

**GENERAL NOTES**

**CODES AND STANDARDS**

1. ALL WORK SHALL COMPLY WITH 2017 NATIONAL ELECTRIC CODE (NEC), 2018 NORTH CAROLINA BUILDING CODE (NCBC), 2015 INTERNATIONAL PLUMBING CODE, AND ALL STATE AND LOCAL BUILDING, ELECTRICAL, AND PLUMBING CODES.
2. DRAWINGS HAVE BEEN DETAILED ACCORDING TO UL LISTING REQUIREMENTS.

**SITE NOTES / OSHA REGULATION**

1. A LADDER SHALL BE IN PLACE FOR INSPECTION IN COMPLIANCE WITH OSHA REGULATIONS.
2. THE PV MODULES ARE CONSIDERED NON-COMBUSTIBLE AND THIS SYSTEM IS AN UTILITY INTERACTIVE SYSTEM WITH NO STORAGE BATTERIES.
3. THE SOLAR PV INSTALLATION SHALL NOT OBSTRUCT ANY PLUMBING, MECHANICAL, OR BUILDING ROOF VENTS.
4. ROOF COVERINGS SHALL BE DESIGNED, INSTALLED, AND MAINTAINED IN ACCORDANCE WITH THIS CODE AND THE APPROVED MANUFACTURER'S INSTRUCTIONS SUCH THAT THE ROOF COVERING SHALL SERVE TO PROTECT THE BUILDING OR STRUCTURE.

**SOLAR CONTRACTOR**

1. MODULE CERTIFICATIONS WILL INCLUDE UL1703, IEC61646, IEC61730.
2. IF APPLICABLE, MODULE GROUNDING LUGS MUST BE INSTALLED AT THE MARKED GROUNDING LUG HOLES PER THE MANUFACTURERS' INSTALLATION REQUIREMENTS.
3. AS INDICATED BY DESIGN, OTHER NRTL LISTED MODULE GROUNDING DEVICES MAY BE USED IN PLACE OF STANDARD GROUNDING LUGS AS SHOWN IN MANUFACTURER DOCUMENTATION AND APPROVED BY THE AHJ.
4. CONDUIT AND WIRE SPECIFICATIONS ARE BASED ON MINIMUM CODE REQUIREMENTS AND ARE NOT MEANT TO LIMIT UP-SIZING AS REQUIRED BY FIELD CONDITIONS.
5. CONDUIT POINT OF PENETRATION FROM EXTERIOR TO INTERIOR TO BE INSTALLED AND SEALED WITH A SUITABLE SEALING COMPOUND.
6. DC WIRING LIMITED TO MODULE FOOTPRINT W/ ENPHASE AC SYSTEM.
7. ENPHASE WIRING SYSTEMS SHALL BE LOCATED AND SECURED UNDER THE ARRAY W/ SUITABLE WIRING CLIPS.
8. MAX DC VOLTAGE CALCULATED USING MANUFACTURER PROVIDED TEMP COEFFICIENT FOR VOC UNLESS NOT AVAILABLE.
9. ALL INVERTERS, MOTOR GENERATORS, PHOTOVOLTAIC MODULES, PHOTOVOLTAIC PANELS, AC PHOTOVOLTAIC MODULES, DC COMBINERS, DC-TO-DC CONVERTERS, SOURCE CIRCUIT COMBINERS, AND CHARGE CONTROLLERS INTENDED FOR USE IN A PHOTOVOLTAIC POWER SYSTEM WILL BE IDENTIFIED AND LISTED FOR THE APPLICATION PER 690.4 (B).
10. ALL SIGNAGE TO BE PLACED IN ACCORDANCE WITH LOCAL BUILDING CODE.
11. TERMINALS AND LUGS WILL BE TIGHTENED TO MANUFACTURER TORQUE SPECIFICATIONS (WHEN PROVIDED) IN ACCORDANCE WITH NEC CODE 110.14(D) ON ALL ELECTRICAL CONNECTIONS.

**EQUIPMENT LOCATIONS**

1. PROPER ACCESS AND WORKING CLEARANCE AROUND EXISTING AND PROPOSED ELECTRICAL EQUIPMENT WILL BE PROVIDED AS PER SECTION [NEC 110.26].
2. EQUIPMENT INSTALLED IN DIRECT SUNLIGHT MUST BE RATED FOR EXPECTED OPERATING TEMPERATURE AS SPECIFIED BY [NEC 690.31 (A)-(B)] AND [NEC TABLE 310.15 (B)].
3. ADDITIONAL AC DISCONNECTS SHALL BE PROVIDED WHERE THE INVERTER IS NOT ADJACENT TO THE UTILITY AC DISCONNECT, OR NOT WITHIN SIGHT OF THE UTILITY AC DISCONNECT.
4. ALL EQUIPMENT SHALL BE INSTALLED ACCESSIBLE TO QUALIFIED PERSONNEL ACCORDING TO NEC APPLICABLE CODES.
5. ALL COMPONENTS ARE LISTED FOR THEIR PURPOSE AND RATED FOR OUTDOOR USAGE WHEN APPROPRIATE.

**AERIAL VIEW**



**DESIGN CRITERIA**

WIND SPEED: 115 MPH  
 GROUND SNOW LOAD: 15 PSF  
 WIND EXPOSURE FACTOR: C  
 SEISMIC DESIGN CATEGORY: B

**SITE SPECIFICATIONS**

OCCUPANCY - R3  
 CONSTRUCTION - V-B  
 ZONING: RESIDENTIAL

**SHEET INDEX**

- PV1 - COVER SHEET
- PV2 - PROPERTY PLAN
- PV3 - SITE PLAN
- PV4 - EQUIPMENT & ATTACHMENT DETAIL
- PV5 - ELECTRICAL SINGLE LINE DIAGRAM
- PV6 - ELECTRICAL CALCULATIONS & ELECTRICAL NOTES
- PV7 - MAIN BREAKER DERATE CALCS. (IF NEEDED)
- PV8 - LABELS & LOCATIONS
- PV9 - CUSTOM DIRECTORY PLACARD (IF NEEDED - NEC 690.56(B))

**SCOPE OF WORK**

INSTALLATION OF UTILITY INTERACTIVE PHOTOVOLTAIC SOLAR SYSTEM

12.48 kW DC PHOTOVOLTAIC SOLAR ARRAY  
 ROOF TYPE: Comp Shingle  
 MODULES: (39) Trina 320  
 INVERTER(S): Enphase IQ7 Microinverters,----  
 RACKING: Unirac SFM Infinity



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CONTRACTOR:  
 BRS FIELD OPS  
 385.498.6700

SITE INFORMATION:

Mark Champion  
 11454 Highway 210 North  
 Angier, North Carolina 27501  
 DC SYSTEM SIZE: 12.48 kW DC

DRAWING BY  
 Cameron Lawson

DATE  
 March 12, 2020

PROJECT NUMBER  
 75089684

SHEET NAME  
**COVER SHEET**

PAGE NUMBER  
**PV1**

REVISION  
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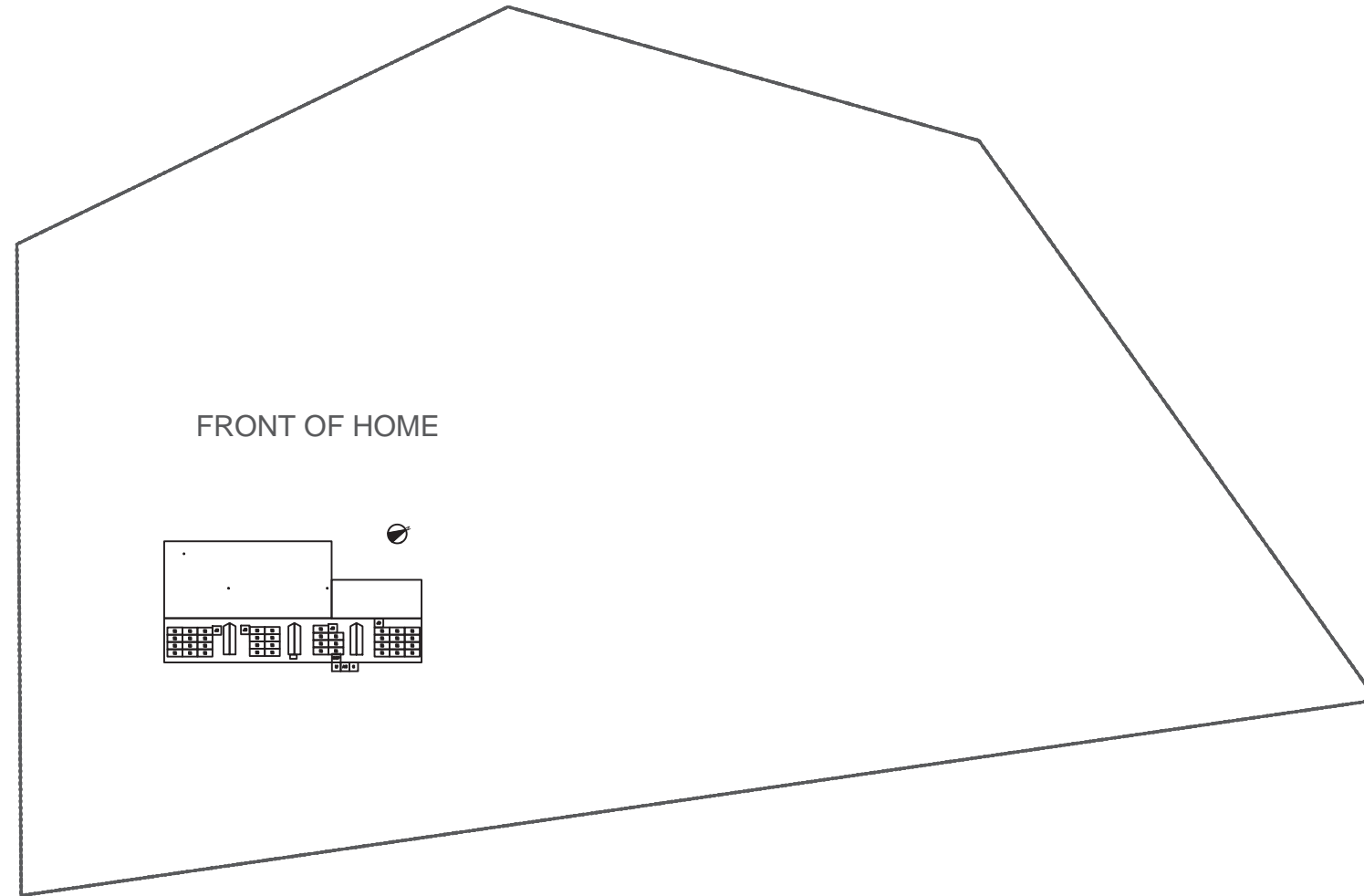
**NOTICE TO CONTRACTOR**  
 All construction must comply with current NC Building Codes and is subject to field inspection and verification.

**APPROVED**  
 Limited building only review  
 Permit holder responsible for full compliance with the code





06/01/2020




11454 Highway 210 North



**LEGEND**

- INV INVERTER & DC DISCONNECT
- SUB (E) SUBPANEL
- LC (N) LOAD CENTER
- AC AC DISCONNECT
- M UTILITY METER
- MSP MAIN SERVICE PANEL
- JB JUNCTION BOX
- TS TRANSFER SWITCH
- C COMBINER BOX/AGGREGATOR
- PV PV REVENUE METER
-  FIRE SETBACK
-  EMT CONDUIT RUN (TO BE DETERMINED IN FIELD)
-  PV WIRE STRING
-  PROPERTY LINE



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DRAWING BY  
Cameron Lawson

DATE  
March 12, 2020

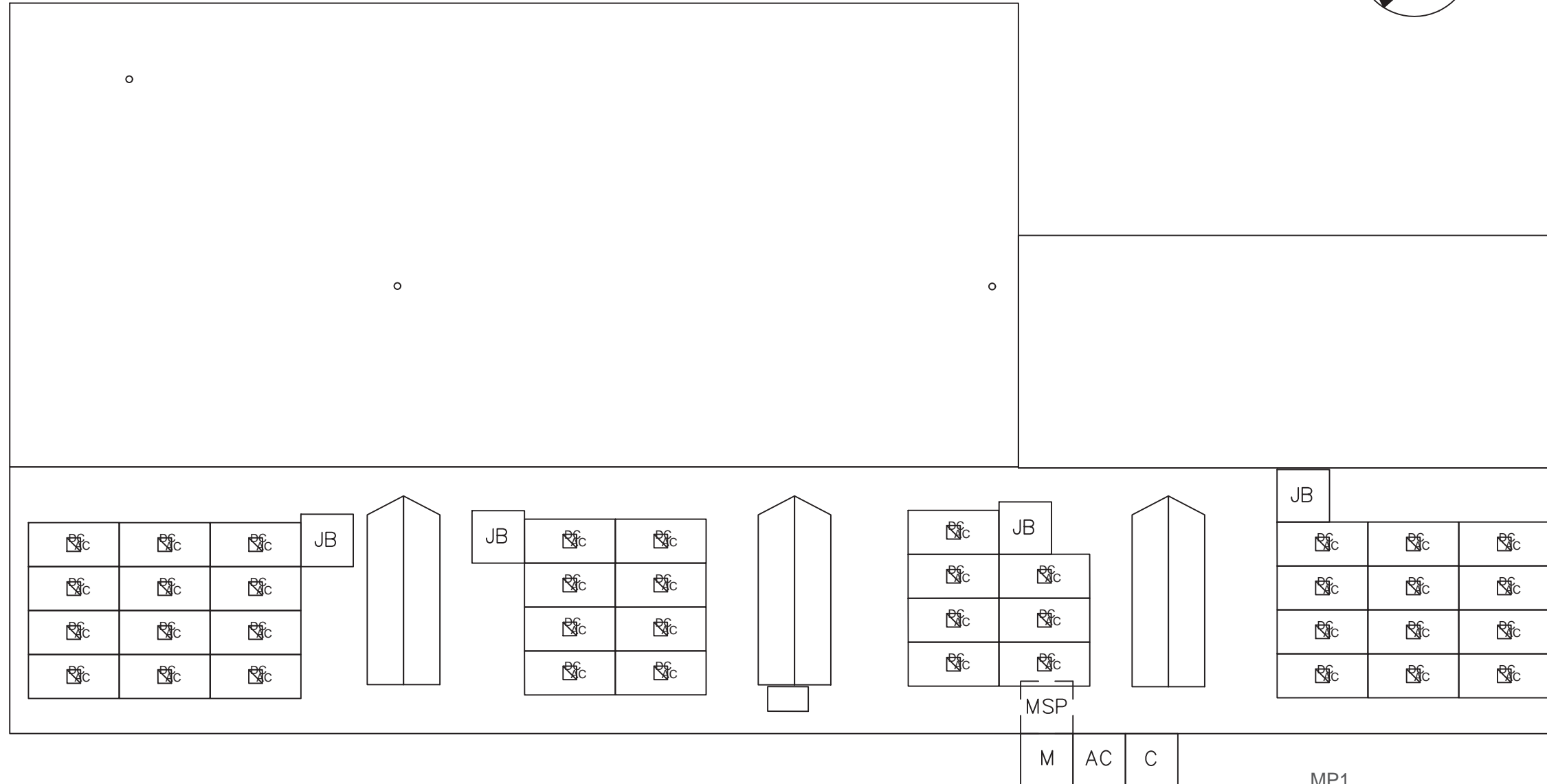
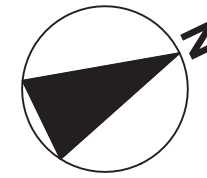
PROJECT NUMBER  
75089684

SHEET NAME  
**PROPERTY PLAN**

PAGE NUMBER  
**PV2**

REVISION  
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FRONT OF HOME



MP1  
 # OF MODULES: 39  
 AZIMUTH:116°  
 PITCH:35°  
 TSRF:85%  
 AREA: 1517 SQ. FT

**LEGEND**

- INV INVERTER & DC DISCONNECT
- SUB (E) SUBPANEL
- LC (N) LOAD CENTER
- AC AC DISCONNECT
- M UTILITY METER
- MSP MAIN SERVICE PANEL
- JB JUNCTION BOX
- TS TRANSFER SWITCH
- C COMBINER BOX/AGGREGATOR
- PV PV REVENUE METER
- FIRE SETBACK
- EMT CONDUIT RUN (TO BE DETERMINED IN FIELD)
- PV WIRE STRING
- PROPERTY LINE



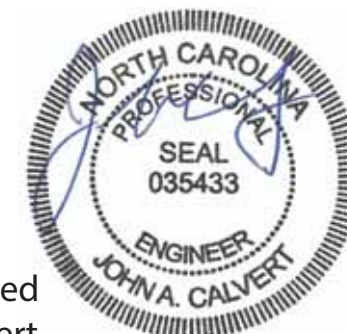
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 by John Calvert  
 Date: 2020.04.07  
 11:48:13 -06'00'

4/7/2020  
 Firm No. : D-0369

**SITE INFORMATION:**

Mark Champion  
 11454 Highway 210 North  
 Angier, North Carolina 27501  
 DC SYSTEM SIZE: 12.48 kW DC

DRAWING BY  
 Cameron Lawson

DATE  
 March 12, 2020

PROJECT NUMBER  
 75089684

SHEET NAME  
**SITE PLAN**

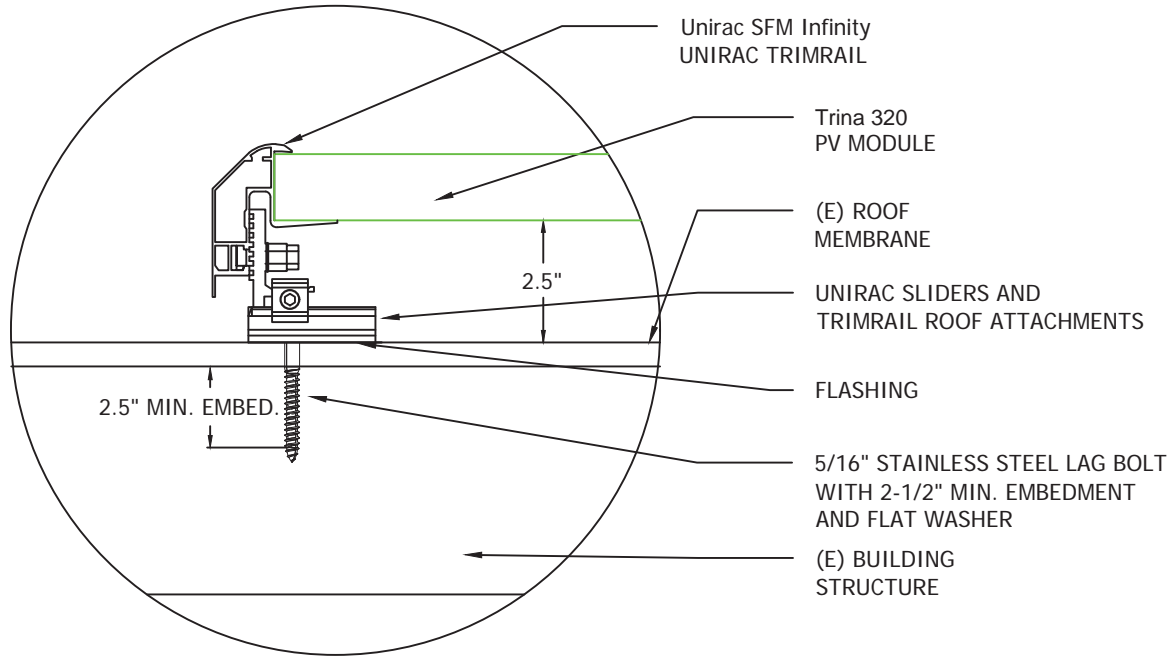
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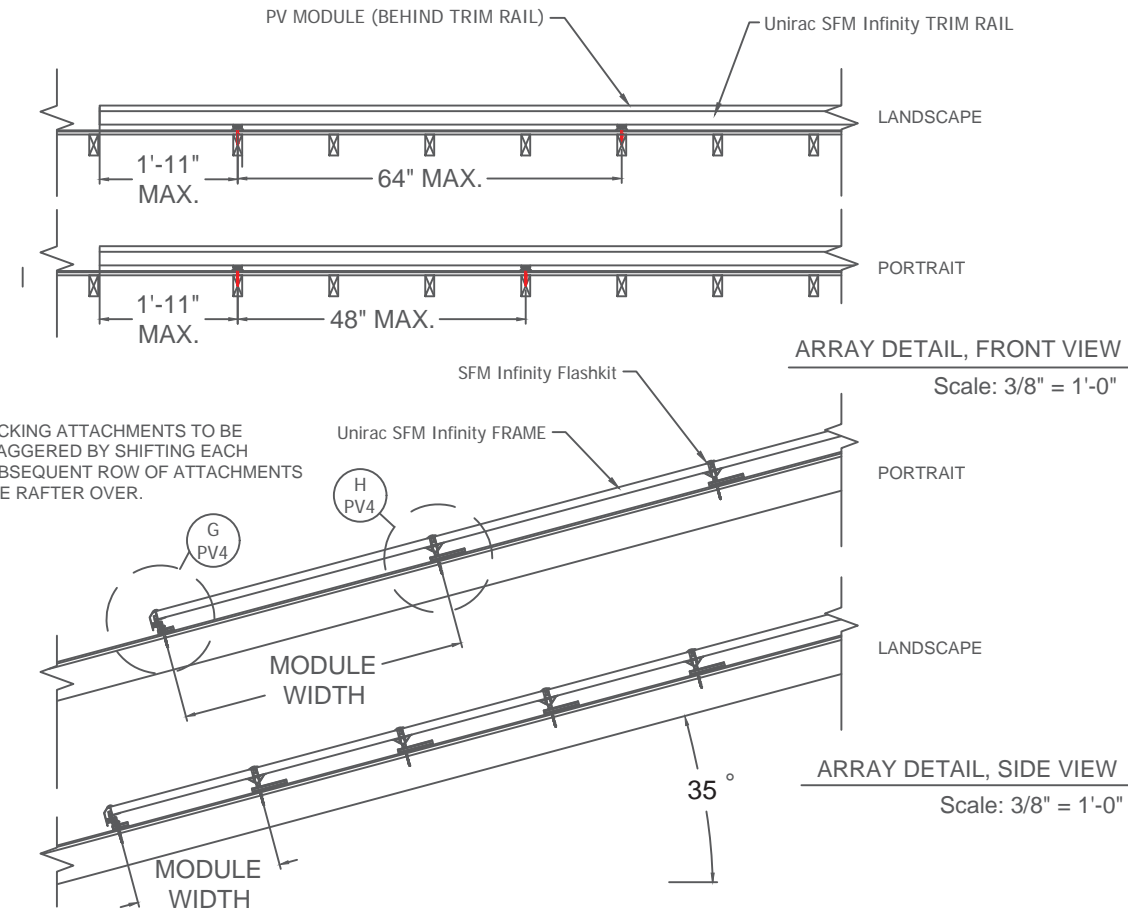
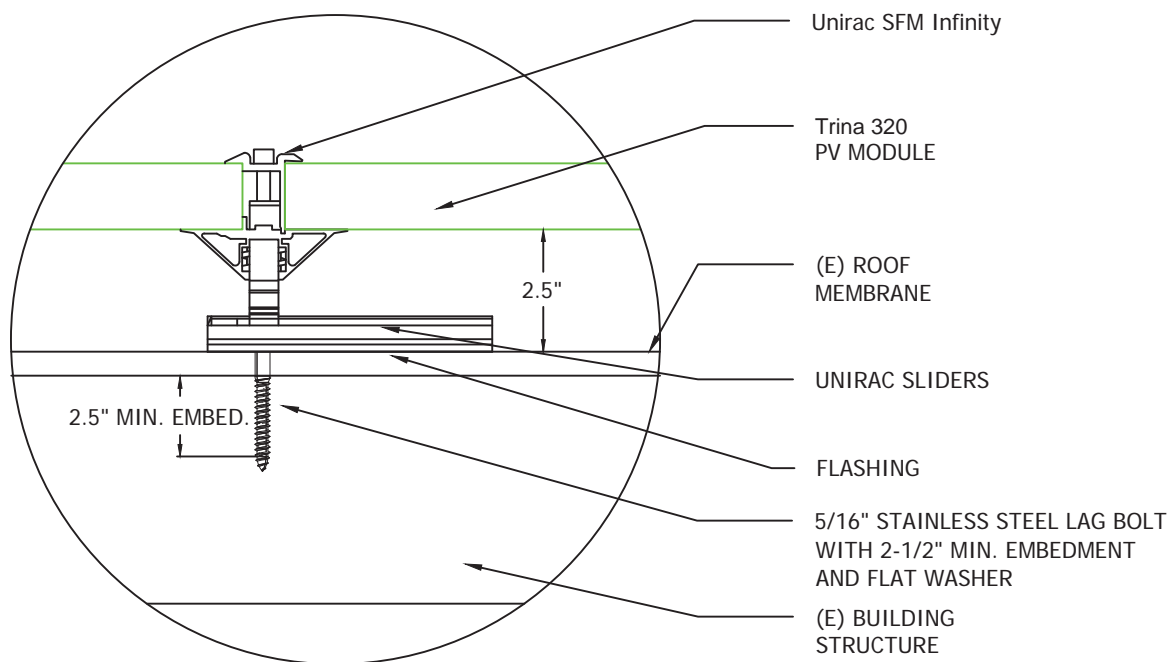
# PV ARRAY INFORMATION

PV MODULE COUNT: 39 MODULES  
 # OF ATTACHMENT POINTS: 79  
 ARRAY AREA: Module Count x 17.51ft<sup>2</sup> = 682.9ft<sup>2</sup>  
 ROOF AREA: 3702.0ft<sup>2</sup>  
 % OF ARRAY/ROOF: 18.4%  
 ARRAY WEIGHT: Module Count x 50lbs = 1950.0lbs  
 DISTRIBUTED LOAD: Array Weight ÷ Array Area = 2.86 lbs/ft<sup>2</sup>  
 POINT LOAD: Array Weight ÷ Attachments = 24.7lbs/attachment

G  
 DETAIL, BOTTOM STANDOFF  
 Scale: 3" = 1'-0"



H  
 DETAIL, MIDDLE/TOP STANDOFF  
 Scale: 3" = 1'-0"



ROOF TYPE: Comp Shingle  
 ROOF FRAMING TYPE: Rafter  
 RAFTER OR TOP CHORD(TRUSS) 2x8 @ 16"O.C.  
 CEILING JOIST OR BOTTOM CHORD(TRUSS) 2x8 @ 16"O.C.

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DRAWING BY Cameron Lawson	
DATE March 12, 2020	
PROJECT NUMBER 75089684	
SHEET NAME EQUIP. DETAIL	
PAGE NUMBER PV4	REVISION ----

15	(1) 6 AWG THHN/THWN-2, CU., BLACK (L1)	39.0 A AC	3	(3) 10 AWG THHN/THWN-2, CU., BLACK (L1)	MAX 13.0 A AC	2	(1) 10 - 2 UF-B (or NM) W/G, THHN/THWN-2, SC	MAX 13.0 A AC	1	(1) 12-2 TC-ER, THHN/THWN-2, CU.	MAX 13.0 A AC
	(1) 6 AWG THHN/THWN-2, CU., RED (L2)	240 V AC		(3) 10 AWG THHN/THWN-2, CU., RED (L2)	240 V AC		(1) 6 AWG BARE, CU (EGC)	240 V AC			
	(1) 10 AWG THHN/THWN-2, CU., WHITE (N)			(1) 10 AWG THHN/THWN-2, CU., GREEN (EGC)							
	(1) 3/4 INCH EMT	EXTERIOR		(1) 3/4 INCH EMT	EXTERIOR			INTERIOR			EXTERIOR
16	(1) 6 AWG THHN/THWN-2, CU., BLACK (L1)	39.0 A AC									
	(1) 6 AWG THHN/THWN-2, CU., RED (L2)	240 V AC									
	(1) 10 AWG THHN/THWN-2, CU., WHITE (N)										
	(1) 3/4 INCH EMT	EXTERIOR									



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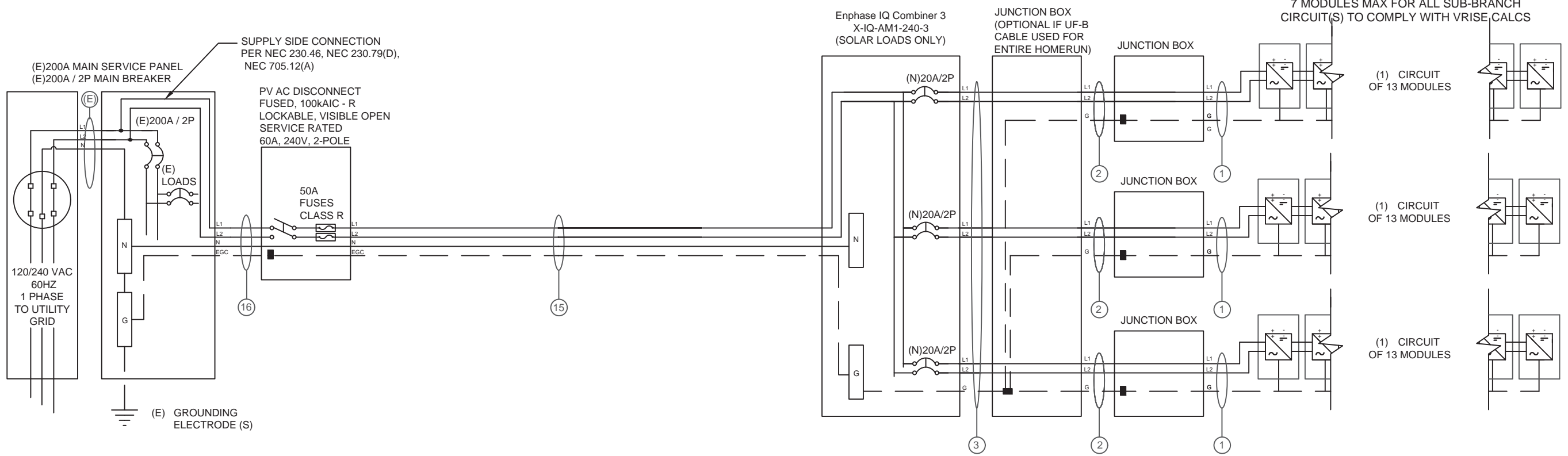
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SITE INFORMATION:  
Mark Champion  
11454 Highway 210 North  
Angier, North Carolina 27501  
DC SYSTEM SIZE: 12.48 kW DC

39 INVERTERS x 240 W AC = 9.36 kW AC  
PANEL WATTAGE = 320 W DC



**INTERCONNECTION NOTES**

- SUPPLY SIDE INTERCONNECTION ACCORDING TO [NEC705.12(A)] WITH SERVICE ENTRANCE CONDUCTORS IN ACCORDANCE WITH [NEC 240.21(B)]

**DISCONNECT NOTES**

- 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)
- AC DISCONNECT MUST BE ACCESSIBLE TO QUALIFIED UTILITY PERSONNEL, BE LOCKABLE, AND BE A VISIBLE-BREAK SWITCH



DRAWING BY Cameron Lawson	
DATE March 12, 2020	
PROJECT NUMBER 75089684	
SHEET NAME ELEC. 3 LINE DIAG.	
PAGE NUMBER PV5	REVISION ----



MODULE SPECIFICATIONS		Trinasolar 320 TSM-DD06M.05(II)
RATED POWER (STC)		320 W
MODULE VOC		40.3 V DC
MODULE VMP		33.4 V DC
MODULE IMP		9.58 A DC
MODULE ISC		10.2 A DC
VOC CORRECTION		-0.26 %/°C
VMP CORRECTION		-0.36 %/°C
SERIES FUSE RATING		20 A DC
ADJ. MODULE VOC @ ASHRAE LOW TEMP.		44.0 V DC
ADJ. MODULE VMP @ ASHRAE 2% AVG. HIGH TEMP		28.3 V DC

MICROINVERTER SPECIFICATIONS		Enphase IQ7 Microinverters
POWER POINT TRACKING (MPPT) MIN/MAX	22 - 48	V DC
MAXIMUM INPUT VOLTAGE	48	V DC
MAXIMUM DC SHORT CIRCUIT CURRENT	15	A DC
MAXIMUM USABLE DC INPUT POWER	350	W
MAXIMUM OUTPUT CURRENT	1	A AC
AC OVERCURRENT PROTECTION	20	A
MAXIMUM OUTPUT POWER	240	W
CEC WEIGHTED EFFICIENCY	97	%

AC PHOTOVOLTAIC MODULE MARKING (NEC 690.52)	
NOMINAL OPERATING AC VOLTAGE	240 V AC
NOMINAL OPERATING AC FREQUENCY	47 - 68 HZ AC
MAXIMUM AC POWER	240 VA AC
MAXIMUM AC CURRENT	1.0 A AC
MAXIMUM OCPD RATING FOR AC MODULE	20 A AC

DESIGN LOCATION AND TEMPERATURES	
TEMPERATURE DATA SOURCE	ASHRAE 2% AVG. HIGH TEMP
STATE	North Carolina
CITY	Angier
WEATHER STATION	SEYMOUR JOHNSON AFB
ASHRAE EXTREME LOW TEMP (°C)	-10
ASHRAE 2% AVG. HIGH TEMP (°C)	35

SYSTEM ELECTRICAL SPECIFICATIONS	CIR 1	CIR 2	CIR 3	CIR 4	CIR 5	CIR 6
NUMBER OF MODULES PER MPPT	13	13	13			
DC POWER RATING PER CIRCUIT (STC)	4160	4160	4160			
TOTAL MODULE NUMBER	39 MODULES					
STC RATING OF ARRAY	12480W DC					
AC CURRENT @ MAX POWER POINT (IMP)	13.0	13.0	13.0			
MAX. CURRENT (IMP X 1.25)	16.25	16.25	16.25			
OCPD CURRENT RATING PER CIRCUIT	20	20	20			
MAX. COMB. ARRAY AC CURRENT (IMP)	39.0					
MAX. ARRAY AC POWER	9360W AC					

AC VOLTAGE RISE CALCULATIONS	DIST (FT)	COND.	/RISE(V)	VEND(V)	%VRISE	IQ7-7
VRISE SEC. 1 (MICRO TO JBOX)	25.2	12 Cu.	0.71	240.71	0.30%	
VRISE SEC. 2 (JBOX TO COMBINER BOX)	65	10 Cu.	2.15	242.15	0.89%	
VRISE SEC. 3 (COMBINER BOX TO POI)	10	6 Cu.	0.40	240.40	0.17%	
TOTAL VRISE			3.26	243.26	1.36%	

PHOTOVOLTAIC AC DISCONNECT OUTPUT LABEL (NEC 690.54)	
AC OUTPUT CURRENT	39.0 A AC
NOMINAL AC VOLTAGE	240 V AC

CONDUCTOR SIZE CALCULATIONS		
MICROINVERTER TO JUNCTION BOX (1)	MAX. SHORT CIRCUIT CURRENT (ISC) =	13.0 A AC
	MAX. CURRENT (ISC X1.25) =	16.3 A AC
	CONDUCTOR (TC-ER, COPPER (90°C)) =	12 AWG
	CONDUCTOR RATING =	30 A
	AMB. TEMP. AMP. CORRECTION =	35 0.96
	ADJUSTED AMP. =	28.8 > 16.3
JUNCTION BOX TO JUNCTION BOX (2)	MAX. SHORT CIRCUIT CURRENT (ISC) =	13.0 A AC
	MAX. CURRENT (ISC X1.25) =	16.3 A AC
	CONDUCTOR (UF-B, COPPER (60°C)) =	17 10 AWG
	CONDUCTOR RATING =	17 30 A
	CONDUIT FILL DERATE =	2 1
	AMB. TEMP. AMP. CORRECTION =	35 0.96
	ADJUSTED AMP. =	28.8 > 16.3
JUNCTION BOX TO COMBINER BOX (3)	MAX. SHORT CIRCUIT CURRENT (ISC) =	13.0 A AC
	MAX. CURRENT (ISC X1.25) =	16.3 A AC
	CONDUCTOR (UF-B, COPPER (60°C)) =	22 10 AWG
	CONDUCTOR RATING =	22 30 A
	CONDUIT FILL DERATE =	6 0.8
	AMB. TEMP. AMP. CORRECTION =	35 0.96
	ADJUSTED AMP. =	23.04 > 16.3
COMBINER BOX TO MAIN PV OCPD (15)	INVERTER RATED AMPS =	39.0 A AC
	MAX. CURRENT (RATED AMPS X1.25) =	48.75 A AC
	CONDUCTOR (THWN-2, COPPER (75°C TERM.)) =	51 6 AWG
	CONDUCTOR RATING =	51 65 A
	CONDUIT FILL DERATE =	3 1
	AMB. TEMP. AMP. CORRECTION =	35 0.96
	ADJUSTED AMP. =	62.4 > 48.8



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**GROUNDING NOTES**

1. A GROUNDING ELECTRODE SYSTEM IN ACCORDANCE WITH [NEC 690-47] AND [NEC 250-50] THROUGH [NEC 250-60] SHALL BE PROVIDED. PER NEC, GROUNDING ELECTRODE SYSTEM OF EXISTING BUILDING MAY BE USED AND BONDED TO AT THE SERVICE ENTRANCE. IF EXISTING SYSTEM IS INACCESSIBLE, OR INADEQUATE, OR IS ONLY METALLIC WATER PIPING, A SUPPLEMENTAL GROUNDING ELECTRODE WILL BE USED AT THE INVERTER LOCATION CONSISTING OF A UL LISTED 8 FT GROUND ROD WITH ACORN CLAMP.
2. THE GROUNDING ELECTRODE CONDUCTOR SHALL BE PROTECTED FROM PHYSICAL DAMAGE BETWEEN THE GROUNDING ELECTRODE AND THE PANEL (OR INVERTER) IF SMALLER THAN #6 AWG COPPER WIRE PER NEC 250-64B. THE GROUNDING ELECTRODE CONDUCTOR WILL BE CONTINUOUS, EXCEPT FOR SPLICES OR JOINTS AT BUSBARS WITHIN LISTED EQUIPMENT PER [NEC 250.64C].
3. GROUNDING ELECTRODE CONDUCTORS SHALL BE NO LESS THAN #8 AWG AND NO GREATER THAN #6 AWG COPPER AND BONDED TO THE EXISTING GROUNDING ELECTRODE TO PROVIDE FOR A COMPLETE SYSTEM.
4. PV SYSTEM SHALL BE GROUNDED IN ACCORDANCE TO [NEC 250.21], [NEC TABLE 250.122], AND ALL METAL PARTS OR MODULE FRAMES ACCORDING TO [NEC 690.46].
5. MODULE SOURCE CIRCUITS SHALL BE GROUNDED IN ACCORDANCE TO [NEC 690.42].
6. THE GROUNDING CONNECTION TO A MODULE SHALL BE ARRANGED SUCH THAT THE REMOVAL OF A MODULE DOES NOT INTERRUPT A GROUNDED CONDUCTOR TO ANOTHER MODULE.
7. EACH MODULE WILL BE GROUNDED USING THE SUPPLIED CONNECTIONS POINTS IDENTIFIED IN THE MANUFACTURER'S INSTALLATION INSTRUCTIONS.
8. ENCLOSURES SHALL BE PROPERLY PREPARED WITH REMOVAL OF PAINT/FINISH AS APPROPRIATE WHEN GROUNDING EQUIPMENT WITH TERMINATION GROUNDING LUGS.
9. GROUNDING SYSTEM COMPONENTS SHALL BE LISTED FOR THEIR PURPOSE, AND GROUNDING DEVICES EXPOSED TO THE ELEMENTS SHALL BE RATED FOR DIRECT BURIAL.
10. GROUNDING AND BONDING CONDUCTORS SHALL BE COPPER, SOLID OR

STRANDED, AND BARE WHEN EXPOSED.

11. EQUIPMENT GROUNDING CONDUCTORS SHALL BE SIZE ACCORDING TO [NEC 690.45] AND BE A MINIMUM OF #10AWG WHEN NOT EXPOSED TO DAMAGE (#6AWG SHALL BE USED WHEN EXPOSED TO DAMAGE).
12. GROUNDING AND BONDING CONDUCTORS, IF INSULATED, SHALL BE COLOR CODED GREEN (OR MARKED GREEN IF #4 AWG OR LARGER)
13. ALL CONDUIT BETWEEN THE UTILITY AC DISCONNECT AND THE POINT OF CONNECTION SHALL HAVE GROUNDED BUSHINGS AT BOTH ENDS.
14. SYSTEM GEC SIZED ACCORDING TO [NEC 690.47], [NEC TABLE 250.66], DC SYSTEM GEC SIZED ACCORDING TO [NEC 250.166], MINIMUM #8AWG WHEN INSULATED, #6AWG WHEN EXPOSED TO DAMAGE.
15. EXPOSED NON-CURRENT CARRYING METAL PARTS OF MODULE FRAMES, EQUIPMENTS, AND CONDUCTOR ENCLOSURES SHALL BE GROUNDED IN ACCORDANCE WITH 250.134 OR 250.136(A) REGARDLESS OF VOLTAGE.

**WIRING & CONDUIT NOTES**

1. ALL CONDUIT SIZES AND TYPES, SHALL BE LISTED FOR ITS PURPOSE AND APPROVED FOR THE SITE APPLICATIONS
2. BOLTED CONNECTION REQUIRED IN DC DISCONNECTS ON THE WHITE GROUNDED CONDUCTOR (USE POLARIS BLOCK OR NEUTRAL BAR)
3. ANY CONNECTION ABOVE LIVE PARTS MUST BE WATERTIGHT. REDUCING WASHERS DISALLOWED ABOVE LIVE PARTS, MEYERS HUBS RECOMMENDED
4. UV RESISTANT CABLE TIES (NOT ZIP TIES) USED FOR PERMANENT WIRE MANAGEMENT OFF THE ROOF SURFACE IN ACCORDANCE WITH NEC 110.2, 110.3(A-B), 300.4
5. SOLADECK JUNCTION BOXES MOUNTED FLUSH W/ROOF SURFACE TO BE USED FOR WIRE MANAGEMENT AND AS FLASHED ROOF PENETRATIONS FOR INTERIOR CONDUIT RUNS.
6. ALL PV CABLES AND HOMERUN WIRES BE TYPE USE-2, AND SINGLE-CONDUCTOR CABLE LISTED AND IDENTIFIED AS PV WIRE, TYPE TC-ER, OR EQUIVALENT; ROUTED TO SOURCE CIRCUIT COMBINER BOXES AS REQUIRED
7. ALL CONDUCTORS AND OCPD SIZES AND TYPES SPECIFIED ACCORDING TO [NEC

690.8] FOR MULTIPLE CONDUCTORS

8. ALL PV DC CONDUCTORS IN CONDUIT EXPOSED TO SUNLIGHT SHALL BE INSTALLED AT LEAST 7/8" ABOVE THE ROOF SURFACE AND DERATED ACCORDING TO [NEC TABLE 310.15 (B)(2)(a), NEC TABLE 310.15(B)(3)(a), & NEC 310.15(B)(3)(c)].
9. EXPOSED ROOF PV DC CONDUCTORS SHALL BE USE-2, 90°C RATED, WET AND UV RESISTANT, AND UL LISTED RATED FOR 600V, UV RATED SPIRAL WRAP SHALL BE USED TO PROTECT WIRE FROM SHARP EDGES
10. PHASE AND NEUTRAL CONDUCTORS SHALL BE DUAL RATED THHN/THWN-2 INSULATED, 90°C RATED, WET AND UV RESISTANT, RATED FOR 600V
11. 4-WIRE DELTA CONNECTED SYSTEMS HAVE THE PHASE WITH THE HIGHER VOLTAGE TO GROUND MARKED ORANGE OR IDENTIFIED BY OTHER EFFECTIVE MEANS.
12. ALL SOURCE CIRCUITS SHALL HAVE INDIVIDUAL SOURCE CIRCUIT PROTECTION
13. VOLTAGE DROP LIMITED TO 2% FOR DC CIRCUITS AND 3% FOR AC CIRCUITS
14. NEGATIVE GROUNDED SYSTEMS DC CONDUCTORS SHALL BE COLOR CODED AS FOLLOWS: DC POSITIVE- RED (OR MARKED RED), DC NEGATIVE- GREY (OR MARKED GREY)
15. POSITIVE GROUNDED SYSTEMS DC CONDUCTORS COLOR CODED: DC POSITIVE- GREY (OR MARKED GREY), DC NEGATIVE- BLACK (OR MARKED BLACK)
16. AC CONDUCTORS >4AWG COLOR CODED OR MARKED: PHASE A OR L1- BLACK, PHASE B OR L2- RED, PHASE C OR L3- BLUE, NEUTRAL- WHITE/GRAY  
\* USE-2 IS NOT INDOOR RATED BUT PV CABLE IS RATED THWN/THWN-2 AND MAY BE USED INSIDE  
\*\* USE-2 IS AVAILABLE AS UV WHITE
17. RIGID CONDUIT, IF INSTALLED, (AND/OR NIPPLES) MUST HAVE A PULL BUSHING TO PROTECT WIRES.
18. IF CONDUIT DETERMINED TO BE RAN THROUGH ATTIC IN FIELD THEN CONDUIT WILL BE EITHER EMT, FMC, OR MC CABLE IF DC CURRENT COMPLYING WITH NEC 690.31, NEC 250.118(10). DISCONNECTING MEANS SHALL COMPLY WITH 690.13 AND 690.15
19. CONDUIT RAN THROUGH ATTIC WILL BE AT LEAST 18" BELOW ROOF SURFACE COMPLYING WITH NEC 230.6(4) AND SECURED NO GREATER THAN 6' APART PER NEC 330.30(B).

**SITE INFORMATION:**

Mark Champion  
11454 Highway 210 North  
Angier, North Carolina 27501  
DC SYSTEM SIZE: 12.48 kW DC

DRAWING BY  
Cameron Lawson

DATE  
March 12, 2020

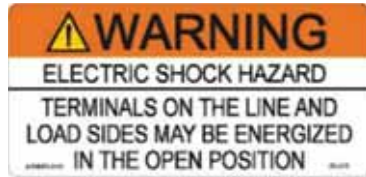
PROJECT NUMBER  
75089684

SHEET NAME  
ELEC. CALCS.

PAGE NUMBER  
PV6

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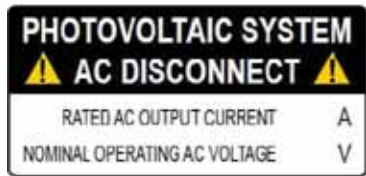




**LABEL 1**  
FOR PV DISCONNECTING MEANS WHERE ALL TERMINALS OF THE DISCONNECTING MEANS MAY BE ENERGIZED IN THE OPEN POSITION. [NEC 690.13(B), NEC 705.22]



**LABEL 2**  
AT EACH DC DISCONNECTING MEANS, INCLUDING THE DC DISCONNECT AT THE INVERTER. [NEC 690.53, NEC 690.13(B)]



**LABEL 3**  
AT POINT OF INTERCONNECTION, MARKED AT AC DISCONNECTING MEANS. [NEC 690.54, NEC 690.13 (B)]



**LABEL 4**  
IF INTERCONNECTING ON THE LOAD SIDE, INSTALL THIS LABEL ANYWHERE THAT IS POWERED BY BOTH THE UTILITY AND THE SOLAR PV SYSTEM: THE MAIN SERVICE PANEL AND SUB-PANELS. [NEC 705.12(B)(3)]



**LABEL 5**  
PLACED ADJACENT TO THE BACK-FED BREAKER FROM THE INVERTER IF TIE IN CONSISTS OF LOAD SIDE CONNECTION TO BUSBAR. [NEC 705.12(B)(2)(3)(b)]



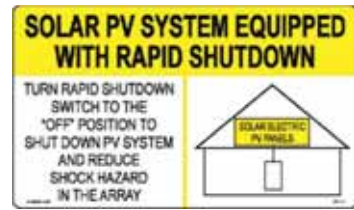
**LABEL 6**  
(ONLY IF 3 OR MORE SUPPLY SOURCES TO A BUSBAR)  
SIGN LOCATED AT LOAD CENTER IF IT CONTAINS 3 OR MORE POWER SOURCES. [NEC 705.12(B)(2)(3)(C)]

**LABELING NOTES:**

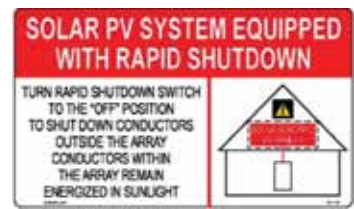
1. LABELS CALLED OUT ACCORDING TO ALL COMMON CONFIGURATIONS. ELECTRICIAN TO DETERMINE EXACT REQUIREMENTS IN THE FIELD PER CURRENT NEC AND LOCAL CODES AND MAKE APPROPRIATE ADJUSTMENTS.
2. LABELING REQUIREMENTS BASED ON THE 2017 NATIONAL ELECTRIC CODE, OSHA STANDARD 19010.145, ANSI Z535.
3. MATERIAL BASED ON THE REQUIREMENTS OF THE AUTHORITY HAVING JURISDICTION.
4. LABELS TO BE OF SUFFICIENT DURABILITY TO WITHSTAND THE ENVIRONMENT INVOLVED AND SHALL NOT BE HANDWRITTEN [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]



**LABEL 7**  
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)]



**LABEL 8**  
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)]



**LABEL 9**  
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)]



**LABEL 10**  
SIGN LOCATED AT RAPID SHUT DOWN DISCONNECT SWITCH [NEC 690.56(C)(3)].



**LABEL 11**  
PERMANENT DIRECTORY TO BE LOCATED AT MAIN SERVICE EQUIPMENT LOCATION IF ALL ELECTRICAL POWER SOURCE DISCONNECTING MEANS (SOLAR ARRAY RAPID SHUTDOWN SWITCH) ARE GROUPED AND IN LINE OF SITE OF MAIN SERVICE DISCONNECTING MEANS. [NEC 690.56(C) & NEC 705.10].

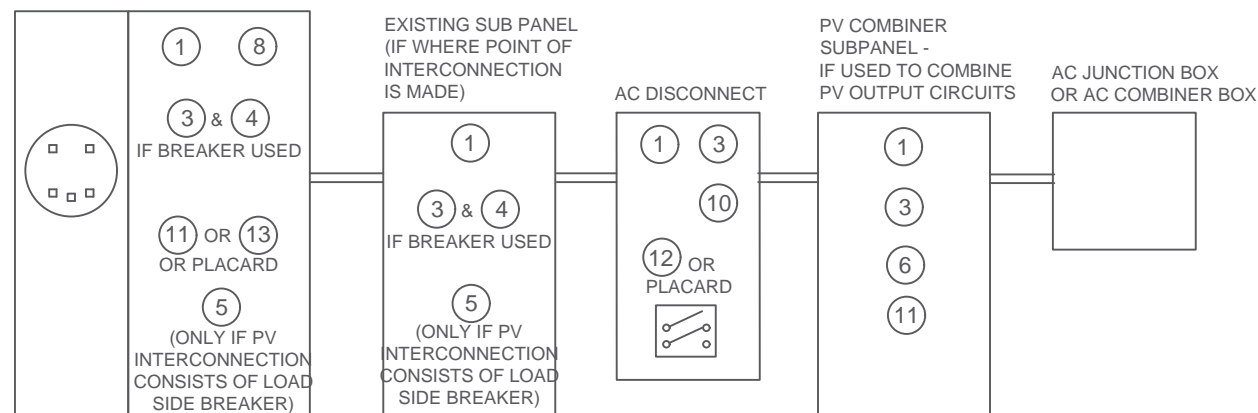


**LABEL 12**  
PERMANENT DIRECTORY TO BE LOCATED AT SOLAR ARRAY RAPID SHUTDOWN SWITCH DENOTING THE LOCATION OF THE SERVICE EQUIPMENT LOCATION IF SOLAR ARRAY RAPID SHUT DOWN DISCONNECT SWITCH IS NOT GROUPED AND WITHIN LINE OF SITE OF MAIN SERVICE DISCONNECTING MEANS. [NEC 705.10]

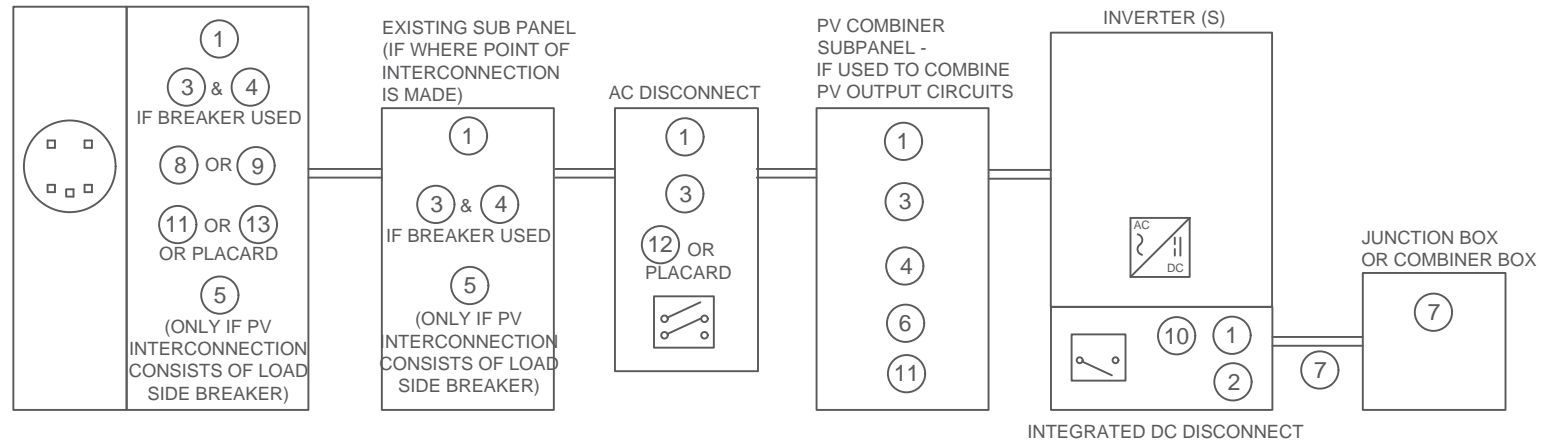


**LABEL 13**  
PERMANENT DIRECTORY TO BE LOCATED AT MAIN SERVICE EQUIPMENT DENOTING THE LOCATION OF THE PV RAPID SHUTDOWN SYSTEM DISCONNECTING MEANS IF SOLAR ARRAY RAPID SHUT DOWN DISCONNECT SWITCH IS NOT GROUPED AND WITHIN LINE OF SITE OF MAIN SERVICE DISCONNECTING MEANS. [NEC 705.10, NEC 690.56(C)(1)]

**LABELING DIAGRAM FOR MICRO INV.:**  
MAIN SERVICE PANEL



**LABELING DIAGRAM FOR STRING INV. / DC OPTIMIZER INV.:**  
MAIN SERVICE PANEL



\*ELECTRICAL DIAGRAM SHOWN ABOVE IS FOR LABELING PURPOSES ONLY. NOT AN ACTUAL REPRESENTATION OF EQUIPMENT AND CONNECTIONS TO BE INSTALLED. LABEL LOCATIONS PRESENTED MAY VARY DEPENDING ON TYPE OF INTERCONNECTION METHOD AND LOCATION PRESENTED ON PV5 OF 3 LINE DIAGRAM. PV5 LINE DIAGRAM TO REFLECT ACTUAL REPRESENTATION OF PROPOSED SCOPE OF WORK.



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CONTRACTOR:  
BRS FIELD OPS  
385.498.6700

SITE INFORMATION:

Mark Champion  
11454 Highway 210 North  
Angier, North Carolina 27501  
DC SYSTEM SIZE: 12.48 kW DC

DRAWING BY  
Cameron Lawson

DATE  
March 12, 2020

PROJECT NUMBER  
75089684

SHEET NAME  
LABELS

PAGE NUMBER  
PV8

REVISION  
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# Enphase IQ 7 and IQ 7+ Microinverters

The high-powered smart grid-ready **Enphase IQ 7 Micro™** and **Enphase IQ 7+ Micro™** dramatically simplify the installation process while achieving the highest system efficiency.

Part of the Enphase IQ System, the IQ 7 and IQ 7+ Microinverters integrate with the Enphase IQ Envoy™, Enphase IQ Battery™, and the Enphase Enlighten™ monitoring and analysis software.

IQ Series Microinverters 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, lighter 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 advanced grid support, 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 7+ Micro is required to support 72-cell modules.



To learn more about Enphase offerings, visit [enphase.com](http://enphase.com)



## Enphase IQ 7 and IQ 7+ Microinverters

INPUT DATA (DC)	IQ7-60-2-US / IQ7-60-B-US		IQ7PLUS-72-2-US / IQ7PLUS-72-B-US	
Commonly used module pairings <sup>1</sup>	235 W - 350 W +		235 W - 440 W +	
Module compatibility	60-cell PV modules only		60-cell and 72-cell PV modules	
Maximum input DC voltage	48 V		60 V	
Peak power tracking voltage	27 V - 37 V		27 V - 45 V	
Operating range	16 V - 48 V		16 V - 60 V	
Min/Max start voltage	22 V / 48 V		22 V / 60 V	
Max DC short circuit current (module Isc)	15 A		15 A	
Overvoltage class DC port	II		II	
DC port backfeed current	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 7 Microinverter		IQ 7+ Microinverter	
Peak output power	250 VA		295 VA	
Maximum continuous output power	240 VA		290 VA	
Nominal (L-L) voltage/range <sup>2</sup>	240 V / 211-264 V	208 V / 183-229 V	240 V / 211-264 V	208 V / 183-229 V
Maximum continuous output current	1.0 A (240 V)	1.15 A (208 V)	1.21 A (240 V)	1.39 A (208 V)
Nominal frequency	60 Hz		60 Hz	
Extended frequency range	47 - 68 Hz		47 - 68 Hz	
AC short circuit fault current over 3 cycles	5.8 Arms		5.8 Arms	
Maximum units per 20 A (L-L) branch circuit <sup>3</sup>	16 (240 VAC)	13 (208 VAC)	13 (240 VAC)	11 (208 VAC)
Overvoltage class AC port	III		III	
AC port backfeed current	0 A		0 A	
Power factor setting	1.0		1.0	
Power factor (adjustable)	0.7 leading ... 0.7 lagging		0.7 leading ... 0.7 lagging	
EFFICIENCY	@240 V		@208 V	
Peak CEC efficiency	97.6 %		97.3 %	
CEC weighted efficiency	97.0 %		97.0 %	
MECHANICAL DATA				
Ambient temperature range	-40°C to +65°C			
Relative humidity range	4% to 100% (condensing)			
Connector type (IQ7-60-2-US & IQ7PLUS-72-2-US)	MC4 (or Amphenol H4 UTX with additional Q-DCC-5 adapter)			
Connector type (IQ7-60-B-US & IQ7PLUS-72-B-US)	Friends PV2 (MC4 intermateable). Adaptors for modules with MC4 or UTX connectors: - PV2 to MC4: order ECA-S20-S22 - PV2 to UTX: order ECA-S20-S25			
Dimensions (WxHxD)	212 mm x 175 mm x 30.2 mm (without bracket)			
Weight	1.08 kg (2.38 lbs)			
Cooling	Natural convection - No fans			
Approved for wet locations	Yes			
Pollution degree	PD3			
Enclosure	Class II double-insulated, corrosion resistant polymeric enclosure			
Environmental category / UV exposure rating	NEMA Type 6 / outdoor			
FEATURES				
Communication	Power Line Communication (PLC)			
Monitoring	Enlighten Manager and MyEnlighten monitoring options. Both options require installation of an 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.  
 3. Limits may vary. Refer to local requirements to define the number of microinverters per branch in your area.

To learn more about Enphase offerings, visit [enphase.com](http://enphase.com)

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 BRS FIELD OPS  
 385.498.6700

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**SPEC SHEET**

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## Enphase IQ Combiner 3 (X-IQ-AM1-240-3)

The **Enphase IQ Combiner 3™** 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
- Optional AC receptacle available for PLC bridge
- Provides production metering and optional consumption monitoring

### Simple

- Reduced size from previous combiner
- Centered mounting brackets support single stud mounting
- Supports back and side conduit entry
- 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



To learn more about Enphase offerings, visit [enphase.com](http://enphase.com)



## Enphase IQ Combiner 3

MODEL NUMBER	
IQ Combiner 3 X-IQ-AM1-240-3	IQ Combiner 3 with Enphase IQ Envoy™ printed circuit board for integrated revenue grade PV production metering (ANSI C12.20 +/- 0.5%) and optional* consumption monitoring (+/- 2.5%).
ACCESSORIES and REPLACEMENT PARTS (not included, order separately)	
Enphase Mobile Connect™ CELLMODEM-03 (4G / 12-year data plan) CELLMODEM-01 (3G / 5-year data plan) CELLMODEM-M1 (4G based LTE-M / 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-10A-2-240 BRK-15A-2-240 BRK-20A-2P-240	Supports Eaton BR210, BR215, BR220, BR230, BR240, BR250, and BR260 circuit breakers. Circuit breaker, 2 pole, 10A, Eaton BR210 Circuit breaker, 2 pole, 15A, Eaton BR215 Circuit breaker, 2 pole, 20A, Eaton BR220
EPLC-01	Power line carrier (communication bridge pair), quantity 2
XA-PLUG-120-3	Accessory receptacle for Power Line Carrier in IQ Combiner 3 (required for EPLC-01)
XA-ENV-PCBA-3	Replacement IQ Envoy printed circuit board (PCB) for Combiner 3
ELECTRICAL SPECIFICATIONS	
Rating	Continuous duty
System voltage	120/240 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)	80A of distributed generation / 90A with IQ Envoy breaker included
Production Metering CT	200 A solid core pre-installed and wired to IQ Envoy
MECHANICAL DATA	
Dimensions (WxHxD)	49.5 x 37.5 x 16.8 cm (19.5" x 14.75" x 6.63"). Height is 21.06" (53.5 cm with mounting brackets).
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: 4 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	Optional, 802.3, Cat5E (or Cat 6) UTP Ethernet cable (not included)
Cellular	Optional, CELLMODEM-01 (3G) or CELLMODEM-03 (4G) or CELLMODEM-M1 (4G based LTE-M) (not included)
COMPLIANCE	
Compliance, Combiner	UL 1741 CAN/CSA C22.2 No. 1071 47 CFR, Part 15, Class B, ICES 003 Production metering: ANSI C12.20 accuracy class 0.5 (PV production)
Compliance, IQ Envoy	UL 60601-1/CANCSA 22.2 No. 61010-1

\* Consumption monitoring is required for Enphase Storage Systems.

To learn more about Enphase offerings, visit [enphase.com](http://enphase.com)

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2018-09-13



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# THE Residential Module

## MULTI-BUSBAR 120 HALF-CELL BOB MODULE



**120-Cell**  
MONOCRYSTALLINE MODULE

**310-335W**  
POWER OUTPUT RANGE

**19.7%**  
MAXIMUM EFFICIENCY

**0~+5W**  
POSITIVE POWER TOLERANCE

Founded in 1997, Trina Solar is the world's leading total solution provider for solar energy. With local presence around the globe, Trina Solar is able to provide exceptional service to each customer in each market and deliver our innovative, reliable products with the backing of Trina as a strong, bankable brand. Trina Solar now distributes its PV products to over 100 countries all over the world. We are committed to building strategic, mutually beneficial collaborations with installers, developers, distributors and other partners in driving smart energy together.

### Comprehensive Products and System Certificates

IEC61215/IEC61730/IEC61701/IEC62716  
ISO 9001: Quality Management System  
ISO 14001: Environmental Management System  
ISO14064: Greenhouse Gases Emissions Verification  
OHSAS 18001: Occupation Health and Safety Management System



PRODUCTS	BACKSHEET COLOR	POWER RANGE
TSM-DD06M.05(II)	Black	310-335W

FRAME COLOR: Black



### High power output

- Reduce BOS cost with high power bin and module efficiency
- New cell string layout and split J-box location reduces the energy loss caused by inter-row shading
- Lower resistance of half-cut cells and increased MBB (Multi Busbar) reflectance ensure higher power



### High energy generation, low LCOE

- Excellent 3rd party validated IAM and low light performance with cell process and module material optimization
- Low Pmax temp coefficient (-0.36%) increases energy production
- Better anti-shading performance and lower operating temperature



### Outstanding visual appearance, easy to install

- Designed for superior rooftop aesthetics
- Thinner wires give a eye catching all black look
- Safe and easy to transport, handle, and install

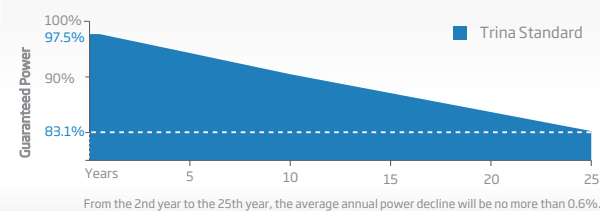


### Certified to perform in highly challenging environment

- High PID resistance through cell process and module material control
- Resistant to salt, acid, sand, and ammonia
- Over 30 in-house tests (UV, TC, HF etc)
- Certified to 5400 Pa positive load and 2400 Pa negative load

### PERFORMANCE WARRANTY

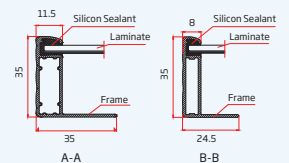
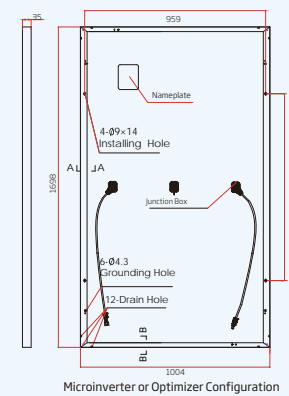
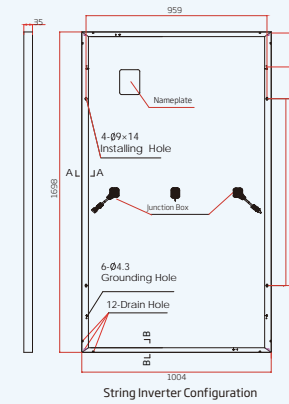
10 Year Product Warranty · 25 Year Power Warranty



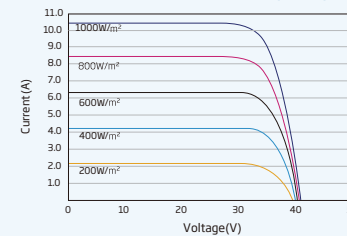
## Residential Module

## MULTI-BUSBAR 120 HALF-CELL BOB MODULE

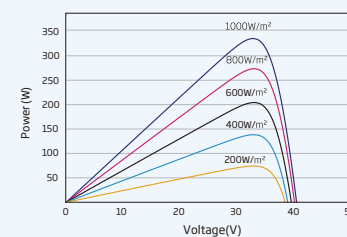
### DIMENSIONS OF PV MODULE(mm)



### I-V CURVES OF PV MODULE (335W)



### P-V CURVES OF PV MODULE (335W)



### ELECTRICAL DATA (STC)

Parameter	310	315	320	325	330	335
Peak Power Watts-P <sub>MAX</sub> (Wp)*	310	315	320	325	330	335
Power Output Tolerance-P <sub>MAX</sub> (W)	0~+5					
Maximum Power Voltage-V <sub>MPP</sub> (V)	33.0	33.2	33.4	33.6	33.8	34.0
Maximum Power Current-I <sub>MPP</sub> (A)	9.40	9.49	9.58	9.67	9.76	9.85
Open Circuit Voltage-V <sub>OC</sub> (V)	39.9	40.1	40.3	40.4	40.6	40.7
Short Circuit Current-I <sub>SC</sub> (A)	10.03	10.12	10.20	10.30	10.40	10.50
Module Efficiency η(%)	18.2	18.5	18.8	19.1	19.4	19.7

STC: Irradiance 1000W/m<sup>2</sup>, Cell Temperature 25°C, Air Mass AM1.5.  
\*Measuring tolerance: ±3%.

### ELECTRICAL DATA (NMOT)

Parameter	235	238	242	246	250	254
Maximum Power-P <sub>MAX</sub> (Wp)	235	238	242	246	250	254
Maximum Power Voltage-V <sub>MPP</sub> (V)	31.0	31.2	31.4	31.6	31.7	31.9
Maximum Power Current-I <sub>MPP</sub> (A)	7.57	7.64	7.71	7.79	7.86	7.94
Open Circuit Voltage-V <sub>OC</sub> (V)	37.6	37.8	38.0	38.1	38.3	38.4
Short Circuit Current-I <sub>SC</sub> (A)	8.08	8.15	8.22	8.30	8.38	8.46

NMOT: Irradiance at 800W/m<sup>2</sup>, Ambient Temperature 20°C, Wind Speed 1m/s.

### MECHANICAL DATA

Solar Cells	Monocrystalline
Cell Orientation	120 cells (6 × 20)
Module Dimensions	1698 × 1004 × 35 mm (66.85 × 39.53 × 1.38 inches)
Weight	18.7kg (41.2lb)
Glass	3.2mm (0.13 inches), High Transmission, AR Coated Tempered Glass
Encapsulant Material	EVA
Backsheet	Black
Frame	35 mm (1.38 inches) Anodized Aluminium Alloy
J-Box	IP 68 rated
Cables	Photovoltaic Technology Cable 4.0mm <sup>2</sup> (0.006 inches <sup>2</sup> ) Portrait: N 140mm/P 285mm (5.51/11.22 inches) Landscape: N 1200 mm /P 1200 mm (47.24/47.24 inches)
Connector	MC4

### TEMPERATURE RATINGS

NMOT(Nominal Module Operating Temperature)	41°C (±3°C)
Temperature Coefficient of P <sub>MAX</sub>	-0.36%/°C
Temperature Coefficient of V <sub>OC</sub>	-0.26%/°C
Temperature Coefficient of I <sub>SC</sub>	0.04%/°C

### MAXIMUM RATINGS

Operational Temperature	-40~+85°C
Maximum System Voltage	1000V DC (IEC)
	1000V DC (UL)
Max Series Fuse Rating	20A

(Do not connect Fuse in Combiner Box with two or more strings in parallel connection)

### WARRANTY

- 10 year Product Workmanship Warranty
- 25 year Power Warranty

(Please refer to product warranty for details)

### PACKAGING CONFIGURATION

- Modules per box: 30 pieces
- Modules per 40'container: 780 pieces



CAUTION: READ SAFETY AND INSTALLATION INSTRUCTIONS BEFORE USING THE PRODUCT.

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Version number: TSM\_DD06M.05(II)\_EN\_2019\_B [www.trinasolar.com](http://www.trinasolar.com)



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OREM, UT 84097

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**SPEC SHEET**

PAGE NUMBER  
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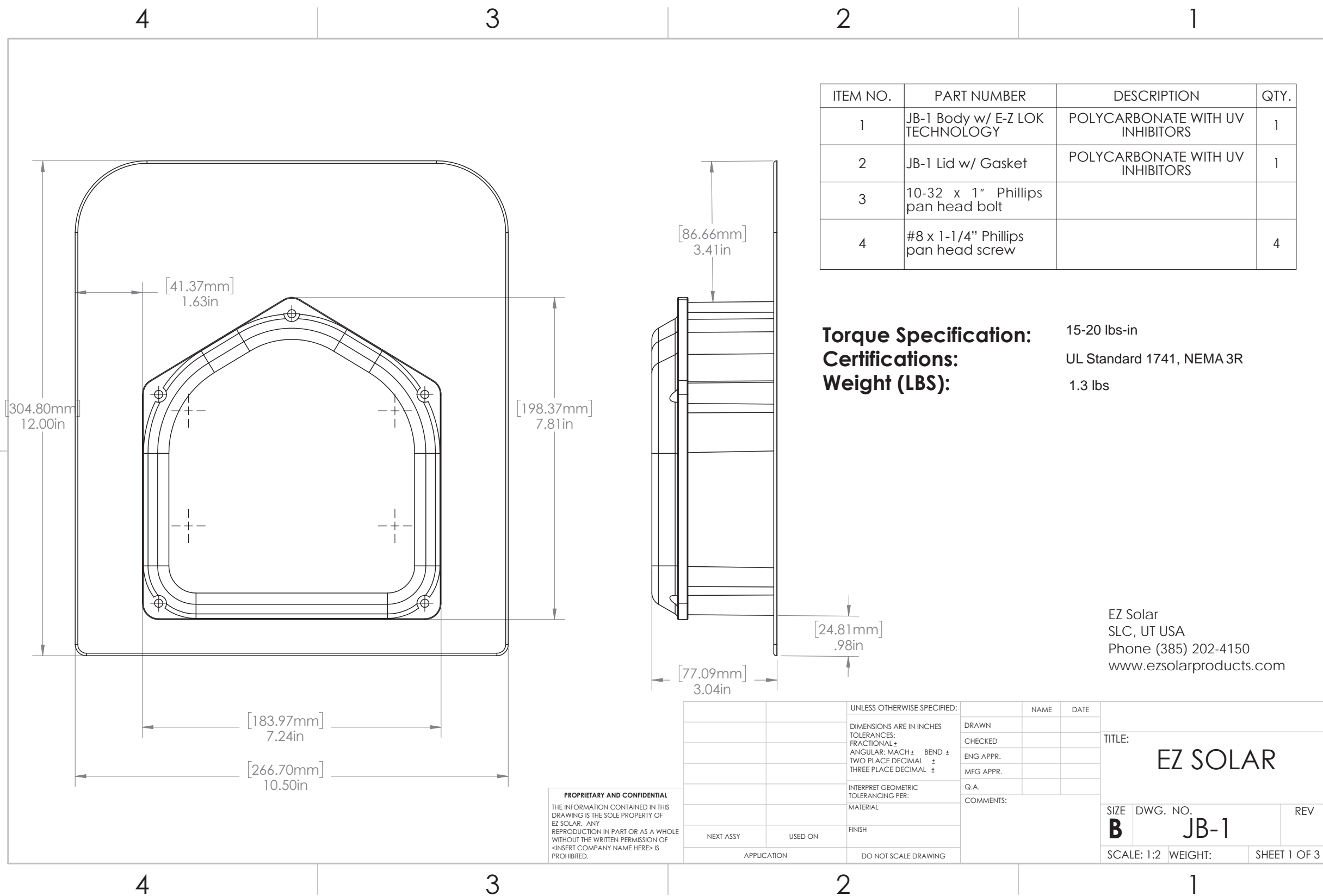
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MFG APPR.			
Q.A.			
COMMENTS:			
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**TITLE:** EZ SOLAR

SIZE: **B** DWG. NO.: JB-1 REV: \_\_\_\_\_

SCALE: 1:2 WEIGHT: \_\_\_\_\_ SHEET 1 OF 3

SHEET NAME  
**SPEC SHEET**

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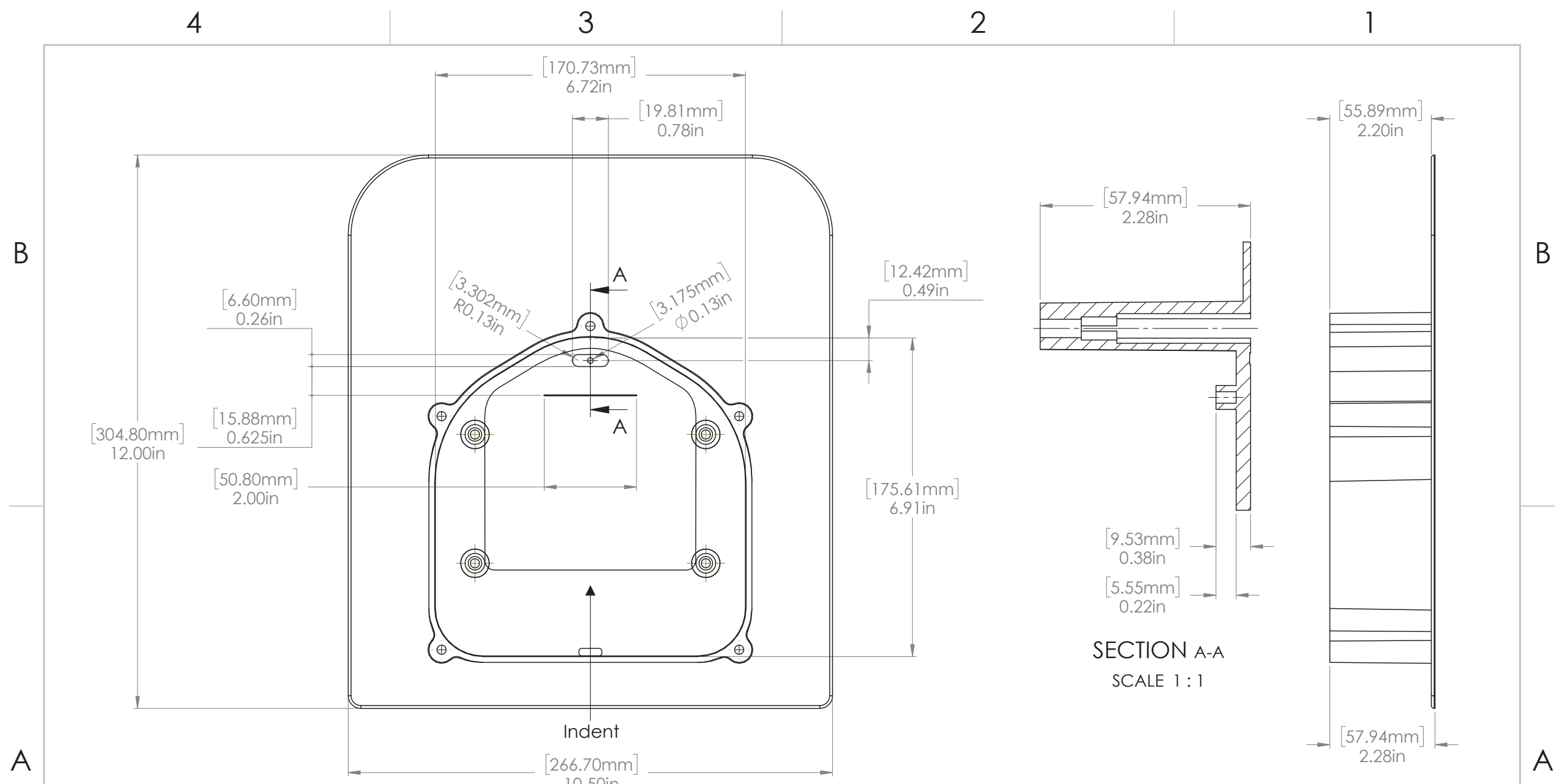


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B

B

A

A

SECTION A-A  
SCALE 1 : 1

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TOLERANCES:		CHECKED		<b>B</b>	<b>JB-1</b>
FRACTIONAL ±		ENG APPR.		SCALE: 1:2	WEIGHT:
ANGULAR: MACH ± BEND ±		MFG APPR.		REVISION	SHEET 2 OF 3
TWO PLACE DECIMAL ±		Q.A.			
THREE PLACE DECIMAL ±		COMMENTS:			
INTERPRET GEOMETRIC TOLERANCING PER:					
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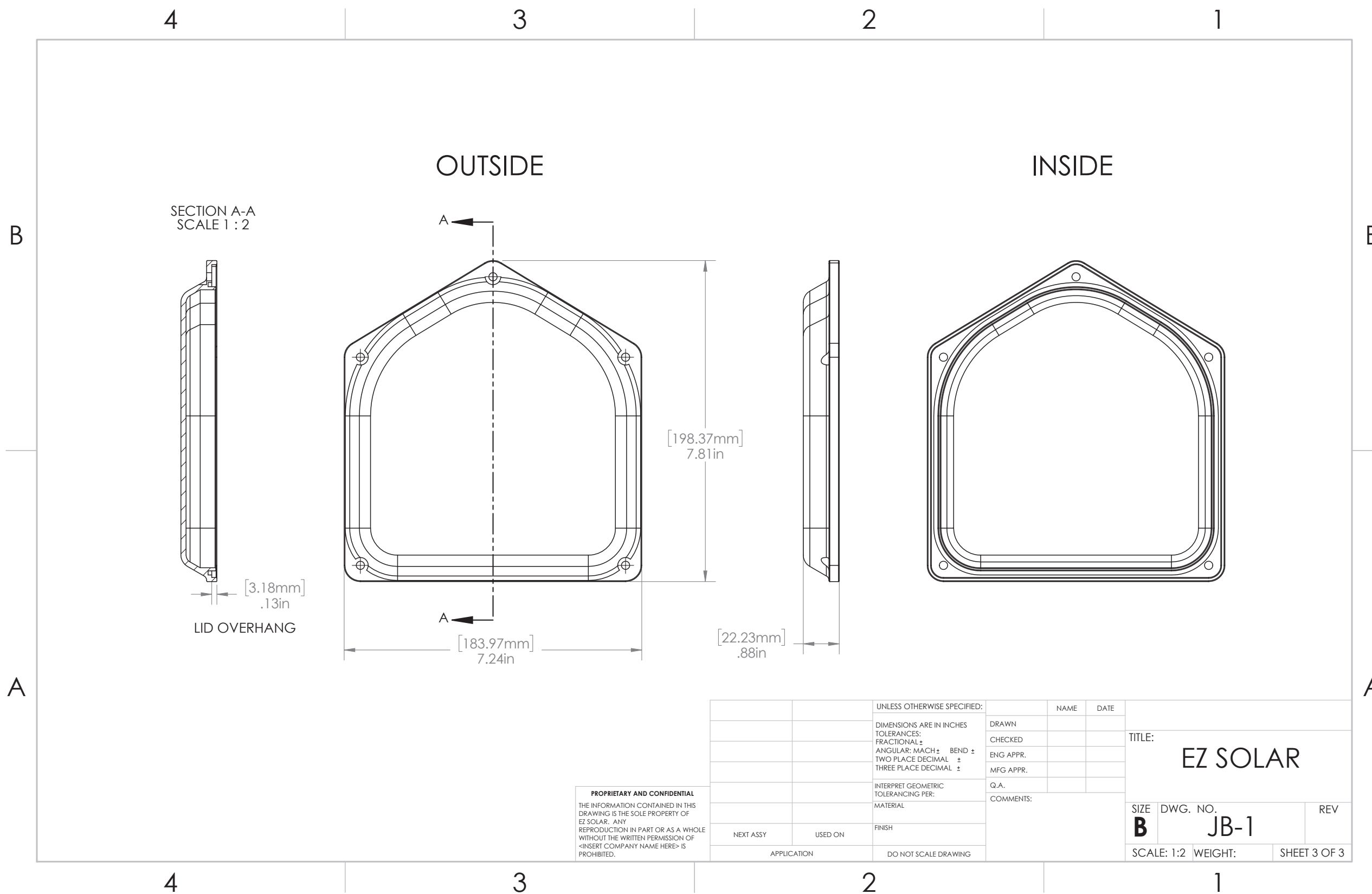
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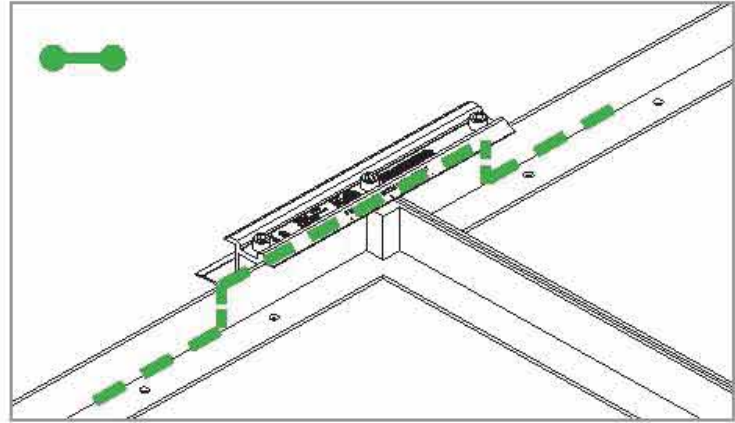
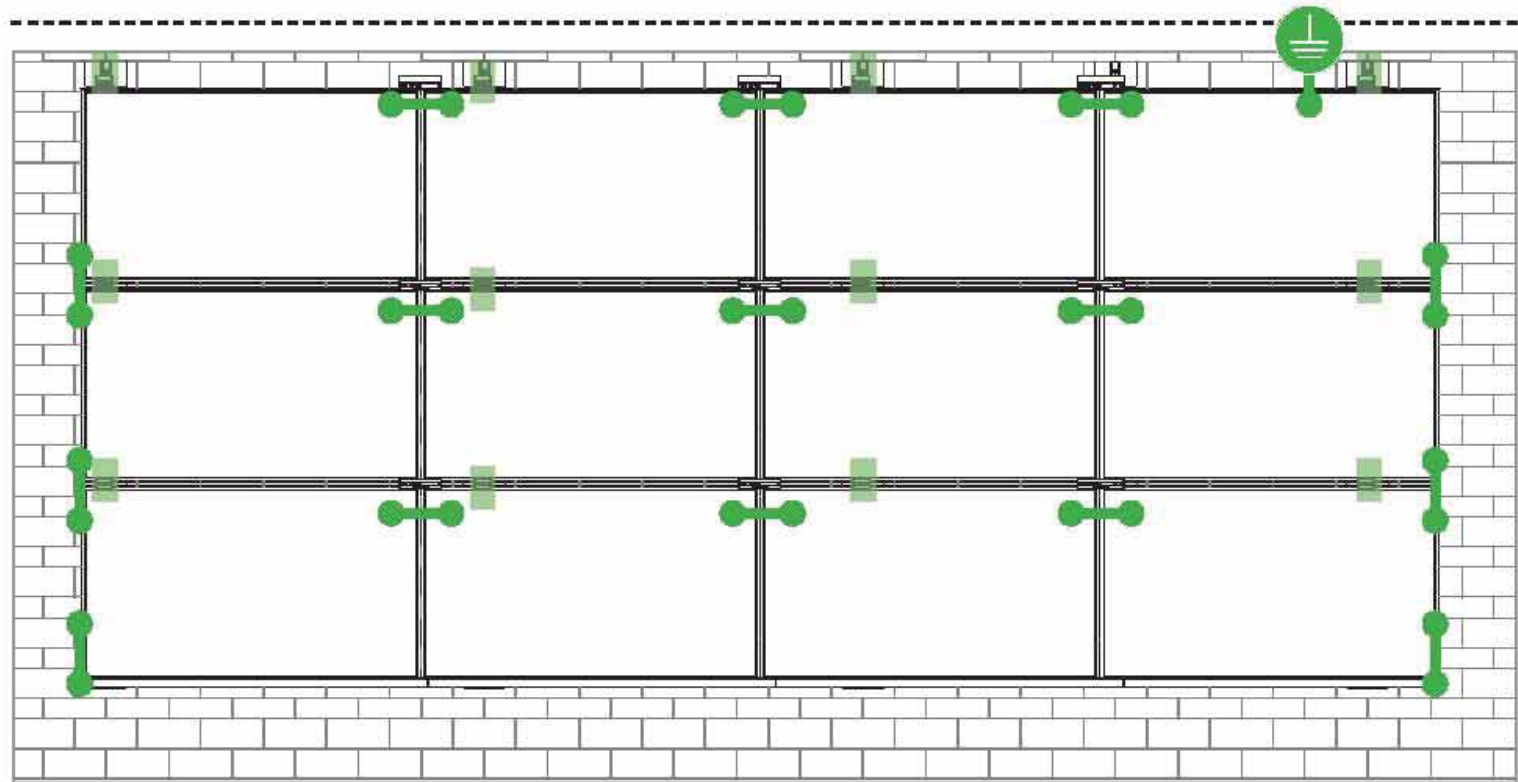
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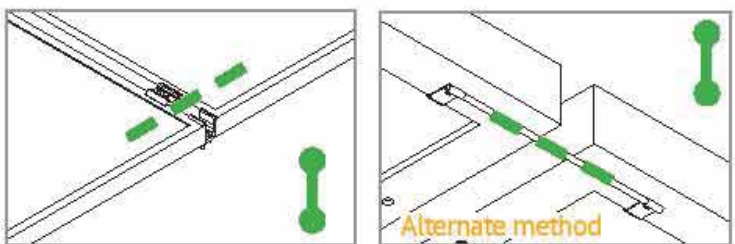


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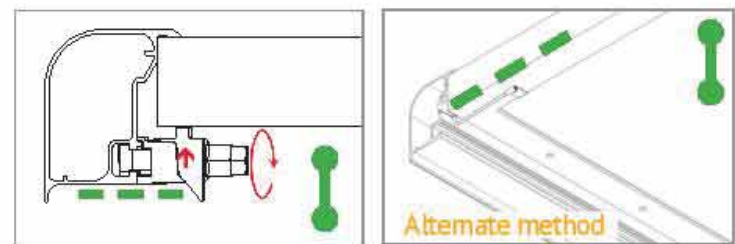
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ANGULAR: MACH ±		MFG APPR.		SIZE DWG. NO. REV <b>B</b> JB-1
TWO PLACE DECIMAL ±		Q.A.		
THREE PLACE DECIMAL ±		COMMENTS:		SCALE: 1:2 WEIGHT: SHEET 3 OF 3
INTERPRET GEOMETRIC TOLERANCING PER:				
NEXT ASSY	USED ON	FINISH		
APPLICATION		DO NOT SCALE DRAWING		



**E-W BONDING PATH:**  
E-W module to module bonding is accomplished with 2 pre-installed bonding pins which engage on the secure side of the Microrail™ and splice.



**N-S BONDING PATH:**  
N-S module to module bonding is accomplished with bonding clamp with 2 integral bonding pins. (refer also to alternate method )



**TRIMRAIL BONDING PATH:**  
Trimrail to module bonding is accomplished with bonding clamp with integral bonding pin and bonding T-bolt. (refer also to alternate method )

Star Washer is Single Use Only



**TERMINAL TORQUE,**  
Install Conductor and torque to the following:  
4-6 AWG: 35in-lbs  
8 AWG: 25 in-lbs  
10-14 AWG: 20 in-lbs

**TERMINAL TORQUE,**  
Install Conductor and torque to the following:  
4-14 AWG: 35in-lbs



WEEBLUG Single Use Only



**TERMINAL TORQUE,**  
Install Conductor and torque to the following:  
6-14 AWG: 7ft-lbs

**LUG DETAIL & TORQUE INFO**  
**IlSCO Lay-In Lug (GBL-4DBT)**

- 10-32 mounting hardware
- Torque = 5 ft-lb
- AWG 4-14 -Solid or Stranded

**LUG DETAIL & TORQUE INFO**  
**IlSCO Flange Lug(SGB-4)**

- 1/4" mounting hardware
- Torque = 75 in-lb
- AWG 4-14 -Solid or Stranded

**LUG DETAIL & TORQUE INFO**  
**Wiley WEEBLug (6.7)**

- 1/4" mounting hardware
- Torque = 10 ft-lb
- AWG 6-14 -Solid or Stranded

**NOTE: ISOLATE COPPER FROM ALUMINUM CONTACT TO PREVENT CORROSION**  
System bonding is accomplished through modules. System grounding accomplished by attaching a ground lug to any module at a location on the module specified by the module manufacturer.



**AUTHORIZATION TO MARK**

This authorizes the application of the Certification Mark(s) shown below to the models described in the Product(s) Covered section when made in accordance with the conditions set forth in the Certification Agreement and Listing Report. This authorization also applies to multiple listee model(s) identified on the correlation page of the Listing Report.

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<b>Address:</b> 1411 Broadway Blvd NE Albuquerque, NM 87102	<b>Address:</b> No. 688 ChaoSheng Road Cixi City Zhejiang Province 315311
<b>Country:</b> USA	<b>Country:</b> China
<b>Contact:</b> Klaus Nicolaedis Tom Young	<b>Contact:</b> Jia Liu Robin Luo
<b>Phone:</b> 505-462-2190 505-843-1418	<b>Phone:</b> +86-15267030962 +86-13621785753
<b>FAX:</b> NA klaus.nicolaedis@unirac.com	<b>FAX:</b> NA
<b>Email:</b> toddg@unirac.com	<b>Email:</b> jia.liu@cxymj.com buwan.luo@cxymj.com

**Party Authorized To Apply Mark:** Same as Manufacturer  
**Report Issuing Office:** Lake Forest, CA U.S.A.

**Control Number:** 5003705      **Authorized by:** *Natalie Johnson*  
for Dean Davidson, Certification Manager



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Intertek Testing Services NA Inc.  
545 East Algonquin Road, Arlington Heights, IL 60005  
Telephone 800-345-3851 or 847-439-5667 Fax 312-283-1672

<b>Standard(s):</b>	Mounting Systems, Mounting Devices, Clamping/Retention Devices, and Ground Lugs for Use with Flat-Plate Photovoltaic Modules and Panels [UL 2703: 2015 Ed.1]
<b>Product:</b>	Photovoltaic Mounting System, Sun Frame Microrail - Installed Using Unirac Installation Guide, Rev PUB2019MAR01 with Annex North Row Extension Installation Guide Rev PUB2019FEB20
<b>Brand Name:</b>	Unirac
<b>Models:</b>	Unirac SFM

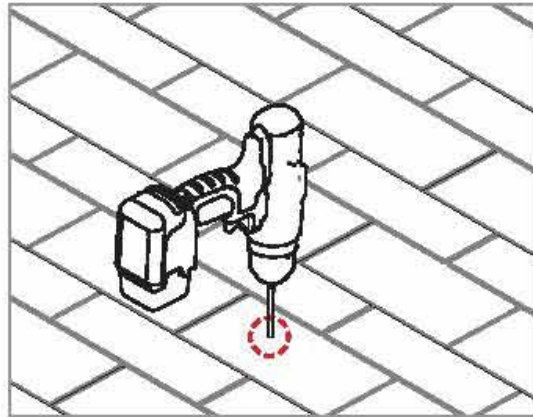


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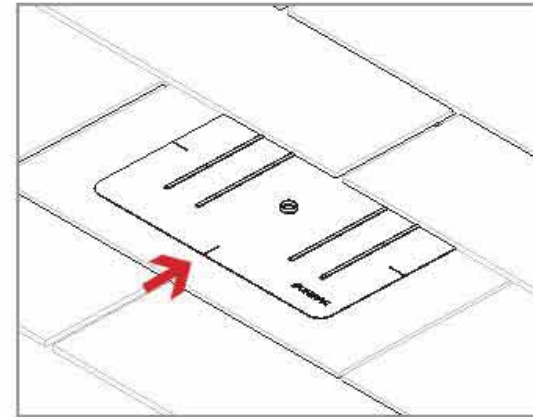


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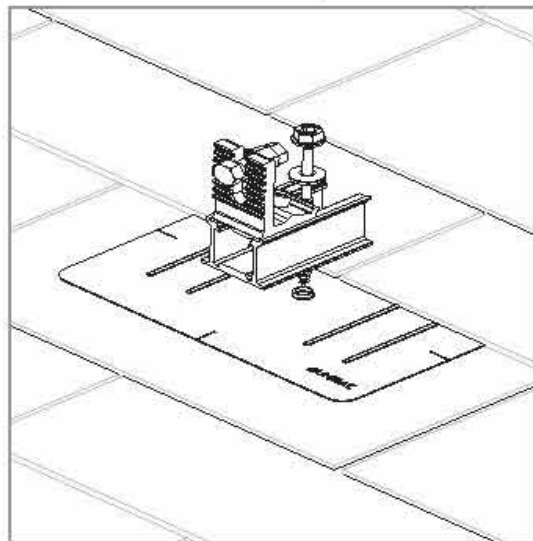
**PILOT HOLES:**

Drill pilot holes for lag screws or structural screws (as necessary) at marked attachment points



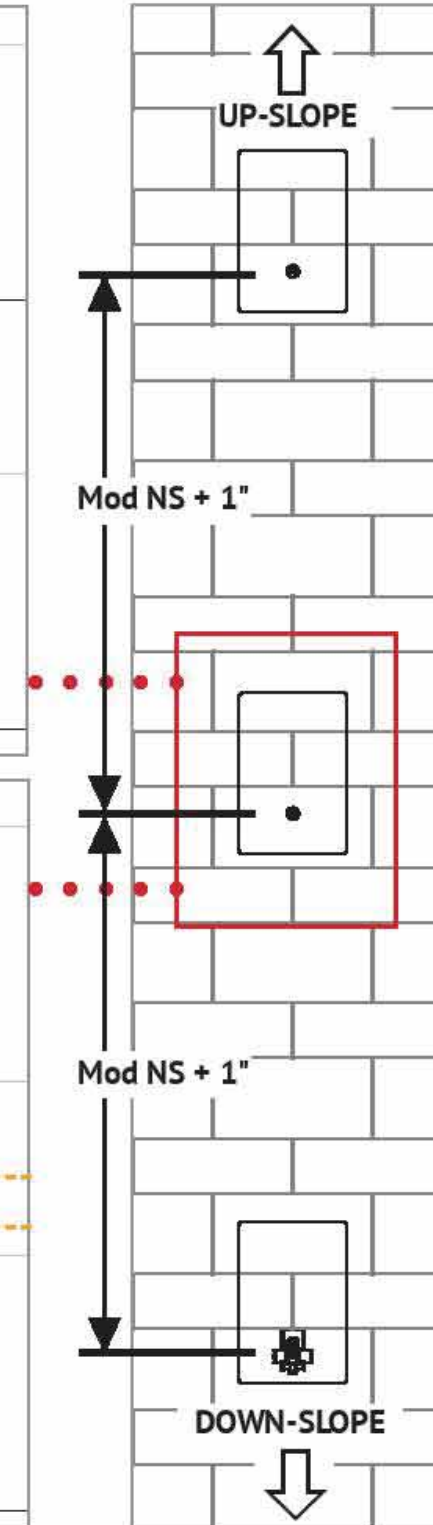
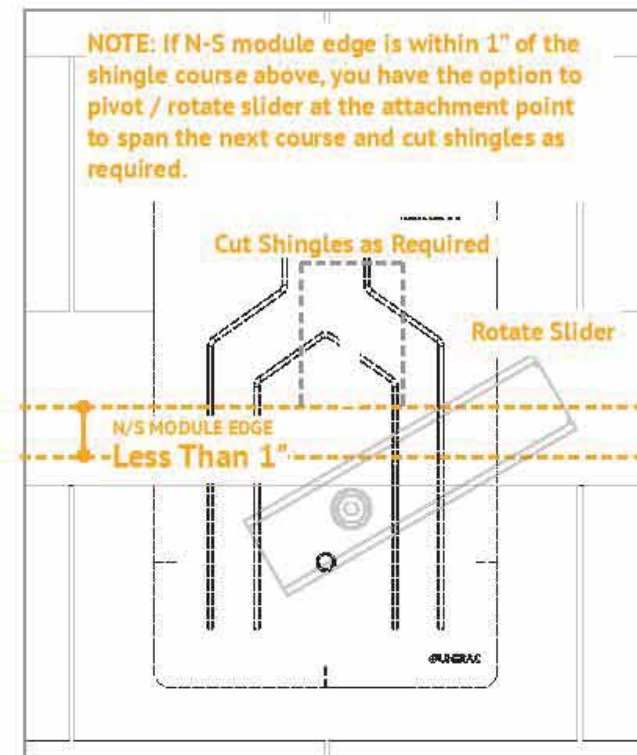
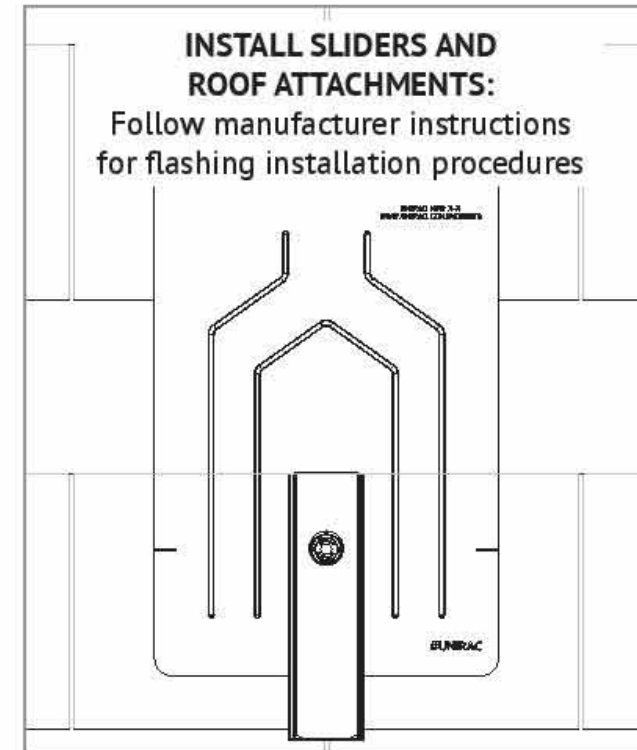
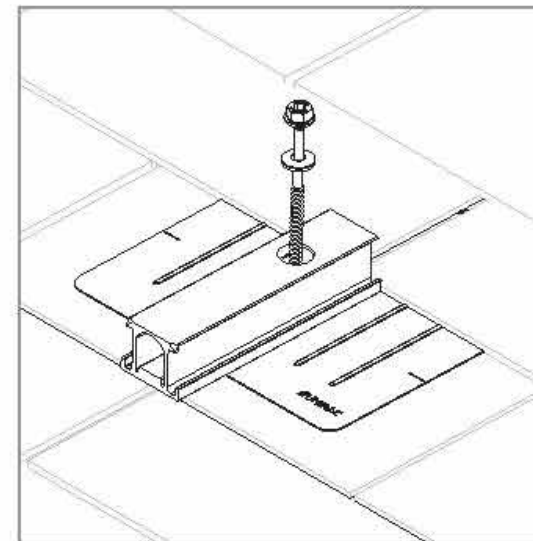
**FLASHINGS:**

Place flashings



**INSTALL SLIDERS AND TRIMRAIL ROOF ATTACHMENTS:**

- Insert flashings per manufacturer instructions
- NOTE: Use Lag screw or structural fastener with a maximum diameter of 5/16"**
- Attach sliders to rafters
- Verify proper row to row spacing for module size (Mod NS + 1")
- Ensure that Trimrail™ roof attachments in each row have sufficient engagement with slider dovetails for proper attachment.







BLUE RAVEN SOLAR, LLC  
Firm License No. D-0396  
1403 North Research Way  
Building J  
Orem, UT 84097

April 7, 2020

To: Blue Raven Solar  
1403 N. Research Way, Bldg. J  
Orem, UT. 84097

Subject: Certification Letter  
Champion Residence  
11454 Highway 210 North  
Angier, NC. 27501

To Whom It May Concern,

A jobsite observation of the condition of the existing framing system was performed by an audit team of Blue Raven Solar. All attached structural calculations are based on these observations and the design criteria listed below.

On the above referenced project, the roof structural framing has been reviewed for additional loading due to the installation of the solar PV addition to the roof. The structural review, including the plans and calculations only apply to the section of the roof that is directly supporting the solar PV system and its supporting elements. The observed roof framing is described below.

The roof structure of (MP1) consists of composition shingle on roof plywood that is supported by 2x6 rafters @ 16"o.c., paired with nominal 2x8 ceiling joists @ 16"o.c.. The rafters are supported by vertical struts which transfer gravity loads to the ceiling joists below. The rafters have a max projected horizontal span of 14'-6", with a slope of 35 degrees. The rafters are connected at the ridge to a ridge board and are supported at the eave by a load bearing wall.

The existing roof framing system of (MP1) is judged to be adequate to withstand the loading imposed by the installation of the solar panels. No reinforcement is necessary.

The spacing of the solar standoffs should be kept at 72" o.c. for landscape and 48" o.c. for portrait orientation, with a staggered pattern to ensure proper distribution of loads.

The scope of this report is strictly limited to an evaluation of the fastener attachment, underlying framing and supporting structure only. The attachment's to the existing structure are required to be in a staggered pattern to ensure proper distribution of loading. All panels, racking and hardware shall be installed per manufacturer specifications and within specified design limitations. All waterproofing shall be provided by the manufacturer.

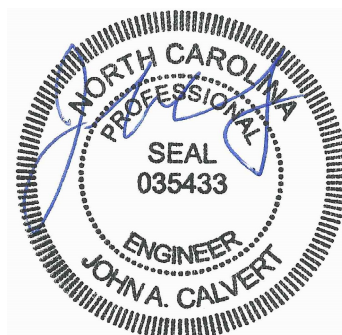
Design Criteria:

- Applicable Codes = 2018 North Carolina State Building Code (NCSBC), ASCE7-10, and NDS-12
- Roof Dead Load = 12 psf (MP1)
- Roof Live Load = 20 psf
- Wind Speed = 115 mph, Exposure C
- Ground Snow Load = 15 psf - Roof Snow Load = 10.5 psf
- Attachments: (1) 5/16" dia lag screw with 2.5" min embedment depth, at spacing shown above.

Please contact me with any further questions or concerns regarding this project.

Sincerely,

John Calvert, P.E.  
Project Engineer





### Gravity Loading

Roof Snow Load Calculations		
$p_g$ = Ground Snow Load =	15 psf	
$p_f = 0.7 C_e C_t I p_g$		(ASCE7 - Eq 7-1)
$C_e$ = Exposure Factor =	1	(ASCE7 - Table 7-2)
$C_t$ = Thermal Factor =	1	(ASCE7 - Table 7-3)
$I$ = Importance Factor =	1	
$p_f$ = Flat Roof Snow Load =	10.5 psf	
$p_s = C_s p_f$		(ASCE7 - Eq 7-2)
$C_s$ = Slope Factor =	1	
<b><math>p_s</math> = Sloped Roof Snow Load =</b>	<b>10.5 psf</b>	

PV Dead Load = 3 psf (Per Blue Raven Solar)	
PV System Weight	
Weight of PV System (Per Blue Raven Solar)	3.0 psf
X Standoff Spacing =	4.00 ft
Y Standoff Spacing =	5.50 ft
Standoff Tributary Area =	22.00 sft
<b>Point Loads of Standoffs</b>	<b>66 lb</b>

Note: PV standoffs are staggered to ensure proper distribution of loading

Roof Live Load = 20 psf	
Note: Roof live load is removed in area's covered by PV array.	

Roof Dead Load (MP1)	
Composition Shingle	4.00
Roof Plywood	2.00
2x6 Rafters @ 16"o.c.	1.72
Vaulted Ceiling	4.00
Miscellaneous	0.28
<b>Total Roof DL (MP1)</b>	<b>12.0 psf</b>
DL Adjusted to 35 Degree Slope	14.6 psf



### Wind Calculations

#### Per ASCE7-10 Components and Cladding

##### Input Variables

Wind Speed	115 mph
Exposure Category	C
Roof Shape	Gable/Hip
Roof Slope	35 degrees
Mean Roof Height	20 ft
Effective Wind Area	19.3 ft

##### Design Wind Pressure Calculations

Wind Pressure  $P = qh * G * Cn$

$qh = 0.00256 * Kz * Kzt * Kd * V^2$	(Eq. 30.3-1)
$Kz$ (Exposure Coefficient) = 0.9	(Table 30.3-1)
$Kzt$ (topographic factor) = 1	(Fig. 26.8-1)
$Kd$ (Wind Directionality Factor) = 0.85	(Table 26.6-1)
$V$ (Design Wind Speed) = 115 mph	(Fig. 26.5-1A)
Risk Category = II	(Table 1.5-1)
$qh = 25.90$	
$0.6 * qh = 15.54$	

##### Standoff Uplift Calculations-Portrait

	Zone 1	Zone 2	Zone 3	Positive	
$G_{Cp}$ =	-0.92	-1.12	-1.12	0.86	(Fig. 30.4-1)
Uplift Pressure =	-14.36 psf	-17.47 psf	-17.47 psf	22.3 psf	
X Standoff Spacing =	4.00	4.00	2.67		
Y Standoff Spacing =	5.50	2.75	2.75		
Tributary Area =	22.00	11.00	7.33		
Footing Uplift =	-316 lb	-192 lb	-128 lb		

##### Standoff Uplift Calculations-Landscape

	Zone 1	Zone 2	Zone 3	Positive	
$G_{Cp}$ =	-0.92	-1.12	-1.12	0.86	(Fig. 30.4-1)
Uplift Pressure =	-14.36 psf	-17.47 psf	-17.47 psf	10.0 psf	(Minimum)
X Standoff Spacing =	6.00	6.00	4.00		
Y Standoff Spacing =	3.50	1.75	1.75		
Tributary Area =	21.00	10.50	7.00		
Footing Uplift =	-302 lb	-183 lb	-122 lb		

##### Standoff Uplift Check

Maximum Design Uplift = -316 lb  
Standoff Uplift Capacity = 450 lb  
450 lb capacity > 316 lb demand **Therefore, OK**

##### Fastener Capacity Check

Fastener = 1 - 5/16" dia Lag  
Number of Fasteners = 1  
Embedment Depth = 2.5  
Pullout Capacity Per Inch = 250 lb  
Fastener Capacity = 625 lb  
w/ F.S. of 1.5 & DOL of 1.6= 667 lb  
667.2 lb capacity > 316 lb demand **Therefore, OK**

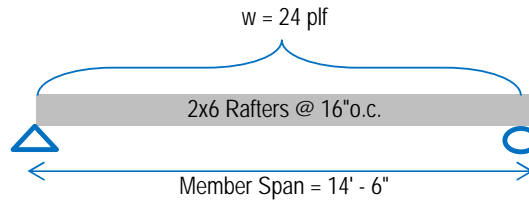


**Framing Check**

(MP1)

PASS

Dead Load 14.6 psf  
 PV Load 3.0 psf  
 Live Load 20.0 psf



Governing Load Combo = DL + SL  
 Total Load 17.6 psf

Member Properties				
Member Size	S (in <sup>3</sup> )	I (in <sup>4</sup> )	Lumber Sp/Gr	Member Spacing
2x6	7.56	20.80	DF#2	@ 16"o.c.

Check Bending Stress								
Fb (psi) =	f <sub>b</sub>	x	C <sub>d</sub>	x	C <sub>f</sub>	x	C <sub>r</sub>	(NDS Table 4.3.1)
	900	x	1.15	x	1.3	x	1.15	
Allowed Bending Stress = 1547.3 psi								

Maximum Moment =  $(wL^2) / 8$   
 $= 618.461 \text{ ft}\#$   
 $= 7421.53 \text{ in}\#$   
 Actual Bending Stress = (Maximum Moment) / S  
 $= 981.4 \text{ psi}$

Allowed > Actual -- 63.5% Stressed -- Therefore, OK

Check Deflection	
Allowed Deflection (Total Load) =	$L/180$ (E = 1600000 psi Per NDS)
	= 0.966 in
Deflection Criteria Based on =	Continuous Span
Actual Deflection (Total Load) =	$(wL^4) / (185E*I)$
	= 0.293 in
	= L/594 > L/180 Therefore OK

Allowed Deflection (Live Load) =	$L/240$
	0.725 in
Actual Deflection (Live Load) =	$(wL^4) / (185E*I)$
	0.000 in
	#DIV/0! > L/240 Therefore OK

Check Shear		
Member Area = 8.3 in <sup>2</sup>	F <sub>v</sub> (psi) = 180 psi	(NDS Table 4A)
Allowed Shear = F <sub>v</sub> * A = 1485 lb	Max Shear (V) = w * L / 2 =	171 lb

Allowed > Actual -- 11.5% Stressed -- Therefore, OK