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

REPORT OF ALTERATIONS TO DESIGNATED RESOURCE
Site Number/Address: 416 E. Plum Street
Laurel School National Register Historic District
ISSUED: August 24, 2021

Susan Catherine Ayasse
416 E. Plum St
Fort Collins, CO 80524

Dear Ms. Ayasse:

This report is to document proposed alterations to the Charles A. & Alice Jensen Property at 416 E. Plum Street, pursuant to Fort Collins Municipal Code Chapter 14, Article IV. A copy of this report may be forwarded to the Colorado Office of Archaeology and Historic Preservation.

The alterations include:

- Installation of twenty-six (26) flush-mounted solar panels and accompanying utility equipment on the roof.

Our staff review of the proposed work finds the alterations do not meet the SOI Standards for Treatment of Historic Properties. A summary is provided below:

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 property's use is not being altered.**	**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.* **The property was built in c.1920 (no building permit for a house is in the record, but in 1920 a frame garage was built at the address, suggesting the home was built around the same time. The first owner on record appears on that 1920 permit as Earl Grant. The first occupants that appear in a city directory are**	**N**

Charles and Alice Jensen, listed as homeowners in 1922, but without occupations.

1948 Assessor Image, Fort Collins Museum of Discovery, https://fchc.contentdm.oclc.org/digital/collection/ph/id/11457/rec/8

1969 Assessor Image, Fort Collins Museum of Discovery, https://fchc.contentdm.oclc.org/digital/collection/ph/id/11458/rec/9

The solar panel installation meets some of the provisions of this Standard, mainly by being flush-mounted to avoid introducing a new roof shape. However, the guidelines for solar installations on historic buildings recommend that panels be installed toward the rear of the roof to reduce visibility (a good rule-of-thumb is to keep panels on the rear 50% of a roof). These panels extend to the front of the roof and will be highly visible from Plum Street. Staff acknowledges the site and roof form constraints that compelled this layout decision.

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.* **The solar panels and accompanying equipment are clearly recognizable as new features that do not date from the historic district's historic period (roughly 1880-1940).**	**Y**
SOI #4	*Changes to a property that have acquired historic significance in their own right will be retained and preserved.* **The project is not affecting or removing potentially historic alterations. Documented changes to the property include:** - **1920 – frame garage constructed for owner Earl Grant** - **1931 – reroof (asphalt composition)** - **1934 – porch glassed in** - **1949 – garage & chicken house reroofed** - **1986 – reroof** - **2013 – reroof**	**N/A**
SOI #5	*Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property will be preserved.*	**N/A**
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.* **No excavation is involved in this project scope.**	**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.* **As noted above, the solar panels do follow some of the guidelines for rooftop solar on residential buildings, mainly by being flush-mounted to match the roof slope. However, they are placed forward onto the front of the roof and will be highly visible, making them not compatible with the architectural features of**	**N**

	the building. Staff acknowledges the site and roof form constraints that compelled this layout decision.	
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.* **Solar panels are generally fully reversible with minimal damage to historic properties.**	**Y**

Staff expects the property to remain contributing to the Laurel School Historic District and eligible for tax incentives, including the Colorado Historic Tax Credit.

If you have any questions regarding this review, please contact me. I may be reached at jbertolini@fcgov.com or at 970-416-4250.

Sincerely,

Jim Bertolini
Historic Preservation Planner

PHOTOVOLTAIC SYSTEM

PV SYSTEM SUMMARY: 9.230 KW

RESIDENTIAL PHOTOVOLTAIC SYSTEM

SYSTEM SIZE (DC)	:	STC: 26 X 355 = 9230W DC
	:	PTC: 26 X 326.8 = 8497W DC
SYSTEM SIZE (CEC-AC)	:	26 X 326.8 X 99% =8411.83W AC
MODULES	:	26 X LONGI SOLAR: LR4-60HPB-355M
OPTIMIZERS	:	26 X SOLAR EDGE: P401
INVERTER	:	SOLAR EDGE: SE6000H-US [SI1]
TILT	:	28°, 28°
AZIMUTH	:	271°, 91°
ROOF	:	COMPOSITION SHINGLE
RAFTER/TRUSS SIZE	:	2X4 TRUSS @ 24" O.C.
ATTACHMENT TYPE	:	UNIRAC: SFM INFINITY MICRORAIL WITH UNIRAC SFM INFINITY RAIL-LESS
MAIN SERVICE PANEL	:	EXISTING 200 AMPS MSP WITH (E) 125 AMPS MAIN BREAKER ON TOP FED
INTERCONNECTION	:	PV BREAKER TIES IN MSP
OCPD RATING	:	35 AMPS
UTILITY	:	CITY OF FORT COLLINS

TABLE OF CONTENTS

PV-1	SITE LOCATION AND HOUSE AERIAL VIEW
PV-2	SITE PLAN
PV-2A	ROOF PLAN WITH MODULES LAYOUT
PV-3	MOUNTING DETAILS
PV-4	THREE LINE DIAGRAM
PV-5	EXISTING SERVICE PANEL
PV-6	NOTES AND EQUIPMENT LIST
PV-7	LABELS
PV-7A	SITE PLACARD
PV-8	OPTIMIZER CHART
PV-9 & 10	SAFETY PLAN

CITY NOTES:

THIS PROJECT COMPLIES WITH THE FOLLOWING:
2018 International Building Code
2018 International Residential Code
2018 International Energy Conservation Code
2018 International Mechanical Code
2018 International Fuel Gas Code
2018 International Swimming Pool and Spa Code
2018 International Plumbing Code
2020 National Electric Code
2006 International Property Maintenance Code
2017 ICC
AS ADOPTED BY CITY OF FORT COLLINS

CONDUIT AND CONDUCTOR SPECIFICATIONS ARE BASED ON MINIMUM CODE REQUIREMENTS AND ARE NOT MEANT TO LIMIT UP-SIZING AS REQUIRED BY FIELD CONDITIONS.

ALL SOLAR ENERGY SYSTEM EQUIPMENT SHALL BE SCREENED TO THE MAXIMUM EXTENT POSSIBLE AND SHALL BE PAINTED A COLOR SIMILAR TO THE SURFACE UPON WHICH THEY ARE MOUNTED.

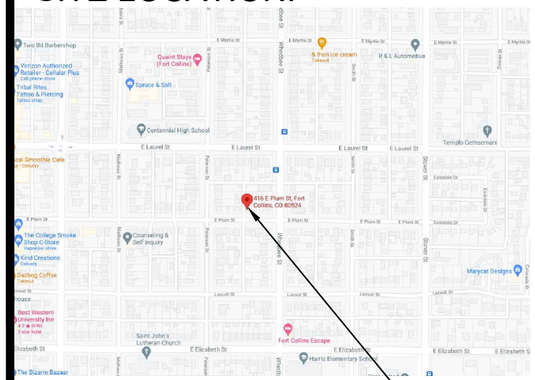
MODULES SHALL BE TESTED , LISTED AND INDENTIFIED WITH FIRE CLASSIFICATION IN ACCORDANCE WITH UL 2703. SMOKE AND CARBON MONOXIDE ALARMS ARE REQUIRED PER SECTION R314 AND 315 TO BE VERIFIED AND INSPECTED BY INSPECTOR IN THE FIELD.

INSTALLATION NOTES:

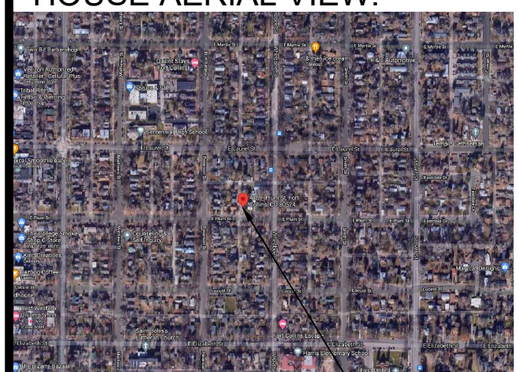
DIG ALERT (811) TO BE CONTACTED AND COMPLIANCE WITH EXCAVATION SAFETY PRIOR TO ANY EXCAVATION TAKING PLACE

INSTALL CREW TO VERIFY ROOF STRUCTURE PRIOR TO COMMENCING WORK.
EMT CONDUIT ATTACHED TO THE ROOF USING CONDUIT MOUNT.

SITE LOCATION:



HOUSE AERIAL VIEW:



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FREEDOM FOREVER COLORADO LLC
9959 E GEDDES AVE, CENTENNIAL, CO 80112
Tel: (800) 385-1075

ELECTRICAL CONTRACTOR NO:
ELECTRICAL CONTRACTOR
EC.0101397; MASTER ELECTRICIAN
ME.0601313

GREG ALBRIGHT

CLIENT:
AYASSE, SUSAN C.
416 E PLUM ST,
FORT COLLINS, CO 80524

REVISIONS:

DESCRIPTION	DATE	REVISION

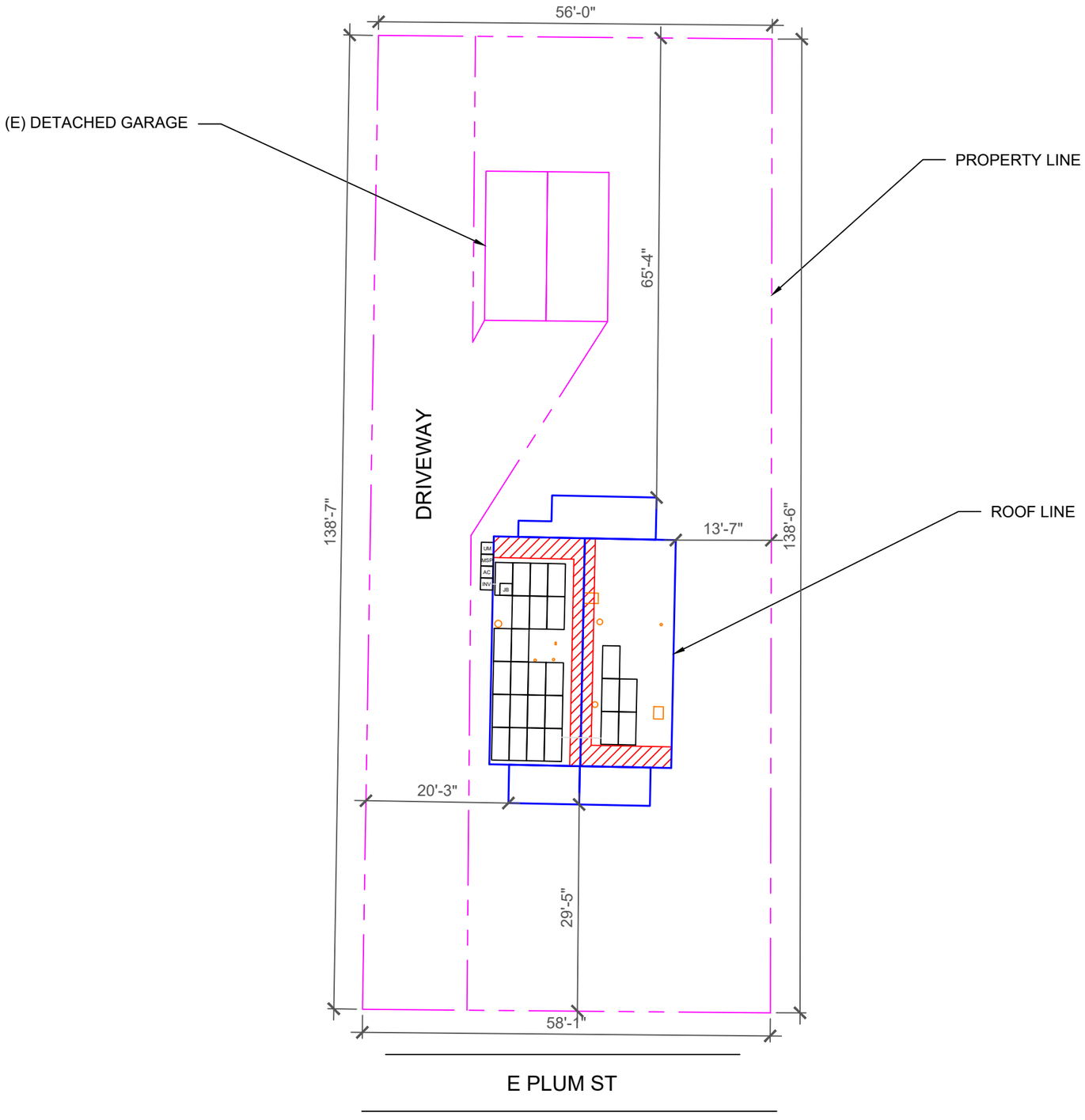
DATE:	7/9/2021
DESIGN BY:	AW
JOB NO.:	F095048

TITLE:
SITE LOCATION AND HOUSE AERIAL VIEW

SHEET:
PV-1

ROOF AREA : 2156.00 SQ FT

PV SYSTEM
9.230 kW-DC
6.000 kW-AC



LEGEND:

- CHIMNEY
- PIPE VENT
- ATTACHMENTS
- MODULES
- RAFTERS
- RAIL
- SETBACK
- AC — AC DISCONNECT
- MSP — MSP
- JB — JUNCTION BOX
- PM — PRODUCTION METER
- INV — INVERTER
- SUB — SUB PANEL

SITE PLAN
SCALE: 0.004883

1

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JOB NO.:	F095048

TITLE: SITE PLAN

SHEET: PV-2

ROOF AREA : 2156 SQ FT

PV SYSTEM
9.230 kW-DC
6.000 kW-AC

ROOF AREA STATEMENT

ROOF	MODULES QTY	PITCH	AZIMUTH	ROOF AREA	ARRAY AREA	ARRAY COVERAGE %	SYSTEM DISTRIBUTED WEIGHT	ATTACHMENT POINT-LOAD
1	21	28°	271°	411.78 SQ FT	379.05 SQ FT	21.77%	2.31 PSF	6.30 LBS
2	5	28°	91°	716.33 SQ FT	90.25 SQ FT			

COLORADO LICENSED
JAMES ADRIAN ADAMS
14793
PROFESSIONAL ENGINEER

LEGEND:

- CHIMNEY
- PIPE VENT
- ATTACHMENTS
- MODULES
- RAFTERS
- RAIL
- SETBACK
- AC — AC DISCONNECT
- MSP — MSP
- JB — JUNCTION BOX
- PM — PRODUCTION METER
- INV — INVERTER
- SUB — SUB PANEL

NOTES:
1. EMT CONDUIT ATTACHED TO THE ROOF USING CONDUIT MOUNTS
2. ATTACHED CLAMPS AT 25% FROM THE EDGE AND 50% FROM THE CENTER OF THE MODULES
3. JUNCTION BOX IS MOUNTED TO THE RAIL.

ROOF PLAN
SCALE: 0.012452

1

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FORT COLLINS, CO 80524

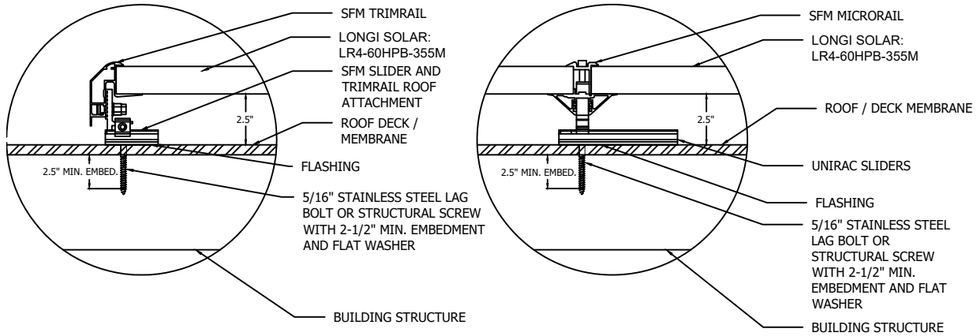
REVISIONS:

DESCRIPTION	DATE	REVISION

DATE: 7/9/2021
DESIGN BY: AW
JOB NO.: F095048

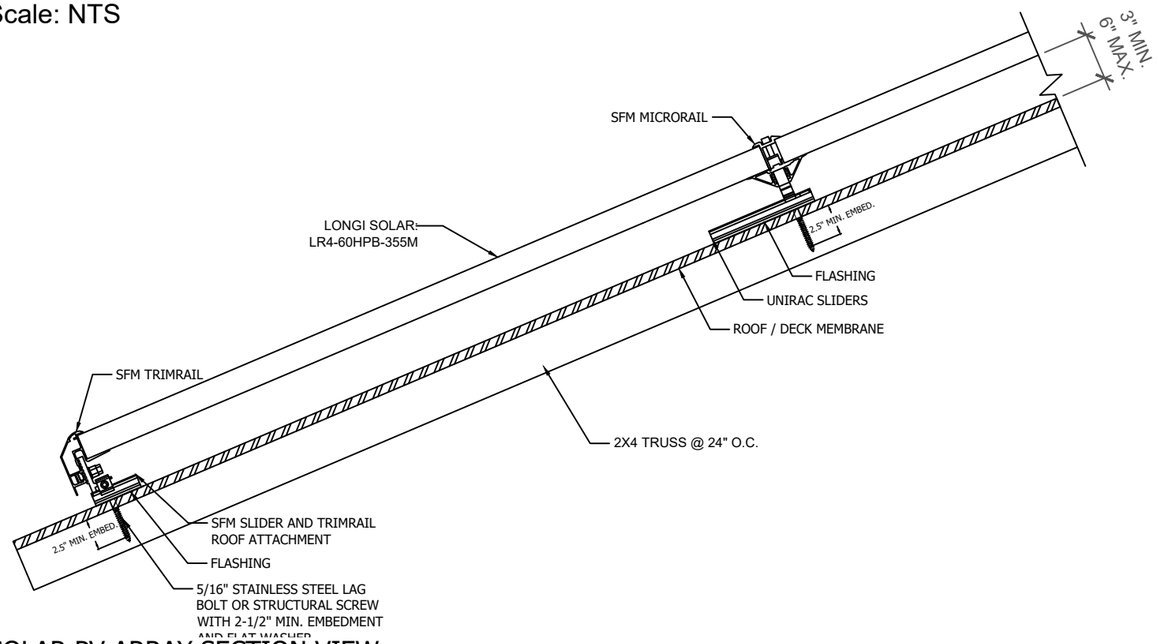
TITLE: ROOF PLAN W/ MODULES LAYOUT

SHEET: PV-2A



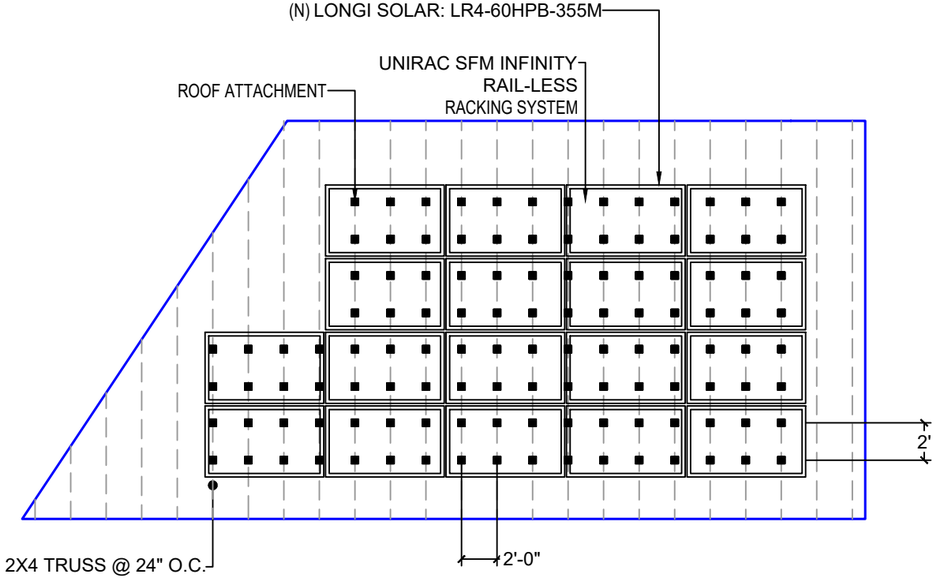
ATTACHMENT DETAIL

Scale: NTS



SOLAR PV ARRAY SECTION VIEW

Scale: NTS



PARTIAL ROOF FRAMING PLAN

Scale: NTS

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REVISIONS:

DESCRIPTION	DATE	REVISION

DATE:	7/9/2021
DESIGN BY:	AW
JOB NO.:	F095048

TITLE: MOUNTING DETAILS

SHEET: PV-3

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14793
PROFESSIONAL ENGINEER

BACKFEED BREAKER SIZING

MAX. CONTINUOUS OUTPUT 25A @ 240V

25 X 1.25 = 31.25AMPS 35A BREAKER - OK

SEE 705.12 OF 2020 NEC

200 X 1.20 = 240

240 - 125 = 115A ALLOWABLE BACKFEED

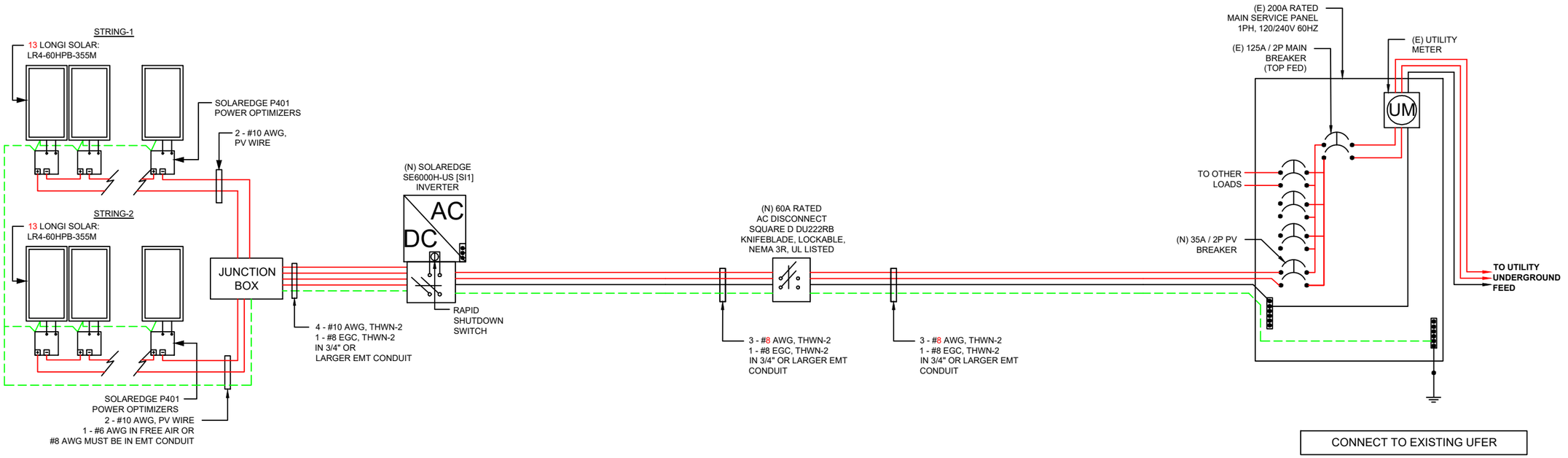
PV SYSTEM

9.230 kW-DC

6.000 kW-AC

CONDUCTOR AMPACITY DE-RATE CALCULATION

	EQUIPMENT				WIRE LOCATION	CONDUCTOR QTY.	AWG WIRE SIZE	NEC FACTORS TABLE 310.15(B)(16)	NEC FACTORS TABLE 310.15(B)(2)(a)	CONDUCTOR AMPACITY @90C ADJ.	NEC FACTORS TABLE 310.15(B)(3)(a)
1	AC	INVERTER	TO	AC DISCONNECT	EXTERIOR WALL	3	8	50	1	50	1.00
2	AC	AC DISCONNECT	TO	POI	EXTERIOR WALL	3	8	50	1	50	1.00



NOTE:
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REVISIONS:

DESCRIPTION	DATE	REVISION

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DESIGN BY:	AW
JOB NO.:	F095048

TITLE: THREE LINE DIAGRAM

SHEET: PV-4

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REVISIONS:

DESCRIPTION	DATE	REVISION

DATE:	7/9/2021
DESIGN BY:	AW
JOB NO.:	F095048

TITLE:

EXISTING SERVICE PANEL

SHEET:

PV-5

GENERAL NOTES:

26 LONGI SOLAR WIRED AND LISTED TO UL1703 STANDARDS

THE SOLAREDGE INVERTER IS INTEGRATED WITH DC DISCONNECTION AND ARC FAULT PROECTION. IT IS ATTACHED WITH SYSTEM ELECTRICAL SPECIFICATIONS W/ GROUND FAULT PROTECTION & LISTED TO UL 1741 STANDARDS.

PHOTOVOLTAIC SYSTEM GROUND WILL BE TIED INTO EXISTING GROUND AT MAIN SERVICE FROM DC DISCONNECT/INVERTER AS PER 2020 NEC SEC 250.166(A).

SOLAR PHOTOVOLTAIC SYSTEM EQUIPMENT WILL BE INSTALLED IN ACCORDANCE WITH REQUIREMENTS OF ART. 690 OF THE 2020 NEC

CONDUIT ABOVE ROOF SHALL BE NO LESS THAN 1 INCH FROM TOP OF THE ROOF TO BOTTOM OF RACEWAY. TABLE NEC 310.15(B)(3)(C)

PHOTOVOLTAIC DC CONDUCTORS ENTERING THE BUILDING SHALL BE INSTALLED IN METALLIC RACEWAY AND SHALL BE IDENTIFIED EVERY 10 FEET -- AND WITHIN 1 FOOT ABOVE AND BELOW PENETRATIONS OF ROOF/CEILING ASSEMBLIES WALLS OR BARRIERS -- WITH MINIMUM 3/8-INCH-HIGH WHITE LETTERING ON RED BACKGROUND READING: WARNING: PHOTOVOLTAIC POWER SOURCE.

SYSTEM GROUNDING ELECTRODE CONDUCTOR FOR PV SYSTEM TO BE SIZED TO MEET THE REQUIREMENTS OF 2020 NEC

THE EXISTING MAIN SERVICE PANEL WILL BE EQUIPPED WITH A GROUND ROD OR UFER

UTILITY COMPANY WILL BE NOTIFIED PRIOR TO ACTIVIATION OF THE SOLAR PV SYSTEM

TERMINALS OF THE DISCONNECTING MEANS MAY BE ENERGIZED IN THE OPEN POSITION

SOLAREDGE INVERTERS ARE LISTED TO UL 1741 AND UL 1699B STANDARDS

SOLAREDGE OPTIMIZERS ARE LISTED TO IEC 62109-1 (CLASS II SAFETY) AND UL 1741 STANDARDS

MATERIAL LIST:

QTY.	PART	PART #	DESCRIPTION
26	MODULES	114-355	LONGI SOLAR: LR4-60HPB-355M
26	OPTIMIZERS	130-401	P401 SOLAREDGE POWER OPTIMIZER - FRAME MOUNTED MODULE ADD-ON
1	JUNCTION BOX	480-276	600VDC NEMA 3R UL LISTED JUNCTION BOX
2	CONNECTORS	240-300	STAUBLI / MULTI-CONTACT MC4 CONNECTORS (FEMALE)
2	CONNECTORS	240-301	STAUBLI / MULTI-CONTACT MC4 CONNECTORS (MALE)
1	INVERTER	120-601	SE6000H-US [SI1] 240V INVERTER UL1741 SA CERTIFIED INTEGRATED ARC FAULT PROTECTION AND RAPID SHUTDOWN
1	AC DISCONNECT	323-060	60A RATED 240VAC NEMA 3R UL LISTED
1	ROOF ATTACHMENT 1	261-602	UNIRAC: SFM INFINITY MICRORAIL
45	MICRORAIL 1	261-602	SFM MICRORAIL 2 INCH
19	SFM TRIM 1	241-253	FLASHKIT SFM TRIM COMP DARK
49	SFM SLIDER 1	261-603	FLASHKIT SFM SLIDER COMP DARK
15	BONDING CLAMP 1	221-100	SFM N/S BONDING CLAMP
6	BONDING CLAMP 1	241-404	SFM TRIM BONDING CLAMP
28	MOUNT ASSEMBLY 1	241-405	MLPE MOUNT ASSY
16	SFM SPLICE 1	261-604	SFM SPLICE
4	SFM ATTACHED SPLICE 1	211-101	SFM ATTACHED SPLICE 8 INCH
22	TRIMRAIL 1	261-606	SFM TRIMRAIL UNIV CLIP W/ HDW
7	TRIM SPLICE 1	261-605	SFM TRIM SPLICE DRK
12	TRIMRAIL 1	211-115	SFM TRIMRAIL UNIV DRK
26	GROUND LUG 1	260-585	ILSCO GROUND LUG
26	TRIM END CAPS 1	221-200	UNIRAC SFM TRIM END CAPS

BREAKER SIZES:

35A PV BREAKER

SERVICE:

FREEDOM FOREVER COLORADO LLC
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GREG ALBRIGHT

CLIENT:

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416 E PLUM ST,
FORT COLLINS, CO 80524

REVISIONS:

DESCRIPTION	DATE	REVISION

DATE:	7/9/2021
DESIGN BY:	AW
JOB NO.:	F095048

TITLE: NOTES AND EQUIPMENT LIST

SHEET: PV-6

NOTES:

1. NEC ARTICLES 690 AND 705 AND NEC SECTION R324 MARKINGS SHOWN HEREON.
2. ALL MARKING SHALL CONSIST OF THE FOLLOWING:
   - A. UV RESISTANT SIGN MATERIAL WITH ENGRAVED OR MACHINE PRINTED LETTERS OR ELECTRO-PLATING.
   - B. RED BACKGROUND COLOR WHITE TEXT AND LINE WORK.
   - C. AERIAL FONT.
3. ALL SIGNS SHALL BE SIZED APPROPRIATELY AND PLACED IN THE LOCATIONS SPECIFIED. SIGNAGE CANNOT BE HAND-WRITTEN.
3. SIGNS SHALL BE ATTACHED TO THE SERVICE EQUIPMENT WITH POP-RIVETS OR SCREWS.

WARNING:
POWER SOURCE OUTPUT CONNECTION
DO NOT RELOCATE THIS OVERCURRENT DEVICE.

705.12(B)(2)(3)(b)

M

"WARNING"
DUAL POWER SOURCES
SECOND SOURCE IS PHOTOVOLTAIC SYSTEM
RATED AC OUTPUT CURRENT - 25.00 AMPS
AC NORMAL OPERATING VOLTAGE - 240 VOLTS

690.54

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

690.56(C)(1)(A)

PV METER

PM

AC

PV SYSTEM AC DISCONNECT
RATED AC OUTPUT CURRENT - **25.00** AMPS
AC NORMAL OPERATING VOLTAGE - 240 VOLTS

690.15, 690.54

RAPID SHUTDOWN SWITCH FOR SOLAR PV SYSTEM

690.56(C)(3)

INVERTER

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

690.13 (B)

PV SYSTEM DC DISCONNECT
MAXIMUM VOLTAGE: 480V
MAXIMUM CIRCUIT CURRENT: 25A
MAX RATED OUTPUT CURRENT OF THE CONTROLLER OR DC-TO-DC CONVERTER: 15A

690.53

DC

J/B

ARRAY

NEC 690.31(G)(3) & (4)

"WARNING"
PHOTOVOLTAIC POWER SOURCE

EVERY 10' ON CONDUIT AND ENCLOSURES

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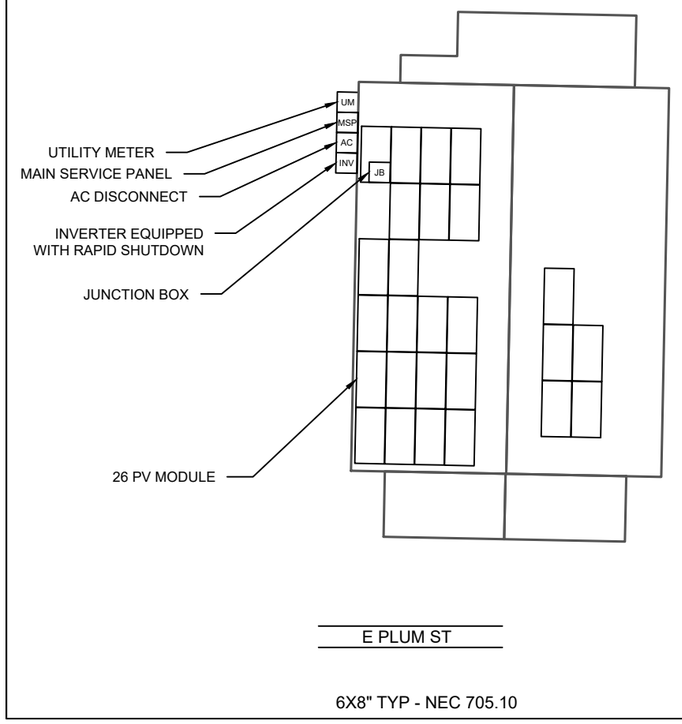
TITLE: LABELS

SHEET: PV-7

CAUTION:

MULTIPLE SOURCES OF POWER LOCATED AS SHOWN.
DANGEROUS VOLTAGE MAY BE PRESENT AT ALL TIMES



6X8" TYP - NEC 705.10

NOTES:

1. NEC ARTICLES 690 AND 705 AND NEC SECTION R324 MARKINGS SHOWN HEREON.
2. ALL MARKING SHALL CONSIST OF THE FOLLOWING:
   A. UV RESISTANT SIGN MATERIAL WITH ENGRAVED OR MACHINE PRINTED LETTERS OR ELECTRO-PLATING.
   B. RED BACKGROUND COLOR WHITE TEXT AND LINE WORK.
   C. AERIAL FONT.
3. ALL SIGNS SHALL BE SIZED APPROPRIATELY AND PLACED IN THE LOCATIONS SPECIFIED. SIGNAGE CANNOT BE HAND-WRITTEN.
3. SIGNS SHALL BE ATTACHED TO THE SERVICE EQUIPMENT WITH POP-RIVETS OR SCREWS.

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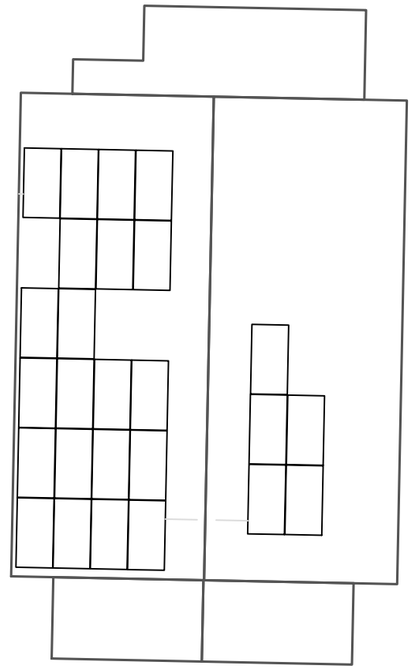
TITLE: LABELS

SHEET: PV-7A

SOLAREDGE OPTIMIZER CHART

	1-10	11-20	21-30	31-40	41-50	51-60
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						



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FREEDOM FOREVER COLORADO LLC
9959 E GEDDES AVE, CENTENNIAL, CO 80112
Tel: (800) 385-1075

ELECTRICAL CONTRACTOR NO:
ELECTRICAL CONTRACTOR
EC.0101397; MASTER ELECTRICIAN
ME.0601313

GREG ALBRIGHT

CLIENT:

AYASSE, SUSAN C.

416 E PLUM ST,
FORT COLLINS, CO 80524

REVISIONS:

DESCRIPTION	DATE	REVISION

DATE:	7/9/2021
DESIGN BY:	AW
JOB NO.:	F095048

TITLE: OPTIMIZER CHART

SHEET: PV-8

SAFETY PLAN

INSTRUCTIONS:

1. USE SYMBOLS IN KEY TO MARK UP THIS SHEET.
2. SAFETY PLAN MUST BE MARKED BEFORE JOB STARTS AS PART OF THE PRE-PLAN
3. DOCUMENT ALL ADDITIONAL HAZARDS ON THIS PAGE & MAKE NOTES ON THE JHA SHEET

IN CASE OF EMERGENCY

NEAREST HOSPITAL OR OCCUPATIONAL/INDUSTRIAL CLINIC

NAME: _____

ADDRESS: _____

SAFETY COACH CONTACT INFORMATION

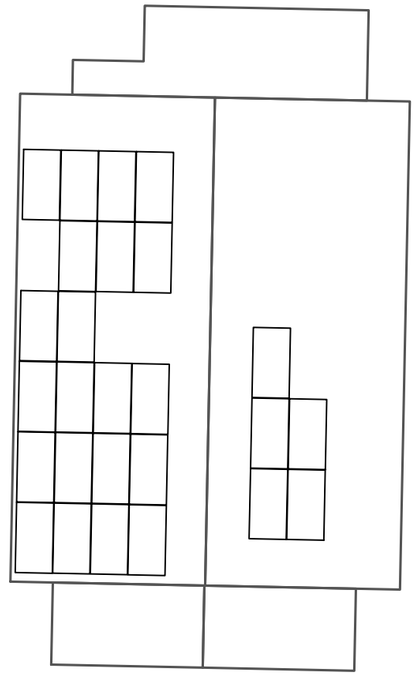
NAME: _____

ADDRESS: _____

ALL EMPLOYEES ON SITE SHALL BE MADE AWARE OF THE SAFETY PLAN AND SIGN INDICATING THAT THEY ARE AWARE OF THE HAZARDS ON-SITE AND THE PLAN FOR WORKING SAFELY.

NAME	SIGNATURE

DATE: _____ TIME:_____



MARK UP KEY

- (P) PERMANENT ANCHOR
- (T) TEMPORARY ANCHOR
- [IL] INSTALLER LADDER
- [B] JUNCTION / COMBINER BOX
- [S] STUB-OUT
- SKYLIGHT
- NO LADDER ACCESS (STEEP GRADE OR GROUND LEVEL OBSTRUCTIONS)
- RESTRICTED ACCESS
- CONDUIT
- (GAS) GAS SHUT OFF
- (H_2O) WATER SHUT OFF
- (7) SERVICE DROP
- (Z) POWER LINES

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REVISIONS:

DESCRIPTION	DATE	REVISION

DATE:	7/9/2021
DESIGN BY:	AW
JOB NO.:	F095048

TITLE: SAFETY PLAN

SHEET: PV-9

JOB HAZARD ANALYSIS

Crew leader to fill out all sections below, hold a pre-job safety meeting with all personnel, and upload this completed document and the Safety Plan to Site Capture

Ladder Access

- Ladders must be inspected before each use.
- Extension ladders must be set up on a firm and level surface at a 4-to-1 rise to run angle (or 75 degrees) and the top must be secured to the structure. Extension style ladders placed on uneven, loose or slippery surfaces must additionally have the base firmly anchored or lashed so the base will not slip out.
- Extension ladders must be used with walk-through devices or the ladder must extend 36" above the stepping off point.
- A-frame ladders must only be climbed with the ladder spreader bars locked in the open position; A-frame ladders shall not be climbed while in the closed position (ex, closed and used while leaned against a structure).
- Additional notes:

Mobile Equipment

- Only Qualified operators will operate equipment; operators must maintain a certification on their person for the equipment being operated.
- Type(s) of mobile equipment (Type/Make/Model):
- Qualified operator(s):

Material Handling and Storage

- Materials will be staged/stored in a way that does not present a hazard to client, personnel or public. Materials stored on the roof will be physically protect from failing or sliding off.

Fall Protection

- A site-specific plan for fall prevention and protection is required prior to starting work and must remain onsite at all times until work is complete; a fall rescue plan must be outlined and discussed among the crew prior to work start.
- First-person-Up (FPU) must install their anchor and connect before any other task, including installing other anchors. The Last-Person-Down (LPD) must be the only person on a roof uninstalling fall protection.
- FPCP (name and title):
- FPU and LPD (name and title):

Electrical Safety

- The Electrical Qualified Person (EQP) is required onsite to perform electrical work.
- All electrical work will be performed with equipment in an electrically safe condition (de-energized) unless approval has been granted prior to work.
- Service drops and overhead electrical hazards will be indentified and protected from contact, as neccessary.
- EQP (name and tile):

Public Protection

- The safety of the Client and the Public must be maintained at all times.
- The Client and the Public shall be prevented from entering the work zone through the use of barriers and/or signage, as required.
- Company, Client and Public property shall be protect from falling objects.
- Pets (including dogs) shall be secured by their owners prior to work start.
- The client should not leave pets, family members, or others in the charge or care of Employees, Contractors, or Temporary Workers.
- Crew leader responsible for communication with the client:
- Client and public is excluded from work area by barricades (N/A, Yes, No):

Training and Pre-Job Safety Briefing

- All employees onsite shall be made aware of the specific hazards of this project and review this HJA during a pre-job briefing, and their signature indicates awareness of site conditions and the plan to eliminate any hazards identified prior to and during the project.
- Crew leader (name/title):
- Crew member (name/title):
- Crew member (name/title):
- Crew member (name/title):
- Crew member (name/title):

Airborne Contaminants:

- Asbestos-containing (Transite) piping (ACP) - Do not disturb (move, drill, cut fracture, etc.)
- Asbestos-containing thermal insulation (ACI) and Asbestos-containing duct wrapping (ACW) - do not disturb, no attic or crawlspace access is allowed if work to be performed could cause exposure to personnel, client or public.
- If yes, list specific tasks and protection in place:

Weather and Environment

- The site supervisor shall forecast the weather conditions at the job site, prior to crew arrival, in order to mitigate any hazards associated with inclement weather (heat, cold, wind, rain, etc.)
- The site supervisor will utilized a portable wind meter (anemometer) to verify actual onsite wind conditions, by checking at the ground and on any elevated work surface (ex, rooftop) prior to work start, at midday and prior to solar panel staging on a roof.
- Elevated work involving the moving or maneuvering of solar panels shall cease at 25mph (sustained wind) until wind subsides.
- Forecasted weather maximum temp (degrees F):

Heat Related Illness Prevention

- Employees shall have access to potable drinking water that is fresh, pure, and suitably cool. The water shall be located as close as practicable to the areas where employees are working. Water shall be supplied in sufficient quantity at the beginning of the work shift to provide at least one quart per employee per hour for drinking for the entire shift. Employees may begin the shift with smaller quantities of water if they identify the location and have effective means for replenishment during the shift to allow employees to drink on quart or more per hour. The frequent drinking of water shall be encouraged.
- Shade shall be present when temperature exceeds 80 degrees Fahrenheit. When the outdoor temperature in the work exceeds 80 degrees Fahrenheit, employees shall have and maintain one or more areas with shade at all times.
- New employees must be acclimatized. New employees will be monitored by their Crew Leader (site supervisor) for the first two (2) weeks of employment or longer when necessary.
- Employees will be allowed and encouraged to implement scheduled breaks during each shift. Employees must take cool-down breaks in the shade any time they feel the need to do so to protect them from overheating. Supervisors are REQUIRED to allow employees any break period they need during high heat conditions.
- Cool Vests are encouraged for all employees at all times during periods of high heat.
- Identify the location of the closet Occupational/Industrial Clinic or Hospital in case a crew member becomes ill.

What is the specific plan to provide and replenish sufficient water for all employees on site?

- If offsite replenish is necessary, where will you go to replenish water (location/address):
- Who will replenish the drinking water (name):

Restroom facilities

- Employees shall have access to restroom facilities with hand-washing stations. Use of onsite restroom is at the client's discretion (location is annotated below). If client does not give permission, location of suitable restroom facilities with hand-washing stations offsite will be provided. The onsite supervisor will identify location and make arrangements to ensure all employees have access at any point.
- Restroom facilities will be (circle one): Onsite - Offsite
- If Offsite, add location name and address:

Incident Reporting Procedure

- Contact your Site Supervisor

  Name:

  Phone:
- Contact your Manager

  Name:

  Phone:
- Contact your Site Supervisor

  Name:

  Phone:

With: Your full name, phone number, office location, brief description of what happen and when.

NOTE ADDITIONAL HAZARDS NOT ADDRESSED ABOVE
(add as many as necessary by using additional sheets)

Define the Hazard:	Method/steps to prevent incident:
Define the Hazard:	Method/steps to prevent incident:
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REVISIONS:

DESCRIPTION	DATE	REVISION

DATE:	7/9/2021
DESIGN BY:	AW
JOB NO.:	F095048

TITLE: SAFETY PLAN

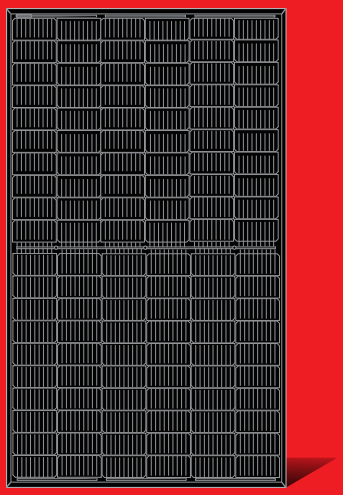
SHEET: PV-10

LR4-60HPB
345~370M

Hi-MO 4m (Black)

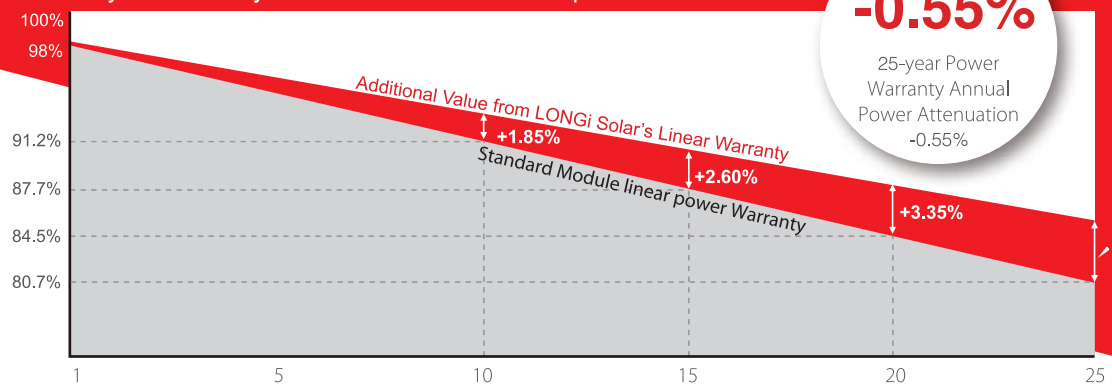
NEW

High Efficiency Low LID Mono PERC with Half-cut Technology



*Both 6BB & 9BB are available

12-year Warranty for Materials and Processing;
25-year Warranty for Extra Linear Power Output



-0.55%
25-year Power Warranty Annual Power Attenuation -0.55%

+4.10%

Complete System and Product Certifications

IEC 61215, IEC 61730, UL 61730

ISO 9001:2008: ISO Quality Management System

ISO 14001: 2004: ISO Environment Management System

TS62941: Guideline for module design qualification and type approval

OHSAS 18001: 2007 Occupational Health and Safety

* Specifications subject to technical changes and tests.
LONGi Solar reserves the right of interpretation.

Positive power tolerance (0 ~ +5W) guaranteed

High module conversion efficiency (up to 20.3%)

Slower power degradation enabled by Low LID Mono PERC technology: first year <2%, 0.55% year 2-25

Solid PID resistance ensured by solar cell process optimization and careful module BOM selection

Reduced resistive loss with lower operating current

Higher energy yield with lower operating temperature

Reduced hot spot risk with optimized electrical design and lower operating current

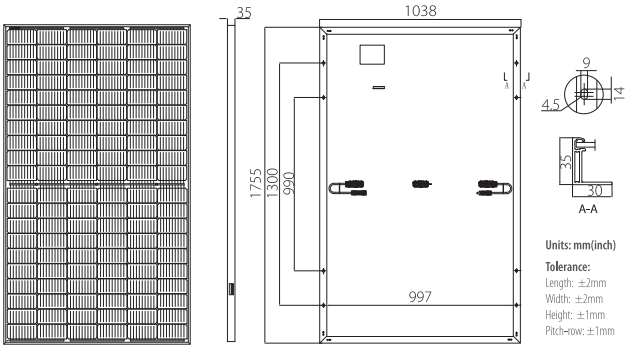
LONGi

Room 801, Tower 3, Lujiazui Financial Plaza, No.826 Century Avenue, Pudong Shanghai, 200120, China
Tel: +86-21-80162606 E-mail: module@longi-silicon.com Facebook: www.facebook.com/LONGi Solar

20200401V11

LR4-60HPB **345~370M**

Design (mm)



Mechanical Parameters

Cell Orientation: 120 (6×20)

Junction Box: IP68, three diodes

Output Cable: 4mm², 300mm in length, length can be customized

Glass: Single glass
3.2mm coated tempered glass

Frame: Anodized aluminum alloy frame

Weight: 19.5kg

Dimension: 1755×1038×35mm

Packaging: 30pcs per pallet
180pcs per 20'GP
780pcs per 40'HC

Operating Parameters

Operational Temperature: -40℃~+85℃

Power Output Tolerance: 0~+5 W

Voc and Isc Tolerance: ±3%

Maximum System Voltage: DC1000V (IEC/UL)

Maximum Series Fuse Rating: 20A

Nominal Operating Cell Temperature: 45±2℃

Safety Class: Class II

Fire Rating: UL type 1 or 2

Electrical Characteristics

Test uncertainty for Pmax: ±3%

Model Number	LR4-60HPB-345M		LR4-60HPB-350M		LR4-60HPB-355M		LR4-60HPB-360M		LR4-60HPB-365M		LR4-60HPB-370M	
Testing Condition	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT
Maximum Power (Pmax/W)	345	257.6	350	261.4	355	265.1	360	268.8	365	272.6	370	276.3
Open Circuit Voltage (Voc/V)	40.2	37.7	40.4	37.9	40.6	38.1	40.8	38.2	41.0	38.4	41.2	38.6
Short Circuit Current (Isc/A)	11.06	8.95	11.16	9.02	11.25	9.09	11.33	9.16	11.41	9.23	11.50	9.30
Voltage at Maximum Power (Vmp/V)	34.2	31.8	34.4	32.0	34.6	32.2	34.8	32.4	35.0	32.6	35.2	32.8
Current at Maximum Power (Imp/A)	10.09	8.09	10.18	8.16	10.27	8.23	10.35	8.30	10.43	8.36	10.52	8.43
Module Efficiency(%)	18.9		19.2		19.5		19.8		20.0		20.3	

STC (Standard Testing Conditions): Irradiance 1000W/m², Cell Temperature 25℃, Spectra at AM1.5

NOCT (Nominal Operating Cell Temperature): Irradiance 800W/m², Ambient Temperature 20℃, Spectra at AM1.5, Wind at 1m/S

Temperature Ratings (STC)

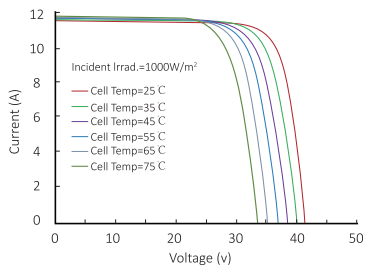
Temperature Coefficient of Isc	+0.048%/℃
Temperature Coefficient of Voc	-0.270%/℃
Temperature Coefficient of Pmax	-0.350%/℃

Mechanical Loading

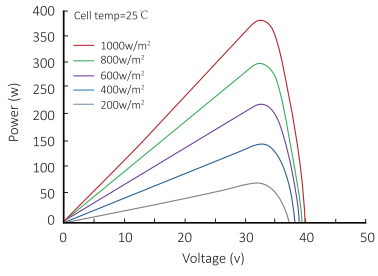
Front Side Maximum Static Loading	5400Pa
Rear Side Maximum Static Loading	2400Pa
Hailstone Test	25mm Hailstone at the speed of 23m/s

I-V Curve

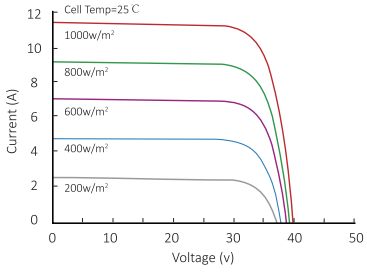
Current-Voltage Curve (LR4-60HPB-360M)



Power-Voltage Curve (LR4-60HPB-360M)



Current-Voltage Curve (LR4-60HPB-360M)



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Tel: +86-21-80162606 E-mail: module@longi-silicon.com Facebook: www.facebook.com/LONGi Solar

20200401V11

Single Phase Inverter with HD-Wave Technology

for North America

SE3000H-US / SE3800H-US / SE5000H-US / SE6000H-US / SE7600H-US / SE10000H-US / SE11400H-US

INVERTERS

12-25 YEAR WARRANTY

Optimized installation with HD-Wave technology

- Specifically designed to work with power optimizers
- Record-breaking efficiency
- Fixed voltage inverter for longer strings
- Integrated arc fault protection and rapid shutdown for NEC 2014 and 2017, per article 690.11 and 690.12
- UL1741 SA certified, for CPUC Rule 21 grid compliance
- Extremely small
- Built-in module-level monitoring
- Outdoor and indoor installation
- Optional: Revenue grade data, ANSI C12.20 Class 0.5 (0.5% accuracy)

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Single Phase Inverter with HD-Wave Technology for North America

SE3000H-US / SE3800H-US / SE5000H-US / SE6000H-US/ SE7600H-US / SE10000H-US / SE11400H-US

	SE3000H-US	SE3800H-US	SE5000H-US	SE6000H-US	SE7600H-US	SE10000H-US	SE11400H-US	
OUTPUT								
Rated AC Power Output	3000	3800 @ 240V 3300 @ 208V	5000	6000 @ 240V 5000 @ 208V	7600	10000	11400 @ 240V 10000 @ 208V	VA
Maximum AC Power Output	3000	3800 @ 240V 3300 @ 208V	5000	6000 @ 240V 5000 @ 208V	7600	10000	11400 @ 240V 10000 @ 208V	VA
AC Output Voltage Min.-Nom.-Max. (211 - 240 - 264)	✓	✓	✓	✓	✓	✓	✓	Vac
AC Output Voltage Min.-Nom.-Max. (183 - 208 - 229)	-	✓	-	✓	-	-	✓	Vac
AC Frequency (Nominal)	59.3 - 60 - 60.5[1]							Hz
Maximum Continuous Output Current @240V	12.5	16	21	25	32	42	47.5	A
Maximum Continuous Output Current @208V	-	16	-	24	-	-	48.5	A
GFDI Threshold	1							A
Utility Monitoring, Islanding Protection, Country Configurable Thresholds	Yes							
INPUT								
Maximum DC Power @240V	4650	5900	7750	9300	11800	15500	17650	W
Maximum DC Power @208V	-	5100	-	7750	-	-	15500	W
Transformer-less, Ungrounded	Yes							
Maximum Input Voltage	480							Vdc
Nominal DC Input Voltage	380				400			Vdc
Maximum Input Current @240V[2]	8.5	10.5	13.5	16.5	20	27	30.5	Adc
Maximum Input Current @208V[2]	-	9	-	13.5	-	-	27	Adc
Max. Input Short Circuit Current	45							Adc
Reverse-Polarity Protection	Yes							
Ground-Fault Isolation Detection	600kΩ Sensitivity							
Maximum Inverter Efficiency	99	99.2						%
CEC Weighted Efficiency	99						99 @ 240V 98.5 @ 208V	%
Nighttime Power Consumption	< 2.5							W
ADDITIONAL FEATURES								
Supported Communication Interfaces	RS485, Ethernet, ZigBee (optional), Cellular (optional)							
Revenue Grade Data, ANSI C12.20	Optional[3]							
Rapid Shutdown - NEC 2014 and 2017 690.12	Automatic Rapid Shutdown upon AC Grid Disconnect							
STANDARD COMPLIANCE								
Safety	UL1741, UL1741 SA, UL1699B, CSA C22.2, Canadian AFCI according to T.I.L. M-07							
Grid Connection Standards	IEEE1547, Rule 21, Rule 14 (HI)							
Emissions	FCC Part 15 Class B							
INSTALLATION SPECIFICATIONS								
AC Output Conduit Size / AWG Range	3/4" minimum / 14-6 AWG					3/4" minimum /14-4 AWG		
DC Input Conduit Size / # of Strings / AWG Range	3/4" minimum / 1-2 strings / 14-6 AWG					3/4" minimum / 1-3 strings / 14-6 AWG		
Dimensions with Safety Switch (HxWxD)	17.7 x 14.6 x 6.8 / 450 x 370 x 174					21.3 x 14.6 x 7.3 / 540 x 370 x 185		in / mm
Weight with Safety Switch	22 / 10		25.1 / 11.4	26.2 / 11.9		38.8 / 17.6		lb / kg
Noise	< 25				<50			dBA
Cooling	Natural Convection							
Operating Temperature Range	-40 to +140 / -25 to +60[4] (-40°F / -40°C option)[5]							°F / °C
Protection Rating	NEMA 4X (Inverter with Safety Switch)							

[1] For other regional settings please contact SolarEdge support
[2] A higher current source may be used; the inverter will limit its input current to the values stated
[3] Revenue grade inverter P/N: SExxxxH-US000NNC2
[4] For power de-rating information refer to: https://www.solaredge.com/sites/default/files/se-temperature-derating-note-na.pdf
[5] -40 version P/N: SExxxxH-US000NNU4

RoHS

Power Optimizer

P370 / P401 / P404 / P405 / P485 / P500 / P505

POWER OPTIMIZER

PV power optimization at the module level

- Specifically designed to work with SolarEdge inverters
- Up to 25% more energy
- Next generation maintenance with module-level monitoring
- Mitigates all types of modules mismatch-loss, from manufacturing tolerance to partial shading
- Superior efficiency (99.5%)
- Flexible system design for maximum space utilization
- Module-level voltage shutdown for installer and firefighter safety
- Fast installation with a single bolt

solaredge

/ Power Optimizer

P370 / P401 / P404 / P405 / P485 / P500 / P505

OPTIMIZER MODEL (typical module compatibilty)	P370 (60/72 Cell modules)	P401 (For high power 60/72-cell modules)	P404 (for 60/72-cell short strings)	P405 (for high-voltage modules)	P485 (for high-voltage modules)	P500 (for 96-cell modules)	P505 (for higher current modules)	UNIT
INPUT								
Rated Input DC Power[1]	370	400	405	405	485	500	505	W
Absolute Maximum Input Voltage (Voc at lowest temperature)	60		80	125		80	83	Vdc
MPPT Operating Range	8 - 60		12.5 - 80	12.5 - 105		8 - 80	12.5-83	Vdc
Maximum Short Circuit Current (Isc)	11	11.75	11			10.1	14	Adc
Maximum Efficiency	99.5							%
Weighted Efficiency	98.8							%
Overvoltage Category	II							
OUTPUT DURING OPERATION (POWER OPTIMIZER CONNECTED TO OPERATING SOLAREDGE INVERTER)								
Maximum Output Current	15							Adc
Maximum Output Voltage	60		85			60	85	Vdc
OUTPUT DURING STANDBY (POWER OPTIMIZER DISCONNECTED FROM SOLAREDGE INVERTER OR SOLAREDGE INVERTER OFF)								
Safety Output Voltage per Power Optimizer	1 ± 0.1							Vdc
STANDARD COMPLIANCE								
EMC	FCC Part15 Class B, IEC61000-6-2, IEC61000-6-3							
Safety	IEC62109-1 (class II safety), UL1741							
RoHS	Yes							
Fire Safety	VDE-AR-E 2100-712:2013-05							
INSTALLATION SPECIFICATIONS								
Maximum Allowed System Voltage	1000							Vdc
Dimensions (W x L x H)	129 x 153 x 27.5 / 5.1 x 6 x 1.1	129 x 153 x29.5 / 5.08 x6.02 x 1.16	129 x 89 x 42.5 / 5.1 x 3.5 x 1.7	129 x 90 x 49.5 / 5.1 x 3.5 x 1.9		129 x 153 x 33.5 / 5.1 x 6 x 1.3	129 x 162 x 59 / 5.1 x 6.4 x 2.3	mm / in
Weight (including cables)	655 / 1.5		775 / 1.7	845 / 1.9		750 / 1.7	1064 / 2.3	gr / lb
Input Connector	MC4[2]				Single or Dual MC4[2][3]	MC4[2]		
Input Wire Length	0.16 / 0.52							m / ft
Output Connector	MC4							
Output Wire Length	1.2 / 3.9							m / ft
Operating Temperature Range	-40 - +85 / -40 - +185							˚C / ˚F
Protection Rating	IP68							
Relative Humidity	0 - 100							%

(1) Rated power of the module at STC will not exceed the optimizer "Rated Input DC Power". Modules with up to +5% power tolerance are allowed.
(2) For other connector types please contact SolarEdge.
(3) For dual version for parallel connection of two modules use the P485. In the case of an odd number of PV modules in one string, installing one P485 dual version power optimizer connected to one PV module is supported. When connecting a single module, seal the unused input connectors using the supplied pair of seals.

PV SYSTEM DESIGN USING A SOLAREDGE INVERTER[4][5]		SINGLE PHASE HD-WAVE	SINGLE PHASE	THREE PHASE	THREE PHASE FOR 277/480V GRID	
Minimum String Length (Power Optimizers)	P370, P401, P500[6]	8		16	18	
	P404, P405, P485, P505	6		14 (13 with SE3K[7])	14	
Maximum String Length (Power Optimizers)		25		50	50	
Maximum Power per String		5700	5250	11250[8]	12750[9]	W
Parallel Strings of Different Lengths or Orientations		Yes				

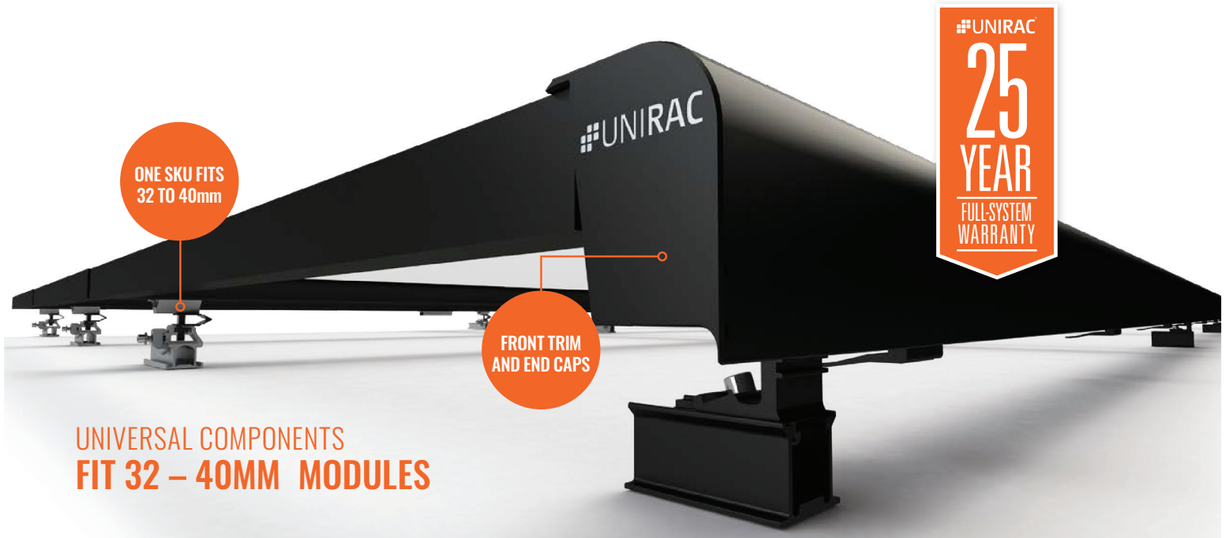
(4) It is not allowed to mix P404/P405/P485/P505 with P370/P401/P500/P600/P650/P730/P801/P800p/P850/P950 in one string.
(5) For SE15k and above, the minimum DC power should be 11KW.
(6) The P370/P401/P500 cannot be used with the SE3K three phase inverter (available in some countries; refer to the three phase inverter SE3K-SE10K datasheet).
(7) Exactly 10 when using SE3K-RW010BNN4
(8) For the 230/400V grid: it is allowed to install up to 13,500W per string when the maximum power diference between each string is 2,000W.
(9) For the 277/480V grid: it is allowed to install up to 15,000W per string when the maximum power diference between each string is 2,000W

CE

SFM INFINITY

UNIRAC®
BETTER SOLAR STARTS HERE

Take your business to the next level with **SFM** INFINITY, UNIRAC's rail-less PV mounting system for flush mount installations on comp shingle and tile roofs. An advanced 3rd generation product platform in use by top solar contractors nationwide, **SFM** INFINITY optimizes your operations on and off the roof, with approximately 40% less labor, 30% logistics savings, and 20% fewer roof attachments than traditional solar racking. Plus, 87% of homeowners prefer **SFM** INFINITY's aesthetics.



SUPERIOR PERFORMANCE
Enhance your business with two installs per day and 30% less cost.

EASY INSTALLATION
Pre-assembled components, 20% fewer roof attachments, and level array in seconds with post height adjustment.

HOMEOWNER PREFERRED
More than 4 out of 5 homeowners prefer **SFM** INFINITY'S aesthetics over a leading rail brand.

SFM INFINITY

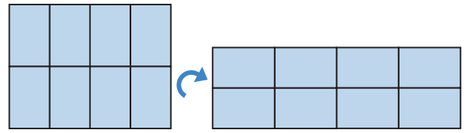
UNIRAC®
BETTER SOLAR STARTS HERE

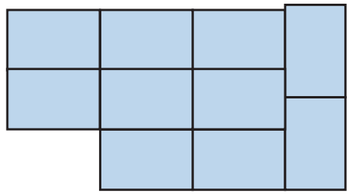
DESIGN GUIDELINES

While you will see advantages simply from switching to **SFM** INFINITY, the following guidelines will help you to maximize its benefits.

DEFAULT TO LANDSCAPE

When possible, design in landscape orientation in order to fit more modules on the roof and minimize roof attachments.





MIX MODULE ORIENTATIONS

SFM INFINITY is easily configured in mixed array shapes and module orientations to maximize array density and to avoid vent pipes and other obstacles. Because mounting locations are not constrained by rails, **SFM** INFINITY has unmatched flexibility to enhance your projects.

CONSULT THE QUICK TIPS VIDEOS

Visit UNIRAC's mobile-friendly library of short, topic-specific videos which answer common questions and demonstrate how simple it is to install **SFM** INFINITY.

Quick Tips Videos: **https://unirac.com/SFM-Infinity/**

DESIGN IN U-BUILDER

Layout your arrays in **U-Builder**, UNIRAC's free solar design software, to optimize **SFM** INFINITY'S capabilities, including mixing module orientations and minimizing roof attachments. Quickly create layouts on Google or Bing Maps and generate project documents.

U-Builder: **https://design.unirac.com/**

REVOLUTIONIZING ROOFTOP SOLAR

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

2.0 Product Description	
Product	Photovoltaic Mounting System, Sun Frame Microrail - Installed Using Unirac Installation Guide, Rev PUB2019MAR01 with Annex North Row Extension Installation Guide Rev PUB2019FEB20
Brand name	Unirac
Description	The product covered by this report is the Sun Frame Micro Rail roof mounted Photovoltaic Rack Mounting System. This system is designed to provide bonding and grounding to photovoltaic modules. The mounting system employs anodized or mill finish aluminum brackets that are roof mounted using the slider, outlined in section 4 of this report. There are no rails within this product, whereas the 3" Micro Rail, Floating Splice, and 9" Attached Splice electrically bond the modules together forming the path to ground. The Micro Rails are installed onto the module frame by using a stainless steel bolt anodized with black oxide with a stainless type 300 bonding pin, torqued to 20 ft-lbs, retaining the modules to the bracket. The bonding pin of the Micro Rail when bolted and torqued, penetrate the anodized coating of the photovoltaic module frame to contact the metal, creating a bonded connection from module to module. The grounding of the entire system is intended to be in accordance with the latest edition of the National Electrical Code, including NEC 250: Grounding and Bonding, and NEC 690: Solar Photovoltaic Systems. Any local electrical codes must be adhered in addition to the national electrical codes. The Grounding Lug is secured to the photovoltaic module, torqued in accordance with the installation manual provided in this document. Other optional grounding includes the use of the Enphase UL2703 certified grounding system, which requires a minimum of 2 micro-inverters mounted to the same rail, and using the same engage cable.
Models	Unirac SFM

2.0 Product Description	
Model Similarity	NA
Ratings	**Fuse Rating:** 30A **Module Orientation:** Portrait or Landscape **Maximum Module Size:** 17.98 ft² **UL2703 Design Load Rating:** 33 PSF Downward, 33 PSF Upward, 10 PSF Down-Slope Tested Loads - 50 psf/2400Pa Downward, 50psf/2400Pa Uplift, 15psf/720Pa Down Slope Trina TSM-255PD05.08 and Sunpower SPR-E20-327 used for Mechanical Loading Increased size ML test: **Maximum Module Size:** 22.3 ft² **UL2703 Design Load Rating:** 113 PSF Downward, 50 PSF Upward, 30 PSF Down-Slope LG355S2W-A5 used for Mechanical Loading test. **Mounting configuration:** Four mountings on each long side of panel with the longest span of 24" **UL2703 Design Load Rating:** 46.9 PSF Downward, 40 PSF Upward, 10 PSF Down-Slope LG395N2W-A5, LG360S2W-A5 and LG355S2W-A5 used for used for Mechanical Loading test. **Mounting configuration:** Six mountings for two modules used with the maximum span of 74.5" Fire Class Resistance Rating: - Class A for Steep Slope Applications when using Type 1 Modules. Can be installed at any interstitial gap. Installations must include Trim Rail. - Class A for Steep Slope Applications when using Type 2 Modules. Can be installed at any interstitial gap. Installations must include Trim Rail. - Class A Fire Rated for Low Slope applications with Type 1 or 2 listed photovoltaic modules. This system was evaluated with a 5” gap between the bottom of the module and the roof’s surface *See section 7.0 illustraction # 1 and 1a for a complete list of PV modules evaluated with these racking systems*
Other Ratings	NA

AUTHORIZATION TO MARK

This authorizes the application of the Certification Mark(s) shown below to the models described in the Product(s) Covered section when made in accordance with the conditions set forth in the Certification Agreement and Listing Report. This authorization also applies to multiple listee model(s) identified on the correlation page of the Listing Report.

This document is the property of Intertek Testing Services and is not transferable. The certification mark(s) may be applied only at the location of the Party Authorized To Apply Mark.

Applicant:	Unirac, Inc	**Manufacturer:**	Cixi Emeka Aluminum Co. Ltd
Address:	1411 Broadway Blvd NE Albuquerque, NM 87102	**Address:**	No. 688 ChaoSheng Road Cixi City Zhejiang Province 315311
Country:	USA	**Country:**	China
Contact:	Klaus Nicolaedis Tom Young	**Contact:**	Jia Liu Robin Luo
Phone:	505-462-2190 505-843-1418	**Phone:**	+86-15267030962 +86-13621785753
FAX:	NA	**FAX:**	NA
Email:	klaus.nicolaedis@unirac.com toddg@unirac.com	**Email:**	jia.liu@cxymj.com buwan.luo@cxymj.com

Party Authorized To Apply Mark: Same as Manufacturer
Report Issuing Office: Lake Forest, CA U.S.A.

Control Number: *5003705* **Authorized by:** Natalie Tohmey

for Dean Davidson, Certification Manager

This document supersedes all previous Authorizations to Mark for the noted Report Number.

Intertek Testing Services NA Inc.
545 East Algonquin Road, Arlington Heights, IL 60005
Telephone 800-345-3851 or 847-439-5667 Fax 312-283-1672

Standard(s):	Mounting Systems, Mounting Devices, Clamping/Retention Devices, and Ground Lugs for Use with Flat-Plate Photovoltaic Modules and Panels [UL 2703: 2015 Ed.1]
Product:	Photovoltaic Mounting System, Sun Frame Microrail - Installed Using Unirac Installation Guide, Rev PUB2019MAR01 with Annex North Row Extension Installation Guide Rev PUB2019FEB20
Brand Name:	Unirac
Models:	Unirac SFM

March 12, 2020

Unirac
1411 Broadway Blvd. NE
Albuquerque, NM 87102

Attn.: Unirac - Engineering Department

Re: Engineering Certification for the Unirac Sunframe Microrail, SFM Infinity U-builder Software Version 1.0

PZSE, Inc. - Structural Engineers has reviewed the Unirac's Sunframe Microrail, proprietary mounting system constructed from modular parts which is intended for rooftop installation of solar photovoltaic (PV) panels; and has reviewed the U-builder Online tool. This U-Builder software includes analysis for the 2" Microrail, 8" Attached Splice, 6" splice, and front trimrail. All information, data and analysis contained within are based on, and comply with the following codes and typical specifications:

1. Minimum Design Loads for Buildings and other Structures, ASCE/SEI 7-05, ASCE/SEI 7-10, ASCE/SEI 7-16
2. 2006-2018 International Building Code, by International Code Council, Inc. w/ Provisions from SEAOC PV-2 2017.
3. 2006-2018 International Residential Code, by International Code Council, Inc. w/ Provisions from SEAOC PV-2 2017.
4. AC428, Acceptance Criteria for Modular Framing Systems Used to Support Photovoltaic (PV) Panels, November 1, 2012 by ICC-ES.

Following are typical specifications to meet the above code requirements:

Design Criteria: Ground Snow Load = 0 - 100 (psf)
Basic Wind Speed = 90 - 180 (mph)
Roof Mean Height = 0 - 60 (ft)
Roof Pitch = 0 - 45 (degrees)
Exposure Category = B, C & D

Attachment Spacing: Per U-builder Engineering report.

Cantilever: Per U-builder Engineering report.

Clearance: 2" to 10" clear from top of roof to top of PV panel.

Tolerance(s): 1.0" tolerance for any specified dimension in this report is allowed for installation.

Installation Orientation: See SFM Installation Guide.
Landscape - PV Panel long dimension is parallel to ridge/eave line of roof and the PV panel is mounted on the long side.
Portrait - PV Panel short dimension is parallel to ridge/eave line of roof and the PV panel is mounted on the short side.
Attachment shall be staggered where ground snow load exceeds 10 PSF.

1478 Stone Point Drive, Suite 190, Roseville, CA 95661
T 916.961.3960 F 916.961.3965 W www.pzse.com
Experience | Integrity | Empowerment

Testing: Values were based on UTR-299 testing provided by Unirac.

Components and Cladding Roof Zones:
The Components and Cladding Roof Zones shall be determined based on ASCE 7-05, ASCE 7-10 & 7-16 Component and Cladding design.

Notes:
1) U-builder Online tool analysis is only for Unirac SFM Sunframe Microrail system only and do not include roof capacity check.
2) Risk Category II per ASCE 7-16.
3) Topographic factor, kzt is 1.0.
4) Array Edge Factor Y_E = 1.5
5) Average parapet height is 0.0 ft.
6) Wind speeds are LRFD values.
7) Attachment spacing(s) apply to a seismic design category E or less.

Design Responsibility:
The U-Builder design software is intended to be used under the responsible charge of a registered design professional where required by the authority having jurisdiction. In all cases, this U-builder software should be used under the direction of a design professional with sufficient structural engineering knowledge and experience to be able to:

- Evaluate whether the U-Builder Software is applicable to the project, and
- Understand and determine the appropriate values for all input parameters of the U-Builder software.

This letter certifies that the Unirac SFM Sunframe Microrail, when installed according to the U-Builder engineering report and the manufacture specifications, is in compliance with the above codes and loading criteria.

This certification excludes evaluation of the following components:

1) The structure to support the loads imposed on the building by the array; including, but not limited to: strength and deflection of structural framing members, fastening and/or strength of roofing materials, and/or the effects of snow accumulation on the structure.
2) The attachment of the SFM 2" Microrail or 8" Attached Splice to the existing structure.
3) The capacity of the solar module frame to resist the loads.

This requires additional knowledge of the building and is outside the scope of the certification of this racking system.

If you have any questions on the above, do not hesitate to call.

Prepared by:
PZSE, Inc. – Structural Engineers
Roseville, CA

SOLAR-ROOF-CHECK THE RLA A RIGOROUS LOAD ANALYSIS
3000 E. Birch Street, Suite 201 Brea, CA 92821 Ph: 844-783-5483

DATE: 07-13-2021/Rev A
FOR: Freedom Forever
43445 Business Park Dr
#110
Temecula, CA 92590
USA

JOB: Ayasse, Susan C.
416 East Plum Street
Fort Collins, CO 80524

To Whom It May Concern

This letter is to certify that we have performed a structural analysis of the existing roof members that are to support photovoltaic panels, as shown on the attached report. The calculations were performed in accordance with the latest editions of IBC, NDS, ASCE/SEI, CBC, and IRC, and the latest edition of the building codes for the state of Colorado.

Our analysis was based on the following design criteria:

Ground Snow (psf)	35 psf
Sloped Snow (psf), reduced per ASCE, Sect. 7.4	30.9 psf
Basic Wind Speed (mph):	110 mph
Roof Slope:	28 degrees
The PV module orientation:	Landscape
The maximum horizontal roof mount spacing:	2 ft.
The maximum vertical roof mount spacing:	1.708 ft.
Staggered roof mounts required?	No

Based on this analysis, we can certify that the individual existing roof framing members that support the PV panels; and the individual roof members as described in the attached report; are adequate to support the design loads as required by the various codes. This includes Dead Loads (including the weight of the PV panels), Live Loads, Snow Loads, and Wind Loads, on the roof members that support the PV panels, combined as required in the codes.

If you have any questions on this or need further clarification,
please contact us at your convenience.

Sincerely,
James A. Adams, S.E.

NOTE:
1. Prior to commencement of work, the Solar Installer shall verify that the roof framing sizes, spacing, and spans (between supports), are as noted in these plans. The Engineer of Record must be notified if any discrepancies are discovered, before proceeding.
2. These plans are Stamped for Structural Code compliance of the roof members that support the PV solar system only.
3. These plans are not stamped for rain water leakage prevention.
4. As a precaution, old or wet snow should be removed from the roof, if the snow builds up to 18" or more.

Date of Report:	07-13-2021/Rev A	Job Name:	Ayasse, Susan C.
Data Input by:	Yunjae Shin	Job Number:	F095048
Contact E-mail:	yunjae@solar-roof-check.com	Job Address:	416 East Plum Street
Contact Phone:	7143322701		Fort Collins, CO 80524

ABSTRACT

This Report is based on Engineering calculations using the input data supplied by the user, listed under Current Input Data. The user input has not been independently reviewed by a licensed Professional Engineer for appropriateness or accuracy, unless Stamped by a P.E. This Report indicates Compliance/Non-Compliance with the reference Codes listed below. The following items have been checked for Code Compliance:

- Load Combination #1:
Wind Uplift on the Standoff attachment to the Roof Framing members: Wind Uplift - 0.6 * DL Solar

- Load Combination #2:
Supporting Rafter Strength with: DL Rf + DL Solar + Roof Live Load

- Load Combination #3:
Supporting Rafter Strength with: DL Rf + DL Solar + Wind Down

- Load Combination #4: Supporting Rafter Strength with: DL Rf + DL Solar + Snow

- Load Combination #5:
Supporting Rafter Strength with: DL Rf + DL Solar + .75Wind + .75Snow

- Load Combination #6: Check Additional Seismic Load

- Load Combination #7:
Supporting Rafter Strength with:
Wind Up - 0.6 * (DL Rf + DL Solar)

Job Information

Data Input By:	Yunjae Shin
Job Number:	F095048
Job Name:	Ayasse, Susan C.
Job Address:	416 East Plum Street
City, State:	Fort Collins, CO 80524

Current Input Data

Payment Method	Invoice
Roof Type	InteriorBearingWall
Ceiling Type	1/2 gyp. Bd.
Collar Tie Space	0
Coverage %	21.77
Frame Size	2x4@24
Ground Snow (psf)	35
Sloped Roof Snow Load (psf)	30.9
Lag Screw Diam. (in)	5/16
Lag Screw Embed. (in)	2.5
Overall Span (ft)	25
PV Weight (psf)	2.31
PV Module Orientation	Landscape
Rafter Span (ft)	7.5
Rail System	2Rail
Roof Mean Height (ft)	20
Roof Slope (degrees)	28
Roofing Type	Comp. Shingle
Sloped Ceiling	No
Max. Horizontal Roof Mount(ft)	2
Max. Vertical Roof Mounts (ft)	1.708
Standoff Staggered	No
Wind Exposure	C
Wind Speed (mph)	110

STRUCTURAL CALCULATIONS FOR PV INSTALLATION

Prepared for

SOLAR-ROOF-CHECK

Freedom Forever
43445 Business Park Dr, #110
Temecula CA, 92590
USA
951-239-3029

USER:	**Yunjae Shin**
COMPANY NAME:	**Freedom Forever**
SRC JOB ID:	**29936**
JOB REPORT DATE:	**2021-07-13/Rev A**
JOB NUMBER:	**F095048**
JOB NAME:	**Ayasse, Susan C.**
JOB ADDRESS:	**416 East Plum Street**
	Fort Collins, CO 80524

USER INPUT:

1.	Ceiling Type		**:= 1/2 gyp. Bd.**
2.	Collar Tie Spacing (ft)		**:= 0**
3.	Roof Coverage %		**:= 21.77**
4.	Roof Framing Size		**:= 2x4@24**
5.	Ground Snow (psf)		**:= 35**
6.	Vertical Snow Load on slope (psf)		**:= 30.9**
7.	Lag Screw Diameter (in)	:= **d**	**:= 5/16**
8.	Lag Screw Embedment (in)	:= **e**	**:= 2.5**
9.	Overall Span (ft)		**:= 25**
10.	PV Weight (psf)	:= $\mathbf{DL_{pv}}$	**:= 2.31**
11.	Rafter Sloped Span (ft)	:= $\mathbf{L_r}$	**:= 7.5**
12.	Rail System		**:= 2Rail**
13.	Roofing Type		**:= Comp. Shingle**
14.	Roof Mean Height (ft)	:= **h**	**:= 20**
15.	Roof Slope (degrees)	:= θ	**:= 28**
16.	Roof Structure Type		**:= InteriorBearingWall**
17.	Sloped Ceiling?		**:= No**
18.	S_{fh} = RF Mount Horizontal Spacing (ft)		**:= 2.00**
19.	S_{fv} = RF Mount Vertical Spacing (ft)		**:= 1.71**
20.	RF Mount Staggered		**:= No**
21.	Wind Exposure		**:= C**
22.	Wind Speed (mph)	:= **V**	**:= 110**
23.	L_{pv}=PV Length (in)		**:= 70**
24.	W_{pv} = PV Width (in)		**:= 41**
25.	Gable, Hip, or Flat/Monoslope		**:= Gable Roof**
26.	Roof Overhangs		**:= Yes**
27.	S_r= Rafter Spacing (ft)		**:= 2.00**
28.	PV Orientation		**:= Landscape**
29.	Elevation Above Sea Level (ft)	:= **Elev**	**:= 4979**

FORMULA SYMBOLS:

TA_{fp}	:=	Tributary Area to RF Mounts with **Portrait** PV Orientation (sf)
TA_{fl}	:=	Tributary Area to RF Mounts with **Landscape** PV Orientation (sf)
TA_r	:=	Tributary Area to Rafters (sf)
γ_{af}	:=	Pressure Equalization Factor for RF Mounts with **Portrait** PV Orientation
γ_{af}	:=	Pressure Equalization Factor for RF Mounts with **Landscape** PV Orientation
γ_{ar}	:=	Pressure Equalization Factor for Rafters
P_{1fp}	:=	Design Wind Pressure to RF Mounts with **Portrait** PV Orientation – **Zone 1** (psf)
P_{2fp}	:=	Design Wind Pressure to RF Mounts with **Portrait** PV Orientation – **Zone 2** (psf)
P_{1fl}	:=	Design Wind Pressure to RF Mounts with **Landscape** PV Orientation – **Zone 1** (psf)
P_{2fl}	:=	Design Wind Pressure to RF Mounts with **Landscape** PV Orientation – **Zone 2** (psf)
P_{rup}	:=	Design Wind Pressure **Up** to Rafters (psf)
P_{rdn}	:=	Design Wind Pressure **Down** to Rafters (psf)
GC_{p1}	:=	External Pressure Coefficient for RF Mounts – **Zone 1** (depends on TA Fastener)
GC_{p2}	:=	External Pressure Coefficient for RF Mounts – **Zone 2** (depends on TA Fastener)
GC_{pup}	:=	External Pressure Coefficient, **Wind Up** for Rafters (depends on TAr)
GC_{pdn}	:=	External Pressure Coefficient, **Wind Down** for Rafters (depends on TAr)
S	:=	Snow on Roof (psf)
S_{fh}	:=	RF Mount Horizontal Spacing (ft)
S_{fv}	:=	RF Mount Vertical Spacing (ft)
S_r	:=	Rafter Spacing (ft)
L_{pv}	:=	PV Length (ft)
W_{pv}	:=	PV Width (ft)
L_r	:=	Span of Rafter (ft)
γ_E	:=	Edge Array Factor

Dead Loads (DL): = psf		
Roofing		:= **2.20**
Ply		:= **1.50**
Rafter		:= **0.65**
Miscellaneous (Misc)		:= **1.00**
Clg. Joists		:= **0.65**
Insulation (Insul)		:= **0.50**
Ceiling		:= **2.20**
Flat Ceiling	DL_{tc} = Roofing + Ply + Rafter + Misc (psf)	:= **5.35**
	DL_{bc} = Clg.joists + Insul. + Ceiling (psf)	:= **3.35**
	wDL_{tc} = DL_{tc} x Sr (plf)	:= **10.70**
Sloped Ceiling	DL_{tc}=DL.tc + Insul. + Ceiling (psf)	:= **N/A**
	wDL_{tc}=DL_{tc} x Sr (plf)	:= **N/A**

DESIGN CRITERIA	**ASCE REFERENCE**		
Risk Category II	Table 1.5-1		
Importance Factor	Table 1.5-2	I	:= **1.00**
Basic Wind Speed	Fig. 26.5-1b	V	:= **110**
Wind Directionality	Table 26.6-1	K_d	:= **0.85**
Exposure Category:	Sect. 26.7.3		:= **C**
Topographic Factor	Sect. 26.8	K_{zt}	:= **1.00**
Elevation above Sea Level	Table 26.9-1	K_e	:= **0.84**
Velocity Pressure Exposure Coeff.	Table 26.10-1	K_z	:= **0.90**
Velocity Pressure	Eq. 26.10-1	q_h=.00256 x K_z x K_{zt} x K_d x K_e x V^2	:= **19.79**
Edge Array Factor	Sect. 29.4.4	γE (Zone 1) =1.0 γE (Zone2) =1.5	
PV Pressure Equalization Factor	Fig. 29.4-8	γa	:= **1.50**

RF MOUNT- Wind UP Pressure (*Note: Divide TA by 2 for 2 Rail System*)

Portrait Orientation:

ASCE Reference				
		$TA_{fl} = S_{fh} \times L_{pv}$	:=	N/A
Fig. 29.4-8		γ_a	:=	N/A
Fig. 30.3-2*	**Zone 1**:	GC_{p1}	:=	N/A
Eq. 29.4-7		$P_{1f} = q_h \times GC_{p1} \times \gamma_E \times \gamma_a$	:=	N/A
Fig. 30.3-2*	**Zone 2e:**	GC_{p2e}	:=	N/A
Eq. 29.4-7		$P_{2ef} = q_h \times GC_{p2e} \times \gamma_E \times \gamma_a$	:=	N/A
Fig. 30.3-2*	**Zone 2r:**	GC_{p2r}	:=	N/A
Eq. 29.4-7		$P_{2rf} = q_h \times GC_{p2r} \times \gamma_E \times \gamma_a$	:=	N/A

Landscape Orientation:

ASCE Reference				
		$TA_{fl} = S_{fh} \times W_{pv}$	:=	3.42
Fig. 29.4-8		γ_a	:=	1.50
Fig. 30.3-2*	**Zone 1:**	GC_{p1}	:=	1.80
Eq. 29.4-7		$P_{1f} = q_h \times GC_{p1} \times \gamma_E \times \gamma_a$	:=	53.40
Fig. 30.3-2*	**Zone 2e:**	GC_{p2e}	:=	2.60
Eq. 29.4-7		$P_{2ef} = q_h \times GC_{p2e} \times \gamma_E \times \gamma_a$	:=	115.70
Fig. 30.3-2*	**Zone 2r:**	GC_{p2r}	:=	1.80
Eq. 29.4-7		$P_{2rf} = q_h \times GC_{p2r} \times \gamma_E \times \gamma_a$	:=	80.10

***NOTE:** For Flat and Monoslope Roofs, refer to Figures 30.3-5A and 30.3-5B

RAFTERS- Wind UP Pressure

ASCE REFERENCE		$TA_r = S_{fh} \times L_r$	:=	**15.00**
Fig. 29.4-8		γ_{ar}	:=	**0.68**
Fig. 30.3-2*	**Zone 1:**	GC_{pup}	:=	**1.62**
Eq. 29.4-7		$P_{rup} = q_h \times GC_{pup} \times \gamma_E \times \gamma_a$	:=	**21.86**

RAFTERS- Wind DOWN Pressure

ASCE REFERENCE		$TA_r = S_{fh} \times L_r$	:=	**15.00**
Fig. 29. 4-8		γ_{ar}	:=	**0.68**
Fig 30. 3-2*	**Zone 1:**	GC_{pdn}	:=	**0.83**
Eq. 29.4-7		$P_{rdn} = q_h \times GC_{pdn} \times \gamma_E \times \gamma_a$	:=	**16.00**

LOAD COMB. #1: WIND UPLIFT ON RF MOUNTS (0.6DL – 0.6 Wind Up) **(Cd = 1.6)**

	t= Withdrawal Capacity (lb/inch)		t :=	**235.00**
	W= Total Withdrawal Capacity	$W := C_d \times t \times e$	W :=	**940.00**
ZONE 1	$P := TA_f \times (0.6 \times P_{1f} - 0.6 \times DL_{PV} \times \cos(\theta \times deg))$		:=	**105.29**
	% = W x 100/P_{1f}		:=	**892.8%**
	Code Compliant if % is equal to or more than 100%			
ZONE 2e	$P := TA_f \times (0.6 \times P_{2ef} - 0.6 \times DL_{PV} \times \cos(\theta \times deg))$		:=	**233.01**
	% = W x 100/P_{2ef}		:=	**403.4%**
	Code Compliant if % is equal to or more than 100%			
ZONE 2r	$P := TA_f \times (0.6 \times P_{2rf} \quad 0.6 \times DL_{PV} \times \cos(\theta \times deg))$		:=	**160.03**
	% = W x 100/P_{2rf}		:=	**587.4%**
	Code Compliant if % is equal to or more than 100%			

LOAD COMB. #2: On RaftersDL RF + DL SOLAR + RF LL (CD=1.25) with LL = 20 psf

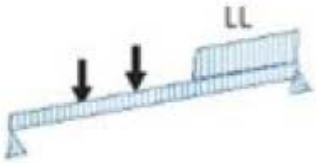
$w := LL \times S_r$ plf (plf) := **35.24**

$P_{sp} := TA_f \times DL_{PV}$:= **7.89**

$c := \frac{(L-5.5)}{2}$ (ft) := **N/A**

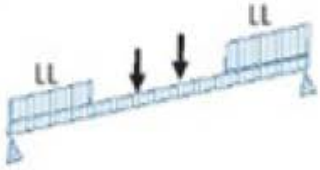
$M_{DL} := \left(wDL_{tc} \times \frac{L^2}{8} + P_{sp} \times \frac{L}{a}\right) \times \cos(\theta)$:= **94.99**

Spans < 10.0 ft



$M_{LL} := \frac{\left(\left(w \times \frac{3}{2 \times L}\right) \times (2 \times L - 3)\right)^2 \times \cos(\theta)}{2 \times w}$:= **89.61**

Spans =>10.0 ft



$M_{LL} := \frac{\frac{\left(\left(w \times c \times (2 \times L - c) + w \times c^2\right)\right)^2}{2 \times L} \times \cos(\theta)}{2 \times w}$:= **N/A**

$M_2 := M_{DL} + M_{LL}$ (lb-ft) := **184.60**

$S_r := M_2 \times \frac{12}{Fb \times Cd_{LL} \times Cf_x \times C_r \times C_{Ls}}$:= **1.03**

$\% := \frac{S_x}{S_r} \times 100$ << If equal to or more than 100% Code Compliant, OK! := **297.9%**

LOAD COMB. #3: On Rafters, Zone 1 DL Rf + DL Solar + Wind Down (Cd =1.6)

$P_3 := TA_f \times \left(0.6 \times P_{rdn} + DL_{PV} \times \cos\theta\right)$:= **39.77**

$M_3 := \left(wDL_{tc} \times \frac{L^2}{8}\right) \times \cos(\theta \times deg) + P_3 \times \frac{L}{a}$:= **229.41**

$S_r := M_3 \times \frac{12}{Fb \times Cd_{Wind} \times Cf_x \times C_r \times C_{LS}}$:= **1.00**

$\% := \frac{S_x \times 100}{S_r}$ << If equal to or more than 100% Code Compliant, OK! := **306.8%**

LOAD COMB. #4: On Rafters **DL Rf + DL Solar + Snow (Cd=1.15)**

S:=Sloped Roof Snow Load (psf) := **30.90**

$P_4 := TA_f \times (DL_{PV} \times S)$:= **113.47**

$M_4 := \left(wDL_{tc} \times \frac{L^2}{8} + P_4 \times \frac{L}{a}\right) \times \cos(\theta)$:= **477.03**

$S_r := M_4 \times \frac{12}{Fb \times Cd_{Snow} \times Cf_x \times C_r \times C_{LS}}$:= **2.89**

$\% := \frac{S_x \times 100}{S_r}$ <<If equal to or more than 100% code compliant, ok! := **106.0%**

LOAD COMB. #5: On Rafters, Zone 1 **DL Rf + DL Solar + .75Wind + .75Snow (Cd=1.6)**

S:=Sloped Roof Snow Load (psf) := **30.90**

$P_5 := TA_f \times (DL_{PV} + .75 \times S) \times \cos\theta + TA_f \times 0.75 \times 0.6 \times p_{rdn}$:= **101.48**

$M_5 := \left(wDL_{tc} \times \frac{L^2}{8} + P_5 \times \frac{L}{a}\right) \times \cos(\theta)$:= **482.34**

$S_r := M_5 \times \frac{12}{Fb \times Cd_{Wind} \times Cf_x \times C_r \times C_{LS}}$:= **2.10**

$\% := \frac{S_x \times 100}{S_r}$ <<If equal to or more than 100% Code Compliant, OK! :=**145.9%**

LOADING COMB. #6: **CHECK SEISMIC LOADING:** C=COVERAGE ON ROOF

Existing DL:= DL_{Rf} + Walls Walls:= 5.5 psf := **14.20**

ProposedDL:=ExistingDL + DL_{Solar} x C := **14.70**

$SeismicIncrease := 100 \times \left(\frac{ProposedDL}{ExistingDL}\right) - 100$ <<If equal to or more than 10% Code Compliant, OK! := **3.5%**

SEISMIC SUMMARY: EXISTING BUILDING PROVISIONS

Section 11B.3- Exceptions:

1. The addition complies with the requirements for new structures.
2. The addition does not increase the seismic force by more than 10%.
3. The addition does not decrease the seismic resistance of any structural element.

LOAD COMB. #7: On Rafters, ZONE 1 (0.6)(DL RF + DL SOLAR) - WIND UP (CD=1.6)

$$P_7 := TA_f \times \left(0.6 \times p_{rup} - 0.6 \times DL_{PV} \times cos\theta\right) := 40.63$$

$$M_7 := \left(P_7 \times \frac{L}{a}\right) - wDL_{tc} \times \frac{L^2}{8} \times cos\left(\theta \times deg\right) := 126.65$$

$$S_r := M_7 \times \frac{12}{Fb \times Cd_{Wind} \times Cf_x \times C_r \times C_{LS}} := 0.55$$

$$\% := \frac{S_x \times 100}{S_r}$$

<<IF EQUAL TO OR MORE THAN 100% CODE COMPLIANT, OK! := 555.7%

LIMITS OF SCOPE OF WORK AND LIABILITY

Note:

1. Prior to commencement of work, the Solar Installer shall verify that the roof framing sizes, spacing, and spans (between supports), are as noted in these documents. The Engineer of Record must be notified if any discrepancies are discovered, before proceeding.

2. These documents are Stamped for Structural Code compliance of the roof members that support the PV solar system only.

3. These documents are not stamped for rain water leakage prevention.

4. As a precaution, old or wet snow should be removed from the roof, if the snow builds up to 18" or more.

5. Existing deficiencies which are unknown and not observable due to their being concealed inside walls or sandwiched behind gypsum board ceilings at the time of inspection are not included in the scope of work. These calculations are only for the roof framing which supports the new PV modules. These calculations do not include a complete lateral analysis of the building, nor a prediction of the life expectancy of the existing building.

Appendix

Table 3 represents the maximum Moment (M = PL/a) resulting from point loads (RF Mounts), for any spans (L) listed.

a = **1.83**

TABLE 3

The Moment Factor "a" for a 2 Rail System

Length	Staggered		Unstaggered	
	Portrait	Landscape	Portrait	Landscape
L = 4'	4.00	4.00	4.00	2.91
L = 5'	4.00	3.50	3.72	2.50
L = 6'	4.00	3.00	3.43	2.09
L = 7'	3.60	2.84	2.95	1.83
L = 8'	3.20	2.67	2.46	1.56
L = 9'	3.03	2.59	2.34	1.44
L = 10'	2.86	2.50	2.22	1.31
L = 11'	2.77	2.25	2.04	1.19
L = 12'	2.67	2.00	1.85	1.07
L = 13'	2.61	1.88	1.74	0.90
L = 14'	2.55	1.75	1.62	0.92
L = 15'	2.51	1.68	1.50	0.86
L = 16'	2.46	1.60	1.38	0.81
L = 17'	2.43	1.45	1.31	0.76
L = 18'	2.40	1.29	1.23	0.72
L = 19'	2.38	1.24	1.17	0.68
L = 20'	2.35	1.18	1.11	0.65
L = 21'	2.22	1.14	1.06	0.62
L = 22'	2.09	1.10	1.00	0.59

The Moment Factor "a" for a Railless or Shared Rail System

Length	Staggered		Unstaggered	
	Portrait	Landscape	Portrait	Landscape
L = 4'	5.00	5.00	5.00	5.00
L = 5'	5.00	5.00	5.00	5.00
L = 6'	5.00	5.00	5.00	5.00
L = 7'	4.50	4.50	4.50	4.19
L = 8'	4.00	4.00	4.00	3.37
L = 9'	4.00	4.00	4.00	3.12
L = 10'	4.00	4.00	4.00	2.86
L = 11'	4.00	4.00	3.70	2.48
L = 12'	4.00	4.00	3.39	2.09
L = 13'	4.00	3.87	3.35	1.98
L = 14'	4.00	3.73	3.30	1.87
L = 15'	4.00	3.32	2.88	1.78
L = 16'	4.00	2.90	2.46	1.68
L = 17'	4.00	2.74	2.36	1.57
L = 18'	4.00	2.57	2.25	1.45
L = 19'	4.00	2.46	2.18	1.38
L = 20'	4.00	2.35	2.11	1.30
L = 21'	4.00	2.28	2.06	1.25
L = 22'	4.00	2.20	2.00	1.20

REFERENCES: LATEST EDITION

Duration Factors

Cd_{wind}	:=	1.6
Cd_{snow}	:=	1.15
Cd_{DL}	:=	0.9
Cd_{LL}	:=	1.25
C_{LS}	:=	**1.00**
Fb	:=	**1000**

Section Modules

S_x	:=	**3.06**	S_{2x12}	:=	31.640
S_{2x2}	:=	0.563	S_{4x4}	:=	7.150
S_{2x4}	:=	3.063	S_{4x6}	:=	17.650
S_{2x6}	:=	7.563	S_{4x8}	:=	30.660
S_{2x8}	:=	13.140	S_{4x10}	:=	49.900
S_{2x10}	:=	21.390	S_{4x12}	:=	73.800

Size Form Factor

Cf_{2x2}	:=	1.5	Cf_{4x4}	:=	1.5
Cf_{2x4}	:=	1.5	Cf_{4x6}	:=	1.3
Cf_{2x6}	:=	1.3	Cf_{4x8}	:=	1.3
Cf_{2x8}	:=	1.2	Cf_{4x10}	:=	1.2
Cf_{2x10}	:=	1.1	Cf_{4x12}	:=	1.1
Cf_{2x12}	:=	1.0			