Historic Preservation Services

Community Development & Neighborhood Services
281 North College Avenue
P.O. Box 580
Fort Collins, CO 80522.0580

970.416.4250
preservation@fcgov.com
fcgov.com/historicpreservation

CERTIFICATE OF APPROPRIATENESS
ISSUED: December 6, 2022
EXPIRATION: December 6, 2023

Greg Parker
116 Pearl St.
Fort Collins, CO 80521

Dear Property Owner:

This letter provides you with confirmation that the proposed changes to your designated Fort Collins landmark property, the Landblom Property at 116 Pearl St., have been approved by the City's Historic Preservation Division because the proposed work meets the criteria and standards in Chapter 14, Article IV of the Fort Collins Municipal Code.

1) Solar PV system as shown on attached plans
    a. *Any mounting points for the equipment associated with the solar PV system on the brick walls of the house or garage should be drilled into mortar only, not the faces of the bricks, to avoid damaging the bricks.*

Notice of the approved application has been provided to building and zoning staff to facilitate the processing of any permits that are needed for the work.

Please note that all ensuing work must conform to the approved plans. Any non-conforming alterations are subject to stop-work orders, denial of Certificate of Occupancy, and restoration requirements and penalties.

If the approved work is not completed prior to the expiration date noted above, you may apply for an extension by contacting staff at least 30 days prior to expiration. Extensions may be granted for up to 12 additional months, based on a satisfactory staff review of the extension request.

Property owners can appeal staff design review decisions by filing a written notice of appeal to the Director of Community Development & Neighborhood Services within fourteen (14) days of this decision. If you have any questions regarding this approval, or if I may be of any assistance, please do not hesitate to contact me. I can be reached at yjones@fcgov.com or at 970-658-0263.

Sincerely,

Yani Jones
Historic Preservation Planner

Applicable Code Standard	Summary of Code Requirement and Analysis (Rehabilitation)	Standard Met (Y/N)
SOI #1	*A property will be used as it was historically or be given a new use that requires minimal change to its distinctive materials, features, spaces, and spatial relationships;* **The use of the property will not change as part of this project.**	**Y**
SOI #2	*The historic character of a property will be retained and preserved. The removal of distinctive materials or alteration of features, spaces, and spatial relationships that characterize a property will be avoided.* **This project will not compromise the historic character of the property because no historic materials or character-defining features will be removed or irreversibly altered.**	**Y**
SOI #3	*Each property will be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development, such as adding conjectural features or elements from other historic properties, will not be undertaken.*	**N/A**
SOI #4	*Changes to a property that have acquired historic significance in their own right will be retained and preserved.* **The garage on which the solar panel array will be attached has significance in its own right, but the flush-mounted array and subpanel will have minimal physical impact to the structure itself and is not easily visible from the street.**	**Y**
SOI #5	*Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property will be preserved.* **The solar panel array and subpanel on the garage and the associated equipment on the house will not destroy any distinctive materials, features, or finishes or examples of construction techniques or craftsmanship.**	**Y**
SOI #6	*Deteriorated historic features will be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature will match the old in design, color, texture, and, where possible, materials. Replacement of missing features will be substantiated by documentary and physical evidence.*	**N/A**

SOI #7	*Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used.*	**N/A**
SOI #8	*Archeological resources will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken.*	**N/A**
SOI #9	*New additions, exterior alterations, or related new construction shall not destroy historic materials that characterize the property. The new work shall be differentiated from the old and shall be compatible with the massing, size, scale, and architectural features to protect the historic integrity of the property and its environment.* **The exterior alterations needed for this solar array and its associated equipment do not destroy any characteristic historic materials. The alterations do not compromise the integrity of the property because they are not easily visible from the street. Although there is a line-of-sight between the location of the solar panel array on the garage and the sidewalk, the location of the garage toward the rear of the lot and the use of flush-mounted panels make them unobtrusive.**	**Y**
SOI #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.* **The solar panel array and its associated equipment are removable and do not compromise the integrity of the historic property.**	**Y**

Planning, Development and Transportation
Building Services Department
281 N. College Ave P.O. Box 580
Fort Collins, CO 80524
Phone 970-416-2740 Fax 224-6134

SOLAR PERMIT APPLICATION FORM

This application is to be used to apply for the following permits only (check the appropriate box):

☒ Photovoltaic Solar (PV)

☐ Thermal Solar (Hot Water System)

Complete all applicable information on the application. Incomplete applications will not be accepted.

Application #_____ Date _____
For office use only

Job Site Address *(required)*				**Value of Construction** (labor, materials, profit)
116 Pearl Street, Fort Collins, CO 80521				13,281
Property Owner Name	Address	City/State	Zip	Phone
Greg Parker	116 Pearl Street	Fort Collins, CO	80521	(734) 657-7437
Applicant Name	Address	City/State	Zip	Phone
Andrew Krueger	112 Racquette Dr Unit C, Fort Collins, CO 80524			(970)673-7733
Solar Contractor License #/Co. Name	Address	City/State	Zip	Phone
S-3665	112 Racquette Dr Unit C, Fort Collins, CO 80524			(970)673-7733

Contractor City of Ft. Collins Sales Tax #
Sales tax number is required by all contractors.
27948818-0000

Are you paying taxes here or by report? ☒ Here ☐ Report
Are you paying with your trust account? ☒ Yes ☐ No

IF SOLAR PV SYSTEM, HAS THE PROJECT BEEN PRE-APPROVED BY CITY LIGHT AND POWER? ☐ Yes ☐ No

Is this a residential or commercial project? ☒ Residential ☐ Commercial

If residential, is it: ☒ Single Family Detached ☐ Condo/townhome (single family attached) ☐ Duplex ☐ Multifamily (apartment) ☐ Garage

If commercial, is it: ☐ Bank ☐ Bar ☐ Church ☐ Hotel/Motel ☐ Medical office ☐ Office ☐ Retail ☐ Restaurant ☐ Other (explain) _____

Is this building **50 years of age** or more? ☒ Yes ☐ No *If yes, you may need to contact Historic Preservation*

Description of work*
Install 3.6 kW grid tied, flush roof mounted PV system

*Please note in description if; roof flush mounted, roof mounted & elevated, ground array, kw amount, how many solar panels.

Subcontractors: *List the company name or City of Ft Collins license # (PV **MUST** list City Registered Electrician – Thermal **MUST** list City Registered Plumber)*

Electrician ME-1713 Plumber_____ Roofer (For solar PV shingles) _____

I hereby acknowledge that I have read this application and state that the above information is complete and correct. I agree to comply with all requirements contained herein and city ordinances and state laws regulating building construction. **I know that a permit is not valid until it has been paid and issued.**

Applicant:
Print Name: Andrew Krueger **Signature** _____ **Date** 12/6/2022

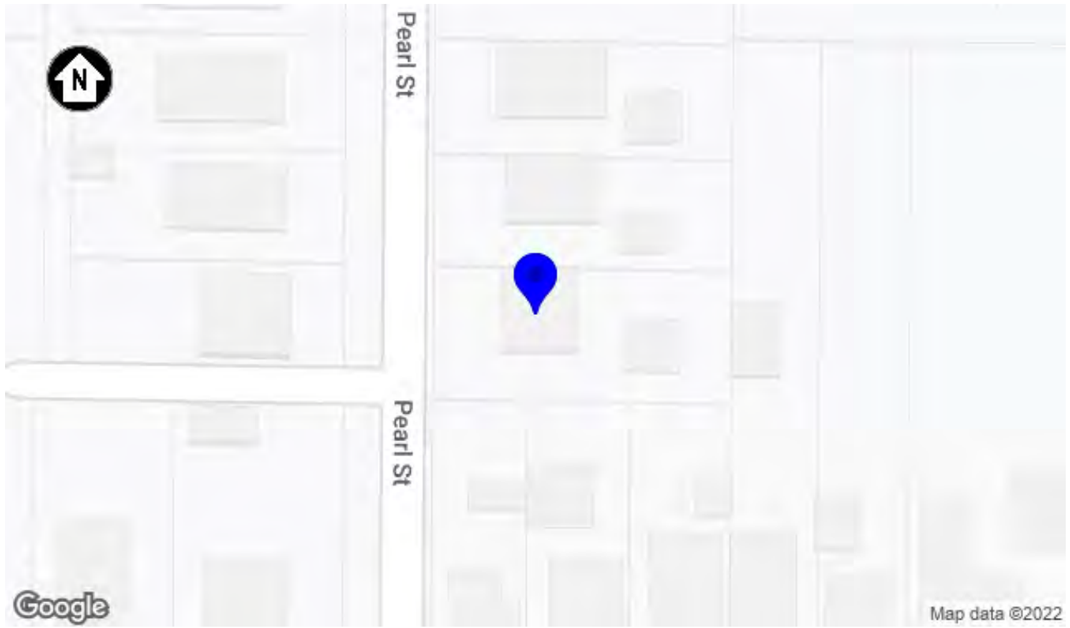
DIRECTORY OF PAGES

PROJECT DETAILS

PROPERTY OWNER	GREG PARKER
PROPERTY ADDRESS	116 PEARL ST, FORT COLLINS, CO 80521
APN	0020206
ZONING	RESIDENTIAL
USE AND OCCUPANCY CLASSIFICATION	ONE- OR TWO-FAMILY DWELLING GROUP (GROUP R3)
AHJ	CITY OF FORT COLLINS
UTILITY COMPANY	CITY OF FORT COLLINS - (CO)
ELECTRICAL CODE	2020 NEC (NFPA 70)
FIRE CODE	2021 IFC
OTHER BUILDING CODES	IBC 2021

CONTRACTOR INFORMATION

COMPANY	SANDBOX SOLAR
ADDRESS	430 N. COLLEGE AVE, FORT COLLINS, CO 80521
PHONE NUMBER	(970) 673-7733
CONTRACTOR SIGNATURE	



1 PV-1 PARCEL
SCALE: NTS

2 PV-1 LOCALE
SCALE: NTS

SCOPE OF WORK

THIS PROJECT INVOLVES THE INSTALLATION OF A GRID-INTERACTIVE PV SYSTEM. PV MODULES WILL BE MOUNTED USING A PREENGINEERED MOUNTING SYSTEM. THE MODULES WILL BE ELECTRICALLY CONNECTED WITH DC TO AC POWER INVERTERS AND INTERCONNECTED TO THE LOCAL UTILITY USING MEANS AND METHODS CONSISTENT WITH THE RULES ENFORCED BY THE LOCAL UTILITY AND PERMITTING JURISDICTION.

THIS DOCUMENT HAS BEEN PREPARED TO DESCRIBE THE DESIGN OF A PROPOSED PV SYSTEM WITH ENOUGH DETAIL TO DEMONSTRATE COMPLIANCE WITH APPLICABLE CODES AND REGULATIONS. THE DOCUMENT SHALL NOT BE RELIED UPON AS A SUBSTITUTE FOR FOLLOWING MANUFACTURER INSTALLATION INSTRUCTIONS. THE SYSTEM SHALL COMPLY WITH ALL MANUFACTURERS INSTALLATION INSTRUCTIONS, AS WELL AS ALL APPLICABLE CODES. NOTHING IN THIS DOCUMENT SHALL BE INTERPRETED IN A WAY THAT OVERRIDES THEM. CONTRACTOR IS RESPONSIBLE FOR VERIFICATION OF ALL DETAILS IN THIS DOCUMENT.

SYSTEM DETAILS

DESCRIPTION	NEW GRID-INTERACTIVE PHOTOVOLTAIC SYSTEM WITH NO ENERGY STORAGE
DC RATING OF SYSTEM	3.60KW
AC OUTPUT RATINGS	3.14KW, 13.1A
INVERTER(S)	9 X ENPHASE IQ8A-72-2-US
MODULE	REC SOLAR REC400AA PURE
ARRAY WIRING	(1) BRANCH OF 9 IQ8A-72-2-US MICROINVERTERS

INTERCONNECTION DETAILS

POINT OF INTERCONNECTION	NEW LOAD-SIDE AC CONNECTION PER NEC 705.12(B)(3)(1) AT EXISTING SUBPANEL
UTILITY SERVICE	120/240V 1Φ
ELECTRICAL PANEL	SUBPANEL W/ TOP-FED 125A BUSBAR (MLO), EXISTING SUBPANEL FEEDER PROTECTED WITH 100A BREAKER IN MSP

SITE DESIGN PARAMETERS

ASHRAE EXTREME LOW	-23°C (-9°F)
ASHRAE 2% HIGH	32°C (90°F)
CLIMATE DATA SOURCE	FORT COLLINS DOWNTOWN
WIND (ASCE 7-16)	140 MPH, EXPOSURE CATEGORY C, RISK CATEGORY II
GROUND SNOW LOAD	35 PSF

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SANDBOX SOLAR

GRID-TIED SOLAR POWER SYSTEM

PARKER RESIDENCE
116 PEARL ST
FORT COLLINS, CO 80521

COLORADO LICENSED
ARASH ZANDIEH
53832
PROFESSIONAL ENGINEER
Exp. 10/31/2023

PROJECT SUMMARY

DOC ID: C34887-3
DATE: 10/25/22
CREATOR: I.S.
REVIEWER:

REVISIONS

PV-1

1 PV-2 SITE PLAN
SCALE: 1" = 20'

GENERAL NOTES	
1	EQUIPMENT LIKELY TO BE WORKED UPON WHILE ENERGIZED SHALL BE INSTALLED IN LOCATIONS THAT SATISFY MINIMUM WORKING CLEARANCES PER NEC 110.26.
2	24/7 UNESCORTED KEYLESS ACCESS SHALL BE PROVIDED TO ALL CITY OF FORT COLLINS - (CO) EQUIPMENT.
3	CONTRACTOR SHALL USE ONLY COMPONENTS LISTED BY A NATIONALLY RECOGNIZED TESTING LABORATORY FOR THE INTENDED USE.
4	CONTRACTOR IS RESPONSIBLE FOR FURNISHING ALL EQUIPMENT, CABLES, ADDITIONAL CONDUITS, RACEWAYS, AND OTHER ACCESSORIES NECESSARY FOR A COMPLETE AND OPERATIONAL PV SYSTEM.
5	ALL EMT CONDUIT FITTINGS SHALL BE LISTED AS WEATHERPROOF FITTINGS AND INSTALLED TO ENSURE A RAINTIGHT FIT, PER NEC 358.42.

1. (N) AC COMBINER (C1), OUTDOOR
2. (E) MAIN SERVICE PANEL (MSP), OUTDOOR
3. (N) VISIBLE-OPEN TYPE, LOCKABLE, READILY ACCESSIBLE, LABELED PV SYSTEM DISCONNECT LOCATED WITHIN 10 FT OF UTILITY METER (SW1), OUTDOOR
4. (E) UTILITY METER, OUTDOOR
5. (E) SUBPANEL (SP), OUTDOOR
6. (N) TRANSITION BOX (JB1), OUTDOOR, OUTPUT CIRCUIT CONDUCTORS SHALL BE RUN IN EMT CONDUIT THROUGH THE INTERIOR OF THE BUILDING
7. (N) PROPOSED ROOF-MOUNTED PHOTOVOLTAIC ARRAY. 7/12 (30.3°) SLOPED ROOF, 9 PV MODULES (BLACK FRAME, BLACK BACKSHEET), 181° AZIMUTH
8. ALL ARRAY CIRCUITS SHALL BE ROUTED THROUGH THE INTERIOR OF THE BUILDING, AND WHERE POSSIBLE, ALONG THE BOTTOM OF LOAD BEARING MEMBERS. NO CONDUIT SHALL BE INSTALLED ABOVE THE ROOF.

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SANDBOX SOLAR

GRID-TIED SOLAR POWER SYSTEM

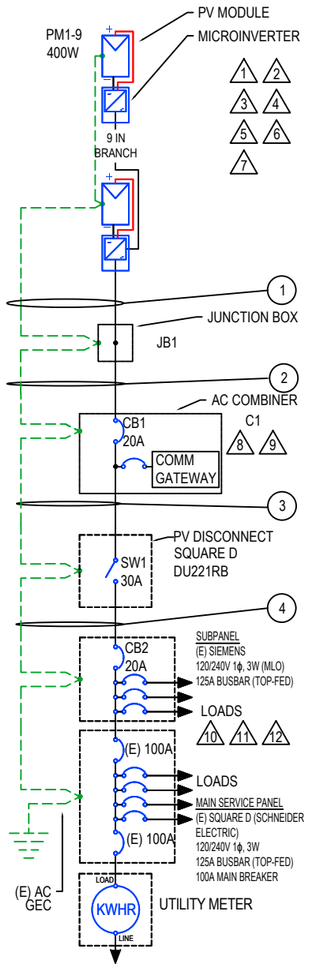
PARKER RESIDENCE
116 PEARL ST
FORT COLLINS, CO 80521

SITE PLAN

DOC ID: C34887-3
DATE: 10/25/22
CREATOR: I.S.
REVIEWER:

REVISIONS

PV-2



MODULES

REF.	QTY.	MAKE AND MODEL	PMAX	PTC	ISC	IMP	VOC	VMP	TEMP. COEFF. OF VOC	FUSE RATING
PM1-9	9	REC SOLAR REC400AA PURE	400W	381W	10.28A	9.51A	48.8V	42.1V	-0.1171V/°C (-0.24%/°C)	25A

INVERTERS

REF.	QTY.	MAKE AND MODEL	AC VOLTAGE	GROUND	RATED POWER	MAX OUTPUT CURRENT	MAX INPUT CURRENT	MAX INPUT VOLTAGE	CEC WEIGHTED EFFICIENCY
I1-9	9	ENPHASE IQ8A-72-2-US	240V	NOT SOLIDLY GROUNDED	349W	1.4A	15.0A	60V	97.0%

DISCONNECTS

REF.	QTY.	MAKE AND MODEL	RATED CURRENT	MAX RATED VOLTAGE
SW1	1	SQUARE D DU221RB OR EQUIV.	30A	240VAC

OCPDS

REF.	QTY.	RATED CURRENT	MAX VOLTAGE	AIC
CB1	1	20A	240VAC	10KA
CB2	1	20A	240VAC	10KA

PASS-THRU BOXES AND COMBINERS

REF.	QTY	MAKE AND MODEL	RATED CURRENT	MAX RATED VOLTAGE
JB1	1	TRANSITION BOX FOR 1 CIRCUIT	30A	240VAC / 600VDC
C1	1	ENPHASE IQ COMBINER 4C W/ IQ GATEWAY FOR PRODUCTION MONITORING	64A	240VAC

SYSTEM SUMMARY

INVERTERS PER BRANCH	9
MAX AC CURRENT	13.05A
MAX AC OUTPUT	3,141W
ARRAY STC POWER	3,600W
ARRAY PTC POWER	3,429W
MAX AC CURRENT	13A
MAX AC POWER OUTPUT	3,141W
DERATED AC POWER OUTPUT	3,141W

1. RAPID SHUTDOWN DEVICES COMPLIANT WITH REQUIREMENTS AS PER NEC 690.12(B)(2). PV CIRCUIT CONDUCTORS LOCATED OUTSIDE THE ARRAY BOUNDARY (DEFINED AS 3 FEET FROM THE POINT OF PENETRATION INTO A BUILDING OR MORE THAN 3 FEET FROM AN ARRAY) SHALL BE LIMITED TO NOT MORE THAN 30V WITHIN 30 SECONDS OF RAPID SHUTDOWN INITIATION. CONDUCTORS LOCATED INSIDE OF THE ARRAY BOUNDARY SHALL BE LIMITED TO NOT MORE THAN 80 VOLTS WITHIN 30 SECONDS OF SHUTDOWN.
2. ENPHASE SYSTEM MEETS REQUIREMENTS FOR PV HAZARD CONTROL SYSTEM, AS PER NEC 690.12(B)(2).
3. THE DC AND AC CONNECTORS OF THE ENPHASE IQ8A-72-2-US AND ARE LISTED TO MEET REQUIREMENTS AS A DISCONNECT MEANS AS ALLOWED BY NEC 690.15(C). MATING CONNECTORS SHALL COMPLY WITH NEC 690.33.
4. THE ENPHASE IQ8A-72-2-US HAS A CLASS II DOUBLE-INSULATED RATING AND DOES NOT REQUIRE GROUNDING ELECTRODE CONDUCTORS (GEC) OR EQUIPMENT GROUNDING CONDUCTORS (EGC). THE RATING INCLUDES GROUND FAULT PROTECTION (GFP). TO SUPPORT GFP, USE ONLY PV MODULES EQUIPPED WITH DC CABLES LABELED PV WIRE OR PV CABLE.
5. MICROINVERTER BRANCH CIRCUIT CONDUCTORS ARE MANUFACTURED ENPHASE Q CABLES LISTED FOR USE IN 20A OR LESS CIRCUITS OF ENPHASE IQ MICROINVERTERS. THEY ARE ROHS, OIL RESISTANT, AND UV RESISTANT. THEY CONTAIN TWO 12 AWG CONDUCTORS OF TYPE THHN/THWN-2 DRY/WET AND CERTIFIED TO UL 3003 AND UL 9703.
6. ALL METAL ENCLOSURES, RACEWAYS, CABLES AND EXPOSED NONCURRENT-CARRYING METAL PARTS OF EQUIPMENT SHALL BE GROUNDED TO EARTH AS REQUIRED BY NEC 250.4(B) AND PART III OF ARTICLE 250 AND DC EQUIPMENT GROUNDING CONDUCTORS SHALL BE SIZED ACCORDING TO NEC 690.45. THE GROUNDING ELECTRODE SYSTEM SHALL ADHERE TO NEC 690.47(A) AND NEC 250.169 AND INSTALLED IN COMPLIANCE WITH NEC 250.64.
7. MAX DC VOLTAGE OF PV MODULE IS EXPECTED TO BE 54.4V AT -23°C (-22.6°C - 25°C) X -0.117V/C + 48.8V = 54.4V).
8. AC AGGREGATION PANEL BUSBAR AND THE OVERCURRENT PROTECTION PROTECTING THE BUSBAR SHALL BE SIZED IN ACCORDANCE WITH NEC 705.12(B)(3)(3).
9. THE ENPHASE IQ COMBINER 4C CONTAINS A FACTORY-INSTALLED COMMUNICATIONS GATEWAY WITH AN OCPD RATED NO MORE THAN 20A.
10. POINT-OF-CONNECTION IS ON LOAD SIDE OF SERVICE DISCONNECT, IN COMPLIANCE WITH NEC 705.12(B)(3)(1). OUTPUT IS BACKFED THROUGH BREAKER IN SUBPANEL. THE SUM OF 125% OF POWER SOURCE(S) OUTPUT CURRENT (13A) AND THE MAIN BREAKER (100A) DOES NOT EXCEED THE BUSBAR RATING (125A). 16A + 100A <= 125A
11. PV SYSTEM DISCONNECT SHALL BE A VISIBLE KNIFE-BLADE TYPE DISCONNECT THAT IS ACCESSIBLE AND LOCKABLE BY THE UTILITY IN ACCORDANCE WITH NEC 690.13(E). THE DISCONNECT SHALL BE LOCATED WITHIN 10 FT OF UTILITY METER AND INSTALLED IN COMPLIANCE WITH NEC 705.20 AND GROUPED AS REQUIRED BY NEC 230.72.
12. PV SYSTEM DISCONNECT MEETS NEC 690.12(C) REQUIREMENT FOR A RAPID SHUTDOWN INITIATION DEVICE

CONDUCTOR AND CONDUIT SCHEDULE W/ELECTRICAL CALCULATIONS

ID	TYP	CONDUCTOR	CONDUIT / CABLE	CURRENT-CARRYING CONDUCTORS IN CONDUIT/CABLE.	OCPD	EGC	TEMP. CORR. FACTOR	FILL FACTOR	CONT. CURRENT	MAX. CURRENT (125%)	BASE AMP.	DERATED AMP.	TERM. TEMP. RATING	AMP. @ TERM. TEMP. RATING	LEN.	V.D.
1	1	12 AWG THHN/THWN-2 IN ENPHASE Q CABLE, COPPER	CABLE	2	20A	6 AWG BARE, COPPER	0.76 (55°C)	1.0	13.05A	16.31A	40A	30.4A	90°C	40A	59.1FT	1.27%
2	1	10 AWG THWN-2, COPPER	0.75" DIA. EMT	2	20A	10 AWG THWN-2, COPPER	0.76 (53°C)	1.0	13.05A	16.31A	40A	30.4A	90°C	40A	92.4FT	1.25%
3	1	10 AWG THWN-2, COPPER	0.75" DIA. EMT	2	20A	10 AWG THWN-2, COPPER	0.96 (33°C)	1.0	13.05A	16.31A	40A	38.4A	75°C	35A	48IN	0.05%
4	1	10 AWG THWN-2, COPPER	0.75" DIA. EMT	2	20A	10 AWG THWN-2, COPPER	0.96 (33°C)	1.0	13.05A	16.31A	40A	38.4A	75°C	35A	57.2FT	0.77%

GENERAL ELECTRICAL NOTES

1. UTILITY HAS 24-HR UNRESTRICTED ACCESS TO ALL PHOTOVOLTAIC SYSTEM COMPONENTS LOCATED AT THE SERVICE ENTRANCE.
2. CONDUCTORS EXPOSED TO SUNLIGHT SHALL BE LISTED AS SUNLIGHT RESISTANT PER NEC ARTICLE 300.6 (C) (1) AND ARTICLE 310.10 (D).
3. CONDUCTORS EXPOSED TO WET LOCATIONS SHALL BE SUITABLE FOR USE IN WET LOCATIONS PER NEC ARTICLE 310.10 (C).

GROUNDING NOTES

1. ALL EQUIPMENT SHALL BE PROPERLY GROUNDED PER THE REQUIREMENTS OF NEC ARTICLES 250 & 690
2. PV MODULES SHALL BE GROUNDED TO MOUNTING RAILS USING MODULE LUGS OR RACKING INTEGRATED GROUNDING CLAMPS AS ALLOWED BY LOCAL JURISDICTION. ALL OTHER EXPOSED METAL PARTS SHALL BE GROUNDED USING UL-LISTED LAY-IN LUGS.
3. INSTALLER SHALL CONFIRM THAT MOUNTING SYSTEM HAS BEEN EVALUATED FOR COMPLIANCE WITH UL 2703 "GROUNDING AND BONDING" WHEN USED WITH PROPOSED PV MODULE.
4. IF THE EXISTING MAIN SERVICE PANEL DOES NOT HAVE A VERIFIABLE GROUNDING ELECTRODE, IT IS THE CONTRACTOR'S RESPONSIBILITY TO INSTALL A SUPPLEMENTAL GROUNDING ELECTRODE.
5. AC SYSTEM GROUNDING ELECTRODE CONDUCTOR (GEC) SHALL BE A MINIMUM SIZE #8AWG WHEN INSULATED, #6AWG IF BARE WIRE.
6. EQUIPMENT GROUNDING CONDUCTORS SHALL BE SIZED ACCORDING TO NEC ARTICLE 690.45, AND BE A MINIMUM OF #10AWG WHEN NOT EXPOSED TO DAMAGE, AND #6AWG SHALL BE USED WHEN EXPOSED TO DAMAGE
7. GROUNDING AND BONDING CONDUCTORS, IF INSULATED, SHALL BE COLOR CODED GREEN, OR MARKED GREEN IF #4AWG OR LARGER

1 / PV-3 SINGLE-LINE DIAGRAM
SCALE: NTS

1530

SANDBOX SOLAR

GRID-TIED SOLAR POWER SYSTEM

PARKER RESIDENCE
116 PEARL ST
FORT COLLINS, CO 80521

SINGLE-LINE DIAGRAM

PROJECT ID: C34887-3
DATE: 10/25/22
CREATED BY: I.S.
CHECKED BY:

REVISIONS

PV-3

C1 - AC COMBINER
(ENPHASE IQ COMBINER 4C)
3

SW1 - DISCONNECT
(SQUARE D DU221RB)
4 5 6 7

CB2
(MODEL NOT SPECIFIED)
5 6 7

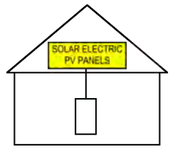
MSP - MAIN SERVICE PANEL
(SQUARE D (SCHNEIDER ELECTRIC))
1 2 8

SP - SUBPANEL
(SIEMENS)
8

1 SEE NOTE NO. 4 (MSP)

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.



NEC690.56(C)(1) AND IFC1205.4.1

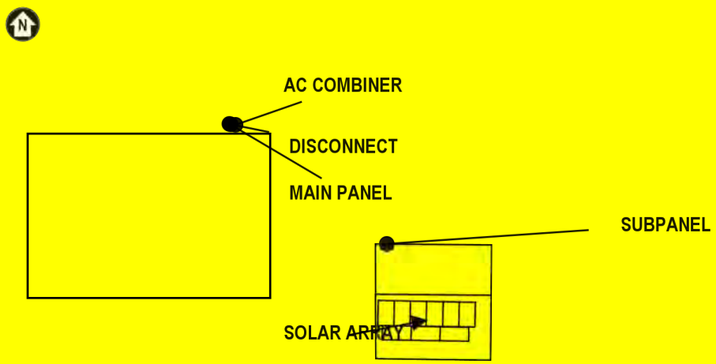
3 AC COMBINER PANEL (C1)

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

NEC705.12(B)(3)(3)

2 POINT-OF-INTERCONNECTION OR AT MAIN SERVICE DISCONNECT (MSP)

! CAUTION: MULTIPLE SOURCES OF POWER !
POWER TO THIS BUILDING IS ALSO SUPPLIED FROM A ROOF-MOUNTED SOLAR ARRAY WITH SAFETY DISCONNECTS AS SHOWN



INSTALLED BY SANDBOX SOLAR • (970) 673-7733

NEC690.56(B),705.10

4 SEE NOTE NO. 5 (SW1)

RAPID SHUTDOWN SWITCH FOR SOLAR PV SYSTEM

NEC690.56(C)(3) AND IFC1205.4.3

5 AC DISCONNECT (SW1, CB2 IN SP)

MAXIMUM AC OPERATING CURRENT: 13.1A
MAXIMUM AC OPERATING VOLTAGE: 240V

NEC690.54

6 EACH DISCONNECTING MEANS FOR PHOTOVOLTAIC EQUIPMENT (SW1, CB2 IN SP)

! WARNING !
ELECTRIC SHOCK HAZARD. TERMINALS ON BOTH LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION.

NEC690.13(B)

7 AC SOLAR DISCONNECT (SW1, CB2 IN SP)

PV SYSTEM DISCONNECT

NEC690.13(B)

8 ANY AC ELECTRICAL PANEL THAT IS FED BY BOTH THE UTILITY AND THE PHOTOVOLTAIC SYSTEM (MSP, SP)

! CAUTION !
MULTIPLE SOURCES OF POWER

NEC705.10

LABELING NOTES

1	ALL PLAQUES AND SIGNAGE REQUIRED BY 2020 NEC AND 2021 IFC WILL BE INSTALLED AS REQUIRED.
2	LABELS, WARNING(S) AND MARKING SHALL COMPLY WITH ANSI Z535.4, WHICH REQUIRES THAT DANGER, WARNING, AND CAUTION SIGNS USED THE STANDARD HEADER COLORS, HEADER TEXT, AND SAFETY ALERT SYMBOL ON EACH LABEL. THE ANSI STANDARD REQUIRES A HEADING THAT IS AT LEAST 50% TALLER THAN THE BODY TEXT, IN ACCORDANCE WITH NEC 110.21(B).
3	A PERMANENT PLAQUE OR DIRECTORY SHALL BE INSTALLED PROVIDING THE LOCATION OF THE SERVICE DISCONNECTING MEANS AND THE PHOTOVOLTAIC SYSTEM DISCONNECTING MEANS IF NOT IN THE SAME LOCATION IN ACCORDANCE WITH NEC 690.56(B).
4	LABEL(S) WITH MARKING, "TURN RAPID SHUTDOWN SWITCH TO THE 'OFF' POSITION TO SHUT DOWN PV SYSTEM AND REDUCE SHOCK HAZARD IN THE ARRAY," SHALL BE LOCATED WITHIN 3 FT OF SERVICE DISCONNECTING MEANS THE TITLE SHALL UTILIZE CAPITALIZED LETTERS WITH A MINIMUM HEIGHT OF 3/8" IN BLACK ON A YELLOW BACKGROUND, AND REMAINING TEXT SHALL BE CAPITALIZED WITH A MINIMUM HEIGHT OF 3/16" IN BLACK ON WHITE BACKGROUND
5	LABEL(S) WITH MARKING, "RAPID SHUTDOWN SWITCH FOR SOLAR PV SYSTEM," SHALL BE LOCATED WITHIN 3 FT OF RAPID SHUTDOWN SWITCH THE LABEL SHALL HAVE 3/8" TALL LETTERS AND BE REFLECTIVE WITH WHITE TEXT ON A RED BACKGROUND

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SANDBOX SOLAR

GRID-TIED SOLAR POWER SYSTEM

PARKER RESIDENCE
116 PEARL ST
FORT COLLINS, CO 80521

SAFETY LABELS

DOC ID: C34887-3
DATE: 10/25/22
CREATOR: I.S.
REVIEWER:

REVISIONS

PV-4

STRUCTURAL DESIGN PARAMETERS	
ELEVATION	5028 FT
SEISMIC	0.213 S_{DS}
WIND (ASCE 7-16)	140 MPH, EXPOSURE CATEGORY C, RISK CATEGORY II
GROUND SNOW LOAD	35 PSF

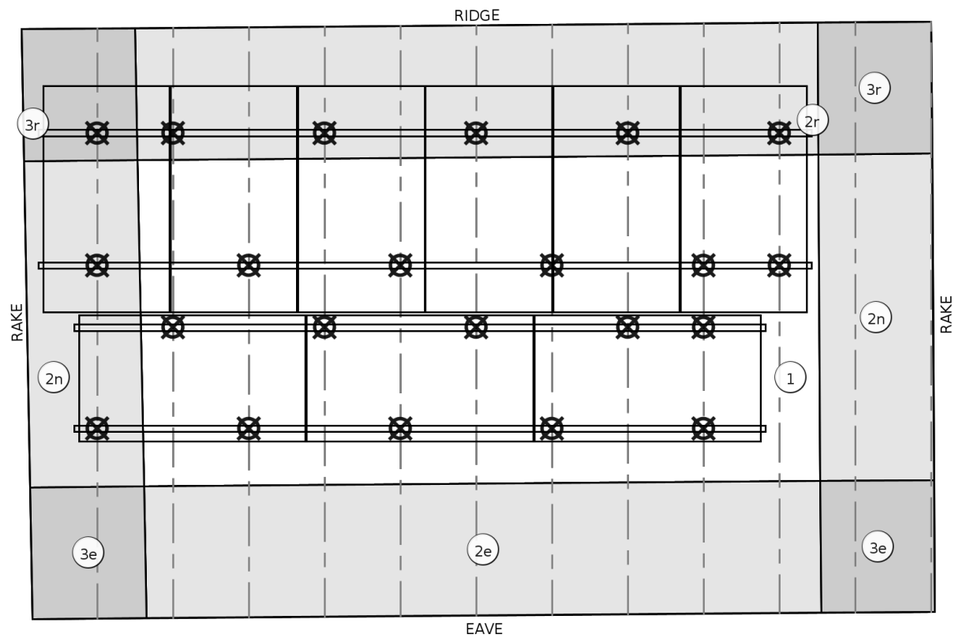
ROOF PROPERTIES	
ROOF MATERIAL	COMPOSITION SHINGLE (1 LAYER)
SLOPE	7/12 (30.3°)
MEAN ROOF HEIGHT	14FT
ROOF DECKING	15/32" OSB
CONSTRUCTION	TRUSSES (2X8 TOP-CHORD), 24IN OC

MODULE MECHANICAL PROPERTIES	
MODEL	REC SOLAR REC400AA PURE
DIMENSIONS (AREA)	71.7IN X 40.0IN X 1.2IN (19.9 SQ FT)
WEIGHT	45.2LB

MOUNTING SYSTEM PROPERTIES	
RAIL MODEL	IRONRIDGE XR100
ANCHOR MODEL	UNIRAC 004085D, 2.5IN AIR GAP
FASTENING METHOD	2.5 INCH EMBEDMENT INTO TRUSSES WITH (1) 5/16IN DIA. FASTENER
GROUNDING AND BONDING	INTEGRAL GROUNDING CERTIFIED TO UL 2703 REQUIREMENTS

DEAD LOAD CALCULATIONS			
LOAD	QTY	LBS	TOTAL LBS
MODULES	9	45.2	406.8
MICROINVERTERS	9	1.1	9.7
LINEAR FEET OF RAIL	77 FT	0.7	52.6
ANCHORS	22	0.2	5.5
MISC. HARDWARE		9.4	9.4
TOTAL ARRAY WEIGHT			483.9 LBS
AREA NAME	QTY	SQFT	TOTAL SQFT
MODULES	9	19.9	179.1
POINT LOAD (483.9 LBS / 22 ATTACHMENTS)			22.0 LBS
DIST. LOAD (483.9 LBS / 179.1 SQFT)			2.7 PSF

NOTES	
1	TRUSS LOCATIONS ARE APPROXIMATE. CONTRACTOR MAY NEED TO MAKE MINOR ADJUSTMENTS TO ANCHOR LOCATIONS. IN NO CASE SHALL THE ANCHOR SPACING EXCEED "MAX. ANCHOR SPACING"



ANCHOR PLACEMENT PARAMETERS (ASCE 7-16)				
WIND PRESSURE ZONE	MODULE WIND EXPOSURE	MAX. ALLOWABLE RAIL SPAN	MAX. ANCHOR SPACING	MAX. ALLOWABLE CANTILEVER
ZONES 1, 2N, 2R, 3R	NORMAL	81.0IN	48.0IN	32.4IN

DISTANCE α IS EQUAL TO 10% OF THE BUILDING'S LEAST HORIZONTAL DIMENSION ("LHD") OR 40% OF THE MEAN ROOF HEIGHT, WHICHEVER IS SMALLER, BUT NOT LESS THAN 4% OF THE LHD OR 3 FT. THESE SETBACKS ARE APPLIED TO THE BUILDING FOOTPRINT AND PROJECTED TO THE ROOF PLANES IN ACCORDANCE WITH GUIDANCE PROVIDED BY ASCE 7-16 FIGURES 30.3-2B–I.

α = MAX(MIN(0.4 * MEAN ROOF HEIGHT, 0.1 * LHD), 0.04 * LHD, 3 FT)

3.0 FT = MAX(MIN(0.4 * 14.0 FT, 0.1 * 23.9 FT), 0.04 * 23.9 FT, 3 FT)

1 / PV-5 ATTACHMENT PLAN (ORTHOGONAL PROJECTION)
SCALE: 1/4" = 1'

1530

SANDBOX SOLAR

GRID-TIED SOLAR POWER SYSTEM

PARKER RESIDENCE
116 PEARL ST
FORT COLLINS, CO 80521

COLORADO LICENSED
ARASH ZANDIEH
53832
PROFESSIONAL ENGINEER
Exp. 10/31/2023

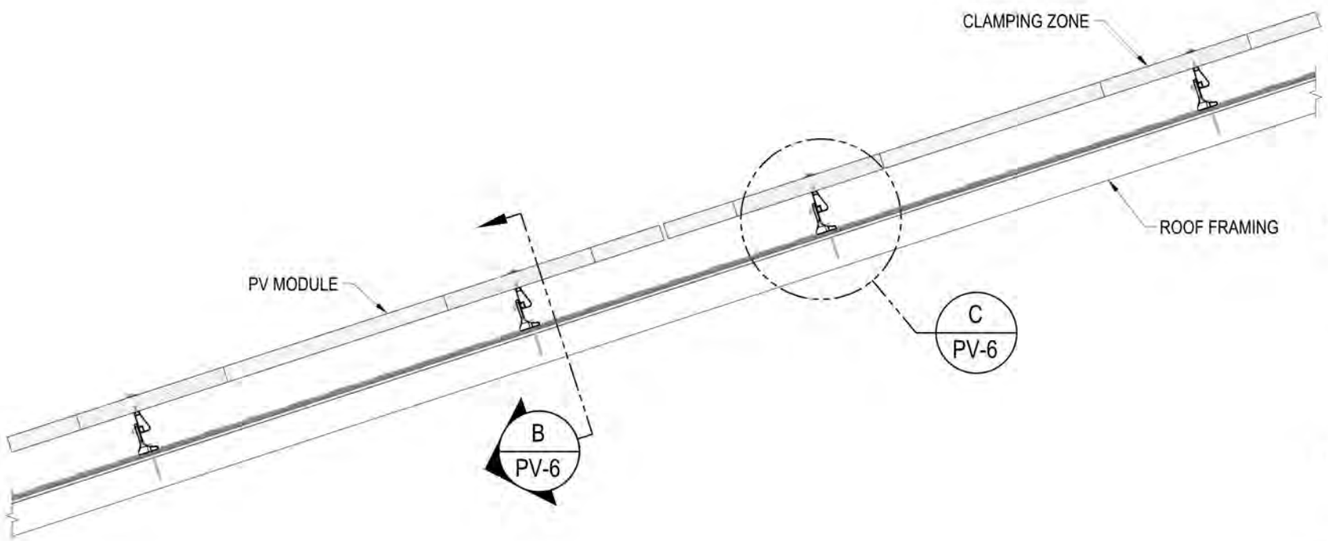
ATTACHMENT PLAN

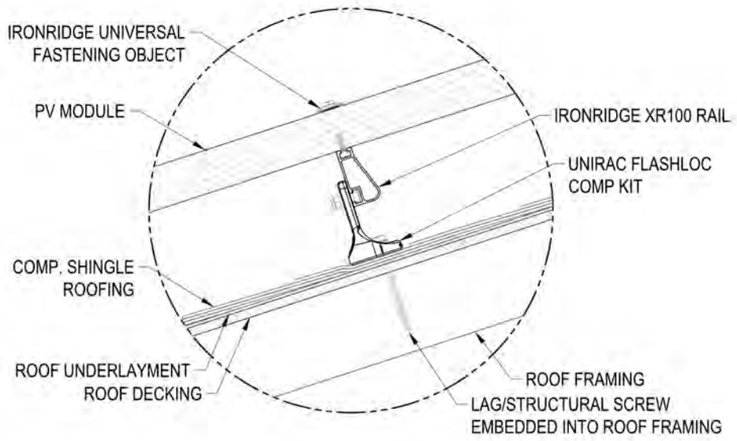
DOC ID: C34887-3
DATE: 10/25/22
CREATOR: I.S.
REVIEWER:

REVISIONS

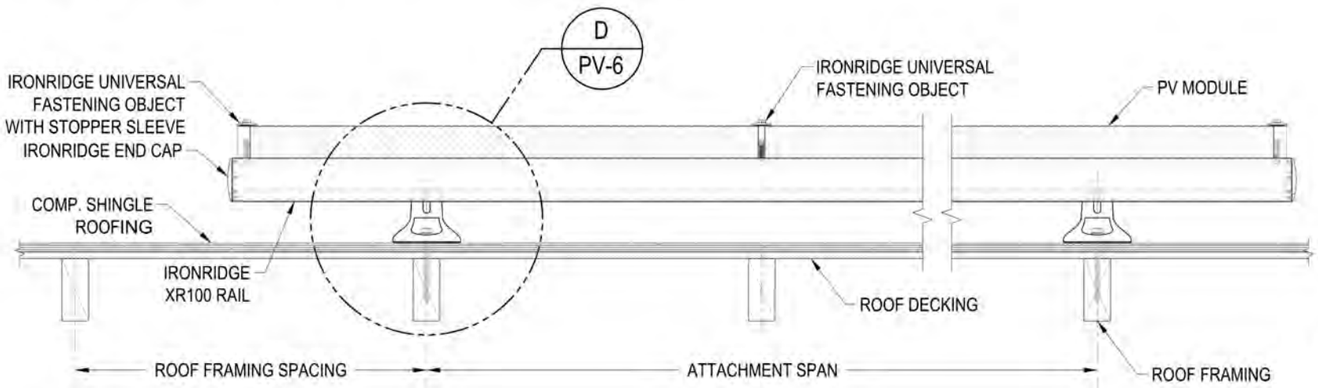
PV-5

MOUNTING SYSTEM NOTES	
1	FLASHING SHALL BE APPLIED IN ACCORDANCE WITH MANUFACTURERS' INSTRUCTIONS.
2	IF THERE IS ANY CONFLICT BETWEEN WHAT IS DEPICTED HERE AND INSTRUCTIONS PROVIDED BY A MANUFACTURER, THE MANUFACTURER'S INSTRUCTIONS SHALL SUPERCEDE.



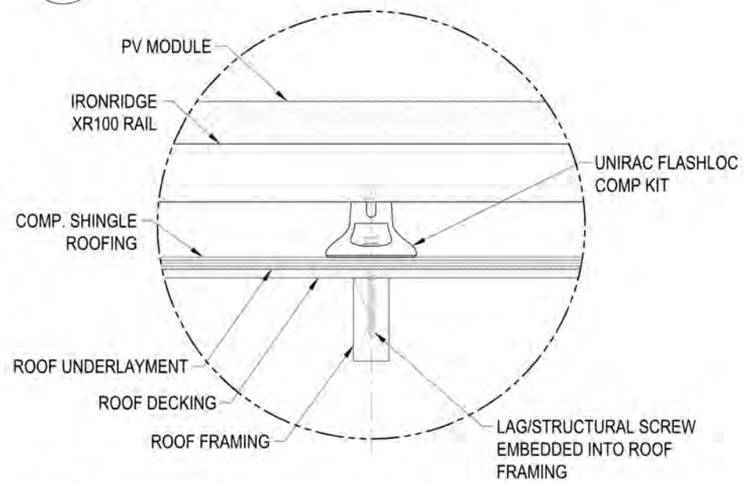


A PV-6 RACKING ELEVATION (TRANSVERSE VIEW)
SCALE: NTS



B PV-6 RACKING ELEVATION (LONGITUDINAL VIEW)
SCALE: NTS

C PV-6 ATTACHMENT DETAIL (TRANSVERSE VIEW)
SCALE: NTS



D PV-6 ATTACHMENT DETAIL (LONGITUDINAL VIEW)
SCALE: NTS

1530

SANDBOX SOLAR

GRID-TIED SOLAR POWER SYSTEM

PARKER RESIDENCE
116 PEARL ST
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ATTACHMENT DETAILS

DOC ID: C34887-3
DATE: 10/25/22
CREATOR: I.S.
REVIEWER:

REVISIONS

PV-6

1 FIRE SAFETY PLAN
PV-7 SCALE: 1" = 20'

GENERAL NOTES	
1	AT LEAST TWO 3'-WIDE PATHWAYS ON SEPARATE ROOF PLANES, FROM LOWEST ROOF EDGE TO RIDGE, SHALL BE PROVIDED ON ALL BUILDINGS, WITH AT LEAST ONE PATHWAY ON THE STREET OR DRIVEWAY SIDE OF THE ROOF. FOR EACH ROOF PLANE WITH A PV ARRAY, AT LEAST ONE SUCH PATHWAY FROM LOWEST ROOF EDGE TO RIDGE SHALL BE PROVIDED ON THE SAME ROOF PLANE, OR ON AN ADJACENT ROOF PLANE, OR STRADDLING THE SAME AND ADJACENT ROOF PLANES. (IFC 1205.2.1.1)
2	FOR PV ARRAYS OCCUPYING 33% OR LESS OF THE PLAN VIEW TOTAL ROOF AREA, A MIN. 18"-WIDE SETBACK IS REQUIRED ON BOTH SIDES OF A HORIZONTAL RIDGE. (IFC 1205.2.1.2)
3	PV MODULES SHALL NOT BE PLACED BELOW AN EMERGENCY ESCAPE/RESCUE OPENING. A MIN. 3'-WIDE PATHWAY SHALL BE PROVIDED TO SUCH AN OPENING. (IFC 1205.2.2)
4	ROOF FACES WITH NO PV ARE DESIGNATED FOR FIRE VENTILATION AND ACCESS

1 1.5' WIDE SMOKE-VENTILATION SETBACK, PER IFC 1205.2.1.2

2 3.0' WIDE FIRE ACCESS PATHWAY, PER IFC 1205.2.1.1

3 ROOF ACCESS POINT

4 PV MODULES INSTALLED ON ROOF WITH IRONRIDGE ROOF MOUNTING SYSTEM. THE MOUNTING SYSTEM IS UL 2703 CLASS A FIRE RATED ON THIS STEEP-SLOPED ROOF WHEN INSTALLED WITH TYPE 1 OR 2 MODULES. THE REC SOLAR REC400AA PURE IS UL 61730-1 CERTIFIED TYPE 2.

5 BUILDING IS GROUP R3

6 TOTAL PLAN VIEW ARRAY AREA IS 154.8 SQ.FT, WHICH REPRESENTS 27.0% OF TOTAL PLAN VIEW ROOF AREA (573.1 SQ.FT)

7 THIS SYSTEM UTILIZES MICROINVERTERS. THERE ARE NO DC CIRCUITS OUTSIDE OF THE ARRAY PERIMETER OR INSIDE THE BUILDING.

8 ALL ARRAY CIRCUITS SHALL BE ROUTED THROUGH THE INTERIOR OF THE BUILDING, AND WHERE POSSIBLE, ALONG THE BOTTOM OF LOAD BEARING MEMBERS. NO CONDUIT SHALL BE INSTALLED ABOVE THE ROOF.

1530

SANDBOX SOLAR

GRID-TIED SOLAR POWER SYSTEM

PARKER RESIDENCE
116 PEARL ST
FORT COLLINS, CO 80521

FIRE SAFETY PLAN

DOC ID: C34887-3
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REVIEWER:

REVISIONS

PV-7

Conductor, Conduit, and OCPD Sizing Validation

1. Maximum System DC Voltage Test

1.1. Enphase microinverter system w/9 REC Solar REC400AA Pure (400W)s

Array Properties

Array Type	Microinverter Array
System Description	Enphase microinverter system w/9 REC Solar REC400AA Pure (400W)s
Module	REC400AA Pure (400W)
Highest number of modules in series in a PV Source Circuit	1
Design Low Temp.	-22.6°C
Module voc	48.8V
Temp. Coefficient voc	-0.117V/C

NEC Code Validation Tests

1.	PV Source Circuit maximum Voc must not exceed 600V 54.37V < 600V = true	***PASS***

NEC Code Calculations

A. Maximum Voltage of PV Source Circuit 54.37V
see 690.7(A)

NEC 690.7(A) requires that if the PV module manufacturer provides a temperature coefficient of open-circuit voltage, it must be used to calculate the PV array's maximum system voltage. It includes an information note recommending the use of the ASHRAE 'Extreme Annual Mean Minimum Design Dry Bulb Temperature' as the design low temperature. Using these values, the module Voc (48.8V) will increase to 54.37V at the design low temperature (-22.6°C).

(-22.6°C - 25°C) X -0.117V/C + 48.8V = 54.37V
The module Voc at the design low temperature is 54.37V.

54.37V X 1 = 54.37V

2. Wire, Conduit, and OCPD Code Compliance Validation

2.1. #1: Branch cables: Microinverter to Transition Box

Circuit Section Properties

Conductor	12 AWG THHN/THWN-2 in Enphase Q Cable, Copper
Equipment Ground Conductor (EGC)	6 AWG Bare, Copper
OCPD(s)	20A
Raceway/Cable	Cable
Lowest Terminal Temperature Rating	90°C
Maximum Wire Temperature	55°C
Power Source Description	Branch of 9 IQ8A-72-2-US microinverters
Power Source Current	13.05A
Voltage	240V

NEC Code Calculations

A. Continuous Current 13.05A
see Article 100

Equipment maximum rated output current is 9 X 1.45A = 13.05A

B. Ampacity of Conductor 30A
see Table 310.15(B)(16)

Ampacity (30°C) for a copper conductor with 90°C insulation in conduit/cable is 30A.

C. Derated Ampacity of Conductor 23A
see Table 310.15(B)(3)(c), Table 310.15(B)(3)(a), and Article 100

The temperature factor for 90°C insulation at 55°C is 0.76.
The fill factor for a conduit/cable that has 2 wires is 1.
The ampacity derated for Conditions of Use is the product of the conductor ampacity (30A) multiplied by the temperature factor (0.76) and by the fill factor (1).

30A X 0.76 X 1 = 22.8A rounded to 23A

D. Max Current for Terminal Temp. Rating 30A
see 110.14(C)

The lowest temperature rating for this conductor at any termination is 90°C.
Using the method specified in 110.14(C), the maximum current permitted to ensure that the device terminal temperature does not exceed its 90°C rating would be the amount referenced in the 90°C column in Table 310.15(B)(16), which is 30A.

E. Minimum Allowed OCPD Rating 16A
see 240.4

NEC 690.9(B) requires that the OCPD be rated for no less than 1.25 times the Continuous Current of the circuit.

13.05A X 1.25 = 16.31A rounded down to 16A

F. Maximum Allowed OCPD Rating 20A
see 240.4(D)

NEC 240.4(D) requires that OCPD rating not exceed 20A when protecting a Copper 12 AWG conductor.

G. Minimum Required EGC Size 12 AWG
see Table 250.122

The smallest EGC size allowed is 12 AWG for OCPD rating 20A according to Table 250.122.

NEC Code Validation Tests

1.	OCPD rating must be at least 125% of Continuous Current (240.4) 20A >= 13.05A X 1.25 = true	***PASS***
2.	Derated ampacity must exceed OCPD rating, or rating of next smaller OCPD (240.4) 23A >= 20A (OCPD Rating) = true	***PASS***
3.	OCPD rating must not exceed max OCPD rating for conductor (240.4) 20 (OCPD Rating) <= 20A = true	***PASS***
4.	Derated Ampacity must be greater than or equal to the Continuous Current (Article 100) 23A >= 13.05A = true	***PASS***
5.	Conductor Ampacity must be at least 125% of Continuous Current (215.2(A)(1)) 30A > 13.05A x 1.25 = true	***PASS***
6.	Max current for terminal must be at least 125% of the Continuous Current. (110.14(C)) 30A >= 13.05A X 1.25 = true	***PASS***
7.	EGC must meet code requirements for minimum size (Table 250.122) 6 AWG >= 12 AWG = true	***PASS***

2.2. #2: AC Branch Output: Transition Box to AC Combiner

Circuit Section Properties

Conductor	10 AWG THWN-2, Copper
Equipment Ground Conductor (EGC)	10 AWG THWN-2, Copper
OCPD(s)	20A
Raceway/Cable	0.75" dia. EMT
Lowest Terminal Temperature Rating	90°C
Maximum Wire Temperature	53°C
Power Source Description	Branch of 9 IQ8A-72-2-US microinverters
Power Source Current	13.05A
Voltage	240V

NEC Code Calculations

A. Continuous Current 13.05A
see Article 100

Equipment maximum rated output current is 9 X 1.45A = 13.05A

B. Ampacity of Conductor 40A
see Table 310.15(B)(16)

Ampacity (30°C) for a copper conductor with 90°C insulation in conduit/cable is 40A.

C. Derated Ampacity of Conductor 30.4A
see Table 310.15(B)(3)(c), Table 310.15(B)(3)(a), and Article 100

The temperature factor for 90°C insulation at 53°C is 0.76.
The fill factor for a conduit/cable that has 2 wires is 1.
The ampacity derated for Conditions of Use is the product of the conductor ampacity (40A) multiplied by the temperature factor (0.76) and by the fill factor (1).

40A X 0.76 X 1 = 30.4A

D. Max Current for Terminal Temp. Rating 40A
see 110.14(C)

The lowest temperature rating for this conductor at any termination is 90°C.
Using the method specified in 110.14(C), the maximum current permitted to ensure that the device terminal temperature does not exceed its 90°C rating would be the amount referenced in the 90°C column in Table 310.15(B)(16), which is 40A.

E. Minimum Allowed OCPD Rating 16A
see 240.4

NEC 690.9(B) requires that the OCPD be rated for no less than 1.25 times the Continuous Current of the circuit.

13.05A X 1.25 = 16.31A rounded down to 16A

F. Maximum Allowed OCPD Rating 30A
see 240.4(D)

NEC 240.4(D) requires that OCPD rating not exceed 30A when protecting a Copper 10 AWG conductor.

G. Minimum Required EGC Size 12 AWG
see Table 250.122 and 690.45

The smallest EGC size allowed is 12 AWG for OCPD rating 20A according to Table 250.122.
According to 690.45, it is not necessary to increase the size of the PV array's EGC when conductors are oversized for voltage drop considerations.

H. Minimum Recommended Conduit Size 0.5" dia.
see 300.17

The total area of all conductors is 0.0633in². With a maximum fill rate of 0.4, the recommended conduit diameter is 0.5.

Qty	Description	Size	Type	Area	Total Area
2	Conductor	10 AWG	THWN-2	0.0211in²	0.0422in²
1	Equipment Ground	10 AWG	THWN-2	0.0211in²	0.0211in²
3					0.0633in²

0.0633in² / 0.4 = 0.1583in² (Corresponding to a diameter of 0.5")

NEC Code Validation Tests

1.	OCPD rating must be at least 125% of Continuous Current (240.4) 20A >= 13.05A X 1.25 = true	PASS
2.	Derated ampacity must exceed OCPD rating, or rating of next smaller OCPD (240.4) 30.4A >= 20A (OCPD Rating) = true	PASS
3.	OCPD rating must not exceed max OCPD rating for conductor (240.4) 20 (OCPD Rating) <= 30A = true	PASS
4.	Derated Ampacity must be greater than or equal to the Continuous Current (Article 100) 30.4A >= 13.05A = true	PASS
5.	Conductor Ampacity must be at least 125% of Continuous Current (215.2(A)(1)) 40A > 13.05A x 1.25 = true	PASS
6.	Max current for terminal must be at least 125% of the Continuous Current. (110.14(C)) 40A >= 13.05A X 1.25 = true	PASS
7.	EGC must meet code requirements for minimum size (Table 250.122) 10 AWG >= 12 AWG = true	PASS
8.	Conduit must meet code recommendation for minimum size (300.17) 0.75in. >= 0.5in. = true	PASS

2.3. #3: AC Combiner Output: AC Combiner to Utility Disconnect

Circuit Section Properties

Conductor	10 AWG THWN-2, Copper
Equipment Ground Conductor (EGC)	10 AWG THWN-2, Copper
OCPD(s)	20A
Raceway/Cable	0.75" dia. EMT
Lowest Terminal Temperature Rating	75°C
Maximum Wire Temperature	33°C
Power Source Description	Enphase microinverter system w/9 REC Solar REC400AA Pure (400W)s
Power Source Current	13.05A
Voltage	240V

NEC Code Calculations

A. Continuous Current 13.05A
see Article 100

Equipment maximum rated output current is 13.05A

B. Ampacity of Conductor 40A
see Table 310.15(B)(16)

Ampacity (30°C) for a copper conductor with 90°C insulation in conduit/cable is 40A.

C. Derated Ampacity of Conductor 38.4A
see Table 310.15(B)(3)(c), Table 310.15(B)(3)(a), and Article 100

The temperature factor for 90°C insulation at 33°C is 0.96.
The fill factor for a conduit/cable that has 2 wires is 1.
The ampacity derated for Conditions of Use is the product of the conductor ampacity (40A) multiplied by the temperature factor (0.96) and by the fill factor (1).

40A X 0.96 X 1 = 38.4A

D. Max Current for Terminal Temp. Rating 35A
see 110.14(C)

The lowest temperature rating for this conductor at any termination is 75°C.
Using the method specified in 110.14(C), the maximum current permitted to ensure that the device terminal temperature does not exceed its 75°C rating would be the amount referenced in the 75°C column in Table 310.15(B)(16), which is 35A.

E. Minimum Allowed OCPD Rating 16A
see 240.4

NEC 690.9(B) requires that the OCPD be rated for no less than 1.25 times the Continuous Current of the circuit.

13.05A X 1.25 = 16.31A rounded down to 16A

F. Maximum Allowed OCPD Rating 30A
see 240.4(D)

NEC 240.4(D) requires that OCPD rating not exceed 30A when protecting a Copper 10 AWG conductor.

G. Minimum Required EGC Size 12 AWG
see Table 250.122 and 690.45

The smallest EGC size allowed is 12 AWG for OCPD rating 20A according to Table 250.122.
According to 690.45, it is not necessary to increase the size of the PV array's EGC when conductors are oversized for voltage drop considerations.

H. Minimum Recommended Conduit Size 0.5" dia.
see 300.17

The total area of all conductors is 0.0633in². With a maximum fill rate of 0.4, the recommended conduit diameter is 0.5.

Qty	Description	Size	Type	Area	Total Area
2	Conductor	10 AWG	THWN-2	0.0211in²	0.0422in²
1	Equipment Ground	10 AWG	THWN-2	0.0211in²	0.0211in²
3					0.0633in²

0.0633in² / 0.4 = 0.1583in² (Corresponding to a diameter of 0.5")

NEC Code Validation Tests

1.	OCPD rating must be at least 125% of Continuous Current (240.4) 20A >= 13.05A X 1.25 = true	PASS
2.	Derated ampacity must exceed OCPD rating, or rating of next smaller OCPD (240.4) 38.4A >= 20A (OCPD Rating) = true	PASS
3.	OCPD rating must not exceed max OCPD rating for conductor (240.4) 20 (OCPD Rating) <= 30A = true	PASS
4.	Derated Ampacity must be greater than or equal to the Continuous Current (Article 100) 38.4A >= 13.05A = true	PASS
5.	Conductor Ampacity must be at least 125% of Continuous Current (215.2(A)(1)) 40A > 13.05A x 1.25 = true	PASS
6.	Max current for terminal must be at least 125% of the Continuous Current. (110.14(C)) 35A >= 13.05A X 1.25 = true	PASS
7.	EGC must meet code requirements for minimum size (Table 250.122) 10 AWG >= 12 AWG = true	PASS
8.	Conduit must meet code recommendation for minimum size (300.17) 0.75in. >= 0.5in. = true	PASS

2.4. #4: Utility Disconnect Output: Utility Disconnect to subpanel

Circuit Section Properties

Conductor	10 AWG THWN-2, Copper
Equipment Ground Conductor (EGC)	10 AWG THWN-2, Copper
OCPD(s)	20A
Raceway/Cable	0.75" dia. EMT
Lowest Terminal Temperature Rating	75°C
Maximum Wire Temperature	33°C
Power Source Description	Enphase microinverter system w/9 REC Solar REC400AA Pure (400W)s
Power Source Current	13.05A
Voltage	240V

NEC Code Calculations

A. Continuous Current 13.05A
see Article 100

Equipment maximum rated output current is 13.05A

B. Ampacity of Conductor 40A
see Table 310.15(B)(16)

Ampacity (30°C) for a copper conductor with 90°C insulation in conduit/cable is 40A.

C. Derated Ampacity of Conductor 38.4A
see Table 310.15(B)(3)(c), Table 310.15(B)(3)(a), and Article 100

The temperature factor for 90°C insulation at 33°C is 0.96.
The fill factor for a conduit/cable that has 2 wires is 1.
The ampacity derated for Conditions of Use is the product of the conductor ampacity (40A) multiplied by the temperature factor (0.96) and by the fill factor (1).

40A X 0.96 X 1 = 38.4A

D. Max Current for Terminal Temp. Rating 35A
see 110.14(C)

The lowest temperature rating for this conductor at any termination is 75°C.
Using the method specified in 110.14(C), the maximum current permitted to ensure that the device terminal temperature does not exceed its 75°C rating would be the amount referenced in the 75°C column in Table 310.15(B)(16), which is 35A.

E. Minimum Allowed OCPD Rating 16A
see 240.4

NEC 690.9(B) requires that the OCPD be rated for no less than 1.25 times the Continuous Current of the circuit.

13.05A X 1.25 = 16.31A rounded down to 16A

F. Maximum Allowed OCPD Rating 30A
see 240.4(D)

NEC 240.4(D) requires that OCPD rating not exceed 30A when protecting a Copper 10 AWG conductor.

G. Minimum Required EGC Size 12 AWG
see Table 250.122 and 690.45

The smallest EGC size allowed is 12 AWG for OCPD rating 20A according to Table 250.122.
According to 690.45, it is not necessary to increase the size of the PV array's EGC when conductors are oversized for voltage drop considerations.

H. Minimum Recommended Conduit Size 0.5" dia.
see 300.17

The total area of all conductors is 0.0999in². With a maximum fill rate of 0.4, the recommended conduit diameter is 0.5.

Qty	Description	Size	Type	Area	Total Area
2	Conductor	10 AWG	THWN-2	0.0211in²	0.0422in²
1	Neutral	8 AWG	THWN-2	0.0366in²	0.0366in²
1	Equipment Ground	10 AWG	THWN-2	0.0211in²	0.0211in²
4					0.0999in²

0.0999in² / 0.4 = 0.2498in² (Corresponding to a diameter of 0.5")

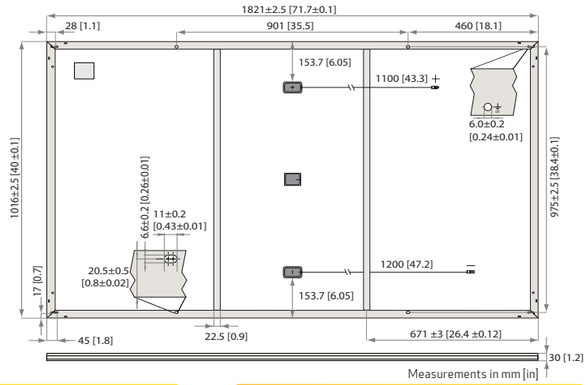
NEC Code Validation Tests

1.	OCPD rating must be at least 125% of Continuous Current (240.4) 20A >= 13.05A X 1.25 = true	PASS
2.	Derated ampacity must exceed OCPD rating, or rating of next smaller OCPD (240.4) 38.4A >= 20A (OCPD Rating) = true	PASS
3.	OCPD rating must not exceed max OCPD rating for conductor (240.4) 20 (OCPD Rating) <= 30A = true	PASS
4.	Derated Ampacity must be greater than or equal to the Continuous Current (Article 100) 38.4A >= 13.05A = true	PASS
5.	Conductor Ampacity must be at least 125% of Continuous Current (215.2(A)(1)) 40A > 13.05A x 1.25 = true	PASS
6.	Max current for terminal must be at least 125% of the Continuous Current. (110.14(C)) 35A >= 13.05A X 1.25 = true	PASS
7.	EGC must meet code requirements for minimum size (Table 250.122) 10 AWG >= 12 AWG = true	PASS
8.	Conduit must meet code recommendation for minimum size (300.17) 0.75in. >= 0.5in. = true	PASS

REC ALPHA PURE SERIES
PRODUCT SPECIFICATIONS

REC
SOLAR'S MOST TRUSTED

GENERAL DATA	
Cell type:	132 half-cut REC heterojunction bifacial cells with lead-free, gapless technology, 6 strings of 22 cells in series
Glass:	0.13 in (3.2 mm) solar glass with anti-reflective surface treatment in accordance with EN 12150
Backsheet:	Highly resistant polymer (black)
Frame:	Anodized aluminum (black)
Junction box:	3-part, 3 bypass diodes, lead-free IP68 rated, in accordance with IEC 62790
Connectors:	Stäubli MC4 PV-KBT4/KST4 (4 mm²) in accordance with IEC 62852, IP68 only when connected
Cable:	12 AWG (4 mm²) PV wire, 43+ 47 in (1.1 + 1.2 m) in accordance with EN 50618
Dimensions:	71.7 x 40 x 1.2 in (19.91 ft²) / 1821 x 1016 x 30 mm (1.85 m²)
Weight:	45 lbs (20.5 kg)
Origin:	Made in Singapore



Measurements in mm [in]

ELECTRICAL DATA	Product Code*: RECxxxAA Pure						
STC							
Power Output - P_{MAX} (Wp)	380	385	390	395	400	405	410
Watt Class Sorting - (W)	0/+5	0/+5	0/+5	0/+5	0/+5	0/+5	0/+5
Nominal Power Voltage - V_{MPP} (V)	40.9	41.2	41.5	41.8	42.1	42.4	42.7
Nominal Power Current - I_{MPP} (A)	9.30	9.35	9.40	9.45	9.51	9.56	9.61
Open Circuit Voltage - V_{OC} (V)	48.4	48.5	48.6	48.7	48.8	48.9	49.0
Short Circuit Current - I_{SC} (A)	10.17	10.18	10.22	10.25	10.28	10.30	10.35
Power Density (W/ft²)	19.1	19.3	19.6	19.8	20.1	20.3	20.6
Panel Efficiency (%)	20.5	20.8	21.1	21.4	21.6	21.9	22.2
NMOT							
Power Output - P_{MAX} (Wp)	290	293	297	301	305	309	312
Nominal Power Voltage - V_{MPP} (V)	38.5	38.8	39.1	39.4	39.7	40.0	40.2
Nominal Power Current - I_{MPP} (A)	7.51	7.55	7.59	7.63	7.68	7.72	7.76
Open Circuit Voltage - V_{OC} (V)	45.6	45.7	45.8	45.9	46.0	46.1	46.2
Short Circuit Current - I_{SC} (A)	8.12	8.16	8.20	8.24	8.28	8.32	8.36

Values at standard test conditions (STC: air mass AM 1.5, irradiance 10.75 W/sq ft (1000 W/m²), temperature 77°F (25°C), based on a production spread with a tolerance of P_{MAX}, V_{OC} & I_{SC} ±3% within one watt class. Nominal module operating temperature (NMOT: air mass AM 1.5, irradiance 800 W/m², temperature 68°F (20°C), windspeed 3.3 ft/s (1 m/s). * Where xxx indicates the nominal power class (P_{MAX}) at STC above.

MAXIMUM RATINGS	
Operational temperature:	-40 ... +85°C
Maximum system voltage:	1000 V
Maximum test load (front):	+7000 Pa (146 lbs/ft²)*
Maximum test load (rear):	-4000 Pa (83.5 lbs/ft²)*
Max series fuse rating:	25 A
Max reverse current:	25 A

* See installation manual for mounting instructions. Design load = Test load / 1.5 (safety factor)

WARRANTY	Standard	REC ProTrust	
Installed by an REC Certified Solar Professional	No	Yes	Yes
System Size	All	≤25 kW	25-500 kW
Product Warranty (yrs)	20	25	25
Power Warranty (yrs)	25	25	25
Labor Warranty (yrs)	0	25	10
Power in Year 1	98%	98%	98%
Annual Degradation	0.25%	0.25%	0.25%
Power in Year 25	92%	92%	92%

See warranty documents for details. Conditions apply

CERTIFICATIONS	
IEC 61215:2016, IEC 61730:2016, UL 61730	
IEC 62804	PID
IEC 61701	Salt Mist
IEC 62716	Ammonia Resistance
UL 61730	Fire Type Class 2
IEC 62782	Dynamic Mechanical Load
IEC 61215-2:2016	Hailstone (35mm)
IEC 62321	Lead-free acc. to RoHS EU 863/2015
ISO 14001, ISO 9001, IEC 45001, IEC 62941	

Lead-Free

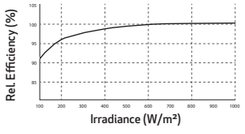
TEMPERATURE RATINGS*	
Nominal Module Operating Temperature:	44°C (±2°C)
Temperature coefficient of P_{MAX}:	-0.26 %/°C
Temperature coefficient of V_{OC}:	-0.24 %/°C
Temperature coefficient of I_{SC}:	0.04 %/°C

*The temperature coefficients stated are linear values

DELIVERY INFORMATION	
Panels per pallet:	33
Panels per 40 ft GP/high cube container:	792 (24 pallets)
Panels per 53 ft truck:	891 (27 pallets)

LOW LIGHT BEHAVIOUR

Typical low irradiance performance of module at STC:



Founded in 1996, REC Group is an international pioneering solar energy company dedicated to empowering consumers with clean, affordable solar power. As Solar's Most Trusted, REC is committed to high quality, innovation, and a low carbon footprint in the solar materials and solar panels it manufactures. Headquartered in Norway with operational headquarters in Singapore, REC also has regional hubs in North America, Europe, and Asia-Pacific.

www.recgroup.com

Specifications subject to change without notice.

Ref: PM-DS-12-06-Rev- G 04.22

ENPHASE

DATA SHEET

IQ8 Series Microinverters

Our newest IQ8 Microinverters are the industry's first microgrid-forming, software-defined microinverters with split-phase power conversion capability to convert DC power to AC power efficiently. The brain of the semiconductor-based microinverter is our proprietary application-specific integrated circuit (ASIC) which enables the microinverter to operate in grid-tied or off-grid modes. This chip is built in advanced 55nm technology with high speed digital logic and has super-fast response times to changing loads and grid events, alleviating constraints on battery sizing for home energy systems.

Part of the Enphase Energy System, IQ8 Series Microinverters integrate with the Enphase IQ Battery, Enphase IQ Gateway, and the Enphase App monitoring and analysis software.

Enphase 25 year limited warranty

IQ8 Series Microinverters redefine reliability standards with more than one million cumulative hours of power-on testing, enabling an industry-leading limited warranty of up to 25 years.

Connect PV modules quickly and easily to IQ8 Series Microinverters using the included Q-DCC-2 adapter cable with plug-n-play MC4 connectors.

UL CERTIFIED SAFETY

IQ8 Series Microinverters are UL Listed as PV Rapid Shut Down Equipment and conform with various regulations, when installed according to manufacturer's instructions.

Easy to install

- Lightweight and compact with plug-n-play connectors
- Power Line Communication (PLC) between components
- Faster installation with simple two-wire cabling

High productivity and reliability

- Produce power even when the grid is down
- More than one million cumulative hours of testing
- Class II double-insulated enclosure
- Optimized for the latest high-powered PV modules

Microgrid-forming

- Complies with the latest advanced grid support
- Remote automatic updates for the latest grid requirements
- Configurable to support a wide range of grid profiles
- Meets CA Rule 21 (UL 1741-SA) requirements

IQ8 Series Microinverters

INPUT DATA (DC)		IQ8-60-2-US	IQ8PLUS-72-2-US	IQ8M-72-2-US	IQ8A-72-2-US	IQ8H-240-72-2-US	IQ8H-208-72-2-US[1]
Commonly used module pairings[2]	W	235 – 350	235 – 440	260 – 460	295 – 500	320 – 540+	295 – 500+
Module compatibility		60-cell/120 half-cell	60-cell/120 half-cell and 72-cell/144 half-cell				
MPPT voltage range	V	27 – 37	29 – 45	33 – 45	36 – 45	38 – 45	38 – 45
Operating range	V	25 – 48	25 – 58				
Min/max start voltage	V	30 / 48	30 / 58				
Max input DC voltage	V	50	60				
Max DC current[3] [module Isc]	A	15					
Overvoltage class DC port		II					
DC port backfeed current	mA	0					
PV array configuration		1x1 Ungrounded array; No additional DC side protection required; AC side protection requires max 20A per branch circuit					
OUTPUT DATA (AC)		**IQ8-60-2-US**	**IQ8PLUS-72-2-US**	**IQ8M-72-2-US**	**IQ8A-72-2-US**	**IQ8H-240-72-2-US**	**IQ8H-208-72-2-US**
Peak output power	VA	245	300	330	366	384	366
Max continuous output power	VA	240	290	325	349	380	360
Nominal (L-L) voltage/range[4]	V	240 / 211 – 264					208 / 183 – 250
Max continuous output current	A	1.0	1.21	1.35	1.45	1.58	1.73
Nominal frequency	Hz	60					
Extended frequency range	Hz	50 – 68					
Max units per 20 A (L-L) branch circuit[5]		16	13	11	11	10	9
Total harmonic distortion		<5%					
Overvoltage class AC port		III					
AC port backfeed current	mA	30					
Power factor setting		1.0					
Grid-tied power factor (adjustable)		0.85 leading – 0.85 lagging					
Peak efficiency	%	97.5	97.6	97.6	97.6	97.6	97.4
CEC weighted efficiency	%	97	97	97	97.5	97	97
Night-time power consumption	mW	60					
MECHANICAL DATA							
Ambient temperature range		-40°C to +60°C (-40°F to +140°F)					
Relative humidity range		4% to 100% (condensing)					
DC Connector type		MC4					
Dimensions (HxWxD)		212 mm (8.3") x 175 mm (6.9") x 30.2 mm (1.2")					
Weight		1.08 kg (2.38 lbs)					
Cooling		Natural convection – no fans					
Approved for wet locations		Yes					
Acoustic noise at 1 m		<60 dBA					
Pollution degree		PD3					
Enclosure		Class II double-insulated, corrosion resistant polymeric enclosure					
Environ. category / UV exposure rating		NEMA Type 6 / outdoor					
COMPLIANCE							
Certifications		CA Rule 21 (UL 1741-SA), UL 62109-1, UL1741/IEEE1547, FCC Part 15 Class B, ICES-0003 Class B, CAN/CSA-C22.2 NO. 107.1-01 This product is UL Listed as PV Rapid Shut Down Equipment and conforms with NEC 2014, NEC 2017, and NEC 2020 section 690.12 and C22.1-2018 Rule 64-218 Rapid Shutdown of PV Systems, for AC and DC conductors, when installed according to manufacturer's instructions.					

(1) The IQ8H-208 variant will be operating in grid-tied mode only at 208V AC. (2) No enforced DC/AC ratio. See the compatibility calculator at https://link.enphase.com/module-compatibility (3) Maximum continuous input DC current is 10.6A (4) Nominal voltage range can be extended beyond nominal if required by the utility. (5) Limits may vary. Refer to local requirements to define the number of microinverters per branch in your area.

Data Sheet
Enphase Networking

Enphase IQ Combiner 4/4C

X-IQ-AM1-240-4
X-IQ-AM1-240-4C

X-IQ-AM1-240-4C

X-IQ-AM1-240-4

The **Enphase IQ Combiner 4/4C** with Enphase IQ Gateway and integrated LTE-M1 cell modem (included only with IQ Combiner 4C) consolidates interconnection equipment into a single enclosure and streamlines IQ microinverters and storage installations by providing a consistent, pre-wired solution for residential applications. It offers up to four 2-pole input circuits and Eaton BR series busbar assembly.

Smart

- Includes IQ Gateway for communication and control
- Includes Enphase Mobile Connect cellular modem (CELLMODEM-M1-06-SP-05), included only with IQ Combiner 4C
- Includes solar shield to match Enphase IQ Battery aesthetics and deflect heat
- Flexible networking supports Wi-Fi, Ethernet, or cellular
- Optional AC receptacle available for PLC bridge
- Provides production metering and consumption monitoring

Simple

- Centered mounting brackets support single stud mounting
- Supports bottom, back and side conduit entry
- Up to four 2-pole branch circuits for 240 VAC plug-in breakers (not included)
- 80A total PV or storage branch circuits

Reliable

- Durable NRTL-certified NEMA type 3R enclosure
- Five-year limited warranty
- Two years labor reimbursement program coverage included for both the IQ Combiner SKU's
- UL listed

UL LISTED

To learn more about Enphase offerings, visit **enphase.com**

ENPHASE

Enphase IQ Combiner 4/4C

MODEL NUMBER	
IQ Combiner 4 (X-IQ-AM1-240-4)	IQ Combiner 4 with Enphase IQ Gateway printed circuit board for integrated revenue grade PV production metering (ANSI C12.20 +/- 0.5%) and consumption monitoring (+/- 2.5%). Includes a silver solar shield to match the IQ Battery system and IQ System Controller 2 and to deflect heat.
IQ Combiner 4C (X-IQ-AM1-240-4C)	IQ Combiner 4C with Enphase IQ Gateway printed circuit board for integrated revenue grade PV production metering (ANSI C12.20 +/- 0.5%) and consumption monitoring (+/- 2.5%). Includes Enphase Mobile Connect cellular modem (CELLMODEM-M1-06-SP-05), a plug-and-play industrial-grade cell modem for systems up to 60 microinverters. (Available in the US, Canada, Mexico, Puerto Rico, and the US Virgin Islands, where there is adequate cellular service in the installation area.) Includes a silver solar shield to match the IQ Battery and IQ System Controller and to deflect heat.
ACCESSORIES AND REPLACEMENT PARTS	(not included, order separately)
Ensemble Communications Kit COMMS-CELLMODEM-M1-06 CELLMODEM-M1-06-SP-05 CELLMODEM-M1-06-AT-05	- Includes COMMS-KIT-01 and CELLMODEM-M1-06-SP-05 with 5-year Sprint data plan for Ensemble sites - 4G based LTE-M1 cellular modem with 5-year Sprint data plan - 4G based LTE-M1 cellular modem with 5-year AT&T data plan
Circuit Breakers BRK-10A-2-240V BRK-15A-2-240V BRK-20A-2P-240V BRK-15A-2P-240V-B BRK-20A-2P-240V-B	Supports Eaton BR210, BR215, BR220, BR230, BR240, BR250, and BR260 circuit breakers. Circuit breaker, 2 pole, 10A, Eaton BR210 Circuit breaker, 2 pole, 15A, Eaton BR215 Circuit breaker, 2 pole, 20A, Eaton BR220 Circuit breaker, 2 pole, 15A, Eaton BR215B with hold down kit support Circuit breaker, 2 pole, 20A, Eaton BR220B with hold down kit support
EPLC-01	Power line carrier (communication bridge pair), quantity - one pair
XA-SOLARSHIELD-ES	Replacement solar shield for IQ Combiner 4/4C
XA-PLUG-120-3	Accessory receptacle for Power Line Carrier in IQ Combiner 4/4C (required for EPLC-01)
XA-ENV-PCBA-3	Replacement IQ Gateway printed circuit board (PCB) for Combiner 4/4C
X-IQ-NA-HD-125A	Hold down kit for Eaton circuit breaker with screws.
ELECTRICAL SPECIFICATIONS	
Rating	Continuous duty
System voltage	120/240 VAC, 60 Hz
Eaton BR series busbar rating	125 A
Max. continuous current rating	65 A
Max. continuous current rating (input from PV/storage)	64 A
Max. fuse/circuit rating (output)	90 A
Branch circuits (solar and/or storage)	Up to four 2-pole Eaton BR series Distributed Generation (DG) breakers only (not included)
Max. total branch circuit breaker rating (input)	80A of distributed generation / 95A with IQ Gateway breaker included
Production metering CT	200 A solid core pre-installed and wired to IQ Gateway
Consumption monitoring CT (CT-200-SPLIT)	A pair of 200 A split core current transformers
MECHANICAL DATA	
Dimensions (WxHxD)	37.5 x 49.5 x 16.8 cm (14.75" x 19.5" x 6.63"). Height is 21.06" (53.5 cm) with mounting brackets.
Weight	7.5 kg (16.5 lbs)
Ambient temperature range	-40° C to +46° C (-40° to 115° F)
Cooling	Natural convection, plus heat shield
Enclosure environmental rating	Outdoor, NRTL-certified, NEMA type 3R, polycarbonate construction
Wire sizes	• 20 A to 50 A breaker inputs: 14 to 4 AWG copper conductors • 60 A breaker branch input: 4 to 1/0 AWG copper conductors • Main lug combined output: 10 to 2/0 AWG copper conductors • Neutral and ground: 14 to 1/0 copper conductors Always follow local code requirements for conductor sizing.
Altitude	To 2000 meters (6,560 feet)
INTERNET CONNECTION OPTIONS	
Integrated Wi-Fi	802.11b/g/n
Cellular	CELLMODEM-M1-06-SP-05, CELLMODEM-M1-06-AT-05 (4G based LTE-M1 cellular modem). Note that an Enphase Mobile Connect cellular modem is required for all Ensemble installations.
Ethernet	Optional, 802.3, Cat5E (or Cat 6) UTP Ethernet cable (not included)
COMPLIANCE	
Compliance, IQ Combiner	UL 1741, CAN/CSA C22.2 No. 107.1, 47 CFR, Part 15, Class B, ICES 003 Production metering: ANSI C12.20 accuracy class 0.5 (PV production) Consumption metering: accuracy class 2.5
Compliance, IQ Gateway	UL 60601-1/CANCSA 22.2 No. 61010-1

To learn more about Enphase offerings, visit **enphase.com**

ENPHASE

Product data sheet
Characteristics

DU221RB
SWITCH NOT FUSIBLE GD 240V 30A 2P NEMA3R

Stock Code: Stock - Normally stocked in distribution facility
Price*: 177.00 USD

Main

Product	Single Throw Safety Switch
Current Rating	30 A
Certifications	UL listed
Enclosure Rating	NEMA 3R
Disconnect Type	Non-fusible disconnect
Factory Installed Neutral	None
Mounting Type	Surface
Number of Poles	2
Electrical Connection	Lugs
Duty Rating	General duty

Ordering and shipping details

Category	00106 - D & DU SW,NEMA3R, 30-200A
Discount Schedule	DE1A
GTIN	00785901490340
Nbr. of units in pkg.	1
Package weight(Lbs)	4.86000000000000003
Returnability	Y
Country of origin	MX

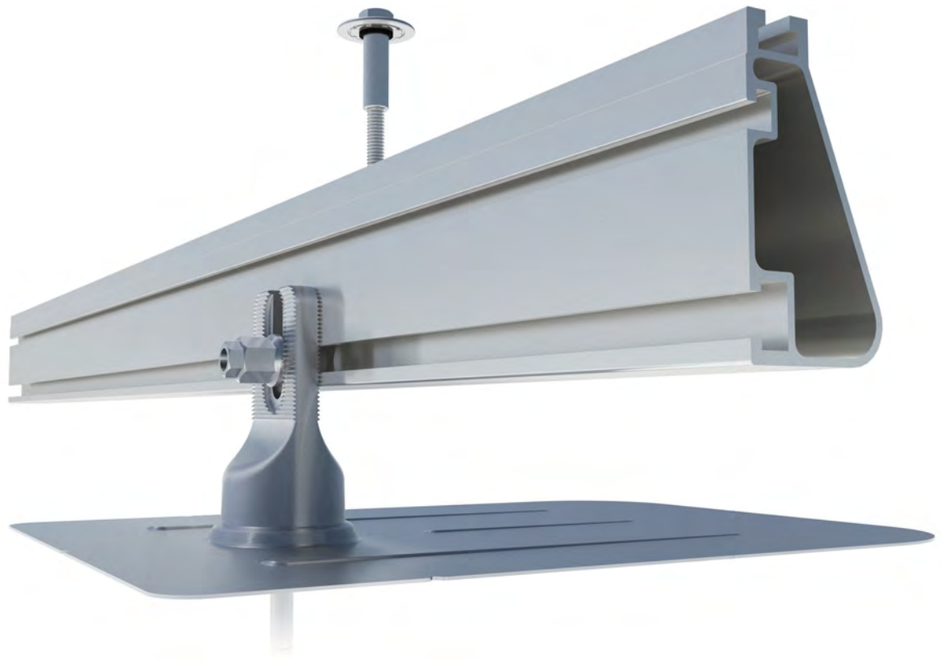
Contractual warranty

Period	18 months

Product Life Status : Commercialised

Datasheet

Flush Mount System



Built for solar's toughest roofs.

IronRidge builds the strongest mounting system for pitched roofs in solar. Every component has been tested to the limit and proven in extreme environments.

Our rigorous approach has led to unique structural features, such as curved rails and reinforced flashings, and is also why our products are fully certified, code compliant and backed by a 25-year warranty.

Strength Tested
All components evaluated for superior structural performance.

PE Certified
Pre-stamped engineering letters available in most states.

Class A Fire Rating
Certified to maintain the fire resistance rating of the existing roof.

Design Assistant
Online software makes it simple to create, share, and price projects.

UL 2703 Listed System
Entire system and components meet newest effective UL 2703 standard.

25-Year Warranty
Products guaranteed to be free of impairing defects.

Datasheet

XR Rails

XR10 Rail

A low-profile mounting rail for regions with light snow.

- 6' spanning capability
- Moderate load capability
- Clear and black finish

XR100 Rail

The ultimate residential solar mounting rail.

- 8' spanning capability
- Heavy load capability
- Clear and black finish

XR1000 Rail

A heavyweight mounting rail for commercial projects.

- 12' spanning capability
- Extreme load capability
- Clear anodized finish

Bonded Splices

All rails use internal splices for seamless connections.

- Self-drilling screws
- Varying versions for rails
- Forms secure bonding

Clamps & Grounding

UFOs

Universal Fastening Objects bond modules to rails.

- Fully assembled & lubed
- Single, universal size
- Clear and black finish

Stopper Sleeves

Snap onto the UFO to turn into a bonded end clamp.

- Bonds modules to rails
- Sized to match modules
- Clear and black finish

CAMO

Bond modules to rails while staying completely hidden.

- Universal end-cam clamp
- Tool-less installation
- Fully assembled

Grounding Lugs

Connect arrays to equipment ground.

- Low profile
- Single tool installation
- Mounts in any direction

Attachments

FlashFoot2

Flash and mount XR Rails with superior waterproofing.

- Twist-on Cap eases install
- Wind-driven rain tested
- Mill and black finish

Conduit Mount

Flash and mount conduit, strut, or junction boxes.

- Twist-on Cap eases install
- Wind-driven rain tested
- Secures ¾" or 1" conduit

Slotted L-Feet

Drop-in design for rapid rail attachment.

- Secure rail connections
- Slot for vertical adjusting
- Clear and black finish

Bonding Hardware

Bond and attach XR Rails to roof attachments.

- T & Square Bolt options
- Nut uses 7/16" socket
- Assembled and lubricated

Resources

Design Assistant
Go from rough layout to fully engineered system. For free.
Go to IronRidge.com/design

NABCEP Certified Training
Earn free continuing education credits, while learning more about our systems.
Go to IronRidge.com/training

28357 Industrial Blvd.
Hayward, CA 94545
1-800-227-9523
IronRidge.com

Attn: Corey Geiger, COO, IronRidge Inc.
Date: July 1st, 2021

Re: Structural Certification and Span Tables for the IronRidge Flush Mount System

This letter addresses the structural performance and code compliance of IronRidge's Flush Mount System. The contents of the letter shall be read in its entirety before applying to any project design. The Flush Mount System is a proprietary rooftop mounting system used to support photovoltaic (PV) modules installed in portrait or landscape orientation and set parallel to the underlying roof surface. PV modules are supported by extruded aluminum XR Rails and secured to the rails with IronRidge mounting clamps. The XR Rails are side mounted to a selected roof attachment with 3/8" stainless steel bonding hardware and then attached directly to the roof structure or to a stanchion that is fastened to the underlying roof structure. Assembly details of a typical Flush Mount installation and its core components are shown in Exhibit EX-0015.

The IronRidge Flush Mount System is designed and certified to the structural requirements of the reference standards listed below, for the load conditions and configurations tabulated in the attached span tables.

- ASCE/SEI 7-16 Minimum Design Loads for Buildings and Other Structures (ASCE 7-16)
- 2018 International Building Code (IBC-2018)
- 2015 Aluminum Design Manual (ADM-2015)
- Report SEAOC (Structural Engineer Association of California) PV2-2017 Wind Design for Solar Arrays

The tables included in this letter provide the maximum allowable spans of XR Rails in the Flush Mount System for the respective loads and configurations listed, covering wind exposure categories B, C, & D, roof zones provided in ASCE 7-16 for gable & hip roof profiles, and roof slopes of 8° to 45°. The tabulated spans are applicable when the following conditions are met:

1. *Span* is the distance between two adjacent roof attachment points (measured at the center of the attachment fastener).

2. Each module shall be supported by 2 rails (2 rail system) or 3 rails (3 rail system). Spans are calculated based on 2 rail systems, and conservatively deemed acceptable for 3 rail systems.

3. The underlying roof slope, measured between the roof surface and horizontal plane, is 8º to 45º.

4. The *mean roof height*, defined as the average of the roof eave height and the roof ridge height measured from grade, does not exceed 30 feet.

5. A clearance from the underside of the array to the roof surface of 2" minimum shall be provided and the height of the array, the distance from the module top surface to the roof surface (defined as h_2), shall not exceed 10".

6. Module length and area shall not exceed the maximum values listed on the respective span tables.

7. All Flush Mount components shall be installed in a professional workmanlike manner per IronRidge's *Flush Mount Installation Manual* and other applicable standards for the general roof construction practice.

28357 Industrial Blvd.
Hayward, CA 94545
1-800-227-9523
IronRidge.com

The span tables provided in this letter are certified based on the structural performance of IronRidge XR Rails only with no consideration of the structural adequacy of the chosen roof attachments, PV modules, or the underlying roof supporting members. It is the responsibility of the installer or system designer to verify the structural capacity and adequacy of the aforementioned system components in regards to the applied or resultant loads of any chosen array configuration.

Sincerely,

2021.07.14
17:00:52
-07'00'

Gang Xuan, PE
Senior Structural Engineer

© 2021 IronRidge, Inc.

RATINGS

UL 2703 LISTED

#5003807

Conforms to STD UL 2703 Standard for Safety First Edition: Mounting Systems, Mounting Devices, Clamping/ Retention Devices, and Ground Lugs for Use with Flat-Plate Photovoltaic Modules and Panels

- Max Overcurrent Protective Device (OCPD) Rating: 40A
- Max Module Size: 30.5 ft²
- Module Orientation: Portrait or Landscape
- System Design Load Rating: 10 PSF downward, 5 PSF upward, 5 PSF lateral
- Actual system structural capacity including spans and cantilevers are defined by PE stamped certification letters.
- CAMO Specific Design Load rating: 50 PSF downward, 50 PSF upward, 15 PSF lateral

Certified to CSA TIL No. A-40 Photovoltaic Module Racking Systems

- Load Rating: 2400 PA [50 PSF]

CLASS A SYSTEM FIRE RATING PER UL 2703

- Any Roof Slope with Module Types 1, 2, 3, 13, 19, 25 & 29.
- Any module-to-roof gap is permitted, with no perimeter guarding required. This rating is applicable with any third-party attachment.
- Class A rated PV systems can be installed on Class A, B, and C roofs without affecting the roof fire rating.

WATER SEAL RATINGS:

- UL 441 (Flashfoot2, All Tile Hook, Knockout Tile, Flashvue, L-Mount)
- TAS 100(A)-95 (Flashfoot2, All Tile Hook, Knockout Tile, Flashvue, L-Mount, Qbase)
- Tested and evaluated without sealant.
- Any roofing manufacturer approved sealant is allowed. Ratings applicable for roof slopes between 2:12 and 12:12

STRUCTURAL CERTIFICATION

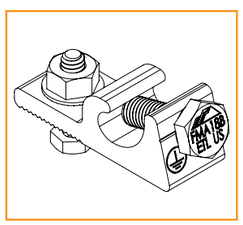
- Designed and Certified for Compliance with the International Building Code & ASCE/SEI-7

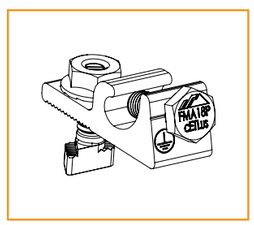
FLORIDA PRODUCT APPROVAL #FL29843

- Conforms to TAS202, TAS100(A)
- Approved for installation both inside and outside High Velocity Hurricane Zones (HVHZ)
- Allowable design pressure up to +100/-100 PSF
- Additional details and full list of approved components can be found Here.

MARKINGS

Product markings are located on the Grounding Lug bolt head.





Intertek

8431 Murphy Drive
Middleton, WI 53562 USA

Telephone: 608.836.4400
Facsimile: 608.831.9279
www.intertek.com

Test Verification of Conformity

In the basis of the tests undertaken, the sample(s) of the below product have been found to comply with the requirements of the referenced specifications at the time the tests were carried out.

Applicant Name & Address:	IronRidge, Inc. 28357 Industrial Blvd Hayward, CA 94545 USA
Product Description:	Flush Mount System with XR Rails.
Ratings & Principle Characteristics:	Fire Class Resistance Rating: -Flush Mount (Symmetrical). Class A Fire Rated for Low Slope applications when using Type 1, 2, 3, 13, 19, 25 and 29 listed photovoltaic modules. Class A Fire Rated for Steep Slope applications with Type1, 2 and 3, listed photovoltaic modules. Tested with a 5” gap (distance between the bottom the module frame and the roof covering), per the standard this system can be installed at any gap allowed by the manufacturers installation instructions. No perimeter guarding is required. This rating is applicable with any IronRidge or 3’rd party roof anchor.
Models:	IronRidge Flush Mount with XR Rails
Brand Name:	IronRidge Flush Mount
Relevant Standards:	UL 2703 (Section 15.2 and 15.3) Standard for Safety Mounting Systems, Mounting Devices, Clamping/Retention Devices, and Ground Lugs for Use with Flat-Plate Photovoltaic Modules and Panels, First Edition dated Jan. 28, 2015 **Referencing** UL1703 Third Edition dated Nov. 18, 2014, (Section 31.2) Standard for Safety for Flat-Plate Photovoltaic Modules and Panels.
Verification Issuing Office:	Intertek Testing Services NA, Inc. 8431 Murphy Drive Middleton, WI 53562
Date of Tests:	08/27/2014 to 03/17/2015
Test Report Number(s):	101769343MID-001r1, 101769343MID-001a, 101915978MID-001 & 101999492MID-001ar1-cr1, 104428358MID-001 EEV
Revision Summary	8/27/2020 Added type 13, 19, 25 and 29 to system, update address.

This verification is part of the full test report(s) and should be read in conjunction with them. This report does not automatically imply product certification.

Completed by:	Chris Zimbrich	**Reviewed by:**	Chad Naggs
Title:	Technician I, Fire Resistance	**Title:**	Technical Team Lead, Fire Resistance
Signature:		**Signature:**	
Date:	08/27/2020	**Date:**	08/27/2020

GFT-OP-11a (24-MAR-2014)

MODULE COMPATIBILITY

The Flush Mount System may be used to ground and/or mount a PV module complying with UL 2703 only when the specific module has been evaluated for grounding and/or mounting in compliance with the included instructions. Unless otherwise noted, “xxx” refers to the module power rating and both black and silver frames are included in the certification.

FRAMED MODULE LIST

MAKE	MODELS
Adani	Adani modules with 35 and 40mm frames ASX-Y-ZZ-xxx Where "X" can be B, M or P, "Y" can be 6 or 7, and "ZZ" can be blank, PERC, B-PERC, or AB-PERC
Aionrise	Aionrise modules with 35 and 40mm frames AIONyyG1-xxx Where "yy" can be 60 or 72
Amerisolar	Amerisolar modules with 35, 40 and 50 mm frames AS-bYxxxZ Where "b" can be 5 or 6; "Y" can be M, P, M27, P27, M30, or P30; and "Z" can be blank, W or WB
Aptos Solar	Aptos modules with 35 and 40 mm frames DNA-yy-zzaa-xxx Where "yy" can be 120 or 144; "zz" can be MF or BF; and "aa" can be 23 or 26
Astronergy Solar	Astronergy modules with 30, 35, 40, and 45 mm frames aaSMbbyyC/zz-xxx Where “aa” can be CH or A; "bb" can be 60, 66, or 72; “yy” can be blank, 10 or 12; "C" can M, P, M(BL), M-HC, M(BL)-HC, P-HC, M(DG), or M(DGT); and “zz” can be blank, HV, F-B, or F-BH
ASUN	ASUN modules with 35 and 40 mm frames ASUN-xxx-YYZZ-aa Where "YY" can be 60 or 72; "ZZ" can be M,or MH5; and "aa" can be blank or BB
Auxin	Auxin modules with 40 mm frames AXN6y6zAxxxB Where "y" can be M or P; "z" can be 08, 09, 10, 11, or 12; and "A" can be F, M or T; and "B" can be blank, A, B or C
Axitec	Axitec Modules with 30, 35 and 40 mm frames AC-xxxY/aaZZb Where "Y" can be M, P, MB or MH; "aa" can be blank, 125- or 156-; "ZZ" can be 54, 60, 72, 108, 120, or 144; "b" can be S, X, V, VB, XV, or MX
Boviet	Boviet modules with 35 and 40mm frames BVMZZaaYY-xxxBcc Where "ZZ" can be 66 or 76; "aa" can be 9, 10 or 12; "YY" is M or P; and "B" can be blank, L or S; and "cc" can be blank, H, H-BF, H-BF-DG, H-HC, H-HC-BF, H-HC-BF-DG, HC-BF or HC-BF-DG
BYD	BYD modules with 35 mm frames BYDxxxAY-ZZ Where "A" can be M6, P6, MH or PH; "Y" can be C or K; and "ZZ" can be 30 or 36
Canadian Solar	Canadian Solar modules with 30, 32, 35 and 40 mm frames CSbY-xxxZ Where "b" can be 1, 3 or 6; "Y" can be H, K, L, N, P, U, V, W, X or Y; and "Z" can be M, P, MS, PX , M-SD, P-AG, P-SD, MB-AG, PB-AG, MS-AG, or MS-SD
CertainTeed	CertainTeed modules with 35 and 40 frames CTxxxYZZ-AA Where "Y" can be M, P, or HC; "ZZ" can be 00, 01, 10, or 11; and "AA" can be 01, 02, 03, 04 or 06
CSUN	Csun modules with 35 and 40 mm frames YYxxx-zzAbb Where "YY" is CSUN or SST; "zz" is blank, 60, or 72; and "A" is blank, P, M or MM; "bb" is blank, BB, 5BB, BW, or ROOF
Dehui	Dehui modules with 30, 35 and 40mm frames DH-MYYYZ-xxx Where “YYY” can be 760, 772, 860, 872; and “Z” can be B, F or W

MODULE COMPATIBILITY

Ecosolargy	Ecosolargy modules with 35, 40, and 50 mm frames ECOxxxYzzA-bbD Where “Y” can be A, H, S, or T; “zz” can be 125 or 156; “A” can be M or P; “bb” can be 60 or 72; and “D” can be blank or B
ET Solar	ET Solar modules with 30, 35, 40, and 50 mm frames ET-YZZZxxxAA Where "Y" can be P, L, or M; "ZZZ" can be 660, 660BH, 672, 672BH, 754BH, 766BH, 772BH; and "AA" can be GL, TB, TW, WB, WW, BB, WBG, WWG, WBAC, WBCO, WWCO, WWBCO or BBAC
Flex	Flex modules with 35, 40, and 50 mm frames FXS-xxxYY-ZZ; Where “YY” can be BB or BC; and “ZZ” can be MAA1B, MAA1W, MAB1W, SAA1B, SAA1W, SAC1B, SAC1W, SAD1W, SBA1B, SBA1W, SBC1B, or SBC1W
GCL	GCL modules with 35 mm and 40 mm frames GCL-ab/YY xxx Where “a” can be M or P; “b” can be 3 or 6; and “YY” can be 60, 72, 72H, or 72DH
GigaWatt Solar	Gigawatt modules with 40 mm frames GWxxxYY Where “YY” can be either PB or MB
Hansol	Hansol modules with 35 and 40 frames HSxxxYY-zz Where “YY” can be PB, PD, PE, TB, TD, UB, UD, or UE; and “zz” can be AH2, AN1, AN3, AN4, HH2, HV1, or JH2
Hanwa Solar	Hanwha Solar modules with 40, 45, and 50 mm frames HSLaaP6-YY-1-xxxZ Where “aa” can be either 60 or 72; “YY” can be PA or PB; and “Z” can be blank or B
Hanwha Q CELL	Hanwha Q CELLS Modules with 32, 35, 40, and 42mm frames aaYY-ZZ-xxx where "aa" can be Q. or B.; "YY" can be PLUS, PRO, PEAK, LINE PRO, LINE PLUS, PLUS DUO or PEAK DUO; and "ZZ" can be G3, G3.1, G4, G4.1, L-G2, L-G2.3, L-G3, L-G3.1, L-G3y, L-G4, L-G4.2, L-G4y, LG4.2/TAA, BFR-G3, BLK-G3, BFR-G3.1, BLK-G3.1, BFR-G4, BFR-G4.1, BFR G4.3, BLK-G4.1, G4/SC, G4.1/SC, G4.1/TAA, G4.1/MAX, BFR G4.1/TAA, BFR G4.1/MAX, BLK G4.1/TAA, BLK G4.1/SC, EC-G4.4, G5, G5/SC, G5/TS, BLK-G5, BLK-G5/SC, BLK-G5/TS, L-G5, L-G5.1, L-G5.2, L-G5.2/H, L-G5.3, G6, G6/SC, G6/TS, G6+/TS, G6+, BLK-G6, L-G6, L-G6.1, L-G6.2, L-G6.3, G7, BLK-G6+, BLK-G6+/AC, BLK-G6+/HL, BLK-G6+/SC, BLK-G6/TS, BLK-G6+/TS, BLK-G7, G7.2, G8, BLK-G8, G8+, BLK-G8+ L-G7, L-G7.1, L-G7.2, L-G7.3, L-G8, L-G8.1, L-G8.2, L-G8.3, L-G8.3/BFF, L-G8.3/BFG, L-G8.3/BGT, ML-G9, BLK ML-G9, ML-G9+, BLK ML-G9+, BLK-G10+, BLK G10+/AC, ML-G10, BLK ML-G10, ML-G10+, BLK ML-G10+, ML-G10.a, BLK ML-G10.a, ML-G10.a+, BLK ML-G10.a+, XL-G9, XL-G9.2, XL-G9.3, XL-G9.3/BFG, XL-G10.2, XL-G10.3, XL-G10.c, XL-G10.d, XL-G10.d/BFG or XL-G10.3/BFG
Heliene	Heliene modules with 40 mm frames YYZZxxxA Where "YY" can be 36, 60, 72, 96, 120 or 144; "ZZ" can be HC, M, P, or MBLK; and "A" can be blank, HomePV, Bifacial or M10 Bifacial
HT-SAAE	HT-SAAE modules with 35 and 40 mm frames HTyy-aaaZ-xxx Where "yy" can be 60, 66, 72 or 78, "aaa" can be 18, 156 or 166, "Z" can be M, P, M-C, P-C, M(S), M(VS), M(V), P(V), M(V)-C, P(V)-C, or X
Hyundai	Hyundai modules with 33, 35, 40 and 50 mm frames HiY-SxxxZZ Where "Y" can be A, D or S; "S" can be M or S; and "ZZ" can be GI, HG, HI, KI, MI, MF, MG, PI, RI, RG, RG(BF), RG(BK), SG, TI or TG
Itek	Itek Modules with 40 and 50 mm frames IT-xxx-YY Where “YY” can be blank, HE, or SE, or SE72

MODULE COMPATIBILITY

JA Solar	JA Solar modules with 30, 35, 40 and 45 mm frames JAyyzz-bbww-xxx/aa Where “yy” can be M, P, M6 or P6; “zz” can be blank, (K), (L), (R), (V), (BK), (FA), (TG), (FA)(R), (L)(BK), (L)(TG), (R)(BK), (R)(TG), (V)(BK), (BK)(TG), or (L)(BK)(TG); “bb” can be 48, 54, 60, 66, 72 or 78; "ww" can be D09, D10, D20, D30, S01, S02, S03, S06, S09, S10, S12, S17, S20, S30 or S31; and “aa” can be BP, MB, MR, SI, SC, PR, 3BB, 4BB, 4BB/RE, 5BB
Jinko	Jinko modules with 35 and 40 mm frames JKMYxxxZZ-aa Where "Y" can either be blank or S; "ZZ" can be M, P, or PP; and "aa" can be blank, 60, 60B, 60H, 60L, 60BL, 60HL, 60HB, 60HBL, 6HBL-EP, 60-J4, 60B-J4, 60B-EP, 60(Plus), 60-V, 60-MX, 6RL3, 6RL3-B, 6TL3-B, 7RL3-V, 7RL3-TV, 72, 72B, 72-J4, 72B-J4, 72(Plus), 72-V, 72H-V, 72L-V, 72HL-V, 72HL4-V, 72HL4-TV, 72-MX, 72H-BDVP, 72HL-TV, or 72HL-V-MX3
Kyocera	Kyocera Modules with 46mm frames KYxxxZZ-AA Where “Y” can be D or U; “ZZ” can be blank, GX, or SX; and “AA” can be LPU, LFU, UPU, LPS, LPB, LFB, LFBS, LFB2, LPB2, 3AC, 3BC, 3FC, 4AC, 4BC, 4FC, 4UC, 5AC, 5BC, 5FC, 5UC, 6BC, 6FC, 8BC, 6MCA, or 6MPA
LG	LG modules with 35, 40, and 46 mm frames LGxxxYaZ-bb Where "Y" can be A, E, M, N, Q, S; "a" can be A, 1, 2 or 3 "Z" can be C, K, T, or W; and "bb" can be A3, A5, A6, B3, B6, E6, E6.AW5, G3, G4, J5, K4, L5, N5, V5, V6
Longi	Longi modules with 30, 35 and 40 mm frames LRa-YYZZ-xxxM Where "a" can be 4, 5 or 6; "YY" can be blank, 60, 66, or 72; and "ZZ" can be blank, BK, BP, HV, PB, PE, PH, HBD, HIB, HIH, HPB, HPH, or HIBD
Mission Solar	Mission Solar modules with 33, 35 and 40 mm frames YYYbb-xxxZZaa Where "YYY" can be MSE or TXS; "bb" can be blank, 6 or 60A; "ZZ" can be blank, MM, SE, SO, SQ , SR, SX, TS, 120 or 144; and "aa" can be blank, BB, BW, 1J, 4J, 4S, 5K, 5R, 5T, 60, 6J, 6S, 6W, 6Z, 8K, 8T, or 9S
Mitsubishi	Mitsubishi modules with 46 mm frames PV-MYYxxxZZ Where “YY” can be LE or JE; and “ZZ” can be either HD, HD2, or FB
Moltech	IM and XS series modules with 40, 45, and 50 mm frames
Next Energy Alliance	Next Energy Alliance modules with 35 and 40mm frames yyNEA-xxxZZ where “yy” can be blank or US; “ZZ” can be M, MB or M-60
Neo Solar Power	Neo Solar Power modules with 35 mm frames D6YxxxZZaa Where “Y” can be M or P; “ZZ” can be B3A, B4A, E3A, E4A, H3A, H4A; and “aa” can be blank, (TF), ME or ME (TF)
Panasonic (HIT)	Panasonic modules with 35 and 40 mm frames VBHNxxxYYzzA Where “YY” can be either KA, RA, SA or ZA; “zz” can be either 01, 02, 03, 04, 06, 06B, 11, 11B, 15, 15B, 16, 16B, 17, or 18; and “A” can be blank, E, G, or N
Panasonic (EverVolt)	Panasonic modules with 30 mm frames EVPVxxxA Where "A" can be blank or H, K or PK
Peimar	Peimar modules with 40 mm frames SbxxxYzz Where “b” can be G, M or P; “Y” can be M or P; and “zz” can be blank, (BF) or (FB)
Philadelphia Solar	Philadelphia modules with 35 and 40 mm frames PS-YzzAA-xxx Where "Y" can be M or P; "zz" can be 60, 72 or 144; and "AA" can be blank, (BF), (HC) or (HCBF)
Phono Solar	Phono Solar modules with 35, 40, and 45 mm frames PSxxxY-ZZ/A Where "Y" can be M, M1, MH, M1H, M4, M4H or P; "ZZ" can be 20 or 24; and "A" can be F, T, U, UH, or TH

MODULE COMPATIBILITY

Recom	Recom modules with 35 and 40 mm frames RCM-xxx-6yy Where “yy” can be MA, MB, ME or MF
REC Solar	REC modules with 30, 38 and 45 mm frames RECxxxYYZZ Where “YY” can be AA, M, NP, NP2, PE, PE72, TP, TP2, TP2M, TP2SM, TP2S, TP3M or TP4; and “ZZ” can be blank, Black, BLK, BLK2, SLV, 72, or Pure
Renesola	ReneSola modules with 35, 40 and 50 mm frames AAxxxY-ZZ Where "AA" can be SPM(SLP) or JC; "Y" can be blank, F, M or S; and "ZZ" can be blank, Ab, Ab-b, Abh, Abh-b, Abv, Abv-b, Bb, Bb-b, Bbh, Bbh-b, Bbv, Bbv-b, Db, Db-b, or 24/Bb
Renogy	Renogy Modules with 40 and 50 mm frames RNG-xxxY Where “xxx” is the module power rating; and “Y” can be D or P
Risen	Risen Modules with 30, 35 and 40 mm frames RSMyy-a-xxxZZ Where "yy" can be 60, 72, 110, 120, 132 or 144; "a" can be 6, 7 or 8; and "ZZ" can be M, P or BMDG
S-Energy	S-Energy modules with 35 and 40mm frames SABB-CCYYY-xxxZ Where “A” can be C, D, L or N; “BB” can be blank, 20, 25, 40 or 45; “CC” can be blank, 60 or 72; “YYY” can be blank, BDE, MAE, MAI, MBE, MBI, MCE or MCI; and “Z” can be V, M-10, P-10 or P-15
SEG Solar	SEG Solar with 30, 35 and 40 mm frames SEG-aYY-xxxZZ Where "a" can be blank, 6 or B; "YY" can be blank, MA, MB, PA, or PB; and "ZZ" can be blank, BB, BG, BW, HV, WB, WW, BMB, BMA-HV, BMA-BG, BMA-TB, BMB-TB, BMB-HV, BMD-HV, BMB-BG
Seraphim USA	Seraphim modules with 30, 35, 40 and 50 mm frames SRP-xxx-YYY-ZZ Where "xxx" is the module power rating; and "YYY" can be BMA, BMD, 6MA, 6MB, 6PA, 6PB, 6QA-XX-XX, and 6QB-XX-XX; ZZ is blank, BB, BG or HV
Sharp	Sharp modules with 35 and 40 mm frames NUYYxxx Where “YY” can be SA or SC
Silfab	Silfab Modules with 35 and 38 mm frames SYY-Z-xxxAb Where "YY" can be IL, SA, LA, SG or LG; "Z" can be blank, M, P, or X; "A" can be blank, B, H, M, N; and "b" can be A, C, G, K, L, N, T, U or X
Solaria	Solaria modules with 35 and 40 mm frames PowerXT-xxxY-ZZ Where "Y" can be R or C; and "ZZ" can be AC, BD, BX, BY, PD, PL, PM, PM-AC, PX, PZ, WX or WZ
Solarcity (Tesla)	Solarcity modules with 40 mm frames SCxxxYY Where “YY” can be blank, B1 or B2
SolarTech	SolarTech modules with 40 and 42 mm frames AAA-xxxYY Where "AAA" can be PERCB-B, PERCB-W, HJTB-B, HJTB-W or STU; "YY" can be blank, PERC or HJT
SolarWorld AG	SolarWorld Sunmodule Plus, Protect, Bisun, XL, Bisun XL, may be followed by mono, poly, duo, black, bk, or clear; modules with 31, 33 or 46 mm frames SW-xxx

MODULE COMPATIBILITY

SolarWorld Americas	SolarWorld Sunmodule Plus, Protect, Bisun, XL, Bisun XL, may be followed by mono, poly, duo, black, bk, or clear; modules with 33 mm frames SWA-xxx
Sonali	Sonali Modules with 40 mm frames SSxxx
Stion	Stion Thin film modules with 35 mm frames STO-xxx or STO-xxxA
SunEdison	SunEdison Modules with 35, 40 & 50 mm frames SE-YxxxZABCDE Where "Y" can be B, F, H, P, R, or Z; "Z" can be 0 or 4; "A" can be B,C,D,E,H,I,J,K,L,M, or N ; "B" can be B or W; "C" can be A or C; "D" can be 3, 7, 8, or 9; and "E" can be 0, 1 or 2
Suniva	Suniva modules with 35, 38, 40, 46, and 50 mm frames OPTxxx-AA-B-YYY-Z MVXxxx-AA-B-YYY-Z Where "AA" is either 60 or 72; "B" is either 4 or 5; "YYY" is either 100,101,700,1B0, or 1B1; and "Z" is blank or B
Sunpower	Sunpower standard (G3 or G4) or InvisiMount (G5) 35, 40 and 46 mm frames SPR-Zb-xxx-YY Where "Z" is either A, E, P, M or X; “b” can be blank, 17, 18, 19, 20, 21, or 22; and “YY” can be blank, BLK, COM, C-AC, D-AC, E-AC, BLK-E-AC, G-AC, BLK-C-AC, or BLK-D-AC
Sunspark	Sunspark modules with 40 mm frames SYY-xxxZ-A Where “YY” can be MX or ST; and “Z” can be M, MB, M3, M3B, P or W; and "A" can be 60 or 72
Suntech	Suntech Modules with 35, 40 and 50mm frames STPxxxy-zz/aa Where "y" is blank or S; and "zz" can be 20, 24, A60 or A72U; and "aa" can be Vd, Vem, Vfw, Vfh, Wdb, Wde, Wd, or Wfhb
Talesun	Talesun modules with 30, 35 and 40mm frames TAByZZaa-xxx-b Where "A" can be D or P; "B" can be 6 or 7; "y" can be blank, F, G, H, I or L; "ZZ" can be 60, 66, 72 or 78; "aa" can be M, M(H), or P; and "b" can be blank, B, T, or (H)
Tesla	Tesla modules with 40 mm frames TxxxY Where "Y" can be H or S
Trina	Trina Modules with 30, 35, 40 and 46mm frames TSM-xxxYYZZ Where "YY" can be DD05, DD06, DD14, DE14, DE15, DE15V, DEG15, DEG15VC, DE18M, DEG18MC, DE09, DE19, DEG19C.20, DE06X, PA05, PC05, PD05, PD06, PA14, PC14, PD14, PE14, or PE15 ; and "ZZ" can be blank, .05, .05(II), .08, .08(II), .10, .18, .08D, .18D, 0.82, .002, .00S, 05S, 08S, .20(II), A, A.05, A.08, A.10, A.18, (II), A(II), A.05(II), A.08(II), A.082(II), A.10(II), A.18(II), H, H(II), H.05(II), H.08(II), HC.20(II), HC.20(II), M, M(II), M.05(II), MC.20(II)
URE	URE modules with 35 mm frames DyZxxxaa Where "D" can be D or F, "y" can be A, 6 or 7; "Z" can be K or M; and "aa" can be H3A, H4A, H8A, E7G-BB, E8G or E8G-BB
Vikram	Vikram solar modules with 40 mm frames VSyy.ZZ.AAA.bb Where "yy" can be M, P, MBB, MH, MS, MHBB, or PBB; "ZZ" can be 60 or 72; "AAA" is the module power rating; and "bb" can be 03, 04 or 05
VSUN	VSUN modules with 30, 35 and 40 mm frames VSUNxxx-YYz-aa Where "YY" can be 60, 72, 108, 120, or 144; "z" can be M, P, MH, PH, or BMH; and "aa" can be blank, BB, BW, or DG

MODULE COMPATIBILITY

Waaree	Waaree modules with 40mm frames WSyy-xxx where “yy” can be blank, M, or MB
Winaico	Winaico modules with 35 and 40 mm frames Wsy-xxxZa Where "y" can be either P or T; "Z" can be either M, P, or MX; and "a" can be blank or 6
Yingli	Yingli modules with 35 and 40 mm frames YLxxxZ-yy Where "Z" can be D or P; "yy" can be 29b, 30b, 34d, 35b, 36b or 40d
ZN Shine	ZN Shine modules with 35mm frames ZXMY-AAA-xxx/M Where "Y" can be 6 or 7, "AAA" can be 72, NH120, NH144, NHDB144, NHLDD144, SH144, SHDB144 or SHLDD144

FRAMELESS MODULE LIST

MAKE	MODELS
Astronergy Solar	Astronergy frameless modules CHSM6610P(DG)-xxx
Canadian Solar	Canadian Solar frameless modules CSbY-xxx-Z Where “b” can be 3 or 6; “Y” is K, P, U, or X; and “Z” can be M-FG, MS-FG, P-FG, MB-FG, or PB-FG
Heliene	Heliene frameless modules YYZZxxxA Where "YY" can be72; "ZZ" can be M; and "A" can be GH
Jinko	Jinko frameless modules JKMxxxPP-DV
Prism Solar	Prism Solar frameless modules BZYY-xxxAAA Where "Z" can be i or N; "YY" can be 48, 60, 60S, 72 or 72S; and "AAA" can be blank or BSTC
Risen	Risen frameless modules RSMyy-6-xxxZZ Where “yy” can be 60, 72, 120 or 144; and “ZZ” can be MDG or PDG
Stion	Stion frameless modules STL-xxx or STL-xxxA
Sunpreme	Sunpreme frameless modules GXB-xxxYY Where “YY” can be blank or SL
Trina	Trina frameless modules TSM-xxxYY Where “YY” can be either DEG5(II), DEG5.07(II), DEG5.40(II), DEG5.47(II), DEG14(II), DEG14C(II), DEG14C.07(II), DEG14.40(II), PEG5, PEG5.07, PEG5.40, PEG5.47, PEG14, or PEG14.40

FLASH LOC

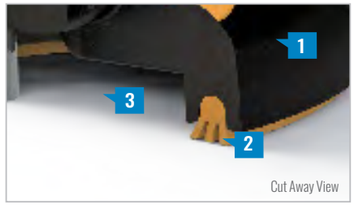
UNIRAC
BETTER SOLAR STARTS HERE

FLASHLOC is the ultimate attachment for composition shingle and rolled comp roofs. The all-in-one mount installs fast — no kneeling on hot roofs to install flashing, no prying or cutting shingles, no pulling nails. Simply drive the lag bolt and inject sealant into the base. **FLASH**LOC's patented TRIPLE SEAL technology preserves the roof and protects the penetration with a permanent pressure seal. Kitted with lag bolts, sealant, and hardware for maximum convenience. Don't just divert water, **LOC it out!**

TESTED TO TAS-100
WIND DRIVEN RAIN TEST
AND UL441 RAIN TEST

PROTECT THE ROOF

Install a high-strength waterproof attachment without lifting, prying or damaging shingles.



LOC OUT WATER

With an outer shield 1 contour-conforming gasket 2 and pressurized sealant chamber 3 the Triple Seal technology delivers a 100% waterproof connection.

HIGH-SPEED INSTALL

Simply drive lag bolt and inject sealant into the port 4 to create a permanent pressure seal.

FLASH LOC

INSTALLATION GUIDE

UNIRAC
BETTER SOLAR STARTS HERE

PRE-INSTALL

Snap chalk lines for attachment rows. On shingle roofs, snap lines 1-3/4" below upslope edge of shingle course. Locate rafters and mark attachment locations.

At each location, drill a 7/32" pilot hole. Clean roof surface of dirt, debris, snow, and ice. Next, BACKFILL ALL PILOT HOLES WITH SEALANT.

NOTE: Space mounts per racking system install specifications.

STEP 1: SECURE

Place **FLASH**LOC over pilot hole with lag on down-slope side. Align indicator marks on sides of mount with chalk line. Pass included lag bolt and sealing washer through **FLASH**LOC into pilot hole. Drive lag bolt until mount is held firmly in place.

NOTE: The EPDM in the sealing washer will expand beyond the edge of the metal washer when proper torque is applied.

STEP 2: SEAL

Insert tip of UNIRAC provided sealant into port. Inject until sealant exits both vents.

Continue array installation, attaching rails to mounts with provided T-bolts.

NOTE: When **FLASH**LOC is installed over gap between shingle tabs or vertical joints, fill gap/joint with sealant between mount and upslope edge of shingle course.

USE ONLY UNIRAC APPROVED SEALANTS: Chemlink Duralink 50, Chemlink M-1, Geocel 4500, or Geocel S-4

FASTER INSTALLATION. 25-YEAR WARRANTY.

FOR QUESTIONS OR CUSTOMER SERVICE VISIT UNIRAC.COM OR CALL (505) 248-2702

CONSULTING ENGINEERS INC.

11/22/2022

SANDBOX SOLAR
430 NORTH COLLEGE AVE
FORT COLLINS, CO 80524

Attn.: To Whom It May Concern

re job: PARKER RESIDENCE
116 PEARL ST
FORT COLLINS, CO 80521

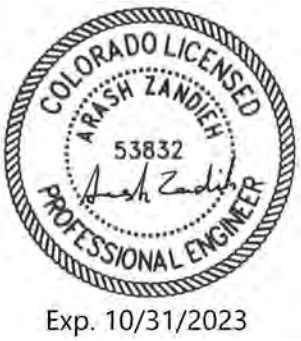
The following calculations are for the structural engineering design of the photovoltaic panels and are valid only for the structural info referenced in the stamped plan set. The verification of such info is the responsibility of others.
After review, I certify that the roof structure has sufficient structural capacity for the applied PV loads.

All mounting equipment shall be designed and installed per manufacturer's approved installation specifications.

Design Criteria:

Code:	2021 IBC		
	ASCE 7-16		
Live Load:	20	psf	
Ult Wind Speed:	140	mph	
Exposure Cat:	C		
Ground Snow:	35	psf	Min Roof Snow: 30

AHZ Consulting Egineers Inc.
Professional Engineer
projects@ahzengineers.com



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Roof Properties:

	Roof 1
Roof Type =	Shingle
Roof Pitch (deg) =	30.3
Mean Roof Height (ft) =	13
Attachment Trib Width (ft) =	2.75
Attachment Spacing (ft) =	4
Framing Type =	Truss
Framing Size =	2x8
Framing OC Spacing (in.) =	24
Section Thickness, b (in.) =	1.5
Section Depth, d (in.) =	7.25
Section Modulus, Sx (in.^3) =	13.1
Moment of Inertia, Ix (in.^4) =	47.6
Framing Span (ft) =	8
Deflection Limit D+L (in.) =	1.6
Deflection Limit S or W (in.) =	1.07
Attachments Pattern =	Fully Staggered
Framing Upgrade =	Adequate
Sister Size =	NA
Wood Species =	DF #2
Wood Fb (psi) =	900
Wood Fv (psi) =	180
Wood E (psi) =	1600000
C_D (Wind) =	1.6
C_D (Snow) =	1.15
C_{LS} =	1.15
$C_M = C_t = C_L = C_i$ =	1.0
C_F =	1.2
C_{fu} =	1.00
C_r =	1.15
F'b_wind (psi) =	2285
F'b_snow (psi) =	1643
F'v_wind (psi) =	288
F'v_snow (psi) =	207
M_allowable_wind (lb-ft) =	2503
M_allowable_snow (lb-ft) =	1799
V_allowable_wind (lbs) =	2088
V_allowable_snow (lbs) =	1501

E' (psi) =	1600000

Load Calculation:

Dead Load Calculations:

Panels Dead Load (psf) =	3.0
	Roof 1
Roofing Weight (psf) =	3.0
Decking Weight (psf) =	2.0
Framing Weight (psf) =	1.2
Misc. Additional Weight (psf) =	1.0
Existing Dead Load (psf) =	7.2
Total Dead Load (psf) =	10.2

Snow Load Calculations:

Ground Snow Load, pg (psf) =	35
Min Flat Snow, pf_min (psf) =	30
Min Sloped Snow, ps_min (psf) =	NA
Snow Importance Factor, Ic =	1.0
Exposure Factor, Ce =	0.9
	Roof 1
Thermal Factor, Ct =	1.2
Flat Roof Snow, pf (psf) =	30
Slope Factore, Cs =	1.00
Sloped Roof Snow, ps (psf) =	30

Wind Load Calculations:

Ultimate Wind Speed (mph) =	140
Directionality Factor, kd =	0.85
Topographic Factor, kzt =	1.0
	Roof 1
Velocity Press Exp Factor, kz =	0.85
Ground Elevation Factor, ke =	1.00
Velocity Pressure, qz (psf) =	36.2
Array Edge Factor, γE =	1.25
Solar Equalization Factor, γa =	0.64
External Pressure Up, GCp_1 =	-1.5
External Pressure Up, GCp_2 =	-1.8
External Pressure Up, GCp_3 =	-2.2
External Pressure Down, GCp =	0.8
Design Pressure Up, p_1 (psf) =	-43.8
Design Pressure Up, p_2 (psf) =	-52.5

Design Pressure Up, p_3 (psf) =	-64.2
Design Pressure Down, p (psf) =	23.3

Hardware Checks:

Lag Screw Checks:

	Roof 1
Ref. Widthrawal Value, W (lb/in) =	266
(C_M = C_t = C_{eg} = 1.0) C_D =	1.6
Adjusted Widthrawal Value, W' (lb/in) =	426
Lag Penetration, p (in.) =	3.67
Allowable Widthrawal Force, W'p (lbs) =	1561.952
Applied Uplift Force (lbs) =	-399
Uplift DCR =	**0.26**
Ref. Lateral Value, Z (lbs) =	270
(C_M = C_t = C_Δ = C_{eg} = 1.0) C_D =	1.15
Adjusted Lateral Value, Z' (lbs) =	311
Applied Laeral Force (lbs) =	183
Angle of Resultant Force, α (deg) =	65
,djusted Interaction Lateral Value, Z'_α (lbs) =	918
Lateral DCR =	**0.20**

Roof Framing Checks:

Force Checks:

	Roof 1
LC1: D+S	
Applied Moment (lb-ft) =	429
Applied Shear (lbs) =	322
Allowable Moment (lb-ft) =	1799
Allowable Shear (lbs) =	1501
Moment DCR =	**0.24**
Shear DCR =	**0.21**
LC2: D+0.6W	
Applied Moment (lb-ft) =	259
Applied Shear (lbs) =	194
Allowable Moment (lb-ft) =	2503
Allowable Shear (lbs) =	2088
Moment DCR =	**0.10**
Shear DCR =	**0.09**

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LC3: D+0.75(S+0.6W)

Applied Moment (lb-ft) =	461
Applied Shear (lbs) =	346
Allowable Moment (lb-ft) =	2503
Allowable Shear (lbs) =	2088
Moment DCR =	**0.18**
Shear DCR =	**0.17**

LC4: 0.6D+0.6W

Applied Moment (lb-ft) =	214
Applied Shear (lbs) =	161
Allowable Moment (lb-ft) =	2503
Allowable Shear (lbs) =	2088
Moment DCR =	**0.09**
Shear DCR =	**0.08**

Deflection Checks (Service Level):

	Roof 1
LC1: D+L	
Deflection (in.) =	0.01
Deflection Limit (in.) =	1.84
Deflection DCR =	**0.00**
LC2: S	
Deflection (in.) =	0.01
Deflection Limit (in.) =	1.23
Deflection DCR =	**0.01**
LC3: W (Down)	
Deflection (in.) =	0.00
Deflection Limit (in.) =	1.23
Deflection DCR =	**0.00**
LC4: W (Up)	
Deflection (in.) =	-0.01
Deflection Limit (in.) =	1.23
Deflection DCR =	**0.01**

Seismic Check:

Existing Weight:

Wall Weight (psf) =	17
Tributary Wall Area (ft^2) =	1000
Total Wall Weight (lbs) =	17000
Roof Weight (psf) =	7

Roof Area (ft^2) =	2400
Total Roof Weight (lbs) =	17391
Total Existing Weight (lbs) =	**34391**

Additional PV Weight:

PV Panel Weight (lbs) =	54
Number of Panels =	9
Total Additional PV Weight (lbs) =	**490**

Weight Increase:

(Existing W + Additional W)/(Existing W) = 101%

The increase in weight as a result of the solar system is less than 10% of the existing structure and therefore no further seismic analysis is required.

Limits of Scope of Work and Liability:

Existing structure is assumed to have been designed and constructed following appropriate codes at time of erection, and assumed to have appropriate permits. The calculations produced are only for the roof framing supporting the proposed PV installation referenced in the stamped planset and were completed according to generally recognized structural analysis standards and procedures, professional engineering and design experience, opinions and judgements. Existing deficiencies which are unknown or were not observable during time of inspection are not included in this scope of work. All PV modules, racking, and mounting equipment shall be designed and installed per manufacturer's approved installation specifications. The Engineer of Record and the engineering consulting firm assume no responsibility for misuse or improper installation. This analysis is not stamped for water leakage. Framing was determined based on information in provided plans and/or photos, along with engineering judgement. Prior to commencement of work, the contractor shall verify the framing sizes, spacings, and spans noted in the stamped plans, calculations, and cert letter (where applicable) and notify the Engineer of Record of any discrepancies prior to starting construction. Contractor shall also verify that there is no damaged framing that was not addressed in stamped plans, calculations, and cert letter (where applicable) and notify the Engineer of Record of any concerns prior to starting construction.

11/22/2022

SANDBOX SOLAR, 430 NORTH COLLEGE AVE, FORT COLLINS, CO 80524

Subject: Structural Certification for Installation of Residential Solar
re job: PARKER RESIDENCE, 116 PEARL ST, FORT COLLINS, CO 80521

Attn.: To Whom It May Concern

A field observation was performed to document the existing framing of the above mentioned address. From the field observation, the existing roof structure was observed as:

ROOF 1: Shingle roofing supported by 2x8 Truss @ 24 in. OC spacing. The roof is sloped at approximately 30.3 degrees and has a max beam span of 8 ft between supports.

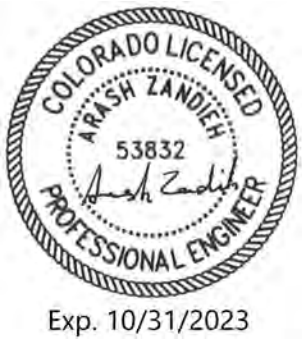
Design Criteria:

Code:	2021 IBC (ASCE 7-16)		
Ult Wind Speed:	140 mph	Ground Snow:	35 psf
Exposure Cat:	C	Min Roof Snow:	30 psf

After review of the field observation report and based on our structural capacity calculations in accordance with applicable building codes, the existing roof framing supporting the proposed solar panel layout has been determined to be:

ROOF 1: adequate to support the imposed loads. Therefore, no structural upgrades are required.

AHZ Consulting Egineers Inc.
Professional Engineer
projects@ahzengineers.com



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