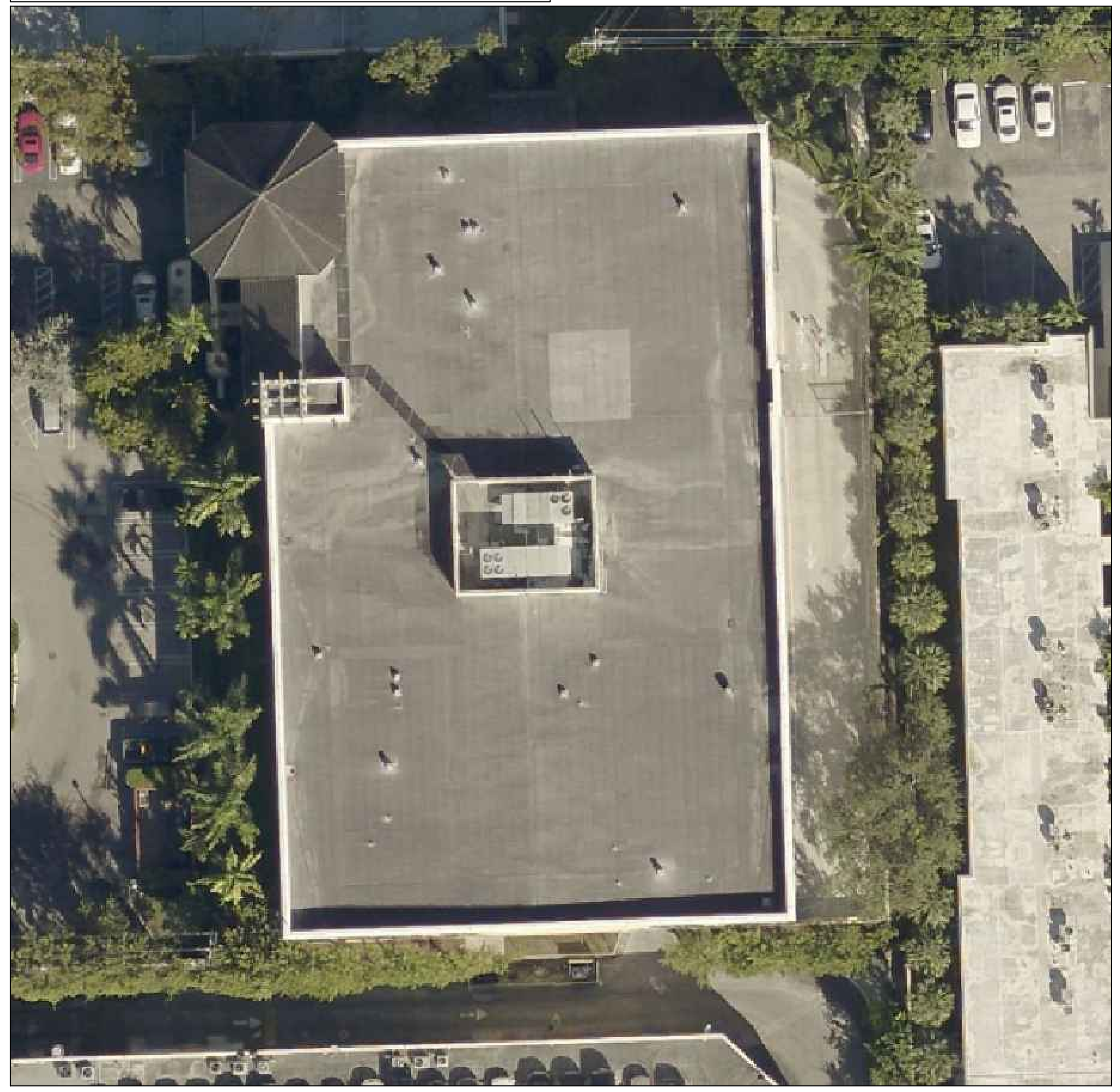
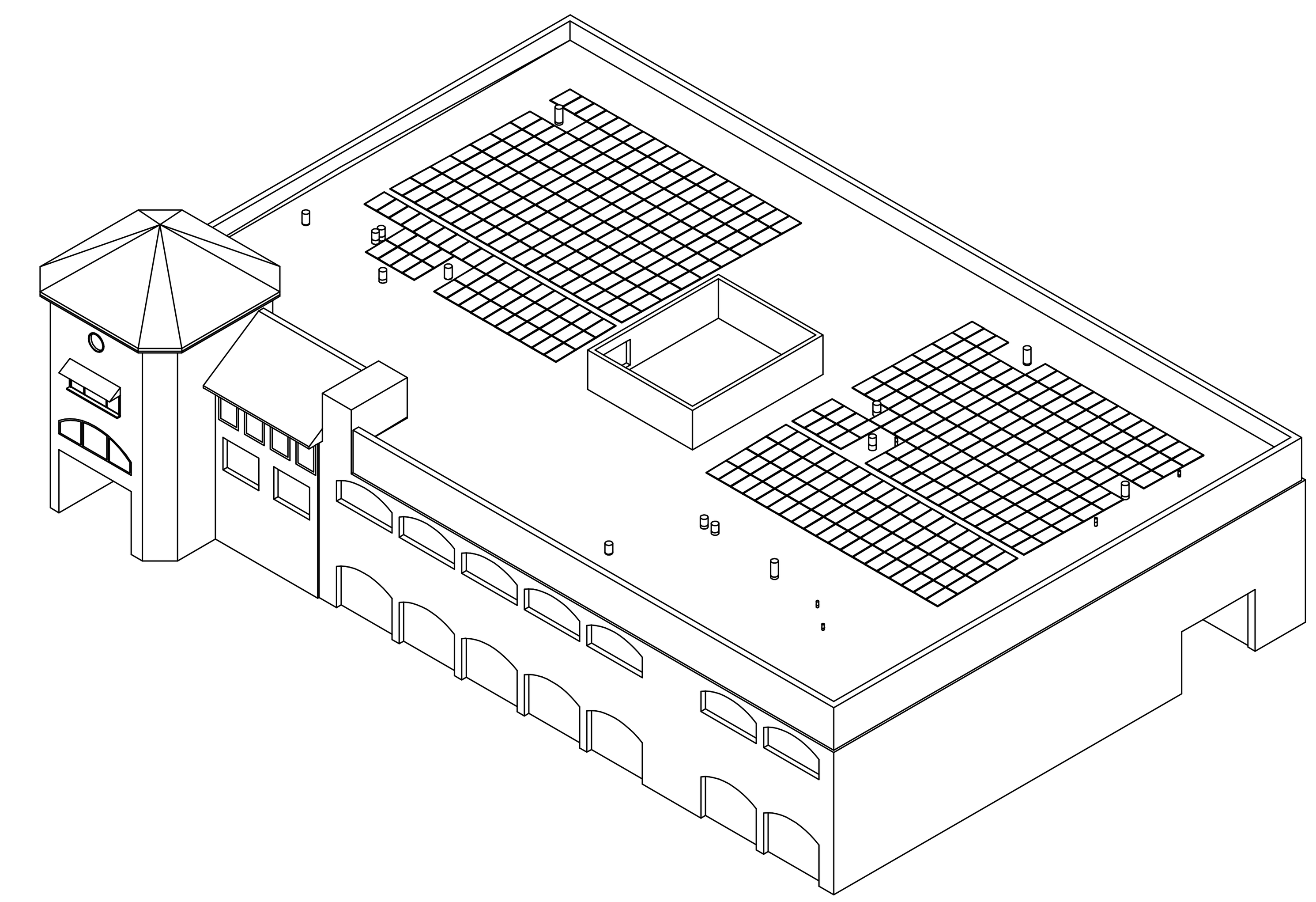
Location Maps:

Aerial View:



Installation Preview:



Index:

Permitting/Planning Notes:

SCOPE OF WORK:

INSTALLATION OF STRUCTURAL ATTACHMENTS AND RACKING FOR GRID-TIED PHOTOVOLTAIC SYSTEM

EXISTING COMMERCIAL BUILDING ALTERATION LEVEL 2

CODE SUMMARY		
STATE:	BUILDING:	ELECTRICAL:
FLORIDA	2017 FBC	2014 NEC

REVISIONS:

Project: ANYTOWNHALL

Address: MAINSTREET FLORIDA, USA

COVER

COMMERCIAL PROJECT BUILDING

GRID-TIE SOLAR PV SYSTEM

SEAL:

EDUARDO R. BAS
FLORIDA P.E. 77463
PUERTO RICO P.E. 17485

FULLY COMPLIES WITH THE REQUIREMENTS OF NEC 690.

DATE: 5/3/2019

SCALE: NTS

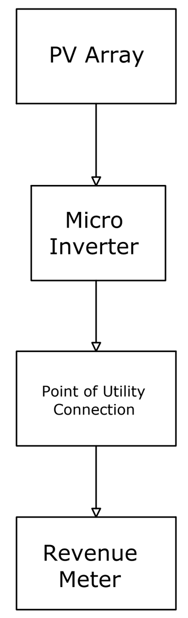
DRAWN BY: BASEL ENGINEERING SERVICES

PAGE: G-1

System Description	
Roof type	Concrete
System type	Grid-Tied Photovoltaic System
Total STC rated DC Power output	141750.00 W
Inverter type	Enphase IQ-7 Micro-Inverter
Inverter #	450
PV module type	LG NeON 2 Black 315W
PV module #	450
Solar Breaker Box	Regular Load Center
Service rating	600.00 A
Inverter characteristics	Maximum Power Point Tracking (MPPT)
	Meets requirements of 3-P Power
	Meets UL1741
All electrical equipment installed are UL listed	

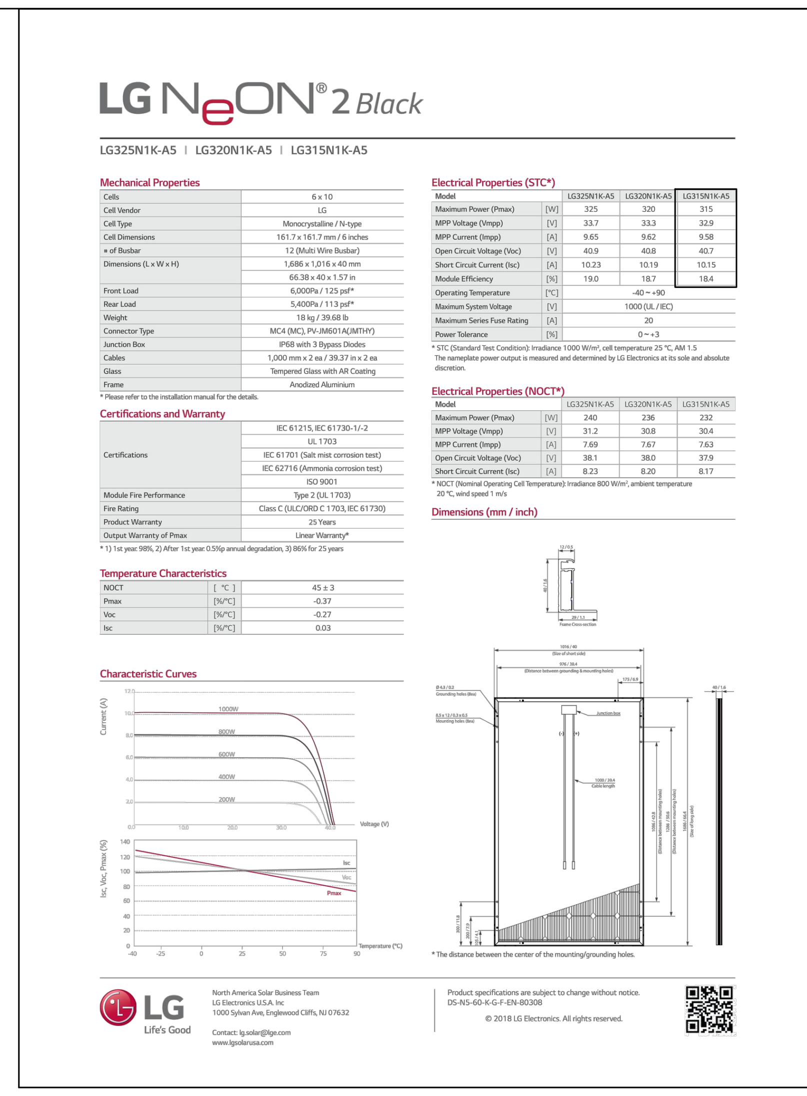
Item	Manufacturer	Model	Listing / Compliance
PV modules	LG NeON 2 Black 315W	315W	UL 1703
Inverters	Enphase	IQ-7	UL 1741
All overcurrent protection	Enphase	DC & AC	UL LISTED

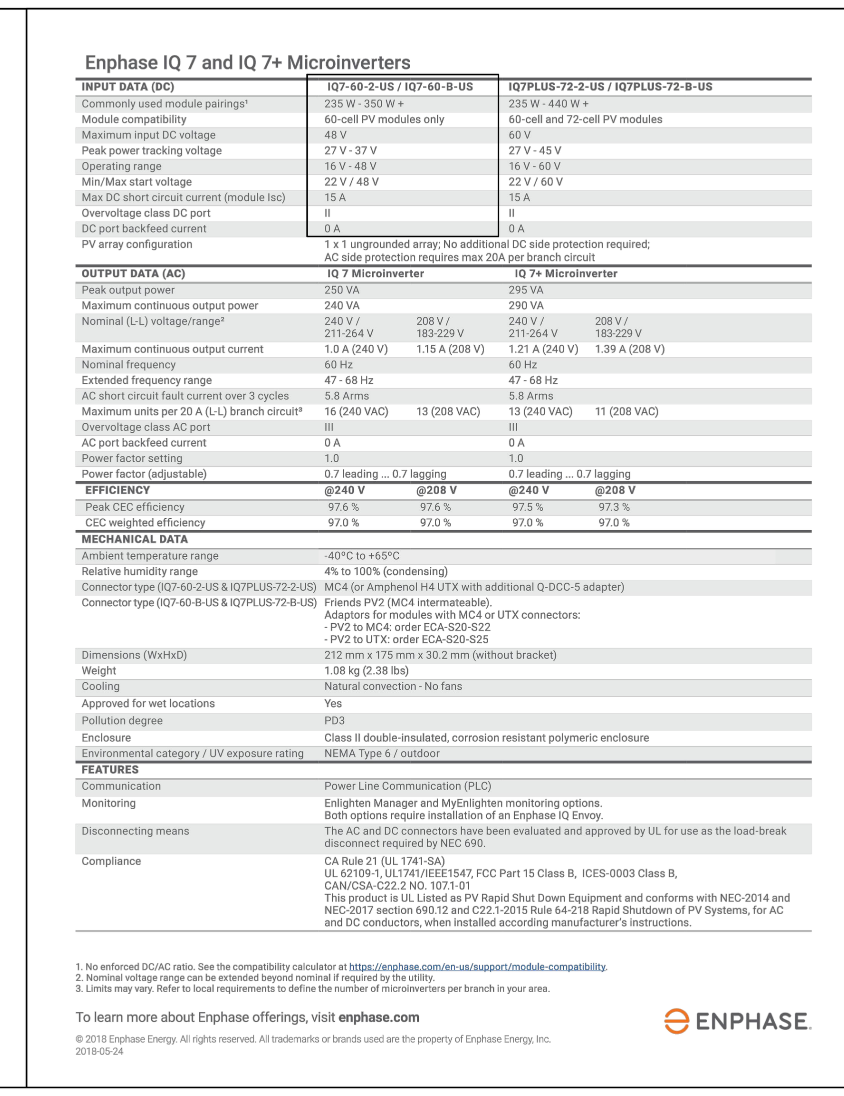
System automatic operation diagram

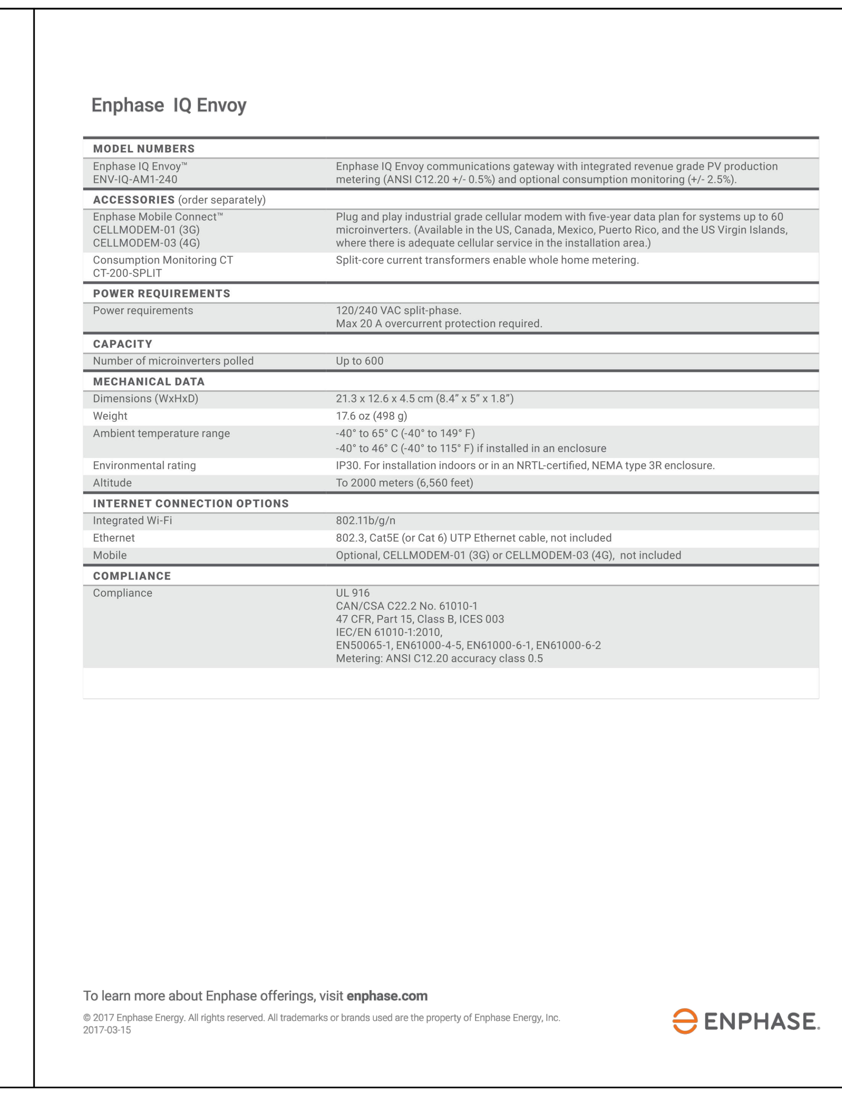


SYSTEM AUTOMATIC OPERATION

1. Grid power is present, photovoltaic system feeds the load at day time.
2. Grid power is lost, photovoltaic system automatically disconnects from the grid.
3. Photovoltaic system will automatically resume feeding power to the grid when the proper voltage and frequency is restored (IEEE Standards) and there is enough sunlight.



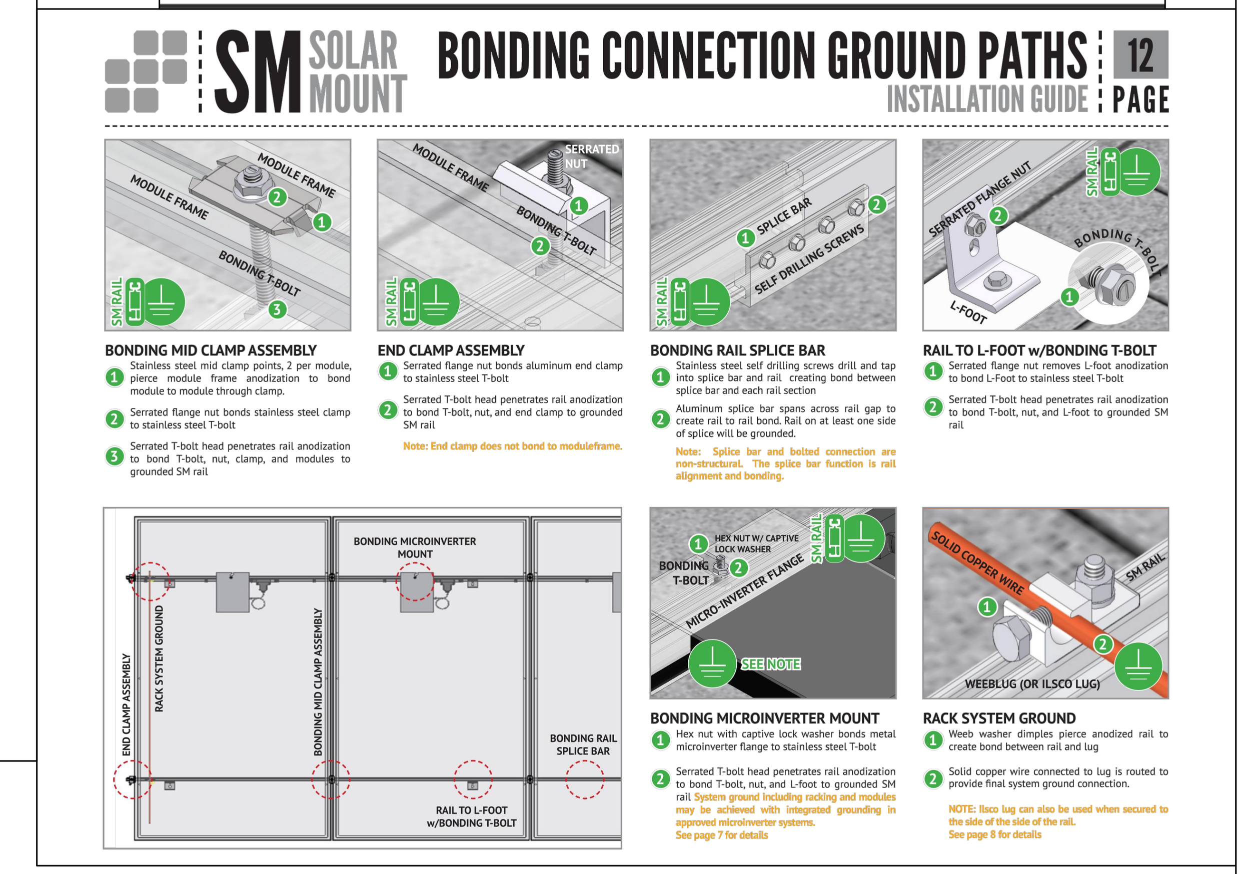




Q CABLE SPECIFICATIONS	
Voltage rating	600V (connector rating 250 V)
Cable temperature rating	90° C (194° F)
Certification	UL3003, DG cable
Flame test rating	FT4
Compliance	RoHS, OIL RES I, CE, UV resistant, combined UL for Canada and United States
Cable insulator rating	THHN/THWN-2 dry/wet

Q CABLE TYPES / ORDERING OPTIONS

Model Number	Max Nominal Voltage	Connector Spacing	PV Module Orientation	Connector Count per Box
Q-12-10-240	250 VAC	1.3 m (4.2 ft)	Portrait	240
Q-12-17-240	250 VAC	2.0 m (6.5 ft)	Landscape (60-cell)	240
Q-12-20-200	250 VAC	2.3 m (7.5 ft)	Landscape (72-cell)	200



Wire ampacity and conduit size calculations	NOTE 1			NOTE 2			NOTE 3		
	QTY	SIZE	TYPE	QTY	SIZE	TYPE	QTY	SIZE	TYPE
Raceway	1	1 inch.	PVC SCH 80	1	2-1/2 inch.	PVC SCH 80	1	1-1/2 inch.	EMT or PVC SCH 80
Current carrying conductors	8	#10	THWN-2 CU	3	3/0	THWN-2 CU	3	#1	THWN-2 CU
Neutral	Not applicable			1	3/0	THWN-2 CU	Not applicable		
EGC/GEC	1	#8	THWN-2 CU	1	#6	THWN-2 CU	1	#6	THWN-2 CU
OCPD	1	OCPD = 20A	Breaker	1	OCPD = 200A	Fuse	1	OCPD = 90A	Fuse

Conductor sizing calculation	**Branch Circuit**	**Main AC Circuit 120/208V**	**Main AC Circuit 277/480V**
Maximum current:	Inverter circuit output = 14.95A	Combined Inverter Output = 156.1A	Combined Inverter Output = 67.7A
Continuous circuit current	Inv. Output x 1.25 = 18.7A	Inv. Output x 1.25 = 195.2A	67.7A x 1.25 = 84.6A
Terminal Temperature requirements:	60° C: 310.15 (B)(16) = 30A ≥20A O.C.P.D.	75° C: 310.15 (B)(16) = 200A ≥200A O.C.P.D.	75° C: 310.15 (B)(16) = 130A ≥ 90A O.C.P.D.
Conductor ampacity:	90° C: 310.15 (B)(16) = 40A ≥20A O.C.P.D.	90° C: 310.15 (B)(16) = 225A ≥200A O.C.P.D.	90° C: 310.15 (B)(16) = 145A ≥ 90A O.C.P.D.
Ambient Temperature:	91°F (33°C)	91°F (33°C)	91°F (33°C)
Temperature adder for conduit height per 310.15(B)(3)(C):	Distance between 3-1/2" & 12" = 30°F	Distance between 3-1/2" & 12" = 30°F	Distance between 3-1/2" & 12" = 30°F
Temperature & Derate per 310.15(B)(2)(a):	121°F = 82%	121°F = 82%	121°F = 82%
Conductors in raceway & Derate per 310.15(B)(3)(a):	8 Current carrying = 70%	3 Current carrying = 100%	3 Current carrying = 100%
Total Conductor derate:	70% X 82% = 57.4%	82% X 100% = 82%	82% X 100% = 82%
Conductor derated ampacity	40A X 57.4% = 22.96A > 20A	225A X 82% = 184.5A > 156.1A	130A X 82% = 106.6 > 67.7A
OCPD Size & Asso. EGC/GEC:	20A OCPD W/ #8 EGC/GEC	200A OCPD W/ #6 EGC/GEC	90A OCPD W/ #6 EGC/GEC
Conductor derated ampacity & OCPD ampacity	#10 WIRE IS OK ON A 20A OCPD	3/0 WIRE IS OK ON A 200A OCPD	#1 IS OK ON A 90A OCPD

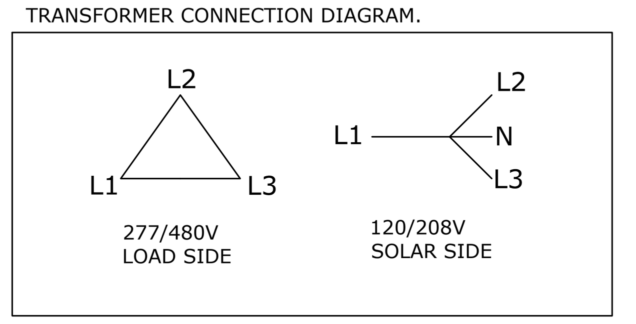
A #6 grounding conductor is specified by NEC 250.120(C), but a #8 conductor may be used if protected from physical damage.

Point of interconnection	
Type of connection	Line side tap
Install	Perform a Line Side Tap at the line side of the Main Breaker. Use Insulated cable connectors.
Supply-Side connection (Line-side connection): Section 705.12 (A) allows for the interconnection of power production sources to the supply side of the service disconnecting means. The condition is that the sum of the overcurrent protection devices (OCPDs) from the PV system connected to the service conductors cannot exceed the rating of the service conductors. Section 705.12 (D)(2) is intended to protect the busbar from overcurrents and it will be only apply when a Load side tap is performed.	
Solar OCPD rating	90 A
Rating of service conductors (Table 310.15 (B)(16))	335 A
Rating of service conductors > Solar OCPD rating	YES
Labels in accordance with NEC 690.64 (B)(7)	

NOTES:

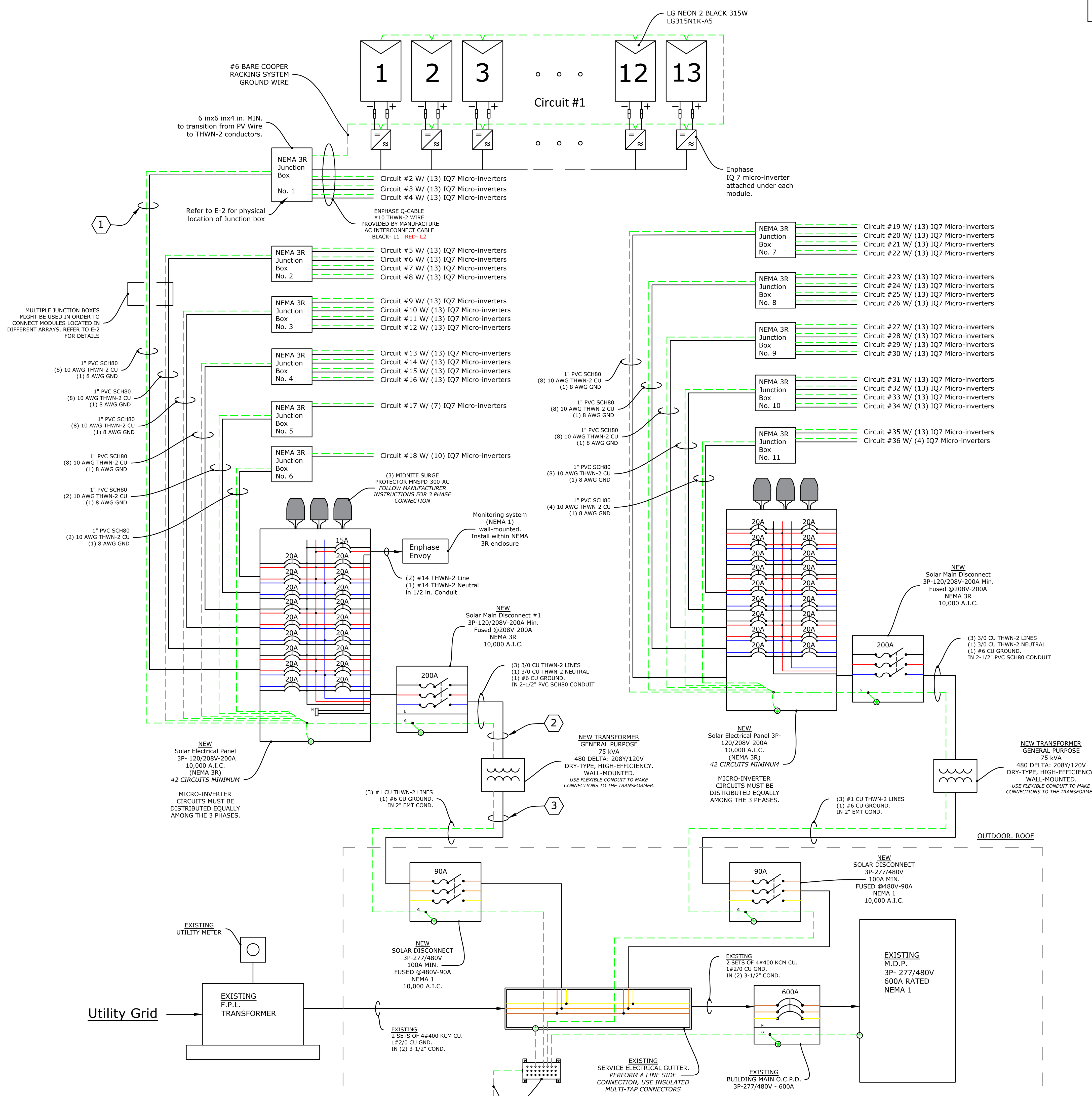
1. Type of connection: **Line Side Tap**
2. All conduits running on the roof surface will have a distance greater than 3-1/2 inch from roof to bottom of conduit.
3. Splice/Taps in gutter shall comply with NEC 376
4. Conductors in Parallel shall comply with NEC 310.10 (H)
5. Refer to E-2 for location of Junction boxes and equipments.
6. Every branch circuit will be protected by a 2P- 20A Breaker unless otherwise specified.
7. Electrical conduits could be installed inside the building by using flexible metal conduits or outside the building by using PVC SCH80 conduits. (If running outside, distance above roof to bottom of conduit shall be greater than 3-1/2 in.).

TRANSFORMER CONNECTION DIAGRAM.



Rapid Shutdown of PV System by NEC 2014 Section 690.12:

- Enphase Microinverter Systems fully meet the rapid shutdown requirement without the need to install additional electrical equipment. Properly labeling the PV system power source and rapid shutdown ability is required per NEC Section 690.56 (B) and (C).
- Solar electrical PV systems with Enphase Microinverters have one utility-interactive inverter directly underneath each solar module, converting low voltage DC to utility grid-compliant AC. When the utility grid is available and the sun is shining, each microinverter verifies that the utility grid is operating within the IEEE 1547 requirements. Only then does it export AC power into the electric service for use by loads onsite or export power to the utility grid for others to use. When the utility grid has a failure, or the PV system AC circuits are disconnected from the utility service via an AC breaker, AC disconnect, or removal of the solar or main utility service meter, the microinverters stop producing AC power in fewer than six AC cycles. Enphase Microinverters are not capable of operating as an AC voltage source. **This means that without an AC utility source, Enphase Microinverters are not able to energize connected wiring and no AC voltage or current can be injected into the inverter output circuits or the grid.**

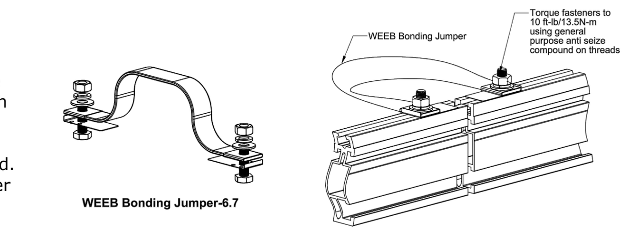


1 E.1 System Riser diagram
Scale: NTS

The NEC gives you the choice of four methods for ensuring electrical continuity at service equipment, service raceways, and service conductor enclosures (250.92 (B)):

1. **Bonding jumpers:** Bond metal parts to the service neutral conductor. This requires a main bonding jumper (250.24 (B) and 250.28). Because the service neutral conductor provides the effective ground-fault current path to the power supply (250.24(C)), you do not have to install an equipment grounding conductor within PVC conduit containing service-entrance conductors (250.142 (A) (1) and 352.60 Ex 2).
2. **Threaded fittings.** Terminate metal raceways to metal enclosures by threaded hubs on enclosures (if made wrenchtight).
3. **Threadless fittings:** Terminate metal raceways to metal enclosures by threadless fittings (if made tight).
4. **Other listed devices:** These include bonding-type locknuts, bushings, wedges, or bushings with bonding jumpers.

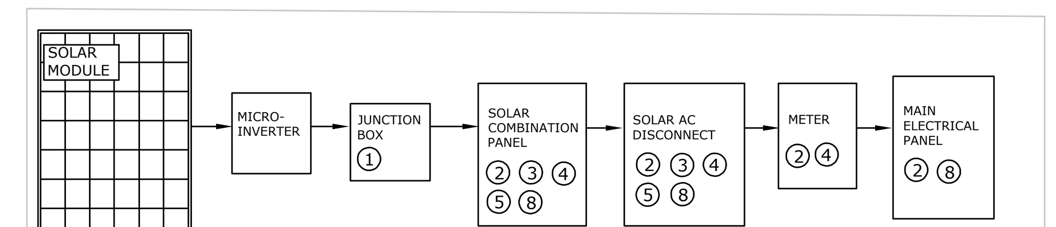
Bonding between rails is achieved by using **Bonding Rail Splice Bar.**
- Stainless steel self drilling screws drill and tap into splice bar and rail creating bond between splice bar and each rail section.
- Although is is not necessary, for extra grounding connection UNIRAC Weeb Bonding Jumper can be used.
  * Use general purpose anti-seize compound on fastener threads when installing WEEBs.
  * WEEBs are intended for SINGLE USE ONLY.



NOTE:
1. **Ground Fault Protection:** In an Enphase system, ground fault protection is provided in the microinverter. In the Enphase Microinverters with integrated grounding, the ground fault protection is provided by a ground fault sensing circuit. The microinverter itself has a Class II double-insulated rating, which includes ground fault protection (GFP). It can be reset using the Enphase Envoy
2. **Maximum circuit voltage on Cold Temperature:** Open circuit voltage for the solar module used is equal or less than 40.7 V and the maximum input DC voltage of the Micro-inverter Enphase IQ7 is 48 V. Table 690.7 requires the open circuit voltage of the solar array to be multiplied by 1.12 (using 23 Degrees F).
   40.7V x 1.12 = 45.6 V
   45.6 V < 48 V
   This shows that in terms of maximum voltage, the micro-inverter will perform correctly.

LABELS

TYPE AND LOCATION



THIS NUMBERS CORRELATE TO THE NUMBERS ON THE TOP LEFT CORNER OF THE LABELS BELOW.

NEC 690.31(G)(3) APPLY TO AC JUNCTION BOXES
1
CAUTION
PV OUTPUT CIRCUIT

NEC 690.54 APPLY PERMANENT LABEL TO MAIN ELECTRICAL PANEL, METER & SOLAR DISCONNECT.
2
WARNING
DUAL POWER SUPPLY
SOURCES: UTILITY GRID AND PV SOLAR ELECTRIC SYSTEM
AC output current 90 A
AC operating voltage 277/480V

NEC 690.05 APPLY TO MAIN ELECTRICAL PANEL
3
WARNING
WARNING: ELECTRIC SHOCK HAZARD. IF A GROUND FAULT IS INDICATED, NORMALLY GROUNDED CONDUCTORS MAY BE UNGROUNDED AND ENERGIZED.

LABEL NOTES:
1. LABELS MUST COMPLY WITH NEC 110.21: ADEQUATE MARKING, PERMANENTLY AFFIXED AND SUFFICIENT DURABILITY.
2. LABELS AND MARKINGS SHALL BE APPLIED TO THE APPROPRIATE COMPONENTS AND IN THE APPROPRIATE WAY IN ACCORDANCE WITH THE NEC.
3. OSHA 1910.145 AND ANSI Z535 SPECIFICATIONS ARE RECOMMENDED BUT NOT REQUIRED.
   3.1. LABELS SHALL HAVE ROUNDED CORNERS
   3.2. LABELS SHALL BE VISIBLE AT A MINIMUM OF 5 FT
   3.3. "WARNING" LABEL BACKGROUND SHALL BE IN ORANGE.
   3.4. "NOTICE" LABEL SHALL BE IN BLUE.

NEC 690.31 APPLY TO CONDUIT & RACEWAY
4
PHOTOVOLTAIC POWER SOURCE

NEC 690.17(E) APPLY TO AC COMBINER SOLAR LOAD CENTER & MAIN ELECTRICAL PANEL
5
WARNING
ELECTRIC SHOCK HAZARD
DO NOT TOUCH TERMINALS. TERMINALS ON BOTH THE LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION.

NEC 690 APPLY TO ELECTRICAL PANELS, AT THE LOCATION OF THE SOLAR BREAKERS.
6
PHOTOVOLTAIC SOLAR BREAKER

APPLY TO ELECTRICAL PANELS, AT THE LOCATION OF THE SOLAR BREAKERS.
7
DO NOT RELOCATE THIS OVERCURRENT DEVICE

NEC 690.56(C) APPLY TO SOLAR ELECTRICAL PANEL, MAIN ELEC. PANEL AND ALL SERVICE DISCONNECTS.
8
PHOTOVOLTAIC SYSTEM EQUIPPED WITH RAPID SHUTDOWN

NOTE:
All load calculations for this panel have been done and this change will not exceed code.

REVISIONS:

Project: ANYTOWNHALL
Address: MAINSTREET FLORIDA, USA
ELECTRICAL DIAGRAM & CALCULATIONS

COMMERCIAL PROJECT BUILDING
GRID-TIE SOLAR PV SYSTEM

SEAL:

EDUARDO R. BAS
FLORIDA P.E. 77463
PUERTO RICO P.E. 17485

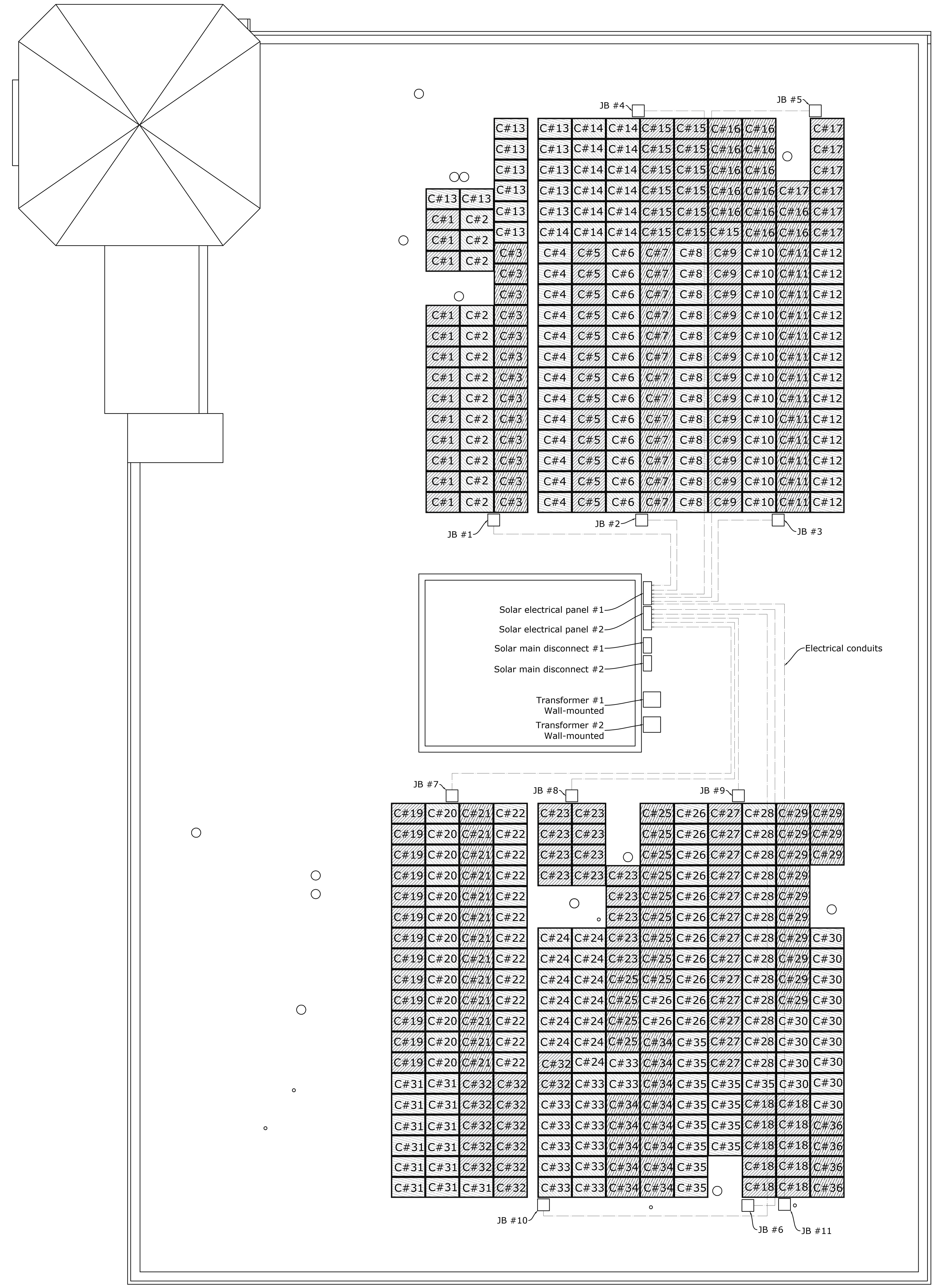
FULLY COMPLIES WITH THE REQUIREMENTS OF NEC 690.

DATE: 5/3/2019

SCALE: NTS

DRAWN BY: BASEL ENGINEERING SERVICES

PAGE: E-1



1
E.2
Electrical layout
Scale: N.T.S.

REVISIONS:

Project: ANYTOWNHALL

Address: MAINSTREET FLORIDA, USA

ELECTRICAL LAYOUT

COMMERCIAL PROJECT BUILDING

GRID-TIE SOLAR PV SYSTEM

SEAL:

EDUARDO R. BAS
FLORIDA P.E. 77463
PUERTO RICO P.E. 17485

FULLY COMPLIES WITH THE REQUIREMENTS OF NEC 690.

DATE:
5/3/2019

SCALE: AS SHOWN

DRAWN BY: BASEL ENGINEERING SERVICES

PAGE:
E-2

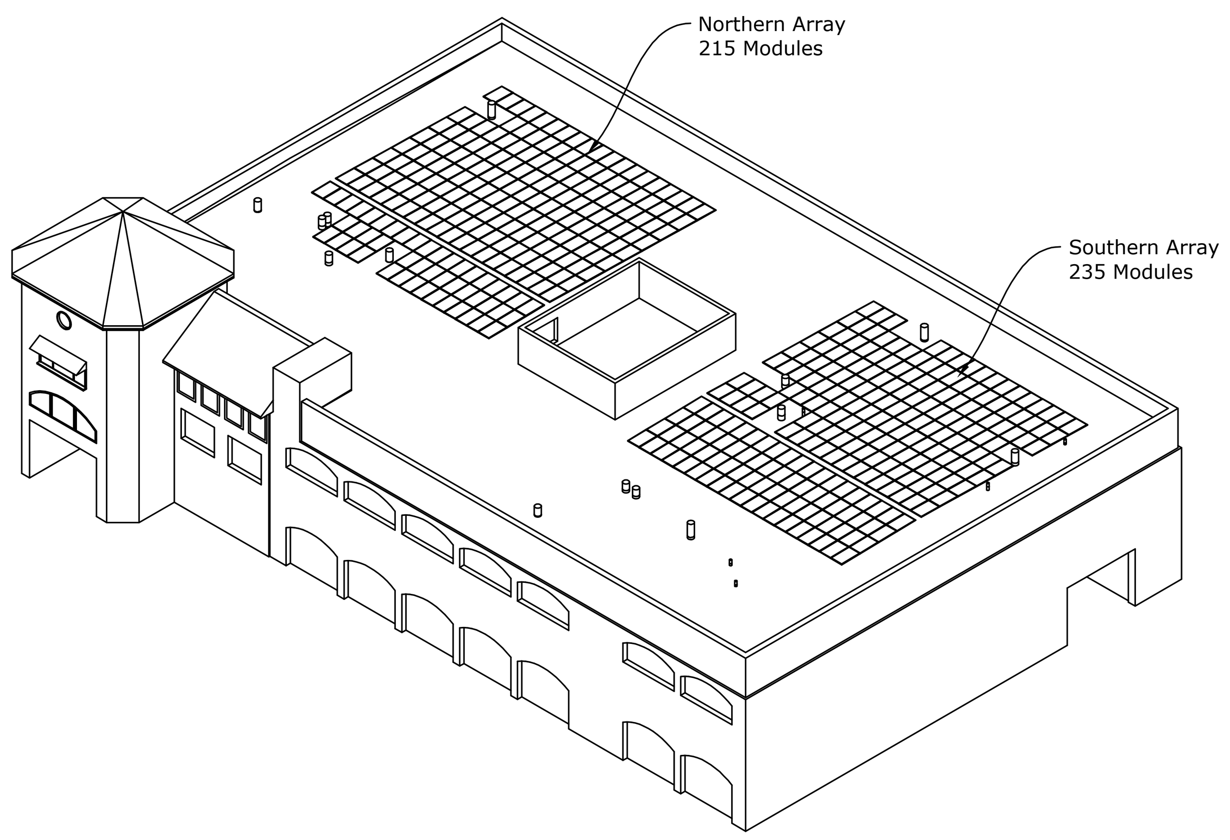
Roof Area	
Existing roof	Concrete
Total number of modules	450
Total roof mounts	660
Total roof area	23000 sq-ft
Total photovoltaic area	8249 sq-ft
Mean roof height	40.2 ft
Roof slope	0:12
Point of connections per module	6
Aluminum rails per module	3

Width of Zone 2 and Zone 3 according to ASCE7-10:	
Least horizontal dimension	128 ft
10% of the least horizontal dimension	12.8 ft
Building mean roof height	40.2 ft
40% of the height of building	16.08 ft

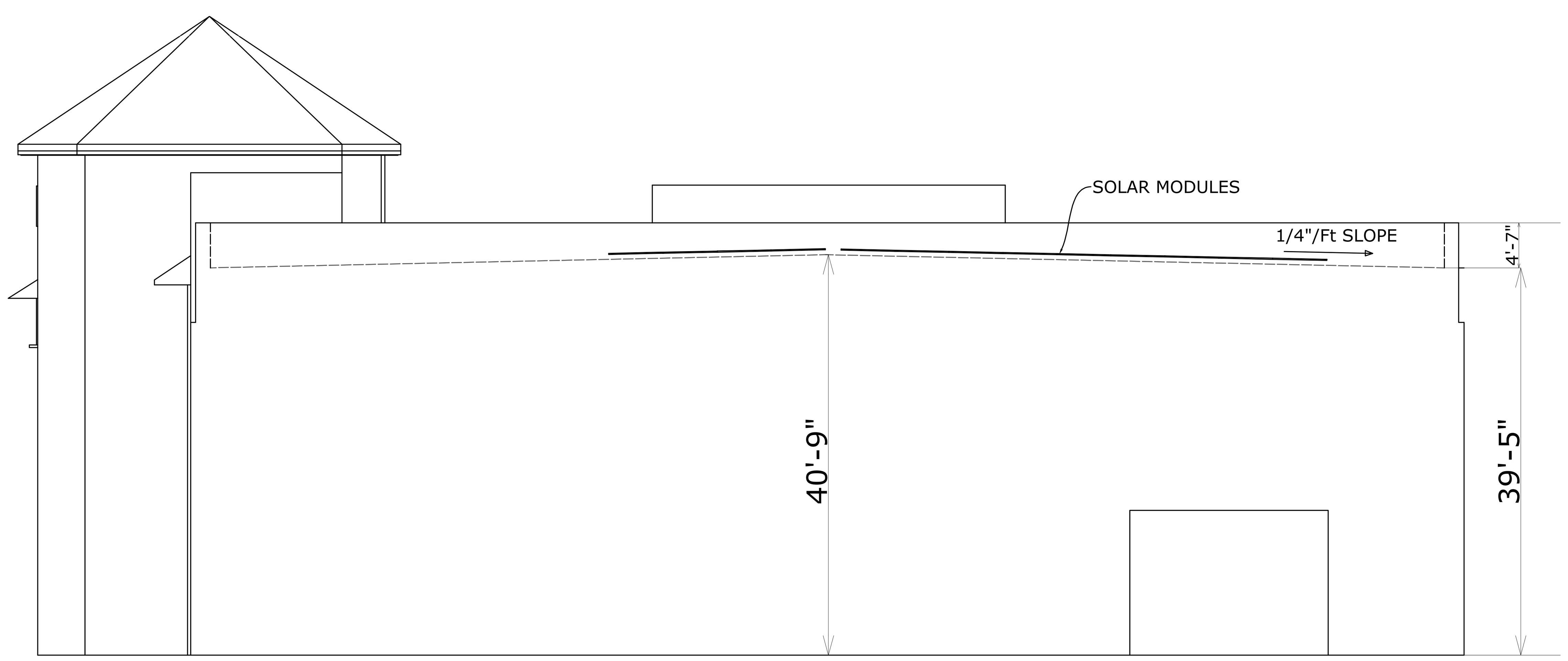
Never less than 3'.

Notes:

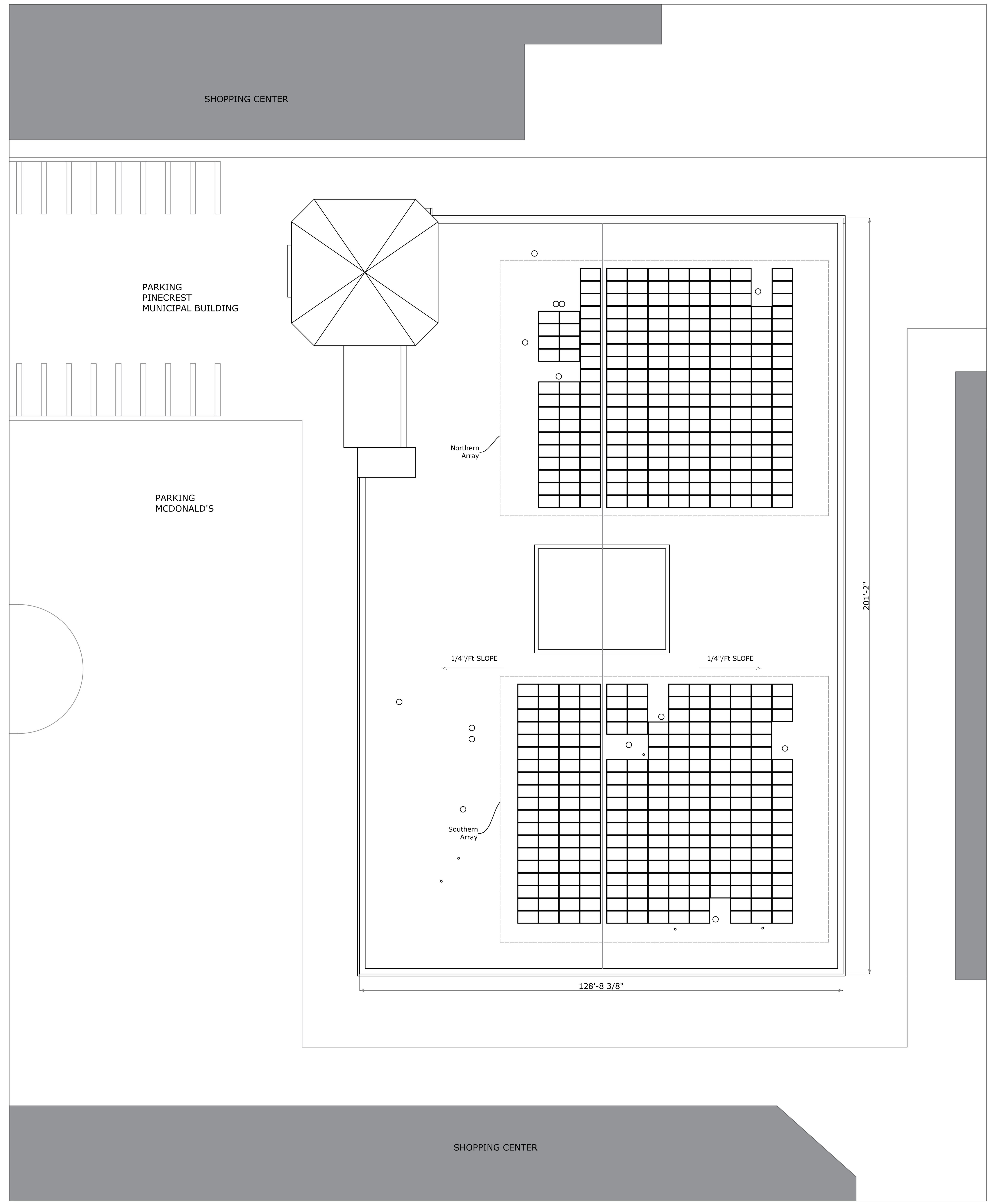
- Install mid clamps between modules and end clamps at the end of each row of modules.
- Aluminum Rails should always be supported by more than one footing on both sides of the splice.
- For connections between PV components refer to E-1.
- Per 690.34 Junction boxes located behind modules or panels shall be so installed that the wiring contained in them can be rendered accessible directly or by displacement of a module(s) secured by removable fasteners and connected by a flexible wiring system.
- Electrical conduits could be installed inside the building by using flexible metal conduits or outside the building by using PVC SCH80 or EMT conduits. (If running outside, distance above roof to bottom of conduit shall be greater than 3-1/2 in.).
- When a system has modules in Zone 1 and Zone 2, structural calculations for the system will be performed assuming that all the modules are located in Zone 2.



3 / S.1 Isometric View
Scale: 1/32" - 1'



2 / S.1 South Elevation
Scale: 3/32" - 1'



N

1 / S.1 Site plan
Scale: 1/16" - 1'

REVISIONS:

Project: ANYTOWNHALL

Address: MAINSTREET FLORIDA, USA

STRUCTURAL DIAGRAMS

COMMERCIAL PROJECT BUILDING

GRID-TIE SOLAR PV SYSTEM

SEAL:

EDUARDO R. BAS
FLORIDA P.E. 77463
PUERTO RICO P.E. 17485

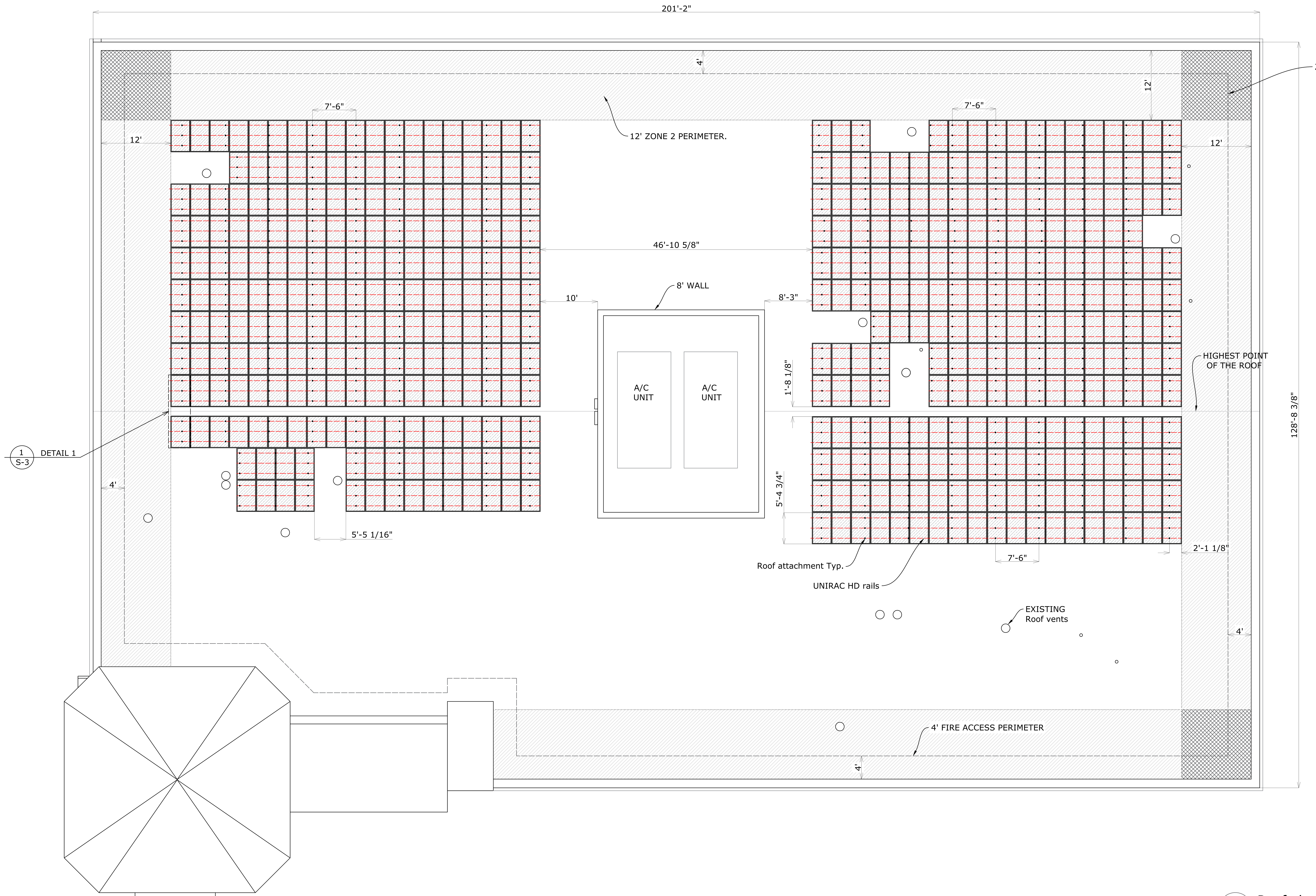
FULLY COMPLIES WITH THE REQUIREMENTS OF NEC 690.

DATE: 5/3/2019

SCALE: AS SHOWN

DRAWN BY: BASEL ENGINEERING SERVICES

PAGE: S-1



N
1
S.2
Roof plan
Location of PV components
Scale: 1/8" - 1'

REVISIONS:

Project: ANYTOWNHALL

Address: MAINSTREET FLORIDA, USA

ROOF PLAN

COMMERCIAL PROJECT BUILDING

GRID-TIE SOLAR PV SYSTEM

SEAL:

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FLORIDA P.E. 77463
PUERTO RICO P.E. 17485

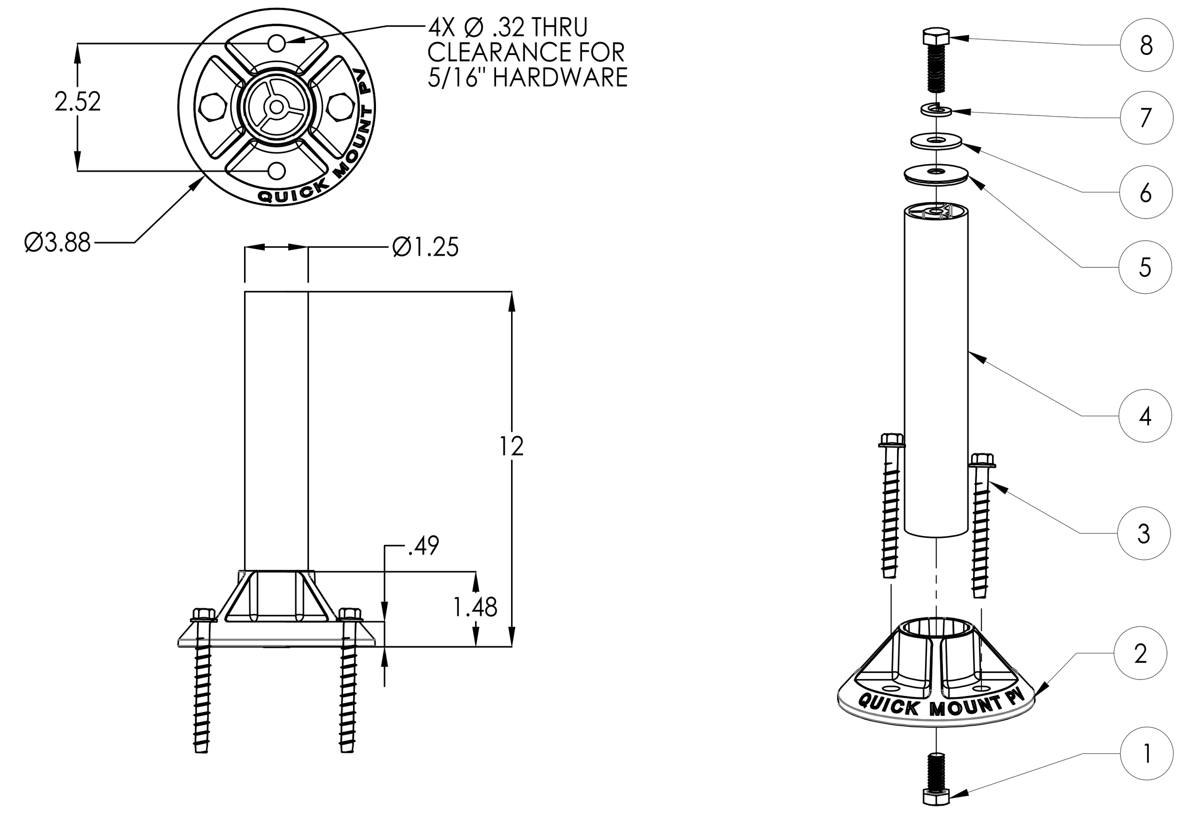
FULLY COMPLIES WITH THE REQUIREMENTS OF NEC 690.

DATE:
5/3/2019

SCALE: AS SHOWN

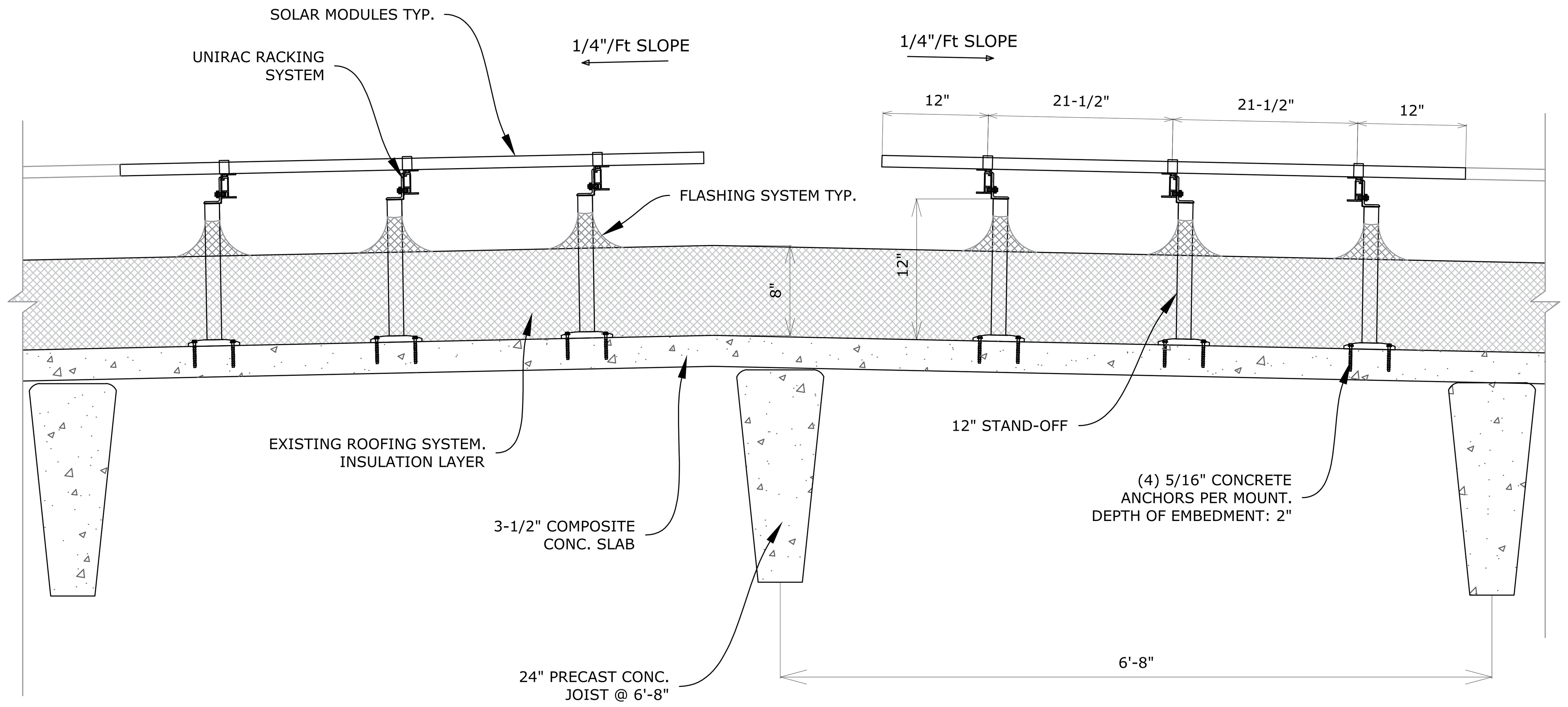
DRAWN BY: BASEL ENGINEERING SERVICES

PAGE:
S-2



ITEM NO.	DESCRIPTION	QTY.
1	CAP SCREW, HEX HEAD, 5/16"-18 X 3/4" UNC-2A, GRADE 8	1
2	QBASE, 1-1/4" ID, FOR 5/16" HARDWARE, A360 CAST AL	1
3	CONCRETE ANCHOR, HEX HEAD, 5/16" X 3"	4
4	POST, 1.25" OD X 11.5", 6063-T5/6063-T6, MILL	1
5	WASHER, SEALING, 5/16" ID X 1-1/4" OD, EPDM BONDED SS	1
6	WASHER, FENDER, 5/16" ID X 1" OD, 18-8 SS	1
7	WASHER, SPLIT-LOCK, 5/16" ID, 18-8 SS	1
8	CAP SCREW, HEX HEAD, 5/16"-18 X 1" UNC-2A, 18-8 SS	1

2 / S-3 STANDOFF DETAIL
SCALE: N.T.S.

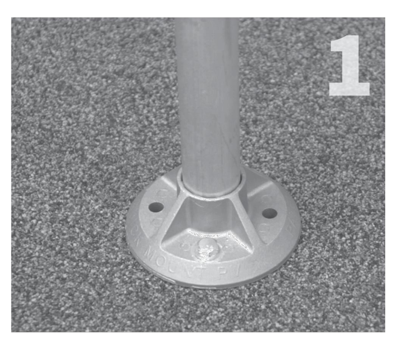


1 / S-3 DETAIL 1
SCALE: 1" = 1'

QBase Low Slope Mount | QMLSH

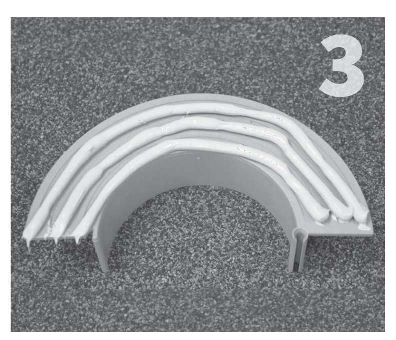
Waterproofing with Chem Link's E-Curb Penetration Seal System

Materials Required: Chem Link's 5" E-Curb, M-1 Structural Adhesive/Sealant, 1-Part Pourable Sealant

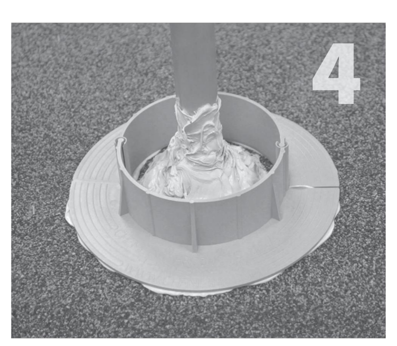


Install QBase to structural member. For more details refer to the QBase Low Slope installation instructions.

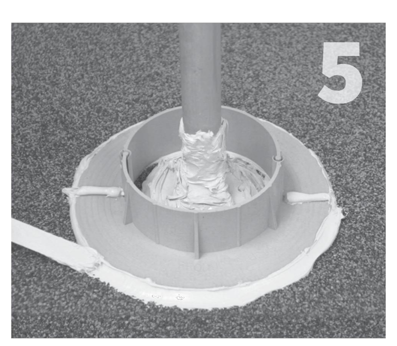
Seal around the base of mount using Chem Link's M-1. Coat the QBase, bolts and post with M-1 to 3" above roof line.



Apply three ¼" beads of M-1 to the flat base of both E-Curb sections.



Place E-Curb sections to form a circle around the QBase, making sure to lock them together. Press firmly in place until excess adhesive extrudes from the outside edges.



Apply M-1 around circumference of E-Curbs and where the two sections intersect. Use the wooden spatula to spread the sealant to form a smooth surface.

Fill the E-Curb cavity to the top with Chem Link's 1-Part solution.

For use on: granulated modified bitumen, asphalt and coal tar B.U.R. (built up roofing), PVC, PIB, and TPO single ply roofing membranes. TPO Primer is required for use with TPO.

NOTE: Be sure to thoroughly read and follow manufacturer instructions for installing Chem Link's E-Curb Penetration System. Find instructions here: www.chemlink.com/e-curb

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Jan-2017, Rev 1

GENUINE & ORIGINAL ULTRACON® MASONRY FASTENERS MADE IN THE U.S.A.

ELCO®

Overview

5/16" UltraCon® Masonry Fastening System

5/16" Diameter UltraCon® Fasteners For Heavy-Duty Applications

Now the proven performance of the UltraCon® masonry fastening system is available in a new 5/16" diameter anchor. This larger size provides increased shear and tensile strength to meet the needs of more demanding applications in poured concrete, block, and brick, including:

- metal door framing
- shelving and racking
- shutter systems
- window frames
- cable trays
- pipe supports

Installation is fast and easy with Elco® masonry bits and 516 installation tools. When all three elements of the fastening system are used, consistent performance and maximum pull-out strengths can be realized.

UltraCon fasteners from Elco Construction Products are coated with silver Stalgard® finish to provide superior corrosion resistance.

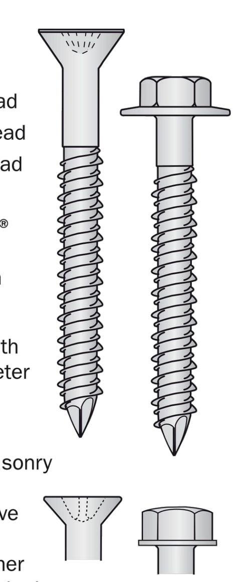
Don't rely on standard-sized fasteners in non-standard applications. Choose the fastener designed for the job – the new 5/16" UltraCon® fastener from Elco Construction Products.

Head Styles:
- Hex head with oversized washer
- Phillips flat head
- TrimFit® hex head
- TrimFit® flat head

Finish
- Silver Stalgard® corrosion-resistant finish

Packaging
- Packed bulk with one 1/4 diameter drill bit

Installation
- 1/4" Elco® masonry drill bits and 516 drive sleeve (ELP400) for use with hammer drills. Hex-shanked SDS bits also available.



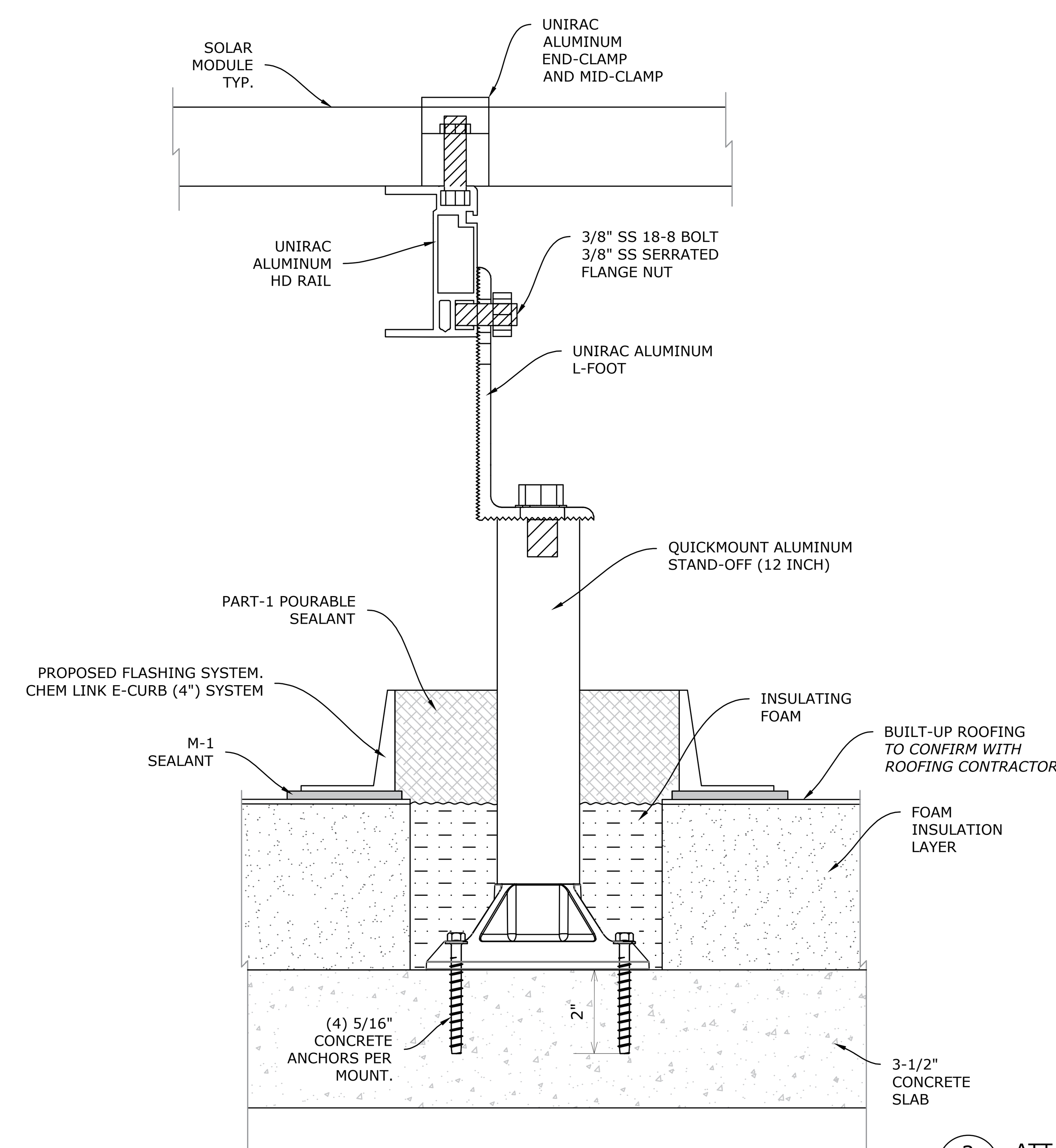
PULL-OUT AND SHEAR VALUES

Anchor Diameter	Depth of Embedment	Hollow Block (1,872 p.s.i)		Concrete (3,513 p.s.i.)		Wood (specific gravity: .55)	
		pull-out	shear	pull-out	shear	pull-out	shear
5/16"	1"	–	–	851	1801	1454	1188
	1-1/4"	1145	1454	–	–	–	–
	1-1/2"	–	–	–	–	2472	1677
	1-3/4"	–	–	2643	3404	–	–
	2"	–	–	3347	–	3233	2407

NOTE: Indicated pullout and shear failure values were obtained in tests witnessed by independent test labs (see below). These figures are offered only as a guide and are not guaranteed in any way by Elco Construction Products. A safety factor of 4:1, or 25% of ultimate pullout value, is generally accepted as a safe working load; however, reference should always be made to applicable codes for the specific safe working ratio. Strength testing performed by Hurricane Engineering and Testing, Inc. (HETI) Miami, FL; Report Nos. HETI-01-5063 (wood), HETI-01-5069 (hollow block), and HETI-01-5013 (concrete).

For more information, please contact: Elco Construction Products

1-800.435.7213
www.elcoconstruction.com



3 / S-3 ATTACHMENT DETAIL
SCALE: N.T.S.

REVISIONS:

Project: ANYTOWNHALL

Address: MAINSTREET FLORIDA, USA

STRUCTURAL DETAILS

COMMERCIAL PROJECT BUILDING

GRID-TIE SOLAR PV SYSTEM

SEAL:

EDUARDO R. BAS
FLORIDA P.E. 77463
PUERTO RICO P.E. 17485

FULLY COMPLIES WITH THE REQUIREMENTS OF NEC 690.

DATE:
5/3/2019

SCALE: AS SHOWN

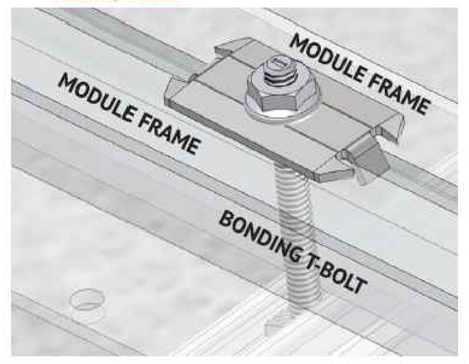
DRAWN BY: BASEL ENGINEERING SERVICES

PAGE:
S-3

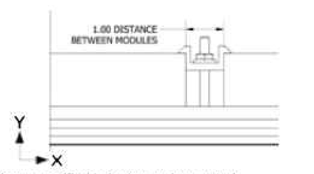
SOLARMOUNT Technical Datasheets

UNIRAC
A HILTI GROUP COMPANY

SolarMount Mid Clamp
Part No. 302101C, 302101D, 302103C, 302104D, 302105D, 302106D



- **Mid clamp material:** One of the following extruded aluminum alloys: 6005-T5, 6105-T5, 6061-T6
- **Ultimate tensile:** 38ksi, Yield: 35 ksi
- **Finish:** Clear or Dark Anodized
- **Mid clamp weight:** 0.050 lbs (23g)
- Allowable and design loads are valid when components are assembled according to authorized UNIRAC documents
- Values represent the allowable and design load capacity of a single mid clamp assembly when used with a SolarMount series beam to retain a module in the direction indicated
- Assemble mid clamp with one Unirac ¼"-20 T-bolt and one ¼"-20 ASTM F594 serrated flange nut
- Use anti-seize and tighten to 10 ft-lbs of torque
- Resistance factors and safety factors are determined according to part 1 section 9 of the 2005 Aluminum Design Manual and third-party test results from an IAS accredited laboratory



Dimensions specified in inches unless noted

Applied Load Direction	Average Ultimate lbs (N)	Allowable Load lbs (N)	Safety Factor, FS	Design Load lbs (N)	Resistance Factor, Φ
Tension, Y+	2020 (8987)	891 (3963)	2.27	1348 (5994)	0.667
Transverse, Z±	520 (2313)	229 (1017)	2.27	346 (1539)	0.665
Sliding, X±	1194 (5312)	490 (2179)	2.44	741 (3295)	0.620

SolarMount End Clamp
Part No. 302001C, 302002C, 302002D, 302003C, 302003D, 302004C, 302004D, 302005C, 302005D, 302006C, 302006D, 302007D, 302008C, 302008D, 302009C, 302009D, 302010C, 302011C, 302012C

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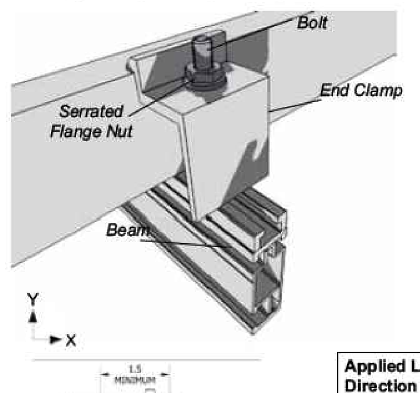
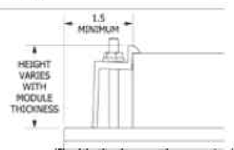


- **End clamp material:** One of the following extruded aluminum alloys: 6005-T5, 6105-T5, 6061-T6
- **Ultimate tensile:** 38ksi, Yield: 35 ksi
- **Finish:** Clear or Dark Anodized
- **End clamp weight:** varies based on height: ~0.058 lbs (26g)
- Allowable and design loads are valid when components are assembled according to authorized UNIRAC documents
- Values represent the allowable and design load capacity of a single end clamp assembly when used with a SolarMount series beam to retain a module in the direction indicated
- Assemble with one Unirac ¼"-20 T-bolt and one ¼"-20 ASTM F594 serrated flange nut
- Use anti-seize and tighten to 10 ft-lbs of torque
- Resistance factors and safety factors are determined according to part 1 section 9 of the 2005 Aluminum Design Manual and third-party test results from an IAS accredited laboratory
- Modules must be installed at least 1.5 in from either end of a beam



Dimensions specified in inches unless noted

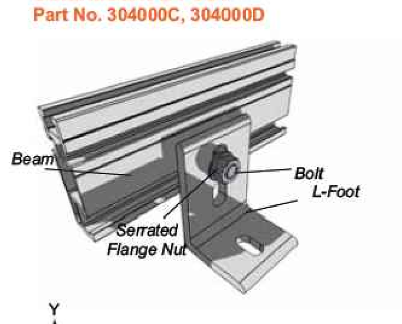
Applied Load Direction	Average Ultimate lbs (N)	Allowable Load lbs (N)	Safety Factor, FS	Design Loads lbs (N)	Resistance Factor, Φ
Tension, Y+	1321 (5876)	529 (2352)	2.50	800 (3557)	0.605
Transverse, Z±	63 (279)	14 (61)	4.58	21 (92)	0.330
Sliding, X±	142 (630)	52 (231)	2.72	79 (349)	0.555

SOLARMOUNT Technical Datasheets

UNIRAC
A HILTI GROUP COMPANY

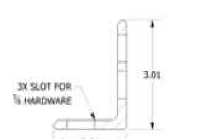
SolarMount Beam Connection Hardware

SolarMount L-Foot
Part No. 304000C, 304000D



- **L-Foot material:** One of the following extruded aluminum alloys: 6005-T5, 6105-T5, 6061-T6
- **Ultimate tensile:** 38ksi, Yield: 35 ksi
- **Finish:** Clear or Dark Anodized
- **L-Foot weight:** varies based on height: ~0.215 lbs (98g)
- Allowable and design loads are valid when components are assembled with SolarMount series beams according to authorized UNIRAC documents
- **For the beam to L-Foot connection:**
  - •Assemblewithone ASTMF593⅜"-16hexheadscrewandone ASTMF594⅜"serratedflangenut
  - •Useanti-seizeandtightento30ft-lbsoftorque
- Resistance factors and safety factors are determined according to part 1 section 9 of the 2005 Aluminum Design Manual and third-party test results from an IAS accredited laboratory

NOTE: Loads are given for the L-Foot to beam connection only; be sure to check load limits for standoff, lag screw, or other attachment method



Dimensions specified in inches unless noted

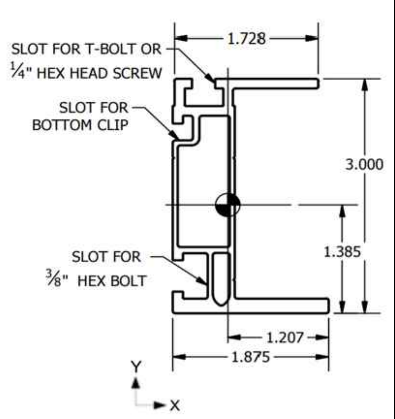
Applied Load Direction	Average Ultimate lbs (N)	Allowable Load lbs (N)	Safety Factor, FS	Design Load lbs (N)	Resistance Factor, Φ
Sliding, Z±	1766 (7856)	755 (3356)	2.34	1141 (5077)	0.646
Tension, Y+	1859 (8269)	707 (3144)	2.63	1069 (4755)	0.575
Compression, Y-	3258 (14492)	1325 (5893)	2.46	2004 (8913)	0.615
Traverse, X±	486 (2162)	213 (949)	2.28	323 (1436)	0.664

SOLARMOUNT Technical Datasheets

UNIRAC
A HILTI GROUP COMPANY

SolarMount Beams
Part No. 310132C, 310132C-B, 310168C, 310168C-B, 310168D 310208C, 310208C-B, 310240C, 310240C-B, 310240D, 410144M, 410168M, 410204M, 410240M

Properties	Units	SolarMount	SolarMount HD
Beam Height	in	2.5	3.0
Approximate Weight (per linear ft)	plf	0.811	1.271
Total Cross Sectional Area	in²	0.676	1.059
Section Modulus (X-Axis)	in³	0.353	0.898
Section Modulus (Y-Axis)	in³	0.113	0.221
Moment of Inertia (X-Axis)	in⁴	0.464	1.450
Moment of Inertia (Y-Axis)	in⁴	0.044	0.267
Radius of Gyration (X-Axis)	in	0.289	1.170
Radius of Gyration (Y-Axis)	in	0.254	0.502



SolarMount HD Beam

Table 14. L-Foot SOLARMOUNT Series Rail Span
Unirac Code-Compliant Installation Manual PG.26

SM - SOLARMOUNT **HD - SOLARMOUNT Heavy Duty**

Span (ft)	20	25	30	40	50	60	80	100	120	140	160	180	200	220	240	260
	Distributed Load (pounds/linear foot)															
2	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM
2.5	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	HD	HD	HD
3	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	HD	HD	HD	HD	HD
3.5	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	HD	HD	HD	HD		
4	SM	SM	SM	SM	SM	SM	SM	SM	SM	HD	HD	HD	HD			
4.5	SM	SM	SM	SM	SM	SM	SM	SM	HD	HD	HD					
5	SM	SM	SM	SM	SM	SM	SM	SM	HD	HD	HD					
5.5	SM	SM	SM	SM	SM	SM	SM	HD	HD	HD						
6	SM	SM	SM	SM	SM	SM	SM	HD	HD							
6.5	SM	SM	SM	SM	SM	SM	SM	HD	HD							
7	SM	SM	SM	SM	SM	SM	HD	HD								
7.5	SM	SM	SM	SM	SM	SM	HD	HD								
8	SM	SM	SM	SM	SM	SM	HD									
8.5	SM	SM	SM	SM	SM	HD	HD									
9	SM	SM	SM	SM	HD	HD	HD									
9.5	SM	SM	SM	SM	HD	HD	HD									
10	SM	SM	SM	HD	HD	HD	HD									
10.5	SM	SM	SM	HD	HD	HD										
11	SM	SM	HD	HD	HD	HD										
11.5	SM	HD	HD	HD	HD	HD										
12	SM	HD	HD	HD	HD	HD										

Determine the *Distributed Load, w (plf)*, by multiplying the module length, B (ft), by the *Total Design Load, P (psf)* and dividing by three. Use the maximum absolute value of the three downforce cases and the Uplift Case. We assume each module is supported by three rails.
w = PB/3
w = Distributed Load (pounds per linear foot, plf)
B = Module Length Perpendicular to Rails (ft)
P = Total Design Pressure (pounds per square foot, psf)

PULL-OUT AND SHEAR VALUES

Anchor Diameter	Depth of Embedment	Hollow Block (1,872 p.s.i) pull-out	Hollow Block (1,872 p.s.i) shear	Concrete (3,513 p.s.i.) pull-out	Concrete (3,513 p.s.i.) shear	Wood (specific gravity: .55) pull-out	Wood (specific gravity: .55) shear
5/16"	1"	–	–	851	1801	1454	1188
	1-1/4"	1145	1454	–	–	–	–
	1-1/2"	–	–	–	–	2472	1677
	1-3/4"	–	–	2643	3404	–	–
	2"	–	–	3347	–	3233	2407

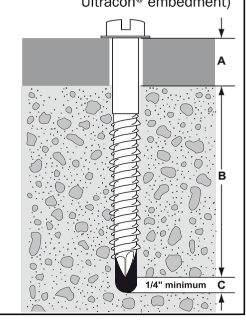
INSTALLATION

The 5/16" Ultracon® masonry fastening system consists of the Ultracon® fastener, the 516 installation tool and an Elco® carbide-tipped drill bit. Consistent performance and maximum pullout strength can be assured only when all three elements of the system are properly used.

Fastener Length and Diameter: The length of the Ultracon fastener to be used is determined by combining the thickness of the attachment (A) with the desired depth of embedment in the masonry material (B). It is recommended that a minimum of 1" and a maximum of 1-3/4" embedment be used in determining fastener length.

A = attachment thickness
B = Ultracon® embedment (min. of 1", max. of 1-3/4")
A + B = Ultracon® length
B + C = hole depth (must be at least 1/4" deeper than Ultracon® embedment)

Hole Depth: A 1/4" Elco carbide-tipped drill bit is supplied with each box of 5/16" Ultracon® fasteners. The correct hole depth (B & C) can normally be obtained by drilling the full length of this bit. In all cases, the hole must be at least 1/4" deeper than the depth of the fastener embedment. Normal safety precautions should be observed when drilling the holes to avoid electrical installations, other utilities and reinforcement bars.



Hole Diameter: The diameter of the drilled hole is also important to the performance of the Ultracon® masonry fastening system. To provide proper hole diameters, Elco® carbide-tipped drill bits are manufactured to closer standards than those called for in the American National Standard. Using Elco® carbide-tipped bits will help assure consistent fastener performance and maximum pullout strength.

Wind Load Calculations

Velocity Pressure (ASCE 7-10 (30.3.2))

Qz = 0.00256 Kz Kzt Kd V^2 (lb/sq-ft)

Exposure category	C
Kz (Velocity pressure exposure)	1.04
Kzt (Topographic factor)	1
Kd (Wind directionality factor)	0.85
V (Wind Speed)	186
Mean height	40.2
Qz (Velocity pressure)	**78.64**
Applying ASD Design Load Factor (0.6)	**47.19**

Design Wind Pressures (ASCE 7-10 (30.4.2))

p = Qz (GCp) - Qz (GCpi) (lb/ sq-ft) (N/ sq-meter)

Effective wind area (ASCE 7-10 (26.2))

Component	Area (sq-ft)
Solar Modules	18.33
Racking system (Smallest area of continuous modules on a run of rails.)	293.28
Mounts	1

Internal Pressure Coefficient (GCpi) (ASCE 7-10 (C26.11))

Uplift	-0.18
Downward	0.18

External Pressure Coefficient (GCp) (ASCE 7-10 Figure 30.4 -2B)

Solar Modules

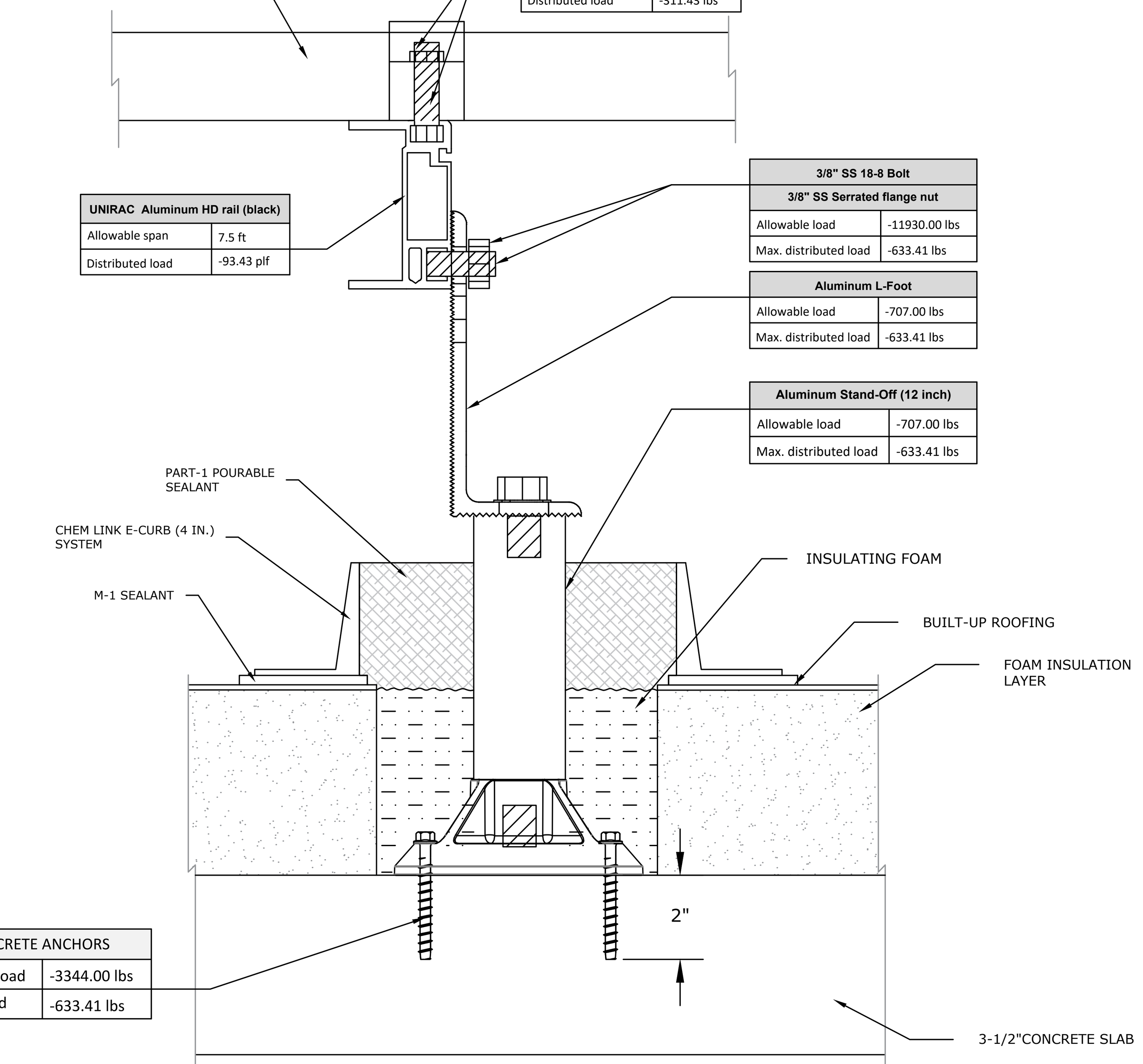
Zones	Uplift	Downward
1	-0.98	0.3
2	-1.68	0.3
3	-2.5	0.3
Total wind load (psf)		
1	**-54.74**	22.65
2	**-87.77**	22.65
3	**-126.46**	22.65

Racking System

Zones	Uplift	Downward
1	-0.90	0.2
2	-1.10	0.2
3	-1.10	0.2
Total wind load (psf)		
1	**-50.96**	17.93
2	**-60.40**	17.93
3	**-60.40**	17.93

Mounts

Zones	Uplift	Downward
1	-0.9	0.5
2	-1.7	0.5
3	-2.6	0.5
Total wind load (psf)		
1	**-50.96**	32.09
2	**-88.71**	32.09
3	**-131.18**	32.09



Solar module	
Max. rated wind load	-112.00 psf
Wind load applied	-54.74 psf
Max. load per panel	-1003.50 lbs

UNIRAC Aluminum PRO end-clamp	
Allowable load	-529.00 lbs
Distributed load	-155.72 lbs
UNIRAC Aluminum PRO mid-clamp	
Allowable load	-891.00 lbs
Distributed load	-311.43 lbs

UNIRAC Aluminum HD rail (black)	
Allowable span	7.5 ft
Distributed load	-93.43 plf

3/8" SS 18-8 Bolt	
3/8" SS Serrated flange nut	
Allowable load	-11930.00 lbs
Max. distributed load	-633.41 lbs

Aluminum L-Foot	
Allowable load	-707.00 lbs
Max. distributed load	-633.41 lbs

Aluminum Stand-Off (12 inch)	
Allowable load	-707.00 lbs
Max. distributed load	-633.41 lbs

5/16" CONCRETE ANCHORS	
Total allowable load	-3344.00 lbs
Max. requed load	-633.41 lbs

1 / S-4 ATTACHMENT DETAIL
Allowable and max. loads
SCALE: N.T.S.

Total Design Load Calculation

This procedure is based on the UNIRAC Code-Compliant Installation Manual, Part II, Step 1. "Determine the Total Design Load". *ASCE 7-10 (2.4.1)*

For this particular case, only the "downforce case 2" and "uplift" have been taken into consideration.

P *(psf)* = 1xD + 1x *Pnet* (Downforce)

P *(psf)* = 0.6xD + 1x *Pnet* (Uplift)

(P = Total Design Load)
(Pnet = Wind Load)
(D = Dead Load)
* *Pnet have been calculated following the Allowable Stress Design method.*

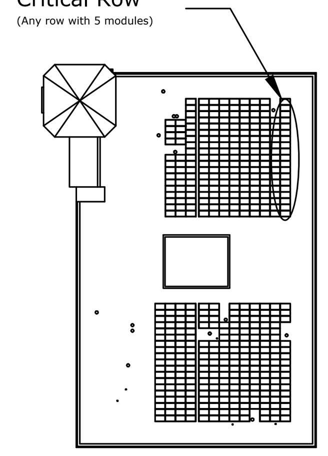
The maximum absolute value of the 2 cases is the Uplift Load. This value have been used for sizing the mounts.

Dead load of the critical row

Components	Weight / Unit	#
Solar module	39.70 Lbs	19
Micro-Inverters	4.00 Lbs	19
Rails	80.43 Lbs	3
Mounts	0.22 Lbs	27.0
Total Weight		1077.4 lbs
Total Area		348.33 sq-ft
Dead Load		**3.09 psf**

Total Design Load on Mounts	**-49.11 psf**

Critical Row
(Any row with 5 modules)



NOTE: The Critical row will contain the highest load per mount.

Mounts load calculations

Solar modules in critical row	19
Total Area	348.27 sq-ft
Wind Load	-49.11 psf
Total Wind Load	-17102.02 lbs
Total Roof Mounts in critical row	27
Tension Force per Mount	-633.41 lbs

CONCRETE ANCHORS, HEX HEAD, 5/16" X 3"	
Allowable load	-836.00 lbs
Number of anchors per mount	4
Total allowable load	-3344.00 lbs
Max. Required load	-633.41 lbs
Safety factor	5.3

Distributed load on the Rails:

The Distributed Load, w (plf) will be determined by multiplying the module length (ft), by the Total Design Load (psf) and dividing by the number of rails for panel.

Distributed load on the rails

Module length perpendicular to rails	5.5 ft
Wind load on rails	-50.96 psf
Number of rails per module	3
Distributed load on the rails	**-93.43 plf**

According to this result, L-Foot maximum spacing can be determined by using "table 14. L-Foot SOLARMOUNT Series Rail Span".

End clamp and Mid clamp load

According to the SOLARMOUNT Technical Datasheets for the End Clamps and Mid Clamps, the following data is obtained:

Allowable Load for Mid Clamp = 891 lbs
Allowable Load for End Clamp = 529 lbs

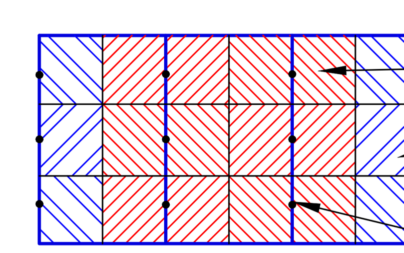
Considering that each Mid Clamp will always be shared with 2 panels, the effective Allowable Load for Mid Clamp will be divided by 2. The weakest area of the array will be the panels held only by Mid Clamps. To determine the distributed load the following procedure has been used:

DL = Mp / (N/2)

DL = Distributed load per Mid Clamp
Mp = Max. wind load (1 sq-ft effective area)
N = Number of Mid Clamps per panel

End-clamps and Mid-clamps load

Allowable load for Mid-clamps	-891.00 lbs
Allowable load for End-clamps	-529.00 lbs
Wind load on clamps (1 sq-ft effective area)	-50.96
Area of module	18.33 sq-ft
Max load over module's area	-934.29 lbs
Distributed load per Mid-clamp	-311.43 lbs
Distributed load per End-clamp	-155.72 lbs



REVISIONS:

Project: ANYTOWNHALL
Address: MAINSTREET FLORIDA, USA
STRUCTURAL CALCULATIONS

COMMERCIAL PROJECT BUILDING
GRID-TIE SOLAR PV SYSTEM

Digitally signed by Eduardo R. Bas Ortiz
Date: 2021.10.20 19:42:26 -04'00'

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FULLY COMPLIES WITH THE REQUIREMENTS OF NEC 690.

DATE: 5/3/2019

SCALE: NTS

DRAWN BY: BASEL ENGINEERING SERVICES

PAGE: S-4