# SOLAR PV PROJECT, KEELER

# 3014 CAMBRIDGE PL. NW WASHINGTON, DC 20007

A) SOLAR MODULE INSTALLED IAW SOLAR MODULE MANUFACTURERS INSTRUCTIONS B) SOLAR MODULE CLAMPS INSTALLED IAW SOLAR MOUNT INSTALLATION INSTRUCTIONS

PV SOLAR SYSTEM NOTES

C) EXISTING ROOF, KNOWN BY OWNER AND PRIME CONTRACTOR TO BE IN SOUND CONDITION AND IAW WITH BUILDING

D) ALL ELECTRICAL WORK SHALL COMPLY WITH THE NATIONAL ELECTRIC CODE (NEC) E) DC CONDUCTORS INSIDE BUILDING SHALL BE IN METALLIC RACEWAY IN ACCORDANCE WITH (IAW) ART 690.3(E) F) GROUNDING: ALL EXPOSED METAL PARTS (BOXES AND MOUNTING RAILS) SHALL BE BONDED WITH EQUIPMENT GROUNDING CONDUCTORS (EGC) AND GROUNDED AT THE MAIN ELECTRICAL

G) PROVIDE A PLACARD ON THE AC CUT OFF SWITCH (SW) WITH THE FOLLOWING INFORMATION IN 1/4' HIGH LETTERING PER NEC 690,54: "CAUTION - POSSIBLE BACKFEED PHOTOVOLTAIC POWER

H) RESERVED

I) PROVIDE A PLACARD ON THE MAIN SERVICE PANEL WITH THE FOLLOWING INFORMATION IN 1/4' HIGH LETTERING PER NEC 690.17: "WARNING: ELECTRICAL SHOCK HAZARD. DO NOT TOUCH TERMINALS, TERMINALS ON LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION"

**GENERAL INSTALLATION NOTES** 1: THE DETAILS AND SPECIFICATIONS CONTAINED IN THESE DRAWINGS ARE CONSIDERED TO BE THE MINIMUM BY THE AHJ AND INSTALLERS.

2: THIS PLAN SPECIFIES THE STRUCTURAL AND ELECTRICAL REQUIREMENTS FOR INSTALLATION OF SOLAR PHOTOVOLTAICS PANELS ON ROOF SURFACE AS SHOWN. 3: USE COMMON SENSE AND OSHA REGULATIONS UNTIL INSTALLATION IS

4: INSTALLED ACCORDING TO 2013

SEAL

I HEREBY CERTIFY THAT THIS DOCUMENT WAS APPROVED BY ME. AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE DISTRICT OF COLUMBIA, MEMBERS LICENSE NO. 907939 , EXPIRATION DATE: 08-31-20

PROJECT NAME SEE TITLE ABOVE

SCOPE OF WORK

SOLAR PV PANELS INSTALLATION ON EXISTING ROOF STRUCTURE BY MANUFACTURER'S

PROJECT DATA

THERE WILL BE A TOTAL OF (28) NEW SUNPOWER X22 360 DC W TYPE-E WITH A TOTAL OF 10.080 KW

## **DRAWING INDEX**

ARRAY PLAN RAIL LAYOUT AT ROOF PARAPET WALL MOUNT RACK -

SINGLE ROW SUPPORT PARAPET WALL MOUNT RACK -MULTIPLE ROW SUPPORT STRUCTURAL CALCULATIONS,

**DETAILS** 

A001

S001

ELECTRICAL SCHEMATIC E002 **ELECTRICAL CALCULATIONS ELECTRICAL MODULE SPECS** HARDWARE MOUNTING M001 DETAILS/SPEC

> HARDWARE MOUNTING DETAILS/SPEC

DISCONNECT LOCATION

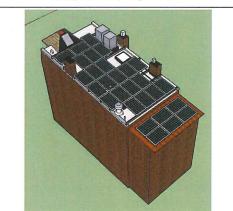


**EXISTING SERVICE PANEL** 



**EXISTING METER** 

**EXISTING ROOF VIEW** 



**MODEL VIEW** 

**EXISTING EXTERIOR** 



3014 CAMBRIDGE PL. NW

WASHINGTON, DC 20007

VICINITY LOCATION

SITE VIEW

NEW ARRAYS ON MULTI-ROOF

## ABBREVIATIONS & LEGEND

AHJ AUTHORITY HAVING JURISDICTION

ALTERNATING CURRENT CIRCUIT BREAKER

FT FOOT

JUNCTION BOX ON CENTER OC

LBS **POUNDS** 

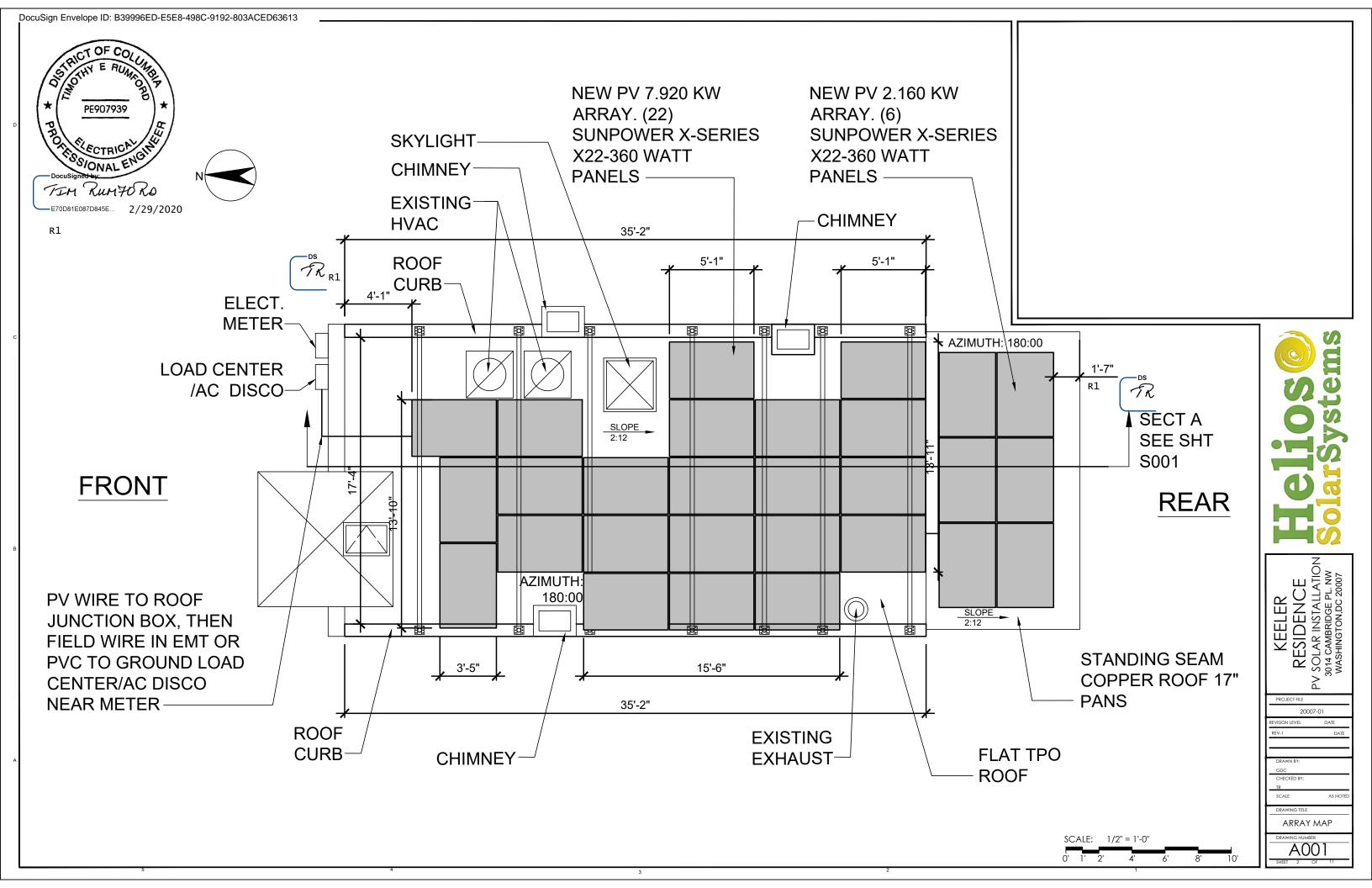
IAW IN ACCORDANCE WITH

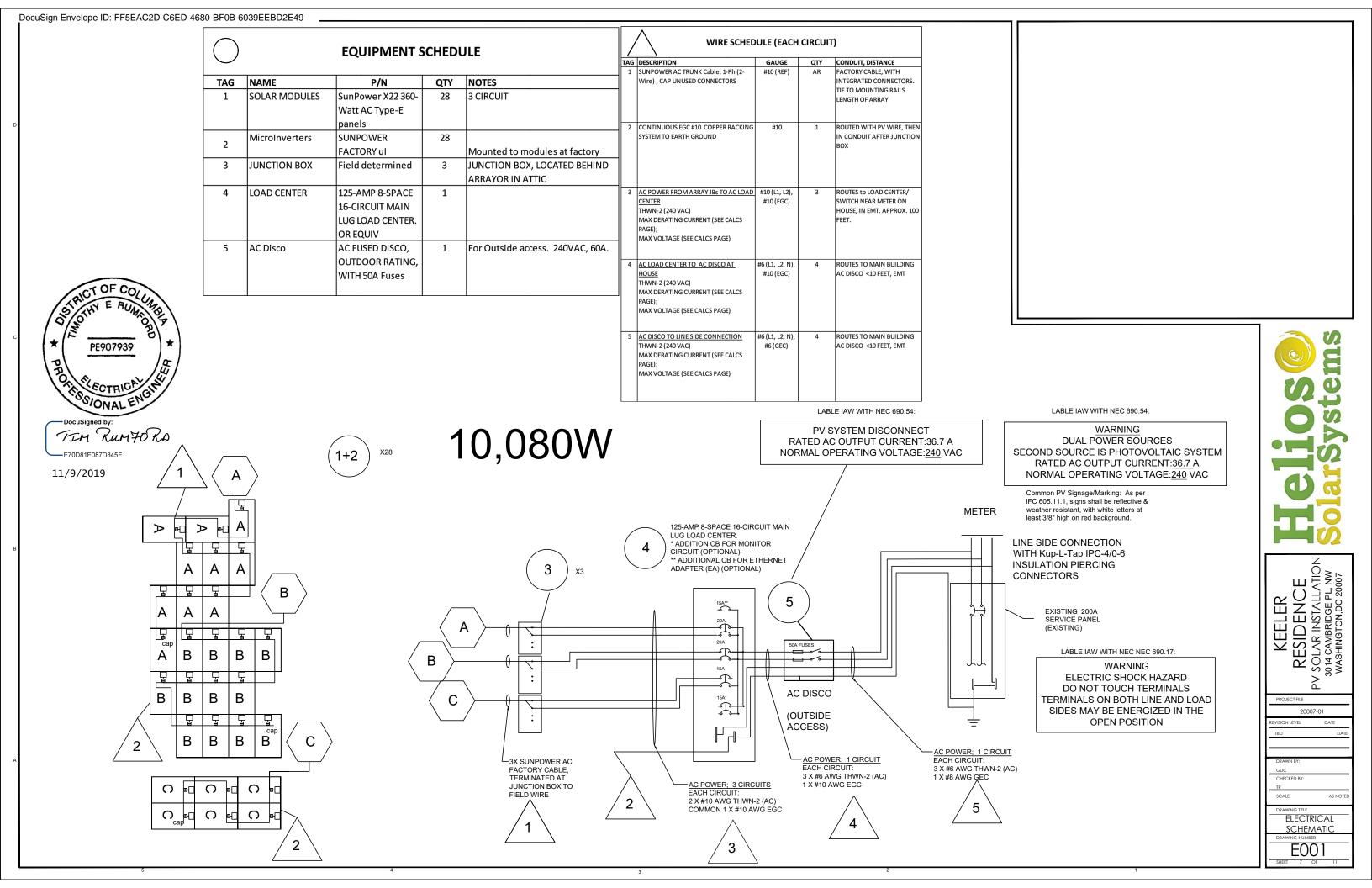
LBS POUNDS MPH MILES PER HOUR

PSF POUNDS PER SQUARE FOOT



**COVER SHEET** 





1. Conductor Sizing per Art. 690.8(B)(1)	ELECTRICAL CALCULATIONS							
	Michael Keeler							
							77	
a. Conductor must have 30 deg. C ampacity >= 125% of continuous	3014 Cambridge Pl NW, Washington, DC 20007						) /	
current per Art 215.2(A)(1).	Module 28 SunPower X22 360-Watt AC Type-E panels				36	360 10080 W STC		
	Inverter		SUNPOWER FACTORY ul			320	W max	
b. Conductor must have (after corrections for conditions of use) >=						8960		
continuous current per Table 310.16	Photovolt	aic Module	AC Electrical Specifications	(REF):				
c. Evaluate conductor temperature at termination per Art 110.14(C).	Pnim (DC)	= 360	W					
Ampacity of wire derated for conditions of termination must be								
>= continuous current * 1.25. All string terminations are rated at	AC Electric	cal Data						
90 degrees C.	Output @	240 (min/n	om/max);	211/240/264 V				
***************************************		-	(min./nom./max.)	59.3/60.0/60.5 Hz				
2. OOP Sizing per Art. 690.8(B)(1)		wer Factor		0.99	9			
a. Round up to next size per Art 240.4(B)	· ·	-	Output Current @ 240 V	1.31 A				
		pecification	<u> </u>	SUNPOWER FACTORY U	ıl	i i		
3. Conductor Sizing per Art. 690.8(B)(1)	Inverters			SOIN SWENT / CONT O	OUTPUT			
a. Conductor must have 30 deg. C ampacity >= 125% of continuous	Input Reco	nn (\M/)	FACTORY	ОК	Rated outp	ı+ (\\/)	320	
current per Art 215.2(A)(1).	Max in DC		FACTORY	ОК	Peak outpu		320	
b. Conductor must have (after corrections for conditions of use) >=	Max In Cui		FACTORY	ОК	Nom. outpu	- · · · · ·	1.31	
continuous current per Table 310.16	IVIAX III CUI	Tene (A)	TACIONI	OK .	max numbe			
c. Evaluate conductor temperature at termination per Art 110.14(C).		-		÷	max numbe	i ili selles.	ok	
Ampacity of wire derated for conditions of termination must be		+				-	OK .	
	Conductor	Cizing Inv	erter Input		1-way lengt	·h (f+)	na	
>= continuous current * 1.25. All string terminations are rated at				ad fartha arreasa	1-way lengi	.11 (11)	IId	
75 degrees C min.			ring is factory cable, design			1		
A CORCUI		-	of inverters per strings is eq	T.		CIDC D. 10	) CIDC C 9	
4. OOP Sizing	max string	;; B	1	1 ok <=12	and	CIKC B=10	), CIRC C = 8,	
D A 2.40 4/D)	Canadurata			DOLINDING (MODET CASE	·\	1	1	
a. Round up to next size per Art 240.4(B)		1	erter Output (each circuit	1	_	1-way len	10	
	Icont=	14.43		(1.31 A x number of inv	1	1	204 ON CIDC 4 45 4 ON C	
	Icont*1.25			OCP		D A	20A ON CIRC A, 15 A ON C	
	Wire		THWN-2		Α	NEC TABL		
5. Conductor Sizing per Art. 690.8(B)(1)		-1	rate factor	-	unitless		C PER NEC TBL 310.15(B)(2)(.c)	
a. Conductor must have 30 deg. C ampacity >= 125% of continuous		derated:		23.2	Z A	OK>	18.0	
			1. 12. 16. 1. 12			1		
			nbined Output from Load Co	T .			250.00	
	Icont=	36.68		(1.33A x number of inv	erters)			
	Icont*1.25	45.85	Α			ļ		
	Wire	#6AWG T		-	5 A	NEC TABL		
		<u>'</u>	rate factor	+	unitless	45	·	
		Conduit I	-ill factor		unitless	Table 310	.15(B)(20(a)	
		Derated		65.25	5 A	OK>	45.8	
current per Art 215.2(A)(1).			use	ОСР	5	D A		
7. Conductor Sizing per Art. 690.8(B)(1)	Voltage Di	rop = (Amp	*2*ft*ohm/ft)/V					
a. Conductor must have 30 deg. C ampacity >= 125% of continuous			<u>Amp</u>	<u>ft</u>	ohm/ft	<u>V</u>	Note	
current per Art 215.2(A)(1).	Inverter o	utput=	14.41	10	0.00126	240	#10	
b. Conductor must have (after corrections for conditions of use) >=	Inverter o	utput=	0.15%	6 ok	<3%	ok		
continuous current per Table 310.16	Load cente	er output=	36.68	100.00	0.00050	240	#6	
c. Evaluate conductor temperature at termination per Art 110.14(C).	Load cente	er output=	1.53%	6 ok	<3%	ok		
Ampacity of wire derated for conditions of termination must be								
>= continuous current * 1.25. All inverter output terminations are								
rated at 75 degrees C min.								

NET METER APPLICATION TECHNICAL PARAMETERS:							
GENERATING FACILITY INFORMATION							
TYPE OF APPLICATION: X_INITIAL ADDITION PRIME MOVER / SOURCE: PV / SO					PV / SOLAR		
DC NAMEPLATE RATING (KW):	10.08	AC INVERTER RAT	ING (KW) &	NO. OF INVERTERS	0.32	28	
C SYSTEM DESIGN CAPACITY (KW <u>AND</u> KVA): 8.96							
GENERATOR (OR PV PANEL) MANUFACTURER, MODEL #, NUMBER OF				SunPower X22 360-Watt AC Type-E panels			
INVERTER MANUFACTURER, MODEL # & RATING (KW):			SUNPOWER FACTORY ul 0.32				
NOMINAL DC VOLTAGE (VDC), POWER FACTOR (%), FREQUENCY (Hz):			100%	60 Hz			
ACCESSIBLE DISCONNECT OR LOCK BOX & LOCATION:			YES	GROUND, OUTS	SIDE		
1-LINE DIAGRAM ATTACHED AND SITE PLAN ATTACHED:			YES- PAGE	5 (DIAGRAM), PAGE 2 (PLAN	)		
DO YOU PLAN TO EXPORT POWER? YES,	YES	IS THE INVERTER IEEE/UL1741 LAB CERTIFIED?			YES		
BATTERY BACK UP?	NO						



20007-01 SCALE

TIM RUM 70 KD 11/9/2019 ELECTRICAL SCHEMATIC

E002







**Fundamentally Different.** 

The SunPower® Maxeon® Solar Cell

Patented solid metal foundation

prevents breakage and corrosion

Factory-integrated Microinverter

 Simpler, faster installation • Integrated wire management, rapid shutdown

Engineered and calibrated by

SunPower for SunPower modules

 Enables highest-efficiency modules available 2

Unmatched reliability<sup>3</sup>

And Better.

**SunPower® X-Series: X22-370 | X22-360** 

## SunPower® Residential AC Module

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



### **Maximum Power. Minimalist Design.**

Industry-leading efficiency means more power and savings per available space. With fewer modules required and hidden microinverters, less is truly more.



### **Highest Lifetime Energy and Savings.**

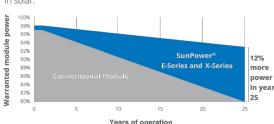
Designed to deliver 60% more energy over 25 years in real-world conditions like partial shade and high temperatures.1





### **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



X-Series: X22-370 | X22-360 SunPower® Residential AC Module

	AC Electrical Data	
Inverter Model: Enphase IQ 7XS (IQ7XS-96-ACM-US)	@240 VAC	@208 VAC
Peak Output Power	320 VA	320 VA
Max. Continuous Output Power	315 VA	315 VA
Nom. (L–L) Voltage/Range <sup>2</sup> (V)	240 / 211-264	208 / 183-229
Max, Continuous Output Current (A)	1.31	1.51
Max. Units per 20 A (LL) Branch Circult <sup>3</sup>	12 (single phase)	10 (two pole) wye
CEC Weighted Efficiency	97.5%	97.0%
Nom. Frequency	60	Hz
Extended Frequency Range	47–6	58 Hz
AC Short Circuit Fault Current Over 3 Cycles	5.8 /	\ rms
Overvoltage Class AC Port	III	
AC Port Backfeed Current	18 r	nA
Power Factor Setting	1.0	)
Power Factor (adjustable)	0.7 lead	. / 0.7 lag.
No	active phase balancing for three-phase installation	ns

DC Power Data					
SPR-X22-370-E-AC SPR-X22-360-E-					
Nominal Power 5 (Pnom)	370 W	360 W			
Power Tolerance	+5/-0%	+5/-0%			
Module Efficiency 5	22.7%	22.1%			
Temp. Coef. (Power)	−0.29%/°C	−0.29%/°C			

	Inree bypass diodes
hade Tolerance	<ul> <li>Integrated module-level maximum</li> </ul>
	power point tracking

-40°F to +140°F (-40°C to +60°C)
122°F (50°C)
Wind: 62 psf, 3000 Pa, 305 kg/m² front & back Snow: 125 psf, 6000 Pa, 611 kg/m² front
1 inch (25 mm) diameter hail at 52 mph (23 m/s)

Mechanical Data
96 Monocrystalline Maxeon Gen III
High-transmission tempered glass with anti-reflective coating
Module: Outdoor rated Inverter: NEMA Type 6 Class II
Class 1 black anodized (highest AAMA rating)
42.9 lb (19.5 kg)
1.3 in. (33 mm)

1 SunPower 360 W compared to a conventional module on same-sized arrays (260 W, 16% efficient, approx. 1.6 m²), 4% more energy per watt (based on third-party module characterization and PVSim), 0.75% yrs (sower degradation (Campeau, Z. et al. "SunPower Module Degradation Rate," SunPower white paper, 2013), 2 Based on search of datashet values from websites of top 10 manufacturers per IHS, as of

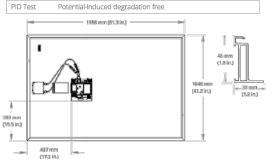
january 2017. 3 #1 rank in "Fraunhofer PV Durability Initiative for Solar Modules: Part 3," PVTech Power Magazine, 2015, Campeau, Z. et al. "Sun Power Module Degradation Rate," Sun Power white

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.

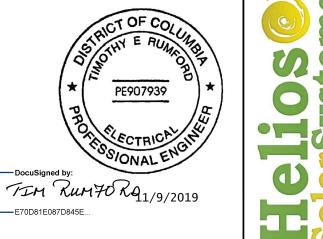
See www.sunpower.com/facts for more reference information See www.stunpower.com/racts to more reterence information. For more details, see extended datasheet www.sunpower.com/datasheets Special Sunpower.com/datasheet are subject to charge without notice, QC018 SUNPOWER logo and MAXEON are registered trademarks of STOMPOWER, the SUNPOWER logo and MAXEON are registered trademarks of STOMPOWER.

W	arranties	25-year limited power warranty     25-year limited product warranty
and	rtifications d mpliance	UL 1703 UL 1741 / IEEE-1547 UL 1741 AC Module (Type 2 fire rated) UL 16219-1 / 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) <sup>4</sup> (Includes Volt/Var and Reactive Power Priority) UL Listed PV Rapid Shutdown Equipment <sup>6</sup>
	I	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)*:  Rated for load break disconnect









20007-01 SCALE

FLECTRICAL

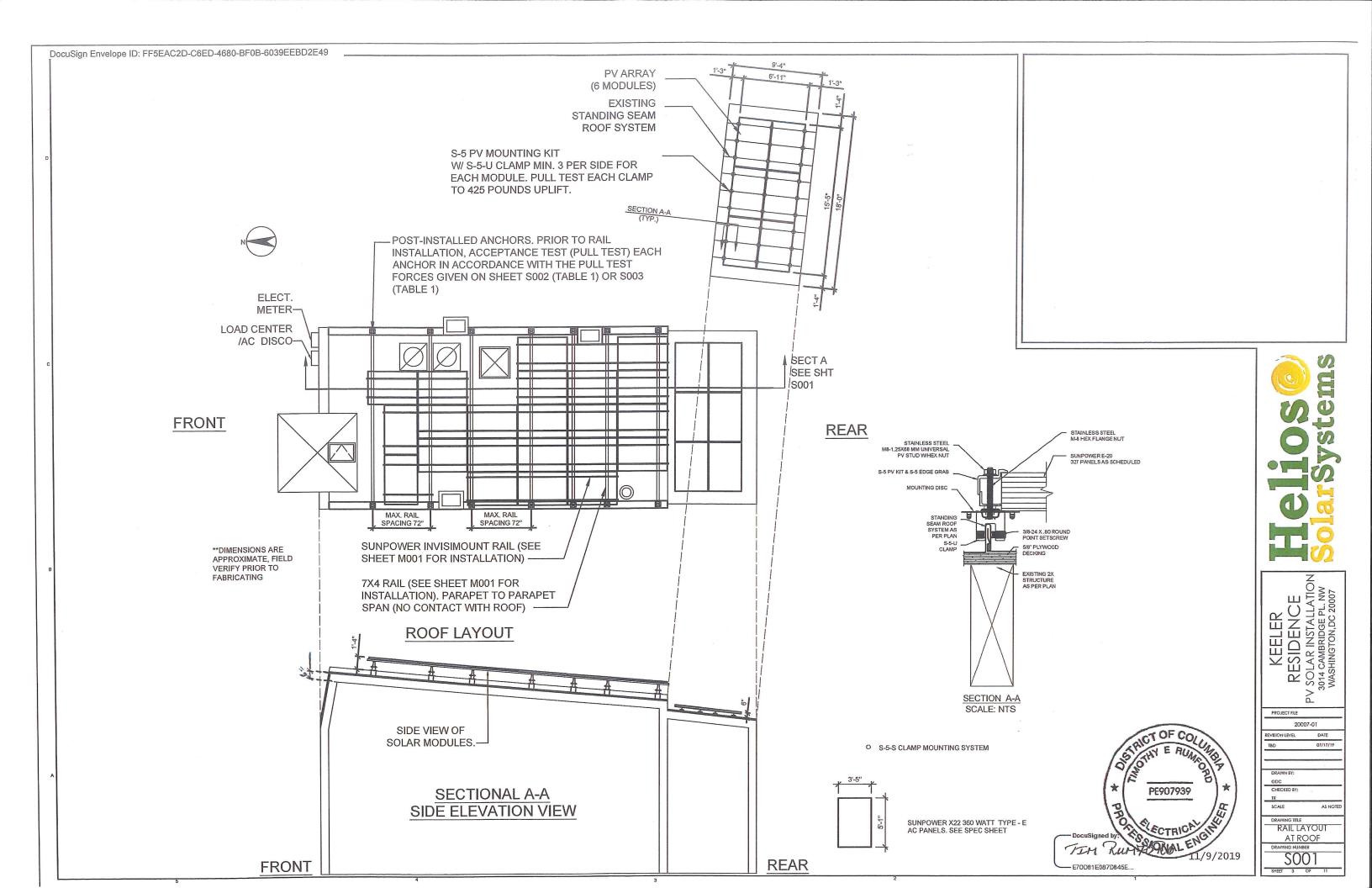
E003

Magazine, 2015, Campeau, Lettal, Surirowei mount-septemberg paper, 2013.

4 Factory set to 1547a-2014 default settings, CA Rule 21 default settings profile set during commissioning. See the Equinox installation Guide #518101 for more information.

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 modula. 393 mm (15.5 in.)

MODULE SPECS



S002

DESIGN CRITERIA: 2012 EDITION OF THE INTERNATIONAL BUILDING CODE, WITH DC AMENDMENTS

LOADS:
THE FOLLOWING DESIGN LOADS HAVE BEEN USED, AS SPECIFIED IN THE INTERNATIONAL BUILDING CODE, 2012 EDITION
THE FOLLOWING DESIGN LOADS HAVE BEEN USED, AS SPECIFIED IN THE INTERNATIONAL BUILDING CODE, 2012 EDITION
TO SE (BC-2012), CHAPTER 16, SECTIONS 1603.1.1 THROUGH 1603.1.9 AND THE DISTRICT OF COLUMBIA MUNICIPAL REGULATIONS (DCMR12A) CONSTRUCTION CODES SUPPLEMENT OF 2013. MORE STRINGENT VALUES HAVE BEEN USED PER PROJECTS LOCAL JURISDICTION SPECIFIC REQUIREMENTS WHERE APPLICABLE.

PLAN

DEAD LOADS: RAIL SELF WEIGHT: 3,92 LBS/FOOT

SOLAR PANEL MODULES: 2.87 PSF LIVE LOAD (SECTION 1607):

CONCENTRATED LOAD ON PORTION OF RAIL NOT SUPPORTING A PANEL: 300 LBS (TABLE 1607.1)

SNOW LOADS (SECTION 1608 AND 2013 DCMR SUPPLEMENT) GROUND SNOW LOAD: Pg = 25.0 PSF (ASCE 7-10 FIG. 7-1)

EXPOSURE FACTOR: Ce = 1.0 (ASCE 7-10, TABLE 7-2, FULLY EXPOSED ROOF) IMPORTANCE FACTOR: I = 1.0 (ASCE 7-10, TABLE 1.5-2)

THERMAL FACTOR: Ct = 1.2 (ASCE7-10, TABLE 7-3)

REQUIRED FLAT ROOF SNOW LOAD:  $(.7) \times (1.0) \times (1) \times (25 \, \text{PSF}) = 21 \, \text{PSF}$  DUE TO LACK OF WALLS AT EDGES OF PANELS, ASSUME NO DRIFTING ON PANELS

WIND LOAD (SECTION 1609, ASCE 7-10 CHAPTER 30.8 ):

ULTIMATE WIND SPEED Vult = 115 MPH (3-SECOND GUST, FIGURE 1609A OR 1609B) RISK CATEGORY II (IBC TABLE 1604.5, ASCE 7-10, TABLE 1.5-1)

EXPOSURE B (SECTION 1609.4)

VELOCITY PRESSURE = 21 PSF (ASCE 7-10 30.3.2) MAX ROOF SLOPE = 15°

NET PRESSURE COEFFICIENT CN (ASCE 7-10 FIG 30.8-1)

FOR ENTIRE RAIL ATTACHMENT CN = +/- 1.9 (AREA > 4.0a²) FOR SINGLE PANEL ATTACHMENT CN = +/- 2.9 (AREA < 4.0a²)

FINAL STRENGTH-LEVEL WIND PRESSURES (ASCE 7-10 30.8-1

FOR ENTIRE RAIL LOADING: 39.9 PSF FOR SINGLE PANEL LOADING: 60.9 PSF

MEANS AND METHODS:
THE STRUCTURAL CONSTRUCTION DOCUMENTS REPRESENT THE FINISHED ALUMINUM RAIL STRUCTURE. THEY DO NOT INDICATE THE METHOD OR SEQUENCE OF CONSTRUCTION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR AND PROVIDE ALL MEASURES NECESSARY TO PROTECT THE EXISTING STRUCTURE DURING CONSTRUCTION. SUCH MEASURES SHALL INCLUDE, BUT NOT BE LIMITED TO, BRACING, SHORING FOR LOADS DUE TO CONSTRUCTION EQUIPMENT, ETC. THE STRUCTURAL ENGINEER SHALL NOT BE RESPONSIBLE FOR THE CONTRACTOR'S MEANS, METHODS, TECHNIQUES, SEQUENCES FOR THE PROCEDURE OF CONSTRUCTION, NOR FOR THE SAFETY PRECAUTIONS AND THE PROGRAMS INCIDENT THERE TO (NO SHALL OBSERVATION VISITS TO THE SITE INCLUDE INSPECTION OF THESE ITEMS). THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DESIGN AND IMPLEMENTATION OF ALL SCAFFOLDING, BRACING AND SHORING.

STRUCTURAL ALUMINUM:
DESIGN, DETAILING, AND FABRICATION OF ALUMINUM MEMBERS SHALL BE IN STRICT ACCORDANCE WITH THE LATEST EDITION OF "ALUMINUM DESIGN MANUAL" OF THE ALUMINUM ASSOCIATION, ALUMINUM MATERIALS SHALL BE ALUMINUM ALLOYS REGISTERED WITH THE ALUMINUM ASSOCIATION, AND APPLICABLE ASTM SPECIFICATIONS.

HOLLOW EXTRUSIONS SHALL BE 6005-T5

MISCELLANEOUS STEEL
MISCELLANEOUS STRUCTURAL STEEL SHALL CONFORM TO THE LATEST EDITION OF THE AISC "SPECIFICATION FOR STRUCTURAL STEEL BUILDINGS".

PLATES SHALL BE ASTM A36 AND HOT-DIPPED GALVANIZED.

BOLTS AND WASHERS SHALL BE 304 STAINLESS STEEL CLASS 2 (A2-70)

AND NUTS SHALL BE 316

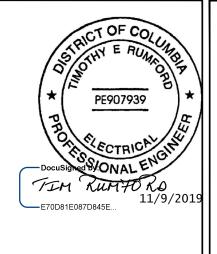
POST-INSTALL EPOXY SYSTEM
THE EPOXY SYSTEM FOR ATTACHING TO CONCRETE AND CMU PARAPET WALLS SHALL BE HT-HY 200 OR OTHER EPOXIES

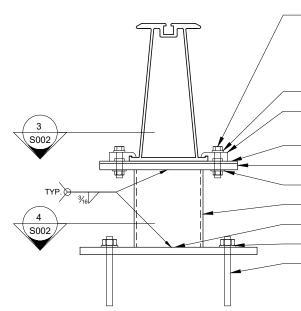
BASE BUILDING DESIGN
OWNER MUST VERIFY WITH PROFESSIONAL ENGINEER THAT ROOF STRUCTURE AND ITS COMPONENTS CAN SUPPORT AND TRANSFER POINT LOAD AT EACH CONNECTION LOCATION RESULTING FROM ADDITION OF SOLAR PANELS AND RACKING. SEE TABLE BELOW FOR REACTIONS AT END OF EACH RAIL. CONNECTION DESIGNS FOR CONCRETE AND CMU PARAPETS PROVIDED ON 2/S1.00. FOR OTHER MATERIALS, EOR TO DESIGN CUSTOM CONNECTION FROM PARAPET TO

TABLE 1 - MAX RAIL REACTIONS							
DAIL LENGTH	MAX UPLIFT		MAX COM	PULL TEST FORCE PER			
RAIL LENGTH (FT)	FACTORED (LBS)	SERVICE (LBS)	FACTORED (LBS)	SERVICE (LBS)	ANCHOR (LBS)		
≤26	1,480	880	3,380	2,200	660		
≤24	1,360	810	3,110	2,030	610		
≤22	1,240	730	2,840	1,850	540		
≤20	1,120	660	2,570	1,670	500		
≤18	1,000	600	2,300	1,500	450		

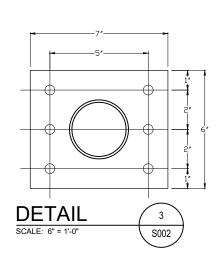
TABLE 2 - RAIL CAPACITIES			
RAIL LENGTH (FT)	MAXIMUM # OF PANELS		
25' - 27'	4		
24' - 24.99'	5		
21.5' - 23.99'	6		
<21.5'	5		

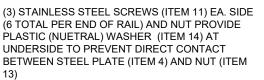
	PA	ARTS LIST
ITEM	PART NUMBER	DESCRIPTION
1	VARIES	SOLAR PANEL MODULE
2	302025D	UNIRAC F-CLAMP FOR MODULES 45MM-47MM THICK.
3	302030D	UNIRAC MIDCLAMP PRO - DRK
4	EE0001-001	HOT-DIPPED GALVANIZED A36 STEEL STANDOFF ASSMEBLY (SEE 1/S1.00)
5	EE0002-001	ALMAG P/N A-27816 (SEE M001 FOR PROFILE)
6	973000-666	TAPE, FOAM, PVC, T=1/8" W=6", CUSTOM
7	TR12SS	½" ALL THREAD SS. SEE SECTION 2/S1.00 FOR LENGTH
8	12FWS	½" FLAT WASHER SS
9	12NS	½" NUTS STAINLESS STEEL
10	EE0003-001	MOUNTING CLAMP, LOCKING, 40 MM
11	943608-035	SCREW, HEX HEAD, M8x40 MM, DIN 933 304 SS
12	943921-010	WASHER, M10, DIN 125, 304 SS
13	943912-010	NUT, FLANGE, SERRATED, M10, DIN 6923 316 SS
14	EE0004-001	PLASTIC WASHER
15	522195	SUNPOWER INVISIMOUNT RAIL
16	519636	SUNPOWER INVISIMOUNT END CLAMP
17	506608	SUNPOWER INVISIMOUNT MID CLAMP











STAINLESS STEEL WASHER (ITEM 12)

(3) ALUMINUM MOUNTING CLAMPS EA. SIDE (6 TOTAL PER END OF RAIL) (ITEM 10)

TAPE, FOAM, PVC, 1/8" THICK (6"x7") (ITEM 6)

6"x7"x5/16" PLATE (GALV.) (ITEM 4)

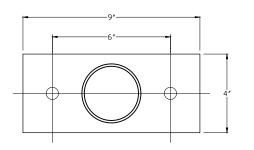
PLASTIC WASHER (ITEM 14)

HSS3x.125 x 0'-4" LONG (GALV.) (ITEM 4)

4"x8"x3/8" PLATE (GALV.) (ITEM 4)

NUT AND WASHER (ITEMS 8 AND 9)

FOR CONCRETE OR CMU PARAPET WALLS: PROVIDE (2) 1/2" DIA THREADED STAINLESS STEEL RODS (ITEM 7) WITH NEUTRAL WASHERS (ITEM 14), DRILLED AND EPOXIED WITH WITH 6" EMBED IN CONCRETE (MIN 2,500 PSI), OR 13" EMBED IN FULLY GROUTED CMU. GROUT CELLS FIRST IF UNGROUTED, AND ENSURE THE RODS ARE INSERTED INTO SEPARATE CELLS. PROVIDE 2.5" EDGE DISTANCE FOR CONCRETE, 3.5" EDGE DISTANCE FOR CMU



**DETAIL** S002



KEELER RESIDENCE DLAR INSTALLATION 4 CAMBRIDGE PL. NW ASHINGTON,DC 20007  $\mathcal{L}$  $\geq$ 

20007-0 SCALE PARAPET WALL MOUNT RACK SINGLE ROW SUPPORT

S002

ANCHORAGE ASSEMBLY, SEE SECTION 2 FOR MORE INFO ADJUSTABLE L-FOOT AND #8 STAINLESS STEEL BOLT FOR ATTACHING 4x3 RAIL TO ALMAG RAIL (ITEMS 17 AND 18)

## PLAN-LAYOUT WITH CROSS RAILS

 $\underline{\text{DESIGN CRITERIA:}}\\2012\,\text{EDITION OF THE INTERNATIONAL BUILDING CODE, WITH DC AMENDMENTS}$ 

LOADS:
THE FOLLOWING DESIGN LOADS HAVE BEEN USED, AS SPECIFIED IN THE INTERNATIONAL BUILDING CODE, 2012 EDITION (BIG-2012), CHAPTER 16, SECTIONS 1603.1.1 THROUGH 1603.1.9 AND THE DISTRICT OF COLUMBIA MUNICIPAL REGULATIONS (DCMR12A) CONSTRUCTION CODES SUPPLEMENT OF 2013. MORE STRINGENT VALUES HAVE BEEN USED PER PROJECTS LOCAL JURISDICTION SPECIFIC REQUIREMENTS WHERE APPLICABLE.

DEAD LOADS:

RAIL SELF WEIGHT: 3.92 LBS/FOOT

SOLAR PANEL MODULES: 2.87 PSF

LIVE LOAD (SECTION 1607):
CONCENTRATED LOAD ON PORTION OF RAIL NOT SUPPORTING A PANEL: 300 LBS (TABLE 1607.1) SNOW LOADS (SECTION 1608 AND 2013 DCMR SUPPLEMENT)

GROUND SNOW LOAD: Pg = 25.0 PSF (ASCE 7-10 FIG. 7-1) EXPOSURE FACTOR: Ce = 1.0 (ASCE 7-10, TABLE 7-2, FULLY EXPOSED ROOF)

IMPORTANCE FACTOR: I = 1.0 (ASCE 7-10, TABLE 1.5-2)

THERMAL FACTOR: Ct = 1.2 (ASCE7-10, TABLE 7-3)
REQUIRED FLAT ROOF SNOW LOAD: (.7) x (1.0) x (1) x (1.2) x (25 PSF) = 21 PSF

DUE TO LACK OF WALLS AT EDGES OF PANELS. ASSUME NO DRIFTING ON PANELS

WIND LOAD (SECTION 1609, ASCE 7-10 CHAPTER 30.8);
ULTIMATE WIND SPEED Vult=115 MPH (3-SECOND GUST, FIGURE 1609A OR 1609B)

RISK CATEGORY II (IBC TABLE 1604.5, ASCE 7-10, TABLE 1.5-1) EXPOSURE B (SECTION 1609.4) VELOCITY PRESSURE = 21 PSF (ASCE 7-10 30.3.2)

MAX ROOF SLOPE = 15°
NET PRESSURE COEFFICIENT CN (ASCE 7-10 FIG 30.8-1)

FOR ENTIRE RAIL ATTACHMENT CN = +/- 1.9 (AREA > 4.0a2)

FOR SINGLE PANEL ATTACHMENT ON = +/- 2.9 (AREA < 4.0a²) FINAL STRENGTH-LEVEL WIND PRESSURES (ASCE 7-10 30.8-1)

FOR ENTIRE RAIL LOADING: 39.9 PSF FOR SINGLE PANEL LOADING: 60.9 PSF

THE STRUCTURAL CONSTRUCTION DOCUMENTS REPRESENT THE FINISHED ALUMNUM RAIL STRUCTURE. THEY DO NOT INDICATE THE METHOD OR SEQUENCE OF CONSTRUCTION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR AND PROVIDE ALL MEASURES, NECESSARY TO PROTECT THE EXISTING STRUCTURE DURING CONSTRUCTION. SUCH MEASURES SHALL INCLUDE, BUT NOT BE LIMITED TO, BRACING, SHORING FOR LOADS DUE TO CONSTRUCTION EQUIPMENT, ETC. THE STRUCTURAL ENGINEER SHALL NOT BE RESPONSIBLE FOR THE CONTRACTOR'S MEANS, METHODS, TECHNIQUES, SEQUENCES FOR THE PROCEDURE OF CONSTRUCTION, NOR FOR THE SAFETY PRECAUTIONS AND THE PROGRAMS INCIDENT THERE TO (NO SHALL OBSERVATION VISITS TO THE SITE INCLUDE INSPECTION OF THESE ITEMS). THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DESIGN AND IMPLEMENTATION OF ALL SCAFFOLDING, BRACING AND SHORING.

DESIGN, DETAILING, AND FABRICATION OF ALUMINUM MEMBERS SHALL BE IN STRICT ACCORDANCE WITH THE LATEST EDITION OF "ALUMINUM DESIGN MANUAL" OF THE ALUMINUM ASSOCIATION, ALUMINUM MATERIALS SHALL BE ALUMINUM ALLOYS REGISTERED WITH THE ALUMINUM ASSOCIATION, AND APPLICABLE ASTM SPECIFICATIONS.

HOLLOW EXTRUSIONS SHALL BE 6005-T5 SOLIDS SHALL BE 6063-T6

MISCELLANEOUS STEEL
MISCELLANEOUS STRUCTURAL STEEL SHALL CONFORM TO THE LATEST EDITION OF THE AISC "SPECIFICATION FOR

PLATES SHALL BE ASTM A36 AND HOT-DIPPED GALVANIZED.

BOLTS AND WASHERS SHALL BE 304 STAINLESS STEEL CLASS 2 (A2-70) AND NUTS SHALL BE 316

POST-INSTALL EPOXY SYSTEM
THE EPOXY SYSTEM FOR ATTACHING TO CONCRETE AND CMU PARAPET WALLS SHALL BE HT-HY 200 OR OTHER EPOXIES WITH THE SAME OR GREATER CAPACITY.

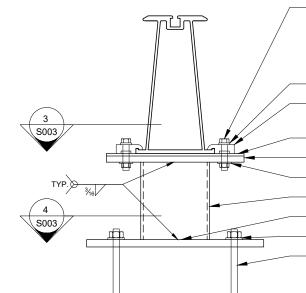
OWNER MUST VERIFY WITH PROFESSIONAL ENGINEER THAT ROOF STRUCTURE AND ITS COMPONENTS CAN SUPPORT AND TRANSFER POINT LOAD AT EACH CONNECTION LOCATION RESULTING FROM ADDITION OF SOLAR PANELS AND RACKING, SEE TABLE BELOW FOR REACTIONS AT END OF EACH RAIL. CONNECTION DESIGNS FOR CONCRETE AND CMU  ${\tt PARAPETS\ PROVIDED\ ON\ 2/S1.00.\ FOR\ OTHER\ MATERIALS, EOR\ TO\ DESIGN\ CUSTOM\ CONNECTION\ FROM\ PARAPET\ TO\ PARA$ 

TABLE 1 - MAX RAIL REACTIONS							
	MAX UPLIFT		MAX COM	PULL TEST FORCE PER			
RAIL LENGTH (FT)	FACTORED (LBS)	SERVICE (LBS)	FACTORED (LBS)	SERVICE (LBS)	ANCHOR (LBS)		
≤26	1,480	880	3,380	2,200	660		
≤24	1,360	810	3,110	2,030	610		
≤22	1,240	730	2,840	1,850	540		
≤20	1,120	660	2,570	1,670	500		
≤18	1,000	600	2,300	1,500	450		

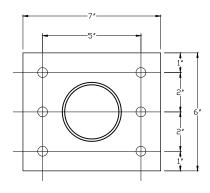
### TABLE 2 - RAIL CAPACITIES AND SPACING RESTRICTIONS

RAIL LENGTH (FT)	MAXIMUM RAIL SPACING	MAXIMUM CANTILEVER OF SECONDARY RAIL
25' - 27'	36"	12"
24' - 24.99'	48"	15"
20.5' - 23.99'	60"	18"
<20.5'	72"	24"

	P	ARTS LIST
ITEM	PART NUMBER	DESCRIPTION
1	VARIES	SOLAR PANEL MODULE
2	302025D	UNIRAC F-CLAMP FOR MODULES 45MM-47MM THICK.
3	302030D	UNIRAC MIDCLAMP PRO - DRK
4	EE0001-001	HOT-DIPPED GALVANIZED A36 STEEL STANDOFF ASSMEBLY (SEE 1/S1.00)
5	EE0002-001	ALMAG P/N A-27816 (SEE M001 FOR PROFILE)
6	973000-666	TAPE, FOAM, PVC, T=1/8" W=6", CUSTOM
7	TR12SS	½" ALL THREAD SS. SEE SECTION 2/S1.00 FOR LENGTH
8	12FWS	½" FLAT WASHER SS
9	12NS	½" NUTS STAINLESS STEEL
10	EE0003-001	MOUNTING CLAMP, LOCKING, 40 MM
11	943608-035	SCREW, HEX HEAD, M8x40 MM, DIN 933 304 SS
12	943921-010	WASHER, M10, DIN 125, 304 SS
13	943912-010	NUT, FLANGE, SERRATED, M10, DIN 6923 316 SS
14	EE0004-001	PLASTIC WASHER
15	522195	SUNPOWER INVISIMOUNT RAIL
16	519636	SUNPOWER INVISIMOUNT END CLAMP
17	506608	SUNPOWER INVISIMOUNT MID CLAMP
17	KU14631	ECOFASTEN L-102-3, ANODIZED BLACK ALUMINUM ADJUSTABLE L-FOOT
18		#8 STAINLESS STEEL BOLT



SECTION 2 SCALE: 1-1/2" = 1'-0 S003



SCALE: 1-1/2" = 1'-0" S003 (3) STAINLESS STEEL SCREWS (ITEM 11) EA. SIDE (6 TOTAL PER END OF RAIL) AND NUT PROVIDE PLASTIC (NUETRAL) WASHER (ITEM 14) AT UNDERSIDE TO PREVENT DIRECT CONTACT BETWEEN STEEL PLATE (ITEM 4) AND NUT (ITEM

STAINLESS STEEL WASHER (ITEM 12)

(3) ALUMINUM MOUNTING CLAMPS EA. SIDE (6 TOTAL PER END OF RAIL) (ITEM 10)

TAPE, FOAM, PVC, 1/8" THICK (6"x7") (ITEM 6)

6"x7"x5/16" PLATE (GALV.) (ITEM 4)

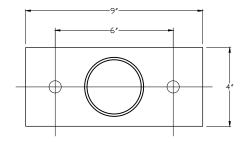
PLASTIC WASHER (ITEM 14)

HSS3x.125 x 0'-4" LONG (GALV.) (ITEM 4)

4"x8"x3/8" PLATE (GALV.) (ITEM 4)

NUT AND WASHER (ITEMS 8 AND 9)

FOR CONCRETE OR CMU PARAPET WALLS: PROVIDE (2) 1/8" DIA THREADED STAINLESS STEEL RODS (ITEM 7) WITH NEUTRAL WASHERS (ITEM 14), DRILLED AND EPOXIED WITH WITH 6" EMBED IN CONCRETE (MIN 2,500 PSI), OR 13" EMBED IN FULLY GROUTED CMU. GROUT CELLS FIRST IF UNGROUTED, AND ENSURE THE RODS ARE INSERTED INTO SEPARATE CELLS. PROVIDE 2.5" EDGE DISTANCE FOR CONCRETE, 3.5" EDGE DISTANCE FOR CMU



**DETAIL** SCALE: 1-1/2" = 1'-0" S003



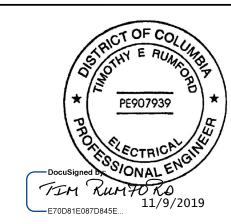
20007-0

PARAPET WALL MOUNT RACK MULTIPLE ROW SUPPORT

**S003** 

SCALE

DocuSign Envelope ID: FF5EAC2D-C6ED-4680-BF0B-6039EEBD2E49	
	Structural Analysis
	Project Name: Michael Keeler 3014 Cambridge Pl NW, Washington, DC 20007
	Address:  Description:  Near flat roof (approx 5 degrees), 28 SunPower X22 360-Watt AC Type-E panels. 22 Mounted with Almag parapet to parapet (see analysis on pages S002 and S003), 6 moudles mounted to a standing seam roof with S5!  Clamps (this analysis)
	Load/Structure Assumptions (1)
	Wind Snow load Roof Importance Wind Roof Wind Zone Speed (psf) Height (ft) factor Cat Exposure (mph)
	115 30 <30 II B 1-3
	Present Conditions and Structure Info
	Six Modules Using S-5! Clamp on a Standing Seam Pitched Copper Roof. 17" Pans, 5 degree pitch
	Wind Loading
	Pnet = Net Design Wind Pressure (psf) From ASCE 7-10, 100 sf eff wind area, 0 to 7 deg (5)
	Down Up 7.7 25.8 assuming ALL zone 3, Module Areas (sf): 17.6
	Pnet * Wind Force (lbs), Per module: Area=
	Down Up  135.6 454.2
	Array number of fasteners 27 Array Number of Modules: 6 Number of fasteners per module: 4.5 Force per fastener:
	(lbs)
	30.1 100.9
	Pull out Force per fastener, lbs (2):  202 requires pull test
	Design Margin (Capability/Exposure). >2 required
	Down Up 6.7 2.0 x margin
	OK OK >=2  Uplift wind loads well below pull out force on fasteners. Down Force, since modules are flush, array not likely to affect forces compared to existing bare roof deflection. Uplift psf < negative snow load. Side wind loads negligible.
	Snow Load  OK Modules are flush and not likely to affect snow drift
	Dead Load
	Module Weight (lbs)
	45.5
	2.6 psf OK (negligible effect)
	Seismic Seismic criteria were not considered per provisions of ASCE 7-10 Section 13.1.4
	NOTES NOTES
	(1) ASCE 7- 10



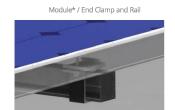


KEELER RESIDENCE PV SOLAR INSTALLATION 3014 CAMBRIDGE PL. NW WASHINGTON, DC 20007

PROJECT FILE	
20007-01	
REVISION LEVEL	DATE
TBD	07/17/
•	
DRAWN BY:	
GDC	
CHECKED BY:	
TR	
SCALE	AS NOTE
DRAWING TITLE	
STRUCTURAL	
CALCULATION: DETAILS	S,
DRAWING NUMBER	
S003	
SHEET 6 OF	11

SunPower® InvisiMount™ | Residential Mounting System

















InvisiMount Component Details		
Component	Material	Weight
Mid Clamp	Black oxide stainless steel AISI 304	63 g (2.2 oz)
End Clamp	Black anodized aluminum aloy 6063-T6	110 g (3.88 oz)
Rail	Black anodized aluminum aloy 6005-T6	830 g/m (9 oz/ft)
Rail Splice	Aluminum alloy 6005-T5	830 g/m (9 oz/ft)
Ground Lug Assembly	304 stainless (A2-70 bolt; tin-plated copper lug)	106.5 g/m (3.75 oz)
End Cap	Black acetal (POM) copolymer	10.4 g (0.37 oz)

Roof Attachment Hardware Supported by InvisiMount System 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 Operating Conditions	
Temperature	-40° C to 90° C (-40° F to 194° F)
Max. Load	2400 Pa uplift 5400 Pa downforce
InvisiMount Warranties And Certifications	

InvisiMount Warranties And Certifications		
Warranties	25-year product warranty 5-year finish warranty	
Certifications	UL 2703 Listed  Class A fire rating when distance between roof surface and bottom of SunPower module frame is ≤ 3.5"	

Refer to roof attachment hardware manufacturer's documentation

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sunpower.com Document #509506 Rev B



## Almag P/N A-27816 SPECIFICATION

CUSTOM RAIL DEVELOPED AS A MAIN SOLAR SUPPORT BEAM STO SPAN LARGE DISTANCES SUCH AS ACROSS PARAPET WALLS FOR RESIDENTIAL STRUCTURES AND FOR SPANNING ACROSS MAJOR BEAMS IN COMMERCIAL BUILDINGS

PHYSICAL CHARACTERISTICS: DIMENSIONS: 7" HIGH X 4" WIDE WEIGHT: 3.7 LBS/FT.

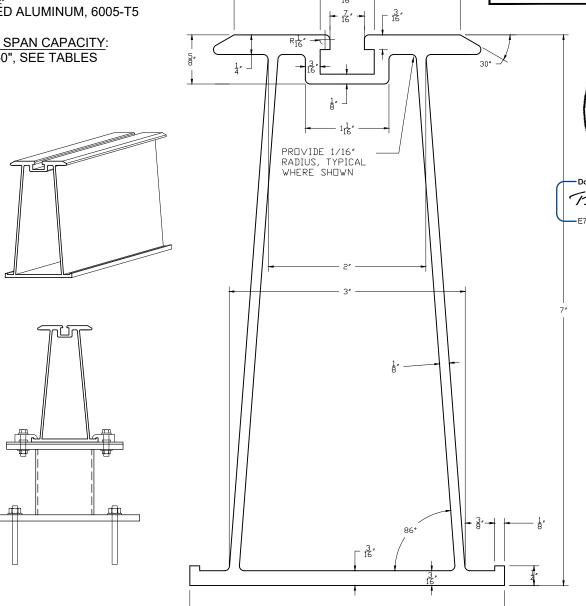
### STRUCTURAL CHARACTERISTICS:

S <sub>zz,comp.</sub>	= 6.83 in <sup>3</sup>
S <sub>zz,tens.</sub>	$= 7.22 \text{ in}^3$
I <sub>zz</sub>	= 24.6 in <sup>4</sup>
$S_{yy}$	$= 2.08 \text{ in}^3$
l <sub>yy</sub>	= 4.15 in <sup>4</sup>
Á	$= 3.3 \text{ in}^2$

### MATERIAL:

-EXTRUDED ALUMINUM, 6005-T5

SUPPORT SPAN CAPACITY: UP TO 26'-0", SEE TABLES





PE907939

20007-01

HARDWARE MOUNTING DETAILS, SPEC

M001

## S-5-PV Kit and EdgeGrab™

metal

anything to

The right way

The concept of combining photovoltaic arrays with standing seam metal roofing is growing—and for good reasons. A standing seam metal roof has a life expectancy consistent with that of framed PV modules. A 30-year power source on a 40-year roof, along with zero-penetration technology, creates the most sustainable roof system available with alternative power generation, all without compromising the roof manufacturer's warranty!

The new S-5-PV Kit boasts an important breakthrough in PV mounting technology. It is one of the first solar module mounting solutions in the industry to be listed to the new UL subject 2703, a standard that covers both bonding and mounting. Furthermore, the S-5!® Mounting Disk has gained an ETL Listing to UL 1703.\*

The S-5-PV Kit features a groundbreaking new stainless steel mounting disk with twelve nodes designed to ensure the module-to-module conductivity of anodized aluminum module frames. This means it automatically provides a ground path in the module frame. No lugs or wire required except to connect one string of modules to another and to ground the system. This connection detail represents installed electrical cost savings of \$6-\$12 per unit. In most cases, the savings in time and materials is sufficient to pay for the entire S-5-PV Kit and clamp setup.

The S-5-PV Kit is a revolutionary new solution to attach solar PV panels to standing seam metal roofs!

The **S-5-PV Kit** is furnished with the hardware shown at right, excluding the attachment clamp, which is supplied separately. (When ProteaBracket™ is used in conjunction with the S-5-PV Kit, an additional nut is required during installation to secure the universal PV stud and mounting disk to ProteaBracket's slotted L-flange.) The S-5-PV Kit is compatible with most common metal roofing materials, including brass. The S-5!® **EdgeGrab™** and S-5-PV Kit together accommodate PV frame thicknesses 30–48 mm (if EdgeGrab's serrated L-flange is positioned below the stud's hex nut) and 34–51 mm (if EdgeGrab's serrated L-flange is positioned above the stud's hex nut).+

The embossed panel guide makes the module placement easier. The mounting disk is multi-directional and rails are not required.

Four strategically placed under-disk hooks assist in wire management. The PV grab ears that hold the solar panel in place are broader to allow for ease of installation and precise module engagement.

Accommodating module thicknesses between 30 and 51 mm, the S-5-PV Kit fits the majority of solar panels on the market. Using the S-5! mini clamps, it fits most standing seam metal roofs. When paired with other S-5! products, the S-5-PV Kit and EdgeGrab will work on most exposed-fastened and corrugated metal roofs. The standard grab is designed to fit field conditions (two adjacent panels), while the new EdgeGrab is designed specifically for end conditions.

Wind dynamics are complex; thus, each system should be reviewed by a qualified licensed professional who understands wind effects on metal roof design and construction prior to purchase and installation. For more detailed information including specifications, installation instructions, and CAD drawings, visit www.S-5.com or your S-5-PV Kit distributor.

The S-5-PV Kit continues to be the easiest, most cost-effective way to install solar panels directly to standing seam metal roofs. remaining the most popular choice worldwide.

825-3432 | www.





(Not UL or ETL Listed)

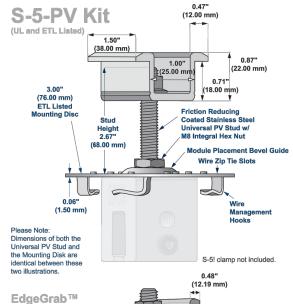
assembly option in the diagram to the right illustrates the serrated

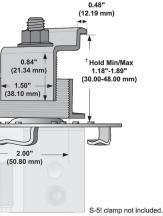
L-flange positioned below

\* Patents pending. Certain components featured in illustration may not be UL listed.

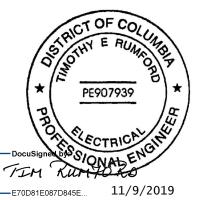
Due to the variety of attachment needs, S-5-PV Kits are sold separately from S-5! mini clamps. The S-5-PV Kit fits only S-5! mini clamps, NOT standard clamps.

### S-5!® Warning! Please use this product responsibly! Distributed by





Please note: All measurements are rounded to the second



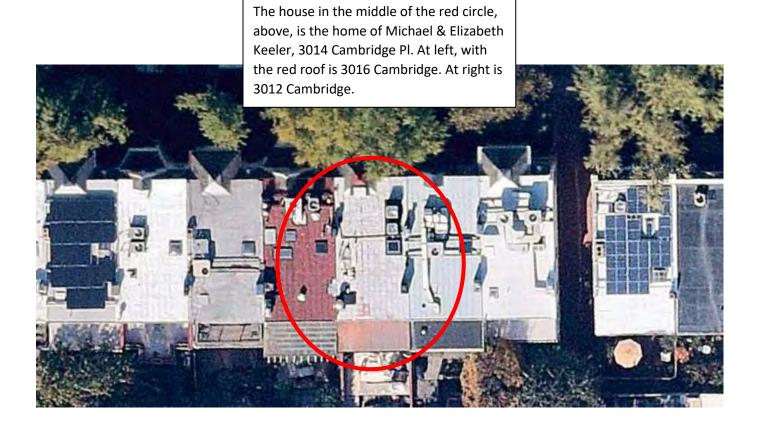
KEELER PESIDENCE DLAR INSTALLATION 4 CAMBRIDGE PL. NW ASHINGTON, DC 20007

20007-0 SCALE HARDWARE MOUNTING DETAILS, SPEC

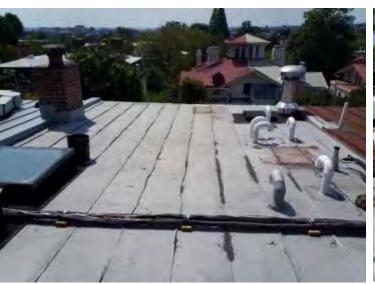
M002

Products are protected by multiple U.S. and foreign patents. Visit the website at www.5-5.com for complete information on patents and trademarks. For maximum holding strength, setscrews should be tensioned and re-tensioned as the seam material compresses. Clamp setscrew tension should be verified using a calibrated torque wrench between 160 and 180 inch pounds when used on 22ga steel, and between 130 and 150 inch pounds for all other metals and thinner gauges of steel. Consult the 5-51 website at www.5-5.com for published data regarding holding strength.

Copyright 2014, Metal Roof Innovations, Ltd. S-5! products are patent protected S-5! aggressively protects its patents, trademarks, and copyrights. Version 0327

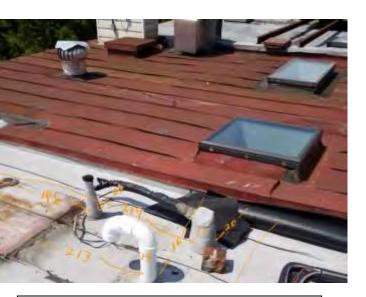


## **Roof Pictures**

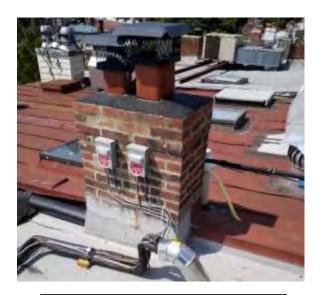


Keeler Home, 3014 Cambridge Place: View from front toward rear.

View from rear toward front.



View of 3016 Cambridge Pl. looking southwest.

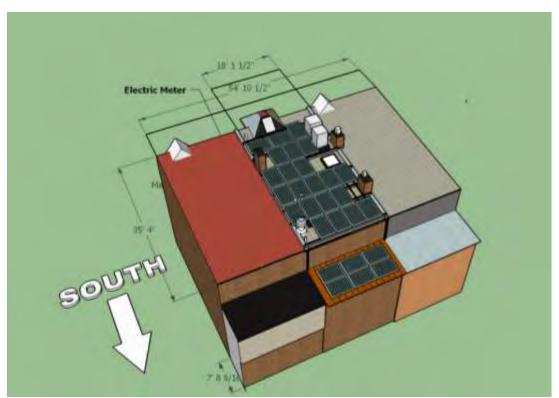


Another view toward 3016 taken from a few feet further to the front

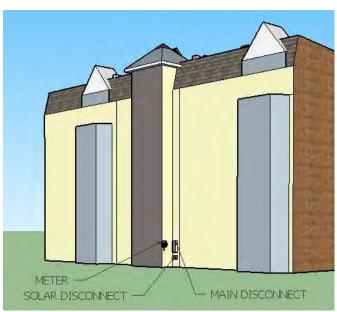




Two Views due east toward 3012 Cambridge Pl. Note condensing units in foreground are on roof of 3016. The metal finial atop the hipped slate roof is 3010 Cambridge.



Left to right, 3016, 3014 & 3012
Cambridge Pl.
Image shows planned arrays on 3014.
Measurements are for reference.
Actuals are shown on construction drawings



Red Circle on drawing at right notes location of meter and disconnects behind steps to 3016 in photo





Current photo of the Keeler home street face showing planned location of solar system shutoff (in red)



Two views of last row of proposed array; at left, from above and, bottom, from below.



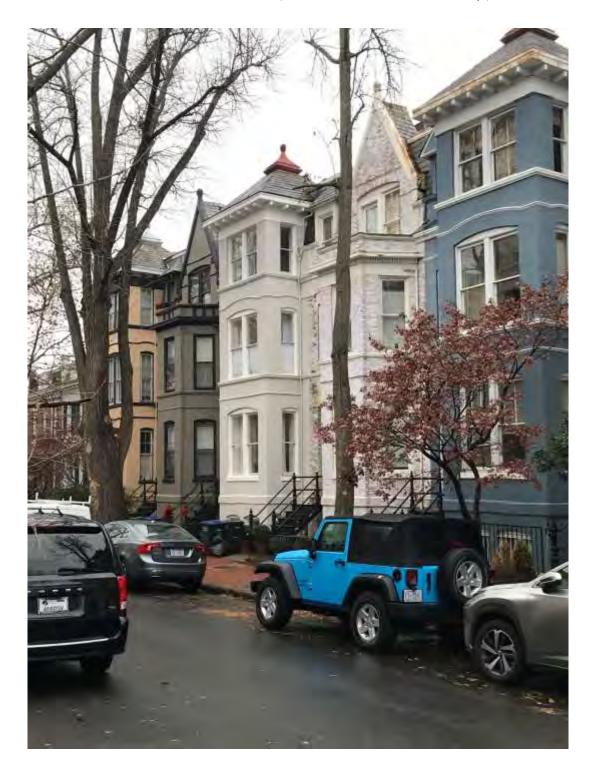
## Before and after installation of the system

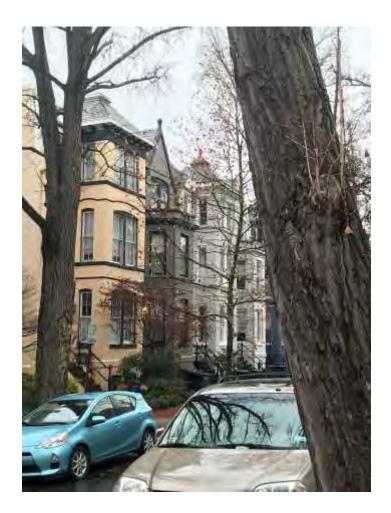




At left, current view of Keeler home from alley. Above, rendering showing prospective rear edge of solar array on upper roof. Smaller, six panel array clamped to standing seam lower roof will not be visible from any angle in alley. (Note "false" downspout from upper gutter will hide conduit serving lower array)

Photos of Street Face
Keeler home at center (home with red finial at top)











## Photos from Alley





