and approved by UL for use as the load-break disconnect required by NEC 690. | | | |
| Compliance | CA Rule 21 (UL 1741-SA) UL 62109-1, UL1741/IEEE1547, FCC Part 15 Class B, ICES-0003 Class B, CAN/CSA-C22.2 NO. 107.1-01 This product is UL Listed as PV Rapid Shut Down Equipment and conforms with NEC-2014 and NEC-2017 section 690.12 and C22.1-2015 Rule 64-218 Rapid Shutdown of PV Systems, for AC and DC conductors, when installed according manufacturer's instructions. | | | |

1. No enforced DC/AC ratio. See the compatibility calculator at <https://enphase.com/en-us/support/module-compatibility>.

2. Nominal voltage range can be extended beyond nominal if required by the utility.

3. Limits may vary. Refer to local requirements to define the number of microinverters per branch in your area.

To learn more about Enphase offerings, visit enphase.com

SOLAR PV SYSTEM: 5.92 kWp

MILLER RESIDENCE

12 MONTGOMERY AVE TAKOMA PARK, MD
20912

PROJECT INFORMATION

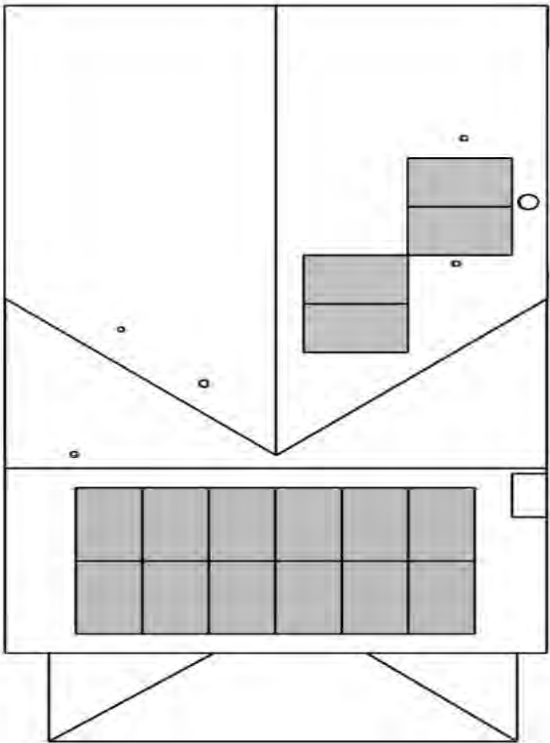
OWNER: PAUL MILLER
ADDRESS: 12 MONTGOMERY AVE
TAKOMA PARK, MD 20912

AHJ: MONTGOMERY (MD)
ADDRESS: 2425 REEDIE DRIVE, 7TH
FLOOR
WHEATON, MD 20902

ZONING: RESIDENTIAL
BUILDING CODE: IBC 2018
ELECTRICAL CODE: NEC 2017
ASCE VERSION: ASCE 7-16

SNOW LOAD: 30 PSF
WIND SPEED: 115 MPH
WIND EXPOSURE: B

DC RATING: 5.92 kW
AC RATING: 4.64 kW
RACKING: UNIRAC SM LIGHT RAIL
MODULE: (16) REC370AA
INVERTER: (16) IQ7PLUS-72-2-US



FOR PERMITTING USE ONLY

PROJECT SCOPE

THIS PROJECT INVOLVES THE INSTALLATION OF (16) REC 370 SOLAR MODULES. THE SOLAR MODULES WILL BE RACKED USING A PRE-ENGINEERED RACKING SYSTEM. THE RACKED MODULES WILL BE ELECTRICALLY CONNECTED TO (16) ENPHASE DC TO AC POWER INVERTERS, AND INTERCONNECTED TO THE LOCAL UTILITY USING MEANS AND METHODS CONSISTENT WITH THE RULES ENFORCED BY THE LOCAL UTILITY AND PERMITTING JURISDICTION.

| INDEX OF PAGES | |
|----------------|---------------------------|
| Z001 | COVER PAGE |
| A001 | ATTACHMENT & SITE PLAN |
| S001 | ASSEMBLY & LOAD CALCS |
| E001 | ELECTRICAL - LINE DIAGRAM |
| E002 | ELECTRICAL - WIRE CALCS |
| E003 | STRING & CONDUIT LAYOUT |
| E004 | EQUIP. RATINGS & SIGNAGE |
| APPENDIX | MODULE DATASHEET |
| | INVERTER DATASHEET |
| | RACKING DATASHEET |
| | ANCHOR DATASHEET |

PROJECT ADDRESS:

PAUL MILLER
12 MONTGOMERY AVE
TAKOMA PARK, MD 20912

CONTRACTOR INFO:



3600 COMMERCE DR
SUITE 601
BALTIMORE, MD 21227
(443) 955-0779

LICENSE NUMBER:

MHIC-30991

| REV | DATE |
|--------|------------|
| PRELIM | 12/27/2021 |

COVER

Z001

GENERAL NOTES

- 1) THIS PHOTOVOLTAIC (PV) SYSTEM SHALL COMPLY WITH THE NATIONAL ELECTRIC CODE (NEC) ARTICLE 690, ALL MANUFACTURERS'S LISTING AND INSTALLATION INSTRUCTIONS, AND THE RELEVANT CODES AS SPECIFIED BY THE AUTHORITY HAVING JURISDICTION (AHJ).
- 2) ALL SIGNAGE TO BE PLACED IN ACCORDANCE WITH LOCAL BUILDING CODE AND AS REQUIRED BY THE NEC AND AHJ.
- 3) PV SYSTEM CIRCUITS INSTALLED ON OR IN BUILDINGS SHALL INCLUDE A RAPID SHUTDOWN FUNCTION TO REDUCE SHOCK HAZARD FOR EMERGENCY RESPONDERS
- 4) THIS SYSTEM IS A UTILITY INTERACTIVE SYSTEM, AND THE PV MODULES ARE CONSIDERED NON-COMBUSTIBLE.

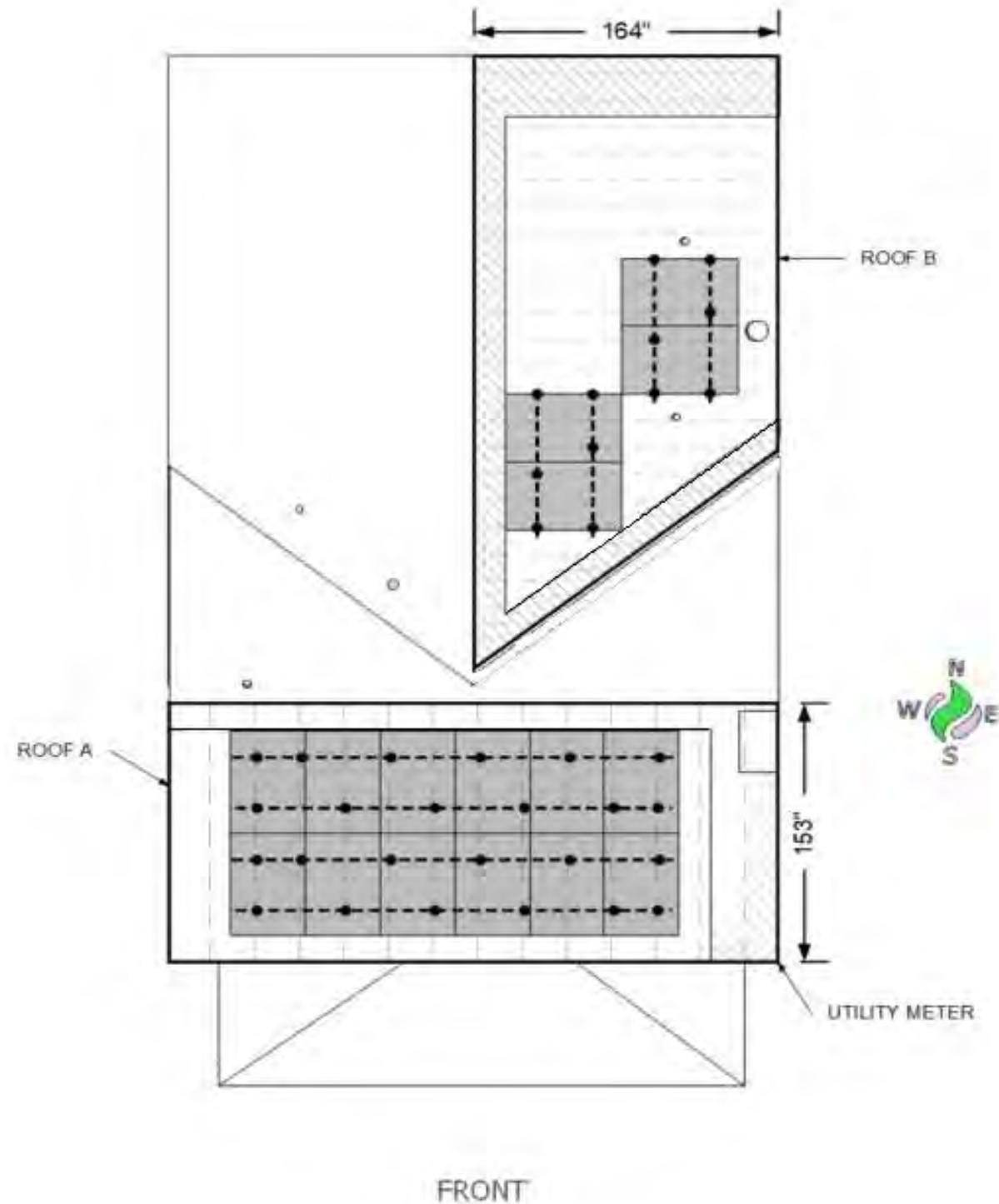


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FOR STRUCTURAL ONLY

Professional Certification: I hereby certify that these documents were prepared or supervised by me, and that I am a duly licensed professional engineer under the laws of the State of Maryland.
License No. 49910 Expires: 9/15/22

FRAMING UPGRADES REQUIRED, SEE
SPECIFICATIONS IN STRUCTURAL
CALCULATIONS PACKET

FOR ENGINEERING USE ONLY



LEGEND

| | |
|--|------------------|
| | ROOF SUPPORT |
| | MOUNTING RAIL |
| | ROOF ATTACHMENT |
| | PV ARRAY |
| | FIRECODE SETBACK |

FOR PERMITTING USE ONLY

PROJECT ADDRESS:

PAUL MILLER
12 MONTGOMERY AVE
TAKOMA PARK, MD 20912

CONTRACTOR INFO:



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SUITE 601
BALTIMORE, MD 21227
(443) 955-0779

LICENSE NUMBER:

MHIC-30991

| REV | DATE |
|--------|------------|
| PRELIM | 12/27/2021 |

ATTACHMENT & SITE PLAN

A001

INSTALLATION NOTES

- 1) ALL SOLAR MODULES SUPPORTED BY ROOF ATTACHMENTS STAGGERED AT 48" O.C. (OR AS INDICATED)
- 2) SOLAR PHOTOVOLTAIC SYSTEM INSTALLED PARALLEL TO ROOF SURFACE
- 3) SOLAR PHOTOVOLTAIC SYSTEM INSTALLED AT A MAXIMUM HEIGHT OF 6" ABOVE ROOF SURFACE (OR AS INDICATED)

- 4) ANY ROOFING PENETRATIONS SHALL HAVE PROPER FLASHING SEALANT USED TO PROVIDE WATERTIGHT ASSEMBLY



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CALCULATIONS PACKET**

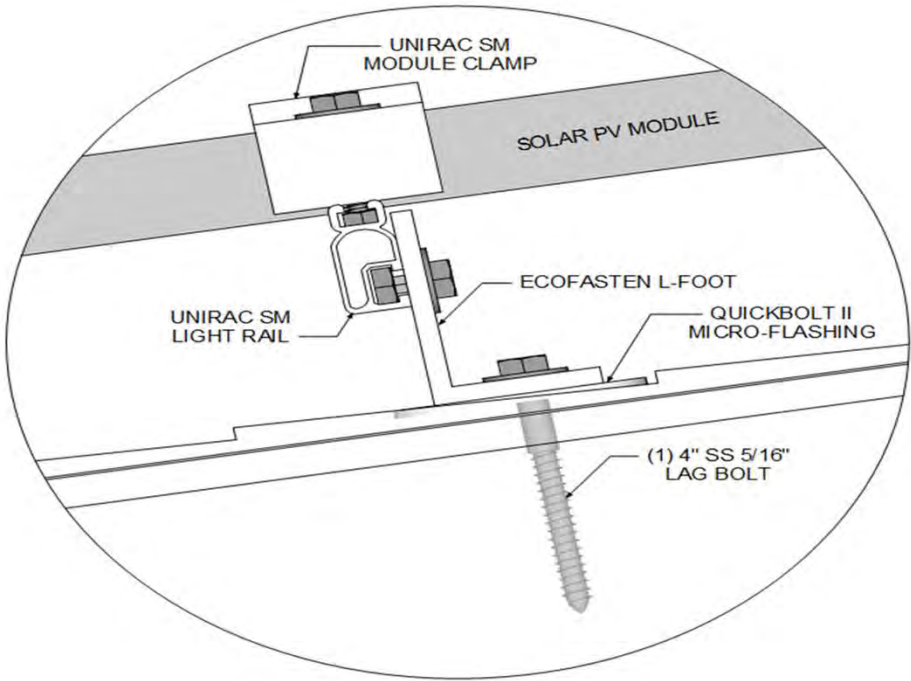
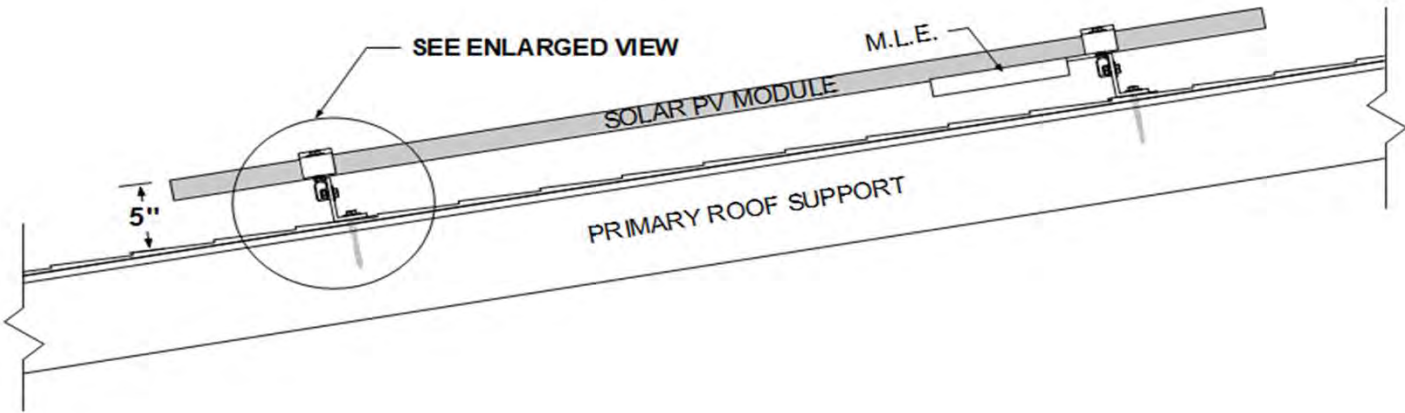
FOR ENGINEERING USE ONLY

| MOUNTING SYSTEM PROPERTIES | |
|----------------------------|----------------------|
| RACKING | UNIRAC SM LIGHT RAIL |
| STANDOFF | QUICKBOLT |
| MAX. RAIL SPAN | 48 IN |
| MIN. FASTENER DEPTH | 2.50 IN |
| MAX. RAIL CANTILEVER | 16 IN |
| MAX. ARRAY HEIGHT | 5 IN |

| DEAD LOAD CALCULATION | | | |
|---------------------------|------------------|-----------------|------------|
| LOAD | QTY. OR LIN. FT. | WEIGHT PER (LB) | TOTAL LBS. |
| MODULES | 16 | 43 | 688.00 |
| M.L.E.'S | 16 | 2.38 | 38.08 |
| RACKING | 109.2 | 0.81 | 88.43 |
| STANDOFF | 40 | 0.5 | 20.00 |
| | | | |
| TOTAL ARRAY WEIGHT (LBS) | | | 834.5 |
| TOTAL ARRAY AREA (SQ.FT.) | | | 301.1 |
| DISTRIBUTED LOAD (PSF) | | | 2.77 |

| POINT LOAD CALCULATION | |
|----------------------------------|--------|
| TOTAL ARRAY WEIGHT (LBS) | 834.51 |
| TOTAL NUMBER OF STANDOFFS (TYP.) | 40 |
| POINT LOAD (LBS/STANDOFF) | 20.86 |

| ROOF PROPERTIES | ROOF LABEL: | A | B |
|-----------------|----------------------------|----------------------|----------------------|
| | MATERIAL: | 3-Tab Comp. Shingle | 3-Tab Comp. Shingle |
| | PITCH: | 27° | 22° |
| | AZIMUTH: | 169° | 79° |
| | PRIMARY SUPPORT: | 2x6 RAFTERS | 2x8 RAFTERS |
| | PRIMARY SUPPORT SPACING: | 24" | 16" |
| | ROOF SPAN (RIDGE TO EAVE): | 13' | 14' |
| | MEAN ROOF HEIGHT: | 25' | 25' |
| | RACKING: | UNIRAC SM LIGHT RAIL | UNIRAC SM LIGHT RAIL |
| | STANDOFF: | QUICKBOLT | QUICKBOLT |



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ASSEMBLY &
LOAD CALCS

S001



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professional engineer under the laws of the State of Maryland.
License No. 49910 Expires: 9/15/22

FRAMING UPGRADES REQUIRED, SEE
SPECIFICATIONS IN STRUCTURAL
CALCULATIONS PACKET

INSTALLATION NOTES

- 1) ALL RACKING SHALL BE INSTALLED PER MANUFACTUER SPECIFICATIONS
- 2) M.L.E.'S = MODULE LEVEL ELECTRONICS (IE, POWER OPTIMIZERS, MICRO-INVERTERS, CABELS, ETC)
- 3) USE 5/16" X 4"HEX HEAD STAINLESS STEEL LAG SCREWS

FOR ENGINEERING USE ONLY

When the AC utility source is removed from the inverter output circuits via any means, such as an AC breaker, AC disconnect or removal of the solar or main utility service meter, this equipment performs the rapid shutdown function per 690.12.

Array bonded with # 6 Bare Cu



This Array 8 Panels / Inverters
8 x 1.21 x 125% = 12.10 on 15 Amp Circuit Breaker



This Array 8 Panels / Inverters
8 x 1.21 x 125% = 12.10 on 15 Amp Circuit Breaker

All conduit sizing will be in accordance to the NEC, Chapter #9
Two Ungrounded conductors per circuit of inverters (Typ)

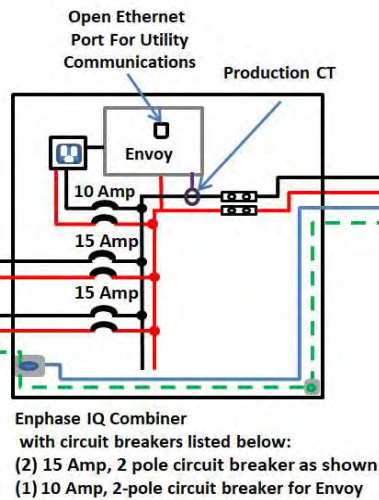
Solar Module Total
16 Modules and Inverters
DC wiring from the solar module (typ)

Enphase Micro Inverter
Ground Fault Protection is integrated within
Inverter Model: IQ7PLUS - 72 - 2 - US
Max DC Volt Rating: 60 VDC
Max Power @ 40 degrees C: 295W
Nominal AC Voltage 240V
Max AC Current: 1.21 Amps

Installation of the 1" PVC conduit (50')
will have two circuits, will consist of :
(4) #10 THHN-THWN-2, phase conductors,
plus (1) # 8 Ground

Enphase Trunk Cable (5')
(2) #12 - THHN-THWN-2 Copper Conductors
(1) #12 - THHN-THWN-2 Copper Ground

Paul Miller
12 Montgomery Ave
Takoma Park, MD 20912

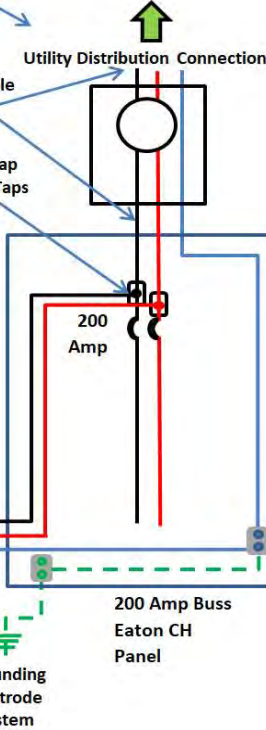


AC Disconnect within 6' of the Utility Meter

Non-Fused
Disconnect Switch
mounted adjacent to
the utility meter
240 Volt, 1 Phase
Model #
DU221RB
30 Amp

240 Volt, 1 Phase, 100 Amp
Circuit Breaker Enclosure
adjacent to the main circuit
breaker panel
Model # QO2100BN
25 Amp

4/0 AL SEU Cable
(20')
Line Side Tap
Insulated Taps



FOR PERMITTING USE ONLY

PROJECT ADDRESS:

PAUL MILLER
12 MONTGOMERY AVE
TAKOMA PARK, MD 20912

CONTRACTOR INFO:



3600 COMMERCE DR
SUITE 601
BALTIMORE, MD 21227
(443) 955-0779

LICENSE NUMBER:

MHIC-30991

| REV | DATE |
|--------|------------|
| PRELIM | 12/27/2021 |

ELECTRICAL -
LINE DIAGRAM

E001

ELECTRICAL NOTES

1) ALL EQUIPMENT TO BE LISTED AND LABELED FOR ITS APPLICATION

2) WORKING CLEARANCES AROUND ALL NEW AND EXISTING ELECTRICAL EQUIPMENT SHALL COMPLY WITH NEC

3) IF USED, PV POWER SOURCE BREAKER TO BE LOCATED AT BOTTOM OF BUS

4) LISTING AGENCY NAME AND NUMBER TO BE INDICATED ON INVERTERS AND MODULES

5) AC COMBINER PANELS SHALL BE LABELED AS "INVERTER AC COMBINER PANEL"

5) PV POWER SOURCE TO BE SUITABLE FOR BACKFEED

| INTERCONNECTION | |
|-------------------------------------|---------------------|
| METHOD | LINE SIDE TAP |
| WIRE SIZE | #4 SER |
| SYSTEM PROPERTIES | |
| FULL LOAD AMPERAGE | 19.36 |
| SOURCE VOLTAGE | 240 |
| LENGTH OF RUN (FT) | 20 |
| LOAD DUTY | CONTINUOUS |
| CONDUCTOR TYPE | XHHW-2 |
| CONDUCTOR MATERIAL | ALUMINUM |
| CONDUCTOR LOCATION | DRY OR WET |
| CONDUCTOR INSULATION TEMP | 90°C |
| AMBIENT TEMP | 26-30°C |
| TERMINAL TEMP RATING | 90°C |
| CIRCUIT TYPE | SINGLE PHASE 3-WIRE |
| QTY. OF CURRENT-CARRYING CONDUCTORS | 2 |
| CONDUCTOR REQUIREMENT | |
| FULL LOAD AMPS | 19.36 |
| LOAD DUTY MULTIPLIER | 1.25 |
| AMBIENT TEMP MULTIPLIER | 1.00 |
| QTY. CONDUCTORS MULTIPLIER | 1.00 |
| REQUIRED CONDUCTOR AMPACITY | 24.20 |
| TERMINAL REQUIREMENT | |
| FULL LOAD AMPS | 19.36 |
| LOAD DUTY MULTIPLIER | 1.25 |
| REQUIRED TERMINAL AMPACITY | 24.20 |
| CONDUCTOR SELECTION | |
| CONDUCTOR AMAPACITY | 55.00 |
| AMBIENT TEMP DERATE | 1.00 |
| QTY. CONDUCTORS DERATE | 1.00 |
| ADJUSTED AMPACITY | 55.00 |
| SELECTED CONDUCTOR SIZE (AWG) | 6 |
| VOLTAGE DROP | |
| OHMS/MILFT | 0.808 |
| LENGTH OF RUN (FT) | 20 |
| REQUIRED CONDUCTOR AMPACITY | 24.20 |
| VOLTAGE DROP | 0.78 |
| VOLTS AT LOAD TERMINAL | 239.22 |
| PERCENT VOLTAGE DROP | 0.33% |

| CALCULATION FOR PV BREAKER | | | | | |
|--|-------|---|------|---|---------|
| CALCULATION FOR MAIN PV BREAKER & CIRCUITS | | | | | |
| SYSTEM CURRENT | 1.21 | x | 16 | = | 19.36 A |
| DESIGN AMPERAGE | 19.36 | x | 125% | = | 24.2 A |
| MAIN BUSS RATING | 200 | x | 120% | = | 240 A |
| EXISTING MAIN BREAKER | | | | | 200 A |
| MAX SOLAR BREAKER | 240 | - | 200 | = | 40 A |

| COMBINER TO ARRAY | |
|--|----------------------|
| WIRE LENGTH (FT) | 50 |
| WIRE SIZE | #10 AWG |
| SYSTEM PROPERTIES | |
| FULL LOAD AMPERAGE | 9.68 |
| SOURCE VOLTAGE | 240 |
| LENGTH OF RUN (FT) | 50 |
| LOAD DUTY | CONTINUOUS |
| CONDUCTOR TYPE | THWN-2 |
| CONDUCTOR MATERIAL | COPPER |
| CONDUCTOR LOCATION | DRY OR WET |
| CONDUCTOR INSULATION TEMP | 90°C |
| DISTANCE ABOVE ROOF | ALL INTERIOR CONDUIT |
| AVERAGE OUTSIDE TEMP (°F) | 90 |
| TEMP ADDER (°F) | N/A |
| ADJUSTED AMBIENT TEMP (°F) | 90 |
| TERMINAL TEMP RATING | 75°C |
| CIRCUIT TYPE | SINGLE PHASE 2-WIRE |
| QTY. OF CURRENT-CARRYING CONDUCTORS | 2 |
| ADDITIONAL CURRENT-CARRYING CONDUCTORS | 2 |
| TOTAL # OF CURRENT-CARRYING CONDUCTORS | 4 |
| CONDUCTOR REQUIREMENT | |
| FULL LOAD AMPS | 9.68 |
| LOAD DUTY MULTIPLIER | 1.25 |
| AMBIENT TEMP MULTIPLIER | 1.04 |
| QTY. CONDUCTORS MULTIPLIER | 1.25 |
| REQUIRED CONDUCTOR AMPACITY | 15.76 |
| TERMINAL REQUIREMENT | |
| FULL LOAD AMPS | 9.68 |
| LOAD DUTY MULTIPLIER | 1.25 |
| REQUIRED TERMINAL AMPACITY | 12.10 |
| CONDUCTOR SELECTION | |
| CONDUCTOR AMAPACITY | 25.00 |
| AMBIENT TEMP DERATE | 0.96 |
| QTY. CONDUCTORS DERATE | 0.80 |
| ADJUSTED AMPACITY | 19.20 |
| SELECTED CONDUCTOR SIZE (AWG) | 10 |
| VOLTAGE DROP | |
| OHMS/MILFT | 1.240 |
| LENGTH OF RUN (FT) | 50 |
| REQUIRED CONDUCTOR AMPACITY | 15.76 |
| VOLTAGE DROP | 1.95 |
| VOLTS AT LOAD TERMINAL | 238.05 |
| PERCENT VOLTAGE DROP | 0.82% |

ELECTRICAL NOTES

- 1) ALL CONDUCTORS SHALL BE COPPER, RATED FOR 90°C AND WET ENVIRONMENT, UNLESS OTHERWISE NOTED.
- 2) ALL WIRE TERMINATIONS SHALL BE APPROPRIATELY LABELED AND READILY VISIBLE.
- 3) MODULE GROUNDING CLIPS TO BE INSTALLED BETWEEN MODULE FRAME AND MODULE SUPPORT RAIL, PER MANUFACTURER'S INSTRUCTION.
- 4) MODULE SUPPORT RAIL TO BE BONDED TO CONTINUOUS COPPER GEC VIA WEEB LUG

| |
|-------------------------|
| |
| FOR PERMITTING USE ONLY |

PROJECT ADDRESS:

PAUL MILLER
12 MONTGOMERY AVE
TAKOMA PARK, MD 20912

CONTRACTOR INFO:



3600 COMMERCE DR
SUITE 601
BALTIMORE, MD 21227
(443) 955-0779

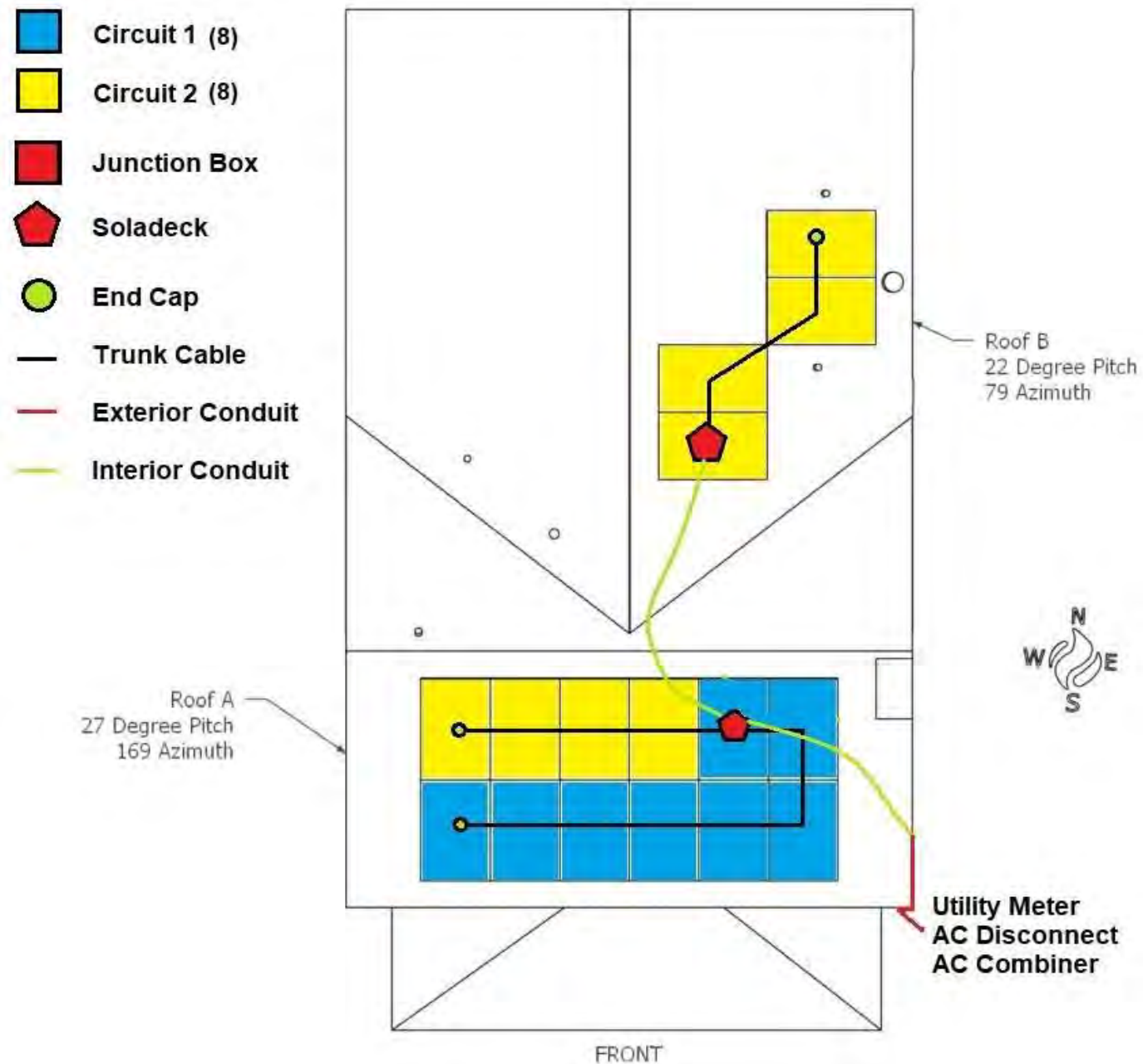
LICENSE NUMBER:

MHIC-30991

| REV | DATE |
|--------|------------|
| PRELIM | 12/27/2021 |

**ELECTRICAL -
WIRE CALCS**

E002



FOR PERMITTING USE ONLY

PROJECT ADDRESS:

PAUL MILLER
12 MONTGOMERY AVE
TAKOMA PARK, MD 20912

CONTRACTOR INFO:



3600 COMMERCE DR
SUITE 601
BALTIMORE, MD 21227
(443) 955-0779

LICENSE NUMBER:

MHIC-30991

| REV | DATE |
|--------|------------|
| PRELIM | 12/27/2021 |

**STRING & CONDUIT
LAYOUT**

E003

| SOLAR MODULE RATINGS | | |
|------------------------|-------|---------|
| REC 370 Specifications | | |
| Length: | 67.75 | in |
| Width: | 40 | in |
| Thickness: | 1.18 | in |
| Weight: | 43 | lbs |
| Imp: | 9.66 | A |
| Vmp: | 38.3 | V |
| Voc: | 44.9 | V |
| Isc: | 10.21 | A |
| OCPD: | 25 | A |
| Pmax: | 370 | W |
| Vmax: | 1000 | V |
| Temp. Coefficient: | -0.24 | %Voc/°C |

| INVERTER 1 RATINGS | | |
|--------------------------------|------|-----|
| IQ7PLUS-72-2-US Specifications | | |
| Max # Per String: | 13 | |
| I _{max} (ac): | 1.21 | A |
| V _{max} (dc): | 60 | V |
| P _{max} : | 290 | W |
| Nom. AC Voltage: | 240 | V |
| OCPD: | 20 | A |
| Weight (Optimizer): | 2.38 | lbs |
| I _{max} (Input): | 15 | A |
| P _{max} (dc) Input: | N/A | V |

**WARNING: PHOTOVOLTAIC
POWER SOURCE**

LABEL TO BE INSTALLED AT EXPOSED
RACEWAYS, CABLE TRAYS, AND OTHER WIRING
METHODS; SPACED AT MAXIMUM 10FT SECTION
OR WHERE SEPARATED BY ENCLOSURES,
WALLS, PARTITIONS, CEILINGS, OR FLOORS.

LETTERS AT LEAST 3/8 INCH; WHITE ON RED
BACKGROUND; REFLECTIVE

**PHOTOVOLTAIC
DC DISCONNECT**

LABEL TO BE INSTALLED AT EACH DC
DISCONNECTING MEANS

**PHOTOVOLTAIC
AC DISCONNECT**

LABEL TO BE INSTALLED AT EACH AC
DISCONNECTING MEANS

**PHOTOVOLTAIC SYSTEM
EQUIPPED WITH RAPID
SHUTDOWN**

LABEL TO BE INSTALLED AT RAPID SHUTDOWN
SWITCH

LETTERS AT LEAST 3/8 INCH; WHITE ON RED
BACKGROUND; REFLECTIVE

SOLAR PV SYSTEM DISCONNECT

RATED AC OUTPUT CURRENT: 19.36 A

NOMINAL OPERATING AC VOLTAGE: 240 V

LABEL TO BE INSTALLED AT AN ACCESSIBLE LOCATION AT THE DISCONNECTING MEANS
AS A POWER SOURCE

WARNING

ELECTRICAL SHOCK HAZARD

**DO NOT TOUCH TERMINALS!
TERMINALS ON BOTH LINE AND
LOAD SIDES MAY BE ENERGIZED
IN THE OPEN POSITION**

LABEL TO BE INSTALLED AT EACH DISCONNECTING MEANS FOR
PHOTOVOLTAIC EQUIPMENT

WARNING

ELECTRICAL SHOCK HAZARD

**IF GROUND FAULT IS INDICATED
NORMALLY GROUNDED
CONDUCTORS MAY BE
UNGROUND AND ENERGIZED**

LABEL TO BE INSTALLED AT EACH DISCONNECTING MEANS FOR
PHOTOVOLTAIC EQUIPMENT

WARNING

**DUAL POWER SOURCE SECOND SOURCE IS
PHOTOVOLTAIC SYSTEM**

LABEL TO BE INSTALLED ON EXTERIOR OF MAIN
ELECTRICAL PANEL

WARNING

**INVERTER OUTPUT CONNECTION. DO NOT
RELOCATE THIS OVERCURRENT DEVICE**

LABEL TO BE APPLIED TO THE DISTRIBUTION
EQUIPMENT

**INTERACTIVE PHOTOVOLTAIC
SYSTEM CONNECTED**

LABEL TO BE INSTALLED AT UTILITY METER

FOR PERMITTING USE ONLY

PROJECT ADDRESS:

PAUL MILLER
12 MONTGOMERY AVE
TAKOMA PARK, MD 20912

CONTRACTOR INFO:



3600 COMMERCE DR
SUITE 601
BALTIMORE, MD 21227
(443) 955-0779

LICENSE NUMBER:

MHIC-30991

REV

DATE

PRELIM 12/27/2021

**EQUIP. RATINGS &
SIGNAGE**

E004

SIGNAGE NOTES

- 1) ALL PLAQUES AND LABELS SHALL HAVE A RED BACKGROUND (OR AS SHOWN HERE)
- 2) ALL LETTERING SHALL BE WHITE AND HAVE A MINIMUM HEIGHT OF 3/8" (OR AS SHOWN HERE)
- 3) FONT SHALL BE ARIAL (OR SIMILAR) AND ALL LETTERING SHALL BE CAPITALIZED
- 4) ALL PLAQUES AND LABELS SHALL BE OF A MATERIAL SUITABLE FOR THE ENVIRONMENT INSTALLED

MAJOR COMPONENTS

| PRODUCT | QTY |
|----------------------------|-----|
| REC 370w Black | 16 |
| EnPhase IQ7+ Microinverter | 16 |
| | |
| | |
| | |
| | |
| | |
| | |

RACKING COMPONENTS

| PRODUCT | QTY |
|------------------------------------|-----|
| 14' Light Rail DRK (315168D) | 12 |
| | |
| Unirac Bnd Splice Bar Serrated Drk | 4 |
| Small Endclamps 30-32mm (302021D) | 16 |
| Unirac SM BND Midclamp BC SS | 24 |
| QuickBolt 3in Microflashing | 40 |
| EcoFasten L-102-3 L Foot Black | 40 |
| | |
| | |
| | |
| Lay-in ground lug | 4 |
| | |
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| | |

INTERCONNECTION COMPONENTS

| PRODUCT | QTY |
|-------------------------------|-----|
| B-Tap 4/0-10 | 2 |
| 100 Amp MBE Surface mount | 1 |
| 2 pole, 25 amp QO breaker | 1 |
| 30 Amp Nema3r Non-fused disco | 1 |
| | |

BALANCE OF INVERTER SYSTEM

| PRODUCT | QTY |
|-----------------------------------|-----|
| Enphase AC Combiner with IQ Envoy | 1 |
| 2 pole, 15 amp BR breaker | 2 |
| | |
| Enphase IQ Trunk Cable Landscape | 16 |
| | |
| | |
| Enphase Terminator Cap | 3 |
| | |
| | |

MISCELLANEOUS

| PRODUCT | QTY |
|------------------------------|-----|
| Lumina Salesperson Yard Sign | 1 |
| 6x6x4 PVC Junction Box | |
| Soladeck | 2 |
| SolaTrim Critter Guards | 2 |

MANUALLY ADD PARTS HERE

| PRODUCT | QTY |
|---------|-----|
| | |
| | |
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| | |
| | |
| | |

INSTALL LEAD SIGNATURE: _____

DATE: _____

FOR PERMITTING USE ONLY

PROJECT ADDRESS:

PAUL MILLER
12 MONTGOMERY AVE
TAKOMA PARK, MD 20912

CONTRACTOR INFO:



3600 COMMERCE DR
SUITE 601
BALTIMORE, MD 21227
(443) 955-0779

LICENSE NUMBER:


MHIC-30991

REV **DATE**

PRELIM 12/27/2021

BILL OF MATERIALS

X001

| | |
|---|-------------|
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| | |
| | |
| FOR PERMITTING USE ONLY | |
| PROJECT ADDRESS: | |
| PAUL MILLER 12 MONTGOMERY AVE TAKOMA PARK, MD 20912 | |
| CONTRACTOR INFO: | |
|  | |
| 3600 COMMERCE DR SUITE 601 BALTIMORE, MD 21227 (443) 955-0779 | |
| LICENSE NUMBER: | |
| MHIC-30991 | |
| REV | DATE |
| PRELIM | 12/27/2021 |
| PROJECT NOTES | |
| X002 | |

MUNICIPALITY LETTER

January 5, 2022

To: Paul Miller / prmi2003@yahoo.com / (240) 644-2818
12 Montgomery Ave
Takoma Park, MD 20912

To: Department of Permitting Services
255 Rockville Pike, 2nd Floor
Rockville, Maryland 20850-4166 Fax 240-777-6398; 240-777-6262; 240-777-6223

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/email: Ola Carew / permits@fusionss.net / 443-425-3023

Location of Project: 12 Montgomery Ave, Takoma Park, MD 20912

Proposed Scope of Work: Installing 16 Roof Mounted Solar Panels

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 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: <https://takomaparkmd.gov/government/public-works/stormwater-management-program/>. The City Engineer should be contacted to determine if a City permit is required 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 Takoma Park 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.

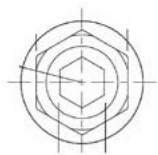
SPEC SHEET

| Part # | Box Quantity |
|--------|--|
| 17660 | 4" QB2 (25) |
| 17662 | 3" Microflashing® (25); 4" QB2 (25); L-Foot (25) |

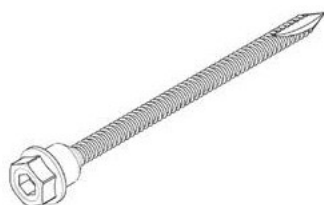


QB2

PN# 17660



Dual Drive Technology
1/2" Hex Outer Drive
6mm Inner Drive



6.60 MIN

4"

MATERIAL:
Stainless Steel 304

SURFACE TREATMENT:
PASSIVATION

TOLERANCE:
AS PER DRAWING

QuickBOLT

NAME:
DATE:
DRAWN:
APPROVED:

MAR. 19'19

MAR. 19'19

ITEM: 5/16 X 4" HEX FLANGE QUICK BOLT

DRAWING NO:
SL20190316-1

STATUS:
Approved

VERSION: 01

FORMAT: A3

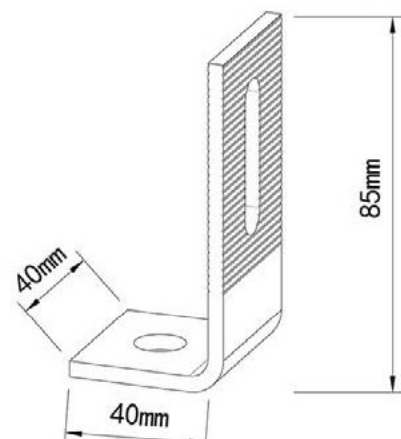
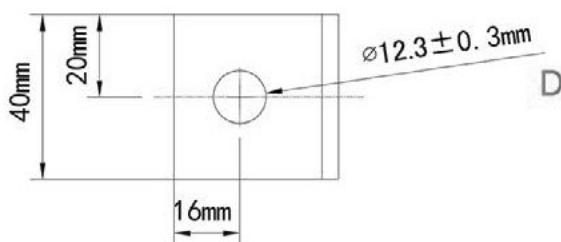
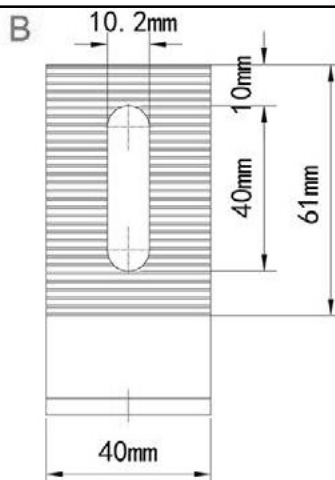
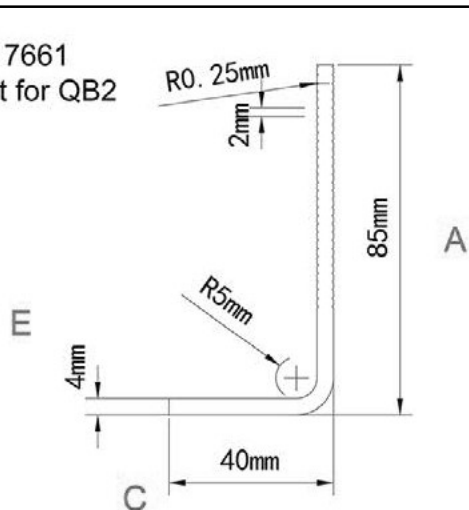
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SALES:

PAGES: 1/1

UNIT: METRIC

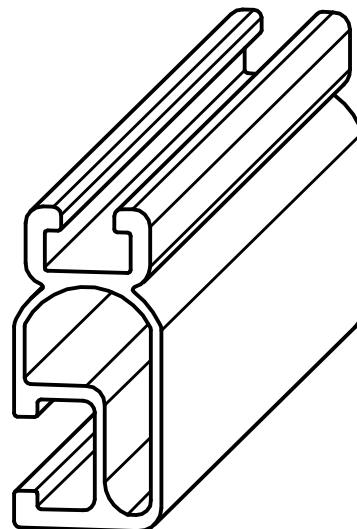
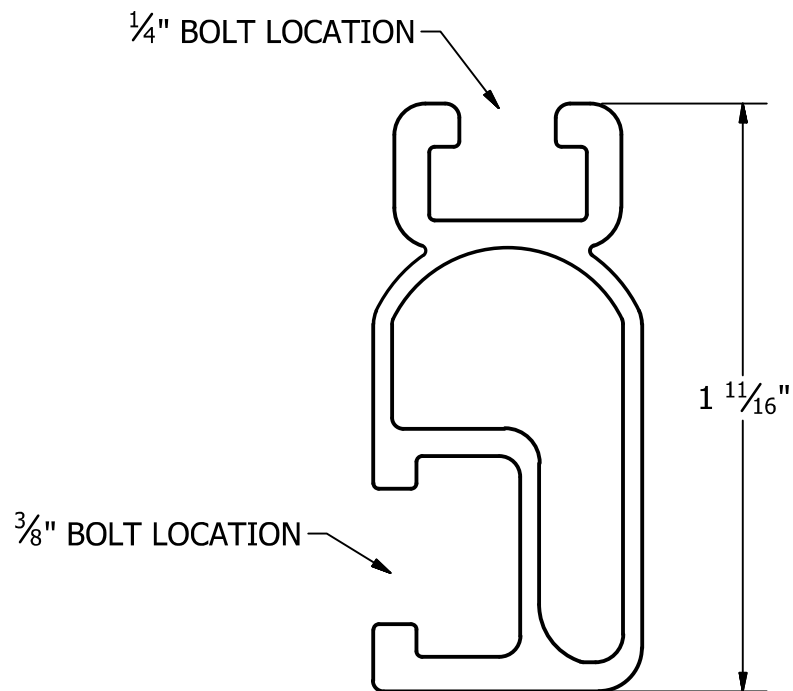
PN# 17661
L-Foot for QB2



Part # 17669

5/16" x 3"
304 Stainless Steel
Compression Washer Black





| PART # TABLE | | |
|--------------|-------------------------|--------|
| P/N | DESCRIPTION | LENGTH |
| 315168M | SM LIGHT RAIL 168" MILL | 168" |
| 315168D | SM LIGHT RAIL 168" DRK | 168" |
| 315240M | SM LIGHT RAIL 240" MILL | 240" |
| 315240D | SM LIGHT RAIL 240" DRK | 240" |



1411 BROADWAY BLVD. NE
ALBUQUERQUE, NM 87102 USA
PHONE: 505.242.6411
WWW.UNIRAC.COM

PRODUCT LINE: SOLARMOUNT

DRAWING TYPE: PART DETAIL

DESCRIPTION: LIGHT RAIL

REVISION DATE: 9/11/2017

DRAWING NOT TO SCALE
ALL DIMENSIONS ARE
NOMINAL

PRODUCT PROTECTED BY
ONE OR MORE US PATENTS
LEGAL NOTICE

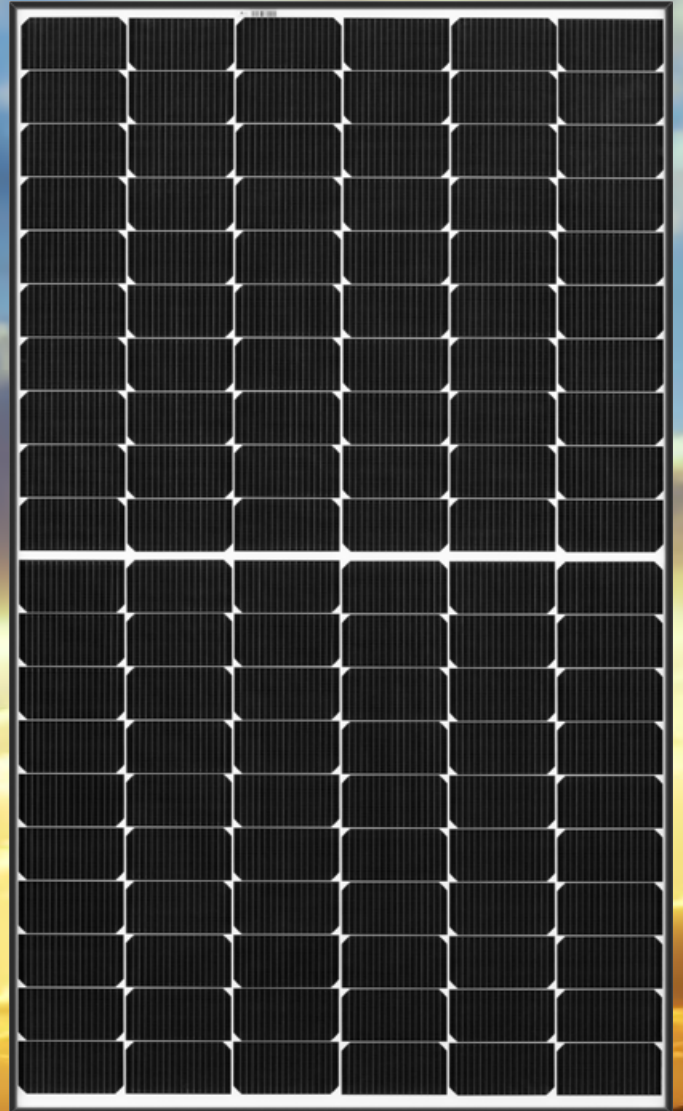
SM-P02

SHEET

SOLAR'S MOST TRUSTED



REC ALPH α SERIES



380 W_P POWER

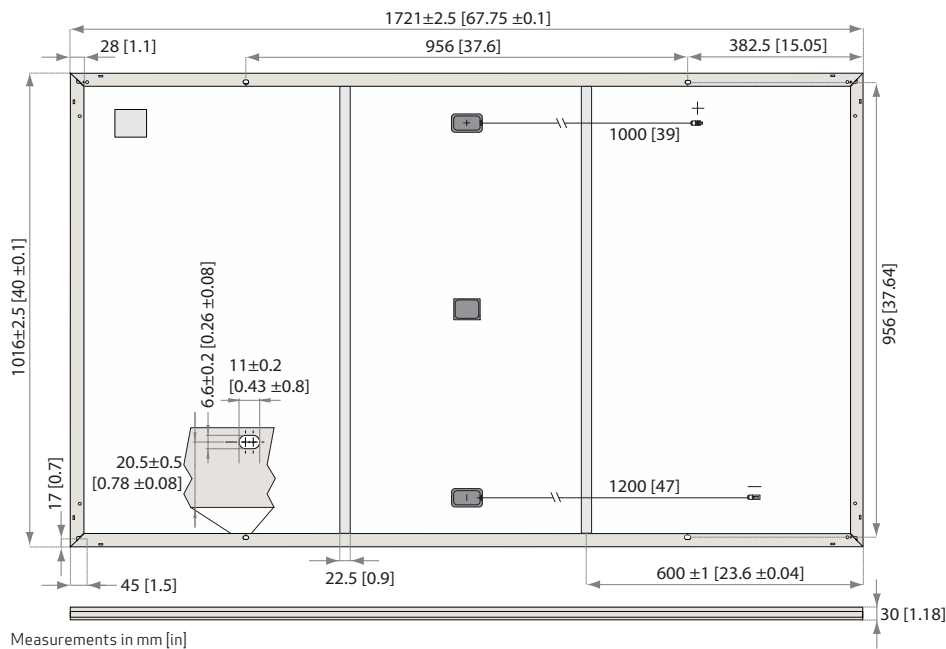
20 YEAR PRODUCT WARRANTY

25 YEAR POWER OUTPUT WARRANTY



recgroup.com/alpha

REC ALPHA SERIES



ELECTRICAL DATA @ STC

Product Code*: RECxxxAA

| | | | | | |
|---------------------------------------|-------|-------|-------|-------|-------|
| Nominal Power - P_{MPP} (Wp) | 360 | 365 | 370 | 375 | 380 |
| Watt Class Sorting - (W) | -0/+5 | -0/+5 | -0/+5 | -0/+5 | -0/+5 |
| Nominal Power Voltage - V_{MPP} (V) | 37.7 | 38.0 | 38.3 | 38.7 | 39.0 |
| Nominal Power Current - I_{MPP} (A) | 9.55 | 9.60 | 9.66 | 9.71 | 9.76 |
| Open Circuit Voltage - V_{OC} (V) | 44.3 | 44.6 | 44.9 | 45.2 | 45.5 |
| Short Circuit Current - I_{SC} (A) | 10.16 | 10.19 | 10.21 | 10.23 | 10.26 |
| Panel Efficiency (%) | 20.6 | 20.9 | 21.2 | 21.4 | 21.7 |

Values at standard test conditions (STC: air mass AM1.5, irradiance 10.75 W/sq ft (1000 W/m²), temperature 77°F (25°C), based on a production spread with a tolerance of V_{OC} & I_{SC} ±3% within one watt class. * Where xxx indicates the nominal power class (P_{MPP}) at STC above.

ELECTRICAL DATA @ NMOT

Product Code*: RECxxxAA

| | | | | | |
|---------------------------------------|------|------|------|------|------|
| Nominal Power - P_{MPP} (Wp) | 272 | 276 | 279 | 284 | 287 |
| Nominal Power Voltage - V_{MPP} (V) | 35.3 | 35.5 | 35.8 | 36.2 | 36.5 |
| Nominal Power Current - I_{MPP} (A) | 7.71 | 7.75 | 7.80 | 7.84 | 7.88 |
| Open Circuit Voltage - V_{OC} (V) | 41.4 | 41.7 | 42.0 | 42.3 | 42.5 |
| Short Circuit Current - I_{SC} (A) | 8.21 | 8.23 | 8.25 | 8.26 | 8.29 |

Nominal module operating temperature (NMOT: air mass AM1.5, irradiance 800 W/m², temperature 68°F (20°C), windspeed 3.3 ft/s (1 m/s).

* Where xxx indicates the nominal power class (P_{MPP}) at STC above.

CERTIFICATIONS



WARRANTY

- 20 year product warranty
 - 25 year linear power output warranty
 - Maximum annual power degradation of 0.25% p.a.
 - Guarantees 92% of power after 25 years
- See warranty conditions for further details.

GENERAL DATA

| | |
|---------------|--|
| Cell type: | 120 half-cut n-type mono cells with REC heterojunction cell technology 6 strings of 20 cells in series |
| Glass: | 0.13 in (3.2 mm) solar glass with anti-reflection surface treatment |
| Backsheet: | Highly resistant polymeric construction |
| Frame: | Anodized aluminum (black) |
| Junction box: | 3-part, 3 bypass diodes, IP67 rated in accordance with IEC 62790 |
| Cable: | 12 AWG (4 mm ²) PV wire, 39 + 47 in (1 + 1.2 m) in accordance with EN 50618 |
| Connectors: | Stäubli MC4PV-KBT4/KST4, 12 AWG (4 mm ²) in accordance with IEC 62852 IP68 only when connected |
| Origin: | Made in Singapore |

MECHANICAL DATA

| | |
|-------------|--|
| Dimensions: | 67.8 x 40 x 1.2 in (1721 x 1016 x 30 mm) |
| Area: | 18.8 sq ft (1.75 m ²) |
| Weight: | 43 lbs (19.5 kg) |

MAXIMUM RATINGS

| | |
|--------------------------|---------------------------|
| Operational temperature: | -40 ... +85°C |
| Maximum system voltage: | 1000 V |
| Design load (+): snow | 4666 Pa (97.5 lbs/sq ft)* |
| Maximum test load (+): | 7000 Pa (146 lbs/sq ft)* |
| Design load (-): wind | 2666 Pa (55.6 lbs/sq ft)* |
| Maximum test load (-): | 4000 Pa (83.5 lbs/sq ft)* |
| Max series fuse rating: | 25 A |
| Max reverse current: | 25 A |

* Calculated using a safety factor of 1.5

* See installation manual for mounting instructions

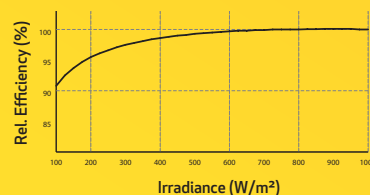
TEMPERATURE RATINGS*

| | |
|--|-------------|
| Nominal Module Operating Temperature: | 44°C (±2°C) |
| Temperature coefficient of P_{MPP} : | -0.26 %/°C |
| Temperature coefficient of V_{OC} : | -0.24 %/°C |
| Temperature coefficient of I_{SC} : | 0.04 %/°C |

* The temperature coefficients stated are linear values

LOW LIGHT BEHAVIOUR

Typical low irradiance performance of module at STC:



Founded in Norway in 1996, REC is a leading vertically integrated solar energy company. Through integrated manufacturing from silicon to wafers, cells, high-quality panels and extending to solar solutions, REC provides the world with a reliable source of clean energy. REC's renowned product quality is supported by the lowest warranty claims rate in the industry. REC is a Bluestar Elkem company with headquarters in Norway and operational headquarters in Singapore. REC employs around 2,000 people worldwide, producing 1.5 GW of solar panels annually.



www.recgroup.com

38

Residential Site Survey

Prepared on: Dec 04, 2021



Basic Fields

GROUP NAME: Paul Miller
LEAD PERSON: Scoop Integration
DUE DATE: No Due Date
PRIORITY: Normal
STAGE: Complete & Closed
START DATE: No Start Date
END DATE: No End Date



Form Section

1. Customer Information

| | |
|------------------------|---|
| 1.1 Customer Name | Paul Miller |
| 1.2 Customer Address | 12 Montgomery Ave, Takoma Park, MD 20912, USA |
| 1.3 Assessment Date | Dec 3, 2021 |
| 1.4 Site Assessor Name | Elayna Birch-Smith |
| 1.5 Site Survey Vendor | Lumina |
| 1.6 Project Notes | Not Applicable |

2. Site Survey PDF Report

2.1 Site Survey PDF Report

3. Red Flag

3.1 Red Flags

3.2 Electrical Red Flags

3.3 Structural Red Flags

Continued on next page



3.4 Roof Red Flags

4. Add Special Survey Forms

4.1 Survey Forms to Add

5. Home Photos & General Information

5.1 General Notes

5.2 Year of House Construction 1912 house the edition is 1922

5.3 Photos of Every Side of House

Pictures related to 5.3 Photos of Every Side of House









5.4 WiFi Router & Location

6. Roof Information

6.1. General Roof Info

6.1.1 General Notes

Continued on next page



6.1.2 Building Height / Ladder Placement

2.5 Story

Pictures related to 7.1.2 Building Height / Ladder Placement

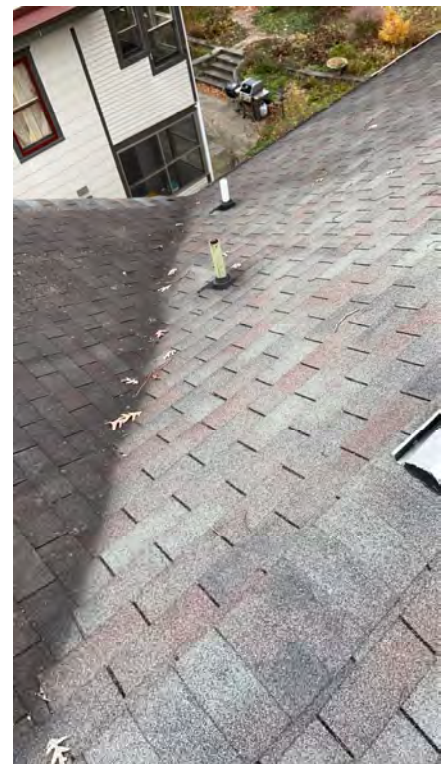
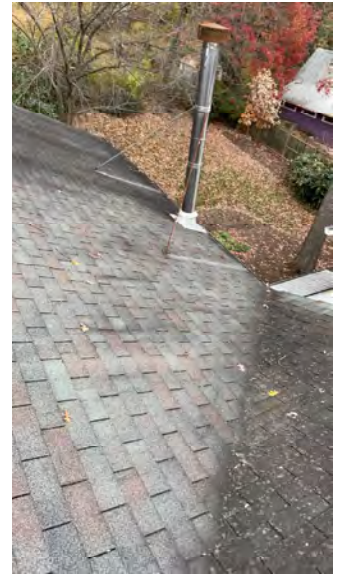


6.1.3 360° View of All Roof Surfaces

Pictures related to 7.1.3 360° View of All Roof Surfaces







6.3. Install Surface (1)

6.3.1 Array Location

Pictures related to 7.2.1 Array Location



6.3.2 Roof Type

3-Tab Asphalt Shingle

Continued on next page



6.3.3 Roof Condition (In General) Fair

Comments related to 7.2.3 Roof Condition (In General)

December 03, 2021 11:53, Elayna Birch-Smith

shows age shingles are peeling and curled shingles have some erosion on it

[related to 7.2.3 Roof Condition \(In General...](#)

Continued on next page



Pictures related to 7.2.3 Roof Condition (In General)



6.3.4 Fading or Rusty Roof Material? No

Continued on next page



6.3.5 Damaged Roof Material? Yes

Comments related to 7.2.5 Damaged Roof Material?

December 03, 2021 11:52, Elayna Birch-Smith

ridge thing is vent and out of shape

[related to 7.2.5 Damaged Roof Material?](#)

Continued on next page



Pictures related to 7.2.5 Damaged Roof Material?



6.3.6 Soft or Cracking Spots? No

6.3.7 Multiple Roof Layers? No

6.3.8 Vegetation Close to or Overhanging the Install Surface? No

6.3.9 Significant Sources of Shade?



6.2. Install Surface (2)

6.2.1 Array Location

Pictures related to 7.2.1 Array Location



6.2.2 Roof Type

3-Tab Asphalt Shingle

Continued on next page



6.2.3 Roof Condition (In General) Fair

Comments related to 7.2.3 Roof Condition (In General)

December 03, 2021 11:51, Elayna Birch-Smith

roof is very old

[related to 7.2.3 Roof Condition \(In General...](#)

Continued on next page



Pictures related to 7.2.3 Roof Condition (In General)



Continued on next page



6.2.4 Fading or Rusty Roof Material? Yes

Comments related to 7.2.4 Fading or Rusty Roof Material?

December 03, 2021 11:51, Elayna Birch-Smith

big fade mark on back of roof

[related to 7.2.4 Fading or Rusty Roof Mater...](#)

Pictures related to 7.2.4 Fading or Rusty Roof Material?



6.2.5 Damaged Roof Material? Yes

Comments related to 7.2.5 Damaged Roof Material?

December 03, 2021 11:51, Elayna Birch-Smith

roof shows age fade marks shingles are peeling and curled at edges (roof is just really old)

[related to 7.2.5 Damaged Roof Material?](#)

Continued on next page



Pictures related to 7.2.5 Damaged Roof Material?



| | |
|-------------------------------|----|
| 6.2.6 Soft or Cracking Spots? | No |
|-------------------------------|----|

| | |
|-----------------------------|----|
| 6.2.7 Multiple Roof Layers? | No |
|-----------------------------|----|

Continued on next page



6.2.8 Vegetation Close to or Overhanging the Install Surface? Yes

Comments related to 7.2.8 Vegetation Close to or Overhanging the Instal ...

December 03, 2021 11:50, Elayna Birch-Smith

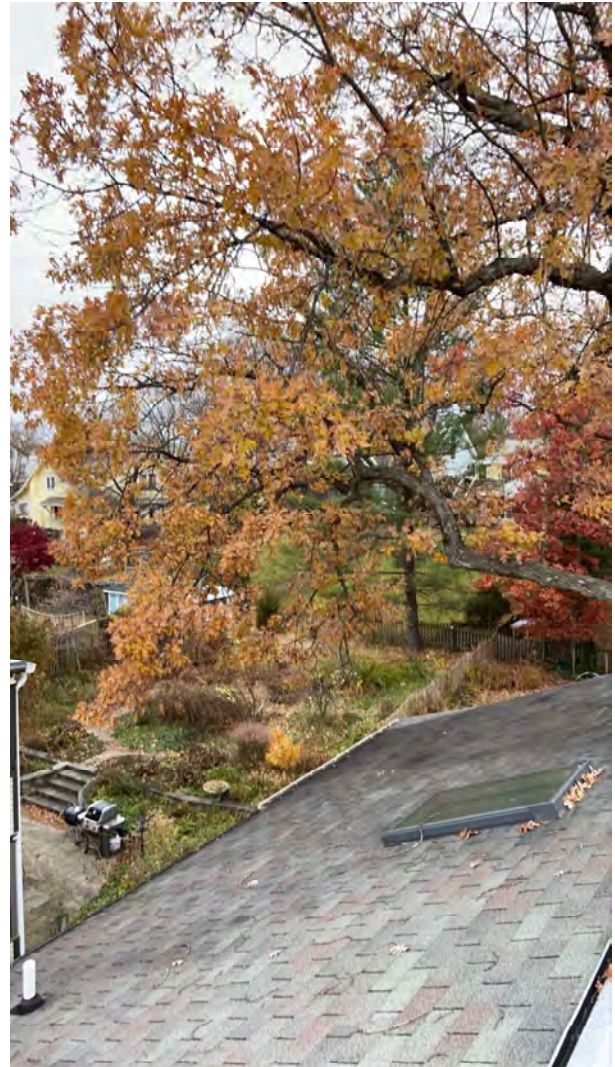
big tree at back of house overhangs roof

[related to 7.2.8 Vegetation Close to or Ove...](#)

Continued on next page



Pictures related to 7.2.8 Vegetation Close to or Overhanging the Instal ...



6.2.9 Significant Sources of Shade?



7. Structural Information

7.2. Install Information (1)

7.2.1 General Notes

7.2.2 Photos of Construction Plans

7.2.3 Roof Attic Access

Pictures related to 8.1.3 Roof Attic Access



Aurora Shade Report

Customer

Paul Miller

Designer

Zac Hare

Organization

Lumina Solar

Address

12 Montgomery Ave
Takoma Park, MD 20912,
USA

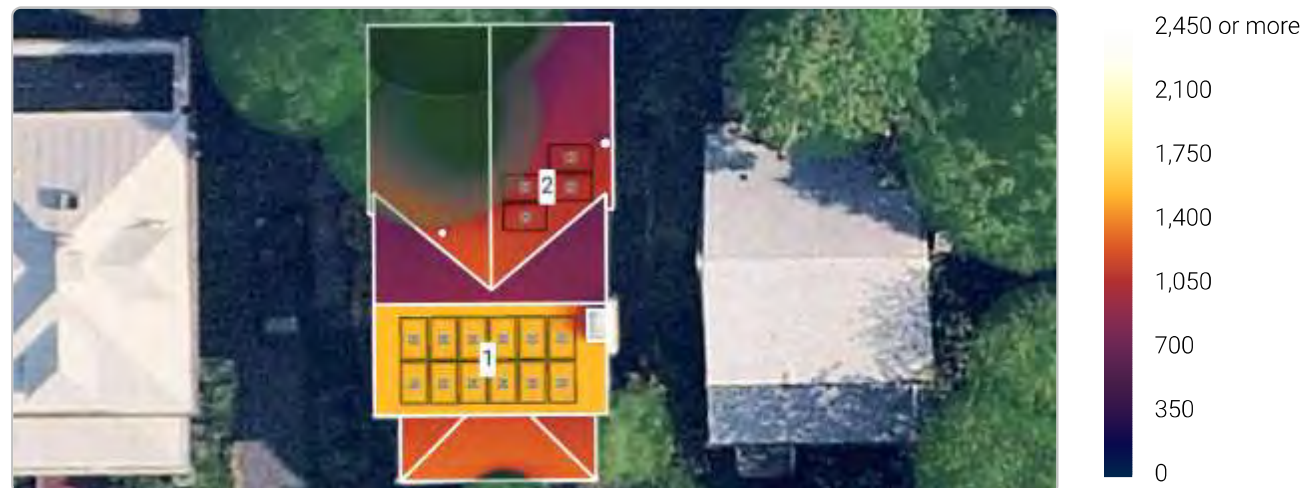
Coordinates

(38.974636, -77.007888)

Date

11 February 2022

Annual irradiance



Summary

| Array | Panel Count | Azimuth (deg.) | Pitch (deg.) | Annual TOF (%) | Annual Solar Access (%) | Annual TSRF (%) |
|------------------------------------|-------------|----------------|--------------|----------------|-------------------------|-----------------|
| 1 | 12 | 169 | 27 | 99 | 93 | 93 |
| 2 | 4 | 79 | 23 | 80 | 78 | 63 |
| Weighted average by panel count | - | - | - | - | 89.7 | 85.1 |

Monthly solar access (%) across arrays

| Array | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1 | 88 | 97 | 97 | 94 | 93 | 93 | 93 | 93 | 96 | 98 | 91 | 83 |
| 2 | 77 | 82 | 85 | 80 | 73 | 72 | 75 | 79 | 83 | 87 | 80 | 76 |

Customer

Paul Miller

Designer

Zac Hare

Organization

Lumina Solar

Address

12 Montgomery Ave
Takoma Park, MD 20912,
USA

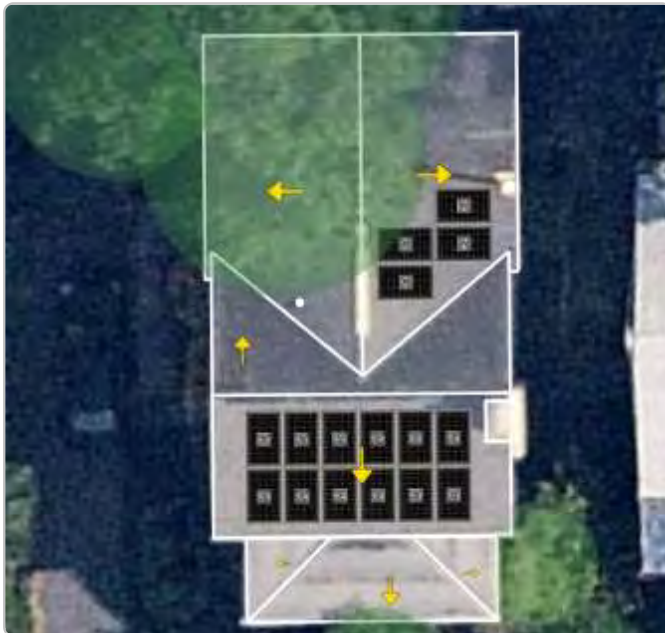
Coordinates

(38.974636, -77.007888)

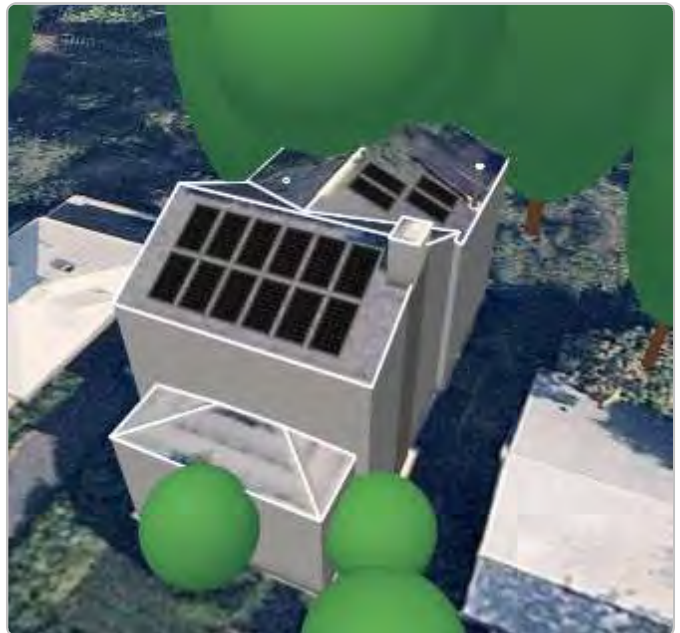
Date

11 February 2022

Zoomed out satellite view



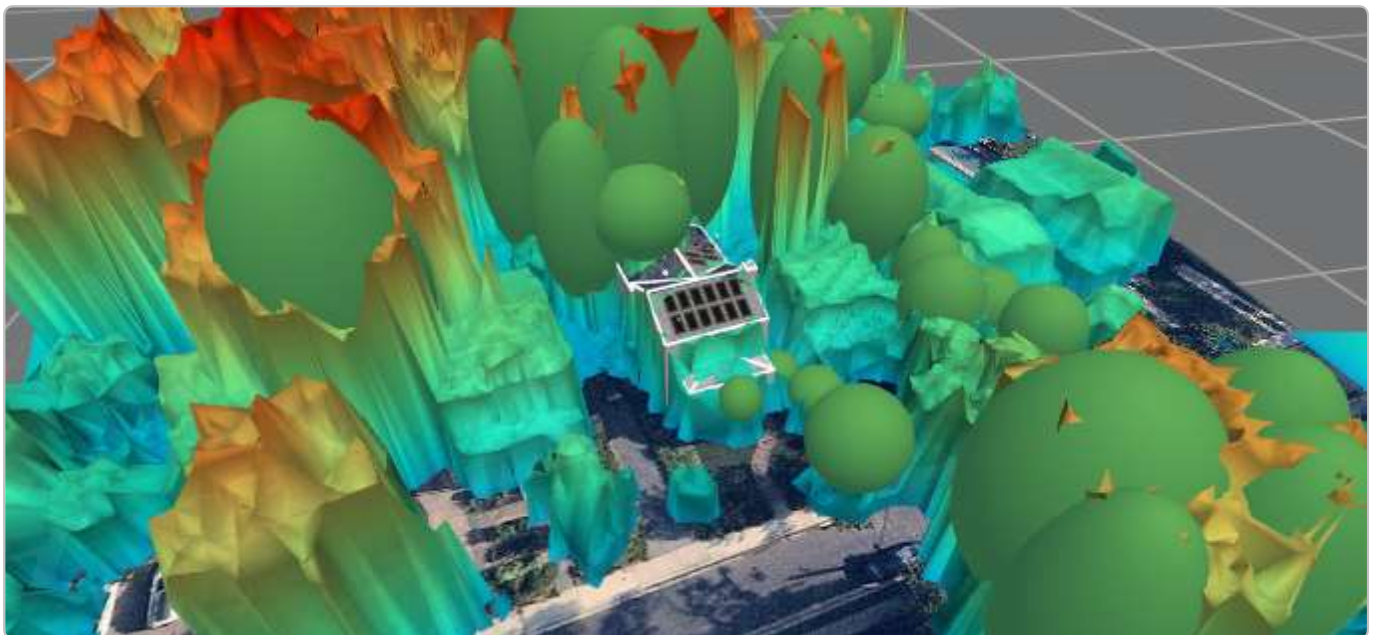
3D model



3D model with LIDAR overlay



14 ft



Customer

Paul Miller

Designer

Zac Hare

Organization

Lumina Solar

Address

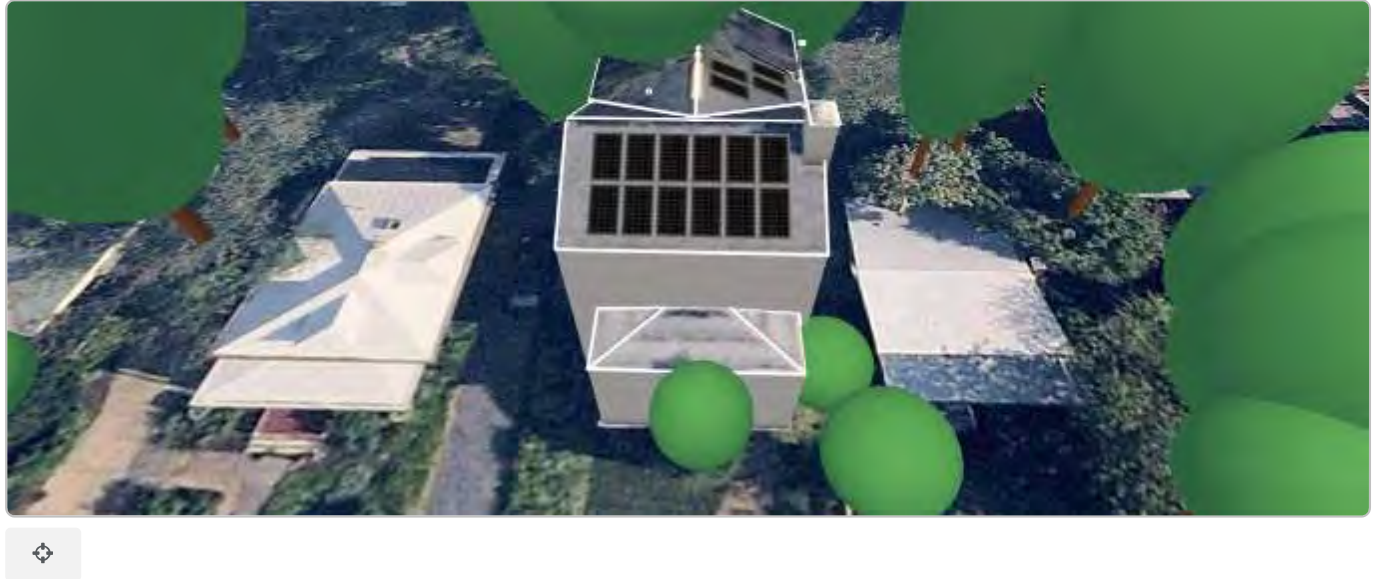
12 Montgomery Ave
Takoma Park, MD 20912,
USA

Coordinates

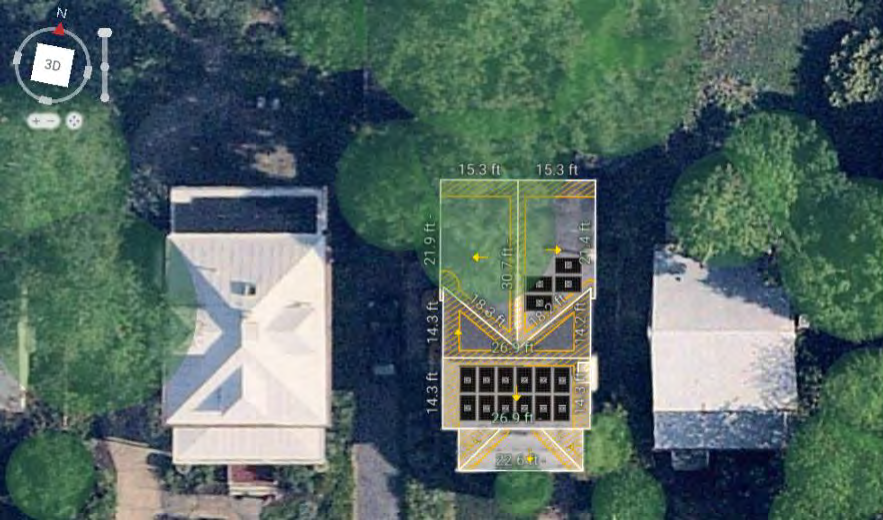
(38.974636, -77.007888)

Date

11 February 2022

Street view and corresponding 3D model

I, **Zac Hare**, certify that I have generated this shading report to the best of my abilities, and I believe its contents to be accurate.



Production

Utility Bill Savings

5.9 kW system
16 panels

Simulate



ANNUAL PRODUCTION

6,963 kWh
Energy

97%
Energy Offset

MONTHLY PRODUCTION



HIDE ADVANCED ^

Yield
1,176 kWh/kWp

65

Performance Ratio
0.884

Aurora Shade Report

Customer

Paul Miller

Designer

Zac Hare

Organization

Lumina Solar

Address

12 Montgomery Ave
Takoma Park, MD 20912,
USA

Coordinates

(38.974636, -77.007888)

Date

11 February 2022

Annual irradiance



Summary

| Array | Panel Count | Azimuth (deg.) | Pitch (deg.) | Annual TOF (%) | Annual Solar Access (%) | Annual TSRF (%) |
|------------------------------------|-------------|----------------|--------------|----------------|-------------------------|-----------------|
| 1 | 11 | 79 | 23 | 80 | 63 | 50 |
| 2 | 3 | 259 | 23 | 87 | 33 | 29 |
| 3 | 2 | 349 | 27 | 63 | 76 | 48 |
| Weighted average by panel count | - | - | - | - | 58.9 | 45.9 |

Monthly solar access (%) across arrays

| Array | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1 | 68 | 69 | 69 | 63 | 57 | 55 | 57 | 62 | 67 | 72 | 70 | 70 |
| 2 | 49 | 44 | 38 | 30 | 24 | 21 | 22 | 28 | 35 | 46 | 48 | 52 |
| 3 | 61 | 66 | 73 | 78 | 79 | 78 | 80 | 78 | 75 | 71 | 63 | 59 |

Customer

Paul Miller

Designer

Zac Hare

Organization

Lumina Solar

Address

12 Montgomery Ave
Takoma Park, MD 20912,
USA

Coordinates

(38.974636, -77.007888)

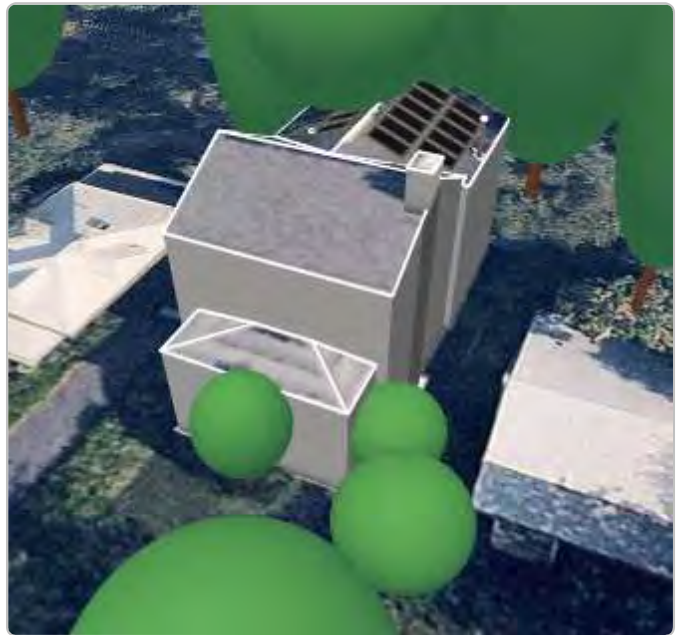
Date

11 February 2022

Zoomed out satellite view



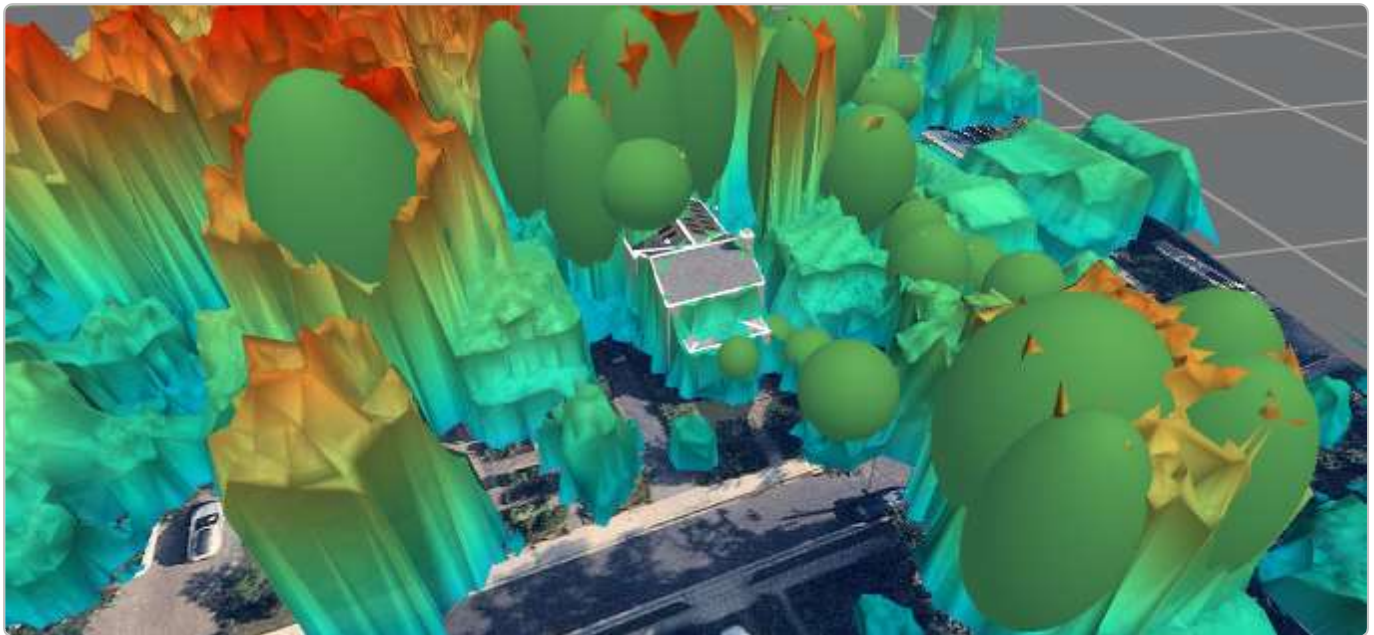
3D model



3D model with LIDAR overlay



14 ft



Customer

Paul Miller

Designer

Zac Hare

Organization

Lumina Solar

Address

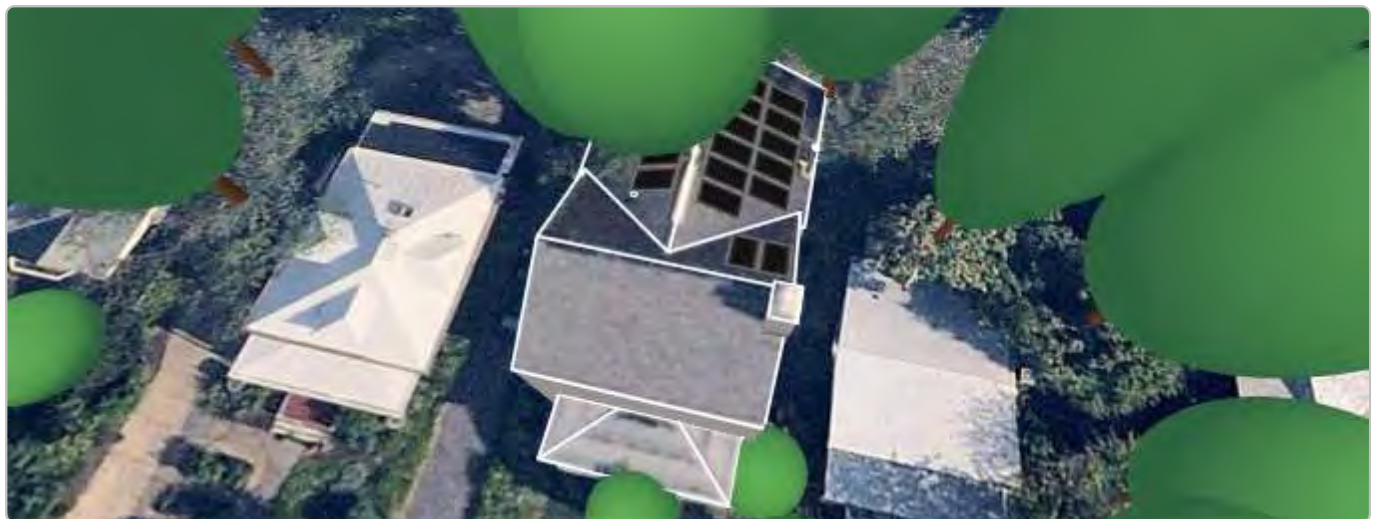
12 Montgomery Ave
Takoma Park, MD 20912,
USA

Coordinates

(38.974636, -77.007888)

Date

11 February 2022

Street view and corresponding 3D model

I, **Zac Hare**, certify that I have generated this shading report to the best of my abilities, and I believe its contents to be accurate.



Production

Utility Bill Savings

5.9 kW system
16 panels

Simulate

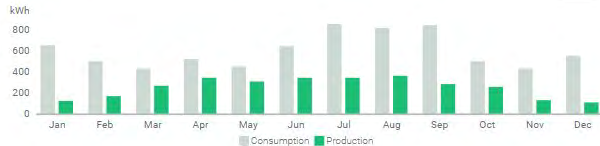


ANNUAL PRODUCTION

3,050 kWh
Energy

43%
Energy Offset

MONTHLY PRODUCTION



HIDE ADVANCED

Yield
515 kWh/kWp

69

Performance Ratio
0.887



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

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.

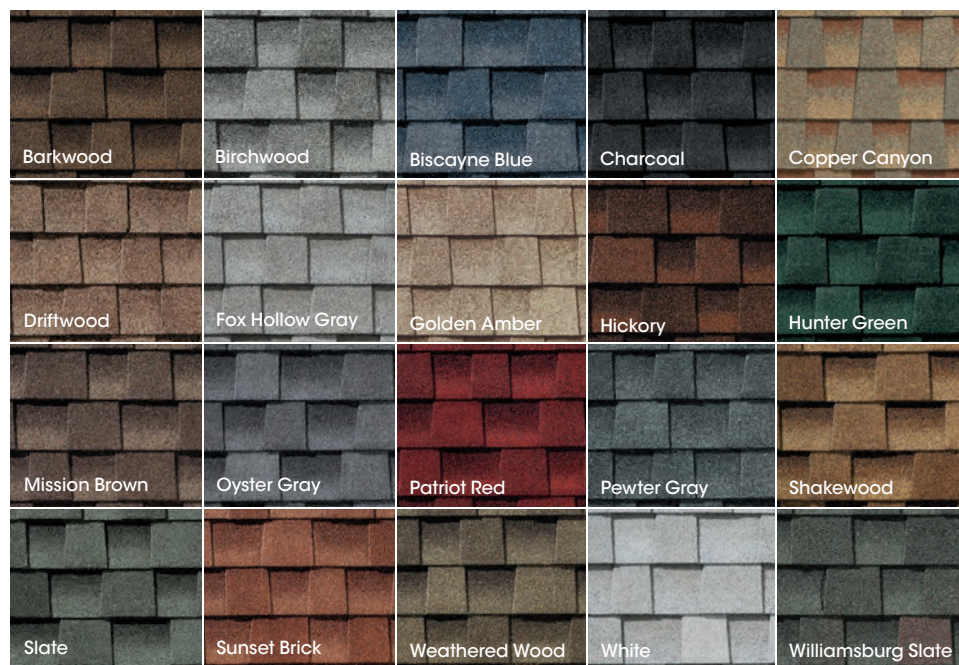


Timberline HDZ® Shingles

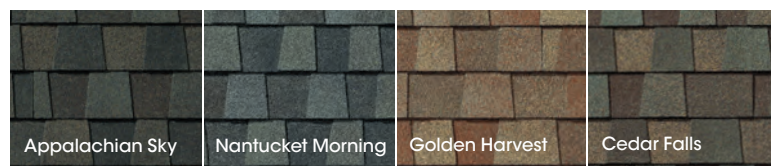
Benefits:

- **LayerLock™ Technology** — mechanically fuses the common bond between overlapping shingle layers
- **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 test¹
- **WindProven™ Limited Wind Warranty** — when installed with the required combination of GAF Accessories, Timberline HDZ® Shingles are eligible for a wind warranty with no maximum wind speed limitation³
- **Dura Grip™** sealant pairs with the microgranule surface of the StrikeZone™ nailing area. Then, an asphalt to-asphalt monolithic bond cures for durability, strength, and exceptional wind uplift performance.
- **25-year StainGuard Plus™ Algae Protection Limited Warranty** against blue-green algae discoloration.² Proprietary GAF Time-Release Algae-Fighting Technology helps protect your shingles from unsightly stains.
- **For the best look** — use TimberTex® Premium Ridge Cap Shingles or TimberCrest® Premium SBS-Modified Ridge Cap Shingles

Colors:



Harvest Blend Colors⁵



Product details:

Product/System Specifics

- Fiberglass asphalt construction
- **Dimensions (approx.):** 13 1/4" x 39 3/8" (337 x 1,000 mm)
- **Exposure:** 5 5/8" (143 mm)
- **Bundles/Square:** 3
- **Pieces/Square:** 64
- **StainGuard Plus™ Algae Protection²** Limited Warranty
- **Hip/Ridge:** TimberTex®; TimberCrest®; Seal-A-Ridge®; Z®Ridge; Ridglass®⁵
- **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 D3462⁴
- Miami-Dade County Product Control approved
- ICC-ES Evaluation Reports ESR-1475 and ESR-3267
- Meets Texas Department of Insurance Requirements
- Rated by the CRRC; Can be used to comply with Title 24 Cool Roof requirements (some colors)

¹ 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 the use of GAF Lifetime Shingles only. See the *GAF Shingle & Accessory Limited Warranty* for complete coverage and restrictions. Visit gaf.com/LRS for qualifying GAF products. Lifetime coverage on shingles and accessories requires the use of any GAF Lifetime Shingle and at least 3 qualifying GAF Accessories. See the *GAF Roofing System Limited Warranty* for complete coverage and restrictions. For installations not eligible for the *GAF Roofing System Limited Warranty*, see the *GAF Shingle & Accessory Limited Warranty*. Visit gaf.com/LRS for qualifying GAF products.

² Results based on study conducted by Home Innovation Research Labs, an independent research lab, comparing installation of Timberline HDZ® 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.

³ 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 and qualifying products.

⁴ 15-year WindProven™ limited wind warranty on GAF Shingles with LayerLock™ Technology 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. For installations not eligible for the *GAF Roofing System Limited Warranty*, see the *GAF Shingle & Accessory Limited Warranty*.

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

⁶ Harvest Blend colors are only available on TimberTex® Ridge Cap Shingles, Seal-A-Ridge® Ridge Cap Shingles, and TimberCrest® Premium SBS-Modified Ridge Cap Shingles.

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.



We protect what matters most™

