19921 White Grand Rd. 2012 HAWP
Boyds M.D.

HISTORIC PRESERVATION COMMISSION

Isiah Leggett
County Executive

Leslie Miles
Chairperson

Date: 5/24/12

MEMORANDUM

TO: Diane Schwartz Jones, Director
Department of Permitting Services

FROM: Anne Fothergill
Planner Coordinator
Historic Preservation Section-Planning Department
Maryland-National Capital Park & Planning Commission

SUBJECT: Historic Area Work Permit #597158—solar panel installation

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The Montgomery County Historic Preservation Commission (HPC) has reviewed the attached application for a Historic Area Work Permit (HAWP) and this application was **approved** by the HPC on May 23, 2012.

THE BUILDING PERMIT FOR THIS PROJECT SHALL BE ISSUED CONDITIONAL UPON ADHERENCE TO THE ABOVE APPROVED HAWP CONDITIONS AND MAY REQUIRE APPROVAL BY DPS OR ANOTHER LOCAL OFFICE BEFORE WORK CAN BEGIN.

Applicant: Duane Emmet
Address: 19921 White Ground Road, Boyds

This HAWP approval is subject to the general condition that the applicant will obtain all other applicable Montgomery County or local government agency permits. After the issuance of these permits, the applicant must contact this Historic Preservation Office if any changes to the approved plan are made. Once the work is completed the applicant will contact the staff person assigned to this application at 301-563-3400 to schedule a follow-up site visit.

RETURN TO: DEPARTMENT OF PERMITTING SERVICES
255 ROCKVILLE PIKE, 2nd FLOOR, ROCKVILLE, MD 20850
240/777-6370

DPS - #8

HISTORIC PRESERVATION COMMISSION
301/563-3400

A/R# 597158

APPLICATION FOR HISTORIC AREA WORK PERMIT

Contact Person: Kate Hinkle
Daytime Phone No.: 443-451-3523

Tax Account No.: 06-00393267
Name of Property Owner: Duane Emmet Daytime Phone No.:
Address: 19921 White Ground Rd, Boyds MD 20841
Street Number / City / State / Zip Code
Contractor: SolarCity Corporation Phone No.: 443-451-3523
Contractor Registration No.: MHIC 126948
Agent for Owner: Kate Hinkle Daytime Phone No.: 443-451-3523

LOCATION OF BUILDING/PREMISE

House Number: 19921 Street: White Ground Road
Town/City: Boyds Nearest Cross Street: Clopper Road
Lot: Block: Subdivision: 0001
Liber: 09741 Folio: 00097 Parcel: P276

PART ONE: TYPE OF PERMIT ACTION AND USE

1A. CHECK ALL APPLICABLE:

☐ Construct ☐ Extend ☐ Alter/Renovate
☐ Move ☑ Install ☐ Wreck/Raze
☐ Revision ☐ Repair ☐ Revocable

CHECK ALL APPLICABLE:

☐ A/C ☐ Slab ☐ Room Addition ☐ Porch ☐ Deck ☐ Shed
☑ Solar ☐ Fireplace ☐ Woodburning Stove ☐ Single Family
☐ Fence/Wall (complete Section 4) ☐ Other:

1B. Construction cost estimate: $ 8,460.00

1C. If this is a revision of a previously approved active permit, see Permit #

PART TWO: COMPLETE FOR NEW CONSTRUCTION AND EXTEND/ADDITIONS

2A. Type of sewage disposal: 01 ☐ WSSC 02 ☐ Septic 03 ☐ Other:
2B. Type of water supply: 01 ☐ WSSC 02 ☐ Well 03 ☐ Other:

PART THREE: COMPLETE ONLY FOR FENCE/RETAINING WALL

3A. Height feet inches

3B. Indicate whether the fence or retaining wall is to be constructed on one of the following locations:

☐ On party line/property line ☐ Entirely on land of owner ☐ On public right of way/easement

I hereby certify that I have the authority to make the foregoing application, that the application is correct, and that the construction will comply with plans approved by all agencies listed and I hereby acknowledge and accept this to be a condition for the issuance of this permit.

Kate Hinkle
Signature of owner or authorized agent

4/23/12
Date

Approved: ✓
For Chairperson, Historic Preservation Commission
Disapproved: Signature: Date: 5/24/12
Application/Permit No.: Date Filed: Date Issued:

Edit 6/21/99

SEE REVERSE SIDE FOR INSTRUCTIONS

EXPEDITED

MONTGOMERY COUNTY HISTORIC PRESERVATION COMMISSION
STAFF REPORT

Address:	19921 White Ground Road, Boyds	**Meeting Date:**	5/23/12
Resource:	Primary Resource Boyds Historic District	**Report Date:**	5/16/12
Applicant:	Duane Emmet	**Public Notice:**	5/9/12
Review:	HAWP	**Tax Credit:**	No
Case Numbers:	18/8-12A	**Staff:**	Anne Fothergill
Proposal:	Solar panel installation on non-historic barn		

STAFF RECOMMENDATION

☑ **Approval**
☐ Approval with conditions

PROPERTY DESCRIPTION

SIGNIFICANCE: Primary Resource—Reverend T. Davis Richards House
STYLE: Queen Anne
DATE: c. 1900

PROPOSAL

The applicants propose to install solar panels on the south side of the roof of the non-historic barn located behind the house. The barn was approved by the HPC and constructed in 2004.

APPLICABLE GUIDELINES

Montgomery County Code; Chapter 24A-8

(a) The commission shall instruct the director to deny a permit if it finds, based on the evidence and information presented to or before the commission that the alteration for which the permit is sought would be inappropriate, inconsistent with or detrimental to the preservation, enhancement or ultimate protection of the historic site or historic resource within an historic district, and to the purposes of this chapter.

(b) The commission shall instruct the director to issue a permit, or issue a permit subject to such conditions as are found to be necessary to insure conformity with the purposes and requirements of this chapter, if it finds that:

(1) The proposal will not substantially alter the exterior features of an historic site or historic resource within an historic district; or

(2) The proposal is compatible in character and nature with the historical, archeological, architectural or cultural features of the historic site or the historic district in which an historic resource is located and would not be detrimental thereto or to the achievement of the purposes of this chapter; or

(3) The proposal would enhance or aid in the protection, preservation and public or private utilization of the historic site or historic resource located within an historic district in a manner compatible with the historical, archeological, architectural or cultural value of the historic site or historic district in which an historic resource is located; or

(4) The proposal is necessary in order that unsafe conditions or health hazards be remedied; or

(5) The proposal is necessary in order that the owner of the subject property not be deprived of reasonable use of the property or suffer undue hardship; or

(6) In balancing the interests of the public in preserving the historic site or historic resource located within an historic district, with the interests of the public from the use and benefit of the alternative proposal, the general public welfare is better served by granting the permit.

(c) It is not the intent of this chapter to limit new construction, alteration or repairs to any 1 period or architectural style.

(d) In the case of an application for work on an historic resource located within an historic district, the commission shall be lenient in its judgment of plans for structures of little historical or design significance or for plans involving new construction, unless such plans would seriously impair the historic or architectural value of surrounding historic resources or would impair the character of the historic district. (Ord. No. 9-4, § 1; Ord. No. 11-59.)

STAFF RECOMMENDATION

Staff recommends that the Commission **approve the HAWP application** as being consistent with Chapter 24A-8(b)(1), (2) and (d);

and with the general condition that the applicant shall present the **3 permit sets of drawings to Historic Preservation Commission (HPC) staff for review and stamping** prior to submission for the Montgomery County Department of Permitting Services (DPS) building permits;

and with the general condition that the applicant shall notify the Historic Preservation Staff if they propose to make **any alterations** to the approved plans. Once the work is completed the applicant will contact the staff person assigned to this application at 301-563-3400 or anne.fothergill@mncppc-mc.org to schedule a follow-up site visit.

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255 ROCKVILLE PIKE, 2nd FLOOR, ROCKVILLE, MD 20850
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Kate Hinkle
Signature of owner or authorized agent

4/23/12
Date

Approved: *For Chairperson, Historic Preservation Commission*
Disapproved: Signature: Date:
Application/Permit No.: Date Filed: Date Issued:

Edit 6/21/99

SEE REVERSE SIDE FOR INSTRUCTIONS

(3)

Adjacent properties

Michael Abrahams
19920 White Ground Rd.
Boyds, MD 20841

Larry Ahalt
19925 White Ground Rd.
Boyds, MD 20841

ABBREVIATIONS

A	AMPERE
AC	ALTERNATING CURRENT
BLDG	BUILDING
CONC	CONCRETE
C	COMBINER BOX
D	DISTRIBUTION PANEL
DC	DIRECT CURRENT
EGC	EQUIPMENT GROUNDING CONDUCTOR
(E)	EXISTING
EMT	ELECTRICAL METALLIC TUBING
G	SOLAR GUARD METER
GALV	GALVANIZED
GEC	GROUNDING ELECTRODE CONDUCTOR
GND	GROUND
HDG	HOT DIPPED GALVANIZED
I	CURRENT
Imp	CURRENT AT MAX POWER
INVS	INVERTERS
Isc	SHORT CIRCUIT CURRENT
kVA	KILOVOLT AMPERE
kW	KILOWATT
LBW	LOAD BEARING WALL
MIN	MINIMUM
(N)	NEW
NEC	NATIONAL ELECTRIC CODE
NIC	NOT IN CONTRACT
NTS	NOT TO SCALE
OC	ON CENTER
P	PANEL BOARD
PL	PROPERTY LINES
PV	PHOTOVOLTAIC
PVC	POLYVINYL CHLORIDE
S	SUBPANEL
SCH	SCHEDULE
SS	STAINLESS STEEL
SSD	SEE STRUCTURAL DRAWINGS
STC	STANDARD TESTING CONDITIONS
SWH	SOLAR WATER HEATER
TYP	TYPICAL
UON	UNLESS OTHERWISE NOTED
UPS	UNINTERRUPTIBLE POWER SUPPLY
V	VOLT
Vmp	VOLTAGE AT MAX POWER
Voc	VOLTAGE AT OPEN CIRCUIT
W	WATT
3R	NEMA 3R, RAINTIGHT

ELECTRICAL NOTES

1. WHERE ALL TERMINALS OF THE DISCONNECTING MEANS MAY BE ENERGIZED IN THE OPEN POSITION, A SIGN WILL BE PROVIDED WARNING OF THE HAZARDS PER ART. 690.17.
2. EACH UNGROUNDED CONDUCTOR OF THE MULTIWIRE BRANCH CIRCUIT WILL BE IDENTIFIED BY PHASE AND SYSTEM PER ART. 210.5.
3. A NATIONALLY-RECOGNIZED TESTING LABORATORY SHALL LIST ALL EQUIPMENT IN COMPLIANCE WITH ART. 110.3.
4. CIRCUITS OVER 250V TO GROUND SHALL COMPLY WITH ART. 250.97, 250.92(B)
5. DC CONDUCTORS EITHER DO NOT ENTER BUILDING OR ARE RUN IN METALLIC RACEWAYS OR ENCLOSURES TO THE FIRST ACCESSIBLE DC DISCONNECTING MEANS PER ART. 690.31(E).
6. ALL WIRES SHALL BE PROVIDED WITH STRAIN RELIEF AT ALL ENTRY INTO BOXES AS REQUIRED BY UL LISTING.
7. MODULE FRAMES SHALL BE GROUNDED AT THE UL-LISTED LOCATION PROVIDED BY THE MANUFACTURER USING UL LISTED GROUNDING HARDWARE.
8. ALL EXPOSED METAL PARTS (MODULE FRAMES, RAIL, BOXES, ETC.) SHALL BE GROUNDED USING UL LISTED LAY-IN LUGS LISTED FOR THE PURPOSE. POSTS SHALL BE MADE ELECTRICALLY CONTINUOUS WITH ATTACHED RAIL.
9. MODULE FRAMES, RAIL, AND POSTS SHALL BE BONDED WITH EQUIPMENT GROUND CONDUCTORS AND GROUNDED AT THE MAIN ELECTRIC PANEL.
10. THE DC GROUNDING ELECTRODE CONDUCTOR SHALL BE SIZED ACCORDING TO ART. 250.166(B) & 690.47.

INDEX

GENERAL NOTES

1. THIS SYSTEM IS GRID-INTERTIED VIA A UL-LISTED POWER-CONDITIONING INVERTER.
2. THIS SYSTEM HAS NO BATTERIES, NO UPS.
3. ALL INVERTERS AND ARRAYS ARE NEGATIVELY GROUNDED.
4. SOLAR MOUNTING FRAMES ARE TO BE GROUNDED.
5. ALL ELECTRICAL WORK SHALL COMPLY WITH THE 2008 NATIONAL ELECTRIC CODE.

LEGEND

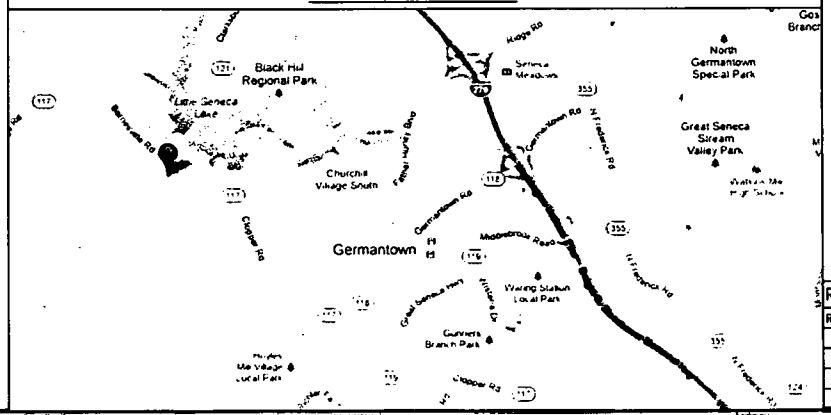
- (E) UTILITY METER (6)
- INVERTER W/ INTEGRATED DC DISCO & WARNING LABELS. (3),(4),(5),(6)
- DC DISCONNECT (4),(5)
- AC DISCONNECT (3),(4),(5),(6)
- JUNCTION BOX
- DC COMBINER BOX (7),(9)
- DISTRIBUTION PANEL (1),(2)
- LOAD CENTER (3),(4),(5),(6)
- DEDICATED PV SYSTEM METER
- CONDUIT RUN ON EXTERIOR
- CONDUIT RUN ON INTERIOR
- GATE
- INTERIOR EQUIPMENT

LICENSE

JURISDICTION NOTES

- ALL ELECTRICAL WORK SHALL COMPLY WITH THE 2008 NEC
- ALL WORK SHALL COMPLY WITH THE 2009 IRC.
-
-Structural design for the supporting structure of the house was performed in accordance with IRC/IBC 2009
-Structural design for the rack system and mounting hardware was performed in accordance with IRC/IBC 2009

VICINITY MAP



REV	BY	DATE	COMMENTS
REV #	#	#/#/#	#

JOB NUMBER: JB-208241 00
MARKET: RESI
PROJECT MANAGER:
PAYMENT TYPE: PPA
MODULES: (36) YINGLI # YL235P-29b
MOUNTING SYSTEM: S-5! CLAMP AND SC RAIL
INVERTER: (1) FRONIUS # IG PLUS V 7.5

PREMISE OWNER: EMMET, DUANE
19921 WHITE GROUND RD
BOYDS, MD 20841
3015896000115

AHJ: Montgomery County

DESCRIPTION: EMMET RESIDENCE
8.46 KW PV Array

PAGE NAME: COVER SHEET

DESIGN: ACHAN

SHEET: PV 1 REV: DATE: 3/6/2012

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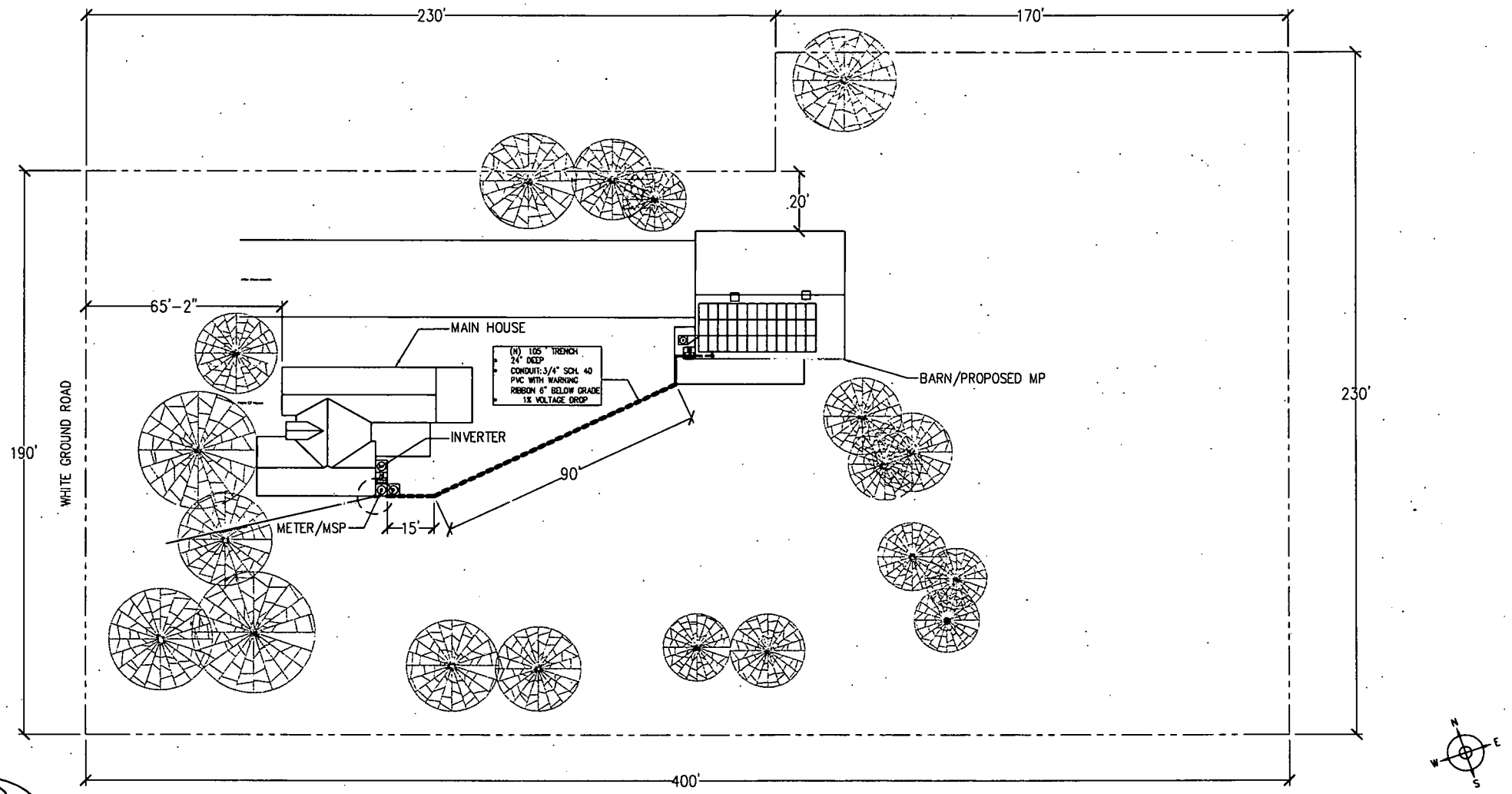

PROPERTY PLAN

Scale: 1/32" = 1'

JOB NUMBER: JB-208241 00	
MARKET: RESI	MODULES: (36) YINGLI # YL235P-29b
PROJECT MANAGER:	MOUNTING SYSTEM: S-5! CLAMP AND SC RAIL
PAYMENT TYPE: PPA	INVERTER: (1) FRONIUS # IG PLUS V 7.5

PREMISE OWNER: AHJ: Montgomery County
EMMET, DUANE
19921 WHITE GROUND RD
BOYDS, MD 20841

3015896000115

DESCRIPTION:
EMMET RESIDENCE
8.46 KW PV Array

PAGE NAME:
PROPERTY PLAN

DESIGN:
ACHAN

SHEET: PV 2
REV:
DATE: 3/6/2012

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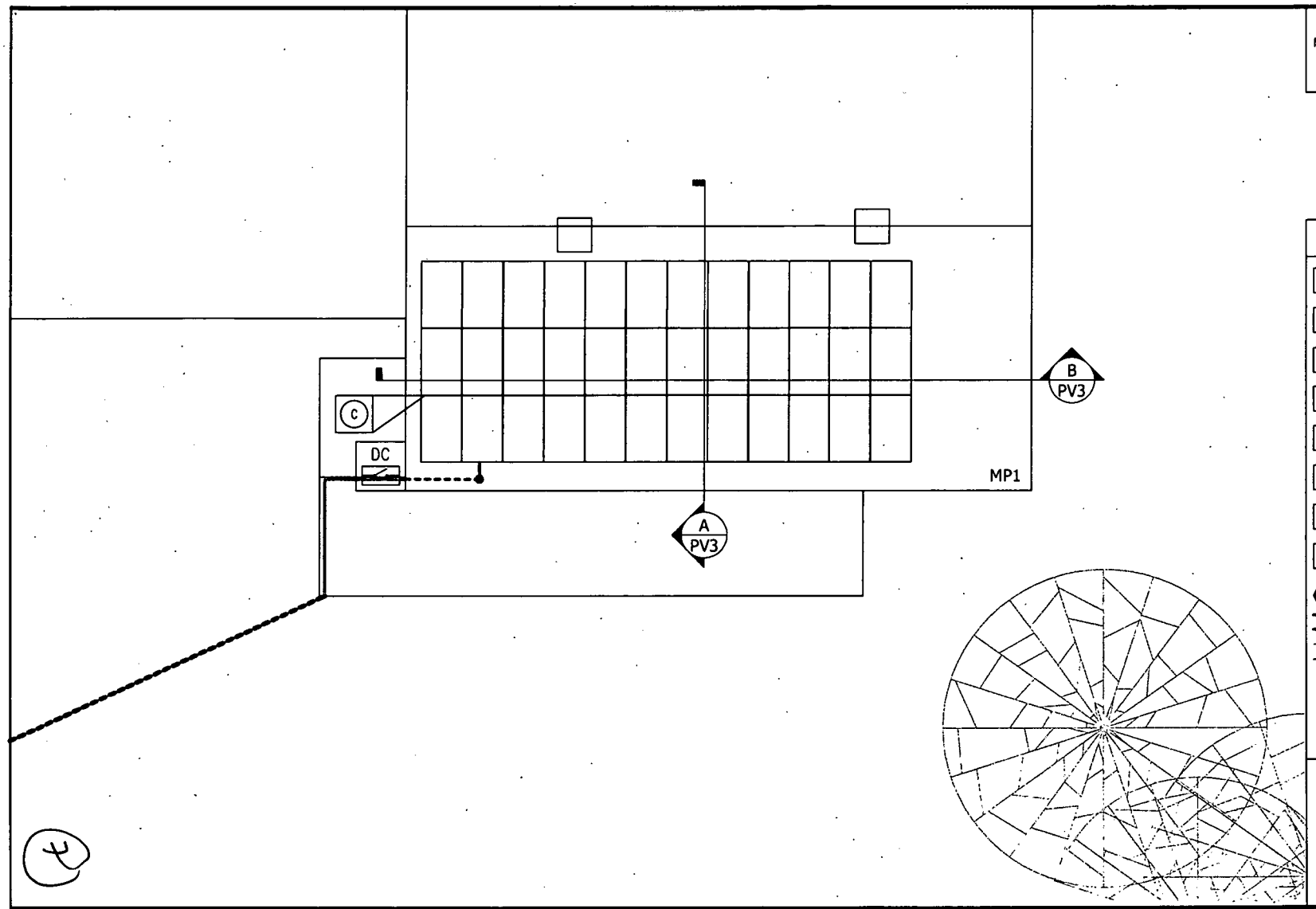

MP1	– Roof Mounted SEE PV5 DETAILS A,B,C PITCH: 26 ARRAY PITCH: 26 AZIMUTH: 199 ARRAY AZIMUTH: 199 STORY: 2 MATERIAL: Metal - Standing Seam

LEGEND

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- INTERIOR EQUIPMENT

SITE PLAN

Scale: 1/8" = 1'

0 1' 8' 16'

JOB NUMBER:	JB-208241 00
MARKET: RESI	MODULES: (36) YINGLI # YL235P-29b
PROJECT MANAGER:	MOUNTING SYSTEM: S-5! CLAMP AND SC RAIL
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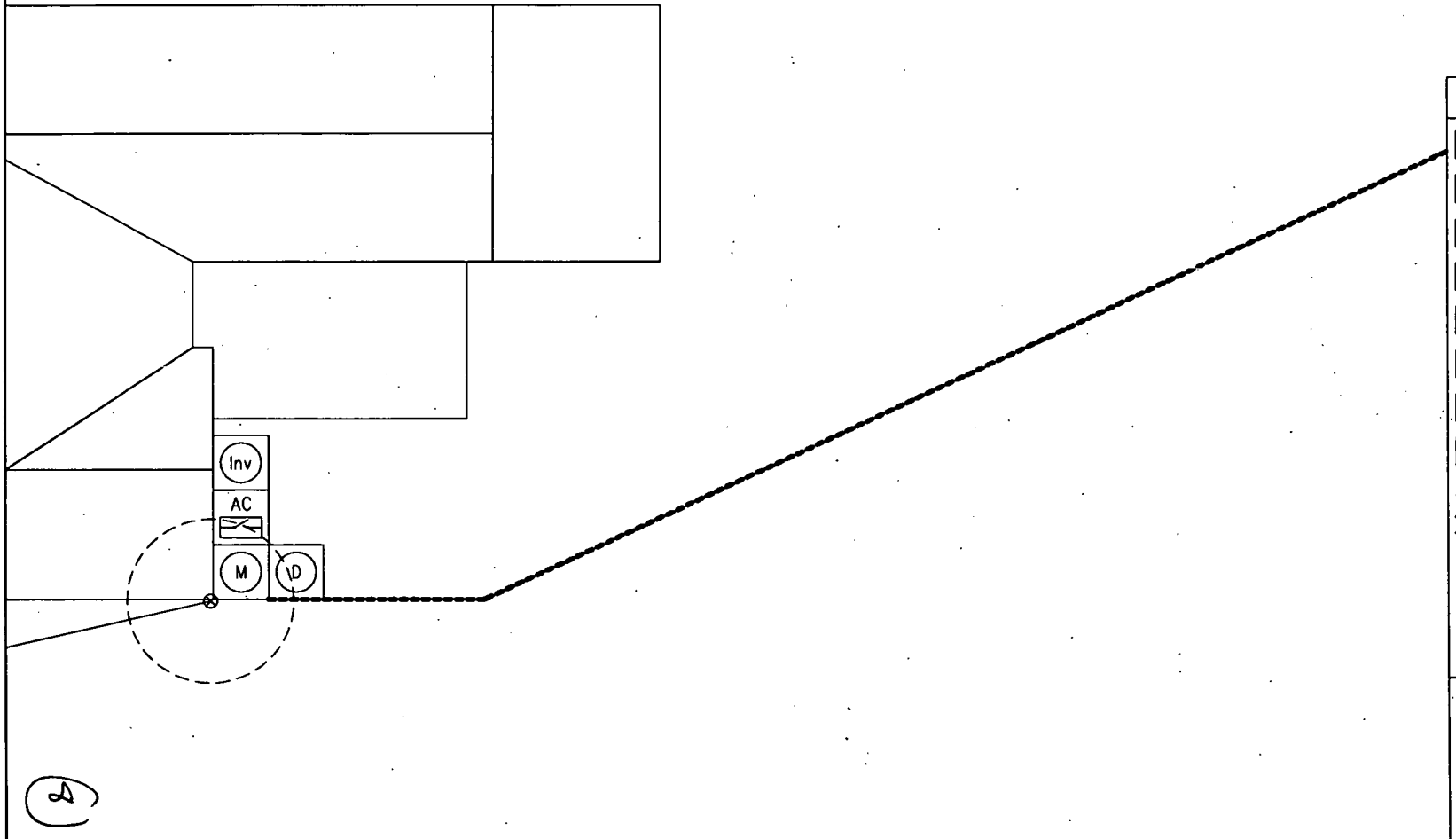

MP1	Roof Mounted	SEE PV5 DETAILS A,B,C
	PITCH: 26	ARRAY PITCH: 26
	AZIMUTH: 199	ARRAY AZIMUTH: 199
		STORY: 2
	MATERIAL: Metal - Standing Seam	

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DESCRIPTION:
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PAGE NAME:
SITE PLAN, CONT.

DESIGN:
ACHAN

SHEET: PV 4 REV: DATE: 3/6/2012

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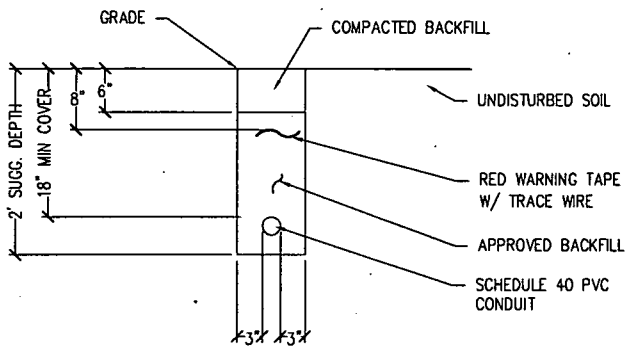
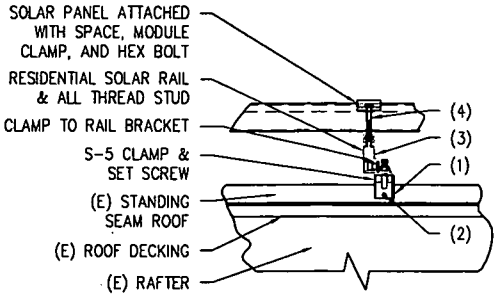


E TRENCH DETAIL

Scale: 3/4"=1'-0"

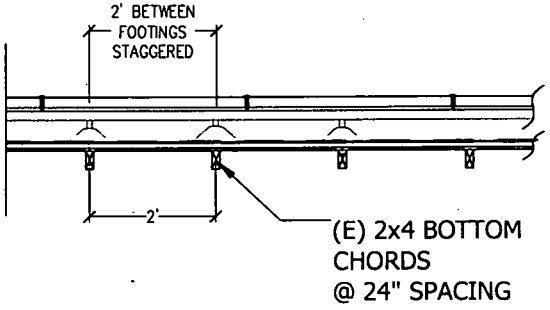


INSTALLATION ORDER	
(1)	LOCATE SEAM, MARK LOCATION, AND PLACE S-5 ON SEAM.
(2)	TIGHTEN SET SCREW ON S-5 CLAMP.
(3)	INSTALL RAIL ONTO S-5 CLAMP WITH L-FOOT BOLT AND WASHERS.
(4)	INSTALL MODULES WITH CLAMPS, AND BOLTS.

HARDWARE AS REFERENCED ON PV 11
SC RAIL AS REFERENCED ON PV 12

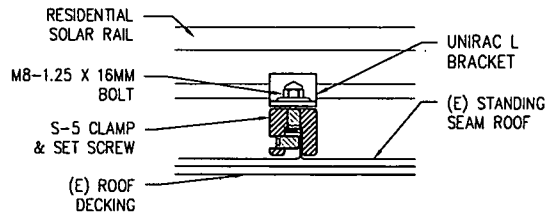
C STANDOFF

Scale: 1-1/2"=1'-0"



B FRONT VIEW OF MP1

SCALE: 1/2" = 1'



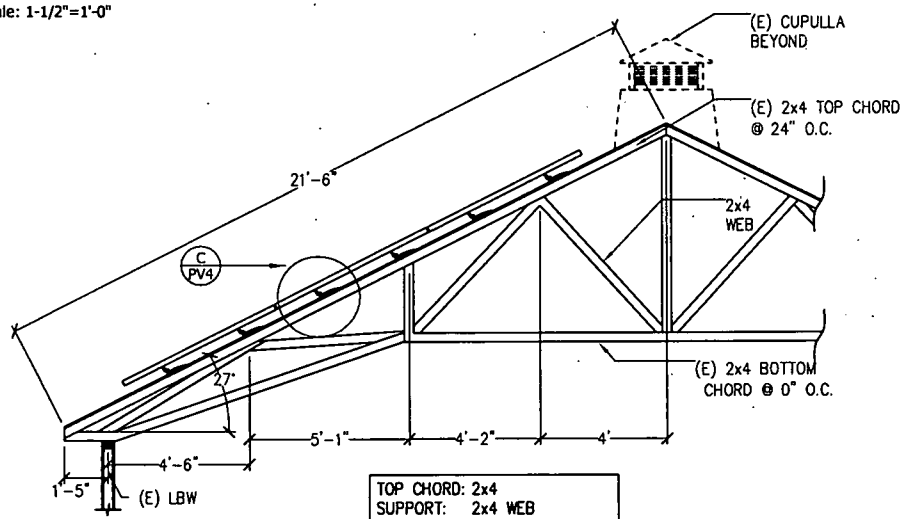
D S-5 DETAIL SHOWING SEAM PROFILE

Scale: 3"=1'-0"

INSTALL INSTRUCTIONS:
CLAMPS ARE MADE FOR TYP. STANDING SEAM PROFILES. WHEN ATTACHING THE MACHINE FOLDED SEAMS CLAMPS ARE DESIGNED TO ENGAGE THE SEAM. FOR HORIZONTAL SEAM APPLICATIONS THE SETSCREW MUST BE ACCESSIBLE FROM THE TOP FOR TIGHTENING.

ON MANY SNAP-TOGETHER TYPE SEAMS, THE SETSCREWS ARE OPPOSITE THE OPEN OR OVERLAP SIDE OF THE SEAM. ON SOME SEAMS THIS ASPECT OF THE CLAMP ORIENTATION IS NOT CRITICAL.

INSTALL WITH A SCREW GUN AND INCLUDED SCREW GUN BIT TIP. FOR OPTIMAL HOLDING STRENGTH, SCREW TENSION SHOULD BE 160 TO 180 POUNDS ON 22 GA STEEL AND 130 TO 150 IN. LBS FOR ALL OTHER METALS AND THINNER GA. OF STEEL. THE S-5-U HAS FOUR SETSCREWS LOCATIONS TO MAKE THE CLAMP MORE VERSATILE, HOWEVER ONLY TWO SETSCREWS ARE USED PER CLAMP. THE SETSCREWS SHOULD ALWAYS BE PLACED ON THE SAME SIDE OF THE CLAMP.



TOP CHORD:	2x4
SUPPORT:	2x4 WEB
MAX SPAN:	5'-1"
TC GRADE:	SPIB No1 KD19 HT

A SIDE VIEW OF MP1

SCALE:

6

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DESCRIPTION:
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8.46 KW PV Array

PAGE NAME:
STRUCTURAL VIEWS - MP1

DESIGN:
ACHAN

SHEET: PV 5 | REV: | DATE: 3/6/2012

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UPLIFT CALCULATIONS

INPUT VARIABLES

Required Variables

Mean Roof Height:	25
Exposure Category:	B
Basic wind speed (or city in the future):	90
Importance factor (1 for residential):	1
Roof shape:	pitched
Roof Angle (degrees):	26
Roof zone:	3
Contiguous sq. feet of array:	176
Least width of the building:	43
Obstructed wind flow?	TRUE

Local Topographical Features

(choose "standard " or refer to pictures right, and below)

Type of hill:	none
Hill height (h) (ft):	
Slope of hill (degrees):	
Horizontal distance from hilltop to house (x):	
Height from bottom of hill to mean roof height (z):	

Design Wind Pressure

P (lbs. per sq. ft.) = qh*Cn*G

Pd (downforce pressure) =	5.24
Pu (uplift pressure) =	13.70

CALCULATIONS AND VALUES

Design wind pressures based upon:
ASCE 7-05 Chapter 6 Wind Loading

Equation 6.5.13.3: Component and Cladding Elements
Wind pressure P = qh*Cn*G

6.5.10: Velocity pressure
qh =0.00256*Kz*Kzt*Kd*V^2*I

From Table 6-3:
Kz = 0.70

From Figure 6-4:
Kzt = 1.00

From Table 6-4:
Kd = 0.85

From figure 6-1:
V = 90

From table 6-1:
I = 1

From Velocity Pressure Equation
qh = 12.34

From Figure 6-19B
Cn (uplift) = -1.31
Cn (down) = 0.50

From 6.5.8.1
G = 0.85

Max Tributary Area

	Feet	Inches
Individual Rows in Portrait		
Yingli YL235 P-29b		
X (E-W distance between standoffs) =	4	0
Y (N-S distance between standoffs) =	2	6
Staggered Penetrations =	Yes	

Amax (sq. ft.) = 0.5*L*X

L (length of panel in ft. perpendicular to rail)	5.41
X =	4.00
Y =	2.50
L =	N/A
Amax =	10.83

Module Rail Max. Span/Cantilever (in) = 48 | 20

Max Uplift Force on a Single Standoff

Pmax (lbs.) = Amax*Pu

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Factor of safety = Fl*D*Nl/Pmax

1/4 x 4 in.	= Lag size and length
375	= Capacity (lbs) of 1 lag (NDS)
2	= Nl (number of lags per standoff)
5.07	= **Factor of safety**

Dead Load Calculations

DL (lbs/sq. ft.) = (Mm+Mh)/(L*W)

L (length of modules)	5.41
W (width of modules)	3.25
Mm (weight of modules)	43.65
Mh (weight of hardware per module) =	3.60
DL =	2.69

Point Load Calculations

PL (lbs) = Amax*DL

29

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JOB NUMBER:	JB-208241 00
MARKET:	RESI
MODULES:	(36) YINGLI # YL235P-29b
PROJECT MANAGER:	
MOUNTING SYSTEM:	S-5! CLAMP AND SC RAIL
PAYMENT TYPE:	PPA
INVERTER:	(1) FRONIUS # IG PLUS V 7.5

PREMISE OWNER: AHJ: Montgomery County
EMMET, DUANE
19921 WHITE GROUND RD
BOYDS, MD 20841

3015896000115

DESCRIPTION:
EMMET RESIDENCE
8.46 KW PV Array

PAGE NAME:
UPLIFT CALCULATIONS

DESIGN:
ACHAN

SHEET: PV 6 REV: DATE: 3/6/2012

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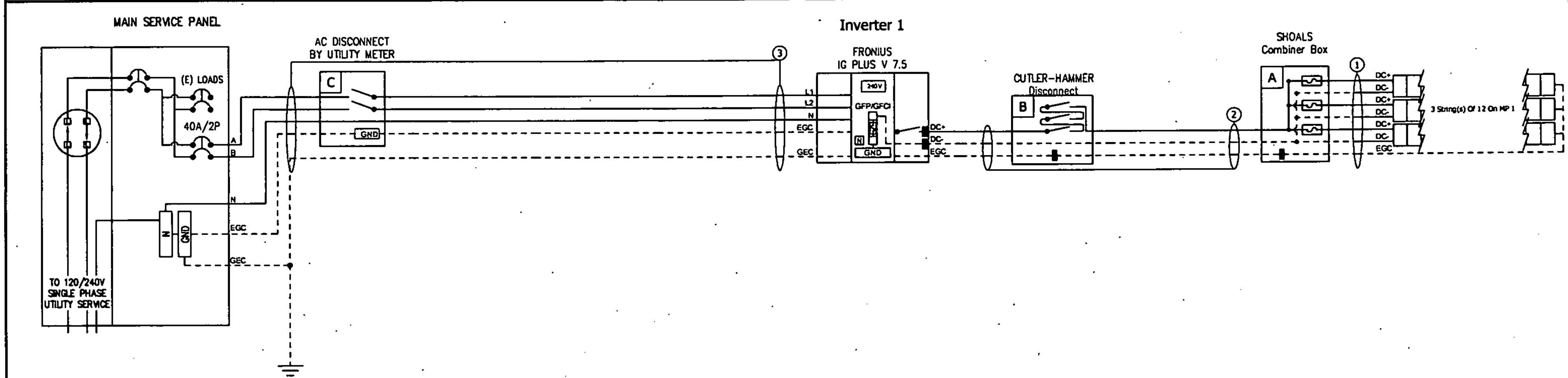
GROUND SPECS	MAIN PANEL SPECS	GENERAL NOTES	INVERTER SPECS	MODULE SPECS	LICENSE
BOND (N) #6 GEC TO (E) GROUND ROD AT PANEL WITH IRREVERSIBLE CRIMP	(E) 100A MAIN SERVICE PANEL NO MAIN BREAKER PRESENT Panel Number: N/A Meter Number: 44 778 887	Inv 1: DC Negatively Grounded	INV 1 — (1) FRONIUS # IG PLUS V 7.5 LABEL: A Inverter (-2011); 7500W, 277V/240V/208V, 96%/95.5%/95% INV 2 INV 3	— (36) YINGLI # YL235P-29b PV Module (-2011); 235W, 211.2W PTC, H4, 50MM, Silver Frame Voc: 37 Vpmax: 29.5 *MODULE CURRENT RATINGS ARE SHOWN AS Isc AND Imp IN THE DC STRINGS IDENTIFIER OF THE SINGLE LINE DIAGRAM.	



POI — (1) SQUARE D # QOB240 PV BACKFEED BREAKER Breaker; 40A, 2 Pole, 120/240V, 10k AIC, Bolt-On

AC

C — (1) CUTLER-HAMMER # DG222URB Disconnect; 60A, 240Vac, Non-Fusible, NEMA 3R
— (1) CUTLER-HAMMER # DG100NB Ground/Neutral Kit; 60-100A, General Duty (DG)

③ — (1) AWG #8, THWN-2, Black
— (1) AWG #8, THWN-2, Red
— (1) AWG #10, THWN-2, White NEUTRAL Vmp = 240 VAC Imp = 31.3 AAC
— (1) AWG #8, THWN-2, Green EGC — (1) Conduit Kit; 3/4" EMT EXCLUDING GEC
— (1) AWG #6, Solid Bare Copper GEC

B — (1) CUTLER-HAMMER # DH162URKN Disconnect; 60A, 600Vdc, Non-Fusible, NEMA 3R

② — (1) AWG #6, THWN-2, Black Voc = 444 VDC Isc = 25.62 ADC
— (1) AWG #6, THWN-2, White Vmp = 354 VDC Imp = 23.91 ADC
— (1) AWG #10, THWN-2, Green EGC
— (1) Conduit Kit; 3/4" PVC, Sch. 40 105 FEET IN TRENCH
— (1) Conduit Kit; 3/4" EMT 25 FEET. FROM ARRAY TO TRENCH

DC

A — (1) SHOALS # STG-CBRH-3-o Combiner Box; 3 String, 90A, 600V, NEMA 4
— (3) FERRAZ SHAWMUTT # TR15R Fuse; 15A, 250V, Class RK5

① — (6) AWG #10, USE-2/RHW-2, Black Voc = 444 VDC Isc = 8.54 ADC
— (1) AWG #10, Solid Bare Copper EGC Vmp = 354 VDC Imp = 7.97 ADC

JOB NUMBER: JB-208241 00
MARKET: RESI
MODULES: (36) YINGLI # YL235P-29b
PROJECT MANAGER:
MOUNTING SYSTEM: S-5! CLAMP AND SC RAIL
PAYMENT TYPE: PPA
INVERTER: (1) FRONIUS # IG PLUS V 7.5

PREMISE OWNER: EMMET, DUANE
AHJ: Montgomery County
19921 WHITE GROUND RD
BOYDS, MD 20841
3015896000115

DESCRIPTION: EMMET RESIDENCE
8.46 KW PV Array
PAGE NAME: SINGLE LINE

DESIGN: ACHAN
SHEET: PV 7 REV: DATE: 3/6/2012

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1. Conductor Sizing per Art 690.8(B)(1)
a. Conductor must have 30 deg. C ampacity >= 125% of continuous current per Art 215.2(A)(1).

b. Conductor must have (after corrections for conditions of use) >= continuous current per Table 310.16.

c. Evaluate conductor temperature at terminations per 110.14(C). Ampacity of wire derated for conditions of termination must be >= continuous current*1.25. All string terminations are rated at 90° C.

---

2. OCP Sizing per Art 690.8(B)(1)
a. Round up to next size per Art 240.4(B)

---

3. Conductor Sizing per Art 690.8(B)(1)
a. Conductor must have 30 deg. C ampacity >= 125% of continuous current per Art 215.2(A)(1).

b. Conductor must have (after corrections for conditions of use) >= continuous current per Table 310.16.

c. Evaluate conductor temperature at terminations per Art 110.14(C). Ampacity of wire derated for conditions of termination must be >= continuous current*1.25. All branch terminations are rated at 75° C min.

---

4. OCP Sizing
a. Round up to next size per Art 240.4(B)

---

5. Conductor Sizing per Art 690.8(B)(1)
a. Conductor must have 30 deg. C ampacity >= 125% of continuous current per Art 215.2(A)(1).

b. Conductor must have (after corrections for conditions of use) >= continuous current per Table 310.16.

c. Evaluate conductor temperature at terminations per Art 110.14(C). Ampacity of wire derated for conditions of termination must be >= continuous current*1.25. All inverter output terminations are rated at 75° C.

---

6. OCP Sizing
a. Round up to next size per Art 240.4(B)

7. Conductor Sizing per Art 690.8(B)(1)
a. Conductor must have 30 deg. C ampacity >= 125% of continuous current per Art 215.2(A)(1).

b. Conductor must have (after corrections for conditions of use) >= continuous current per Table 310.16.

c. Evaluate conductor temperature at terminations per Art 110.14(C). Ampacity of wire derated for conditions of termination must be >= continuous current*1.25. All inverter output terminations are rated at 75° C min.

ELECTRICAL CALCULATIONS

Module:	36 Yingli YL235P-29b	211.2 Inv Pwr	W PTC	StrLen	
Inverter 1:	1 Fronius IG Plus-V 7.5-1 (240)	96.0%	7,500	7,261	12
Module:					
Inverter 2:					
Module:					
Inverter 3:					
Module:					
Inverter 4:					

Total: 36 modules — Total Inv Pwr: 7,500 — 7,261 PTC — Total STC: 8,460

Photovoltaic Module Electrical Specifications:

Voc=	37 V	deg F	deg C
Vmp=	29.6 V	Record Low Temp:	7 -13.889
Isc=	8.54 A	Max Average Hi Temp:	95 35
Imp=	7.97 A		
Tvoc=	-0.1368 V/deg C		
Tisc=	5.124 mA/deg C		

String Type A and 2 Combined Strings Type A — Voc Correction Method: Manuf Tvoc data

Fronius IG Plus-V 10.0-1 (240) — 12 Yingli YL2

Voc=	444 V	Inverter Min Vdc Input:	230 Vdc
Vmp=	354 V	Min Vmp at Max Temp:	307 Vdc
Isc=	8.54 A	Max Voc at Min Temp:	508 Vdc
Imp=	7.97 A	Inverter Max Vdc Input:	600 Vdc
Icont=	10.68 A	Max String Size:	14
	Art 690.8(A)(1)	1-way wire length:	40 ft

1.a	Conductor: C AWG 10	USE-2/RHW-2 at 90 deg C: Table 310.16	
	Icont * 1.25 = (Amps)	13.34	
	30 deg C ampacity =	40	
1.b	Icont= (Amps)	10.68	
	Start ampacity	40	
	Temperature derate (%=F)	0.96	
	Conduit fill derate (%=#)	1	
	Derated ampacity	38.4	
1.c	Icont*1.25= (Amps)	13.34	
	Ampacity	40	
1.d	Icont * 1.25 = (Amps)	13.34	
	OCP size =	15	

Inverter Type A Output — Fronius IG Plus-V 7.5-1 (240) — 1-way wire length: 5 ft

Icont=	31.25 A		Art 690.8(A)(1)
3.a	Icont *1.25 = (Amps)	39.13 A	Art 690.8(B)(1)
	OCP size =	40 A	Art. 240.6(A)
3.b	Conductor C AWG 08	THWN-2 at 90 deg C: Table 310.16	
	Icont * 1.25 = (Amps)	39.13	
	30 deg C ampacity =	55	
3.c	Icont= (Amps)	31.30	
	Start ampacity	55	
	Temperature derate (%=F)	0.91	
	Conduit fill derate (%=#)	1	
	Derated ampacity	50.05	
3.d	Icont*1.25= (Amps)	39.13	
	Ampacity	50	
3.e	EGC =	C AWG 10	Art. 250.122
	GEC =	E AWG 06	Art. 690.47, 250.166(B)

Voltage Drop Calculations — Version 5_8.16

Vdrop = (Imp) * (2 * Length) * (Resistance) / (Vmp)

	Imp (A)	Max. Length (ft)	Wire		
String:	7.97	40	C AWG 10	at Max Ave Hi:	95 deg F
Vdrop =	(7.97 A * 80 ft * 0.00124 Ohms) /			307 V =	0.26%
Branch:	23.91	130	E AWG 06	at Max Ave Hi:	95 deg F
Vdrop =	(23.91 A * 260 ft * 0.00049 Ohms) /			307 V =	0.99%
	Total voltage drop in DC conductors =				1.25%
Inverter:	31.30	5	D AWG 08	at 240V	
Vdrop =	(31.30 A * 10 ft * 0.00078 Ohms) /			240 V	0.10%
Combined	31.25	0	E AWG 06	at 240V	
Vdrop =	(31.25 A * 0 ft * 0.00049 Ohms) /			240 V	0.00%
	Total voltage drop in AC conductors =				0.10%
	Total voltage drop in AC and DC conductors =				1.35%

Branch Circuit Type A — 1-way wire length: 130 ft

3 strings per branch 1
12 modules per series string

Voc=	444 V	
Vmp=	354 V	
Isc=	25.62 A	
Imp=	23.91 A	
Icont=	32.03 A	Art 690.8(A)(1)

2.a	Conductor 1: E AWG 06	THWN-2/USE-2 at 90 deg C: Table 310.16	
		Conductor 1:	
	Icont * 1.25 = (Amps)	40.03	
	30 deg C ampacity =	75	
2.b	Icont= (Amps)	32.03	
	Start ampacity	75	
	Temp. derate (%=F)	0.96	
	Cndt. fill derate (%=#)	0.8	
	Derated ampacity	43.2	
		Term 1	Term 2
	Temp table	75deg C	75deg C
2.c	Icont*1.25= (Amps)	40.03	40.03
	Ampacity	65	65
2.d	EGC	C AWG 10	C AWG 10 Art. 250.122
	OCP size =		60

Combined Inverter Output

Service Voltage= 240 Volts
Total Inverter Power= 7,500 Watts — 1-way wire length: 0 ft
Icont = # of inverters*max inverter current — Art 690.8(A)(1)
Icont = (Amps) 31.25

4.a	Icont *1.25 = (Amps)	39.06 A	Art 690.8(B)(1)
	OCP size =	40 A	Art. 240.6(A)
4.b	Conductor E AWG 08	THWN-2 at 90 deg C: Table 310.16	
	Icont * 1.25 = (Amps)	39.06	
	30 deg C ampacity =	75	
4.c	Icont= (Amps)	31.25	
	Start ampacity	75	
	Temp. derate (%=F)	0.91	
	Cndt. fill derate (%=#)	1	
	Derated ampacity	68.25	
4.d	Icont*1.25= (Amps)	39.06	
	Ampacity	65	

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JOB NUMBER: JB-208241 00
MARKET: RESI
PROJECT MANAGER:
PAYMENT TYPE: PPA
MODULES: (36) YINGLI # YL235P-29b
MOUNTING SYSTEM: S-5! CLAMP AND SC RAIL
INVERTER: (1) FRONIUS # IG PLUS V 7.5

PREMISE OWNER: EMMET, DUANE
AHJ: Montgomery County
19921 WHITE GROUND RD
BOYDS, MD 20841
3015896000115

DESCRIPTION: EMMET RESIDENCE
8.46 KW PV Array

PAGE NAME: ELECTRICAL CALCULATIONS

DESIGN: ACHAN

SHEET: PV 8 REV: DATE: 3/6/2012

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PV MODULE

YGE235 SERIES

YL235P-29b
YL230P-29b
YL225P-29b

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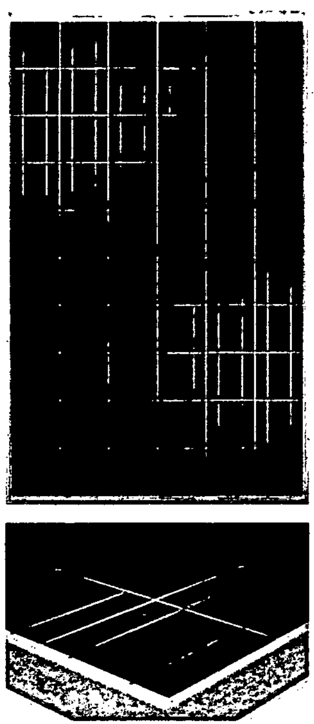

COMPANY

Yingli Green Energy (NYSE:YGE) is one of the world's largest fully vertically integrated PV manufacturers. With over 1 GW of modules installed globally, we are a leading solar energy company built upon proven product reliability and sustainable performance. Founded in 1998, Yingli Green Energy opened offices in New York and San Francisco in 2009. We are the first renewable energy company and the first Chinese company to sponsor the FIFA World Cup™.

PERFORMANCE

Industry leading in-house manufacturing of polysilicon, ingots, wafers, cells and modules ensures tight control of our material and production quality.

High performance, multicrystalline solar cells deliver a module series efficiency of up to 14.4%, reducing installation costs and maximizing the kWh output per unit area.

Power tolerance of +/-3% minimizes PV system mismatch losses.

QUALITY & RELIABILITY

Robust, corrosion resistant aluminum frame independently tested to withstand wind and snow loads of up to 50 psf and 113 psf, respectively, ensuring a stable mechanical life.

Manufacturing facility certified to ISO9001 Quality Management System standards.

Module packaging optimized to protect product during transportation and minimize on-site waste.

WARRANTIES

Extensive 5-year limited product warranty and a 25-year limited power warranty.
Limited power warranty* = 90% of the minimum rated power output for 10 years, 80% of the minimum rated power output for 25 years.

* In compliance with our warranty terms and conditions

QUALIFICATIONS & CERTIFICATES

UL 1703 and ULC 1703, UL Fire Safety Class C, CEC, FSEC
ISO 9001:2008, ISO 14001:2004, BS OHSAS 18001:2007, SA8000

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YGE235 SERIES

ELECTRICAL PERFORMANCE

Electrical parameters at Standard Test Conditions (STC)					
Module name			YGE 235	YGE 230	YGE 225
Module type			YL235P-29b	YL230P-29b	YL225P-29b
Power output	P_{max}	W	235	230	225
Power output tolerances	ΔP_{max}	%	+/- 3		
Module efficiency	η_m	%	14.4	14.1	13.8
Voltage at P_{max}	V_{mpp}	V	29.5	29.5	29.5
Current at P_{max}	I_{mpp}	A	7.97	7.80	7.63
Open-circuit voltage	V_{oc}	V	37.0	37.0	36.5
Short-circuit current	I_{sc}	A	8.54	8.40	8.28

STC: 1000W/m² irradiance, 25°C T_{module}, AM1.5g spectrum according to EN 60904-3
Ave. efficiency reduction of 7% at 200W/m² according to EN 60904-1

Electrical parameters at Nominal Operating Cell Temperature (NOCT)					
Power output	P_{max}	W	169.9	166.4	162.7
Voltage at P_{max}	V_{mpp}	V	26.5	26.5	26.5
Current at P_{max}	I_{mpp}	A	6.41	6.28	6.14
Open-circuit voltage	V_{oc}	V	33.8	33.8	33.4
Short-circuit current	I_{sc}	A	6.92	6.8	6.71

NOCT: open-circuit module operation temperature at 800W/m² irradiance, 20°C $T_{ambient}$, 1 m/s wind speed

THERMAL CHARACTERISTICS

Nominal operating cell temperature	NOCT	°C	46 +/- 2
Temperature coefficient of P_{max}	γ	%/°C	-0.45
Temperature coefficient of V_{oc}	β_{Voc}	%/°C	-0.37
Temperature coefficient of I_{sc}	α_{Isc}	%/°C	0.06

OPERATING CONDITIONS

Max. system voltage	600Vdc
Max. series fuse rating	15A
Limiting reverse current	Do not apply external voltages larger than V_{oc} of the module
Operating temperature range	-40 to 194°F (-40 to 90°C)
Max. static load, front (e.g., snow and wind)	113 psf (5400 Pa)
Max. static load, back (e.g., wind)	50 psf (2400 Pa)
Hailstone impact	1 in (25mm) at 51 mph (23m/s)

CONSTRUCTION MATERIALS

Units: inch (mm)

Front cover (material/type/thickness)	low-iron glass/tempered/3.2mm
Cell (quantity/material/type/dimensions/area)	60/polysilicon/multicrystalline/156x156mm/243.3cm²
Encapsulant (material)	ethylene vinyl acetate (EVA)
Frame (material/color/anodization color)	anodized aluminum alloy/silver/clear
Junction box (protection degree)	IP65
Cable (length/cross-sectional area)	47.24 (1200)/12 AWG
Plug connector (manufacturer/type/protection degree)	MC/MC4/IP67

- The specifications in this datasheet are not guaranteed and are subject to change without prior notice.
- This datasheet complies with EN 50380 2003 requirements

GENERAL CHARACTERISTICS

Units: inch (mm)

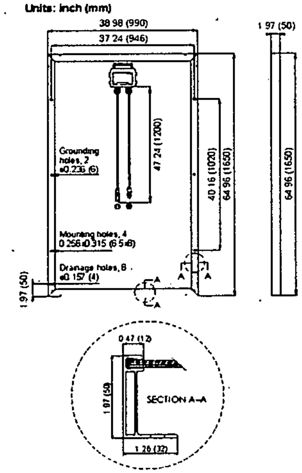
Dimensions (length/width/height)	64.96 (1650)/38.98 (990)/1.97 (50)
Weight	43.7 lbs (19.8 kg)

PACKAGING SPECIFICATIONS

Units: inch (mm)

Number of modules per pallet	20
Number of pallets per 53' container	36
Packaging box dimensions (L/W/H)	67 (1710)/45 (1150)/47 (1190)
Box weight	997 lbs (450 kg)

Units: inch (mm)



Warning: Read the instruction manual in its entirety before handling, installing, and operating Yingli modules

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(3)

JOB NUMBER: JB-208241 00
MARKET: RESI
MODULES: (36) YINGLI # YL235P-29b
PROJECT MANAGER:
MOUNTING SYSTEM: S-5! CLAMP AND SC RAIL
PAYMENT TYPE: PPA
INVERTER: (1) FRONIUS # IG PLUS V 7.5

PREMISE OWNER: EMMET, DUANE
AHJ: Montgomery County
19921 WHITE GROUND RD
BOYDS, MD 20841
3015896000115

DESCRIPTION: EMMET RESIDENCE
8.46 KW PV Array

PAGE NAME: CUTSHEETS

DESIGN: ACHAN

SHEET: PV 9 REV: DATE: 3/6/2012

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14

INVERTER

INPUT DATA Fronius IG Plus V	3.0-1	3.8-1	5.0-1	6.0-1	7.5-1	10.0-1	11.4-1	10.0-3	11.4-3	12.0-3
Recommended PV-Power (kWp)	2.50 - 3.45	3.20 - 4.40	4.25 - 5.75	5.10 - 6.90	6.35 - 8.60	8.50 - 11.50	9.70 - 13.10	8.50 - 11.50	9.70 - 13.10	10.20 - 13.80
MPP1-voltage range	230 500 V									
DC startup voltage	245 V									
Max. input voltage (at 1000 W/m² 14 °F (-10 °C) in open circuit operation)	600 V									
Nominal input current	8.3 A	10.5 A	13.8 A	16.5 A	20.7 A	27.6 A	31.4 A	27.6 A	31.4 A	33.1 A
Max. usable input current	14.0 A	17.8 A	23.4 A	28.1 A	35.1 A	46.7 A	53.3 A	46.7 A	53.3 A	56.1 A
Admissible conductor size (DC)	No 14 - 6 AWG									
Number of DC input terminals	6									
Max. current per DC input terminal	20 A, Bus bar available for higher input currents									

OUTPUT DATA Fronius IG Plus V		3.0-1	3.8-1	5.0-1	6.0-1	7.5-1	10.0-1	11.4-1	10.0-3	11.4-3	12.0-3
Nominal output power (P_)		3000 W	3800 W	5000 W	6000 W	7500 W	9995 W	11400 W	9995 W	11400 W	12000 W
Max. continuous output power 104 °F (40 °C) 208 V / 240 V / 277 V		3000 W	3800 W	5000 W	6000 W	7500 W	9995 W	11400 W	9995 W	11400 W	12000 W
Nominal AC output voltage		208 V / 240 V / 277 V							208 V / 240 V		277 V
Operating AC voltage range (default)	208 V	183 - 229 V (-12 / +10 %)									
	240 V	211 - 264 V (-12 / +10 %)									
	277 V	244 - 305 V (-12 / +10 %)									
Max. continuous output current	208 V	14.4 A	18.3 A	24.0 A	28.8 A	36.1 A	48.1 A	54.8 A	27.7 A*	31.6 A*	n.a.
	240 V	12.5 A	15.8 A	20.8 A	25.0 A	31.3 A	41.6 A	47.5 A	24.0 A*	27.4 A*	n.a.
	277 V	10.8 A	13.7 A	18.1 A	21.7 A	27.1 A	36.1 A	41.2 A	n.a.	n.a.	14.4 A*
Number of phases		1							3		
Admissible conductor size (AC)		No. 14 - 4 AWG									
Max. continuous utility back feed current		0 A									
Nominal output frequency		60 Hz									
Operating frequency range		59.3 - 60.5 Hz									
Total harmonic distortion		< 3 %									
Power factor		1 (at nominal output power)									

GENERAL DATA Fronius IG Plus V		3.0-1	3.8-1	5.0-1	6.0-1	7.5-1	10.0-1	11.4-1	10.0-3	11.4-3	12.0-3
Max. efficiency		96.2 %									
CEC efficiency	208 V	95.0 %	95.0 %	95.5 %	95.5 %	95.0 %	95.0 %	95.0 %	95.0 % **	95.0 %	n.a.
	240 V	95.5 %	95.5 %	95.5 %	96.0 %	95.5 %	95.5 %	95.5 %	96.0 % **	96.0 %	n.a.
	277 V	96.0 %	96.0 %	96.0 %	96.0 %	96.0 %	96.0 %	96.0 %	n.a.	n.a.	96.0 %
Consumption in standby (night)		< 1.5 W									
Consumption during operation		8 W		14 W			20 W				
Cooling		Controlled forced ventilation, variable speed fan									
Enclosure type		NEMA 3R									
Unit dimensions (W x H x D)		17.1 x 26.5 x 9.9 in.		17.1 x 38.1 x 9.9 in.			17.1 x 49.7 x 9.9 in.				
Power stack weight		31 lbs. (14 kg)		57 lbs. (26 kg)			84 lbs. (38 kg)				
Wiring compartment weight		24 lbs. (11 kg)		24 lbs. (11 kg)			26 lbs. (12 kg)				
Admissible ambient operating temperature		-13 °F ... +131 °F (-25 °C ... +55 °C)									
Compliance		UL 1741-2010, IEEE 1547-2003, IEEE 1547.1, ANSI/IEEE C62.41, FCC Part 15 A & B, NEC Article 690, C22. 2 No. 107.1-01 (Sept. 2001), California Solar Initiative - Program Handbook - Appendix C: Inverter Integral 5 % Meter Performance Specification									

PROTECTION DEVICES Fronius IG Plus V	3.0-1	3.8-1	5.0-1	6.0-1	7.5-1	10.0-1	11.4-1	10.0-3	11.4-3	12.0-3
Ground fault protection	Internal GFDI (Ground Fault Detector/Interrupter), in accordance with UL 1741-2010 and NEC Art. 690									
DC reverse polarity protection	Internal diode									
Islanding protection	Internal; in accordance with UL 1741-2010, IEEE 1547-2003 and NEC									
Over temperature	Output power derating / active cooling									

* per Phase
** preliminary

Fronius USA, LLC
10421 Citation Drive, Suite 1100
Brighton, MI 48116
E-Mail: pv-us@fronius.com
www.fronius-usa.com

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JOB NUMBER: JB-208241 00		PREMISE OWNER: EMMET, DUANE 19921 WHITE GROUND RD BOYDS, MD 20841	AHJ: Montgomery County
MARKET: RESI	MODULES: (36) YINGLI # YL235P-29b	DESCRIPTION: EMMET RESIDENCE 8.46 KW PV Array	DESIGN: ACHAN
PROJECT MANAGER:	MOUNTING SYSTEM: S-5! CLAMP AND SC RAIL	3015896000115	
PAYMENT TYPE: PPA	INVERTER: (1) FRONIUS # IG PLUS V 7.5	PAGE NAME: CUTSHEETS	SHEET: PV 10 REV: DATE: 3/6/2012

SolarCity
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San Mateo, CA 94402
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(888)-SOL-CITY (765-2489) | www.solarcity.com

MOUNTING HARDWARE

S-5! Attachment Hardware

Modern standing seam roofing systems boast that by design, fastening through the weathering membrane is greatly reduced or eliminated. Unfortunately, when it becomes necessary to attach something to the roof, there has never been a way to do it without compromising roof integrity and voiding system warranties. Such attachments have in the past been the source of leaks, panel corrosion and repeated maintenance problems.

Look at all the things you don't get with S-5!

- no holes
- no leaks
- no corrosion
- no caulking
- no panel damage
- no wood blocking
- no violation of thermal movement
- no warranty violation
- no maintenance
- no hassles
- no callbacks
- NO PROBLEMS

The S-5! clamp systems now offer a complete solution to the attachment of a wide variety of ancillary rooftop accessories, including HVAC equipment, signage, solar panels, snow retention hardware, gas piping and conduit, rooftop lighting, fascias, equipment screens, parapet bracing, condensate lines, stack and flue bracing, antennae, roof walkways and more.

A variety of S-5! clamp styles are available:

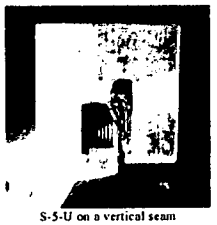
- The S-5-U will fit most "structural" and "architectural" panel seam styles.
- The S-5-Z is specially designed to fit ZipRib, Kal-Zip and similar profiles.
- The S-5-B is a brass clamp, designed for use on double-folded standing seam or traditional batten seam copper.
- The S-5-E is an aluminum clamp designed to fit traditional double-folded standing seam profiles.

Metal Roof Innovations, Ltd., also develops custom clamps. We invite you to Contact Us with inquiries about special requirements.

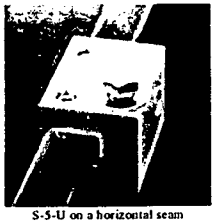
Aluminum clamps are metallurgically compatible with bare or painted galvanized, Galvalume, Aluminized and Galfan coated steel, as well as bare or painted aluminum, stainless and zinc sheet products. In most applications, the clamp should be installed at a location on the seam that avoids the panel's attachment clip location. S-5! clamps may also be used at a clip location, provided the clip is an expansion (dual-component) clip. All aluminum clamps are furnished with a stainless steel bolt and washer (3/8" diameter x 5/8" length; bolt head size is 9/16").

For more detailed installation instructions, see the Installation section.

S-5! clamps attach to the panel seam by the tightening of two "bullet-nosed" stainless steel set screws against the seam material (this is usually done with an industrial grade screwgun). The set screws compress the seam material against the opposite wall of the clamp. They will "dimple" the seam material, but will not penetrate it. Threaded holes in the clamp (and stainless hardware provided) enable the easy attachment of various ancillary items to the clamps



S-5-U on a vertical seam



S-5-U on a horizontal seam

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	MARKET: RESI	MODULES: (36) YINGLI # YL235P-29b			
	PROJECT MANAGER:	MOUNTING SYSTEM: S-5! CLAMP AND SC RAIL		PAGE NAME: CUTSHEETS	SHEET: REV: DATE: PV 11 3/6/2012
	PAYMENT TYPE: PPA	INVERTER: (1) FRONIUS # IG PLUS V 7.5			

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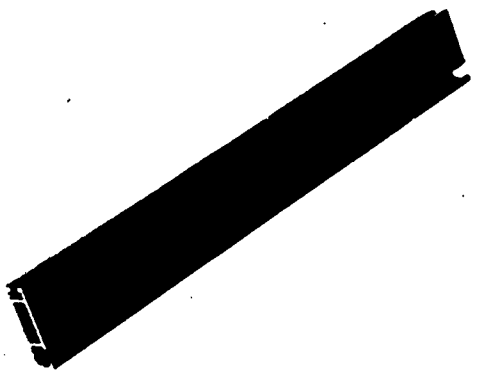
CANOPY STANDARD RAIL

Solar City Standard Rail is an integral platform of the Canopy mounting system offering a solid platform for solar arrays. The rail profile is extruded from high strength structural grade aluminum 6005A-T5, which also offers excellent corrosion resistance. Convenient tracks provide easy attachment with standard fasteners.

- Offered in aesthetic finishes to match most solar panel frames
  - Black and mat
  - Clear architectural anodizing
  - Mill finish
- 6005A-T5 high strength structural grade aluminum
  - Provides a strong mounting platform with spans up to 12 feet when conditions allow
  - Provides excellent corrosion resistance
- Track style attachment offers convenient mounting with
  - Standard fasteners
  - and SolarCity latching clamp
- Standard rail is approved for use with all SolarCity mounting hardware



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MOUNTING RAILS

CANOPY STANDARD RAIL

SolarCity Standard Rail Design Instructions

Parameters

P (lb/sqft) : Overall design pressure on solar array
w (lb/ft) : Distributed rail load
H (ft) : Panel dimension perpendicular to the rail
N : Number of rails supporting each panel
S : Safe rail span
PL : Point load

1. Calculate overall design pressure on solar array P. Refer to ASCE 7-05 and local building code.
2. Calculate distributed rail load w by multiplying the design pressure P with the perpendicular panel dimension H and dividing the result by the number of rails supporting each panel. Make sure that inputs have consistent units.

$$w = P * H/N \quad \text{(typically } N = 2\text{)}$$

3. Round up the distributed rail load w to the next 5lb/ft.
4. Select the appropriate row for the rounded up distributed rail load w in the following table
5. Select any of the green (safe) rail spans S from the selected row.
6. Calculate the point load PL of the rail support by multiplying the rail load w with rail span S divided by 2.

$$PL = w * S/2$$

7. Verify that the building can support this point load force. It is the designer/installers responsibility to ensure that the building can support the point load forces.
8. Structural design for rail system and mounting hardware is performed in accordance with IRC/IBC 2009.

JOB NUMBER: JB–208241 00	
MARKET: RESI	MODULES: (36) YINGLI # YL235P-29b
PROJECT MANAGER:	MOUNTING SYSTEM: S-5! CLAMP AND SC RAIL
PAYMENT TYPE: PPA	INVERTER: (1) FRONIUS # IG PLUS V 7.5

PREMISE OWNER: EMMET, DUANE
AHJ: Montgomery County
19921 WHITE GROUND RD
BOYDS, MD 20841
3015896000115

DESCRIPTION: EMMET RESIDENCE
8.46 KW PV Array

PAGE NAME: CUTSHEETS

DESIGN: ACHAN

SHEET: PV 12 REV: DATE: 3/6/2012

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EAH CONSULTING

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Phone: 1.978.406.8921
Elaine.Huang@alum.mit.edu

March 27th, 2012

To: SolarCity
3055 Clearview Way
San Mateo, CA 94402

Subject: Structural Certification for
Installation of Solar Panels
Emmet Residence
19921 White Ground Road
Boyds, MD 20841

To whom it may concern:

A design check for the subject residence was done on the existing roofing and framing systems for the installation of solar panels over the roof. From a field inspection of the property, the existing MP1 roof support structure consists of 2"x4" Triple Fan Cove trusses spaced at 24" oc. The trusses have a slope of 27 degrees and a span of approximately 36' between load bearing walls. The members of the trusses are connected by steel gusset plates. The roof coverings consist of metal standing seam on plywood sheathing.

The existing roof framing systems are judged to be adequate to withstand the loadings imposed by the installation of the solar panels. No reinforcement is necessary.

I further certify that all applicable loads required by IRC 2009 and Maryland Building Performance Standards with DHCD modifications were applied to the SolarCity solar rail system and analyzed. The applicable loads are indicated in the load combination table and the summation of maximum loads indicated on permit plan sheet PV-4, which is part of this submittal package. Furthermore, the installation crews have been thoroughly trained to install the solar panels based on the specific roof installation instructions developed by SolarCity for the racking system, and by EcoFasten/S-5 for the roof connections. Finally, I accept the certifications indicated by the solar panel manufacturer for the ability of the panels to withstand high wind and snow loads.

Sincerely,

Elaine A. Huang, P.E.
Structural Engineer

Professional Certification: I hereby certify that these plans were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Maryland; License No. 41161; Expiration Date of October 12, 2013.

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Elaine.Huang@alum.mit.edu

Project:	**Emmet Residence**
Client:	**SolarCity**
Location:	**19921 White Ground Road, Boyds, MD 20841**
Date:	**3/27/2012**
Engineer:	**Elaine A Huang, PE**

Load and Load Combination:

Dead Load:

Plywood Roof Deck = 5 psf (ASCE-7 Table C3-1)
Metal Standing Steam Roof = 2 psf (ASCE-7 Table C3-1)
Insulation = 1 psf
Solar Panels = 4 psf (Given by SolarCity)
Total Dead Load = 5 + 2 + 1 + 4 = **12 psf**

Live Load:

Tributary area of each rafter < 200 ft^2
Slope of roof = 27°
From IRC Table R301.6, the minimum roof live load is **16 psf.**

Snow Load:

Ground Snow Load, P_g:
City of Boyds, MD = 25 psf (IRC 2009)

Flat Roof snow load = $P_f = 0.7\ C_e\ C_t\ I\ p_g = 0.7 \times 0.9 \times 1 \times 1 \times 25$ psf = 16 psf (ASCE-7, Eq. 7-1)

C_e = exposure factor = 0.9, (ASCE-7, Table 7-2), Terrain B, fully exposed
C_t = thermal factor = 1.0 (ASCE-7, Table 7-3), heated structure
I = importance factor = 1.0 (ASCE-7, Table 7-4), occupancy category II

Sloped roof snow load $P_s = C_s\ P_f = 1.0 \times P_f$ = 16 psf (ASCE-7, Equation 7-2)

C_s = slope factor = 1.0 (ASCE-7 Fig. 7-2a), Cold roofs with C_t = 1.0

Unbalanced Snow Load:

For rafters with an eave to ridge distance smaller than 20',

Unbalanced Snow load = IP_g = 1.0 x 25 psf = **25** psf (ASCE-7, Section 7.6.1)

Wind Speed:

Basic Wind Speed:
City of Boyds, MD = 90 mph (IRC 2009)

Wind Pressure:

From IRC Table R301.2 (2), Wind Load for Components and Cladding (Solar panels)

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Roof pitch = approximately 27°
Roof zone = 3
Effective Wind Area = 20 ft^2
Wind Pressure = 10 psf (downward) or -26 psf (uplifting) for exposure B (surburban)

From ASCE-7, for Main Wind Force Resisting System (wood rafters)

$Q_z = 0.00256\ K_z\ K_{zt}\ K_d\ V^2\ I$ (ASCE-7, Equation 6-15)

K_z = velocity pressure exposure coefficient = 0.70 (ASCE-7, Table 6-3), 30' building
K_{zt} = topographic factor = 1.0 (ASCE-7, Section 6.5.7.2)
K_d = wind directionality factor = 0.85 (ASCE-7, Table 6-4), main wind force resisting system
V = 90 mph (IRC 2009)
I = 1.0 (category II)

Therefore, $q_z = 0.00256 \times 0.70 \times 1 \times 0.85 \times 90^2 \times 1 = 12.3$ psf (downward)

From ASCE-7 Figure 6-2, Design Wind Pressures for Main Wind Force Resisting System (enclosed building),

Wind Vertical Pressure = 5.6 or -8.8 psf maximum (uplift)

Use downward force **12 psf** downward force and **-26 psf** upward force for calculation to maximize load forces.

Downward Load Combination (ASD):

D + S = 37 psf
D + W = 24 psf
D + 0.75W + 0.75S = **40 psf (controls)**

Uplift Load Combination (ASD)

D + S = 37 psf
0.6D + W = **-19 psf**
D + 0.75W + 0.75S = 11 psf

Roof Structures

MP1
The roof consists of asphalt shingle on plywood that is supported by 2"x4" Triple Fan Cove Trusses spaced at 24" oc. The trusses have a span of approximately 36' and a slope of 27 degrees. All the members of the trusses are connected by steel gusset plates. The trusses are simply supported by load bearing walls. The maximum unsupported span of the top chord is 5.1' with two attachments.

Structural Analysis and Calculation

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MP1

Top Chords:

Member Size = 2"x4"

Spacing = 24" O.C.

Span Length = 5.1'

w = 40 psf

A_{max} = 5.42' (length of panel) x 4.0' (distance between standoffs)/2 = 10.83 ft^2

P = w x A_{max} = 40 psf x 10.83 ft^2 = 433 lbs

Check downward moment capacity of top chords:

M =0.33 PL = 0.33 x 433 lbs x 5.1' = 729 lbs-ft (2 attachments per span)

S = $bd^2/6$ = 3.06 in^3

M/S = 729 lbs-ft x 12 (in/ft) / 3.06 in^3 = 2857 psi

F_b (SYP no 1/no 2) = 1500 psi x C_r x C_D x C_F
= 1500 psi x 1.15 x 1.6 x 1.5
= 4140 psi, OK

C_r = repetitive factor = 1.15 (2" width) (NDS Table 4A)
C_D = duration factor for wind load = 1.6 (NDS Table 2.3.2)
C_F = shape factor = 1.5 (2"x4") (NDS Table 4A)

Check uplift moment capacity of top chords:

P = w x A_{max} = 19 psf x 10.83 ft^2 = 206 lbs

M =0.33 PL = 0.33 x 206 lbs x 5.1' = 347 lbs-ft (2 attachments per span)

S = $bd^2/6$ = 3.06 in^3

M/S = 347 lbs-ft x 12 (in/ft) / 3.06 in^3 = 1360 psi

F_b (SYP no 1/no 2) = 1500 psi x C_r x C_D x C_F x C_L
= 1500 psi x 1.15 x 1.6 x 1.5 x 0.80

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= 3312 psi, OK

C_r = repetitive factor = 1.15 (2" width) (NDS Table 4A)
C_D = duration factor for wind load = 1.6 (NDS Table 2.3.2)
C_F = shape factor = 1.5 (2"x4") (NDS Table 4A)
C_L = stability factor = 0.80

Check shear capacity of top chords:

V = 2P/2 = 433 lbs

V_{max} = 3V/2A = [3 (433 lbs)]/[2 (5.25 in^2)] = 124 psi

F_v = 175 psi, OK

Check deflection of top chords:

W = 433 lbs x 2.667 / 5.1' = 226 lbs/ft

Δ_{total} = $5wL^4/384EI$ = (5 x 0.226 K/ft x 5.1^4 ft^4 x 12^3 in^3/ft^3)/(384 x 1600 psi x 5.36 in^4) = 0.401"

L/180 = 5.1' x (12 in/ft) /180 = 0.340 in, No Good (IRC Table R301.7)

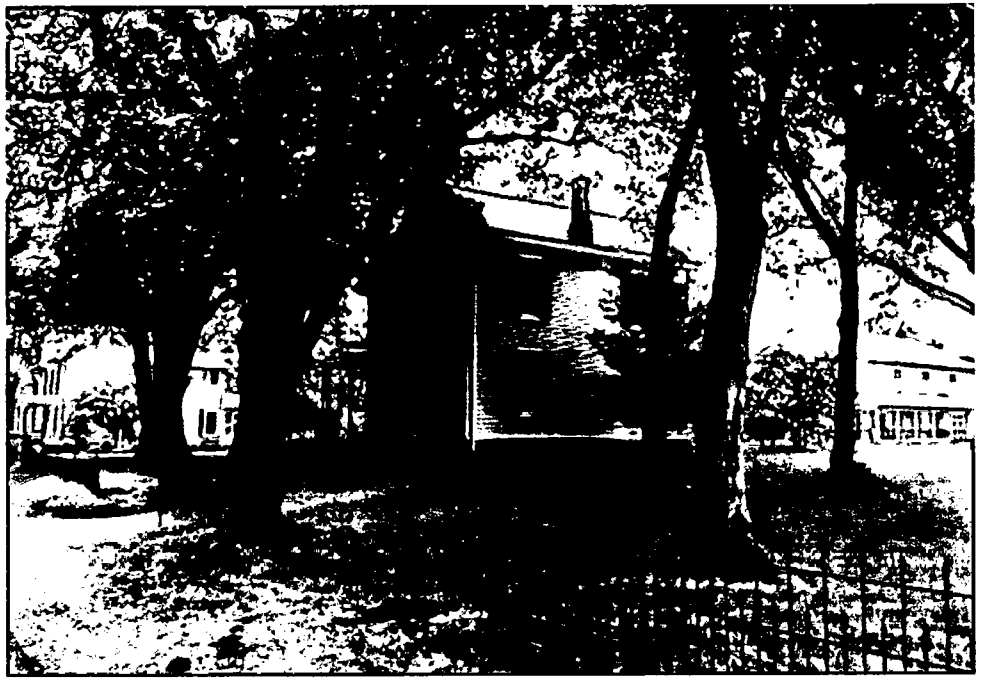
In reality, there are four spans and use the formula of max deflection for three spans:

Δ_{total} = $0.0065wL^4/EI$ = (0.0065 x 0.226 K/ft x 5.1^4 ft^4 x 12^3 in^3/ft^3)/(1600 psi x 5.36 in^4) = 0.200"


BARNESVILLE RD
117
121
CLOPPER RD
117
WHITE GROUND RD
19921
PA18

19921 White Grand Rd.


03/06/2012

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