

## ANN ARBOR HISTORIC DISTRICT COMMISSION

### Staff Report

**ADDRESS:** 224 Murray Avenue, Application Number HDC21-318

**DISTRICT:** Old West Side Historic District

**REPORT DATE:** December 9, 2021

**REPORT PREPARED BY:** Jill Thacher, Historic Preservation Coordinator

**REVIEW COMMITTEE DATE:** December 6, 2021

#### OWNER

**Name:** Ann Verhey-Henke  
**Address:** 224 Murray Ave  
 Ann Arbor, MI 49103  
**Phone:**

#### APPLICANT

Gary Pipa – Oak Electric  
 5492 Dixie Hwy  
 Waterford, MI 48329  
 (248) 623-4900

**BACKGROUND:** This 1 ¾ story gable-fronter features one-over-one windows, a screened in front porch with a hipped roof, a gabled wall dormer on the south elevation, and a large rear addition. It was first occupied in 1914 by Warren Burkley, a clerk at F.W. Gross.

**LOCATION:** The property is located on the west side of Murray Avenue, south of West Washington and north of West Liberty.

**APPLICATION:** The applicant seeks HDC approval to install a solar array of black-on-black panels on the south-facing roof of the house.

#### APPLICABLE REGULATIONS:

##### From the Secretary of the Interior's Standards for Rehabilitation:

- (2) The historic character of a property shall be retained and preserved. The removal of historic materials or alteration of features and spaces that characterize a property shall be avoided.
- (9) New additions, exterior alterations, or related new construction 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.



- (10) New additions and adjacent or related new construction shall 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.

### **From the Secretary of the Interior's Guidelines for Rehabilitating Historic Buildings:**

#### **Roofs**

Recommended: Identifying, retaining, and preserving roofs--and their functional and decorative features—that are important in defining the overall historic character of the building.

Not Recommended: Changing the configuration of a roof by adding new features such as dormer windows, vents, or skylights so that the historic character is diminished.

#### **Energy Efficiency**

Recommended: Placing a new addition that may be necessary to increase energy efficiency on non-character-defining elevations.

Not Recommended: Designing a new addition which obscures, damages, or destroys character-defining features.

#### **Mechanical Equipment**

Recommended: Providing adequate structural support for new mechanical equipment.

Not Recommended: Failing to consider the weight and design of new mechanical equipment so that, as a result, historic structural members or finished surfaces are weakened or cracked.

Installing a new mechanical system so that character-defining structural or interior features are radically changed, damaged, or destroyed.

### **From the Ann Arbor Historic District Design Guidelines (other Guidelines may apply):**

#### **Solar**

Appropriate: Mounting solar panels at grade or on ground pole mountings. In the absence of an appropriate ground-based mounting location, panels should be mounted on side or rear facing roof surfaces.


Installing mechanical and service equipment on the roof related to the solar units and their related devices so that they are inconspicuous from the public right-of-way and do not damage or obscure character-defining features.

For sloped roof installations, mounting solar panels parallel to and within 8" of roof surface.

**Not Appropriate:** Mounting solar panels and their related devices on primary elevations or roofs that face the primary elevation or in planes that are highly visible from the street view. This location has the highest impact on the historic character of the historic building and all other options should be thoroughly explored.

Any other alteration or installation procedure that will cause irreversible changes to historic features or materials.

### **STAFF FINDINGS:**

1. The application proposes to install an array of thirteen 360 watt solar panels on the south face of the main in three sections. Black modules with black framing are appropriately proposed (this was confirmed with the applicant via email). The array is 18" below the roof ridge on the main house block and on the addition. The roof has dark gray asphalt shingles. The service panel and meter are located on the north (side) elevation.
 
2. Three panels are proposed to be located on the historic part of the house, in front of the wall dormer. Two more face the street on the addition; these are set back about 30' from the sidewalk and partially obscured by the wall dormer. The remaining eight panels are behind the addition's cross gable. Staff believes the panels will not be a visual distraction from the historic house or nearby properties.
3. Staff believes that the materials and design of the solar panels are compatible with the existing structure, neighboring buildings, and the surrounding historic district, and meet both the Secretary of the Interior's Standards and the *Ann Arbor Historic District Design Guidelines*.

**POSSIBLE MOTIONS:** (Note that the motion is only a suggestion. The Review Committee, consisting of staff and at least two Commissioners, will meet with the applicant on site and then make a recommendation at the meeting.)

I move that the Commission issue a certificate of appropriateness for the application at 224 Murray Avenue, a contributing property in the Old West Side Historic District, to install a black-on-black solar array, as proposed. The work is compatible in exterior design, arrangement, texture, material and relationship to the rest of the building and the surrounding area and meets *The Secretary of the Interior's Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings*, in particular standards 2, 9 and 10 and the guidelines for roofs, energy efficiency, and mechanical systems, as well as the *Ann Arbor Historic District Design Guidelines*, particularly as they pertain to solar installations.

**ATTACHMENTS:** application, drawings, technical information.

224 Murray Avenue (November 2020, Google Street View)





# HISTORIC DISTRICT COMMISSION

## PLANNING AND DEVELOPMENT SERVICES

City Hall: 301 E. Huron St. Ann Arbor, MI 48104-6120  
 Mailing: P.O. Box 8647, Ann Arbor, MI 48107-8647  
 Phone: 734.794.6265 ext. 42608 [ithacher@a2gov.org](mailto:ithacher@a2gov.org)  
 Fax: 734.994.8460

OFFICE USE ONLY	
Permit Number	HDC# _____
	BLDG# _____
DATE STAMP	

**APPLICATION MUST BE FILLED OUT COMPLETELY**

### PROPERTY LOCATION/OWNER INFORMATION

NAME OF PROPERTY OWNER <b>Ann Verhey-Henke</b>		HISTORIC DISTRICT	
PROPERTY ADDRESS <b>224 Murray Ave</b>			CITY <b>ANN ARBOR</b>
ZIPCODE <b>48103</b>	DAYTIME PHONE NUMBER <b>( 734 ) 646-2541</b>	EMAIL ADDRESS <b>averhey@umich.edu</b>	
PROPERTY OWNER'S ADDRESS (IF DIFFERENT FROM ABOVE)		CITY	STATE, ZIP

### PROPERTY OWNER'S SIGNATURE

<b>SIGN HERE</b>	<b>PRINT NAME</b> Ann Verhey-Henke	<b>DATE</b> 11/3/2021
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### APPLICANT INFORMATION

NAME OF APPLICANT (IF DIFFERENT FROM ABOVE) <b>Gary Pipia Oak Electric</b>			
ADDRESS OF APPLICANT <b>5492 Dixie Hwy.</b>			CITY <b>Waterford</b>
STATE <b>MI</b>	ZIPCODE <b>48329</b>	PHONE / CELL # <b>( 248 ) 623-4900</b>	FAX No <b>( )</b>
EMAIL ADDRESS <b>Jessica@oakelectric.com</b>			

### APPLICANT'S SIGNATURE (if different from Property Owner)

<b>SIGN HERE</b>	<b>PRINT NAME</b> <sup>x</sup> Gary Pipia	<b>DATE</b> 11/3/21
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### BUILDING USE – CHECK ALL THAT APPLY

<input type="checkbox"/> SINGLE FAMILY	<input type="checkbox"/> DUPLEX	<input type="checkbox"/> RENTAL	<input type="checkbox"/> MULTIPLE FAMILY	<input type="checkbox"/> COMMERCIAL	<input type="checkbox"/> INSTITUTIONAL
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### PROPOSED WORK

Describe in detail each proposed exterior alteration, improvement and/or repair (use additional paper, if necessary).

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### DESCRIBE CONDITIONS THAT JUSTIFY THE PROPOSED CHANGES:

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For Further Assistance With Required Attachments, please visit [www.a2gov.org/hdc](http://www.a2gov.org/hdc)



# HISTORIC DISTRICT COMMISSION APPLICATION

## FEE CHART

DESCRIPTION	
STAFF REVIEW FEES	FEE
Application for Staff Approval	\$35.00
Work started without approvals	Additional \$50.00
HISTORIC DISTRICT COMMISSION FEES	
All other proposed work not listed below	\$100.00
Work started without approvals	Additional \$250.00
RESIDENTIAL – Single and 2-story Structure	
Addition: single story	\$300.00
Addition: taller than single story	\$550.00
New Structure - Accessory	\$100.00
New Structure – Principal	\$850.00
Replacement of single and 2-family window(s)	\$100 + \$25/window
COMMERCIAL – includes multi-family (3 or more unit) structures	
Additions	\$700.00
Replacement of multi-family and commercial window (s)	\$100 + \$50/window
Replacement of commercial storefront	\$250.00
DEMOLITION and RELOCATION	
Demolition of a contributing structure	\$1000.0
Demolition of a non-contributing structure	\$250.00
Relocation of a contributing structure	\$750.00
Relocation of a non-contributing structure	\$250.00

**FOR COMMISSION REVIEWS:**

- Application withdrawals made before public notice is published will qualify for a 50% refund of the application fee.
- Application withdrawals made after public notice is sent but before the public hearing will qualify for a 25% refund of the application fee.

## INSTRUCTIONS FOR SUBMITTING APPLICATIONS

All HDC applications must be signed by the property owner and the applicant, if different, with the exception of staff approvals, which may be signed by only the applicant.

All completed HDC applications and their attachments may be submitted to Planning and Development Services by mail, in person (paper or digital), faxed, or via email to [building@a2gov.org](mailto:building@a2gov.org).

We accept CASH, CHECK, and all major credit cards. Checks should be made payable to “City of Ann Arbor”

HDC applications that are incomplete or not submitted with the required documentation or payment will not be processed or approved.

## APPLICATION EXPIRATION

HDC applications expire three (3) years after the date of approval.

## OFFICE USE ONLY

Date of Hearing:		
Action	<input type="checkbox"/> HDC COA	<input type="checkbox"/> HDC Denial
	<input type="checkbox"/> HDC NTP	<input type="checkbox"/> Staff COA
Staff Signature		
Comments		
Fee:	\$ _____	
Payment Type	<input type="checkbox"/> Check: # _____ <input type="checkbox"/> Cash <input type="checkbox"/> Credit Card	

## SCOPE OF WORK

PHOTOVOLTAIC SYSTEM SUMMARY  
SYSTEM SIZE: DC STC - 4.680 KW

MODULES: (13) SUNPOWER SPR-X22-360-E-AC (360W)  
MICRO-INVERTER MODULES

ROOF 1:-ARRAY TILT: 23°      ROOF 2:-ARRAY TILT: 23°  
ROOF 1:-AZIMUTH: 180°      ROOF 2:-AZIMUTH: 90°

ROOF 3:-ARRAY TILT: 23°  
ROOF 3:-AZIMUTH: 180°

ELECTRICAL INFORMATION  
UTILITY COMPANY: N/A  
MAIN SERVICE AMPERAGE: 100A

BUILDING INFORMATION: TWO STORY HOUSE  
OCCUPANCY: II  
CONSTRUCTION: SINGLE-FAMILY  
ZONING: RESIDENTIAL  
GROUND SNOW LOAD: 25 PSF  
WIND EXPOSURE: B  
WIND SPEED: 107 MPH

GOVERNING CODES & STANDARDS  
MICHIGAN RESIDENTIAL CODE 2015  
NEC 2017

AUTHORITIES HAVING JURISDICTION  
BUILDING: N/A  
ZONING: N/A  
UTILITY: N/A

## GENERAL NOTES:

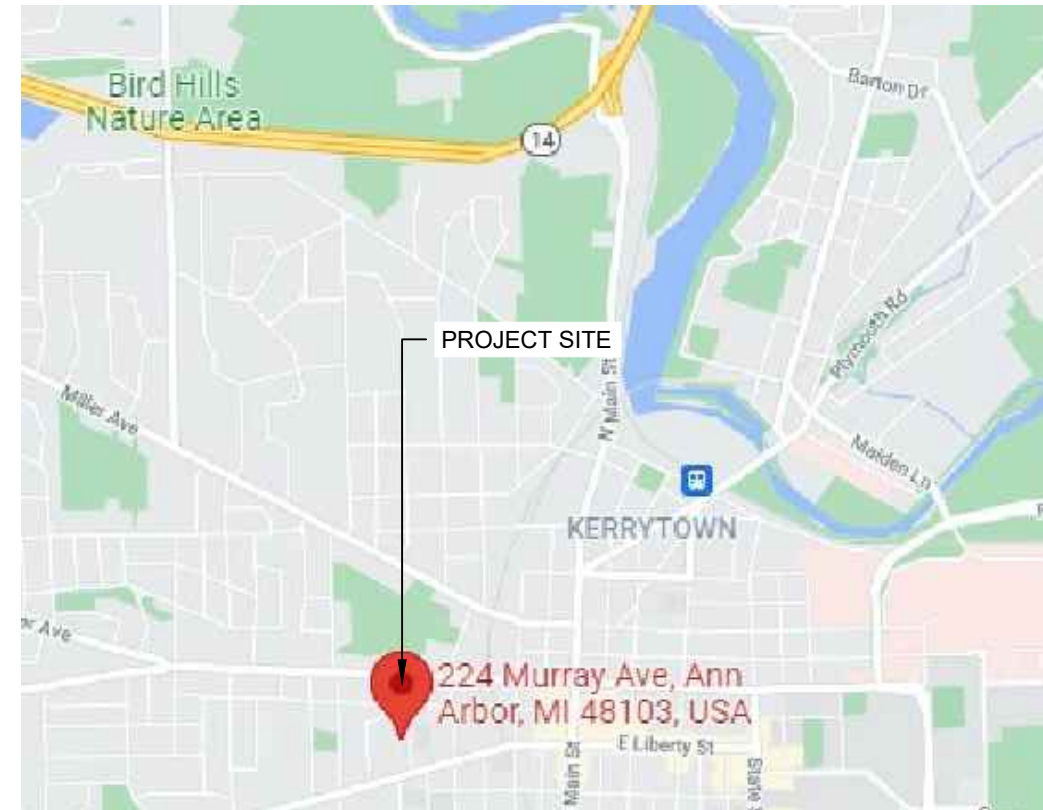
- CONTRACTOR SHALL FIELD VERIFY ALL DIMENSIONS PRIOR TO INITIATING CONSTRUCTION.
- CONTRACTOR SHALL REVIEW ALL MANUFACTURER INSTALLATION DOCUMENTS PRIOR TO INITIATING CONSTRUCTION.
- ALL EQUIPMENT SHALL BE LISTED BY U.L. (OR EQUAL) AND LISTED FOR ITS SPECIFIC APPLICATION.
- ALL EQUIPMENT SHALL BE RATED FOR THE ENVIRONMENT IN WHICH IT IS INSTALLED.
- ALL EQUIPMENT SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S INSTALLATION INSTRUCTIONS.
- ACCESS TO ELECTRICAL COMPONENTS OVER 150 VOLTS TO GROUND SHALL BE RESTRICTED TO QUALIFIED PERSONNEL.
- WHERE SIZES OF JUNCTION BOXES, RACEWAYS, AND CONDUITS ARE NOT SPECIFIED, CONTRACTOR SHALL SIZE THEM ACCORDING TO APPLICABLE CODES.
- PV MODULE FRAMES SHALL BE BONDED TO RACKING RAIL OR BARE COPPER G.E.C. PER THE MODULE MANUFACTURER'S LISTED INSTRUCTION SHEET.
- PV MODULE RACKING RAIL SHALL BE BONDED TO BARE COPPER G.E.C. VIA WEEB LUG, ILSCO GBL-4DBT LAY-IN LUG, OR EQUIVLENT LISTED LUG.
- GROUNDING ELECTRODE CONDUCTOR (G.E.C.) SHALL BE CONTINUOUS AND/OR IRREVERSIBLY SPLICED/WELDED.
- ALL JUNCTION BOXES, COMBINER BOXES, AND DISCONNECTS SHALL BE INSTALLED IN AN ACCESSIBLE LOCATION.
- WORKING SPACE AROUND ELECTRIAL EQUIPMENT SHALL COMPLY WITH NEC 110.26



**1** | AERIAL VIEW

PV-0

SCALE: NTS



**2** | VICINITY MAP

PV-0

SCALE: NTS



5492 Dixie Hwy #1,  
Waterford Twp, MI 48329, USA  
Phone No: +1 800-964-7070

### REVISIONS

DESCRIPTION	DATE	REV

Signature with Seal

PROJECT NAME & ADDRESS

**HENKE**  
224 MURRAY AVE  
ANN ARBOR, MI 48103

SHEET NAME

**COVER SHEET**

SHEET SIZE

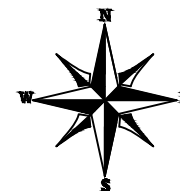
**ANSI B  
11" X 17"**

SHEET NUMBER

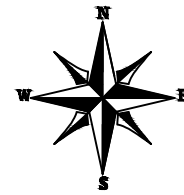
**PV-0**

## SHEET INDEX

PV-0	COVER SHEET
PV-1	SITE PLAN AND ROOF PLAN
PV-2	ROOF PLAN & MODULES
PV-2A	ELECTRICAL SITE PLAN
PV-3	ATTACHMENT DETAIL
PV-4	ELECTRIC LINE DIAGRAM
PV-5	WIRING CALCULATIONS
PV-6	PLACARDS
PV-7 to 12	EQUIPMENT SPECIFICATION



ROOF ACCESS POINT SHALL BE LOCATED IN AREAS THAT DO NOT REQUIRE THE PLACEMENT OF OF GROUND LADDERS OVER OPENINGS SUCH AS WINDOWS OR DOORS, AND LOCATED AT STRONG POINTS OF BUILDING CONSTRUCTION IN LOCATIONS WHERE THE ACCESS POINT DOES NOT CONFLICT WITH OVERHEAD OBSTRUCTIONS SUCH AS TREE LIMBS, WIRES OR SIGNS.



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REVISIONS

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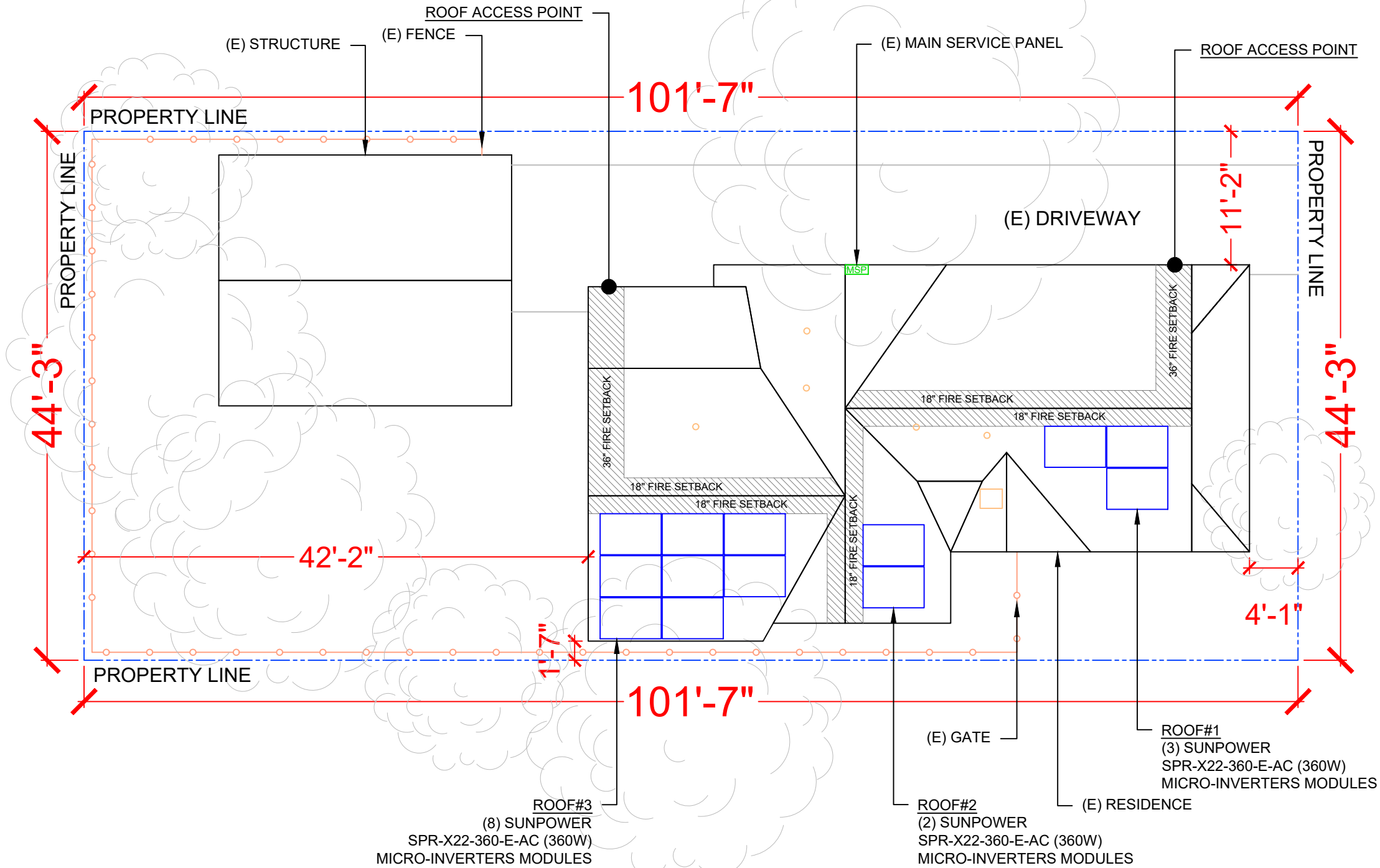
PROJECT NAME & ADDRESS

HENKE  
224 MURRAY AVE  
ANN ARBOR, MI 48103

SHEET NAME  
SITE PLAN &  
ROOF PLAN

SHEET SIZE  
ANSI B  
11" X 17"

SHEET NUMBER  
PV-1



MURRAY AVE



**MODULE TYPE, DIMENSIONS & WEIGHT**

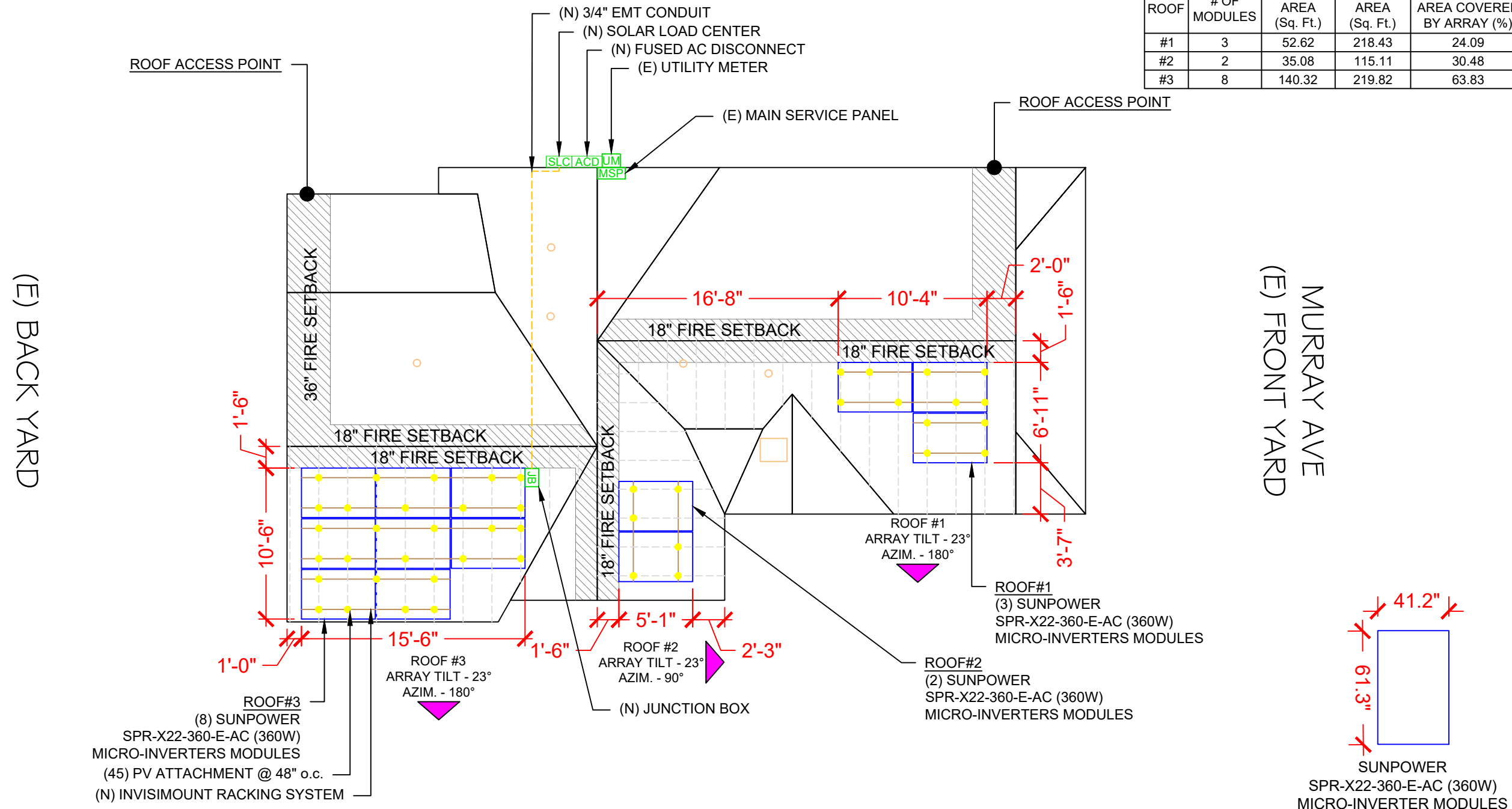
NUMBER OF MODULES = 13 MODULES  
 MODULE TYPE = SUNPOWER SPR-X22-360-E-AC (360W)  
 MICRO-INVERTER MODULES  
 MODULE WEIGHT = 42.9 LBS / 19.5 KG.  
 MODULE DIMENSIONS = 61.3"x 41.2"= 17.54 SF  
 UNIT WEIGHT OF ARRAY = 2.45 PSF

ROOF DESCRIPTION				
ROOF TYPE			COMPOSITE SHINGLE	
ROOF	ARRAY TILT	AZIMUTH	RAFTER SIZE	RAFTER SPACING
#1	23°	180°	2"x4"	24" O.C.
#2	23°	90°	2"x4"	24" O.C.
#3	23°	180°	2"x4"	24" O.C.

ARRAY AREA				
ROOF	# OF MODULES	ARRAY AREA (Sq. Ft.)	ROOF AREA (Sq. Ft.)	ROOF AREA COVERED BY ARRAY (%)
#1	3	52.62	218.43	24.09
#2	2	35.08	115.11	30.48
#3	8	140.32	219.82	63.83

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REVISIONS		
DESCRIPTION	DATE	REV



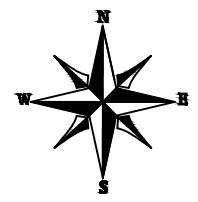
Signature with Seal

PROJECT NAME & ADDRESS  
**HENKE**  
 224 MURRAY AVE  
 ANN ARBOR, MI 48103

SHEET NAME  
**ROOF PLAN & MODULES**

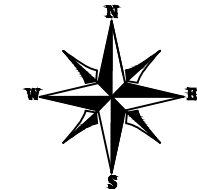
SHEET SIZE  
**ANSI B  
 11" X 17"**

SHEET NUMBER  
**PV-2**



**LEGEND**

- VENT, ATTIC FAN (ROOF OBSTRUCTION)
- MSP - MAIN SERVICE PANEL
- JB - JUNCTION BOX
- ACD - AC DISCONNECT
- SLC - SOLAR LOAD CENTER
- - PV ATTACHMENT @ 48" o.c.
- - CONDUIT



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REVISIONS		
DESCRIPTION	DATE	REV

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ANN ARBOR, MI 48103

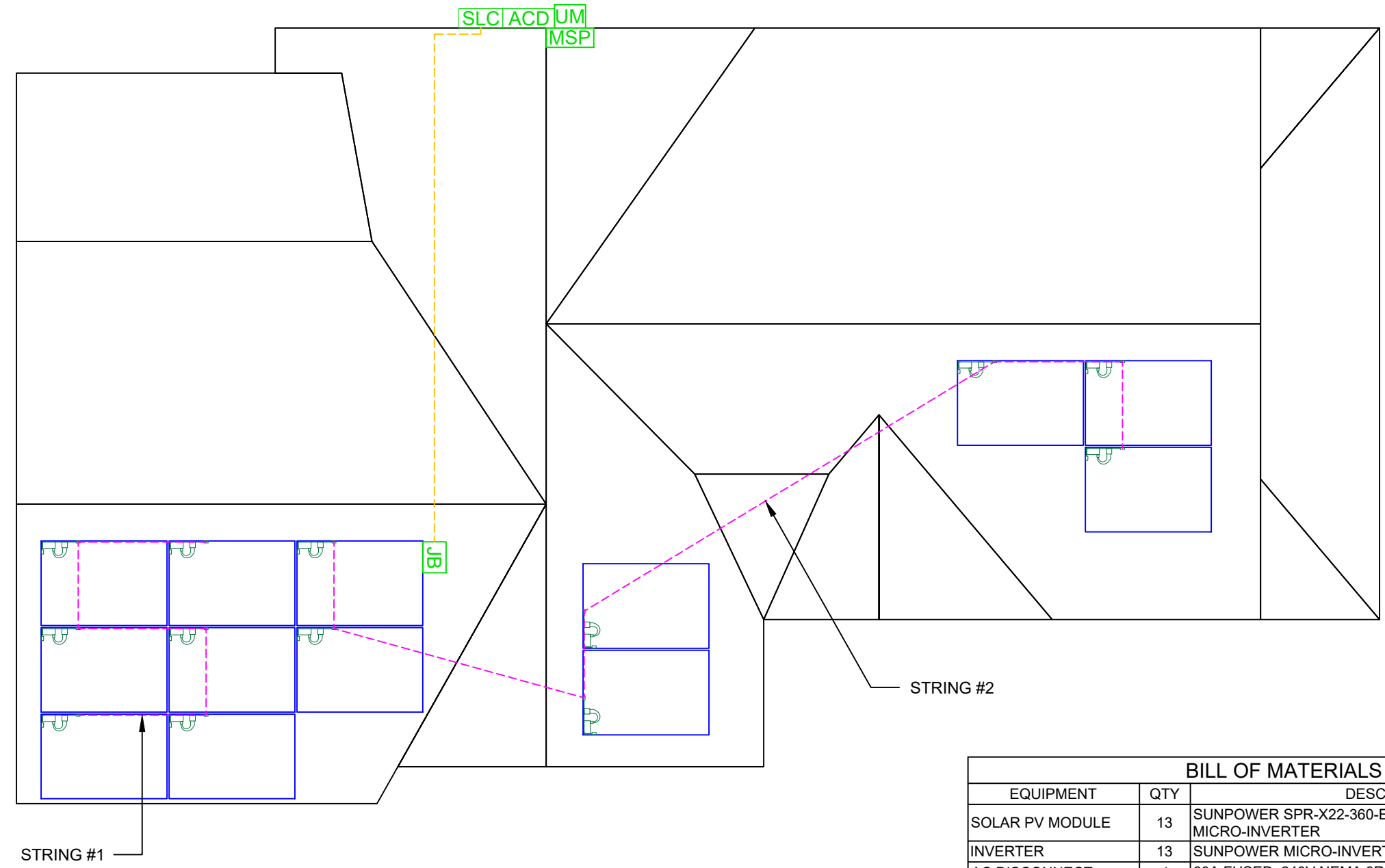
SHEET NAME  
**ELEC. SITE PLAN**

SHEET SIZE  
**ANSI B  
11" X 17"**

SHEET NUMBER  
**PV-2A**

(E) BACK YARD

MURRAY AVE  
(E) FRONT YARD



BILL OF MATERIALS		
EQUIPMENT	QTY	DESCRIPTION
SOLAR PV MODULE	13	SUNPOWER SPR-X22-360-E-AC (360W) MICRO-INVERTER
INVERTER	13	SUNPOWER MICRO-INVERTERS
AC DISCONNECT	1	60A FUSED, 240V NEMA 3R, UL LISTED,
ATTACHMENT	45	PV ATTACHMENT @ 48" O.C.
RAILS	13	INVISIMOUNT RAILS-129" SECTION
RAIL SPLICE	4	SPLICE
MID CLAMPS	14	MID CLAMPS
END CLAMPS	24	END CLAMPS
GROUNDING LUG	6	GROUNDING LUG

REVISIONS

DESCRIPTION	DATE	REV

Signature with Seal

PROJECT NAME & ADDRESS

**HENKE**  
 224 MURRAY AVE  
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SHEET NAME

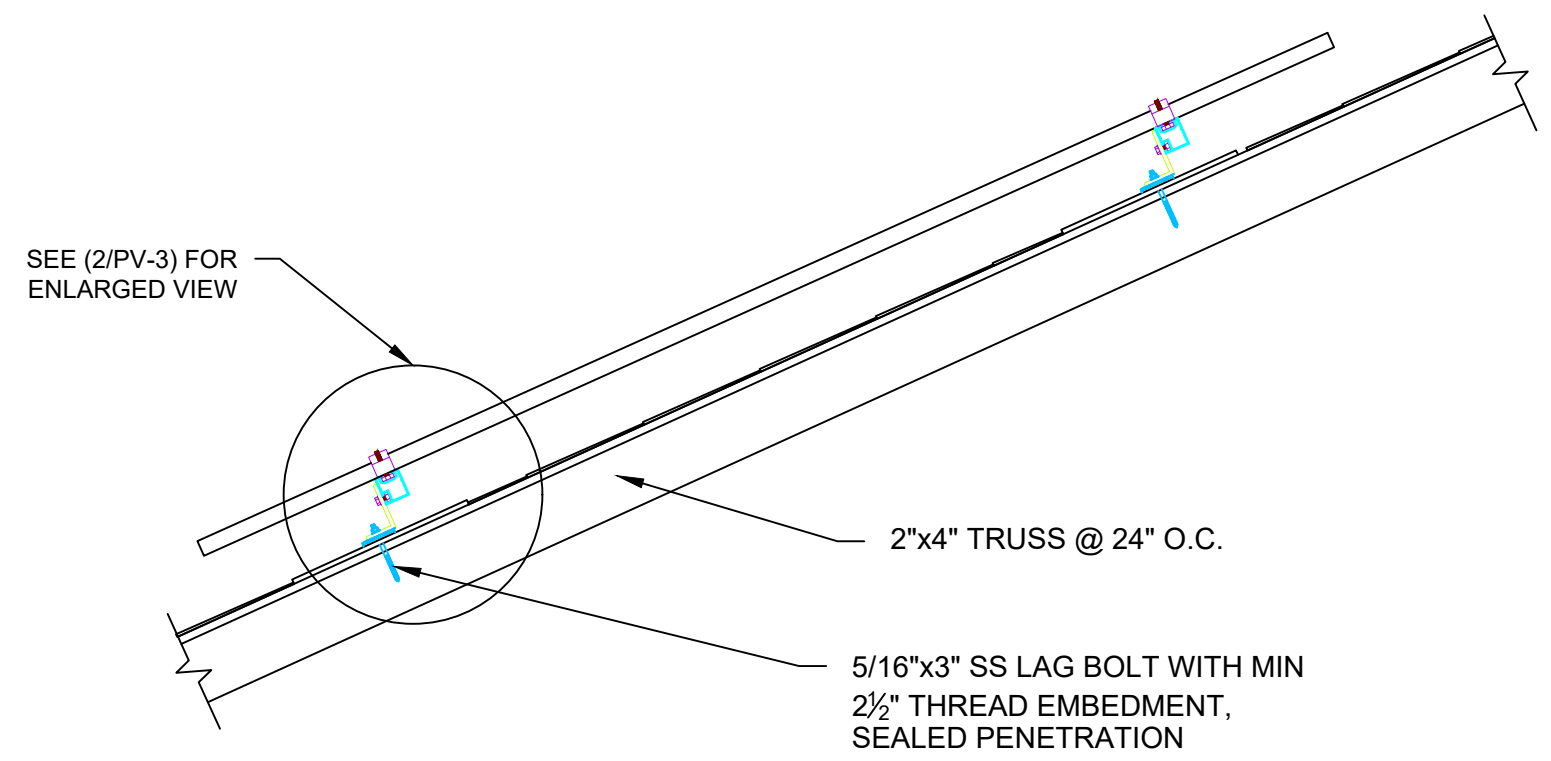
**RACKING  
 DETAIL**

SHEET SIZE

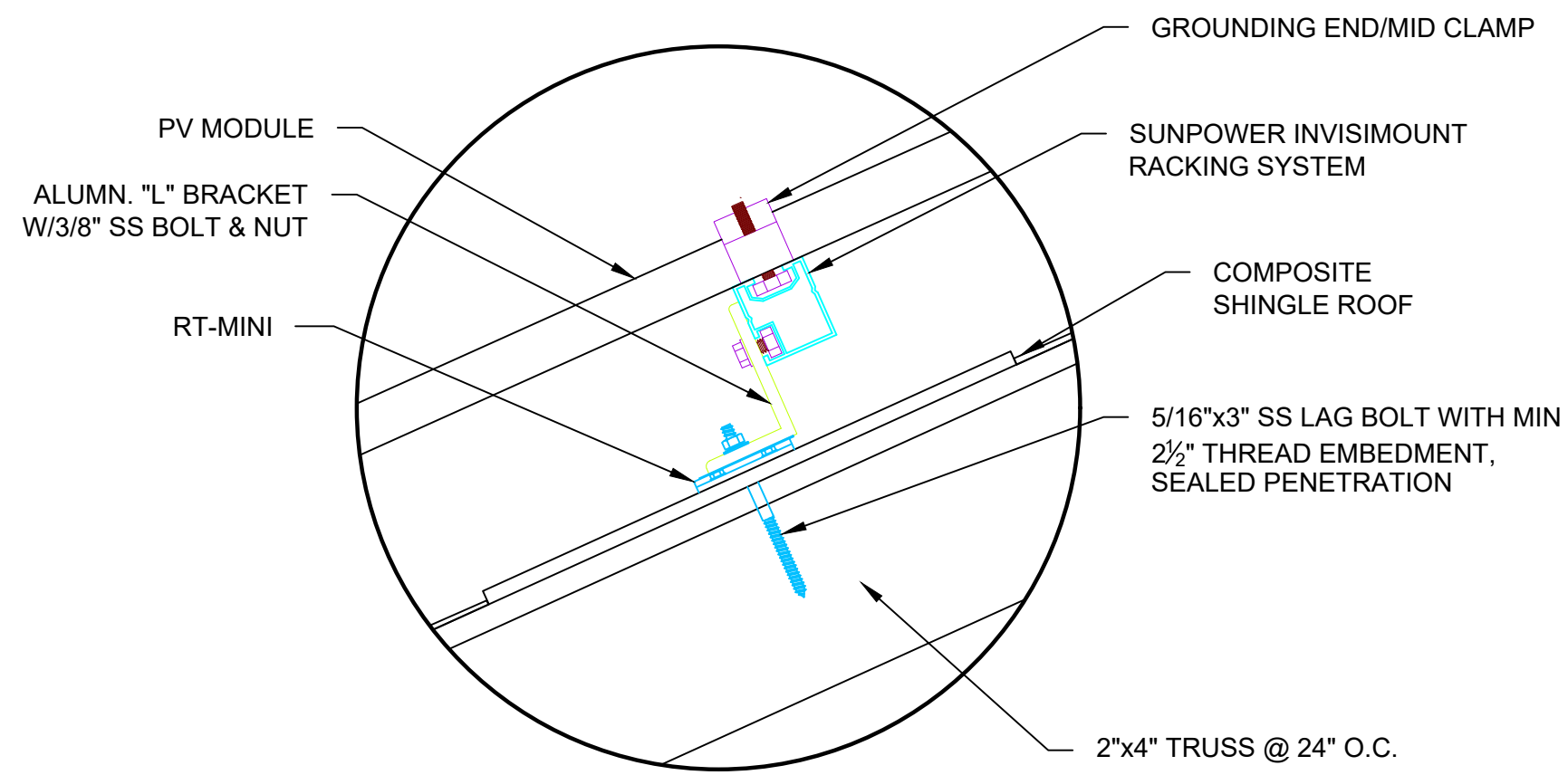
**ANSI B  
 11" X 17"**

SHEET NUMBER

**PV-3**

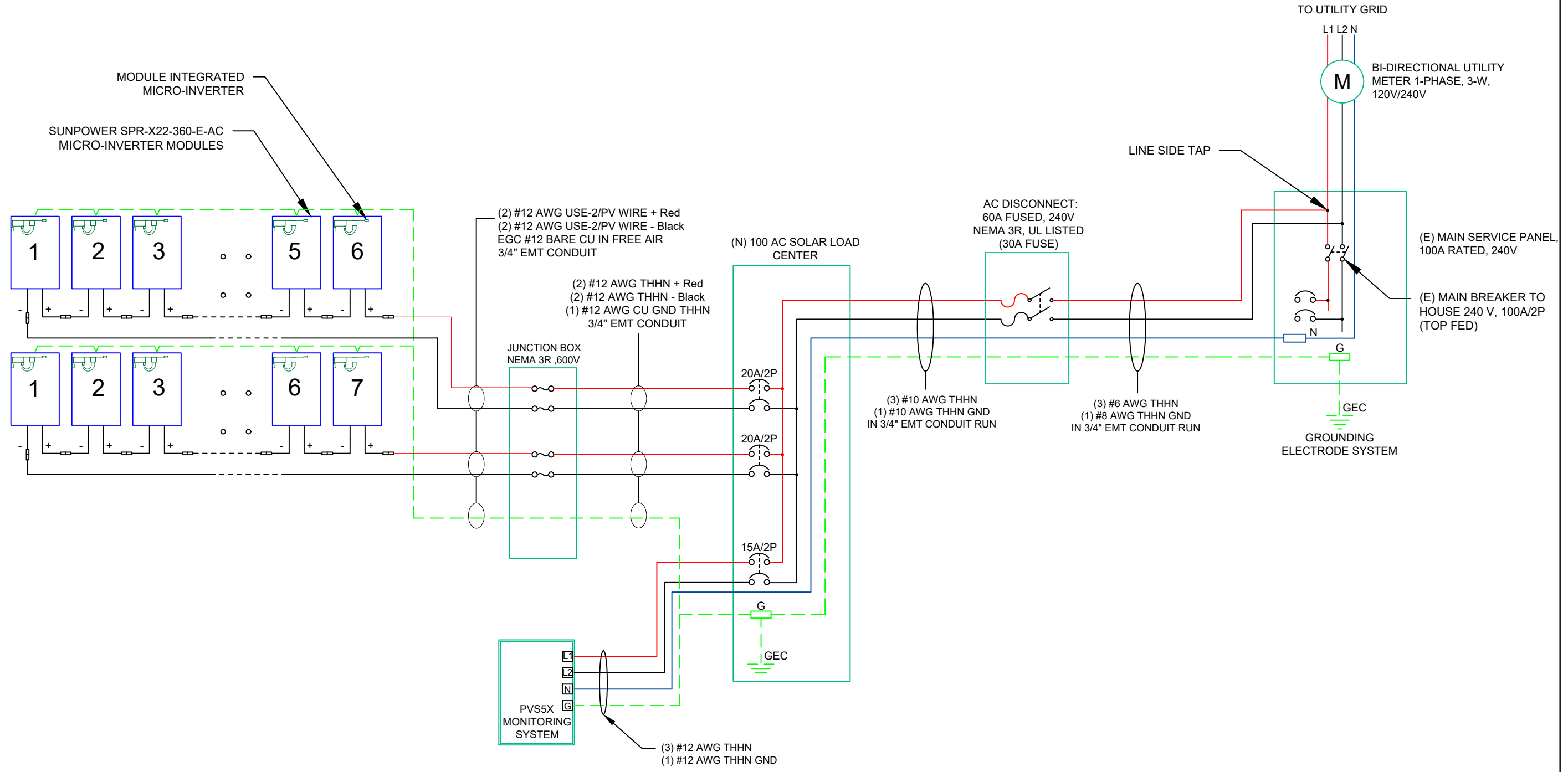


**1** | **ATTACHMENT DETAIL**  
 PV-3 | SCALE: 1"=1'-0"



**2** | **ATTACHMENT DETAIL (enlarged view)**  
 PV-3 | SCALE: NTS

(13) SUNPOWER SPR-X22-360-E-AC (360W) MODULES  
 (01) STRING OF 06 MODULES  
 (01) STRING OF 07 MODULES



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REVISIONS		
DESCRIPTION	DATE	REV

Signature with Seal

PROJECT NAME & ADDRESS

**HENKE**  
 224 MURRAY AVE  
 ANN ARBOR, MI 48103

SERVICE INFO	
UTILITY PROVIDER:	N/A
MAIN SERVICE VOLTAGE:	240V
MAIN PANEL BRAND:	N/A
MAIN SERVICE PANEL:	100A
MAIN CIRCUIT BREAKER RATING:	100A
MAIN SERVICE LOCATION:	NORTH
SERVICE FEED SOURCE:	OVERHEAD

SHEET NAME  
**ELECTRICAL  
 LINE DIAGRAM**

SHEET SIZE  
**ANSI B  
 11" X 17"**

SHEET NUMBER  
**PV-4**

## AC CONDUCTOR AMPACITY CALCULATIONS: FROM ROOF TOP JUNCTION BOX TO LOAD CENTER

AMBIENT TEMPERATURE ADJUSTMENT FOR EXPOSED CONDUIT  
PER NEC 310.15(B)(2)(c): + 22°  
EXPECTED WIRE TEMP (°C): 32° + 22° = 54°  
TEMP CORRECTION PER TABLE 310.16: 0.76  
# OF CURRENT CARRYING CONDUCTORS: 4  
CONDUIT FILL CORRECTION PER NEC 310.15(B)(2)(a): 0.80  
CIRCUIT CONDUCTOR SIZE: 12 AWG  
CIRCUIT CONDUCTOR AMPACITY: 30 A

REQUIRED CIRCUIT CONDUCTOR AMPACITY PER NEC 690.8(A&B):  
1.25 X MAX AC OUTPUT CURRENT X # OF INVERTERS PER STRING  
STRING 1 = 1.25 X 1.31 X 6 = 9.83A  
STRING 2 = 1.25 X 1.31 X 7 = 11.46A

DERATED AMPACITY OF CIRCUIT CONDUCTOR PER NEC TABLE 310.16  
TEMP CORR. PER NEC TABLE 310.16 X CONDUIT FILL CORR. PER NEC 310.15(B)(2)(a) X  
CIRCUIT CONDUCTOR AMPACITY = 0.76 X 0.8 X 30 = 18.24A

## AC CONDUCTOR AMPACITY CALCULATIONS: FROM LOAD CENTER TO MSP

EXPECTED WIRE TEMP (°C): 32°  
TEMP CORRECTION PER NEC TABLE 310.16: 0.96  
CIRCUIT CONDUCTOR SIZE: 10 AWG  
CIRCUIT CONDUCTOR AMPACITY: 40 A  
# OF CURRENT CARRYING CONDUCTORS: 3  
CONDUIT FILL PER NEC 310.15(B)(2)(a): 1  
REQUIRED CIRCUIT CONDUCTOR AMPACITY PER NEC 690.8(B):  
1.25 X MAX AC OUTPUT CURRENT X # OF INVERTERS  
1.25 X 1.31 X 13 = 21.29A

DERATED AMPACITY OF CIRCUIT CONDUCTORS PER NEC TABLE 310.16:  
TEMP CORR. PER NEC 310.16 X CONDUIT FILL CORR. PER NEC 310.15(B)(2)(a) X  
CIRCUIT CONDUCTOR AMPACITY = 0.96 X 1 X 40 = 38.4A

## ELECTRICAL NOTES

- 1.) ALL EQUIPMENT TO BE LISTED BY UL OR OTHER NRTL, AND LABELED FOR ITS APPLICATION.
- 2.) ALL CONDUCTORS SHALL BE COPPER, RATED FOR 600 V AND 90 DEGREE C WET ENVIRONMENT.
- 3.) WIRING, CONDUIT, AND RACEWAYS MOUNTED ON ROOFTOPS SHALL BE ROUTED DIRECTLY TO, AND LOCATED AS CLOSE AS POSSIBLE TO THE NEAREST RIDGE, HIP, OR VALLEY.
- 4.) WORKING CLEARANCES AROUND ALL NEW AND EXISTING ELECTRICAL EQUIPMENT SHALL COMPLY WITH NEC 110.26.
- 5.) DRAWINGS INDICATE THE GENERAL ARRANGEMENT OF SYSTEMS. CONTRACTOR SHALL FURNISH ALL NECESSARY OUTLETS, SUPPORTS, FITTINGS AND ACCESSORIES TO FULFILL APPLICABLE CODES AND STANDARDS.
- 6.) WHERE SIZES OF JUNCTION BOXES, RACEWAYS, AND CONDUITS ARE NOT SPECIFIED, THE CONTRACTOR SHALL SIZE THEM ACCORDINGLY.
- 7.) ALL WIRE TERMINATIONS SHALL BE APPROPRIATELY LABELED AND READILY VISIBLE.
- 8.) MODULE GROUNDING CLIPS TO BE INSTALLED BETWEEN MODULE FRAME AND MODULE SUPPORT RAIL, PER THE GROUNDING CLIP MANUFACTURER'S INSTRUCTION.
- 9.) MODULE SUPPORT RAIL TO BE BONDED TO CONTINUOUS COPPER G.E.C. VIA WEEB LUG OR ILSCO GBL-4DBT LAY-IN LUG.
- 10.) THE POLARITY OF THE GROUNDED CONDUCTORS IS NEGATIVE

SOLAR MODULE SPECIFICATIONS	
MANUFACTURER / MODEL #	SUNPOWER SPR-X22-360-E-AC (360W) MICRO-INVERTER MODULES
OUTPUT POWER FACTOR (min)	0.99
AC MAX CONTINUOUS OUTPUT	1.31A
AC MAX. CONT. OUTPUT POWER	315W
DC/AC CEC CONVERSION EFFICIENCY	97.5%

PERCENT OF VALUES	NUMBER OF CURRENT CARRYING CONDUCTORS IN EMT
.80	4-6
.70	7-9
.50	10-20

AMBIENT TEMPERATURE SPECS	
RECORD LOW TEMP	-20°
AMBIENT TEMP (HIGH TEMP 2%)	32°
CONDUIT HEIGHT	0.5"
ROOF TOP TEMP	54°
CONDUCTOR TEMPERATURE RATE	90°
MODULE TEMPERATURE COEFFICIENT OF Voc	-0.29%/°C



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### REVISIONS

DESCRIPTION	DATE	REV

Signature with Seal

PROJECT NAME & ADDRESS

**HENKE**  
**224 MURRAY AVE**  
**ANN ARBOR, MI 48103**

SHEET NAME

**WIRING  
CALCULATIONS**

SHEET SIZE

**ANSI B  
11" X 17"**

SHEET NUMBER

**PV-5**

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

LABEL LOCATION:  
 DC DISCONNECT, INVERTER  
 (PER CODE: CEC 690.35(F))  
 [To be used when inverter is ungrounded]

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

LABEL LOCATION:  
 DC DISCONNECT, INVERTER  
 (PER CODE: CEC 690.35(F))  
 [To be used when inverter is ungrounded]

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

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

LABEL LOCATION:  
 AC DISCONNECT, POINT OF INTERCONNECTION  
 (PER CODE: CEC 690.17(E))

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

LABEL LOCATION:  
 AC DISCONNECT, POINT OF INTERCONNECTION  
 PER CODE: CEC 690.17(E), CB

**⚠ WARNING - Electric Shock Hazard**  
 No user serviceable parts inside  
 Contact authorized service provider for assistance

LABEL LOCATION:  
 INVERTER, JUNCTION BOXES (ROOF), AC DISCONNECT  
 (PER CODE: CEC690.13.G.3 & CEC 690.13.G.4)

**WARNING: PHOTOVOLTAIC  
 POWER SOURCE**

LABEL LOCATION:  
 CONDUIT, COMBINER BOX  
 (PER CODE: CEC690.31(G)(3)(4) & CEC 690.13(G)(4))

- ADHESIVE FASTENED SIGNS:
- THE LABEL SHALL BE SUITABLE FOR THE ENVIRONMENT WHERE IT IS INSTALLED.
  - WHERE REQUIRED ELSEWHERE IN THIS CODE, ALL FIELD APPLIED LABELS, WARNINGS, AND MARKINGS SHOULD COMPLY WITH ANSI Z535.4 [NEC 110.21(B) FIELD MARKING].
  - ADHESIVE FASTENED SIGNS MAY BE ACCEPTABLE IF PROPERLY ADHERED. VINYL SIGNS SHALL BE WEATHER RESISTANT [IFC 605.11.1.3]

**PHOTOVOLTAIC SYSTEM AC DISCONNECT  
 RATED AC OPERATING CURRENT 17.03 AMPS  
 AC NOMINAL OPERATING VOLTAGE 240 VOLTS**

LABEL LOCATION:  
 AC DISCONNECT, POINT OF INTERCONNECTION  
 (PER CODE: CEC690.54)

**⚠ WARNING**  
**INVERTER OUTPUT CONNECTION DO NOT  
 RELOCATE THIS OVERCURRENT DEVICE**

LABEL LOCATION:  
 POINT OF INTERCONNECTION  
 (PER CODE: CEC 705.12(D)(7))  
 [Not required if panelboard is rated not less than sum of ampere ratings  
 of all overcurrent devices supplying it]

**CAUTION: SOLAR CIRCUIT**

LABEL LOCATION:  
 MARKINGS PLACED ON ALL INTERIOR AND EXTERIOR DC CONDUIT, RACEWAYS, ENCLOSURES,  
 AND CABLE ASSEMBLIES AT LEAST EVERY 10 FT, AT TURNS AND ABOVE/BELOW PENETRATIONS  
 AND ALL COMBINER/JUNCTION BOXES. (PER CODE: IFC605.11.1.4)

**SOLAR DISCONNECT**

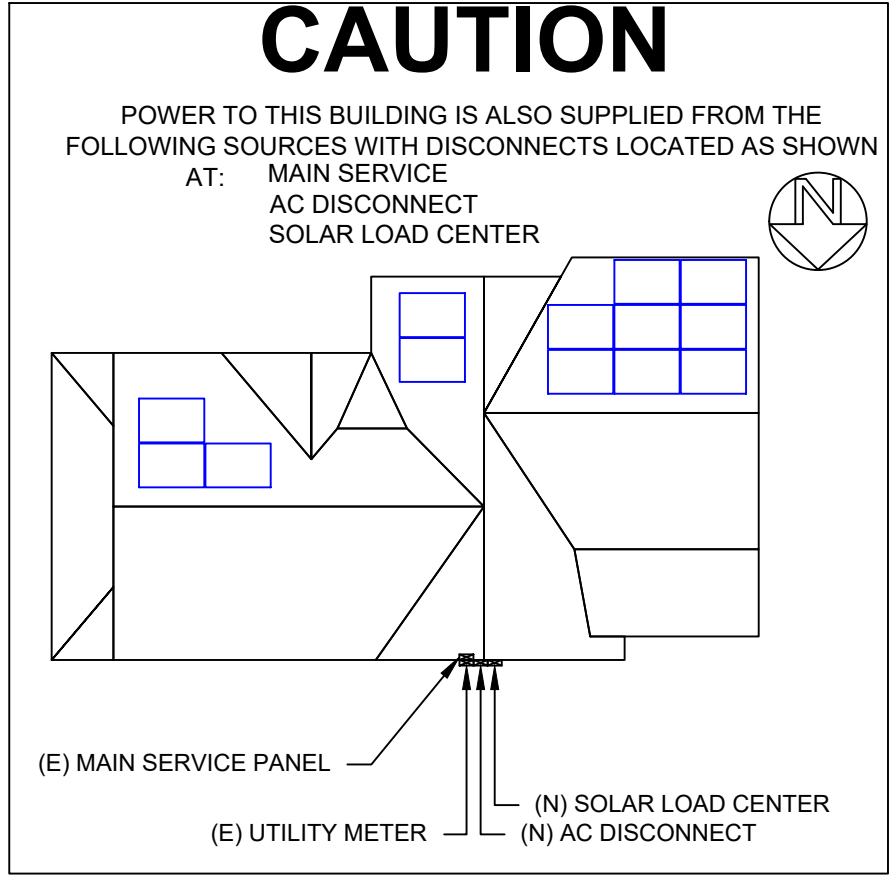
LABEL LOCATION:  
 DISCONNECT, POINT OF INTERCONNECTION  
 (PER CODE: CEC690.13(B))

**⚠ WARNING DUAL POWER SOURCE  
 SECOND SOURCE IS PHOTOVOLTAIC SYSTEM**

LABEL LOCATION:  
 POINT OF INTERCONNECTION  
 (PER CODE: CEC 705.12(D)(4))

**CAUTION: SOLAR ELECTRIC  
 SYSTEM CONNECTED**

LABEL LOCATION:  
 WEATHER RESISTANT MATERIAL, DURABLE ADHESIVE,  
 UL969 AS STANDARD TO WEATHER RATING (UL LISTING  
 OF MARKINGS NOT REQUIRED), MIN 3/16" LETTER HEIGHT  
 ARIAL OR SIMILAR FONT NON-BOLD, PLACED WITHIN  
 THE MAIN SERVICE DISCONNECT, PLACED ON THE  
 OUTSIDE OF THE COVER WHEN DISCONNECT IS  
 OPERABLE WITH SERVICE PANEL CLOSED.  
 (PER CODE: CEC690.15, 690.13(B))



**OAK** Generators  
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 ONE CALL COVERS IT ALL  
 800-964-7070  
 OakElectric.com  
 OakHCP.com  
 5492 Dixie Hwy #1,  
 Waterford Twp, MI 48329, USA  
 Phone No: +1 800-964-7070

REVISIONS		
DESCRIPTION	DATE	REV

Signature with Seal

PROJECT NAME & ADDRESS

HENKE  
 224 MURRAY AVE  
 ANN ARBOR, MI 48103

SHEET NAME  
**PLACARDS**

SHEET SIZE  
**ANSI B  
 11" X 17"**

SHEET NUMBER  
**PV-6**



# SUNPOWER®

## 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.



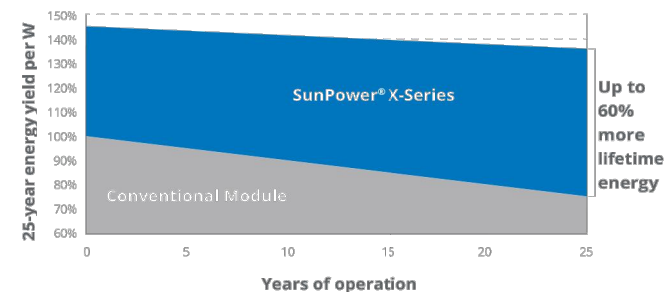
### Maximum Power. Minimalist Design.

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



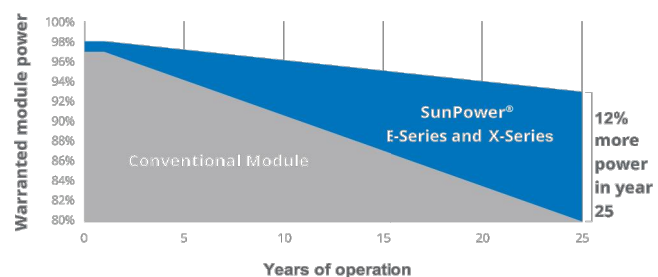
### Highest Lifetime Energy and Savings.

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



### 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.



### Fundamentally Different. And Better.



The SunPower® Maxeon® Solar Cell

- Enables highest-efficiency modules available<sup>2</sup>
- Unmatched reliability<sup>3</sup>
- 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

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

AC Electrical Data	
Inverter Model: Type E (IQ 7XS)	@240 VAC
Peak Output Power	320 VA
Max. Continuous Output Power	315 VA
Nom. (L-L) Voltage/Range <sup>2</sup> (V)	240 / 211-264
Max. Continuous Output Current (A)	1.31
Max. Units per 20 A (LL) Branch Circuit <sup>3</sup>	12 (single phase)
CEC Weighted Efficiency	97.5%
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	18 mA
Power Factor Setting	1.0
Power Factor (adjustable)	0.7 lead. / 0.7 lag.
No active phase balancing for three-phase installations	

DC Power Data		
	SPR-X22-370-E-AC	SPR-X22-360-E-AC
Nominal Power <sup>5</sup> (P <sub>nom</sub> )	370 W	360 W
Power Tolerance	+5/-0%	+5/-0%
Module Efficiency <sup>5</sup>	22.7%	22.1%
Temp. Coef. (Power)	-0.29%/°C	-0.29%/°C
Shade Tolerance	<ul style="list-style-type: none"> <li>• Three bypass diodes</li> <li>• Integrated module-level maximum power point tracking</li> </ul>	

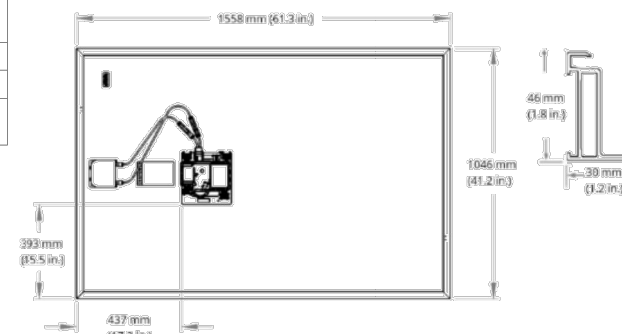
Tested Operating Conditions	
Operating Temp.	-40°F to +185°F (-40°C to +85°C)
Max. Ambient Temp.	122°F (50°C)
Max. Test Load <sup>7</sup>	Wind: 154 psf, 7400 Pa, 754 kg/m <sup>2</sup> back Snow: 208 psf, 10000 Pa, 1019 kg/m <sup>2</sup> front
Design Load	Wind: 62 psf, 3000 Pa, 305 kg/m <sup>2</sup> back Snow: 125 psf, 6000 Pa, 611 kg/m <sup>2</sup> front
Impact Resistance	1 inch (25 mm) diameter hail at 52 mph (23 m/s)

Mechanical Data	
Solar Cells	96 Monocrystalline Maxeon Gen III
Front Glass	High-transmission tempered glass with anti-reflective coating
Environmental Rating	Module: Outdoor rated Inverter: NEMA Type 6 Class II
Frame	Class 1 black anodized (highest AAMA rating)
Weight	42.9 lb (19.5 kg)
Recommended Max. Module Spacing	1.3 in. (33 mm)

<sup>1</sup> SunPower 360 W compared to a conventional module on same-sized arrays (260 W, 16% efficient, approx. 1.6 m<sup>2</sup>), 4% more energy per watt (based on third-party module characterization and PVSIM), 0.75%/yr slower degradation (Campeau, Z. et al. "SunPower Module Degradation Rate," SunPower white paper, 2013).  
<sup>2</sup> Based on search of datasheet values from websites of top 10 manufacturers per IHS, as of January 2017.  
<sup>3</sup> #1 rank in "Fraunhofer PV Durability Initiative for Solar Modules: Part 3," PV Tech Power Magazine, 2015. Campeau, Z. et al. "SunPower Module Degradation Rate," SunPower white paper, 2013.  
<sup>4</sup> Factory set to 1547e-2014 default settings. CA Rule 21 default settings profile set during commissioning.  
<sup>5</sup> Standard Test Conditions (1000 W/m<sup>2</sup> irradiance, AM 1.5, 25°C, NREL calibration standard: SOMS current, LACCS FF and voltage. All DC voltage is fully contained within the module.  
<sup>6</sup> This product is UL Listed as PV/RE 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.  
<sup>7</sup> Please read the safety and installation instructions for more information regarding load ratings and mounting configurations.

See [www.sunpower.com/facts](http://www.sunpower.com/facts) for more reference information. For more details, see extended datasheet [www.sunpower.com/datasheets](http://www.sunpower.com/datasheets). Specifications included in this datasheet are subject to change without notice.  
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Warranties, Certifications, and Compliance	
Warranties	<ul style="list-style-type: none"> <li>• 25-year limited power warranty</li> <li>• 25-year limited product warranty</li> </ul>
Certifications and Compliance	<ul style="list-style-type: none"> <li>• UL 1703</li> <li>• UL 1741 / IEEE-1547</li> <li>• UL 1741 AC Module (Type 2 fire rated)</li> <li>• UL 62109-1 / IEC 62109-2</li> <li>• FCC Part 15 Class B</li> <li>• ICES-0003 Class B</li> <li>• CAN/CSA-C22.2 NO. 107.1-01</li> <li>• CA Rule 21 (UL 1741 SA)<sup>4</sup> (includes Volt/Var and Reactive Power Priority)</li> <li>• UL Listed PV Rapid Shutdown Equipment<sup>6</sup></li> </ul>
Enables installation in accordance with: <ul style="list-style-type: none"> <li>• NEC 690.6 (AC module)</li> <li>• NEC 690.12 Rapid Shutdown (inside and outside the array)</li> <li>• NEC 690.15 AC Connectors, 690.33(A)-(E)(1)</li> </ul>	
When used with InvisiMount racking and InvisiMount accessories (UL 2703): <ul style="list-style-type: none"> <li>• Module grounding and bonding through InvisiMount</li> <li>• Class A fire rated</li> </ul>	
When used with AC module Q Cables and accessories (UL 6703 and UL 2238) <sup>5</sup> : <ul style="list-style-type: none"> <li>• Rated for load break disconnect</li> </ul>	
PID Test	Potential-induced degradation free



# SUNPOWER®

Please read the Safety and Installation Instructions for details.

531945 RevC



5492 Dixie Hwy #1,  
Waterford Twp, MI 48329, USA  
Phone No: +1 800-964-7070

REVISIONS		
DESCRIPTION	DATE	REV

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PROJECT NAME & ADDRESS

HENKE  
224 MURRAY AVE  
ANN ARBOR, MI 48103

SHEET NAME  
EQUIPMENT  
SPECIFICATION

SHEET SIZE  
ANSI B  
11" X 17"

SHEET NUMBER  
PV-7



## SunPower® InvisiMount™ | Residential Mounting System

## 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 even module spacing
- Simple, pre-drilled rail splice
- UL 2703 Listed integrated grounding

### Flexible Design

- Addresses nearly all sloped residential roofs
- Design in landscape and portrait
- 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 end clamps hardware, and capped, flush rails

### Part of Superior System

- Built for use with SunPower DC and AC modules
- Best-in-class system reliability and aesthetics
- Combine with SunPower modules and 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 will amplify the aesthetic and installation benefits for both homeowners and installers.

[sunpower.com](http://sunpower.com)

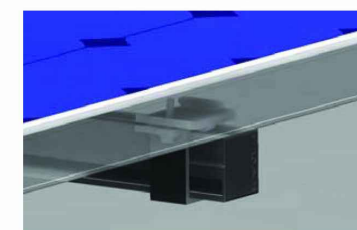


### InvisiMount Component Images

Module\* / Mid Clamp and Rail



Module\* / End Clamp and Rail



Mid Clamp



End Clamp



Rail & Rail Splice



Ground Lug Assembly



End Cap



### InvisiMount Component Details

Component	Material	Weight
Mid Clamp	Black oxide stainless steel AISI 304	63 g (2.2 oz)
End Clamp	Black anodized aluminum alloy 6063-T6	110 g (3.88 oz)
Rail	Black anodized aluminum alloy 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	Supported Hardware
	<ul style="list-style-type: none"> <li>• Composition Shingle Rafter Attachment</li> <li>• Composition Shingle Roof Decking Attachment</li> <li>• Curved and Flat Tile Roof Attachment</li> <li>• Universal Interface for Other Roof Attachments</li> </ul>

### 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

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"

### 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.

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[sunpower.com](http://sunpower.com)  
Document #509506 Rev B

### REVISIONS

DESCRIPTION	DATE	REV

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### PROJECT NAME & ADDRESS

**HENKE**  
224 MURRAY AVE  
ANN ARBOR, MI 48103

SHEET NAME  
**EQUIPMENT  
SPECIFICATION**

SHEET SIZE

**ANSI B  
11" X 17"**

SHEET NUMBER

**PV-8**

**SUNPOWER®**

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REVISIONS		
DESCRIPTION	DATE	REV

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PROJECT NAME & ADDRESS

HENKE  
224 MURRAY AVE  
ANN ARBOR, MI 48103

SHEET NAME  
EQUIPMENT  
SPECIFICATION

SHEET SIZE  
ANSI B  
11" X 17"

SHEET NUMBER  
PV-9



# InvisiMount<sup>®</sup> Residential Mounting System

## INSTALLATION GUIDE



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March 2016

**Important!** If an L-foot in its final installed position extends *above* the top surface of the rail, you must ensure that the L-foot *does not contact any part of the module or module frame* (Fig. 20).

**Warning!** Do not step on, stand on, or walk on the modules or the module frames, and do not place anything whatsoever on them—even for a moment.

- Slide an end clamp over the same end of each of the row's two rails, such that the clamp opens away from the roof peak (Fig. 21). Position the clamp near the end of the rail.
- Position the first module atop the rails.

Always have **two** workers transport and position each module.

**Important!** If you are installing modules in landscape position, ensure that you review the rail positioning table at the beginning of this section.

- Move the first module into position near the end of the rails, and then reach under the module and slide the end clamps toward the rail ends, ensuring that each clamp fits over the module frame edge as far as it will go (Fig. 22).

**Note.** Clearance between the roof surface and the modules is a function of the roof attachment method chosen.

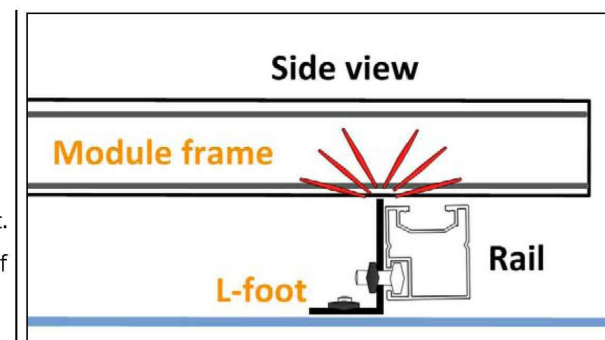


Fig. 20

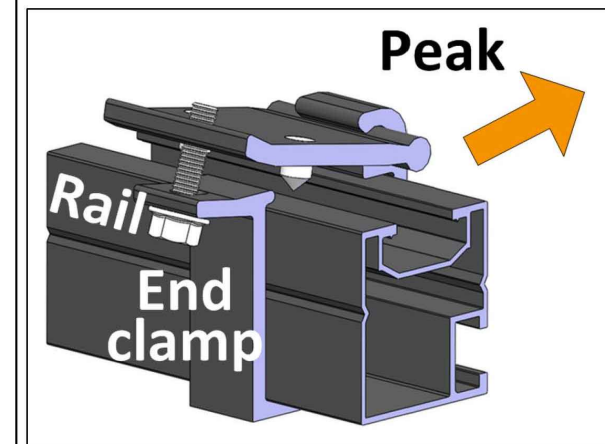


Fig. 21

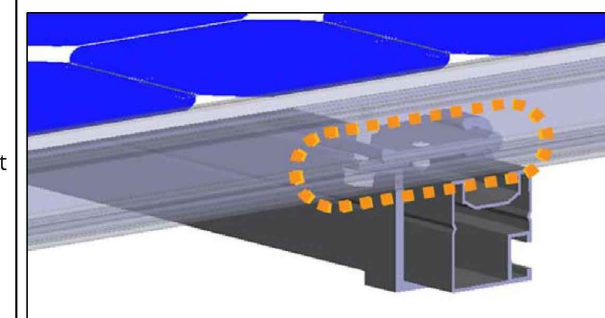


Fig. 22

REVISIONS		
DESCRIPTION	DATE	REV

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PROJECT NAME & ADDRESS

**HENKE**  
224 MURRAY AVE  
ANN ARBOR, MI 48103

SHEET NAME  
**EQUIPMENT SPECIFICATION**

SHEET SIZE  
**ANSI B  
11" X 17"**

SHEET NUMBER  
**PV-10**

# SUNPOWER®

## Safety and Installation Instructions (United States and Canada)

### 1.0 Introduction

This manual provides safety and installation instructions for UL Listed SunPower photovoltaic (PV) modules that have the UL logo on the product label:



**IMPORTANT!** Please read this manual in its entirety before installing, wiring, or using this product in any way. Failure to comply with these instructions will invalidate the SunPower Limited Warranty for PV Modules.

### 1.1 Disclaimer of Liability

The installation techniques, handling, and use of this product are beyond company control. Therefore, SunPower assumes no responsibility for loss, damage or expense resulting from improper installation, handling, or use.

### 1.2 Underwriters Laboratories (UL) Listing Information

This product meets or exceeds the requirements set forth by UL 1703 and ULC/ORD-C1703-01 for PV Modules while -VC modules are listed to UL1741. These Standards cover flat-plate PV modules and panels intended for installation on buildings or those intended to be freestanding. To satisfy the Listing for this product the modules must be mounted with a rack or standoff structure. The Listing does not include integration into a building surface because additional requirements may apply. This product is not intended for use where artificially concentrated sunlight is applied to the module.

### 1.3 Limited Warranty

Module limited warranties are described in full in the SunPower warranty certificates obtainable at [www.sunpower.com](http://www.sunpower.com). In summary, the Limited Warranties do not apply to any of the following:

Modules which in SunPower's absolute judgment have been subjected to misuse, abuse, neglect or accident; alteration; or improper installation, application or removal. This includes, but is not limited to, installation, application, or removal by any party other than a SunPower authorized dealer; non-observance of SunPower's installation, user's and/or maintenance instructions; repair or modifications by someone other than an approved service technician of SunPower; power failure surges, lightning, flood, fire, accidental breakage, or other events beyond SunPower's control.

### 2.0 Safety Precautions

Before installing this product, read all safety instructions in this document.

**DANGER!** Module interconnection cables pass direct current (dc) and are sources of voltage when the module is under load and when it is exposed to light. **Direct current can arc across gaps and may cause injury or death if improper connection or disconnection is made; or if contact is made with module leads that are frayed or torn.** Do not connect or disconnect modules when a current source is energizing the conductors. Modules may contain high voltage when interconnected with other modules.

- All installations must be performed in compliance with the National Electrical Code (NEC) and any applicable local codes.
- For Canadian jurisdictions, installations shall be in accordance with CSA C22.1, Safety Standard for Electrical Installations, Canadian Electrical Code, Part 1
- There are no user-serviceable parts within the module. Do not attempt to repair any part of the module.
- Installation should be performed only by qualified personnel.

SUNPOWER CORPORATION  
Safety and Installation Instructions - Document 001-14158 Rev Y

- Do not stand on, drop, scratch, or allow objects to fall on modules as it may damage them and void the warranty.
- Do not place anything on the modules, even for a moment because resulting residue may damage or stain the glass surface.
- If the front glass is broken, or the backsheets is torn, contact with any module surface or module frame can cause electric shock.
- Broken J-boxes or connectors are electrical hazards as well as laceration hazards. Installers should remove any such module from the array and contact SunPower for disposal instructions.
- Do not install or handle the modules when they are wet or during periods of high wind.
- Do not block drain holes or allow water to pool in or near module frames.
- SunPower recommends a conservative minimum cable bend radius of equal to or greater than 40 mm (1.5").
- Contact SunPower if maintenance is necessary.
- Save these instructions!

### 2.1 Fire Rating

The module fire rating is Type 2 per UL1703, 2013 edition and Class C per UL1703, 2002 edition. Fire rating classification for any PV system using UL1703:2013 can only establish a fire rating in combination with the mounting system ratings normally found in the mounting system installation instructions.

### 3.0 Electrical Characteristics

Electrical characteristics of the modules are described in Table 1 below. Each module contains three bypass diodes. For all modules, the maximum series fuse rating is 15A. Under normal conditions, a photovoltaic module may experience conditions that produce more current and/or voltage than reported at Standard Test Conditions. Accordingly, the values of ISC and VOC marked on UL Listed modules should be multiplied by a factor of 1.25 when determining component voltage ratings, conductor capacities, fuse sizes and size of controls connected to the module output. Refer to Section 690-8 of the NEC for an additional 1.25 Safety factor which may be applicable. For VC Modules (all modules ending in "-VC"), Vmax should be used instead of Voc when determining component voltage ratings. Refer to ([www.sunpower.com/PVCommericalSTS](http://www.sunpower.com/PVCommericalSTS)) for details on voltage correction rules for VC modules.

**Table 1: Electrical Characteristics<sup>1</sup>**

Module	Rated Power (W)	Voltage at Rated Power Vmpp (V)	Current at Rated Power, Imp (A)	Open Circuit Voltage Voc (V)	Short Circuit Current, Isc (A)	Maximum System Voltage UL Vmax (V)
SPR-X22-360-COM	360	60.6	5.94	69.5	6.48	1000
SPR-X22-360						600
SPR-X21-345-COM	345	57.3	6.02	68.2	6.39	1000
SPR-X21-345						600
SPR-X21-335	335	57.3	5.85	67.9	6.23	600
SPR-X21-335-BLK						
SPR-X20-327-COM	327	57.3	5.71	67.6	6.07	1000
SPR-X20-327-BLK						600
SPR-X22-275	275	44.8	6.14	52.7	6.54	600
SPR-X21-255	255	42.8	5.95	51	6.3	600
SPR-X20-250-BLK	250	42.8	5.84	50.9	6.2	600
SPR-X21-245	245	42.8	5.72	50.8	6.08	600
SPV-X19-310-COM	310	57.3	5.41	67.2	5.82	1000
SPR-X19-310						600
SPR-X19-310-BLK						600

(Continued on the next page)

<sup>1</sup> For models not shown here, please contact SunPower technical support or visit [www.sunpower.com](http://www.sunpower.com). Electrical parameters are measured at Standard Test Conditions (STC). The series fuse must have an interrupting rating that is equal to or greater than the maximum fault current that the fuse is required to interrupt, including contributions from all connected sources of energy. Refer to NEC Article 100, Part II as to what type of series fuse is acceptable for modules rated at higher than 600 V dc system voltage.

# SUNPOWER®

## Safety and Installation Instructions

United States and Canada

This document applies to all SunPower modules listed in Table 1.

This document includes references to SunPower E-Series, X-Series, P-Series, and NE modules. These modules do not have grounding restrictions and all are compatible with high-efficiency transformerless inverters.

Contents of this manual are subject to change without notice.

For the latest US & Canada manual please refer to [www.sunpower.com/PVInstallGuideUS](http://www.sunpower.com/PVInstallGuideUS)



SunPower Corporation  
[www.sunpower.com](http://www.sunpower.com)

For the latest for Europe, Asia, Australia, Latin America and Africa manual please refer to [www.sunpower.com/PVInstallGuideIEC](http://www.sunpower.com/PVInstallGuideIEC)

For the latest US & Canada technical specifications please refer to [www.sunpower.com/PVResidentialSTS](http://www.sunpower.com/PVResidentialSTS) (for residential modules)  
[www.sunpower.com/PVCommericalSTS](http://www.sunpower.com/PVCommericalSTS) (for commercial and utility modules)

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Module	Rated Power (W)	Voltage at Rated Power Vmpp (V)	Current at Rated Power, Imp (A)	Open Circuit Voltage Voc (V)	Short Circuit Current, Isc (A)	Maximum System Voltage UL Vmax (V)
SPR-E20-440-COM	440	72.9	6.04	86.5	6.5	1000
SPR-E20-435-COM	435	72.9	5.97	85.6	6.43	1000, 1500
SPR-E19-410-COM	410	72.9	5.62	85.3	6.01	1000
SPR-E20-327	327	54.7	5.98	64.8	6.46	600
SPR-E20-327-COM	327	54.7	5.98	64.8	6.46	1000
SPR-E19-320	320	54.7	5.86	64.7	6.24	600
SPR-E19-315	315	54.7	5.76	64.6	6.14	600
SPR-E19-310-COM	310	54.7	5.67	64.4	6.05	1000
SPV-E19-310-COM	310	54.7	5.67	64.4	6.05	1000
SPR-E18-305	305	54.7	5.58	64.2	5.96	600
SPR-E18-295-COM	295	54.2	5.45	63.3	5.83	1000
SPR-E20-245	245	40.5	6.05	48.8	6.43	600
SPR-E19-235	235	40.5	5.8	48.4	6.175	600
SPR-230NE-BLK	230	40.5	5.68	48.2	6.05	600
SPR-P17-320-COM	320	41.3	7.76	50.5	8.38	1000, 1500
SPR-P17-325-COM	325	41.6	7.82	50.7	8.43	1000, 1500
SPR-P17-330-COM	330	41.9	7.88	50.9	8.47	1000, 1500
SPR-P17-335-COM	335	42.2	7.94	51.1	8.51	1000, 1500
SPR-P17-340-COM	340	42.5	8	51.3	8.52	1000, 1500
SPR-P17-345-COM	345	42.8	8.06	51.5	8.57	1000, 1500
SPR-P17-350-COM	350	43.1	8.12	51.7	8.65	1000, 1500
SPR-P17-355-COM	355	43.4	8.18	51.9	8.68	1000, 1500
SPR-P17-360-COM	360	43.7	8.24	52.1	8.72	1000, 1500
SPR-P17-365-COM	365	44	8.3	52.3	8.77	1000, 1500
SPR-P17-370-COM	370	44.3	8.36	52.5	8.81	1000, 1500
SPV-P15-315-COM	315	42.6	7.4	51	8.3	1000, 1500
SPV-P17-345-COM	345	44.3	8.36	52.5	8.81	1000, 1500

**Electrical parameters for VC modules**

Module	Rated Power (W)	Maximum Voltage Vmax (V)	Voltage at Rated Power Vmpp (V)	Current at Rated Power, Imp (A)	Open Circuit Voltage Voc (V)	Short Circuit Current, Isc (A)	Maximum System Voltage UL Vmax (V)
SPR-E20-435-COM-VC	435	76	72.9	5.97	84.2	6.43	1000

Tempco (Vmax) for VC Modules: 0mv/C  
Tempco (Vmp) for VC Modules: -265.4mV/C

Rated electrical characteristics are within 10% of measured values at Standard Test Conditions of: 1000W/m², 25°C cell temperature and solar spectral irradiation of AM 1.5 spectrum.

**4.0 Electrical Connections and System Monitoring**

Modules may be connected in series or parallel to achieve the desired electrical output provided certain conditions are met.

SunPower recommends using the same brand connector in a PV system. Currently approved compatible connectors found on SunPower modules are: Tyco Solarlok PV4 and PV4S, Yukita (YS-254/YS-255) and Multicontact MC4 (PVKBT4/6II, PVKST4/6II). SunPower warrants the connectors delivered on SunPower supplied modules and harnesses as being compatible.

**4.1 System Voltage Monitoring**

SunPower’s VC modules include a proprietary technology that limits the maximum voltage available at the terminals of the PV module. Model SPR-E20-435-COM-VC shall be used only in a system that contains multiple model SPR-E20-435-COM-VC modules operating together. If the VC modules fail to regulate the PV system's DC voltage, the inverter will trip off line when the voltage exceeds 1,000V. Model SPR-E20-435-COM-VC shall be used only in a system where the system's inverter is providing Electrical Supervision in compliance with UL 991 functional safety requirements. One of the following inverters may be used:  
1 - SMA Solar Technology AG Sunny Central Kodiak, models SC 2200-US and SC 1850-US.  
If the inverter is reporting that the system voltage has exceeded 1,000V, a SunPower qualified field service technician will need to inspect the system to resolve the error.

**4.2 System Surge Protection**

SunPower’s VC modules must be protected using an Erico, UL Recognized model DSD501000DCSP1, surge arrester located in the combiner box.

**4.3 Equipment Grounding**

To reduce the possibility of electrical shock, ground the frame of the module or array per NEC before wiring the circuit. In order to install in accordance with their UL Listing, SunPower modules must be grounded using grounding hardware that meets requirements for grounding systems in UL 467, UL 1703, or UL 1741; on anodized aluminum frames. SunPower recommends using one of the following methods of grounding the module frame. In addition, to avoid corrosion due to the use of dissimilar metals SunPower recommends stainless steel between copper and aluminum. For the Generation 5 (G5) frame, only methods 1 and 2 apply.

- Attach a lay-in lug (IlSCO GBL-4DBT, Burndy CL50-DB-T or Tyco Solklip 1954381-2) to one of the grounding holes on the module frame, and attach the ground conductor to the lug. Use stainless steel hardware (bolt, washers, and nut). Use an external-tooth star washer between the lug and the module frame in order to pierce the anodizing and establish electrical contact with the aluminum frame. The assembly must end with a nut that’s torqued to 20–25 in-lb (for a #10-32 bolt). A lock washer or other locking mechanism is required to maintain tension between the bolt and the assembly. The conductor must be attached to the ground lug using the lug’s set screw. Refer to NEC 690.
- SunPower modules may also be grounded through the use of SunPower IFF clips which are UL Listed (1703 and 1741). IFF clip torque value is 35–45 in-lbs for a 1/4-20 or M6 bolt, but may be higher in specific applications. When using IFF clips, the module mounting system must be grounded as per NEC 250.
- SunPower modules may also be grounded through the use of an Everest Solar Systems Mid or End Clamp assembly. The assembly consists of a stainless M-K2 slot nut, WEEB KMC grounding clip, Everest Solar aluminum End or Mid clamp, stainless M8 bolt and stainless Belleville lock washer. The WEEB is placed under the bottom edge of the module and the clamp is placed on the top edge of the module. The bolt captures the Belleville washer, the clamp, the WEEB and the M-K2 nut and must be torqued to min. 10.3 ft-lbs. This method is valid when the modules are being secured to Everest Solar aluminum Dome D1000, Dome S1000 or Dome SD mounting components. A SunPower IFF clip #509206 may be substituted for the actual Everest Mid Clamp itself, but only when the modules are being installed using SunPower’s D10 or S10 product; with 72- and 96-cell modules only. The IFF clip must be torqued to 35-45 in-lbs. When the end clamp is used for securing the last module in a row, the last module must be separately grounded when servicing the adjacent module.

Note: Method 4 is evaluated to UL 1703 by ETL. As such, the use of these devices is not considered part of the UL Listing of these modules.

- If the Unirac SOLARMOUNT system is used for mounting the modules, grounding is achieved using either a BURNDY Wiley WEEB-UMC or WEEB-UGC-1 grounding clip in combination with Unirac’s Mid or End clamps and 1/4-20 bolt and flanged nut, torqued to 120 in-lbs. If the Solarmount-I system is used grounding is achieved with the UniRac UGC-2 grounding clips in combination with UniRac’s Mid or End clamps and Sliders with a 1/4-20 bolt and flanged nut torqued to 120 in-lbs.

Note: Method 5 was evaluated to UL 2703 by TUV. As such, the use of these devices is not considered part of the UL Listing of these modules.

- SunPower modules may also be grounded using a WEEB-9.5NL ground clip in between the module and supporting structure. This combination is secured with a 1/4" stainless steel rivet or a 1/4-20 by 3/4" zinc-plated bolt with zinc-plated K-nut torqued to min. 6 ft-lbs to secure the module to minimum 12 ga. G90 coated steel or Z-purlin, either painted or unpainted. The WEEB-9.5NL is for single use only.
- Other grounding methods may be used in conjunction with a module mounting system tested to UL2703. For these installations, the SunPower module and frame style must be tested and part of the instructions for the listed mounting product. The SunPower module must be installed in accordance with these instructions as well as the mounting system’s listed instructions.

7) SunPower G5-frame modules may be grounded through the use of an InvisiMount™ mid clamp that bonds the module frame to the InvisiMount™ rail. InvisiMount™ rail sections must be bonded and connected to a grounding conductor using methods and materials specified in the InvisiMount™ manual.

When using methods 2, 3, 4, 5 or 6 the module mounting structure must be grounded as per NEC 250. To ensure system safety and structural integrity, strict adherence to application-specific SunPower documentation is required.

**4.4 System Grounding**

Review the Table 2 below for the proper grounding techniques for the installation of your particular SunPower modules.

**Table 2: Module Grounding Key**

Module Model Grounding Key <sup>2</sup>		
SunPower P-Series, E-Series, X-Series, and NE modules have no grounding restrictions:		Legacy modules must be positively grounded:
All model numbers starting with "SPR-PYYY", "SPR-EYYY" or "SPR-XYYY"	SPR-ZZZNE-BLK-D SPR-ZZZNE-WHT-D	SPR-ZZZE-WHT-D SPR-ZZZ-WHT-D SPR-ZZZE-BLK-D SPR-ZZZ-BLK-D
<b>IMPORTANT!</b> For optimal performance, SunPower modules listed above as needing positive grounding must be configured as described. <i>Failure to comply with this requirement will reduce system performance and invalidate SunPower’s Limited Power Warranty for PV Modules.</i>		

**5.0 Module Mounting**

The SunPower Limited Warranty for PV Modules is contingent upon modules being mounted in accordance with the requirements described in this section.

**5.1 Site Considerations**

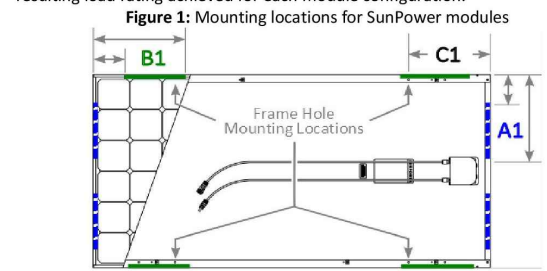
SunPower modules should only be mounted in locations that meet the following requirements:

**Operating Temperature:** All SunPower modules must only be mounted in environments that ensure they will operate within the following temperatures:

Operating Temperature range	-40°C to +85 °C -40°F to +185 °F
Ma. Ambient Temperature for VC modules	60 °C or 140 °F

Care should be taken to provide ventilation behind or underneath the modules, especially in hot environments.

**Design Strength:** SunPower modules are designed to meet a maximum positive (or up/down, e.g. wind) and negative (or downward, e.g. static or snow load) design pressure described in the Table 3. Design strength of 2400Pa wind load corresponds approximately to a wind speed of 130 km/h (approximately 800 Pa, per IEC reference) with a safety factor of 3 for gusty winds. Modules have also been evaluated by UL for a maximum negative or positive design load of 30 psf. **Figure 1: Mounting locations for SunPower Modules** shows where to mount to the module frame. Table 3 defines mounting options, attachment locations and resulting load rating achieved for each module configuration.



**Figure 1: Mounting locations for SunPower modules**

**Table 3: Mounting Configurations and Load Resistance**

Module Configuration	Frame type (frame color)	Mounting configuration (valid mounting location in mm)			Load rating <sup>3</sup> / Wind (up & down) / Snow (down) / Cyclonic Wind (back) (units in Pa)
		End mount (A1)	Pressure clamp or clip (B1)	Frame holes (C1)	
72 cell	G5 (black)		300-400		4000 / 8000 / NA
		50-300	50-400		4000 / 4000 / NA
96 cell	G5 (black)		300-400		3000 / 6000 / NA
		50-400	50-400		3000 / 3000 / NA
72 cell	G3 (black)	50-250	150-380	322	2400 / 5400/ 7500
96 cell	G3 (black)		150-380	322	
96 cell	Silver		150-380	322	
96 cell	Silver		50-350 <sup>4</sup>		1300 / 2400 / 2700
		128 cell & P17-COM	Any	400-460	433
128 cell & P17-COM	Any			Center	2160 / 5100 / NA
		50-350 <sup>4</sup>			1300 / 2400 / 2700

- Safety factor of 1.67 has been included in wind load values, and 1.1 included in snow load values, unless otherwise noted. UL tested load rating is ≥ 30psf (1436 Pa) with 1.5x safety factor for all mounting configurations. Cyclonic wind tested per AS/NZS4040.2 Static strength test regime, AS/NZS1170.2 Structural Design Actions – Wind Actions.
- In order to support load rating in the table, end mount requires that the short side frame is supported along its entire length by BOS railing
- Safety factor 1.06 is included

**Excluded Operating Environments**

Certain operating environments are not recommended for SunPower modules, and are excluded from the SunPower Limited Warranty.

**Performance Series Mounting Orientation**

Commercial Performance Series (P-Series) modules are designed to be installed in landscape orientation. In landscape orientation, P-series modules maintain higher power under row to row shading and edge soiling.

**5.2 Mounting Configurations**

Modules integrated into or mounted over a roofing system must be mounted over a fire-resistant roof covering rated for the application. Modules may be mounted at any angle, from horizontal to vertical. To reduce soiling, modules should be mounted at a minimum of 10 degrees.

Residential (black) module frames have two profile types, G3 and G5. Commercial (silver) module frames have permanently attached stacking pins. **Mounting system hardware used with commercial modules must account for the presence of these stacking pins.** Mechanical specifications for modules are shown in Table 4.

In order to prevent water from entering the junction box, which could present a safety hazard, modules should be oriented with the junction box in the uppermost position and not be mounted such that the cell faces downward (e.g. on a tracking structure that positions the modules with the junction box facing skyward during sleep mode).

For 128-cell and P-Series modules a minimum of 4" of clearance between the module frames and the structure (or grade) is required; for all other modules a minimum of 1.5" of clearance is required. The recommended clearance between installed modules is a minimum of ¼ inch distance.

The module is only UL Listed for use when its factory frame is fully intact. Do not remove or alter the module frame, and do not create additional mounting holes because doing so may compromise the integrity of the frame.

Modules may be mounted using the following methods only:

- Frame Holes:** Secure the module to the structure using the factory mounting holes. Four 1/4" stainless steel bolts, with nuts, washers, and lock washers are recommended per module; tightened to a min. torque of 10 in-

REVISIONS

DESCRIPTION	DATE	REV

Signature with Seal

PROJECT NAME & ADDRESS

HENKE  
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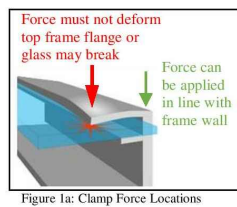
SHEET NAME  
EQUIPMENT SPECIFICATION

SHEET SIZE  
ANSI B  
11" X 17"

SHEET NUMBER  
PV-11

lbs. Refer to Table 4 for the module dimensions and hole locations. This method has been certified by a third-party organization according to UL 1703. For frame hole mounting, modules must be secured using the holes located at 322mm from the short end of the module for 72 and 96 cell modules and 433mm from the end of the module for 128 cell modules. For carport installations the supporting structure has been pre-drilled. For 128 cell modules for carport assembly, modules must be secured using only the holes located 433mm from the ends of the module and hardware described above in Section 4.1, Item 5. See Figure 2 for carport assembly details.

2) **Clamps or Clips:** Mount the module with the IFF clips on the longer sides of the module. The centerline of the clips must be 50mm-400mm for G5 frame (150-380mm for G3 frame) from the corner of the module. Ensure that the clamps are of sufficient strength to allow for the maximum design pressure of the module. The IFF clip hardware must be tightened to a torque of 35-45 in-lbs. Clamps that secure to the top of the frame must not deform the top flange. Clamps must apply force collinear with the 'wall' of the module frame and not only to the top flange. Clamps or installation procedures that put excessive force on the top flange will deform the frame, void the module warranty and risk glass breakage. **Figure 1a** illustrates locations for top frame clamp force. Avoid clamping within 50mm of module corners to reduce risk of frame corner deflection and glass breakage. When clamping to the module frame, torque should never exceed 120 in-lbs to reduce chances of frame deformation. Maximum allowable torque may be less than 120 in-lbs depending on clamp design. Mounting systems should be evaluated for compatibility before installing.



To clean a module, wash its glass surface with potable, non-heated water. Normal water pressure is adequate, but pressurized water (up to 1500 psi) may be used. Some fingerprints, stains, or accumulations of dirt on the glass may be removed with over-the-counter glass cleaners (such as Windex® or equivalent), or with a 3% soap-and-water solution. For smaller systems, wet the module glass with the solution, let it stand for five minutes, and then wet them again and use a soft sponge or seamless cloth to wipe the glass surface in a circular motion. For large systems, wet the modules with the cleaning solution, let them stand for five minutes, and then rinse them with high-pressure water or a soft squeegee. Do not use harsh industrial-strength cleaning materials such as scouring powder, steel wool, scrapers, blades, or other sharp instruments to clean the module glass. Use of such materials will void the product warranty.

Figure 2: Carport Assembly

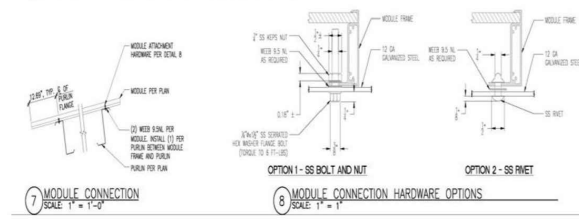


Table 4: Module Frame Details

Platform	Module mounting and ground hole detail	Frame Profile
Residential Modules	<b>RESIDENTIAL G3 FRAME ONLY</b>	
	<b>72 CELL MODULE FRAME DETAIL</b>	<b>SIDE FRAME PROFILE</b>
	<b>96 CELL MODULE FRAME DETAIL</b>	<b>END FRAME PROFILE</b>

**5.3 Module Handling**

Use gloves when handling modules. The module glass is sensitive to oils and abrasive surfaces, which may lead to scratches and irregular soiling. Do not place modules such that the glass comes in contact with abrasive surfaces, and minimize any contact with the glass in general. Do not place anything on the modules, even for a moment. Never lift or move the module using the cables or the junction box under any circumstances. Remove any fingerprints by washing the module glass as described in Section 6.0 below.

**6.0 Maintenance and Cleaning**

Trained SunPower dealer or trained SunPower support personnel should inspect all modules annually for safe electrical connections, sound mechanical connections, and freedom from corrosion. Periodic cleaning of module glass has resulted in improved performance levels, especially in regions with low levels of annual precipitation; therefore SunPower recommends periodic cleaning of the modules.

Platform	Module mounting and ground hole detail	Frame Profile
Residential Modules	<b>RESIDENTIAL G5 FRAME ONLY (a.k.a., INVISIMOUNT COMPATIBLE FRAME)</b>	
	<b>72 CELL MODULE (NO MOUNTING HOLES)</b>	<b>96 CELL MODULE (NO MOUNTING HOLES)</b>
		<b>SIDE FRAME PROFILE</b> 
		<b>END FRAME PROFILE</b> 
Commercial Modules	<b>FOR COMMERCIAL (SILVER FRAME) MODULES ONLY, INCLUDES STACKING PINS</b>	
	<b>96 CELL COMMERCIAL MODULE</b>	<b>128 CELL COMMERCIAL MODULE</b>
		<b>With Stacking Pins</b> 
		<b>END FRAME PROFILE</b> 
Commercial Modules	<b>FOR P-SERIES (SILVER FRAME) MODULES ONLY</b>	

\*See Product Rating Label for Maximum System Voltage.

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DESCRIPTION	DATE	REV

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PROJECT NAME & ADDRESS

HENKE  
224 MURRAY AVE  
ANN ARBOR, MI 48103

SHEET NAME  
EQUIPMENT  
SPECIFICATION

SHEET SIZE  
ANSI B  
11" X 17"

SHEET NUMBER  
PV-12