MONTGOMERY COUNTY HISTORIC PRESERVATION COMMISSION
STAFF REPORT

Address:	5510 Lambeth Rd., Bethesda	**Meeting Date:**	6/14/2023
Resource:	Non-Contributing Resource **Greenwich Forest Historic District**	**Report Date:**	6/7/2023
Applicant:	Beth Vallandingham	**Public Notice:**	5/31/2023
Review:	HAWP	**Tax Credit:**	n/a
Case No.:	1031842	**Staff:**	Dan Bruechert
Proposal:	Rooftop Solar Installation		

STAFF RECOMMENDATION

Staff recommends the HPC **approve the HAWP with one (1) condition**:

1. The solar panels that are at all visible from the public right-of-way violate the Greenwich Forest Historic District Design Guidelines. Only the panels on the rear roof slope are approved. A revised roof plan shall be submitted to Staff for review and final approval before approval documents can be released.

ARCHITECTURAL DESCRIPTION

SIGNIFICANCE: Non-Contributing Resource within the Greenwich Forest Historic District
STYLE: Colonial Revival
DATE: 2003

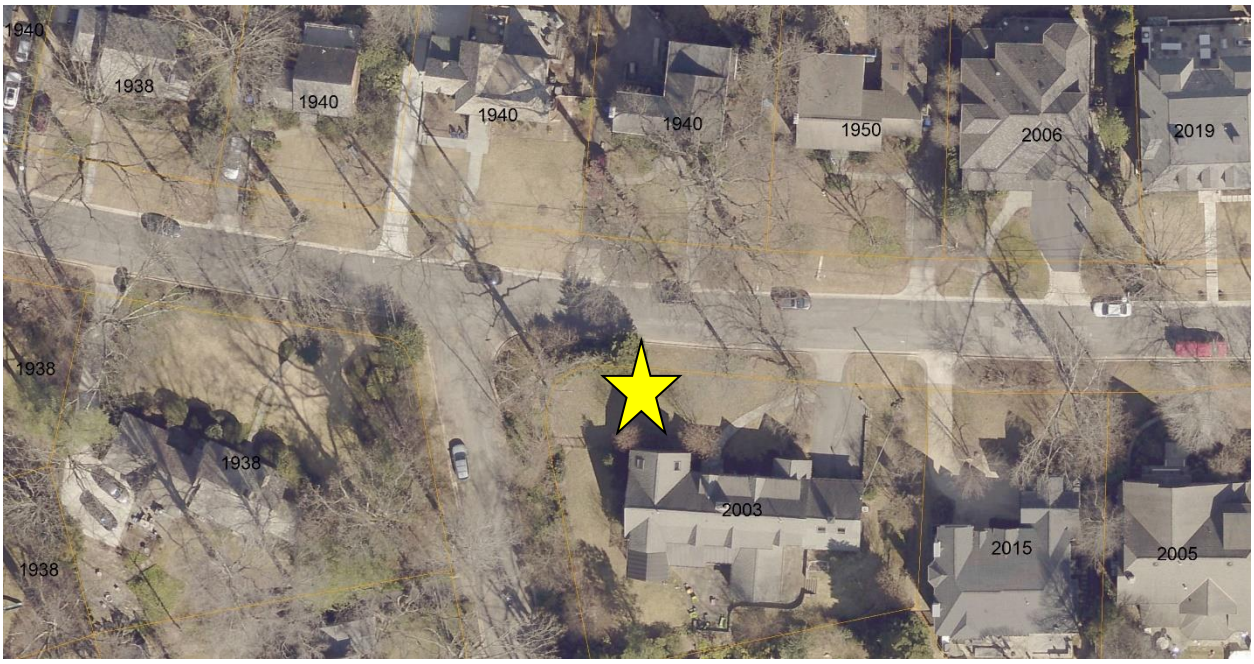


Figure 1: The subject property is located at the corner of Lambeth Rd. and Westover Rd.

PROPOSAL

The applicant proposes to install forty-seven roof-mounted solar panels.

APPLICABLE GUIDELINES

When reviewing alterations and new construction within the Greenwich Forest 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 *Greenwich Forest Historic District (Guidelines), Montgomery County Code Chapter 24A (Chapter 24A*), and *the Secretary of the Interior's Standards for Rehabilitation (Standards)* the HPC's *Policy No. 20-01 ADDRESSING EMERGENCY CLIMATE MOBILIZATION THROUGH THE INSTALLATION OF ROOF-MOUNTED SOLAR PANELS.* The pertinent information in these documents is outlined below.

Greenwich Forest Historic District Guidelines

A. PRINCIPLES

The preservation of the following essential elements of Greenwich Forest is the highest priority in making decisions concerning applications for work permits. These Principles are not meant to stop or create unreasonable obstacles to normal maintenance, reasonable modifications, and the evolving needs of residents.

A1. Greenwich Forest was conceived of, built, and to a great degree preserved as a park-like canopied forest with gentle topographic contours, in which the presence of houses and hardscape are understated relative to the natural setting. The removal of mature trees and the significant alteration of topographic contours on private property, the Greenwich Forest Triangle, and the public right-of-way in Greenwich Forest should be avoided whenever possible. The Greenwich Forest Citizens Association (GFCA) will continue to support the replacement of trees. In order to protect mature trees and the natural setting of Greenwich Forest, and to limit runoff into the Chesapeake Bay, the creation of extensive new impermeable hardscape surfaces should be avoided whenever possible.

A2. The houses in Greenwich Forest create an integrated fabric well-suited to its forest setting. These Guidelines are intended to preserve this environment by ensuring that approved work permits include appropriate safeguards that protect the following three essential elements of this fabric:

c. High quality building materials and high level of craftsmanship.

A3. The neighborhood needs to evolve to meet the needs of its residents while maintaining the charm and architectural integrity that have been maintained since the 1930s. Introducing new *architectural styles* that are not already present in the neighborhood will detract from its integrated fabric.

B. BALANCING PRESERVATION AND FLEXIBILITY

Greenwich Forest represents a period in the evolution of Montgomery County worthy of preservation, but it has also changed in response to the needs of residents since it was created in the 1930s. These Guidelines seek a reasonable compromise between preservation and the needs of residents in several ways.

D14. Solar panels are not permitted on forward-facing roof surfaces. Solar panels on non-forward-facing areas are permitted, subject to the decision-making body's review, to ensure that they are not visible from

the public right-of-way. Solar panels on non-forward-facing roof surfaces should be of a type that blends with the existing materials, such as solar shingles rather than large solar panels.

Sec. 24A-8. Same-Criteria for Issuance

(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 insure 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

(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 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." Standards 2, 9, and 10 most directly apply to the application before the commission:

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

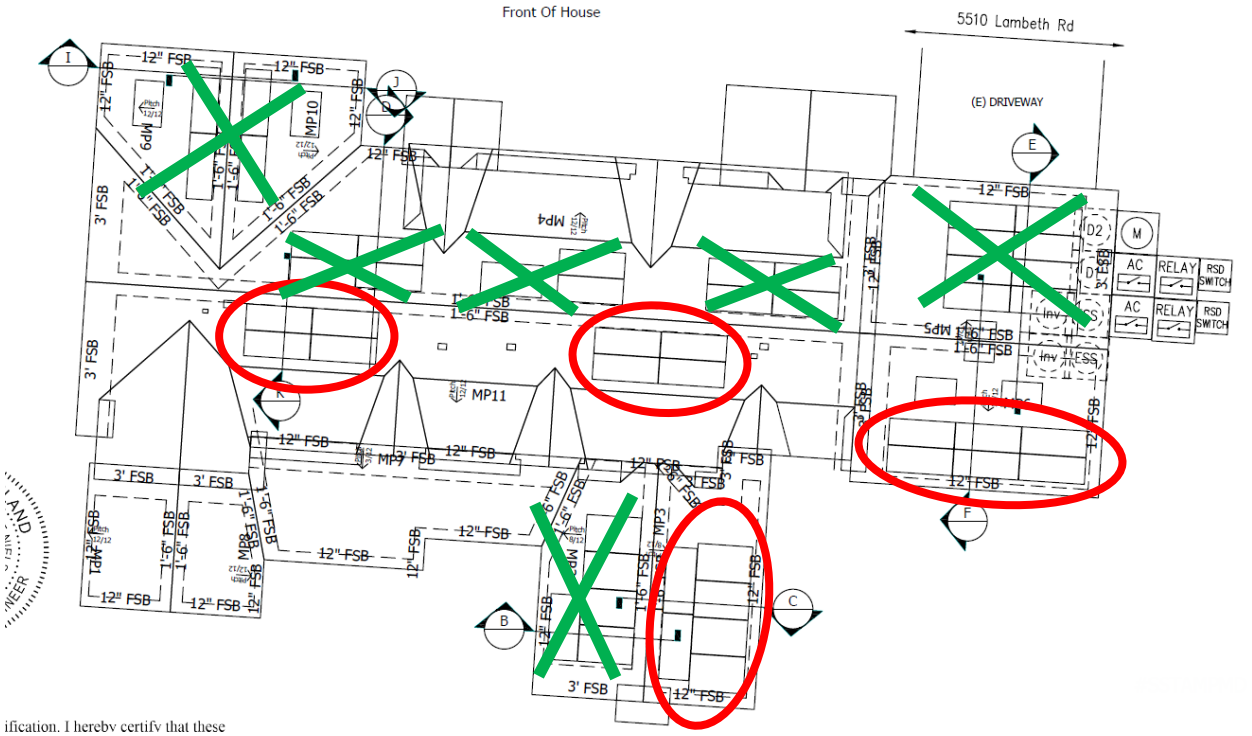
4. The public welfare is better served by approving a Historic Area Work Permit for solar panels on all visible side or front roof slopes under Section 24A-8(b)(6).

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

STAFF DISCUSSION

The subject property is a 2003 infill construction (Non-Contributing Resource) at the corner of Lambeth Rd. and Westover Rd. The applicant proposes to install 47 (forty-seven) solar panels at the subject property. Twenty-two (22) of the proposed panels are on the front-facing roof slope. The remaining 25 (twenty-five) solar panels are on the rear of the house.

The Greenwich Forest Design Guidelines are explicit about the placement of solar panels within the historic district. Because these guidelines were approved by the County Council, they have the power of law and supersede the HPC's adopted solar panel policy. The *Design Guidelines* do not allow solar panels on the front-facing roof slopes. Solar panels on the rear roof slopes are allowed, provided the panels are not visible from the public right-of-way. Because the subject property is on a corner lot, some of the panels on the east slope of the rear gable would be visible from the public right-of-way. Staff finds 20 (twenty of the proposed panels satisfy this requirement (circled below); and recommends the HPC condition the approval of the HAWP so it extends only to these 20 (twenty panels). A revised roof plan needs to be submitted to Staff to review and approve to ensure the condition has been satisfied.



ification. I hereby certify that these

Figure 2: Roof plan showing the proposed solar panels. Panels that satisfy the requirements of the Greenwich Forest Design Guidelines are circled. Panels Staff finds are inappropriate are marked with an 'X.'

STAFF RECOMMENDATION

Staff recommends that the Commission **approve the HAWP application with one (1) condition**:

1. The solar panels that are at all visible from the public right-of-way violate the Greenwich Forest Historic District Design Guidelines. Only the panels on the rear roof slope are approved. A revised roof plan shall be submitted to Staff for review and final approval before approval documents can be released.

under the Criteria for Issuance in Chapter 24A-8(b)(1), (2), and (d), and the *Greenwich Forest Historic District Guidelines*, 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 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# 1031842
DATE ASSIGNED_____

APPLICATION FOR HISTORIC AREA WORK PERMIT

HISTORIC PRESERVATION COMMISSION
301.563.3400

APPLICANT:

Name: BETH VALLANDINGHAM E-mail: LVALLANDINGHAM@TESLA.COM

Address: 9000 VIRGINIA MANOR RD, STE 250, City: BELTSVILLE Zip: 20705

Daytime Phone: 240-917-9885 Tax Account No.: _____

AGENT/CONTACT (if applicable):

Name: BETH VALLANDINGHAM E-mail: LVALLANDINGHAM@TESLA.COM

Address: 9000 VIRGINIA MANOR RD, STE 250, City: BELTSVILLE Zip: 20705

Daytime Phone: 240-917-9885 Contractor Registration No.: MHIC 218948

LOCATION OF BUILDING/PREMISE: MIHP # of Historic Property Greenwich Forest Historic District

Is the Property Located within an Historic District? X Yes/District Name GREENWICH FOREST
__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: 5510 Street: LAMBETH RD

Town/City: BETHESDA Nearest Cross Street: WESTOVER RD

Lot: 5 Block: J Subdivision: 0026 Parcel: 0000

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: ENERGY STORAGE SYSTEM

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.

Beth Vallandingham 5/19/23

Signature of owner or authorized agent Date

HAWP APPLICATION: MAILING ADDRESSES FOR NOTIFING [Owner, Owner's Agent, Adjacent and Confronting Property Owners]	
Owner's mailing address Eric Lightfoot 5510 Lambeth Rd, Bethesda, MD 20814	**Owner's Agent's** mailing address TESLA ENERGY OPS, INC. ATTN: BETH VALLANDINGHAM 9000 VIRGINIA MANOR RD, STE 250, BELTSVILLE MD, 20705
Adjacent and confronting Property Owners mailing addresses	
ERIC & MARIA LONG 5506 LAMBETH RD BETHESDA MD 20814	LAUREN BREITENOTHER & JEFFREY CLARK 5511 LAMBETH RD BETHESDA MD 20814

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

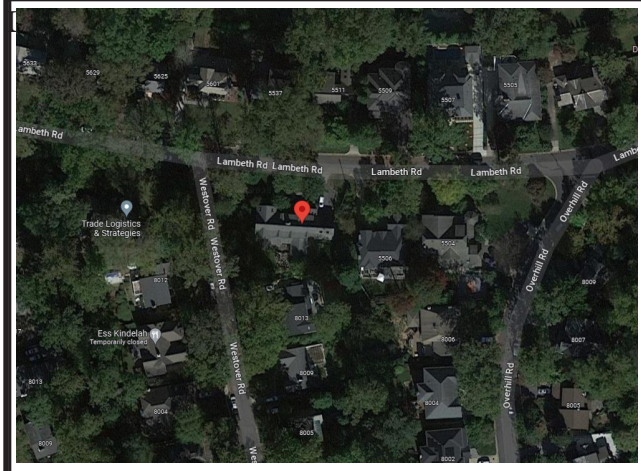
5,163 SF RESIDENTIAL HOME BUILT IN 2003

PROPERTY AREA IS 16,685 SF

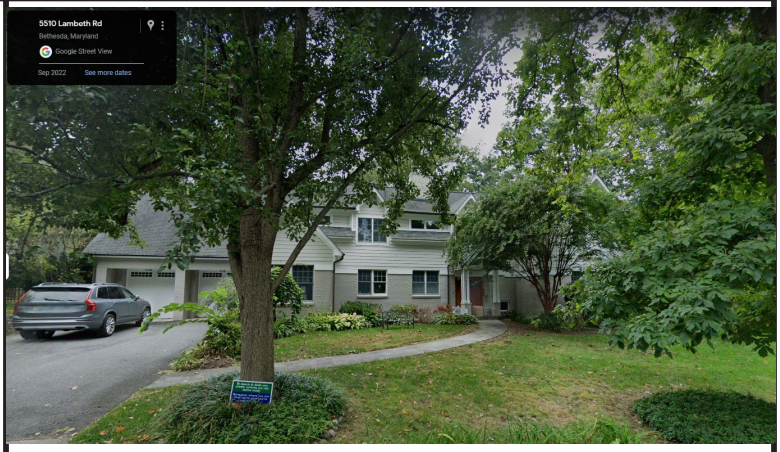
Description of Work Proposed: Please give an overview of the work to be undertaken:

INSTALL ROOF MOUNTED SOLAR PANELS AND ENERGY STORAGE SYSTEM

Work Item 1: AERIAL



FRONT OF HOME



Work Item 2: LEFT FRONT OF HOME

RIGHT FRONT OF HOME

Work Item 3: BACK OF HOME

METER

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	*	*	*	*	*		*

1 Tesla Road, Austin, TX 78725
P 650 681 5100 F 650 681 5101

Version #95.6 - 3

November 17, 2022

Certification Letter

Project/Job # 20812222
Project Address: Lightfoot Residence
5510 Lambeth Rd
Bethesda, MD 20814

AHJ Montgomery County
SC Office Beltsville

Design Criteria:

- Total Number of Modules = 47
- Applicable Codes = 2018 IEBC/IBC, 2018 IRC, ASCE 7-16, and 2018 NDS
- Risk Category = II
- Wind Speed = 115 mph (3-s Gust - Vult), Exposure Category C, Partially/Fully Enclosed Method
- Ground Snow Load = 30 psf
- MP9&MP10: 2x10 Stick Frame @ 16" OC, Comp Roof, Roof DL = 11 psf, Roof LL/SL = 16 psf (Non-PV), Roof LL/SL = 8.7 psf (PV)
- MP11: 2x10 Stick Frame @ 16" OC, Comp Roof, Roof DL = 11 psf, Roof LL/SL = 16 psf (Non-PV), Roof LL/SL = 8.7 psf (PV)
- MP2&MP3: 2x10 Stick Frame @ 16" OC, Comp Roof, Roof DL = 11 psf, Roof LL/SL = 20.8 psf (Non-PV), Roof LL/SL = 12.5 psf (PV)

- MP4: 2x10 Stick Frame @ 16" OC, Comp Roof, Roof DL = 11 psf, Roof LL/SL = 16 psf (Non-PV), Roof LL/SL = 8.7 psf (PV)
- MP5: 2x10 Stick Frame @ 16" OC, Comp Roof, Roof DL = 11 psf, Roof LL/SL = 16 psf (Non-PV), Roof LL/SL = 8.7 psf (PV)
- MP6: 2x10 Stick Frame @ 16" OC, Comp Roof, Roof DL = 11 psf, Roof LL/SL = 16 psf (Non-PV), Roof LL/SL = 8.7 psf (PV)

Note: Per IBC 1613.1; Seismic check is not required because Ss = 0.135 < 0.4g and Seismic Design Category (SDC) = B < D

To Whom It May Concern,

[√] I reviewed the design of the photovoltaic (PV) system, as designed by the manufacturer, and the design criteria utilized for the mounting equipment and panel mounting assembly (rack system) for the installation of panels supported by the rack system, 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 PV system. 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 PV system.

[ ] 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 PV system. 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 PV system. 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.

11/17/2022

STRUCTURAL ONLY

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. 46671, Expiration Date: 05/18/2023

1 Tesla Road, Austin, TX 78725
P 650 681 5100 F 650 681 5101

HARDWARE DESIGN AND STRUCTURAL ANALYSIS RESULTS SUMMARY TABLES

Landscape Hardware	Hardware - Landscape Modules' Standoff Specifications					
	X-X Spacing	X-X Cantilever	Y-Y Spacing	Y-Y Cantilever	Configuration	Uplift DCR
MP9&MP10	64"	24"	41"	NA	Staggered	61.6%
MP11	64"	24"	41"	NA	Staggered	61.6%
MP2&MP3	64"	24"	41"	NA	Staggered	60.8%
MP4	64"	24"	41"	NA	Staggered	61.6%
MP5	64"	24"	41"	NA	Staggered	61.6%
MP6	64"	24"	41"	NA	Staggered	61.6%

Portrait Hardware	Hardware - Portrait Modules' Standoff Specifications					
	X-X Spacing	X-X Cantilever	Y-Y Spacing	Y-Y Cantilever	Configuration	Uplift DCR
MP9&MP10	48"	19"	74"	NA	Staggered	83.5%
MP11	48"	19"	74"	NA	Staggered	83.5%
MP2&MP3	48"	19"	74"	NA	Staggered	82.3%
MP4	48"	19"	74"	NA	Staggered	83.5%
MP5	48"	19"	74"	NA	Staggered	83.5%
MP6	48"	19"	74"	NA	Staggered	83.5%

Mounting Plane	Structure Information			Qualification Results
	Type	Pitch	Spacing	Member Evaluation Results
MP9&MP10	Stick Frame	45°	16" O.C.	Member Impact Check OK
MP11	Stick Frame	45°	16" O.C.	Member Impact Check OK
MP2&MP3	Stick Frame	34°	16" O.C.	Member Impact Check OK
MP4	Stick Frame	45°	16" O.C.	Member Impact Check OK
MP5	Stick Frame	45°	16" O.C.	Member Impact Check OK
MP6	Stick Frame	45°	16" O.C.	Member Impact Check OK

STRUCTURE ANALYSIS - LOADING SUMMARY AND MEMBER CHECK - MP9&MP10

Member Properties Summary					
MP9&MP10		Horizontal Member Spans		Rafter Properties	
		Overhang	1.20 ft	Actual W	1.50''
Roof System Properties		Span 1	11.30 ft	Actual D	9.25''
Number of Spans (w/o Overhang)	1	Span 2		Nominal	Yes
Roofing Material	Comp Roof	Span 3		A (in^2)	13.88
Re-Roof	No	Span 4		Sx (in.^3)	21.39
Plywood Sheathing	Yes	Span 5		Ix (in^4)	98.93
Board Sheathing	None	Total Rake Span	17.68 ft	TL Defl'n Limit	120
Vaulted Ceiling	No	PV 1 Start	8.75 ft	Wood Species	SPF
Ceiling Finish	1/2" Gypsum Board	PV 1 End	11.25 ft	Wood Grade	#2
Rafter Slope	45°	PV 2 Start		Fb (psi)	875
Rafter Spacing	16'' O.C.	PV 2 End		Fv (psi)	135
Top Lat Bracing	Full	PV 3 Start		E (psi)	1,400,000
Bot Lat Bracing	At Supports	PV 3 End		E-min (psi)	510,000

Member Loading Summary					
Roof Pitch	12/12	Initial	Pitch Adjust	Non-PV Areas	PV Areas
Roof Dead Load	DL	11.0 psf	x 1.41	15.6 psf	15.6 psf
PV Dead Load	PV-DL	3.0 psf	x 1.41		4.2 psf
Roof Live Load	RLL	20.0 psf	x 0.60	12.0 psf	
Snow Load	SL[1,2]	30.0 psf	x 0.53 l x 0.29	16.0 psf	8.7 psf
Total Load (Governing LC)	**TL**			**31.6 psf**	**28.5 psf**

Notes: 1. ps = Cs*pf; Cs -roof, Cs -pv per ASCE 7 [Figure 7.4-1]; 2. pf = 0.7 (Ce) (Ct) (Is) pg ; Ce=0.9, Ct=1.1, Is=1.0;

Member Analysis Results Summary					
Governing Analysis	Pre-PV	Load (psf)	Post-PV	Net Impact	Result
Gravity Loading Check	**31.6**		**28.5**	**-10%**	**Pass**

ZEP HARDWARE DESIGN CALCULATIONS - MP9&MP10

Mounting Plane Information			
Roofing Material		Comp Roof	
Roof Slope		45°	
Framing Type / Direction		Y-Y Rafters	
PV System Type		SolarCity SleekMount™	
Zep System Type		ZS Comp	
Standoff (Attachment Hardware)		ZS Comp V4 with Flashing Insert	
Spanning Vents		No	

Wind Design Criteria			
Design Standard		ASCE 7-16	
Wind Design Method		Partially/Fully Enclosed Method	
Ultimate Wind Speed	V-Ult	115 mph	Fig. 26.5-1B
Exposure Category		C	Section 26.7
Roof Style		Gable Roof	Fig. 30.3-2A/B/C/D/E/G/H-5A/B
Mean Roof Height	h	25 ft	Section 26.2

Notes: 1. Risk Category = II

Wind Pressure Calculation Coefficients			
Wind Pressure Exposure	K_z	0.95	Table 26.10-1
Topographic Factor	K_{zt}	1.00	Section 26.8
Wind Directionality Factor	K_d	0.85	Section 26.6-1
Ground Elevation Factor	Ke	1.00	Table 26.9-1
Velocity Pressure	**q_h**	**qh = 0.00256 (Kz) (Kzt) (Kd) (Ke) (V^2) 27.2 psf**	**Equation 26.10-1**

		Wind Pressure	
Ext. Pressure Coefficient (Up)	GCp (Up)	-1.47	Fig. 30.3-2A/B/C/D/E/G/H-5A/B
Ext. Pressure Coefficient (Down)	GCp (Down)	0.77	Fig. 30.3-2A/B/C/D/E/G/H-5A/B
Design Wind Pressure	p	p = qh (yE) (ya) (GCp); yE = 1.15, yA = 0.60	Equation 29.4-7
Wind Pressure Up (Design | Ult)	**$p_{(up)}$**	**-16.6 | -27.7 psf**	
Wind Pressure Down (Design | Ult)	**$p_{(down)}$**	**9.6 | 16 psf**	

Notes: 1. Wind Zone Perimeter Width (a) = 6.4 ft.; Effective Wind Area (A) = 21.3 sf

2. yE = Array Edge Factor and yA = Solar Panel Pressure Equalization Factor per SEAoC PV2-2017

ALLOWABLE STANDOFF SPACINGS

		X-Direction	Y-Direction
Max Allowable Standoff Spacing	Landscape	64''	41''
Max Allowable Cantilever	Landscape	24''	NA
Standoff Configuration	Landscape	Staggered	
Max Standoff Tributary Area (Interior)	Trib	18 sf	
PV Assembly Dead Load	W-PV	3.0 psf	
Net Wind Uplift at Standoff (Interior)	T-actual	-281 lbs	
Uplift Capacity of Standoff	T-allow	456 lbs	
Standoff Demand/Capacity (Interior)	DCR	61.6%	

		X-Direction	Y-Direction
Max Allowable Standoff Spacing	Portrait	48''	74''
Max Allowable Cantilever	Portrait	19''	NA
Standoff Configuration	Portrait	Staggered	
Max Standoff Tributary Area (Interior)	Trib	25 sf	
PV Assembly Dead Load	W-PV	3.0 psf	
Net Wind Uplift at Standoff (Interior)	T-actual	-381 lbs	
Uplift Capacity of Standoff	T-allow	456 lbs	
Standoff Demand/Capacity (Interior)	DCR	83.5%	

STRUCTURE ANALYSIS - LOADING SUMMARY AND MEMBER CHECK - MP11

Member Properties Summary					
MP11		**Horizontal Member Spans**		**Rafter Properties**	
		Overhang	1.20 ft	**Actual W**	1.50''
Roof System Properties		**Span 1**	5.80 ft	**Actual D**	9.25''
Number of Spans (w/o Overhang)	1	**Span 2**		**Nominal**	Yes
Roofing Material	Comp Roof	**Span 3**		**A (in^2)**	13.88
Re-Roof	No	**Span 4**		**Sx (in.^3)**	21.39
Plywood Sheathing	Yes	**Span 5**		**Ix (in^4)**	98.93
Board Sheathing	None	**Total Rake Span**	9.90 ft	**TL Defl'n Limit**	120
Vaulted Ceiling	No	**PV 1 Start**	0.92 ft	**Wood Species**	SPF
Ceiling Finish	1/2" Gypsum Board	**PV 1 End**	5.92 ft	**Wood Grade**	#2
Rafter Slope	45°	**PV 2 Start**		**Fb (psi)**	875
Rafter Spacing	16'' O.C.	**PV 2 End**		**Fv (psi)**	135
Top Lat Bracing	Full	**PV 3 Start**		**E (psi)**	1,400,000
Bot Lat Bracing	At Supports	**PV 3 End**		**E-min (psi)**	510,000

Member Loading Summary					
Roof Pitch	**12/12**	**Initial**	**Pitch Adjust**	**Non-PV Areas**	**PV Areas**
Roof Dead Load	**DL**	11.0 psf	x 1.41	15.6 psf	15.6 psf
PV Dead Load	**PV-DL**	3.0 psf	x 1.41		4.2 psf
Roof Live Load	**RLL**	20.0 psf	x 0.60	12.0 psf	
Snow Load	**SL**[1,2]	30.0 psf	x 0.53 l x 0.29	16.0 psf	8.7 psf
Total Load (Governing LC)	**TL**			**31.6 psf**	**28.5 psf**

Notes: 1. ps = Cs*pf; Cs -roof, Cs -pv per ASCE 7 [Figure 7.4-1]; 2. pf = 0.7 (Ce) (Ct) (Is) pg ; Ce=0.9, Ct=1.1, Is=1.0;

Member Analysis Results Summary					
Governing Analysis	**Pre-PV**	**Load (psf)**	**Post-PV**	**Net Impact**	**Result**
Gravity Loading Check	**31.6**		**28.5**	**-10%**	**Pass**

ZEP HARDWARE DESIGN CALCULATIONS - MP11

Mounting Plane Information			
Roofing Material		Comp Roof	
Roof Slope		45°	
Framing Type / Direction		Y-Y Rafters	
PV System Type		SolarCity SleekMount™	
Zep System Type		ZS Comp	
Standoff (Attachment Hardware)		ZS Comp V4 with Flashing Insert	
Spanning Vents		No	

Wind Design Criteria			
Design Standard		ASCE 7-16	
Wind Design Method		Partially/Fully Enclosed Method	
Ultimate Wind Speed	V-Ult	115 mph	Fig. 26.5-1B
Exposure Category		C	Section 26.7
Roof Style		Gable Roof	Fig. 30.3-2A/B/C/D/E/G/H-5A/B
Mean Roof Height	h	25 ft	Section 26.2

Notes: 1. Risk Category = II

Wind Pressure Calculation Coefficients			
Wind Pressure Exposure	K_z	0.95	Table 26.10-1
Topographic Factor	K_{zt}	1.00	Section 26.8
Wind Directionality Factor	K_d	0.85	Section 26.6-1
Ground Elevation Factor	Ke	1.00	Table 26.9-1
Velocity Pressure	**q_h**	**qh = 0.00256 (Kz) (Kzt) (Kd) (Ke) (V^2) 27.2 psf**	**Equation 26.10-1**

		Wind Pressure	
Ext. Pressure Coefficient (Up)	GCp (Up)	-1.47	Fig. 30.3-2A/B/C/D/E/G/H-5A/B
Ext. Pressure Coefficient (Down)	GCp (Down)	0.77	Fig. 30.3-2A/B/C/D/E/G/H-5A/B
Design Wind Pressure	p	p = qh (yE) (ya) (GCp); yE = 1.15, yA = 0.60	Equation 29.4-7
Wind Pressure Up (Design | Ult)	**$p_{(up)}$**	**-16.6 | -27.7 psf**	
Wind Pressure Down (Design | Ult)	**$p_{(down)}$**	**9.6 | 16 psf**	

Notes: 1. Wind Zone Perimeter Width (a) = 6.4 ft.; Effective Wind Area (A) = 21.3 sf

2. yE = Array Edge Factor and yA = Solar Panel Pressure Equalization Factor per SEAoC PV2-2017

ALLOWABLE STANDOFF SPACINGS

		X-Direction	Y-Direction
Max Allowable Standoff Spacing	Landscape	64''	41''
Max Allowable Cantilever	Landscape	24''	NA
Standoff Configuration	Landscape	Staggered	
Max Standoff Tributary Area (Interior)	Trib	18 sf	
PV Assembly Dead Load	W-PV	3.0 psf	
Net Wind Uplift at Standoff (Interior)	T-actual	-281 lbs	
Uplift Capacity of Standoff	T-allow	456 lbs	
Standoff Demand/Capacity (Interior)	DCR	61.6%	

		X-Direction	Y-Direction
Max Allowable Standoff Spacing	Portrait	48''	74''
Max Allowable Cantilever	Portrait	19''	NA
Standoff Configuration	Portrait	Staggered	
Max Standoff Tributary Area (Interior)	Trib	25 sf	
PV Assembly Dead Load	W-PV	3.0 psf	
Net Wind Uplift at Standoff (Interior)	T-actual	-381 lbs	
Uplift Capacity of Standoff	T-allow	456 lbs	
Standoff Demand/Capacity (Interior)	DCR	83.5%	

STRUCTURE ANALYSIS - LOADING SUMMARY AND MEMBER CHECK - MP2&MP3

Member Properties Summary					
MP2&MP3		Horizontal Member Spans		Rafter Properties	
		Overhang	1.20 ft	Actual W	1.50''
Roof System Properties		Span 1	9.26 ft	Actual D	9.25''
Number of Spans (w/o Overhang)	1	Span 2		Nominal	Yes
Roofing Material	Comp Roof	Span 3		A (in^2)	13.88
Re-Roof	No	Span 4		Sx (in.^3)	21.39
Plywood Sheathing	Yes	Span 5		Ix (in^4)	98.93
Board Sheathing	None	Total Rake Span	12.62 ft	TL Defl'n Limit	120
Vaulted Ceiling	No	PV 1 Start	1.08 ft	Wood Species	SPF
Ceiling Finish	1/2" Gypsum Board	PV 1 End	9.25 ft	Wood Grade	#2
Rafter Slope	34°	PV 2 Start		Fb (psi)	875
Rafter Spacing	16" O.C.	PV 2 End		Fv (psi)	135
Top Lat Bracing	Full	PV 3 Start		E (psi)	1,400,000
Bot Lat Bracing	At Supports	PV 3 End		E-min (psi)	510,000

Member Loading Summary					
Roof Pitch	8/12	Initial	Pitch Adjust	Non-PV Areas	PV Areas
Roof Dead Load	DL	11.0 psf	x 1.21	13.3 psf	13.3 psf
PV Dead Load	PV-DL	3.0 psf	x 1.21		3.6 psf
Roof Live Load	RLL	20.0 psf	x 0.80	16.0 psf	
Snow Load	SL[1,2]	30.0 psf	x 0.69 I x 0.42	20.8 psf	12.5 psf
Total Load (Governing LC)	TL			34.1 psf	29.4 psf

Notes: 1. ps = Cs*pf; Cs -roof, Cs -pv per ASCE 7 [Figure 7.4-1]; 2. pf = 0.7 (Ce) (Ct) (Is) pg ; Ce=0.9, Ct=1.1, Is=1.0;

Member Analysis Results Summary					
Governing Analysis	Pre-PV	Load (psf)	Post-PV	Net Impact	Result
Gravity Loading Check	34.1		29.4	-14%	Pass

ZEP HARDWARE DESIGN CALCULATIONS - MP2&MP3

Mounting Plane Information			
Roofing Material		Comp Roof	
Roof Slope		34°	
Framing Type / Direction		Y-Y Rafters	
PV System Type		SolarCity SleekMount™	
Zep System Type		ZS Comp	
Standoff (Attachment Hardware)		ZS Comp V4 with Flashing Insert	
Spanning Vents		No	

Wind Design Criteria			
Design Standard		ASCE 7-16	
Wind Design Method		Partially/Fully Enclosed Method	
Ultimate Wind Speed	V-Ult	115 mph	Fig. 26.5-1B
Exposure Category		C	Section 26.7
Roof Style		Gable Roof	Fig. 30.3-2A/B/C/D/E/G/H-5A/B
Mean Roof Height	h	25 ft	Section 26.2

Notes: 1. Risk Category = II

Wind Pressure Calculation Coefficients			
Wind Pressure Exposure	K_z	0.95	Table 26.10-1
Topographic Factor	K_{zt}	1.00	Section 26.8
Wind Directionality Factor	K_d	0.85	Section 26.6-1
Ground Elevation Factor	Ke	1.00	Table 26.9-1
Velocity Pressure	**q_h**	**qh = 0.00256 (Kz) (Kzt) (Kd) (Ke) (V^2) 27.2 psf**	**Equation 26.10-1**

		Wind Pressure	
Ext. Pressure Coefficient (Up)	GCp (Up)	-1.47	Fig. 30.3-2A/B/C/D/E/G/H-5A/B
Ext. Pressure Coefficient (Down)	GCp (Down)	0.77	Fig. 30.3-2A/B/C/D/E/G/H-5A/B
Design Wind Pressure	p	p = qh (yE) (ya) (GCp); yE = 1.15, yA = 0.60	Equation 29.4-7
Wind Pressure Up (Design | Ult)	**$p_{(up)}$**	**-16.6 | -27.7 psf**	
Wind Pressure Down (Design | Ult)	**$p_{(down)}$**	**9.6 | 16 psf**	

Notes: 1. Wind Zone Perimeter Width (a) = 6.4 ft.; Effective Wind Area (A) = 21.3 sf

2. yE = Array Edge Factor and yA = Solar Panel Pressure Equalization Factor per SEAoC PV2-2017

ALLOWABLE STANDOFF SPACINGS

		X-Direction	Y-Direction
Max Allowable Standoff Spacing	Landscape	64''	41''
Max Allowable Cantilever	Landscape	24''	NA
Standoff Configuration	Landscape	Staggered	
Max Standoff Tributary Area (Interior)	Trib	18 sf	
PV Assembly Dead Load	W-PV	3.0 psf	
Net Wind Uplift at Standoff (Interior)	T-actual	-277 lbs	
Uplift Capacity of Standoff	T-allow	456 lbs	
Standoff Demand/Capacity (Interior)	DCR	60.8%	

		X-Direction	Y-Direction
Max Allowable Standoff Spacing	Portrait	48''	74''
Max Allowable Cantilever	Portrait	19''	NA
Standoff Configuration	Portrait	Staggered	
Max Standoff Tributary Area (Interior)	Trib	25 sf	
PV Assembly Dead Load	W-PV	3.0 psf	
Net Wind Uplift at Standoff (Interior)	T-actual	-375 lbs	
Uplift Capacity of Standoff	T-allow	456 lbs	
Standoff Demand/Capacity (Interior)	DCR	82.3%	

STRUCTURE ANALYSIS - LOADING SUMMARY AND MEMBER CHECK - MP4

Member Properties Summary					
MP4		**Horizontal Member Spans**		**Rafter Properties**	
		Overhang	1.20 ft	**Actual W**	1.50''
Roof System Properties		**Span 1**	7.07 ft	**Actual D**	9.25''
Number of Spans (w/o Overhang)	2	**Span 2**	6.23 ft	**Nominal**	Yes
Roofing Material	Comp Roof	**Span 3**		**A (in^2)**	13.88
Re-Roof	No	**Span 4**		**Sx (in.^3)**	21.39
Plywood Sheathing	Yes	**Span 5**		**Ix (in^4)**	98.93
Board Sheathing	None	**Total Rake Span**	20.51 ft	**TL Defl'n Limit**	120
Vaulted Ceiling	No	**PV 1 Start**	8.33 ft	**Wood Species**	SPF
Ceiling Finish	1/2" Gypsum Board	**PV 1 End**	13.33 ft	**Wood Grade**	#2
Rafter Slope	45°	**PV 2 Start**		**Fb (psi)**	875
Rafter Spacing	16'' O.C.	**PV 2 End**		**Fv (psi)**	135
Top Lat Bracing	Full	**PV 3 Start**		**E (psi)**	1,400,000
Bot Lat Bracing	At Supports	**PV 3 End**		**E-min (psi)**	510,000

Member Loading Summary					
Roof Pitch	**12/12**	**Initial**	**Pitch Adjust**	**Non-PV Areas**	**PV Areas**
Roof Dead Load	**DL**	11.0 psf	x 1.41	15.6 psf	15.6 psf
PV Dead Load	**PV-DL**	3.0 psf	x 1.41		4.2 psf
Roof Live Load	**RLL**	20.0 psf	x 0.60	12.0 psf	
Snow Load	**SL**[1,2]	30.0 psf	x 0.53 l x 0.29	16.0 psf	8.7 psf
Total Load (Governing LC)	**TL**			**31.6 psf**	**28.5 psf**

Notes: 1. ps = Cs*pf; Cs -roof, Cs -pv per ASCE 7 [Figure 7.4-1]; 2. pf = 0.7 (Ce) (Ct) (Is) pg ; Ce=0.9, Ct=1.1, Is=1.0;

Member Analysis Results Summary					
Governing Analysis	**Pre-PV**	**Load (psf)**	**Post-PV**	**Net Impact**	**Result**
Gravity Loading Check	**31.6**		**28.5**	**-10%**	**Pass**

ZEP HARDWARE DESIGN CALCULATIONS - MP4

Mounting Plane Information			
Roofing Material		Comp Roof	
Roof Slope		45°	
Framing Type / Direction		Y-Y Rafters	
PV System Type		SolarCity SleekMount™	
Zep System Type		ZS Comp	
Standoff (Attachment Hardware)		ZS Comp V4 with Flashing Insert	
Spanning Vents		No	

Wind Design Criteria			
Design Standard		ASCE 7-16	
Wind Design Method		Partially/Fully Enclosed Method	
Ultimate Wind Speed	V-Ult	115 mph	Fig. 26.5-1B
Exposure Category		C	Section 26.7
Roof Style		Gable Roof	Fig. 30.3-2A/B/C/D/E/G/H-5A/B
Mean Roof Height	h	25 ft	Section 26.2

Notes: 1. Risk Category = II

Wind Pressure Calculation Coefficients			
Wind Pressure Exposure	K_z	0.95	Table 26.10-1
Topographic Factor	K_{zt}	1.00	Section 26.8
Wind Directionality Factor	K_d	0.85	Section 26.6-1
Ground Elevation Factor	Ke	1.00	Table 26.9-1
Velocity Pressure	**q_h**	**qh = 0.00256 (Kz) (Kzt) (Kd) (Ke) (V^2) 27.2 psf**	**Equation 26.10-1**

		Wind Pressure	
Ext. Pressure Coefficient (Up)	GCp (Up)	-1.47	Fig. 30.3-2A/B/C/D/E/G/H-5A/B
Ext. Pressure Coefficient (Down)	GCp (Down)	0.77	Fig. 30.3-2A/B/C/D/E/G/H-5A/B
Design Wind Pressure	p	p = qh (yE) (ya) (GCp); yE = 1.15, yA = 0.60	Equation 29.4-7
Wind Pressure Up (Design | Ult)	**$p_{(up)}$**	**-16.6 | -27.7 psf**	
Wind Pressure Down (Design | Ult)	**$p_{(down)}$**	**9.6 | 16 psf**	

Notes: 1. Wind Zone Perimeter Width (a) = 6.4 ft.; Effective Wind Area (A) = 21.3 sf

2. yE = Array Edge Factor and yA = Solar Panel Pressure Equalization Factor per SEAoC PV2-2017

ALLOWABLE STANDOFF SPACINGS

		X-Direction	Y-Direction
Max Allowable Standoff Spacing	Landscape	64''	41''
Max Allowable Cantilever	Landscape	24''	NA
Standoff Configuration	Landscape	Staggered	
Max Standoff Tributary Area (Interior)	Trib	18 sf	
PV Assembly Dead Load	W-PV	3.0 psf	
Net Wind Uplift at Standoff (Interior)	T-actual	-281 lbs	
Uplift Capacity of Standoff	T-allow	456 lbs	
Standoff Demand/Capacity (Interior)	DCR	61.6%	

		X-Direction	Y-Direction
Max Allowable Standoff Spacing	Portrait	48''	74''
Max Allowable Cantilever	Portrait	19''	NA
Standoff Configuration	Portrait	Staggered	
Max Standoff Tributary Area (Interior)	Trib	25 sf	
PV Assembly Dead Load	W-PV	3.0 psf	
Net Wind Uplift at Standoff (Interior)	T-actual	-381 lbs	
Uplift Capacity of Standoff	T-allow	456 lbs	
Standoff Demand/Capacity (Interior)	DCR	83.5%	

STRUCTURE ANALYSIS - LOADING SUMMARY AND MEMBER CHECK - MP5

Member Properties Summary					
MP5		**Horizontal Member Spans**		**Rafter Properties**	
		Overhang	1.20 ft	**Actual W**	1.50''
Roof System Properties		**Span 1**	6.69 ft	**Actual D**	9.25''
Number of Spans (w/o Overhang)	2	**Span 2**	6.67 ft	**Nominal**	Yes
Roofing Material	Comp Roof	**Span 3**		**A (in^2)**	13.88
Re-Roof	No	**Span 4**		**Sx (in.^3)**	21.39
Plywood Sheathing	Yes	**Span 5**		**Ix (in^4)**	98.93
Board Sheathing	None	**Total Rake Span**	20.59 ft	**TL Defl'n Limit**	120
Vaulted Ceiling	No	**PV 1 Start**	1.92 ft	**Wood Species**	SPF
Ceiling Finish	1/2" Gypsum Board	**PV 1 End**	12.08 ft	**Wood Grade**	#2
Rafter Slope	45°	**PV 2 Start**		**Fb (psi)**	875
Rafter Spacing	16'' O.C.	**PV 2 End**		**Fv (psi)**	135
Top Lat Bracing	Full	**PV 3 Start**		**E (psi)**	1,400,000
Bot Lat Bracing	At Supports	**PV 3 End**		**E-min (psi)**	510,000

Member Loading Summary					
Roof Pitch	**12/12**	**Initial**	**Pitch Adjust**	**Non-PV Areas**	**PV Areas**
Roof Dead Load	**DL**	11.0 psf	x 1.41	15.6 psf	15.6 psf
PV Dead Load	**PV-DL**	3.0 psf	x 1.41		4.2 psf
Roof Live Load	**RLL**	20.0 psf	x 0.60	12.0 psf	
Snow Load	**SL**[1,2]	30.0 psf	x 0.53 I x 0.29	16.0 psf	8.7 psf
Total Load (Governing LC)	**TL**			**31.6 psf**	**28.5 psf**

Notes: 1. ps = Cs*pf; Cs -roof, Cs -pv per ASCE 7 [Figure 7.4-1]; 2. pf = 0.7 (Ce) (Ct) (Is) pg ; Ce=0.9, Ct=1.1, Is=1.0;

Member Analysis Results Summary					
Governing Analysis	**Pre-PV**	**Load (psf)**	**Post-PV**	**Net Impact**	**Result**
Gravity Loading Check	**31.6**		**28.5**	**-10%**	**Pass**

ZEP HARDWARE DESIGN CALCULATIONS - MP5

Mounting Plane Information			
Roofing Material		Comp Roof	
Roof Slope		45°	
Framing Type / Direction		Y-Y Rafters	
PV System Type		SolarCity SleekMount™	
Zep System Type		ZS Comp	
Standoff (Attachment Hardware)		ZS Comp V4 with Flashing Insert	
Spanning Vents		No	

Wind Design Criteria			
Design Standard		ASCE 7-16	
Wind Design Method		Partially/Fully Enclosed Method	
Ultimate Wind Speed	V-Ult	115 mph	Fig. 26.5-1B
Exposure Category		C	Section 26.7
Roof Style		Gable Roof	Fig. 30.3-2A/B/C/D/E/G/H-5A/B
Mean Roof Height	h	25 ft	Section 26.2

Notes: 1. Risk Category = II

Wind Pressure Calculation Coefficients			
Wind Pressure Exposure	K_z	0.95	Table 26.10-1
Topographic Factor	K_{zt}	1.00	Section 26.8
Wind Directionality Factor	K_d	0.85	Section 26.6-1
Ground Elevation Factor	Ke	1.00	Table 26.9-1
Velocity Pressure	**q_h**	**qh = 0.00256 (Kz) (Kzt) (Kd) (Ke) (V^2) 27.2 psf**	**Equation 26.10-1**

		Wind Pressure	
Ext. Pressure Coefficient (Up)	GCp (Up)	-1.47	Fig. 30.3-2A/B/C/D/E/G/H-5A/B
Ext. Pressure Coefficient (Down)	GCp (Down)	0.77	Fig. 30.3-2A/B/C/D/E/G/H-5A/B
Design Wind Pressure	p	p = qh (yE) (ya) (GCp); yE = 1.15, yA = 0.60	Equation 29.4-7
Wind Pressure Up (Design | Ult)	**$p_{(up)}$**	**-16.6 | -27.7 psf**	
Wind Pressure Down (Design | Ult)	**$p_{(down)}$**	**9.6 | 16 psf**	

Notes: 1. Wind Zone Perimeter Width (a) = 6.4 ft.; Effective Wind Area (A) = 21.3 sf

2. yE = Array Edge Factor and yA = Solar Panel Pressure Equalization Factor per SEAoC PV2-2017

ALLOWABLE STANDOFF SPACINGS

		X-Direction	Y-Direction
Max Allowable Standoff Spacing	Landscape	64''	41''
Max Allowable Cantilever	Landscape	24''	NA
Standoff Configuration	Landscape	Staggered	
Max Standoff Tributary Area (Interior)	Trib	18 sf	
PV Assembly Dead Load	W-PV	3.0 psf	
Net Wind Uplift at Standoff (Interior)	T-actual	-281 lbs	
Uplift Capacity of Standoff	T-allow	456 lbs	
Standoff Demand/Capacity (Interior)	DCR	61.6%	

		X-Direction	Y-Direction
Max Allowable Standoff Spacing	Portrait	48''	74''
Max Allowable Cantilever	Portrait	19''	NA
Standoff Configuration	Portrait	Staggered	
Max Standoff Tributary Area (Interior)	Trib	25 sf	
PV Assembly Dead Load	W-PV	3.0 psf	
Net Wind Uplift at Standoff (Interior)	T-actual	-381 lbs	
Uplift Capacity of Standoff	T-allow	456 lbs	
Standoff Demand/Capacity (Interior)	DCR	83.5%	

STRUCTURE ANALYSIS - LOADING SUMMARY AND MEMBER CHECK - MP6

Member Properties Summary					
MP6		Horizontal Member Spans		Rafter Properties	
		Overhang	1.20 ft	Actual W	1.50''
Roof System Properties		Span 1	6.25 ft	Actual D	9.25''
Number of Spans (w/o Overhang)	2	Span 2	6.15 ft	Nominal	Yes
Roofing Material	Comp Roof	Span 3		A (in^2)	13.88
Re-Roof	No	Span 4		Sx (in.^3)	21.39
Plywood Sheathing	Yes	Span 5		Ix (in^4)	98.93
Board Sheathing	None	Total Rake Span	19.24 ft	TL Defl'n Limit	120
Vaulted Ceiling	No	PV 1 Start	1.08 ft	Wood Species	SPF
Ceiling Finish	1/2" Gypsum Board	PV 1 End	6.17 ft	Wood Grade	#2
Rafter Slope	45°	PV 2 Start		Fb (psi)	875
Rafter Spacing	16'' O.C.	PV 2 End		Fv (psi)	135
Top Lat Bracing	Full	PV 3 Start		E (psi)	1,400,000
Bot Lat Bracing	At Supports	PV 3 End		E-min (psi)	510,000

Member Loading Summary					
Roof Pitch	12/12	Initial	Pitch Adjust	Non-PV Areas	PV Areas
Roof Dead Load	DL	11.0 psf	x 1.41	15.6 psf	15.6 psf
PV Dead Load	PV-DL	3.0 psf	x 1.41		4.2 psf
Roof Live Load	RLL	20.0 psf	x 0.60	12.0 psf	
Snow Load	SL[1,2]	30.0 psf	x 0.53 I x 0.29	16.0 psf	8.7 psf
Total Load (Governing LC)	**TL**			**31.6 psf**	**28.5 psf**

Notes: 1. ps = Cs*pf; Cs -roof, Cs -pv per ASCE 7 [Figure 7.4-1]; 2. pf = 0.7 (Ce) (Ct) (Is) pg ; Ce=0.9, Ct=1.1, Is=1.0;

Member Analysis Results Summary					
Governing Analysis	Pre-PV	Load (psf)	Post-PV	Net Impact	Result
Gravity Loading Check	**31.6**		**28.5**	**-10%**	**Pass**

ZEP HARDWARE DESIGN CALCULATIONS - MP6

Mounting Plane Information			
Roofing Material		Comp Roof	
Roof Slope		45°	
Framing Type / Direction		Y-Y Rafters	
PV System Type		SolarCity SleekMount™	
Zep System Type		ZS Comp	
Standoff (Attachment Hardware)		ZS Comp V4 with Flashing Insert	
Spanning Vents		No	

Wind Design Criteria			
Design Standard		ASCE 7-16	
Wind Design Method		Partially/Fully Enclosed Method	
Ultimate Wind Speed	V-Ult	115 mph	Fig. 26.5-1B
Exposure Category		C	Section 26.7
Roof Style		Gable Roof	Fig. 30.3-2A/B/C/D/E/G/H-5A/B
Mean Roof Height	h	25 ft	Section 26.2

Notes: 1. Risk Category = II

Wind Pressure Calculation Coefficients			
Wind Pressure Exposure	K_z	0.95	Table 26.10-1
Topographic Factor	K_{zt}	1.00	Section 26.8
Wind Directionality Factor	K_d	0.85	Section 26.6-1
Ground Elevation Factor	Ke	1.00	Table 26.9-1
Velocity Pressure	**q_h**	**qh = 0.00256 (Kz) (Kzt) (Kd) (Ke) (V^2) 27.2 psf**	**Equation 26.10-1**

		Wind Pressure	
Ext. Pressure Coefficient (Up)	GCp (Up)	-1.47	Fig. 30.3-2A/B/C/D/E/G/H-5A/B
Ext. Pressure Coefficient (Down)	GCp (Down)	0.77	Fig. 30.3-2A/B/C/D/E/G/H-5A/B
Design Wind Pressure	p	p = qh (yE) (ya) (GCp); yE = 1.15, yA = 0.60	Equation 29.4-7
Wind Pressure Up (Design | Ult)	**$p_{(up)}$**	**-16.6 | -27.7 psf**	
Wind Pressure Down (Design | Ult)	**$p_{(down)}$**	**9.6 | 16 psf**	

Notes: 1. Wind Zone Perimeter Width (a) = 6.4 ft.; Effective Wind Area (A) = 21.3 sf

2. yE = Array Edge Factor and yA = Solar Panel Pressure Equalization Factor per SEAoC PV2-2017

ALLOWABLE STANDOFF SPACINGS

		X-Direction	Y-Direction
Max Allowable Standoff Spacing	Landscape	64''	41''
Max Allowable Cantilever	Landscape	24''	NA
Standoff Configuration	Landscape	Staggered	
Max Standoff Tributary Area (Interior)	Trib	18 sf	
PV Assembly Dead Load	W-PV	3.0 psf	
Net Wind Uplift at Standoff (Interior)	T-actual	-281 lbs	
Uplift Capacity of Standoff	T-allow	456 lbs	
Standoff Demand/Capacity (Interior)	DCR	61.6%	

		X-Direction	Y-Direction
Max Allowable Standoff Spacing	Portrait	48''	74''
Max Allowable Cantilever	Portrait	19''	NA
Standoff Configuration	Portrait	Staggered	
Max Standoff Tributary Area (Interior)	Trib	25 sf	
PV Assembly Dead Load	W-PV	3.0 psf	
Net Wind Uplift at Standoff (Interior)	T-actual	-381 lbs	
Uplift Capacity of Standoff	T-allow	456 lbs	
Standoff Demand/Capacity (Interior)	DCR	83.5%	

ABBREVIATIONS

A AMPERE AC ALTERNATING CURRENT BLDG BUILDING CONC CONCRETE DC DIRECT CURRENT EGC EQUIPMENT GROUNDING CONDUCTOR (E) EXISTING EMT ELECTRICAL METALLIC TUBING FSB FIRE SET-BACK GALV GALVANIZED GEC GROUNDING ELECTRODE CONDUCTOR GND GROUND HDG HOT DIPPED GALVANIZED I CURRENT Imp CURRENT AT MAX POWER Isc SHORT CIRCUIT CURRENT kVA KILOVOLT AMPERE kW KILOWATT LBW LOAD BEARING WALL MIN MINIMUM (N) NEW NEUT NEUTRAL NTS NOT TO SCALE OC ON CENTER PL PROPERTY LINE POI POINT OF INTERCONNECTION PV PHOTOVOLTAIC SCH SCHEDULE S STAINLESS STEEL STC STANDARD TESTING CONDITIONS TYP TYPICAL UPS UNINTERRUPTIBLE POWER SUPPLY V VOLT Vmp VOLTAGE AT MAX POWER Voc VOLTAGE AT OPEN CIRCUIT W WATT 3R NEMA 3R, RAINTIGHT

ELECTRICAL NOTES

1. THIS SYSTEM IS GRID-INTERTIED VIA A UL-LISTED POWER-CONDITIONING INVERTER.
2. A NATIONALLY - RECOGNIZED TESTING LABORATORY SHALL LIST ALL EQUIPMENT IN COMPLIANCE WITH ART. 110.3.
3. WHERE ALL TERMINALS OF THE DISCONNECTING MEANS MAY BE ENERGIZED IN THE OPEN POSITION, A SIGN WILL BE PROVIDED WARNING OF THE HAZARDS PER ART. 690.17.
4. EACH UNGROUNDED CONDUCTOR OF THE MULTIWIRE BRANCH CIRCUIT WILL BE IDENTIFIED BY PHASE AND SYSTEM PER ART. 210.5.
5. CIRCUITS OVER 250V TO GROUND SHALL COMPLY WITH ART. 250.97, 250.92(B).
6. DC CONDUCTORS EITHER DO NOT ENTER BUILDING OR ARE RUN IN METALLIC RACEWAYS OR ENCLOSURES TO THE FIRST ACCESSIBLE DC DISCONNECTING MEANS PER ART. 690.31(E).
7. ALL WIRES SHALL BE PROVIDED WITH STRAIN RELIEF AT ALL ENTRY INTO BOXES AS REQUIRED BY UL LISTING.
8. MODULE FRAMES SHALL BE GROUNDED AT THE UL - LISTED LOCATION PROVIDED BY THE MANUFACTURER USING UL LISTED GROUNDING HARDWARE.
9. MODULE FRAMES, RAIL, AND POSTS SHALL BE BONDED WITH EQUIPMENT GROUND CONDUCTORS.

JURISDICTION NOTES

STRUCTURAL DESIGN FOR THE SUPPORTING STRUCTURE OF THE HOUSE WAS PERFORMED IN ACCORDANCE WITH IRC/IBC 2018 - STRUCTURAL DESIGN FOR THE RACK SYSTEM AND MOUNTING HARDWARE WAS PERFORMED IN ACCORDANCE WITH IRC/IBC 2018.

LICENSE

#11805 MASTER ELECTRICIAN
Nicholaus Meyers

MODULE GROUNDING METHOD: ZEP SOLAR

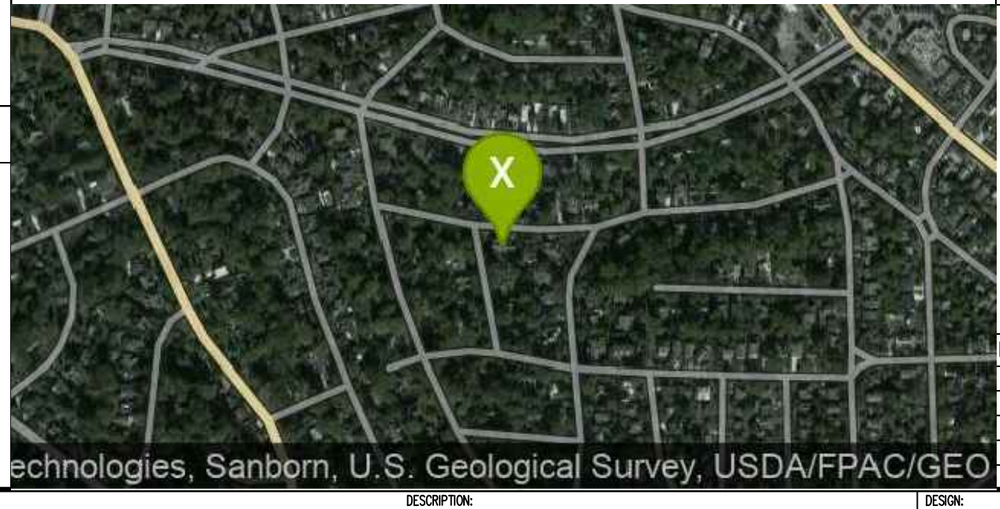
AHJ: Montgomery County

UTILITY: PEPCO (MD)

GENERAL NOTES

1. ALL WORK SHALL COMPLY WITH THE 2018 IBC AND 2018 IRC. 2. ALL ELECTRICAL WORK SHALL COMPLY WITH THE 2017 NATIONAL ELECTRIC CODE.

VICINITY MAP



INDEX

REV BY DATE COMMENTS

REV A	NAME	DATE	COMMENTS
*	*	*	*
*	*	*	*
*	*	*	*
*	*	*	*

JOB NUMBER: JB-20812222 00

MOUNTING SYSTEM: ZS Comp V4 w Flashing-Insert

MODULES: (47) Tesla # T400H

INVERTER: Powerwall+ [240V] #1850000-00-C / PVI Assy. 1538000-35-F

CUSTOMER:
Eric Lightfoot
5510 Lambeth Rd
Bethesda, MD 20814

2409945381

DESCRIPTION:
18.8 KW PV ARRAY
27 KWH ENERGY STORAGE SYSTEM

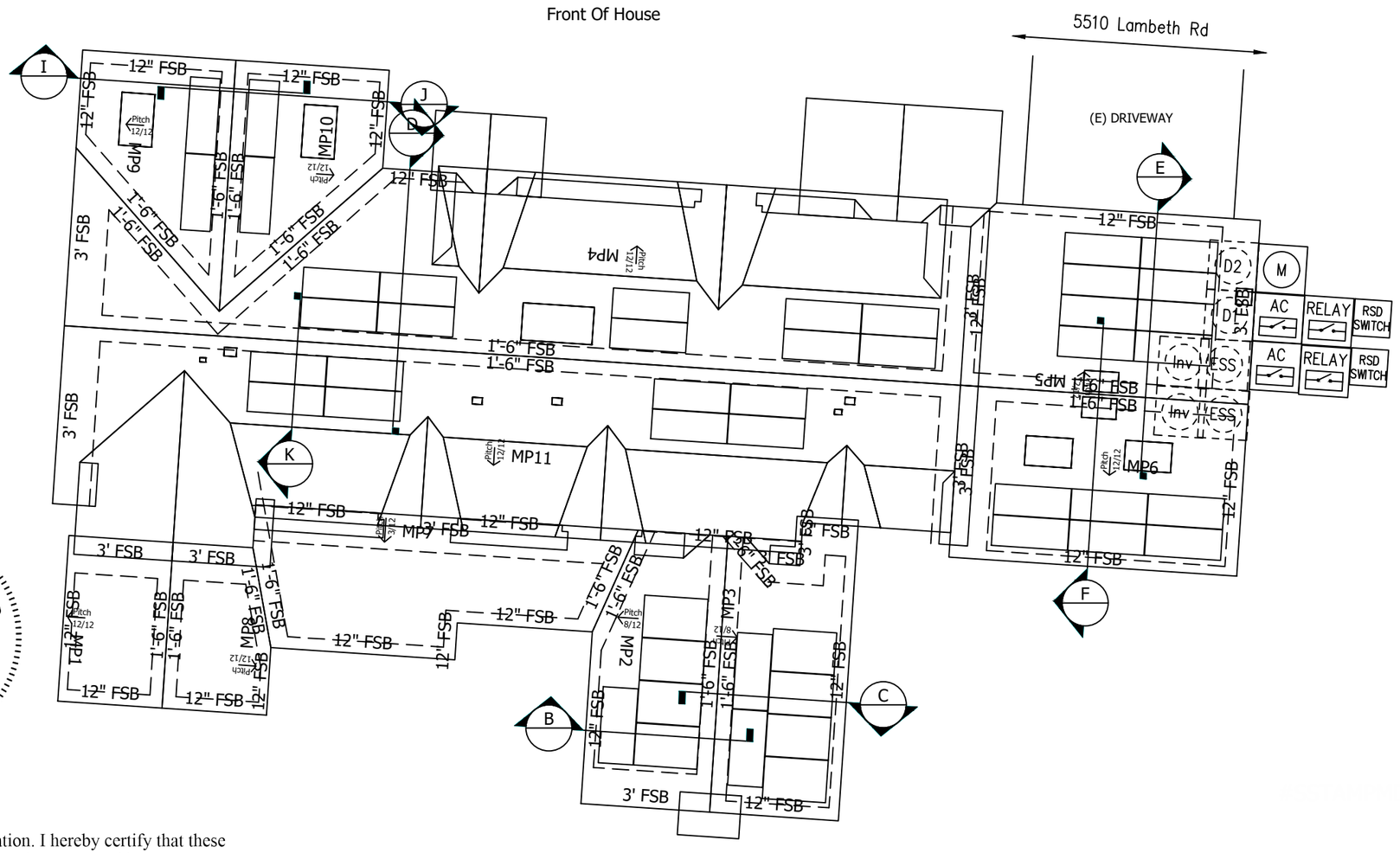
PAGE NAME: COVER SHEET

DESIGN: LUIS CODINA

SHEET: 1 REV: DATE: 10/27/2022

TESLA

NOTE: HOUSE HAS A SPRINKLER SYSTEM: NO



MP1	PITCH: 45° (12:12) ARRAY PITCH: 45° (12:12) AZIMUTH: 274 ARRAY AZIMUTH: 274 MATERIAL: Metal Standing Seam STORY: 2 Stories
MP2	PITCH: 34° (8:12) ARRAY PITCH: 34° (8:12) AZIMUTH: 274 ARRAY AZIMUTH: 274 MATERIAL: Comp Shingle STORY: 2 Stories
MP3	PITCH: 34° (8:12) ARRAY PITCH: 34° (8:12) AZIMUTH: 94 ARRAY AZIMUTH: 94 MATERIAL: Comp Shingle STORY: 2 Stories
MP4	PITCH: 45° (12:12) ARRAY PITCH: 45° (12:12) AZIMUTH: 4 ARRAY AZIMUTH: 4 MATERIAL: Comp Shingle STORY: 2 Stories
MP5	PITCH: 45° (12:12) ARRAY PITCH: 45° (12:12) AZIMUTH: 4 ARRAY AZIMUTH: 4 MATERIAL: Comp Shingle STORY: 2 Stories
MP6	PITCH: 45° (12:12) ARRAY PITCH: 45° (12:12) AZIMUTH: 184 ARRAY AZIMUTH: 184 MATERIAL: Comp Shingle STORY: 2 Stories

LEGEND

- (M) (E) UTILITY METER & WARNING LABEL
- (Inv) INVERTER W/ INTEGRATED DC DISCO & WARNING LABELS
- (RELAY) AUTOMATIC RELAY
- (DC) DC DISCONNECT & WARNING LABELS
- (AC) AC DISCONNECT & WARNING LABELS
- (B) DC JUNCTION/COMBINER BOX & LABELS
- (ESS) ENERGY STORAGE SYSTEM FOR STAND ALONE OPERATION
- (D) DISTRIBUTION PANEL & LABELS
- (LC) LOAD CENTER & WARNING LABELS
- (M) DEDICATED PV SYSTEM METER
- (RSD) RAPID SHUTDOWN
- STANDOFF LOCATIONS
- CONDUIT RUN ON EXTERIOR
- CONDUIT RUN ON INTERIOR
- GATE/FENCE
- HEAT PRODUCING VENTS ARE RED
- INTERIOR EQUIPMENT IS DASHED

11/17/2022

STATE OF MARYLAND
MARCUS ANDREW HECHT-NIELSEN
No. 46671
PROFESSIONAL ENGINEER

STRUCTURAL ONLY

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. 46671, Expiration Date: 05/18/2023

TOTAL ARRAY AREA (SF): 1019
TOTAL ROOF AREA (SF): 5817

TOTAL ARRAY AREA IS ≈ 17.52 PERCENT OF TOTAL ROOF AREA

SITE PLAN

Scale:1/16" = 1'

01' 16' 32'

N W E S

JOB NUMBER: JB–20812222 00

MOUNTING SYSTEM: ZS Comp V4 w Flashing–Insert

MODULES: (47) Tesla # T400H

INVERTER: Powerwall+ [240V] #1850000–00–C / PVI Assy. 1538000–35–F

CUSTOMER:
Eric Lightfoot
5510 Lambeth Rd
Bethesda, MD 20814

2409945381

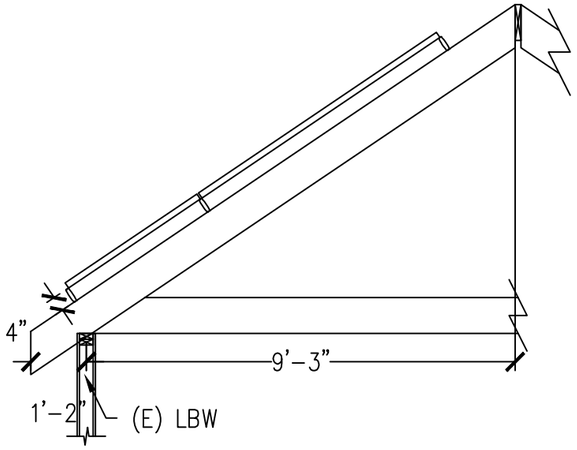
DESCRIPTION:
18.8 KW PV ARRAY
27 KWH ENERGY STORAGE SYSTEM

PAGE NAME: SITE PLAN

DESIGN: LUIS CODINA

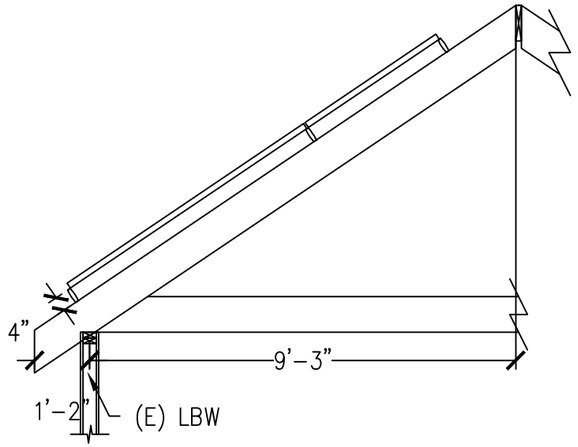
SHEET: 2 REV: DATE: 10/27/2022

TESLA



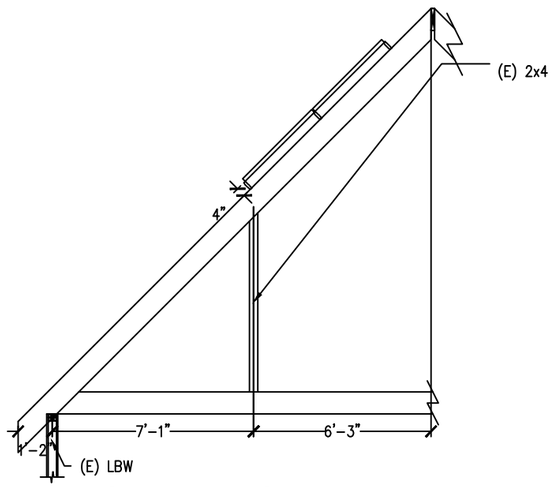
B SIDE VIEW OF MP2 NTS

MP2					
RAFTER	2x10 @ 16" OC	ROOF AZI	274	PITCH 34	STORIES: 2
C.J.	2x10 @16" OC	ARRAY AZI	274	PITCH 34	
		Comp Shingle			



C SIDE VIEW OF MP3 NTS

MP3					
RAFTER	2x10 @ 16" OC	ROOF AZI	94	PITCH 34	STORIES: 2
C.J.	2x10 @16" OC	ARRAY AZI	94	PITCH 34	
		Comp Shingle			



D SIDE VIEW OF MP4 NTS

MP4					
RAFTER	2x10 @ 16" OC	ROOF AZI	4	PITCH 45	STORIES: 2
C.J.	2x10 @16" OC	ARRAY AZI	4	PITCH 45	
		Comp Shingle			

11/17/2022

STATE OF MARYLAND
MARCUS ANDREW HECHT-NIELSEN
No. 46671
PROFESSIONAL ENGINEER

STRUCTURAL ONLY

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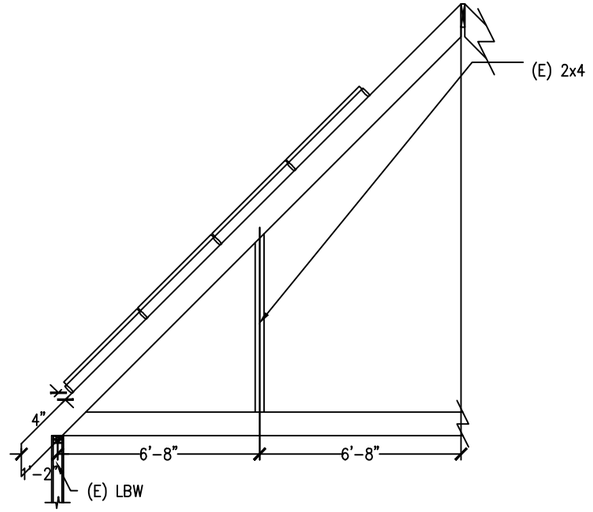


E SIDE VIEW OF MP5 NTS

MP5					
RAFTER	2x10 @ 16" OC	ROOF AZI	4	PITCH 45	STORIES: 2
C.J.	2x10 @16" OC	ARRAY AZI	4	PITCH 45	
		Comp Shingle			

JOB NUMBER: JB-20812222 00

MOUNTING SYSTEM: ZS Comp V4 w Flashing-Insert

MODULES: (47) Tesla # T400H

INVERTER: Powerwall+ [240V] #1850000-00-C / PVI Assy. 1538000-35-F

CUSTOMER:
Eric Lightfoot
5510 Lambeth Rd
Bethesda, MD 20814

2409945381

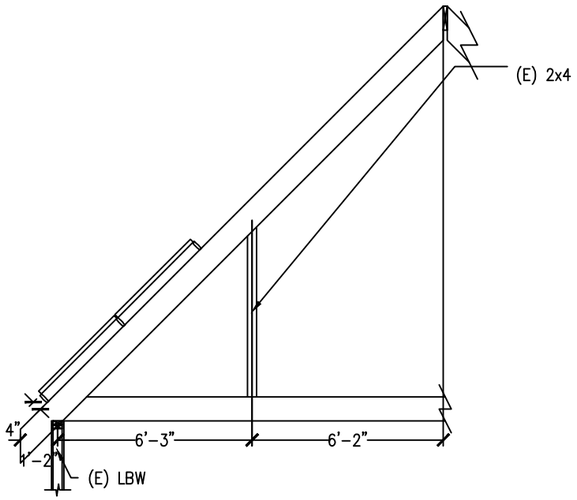
DESCRIPTION:
18.8 KW PV ARRAY
27 KWH ENERGY STORAGE SYSTEM

PAGE NAME: STRUCTURAL VIEWS

DESIGN: LUIS CODINA

SHEET: 3 REV: DATE: 10/27/2022

TESLA



F SIDE VIEW OF MP6 NTS

MP6			
RAFTER	2x10 @ 16" OC	ROOF AZI 184 PITCH 45 ARRAY AZI 184 PITCH 45	STORIES: 2
C.J.	2x10 @16" OC	Comp Shingle	

11/17/2022

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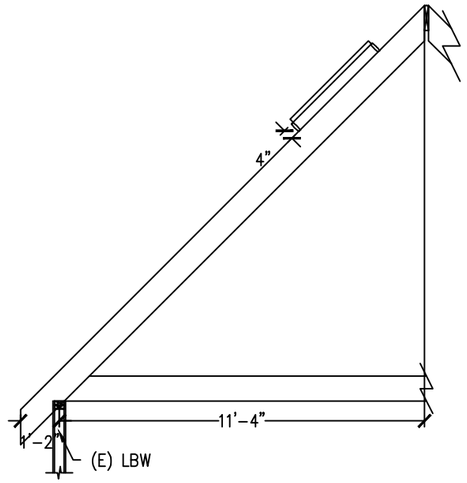
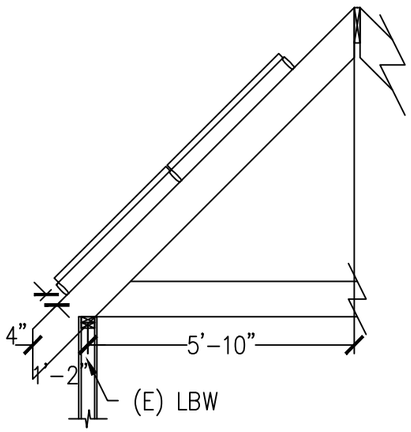


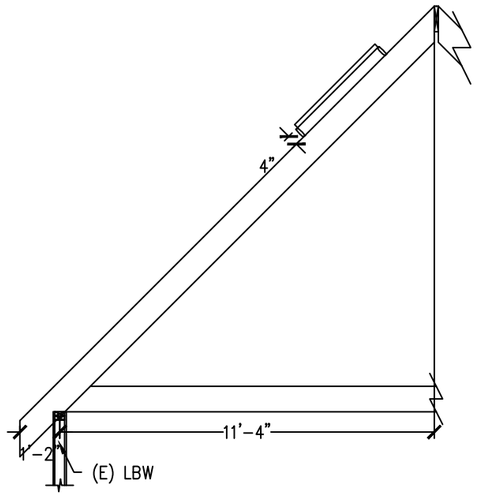
I SIDE VIEW OF MP9 NTS

MP9			
RAFTER	2x10 @ 16" OC	ROOF AZI 274 PITCH 45 ARRAY AZI 274 PITCH 45	STORIES: 2
C.J.	2x10 @16" OC	Comp Shingle	



K SIDE VIEW OF MP11 NTS

MP11			
RAFTER	2x10 @ 16" OC	ROOF AZI 184 PITCH 45 ARRAY AZI 184 PITCH 45	STORIES: 2
C.J.	2x10 @16" OC	Comp Shingle	



J SIDE VIEW OF MP10 NTS

MP10			
RAFTER	2x10 @ 16" OC	ROOF AZI 94 PITCH 45 ARRAY AZI 94 PITCH 45	STORIES: 2
C.J.	2x10 @16" OC	Comp Shingle	

JOB NUMBER: JB-20812222 00
MOUNTING SYSTEM: ZS Comp V4 w Flashing-Insert
MODULES: (47) Tesla # T400H
INVERTER: Powerwall+ [240V] #1850000-00-C / PVI Assy. 1538000-35-F

CUSTOMER:
Eric Lightfoot
5510 Lambeth Rd
Bethesda, MD 20814

2409945381

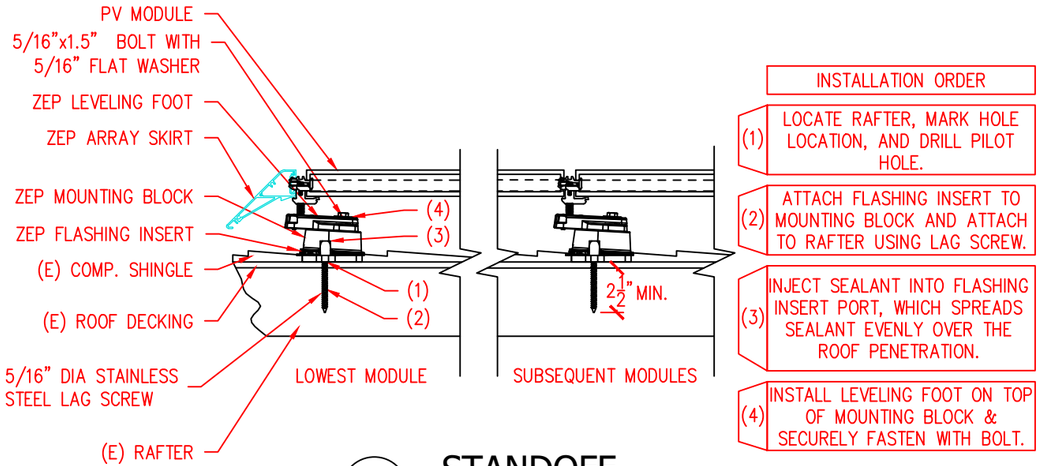
DESCRIPTION:
18.8 KW PV ARRAY
27 KWH ENERGY STORAGE SYSTEM

PAGE NAME:
STRUCTURAL VIEWS CONT

DESIGN:
LUIS CODINA

SHEET: 4 REV: DATE: 10/27/2022

TESLA



S2 STANDOFF

Scale: 1 1/2" = 1'

11/17/2022

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Jobsite Specific Design Criteria			
Design Code		ASCE 7-16	
Risk Category		II	Table 1.5-1
Ultimate Wind Speed	V-Ult	115	Fig. 1609A
Exposure Category		C	Section 26.7
Ground Snow Load	pg	30	Table 7-1
Edge Zone Width	a	6.4 ft	Fig. 30.3-2A to I

MP Specific Design Information								
MP Name	MP10	MP11	MP2	MP3	MP4	MP5	MP6	MP9
Roofing	Comp Shingle	Comp Shingle	Comp Shingle	Comp Shingle	Comp Shingle	Comp Shingle	Comp Shingle	Comp Shingle
Standoff	ZS Comp V4 w Flashing-Insert	ZS Comp V4 w Flashing-Insert	ZS Comp V4 w Flashing-Insert	ZS Comp V4 w Flashing-Insert	ZS Comp V4 w Flashing-Insert	ZS Comp V4 w Flashing-Insert	ZS Comp V4 w Flashing-Insert	ZS Comp V4 w Flashing-Insert
Pitch	45	45	34	34	45	45	45	45
SL/RLL: PV	8.7	8.7	12.5	12.5	8.7	8.7	8.7	8.7
SL/RLL: Non-PV	16.0	16.0	20.8	20.8	16.0	16.0	16.0	16.0

Standoff Spacing and Layout								
MP Name	MP10	MP11	MP2	MP3	MP4	MP5	MP6	MP9
Landscape X-Spacing	64	64	64	64	64	64	64	64
Landscape X-Cantilever	24	24	24	24	24	24	24	24
Landscape Y-Spacing	41	41	41	41	41	41	41	41
Landscape Y-Cantilever	-	-	-	-	-	-	-	-
Portrait X-Spacing	48	48	48	48	48	48	48	48
Portrait X-Cantilever	19	19	19	19	19	19	19	19
Portrait Y-Spacing	74	74	74	74	74	74	74	74
Portrait Y-Cantilever	-	-	-	-	-	-	-	-
Layout	Staggered	Staggered	Staggered	Staggered	Staggered	Staggered	Staggered	Staggered
X and Y are maximums that are always relative to the structure framing that supports the PV. X is across rafters and Y is along rafters.								

JOB NUMBER: JB-20812222 00

MOUNTING SYSTEM: ZS Comp V4 w Flashing-Insert

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CUSTOMER:
Eric Lightfoot
5510 Lambeth Rd
Bethesda, MD 20814

2409945381

DESCRIPTION:
18.8 KW PV ARRAY
27 KWH ENERGY STORAGE SYSTEM

PAGE NAME: UPLIFT CALCULATIONS

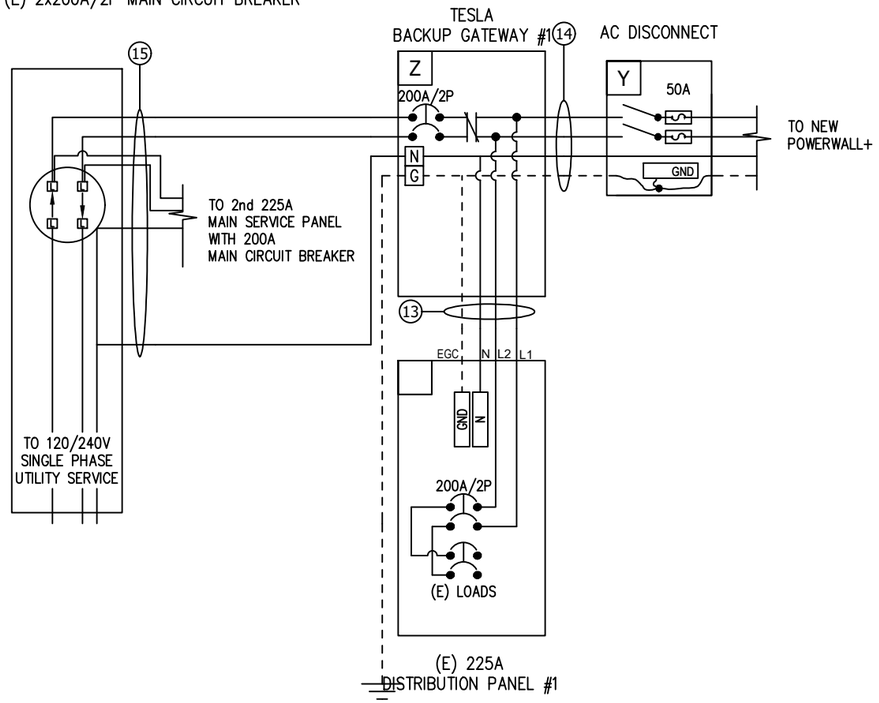
DESIGN: LUIS CODINA

SHEET: 5 REV: DATE: 10/27/2022

TESLA

MAIN PANEL SPECS	GENERAL NOTES			LICENSE
Panel Number: NO MATCH Meter Number: 3KD351055796 Underground Service Entrance	*			#11805 MASTER ELECTRICIAN Nicholaus Meyers

(E) 400A MAIN SERVICE WITH (2) 225A MAIN SERVICE PANEL
(E) 2x200A/2P MAIN CIRCUIT BREAKER



CONDUIT RUNS MAY BE CONDENSED DUE TO SITE CONDITIONS AND/OR INSTALLATION EASE. ALL CONDUIT FILL DERATES AND PROPER CALCULATIONS HAVE BEEN COMPLETED PER NEC CHAPTER 9, TABLE 4

" WIRES ARE ALL COPPER OR ALUMINUM EQUIVALENT."

CONDUCTORS RATED TO 100A OR GREATER MAY BE INSTALLED WITH ALUMINUM RATED EQUIVALENT WIRE SIZE AND THE RESULTING CONDUIT SIZE. REFERENCE THE 'WIRE & CONDUIT SIZE EQUIVALENCE TABLE' ATTACHED TO THE PLANSET.

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Panel Limit feature for Powerwall unit(s)
to be utilized
Field label to be at the point of interconnection:
"PCS Controlled Current Setting: 200A

The maximum output current from this system towards the main panel is controlled electronically. Refer to manufacturer's instructions for more information."

POI — (1) Ground Rod 5/8" x 8', Copper

Z — (1) Tesla # 1232100-00-G Back-up Gateway 2.0 NA for AC PW 2.0
— (1) Eaton # CSR2200N 200A MB ONLY; 2-Pole, 120V/240V, 25kAIC, Bolt On

Y — (1) CUTLER-HAMMER #DS16FK Class R Fuse Kit
— (2) FERRAZ SHAWMUT # TR50R Fuse; 50A, 250V, Class RK5
— (1) CUTLER-HAMMER # DG100NB Ground/Neutral Kit; 60-100A, General Duty (DG)
— (1) CUTLER-HAMMER # DG222NRB Disconnect; 60A, 240Vac, Fusible, NEMA 3R

X — (1) UL 508 Emergency Stop Device - NEMA 4X

AC

13 — 2 ft — (3) AWG #2/0, THWN-2, Black
(1) AWG #6, THWN-2, Green
(1) Conduit 2" PVC; Schedule 80

14 — 10 ft — (1) AWG #6, THWN-2, White
(1) AWG #6, THWN-2, Red
(1) AWG #6, THWN-2, Black
(1) AWG #6, THWN-2, Green
(1) Conduit Kit; 3/4" EMT

15 — 2 ft — (3) AWG #2/0, THWN-2, Black
(1) AWG #6, THWN-2, Green
(1) Conduit 2" PVC; Schedule 80

JOB NUMBER: JB-20812222 00
MOUNTING SYSTEM: ZS Comp V4 w Flashing-Insert
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Eric Lightfoot
5510 Lambeth Rd
Bethesda, MD 20814

2409945381

DESCRIPTION:
18.8 KW PV ARRAY
27 KWH ENERGY STORAGE SYSTEM

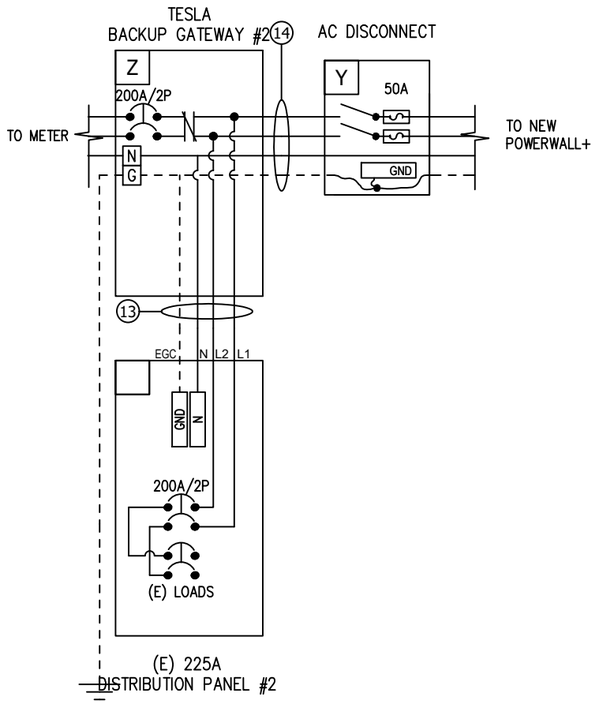
PAGE NAME:
THREE LINE DIAGRAM

DESIGN:
LUIS CODINA

SHEET: 6 REV: DATE: 10/27/2022

TESLA

MAIN PANEL SPECS	GENERAL NOTES			LICENSE
	*			#11805 MASTER ELECTRICIAN Nicholaus Meyers



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- (1) Eaton # CSR2200N 200A MB ONLY; 2-Pole, 120V/240V, 25kAIC, Bolt On

Y
- (1) CUTLER-HAMMER #DS16FK Class R Fuse Kit
- (2) FERRAZ SHAWMUT # TR50R Fuse; 50A, 250V, Class RK5
- (1) CUTLER-HAMMER # DG100NB Ground/Neutral Kit; 60-100A, General Duty (DG)
- (1) CUTLER-HAMMER # DG222NRB Disconnect; 60A, 240Vac, Fusible, NEMA 3R

X
- (2) UL 508 Emergency Stop Device - NEMA 4X

AC

13 — 2 THWN-2
- (3) AWG #2/0, THWN-2, Black
- (1) AWG #6, THWN-2, Green
- (1) Conduit 2" PVC; Schedule 80

14 — 1 THWN-2
- (1) AWG #6, THWN-2, White
- (1) AWG #6, THWN-2, Red
- (1) AWG #6, THWN-2, Black
- (1) AWG #6, THWN-2, Green
- (1) Conduit Kit; 3/4" EMT

JOB NUMBER: JB-20812222 00

MOUNTING SYSTEM: ZS Comp V4 w Flashing-Insert

MODULES: (47) Tesla # T400H

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CUSTOMER:
Eric Lightfoot
5510 Lambeth Rd
Bethesda, MD 20814

2409945381

DESCRIPTION:
18.8 KW PV ARRAY
27 KWH ENERGY STORAGE SYSTEM

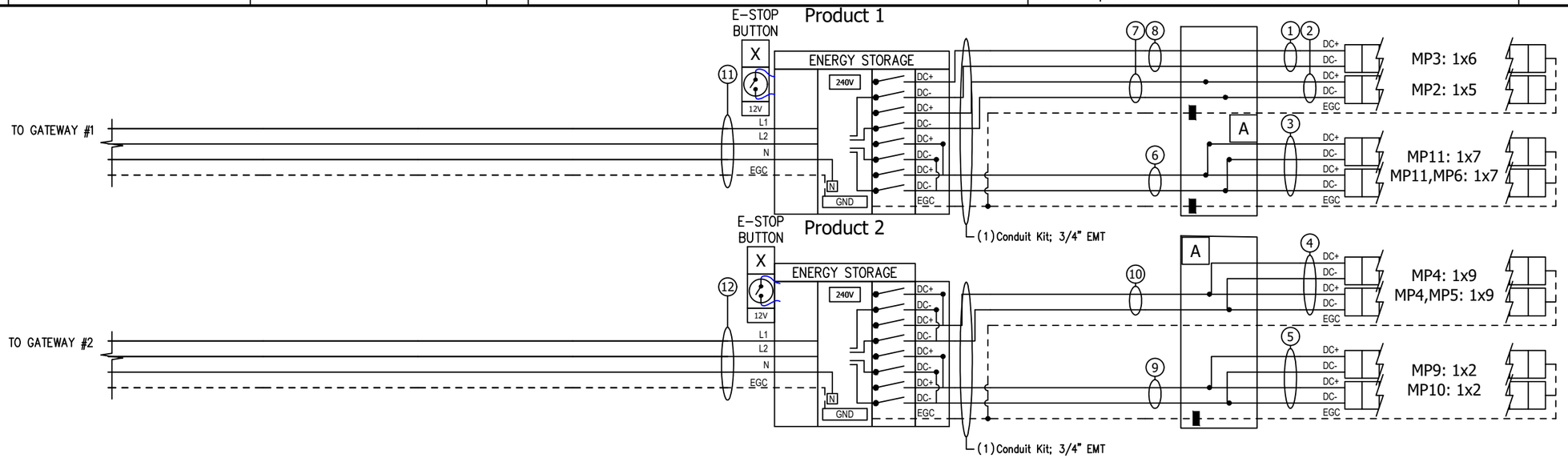
PAGE NAME: THREE LINE DIAGRAM CONT.

DESIGN: LUIS CODINA

SHEET: 7 REV: DATE: 10/27/2022

TESLA

MAIN PANEL SPECS	GENERAL NOTES	PRODUCT SPECS	MODULE SPECS	LICENSE
	Inv 1: DC Ungrounded Inv 2: DC Ungrounded	1 – (1) Powerwall+ [240V] #1850000-00-C / PVI Assy. 1538000-35-F 2 – (1) Powerwall+ [240V] #1850000-00-C / PVI Assy. 1538000-35-F 3	– (47) Tesla # T400H PV Module, 400W, 371.5 PTC, 40MM, Black Frame, MC4/MC4-EVO2, ZEP, 1000V Voc: 45.3 Vpmax: 37.13 Isc AND Imp ARE SHOWN IN THE DC STRINGS IDENTIFIER	#11805 MASTER ELECTRICIAN Nicholaus Meyers



CONDUIT RUNS MAY BE CONDENSED DUE TO SITE CONDITIONS AND/OR INSTALLATION EASE. ALL CONDUIT FILL DERATES AND PROPER CALCULATIONS HAVE BEEN COMPLETED PER NEC CHAPTER 9, TABLE 4

" WIRES ARE ALL COPPER OR ALUMINUM EQUIVALENT."

CONDUCTORS RATED TO 100A OR GREATER MAY BE INSTALLED WITH ALUMINUM RATED EQUIVALENT WIRE SIZE AND THE RESULTING CONDUIT SIZE. REFERENCE THE 'WIRE & CONDUIT SIZE EQUIVALENCE TABLE' ATTACHED TO THE PLANSET.

Voc* = MAX VOC AT MIN TEMP

CONDUCTORS RATED TO 100A OR GREATER MAY BE INSTALLED WITH ALUMINUM RATED EQUIVALENT WIRE SIZE AND THE RESULTING CONDUIT SIZE. REFERENCE THE 'WIRE & CONDUIT SIZE EQUIVALENCE TABLE' ATTACHED TO THE PLANSET.

AC

11 — 10ft — (1)AWG #8, THWN-2, Black — (1)AWG #8, THWN-2, White
(1)AWG #8, THWN-2, Red
(1)AWG #8, THWN-2, Green EGC — Vmp = 240 VAC — Imp= 32 AAC
— (1)Conduit Kit; 3/4" EMT

12 — 10ft — (1)AWG #8, THWN-2, Black — (1)AWG #8, THWN-2, White
(1)AWG #8, THWN-2, Red
(1)AWG #8, THWN-2, Green EGC — Vmp = 240 VAC — Imp= 32 AAC
— (1)Conduit Kit; 3/4" EMT

DC

GD — Please see MCI wiring detail page for more information

A — (2)Tesla 4J 4-String Combiner Box
UNFUSED, GROUNDED, Black, Diag DIN Rail with Bracket/ Cord Grip

PV — (18)Tesla MCI, 650V, 12A

1 — 15ft — (2)PV Wire, AWG 10 — Voc* = 308.49 VDC Isc = 11.14 ADC
(1)AWG #10, Solid Bare Copper EGC — Vmp = 222.78 VDC Imp= 10.77 ADC

2 — 15ft — (2)PV Wire, AWG 10 — Voc* = 257.08 VDC Isc = 11.14 ADC
(1)AWG #10, Solid Bare Copper EGC — Vmp = 185.65 VDC Imp= 10.77 ADC

3 — 20ft — (4)PV Wire, AWG 10 — Voc* = 359.91 VDC Isc = 11.14 ADC
(1)AWG #10, Solid Bare Copper EGC — Vmp = 259.91 VDC Imp= 10.77 ADC

4 — 25ft — (4)PV Wire, AWG 10 — Voc* = 462.74 VDC Isc = 11.14 ADC
(1)AWG #10, Solid Bare Copper EGC — Vmp = 334.17 VDC Imp= 10.77 ADC

5 — 5ft — (4)PV Wire, AWG 10 — Voc* = 102.83 VDC Isc = 11.14 ADC
(1)AWG #10, Solid Bare Copper EGC — Vmp = 74.26 VDC Imp= 10.77 ADC

6 — 50ft — (1)AWG #8, THWN-2, Black — Voc* = 359.91 VDC Isc = 22.28 ADC
(1)AWG #8, THWN-2, Red — Vmp = 259.91 VDC Imp= 21.54 ADC
(1)AWG #10, THHN/THWN-2, Green EGC — (1)Conduit Kit; 3/4" EMT

7 — 50ft — (1)AWG #10, THWN-2, Black — Voc* = 257.08 VDC Isc = 11.14 ADC
(1)AWG #10, THWN-2, Red — Vmp = 185.65 VDC Imp= 10.77 ADC
(1)AWG #10, THHN/THWN-2, Green EGC — (1)Conduit Kit; 3/4" EMT

8 — 50ft — (1)AWG #10, THWN-2, Black — Voc* = 308.49 VDC Isc = 11.14 ADC
(1)AWG #10, THWN-2, Red — Vmp = 222.78 VDC Imp= 10.77 ADC
(1)AWG #10, THHN/THWN-2, Green EGC — (1)Conduit Kit; 3/4" EMT

9 — 50ft — (1)AWG #8, THWN-2, Black — Voc* = 102.83 VDC Isc = 22.28 ADC
(1)AWG #8, THWN-2, Red — Vmp = 74.26 VDC Imp= 21.54 ADC
(1)AWG #10, THHN/THWN-2, Green EGC — (1)Conduit Kit; 3/4" EMT

10 — 50ft — (1)AWG #8, THWN-2, Black — Voc* = 462.74 VDC Isc = 22.28 ADC
(1)AWG #8, THWN-2, Red — Vmp = 334.17 VDC Imp= 21.54 ADC
(1)AWG #10, THHN/THWN-2, Green EGC — (1)Conduit Kit; 3/4" EMT

JOB NUMBER: JB-20812222 00

MOUNTING SYSTEM: ZS Comp V4 w Flashing-Insert

MODULES: (47) Tesla # T400H

INVERTER: Powerwall+ [240V] #1850000-00-C / PVI Assy. 1538000-35-F

CUSTOMER:
Eric Lightfoot
5510 Lambeth Rd
Bethesda, MD 20814

2409945381

DESCRIPTION:
18.8 KW PV ARRAY
27 KWH ENERGY STORAGE SYSTEM

PAGE NAME: THREE LINE DIAGRAM CONT.

DESIGN: LUIS CODINA

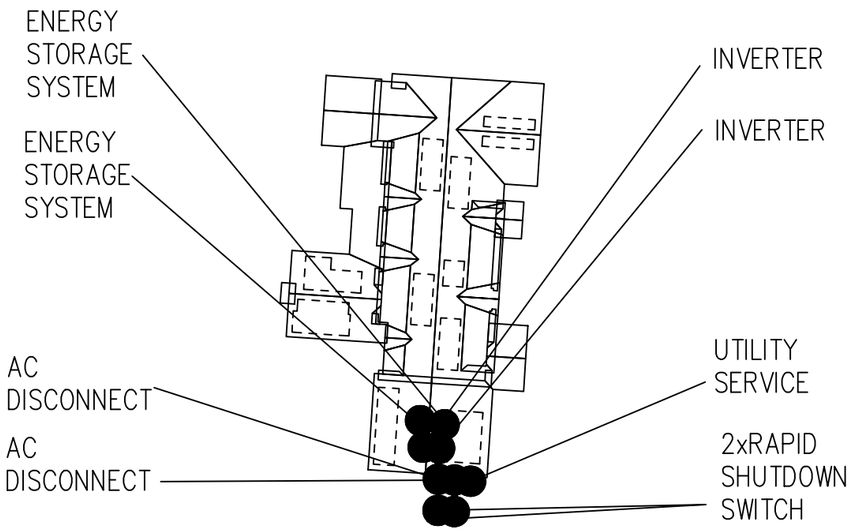
SHEET: 8 REV: DATE: 10/27/2022

TESLA

SOLAR PV SYSTEM EQUIPPED WITH RAPID SHUTDOWN

TURN RAPID SHUTDOWN SWITCH TO THE "OFF" POSITION TO SHUT DOWN PV SYSTEM AND REDUCE SHOCK HAZARD IN THE ARRAY

- Address: 5510 Lambeth Rd



OPERATING VOLTAGE = 240V

JB-20812222-00

JOB NUMBER: JB–20812222 00

MOUNTING SYSTEM: ZS Comp V4 w Flashing–Insert

MODULES: (47) Tesla # T400H

INVERTER: Powerwall+ [240V] #1850000–00–C / PVI Assy. 1538000–35–F

CUSTOMER:
Eric Lightfoot
5510 Lambeth Rd
Bethesda, MD 20814

2409945381

DESCRIPTION:
18.8 KW PV ARRAY
27 KWH ENERGY STORAGE SYSTEM

PAGE NAME: SITE PLAN PLACARD

DESIGN: LUIS CODINA

SHEET: 9 REV: DATE: 10/27/2022

TESLA

WARNING: PHOTOVOLTAIC POWER SOURCE

Label Location:
(C)(CB)(JB)
Per Code:
NEC 690.31.G.3

PHOTOVOLTAIC DC DISCONNECT

Label Location:
(DC) (INV)
Per Code:
NEC 690.13.B

MAXIMUM POWER-POINT CURRENT (Imp) ____ A
MAXIMUM POWER-POINT VOLTAGE (Vmp) ____ V
MAXIMUM SYSTEM VOLTAGE (Voc) ____ V
SHORT-CIRCUIT CURRENT (Isc) ____ A

Label Location:
(DC) (INV)
Per Code:
NEC 690.53

WARNING

ELECTRIC SHOCK HAZARD
IF A GROUND FAULT IS INDICATED
NORMALLY GROUNDED
CONDUCTORS MAY BE
UNGROUNDED AND ENERGIZED

Label Location:
(DC) (INV)
Per Code:
690.41.B

WARNING

ELECTRICAL SHOCK HAZARD
DO NOT TOUCH TERMINALS
TERMINALS ON BOTH LINE AND
LOAD SIDES MAY BE ENERGIZED
IN THE OPEN POSITION

DC VOLTAGE IS
ALWAYS PRESENT WHEN
SOLAR MODULES ARE
EXPOSED TO SUNLIGHT

Label Location:
(DC) (CB)
Per Code:
CEC 690.13.B

PHOTOVOLTAIC AC DISCONNECT

Label Location:
(AC) (POI)
Per Code:
NEC 690.13.B

MAXIMUM AC OPERATING CURRENT ____ A
MAXIMUM AC OPERATING VOLTAGE ____ V

Label Location:
(AC) (POI)
Per Code:
NEC 690.54

WARNING

ELECTRIC SHOCK HAZARD
DO NOT TOUCH TERMINALS
TERMINALS ON BOTH LINE AND
LOAD SIDES MAY BE ENERGIZED
IN THE OPEN POSITION

Label Location:
(AC)(POI)
Per Code:
NEC 690.13.B

WARNING

INVERTER OUTPUT
CONNECTION
DO NOT RELOCATE
THIS OVERCURRENT
DEVICE

Label Location:
(POI)
Per Code:
NEC 705.12.B.2.3.b

PHOTOVOLTAIC SYSTEM
EQUIPPED WITH RAPID
SHUTDOWN

Label Location:
(INV)
Per Code:
NEC 690.56.C.3

CAUTION

PHOTOVOLTAIC SYSTEM
CIRCUIT IS BACKFED

Label Location:
(D) (POI)
Per Code:
NEC 690.64.B.4

CAUTION

DUAL POWER SOURCE
SECOND SOURCE IS
PHOTOVOLTAIC SYSTEM

Label Location:
(POI)
Per Code:
NEC 705.12.B.3

PHOTOVOLTAIC POINT OF INTERCONNECTION

WARNING: ELECTRIC SHOCK HAZARD. DO NOT TOUCH TERMINALS. TERMINALS ON BOTH THE LINE AND LOAD SIDE MAY BE ENERGIZED IN THE OPEN POSITION. FOR SERVICE DE-ENERGIZE BOTH SOURCE AND MAIN BREAKER.

PV POWER SOURCE

MAXIMUM AC OPERATING CURRENT ____ A
MAXIMUM AC OPERATING VOLTAGE ____ V

Label Location:
(POI)
Per Code:
CEC 690.13.B

WARNING

ELECTRIC SHOCK HAZARD
THE DC CONDUCTORS OF THIS
PHOTOVOLTAIC SYSTEM ARE
UNGROUNDED AND
MAY BE ENERGIZED

Label Location:
(DC) (INV)

(AC): AC Disconnect
(C): Conduit
(CB): Combiner Box
(D): Distribution Panel
(DC): DC Disconnect
(IC): Interior Run Conduit
(INV): Inverter With Integrated DC Disconnect
(LC): Load Center
(M): Utility Meter
(POI): Point of Interconnection

BACKUP LOAD CENTER

Label Location:
(BLC)
Per Code:
NEC 408.4

CAUTION
DO NOT ADD NEW LOADS

Label Location:
(BLC)
Per Code:
NEC 220

CAUTION
THIS PANEL HAS SPLICED FEED-THROUGH CONDUCTORS.
LOCATION OF DISCONNECT AT ENERGY STORAGE BACKUP LOAD PANEL

Label Location:
(MSP)
Per Code:
NEC 312.8.A(3)

CAUTION
DUAL POWER SOURCE
SECOND SOURCE IS
ENERGY STORAGE SYSTEM

Label Location:
(MSP)
Per Code:
NEC 705.12(B)(3)

ENERGY STORAGE SYSTEM ON SITE
LOCATED WITHIN LINE OF SIGHT

Label Location:
(MSP)
Per Code:

ENERGY STORAGE SYSTEM ON SITE
LOCATED ON ADJACENT WALL

Label Location:
(MSP)
Per Code:

ENERGY STORAGE SYSTEM ON SITE
LOCATED ON OPPOSITE WALL

Label Location:
(MSP)
Per Code:

ENERGY STORAGE SYSTEM ON SITE
LOCATED INSIDE

Label Location:
(MSP)
Per Code:

CAUTION
TRI POWER SOURCE
SECOND SOURCE IS PHOTOVOLTAIC SYSTEM
THIRD SOURCE IS ENERGY STORAGE SYSTEM

Label Location:
(MSP)
Per Code:
NEC 705.12(B)(3)

WARNING
THIS EQUIPMENT FED BY MULTIPLE SOURCES. TOTAL RATING OF ALL OVER CURRENT DEVICES, EXCLUDING MAIN SUPPLY OVERCURRENT DEVICE, SHALL NOT EXCEED AMPACITY OF BUSBAR.

Label Location:
(MSP)
Per Code:
NEC 705.12.B.2.3.c

NOMINAL ESS VOLTAGE: 120/240V
MAX AVAILABLE SHORT-CIRCUIT FROM ESS: 32A
ARC FAULT CLEARING TIME FROM ESS: 67ms
DATE OF CALCULATION:

Label Location:
(MSP)
Per Code:
Per 706.7(D) label to be marked in field

(AC): AC Disconnect
(BLC): Backup Load Center
(MSP): Main Service Panel

POWERWALL

Backup Gateway 2

The Backup Gateway 2 for Tesla Powerwall provides energy management and monitoring for solar self-consumption, time-based control, and backup.

The Backup Gateway 2 controls connection to the grid, automatically detecting outages and providing a seamless transition to backup power. When equipped with a main circuit breaker, the Backup Gateway 2 can be installed at the service entrance. When the optional internal panelboard is installed, the Backup Gateway 2 can also function as a load center.

The Backup Gateway 2 communicates directly with Powerwall, allowing you to monitor energy use and manage backup energy reserves from any mobile device with the Tesla app.

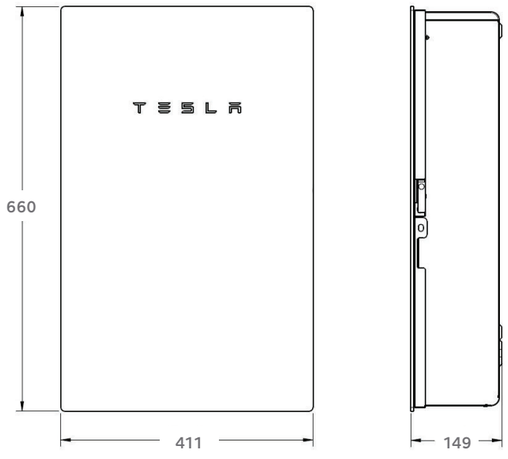
PERFORMANCE SPECIFICATIONS

Model Number	1232100-xx-y
AC Voltage (Nominal)	120/240V
Feed-In Type	Split Phase
Grid Frequency	60 Hz
Current Rating	200 A
Maximum Input Short Circuit Current	10 kA[1]
Overcurrent Protection Device	100-200A; Service Entrance Rated[1]
Overvoltage Category	Category IV
AC Meter	Revenue accurate (+/– 0.2 %)
Primary Connectivity	Ethernet, Wi-Fi
Secondary Connectivity	Cellular (3G, LTE/4G)[2]
User Interface	Tesla App
Operating Modes	Support for solar self-consumption, time-based control, and backup
Backup Transition	Automatic disconnect for seamless backup
Modularity	Supports up to 10 AC-coupled Powerwalls
Optional Internal Panelboard	200A 6-space / 12 circuit Eaton BR Circuit Breakers
Warranty	10 years

[1] When protected by Class J fuses, Backup Gateway 2 is suitable for use in circuits capable of delivering not more than 22kA symmetrical amperes.
[2] The customer is expected to provide internet connectivity for Backup Gateway 2; cellular should not be used as the primary mode of connectivity. Cellular connectivity subject to network operator service coverage and signal strength.

MECHANICAL SPECIFICATIONS

Dimensions	660 mm x 411 mm x 149 mm (26 in x 16 in x 6 in)
Weight	20.4 kg (45 lb)
Mounting options	Wall mount, Semi-flush mount



COMPLIANCE INFORMATION

Certifications	UL 67, UL 869A, UL 916, UL 1741 PCS CSA 22.2 0.19, CSA 22.2 205
Emissions	FCC Part 15, ICES 003

ENVIRONMENTAL SPECIFICATIONS

Operating Temperature	-20°C to 50°C (-4°F to 122°F)
Operating Humidity (RH)	Up to 100%, condensing
Maximum Elevation	3000 m (9843 ft)
Environment	Indoor and outdoor rated
Enclosure Type	NEMA 3R

MCI WIRING DETAIL

GENERAL NOTES

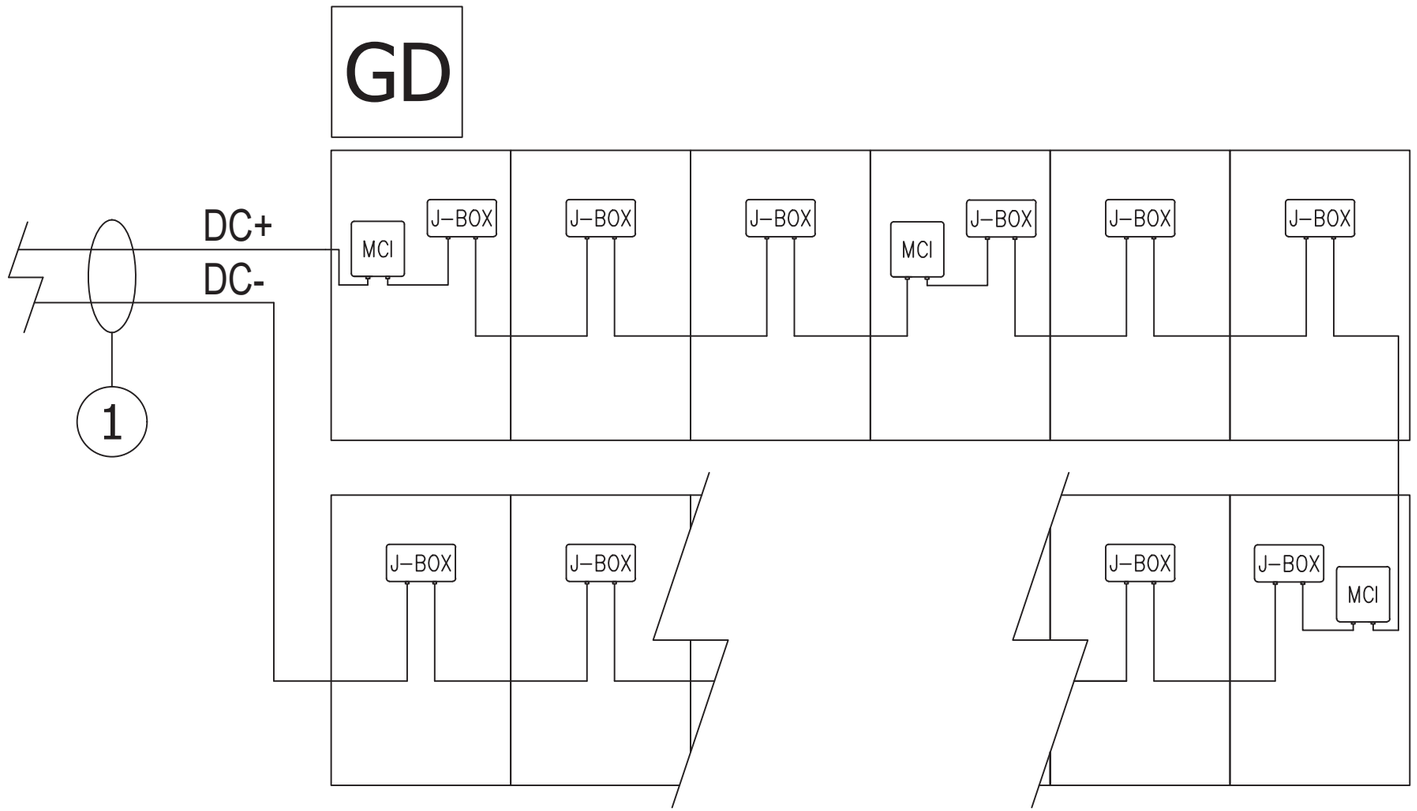
- DRAWING OF STANDARD MCI WIRING DETAIL FOR ANY GIVEN STRING LENGTH
- IF INITIATED, RAPID SHUTDOWN OCCURS WITHIN 30 SECONDS OF ACTIVATION AND LIMITS VOLTAGE ON THE ROOF TO NO GREATER THAN 165V (690.12.B.2.1)
- MID CIRCUIT INTERRUPTER (MCI) IS A UL 1741 PVRSE CERTIFIED RAPID SHUTDOWN DEVICE (RSD)

RETROFIT PV MODULES

- MCIS ARE LOCATED AT ROOF LEVEL, JUST UNDER THE PV MODULES IN ACCORDANCE WITH 690.12 REQUIREMENTS
- THE QUANTITY OF MCIS PER STRING IS DETERMINED BY STRING LENGTH
  - NUMBER OF MODULES BETWEEN MCI UNITS = 0–3
  - MAXIMUM NUMBER OF MODULES PER MCI UNIT = 3
  - MINIMUM NUMBER MCI UNITS = MODULE COUNT/3

*Exception: Tesla (Longi) modules installed in locations where the max Voc for 3 modules at low design temperature exceeds 165V shall be limited to 2 modules between MCIs.

PLEASE REFER TO MCI CUTSHEET AND PVRSA INSERT FOR MORE INFORMATION



1 — (2) AWG, PV Wire, 600V, Black

DC

POWERWALL+

Powerwall+ is an integrated solar battery system that stores energy from solar production. Powerwall+ has two separate inverters, one for battery and one for solar, that are optimized to work together. Its integrated design and streamlined installation allow for simple connection to any home, and improved surge power capability brings whole home backup in a smaller package. Smart system controls enable owners to customize system behavior to suit their renewable energy needs.

KEY FEATURES

- Integrated battery, inverter, and system controller for a more compact install
- A suite of application modes, including self-powered, time-based control, and backup modes
- Wi-Fi, Ethernet, and LTE connectivity with easy over-the-air updates

PHOTOVOLTAIC (PV) AND BATTERY ENERGY STORAGE SYSTEM (BESS) SPECIFICATIONS

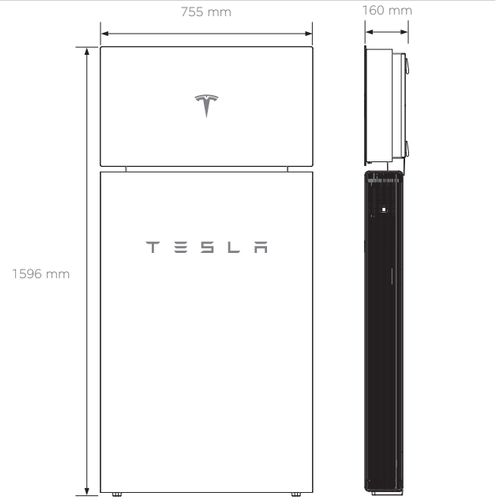
Powerwall+ Model Number	1850000-xx-y
Solar Assembly Model Number	1538000-xx-y
Nominal Battery Energy	13.5 kWh
Nominal Grid Voltage (Input / Output)	120/240 VAC
Grid Voltage Range	211.2 - 264 VAC
Frequency	60 Hz
Phase	240 VAC: 2W+N+GND
Maximum Continuous Power On-Grid	7.6 kVA full sun / 5.8 kVA no sun[1]
Maximum Continuous Power Off-Grid	9.6 kW full sun / 7 kW no sun[1]
Peak Off-Grid Power (10 s)	22 kW full sun / 10 kW no sun[1]
Maximum Continuous Current On-Grid	32 A output
Maximum Continuous Current Off-Grid	40 A output
Load Start Capability	98 - 118 A LRA[2]
PV Maximum Input Voltage	600 VDC
PV DC Input Voltage Range	60 - 550 VDC
PV DC MPPT Voltage Range	60 - 480 VDC
MPPTs	4
Input Connectors per MPPT	1-2-1-2
Maximum Current per MPPT (I_{mp})	13 A[3]
Maximum Short Circuit Current per MPPT (I_{sc})	17 A[3]
Allowable DC/AC Ratio	1.7
Overcurrent Protection Device	50 A breaker
Maximum Supply Fault Current	10 kA
Output Power Factor Rating	+/– 0.9 to 1[4]
Round Trip Efficiency	90%[5]
Solar Generation CEC Efficiency	97.5% at 208 V 98.0% at 240 V
Customer Interface	Tesla Mobile App
Internet Connectivity	Wi-Fi, Ethernet, Cellular LTE/4G)[6]
PV AC Metering	Revenue grade (+/-0.5%)
Protections	Integrated arc fault circuit interrupter (AFCI), PV Rapid Shutdown
Warranty	10 years

COMPLIANCE INFORMATION

PV Certifications	UL 1699B, UL 1741, UL 3741, UL 1741 SA, UL 1998 (US), IEEE 1547, IEEE 1547.1
Battery Energy Storage System Certifications	UL 1642, UL 1741, UL 1741 PCS, UL 1741 SA, UL 1973, UL 9540, IEEE 1547, IEEE 1547.1, UN 38.3
Grid Connection	United States
Emissions	FCC Part 15 Class B
Environmental	RoHS Directive 2011/65/EU
Seismic	AC156, IEEE 693-2005 (high)

MECHANICAL SPECIFICATIONS

Dimensions	1596 x 755 x 160 mm (62.8 x 29.7 x 6.3 in)
Total Weight	140 kg (310 lb)[7]
Battery Assembly	118 kg (261 lb)
Solar Assembly	22 kg (49 lb)
Mounting options	Floor or wall mount



ENVIRONMENTAL SPECIFICATIONS

Operating Temperature	–20°C to 50°C (–4°F to 122°F)[8]
Recommended Temperature	0°C to 30°C (32°F to 86°F)
Operating Humidity (RH)	Up to 100%, condensing
Storage Conditions	–20°C to 30°C (–4°F to 86°F) Up to 95% RH, non-condensing State of Energy (SoE): 25% initial
Maximum Elevation	3000 m (9843 ft)
Environment	Indoor and outdoor rated
Enclosure Type	Type 3R
Solar Assembly Ingress Rating	IP55 (Wiring Compartment)
Battery Assembly Ingress Rating	IP56 (Wiring Compartment) IP67 (Battery & Power Electronics)
Noise Level @ 1 m	< 40 db(A) optimal, < 50 db(A) maximum

[1]Values provided for 25°C (77°F).
[2]Load start capability may vary.
[3]Where the DC input current exceeds an MPPT rating, jumpers can be used to allow a single MPPT to intake additional DC current up to 26 A I_{mp} / 34 A I_{sc}.
[4]Power factor rating at max real power.
[5]AC to battery to AC, at beginning of life.
[6]Cellular connectivity subject to network service coverage and signal strength.
[7]The total weight does not include the Powerwall+ bracket, which weighs an additional 9 kg (20 lb).
[8]Performance may be de-rated at operating temperatures below 10°C (50°F) or greater than 43°C (109°F).

SOLAR SHUTDOWN DEVICE

The Tesla Solar Shutdown Device is a Mid-Circuit Interrupter (MCI) and is part of the PV system rapid shutdown (RSD) function in accordance with Article 690 of the applicable NEC. When paired with Powerwall+, solar array shutdown is initiated by pushing the System Shutdown Switch if one is present.

ELECTRICAL SPECIFICATIONS

Model Number	MCI-1
Nominal Input DC Current Rating (I_{MP})	12 A
Maximum Input Short Circuit Current (I_{SC})	15 A
Maximum System Voltage	600 V DC

RSD MODULE PERFORMANCE

Maximum Number of Devices per String	5
Control	Power Line Excitation
Passive State	Normally open
Maximum Power Consumption	7 W
Warranty	25 years

COMPLIANCE INFORMATION

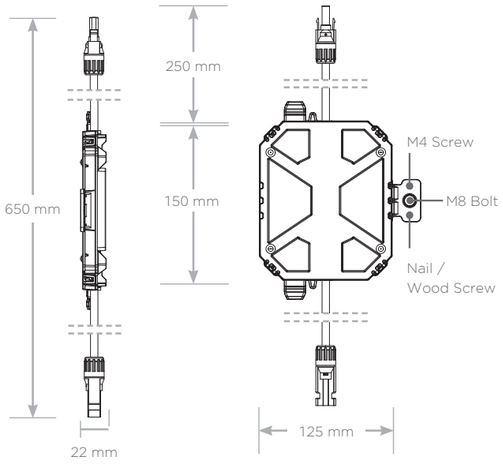
Certifications	UL 1741 PVRSE, UL 3741, PVRSA (Photovoltaic Rapid Shutdown Array)
RSD Initiation Method	External System Shutdown Switch
Compatible Equipment	*See Compatibility Table below*

ENVIRONMENTAL SPECIFICATIONS

Ambient Temperature	-40°C to 50°C (-40°F to 122°F)
Storage Temperature	-30°C to 60°C (-22°F to 140°F)
Enclosure Rating	NEMA 4 / IP65

MECHANICAL SPECIFICATIONS

Electrical Connections	MC4 Connector
Housing	Plastic
Dimensions	125 mm x 150 mm x 22 mm (5 in x 6 in x 1 in)
Weight	350 g (0.77 lb)
Mounting Options	ZEP Home Run Clip M4 Screw (#10) M8 Bolt (5/16") Nail / Wood screw



UL 3741 PV HAZARD CONTROL (AND PVRSA) COMPATIBILITY

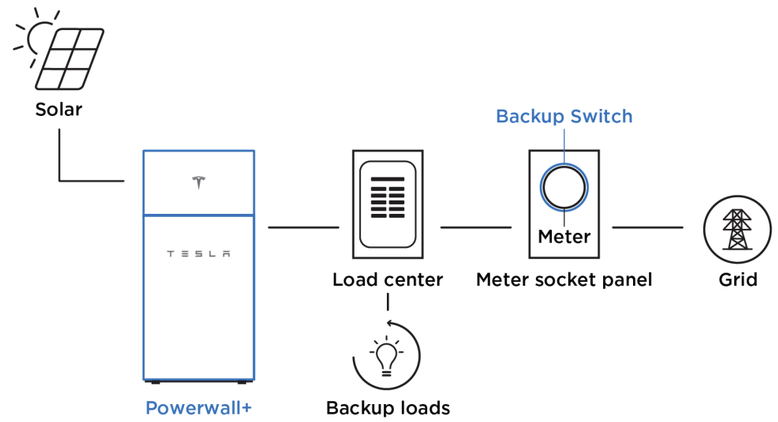
Tesla Solar Roof and Tesla/Zep ZS Arrays using the following modules are certified to UL 3741 and UL 1741 PVRSA when installed with the Powerwall+ and Solar Shutdown Devices. See the Powerwall+ Installation Manual for detailed instructions and for guidance on installing Powerwall+ and Solar Shutdown Devices with other modules.

Brand	Model	Required Solar Shutdown Devices
Tesla	Solar Roof V3	1 Solar Shutdown Device per 10 modules
Tesla	Tesla TxxxS (where xxx = 405 to 450 W, increments of 5)	1 Solar Shutdown Device per 3 modules[1]
Tesla	Tesla TxxxH (where xxx = 395 to 415 W, increments of 5)	1 Solar Shutdown Device per 3 modules
Hanwha	Q.PEAK DUO BLK-G5	1 Solar Shutdown Device per 3 modules
Hanwha	Q.PEAK DUO BLK-G6+	1 Solar Shutdown Device per 3 modules

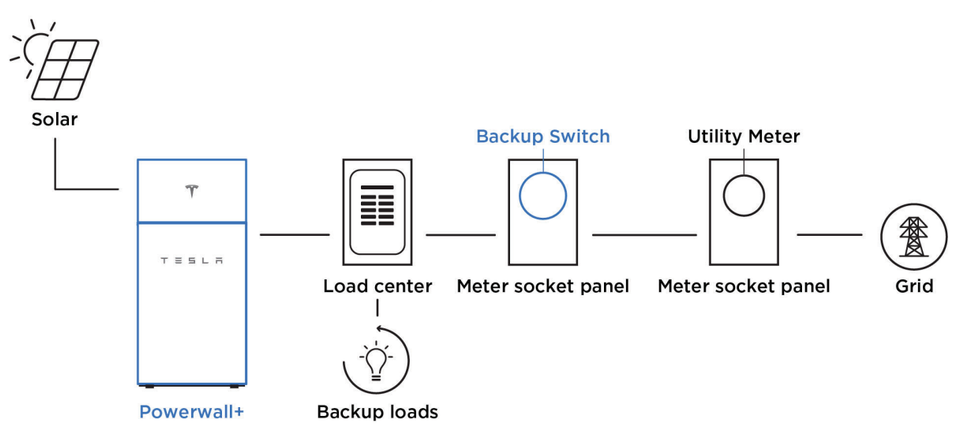
[1]**Exception**: Tesla solar modules installed in locations where the max Voc for three modules at low design temperatures exceeds 165 V shall be limited to two modules between Solar Shutdown Devices.

SYSTEM LAYOUTS

Powerwall+ with Backup Switch Installed Behind Utility Meter



Powerwall+ with Backup Switch Installed Downstream of Utility Meter



Tesla Photovoltaic Module

T395H, T400H, and T405H

—

The Tesla module is one of the most powerful residential photovoltaic modules available and exceeds industry engineering and quality standards. Featuring our proprietary Zep Groove design, the all-black module mounts close to your roof for a minimalist aesthetic. Modules are certified to IEC / UL 61730 - 1, IEC / UL 61730 - 2 and IEC 61215.

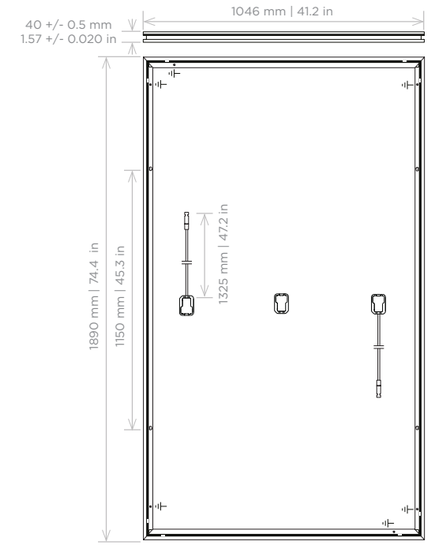
Module Specifications

Electrical Characteristics						
Power Class	T395H		T400H		T405H	
Test Method	STC	NMOT	STC	NMOT	STC	NMOT
Max Power, P_{MAX} (W)	395	296.3	400	300.1	405	303.8
Open Circuit Voltage, V_{OC} (V)	45.27	42.69	45.30	42.72	45.34	42.76
Short Circuit Current, I_{SC} (A)	11.10	8.95	11.14	8.97	11.17	9.00
Max Power Voltage, V_{MP} (V)	36.88	35.03	37.13	35.25	37.39	35.46
Max Power Current, I_{MP} (A)	10.71	8.46	10.77	8.51	10.83	8.57
Module Efficiency (%)	≥ 20.1		≥ 20.4		≥ 20.6	
STC	1000 W/m², 25°C, AM1.5					
NOCT	800 W/m², 20°C, AM1.5, wind speed 1 m/s					

Mechanical Loading		
Front Side Test Load	6120 Pa | 128 lb/ ft²	Refer to module and system installation manuals for allowable design loads, foot spacings, and cantilever specifications.
Rear Side Test Load	6120 Pa | 128 lb/ ft²	
Front Side Design Load	4080 Pa | 85 lb/ft²	
Rear Side Design Load	4080 Pa | 85 lb/ft²	
Hail Test	35 mm at 27.2 m/s	

Temperature Rating (STC)	
Temperature Coefficient of Isc	+0.04% / °C
Temperature Coefficient of V_{OC}	-0.27% / °C
Temperature Coefficient of P_{MAX} (W)	-0.34% / °C

Mechanical Parameters	
Cell Orientation	132 (6 x 22)
Junction Box	IP68, 3 diodes
Cable	4 mm² | 12 AWG, 1325 mm | 47.2 in. Length
Connector	Staubli MC4
Front Cover	0.13 in (3.2 mm) thermally pre-stressed glass
Frame	Black Anodized Aluminum Alloy
Weight	23.5 kg | 51.8 lb
Dimension	1890 mm x 1046 mm x 40 mm 74.4 in x 41.2 in x 1.57 in



Operation Parameters	
Operational Temperature	-40°C up to +85°C
Power Output Tolerance	-0 /+5 W
V_{OC} & I_{SC} Tolerance	+/- 5 %
Max System Voltage	DC 1000 V (IEC/UL)
Max Series Fuse Rating	20 A
NOCT	45.7 +/- 3 °C
Safety Class	Class II
Fire Rating	UL 61730 Type 2

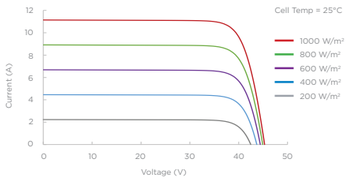
Linear Power Warranty

Materials and Processing	25 years
Extra Linear Power Output	25 years

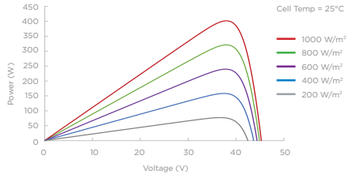
At least 98% of nominal power during first year. Thereafter max. 0.5% degradation per year. At least 93.5% of nominal power up to 10 years. At least 86% of nominal power up to 25 years.

IV Curves

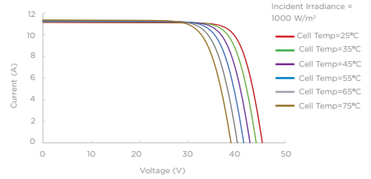
Current vs. Voltage



Power vs. Voltage



Current vs. Voltage

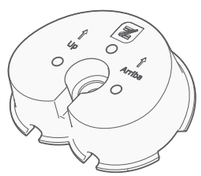


ROOFING SYSTEM SPECIFICATIONS

DESCRIPTION	PV mounting solution for composition shingle roofs.
	Works with all Zep Compatible Modules.
	Auto bonding UL-listed hardware creates structural and electrical bond.
SPECIFICATIONS	Designed for pitched roofs.
	Installs in portrait and landscape orientations.
	Engineered for spans up to 72” and cantilevers up to 24”.
	ZS Comp has a UL 1703 Class “A” Fire Rating when installed using modules from any manufacturer certified as “Type 1” or “Type 2”.
	Attachment method UL listed to UL 2582 for Wind Driven Rain.
	ZS Comp supports 50 psf (2400 Pa) front and up to 72 psf (3450 Pa) rear side design load rating for Portrait module orientation per UL 2703.
	ZS Comp supports 50 psf (2400 Pa) front side and up to 72 psf (3450 Pa) rear side design load rating for Landscape module orientation.
	Engineered for compliance with ASCE 7-05, 7-10, and 7-16 wind load requirements.
	Zep wire management products listed to UL 1565 for wire positioning devices.
	ZS Comp grounding products are listed to UL 2703 and UL 467.
	ZS Comp bonding products are listed to UL 2703.

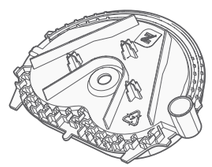
MOUNTING BLOCK

Listed to UL 2703
Part #850-1633



FLASHING INSERT

Listed to UL 2703 and UL 2582 for Wind Driven Rain
Part #850-1628



CAPTURED WASHER LAG

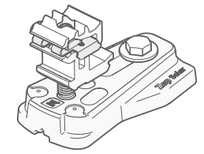
Part #850-1631-002 and #850-1631-004

GROUND ZEP

Listed to UL 2703
Part #850-1511

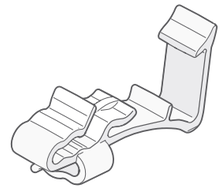
LEVELING FOOT

Listed to UL 2703
Part #850-1397



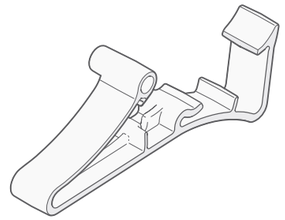
DC WIRE CLIP

Listed to UL 1565
Part #850-1509



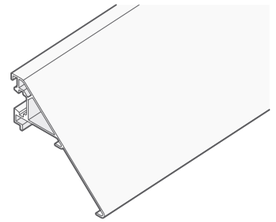
HOME RUN CLIP

Listed to UL 1565
Part #850-1510



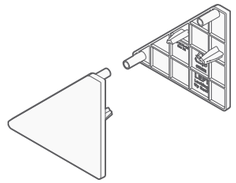
ARRAY SKIRT

Listed to UL 2703
Part #850-1608



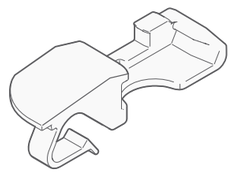
END CAP

Listed to UL 2703
Part #850-1586 (Left)
Part #850-1588 (Right)



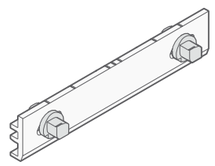
SKIRT GRIP

Listed to UL 2703
Part #850-1606



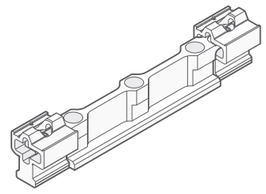
INTERLOCK

Listed to UL 2703
Part #850-1613



HYBRID INTERLOCK

Listed to UL 2703
Part #850-1281



Wire & Conduit Size Equivalence Table: Copper & Aluminum					
Rating (A)	**Copper**			**Aluminum**	
	Conductor (AWG or kcmil)	**Min. EGC (AWG)**	**Conduit**	**Conductor (AWG or kcmil)**	**Conduit**
100	3	8	1" - EMT	1	1-1/4" - EMT
115	2	6	1-1/4" - EMT	1/0	2" - PVC
130	1	6	1-1/4" - EMT	2/0	2" - PVC
150	1/0	6	2" - PVC	3/0	2" - PVC
175	2/0	6	2" - PVC	4/0	2" - PVC
200	3/0	6	2" - PVC	250	2" - PVC

NEC Code references

NEC Table 310.15(B)(16) (formerly Table 310.16)

NEC Table 250.122

Table 310.104(A)

PV HAZARD CONTROL SYSTEM | ZS PVHCS

UL 3741 REPORT DATE 10-20-21 (APPLICABLE TO ZS COMP, ZS SPAN, ZS RAMP, AND ZS SEAM)
PV RAPID SHUTDOWN ARRAY, UL 1741 CATEGORY QIJR

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

PV HAZARD CONTROL EQUIPMENT AND COMPONENTS

Function	Manufacturer	Model No.	Firmware Versions and Checksums	Certification Standard
PVRSE Mid Circuit Interrupter (MCI)	Tesla	MCI-1	N/A	UL 1741 PVRSE
Inverter or Powerwall+	Tesla	7.6 kW: 1538000 [1] 3.8 kW: 1534000 [1] 7.6 kW: 1850000 [1]	V4, CEA4F802 V4, FF7BE4E1 V4, CEA4F802	UL 1741, 1998 PVRSS/PVRSE
PV Module	Hanwha/ Q-CELLS Tesla	Q.PEAK DUO BLK-G5/SC310-320 Q.PEAK DUO BLK G6+/SC330-345 Tesla TxxxS (xxx = 405 to 450) Tesla TxxxH (xxx = 395 to 415)	N/A	UL 1703 UL 61730
PVHCS Initiator (PV Inverter)	Dedicated PV system AC circuit breaker or AC disconnect switch, labeled per NEC 690.12 requirements.			N/A
PVHCS Initiator (Powerwall+)	Emergency stop device (NISD)- Listed "Emergency Stop Button" or "Emergency Stop Device" or "Emergency Stop Unit".			UL 508 or UL 60947 Parts 1, 5-1 and 5-5

[1] Applies to variations of this part number with suffix of two numbers and one letter.

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

PVHCS INSTALLATION REQUIREMENTS

Max System Voltage	600 VDC
PVHCS Maximum Circuit Voltage (Array Internal Voltage After Actuation)	165 VDC (cold weather open circuit)
Max Series-Connected Modules Between MCIs: *Exception: Tesla S-Series (TxxxS) modules installed in locations where the max VOC for 3 modules at low design temperature exceeds 165V shall be limited to 2 modules between MCIs.	3*

OTHER INSTALLATION INSTRUCTIONS

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

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

3. For PV Inverter: The PVHCS initiator (AC breaker or switch) shall be sized and installed in accordance with NEC requirements. The specific part shall be identified on the as-built system drawings.

4. For Powerwall+: The PVHCS emergency stop initiator shall have the following minimum ratings: Outdoor (Type 3R or higher), 12V, 1A, and shall be installed in accordance with NEC requirements. The specific part shall be identified on the as-built system drawings. Refer to the Powerwall+ installation manual for further details.

Certification Mark of UL on the installation instructions is the only method provided by UL to identify products manufactured under its Certification and Follow-Up Service. The Certification Mark for these products includes the UL symbol, the words "CERTIFIED" and "SAFETY," the geographic identifier(s), and a file number.

PV HAZARD CONTROL SYSTEM PVHCS | CERTIFICATION

UL 3741 REPORT DATE 8-12-21
PV RAPID SHUTDOWN ARRAY, UL 1741 CATEGORY QIJR, REPORT DATE: 2021-06-11 (REV 8-10-21)

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

PV HAZARD CONTROL EQUIPMENT AND COMPONENTS

Function	Manufacturer	Model No.	Firmware Versions and Checksums	Certification Standard
PVRSE Mid Circuit Interrupter (MCI)	Tesla	MCI-1 1550379[1]	N/A	UL 1741 PVRSE
Inverter or Powerwall+	Tesla	7.6 kW: 1538000 [1] 3.8 kW: 1534000 [1] 7.6 kW: 1850000 [1]	V4, CEA4F802 V4, FF7BE4E1 V4, CEA4F802	UL 1741, 1998 PVRSS/PVRSE
PV Module	Tesla	SR60T1, SR72T1 SR72T2	N/A	UL 61730
Diode Harness (Not applicable to SR72T2)	Tesla	SRDTH	N/A	UL 9703
PV Wire Jumper(s)	Tesla	SR-BJ2X, SR-BJ3X, SR-BJ4X, SR-BJMini	N/A	UL 9703
Pass-Through Box	Tesla	SRPTB-4	N/A	UL 1741
PVHCS Initiator : (PV Inverter)	Dedicated PV system AC circuit breaker or AC disconnect switch, labeled per NEC 690.12 requirements.			N/A
PVHCS Initiator : (Powerwall+)	Emergency stop device (NISD)- Listed "Emergency Stop Button" or "Emergency Stop Device" or "Emergency Stop Unit"			UL 508 or UL 60947 Parts 1, 5-1 and 5-5

[1] Applies to variations of this part number with suffix of two numbers and one letter.

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

PVHCS INSTALLATION REQUIREMENTS

Max System Voltage	600 VDC
PVHCS Maximum Circuit Voltage (Array Internal Voltage After Actuation)	165 VDC (cold weather open circuit)
Max Series-Connected Panels between MCIs	10

OTHER INSTALLATION INSTRUCTIONS

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

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

3. For PV Inverter: The PVHCS initiator (AC breaker or switch) shall be sized and installed in accordance with NEC requirements. The specific part shall be identified on the as-built system drawings.

4. For Powerwall+: The PVHCS emergency stop initiator shall have the following minimum ratings: Outdoor (Type 3R or higher), 12V, 1A, and shall be installed in accordance with NEC requirements. The specific part shall be identified on the as-built system drawings. Refer to the Powerwall+ installation manual for further details.

Certification Mark of UL on the installation instructions is the only method provided by UL to identify products manufactured under its Certification and Follow-Up Service. The Certification Mark for these products includes the UL symbol, the words "CERTIFIED" and "SAFETY," the geographic identifier(s), and a file number.