RIGHT ANGLE ENGINEERING

November 12, 2018

Energy Conservation Solutions
116 Gasoline Alley, Suite 105
Mooresville, NC 28117

RE: Pole Mount Footing of Solar Array for the ***Stone Residence: 114 Esther Stone Lane, Coats, North Carolina***

As per your request I evaluated the proposed pole mount footing for the solar array. The solar array consists of 12 panels with a total of 8 footings. The following loads were used in the analysis of the pole mount system:

1. 293 lb vertical snow & dead load
2. 295 lb lateral wind load at 7.8 feet

It is my recommendation that a 2" Schedule 40 Steel Pipe with an 18" wide diameter and 3' 8" deep footing reinforced with (4) #3 vertical bars with #3 rings @ 10" o.c. will safely and adequately support the solar array. The mounting hardware should be installed according the manufacturer's specifications.

Respectfully,

11/12/18

Robert D Smythe, P.E.
Right Angle Engineering

55 WEST 500 SOUTH, HEBER CITY, UT 84032
T 925.787.3067 U RIGHTANGLEENG.COM

RIGHT ANGLE ENGINEERING

Solar Panel and Array Dimensions

PV Width:	3.33 ft
PV Length:	5.20 ft
PV Weight:	42.0 lbs
	2.4 lbs/ft²
Configuration:	Portrait
Rows:	2 ea
Columns:	6 ea
Support Posts:	8 ea
Solar Panel Slope Angle:	25°

	Array Length	Array Width	Area
Gross Dimensions of Array:	20.00 ft	10.40 ft	208.0 ft²
Normalized Array on Single Pole:	2.50 ft	10.40 ft	26.0 ft²

Normalized Horizontal Loading

Vertical Exposure of Sloped Panel:	4.40 ft
Wind Surface Area on Single Pole:	11.0 ft²
Bottom of Panel Height:	2.00 ft
Top of Panel Height:	7.80 ft

Normalized Vertical Loading

Vertical Exposure of Sloped Panel:	9.43 ft
Vertical Area on Single Pole:	23.6 ft²
Weight of PV Panels:	63.0 lbs
Racking Weight @ 1 lb/ft^2:	26.0 lbs
Snow Load	10.0 lbs
Snow Load on Single Pole	204 lbs
Vert. Weight on Each Post:	**293 lbs**

RIGHT ANGLE ENGINEERING

ASCE 7-10 29.4.1 DESIGN WIND LOADS--SOLID FREESTANDING SIGNS

Basic Parameters

$F=q_hGC_fA_s$ (LB)		Section 29.4-1
$q_h=0.00256K_zK_{zt}K_dV^2$(LB/FT^2)		Section 29.3-1
Risk Category	I	Table 1.5-1
Basic Wind Speed, V	128 mph	Figure 26.5-1A
Exposure Category	C	Secton 26.7.3
Height To Top of Sign h	7.80 ft	
Sign Height s	4.40 ft	
Sign Width B	2.50 ft	
Wind Directionality Factor, K_d	0.85	Table 26.6-1
Velocity pressure exposure coef. K_z	0.85	Table 29.3-1
Topographic Factor, K_{zt}	1.00	Section 29.3.1
Gust Effect Factor, G	0.850	Section 26.9
Net Force Coefficient C_f	1.7	Figure 29.4-1
Gross Area A_s	11.0 ft^2	Section 26.10
Clearance Ratio s/h	0.56	Table 26.11-1
Terrain Exposure Constant, a	9.5	Table 26.9-1
Terrain Exposure Constant, z_g	900 ft	Table 26.9-1

F= **295 (LB)** @ 7.80 ft **From Ground Surface**

RIGHT ANGLE ENGINEERING

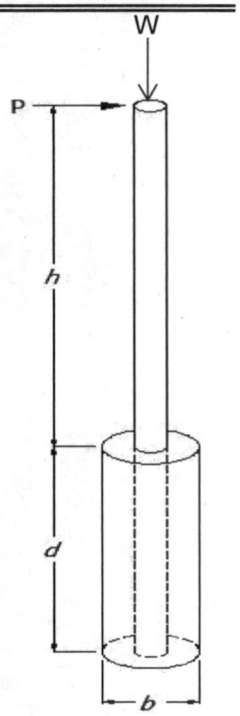
Pole Foundation Analysis (Non-Constained Embedded Pole):

Lateral Capacity of Soil:

Embedment Depth: $d = 0.5A \{1 + [1 + (4.36h/A]^{1/2}\}$

Where: $A = 2.34P/(S_1 b)$

P =	294.64 lbs	Estimate *d* -	3.58 ft
b =	1.5 ft	Lateral Soil Bearing Pressure:	150 psf*
h =	8.0 ft	Vertical Soil Bearing Pressure:	1500 psf*
S_1 =	537 psf	*Based on IBC Table 1806.2	
A =	0.86		
d =	3.59 ft		



Vertical Capacity of Soil:

Area of Foundation:	1.77 sf	
Vertical Load from Panels:	292.59 lbs	
Vertical Load from Pipe:	29.20 lbs	
Vertical Load from Foundation:	951.06 lbs	
Coefficient of Friction:	0.25*	
Total Vertical Load:	318.21 lbs	
Soil Bearing Capacity:	2650.72 lbs	PASS

Compression and Bending Capacity of Pipe:

Pipe size / Type: 2.0 inch diameter SCH 40 galv. steel pipe.

Inside Diameter: 2.07 in Outside Diameter: 2.38 in

P_r = 498.58 lbs			
$P_c = P_n / \Omega_c$ =	4,560 / 1.67 =	2,736 lbs	PASS
P_n = 4559.64 lbs			
M_{rx} = 2,357.1 ft-lbs			
$M_{cx} = M_n / \Omega_b$ =	20,242 / 1.67 =	12,145 ft-lbs	PASS

Use:

2 inch diameter SCH 40 galv. steel pipe.

1.5 ft diameter foundation at 3.6 ft deep.

ECS Solar
Energy Conservation Solutions

CONTRACTOR INFORMATION:

ENERGY CONSERVATION SOLUTIONS
116 GASOLINE ALLEY, SUITE 105
MOORESVILLE, NC 28117

SITE INFORMATION:
Thomas Martin Stone
114 Esther Stone Ln, Coats, North Carolina 27521

DC SYSTEM SIZE: 3.48 kW DC

(12) Sunmodule Plus SW 290M Black PV MODULES
(12) Enphase IQ6-60-2-US MICRO INVERTER(S)

DATE: November 15, 2018

PAGE:	SHEET NAME:
PV01	COVER PAGE
DRAWN BY: SoloCAD	VERSION: 0

AERIAL VIEW:

STREET VIEW:

SHEET INDEX:

GENERAL NOTES:

1. INSTALLATION OF SOLAR PHOTOVOLTAIC SYSTEM SHALL BE IN ACCORDANCE WITH NEC ARTICLE 690, AND ALL OTHER APPLICABLE NEC CODES WHERE NOTED OR EXISTING.
2. PROPER ACCESS AND WORKING CLEARANCE AROUND EXISTING AND PROPOSED ELECTRICAL EQUIPMENT WILL COMPLY WITH NEC ARTICLE 110.
3. ALL WIRES, INCLUDING THE GROUNDING ELECTRODE CONDUCTOR SHALL BE PROTECTED FROM PHYSICAL DAMAGE IN ACCORDANCE WITH NEC ARTICLE 250
4. THE PV MODULES ARE CONSIDERED NON-COMBUSTIBLE; THIS SYSTEM IS UTILITY INTERACTIVE PER UL 1741 AND DOES NOT INCLUDE STORAGE BATTERIES OR OTHER ALTERNATIVE STORAGE SOURCES.
5. ALL DC WIRES SHALL BE SIZED ACCORDING TO [NEC 690.8]
6. DC CONDUCTORS SHALL BE WITHIN PROTECTED RACEWAYS IN ACCORDANCE WITH [NEC 690.31]
7. ALL SIGNAGE TO BE PLACED IN ACCORDANCE WITH LOCAL JURISDICTIONAL BUILDING CODE.

DESCRIPTION OF DESIGN:
INSTALLATION OF GRID -TIED, UTILITY INTERACTIVE PHOTOVOLTAIC SYSTEM

EQUIPMENT:
DC SYSTEM SIZE: 3.48kW DC
PV MODULES: (12) Sunmodule Plus SW 290M Black
INVERTER(S): (12) Enphase IQ6-60-2-US
RACKING: UNIRAC ULA FLUSH MOUNT RAILING & ROOF ATTACHMENT SYSTEM - 48 O.C.

APPLICABLE GOVERNING CODES:

2017 NATIONAL ELECTRICALCODE [NEC]
2015 INTERNATIONAL BUILDING CODE [IBC]
2015 INTERNATIONALRESIDENTIALCODE [IRC]
2015 INTERNATIONAL FIRE CODE [IFC]

SITE SPECIFICATIONS:

OCCUPANCY: R-3
ZONING: RESIDENTIAL
EXPOSURE CATEGORY: B

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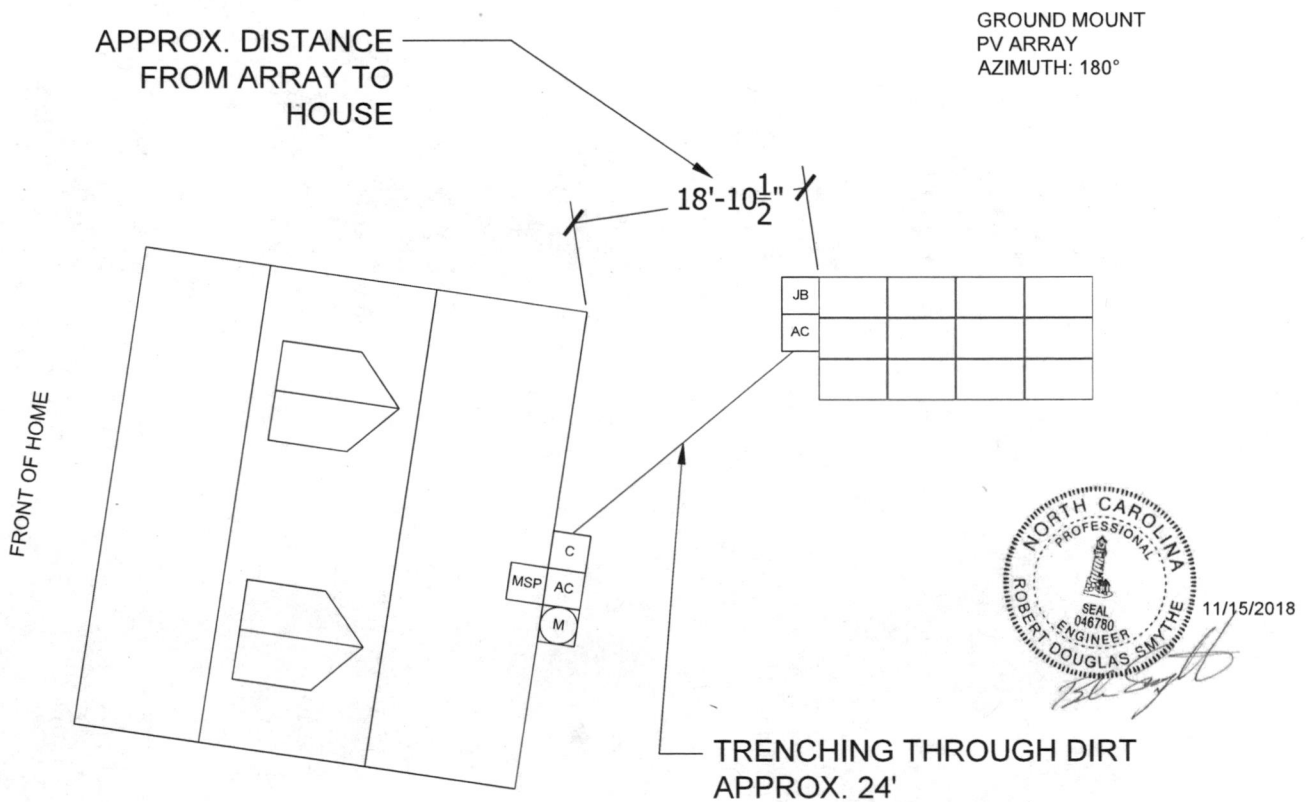
(12) Enphase IQ6-60-2-US MICRO INVERTER(S)

DATE: November 15, 2018

PAGE	SHEET NAME
PV03	ROOF PLAN
DRAWN BY: SoloCAD	VERSION: 0

EQUIPMENT LEGEND:

- M — UTILITY METER
- MSP — MAIN SERVICE PANEL
- AC — VISIBLE, LOCKABLE, LABELED AC DISCONNECT
- PV — METER SOCKET (FOR UTILITY PV METER)
- INV — INVERTER
- C — COMBINER BOX
- LC — LOAD CENTER
- FIRE SETBACK (3' TYP)
- TRENCHING



NORTH CAROLINA PROFESSIONAL SEAL 046780 ENGINEER ROBERT DOUGLAS SMYTHE

11/15/2018

ECS Solar
Energy Conservation Solutions

CONTRACTOR INFORMATION:

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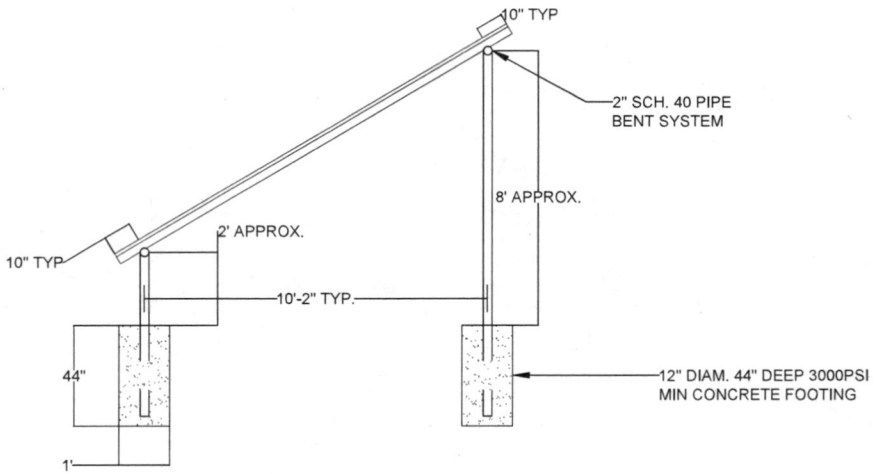
DATE: November 15, 2018

PAGE:	SHEET NAME:
PV04	MOUNTING DETAIL
DRAWN BY: SoloCAD	VERSION: 0

STRUCTURAL SIDE VIEW:

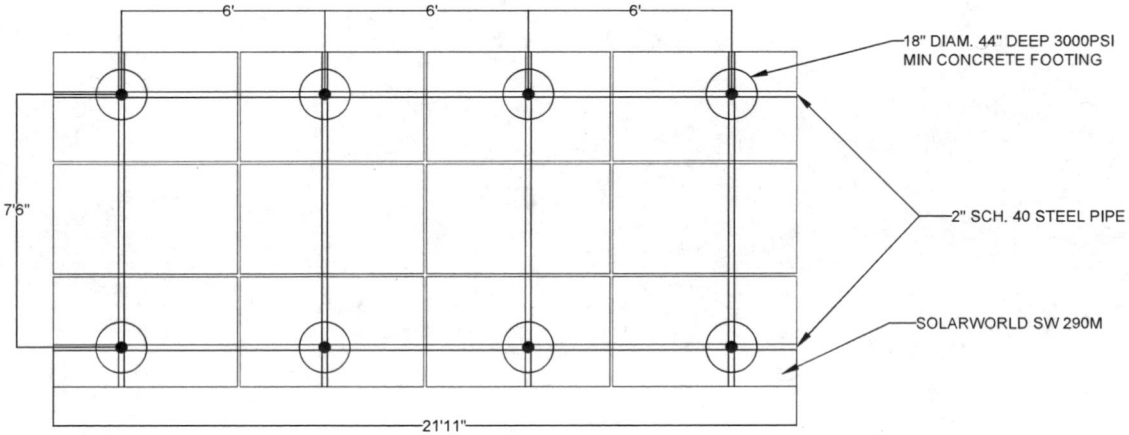


NORTH CAROLINA PROFESSIONAL SEAL 046780 ENGINEER ROBERT DOUGLAS SMYTHE

11/15/2018

E-W PIER SPACING

N-S PIER SPACING 7'6"



STRUCTURAL TOP VIEW

ECS Solar
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CONTRACTOR INFORMATION:
ENERGY CONSERVATION SOLUTIONS
116 GASOLINE ALLEY, SUITE 105
MOORESVILLE, NC 28117

SITE INFORMATION:
Thomas Martin Stone
114 Esther Stone Ln, Coats, North Carolina 27521

DC SYSTEM SIZE: 3.48 kW DC

(12) Sunmodule Plus SW 290M Black PV MODULES
(12) Enphase IQ6-60-2-US MICRO INVERTER(S)

DATE: November 15, 2018

PAGE	SHEET NAME:
PV05	ELECTRICAL DIAGRAM
DRAWN BY: SoloCAD	VERSION: 0

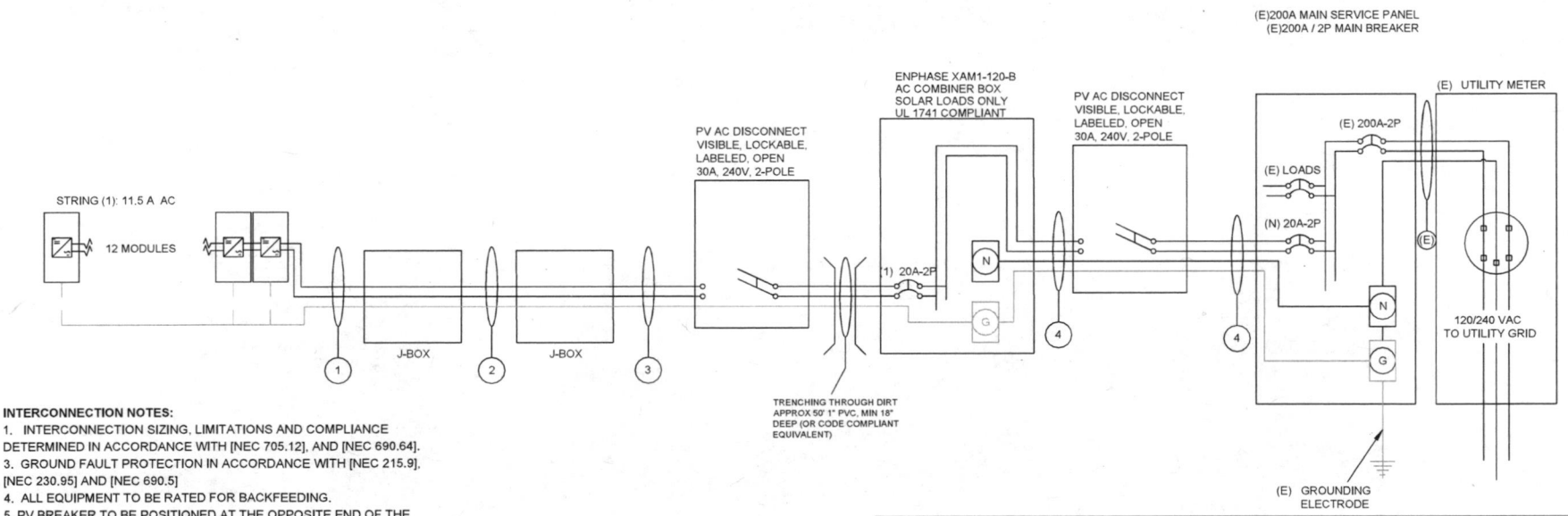
WIRE SCHEDULE

1	(1) 12-2 TC-ER, THWN-2, COPPER (OR NEC APPROVED EQUIVALENT) (1) 6 AWG BARE, COPPER (GROUND)	2	(1) 10 AWG THWN-2, or THHN - (POSITIVE) (1) 10 AWG THWN-2, or THHN - (NEGATIVE) (1) 10 AWG THWN-2, or THHN - (GROUND) (1) 3/4" LIQUID TIGHT CONDUIT or 3/4" EMT or FMC (OR NEC APPROVED EQUIVALENT)	3	(1) 10 AWG THWN-2, or THHN, COPPER - (POSITIVE) (1) 10 AWG THWN-2, or THHN, COPPER - (NEGATIVE) (1) 10 AWG THWN-2, or THHN, COPPER - (GROUND) (1) 3/4" LIQUID TIGHT CONDUIT or 3/4" EMT (OR NEC APPROVED EQUIVALENT)	4	(1) 10 AWG THWN-2, or THHN, or 10/2 MNB COPPER - (L1) (1) 10 AWG THWN-2, or THHN, or 10/2 MNB COPPER - (L2) (1) 10 AWG THWN-2, or THHN, or 10/2 MNB COPPER - (NEUTRAL) (1) 10 AWG THWN-2, or THHN, or 10/2 MNB COPPER - (GROUND) (1) 3/4" LIQUID TIGHT CONDUIT or 3/4" EMT (OR NEC APPROVED EQUIVALENT)

GROUNDING & GENERAL NOTES:

1. A SECOND FACILITY GROUNDING ELECTRODE IS NOT REQUIRED PER [NEC 690.47(C)(3)]
2. PV INVERTER IS UNGROUNDED, TRANSFORMER-LESS TYPE.
3. DC GEC AND AC EGC TO REMAIN UNSPLICED, OR SPLICED TO EXISTING ELECTRODE
4. ANY EXISTING WIRING INVOLVED WITH PV SYSTEM CONNECTION THAT IS FOUND TO BE INADEQUATE PER CODE SHALL BE CORRECTED PRIOR TO FINAL INSPECTION.

AC SYSTEM SIZE: 2.88 kW



INTERCONNECTION NOTES:

1. INTERCONNECTION SIZING, LIMITATIONS AND COMPLIANCE DETERMINED IN ACCORDANCE WITH [NEC 705.12], AND [NEC 690.64].
3. GROUND FAULT PROTECTION IN ACCORDANCE WITH [NEC 215.9], [NEC 230.95] AND [NEC 690.5]
4. ALL EQUIPMENT TO BE RATED FOR BACKFEEDING.
5. PV BREAKER TO BE POSITIONED AT THE OPPOSITE END OF THE BUSBAR RELATIVE TO THE MAIN BREAKER.

DISCONNECT NOTES

1. DISCONNECTING SWITCHES SHALL BE WIRED SUCH THAT WHEN THE SWITCH IS OPENED THE CONDUCTORS REMAINING LIVE ARE CONNECTED TO THE TERMINALS MARKED "LINE SIDE" (TYPICALLY THE UPPER TERMINALS)
2. AC DISCONNECT MUST BE ACCESSIBLE TO QUALIFIED UTILITY PERSONNEL, BE LOCKABLE, AND BE A VISIBLE-BREAK SWITCH

VISIBLE, LOCKABLE,
LABELED AC DISCONNECT
LOCATED WITHIN 10'
OF UTILITY METER

EQUIPMENT SCHEDULE:

TYPE:	QTY:	DESCRIPTION:	RATING:
MODULES:	(12)	Sunmodule Plus SW 290M Black	290 W
INVERTERS:	(12)	Enphase IQ6-60-2-US	330 W
AC DISCONNECT(S):	(1)	PV AC DISCONNECT, 240V, 2-POLE	30 A

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Energy Conservation Solutions

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(12) Enphase IQ6-60-2-US MICRO INVERTER(S)

DATE: November 15, 2018

PAGE:	SHEET NAME:
PV06	LABELS
DRAWN BY: SoloCAD	VERSION: 0

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

LABEL 1
AT EACH JUNCTION BOX, COMBINER BOX, DISCONNECT, AND DEVICE WHERE ENERGIZED UNGROUNDED CONDUCTORS MAY BE EXPOSED DURING SERVICE.
NEC. 690.35(F)

⚠WARNING
ELECTRIC SHOCK HAZARD
TERMINALS ON THE LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION

LABEL 2
FOR PV DISCONNECTING MEANS WHERE ALL TERMINALS OF THE DISCONNECTING MEANS MAY BE ENERGIZED IN THE OPEN POSITION.
NEC 690.17(E), NEC 705.22

PHOTOVOLTAIC SYSTEM
⚠ AC DISCONNECT ⚠
RATED AC OUTPUT CURRENT 11.520000
NOMINAL OPERATING AC VOLTAGE 240 V

LABEL 4
AT POINT OF INTERCONNECTION, MARKED AT AC DISCONNECTING MEANS.
NEC 690.54, NEC 690.13 (B)

⚠WARNING
DUAL POWER SUPPLY
SOURCES: UTILITY GRID AND PV SOLAR ELECTRIC SYSTEM

LABEL 5
AT POINT OF INTERCONNECTION FOR EQUIPMENT CONTAINING OVERCURRENT DEVICES IN CIRCUTS SUPPLYING POWER TO A BUSBAR OR CONDUCTOR SUPPLIED FORM MULTIPLE SOURCES, EACH SERVICE EQUIPMENT AND ALL ELECTRIC POWER PRODUCTION SOURCE LOCATIONS.
NEC 705.12(D)(3)

WARNING: PHOTOVOLTAIC POWER SOURCE

LABEL 6
AT DIRECT-CURRENT EXPOSED RACEWAYS, CABLE TRAYS, COVERS AND ENCLOSURES OF JUNCTION BOXES, AND OTHER WIRING METHODS; SPACED AT MAXIMUM 10FT SECTION OR WHERE SEPARATED BY ENCLOSURES, WALLS, PARTITIONS, CEILINGS, OR FLOORS.
NEC 690.31(G)(3&4)

⚠WARNING
INVERTER OUTPUT CONNECTION
DO NOT RELOCATE THIS OVERCURRENT DEVICE

LABEL 7
PLACED ADJACENT TO THE BACK-FED BREAKER FROM THE INVERTER IF TIE IN CONSISTS OF LOAD SIDE CONNECTION TO BUSBAR.
NEC 705.12(D)(2)(3)(B)

PHOTOVOLTAIC SYSTEM EQUIPPED WITH RAPID SHUTDOWN

LABEL 8
SIGN LOCATED AT UTILITY SERVICE EQUIPMENT.
NEC 690.56(C)

⚠WARNING
THIS EQUIPMENT FED BY MULTIPLE SOURCES. TOTAL RATING OF ALL OVERCURRENT DEVICES, EXCLUDING MAIN SUPPLY OVERCURRENT DEVICE, SHALL NOT EXCEED AMPACITY OF BUSBAR.

LABEL 9 (ONLY IF 3 OR MORE SUPPLY SOURCES TO A BUSBAR)
SIGN LOCATED AT LOAD CENTER IF CONTAINS 3 OR MORE POWER SOURCES.
NEC 705.12(D)(2)(3)(C)

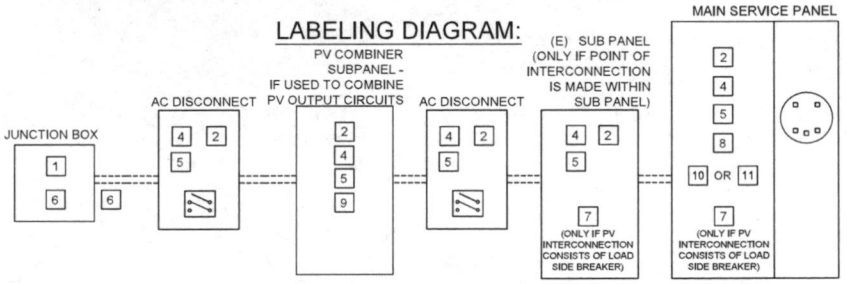
SOLAR PV SYSTEM EQUIPPED WITH RAPID SHUTDOWN
TURN RAPID SHUTDOWN SWITCH TO THE "OFF" POSITION TO SHUT DOWN PV SYSTEM AND REDUCE SHOCK HAZARD IN THE ARRAY

LABEL 10
FOR PV SYSTEMS THAT SHUT DOWN THE ARRAY AND CONDUCTORS LEAVING THE ARRAY:
SIGN TO BE LOCATED ON OR NO MORE THAN 3 FT AWAY FROM SERVICE DISCONNECTING MEANS TO WHICH THE PV SYSTEMS ARE CONNECTED AND SHALL INDICATE THE LOCATION OF ALL IDENTIFIED RAPID SHUTDOWN SWITCHES IF NOT AT THE SAME LOCATION.
[NEC 690.56(C)(1)(A)]

SOLAR PV SYSTEM EQUIPPED WITH RAPID SHUTDOWN
TURN RAPID SHUTDOWN SWITCH TO THE "OFF" POSITION TO SHUT DOWN CONDUCTORS OUTSIDE THE ARRAY CONDUCTORS WITHIN THE ARRAY REMAIN ENERGIZED IN SUNLIGHT

LABEL 11
FOR PV SYSTEMS THAT ONLY SHUT DOWN CONDUCTORS LEAVING THE ARRAY:
SIGN TO BE LOCATED ON OR NO MORE THAN 3 FT AWAY FROM SERVICE DISCONNECTING MEANS TO WHICH THE PV SYSTEMS ARE CONNECTED AND SHALL INDICATE THE LOCATION OF ALL IDENTIFIED RAPID SHUTDOWN SWITCHES IF NOT AT THE SAME LOCATION.
[NEC 690.56(C)(1)(B)]

LABELING DIAGRAM:



LABELING NOTES:
1. LABELS CALLED OUT ACCORDING TO ALL COMMON CONFIGURATIONS. ELECTRICIAN TO DETERMINE EXACT REQUIREMENTS IN THE FIELD PER CURRENT NEC AND LOCAL CODES AND MAKE APPROPRIATE ADJUSTMENTS.
2. LABELING REQUIREMENTS BASED ON THE 2017 NATIONAL ELECTRIC CODE, OSHA STANDARD 19010.145, ANSI Z535.
3. MATERIAL BASED ON THE REQUIREMENTS OF THE AUTHORITY HAVING JURISDICTION.
4. LABELS TO BE OF SUFFICIENT DURABILITY TO WITHSTAND THE ENVIRONMENT INVOLVED [NEC 110.21]
5. LABELS TO BE A MINIMUM LETTER HEIGHT OF 3/8", WHITE ON RED BACKGROUND; REFLECTIVE, AND PERMANENTLY AFFIXED [IFC 605.11.1.1]

** ELECTRICAL DIAGRAM SHOWN ABOVE IS FOR LABELING PURPOSES ONLY. NOT AN ACTUAL REPRESENATION OF EQUIPMENT AND CONNECTIONS TO BE INSTALLED. LABEL LOCATIONS PRESENTED MAY VERY DEPENDING ON TYPE OF INTERCONNECTION METHOD AND LOCATION PRESENTED ELECTRICAL DIAGRAM PAGE. **

ECS Solar
Energy Conservation Solutions

CONTRACTOR INFORMATION:

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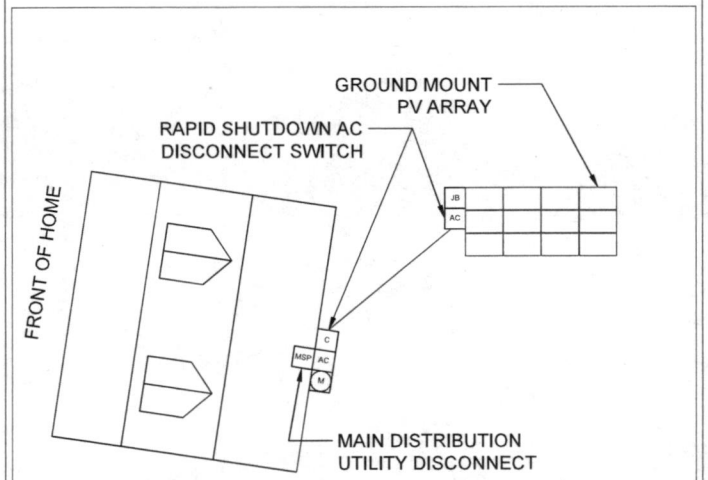
DATE: November 15, 2018

PAGE:	SHEET NAME:
PV07	PLACARD
DRAWN BY: SoloCAD	VERSION: 0

CAUTION

POWER TO THIS BUILDING IS ALSO SUPPLIED FROM ROOF MOUNTED SOLAR ARRAYS WITH SAFETY DISCONNECTS AS SHOWN:



114 Esther Stone Ln, Coats North Carolina 27521

DIRECTORY

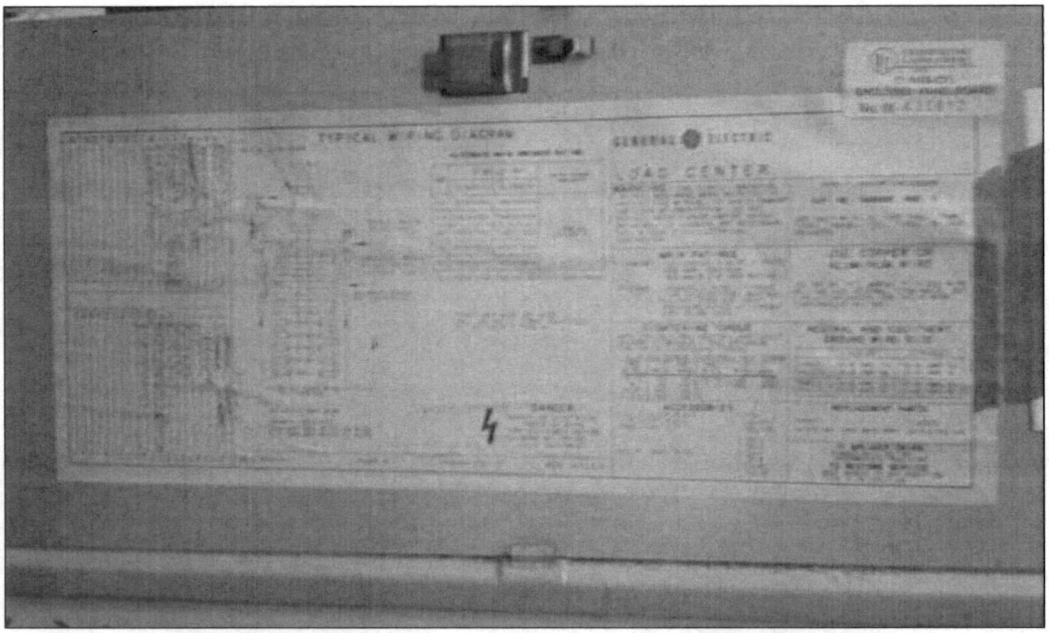
PERMANENT PLAQUE OR DIRECTORY PROVIDING THE LOCATION OF THE SERVICE DISCONNECTING MEANS AND THE PHOTOVOLTAIC SYSTEM.

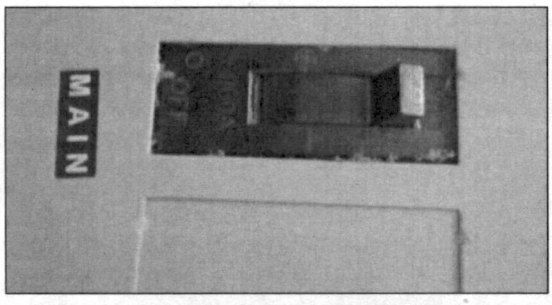
(ALL PLAQUES AND SIGNAGE WILL BE INSTALLED AS OUTLINED WITHIN: NEC 690.56(B)&(C), [NEC 705.10])

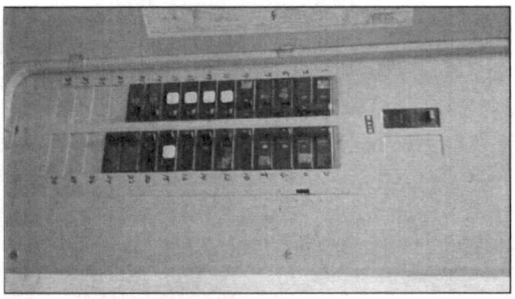
DRAWN BY: SolarCAD	PAGE: PV08	DATE: November 15, 2018	SITE INFORMATION: Thomas Martin Stone 114 Esther Stone Ln, Coats, North Carolina 27521 DC SYSTEM SIZE: 3.48 kW DC (12) Sunmodule Plus SW 290M Black PV MODULES (12) Enphase IQ6-60-2-US MICRO INVERTER(S)	CONTRACTOR INFORMATION: ENERGY CONSERVATION SOLUTIONS 116 GASOLINE ALLEY, SUITE 105 MOORESVILLE, NC 28117
VERSION: 0	SHEET NAME: SITE PHOTOS			

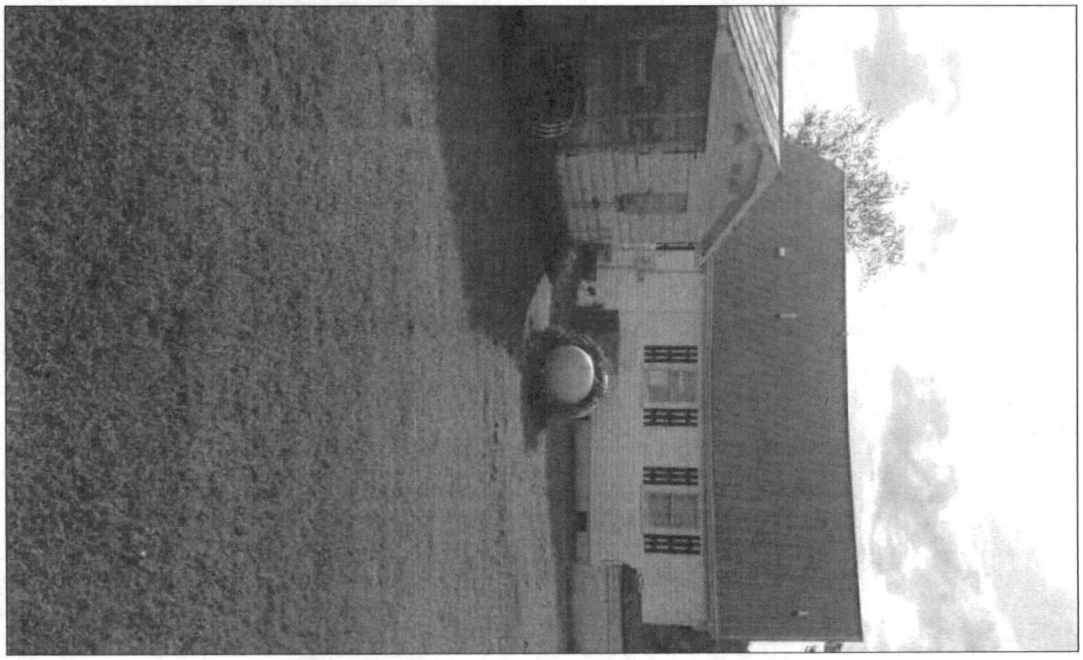
ECS Solar
Energy Conservation Solutions

SITE PHOTOS:





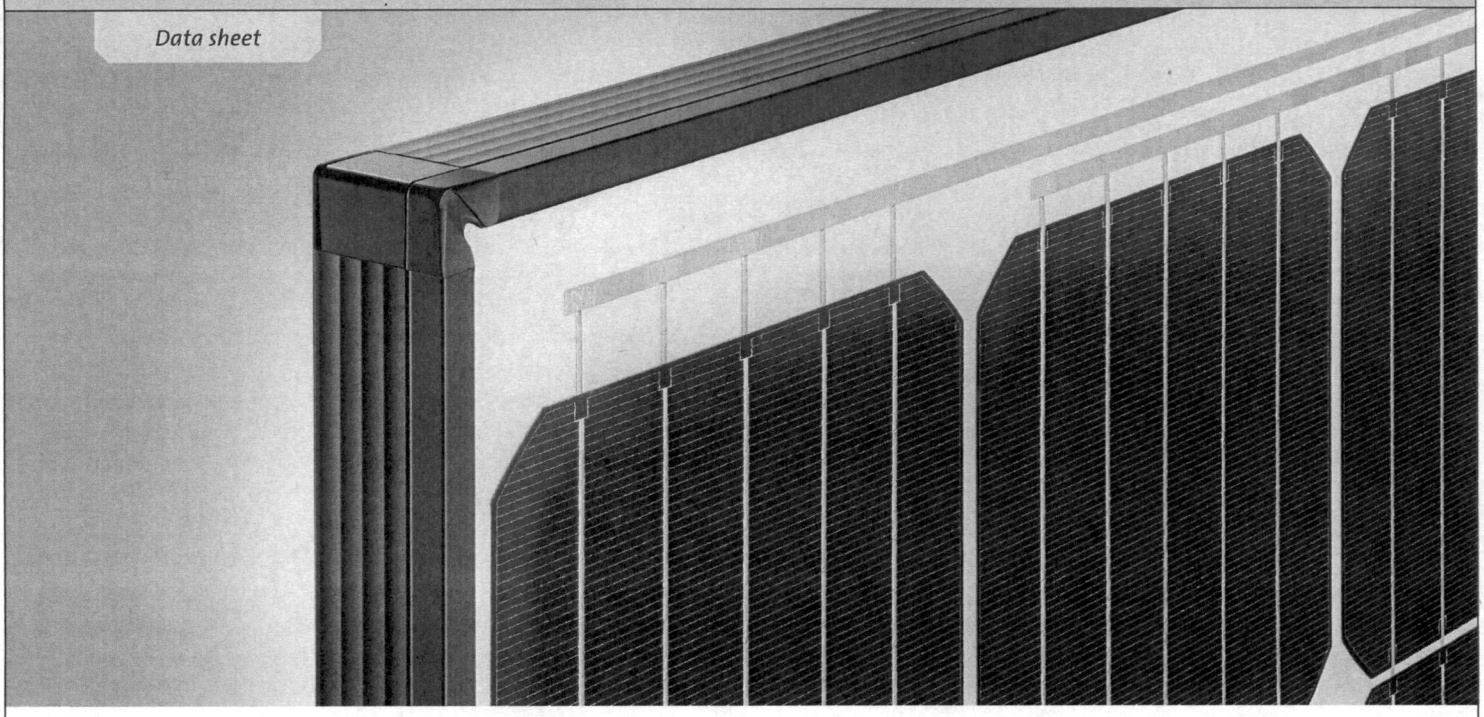




Sunmodule® Plus
SWA 290 - 300 MONO

SOLARWORLD
REAL VALUE

Data sheet



SOLARWORLD ASSURANCE™
WARRANTY PROTECTION PROGRAM

POWERING AMERICAN HOMES FOR MORE THAN 40 YEARS

For over four decades SolarWorld Americas has been creating the highest quality solar cells and panels. Driven by uncompromising standards of quality and reliability, every solar panel we produce demonstrates our commitment to American innovation, manufacturing and sustainability.

- Our **Watts+** guarantees our panels will produce at least the minimum advertised nameplate power
- **PowAR-TECH**™ Glass features the industry's best anti-reflective coating, capturing more light and increasing your panels' power
- Our patented **INFINITEE**™ Corners and Frame Technology are press-fit for superior strength and aesthetics and enhanced drainage
- By capturing more light, **OPTIGRID**™ Cell Layout increases lifetime performance while also greatly increasing durability
- **Perma-Sil**™ J-Box sealing encloses critical electrical connections, protecting them against moisture intrusion
- With **CoAST** Salt Resistance, installations on islands or near coastal areas are certified against salt corrosion

MADE IN USA
OF US & IMPORTED PARTS

TOP PERFORMER 2017
DNV·GL
PV MODULE RELIABILITY SCORECARD

www.solarworld-usa.com

Sunmodule® Plus
SWA 290 - 300 MONO

SOLARWORLD
REAL VALUE

PERFORMANCE UNDER STANDARD TEST CONDITIONS (STC)*

		SWA 290	SWA 295	SWA 300
Maximum power	P_{max}	290 Wp	295 Wp	300 Wp
Open circuit voltage	V_{oc}	39.6 V	39.8 V	40.0 V
Maximum power point voltage	V_{mpp}	31.9 V	32.3 V	32.6 V
Short circuit current	I_{sc}	9.75 A	9.78 A	9.83 A
Maximum power point current	I_{mpp}	9.20 A	9.25 A	9.31 A
Module efficiency	η_m	17.3 %	17.59 %	17.89 %

Measuring tolerance (P_{max}) traceable to TUV Rheinland: +/- 2%

*STC: 1000W/m², 25°C, AM 1.5

PERFORMANCE AT 800 W/m², NOCT, AM 1.5

		SWA 290	SWA 295	SWA 300
Maximum power	P_{max}	219.6 Wp	223.6 Wp	226.7 Wp
Open circuit voltage	V_{oc}	36.7 V	36.9 V	37.0 V
Maximum power point voltage	V_{mpp}	29.5 V	29.9 V	30.2 V
Short circuit current	I_{sc}	7.99 A	8.01 A	8.06 A
Maximum power point current	I_{mpp}	7.43 A	7.47 A	7.52 A

Minor reduction in efficiency under partial load conditions at 25 °C: at 200 W/m², 97% (+/-3%) of the STC efficiency (1000 W/m²) is achieved.

PARAMETERS FOR OPTIMAL SYSTEM INTEGRATION

Power sorting	-0 Wp / +5 Wp
Maximum system voltage SC II / NEC	1000 V
Maximum reverse current	25 A
Number of bypass diodes	3
Operating temperature	-40 to +85 °C
*Maximum design loads (Two rail system)**	113 psf downward, 64 psf upward
*Maximum design loads (Three rail system)**	178 psf downward, 64 psf upward

*Please refer to the Sunmodule installation instructions for the details associated with these load cases.

COMPONENT MATERIALS

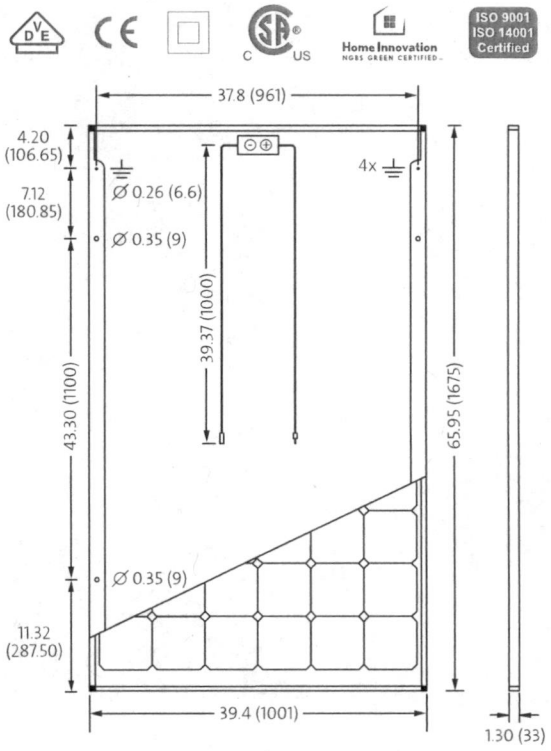
Cells per module	60
Cell type	Monocrystalline PERC
Cell dimensions	6 in x 6 in (156 mm x 156 mm)
Front	Tempered safety glass with ARC (EN 12150)
Back	Multi-layer polymer backsheet, white
Frame	Black anodized aluminum
J-Box	IP65
Connector	PV wire (UL4703) with Amphenol UTX connectors
Module fire performance	(UL 1703) Type 1

DIMENSIONS / WEIGHT

Length	65.95 in (1675 mm)
Width	39.40 in (1001 mm)
Height	1.30 in (33 mm)
Weight	39.7 lb (18.0 kg)

THERMAL CHARACTERISTICS

NOCT	46 °C
TC I_{sc}	0.07 % /C
TC V_{oc}	-0.29 % /C
TC P_{mpp}	-0.39 % /C



All units provided are imperial. SI units provided in parentheses.

ORDERING INFORMATION

Order number	*Description*
82000482	Sunmodule Plus SWA 290 mono (black frame)
82000430	Sunmodule Plus SWA 295 mono (black frame)
82000432	Sunmodule Plus SWA 300 mono (black frame)

CERTIFICATES AND WARRANTIES

Certificates	IEC 61730	IEC 61215	UL 1703
	IEC 62716	IEC 60068-2-68	IEC 61701
*Warranties**	Product Warranty		20 years
	Linear Performance Guarantee		25 years

Supplemental warranty coverage available through SolarWorld Assurance™ Warranty Protection Program – www.solarworld-usa.com/assurance

SolarWorld Americas Inc. reserves the right to make specification changes without notice. This data sheet complies with the requirements of EN 50380.

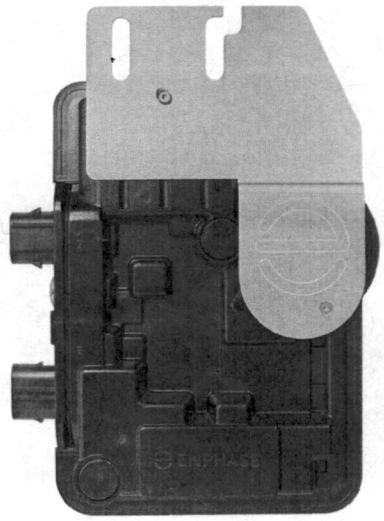
SW-01-7506US 20180126

Enphase IQ 6 and IQ 6+ Microinverters

The high-powered smart grid-ready **Enphase IQ 6 Micro™** and **Enphase IQ 6+ Micro™** dramatically simplify the installation process while achieving the highest efficiency for module-level power electronics.

Part of the Enphase IQ System, the IQ 6 and IQ 6+ Micro integrate seamlessly with the Enphase IQ Envoy™, Enphase Q Aggregator™, Enphase IQ Battery™, and the Enphase Enlighten™ monitoring and analysis software.

The IQ 6 and IQ 6+ Micro extend the reliability standards set forth by previous generations and undergo over a million hours of power-on testing, enabling Enphase to provide an industry-leading warranty of up to 25 years.



Easy to Install

- Lightweight and simple
- Faster installation with improved two-wire cabling
- Built-in rapid shutdown compliant (NEC 2014 & 2017)

Productive and Reliable

- Optimized for high powered 60-cell and 72-cell* modules
- More than a million hours of testing
- Class II double-insulated enclosure
- UL listed

Smart Grid Ready

- Complies with fixed power factor, voltage and frequency ride-through requirements
- Remotely updates to respond to changing grid requirements
- Configurable for varying grid profiles
- Meets CA Rule 21 (UL 1741-SA)

* The IQ 6+ Micro is required to support 72-cell modules

UL CERTIFIED SAFETY US-CA E341165

To learn more about Enphase offerings, visit **enphase.com**

ENPHASE

Enphase IQ 6 and IQ 6+ Microinverters

INPUT DATA (DC)	IQ6-60-2-US		IQ6PLUS-72-2-US	
Commonly used module pairings[1]	195 W - 330 W +		235 W - 400 W +	
Module compatibility	60-cell PV modules only		60-cell and 72-cell PV modules	
Maximum input DC voltage	48 V		62 V	
Peak power tracking voltage	27 V - 37 V		27 V - 45 V	
Operating range	16 V - 48 V		16 V - 62 V	
Min/Max start voltage	22 V / 48 V		22 V / 62 V	
Max DC short circuit current (module Isc)	15 A		15 A	
Overvoltage class DC port	II		II	
DC port backfeed under single fault	0 A		0 A	
PV array configuration	1 x 1 ungrounded array; No additional DC side protection required; AC side protection requires max 20A per branch circuit			
OUTPUT DATA (AC)	**IQ 6 Microinverter**		**IQ 6+ Microinverter**	
Peak output power	240 VA		290 VA	
Maximum continuous output power	230 VA		280 VA	
Nominal (L-L) voltage/range[2]	240 V / 211-264 V	208 V / 183-229 V	240 V / 211-264 V	208 V / 183-229 V
Maximum continuous output current	0.96 A	1.11 A	1.17 A	1.35 A
Nominal frequency	60 Hz		60 Hz	
Extended frequency range	47 - 68 Hz		47 - 68 Hz	
Power factor at rated power	1.0		1.0	
Maximum units per 20 A (L-L) branch circuit	16 (240 VAC)		13 (240 VAC)	
	14 (208 VAC)		11 (208 VAC)	
Overvoltage class AC port	III		III	
AC port backfeed under single fault	0 A		0 A	
Power factor (adjustable)	0.7 leading ... 0.7 lagging		0.7 leading ... 0.7 lagging	
EFFICIENCY	**@240 V**	**@208 V**	**@240 V**	**@208 V**
CEC weighted efficiency	97.0 %	97.0 %	97.0 %	97.0 %
MECHANICAL DATA				
Ambient temperature range	-40°C to +65°C			
Relative humidity range	4% to 100% (condensing)			
Connector type	MC4 locking type			
Dimensions (WxHxD)	219 mm x 191 mm x 37.9 mm (without bracket)			
Weight	1.29 kg (2.84 lbs)			
Cooling	Natural convection - No fans			
Approved for wet locations	Yes			
Pollution degree	PD3			
Enclosure	Class II double-insulated			
Environmental category / UV exposure rating	NEMA Type 6 / outdoor			
FEATURES				
Communication	Power line			
Monitoring	Enlighten Manager and MyEnlighten monitoring options Compatible with Enphase IQ Envoy			
Disconnecting means	The AC and DC connectors have been evaluated and approved by UL for use as the load-break disconnect required by NEC 690.			
Compliance	CA Rule 21 (UL 1741-SA) UL 62109-1, UL1741/IEEE1547, FCC Part 15 Class B, ICES-0003 Class B, CAN/CSA-C22.2 NO. 107.1-01 This product is UL Listed as PV Rapid Shut Down Equipment and conforms with NEC-2014 and NEC-2017 section 690.12 and C22.1-2015 Rule 64-218 Rapid Shutdown of PV Systems, for AC and DC conductors, when installed according manufacturer's instructions.			

1. No enforced DC/AC ratio. See the compatibility calculator at https://enphase.com/en-us/support/module-compatibility.
2. Nominal voltage range can be extended beyond nominal if required by the utility.

To learn more about Enphase offerings, visit **enphase.com**

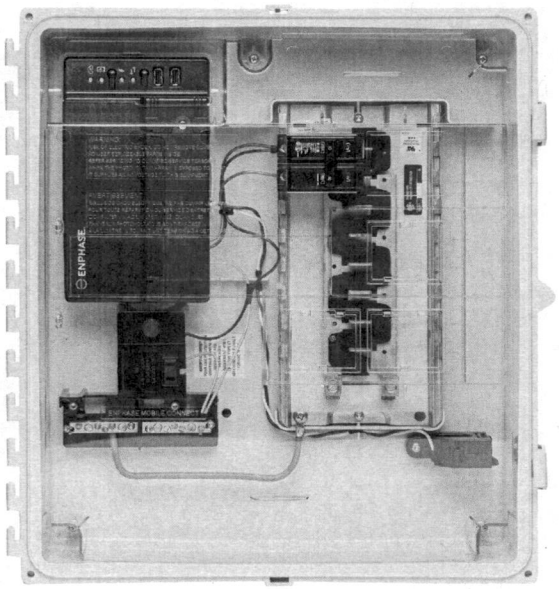
2018-01-25

ENPHASE.

Enphase IQ Combiner+

(X-IQ-AM1-240-2)

The **Enphase IQ Combiner+**™ with Enphase IQ Envoy™ consolidates interconnection equipment into a single enclosure and streamlines PV and storage installations by providing a consistent, pre-wired solution for residential applications. It offers up to four 2-pole input circuits and Eaton BR series busbar assembly.



Smart

- Includes IQ Envoy for communication and control
- Flexible networking supports Wi-Fi, Ethernet, or cellular
- Provides production metering and optional consumption monitoring
- Supports installation of the Enphase Q Aggregator™

Simple

- Eaton BR series panelboard interior
- Up to four 2-pole branch circuits for 240 VAC plug-in breakers (not included)
- 80 A total PV or storage branch circuits

Reliable

- Durable NRTL-certified NEMA type 3R enclosure
- Five-year warranty
- UL listed

UL LISTED

To learn more about Enphase offerings, visit **enphase.com**

ENPHASE

Enphase IQ Combiner+

MODEL NUMBER	
IQ Combiner+ X-IQ-AM1-240-2	IQ Combiner+ with Enphase IQ Envoy™ for integrated revenue grade PV production metering (ANSI C12.20 +/- 0.5%) and optional* consumption monitoring (+/- 2.5%).
ACCESSORIES (order separately)	
Enphase Mobile Connect™ CELLMODEM-03 (4G / 12-year data plan) CELLMODEM-01 (3G / 5-year data plan) CELLMODEM-M1 (4G LTE CAT-M1 / 5-year data plan)	Plug and play industrial grade cellular modem with data plan for systems up to 60 microinverters. (Available in the US, Canada, Mexico, Puerto Rico, and the US Virgin Islands, where there is adequate cellular service in the installation area.)
Consumption Monitoring CT CT-200-SPLIT	Split core current transformers enable whole home consumption metering* (+/- 2.5%).
Circuit Breakers BRK-15A-2-240 BRK-20A-2-240	 Breaker, 2 pole, 15A, Eaton BR215 Breaker, 2 pole, 20A, Eaton BR220
ELECTRICAL SPECIFICATIONS	
Rating	Continuous duty
System voltage	240 VAC, 60 HZ
Eaton BR series busbar rating	125 A
Max. continuous current rating (output to grid)	65 A
Max. fuse/circuit rating (output)	90 A
Branch circuits (solar and/or storage)	Up to four 2-pole Eaton BR series Distributed Generation (DG) breakers only (not included)
Max. continuous current rating (input from PV)	64 A
Max. total branch circuit breaker rating (input)	80 A (any combination)
Production Metering CT	200 A solid core pre-installed and wired to IQ Envoy
MECHANICAL DATA	
Dimensions (WxHxD)	49.3 x 46.5 x 16.0 cm (19.4" x 18.3" x 6.3")
Weight	7.5 kg (16.5 lbs)
Ambient temperature range	-40° C to +46° C (-40° to 115° F)
Cooling	Natural convection, plus heat shield
Enclosure environmental rating	Outdoor, NRTL-certified, NEMA type 3R, polycarbonate construction
Wire sizes	• 20 A to 50 A breaker inputs: 14 to 4 AWG copper conductors • 60 A breaker branch input: 3 to 1/0 AWG copper conductors • Main lug combined output: 10 to 2/0 AWG copper conductors • Neutral and ground: 14 to 1/0 copper conductors Always follow local code requirements for conductor sizing.
Altitude	To 2000 meters (6,560 feet)
INTERNET CONNECTION OPTIONS	
Integrated Wi-Fi	802.11b/g/n
Ethernet	802.3, Cat5E (or Cat 6) UTP Ethernet cable - not included
Cellular	Optional, CELLMODEM-01 (3G) or CELLMODEM-03 (4G) (not included)
COMPLIANCE	
Compliance, Combiner	UL 1741 CAN/CSA C22.2 No. 107.1 47 CFR, Part 15, Class B, ICES 003 Production metering: ANSI C12.20 accuracy class 0.5 (PV production)
Compliance, IQ Envoy	UL 916 CAN/CSA C22.2 No. 61010-1

* Consumption monitoring is required for Enphase Storage Systems.

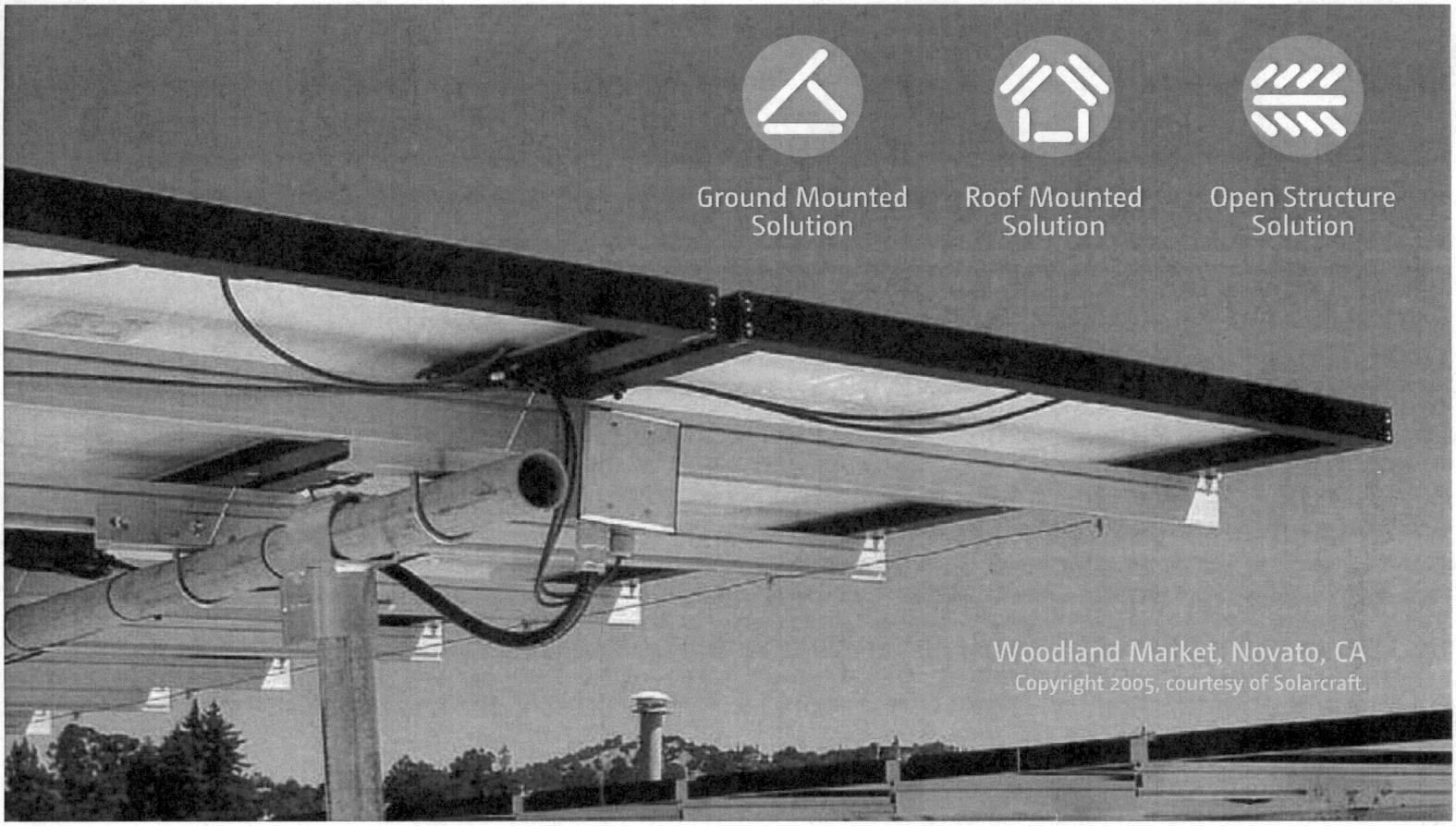
To learn more about Enphase offerings, visit **enphase.com**

2018-05-02

ENPHASE.

Unirac Large Array (U-LA)

Megawatts of experience



Unirac Large Arrays start at 3 kilowatts, but their size is limited only by the size of your ground site or the structural strength of your flat roof.

We design U-LAs to support a wider range of site and climactic challenges than any other PV structure on the market. U-LA aluminum or steel components merge with SolarMount rails and installer-supplied steel pipe to form durable, rigid truss structures.

It's a cost-effective mounting solution that has grown with the vision of the PV industry. Today, U-LA customers routinely reap hundreds of kilowatts to megawatts per installation.

UNIRAC®
Bright Thinking in Solar

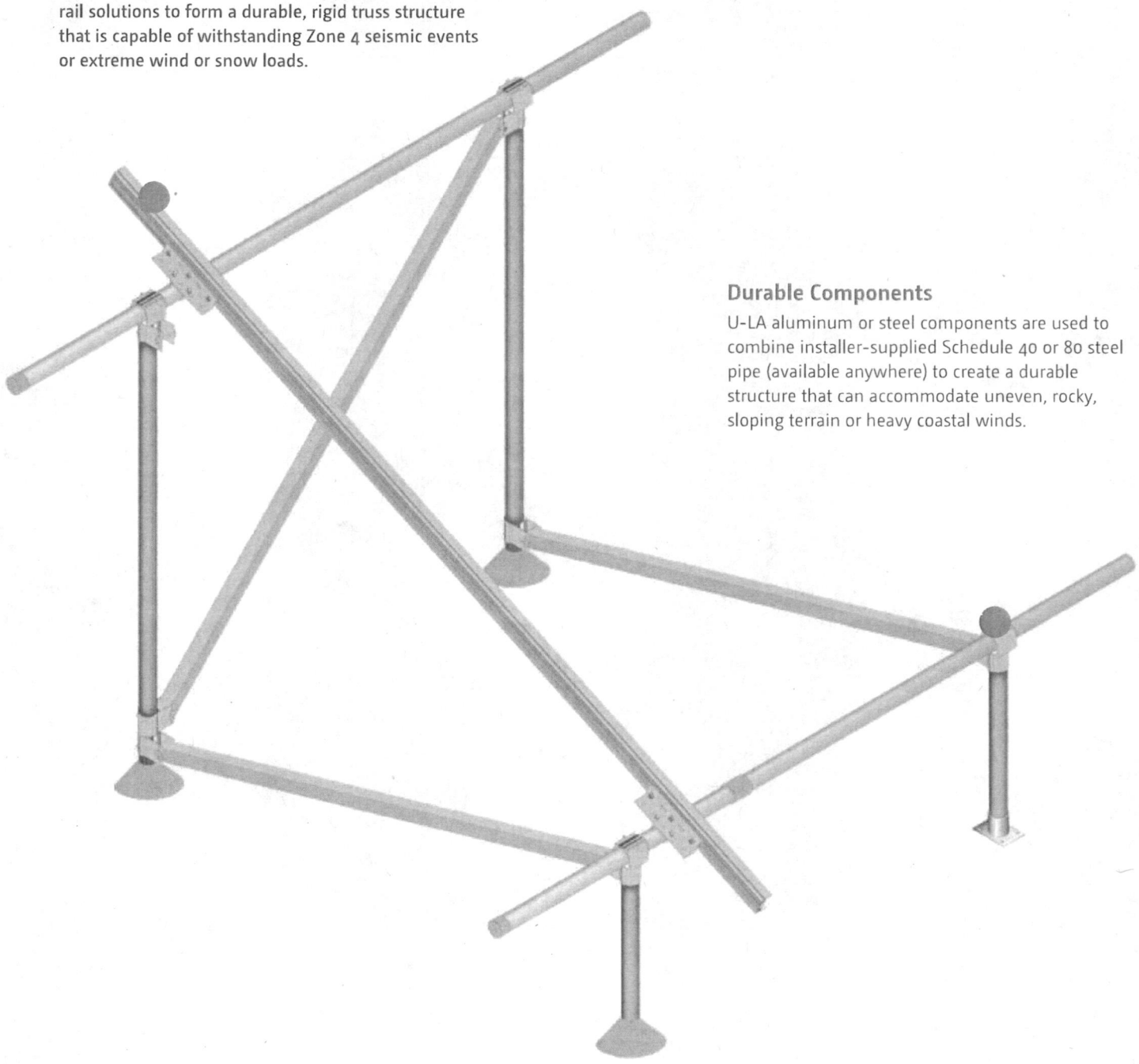
Visit us online at www.unirac.com

UNIRAC LARGE ARRAY (U-LA)

Megawatts of Power

Strength with SolarMount Rail

Unirac Large Arrays use installer-friendly SolarMount rail solutions to form a durable, rigid truss structure that is capable of withstanding Zone 4 seismic events or extreme wind or snow loads.

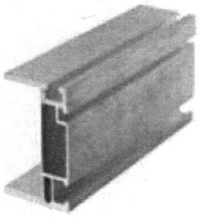


Durable Components

U-LA aluminum or steel components are used to combine installer-supplied Schedule 40 or 80 steel pipe (available anywhere) to create a durable structure that can accommodate uneven, rocky, sloping terrain or heavy coastal winds.

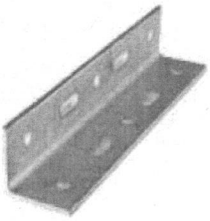
U-LA COMPONENTS

Designed to meet your needs



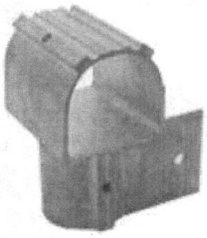
SolarMount Standard or HD Rails

Modules are supported on top of rails giving ultimate flexibility to use top or bottom mounting hardware. SolarMount HD provides strength to accommodate larger spans than SolarMount Standard.



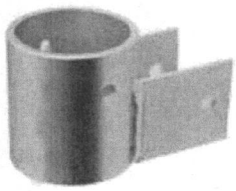
Rail Mounting Brackets

Secure SolarMount Rails to installer-supplied Schedule 40 or 80 steel pipe.



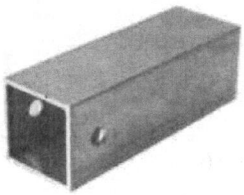
Front and Rear Leg Cap

Attaches front and rear horizontal pipe to vertical pipes and anchors upper end of north-south braces. Includes 3/8-inch hardware: 2 U-bolts and cross-brace bolt sized for pipe, 5 flange nuts, and 2 or 4 set screws. Available in steel and aluminum options.



Sliders

Attaches lower end of north-south cross braces to rear legs. Anchors both ends of east-west braces (if needed). Includes 3/8-inch hardware: 1 cross-brace bolt sized for pipe, 1 flange nut, and 2 or 4 set screws.



Cross Pipe

Provides north-south and east-west diagonal bracing. Extrusion size matches other 2- or 3-inch components.

Visit us online at www.unirac.com

KEY BENEFITS

of a Unirac Large Array

Versatility

- **Custom-designed arrays for ground or flat roof applications**
- **Design software to ensure minimum attachments without overstressing any roof member**
- **Optimal tilt angle and array clearance over other rooftop equipment**
- **Accommodates uneven, rocky, sloping terrain or heavy costal winds**

Value

- **Better alternative than designing from scratch**
- **Lightweight components ship economically and combine easily with installer-supplied Schedule 40 or 80 steel pipe, available everywhere**

Ease of Installation

- **Uses SolarMount standard and HD (heavy duty) rails**
- **Ready with design documentation and testing reports**

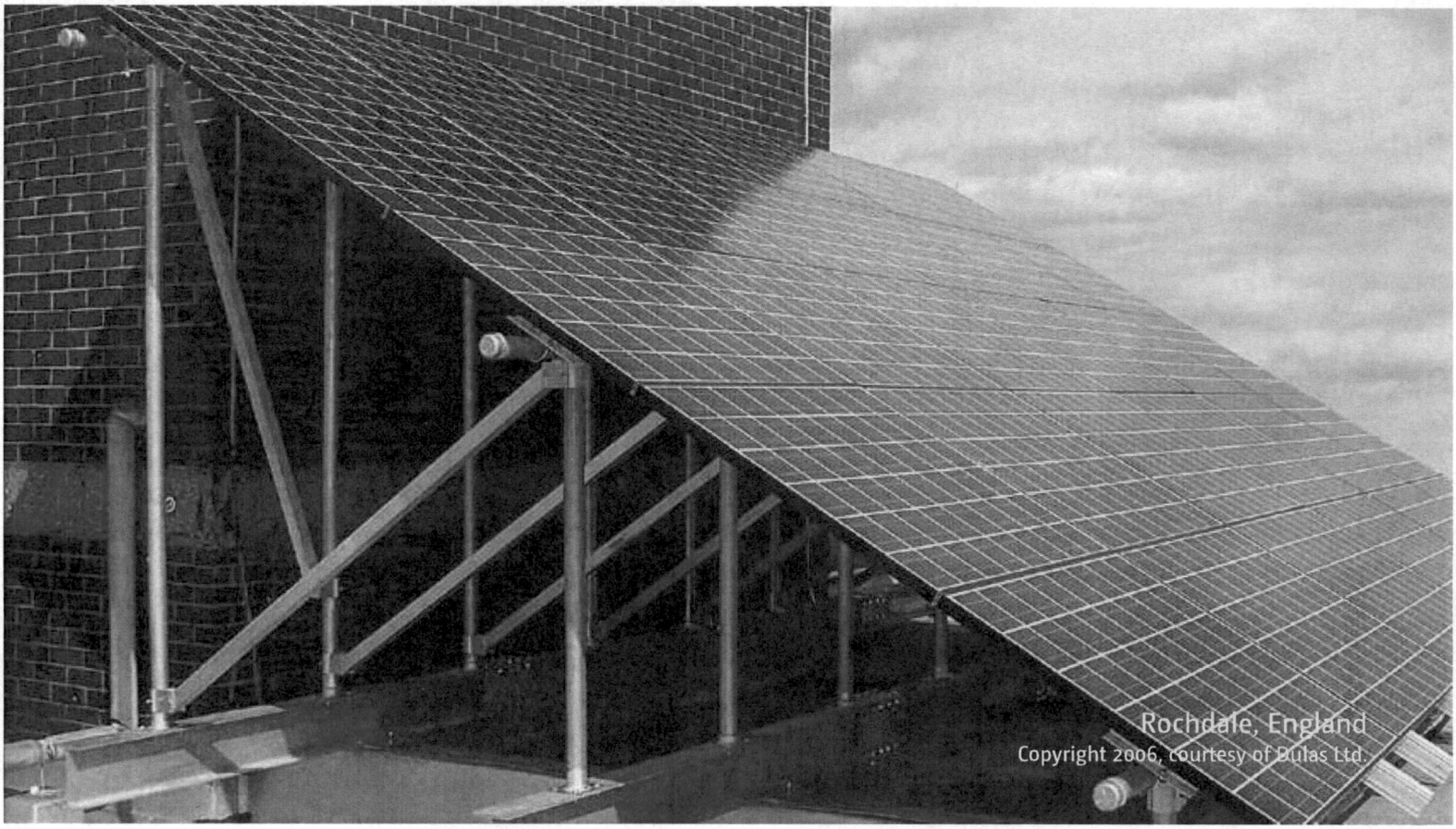
Strength

- **Capable of withstanding Zone 4 seismic events or extreme wind or snow loads**
- **Diagonally braced**

UNIRAC®

Bright Thinking in Solar

Bright Thinking in Solar



Component Specifications

6105-T5 aluminum extrusion

- SolarMount® HD or standard rails
- Brackets and cross braces
- Pipe caps and truss sliders (aluminum option)
- Mounting clips and clamps

Severe Condition 4 (very severe) zinc-plated welded steel

- Pipe caps and truss sliders (steel option)

18-8 stainless steel

- Fasteners

ASTM A53 Schedule 40 galvanized steel

- Installer-supplied legs and cross pipes (2-, 2½-, and 3-inch options)

Warranty

U-LA is covered by a 10-year limited product warranty and a 5-year limited finish warranty.

For complete warranties, download any U-LA installation manual from our web site.

UNIRAC®
Bright Thinking in Solar

Visit us online at www.unirac.com