SEA · AIR · LAND
TECHNOLOGIES

FL Solar Contractor CVC 56734
FL Electrical Contractor 13008657

Serving the Florida Keys since 1989

Date: March 9, 2021

Prepared by: Caleb Mandile

Description: Historic Architecture Review Commission Application for a Grid-Tied Solar PV System for the Herr Residence: 898 United Street, Key West FL 33040.

Preferred Layout: 10x SunPower A410 Solar Panels resulting in 4,100 watts, with 3 mounted on the back flat roof, and 7 mounted as far back from the street as possible on the Southwest roof location. This system is designed to offset roughly 25% of the property's electricity consumption.

Image 1: Preferred Layout

HARC Guidelines: SALT Energy believes that the Preferred Layout shown above makes use of the most efficient roof surfaces while also accommodating the guidelines put in place by the Historic Architectural Review Commission to preserve the character of Key West. Each guideline is addressed in detail below.

1. *HARC supports the introduction of new and emerging technology for renewable energy but will seek to achieve this by ensuring equipment is installed without permanent detriment to the historic fabric already established in the district and the least visual impact to buildings and streetscapes HARC's goal is high performance conservation with low public visibility. HARC recommends applicants exhaust all other ways of reducing the carbon footprint before putting forward applications for the installation of solar devices.*
   The Herr Residence has already exhausted all other means to lower their carbon footprint. Since purchasing the house in January 2020, they have replaced the old A/C, ceiling fans, mini-fridge, and lightbulbs with new energy star models. They also installed a new ecobee thermostat to better regulate the temperature inside the home. Mr. and Mrs. Herr typically use their motor-scooters or bicycles as their primary source of transportation around the island. They do own one automobile that they rarely use except for long trips outside of Key West or for grocery runs.

2. *Any proposal to install solar energy collectors shall be based on a hierarchy of preferred locations starting with roofing not visible from public streets, then locations within rear gardens or on pergolas and only if none of these are viable because of orientation or overshadowing will HARC consider schemes which involve collectors on roofing areas or other locations visible from public streets.*
   Image 2.1 below is a reference of roof locations and how they will be referred to moving forward. The 4 solar water heater panels depicted in Image 2.1 are no longer present and were installed by the previous owner. Mr. and Mrs. Herr were not responsible for the solar water heaters and removed them since obtaining ownership in January 2020.

Image 2.1

Image 2.2: **Preferred Layout**, Layout 1

Image 2.2 above shows Layout 1, or the preferred layout that was decided upon using a hierarchy of roof surface preference based on maximizing efficiency while still meeting HARC guidelines. First, SE was prioritized as it has no visibility and is the most efficient location. When designing a layout, solar must allow a 36" perimeter around all rooftop equipment like A/C units for fire code, and a minimum of 10" between the edge of the array and any roof edges for wind-load requirements. Because of these limitations, only 3 panels could be mounted on SE. The remaining 7 panels could be mounted on SW or NE.

Both SW and NE are visible from United Street, but NE is obscured from view by the large tree in front of the house. However, according to criteria discussed during the pre-application meetings, trees are not considered when determining if a roof surface is visible or not. Therefore, SW and NE should be considered equally in terms of visibility from United Street.

SW is also visible from Margaret Street, as shown in Appendix 1 with 898 United circled in red. However, SALT would consider this visibility from Margaret street to be negligible due to past precedent with the solar water panels, which again Mr. and Mrs. Herr had no part in. These 4 solar water panels were never brought before HARC when they were initially installed by the previous owner and were never discovered by or reported to HARC during the duration they were on the roof. It was not until SALT provided an outdated satellite view layout of the new solar panel locations that the previous existence of these solar water panels was made known. SALT believes that the new 7 solar PV modules would have similar visibility. Unless a person had prior knowledge of their existence or saw them from a satellite view, the panels would not disrupt the view of the historic architectural landscape, even from Margaret Street. Therefore, the remaining 7 panels are mounted on SW according to Layout 1 for efficiency.

3. *Any proposals that include collectors and/or related equipment and cabling visible from public streets will be required to show (by way of calculation of energy outputs) that it is not possible to achieve similar performance from equipment located away from public view.*
   The preferred layout shown again in Image 2.2 was created using a hierarchy of roof surface preference based on maximizing efficiency while still meeting the HARC guidelines. If the 7 panels on SW are still considered visible from the street, the following calculations are provided to demonstrate the loss in efficiency of moving any of these panels to NE, the only other available surface. A ratio known as the Kilowatt-Hour per Kilowatt (kWh/kWp) is used as the basis for the efficiency loss calculations. This ratio tells us the expected yearly kWh energy yield for each kW of solar installed on a particular roof surface. This value changes depending on the geographic location, tilt, and azimuth of the solar array. An azimuth greater than 90° (East) and less than 270° (West) is ideal for solar. SALT Energy has determined the values in Table 3.1 using Helioscope software which accounts for these parameters.

Roof Surface	SE	SW	NE
Azimuth	145°	235°	55°
Tilt	5°	30°	30°
kWh/kWp	1,547.6	1,537.5	1281.4
Energy Loss	N/A	0.7%	17.3%

Table 3.1

   This means that every watt of solar installed on NE will produce 16.6% less energy per year than the equivalent on SW. Since 70% of this system is located on SW, moving those 7 panels to NE would reduce the energy output of the entire system by 13%. This is why the preferred layout utilizes SW for the remaining 7 panels.

4. *Installations shall not exceed power generation greater than that reasonably needed for the property. All applications must contain calculations of power outputs and on energy retained.*
   898 United utilized 27,485 kWh of electricity between November 8th 2019 and November 7th 2020 according to Keys Energy records shown in Appendix 2. Layout I Image 2.2, using the expected energy yield values shown in table 3.1 above, would be expected to produce about 6,400 kWh of electricity per year. This equates to an electricity use offset of about 25%.

5. *Character defining features of existing buildings (i.e. roofline, chimneys, and dormers) shall not be damaged or obscured when introducing new roof or exterior wall-mounted energy conservation systems.*
   The roofline of 898 United will not be affected by the addition of solar panels according to Layout I, Image 2.2. All panels will be installed a minimum of 10” from all roof edges to meet wind-load requirements.

6. *All energy collection equipment shall be screened or hidden to the greatest possible while still achieving maximum function and effectiveness.*
   Layout I maximizes the use of low visibility locations to screen or hide the panels while still prioritizing the more efficient surfaces over less efficient surfaces. The panels on SE will be hidden from view as SE is a rear facing roof section that is entirely hidden from street view. The panels on SW will be mounted as far away from the road as possible with the distance from the back edge of the array to the back edge of SW being 10". This leaves over 10 feet of space from the front of SW to the leading edge of the array.

7. *On pitched roofs, solar collector arrays shall run parallel to the original roofline and shall not rise above the peak of the roof. On flat roofs, solar collector arrays shall be set back from the parapet edge or wall/ roof conjunction and may be set at a slight pitch if not highly visible from public streets.*
   All panels will be installed a minimum of 10" from the roof peak and any roof edges to meet wind-load requirements, therefore the panels will not rise above the peak of the roof. All panels will be installed parallel to the original roofline.

8. *All energy collection equipment shall be considered part of the overall design of the structure. Color, shape and proportions of the solar collection array shall match the shape and proportions of the roof. Single installations on single-plane roofs are preferable to disjointed arrays or arrays on multiple roof planes. If more than one array is needed, it shall be limited to one panel section on each side of the structure if the arrays cannot be placed on a rear location. Scattered or disjointed arrays are not appropriate.*
   The proportions and shapes of all arrays are designed to match the shape and proportions of the roof. No arrays will exceed the proportions of the roof they are installed on. All arrays will stay within the "shape" or boundary of the roof surface it is installed on. Layout I utilizes all available space on the rear location (SE) and based on visibility from the street, qualifies as a single installation on a single plane roof as described above with the remaining 7 panels mounted on SW.

9. *All energy collection equipment shall not be mounted to project from walls or other parts of the building.*
   No equipment will be mounted to project excessively from the walls of the building. No wall-mounted equipment will be visible from the street.

Appendix 1: Margaret Street Visibility

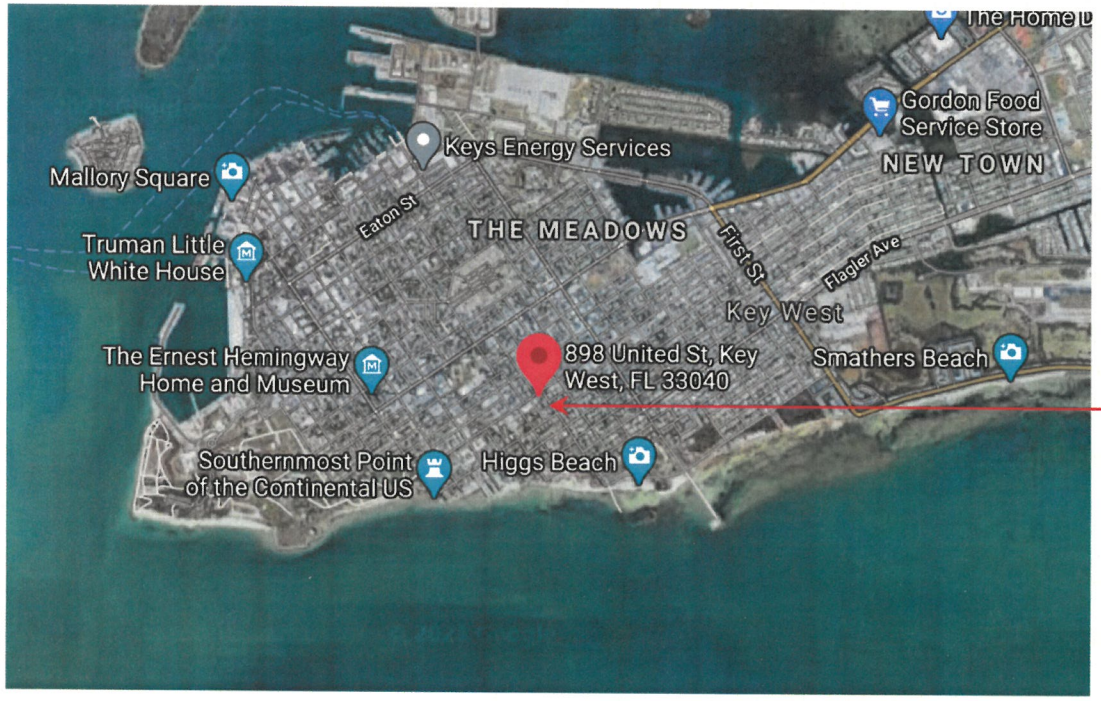
Appendix 2: Keys Energy Records:

ACCOUNT_NO	OCCUPANT_CODE	BILLDATE	USAGE_BILLED	DEMAND_KW	ACCOUNT_NO2	OCCUPANT_CODE3	NAME	SERV_STREET_NO	SERV_STREET	SERV_UNIT
1024210	31	Nov 6, 2019 12:00:00 AM	1583		1024210	31	THOMAS JOSEPH HERR	898	UNITED ST	
1024210	31	Dec 6, 2019 12:00:00 AM	2085		1024210	31	THOMAS JOSEPH HERR	898	UNITED ST	
1024210	31	Jan 8, 2020 12:00:00 AM	1451		1024210	31	THOMAS JOSEPH HERR	898	UNITED ST	
1024210	31	Feb 6, 2020 12:00:00 AM	2358		1024210	31	THOMAS JOSEPH HERR	898	UNITED ST	
1024210	31	Mar 6, 2020 12:00:00 AM	3423		1024210	31	THOMAS JOSEPH HERR	898	UNITED ST	
1024210	31	Apr 9, 2020 12:00:00 AM	2991		1024210	31	THOMAS JOSEPH HERR	898	UNITED ST	
1024210	31	May 6, 2020 12:00:00 AM	2206		1024210	31	THOMAS JOSEPH HERR	898	UNITED ST	
1024210	31	Jun 8, 2020 12:00:00 AM	2428		1024210	31	THOMAS JOSEPH HERR	898	UNITED ST	
1024210	31	Jul 8, 2020 12:00:00 AM	2189		1024210	31	THOMAS JOSEPH HERR	898	UNITED ST	
1024210	31	Aug 6, 2020 12:00:00 AM	1718		1024210	31	THOMAS JOSEPH HERR	898	UNITED ST	
1024210	31	Sep 9, 2020 12:00:00 AM	1783		1024210	31	THOMAS JOSEPH HERR	898	UNITED ST	
1024210	31	Oct 7, 2020 12:00:00 AM	2279		1024210	31	THOMAS JOSEPH HERR	898	UNITED ST	
1024210	31	Nov 6, 2020 12:00:00 AM	2574		1024210	31	THOMAS JOSEPH HERR	898	UNITED ST	

CONSTRUCTION PLANS FOR

HERR RESIDENCE

SOLAR PV SYSTEM



Site Location:
898 United Street
Key West FL 33040

Solar Installer:
Salt Service Inc.
2992 Overseas Highway
Marathon, FL 33050
(305) 289-1150
FL SOLAR CONTRACTOR LICENSE: CVC56734

TITLE:	Herr Site	PROJECT #:	SCO 027
		DATE:	2/23/21
SHEET #:	SCO 027-100		
SYSTEM:	10 x Sunpower A410's - 4100 Wp		
CUSTOMER:	Traci Herr 898 United Street, Key West FL 33040		

SALT ENERGY
SALT Service, Inc.
2992 Overseas Highway, Marathon, FL
(305) 289-1150
Florida Solar Contractor License CVC 56734

Structural Calculations - PV racking & attachment
Florida Building Code 2014, ASCE 7-10, CPP Wind Tunnel Test Report 9790 (12/29/16)

Dimensions

Roof height:	30 ft
Roof slope:	18.50 deg
PV module long dimension:	5.12 ft
PV module short dimension:	3.43 ft
Rail tributary width:	2.56 ft
Gable End Width, W =	40.00 ft
Ridge Length, L =	60.00 ft

Dead Loads

Rail:	0.56 lb/ft
	0.2 psf
Module:	46 lb
	2.6 psf
Total:	2.8 psf
	7.3 lb/ft along rail
Load normal to PV surface:	6.88 lb/ft along rail
Load parallel to PV surface:	2.30 lb/ft along rail

Snow Loads

Ground snow load pg:	0 psf (ASCE 7 Figure 7-1 and Table 7-1)
Ct:	1.20 (ASCE 7 Table 7-3)
Ce:	0.90 (ASCE 7 Table 7-2)
Is:	1 (ASCE 7 Table 1.5-2)
Cs:	0.94 (ASCE 7 Figure 7-2)
Flat roof snow load pf:	0.00 psf (ASCE 7 Equation 7.3-1)
Sloped roof snow load ps:	0.00 psf (ASCE 7 Equation 7.4-1)
Load normal to PV surface:	0.00 lb/ft along rail
Load parallel to PV surface:	0.00 lb/ft along rail

Wind Loads

Wind Speed V:	180 mph (ASCE 7 Figure 26.5-1)
Exposure:	D (ASCE 7 Section 26.7.3)
Kz:	1.16 (ASCE 7 Table 30.3-1)
(Note: More conservative than 15% increase over Exp C as recommended in wind tunnel report, so ok.)	
Kzt:	1.00 (ASCE 7 Section 26.8.2)
Kd:	0.85 (ASCE 7 Table 26.6-1)
q = 0.00256KzKztKdV^2 =	81.94 psf (ASCE 7 Equation 30.3-1)
GCn =	-0.92 (CPP Report Figure 3-2)
γE =	1.00 (CPP Report Figure 3-3)
γP =	1.00 (CPP Report Figure 3-4)
γH =	1.00 (CPP Report Figure 3-5)
Pressure Up =	-75.64 psf (CPP Report Equation 8)
Pressure Down =	40.97 psf (ASCE 7 Downforce)
Load normal to PV surface Up =	-193.50 lb/ft along rail
Load normal to PV surface Up =	104.81 lb/ft along rail

Seismic Loads

Ss:	1 g (ASCE 7 Figure 22-1)
Site Class:	D (ASCE 7 Section 11.4.2 - Assumed)
Fa:	1.1 (ASCE 7 Table 11.4-1 -Site Class D)
Sms:	1.1 (ASCE 7 Equation 11.4-1)
Sds:	0.733333 (ASCE 7 Equation 11.4-3)
Ip:	1.00 (ASCE 7 Section 13.1.3)
ap:	1 (ASCE 7 Table 13.6-1)
Rp:	1.5 (ASCE 7 Table 13.6-1)
z/h:	1.00 (ASCE 7 Section 13.3.1)
Fp = (0.4*ap*Sds*Wt*(1 + 2*zh)) / (Rp/Ip) =	1.66 psf (ASCE 7 Section 13.3.1)
Fv = 0.2*Sds*Wt =	0.42 psf (ASCE 7 Equation 12.4-4)
Horizontal load Eh:	4.26 lb/ft along rail
Vertical load Ev = 0.2*Sds*Wt =	1.06 lb/ft along rail
Load normal to PV surface: +/-	-0.34 lb/ft along rail
Load parallel to PV surface: +/-	4.38 lb/ft along rail

Load Combinations - lb/ft along rail

1.4D	9.6	DOWN	NORMAL TO PV SURFACE
1.2D+1.6S+0.5W (All Zones)	60.7		
1.2D+0.5S+1.0W (All Zones)	113.1		
1.2D+1.0E+0.2S	7.9		
0.9D+1.0W	-187.3	UP	
1.4D	3.2	DOWN	PARALLEL
1.2D+1.6S	2.8		
1.2D+0.5S	2.8		
1.2D+1.0E+0.2S	7.1		
0.9D	2.1		

Maximum Demands on Rail/Connections

Worst Case Uplift	-187.31	plf
Worst Case Downward	113.07	plf
Worst Case Seismic Demand	7.92	plf
Worst Case Shear for Uplift Cases	2.07	plf
Worst Case Shear for Downward Cases	3.22	plf
Worst Case Shear for Seismic Cases	7.14	plf

Maximum Allowable Spacings

Designed attachment spacing	48.00	in
Max allowable cantilever	14.00	in

Check Strength of Rail

$M_{max,up} = 1/8*w*L^2 =$	-375	lb-ft
$M_{allow,up} =$	-548	lb-ft
$D/C_{up} =$	0.68	OK
$M_{max,down} = 1/8*w*L^2 =$	226	lb-ft
$M_{allow,down} =$	580	lb-ft
$D/C_{down} =$	0.39	OK

Attachment Loads

$T_{up} = w*L =$	-749 lb
$P_{down} = w*L =$	452 lb
$V_{attach} = w*L =$	29 lb

TITLE:	Wind Load Calulations
SHEET #:	SCO 027-200
SYSTEM:	10 x Sunpower A410's - 4100 Wp
CUSTOMER:	Traci Herr
	898 United Street, Key West FL 33040
PROJECT #:	SCO 027
DATE:	2/23/21

SALT ENERGY
SALT Service, Inc.
2992 Overseas Highway, Marathon, FL
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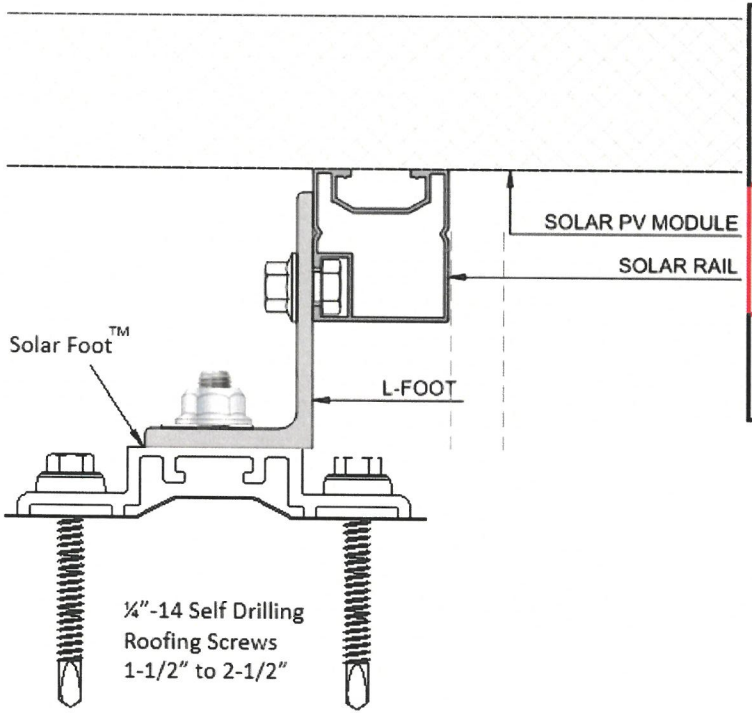
Florida Solar Contractor License CVC 56734



WIND LOAD CALCS	180D		
Pressure UP Wind Tunnel)	-75.64	Trib Area	
L (1/2 of 1 Panel in portrait)	3.008333		10.03
W (LB/ft on Rail)	-227.55		
D (p/f)	8.423333		
D (psf)	2.8		
0.9 D + W (psf)	-219.969	WORST CASE UPLIFT	
ASCE 7-10 Chapter 31 (Wind Tunnel Procedure)			
Attachment Spacing (Wind Tunnel):	24	in.	
ATTACHMENT LOADS	-455.101	lb	
Allowable Load (LB)	558	SOLARFOOT	
Allowable Spacing (Wind Tunnel)	29.4		
Max Cantilever	14		
Max,up L^2*W/8	-113.8	ft-lb	
Load,up on Rails	-548	ft-lb	
CHECK	0.207619	OK	

Small Frame Panel A-Series	
Panel L (ft)	Panel W(ft)
6.02	3.33
Panel L (in)	Panel W (in)
72.2	40
Racking Weight (lbs)	56.16

ASCE 7-10 Chapter 30 (Components and Cladding)
S-5 SOLARFOOT ANCHOR in MINIMUM 19/32" PLWOOD
MAXIMUM SPACING BASED ON 2X SAFETY FACTOR
Solarfoot with 4 x 1/4" Screws

Max Attachment Spacing C&C ZONE 1 (in)	42.8
Max Attachment Spacing C&C ZONE 2 (in)	24.6
Max Attachment Spacing C&C ZONE 3 (in)	16.6

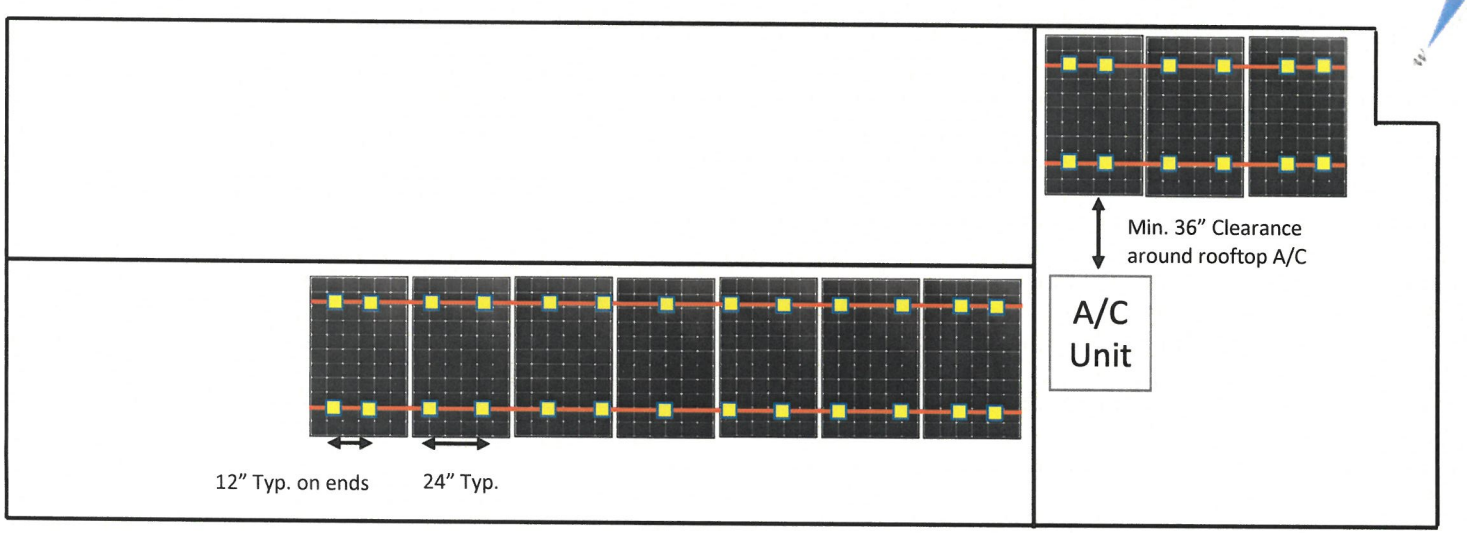
Max Allowed Load on rail is 1096 lb
a = 4.00

Load Test Results

Name	Product Information	Panel Information	Peak Load (lbf)
Test 1	SolarFoot (4) 0.25 14 Self Drilling Screw 1-1/2" to 2-1/2"	19/32" Plywood	915.608
Test 2	SolarFoot (4) 0.25 14 Self Drilling Screw 1-1/2" to 2-1/2"	19/32" Plywood	1209.744
Test 3	SolarFoot (4) 0.25 14 Self Drilling Screw 1-1/2" to 2-1/2"	19/32" Plywood	1038.427
Test 4	SolarFoot (4) 0.25 14 Self Drilling Screw 1-1/2" to 2-1/2"	19/32" Plywood	1300.195
		Mean	1115.993
		Standard Deviaton	172.134
		Allowable load (Safety factor of 2)	557.9965

TITLE:	Attachment Details
SHEET #:	SCO 027-300
SYSTEM:	10 x Sunpower A410's - 4100 Wp
CUSTOMER:	Traci Herr
	898 United Street, Key West FL 33040
PROJECT #:	SCO 027
DATE:	2/23/21

SALT ENERGY
SALT Service, Inc.
2992 Overseas Highway, Marathon, FL
(305) 289-1150
Florida Solar Contractor License CVC 56734



SUNPOWER
Solar PV Panel with Micro-Inverter

Panel Technical Information

TYPE:	SPR-A410-G-AC
Size:	72.2 x 40 x 1.57in.
Nominal Power:	410 W
AC Output:	240V
Frequency:	60.0 Hz
AC Imax:	1.45 A @ 240V
Max Output:	366 VA

Rails

SolarFoot Rail Attachments

TITLE:	PV Panel & Attachment Layout
SHEET #:	SCO 027-400
SYSTEM:	10 x Sunpower A410's - 4100 Wp
CUSTOMER:	Traci Herr
PROJECT #:	SCO 027
DATE:	2/23/21

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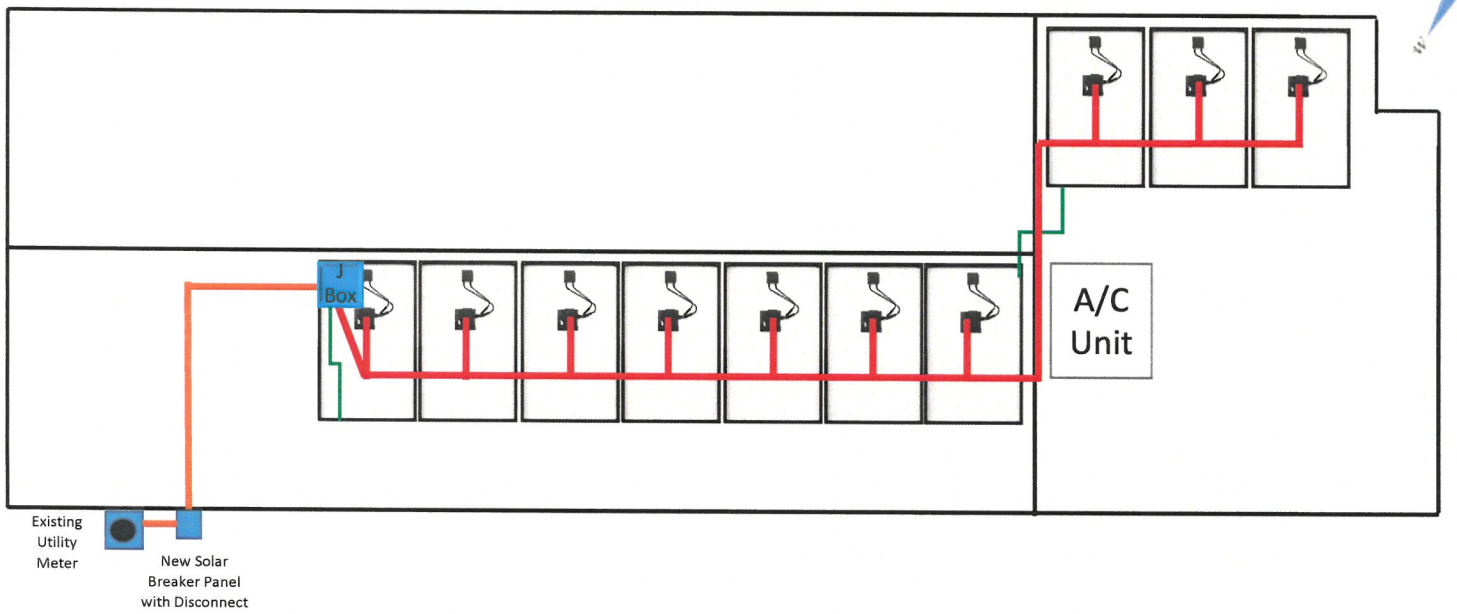
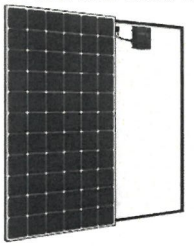


SUNPOWER

Solar PV Panel with Micro-Inverter



Panel Technical Information

TYPE:	SPR-A410-G-AC
Size:	72.2 x 40 x 1.57in.
Nominal Power:	410 W
AC Output:	240V
Frequency:	60.0 Hz
AC Imax:	1.45 A @ 240V
Max Output:	366 VA

Ground Lug

AC Home Run w/ Ground

AC Trunk Line

TITLE:	AC Module Array Wiring
SHEET #:	SCO 027-500
SYSTEM:	10 x Sunpower A410's - 4100 Wp
CUSTOMER:	Traci Herr
	898 United Street, Key West FL 33040
PROJECT #:	SCO 027
DATE:	2/23/21

SALT ENERGY

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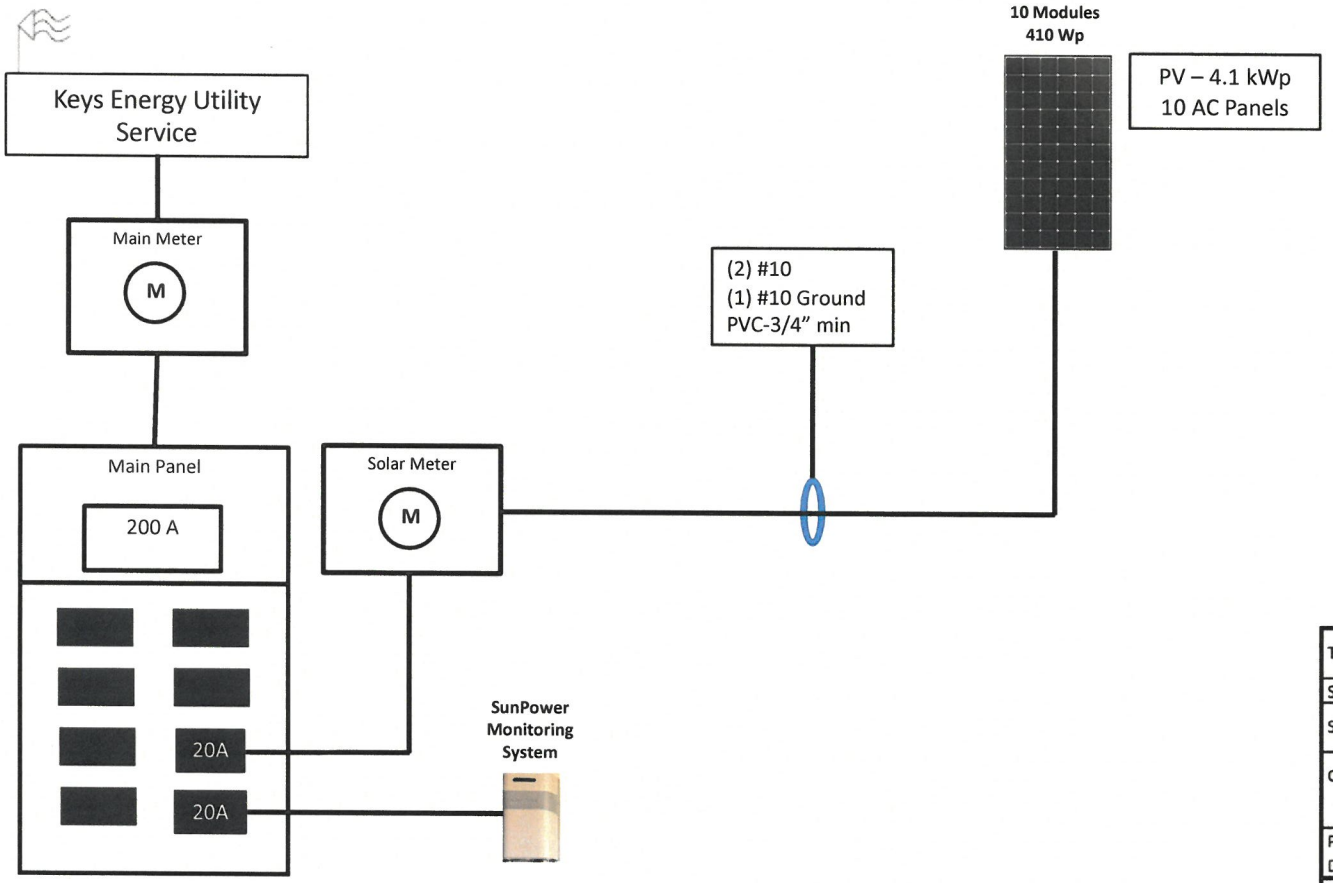


TITLE:	Riser Diagram - PV Grid Tie
SHEET #:	SCO 027-600
SYSTEM:	10 x Sunpower A410's - 4100 Wp
CUSTOMER:	Traci Herr
	898 United Street, Key West FL 33040
PROJECT #:	SCO 027
DATE:	2/23/21

SALT ENERGY
SALT Service, Inc.
2992 Overseas Highway, Marathon, FL
(305) 289-1150
Florida Solar Contractor License CVC56734

1 ⚠ WARNING

THIS SERVICE METER IS ALSO SERVED BY A PHOTOVOLTAIC SYSTEM

2 ⚠ WARNING

ELECTRIC SHOCK HAZARD

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

PHOTOVOLTAIC SYSTEM

3 AC DISCONNECT

OPERATING CURRENT 14.5 A

OPERATING VOLTAGE 240 VOLTS

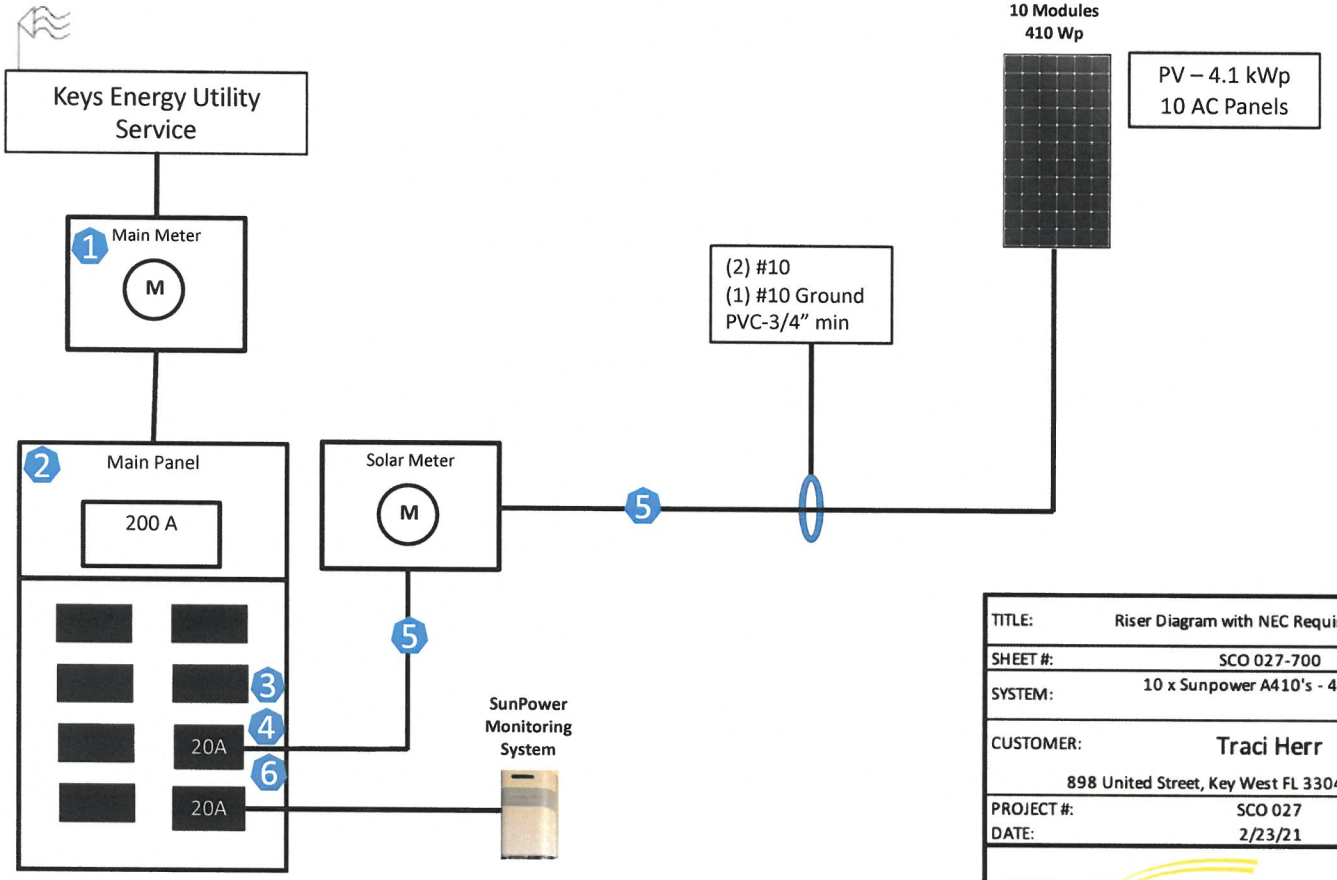
4 ⚠ WARNING ⚠

SOLAR ELECTRIC BREAKER IS BACKFED

5 ⚠ WARNING

PHOTOVOLTAIC POWER SOURCE

6 SOLAR BREAKER



TITLE:	Riser Diagram with NEC Required Labeling
SHEET #:	SCO 027-700
SYSTEM:	10 x Sunpower A410's - 4100 Wp
CUSTOMER:	Traci Herr
	898 United Street, Key West FL 33040
PROJECT #:	SCO 027
DATE:	2/23/21

SALT ENERGY

SALT Service, Inc.

2992 Overseas Highway, Marathon, FL

(305) 289-1150

Florida Solar Contractor License CVC56734

SUNPOWER®

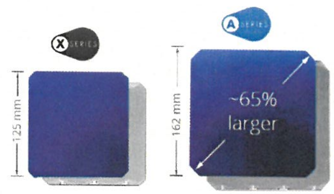
420–390 W Residential AC Module

SunPower® Maxeon® Technology

Built specifically for use with the SunPower Equinox™ system, the only fully integrated solution designed, engineered, and warranted by one manufacturer.

Highest Power Density Available.

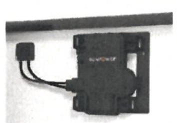
SunPower's new Maxeon® Gen 5 cell is 65% larger than prior generations, delivering the most powerful cell and highest-efficiency module in residential solar. The result is more power per square meter than any commercially available solar.



Fundamentally Different. And Better.

SunPower® Maxeon® Technology

- Most powerful cell in home solar
- Delivers unmatched reliability
- Patented solid metal foundation prevents breakage and corrosion

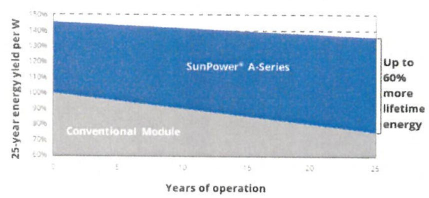


Factory-integrated Microinverter (MI)

- Highest power integrated AC module in solar
- 60% lighter than prior SunPower MIs
- Engineered and calibrated by SunPower for SunPower AC modules

Highest Lifetime Energy and Savings.

Designed to deliver 60% more energy over 25 years in real-world conditions like partial shade and high temperatures.



Best Reliability. Best Warranty.

With more than 25 million modules deployed around the world, SunPower technology is proven to last. That's why we stand behind our module and microinverter with the industry's best 25-year Combined Power and Product Warranty, including the highest Power Warranty in solar.

A-Series: A420 | A415 | A410 | A400 | A390 SunPower® Residential AC Module

AC Electrical Data	
Inverter Model: SPWR-A4 (Enphase IQ 7AS)	**@240 VAC**
Peak Output Power	366 VA
Max. Continuous Output Power	349 VA
Nom. (L–L) Voltage/Range (V)	240 / 211–264
Max. Continuous Output Current (A)	[illegible]
Max. Units per 20 A (L–L) Branch Circuit	[illegible]
CEC Weighted Efficiency	97.0%
Nom. Frequency	60 Hz
Extended Frequency Range	47–68 Hz
AC Short Circuit Fault Current Over 3 Cycles	5.8 A rms
Overvoltage Class AC Port	III
AC Port Backfeed Current	0 mA
Power Factor Setting	1.0
Power Factor (adjustable)	0.7 lead / 0.7 lag

DC Power Data	A420-G-AC	A415-G-AC	A410-G-AC	A400-G-AC	A390-G-AC
Nom. Power[5] (Pnom) W	420	415	410	400	390
Power Tol.	+5/–0%				
Module Efficiency	[illegible]	22.3	22.0	21.5	20.9
Temp. Coef. (Power)	–0.29%/°C				
Shade Tol.	Integrated module-level max. power point tracking				

Tested Operating Conditions	
Operating Temp.	–40°F to +185°F (–40°C to +85°C)
Max. Ambient Temp.	122°F (50°C)
Max. Test Load[7]	Wind: 187 psf, 9000 Pa, 917 kg/m² back Snow: 187 psf, 9000 Pa, 917 kg/m² front
Design Load	Wind: 62 psf, 3000 Pa, 305 kg/m² back Snow: 125 psf, 6000 Pa, 611 kg/m² front
Impact Resistance	1 inch (25 mm) diameter hail at 52 mph (23 m/s)

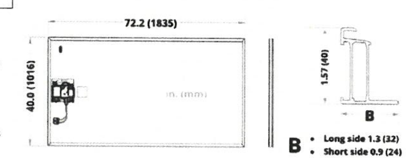
Mechanical Data	
Solar Cells	66 Monocrystalline Maxeon Gen 5
Front Glass	High-transmission tempered glass with anti-reflective coating
Environmental Rating	Outdoor rated
Frame	Class 1 black anodized (highest AAMA rating)
Weight	46.5 lbs (21.1 kg)
Recommended Max. Module Spacing	1.3 in. (33 mm)

Warranties, Certifications, and Compliance	
Warranties	• 25-year limited power warranty • 25-year limited product warranty
Certifications and Compliance	• UL 1703 • UL 1741 / IEEE 1547 • UL 1741 AC Module (Type 2 Fire Rated) • UL 62109-1 / IEC 62109-2 • FCC Part 15 Class B • ICES-0003 Class B • CAN/CSA C22.2 NO. 107.1-01 • CA Rule 21 (UL 1741 SA)[4] (includes Volt/Var and Reactive Power Priority) • UL Listed PV Rapid Shutdown Equipment[6] Enables installation in accordance with: • NEC 690.6 (AC module) • NEC 690.12 Rapid Shutdown (inside and outside the array) • NEC 690.15 AC Connectors, 690.33(A)–(E)(1) When used with InvisiMount racking and InvisiMount accessories (UL 2703): • Module grounding and bonding through InvisiMount • Class A fire rated When used with AC module Q Cables and accessories (UL 6703 and UL 2238)[6]: • Rated for load break disconnect
PID Test	Potential-induced degradation free

1 SunPower 415 W, 22.3% efficient, compared to a Conventional Panel on same-sized arrays (260 W, 16% efficient, approx. 1.6 m²), 7.9% more energy per watt (based on PVSyst pan files for avg. US climate), 0.5%/yr slower degradation rate (Jordan, et. al. "Robust PV Degradation Methodology and Application," PVSC 2018).
2 Based on search of datasheet values from websites of top 10 manufacturers per IHS, as of January 2019.
3 #1 rank in "Fraunhofer PV Durability Initiative for Solar Modules: Part 3." PVTech Power Magazine, 2015. Campeau, Z. et al. "SunPower Module Degradation Rate," SunPower white paper, 2013.
4 Factory set to 1547a-2014 default settings. CA Rule 21 default settings profile set during commissioning.
5 Standard Test Conditions (1000 W/m² irradiance, AM 1.5, 25°C). NREL calibration standard: SOMS current, LACCS FF and voltage. All DC voltage is fully contained within the module.
6 This product is UL Listed as PVRSE and conforms with NEC 2014 and NEC 2017 690.12; and C22.1-2015 Rule 64-218 Rapid Shutdown of PV Systems, for AC and DC conductors; when installed according to manufacturer's instructions.
7 Please read the safety and installation instructions for more information regarding load ratings and mounting configurations.

See www.sunpower.com/facts for more reference information.

For more details, see extended datasheet www.sunpower.com/datasheets Specifications included in this datasheet are subject to change without notice.



LISTED
Module Fire Performance: Type 2

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Please read the Safety and Installation Instructions 532626 for additional details.

534092 RevB

SunPower® InvisiMount™ | Residential Mounting System

Simple and Fast Installation
- Integrated module-to-rail grounding
- Pre-assembled mid and end clamps
- Levitating mid clamp for easy placement
- Mid clamp width facilitates consistent, even module spacing
- UL 2703 Listed integrated grounding

Flexible Design
- Addresses nearly all sloped residential roofs
- Design in landscape and portrait with up to 8' rail span
- Pre-drilled rails and rail splice
- Rails enable easy obstacle management

Customer-Preferred Aesthetics
- #1 module and #1 mounting aesthetics
- Best-in-class system aesthetics
- Premium, low-profile design
- Black anodized components
- Hidden mid clamps and capped, flush end clamps

Part of Superior System
- Built for use with SunPower DC and AC modules
- Best-in-class system reliability and aesthetics
- Optional rooftop transition flashing, rail-mounted J-box, and wire management rail clips
- Combine with SunPower modules and SunPower EnergyLink® monitoring app

Elegant Simplicity

SunPower® InvisiMount™ is a SunPower-designed rail-based mounting system. The InvisiMount system addresses residential sloped roofs and combines faster installation time, design flexibility, and superior aesthetics.

The InvisiMount product was specifically envisioned and engineered to pair with SunPower modules. The resulting system-level approach amplifies the aesthetic and installation benefits—for homeowners and for installers.

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Datasheet

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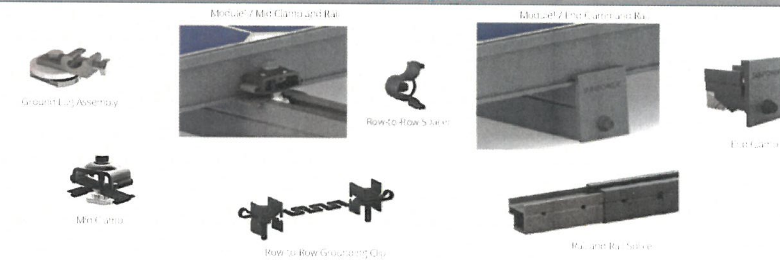
SunPower® InvisiMount™ | Residential Mounting System

InvisiMount Components



InvisiMount Component Details		
Mid clamp	Black oxide stainless steel 300 series	63 g (2.2 oz)
End clamp	Black anodized aluminum 6000 series	110 g (3.88 oz)
Rail	Black anodized aluminum 6000 series	830 g/m (9 oz/ft)
Rail splice	Aluminum alloy 6000 series	830 g/m (9 oz/ft)
Rail bolt	M10-1.5 × 25 mm custom T-head SS304	18 g (0.63 oz)
Rail nut	M10-1.5, DIN 6923 SS304	nominal
Ground lug assembly	SS304, A2-70 bolt, tin-plated copper lug	106.5 g (3.75 oz)
Row-to-row grounding clip	SS 301 with SS 304 M6 bolts	75 g (2.6 oz)
Row-to-row spacer	Black POM grade plastic	5 g (0.18 oz)

InvisiMount Component LRFD Capacities*		
Mid clamp	[illegible]	664 lbf
	Shear	540 lbf
End clamp	[illegible]	830 lbf
	Shear	220 lbf
Rail	Moment upward	546 lbf-ft
	Moment downward	580 lbf-ft
Rail splice	Moment upward	546 lbf-ft
	Moment downward	580 lbf-ft
L-foot	Uplift	1000 lbf
	Shear	250 lbf

InvisiMount Operating Conditions	
Temperature	-40° C to 90° C (-40° F to 194° F)
Max. Load (LRFD)	• 3000 Pa uplift • 6000 Pa downforce

Roof Attachment Hardware Supported by Design Tool	
Application	• Composition Shingle Rafter Attachment • Composition Shingle Roof Decking Attachment • Curved and Flat Tile Roof Attachment • Universal interface for other roof attachments

InvisiMount Warranties And Certifications	
Warranties	• 25-year product warranty • 5-year [illegible] warranty
Certifications	• UL 2703 Listed • Class A Fire Rated

Roof Attachment Hardware Warranties
Refer to roof attachment hardware manufacturer's documentation.

*Module frame that is compatible with the InvisiMount system required for hardware interoperability. [illegible] SunPower recommends that all [illegible] InvisiMount [illegible] AC module systems always be designed using the [illegible] this document to design a system, note that the capacities [illegible] are Load and Resistance Factor Design [illegible] Allowable Stress Design (ASD) [illegible] Professional Engineer (PE) must then state all calculations. If you have any questions please contact SunPower [illegible]

Datasheet

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2.1 Fire Classification

- The maximum distance between the roof deck and the bottom of the module frame is 3" (7.6 cm).
- In order to maintain the system classification, this assembly must be mounted over a fire resistant roof covering for the application.
- The system achieves a Class A fire rating when installed with modules having a Type 2 fire classification; or for modules specifically fire tested with the InvisiMount system.
- The system achieves a Class A fire rating when installed in the manner specified in these instructions.
- The system was evaluated for use on roofs having a pitch ≥ 2"/foot (greater than or equal to 2:12).

3.0 System Ground Path

The InvisiMount system features:

- Integrated module-to-rail as well as adjacent-module bonding (achieved through the mid clamp and end clamp).
- Integrated rail-to-rail bonding (achieved through the self-drilling splice screws and the splice).
- System bonding achieved through the equipment ground conductor (EGC).

  For arrays where the installer chooses to use row-to-row (R2R) grounding clips (refer to Section 5.6.1) instead of additional ground lugs and copper wire, system bonding is achieved through the R2R clips.

The following two diagrams illustrate the key grounding and bonding aspects of the InvisiMount system with and without the R2R grounding clip:

- the system ground path
- each component
- each bonding point
- the applicable NEC and UL references

5.5 Attach Ground Wire

For arrays with two or more rows, in order to achieve row-to-row grounding, you must install either:

- one ground wire, one ground lug assembly, and an R2R grounding clip (Fig. 10 and Section 5.6.1)

  Note: An R2R grounding clip is required between each row pair—e.g. a three-row array would require two R2R clips.

  or
- two ground wires and two ground lug assemblies (Fig. 11)

If your array has a standalone module (refer to Section 5.7), you must install a ground lug assembly on one of its rails as well.

Important! Ensure that you install the system such that the copper ground wire will never contact any aluminum! (Refer to Fig. 16.)

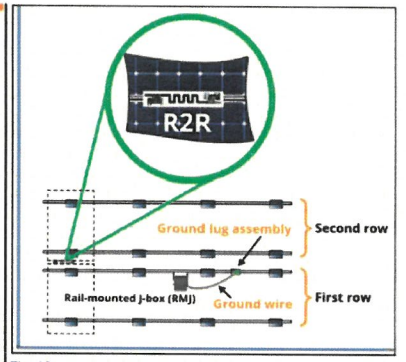


Fig. 10

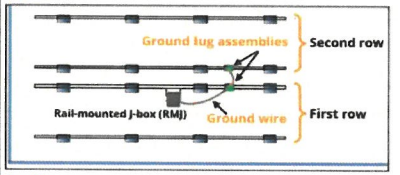
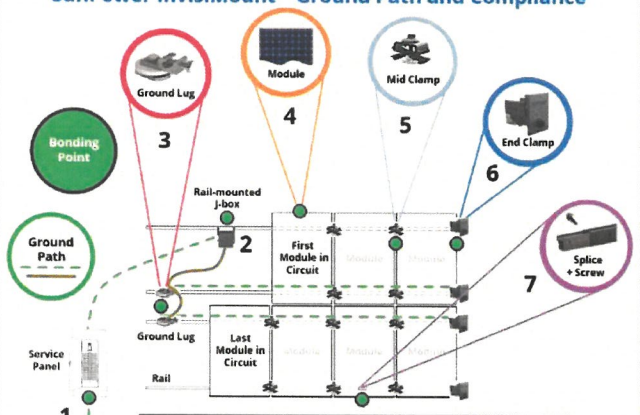


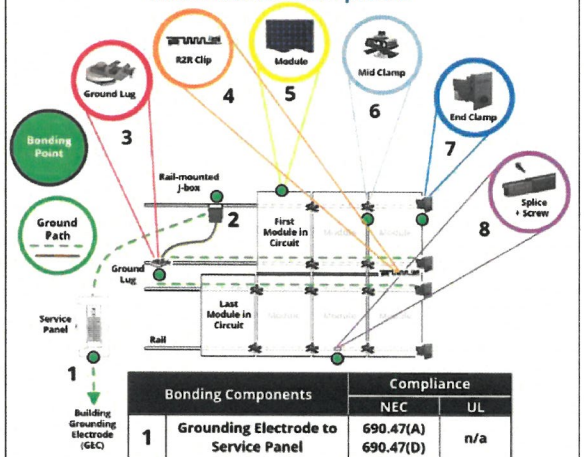
Fig. 11

SunPower InvisiMount™ Ground Path and Compliance



	Bonding Components	Compliance	
		NEC	UL
1	Grounding Electrode to Service Panel	690.47(A) 690.47(D)	n/a
2	Service Panel to Ground Wire	690.43(C)	1741
3	Ground Wire to Ground Lug to Rail	690.43(C)	2703
4	Module Frame	n/a	1703
5	Rail to Mid Clamp to Module Frame	690.43(A) 690.43(C) 690.43(D)	2703
6	Module Frame to End Clamp to Rail	690.43(A) 690.43(C) 690.43(D)	2703
7	Rail to Splice	690.43(A) 690.43(C) 690.43(D)	2703

SunPower InvisiMount™ with R2R Grounding Clip Ground Path and Compliance



	Bonding Components	Compliance	
		NEC	UL
1	Grounding Electrode to Service Panel	690.47(A) 690.47(D)	n/a
2	Service Panel to Ground Wire	690.43(C)	1741
3	Ground Wire to Ground Lug to Rail	690.43(C)	2703
4	Module Frame to Module Frame	690.43(C)	2703
5	Module Frame	n/a	1703
6	Rail to Mid Clamp to Module Frame	690.43(A) 690.43(C) 690.43(D)	2703
7	Module Frame to End Clamp to Rail	690.43(A) 690.43(C) 690.43(D)	2703
8	Rail to Splice	690.43(A) 690.43(C) 690.43(D)	2703