

PROJECT DESCRIPTION

THIS ROOF MOUNTED PHOTOVOLTAIC (PV) SYSTEM IS TO BE INSTALLED AT THE OFFICE BUILDING IN MANHATTAN BEACH, CALIFORNIA. THE ENERGY PRODUCED BY THE PV SYSTEM SHALL BE INTERCONNECTED WITH THE UTILITY GRID THROUGH THE EXISTING ON-SITE ELECTRICAL EQUIPMENT VIA A SUPPLY SIDE CONNECTION IN THE MAIN SERVICE PANEL. THIS PROJECT INCLUDES STORAGE BATTERIES.

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BUILDING SPECIFICATIONS

OCCUPANCY GROUP: B, S-2
 DESCRIPTION OF USE: FIRST & SECOND FLOOR
 OFFICES, PARKING LEVEL 1 CAFÉ, PARKING GARAGE
 TYPE OF CONSTRUCTION: 2A
 SPRINKLERS: YES
 STORIES: 2 + 2 LEVELS OF PARKING
 HEIGHT: 102.6 FT
 FLOOR AREA: 16250 S.F.

SCOPE OF WORK

- (208) PV MODULES (TOTAL: 3,648 SQ. FT.)
 - (1) 24.0 kW INVERTER
 - (2) 20.0 kW INVERTER
- (2) AC BATTERY, 480 VAC, NEMA 3R
- (4) AC DISCONNECT, 600 VAC, NEMA 3R
 - (1) AC DISCONNECT, 240, NEMA 3R
 - (2) LOAD CENTER, 480 VAC, NEMA 3R
- (1) PV METER, 240 VAC, NEMA 3R
- (1) PV MONITOR, 240 VAC, NEMA 1
- (1) GROUNDING TRANSFORMER, NEMA 3R
 - (1) TRANSFORMER, 150 kVA, NEMA 3R,
- PV-SIDE: 480 VAC, UTILITY-SIDE: 120/208 VAC
 - (1) INTERCONNECTION RELAY, NEMA 3R
 - (1) CONTACTOR, 600 VAC, NEMA 3R

SITE SPECIFICATIONS

OCCUPANCY CATEGORY: II
 DESIGN WIND SPEED: 110 MPH
 EXPOSURE CATEGORY: B
 GROUND SNOW LOAD: 0 PSF

GOVERNING CODES

2016 CA ELECTRICAL CODE: § 110, 240, 250, 690, 705
 2016 CA BUILDING CODE: § 1507.17, 1510.7, 3111
 2016 CA FIRE CODE: § 605.11
 UNDERWRITERS LABORATORIES (UL) STANDARDS
 OSHA 29 CFR 1910.269

CONSTRUCTION NOTES

- 1.) CONTRACTOR SHALL FIELD VERIFY ALL DIMENSIONS PRIOR TO INITIATING CONSTRUCTION.
- 2.) CONTRACTOR SHALL REVIEW ALL MANUFACTURER INSTALLATION DOCUMENTS PRIOR TO INITIATING CONSTRUCTION.
- 3.) ALL EQUIPMENT SHALL BE LISTED BY U.L. (OR EQUAL) AND LISTED FOR ITS SPECIFIC APPLICATION.
- 4.) ALL EQUIPMENT SHALL BE RATED FOR THE ENVIRONMENT IN WHICH IT IS INSTALLED.
- 5.) ALL EQUIPMENT SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S INSTALLATION INSTRUCTIONS.
- 6.) ACCESS TO ELECTRICAL COMPONENTS OVER 150 VOLTS TO GROUND SHALL BE RESTRICTED TO QUALIFIED PERSONNEL.
- 7.) ALL CONDUCTORS SHALL BE COPPER, RATED FOR 600 VOLTS AND 90°C WET ENVIRONMENT, UNLESS OTHERWISE NOTED.
- 8.) WHERE SIZES OF JUNCTION BOXES, RACEWAYS, AND CONDUITS ARE NOT SPECIFIED, CONTRACTOR SHALL SIZE THEM ACCORDING TO APPLICABLE CODES.
- 9.) PV MODULE FRAMES SHALL BE BONDED TO RACKING RAIL OR BARE COPPER G.E.C. PER THE MODULE MANUFACTURER'S LISTED INSTRUCTION SHEET.
- 10.) PV MODULE RACKING RAIL SHALL BE BONDED TO BARE COPPER G.E.C. VIA WEEB LUG, ILSCO GBL-4DBT LAY-IN LUG, OR EQUIVLENT LISTED LUG.
 - 11.) GROUNDING ELECTRODE CONDUCTOR (G.E.C.) SHALL BE CONTINUOUS AND/OR IRREVERSIBLY SPLICED/WELDED.
- 12.) ALL JUNCTION BOXES, COMBINER BOXES, AND DISCONNECTS SHALL BE INSTALLED IN AN ACCESSIBLE LOCATION.
- 13.) ROOF ACCESS POINTS SHALL BE AT A STRONG POINT ON THE BUILDING AND NOT REQUIRE THE PLACEMENT OF LADDERS OVER EXTERIOR WALL OPENINGS.
- 14.) WORKING SPACE AROUND ELECTRICAL EQUIPMENT SHALL COMPLY WITH NEC 110.26

Project:
 MANHATTAN BEACH, CA 90266

Project Details:
 74.88 kW_{stc}, 67.93 CEC-kW AC
 AHJ: MANHATTAN BEACH, CITY OF

Engineering Approval:

REVISIONS		
DESCRIPTION	DATE	REV
ORIGINAL	11/27/2017	1
REDLINES	12/6/2017	2
FULL PLANSET	1/8/2017	A

Sheet Title:
 COVER

Sheet Number:
 T1.0

Sheet Size:
 ARCH C - 24" x 18"

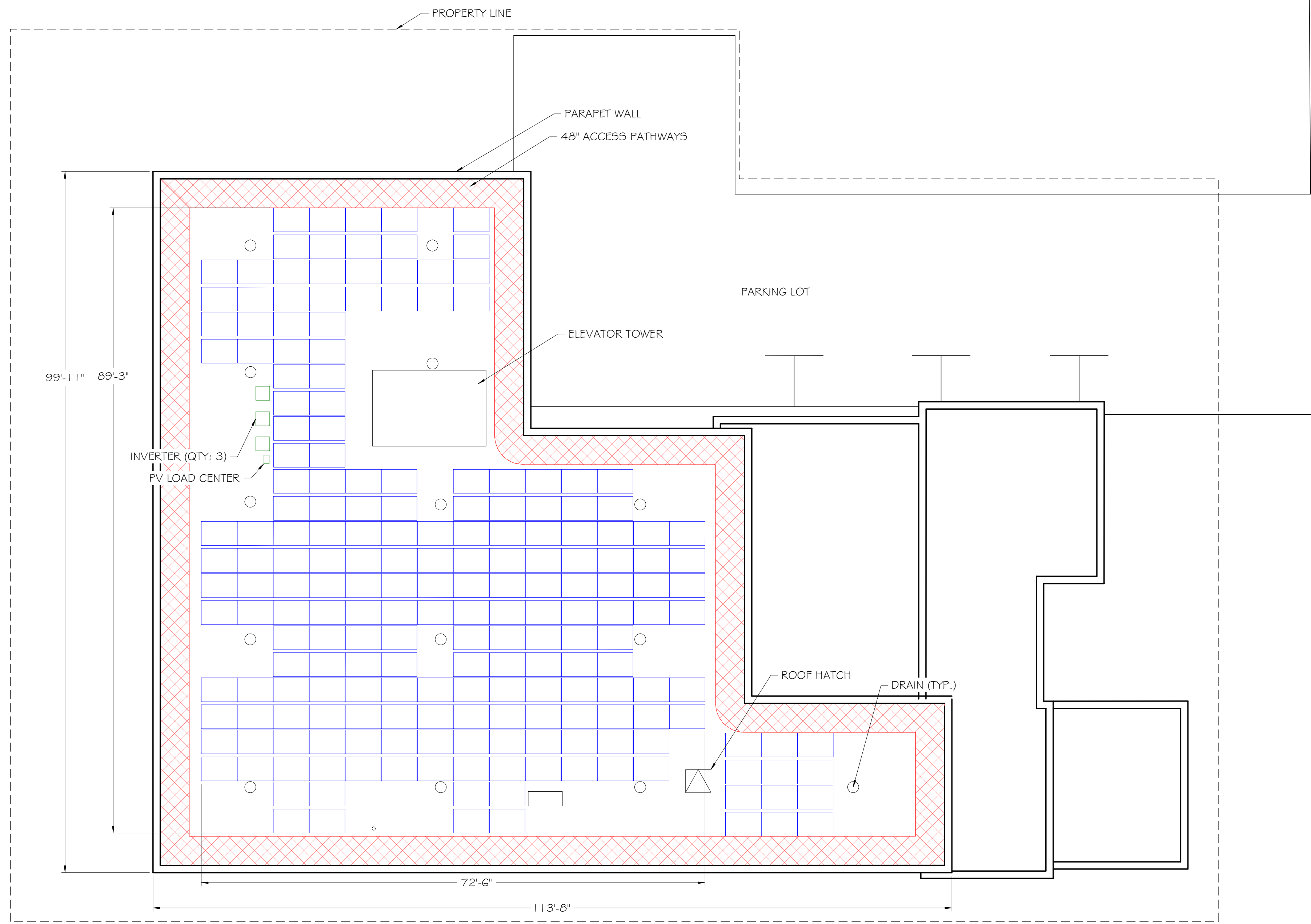
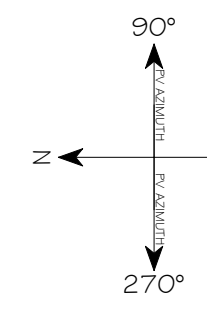
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 TAYLOR BOHLEN 



Reviewed & Approved by:
 RD 

CITY OF MANHATTAN BEACH NOTES:

- 1.) EXTERIOR REMOTE DISCONNECT: AT ROOF TOP DC ARRAY CONDUCTORS THAT ARE ROUTED AND INSTALLED COMPLETELY ON THE EXTERIOR OF THE BUILDING SHALL BE CONTAINED IN GALVANIZED RIGID STEEL CONDUIT FROM ANY PV ARRAY ROOFTOP JUNCTION BOX, FUSIBLE COMBINER BOX, OR FUSIBLE DC DISCONNECT AT ROOFTOP TO THE GROUND LEVEL DC DISCONNECT AND/OR INVERTER. THESE DC ARRAY CONDUCTORS INSTALLED IN GALVANIZED RIGID STEEL CONDUIT NEED TO BE RUN ENTIRELY ON THE EXTERIOR OF THE BUILDING.
- 2.) INTERIOR REMOTE DISCONNECT: DC ARRAY CONDUCTORS THAT ARE ROUTED THROUGH THE BUILDING ARE REQUIRED TO BE IN GALVANIZED RIGID STEEL CONDUIT FROM ANY PV ARRAY ROOFTOP JUNCTION BOX, FUSIBLE COMBINER BOX, OR FUSIBLE DC DISCONNECT THROUGH ANY ATTIC. CONDUIT RUN THROUGH THE INTERIOR OF THE BUILDING SHALL BE INSTALLED A MINIMUM OF 18 INCHES BELOW THE ROOF SURFACE. EMT CONDUIT IS NOT APPROVED FOR EXTERIOR USE OR THE INTERIOR ATTIC SPACE.
- 3.) INSPECTION REQUIRED FOR ROOF CONNECTION MOUNTING ASSEMBLIES PRIOR TO INSTALLING SOLAR MODULE(S).
- 4.) THE ROOF MOUNTED PHOTOVOLTAIC MODULES, PANELS OR SOLAR VOLTAIC ROLL ROOFING MATERIAL SHALL HAVE THE SAME OR BETTER LISTED FIRE-RESISTANCE RATING THAN THE BUILDING ROOF-COVERING MATERIAL



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Sheet Title:
SITE PLAN

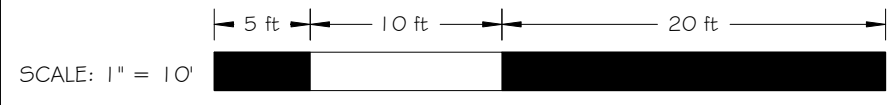
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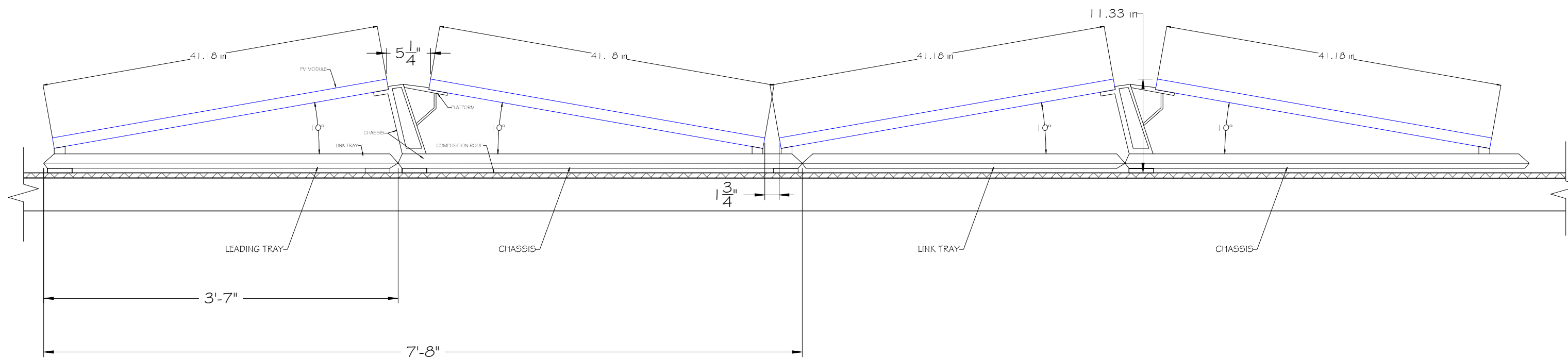
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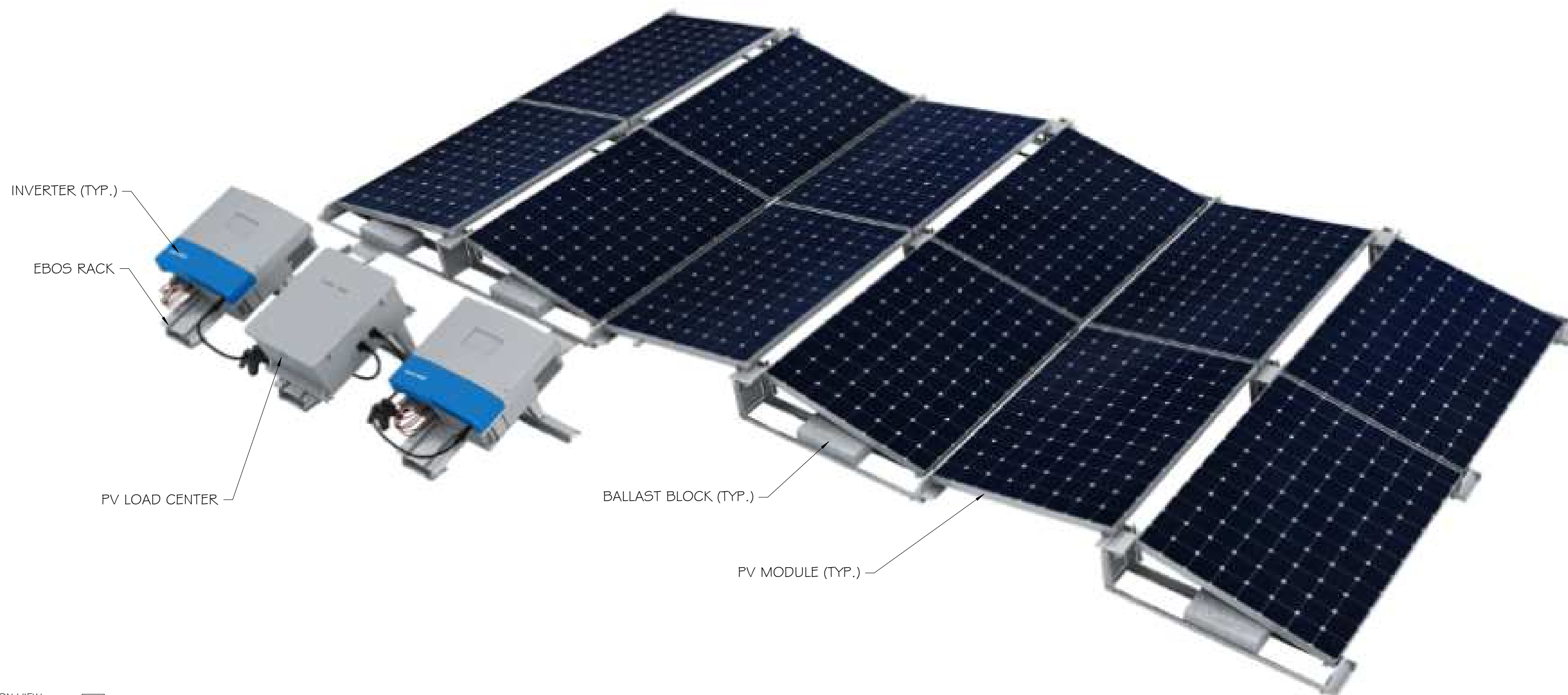


NOTE: NO MODIFICATIONS REQUIRED TO EXISTING DRAINAGE PLAN. NO EXISTING DRAINS COVERED OR INACCESSIBLE FOR CLEANING. SOLAR RACKING ASSEMBLY IS RAISED OFF OF ROOF APPROX. 1/4" WITH 3" x 7" NON-SLIP PADS (A2.0 - 7/8) SO AS TO NOT RESTRICT THE DRAINAGE FLOW.



RACKING DETAIL
SCALE: 1" = 12"

1



RACKING INSTALLATION VIEW
SCALE: N.T.S.

2

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RACKING DETAIL

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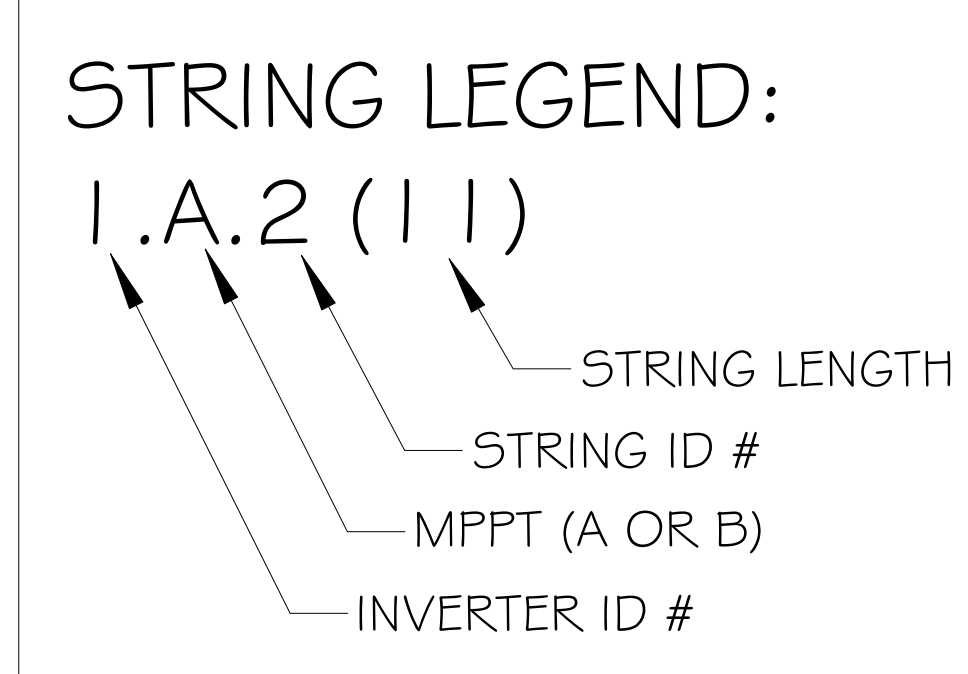
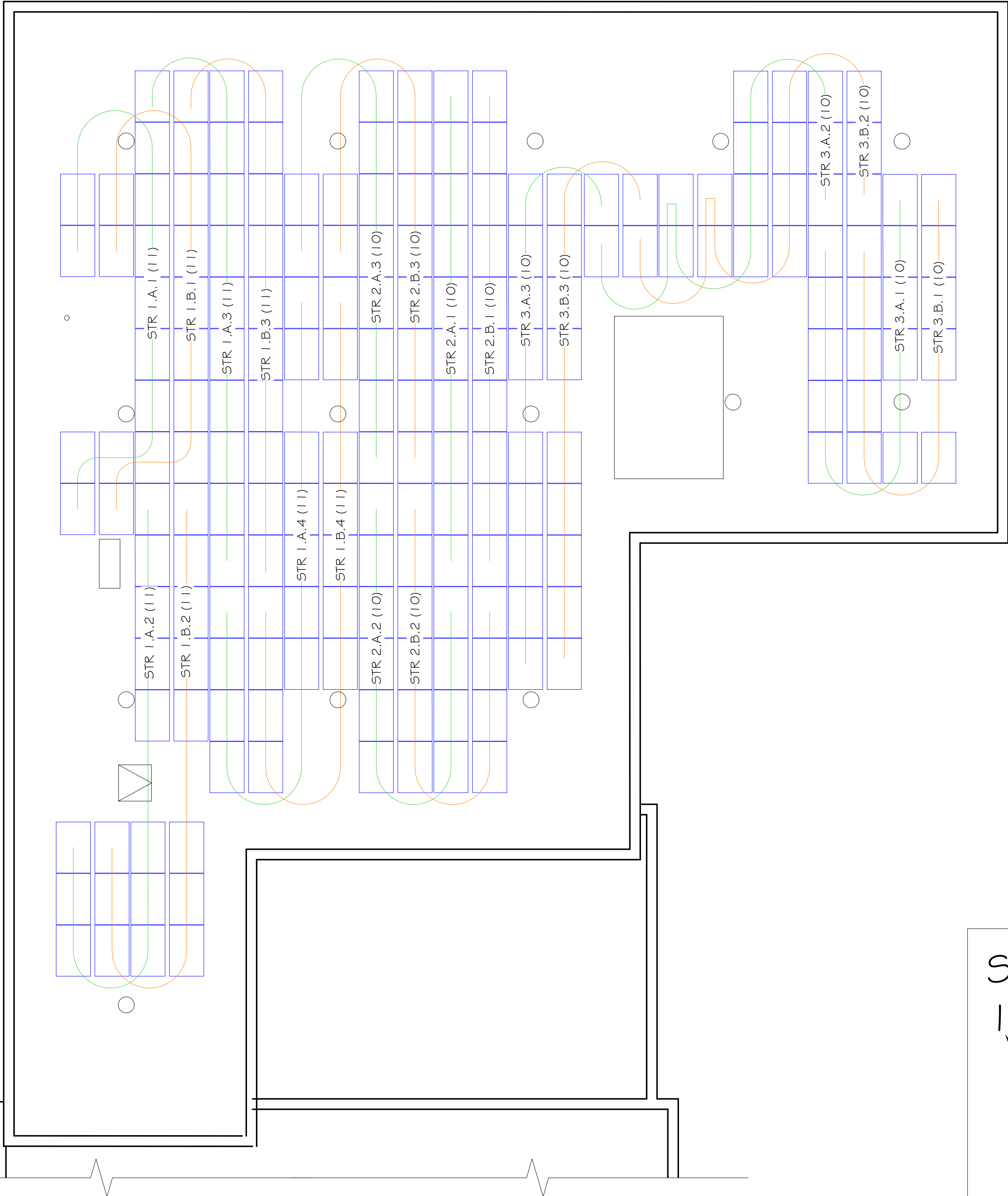
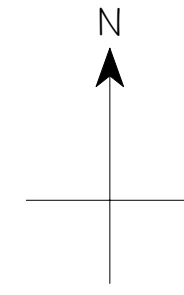


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NOTE:
 STRINGS CONTAINING WEST-FACING MODULES ARE COLORED GREEN
 STRINGS CONTAINING EAST-FACING MODULES ARE COLORED ORANGE
 ALL MODULES HAVE 10° TILT (TYP.)



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Sheet Title:
STRING MAP

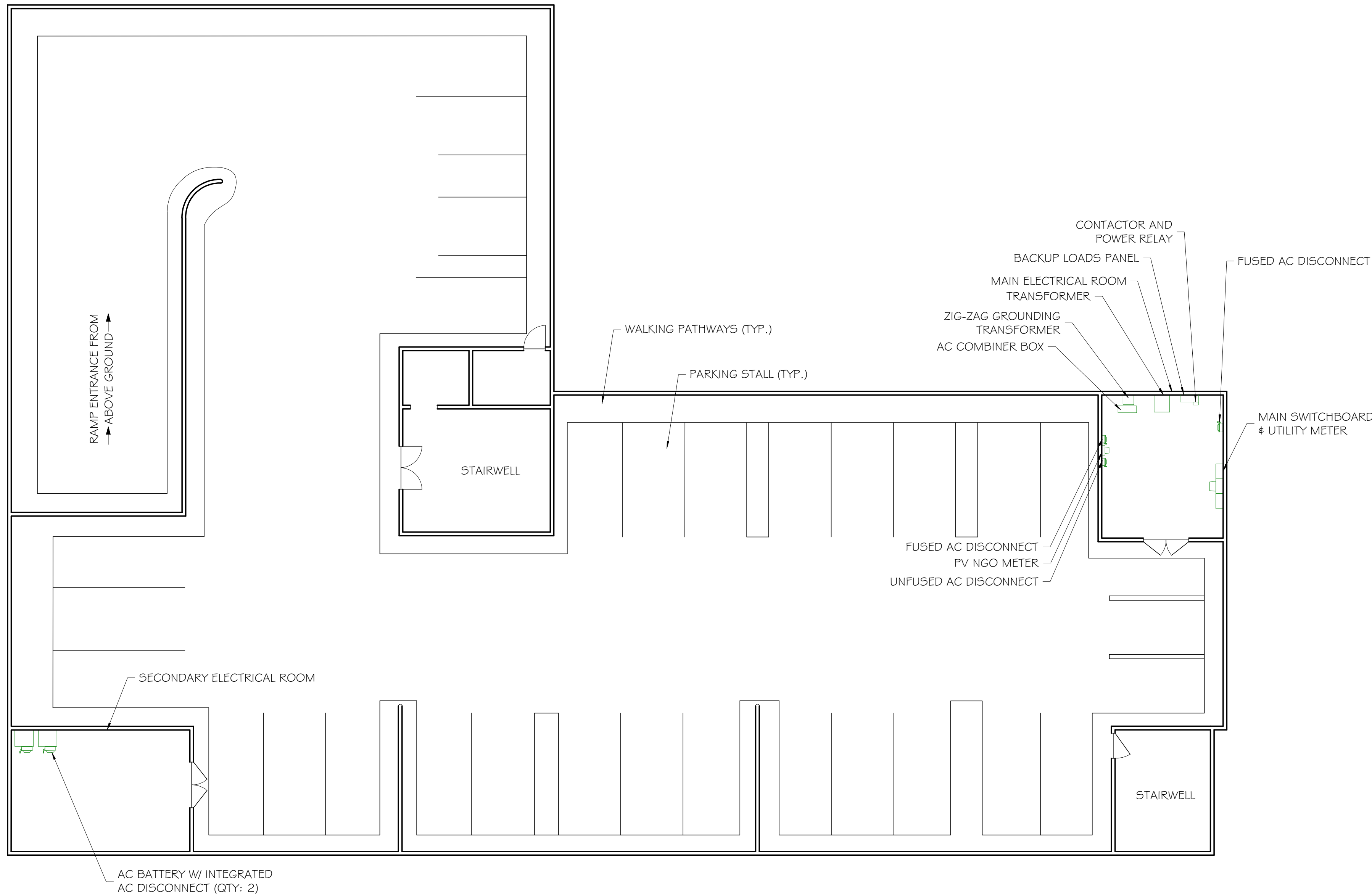
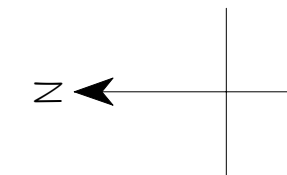
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Sheet Title:
BASEMENT PLAN

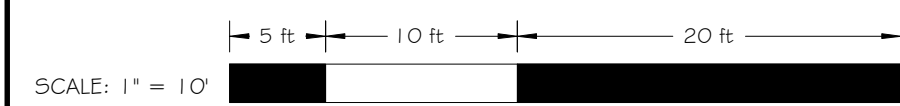
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480V	---	EQUIP. GROUNDING CONDUCTOR	---	CIRCUIT CONDUCTOR	---	FUSE	---	CIRCUIT BREAKER	(N)	=	NEW EQUIP.	(E)	=	EXISTING EQUIP.	L1	=	LINE 1 (BROWN)	L2	=	LINE 2 (ORANGE)	L3	=	LINE 3 (YELLOW)	N	=	NEUTRAL (WHITE)	G	=	GROUND (GREEN)	+	=	POSITIVE (RED)	-	=	NEGATIVE (BLACK)
208V	---	EQUIP. GROUNDING CONDUCTOR	---	CIRCUIT CONDUCTOR	---	FUSE	---	CIRCUIT BREAKER	(N)	=	NEW EQUIP.	(E)	=	EXISTING EQUIP.	L1	=	LINE 1 (BLACK)	L2	=	LINE 2 (RED)	L3	=	LINE 3 (BLUE)	N	=	NEUTRAL (WHITE)	G	=	GROUND (GREEN)	+	=	POSITIVE (RED)	-	=	NEGATIVE (BLACK)

Array Configuration

System: 74.88 kWstc, 64 kW AC
Total PV Module Qty: 208

Inverter I.D.#	Inv #1	Inv #2	Inv #3
Inverter AC Power (kW):	24.00	20.00	20.00
PV Power (kWstc):	31.68	21.60	21.60
Inverter DC:AC Ratio	1.32	1.08	1.08
Module Total Qty:	88	60	60
String Qty:	4	3	3
String Length:	11	10	10
Max Open Circuit Voltage	813	739	739
Operating Voltage:	665	604	604
Max Short Circuit Current	32.4	24.3	24.3
Operating Current:	23.8	17.8	17.8

MPPT "A"	MPPT "B"
String Qty:	4
String Length:	11
Max Open Circuit Voltage	813
Operating Voltage:	665
Max Short Circuit Current	32.4
Operating Current:	23.8

PV Module Specifications

Model Number: **SUNPOWER SPR-X22-360-COM**
 Weight: **45.5** lbs
 Dimensions: **61.3 x 41.2 x 1.8** (in)
 Power @ STC: **360** Watts
 Voc: **69.5** Volts DC
 Vmp: **60.6** Volts DC
 Isc: **6.48** Amps
 Imp: **5.94** Amps
 Voc Temp Coeff: **-0.30** %/°C
 Max DC Voltage: **1,000** Volts DC

Inverter #1 Specifications

Model Number: **SMA STP 24000TL-US-10**
 Power Rating: **24.00** kW AC
 Nominal Voltage: **480** Volts AC
 Max Output Current: **29.0** Amps
 CEC Weighted Efficiency: **98.0%**
 Maximum DC Voltage: **1000**
 DC Start Voltage: **188**
 Max. MPPT Voltage: **800** Max Current MPPT A: **33.0**
 MPPT Quantity: **2** Max Current MPPT B: **33.0**
 Inverter Quantity: **1** Max Current MPPT C: **N/A**

Inverter #2 - #3 Specifications

Model Number: **SMA STP 20000TL-US-10**
 Power Rating: **20.00** kW AC
 Nominal Voltage: **480** Volts AC
 Max Output Current: **24.0** Amps
 CEC Weighted Efficiency: **97.5%**
 Maximum DC Voltage: **1000**
 DC Start Voltage: **188**
 Max. MPPT Voltage: **800** Max Current MPPT A: **33.0**
 MPPT Quantity: **2** Max Current MPPT B: **33.0**
 Inverter Quantity: **2** Max Current MPPT C: **N/A**

Transformer Calculations

Sec. Voltage:	480	VAC	Pri. Voltage:	208	VAC
Sec. Current:	155	Amps	Pri. Current:	358	Amps
Minimum Transformer kVA Rating:		150.0	kVA		

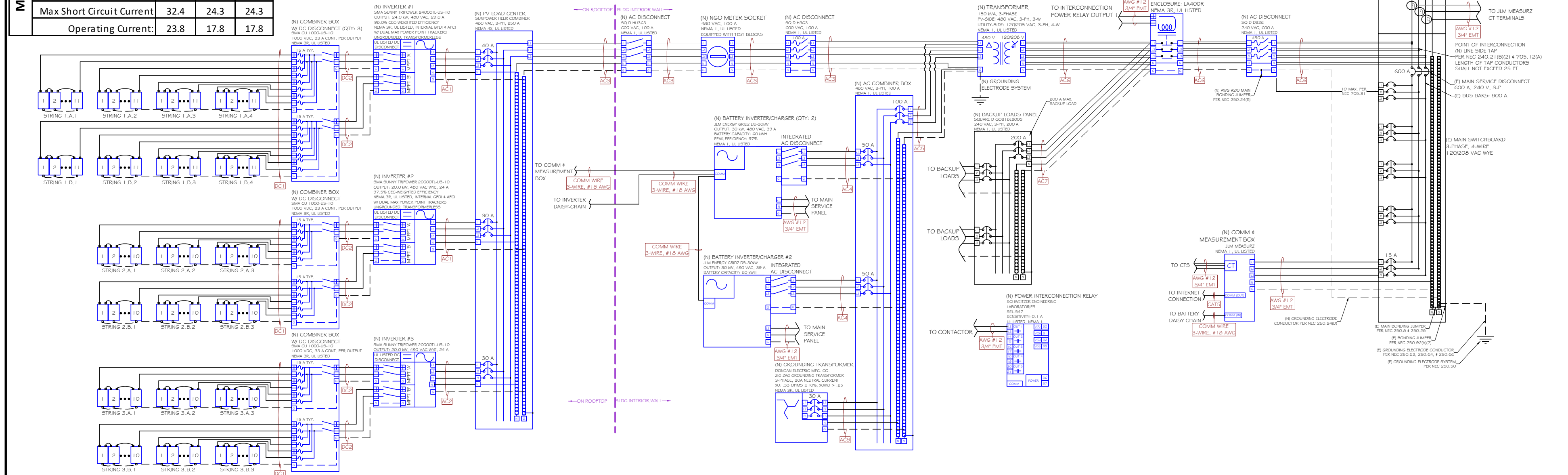
Primary AC System Summary		Secondary AC System Summary	
NOMINAL SYSTEM VOLTAGE:	208 Volts AC	NOMINAL SYSTEM VOLTAGE:	480 Volts AC
MAX CURRENT PER 690.8(A):	358 Amps	MAX CURRENT PER 690.8(A):	155 Amps
MAX CURRENT PER 690.8(B):	447 Amps	MAX CURRENT PER 690.8(B):	194 Amps

PV System Maximum Voltage Calculation per NEC 690.7(A)

Local Record Low Temp: **4 °C** Data Source: **LOS ANGELES INTL ARPT**

Voc Temp Coefficient	Record Low Temp.	Voc	Correction Factor	Max # of Series	Temperature	Corrected Open Circuit Voltage
0.3%/°C	21°C	69.5	+1 = 1.063	11	4 °C	812.7 Volts DC

NOTE: SOFTWARE DRIVERS TO PREVENT EXCESS PHOTOVOLTAIC BACKFEED DURING ISLANDING BATTERY MODE TO BE PROVIDED BY JLM ENERGY



WIRE AND CONDUIT SCHEDULE

TAG	# OF PARALLEL SETS	PHASE CONDUCTOR QTY, SIZE AND TYPE PER CONDUIT	NEUTRAL CONDUCTOR QTY, SIZE AND TYPE PER CONDUIT	GROUND CONDUCTOR QTY, SIZE AND TYPE PER CONDUIT	# OF PARALLEL CONDUITS	CONDUIT SIZE	CONDUIT TYPE	EST. DIST.
DC1	(1)	2/STRING AWG #10 PV-WIRE	N/A	N/A	(1)	N/A	N/A	5
DC2	(1)	2 AWG #8 PV-WIRE	N/A	N/A	(1)	3/4"	GRC	75
AC1	(1)	3 AWG #8 THWN-2	1 AWG #8 THWN-2	1 AWG #8 THWN-2	(1)	3/4"	GRC	10
AC2	(1)	3 AWG #10 THWN-2	1 AWG #8 THWN-2	1 AWG #8 THWN-2	(1)	3/4"	GRC	10
AC3	(1)	3 AWG #2 THWN-2	1 AWG #6 THWN-2	1 AWG #6 THWN-2	(1)	1-1/4"	GRC	175
AC4	(1)	3 AWG #6 THWN-2	N/A	N/A	(1)	1"	EMT	150
AC5	(1)	3 AWG #3 THWN-2	1 AWG #8 THWN-2	1 AWG #8 THWN-2	(1)	1-1/4"	EMT	15
AC6	(2)	3 AWG #4/0 THWN-2	1 AWG #2/0 THWN-2	1 AWG #2/0 THWN-2	(1)	3"	EMT	15
AC7	(1)	3 AWG #3/0 THWN-2	1 AWG #6 THWN-2	1 AWG #6 THWN-2	(1)	2"	EMT	15
AC8	(1)	3 AWG #10 THWN-2	1 AWG #8 THWN-2	1 AWG #8 THWN-2	(1)	3/4"	EMT	15

Battery Inverter Specifications

Model Number: **JLM ENERGY GRIDZ DS-30kW**
 Power Rating: **30** kW AC
 Nominal AC Voltage: **480** Volts AC
 Max Output Current: **39** Amps
 Nominal DC Voltage: **600** Volts DC
 DC Voltage Range: **200-1000** Volts DC
 CEC Efficiency: **96.5%**
 Quantity: **2**

CEC Rating Calculation

Module PTC Rating (W)	x	No. of Modules	x	Average Inverter CEC Efficiency	=	CEC System Size
334.4 W	x	208	x	97.7%	=	67.93 kW AC

TAG	CIRCUIT ORIGIN	CIRCUIT DESTINATION	CONDUCTOR SPECIFICATIONS			REQUIRED CONDUCTOR AMPACITY			AMPACITY CHECK #1		
			MATERIAL	TEMP. RATING	TRADE SIZE	MAX CURRENT PER 310.15(B)(16) & 310.15(B)(17)	MAX CURRENT x I _{sc}	# OF COMBINED STRINGS	MAX CURRENT PER 125% PER 690.8(A)(1)	MAX CURRENT PER 690.8(B)(1)	MAX CONDUCTOR AMPACITY
DC1	PV STRING	COMBINER BOX	COPPER	90°C	AWG #10	55 Amps	1.25 x 6.48 x 1	8.1 Amps	1.25 = 10.1 Amps	10.1 Amps < 55.0 Amps	
DC2	COMBINER BOX	INVERTER	COPPER	75°C	AWG #8	50 Amps	1.25 x 6.48 x 4	32.4 Amps	1.25 = 40.5 Amps	40.5 Amps < 50.0 Amps	

TAG	CIRCUIT ORIGIN	CIRCUIT DESTINATION	CONDUCTOR SPECIFICATIONS			REQUIRED CONDUCTOR AMPACITY			AMPACITY CHECK #1		
			MATERIAL	TEMP. RATING	TRADE SIZE	MAX CURRENT PER 310.15(B)(16) & 310.15(B)(17)	INVERTER OUTPUT x # OF INVERTERS	MAX CURRENT PER 125% PER 690.8(A)(3)	MAX CURRENT PER 690.8(B)(1)	MAX CONDUCTOR AMPACITY	
AC1	INVERTER #1	PV LOAD CENTER	COPPER	75°C	AWG #8	50 Amps	29.0 x 1	29.0 Amps	1.25 = 36.3 Amps	36.3 Amps < 50 Amps	
AC2	INVERTERS #2 - #3	PV LOAD CENTER	COPPER	75°C	AWG #10	35 Amps	24.0 x 1	24.0 Amps	1.25 = 30.0 Amps	30.0 Amps < 35 Amps	
AC3	PV LOAD CENTER	TRANSFORMER	COPPER	75°C	AWG #2	115 Amps	77.0 x 1	77.0 Amps	1.25 = 96.3 Amps	96.3 Amps < 115 Amps	
AC4	BATTERY	AC COMBINER BOX	COPPER	75°C	AWG #6	65 Amps	39.0 x 1	39.0 Amps	1.25 = 48.8 Amps	48.8 Amps < 65 Amps	
AC5	AC COMBINER BOX	TRANSFORMER	COPPER	75°C	AWG #3	100 Amps	78.0 x 1	78.0 Amps	1.25 = 97.5 Amps	97.5 Amps < 100 Amps	
AC6	TRANSFORMER	LINE SIDE CONN.	COPPER	75°C	AWG #4/0	460 Amps	SEE XFMR CALCS	358.0 Amps	1.25 = 447.5 Amps	447.5 Amps < 460 Amps	
AC7	BACKUP LOAD PANEL	CONTACTOR	COPPER	75°C	AWG #3/0	200 Amps	N/A	155.0 Amps	1.25 = 193.8 Amps	193.8 Amps < 200 Amps	
AC8	AC COMBINER BOX	GROUNDING XFMR	COPPER	75°C	AWG #10	35 Amps	24.0 x 1	24.0 Amps	1.25 = 30.0 Amps	30.0 Amps < 35 Amps	

TAG	CIRCUIT ENVIRONMENT	CONDUCTOR TEMPERATURE DERATING			CONDUIT FILL DERATING		CORRECTED AMPACITY CALCULATION			AMPACITY CHECK #2		VOLTAGE DROP	
		LOCAL 2% AVG. HIGH TEMP (°C)	HEIGHT ABOVE ROOF (in)	TEMP. ADDED PER 310.15(B)(3)(c)	OPERATING TEMP (°C)	AMPACITY CORRECTION 310.15(B)(2)(a)	# OF UNGROUND CONDUCTORS	AMPACITY CORRECTION 310.15(B)(3)(a)	90°C CONDUCTOR x TEMP DERATE	CONDUIT FILL = DERATE	DERATED CONDUCTOR AMPACITY	MAX CURRENT PER 690.8(B)(2)	DERATED AMPACITY
DC1	ROOFTOP, FREE AIR	26	-	N/A	26	1	N/A	1.00	55 x 1 x 1.00 = 55 Amps	55	8.1 Amps < 55.0 Amps	5 ft	0.01%
DC2	ROOFTOP, IN CONDUIT	26	1	22	48	0.82	2	1.00	55 x 0.82 x 1.00 = 45.1 Amps	45.1	32.4 Amps < 45.1 Amps	75 ft	0.12%

TAG	CIRCUIT ENVIRONMENT	CONDUCTOR TEMPERATURE DERATING			CONDUIT FILL DERATING		CORRECTED AMPACITY CALCULATION			AMPACITY CHECK #2		VOLTAGE DROP	
		LOCAL 2% AVG. HIGH TEMP (°C)	HEIGHT ABOVE ROOF (in)	TEMP. ADDED PER 310.15(B)(3)(c)	OPERATING TEMP (°C)	AMPACITY CORRECTION 310.15(B)(2)(a)	# OF UNGROUND CONDUCTORS	AMPACITY CORRECTION 310.15(B)(3)(a)	90°C CONDUCTOR x TEMP DERATE	CONDUIT FILL = DERATE	DERATED CONDUCTOR AMPACITY	MAX CURRENT PER 690.8(B)(2)	DERATED AMPACITY
AC1	ROOFTOP, IN CONDUIT	26	1	22	26	1.00	3	1.00	55 x 1.00 x 1.00 = 55 Amps	55	29.0 Amps < 55.0 Amps	10 ft	0.19%
AC2	ROOFTOP, IN CONDUIT	26	1	22	26	1.00	3	1.00	40 x 1 x 1.00 = 40 Amps	40	24.0 Amps < 40.0 Amps	10 ft	0.25%
AC3	ROOFTOP, IN CONDUIT	26	1	22	26	1.00	3	1.00	130 x 1 x 1.00 = 130 Amps	130	77.0 Amps < 130.0 Amps	175 ft	2.18%
AC4	INDOORS (+0°C)	26	1	22	26	1.00	3	1.00	75 x 1 x 1.00 = 75 Amps	75	39.0 Amps < 75.0 Amps	150 ft	2.39%
AC5	INDOORS (+0°C)	26	1	22	26	1.00	3	1.00	115 x 1 x 1.00 = 115 Amps	115	78.0 Amps < 115.0 Amps	15 ft	0.24%
AC6	INDOORS (+0°C)	26	1	22	26	1.00	6	0.80	520 x 1 x 0.80 = 416 Amps	416	358.0 Amps < 416.0 Amps	15 ft	0.14%
AC7	INDOORS (+0°C)	26	1	22	26	1.00	3	1.00	225 x 1 x 1.00 = 225 Amps	225	155.0 Amps < 225.0 Amps	15 ft	0.15%
AC8	INDOORS (+0°C)	26	1	22	26	1.00	3	1.00	40 x 1 x 1.00 = 40 Amps	40	24.0 Amps < 40.0 Amps	15 ft	0.37%

Project: **MANHATTAN BEACH, CA 90266**

Project Details: **74.88 kWstc, 67.93 CEC-kW AC**
 AHJ: **MANHATTAN BEACH, CITY OF**

Engineering Approval:

REVISIONS

DESCRIPTION	DATE	REV
ORIGINAL	11/27/2017	1
REDLINES	12/6/2017	2
FULL PLANSET	1/8/2017	A

Sheet Title: **ELECTRICAL DIAGRAM**

Sheet Number: **E1.0**

Sheet Size: **ARCH C - 24" x 18"**

DESIGN & DRAFTING BY: **TAYLOR BOHLEN**



Reviewed & Approved by: **RD**



SIGNAGE REQUIREMENTS

- 1.) RED BACKGROUND
- 2.) WHITE LETTERING
- 3.) MIN. 3/8" LETTER HEIGHT
- 4.) ALL CAPITAL LETTERS
- 5.) ARIAL OR SIMILAR FONT
- 6.) WEATHER RESISTANT MATERIAL, PER UL 969

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

REQ'D BY: NEC 690.17
APPLY TO:
DISCONNECTS
PV LOAD CENTERS
COMBINER BOXES

1

PHOTOVOLTAIC POWER SOURCE

REQ'D BY: NEC 690.31(E)(3)
APPLY TO:
EXPOSED RACEWAYS, CABLE TRAYS
COVERS OR ENCLOSURES OF JUNCTION BOXES
CONDUIT BODY W/ AVAILABLE CONDUIT OPENING

2

**THIS ELECTRIC SERVICE IS
ALSO SERVED BY A
PHOTOVOLTAIC SYSTEM**

REQ'D BY: NEC 705.12(D)(4)
APPLY TO:
MAIN SERVICE PANEL

3

WARNING
INVERTER OUTPUT
CONNECTION. DO NOT
RELOCATE THIS
OVERCURRENT DEVICE

REQ'D BY: NEC 705.12(D)(7)
APPLY TO:
PV SYSTEM BREAKER

4

SOLAR AC DISCONNECT

REQ'D BY: NEC 690.14(C)(2)
APPLY TO:
PV SYSTEM AC DISCONNECTS

5

**WARNING: PHOTOVOLTAIC
POWER SOURCE**

REQ'D BY: CRC R331.7
APPLY TO:
MAIN SERVICE DISCONNECT

6

WARNING
IF A GROUND FAULT IS
INDICATED, THE NORMALLY
GROUNDED CONDUCTORS
MAY BE ENERGIZED AND
UNGROUNDED.

REQ'D BY: NEC 690.5(C)
APPLY TO:
INVERTER

7

SOLAR DC DISCONNECT

REQ'D BY: NEC 690.13(B)
APPLY TO:
PV SYSTEM DC DISCONNECTS

8

**PHOTOVOLTAIC SYSTEM
DISCONNECT
AC CURRENT: 447 A
VOLTAGE: 208 VAC**

REQ'D BY: NEC 690.54
APPLY TO:
PV SYSTEM DISCONNECT

9

WARNING
ELECTRIC SHOCK HAZARD.
THE DC CONDUCTORS OF
THE PV SYSTEM ARE
UNGROUNDED AND MAY BE
ENERGIZED.

REQ'D BY: NEC 690.35(F)
APPLY TO:
JUNCTION BOXES, COMBINER BOXES
DC DISCONNECTS, INVERTERS

10

**GRID TIED PHOTOVOLTAIC
POWER SOURCE**
MPPT 'A' SPECIFICATIONS:
OPERATING CURRENT: 23.8 A
OPERATING VOLTAGE: 665 V
MAX SYSTEM VOLTAGE: 813 V
MAX SYSTEM CURRENT: 32.4 A
MPPT 'B' SPECIFICATIONS:
OPERATING CURRENT: 23.8 A
OPERATING VOLTAGE: 665 V
MAX SYSTEM VOLTAGE: 813 V
MAX SYSTEM CURRENT: 32.4 A
MAX INVERTER OUTPUT:
24 kW, 29 A, 480 VAC

REQ'D BY: NEC 690.53
APPLY TO:
INVERTER #2

11

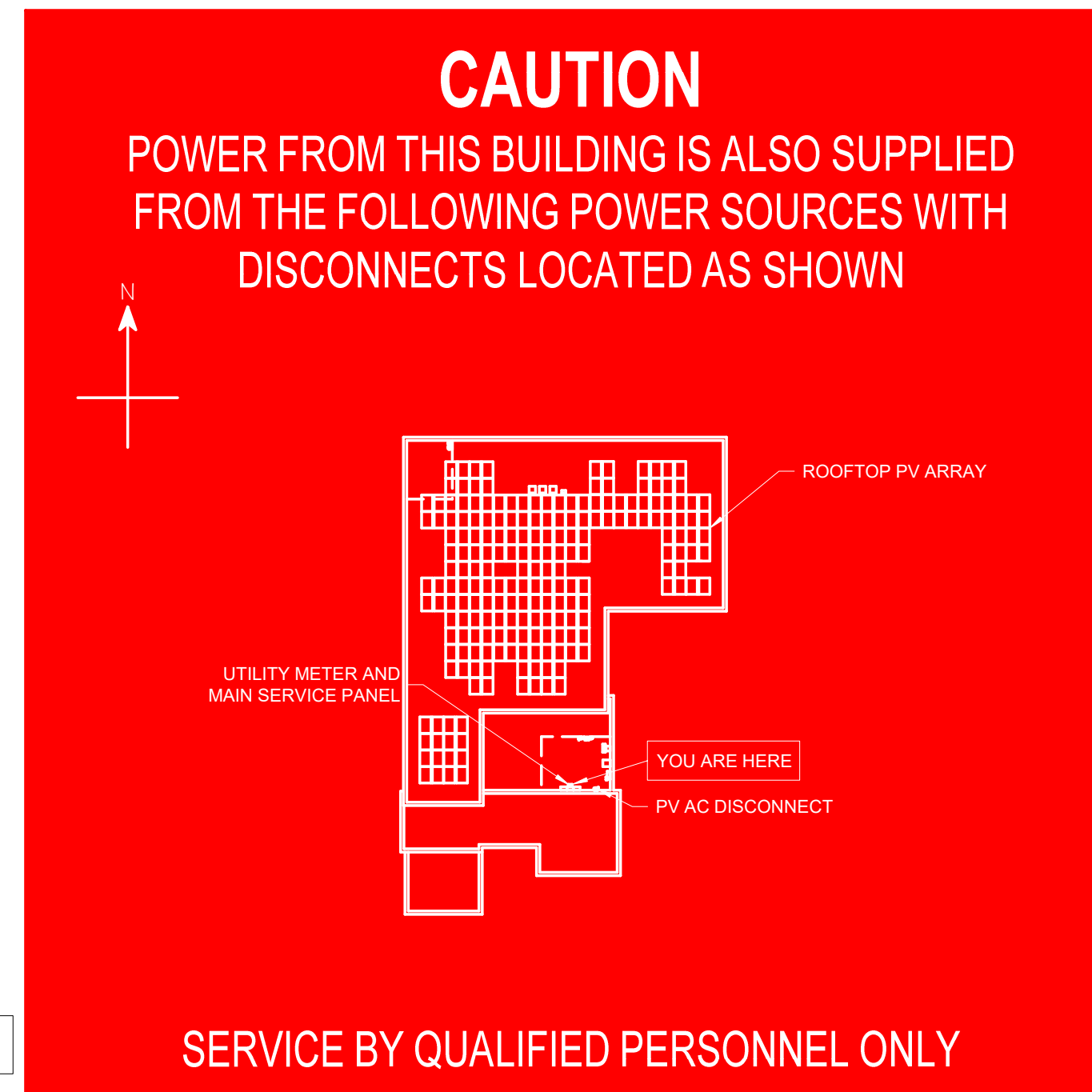
**GRID TIED PHOTOVOLTAIC
POWER SOURCE**
MPPT 'A' SPECIFICATIONS:
OPERATING CURRENT: 17.8 A
OPERATING VOLTAGE: 604 V
MAX SYSTEM VOLTAGE: 739 V
MAX SYSTEM CURRENT: 24.3 A
MPPT 'B' SPECIFICATIONS:
OPERATING CURRENT: 17.8 A
OPERATING VOLTAGE: 604 V
MAX SYSTEM VOLTAGE: 739 V
MAX SYSTEM CURRENT: 24.3 A
MAX INVERTER OUTPUT:
20 kW, 24 A, 480 VAC

REQ'D BY: NEC 690.53
APPLY TO:
INVERTERS #2 & #3

12

REQ'D BY: NEC 690.56
APPLY TO:
UTILITY METER

13



Project:
MANHATTAN BEACH, CA 90266

Project Details:
74.88 kWstc, 67.93 CEC-kW AC
AHJ: MANHATTAN BEACH, CITY OF

Engineering Approval:

REVISIONS

DESCRIPTION	DATE	REV
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REDLINES	12/6/2017	2
FULL PLANSET	1/8/2017	A

Sheet Title:
**SAFETY
PLACARDS**

Sheet Number:
E2.0

Sheet Size:
ARCH C - 24" x 18"

DESIGN & DRAFTING BY:
TAYLOR BOHLEN



Reviewed & Approved by:
RD



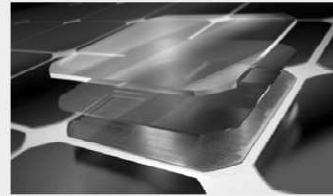


SunPower® X-Series Commercial Solar Panels | X22-360-COM

More than 22% Efficiency
Captures more sunlight and generates more power than conventional panels.

Maximum Performance
Designed to perform in demanding real-world conditions of high temperatures, partial shade from overhead wires, and low light.^{1,2,4}

Commercial Grade
Intended for commercial sites where maximum energy production is critical.



Maxeon® Solar Cells: Fundamentally better.

Engineered for performance. Designed for reliability.

Engineered for Peace of Mind
Designed to deliver consistent, trouble-free energy over a very long lifetime.^{3,4}

Designed for Reliability
The SunPower Maxeon Solar Cell is the only cell built on a solid copper foundation. Virtually impervious to the corrosion and cracking that degrade conventional panels.³

Same excellent durability as E-Series panels.
#1 Rank in Fraunhofer durability test.⁹
100% power maintained in Atlas 25+ comprehensive durability test.¹⁰

High Performance & Excellent Reliability



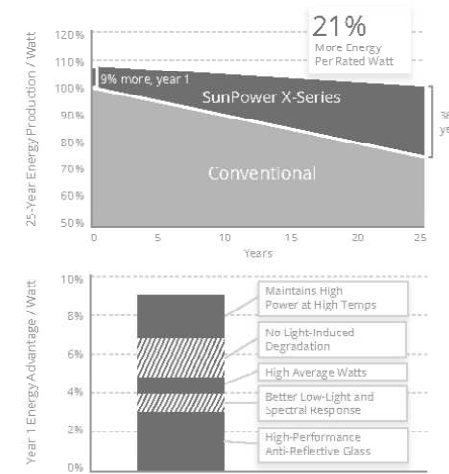
SPR-X22-360-COM

Highest Efficiency³

Generate more energy per square foot
X-Series commercial panels convert more sunlight to electricity by producing 38% more power per panel¹ and 70% more energy per square foot over 25 years.^{1,2,3}

Highest Energy Production⁵

Produce more energy per rated watt
More energy to power your operations. High year-one performance delivers 8-10% more energy per rated watt.² This advantage increases over time, producing 21% more energy over the first 25 years to meet your needs.²



SunPower® X-Series Commercial Solar Panels | X22-360-COM

SunPower Offers The Best Combined Power And Product Warranty



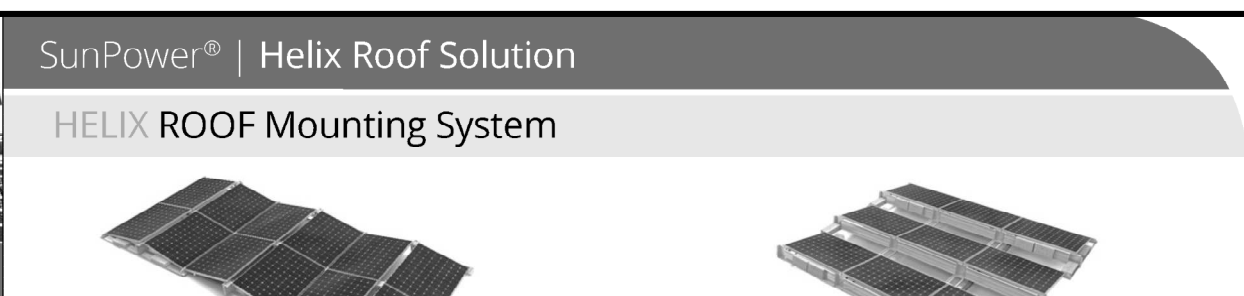
More guaranteed power: 95% for first 5 years, -0.1%/yr. to year 25.¹
Combined Power and Product defect 25-year coverage that includes panel replacement costs.²

Electrical Data		Tests And Certifications	
Nominal Power (P _{nom}) ¹	360 W	Standard Tests ^{1,2}	UL1703 (Type 2 Fire Rating), IEC 61215, IEC 61730
Power Tolerance	+5/-3%	Quality Certs	ISO 9001:2008, ISO 14001:2004
Temp. Panel Efficiency ²	22.7%	EHS Compliance	RoHS, OHSAS 18001:2007, lead free, REACH
Rated Voltage (V _{mp})	60.6 V	Sustainability	SiVCS-163, PV Cycle
Rated Current (I _{mp})	5.94 A	Ammonia Test	Cradle to Cradle (eligible for LEED points) ⁴
Open-Circuit Voltage (V _{oc})	69.5 V	Desert Test	TU 1109/PS/C-2013-6744437
Short-Circuit Current (I _{sc})	6.48 A	Salt Spray Test	IEC 61701 (Maximum severity)
Max. System Voltage	1000 V UL & 1000 V IEC	PID Test	Potential-Induced Degradation Free: 1000 V ⁸
Maximum Series Fuse	15 A	Available Listings	UL, TUV, JET, CEC
Power Temp. Coef.	-0.306%/°C	Operating Condition And Mechanical Data	
Voltage Temp. Coef.	-167.4 mV/°C	Temperature	-40° F to +185° F (-40° C to +85° C)
Current Temp. Coef.	3.5 mA/°C	Impact Resistance	1 inch (25 mm) diameter ball at 52 mph (23 m/s)

REFERENCES:
1 All comparisons are SPR-X21-345 vs. a representative conventional panel: 250 W, approx. 1.8 m², 15.3% efficiency.
2 Typically 8-10% more energy per watt, BEA/DMV Engineering "SunPower Yield Report," Jan 2013.
3 SunPower 12.2% degradation vs. 1.0%/yr. conv. panel. Campeon, J. et al. "SunPower Module Degradation Rate," SunPower white paper, Feb. 2013; Jordan, Dirk. "SunPower Test Report," NREL, Q1 2015.
4 SunPower Module 40-Year Useful Life, SunPower white paper, May 2015. Useful life is 99 out of 100 panels operating at more than 70% of rated power.
5 Highest of over 3,200 silicon solar panels, Photon Module Survey, Feb. 2014.
6 1% more energy than E-Series panels, 8% more energy than the average of the top 10 panel companies tested in 2012 (51 panels, 162 companies) Photon International, Feb. 2013.
7 Compared with the top 15 manufacturers, SunPower Warranty follows, May 2015.
8 Some restrictions and exclusions may apply. See warranty for details.
9 X-Series same as E-Series, 5 of top 8 panel manufacturers tested in 2013 report, 3 additional panels in 2014. Ferraz, C. et al. "Fraunhofer PV Durability Initiative for Solar Modules Part 2," Photovoltaics International, 2014.
10 Compared with the non-stress tested control panel, X-Series same as E-Series, tested in Atlas 25+ Durability test report, Feb. 2013.
11 Standard Test Conditions (1000 W/m² irradiance, AM 1.5, 25° C). NREL calibration Standard: SOMS current, LAC/CS-F and voltage.
12 Based on average of measured power values during production.
13 Type 2 fire rating per UL1703 2013, Class C fire rating per UL1703 2002.
14 See datasheet for details.

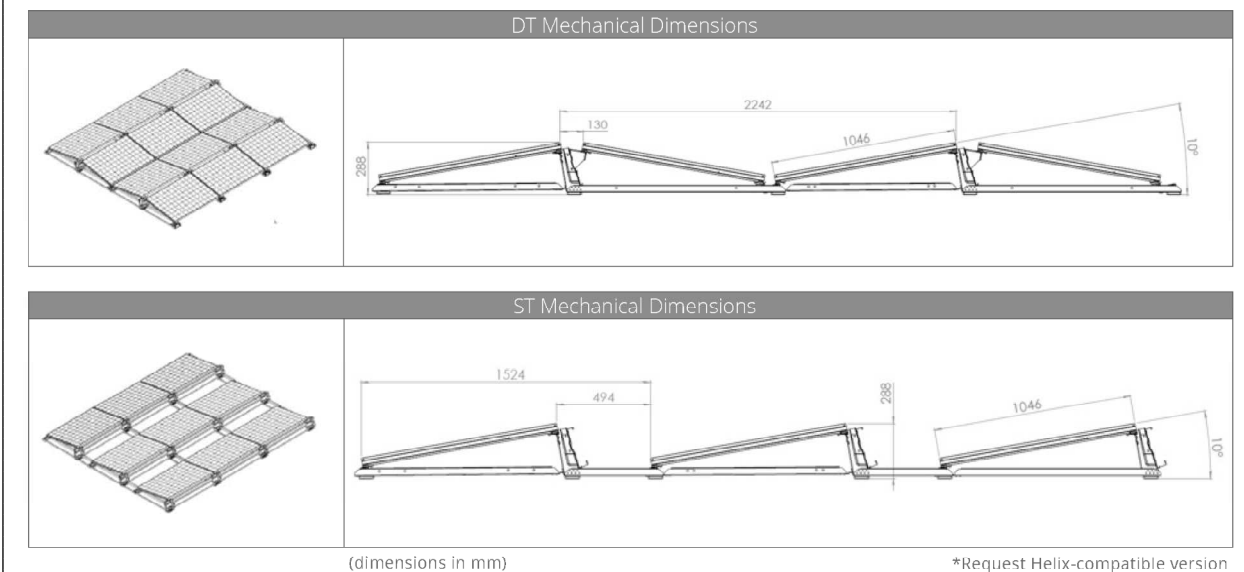
See www.sunpower.com for more reference information. For more details, see extended datasheet: www.sunpower.com/datasheets

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HELIX DT HELIX ST

General	HELIX DT	HELIX ST
Configuration	Dual Tilt	Single Tilt
Tilt angle	10 degrees	
Module compatibility	SPR-E20-327-COM (327 W DC)*	
Ground coverage ratio (GCR)	0.91	0.67
Base system weight	9.3 kg/m ² (1.9 psf)	12.2 kg/m ² (2.5 psf)
Maximum ballast capacity	58.6 kg/m ² (12 psf)	
Warranty	25 years	
Certifications	UL 2703 (pending)	
Wind tunnel testing	ASCE 7-10 and SEAOC PV2 compliant	
Material (structure)	5052 H32 aluminum and 301 stainless steel	
Material (foot pad)	Recycled rubber (92% approx.), polyurethane binder (8% approx.)	
Compatible roof anchors	EcoFasten Solar® Eco-65/F-202, OMG Power Grip®, OMG Power Grip Plus®	



Specifications SUNPOWER®

SUNPOWER®

SUNNY TRIPOWER 12000TL-US / 15000TL-US / 20000TL-US / 24000TL-US / 30000TL-US



DESIGN FLEXIBILITY
• 1000 V DC or 600 V DC
• Two independent DC inputs
• 15° to 90° mounting angle range
• Detachable DC Connection Unit

SYSTEM EFFICIENCY
• 98.0% CEC, 98.6% Peak
• 1000 V DC increases system efficiency
• OptiTrac Global Peak MPPT

ENHANCED SAFETY
• Integrated DC AFCI
• Flooding system with all pole sensitive ground fault protection
• Reverse polarity indicator in combination with Connection Unit

FUTURE-PROOF
• Complete grid management feature set
• Integrated Speedwire, WebConnect, ModBus interface
• Bi-directional Ethernet communications
• Utility interactive controls for active and reactive power

SUNNY TRIPOWER 12000TL-US / 15000TL-US / 20000TL-US / 24000TL-US / 30000TL-US

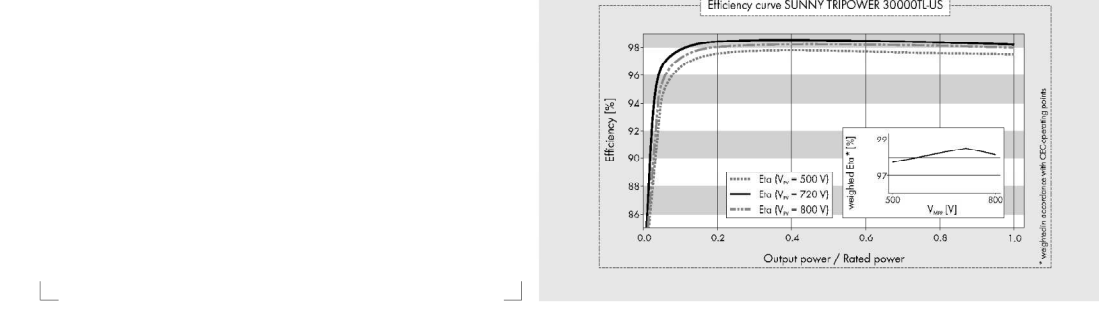
The ultimate solution for decentralized PV plants, now up to 30 kilowatts

The world's best-selling three-phase PV inverter, the SMA Sunny Tripower TL-US, is raising the bar for decentralized commercial PV systems. This three phase, transformerless inverter is UL listed for up to 1000 V DC maximum system voltage and has a peak efficiency above 98 percent, while OptiTrac Global Peak minimizes the effects of shade for maximum energy production. The Sunny Tripower delivers a future-proof solution with full grid management functionality, cutting edge communications and advanced monitoring. The Sunny Tripower is also equipped with all-pole ground fault protection and integrated AFCI for a safe, reliable solution. It offers unmatched flexibility with a wide input voltage range and two independent MPPT trackers. Suitable for both 600VDC and 1000VDC applications, the Sunny Tripower allows for flexible design and a lower levelized cost of energy.



Technical data	Sunny Tripower 12000TL-US	Sunny Tripower 15000TL-US	Sunny Tripower 20000TL-US	Sunny Tripower 24000TL-US	Sunny Tripower 30000TL-US
Input [DC]					
Max. input DC power (θ cos φ = 1)	12250 W	15300 W	20400 W	24500 W	30800 W
Max. DC voltage	*1000 V	*1000 V	*1000 V	*1000 V	*1000 V
Rated MPPT voltage range	300 V...800 V	300 V...800 V	380 V...800 V	450 V...800 V	500 V...800 V
MPPT operating voltage range	150 V...1000 V	150 V...1000 V	150 V...1000 V	150 V...1000 V	150 V...1000 V
Min. DC voltage / start voltage	150 V / 188 V	150 V / 188 V	150 V / 188 V	150 V / 188 V	150 V / 188 V
Number of MPPT tracker inputs	2	2	2	2	2
Max. input current / per MPPT tracker input	66 A / 33 A	66 A / 33 A	66 A / 33 A	66 A / 33 A	66 A / 33 A
Output [AC]					
AC nominal power	12000 W	15000 W	20000 W	24000 W	30000 W
Max. AC apparent power	12000 VA	15000 VA	20000 VA	24000 VA	30000 VA
Output phases / line connections	3 / 3NPE		3 / 3NPE		3 / 3NPE, 3PE
Nominal AC voltage	480 / 277 V WYE		480 / 277 V WYE		480 V Delta
AC voltage range	244 V...305 V		244 V...305 V		
Rated AC grid frequency	60 Hz		60 Hz		
AC grid frequency / range	50 Hz, 60 Hz / ±6 Hz...±5 Hz		50 Hz, 60 Hz / ±6 Hz...±5 Hz		
Max. output current	14.4 A	18 A	24 A	29 A	36.2 A
Power factor of rated power / adjustable displacement	1 / 0.0 leading...0.0 lagging		1 / 0.0 leading...0.0 lagging		
Harmonics	< 3%		< 3%		
Efficiency					
Max. efficiency / CEC efficiency	98.2% / 97.5%	98.2% / 97.5%	98.5% / 97.5%	98.5% / 98.0%	98.6% / 98.0%
Protection devices					
DC reverse polarity protection	•	•	•	•	•
Ground fault monitoring / grid monitoring	•	•	•	•	•
All-pole sensitive residual current monitoring unit	•	•	•	•	•
DC AFCI compliant to UL 1699B	•	•	•	•	•
AC short circuit protection	•	•	•	•	•
Protection class / overvoltage category	1 / IV	1 / IV	1 / IV	1 / IV	1 / IV
General data					
Dimensions (W / H / D) in mm [in]	665 / 650 / 265 [26.2 / 25.6 / 10.4]		665 / 650 / 265 [26.2 / 25.6 / 10.4]		
Packing dimensions (W / H / D) in mm [in]	780 / 790 / 390 [30.7 / 31.1 / 15.0]		780 / 790 / 390 [30.7 / 31.1 / 15.0]		
Weight	55 kg [121 lbs]		55 kg [121 lbs]		
Packing weight	61 kg [134.5 lbs]		61 kg [134.5 lbs]		
Operating temperature range	-25°C...+60°C		-25°C...+60°C		
Noise emission (typical) / internal consumption at night	51 dB(A) / 1 W		51 dB(A) / 1 W		
Topology	Transformerless		Transformerless		
Cooling concept / electronics protection rating	OptiCool / NEMA 3R		OptiCool / NEMA 3R		
Features					
Display / LED indicators (Status / Fault / Communication)	- / •		- / •		
Interface: RS485 / Speedwire, WebConnect	• / •		• / •		
Data interface: SMA ModBus / SunSpec ModBus	• / •		• / •		
Mounting angle range	15°...90°		15°...90°		
Warranty: 10 / 15 / 20 years	• / • / •		• / • / •		
Certifications and approvals	UL 1741, UL 1998, UL 1699B, IEEE 1547, FCC Part 15 (Class A & B), CAN/CSA C22.2 107.1		UL 1741, UL 1998, UL 1699B, IEEE 1547, FCC Part 15 (Class A & B), CAN/CSA C22.2 107.1		

NOTE: US inverters ship with gray lids. Data at nominal conditions. *Suitable for 600 V DC max. systems
• Standard features □ Optional features - Not available



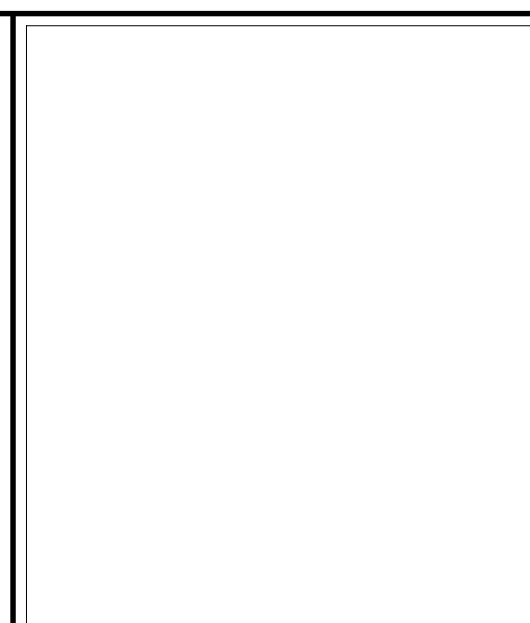
SunPower® | Helix Roof Solution HELIX ROOF Mounting System



Configuration	Components	
DT	Chassis Base (#514056)	Chassis Platform (#514057)
ST	Chassis (#513831)	Following Tray (#513832)
Common	RH Deflector (#513842)	Leading Tray (#513834)
	LH Deflector (#513841)	
Optional	Anchor Plate (#513843)	Cross Tray (#513844)
	Link Tray (#513833)	

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Project:
MANHATTAN BEACH, CA 90266

Project Details:
74.88 kWstc, 67.93 CEC-kW AC
AHJ: MANHATTAN BEACH, CITY OF

Engineering Approval:

REVISIONS		
DESCRIPTION	DATE	REV
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REDLINES	12/6/2017	2
FULL PLANSET	1/8/2017	A

Sheet Title:
EQUIPMENT DATA SHEETS I

Sheet Number:
D I O

Sheet Size:
ARCH C - 24" x 18"

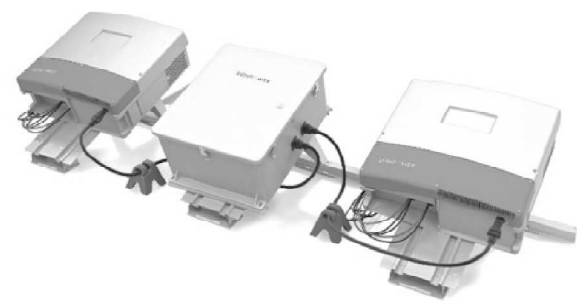
DESIGN & DRAFTING BY:
TAYLOR BOHLEN



Reviewed & Approved by:
RD



HELIX ROOF Power Station



General

Operating temp. -4 to 140° F (-20 to 60° C)

- Components
- Helix plug-and-play SMA Tripower Inverter
 - Helix plug-and-play AC Combiner
 - Helix plug-and-play DC Branch
 - Helix plug-and-play AC Whip
 - Helix eBOS Mount
 - Helix Cable Clip and Cable Clip+
 - Helix Cable Cone
 - Helix Cable Tray

Warranty 10-year factory warranty (Extension available up to 20 years)

Inverter

Model	Helix plug-and-play SMA Tripower (STP-US)
AC power ratings	12, 15, 20, 24 kW AC
Rated grid voltage	480 V / 277 V WYE
Max. DC input voltage	1000 V
Dimensions (w x h x d)	665 x 650 x 265 mm (26.2 x 25.6 x 10.4 in.)
Weight	55 kg (121 lbs.)
Enclosure rating	NEMA 3R
DC connector	H4-UTX-XL
AC connector	APP Mid-Power SPEC Pak®
Communications connector	RJ-45
Communications protocol	Modbus TCP-IP

AC Combiner

Model	Helix plug-and-play AC Combiner
Rated amperage	750 A
Inverter input options	2, 3, and 4 inverter input configurations
Inverter input max. amperage	50 A
Optional auxiliary input rated amperage	15 A
Dimensions (w x h x d)	699 x 561 x 297 mm (27.2 x 22.2 x 12 in.)
Enclosure rating	NEMA 4X non-metallic
AC connector	APP Mid-Power SPEC Pak®

Specifications



HELIX ROOF Power Station



DC Branch

Model	Helix plug-and-play DC Branch
String input options	2, 3, and 4 string
String fuse rating	15 A
Conductor size	#12 to #8 AWG
Conductor insulation rating	Sunlight-resistant PV Wire
Voltage rating	2000 VDC
Fusing	12 A
Connectors	String side: Tyco PV4 Solarlock Combined side: Amphenol H4-UTX-XL



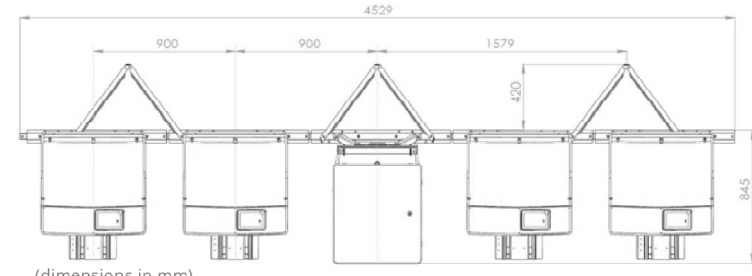
AC Whip

Model	Helix plug-and-play AC Combiner
Length	1.8 m (71 in.)
Conductor size	#8 AWG 5-strand multiconductor
Conductor insulation rating	Sunlight-resistant TC-ER
Voltage rating	600 V
AC connector type	APP Mid-Power SPEC Pak®



eBOS Mount

Mounting structure model	Helix eBOS Mount
Mounting structure material	5052 H32 aluminum 301 stainless steel
Roof pad material	Recycled rubber
Tilt angle	15 degrees
Sunshade	Optional



(dimensions in mm)

Rev 1.1

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HELIX ROOF Cable Management



General

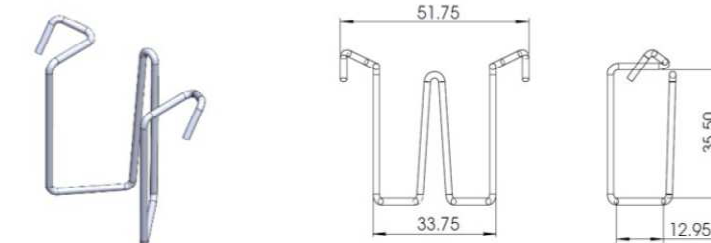
Operating temp. -13 to 140° F (-25 to 60° C)

- Components
- Helix Cable Clip
 - Helix Cable Clip+
 - Helix Cable Cone
 - Helix Cable Tray
 - Helix Cable Tray Cover

Warranty 20-year factory warranty

Cable Clip (#512199)

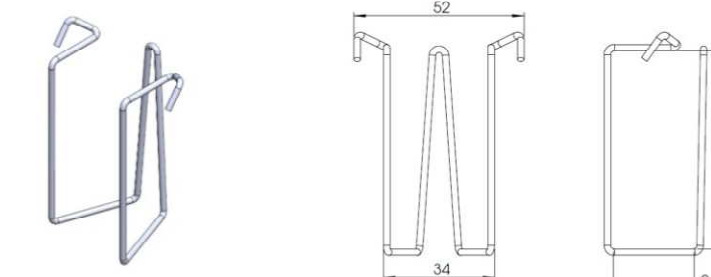
Material	302 stainless steel
Installation	Attaches to module frame and supports DC cables within the array
Max. cable bundle	Quantity 10 of #8 AWG, supports DC, AC, and communications cables



(dimensions in mm)

Cable Clip + (#512198)

Material	302 stainless steel
Installation	Attaches to module frame and supports DC cables within the array
Max. cable bundle	Quantity 32 of #8 AWG, supports DC, AC, and communications cables



(dimensions in mm)

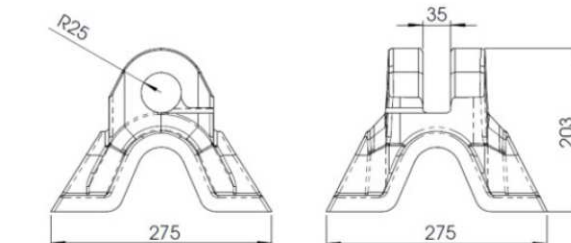
Specifications



HELIX ROOF Cable Management

Cable Cone (#512021)

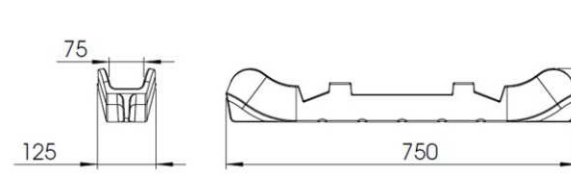
Material	Recycled rubber (92% approx.), polyurethane binder (8% approx.)
Installation	Placed strategically to support DC, AC, or communications cables under modules or outside of the array
Max. cable bundle	50 mm (1.97 in.) o.d., or quantity 32 of #8 AWG



(dimensions in mm)

Cable Tray (#512511)

Material	Recycled rubber (92% approx.), polyurethane binder (8% approx.)
Installation	Placed strategically to support DC, AC, or communications cables under modules or outside of the array
Max. cable bundle diameter	Quantity 32 of #8 AWG
Cable Tray Cover (#512510)	Optional (same material as Cable Tray)



(dimensions in mm)

Rev 1.1

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System Specifications
Gridz 30 kW

	Grid Synergistic	Grid Resilient
AC Power Port		
Max Power Output	30 kW	30 kW
Max AC Current	39 A	39 A
Voltage Range	480 V _{ac} Nominal	480 V _{ac} , 400 V _{ac} and 380 V _{ac} Grid std.
Power Factor	>0.97 at Rated Output Power	>0.97 at Rated Output Power
Frequency Range	60 Hz	Supports 60 Hz, 50 Hz, and 57.5 Hz
CEC Efficiency	96.50%	96.50%
Peak Efficiency	97%	97%
Tare Losses	< 25 W	< 25 W
Current Harmonics	IEEE 1547 Compliant, < 4% THD	IEEE 1547 Compliant, < 4% THD
Transient Protection	IEEE C62.41 Class B	
Microgrid		Voltage forming, Load Following
Bidirectional	Yes	Yes
DC Power Port		
Max DC Power	30 kW	30 kW
Max DC Current	60 Amps	50 Amps
Operating Voltage Range	100-500 V _{dc} (200-1000 V _{ac})	100-500 V _{dc} (200-1000 V _{ac})
Full Power Voltage Range	250-500 V _{dc} (500-1000 V _{ac})	300-500 V _{dc} (600-1000 V _{ac})
Available Control Methods	Constant Power, Constant Voltage, MPPT (PV)	Constant Power, Constant Voltage, MPPT (PV)
Wiring Configuration	4 wire Bipolar with Integral GFDI Circuit	4 Wire Bipolar with Integral GFDI Circuit
Max GFDI Current	1A Fused	1A Fused
Transient Overvoltage	Yes, MOV Voltage Clamps	Yes, MOV Voltage Clamps
Bidirectional	Yes	Yes



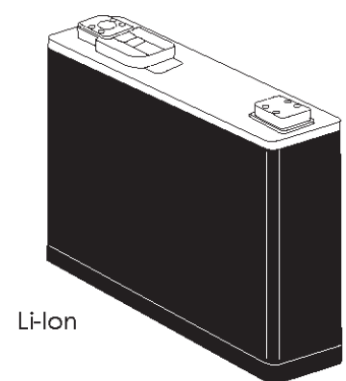
System Specifications
Gridz 30 kW

Li-Ion Battery Cell

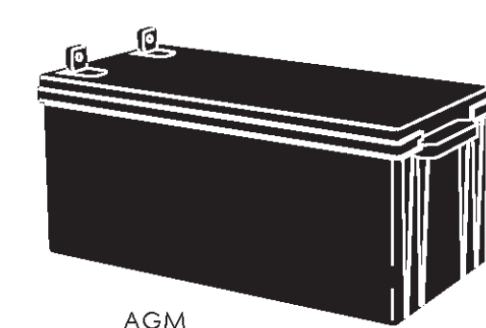
Dimensions	6.85" L x 1.8" W x 5" H
Weight	4.6 lbs
Capacity	94 Ah
Nominal Voltage	3.68 V
Upper Limit Voltage	4.15 V
Lower Limit Voltage	2.70 V
Operating Temperature Range	-25°C to 50°C
Storage Temperature Range	-40°C to 60°C

AGM Battery Cell

Dimensions	20.47" L x 9.44" D x 8.15" H
Weight	130 lbs
Nominal Voltage	12 V
Capacity (25°C)	20 hr rate (10.5 A) 210Ah 10 hr rate (20 A) 200Ah 5 hr rate (34 A) 170Ah 3 hr rate (50 A) 150Ah 1 hr rate (110 A) 110Ah
Capacity Affected by Temperature	40°C (104°F) 102% 25°C (77°F) 100% 0°C (32°F) 85%



Li-Ion



AGM

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Project:
MANHATTAN BEACH, CA 90266

Project Details:
74.88 kW_{stc}, 67.93 CEC-kW AC AHJ: MANHATTAN BEACH, CITY OF

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FULL PLANSET	1/8/2017	A

Sheet Title:
EQUIPMENT DATA SHEETS 2

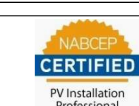
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DESIGN & DRAFTING BY:
TAYLOR BOHLEN



Reviewed & Approved by:
RD



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Specifications

General

AC Voltage Inputs

Nominal: 208-480 V_{LL}
 Continuous: 600 V_{LL}
 Measurement Range: 50-600 V_{LL}
 Burden: < 0.05 VA at 277 V_{LL}

AC Current Input

Nominal: 5 A
 Continuous: 15 A
 1 Second Thermal: 100 A
 Measurement Range: 0.1 A-5 A
 Burden: < 0.5 VA at 5 A

Frequency and Rotation

System Frequency: 50 or 60 Hz
 Phase Rotation: ABC or ACB
 Frequency Tracking: 40-70 Hz

Power Supply

Input Voltage: 6-32 Vdc
 Power Consumption: ≤ 2 W

Output Contacts

Make: 30 A per IEEE C37.90
 Carry: 6 A continuous carry at 70°C
 4 A continuous carry at 85°C

Voltage Rating: 250 Vac/330 Vdc continuous
 Pick-up Time: 8 ms, resistive load
 Dropout Time: 16 ms, resistive load
 Interrupt Rating: < 0.1 A dc, resistive

Optoisolated Inputs

Whetting: 6-32 Vdc
 Debounce Time: 1 power system cycle

Operating Temperature

-40° to +85°C (-40° to +185°F)

Dimensions

Refer to Figure 2.1 for relay dimensions.

Humidity

5% to 95% noncondensing

Weight

1.16 kilograms (2.55 pounds)

Terminal Connections

See Table 2.1.

Processing Specifications

AC Voltage and Current Inputs:
 16 samples per power system cycle

Digital Filtering

One-cycle full cosine after low-pass analog filtering. Net filtering (analog plus digital) rejects dc and all harmonics greater than the fundamental.

Protection and Control Processing

4 times per power system cycle

Relay Element Settings Ranges and Accuracy

Directional Power (device 32)

Setting Range: OFF, 40-900 W (secondary) to 1-W zero
 Accuracy: ±3% of setting and ±5 W power factor > 0.5 at nominal frequency

Time Delay Range: 0-16000 cycles in 0.25-cycle steps
Timer Accuracy: ±2% of setting and ±1 cycle

Note: Up to an 8-cycle delay is noticeable on the directional power element—especially if the power level is just above pickup. This additional delay is due to data averaging for accuracy at low power levels.

Frequency (device 81)

Setting Range: OFF, 40.1-49.9 Hz, 0.1-Hz steps (not settable within 0.2 Hz of nominal frequency)
 Accuracy: ±0.1 Hz

Time Delay Range: 5-16000 cycles in 0.25-cycle steps
Timer Accuracy: ±2% of setting and ±1 cycle

Reverse-Phase-Sequence Voltage (device 47)

Threshold: Fixed at 50% of $V_{Nom,LL}$
 Accuracy: ±3% of setting and ±2 V at nominal frequency

Time Delay: Fixed at 30 cycles
Timer Accuracy: ±1 cycle

Undervoltage (device 27) and Overvoltage (device 59)

Specifications are at 20°C and at nominal system frequency.

Device 27: OFF, 50-100% of $V_{Nom,LL}$, 1% steps
Device 59: OFF, 50-144% of $V_{Nom,LL}$, 1% steps
 Accuracy: ±3% of setting and ±2 V at nominal frequency

Time Delay Range: 0-16000 cycles in 0.25-cycle steps
Timer Accuracy: ±2% of setting and ±1 cycle

Voltage Synchronization (device 25)

Slip Frequency: 1 Hz
 Slip Frequency Pickup Range: 0.1-0.5 Hz in 0.1-Hz steps
 Slip Frequency Pickup Accuracy: ±0.1 Hz

Close Angle: Range: 2-60 degrees in 1-degree steps
 Greater of:
 • 1 degree or
 • (system slip [Hz] • 12 degrees/Hz)

Introduction and Specifications | U.1.15
 Specifications

Date Code 20120719 User's Guide SEL-547 Relay

U.1.16 Introduction and Specifications
 Specifications

Voltage Difference:
 Setting Range: OFF, 1-50% of $V_{Nom,LL}$, 1% steps
 Accuracy: ±3% of setting and ±2 V

Metering

Accuracies specified at 20°C and at nominal system frequency unless otherwise noted.

Voltages (45 V_{LL} to 440 V_{LL})
 VA, VB, VC, VS: ±1%
 Phase Angle Accuracy: ±1 degree
 Current (0.05 A to 6.25 A)
 IA: ±1% and ±1 mA
 Phase Angle Accuracy: ±1 degree
 Frequency Accuracy: ±0.1 Hz (40-70 Hz)

Integration and Automation

Communications Ports

EIA-232: 1 Front, DB 9-pin female receptacle
 EIA-485: 1 Side, 5-pin terminal block
 Data Speed: 300-19200 bps

Type Tests

Electromagnetic Compatibility

Electromagnetic Compatibility Emissions: IEC 60255-25:2000
 Radiated and conducted emissions

Electromagnetic Compatibility Immunity

Fast Transient Disturbance: IEC 60255-22-4:1992
 4 kV at 2.5 kHz
 Radiated EMI: IEC 60255-22-3:2000, 10 V/m
 IEC 60255-22-1:1995, 35 V/m
 Electrostatic Discharge: IEC 60255-22-2:1996
 IEC 60255-22-2:2001, 8 kV contact
 Magnetic Field Immunity: IEC 61000-4-8:1993
 1000 A/m for 3 seconds, 100 A/m for 1 minute
 IEC 61000-4-9:1993
 1000 A/m pulse

Surge Withstand Capability Immunity: IEC 60255-22-1:1998
 All Except Contact Inputs:
 2.5 kV peak common mode
 2.5 kV peak differential mode
 Contact Inputs:
 1 kV peak common mode
 500 V peak differential mode
 IEEE C37.90.1-1989
 3.0 kV oscillatory
 5.0 kV fast transient

Environmental Tests

Cold: IEC 60068-2-1:1990
 Normal operating status at -40°C for 16 hours
 Dry Heat: IEC 60068-2-2:1974
 Normal operating status at +85°C for 16 hours
 Damp Heat Cyclical: IEC 60068-2-30:1980
 Normal operating status at 55°C, 6 cycles, 95% humidity
 Sinusoidal Vibration: IEC 60255-21-1:1998
 Vibration endurance, Class 1
 Vibration response, Class 1
 Shock and Bump: IEC 60255-21-2:1998
 Shock withstand and bump, Class 1
 IEC 60255-21-3:1993
 Quake response, Class 2

Safety

Dielectric Strength and Impulse

Dielectric (HIPOT): IEEE C37.90-1989
 Impulse: IEC 60255-5:2000

Certifications

ISO

Relay designed and manufactured using ISO 9001 certified quality program.

UL

UL 508 Industrial Control Equipment.

CSA

CSA C22.2 No. 14-95 Industrial Control Equipment

CE

CE Mark—EMC Directive
 Low Voltage Directive

User's Guide SEL-547 Relay Date Code 20120719

Bussmann Low-Peak CUBEFuse

Finger-Safe, Dual-Element, Time-Delay Class CF Fuse, 1-100A, 600Vac/300Vdc



Catalog Symbols: TCF (indicating fuse (6-100A))
 TCF-IR (Non-indicating fuse (1-100A))
Dual-Element, Time-Delay Fuse: 10 Seconds Minimum Operating Time at 500% Rated Current
Ratings:
 Volts—600Vac/300Vdc
 Amps—1 to 100A
 IR—300kA RMS Sym. (UL)
 —200kA RMS Sym. (CSA)
 —100kA DC (UL & CSA)

Agency Information:
 • UL Listed Fuse; Guide JFH; File E4273
 • CSA Certified Fuse; Class 1422-02; File 53787
 • CE compliance for the European Union low voltage directive
 • RoHS Compliant

- Features and Product Benefits**
- The world's first finger-safe power fuse system.
 - Smallest footprint of any class fuse including Class J, CC, T and RK.
 - Meets Class CF and Class J time-delay electrical performance requirements.
 - Available with and without open fuse indication.
 - The indicating version features easy-ID™ open fuse technology for faster troubleshooting and reduced downtime.
 - Faster response to damaging faults to help reduce destructive thermal and magnetic forces.
 - True dual-element fuse construction with a minimum of 10 seconds time-delay at 500% of rating.
 - Long time-delay minimizes nuisance circuit openings due to temporary overloads and transient surges.
 - High interrupting rating to safely interrupt faults up to 300kA.
 - No venting of arc or molten metal and gases during opening.
 - Robust cycling and inrush current withstand.
 - Low let-through currents under fault conditions.
 - Provides Type 2 "No Damage" protection for IEC motor starters when properly sized.
 - Easy selective coordination with any other Cooper Bussmann Low-Peak Class CC, L, J, and RK1 fuse with simple 2:1 amp ratio between upstream and downstream fuses.

CUBEFuse Holders, Disconnects and Panelboards

The CUBEFuse is used in the following Cooper Bussmann products:

Operating and Storage Temperature Range: -40 to 80°C
 TCF100: 9.51W
 TCF60: 6.23W

Material Specifications:
 • Case: Glass filled PEEK (Polyethersulfone)
 • Terminals: Copper alloy
 • Terminal plating: Electroless tin
 • Indicator lens: PES (Polyethersulfone) (indicating version only)
 • Indicator: Energetic chemical

Catalog Numbers (amp rating)

Indicating CUBEFuse	
TCF6	TCF10 TCF15 TCF17-½ TCF20 TCF25
TCF30	TCF35 TCF40 TCF45 TCF50 TCF60
TCF70	TCF80 TCF90 TCF100
Non-Indicating CUBEFuse	
TCF1RN	TCF3RN TCF6RN TCF10RN TCF15RN TCF17-½RN
TCF20RN	TCF25RN TCF30RN TCF35RN TCF40RN TCF45RN
TCF50RN	TCF60RN TCF70RN TCF80RN TCF90RN TCF100RN

Carton Quantity and Weight

Amp Rating	Carton Qty.	Weight Per Carton
		lbs
TCF1-90A	12	1.39
TCF35-60A	12	1.42
TCF70-100A	6	1.74

At 100, 80 & 30A CUBEFuse holders can be daisy-chained together for the smallest footprint possible in any Class J fuse solution. See CUBEFuse holder data sheet 3007.

The DIN-Rail mounted 1-, 2- and 3-pole CCP_CF comes in 30, 80 and 100A versions. See data sheet 1151.

1-, 2- & 3-pole CCPB is an ampacity rejecting branch disconnect for the Quik-Spot™ Coordination Panelboard that uses the CUBEFuse up to 100A. See data sheet 1150.

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MIRA CONTACTORS AND OVERLOAD RELAYS

Specifications

MIRA 3-Pole MRC (AC/DC) Magnetic Contactors

Frame size	Electrical	Mechanical	
Type			
Terminal type			
Number of poles			
Rated operation voltage, U _e			
Rated insulation voltage, U _i			
Rated frequency			
Rated impulse withstand voltage, U _{imp}			
Maximum opening rate in operating cycles per hour (ACS)			
Durability	AC-1, Thermal current	A	
Current and power	AC-3	200/240V A	230
		380/440V kW	55
		500/550V kW	195
		600V A	90
		600V kW	185
UL rating (50/60Hz)	Single Phase	110-120V HP	110
		200-240V HP	190
		200-200V HP	110
		220-240V HP	120
		440-480V HP	230
Size and weight	NEMA size	110-120V HP	15
		200-240V HP	30
		200-200V HP	60
		220-240V HP	80
		440-480V HP	110
Weight (WxHxD)		lbs	
Size (WxHxD)		in	

Frame size	Electrical	Mechanical	
Type			
Terminal type	Screw		
Number of poles	3 pole		
Rated operation voltage, U _e	600V		
Rated insulation voltage, U _i	1000V		
Rated frequency	50/60Hz		
Rated impulse withstand voltage, U _{imp}	8kV		
Maximum opening rate in operating cycles per hour (ACS)	1600 operations per hour		
Current and power	AC-3	200/240V A	230
		380/440V kW	55
		500/550V kW	195
		600V A	90
		600V kW	185
UL rating (50/60Hz)	Single Phase	110-120V HP	110
		200-240V HP	190
		200-200V HP	110
		220-240V HP	120
		440-480V HP	230
Size and weight	NEMA size	110-120V HP	15
		200-240V HP	30
		200-200V HP	60
		220-240V HP	80
		440-480V HP	110
Weight (WxHxD)		lbs	
Size (WxHxD)		in	

MTK Thermal Overload Relays

Frame size	Electrical	Mechanical
Type		
Rated operation voltage, U _e	600V	
Rated insulation voltage, U _i	600V	
Rated impulse withstand voltage, U _{imp}	8kV	
Trip class	10	
Setting range	65-400A	
Size and weight	Weight	lbs
	Size (WxHxD)	in

Frame size	Electrical	Mechanical
Type		
Rated operation voltage, U _e	600V	
Rated insulation voltage, U _i	600V	
Rated impulse withstand voltage, U _{imp}	8kV	
Trip class	10	
Setting range	65-400A	
Size and weight	Weight	lbs
	Size (WxHxD)	in

3-POLE CONTACTORS

Frame size	Electrical	Mechanical	
Type			
Terminal type	Screw		
Number of poles	3 pole		
Rated operation voltage, U _e	600V		
Rated insulation voltage, U _i	1000V		
Rated frequency	50/60Hz		
Rated impulse withstand voltage, U _{imp}	8kV		
Maximum opening rate in operating cycles per hour (ACS)	1200 operations per hour		
Current and power	AC-3	200/240V A	230
		380/440V kW	55
		500/550V kW	195
		600V A	90
		600V kW	185
UL rating (50/60Hz)	Single Phase	110-120V HP	110
		200-240V HP	190
		200-200V HP	110
		220-240V HP	120
		440-480V HP	230
Size and weight	NEMA size	110-120V HP	15
		200-240V HP	30
		200-200V HP	60
		220-240V HP	80
		440-480V HP	110
Weight (WxHxD)		lbs	
Size (WxHxD)		in	

Frame size	Electrical	Mechanical
Type		
Rated operation voltage, U _e	600V	
Rated insulation voltage, U _i	600V	
Rated impulse withstand voltage, U _{imp}	8kV	
Trip class	10	
Setting range	65-400A	
Size and weight	Weight	lbs
	Size (WxHxD)	in

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Project Details: 74.88 kWstc, 67.93 CEC-kW AC AHJ: MANHATTAN BEACH, CITY OF

Engineering Approval:

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Sheet Title: EQUIPMENT DATA SHEETS 3

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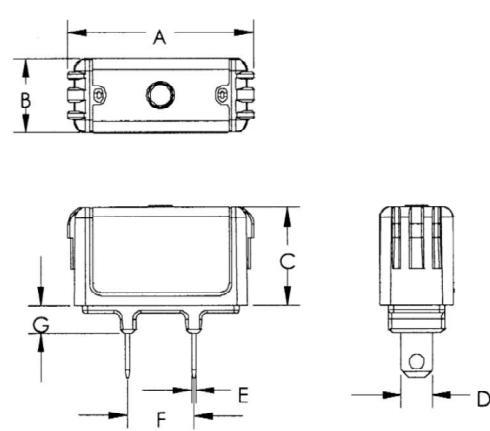


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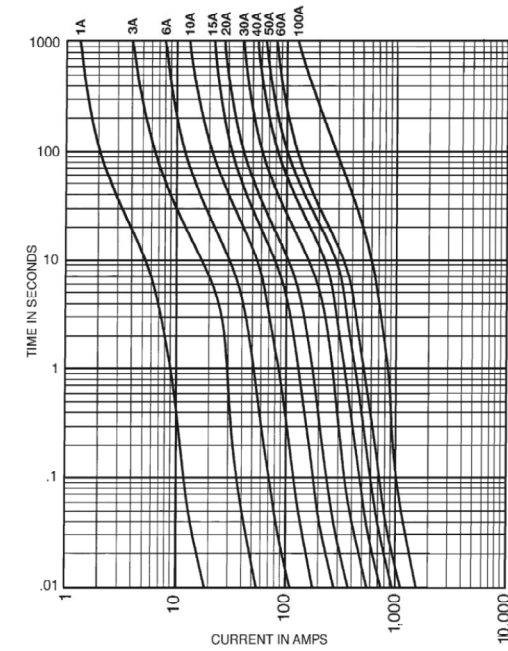
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TCF_ and TCF_RN Dimensions - in (mm)

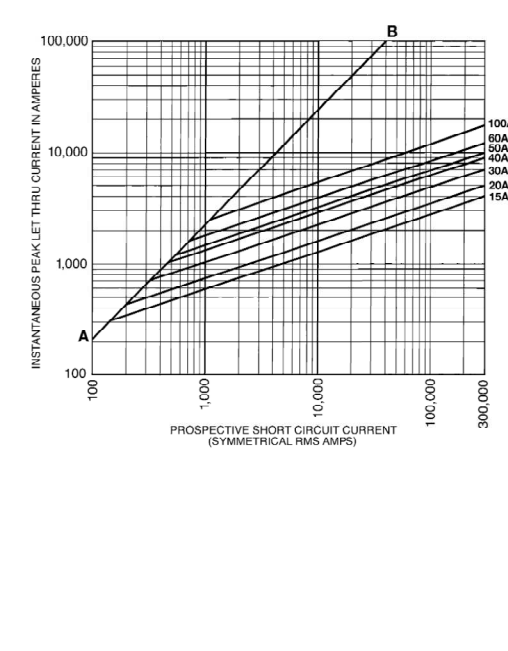


Fuse Amps	Dimensions - in (mm)								
	A	B	C	D	E	F	G	H	
1-15	1.88 (47.75)	0.75 (19.05)	1.00 (25.40)	0.23 (5.84)	0.04 (1.02)	0.63 (15.93)	0.28 (7.11)		
17 1/2	1.88 (47.75)	0.75 (19.05)	1.00 (25.40)	0.31 (7.87)	0.04 (1.02)	0.63 (15.93)	0.28 (7.11)		
20	1.88 (47.75)	0.75 (19.05)	1.00 (25.40)	0.31 (7.87)	0.04 (1.02)	0.63 (15.93)	0.28 (7.11)		
25-30	1.88 (47.75)	0.75 (19.05)	1.00 (25.40)	0.31 (7.87)	0.04 (1.02)	0.63 (15.93)	0.28 (7.11)		
35-40	2.13 (54.10)	1.00 (25.40)	1.13 (28.58)	0.36 (9.10)	0.04 (1.02)	0.63 (15.93)	0.38 (9.65)		
45-50	2.13 (54.10)	1.00 (25.40)	1.13 (28.58)	0.44 (11.13)	0.04 (1.02)	0.63 (15.93)	0.38 (9.65)		
60	2.13 (54.10)	1.00 (25.40)	1.13 (28.58)	0.44 (11.13)	0.04 (1.02)	0.63 (15.93)	0.38 (9.65)		
70	3.01 (76.45)	1.00 (25.40)	1.26 (32.00)	0.49 (12.45)	0.06 (1.52)	0.58 (14.78)	0.38 (9.65)		
80-90	3.01 (76.45)	1.00 (25.40)	1.26 (32.00)	0.49 (12.45)	0.06 (1.52)	0.58 (14.78)	0.38 (9.65)		
100	3.01 (76.45)	1.00 (25.40)	1.26 (32.00)	0.57 (14.48)	0.06 (1.52)	0.58 (14.78)	0.38 (9.65)		

Time-Current Characteristic Curves-Average Melt



Current Limitation Curves



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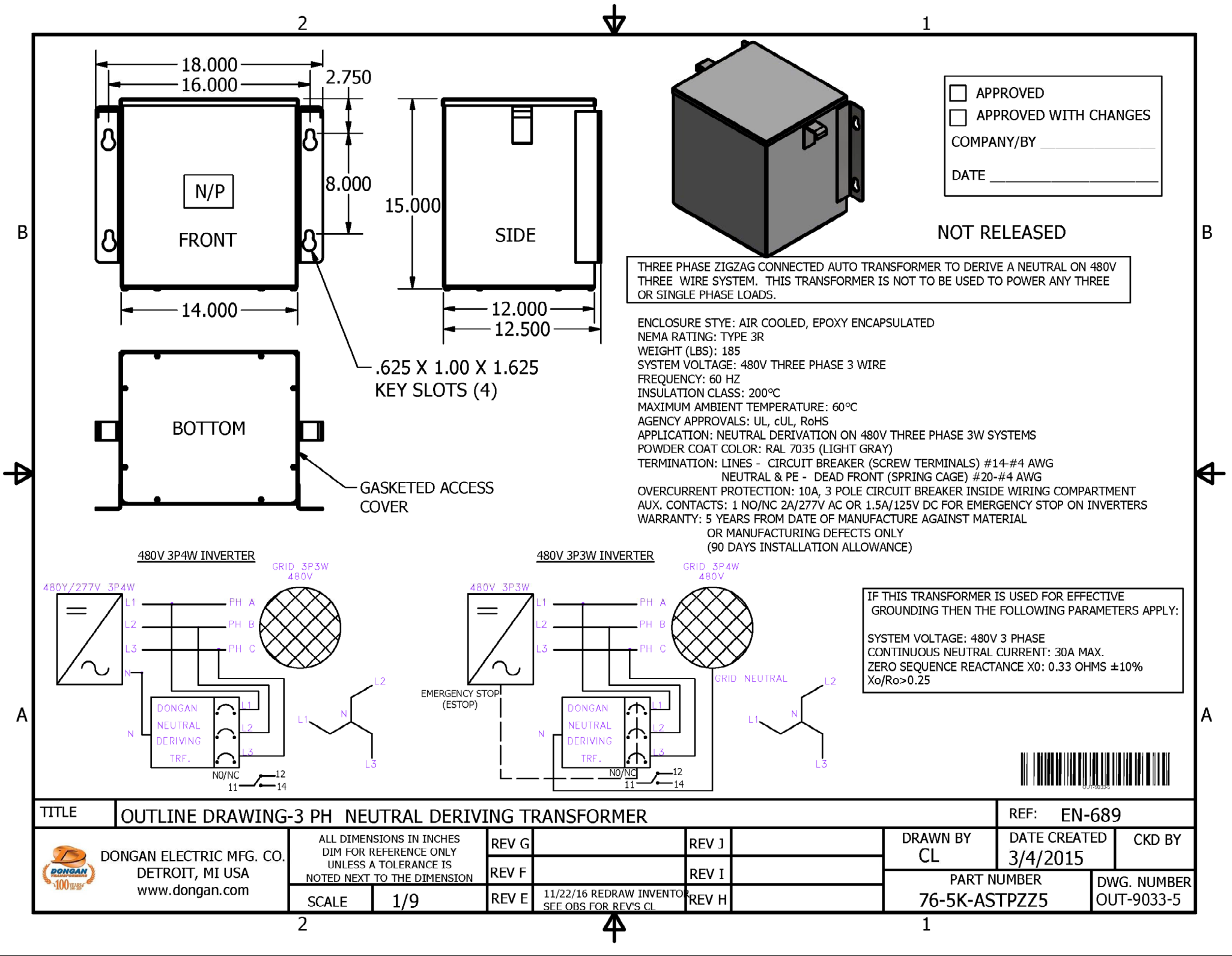
Each Helix™ product is a complete solution, fully engineered and optimized so that all components operate as a unified system



- Simpler**
 - Array integrated inverters
 - Snap-in module installation
 - Highly adaptable ballasting options
- Faster**
 - Pre-configured parts eliminate 67% of electrical connections
 - Integrated grounding
 - No bolts or tools required for eBOS installation
- Better**
 - Industry-leading roof coverage¹
 - World record efficiency SunPower solar modules²
 - Optimized and robust cable management
 - Aluminum and stainless steel design
 - 62% more energy in year¹
 - Designed to evolve for a Smart Energy future

¹ Internal SunPower analysis
² Highest of over 3,200 silicon solar panels. Photon Module Survey, Feb 2014.

Dual Tilt: Optimize NPV



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PV Installation Professional